SUBMISSION RE:
Manitoba Environment Act Proposal
Public Registry 6119.00
Silica Sand Extraction Project
Sio Silica Corporation (formerly CanWhite Sands)

To: Clean Environment Commission
13 February 2023

Submitted by E. Pip, B.Sc. (Hons.), Ph.D.

Acronyms and abbreviations

BMP = Best Management Practices

CEC = Clean Environment Commission

CPA = CanWhite Patent Application CA 3080017 (Received 2020-05-01)
https://www.ic.gc.ca/opiccipo/cpd/eng/patent/3080017/summary.html?query=CanWhite+sands+corp&type=basic_search

CWQG = Canadian Water Quality Guidelines for Drinking Water
https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html

EAP1 = CanWhite Sands Corp. Vivian Sand Extraction Project Environment Act Proposal, Part 1
https://www.gov.mb.ca/sd/eal/registries/6119/eap_part1.pdf

EAP2 = CanWhite Sands Corp. Vivian Sand Extraction Project Environment Act Proposal, Part 2
https://www.gov.mb.ca/sd/eal/registries/6119/eap_part2.pdf

AppA1 = EAP Appendix A Part 1
https://www.gov.mb.ca/sd/eal/registries/6119/appendix_a_part1.pdf

AppA2 = EAP Appendix A Part 2
https://www.gov.mb.ca/sd/eal/registries/6119/appendix_a_part2.pdf

AppA3 = EAP Appendix A Part 3
https://www.gov.mb.ca/sd/eal/registries/6119/appendix_a_part3.pdf

AppA4 = EAP Appendix A Part 4
https://www.gov.mb.ca/sd/eal/registries/6119/appendix_a_part4.pdf

AppA5 = EAP Appendix A Part 5
https://www.gov.mb.ca/sd/eal/registries/6119/appendix_a_part5.pdf

AppA6 = EAP Appendix A Part 6
https://www.gov.mb.ca/sd/eal/registries/6119/appendix_a_part6.pdf

AppB = EAP Appendix B https://www.gov.mb.ca/sd/eal/registries/6119/appendix_b.pdf

AppC = EAP Appendix C https://www.gov.mb.ca/sd/eal/registries/6119/appendix_c.pdf

AppE = EAP Appendix E https://www.gov.mb.ca/sd/eal/registries/6119/appendix_e.pdf

AppG(AppA6) = EAP Appendix G (located in AppA6)
https://www.gov.mb.ca/sd/eal/registries/6119/appendix_a_part6.pdf
Note: there are TWO Appendices G in different places: this one, in AppA6, and the other, separate Appendix G which relates to Heritage Resources.

AppH(AppA6) = EAP Appendix H (Note: located in AppA6) https://www.gov.mb.ca/sd/eal/registries/6119/appendix_a_part6.pdf

EAPPF = Vivian Sand Facility Project Environment Act Proposal, Public Registry 6057.00, Appendix I https://www.gov.mb.ca/sd/eal/registries/6057canwhite/appendix_h_and_i.pdf

GHG = Greenhouse Gases

GTTR = Geotechnical Technical Review (2022) http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/Geotechnical_Technical_Review.pdf

HDPE = High density polyethylene

HGTR = Hydrogeology Technical Review (2022) http://www.cecmanitoba.ca/cecm/hearings/pubs/silicasandextractionproject/backgroundinformation/hydrogeology_technical_review.pdf

MAC = Maximum Acceptable Concentration (regulatory)

MPN = Most Probable Number: bacterial counts per 1 dL (0.1 L) of water

NREP = Notice of Revised Extraction Plan. January 24, 2023. http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/notice_sio_silica_vivian_sandextractionprj.pdf

NTU = Nephelometric Turbidity Unit

PAM = Polyacrylamide

PCR = Public Comments Received. https://www.gov.mb.ca/sd/eal/registries/6119/index.html

RMSF = Sio Silica Corporation (SSC) Responses to Information Requests (IRs) Round No. 1, Rural Municipality of Springfield. http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/ir_rm_of_springfield.pdf

RPCR = Reply to Public Comments Received. https://www.gov.mb.ca/sd/eal/registries/6119/tab2_responses.pdf

SIO = Sio Silica Sustainability Report 2020. https://static1.squarespace.com/static/610afe20c55b9077df8f8a64/t/622be1166edc7c16a4a8051b/1647042845107/SIO+SILICA+ESG+v8+SINGLE.pdf

SIO2 = Vivian Silica Project https://viviansilicaproject.com/home/#facts-matter

SRM, 2019 = "Surface Rights in Manitoba" https://www.gov.mb.ca/iem/board/srights_pdfs/surface_rights_guide.pdf

SRTER = Sio Silica Corporation (SSC) Responses to Technical Experts Reports – Geotechnical November 2022 http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/siosilica_technical_reports_response.pdf

SSCR = Sio Silica Corporation (SSC) Responses to Technical Experts Reports – Hydrogeology November 2022 http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/siosilica_technical_reports_response.pdf

SSCRIR1 = Sio Silica Corporation (SSC) Responses to Information Requests (IRs) Round No. 1.

CEC-IR = http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/ir_response_round1_part1.pdf

DLN-IR = http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/ir_dln_wtfmb.pdf

MBEN-IR = http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/ir_mben_ols.pdf

MSSAC-IR = http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/ir_mssac.pdf

SSRIR2 = Sio Silica Corporation (SSC) Responses to Information Requests (IRs) Round No. 2

CEC-IR = http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/cec_ir_res_r2.pdf

CEC-IR AppA = http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/appendix_a-b-c-cec-ir_14.pdf

DLN-IR = http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/dln_ir_res_r2.pdf

MBEN-IR = http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/mben_ols_ir.pdf

MSSAC-IR = http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/mssac_ir_res.pdf

SUPPL1 = SioSilica Supplemental Information Document #1 - Silica Extraction Method SioSilica, 2 June 2022. http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/silosicilia_supplimental_information_extraction_method_suppliment1.pdf

SUPPL3 = Progressive Well Abandonment and Site Closure Additional Information, 29 June, 2022. http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/siosicilia_supplemental_information3_progressive_abandonment.pdf

SUPPL4 = Process Wastewater Treatment Options Technical Memorandum, June, 2022. http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/siosicilia_supplimental_information4_process_wastewater_treatment_options.pdf

TAC = Proponent Response to Technical Advisory Committee (TAC) Comments

https://www.gov.mb.ca/sd/eal/registries/6119/table1_responses_to_tac_20211215.pdf

WDR = CanWhite well drilling records (not in EAP)
https://registrydocumentsprd.blob.core.windows.net/commentsblob/project-80974/comment-48101/CanWhiteWellDrillingRecords2020_10_01.pdf

Acronyms used in citation sources are provided in the References section.

Note regarding color coding in this document:

Verbatim quotes from public documents submitted by the proponent or in the Registry have been highlighted in color. Proposal documents (EAP) cited in this text have been highlighted in red, other quoted documents appear in various colors to identify them in the text.

Scientific literature, industry sources and others quoted verbatim are not color coded, but are enclosed in quotation marks " ".

[ ] Square brackets have been used to delineate editorial comments and personal interjections.

Because of the complexity of this submission, in order to reduce redundancy, numerous internal cross-references are used. These are identified in parentheses as (see p. ….).

Proponent name

In the present submission, in order to skirt confusion associated with serial name changes, past, ongoing and future, the **proponent company is herein identified as CanWhite**, since the original EAP proposal and associated documents, and Environment Act License No. 3367 for the processing facility are all under that name. It is recognized that HD Minerals, CanWhite, Sio Silica and possibly others yet to come are different morphs of essentially the same operation.

Furthermore, the term 'proponent(s)' is used collectively herein to designate the company, and its consultants and others who are responsible for submitted proposal and ancillary documents.

Declaration

I am **opposed** to the proposed project. / *Je suis **opposée** au projet proposé.*

Disclosure

This document is a voluntary submission, not a report. No remuneration or other compensation/consideration was received or promised from any individual, group or agency in the preparation of this document, nor am I, or have been, a member of any group or lobby involved in this issue.

Professional opinions expressed herein derive from my qualifications as a career Research Scientist and Professor, and international publisher, in the fields of biology, toxicology, and water quality/public health. I have also published in the discipline of geology.
Personal cogitations expressed herein derive from my qualifications as a seasoned human being. I recognize that my personal views might not be shared by all parties, but we all respect and honor the right to speak.

Contents

Synopsis

1. The Red River Carbonate and the deeper Winnipeg Sandstone aquifers of concern in the project area are separated by a relatively impermeable shale aquitard which is of variable thickness, brittle, and in some places degraded to clay. The current project proposes to extract silica sand from the deep Sandstone aquifer.

2. The proposed project initially planned to drill up to 467 (subsequently amended to 324) production wells per year, penetrating the aquitard and intruding on both aquifers. Current estimates amount to >7700 wells over a 24 year period. An unknown number of additional wells will be used for monitoring and testing or will be unusable. The present application refers only to the first 4 (possibly 5) years.

3. The great majority of existing domestic wells within the Regional Project area are completed in the Carbonate aquifer and do not penetrate the shale aquitard.

4. The enormous number of planned new wells into the deep Sandstone aquifer will unavoidably contribute to interconnections between the aquifers and their intermixing, and will vastly increase the risk of contaminant transport from the surface. This project is contrary to the 2019 Friesen Drillers report on Springfield groundwater status, which advised against new interconnecting wells, and recommended reduction of existing ones.

5. Perched aquifers in the sand and gravel overburden in the area have not been considered in any of the models. If their aquicludes are punctured, this may introduce another source of intermixing, and may compromise associated domestic wells.

6. Multiple shale layers are present in the Sandstone aquifer at many locations. Water chemistry within these subunits has not been investigated, nor have any potential impacts of their intermixing. Water chemistry also differs between upper and lower portions within the Carbonate aquifer.

7. Artesian conditions are present in the region, and require special management and sealing techniques. Wells that are not flowing at the time of decommissioning may erupt at a later time. The proponents expect to extract such wells when they are not flowing.

8. Sampling methodology and results for groundwater chemistry reported in the EAP are in some cases invalid. Statistical analysis of data has not been conducted, in large part due to the exceedingly small number of samples, and as such these cannot be accepted as representative of conditions in the wider project area, or of a wider period of time. Further invalid samples are planned (e.g. water softener samples).

9. The boreholes will be 20.3 - 40.6 cm in diameter, much larger than the typical 15 cm (or less) bores used for domestic wells.

10. Circular well clusters will be 60 m in diameter, with one well in the center; individual wells will be approximately 18 m apart. There is uncertainty whether 5 or 7 or some other number of wells will comprise a cluster, as various configurations have been inconsistently proposed. Clusters will be 60 m (one cluster width) apart, and will each encompass up to 0.28 ha. Therefore all of the extraction and processing equipment, mobile office, fuel storage, parking, etc. will be distributed between and among the wells, in intimate proximity to them.

11. All of the wells will be located on private land, on parcels as small as 0.3 ha. Larger parcels will contain multiple clusters arranged in blocks.

12. Setbacks from homes, domestic wells, and hamlets, will be only 100 m, or somehow determined "on a case-by-case basis, for which criteria are not known.

13. Some form of air lifting will be used, but the actual final design is not disclosed in the EAP, only an example is given. However a separate patent application contains additional information not included in the EAP.

14. Water and sand brought to the surface by air lifting will be subjected onsite to vibrating screens to remove larger materials, a dewatering station including a centrifuge (cyclone) and a screen, some sort of attempt at water disinfection, and proposed reintroduction of recovered water into the aquifer.

15. Air lifting and return of water will occur at the same time, presenting the likelihood that some of the returned water will be re-exposed to the surface multiple times.

16. The dewatering station description is problematic. The 65% sand target at post-centrifuging does not account for extractions with higher initial sand contents, and it is unclear whether the cyclones and dewatering screens will be bypassed as redundant in such cases. Water from the cyclones is not accounted for. These factors need to be considered in relation to well interference.

17. The disinfection system has not yet been designed. The proposed ultraviolet light treatment will be inappropriate because of high turbidity, and high iron and manganese levels which vastly disqualify this method from this application, in addition to other factors such as lamp sleeve fouling and variable flow rates. Potential UV lamp breakage could release mercury into the aquifer. Grave misunderstanding is evident regarding the difference between drinking water standards and sewage treatment effluent.

18. A proposed method for reduction of turbidity using chitosan addition faces expected challenges in effective dosage, insolubility in alkaline water, and residues of chitosan and its breakdown products in the treated water destined for reinjection. It is not known whether inorganic metallic co-coagulants will also be used.

19. Any turbidity removal treatments will generate large amounts of sludge. Sludge drainage using drying beds has been proposed, but this process presents numerous logistical challenges that render this method impractical. A filter press system for sludge has been proposed as a possible alternative to drying beds. Sludge will contain coagulants from the treatment process and will require disposal. No basic plans have been finalized.

20. Contaminated drainage water from the sludge drying beds (if used) would be integrated into the extracted water recovered onsite destined for 'disinfection' (but not treatment for chemical contaminants), and reinjection to the aquifer. If a filter press is used, presumably the extracted water will be similarly reintegrated.

21. A number of exploratory wells have already been drilled, and four injection well permits have been issued. None of the permits have required water quality monitoring of the return water or its disinfection.

22. For injection wells, remarkably, re-injected water was treated with *ad hoc* chlorination. Form of chlorine, method of delivery, dosage, volumes of chlorinated water injected into the aquifer, and monitoring results are not disclosed. Since dissolved organic matter is present in the groundwater, harmful chlorinated byproducts can result and can continue to form in the aquifers after chlorine introduction.

23. The processed sand/water slurry will be pumped into plastic slurry lines and travel along cleared pathways to the processing facility, where the sand will be removed and the water will be endlessly recirculated via return lines to the extraction sites.

24. Some of the water in the slurry line system will contain water from the facility clarifier and thus potentially residues of polyacrylamide, which degrades to toxic acrylamide.

25. Some drilling muds, grouting agents and borehole linings also contain polyacrylamide or acrylamide. While such materials are not *normally* used in domestic water supply wells, it is not known whether the thousands of sand extraction wells and additional monitoring and test wells will be considered 'industrial'.

26. Pumping stations of undisclosed design and configuration will maintain pressure at intervals along the slurry lines.

27. Plastic slurry lines, i.e. HDPE pipes of inadequate description, will be placed on the ground, will be moveable to different locations, will cross under or over roads, and may obstruct culverts. Sections will be permanently fused into undetermined lengths, and also joined with flanges which can be disassembled. It is not known how the fused lengths between the flanges will be periodically relocated.

28. Use of HDPE tubing for this application raises concerns: it is not optimal for high pressure applications, becomes brittle at cold temperatures, withstands less pressure at warm temperatures, is prone to various modes of cracking, will be continually abraded by silica

sand, and requires gentle handling and protection from scratches. It will be exposed to the rigors of the environment, fluctuating pressures, impact, heating in sunlight, photodegradation, repeated disassembling, relocation and handling, and potential human/animal interference. Risks of leakage or rupture are significant.

29. Drilling will occur year-round, with extraction 24/7 during April to November. Slurry lines will not be used in winter, and the slurry water will be stored.

30. Drawdown of domestic wells surrounding the extraction sites may/will occur during and after operation activities. Simulation modelling does not encompass the range of proposed operating parameters. While 50% reinjection rates are hypothesized, the volume of groundwater actually reinjected is uncertain and will likely vary.

31. Several extraction wells operating in close proximity will result in complex superposition of drawdown cones, increasing the amount and surrounding radius of drawdown. Extraction of a well cluster has not been tested.

32. The volume and mechanical support of the removed sand and some of the water will not be replaced. Removal will create cavities (voids) of irregular and inconsistent configurations underneath the extraction wells, which will permanently alter the physical structure and characteristics of the Sandstone aquifer within the project area. The large volume of water in the many voids, and changes in Sandstone properties may alter water levels and hydraulic flow, as well as pathways of contaminant travel within the aquifer.

33. Damage to the brittle and fractured shale (or the pliable clay) aquitard, combined with the circular perforation placements of the boreholes (+ 1 in the center), could lead to its weakening and collapse across the well cluster, resulting in a large hole between the two aquifers that cannot be sealed. This constitutes a fundamental and insuperable flaw in the project.

34. Over time the cavities will enlarge due to spalling and sand displacement due to hydrological forces and gravity. Cavities may coalesce into larger voids. Collapse of the cavities could manifest at the surface as land subsidence and sinkholes in areas of insufficient or incompetent limestone layers. This could happen unpredictably at any future time, and could affect future land use and safety concerns.

35. Potential subsidence monitoring during and shortly after extraction is insufficient, as stresses and failure leading to ultimate collapse must first propagate upwards over a period of time.

36. Sudden caprock collapse may forcefully displace the water in the void, sending a sudden pulse of pressurized water against the sides and ceiling, causing catastrophic damage and enlarging the void. A cascading failure of successive adjacent clusters may be triggered by the force of the hydraulic blast.

37. The critical minimum limestone thickness model, whose aim is to guide operation decisions, requires recalibration, recalculation and refinement, based on a more substantial database rather than a few samples and many assumptions, and better alignment with proposed operating conditions. Many locations do not meet the minimum 15 m thickness threshold. The model apparently disregards the *numerous* other factors which govern porosity, mechanical strength, and hydraulic conductivity. Fractures, discontinuities, inclusions, fossil beds, stylolites, heterogeneous lamination, and other features of secondary porosity in the limestone are not accounted for. Simplistic consideration of thickness *per se* is not an adequate criterion of subsidence prevention.

38. The treatment of roof limestone as supporting beams does not take into account that the longest beam at the center is pierced by a borehole at the point of greatest stress.

39. The limestone thickness model disregards the shale aquitard, and failure of the shale is deemed by the proponent as *acceptable*.

40. Operations will be associated with zones of *irreversible* shale degradation, with an estimated radius of 200 m, the cumulative area of which will expand as the project advances and enlarges.

41. The most recent explanation in RPCR regarding the decommissioning of wells, is that PVC casings will be severed below ground and capped, then camouflaged at the surface. People won't know they are there until at some point they may be eroded, accidentally excavated, or exposed and shattered by sinkhole collapse. There will be many thousands of these abandoned wells.

42. The municipality must keep accurate records of all decommissioned wells, and consider carefully the future uses, building permits and construction allowed at these sites. Permanent markers should be installed. On agricultural land, spreading of manure, or pesticide and chemical fertilizer application overtop these wells could provide risks of groundwater contamination.

43. The proponent's attraction to setting up operations in gravel pits raises multiple additional concerns, for example the lack of overburden protection as a buffer against surface contamination, and exceptional noise. After decommissioning, when gravel pits resume normal operation, the vibration and compaction from heavy machinery may compromise the abandoned wells, and promote caprock failure and sinkhole formation. Will blasting activities be forever banned in such tainted pits?

44. Since the decommissioned wells will remain in perpetuity, the seals and casings will eventually fail on at least some of them, as there will be many thousands of them. This will provide conduits for contaminants to the aquifers below.

45. Groundwater contaminant plumes will be drawn to active pumping wells.

46. Both steel and plastic casings leach toxic substances into groundwater as they age. This will be aggravated by the larger surface area of the casings, and the vast numbers of them. Sealing grouts and cements may also leach undesirable chemicals.

47. Oxygen will be introduced into the Sandstone aquifer with the reinjected groundwater. The separate patent application also describes potential direct injection of pressurized air pulses into the aquifer to loosen the sand, and potential horizontal reach beyond the borehole axis. Air pockets may lodge against the shale ceiling, and become enriched with radon and hydrogen sulphide gases.

48. Aeration and agitation of the water will displace dissolved radon gas and hydrogen sulphide; the latter gas may generate increased nuisance odor complaints in neighboring wells during and after operation. Radon will be silent and cannot be detected by smell or taste.

49. Modelling to predict water quality changes resulting from oxygen in the reinjected water is not based on measured data, but on assumptions which underestimate the dissolved oxygen content.

50. Oxygen will oxidize soluble iron and manganese to form insoluble precipitates, which may discolor untreated tapwater and further increase turbidity.

51. Oxygen will promote pyrite oxidation in the shale layer, which may contribute to water chemistry changes due to acidification, and heavy metal and trace element mobilization.

52. Oxygen will create favorable conditions for proliferation of iron and manganese bacteria and fungi, should they be introduced into the aquifer with infected tools and equipment, or be already present in nearby infested domestic wells.

53. Extraction sites for well clusters, monitoring and test well sites, access trails for large equipment, and smaller trails for slurry lines will be bulldozed in winter, unless unrestricted access is already available. Since clusters will be 60 m apart, multiple clusters will require interconnecting access. Drainage ditches are also planned. The proposed 2 m width for slurry line trails is deemed unrealistic.

54. While the onsite dewatering station and the undescribed slurry pumping stations will run on mainline power, no mention is made of where hydro poles and power lines will be routed and the additional clearing required. However a late comment suggests that the dewatering station can only be moved once a year, thus bringing into question how dewatering at each cluster will occur.

55. Clearing of sites and trails, and equipment and vehicle transfer may promote spread of plant diseases and pests, as well as invasive plant species.

56. Extraction operations will continue 24/7, possibly even some extending into winter. Each well will operate 3-7 days and nights (there are several different estimates, 4 days seems to

be a general target). Not all wells in a cluster may operate at the same time, extending the total duration of operation of a given cluster. The number of wells operating at the same time is stated as 7, although 10 extraction rigs are specified. There may be many clusters on a land parcel, materially extending its occupation time. Landowners will be excluded from occupied areas of their land.

57. The 24/7 operation will generate continuous noise from all of the numerous pieces of equipment operating simultaneously, only some of which will be powered by mainline electricity (although the latter also will emit noise). The 100 m setback limit from somebody's house is colossally inadequate and cruel. Noise has been indubitably demonstrated to affect health and wellbeing of people, and will disturb farm animals, birds and other wildlife. Additional noise will occur during clearing, site setup, drilling, pipe relocation, powerline installation and removal, and decommissioning. The slurry pumping stations will generate noise. Noise assessment studies have not been conducted.

58. It will not be possible for the extraction sites to meet the 83 dBA mandated Workplace Safety and Health maximum for a 12-hour shift. Workers will require the most robust hearing protection. Noise fatigue may affect worker performance and safety.

59. Highly annoying low sound frequencies which propagate for greater distances will be produced by compressors, generators, pumps, cyclones, vibrating screens, and other equipment, particularly diesel powered. Proposed outdoor noise measurement with a dBA meter will not be adequate to reflect true exposures, which penetrate construction materials, and which are <u>amplified indoors</u> due to resonance. Exposures are also greater at night because the light plants will be operating in addition, and sound propagation is higher at this time. Indoor measurements with a dBC or dBZ meter will be required. Surrounding exposures will be further amplified by sound reflection, refraction, curvature, and lift. Simple sound barriers will not remedy the problem.

60. Infants and children will be most affected by the noise, since they can hear higher operating frequencies that are inaudible to adults and elders. Animals will also be differentially affected for this reason.

61. The proposal bashfully skirts around the issue of light pollution. Since operations will be 24/7, industrial lighting will be required. There is no information regarding details of the intensity, type and disposition of lighting at the sites, other than that 8 light arrays are planned. Light pollution affects the health of people and behavior of nocturnal wildlife. Birds especially are disturbed by light, and extraction operations will overlap with the breeding season of all bird species. The disturbance from light will be combined with that from noise.

62. Air quality will be a nuisance on days when the site is upwind. Diesel exhaust can exacerbate respiratory conditions, create stress, affect neurocognitive function. Diesel particulates are carcinogenic. Dust and mold exposure is possible. No air dispersion studies

for extraction activities are included in the EAP, and data for the processing facility are not transferable or appropriate. Workers will be continuously exposed during their 12-hour shifts.

63. Greenhouse gas emissions are underestimated due to omissions, gaps, and fundamental calculation errors.

64. Impacts on vegetation and ecology, all on private lands, have received little attention from both the proponents and the reviewers. All effects are dismissed by the proponent as “minor” and “negligible”, without supporting data.

65. Baseline vegetation surveys were “desktop reviews”. On site field reconnaissance was not conducted.

66. The revegetation and restoration plans are deemed inadequate in multiple ways. Much of the restoration appears to be based on allowing areas to “revegetate naturally”, i.e. walk away. There is noncommittal nebulous mention of possible reseeding with “native seed mixtures” in some cases. Property owners will apparently obtain and replant new tree saplings themselves. Restoration of wooded land will require decades for trees to regrow; however plant community composition will not duplicate the original, and the trees comprising the stands will all be of the same age and possibly same species.

67. The patchwork and network clearing will create dysfunctional ecological edge effects for vegetation and wildlife. Continued damage may occur due to windthrow, and death of trees injured by equipment.

68. The proposal ignores or minimizes the role and rights of the property owner. It is not clear what the rights are of adjacent landowners who are not directly involved in landowner agreements with the company.

69. Complaints of residents are to be directed to the company.

70. As admitted by the proponents themselves, the procedures and technology to be used in this project are untried and undocumented elsewhere. The first four years (at least) are expected to be experimental learning.

71. Post-closure, long-term accountability is absent. There is no provision for compensating/addressing permanent damage to property or water supply as a subsequent consequence of operations.

72. Numerous Plans, Programs and Reports referenced in the EAP are inadequate/missing and not available for evaluation, including:

    Waste Characterization and Management Plan
    Water Management Plan
    Groundwater Monitoring and Impact Mitigation Plan

Limestone Competency Testing Plan
Noise Mitigation Plan
Progressive Well Abandonment Plan
Water Sampling Program Plan
Environmental Emergency Response Plan
Air Quality Plan
Wildlife Assessment Report
Vegetation Survey Report
Revegetation and Monitoring Plan
Stakeholder and Indigenous Engagement Plan
Closure Plan

Drafts of three late submitted Plans are rudimentary, with fundamental gaps and omissions.

The proponent indicates that missing Plans will be drawn up after licensing. Internal "living documents" for staff and contractors will be altered and amended at will. Documents and reports deemed 'proprietary' will be viewed only by provincial regulators and consultants, and regulatory approvals and decisions may rest on these suppressed materials.

73. Endless 'Notices of Alteration' will be presented over the 24-year lifespan of the project, bringing into question how much of the original EAP and the current decisions based on it will remain relevant. Possibilities of longer 'multi-generational' timelines are mentioned.

74. Current mining regulations and guidelines are inadequate to address this type of mining. Similarly a number of pieces of legislation relating to groundwater, wells, and drilling regulations require updating. What we do here with this project will set some serious precedents. The project should proceed with appropriate regulatory frameworks in place.

75. Regulations are irrelevant if monitoring and enforcement are lacking. A proactive, preventative, as well as deterrent, approach is required, rather than the current *laissez-faire*, largely complaint-driven system. As we have already seen, but not learned, hundreds of times in Manitoba, it is difficult or impossible to remediate a situation after it has already arisen, and harm has been done.

76. In the end, the proposal fails to provide substantive information on multiple key aspects of the project, many very basic assumptions are flawed, data are severely lacking, and the proposal has not been adequately considered, researched, or presented. The public are being asked to buy something in a sack. Even so, the proposed project will impose invasive and permanent changes on the aquifers, facilitate groundwater contamination, inflict environmental and ecological damage, mar and scar people's properties, subject residents to unconscionable inconvenience, intrusion, nuisance, and stress, and create future liabilities and risks for landowners.

Terms of Reference

A letter of notification dated 15 November 2021 was addressed to Mr. Somji of CanWhite Sands by the Minister of Conservation and Climate regarding a CEC review process and forthcoming "Terms of Teference" [sic] (https://www.gov.mb.ca/sd/eal/registries/6119/20211115_CEC_Notification.pdf) regarding **Manitoba Environment Act Proposal Public Registry 6119.00 CanWhite Sands Corp. Silica Sand Extraction Project.** A letter dated the same day to the CEC Chair circumscribed the **Terms of Reference** as pertaining to: "**potential environmental and health effects of the proposed sequential installation, operation and decommissioning of silica sand extraction wells for the silica sand extraction project**" (https://gov.mb.ca/sd/pubs/terms-reference-canwhite.pdf).

These **Terms of Reference** are interpreted in the present submission as: effects relating to geology, aquifer integrity, water quality, air quality, human health (residents and workers), ecological impacts with respect to wildlife and vegetation, and post-closure and permanently persisting issues. "Installation" is interpreted as clearing, site and site access preparation, the drilling of wells, equipment setup, and slurry pipe deployment. "Operation" is interpreted as activities during the sand extraction process and associated operational procedures/practices including operation of slurry lines. "Decommissioning" is interpreted as effects from activities in the time period after sand extraction from a well is complete, and extending to Post-Closure and ongoing (indefinite) consequences. An overview of these interpretations is summarized in Table 1.

Table 1. Summary of interpretation of **Terms of Reference** with respect to impact components and associated environmental and health effects discussed in the present document.

Term of Reference	Identified Component	Effects
Preparation and Installation	Vegetation	Destruction of trees: site clearing, access trails, site interconnection trails, slurry line trails, hydro service trails Injury of bordering trees by equipment Root compaction of living trees Disturbance/destruction of vulnerable/rare species Soil disturbance and compaction Soil seed bank interference/destruction Digging drainage ditches: destruction, and alteration of prevailing moisture conditions Propagation/introduction of invasive species via movement of drilling, construction and other equipment and vehicles, and workers, especially to and from gravel pits where invasive species most commonly occur Potential introduction/spread of plant diseases and pests

		Destruction of wild foods (berries, mushrooms, medicines) Indigenous harvester treaty rights Sentimental/spiritual value Destruction/damage of trees planted and cared for by landowner Machine fluid spills
	Wildlife	Physical disturbance, especially during night clearing Noise: clearing, drilling, traffic Habitat destruction Habitat fragmentation Loss of food and cover Destruction of dens and permanent nests Exodus or destruction of vulnerable species Destruction of sedentary or small creatures unable to flee Ingestion of harmful garbage (antifreeze, plastic food wrappers, remains of human foods that are toxic to animals) Injury and entanglement hazards Indigenous harvester treaty rights
	Aquifer and water quality	Aquitard compromise and intermixing of aquifers Chemical contamination during drilling and casing manipulation Vulnerable exposed PVC casings Biological contamination: nonsterile drill bits, tools and equipment Surface water incursion into open boreholes Artesian conditions: loss of head, flooding Puncture of aquicludes Spills of machine fluids, oils, fuels, lubricants, antifreeze, hydraulic fluids, other
	Human health (residents)	Noise: clearing, drilling, digging; transport of heavy machinery, mobile office, fuel tanks, portapotties; worker traffic; installation and setup of equipment, hydro poles, slurry pipes, pumping stations Stress (other than noise, e.g. psychological distress due to property damage, destruction of areas of personal significance, destruction of planted or valuable trees, dealing with company representatives and unresponsive officials) Air quality Deprivation of access to one's property (walking, recreation, meditation) Privacy: Intrusions into private wells
	Worker environment	Noise Air quality

		Stress (extended shifts, night shifts, hazardous workplace, other issues, e.g. extra hours, illness) Exposure to toxic materials (e.g. equipment maintenance) Working in cold weather Need for quiet break times
	Air quality	Diesel exhaust emissions Burning of cleared debris, branches, banned wood transport species, garbage Dust Mold spores, e.g. blastomycosis, from disturbed soil Greenhouse gases
	Waste materials	Garbage: litter, food wrappers and cups, cans, clothing, discarded machine and equipment parts, machine fluid and lubricant containers, chemical containers (drilling fluids, grouts and cements, etc.)
	Infrastructure	Interference with roadways and culverts at installation of slurry pipe crossings Hydro transmission line crossings Shoal Lake aqueduct in regional project area
Operation	Aquifer and water quality	Water quality changes: pH, turbidity, trace elements and metals, unknown products of disinfection Exhaust gases introduced with compressed air, return water Oxygen introduction: oxidation of iron and manganese, promotion of aerobic microbial growth Radon, hydrogen sulphide displacement Ineffective disinfection: microbial contamination Well interference due to drawdown, turbidity, discoloration Drawdown of **both** aquifers during and after pumping Shale degradation and/or collapse Acceleration of downward surface contaminant migration Direct contamination: introduction of infected equipment, surface water incursion, compressed air On site spills of fuels, machine oils, fluids such as antifreeze Mercury release into aquifer from risk of UV lamp breakage Slurry fluid spills on site and on slurry line trails Fuel spills and machine oils from pumping stations on slurry line trails Existing injection well received chlorinated water: ongoing formation of hazardous chlorinated organic compounds
	Topography	Subsidence and collapse

	Human health (residents)	High levels of cumulative and continuous noise: intensity, audio frequency characteristics, periodicity, duration, hammering and bangs, no respite Nocturnal noise Light pollution: intensity, spectral characteristics, duration, disposition Changes in well water quality: turbidity, discoloration, odor Stress from well failure or fouling, and immediate need for water supply with no timely aid, cost burden of buying and transporting bottled water, cost of well pump damage Inconvenience or inability to carry trucked water into home for washing and sanitation No hot water Stress from continuous disturbance 24/7 from worker and equipment traffic Stress from dealing with unresponsive officials Stress from disruption due to relocation to alternate accommodations for duration, and cost hardship Stress from requiring/finding alternate arrangements for livestock and flocks, other domestic animals
	Worker environment	Constant high decibel noise Air quality Stress: shift work, extended shifts, pressure to maintain schedule, other work conditions, working while ill or injured Exposure to harmful substances
	Air quality	Diesel and other fossil fuel emissions (CO_2, CO, NO_x, hydrocarbons, particulates, heavy metals) Exposure to hydrogen sulphide (increased odor levels), radon Dust and mold, silica sand spills Greenhouse gases Silica and coagulant dust from sludge drying beds/or maybe filter press?
	Wildlife	Continuous noise disturbance: site operation, slurry line pumping stations, worker and delivery/maintenance traffic, slurry line patrols Reduction in food and cover availability Light pollution for nocturnal species Interference with bird breeding season Stress from loss of home territory, shelter, failure of reproductive effort Edge effect, fragmentation Vehicle-wildlife collisions on trails Depopulation of surrounding wooded areas

	Farm animals and pets	Continuous noise Light pollution Stress: disturbance, reduction in milk yield, reduction in reproductive success Stress: relocation of farm animals to unfamiliar surroundings Well and dugout interference for livestock watering Disruption of pastureland by placement of extraction sites
	Drainage	Site flooding: water spills from operations, artesian conditions, hydraulic fracture, dump water from dewatering cyclones, other (?) Obstruction of municipal culverts by slurry pipes
	Vegetation	Vegetation control on access and slurry line trails Enlargement of clearings due to edge tree toppling
Decommissioning	Aquifer and water quality	Thousands of hidden abandoned wells Partial casing removal Sealing: fill materials, potentially toxic Incomplete sealing and contamination avenues from surface Sealing of artesian wells Monitoring and certain wells remaining open significantly past 180 days
	Site restoration (if any)	Noise Dismantling and removal of structures and equipment Levelling and grading Indifferent surface soil restoration Soil contamination from drips and spills Tree root compaction and damage Filling in of drainage ditches? Traffic Garbage
	Trail restoration	Apparently none planned: residual damage from vegetation destruction and traffic, injured edge trees, tree root compaction, slurry pipe removal, spills, removal of hydro poles and lines
	Human health	Noise Exhaust fumes Disturbance from traffic, heavy machinery at extraction sites and on access, slurry, interconnecting, hydro trails Stress of waiting for remediation, revegetation Stress of dealing with unresponsive/disinterested officials

	Revegetation	Site abandonment with no replanting ('natural' revegetation) Destroyed native seed soil seed banks Reseeding with native (?) species Inability to replace rare or specialized plants, medicines Inappropriate or invasive species introduction Necessity for weed control Traffic for subsequent revegetation monitoring (?) Different resulting community composition and cohort structure from original Edge effect and fragmentation Absence/reduction of tree canopy shading for seedlings Introduction of new genetics into local population gene pools Reseeding appropriate mixes for damaged pasture areas Changes in soil structure, texture, compaction Changes in soil microbiota, missing symbionts Changes in pollinator populations Increased opportunities for trampling due to trespassing and motorized vehicles Required ongoing commitment from landowner to care for and water planted trees Obtaining and replanting of native berry bushes
	Wildlife	Noise Alteration of habitat, wasteland conditions Lack of cover and food Visibility of nests to predators Edge effect, fragmentation
Post closure to long-term effects	Aquifers	Thousands of permanent abandoned wells Intermixing of Carbonate and Sandstone aquifers Compromised sand and gravel wells due to aquiclude damage Permanent changes to aquifer structure Potential intermixing of Sandstone aquifer subunits delineated by multiple shale layers Swaths of degraded Winnipeg shale Enlarging voids over time Pyrite oxidation, acidification, water chemistry effects Persistent effects from oil, machine fluid, mercury spills Contamination via improperly sealed/decommissioned wells Progressive eventual deterioration of wells and well seals Leaching of toxic substances from aging well casing materials and grouts

		Emergence of new artesian flows due to hydraulic fracture, or failure of annular seals, or casing corrosion, especially during high head in wet seasons Damaged casings and seals caused by collapse and subsidence Damaged casings due to accidental excavation of hidden unmarked wells
	Topography	Scarring (up to decades) Collapse and subsidence, permanent sinkholes Potential for hydraulic blast and cascade failure of multiple voids
	Vegetation	Many years until community stabilizes Long-term effects of slow or failed recovery Soil and root compaction Destruction of natural soil seed bank Reduction in species diversity Edge effect and fragmentation, continuity dissected by many trails Remaining trees along clearings and trails damaged by machinery Toppling of edge trees due to removal of supporting trees Potential extirpation of rare species due to fragmentation or population depletion below sustainable recruitment levels Repopulated tree stands all of same age and species, absence of cohorts, reduction in community stability Absence or insufficiency of understory Naturalization of new species introduced with seed mixes for reseeding Invasive species Plant diseases and pests Possible residues of oil and other toxic fluids, trash debris in soil
	Wildlife	Alteration and loss of animal community diversity Changes in community structure and composition Long-term effects: slow or no recovery, failure to return annually to nesting sites, avoidance of area Loss of cover and food Alteration of predator-prey relationships Potential extirpation of rare species with limited mobility and distributions (e.g. amphibians, reptiles, invertebrates) Nonbiodegradable garbage hazards (e.g. 6-pack rings, plastic straws, plastic twine, packaging) Disturbance by monitoring drones

	Farm animals	Vegetation loss (cover and food in pastures) Nonbiodegradable garbage hazards (e.g. sharp metal objects, wire) Stress and stampede injury due to monitoring drones
	Human health	Altered quality of life Long-term stress, depression and residual trauma from dealing with unresolved property damage and injured landscape, reduced property values, land use restrictions due to permanent well clusters, increased cost burden (e.g. buying and planting trees, fixing fences and damaged property, fixing well issues denied by company Permanent well problems (perched aquifers, altered hydraulic flows, altered water quality) Continued intrusion from post-closure monitoring by personnel or drones Inability to sell property, insurance issues
	Air quality	Exposed spilled silica sand

Incerta Stans

- The Silica Sand Extraction and Processing Project was presented for approval by the proponent as two separate proposals: **Public Registry 6057.00 CanWhite Sands – Vivian Sand Processing Facility** and **Public Registry 6119.00 CanWhite Sands Corp. Silica Sand Extraction Project.** These two proposals intersect materially and inextricably, and therefore many components unavoidably overlap, with many environmental and health concerns in common. It is not possible for one proposed endeavor to operate without the other, each constitutes *sine qua non*, nor is it possible to evaluate one without implicating the other.

- However, after the Clean Environment Commission hearing notification was posted on 23 November 2021, the processing facility was granted Environment Act License No. 3367 on 16 December 2021, posted 17 December 2021. This hasty approval, inopportune if not prejudicial, renders the present consultation process, concerning only the remaining half of the entire project, awkward and uncertain, and places the reviewer in the strange position of having to comment on intrinsically linked aspects of the operation **that have already been approved.**

- The concerns of dividing the project into physical operational portions, as well as temporal 4-year segments, in order to diminish the perceived impact of the whole (a similar strategy employed by industrial hog operations in Manitoba), has also been echoed by the geotechnical reviewers in SRTER (#3): "the abbreviated temporal scope, substantively smaller spatial scope and exclusion of critical project components constitutes "project splitting". In simple terms, this involves breaking a project into smaller pieces that individually fall below EA impact thresholds that might otherwise result in significant impacts. Arcadis considers this to be a material deficiency with the Project Proposal and recommends that the CEC explore options to evaluate the **potential environmental impacts of the entire Vivian Sand Project, not just sand extraction**". (Emphasis is mine). Note: the proposed first term is now 5 years (see p. 525).

  But unfortunately, the processing facility is already approved. The proponent responds to the above concerns: "It is AECOM's [proponent's consultant's] opinion that commentary on the permitting of the Facility Project, which has already obtained an EAL, is outside of the scope of what the Clean Environment Commission (CEC) and Arcadis were instructed to review." (SRTER #3). These constraints hinder, blot and muddy the thoroughness, credibility, and optics of the pinioned CEC process. How is it even possible to divorce the two applications, when the EAP itself references the processing facility on numerous occasions? It should be noted that this fragmented approach proceeded with the benediction of the Province: the proponents "discussed at length and reviewed in detail with provincial regulatory agencies, and at no time was there an indication that the filing of Sio's EAPs were inappropriate and/or fail to meet the requirements of The Environment Act." (SRTER #3).

Furthermore, the proponent claims that new procedural concerns cannot be raised for the current application if the Processing Facility has been previously approved using the same procedures. For example: "If the effects assessment approach and methods used by AECOM were deemed unacceptable by the EAB, we expect that the EAB would not have accepted EAPs produced by AECOM, and the EAB would not have issued Environment Act Licences(EALs) for other projects based on AECOM EAPs (e.g., Vivian Sand Facility Project; EAL No. 3367)." (SSCRIR2 #MBEN-IR-033).

- It should be further noted that the areal scope of the current proposal is but a deceptively modest fraction (633 ha (NREP)) of the colossal extent of the eventual operations planned in southeastern Manitoba. Its actual reach, however, is shrouded in ambiguity, as different numbers have trickled out at different times.

  The Sio website indicates that 390 mining claims for 85,000 ha or >850 square kilometers have been already secured; these include several tracts in other municipalities besides the current Vivian project (https://www.siosilica.com/silica, accessed 10 December 2022).

  However in information released to the public in Steinbach in 2019, a previous incarnation of this company revealed that "H D Minerals has claims on 120,328 hectares of land in several municipalities in the southeast including Hanover, La Broquerie, Tache, Ste. Anne and Springfield."(https://steinbachonline.com/articles/results-of-mystery-mineral-drilling-to-be-made-public).

  In SSCR (#4), the reviewer states that "**the project area is crudely estimated at 168,000 hectares**". The proponents do not dispute this number in their reply. In SSCRIR2 (#MBEN-IR-036):

  Reviewer: "Preamble: Sio Silica does not dispute the CEC technical experts' finding that the "project area is crudely estimated at 168,000 hectares…"

  Request: a) Please reconcile the figure in the Preamble with the statement on the Sio Silica website asserting that the project area covers "over 85,000 hectares…"

  Response: a) Sio's website states "the company has secured a total of 390 mining claims, which covers over 85,000 hectares of land." The 85,000 hectares relates only to the area of land associated to Sio's claims. Sio is not clear where the 168,000 hectare value came from in the Reference. This is not a value Sio has ever **released**." (Emphasis is mine).

  We note the murkiness of the response. The proponent only states that the larger value was not ever *released*, and what the current claims seem to be, but does not categorically deny the larger number either. Why was that number not disputed if it is erroneous? The proponent also does not deny the 120,328 ha claim made in Steinbach as noted above.

  In any case, **should not the ENTIRE PROJECT be assessed?** Should we not even know what it actually is? Should this not be dealt with in its true context and comprehensive,

unprecedented impact, rather than sleight of hand to focus our short and fickle attention span only on a little corner: 'See? It's not so bad". The public advertising breathes nary a whisper of the actual scope: "Initial production will be on an existing aggregate site, then will expand within three miles of the proposed facility." (The Clipper, January 19, 2023, p. 24).

Smaller doses become more palatable: heck, an Australian man ate a whole car over a period of 4 years. According to the source, "Here is how he did it: he ground everything up into tiny pieces" (http://www.classclownacademy.com/the-man-who-ate-a-car-so-weirdand-yet-so-true/). The strategy is transferable, and has worked so far.

The map of claims provided in SIO (Figure 1) presumably shows only the 85,000 ha referred to above, half of the estimate in SSCR (#4). Even so, it provides a hint of the huge extent and scope of the planned mining in southern Manitoba, and the vast area that will be affected. It is assumed that a series of additional applications for licences in each color-coded grouping on the map will be forthcoming. The present initial 4-year proposal deals with a few of the yellow ones. Presumably the expired claims listed in AppC have been renewed.

The project is now pitched as "multi-generational" (The Clipper: February 22, 2022, p. 5; January 12, 2023, p. 10; CJOB radio ads), apparently open-ended, trailing off into the indefinite tremulous future.

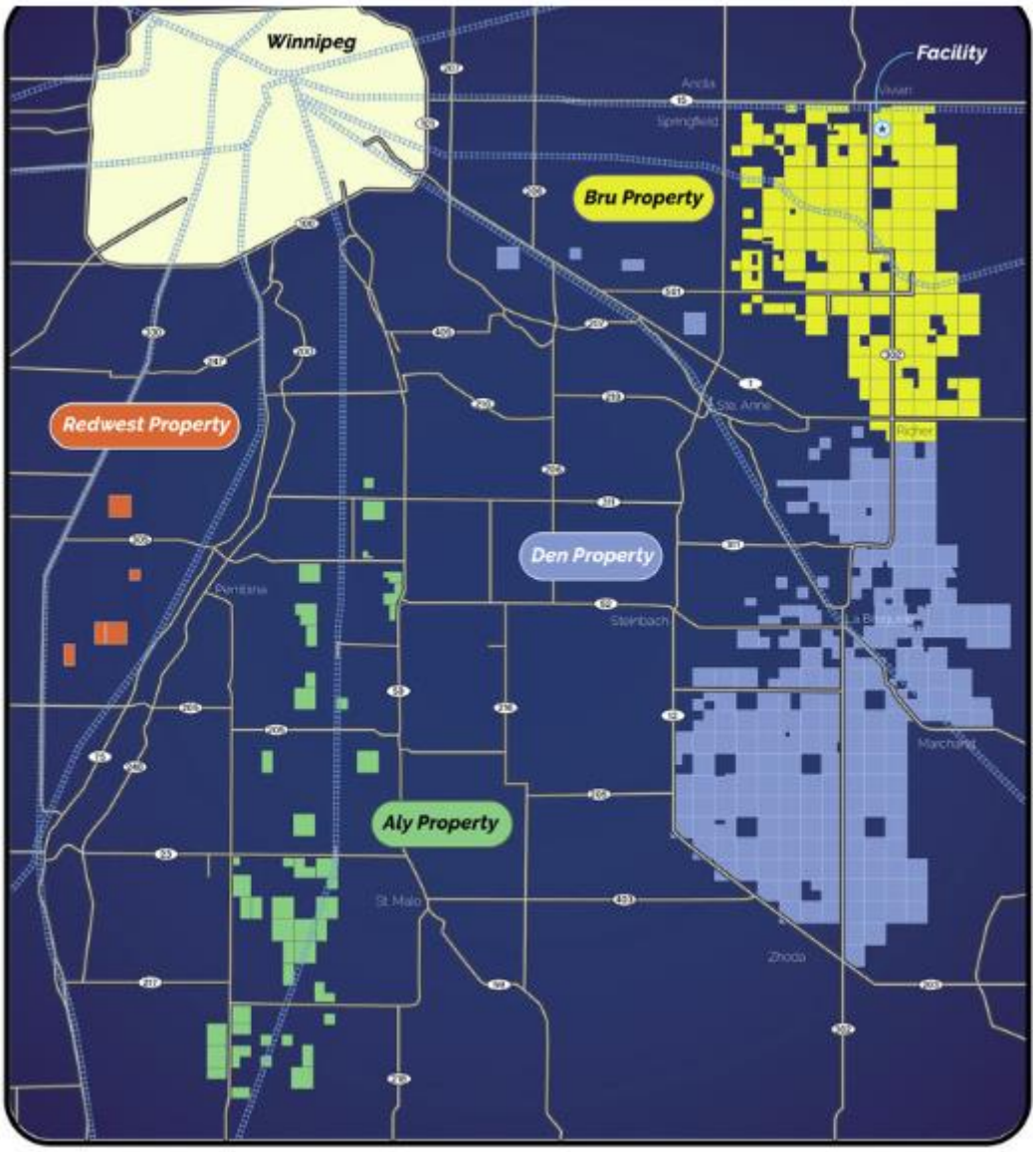

Figure 1. Map of mining claims secured by Sio, according to the company's website. Source: https://www.siosilica.com/silica . According to SSCR (#4), claimed area may be much higher.

- The original unrealistic target date of 15 March 2022 for completion of the CEC review for another part of another part of the project, set by the Minister of Conservation and Climate was understandably deemed impossible to meet by the CEC, which put forward a request for an extension on 14 December 2021 (screenshot):

  In preparation for the hearing, it has come to our attention that the deadline of March 15, 2021 to complete the project will be difficult to meet while ensuring a complete technical review of the proposal as well as accommodating full public participation.

(http://www.cecmanitoba.ca/cecm/hearings/pubs/silicasandextractionproject/termsofreference/letter,_canwhite_sands_schedule.pdf).
Note: the date of March 15, **2021** is obviously in error.
The Minister approved the request for an extension on 13 January 2022.

- In an April 20, 2021 letter concerning the present project to federal Minister of Environment and Climate Change, the Hon. Daniel Blaikie MP wrote,: "Unfortunately, we have a provincial government that has demonstrated a high level of enthusiasm for the project and a low level of concern for its environmental and human consequences." He further notes "the lack of trust in, and the low level of scrutiny by, the Manitoba government in this regard" (https://www.ernstversusencana.ca/vivian-silica-sands-extraction-wells-manitoba/).

- In June, 2022, the Province pledged its wholehearted and unflinching dedication to attracting and supporting the mining industry: "We are taking a whole-of-government approach to show our commitment to the mining sector". (https://news.gov.mb.ca/news/index.html?item=55123&posted=2022-06-13).
  Should we not be taking a 'whole-of-government' approach towards finding and striking a responsible *balance* between industry, environment and health?

- In considering projects of such magnitude and scope as is the present application, should we not first deal with the hundreds of abandoned and toxic sites that we *already have*, should we not overhaul our outdated and loopholed rickety legislation, should we not take away incentives for environmental abuse, and should we not first set in place an effective and credible fabric of monitoring and enforcement - before plunging with gleeful abandon into *more of what we already have*? If we keep endlessly looking away, eventually we will not have anywhere to look at all.

- In the interim, the corporation known as CanWhite Sands has announced that it has become Sio Silica, which change has been amended in the Public Registry title for the proposal. Prior to its incarnation under CanWhite Sands, this project was pitched under the name of HD Minerals. The currently planned lifespan of this project is 24 years, with consequences far beyond. In the present document, the proponent is identified as CanWhite throughout, to simplify any confusion associated with past, present, and future serial name changes and transmogrifications.

- The present submission is presented with acknowledgement of the above public position of the Province to encourage and promote non-renewable resource extraction. The present submission is also presented under constraint, as not enough time has been allowed to properly examine relevant post-proposal documentation in advance of the

written submission deadline of February 13, 2023. This is especially concerning in that so much of this subsequent documentation negates, contradicts, invalidates and materially alters the already inadequate information put forward in the original proposal (EAP), so that it is difficult to sort out what exactly we are reviewing, further complicated by the admitted existence of unavailable parallel 'secret' information that is not publicly accessible but is heavily referenced. Many essential components of the project, such as aquifer protections, disinfection, monitoring programs, mitigations, property restorations and nuisance abatement have not even been formulated. Yet our response is demanded by the onerous and quite insufficient deadline.

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Aquifers and groundwater

Introduction

- The proposed project in the Municipality of Springfield will initially focus on the Vivian area in southeastern Manitoba, and will involve the extraction of silica sand from the Winnipeg Sandstone Formation, which underlies Red River Carbonate deposits

- The age of the Winnipeg Sandstone Formation is approximately 461- 472 million years (Middle Ordovician)(https://weblex.canada.ca/html/016000/GSCC00053016596.html). It consists largely of quartzose sandstone. The Red River Carbonate is approximately 444 – 461 million years old (Late Ordovician) (https://weblex.canada.ca/html/012000/GSCC00053012586.html). This limestone formation is covered by recent (2.6 million years ago to present) Quaternary sediments of varying thickness and composition. They are largely unconsolidated and have been much 'mixed' and pushed around by a series of glaciations.

  This sandstone-shale-limestone stratigraphic sequence is indicative of a major transgressive marine environment (Figure 2), that records gradually rising sea levels in the Williston Basin during Mid- and Upper Ordovician times (Bezys and Conley, 1998).

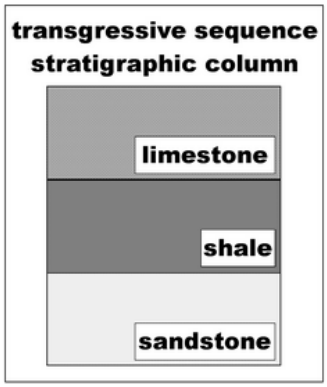


Figure 2. Transgressive marine sequence. Source: https://commons.wvc.edu/rdawes/g101ocl/basics/depoenvirons.html

These Sandstone and Carbonate strata form two important, irreplaceable and unique groundwater reservoirs. "These two aquifers are hydraulically separated by a relatively thin shale which forms the upper part of the Winnipeg Formation." (Wang et al., 2008). The depth at which Winnipeg shale occurs and its thickness vary in the project region. However information is incomplete: "The shale unit is not well understood as it has not been consistently mapped" (AppA1, p. 60). A number of drill cores in the project area have shown additional multiple shale layers interbedded within the Sandstone (e.g Well PID 197863, 199980)(WDR); this phenomenon has previously been noted by Betcher et al. (1995).

- To extract silica sand from the Sandstone layer, the proposed project will involve the drilling of thousands of new boreholes over a planned 24 years, that will puncture the shale and will intrude on both aquifers. The entire eventual project area in southeastern Manitoba is currently estimated to encompass at least 85,000 hectares, possibly much more (see Figure 1, p. 29).

- EAP2 (section 6.2.1) claims that "approximately 1.06% [of sand] removed throughout the 24-year life of the project", and in RPCR (#1): "Only a very small fraction of sand (approximately 1.06%) will be removed **from the target aquifer** (Carman Sand Member of the Winnipeg Sandstone Formation) during the 24-year life of the Project". (Emphasis is mine). How was the 1.06% value obtained? The thickness of the Sandstone is variable; even among the exploratory boreholes already drilled (WDR), some well logs have not reported a sandstone layer (e.g. Well PID 199971, 197858, 199974, 201398).

  In any case, the above statements, as written, indicate that the 1.06% refers to "the target aquifer (Carman Sand Member of the Winnipeg Sandstone Formation)", i.e. the *entire aquifer*, not the project area. If this is correct, the volume is staggering, given the size of the aquifer. But because activity will be concentrated in the project region, the relative impact would be **exponentially greater**. (EAP2, section 6.2.1). We all agree that this is a non-renewable resource.

We further note here that the proponent is advertising that the project is "multi-generational" (e.g. The Clipper, February 22, 2022, p. 5 and others; CJOB radio ads), which implies aspirations of even longer timelines, and even more extensive impacts, than those over the first 24 years.

- The sand is visually of varying purity. A study of the well logs in WDR indicates that in addition to the premium white sand, a range of other colors also occurs: yellow, grey, green, brown and black, presumably reflecting differences in chemistry and composition. In some instances (e.g. Well PID 197862), different colors are separated by shale layers in the same stratigraphic sequence. The EAP provides no information characterizing these different sands, nor the associated water chemistries. There is no indication whether these colored sands will also be exploited.

  Only one sand sample, presumably some of the 'premium white sand', appears to have been analyzed. In Figure 3 (screenshot) we are favored with the exact results as submitted by the proponent for our illumination (http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/appendix_a_dln_ir_003.pdf):

Table 1: Results of quantitative mineral analysis (relative weight %) of X-ray diffraction data for sample 1 [WASH A] using Rietveld method

[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]

Remark: The XRD results indicate that this sample consists almost entirely of quartz, with trace amounts of clays (kaolinite and illite). The peak profiles and background of the XRD pattern indicate that the sample is fully crystalline.

[redacted]

Figure 3. Screenshot showing results of analysis of one sand sample submitted by the proponent in http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/appendix_a_dln_ir_003.pdf

- The planned markets for the extracted sand are various, including the "oil and gas industry". In the companion, already approved Processing Facility documentation (EAPPF Appendix I), questions 44 and 46 from the public are answered thus (screenshots, highlights are mine):

Project Description - Sand Product Market Use	44	By using rail as your main transportation source, are you shipping the silica sand to be used in the oil industry outside of the province and/or country?	Email (1)	Sand will be shipped within Canada, the United States and internationally through ports on either ~~or both the east coast and west~~ coast of Canada. Although some of our sand may be sold to the oil and gas industry, it is of high enough silica purity that our target markets are other industries such as the medical glass industry, renewable energy industry (e.g., solar panel production), electronics (e.g. cell phones, computer chips) and telecommunications (e.g., fibre optics). Until such time that these target markets have operations in Manitoba, the sand will be shipped to established markets within Canada, the United States and internationally.

46	What percentage of your sand product will be sold to markets other than the oil sector?	Virtual Meeting (2)	We forecast that at least 60% of the sand product will be going to various industries outside of the oil and gas industry. Also see responses to #44 and #45 above.

However all mention of this significant and unsavory portion of the destination is meticulously avoided in the website, print and radio public ad campaigns: only the nice cell phones, solar panels and suchlike are touted.

Water quality

- Intact, unfractured shale is an effective aquitard. One of the greatest concerns with the present project proposal is the risk, indeed expectation, that with increases in the number of interconnecting boreholes, **the shale aquitard barrier** between the Carbonate and Sandstone aquifers **will be further compromised and mixing will inevitably occur**. According to the peer reviewers, "It is our opinion that interconnection will result from this project in some way shape or form" (AppB, FRIESEN-3). According to FD (2019), "A well connecting both aquifers in the east of the RM would result in carbonate groundwater mixing down into the sandstone aquifer."

  For the proposed project, "It is possible that project operations will result in increased hydraulic communication between the Red River Carbonate and the Winnipeg Sandstone within the Project Area due to fractures and borehole annuli that may extend across the Winnipeg Shale aquitard." (AppA1, p. 53). There is the potential of "Degradation of the Winnipeg Shale as a result of project operations resulting in mixing of groundwaters om [sic] the Winnipeg Sandstone and Red River Carbonate with possible impacts on groundwater quality in one or more of the aquifers." (AppA1, p. 79).

- Clause 6(1) of The Mines and Minerals Act (C.C.S.M. c. M162), Drilling Regulation, 1992 states "A licensee shall drill and abandon a borehole in such a manner as to prevent the vertical movement of fluids between permeable water bearing zones penetrated by the borehole."

Furthermore, the aquifers of the project area are specifically protected by provincial legislation, and interconnection and mixing involving the Winnipeg Formation is prohibited:

Under Section 3(1) of The Groundwater and Water Well Act (C.C.S.M. c.Gg110) Well Standards Regulation, "**a person must not construct or seal a well or test hole in a manner that allows the interconnection or mixing of groundwater between the Winnipeg Formation and any overlying aquifer.**"

Under Section 3(2): "In this section, **"Winnipeg Formation" means the shale, sandstone and sands of the Winnipeg Formation.**"

- While the overwhelming majority of existing Springfield wells are completed in the Carbonate aquifer (Table 1, 2016 data)(FD, 2019), and do not breach the aquitard, a number of mostly domestic wells already span both aquifers (AppA1, Figure 1-3). According to Betcher et al. (1995), "Most wells drilled into the Winnipeg Formation aquifer have been completed as open holes through the bedrock section, interconnecting the Winnipeg Formation aquifer with the overlying carbonate-evaporite unit. This has allowed a **continuous exchange of fluids of differing quality between the two aquifers**, resulting in substantial loss of groundwater from the Winnipeg Formation. This may eventually result in **significant water quality changes in the aquifer**." (Emphases are mine). In southeastern Manitoba, "these interconnecting boreholes have resulted in localized losses in the naturally softened groundwater from the Winnipeg Formation, and local water quality changes in the carbonate aquifer." (Betcher and Ferguson, 2003) (in AppA1, p. 66). Thus, although interconnecting wells are much fewer in number (1.2%) compared to the number of shallower Carbonate wells (77.4%)(Table 1), **existing interconnecting boreholes have already had measurable effects on water quality**. This is a compelling argument for not drilling any more.

Table 1. Aquifer completions of wells in Springfield (2016 data). Source: FD, 2019.

Groundwater Wells by Aquifer RM of Springfield		
Aquifer Type	**Number of Wells**	**Percent of Total**
All aquifers	6,080	100
Sand and gravel aquifers	282	4.6
Carbonate aquifer	4,707	77.4
Sandstone aquifer	66	1.2
Carbonate and Sandstone	215	3.5
Unknown or other	747	12.3
Dry Well/Insufficient supply	63	1.0

– Groundwater wells within the RM. (source – GWDRILL, 2016)

It should be noted that the Town of Anola draws its domestic water supply from the Sandstone aquifer (FD, 2019).

According to RMSF-IR-001, "Within the Project Site Area, an estimated 19 wells are completed in the Winnipeg Sandstone aquifer, with a further 62 wells completed in the Red River Carbonate aquifer. Five wells are completed in the overburden aquifer." Therefore comparatively few wells currently within the project area are interconnecting boreholes. Drilling many hundreds more in this area would be a drastic change.

- One of the concerns is the occurrence of saline water in *portions* of the Sandstone aquifer which could foul Carbonate water quality. In SSCR (#7), the proponent notes that "The referenced paper [i.e. Betcher et al., 1995] discusses the risk of upwelling saline water from within the saline portion of the Winnipeg Sandstone aquifer."

  A number of observations arise:

  1. According to the comprehensive Betcher et al. (1995) paper quoted above, wells in southeastern Manitoba drilled into the Sandstone aquifer are mostly "in the area of naturally "soft" groundwaters bordering the fresh water-saline water front." Sandstone waters behind the saline front are not desirable water supply sources.

  2. It is recognized in the reviewer's comment (SSCR #10) that "parts of the study area to the east [of Winnipeg] are affected with this physical problem", i.e. salinity in the Sandstone.

  In SSCR (#10), the proponent states that: "The overall low TDS (<500 mg/L) indicates groundwater in the Project Area is fresh and not brackish or saline because much of the water entrained in the rock at the time of deposition and diagenesis has since been flushed by more recent recharge.", and "Within the Project Site Area and for some distance west, groundwater quality is fresh in both aquifers and simulation of density effects for the purposes of impact assessment is therefore less important." (SSCR #28).

  In other words, we all agree that water quality in both aquifers in the project area is a **premium resource**, unlike other regions nearby**:** is it not all the more necessary to safeguard it?

  While the current limited project area may at this time be blessed with fresh water, saline waters in the Sandstone occur to the west and north of the area, not a great distance away (Figure 4). According to Ferguson et al. (2006), in the Winnipeg Formation "the flow system in parts of the area is not in a state of equilibrium and saline waters will encroach on areas currently occupied by freshwater in some areas, while in other areas, freshwater will replace saline water. These features must be considered in

groundwater resource management, as groundwater withdrawals will likely hasten these processes."

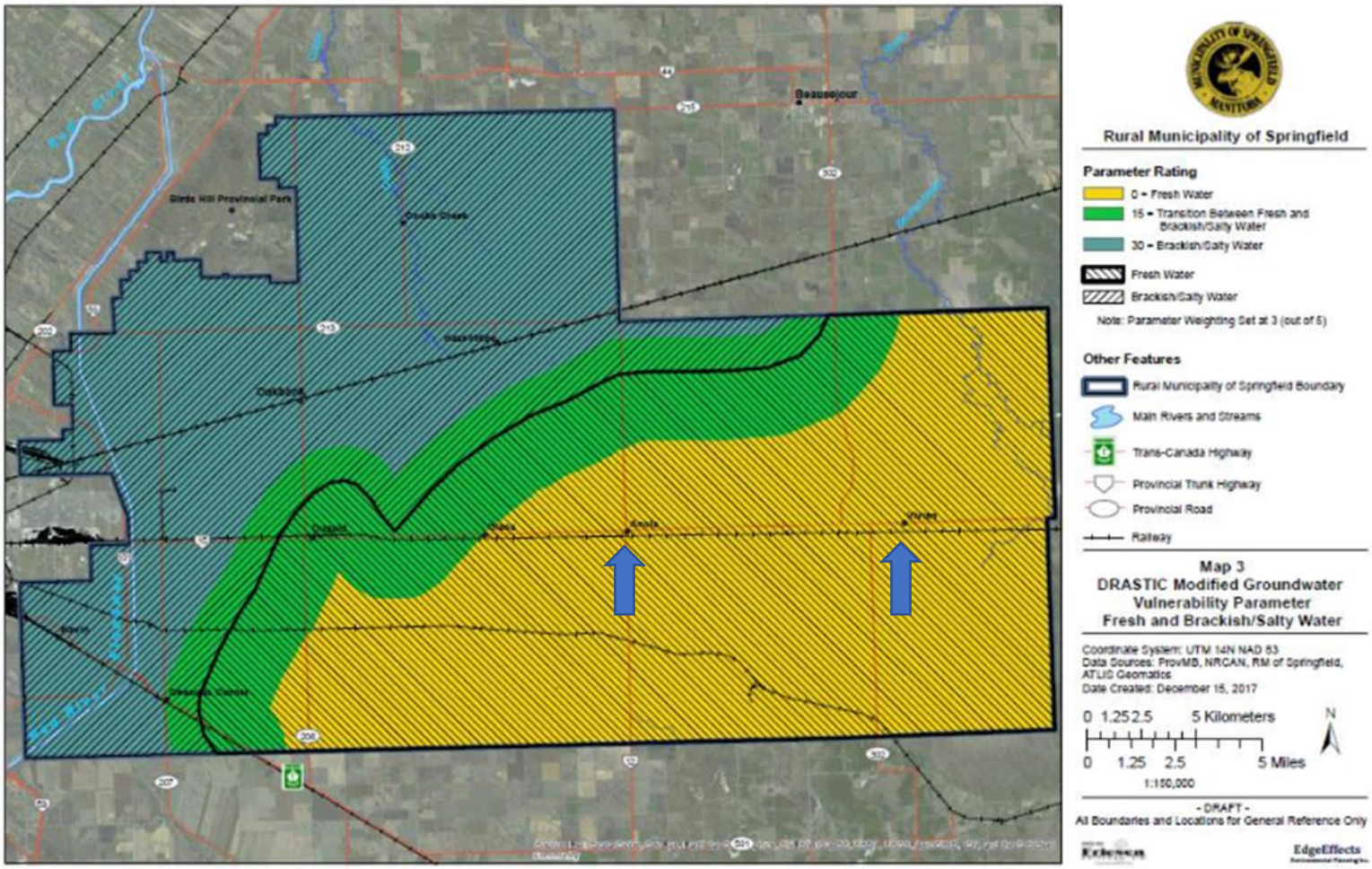


Figure 4. Map of saline and freshwater zones in the Winnipeg Sandstone aquifer in Springfield. Note the proximity of the transition zone to Anola and Vivian (arrows). Arrows are mine. Modified from FD (2019).

In SSCR (#31), the reviewer notes: "the model domain may not be large enough to account for large scale physical effects such as saline water intrusion or long-term sustainability". Given the large eventual scope of the impacted area (*at least* 85,000 ha (SSCRIR2 #MBEN-IR-036), surely a very robust and comprehensive data bank is required. How will disturbance of the Sandstone aquifer, alterations of hydraulic flow, and the planned future expansions of the proposed project, affect **potential incursion of saline water further to the east and south** of the current transition boundary?

It should also be noted that future operations are planned for large tracts in other municipalities (e.g. Figure 1, p. 29), where saline conditions will be encountered. This will present a major technical issue for future operations in those areas.

3. "The Groundwater Monitoring and Mitigation Plan will monitor groundwater quality with a view to tracking concentrations over time and **confirming** that water is not becoming more saline as a result of project operations, and **confirm** the findings of the Hydrogeology and Geochemistry Assessment Report." (SSCR #10) (Emphases are mine):

- The aim of the (apparently nonexistent) Plan is to *confirm* the proponent's assumptions, which are currently based on scant supporting data.
- Who will *independently* scrutinize the "tracking"? Will anybody outside the 'proprietary' circle be notified or aware?
- Tracking requires comparative baseline data, which must be obtained *before* start of operations.

"Analytical results will be regularly evaluated by a qualified professional to specifically determine whether there is evidence of saline water intrusion from areas of the aquifer that are presently brackish or saline. Should any changes be identified, mitigation measures will be implemented in accordance with a Trigger Action Response Plan (TARP)." (SSCRIR2 #CEC-IR-015).

- Where is this Trigger Action Response Plan?
- In the possible event that there ARE changes detected, how does the (nonexistent) Plan advance measures to **<u>reverse</u>** the changes, and **<u>restore</u>** prior water quality to the area? Or is the entirety of the Plan: walk away? Indeed, what else is even possible?

- In SSCRIR2 (#CEC-IR-012), the proponent asserts that "The aquifers both contain fresh water within the project area, which dramatically reduces any concerns over upwelling of saline water from the Winnipeg Sandstone aquifer into the Red River Carbonate aquifer".

  Water quality differs in the Red River Carbonate and the Winnipeg Sandstone aquifers, and local changes depend on direction of intrusion. Dr. Ferguson comments in AppB (#FERGUSON-8): "There is evidence of Pleistocene age water in Lake Agassiz sediments". According to Ferguson et al. (2006), "Large areas of the Winnipeg Formation still contain subglacial recharge", with "Relict glacial meltwater present in southeastern Manitoba aquifers."

In Springfield, southeast of the saline transition zone, the water is generally softer (less calcium and magnesium) and concentrations of many (not all) chemical parameters are lower in the Winnipeg Sandstone (Table 2)(FD, 2019). However the latter may be more saline, with higher sodium, potassium and chloride levels as the transition boundary (Figure 4) is approached and crossed. In EAP Figure 4-6 (AppA2), higher overall total dissolved solids are seen in the (limited) Sandstone samples compared to the Carbonate, but it is unfortunate that **no statistical comparison tests** (e.g. unpaired t-tests, or nonparametric tests, depending on eligibility) were done for any of the water chemistry data. It is difficult to draw conclusions since so few data were obtained, and corrupted samples should not be included (see p. 285+).

Despite these aquifer differences, the proponent claims that "even if there were migration of groundwater between aquifers through unsealed boreholes in the Project Area, it would not degrade water quality." (RPCR, #61). In SSCR (#32), we are assured that "groundwater quality in the Project Site area is relatively consistent". Since water quality studies have apparently not been carried out in the project area, where is the evidence for these statements?

- A number of wells in WDR show **multiple layers of shale** in the Sandstone. There appear to be no studies comparing water chemistry among the strata delineated by these mini-aquitards. Are there differences? **Are some more saline than others?** These data are important, in order to ascertain whether *these* interconnections could impact water quality in these areas.

  "Geochemical equilibration modelling to simulate the result of mixing indicates that changes will be minimal" (SSCRIR2 #CEC-IR-012). Did the modelling take into account the known potential presence of multiple shale layers?

- With respect to the potential confounding factors of existing interconnecting wells in the groundwater model, the proponent notes: "a complete assessment of each private well and the potential for cross-connection of the Red River Carbonate and Winnipeg Sandstone aquifers was not explicitly assessed. While the magnitude of the inter-aquifer flux is moderate and demonstrates that the aquifers are presently interconnected in several locations, the magnitude is relatively small in the context of the overall water balance of the aquifers." (SSCR #31),

  - While "each private well" could not be assessed, how many, and which, of the wells listed in AppG(AppA6) were investigated? What does "a complete assessment….was not explicitly assessed" mean? Were none of them assessed?

- "the magnitude is relatively small": how small? Existing interconnecting wells are indeed not numerous at the present time, especially in relation to thousands more planned. What is the potential then, even if, say, only 10% of them become problems? They are also larger bores than the private wells.

- Dr. Ferguson in his review (AppB #FERGUSON-1) notes: "there might be wells in the area that do not appear on the Province of Manitoba database. This could include improperly abandoned wells that connect the Winnipeg Formation with the overlying Red River formations. This could introduce some uncertainty into the results of the model."

  The proponent responds: "AECOM agrees that the possible presence of additional water wells presents some uncertainty in the modelling results and wells that **may require mitigation during operations**….it will **be important to identify all wells (active and abandoned)** within the zone of influence of sand extraction activities to allow for effective monitoring and **mitigation**….To supplement a physical survey of the land for water wells, a comprehensive monitoring plan is proposed to aid in this by **indirectly determining the presence and overall magnitude of cross-connecting wells based on the observed water level response** in each aquifer." (Emphases are mine).

  - How exactly will *all* wells be identified? Many old abandoned wells are no longer evident at the surface (personal observation), others, active or not, might be inside residences or farm buildings. Currently, much reliance is placed on the public to report abandoned wells for sealing to the province or local water conservation districts, but obviously unknown numbers remain unidentified. Basing deductions on "observed water level response" is also difficult because of the many confounding factors of joints, fractures, channeling, etc. (see p. 78+).

  - What is the monitoring plan?
  - **What is the mitigation being proposed?**
  - Should not mitigation be considered *before* operations, rather than *after*, when the undesirable is already observable, and we are in the position of: now what?

  In AppB (#FERGUSON-6), "It is acknowledged that there may be additional wells that are not included in the database. These wells will be identified in advance of operations to the best of CanWhite's ability as described in a **forthcoming** Groundwater Monitoring and Impact Mitigation Plan as described in Section 7.5 of the report……Contingency measures for ensuring water supply to well users is maintained [and] will be described in detail in the Groundwater Monitoring and Impact Mitigation Plan." (Emphasis is mine).

  - There is no section 7.5 in EAP2.
  - However section 8.4 Groundwater Monitoring and Impact Mitigation Plan (EAP2) is a page of "This document will establish a framework" (EAP2, p. 96) ideas, with no

concrete details other than the areas which this future document might or might not address. The draft document submitted very late (see pp. 527+) is little better.

- Not only does water chemistry differ between the Carbonate and Sandstone (*sensu lato*) aquifers, and possibly within multiple shale demarcated subunits of the latter, but it can also **differ vertically within strata of the Carbonate aquifer,** which is interpreted as typical for fractured bedrock (https://www.gov.mb.ca/sd/eal/registries/6154/eap.pdf, Appendix E). Such vertical variations at the same location within the same aquifer must be taken into account, because **water chemistry is not homogeneous throughout**. This has implications for borehole penetrations, as well as for water quality monitoring: results may differ according to the depth where the samples are taken.

- Nitrate, a contaminant of public health concern, is not included in Table 2. Pip (unpublished data) has found that nitrate levels in Springfield Carbonate wells vary greatly, depending on local contamination sources and hydrological flow patterns, ranging from below detectable concentrations (<0.01 mg/L) to 12.5 mg/L as NO_3-N, i.e. in excess of the Canadian drinking water guideline of 10 mg/L NO_3-N in some intensive livestock production areas). In Table 4-8 (AppA4), nitrate levels were generally below detection limits, except for BRU 95-9 from Winnipeg Shale, where the sample dated 2021-Feb-0 [sic] showed clear evidence of contamination, compared to the pre- and post-test samples from the same well collected on November 2 and December 2, which were below detection limits. These three samples from the same well also showed unaccountable variations for a number of other parameters: the EAP provided no comment. This well should be resampled.

- It must be pointed out that the best water quality (i.e. lower dissolved parameter values) is found in the eastern portion of the RM (FD, 2019; Pip, unpublished data), which is also unfortunately the target area for the proposed project. Indeed, **some waters in that region compare favorably with commercial bottled waters** (Pip, 2000), **and should be protected as a valuable future resource**.

Table 2. Summary of ranges of water chemistry parameters in the Carbonate and Sandstone aquifers in the RM of Springfield. The lower values are found in the eastern reaches of the RM. Source: FD, 2019

Comparison of Carbonate and Sandstone Aquifers in the RM		
Parameter	**Carbonate Aquifer**	**Sandstone Aquifer**
Calcium (Ca)	1.5-220 mg/L	6.7-46 mg/L
Magnesium (Mg)	7.3-220 mg/L	1.8-24 mg/L
Sodium (Na)	2.5-210 mg/L	65-380 mg/L
Potassium (K)	1.1-12 mg/L	7.2-14 mg/L
Carbonate (CO_3)	< 0.5 mg/L	<0.5 mg/L
Bicarbonate (HCO_3)	200-680 mg/L	310-380 mg/L
Chloride (Cl)	0.87-12 mg/L	12-310 mg/L
Sulphate (SO_4)	5.8-970 mg/L	1.8-150 mg/L
Total Dissolved Solids (TDS)	240-1,800 mg/L	270 - >2,000 mg/L

- Besides the concerns presented by aquifer interconnections, there is the potential of the thousands of new proposed boreholes to facilitate the downward migration of pollutants from their surface origins, and thus into both aquifers. According to Cherry et al. (2004), "Aquitards are critical to protecting water supply wells from contamination". Concerns with this project are further augmented by the large diameter (20.3- 40.6 cm (EAP1, p. iv)) of the boreholes.

  In the original EAP1 (p.13), "CanWhite anticipates extracting sand as a sand and water slurry from up to 467 extraction wells per year at an approximate depth of 61 m (200ft) in Winnipeg Sandstone aquifer. Operations will start out with lower numbers of wells (up to 392 extraction wells), with the number of extraction wells gradually increasing over the first few years of operations." or "an **initial** average of 56 well clusters of seven extraction wells per cluster, annually" (EAP1, p. iv). However quoting from the later (2022) SUPPL1 (p. 1), "Sio Silica has reduced the total number of wells required per year from 467 to 324 (a 30% reduction)". The projected lifespan is 24 years.

  There is uncertainty regarding the total eventual number of wells. According to the reviewer in HGTR (p. 13), "the proponent refers to 1680 wells over a four 4-year [sic] horizon but there is no mention of the total number of wells over the entire 24-year planning horizon which could total more than 10,000 wells." In any case, the expected

number amounts to **many thousands of invasive penetrations of <u>both aquifers</u>**. There will also be additional wells that, for various reasons, will be unusable or unintended for extraction purposes.

- Clause 3(1) of the Manitoba Groundwater and Water Well Act (C.C.S.M. c. G110) states: "a person must not construct or seal a well or test hole in a manner that allows the interconnection or mixing of groundwater between the Winnipeg Formation and any overlying aquifer."

  According to the proponent, "When each well is drilled, casing will be installed and grouted in place to isolate the Red River Carbonate and Winnipeg Sandstone aquifers from one another and thereby preventing vertical mixing of waters." (EAP1, p. vii). "After sand extraction is complete at a well, the extraction piping is removed. The well is then sealed in accordance with The Groundwater and Water Well Act using a grout plug with layers mimicking that of the formation using materials such as pea gravel, native material and/or bentonite on top to prevent any vertical movement between aquifers." (EAP1, p. 20).

  This does not eliminate the potential for intrusion during drilling and casing manipulation, imperfect sealing, carelessness or accidents, more so given the thousands of wells involved. It is almost certain that a number of them will be flawed, and even more certainly over time the integrity of some/many of the casings and seals will be compromised or degraded. Some wells already drilled have no casings remaining but were otherwise sealed on decommissioning (WDR).

- The regional project area contains a number of surface watercourses including the Brokenhead River and Fish Creek (AppA1, Figure 1-3), which are likely to be impacted over the 24 year duration of the project. The Brokenhead River is a watercourse of particular and unique ecological importance, and indeed is highlighted with a nice picture in SIO advertising material (SIO, p. 19).

- Water quality and contaminants in the Sandstone aquifer present **potential impacts beyond the Municipality of Springfield**. According to Wang et al. (2008), "Discharge from the highly confined sandstone aquifer is likely by slow seepage through the upper confining layer near or beneath Lake of Winnipeg. [Sic]" In addition, surface drainage from the eastern portion of the project area discharges to the Brokenhead River, which also subsequently flows to Lake Winnipeg. Surface water from other portions of the project area eventually drain to the Red River (EAP2, p. 37).

- It must be borne in mind that the current proposal is but a piece of a much larger and more extensive future plan. "This Environment Act application fully addresses the first 4 to 5 years of extraction. Any change in potential environmental impact that could result from relocating operations in subsequent years will be addressed through the Notice of Alteration process set out in section 14 of

Act, and as described in the regulatory framework section of the EAP (Section 1.7). Each future Notice of Alteration for proposed extraction activities beyond 2025 will project a block of proposed annual extraction areas, describe in detail the existing environment in that block and include a thorough environmental assessment using monitoring data collected during extraction operations and the follow-up activities proposed in the EAP (Section 8)." (RPCR #63, #73, #185, #213, #220, #280).

Therefore **the current initial proposal is a bellwether**: its approval must be exceptionally carefully considered, as it will open the door for a sequence of future iterations that are planned to expand into additional regions and potential additional municipalities, with the concomitant multiplicity of impacts and concerns that may ensue.

In their full-page ad in The Clipper (February 22, 2022, p. 5), the proponents boast that their project will affect **generations**, with their "multi-generational job creation" and "multi-generational planning". Therefore this is not just a transitory and ephemeral undertaking, but one that will impact significant numbers of Manitobans for a long time. In the January 5, 2023 ad in The Clipper (p. 2), the company is "sharing the impacts and benefits Sio Silica will have on your life and on future generations." Yes, these impacts will certainly persist for us, but we can't help asking, how much of the profits will remain to benefit Manitoba?

Boreholes and wells

- Some boreholes have already been drilled and extraction has occurred under the latitude of Mineral Exploration. According to AppA1 (p. 58) "CanWhite drilled over 40 boreholes between 2017 and 2020". Drilling records can be found in WDR. Injection has also occurred. Permits for injection wells are: Permits #IW-2019.02.1 HD Minerals; #IW-2019.01.1 HD Minerals; #IW-2020.01.1 HD Minerals; #2021.01.1 CanWhite Sands Corp.

  The estimated ≈ 7800 well number (from new amendment in SUPPL1, p.1) presumably relates only to producing wells, i.e. non-producing boreholes, and abandoned "duds" are not included. Some wells already drilled are described in WDR as "for monitoring purposes", some boreholes caved in after drilling (e.g. Well PID 197869, 197923)(WDR), while yet others turned out to be associated with flowing conditions (e.g. Well PID 200824, 200861). These non-producing **extra wells** will also pose potential environmental risks.

  "CanWhite Sands Corp. ('CanWhite') is proposing to extract high purity silica sand from the Winnipeg Sandstone aquifer (approximately 61 m, or 200 ft below ground)" (EAP1, p. 1), or "an approximate depth of 51 m to 76 m" (AppA1, p. 19). Some test wells already drilled have been in excess of 300 feet, or more than 90 m (e.g. Well

PID 197860)(WDR). The environmental impacts of such exceptionally deep boreholes have not been studied.

- Each of the thousands of invasive penetrations will present the risk for movement of surface contaminants to the groundwater strata below (Figure 25, p. 122). It is important to place this number of penetrations in the context that:

  a) they will all involve drilling through **both aquifer strata**
  b) they will be in addition to existing water wells that penetrate both strata, which are already associated with documented adverse effects (Betcher and Ferguson, 2003)
  c) **they will <u>substantially</u> outnumber existing wells**.

  According to Cherry et al. (2004), it is of paramount importance to "**prevent well designs that cross connect or breech aquitards**" because of "**vulnerability to contamination**". **Therefore indiscriminate drilling into the Sandstone aquifer will aggravate already existing issues, and create new ones.**

  A report on groundwater status commissioned by Springfield (FD, 2019) unequivocably recommends that *<u>existing</u> interconnecting wells be decommissioned*: "The following specific recommendations are provided for the RM of Springfield: **Wells that interconnect both the sandstone and carbonate aquifers should be targeted for proper sealing and abandonment.**" (Emphasis is mine). In other words, the number of existing interconnecting wells should be abated.

  The drilling of vast numbers of new interconnecting wells outlined by the present proposal is entirely contrary to this recommendation, as is the drilling work that has already been carried out.

- Localized **perched water tables** (Figure 5) have received almost no attention in the EAP. Clay layers of variable extent and thickness occur erratically at various stratigraphic levels in the overburden (Figures 6 and 7), and may function as **aquicludes**. The well logs in WDR for wells already drilled demonstrate the occurrence of clay in several instances at inconsistent depths above the limestone; indeed, there may be several clay layers, for example Well PID 200824 (screenshot below)(Markers are mine):

WELL LOG (Imperial units)

From	To(ft.)	Log
0.0	2	ORGANICS
2.0	10	BROWN SAND
10.0	22	GREY CLAY
22.0	64	GREY SAND
64.0	74	GREY CLAY
74.0	90	GREY SAND
90.0	110	GREY CLAY
110.0	131	GREY TILL
131.0	140	GREY TILL
140.0	176	LIMESTONE
176.0	199	RED/ GREEN SHALE
199.0	239	SANDSTONE

Note that **each of these above layers** is of more than ample thickness to meet impermeability criteria (if intact), and restrict vertical water flow. For comparison, the requirement for a compacted clay liner for earthen liquid manure storage lagoons in Manitoba is only 1 meter (https://www.gov.mb.ca/sd/ece/programs/pdf/clay_liner_feb-2007.pdf).

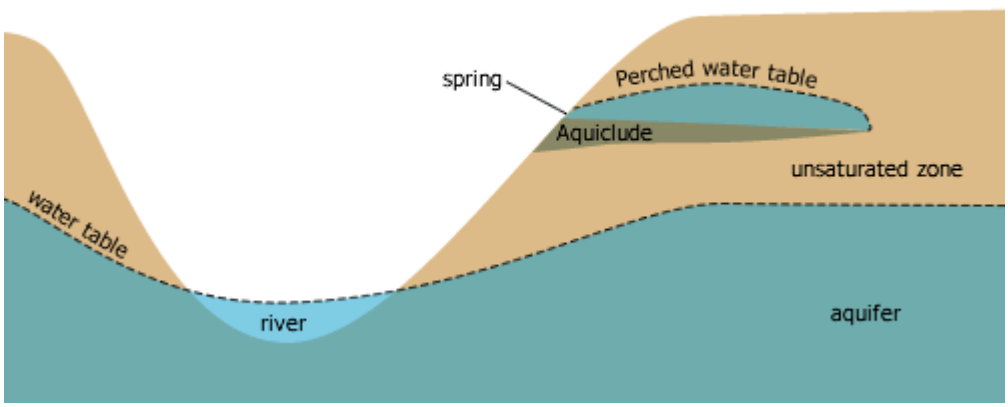


Figure 5. Schematic diagram of perched water table, showing typical mounding. Source: https://i.pinimg.com/originals/5b/5e/5c/5b5e5c4e51c15df46cf04a8562dfe1df.gif

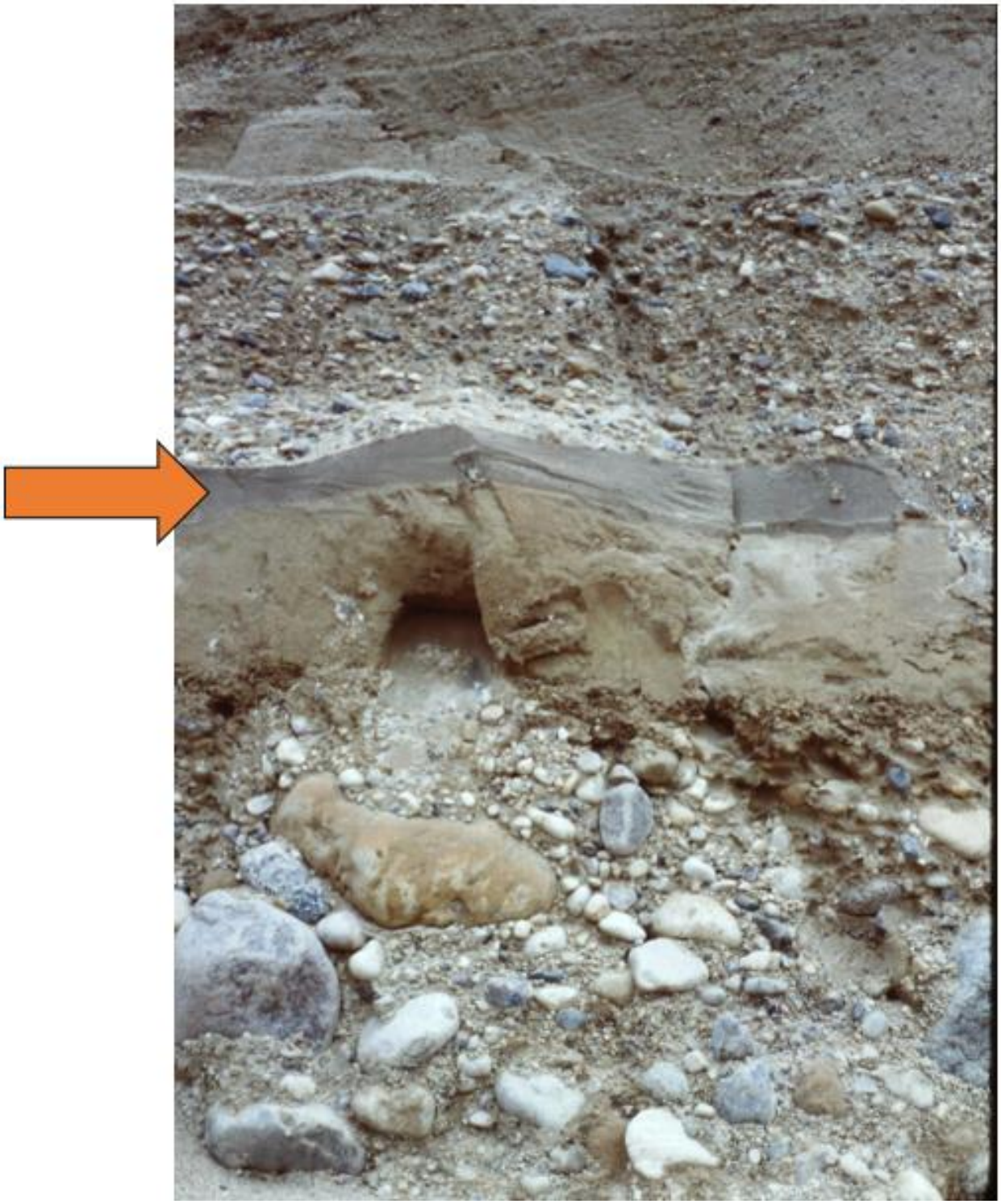


Photo: E. Pip

Figure 6. Overburden cross section showing interbedded grey clay layer (arrow) in a Springfield gravel pit. Note extreme variability in size of the materials (i.e. poorly sorted) in some strata, ranging from boulders to fine clay.

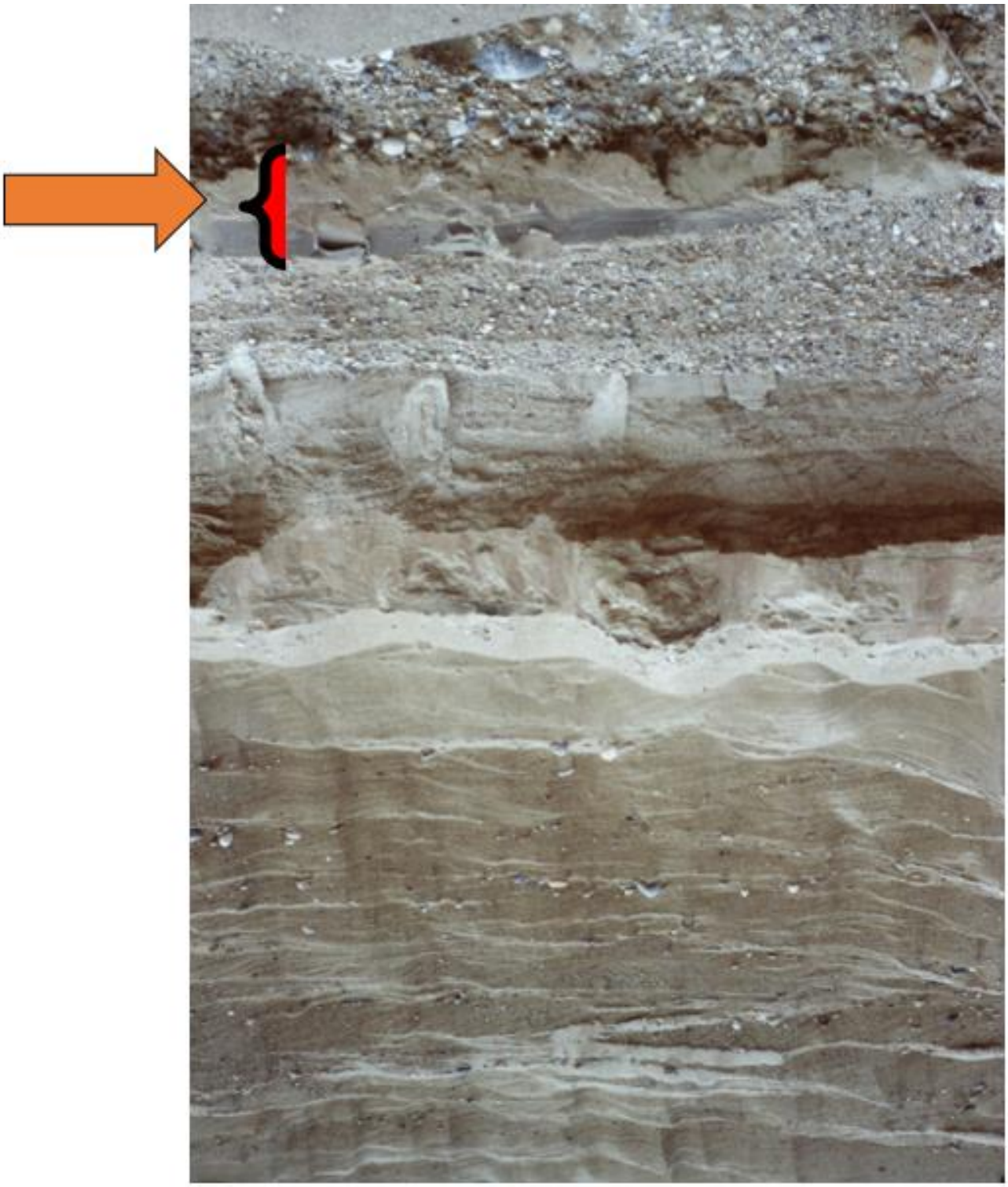
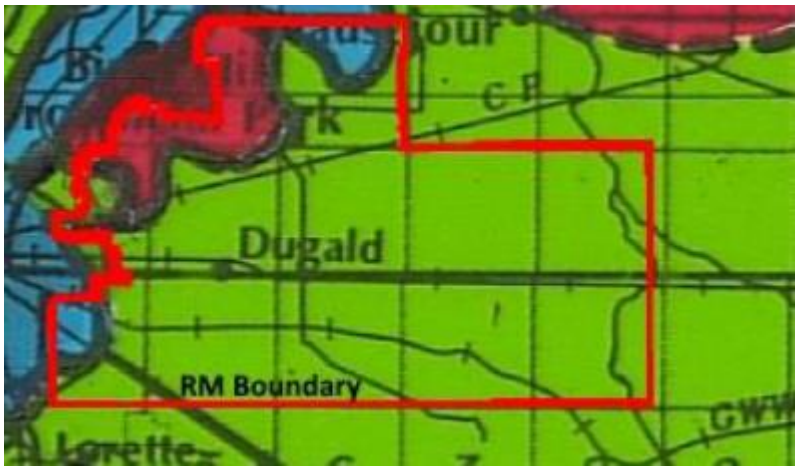


Photo: E. Pip

Figure 7. Overburden cross section showing clay stratum (arrow) comprised of two distinct (mainly in iron content) contiguous layers (brown and grey) in a Springfield gravel pit. The fan shaped blowouts in the sand strata below are points of preferred vertical water percolation.

Table 1 (above) identifies a number of wells in “sand and gravel aquifers” (i.e. within overburden) in Springfield. The size of these mini-aquifers or “lenses” is highly variable (FD, 2019), as is their water quality. Surficial deposits where these lenses can occur are present throughout Springfield and areas to the east and south (Figure 8). It is important to be aware of the occurrence of these lenses in the project area, and to avoid them, because **they may introduce an additional potential source of intermixing**.

In AppG(AppA6) numerous “regional” shallow wells are listed that draw from the Quaternary sediments; some are only a few meters deep. The proponent notes that “Five wells are completed in the overburden aquifer” within the project area itself (RMSF-IR-001), thus there is no doubt regarding the need to identify and avoid these areas.



LENSES OF SAND AND GRAVEL: the aquifers occur in till and other surficial deposits; depth to the aquifers ranges from a few to more than 100 m; the size of the aquifers varies over a wide range - they can be from less than a hectare to several square kilometres in area; in some areas the aquifers are very common and in others they are scarce. Well yield ranges from less than 0.1 L/s to more than 10 L/s; water quality ranges from very poor to excellent.

Figure 8. Potential occurrence of water-bearing lenses in Springfield (indicated in green). Extracted from FD (2019).

Percolating contaminants may accumulate in the clay ‘saucers’, and are released when the aquiclude is punctured, in this case with multiple holes for one or more extraction well clusters. Note that existing “sand and gravel” wells terminate in the lenses and do not pierce the aquiclude. Interconnections of such isolated pools with the major aquifers beneath present potential concerns for the reasons that:

1. The lenses are relatively closer to the surface, and are more readily contaminated.

2. Their water chemistry is different, variable, and respectively unique, and unlike that of either the Carbonate or Sandstone aquifers (Pip, unpublished data).

3. The clay aquicludes provide local protection for the aquifers below by intercepting and detaining pollutants.

4. Domestic wells which draw from a perched pocket may become permanently compromised if the aquiclude is damaged.

5. Even if the casings are adequately sealed, their integrity is not eternal: they will eventually corrode and degrade, and seals may fail.

The EAP sidesteps these issues.

- In some cases, clay layers will be needlessly punctured with no Sandstone layer available to exploit in the end, a wasted borehole, for example Well PID 199971 (WDR)(screenshot):

WELL LOG (Imperial units)

From	To(ft.)	Log
0.0	28	FINE SAND
28.0	61	GREY CLAY
61.0	102	GREY SANDY TILL
102.0	121	GREY CLAY
121.0	218	GREY SANDY TILL
218.0	295	GREY SANDY TILL WITH CLAY LAYERS
0.0	295	BLUE SHALE

Note that there is no limestone either, only till.

- Not acknowledged in the EAP is the common occurrence of **organic soils** in the project area. Of the 42 wells documented in WDR, well logs report organic strata (not further characterized) at the top of the core (Well PID 200818,203688,203699,199976, 200824, 199978, 199984,199881, 199979, 201054, 199968, 200861; another case is 205642 in additional wells in Well%20Information%20ReportsQuarriesNearVivian%20(2).pdf). An additional five wells in WDR reported **1.5 – 2.5 m of peat moss** (Well PID 201401, 201400, 201399, 201159, 201398).

This is a disturbing concern because:

1. Peat moss is associated with saturated **dystrophic** surface conditions, where the water contains high loadings of diverse refractory and non-refractory organic compounds. The water is also **acidic** due to cation exchange by *Sphagnum* moss (Clymo, 1963), and other biological activities, with a typical pH range of 3.3 – 4.5 (Clymo, 1964).

2. Boreholes will facilitate direct contamination of aquifers with particulate and dissolved organic matter, microorganisms, and will introduce acid water.

3. Highly acidic water will aggravate other potential acidification issues in the aquifer, for example carbonate leaching and pyrite oxidation (see p. 274+).

4. Organic matter provides substrates for bacterial and fungal growth, and results in carcinogenic byproducts in the event this water is treated at some point by chlorination (see p. 329+).

5. Dissolved organic carbon is already present in the aquifers, according to Table 4-8 (AppA4), in some cases in significant amounts, demonstrating existing pollution, from sources such as septic fields and livestock production. Intrusion of organic-rich water would add to these levels.

These are highly unsuitable conditions for boreholes, and it is unfortunate that a number of them have already been drilled.

- "Drainage ditching will be constructed along Project access trails and at disturbed areas, as required, to assist in directing runoff flow from rain and snow and maintaining natural drainage pathways through low areas" (section 6.4.1, EAP2) (see p.).

  As pointed out above, there are swampy/boggy areas in the project zone. The EAP (section 4.3.1, EAP2, p. 37) minimizes/dismisses consideration of any surface water within the project area, although it admits "ditches and low drainage areas" are present.

  RPCR (#168) states: "There are no plans to install wells in swampy areas." How are "swampy areas" defined? Furthermore, if there are no plans for such wells, why have numerous wells with logs reporting significant peat moss accumulations (WDR, see above) already been drilled? Peat moss is easy to spot, without digging or elaborate fancy reconnoitering.

  Is there the same assurance for areas which may be subject to overland flooding in spring or in wet seasons?

- "Water well rigs that are the typical size used to install domestic water wells will be used to install the sand extraction wells." (EAP1, p. 14).

  This is misdirection: *of course* the **rigs** may be standard, but **the holes will be much larger**, with diameters of **20.3 - 40.6 cm** (EAP1, pp. iv, 1). Specifically, "Each well is anticipated to be 16" diameter through the Quaternary Sediments, 10" diameter

through the Red River Carbonate and Winnipeg Shale, and 7" diameter within the Winnipeg Sandstone (production casing)" (AppA1, p. 23).

The largest bore is a third greater than the 30 cm (12 in) size of many town water supply wells (e.g. Beausejour). "The Anola water supply receives groundwater from a single 8 inch [20 cm] diameter well completed into the sandstone aquifer" (FD, 2019). All three bores for the proposed project are larger than typical domestic wells, for which the Canadian standard is 15 cm (6 in), although many wells in Manitoba are smaller: for example my own Red River Carbonate well, drilled in 1979, is 10 cm (4 in). **The potential for contamination and future issues is proportionately increased with larger bores.**

However the proponent responds: "The Project utilizes standard diameter well pipe available to all well drilling contractors. Well dimensions are of similar size to wells used to source water for **larger use community and industrial supply**." (RPCR #176)(Emphasis is mine).

Therefore these project well boreholes will be the staggering size equivalents of thousands of "larger use community and industrial supply" wells, crammed into the limited operational area: "Regional Project Area – is comprised of an area up to 10 km beyond the Project Site which is intended to account for the maximum spatial extent of potential effects of the Project" (EAP1, p. 29)**.** And of course, there are the future additional aspirations to consider (see Figure 1).

- According to Wang et al. (2008), "vertical recharge from overburden material" of the *Sandstone* aquifer is becoming an increasingly important component of the total recharge, and as demand on the aquifer grows, "vertical recharge will play a bigger role". Therefore **vertical movement of associated contaminants from upper strata will become more significant over time.** This emphasizes the importance of minimizing potential opportunities for contaminant sources and transport, and restricting activities and development which may present risk.

  The proponent claims that "The potential for contamination from surface to reach the Winnipeg Sandstone aquifer would remain **very low due to the presence of relatively low permeability overburden** materials from ground surface to a depth of approximately 25 m, and the presence of a much more permeable aquifer overlying the Winnipeg Shale aquitard, which will act to convey any contaminants laterally rather than vertically downward toward the sandstone at a depth of approximately 75m below ground surface." (SSCRIR2 #CEC-IR-012)(Emphasis is mine).

  Thus, although the virtues of protective overburden are hailed, "**Most** sites that have been selected for Project activities are on previously disturbed sites such as gravel quarries or open fields." (TAC #25)(Emphasis is mine). The protection of overburden has been removed or diminished in gravel quarries, and the water table may be exposed in the pit ponds. "The degree of aquifer vulnerability is dependant [sic] largely upon the thickness and properties of material overlying the aquifer and the properties of the

pollutant.", and "Aquifers that are exposed at or near to the surface have an increased vulnerability to quality degradation from surface activities." (FD, 2019). These sites are at the greatest risk of direct contamination, and the permeable nature of the aggregate matrix facilitates pollutant travel to surrounding wells, which attract contaminant plumes (Figure 25, p. 122). Open fields, on the other hand, are at great future risk when the abandoned decommissioned boreholes/casings provide eventual conduits for manure, chemical fertilizers and pesticides.

- While sand extraction will occur primarily in April to November, well drilling will occur year-round (EAP1, pp. 2, 11, 14). Therefore extraction will in many cases not commence immediately on drilling. In SUPPL1 (p. 3), "Wells that are capped and not active resemble a domestic water well with 1-3 ft of white PVC casing coming from the ground and a locked cap on top."

  In RPCR (#169) we further learn that: "Well casings will be secured (capped and locked) at all times when no active work is occurring at the well. All wells will be installed with a lockable cap and will be identified with a tag and flagging to mark their locations to prevent accidental damage from vehicles. Caps will be secured so that only authorized personnel will have access to them."

  In the interim, the protruding plastic casings seem vulnerable to vandalism or damage (e.g. farm machinery, recreational and other vehicles, etc.); caps and a "tag and flagging" will apparently provide the only protection. There will be no bollards, barriers, warning signs or enclosures. Will the inactive sites be monitored for casing damage and condition? What remedial procedures will be in place in the event casings are breached or destroyed? How will possible contamination be assessed, and what, if anything, will be done about it?

  There is no mention of mounding: will the casings be mounded to safeguard them from spring runoff or storm flooding? Wells drilled in winter may experience spring overland flooding (e.g. Figure 9), especially in fields and "low drainage areas" (section 4.3.1, EAP2, p. 37). Locations which did not flood in previous years may flood in others.

Photo: E. Plp

Figure 9. Incursion of contaminated spring meltwater onto recently winter-installed (2020) wellhead (in foreground) for Beausejour town water supply. When dry, the ditch is a popular town dog nuisance ground; in summer, manure is applied to the field (see Figures 87 and 88, pp. 341-342). (Item to the right of wellhead is a discarded beer can).

- According to the proponent, "PVC is preferred at this time for ease of handling, and cost. PVC casing also will not rust." (SSCRIR2 #DLN-IR-002). How will soil expansion and contraction associated with freeze-thaw cycles affect the upper embedded portions of the PVC casings? And how will the protruding and exposed portions fare in prolonged freezing conditions (Figure 10)?

Because CPVC pipe is brittle, it will crack if it endures freezing temperatures for too long.

Figure 10. CPVC pipe cracking due to brittleness at prolonged freezing temperatures. Source: https://www.1tomplumber.com/best-pipes-freezing-conditions/. Note: CPVC pipe (shown here) is more robust and durable than the planned PVC (https://www.astralpipes.com/blog/know-the-major-differences-between-cpvc-pipes-and-pvc-pipes-27).

- Section 20(1) of The Groundwater and Water Well Act (C.C.S.M. c.Gg110) Well Standards Regulation mandates a minimum casing stick-up: "a person constructing a well must ensure that the well casing extends not less than 30 cm (1 ft) above any finished surface or the established ground surface when the well is completed."

  Furthermore, according to section 20(2), the **landowner** is responsible: "After the completion of construction, **the owner of the land on which the well is located** is responsible for ensuring that the requirements of subsection (1) remain satisfied." (Emphasis is mine). This presents an awkward enforcement situation, since the well does not belong to the landowner. It seems that it is time to freshen up the legislation.

Extraction process

- The schematic in Figure 2-2 (EAP1), also Figure 2-A (AppA1) showing the components and configuration of the sand well apparatus has the disclaimer "Example Only". Therefore the actual situation will possibly be "not as shown". The real design is not disclosed in the EAP: "The design is proprietary to CanWhite (patent pending)" (RPCR #165). In SSCRIR2 (#DLN-IR-001), the proponent indicates "the method has been patented by Sio", indicating the patent is granted; however the relevant site does not show that the patent is issued (https://www.ic.gc.ca/opiccipo/cpd/eng/patent/3080017/summary.html?query=CanWhite+sands+corp&type=basic_search).

Air lifting has already been conducted at a number of wells (WDR; also Permits #IW-2019.02.1 HD Minerals; #IW-2019.01.1 HD Minerals; #IW-2020.01.1 HD Minerals; #2021.01.1 CanWhite Sands Corp). The proponent declares: "Mining out" of the aquifer is not permitted until an Environment Act Licence (EAL) is issued. In the absence of an EAL, no mining activity has occurred to date." (SSCR #15; SSCRIR1 #MBEN/OLS-IR-021). Thus we learn that the sand piles in Figure 11 and other places were not mining activity.

Photo used with permission (OLS)

Figure 11. Not mined, not covered silica sand piles extracted from a sand well in Springfield.

From the information solely in the EAP, no evaluation is possible either of the design or of the risk posed from air escaping into the surrounding aquifer from the apparatus. We learn in RPCR (#165) that the process is "much like blowing bubbles in a cup of water."

However, design of the air lift apparatus that will presumably be (and likely has been) used is found in the Patent Application (CPA), which latter is not included or referenced in the EAP documentation, but has been provided in SUPPL1. In RPCR (#24, also RPCR #153), "CanWhite's drilling and extraction method utilizes an air lift method that is routinely used in water well drilling throughout the world, including in Manitoba and the local area where thousands of these wells have historically been drilled." Why, then, is

there a patent application by the proponent for this method, if it is already "routinely used in water well drilling throughout the world"?

Perhaps an attempt at a partial answer is given in RPCR (#153): "The design is proprietary to CanWhite (patent pending), but a diagram of the extraction method and description is provided in the EAP Section 2.2.1 and Figure 2-2. While the exact activity of extracting sand from the ground through a water well drill hole using an airlift method does not exist anywhere else that CanWhite is aware of, the use of airlift drilling methods is a common practice and can be applied to extract sand."

It is a "method that is routinely used", and "is a common practice", but at the same time the "method does not exist anywhere else" (see also p. 472). While the *purpose* of lifting water AND sand is touted as a difference from its application in plain water wells, air lift is already used to clean out sand, debris and drilling fluids in the course of developing drilled water wells, although the duration of the procedure is much shorter. The absence of a well screen is another distinction: "The key difference is that normally once a water well is drilled a screen is installed in the sandstone to prevent sand from entering the well." (RPCR #153).

Indeed, in SSCRIR2 (#MSSAC-IR-016(a)), the proponent uses the commonness of these procedures as an excuse to evade environmental assessment of them: "Both air lifting and rotary drilling are, individually, relatively common practices, and these methodologies have been subject to prior environmental assessment on other projects". But, the process is "unique in that it combines the air lifting and dual rotary drilling methodologies". So is it unique or common? If we combine two common things, does the combination become rare? The conundrum can be compared to viewing Escher's famous endless stairs……we get a headache and never decide in the end.

- "Since April of 2019, many successful tests have occurred demonstrating the feasibility and repeatability of the method. The results and data collected have been thoroughly studied by engineers, scientists, geotechnical engineers and hydrogeologists. Additional studies have been conducted and results modeled and analyzed: (geotechnical report [Stantec 2022]; and Hydrogeology and Geochemistry Assessment Report [EAP, Appendix]). Thus, the extraction method is well understood and has been successfully demonstrated." (RPCR #153, also #158).

  - The "many successful tests" have presumably occurred under the umbrella of the few exploration and injection well permits (but not all exploration wells were air-lifted (WDR)).
  - Since there seems to be so much of "results and data", and so many people have allegedly seen and admired them, why are these findings, or at least a statistical summary, excluded from the EAP?
  - Where are all of these studies, and the evaluations by the crowd of "engineers, scientists, geotechnical engineers and hydrogeologists?

- Where is the Stantec 2022 report? It has not been posted on the Registry site.

- The EAP omits mention of the '**pulsed pressurized air bursts**' that are described in the patent application (CPA), the purpose of which is to loosen the sand. The GTTR similarly does not refer to this aspect of the intended air lift process. Since this feature is included in CPA, presumably it has been tested: was this done at the injection wells for which permits have already been issued (Permits #IW-2019.02.1 HD Minerals; #IW-2019.01.1 HD Minerals; #IW-2020.01.1 HD Minerals; #2021.01.1 CanWhite Sands Corp)? These permits make no mention of air injection into the aquifer.

  Yet Figure 2 in SUPPL1 shows the production pipe extending beyond the compressed air conduit, implying no air escape into the aquifer. This incongruity requires clarification because of its importance in the consequences of oxygen introduction into the anoxic aquifer.

- My RPCR question (#193) requesting more information regarding the **compressors** elicited the following response: "At this stage of application for the Environment Act Licence, detailed design information (e.g., pumping capacity and horsepower) is not yet available. Such proprietary information would be provided only to regulatory authorities." *Ergo*, none of our business.

  Yet Table 6-3 in EAP2 seems, perhaps inadvertently, to leak the secret: the " 1550 Tier 4 Final Oil Free Rotary Screw Air Compressor". We look up this Sullair product ourselves (Figure 12) and see the following information shamelessly and openly displayed: rating 125 psi (75-150 psi range), 1550 cubic feet per minute, 500 hp (373 kW) (https://america.sullair.com/sites/default/files/2021-02/LIT%20Sullair%20OFD1550%20Tier%204%20Final%20Brochure_PAP1550OFDT4F202102-7_EN.pdf).

  It is mystifying that the compressor was identified in the original EAP2 document, then in the much *later* RPCR we have suddenly clammed up. Has the magnificent OFD1550 been sidelined?

  Much later again, we see that no, apparently not, as it (only one) reappears in SSCRIR1 (#MBEN/OLS-IR-016) and has, at least for the time being, been declassified and restored to glory.

  Regarding operating extraction pressure, we have to refer to the CPA which provides the following example: "In the present example, a compressor (not shown) at the surface may be used to inject air with a positive pressure and high volume flow rate, such as at a pressure within the range of about 30 psi to 90 psi with a flow rate of about 300 cubic feet per minute to about 600 cubic feet per minute." These metrics are understood to refer to one operating well.

Will one compressor service multiple wells? The answer is yes, "All wells comprising a 'cluster' will be serviced by one rotary screw, oil-free compressor" (RPCR #193).

But what about two adjacent clusters? The EAP1 (p. 3) unequivocably states that up to **a maximum of seven wells** can operate at the same time: "although up to seven extraction wells may be operating simultaneously in one well cluster at any given time, **this maximum number of wells** operating simultaneously maybe [sic] spread across two adjacent well clusters (e.g. four operating wells in one cluster and three in an adjacent well cluster.)" (Emphasis is mine). This target number of seven re-emerges in several places in the documentation. However Table 6-3 in EAP2 specifies **10 operating extraction rigs**. The discrepancy is not explained. Which is correct? Could ten wells potentially operate at the same time? If so, all of the EAP models need to be adjusted.

But then, in SUPPL1, Figure 1-1 (also GTTR, p. 5), there are now FIVE wells per cluster. If THIS version is the correct one, will a maximum of seven wells still operate at the same time, as this latter number has not been amended? But with 10 extraction rigs, this would mean that all wells in two 5-well clusters could/might operate simultaneously. The reader starts to get dizzy.

But wait. In the still later RMSF-IR-004, "each well cluster will consist of seven wells" again. Furthermore, the 7-well arrangement is also reproduced in the figure in RMSF-IR-006. Here is a summary:

Date	Source	Page	Number of wells per cluster
Original proposal	EAP1	Figure 2-3	7
"	AppH(AppA6)	entire	7
June, 2022	SUPPL1	2 (Figure 1-1)	5
September, 2022	GTTR	5	5
November, 2022	RMSF-IR	-004 **and** -006	7
November, 2022	SSCRIR1 #MSSAC-IR RMSF-IR	009 006	secret
January, 2023	NREP	1/8	Any number <6

Note: AppH is located in AppA6

But then we learn that there is a special "confidential" version: "The confidential version was also filed to the Approvals Branch and the CEC." (SSCRIR1 #MSSAC-IR-009, also RMSF-IR-006). And then in the January 24, 2023 NREP, "Well clusters are also reduced from seven wells to a variable number of wells, but less than six, depending upon cap rock thickness in the extraction area. For example, some clusters are now as few as one single well while others may be as high as five wells." One would think that something as acutely basic as this would have been established long before the application was

submitted. We give up, and don't want to play anymore. Let's just leave the scene of the pile-up and push on.

The number of wells operating at the same time appears to remain unchanged. Since presumably up to seven (?), or perhaps more, wells will operate simultaneously, possibly/likely in different adjacent clusters (EAP1, p. 3), will the valiant, solitary OFD1550 be able to generate enough oomph for this many wells, at the pressure and flow rate required for each? Furthermore, superposition of drawdown cones may require more pressure (see p. 83+). And hoses would need to be snaked between different operating clusters from the one machine, adding to the pressure attrition headache. And then there are the additional "pressure bursts" described in the CPA: we don't want it to bust a gut, look at what we are asking of it already. It likely needs a partner. (However, see Noise p. 363).

In the latest cluster revision in NREP, some clusters may have very few wells. In areas where such clusters occur, will *more than two clusters* have to operate at the same time in order to maintain the necessary window of flow rates in the system? How would this translate in terms of logistics?

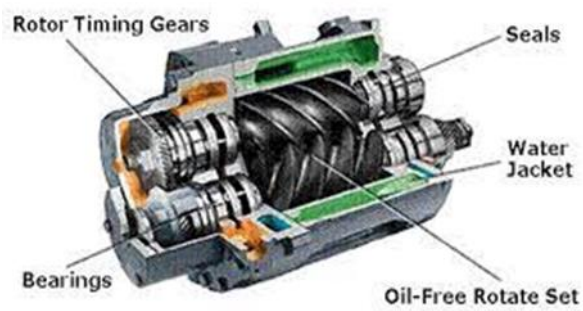
- In TAC (#57), the reviewer comments: "The air used to lift the sand-water mixture must be free of lubricants, hydrocarbons or other chemicals that may impact water quality". The proponent responds: "CanWhite agrees, and its contractors will use oil-free compressors." The plural here suggests that indeed more than one compressor will operate (see pp. 363-364). More uncomfortably, does the future tense suggest that oil-free compressors have not been used in the Permitted test wells that have been extracted already? For a possible answer, see https://www.winnipegfreepress.com/the-carillon/local/Former-CanWhite-employee-alleges--well-contamination-lax-site-safety-575758671.html?fbclid=IwAR0_3_MXoo3we8hCYt2g_tHrzXI2tG_tI1rxWPOsKX8guTaHCFAm4jsE7uM

- The continuously operating compressor(s) will generate a great amount of heat, especially in hot weather: "increasing the ambient temperature will increase working temperature of the air compressor." (https://www.airbestpractices.com/technology/air-compressors/what%E2%80%99s-possible-when-operating-rotary-screw-air-compressors-hot-ambient-c). In addition, dusty environments can aggravate the situation; the manufacturer recommends: "you do not want to install an industrial air compressor in an area with a high amount of particulate. That can clog a cooler and cause overheating." (https://america.sullair.com/en/blog/tips-help-your-industrial-air-compressor-withstand-summer-heat). There are two cooling options for these types of oil-free compressors: air or water/liquid coolant. While air cooling is more common in smaller machines, "Water-cooled compressors become more common in larger machines, between 125-600 hp." (Sullair, 2019).

- While the hp information is classified as "proprietary" in RPCR (#193), the OFD1550 that is lusted after in EAP2 (Table 6-3) is a 500 hp machine (see above source). It has a large 110 L radiator. According to the manufacturer, the liquid coolant in this machine is standard antifreeze, while the engine side coolant system is air over liquid cooled, which therefore must be kept clear of dust and obstructions.

  The safety concern here relates to the strict prevention of antifreeze spills due to carelessness or negligence when servicing, operating, or transporting the machine, and to proper disposal of the used fluid. Ethylene glycol is toxic to animals and plants, and animals are attracted to spills because of the sweet taste, with lethal consequences. It completely dissolves in water, which renders it highly transportable. While it eventually degrades, this process is much slower in groundwater (up to one month) than at the surface due to factors such as cold temperatures and absence of photolysis (Staples et al., 2001). In use, antifreeze becomes progressively contaminated with lead and other heavy metals, as well as toxic hydrocarbons including carcinogenic benzene, to the point where it must be managed as **hazardous waste** (https://www.enr.gov.nt.ca/sites/enr/files/guidelines/antifreezeguideline.pdf). The hydrocarbon contaminants are much more persistent in groundwater than the glycol, and metals never degrade.

  These concerns also extend to any systems that will be winterized using ethylene glycol, or vehicles and equipment that utilize antifreeze.



Cutaway schematic of standard liquid-cooled oil-free screw compressor showing innards.

https://www.gascompressors.co.uk/wp-content/uploads/sites/11/2021/03/Oil-Free-Screw-Compressor.jpg

Figure 12. The OFD1550 Tier 4 Final Oil Free Rotary Screw Air Compressor.
Source: https://america.sullair.com/sites/default/files/2021-02/LIT%20Sullair%20OFD1550%20Tier%204%20Final%20Brochure_PAP1550OFDT4F202102-7_EN.pdf)

- The EAP contains almost no information regarding the onsite dewatering process:

  "The water portion of the sand and groundwater slurry that will be brought to surface through extraction wells will be separated from the sand at the extraction site." (EAP1, p. 11). "The sand and groundwater slurry will … move to a dewatering station at the extraction site where the sand will be separated from the groundwater." (EAP1, p. 14, also see p. 18).

  "The dewatering equipment is designed to handle large volumes of water and has been sized appropriately to handle fluctuations in water volumes to avoid overflows." (EAP1, p. 23). It will use a lot of power: "It is expected that the dewatering and pump station will require 1460 connected hp to operate." (EAP1, p. 26).

  In response to questioning, the proponent provides an exterior view of a "primary dewatering screen" (Sio Silica Corporation (SSC) Responses to Information Requests (IRs) Round No. 2 Appendix A), which shows a laughably uninformative rendering of something that could be anything, a piece of commercial bakery equipment perhaps, attached to a ladder with green rungs (Figure 13). The only helpful labelling is: "Example Only". So whatever it is, it will likely be different anyway.

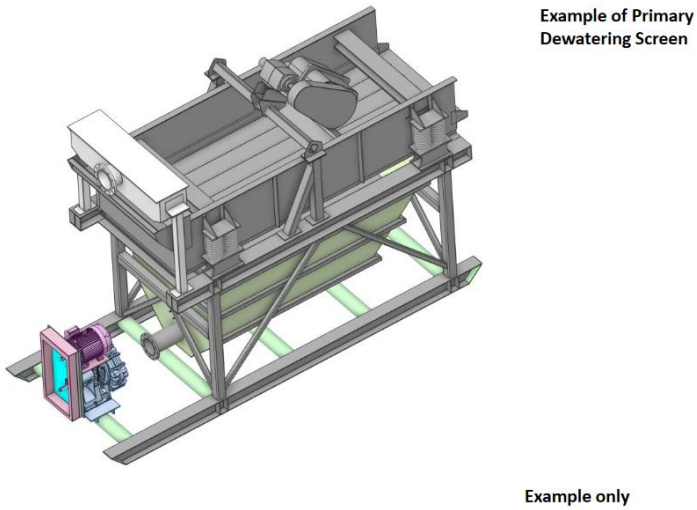


Figure 13 . Proponent's rendering of an alleged "Primary Dewatering Screen." Note that it is an "Example only". From: Sio Silica Corporation (SSC) Responses to Information Requests (IRs) Round No. 2 Appendix A

It cannot be overemphasized how critical the dewatering stage is in risk management, as it will be on site, and the manipulated water will be very vulnerable to contamination during this process.

However, it also might not always be on site (?): "The design of the dewatering and pumping station provides for it to be **relocated only once per year**." (RPCR #122)(Emphasis is mine). **So where will it be?** In TAC (#9) it is clearly stated that dewatering will occur "**at the well cluster site".** Similarly in SSCRIR2 (#DLN-IR-003), "The sand and groundwater slurry will then move to a **dewatering station at the extraction site** where the sand will be separated from the groundwater." (Emphases are mine). There is no explanation of this very severe discrepancy. Huh.

- TAC query (#9) elicited a little more information about the actual process:

"The dewatering process is as follows: The sand and water extracted from wells will first pass through a cyclone **at the well cluster site** to remove some water. Then the sand and water at 65% sand will pass over a dewatering screen. A dewatering screen is a one layer inclined screen. The screen catches the sand, and allows the water to pass through. The wet sand then travels off the inclined screen into a sump, and the water that flows out the bottom of the screen feeds into the UV light treatment system before reinjection (by gravity flow) back to the sandstone aquifer. When the wet sand enters the sump it is mixed with recycled water from the Processing Facility and is then transported (pumped) as a sand and recycled water slurry through a slurry line to the Processing Facility." (also RPCR #191)(Emphasis is mine).

The following questions arise:

1. What is the design, capacity, flow rate and centrifugal force exerted by the cyclone(s)?

2. "Except for a residual amount of moisture that remains with the sand as it transfers to the slurry line, the entirety of the groundwater (once separated from the sand) will be returned to the aquifer." (RPCR #32).

The percentage of sand in the raw extracted mixture will greatly vary: "Early in the extraction process for each well, the slurry will consist primarily of solids (est. 70%) and will slowly reduce to approximately 20-30% near the end of well production." (AppA1, p. 22). In the EAPPF (Appendix H), "Slurry from the well are [sic] as high as 90% sand", and in SSCRIR1 #DLN-IR-007, "The sand water ratios can be as high as 90% sand, 10% water."

The proponent's TAC (#9) description implies that the target result from the centrifuge will be a constant ≈ 65% sand. This is puzzling. In order to maintain this content, **water would have to be added** to reduce the sand content from the 90 or even 70% that occurs earlier in the extraction of the well. Obviously (or hopefully) water addition will not be happening.

Therefore, where initial sand content already exceeds 65%, will the cyclone(s) be bypassed? How? In these 'drier' cases, there will be less reinjection water from the dewatering screen, with implications for well interference issues.

Or, might the mixture proceed through the cyclone and screen regardless? If so, is there a maximum sand content limit (above 65%) beyond which the equipment clogs up? We are stuck: we need a critical piece of information: **What is the sand/water content after the entire dewatering process,** before it enters the slurry train?

3. Where the initial sand content is less than 65%, an ambiguous initial amount of water will be removed by centrifuging. **Where will this supernatant water from the cyclone(s) go**? According to the above TAC description, apparently only the 65% sand/water centrifuged mixture will proceed to the inclined screen and only this water will be captured for subsequent reinjection. How much total volume (m^3) of water will the supernatant represent – the description of it as "some water" does not suffice: it may be substantial at the lower sand percentages in the latter stages of well production. **What will be done with this "some water"** that apparently does not proceed to the dewatering screen?

4. To add to the confusion, the later description in SSCRIR2 (#DLN-IR-003) makes no mention of cyclones:

"Extracted sand passes over a dewatering screen where the water is separated from the sand. The water drops below to a different level of the screen and the sand remains on top. The sand travels off the dewatering screen into a sump which is fed by the recycled slurry line water and feeds into the slurry loop. The water that comes off the dewatering screen, comes out of the screen in a different location where it flows into the water filtration and then UV system. It is not mechanically possible to mix the two.

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.

The sand and groundwater slurry will then move to a dewatering station at the extraction site where the sand will be separated from the groundwater."

Comparing, in TAC (#9), the cyclone was the first step, but absent here. Next in TAC were the dewatering screen, sump for the sand, and the water diverted for treatment. Then the sand from the sump enters the slurry lines. In the SSCRIR2 version, we have a dewatering screen, then vibrating screens and sump. Sand then travels to the dewatering station – is this where the cyclones are? Is it correct that now the cyclones are at the end of the process rather than at the beginning?

It would be immensely helpful if the actual design could be finalized and the operations decided upon. But edification is denied us: "Detailed design with precise configurations, etc., are still being finalized and those details are not required to understand and assess the potential environmental effects from the proposal." (SSCRIR2 #DLN-IR-003). Actually the design details are important in order to understand how and where the water will be routed and processed, because there will be a lot of it, and people will be drinking it. It is true that "the devil is in the details". How does this latter version change the above 65% sand content value that was specified in TAC (#9)?

5. RPCR (#32) contends that "the **entirety** of the groundwater (once separated from the sand) will be returned to the aquifer." (Emphasis is mine).
Again in SSCR (#22), "In reality, all groundwater except for residual moisture content in the sand will be re-injected into the sandstone aquifer."
Again, "Only the small volume of residual moisture held in the sand (~10 US gpm) is not reinjected." (RMSF-IR-004).
In RMSF-IR-005, references are made to "the **planned** 100% reinjection scenario". (Emphasis is mine). Similarly in a September 11, 2020 letter to the IAAC, a top CanWhite official wrote: "A **net zero solution**, CWS **has proven** the ability to not remove aquifer water while harvesting the sand, therefore there is no anticipated water draw from the aquifer or need for water disposal or discharge at surface" (https://www.ernstversusencana.ca/vivian-silica-sands-extraction-wells-manitoba/)(Emphases are mine).

These statements do not reconcile with TAC (#9) and RPCR (#32). They cannot be true, as, aside from the water in the massive volumes of wet sand, not all of the water from the cyclones or 'overs' will be returned (see p. 64), among other losses. What about losses in the sludge drying fields (SUPPL4) and/or the "filter press" (RMSF-IR-002)? And, where is this vaunted **proof**?

"Pilot testing has demonstrated that reinjection of **essentially all** groundwater extracted with the sand slurry is feasible."(SSCR #22)(Emphasis is mine). Where are these data? Apparently, from these remarks, the dewatering station has already been tested. Aside from screening, what about the other stages in the convoluted concatenation of steps? And evaporation from the future massive sludge drying fields (if used), and the mountains of moist sludge destined for disposal afterwards (SUPPL4)? At what points were water volumes measured to allow for these claims to be made? And, where did the water from the "pilot testing" go, since it could not be disinfected according to the proposed protocol? Was it reinjected regardless (see chlorination on p. 329)?

6. In SSCRIR1 (DLN-IR-002), "It is assumed that there will be some water loss in the system from evaporation from the stockpiles. Stockpiled sand is deposited at approximately 15% moisture content and will drain or evaporate down to approximately 7% or less moisture content".

In RMSF-IR-009, "An **estimated** water loss of 54 m3/day (10 US gpm) was initially **estimated** by Sio Silica staff based on flow monitoring and laboratory testing conducted during field trials." (Emphases are mine). We assume this is the daily loss for one well.

Further, "A loss of 10 US gpm equates to a residual moisture content [in the sand] of approximately 3.6% which was judged to be reasonable in the context of literature values.", therefore "the value of 54 m3/day (10 US gpm) was adopted as the volume of water that was retained by the sand, and hence unavailable for reinjection."

Where are the results of all of this "flow monitoring and laboratory testing"? How many data points contributed to this final estimate?

Could we please explain the 3.6% residual moisture content loss versus the much greater 15% and then drained to 7% moisture content in the stockpiled sand? It seems that all of that 15% is lost. Where does the excess (above 3.6%) in the stockpiled sand come from? If it comes from the slurry line fluid, or another source, including the processing facility well, it must be replenished, involving draw. Wherever it is coming from (excluding rain), would not this amend the 54 value to 225 m^3 per day?

- Since the proportion of sand will vary enormously at different stages of a well extraction (AppA1, p.22), in some cases up to 90% sand (e.g. SSCRIR1 #DLN-IR-003), obviously the water loss due to residual moisture will also vary day-to-day. But only the one daily value of "54 m3/day" is provided: how was it obtained? Is it an *average* over the 4-7 production days for a well? Or is it a minimum? What were the *ranges* of values over the production life cycle of a well? We expect the sand proportions to have been front-loaded, and to decline in the latter phases of extraction (see also p. 90).

  In any case, this is the daily value given for one well. Using this value, seven wells will amount to 378 m^3 per day. Over a total production cycle of 4-7 days, this will amount to 1512 – 2646 m^3 of loss per cluster equivalent, a not insubstantial amount.

- The projections are complicated by the uncertainty surrounding the number of days an individual well will operate, and likely will depend on the sand supply. Four days is specified in AppH(AppA6), 5-7 days in TAC (Memo 1)(see discussion on p. 59). Might different wells in the *same cluster* have different durations of production?

- What daily records will be kept regarding pumping rates for each well, total volume extracted per well and cluster, and volume of water returned? Since presumably these data will be "proprietary", what or will, independent oversight monitor this information?

- In EAP1 (p. 14) we see the reference to "water that is returned to the sandstone". There is much confusion surrounding the exact configuration of the air lift apparatus, and clarification is badly required regarding concerns raised in https://www.ernstversusencana.ca/vivian-silica-sands-extraction-wells-manitoba/, regarding where exactly the water will be returned. According to the latter source, since water returned to the sandstone will likely be sucked into the air lift apparatus again, there has been some interpretation of the vague documentation available that 'excess' aerated returned water might be injected to the Carbonate above the shale aquitard, which would reduce continuous recycling (and treating) of the same water. If true, this would be a gross violation of mixing water from different aquifers, especially given the vast volumes involved. Furthermore, there would be a 'push' downwards onto the shale from the reinjected water, combined with a 'pull' from the suction incurred from the extraction underneath, imperilling the shale. Further inquiry is indicated.

- How will the 65% sand proportion from the cyclone(s) be maintained/monitored? Or is this just a value with little practical significance or meaning?

- What is the mesh size of the "one layer inclined screen"? This will dictate the size of the largest suspended particles that proceed to disinfection. However in SUPPL4 (p. 7), there are now apparently two screen layers: 140 and 200 mesh.

- How is/are the screen(s) declogged? Mechanically only, or are any chemical assists used (e.g. sodium hexametaphosphate)?

- What material is/are the screen(s) made of? Metal, which can shed abraded metal nanoparticles? Or synthetic material, which can fray and degrade?

- Are the dewatering screen(s) and collection tank open to the air (i.e. subject to unrestricted contamination), or are they completely enclosed?

- How does the water from the collection tank feed in to the disinfection system?
- How are sediments in the tank cleaned?

- "The construction method of the extraction well will prevent water that is returned to the sandstone from contacting any potential source of contamination." (EAP1, p. 14).

  Existing injection well permits (Permits #IW-2019.02.1 HD Minerals; #IW-2019.01.1 HD Minerals; #IW-2020.01.1 HD Minerals; #2021.01.1 CanWhite Sands Corp) stipulate that "The injection water will not contain any substances that will degrade the quality of the water in the receiving zone."

  The permit stipulation is ambiguous and nominal: there are thousands of possible substances that may degrade water but there is no hint regarding how monitoring is to be conducted, nor for what, nor by whom, nor how often, nor are there any exceedance or spill reporting requirements, nor are there any punitive consequences. Was anything monitored at all? Should not there be minimum standards for the returned water? Should not there be oversight? **Substances introduced into the aquifer cannot be retrieved.** According to TAC (#10), **information on the return water is lacking**. Therefore, **how can we know whether any such substances may have been present?** Why include such a statement in the permits when it is of little account? Perhaps the *appearance* of the water looked okay. But even if it didn't…….

  ……how was the alleged oil spill into the test well cleaned up, for example? (https://www.winnipegfreepress.com/the-carillon/local/Former-CanWhite-employee-alleges--well-contamination-lax-site-safety-575758671.html?fbclid=IwAR0_3_MXoo3we8hCYt2g_tHrzXI2tG_tI1rxWPOsKX8guTaHCFAm4jsE7uM)

  In TAC (#10) we read that "The water will be contained and under continuous flow during extraction and treatment, and therefore will not have been exposed to organic materials, chemicals or contaminants through the extraction and treatment process.

CanWhite will develop and implement a program for regular sampling of the groundwater extracted from the wells and as it is returned to the Winnipeg Sandstone aquifer following UV treatment. The program will be supervised by a qualified professional. All laboratory testing of samples will be carried out by a certified laboratory. The water sampling program plan will be submitted to the Director before operations commence." Similar iterations of this response occur in RPCR (#3, #11, #24, #211).

The water will have contacted, at the very least: compressed air from a compressor, the air line, the production pipe and its joins, vibrating screens to remove 'overs', a cyclone, a dewatering screen, a catch tank for the screen water, another possible pump, another pipe, a disinfection attempt station tank and subsequent piping, and a pipe to return it to the aquifer *after* disinfection (EAP1, Figure 2-2). Contamination can occur at any of these points. General dust at the surface (presumably the "vibrating screens installed over a sump pit" (EAP1, p. 14) and dewatering station will be exposed to air), lubricants, various machine fluids and oils, diesel fumes and particulates, machinery metal wear particles, rubber and synthetic particles, paint particles, somebody sneezing……Some of the same water may have been brought to the surface multiple times, since extraction and injection are simultaneous. Then there is the sludge drainage water returned from the 'drying fields' and dumped in with the recovered onsite water (SUPPL4)(if used), or maybe a filter press. It is an unrealistic and naïve overreach to claim no potential source of contamination. And where is this elusive "water sampling program plan"?

With respect to microbial contamination, in TAC (#42) we are astonished to read:

(Reviewer): "It is also not apparent how bacteria could be introduced during separation and if it [sic] would present in the return water".
(Proponent): "CanWhite agrees with the reviewer that introduction of bacteria or other microbial contaminants into the water is unlikely during separation of the water and sand."
In RPCR (#25)(proponent): "there is no potential for bacteria or other microbial contaminants to be introduced into the water", and "It should be noted that the use of UV is purely precautionary, as contamination is not expected during the sand extraction process." (SRTER #7).

Given the above described convoluted processing and handling of the water, it is emphasized herein that **opportunities for microbial contamination are high to the point of certainty**, since the system is neither sealed nor aseptic, it is outdoors, it is vulnerable to carelessness and accident, the workers are not wearing sanitary PPE, the machines and tools are not sterile, and large volumes of water are exposed to the air at

dusty and tumultuous work sites. See pp. 126+ for further discussions of microbial aquifer contamination.

- "When a well is no longer producing sand, the production piping will be removed, the slurry line connection will be disconnected, and the well will be capped. All equipment will then be moved to the next well in the cluster and re-connected. While this is occurring, the other wells (up to seven) will continue to operate so that the slurry loop system continues to supply sand to the facility for processing." (EAP1, pp. 14-15.)

  This cannot be occurring while seven other wells continue to operate: these plus the just disconnected well or the just reconnected well make too many wells when "Maximum of up to seven extraction wells [will be] operating simultaneously" (EAP1, p. iv). We can simplify: either all, or maybe some, wells in a cluster will be operating at any given time.

- At the end of all of the above, we cite a statement from a top CanWhite official in a September 11, 2020 letter to the IAAC: "No traditional mining activities take place and therefore there are no open pits and **no underground operations**." (https://www.ernstversusencana.ca/vivian-silica-sands-extraction-wells-manitoba/)(Emphasis is mine). The only thing missing from underground operations here are actual underground personnel, but the physical impacts and consequences of underground mining are copiously there. The resource is underground, is it not?

  In SIO (p. 17), "We plan to develop the area using an **underground** extraction technique". (Emphasis is mine). In RMSF-IR-016, the proponents state: "**Similar to other conventional underground mining** projects, it is not possible to directly measure the magnitude of any change in aquifer properties prior to completion of mining." (Emphasis is mine). But we do learn from this last quote that they will be able to assess the effects on aquifers *after* the mining operation has left. Therefore we have to let the mining happen first, and then see….

Aquifer mixing

- "The Regional Project Area (Figure 1-2) contains approximately 1,505 domestic water wells (AppA1 (p. 81). Some additional wells are used for livestock watering (54), industrial use, irrigation, air conditioning, municipal water supplies and miscellaneous (AppA1, p. 16). The majority are completed within the Carbonate aquifer (AppA1, Figure 1-3) and do not penetrate the shale aquitard: "most groundwater wells and boreholes terminate before they intersect the shale" (AppA1, p. 60).

- "A summary of groundwater users is provided in Appendix G of the Hydrogeology and Geochemistry Assessment Report, and lists the well ID, northing, easting, water use, well depth and the assigned lithology (aquifer). Ownership of wells has not been included to avoid sharing of personal information of domestic well owners in public documents." (TAC, #48). According to the Public Registry (https://www.gov.mb.ca/sd/eal/registries/6119/index.html), both parts of Appendix G pertain to Heritage Resources, so we are out of luck there. But wait, we discover *another* Appendix G, *inside* AppA6: this turns out to be the correct one. No statistical analyses or summaries are provided for any of these data.

- According to FD (2019), **hydraulic gradients indicate that "A well connecting both aquifers in the east of the RM** [Springfield] **would result in carbonate groundwater mixing down into the sandstone aquifer."** (Emphasis is mine).

  Although pumping will occur from the Sandstone aquifer, both the pumping tests and the drawdown modelling indicate that **drawdown will occur in both the Sandstone and the Carbonate aquifers** (AppA1, section 7.2.1; Figures 6-9 - 6-13, AppA4). One concern with this interconnection is the potential for contaminants to be drawn from upper to lower strata as pumping proceeds.

  Despite their own AppA1 projections, the proponents take a different stance in RPCR (#46): "The CanWhite extraction method does not intermix aquifers. It does not draw or return water from any aquifer other than the Winnipeg Sandstone aquifer."

  "Sio's activities are solely in the Winnipeg Sandstone aquifer with no anticipated usage of the more popular Red River Carbonate (limestone) aquifer." (SIO, p. 18).
  While water from the Carbonate aquifer might not be extracted directly, its intrusion into the Sandstone would be accelerated through shale fractures and failures, as well as breaches around annular seals and open boreholes, promoted by differential hydraulic head conditions. In other words, both aquifers must perforce be involved.

  This involvement extends to existing domestic wells completed in the Sandstone aquifer: where shale has been breached or degraded, according to the proponent's own report (AppA1, p. 79), "**extracted water would be derived from both aquifers** rather than being derived almost entirely from the Winnipeg Sandstone if the Winnipeg Shale remained intact." (Emphasis is mine). Further in SSCR (#7) the proponent states: "During the pumping test, pumping in the Winnipeg Sandstone aquifer initiated a response in the overlying Red River Carbonate aquifer", while in SSCR (#16) the reviewer notes "Drawdown data suggests [sic] a leaky connection between the two main aquifers". In SSCRIR2 (#MBEN-IR-028), the proponent admits that "During operations, downward vertical gradients can be expected to increase." This would be unavoidably reflected in water chemistry for affected users.

- In the Sio "'Facts Matter' Series" (The Clipper, February 10, 2022, p. 12), the proponent asserts: "Artesian conditions are not present within Sio's focus area, therefore there is little to no driving force for the exchange of water between aquifers."

  This statement naïvely supposes that high hydraulic head is largely/solely responsible for interaquifer mixing. It fails to recognize that local **downward transfer may be promoted by the extraction activities** as a result of the volume deficit created from the removal of sand (and some unreturned water) when a well is not flowing. Furthermore such movement may entrain contaminants from upper strata into the Winnipeg Sandstone.

  The proponent dismisses the importance of vertical transfer: "the permeability of the shale is much less important in the study area than previously thought. The relatively small vertical gradients indicate groundwater flow is primarily horizontal through the Project Site Area." (SSCR #16). Yes, but how will extraction activities alter and affect this flow? Of course flow is mainly horizontal if an aquitard impedes vertical exchange. But if the aquitard is damaged….those "small vertical gradients" might not then be so small…..

Drawdown and well interference

- Drawdown in surrounding wells is a major concern. Heavy pumping creates a cone of depression in the water table which extends laterally to other wells (Figures 14 and 15). The cones of depression may not be uniform, as "heterogeneous and anisotropic aquifer conditions" may result in "distorted cones of depression" (Keely, 1984); thus cones may be asymmetric and some wells may be disproportionately affected compared to predicted levels.

- The minimum setback of operations is only 100 m from a neighboring well (EAP1, p.4). In response to a question by a reviewer regarding drawdown (SSCR #23), the proponent responds: "The setback distances were established primarily to minimize noise and interruptions to private landowners." (Unfortunately, these distances will be ineffective for those purposes as well (see Noise, pp. 349+)). Therefore, well interference issues are not a priority.

  The proponent further states: "The Groundwater Monitoring and Mitigation Plan will establish acceptable levels of drawdown" (SSCR #23):

  1. What are "acceptable" drawdown levels, and why should **any** well interference be "acceptable"? How would "acceptable" levels be determined and what criteria would be used? Further, acceptable to the homeowner, or the company?

  2. There is no "Groundwater Monitoring and Mitigation Plan".

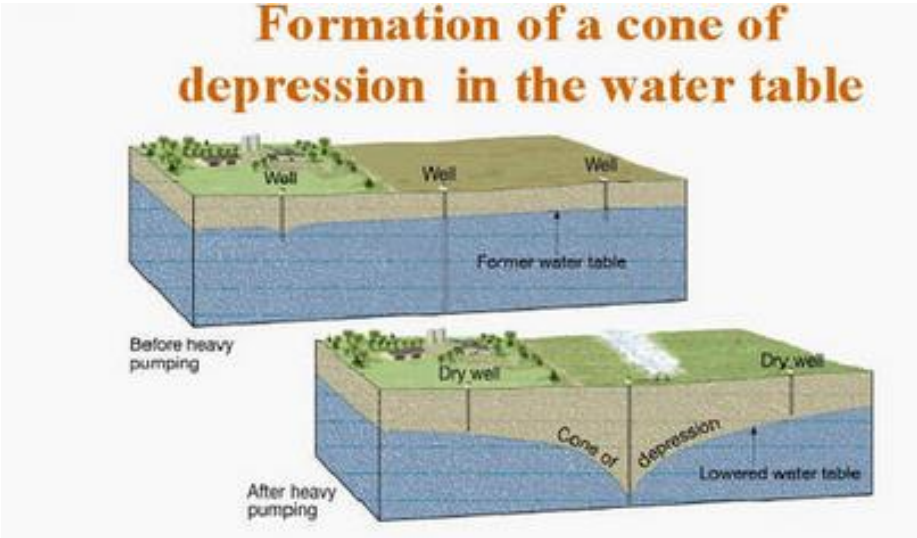


Figure 14. Drawdown cone in the water table as a result of heavy pumping. Neighboring wells are compromised. Source: https://courses.lumenlearning.com/suny-monroe-environmentalbiology/chapter/7-2-water-supply-problems-and-solutions/

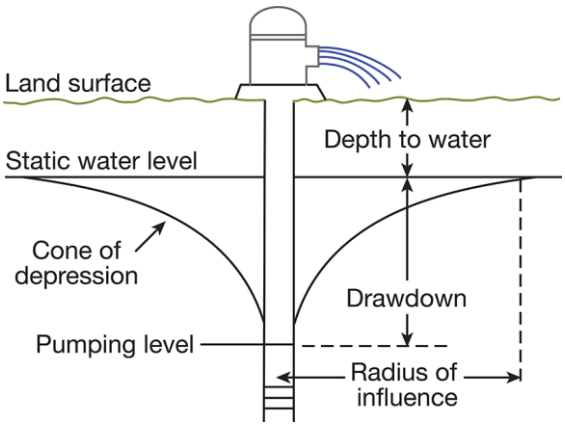


Figure 15. Schematic diagram of cone of depression and drawdown. From https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.kgs.ku.edu%2FGeneral%2FGeology%2FKingman%2F05_gw2.html&psig=AOvVaw2Z6ZL_PhdsgoMSDgRZkt1H&ust=1647984907127000&source=images&cd=vfe&ved=0CAgQjRxqFwoTCMiq5LOU2PYCFQAAAAAdAAAAABAw

- According to simulation modelling (at 50% reinjection of extracted water), "Although the spatial extent of the drawdown is anticipated to be laterally extensive, the magnitude of drawdown impacts is anticipated to be between 1 m and 5 m for the majority of the licensed water supply wells. Because most pumps are installed at depths of 30 m or more, impacts of this magnitude will not likely require any mitigation." (AppA1, p. 5).

  This statement deceives and misleads. It reassures the public that 1 - 5 m is small compared to 30 m, implying there is 30 m of water above the pump, i.e. the water level is at or near the surface. However it matters not, how deeply the pump is situated *per se* below the surface, but **how deep it is relative to the water table** **(**Figures 16 and 17). If the static water level is at 10 m below the ground surface, and the pump at 30 m, a 1-5 m drawdown will not imperil the well. But if the water table is 25 or 30 m below the surface, yes, the drawdown will create a problem. The pump is at 30 m in both cases, and the drawdown is 1-5 m in both cases, but the outcomes are not the same.

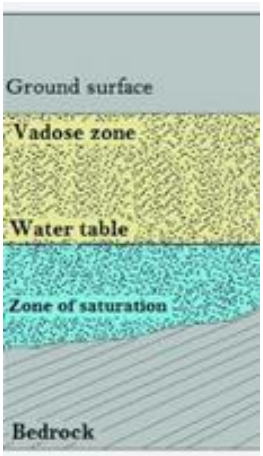


Figure 16 . Schematic diagram of relationship of water table to unsaturated vadose zone and saturated aquifer zone
Source:
https://www.google.com/url?sa=i&url=https%3A%2F%2Flink.springer.com%2Fchapter%2F10.1007%2F978-3-319-733838_4&psig=AOvVaw0GIDyot2JI4737MT0b8P3o&ust=1673804667867000&source=images&cd=vfe&ved=0CA0QjRxqFwoTCLj4mqTQx_wCFQAAAAAdAAAAABAQ

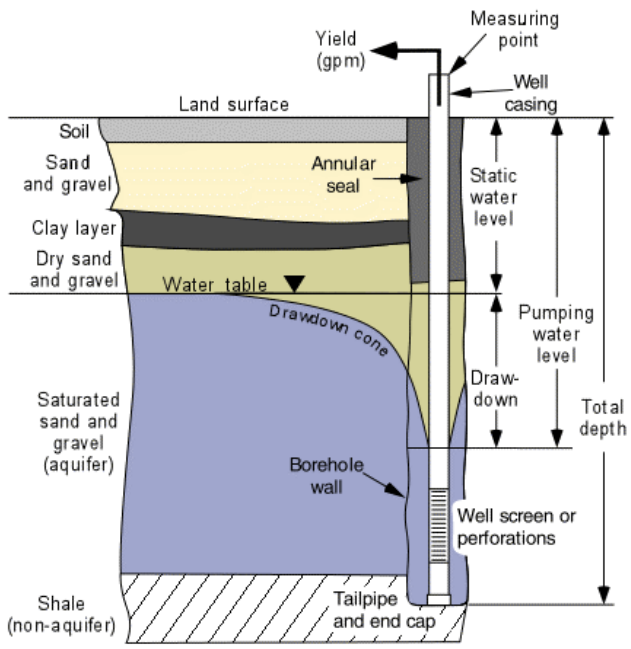


Figure 17. Schematic diagram of water supply well configuration. Source: https://mbmggwic.mtech.edu/sqlserver/v11/help/welldesign.asp

- Further to the above: "Because most pumps are installed at depths of 30 m or more, impacts of this magnitude will not likely require any mitigation." (AppA1, p. 5).
  The TAC (#36) reviewer's comment is particularly germane: "*Within Canwhite's Local Project area wells completed in the sandstone in which well drillers have provided a pump intake depth the values range from 18' to 60' and driller recommended pump depth for the carbonate aquifer is between 20' and 80'.* ***No recorded intake depths are 30 m or greater.*** *The Consultant should reassess this statement.*" (Emphasis is mine).

  We note for example that data for **well** (not pump) depth in AppG(AppA6) show **well** depths of <30 m for considerably in excess of 100 users (some are <5 m), therefore pump depths for such wells of >30 m are physically impossible. Such users are at greatest risk of drawdown.

  [According to Section 19 of The Groundwater and Water Well Act (C.C.S.M. c.Gg110) Well Standards Regulation, casings must extend at least 6 m below the ground surface. Some of the wells listed do not meet this standard.]

  For the reader's convenience the corresponding metric conversions for the above pump intake depths within the local project area are:

Actual	5.5 – 18 m
Recommended	6 – 24 m
Proponent's claim	**30+ m**

The proponent's response to this gaffe (TAC #36) recites a litany of grievances lamenting the data (paraphrasing is mine):

- The well drillers' data are old.
- Data quality and reliability are questionable.
- The reported well locations are wrong.
  [The proponent wells are not entirely sinless themselves: for Well PID 197860, well driller's comments are: "Coordinates and legal on report do not match" (WDR)]
- Cheap, ignorant homeowners might have ineptly installed pumps themselves to save costs.
  [But how would so much wrong data become ensconced in the well drillers' databases – presumably the well drillers aren't dolts?]
- Lazy, no-good deadbeats wanted to avoid the effort and cost of installing deeper wells. [ditto]
- Nincompoops thought they could increase available drawdown and yield by installing shallower wells. [Implication as worded]
- Nobody knows the status of the *majority* of the pumps anyway.

For the incredulous or doubtful, the relevant section of TAC (#36) is reproduced verbatim here: "It is AECOM's experience that well driller reports span several tens of decades, and the quality and completeness of the information in the well database is variable. Firstly, the well locations are plotted at the centre of each section or quarter section, rather than at the exact location of the well. This will have a very important influence on the magnitude and duration of drawdown impacts. Secondly, homeowners and pump installers may have departed from the recommendations of drillers by installing pumps themselves or installing wells at shallower depths to minimize costs and effort associated with pump installation and servicing, or to increase the Total Available Drawdown and overall well yield. Given the unknown status of the majority of pumps, it is prudent to conduct a physical survey…"

The proponents have with this reply scored an 'own goal' and copiously invalidated their own models. If, by their own admission, their data are so hopelessly flawed, why did they use them? There is no reconciling of the chasm between the EAP's brash assertion of '**most** pumps at 30 m or more', and the TAC reviewer's sober '**no** recorded cases of 30m or more'. Then there is the contradiction of the claim for '**most** pumps' and the subsequent backtrack: "the unknown status of the majority of pumps" (TAC #36). We come away from this knowing about most of them, yet at the same time don't know about most of them, perhaps a problem for Kierkegaard's existensialist philosophy dogmata.

- According to TAC (#37), the outdated Groundwater Information Network (GIN) was used in the EAP: "CanWhite understands that the locations of the existing wells and newly constructed/decommissioned wells are not present in the GIN database, but the physical well survey described above will remedy that information gap in advance of CanWhite's operations."

  Surely this "information gap" ought to have been the first thing to be addressed in the proposal, before erecting a superstructure on it of illusory conclusions and purported fact. The proponents admit they knew about the data deficiencies, as per list of grievances in the preceding bullet above, and thus about the resultant dubious modelling, **on which a large part of the decision to approve the project rests**.

- "In these [provincial monitoring] wells, recorded groundwater elevations in the carbonate and sandstone aquifers ranged from 256-261 masl between 2007 and 2021. The base of the carbonate aquifer is at an elevation of 200-220 masl across the Project Site, indicating that wells completed in the carbonate aquifer have 36 m to 61 m of total available drawdown if the pump is installed near the bottom of the well." (RPCR #49).

  1. There is a reality disconnect in this portrayal. In order to have this total available drawdown, Carbonate wells must be completed **at the base** of the Carbonate, next to the shale, since that where the 200-220 masl reference elevation is sited. Actual Carbonate wells are often, indeed *mostly*, completed somewhere **above the base** of the Carbonate, therefore the **available drawdown values provided are overinflated**. The range of *actual* well depths must be considered to give a more realistic assessment of the true ranges of possibilities, not just the best-possible-case, for how representative is it?

  2. A similar reasoning flaw extends for pump depth: even when installed near the bottom of the well, that bottom will not typically be at the base of the Carbonate near the shale.

  3. Given the 24-year projected timeline for the project, climate change must be factored into the discussion, as it will affect groundwater elevations.

  Similarly, "The base of the sandstone aquifer is at an elevation of 180-200 masl over the majority of the Project Site, indicating wells completed in the sandstone aquifer have 56 m to 81 m of total available drawdown if the pump is installed near the bottom of the well. For wells in the sandstone aquifer, drilling and well completion methods may limit pump installation depths to near the base of the carbonate aquifer." (RPCR #49).

Since it is here admitted that realistically, Sandstone-completed wells are unlikely to extend significantly below the top of that Formation, how relevant is the total hypothetical drawdown in these cases, when it is unavailable in practical terms?

Thus we can conclude that **available drawdown will depend on the pump depth and groundwater elevations, and well completion depth will be irrelevant if the pump is not at the bottom.** The point here is that theoretical best-case drawdown projections are of little value when maximal, optimal well conditions are not present, and will not be present in the majority of cases. Indeed, each case will represent a situation unique unto itself.

- In TAC (#34), "At a distance of 100 m [i.e. residential setback], the drawdown in the sandstone aquifer is estimated to be between 5 m and 10 m, and drawdown in the carbonate aquifer is estimated to be 1 to 2 m." These drawdowns could be incapacitating for some well users.

  "The Project is forecast to temporarily lower water levels by **1 to 5 metres**, but only within 1.5 km from the active well cluster, and with the amount of drawdown decreasing with distance from the active extraction wells." (RPCR #32)(Emphasis is mine). This will be a 3 km diameter zone, which will advance as the active clusters change. In SSCR (#23), the reviewer notes that: "Based on a well-known hydraulics formula, this drawdown would be about 12 m after 72 hours. This amount, if realized, **exceeds the stated the magnitude of the groundwater impacts of between 1 m and 5 m for the majority of the water supply wells.**" (Emphasis is mine). We need to add here that the drawdown timeline will be somewhat elastic because porosity and hydraulic conductivity, and therefore speed of drawdown, will vary in different places.

  In the "'Facts Matter' Series" in The Clipper (February 17, 2022, p. 15), the claims have mellowed even more: "A well located in the Sandstone within close proximity (1.5 kilometres) or in the Carbonate (within 800 metres) may experience a short-term drawdown effect (lowering of the groundwater level) **up to one metre**.", i.e. less than 1 m (Emphasis is mine). A distance of 1.5 km is "close proximity"? Has the model changed? There is no allusion to *really* close, "close proximity", such as maybe 100 m: we politely look away here.

  Obviously these versions do not agree, and we cannot know which, if any, is correct. We can say, though, that the projected drawdown seems to have decreased as time wears on.

  However, it must be further pointed out that even these generic **drawdown projections will not be uniformly applicable.** The "secondary joints, bedding planes, fractures, and

karstic features" characteristic of these Carbonate strata (FD, 2019) introduce a great deal of unpredictability and uncertainty. According to Betcher et al. (1995), "Groundwater movement occurs principally through an extensive network of discontinuities consisting of joints, bedding planes, and solution features. **The density and interconnection of discontinuities exhibits considerable spatial variability, both laterally and vertically.**" (Emphasis is mine). The upper portions of the Carbonate are particularly "extensively fractured" (Wang et al., 2008), but fracturing is not restricted to particular stratigraphic units (Chen et al., 2004).

"Due to variability in the number, size, type and interconnected nature of the permeable features, **well yields can vary substantially over relatively short distances** depending on the fractures encountered while drilling the well." (FD, 2019)(Emphasis is mine). The issue may be further complicated in that in some areas, "thin extensive argillaceous [i.e. shale] units act as inter- or intra-formational aquitards" within the Carbonate (McCabe, 1971 *in* Chen et al., 2004). Therefore anomalies can be anticipated which do not conform to theoretical expectations and projections.

To be frank, we don't know what the real drawdown will be, because of impediments such as scantiness of actual data, and factors such as the number of sand extraction wells operating at the same time (see below), as well as local geological irregularities and spatial inconsistencies in water levels (e.g. FD, 2019).

- Groundwater elevations in reference to sea level vary in both aquifers (AppA1, p. 64). Superimposed on this variability are variations in surface topography and therefore thickness of the vadose zone above the water table. Groundwater elevations are also dynamic and fluctuate depending on recharge and discharge conditions in different years as well as seasonally, and on the vagaries of demand. For a given pump located near the zone of natural variation, a given industrial drawdown may be inconsequential one year, but problematic the next.

- With undeniable climate change already evident, hydraulic regimes will change (Chen et al., 2004). Depending on global carbon emissions, temperatures in the Cooks-Devils Creek watershed are expected to rise dramatically (Table 3):

Table 3. Projected temperature and precipitation in the Cooks-Devils Creek watershed under mid- and high-carbon emission levels. Source: https://www.northeastred.ca/images/Cooks_Devil_Creek_IWMP_FINAL_LR_1.pdf).

Projected Annual Climate Variables in the Watershed	1981-2010 average	2021-2050 projections		2051-2080 projections	
		Mid carbon emissions	High carbon emissions	Mid carbon emissions	High carbon emissions
Mean temperature	2.7 °C	4.5 °C	4.9 °C	5.7 °C	7.0 °C
Precipitation	523.2 mm	555.8 mm	553.6 mm	554.3 mm	566.9 mm
Days ≥ 30 °C	8.9 days	18.2 days	21.5 days	27.5 days	41.5 days
Days ≤ -30 °C	10.6 days	5.5 days	4.6 days	2.9 days	1.5 days
Frost-free period	126.7 days	142 days	146.3 days	148.6 days	162.6 days

These projections, combined with increased land use and development, and water demand (including for agriculture and greater cooling needs) will render good quality water a premium resource. Furthermore over the long term, "the portion of the sandstone aquifer presently occupied by fresh groundwater is expected to change." (FD, 2019). The advisability of embarking at this time on projects, for which the long term effects are unknown, is thus questionable and risky.

- Further, according to the above simulation modelling, "With the planned re-injection of groundwater, wells beyond 1.5 km from active extraction wells are not likely to be affected." (AppA1, p. 5).

  Thus "Drawdown effects are largely restricted to the Project Site boundary, but minor effects are anticipated to extend beyond it during and immediately following operation of extraction wells close to the boundary." (EAP1, p. vi).

  Further, "Wells completed in the Red River Carbonate aquifer range from 13 m to 60 m in depth, with groundwater levels generally within 15 m of ground surface." (AppA1, p. 57). Clearly shallower wells must be especially protected from drawdown.

  The "planned re-injection of groundwater" should read "planned re-injection of some of the groundwater", as some will remain with the wet sand, the disposition of the cyclone water is not clear (TAC #9), and there may be other incidental losses, for example with sludge drying/pressing. Drawdown created by extraction of the sand itself will not be replaced.

Yet in RPCR (#13), "the drawdown created **by the extraction** can be replaced by the water being returned to the aquifer". (Emphasis is mine). In SSCR (#10): "It is important to recognize that the project activities will not be consuming large quantities of water and will reinject **essentially all** of the groundwater back into the aquifer." (Emphasis is mine). What percentage does "essentially all" represent? Show us the (real) numbers!

- The peer reviewer indicates: "In our review, the aquifer testing section is the most challenging aspect of this report." (AppB, #FRIESEN-8).

  In TAC (#34) the reviewer asks: "Section 6.2.3 [EAP] states that "Water level in the observation well network declined by up to 8.5 m(Winnipeg Sandstone) and 1.5 m (Red River Carbonate) at a distance of 89.3 m from the pumping well. Setbacks (Sctn. 1.4.1) include 100m from a dwelling and the dwelling's drinking water well. Extraction wells will be operating simultaneously (Sctn. 1.1). What will be the effect on a domestic well water level at this separation distance with multiple extraction wells operating and what plans will be in place to mitigate negative effects for the water user? Will the 100 m separation distance be adequate?"

  The circuitous reply: "The November 2020 pumping test utilized a pumping rate of approximately 26.6 L/s (372 US GPM) for a period of 72 hours. However, the proposed pumping rate during operations was evaluated at 2,998 m3 /day (550 US GPM) and 1,526 m3 /day (280 US GPM) within the numerical groundwater model to evaluate various operational pumping scenarios and better align with CanWhite's proposed operations. The results of the pumping test and numerical modelling are relatively consistent. Based on numerical modelling, the anticipated drawdown in the carbonate and sandstone aquifers is shown on Figures 6-9 to 6-13 of AECOM's Hydrogeology and Geochemistry Assessment Report. At a distance of 100 m, the drawdown in the sandstone aquifer is estimated to be between 5 m and 10 m, and drawdown in the carbonate aquifer is estimated to be 1 to 2 m."

  This is a non-answer. According to AppA1 (p. 22), "Each well will operate for four (4) days and will produce from 262 m3/day (40 gpm) to a maximum of approximately 654 m3/day (120 US gpm) of water and sand. Several wells at a given well cluster will operate at any one time, with a combined production rate of approximately 2,943 m3/day (540 US gpm) per well cluster."

  In the above TAC (#34) response, these AppA1 production numbers have been amended to "2,998 m3 /day (550 US GPM)" (also RMSF-IR-004). The proposed 550 GPM cluster value greatly exceeds the 372 GPM actual test pumping rate; a 550 GPM pumping rate was not tested.

  The daily minimum for 7 wells (40 GPM x 7 wells = 280 GPM) remains the same in both the EAP and TAC. However the maximum of 120 GPM x 7 wells would equal **840 GPM**.

  The provenance of the value of 550 GPM used in the model (TAC #34 version) is not given: perhaps it is close to the median between the minimum and maximum (280 + 840 = 1120, and 1120 ÷ 2 = 560 GPM. Or, indulging in mathematical arcana, maybe it is the median between the 560, and the 540 originally given in AppA1 above. **Why was the**

maximum of 840 GPM, i.e. worst-case, not evaluated by the model? What would be the drawdown in that scenario?

Table 6-3 in EAP2 indicates **10 extraction rigs**: what would the drawdown be for 10 wells operating simultaneously, in adjacent clusters, at a maximum capacity of 1200 GPM?

- "Pumping rates implemented during the 2020 field investigation (372 GPM; 26.56 L/s) were higher than the effective pumping rates that would result from operations (approximately 270 GPM; 17.03 L/s), and field testing therefore conservatively measured aquifer response to pumping at rates that are equivalent or higher than those proposed during operations." (RPCR #42).

1. The minimum pumping rate has unaccountably dropped to 270 GPM (also in RPCR #39) from the 280 in the TAC (#34) comments.

2. **Why is only the minimum value of 270 GPM identified**, but no mention is made of the maximum (840) or even the median (550?), both of which are higher than the pump test rate of 372 GPM?

   The 372 GPM pump test value is here purported as "pumping at rates that are equivalent or higher than those proposed during operations." (RPCR #42), i.e. the minimum 270 GPM. But "the proposed pumping rate **during operations** was evaluated at 2,998 m3 /day (550 US GPM) and 1,526 m3 /day (280 US GPM)" (TAC #34)(Emphasis is mine). Yet this model is described as "conservative and relevant to the proposed sand extraction activities." (RPCR #42). Perhaps the term "conservative" is meant as: "only minimum values were used".

   The reviewer in SSCR (#35) expresses similar unhappiness: "A general worst-case analysis on all parameters has not been performed."

3. How representative is a pump test of a single well at a constant rate, and how appropriate is its extrapolation to large numbers of wells in the same circumscribed area?

4. The greater the distance from operations, the greater the lag time in development of drawdown.

5. Table 5-B (AppA1, p. 65) lists "Vertical Gradients Between Red River Carbonate and Winnipeg Sandstone" for four pairs of observation wells. However Figures 5-12 to 5-14 (AppA3) show hydrographs only for three pairs. Why was one pair omitted?

- How were the planned production rates in AppH(AppA6) determined for the individual wells that are listed?

- Several (5 or 7 or some other number <6) wells will operate simultaneously in close proximity, therefore the phenomenon of **superposition** of drawdown cones must be considered in estimating the drawdown projection zones in a multiple well system (e.g. Reilly et al., 1987)? The 'effective' radius of influence, i.e. the distance at which drawdown becomes zero, derives from the combined effects of smaller loci whose individual radii overlap (Yihdego, 2017), represented schematically in Figure 18:

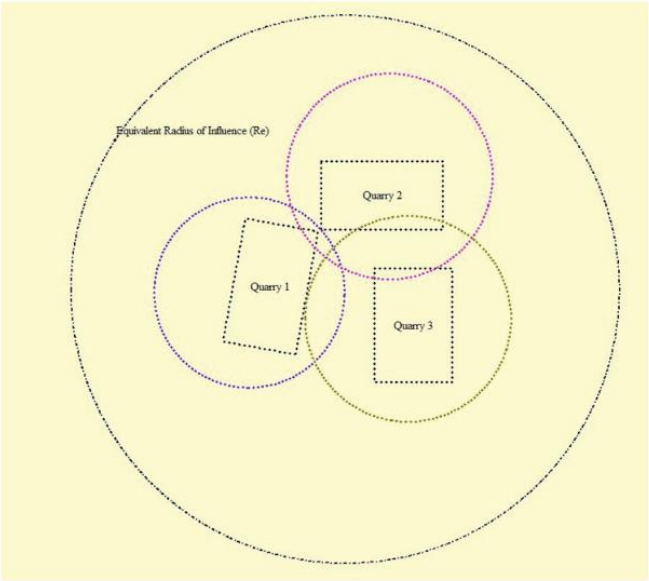


Figure 18. Schematic representation of effective radius of drawdown influence resulting from overlapping zones of individual drawdown areas. From Yihdego (2017).

As a result, the impact from multiple wells pumping at the same time creates a greater and more complex drawdown pattern (Figure 19). As the number of wells increases, the drawdown effects become greater, and pumping lift required in each affected well becomes higher (Kumara, 2023). In a late document, the proponent states that "Drawdown was simulated to be greatest when multiple wells are operating in close proximity" (see GMIMP, p. 14, in this Submission Addendum, p. 522). In the latter document, it is admitted that modelling of zones of concern was associated with "limited groundwater data", and that zones will be "adjusted after initial monitoring data are received and may require expansion over time." Thus the projected zones are likely underestimated, and "initial monitoring data" are lacking. In any case, the same model will not apply in different locations.

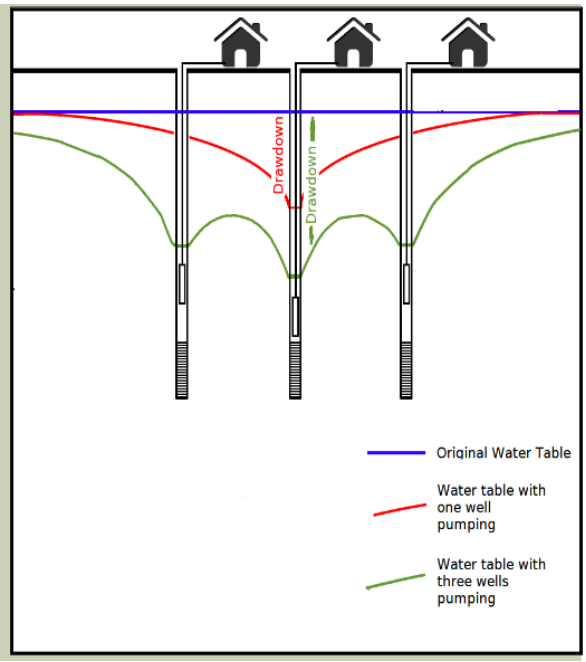


Figure 19. Drawdown and mutual interference of combined pumping wells. Effect multiplies with increasing numbers of wells. Source: Kumara (2023).

In the present situation, the wells in a cluster are only 18 m apart, and clusters are only 60 m apart. Thus the drawdown cone for a previous well/cluster will certainly not have recovered before pumping in the next well/cluster starts, i.e. when pumping starts in a well, there will already be an existing drawdown. Drawdowns from individual wells will combine into drawdowns of clusters, which will combine into overlapping drawdowns of different clusters. Commonly used equations such as the Sichardt formula do not apply in these situations (Yihdego, 2017).

The problem is complicated by a number of considerations:

1. Pumping and recovery are sequential in the different individual well/cluster zones. Therefore drawdown attenuation has started in the previous cluster, when the next cluster starts. Pumping in that next cluster will retard recovery in the previous cluster. The rate of recovery will depend on a number of non-uniform local aquifer conditions, such as hydraulic conductivity, and will not be a universal constant. No equilibrium, and therefore recovery, will be reached, until extraction has moved beyond the effective radius of influence.

2. Radius of influence for individual clusters is likely to be some other shape (not circular), depending for example on transmissivity heterogeneities in the limestone

3. Radius of influence will be modified by variations in pumping rates and volumes, which will certainly occur as individual wells are completed and new ones are brought into production, or interruptions, etc.

4. The contributory role of the water storativity of the previous cavity towards the replenishment of the new cavities, and therefore drawdown intensity, is an unknown quantity, and will depend on hydraulic conductivity of the intervening walls between clusters. Depending on degree of consolidation of the sandstone walls, the hydraulic forces may promote their (i.e. walls) erosion and potential eventual collapse.

5. We can conclude that the system at any location will be dynamic and unpredictable.

6. The effective radius of influence will impinge, in many cases unpredictably, on surrounding domestic wells. Thus the actual drawdown in a given domestic well may exceed the projected value.

- We note in Figure 19 that the **greatest depression occurs in the central well** of the group; we can interpret this diagram as a cross section of an extraction well cluster. Will reinjection of a well cluster need to be adjusted so that relatively more water is returned to the central well than to the peripheral ones, to offset somewhat the greater differential forces at the center?

- According to Kumara (2023), "Note that as the number of wells in the group increases, the mutual interference between wells becomes more, which results in the reduction of production capacity of individual wells.", and "The efficiency of each well is decreased."

  Has this reduced production capacity been considered, and will air-lifting psi have to be adjusted to compensate for this reduction?

- Figures 6-9 (2x), 6-11, 6-12 and 6-13 in AppA4 (note there are two Figs. 6-9, but no 6-10) indicate drawdown projection zones in the initial project area over four years for the two reinjection scenarios (0 and 50%) in the Sandstone and Carbonate aquifers. It would have been more useful if the respective reinjection scenarios were grouped into separate sequences.

  It is evident from these figures that even with 50% reinjection, ***ongoing*** **focal extraction will create drawdowns that will plague the area for years**. In the Sandstone aquifer, in Year 3 the drawdown zone "extends approximately 1,500 m [radius] from the active production wells", and "approximately 800 m [radius] …for production Year 2" (AppA1, p. 77) in the Carbonate. In light of the above discussion regarding superposition:

  -How exactly was superposition and mutual interference handled in the model?
  -How was the **travelling nature of the extraction** accounted for in the model?

-Since the extraction location will not be static but will progress from cluster to cluster, why are the projected zones of influence said to be *circular*, and not elongated or distorted, in keeping with the extraction pattern? Is the term *asymmetrically concentric* perhaps more accurate?

-How realistic were the boundary conditions used in the model? Was this treated as a linear system?

-The projected zones may be aggravated in seasons of low recharge rates: assumptions of constant recharge rates are not realistic.

-**An actual cluster as well as adjacent clusters have not been tested to ascertain actual example drawdown impacts**.

- A very material question intrudes here: what will be the drawdown impacts of the *superpositioned* multiple well system on a domestic well at the setback of 100 m, i.e. **only 1.67 cluster diameters away**?

- The model "simulated groundwater levels at observation points return to static water level conditions approximately 20 days after production ceases each year. Removal of solids will change the aquifer properties within the void created by sand removal and complete recovery may take up to four times longer in proximity to sand extraction wells." (AppA1, p. 77), i.e. up to nearly 3 months. In actual practice, this may be even longer, since some assumptions may not reflect operating conditions. Production ceases at the end of November and resumes in April (RPCR #166). Therefore the allotted **recovery period will not coincide with time of recharge**. According to the projection above, recovery is expected to be completed by the end of February, but if it takes longer, it will start to approach the time of extraction resumption in April, when recharge commences. In any case, there will hardly be a time during the year where static levels are normal, if extraction continues within the same area or cluster block.

- It should also be noted that creation of the large subterranean voids resulting from removal of the sand will create reservoirs. Their large numbers in an extraction area may affect water levels, and thus may influence magnitude of drawdown. Has this been considered in the modelling?

- In AppB (#FERGUSON-7), in relation to the pump tests, the proponent states: "As noted by Dr. Ferguson, the resultant estimates of aquifer properties are remarkably consistent.", but then we find out that "Well Bru 95-7 was **ignored** in favor of matching

the observation wells as the pumping well was **interpreted** to suffer from skin effects, turbulent head loss, etc. imparting excess drawdown in the well". (Emphases are mine). If this well did not conform, why was it culled for that reason? Since so few wells were tested, is an outlier not all the more important? Are there not likely to be more non-conforming (and non-confirming) wells in the project? Could this please be clarified?

- According to Mucha and Paulikova (1986), "The course of drawdown during a pumping test (and recovery) is **influenced by diameter** of production and observation wells." (Emphasis is mine). These authors found that "The effect of well storage is important… in aquifers where elastic storage and leakage are to be estimated.", as drawdown cones may be affected. Further, "Neglecting this, can lead to erroneous interpretation of pumping tests." Was this factor considered in the present modeling of drawdown and recovery?

- We must mention here the well monitoring network that provided pressure transducer data. In RMSF-IR-011, the proponent states: "Water levels in Unknown Well Obs S1 (screened in Winnipeg Sandstone) were monitored using both manual methods and a pressure transducer.". The subsequent description of water level measurements progresses well, until we are whacked with: "Although not described in the text, the well is operated as a **geoexchange well** that utilizes groundwater as a source of heat and/or cooling for the associated residence. **This is evident based on the cyclic low amplitude increases and decreases in water levels throughout over the duration of monitoring.**" (Emphasis is mine).

  We infer that this geothermal system may have been open loop (as opposed to closed loop), since the water level measurements in this well were apparently complicated by geoexchange pumping (https://portal.ct.gov/-/media/Departments-and-Agencies/DPH/dph/environmental_health/pdf/31GeothermalWellspdf.pdf). How valid are the necessary finer measurements of the superimposed proponent's pumping test? Why would a well that has simultaneous other activity even be considered as an indicator for a precision water level pumping test? The instrument manufacturer of the VW2100 model transducer used in the monitoring (AppA5) also cautions: "It is not recommended that vibrating wire piezometers be installed in wells or standpipes where an electrical pump and/or a power supply cable is present or nearby. Electrical interference from these sources can cause unstable readings." (https://rstinstruments.com/wp-content/uploads/ELM0005T-VW2100-Vibrating-Wire-Piezometer-Instruction-Manual.pdf). At the very least, why was the pump not shut off for the duration of the monitoring?

- An inquiry in RMSF-IR-012 about the reliability of the vibrating wire piezometers elicited the following proponent reply in part: "The instruments are factory calibrated near Maple Ridge, British Columbia [AppA5], and were shipped overland in boxes with the

instruments protected in foam and bubble wrap. Upon arrival, the instruments were inspected by trained personnel and confirmed to be in good condition."

Unless the delicate instruments were transported on clouds by feather-soft downy angels – oh wait, it was land transportation - foam and bubble wrap in themselves do not fully protect against the momentum of bumping trucks hitting potholes, screeching stops at traffic lights, sudden brake applications after spying speeding enforcement as parcels topple in the back, and overenthusiastic workers at loading docks practising penalty kicks (judging from sometime appearances). That they arrived in "good condition" was apparently a relief, there were no chunks that had broken off.

Because of potential internal disarray, a field calibration check is required before each installation. In AppA1 (p.26), "initial readings were taken with no load applied immediately before installation. These initial readings were used to apply correction factors to the post-installation readings." (Also RMSF-IR-012). It is not clear from this description whether this refers to just the initial zero reading with no applied load, or whether the *entire field calibration procedure*, with calculation of the instrument calibration factor (CF), described by the manufacturer of the relevant VW2100 model, was also followed, as no mention is made of the latter verification or its result (https://rstinstruments.com/wp-content/uploads/ELM0005T-VW2100-Vibrating-Wire-Piezometer-Instruction-Manual.pdf). According to the manufacturer, "The two values should agree within ± 0.5%", i.e. both the factory and field calibration factors. Otherwise the instrument cannot be used: "It is not recommended to install the piezometer if the calibration record sheet CF value cannot be confirmed by the field calibration test." The point of this query is that details of the inspection, zeroing and subsequent installation procedures as specified by the manufacturer are duly chronicled in AppA1 and RMSF-IR-012, but there is no allusion in either document to essential field calibration, and CF concordance percentages are not reported.

- It is important to recall that while the plan is to reinject some of the extracted water, **the volume and mass occupied by the sand will not be replaced**.

  In this regard (RPCR #39) a citizen comments: "This summer's extreme drought saw some citizen's wells dry up. If CanWhite doesn't plan to replace the equal volume of sand being extracted, our water table will drop significantly."

  The proponent responds: "The replacement of the sand has already been considered in the assessment. Except for a residual amount of moisture that remains with the sand as it transfers to the slurry line, the entirety of the groundwater (once separated from the sand) will be returned to the aquifer. Overall, the extraction of sand and water will result in an effective pumping rate of approximately 270 US GPM. The effective pumping rate was calculated and applied in the assessment to account for the volume

of groundwater required to "replace" the sand removed from the aquifer." (also a similar reply in RPCR #45).

The following observations intrude:

1. In SSCR (#10), the proponent again states: "The net "pumping" rate will be limited to the volume of groundwater required to **replace the volume of solids** removed from the sandstone aquifer." The pumping rate in the above RPCR (#45) quote refers to the total volume of water and sand, albeit it is the *minimum* value, and represents the total volume removed, but **the fact remains that the volume occupied by the sand will not be replaced**, and only some of the water will be returned. To replace the entire volume, including the "volume of solids", a supplementary source of water would be required. It would also be a moving target, as the relative volume of sand in the extracted mixture will greatly and constantly vary (AppA1, p. 22).

2. Why was the minimum cluster pumping rate of 270 US GPM used? What happened to the 550 US GPM value (e.g. TAC #34), to say nothing about even higher possibilities?

3. In RPCR (#43), "**There will be excess capacity in the aquifer following sand extraction**", and "it will not be possible to reinject 100% of the volume of materials (sand and groundwater) that are removed during extraction" (RPCR #58)(Emphasis is mine). "Capacity" here means that this empty space will fill with water.

4. From RPCR (#39) above: "to account for the volume of groundwater required to "replace" the sand removed from the aquifer": it was apparently meant that, in calculation of drawdown, the model accounted for the volume of sand that will not be replaced. However, if this is true, how was the great variability in sand/water content handled? AppA1 (p. 22) estimates 20 - 70+ % sand content, even 90% at initial stages (EAPPF AppH; SSCRIR1 #DLN-IR-007).

   RPCR (#58) claims "The sand will account for approximately 50% of the volume of material that is removed." The value of 50% was used in the simulation model: "the maximum reinjection rate will be equivalent to 50% of the slurry extraction rate, which was simulated. The remaining 50% that was not simulated to be reinjected represents the volume of sand that is extracted and therefore removed from the system" (RPCR #58). The equation does not balance, as, regardless of the reinjection scenario, a maximum 'perfect' recovery and reinjection can never be achieved: i.e. if there is 50% sand, there will never be a 50% reinjection rate, and it is pointless to simulate its results.

- On what basis was the value of 50% chosen, and how representative is it of the **entire extraction cycle**?

- Why was the 15% (or other, see p. 66) water content of the (stockpiled) sand (SSCRIR1 (DLN-IR-002) not included in the 50% reinjection modelling? Besides the volume of the sand, some water will also be retained or otherwise dispersed in the course of other steps in the procedure, and not reinjected. Was this volume also accounted for in the model? Is there any estimate of what this value might be?

- Worst-case would be 70+ % sand (perhaps 90%), during the first days where less than a third of the volume would be water, and not all of that water would be returned. **Drawdown could thus be 'front-loaded' and more severe at this time**. The temporal cumulative effect of several wells in a cluster would depend on how many are operating, at what pumping rates, and the degree to which they are staggered in their operational cycle. In other words, how many wells in a cluster will start up at the same time, and to what degree will they be synchronized?

- RPCR (#59) refers to "the limited temporary zone of influence of extraction activities." Effects will not be evident immediately. What is the **lag time** between extraction pumping and initiation of drawdown in surrounding wells at various distances, i.e. what is the **timeline for formation of the drawdown cone**, for a given set of porosity and hydraulic conductivity values and pumping rates?

  In other words, it may be too late to modify/mitigate operations that caused a problem by the time a well owner notices it, as the operation will have moved on.

- "An exact replica of site conditions and extraction activities is not required to produce meaningful results." (RPCR #58). *Of course*, an exact replica is not possible, and nobody is expecting one. The point is that every effort should be marshalled to pursue and obtain as many real facts as possible, rather than **rely on assumptions**. *That* is what will give the much strived-for "meaningful results", and even these will not be infallible, as no model can be completely accurate, because all of the contributory factors can never be fully accounted for. Each site will be unique.

- Cutting through the tangle, the bottom line is: we can expect that, given the large numbers of extraction wells, and their comprehensive distribution throughout the project area, many private wells may be affected by drawdown to some extent at some point in the proceedings. The buffer from homes and private wells is only 100 m; the closest wells will experience the greatest effects soonest and for a period after operation. If superimposed on a drought year, impacts will be more apparent and

numerous, and recovery longer. As the project creeps along, new wells will be engaged along its path.

- "Groundwater levels in the sandstone and carbonate aquifers are expected to recover shortly after operations cease in each extraction well and well cluster" (RPCR #32).

  1. What is meant by "shortly"? Days, weeks, months?
  2. Operations may "cease in each extraction well and well cluster", but the next cluster is just 60 m away….(Figure 2-3, EAP1)(see Figure 116, p. 427). Recovery in an area may thus be staggered over some time, as we see in the 4-year model projections in Figures 6-9 – 6-13 in AppA4 (there is no Fig. 6-10).

  "Groundwater levels are anticipated to return to static water level conditions approximately 20-80 days after production ceases at each well cluster. These results account for other existing draws on the aquifer, and therefore account for cumulative effects with existing water wells and other industrial activities in the region." (SSCRIR2 #CEC-IR-014). What "other existing draws" are referred to here? Can they be itemized: while the volumes of industrial draws can be inferred from their licenses, how were draws for all of the domestic wells calculated? How were they integrated into the simulation?

- How will aquifer recharge conditions affect recovery rates? Apparently recharge rates were not investigated (*cf.* TAC #50), yet this is the most basic of relevant data for such a project.

  In SSCR (#3), the proponent claims: "The cessation of pumping over winter months was simulated to allow groundwater elevations to recover each year."
  It should be noted that for shallow aquifers, much of the recharge occurs in spring when the snowpack melts, plus spring precipitation, but "Seasonal fluctuations of water table are not transmitted down to the deep aquifers." (Chen et al., 2004). Deep aquifers show a different cycle, according to the latter authors: "annual fluctuation in those deep confined aquifers show a gradual rise in head from October to May/June and a rapid drop from May/June to October. However, **few quantitative data** is [sic] publicly available with respect to recharge rates and relative contributions from the two different recharge sources for the fresh water in the Upper Carbonate aquifer." (Emphasis is mine).

  Several comments can be made here:

1. During the spring recharge period of the Carbonate aquifer, extraction is already proceeding (RPCR #166). The aquifer has not fully recharged.

2. The "rapid drop from May/June to October" in the Sandstone aquifer will coincide with the additional drawdowns due to extraction.

3. In SSCR (#4) the proponent contends that "the aquifer systems are well understood", contradicting Chen et al., (2004).

4. The proponent repeatedly stresses that "the scale of the project is regional" (e.g. SSRC #3). However the reviewer in SSRC (#4) states that "the project area is crudely estimated at 168,000 hectares" (SSRC #4), although the actual extent is not clear (see p. 27).

- "Measures will be developed to avoid and/or mitigate any well interference issues as required by The Water Rights Act of Manitoba." (EAP2, p. 84). "Appropriate mitigations may include conducting a survey in advance of operations to determine the location, depth, use and configuration of each well, lowering of pumps in advance of sand extraction or providing treated makeup water during periods of time when drawdown impacts may occur." (AppA1, p. 81).

  Similarly in SSCR (#3): "Protocols will be established to survey existing domestic wells in advance of operations, monitor groundwater quantity and quality during and following project operations, and respond if there are any well owner complaints."

  In TAC (#36) we read: "Given the unknown status of the majority of pumps, it is prudent to conduct a physical survey of water supply wells in advance of operations in each area to document the well location, well condition, water level, pump installation depth, water use and water quality, followed by monitoring during and following operations. CanWhite will conduct a detailed pre-development well survey to obtain accurate well coordinates and document well construction and operational use to establish appropriate mitigation measures which may include setbacks, modified operations or adjustments to pump installation depth at CanWhite's cost. The details of this survey will be provided for in the Groundwater Monitoring Mitigation Plan (EAP, Section 8.4)."

  A number of observations arise:

  1. Where are these 'protocols'?

  2. Since the status of the majority of well pumps is unknown, how could this proposal have proceeded this far without such extremely vital and basic data?

  3. Who will actually do this physical survey?

The proponent will "survey existing domestic wells" (above quote); also "Prior to any activity, nearby landowner wells will be surveyed by 3rd party hydrogeologists and experts." (''Facts Matter'' public ad campaign, The Clipper, 8 December 2022, p. 9).

- Who are these "3rd party hydrogeologists and experts"? Consultants employed and paid by the proponent? The proponent will own and control all of the data. This is not impartial 3rd party. An *independent* watchdog is needed to oversee and intervene when necessary. However our legislation and administrative system do not seem to provide for such a protection for citizens.

- The data to be collected are intrusive and invasive. What if homeowners do not wish to participate in the survey? What if those 'nearby landowners', who may not even be directly involved with the operation nor have landowner agreements, do not wish or trust for a private mining company to meddle with their wells, which are technically their (i.e. landowners') property and responsibility under the Manitoba Groundwater and Water Well Act? What are their rights to choose/refuse? What if their rights to refuse are not respected?

If they decline, will they be later shunned or blacklisted from response as punishment if they develop a problem? They just want to live their lives. **What other recourse will be available to them**?

(See the Appendix at the end of this document, also p. 290+ in the Water quality analysis section).

-Will homeowners have transparent access to their unredacted results, or will the results be classed as "proprietary" secrets, along the same lines as the elusive 'Homeowner Water Well Survey', for example? Aside from a list of anonymous groundwater users and well depths in AppG(AppA6), other information is redacted. (Note that there are TWO Appendices G: The first one, 'Summary of Groundwater Users' is located in AppA6. The **other** Appendix G, located after Appendix F, relates to Heritage Resources.)

To illustrate, Section 3.2 of App1 deals with (presumably already existing) homeowner water well surveys. The proponent demurs: "Homeowner well surveys have not been included in this report due to privacy and confidentially [sic] reasons" (App1, p.24). There is a multitude of ways in which data could have been compiled, tabulated, and interpreted without violating individual privacy. A whole learned field is dedicated to this art: it is called 'Statistics'. Why does the EAP omit this important information? Why was this work even conducted, if the results are secret? Was an impartial outside agency hired to do this work? Private homeowner wells are not company property.

How were the results of these confidential surveys *utilized* in the EAP? What sorts of information did they provide?

- In SSCRIR1 (#CEC-IR-003), monitoring wells are now introduced between the mining sites and people's houses: "Sio will actively monitor water quantity and most water quality parameters surrounding its operations 24/7. Additional water quality measurements will be taken regularly before, during and after the extraction activities. These **monitoring locations will always be between the operations and any landowner wells.**"

  Similarly, in the 'Facts Matter' public ad campaign: "Sio will also install **monitoring wells between Sio's operations and private residences** so that water levels can be monitored at a distance. Monitoring wells will be used to monitor water quality 24/7 and water quality [sic] before during and after extraction in the sandstone and limestone aquifers." (The Clipper, 8 December 2022, p. 9).(Emphases are mine).

  In SSCRIR2 (#MBEN-IR-031), the number of monitoring wells has burgeoned: "The configuration of the monitoring well network will focus on the perimeter of the **5-year** operational footprint. Wells will be installed in **proximity** to early-stage extraction wells to monitor system performance and **validate** previous assumptions and the results of groundwater modelling assessments. As part of routine operations, additional monitoring wells will be established between extraction wells and any nearby private wells to monitor aquifer response to extraction activities." (Emphases are mine).

  Similarly in SSCRIR2 (#CEC-IR-011), "Specific actions taken to monitor groundwater levels include establishment of a monitoring well network that is able to monitor groundwater levels **at a range of distances between sand extraction wells and adjacent wells. It will include wells proximal to operations, upgradient of operations and downgradient of operations. These wells will be both inside the project area and outside the project area**. Wells will be completed in both of the primary aquifers including the Red River Carbonate and Winnipeg Sandstone aquifers." (Emphasis is mine).

  A number of questions arise:

  1. We now learn that there will be many more boreholes, in addition to just the sand wells. **<u>HOW MANY OF THESE ADDITIONAL BOREHOLES WILL THERE BE?</u>** The sand production well numbers in themselves are unimaginably enormous, but we learn that another large but unspecified contingent will not even be for mining, but will **still span both the Carbonate and Sandstone aquifers nonetheless.** These extra boreholes will perforate the areas that are not already ravaged by the sand wells. **They will even extend "outside the project area".**

  2. Since they "will always be between the operations and any landowner wells", **what if the setback from domestic wells is only 100 m?** Will the private well become the monitoring well? "Actions may also include direct monitoring of existing water supply wells with the permission of well owners." (SSCRIR2 #CEC-IR-011). But water quality will

be monitored 24/7, this will be intrusive and disruptive. Or maybe the homeowner will be tasked with collecting the samples, 24/7?

3. There will be a **lag time** for measurable changes to be expressed How long "after the extraction activities" shall monitoring continue?

4. "most water quality parameters" will be monitored. The proponent indicates that these will include "anions, total metals, dissolved metals, nutrients, microbes and other regulated constituents. Field parameters including pH, temperature, electrical conductivity, oxidation-reduction potential and dissolved oxygen will be monitored using a calibrated handheld water quality monitoring probe and/or in-field water quality kits." (SSCRIR2 #CEC-IR-011). Total dissolved solids, total alkalinity, cations and organic parameters are excluded, even generic oil and grease, which should be tested. What are "other regulated constituents"? Will somebody know how to calibrate the probes, and do this every time (see p. 257)? Water quality kits that rely on addition of chemicals and eyeball comparisons of resulting color changes are not adequate for the level of scrutiny required. Furthermore, these kits create chemical waste – where will this be disposed of?

In SSCRIR2 (#DLN-IR-003), "A range of possible constituents of concern will be monitored before, during and after operations." What are these "constituents of concern"?

The samples will need to be delivered to the lab promptly and continuously. Normally it may take days to weeks for a certified lab to analyze samples. How will the process be speeded up here, so that **results are promptly available**? What use is it, if a change is detected a week or more after it has first occurred? Will a contract be drawn up with the lab for this long term undertaking?

5. "While it is not expected, if there is a concern with water quantity or water quality, Sio would likely see this on one of the monitoring wells before any landowner wells due to the proximity" (SSCRIR1 #CEC-IR-003).

What is the actual "proximity" of the monitoring well? Proximity to the operations, or to the landowner well? According to Cowlishaw (2014), the utility of observation wells for measuring drawdown requires a number of conditions which must be considered: "the smallest possible diameter involves the least time lag", longer screens (at least 1-2 m) are required, the well cannot be too close ("if too close (<3 to 5 x aquifer thickness) can be strongly influenced by anisotropy (stratification)"), and "if too far away (>200 m unconfined), $\Delta h(t)$ increases with time so a longer test is required – boundary and other effects can swamp aquifer response". Thus it may not be possible for all of these conditions to be met.

Furthermore, as discussed above, joints and fractures in the limestone may channel water in unpredictable ways between the operations and the houses, and **may not be in a direct line**, therefore the **monitoring well may not intersect with the actual path that the groundwater follows**. It is conceivable that in some, or many, situations, the monitoring wells may not reflect what is happening at the homeowner's well. The company can then say: It's not us! No sirree. Complete coincidence.

6. Why is there a "5-year operational footprint", when the current instalment of the application claims to be for 4 years?

- Frustrating confusion and double-speak surround the sampling effort. What is the sampling frequency? It seems to be a simple question.

"Sio will actively monitor water quantity and **most water quality parameters** surrounding its operations **24/7**." (SSCRIR1 #CRC-IR-003).
"Monitoring wells will be used to monitor **water quality 24/7**" (The Clipper, 8 December 2022, p. 9).

And then "**Additional water quality** measurements will be taken **regularly** before, during and after the extraction activities." SSCRIR1 (#CEC-IR-003).
"Additional" to what? How regularly is "regularly" – every few hours, once daily, weekly, what?

"**Groundwater quality sampling will be conducted quarterly** for perimeter monitoring wells, **and monthly** for wells in proximity to extraction wells **during operations**. Samples will be collected directly from private water wells in advance of any extraction activities, and again during and after operations. Sampling activities will continue at a quarterly frequency following operations for at least five years. Monitored parameters will include field parameters, physical parameters, anions, dissolved and total metals, pathogens and isotopes." (SSCRIR2 #MBEN-IR-031).

"Groundwater in proximity to **ongoing operations** and private wells will be monitored and evaluated **monthly**." (SSCRIR2 #MBEN-IR-031). (All emphases are mine).

1. The 24/7 promise means that at least two samples will be collected every 24 hours. How many samples per day would actually be collected? If it is once a day, the "24" should not be promised.

2. If 24/7 sampling is promised, as it also has been in the public media, how does this align with "**monthly** for wells in proximity to extraction wells **during operations**"? Monthly/quarterly are in a completely different ballpark from 24/7, are they not?

3. What is meant by "proximity"?

4. Who will conduct the sampling? Will company employees collect and select/cull the samples, and how will proper independent chain-of-custody be maintained?

5. "Samples will be collected directly from private water wells": the proponents have thus far encountered difficulties in obtaining direct water samples in two out of three attempted wells due to obstructing wiring and equipment (AppA1, p. 46). How will this obstacle be resolved? More water softener samples (p. 285+)? Yes (see p. 528).

6. What if homeowners do not wish for company personnel to interfere with their wells? This may be particularly onerous and intrusive "following operations for at least five years". Will a formal agreement be required? The Surface Rights Act entitles the homeowner to compensation for time (see Appendix). What if the home changes ownership?

7. The chemical and pathogen parameters to be monitored are not specified. Monitoring only anions and metals excludes a very large and important sector of chemical parameters. No organic parameters are mentioned. What "physical parameters" will be examined? What isotopes are envisioned here: radon? What about other toxic gases (hydrogen sulphide)?

8. "The program will be supervised by a qualified professional." (RPCR #3, #11, #24, #211). This "qualified professional" will only supervise the program, not conduct it. What is meant by "supervised"? This can range from designing and conducting the sampling program onsite, to glancing at the data every few months. This will be a multi-year commitment. Who will be the *independent* "qualified professional" who will oversee and enforce monitoring responsible for the program? We hope these are not the same personnel who collected samples from water softeners (p. 285+).

"Quarterly evaluation of water quality by qualified hydrogeologist and/or geochemist, with results shared publicly; and others. Private Well Owners notified in the event there are deemed to be risks to water quantity and quality in private wells." (SSCRIR2 #CEC-IR-011). If there are risks to water quality in private wells, **a quarterly evaluation will mean that people may have been drinking tainted water for months**. Should there not be a more immediate alert?

9. What **long-range commitment** is there to ensure any aftermath will continue to be addressed after the company has left, or after it has dissolved or transmogrified (many times) under a new name, ownership and structure?

- This leads to the primary issue of concern. Even with the best sampling/monitoring program, what happens when the results indicate trouble?

- How soon can response occur? At least days, possibly weeks, have elapsed by the time data are returned from the lab and are reviewed.

- The troubled water is already **long gone back into the aquifer** and cannot be retrieved. What sort of response is even possible at this point, when any meaningful action needs to happen *before* the water hits the…….

-" Data will be evaluated on a regular basis (minimum **annually**)" and "Groundwater in proximity to ongoing operations and private wells will be monitored and evaluated **monthly**." (SSCRIR2 (#MBEN-IR-031)(Emphases are mine). Which data will only merit perusal *annually*? If there is an issue, is this not late to discover it? How do these annual data differ from the "in proximity" "monthly" ones? Isn't 'monthly' again rather lax, especially if there is a problem? A monthly sample may conceivably be collected when an issue has existed for nearly a month, and then there is the lab turn-around time, and then somebody has to see it….Then somebody has to decide what to do. Then so much time has passed, that it is all 'water under the bridge', so to speak. Why worry. If someone were to get sick, it would have happened already.

- For the Permitted injection well(s) that have already operated, there are evidently no data for the water returned to the aquifer (TAC #10). Why? Is this not critically important?

- **Why is the detailed sampling program plan not available for evaluation NOW?** Surely a project component as fundamental as this could have been formulated already? Approval is sought without a plan, which may or may not be submitted later, and which will disperse within the mists of the "living documents" once operations are underway. What happens if the plan is deemed inadequate? Will anybody check? Will approval be revoked? Sadly, we can predict the answers.

- "The results of monitoring will be used to **validate** the existing numerical groundwater model. Any **material differences** between simulated changes and measured data during operations will be rectified by refining the conceptual model, recalibrating the numerical groundwater model or addressing any residual data gaps." (SSCRIR #MBEN-IR-031)(Emphasis is mine).

  It looks like the conclusions are foregone. Isn't this backwards? Shouldn't the results be used to objectively ascertain and construct a model, without favoring a particular outcome? Will nonconforming data be rejected because they don't 'validate' the narrative? What are "material differences"? Shouldn't there already have been far more data to inform the model, *which is already being applied*, especially if there may be

"material differences" looming, rather than sampling in its wake, on the fly, sweeping up the debris? Is this not a reckless approach to such a huge undertaking?

- As for mitigation, "well yield can typically be restored by lowering the pumps in the affected wells." (RPCR #32); "some pumps may become too shallow to access the ground water. In these instances, the pumps would need to be lowered to allow for pumping of water from the aquifer." (RPCR #49). Many pumps are already installed at the bottom of the well and cannot be lowered any further. According to the peer reviewer/well driller, "Lowering of pumps is **not a practical solution in this area** when most pumps are traditionally set at the base of the casing." (AppB #FRIESEN-10) (Emphasis is mine).

  "CanWhite will assume the cost of lowering the pumps" (RPCR #214). Where/if adjustments can be made, will the homeowner have the option to engage the services of a trusted plumber and to submit the bill to the company for reimbursement, in lieu of a company representative/contractor making any alterations to private infrastructure? This is especially important since presumably the alterations will be permanent, and liability issues may arise.

  Will CanWhite also assume the cost of a new pump if the homeowner's submersible pump burns out as a result of pumping air?

  As a real life illustration, a gravel pit operator in Brokenhead Municipality wished to dewater his pit pond by pumping the water out into the municipal ditch. He went to the municipal office, where the CAO gave his blessing to proceed. The high speed pumping caused two neighboring domestic wells to go dry. One of the pumps burned out while the homeowner was away at work. The installation of a new pump cost more than $1000, in addition to the inconvenience of being without water until a plumber could do the work. The homeowner could not sue the gravel pit operator, as he had the CAO's (verbal) permission to do the pumping. The Reeve told the homeowner to "Keep the receipt.", pending municipal council palaver and deliberation. Now, more than 20 years later, the homeowner is still "keeping the receipt". A memento for the family album perhaps.
  The moral of this story is that an operator can hide behind so-called permission or approval, and evade liability, while the unfortunate homeowner is left with the bill. Civil servants are not liable for their decisions. Not fair? S*ic vita est.*

  "lowering pumps in water wells that may experience a temporary water supply issue is one potential mitigation strategy that can be used to maintain water supply, if needed" (RPCR #64). **What are other mitigation strategies or corrective measures that will be available?**

  A citizen's comment (RPCR #68) is relevant here: "CanWhite Sands assures concerned citizens that the aquifer will not be disrupted in any way by their business. This is confusing in the sense that CanWhite Sands has mitigation plans for homeowner's well

water decline – solution, in their own words during their August 24th open house will be to truck in water!"

In the reply, the proponent states: "CanWhite is required to look at any and all situations that could require mitigation and all practicable mitigation measures that could address such situations, even if they are highly unlikely to occur. The reference to trucking in water is one such example." The only other example suggested is lowering of well pumps. However **in the case of water quality issues, the options reduce solely to trucking.** (See pp. 536-537).

- Where will the trucked "treated makeup water" (AppA1, p. 81) come from? How will it be stored at the homeowner's place? Will the water truck be parked at the house, or will the homeowner have to buy a tank or cistern to transfer and store the water, or will the company supply one? Since the "makeup water" will not be connected to the plumbing in the house, it will have to be transported/carried manually for the various needs. It will be required for consumption, cooking, washing food and dishes, laundry, flushing toilets, washing hands and surfaces, bathing. If the home is not a bungalow, the bathtubs are upstairs. There may be animals and a garden to water. Will hot water be provided for washing dishes, laundry, bathtubs and showers, or will it have to be heated on the stove? What if there are children? A senior living alone may not be able to manage. Will the company provide help? Will compensation be available? What about farmers with livestock?

  Given that not all wells in the cluster and/or cluster block on a parcel or in the vicinity will be operating at the same time, or possibly even the same year, resulting in an extended period within the zone of influence, how long/often would the property owner be expected to subsist on "makeup water"? Will the company pay for a hotel to house affected families during this tribulation period? Animals will require immediate arrangements.

- At the CanWhite virtual open house on August 24, 2021, a company official was quoted in the media thus: "If there is an issue with their water, we'll immediately step in…We'll ensure they have water, whether we bring in potable water. (We'll) cease the operation nearby and determine very quickly if it's the result of their well, or whether it's the result of our activities. If it's our activities obviously we'll cease them immediately." (The Clipper, September 2, 2021, p. 5).

  In the public ad campaign in The Clipper (January 12, 2023, p. 10), "We must test water again and again and must quickly pause operations to solve any issues related to that, **no matter how minor**." (Emphasis is mine.)

"CanWhite will have a stringent mitigation and monitoring program that will monitor aquifer conditions before, during and after extraction activities. A pre-development assessment (like what was completed for the hydrogeological and geochemical field investigation) will be completed for wells near the proposed extraction activities in the area. Groundwater elevations will be monitored in real time so that **operations can be stopped if water levels approach intolerable ranges**. If any intolerable levels are observed, CanWhite will investigate to determine if the cause is related to CanWhite's extraction activities. Should Project activities impact the availability of water to nearby residents, including during drought conditions, CanWhite will immediately take actions to ensure access to water at CanWhite's cost." (RPCR #32) (Emphasis is mine).

There is conciliatory talk of mitigation, but there is no information regarding this "stringent mitigation and monitoring program". Where is the protocol for this testing "water again and again" to be found? Which water, what exact parameters, how often? As discussed above, lab results may take a week or more.

"If a homeowner's access to water is negatively impacted, the impacted homeowners will be provided with potable water available for **immediate use** at CanWhite's cost." (RPCR #60) (Emphasis is mine).

In actual life terms, there is a glaring reality disconnect here: the homeowner will require water immediately, but assistance will not be forthcoming in any timely way. On the one hand, the water will supposedly be "available for immediate use", yet the problem must first be detected **after it has occurred**, then the homeowner has to report it someplace:

According to the proponent, "Landowners would have to contact Sio." (SSCRIR2 #DLN-IR-002).
"CanWhite will provide local residents with contact information to file any complaint or concern." (RPCR #214). "Landowners nearby will be notified of activities nearby and expected timelines. They will also be provided with a 24 hour phone line and email that can be reached in the event that they believe there is a problem **with their well**." (RPCR #253, #254)(Emphasis is mine). Also, "Should a concern arise, a 24-hour contact number will be available." (''Facts Matter'' public ad campaign, The Clipper, 8 December 2022, p. 9).
"Sio will make efforts to resolve any complaints that are received in a timely manner, and in good faith. Complaints will be managed in order of urgency." (SSCRIR1 # CEC-IR-003).

The residents cannot report the problem directly in person, at the mobile office for example, as they are not allowed on the work site: "only authorized personnel will be permitted on the active worksites" (RPCR #137, #256). Will they have to leave messages or wait until next morning or after the (long) weekend when somebody returns their call, then hope that "CanWhite will investigate" itself (RPCR #32)? What is "a timely

manner"? Will somebody monitor the emails and respond 24 hours a day, or does "24 hour phone line and email" mean that complaints can be left on Voicemail any time, but response will be whenever? And further, "response" means actual on site in-person response, not just a returned phone call. How will "order of urgency" be determined?

We note that the 24 hour contact seems to **specify well problems**. Will this line also handle response to other problems, such as noise, especially at night?

What are the criteria for "intolerable ranges"? Intolerable for whom - the homeowner or the company? If there are "intolerable ranges" observed through the monitoring, the problem has already affected the homeowner, the data must be transmitted and evaluated someplace, but then the company still has to "investigate" itself and consult and deliberate. In any case, evidence will first be needed that the operations are causing the problem, accompanied by significant delay. Who will conduct the investigation? What is the standard protocol that will be followed, and how long will it take? Will reports then have to be awaited? The complaint must then be referred to somebody in the company pantheon to make a final decision. The company will understandably not be excessively eager to embrace responsibility/liability and may engage in evasive measures. There may be wrangling and recrimination. And then, in the event that/if the company should finally admit culpability, how much time has passed? Will the water truck only be dispatched at this point to get fresh water, then bring it to the home? The family has been without water this entire time. They have had to fend for themselves and purchase and bring their own water. It is small comfort that when the water truck does arrive, the water will at last be "available for immediate use." The family will be scanning the road with binoculars and anxiously waiting with their empty jugs and pails. And they will be extraordinarily grateful that this generous favor would be bestowed even in "drought conditions", think of that, when presumably the company really wouldn't have to condescend to such charitable lengths.

Thus, timely stoppage of operations and swift relief for the homeowner will be unlikely. It seems that poor Joe Blankowsky and his six unwashed children are out of luck.

Time will grind on, and if the eventual company decision is unfavorable, there will possibly be no redress in the end. By then the operation will have moved on. How will/can mitigation occur after the fact?

- "Should the landowner and Sio disagree on the cause of the issue or appropriate mitigation measures, Sio would contact a 3rd party water well drilling company and/or hydrogeologist to provide their expert opinion on the mater [sic]. This would determine the course of action. If Sio's experts or the 3 rd party finds that the landowner's well is being negatively impacted by Sio's activities, Sio will cease operations until an appropriate solution is determined." (SSCRIR1 # CEC-IR-003).

1. The 3rd party well drilling company is employed by the company, and will be investigating itself and its own work. The hydrogeologist will also be paid by the company. A real 3rd party could be, to use a silly example, the Province. But wait, the Province approved the thing and does not want the stains, so…..somebody outside the area, or the province, maybe? Unlikely, you say?

2. In the mostly improbable event that it is admitted that the resident's well is affected (with undesirable liability issues), the company will only "cease operations until…", not drop operations altogether. The homeowners will endure various manipulations of their wells, or have to settle for that odious 'trucked water'.

But, since all of this consultation and opinion seeking and rumination will take more than a few hours or even a couple of days (the hydrogeologist doesn't work at night or on weekends and holidays, unless he/she is paid to be on call), the operation will have moved anyway. If the next clusters are now causing a problem, we need a new assessment……

3. Through all of this, the most glaring and conspicuous omission is the absence of any provincial oversight, involvement, intervention, interest, assistance whatsoever. The homeowner is left to deal on his own, with a situation that has been forced upon him through no fault of his own.

4. In a just world, the company should not be investigating itself, for obvious reasons. An impartial, objective third party is required, but who? Nobody wants to get involved. The regulators will not be overly zealous to handle the consequences of their permissive and ill-considered decisions: their mandate is to help and justify the industry. If there is a dispute, will litigation be the only recourse? But another obstacle pops up: will the crucial evidentiary data be "proprietary" and inaccessible? The homeowner will have to prove her/his case and incur the expense of hiring an engineer and lawyer, and pursue years of thankless struggle. Most will be unable to undertake this.

In a utopian, just, and humane world, unattainable as it seems, the following would happen. **The homeowner would be immediately provided with water**, without dithering and delay, regardless of whether the company is subsequently demonstrated to be at fault or not – this is the least they could do, given the other nuisances that they are creating. This presumptive approach would be bolstered by:

A) the **timing** of the complaint relative to active operations (i.e. after commencement of operations, even more than a week after),
B) the **nature** of the complaint: deprivation or diminished quantity of water, or discolored, stinky, or otherwise tainted water.

These factors would make it unlikely that some other cause exists. Further investigation can then be conducted if warranted, but human beings should not be without water, which is a **Fundamental Human Right**.

The length of time during which water is supplied should extend until the problem has been rectified. If it persists for more than two days, the family should be offered compensation for hotel accommodations and meal expenses, until they can return home to a restored and safe water supply, as demonstrated by a lab result. Arrangements for their domestic animals should also be covered.

- According to the peer reviewer/well driller, "Projects that could develop a widespread area of impact typically also include a groundwater interference plan, or some means in which a resident can have a private well complaint assessed. Groundwater interference plans are mandatory on projects such as this one." (AppB, #FRIESEN-10).

  The proponent reiterates that "The Groundwater Monitoring and Impact Mitigation Plan will include a robust procedure for responding to unforeseen issues in a timely manner. CanWhite has demonstrated its commitment in responding to complaints". (RPCR #60).

  - Where is this Groundwater Monitoring and Impact Mitigation Plan?
  - What is meant by "robust procedure"?
  - Why are the issues "unforeseen"?
  - What are the protocols for responding to complaints?
  - How has "commitment in responding to complaints" been demonstrated?
    See Public Comments in Registry
    (https://www.gov.mb.ca/sd/eal/registries/6119/public_comments_2.pdf , page 6.)

  - Will an option for a third-party, arm's-length, *non-company* contact be available?
  - How soon will response occur, i.e. what is "timely"? (Please let us not see the glib and meaningless "as soon as feasible" yet again.)
  - Will the Province maintain records of complaints, and their outcomes, or will everything remain '*en famille*', so to speak?
  - Where can appeals be directed? (Other than having to resort to the cumbersome legal proceedings under Part 3 of the Manitoba Mines and Minerals Act).
  - Will the Province participate in resolution and enforcement?

  In any case, **people should not be forced to deal with the company on their own**, without any independent oversight, accountability or support. The Province, which issues the license, must be involved and take responsibility to inquire, and require a solution. There should be a provincial office where people can report their issues, and

expect proper attention and action. They should not have to resort to the public media out of desperation.

Under a previously issued provincial exploration permit (valid November 5, 2020 – April 30, 2021), condition #9 states: "HD Minerals Ltd. is responsible to correct any water supply problems or provide temporary water supply to anyone whose well(s) are negatively impacted as a result of pumping." (AppA4).

We note that water quality complaints brought forward by citizens within this period were not resolved to the latters' satisfaction. According to the reviewer in SSCRIR2 (#DLN-IR-002), "A complaint of brown water in a domestic well near the Sio Silica Centre line Road extraction site that occurred only during Sio Silica sand extraction was documented in the response to public comments key issue 204 of the Vivian Processing Facility EAP. Several well owners documented Feb. 5, 2021 in a Report of Suspected Violation of the Groundwater and Water Well Act occurrence of discoloured water and increased iron staining following Sio Silica's extraction operations in the Vivian area." The proponent asserts that "Sio is not aware of any impacts to local water supplies associated with its testing to date.", and that the problem was "deemed unrelated to Sio's activities and **more likely** a maintenance issue" (SSCRIR1 #DLN-IR-002) (Emphasis is mine). "More likely"? We don't actually know?

- During the pumping test, "no negative effects were reported by well owners" (EAP1, p. vi). Were well owners alerted prior to the test, and provided with contact information where any well issues could be reported? **Virtually all well owners do not know where to report issues with their wells.** In my own personal experience, even provincial civil servants seldom know, and I can attest that it has taken more than 6 months for a complaint to wend its way to the appropriate person. I also personally know of a recent example in the Municipality of Brokenhead where a rural resident's well failed during a pumping test of the new drilled Beausejour water supply wells, yet the driller's report stated that no complaints were received, which is technically true. In other words, 'no complaints' does not necessarily mean 'no problems'. Pumping tests should not be conducted without the courtesy of letting people know. Much helpful information can be gained that way.

- A monitoring network is proposed "to establish conditions of groundwater levels and groundwater quality in advance of operations, and then allow for real-time monitoring of water levels between extraction activities and existing water supply wells during and following extraction activities." (TAC #35)(also RPCR #253).

  "Groundwater elevations will be monitored in real time" (RPCR #32, #253).

  "Monitoring will continue for at least five years after operations end in each area, or until groundwater levels and groundwater quality have stabilized at pre-mining levels/concentrations." (TAC #35).

"Groundwater monitoring will continue for at least five years following completion of sand extraction and well decommissioning activities. Thresholds for cessation of monitoring will include groundwater levels that have recovered to baseline conditions and are in dynamic equilibrium with the surrounding aquifer, and groundwater quality that is similar to baseline conditions." (SSCRIR2 #MBEN-IR-031).

"groundwater quality samples will be collected in advance of development and following development for a period of two (2) to five (5) years under the direction of a qualified professional with experience in the interpretation of geochemistry and groundwater quality. The monitoring program will continue until groundwater quality is stable and similar to background (predevelopment) concentrations. (SSCRIR2 #CEC-IR-011).

-How "similar to background" will concentrations have to be, in order to qualify as stable? I.e., within 5%, 2%, or…… Milligram level parameters have different stability criteria than microgram or nanogram level parameters.

What assurance is there that monitoring for **at least five years after operations end** in each area will occur (in SSCRIR2 #CEC-IR-011 this has been whittled down to the **possibility of as few as two**)? In order to pronounce that levels and quality "have stabilized at pre-mining levels/concentrations", a series of measurements over an extended period is required, a single "similar" data point does not qualify: stability is defined by time.

The program will presumably utilize its own and/or provincial monitoring wells to alert for water level changes. However local geologic features may result in discontinuities and irregularities that affect individual private well response. According to FD (2019), "Due to variability in the number, size, type and interconnected nature of the permeable features, well yields can vary substantially **over relatively short distances**" (Emphasis is mine). Thus the monitoring wells may not necessarily concurrently or accurately reflect conditions at private wells, which may experience a problem that is less obvious in the local monitoring well. Other considerations may also intrude:

In my own case, a provincial monitoring well is located 1 km from my well. It does not accurately reflect water level (or water quality) changes in my well. I respectfully submit that locations of monitoring wells may be an important contributing factor: are they located hydraulically upstream or downstream (i.e. upgradient or downgradient) of the private well, and/or of the pumping activity that is generating the drawdown, or perhaps they are located in a separate lateral flow channel or cross-gradient entirely?

Therefore, where will the proposed monitoring wells be located, and how many are feasible, given the scope of the project? (See pp. 527+).

But, in order for stabilization to be evaluated, those "pre-mining levels/concentrations" **must be known**, in order to compare. Furthermore, the **baseline pre-operation stability must inherently be assessed over a period of time**, as it cannot be based on one or two measurements, or one or two years.

In the event that problems are found, how CAN issues with "groundwater levels and groundwater quality" ever be fixed? No Plan is possible for those outcomes.

- How will the **steepness of the drawdown cone** be assessed?

- "CanWhite is exploring wireless telemetry systems that are capable of transmitting water levels to extraction well operators so that impacts can be detected and rapidly mitigated by reducing pumping rates, lowering pump elevations, increasing setback distances or stopping operations in extreme situations." (TAC #35).

  - Monitoring systems are only being explored, with no assurance of implementation, even though operations are imminent.
  - What are the monitoring strategies in the meantime?
  - Increasing setback distances would require a new site to be cleared and set up, with more damage, and new well clusters to be drilled, and mainline power to be installed, with no guarantee that the problem will not reoccur. What is the likelihood of all of this happening?
  - As discussed above, many domestic pumps cannot be lowered any further.
  - It cannot be overemphasized that **changes in water levels in wells are not instantaneous**. Depending on distance and geology, there may be a lag of several days, or more, for the drawdown cone to reach the impacted well. By then the problem cannot be immediately reversed.

- "A Waste Characterization and Management Plan, Groundwater Monitoring and Impact Mitigation Plan, Progressive Well Abandonment Plan, and Water Management Plan will be developed and implemented to protect groundwater quality and guide responses to any potential impacts." (EAP2, p. 84).

  "a Water Management Plan will be developed and submitted to regulators prior to operations. It will include a refined water and material balance for the extraction, reinjection and treatment of groundwater and sand. This information will be presented in a series of process flow diagrams (PFDs), plan maps, tables and graphs to illustrate all groundwater and sand inputs and outputs over the life of the project. The location of flow monitoring instruments and water quality monitoring locations throughout the system will be shown. The frequency of measurements and sampling will also be specified. It will also describe how various streams of water and solids will be managed to ensure groundwater and surface water resources are protected." (RPCR #44).

"In accordance with CanWhite's Groundwater Monitoring and Impact Mitigation Plan, water quality in the sandstone and carbonate aquifers will be monitored before, during and following operations to confirm that water quantity and quality is preserved in both aquifers. The results will be evaluated by a professional hydrogeologist or geochemist with experience evaluating water quality, with results provided to regulatory agencies for review. In summary, the Project will not contaminate the sandstone or carbonate aquifers, and water quality is not anticipated to be **materially affected** by Project operations." (RPCR #30, #36, #43) (Emphasis is mine).

1. Where are these Plans?

2. We are promised a lot of information which should have been available NOW and which is **material to the EAP**. Why is this information not available/withheld at such a late stage in the application? Does it even exist? What if there are issues which need to be adjusted and addressed? What, if any, opportunities will exist for outside (including public) input once the project has been approved? Would scrutiny after the license has been issued have any meaning?

3. The monitoring will "confirm" that no problem exists, because it is not "anticipated". "The Groundwater Monitoring and Impact Mitigation Plan will include a robust monitoring plan to **confirm** that water quality is not impacted." (RPCR #43) (Emphasis is mine).

   - Is not this biased from the start? 'We already know the results, so we will just confirm them.' Surely a more objective and unbiased process is needed.

   - Given the dearth of current data, **what happens when no such confirmation is forthcoming?** How will/can water quality be fixed if it *has* been impacted?

4. Who will conduct the monitoring? The "professional hydrogeologist or geochemist" will only 'evaluate' the end product: will this person be a company employee?

5. "water quality is not anticipated to be materially affected": what does "materially" mean in this context? Significantly, severely, intolerably? Is it acceptable if it is affected only somewhat? Why should there be any effects at all?

- Will the property owners have access to the results? Or will they be secret, 'proprietary', only "provided to regulatory agencies for review", along the same stripe as so much of the other unavailable alleged Reports and documents? Or perhaps 'transparency' (such as the "Public Version" (*à la* Table 2, Attachment A, RPCR), with the awkward bits redacted?

"Findings will be reported to the community on a regular basis." (SSCR #3).
"Annual reporting will be available to the public. These reports are prepared by a 3rd party with qualifications in hydrogeology and geochemistry." (''Facts Matter'' public ad campaign, The Clipper, 8 December 2022, p. 9).

How complete or how selective will this be? What form(s) will this take: a dedicated open-access website, a closed website available only to 'approved' participants ('subscribers'), a section on the public municipal website, documentation that can be viewed at the municipal office for those without Internet, or just a dressed-up public ad series along the lines of the awkward 'Facts Matter' campaign?

- In SSCR (#8): "The Groundwater Monitoring and Impact Mitigation Plan intends to establish a program for monitoring of groundwater levels and quality to **confirm** the results of the Hydrogeology and Geochemistry Assessment and **ensure that operations do not negatively affect the quantity or quality of water in the aquifer.**" (Emphases are mine).

  The monitoring will "guide management decisions to avoid and/or mitigate any impacts to groundwater users" (Response to Additional Technical Advisory Committee (TAC) Comments); also "guide responses to any potential impacts." (EAP2, p. 84).

  Again, ongoing data collection will be used to "confirm the results of the modelling". What if additional data don't conform? What happens if/when simulation modelling results are not vindicated? Will data become selective?

  The proponent's Response to Additional Technical Advisory Committee (TAC) Comments states: "Models are tools that should be periodically updated as new information becomes available to inform management of the groundwater resource. It is agreed that further refinements to the calibration could be implemented…"

  Additional data will continually alter and modify the model, therefore by definition, earlier versions are no longer suitable or useful, yet **they have already guided** previous "management decisions".

  When monitoring reveals what NOT to do, at that point, <u>impacts have already occurred</u>. While 'Gee, who knew?' moments hopefully might help to readjust, although they cannot entirely correct, future operations, the people and properties already affected in the experimental exercise have become expendable collateral damage if there is no available resolution. But, what resolution can there be? If adverse impacts are evident, **how can they possibly be reversed**? What possible meaningful responses can there be?

Models are only as good as the data and assumptions that feed them. Presently, there are serious concerns with the adequacy of both. An irreversible decision to proceed with such a momentous project must be based on a solid foundation of irrefutable and reproducible data, not "we will try to fix it later, as we go along."

- **There is no Groundwater Monitoring and Impact Mitigation Plan** in the EAP. In the Response to Additional Technical Advisory Committee (TAC) Comments (https://www.gov.mb.ca/sd/eal/registries/6119/response_to_groundwater.pdf) the proponent states: "A robust groundwater monitoring and mitigation will be developed to monitor the aquifer, **confirm** modelling results, and guide management decisions to avoid and/or mitigate any impacts to groundwater users." (Emphasis is mine).

  In RPCR (#32) the proponent again reiterates: "Mitigation measures will be described in the Groundwater Monitoring and Impact Mitigation Plan that will be prepared in advance of commencing operations which will include monitoring of groundwater elevations in real time so that operations can be modified to avoid unacceptable lowering of water levels and impacts on well yield." Further, in SSCR (#3), again there is still no Plan.

  1 . This Plan is a critically important keystone in the management and design of the project, yet it is **completely missing** and suspended in the dreamy future. The word "robust" appears, therefore surely there are some embryonic stirrings about how exactly this plan shall proceed: why is it only a tantalizing maybe-promise at this point, and there is no way to evaluate the design, proposed methodology, relevance and recommendations/guidelines/mandates in order to gauge whether they will be appropriate or useful? The late draft document (see pp. 527+) is disappointing.

  2. Since in the real corporate world, budget, costs and profit are a core consideration, who will **independently** oversee what the Plan contains, how it is altered, how it is administered and implemented, what the monitoring results are, how the results are interpreted, how they are transformed into management decisions, how they are adhered to, and what are mitigation Plans B, C and D when Plan A fails? Or will this be a completely internal and private loop, with no public accountability or transparency?

  3. "The simulated impacts of Project operations suggest impacts to surrounding wells can be avoided or effectively mitigated through implementation of a robust Groundwater Monitoring and Impact Mitigation Plan." (RPCR #49).

  Since this Plan will provide all of the solutions, **where is it**? In SSCR (#7): "Groundwater elevations and pumping rates will be monitored prior to, during and following operations as defined by the Groundwater Monitoring and Impact Mitigation Plan, **to confirm the results of the modelling** assessment. Results will be utilized to support future updates to the model."

In SSCR (#8): "The Hydrogeology and Geochemistry Assessment recommended a Groundwater Monitoring and Impact Mitigation Plan be developed and implemented prior to, during and following operations to establish a **robust monitoring program** that is able to detect changes in response to operations and guide mitigation measures**. It is not a study**, but rather an operational monitoring and management plan that will guide implementation of mitigation measures in the event they are required." (Emphases are mine).

- In an ad in The Clipper (January 19, 2023, p. 24), "Well and reservoir monitoring operations are active year-round 24 / 7." This is the first time we see mention of "reservoirs": what exactly are these, and where are they located? Do they refer to the cavities? If so, how exactly will they be monitored? If they are monitored "year-round", and "24/7", how many times per day will data be collected?

- Completely left out of the picture are wells which utilize water pockets in the overburden, and depend on aquicludes to maintain the perched water table above (see p. 46). Damage to aquicludes may result in permanent compromise of such wells. There seems to be no Plan to assess locations, implement avoidance or provide permanent alternatives, and compensate homeowners that may be affected.

- Drawdown may also affect dugouts and ponds, if these are unlined and depend on the water table. This may affect livestock.

  In RPCR (#32), the proponent contends that "The thick and relatively low permeability glacial sediments overlying the limestone aquifer will prevent measurable drawdown in any shallow glacial sediment aquifers or dugouts." This statement contradicts FD (2019)(Figure 27, p. 124).

  The glacial and post-glacial deposits are heterogeneous and extremely variable; no blanket statement can be made attributing low permeability to these materials, when in fact in Springfield the entire conductivity spectrum may be found within very small distances. According to FD (2019), in Springfield "hydraulic characteristics of these materials **vary widely**, from the highly porous sand and gravel to the very fine grained, low permeability clays. In the context of vulnerability, material which transmits more water at higher rates presents an increased risk for negatively impacted aquifers from surface activities." (Emphasis is mine). The reverse is also true: aquifer disruption may transmit effects to surface water features. In permeable circumstances, regression of an unconfined water table which is exposed in a pond may result in drawdown of the pond, particularly in perched aquifers. Thus this remains a potential local concern.

- A completely different type of well interference is also possible. For most of the extraction season, except possibly the beginning and end, surface temperatures will be

higher, often considerably higher, than those of the emerging groundwater. We have no information regarding the amount of time the water will have spent at the surface before it is reinjected, but it will be sufficient to raise the water temperature. Reinjection of large volumes of warmer water may modify the local temperature such that it may interfere with adjacent residential geothermal cooling systems (Abesser, 2007). Warmer temperatures may also accelerate chemical reactions in the aquifer.

- The general impression of the EAP is that it seems to be afflicted with a discouraging tone of disregard and disrespect for the people whose wells may be affected. They seem to be a disposable collateral annoyance. Even the peer reviewers (AppB, p. 8) noticed this: "Throughout the report, the treatment of private water wells/private water well resident concerns throughout the course of the project is inadequate."

Artesian wells

- The subject of **artesian wells** is associated with another set of challenges and risks. The EAP is silent on this topic, and none of the well decommissioning protocols (see p. 240+) addresses it.

- According to FD (2019), "Within the RM [Springfield], the carbonate and sandstone aquifers are largely confined and, consequently, are considered to be artesian throughout the area. The distinction of flowing artesian wells is made when a well flows freely at the ground surface without pumping. In these cases, the elevation of the potentiometric surface of the aquifer is higher than the ground surface elevation at the same location."

  Flowing artesian wells discharge at the surface under hydraulic pressure (Figure 20). Extracted water cannot be returned to the well. According to WDR, two of the 42 already drilled wells described therein were capped to prevent flowing conditions (Well PID 200824, 200861). Will the purpose of some of the drainage ditches mentioned in EAP1 (p. viii) be to divert water to keep the site from flooding before/until the well can be stoppered?

- This matter raises some concerns. In the course of this project, there is strong likelihood that artesian wells will be encountered. This is heartbreaking, as flowing conditions in many other parts of Springfield have declined or disappeared. The very name of Spring Field reflects this history. Figure 21 shows extent of high static groundwater areas (at or less than 3 m below the surface) in Springfield, while areas of flowing wells and springs are shown in Figure 22. If water regimes change, for example in wet seasons, some wells that are not flowing at the time of drilling and decommissioning may later erupt.

- Section 4 of The Groundwater and Water Well Act (C.C.S.M. c.Gg110) Well Standards Regulation states: "Before beginning the construction or sealing of a well or test hole, the person performing the work **must determine if the area has a history of flowing artesian conditions and whether it is likely or reasonably possible that flowing artesian conditions will occur.**" (emphasis is mine).

  In TAC (#55), the technical reviewer points out that: "The claims area may include high static and flowing well conditions. The driller and operator must be prepared to handle flowing well conditions during drilling, operation and sealing. Wells that have high water levels may become flowing in the future and should be sealed as if flowing conditions are present." The proponent responds: "CanWhite acknowledges and will comply with this requirement."

  Flowing artesian wells require sealing using specialized and expensive techniques, with possibility of breakthrough hydraulic fractures (BCGWA, 2015). An annular space leak around an artesian well may also develop at any time, sending water to the surface around the wellhead (IAP, 2021). Over time, the flow will erode adjacent geology and soils. Infiltration and saturation of upper strata with water may also significantly increase the risk of slumping.

- Despite acknowledging the artesian issue in TAC (#55) above, in response to my concern in RPCR (#47, #216) the proponent states: "There are no areas that are expected to be artesian for the majority of the 24-year mine life. However, if flowing artesian wells are encountered, they will not be allowed to flood the site and will be contained. In many cases, if a well is artesian it is only artesian at a certain time of year (usually spring). In these cases, **extraction activities can take place when water levels are seasonally low**." (RPCR #47) (Emphasis is mine).

  My rebuttal follows:

  1. Both the TAC and the RPCR quotes identify artesian conditions as a potential issue.

  2. Existing data are insufficient. Artesian conditions cannot always be predicted. We often do not know until we have already punctured the aquitard. However Section 4 of The Well Standards Regulation (see above) explicitly requires the operator to obtain at least the **history** beforehand and adjust accordingly. In less well populated areas, history may not be obtainable.

  3. "In many cases…it is only artesian at a certain time of year". In many other cases, it is also active year-round, as can be attested by many well owners with this type of well. On the other hand, it may not be active at the time of puncture, but may become active later, **even several years later**. Since many wells will be drilled during the winter, before spring recharge has occurred, this increases the chances that flowing conditions may not be evident at the time of drilling.

Note that with climate change, projected levels of precipitation in the region are expected to increase (see Table 3, p. 80), and affect future hydraulic head conditions.

4. Clearly, the above RPCR (#47) response indicates that **extraction is intended at these wells** when/if they are not flowing. If they are flowing at the time of construction, they will presumably be monitored in the interim to determine whether flowing conditions are intermittent or continuous. The water will be wasted. **Over what time period will these wells be monitored prior to extraction** and remain not permanently sealed? In other words, how much time will be required to decide whether or when a well will be usable before it is sealed and abandoned? What criteria will be used to determine when extraction can occur? The logistics of extraction site setup and hydro servicing need to be scheduled some time in advance of operations. **What will be the policy on how these situations will be managed?**

   There is not even a reference in the EAP to any missing Plan to address these issues.

However in the Sio "'Facts Matter' Series" (The Clipper, February 10, 2022, p. 12), the proponent categorically states: "Artesian conditions are not present within Sio's focus area". What is the "focus area"? In Figure 22, flowing wells and springs are shown in the Anola and Vivian area. The project is planned to expand over its 24 year lifespan, perhaps even infiltrate numerous adjacent municipalities, through endless Notices of Alteration (RPCR #63,#73, #185, #213, #220), and artesian conditions will be unavoidable. Yes, facts do matter. Where are they?

Thus **this issue has sequentially mutated** from omission and disregard in the EAP, to acknowledgement and agreement in response to TAC concern, to semi-denial in response to my comments in RPCR, to outright denial in the proponent's public ad campaign. It is plain that there is no desire to deal with this concern. Yet, somebody will have to.

- The Manitoba Groundwater and Well Act C.C.S.M. c. G110, Section 39(3) states: "An owner of land on which a flowing artesian well or a flowing artesian test hole is located must ensure - except during construction and any period after construction necessary for the person who performed the construction to bring the flow of water under control - that water does not flow from the well or test hole in an uncontrolled manner." (https://web2.gov.mb.ca/laws/statutes/ccsm/g110e.php).

  Accordingly, while drillers are responsible to control the initial flow from the puncture, **landowners are responsible thereafter** for rectifying uncontrolled flowing conditions should such happen at a future time.

Aside from being against the law, if allowed to flow unrestricted, artesian wells will significantly decrease head and unnecessarily waste valuable water, spilling the lifegiving blood of Mother Earth. This is a treasure that ought to be protected and conserved. Riddling it with masses of boreholes is not the way to do so. It would amount to environmental vandalism.

Figure 20. Freshly drilled flowing artesian well. Source: https://www.bcgwa.org/flowing-artesian-water-well-control-methods/

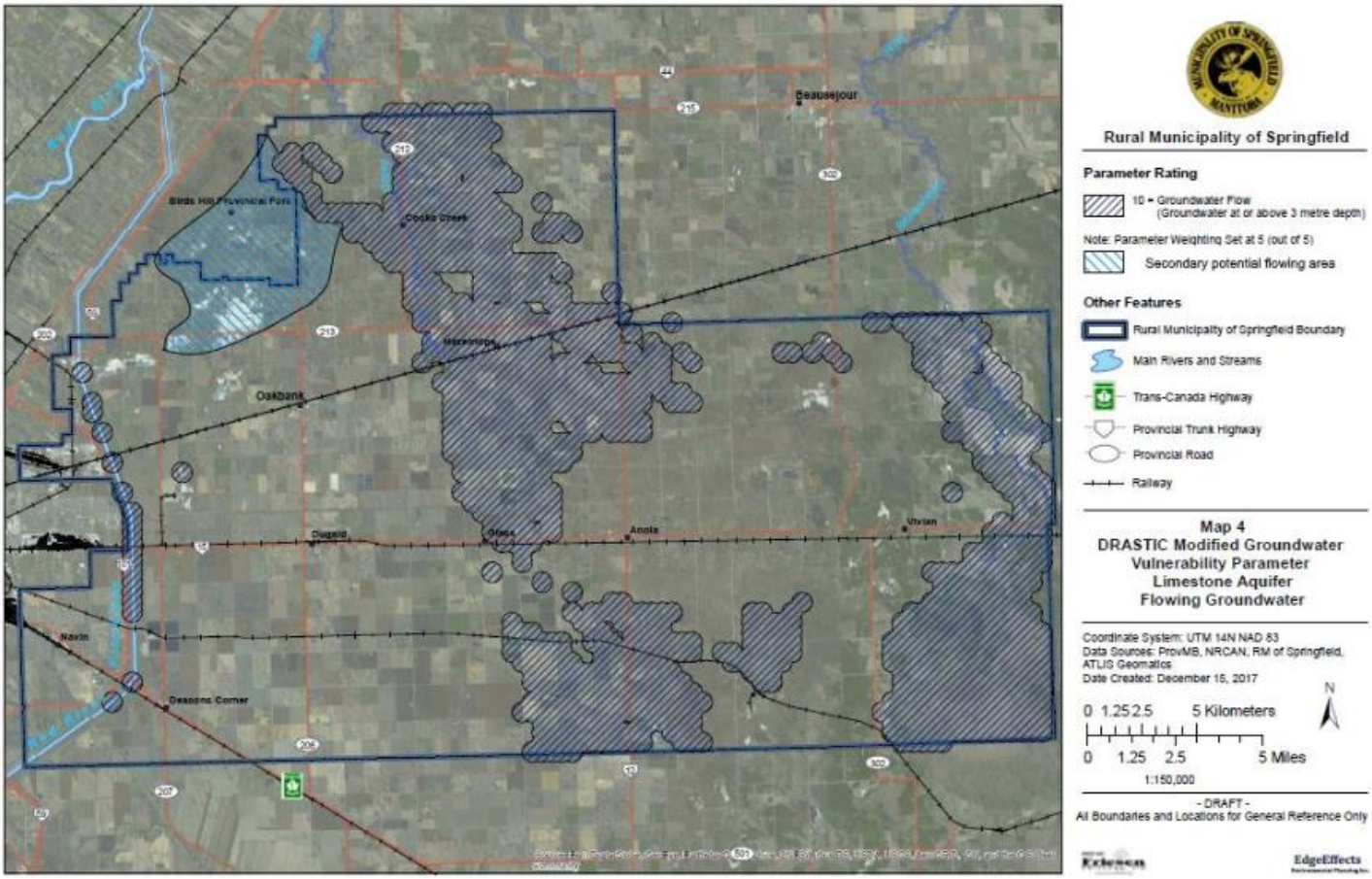


Figure 21. Map of flowing Carbonate groundwater in Springfield; criterion is static water elevation is ≤ 3 m below surface. Source: FD, 2019.

Figure 22. Map of flowing wells in Anola and Vivian area (Highlight is mine). (Map 4-5, Manitoba-Minnesota Transmission Project, Manitoba Hydro, https://www.hydro.mb.ca/docs/regulatory_affairs/projects/mmtp/eis/mmtp_tdr_biophys_groundwater.pdf

Shale aquitard and contaminant travel

- The proposed project has the potential to promote contaminant travel in two major ways:

  A. horizontal travel of contaminant plumes within the same aquifer in response to hydraulic gradients created by pumping 'suction', and
  B. vertical travel between aquifers via breaches in their separating aquitard.

- Concerns abound regarding the integrity of the shale layer. The Winnipeg shale is variable in thickness and in some places may be quite thin: "Within the Local Project Area, the thickness of this shale was found to be on the order of 3 m thick, but the literature reports the thickness may vary from 1 m to 24 m" (AppA1, p. 60). Indeed, there may no longer be shale remaining, only ductile clay: "the shale is variably weathered and has been reduced to high plasticity clay minerals in some areas." (AppA1, p. 60). This shale (or clay) acts as an aquitard between the Carbonate limestone and Winnipeg Sandstone aquifers (Wang et al., 2008).

  Besides this primary aquitard, multiple secondary shale layers have been found in the Sandstone in a number of the test wells (WDR). Furthermore, secondary shale layers in the limestone have also been observed (WDR). In turn, many of these

shale/mudstone/siltstone layers may contain various interbeddings of thin carbonate strata, often abruptly discontinuous, distorted or bioturbed in various ways (Figure 23).

Photo: E. Pip

Figure 23. Views of both sides of water-worn siltstone interbedded with carbonate lamellae (Springfield). Note abrupt discontinuities in the carbonate layers, and evidence of bioturbation. Dr. E. Pip Collection.

Multilayering in aquifer systems has been pointed out by the reviewer in SSCR (#26) in relation to suggested investigation of leakage properties of shale and analysis of pump tests. The proponent's response was unenthusiastic: "this is not deemed necessary or reasonable at this time."

- Shale is not homogeneous, and its integrity cannot be predicted without actual examination and evaluation. In SSCR (#33), the reviewer points out that in the proponent's models: "The heterogeneous nature of these aquifers is ignored. The shale layer that separates the two aquifers is viewed as being homogenous but anisotropic; unfortunately, there is [sic] no field data to support this conjecture."

  Sutton et al. (2004) studied Cretaceous (i.e. much younger) shale in Colorado and reported "highly variable sealing capacity, even between some adjacent samples." The latter workers found that numerous local factors influenced shale competency, including textural sorting characteristics, total organic carbon content, degree of (ancient) bioturbation, and orientation of matrix clays with respect to bedding planes. In the present instance, the shale is itself stratified with fine layers of varying composition, as well as evidence of assorted local bioturbation. The laminations confer fissile properties, i.e. the material tends to split along the laminations, which render it brittle and sensitive to stress (Figure 24).

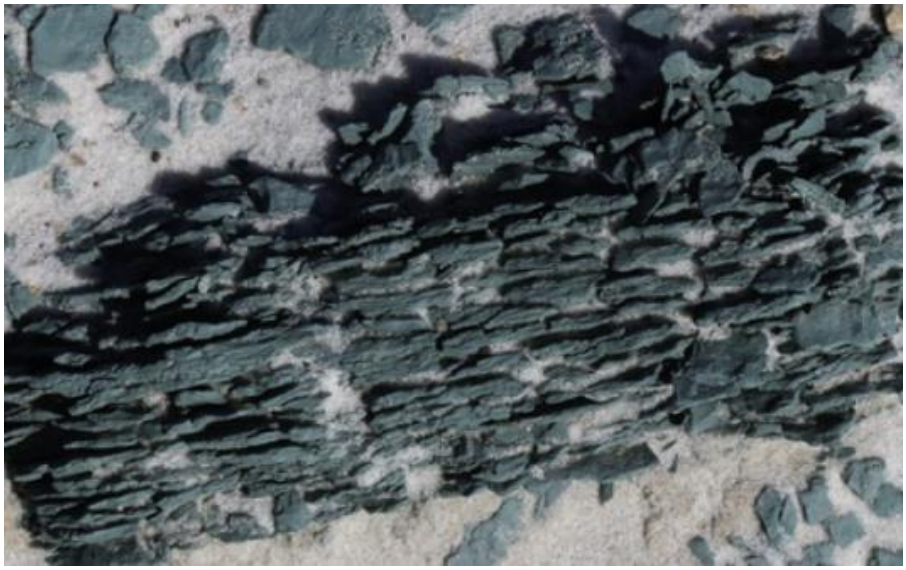


Photo used with permission (OLS)

Figure 24. Shale reposing on extracted silica sand at a sand test well in Springfield. Note extreme fissility, and blue color associated with reduced (unoxidized) iron indicative of anoxic conditions.

According to the proponents, "Slug testing of the shale was limited to **one test**, but **visual observations** of a core suggest it is **generally** a low permeability unit that restricts flow between the Winnipeg Sandstone and Red River Carbonate aquifers." (SSCR #16)(Emphases are mine).

Thus from "visual observations" of "a core" we extrapolate that the shale is "generally a low permeability unit". Eyeballing a sample → conclude 'generally'. Eyeballing a sample with a bionic eye → conclude 'low permeability'. Slug testing "limited to one test". From this, we draw a whole plethora of conclusions and pronouncements.

A perusal of WDR well logs indicates a veritable rainbow of visually different shales, including red, green, brown, pink, purple, blue, white (Well PID 197863, 201400, 201401) and 'multicolored', present both in the "primary" aquitard of concern at the top of the Sandstone, and also interbedded in layers within the Sandstone, with different types of shale occasionally in discrete but stratigraphically contiguous layers. We hypothesize that these variations may reflect not only oxidation conditions, but chemical composition as well. Superimposed on these are the additional physical attributes of fluidity, particle size, fissility, degree of degradation, etc. Given this undeniable macroscopic diversity, **how can one single slug test possibly represent the entire region?** In the numerous boreholes in WDR with multiple shale layers in the Sandstone, a single test would not even represent the variety in one borehole.

- Shale aquitards are prone to fractures, which in turn facilitate and accelerate contaminant transport between overlying aquifers (Cherry et al., 2004). According to AppA1 (p. 37), "the shale material encountered within the Project Area is characterized as fine-grained, moderate to highly fractured", and "The Winnipeg Shale encountered during the 2020 drilling campaign was friable and deeply weathered to clay minerals in some boreholes." (AppA1, p. 66) (friable = crumbly). We can see the dilapidated and degraded state of the shale in the few (i.e. *three*) core samples shown in AppA5 (C.3), also Figure 24 above. We must keep in mind that this shale in particular is very old. It would be instructive to see the other core samples in order to obtain a wider representation: what was the rationale for selecting these three? Were they the best ones, perhaps?
- Figure 25 illustrates the pathway of contaminants originating at the surface into aquifers below. The area bordering/ immediately west of Vivian is already deemed by FD (2019) to be at high risk of vulnerability to contamination (Figure), and potentially hazardous activities are incompatible for this region. The high risk zone highlighted in Figure 26 corresponds with highly permeable overburden of sand and gravel deposits only 1 – 20 m thick (Fig. 27)(FD, 2019), which provides minimal protection of the Carbonate aquifer

from surface seepage. According to John and Rose (2005), “Percolation through the vadose [unsaturated] zone has been shown to be a significant factor in removing possible contaminants before ground water reaches the saturated zone of an aquifer.”; thus where overburden is thin and permeable, contaminants are less adequately intercepted. According to FD (2019), high risk areas are identified in Figure 26 “where impacts from surface activities have an increased risk of entering the aquifer systems”, and high risk endeavors and “**heavy industry should not be located within groundwater sensitive areas** without suitable protections put in place.” (FD, 2019)(Emphasis is mine).

Quarries carry a particularly high risk of groundwater contamination because protective overburden has been removed. Here is pollution from oil and mechanical fluids from machinery and recreational vehicles, dumping of garbage, historic lead shot accumulations from target shooting, partying without portapotties and other unrestricted activities. Boreholes may channel this material directly into the aquifers beneath.

In disregard, or perhaps unawareness, of the above recommendations in FD (2019), unfortunately the sand processing facility (Public Registry 6057.00) has already been approved for this area. By its invasive nature, the present proposed project shall inflict an even more direct and comprehensive impact, which cannot later be rectified.

- While the aquifers closest to the surface are at greatest risk of contamination, underlying aquifers may also be impacted. In the Anola area, “wells developed into the sandstone aquifer are still considered to be somewhat vulnerable to surface impacts” because here “it is expected that at least 50 wells interconnect the carbonate and sandstone aquifers” (FD, 2019).

Obviously, an increase in the number of interconnecting wells will greatly amplify these concerns. Indeed, FD (2019) advises that “**efforts should be taken to <u>reduce</u> the number of wells that connect both aquifers in the area**” (Emphasis is mine). Thus the current proposal is contrary to what is required to protect the quality of the Sandstone aquifer from deteriorating further.

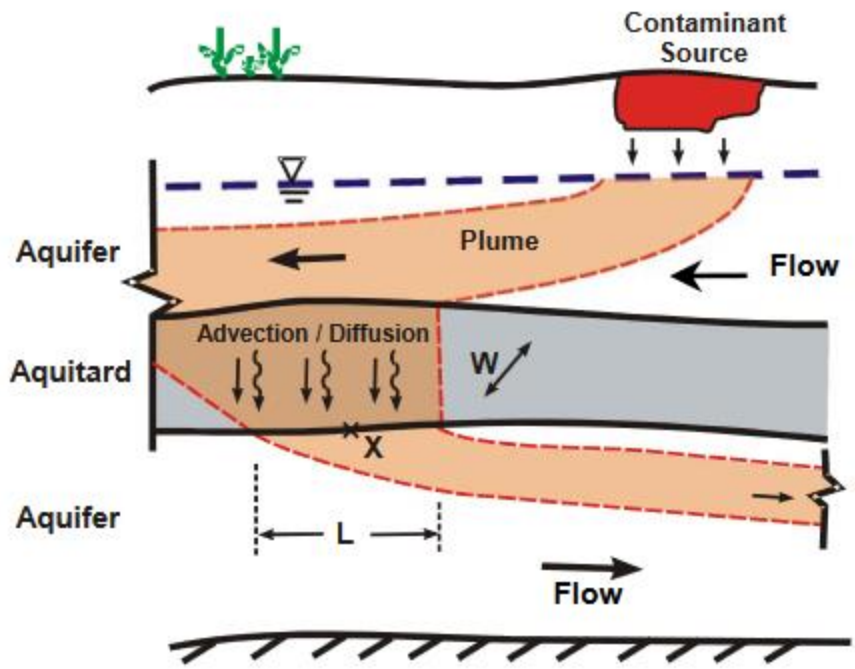


Figure 25. Pathway of contaminants originating at the surface in a stacked aquifer/aquitard system. Holes and fractures in the aquitard will greatly accelerate vertical movement of contaminants to the underlying aquifer. From Cherry et al. (2004).

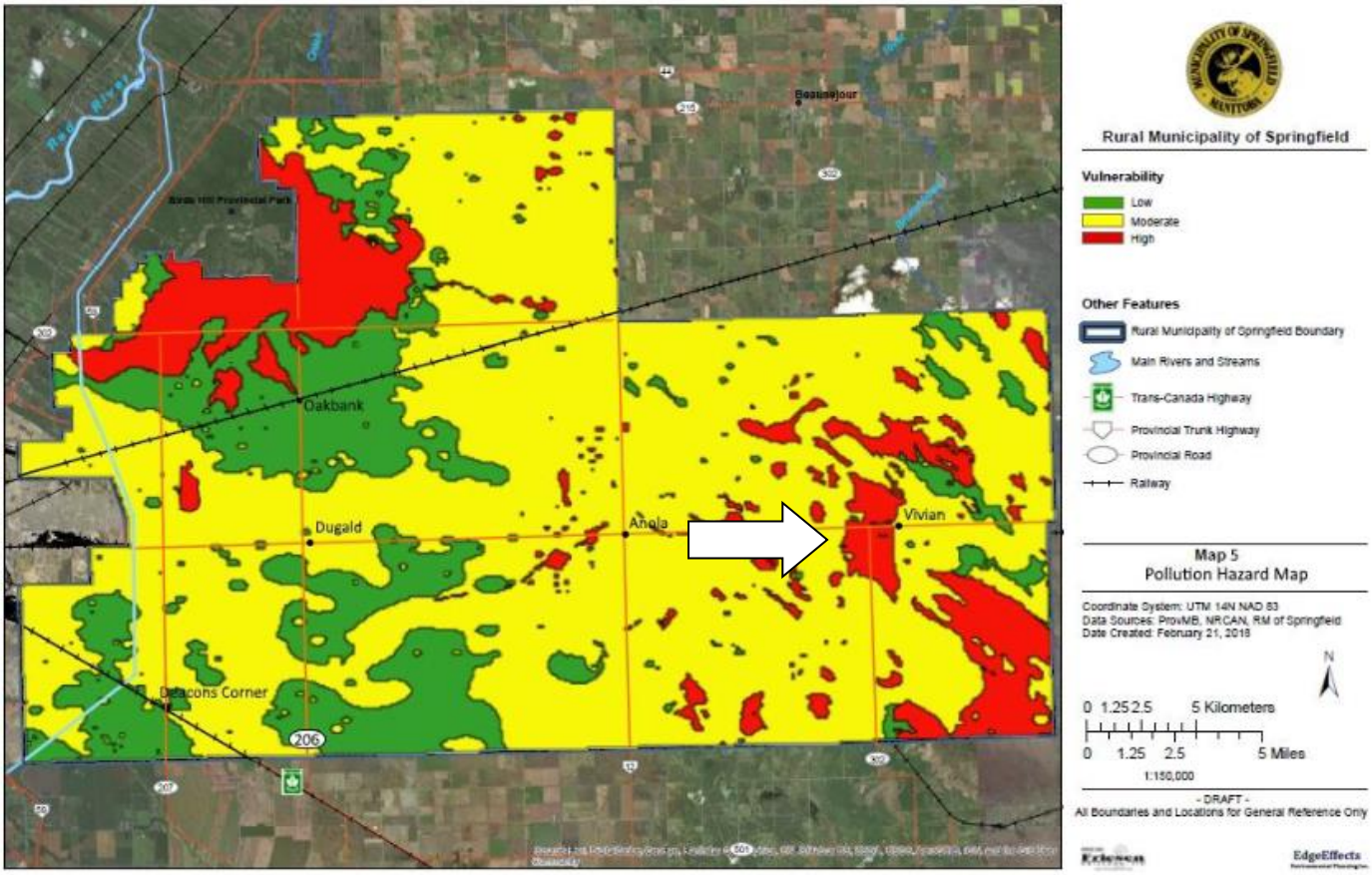


Figure 26. Aquifer vulnerability to contamination from surface activities. Note that the Vivian area borders/intersects a high risk zone (Arrow highlight is mine). Source: FD, 2019.

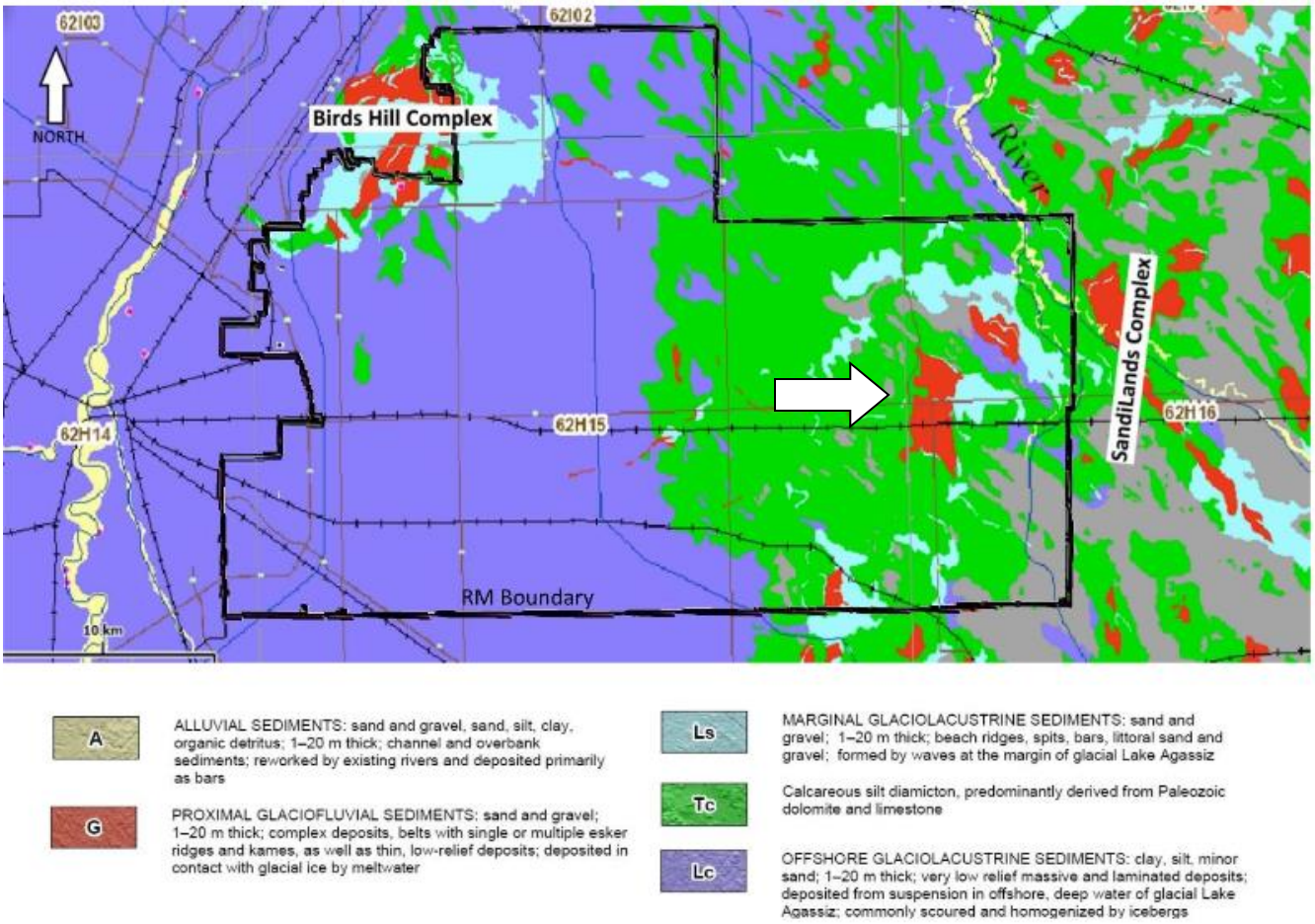


Figure 27. Surficial deposits in Springfield. Note that the high risk zone in the Vivian area in Figure 26 corresponds to highly permeable thin overburden (Arrow highlight is mine). Source: FD, 2019.

- Within aquifers, horizontal downgrade contaminant concentrations are heterogeneous and unpredictable because of travel where hydraulic conductivity is greatest, as well as channeling, and variable and anisotropic aquifer conditions (Keely, 1984)(Figure 28). Contaminants tend to travel in aquifers as plumes (Nichols and Roth (2006). **Domestic well pumping may disproportionately attract contaminants originating some distance away** (Figure 28).

  Furthermore, the vast volumes that will be pumped at the extraction well clusters may draw contaminants (from both aquifers) towards the active extraction clusters, and may thus impact local domestic wells that are in the path or vicinity of the plumes.

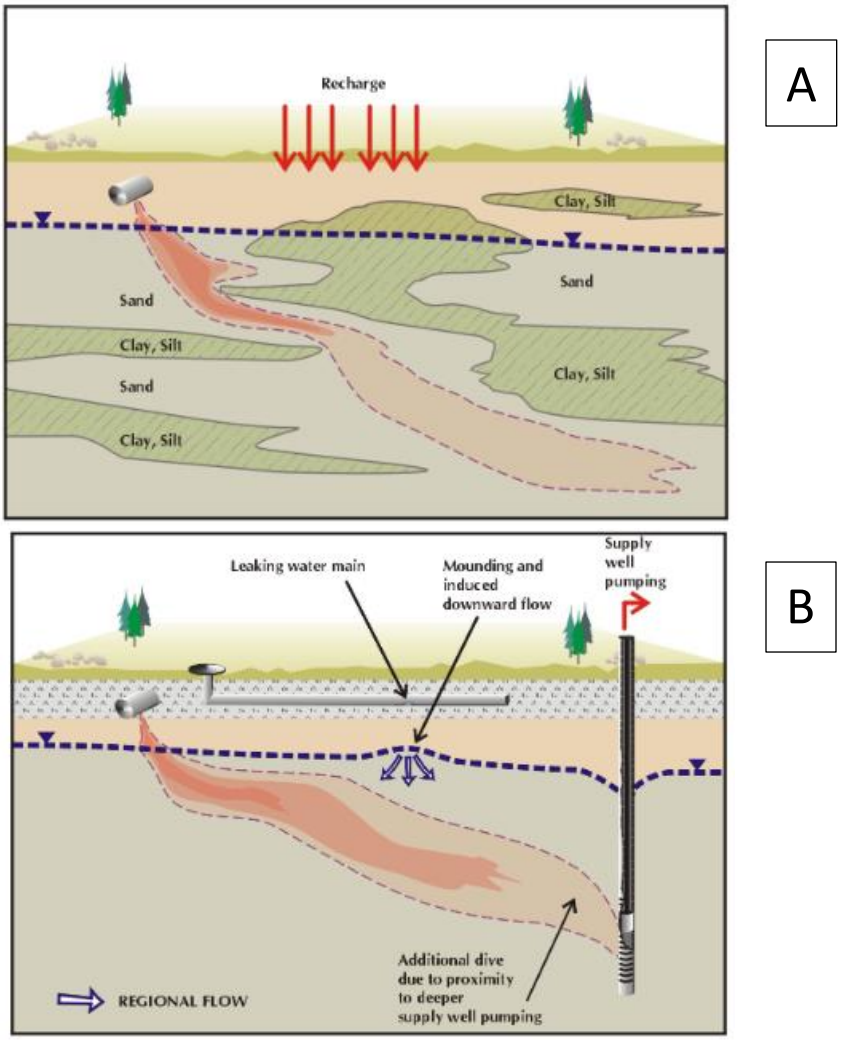


Figure 28. A: Contaminant plume travels where hydraulic conductivity is greatest. B: Contaminant plume is attracted to pumping well. User of well receives a disproportionately higher concentration. (Dashed lines represent water table). From Nichols and Roth (2006).

Nonetheless, the proponent does not think much of the hydrological concept of plumes: "Over large distances, longitudinal and transverse dispersion would spread the contaminants across the thickness of the aquifers and typically act to reduce concentrations associated with instantaneous point source releases." (SSCRIR2 #MBEN-IR-028). The message seems to be that in the event of a spill, contaminant concentrations will eventually drop in the aquifer due to dilution and become distributed throughout, not to worry. It ignores the fact that pumping wells may attract the contaminant by advection before it may or may not disperse, the latter depending on hydraulic flow rates, direction and geological parameters. Water quality within an aquifer also inherently varies: horizontally and vertically, therefore NOT homogeneous.

Plumes of organic substances such as hydrocarbons do not readily disperse (e.g. Cozzarelli et al., 2001). Different organic components may be transported at different rates. Oil may also float on the water table (Baedecker et al., 1993), and in drawdown conditions may be advected and drawn into domestic wells. In the spill into the Carbonate aquifer of Rockwood Municipality for example, the organic contaminant plumes have not dispersed after three decades (see pp. 393-394).

- Fractures and openings in the aquitard vastly increase the rate of downward passage of contaminants because they provide portals into the aquifer below. Interconnections from boreholes, failed seals (see p. AA), and subsidence amplify the contamination potential.

  The proponent claims: "There is limited to no potential for changes in physical and/or geochemical conditions in the aquifer due to Project operations that would result in contamination of groundwater. Any changes that do occur will be minimal, localized, and/or temporary." (RPCR, #26). Since ALL of the *thousands* of proposed boreholes will pierce the aquitard, how can such a statement be true?

- Besides chemicals, pathogens may also travel in aquifers; instances of fecal bacterial groundwater contamination have been documented at distances as great as 900 meters from the source (see Pedley and Howard, 1997). According to Cherry et al. (2004), "Particulate contaminants very small in size, such as viruses, have the next largest propensity [after certain chemicals] to travel quickly through fractured aquitards". Viruses for example may remain viable for extended periods of time (Table 4), due to factors such as the lower temperatures of groundwater (John and Rose, 2005). Indeed "viruses are considered to be the most critical pathogens for groundwater contamination, because of their ability to travel through the subsurface and their high infectivity." (Schijven et al., 2010).

Table 4. Human pathogens found as contaminants in groundwater. From Cherry et al. (2004).

Characteristics of biological contaminants in groundwater

Biological contaminant[1]	Typical size	Metabolic state in groundwater	Frequency in unconfined aquifers	Survival time in groundwater
Viruses	27 – 75 nm	Infectious, but cannot replicate without host	5 – 30% of wells in USA	1 – 2 years
Bacteria	0.5 – 2 μm	Infectious, potentially replicating in water	Less frequent than viruses	Months
Protozoa	4 – 30 μm	Infectious, environmentally resistant cyst, cannot replicate without host	Rare, unless surface water influence	Unknown

[1]Refers to human pathogenic forms

More comprehensively, quoting from John and Rose (2005), "The main pathogenic microorganisms of concern may be grouped into enteric viruses, bacteria, and protozoa. Waterborne viruses include enteroviruses, coxsackievirus, echovirus, rotavirus, norovirus, and hepatitis A and E. Bacteria of concern are chiefly enteropathogenic *E. coli, Salmonella* and *Shigella* spp., *Campylobacter jejuni*, and *Aeromonas hydrophila*, among others. The main protozoa that have been transmitted by groundwater are *Cryptosporidium parvum* and *Giardia lamblia*." We can add here that eggs of helminthic parasites have also been documented in groundwater, with a high resistance to disinfection (Bandala et al., 2012). (For example, I observed *Ascaris* eggs in water from a well south of Brandon in the 1990s).

Schijven et al. (2017) note that viral disease outbreaks are facilitated by "fractured rock aquifers, cross-connecting well bores, or leaking well cases in sandstone and shale aquifers", where contamination sources such as livestock manure or septic fields are present. We note here that these sources also host pathogenic bacteria, particularly fecal bacteria (Pip, 2015b), as well as protozoan and helminthic parasites. Therefore proper well management and restriction of numbers of cross-connecting boreholes is important in vulnerable geological areas where risks of contamination exist.

- "Prior to drilling, the area will be visual [sic] inspected to determine if the ground may be contaminated. If the inspection indicates signs of potential contamination, samples will be collected and analyzed for contaminants suspected based on observation (pathogens, hydrocarbons, metals, nutrients, pesticides). If laboratory testing confirms the presence of contaminants remedial action (removal of contaminated material and contaminants source) will be undertaken prior to the initiation of drilling operations. This may involve

relocation of boreholes to establish a safe distance from agricultural waste piles." (SSCRIR2 #MSSAC-IR-019; SSCRIR2 #MBEN-IR-032).

- Visual inspection can detect contamination? Especially 'pathogens, nutrients, pesticides'? Eyeballing pathogens? Extraordinary. Even metals that are highly toxic at nanogram levels, e.g. mercury, cadmium, lead, etc.? Perhaps what is meant here is: "we will become suspicious before we drill in a garbage dump, sewage lagoon, gas station, feed lot, or hazardous waste storage site".

- "analyzed for contaminants suspected based on observation": who is this prodigy who can sniff out and *distinguish* all of these various contaminants with his magic laser eyeballs?

- "If laboratory testing confirms the presence of contaminants… removal of contaminated material and contaminants source …" Removal of material and sources is not sufficient if the soil is contaminated, because contamination will still be present. But if these materials and sources are already SEEN, for example old jalopy collection, maybe we should not drill there.

- What is a "safe distance from agricultural waste piles"? What if the manure pile is on more elevated ground than the borehole?

- According to the proponent, "The Red River Carbonate and Winnipeg Sandstone aquifers are deeply buried, so it is highly unlikely that anthropogenic activities will release contaminants to those aquifers." (SSCRIR2 #MBEN-IR-028).

  We must strongly disagree. This statement contradicts the wealth of global literature which documents deep aquifer contamination. Evidence of ammonia and dissolved organic carbon **in both the Carbonate and Sandstone aquifers** is presented in the proponent's own water analyses (Table 4-8, AppA4). According to Santi et al. (2006), "Shallow aquifers can cross-contaminate deeper aquifers through penetration of an intervening aquitard… along well casings, across long well screens, or around aquitard pinchouts." (Figure 29). Indeed contamination has been demonstrated in wells deeper than 250 m; according to Jasechko et al. (2017): "contemporary contaminants may be able to reach deep wells that tap fossil aquifers".

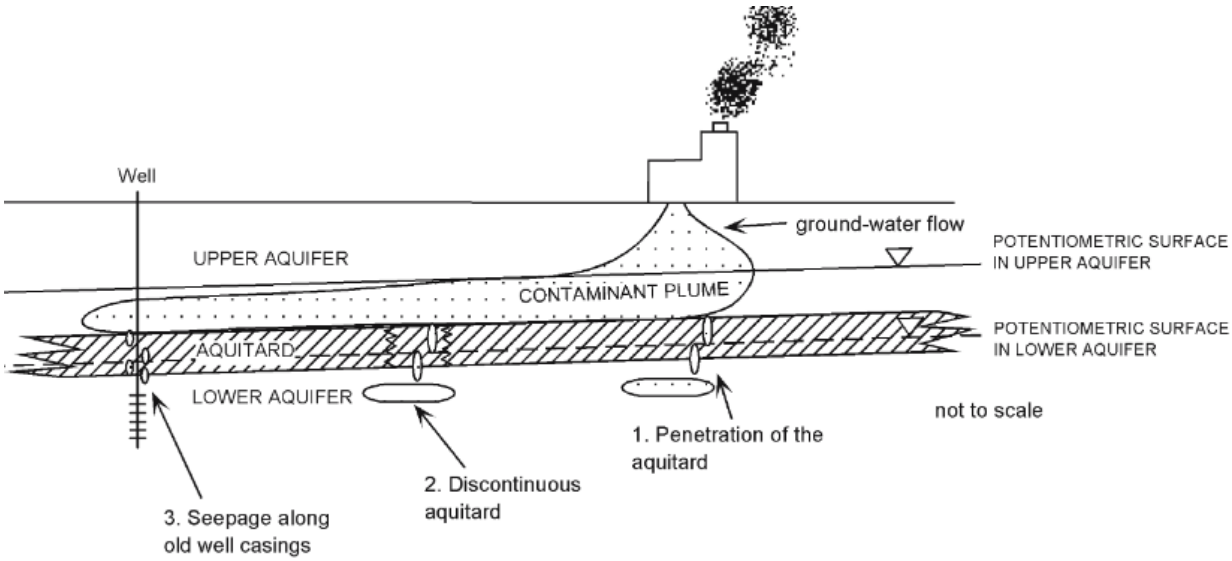


Figure 29. Routes of contamination from surface through overburden to upper and deep aquifers. From Santi et al. (2006).

In Table 4-8 (AppA4) we note the significant concentrations of ammonia and nitrate/nitrite in one sample of the shale of BRU 95-9, while the other two samples (pre-test and post-test) from the same well were below detection limits. The pre-test value for ammonia has also been corrupted and not fixed. We question the validity of the sampling of this well.

- **The voids** (conical and otherwise) created under each well due to the extraction of sand **are expected to span the thickness of the sandstone stratum**, i.e. "extending from the bottom of the Carman Sand Member to the base of the Winnipeg Shale" (appA1, p.81). Lack of underlying support due to the voids, as well as drilling vibration, may promote and exacerbate **fractures in the shale**, which according to AppA1 (p. 37) is already characterized as moderately to highly fractured.

- Furthermore, the CPA indicates that **pressurized injected air may be pulsed** to loosen the sand: "in some examples, the gas injection line …may be used to further **inject gas beyond the conduit**... **to generate a pressure vibration or pulsed air** to agitate the sand in the sandstone formation from time to time." Further again: "the gas injection line… may also be lowered beyond the lower end of the conduit and **into the sandstone formation** … **to generate a pressure vibration or inject a pulse of air to agitate the sand** from time to time." (Highlights are mine). Thus:

1. The pressure pulses/vibrations would further risk/promote shale fracture.

2. Air would be injected directly into the aquifer; air that doesn't escape through the borehole would create **air pockets lodged against the shale ceiling**, especially since angling and horizontal manipulation of the apparatus is possible underground (CPA), and would therefore in such cases extend beyond the well axis. The cavity may also be elongated and its upper surfaces irregular (SSCRIR2 #CEC-IR AppA).

3. The injected air has not been filtered to prevent microbial contamination. Gaseous and particulate contamination from dust and engine emissions have also not been addressed.

- Furthermore again, quoting from CPA: "**water may be added to the well from an external source** to establish the water level… at a sufficient height **to increase the water pressure within the sandstone formation** … to facilitate the extraction of the sandstone slurry." (Highlight is mine). Thus:

  1. Pressure within the sandstone may be **intentionally boosted**, further threatening shale stability.

  2. **<u>Where would the "external source" injected water come from?</u>** What are its water chemistry, contaminants, microbiology? What treatment would it receive? How much of it would be injected?

  3. How would pressure be monitored, and what criteria would be used to determine maximum pressure that is sustainable for the shale at the particular location?

  4. What areal extent surrounding the well would be impacted by this pressure boosting and potentially stressed shale?

  5. Since this addition of external source water is detailed in CPA, we conclude that it has already been tested. What external water was used? Was it analyzed? How was this allowed? What oversight did it receive? Where are the resultant data?

- Existing injection well permits (Permits #IW-2019.02.1 HD Minerals; #IW-2019.01.1 HD Minerals; #IW-2020.01.1 HD Minerals; #2021.01.1 CanWhite Sands Corp) stipulate that: "**If possible**, measurement of the water pressure in the carbonate aquifer be conducted through the entire injection test and during any recovery to monitor the isolation between the Winnipeg sandstone aquifer and the overlying carbonate aquifer. The test must cease if breakthrough is evident in the monitoring." Further, "The injection well will be continuously monitored to ensure the injection formation is not over-pressured." (Emphasis is mine).

1. Has such monitoring in fact occurred?
2. How was this monitoring conducted and who oversaw it? Why are the results not available?
3. **How was over-pressuring determined,** when the threshold pressure value is not given/known?
4. Why are these permits not included or referenced in the EAP documentation?

- In the present proposal, the configuration of the well cluster layout indicates that wells are spaced 18 m apart (Figure 2-3, EAP1, also SUPPL1, p.1), although 22 m has been cited in AppA1 (p. 22). They are arranged in a circle (+ one in the center), with each cluster spanning a diameter of 50-60 m (Figure 2-3, EAP1), or maybe 60-70 m (AppA1, p. 22). The EAP and AppA1 text do not agree, and the text on p. 22 of AppA1 does not agree with Figure 2-B *on the same page*. Figure 2-B (AppA1) also indicates a 9 m wide zone around the circle of peripheral wells. The clusters are spaced from each other at the same distances that are equivalent to the cluster diameters; the SIO document (p. 21) states, "ALL WELL CLUTERS [Sic] ARE SEPARATED BY 50-60 M IN ALL DIRECTIONS. EACH CLUSTER CAN PRODUCE APPROX, 21,000 TOINNES [Sic] OF SAND".

  A subsequent amendment in SUPPL1 (p.1) indicates 5 wells per cluster (reduced from 7), with a cluster diameter of 60 m, but retains an unchanged 18 m spacing between wells. The calculated diameter including the well spacings plus the outer zone gives a total of 54 m: since the well spacing has remained the same, presumably the outer peripheral zone has been widened (?). However in RMSF-IR-004 and 006, the arrangement has reverted back to 7 wells per cluster; the latest seems to be <6 (NREP).

  Despite the cookie-cutter configuration and size of the well clusters that is everywhere replicated for the public mock-up version, in SSCRIR1 (#DLN-IR-008) we discover that "there is no requirement for a cluster design to be universal across all areas." Would this mean that clusters and/or numbers of wells could be larger, or the distances between wells or clusters smaller?

  Further, "The cluster configuration will be redesigned" (RMSF-IR-006). And then, in SSCRIR1 (#MSSAC-IR-009, also RMSF-IR-006), we learn that there is a secret version of well cluster layout: "The confidential version was also filed to the Approvals Branch and the CEC." So, we are likely wasting our time here running after soap bubbles. However we cannot escape the gnawing feeling that the proponent would beam with pride to disclose the new design if it were more environmentally considerate, but since it is something that must be kept from us, it cannot be good (for the environment and landowners, not the company).

- According to EAP2 (section 6.2.1),
  "the **preliminary** analysis indicated that:
  • The diameter of extraction voids (areas where sand is extracted at each drill hole site) should not extend beyond 60 m in any circumstance, and should be reduced to 50 m as the overlying limestone layer thins to 15 m.
  • The distance from the edge of one extraction void to the edge of the next extraction void should not be less than 60 m in direction. (Emphasis is mine).

  It is here supposed that "each drill hole site" refers to a cluster, and the above wording appears to reference a cluster as one void. The diameter of the void for an individual well is not identified, and will likely vary, especially given the versatility and reach of the air lift apparatus, and differences in sand consolidation, as well as thickness of the sandstone layer. Thus these voids may connect, especially since **they may expand over time** (see below).

  A number of observations arise:

  1. These numbers are "preliminary" only; they will therefore likely change with more trial and error. How much trial and error, and can a reliable number be achieved, given the large number of confounding factors and their great variability?

  2. Since the clusters will be 50-60 m apart, presumably including the outer zone (Figure 1-1, SUPPL1), and their extraction voids may each extend up to 60 m, there is not much 'freeboard' between them, especially since the voids are expected to enlarge over time.

  In SSCR (#3), the proponents state: "Between the voids, the sandstone aquifer will not be disturbed by mining and will remain intact." But elsewhere, the proponents have themselves admitted that the voids will enlarge afterwards (Table 9, in Table 2, Attachment A, RPCR). This can only occur at the expense of the inter-void "intact" portions of the sandstone, and will be promoted by changes in hydraulic flows associated with decreased flow resistance in the voids. According to Longoni et al. (2016), "enlarged voids induce a state of instability in the system". We are further comforted here that "However, the scale of the project is regional", so we only need to write off that area of the aquifer. Refer to Figure 1 (p. 29) for a partial glimpse regarding what 'regional' will eventually mean.

  3. Testing thus far has apparently been limited to single wells, whose impact is very different from that of a cluster. In SSCRIR1 (#MSSAC-IR-011), the reviewer asks: "Why wasn't sand extraction at a full well cluster scale done, when doing this would have drastically improved your contingency planning and ability to address geotechnical risk?"

The response is: "Current testing is understood to be **representative of most likely case full scale extraction performance** and the conservatism built into the Stantec model". (Emphasis is mine). How can such a response be accepted, when the impact of a full well cluster could/will be (at least) 5 x greater? (In RMSF-IR-004 and 006, we have reverted back to 7 wells per cluster, then <6 in NREP.) The Stantec model is unavailable. Anyway, "it is not **expected** that the results of the multi-well testing will vary markedly from previous assumptions" (SSCRIR2 #MSSAC-IR-001)(Emphasis is mine).

- The absence of testing of a full well cluster was an issue already discussed herein in relation to drawdown cone superposition (p. 83+). Superposition due to the pumping of several wells simultaneously in a cluster will result in the **greatest depression at the central well** (Figure 19, p. 84). This will in turn exert the **greatest stress on the shale at the center of the cluster,** and this is where shale failure may be initiated**.**

- The question next arises: **since in some areas the shale may be thin, or reduced to clay, will clustering this many boreholes so close together in a geometrical pattern create the potential for the entire shale plate within the cluster to fail?** In other words, will the tight **perforation pattern** induce weakening (in the manner of *déchirez ici*) and **cause the shale to implode when the sand and water are removed from underneath** (Figure 30)? Where there is clay, the clay would sag into the void beneath. Recall that the punctures are also larger than those of domestic wells: i.e. " 10" [25.4 cm] diameter through the Red River Carbonate and Winnipeg Shale" (AppA1, p.23).

  This would create a huge opening (36+ m) between the aquifers that would relegate concerns with individual boreholes into comparative insignificance. **This hole would of course be impossible to seal.** Consider the possibilities of even some such failures in relation to the vast number of well clusters that are planned.

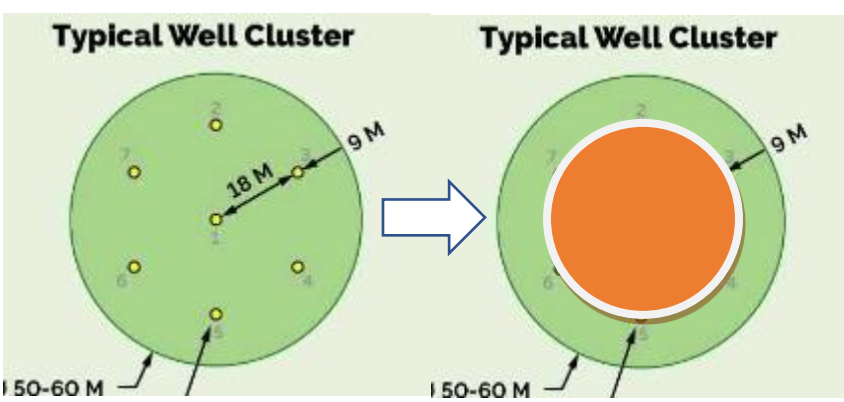


Figure 30. Implosion of central shale core along borehole perforations due to removal of sand and water underneath. Well schematic modified by the present author from Figure 2-B (AppA1). In SUPPL1 (p.1) the number of wells per cluster has been amended from 7 to 5, in a quincunx arrangement, but in RMSF-IR-004 and 006 the 7 well arrangement is again resumed.

Note that heretofore our simple minds imagined that the void underneath a cluster will be approximately round. However this may not necessarily be the case, and the geometry may be vastly different, as shown in the sonograms in SSCRIR2 (CEC-IR-AppA). Thus the shape of the area of failed shale will likely vary as well.

The EAP1 (p. 3) states: "although up to seven extraction wells may be operating simultaneously in one well cluster at any given time, this maximum number of wells operating simultaneously maybe [sic] spread across two adjacent well clusters". In keeping with the constantly changing proposal, the number of wells per cluster has been subsequently altered to five, with four on the circumference and one in the center (SUPPL1, pp. 1 + 5, Figure 1-1), i.e. arranged in a quincunx, then subsequently reverted back to seven (RMSF-IR-004, -006), and then any number <6 (NREP)).

While the above EAP1 quote suggests that all wells in the same cluster may operate at the same time, in SUPPL1 (p. 1), "All wells within a well cluster are not planned to be operating at the same time." Nonetheless, the total number of wells producing at the same time remains unchanged from the original EAP1: in SUPPL1 (p. 1), "up to seven extraction wells may be operating simultaneously in the Project area at any given time, this maximum number of wells operating simultaneously may be spread across two adjacent well clusters (e.g., four operating wells in one cluster and three in an adjacent well cluster)."

Thus the risk of collapse could be aggravated by the magnitude of the volume of simultaneous sudden sand and water removal from several wells within the same cluster: "Each well will operate for four (4) days and will produce from 262 m3/day (40 gpm) to a maximum of approximately 654 m3/day (120 US gpm) of water and sand. Several wells at a given well cluster will operate at any one time, with a combined production rate of approximately 2,943 m3/day (540 US gpm) per well cluster." (AppA1, p. 22). These values give a combined range of 280 – 840 US GPM for seven wells.

These metric volume numbers are daily values. In SUPPL1 (p.1), "these wells will be producing for five to seven days.", instead of four. This latter amendment implies a material change in the total volume that will be removed per well over the increased production period, assuming that rates of extraction per day will remain the same as in the above AppA1 quote; in any case, these daily volumes do not appear to have been amended.

- The RPCR (#1) promises that activities "would not create a risk of new connections between aquifers underground". **In order for new connections between aquifers to occur, the shale aquitard must be compromised.** The limestone competence model in Table 9 (RPCR) deals with supporting limestone caprock only (see discussion below). The shale is non supporting and fragile. Even if no subsidence is evident at the surface, and the limestone caprock remains intact, **how will shale**

breaches be detected? Therefore how can such a promise be made?

The end response to this is contradictory to the above RPCR (#1) assurance, and is brutal and horrific: it is baldly admitted in GTTR (p. 16) that:

"Sio Silica's geotechnical engineers (Stantec 2022) predict that the lower layers of the limestone carbonate cap rock may collapse into the void that is left after sand extraction. The geotechnical design concept **considers this collapse to be acceptable**, provided that some of the limestone carbonate layers remain intact to support the overlying quaternary deposits, thereby preventing surface subsidence." (Highlight is mine).

Several observations arise:

- LIMESTONE COLLAPSE MEANS PERFORCE THAT THE SHALE AQUITARD IS GONE, AND A LARGE INTERCONNECTION BETWEEN AQUIFERS HAS BEEN FORMED.

- It is openly admitted that collapse is possible, AND, shockingly, <u>acceptable</u>. Acceptable by whom – the property owner, for example? The people who will depend on this water? All future generations of residents?

- As long as the damage is not evident at the surface, it seems that we don't worry about it. *Loin des yeux, loin du cœur*.

Acceptable? Indeed, GTTR (p. 16) notes "the failure modes evaluated by Stantec (2022) do not assess the geotechnical fate of the shale aquitard between the limestone carbonate and sandstone aquifers". Is this not a gigantic and inexcusable (and perhaps deliberate) omission?

GTTR (p. 17) admits that "the shale aquitard has the potential to collapse into the sand extraction void if: a) the overlying limestone carbonate layers collapse; and/or b) the shale collapses independent of the limestone carbonate layers." Further (GTTR p. 17), "The geotechnical failure of the shale aquitard has potentially significant hydrogeological implications. Specifically, given the **anticipated diameter of the void at each well cluster (i.e., up to 40 m**), significant breaches in the shale aquitard will occur when the shale collapses into the underlying void. Conceptually, this will create a hydraulic connection between the Red River Carbonate Aquifer (i.e., limestone carbonate) and the Winnipeg Sandstone Aquifer." (Highlight is mine).

In areas where the shale is reduced to clay, sagging and falling are guaranteed.

We can only concur with the reviewer in GTTR (p. 17), which concludes that ”the collapse of the shale aquitard represents a potentially significant failure mode for the Project. In this regard, the Project Proposal’s silence on the matter represents a material deficiency in the Project Proposal.” Yes, that it does.

In the subsequent SSCR (#8), the reviewer’s issue is again raised: “The worst-case should be defined as the collapse of the shale barrier ... Any impacts related to groundwater quality are not investigated.” The proponent’s reply slides over the ‘elephant in the room’, i.e. the large interconnecting hole that would be created, and meanders off into the porewater within the shale itself. “The effect of release of shale porewater (collapse of shale aquitard) into sandstone was not considered in the PHREEQC model.”, and “the volume of water stored within shale aquitard is small or negligible” (SSCR #8). **But what about the interconnection?**

The proponent does not understand everyone’s obsession with shale collapse: “The scenario of shale collapse, or shale not being present was considered in the Hydrogeology and Geochemistry Assessment and **considered to not be a concern should this occur**” (SSCRIR2 #MBEN-IR-029)(Emphasis is mine).

In SSCRIR1 (#CEC-IR-009), the interconnection concern regarding potential salinity issues is also deemed to be of no account: ”It is Sio’s understanding that the current regulations that prohibit interaquifer mixing are in place due to saline and freshwater differences in areas farther to the west of Sio’s proposed operation. Where Sio has proposed to operate, both aquifers contain fresh water of a similar quality.” Therefore, the proponent does not feel that interaquifer mixing prohibitions apply to the current proposal.

A number of comments can be made:

1. According to Ferguson et al. (2006), in the Winnipeg Formation “the flow system in parts of the area is not in a state of equilibrium and saline waters will encroach on areas currently occupied by freshwater in some areas, while in other areas, freshwater will replace saline water.” These workers note that interference will hasten these processes. In short, what we see now may not be what we see later.

2. If the regulations only applied to part of the aquifer, maybe they would say so. Does the proponent have the authority to modify the inconvenient bits of the regulations?

3. Areas to the west of the **current** proposed operation **are** already earmarked for future extraction as well (see Figure 1, p. 29). A foot-in-the-door with the present proposal will unfold the rest of the course through sequential “Notices of Alteration”.

4. In the current area, "both aquifers contain fresh water of a similar quality". Similar ≠ identical. The best water quality resides in the eastern portion (FD, 2019; Pip, unpublished data), which unfortunately is also the present area of concern.

5. In the proponent's view, thousands more boreholes can't make much difference.

6. "The casing installed during well construction will be cemented into the limestone so that the wellbore remains continuous." (SSCRIR1 # CEC-IR-009).

What if:
- The casing and/or annular seals become compromised?
- Drilling through the limestone has initiated new fractures around the borehole outside of the cemented zone?
- The limestone in the area subsequently fractures and/or moves?
- Areas of decrepit and disturbed shale adjacent to the borehole collapse?

- The above promise in RCPR (#1) of no new connections between aquifers was made when the Stantec 2022 conclusions were already known to the proponent. Indeed, the proponent makes multiple references (RPCR #7, #153, #179) to this report at the same time the assurance in #1 is made. What does this say about disclosure, transparency, forthrightness, truth, DECENCY?

  Perhaps we are trusting and naïve enough to believe that **IF** the few simplistic, generic Stantec recommendations (as relayed secondhand in GTTR) are meticulously followed, there will be no risk of shale collapse or subsidence. Has Stantec guaranteed this, when the shale was allegedly (as *per* GTTR, p. 17) not even studied, nor included in the models? Yet it is the **principal issue of concern**. As we can see from the well logs in WDR, NO TWO WELLS EXHIBIT IDENTICAL LITHOLOGY AND STRATIGRAPHY. Furthermore, the shale itself is highly variable in thickness, condition, cross bedding, and consistency, indeed reduced only to clay in some places. Yet the integrity and stability of the aquitard constitutes **a**, or even **the,** primary factor in determining longterm and irreversible consequences of punching through it many thousands of times. We can expect with virtual certainty that despite the skeletal and generic recommendations, of the thousands of wells that are planned, there will be a number, possibly many, of "Oops, who knew? We can't do anything about it now. *Tant pis*." outcomes.

- Subsequently, in SRTER (#6), the proponent admits that: "the shale unit was identified…. as typically not competent material. Therefore, the shale was considered to provide zero stability as caprock and was not included in the model or assessment as a result. In other

words, from a geotechnical perspective, the **assessment was conducted assuming that the shale aquitard could collapse.**" (Emphasis is mine). Thus, it can't be denied any longer. There is no concern for the appalling consequences of shale collapse.

- In RMSF-IR-017, "After the sand is mined from the Winnipeg Sandstone, Scenarios 4 and 5 [of the model] assumed that the overlying Winnipeg Shale will degrade, and the hydraulic properties will be **permanently** changed." Also, for these projections, "the model simulates the **progressive expansion of the area of shale degradation**", resulting in "an estimated area of 188 ha (Year 0) to 691 ha (Years 1 through 4) with the potential for degradation of the Winnipeg Shale based on the simplified assumptions taken during groundwater modelling." (Emphases are mine). What about by Year 24? What about by "multi-generational" year XXXX?

  The radial extent of the shale degradation zone has been estimated at 200 m surrounding an extraction well (RMSF-IR-018): "Extraction well clusters are spaced less than 200 m apart, and the result is an assumed **area of shale degradation that extends across the footprint of extraction activities** each year, and beyond that footprint a radial distance of 200 m." (Emphasis is mine). Since the degradation is irreversible, "The degraded shale zone is assumed to progressively expand over time." (Ibid.) Potential water quality changes over such a scale seem to be pushed aside.

  How was the 200 m radius calculated?

- **What will be the permeability characteristics of the degraded shale?**
  In SSCRIR2 (#CEC-IR-012), "shale degradation would increase the magnitude and extent of drawdown in the overlying Red River Carbonate aquifer and decrease the magnitude and extent of drawdown in the Winnipeg Sandstone aquifer", but "Vertical gradients **may** diminish over time as they have elsewhere in the aquifer where there are multiple interconnections associated with open boreholes extending across both the Red River Carbonate and the Winnipeg Sandstone.". And then we learn here that "Modelling shows that groundwater flow directions and the quantity of groundwater moving through the aquifer system **will be similar with and without the project, even if the Winnipeg Shale is degraded**." (Emphases are mine). Further, "the exchange of groundwater between the aquifers is anticipated to be similar to that observed presently" (SSCRIR2 #MBEN-IR-028).

  We have to ask the question: **how will flows be similar to the existing state with thousands of additional boreholes?**

Further, "Vertical gradients may diminish over time as they have elsewhere in the aquifer where there are multiple interconnections associated with open boreholes". Boreholes are one thing, and they are important, but what about gigantic 36 m+ blowouts? How may *they* diminish over time as 'they have elsewhere'?

Then it is admitted that: **"Local scale exchange** may occur through any areas where the Winnipeg Shale has degraded or collapsed and where there is also a hydraulic gradient driving exchange of groundwater between the two aquifers."(SSCRIR2 (#MBEN-IR-028)(Emphasis is mine). It would be local if it only happened in one or two places, but when we consider the vast scope of the eventual project, and the real potential for collapse….

- The 200 m radial shale degradation zone raises a vital concern: the setback of well clusters from a private well or residence is only 100 m. Therefore this setback will place the domestic well indubitably within the shale degradation zone. According to the information gleaned from RMSF-IR-017, we contend that even a 200 m residential setback would be unacceptable. There is no acknowledgement of this predicament in the documentation available to us.

  How will the presence of a domestic well affect the shale degradation zone? Further, if a domestic well or residence is present, a septic field is inevitable, as few, if any, residences in the area would have holding tanks. Animal enclosures or barns may also be present at the yard site. What is the envisioned outcome when leaching from above arrives at the degraded shale?

  [For those who think vertical travel is unlikely, I have personally documented a Carbonate well near the northeast corner of the intersection of Highways 15 and 302 which showed significantly elevated nitrate concentrations as a result of the area surrounding the well head being used as the year-round nuisance ground for the owner's dogs. In such a case, a compromised aquitard further below would result in contamination of the Sandstone aquifer as well.]

- In GTTR (2022)(p. ES-1) the reviewer concurs that risk of shale failure is an overriding concern: "The most notable technical conclusion deals with the potential geotechnical failure of the Winnipeg Shale". The SSCR (#24) reviewer states: "None of the analysis investigated groundwater quality changes due to the mining operations. The worst-case should be defined as at the collapse of the Winnipeg Shale. Any impacts related to groundwater quality are not investigated. The goal with regard to water qualify [sic] was also somehow unclear, as the report recommends a water quality study which should have been finalized at this point." It is disappointing that such a major (and probable) risk has been pushed off the page without due and serious consideration.

- In SSCRIR2 (#MBEN-IR-030), water quality concerns arising from aquifer intermixing are raised:
  Reviewer: "Please clarify how mitigative water quality measures can be reversible and sustainable, if inter-aquifer mixing conditions are the root cause of cross contamination between aquifers?"
  Proponent: "There are several physical and chemical processes that may act to reverse water quality impacts or otherwise attenuate constituent concentrations. The relevance, magnitude, importance and reversibility of each mechanism is different for each constituent. Notable mechanisms that affect contaminant fate and migration include: dispersion, dilution, sorption, chemical precipitation/dissolution, decay and volatilization, among others. Many of the relevant geochemical reactions are equilibrium reactions that are reversible dissolution/precipitation reactions. Others rely on reagents (e.g. oxygen) that are finite in their abundance, and once depleted, prevailing geochemical conditions in advance of disturbance are anticipated to be restored. Further, the **groundwater flow pathways are very long** which will encourage dispersion and therefore dilution of constituents emanating from a point source into the over/underlying aquifer." (Emphasis is mine).

  The proponent has identified some of the multitudinous effects on water chemistry that may be encountered in the course of this project. We are assured that the problems will disperse, dilute, and go away. We can comment:

  - Groundwater flow pathways can indeed be very long. Therefore contaminants can easily travel considerable distances from their origin and impact distant domestic wells.
  - Some contaminants, such as metals, never degrade.
  - Some contaminants, such as certain pesticides and/or their adjuvants, may be converted through degradation into more toxic substances than the original.
  - Contaminants may react with other substances in the aquifer to create more potent toxic materials (e.g. nitrate or organic matter + chlorine or chloramine = nitrosamines which are highly carcinogenic in very small quantities). Note: this is one reason why we should never put chlorine into an aquifer (see p. 329+).
  - The aquifers are already not pristine and often contain measurable levels of various contaminants, whose concentrations differ in different locations.
  - Any new contaminant inputs will add to the cumulative contaminant pool that is already present.
  - We would expect dispersion and dilution to be helpful only **where there is no ongoing source of contamination.** The proposed project will extend over many years and will operate within the same aquifers throughout its lifespan, with potential for ongoing impacts.
  - **Point source contamination does not always disperse**, with no additional ongoing contributions, even after many years, for example **hydrocarbons**, such as in the Carbonate aquifer in Rockwood Municipality (see pp. 393-394).
  - Microbial contamination does not uniformly disperse, and can be notoriously patchy (Pip, unpublished data). Furthermore, Smith et al. (1991) demonstrated that both

chemical and microbial contaminant plumes may also show sharp variation vertically within an aquifer: "The existence of these gradients argues for the need for closely spaced vertical sampling in ground-water studies because small differences in the vertical placement of a well screen can lead to incorrect conclusions about the chemical and microbiological processes within an aquifer." Therefore **a contaminant plume may occupy a very narrow spatial zone, which may not be captured by an intervening monitoring well**.

- The proponents remain undeterred. In a public full-page ad they trumpet the claim: "We are running out of international and local experts to assess the project – **because all of them have fact-checked that it's safe for the water and the environment.**" (The Clipper, January 12, 2023, p. 10; also Winnipeg Free Press, January 14, 2023)(Emphasis is *theirs*). Apparently the above documented and cited reviewers in the CEC process (GTTR etc.) are not experts and their professional opinions are of no account. But where are all of these proponent's "international and local experts"? Where are their 'fact-checks'? Wouldn't the proponent be anxious for the world to see these glowing endorsements and the supposed vindication of the project? Are they "proprietary", maybe?

  We are comforted, though, by another of the proponent's public ads: "How do you [not we] KNOW our [not your] water will be safe?" "Protecting the aquifer is at the heart of everything we do." (The Clipper, December 8, 2022, p. 9)(Emphasis is theirs). So it's 'their' water, now.

Limestone competency and subsidence

- EAP2 (p. 83) contains the following description of how the drill locations will be selected: "The locations of annual extraction wells will be determined in consideration of the results of preliminary geotechnical modeling used to predict thresholds of extraction amounts to mitigate adverse effects related to the **potential for underground and surface subsidence**". (Emphasis is mine).

  <u>Potential for subsidence is a big concern</u>. Why are the adverse potential effects of subsidence not examined in the EAP? Surely this would be of interest to landowners, and especially homeowners? How reliable and accurate will this "**preliminary** geotechnical modeling" be, to **<u>ensure</u>** that subsidence does not occur, both at the time, and in the future? Will the modelling contain unverified assumptions? Will it be an indefinitely ongoing learning experience?

- "Removal of the sand will form a void in the shape of a cone extending from the

bottom of the Carman Sand Member to the base of the Winnipeg Shale. The pattern of extraction cones is planned to extend laterally by successively extracting from new boreholes across the extraction area" (AppA1, p. 5).

According to the air lift apparatus patent application (CPA), "the well may include horizontal portions or the conduit… may extend at an angle in the underground reservoir as a void is formed from the removal of sand to remove sand from the sides of the void." Thus the void for each well may be substantially laterally enlarged, and horizontal extraction is possible.

- In any case, extensive arrays of voids (cavities) will be created under the shale as the scope of the extraction area expands. According to the proponents themselves, "The extracted silica sand will not be replaced; therefore, **impacts to the geology will be irreversible/permanent.**" Further, "the removal of sand will **permanently increase the effective porosity** and storativity of the Winnipeg Sandstone aquifer within the Project Site through the annual extraction of material and resulting creation of void space" (AppA1, p. 81). Further: "Extraction of the silica sand resource will result in a **permanent change to the underground geology** in the form of horizontal arrays of rooms and pillars in the sandstone geological layer (between 52 m to 76 m), in the Winnipeg Formation aquifer within the Project Site."(EAP2, section 6.2.1)(Emphases are mine).

  Note the changes will be <u>permanent</u>. What impacts will these voids have on topographical stability? There will be thousands of them, over a comprehensive area. According to Waltham et al. (2005), "All ground voids constitute elements of weakness within a rock mass". This weakness is amplified when the mass is poorly consolidated, as in the case of the Sandstone.

  In TAC (#51) the proponent states: "pressure changes alter the effective stress conditions and may bring about changes in the hydraulic conductivity and porosity… water will not be injected under pressure… the magnitude of this effect is anticipated to be relatively minor." While the returned water (not all will be returned) will not be injected under pressure, the volume and hydraulic properties attributable to the sand will not be replaced.

  Furthermore, what effects on hydraulic conductivity and porosity might the injection of **air** under pressure have (i.e. the "air bursts" described in CPA)? This aspect of the extraction process is completely ignored in the EAP.

  In TAC (#53), the reviewer notes: "it is worthy to conduct a sensitivity test on Sandstone porosity to understand its impact to the well-head and model robustness in the prediction scenarios". The proponent's reply states: "The impact of porosity was evaluated during model calibration. Any changes in bulk porosity of the aquifer in

response to pumping or injection are **anticipated to be reversible and short-lived**." (Emphasis is mine).

In SSCRIR2 (#CEC-IR-011), "The porosity and hydraulic conductivity will increase within the water filled voids established in the Winnipeg Sandstone aquifer [Emphasis *theirs*]. However, the changes are not **anticipated** to produce measurable differences in regional scale aquifer properties". (Emphasis is mine).

"Anticipated" – does this mean assumed, hoped for? So porosity will either be permanently increased (EAP and CEC versions), or changes will be reversible, short-lived, and minor (TAC version). The contradictions between EAP2 and TAC responses appear irreconcilable.

- In SSCR (#35), the proponent states that afterwards, "Local hydrogeological properties (e.g., hydraulic conductivity and storativity) will be quite variable depending on whether measurements are collected within a water-filled void or within the intact aquifer between the voids. However, the scale of the project is regional…" As noted elsewhere, the eventual scope of the project may encompass at least 85,000 ha (see p. 29). It seems not to be a problem if it is only regional.

- The increased hydraulic conductivity of the voids will increase the rate of transport of contaminants which enter the Sandstone aquifer (Figure 31): they will be distributed faster and farther.

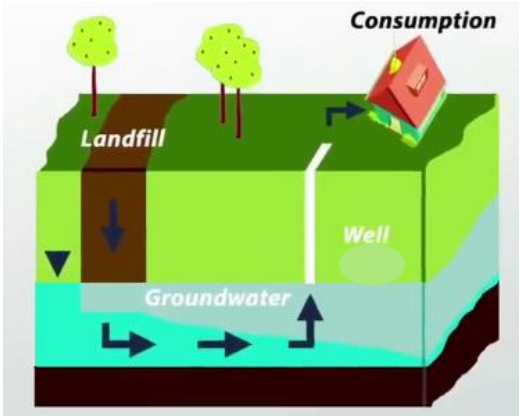


Figure 31. Increased flow of contaminants in void space. Source: https://study.com/learn/lesson/cavern-sinkhole-formation.html

- The post-extraction stability of the ground above the voids depends primarily on the strength and support of the overlying caprock. Any factors which can lead to subsidence

and/or collapse must be carefully considered before embarking on a project of the present proposed scope. According to Whyatt and Varley (ND), “Deep and high extraction mining is possible only through management of rock mass failure.”

- Limestone stability over voids “is a function of its unsupported span and the structural integrity of its roof rock.” (Waltham et al., 2005). We can also add here the additional load imposed by overburden. According to Sinclair (1982), weakening of support underneath overburden and/or caprock may lead to collapse and sinkhole formation (Figures 32-36). “Thickness and cohesiveness of overburden control, to a large degree, the shape and size of collapse areas at land surface.” When support fails, “**a relatively large sinkhole will probably form abruptly**.” (Sinclair, 1982). This event is **unpredictable** (https://www.msha.gov/sites/default/files/events/Pillar-Collapse-Risk-Analysis-2021-.pdf). In instances where a subsidence depression may first form at the surface, the final collapse may occur at any time; however there may be little visible advance indication at the surface that failure is imminent.

  Depending on the size of the sinkhole and the mass of falling material, it may involve sudden displacement of air and water, potentially endangering nearby workers/public (Figure 32)(see pp. 189-190). For partial extractions involving cavities where supports, such as pillars and roof fail, “The amplitude of the subsidence is proportional to the volume of the cavities in underground workings.”; for sinkholes, “The depth of the crater mainly depends on the depth and dimensions of the underground workings.” (ICMC, 2008).

Figure 32. Moment of sudden collapse (implosion) of caprock and overburden resulting in formation of a sinkhole. This can present a danger to workers and bystanders. Source: https://www.msha.gov/sites/default/files/events/Pillar-Collapse-Risk-Analysis-2021-.pdf

- The **predilection for gravel pits in site selection** (e.g. SSCRIR1 #CEC-IR-002) creates additional risks: since presumably the pits will continue to operate after the wells are decommissioned, could **vibration** from heavy earth-moving equipment, rock crushers, conveyors, vibrating screens, cranes and other robust machinery affect limestone integrity and destabilize the weakened shale, especially since the 'cushion' of (somewhat) shock-absorbing overburden will have diminished?

  Gravel pits are also places where blasting occurs. **<u>Will gravel pits associated with sand extraction be permanently banned from future blasting operations?</u>**

  From this standpoint, as well as contamination and other concerns, gravel pits are among the worst venues for the proposed project activities.

- The voids will offer little resistance to water flow compared to the undisturbed sandstone. Subterranean flows, especially in wet seasons, **may enlarge the cavities** through spalling and redeposition, causing sudden collapse (Figures 32-36). The RPCR (Table 9 Notes, in Table 2, Attachment A) admits "possible long-term cavity expansion" over time. **Therefore subsidence risks will not only continue after the project has moved on, <u>but are likely to increase</u>.**

Once subsidence has occurred, the surface circumference of the crater will expand as the lip and sides erode over time. In low-lying locations the depression may fill with water (Figure 36), which will percolate downwards into the loose material and soil at the bottom, and into the aquifer. John and Rose (2005) identified sinkholes as a significant entry portal to groundwater for "microorganisms of public health concern". The decommissioned **well casings in the sinkhole may be broken** in the force of the collapse. In any case, they will provide conduits for direct chemical and microbial contamination of the aquifers. Even if casings remain intact, the annular seals around them will be compromised. We are reassured, however, that "In the absence of subsidence, well seal failure would not be expected." (RPCR #162). But, our worry is: what about in the *presence* of subsidence…….?

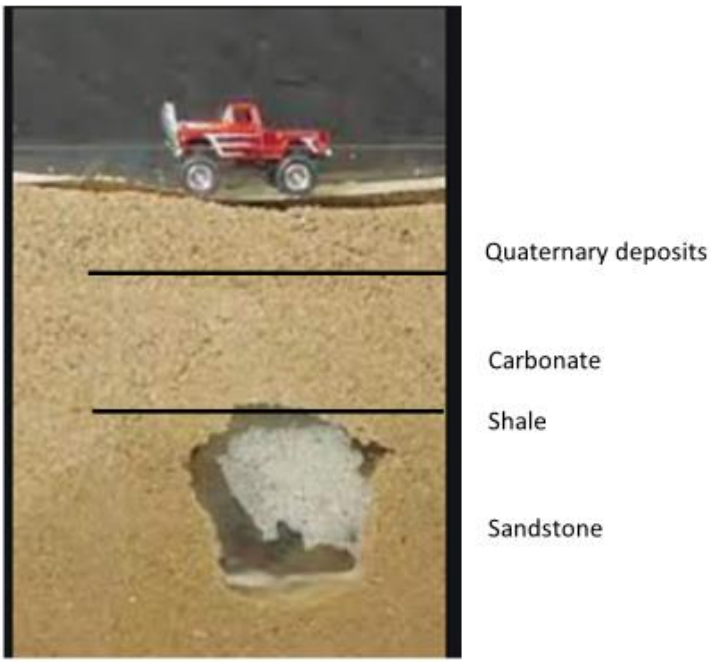


Figure 33. Model illustration of formation of an underground void space by interior removal of sand. Modified from https://www.youtube.com/watch?v=e-DVIQPqS8E. Not to scale.

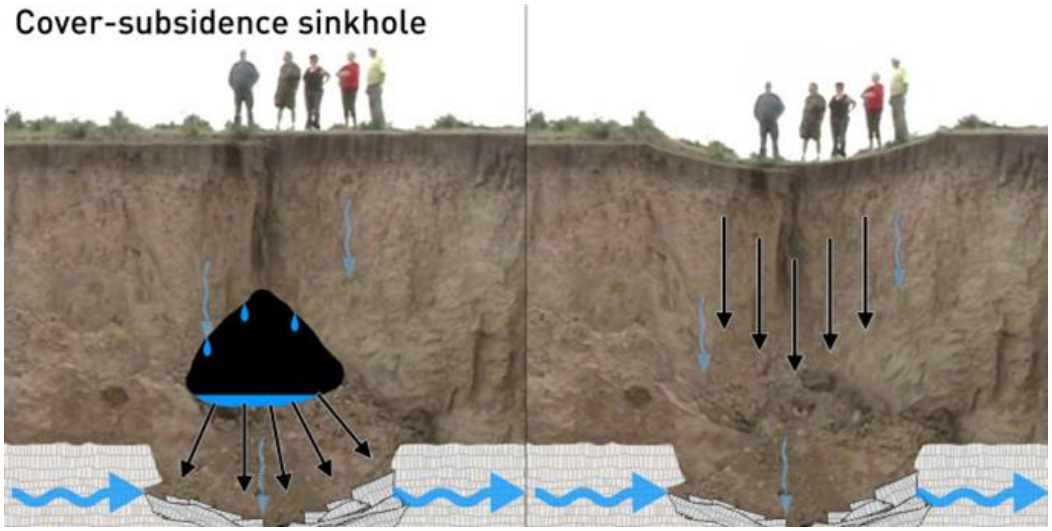


Figure 34. Collapse of void space assisted by water flow in aquifer. Source:
https://www.meteomedia.com/tj/nouvelles/article/science-of-sinkholes-how-do-they-form-and-why

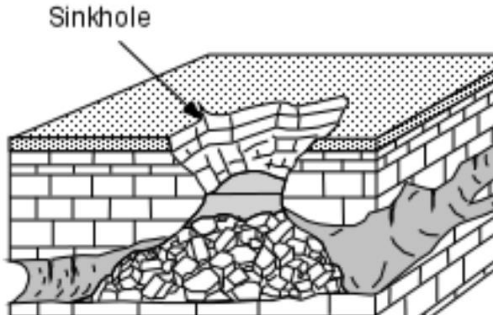


Figure 35. Formation of a sinkhole by failure of caprock. Source:
https://www.weathernationtv.com/news/sinkholes-whole-lot-danger/

Figure 36. Sinkhole caused by subsidence from excessive aquifer pumping, analogous to interior removal of support. From Perkins (2021).

- While the subterranean voids will be filled with water, pooling as influx from surrounding matrix, support of the cavity roofs will be significantly compromised, as buoyant support of rock by water alone is inadequate (Waltham et al., 2005), and former support from the sandstone will be gone. The pool will also concentrate contaminants that will percolate to the aquifers below.

- The EAP2 (section 6.2.1) states: "the overlying carbonate (limestone) geological layer needs to be at least 15 m thick to minimize the possibility of surface subsidence during sand extraction activities". Similarly Table 2, Attachment A (p. 2) in RPCR states: "Limit extraction to areas with competent limestone thicker than 15 m." The note for Table 9 of the *same report excerpt* in RPCR (in Table 2, Attachment A) states: "Extraction in areas of only 10 m of competent limestone is discouraged due to competency uncertainties."
    - So what do we do when thickness is between 10 and 15 m? This is a full one-third latitude.

- Is this difference the amount of uncertainty inherent in the model, just for *competent* limestone?

- **How will limestone competency be determined, and how will "competency uncertainties" be identified, for each site?** Will some form of downhole imaging technology be utilized (see p. 181)? If so, **imaging is limited to the immediate vicinity of the borehole wall** (https://wiki.aapg.org/Borehole_imaging_devices). Thus fractures, discontinuities, and weaknesses in the 60 m cluster diameter can easily be overlooked.

- How will the results of competency tests (if any) be used to modify operations? Will some reduced extraction still proceed – we are frightened by extraction only being *discouraged* (not forbidden) where only 10 m of competent limestone exist! Who will check and oversee what actually happens?

- Competency does not just depend on thickness (see discussion below). What additional criteria will be applied? Or is generic thickness the only determinant?

Considerable **site-specific** data regarding the Carbonate stratum are needed **before** comprehensive sand extraction can be undertaken, as subsidence is irreversible. "Additional testing will be conducted to further assess and confirm the limestone and overburden thickness and structure as the Project progresses geographically." (EAP2, section 6.2.1). There are no details in the EAP regarding the plan for this testing, including distribution and number of anticipated tests and how they will relate to the well cluster locations. How will the necessary advance data be obtained – from test boreholes, from real-time drilling of extraction wells? Of particular concern is the proponent's attraction to **quarries** (e.g. TAC #25, RPCR #145, #150), **where significant amounts of materials have already been removed**.

- The EAP seems not to notice that, according to the well logs in WDR, a number of test wells **did not meet the 15 m minimum limestone thickness criterion** (e.g. Well PID 200824 with a limestone thickness of 11 m)(WDR). But Note: Table A in the Waste Characterization and Management Plan (February 6,2023) cites an assumed limestone thickness of **13 m** (see pp. 525-526 below). How does this align with the 15 m model?

- In RPCR (#1), "The exploration and environmental planning phase of CanWhite's activities involved studying the geology and geotechnical conditions to ensure that the method of extraction would not cause surface subsidence (including shifting, sinking, collapsing or slumping at the surface) and would not create a risk of new connections between aquifers underground. In 2021, the extraction method was tested at **three** test hole locations where "surface settlement" was monitored before and after sand extraction was completed." (Emphasis is mine).

  Further, "Stantec's geotechnical 'model' was designed to guide the Project extraction activities so that adverse impacts on surface and sub-surface geology are eliminated." and "CanWhite will conduct

physical subsidence monitoring and assessment before, during, and after extraction operations" (RPCR #1). Further, "The information used to develop the geotechnical model was drawn from field investigations completed by CanWhite and others (Stantec, AECOM, Friesen Drilling) including borehole drilling (lithology, structure and other properties) and downhole imaging and testing, assessment of limestone material properties, laboratory strength testing, standard penetration tests (SPT), geotechnical modeling, and subsidence monitoring before, during, and after exploratory test drilling." (RPCR #1).

The following observations can be made:

1. The two CanWhite studies referenced are not provided in the EAP, nor are the Stantec reports of 2019, 2020 and 2021, nor are there any links to them. The RPCR also references a Stantec 2022 report multiple times (#7, #153, #179), which has not been posted to the Registry. Only a tiny heavily redacted excerpt is shown without context in RPCR, Table 2, Attachment A. We do not know how faithful the paraphrased snippets in the above RPCR quote are to the original report, which is unavailable. Readers are unable to assess the models and the extent, quality and limitations of the data, nor the validity of assumptions, nor the fitness of conclusions for themselves.

   The proponent's reason (RPCR #2) is that "Reports which contain trade secrets, scientific or technical business information, or other information of a proprietary nature are shared with the regulator on a confidential basis.", and therefore are not for the rude gaze of the indiscreet, gawking and interfering public. Surely the *entire reports* cannot consist of confidential information? This excessive secrecy only fuels suspicion and distrust by the public of both regulator and proponent.

   "Sio is willing to share its modeling results with the CEC experts, yes. However, these results contain confidential information and will only be shared with those CEC technical experts who have signed an NDA." (SSCRIR1 #MSSAC-IR-011).
   Since the crux of the project is centred on these very models and their credibility, and since critical approval decisions will depend on this information and its validity and soundness, this places scrutiny, evaluation, and due diligence in the hands of a very limited, select, and restricted few.

   A project of this immense magnitude and potential impact surely ought to be examined by as wide an array of interests as possible in order to ensure that a broader consensus and range of expertise are engaged. Surely there is very little truly 'proprietary' information that needs to be protected? What is so secret about our limestone and shale – those are not being mined and sold, are they? Are people drinking secret water from their wells?

   More extracts, however, from the elusive Stantec 2022 report are subsequently relayed in GTTR, where we learn that the Stantec report dealt with five potential limestone failure modes, focusing on one (i.e. **bending**) in particular:

"analysis concluded that the lowest limestone layer was at risk of failing (i.e., breaking) and collapsing into the void if the diameter of the void became too large for the layer to "span" the opening. Following the collapse of the lowest limestone layer, the overlying layer would no longer be supported from below and would also be at risk of collapsing into the void. This failure mode would continue in an upward direction until a limestone layer has sufficient strength to span the underlying void. In the event that all of the limestone layers failed, the overlying quaternary deposits would no longer be supported, and they would also be at risk of collapsing into the void. Such a collapse would have the potential to result in subsidence at surface (e.g., sink holes). (GTTR, pp. 13-14).

According to Waltham et al. (2005), voids progressively propagate upwards in overlying limestone failure (Figure 37A and B). The duration of this failure is variable, but may occur over a prolonged period of time: "Although the development of an expansion dome is very slow and may take several years or decades [but] The appearance of a sinkhole on the surface is very sudden, which makes it potentially dangerous to people and property in the vicinity" (ICMC, 2008).

Waltham et al. (2005) proposed that, in simplified fashion, bending failure may be described thus, i.e. "to treat the beds as beams failing under their own weight":

For an unsupported beam of span length L, of unit width, of depth d, of unit weight γ and of weight W $(= Ld\gamma)$, the bending moment $M = WL/12 = L^2 d\gamma/12$, and the section modulus $Z = d^2/6$.
Assuming elastic behaviour of the rock, failure occurs when the tensile strength T is reached at M/Z in the outer surface of the deforming beam.
Consequently the stable beam depth (or bed thickness) $d = L^2\gamma/2T$.
This assumes that the beam is constrained at its ends, which is the normal situation in a rock mass. If the beam is unconstrained, due to the presence of open fissures, the bending moment is $WL/8$ and the stable beam depth $d = 6L^2\gamma/8T$.
For limestone, the unit weight γ may be taken as $26\,\mathrm{kN/m^3}$.

[kN = kiloNewton]. These authors noted, and we can see from the above, that "The critical factor is therefore the tensile strength *T* of the limestone". This model assumes that the limestone span or beam is *homogeneous and intact*. In the present situation, however, the latter assumptions may not hold. For example, unit weight of limestone may vary both horizontally and vertically in the project area.

Figure 37A. Progressive limestone roof failure above subterranean cavity, with detachment and collapse occurring sequentially along successive planes of weaker interbedded layers. From Waltham et al. (2005).

Figure 37B. Progressive limestone roof failure. Sequential detachment along bedding planes results in a smooth flat ceiling. The cavity gradually increases in height. Note fractures in the next layer that will fall. Source:
https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.lyellcollection.org%2Fdoi%2F10.1144%2Fsp279.3&psig=AOvVaw1y84viUiBP65xFtZFrjLfc&ust=1673801813864000&source=images&cd=vfe&ved=0CA0QjRxqFwoTCNik06bEx_wCFQAAAAAdAAAAABAQ

"Stantec estimates that the limestone beddings will behave as a **multi beam** supporting system for the combined load from overburden and limestone. Although **the lower beams can be unsupported and damaged (and potentially collapse into the cavity)**, a portion of the beam will remain stable and act as a cantilever beam to support the upper stratigraphy. This will result in **a progressively smaller unsupported beam span upward**." (SSCRIR1 #MSSAC-IR-009) (Emphases are mine).

- Evaluation would be required for each site, as caprock and overburden conditions are **site-specific**.
  "Sio will be drilling and coring wells regularly in areas of extraction prior to drilling the extraction wells to **confirm** overburden and limestone thickness. Core samples will be taken and analyzed to **confirm** limestone competency." (SSCRIR1 #MSSAC-IR-009). "Confirm", not ascertain? We already know the outcome beforehand?

  A. What does "regularly" mean? Not at each site?
  B. There will be "drilling and coring wells" *before* extraction wells are drilled. **How many boreholes of the various descriptions will there actually be?** Will some/all of these preliminary wells become extraction wells? What is the protocol for abandoning the inutile, presumably narrow-gauge, coring wells?
  C. How much time will be required for the samples to be analyzed before extraction drilling proceeds?

- "a portion of the beam will remain stable", provided that the portion is not beset with incipient or actual fractures, discontinuities, irregularities or inclusions. How will this be **evaluated from a small-diameter core sample and borehole**?
  "The zones of carbonate limestone with vertical joints are excluded from the beam system evaluation" (SSCRIR2 #MSSAC-IR-009(f)). What about horizontal weaknesses within the beams?

- A "progressively smaller unsupported beam span upward" can be expected when the limestone is competent, homogeneous, and intact. But it may be riddled with joints and fractures, in which case the unsupported beam span may not decrease as the lower layers fall away. It will have been perforated by 5 or 7 boreholes (or an unknown number – see p. 59). **One of the boreholes will be in the center of the beam**. The span will have sustained vibration from multiple drilling.

- In Figure 37, we see that the limestone walls of the collapsed area have remained reasonably vertical and roof span has not substantially decreased. The issue is confounded by the fact that **cavity shapes will be irregular** (SSCRIR2 #CEC-IR AppA). How will widest span in oblong cavities (*perpendicular* to the long axis of the cavity) be calculated or measured?

- Over time, as supporting caprock thins, it offers less resistance to vertical flow of water from above, and karstic solution of the carbonate may accelerate and further weaken the caprock, and consequently its ability to support the same overburden mass.

In practice, and certainly in the instance of Red River Carbonate, the simplified model is confounded: "Factors that reduce stability include rock jointing that weakens or destroys the beam, any overburden load that bears on the beam, dipping geological structures that complicate the roof profile and time that allows strength decrease" (Waltham et al., 2005). We can add here any anthropogenic activities that may destabilize or place added load on the span.

The age of the Ordovician Red River Carbonate is also a factor: "Rock strength decreases with time due to fracture propagation from stress points at grain boundaries on critical surfaces, and it is realistic to cite a long-term decrease of tensile strength to about 30%" (Tharpe, 1995 *in* Waltham et al., 2005).

We are not vouchsafed the "proprietary" details of the Stantec model and exactly which and how parameters were used to arrive at the 'minimum thickness'. Waltham et al. (2005) have warned that some model versions have erred because they: "used shear strength in place of tensile strength for failure and therefore achieved an unrealistically large stability envelope". In any case, "Shear strength is immensely variable for a rock mass, as it depends on the immediate disposition of fractures and fissures; a very approximate figure may be taken as about *one-tenth of the shear strength of the intact rock*" (Waltham et al., 2005)(Emphasis is mine).

2. Besides the unknown extent and quality of the data in the suppressed Stantec reports, some other data were sourced from AECOM, as well as WDR which contains descriptive lithology for 42 boreholes. 'Subsidence monitoring' was apparently conducted at **only three locations** (presumably *à propos* some of the injection well permits).

   Given the information needed, is this enough to generate a reliable and accurate model, particularly in light of the questions below? Is confidence in the robustness and dependability of the unrefined model justified when so much is at stake: it "will guide the location, arrangement, and depth of the annual extraction wells. The rules for operation will determine locations for well clusters, how far apart the extraction wells are from each other, and how much sand can be extracted from any one well." (RPCR #1).

In other words, the proposed EAP descriptions for well cluster locations, well arrangements and other details laid out in the EAP may be *passé* and actual configurations and practices may depart from those in the proposal. Who will oversee whether these departures are acceptable or allowed? Will these routine and ongoing deviations be obscured within the cosy *seulement-entre-nous* confines of the so-called "living documents"?

3. "Stantec developed the basis of geotechnical design to meet the short- and long-term stability requirements for the extraction cavity and caprock." (RPCR, #1).
"The cavity opening size is limited such that the expected damaged caprock does not reach the upper layers of the caprock and the undisturbed caprock layers are thick enough to support the overburden load." (SSCRIR1 #MSSAC-IR-009). Again, this is for homogeneous, undamaged limestone: how representative is such limestone throughout the area?

   What does the model show where the **center** of the caprock, where stresses are greatest, is **pierced by a borehole**, i.e. the central well of the cluster?

   Table 9 in RPCR provides extraction disturbance zone dimensions and limestone thicknesses which appear to have been generated by the model, the modus and assumptions of which are mostly not known/provided (except for some selected additional parameters in SSCRIR1 (#MSSAC-IR-009)), neither are the data which feed the model. The notes below the table suggest the many severe limitations and theoretical nature of the exercise. **Will this be the one-size-fits-all protocol for decisions on extraction conditions and operations?** "Proactive modelling before annual extraction activities will be used to restrict extraction activities to the 'Allowable Extraction Disturbance Zone Dimensions' " (RPCR #1). Is this 'generally' for the area, or 'respectively' for each site?

   On what data will this "proactive modelling" be based? What assumptions will continue to be made? What happens when reality turns out to be different, because confounding factors were not included or foreseen? The proponent indicates that additional parallel data collection will be ongoing, which is a concern, because surely **it would be appropriate to embark on the work with a more robust and reliable data set already in place**. And, we have to wonder, what of the luckless abandoned sites that identified the need for corrections and adjustments in the first place? What is *their* fate?

According to RPCR (#179), the proponent indicates that "the modelling described in both the geotechnical study (Stantec 2022) and the Hydrogeology and Geochemistry Assessment Report (EAP, Appendix A) will be periodically updated and improved over

time as more data continues to be collected in accordance with hydrogeological and geotechnical monitoring plans." [Note: datum = singular, data = plural]

The uncomfortable message here is that application of earlier versions of the model will identify shortcomings in that model, which will be continually adjusted as time and experience dictate the necessity to do so. Again, what will happen to all of those interim 'learn-as-you-go' wells, and will there be liability for mistakes?

4. Monitoring for subsidence was apparently conducted only "before and after sand extraction was completed", and "The maximum measured change in ground elevation at any of the extraction sites was only ¬0.002 m (2 mm)".

   "Stantec assumes that the results of settlement monitoring to date, which indicates no apparent early-term settlement, is representative of probable settlement during full-scale mining and the long term. **There remains some potential for changes in local support conditions to generate settlement in the short or long term**." (SSCRIR1 #MSSAC-IR-009).

   Unless some very drastic disturbance transpired, such as an underground explosion, or unless the cavity was very large and near the surface, **surface subsidence would not occur immediately**, since the void is some considerable distance below, and stresses from interior collapse would propagate in the unsupported weight over a period of time before failure would be evident at the surface. Quoting from Waltham et al. (2005), "The natural consequence of **progressive roof failure is upward void migration**, which may reach the surface where it causes instantaneous major subsidence in the form of a collapse sinkhole." (Emphasis is mine). According to the latter author, it is not possible to predict when final collapse will occur: it may be months, years, or centuries. How can "early-term" conditions be "representative" of future situations?

   Therefore monitoring would be more usefully done over months, years, decades+ rather than days, or "early-term".

- What is the time period for the monitoring "after extraction operations" promised above (RPCR #1)? Is monitoring of **each cluster** being promised? For the length of time (years) that would be required, surely this is an impossible task? Therefore, in realistic terms, subsidence could easily occur at unmonitored sites at any time.

- What were the thicknesses and other characteristics of the overlying strata at the three test sites? How dissimilar were the detailed lithology and stratigraphy including overburden among the three sites?

- In order for surface subsidence to occur, the cavity roof must first sag and fail. Even if this could be the best place to monitor imminent collapse, it would not be technically practical or even possible, given the overwhelming number of sites. However, even with appropriate monitoring there is little that could be done about it other than to warn the landowner/public and fence off the area.

5. Furthermore, the reported **monitoring involved single wells rather than clusters**. Would not risk of subsidence be concomitantly greater when several wells are operating in mutual proximity? While seven simultaneously operating wells are mentioned throughout, Table 2-1 (EAP1) and Table 6-3 (EAP2) identify 10 extraction rigs (thus potentially two entire 5-well clusters could be operating at the same time, unless there are 7 well clusters). Yet even with multiple operations, immediate subsidence would not be expected unless the strata overlying the cavities are exceptionally thin or loose.

6. How will the model take into account the *variation* in amounts of reinjected water?

7. "so that adverse impacts on surface and sub-surface geology are eliminated." Perhaps "reduced" or "attenuated" would be more realistic than "eliminated", which is a categorical and impossible guarantee. The above repeated words "would not" also promise and guarantee. Who would independently monitor, enforce and underwrite this guarantee, well into the misty future? And then, should the guarantee fail, how could the damage possibly be fixed?

8. Besides simple thickness, horizontal and vertical differences in mechanical attributes of the limestone may also affect its stability, for example it may vary substantially in **porosity** (Manger, 1963), **chemical and physical composition** (https://geology.com/rocks/limestone.shtml), and **density** (a general range of 1.55 - 2.75 g/cm^3) (https://chem.libretexts.org/Ancillary_Materials/Exemplars_and_Case_Studies/Exemplars/Geology/Density_of_Rocks_and_Soils). Porosity in turn is not absolute, but may vary in response to stressors such as pressure (*cf.* TAC #51). It is not known what values for limestone properties were used in the Stantec model, and whether they reflected or were representative of **the ranges of values found in the project area**.

   In RPCR (#1) apparently "assessment of limestone material properties, laboratory strength testing, standard penetration tests (SPT)" were conducted. How many samples were analyzed, and how did they relate to the project area and local stratigraphy? Where are the statistical analyses, what variability was found, and were these **ranges** incorporated into the model parameters? Where are these data, for surely limestone material properties are not proprietary?

9. ‘Limestone’ (*sensu lato*) is not a uniform material. At the broadest level, ‘limestone’ and calcite consist of calcium carbonate, dolomite also contains magnesium. In practice, these materials present as a spectrum depending on relative composition, hence classification is somewhat arbitrary, for example:

- Calcite limestone – more than 90% calcite and 10 % dolomite
- Dolomitic Limestone – calcite 50-90% with dolomite 10-50%
- Calcite dolomite – calcite 10-50% and dolomite 50-90%
- Dolomite – calcite less than 10% with dolomite more than 90%

(https://spectralevolution.com/applications/mining/identifying-calcite-dolomite-and-clays-in-limestone/).

In the field, limestones, dolomites and clay can be broadly differentiated by their reflectance spectra using a field spectrometer (Figure 38)(Ibid.). However intergrading is common, resulting in further overlapping petrological terms such as argillaceous dolomite, dolomitic shale, etc. A further level of complexity is the incorporation of other elements, such as silica, iron and manganese, that may affect mechanical properties. The point here is that virtually all of these combinations can occur in Red River Carbonate. Therefore the proponent’s criterion of ‘limestone thickness’ needs substantial further refinement, as competency will be site specific and complex.

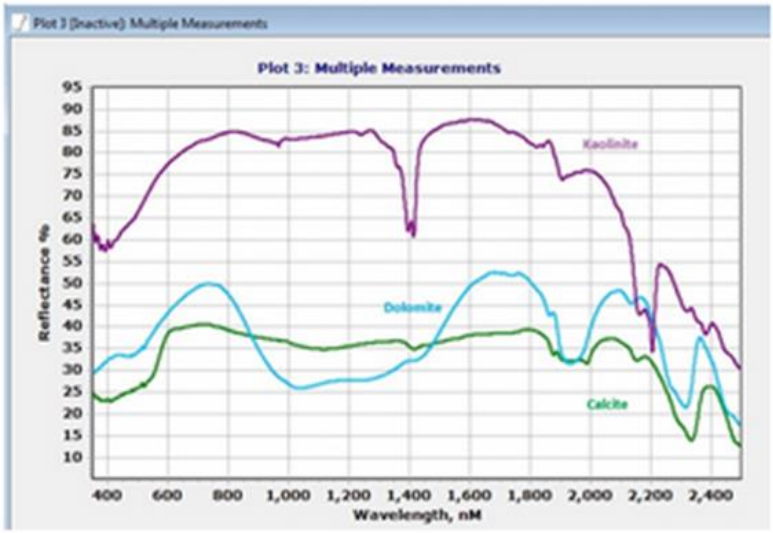


Figure 38. Reflectance spectra for dolomite, calcite and kaolinite (i.e. clay). Source: https://spectralevolution.com/applications/mining/identifying-calcite-dolomite-and-clays-in-limestone/

Limestone contains **layers of varying hardness and tensile strength**, which materially affect its ability to support load (Figure 39):

Figure 39. Limestone pillar showing banding of stronger and weaker strata. Weaker cementing bands may be quite thin, and the layers below them are more likely to fall away. (Highlight is theirs). Source: https://www.msha.gov/sites/default/files/events/Pillar-Collapse-Risk-Analysis-2021-.pdf

Unless it has been subject to extensive early reworking and turbation, Red River Carbonate, due to its sedimentary nature and lengthy period of deposition, is composed of **layers of varying hardness, thickness and composition** (Haidl, 1992), with attendant variable material properties and susceptibility to fracture, dissolution and erosion, which manifests as rib slabbing (Figures 40-41). On close examination, we can also see this layering in the three drill cores shown in AppA5 (C.3). The question arises: **how will/can competency be assigned for the <u>entire thickness</u> of heterogeneous limestone at any given site?**

Photo: E. Pip

Figure 40. Groundwater-worn Red River carbonate specimen (Springfield) demonstrating rib slabbing, due to unequal attrition of closely spaced strata of varying hardness. The harder ridges have a melted appearance as softer interbedded layers have been differentially dissolved by water. Under stress, the layers will tend to separate along the weaker bedding planes. Dr. E. Pip Collection.

Photo: E. Pip

Figure 41. Weathered Red River Carbonate dornick showing superficial macroscopic layering of strata. There are actually many fine layers (lamination). Dr. E. Pip Collection

9. Layers can also be erratically folded in a myriad of ways, illustrating the tremendous variability that can occur even within a very small distance (Figure 42). Thus a core sample may not accurately represent geological conditions even a meter away.

Photo: E. Pip

Figure 42. Weathered Red River Carbonate boulder showing erratic folding of layers. Arrows indicate incipient fracture zones (i.e. secondary porosity), note: they are here *perpendicular* to bedding planes. Cavity on left is biogenic, entire structure may be a stromatolite (compare similar https://www.dreamstime.com/stock-photo-fossil-stromatolite-wyoming-image-shows-collected-big-horn-mountains-stromatolites-were-formed-blue-green-algae-image54326532). Dr. E. Pip Collection.

10. The Red River Carbonate contains diverse additional lithological constituents, which influence overall mechanical and hydraulic conductivity properties. Various lutites (shale, claystone, mudstone, siltstone) are common (Figure 43).

Photo: E. Pip

Figure 43. Laminated claystone (Springfield) showing fine stratification. Also note pitting and tunnels from ancient bioturbation. Dr. E. Pip Collection.

Nodular chert is frequently found (Figure 44 A and B), and here varies through the entire chert color spectrum: pure white to yellow, red, dark green, brown, light to dark gray, and black (personal observation)(Figure 44 C). Their disposition and occurrence is highly variable, as we see on magnification of the Chip Tray Photo Logs in AppA5. Concretions may also occur (Figure 45), as well as pyrite (see Figure 74, p. 275-276). The presence of such materials and structures, and their unpredictability, must be considered in the stress response of the limestone, although they are likely to be missed by the borehole core.

Figure 44 A-B. Chert nodules from Red River Carbonate (Springfield). A: Typical 'knobby' morphology within highly porous soft limestone matrix. B: Waxy distressed chert nodule stained with iron, showing irregular 'flaky' cleavage that is not related to any bedding plane. Photos: E. Pip, Dr. E. Pip Collection.

Photo: E. Pip

Figure 44 C. Harlequin "mash-up" of gray, brown and white waxy chert (Springfield), with ancient exceptionally well preserved 'gouge', apparently made by an animal approximately 450 million years ago while the layers were still fictile: their exact original texture is reproduced. Underside contains burrows and vugs lined with calcite crystals. Dr. E. Pip Collection.

Photo: E. Pip

Figure 45. Banded argillaceous concretion (Springfield). Note fissility into thin layers, *across* accretionary planes in this example. Dr. E. Pip Collection.

10. Geochemistry of the limestone is heterogeneous (Figure 47 A-F). In Red River Carbonate, frequent pockets of oxidized precipitated iron occur as staining, or brittle concretions, resulting from ancient bacterial iron metabolism (e.g. Figure 46 C), or ancient shifts in environmental anoxic/oxic balance. These may substantially compromise mechanical strength.

11. Extensive personal observation has shown that, in addition to the well-known mottled dolomitic Ordovician Tyndall limestone (Selkirk Member of Red River Carbonate)(e.g. https://www.manitoba.ca/iem/geo/stratmaps/pdfs/orr-1.pdf), numerous highly fossiliferous beds occur sporadically, which are structurally very porous and brittle (Figure 46 A-F). The Red River Carbonate is a treasure trove of the remains of a diverse, lively and abundant ancient marine ecosystem of the Williston Basin, and is riddled with numerous vacant burrows, molds, vugs, and abundant stromatolites, corals,

brachiopods, crinoids, trilobites, molluscs, and mystery organisms which represent body-organization types that no longer exist. (It is estimated that 61% of marine genera were extinguished at the end of the Ordovician period in this first of five Phanerozoic mass extinctions, and occurred due to climate cooling and associated habitat loss (Finnegan et al., 2012)). Since taphonomic conditions are such that softer parts undergo greater shrinkage and attrition than harder structures in bottom sediments (Pip, 1988), disappearance of the former may leave cavities and porosity in the lithified matrix. In Red River Carbonate, bedding planes tend to separate and crumble in these zones of weakness. Such strata cannot be considered competent limestone.

It should be noted that Winnipeg Sandstone may also harbor fossils: “Large gastropods, receptaculitids and ichnofossils are common in the sandstone.” (Lapenskie, 2016).


B


C


D

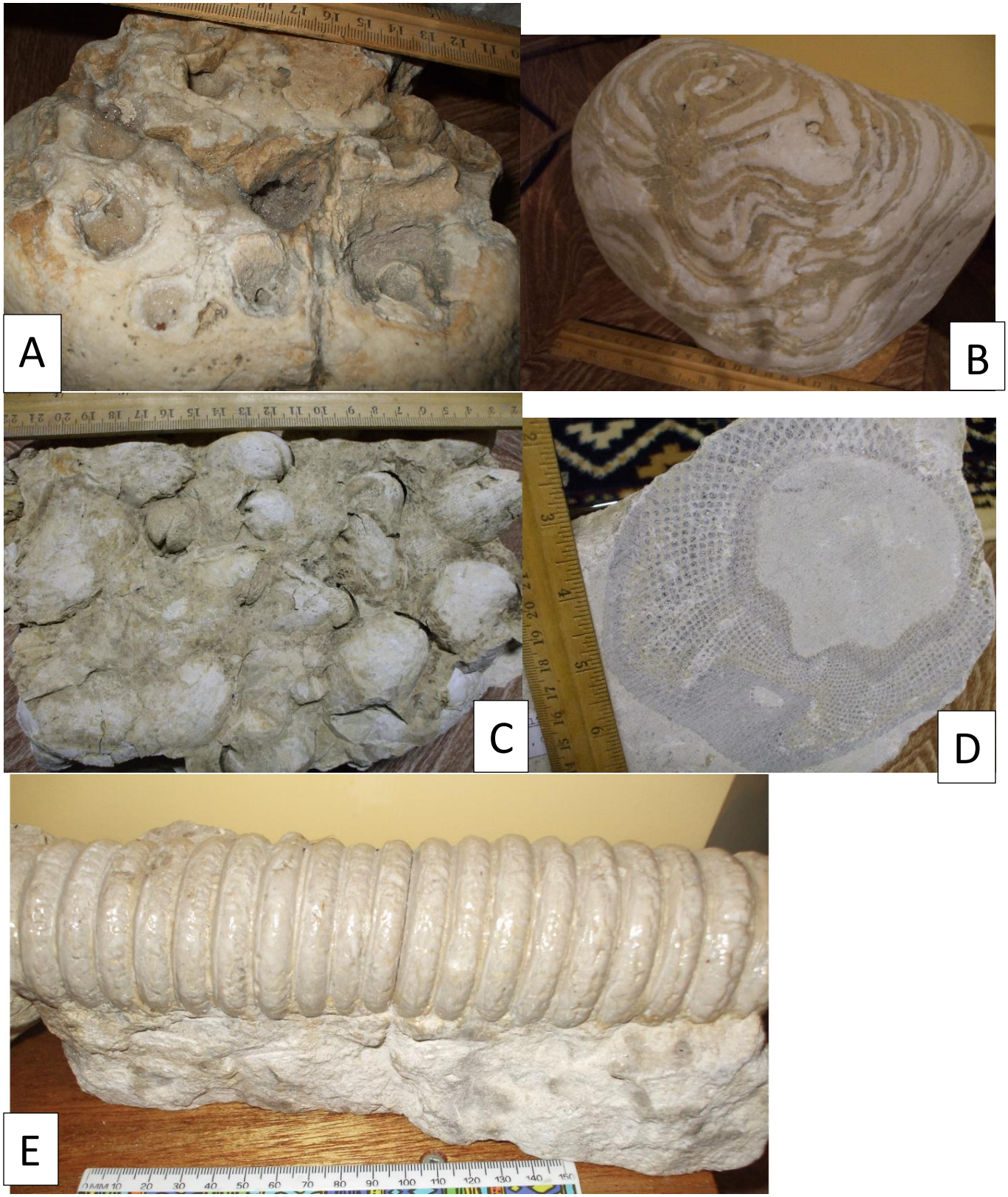

E


F

Figure 46 A-F. (above). Red River Carbonate (All from Springfield). None of these can be considered competent limestone.

A: Specimen showing a high degree of heterogeneity and porosity due to fossils, burrows and debris.
B: Boulder (vicinity of proposed project) showing heterogeneity and embedded fossils.
C: Boulder showing severe distortion, with cavities and burrows. Arrow indicates iron precipitate resulting from ancient bacterial metabolism: such areas are extremely brittle, and are common in Red River Carbonate.
D: Patchwork limestone and dolomite, arrows indicate holes and burrows.
E: Limestone slab with gastropods and brachiopods.
F: Very loosely consolidated specimen displaying a longitudinal section of a rugose coral. These kinds of friable deposits may be many meters thick.

All photos by E. Pip from Dr. E. Pip Collection.


A
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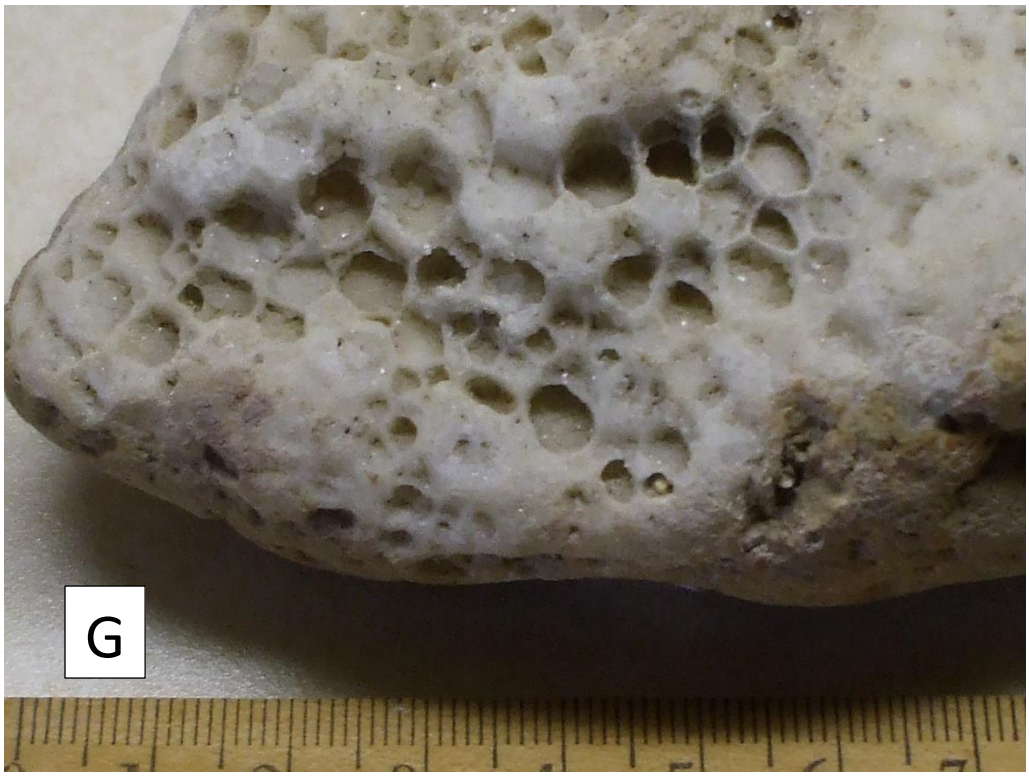
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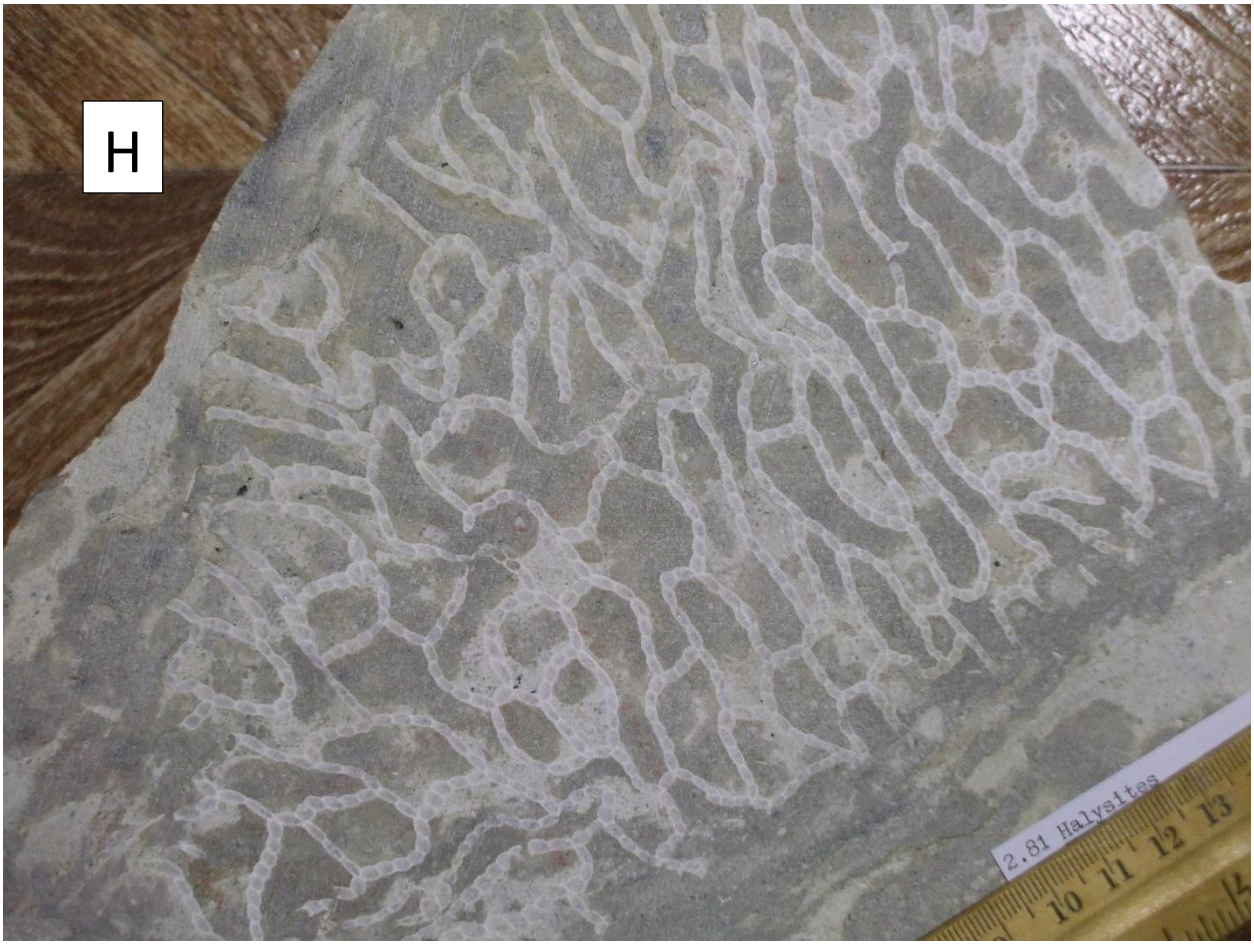


Figure 47 A-H (above). Fossiliferous Red River Carbonate (All from Springfield).

FIRST PAGE

A: Biogenic vugs lined with calcite crystals in limestone matrix

B: Stromatolite boulder

C: Plate of benthic marine brachiopods, note crevices and fissures where matrix has separated

D: Globose receptaculitid: an ancient evolutionary dead end, now hypothesized to be an alga rather than a coral (aka 'sunflower coral')

E: Ellesmeroceratid nautiloid (cephalopod mollusc)

SECOND PAGE

F: Large chain coral, possibly a *Halysites* species. These two specimens are portions of a single specimen originally >1 m tall, extremely friable and unstable, crumbles on handling.

G: Tabulate coral

THIRD PAGE

H: Slab showing chain coral (*Halysites*)in cross section

All photos by E. Pip, All Dr. E. Pip Collection

And, even when the limestone matrix appears to be comparatively uniform and non fossiliferous, it can be interrupted by various concretions and other structures that tend to separate from the matrix and create areas of weakness (Figure 48).

Photo: E. Pip

Figure 48. Large mystery concretion or pseudomorph (?) in Red River limestone matrix (Springfield). There appears to be no macroscopic evidence of any structure inside, with completely uniform indurated and lithified clay, and no visible accretion pattern. If it is a fossil, it would be new to science. A real stumper. Dr. E. Pip Collection.

12. The **competency models appear to have considered only (basic) primary porosity**, i.e. porosity obtaining from the original deposition of sediments (https://books.gw-project.org/hydrogeologic-properties-of-earth-materials-and-principles-of-groundwater-flow/chapter/primary-and-secondary-porosity/). **Taphonomic deposition** and other

irregularities described above **were not acknowledged** in the EAP nor in any supporting documentation, yet they are integral and well-known, indeed world-famous features of Red River Carbonate.

Secondary porosity refers to stresses and factors acting after initial deposition. The sedimentary Late Ordovician limestone that forms the Red River Carbonate Formation is hundreds of millions of years old (ca. 461 – 444 million years) (https://weblex.canada.ca/html/012000/GSCC00053012586.html)), and has passed its best-before date many millions of years ago. It was already ancient when dinosaurs presided over the earth, and has acquired many battle scars in the mists of time since its original formation. Thus fractures, joints and discontinuities resulting, for example, from compressive/decompressive stresses of many serial glaciations (e.g. Teller, 1976; Chong, 2016), hydrodynamic pressure fluctuations, various global and climatic cataclysmic events, deep diagenetic effects (Perkins, 1991), or idiopathic causes may now compromise its stability (Figure 49). Stylolites, fracturing, and deformation due to compaction and dissolution in Red River Carbonate (Perkins, 1991) may affect its stratigraphic thickness, hydraulic conductivity as well as facility of contaminant travel. We note reports of "limestone rubble" in some of the well logs in WDR (e.g. Well PID 199969, 200861).

Photo: E. Pip

Figure 49. Red River Carbonate dornick showing fractured dolomitic polyhedrons (pink due to magnesium), with the seams loosely filled, in some places incompletely, with calcite. This phenomenon has also been reported in Ordovician Red River Carbonate by Perkins (1991). Dr. E. Pip Collection.

Secondary porosity, or **geomorphological integrity of the limestone is a major concern in the project area.**

"The upper carbonate aquifer is characterized by a network of fractures, joints and bedding planes and intensive dissolution which provide substantial permeability to the aquifer." (AppA1, p.61), and the carbonate is "a relic rock mass that is variably weathered ranging from extensive to minor fracturing and dissolution resulting in a vuggy fabric that in turn affect the permeability of the rock mass (Render 1970 *in* AppA1, p. 61).

An example of a vug in limestone from the vicinity of the project area is shown in Figure 50). These cavities may originate as karstic dissolution features, or they may have much older origins as chambers and burrows of ancient benthic creatures, or hollows remaining after soft-tissue organisms have decomposed. After lithification, these spaces decrease the competency of the limestone matrix, and increase hydraulic conductivity.

Given the extensive occurrence and irregular nature of these weaknesses, **primary porosity and thickness *per se* are not adequate determinants of limestone competency**; indeed, structural flaws may override the physical attributes of the intact rock. According to FD (2019), "The **main porosity within the carbonate bedrock** occurs within the secondary joints, bedding planes, fractures, and karstic features that are extremely common in many parts of the carbonate bedrock (Render, 1970). Due to variability in the number, size, type and interconnected nature of the permeable features, well yields can vary substantially over relatively short distances depending on the fractures encountered while drilling the well." (Emphasis is mine).

Reader's Note: Perhaps the most famous example of the propensity of Red River limestone to separate along bedding planes is found in its unfortunate use on the exterior of the City of Winnipeg Public Safety building, that was demolished in 2020 due to structural issues and irreparable failure of the Tyndall limestone cladding, which, ironically, presented a hazard to public safety (https://www.canadianarchitect.com/public-safety-building-permanently-closed/.)(https://en.wikipedia.org/wiki/Public_Safety_Building_(Winnipeg)). Similar Tyndall Stone has fared much better on other buildings such as the Manitoba Legislature, illustrating the variability and unpredictability of mechanical properties of stone from the same quarry.

Photo: E. Pip

Figure 50 . Limestone vug, lined with drusy calcite crystals. (Springfield, vicinity of project area). Dr. E. Pip Collection.

Numerous well logs in WDR reference limestone fractures and rubble. A more graphic illustration is evident in the drilling log for Well PID 207212, where **void space in the limestone is documented** (screenshot)(marker is mine) (Well%20Information%20ReportsQuarriesNearVivian%20(2).pdf):

WELL LOG (Imperial units)

From	To(ft.)	Log
0.0	6	BROWN TILL
6.0	76	GREY TILL
76.0	113	GREY TILL AND BOULDER
113.0	153	PURPLE LIMESTONE
153.0	155	VOID IN LIMESTONE

The drillers did not proceed further. We can suppose that this void is karstic in nature. It would have been instructive to investigate the extent of the void by sonography.

All of these examples emphasize that **heterogeneity and secondary porosity present a serious problem which is not addressed by the competency model**, at least judging from the paltry information provided in Table 2, Attachment A in RPCR. It must be considered that multiple drilling operations in close mutual proximity may aggravate limestone fracture and crumbling, leading to failure.
The reviewer in SSCR (#17) notes: "The lithology at the site is described by the proponent in their conceptual model in terms of large zones and/or layers representing homogeneous aquifers and aquitards. However, there is considerable information on material heterogeneity not considered by the proponent."

The proponent's response dismisses this fundamental concern as an alternate view of the grand confluence of scale: "It was therefore assumed that the heterogeneity within each hydrostratigraphic unit could be represented at the **scale** of the problem, with an **equivalent homogeneous porous material that is attributed to a single value** for its hydraulic conductivity, storativity, and other parameters which govern fluid flow through the porous material. Although heterogeneity of materials is expected due to spatial variability of materials, incorporating fine scale variability **was not considered** to materially affect the numerical modeling results **even though realworld hydrogeologic response may be locally sensitive to heterogeneity.**" (SSCR #17) (Emphases are mine).

"Stantec assumed that the results of geotechnical borehole logging, point load testing, laboratory testing and ABI/OBI as well as supporting information from other boreholes geological logging **are representative of the site-wide rock mass characteristics**, with the exception that the thickness of lithologic units varies. Although borehole logging indicates that conditions are **relatively** consistent, there remains **some potential for local variability of rock strength and structure to occur which may contribute to the local settlement**" (SSCRIR1 #MSSAC-IR-009)(Emphases are mine).

These responses attempt to gloss over the risks: It is the **local site-specific** variability and anomaly that will determine risks and cause **local** failures. Just because a failure is local, does not mean that it can be discounted. The landowner or homeowner is not going to say: Oh well, it's just local, no big deal." Given the infinite variability of the deposits, in actual practice, only a minor proportion of real situations will conform to all assumptions of *any* universal homogeneous model. 'Scale' is not good or responsible enough. After all, *le diable est dans les détails.*

- Thus the 'acceptable' conditions allegedly listed by Stantec (2022) as reported in GTTR (p. 14), i.e.:

"Limiting the horizontal extent of sand extraction voids;
- Limiting sand extraction to locations that have a competent limestone thickness greater than 15 m;
- Locating clusters of extraction wells at least 60 m apart;
- Completing full scale extraction tests to confirm performance prior to advancing the full Project;
- Preparing and following site-specific extraction designs, taking into consideration the geological properties at each location."

do not include the overarching fact that **simple thickness is a far from adequate all-purpose measure of competency**, as the limestone is enormously variable over horizontal distance, and vertically consists of strata of differing porosity, texture, density, friability, compaction, continuity, geochemistry, and whatever other parameters that one cares to name. It obviously follows that **distances between well clusters cannot be standardized according to one absolute numerical value, or one simple measurement**.

The 15 m competent limestone dictum presents another practical dilemma: Does it refer to 15 m of **solid, uninterrupted, unvarying** limestone? Or does it refer to a **total** of 15 m of competent strata within a thicker extent of carbonate containing weaker interspersed strata as well? Behavior under stress would greatly differ for these two situations.

"Cross-bedded limestone was also excluded from the caprock strength. Design was based on the **sequence of competent** (predominantly unfractured) caprock which was found to be present." (SSCRIR1 #MSSAC-IR-009). Presumably this refers to an *unbroken continuous* sequence. Further, "Limestone tensile strength was estimated based on laboratory tests on 19 specimens from **five different wells**." (Emphases are mine). "The portion of carbonate limestone that is considered for stability evaluation of the cavity is the horizontally bedded portion (cross joints and weak areas are excluded)." (SSCRIR2 #MSSAC-IR-009e).

-The tensile strength parameter for the model was based on materials from only "five different wells"? How representative is this for the entire project area? What were the criteria for choosing these five particular wells?

-**Assessment of a limited core may not identify fractures or flaws that are adjacent.**
-How many of the *existing* exploration wells meet this 15 m competent sequence?
-The carbonate core would have to be analyzed individually at each site.

13. "Geotechnical analysis focused on competent units above the shale to identify void spans which would remain intact and **eliminate** the potential for surface subsidence" (SRTER #6). (Emphasis is mine). "Eliminate"? This means that not one failure would occur. Out of perhaps 10,000?

But then, in SRTER (#15), the proponent hedges: "It should be noted that the Project has been specifically designed such that no subsidence is **expected**. If the assumption is made that a major subsidence at surface has occurred, **impacts would be limited to Project areas** within the extraction area with progressively lesser impacts further from the extraction area. This would be **expected to result in little to no impacts <u>outside</u> the Project area**." (Emphases are mine).

Therefore, no worries, because the problems would only be in the project areas, with no subsidence issues farther away. Okay, people, just keep your new houses and things away from project areas. Eventually, we will only need to worry about these possibilities in only about 85,000 ha (possibly more) of southeastern Manitoba (see p. 29).

14. "The analysis considered overburden thickness variation between 25 and 35 m in the extraction area." (SSCRIR1 #MSSAC-IR-009). Apparently, overburden was assumed to be homogeneous in composition, which it is not (Figures 6 and 7, pp. 47-48). Where were these data obtained? How many samples were included?

    "Additional testing will be conducted to further assess and **confirm** the limestone and overburden thickness and structure as the Project progresses geographically." (EAP2, section 6.2.1). In the EAP, overburden is mentioned *en passant*. It will be 'assessed and *confirmed'*, but how will these data actually be utilized to adjust extraction operations - particularly in view of the plan that "the first year of activities are on an old highly disturbed gravel quarry" (SSCRIR1 #MSSAC-IR-2011). Therefore in these circumstances the effect of overburden cannot be properly factored in, because normal overburden will not be present. The data gained from this venue will not apply to other and subsequent locations.

    A major shortcoming of the Stantec model, or at least what is evident from the picayune crumbs that we have been tossed secondhand in GTTR (p. 14), is the importance of **not only the thickness, but also composition and weight (i.e. load pressure) of the unconsolidated Quaternary deposits that are supported by the limestone** (Figures 6 and 7, pp. 47-48)**.**

    Not only will these loose sediments vary at different locations in terms of density (for example proportions of boulders vs. sand and clay), but their **weight may also vary with time**, depending on variations in the amount of water contained therein and degree of saturation, occurrence of perched aquifers, etc. Wet seasons may exacerbate instability not only by alteration of hydrodynamic patterns within the aquifer, but also via **additional top weight** imposed by water saturation of the vadose zone, and liquefaction or dilation of overburden soils in response to rapid loading such as storm events and

flooding. Sandy soils are particularly prone to liquefaction and ensuing sudden loss of support (Casagrande, 1976; Youd et al., 2001). Storm events may trigger sinkhole formation: "heavy rainfall/storm(s) and rapid increase of head differences within a relatively short period of time are major factors affecting the timing of sinkhole occurrences" (Xiao et al., 2018).

How will these additional stresses be factored into the so-called 'recommended minimum limestone thickness'?

15. The above Stantec recommendation (GTTR, p. 14) of vaguely "taking into consideration the geological properties **at each location**" provides no substantive information on how exactly competency tests would be performed and used to guide extraction limitations **at each site**. It seems that, in practice, the latter exercise would take years and be ultimately overwhelming and unattainable, given the sheer numbers of the well clusters that are planned. Does "location" refer to each cluster site, or generally to a block or even larger area?

    Meanwhile, the primitive Stantec model will be gospel: "Sio Silica will be adhering to this design and these parameters as set out in Table 9 by Stantec." (SSCRIR1 #008), and "The well numbers and spacing in each cluster will be arranged to follow the allowable extraction disturbance zone dimensions provided in Table 9 of the Geotechnical report." (RMSF-IR-010). Of course, there is also the "confidential" version of cluster layout, and we don't know what they are adhering to there (SSCRIR1 #MSSAC-IR-009, also RMSF-IR-006).

16. Table 9 (in Table 2, Attachment A, RPCR) indicates fixed side wall slope of 65° and possible cavity dimensions according to the model. How was the 65° angle determined? Will the angle vary with degree of sand consolidation? Further, will angle steepness vary with depth (i.e. vertical span) of extraction?

    The SSCR (#12) response to these questions is "See the Geotechnical Assessment Report by Stantec (2021) for detailed information pertaining to the cavities that will be created by mining." It is not possible to see a suppressed, inaccessible report.

    In SSCRIR2 (#CEC-IR-010), "the very steep and overhanging material will slough over time to slopes shallower than 65 degrees." In SSCRIR1 (#MSSAC-IR-009), the final repose angle generated by modelling is more precise: "In the long-term, the collapsed sand would settle to a natural unconsolidated sand angle of repose of 31 degrees in front of a less disturbed cavity wall." This apparently applies to a well cluster: "The void space is representative of full well cluster void spaces" (SSCRIR2 #MSSAC-IR-009c). How could

the precise angle of 31 degrees possibly apply to all cavities, with their varying sizes, heights, and irregular shapes?

Further, would the angles not vary with degree of (un)consolidation? The firmness and support of the original packed sand will have been diminished. The air lift process itself relies on enough looseness in the sand that it can be suspended in the water to bring it to the surface, it is not hard rock. The remaining walls will have been blasted with pressure bursts to further loosen the sand (CPA). How 'stiff' and stable can the "less disturbed" cavity walls be? What about increased and fluctuating changes in hydraulic conductivity in the voids that would exert continuing and variable erosive forces? Might not the oozy nature of the remaining intervening sand cause it to sink and redistribute at the bottom, creating a large horizontal cavern, which combined with hydraulic flows, could result in the detachment and fall of large portions of the exposed and unsupported shale, and possibly limestone, ceiling?

Further again, the above 31 degrees would apply to "a 100 year time frame" (Ibid.). They can predict climate and water regimes for 100 years? [This is truly 'proprietary' information: just think of all the global governments, banks and companies that would pay billions to possess this knowledge.]

17. Did this model include the effects of the 'pulsed pressurized air bursts' described in the air lift apparatus patent (CPA), and "the well may include horizontal portions or the conduit… may extend at an angle in the underground reservoir as a void is formed from the removal of sand to **remove sand from the sides of the void**." (CPA)(Highlight is mine). In such a case, would the 65° side wall slope specified in the model still be maintained during extraction?

18. Will disturbance resulting from previously extracted wells affect subsequent wells/clusters as the extraction progresses to new wells? The modelling seems to have focused on single wells: what about *combined* effects?

19. How was "downhole imaging" (RPCR #1) conducted, given the tremendous turbidity challenges precluding the use of a downhole camera? What alternate technology was used, for example high-resolution acoustic downhole imaging, electrical formation borehole microscanning, or the various downhole options of gamma ray, accelerator porosity, or lithodensity sondes? (http://www-odp.tamu.edu/publications/189_IR/chap_02/c2_9.htm).
The results of these investigations are not provided in the EAP. What technology will be used to monitor the voids during extraction?

However in SSCRIR1 (#MSSAC-IR-009), "The shape [of the cavity] is derived from the shape measured by the side scan sonar survey completed on wells after or during a paused extraction, where the walls are left close to vertical in the short-term.", i.e. acoustic imaging was used. "Results of two side scan sonar surveys were used to estimate the cavity shape… Stantec estimated that the findings from these **two** side sonar surveys provided the **range of expected conditions**" (SSCRIR1 #MSSAC-IR-010). Further, "it is **not expected** that the results of the [future] multi-well testing will vary **markedly** from **expectations**."(SSCRIR1 #MSSAC-IR-011) (Emphases are mine).

- Does this mean that two scans were used to extrapolate one and the same entire cavity shape for each well? Or was there one scan performed on two separate wells?
- If option 1 in the above bullet is correct, **how many wells** were scanned, and how many cavities were mapped? Only two?
- Does "range of expected conditions" extend to all of the proposed project wells?
- If there were **only two scans, i.e. two wells, how can this be deemed a "range"**? Even if there were four wells, this is still not a statistically confident range, unless all of the results were identical, and even then…..
- Did the "range" include various sand consolidation possibilities?
- What was the time frame for the scanning, how many scans were performed for each well, and how did the shape of the cavity change over this time? How long after extraction did scanning continue?

Sonograms are finally presented without comment for two single wells (BRU 92-8 and Well1) in SSCRIR2 (CEC-IR AppA). We note a number of disturbing features:

- The two cavities are very different. BRU 92-8 is not round, but oblong in shape (see Figure 53 A and B, p. 193). Why? Was the reason due to much greater **heterogeneity** of the Sandstone in BRU 92-8 and therefore much more irregular extraction? Or was the elongated shape due to the horizontal extension of the air lift apparatus as described in CPA: "may extend at an angle in the underground reservoir as a void is formed from the removal of sand to remove sand from the sides of the void.", while in the other well, no extension occurred? This is a critically important piece of information, as it determines subsequent behavior and risks.

- The cavities are **irregular in shape** vertically and horizontally. From only the two cases, we can see that each cavity that will be extracted will be unique. Therefore any standard generic model for prediction of cavity characteristics, expansion, coalescence of cavities, and subsidence risks cannot apply.

- "During full scale testing, Sio will **confirm** the range of cavity shapes and will design well locations and spacing for the confirmed range." (SSCRIR2 #DLN-IR-

008)(Emphasis is mine). We only have two shapes, which do not at present constitute a range. Since the wells and locations will come first, before the cavity shapes are known, how will cavity shapes inform subsequent well designs, since the materials are heterogeneous? How will applicability of a cavity shape in one situation be valid for another location? Since the cavities are in the Sandstone, what parameters will be used for this determination?

- The scans presented were obtained **during and shortly after extraction** of individual wells. Their jagged outlines in all three dimensions suggest that much spalling and restructuring of the space is yet to occur. What will be the long term configurations of these two spaces? Is it even possible to extrapolate, given the unique character of each space?

- Could the proponent please explain the following sonogram from SSCRIR2 (CEC-IR App A) for this well (BRU 92-8)(Figure 51), specifically: what has occurred in the area *above* the shale? Its upper boundary at 149 feet is very strongly demarcated.

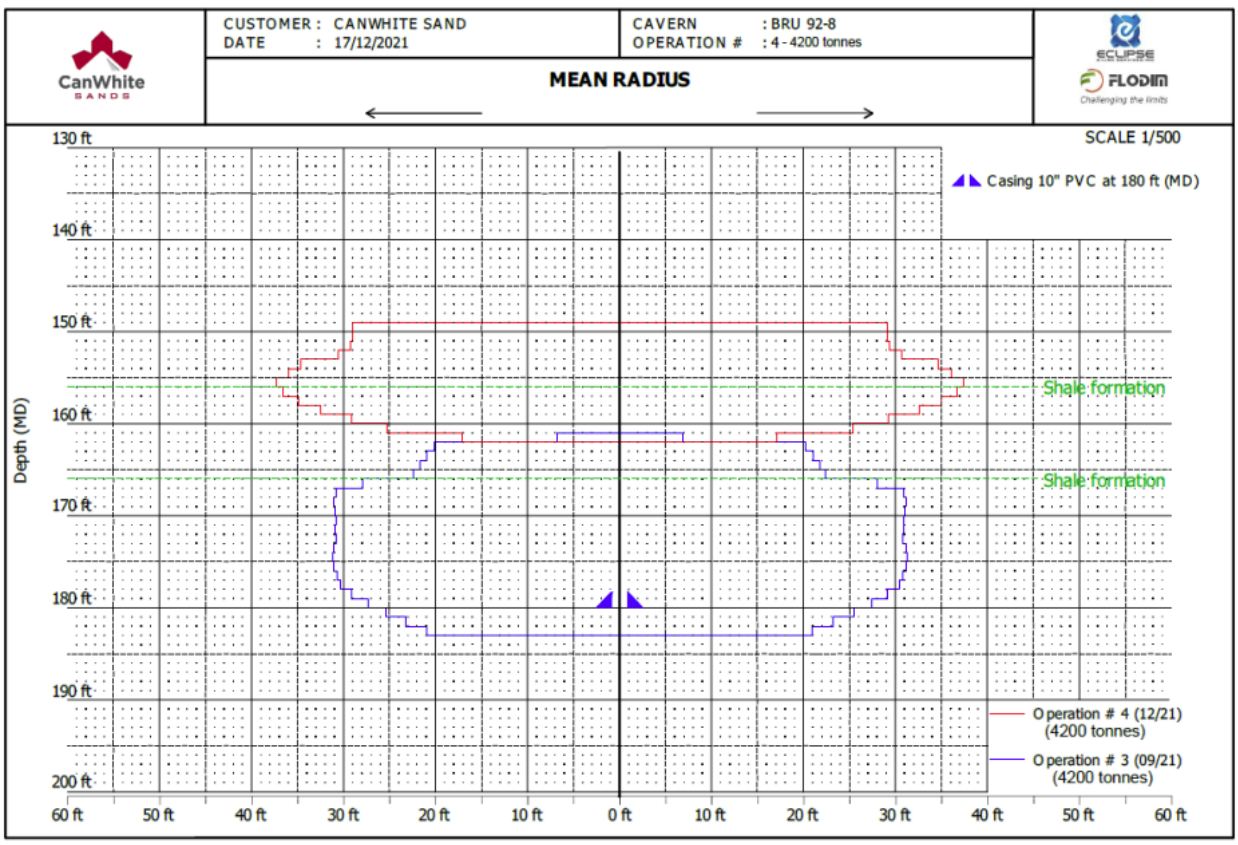


Figure 51. Sonogram vertical plot from SSCRIR2 (CEC-IR App A) for BRU 92-8.

BRU 92-8 is identified in well records (= Well PID 208473) as a reinjection well. Consulting the well log for BRU 92-8 (Well PID 208473), we see the upper terminus of the shale at 156 feet, also marked correctly in Figure 51:

```
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
```

There is no identified lithological feature at 149 feet, it is purported to be continuous limestone down to the top of the shale, yet there is an obvious restricting element. What does the red zone in the shale and limestone in Figure 51 represent? How have the characteristics of the shale within the demarcated zones been altered?

The proponent mentions a *recommended* (not promised) staged approach to scanning after the licence is issued: "This staged approach will allow Sio Silica to **confirm** expected conditions before a larger multi well extraction and make adjustments that may be required." (SSCRIR1 #MSSAC-IR-010; also SSCRIR2 #MSSAC-IR-010(b))(Emphasis is mine). Should not this information have been firmed up already, so that "adjustments" are not made at the cost of "oops" wells? What if expected conditions are not confirmed, and the adjustments are no better? Furthermore, will each site be thus investigated, or will the current EAP *modus operandi* continue, i.e. one or two samples are deemed "representative" and a "range" of the whole?

"According to the Geotechnical Design **recommendations**, there is a **recommendation** according to the void space geometry which is "*Complete side scan sonar survey after **each borehole** completion and assess results against cavity extraction assumptions*". This **recommendation** acknowledges that Sio is aware of the importance of **completing** monitoring. Sio will conduct this monitoring **during extraction operations.**" (SSCRIR2 #MSSAC-IR-010c).

- How firmly committed is the proponent to actually doing this, many thousands of times? There is a lot of emphasis on optional 'recommendations'.
- Who will enforce this and independently review the data?
- If they are "aware of the importance of completing monitoring", why will it be conducted only during extraction operations? 'Completing' means after-sales service as well.
- If there is a problem, it has already started/happened: what will they do about it, other than cover it up with soil and walk away?

20. The notes in Table 9 indicate "**Extraction depth is 20 m**", thus presumably this value was used for the model.

According to the EAP, **sand extraction is expected to span** the Carman Sand Member, less the shale: "Removal of the sand will form a void in the shape of a cone extending from the bottom of the Carman Sand Member to the base of the Winnipeg Shale." (AppA1, p.5 and p. 81). The Winnipeg Shale forms the top boundary for the Carman Sand member, and is reported as ca. 3 m thick in the project area (AppA1, p. 60) but varies (WDR). According to AppA1 (p. 58), in the project area, using WDR, "[CanWhite] found the Carman Sand Member ….with a **consistent thickness ranging from 20 m to 30 m.**" (Emphasis is mine). However in RMSF-IR-007, "the thickness of the Winnipeg Sandstone is between **20 m and 25 m** across the Project Site Area.", and "extraction wells and the depth of material extraction will be progressively deeper from east to west across the Project Area." (Emphasis is mine).

Since the void space will extend from the bottom to the top of the sand stratum, **why was only the MINIMUM of 20 m used in the model?** This value is not even an average, which in itself would be greater than 20 m. If the sidewall slope is maintained at 65°, does this not mean that Extraction Disturbance Zone Dimensions in Table 9 will not be reflective of actual extraction conditions, as **the cone will be much larger**? **What should the values be for ≥25 m, or approaching 30 m)?** As the model stands, it will not apply in cases of >20 m. What is the actual prevalence of the minimal 20 m of sand thickness in the project area; presumably the 20 m cases will be found on the east side of the area where the material is thinnest?

21. The well drilling logs (WDR) indicate that frequently the sand stratum is not continuous, but is interrupted by additional shale layers (e.g. arenaceous mudstone (Lapenskie, 2016)). What will be the extraction protocol in these cases? Will several of these sandstone layers be exploited, with drilling through the intervening shales, to access the entire sequence? Has water quality been investigated in these separate sandstone layers, where they occur, and how much water chemistry may differ among them, i.e. **are these separate aquifer subunits?** What would be the effects on water chemistry and void geometry resulting from the compromise and degradation of these multiple shale layers?

22. The quality of the Sandstone is not uniform and homogeneous. The well logs in WDR indicate a variety of visually different colored sands, including black (e.g. Well PID197863) (see p. 33). In some cases, different types of sands are **stratigraphically separated by shale layers**. No information is provided in the EAP or associated documents regarding respective chemical composition, and most pertinently, the **differences in water chemistry**. Are there any plans to exploit these non-white sands as

well? Will any drilling occur beyond the 30 m thickness zone indicated above, into the granite basement?

23. The above recommendations apparently do not account for **enlargement of the voids over time**. The notes in Table 9 admit **long-term expansion of the voids over time**, and the model apparently extrapolated "the long-term allowable unsupported span" of limestone. "There is some potential that additional changes to the cavity and the area of influence of sand extraction may change over the long term." (SSCRIR1 #MSSAC-IR-009).

    What time span is defined by "long-term"? A few years, decades, centuries? How was this time span determined, and how would it be tested? Would the model account for fractured limestone? What about changes in hydrological regimes (e.g. increased karst leaching) and climate?

24. According to the model, which apparently relied on a slope of 65° and a depth of 20 m, "The long-term diameter of the extraction cavity is expected to be 10 m larger than the short-term diameter." (Table 9, in Table 2, Attachment A, RPCR). Similarly in SSCRIR2 (#CEC-IR-010): "The maximum **probable** increase in cavity radius is **estimated** to be 5 m in 100 years. Propagation after 100 years is **expected** to be limited in comparison to the first 100 years propagation due to increasing support in the cavity from natural backfilling of failed sand from the cavity wall." i.e. a 10 m increased diameter, plus some more thereafter. (Emphases are mine).

    The following concerns arise:

    - On what data is the "expected", "probable", "estimated" expansion value based, and what is the statistical confidence level in this number? The word "probable" is used: calculated probability has a number, or is it an abstract *nos quidem speramus* term?

    - **What is the 'expected' expansion size for a 25 or 30 m extraction depth?**

    - Will a slope of 65° continue to be maintained with extraction depths of >20 m?

    -Do the estimates quoted above apply to the 31° as the estimated final repose angle of the sand (SSCRIR1 #MSSAC-IR- 009)?

    - These 'expected' numbers assume that consistency of the matrix is homogeneous.

    -Do these estimates apply only to the premium white sand, or will other sands with other qualities and characteristics also be extracted (WDR)?

- Will not spalling and oozing of the sides over time vary at different sites because of myriad inconstant factors, for example amount, spatial pattern, depth, and speed of sand extraction, degree of matrix consolidation and cohesion (stability), degree of turbation from the 'pressurized air bursts' described in CPA, variable hydraulic pressure and flow in the aquifer, proximity of water wells, and others?

-**How will multiple shale layers in the Sandstone affect eventual void geometry?**

-How can the proponents predict climate/hydrological conditions over the next 100 years, and **after**?

Similarly, the reviewer in SSRC (#13) notes that the proponent "assumes that the sandstone 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."

The proponent responds: "the Geotechnical Assessment Report by Stantec (2021) provides the basis for the slope and shape of each cavity created by mining. Several post-extraction surveys have been conducted by a third-party wireline logging company specializing in underground caverns and well logging. The results were then reviewed by Stantec and there is empirical information that documents the shape of the cavities." Further, "Several pilot test extractions have been conducted over the past several years by Sio Silica. The data and learnings from these tests have been leveraged into the Sio Silica Corporation work to date and will inform the follow up plans, such as the Groundwater Monitoring and Mitigation Plan." (SSCR #15). In other words, we have the data but nobody outside of the anointed priesthood can see them. The "Groundwater Monitoring and Mitigation Plan" is now a "follow up" plan.

Where is this inaccessible, legendary, tantalizing, succulent Stantec (2021) report? How many *years* of post-extraction did the surveys encompass?

According to the proponent (SSCR #35), "the effective porosity of the water-filled void will be 100%. Between the voids, the sandstone aquifer will not be disturbed by mining and will remain intact." In RMSF-IR-010, "strength reduction is expected to be reduced with distance from the void. **Most** loss of strength is understood to occur in the immediate area of each well cluster with **minimal** affects [sic] **beyond** the area." (Emphasis are mine). We understand here that there will still be *some* "affects", but are unclear how "immediate area" and "beyond" are defined.

In SSCR (#35), the proponent also suggests that "the lateral extent of drawdown cones induced by subsequent extraction events may be reduced by the release of

groundwater from the enhanced storage zones associated with the residual water-filled caverns." In other words, flow will probably increase from preceding already-formed cavities towards the current active ones and surrounding area during, and as a result, of sequential extractions. Will such increased flow also erode the intervening sandstone at a greater rate? It seems doubtful that assurance can be given that the sandstone will remain intact.

How, in the end, is **a rigid 10 m value for future expansion deemed to be a 'one-size-fits-all'?** Are geophysical conditions not variable? Are extraction conditions not variable? Are hydraulic conditions not variable?

The model is claimed to be "conservative" and assuming a "worst-case scenario" (RPCR #1). One has to disagree.

25. And then, in SSCRIR1 (#MSSAC-IR-009), the proponent admits "There is some potential for interconnection from well to well" and "The **total allowable span may contain more than one well**, and these wells within the same cluster area may interconnect in the sandstone." (Emphasis is mine). In RMSF-IR-010, "While immediately after each well's drilling pillars might exist between individual extraction wells in each cluster, these pillars are expected to settle out shortly after extraction completion leaving a larger **combined void**." (Emphasis is mine).

    Therefore large, multi-voids are possible. Under these insupportable conditions, the entire shale plate is likely to fail (as in Figure 30, p. 133).

    "Room and pillar" mining relies on remaining columns and walls to support the weight of the roof. "Pillars are blocks of rock left to support the overlying strata. A pillar collapse is when an array of pillars fail suddenly. Pillar collapses can occur with very little warning." (https://www.msha.gov/sites/default/files/events/Pillar-Collapse-Risk-Analysis-2021-.pdf).

    Figure 52 illustrates a limestone pillar, however sandstone is much softer and much more likely to fail. Under the increased hydraulic flows in the chambers, erosion of pillars will enable collapse.

Figure 52. "Room and pillar" cavity showing supporting pillar left in place. If the pillar is further eroded, roof collapse may ensue. Source: https://www.msha.gov/safety-and-health/safety-and-health-initiatives/pillar-collapse-initiative

Pillar collapses are often accompanied by "the formation of a large surface sinkhole " when the entire caprock suddenly fails, and is accompanied by an air blast as caprock and overburden plummet into the hole (Figure 32, p. 144). (https://www.msha.gov/safety-and-health/safety-and-health-initiatives/pillar-collapse-initiative). According to the latter source, multiple pillar arrangements are less stable: "A larger pillar array is more likely to collapse because there is less pressure arch potential, and it will also cause a greater airblast". Therefore the cluster well configuration may not be a good idea, especially since there is also a well in the center.

26. We are comforted, though, that "The distance between adjacent well clusters is set to **eliminate** interconnections between adjacent well **clusters**."(SSCRIR1 #MSSAC-IR-009), i.e. not between adjacent wells, which is apparently acceptable. (Emphases are mine). But what if *that* distance turns out to be wrong? What if sand in the intervening walls is particularly oozy, and hydraulic flows are particularly flowy?

    A topic that has not been acknowledged in any of the EAP documentation, nor by any reviewers, is the **potential for blast to occur with sudden subsidence**. In 'dry' cavities, roof collapse is associated with powerful airblast, as the air in the cavity is abruptly

displaced by the falling rock mass (Palma et al., 2019; https://www.msha.gov/sites/default/files/events/Pillar-Collapse-Risk-Analysis-2021-.pdf). The compressed air is under very high pressure, similar to an internal explosion, and workers even some distance away have been injured or killed in mine tunnels or portals by the force of the airblast generated by roof collapse (http://www.mineaccidents.com.au/mine-accident/186/northparkes-airblast-1999).

In the present situation, the **cavities will be filled with water**. **The collapsing rock and overburden mass will act like a plunger and will displace the water under sudden and very high pressure**, causing a hydraulic blast. Since "The compressibility of water (β) is small at 4.4 x 10-10 m2 /N" (SSCRIR2 #CEC-IR-011), the trapped water will have nowhere to go, and the horizontal component of this hydraulic pressure will strike the walls with great force, causing them to collapse. The conical shape of the void and the wall slope will momentarily deflect some of the pressurized water turbulently upwards around the sides of the falling mass, towards the surrounding shale ceiling, striking it as well. The rest of the pressure will be relieved by forcing water through joints and cracks in the limestone, weakening the adjacent rock mass.

Since clusters are only 60 m apart, and they may/will be peppered together in substantive fields (Figure 1-1, SUPPL1; also Figure 116, p. 427), underground propagation of the shock wave from collapse and blast of one cluster may trigger cascading failure in one or more adjacent clusters, as well as blowout of the intervening walls. The result may be a **catastrophic collapse** of the surrounding shale and other rock, and possibly slumping of an extensive expanse of land within the cluster block. **What does the model have to say about *this* potential scenario?**

Alternatively, as debridement of sequential layers of limestone proceeds (e.g. Figure 37 A and B, pp. 151 and 152), the succession of rock falls into the cavity may generate a series of lesser hydraulic shocks. In this case, the pillars and walls will sustain a recurring pounding that will weaken them and promote sudden failure.

27. The supporting effect of buoyancy of water will not significantly moderate the effects of limestone ceiling support or of rock falling into water, and therefore was not included in the modelling. Density of limestone is 2.3-2.7 times that of water (https://www.google.com/search?client=firefox-b-d&q=buoyancy+of+water+and+limestone). In relation to buoyancy effects, the proponent states: "The water level will be recorded prior to extraction and in areas of high groundwater the extraction limit will be adjusted to a safe extraction limit. (SSCRIR2 #CEC-IR-010), an apparent *non sequitur*. However it gives rise to another question: what is a "safe extraction limit", how is it calculated, and what is it safe for, especially since "Hydrostatic pressure (i.e., buoyancy effects) was not included in the FLAC modelling."?

28. According to the reviewer in SSCR (#21), "conclusions listed in the model simulation discussion all rely on an assumption that the mining operation does not affect the hydraulic properties of the sandstone aquifer and hence **cannot be viewed as being conservative.**" (Emphasis is mine). The proponent replies by referring to the provocative mysteries of the nonexistent "Water Management Plan and a Groundwater Monitoring and Mitigation Plan".

    In SSCRIR2 (#CEC-IR-011), "It is **anticipated** that aquifer properties will remain very similar within undisturbed portions of the aquifer but will change locally within the water filled voids created following sand extraction. However, at the regional scale the water filled voids created following sand extraction will be separated by intact aquifer materials that will be **largely** unaltered. Overall, the aquifer is anticipated to maintain its current characteristics, but **will locally have more variable properties** in proximity to sand extraction wells." (Emphases are mine).

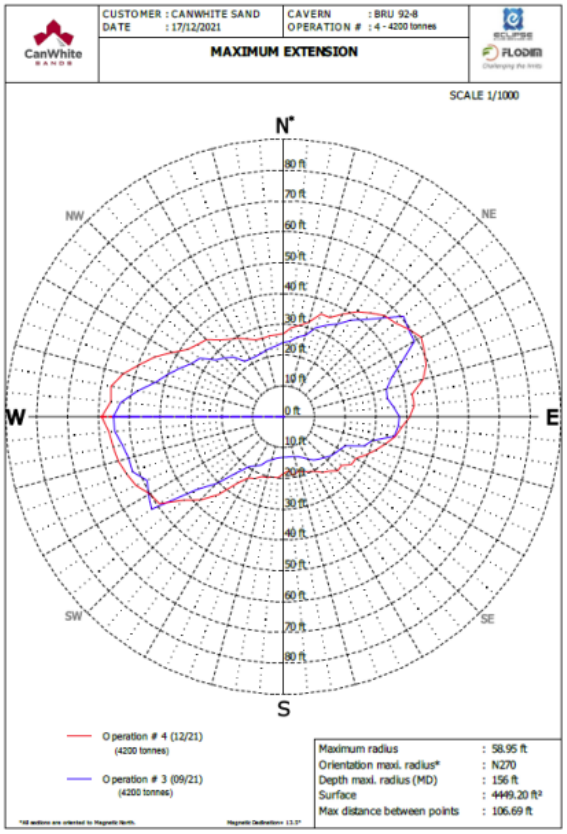
    The 60 m wide clusters will be 60 m apart, each cluster void expanding by 10+ m in diameter (SSCRIR2 #CEC-IR-010), therefore voids may be 50 m or less apart. In areas of cluster blocks, this would amount to ca. a third of the block area occupied by voids, assuming that no further void expansion occurs: a not insignificant amount.

29. And then, the whole entire discussion above buckles when we introduce another scorchingly fundamental fact: the **shape of the individual well voids is irregular and unique** (SSCRIR2 CEC-IR AppA)(e.g. Figure 53 A and B). This has the following implications:

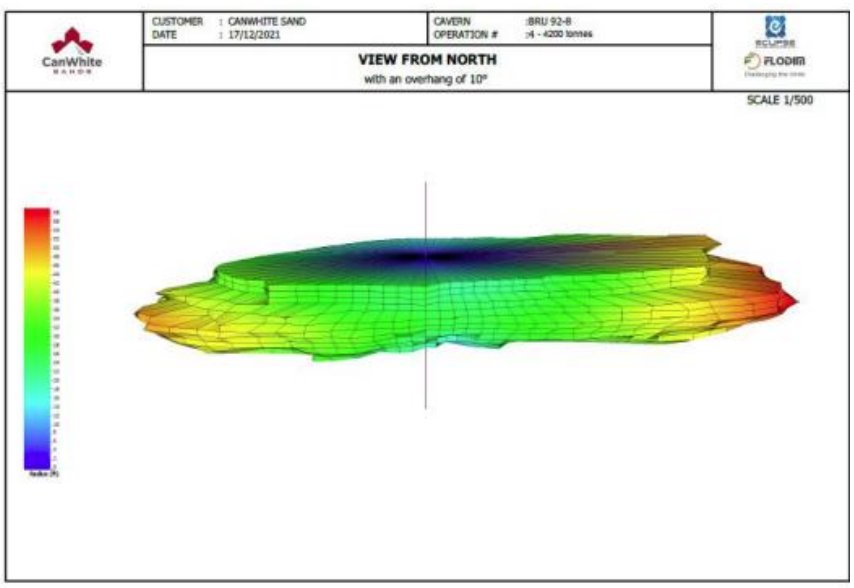
    - No consistent long term expansion metrics can be predicted for individual well cavities.
    - The jagged walls will erode more readily because the irregular shape will greatly magnify the wall surface area available for erosion, and its resistance to hydraulic pressure. The least wall/area ratio is a smooth circle, which will likely seldom be achievable.
    - Rate and degree of erosion will be contingent on orientation of the long walls/short walls in relation to direction of hydraulic flow. This will in turn affect flow velocity and contaminant travel.
    - Is the jaggedness due to heterogeneous sand consolidation, or to the randomness of the 'high pressure bursts'?
    - Angle of reposed walls will not be universal and cannot be accurately predicted.
    - **The irregularly shaped individual voids will combine in unpredictable ways to form a common cavity under each cluster, of variable shape, size and configuration**.
    - The combined cavity may encroach on those of neighboring clusters. Preferential hydraulic flow along the long axis may establish channels that interconnect clusters, and further erode the interconnections.

- What model could possibly be applied whatsoever in such diverse circumstances to meaningfully predict risks of cavity expansion, subsidence and collapse? However in SSCRIR2 (MSSAC-IR-009(b)), "The FLAC model results show that propagation is 5 m (areas of a factor of safety less than 2). This approach considers **sensitivity to risk of different void shapes** by using a conservative estimate of void dimensions and a high target Factor of Safety (FOS) of 2." (Emphasis is mine). How, specifically, were the shapes such as those in SSCRIR2 (#CEC-IR AppA)(Figure 53 B) included in the FLAC model?

- Of course, the two sonogram sets in the above Appendix A are merely a glimpse, but we are grateful nonetheless: "Some of these results are shared as examples in the confidential version" (SSCRIR2 CEC-IR-014). Are there results for other wells?



A



B

Figure 53 A and B. Sonogram plots showing cavity configuration of BRU 92-8. Note that this single-well cavity is not round (A). The walls are also vertically irregular (B). Source: SSCRIR2 CEC-IR App A

30. Actual dimensions of the voids will/might apparently be determined during operation. "The geotechnical design includes **recommendations** for operational monitoring systems to **confirm** the design assumptions and performance during the extraction process." (SSCRIR1 #MSSAC-IR-009). "Recommendations", not requirements?

"Stantec's modeling will be **confirmed** by monitoring and **minor** adjustments **might be required** to the design. Should results of testing yield requirements for parameter changes, Sio will provide this to the Approvals Branch for review." (SSCRIR1 #MSSAC-IR-011)(Emphases are mine).

- The necessary additional data will/might be obtained after the licence has been issued.
- What if the assumptions are *not* confirmed?
- What independent third party will conduct/oversee this monitoring and ensure that all data are correctly reported?
- What remediation measures will be applied to the failed wells?
- What if results indicate the project should not have been approved? *Trop tard maintenant, mes amis.*

31. In yet another possibility, what if 15 m of 'competent' limestone do exist, but they **overlie** weaker, noncompetent strata? In such a case, the upper portions of caprock could remain intact, but the lower layers and the shale could collapse, leading to aquifer **interconnection without visible evidence at the surface**. Such a situation is not only plausible, but probable, since the lower layers are (comparatively) older than the upper strata.

    In RMSF-IR-010: "**Some collapse of the overlying strata may occur** but collapse is expected to be **limited** and to not spread to the surface. Extraction well clusters have been designed to reduce the **probability** of collapse and to further limit the impact of collapse to **little** to no subsidence in the immediate area of the extraction voids and to no subsidence beyond the immediate area of the extraction voids." (Emphases are mine).

    - The shale has collapsed, but we don't worry about it because we don't see collapse at the surface.
    - Probability of any collapse does not equate to certainty of no collapse.
    - A little subsidence is apparently okay. We'll just deal with it and suck it up. No need for silly worries about complete collapse, for we know that the company and the Province will always have our backs.

- Yet, in spite of all of the above considerations, the geotechnical reviewer in SRTER (#4) states: "If the Project implements the design parameters recommended by Stantec (2022), Arcadis supports the Proponent's conclusion that the undertaking will not result in significant adverse impacts to the geotechnical/topographic environment."; this is qualified as applying to the surface. Reasons are not provided.

Further, in SSCRIR1 (#CEC-IR-002), the proponent asserts that "With use of geotechnical design recommendations, which have been incorporated into Sio's extraction plans and will be filed as a Notice of Alteration, no **large-scale** surface subsidence is expected to occur as a result of sand extraction." (Emphasis is mine).

1. What is meant by "large-scale"? A tract of land? Would subsidence of an individual cluster qualify as "small-scale", and therefore inconsequential? **Any scale** of subsidence is unconscionable.

2. Are these the same "geotechnical design recommendations", i.e. a simple elementary competent limestone thickness limit, that have been questioned in the above discussion? Or an entirely different proposition, which will not be scrutinized?

3. The proponent already has the next Notice of Alteration waiting in the wings, to be submitted *after* approval of the present proposal. So why is the present proposal even being considered, when it is admitted that what will actually occur will be different?

- "The design includes operations-level recommendations for **mitigation options** should monitoring data show **changes in design assumptions** or if **less favourable conditions** are observed **during operation**." (SSCRIR1 #MSSAC-IR-009). (Emphases are mine).

  1. What are the criteria for these "less favourable conditions"?
  2. How will they be observed, and who will be doing the observing?
  3. By the time they are observed, failure is already imminent or underway.
  4. What are these "mitigation options"? Will the operators immediately replace the sand, fix the shale, and shore up the limestone?

- The abandoned well clusters will forever pose a risk of unpredictable collapse. Aside from the problem of the well casings as conduits for contaminants, future construction on the sites is ill-advised. According to Waltham et al. (2005), in limestone, "Failure of a cave roof can be initiated or accelerated by imposed loads from construction works".

  A site tracking system is all the more required, as the proponent feels that "it is anticipated that **there will be an increased demand for housing in the area** which could result in an increase in property values." (!) (RPCR #130) (Emphasis is mine).

  [Note: Yes, any dimwits such as ourselves can see that the area will have been mightily primed for development: people will be clamoring to build in such an interesting and edgy place, the area will be bulging with construction, there will be a wait list for people who have never thought of moving there before. Foremost among these will be the company executives who will build their new palaces and bring their eager families to live in the salubrious and exciting atmosphere of the adjacent processing plant.]

Vibration and overburden disturbance and removal (e.g. digging foundations) may trigger subsidence, or collapse may occur at any future time (Figure 54 A and B). In agricultural fields or gravel pits, heavy machinery may trigger cover failure. Structures erected on or near abandoned extraction sites may not be eligible for insurance.

The proponent, however, maintains that "subsidence is not expected to have any impact on future municipal development plans." (SSCRIR1 # CEC-IR-002). What response is possible to this?

In a public ad campaign (The Clipper, January 12, 2023, p.10), the proponent envisions "active and vibrant communities", and "It's a once in a generation chance to build up this region and Manitoba as a whole." The proponent promises, among other grand things:

The benefits are huge. **I want you to imagine this in your home community for a minute:**

$1.2 billion going to your local government and the province, which means funding for new schools, hospitals, better roads and more teachers and doctors

The possibility of lower taxes, thanks to a larger tax base and new government revenue

We can comment on the obvious here:

1. We can also imagine winning the lottery.

2. What about the people deciding for themselves what communities they want? Will the company CEOs and their families be 'vibrant' parts of these communities?

3. Apparently we don't have the *savoir faire* to build up our "region and Manitoba as a whole", even "once in a generation". Poor deprived inept Manitoba.

4. According to FD (2019), this region is not suitable for much building up as it is a vulnerable groundwater area.

5. Does the proponent warrant that these gigantic profits will stay in Manitoba and "local government"? Is this number the total "multi-generational" dreamy number? How can this number be predicted, when even banks fail miserably in their *quarterly* projections. What happens to this promise if the company no longer exists?

6. The "lower taxes" will be offset by the costs of addressing the aftermath.

- While the landowner may undertake the expense of leveling subsidence craters at the surface with clean fill, the damaged shale and the interconnections can never be addressed.

A

B

Figure 54 A and B. Damage due to subsidence from removal of support underneath. A. Source: http://upriser.com/posts/california-is-sinking-at-shockingly-fast-rate-due-to-groundwater-pumping-during-the-drought. B. Source: https://arcwinsurance.com/article/property/sinkholes-what-are-they/

- Section 5.4 of Manitoba Mine Closure Regulation 67/99 General Closure Plan Guidelines states: "No sudden rupture of the surface subsidence may occur. Otherwise, if a surface subsidence is formed, it must be stopped and filled up before reaching the surface. Stability calculations must be consistent with current standards." (https://www.manitoba.ca/iem/mines/acts/closureguidelines.html).

  The EAP includes no relevant Plan.

- Similarly, Section 4.5.4, R509 of the Canadian federal Environmental Code of Practice for Metal Mines (2009) states:

R 509: The risk of subsidence in underground mines should be assessed. Appropriate measures should be taken to prevent subsidence in cases where the risk of subsidence is determined to be significant. The primary measure used to prevent subsidence is the backfilling of underground voids.

Obviously, backfilling of thousands of extraction voids is not an option here. Even if it were possible, what materials would we use that would be free of contamination?

- Unfortunately, the current federal and provincial mining regulations and pusillanimous guidelines must be stretched like old galoshes over a very large boot, as this kind of mining is not embraced within our blinkered and archaic regulatory framework.

- "Subsidence monitoring will be **ongoing**. Once extraction is complete monitoring will **continue**. There are effective high resolution subsidence monitoring approaches available which Sio Silica has investigated and for long term subsidence monitoring of large areas, one of these, such as aerial drone LiDAR or InSAR, **may** be used. Monitoring frequency begins with **frequent** monitoring and frequency increases or decreases based upon monitoring results (**more frequent monitoring if subsidence is measured**, less frequent if no subsidence is measured)." (SSCRIR1 #MSSAC-IR-009).

1. How long will monitoring "continue" and be "ongoing"? It needs to extend at least into several decades and more.

2. Of course there are systems available, but what exactly will be used in the present application? Should not this have been already figured out?

3. What is "frequent monitoring"? Weekly, monthly, annually, every 5 years…..?

4. "**if subsidence is measured**", **<u>what will the proponent do about it</u>**, other than step up monitoring frequency? How will it be fixed?

5. Will these data become "proprietary" and hidden away because of the liability issues, or will landowners and the public be (immediately) made aware of the danger?

6. Since subsidence is often unpredictable, monitoring may not be useful in such cases (https://www.msha.gov/sites/default/files/events/Pillar-Collapse-Risk-Analysis-2021-.pdf).

7. Will compensation be provided to the unfortunate landowners? Will the Province also set up a fund as a backstop in the event the company becomes defunct?

8. What provisions for "long term subsidence monitoring" are made in the event that the company changes hands or ceases to exist?

Any Plan for subsidence monitoring is apparently within the legendary Stantec report. In SSCRIR2 (#MSSAC-IR-009(g)):
Reviewer: "The monitoring and mitigation plan requires development in full and in a timely manner to allow for review and assessment, within the CEC process. In addition, the rate of subsidence may or not follow a "linear" progression; depending on the design of the monitoring and mitigation program, warning signs leading into unacceptable subsidence scenarios may be completely missed, with no time to apply **mitigative measures**."
Proponent: "At this stage of the project the monitoring program level of detail in the Stantec report is appropriate and conservative. The current plan emphasizes the importance of monitoring to identify warning signs. A detailed monitoring and **emergency response** plan will need to be **developed after issuance of a licence for the project**." (Emphases are mine).

How can work be started without any such detailed plan? What if one of the early clusters turns into an emergency? We are busting with curiosity as to what these "mitigative measures" and "emergency response" could possibly be. Fencing around the hole, maybe? Decorative yellow police tape?

- **Subsidence risks will extend indefinitely into the future**. Who will assume eternal post-closure liability for damage to property, life and limb? Most likely this will be the landowner. What will be the property value of such land? What will be the insurability against perils?

  What is the value of these precious aquifers? For those depending on them now, and all of those to come in the future? In the face of undeniable looming climate change?

  According to the proponent, "The geotechnical analysis was completed to identify stable geometries for a quasi-permanent (100 year) timeline." (SSCRIR1 #CEC-IR-002). A 100 year timeline? How can *anyone* possibly know what **climate changes** will occur in the next 100 years, other than that they will be substantial, what **development** will occur in the area as world population and immigration skyrocket, what **challenges** will be encountered as water demand outstrips supply, what intensive **land use** policies will be required? And, how will the company assume responsibility and liability for the next 100 years? How is its existence guaranteed for 100, or even 10, years?
  "It is assumed that if the adverse stability effect is not observed during this time frame, there is minimal risk for the development of adverse effects in the longer term." (SSCRIR1 (#MSSAC-IR-009).

Several comments arise:

1. Climate is assumed to remain at *status quo,* which is an important omission.

2. We have no idea what seismic processes may occur in the region in the future, especially as human interference increases. According to the Seismic Hazard Calculation, "The NBCC PGA (Peak Ground Acceleration) of the project site for a 100 year return period (design lifespan of the project) is 0.002 g." (SSCRIR2 #CEC-IR-010). We notice that the risk is not zero. We also note that this estimate assumes steady state conditions over this time frame, including human activity, which may not be the case.

3. The above quoted statement is "**assumed**" and "**minimal risk**" is hoped for. But there is no guarantee extended to us. We can never assume that things will not change.

4. The above supposition that, if subsidence is not evident in the short-term, there will be none in the long-term, is untenable. There is **no expiry date on collapse risks** for underground mining voids.

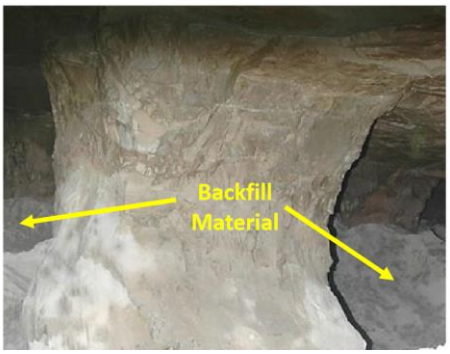
According to ICMC (2008), destabilization of cavities associated with partial extraction may occur over a prolonged period, which "may be very long (several years to several hundred years). It is attributed to the gradual weakening of pillars under the cumulative effect of time, pressure from overlying formations and environmental parameters".

According to Longoni et al. (2016), "Ground collapses over abandoned underground mines constitute a new environmental risk in the world. The **high risk associated with subsurface voids**…makes abandoned underground mines one of the current challenges for countries with a **long mining history**.". Old mines with underground voids become a problem as time passes, and the action of water combined with changing surface land uses weaken and destabilize subterranean geology. "Legacy areas", i.e. older, no longer active mining areas, are especially prone to collapse (https://www.msha.gov/sites/default/files/events/Pillar-Collapse-Risk-Analysis-2021-.pdf).
In other words, time does not heal, and may exacerbate the wound.

5. It won't be our problem by then.

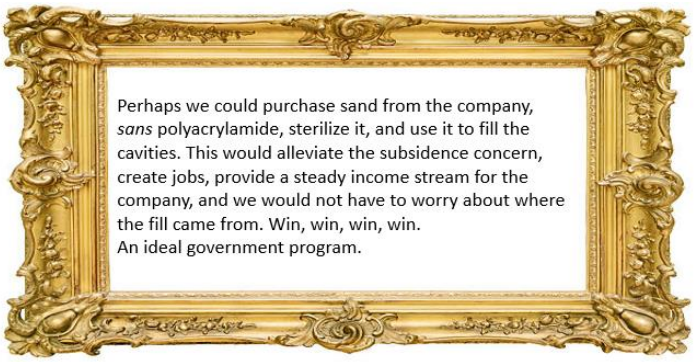
Furthermore, not just subsidence issues are at stake, but all of the **thousands of permanently embedded wells, and the thousands of aquitard punctures.** Nobody seems to have modelled those.

Interesting Note: There is a solution to the subsidence problem which has somehow been overlooked. Backfilling of voids around pillars is a suggested industrial remediation measure:



Source:
https://www.msha.gov/sites/default/files/events/Pillar-Collapse-Risk-Analysis-2021-.pdf

The proponents have indicated that the voids will backfill themselves: "The void is estimated to be partially backfilled by the loose failed sand from the sandstone wall." (SSCRIR2 #MSSAC-IR-009(b). However this fallen **backfill will be at the expense of the pillars,** whose support will be concomitantly diminished, and the most important part of the cavity, i.e. the portion next to the ceiling, will remain unsupported. No compensation will occur for the volume attributed to the missing extracted sand.



Slurry system

- **"**The majority of the slurry lines be temporarily installed on private land, or easements that will have private surface access agreements for land to be accessed. Any land controlled by the RM would involve a land access agreement with the RM." (SSCRIR1, #CEC-IR-002). What happens if some of the easements are declined by the landowner? What about Manitoba Hydro transmission line crossings?

- It has been presumed that the pipes for the slurry and the return fluid will be located side-by-side on the slurry trails. EAP1, p. 23 refers to a "parallel slurry and water return line". However in RPCR (#258), "The areas to be reclaimed will include temporary drilling rig access trails, equipment laydown areas, **slurry line trails and return water line trails.**" (Emphasis is mine). The latter wording implies that the lines for slurry and for the return will be on separate trails, and would thus require separate pumping stations. This would mean that twice the number of trails will be required. We hope this is an error?

- "the slurry lines are relatively small (35.6 cm [14-inches]) in diameter" (RPCR #113). What is the thickness of the plastic tubing walls? It is not even clear in the EAP whether the lines will be flexible tubing or rigid pipe. What will the pressure be in the slurry lines? What will the flow rates be? How soon will there be a round-the-clock response to a cut or ruptured line? Will this necessitate suspension of extraction activities until repairs are made, and thus extend the duration of the extraction window?

- There will apparently be tremendous variability in the proportion of sand in the slurry. "Early in the extraction process for each well, the slurry will consist primarily of solids (est. 70%) and will slowly reduce to approximately 20-30% near the end of well production." (AppA1, p. 22). According to EAPPF (Appendix H), "Slurry from the well are [sic] as high as 90% sand", also SSCRIR1 #DLN-IR-007. Presumably these values are for slurry before it has entered the slurry lines.

  According to EAP1 (p. 18), "The slurry loop will typically operate at approximately 15% sand and 85% water, with the ratio of sand and water varying by up to approximately 35%."; "the slurry line will contain 15% sand up to 35% sand" (SSCRIR1 #DLN-IR-002). Presumably this dilution of sand to 15% or even 35% will come primarily from the water circulating in the loop. How will concentrations (as distinct from pressure) be monitored, adjusted, and maintained within this range?

- There are few details on how exactly the slurry lines will be deployed, other than that they "will be positioned at ground level" (EAP1, p. 23) i.e. lying exposed on the ground. They will be "diverted underground at road crossings" (EAP1, p. 13), although it is not known where the diversions will start relative to the road allowances and edge of the

travelled surface. Maybe they will even be "elevated over crossings" (EAP1, p. 23), although how this would be constructed or allowed is hard to imagine.

"Where road crossings are necessary, CanWhite will work with the Province and Municipality to determine the most suitable option which would include crossing above or below the road. Regardless of the crossing type (above or below), the piping material will remain the same." (RPCR #197). The roads are public infrastructure, and any alterations or interference are subject to approval, licensing and regulation. The taxpayers must not be left with the cost of repairs.

Figure 2-5 of EAP1 appears to show the lines running in existing hydro transmission corridors and between quarter sections. Since the polyethylene plastic pipes run between quarters, they impinge at the middle between intersecting roads when they emerge from private property, not at Mile Road intersections. Apparently they will "go temporarily below the road and trails using existing culverts where possible" (EAP1, p. 23), although most culverts across roadways are found near intersections except in low places with drainage issues. Routing the pipes "using existing culverts where possible" presents numerous problems:

1. "the slurry lines are relatively small (35.6 cm [14-inches]) in diameter (in comparison to an oil/gas pipeline or culvert, for example)" (RPCR #113, also EAP1, p. 18). Presumably these metrics refer to outer diameter. We assume that **there will be two pipes** (despite the confusion in RPCR #258), occupying more than 70 cm of combined width inside the culvert. This would require a culvert that would be large enough to accommodate this width. The pipes will probably not be touching each other, to reduce abrasion from friction as water pressures fluctuate in the pipes.

   Some municipal and provincial regulation culverts are smaller than this width (see Manitoba Infrastructure Approved Products List for culvert specifications in use in Manitoba: https://www.gov.mb.ca/mit/contracts/pdf/manual/1285.pdf).

2. The space occupied by the pipes will occlude the culvert and **retard drainage**. There is a reason for the location and purpose of the existing culvert.

3. Where no culvert is available, or it is too small, a culvert of large enough size may have to be installed across the roadway, which would engage the Water Act, and Manitoba Infrastructure (if a provincial road), or municipal regulations.

   According to the Water Rights Act C.C.S.M. c. W80, Water Rights Regulation 126/87, Section 11, a Class D registration as a Minor Work involves "Replacing an existing culvert with a culvert that does not change the hydraulic capacity of the culvert by more than 15%, as long as there is no change in the invert elevation of the culvert."

Larger changes must be licensed under a Standard Permit.

4. Presumably, trenchless technology, for example horizontal directional drilling, will be used to route pipes and other crossings where existing culverts are not usable or present. It is not clear whether the pipes will always be enclosed in culverts, or whether in some cases they will be installed "naked" in the horizontal borehole.

   A. At road intersections, there may not be enough room alongside the existing culvert to accommodate another culvert.

   B. Underground utilities such as telephone cables or natural gas conduits that run parallel to roadways in the municipal road allowances would need to be considered and avoided, and permission obtained.

   C. For horizontal drilling, "it is recommended that all horizontally-bored holes be grouted from end to end to ensure contact between the earth" (http://blog.geoconnectionsinc.com/2010/05/grouting-practices-for-horizontally.html). Will **nontoxic**, i.e. polyacrylamide-free drilling mud or grout be used? (see p. 235). Will drilling mud spills be cleaned up (Figure 108, p. 402)?

5. The corrugations in the culvert, combined with the weight of the pipes and pressure fluctuations, could initiate cracks in the pipes. The pipes would have to be padded, increasing the amount of required space (see p. 226).

6. Ditch water from rain events would carry debris that could damage the pipes. If the pipes are left in place during winter, the pipes could be damaged by ice in the spring. If pipes are removed for winter, culverts could still be frozen at the beginning of April when operations resume.

7. Leaks would be very difficult/impossible to detect underwater.

8. At the road crossing points, will the exposed portions of the pipes at the road allowances be affected by municipal maintenance activities on the road allowance, for example mowing of road shoulders, grading, spraying, ditch clearing?

9. How will exposed portions of pipes at road allowances be protected from recreational vehicles and other public off-road traffic and activities, or vandalism? Will warning signs be posted?

10. How will the channel be backfilled after the pipes are removed, so that a subsidence trough does not form across the road surface (e.g. NJDEP, 2021)?

11. Who will conduct and pay for the backfilling, since roadway work falls under the jurisdiction of municipal or provincial Works or Infrastructure departments, and ought to be completed by qualified staff, using approved materials and techniques? Liability issues are also involved.

- The other proposed option, where the pipes are "elevated over crossings" would presumably require them to be securely contained in a protective pipe or sleeve, as overhead rupture could spew sand slurry over vehicles passing underneath, and present the potential for road crashes and fatalities.

  The structure would require permits and need adequate clearance above the road to accommodate Manitoba maximum traffic height (4.15 m without a trucking permit, 4.8 m for oversize permit hauls) (https://wideloadshipping.com/manitoba-shipping-regulations/). It would need to incorporate anticlimbing measures to deter tagging, and vandal damage to both the infrastructure and to passing traffic below. Liability would apply.

- According to Figure 2-5 in EAP1, some of the slurry pipes will be routed along a Manitoba Hydro transmission line corridor. Will easements and licensing be possible? If they are not, what alternatives would exist?

  Assuming that the corridors can be used, what happens if power lines, or worse – transmission towers - are damaged in storms and fall onto the pipes?

  Manitoba Hydro conducts weed and brush control on its rights-of way using spraying and/or brush cutting/mowing. How will these maintenance activities ensure that the slurry lines are not damaged?

  The corridors are popular avenues for recreational vehicles and other traffic. How would the pipes be protected from damage or vandalism?

- One of the legends in both Figures 1-1 and 1-2 of EAP1 refers to "slurry pipe right-of-ways". [Note: the correct term is "rights-of-way".] Under what legal provisions/licences will these become "right-of-ways", and what legal rights do these confer? The term "right-of-way" means "taking precedence over other uses/needs". The municipal and provincial road allowances are rights-of-way. So are Manitoba Hydro transmission corridors (and the Shoal Lake aqueduct). Will the slurry pipe rights supersede those of utilities and public roadways?

- The slurry trails will be ≈ 2 m wide (EAP1, p. 23). How will they be maintained throughout the season to control vegetation? They cannot be mowed because of the pipes. "CanWhite will not be using herbicides." (RPCR #104).

- "Sand will be wet and will either be contained within the extraction well lines or the slurry line" (EAP1, p. vii). In winter the slurry pipes will not be used as they are not heated and will freeze. Where will the sand be contained during extraction in winter (see next bullet point), since it won't be conveyed by pipes to the processing plant at this time? Will it be stockpiled at the extraction site until spring? How will it be covered?

- There is confusion regarding the actual months of extraction. On p. 11 of EAP1, we see: "Sand extraction activities will occur 24/7 from April through November (and winter, weather dependant [Sic])".

  In Table 1-2 (EAP1, p. 10), **slurry operation is clearly linked to winter as well.** Here is a screenshot of the relevant portion of the table (Highlight is mine):

Operation	
Pumping of sand and water slurry via slurry lines to the sand Processing Facility and return of water from the Processing Facility to the aquifer at the extraction sites.	Q3/Q4 2021 for initial production extraction year, then April through November (and winter, weather dependant) for each extraction year thereafter. Activities will occur 24/7.

  However the final word on winter operation seems to be RPCR (#166): "No sand extraction will take place during winter conditions and therefore the slurry lines and extraction sites will not be operational in the winter time. The commencement of operations in April and cessation of operations in November will be determined based on the favourability of weather conditions during these months (consistently above freezing to avoid the risk of a freeze up of water in any of the systems)."

  If we include the *entire* months of April and November, this comprises 244 days, or 5856 hours. In Table 6-3 (EAP2), 6000 hours of annual operation are indicated. Indeed, the production schedule in AppH (located in AppA6) specifies start and end dates of April 1 and November 30 (which would be 244 days), but indicates only 224 producing days per year. In any case, operations are planned to extend into what is clearly freezing weather.

  In AppH(AppA6), production windows of individual wells are uniformly set at 4 days. In the real world, this schedule will not be possible, as there will be delays and interruptions due to unforeseen logistical problems, well issues, power failures, equipment breakdowns, severe weather, worker absenteeism, accidents, and many other potential factors. Are the three weeks indicated above, a contingency buffer? Or seasonal setup and takedown? Could this window stretch even more, when the inevitable delays cause production to fall short of the annual target, and schedules back up?

- On pages 11 and 15 of EAP1: "In the winter months, the water in the system is stored on site in tankage". How secure will the tankage be? How much tankage will be required,

especially as the volume will progressively increase with extension of the slurry pipe system? How much freezing might there be?

The response in RPCR (#171): "Water in the slurry loop system will be drained into appropriate portable tanks to hold water over the winter months for re-use in the spring. These temporary water storage tanks will be large volume modular tanks (lined) which will vary in size from 1,300 m3 to 6,000+ m3 , as needed. Water tanks will be temporarily stored in appropriate locations depending on the length and location of the slurry line that year."

"Where possible, water will be moved to a holding tank for the winter months to reduce the volume of water taken to a treatment facility." (SSCRIR2 #DLN-IR-007).

The reference to "appropriate locations" implies that the unsightly tanks will presumably be stored on private properties over the winter. **Why can't the slurry fluid be stored at the processing facility?** Will the tanks in the various "appropriate locations" be checked to ensure there is no leakage?

As for the "water taken to a treatment facility", which treatment facility? How much volume would this entail?

How will the fluid in the multiple locations be transferred into the slurry system in the spring? It seems these will be places where spills would be likely.

- SIO (p. 19) states: "Slurry and water return slurry lines are monitored throughout operation and inspected on a regular basis and after extreme weather events to check for leaks." The EAP1 (p. 23) indicates: "visually [sic] monitoring will occur 24/7 while slurry lines are in use". "The slurry line will be inspected on a daily basis, and after extreme weather events, to check for leaks and/or breaks in the line." (RPCR #93, #197).

  Since the inspection is visual and 24/7, this indicates 24-hour patrols. The RPCR quote whittles this down to a "daily basis". Which is correct? Will staff travel on noisy ATVs or dirt bikes day and night? Flashlights/spotlights and vehicle headlamps will disturb people and wildlife at night. There may be a delay in seeing leaks on the pipe underside that is in contact with the ground. They won't be able to see oozing leaks when it is raining, unless there is spouting, nor will they see leaks where the pipe is underwater in a ditch or in an active culvert. How will they "visually" assess sections under (or over) roadway crossings?

  In any case, visual inspection of the lines will only detect leaks that are already underway and a spill has occurred. Visual inspection will not detect weakness and cracks that signal incipient failure.

- Apparently an "automated pressure transducer" (RPCR #93, #127) will gauge pressure.

  "an automated pressure transducer for leak detection will be installed along the slurry line. If any leaks or breaks in the line that require repair are detected, flow to the line will be shut down" (RPCR #93, #127).
  "Pressure transducers are standard industry components which will be sourced in the market in accordance final design specifications." (RPCR #155).
  "The slurry line will be equipped with a leak detection system and will have shut-off valves placed throughout the slurry line to allow for isolation in the unlikely event of a leak." (RPCR #154; also similar in The Clipper, January 19, 2023, p. 24).

  "A leak of 50 US gpm will initiate a shut down sequence and will be identified within minutes of a failure." (SSCRIR2 #DLN-IR-003). In order for the leak to be detected, it has already occurred. A 50 US gallon **per minute** leak is substantial: it will only be identified at this point, but the spill will be ongoing until it is addressed. Even when the system is shut off, leakage will continue until positive pressure in the pipe is exhausted. Does this 50 gpm value relate to the entire system, or respective sections? As the system expands, more volume will need to be tracked. The farther away the leak is from the transducer, the greater the lag time for detection.

  Apparently "final design specifications" have not yet been formulated. How will the transducers distinguish between leaks and normal operational pressure fluctuations in the pipe? For example, is it possible for there to be a 50 gallon leak, but it is not detected until the overall system pressure falls below the critical minimum operating pressure level?

- A leak may present a danger to workers and the public; in reference to HDPE pipe: "Even at relatively low internal pressures… a pressurized internal fluid can generate very high forces that can be dangerous or even fatal if suddenly released by the failure of a joint or system component" (PPI, 2009).

- "A one-time water draw at the beginning of the initial extraction year is needed to prime the sand slurry transport system. After that, the initial one-time water draw remains in the slurry transport loop system while the sand enters and exists the loop system. The water component of the slurry will consist of recycled water that will remain in the system constantly flowing in a loop from the extraction sites to the proposed Processing Facility." (EAP1, p. 11).

  On the one hand, additional water will constantly enter the loop system with the wet sand, but on the other hand there may be losses through leaks, spills and general attrition, and there is uncertainty regarding what happens at the processing facility in

terms of efficiency of water recovery from the slurry and its re-entry into the slurry system. Additional water will also be required as the movable slurry pipe system expands with increasing distances (EAP1, p. 18).

In order to maintain an acceptable and consistent range of pressure within the pipes, the system will require constant monitoring and adjustment to balance the total volume in the pipes in order to prevent rupture at high pressure, and to maintain enough flow rate at low pressure. How will volumes within the system will be regulated if the pressure rises or drops outside the optimal or safe range indicated by the pressure transducers, nor what apparatus will be incorporated into the design for this purpose? In SSCRIR2 (#DLN-IR-003) we learn that the adjustments will be made at the processing facility: "Water will be added to the system by the water captured from the French drain system.", and possibly an auxiliary "on-site surface tank". Is the latter tank resident at the extraction site?

- Section 2.4.2 of EAP1 makes no mention regarding how the pipe system will be made **secure** from farm equipment accessing/working fields, recreational vehicles, vandals, hunters' target practice, stubble burning, wildfire and other misadventure.

  The proponent responds: ""No Trespassing" signs will be in place, and additional provisions for future site security and authorized access are being developed and will be implemented prior to operations." (RPCR #256).

  Signage is far from adequate protection, as the proponent has already admitted and complained about regarding the processing facility location (RPCR #221). While extraction site security will be easier to manage than the rest of the system, since operations and staff will be onsite 24/7, and "only authorized personnel will be permitted on the active worksites" (RPCR #137, #256), will the clearings be fenced, since they can be accessed from any side, not just the access trail? The slurry pipes and trails are another matter, and they too will be located on somebody's private property.

  The legal ramifications are complex. Does the company have the right to deal with and remove persons deemed trespassers *on the trails* when they are also on third party private land? How would trespassers be prosecuted? Would RCMP be involved? What if the interlopers have the landowner's permission to enter her land? Is the landowner himself a trespasser on his own land, if he wishes to hike or walk his dog on his own trails? Can the company deny access or use of the trail system, especially since *previously existing trails* belonging to the landowner may have been commandeered?

  What are these "additional provisions for the future site security and authorized access"? It will not be possible to have guard/attack dogs at the sites, as this would constitute animal cruelty due to intolerable noise.

- "An accidental release of slurry or return water may also occur if a break or crack occurs in the slurry and/or water return line." and "If leaks or breaks in the line are detected, appropriate spill containment and clean-up measures will be applied as soon as feasible and the line will be repaired or replaced" (EAP2, section 6.9.2, no page numbers).

  Over the 24 year span of the proposed project, spills are virtually certain. Containment and clean-up will be "as soon as feasible", why not "immediately"? And what are these "appropriate spill containment and clean-up measures"?

  A rupture or spill will require clean-up of sand and fluid. The sand at this stage has been contaminated by the endlessly recirculated and ripened fluid and is no longer environmentally innocuous.

  "Should a spill occur, the sand would need to be cleaned up with a vacuum truck" (SSCRIR1 #DLN-IR-003).

  Yes it would. BUT the slurry trails will only be 2 m wide. Furthermore, the slurry and return pipes will occupy part of the trail. Furthermore again, the pumping stations (see below) will obstruct the trails (that is, if they are located on the trails, this is wild conjecture). Unless the pipes and spill are located in the open where they are readily accessible, how will it be possible for a vacuum truck to reach the spill site?

  In such an event, will wooded access trails (either new or the existing path) have to be cleared or widened to reach the spill location, involving more destruction? And, of course, serious delay in starting clean-up? By then the spilled fluid will have percolated into the ground or drained into the surrounding area, and will not be recoverable. The sand will eventually dry and present risks of inhalation. In realistic terms then, in all likelihood spills will not be cleaned up, unless they are in an accessible location, and only when "feasible".

- Another place where spills and leaks from the slurry system could cause particular risk is the extraction site itself, where the slurry pipe system comes into proximity with the open wells. Apparently, feeder pipes will service the slurry pipes; how far are the slurry pipes from the wells, and from the processing components, such as the dewatering station, that handle water which will be directly returned to the aquifer? Are these components contained and safely enclosed? If an onsite rupture occurs, a geyser would spew the pressurized slurry over a broad area and could directly contaminate the open well(s) with slurry fluid. How will the open wells be safeguarded during operation from spills or flooding?

- "Prior to the mobile slurry lines being moved between extraction well sites, the slurry line segments are emptied via periodic access points in the slurry line to eliminate any spills or leaks of water onto the ground." (EAP1, p.18). The pipes are on the ground.

How will slurry line segments be emptied: by some sort of vacuuming device into drums, on wagons or pickup trucks? Into a tanker truck? But the trails are only 2 m wide, the pipes occupy part of the trail, the pumping stations (if they are on the trail?) present serious obstacles to traffic……

- The pipes are moveable, and they are "fused together to create one continuous line" (EAP1, p. 18), and "Slurry lines are fused for sectional length and flanged together through the length of the system" (EAP1, p. 23).

  Dismantling will presumably occur at the flanges: "Dismantling and relocating the above-ground slurry and water return lines and pumping stations, as needed, to the subsequent annual sand extraction area" (EAP1, p. v).

  First of all, are the pipes flexible or rigid? Presumably the sections are fused onsite on the slurry trails (see p. 219+)? How long are the resultant sections and how far apart are the flanges? Will they be moved with machinery or person-power and coiled (if flexible) or piled (if rigid) onto a flatbed truck? But the slurry trails are "approximately two meters wide." (EAP1, p. 23), and "The pathway required to accommodate the parallel slurry and water return line will be very narrow (2 m wide)" (section 6.5.1, EAP2).

  A standard semi or flatbed truck is 2.6 m wide (https://www.summittruckgroup.com/blog/by-the-numbers---standard-dimensions-of-a-semi-truck--26281). It would be a tight fit; everything considered, it seems that the trails will not/cannot be only 2 m wide. The pipes require gentle handling and are easily damaged, they cannot be dragged or thrown (GET, 2021). This also raises the questions of how they were deployed in the first place, and how they will be visually monitored. Monitoring vehicles would have to travel overtop the pipes, with the latter between the wheels, with sufficient clearance over the pipes and flanges, risking scuffing and striking (see p. 226+).

  However a logistical query arises. Table 6-3 (EAP2) lists two F350 trucks (for welding and for mechanical service) under Support. We are nor certain whether the welding truck refers to butt-fusion welding of the slurry pipes (Table 6-3, EAP2). In any case, only these two *pickup* trucks are identified. The 2022 F350 has a ground clearance of 7.7 – 8.5 inches depending on options, therefore it cannot travel overtop the 14 inch pipes, and certainly not over the protruding butt-fusion welds, and most certainly not over the flanges. It would have to be specially modified (Monster Truck). Since the F350 is, without side mirrors, 2 m wide, it cannot travel beside them either, and can only just squeeze by on the 2 m wide trails if the mirrors are folded (https://fordf350ca.com/specs/ground-clearance/2022/).

The questions are:

1. Assuming that butt-fusion welding of the pipes will occur *in situ* on the slurry trails, what conveyance will be used to haul the HDPE Tube welding machine, i.e. will the welding truck be able to travel on the trails (Table 6-3, EAP2)?

2. What vehicle will be used to monitor the slurry pipes on the 2 m wide trails?

It seems that the 2 m width of the slurry trails will be challenge, and likely will be rather more than 2 m.

- What will the **unattended pumping stations** look like? What equipment will they include besides the pumps? What is the size/capacity of the pumps? Will they be enclosed to protect against weather, and secure against misadventure and interference, in a locked structure? Will they perhaps be trailers?

  Information is scant, other than: "The footprint area for the pumping stations along the slurry line is small (approximately 63 m^2)."(EAP1, p. 18), also section 6.5.1 (EAP2). This converts to nearly 700 square feet – large enough to live in: compare the size of a standard "tiny house" at ~ 200 square feet, but ranging from 40 to 600 square feet (https://thetinylife.com/tiny-house-dimensions-what-size-can-a-tiny-house-be-without-breaking-the-law).

  There will eventually be a number of these stations. Does this "footprint area" refer to the station itself, or does it include a clearing area needed to accommodate it? "The trails to accommodate the slurry lines will be approximately two meters wide." (EAP1, p. 23). Thus in the absence of clearings around them, the stations will present obstructions on the slurry trails and will require room for passing. **What will be the dimensions of the actual structures** or whatever they will be? Neither the EAP nor the TAC nor the RPCR provide any clue, yet since the footprint is known, it must have been derived from some sort of information. This omission is surprising, since these stations will have **multiple environmental implications**.

  The RPCR response to this question (#191) states: "A description of the sand slurry conveyance and pumping station is provided in Section 2.2.3, 'Sand Slurry Pre-Screening and Overs/Fines Temporary Stockpiling' and 2.2.4, 'Sand Slurry Conveyance to Processing Facility' in the EAP.", followed by a description of the dewatering station, which is not the same as a trail pumping station. We are short-circuited back to Sections 2.2.3 and 2.2.4 in the EAP, which do not provide the requested information, and which elicited the questions in the first place.

- Since the pumping stations will presumably service both the slurry and the return lines, they will be pumping simultaneously in both directions, as flow will be opposite in the two lines. Presumably this will require two pumps, of different kinds, at each station.

- There will be multiple pumping stations: "Pumping stations will be installed as necessary along the slurry line and water return line trails to facilitate transport of the sand and water slurry" (EAP1, p.13). As the slurry line system expands, more pumps will be added: "When the slurry line increases in length during subsequent years of operations, a pumping station will be needed approximately every 450 m to 550 m along the length of slurry line."(EAP1, p. 18). "Extraction activities will gradually progress further from the Processing Facility each year within blocks of land adjacent to previous year extraction activity land areas over the anticipated 24-year life of the Project." (EAP1, p. v).

  The maximum reach of the slurry system from the processing facility is reported as 3.5 km (EAP1, p. 23), also RPCR (#113). This translates to approximately six eventual pumping stations on the trails. However eventually, according to SIO (p. 19), "the distance between the extraction sites and the processing facility is between 1 and 4 km, **growing to approximately 15km in the latter years of the project**." (Emphasis is mine). The latter would mean 30 km of pipe to monitor, maintain, and (presumably) disassemble and store in winter.

  Table 2-1 (EAP1, p. 27) indicates that sixteen slurry pumps will be required during the (initial) extraction phase, enough to service eight stations, or one slurry line. They are all grouped together in Table 2-1, implying that they will all be the same. However half of them will pump return fluid only, while the other half will sustain a greater load as they will be pumping slurry which will be denser, heavier and will offer more resistance. The load will be inconstant as the proportion of sand in the slurry will vary greatly (AppA1, p. 22; EAPPF, Appendix H). They will also sustain more wear from sand abrasion. What types of pumps will be used? How durable are the interior components to constant 24/7 sand abrasion?

  Will there eventually really be 15 km of double slurry lines? Or will sand transportation shift to another conveyance method once distances expand?

- "The pumping station will be powered by an extension of a local power line" (EAP1, p. 24), and "Back-up power will be supplied by an onsite diesel generator if necessary" (EAP1, p. 24). Presumably the generator(s) will be triggered automatically when the electrical supply fails – to just one station, or a power outage for all. When the system starts up and when it shuts down, all of the pumps must be synchronized to turn on and off at the same time, perhaps with a master switch at the mobile office. This will create a pressure surge in the lines, with associated stress on the pipes (see pp. 217-218).

- The "extension of a local power line" will require hydro poles and corridors. This would increase the amount of clearing required. Where would these hydro corridors be located – they cannot be on the 2 m wide trails, unless the trails are substantially wider. Since the pumping stations will be moved along with the slurry lines to a series of new

locations, the number of hydro pole corridors will be multiplied accordingly. None of this is considered in the EAP.

The proponent responds (RPCR #105): "Any additional vegetation clearing that may be required by Manitoba Hydro to accommodate power to the dewatering and pump station is expected to be minimal and completed in accordance with Manitoba Hydro's Environmental Management System and Policy."

- This response seems to relate to the "dewatering and pump station", which is located at the extraction site anyway, not to the series of pumping stations on the slurry line trails. However even the location of the dewatering station is in question, as per RPCR (#122).

- It should be noted that clearing for hydro poles on private land is the responsibility and expense of the landowner, not Manitoba Hydro.
- A voluntary easement is required. If the path of the hydro line must cross another property, an additional easement is required.
- Will the hydro corridors be rehabilitated by the proponent, or will this fall to the landowner? Perhaps this is an item to be considered in the Landowner Agreement (see Appendix).

- The generators will require a stored diesel supply for back-up power, i.e. fuel tanks: what will be their capacity and how will they (and fuel) be **secured from tampering and spills**? Will they be inside the pumping station structures, if there are such? Will they constitute risk in the event of wildfire?

- Since the pumps will operate 24/7, they will heat up. What measures will be taken to ensure that wildfires are not triggered by hot machine parts and exhaust ports during dry conditions? Are the machines enclosed, but if so, are they adequately ventilated and cooled? How will grass and other encroaching vegetation be controlled around the pumping stations?

- **What happens when one of the pumps within the series fails?** The generator cannot power a broken pump. Will the buildup of unrelieved pressure in the upstream portion of the line cause a **rupture**? Will there be an integrated safety mechanism to shut all of the pumping stations down automatically in the event of emergency?

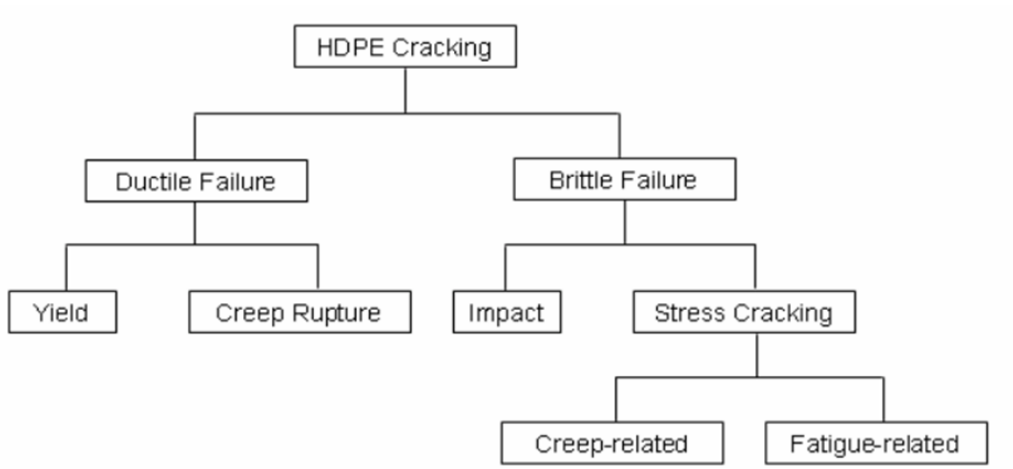
- Presumably pressure in each pipe section between stations will be monitored remotely. Will the mobile office control centre be staffed 24 hours a day? Will an alarm be triggered? How long will it take to get someone actively responding at the scene, which may be kilometers away from the office?

- Since pumping stations will need to be moved with the pipe relocations, will they remain dormant *in situ* through the winter; if not, where will they be located/stored/secured when not in use?

High density polyethylene (HDPE) pipes

- The slurry and return water lines will consist of high-density polyethylene (HDPE): "The slurry loop system is a temporary line made of high-density polyethylene (HDPE) tubing fused together to create one continuous line that is 35.6 cm (14-inches) in diameter which transports sand to the facility site." (EAP1, p. 18). There are no further specifications: is it flexible or rigid, what is the thickness of the HDPE, which of the many types of HDPE is it composed of, what pressures can it sustain? We do, however, learn that the HDPE feeder lines at the extraction sites are "thick-walled" (EAP1, p. 18). As for flow rate specifications of slurry in the tubing, we learn that flows will be "at an optimal and manageable rate" (EAP1, p. 3).

- As described by Zhang (2005), "HDPE pipes are prone to stress cracking, one of the most common causes of premature failure. Cracking may be ductile or brittle. Ductile failure is associated with deformation caused by high stresses, causing creep rupture, and may occur in a short period of time. Creep is cracking under constant loading conditions. Brittle failure is more insidious (but can vary from hours to years), usually occurs under low stresses, propagates via crack growth and **shows no exterior sign prior to failure**." (Emphasis is mine). Cracking failures are summarized in Figure 55:



e 1.5 Failure modes that could occur in HDPE pipes

Figure 55. Types of HDPE pipe failure. From Zhang (2005).

- The degree of pressure in the slurry system is important: quoting a plastics industry source (Fast Radius, 2021), HDPE is "not well-suited for high-pressure applications**."** although its utility varies with the conditions and uses where it is deployed, and there is much confusion regarding claims and advertising by manufacturers. The proponent indicates (RPCR #201) that: "the CanWhite process is not a high-pressure application". The actual pressure, however, is not divulged. Yet it can be surmised that, since pumping will be involved over substantial distances, there will be pressure in the pipes. Even if it were to be a gravity-fed system, this would apply only to one direction, the other loop would need to be pumped uphill.

  The pressure problem has been the subject of extensive experimentation within the plastic pipe industry through manipulation of various polymers and molecular side chains; in short, "Increasing density yields higher short-term strength, but reduces long-term strength" (https://wlplastics.com/wp-content/uploads/Docs/WL123-0117%20High-Performance%20PE.pdf).

  A type of HDPE, i.e. PE4710 (Figure 56) is claimed by its manufacturers to provide the best current 'improved' and 'enhanced' option (https://wlplastics.com/wp-content/uploads/Docs/WL123-0117%20High-Performance%20PE.pdf). While this type of product may show somewhat higher hydrostatic strength and improved resistance to slow crack growth over a longer period compared to its predecessor PE100, its behavior re rapid failures is more uncertain and obscure. We here guess, without any clues, that PE4710 will be used for the slurry pipes.

  Differences are relative: quoting from https://plasticpipe.org/common/Uploaded%20files/1-PPI/Divisions/Municipal%20and%20Industrial/AWWA%20C906/pe-100-pipe-the-precursor-to-pe4710.pdf, "The physical properties of PE100 and PE4710 materials are extremely similar. PE4710 uses a more stringent Design Factor and has higher performance requirements. Therefore, the performance of PE4710 materials can generally be considered to be similar, if not better, to that of PE100 materials."

  'Long period' is a speculative term, as of course the product has not been in existence for the periods of time for which its longevity is claimed. Its direct precursor, PE100 pipe, has been used in Europe for several decades; the first HDPE products have only been available for ca. 40 years (https://plasticpipe.org/common/Uploaded%20files/1-PPI/Divisions/Municipal%20and%20Industrial/AWWA%20C906/pe-100-pipe-the-precursor-to-pe4710.pdf). PE4710 is even more recent, introduced around 2004 (https://wlplastics.com/wp-content/uploads/Docs/WL122-0117%20PE4710%20Performance.pdf). Expansive longevity claims touted in manufacturers' advertising greatly, and perhaps irresponsibly, exceed the product experience and practical observation times, and predictive models that assume linear deterioration do not address accelerated and

compounding rates of failure with time. Furthermore, claims apply only to performance under optimal conditions, not where pipe will be permanently exposed, subjected to internal and external abrasion, pressure and temperature fluctuations, and impact. It will be repeatedly disassembled, relocated and reassembled, accruing flaws, weaknesses and wear that are not accounted for in normal design specifications.

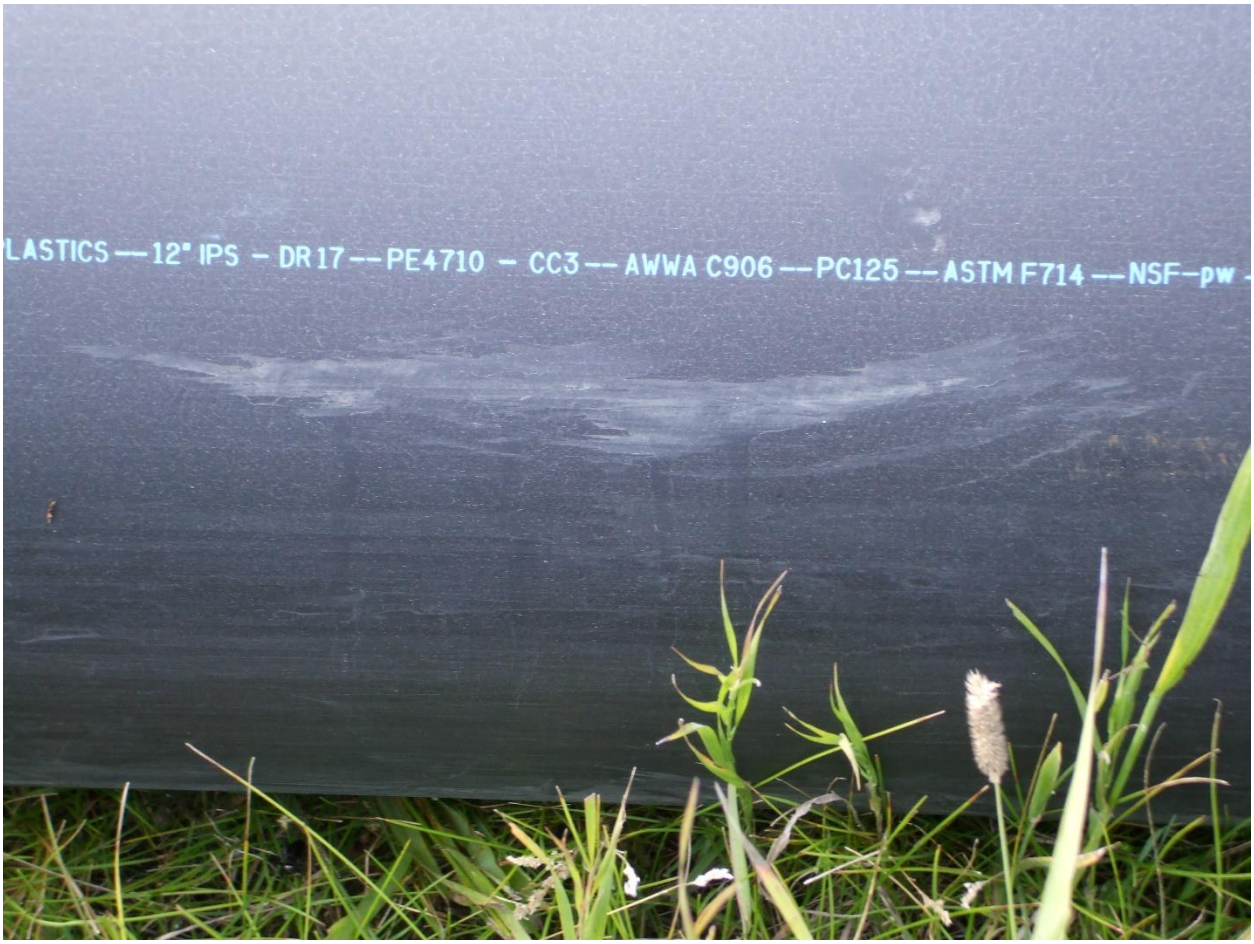


Photo: E. Pip

Figure 56. Close-up of (HDPE) PE4710 pipe. Note scuff marks.

- In the present proposed application, **pressures will also fluctuate, and surge pressures will occur**. According to Pankow (1987), pressure variations affect HDPE pipe performance: "long-term creep (relaxation) results in a slow thinning of the pipe wall, which lowers the pipe pressure rating". The inconsistent stresses fatigue the walls and age the plastic. According to Zhang (2005), "Fatigue or dynamic loading associated with fluctuating stresses significantly increase cracking. Thus **variations in line pressure must be mininized**." (Emphasis is mine). How will line pressure variation be addressed in this project?

Furthermore, the pipes will also apparently be used year to year, and will thus be subjected to additional seasonal cycles **ranging from empty to pressurized each year**. Surge tolerance varies with pipe diameter and wall thickness. Table 5 presents surge capacity for PE4710 pipe of various dimensional configurations. It is thus important to know the amplitude of potential pressure and velocity changes, but the EAP vouchsafes no information regarding these necessary considerations.

Table 5. Allowable maximum pressure and velocity changes for various dimension ratios (diameter and wall thickness ratios) of PE4710 pipes. Source: https://plasticpipe.org/common/Uploaded%20files/1-PPI/Divisions/Municipal%20and%20Industrial/Division%20Publications/Potable%20Water/Fatigue/Resistance%20of%20PE4710%20Piping%20to%20Pressure%20Surge%20Events%20in%20Force%20Main%20Applications,.pdf

Surge Capacity of PE4710 Pipe and Resultant Allowable Sudden Change in Velocity

PE4710 Dimension Ratio	Allowance for Occasional Surges, psi (bar)	
	Allowable Peak Pressure, psig (bar)	Maximum Allowable Sudden Change in Velocity, fps (m/s)
13.5	320 (22.1)	12.4 (3.78)
17	250 (17.2)	11.2 (3.41)
21	200 (13.8)	10.0 (3.05)
26	160 (11.0)	8.9 (2.71)
32.5	128 (8.8)	8.0 (2.44)

- The lines will apparently or possibly remain in place through the Manitoba winters (?). Even if stored indoors in winter, they will still operate during cool weather months. The question arises concerning the **durability of HDPE at low temperatures**, particularly when subjected to subsequent and repeated strain. Qi et al. (2004) reported that "As the testing temperature is lowered, stiffness of HDPE materials increased rapidly." Therefore "impact strength is reduced at low temperature" (PPI, 2009).

  If the stored pipes are redeployed in the spring, they will be handled and manipulated during relatively cool weather, they will have less elasticity which will render them more vulnerable to damage. They will also be disassembled during cool conditions in the fall (November). During these times they will be at greater risk of impact.

- The EAP provides almost no information regarding how pipe will be joined together. "Slurry lines are fused for sectional length and flanged together through the length of the system" (EAP1, p. 23). This statement mentions both fusing (fusion welding)(Figure 57 A) and flanging (mechanical assembly)(Figure 57 B), indicating that both methods will be used. Each of these methods has different turbulence and wear profiles, as well as different risks of leakage and failure. However SIO (p. 19) indicates only fusion: "The

slurry line used to transport the wet silica from the extraction site to the facility is fused together", and makes no mention of flanges. We do not know which to believe.

We have no information on lengths of sections, but quoting an industry source, "Standard laying lengths of HDPE pressure water pipe is [sic] 40/50 foot lengths." (https://www.jmeagle.com/sites/default/files/HDPESpecSheet4710%20.pdf).

Presumably the slurry pipes would be disassembled and reassembled at flanged connections (Figure 57 B). These connections are used in applications where HDPE pipes can be dismantled, or connected to non-HDPE pipe (PPI, 2009). According to Shahin et al. (2021), flanged joins pose environmental risks, because they are prone to leaks. These authors found that such leaks may occur at all temperatures, but especially as temperature increases. This would particularly be a concern in exposed outdoor applications.

The above EAP1 (p. 23) quote and SIO (p. 19) both mention fusing, but do not specify whether butt-fusion or electrofusion will be used, as they each carry different failure and environmental risks. The proposed pipes are 356 mm in diameter (EAP1, p. 18)(assuming outer diameter) and therefore qualify for either butt-fusion (50-2000 mm) or electrofusion (16-710 mm)(TWI, 2022).

We here assume that butt-fusion will be used because "Butt-fusion welding is the main technology to join high-density polyethylene (HDPE) plastic pipes" (Qi et al., 2004)(Figure 57 A). A welder with specialized training in HDPE fusion techniques is required (https://www.pe100plus.com/PE-Pipes/Technical-guidance/model/Construction/methods/r1049.html). Welding technology "directly affects the safety application of high-density engineering plastic pipe." (Qi et al., 2004); in other words, the strength and safety of the weld is only as good as the skill of the welder. The EAP provides no information regarding the eventual length of the fused sections, presuming that flanged connections will also occur. The length of fused sections is important, as it will directly affect the amount of stresses that will be sustained on relocation and reassembly.

Butt-fusion welds are permanent, and these sections cannot be taken apart without cutting. This brings into question the above SIO (p. 19) reference which identifies fusing only. If this is correct, how will the pipes be relocated? Will they be cut up and re-fused in different spots along the pipe again and again, resulting in an ever increasing number of welds as time goes on?

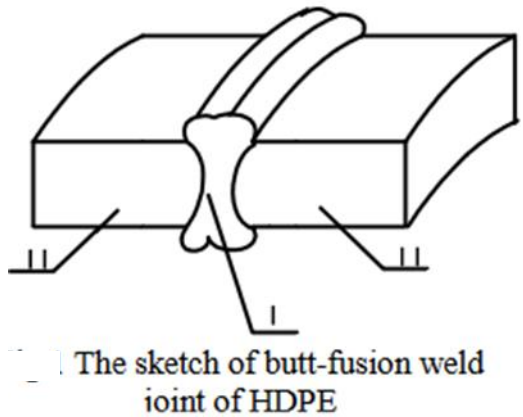


Figure 57 A. Butt-fusion weld. These connections are permanent. Source: Qi et al. (2004).

[Interesting Note: The etymology of the highly technical term "butt-fusion" likely derives from the *butt ends* which are a*butted* and fused, rather than derived from the resulting shape.]

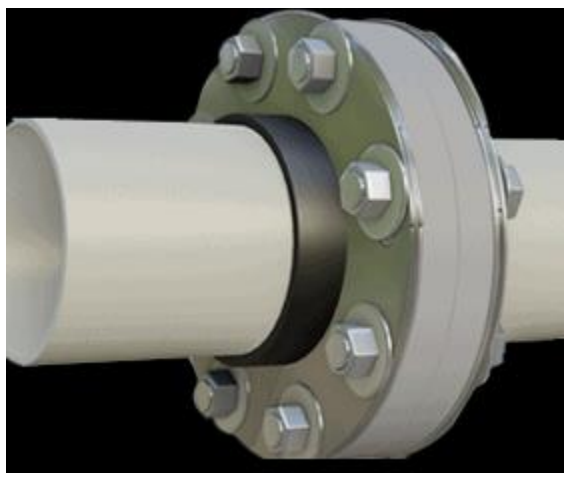


Figure 57 B. Flanged-type connection. These connections can be disassembled. Source: https://marzolf.com/flange-products/

- As discussed above in the Slurry system section, operation is planned at least into April and November, when freezing outdoor temperatures occur. "**Decreasing temperature is a major factor in crack initiation in both the pipe walls AND in the butt-fusion joints** (Figure 58), due to increasing stiffness in colder conditions." (Qi et al., 2004)(Emphasis is mine). Weakness at the butt-fusion joint "is due to alterations in the micro-properties of HDPE during the heating and subsequent annealing of the plastic associated with the welding process." (Qi et al., 2004).

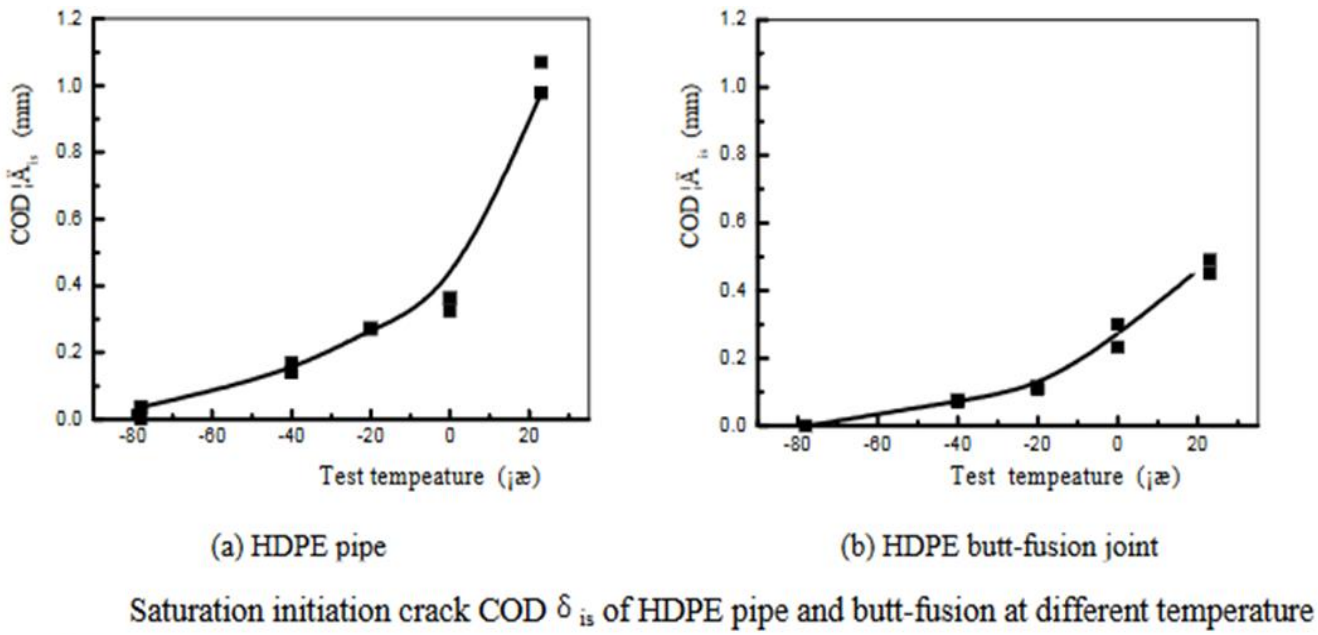


Figure 58. Crack initiation in HDPE pipe wall (left) and butt-fusion joint (right) as a function of temperature. COD = crack opening displacement. The lower the COD value, the *greater* the fracture initiation. From Qi et al. (2004).

Therefore integrity at lower temperatures can be unpredictable, even more so when other components in the formulation of the plastic are introduced, for example stabilizers, plasticizers, pigments, and other additives.

The EAP is silent on these considerations. Even more uncertain is how repeated assembly and disassembly will affect mechanical properties of the pipes and flow characteristics, turbulence and abrasion within them.

- HDPE pipes are designed to be installed underground. However in the present application, the HDPE lines will apparently rest on the ground. Whether in use or not, they will be exposed to sunlight. According to Sahu et al. (2019), "The Ultra Violet (UV) rays present in the natural environment degrade HDPE materials", causing loss of mechanical properties. Martinez-Romo et al. (2015) found that after 30 days of exposure to UV-B radiation, "physical properties such as stiffness, dissolution resistance, and dimensional stability" of HDPE were affected. These workers concluded that UV-B radiation has "a crucial influence on the physical properties of the polyethylene." Since the environmental issues associated with eventual HDPE disposal are a problem, Martinez-Romo et al. (2015) even went further and proposed that UV-B pre-treatment was a way to make this plastic more readily degradable in the environment after it was discarded: "HDPE pretreated with the correct dose of UV-B radiation, before its

commercial uses or after its final disposition, may be an option of biodegradable material".

To confer UV resistance, HDPE for outdoor use often has additives and stabilizers. Most often, carbon black is added to the plastic for this purpose: "The particle size of carbon black used and its type determines the resistance to degradation" (Sahu et al. 2019). According to the latter authors, UV resistance increases with percentage of carbon black; however increases in carbon black beyond 3% reduce "the mechanical properties due to the development of stress concentration and crack propagation." Because of the adverse effects of sunlight, commercial HDPE pipe suppliers recommend that "**It is preferable to cover the pipes while transporting them over long distances involving exposure to the sun**,,,because irregular heat distribution on the pipe circumference may result in kinking or distortion." (GET, 2021)(Emphasis is mine). The EAP does not specify what type of HDPE plastic will be used; this is important, as different types show different performance and durability characteristics (e.g. https://wlplastics.com/wp-content/uploads/Docs/WL123-0117%20High-Performance%20PE.pdf). If (HDPE) PE4710 (Figure 22) will be used, then according to the latter website, its carbon content is 2%.

While manufacturers' directions to protect the pipe before installation and during handling are quite emphatic and specific, in practice we see that they are not always followed. For example the PE4710 pipes (Figure 59) intended to carry the water supply from the new Beausejour wells to the treatment plant have been left exposed in the strong summer sun for many weeks prior to eventual installation underground in the municipal ditch. In the present slurry line application, the pipes will be left permanently exposed.

Photo: E. Pip

Figure 59. Exposed, unprotected (HDPE) PE4710 pipe in municipal ditch (Brokenhead RM), destined for water supply, baking in the summer sun, for more than a month before installation underground (2022). This pipe is 12”, the slurry pipe will be larger at 14”.

- Carbon black HDPE tubing is black in color, it heats up in the sun and can achieve high temperatures (PPI, 2009). **Higher temperatures decrease the maximum working pressure of HDPE tubing**, making it more prone to failure (Figure 60). Merah et al. (2006) found that “The average yield strength decreased linearly from 32 to 9 MPa when the temperature is increased from − 10 to 70°C. The modulus of elasticity varied in the same fashion as the yield strength……Ductile fracture is observed to be the controlling failure mechanism at all the temperatures of interest. The deformation at room and high temperatures is accompanied by considerable necking.”

  Therefore “When operating a pipeline **above 20°C it is important to allow reduction in the strength** of the material at warm temperatures.” (GET, 2021) (Emphasis is mine).

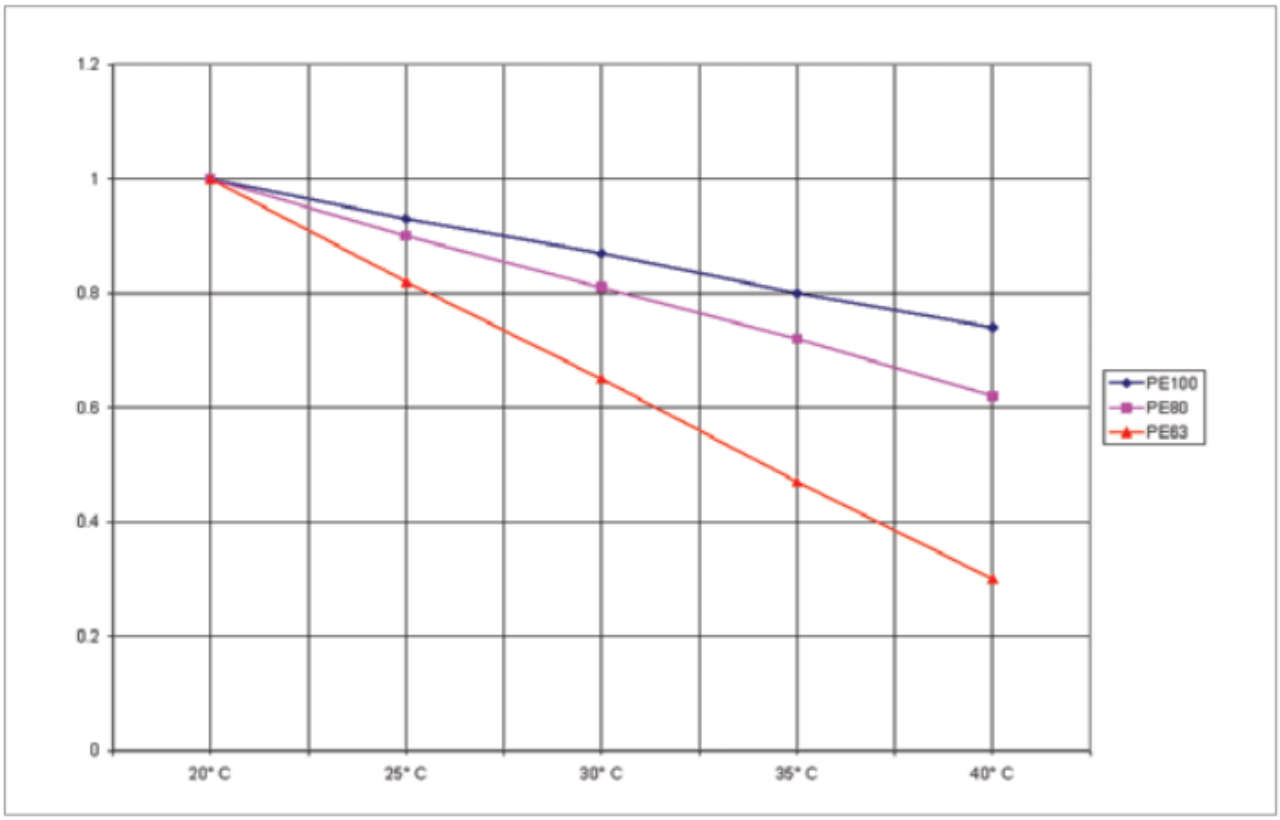


Figure 60. Pressure reduction factor vs. temperature of different pipe grades of HDPE. A baseline factor of 1.0 was used for 20°C. Source: https://gulf-eternit.com/wp-content/uploads/2019/03/HDPE-Product-Information-GET-2019.pdf. Note: PE100 is the precursor of (HDPE) PE4710 (https://plasticpipe.org/common/Uploaded%20files/1-PPI/Divisions/Municipal%20and%20Industrial/AWWA%20C906/pe-100-pipe-the-precursor-to-pe4710.pdf).

Furthermore, contraction and expansion from heating in the sun also "can generate force which could result in pull-out at mechanical couplings" (PPI, 2009), i.e. at flange connections.

The problem is further complicated by **uneven heating** of the pipes:

1. The upper surface will heat significantly more than the lower parts that are shaded or in contact with the ground. Thus expansion/contraction will be greater on the upper side.

2. The thickness of the pipe wall is unknown. Nonetheless, the inner side will be cooled somewhat by the circulating slurry. This will create a thermal gradient across the thickness of the wall, which will be greatest on sunny days. This will cause uneven

expansion/contraction across the wall, especially on the upper side of the pipe, resulting in internal stresses.

3. Expansion/contraction will occur repeatedly in each 24-hour cycle.

4. A sudden rainstorm may cause abrupt contraction of the heated surface and initiate cracking.

- A great concern with the present project is that the slurry and return lines are planned to be exposed not only for months, but reused for years. The mechanical effect of handling and moving the lines periodically will further exacerbate degeneration initiated by thermal, UV and pressure influences and predispose them to mechanical failure.

  For reasons discussed above, HDPE pipe performs best under protected conditions and is usually installed underground (PPI, 2009). Quoting Nguyen et al. (2021), "exposure criteria, such as environment and service conditions, could affect pipe service life…Such concerns were raised by Quebec's Ministry of Transportation (MTQ) to assess the durability of HDPE pipes made with recycled or virgin resins taking into consideration exposure conditions in northern climates."

  "During the winter months and prior to start up of the slurry line each season, a full inspection for wear of seals and connections will be conducted. Slurry lines will be replaced based on a maintenance schedule or early wear." (EAP1, p.24). This quote mentions inspection only of "seals and connections", but the pipes themselves are not mentioned.

  Assuming (hoping) that the pipe will also be inspected, in the present proposal up to 3.5 x 2 = 7 km of pipe will have to be assessed, although SIO (p. 19) implies up to 15 x 2 = 30 km of pipe might eventually exist. It is not known whether the lines will be stored indoors in winter, or will they remain outside? **Visible** early wear can only be eyeballed on the outside of the line, at which point it is likely serious, but how will abrasive and other **damage and cracks on the interior be observed?** Even on the outside, according to Zhang (2005), "Brittle failure…usually occurs under low stresses, propagates via crack growth **and shows no exterior sign prior to failure**." (Emphasis is mine). Thus even with the most diligent inspection, some types of failure cannot be predicted.

  Traditionally, before the advent of objective testing methods, failure risks posed by cuts and scratches were assessed according to the simplistic and unspecific 10% rule, i.e. depth of damage in relation to wall thickness (Ampfer et al., 2021). Unfortunately we do not know and cannot surmise what the wall thickness of the slurry pipe will be, as 14" PE4710 pipe (as well as other types of HDPE) is supplied at a range of thicknesses (https://www.mtncom.net/store-files/spec-sheets/HDPE/HDPE%20IPS%20SUBMITTAL.pdf).

But, as demonstrated above, pipe integrity depends on a number of factors, including location, exposure and elapsed service time (de Silva et al., 2018), as well as "the pipe's slow crack growth resistance, operating temperature, and operating pressure" (Ampfer et al., 2021). According to de Silva et al. (2018), rather than relying on visible clues, pipes that are in service are examined for integrity and remaining service life using appropriate and approved fatigue test methods for pipe wall material. There is no mention in the EAP that any of this will be done, nor who would do it. The long 24-year lifespan of the proposed project and the probabilities/certainties of pipe failure during this time underscore all the more the **unaccountable absence of a plan** to deal with these events and the ensuing environmental fallout.

"The operation and maintenance procedures regarding the slurry lines will be included in standard operating procedures prepared in accordance with the detailed design and manufacturer specifications, and will include monitoring and repair." (RPCR #199, #209). It is disheartening that design, operation, maintenance, monitoring, and repair protocols have not yet been conceived for such a major component of the proposal.

- At the road crossings the adjacent exposed portions may be vulnerable to road salt, dust control chemicals, and municipal spraying for weed control on road shoulders and in ditches, as well as gravel flung by passing traffic. Recreational vehicles and snowmobiles favor road shoulders: the pipes would need robust protection from being ridden over or struck. The sections at road crossings that are diverted underground beneath the roadway will be subject to constant or intermittent vibration from road traffic. How will this affect their durability and resistance to leaks and rupture? They will require special cushioning fill around them (PPI, 2009).

- These pipes are sensitive to disturbance, and should have as little of it as possible (PPI, 2009). HDPE pipe suppliers stress the importance of handling them with gentle care. For example, if flexible, "Coils should be stored horizontally just as they are normally delivered by the factory, if it is necessary to transport them vertically care should be taken to avoid any overloading or excess movement which may result in the deformation of the pipe". If rigid, "Straight lengths should be stored on a flat, clean surface without being allowed to bend in any direction", with the stacks not exceeding 1 m in height (GET, 2021). "The HDPE pipes should not be dragged, thrown or stacked on uneven surfaces. Whenever loading or unloading is carried out, it is recommended to use cotton or nylon (synthetic) belts to avoid damage to the pipes. If at all metal slings are used, the pipe should be protected against scratches." (GET, 2021). "Chains, steel cables, wire ropes and hooks must not be used directly on polyethylene pipe or fittings." and "Bundles should be unloaded with fork trucks or cranes equipped with spreader bars with at least three wide web slings." (PPI, 2009). "The storage area should have a relatively smooth, level surface free of stones, debris or other materials that could

damage the pipe or fittings." (PPI, 2009). The question intrudes: how will the kilometers of slurry line trails be kept free of "stones, debris or other materials"?

Damage can occur from impact, bending and stress during pipe installation and handling (Lucas et al., 2011). Failure caused by impact and rough handling can be **catastrophic**: "Impact failure happens fast, with the crack-growth rate close to the speed of sound (300m/s), called rapid crack propagation." (Zhang, 2005). An instantaneous rupture can result. It is particularly enabled at lower temperatures and higher loads (Zhang, 2005).

Figure 61 shows a damaged area (highlighted by its handlers) of new pipe laid out in a municipal ditch prior to installation underground: the scratches, score marks and blemishes were apparently incurred during transportation and handling of the pipe. There are also numerous scuff marks and abrasions (Figure 56). Additional damage may not be visible.

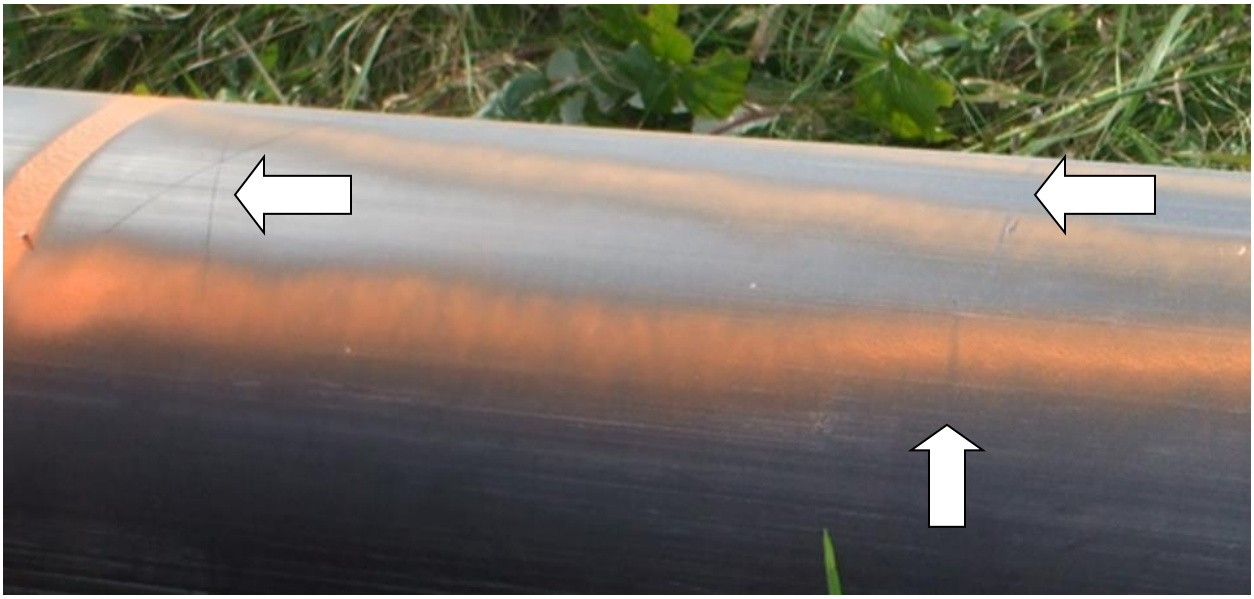


Photo: E. Pip

Figure 61. Visible scratches, score marks and cracks (arrows) highlighted by pipe handlers prior to installation underground. Risk of pipe failure is greatest in damaged sections.

In the present above-ground application, the pipes will be left exposed to the vagaries of what the environment will offer: getting stepped on and ridden over by people, horses, recreational vehicles, machinery; the attentions of wildlife (bears are attracted to hoses, tubing, and plastic pipe (personal observation)); fallen trees; hailstorms; cycles

of thawing and freezing ice; the pipes will be dismantled and relocated and manipulated multiple times.

- We are not favored with the design and connections of the system at the wellhead, but the possible influence of vibration/pulsation from the rotary screw compressor (RPCR #193) used for air lifting may need to be considered. According to Clark (2017), "Damage to off-line equipment" may occur due to the high frequency pulsations associated with and transmitted to system components including connected pipe by this type of compressor. Pulsation vibration needs to be minimized; Clark (2017) underlines the need for proper adjustment of the compressor: "Efficiency decreases and pulsation levels increase with over- or under-compression." Will this be done?

- The slurry pipes and joins will be exposed to **constant abrasion from sand under pressure and velocity**, which will erode the pipe. According to EAP1 (p. 18), "The slurry loop will typically operate at approximately 15% sand and 85% water, with the ratio of sand and water varying by up to approximately 35%." Yet according to an HDPE pipe supplier, "**the pipe should be protected against scratches**" (GET, 2021).

  HDPE **abrasive wear** occurs through scratches, gouges and score marks (Lucas et al., 2011). Pankow (1987) reported that **sand quickly eroded HDPE pipe**, enhanced by "the additional turbulence induced by the flanges". This worker recommended "rotation of pipe to distribute wear patterns" in order to extend its service life and postpone failures. In abrasion tests with silica sand, Budinski (1997) found that HDPE was not among the best performers of the range of plastics tested.

- Another factor to consider is that the specific composition of HDPE pipe with respect to the amount of virgin and recycled plastic can affect its mechanical properties: "post-consumer recycled (PCR) polymer, for example in HDPE, weakens when reprocessed and therefore limits the amount that can be used in engineering applications, such as pipe" (see Nguyen et al., 2019). There is no information in the EAP regarding the quality and source of the HDPE pipe that is proposed.

  Although virgin polymer HDPE has better mechanical properties, it has an environmental drawback: greenhouse gas emissions are greater for virgin HDPE. "The average GHG emissions for the production of 1 kg of pristine HDPE resin is higher than the proposed alternatives, largely due to the energy consumed to convert crude oil and natural gas to ethylene." Furthermore incineration or recycling "result in a direct release of CO_2 to the atmosphere during the reprocessing and combusting processes" (see Nguyen et al., 2019). Thus according to the latter authors, HDPE "consumes substantial energy resources and emits greenhouse gases, air pollutants, and solid waste at end-of-life that impose environmental risks to land and water". The EAP does not include these GHG emissions in its GHG budget.

- HDPE pipes may pose a hazard to workers, property owners and members of the public in the vicinity if a leak or rupture occurs. As cited above, "Even at relatively low internal pressures… a pressurized internal fluid can generate very high forces that can be dangerous or even fatal if suddenly released by the failure of a joint or system component" (PPI, 2009). This presents serious liability which cannot be discounted.

  Because of unknown factors in individual performance expectations, PE4710 manufacturers include disclaimers to avert legal liability issues, for example: "Before using the piping product, the user is advised and cautioned to make its own determination and assessment of the safety and suitability of the piping product for the specific use in question and is further advised against relying on the information contained herein as it may relate to any specific use or application. It is the ultimate responsibility of the user to ensure that the piping product is suited and the information is applicable to the user's specific application." (https://hdpe.ca/wp-content/uploads/2016/03/PE4710-DATASHEET.pdf).
  Therefore the burden of responsibility for the safety and suitability of the pipe throughout its service life rests with the **user**. There are many, many confounding factors that will be associated with its current proposed application.

- **In conclusion, the proposed use and reuse of HDPE tubing, its exposed above-ground location, and repeated manipulation as described in the EAP, are associated with significant risks of leaks and rupture from multiple causes.**

  The proponent maintains: "The slurry line will be made of HDPE (high density polyethylene) which is not prone to leakage and which is very commonly and successfully used in similar industrial applications with high flow volumes, including for transportation of industrial sand. HDPE systems are also used locally for agricultural use in Manitoba to move animal manure used as fertilizer on crop fields." (RPCR #154, #197).

  "The HDPE type slurry lines are used in many industries and are utilized to move abrasive materials. This type of HDPE material was purposely selected for robustness and wear resistance." (RPCR #198).

  As belabored in my tiresome discussion above, numerous researchers and engineers disagree. Where HDPE tubing is used for the applications mentioned, its useful life is all too often brief and troubled. It behooves the proponent to be cognizant of its shortcomings, and to take precautionary steps, rather than to deny them. In short, the ideal plastic has not yet been invented.

Polyacrylamide and acrylamide

- The fluid in the lines may potentially contain residues of **polyacrylamide** (PAM) from the processing plant. The companion Environment Act proposal for the processing plant (EAPPF) indicates that the clarifier at the facility will utilize polyacrylamide as a flocculant for water associated with the dewatering process. The EAPPF (p.3) refers to "using food grade biodegradable flocculant (anionic polyacrylamide)". We also see this cruelly duplicitious phrase repeated in EAPPF, Appendix I, question 29; as well as in RPCR (#248), and also in promotional material meted out to the public (SIO, p. 23). There is no hint from this 'reassuring' pronouncement that polyacrylamide biodegrades into highly toxic acrylamide, which is where the problem lies.

- PAM and its breakdown product, acrylamide, are NOT ever added intentionally to any food because of the risk to health from the breakdown product (Health Canada, 2019). Acrylamide is an **objectionable toxic contaminant** in some starchy foods, resulting from processing or cooking at temperatures in excess of 120° C. (e.g. Tepe and Cebi, 2019). The topic has been reviewed in "Acrylamide – a potent carcinogen in food" by Thomas and Thomas (2012). Acrylamide may also occur as a contaminant in some food packaging. Health Canada (2019) is engaged in monitoring programs and reduction strategies to lessen unwanted incidental acrylamide levels in Canadian food that can harm the health of Canadians.

- While PAM has been used as a flocculant in some domestic water treatment plants in some countries, the presence of resulting acrylamide residues and concerns regarding its health effects have prompted the World Health Organization (WHO, 2011) to caution this use. "Residual of PAM during the treatment and flocculation process can contaminate the drinking water by the release of the residue." (Tepe and Cebi, 2019). According to WHO (2011), "Conventional treatment processes do not remove acrylamide."

- According to the World Health Organization, for drinking water, "the maximum acceptable dose of polymer [polyacrylamide] is 1 mg/litre. At a monomer [acrylamide] content of 0.05%, this corresponds to a maximum theoretical concentration of 0.5 µg of monomer per litre in water (NSF, 1988 *in* WHO, 2003). Notes: (1 mg = 1000 µg).

  In our adjacent jurisdiction of Minnesota, we see "a guidance value of 0.2 parts per billion (ppb) [i.e. 0.2 µg/L] for acrylamide in drinking water. **The guidance value is based on protecting Minnesotans from cancer.**" (Emphasis is mine) (https://www.health.state.mn.us/communities/environment/risk/docs/guidance/gw/acrylainfo.pdf).

According to Canbay and Doganturk (2019), for acrylamide, "restrictive quality requirement limits of 0.1 µg l^{-1} for water intended for human consumption have been regulated in European Union".

In British Columbia, the drinking water acrylamide limit is also 0.1 µg/L (https://www.carexcanada.ca/profile/acrylamide/).

According to the U.S. Environmental Protection Agency (2022), for acrylamide, "The level of a contaminant in drinking water below which there is no known or expected risk to health" is **ZERO**. Therefore *any* exposure is undesirable, although in practice, difficult to avoid.

Note: You are asking, what about Canadian federal water quality standards? What, indeed. Occupational exposure limits exist for workplace exposures to acrylamide vapors in the air, due to associated absorption via inhalation and skin, both in the Canadian Labour Code and individual provinces (https://www.carexcanada.ca/profile/acrylamide/). With regard to water quality, like for so many other substances that are on the 'bad' list in other countries, in Canada we are typically in arrears, sometimes by a decade or more. Perhaps this is due to our national pride in being perceived as "tough Canadians". It seems we don't need sissy regulations, when we can take it! Plus, there is *always* some industry or lobby group whose feelings would be hurt by any attempt to curb their right to pollute. In fact, in Canada (except for a few selected microbiological parameters), we only have pie-in-the-sky unenforceable federal Water Quality *Guidelines*, i.e. targets to shoot for, rather than enforceable *Standards* (Pip, 2015a). Go figure. Some individual more enlightened provinces have taken matters into their own hands and have formulated their own lists.
In an ad in The Clipper (January 12, 2023, p. 10), the proponent states: "I know Canada has some of the world's best laws to protect water." Nope.

- Polyacrylamide, a polymer, degrades into monomeric acrylamide, which poses human health risks. "Acrylamide is a chemical which is highly toxic, carcinogenic, reprotoxic, and neurotoxic" (Tepe and Cebi, 2019). It causes acrylamide encephaloneuropathy in humans (Igisu et al., 1975; Charoenpanich, 2013), characterized by "hallucinations, drowsiness and numbness in the hands and legs" (PubChem, 2021), as well as "abnormal fatigue, memory difficulties, and dizziness", slurred speech, unsteadiness in walking and standing, headache, nausea, and numerous other effects indicative of "involvement of central, peripheral and autonomic nervous systems" (Proctor et al., 1989). According to Parry (2008), "There is no treatment for acrylamide intoxication other than removal from the toxic environment."

  In drinking water, acrylamide residues have been associated with reproductive impairment (AFR, 2005). It is a genotoxin and probable human carcinogen (EPA, 2000; King and Noss, 2016), and has been shown to act as a tumor initiator (AFR, 2005). A literature review by Thomas and Thomas (2012) found that "All studies reported the induction of dominant lethal mutations by **acrylamide**." (Emphasis is theirs).

According to a document issued jointly by Environment Canada and Health Canada (ECHC, 2010), "On the basis of the carcinogenic potential of acrylamide, for which there may be a **probability of harm at any level of exposure**, as well as the potential inadequacy of margins between estimated exposure and critical effect levels for non-cancer effects, it is concluded that **acrylamide is a substance that may be entering the environment in a quantity or concentration or under conditions that constitute or may constitute a danger in Canada to human life or health.**" (Highlights are mine). Further, "The substance acrylamide was identified as a high priority for assessment of human health risk because it was considered to present the greatest potential for exposure (GPE) and had been classified by other agencies on the basis of carcinogenicity, genotoxicity and reproductive toxicity."

While polyacrylamide is not well absorbed through the skin (AFR, 2005) due to its large molecular size, hence its comparatively lesser toxicity, the smaller monomer acrylamide is well absorbed through "unbroken skin, mucous membranes, lungs, and the gastrointestinal tract." (Charoenpanich, 2013). Workers are at risk. In Manitoba regulations, as well as in the Canada Labour Code, occupational air exposure limits are identified for acrylamide inhalation; however general exposure may also occur through drinking water and food (https://www.carexcanada.ca/profile/acrylamide/).

- "Acrylamide has high risk of contamination into surface and ground water supplies due to its rapid solubility and mobility in water" (Tepe and Cebi, 2019), because "the adsorption of AMD [acrylamide] onto particles is very low, which could favor its transfer in surface waters and groundwater" (Guezennec et al., 2014). According to Tepe and Cebi, 2019), its main route of breakdown in *surface* water is bacterial degradation, where it is metabolized as a nitrogen source. In rivers (i.e. **surface water**), where light and bacteria are available, the half-life of acrylamide ranges from weeks to months (Brown et al. 1980 in Guezennec et al., 2014).

  The proponent argues (SSCRIR2 (#DLN-IR-003) that the risk is trivial and cites some inapt references due to confusion between the polymer and monomer:

  "El Mamouni et al, 2002, showed that a combination of photolysis and microbial attack leads to natural attenuation of these **polymers**…"

  1. Photolysis (i.e. degradation through the action of light) and appropriate microbial taxa are not available in groundwater aquifers. The cited study dealt with soil.

  2. Degradation of the *polymers* results in *monomers,* i.e. toxic acrylamide.

  3. In the Hennecke et al. (2018) reference cited, "The **polymer** was degraded **biologically** by at least 20% in 2 years giving a degradation half-life of 5.4 years." Again, this related to the degradation of the **polymer in soil** which resulted in **acrylamide**. A degradation

half-life in this particular case of 5.4 years **in soil** means that a quarter of the original polymer is still undegraded after 10.8 years.

- If photolysis and bacterial degradation are not available, for example in unpolluted groundwater, **decomposition proceeds via hydrolysis**, which is a much slower process: "The hydrolysis **half-life** of acrylamide at **25ºC** has been determined to be very slow, at 13 870 days or **38 years** (Ellington et al. 1988 *in* ECHC, 2010)." Therefore after approximately 76 years, a quarter of the chemical still remains, plus the parent PAM material continues to decompose. Due to the much **colder temperatures of groundwater** (compared to the above cited 25°C)(Nawaz et al., 1998 in Guezennec et al., 2014), the estimated hydrolytic half-life in these conditions would be significantly longer. Labahn et al., 2010 *in* Guezennec et al. (2014) reported poor degradation below 15° C. Thus "Acrylamide **may travel great distances in the ground water** of deep rock aquifers, where **biodegradability is reportedly absent**." (Conway et al., 1979 *in* WHO (1985)) (Emphases are mine).

  As a result, "**inorganic acrylamide contamination into environment is a big threat and has potential hazards for public health.**" (Tepe and Cebi, 2019). According to Xiong et al. (2018), "**applications of PAM can result in significant environmental challenges, both in water management and in contamination of local water supplies after accidental spills.**" (Emphases are mine).

  Groundwater contamination with acrylamide has been reported where PAM flocculants are used in sand mining operations (e.g. WHO, 2011; Touze et al., 2015). PAM may also be used in fracking (Xiong et al., 2017). Contamination is particularly an issue where ongoing introduction is occurring.

  The proponent dismisses the work of Xiong et al. (2018): "The conditions the article discusses for potential breakdown of polyacrylamide to the acrylamide monomer are not likely to exist in Sio's application" (SSCRIR2 #DLN-IR-003). Since PAM and its oligomers will naturally degrade in groundwater to acrylamide through hydrolysis, the arguments presented by the proponent as not applicable do not address the central issue of the eventual end product, regardless of the pathways via which it gets there.

- Furthermore, presence of **aqueous oxygen increases the rate of PAM degradation to form acrylamide** (Xiong et al., 2017). This is a factor to consider in the context of oxygen introduction into the aquifer during well injection (see p. 259).

- The slurry water will be endlessly recirculated in the lines, added to, and recycled year to year. PAM degradation into monomer (acrylamide) can be enabled by "chemical, mechanical, thermal, photolytic, and biological processes." (Xiong et al., 2018). All of these mechanisms (including photolytic, if the water is exposed at some stage) will be

available for the fluid in the slurry and return lines. Furthermore, **a wide variety of bacteria, a number of them pathogenic to humans, can grow on PAM in water** (see Xiong et al., 2018), and may potentially grow in the slurry and return lines. Thus risks of leaks and spills are of concern. Aside from the processing facility itself, this is especially important at active extraction sites, where slurry water and open wells will be in close proximity, and accidents and carelessness can and will happen, given the thousands of extraction wells. The methodology is experimental and wobbly. **How will the endlessly recycled slurry water be eventually disposed of?**

According to the EAPP (p. 13), the water from the processing plant "may be reused in the slurry system loop" (EAPPF, p. 13). The EAPPF (p. 13) claims that "The levels of flocculant remaining in the water after leaving the clarifier will be virtually undetectable.": what does "virtually undetectable" mean? **On what data is this statement based?** This dismissive declaration indicates that levels will not be monitored or even considered.

The RPCR (#208) categorically states: "The slurry line, which will contain only a sand and water slurry for transport to the processing facility, will not contain acrylamide".

This statement would be true under one of the following conditions:

A. Clarifier water does not enter the slurry loop, OR
B. Clarifier water is purified (for example reverse osmosis) before entering the slurry loop, OR
C. No polyacrylamide is used in the clarifier.

The RPCR does not indicate which of these conditions will apply, nor does it elaborate further or provide evidence to support its claim. Otherwise, it is not possible for NO polyacrylamide/acrylamide to be present in the clarifier water, *ergo* in the continuously recycled slurry loop. "Recycled water for the slurry loop system is sourced from the Processing Facility site water treatment process." (RPCR #248).

At the same time, in contradiction to RPCR (#208) above, RPCR (#154, #197) admits: "the slurry line will contain only a sand/water slurry and **a residual amount** of a non-toxic biodegradable flocculant (from recycled water as described in the Facility project EAP)." (Emphasis is mine).

1. What is a residual amount?
2. If polyacrylamide is the referenced flocculant, then acrylamide will unavoidably also occur, and is most certainly not non-toxic.

The composition of the slurry fluid should be independently and periodically verified, with full disclosure. It is the legal right of the workers to know what is in it, and it is also

the right for anyone (landowners, members of the public) who may come into contact with it via spills and cleanup.

- Reassurance is needed regarding yet other, even more insidious industry practices involving PAM. Polyacrylamide is used in **drilling fluids** as an aid to reduce friction at the drill bit (Charoenpanich, 2013). According to industry expert Jie (2020), "During the drilling process, due to the geological structure, the drilling fluid will leak."

  The present concerns revolve around the thousands of wells that will be drilled. Since they are not, and will not, be developed as water wells, does Manitoba water well legislation (see below) apply, specifically regarding what materials may be used? Is this a potential loophole? Further, since they are not water wells and have no well screens, will they be *promptly* flushed out after drilling in the same manner as the protocols for water wells, in order to remove some of the drilling fluids before they have dispersed into the aquifer?

- Since slurry pipes are planned to cross roadways (EAP1, p. 23), horizontal directional drilling may be required, in intimate association with drainage ditches. Environmental spills of drilling muds are common with this drilling method (NJDEP, 2021)(see Figure 61). According to NJDEP (2021), this type of drilling "represents a potential risk to groundwater as well as to surface water". Further, "fugitive drilling mud and fluids…can include contaminants or otherwise become a source of pollution in groundwater, surface water/sediments, and/or ecologically sensitive areas." The primary clay used in drilling mud for horizontal drilling applications is bentonite, which may often be combined with polyacrylamide polymers (e.g. http://www.pvcplus.com/media/website_product.pdfSpecs/en-CA/POLY-BORE.pdf); other additives may include surfactants and flocculating agents (NJDEP, 2021).

  Skonberg et al., (2008 *in* NJDEP, 2021) pointed out that "The release of bentonite slurries into sensitive environments such as surface water bodies and wetlands can cause impacts that are difficult to mitigate effectively." Further, "Drilling mud, classified as a contaminant by the Clean Water Act [U.S.] when released, has the potential to negatively impact freshwater ecosystems by increasing water turbidity, altering overall water chemistry, and introducing harmful chemicals to plants and animals that could cause injury", and "The release of drilling mud into a stream or similar…habitat may subject benthic invertebrates, aquatic plants, and/or fish and their eggs to sedimentation or suspended solids that can potentially be detrimental to their populations." (NJDEP, 2021). Bentonite does not degrade in the environment.

- PAM is also industry-standard in many commercial grouts and cements, for example calcium bentonite grouts are often admixed with PAM to improve their rheological properties (Choo et al., 2020)(i.e. bentonite-acrylamide polymer grouts). There is a

dizzying multiplicity of associated PAM-containing products used as borehole stabilizers, viscosifiers, encapsulating agents, anti-swelling agents for reactive shale, carrying capacity extenders of air or foam injection fluids, etc. (e.g. http://www.pvcplus.com/category/polymers-control-agents-260.aspx).

Accordingly, some grouting agents used in well and borehole linings have been reported to contaminate the well water with acrylamide, and consequently human acrylamide poisonings have occurred from grout used in such water well installations (Igisu et al., 1975; WHO, 1985, 2011; Tepe, 2016; UKgov, 2021). Indeed, according to WHO (1985), of the various uses of this chemical, "**The use of acrylamide as a grouting agent has proved to be the greatest potential hazard for man, due to contamination of ground water.**" Further, "In the vicinity of local grouting operations, high levels of acrylamide may be found in wells and ground water." Livestock poisoning has also been attributed to PAM grouts in water wells in pastures (Godin et al., 2002).

Parry (2008) has reported that "most cases of poisoning occur during the manufacture of the monomer or **during the polymerization process at the work site**. As mentioned above, acrylamide may be absorbed by inhalation or ingestion and through the skin. The latter is probably the major route of absorption in the workplace." (Emphasis is mine). Thus **worker exposure to acrylamide during well sealing activities is an important concern**. In a case in Norway where workers became ill from working with acrylamide grout, they had not been informed: "As the contractors had not previously known that the grout contained acrylamide, workers had been exposed to it." (UK, 2000). This can be an issue, as many products currently on the market do not fully disclose all of the ingredients in the formulation, under the protective "proprietary" Trade Secrets banner.

Risks to the environment must also be considered. According to a UK government review (UK, 2000) of acrylamide and related n-methylolacrylamide (NMA) grouts, "Risks to the environment are to aquatic organisms following use that is not 'normal' (i.e. where some problem occurs that prevents the grout setting properly, allowing it to leak from its injection site to pollute watercourses and/or groundwater)."

In a 1997 case in Sweden, where acrylamide and NMA entered both surface and ground water from construction leakage (UK, 2000), "nearby streams became contaminated with acrylamide and NMA, causing a fish kill and the paralysis of cows drinking from it." The contamination of water had far-reaching consequences: "There were considerable impacts on commercial activities within the area, particularly on farmers. A total of 370 animals were slaughtered. Milk suppliers were also affected with 330,000 kg of milk disposed of and nine milk suppliers excluded from milk collection services. Vegetable and root crops were also destroyed." A number of private wells in the area were affected.

In the above case, the disaster occurred because the grout did not set correctly: "the groundwater leakage rates were so high that they caused dilution of the components. This meant that polymerisation was slowed or could not occur; the temperature in the [construction] tunnel, less than 9°C, was too low and lay outside of the application range for the grout; and return flow from the process of injecting the grout into the rocks added to the concentration of acrylamide and NMA in water" (UK, 2000). This is a lesson to ponder.

As a local illustration, a bentonite spill (Figure 61) occurred in the summer of 2022 into the Brokenhead River during installation of an outfall wastewater concentrate pipe into the river for the new Beausejour reverse osmosis water treatment plant. Nobody seems to know (perhaps admit) how much was spilled. A water sample was collected downstream from the spill on 25 September 2022, more than SIX WEEKS after the spill. Certified laboratory analysis showed 11 ppm (= mg/L)(i.e. 11,000 µg/L) of polyacrylamide in the water was still present. Two independent citizens, unknown to each other, each tried to report the spill to authorities. In separate communications with me, they each alleged *in the same words* that they were encouraged to drop it. Others such as myself tried to report it as well. In the meantime citizens were swimming in that water, wildlife and livestock utilized it, some people even drank it (personal observation). There were no warning signs posted, no advisories issued. This situation does not inspire confidence that health and environment are or will be protected or are a priority, nor that we can depend on authorities to intercede on our behalf. Is it so surprising, then, that there is so much anxiety and distrust, when so much of it is justified?

Photo used with permission

Figure 61. Drilling mud released into the Brokenhead River as a result of a horizontal directional drilling spill during the summer of 2022. More than 6 weeks later, polyacrylamide levels in the water were still very high. The public was not notified, and the issue was viewed with a glass eye by authorities.

- In the present project, the proponent proposes to "Cement borehole through shale and lower Red River Carbonate" (SUPPL1, p. 3). Since cement-based sealing materials can also contain acrylamide (https://www.sciencedirect.com/science/article/pii/S095006182103837X), the composition of the materials that will be used is important, as any leaching through these layers will affect both aquifers.

- In Canada, PAM grouts are used as groundwater infiltration sealants because of their extended functional **half-life**, calculated as more than 360 years (Gentry and Magill, 2012). While acrylamide grout is apparently not, or no longer (this is not certain, as monitoring is largely lacking), used for drinking water wells in Canada, it is still a component of many grouts used in wastewater and other piping systems, and in **industrial wells** (ECHC, 2010).

- The Manitoba Groundwater and Water Well Act (C.C.S.M. c. G110) does include "polymers" as undesirable additives in Clause 7(2)b: "additive includes, but is not limited to, clays, polymers, surfactants, disinfection products and acids" in the construction and sealing of water wells (https://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=215/2015). However these terms lack precise definition: for example, bentonite is clearly a clay, but is routinely used. 'Disinfection products' presumably refers to products used *for* disinfection, not the products *of* disinfection such as trihalomethanes: yet bleach is used in water well development (see pp. 330-331). "Polymers" are not further defined or identified, and are left to interpretation. There are also many modifiers and loopholes in Clause 7(1), for example, "generally accepted industry standards and practices" (how is "generally" determined?), or adhering to manufacturers' directions, and so on. And of course, in Clause 11, "Upon written application by or on behalf of the owner of a well or test hole, the minister may vary any requirement of this regulation with respect to the construction or sealing of a well or test hole." Thus there is a good deal of latitude and poofiness, and this legislation much needs to be revised and updated in view of both precision, and consideration of data regarding current availability of synthetic materials in the industry and their potential health and environmental impacts. Disturbingly, there seems to be no onsite supervision or monitoring, and of course subterranean installations are impossible to revisit and review later.

- In RPCR (#24): "CanWhite will use only industry-standard well grouting materials that are used in the water well industry and known not to impact water quality." This response does not answer the question: **Can we have absolute assurance that NO materials used in the thousands of sand wells will contain acrylamide polymer? Specifically, is there the possibility that these wells may be considered "industrial", since they are not water wells, are being abandoned, and will not be used in the**

future? We are hesitant to take the proponent's word that these substances are "known not to impact water quality", without any evidence, short-term or longterm, thereof.

In RPCR (#160), the proponent indicates: "CanWhite utilizes an industry-accepted grout/cement mixture that provides both stability (from the cement) and sealing properties (from the bentonite grout) to establish a competent seal in the shale layer and up into the limestone."

Both grout and cement may contain PAM. **The question remains unanswered**, because the concern *is* with some "industry-standard" and "industry-accepted" grouts and cements. We must learn from our long and sordid history of using toxic materials in our water supplies, which have later become burdensome monuments to our ignorance and carelessness – recall our previous and now regretted infatuations with asbestos-cement municipal water pipes, lead water distribution pipes and plumbing, 60/40 lead join solder for copper water pipe, and numerous other examples – all were "industry-standard" in their day. While the aforementioned pipes and plumbing can be ripped out (at least theoretically, although much more difficult to achieve in practice, as we have seen in Winnipeg and other places), an aquifer cannot be removed and replaced.

It should be noted that in WDR, according to the driller, the wells drilled so far have been decommissioned according to The Mines and Minerals Act (C.C.S.M. c. M162), Drilling Regulation, 1992, which stipulates "sulphate resistant (CSA Type 50) grout". Presumably this has been used, as per Clause 7(a) of the Regulation. This is a Portland cement, which contains fly ash and slag, of complex chemical composition (http://ecosmartconcrete.com/docs/prdaycsa04.pdf), addressed by the CAN/CSA-A3000-98 Standard. (Note: Type 50 is now designated as HSb. The Regulation needs updating.)

- Another factor to consider is that **in downhole conditions and presence of iron, shale has been found to catalyze the degradation of PAM to acrylamide** (Xiong et al., 2017). As discussed above, in the thousands of injection wells, grouts and cements will be used "to establish a competent seal in the shale layer" (RPCR #160; also SUPPL1, p. 3). Therefore the composition of these sealing materials is of crucial importance. Neither the EAP nor any of the supplemental documents provide any clue regarding this issue.

- Besides the above sources, a number of other potential materials may contact or contaminate the extracted water with PAM during its sojourn at the surface, for example a variety of other sealants, as well as adhesives, hydraulic fluids, construction materials, adhesive tapes, latex, waterproofing agents, epoxy, polystyrene, and many others; cigarette smoke is a notable source of acrylamide (ECHC, 2010).

- Finally, if acrylamide that is present in raw water enters a drinking water treatment plant, chlorination may create N-nitrosodimethylamine, a nitrosamine which is

extremely toxic at very low concentrations (MEQB, 2013). Chlorination of a well during domestic well development, combined with PAM or acrylamide-containing well grout, could also create this contaminant. In the present circumstances, any injection well chlorination must be banned.

Decommissioning

- The proponents indicate that the wells will be sealed on decommissioning (EAP1, section 2.2.6). Sealing "will occur sequentially over the April to November timeframe with all wells being sealed (i.e. decommissioned) sequentially" (EAP1, p. 13).

  "In accordance with the borehole license conditions, wells are permitted to be left unsealed for up to one year after they are drilled. Some wells (which are located in private land) have been intentionally left unsealed to allow for monitoring, and continue to be unsealed to accommodate ongoing testing." (RPCR #222).

  According to https://www.ernstversusencana.ca/vivian-silica-sands-extraction-wells-manitoba/, "sealing of well 199982/002472 did not occur until June 18, 2020, almost two years after completion in September 28, 2018." In another example, "The 197859 well information report shows sealing did not occur until June 17, 2020 more than two years after completion." (See more complete discussion in latter source, well numbers are from WDR).

  How long can monitoring wells remain unsealed? How are they protected in the interim?

- In RPCR (#160) we see the rather scary statement: "the wells will be decommissioned in accordance with provincial guidelines and **best practices established by CanWhite**." (Emphasis is mine). What are "best practices established by CanWhite"? On what technical, empirical and legal grounds can CanWhite (≈ Sio) establish their own standards? How will the practices differ or deviate from the provincial protocols? To put it bluntly, how much experience, and how much authority, do they have?

- In the Progressive Well Abandonment Plan (EAP2, section 8.3), the following procedure is stipulated, reproduced verbatim below:

  "The following procedures will be used to abandon or seal Project wells:

  1. A mechanical plug will be placed at the predetermined depth to isolate the movement of water within the already cemented casing between the sandstone and limestone aquifers. Then a bentonite plug will be placed prior to cementing to ensure the cement does not dilute or leak into the water prior to setting.
  2. Above this plug, a several foot-thick cement plug will be placed and allowed to set. Cement will be pumped into place using a tremie grout system. The cement plug will be confirmed by manual contact prior to proceeding to the next step.

3. Once set, layers of bentonite and pea gravel will be used, or a benitoite [sic] grout to 5 feet (1.5 m) within surface.
4. Where pea gravel and bentonite are used, no more than 15 feet (4.6 m) of pea gravel will be used before another layer of bentonite. In addition, careful attention will be paid to the layering of bentonite across any interfaces between aquifers (e.g., the to the till interface) to prevent vertical mixing of the aquifers.
5. A 5 feet (1.5 m) thick cement cap will be placed at the very top, allowed to set and then the topsoil/organics are replaced on top of the cement to allow for vegetation regrowth/remediation of the surface land to occur.
6. Detailed logs will be kept of the well abandonment and depths of each layer, in addition to the GPS coordinates of each well.

This procedure will be used in all extraction wells and wells that exceed 2 inches (5 cm) in diameter."

[Reader's Note: The text was not proofread: Step 3 is using "benitoite grout". We cannot say for sure, but possibly the writer was subliminally thinking of toities whilst multitasking this section.]

This description, which is supposed to apply to all wells, raises the following concerns:

1. According to this plan, the casing will be left in place (for example reference to "the already cemented casing"), and no mention is made of removal in whole or in part. Yet according to wells already drilled, in numerous instances the casing has been removed (WDR).

2. Step 5, i.e. "the topsoil/organics are replaced on top of the cement to allow for vegetation regrowth/remediation of the surface land to occur.", indirectly indicates that the casing will be severed below ground level and covered over (camouflaged) with soil, but this is not admitted as such in the plan. This "cut-and-cap" approach is an issue because of **lack of visible evidence at the surface for abandoned wells.** Furthermore, these will not be isolated wells: the concealed wells will be in clusters, the clusters will be in blocks. The sheer number of them will be staggering.

Future excavations, construction, farming activities or trenching for utilities may compromise the hidden plugs or damage the casings. Since "cut-and-cap" is not mentioned, neither is the depth below ground level at which the casing is severed. However in wells already drilled and abandoned, this depth has not been consistent, but has been up to 1.2 m, although usually less (WDR).

Subsequent soil erosion may reduce the distance of the cap from the soil surface, or eventually expose it. Future flooding may present a risk (e.g. Figure 9, p. 54), or the soil overtop may subside to form a depression which collects runoff that percolates down along the exterior of the casing. The EAP makes no mention of mounding wells to direct surface water away.

3. Casings of already drilled wells are in some instances at ground level or protrude above the ground (WDR).

Therefore, will the above stipulated abandonment protocol be followed in all subsequent cases henceforth when thus far a spectrum of well sealing strategies has been applied? If the latter multiplicity of methods will continue to occur, the plan needs to be revised, and criteria for choosing which method shall be applied in each instance be clearly laid out.

4. As queried above, the types of bentonite grouts and cements are not specified, i.e. will they contain synthetic polymer or other admixtures?

- The above Progressive Well Abandonment Plan in EAP2 conflicts with the protocol given in the Hydrogeology and Geochemistry Assessment Report (AppA1, p. 20) which explicitly states as the last step in the well decommissioning process: "Remove casing and progressively rehabilitate well clusters and other temporarily disturbed areas". Thus according to this version of events, casing will not remain.

  The peer reviewer, who is also a well driller, remarks: "The details on the grouting are difficult to understand." (AppB, #FRIESEN-7).

  The response to this conundrum is given in RPCR (#167), a sort of 'hybrid':
  "The decommissioning protocol is not contradictory. The well casings will be cemented in place for the duration of the extraction activities. Upon well sealing ("abandonment") the upper section of the **casing above the grouted section will be removed for re-use in other wells**. This reduces the amount of casing left in the ground."(Emphasis is mine).

  This again seems to describe a "cut-and-cap" approach. A significant portion of the casing will remain, including the section that pierces the aquitard. However not all of the wells in WDR were decommissioned this way. How long will "the upper section of the casing above the grouted section" be? Step 3 above indicates "grout to 5 feet (1.5 m) within surface." Will 1.5 m be removed – if so, how will such a short section be reused "in other wells"? Perhaps assembled into a *fatras* of random bits and pieces?

- The issue of proposed re-use of the casing must be further clarified. According to Section 18 of The Groundwater and Water Well Act (C.C.S.M. c.Gg110) Well Standards Regulation, "a person constructing a well must ensure that the well casing, including any well liners, meets the following requirements: (a) **be made of previously-unused material**…"(Emphasis is mine).

  " In accordance with the borehole license conditions, wells are permitted to be left **unsealed for up to one year** after they are drilled. Some wells (which are located in private land) have been intentionally left unsealed to allow for monitoring, and continue to be unsealed to accommodate ongoing testing." (RPCR #222) (Emphasis is mine).

According to Section 24 of the Well Standards Regulation, "Clauses 18(a) [i.e. prohibiting re-use of materials]…do not apply to a test well or a dewatering well **if the well is abandoned and sealed not later than 180 days**, or such further time as the director may allow, after its installation." (Emphasis is mine).

According to this, re-used casing can be used in another well if the well remains open for less than 180 days, or longer with special permission.

The following observations arise:

1. The proponent has apparently been granted an exclusion from the normal time limit for sealing: instead of 180 days, it is one year, or even more for monitoring wells.
2. How many times will the same casing be re-used in different wells?
3. How many of the proposed wells yet to come will have the same long time limit exclusion?
4. How frequently are these wells checked to ensure they are secure?

It should be kept in mind that re-use of casing: a) may cross-contaminate other wells, and b) it may be damaged in the course of handling, removal, transport, assembly, and reinstallation.

- Thousands of decommissioned and capped well casings will remain **permanently** after the 24-year life of the project has expired. Each well cluster of 5 or 7 or other number of wells (see p. 59) will be 50–60 m in diameter, and the clusters will be 60 m apart (EAP1, Figure 2-3). Some larger land parcels will have several of these clusters (see EAP1, Figures 1-2, 2-3), while small properties may have a substantial part of their parcel affected.

- Carelessness or haste may result in incomplete sealing. "Annular seals are not always perfect and leakage along the well can occur." (Ramos and Camus, 2017). Therefore "failure to seal the annular space around the well casing exterior, risks contamination of conventional drilled wells as surface and ground water leak down into the aquifer around the casing." (IAP, 2021). This enables "groundwater contamination from downward leakage along the side of the borehole as well as inter-aquifer flow" (Abesser, 2007).

Over time, the seals around and within the casing may deteriorate, or seals may be inadequate from the start, depending on the materials used. "Since well construction

materials are prone to degradation with age and upon exposure to downhole fluids, pressures and temperature variations, the number of well integrity problems tends to increase as the wells age." (Ramos and Camus, 2017). Thus probability of failure increases over time.

However the integrity of casings and seals may be compromised at any time, and provide direct routes for contamination. Casings can be affected by "pressure from stones or other objects outside the casing, splits at a welded or defective casing seam" or construction activities; steel casings can be corroded by oxygen (IAP, 2021).

- There is much overlap and gradation within the cement/grout terminology spectrum, and both of these materials are cement based. According to NJDEP (2021), "Bentonite grout offers low permeability. However, the colloidal suspension or gel can be washed away by groundwater in highly porous soils and fractured rock formations. In the unsaturated zone, it shrinks significantly, creating cracks and allowing groundwater to flow through. The solids in dilute bentonite grout can settle, resulting in an open upper bore hole and annulus." The latter source concludes: "bentonite grouts should not be used in porous formations", and cement grout slurry is more stable. Yet further again, "The State of California has issued a notice of exclusion on the use of bentonite slurries as a sealing material for annular seals for the construction and the decommissioning of wells…. Only high solids bentonite grout and non-slurry bentonite are recommended. The State of California also reported that bentonite may not perform adequately in unsaturated zones." In Manitoba, it seems to the present writer that the zone of frost penetration also ought to be considered.

  According to the proponent, "Cementing is preferred over grouting as grouting can migrate over time. A cement with a 5% bentonite additive allows the cement to be more flexible in the event of any movement or fracture existence/ development." (SSCRIR2 #MBEN-IR-029). In a comparison study by Edil et al. (1992), cement and bentonite-cement mixtures showed good durability and low permeability, although they allowed "some infiltration at the seal-casing interface".

- The Mines and Minerals Act (C.C.S.M. c. M162), Drilling Regulation, 1992, Clause 7(a) stipulates "sulphate resistant (CSA Type 50) grout". This is a complex Portland cement mixture (now designated HSb) (http://ecosmartconcrete.com/docs/prdaycsa04.pdf). According to the latter source, over time this type of material undergoes deterioration; this would be expected particularly in unsaturated and frost zones in the upper reaches of the installation. While Type 50 cement is relatively more resistant to sulphate and sulphuric acid (for example from pyrite oxidation, p. 274+), the environmental presence of chloride and nitrate salts of ammonium, magnesium, iron and aluminum is destructive

to cement over time (PCA, 2002). Damage can also occur when silica reacts with cement alkali to form water-absorbent gels which can swell and crack the cement (PCA, 2002).

Cement seal failures are not uncommon: according to Ramos and Camus (2017), "the loss of proper zonal isolation has been observed in numerous wells, even in those where the cement was properly placed providing an initially good hydraulic seal". A variety of destructive mechanisms, such as radial fractures and increasing porosity of the deteriorating cement around the casing, as well as formation of seepage flow channels between the cement and the casing and/or the surrounding soil, can lead to aquifer contamination (Figure 62). Another factor is that "cement heats up significantly when it cures and so cement grout is not recommended for plastic or PVC well casing" (https://agwt.org/content/sealing-well-casing).

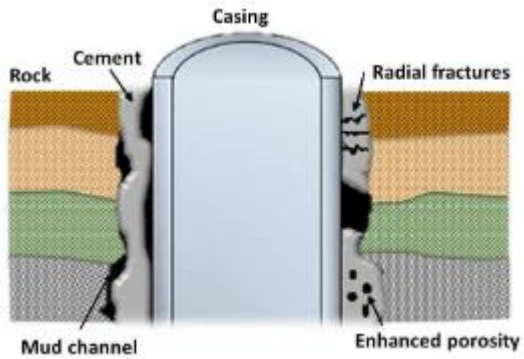


Figure 62. Schematic diagram of cement seal failure surrounding well casing. Source: Ramos and Camus (2017).

A thesis by Haney (2015) concluded that cement with bentonite additives "may not be the most appropriate method for completing monitor wells, because of fractures that form during curing of the grouts", and "it is clear that the common practice of completing monitor wells with cement-bentonite grouts in most geologic conditions is inappropriate."

In the present situation, the casing will be very long and will span both aquifers through the vulnerable reactive shale. Amongst the thousands of wells, it is a certainty that some of them will become sources of interconnection and contamination.

- **Well sealing materials may contaminate groundwater.** According to Remenda and van der Kamp (1997), "materials used to seal monitoring wells in aquitards can have a significant and long-lasting impact on the chemistry of the water in the wells." These workers found that solute contamination from sand-bentonite seals contributed measurable levels of contaminants for at least several years.

According to Smith et al. (2014), "results show that cured cements in monitoring or water wells can contaminate groundwater samples with glycols and phenol." If used, grouts and cements containing polyacrylamide may also leach acrylamide (see section on Polyacrylamide).

- **Over time, casing materials may themselves contribute contaminants to the aquifer**. The present concern is that the **thousands of implanted casings left behind,** aggravated by the larger surface area of the pipe, will contribute **undesirable toxic substances to the aquifer as the materials age.**

  Steel casings have been shown to leach various metals, including cadmium, chromium, copper, iron, manganese and zinc (Hunkin et al., 1984 and Houghton and Berger (1984), both *in* Llopis, 1991; Hewitt, 1989). Even stainless steel is susceptible and may release iron, chromium and nickel (Llopis, 1991). Leaching is especially notable in the regions of cuts and welds in the casing (Hewitt, 1989). The issue is further amplified by the **proposed re-use of casing**: the additional cuts and scratches will exacerbate leaching (Llopis, 1991). According to Hewitt (1989), "any abrasions would readily act as oxidation sites", promoting active sites for sorption and release of "impurities and major constituents".

  Similarly, according to Llopis (1991), **plastic casings such as polyvinyl chloride (PVC), may leach compounds** such as vinyl chloride monomer, thermal stabilizers (e.g. toxic organic compounds of tin, zinc or antimony), lubricants, fungicides, fillers and pigments, as well as other numerous organic contaminants. Hewitt (1989) also reported PVC casing as a source of cadmium; lead can also occur as an additive (https://www.astralpipes.com/blog/know-the-major-differences-between-cpvc-pipes-and-pvc-pipes-27). Dimethyltin, an organometallic thermal stabilizer in PVC, may be released as the casing degrades (Boettner et al. (1981) *in* Llopis, 1991): this chemical is neurotoxic and bioaccumulates in the body (https://pubmed.ncbi.nlm.nih.gov/23478947/). See Parker (1992) for a review of the leaching potentials of metals and organic species for various materials used in well casings.

  Apparently PVC is intended in the present applications (SUPPL1, p. 3), and it also seems to have been popular in WDR. How stable will PVC be after many years? Industry ball-park estimates for underground installations are: "PVC pipes last approximately 100 years" (https://www.pvcfittingsonline.com/resource-center/how-long-pvc-lasts/). However its longevity varies depending "on the quality of raw materials and the percentage of fillers used in the pipes" (https://www.astralpipes.com/blog/know-the-major-differences-between-cpvc-pipes-and-pvc-pipes-27), and durability may be reduced by "debris, soil movement, and freezing temperatures", but that "it's often soil movement that can cause it to fail.", so "it's essential that the soil is as rock- and debris-free as possible" (https://www.pvcfittingsonline.com/resource-center/how-long-pvc-lasts/).

This brings us to the question of how future activities overtop the abandoned casings (including levelling) may generate soil vibration, shifting, or compaction. But the overriding question is: what happens after the most-optimistic estimate of 100 years? What do our successors do then? Well, it's not our problem. Maybe the company will be around to help.

An additional and credible concern is the breakage and splintering of PVC casing and pipes during manipulation and operation; allegedly this has already occurred (https://www.winnipegfreepress.com/the-carillon/local/Former-CanWhite-employee-alleges--well-contamination-lax-site-safety-575758671.html?fbclid=IwAR0_3_MXoo3we8hCYt2g_tHrzXI2tG_tI1rxWPOsKX8guTaHCFAm4jsE7uM).

- Abandoned well sites on agricultural cropland and hay fields will present another series of permanent problems, as agricultural chemicals and manure can travel along the exterior of the casings to the groundwaters below. If the bentonite plug at the top is near the surface, it may be dislodged by farm machinery or earth moving equipment. Further, the PVC casings will eventually expire.

- Where abandoned casings protrude above the ground, they are vulnerable to damage from recreational vehicles, farm machinery, vandalism, and sundry mishap.

- The question arises regarding future land use for decommissioned areas **in perpetuity.** The cut-and-cap procedure (RPCR #167)(see p. 241) will obviously present a risk for potential future excavation and construction activities such as digging foundations, septic/ejection fields, landscaping, ponds, dugouts, etc., which may cause casing damage/destruction and disturb the soil around the casing. **How will the locations of the concealed casings be permanently marked?** Perhaps not at all?

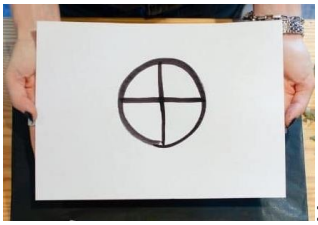
  Note: Standard orange marker spray paint (Figure 63) is toxic (www.P65Warnings.ca.gov), known to contain chemicals that cause cancer or reproductive harm, for example mercury. This material should not be leaching into a well.

Figure 63. 'Marked' purported sand well site in a Springfield gravel quarry (14 May 2021). Note the extremely porous overburden. Source: https://ourlineinthesandmanitoba.ca/about/

[Interesting Note: Before we jump prematurely to outrage and condemnation, this well may actually be more protected than we think. The spray painted symbol on the piece of rubbish used as a marker is actually a powerful ancient symbol of protection (i.e. the **Solar Cross**), sacred in European and Indigenous mysticism, as well as in witchcraft or Wicca (see picture below). (Also note however that this symbol is banned in Germany in political context as a racist symbol.) (https://wiccanow.com/9-protection-symbols/).

Furthermore, for an added layer of protection, the **magic sticks** seen in Figure 63 are arranged around the talisman in a **sigil** signifying 'Protection from Evil'

(e.g. https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.quora.com%2FAre-there-protection-runes-to-wardoffghosts&psig=AOvVaw0AKa_fbHJk7zACx7T1B3D9&ust=1647451110890000&source=images&cd=vfe&ved=0CAgQjRxqFwoTCNDVveTPyPYCFQAAAAAdAAAAABAM).
Therefore at least the well has some protection, as long as the talisman remains and until the spray paint fades in two years, unless it is covered sooner.]

 : https://wiccanow.com/9-protection-symbols/

In another example, the Well Information Report for Well PID 205588 (file:///C:/Users/Owner/Downloads/Well%20Information%20ReportsQuarriesNearVivian.pdf) contains the following driller's sealing remarks: "**A steel plate was placed on top of the well after sealing just bgs** [below ground surface] **as this was on undisturbed land in a gravel quarry, should this area be disturbed in the future this will mark location of well.**"

Really? Nobody will move it or carry it off for scrap? Future generations will know exactly what it is? It will never get buried under a pile of dirt or get obscured by weeds? Secure and vandal-proof? A permanent warning? The guy operating the giant bulldozer will notice it right away?

But, to be fair, we must emphasize here that **we cannot fault the driller**: it is not the driller's fault that he worked for such cavalier taskmasters, or that he had a conscience, carried out his designated duties in exemplary fashion, and worried about the future risk the well will pose and his powerlessness to do much about it, or that there was no provincial oversight or direction of any kind, or that such a situation was permitted to arise in the first place. The buck stops at the top, where it gets swallowed, and nobody sees it again.

Might this not be better? Just a suggestion……

I devised this myself as it does not seem to be commercially available.

- Permanently marking the locations of the wells is imperative, but it raises another issue. The world we now live in is precarious, and fraught with iniquity and menace. All it takes is one act of vandalism, subversion, stupidity, or negligence at any future time to ruin the water supply for thousands of people. This is something to consider, not think that it can't happen here.

  The proponent refers to "sabotage and tampering by others as has been seen on other wells. Sio notes that these wells are located on private property and the property should not be entered without Sio Silica's explicit permission." (SSCRIR1 #DLN-IR-009).

  1. Could we please have more information on the "other wells" that sustained tampering? What sort of tampering occurred? Where? How many wells were involved? How was it/could it be rectified? Were water samples collected to check for contamination? Were the police or provincial authorities notified? What preventative measures have been implemented subsequently? What precautionary monitoring of adjacent domestic wells was carried out?

  2. The private property should be entered only with the company's permission: was this the company's own private property? If not, can the company prevent entry onto somebody else's private land? After decommissioning, what are the provisions for subsequent security of the wells? Will this be entirely the responsibility of the landowner in perpetuity? (Yes).

  3. There have been relatively few wells thus far, in comparison with the many thousands that are planned. If there has been "sabotage and tampering" already, what can we expect later in the project? How dare our water be exposed to threat and harm's way, without adequate safety precautions in place? This is dereliction, both on the part of those who enabled this vulnerability in the first place, and those who did nothing to oversee and protect it on our behalf.

- According to EAP2 (section 7.2), "At the Project end of life, the Project Site will be returned to a natural state to the extent possible, **with no known plans for residential, commercial or industrial development on the site at this time.**" (Emphasis is mine). This is an odd statement because: what are the legal implications if there *are* such 'known' plans (e.g. the parcel is zoned for development)?
  Or does this statement mean that it is acknowledged that there shall be no plans for development? In any case, the problem descends onto the Municipality.

Municipal development plans and zoning must therefore reflect and accommodate the locations of these sites. This is especially important if the land is sold, and even more so if the land is later subdivided into smaller parcels where development might occur.

- However the proponent does not view future development as a significant issue: "The mining plan specifically focuses extraction activities on previously disturbed land such as gravel quarries or areas allocated by landowners on private land. It is **unlikely** that municipal developments would occur in these locations."(SSCRIR1, #CEC-IR-002). (Emphasis is mine). Unlikely, because the land will be ugly, but not ruled out.

- "Levelling and grading will occur upon Project decommissioning to return the landscape to elevations typical to the surrounding area" (EAP1, p. v).

  Within what time frame will this occur? In a September 1, 2020 letter to the IAAC by a top CanWhite official, upon abandonment, "the surface is immediately remediated. As the harvest sites are temporary and portable, the site returns to its natural state within weeks of CWS harvest completion." (https://www.ernstversusencana.ca/vivian-silica-sands-extraction-wells-manitoba/). It is not clear how sites are "portable".

  A concern with this step is that heavy earth moving equipment will be rehashing the soil that is covering and surrounding the wells, and damage to casings and seals may occur. The "natural state" return is examined in the Revegetation section (pp. 457+).

- The EAP1 (p. x) states: "Use of the land for other purposes will not be available in the locations of annual Project activities. However, due to the progressive annual reclamation of extraction sites and other Project-related disturbed areas, parcels of land used for Project activities during any given year of Project operation will be available for other uses the following year or once the activities are complete." Whatever uses these might be, they will be limited henceforth by the abandoned wells and by the risks of subsidence. The well locations must be recorded, perhaps permanently marked on the land titles. Recording must be prompt and timely, not entrusted to unreliable memory later, after they have been hidden. PVC casings will not be located with metal detectors.

- Will bentonite spills be cleaned up? Bentonite dust poses an inhalation hazard (see section on Dust pp. 401-402).

- Will all utilized areas be properly cleaned up, including removal of all litter on the ground as well as in the surrounding area, such as we too often see left behind at water well drilling sites and construction sites once the workers have left: discarded coffee cups, cigarette butts and packaging, plastic water bottles, beer cans, plastic packaging and gloves, styrofoam containers, straws, foil, plastic pails, wire, broken glass, metal

parts….(e.g. Figure 64 A and B)? Or will it be surreptitiously incorporated into the levelling and grading? Sharp metal scrap may injure children, horses, cattle. Wildlife may succumb from ingesting plastic and aluminum food wrappings, and the majority of trash may not biodegrade. Small metal pieces may be ingested as grit by birds, with lethal consequences (personal observation). Gimcracks such as seen in Figure 64 A at an abandoned sand well in Springfield can pose a tripping hazard or create an expensive jam for farm machinery. Access trails as well may be peppered with refuse thrown out of workers' vehicles in passing. People's properties deserve some respect.

Relevant legislation:

Manitoba Workplace Safety and Health Act (C.C.S.M. c. W210) Operation of Mines Regulation, Section 4.10(2).

The Groundwater and Water Well Act (C.C.S.M. c.Gg110) Well Standards Regulation, Section 41.

Figure 64 A. Discarded gimcrack left behind in the exposed silica sand at an abandoned test well in Springfield.
Source:https://ourlineinthesandmanitoba.ca/?fbclid=IwAR2DUPHPfOu6vP7oqEmVI_hFJjJb9INrmYe2GyEfi_bBJBm7uXRwOCsdo68

Photo: E.Pip

Figure 64 B. Abandoned debris emerging under melting snow at new water well site (Brokenhead Municipality). A very wide selection, including a rubber boot (left center), useful for a monopodial ipsilateral shopper.

According to Section 4.3.7, R 329 of the Canadian federal Environmental Code of Practice for Metal Mines (2009), "Measures should be put in place to ensure that all food wastes and food containers are properly disposed of, including those used away from kitchen and dining facilities. Training programs should be put in place to ensure that all employees and on-site contractors are aware of the importance of proper disposal of food wastes and the importance of not feeding wildlife on site." Further, "Food and food wastes can attract animals to mine sites. This puts the animals at risk and, depending on the type of animals attracted, may also put staff at risk. Animals that are attracted to sites and become a risk to humans may have to be relocated or destroyed".

After the noise has abated, bears and various scavengers may be attracted to the area. Some food waste, for example coffee, chocolate, grapes, or onions, may be toxic (even lethal) to wild animals and pets.

The EAP makes no mention that the proponents are responsible for the actions and behavior of their contractors.

- "In accordance with the Manitoba Mine Closure Regulation 67/99, the Closure Plan will include a detailed schedule of costs for proper closure and rehabilitation activities, including costs for programs to monitor and manage the site after closure, **if required**." (RPCR #242)(Emphasis is mine).

  - Once again we smack up against the weaselly "if required". Therefore sites will be monitored only if required? What criteria will be necessary for this to occur? Because there is already trouble? Who will determine this? Who will execute it? Who will ever enforce it?

  - How many years would this monitoring, 'if required', last? What would be monitored?

  - **Disturbance to the landowner will continue.** Will the landowner be required to maintain access to the sites, including clearing trails for vehicles?

  - If the monitoring shows that things are not going well, for example contamination has occurred, so what? How can it be reversed? Or anything done about it at all?

  - There will be no inspection program to monitor the abandoned wells for the vast lifetime of their existence. As the proponents have indicated in their ad (The Clipper, February 24, 2022, p.5), this project is "multi-generational". It is also cumulative as more and more of these assaults are imposed.

  - As for the 'if-required' monitoring and managing costs after closure, how will the cost schedule be adjusted for future monetary inflation? What good will these cost reassurances be if the company no longer exists? Will an environmental surety be required at the time of approval?

  "CanWhite will be responsible for addressing environmental issues related to Project activities, if they occur, in accordance with applicable legislation and as outlined in follow-up Plans for the Project" (RPCR #243). Since there are no follow-up plans, who can say whether these plans will be sufficient or even reasonable? And even if they will be, who will enforce them in the real world?

- A subsidence risk must also be considered (see discussion above).

- The issue of property values inescapably arises. How will these permanent installations affect desirability and future potential usage, and ability to sell the property? The seller will need to disclose the defect to potential buyers. She likely will be unable to sell the property at all during the clearing, occupation, and decommissioning phases, and marketability will be problematic afterwards while there is visible damage, or the land title is marred. The property will be *sur la liste douteuse,* but records are essential. Will the municipality offer tax reductions to impacted landowners? Will the province offer assistance where additional rehabilitation work must be done (i.e. unforeseen damage not covered in the landowner agreements, need for proper cleanup, filling in ditches, or planting trees), and the company does not wish to do it? How enforceable will landowner agreements be? These are all rhetorical questions…..

Oxygen in groundwater

Dissolved oxygen, temperature and pressure

- Groundwater is typically devoid of oxygen. This condition is particularly evident in the Sandstone stratum and shale aquitard, and has remained that way for a long time: "The Winnipeg Shale is extensively weathered to clay and shows a strong blue color in the bottom half of its thickness at some locations suggesting limited access to oxygen." (AppA1, p. 62). We also see the blue-green color of reduced iron associated with anoxic conditions in the core log photos of the shale in AppA5 (C.3); also see Figure 24 (p. 119).

- Solubility of oxygen in water varies inversely with temperature (Figure 65). The literature reports a groundwater temperature of 4.7 ^{o}C. in the Carbonate aquifer at Dugald. More broadly in southeastern Manitoba, "the highest temperatures observed in the upper few metres of the Carbonate Rock Aquifer are less than 6.5 ^{o}C." (Ferguson, 2004). Shallow groundwater temperature maps estimate temperatures as low as 2-3 ^{o}C. for southeastern Manitoba (https://enoscientific.com/groundwater-temp-map/), but local temperatures vary. Almost no data are available for the deeper Winnipeg Formation, with the few (i.e. four) sampling records reported at <8 ^{o}C**.** (Ferguson, 2004).

  Temperature data provided by the proponent in Table 4-8 (AppA4) show a range of 2 – 6.5 ^{o}C. in Carbonate and Sandstone, and are therefore largely in agreement with above reported values. A strikingly anomalous value of 10.1 ^{o}C. appears in Winnipeg Shale for "We l 6612" [sic]; we postulate that this may have been a warmed up delayed reading of a sample acclimating at the surface. We have no information regarding the protocols that were followed in taking measurements, nor of how promptly this was done.

It is not clear from the methodology in AppA1 (p. 46) exactly how field measurements were obtained, other than the instrument used (i.e. a YSI model). Testing was reportedly conducted during well development. Were readings taken *in situ* with downhole sensors, or were water samples collected and tested at the surface (if so, how were they collected and handled?) Was there any lag time between collection and testing, as this would affect results: we note the variation between well pre-test and post-test samples, how is this explained? We note that some of the temperature values appear to be corrupted (i.e. .7 and .8 with no digit preceding the decimal point). Were these intended as 0.7 and 0.8, or is some other number missing? Perhaps they were 7.0 and 8.0? We see the same defect for some other parameters in Table 4-8. This is sloppy and unprofessional. Why were these oversights not corrected? "Proprietary" maybe?

Groundwater is cool year round in southeastern Manitoba, with little seasonal variation. This is important, as **oxygen readily dissolves in groundwater on exposure to air, especially at cool temperatures, where it can achieve relatively high saturation concentrations.**

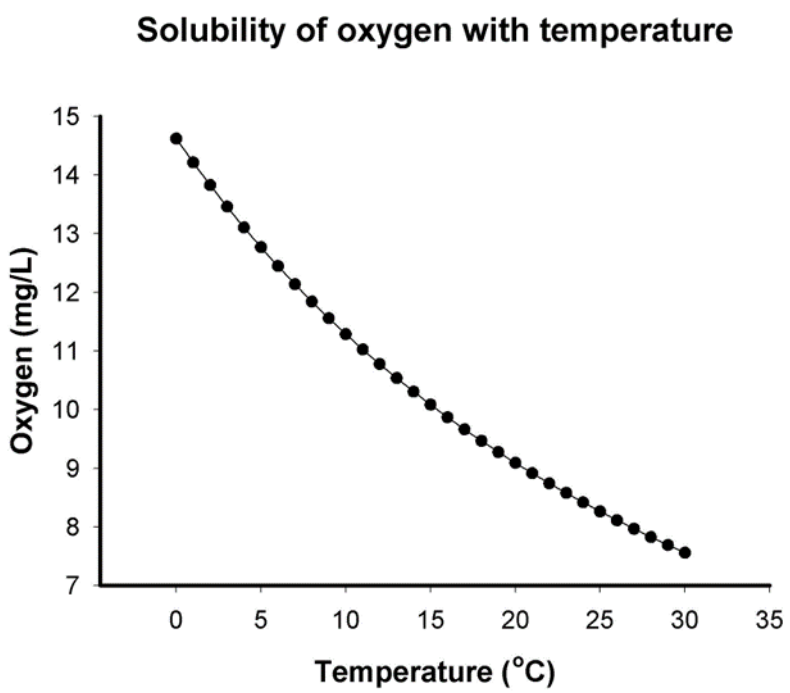


Figure 65. Oxygen solubility in water as a function of temperature at standard atmospheric pressure of 760 mm mercury (1 atm) and zero dissolved solids. Colder water holds substantially more oxygen. Source: https://www.esf.edu/efb/schulz/Limnology/Oxygen.html

However the proponent claims that "The solubility of oxygen in water is very low." (SSCRIR2 #DLN-IR-011). If this were so, fish and aquatic organisms would be out of luck. (See Figure 75, p. 283).

- The previous query regarding exactly how samples were collected and tested especially applies to the erratic dissolved oxygen values shown in Table 4-8 (AppA4). Again, some of the data are corrupted: digits are missing, or are clearly wrong (e.g. % value for BRU 95-9). Some post-test concentrations increased compared to pre-test, others were the reverse. The data are troubling, and appear to show that oxygen exposure has already occurred: some samples even show elevated values that are more characteristic of surface lacustrine waters, and include not only Carbonate, but also Sandstone and *Winnipeg Shale* (Well 6612)**!** How is this possible? More troubling, *were these data used in the modelling*?

  Note: As somebody who is excessively familiar with the evolution of YSI instrumentation over more than 50 years, I can say that the instruments ALWAYS need to be carefully calibrated beforehand, never used 'as is' out of the box. In the field, zero baseline calibration is also ALWAYS checked first, using either a reference standard (e.g. sodium sulphite/cobalt chloride solution), or air, adjusted for **the relevant water temperature**. The most accurate measurements are made *in situ*, which would be downhole in this case. For proper protocols, see
  http://monitoringprotocols.pbworks.com/w/file/fetch/50395531/ASTM%20D888.pdf
  Similar calibrations and field checks must be carried out for the other field parameters listed in AppA1, p. 46 (except temperature). Were calibrations/baseline checks done each time during field data collection?

- Oxygen solubility in water increases with pressure (Fig. 66):

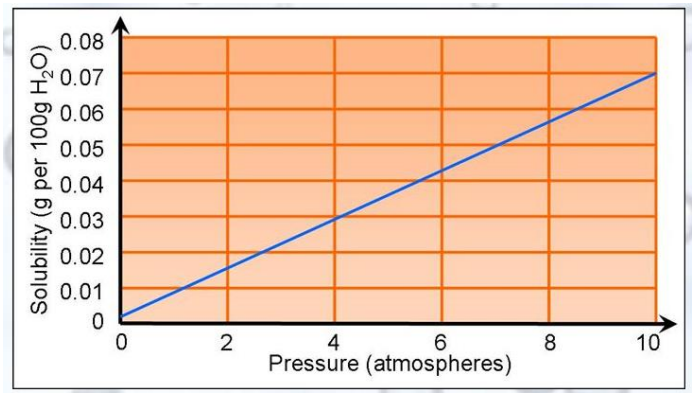


Figure 66. Oxygen solubility increase as a function of pressure at constant standard temperature. Source: https://images.slideplayer.com/15/4628163/slides/slide_2.jpg

The Sandstone aquifer is confined and hydraulic pressure is manifested as head; in some areas (see p. 112+) it is high enough to result in flowing wells. In static well conditions, oxygen solubility may be influenced by hydrostatic pressure in the borehole, which in turn is dependent on water depth and density. According to Ferguson et al. (2006), "In the Winnipeg Formation, groundwater density varies spatially, primarily due to

variations in the total dissolved solids (TDS) content of the water." Suspended solids (turbidity) also influence density.

It should be noted here that water is also significantly denser at cold temperatures, such as those in aquifers, achieving maximum density at ~4^0 C. (i.e. for distilled water)(Figure 67):

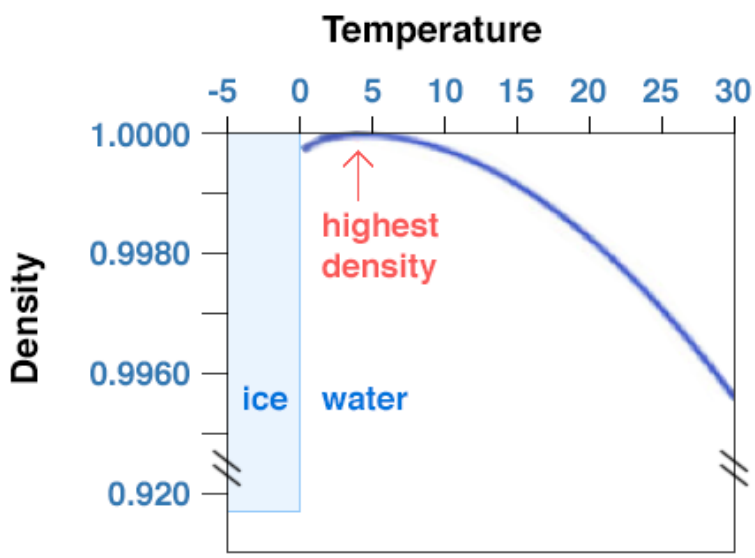


Figure 67. Density of distilled water in relation to temperature. Greatest density is attained at 3.98°C. Source: https://www.e-education.psu.edu/earth111/node/842

The proposed project will not only introduce oxygen absorbed at the surface via the reinjection water, but direct introduction of pressurized air from the "pressure bursts" described in CPA, as well as potential leakage of compressed air from the air lift apparatus, may result in higher dissolved oxygen concentrations in the vicinity of the wells. This would:

- have implications for redox and other oxygen-dependent factors in the aquifer
-underestimate dissolved oxygen monitoring that is not measured *in situ*
-affect displacement of natural dissolved gases (see p. 404+).

Did the modelling simulations include the effects of pressure in the Sandstone aquifer?

- Dissolved oxygen is inversely correlated with salinity (Figure 68):

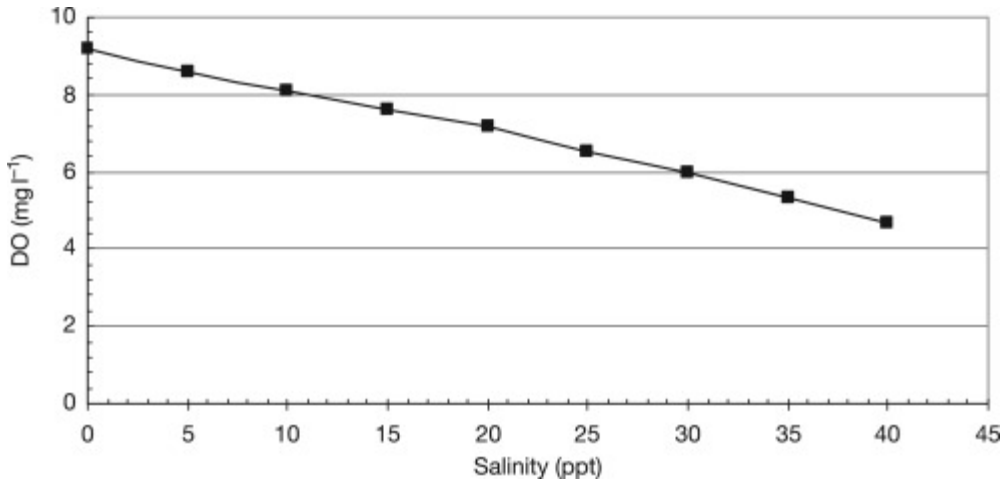


Figure 68. Decline of dissolved oxygen concentrations as salinity increases. Source: https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.sciencedirect.com%2Ftopics%2Fchemical-engineering%2Fdissolved-oxygen&psig=AOvVaw27WpcVASs8TkmOc-bl__vQ&ust=1670178326955000&source=images&cd=vfe&ved=0CA0QjRxqFwoTCOD91KuJ3vsCFQAAAAAdAAAAABAI

Saline waters in the Sandstone occur to the west and north of the current project area (see Figure 4, p. 37). In the current project area, the freshness of the water will allow it to absorb and hold comparatively more oxygen.

Oxygen introduction

- According to the EAP, as well as RPCR (#12), oxygen and other atmospheric gases will enter the Sandstone aquifer primarily as dissolved gases via the reinjected water that has been exposed to compressed air during the air lift process, and during processing at the surface, including screening and centrifuging, where the turbulent water will be thoroughly aerated, and then, according to RPCR (#52), "exposure to air in storage tanks during the extraction process." SUPPL4 introduces a further plethora of air exposures through turbidity treatments, disinfection, and return water processing from the sludge drying fields (if used), or maybe a filter press. Thus, from these sources alone, **oxygen saturation** of the reintroduced water is *certain*.

  However the proponent claims that "Water returned to the wellbore may be **slightly** oxygenated, however the quantity of oxygen would be **very low** and finite and will dissipate over time." (SSCRIR2 #MSSAC-IR-016e)(Emphases are mine). An interesting assertion, especially given that actual oxygen concentrations were not measured. How would the water possibly be only "slightly oxygenated", unless it was heated to a high temperature?

- Concerning direct introduction of gaseous oxygen into the aquifer, the EAP does not indicate whether any additional leakage of air will occur from the particular air lift process in this project: Figure 2-2 in the EAP is labelled "Example Only" and further information is undisclosed. A number of wells previously drilled have been air lifted already (WDR), but details of the equipment and procedures used are not revealed in the EAP.

  Since air will be injected under pressure in the air lift apparatus, into water that is under hydrostatic pressure, the release of pressure when the water is brought to the surface will result in *eau pétillante* due to supersaturation combined with escape of excess free air bubbles. This *bouillonnement* will agitate and suspend existing particles, and create optimum oxidizing conditions which will generate additional particles from iron and manganese precipitate. However the gaseous composition will not be identical to that of the injected air, as it may also contain displaced radon and hydrogen sulphide (see p. 404+), and differential concentrations of dissolved exhaust gases from the compressor (p. 284).

  The air lift apparatus patent application (CPA; also Appendix A in SUPPL1) indicates that air may also be directly injected under pressure into the aquifer: "the gas injection line… may also be lowered beyond the lower end of the conduit and **into the sandstone formation** … to generate a pressure vibration or **inject a pulse of air** to agitate the sand from time to time." (Highlights are mine). Thus **pressurized air may be injected directly into the aquifer**. (Emphasis is mine).

  This, combined with the ability to angle and maneuver the apparatus horizontally underground (CPA), could result in **trapped air against the shale ceiling of the irregular cavity** (see Figure 53B, p. 193). These air pockets and reservoirs could greatly exacerbate the adverse effects associated with oxygen, some of which are discussed below.
  The proponent claims that "any air that escapes the production pipe will tend to be report to the well and be removed during extraction." (SSCRIR2 #MSSAC-IR-016(e)). This would be true if the ceiling is smooth and its highest point is at the borehole.

  Regarding the pressurized air pulses described in CPA, the proponent states that "This is a point of the process in the patent that is broadened to protect process infringement, but not a part of Sio's proposed production in the licence application before the CEC." (SSCRIR2 #DLN-IR-009). It is unlikely that this procedure would have been presented in the CPA simply on the basis of imagination and without actual prior testing, therefore it can be inferred that this process already occurred at some of the permitted extraction wells. How was this allowed? Furthermore, there are many things that are not in the current proposed licence application: we note that the proponent does not categorically deny that this process will be used.

- "In the event that a trace amount of air escapes from the production pipe to the sandstone aquifer, the majority of the trace amount of air will move in the direction of groundwater flow and eventually escape to the atmosphere." (SSCRIR1 #MSSAC-IR-016e)). Air absorbed at the surface, combined with air from the pressurized direct bursts (CPA) or apparatus leaks may enter flows and plumes within the aquifer that will carry the **introduced oxygen to areas beyond the sand extraction sites**. This is important because **oxygen in groundwater promotes chemical oxidation reactions, and enables survival and growth of organisms which otherwise would be absent.**

- According to AppA1 (p. 53), "pe values in *existing groundwater samples* were calculated based on field measurements of ORP and ranged from 2.44 to 3.2. **Under future operating conditions**, simulated pe values were greater than 13, indicating **oxidizing conditions in groundwater**."; "Pe" is parameter used to measure redox potential. Higher pe values usually indicate oxidizing conditions and lower pe values are indicative of reducing conditions." (Emphases are mine).

  Thus this modelling indicates that return of oxygenated water to the aquifer will increase oxidizing conditions therein. **Note that the model does not include additional direct injection of air**, and therefore does not completely reflect expected operating parameters.

  This has implications for **changes in water chemistry beyond those predicted in the model.** Even so, **"**Oxygenation of groundwater during sand extraction and groundwater reinjection was simulated to result in groundwater that is more alkaline and oxidizing " (AppA1, p. 54).

  The above quote (AppA1, p. 53) clearly states the ORP "field measurements" were made, in which case we would query whether the ORP field data were reliable, given the problems noted above with other field measurements.

- However, the proponent admits that "ORP and DO **were not measured** on *filtrate* following sand extraction activities. However, **reasonable assumptions** were made for the purposes of geochemical modelling and the results suggest negligible to slightly positive impacts on water quality. **Measured data collected during operations can be used to inform future assessments**." (TAC #42). (Emphases are mine).

  "The groundwater returned to the aquifer after treatment will contain **only a very small volume of dissolved oxygen** introduced from the compressed air and/or exposure to air in storage tanks during the extraction process" (RPCR #26)(Emphasis is mine).

  The proponent claims that "only a very small volume of dissolved oxygen" will be present in the water after manipulation, yet **actual measurements to substantiate this**

claim were not made. Instead of actual facts, that are not that hard to obtain, why were "reasonable assumptions", i.e. guesses, made instead? What are "reasonable assumptions"? Were these assumptions the 'saturation' at the temperature of the water, which is what would be the case? Obviously not, since it was "only a very small volume". In any case, the proponent has forgotten about the violent agitation of the water in the cyclones and vibrating screens, etc., and the turbidity treatment/disinfection/sludge drying train OR filter press (SUPPL4). It could not possibly have been "only a very small volume". We submit that the modelling is unrealistic and invalid. Further:

- *Of course* the results would suggest 'negligible' impacts if amounts of oxygen were curtailed/assigned to "only a very small volume", instead of the real values. This is a slanted, predetermined outcome. The "slightly positive effects" are harder to fathom. We could easily do these calculations properly, if only we knew what the temperature and volume of the reinjected water are, but evidently measurements for temperature are lacking as well. These are **fundamental data** which need to guide modelling, and to evaluate potential water quality impacts.

- *Even if*, oxygen volumes happened to be small, if for example the water had been somehow heated to a high temperature to purge the gases, the total amount of oxygen introduced with the return water would still burgeon due to the **enormous volumes of water involved, from multiple wells.**

- "Measured data collected during operations can be used to inform **future** assessments." (Emphasis is mine). Data have yet to be acquired "during operations"? Is that not too late? And "inform future assessments" is an admission that the present assessment is less than stellar. In other words, we will be embarking without any reality-based information. When it does become clear that reality is very different, operations will already be well underway, and it is highly unlikely that they will stop.

Furthermore, the predicted effects on water quality derived from the above modelling are based **only on (unmeasured) dissolved oxygen in water returned to the aquifer**. Additional **potential or planned direct gaseous air introduction** into the aquifer is not considered. The value of a model is only as good as the accuracy of the data that inform it. Very serious and far-reaching decisions depend on it right now, and they are not retroactive.

- Other impacts on gas equilibrium (e.g. radon and hydrogen sulphide) are considered in the Air Quality section (pp. 404+).

Iron and manganese

- In the anoxic conditions of groundwater, iron is present in the divalent, soluble, ferrous form. The water appears clear. On exposure to oxygen, divalent ferrous iron is oxidized to the insoluble trivalent ferric form. The water appears turbid and discolored (Figure 69). Aside from the esthetic and organoleptic concerns, precipitate may form deposits on pipes, plumbing and fixtures, and clog filters. Iron concentrations reported in Table 4-8 (AppA4) are variable, in some cases much in excess of the esthetic Canadian drinking water quality guideline (CWQG, 2009).

Figure 69. Iron-containing well water with (left) and without (right) oxygen exposure. Source: http://www.coakleywater.ie/products/iron-manganese-removal/

- Manganese is also present in Red River Carbonate, Winnipeg Shale and Sandstone (AppA4, Table 4-8; AppA6). In Red River Carbonate and overburden, it may be visibly manifested as dendritic deposits of pyrolusite (manganese dioxide) on water-saturated limestone surfaces and fractures (Figure 70). In the groundwater samples (Table 4-8, AppA4), manganese concentrations reflect the general variability and unpredictability of this element (and other water chemistry variables) in different locations: we note that a number of reported manganese values in this table have been corrupted and were not corrected.

  For some reason, manganese does not appear in the mineral composition analyses in Table 4-2 (AppA4), even though ankerite-dolomite: $Ca(Fe^{2+},Mg,Mn)(CO_3)_2$-$CaMg(CO_3)_2$ is identified in the QUANTITATIVE PHASE ANALYSIS OF SEVEN POWDER SAMPLES USING THE RIETVELD METHOD AND X-RAY POWDER DIFFRACTION DATA report in AppA5. The discrepancy is not explained.

Photo: E. Pip

Figure 70. Dendritic pyrolusite graffiti deposited by groundwater on water-worn Red River Carbonate dornicks in the overburden saturation zone (Springfield). Dr. E. Pip Collection.

- Exposure of groundwater to oxygen can oxidize manganese from the soluble divalent to the insoluble trivalent or tetravalent form, resulting in oxides that "can impart a dark color to the water and may lead to noticeable amounts of discrete particles in delivered water." (Tobiason et al., 2016)(Figure 71). Black deposits may also form in pipes and on fixtures and appliances. Oxidation can occur even at very low manganese threshold concentrations: Li et al. (2019) found that "10 µg/L of soluble Mn could still transform into particulate Mn". Table 4-8 (AppA4) shows groundwater levels that exceed, sometimes substantially, this threshold concentration.

Consumer distress associated with manganese tapwater discoloration can be illustrated by the case of the new City of Winnipeg water treatment plant, whose brown-water woes were due to manganese as a trace contaminant in the ferric chloride product used in the water treatment process (https://legacy.winnipeg.ca/waterandwaste/water/discolouredfaq.stm#13).

Figure 71. Unoxidized (left) and oxidized (right) manganese in well water. Source: https://www.google.com/url?sa=i&url=https%3A%2F%2Ftheberkey.com%2Fblogs%2Fwater-filter%2Fmanganese-removal-from-the-drinking-water&psig=AOvVaw0YIUOdDgfEeJBDVyRNMKg7&ust=1629818062453000&source=images&cd=vfe&ved=0CAcQjRxqFwoTCNDy98i3x_ICFQAAAAAdAAAAABAE

- Despite this well-known and straightforward oxidation process, the simulation in Table 4-11 (AppA4) shows no effect on manganese "in response to changing redox conditions" in any of the carbonate, shale or sandstone groundwater. Yet the saturation indices in the same table, for magnesium-containing minerals (manganite and rhodochrosite – pyrolusite was for some reason not included, even though it is obviously present) show a very definite, expected and significant change in dissolution potential due to conversion from soluble to less soluble forms, and therefore potential for water discoloration. Huh. It is time to revisit the model.

[Helpful Note: The saturation indices in Table 4-11 in the simulation model change from negative (soluble) to positive (insoluble precipitate) for manganite, and also become less negative (more insoluble) for rhodochrosite under oxidizing conditions. Yet in groundwater, the zero change indicates chemical equilibrium. Huh again. How is this difference reconciled? No explanation has been offered.]

[Pernickety Note: Presumably the groundwater parameter values in the Tables in AppA4 are mg/L. Some have 4 decimal places, some have 5, even for the same parameter in different samples in the same table. We interject a reminder regarding the statistical utility of 'significant figures', i.e. one does not report extra decimal places which exceed the analytical confidence level, as they are likely to be meaningless, and we invoke instead the time-honored principle called "rounding-off".]

- The proponent indicates (EAP1, p. vi) that "For some constituents, the impact was simulated to be positive due to reduction of concentrations of iron and manganese when oxygen (air) is introduced into the aquifer or is allowed to mix with water containing lower concentrations of those elements." Also, "the increasingly oxidizing conditions will tend to further reduce iron, manganese and aluminum concentrations" (AppA1, p. 82).

  The above needs clarification – it is technically true only for the **dissolved** forms as they are converted to insoluble compounds. Thus the statements should read: "*dissolved* concentrations…will be reduced". **The iron and manganese are still present**: their valency is altered and **they will now be in visible form** as suspended precipitate particles in the well water, and thus more objectionable. Oxidation will have already occurred before the water is pumped to the surface, whereas in the natural course of events, the water would "turn" following a lag period after being exposed to air, subsequent to being brought to the surface. This is the principle of a bubble aerator water filter for iron/manganese removal. In the aquifer, while some of the precipitated compounds may adsorb onto clay particles in the matrix, raw **untreated tapwater will appear discolored** as in Figure 72: in practical consumer terms this does not constitute an "improvement" in water quality.

  Neighboring well owners proximate to sand extraction sites may notice this change if they do not have iron filters. Since plumes containing oxygen can travel some distance, in unpredictable ways, well owners farther away may also be affected. Discoloration may persist for some time, as oxidized nanoparticles continue to be drawn into the well from the surrounding aquifer. Deposits also precipitate within the plumbing system, which can then continue to taint the water later (Li et al, 2019). Since "Mn deposits can be readily resuspended" by physical and/or chemical processes (see Gerke et al., 2015), they may affect tapwater quality for a period of time after incoming water quality improves.

Figure 72. Untreated iron-containing well water that has been exposed to oxygen prior to emerging at the tap. Source: https://angelwater.com/wp-content/uploads/2021/03/top-well-water-problems-and-how-to-solve-750x550.jpg

A citizen's comment in RPCR (#55) reports that "Citizens filed a formal complaint that clearly stated discoloured water, among other things, is unacceptable, not an improvement.", relating to a domestic well in the vicinity of extraction operations. The proponent's contention is maintained: "water quality will be similar or better following exposure to oxygen due to precipitation of metals." (RPCR #56, ++). Furthermore, "A similar **monitoring and mitigation program was implemented** during the hydrogeological testing program (Fall of 2020) and it demonstrated that testing activities **caused no unacceptable impacts** to water supply wells and household water systems located close to the hydrogeological testing wells.", and "All investigations prompted by public concerns completed to date have determined that the reported issues were not attributable to CanWhite operations." (RPCR #60). (Emphases are mine).

Where is this Monitoring and Mitigation 2020 Program report that is referenced and **<u>has already been implemented</u>**? Why are the results of the alleged testing not available? Surely WATER IN PEOPLE'S WELLS cannot be the company's "proprietary" property?

Even with the very limited operations thus far, RPCR (#60) admits that there have been a number of concerns. How many concerns have there been, and what were they? What was their timing and location in relation to operations? Who conducted the investigations – was the company investigating itself? And, why did the Province, which knew of the discoloration issues, not conduct an *independent* investigation, but instead allegedly dismissed the complaints, when it was responsible for allowing this operation and ensuring that there were no untoward impacts [Source: Affected citizen personal communication]?

The proponent warrants that "Any changes that do occur will be minimal, localized, and/or temporary.", and "In the event that a water supply well is **unacceptably** impacted by CanWhite's operations"… (RPCR #60). How is "unacceptably" defined? Moreover, **why should <u>ANY</u> adverse changes be 'acceptable'**?

- We should add here that oxidized precipitates may have other undesirable effects. For example for chromium, "Mn oxides can oxidize Cr^{3+} to Cr^{6+} resulting in the metal ion being converted from a non-toxic to toxic state" (see Gerke et al., 2015), i.e. conversion from trivalent to the highly toxic hexavalent form.

Regarding chromium, in AppA4, Table 4-8, we have a query about BRU 96-1, which showed a marked increase from below detectable levels pre-test, to 0.13 µg/L post-test. No explanation is offered. Chromium has multiple valency states, the hexavalent form is by far the most noxious. Are the chromium data for total chromium, or just certain chromium species?

Another concern is that in circumneutral to alkaline pH water, such as in the present case, other metals may be entrained as a result of manganese oxidation. Manganese oxides adsorb metal ions such as copper, chromium, lead and strontium. Suspended manganese oxide/oxhydroxide particulates can convey these metal ions to drinking water, which may pose consumer health risks (Gerke et al., 2015).

Iron and manganese bacteria

- Iron bacteria such as *Gallionella* and *Sphaerotilus* are **aerobic** aquatic procaryotes which oxidize soluble ferrous iron in water (Andrews et al., 2013). According to Tyrrel and Howsam (1997), "Iron bacteria are well known to borehole operators as the cause of iron biofouling" because they can create significant problems in water systems and pipes. According to Cullimore and McCann (1978), these bacteria cause "corrosion of water pumps, pressure tanks, galvanized pipes and fittings; the clogging of metal and plastic pipes (Figure 73); the reduction of water flow and water pressure and the coating of the resin beds of water softeners with slime, reducing efficiency and imparting unpleasant tastes and odours to the water". They may also affect groundwater chemistry; infestations are common in the southern Canadian Prairies, and are frequently the result of infected drill bits, tools and repair equipment (Tyrrel and Howsam, 1997).

Figure 73. Iron bacterial biofouling in water pipe.

Source: https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.h2oequipment.com%2Fwater-problems%2Firon-bacteria%2F&psig=AOvVaw2GyT9i6uCKfiUHWsEhpRqK&ust=1631293466840000&source=images&cd=vfe&ved=0CAYQjRxqFwoTCNi8m_2v8vICFQAAAAAdAAAAABAd

The bacteria proliferate in the presence of iron and oxygen. The amounts of oxygen need not be significant as these bacteria can be **microaerophilic** and subsist on very small concentrations: huge growths of iron bacteria have been reported in wells containing less than 5 mg/L of dissolved oxygen (see Cullimore and McCann, 1978). Maamar et al. (2015) found Gallionellaceae in groundwater at less than 2.5 mg/L of dissolved oxygen, while Andrews et al. (2013) reported that microbial iron oxidation can occur at concentrations as low as 0.1 - 0.3 mg/L.

- The introduction of oxygen into the aquifer at large numbers of sites in the proposed project presents the potential of promoting iron bacterial growth, whether such bacteria have been introduced through the drilling and extraction process, or by facilitating the spread of existing local infestations. Considering that only small concentrations of oxygen are enough for iron bacterial proliferation, **this presents the potential for growth of these bacteria in the aquifer and the fouling of wells.** Once a well is infested, the problem is notoriously hard to eradicate. According to 'The Driller' publication, "It is almost impossible to completely remove all the bacteria. The bacterial populations will increase with time." (https://www.thedriller.com/articles/86301-iron-bacteria-in-water-wells-maintenance-recommendations-and-remediation-techniques). The problem often recurs after attempts at control because the bacteria easily spread outside the treatment zone (Cullimore and McCann, 1978). In the present instance, the large numbers of boreholes

that will be drilled over 24 years provide the risk for spreading the problem over a wide area if drilling or extraction equipment happens to become contaminated.

According to our adjacent jurisdictional Minnesota Department of Health (MDH, 2022), iron bacteria are present in "most soils in Minnesota", and because of this, MDH has issued the following recommendations: "Only place disinfected water in a well for drilling, repair, or priming pumps.; **Avoid placing pumps, well pipes, and well equipment on the ground** when doing repairs.; Disinfect the well, pump, and plumbing after repairs." (Emphasis is mine).

There is no mention of this issue in the EAP. How will the proponent **ensure that no iron bacteria are introduced into the aquifer** during drilling, casing and pipe manipulation, grouting, and during extraction and decommissioning, and transfer of casing portions that are intended to be re-used in different wells (e.g. RPCR #167)?

An additional concern is the proponent's plan to intrude into private wells for purposes such as lowering well pumps (e.g. RPCR #64), or sampling (e.g. TAC #41) and measurement of water levels (e.g. SSCRIR2 #MBEN-IR-031). This could involve a large number of existing domestic wells, with high potential for cross-contamination. How will this be addressed?

- Manganese may also undergo either chemical or microbial oxidation. A large phylogenetic variety of aerobic manganese-oxidizing bacteria may proliferate with the introduction of oxygen, converting divalent soluble Mn to MnO_x (Gounot, 1994). Effects of MnO_x on drinking water chemistry can extend to several issues: "*biogenic* Mn oxides may affect water quality in terms of aesthetic appearance, speciation of metals and oxidation of organic and inorganic compounds." (Marcus et al., 2017).

- In SSCRIR1 (#DLN-IR-001), we see the amazing statement: "Microbial contamination due to drill rigs or exhaust is not a known issue." Do we conclude, then, that the Minnesota Department of Health (MDH, 2022), and numerous scientists and industry sources are incompetent colluding wackos? In other words, **no care will be taken to prevent contamination**. In view of the thousands of wells, and the involvement of (at least) two aquifers [recall #3 perched aquifers], how can it be possible that the proponents' equipment will always and forever remain pure as the driven snow (actually driven snow contains a lot of bacteria).

  Here is a starting list of science on iron bacterial contamination of wells:
  https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=iron+bacteria+in+wells&btnG=

  The proponent dismisses the concern: "it is unlikely that dissolved oxygen will facilitate the proliferation of iron bacteria and other microbes.", and "The groundwater returned to the aquifer after treatment will contain only a very small volume of dissolved oxygen.

Extraction activities **will not** introduce any biological contaminants into the aquifer."(SRTER #8; also RPCR #52). Microaerophilic, people.

Further, "**most** of the air utilized during the extraction process will not interact with the aquifer… **a net addition** of a small amount of dissolved oxygen may **occasionally** occur within the aquifer." (SRTER #8). (Emphases are mine). Are these coy 'net additions' the result of the 'occasional' "pressurized air bursts" (CPA)?

In RPCR (#33) the response to these concerns again is: "It is **unlikely** that this dissolved oxygen will facilitate the proliferation of iron bacteria and other microbes. **Most** of the air utilized during the extraction process will not interact with the aquifer but will return to surface with the sand slurry and return to the atmosphere and the groundwater returned to the aquifer after treatment will contain only a very small volume of dissolved oxygen**. Extraction activities will not introduce any biological contaminants into the aquifer.**
As an additional measure of protection, UV sterilization will be applied to the extracted groundwater prior to it being returned to the aquifer to remove naturally occurring microorganisms that may be present in the groundwater." (Emphases are mine).

My rebuttal is:

1. As described above, these organisms are **microaerophilic**, which means that they can subsist on **minuscule amounts of oxygen.** They can live in the zone surrounding the terminus of wells by utilizing the minute amount of oxygen diffusion originating from the end of the casing and perforations, where no extraneous water or air from the surface has been introduced. In order to make the claim of no microbial facilitation, the return water would have to contain virtually no oxygen, which is neither possible nor practicable under the proposed extraction conditions.

2. Gaseous air is already turbulently introduced under pressure into the extracted water before it even reaches the surface, via the bubbling air lift apparatus. Additional air leakage into the aquifer occurs from air lift air escape, entrainment, and the 'pressurized air bursts' described in CPA. All of the ensuing dewatering and subsequent manipulations turbulently and thoroughly expose the water to outdoor air. The exposure of any air-water interface allows for gas diffusion, the rate of which is greatly accelerated by agitation, which latter state multiplies interface surface area and maintains steepness of dissolved gaseous concentration gradients. The water will be at saturation for its temperature and pressure.

3. Since dissolved oxygen concentrations in the return water have not been measured, claims that are not anchored in actual data should not be presented as fact.

4. "Extraction activities will not introduce any biological contaminants into the aquifer." (also RPCR #52). This statement would be true if all tools and equipment are sterile, the workers are practicing strict aseptic techniques, and the water has not been

anywhere exposed to unpurified air.

There is a reason we do not perform surgery outdoors in the fields and woods and gravel pits. Even in the hygienic confines of hospitals, many thousands of unintended nosocomial and iatrogenic Infections occur in Canada each year, many of which are fatal.

Biofilm formation and growth are known sequelae of reinjection of water into an aquifer (Abesser, 2007).

In SSCRIR2 (#DLN-IR-003), the proponent promises that "The system will be designed to minimize the possibility for proliferation of bacteria." How, exactly?

5. It is further necessary to consider the non-sterile air from the air lift apparatus. Air escape, especially from the "pressurized air bursts" described in CPA to loosen the sand, can potentially introduce microorganisms directly into the aquifer (see discussion below).

6. As discussed further below, UV disinfection of water will be inappropriate because of prohibitive turbidity and other factors. Furthermore, drill bits, casings, pipes, air lift equipment, sealing materials, cavity scanning/monitoring instruments, piezometers, etc. will not pass through the disinfection station, but will be reused in many wells. How will they be cleaned? What measures will be taken to help the homeowner in the event that contamination occurs?

7. While normal nonpathogenic microflora may be naturally present in some groundwaters, the concern is **expansion and diversification of these assemblages through the introduction of new taxa, or overgrowth of existing opportunists that could create nuisance or pose opportunistic risks to public health**. However deeper aquifers are much less likely to contain natural microflora (Ginige et al., 2013).

"UV sterilization will be applied… to remove naturally occurring microorganisms that may be present in the groundwater." This is a ludicrous and fatuous statement, also found in RPCR (#40): it is not worthy of even a silly reply. Ignorance is nothing to be proud of. But, this smirky remark encapsulates the wider supercilious corporate attitude towards environment and health, and ridicules and belittles the legitimate concerns of the people that will have to live there. Such are the hands entrusted with our water.

Fungi and other microbiota

- Many aquifers may contain some environmental levels of *nonpathogenic* bacteria, introduced through surface recharge processes, but greater numbers are present in unconfined subsurface aquifers compared to deeper aquifers below the aquitard (Ginige et al., 2013). According to the latter author, oxygen introduction can result in increased bacterial numbers and altered microbial community composition, reflecting the elevated redox potentials and pH changes. Dissolved oxygen in the reinjected groundwater (as well as direct air introduction) can enable the growth of obligatory and facultative aerobic organisms that are not normally found in anoxic groundwater, including bacteria, fungi, protozoa and even some heterotrophic algae that can survive in darkness.

- Fungi can easily contaminate groundwater and result in both aesthetic and public health concerns. Groundwater contamination with fungi can result from well drilling and inadequate sealing (DEFR, 2011). A number of fungal and yeast taxa have been isolated from contaminated groundwater, some of which are human pathogens (Oliveira et al., 2016). Fungi can block pipes, generate undesirable tastes and odors, cause allergies, create infections, or produce toxins (e.g. mycotoxins)(Babic et al., 2017). For example Taylor et al. (2001, *in* Oliveira et al, 2016) reported that 307 fungal species out of 1415 infectious organisms occurring in drinking water were known to be pathogenic to humans. Arroyo et al. (2019), found that "wells were shown to be potential reservoirs of many types of fungi, including filamentous fungi and yeast. Many of these may become opportunistic pathogens when they infect immunosuppressed individuals."

- In response to a question regarding filtration of compressed air (SSCRIR1 #DLN-IR-001), the proponent responds: "Sio did not monitor the air quality in the air from the compressor", and "Sio did not monitor the ambient air around the compressor". Further, "Sio is not proposing to use "air decontamination methods", and "Sio is not proposing to monitor air quality in the compressed air", and "Sio is not proposing to use air filtration." (the latter statement is repeated 3 times in succession). Therefore we have reason to suspect that quality of the compressed air used for air lifting will not be monitored, nor will precautions be taken.

  The proponent maintains that "Sio disagrees with the suggestion that "raw unfiltered air" will be used for the proposed extraction. Most compressors come with a standard intake filter which is designed to remove 99% of 5 micron or larger contaminants and 95% of 3 micron or larger contaminants." (SSCRIR2 #DLN-IR-001).

1. Thus 1% of 5 µ or larger, and 5% of 3 µ or larger particles can pass through the filter. Given the enormous volumes of outdoor air involved, these passes in themselves constitute a significant number.

2. However "The average diameter of **spherical bacteria is 0.5-2.0 µm**. For rod-shaped or filamentous bacteria, length is 1-10 µm and **diameter is 0.25-1 .0 µm**." (https://microbiologyinfo.com/different-size-shape-and-arrangement-of-bacterial-cells/). Therefore **virtually all bacteria** can pass through a 3 µ filter.

3. For fungi, "unicellular spores with diameters of 1–10 µm and fragments <1 µm combine to permit a broad size distribution of airborne fungal material" (Yamamoto et al., 2012). Thus some fungal propagules can pass through a 3 µ filter. The 5 µ filter would allow unicellular amerospores of the environmental fungus *Aspergillus*, which can cause fatal infections of lungs and other organs, to pass through; in general "**fungal pathogens** were typically observed with aerodynamic diameters <4.7 µm" (Yamamoto et al., 2012) (Emphasis is mine). Therefore the risk of introducing such organisms into the aquifer is significant.

According to Bjerring and Øberg (1986), "**ambient air being taken into the compressors without interposition of a bacterial filter" may be a source of bacteria in the compressed air output.** Quoting White (2021a), "**Particles the size of micro-organisms are too small to be captured by the panel filters and intake filters used on modern air compressors, therefore, they travel unrestricted into the compressed air system**." In the present circumstances, these organisms may directly contaminate groundwater from air escape and the 'pressure bursts' described in CPA.

The phenomenon of microorganism contamination of compressed air is widely recognized in industry and medicine, and for this reason, **Compressed Air Microbial Test Unit kits** are commercially available to test for basic bacteria and fungi in compressor air outputs (e.g. https://www.quincycompressor.com/avoid-bacteria-in-compressed-air/). However more specialized tests may be required and are available for viruses and broader bacterial and fungal taxa.

Pyrite oxidation and acidification

- Oxygen introduction into an anoxic aquifer is frequently associated with "water quality deterioration…induced by the oxidation of the reduced aquifer components by the oxygenated injection water" (Antoniou et al., 2014). One primary consequence is the oxidation of pyrite (iron sulphide), which can be "the main driver for water quality changes", that evolve over a long period of time (Prommer and Stuyfzand, 2005). In the

present setting, depending on its abundance, presence of pyrite may be associated with potential post-closure impacts on aquifer water quality.

- Iron sulphide nodules and ooids in the Winnipeg Formation have been recognized for a long time (e.g. Genik, 1952). According to AppA1 (p. 36), "Pyrite was identified as a sulphide mineral in two out of three samples collected from drill core advanced through the Winnipeg Shale", which, although sample size is extremely small, is consistent with the pyritic nature of Winnipeg Shale described by numerous workers (e.g. Binda, 1991; Lapenskie, 2016). However distribution of pyrite is heterogeneous: for example in the Black Island Member of the Winnipeg Formation, "In places, the shale is composed of up to 50% pyrite nodules" (Lapenskie, 2016).

  Pyrite is not limited to shale, but is also found in Winnipeg Sandstone (Schieber and Riciputi, 2005). The sulphides are a relict of ancient procaryotic metabolism: according to the latter workers, "Sulfur isotope data point to bacterial sulfate reduction as a sulfide source." Sulphide content varies throughout the Winnipeg Formation in Manitoba, which is reflected in varying levels of purity of the silica sand (Lapenskie, 2016).

  According to Schieber (2002), pyrite may be found as concretions in the sandstone, which in the Black Island Member of Winnipeg Sandstone, range from 3-15 mm in size. They may be connected into a "a winding, curved, and meandering path", and may be associated with pyrite mineralization of ancient burrows and organic trails. Another notable feature of the Sandstone Formation is the occurrence of iron sulphide-coated sand grains, which contain alternating laminae of pyrite and marcasite (Schieber and Riciputi, 2005). Marcasite is a dimorph of pyrite with similar chemical composition. In contrast, AppA1 (p. 40) did not find sulphides in the small number of sandstone samples (3 samples). Clearly a larger representation is needed.

  I would further like to add from personal experience that pyrite may occur in the Red River Carbonate as well (Figure 74). It is important to note that pyrite distribution is heterogeneous in all of the strata under consideration and reflects the local occurrence of appropriate ancient marine bacterial communities and oxygen-poor, chemically reducing sedimentary environments. Thus no consistent universal model for its presence or absence can be devised for the region as a whole.

Photo: E. Pip

Figure 74. Pyrite crystals in limestone matrix, Red River Carbonate (Dr. E. Pip Collection).
I collected this specimen in 1959 in material from a now-defunct quarry, in the context of a highly fossiliferous and soft porous and vuggy Ordovician limestone indicative of a productive, shallow, ancient benthic marine ecosystem.

- The oxidation of pyrite is an exothermic process. On exposure to air (i.e. oxygen) and moisture, pyrite oxidizes readily and the resulting sulphate combines with water to form sulphuric acid. Therefore when present in quantity, pyrite oxidation can contribute to acidification and corrosion concerns (Ginige et al., 2013).

$$2\,FeS_2{}_{(s)} + 7\,O_2{}_{(g)} + 2\,H_2O_{(l)} \longrightarrow 2\,Fe^{2+}{}_{(aq)} + 4\,SO_4^{2-}{}_{(aq)} + 4\,H^+{}_{(aq)}$$

- AppA1 (p. 39) indicates "pyrite is present in both [shale] samples with uncertain acid generation potential…and could contribute to acid generation." Obviously the sample number is exceptionally small, and considerably more comprehensive information is needed: "Additional sampling and ongoing monitoring are required to expand the data set and directly observe behaviour of the Winnipeg Shale under simulated or actual field conditions." At the same time, AppA1 (p. 33) hints that additional lithogeochemical data do exist: "CanWhite completed two analytical programs within the Project Area between 2017 and 2019 to determine the mineralogy of the Winnipeg Sandstone locally."

Where are these reports? The above quotes appear to contradict each other – if multi-year mineralogical investigations were carried out, why were only two shale samples tested and "additional sampling" is required? What happened to all the other samples?

Uncertainty concerning acid-generating potential, pending the collection of additional data, has led to the proposal recommendation that "Until this information is available and has been assessed, waste derived from the Winnipeg Shale should be managed conservatively" (AppA1, p. 42).

- Presumably shale fragments would be managed together with "overs", which (in theory) are concretions (e.g. ooids composed of calcium, magnesium or iron minerals), and other geological oddments (e.g. lumps of consolidated sand grains) that are 'over' ≈ 840 µ (= 0.84 mm) in size (EAP1, p. 18; SSCRIR1 #CEC-IR-008 and DLN-IR-005), although TAC (#6) indicates a different size: "larger than 400 microns".

In RPCR (#11), we learn that "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. These materials will be separated and managed conservatively in accordance with the Waste Characterization and Management Plan and will likely be disposed at a licensed facility."

[Note: Ooids are accretionary, fairly small (<1 cm, but usually much smaller) individual structures; oolites are **sedimentary rocks**, usually limestone, composed of cemented ooids (https://geokansas.ku.edu/oolite), therefore the term 'oolite' is here used inappropriately, unless a small bunch of cemented ooids would be considered a rock.]

For some reason the **actual composition** of these materials is not disclosed, other than the above RPCR (#11): "Oolites are commonly composed of calcium carbonate and are not likely to negatively influence water quality.", as well as RPCR (#127): the sand "will be pre-screened to remove 'overs' such as concretions (calcified sand)". Table 4-1 (AppA4) lists iron oxide concretions as well as broken shale in Sandstone samples.

These descriptions would render the materials innocuous. Data apparently exist, as "Some of these materials were contained within the sand samples submitted for geochemical analysis." (RPCR #11). This same confusion is reflected in the TAC (#7) reviewer's comment: "ECE recommends CanWhite investigate alternative disposal or end-use options for 'overs' material." The proponent responds cryptically: "CanWhite submits that the disposal / end use of the overs material is appropriate as described in response to #6", with no supporting reasons, and the TAC #6 response is not edifying. Why the mystery? **If these materials are indeed calcium carbonate, why do they need**

to be managed conservatively? If there is no concern, surely the proponent would wish to bring this to the attention of the public, rather than suppress it?

Furthermore, if on the one hand, they must be stored away from rain or snow exposure and be remitted to a "licenced facility" - on the other hand, how appropriate is it for them to be "**used in well sealing activities**" (TAC #6)? In SSCRIR1 (#CEC-IR-008) this is somewhat clarified: the destination is a "licensed landfill facility", therefore apparently not a hazardous waste facility. But, won't these materials be exposed to rain or snow at a landfill facility? In SSCRIR1 (#CEC-IR-008), they may be "used in reclamation activities as they are not considered harmful." But what exactly are they? This information must be known if any are indeed used in well sealing.

- These structures are shown in the sample photos in AppA5 (C.3); how much of this material is pyritic? In RPCR (#11) the proponent states: "The samples that showed concentrations of sulphide minerals (i.e., pyrite) were at levels that were either very low or below the lowest concentrations that could be measured. Although these materials may be sensitive to oxygen inputs if brought to surface**, any potential acid-generating materials will be separated** and transported to a licensed facility for disposal.", also RPCR (#26, #227)(Emphasis is mine).

  1. Here, the "licensed facility" will receive "potential acid-generating materials". Since sulphuric acid (CAS 7664-93-9) is a potent corrosive and oxidizer, and it is listed in Manitoba as a suspected human carcinogen, it qualifies as hazardous waste (https://www.cezinc.com/.rest/api/v1/documents/fbdb258a9f378d20365bab77a4ea6900/1-%202020%20Sulphuric%20Acid%20(EN).pdf).

  2. What were these low or lower concentrations? What was the detection limit? How many samples were there?

  3. **How will "potential acid-generating materials" be identified and "separated"?** On the basis of size only, and included with other 'overs'? This would lead to inclusion of great amounts of innocent material. On the other hand, what about sulphide coated sand grains that are known to occur in this Formation (Schieber and Riciputi, 2005), some of which might be smaller than 400 or 840 µ (see confusion above)?

  In seeming contradiction, RPCR (#16) states: "CanWhite's design **does not provide for the removal of iron pyrite from the sand**. Nor is any such process required." (Emphasis is mine). So we can be assured that all eventualities have been covered: potential acid-generating materials will, and will not, be removed.

  4. We also know little about the actual quantities of this material to be expected: "Oolites and concretions comprise a very small proportion (<5%) of the overall

sandstone aquifer" (RPCR #11). In RPCR (#190) and SSCRIR1 (#CEC-IR-008), "Mine waste (e.g., overs) is estimated to range from 0.1% to 0.8% of the extracted material."
In themselves, these numbers are of limited value, because they are not in the context of the total amount or the baselines referenced. "Extracted material" is not defined. Are these percentage numbers relative to: A) total volume of sand and water extracted, or B) weight or maybe volume of the wet sand, or C) weight or maybe volume of the finished dry processed sand? In other words, what is the estimated annual tonnage of these materials expressed as dry weight? How would this tonnage break down into its different mineral constituents?

- "In addition, fines, which are estimated at about 1.9% of total extracted material, will be collected at the extraction site and pressed into a filter cake", and "The fines are largely kaolinite clay material and are therefore a salable material to industries" (SSCRIR1 # CEC-IR-008 and #DLN-IR-004).
  The same questions apply as for 'overs'. "The fines are **largely** kaolinite clay": what does "largely" mean? What is the rest of the material? Is any of it acid-generating?

- According to EAP1 (p. 18), "These 'overs' that are captured will be temporarily stockpiled in a containment tank on site before being removed off site for disposal at a licenced facility." In TAC (#6): "Overs will be stored in covered containment tankage, periodically removed from site and disposed of at a licenced facility during the extraction year, or used in well sealing activities. This plan will prevent the overs from being exposed to rain or snow."

  There is little information on what kind of "containment tankage" will be used to store these materials on site and transport them on public roadways, nor what sorts of hazards (if any) they pose to workers and environment. "When overs are captured, they will be stored in covered, open to atmosphere tankage. The coverage reduces rainwater collection in the tankage." (SSCRIR1 #CEC-IR-008 and DLN-IR-005). We thus learn that tankage will be covered, AND "open to atmosphere". Perhaps a tarp that can be ruffled by wind? It will be kept from rain or snow, but in "well sealing activities", won't it be exposed to moisture?

  What sort of processing/separation will it require at the "licensed facility", where and how will this material be ultimately disposed of, can any of it be utilized for other purposes (other than 'well sealing')? If not, why?

  The recipient "licensed facility" is not identified. How far away is it, and is it located in Manitoba? [Perhaps we have a possible hint regarding the waste processing facility that has recently been approved in Springfield (see also p. 327].

There is no "Waste Characterization and Management Plan" which is repeatedly referenced as containing all of the answers but does not seem to exist.

- In the water samples analyzed, measurable to elevated sulphide was reported in some samples (AppA1, p. 48). The oxidation of aqueous sulphide in the presence of oxygen is catalyzed and accelerated by Mn^{2+}, Co^{2+}, Ni^{2+}, Fe^{2+} and Cu^{2} ions (CWQG, 2014), which have all been reported in the water samples (Table 4-8, AppA4). "Sulphides can also react chemically with dissolved oxygen…producing a variety of products, including thiosulphate, sulphite and sulphate" (CWQG, 2014). The intermediates (thiosulphate and sulphite) may persist in water for extended periods, affecting well water quality in addition to the parent sulphides (CWQG, 2014).

- As discussed above, pyrite oxidation results in eventual sulphate release and acidification. Since hydrogen sulphide is also present in some wells (Table 4-8, AppA4), it too can be oxidized to sulphuric acid, further contributing to acidification (Hose et al., 2000). Acidification in turn mobilizes release of heavy metals and trace elements, for example iron, nickel, cobalt, zinc, lead, uranium, and particularly arsenic (Dubrovsky et al., 1984; Larsen and Postma, 1997; Stuyfzand, 1998; Antoniou et al., 2014). All of the latter elements have been reported in the project region, and some metals (Fe, Cu, Zn, Mo) were elevated in certain samples (Table 4-8, AppA4; AppA1, p. 48).

  Dissolved manganese concentrations also increase due to the dissolution of Mn-containing carbonates associated with pyrite oxidation (Antoniou et al., 2014).

- The sources of metals may be various: "high correlations [of metals] with iron suggest that these metals may be contained in pyrite minerals present in some samples or complexed or coprecipitated and/or adsorbed on oxyhydroxide minerals" and "Trace elements could also be released from organic matter under oxidizing conditions." (AppA1, p. 38). Metal leaching potential of rock samples from the three stratigraphic layers identified **aluminum, selenium, arsenic and uranium** as elements of potential leaching concern in some cases (AppA1, p. 42). Since many of these processes occur slowly, mobilization of heavy metals and trace elements should be monitored over an extended period post-closure to ensure that no health risks arise.

- In response to a concern regarding "release of potentially health impacting substances from the shale formation into aquifers" (SSCR #2), the proponent responds in part: "the shale aquitard is present across the majority of the study area and has not been linked to any health impacts". This obtuseness completely dismisses the point: *changes* such as redox alteration attendant and consequent on oxygen introduction may *initiate* unintended health risks in drinking water, as belabored in the preceding bullets above.

- Acidification of ground water may also increase the release of metals from well casings and construction materials, and accelerate their corrosion (Hewitt, 1989)(see p. 246). This should be considered in the context of the multitudinous well casings that will permanently remain, as well as potential effects on domestic wells.

- Other water chemistry changes resulting from the introduction of oxygen into anoxic aquifers include: "cation exchange, SiO_2 desorption, PO_4 and F exchange, … acid-buffering by calcite dissolution or HCO_3^-, and oxidation of organic matter" (Stuyfzand, 1998). Acidification in carbonate systems may also affect **greenhouse gases**: "Lowering the pH would shift the carbonate equilibrium from predominantly bicarbonate species toward carbon dioxide (Manahan, 1972 *in* Hewitt, 1989).

- Fluoride was naturally present, but not excessively so, in all reported samples (Table 4-8, AppA4) due to fluoride-bearing minerals in the parent rocks. None of the samples exceeded the 1.5 mg/L maximum stipulated by CWQG (2010). Fluoride dissolution in groundwater is dependent on pH, among other factors (Jha and Tripathi, 2021).

- Pyrite oxidation in turn drives denitrification in groundwater (Schwientek et al., 2008), with concomitant health effects (e.g. methemoglobinemia), as nitrite is much more toxic than nitrate.

Carbon monoxide (CO), nitrogen oxides (NO_x), and other toxic gases

- Toxic gases may be **introduced into groundwater** via air in the reinjected water. The extracted water will be exposed to exhaust fumes from various machinery powered by fossil fuels. For example, the various models of the CAT C18 Diesel Generator Set listed in Table 6-3 of EAP2 emit both NO_x and CO, some models being quite substantial emitters (https://www.wpowerproducts.com/power-generation-resources/manufacturer-profiles/caterpillar/models/c18/).

  Direct injection of large amounts of compressed air will also occur. According to White (2021b), "The primary source of contamination found in a compressed air system is the ambient air surrounding the compressor." The composition of the injected air will reflect the air quality in the **vicinity of the compressor**. White (2021b) explains it thus: the compressor "acts like a large vacuum cleaner, pulling in invisible contaminants. So, when the ambient air is compressed, the compressor is also concentrating the contamination at the same time." Atmospheric particulates and microorganisms are also present in ambient air.

- Incomplete fuel combustion is associated with CO. Ultra low levels of CO occur naturally as a result of various physical and biological processes: "CO is present ubiquitously in ground water at concentrations ranging from 0.2 to 20 nM." (Chapelle and Bradley, 2007), i.e. ultralow amounts.

  The reinjection of water into the aquifer will affect CO concentrations via three separate mechanisms. Dissolved CO from fumes at the work site will be carried into the wells directly with the returned water. Secondly, gaseous CO will be introduced with the compressed air. Thirdly, "delivery of dissolved oxygen….stimulates oxic metabolism and produces transiently high CO concentrations" via microbial activity in aquifers and soils (Chapelle and Bradley, 2007); thus oxygen introduction may enable microorganisms (if available) to produce biogenic CO.

  The concern here is that CO availability in ground water may promote the growth of bacteria which can in turn utilize CO as a carbon and energy source at environmental concentrations of <50 ppm (King, 2003). Unfortunately, some of these organisms are human pathogens, e.g. *Mycobacterium tuberculosis,* which is present as a latent infection in one third of the world's population (King, 2003). Others, e.g. *M. bovis,* infect cattle. These bacteria are capable of prolonged survival even in the absence of oxygen.

- NO_x is a toxic contaminant gas present in fuel combustion exhaust and presents adverse environmental effects even at very low levels. Jacquemet et al. (2011) found that where the contaminant was introduced in dissolved aqueous form into a sandstone aquifer, "NO in the contaminant gas **even in very low concentrations** induces a local negative pH shift of 1 unit….This pH shift results in an **increased release of Fe and Mn**." (Emphases are mine). The authors hypothesize the ultimate fate of NO_x is "to be oxidized by O2 into nitrite or nitrates (health-significant substances) that **persist into the aquifer**." (Emphasis is mine). Therefore nitrogen oxide introduction could be coupled with ancillary oxidation reactions (in the presence of oxygen) that would impact water quality by acidification, enlargement of the nitrogen pool, and potential health effects.

- Solubilities of the various gases in water differs (Figure 75). While oxygen is quite soluble in water, nitrogen oxide is even more so, which results in **proportionately greater concentrations** of the latter in water than oxygen. Carbon monoxide and methane are somewhat less soluble than oxygen, but can still achieve significant concentrations at lower temperatures.

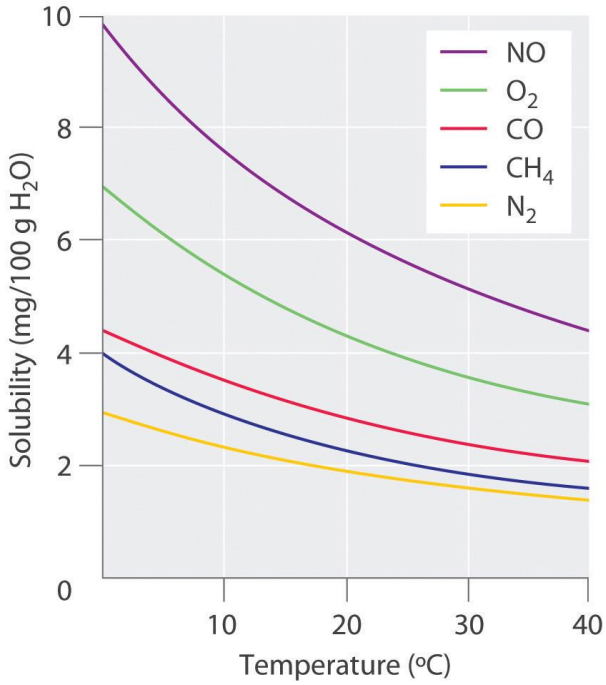


Figure 75. Solubilities of various gases in water. Note that nitrogen oxide is much more soluble in water than oxygen, while carbon monoxide and methane are less soluble. Elemental nitrogen gas is considerably less soluble than oxygen. Source: https://saylordotorg.github.io/text_general-chemistry-principles-patterns-and-applications-v1.0/s17-04-effects-of-temperature-and-pre.html

- Sulphur dioxide is also present in fossil fuel exhaust. White (2018) explains: "In an oil free compressor there is no oil to neutralise harmful vapours such as SO2. As the intercooler and aftercooler in an oil-free compressor condenses water vapour into liquid water, the SO2 from the air reacts with condensed water vapour to form sulphurous acid." Thus both NO and SO_2 in compressed air may contribute to acidification.

- In response to the reviewer's question in SSCRIR2 (#DLN-IR-001) "regarding the potential NO2, SO2, CO2 and benzene contamination in the injected air", the proponent provides the following explanation:
  "Sio does not agree that contamination of intake air for the compressors is meaningful risk for Sio's extraction proposal… Sio notes that compressors are mobile units. They can be set up **at distances from other equipment**, much of which will be electrified during operations. This will further limit the potential for contaminants entering through the intake at the compressors." (Emphasis is mine). Note: the only electrified equipment that is identified in the EAP is the dewatering/pump station (EAP1, p. 26).

The proponent has forgotten that the planned ODF1550 compressor (see Figure 12, p. 62), is an **integrated unit**, and contains a Cummins 151 diesel engine that consumes 93.2 L/hour of fuel at full load (https://america.sullair.com/sites/default/files/2021-02/LIT%20Sullair%20OFD1550%20Tier%204%20Final%20Brochure_PAP1550OFDT4F202102-7_EN.pdf). Does the proponent intend to cut the OFD1550 in half, and separate the generator from the compressor, so that the compressor does not imbibe any of its own exhaust?

- The effect of groundwater aeration on innate radon and hydrogen sulphide gases is discussed in the Air quality section (p. 404).

Enhanced contaminant transport

- According to Chapelle and Bradley (2007), "**It is well known that the presence or absence of dissolved oxygen affects the fate and transport of many natural and anthropogenic contaminants in ground water.**" For example, dissolved oxygen has been demonstrated to affect behavior of nitrate plumes. In another example, highly chlorinated contaminants "do not biodegrade readily under oxic conditions and can be transported relatively long distances". These may include pesticides and carcinogenic water chlorination by-products. The latter authors warn that "**The oxygen status of ground water systems, therefore, can have significant water quality impacts.**"

Water quality analysis

- The EAP and various followup documents (e.g. RPCR, #24) repeatedly claim that returned extraction water may actually be better than the original: "The quality of the water returned to the aquifer following the sand extraction process will be similar to or better than the water removed from the aquifer during the extraction process." The categorical "will be" is used. Yet no factual foundation is provided to support such assertions: quality of the reinjected water was purportedly not analyzed (e.g. TAC #10). Wishing it were so, and telling us that it is so, does not automatically make it so.

  According to Abesser (2007), "where water is withdrawn from and returned to the same aquifer, dissolved solid and suspended solid contents can differ between the abstracted and the re-injected water". These changes at the surface include degassing (see p. 407), pH increase, and calcite and metal precipitation leading to increased turbidity, which may affect local consumers. Further, "the injection water may also contain other types of contaminants, such as metals leached from pipes and pumps, bacteria, precipitated iron and manganese hydroxides and/or chemical additives". It is thus important for the reinjection water in the present project to be rigorously monitored.

- A grave concern regarding water sampling methodology is raised by the following: "Groundwater samples from select residential water wells were collected from a point of consumption within the house (e.g. tap in kitchen). Samples could not be collected directly from the residential water wells because downhole equipment and wiring obstructed sampling equipment." (AppA1, p. 46).

  The technical reviewer (TAC #41) notes: "Two of the three analysis [sic] were most likely sampled after running through a water softener and are of little value in characterizing the carbonate water quality. It should be ensured that future water quality sampling is from a 'raw', untreated source." Thus the majority of the (only) three samples was invalidated, leaving only one credible sample. The very modest number of residential samples, further reduced to one, cannot form the foundation for far-reaching inferences regarding the state of domestic well water quality in the region.

  Evidently the systems that were sampled had no drain valve between the well and the system line (Figure 76). This is the 'next best' sampling option. A hose can be attached at this point, but this is not recommended as the hose and fittings can add potential contamination to the sample. The adjacent water shut off valve leading to the plumbing system must be closed during this operation to prevent backflow, and the tap should be flushed as well.

  Note, however, that even this type of sampling may result in incorrect results, because steel well casing materials may alter water chemistry, particularly for trace metals. Marsh and Lloyd (1980 *in* Llopis, 1991) found that samples from steel-cased wells did not accurately represent the original aquifer conditions. According to Hewitt (1989), "stainless steels are prone to imposing specific signatures on ground water and are not suitable where trace metal determinations are planned." Houghton and Berger (1984 *in* Llopis, 1991) reported that water samples from steel-cased wells were enriched with cadmium, chromium, copper, iron, manganese and zinc relative to plastic-cased wells. Metals may also adsorb organic compounds and can thus result in underestimates of these substances (Pettyjohn et al., 1981 *in* Llopis, 1991). However PVC pipe may also contribute contaminants (see p. 246).

  Therefore the most ideal samples would be collected downhole after flushing. But when this is not possible, a next-best nearest option must be sought, with awareness that some trace elements and organic substances may be overestimated.

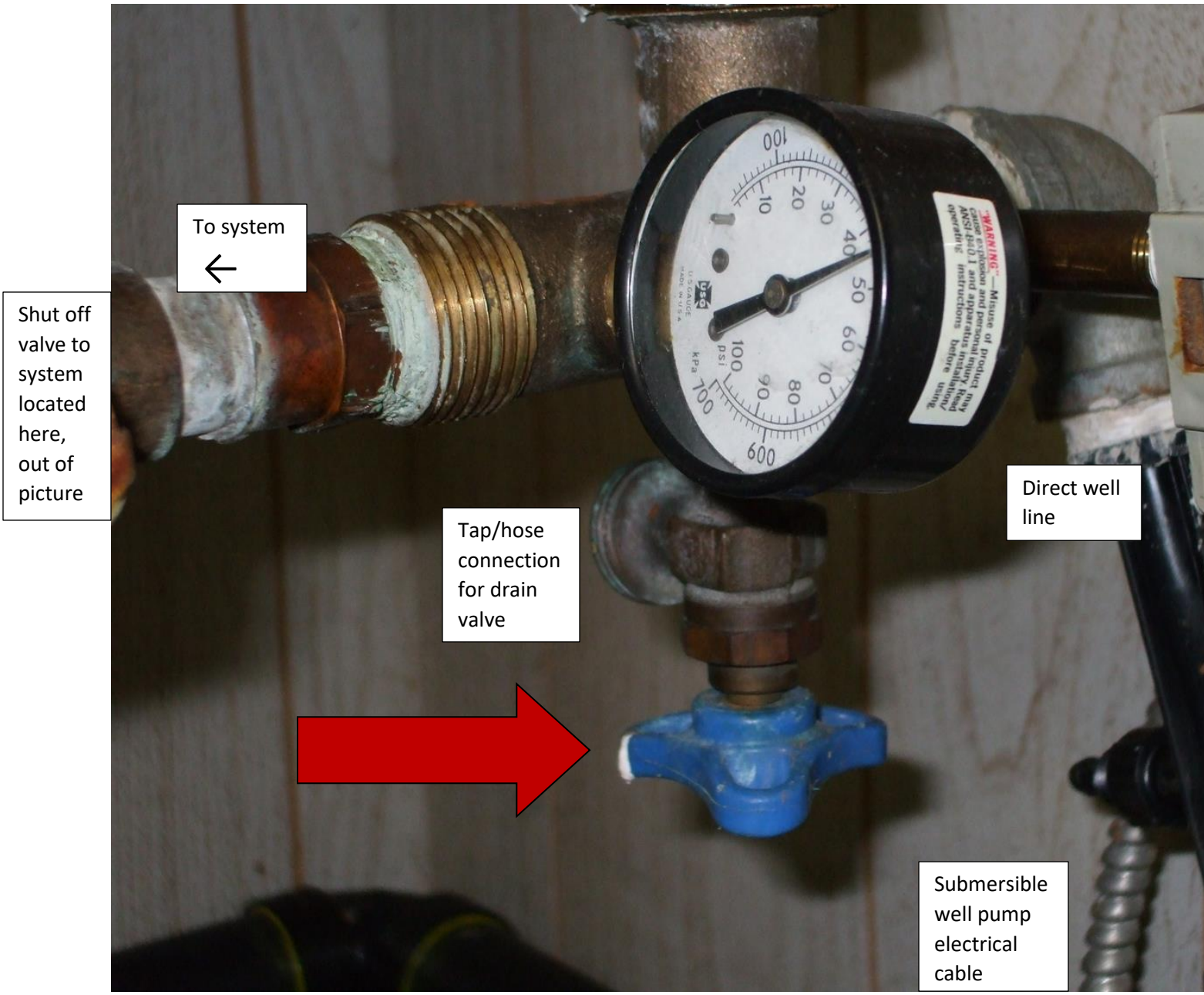


Photo: E. Pip

Figure 76. Drain valve (red arrow) at well line terminus on 43 year old plumbing. Valve (on left, out of picture) must be closed to prevent system backflow.

The procedure described in AppA1 regarding sampling at point-of-consumption is remarkable, as many changes and interventions can occur between well and tap, for example:

- Leaching from the interior of captive air tanks and pipe
- Water softeners are used to **reduce hardness**. The cation exchange resins in water softeners **adsorb calcium and magnesium, and substitute sodium ions from the softener salt (sodium chloride) instead.** Other cations such as iron, manganese and barium may be affected as well. Associated changes in alkalinity, conductivity and pH occur.
- Softener salt is not regulated for purity or suitability for consumption and may contain a variety of impurities and trace elements, for example boron and metals, depending on the source of the salt and the manufacturing method. These impurities will appear in the finished water.
- Iron filters (bubble aerator type)
  Air stripping oxidizes and precipitates iron, manganese, and other reduced elements, and displaces dissolved gases such as hydrogen sulphide, carbon dioxide, methane and radon.
- Water conditioners (many types available, not synonymous with salt type softeners)
- Home reverse osmosis systems
- Activated carbon or ceramic filters
- Leaching from copper plumbing pipe
  Presence of manganese in the water further increases rate of copper leaching from plumbing systems.
- Leaching from high-lead solder plumbing joints in houses built before the 1989 Manitoba Plumbing Code-mandated plumbing solder of no more than 0.2% lead.
- Some pre 1950s houses may have lead plumbing pipe
- Certain types of PVC pipe may contain lead- or cadmium-based stabilizers
- Galvanized pipe and components may contribute zinc
- Brass plumbing fixtures may contribute lead and zinc
- Corrosion-resistant fittings may contribute cadmium
- Fixtures and tap aerators may leach chromium and other plated metals
- Tap screens/filters/aerators may leach accumulated organic matter from bacteria, and other foreign materials

- Leaching of many materials, including petroleum hydrocarbons and PAHs, from rubber seals, washers, O-rings, plumber's tape
- Since the tap carries both hot and cold water, scale in the tap components includes the many substances leached from hot water tanks and pipes. Water heaters may contain magnesium or aluminum anodes (MDH, 2021). Elevated temperatures greatly increase leaching rates of copper, lead, zinc and cadmium, which may be redeposited elsewhere in the system. Solution of mineral salts is also increased at high temperatures, thus water chemistry of hot and cold tapwater differs.
- *Legionella* bacteria may colonize hot water pipes and taps
- Sulphur bacteria may colonize water softeners (MDH, 2021)

Source: Pip Water Quality lectures, University of Winnipeg

Consider the following disingenuous statements in light of the above:

"Private wells (23901 and 66124) were screened in the Red River Carbonate, and water quality is characterized by higher sodium (i.e. 134-138 mg/L) and low calcium and magnesium (<0.2 mg/L) concentrations" (AppA1, p. 49). Therefore we see that the water softeners were doing their job.

"The elevated sodium and low calcium/magnesium concentrations are likely due to the use of a water softener (i.e. water softener salt), which is primarily composed of sodium chloride." (AppA1, p. 49).

The **purpose** of water softeners and conditioners is to alter the water chemistry, *substantially*. The results "are **likely** due to the use of a water softener"? "Without application of the water softener, groundwater in these two private wells **would likely be similar** to water samples from the carbonate or sandstone units" (AppA1, p. 49)(Emphases are mine). It would "likely be similar"? These are the data? Why were sampling and analysis even conducted, when it could just have been imagined what the results "likely" are?

Some homes have a dedicated tap for consumption in the kitchen which bypasses the water softener. However even in these instances leaching from the various components of the plumbing system still occurs, and the water is usually also treated for iron. Therefore **water from point-of-consumption taps is not representative of the original raw groundwater, and results obtained in this way are <u>invalidated</u>**. Two of the three (!) samples are corrupted.

The reviewer in TAC (#41) identified this very problem. This elicited the following reply: "The author agrees with the reviewer that water softeners impact the chemistry of the water in the sample. However, the purpose was not solely to characterize the quality of the water. Rather, it was to **document any changes in water quality before and after the**

pumping test as a matter of due diligence. Further, it would be inappropriate for CanWhite and their consultants to modify the plumbing and well construction to provide access to the wellhead for sampling purposes at this stage." (Emphasis is mine).

The hole just gets deeper and deeper. The following observations can be made:

1. It now appears that the corrupted samples were not really "solely" for the purpose of characterizing water quality, even though in AppA1 (p. 49), the actual word "characterized" is used (AppA1, p. 49).

2. "Rather, it was to document any changes in water quality before and after the pumping test as a matter of due diligence." Diligence?

It was a poor and unacceptable way to document water quality changes for the pumping test, as there was no assurance that the various unknown extraneous factors remained constant for valid comparison. For example, at the two times the samples were collected (i.e. before and after pumping), **the softener may have been, and highly probably was, in a different stage of its regeneration (backwash) cycle** (Figure 77). Sheesh, people.

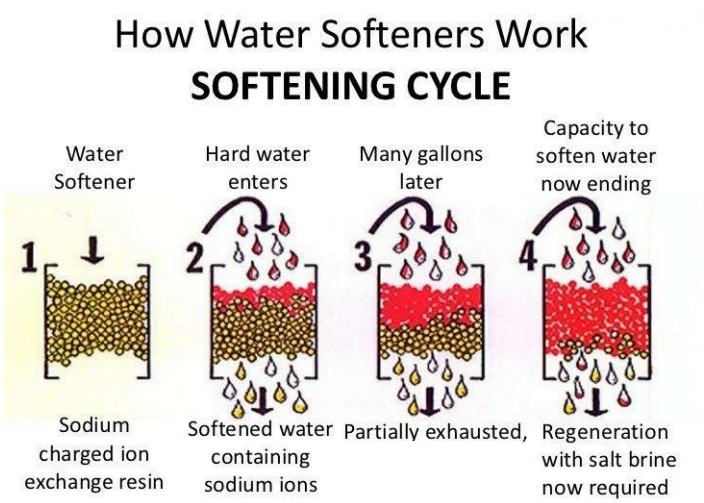


Figure 77. Water softener cycle. Note that exiting water quality depends on the cycle phase. Source: https://www.alibaba.com/product-detail/High-efficient-40m3-hour-water-softener_60792442533.html

The softener may have completed regeneration in the interim between samples, the brand of softener salt added in the interim may have changed, the brine tank may have been cleaned of salt impurity deposits, scuzz and drowned bugs, flow rates (usage) may not have been constant, etc. And if there was an iron filter as well with its own regeneration cycle…….or an activated carbon cartridge may have been replaced…or….. All of these contribute to fluctuations in what finally comes out of the tap. We are also *assuming* that

the line was flushed to purge any water originating from the hot water tank or standing in the *entire* system before the sample was collected at the tap. The flushing would have to have been sufficient to ensure the water was new-draw water from the aquifer beyond the well pipe, and would include a completely purged water tank. If it was water that was already in the pipe or tank, it is invalid. But it is invalid anyway if it has passed through water treatment devices or been exposed to plumbing components.

"Dissolved copper and zinc concentrations exceeded CCME for aquatic life." (AppA1, p. 48). We infer that the copper came from copper plumbing, the zinc from hot water tank residues in the pipe (tap not flushed before sampling), or from fixtures.

3. Modifying plumbing and well construction is rather radical when simple drain valves can be accessed before the water enters the system. [The valves are simple enough that they can be operated without the need for an Engineering or Physics degree, and there is only one rule to remember, the Plumber's School battle cry: "Righty Tighty, Lefty Loosey,".] Flushing of the well casing and cutoff from the system still need to be observed.

4. Reference is made to modifying plumbing and well construction "at this stage". Are there plans to do so in the future?

Apparently the answer is yes. "Given the unknown status of the majority of pumps, it is prudent to conduct a physical survey of water supply wells in advance of operations in each area to document the well location, well condition, water level, pump installation depth, water use and water quality, followed by monitoring during and following operations. CanWhite will conduct a detailed pre-development well survey to obtain accurate well coordinates and document well construction and operational use to establish appropriate mitigation measures which may include setbacks, modified operations or **adjustments to pump installation depth** at CanWhite's cost." (TAC, #36)(Emphasis is mine).

"Water quality monitoring will include sampling the landowner well water." (TAC #56).

Most certainly **actual uncorrupted data** would be desirable and refreshing. However a number of logistic and legal issues arise:

- Intrusive physical access to the private wells is required on several occasions (in advance, during and following operations), which includes opening the wellheads and may require admission to people's homes. Homeowners may have privacy concerns and be uncomfortable or opposed to allowing admission to strangers and company representatives. The latter have no legal rights to enter people's homes (see below), however can they tamper with outdoor wellheads without the homeowner's permission? The law is somewhat blurry on this issue:

  According to Section 57(1) of The Groundwater and Water Well Act (C.C.S.M. c.Gg110), "the director or a well drilling officer may, without a warrant, enter and inspect any

place or premises at any reasonable time for the purpose of administering or determining compliance with this Act."

Note that **inspection is for the purpose of compliance with the Water Well Act**. In the present instance, compliance with the Act is not at issue, rather it is compliance with a private company's data collection program. The wellhead is usually outdoors and accessible. Where is the legal line and how much authority does the company have? Further, a *dwelling* can only be entered with the owner's permission, or with a warrant. However a warrant may be waived in "exigent circumstances". It can also get nasty (Section 57(5)), no more said.

Further, it depends on who a "drilling officer" is (this is not defined in the Act). Would this be the driller employed by the company? Would a company representative also qualify, as a sort of *zone grise* deputy?

Does this "drilling officer" also have the right to make modifications to people's wells if the owners are opposed? The legislation peters out here. We can see the potential for legal challenges springing up. It is certainly time to update the inadequate and mushy Act.

- Will a written agreement include **exact** details regarding what will be done? (see Appendix). "Agreement" means that **both** parties consent.
- Does the company assume liabilities for any damage to well infrastructure that may be inflicted by inexperienced, rushed, indifferent, or bumbling staff? For everybody's protection, the well owner would be advised to be present and should document the proceedings with a camera. The owner should also be notified of all visits in advance.
- Given the difficulties encountered above with water quality sampling and the excuses provided in the EAP (AppA1, p. 46): "Samples could not be collected directly from the residential water wells because downhole equipment and wiring obstructed sampling equipment.", how indeed, then, will "well condition, water level, pump installation depth" and water quality be assessed? For hundreds and hundreds of private wells?

- An entirely different source of contamination must also be considered with respect to the well pumping samples: "It is AECOM's opinion that the sample collected prior to the end of the pumping test was influenced by grouting during well installation. Grouting can impact water quality temporarily in the area around the borehole until the grout has set." (AppA1, p. 50). How many other samples may have been corrupted in this way? And how "temporarily" would water quality be affected, since leaching can continue long after grout has set (see p. 246)?
- Yet, despite all of the foregoing travail, and the proponent's admission regarding concerns with water sample collection in TAC (#41), said proponent then denies such in

response to my comments in RPCR (#50), where I am referred to RPCR #5, which in turn refers me to the dead-end blank wall of some inaccessible Stantec 2022 report, and to the EAP which elicited the comments in the first place. One just cannot get ahead.

The RPCR (#5) response includes: "Proper Chain-of-Custody (COC) procedures were applied and all testing was conducted by independent accredited laboratories." The reply misses the point entirely: COC procedures and laboratory testing are irrelevant if the sample was **collected from an inappropriate or corrupted source**. The best protocols in the world that follow after will not magically correct the initial mistake.

I respectfully submit that my comment regarding invalid samples stands.

- Since pH is dependent on factors such as temperature (which in turn affects solubility of carbon dioxide, which in turn affects carbonic acid concentrations and the carbonate buffer system equilibrium), pH *in situ* virtually always differs from pH measured after the sample has been bottled, transported, and stored. We see this difference in Table 4-8 (AppA4), where all of the lab values are higher than those obtained in the field, and are of little evidentiary value. Given the importance of carbon dioxide in groundwater, it is important to obtain field measurements in order to obtain accurate results. Similarly oxygen must be measured *in situ* as well because of solubility differences with different temperatures, pressures, and salinity.

- On pp. 46-47 of AppA1, "The following additional parameters were also **analyzed at the water well:**
  Biological oxygen demand (BOD); Chemical oxygen demand (COD)
  Polycyclic aromatic hydrocarbons (PAHs)
  Phenols
  Petroleum hydrocarbons (i.e. benzene, toluene, ethylbenzene and xylenes)"
  (Emphasis is mine).

  These parameters are separate from those described as "submitted for analysis". The statement indicates that apparently these parameters were analyzed in the field (i.e. "analyzed at the water well"). What methodology and instrumentation were/could have been used, since most of these procedures require specialized laboratory techniques?

- Question #37 in RPCR pertains to the presence of lithium in groundwater in the region. The proponent responds that "Lithium will be analyzed in all samples and compared to applicable water quality guidelines." Three comments should be made here:

  1. There is no Guideline for lithium in the Canadian Water Quality Guidelines for Drinking Water.
  2. Moderate amounts of lithium are beneficial in drinking water in that "lithium has moderating effects on suicidal and violent criminal behavior at levels that may be

encountered in municipal water supplies." (Schrauzer and Shrestha, 1990).

3. However lithium is toxic at higher concentrations (Aral and Vecchio-Sadus, 2008); elevated levels may arise from contamination, e.g. lithium batteries.

- The provided water chemistry data are incomplete. Table 4-8 (AppA4) for example, is plagued by missing digits or clearly incorrect results. Nobody checked the data before they were put forward.

- Despite all of the above and foregoing, the proponent publicly claims that "The application [EAP] includes a **thorough study** of what will happen to the quantity and quality of the groundwater in the aquifer that supplies homes and businesses in Eastern Manitoba." (SIO2) (Emphasis is mine). A thorough study? Perhaps it somehow accidentally got left out?

Ultraviolet light irradiation

Disinfection purpose and rationale

- A variety of microorganisms that may pose a public health risk have been reported in contaminated groundwater (see p. 127). It is abundantly documented in the literature that groundwater may be tainted with pathogens during well construction, and in the absence of sanitary measures, "bacterial contamination from the construction phase can last for several months." (Pedley and Howard, 1997), while viruses can remain viable for much longer (see p. 126). During this time, pathogenic organisms may travel to neighboring domestic wells. In the present proposed project, besides the construction phase, many additional opportunities for contamination will occur as the water journeys through the various processing stages before being reinjected to the aquifer. It must, therefore, be sanitized in order to prevent the introduction of undesirable microbial contamination.

- The EAP proposes onsite ultraviolet light treatment, but details are significantly lacking. According to EAP1 (p. 11), "The water portion of the sand and groundwater slurry that will be brought to surface through extraction wells will be separated from the sand at the extraction site. This groundwater is then returned to the aquifer via the sand producing well after being treated with UV light."

  On p. 19 of EAP1 we see the comforting statement: "UV light acts very rapidly by rending [sic] any bacteria, viruses or protozoa that may be present inert when they are exposed to the UV light". Further, in TAC (#42): "UV systems are widely used to disinfect industrial and municipal water for potable and non-potable uses."

<u>UV disinfection systems are used ONLY when a number of strict conditions are met</u> (see discussion below). They are **an ancillary treatment** when used for industrial and municipal water, **not as stand-alone**. According to the Manitoba Office of Drinking Water (MODW, 2020), "UV is typically used as an **Additional** Primary Disinfection Barrier" (Emphasis is mine). It is generally combined with filtration and chlorination (or ozonation) at the very least, but may comprise the latter part of a more complex treatment system, for example a sequential suite of "oxidation with chlorine dioxide (ClO2), ballasted flocculation, ozonation, biological filtration, GAC adsorption, UV disinfection, and chlorination" (Hulsey et al., 2004).

In potable water treatment, the primary purpose of UV disinfection is to inactivate protozoan *Cryptosporidium* oocysts, which are resistant to chlorination, although other microorganisms are inactivated as well. The City of Winnipeg, for example, utilizes coagulation/flocculation, air flotation, ozonation, filtration, chlorination, and finally UV irradiation. Even for small treatment systems, such as residential point-of-use applications, a pre-filtration step is still required, unless the raw water is free of particles and dissolved chromophore materials that may absorb UV wavelengths or interfere with their penetration.

- The EAP1 (pp. 18-19) neglects to disclose any actual information: a simple generic diagram of a UV lamp is provided, but specifics intended for this project are completely absent: the type of mercury arc low or high pressure lamp, its primary wavelengths and monochromatic or polychromatic characteristics (200-300 nm are required, but generally 254 nm is used (McElmurry and Khalaf, 2016), the radiation output, collimated beam or other, sleeve characteristics, and the configuration and size of the reactor chamber. There is no information regarding how the unit will be powered onsite, or what failsafe features will be available in the event of power interruption or failure. The proponent's TAC response (#11) does not address this.

  "In TAC (#11): "Treatment will use previously validated UV disinfection equipment which will provide the required pathogen inactivation based on a set UVT (UV transmittance), UVA (UV absorbance) and turbidity. It is likely that this system will be designed based on an incoming UVT of >65%. Online metering of UVA and UVT will be included in accordance to the United States Environmental Protection Agency's UV Disinfection Guidance Manual, which is considered the industry standard for this type of treatment. Additional testing related to fecal/total coliforms would also be considered."

  A number of observations arise:

  1. The USEPA (2003) 'UV Disinfection Guidance Manual', and the USEPA (2006) 'Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment' Rule identify turbidity and other water characteristics as major issues

affecting UV disinfection effectiveness and suitability, and thus render this method inappropriate in the present context.

2. What exactly is meant by **"previously validated"?** Proper system validation and calibration depends on a series of factors **unique to the individual system** and is normally conducted by a qualified technician within the setting where it has been installed. Testing at the factory to ensure the system works does not reflect actual operating conditions.

The USEPA UV (2003) Manual Rules have been summarized by Hulsey et al. (2004) - I quote verbatim:

"The test conditions for validation must include flow rate, UV light intensity, and lamp status. Validation of the UV reactors must also take into account the following factors: UVT of the water, lamp fouling and aging, measurement uncertainty of on-line UV intensity sensors, UV dose distributions arising from the velocity profiles through the reactor, failure of UV lamps or other critical components, and configuration of inlet and outlet piping." Further, validation also requires "Inactivation of a test microorganism whose dose-response characteristics have been quantified with a low-pressure (LP) mercury vapor lamp."

Clearly these factors cannot be "previously validated" when the system has not even yet been designed.

3. The issue of calibration is a concern because the system will not remain in place, but will be continually relocated. For example vibration and jarring may affect precise component alignments and settings, which may in turn affect performance quality. How will the system be revalidated/checked once it is set up at each new location?

4. What was the rationale for a UVT of >65% in the apparent absence of supporting data?

5. There is no indication of how a UVT of >65% will be achieved, for it is impossible at an NTU of 20+ in the present field conditions without substantial pretreatment (AppA1, p. 48)(see Figure 39).

6. "Additional testing related to fecal/total coliforms would also be **considered**." **?** (Emphasis is mine). As they haven't been considered thus far, future consideration is doubtful. Yet in the present situation this type of common contamination is a primary reason for disinfection in the first place.

7. It is not clear what is referenced under the term of "pathogen", since the most commonly monitored pathogens in drinking water are coliform bacteria, but these have not yet even been "considered". Besides the many varieties of coliforms, there are numerous other harmful human pathogens that may contaminate and persist in

groundwater (see p. 127). Besides pathogens, other biological organisms of aesthetic or operational concern can also contaminate groundwater (see p. 268+). Disinfection must therefore be designed with a broader range of potential targets in mind.

8. **Flow rates** are not mentioned but are essential core information because different pathogens vary in their response to UV light and require **minimum threshold exposure times** (e.g. Table 6). Flow rates, calculated and calibrated for the specific system and requirements, and UV dosage **must remain constant** for adequate and consistent pathogen inactivation. According to USEPA (2003), "It is very important that the operators are able to control the UV output in the reactor so that at least a minimum UV dose is applied at all times." Variations in flow rates, turbidity, and UV absorbance of inorganic and organic solutes, and other factors must therefore be considered.

Table 6. UV dosages (top row) required for three sample pathogens (two protozoa and a virus) according to level of inactivation achieved. Inactivation level increases with higher dosage. Source: Passantino and Yonkin, 2003).

UV dose (in mJ/cm2) required by LT2ESWTR to inactivate target pathogens

Log Inactivation								
	0.5	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**
Cryptosporidium	6.8	11	15	21	28	36	-	-
Giardia	6.6	9.7	13	20	26	34	-	-
Virus	55	81	110	139	169	199	227	259

Flow rates in the proposed system will vary, as the water destined for disinfection will derive from the dewatering screen (TAC #9): "A dewatering screen is a one layer inclined screen. The screen catches the sand, and allows the water to pass through. The wet sand then travels off the inclined screen into a sump, and the **water that flows out the bottom of the screen feeds into the UV light treatment system** before reinjection (by gravity flow) back to the sandstone aquifer." (Emphasis is mine).

However the percentage of sand in the raw extracted mixture will greatly vary: "Early in the extraction process for each well, the slurry will consist primarily of solids (est. 70%) and will slowly reduce to approximately 20-30% near the end of well production." (AppA1, p. 22). In the EAPPF (Appendix H), "Slurry from the well are [sic] as high as 90% sand", and "At the time of field testing, Sio saw production rates with sand (solids) as high as 90% sand concentration." (SSCRIR1 #DLN-IR-003). The number of wells operating at the same time may vary as well.

Therefore the volumes of "water that flows out the bottom of the screen" will also vary. Presumably this water will be captured in some sort of collection tank, from which it will be pumped at constant flow rates, although this is not stated. However the volume in the tank will be variable. Collected water would derive from up to seven wells combined, in addition to intermittent contributions from the sludge drying field or filter press (SUPPL4). Given the volume, a skid of multiple UV lamps in parallel would be required. Thus extraction rates and reinjection rates will vary; water collection cannot exceed reactor chamber flow rates, otherwise the collection tank will overflow. Minimal UV contact times must be maintained. What impact will extraction stoppages and restarts have?

"The control narrative related to pumping operation is still in the preliminary design stages, but will include industry-standard operational fail safe requirements such as: alternating Duty/Standby UV disinfection units, the inability for the UV system to be bypassed, separate alarms to indicate lamp failure, low UV intensity and other causes of UV disinfection unit failure. A dedicated programmable logic controller (PLC) may be provided given the mobile nature of the systems, and multiple PLCs may be provided as necessary to ensure continuous treatment, depending on the final controls design." (SRTER #7, TAC #11).

Such an important component of the process "is still in the preliminary design stages", a "narrative" only, yet the proponents are anxious to start operations. Where is the actual design of the actual system that will be used in the actual operation? Should this not be finalized, tested, and in place *before* any operations are contemplated? What about the test wells that have already been injected: no UV system was present there. How can the project proceed without a completely functioning system already in place?

- In TAC (#42): "However, in an abundance of caution, CanWhite intends to treat reinjected water to prevent the risk of inadvertent microbial contamination. CanWhite is working with industry leading UV treatment specialists and a certified lab to determine the required level of UV treatment and filtration (refer to response for #11). UV systems are widely used to disinfect industrial and municipal water for potable and non-potable uses. To support the design of the UV treatment system, CanWhite will be undertaking additional water quality testing to support the design of the UV treatment system [redundant sic]. Several parameters will be monitored in the field and verified by the analytical laboratory to guide system design." (also RPCR #211, SRTER #7).

  The following questions arise:

  1. Who are these "industry leading UV treatment specialists", and why are their opinions/comments regarding UV feasibility for this application not available, since they are already working on the problem?

2. **The treatment system has not yet been designed**. "At this preliminary stage, the final design criteria for the UV treatment system are being developed." (TAC #11). "Sio has not finalized the filtration and UV system design." (SSCRIR1 #DLN-IR-004).

- What "additional water quality testing to support the design of the UV treatment system" will be undertaken, and who will independently conduct and approve it?

- What are the "several parameters" that will be "monitored in the field" "to guide system design"?
- How does one monitor pathogens, which are the purpose of the system, in the field?
- Given the sorry state of many of the field data already reported in Table 4-8 (AppA4)(see p. 255+), will this future monitoring be any better?

3. The following portion of the proponent's response (TAC #11) is **FRIGHTENING**: "Regarding technical specifications of the UV treatment system, a design dose of 25-30 mJ/cm2 is typical for **waste water treatment systems** designed to meet **200 MPN/100mL fecal coliform** limit, but **a higher dose may be required** based on local water quality and UV lamp fouling estimates. At this preliminary stage, the final design criteria for the UV treatment system are being developed. The final system design may also include a system that provides a target of 3-log (99.9%) Inactivation of both Giardia and Cryptosporidium in accordance with local drinking water standards, although this is a higher level of treatment than is typically used in other applications when returning treated water back to the environment. An upstream filtration system may be required." (also RPCR #211; SRTER #7; SSCRIR1 #MSSAC-IR-011; SSCRIR2 #DLN-IR-004)(Emphases are mine).

The following comments are necessary:

1. Waste water **=** sewage.

2. The above response shows a complete lack of understanding of what coliform bacteria are, what protozoa are, what **drinking water** regulations are, how UV treatment systems work. This seems to be a bunch of buzz-word gibberish randomly slapped together from the internet without any consideration for the intelligence of the readers.

It is soul-destroying that our water is handed over into such dismal custody, with the acquiescence of regulators, who, in the 21st century, can make the statement "It is also not apparent how bacteria could be introduced during separation and if it [sic] would present in the return water" (TAC #42). If we slather enough mustard on the baloney, the feeble-minded public just might not recognize what it actually is.

3. Standard monitoring of bacteria in water targets two basic groups: total coliforms and fecal coliforms. Total coliforms encompass a broad range of both pathogenic and innocuous environmental bacteria. They are a general indicator of the bacterial load, and of the general likelihood of fecal coliforms to be present. Fecal coliforms are present in animal intestines, primarily of warm-blooded species. **Fecal coliforms in water indicate contamination with feces.** Fecal coliforms include *E. coli* (see Pip, 2015b).

4. According to Manitoba regulations, "COLIFORM BACTERIA **SHOULD NOT BE PRESENT** IN DRINKING WATER. IF COLIFORM BACTERIA ARE PRESENT, THE WATER IS CONSIDERED UNSAFE." (MSD, 2017). This same information can also be accessed on the Springfield municipal website: "**The MAC for total coliform (TC) and E. coli (EC) bacteria in water is '0,' '<1' or 'not detected.**' (MAC = Maximum Acceptable Concentration). (https://springfield.municipalwebsites.ca/ckfinder/connector?command=Proxy&lang=en&type=Files&currentFolder=%2F&hash=c245c263ce0eced480effe66bbede6b4d46c15ae&fileName=Manitoba%20Private%20Well%20Fact%20Sheet.pdf). The above **requirement of zero also applies to well water in Manitoba** (https://www.gov.mb.ca/health/publichealth/factsheets/how_test.pdf).

At the federal level, the requirement is the same. According to Health Canada (2020), "If total coliforms are detected, it indicates a serious breach in treatment and is therefore unacceptable." "**The maximum acceptable concentration (MAC) for total coliforms in water leaving a treatment plant and in non-disinfected groundwater leaving the well is none detectable per 100 mL.**" (Health Canada, 2020). **"None" means "zero".**

5. Sewage treatment plants and domestic water treatment plants have completely different outputs, which would seem obvious. We drink one, but not the other. The proponents unaccountably refer to waste water treatment, i.e. **sewage**, which they apparently use as a reference point. We also see the inclusion of wastewater effluent standards in SUPPL #4 (p. 4), even though these relate to domestic and industrial sewage treatment effluent. **Effluents meeting these limits are not intended to be somebody's drinking water or to appear in somebody's water supply well.** For the latter applications, i.e. drinking water, we have the separate and *extensive* Canadian Water Quality Guidelines (CWQG, 2014). Well water quality falls in a domain of particular concern, as it is neither disinfected, nor monitored, nor regulated in the way municipal drinking water treatment systems are, and homeowners may be unaware when their well water is unsafe for consumption. It is thus paramount to safeguard the quality and safety of the aquifer sources and not endanger them in any possible way.

The 200 MPN fecal coliform limit on which the EAP and SUPPL4 seem fixated is applicable to both wastewater effluent (https://www.gov.mb.ca/sd/eal/registries/4864wpgww/hpmc/effluent-limits.pdf) and **RECREATIONAL** surface water, i.e. swimming, wading, boating, where the water is not ingested, but physical contact is possible (Health Canada, 2012). It is **not safe** to

consume this water. Levels above this threshold trigger beach closures. Since treated wastewater is discharged to the environment, it follows that the fecal coliform limit in discharged effluent should conform with the recreational limit in the receiving surface waters.

Uncontaminated wells have no coliform bacteria. In surface waters, it is impossible for bacterial levels to be zero, because of multitudinous factors including the inherent ecosystem, soil runoff, air fallout, and anthropogenic contributions: hence the 200 MPN maximum threshold, beyond which contact with the water becomes progressively more unsafe. However in unpolluted surface water, MPN values are normally well below this threshold (Pip, 2015b).

In contrast, in **drinking water**, and domestic wells, as stressed above, the limit of fecal coliforms is unequivocably **ZERO,** i.e. **ZERO.** The presence of coliforms in wells requires that the water be boiled before consumption; for communities, this triggers a boil water advisory.

6. From the above response, we quote: "…designed to meet 200 MPN/100mL fecal coliform limit, but **a higher dose may be required** based on local water quality…".
In SUPPL4 (p. 6), it is even more plain that **the sewage effluent MPN value is the proposed treatment objective**: "This Technical Memorandum assumes that the **expected treatment objectives** include the removal of TSS and disinfection according to limits presented below.", **i.e. 200 MPN**. (Highlights are mine).

Parameter	Limit	Basis of Compliance
TSS	≤25 mg/L	monthly arithmetic mean
E. coli	≤200 CFU per 100 mL	monthly geometric mean
Fecal coliforms	≤200 CFU per 100 mL	monthly geometric mean

This abomination is also repeated in Table 4-2 of SUPPL4 and SSCRIR1 (#DLN-IR-004).

Saints Preserve Us!

Urban sewage treatment disinfects incoming wastewater **down to** the recreational level of 200 MPN for surface water. Wastewater plants are unable to put out water at 0 MPN, i.e. drinking water standards (unless the system is on the Space Station where *all* water has to be recycled and purified).

How would perfectly good water from the aquifer become contaminated with such a staggering level of bacteria? To obtain these levels, will the Portapotties be dumped into the water? **And "a higher dose may be required" than for 200 MPN?** Really? Words fail us. If we ever saw such levels in the aquifer, it would be under permanent "DO NOT USE" health orders and wells would be sealed. **Sewage treatment plant criteria do not**

apply to drinking water. We would not drink from the outfall pipe from a sewage treatment plant. Drinking water criteria are necessarily vastly more stringent. Evidently there is no understanding or awareness of even the most basic public health concepts regarding safety and risk of water supply. It is terrifying.

In their "'Facts Matter'" public ad campaign in The Clipper (November 24, 2022, p. 8), the proponents declare: "Yes, your water is safe." We can understand that this innocent and unintentional typo ought to read: "No, at a whopper of 200 MPN, the water would definitely NOT be safe." The things that one reads in the papers nowadays, it makes one blush.

In The Clipper (January 12, 2023, p. 10), the proponent trumpets: "Canada has some of the world's best laws to protect water… but even with that, **we exceed them."**
(Emphasis is theirs).
To this we can answer, YES, 200 MPN does exceed zero.

7. As an illustration, in Walkerton, Ontario, where 2300+ people were sickened in the year 2000 and at least 7 died, "The highest bacterial density was 260 total coliforms and 230 fecal coliforms per 100 mL. This water was seriously contaminated: these levels of fecal coliform contamination should not be found in a secure groundwater source." (RWI, 2000-2002). Well water was contaminated with livestock manure. To avoid a similar situation, **what precautions** will be taken in the present project where wells will be located in pastures or near barns?

8. In SUPPL4 (p. 8), "Several microbiological analyses [i.e. only 6 samples, note is mine] have been conducted at different sampling wells to investigate the presence of fecal coliforms and E. Coli. As expected from a deep groundwater source, none of the microbiological pathogens were present in the samples."

Yes, *of course* this is expected from a relatively pristine water source (for the time being) – it would be alarming otherwise. Reiterating point no. 4 previous, how would this fine water acquire 200 MPN, without some egregious accident or deliberate act of malice?

-More to the point, **why was the reinjected water not tested, to ENSURE that the MPN REMAINED at zero** when the water was introduced**?**

-Were these microbiological samples collected after the bleach had been dumped into the wells? (See p. 329).

-in SSCRIR1 (#DLN-IR-001), we learn for the first time that: "Sio also took microbial samples 6 months after the extraction test both on the extraction test location including the extraction well and monitoring wells, as well as monitoring wells off location. The results were all negative for total coliforms and E.coli."

We have to point out here that unless there was an **ongoing source of contamination**, it would have been strange and alarming to see continued presence of coliforms at the same place where they were introduced, because they would have **moved on** with hydraulic flow, especially after half a year. Groundwater flows, this is a basic principle of hydrology. Contaminants do not remain stuck in the same place where they were introduced. This is why aquifer contamination is such a concern, because it can affect a large number of other users. And groundwater flows even more when cavities have been created.

9. "UV lamp fouling estimates": lamp fouling is an ongoing worsening progression, and therefore continually increases (see discussion below). Rates of fouling dictate frequency of lamp sleeve cleaning, and this should not be based on "estimates" (i.e. guesses), but on known and monitored metrics. While fouling is cumulative, fouling rates are not constant, but fluctuate according to the precipitate incurred from the water passing through the reactor chamber at any given time, and flow rate. Furthermore, since the unit will not be stationary, but will deal with water from different locations, these factors will vary at different sites.

10. "The final system design may also include a system that provides a target of 3-log (99.9%) Inactivation of both Giardia and Cryptosporidium". These protozoan parasites are addressed in drinking water treatment plants with UV light because they are resistant to chlorination. Significant numbers of cysts are required in order to calculate 3-log inactivation. In drinking water treatment plants, **UV is used in combination with filtration** of the cysts through sand bed filters. UV does not work in turbid water. "An upstream filtration system may be required." Presumably this nebulous afterthought refers to turbidity, not protozoan cysts.

11. "At this design stage a detailed level of scheduled maintenance and upgrades is **not practical**, but would **likely** include regular UV lamp replacement, regular calibration of sensors, and the **potential** for additional UV disinfection units to be installed within the overall piping system based on **projected** changes in flow." (TAC #11)(also RPCR #211) (Emphases are mine). In other words, this hasn't been thought of yet: "not practical", "likely", "potential", "projected", and is just a speculative twinkle in the eye of the proponent. Which sensors are being referred to, who will do the regular technical calibration, where in "the overall piping system" would these additional units be installed, and how will the problem of "changes in flow" be surmounted? Perhaps the project itself "is not practical"?

"At this preliminary stage, the final design criteria for the UV treatment system are being developed." The proposal should not have been brought forth at such a 'preliminary' and dysfunctional stage. In the meantime, there is no plan, yet operation is imminent, indeed <u>extraction and injection have already occurred, without benefit of a functional system</u>.

12. In SUPPL4, there is still no design or plan. Some available UV systems are mentioned, but "these specific solutions are not currently proposed, used for example purposes only" (SUPPL4, p. 17), apparently as fillers. Some are not mobile, some are too small and would need to be multiplexed, multiplying logistical, maintenance and monitoring issues. However, that section of SUPPL4 does show that some brochures have been viewed at least, so it is not as though nothing has been accomplished.

The proponent remains undeterred: "Sio is confident that water can be effectively treated utilizing UV." (SRTER #7). "Sio is confident that water can be effectively treated utilizing UV and filtration, and that reinjection of water into the aquifer will not cause any **significant** impacts to water quality." (SSCRIR1 #DLN-IR-004)(Emphasis is mine).

1. What does "**significant'** mean? ANY impacts are unacceptable.

2. After all of the foregoing head-banging, we have to point out that water quality also includes *chemical* characteristics, which are another question entirely.

Lamp aging

- UV lamps have a limited, rather short, effective lifespan and must be monitored to ensure they are replaced when output starts to decline. Figure 78 shows that declines are well evident within a year of operation (Brooks et al., 2017). UVT monitors to account for actual lamp output require periodic calibration to ensure measurement accuracy. The latter authors also recommended that the UV system be housed within "a closed building" in the interests of cleanliness and protection. Because the units would be continually relocated, disturbance would elicit a greater and more frequent need for recalibration. Who would be responsible for this necessary service?

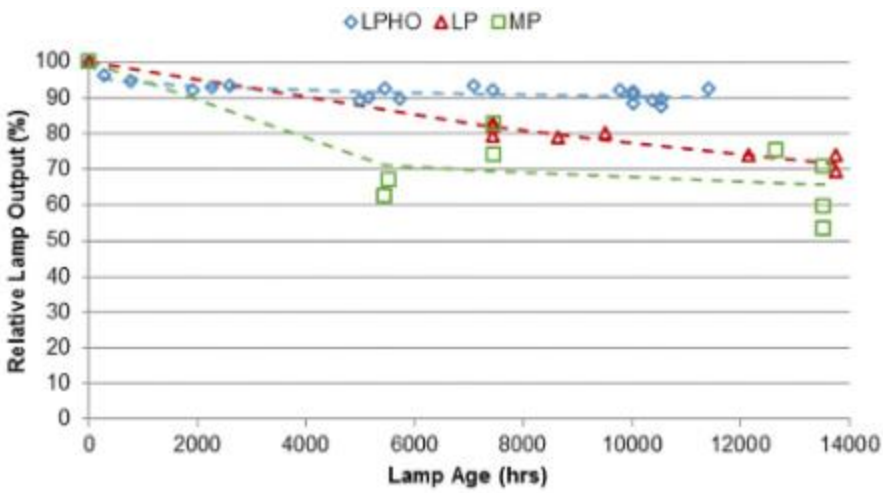


Figure 78. Decline in percent energy output with increased operating time of three reactor types of UV disinfection lamps. Source: Brooks et al. (2017). It is not known which type is planned.

Fouling

- For hard waters, as in the present case, UV light can cause carbonate precipitation (fouling) on the quartz sleeve, which can lead to significant declines in effectiveness, therefore **the lamp needs to be continually cleaned** (USEPA, 1999). Additional fouling occurs due to "solarization of the lamp quartz envelope by the mercury contained within an operating UV lamp" (Brooks et al., 2017), where the heat of the lamp vaporizes the mercury and it is redeposited on the internal surface, increasingly obscuring it over time; this type of fouling cannot be cleaned.

  Fouling is particularly problematic in water containing iron and manganese, as in the present situation. "Over time, these elements will bond to the quartz sleeve that surrounds the UV lamp" (WUVC, 2021) and impair light transmission (Figure 79). According to WUVC (2021), "concentrations greater than 0.3 ppm of iron or 0.05 ppm of manganese are enough to create a concern when it comes to ensuring reliable UV disinfection." According to Table 4-8 (AppA4), iron and manganese levels exceeding 0.8 ppm or approaching 0.05 ppm (ppm = mg/L) respectively have been reported in the project area.

  As shown in Figure 80, significant declines in UVT occur as iron concentrations increase (Wait and Blatchley III, 2010). The latter authors found that iron and calcium were dominant elements in fouling, but manganese, aluminum and zinc may also contribute. All of these are present (Table 4-8, AppA4), including aluminum and zinc, with elevated levels of the latter metals in some samples. Thus this problem would warrant additional consideration.

Figure 79. Iron and manganese fouling of quartz sleeves. Source: WUVC, 2021

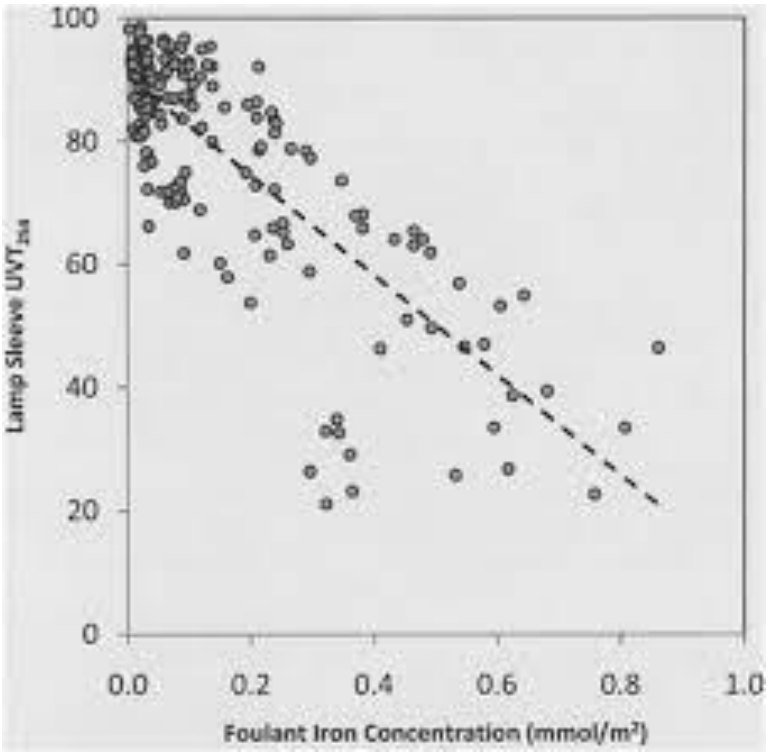


Figure 80. Decrease of UVT (transmittance) with increasing lamp sleeve fouling by iron. Source: Wait and Blatchley III (2010).

- Another associated issue that should be noted is the fact that cyanobacteria (bluegreen algae) may colonize the lamp sleeves as UV transmittance starts to decline (e.g. compare the green patches seen in Figure 79). The atmosphere contains abundant cyanobacteria and microalgae, some of which are public health concerns (Wiśniewska et

al., 2022). Exposure of the water to the atmosphere may result in contamination. According to Phukan et al. (2019), "lower UV-C doses can potentially augment cyanobacterial growth and use of unstandardized UV-C doses for restricting cyanobacterial growth may in fact produce contrary result.", as these organisms may use some of this radiation for photosynthesis and growth. Disinfection lamps generate radiation within the 200-280 nm UVC range.

As is well known, many cyanobacteria produce a variety of toxins, including the neurotoxin BMAA (Pip et al., 2016). Sun et al. (2021) reported that "only 10% of BMAA was removed by UV irradiation" in five minutes of exposure. While the potential amounts in the present circumstance may be small, they are environmentally persistent and their fate in groundwater is not known.

Breakage

- A significant concern with the use of UV lamps for water treatment is the possibility of lamp breakage (Borchers et al., 2008). Virtually all industrial UV irradiation lamps contain mercury, which can present a contamination and public health hazard when it escapes into the water being treated (Passantino and Yonkin, 2003). According to Borchers et al. (2008), "After mercury enters the system, it has the potential to directly affect the unsuspecting water consumer." In an aquifer, cleanup is not possible.

- A typical medium pressure mercury vapor lamp contains approximately 400 mg of elemental mercury (Borchers et al., 2008). The Canadian Water Quality Guideline for drinking water (CWQG, 2009) stipulates a maximum mercury concentration of 1 µg/L (= 0.001 mg/L). Thus the mercury from **one lamp** can potentially contaminate 400,000 L of water up to the maximum allowable level, assuming that no additional mercury is already present in the water.

- UV lamp breakage has been documented as a result of **rough handling, power surges, orientation angle of the lamp relative to the ground (resulting in differential lamp and sleeve heating), faulty manufacture, accidental impact from debris such as stones entering the reactor chamber, interruption of water flow, accidental bumping of the unit by machinery or vehicles, and changes in water pressure** (Borchers et al., 2008). **The foregoing assumes that the unit is not moved and remains undisturbed *in situ*.**

  Lamp breakage poses an inhalation risk of mercury vapor to workers engaged in cleanup (Borchers et al. 2008). These lamps constitute hazardous waste and require special disposal. Under the rigors of the outdoor conditions of the proposed project, the constant relocation of the unit, and the fragility of the lamps, **mercury contamination is a risk to consider**. By the time the breakage is detected, the mercury has escaped.

Since the spill into the aquifer is irreversible**,** surrounding residential wells would need to be monitored and closed if necessary, as the consumer will be unaware: therefore **immediate reporting is critical**.

A propos reporting - related link: https://www.winnipegfreepress.com/the-carillon/local/Former-CanWhite-employee-alleges--well-contamination-lax-site-safety-575758671.html?fbclid=IwAR0_3_MXoo3we8hCYt2g_tHrzXI2tG_tI1rxWPOsKX8guTaHCFAm4jsE7uM

Turbidity

- The above questions become moot, when turbidity is considered.

As mentioned above, UV disinfection is practical and effective ONLY when **requisite conditions are met**. **BUT the <u>very first prerequisite</u> is: the water must be clear and colorless**.

In the present application, the untreated water destined to be irradiated will be **highly turbid.** The groundwater in itself is already of high turbidity: the consultant's report found that for the **raw** water: "The field turbidity values were generally above 20 NTU, and well above the treatment limit ranges (0.1 to 1 NTU). (AppA1, p. 48). However the bubbled and agitated and manipulated and vibrated and screened groundwater will contain **<u>an even greater burden of suspended particles</u>:** not only calcium carbonate, silica, and various other minerals (as detailed in AppA1), but additional suspended oxidized particles of ferric iron and manganese compounds resulting from exposure to oxygen. Additional very fine particles may be generated autochthonously as a result of temperature changes when the water is brought to the surface: solubility of calcite decreases significantly at warmer temperatures; this effect is exacerbated by accompanying degassing of CO_2 and reduced pressure when the water is brought to the surface (Abesser, 2007).

Figure 81 illustrates the visual appearance of a series of turbidity standards.

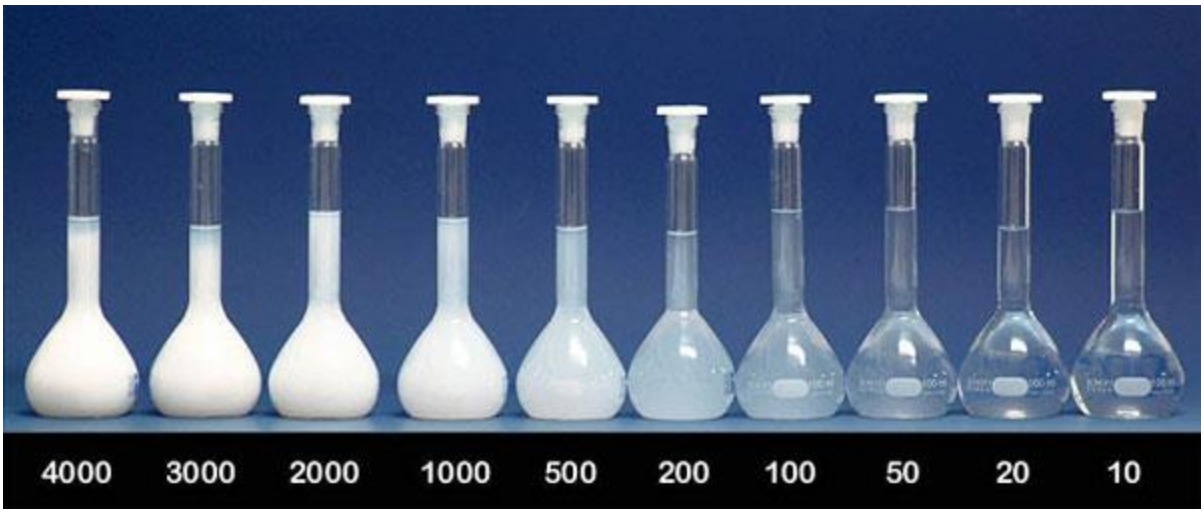


Figure 81. Visual appearance at different NTU levels. Source: https://camblab.info/turbidity-standards-quick-reference-guide/

Furthermore, the violent pressurized air bursts described in CPA will increase the ambient turbidity levels in the aquifer, and may become apparent as nuisance in neighboring well water. According to RPCR (#43), "Because groundwater moves very slowly, any disturbed natural sediments likely will settle within the aquifer and therefore will not migrate away from the active extraction area." This statement does not take into account that a pumping water well draws contaminants and suspended materials toward it in the form of plumes. A well at the small setback of 100 m may easily be affected, but plumes can travel farther, and fine particles may remain suspended for extended amounts of time (Peterson, 2001). Furthermore, oxidized iron and manganese particles will **continue to form** as oxygen is introduced into the aquifer.

"Any changes that do occur will be minimal, localized, and/or temporary. Therefore, the Project will not cause turbidity and clogging in household water systems." (RPCR #60). Turbidity is a change and inconvenience, regardless of how "minimal, localized, and/or temporary" it is. The particles will settle in the plumbing systems and clog screens, and point-of-use treatment resins and filters.

- Although there are rather few data for turbidity presented, nonetheless we can see in Table 4-8 (AppA4) that it is highly variable. The following items are noted:

  1. How was turbidity measured in the field?

  2. While many of the NTU values exceed 20, the problematic BRU 96-1 showed 105 NTU (this well has also shown highly irregular values for other parameters (Table 4-8, AppA4) and should be resampled).

3. For 'We l 6612' [sic] an NTU value of -0.10 is recorded. Because we trust that the proponent's data are always meticulously accurate and double-checked, this means that this water was clearer than pure distilled water! Even newly minted juvenile water is not this pure. This is new to science! Negative turbidity! What a tremendous discovery! No wonder the proponent is so zealous about guarding 'proprietary' secrets. Now we understand.

[Interesting Note: In order to get a real negative value, the sample would have to be luminous, and would AUGMENT the light beam in the nephelometer or turbidimeter. This would mean that the well would be lit up! Phosphorescence? Scintillation? Bioluminescent bacteria or fungi? Luciferin photoproteins? Cold nuclear fusion? Certainly a candidate for a UNESCO World Heritage Site! A shrine around the well, a Gifte Shoppe, Pilgrim revenue for Springfield.

Back to earth, we can see what happened. Some untutored novice didn't know that the nephelometer or turbidimeter (we have no idea which of these they used) needs to be calibrated beforehand, or perhaps a wrong standard, that was more turbid than the sample, was used to zero the machine. Since a negative value could be obtained even with this turbid water, this leads us to question how badly the other readings may have been underestimated. It is also concerning that such a glaringly wrong value was not even noticed, much less expunged, by the consultants.]

- A serious impediment to UV treatment efficiency is that **turbidity will not be constant** (McElmurry and Khalaf, 2016), and therefore **consistent irradiation dosage cannot be calibrated**.

- Suspended particles cause UV attenuation and **reduce penetration of the light beam** (Christensen and Linden, 2003), decreasing its disinfection capacity (Figure 82). Note that Figure 82 terminates at 10 NTU, at which point there already is a 35% decrease in effective UV dose. In the present application, reported turbidity values in the raw *unmanipulated* Sandstone aquifer water (see above) exceeded 20 NTU, well beyond the limit shown in the graph.

  Also note in Figure 82 that differences in particle sizes (at a given NTU) had only minor effects on attenuation: the end result in dose reduction was similar regardless of particle size. Filtration through a 5 µm filter showed that the dose reduction of turbidity consisting of small particles was similar to that caused by larger particles (at a given NTU). Thus filtration through a 5 µm filter would still result in some objectionable turbidity in the filtrate; the amount of turbidity reduction would depend on the particle size distribution (for which data are unavailable in the EAP), and filter mesh size. However the finer the mesh size, the greater the amount of clogging and flow interference.

Particle size distribution has however been provided in SUPPL4 (p. 7), which reveals that "around 20% of the remaining particles [after 75 µ filtration] are smaller that [sic] 38 µm", and "The removal of the smallest fraction of the particles would most likely require coagulation and filtration system." Since coagulation involves the addition of chemical coagulants, this treatment is an objectionable option.

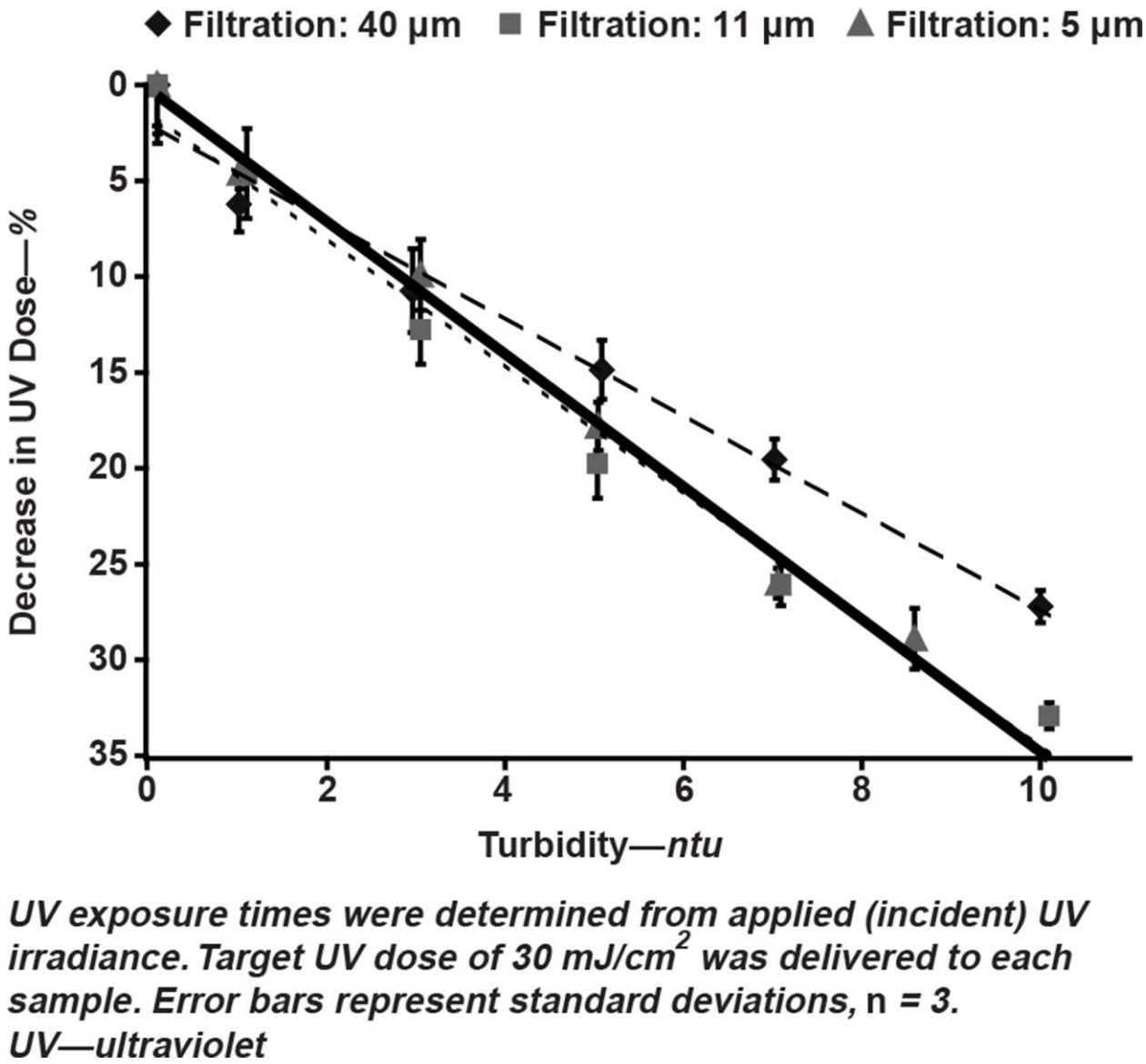


Figure 82. Relationship between effective UV dose and turbidity in water. Source: https://awwa.onlinelibrary.wiley.com/cms/asset/94d857ed-e575-4a88-9413-945a83ec1a52/awwa10344-fig-0004-m.jpg

- SUPPL4 (pp. 7-8) includes photographs (Figures 3-1 and 3-2) of two different samples of the opaque process water, before and after a period of passive settling (gravity sedimentation). The descriptions appear to be contradictory: in the first case, "the sample settled completely after prolonged period of settling time." It is not clear what is meant by "prolonged period" (hours, days), or "completely" – the latter would mean 0 NTU. In the second case, after 40 minutes of settling, "Most of the solids had settled out; however, the supernatant was still very murky." It would have been useful to quantify the turbidity using simple nephelometry. What was the NTU difference, and what NTU is "very murky"? It is not stated whether the settling time was the same or different in the two cases. In other words, what is the difference between the two samples that caused these disparate results?

  There is no further elaboration on these two Figures, and there is some murkiness regarding terminology in Table 3-2 and Figures 3-1 and 3-2. "Raw water", as characterized in Table 3-2, is plain enough, this is the water that emerges from the well in its original (but air lift agitated) state, and has not yet been further molested at the surface. Is the "raw process wastewater" in Figures 3-1 and 3-2 still the "raw water" before the removal of sand, or is it the "process wastewater" remaining after removal of the >106 µ sand fraction? If the latter, then it is not really "raw", because it is minus some components that were present in the original raw composition.

- Pathogens such as **bacteria can escape irradiation** by being **shaded** from the UV light by the particles, or **shielded** if the organisms are attached to them (i.e. tailing). A single particle may shield multiple organisms, depending on its and the organisms' size (Emerick et al., 2000). The size of the majority of bacteria ranges from 1 to 10 µm (maximum length); that of *Escherichia coli* is 1-2 µm (Riley, 1999). Thus filtration through a 5 µm mesh size will still admit *E. coli* and the particles to comfortably shield them. According to Christensen and Linden (2003), "particles entering a UV reactor, if not adjusted and accounted for, may compromise lethal delivery of UV energy".

  Farrell et al. (2018) found that *Escherichia coli* and *Enterococcus faecalis* showed the **strongest affinity for attachment to ferric iron**, **followed by calcium carbonate particles, resulting in the poorest disinfection rates**. Both of these materials are predominant in the present situation.

- While UV dose reduction increases with turbidity irrespective of particle size (Figure 82), when bacteria are added to the system, particle size becomes important: **relative disinfection efficiency declines with smaller particle size at all UV dose intensities** (McElmurry and Khalaf, 2016)(Figure 83):

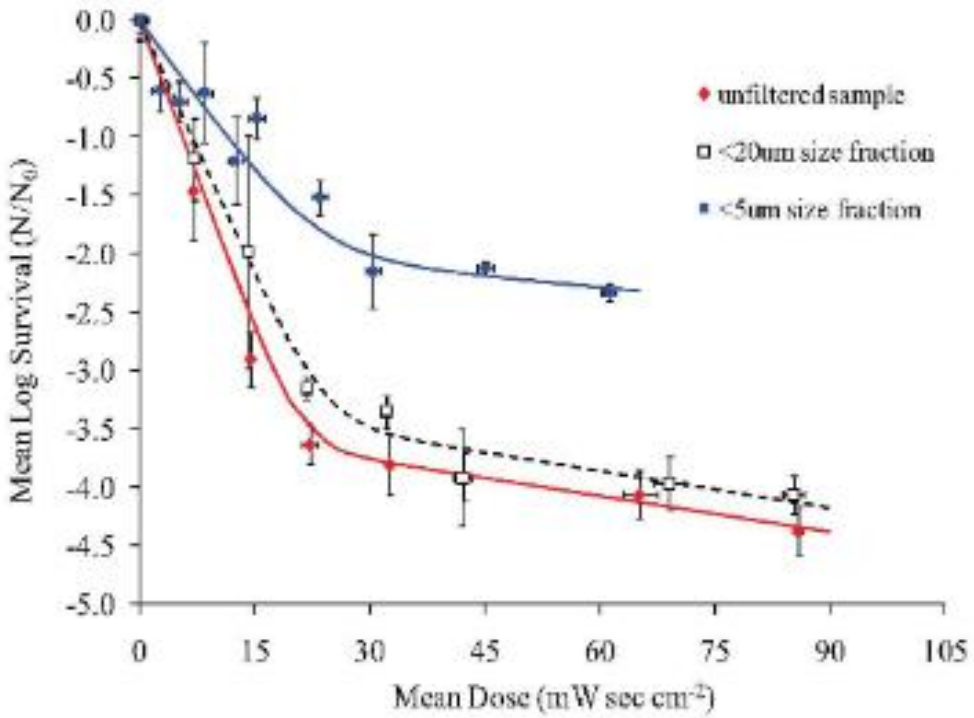


Figure 83. Exponential survival of *E. coli* irradiated with different UV doses associated with two different particle size ranges. From McElmurry and Khalaf (2016).

Thus particles <5 µm are associated with comparatively **greater** bacterial survival than <20 µm sizes (McElmurry and Khalaf, 2016). Therefore **turbidity associated with smaller particles requires more disinfection**. In the present application, **filtration to remove larger particles will still leave smaller particles that favor bacterial survival.**

- Water clarity can also be measured in terms of **suspended solids concentrations**. USEPA (1999) does not recommend UV disinfection at total suspended solids levels above 30 mg/L. The suspended solids data presented in Table 4-8 of AppA4 show that values in the Sandstone aquifer substantially exceed this threshold. However agitation and turbulence arising from the rigors of processing will further elevate suspended solids by orders of magnitude. According to SUPPL4 (p. 7), "The process water requiring treatment is expected to have effectively approximately 10,000 mg TSS/L.". In the Process Water Treatment Options technical memorandum: "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. This is a relatively high concentration. The flow is expected to range from 1,100 m3 /d to a peak of approximately 6,000 m3 /d." i.e. 10 **grams** TSS/L - this is massively substantially more than the 30 mg/L (0.03 g/L) USEPA maximum.

- In SUPPL 4, the proponent reviews a number of available treatment options for dealing with the (likely insuperable) issue of turbidity and suspended solids. These are summarized below.

  Equipment mobility is a requisite feature, but the proponent envisions that treatment will likely be a multistage, multiunit procedure, and all of the components and their physical interconnections will need to be relocated to each new working site. The proponent admits that "From an operational and logistical perspective this might be challenging." (SUPPL4, p.10). It will also necessitate the space at the extraction sites to accommodate all of the extra equipment.

  Vortex grit removal utilizes a rotational flow system (https://hydro-int.com/sites/default/files/grit_king_0.pdf), while a *hydrocyclone system* is a centrifuge type apparatus: both of these would remove only a portion of the suspended solids, and the proponent admits that an additional removal stage would still be required prior to filtration.

- Suspended particle reduction can be achieved by sedimentation in a *clarifier,* where particles are aggregated (flocculated), and settle to the bottom of a tank. The agglomerated flocs are then removed. A mechanical flocculation method would need to be chosen, as chemical coagulation and flocculation, commonly using iron, magnesium or aluminum salts is not a desirable option here. Although some silica sand processing facilities utilize polymer flocculants to remove clays during sand washing, this water is not suitable for return to the aquifer because of contamination with acrylamide and other carcinogens and neurotoxins (MDH, 2019; Pruser and Flynn, 2011)(e.g. "Acrylamide has been detected in surface waters that are not used for drinking water near a sand mine in southern Minnesota." (https://www.health.state.mn.us/communities/environment/risk/docs/guidance/gw/acrylainfo.pdf)).

  Sedimentation times depend on a number of factors, including (individual or agglomerated) particle size, shape, density, depth of the water column, and the degree of stasis and density of the water medium, which latter in turn depends on water temperature and concentration of dissolved substances. Formulae for calculating and predicting particle settling velocities are discussed in Zhiyao et al. (2008).

  However sedimentation achieves only partial removal, and presents an additional potential for contamination of the water. A *lamella clarifier* is a related but more efficient design, but it is disturbing that the proponent thoughtlessly includes the use of "coagulation chemicals" in the discussion because "According to the manufacturer fully treating the raw water without any chemicals is not possible." (SUPPL4, p. 14). For very obvious reasons, this method must be excluded. The proponent helps us along in SSCRIR1 (#DLN-IR-007): "As a point of calcification, [sic !] chemicals required for a lamella clarifier are not the same as what is required for the Chitosan Enhanced Sand

Filtration (CESF) system." Further, "However, as a point of calcification, [sic !] once a final design is reached after the issuance of an EAL, Sio will provide the design to the Approvals Branch for approval."

While the proponent seems to lean towards a sedimentation method (ideally chemical free), "Visual observations of the process wastewater suggest that the finest particle fraction <38 µm does not settle readily." (SUPPL4, p. 14), and therefore additional filtration is needed in order to further reduce turbidity.

Chitosan

- The proponent seems impressed with the mobile Chitosan Enhanced Sand Filtration system (SUPPL4, p. 15), although an "additional clarification module" would be required to pretreat the water to reduce suspended solids to ca. 1000 mg/L total suspended solids. This system utilizes **chitosan**, a partially deacetylated mucopolysaccharide obtained from marine arthropod chitin (Lichtfouse et al., 2019; Pandit et al., 2021), or from some fungi (CTCF, 2021). It is a copolymer, consisting of glucosamine and N-acetylglucosamine units, and therefore may vary enormously in its size and molecular weight: "commercial chitosan varies between 10–100,000 kDa" (i.e. kiloDaltons)(Pandit et al., 2021).

Note: We quote: "the process of converting **chiton** (as a raw material) to chitosan" (SSCRIR2 #DLN-IR-007). The proponent means **chitin,** an aminopolysaccharide found in arthropod exoskeletons and fungal cell walls**.** A chiton is an unrelated polyplacophoran marine mollusc.

- While chitosan has the advantages of being nontoxic and biodegradable, its drawbacks have been itemized by Lichtfouse et al. (2019):

  - the technology is still being developed
  - chitosan is expensive compared to traditional inorganic coagulants
  - it is not soluble in most water and requires a weak acid treatment to dissolve
  - chitosan is not just one molecular structure and configuration, there are numerous kinds, which vary in terms of their properties and performance, depending on the specific source and molecular structure; the specific variant used must be tailored to specific applications

- The majority of commercial chitosan is derived from crustacean sources, and thus contains residues of allergenic proteins, such as tropomyosin, in the final product. "It is estimated that about 1 % of the world population is allergic to shrimp, where serious adverse reactions can occur", and both chitin and chitosan products can elicit

hypersensitivity and allergic reactions in these people (see CTCF, 2021). The allergenicity of chitosan residues in drinking water have not been studied.

- The most familiar application of chitosan is in the "purification of construction stormwater", although it may also be used in treating industrial and municipal wastes (http://www.dungenessenviro.com/residualkit.html). Although chitosan is most commonly used for the **treatment of wastewater** (Lichtfouse et al., 2019), some studies are available regarding its potential use in tapwater (e.g. Soros et al., 2019), although not in Canada.

  In the U.S., chitosan is registered with the EPA as a low-risk "fungicide, antimicrobial agent, and plant growth regulator that boosts the ability of plants to defend against fungal infections." (https://www.epa.gov/pesticides/epa-adds-chitosan-list-active-ingredients-eligible-minimum-risk-pesticide-exemption). However there are many other uses as well.

- "This system is used in many places in Canada and discharges cleaned water into rivers and streams regularly." (SSCRIR1 #DLN-IR-007).

  1. "many places in Canada": it is used to treat **stormwater** in some places in British Columbia (https://www.flowlink.ca/post/2019/01/02/is-chitosan-safe-for-use-in-stormwater-treatment).

  2. "discharges cleaned water into rivers and streams": however it has been shown to be toxic to fish. For example Bullock et al. (2000) reported "that soluble acidified chitosan is highly toxic to rainbow trout even at low concentrations."

  3. In "rivers and streams" chitosan can degrade enzymatically through the action of chitinases, which may be produced by bacteria and fungi that are present in surface waters (e.g. Rathore and Gupta, 2015). In groundwater, these organisms are usually lacking, and temperatures are cold year-round.

- In water treatment, Fabris et al. (2010) reported that chitosan is effective for particle removal, but it has a narrow window of application: "When applied as the final clarification stage of a multi-step treatment process, chitosan exhibited limited turbidity reduction due to specific flocculation requirements." Perhaps this finding was due to a less efficient molecular form of chitosan, as a number of structural factors, such as degree of deacetylation and molecular weight (i.e. size of molecule) influence its performance in turbidity removal (Bhalkaran and Wilson, 2016). The latter authors noted that ultrafiltration has been used to address the smallest particles, which may not have been efficiently removed by flocculation; however chitosan residuals may clog these after-filters (Lichtfouse et al., 2019; Pandit et al., 2021).

- Where chitosan has been applied in turbidity treatment, it has usually been used as an **auxiliary coagulant** combined with traditional inorganic metallic salts, i.e. aluminum or iron, in order to boost removal efficiency and reduce the amount of chitosan coagulant needed (Bhalkaran and Wilson, 2016), as well as to bring residual turbidity down to a level suitable for filtration by sand beds, which latter level is **difficult to achieve with chitosan alone** (Hu et al., 2013). (Emphasis is mine).

  Using Figure 84 below as an example, it is evident that even under optimum conditions and at optimum dose, chitosan used alone resulted in more than a third of the initial turbidity present in the raw water to remain after treatment.

  In the present situation, use of inorganic metallic coagulants, particularly aluminum, would be problematic, as their residues would persist in the reinjected water: according to Niquette et al. (2004), "Water treated with aluminum salts contain forms of soluble aluminum." Aluminum in drinking water (and other sources) has been linked to Alzheimer's disease and other neurodegenerative conditions associated with brain neurofibrillary tangles (Mold et al., 2020). "In order to reduce its [i.e. aluminum] presence in drinking water, Health Canada considers that the use of alternative coagulants or alternative treatment processes must be considered", and "Health Canada and Environment Canada are conducting many studies linking drinking water, aluminum ingestion and Alzheimer's disease." (Niquette et al., 2004). Iron, on the other hand, generally applied as ferric chloride or ferric sulphate, brings its own set of drawbacks and faults: these have been reviewed by Niquette et al. (2004).

  The problem here before us lies in the fact that enormous volumes of treated water will be reinjected into the aquifer. Any residual metals present in it, even if in small concentrations, will be cumulative, and will augment existing concentrations in the aquifer. Although SUPPL4 is silent on the subject, we suspect that the chitosan system touted by the proponent may be a co-coagulant system. If this is the case, what will be the consequences of introducing these (indestructible) metals into the aquifer 24 hours a day for 24 years?

- According to Pontius (2016), finding the optimum chitosan dosage is essential, because "**When present in excess, chitosan has a negative effect on performance**", thus avoidance of overdosing is important (Figure 84). "Many studies have highlighted the fact that above a certain dosage of chitosan, re-stabilization of colloidal dispersions and reduced removal of the contaminant species may occur" (Bhalkaran and Wilson, 2016). According to the latter workers, "An effective dosage of chitosan relates to many factors, such as temperature, pH, the identity of the coagulant-flocculant" and other attributes of the particular system. For example, as temperature increases, a lower

dosage of chitosan is required (Yang et al. 2011). In the present situation, cold groundwater will need more coagulant. The proponent has not indicated how coagulant dosage will be calibrated; variations in amount of suspended particles in the process water will pose additional challenges.

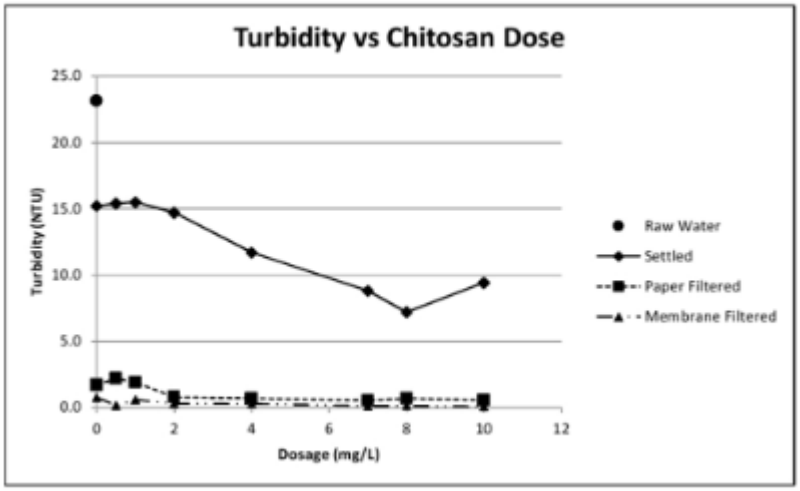


Figure 84. Turbidity reduction as a function of chitosan dosage for settled, paper filtered and membrane filtered water. Note that optimum turbidity reduction for settled water occurs at a specific dosage; greater and lesser dosages are less effective. However the optimum point will vary with other factors such as temperature. From Pontius (2016).

In SSCRIR1 (#DLN-IR-007), the proponent claims: "The concentration for the dosage of the chitosan system based on testing of the extraction water to date is in the low range of typical dosages." At the enormous turbidity levels, this statement is hard to accept. In the Process Water Treatment Options technical memorandum: "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." Where can the results of this testing be accessed? [Note: NTU is not directly convertible to mg/L because the latter depends on particle mass.]

- **Chitosan is effective at low pH** (Pontius, 2016)(Figure 85), due to ionization of the functional groups, i.e. protonation of the amino groups (Bhalkaran and Wilson, 2016), and therefore **control of pH is material to the use of this coagulant** (Pontius, 2016). According to Bhalkaran and Wilson (2016), "the pH of water and wastewater systems may be neutral or alkaline, where chitosan has limited use due to its poor solubility above its pK_a.". For unmodified chitosan, the pK_a is approximately 6.3 - 6.5, above this pH it is insoluble and ineffective (Pandit et al., 2021). For this reason, a number of modifications of the molecular structure have been synthesized and investigated in attempts to yield better performance in specific applications: some of these are

reviewed by Bhalkaran and Wilson (2016). Chitosan products for non-drinking water applications may be supplied in a dilute solution of acetic acid to address the pH problem (http://www.dungenessenviro.com/residualkit.html).

In Table 4-8 (AppA4), the range of field pH is 7.5 – 9.4 (!)(the latter suspect value is (again) attributable to the problematic BRU 96-1 well), i.e. the **reported water samples are all alkaline**. Since air lifted water will have been stripped of some of its carbon dioxide by oxygen and other atmospheric gases, the actual treatment pH will be even higher than the raw field values. In any case, pH will far exceed the above required effective plain-chitosan value. Other chitosan derivatives will have to be investigated to determine whether any can be useful, and the cost for specialized product will skyrocket. Adjusting pH of the treatment water is not an option.

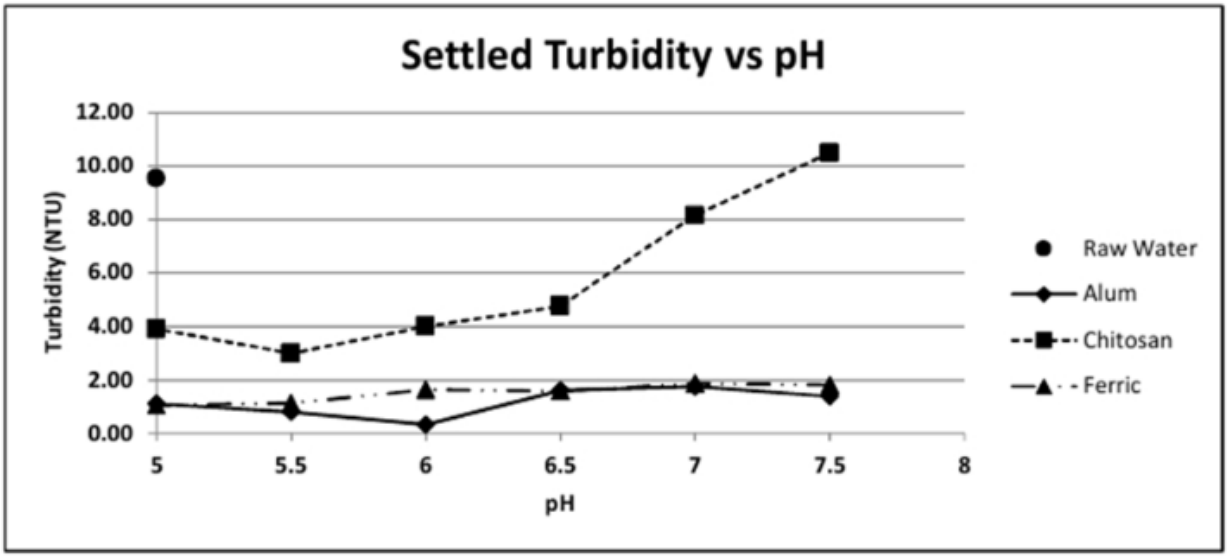


Figure 85. Chitosan is effective in turbidity reduction at low pH; at pH values above neutral, it is ineffective. The performance of inorganic coagulants shows little change. At pH 7.5, the turbidity with chitosan treatment is actually *higher* than in the raw water, likely due to the additional nanoparticles of chitosan, which is now insoluble. From Pontius (2016).

- The effectiveness of chitosan varies with the types of clay particles that are present. "The fines are largely kaolinite clay material" (RMSF-IR-002). Soros et al. (2019) found that chitosan achieved lower rates of reduction at optimal dosage for kaolinite than for bentonite. Sedimentation and filtration are also required because clay particles are small.

- Concerns are being raised regarding the environmental impacts of chitosan (e.g. Liu et al., 2021), but little information appears to exist regarding its persistence and fate in groundwater aquifers, probably because nobody has thus far thought of injecting it there. Its **degradation is largely enzymatic**, which requires the presence of appropriate microorganisms that may not be present in groundwater. Thus their absence will extend its persistence time.

  The proponent states: "If there were any residual chitosan, this residual would be extremely limited, biodegradable, and **in order to degrade, the presence of an enzyme would be required, of which there is none.**" (SSCRIR1 #DLN-IR-007) (Emphasis is mine). It is correct that chitinolytic enzymes biodegrade chitosan, and indeed there are none in most groundwaters, which would limit biodegradation.

- Some residual chitosan, although insoluble at higher pH, as well as any of its degradation products, **would still be present in the reinjected water.** Ultraviolet light alone does not degrade chitosan and must be paired with chemicals such as hydrogen peroxide (Pandit et al., 2021), therefore residual chitosan will not be destroyed during UV disinfection. According to the APSC (2022) Safety Data Sheet for chitosan (http://www.ampolymer.com/SDS/ChitosanSDS.html), we find the caution: "Prevent from entering into soil, ditches, sewers, waterways and/or **groundwater**." (Emphasis is mine).

- Chitosan degradation proceeds via depolymerization into smaller fragments, with deacetylation. An undesirable sidebar of its decomposition is that "chitosan depolymerization may lead to formation of free radicals which induce oxidation processes", indeed **exposure to UV has been shown to increase free radical formation** (Pandit et al., 2021). In the aquifer, free radicals could aggravate oxidation issues identified above. Chitosan and its degradation products would also add to the organic pool (which is already in itself indicative of contamination), and these materials would provide substrates for bacterial growth. Since chitosan contains amino groups, its introduction would also contribute to the nitrogen pool.

- The chitosan product must be certified to ensure that it does not contain impurities (Pontius, 2016). According to Pandit et al. (2021), "The wide range of chitosan sources and variety of its manufacturing processes lead to great differences in the quality and properties of chitosan products", and "chitosan material may contain some impurities, such as ash, heavy metals, or protein". Its application in the present scenario would require consistent quality control and standard of purity, which are expensive and difficult to maintain over time.

- Chitosan also presents logistical challenges: it has a shelf life and "is very sensitive to environmental conditions, hence it is recommended to store in closed containers at low temperatures (2–8 °C)" (Pandit et al., 2021).

- The above discussion leads us to a number of fundamental questions:

  1. What specific form (powder or liquid) of chitosan will be added?
  2. What specific type of chitosan will be used?
  3. **How much chitosan** will be added per liter of water?
  4. **Will metallic inorganic co-coagulants be used?**
  5. How will pH restrictions be resolved?
  6. **How much chitosan will be recovered from the water**? How much chitosan residue will remain in the reinjected water?

     In SSCRIR1 (#DLN-IR-007), the proponent claims: "Treated water from the CESF system would not have any chitosan remaining after treatment." Again, the proponent maintains, multiple times, that "There is no residual chitosan in the water that is discharged from the CESF system." (SSCRIR1 #DLN-007). Although it is begrudged that "If there were any residual chitosan, this residual would be extremely limited". Where are the supporting data?

     Test kits are available from **numerous suppliers** specifically for testing levels of residual chitosan in post-treatment water (e.g. http://www.dungenessenviro.com/residualkit.html). Why would this be, if "there is no residual chitosan"? "Fail" criteria as values exceeding 0.1 mg/L free chitosan." are specified for treated *stormwater* in the U.S. (https://www.dober.com/hubfs/HaloKlear%20Chitosan%20Residual%20Test%20Kit%20Instructions.pdf).

  7. How will dosage be adjusted for fluctuating suspended solids loads and temperatures?
  8. What is the coagulation contact time and water residence time of the tank?
  9. How large a tank will be required? This will be yet another footprint crammed into the extraction site.
  10. How will suspended solids be monitored, **at each step of the process**?
  11. How will all of the chitosan (and potential co-coagulants) in the **sludge** be managed (see discussion below).

- Another technical issue should be mentioned: residual chitosan in the water entering UV disinfection has an initial absorption band at 250 nm (Sionkowska et al., 2013), which materially coincides with the ~ 254 nm output of standard UV lamps (McElmurry and Khalaf, 2016), but as irradiation time increases, this band is replaced, and "absorbance in the region 260 – 330 nm increases after UV-irradiation." (Sionkowska et al., 2013). Thus residual chitosan may attenuate effective UV dosage.

- The chitosan system described and contemplated in SUPPL4 (pp. 15-16) as well as the supplier have been difficult to track down. The proponent notes that "this equipment is not available for purchase. Renting the equipment is currently the only option." (SUPPL4, p. 16), and it is a monthly fee (SUPPL4, p. 22). So, what happens when the supplier cuts off the rental or goes out of business? We should also ask why this system is not widely available?

Proposed treatment summary

- In SUPPL4, "Table 4-1: Sumamry [sic] of the Proposed Technologies", there is a listing of the *available* technologies – obviously all of these technologies are not being proposed (planned) to be used! In fact, these are *available* technologies: only some of them, or perhaps none, will end up being proposed, after further scrutiny and due diligence. An environmental intrusion of such import needs proper study and environmental assessment.

- The proposed turbidity treatment train, according to our understanding of SUPPL4, can be summarized as follows, and may or may not consist of the following:

1. The purpose of reducing turbidity is to allow for UV disinfection.
2. The extremely high suspended solids load must be reduced before any other treatment can be applied.
3. Hydrocyclones would reduce some of the suspended solids.
4. For the next step, a chitosan enhanced sand filtration process seems to have been approached, although the equipment can only be rented.
5. The threshold for entry into this system is 1000 mg/L total suspended solids (SUPPL4, p. 15). Hydrocyclones alone are unlikely to achieve this level, another (unknown) reduction step must be inserted, but this is not identified. How exactly would this be accomplished? More filtration?
6. Chitosan clarifier. This requires careful dosage calculations, and low pH. These are issues of concern. Further worries are the questions surrounding the use of inorganic metallic co-coagulants in tandem with chitosan.

7. UV irradiation (see discussion above).
8. Residues of chitosan and its breakdown products will persist in the reinjected water. If metallic inorganic co-coagulants are used, these too will leave residual contamination of the water.

Or maybe:

1. Hydrocyclones would reduce some of the suspended solids.
2. "Lamella clarifier with coagulant dosing system" (p. 20). Apparently this includes the chitosan system.
3. Cloth disc filtration for final filtration (pp. 16-17). But the *incoming* solids concentration threshold is only 100 mg/L (p. 17). Is this achievable, or likely some further solids removal will be needed beforehand. How exactly would this be accomplished?
4. UV irradiation.
5. Residues of chitosan and its breakdown products will persist in the reinjected water, and possible metallic inorganic co-coagulants as well.

The more steps there are, the greater the potential for compounding contamination.

- In the end, "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." (SUPPL4, p. 22)(Emphases are mine).

  According to the proponent, "Detailed design and final plans are still being finalized and those details are not required to understand and assess the potential environmental effects from the proposal." (SSCRIR2 #DLN-IR-004).

  Let's stop right there. We have not seriously tested anything beforehand, we have not even decided what the logistics will be or what exactly is needed, we have no idea if any of this will work, we have no idea what the drawbacks are, we have no idea how this will grind on, day in and day out, who will oversee, monitor and maintain it, how much it will cost. We have no idea what the short-term and long term consequences will be. In lieu of any concrete PLAN, the only 'plan' is to flounder around with this and that, and see if any of it will be any good, and keep learning from mistakes 'on the fly'. If it doesn't work out, what then? We can't undo it. Meanwhile, the water is flowing, and residents, children, seniors and ill people are drinking it, **how are we safeguarding it?** And these little piddly details "are not required to understand and assess"?

Sludge

- Should the daunting obstacle course of turbidity treatment be somehow successfully navigated, another problem arises. The proponent has indicated in AppA1 (p. 22) that 262 – 654 m^3 will be extracted from each well per day. There will be seven wells operating. In TAC #34 the estimated combined daily average production has been amended to 2998 m^3 per day.

  The proportion of the raw extract comprised by (presumably >106 µ) sand will be variable, but has been estimated as 20-70% of the raw volume (AppA1, p. 22), therefore leaving 30-80% as post-extraction water and remaining solids. Assuming a constant 10 grams of suspended solids per liter (i.e. requiring treatment, as per SUPPL4, p. 7), and 1000 liters per m^3, this translates to ca. 29980 kg of suspended solids. Assuming 90% filtration/removal efficiency, and 50% reinjection rates (AppA1, p. 5)(assuming only the reinjected water will be treated), this yields an estimate of approximately 13,500 kg of solids (dry weight) **per day**.

  However "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." (SUPPL4, p. 7). The details of this reduction are withheld, but we are still left with an excess of 8500 mg TSS/L, which apparently is not directed for treatment. Will this material be diverted by the cyclones and maybe filtration? What will be done with this additional material? Will it be disposed of with the sludge? If so, this would increase the amount of solids requiring disposal by >80%.

- In SUPPL4 (pp. 19-20), the section 4.6 entitled Sludge Management contains a very perfunctory and sketchy description of the dewatering and drying of the sludge. A number of questions arise:

  1. **Where will the drying beds be located?** "Drying beds are equipped with lateral drainage lines (perforated plastic pipe or vitrified clay pipe laid with open joints)" (SUPPL4, p. 20). The pipe system suggests that this may be a permanent area someplace. Where?

  If this is not a permanent area, but is temporarily located at each operation site, it will require significant additional cleared area, and significant decommissioning as well. We cannot envision or tolerate a landscape wracked by construction/remains of more than a thousand sludge beds.

  2. **How large are the drying beds?** "Applied sludge depth should be 200 mm to 750 mm for coagulant sludges.", and "Loading rates are typically between 1.0 2.4 kg/m2and [sic] 2.4 kg/m2" (SUPPL4, p. 20).

The sludge layer would thus require a large area, since it is added to every day and "Draining time is typically 3 to 4 days." (SUPPL4, p. 20). We could attempt to make a theoretical calculation using our theoretical estimated daily sludge yield above, but we are stuck because the latter figure represents dry weight, and we do not know how much moisture there is in the applied sludge. It is sufficient to say that this will be a very large area indeed.

- What is the physical design of the drainage/collection system?

- If the drying beds are permanently sited someplace, **how will the tonnes of wet sludge be transported to the drying beds each day**? By a sludge tanker truck? What route will it take? According to the Sio website, "Our Extraction of silica is an innovative patent pending method that does not require truck traffic….", and "Eliminating dust and truck traffic while transporting Silica." (https://www.siosilica.com/silica), but what about transporting sludge? Will sludge be stockpiled whilst awaiting transport to the drying bed? If so, will it be held in on site tanks?

- **How will the sludge be applied?** Heavy equipment or vehicles travelling on the beds could compromise the drainage lines underneath: both "perforated plastic pipe" and/or "vitrified clay pipe" are subject to breakage and cracking. Will a walking gun sprayer be used perhaps, analogous to the types used for manure slurry? If so, how will aerosols be contained and managed?

- **Will the drying beds present an inhalation hazard?** The sludge will contain silica, precipitated iron and manganese, and substantial amounts of flocculants/coagulants, possibly consisting of organic chitosan and inorganic metallic co-coagulants.

  Will the beds be enclosed, or will they be open and exposed to wind? Since air drying is involved, this requires good air flow. How will this exiting air be filtered? Will there be a fan (if enclosed)? This is a major concern, as fine particles may travel significant distances downwind. Not all of the settled particles will have been sequestered by the coagulant(s). How will dust be contained? Will the dried sludge be wetted again during handling to minimize clouds of dust, or will it still be wet? How will dust emissions be monitored? Is there an air dispersion study?

- **The sludge will contain large amounts of chitosan**. According to the APSC (2022) Safety Data Sheet (http://www.ampolymer.com/SDS/ChitosanSDS.html), the following hazard classifications are listed for chitosan: "**GHS:H411** – Toxic to aquatic life with long lasting effects; **P273** – Avoid release to the environment; **P391** – Collect spillage; **P501** – Dispose of contents/container to an approved waste disposal plant.". We find the caution: "Avoid creation of dust." While not

toxic (unless the subject is allergic), the physical threat posed by chitosan dust particles may elicit respiratory tract irritation, thus inhalation is identified as a health risk. Individuals with existing respiratory conditions will be at greater risk.

- "Sludge can be removed from the drying bed after it has drained and dried sufficiently." (p. 20). What is meant by "sufficiently"?

  The 3-4 day draining/drying time (SUPPL4, p. 20) will vary somewhat according to weather, humidity, temperature, time of year.

  How much moisture content will the sludge still have? This will be moisture that will not be returned and must be considered in the reinjection volume calculations. In the EAPPF and RPCR, the proponent minimizes inhalation risks by warranting that any exposed sand at the processing facility will be wet. However here presumably we will be drying the material, but only partially. How will moisture content be monitored and how will removal of the sludge from the drying bed be triggered?

- How will the dried sludge be harvested? Again, heavy equipment travelling over the surface may damage the drainage system pipes. Will the sludge removal method be associated with an inhalation hazard?

- Will dried sludge be stockpiled whilst awaiting transport for disposal? **How will the dried sludge be transported?** Will it be loaded onto trucks as cake? What route will it take to the disposal site? How frequently will these transport trips occur?

- How much water will be collected by the drainage system?
  "Since one of the stipulated requirements is to disinfect all process water discharged back to the environment, it is expected that the drainage from the drying beds would need to be collected and returned to the treatment train." (SUPPL4, p. 20).

- **What potential contamination will this water acquire through this additional diversion?** It will have been exposed for a lengthy time (3-4 days (SUPPL4, p. 20)) to nonsterile air during the drying process. While the extract will be "returned to the treatment train" for (theoretically) disinfection:

  - It will contain *concentrated* dissolved coagulant residues.

  -It will also potentially harbor, if it has not been covered and contained, marinated leachings from agricultural and road dust, agricultural spray drift, bird poop, dead insects, etc. which it has acquired from days of exposure on the drying beds.

  -It will have percolated into and through drainage pipes and channels (with 'open joints') that are continuously wet and are perfect for the growth of molds and bacteria,

indeed an entire ecosystem, that will form coatings of biofilms and slimes. Even though the organisms themselves in the collected water may have been eventually killed by a disinfection step, their carcasses, and dissolved endotoxins/exotoxins and exudates will remain in the reinjection water.

-It will have also been in contact with a variety of synthetic materials that constitute the drainage system, the trucks used to transport the sludge to the drying beds, machinery used to apply and harvest sludge, and the trucks used to transport the drainage water back to the extraction sites.

Such diverse factors will contribute to water quality issues. This water will not be treated for chemical contaminants. It is concerning that this questionable water will be continuously fed into the same "treatment train" that services the water recovered during the onsite extraction process. Will this sludge drainage water not taint the relatively "cleaner" extraction water? Would the proponent drink this sludge drainage water, to demonstrate its salubrious qualities, and its suitability to be reinjected into the aquifer, where it could become somebody's else's drinking water?

- What would happen in the event of a rainstorm? Could excess stormwater overload the drying bed drains? Would runoff occur, bypassing or escaping from the drainage system? Would sludge escape from the drying beds and enter local ditches?

- If stormwater is collected, its volume would create a spike in the volume of water requiring treatment. Since the envisioned treatment system(s) relies on constant flows, how would spikes be managed without a reservoir?

- How will broken pipes and leaks be detected underneath the sludge bed?

- How will the sludge drainage water be transported from the drying beds to the current active extraction site? By tanker truck? How frequently will these trips occur?

- **Where would the massive amounts of sludge be disposed of?** Wherever it is dumped, it will present an inhalation hazard and will need to be managed.

"Disposal of the waste material is managed by a 3rd party using a vacuum truck to take waste to a licensed facility." (SSCRIR1 #DLN-IR-007).

- Springfield has approved a hazardous waste facility to be located within the RM (https://www.cbc.ca/news/canada/manitoba/springfield-tervita-hazardous-waste-1.5266582). It is interesting that the company identified in SUPPL4 (p. 16) as the supplier of the rental chitosan treatment equipment has merged with this hazardous waste company (https://www.secure-energy.com/transaction).

  Will this hazardous waste company be the recipient of the sludge generated by its rental equipment? If so, how will it be managed – will it be stored and eventually become a ski hill, or will it be transported further to someplace else? If it remains in Springfield, how will it be maintained? Should inorganic metallic co-coagulants be unfortunately used with the chitosan, how will metallic runoff and ground seepage be prevented?

  Further, will this hazardous waste company also be the "licensed facility" that will receive the "overs" mentioned in EAP1 (p. 18)?

- How will the drying beds be decommissioned?

- It is incomprehensible that only 6 paragraphs of 1-4 desultory sentences each have been begrudged to us on this topic (SUPPL4, pp. 19-20), when they concern such a major and impactful component of the operation. A potentially hazardous operation of such magnitude and duration would surely require environmental assessment and a closure plan?

- And finally (or not), after all of the above yammering on my part, in SSCRIR1 (#DLN-IR-007), we are suddenly tossed a new bone, that sends us off to play fetch in an entirely new direction: "Sio is also **exploring** other options such as a **filter press** which have a far smaller footprint." for sludge management (Emphasis is mine). And in RMSF-IR-002, this new tack seems more assertive: "Solids will be managed by first a filter press to remove excess water. Damp fines will be stored in an enclosed tankage before they are taken away from the site."

  Drying beds are now *aus dem Bild*? Apparently, or maybe, so. In SSCRIR2 (#DLN-IR-004), the proponents now disavow responsibility for their previous SUPPL4 musings:

  "Round 1 IRs assumed that Sio would be using drying beds, when in fact there is more then [sic] one type of method to process the fines and Sio is considering other options. Many assumptions were made in round 1 surrounding this, when **Sio has never stated that drying beds would be used**." **(!)** (Emphasis is mine). Apparently the fable in SUPPL4 was our hallucination. Forgive us for taking the proponents seriously.

So now, are we still keeping the chitosan, what? Will the filter press water contain chitosan, and so on and so on…….

And further, "The fines are largely kaolinite clay material and are therefore a salable material to industries such as paper, porcelain, paint, cement filler, cosmetics, medical and others. Sio therefore intends to sell the fines to one of these industries." (RMSF-IR-002). All we can say is, if we are pressing sludge, those industries had better not mind chitosan in their purchases….that is, of course, if we are still keeping the chitosan, or maybe not……

It might be landfill after all: "Sio plans to sell these fines to markets as listed, otherwise they will be disposed of at a licensed landfill." (SSCRIR1 #DLN-IR-007).

And how will the fine material from the filtration (and initial dewatering/screening) steps be managed? "In addition, fines, which are estimated at about 1.9% of total extracted material, will be collected at the extraction site and pressed into a filter cake" (SSCRIR1 # CEC-IR-008 and #DLN-IR-004).

This particular material won't have chitosan in it, because the filtration precedes the flocculation. Its end use would depend on its purity level; would it contain any pyrite/marcasite? The two kinds of pressings will be different.

Will this filter pressing occur on site near the wells? Will this be yet another piece of equipment to add to the noise and congestion and exhaust fumes of the active site?

But then…..Oh no. "Sio has not finalized if it will use a filter press or not." (SSCRIR2 #DLN-IR-007). Has ANYTHING been finalized?

Other issues

- **Dissolved organic compounds** present yet another confounding factor that can affect UV effectiveness. Dissolved organic carbon may include thousands of compounds from both natural (e.g. humic acids, tannins, polyphenols, sesquiterpenes) as well as anthropogenic sources (e.g. hydrocarbons, pesticides), and is shown to occur at significant concentrations at some locations within the region (Table 4-8, AppA4), due to percolation of bog (dystrophic) surface waters or from agricultural practices. These compounds are associated with color and also have UV absorption peaks within the 200-300 nm germicidal wavelength band that is required for disinfection, and therefore limit effective radiation dosage.

- One of the side effects of UV disinfection is the **photolysis of nitrate**, which is present particularly in agricultural or otherwise polluted areas (AppA4, Table 4-8), to form carcinogenic nitrite (Sharpless and Linden, 2001). Nitrate also absorbs UV light and therefore may affect transmittance.

- **Thus the ultraviolet treatment process** (as described in section 2.2.5, EAP1) **is not suitable for this application.** Ozone treatment, which is an effective and benign disinfection method, is also unfortunately not an option here, as it will only introduce even more oxygen into the aquifer. Neither is chlorination a viable alternative, for obvious reasons (a rational person would think so…….but….wait…..):

Injection well chlorination

- In RPCR (#218), without warning or preamble, a sparse but vastly pregnant scrap of information suddenly bursts upon us: "Re-injected water was treated with chlorination in accordance with CanWhite's application for the re-injection permit. Monitoring data was collected and would be made available to regulatory authorities upon their request."

  This statement concerns re-injection that has already occurred, where extracted water has been returned to the aquifer (Four permits have been issued: Permits #IW-2019.01.1 HD Minerals; #IW-2019.02.1 HD Minerals; #IW-2020.01.1 HD Minerals; #2021.01.1 CanWhite Sands Corp, issued by Manitoba Sustainable Development Water Science and Watershed Management Branch).

  While it is claimed that chlorination was disclosed in the well permit *application*, **none of the above permits identifies any requirement for, or approval of, or monitoring of, disinfection.** The only tangential allusion therein is: "The injection water will not contain any substances that will degrade the quality of the water in the receiving zone." (Clause No. 4, Permits #IW-2019.01.1, #IW-2019.02.1, #IW-2020.01.1).

  The word "substances" is not defined, biological contamination is not identified (i.e. are organisms "substances"?). Permit conditions should not require Supreme Court decisions for interpretation. In its abstruse and trite tokenism, it is unenforceable, and no enforcement mechanism is even provided.

  In the most recent Permit 2021.01.1, even this inept Clause has been dropped, and replaced with Clause No. 5: "The injection water will remain isolated from the environment." But the water will not remain isolated from all of the machinery and equipment and manipulation that it encounters during processing. At the very least, it is

also unavoidably exposed to air, which is a constituent of "environment". Therefore what, if anything at all, does "environment" mean in this context?

- Chlorine may be applied to water as free chlorine gas administered through a chlorinator (e.g. in water treatment plants), or as several different chemical compounds, for example sodium hypochlorite, which may be in the form of a powder, or in solution, for example bleach. Household bleach is not pure sodium hypochlorite, but is a mixture of chemicals, and may contain additives such as detergents, scents, corrosion inhibitors, and incidental unregulated impurities from the manufacturing process. Industrial bleach is used in applications involving water supplies. Products which carry certifications such as NSF 60 are recommended for quality control.

- Chlorination of distributed water from water treatment plants may be used for primary disinfection and to maintain a small residual in the distribution system until the water reaches point-of-use. Because chlorine is toxic, concentrations in the water leaving the treatment plant are carefully and continuously monitored. By the time the water is eventually returned to the environment as wastewater, i.e. to **surface, never groundwater**, the main environmental concern is the **persistence of chlorinated organic byproducts,** which have arisen as the result of chemical reactions of chlorine with natural organic materials present in the water (see below).

- Chlorine is used for disinfection of a newly developed well. According to Section 40 of The Groundwater and Water Well Act (C.C.S.M. c.Gg110) Well Standards Regulation, "Immediately upon completing construction of a well for domestic purposes, the person who constructed the well must (a) disinfect the well so that a concentration of between 50 and 200 mg/l of available chlorine is present throughout the water in the well; and (b) maintain the concentration described in clause (a) in the well for a period of at least 12 hours." The **well is subsequently flushed** and chlorine is not injected into the aquifer. Once chlorine has been purged from the well, the water can be consumed.

- The third application of chlorination is in "shocking" a contaminated or newly developed well, where sodium hypochlorite solutions are briefly added to the well, and then thoroughly flushed, so that **no chlorine can invade the aquifer**.

The amounts of sodium hypochlorite added to the well **must be carefully calculated** to achieve the recommended minimum of 50 ppm chlorine concentration (Table 7). In particularly refractory situations, up to 300 ppm may be briefly used, but these higher concentrations increase the amount of hazardous disinfection byproducts (Artiola et al., 2013)(see below), as well as corrosion of well infrastructure.

Table 7. Amount of Chlorine Bleach and Water Required to Obtain 50 ppm chlorine (i.e sodium hypochlorite) solution

Casing Diameter		Volume of Water Needed per 1 ft (30 cm) of water in casing		Millilitres of 5.25% Bleach needed per 1 ft (30 cm) of water	Millilitres of 12% Industrial Bleach needed per 1 ft (30 cm) of water
(in)	(mm)	(Gallons)	(Litres)	(millilitres)	(millilitres)
4	100	1.1	5	4.75	2.1
6	150	2.4	10.9	10.5	4.55
8	200	4.2	19.1	18	8

Source: AHS, 2011

The mixed bleach in the calculated volume of clean water, equivalent to the volume of water in the casing, is introduced into the well. **This water is toxic**.
The faucets, both hot and cold, are then sequentially opened, and toilets are flushed, until chlorine odor is apparent. The system is then left undisturbed for 8-12 hours.

The water is then completely flushed to remove the chlorine, and may not be ingested until rinsing is complete. According to AHS (2011), "following shock chlorination, it is very important to flush residual chlorine and any toxic chemicals that may have been formed or released from the well components or aquifer materials. Shock chlorinated wells should be purged at least four (4) well volumes or until no residual chlorine is detected in the well water", and "It will usually take 4 to 8 hours to flush the well after a standard well chlorination."

A licensed, qualified professional should undertake this procedure. **Chlorinated water must not infiltrate the aquifer beyond the well.**
While this well shocking procedure addresses coliform bacteria, it does not adequately address iron bacteria (Artiola et al., 2013).

- In the disturbing RPCR (#218) statement above, "**Re-injected water was treated with chlorination**":

1. This implies that chlorinated water was introduced in large quantities into the well and the aquifer. Instead of the normal procedure of removing any escaped disinfectant and its byproducts during well disinfection, these substances were deliberately released into the wells.

2. None of this is winked at in any of the four injection well permits, or elsewhere in the available EAP and its satellite documents.

"Sio proposed to **utilize chlorine for re-injection** in its injection permit **applications** for testing purposes. Sio followed the Groundwater and Water Well Act – Well Standards Regulation Section9(2) b, which provides that the source of water for construction, sealing, etc must: "contain a minimum 10 mg/L free chlorine at all times, except for monitoring wells where chlorine will interfere with water quality analysis or remediation" (SSCRIR1 #DLN-IR-002)(Emphasis is mine).

- While chlorination may have been in the applications, neither it nor does any other disinfection requirement appear in the permits. Why?

-The **entirety** of Section 9(2) of the referenced Well Standards Regulation (https://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=215/2015) states:

Source of water for construction, sealing, etc. — other wells

9(2) All water used in the construction, sealing, rehabilitation, maintenance or servicing of a well or test hole not specified in subsection (1) must

(a) be from a licenced public water system or semi-public water system, or from a groundwater or surface water source that is chlorinated;

(b) contain a minimum 10 mg/L free chlorine at all times, except for monitoring wells where chlorine will interfere with water quality analysis or remediation; and

(c) be stored and conveyed in clean, sanitary tanks and water lines.

This does not refer to consumable water. This section also does not identify reinjected water, which differs enormously in volume and destination from the circumscribed amounts used in the servicing activities specified therein. Note that the servicing water in the Regulation is not intended to exit the well into the aquifer.

"There are no listed requirements to Sio's knowledge for water to be treated before it is returned to the aquifer." (SSCRIR2 #MSSAC-IR-018). This is because reinjected water is not listed in our shamefully inadequate and outdated legislation. Further in SSCRIR2 (#MSSAC-IR-018): "Injection well permits do not list any requirements for water to be treated prior to re-injection."

"Sio did not find any specific requirements for treatment of water returned to the aquifer and proposed 10 mg/L as a conservative approach. Chlorine does dissipate

and in a large body of water would not remain at such a concentration." (SSCRIR2 #DLN-IR-002). From this we infer that it is fine to add anything to an aquifer because everything will dissipate in it.

The question SCREAMS: **WHY WAS CHLORINE USED**?

- How was chlorine dosage measured, applied, and in what form? Since the proponent attests that the 10 mg/L free chlorine residual regulation was **followed**, this means that the levels were measured and monitored. **How was this done?** What apparatus was used to measure volumes and flow rates, and to blend the bleach and the water to ensure the consistent correct dosage?

  What form of chlorination was used? According to: https://www.winnipegfreepress.com/the-carillon/local/Former-CanWhite-employee-alleges--well-contamination-lax-site-safety-575758671.html?fbclid=IwAR0_3_MXoo3we8hCYt2g_tHrzXI2tG_tI1rxWPOsKX8guTaHCFAm4jsE7uM , bleach was allegedly used onsite. What kind of bleach product was this? Household or certified?

  <u>How much total chlorine was added to the injection wells?</u>

  In answer to the reviewer's question in SSCRIR2 (#DLN-IR-002): "Please clarify how Sio Silica dispensed the chlorine into the re-injected water and how the levelof [sic] chlorine was measured.", the proponent responds: "Sio declines to respond based on the relevancy." It is very much relevant to any person who drinks that water.

- This is **an enormous volume of chlorinated water**. According to AppA1 (p. 22), "Each well will operate for four (4) days and will produce from 262 m3/day (40 gpm) to a maximum of approximately 654 m3/day (120 US gpm) of water and sand." We assume only one well was operating each time. We don't know how much of this volume of water remained after the sand was subtracted, but it still ought not to have been dumped into the aquifer in this condition.

- With respect to the efficacy of disinfection with sodium hypochlorite, "its effectiveness drops dramatically for water pH values greater than 7", and pH must be adjusted (Artiola et al., 2013). Optimal pH ranges are 5.5 – 6.5 (Miller, 2017). Therefore in the alkaline and hard water conditions of the project area (see Table 4-8, AppA4), this disinfection method needs pre-conditioning. (This is to point out correct procedure only, for prescribed uses. To be clear, I am not advising this additional travesty for the water returned to the aquifer!) The point of this note is to show that disinfection benefits were minimal under these conditions anyway, but the harms were unabated.

- "Monitoring data was [sic] collected and would be made available to regulatory authorities upon their request." (RPCR #218).

- What were these "monitoring data"? How were they collected? Who did the analysis and where did the results come from - a lab, or dollar store swimming pool test strips, or…….?

- "would be made available to regulatory authorities upon their request": are we to understand that these authorities have not yet bestirred themselves sufficiently to take an interest in such an irregular and startling activity?

- Where are the results of this monitoring? Surely they cannot be 'proprietary', as they relate neither to the commercial aspects of the mining nor does the proponent even plan to use this disinfection method, at least according to the EAP.

- A monstrous thought intrudes: if the UV disinfection is recognized as inappropriate (as it should), will chlorination be adopted instead, which would assault the aquifers with chlorinated byproducts from the thousands of projected wells?

- What qualified licensed self-respecting professional would have conducted/overseen this? Or were jugs of bleach indiscriminately glopped into the wells now and then?

  How was this allowed? What poltroon approved this? Why are they still employed? Oh wait…..authorities who make a poor decision are not legally accountable for it: "No action or proceeding may be brought against the minister, a director, a well drilling officer or any other person acting under the authority of this Act for anything done or omitted to be done, in good faith, in the exercise or intended exercise of a power or duty under this Act." (Section 84, Manitoba Groundwater and Well Act C.C.S.M. c. G110). *Quel dommage, quelle surprise.*

- According to TAC (#10), "ECE requests information on characterization of the water from the extraction and return processes and the risk of other contamination or **additions to the water**." (Emphasis is mine). The proponent's response is in the future tense, with no suggestion of surrendering existing data. We can infer that analysis of the return water did not occur. The injection well permits also make no reference to such a requirement. The reviewer's reference to "additions to the water" is ominous, and may be obliquely referring to the chlorination. In any case, it is too late. Will there be more of this, while waiting for some sort of functional disinfection system to be devised?

- Dissolved organic matter (reported as carbon) is extensively present in the water samples throughout the wells examined (Table 4-8, AppA4). **Presence of organic matter results in the formation of chlorinated organic byproducts** when the water is

chlorinated. These can include a very wide array of different molecules (Nikolaou et al., 1999; Hrudey, 2009), ranging from small volatile organic compounds (VOCs) such as trihalomethanes (e.g. chloroform), to haloacetic acids, to complex chlorinated structures, depending on the materials that are initially present in the water; at least 600 have been identified in chlorinated drinking water thus far (Hrudey, 2009).

- From a public health perspective, **chlorinated organic substances in drinking water are carcinogenic** (USEPA 2013), and their oncogenic/carcinogenic potency increases with degree of chlorination, i.e. number of chlorine atoms that are covalently bound to the molecule. For example incidence of bladder cancer (Morris et al., 1992) and colorectal cancers increases "in people exposed to chlorinated drinking water or chemical derivatives of chlorination." (El-Tawil, 2016). These substances present adverse effects for reproduction and development as well (Hrudey, 2009). These health effects began to come to light after water treatment plants adopted chlorination as a disinfection measure, and the effects were shown to be correlated with this disinfection method (Hrudey, 2009). The Canadian Water Quality Guidelines for Drinking Water set out maximum concentrations for trihalomethanes and a number of other selected chlorinated compounds.

The proponent flicks off the concern with "Chlorination and disinfection is used on municipal water supplies everyday." (SSCRIR1 #DLN-IR-009).

1. Chlorination of municipal systems is done to fulfill the chlorine residual requirements for water sanitation within the distribution system (Source: https://www.gov.mb.ca/sd/pubs/water/drinking_water/odw_og_09.pdf):

> Section 22 of the Drinking Water Safety Regulation states that the minimum allowable disinfectant residual at any point within a water distribution system is
>
> - 0.1 mg/L of free chlorine for water systems using chlorine as the disinfectant; or
> - 0.3 mg/L of monochloramine for water systems approved to use chloramines as the disinfectant

2. The unreacted portion of the chlorine residual dissipates into the air once water is released from the tap, and the chlorine may be inhaled. However many chlorinated byproducts remain in the water and may be ingested. Volatile chlorinated compounds such as trihalomethanes (e.g. chloroform) may also be released into the air and inhaled, ingested, or absorbed through skin.

3. Formation of chlorinated byproducts within the distribution system is a universal health concern. According to Gopal et al. (2007), in drinking water "There have been epidemiological evidences of close relationship between its [chlorine] exposure and adverse outcomes particularly the cancers of vital organs in human beings."

4. Chlorination of municipal supplies is carried out under strict regulation and repetitive testing. Minimal dosages are used.

5. In efforts to reduce the amounts and impacts of chlorine, many municipal supplies have implemented ozonation as primary disinfection, with only a small dose of post-chlorination to maintain the mandated residual in the water system.

6. Chlorine is **never** added to any water ***source***: neither surface nor groundwater.

- Concentrations of chlorinated byproducts in water are a function of chlorine dose and contact exposure time (Nikolaou et al., 1999). These factors also increase the number of chlorine atoms bound to the same organic molecule, amplifying their carcinogenicity.

- Many **chlorinated organic compounds are persistent in groundwater**, and therefore may travel within aquifers. The cold temperatures and lack of photolytic opportunities for degradation contribute towards longer persistence in groundwater, compared to surface water. When chlorinated molecules do degrade, they transform or degrade into **other chlorinated products** (Kristiana et al., 2020).

- Pavelic et al. (2004) studied trihalomethanes and reported that well injection of chlorinated water was associated with substantial increases of these contaminants **within the aquifer** because the **residual chlorine continued to react with natural organic matter after injection**. The amounts of trihalomethanes formed, for example, increase with length of chlorine exposure time (Figure 86). Thus **concentrations of these compounds continue to rise after the chlorine has entered the aquifer**.

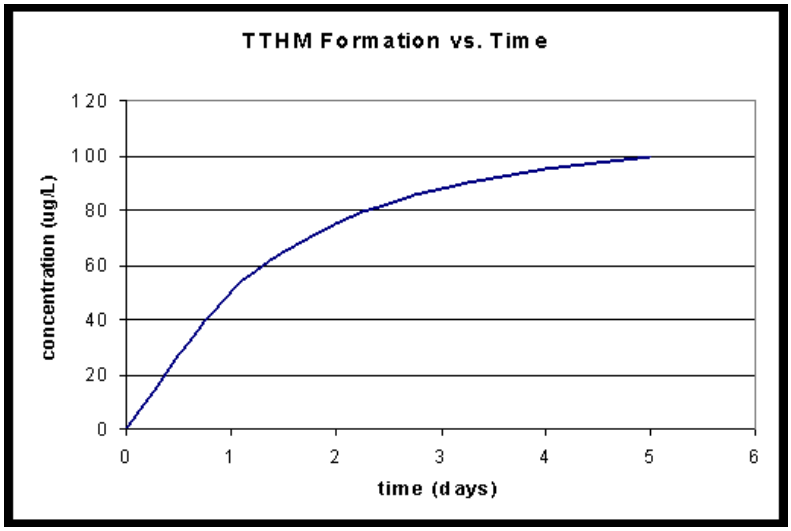


Figure 86. Increase of total trihalomethanes (TTHM) with exposure to chlorine over time. Source: http://civil.colorado.edu/~silverst/REU/bodies/2002/Stacia/

Therefore, it would seem, in the present unusual situation, that monitoring for trihalomethanes (at this time, the most easily monitored group) must be undertaken **in the aquifer, not in the injected return water**. With respect to public health, it is also important to monitor at point-of-use, because of the known adverse health effects.

- Since extraction and injection of a well will be conducted at the same time, potentially a significant portion of the **same water** may be recirculated to the surface and reinjected multiple times. If it is chlorinated each time, it may acquire hazardous levels of chlorinated byproducts, since their concentrations are related to chlorine dosage. These focal pools with their byproducts may travel as plumes to domestic area wells (see Figure 28, p. 125).

- Another concern is that chromium in casing and piping material, often added to confer greater corrosion resistance, may interact with chlorine (as hypochlorous acid) to form highly toxic hexavalent chromium, that may appear in the drinking water (https://news.ucr.edu/articles/2020/12/03/common-pipe-alloy-can-form-cancer-causing-chemical-drinking-water).

- The following rhetorical comments can be made here:

  1. The proponent states that: **"**The water will be contained and under continuous flow during extraction and treatment, and therefore **will not have been exposed to organic materials, chemicals or contaminants** through the extraction and treatment process." (TAC #10, also RPCR #3, #11, #24, #211)(emphasis is mine). Apparently bleach is not a chemical or contaminant, nor are toxic chlorinated organic byproducts. (The benefits of bleach can be vouched for by Donald Trump.)

  2. Similarly, according to three of the injection well permits "The injection water will not contain any substances that will degrade the quality of the water in the receiving zone." (Clause No. 4, Permit #IW-2019.01.1, #IW-2019.02.1, #IW-2020.01.1). Apparently bleach and toxic disinfection byproducts do not affect water quality.

  3. "Sio has no reason to believe it has injected any contaminants into groundwater." (SSCRIR1 #DLN-IR-001). How would anybody know anyway, since the water was not monitored?

- "Sio has not proposed any chlorine for the EAP before the CEC. Therefore this topic is not relevant to the CEC process." (SSCRIR2 #DLN-IR-002).

  There are many things that are not proposed in the EAP, including all of the Plans and programs, and even protocols for basic logistical/operational procedures. This does not mean that an item missing from the EAP will not materialize in one of the many Notices of Alteration, or not acquire a surreptitious dishonorable mention in one of the internal "living documents", or will not be carried out in the future, *ad hoc,* as this one was. We note that the proponent does not categorically rule out chlorine, just has not "proposed" it.

  As for this topic not being relevant to the CEC process, it is very much relevant, because no license has been issued for operation thus far, yet already questionable practice has occurred.

- There is no applicable legislation in The Groundwater and Water Well Act (C.C.S.M. c.Gg110) Well Standards Regulation to address this situation. Since thousands of wells will be involved, is it not time to enact some boundary lines for these types of operations?

Respect for property and environment

Setbacks

- The proponents have indicated setbacks of only 100 m for residences and water wells (e.g. EAP1, p. 4), although we subsequently see the ambiguous statement: "setbacks are determined on a case-by-case basis" (TAC #13, RPCR #164).

  In response to my query (RPCR # 164), "The minimum 100 m setback distance will be calculated from the periphery of the well cluster (as compared with the specific location of the well)." Does this refer to the cluster of boreholes, or the cleared extraction site including the peripheral belt? SIO (p. 22) also refers to an ambiguous "bridge" area between forest and cleared land, with no explanation.

- The only other features identified for setbacks are Manitoba Hydro infrastructure, hamlets and property boundaries (EAP1, p. 4). Presumably "communal living" colonies would be classified as hamlets.

- According to Pedley and Howard (1997), well siting must be adequately distanced from "on-site sanitation", i.e. septic systems and fields, and where they still exist, ejection systems and privies. The EAP makes no reference to setbacks from these features, which may in many instances be less than 100 m away (i.e. between the residence and the extraction site.

- Schedule (Section 14) of The Groundwater and Water Well Act (C.C.S.M. c.Gg110) Well Standards Regulation requires **setbacks of 100 m from manure storage areas or confined livestock exceeding 10 animal units**.

  For definitions of these terms the Act refers us to the Livestock Manure and Mortalities Management Regulation 42/98:

  "'**manure storage facility**" means a structure, earthen storage facility, molehill, tank or other facility for storing or treating manure or where it is stored or treated, and includes any permanent equipment or structures in or by which manure is moved to or from the storage facility, but does not include
  (a) a field storage site,
  (b) a vehicle or other mobile equipment used to transport or dispose of manure
  (c) a gutter or pit used to contain liquid or semi-solid manure for less than 30 days for the purpose of moving the manure to a storage facility,
  (d) a collection basin, or
  (e) a temporary composting site for manure"

  In other words, this would primarily be a manure tank or lagoon.

"”**confined livestock area**" means an outdoor, **non-grazing area** where livestock are confined by fences or other structures, and includes a feedlot, paddock, corral, exercise yard and holding area, as well as a covered structure used to confine livestock that has one or more sides without a wall that exposes the interior of the structure to the elements, but does not include a seasonal feeding area”

In other words, a barn, feedlot, shelter, or fenced compound, but not a pasture even though it has fences too.

This leads us to a concerning question: on agricultural land, will extraction wells be situated **in or beside manure spread fields**? This is particularly relevant, as even town water supply wells have not been protected in Manitoba (Figures 87 and 88). Evidently provincial regulators have not heard of Walkerton or the people that died there in 2000 (see p. 301); in any case we have learned nothing from that tragedy and are left to rediscover its perils for ourselves. How will the thousands of proposed extraction wells, with their large bores, fare?

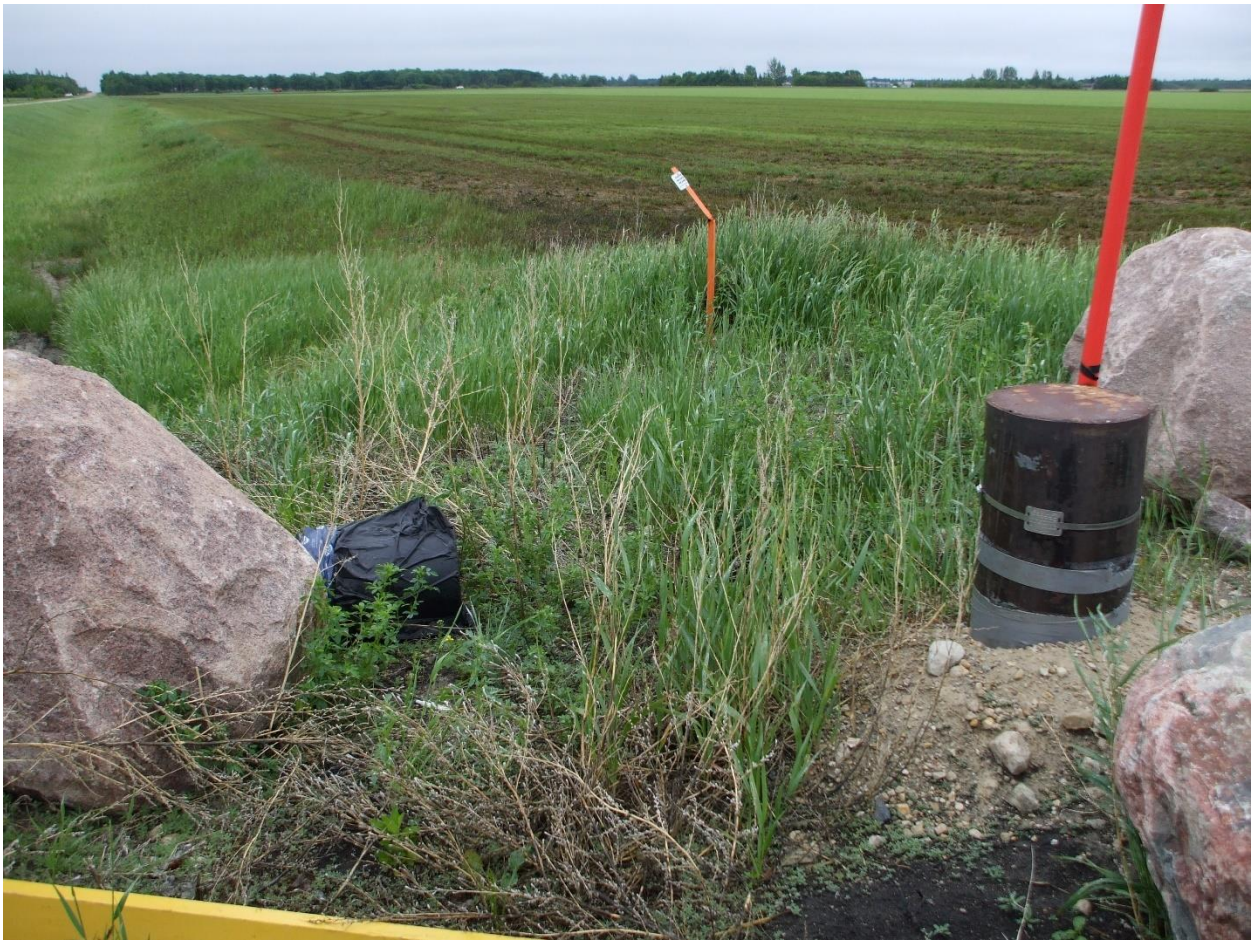


Photo: E. Pip

Figure 87. Entire field thickly spread with fresh uncomposted manure (all of the brown material), beside recently drilled Beausejour town water supply well (foreground). July, 2021. The well site has also turned into a garbage disposal hub, and the ditch is the town dog park.

Photo: E. Pip

Figure 88. Close-up of uncomposted manure in Figure 87 immediately after a rain storm, beside Beausejour town water supply well (not yet activated). July, 2021. The image does not convey the intolerable odor.

While some of the land uses and possibilities identified above might not be currently extant within the project zone, they may easily arise within the next 24 years of the projected operation, and certainly within the publicly touted "multi-generational" vision.

- Clearing activities (bulldozing) of trails and digging of drainage ditches (EAP1, p. viii) may encounter various underground utility lines. The EAP does not mention setback policies regarding buried electrical lines, telephone or cable service lines, or natural gas lines on private property. "CanWhite arranges for a utility line assessment prior to any work on-site." (RPCR #164). If identified, what is the setback policy? Is allowance made for future subsidence potential? How are locations of decommissioned wells marked in the event of future utility installations?

- Two railway lines are material to the project area (EAP1, Figure 1-1). In the 24 year life of the project area, a small but real possibility of derailments and spills of hazardous goods does exist. What are the setbacks for extraction wells from rail lines?
- The area is gridlined with municipal roads, and a provincial trunk highway intersects it. What are the setbacks for this infrastructure?

Disturbance

- "Project components will be located on previously disturbed land to the extent feasible." (EAP1, p. ix). Some of this previously disturbed land may be in the process of rehabilitation and may contain planted trees. Some of it may be abandoned gravel pits from which overburden has been removed, facilitating transfer of surface contaminants. In any case, land which has sustained previous insult should not be regarded as reason to assault it some more.
- "measurable disturbances will be imposed on topographic features during Project construction and operation" (EAP1, p. v). "Temporarily disturbed areas include areas to accommodate the extraction wells, drilling rig access trails, equipment laydown areas (within well cluster areas) and trails to accommodate the slurry lines and water return lines." (EAP1, p. 13). Also a mobile office, worker parking, fuel storage, supply depot, portapotties ….
- "Project activities will setback a minimum of 100 m from nearest residences" (EAP1, p. viii), or "100 m from a dwelling and the dwelling's drinking water well", **even 100 m from a hamlet!** (EAP1, p. 4).

  This is an ineffective distance for disturbance, heavy equipment noise, and diesel/exhaust odors. Does this setback apply only to the drill sites, or **does it also include access trails** (to prevent heavy equipment and traffic and portable toilets and a mobile office and all manner of paraphernalia and appurtenances from trundling beside somebody's house)? Visitors are also mentioned (EAP1, p. x). Does the setback distance also include slurry and hydro line trails? Are there extra setbacks for slurry pumping stations because of the length of time they will remain in place?
- "Project staff will be limited to approximately 35 to 45 personnel during Project operations with staff arrivals and departures being staggered daily to accommodate the 24 hours, seven days/week (24/7) operation schedule." (EAP1, p. xi). This number is also the total workforce for the entire project (EAP1, p. 25).

  In RPCR (#233, also Memo 1, TAC), this employee number has been reduced: "Employees will be working two 12-hr shifts per day with shift changes occurring at 7:00 am and 7:00 pm. CanWhite estimates between 13 and 20 employees will be required

per shift." Since carpooling will presumably not be the norm, this means 13-20 individual vehicles x 2 (coming and going) x 2 shifts = 52 - 80+ passes per each day (and night), plus any additional trips for lunch, supplies, or other purposes, plus fuel and parts deliveries, management visits, sundry visitors, police looking into vandalism, etc.

The shift changes will be superimposed on the continuous disturbance of operations. **At each change, 13-20 vehicles will be leaving, while 13-20 vehicles are arriving.** At 7:00 AM, families at nearby homes are getting ready for work and school; on weekends and holidays they may have liked to sleep in, although this is superfluous due to the ongoing site noise. At 7:00 PM they will be concluding their supper. Maybe they will want to eat out every day instead. This could be an extended period.

- "Workers using the temporary access trails to access the Project Site (e.g. well cluster sites) will be required to limit vehicle speed to a maximum of 30 km/hr". (EAP2, p. 87).

A speed of 30 km/hr on these rough, stumpy and bumpy, soft and sometimes slippery and muddy trails, is not prudent. And personnel will be **limited** to this speed, i.e. they could go faster? **Including at night**? As a point of reference, the speed limit on the groomed roads in Manitoba Provincial Parks campgrounds is 20 km/hr (https://accesswinnipeg.com/2011/07/manitoba-provincial-park-camping-rules/). Note: these are actual paved or graded **roads**.

"Employees will be working two 12-hr shifts per day with shift changes occurring at 7:00 am and 7:00 pm." (#233, also Memo 1, TAC). Both shift changes will occur in the dark for some portions of the operating season, especially in the fall.

According to the Car Stopping Distance Calculator (https://www.random-science-tools.com/physics/stopping-distance.htm), a car speed of 30 km/hr requires a driver reaction distance of 6 m, and a braking distance of 5 m, giving a total stopping distance of 11 m under **ideal road conditions,** on an actual **dry, well-lit road** with perfectly working brakes and an alert driver (not one after a 12 hour shift who is anxious just to go home, or a distracted driver catching up on his cell phone). Note that this stopping distance does not take into account the additional time required to spot and recognize the hazard before reaction time starts. They will likely be driving trucks, rather than compact cars, which further increases stopping distance because of inertia. At these distances, small wildlife on the road will not be spotted in time, especially in the dark, and we cannot depend on all drivers to care.

Given that **this is somebody's private property**, visibility on the trails (**not roads!**) may be restricted – should it not be respectful and responsible to observe a suitably low speed limit? What catastrophe shall befall if a worker takes an extra minute or two to

arrive or leave? Will profits suffer? In the words of a hearty Ukrainian aphorism, ***Їм руки не відпадуть****.*

In any case, who would/could enforce this? Even if the landowner is a police officer himself (with very elastic jurisdictional latitudes), he is *pas de chance*.

Pagany (2020) found that speed and proximity of forest or cropland were important factors in vehicle-wildlife collisions. Slow moving (e.g. turtles, frogs, garter snakes, etc. which are present in the project area) and small creatures with limited mobility and unable to flee in time, will not have adequate chance of getting out of the way. At night, they will have no chance. People should have some decency.

While setbacks of homes may be only 100 m away, setbacks of access trails are not mentioned and may possibly be exempt, and even the RPCR has failed to provide an answer. Presumably children and pets will not be allowed to play on their own property, or at least, beyond the ***verbotene Grenze***. If they happen to stray, what are the liabilities?

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A sign of respect and consideration.

- According to AppC, some of the mining claims have land areas of less than 2 ha. No information is given whether there are homes on these parcels. Apparently there is no minimum size of the property that can be occupied. There seems to be no protection to ensure that small-acreage plots will not suffer what amounts to major damage and loss of the small amount of cover they have. One parcel (in Bru 92)(EAP1, Figure 1-2; AppC) is 0.3 ha in size, but it seems adjacent to a larger claimed piece; yet the existence of a claim on this crumb of land indicates that mining is planned for it. Thus this parcel will be denuded almost in entirety, because: "The footprint area of each well cluster [will be] 0.20 ha to 0.28 ha" (EAP2, section 6.5.1).

- The EAP repetitively stresses the ephemeral and transitory nature of the disturbances, claiming that extraction activities at an individual well will span only a matter of days: 5-6 days (EAP1, p. 3) or maybe 5-7 days (EAP1, pp. 2, 14), although AppA1 (p. 22) states categorically "Each well will operate for four (4) days", and AppH(AppA6) also uses this number. But wait, "A CanWhite well is produced for only 3 days" (EAPPF, Appendix H). More recently, "A maximum of seven extraction wells will operate 24 hours per day for 5 to 7 days each before the extraction wells are decommissioned and operations move to a different well cluster." (TAC, Memo 1), thus invalidating and dragging out the unvarying 4 day production schedule set out in AppH(AppA6). It not explained why Table 2-1 (EAP1) and Table 6-3 (EAP2) identify a requirement for 10 extraction rigs.

  "All wells within a well cluster may not be operating at the same time." (EAP1, p. 3), but "24 hours per day for 5 to 7 days **each**" for a maximum of seven (?) at the same time (TAC, Memo 1). Staggering the wells will prolong the duration of inconvenience, disturbance and stress for the homeowner. On p. x of EAP1 we see: "Sand Extraction activities occur over weeks in one area rather then [sic] months, with individual wells over days."

  In Sio's ad in The Clipper (February 17, 2022), the public is reassured that: "Sio's well operations are only a matter of days (not an entire season)." This is heartless mismessaging: it implies that extraction operations will be brief and transitory. In truth, while an *individual well* may operate only for a few days or up to a week, only a maximum of seven wells can be accommodated at any one time, and not even necessarily within the same cluster [Note however that Table 2-1 (EAP1) and Table 6-3 (EAP2) specify 10 extraction rigs.].

  Therefore "only a matter of days" is not what residents will experience. In an ad in The Clipper (January 19, 2023, p. 24), "The total accumulation of days working on one well will less [sic] than two weeks. A site is anticipated to be active from 2-4 weeks." In TAC (#18), "Occupation of any site for extraction activities will last no longer than a year". This is inferred as 12 months total, possibly overlapping different calendar years. Does this time frame include decommissioning?

  But individual extraction sites are only one scale of the problem: the next cluster will be only 60 m away, and the next, and the next…. From Figures 1-2 and 2-3 in EAP1, it is evident that, since clusters are 60 m apart, **multiple clusters may be, and will often be, located on the same land parcel.** No information is given regarding what the maximum number might be on an individual parcel. There are "an initial average of 56 well clusters of seven extraction wells per cluster, annually" (EAP1, p. iv), over a projected 24 year

lifespan, or 392 wells per year. This, of course, may change once the licence has been granted.

The response in RPCR (#172) is: "The number of well clusters and wells [in] each extraction year is determined by the available land area that is accessible (e.g. terrain suitable for equipment access) land owner agreements and the geotechnical conditions". This seems to imply that placement will strive for the maximum, which, on a larger parcel, could be substantial (e.g. Figure 116 , p. 427).

- The clusters are arranged in blocks, which will require some time to process. Where there are large blocks of sites, extraction may extend over much of the season, affecting the same residents during this length of time. Activities on the same parcel could straddle different years. This raises the level of impact for the property owner to an entirely different level, affecting duration of disruption and ability to have the use of her/his own property.

- Given the slow pace of extraction, and the large numbers of wells and clusters, we have a question that nobody seems to have asked. **Will more than one suite of extraction paraphernalia operate in different locations at the same time?** If so, this would magnify the disturbance and potential noise overlap for local residents. It would also require well drawdowns to be reimagined.

- Disturbance and intrusion may continue for years after decommissioning. "There are effective high resolution subsidence monitoring approaches available which Sio Silica has investigated and for long term subsidence monitoring of large areas, one of these, such as aerial drone LiDAR or InSAR, may be used." (SSCRIR1 #MSSAC-IR-009).

  The following issues need consideration:

  1. Will people be annoyed by the intrusion of drones on their properties? How often and what time of day would this occur? For how many years?

  2. Presumably consent would be required for this trespass. What happens if some homeowners refuse?

  3. How large are these drones? LiDARs for example may be of various dimensions and weights.
  4. How noisy are these drones?
  5. How high above the ground will they operate?
  6. How long will each session take?

7. **Drones will scare people and animals**. They can startle and stampede livestock that are not used to them. Frightened animals may be injured, trampled, lost or killed by vehicles on roadways. If one member is spooked, the whole herd panics. Drone laws in the UK forbid drones near animals and livestock: "drones should also be kept away from animals and livestock including horses, as they can scare them and cause fatal consequences. There are increasing numbers of reports of horses being spooked by close flying drones, with riders being injured and horses being killed." (http://www.droneguideuk.com/droneguideuk_ukdronelaws.html). Domestic animals may die of exhaustion attempting to flee, or sustain barbed wire injuries and infections (e.g. tetanus). Thus drones cannot be operated in or near pastures, paddocks, corrals, barns.

8. **Drones are harmful to wildlife**. Animals and birds may perceive them as some sort of aerial predator. "When animals come into contact with drones, they may experience physiological changes such as an increased heart rate, behavioural responses such as running or flying away, or even suffer stress that could disrupt their reproductive process. If they decide to avoid specific areas as a result of frequent disturbing drone encounters, this could fragment and ultimately damage the whole population." (https://theconversation.com/viral-bear-video-shows-how-drones-threaten-wildlife-and-what-to-do-about-it-106903).

Drones also disturb nesting and foraging birds. Terrified deer and moose may blindly charge fences or bolt out into traffic and cause crashes (moose are present in the Vivian area (personal observation)).

9. While advance warning may allow the homeowner to prepare and to shelter her animals, there is no way to prepare wildlife for these encounters.

10. Drones may attract target practice by hunters, or shooting by homeowners who feel acutely threatened or annoyed.

11. Drone accidents and malfunctions may cause injury or property damage. Will compensation be offered for injured or dead livestock, or property damage?

12. LiDAR (Light Detection and Ranging) is a complex methodology that uses pulsed lasers to measure distances (ranges). Its accuracy depends on many factors, including whether the surface is bare or vegetated, land cover type and terrain, flight parameters, calibration parameters, interference ("noise"), reference checkpoints, number of passes, and how data points are processed (Njambi, 2021). For terrain modeling, it works best in flat areas where the ground can be easily separated from non-ground elevated features such as fences, rocks, animals, etc. However even if ground elevation changes are detected in the present monitoring application, the change has already occurred at a

large enough scale to be detected. Therefore no advance warning of subsidence is obtained.

Noise

Extraction sites and noise effects on human health

- In an ad in The Clipper (January 19, 2023, p. 24), the proponent feigns a coy and play-dumb question: "What will life be like living near an active extraction site?" What, indeed, if it can be called life. Let us think for a couple of seconds.

  All aspects of the proposed operation will be associated with offensive, intrusive, distressing noise. This noise will occur on private properties, where frequently people are living, and/or where adjacent neighbors reside. In winter, clearing and drilling will occur. The rest of the year **massive unrelenting noise will emanate from extraction sites**, with their generators, pumps, compressors, vibrating screens, hydrocyclones/dewatering station, heavy earth moving equipment, worker and supply traffic, sundry chugging and chattering, clanging and banging, shouting and swearing. The workers will require robust hearing protection. In addition, we must consider the various paraphernalia that are proposed for onsite turbidity removal and disinfection, sludge truck traffic, drying bed drainage water returns, and other as yet undisclosed activities (SUPPL4).

  There will also be more drilling in summer, as well as slurry pumping stations, slurry line patrols, and whatnot. There will be other noise when slurry lines are relocated, and other noise during site decommissioning. There will be noise when hydro poles and power lines are installed and removed. While it appears a few of the equipment items might be powered by mainline, that electric running equipment itself will still make noise. There will be traffic from workers coming and going, truck deliveries, patrols.

  There will be different layers of noise superimposed: some will be continuous, some fluctuating, some intermittent. People experiencing continuous noise will find it harder to tolerate additional overlays of fluctuating and intermittent noises.

- The EAP1 document (p. 11) states that "Sand extraction activities will occur 24/7 from April through November (and winter, weather dependant) while extraction well drilling will occur year-round". Apparently there will be no let-up on Sundays and statutory holidays. How considerate for the residents: perhaps they would best vacate their homes and move to a hotel.

- Up to seven wells in the clusters may or may not operate simultaneously (EAP1, pp. iv, 3). Either option is disheartening – if operation is simultaneous, the level of noise, smell, disturbance and traffic is correspondingly additive and superimposed; if operation is

staggered, so is the misery for the people living there. Furthermore, this time window **does not include** time involved in the preliminary activities of destroying property, drilling, movement and setup of extraction equipment and associated impedimenta, and dismantling the site and other sequelae such as levelling and grading.

- The "power for all the extraction equipment will either be supplied by a generator on site or the equipment will have its own power generation, such as the water well rigs or light plant. A diesel generator will be used to power the slurry pumps, vibrating screens" and mobile office (EAP1, p. 26). This is a confusing statement: there will be a "generator on site" (only one?), some equipment will have its own generated power (presumably integrated generators, such as the OFD1550 compressor(s)), and then the slurry pumps and vibrating screens will have a (single?) diesel generator. The ten extraction rigs (Table 2-1 (EAP1) and Table 6-3 (EAP2) will be individually diesel powered. The above quote identifies a light plant (singular), with integrated generator, but actually both Table 2-1 (EAP1) and Table 6-3 (EAP2) indicate there will be eight.

  It would be useful to provide a table which sorts out which is powered by what. In any case, according to this, multiple generators will run simultaneously, whether integrated or separate. However, Table 2-1 (EAP1, p. 27) lists only two diesel generators required during the extraction phase, but not their size nor what they will power. In Table 6-3 (EAP2), there is only a diesel generator for slurry handling; the extraction phase generators, as well as 20 water pumps in Table 2-1, have disappeared from the equipment list.

  The RPCR (#135) responds to the question of power sources: "Sources of power for key Project components are described in the EAP, Section 2.7 (Power Use).", i.e. we are looped back to the original EAP statement that elicited the original question, and are no further ahead.

  Regardless, will generators have exhaust silencers? **Generator noise will be superimposed on the noise of the equipment that they power.**

- An exception to generator power will be: "The dewatering and pump station will be powered via direct mainline from Manitoba Hydro", and "will require 1460 connected hp to operate" (EAP1, p. 26). Since there will be a mainline, why won't it be used to power more items, rather than using generators and other equipment that produces noise, noxious exhaust fumes, and greenhouse gases?

  The proponent's website claims "***It is our mission to continue to evolve our environmental program to reduce our carbon footprint.***" **(**https://www.canwhitesands.com/environment/**).** How about starting here? In an ad in The Clipper (January 19, 2023, p. 24), "Sio is working to implement dual fuel equipment allowing the eventual switch to electric operations while extracting."

However an obstacle at present might be that difficulties could be encountered with electrical power supply logistics: "The design of the dewatering and pumping station provides for it to be **relocated only once per year**." (RPCR #122) (Emphasis is mine). The implications of this are that mainline power to individual extraction sites may require some rethinking. What would be the logistics of conveying the undewatered sand to the dewatering station at some fixed location, and of conveying the dewatering water back to the extraction sites?

However in SSCRIR2 (#DLN-IR-003), "The sand and groundwater slurry will then move to a **dewatering station at the extraction site** where the sand will be separated from the groundwater." (Emphasis is mine). Clearly the dewatering station is here implied as resident at the extraction sites. We give up.

There is silence regarding how exactly the slurry pumping stations will be supplied with electrical power.

- Will the mainline power equipment have separate backup generator power in the event of power interruption? How will the mobile office be powered, with its sensor monitoring equipment? Will it have backup power?

- In EAP1 (p. 3) we see: "up to seven extraction wells may be operating simultaneously in one well cluster at any given time". However in section 6.5.1 of EAP2 we see: "with only seven well clusters active any one time". Which is correct? Is this a typo? Will wells from seven different clusters operate at the same time? The RPCR answer is yes, this is a typo (RPCR #173). In SUPPL (p.1) the number of simultaneously operating wells has been reduced to five, then restored back to seven (RMSF-IR-004, -006).

- "The impact of the Project on noise levels at nearest points of reception (e.g. nearest residences) is assessed as **minor to moderate** with intermittent duration and short-term frequency." (EAP1, p. viii) (Emphasis is mine.)

  Since no noise studies have been done, on what premise is this impact "assessed"? Operation will occur 24/7, so will the noise, only at times it will be even worse. The setbacks from houses are only 100 m, which is a negligible distance for noise that will be heard 1 - 2++ kilometers away, especially at night (this is the distance that gravel pit noise travels to surrounding residences (personal observation)). Yet this proposed separation distance may only be hypothetical, as "setbacks are determined on a case-by-case basis" (TAC #13, RPCR #164). Based on what criteria?

- During the operation of a single test extraction well, "Nearby residents reported deafening noise from the drilling and extraction operations."
  (https://www.ernstversusencana.ca/vivian-silica-sands-extraction-wells-manitoba/).

A preliminary example of the type of noise that will occur can be accessed at https://www.dropbox.com/s/0hfqzckgv68f61o/img_0623.mov?dl=0
This video of a silica sand well operation was recorded in Springfield on 24 August 2021 at 8:45 P.M., at a setback distance of ≈ 130 m. Note that not all machinery and **only one well** would be operating at this time, and slurry lines, disinfection train, etc. were not in use.

- In order to understand the annoying and harmful effects of noise, we need to review (briefly) our old Physics courses on the nature of sound:

  1. It propagates as a series of compressions and rarefactions through a medium (air, water, walls, windows, foundations). The only places it can't travel is in a vacuum or in space.

  2. It is a wave and conforms to the laws of Wave Mechanics:
     - Its speed depends on the density of the medium and its elastic modulus properties, e.g. temperature and humidity of air.
     - The amplitude (strength) of the wave reflects its intensity or level (decibels). Amplitude and direction may be modified by wind.
     - The number of waves per second is its frequency (Hertz). 1 cycle/second = 1 Hertz (Hz)
     - Different waves can collide; if any of the wave crests coincide, they amplify each other.

     - Because they are waves, they can exhibit:
       a. Reflection (angle of incidence = angle of reflection): e.g. Echo
       b. Refraction (change of direction in media of different density): e.g. bending in layers of different air temperature and/or humidity
       c. Absorption (acoustic blankets and barriers): Noise Reduction Coefficient = % of noise absorbed or soundproofing effectiveness
       d. Resonance (creation of standing waves in a space confined by walls or edges of a clearing, or **inside homes and buildings**: a number of nodes arise where sound is most intense): e.g. outdoor sound may be louder indoors, especially at lower frequencies (Hz).

  ALL of these behaviors combine and contribute to the amount of annoyance that individual residences will experience, and each case will be different and unique. A standard setback distance cannot apply, neither will generic sound barriers provide satisfactory relief in many cases.

- The decibel scale is **exponential,** not linear. A change from 40 to 50 dB is many times greater than from 10 to 20 (Figure 89). Thus increases in decibel levels very rapidly become dangerous (SWM, 2020)(Table 8).

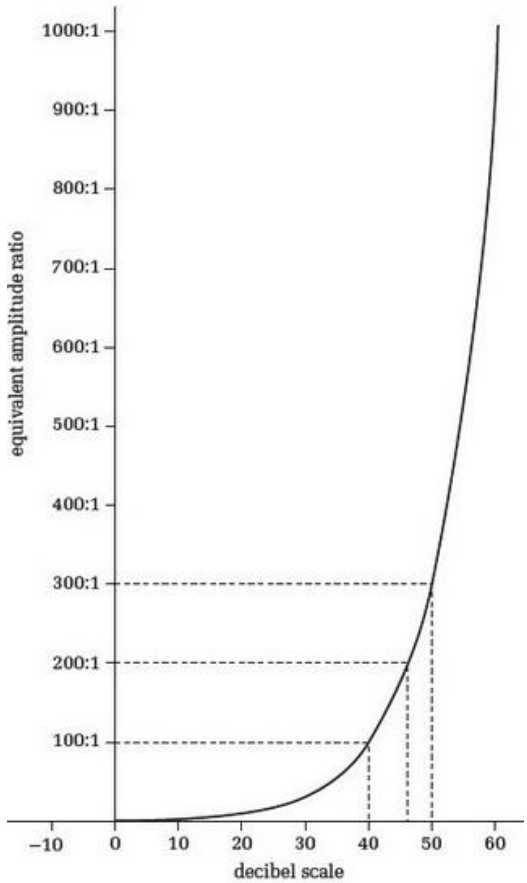

Figure 89. Exponential nature of decibel scale. Sound intensity increases disproportionately rapidly as decibel levels increase.

Source:
https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.open.edu%2Fopenlearn%2Fscience-maths-technology%2Fengineering-technology%2Fsound-music-technology-an-introduction%2Fcontent-section-10.1&psig=AOvVaw2b7Oizyx-iuOPs8g2I8uK6&ust=1670437067650000&source=images&cd=vfe&ved=0CA0QjRxqFwoTCPCpk5jN5fsCFQAAAAAdAAAAABAR

Table 8. Illustration of average human perception at increasing decibel levels. Source: https://www.audiolabs-erlangen.de/resources/MIR/FMP/C1/C1S3_Dynamics.html

Source	Intensity	Intensity level	× TOH
Threshold of hearing (TOH)	10^{-12}	0 dB	1
Whisper	10^{-10}	20 dB	10^{2}
Pianissimo	10^{-8}	40 dB	10^{4}
Normal conversation	10^{-6}	60 dB	10^{6}
Fortissimo	10^{-2}	100 dB	10^{10}
Threshold of pain	10	130 dB	10^{13}
Jet take-off	10^{2}	140 dB	10^{14}
Instant perforation of eardrum	10^{4}	160 dB	10^{16}

Figure 90 shows the relationship between decibel levels and perception of loudness. Again note that loudness perception increases rapidly and disproportionately exponentially as decibel levels rise. **At higher decibel levels, even small increments have a huge impact on nuisance and discomfort.**

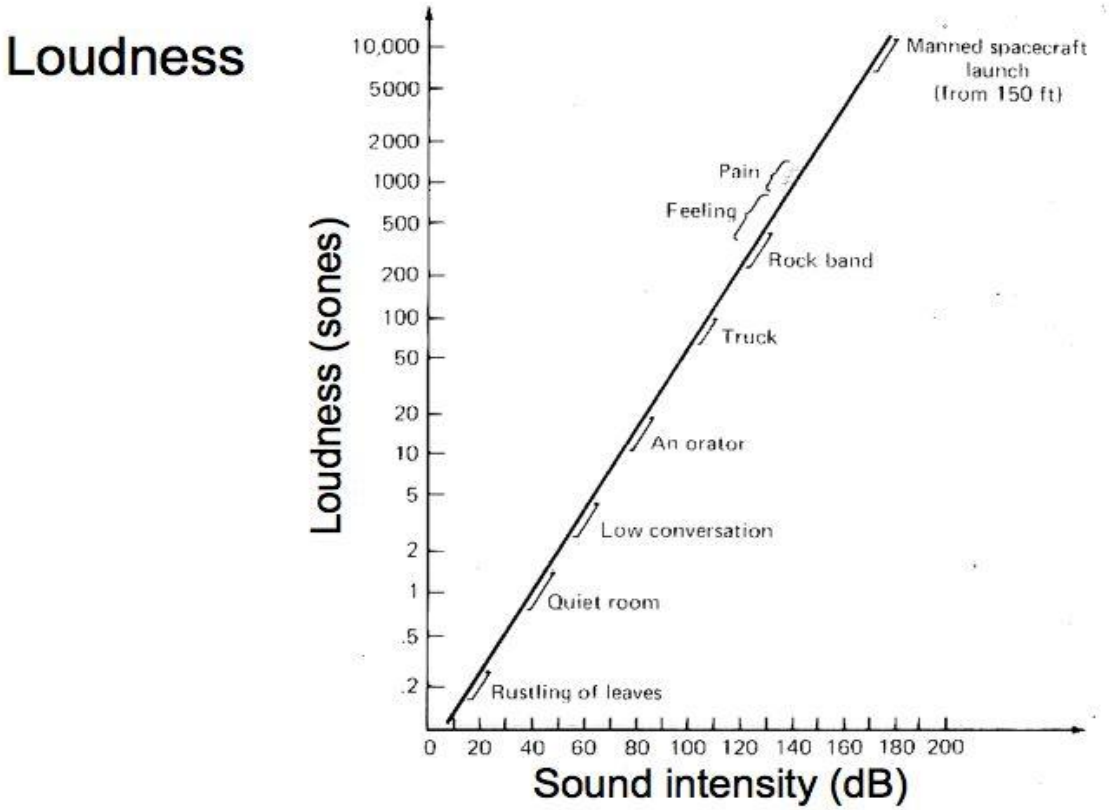

Figure 90. Sound intensity and perceived loudness. Note that sound intensity is shown as a linear scale, while corresponding loudness is exponential. Thus loudness increases at a disproportionately greater rate as decibel value rises. Source: http://www.cns.nyu.edu/~david/courses/perception/lecturenotes/loudness/loudness.html

- The audible frequencies (Hz) change with age (Figure 91). The highest frequencies can be perceived by infants, children and teenagers:

  young children: to 24,000 Hz
  under age 24: to 17,000 Hz
  under 30: to 16,000 Hz
  under 40: to 15,000 Hz
  under 50 to 12,000 Hz.
  All ages can hear ~20 – 8000 Hz.
  Source: https://www.goodhousekeeping.com/uk/health/health-advice/a559784/hearing-loss-ageing-ears/

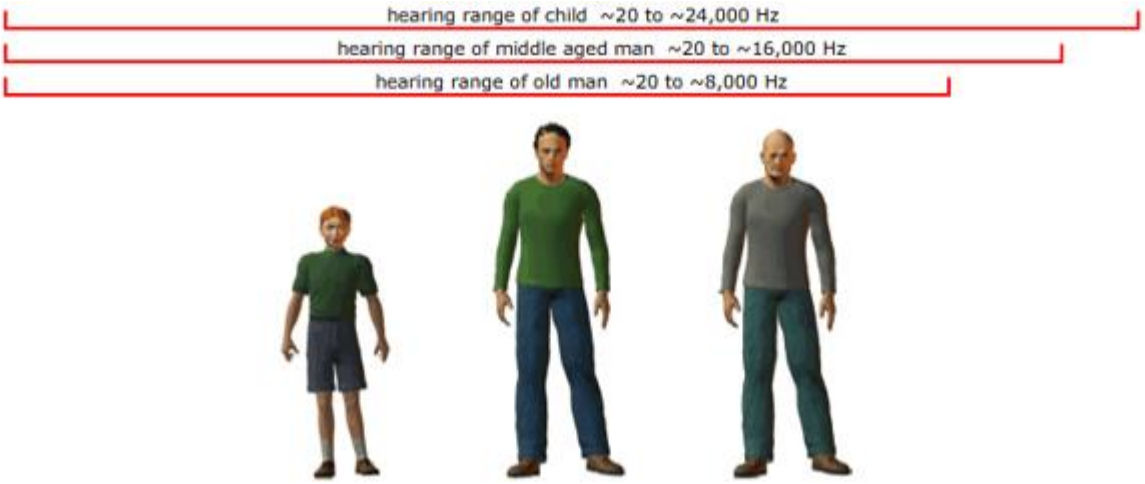

Figure 91. Hearing range frequencies at different ages. Source: https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.quora.com%2FWhat-frecuency-range-of-sounds-can-humans-hear&psig=AOvVaw1N7exJOoqQXbETNABfrOy8&ust=1645627196086000&source=images&cd=vfe&ved=0CAgQjRxqFwoTCMCs95zFk_YCFQAAAAAdAAAAABAa

However the human ear is most sensitive in the range of 500 – 6000 Hz, with a peak in the region of 4000 Hz (Source: https://pulsarinstruments.com/news/understanding-a-c-z-noise-frequency-weightings/).

A gender difference is also reported: women generally have better hearing above 2000 Hz than men, but less acute than men between 1000 – 2000 Hz (Helfer, 2001). Accordingly, men may experience more annoyance at low frequencies than women, while the reverse is true above 2000 Hz.

Therefore noise will be experienced differently depending on the age and gender of the recipients, and on the sound frequency profiles of the various pieces of equipment. Young children and infants may be the most affected at higher sound

frequency ranges, and at **frequencies which are inaudible to adults**. Different members of the same family may react to different degrees to the same noise profile.

- For reference, the most common decibel meter (dBA or dB(A)) measures the sound pressure (intensity) of frequencies in the general human hearing range of **~ 20 – 20,000 Hz**, although infants and young children may hear up to 24,000 Hz, which latter is not included in standard dBA measurements.

  However the response of the human ear to different frequencies varies with the sound intensity. A dBC measurement takes into account the **greater relative human response to low frequencies**, and also accounts for peak levels.

  A dBZ measurement comprises a range of **10 - 20,000 Hz**. It differs from dBA in that it includes the lowest frequencies of 10 – 20 Hz which are marginally inaudible, but can still cause discomfort (see discussion below). However a dBZ measurement reflects a flat frequency spectrum response with no weighting for relative human response (Reference: https://www.noisemeters.ca/help/faq/frequency-weighting/) It may also be expressed as plain dB.

- **"Noise is a source of stress."** (GQ, 2021). "It is evident that interference of noise is a serious health issue whose effects are widespread and not just restricted to auditory effects. Due to acoustic interference, physiological changes take place in the body and these changes are related to the frequency of the sound and its intensity level" (Prashanth and Venugopalachar, 2011).

  Noise pollution is associated with multiple adverse health effects: disrupted sleep patterns, altered quality of sleep, mental health issues, irritability, reduced ability to concentrate, high blood pressure, cardiovascular disturbances, hypertension, hormone disruption, stress; children are especially susceptible (Ising et al., 1999; Goines and Hagler, 2007; GQ, 2021). Immediate effects of sleep disturbance and deprivation due to noise can persist into the following day (GQ, 2021). At its most basic cellular level, "environmental noise can lead to DNA damage, alterations in gene expression and changes to a myriad of cellular processes related to appropriate neural, developmental, immunological and physiological functioning" (Kight and Swaddle, 2011). Entire medical journals are dedicated to the effects on health of noise exposure (e.g. Noise & Health).

- High frequency sound is defined variously in different jurisdictions, for example in the range of 8,000 - 20,000 Hz (HFCSE, 2022) or 11,200 –17,800 Hz (Fletcher et al., 2018). Affected individuals report this type of noise as ""extremely annoying," "unpleasant," and "hard to ignore"" (Fletcher et al., 2018). It may be continuous, produced for example by electrical equipment, or it may be intermittent screeching, squealing and

whistling sounds, for example from mechanical friction, gas escape under pressure, or cavitation in pumps.

When continuous, this type of noise causes "effects which may already occur after a few minutes: headache, tinnitus, fatigue, dizziness and nausea." (HFCSE, 2022). Since the higher frequency ranges are age-discriminatory, younger individuals are relatively more affected. Parents may mistake the symptoms in infants and children as "stomach flu", and be unaware of the real cause as they may be unable to hear it if it is near the higher end of the spectrum.

- Low frequencies may generate **annoyance that is disproportionate to the sound pressure level measured as dBA**. According to Ziaran (2014), "sounds with strong low-frequency content (but not only strong) engender **greater annoyance than is predicted** by an A-weighted sound pressure level.", and "Low-frequency sound, where the frequency ranges from approximately (10 to 160) Hz, has been recognized as a special environmental noise problem, particularly to sensitive people in their homes." Waye (2011) estimates that "the proportion of complaints on low frequency noise comprises 30–40% of complaints on noise in general."

  According to Ziaran (2014), low frequency noise "can be **more noticeable indoors**, which is why it is often associated with attention reduction, sleep disturbance, adverse effects on health, etc.". (Emphasis is mine). These frequencies penetrate walls, windows, and building structures (Waye, 2011), thus **refuge indoors does not bring relief, and may actually be worse**. "Low frequency noise annoyance is related to headaches, unusual tiredness, lack of concentration, irritation, and pressure on the eardrum. Data suggest that sleep may be negatively affected. In occupational environments, low frequency noise may negatively affect performance at moderate noise levels" (Waye, 2011). We note that some of the symptoms may be similar to those for exposures to high frequencies, largely because the ear is primarily physically impacted and can respond only in a limited number of ways.

  Low frequency noise is particularly invidious when it is combined with fluctuations: "fluctuating low frequency noise has been indicated to enhance adverse effects", and "rapidly fluctuating low frequency sounds have a lower acceptability threshold and will also increase unpleasantness and annoyance." The reader is referred to the latter author for an exhaustive review of the health and psychological effects.

- Physiological effects, particularly neuroendocrine responses, to low frequency noise have been demonstrated by a number of studies. For example, Waye et al. (2002) showed that subjects exposed to low frequency noise at 40 dBA for 2 hours developed

increased levels of **cortisol**, a major glucocorticoid hormone that is secreted in response to stress. These investigators also found that the normal circadian cycle of higher morning/daytime cortisol levels and low nighttime concentrations was altered by noise exposure, with higher than normal levels persisting at night. Ising and Ising (2002) reported that "exposure to low frequency noise with Lmax <50 dBA for a long time during nights leads to chronic increase of excretion of free cortisol in the first half of the night." Thus physiological effects of exposure are more deleterious at night, and exposure **during sleep** (Spreng, 2000).

In addition to cortisol secretion, production of another stress hormone, adenocorticotropic hormone (ACTH), is also increased. For both of these hormones, "**effects occur below the waking threshold of noise**" (Spreng, 2000). According to the latter author, stress hormones "influence nearly all regulatory systems" in the body, including cardiovascular, immunological, digestive, reproductive, and neurological systems, and impact health issues such as insulin resistance, osteoporosis and mental health.

The importance of low frequency noise has been acknowledged in the World Health Organization document on community noise, which states that ''health effects due to low frequency components in noise are estimated to be more severe than for community noise in general'' and that ''special attention should be given to sources with low frequency components.'' (quoted from Waye, 2011).

- Unlike higher frequencies, "the effect of age has been found to be of less relevance for hearing of low frequencies" (Waye, 2011). Therefore all ages, including elders, perceive this kind of noise. While 20 Hz is generally considered as the lower human hearing threshold, research has shown that even lower frequencies (infrasound) can be perceived: however below 16 Hz, low frequencies impinge as "a sensation of pulses or pressure variations of the eardrum" (Waye, 2011).

- The types of machinery which generate these harmful frequencies include "**compressors, diesel engines**, **machines with large rotating and/or reciprocating motion**" (Ziaran, 2014); Waye (2011) identifies **generators** as well.

  Table 6-3 (EAP2) identifies a single CAT C18 Diesel Generator Set destined for slurry handling. The specific model is not identified, of which there are many (https://www.wpowerproducts.com/power-generation-resources/manufacturer-profiles/caterpillar/models/c18/), but they are **60 Hz**. Will this generator be equipped with the additional, optional factory-installed "C18 High Ambient Acoustic Enclosure" offered by the manufacturer to help mitigate the noise?

- Waye (2011) points out that the environmental and health impacts of low frequency noise cannot be properly evaluated using a decibel A meter, and require **C or Z measurement instead, and should be measured indoors,** where human impacts are amplified due to "resonance within enclosed spaces". According to the same author, for low frequencies, "**it is not possible to get a correct measure of people's exposure based on outdoor measurements.**"

  Waye (2011) points out that "**Compared to high frequencies, low frequencies propagate for long distances**". Therefore setbacks for this type of noise must be significantly greater.

  Accordingly, we must recognize that machinery with sound outputs in **low frequency ranges may provoke greater disturbance and health impacts for neighbors than would be expected from standard dBA readings alone**. It must also be noted that effects from multiple different pieces of equipment operating simultaneously will be superimposed.

- **Hearing loss persists after cessation of the noise**, the length of time depending on the noise intensity and duration of exposure. Figure 92 shows an example of human hearing loss after a broadband noise exposure of a set intensity and duration. It is evident that hearing loss in the peak sensitivity region of 4000 Hz is most affected, and may persist for some time after the noise stops. According to the author of this research (Chirkin, 2016), if exposure is long or intense enough, hearing loss may become permanent.

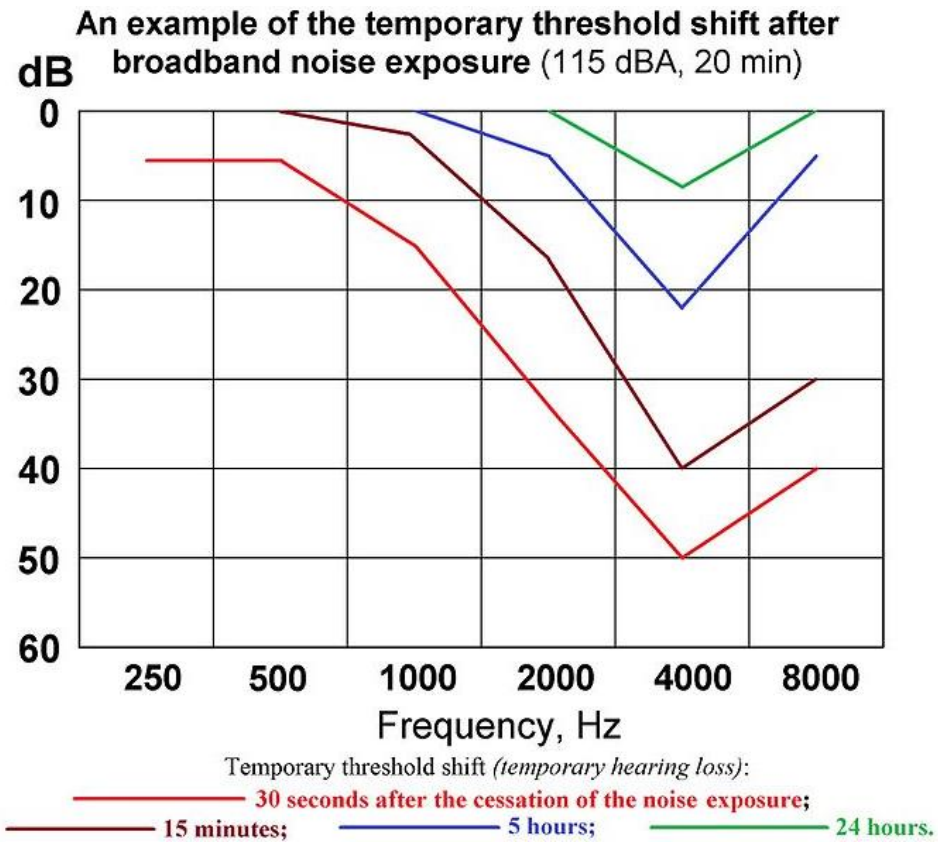

Figure 92. Duration of human hearing loss, i.e. decibel threshold detected, *after* 115 dBA exposure for 20 minutes. Source: Chirkin, 2016.

- According to WHO (https://www.who.int/docstore/peh/noise/Comnoise-4.pdf), continuous **daytime residential noise levels should not exceed 50-55 dB**, which in turn should not exceed 16 hours per day, and not exceed **45 dB at night**. Above these thresholds adverse health effects start to manifest.

  While noise level thresholds are higher in daytime, the assumption is that people are sleeping at night. However shift workers, or people (including young children) needing rest in the daytime will have their sleep disturbed at these daytime thresholds. According to GQ (2021), "**sleep can be disturbed by an outdoor noise of 40 dBA**."

- Section 4.4.7, R 419 of the Canadian federal Environmental Code of Practice for Metal Mines (2009) states, under "**Ambient Noise from Mining Operations**": "**In residential areas adjacent to mine sites, the equilibrium sound pressure level (Leq) from mining activities should not exceed 55 dBA during the day and 45 dBA at night.**" In other words, the same as the WHO thresholds. It will not be possible for the extraction operations to meet these thresholds, certainly not at a 100 m setback. Possibly this is the reason that no Noise Study was conducted for this portion of the project.

[Although the above Code of Practice addresses metal mines, this document states that "The Code applies specifically to metal mines but will provide useful guidance for **all sectors of the mining industry**."]

- As sound intensity increases, research has found that the percentage of residents highly annoyed rises (Figure 93). While these data relate to continuous noise, the effects of "bangs that can provoke a "startle effect" are increased 13 dBA over their measured values" (Everbach, 2001). Thus sudden bursts of noise have a greater effect than their absolute dBA would imply. In the proposed project activities, bangs will be superimposed on the continuous noise levels.

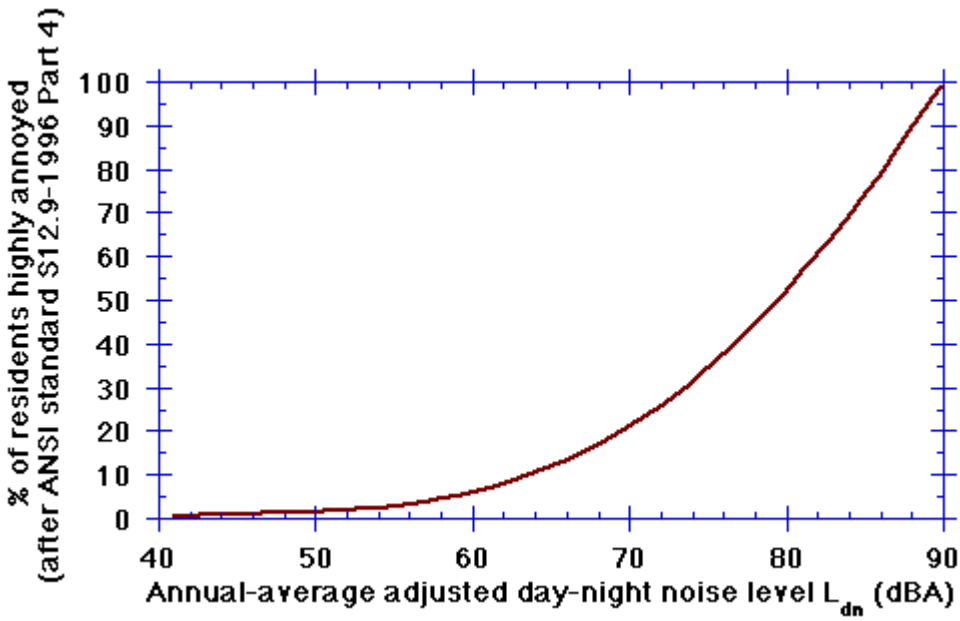

Figure 93. Percentage of highly annoyed residents in relation to noise decibel levels. From Everbach, 2001.

- **Springfield By-Law 19-11** has been enacted in 2019 "to regulate and prohibit unnecessary and harmful noise within the RM of Springfield" (https://www.rmofspringfield.ca/Home/DownloadDocument?docId=74b2170f-02b3-4a07-82e6-72e7ead2bf74).

  The closest-applicable sections seem to be under Prohibited Noises Sections 3(1):

> 1. No person shall make or continue or cause or permit to make any noise or sound which:
> a) Is such that it does, or is likely to annoy, inconvenience or disturb persons;
> b) Cause the loss of enjoyment of the normal use of one's property;
> c) Interfere with the normal conduct of business;

and, during nighttime hours, Section 3(2b): “The sound emanating from excavation or construction work of any nature.”, and Section 3(2c):

> c) The sound resulting from the use and/or operation of any power tool, motorized lawn mower, snow clearing device, chain saw, leaf blower, motorized garden tiller, weed/grass trimmer or similar device used outdoors;

No decibel value is stipulated, which materially undercuts evidence-based enforcement and renders it vulnerable to challenge and subjective interpretation. Given the prominence of gravel pits in the municipality, it is strange that they are nowhere specifically addressed in this By-Law. It is certainly time to update it.

- **The landowner is entitled to compensation for noise nuisance.** According to SRM, 2019 (Surface Rights in Manitoba)(see Appendix), “First year compensation will include compensation for the value of the land to be used in connection with surface rights. Also included are other elements….This is to compensate the landowner for his or her time and effort in negotiating the lease, the **nuisance, inconvenience, disturbance or noise** by the drilling and/or construction operations, and the company’s utilization of the entire lease area.” (Emphasis is mine).

  In addition, noise compensation takes into account distance from the home: “A well site on the home quarter may result in higher compensation, if owners/occupants consider the additional noises or odors than those in a more distant site.” (SRM, 2019).

- **Worker safety is paramount**, as these people will be exposed to the noise maximum during every shift, and will accompany the noise as it moves from site to site.

  In Manitoba, the maximum permitted exposure level for an **8 hour shift is 85 dBA** (Workplace Safety and Health Act [R.S.M. 1987, c. W210]
  Workplace Safety and Health Regulation (Man. Reg. 217/2006) Part 12) (CCOHS, 2021).

  However the proponent indicates **12 hour shifts** (TAC, AECOM Memo 1), thus the exposure level **cannot exceed 83 dBA.**
  (https://www.ccohs.ca/oshanswers/phys_agents/exposure_ext.html.) According to CR (2022), “noise should be measured at the position of the operator’s [i.e. worker’s] head.”

  [Note that these levels are more generous than in jurisdictions such as the U.K., where The Control of Noise at Work Regulations 2005 stipulates a maximum of 80 dBA for an 8 hour shift (CR, 2022). As in many other areas of Safety, Canadians are tougher.]

  Section 12 of Manitoba Regulation 217/2006 Workplace Safety and Health Regulation deals with noise exposure of workers. Section 12.2 indicates: “An employer must conduct a noise exposure assessment at the workplace in accordance with CAN/CSA Standard-Z107.56-06, Measurement of Occupational Exposure to Noise, and prepare and post in a conspicuous place in the workplace a written report of the assessment, if

(a) a worker is or is likely to be exposed to noise at a workplace in excess of 80 dBA". Workers are also entitled to hearing protection, transfer to different duties, and hearing tests. The extraction sites will certainly meet and exceed the 80 dBA threshold.

Additional federal restrictions apply to high frequencies: even though older workers may not be able to hear them, these frequencies may still cause damage. In the range of **16,000 - 20,000 Hz, a maximum of 75 dB** (or dBZ) is imposed (see HFCSE, 2022).

With respect to diesel generators, for example, "A fairly small generator could have an output of 50 kW and might generate…about 85 decibels. In contrast, 1,500 kW models may emit about 105 decibels, which you could compare to the sound of a jet airplane flying about 1,000 feet over your head." (WPP, 2021).

At the working sites, multiple generators will operate at the same time, either stand-alone or integrated into the equipment, for example 10 diesel extraction rigs, 8 light plants (Table 2-1, EAP1). Compressors are another example: the proponent indicates that (at least one) rotary screw compressor will be used for the air lift process (RPCR #193). According to Mujić et al. (2016), "Screw compressors, however, **generate a considerable level of noise** during their operation, **which sometimes inhibits the scope for their use**." (Emphases are mine). According to an industry source, rotary screw machines are "**infamous for being one of the noisiest units**." (https://www.enoisecontrol.com/chiller-compressor-removable-sound-blankets/).

The OFD1550 Tier 4 Final Oil Free Rotary Screw Air Compressor referenced in Table 6-3 (EAP2) has a decibel rating of 76 dBA (https://america.sullair.com/en/products/ofd1550-tier-4-final-oil-free-rotary-screw-air-compressor), under *optimum* mechanical operating conditions. This **one piece of equipment alone** approaches the allowable total noise limit of 83 dBA per 12-hour shift for workers.

- Noise outputs of screw compressors have a comprehensive noise frequency spectrum and range from 31 - 8000+ Hz (Fourouharmajd, 2012). The screw compressor noise output will affect surrounding residents: "The compressors typically create a hum or whine noise that is at a frequency that irritates people." (https://www.enoisecontrol.com/chiller-compressor-removable-sound-blankets/).

- Will one compressor service multiple wells? The answer is yes, "All wells comprising a 'cluster' will be serviced by one rotary screw, oil-free compressor" (RPCR #193).

From this response, it is inferred that there will be one compressor per cluster. Since wells from more than one cluster may operate simultaneously (EAP1, p. 3), will each of these clusters be serviced by a separate compressor, i.e. **will more than one compressor operate simultaneously**? However Table 6-3 (EAP2) lists only one compressor (singular) for extraction duties (part screenshot):

Emission Sources	Total Utilization (hours/year)
DIRECT EMISSIONS	
EXTRACTION	
10 x Extraction Rigs @ 200,000 each - Off-Road	60,000
Compressor trailer for extraction / OFD1550 Tier 4 Final Oil Free Rotary Screw Air Compressor	12,000

Our strong suspicion that more than one compressor will be used is based on the following evidence:

1. There are 365 x 24 = 8760 hours in one year.
2. The Total Utilization of the compressor is given in the Table 6-3 portion above as 12,000 hours per year.
3. If 10 extraction rigs operate 60,000 hours per year, then one rig operates 6000 hours.
4. This means that one compressor (servicing multiple wells at the same time) will also operate about 6000 hours, which is realistic, given annual deductions for servicing, relocation, and WINTER.
5. Therefore 12,000 hours equates to two compressors, or 2 x 6000 hours per year.
6. Table 2-1 (EAP1) indicates two diesel compressors (unlike Table 6-3, EAP2).
6. Why are there 10 extraction rigs, not 7? The EAP1 (p. 3) definitively states that seven is the maximum number of wells operating at a time: "although up to seven extraction wells may be operating simultaneously in one well cluster at any given time, this maximum number of wells operating simultaneously maybe [sic] spread across two adjacent well clusters (e.g.four operating wells in one cluster and three in an adjacent well cluster)." TAC, Memo 1 reiterates this plan. An explanation is needed.
   What does "@200,000 each -Off-Road" refer to?

If it is true that more than one compressor will operate (see also p. 60), the combined noise level from the compressors alone (at 76 dBA each for the OFD1550s) will be intolerable, and this is not accounting for all of the other generators servicing multiple extraction rigs, light plants, pumps, cyclones, vibrating screens, disinfection, etc.

- The noise texture generated by screw compressors is not a flat acoustic. Figure 94 demonstrates the rapidly fluctuating or **vibrating** character of the different frequency outputs, which materially raises the annoyance level. "It is not unusual for screw compressors to have higher vibration than most other industrial equipment due to the basic nature of the machine." (VSC, 2022). The latter reference provides detailed vibration analyses for this type of compressor. Furthermore, according to Clark (2017), screw compressor noise may be further amplified by the vessels which can act as "speakers" to create "extreme noise": the high frequency pulsation causes "acoustical resonance in piping and vessels" as well as vessel wall flexing.

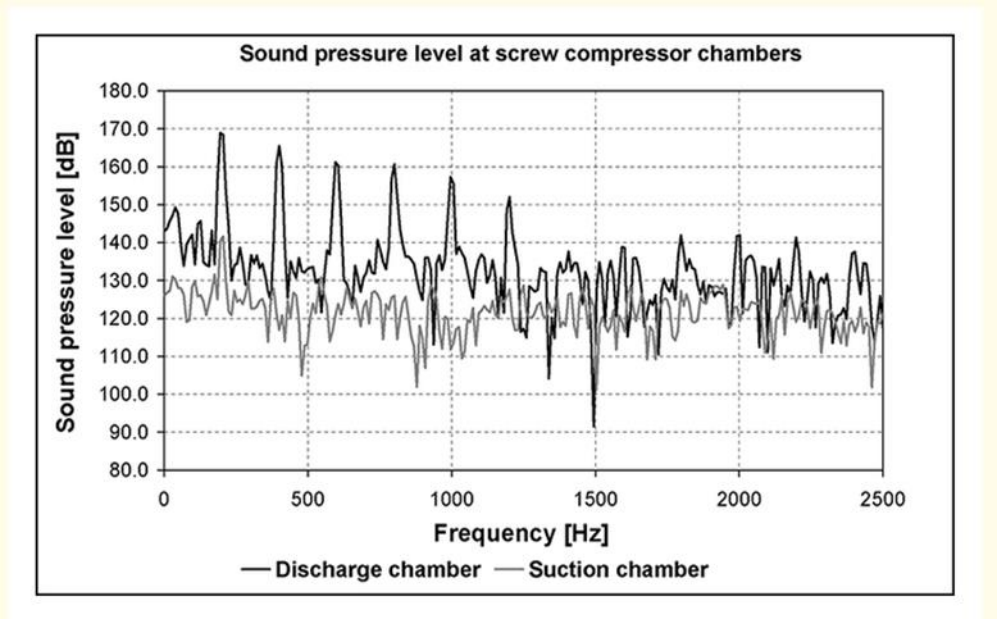

Figure 94. Sound pressure level as decibels at screw compressor chambers. Source: Mujic et al., 2016.

- Workers are especially vulnerable to the **mental health impacts** of noise stress, and may experience depression, irritability, unhappiness and other effects that can influence their job performance: according to Fouladi et al. (2012), "These extra-auditory effects of noise can be observed on performance efficiency of intellectual, attention, and memory tasks". In other words, noise is distracting. This is very important since the workers will be managing large, continuously operating equipment, and will need to be alert and pay close attention to prevent carelessness and accidents. It must also be pointed out that noise levels combined with robust hearing protection will prevent workers from hearing safety devices such as beeping from reversing vehicles and heavy equipment. In the present situation, we also have to be aware of additional stress and fatigue imposed by the 12 hour shifts, as well as night shifts. **Safe environment and worker comfort must be promoted and enforced at all times.**

  1. Will workers have a quiet place to retreat to during breaks and meals? In the circumstances, this would have to be off site, unless the mobile office is a highly soundproofed bunker.

  2. Will someone trained in first aid be available on site at all times? Extraction sites present a high risk of potential accidents. A designated Safety Officer must be present on all construction/mining sites to spot unsafe conditions and ensure workers and all on site personnel are wearing their required protective gear, including hearing protection, at all times.

3. The 12 hour shifts are onerous enough, but **will workers be required to work even longer hours,** for example in instances of worker absenteeism or labor shortage? And in such a noisy environment? (See whistleblower allegation in https://www.winnipegfreepress.com/the-carillon/local/Former-CanWhite-employee-alleges--well-contamination-lax-site-safety-575758671.html?fbclid=IwAR0_3_MXoo3we8hCYt2g_tHrzXI2tG_tI1rxWPOsKX8guTaHCFAm4jsE7uM).

In mining industry workers, according to Bauerle et al. (2022), the additional stresses of either 12-hour shifts or night shifts are associated with significant declines in attention and performance, decision-making and hazard recognition, as well as elevated incidence of injuries and fatalities.

Incidents of mining industry injuries have been increasing for workers during long hour shifts (Figure 95, U.S. data), where long hours are defined as equal to or greater than 9 hours (Friedman et al., 2019):

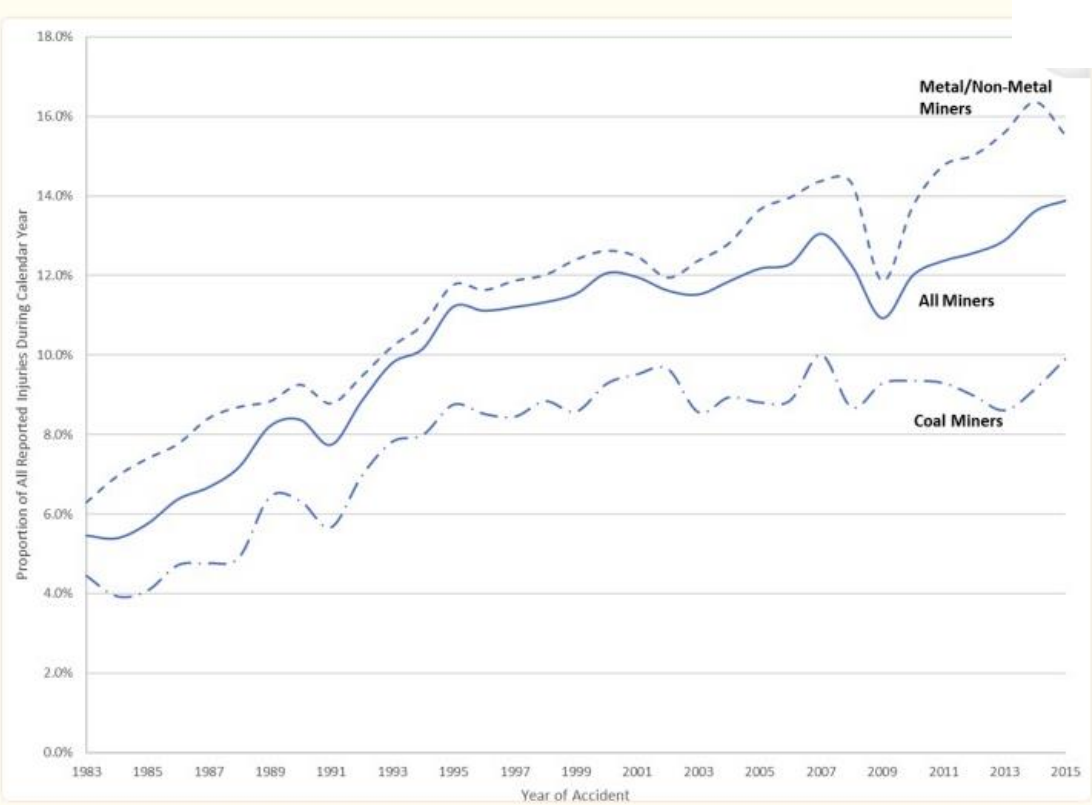

Figure 95.

Increase in the proportion of injuries occurring during long working hours (≥9 hours into a shift) by year of accident. Yearly data for all reported injuries to MSHA Part 50 Program in USA: 1983–2015. MSHA, Mine Safety and Health Administration.

From Friedman et al. (2019).

According to Bauerle et al. (2022), likelihood of an accident increases with number of consecutive 12-hour shifts. These workers are more prone to sleep disruption and cardiovascular disorders, and adverse health effects of noise and noxious fumes. According to the latter author, a number of mining fatalities have been attributed to "cell phone usage due to boredom and monotony or cognitive fatigue and sleepiness". Among the "significant predictors of long-working-hour injuries" were "small mine size (less than 20 employees)…and working on Sunday at time of injury". These two factors were also identified as significant by Friedman et al. (2019). The latter workers further reported that "Incidents occurring during long working hours were more likely to result in a death or multiple workers injured." Muller et al. (2007) reported that the effects of 12 hour shifts in mining workers were comparable to alcohol impairment. Friedman et al. (2019) emphasized the additional importance of "managing noise exposure".

Further, how many consecutive days of 12 hour shifts will/may occur?

In Australia, "in order to promote 'good jobs' in the mining industry, there is both a need to revisit protections for employees against being forced to work 'unreasonable' hours above the ostensible national standard of 38 hours per week and strong support even amongst mine-workers for a ceiling on hours worked per week." (Peetz and Murray, 2011). Canadians, however, are tough. None of that prissy stuff for us.

Note: We are concerned about what happened to this worker at this site. We hope he is okay.

Source: https://www.facebook.com/ourlineinthesandmanitoba/posts/pfbid0Eeyb813We6f5qYs7vSLeoA2AHFSwA6hApPNntE6eNCTxnwMSSFArcVbVbKBsfRrCl

- Noise stress may also affect the job performance of surrounding residents who work from home, and have no respite time. The workers company will be able to go to their quiet homes for 12 hours. Both will be affected: the workers will be exposed to greater noise intensity, but for half the time; the residents will be exposed to somewhat lesser intensity, but all the time.

- A significant proportion of extraction sites will occur in open areas such as fields and gravel pits (e.g. SSCRIR1 # CEC-IR-002), where sound can travel unrestricted. In gravel pits, noise may be amplified by reverberation from excavation walls and faces, gravel piles, and berms. The character of the ground surface itself is also important: according to Ziemann et al., (2016), "sound waves interact frequency-dependently with the ground surface", i.e. low and high frequencies behave differently. The degree of ground-effect reflection is also related to the amount, type and height of vegetation cover.

  The effectiveness of plant cover for noise mitigation has been found to be extremely variable and unpredictable: "there is a considerable divergence of opinion on the effectiveness of vegetation as a noise control measure" (Fricke, 1984). The results range from significant noise suppression to an increase in noise depending on capacity of trees to "reflect, refract, scatter and absorb" various sound frequencies (Maleki and Hosseini, 2011). **Both attenuation and amplification have been reported,** for example sound amplification being greatest at the edge of a forest clearing, which can act as a reflective wall (Figure 96)(Ziemann et al., 2016).

  In wooded areas, sound attenuation is highly heterogeneous and inconstant, depending on numerous factors, including tree density, maturity, species, and stand diversity. Watanabe and Yamada (1996) found that "sound energy was absorbed mainly by the leaves of trees and not their trunks.", and concluded that deciduous tree buffers are of less value when there is no foliage. However leaf size was correlated with attenuation, thus broadleaf species were superior to conifers when they were in leaf. Leaf texture, thickness and shape may also play a role.

  Other workers have found that tree trunks may also influence sound reflection, refraction and absorption (see Ziemann et al., 2016). The latter workers found that "channelling of sound propagation" may occur in forests, and attenuation was greater in daytime than at night, thus **noise travel was more pronounced at night** in the same forest stand (Figure 97). Environmental factors such as temperature, humidity and wind were important. Both Ziemann et al. (2016) and Watanabe and Yamada (1996) reported that attenuation was not equal for different sound frequencies, as some frequencies do not propagate in spherical fashion. **Lower frequencies were attenuated less than higher frequencies**, and thus travelled farther, but the effects were not continuously predictable through the sound spectrum examined.

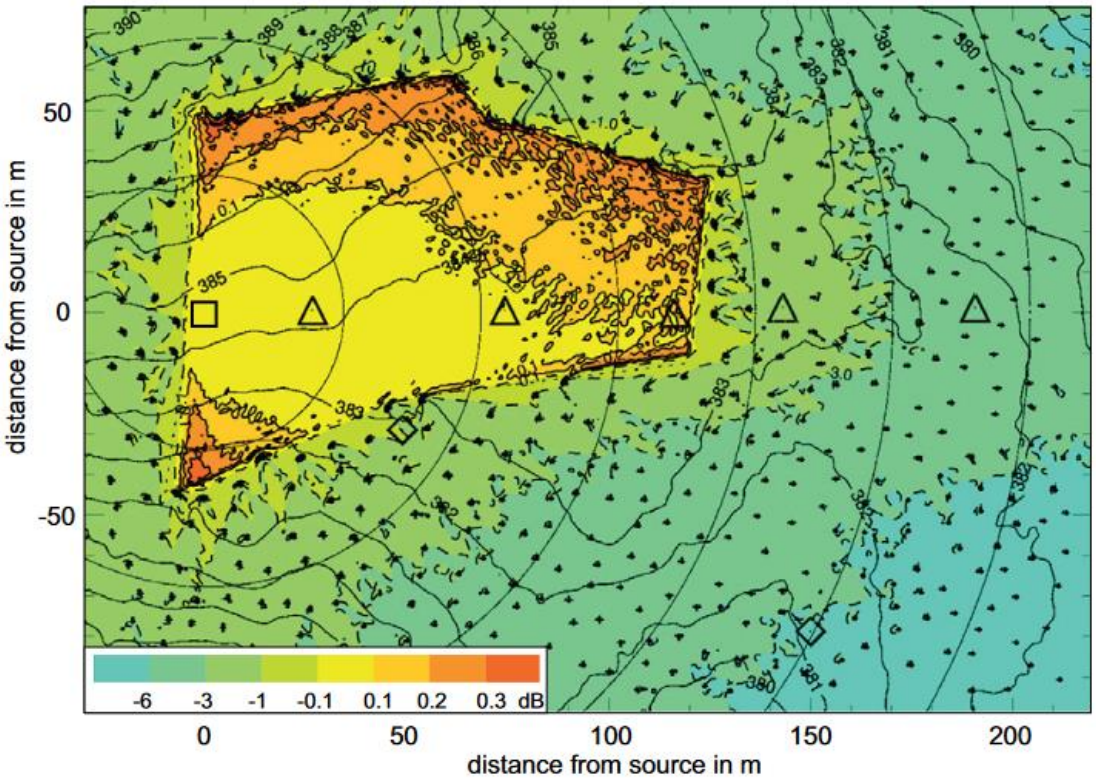

Figure 96. Low frequency (<141 Hz) **sound travel in a clearing and surrounding forest**, total distance 200m, 1.5 m above ground, averaged over 24 hours. The square is the sound source, black dots represent trees. **Sound is amplified in the clearing** (yellow and orange), and attenuated in surrounding spruce forest (green and blue). **Notice that amplification is greatest in the clearing at forest edge.** Clearing edge consists of one row of 20 m deciduous trees, spruce forest is 33 m tall. From Ziemann et al. (2016).

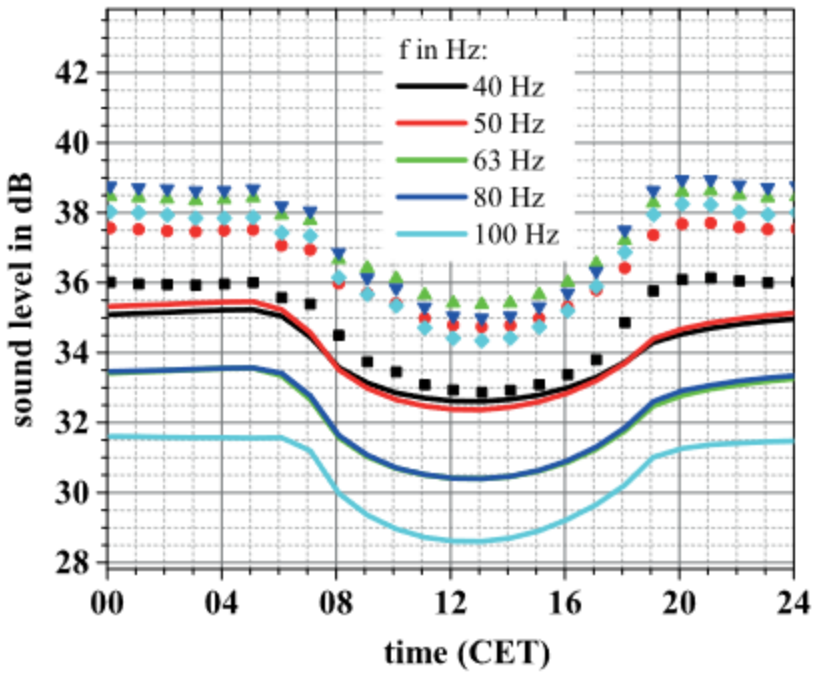

Figure 97. Variation in low frequency sound attenuation in a spruce forest over a 24 hour period (1.5 m above ground, 190 m from sound source). Solid lines are values inside forest, symbols are in clearing without forest. Note the **greater sound levels in nighttime hours** in both forest and clearing. From Ziemann et al. (2016).

The above discussion has focused on sound fairly close to the ground. However houses may have two or more storeys, and bedrooms are usually located on the higher levels. Sound propagation from forest clearings to surrounding terrain is subject to “lifting” and curvature due to upward refraction (Ziemann et al., 2016)(Figure 98).

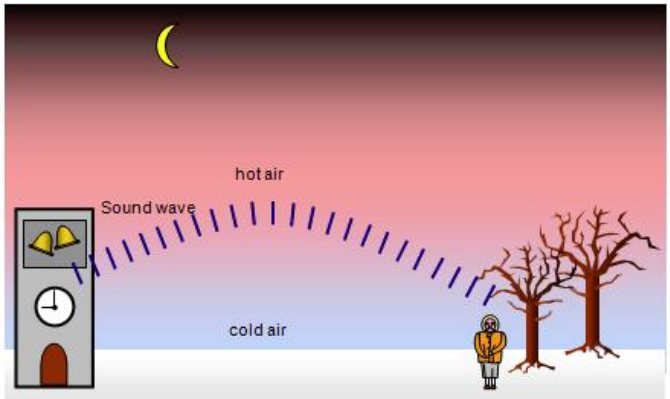

Figure 98. Lifting and curvature of sound as it passes through temperature gradients in the air. Sound may be lifted above a noise barrier in this way. Source: https://www.schoolphysics.co.uk/age11-14/Sound/text/Refraction_of_sound/index.html

In open areas such as fields and gravel pits, sound may travel farther not only because of refraction, but enhanced by bouncing along the ground surface (Figure 99). Sound is perceived to be louder at the bounce points: if a residence is located here, it will suffer the brunt of the noise. Noise barriers will be ineffective if they are placed under the arch of the curve.

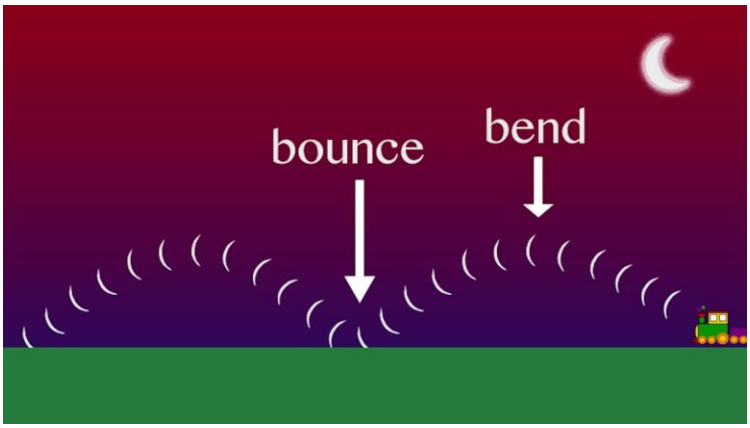

Figure 99. Bouncing and distance travel of sound in open areas such as fields and gravel pits. Source: https://bikehike.org/why-does-sound-travel-further-in-cold-weather/

Bounce-and-bend sound propagation may also utilize clearings for bouncing, with lift over intervening trees. In the present situation, the **patchwork of geometrically spaced clearings** and the open yardsites may facilitate such sound travel, particularly at lower frequencies.

For example, visitors and I can distinctly hear, both outside and inside my home, each passage of the CP Rail trains 4 km away, including through nearly 1 km of intervening adjacent forest. I can already start to hear their approach about 6 km away (excluding horn). Sound intensity depends on time of day (i.e. more pronounced at night), and temperature and humidity.

Since sound travels as waves, it may also be **reflected and redirected horizontally**, creating the illusion that the source is located in another direction entirely. Echo and reverberation may occur at edges of clearings (e.g. Figure 96), the sides of buildings and landscape features. In a personal example, my home is located in a clearing; machinery noise to the northeast 250 m beyond the intervening forest hits and reflects from the forest edge at the south of my home, such that the noise appears to come from the south at the location of my home. In such cases, **a noise barrier between the sound source and the house would not mitigate the noise, due to lifting, curvature, refraction and reflection.** But placing a noise barrier to the south would intensify the echo.

If the forest edge, or portions of it, around the clearing are circular or elliptical in shape, an even more extreme phenomenon of sound transmission may occur, where sound waves reflected from multiple points are focused on a particular spot, similar to a satellite dish (Figure 100). This '**whispering gallery effect**' is common in nature (e.g. https://www.acousticalsurfaces.com/blog/acoustics-education/whispering-galleries/ . In my own yard, there is a specific node where conversations ~600 m beyond the intervening forest can be heard distinctly.

The most spectacular outdoor example in my own experience was on the south shore of Lake Manitoba, where quiet conversations on the Delta Field Station porch could be clearly heard at a specific point more than 3 km away along the curving lake shore.

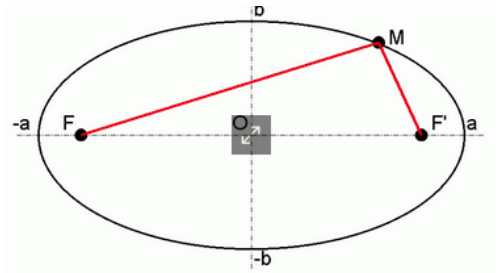

Figure 100. Sounds at F can be clearly heard at F', and vice versa. Only a small portion of the reflective curved surface is actually required. Placing a sound barrier between F and F' will not eliminate the problem. Source: https://www.wikiwand.com/en/Elliptical_dome

This discussion illustrates how complex the noise abatement issue is; suffice it to say that:

1. Sound wave propagation in clearings and forested areas is complex and depends on many intrinsic and extrinsic factors.

2. Sound propagates differently at different frequencies. Low frequency sound travels farthest and is most pronounced at night.

3. Sound from forest clearings may impinge surrounding areas in **unpredictable ways**. Homes near noise-producing clearings may experience the worst noise, but nodes farther away may reproduce a comparable disturbance.

Therefore **no 'one-size-fits-all' setback distance from homes is practical for noise control, because every single case will be different**. Actual measurement, including low frequencies, at night, and at the level of the bedroom windows is necessary. We can conclude that **a 100 m setback will be insufficient to mitigate against extraction site noise.**

- The TAC (#13) document states: "In the absence of mandated setback distances and the various influences on noise, setbacks are determined on a case-by-case basis. Based on the findings of the Noise Impact Assessment completed by AECOM for the CanWhite Vivian Sand Facility Project, an initial setback distance of 100 m of Project activities from the nearest residences has been selected as an initial measure to mitigate nuisance noise that maybe generated by Project activities at local residences. A review of the isopleths from the Noise Impact Assessment indicates that noise levels **typically** do not exceed an average of 60 dBA (the Manitoba Guidelines Maximum Desirable Sound Level for year-round operations) at a distance of 100 m from the loudest noise generating activities at the Processing Facility during daytime hours. We consider the highest sound level generated at the Processing Facility to be comparable to the noise that will be generated during extraction activities." (also RPCR #82, #164; SRTER #11)(Emphasis is mine).

A number of questions arise:

1. **THIS RESPONSE RELATES TO THE <u>PROCESSING FACILITY</u>, NOT THE EXTRACTION OPERATION.**

The TAC (#13) question clearly was: "ECE requests more information regarding the estimated noise level of the **extraction operation** 100 m from a residence and potential noise mitigation measures available." (Emphasis is mine).

The reply is not just negligent, but insulting. In other words, we can surmise that there are **no noise measurement studies for extraction activities**. "We consider the highest sound level generated at the Processing Facility to be comparable to the noise that will be generated during extraction activities." How can this possibly be assumed, when the sites, operating parameters, types of equipment, number of different equipment pieces, different sound frequencies and characteristics, and scope, types and hours of activity

are different? In addition, some of the noise at the Processing Facility will presumably occur inside the walls of a building, as there is one planned at the site. **None of the facility study can be transferred or extrapolated to extraction site conditions.**

In SSCRIR1 (#MSSAC-IR-003), "It should be noted that although a section on cumulative effects was not included in the EAP, cumulative effects were considered in the Hydrogeology and Geochemistry Assessment Studies that were completed in support of the EAP and the **noise assessment which considered cumulative effects in the form of ambient noise.**" Is this assessment the same as the immaterial Processing Facility reference above? If not, why is this other study not available?

2. Only daytime hours seem to have been important: presumably people become deaf after hours. However the operation **noise will be continuous**, day and night. The "loudest noise generating activities at the Processing Facility during daytime hours" implies that maximum operations at the facility will occur in daytime, unlike extraction operations. Furthermore, noise travel and perception are greater at night, yet the facility Noise Impact Assessment only included daytime conditions.

3. The noise will fluctuate and vary in intensity and acoustic properties. The "noise levels typically do not exceed an average of 60 dBA" (i.e. for the Processing Facility). This is self-contradictory: if it is an **average**, by definition a significant number of measurements will fall **above** the average, and therefore exceed it. What does "typically" mean – obviously not 'never'. Is it 'typical' for the level to be exceeded once, twice, five, ten times a day? What sort of data points does the "average" comprise, i.e. actual measurements, not "assumptions"? We see these mollifying plastering-over terms, but what are the unembellished maximum values that can and will occur? At the extraction sites?

4. There are a number of components to the acoustic profile of noise, which may include infrasonic and ultrasonic frequencies, in addition to the normal human audible range of ~20 - 20,000 Hz (see above discussion). As discussed above, each piece of machinery has its own sound spectrum characteristics, composed of the various frequencies emitted. According to Prashanth and Venugopalachar (2011), "**For an efficient evaluation of noise effects, frequency spectrum analysis should also be included.**" (emphasis is mine). Since no study was done, obviously this analysis was not included.

5. Since many pieces of equipment will be operating at the same time, with different noise frequency spectra, their wave patterns will collide and interact, resulting in interference. In constructive interference, amplitudes of waves may be combined, such that at certain points or nodes, sound will be particularly intense. For example, when two pieces of the same kind of equipment operate at a separation distance (Figure 101), there will be multiple nodes where the sound overlaps and is amplified. Note the effect

is three-dimensional. At the nodes, decibel levels may greatly exceed those measured from a single source.

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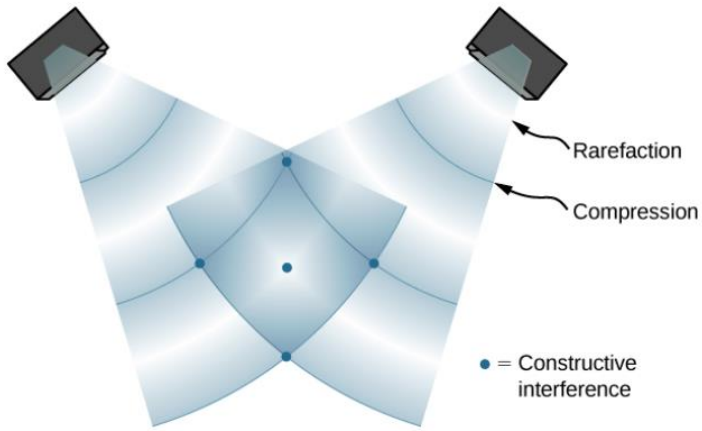


Figure 101. Interference from two identical sound sources. Sound is amplified at the nodes (points of constructive interference). Source: https://courses.lumenlearning.com/suny-osuniversityphysics/chapter/17-4-normal-modes-of-a-standing-sound-wave/

Another analogous situation of amplification can occur if there is only one sound source, but it interferes with its echo, for example in a quarry.

- Many different kinds of equipment operating together will result in complex patterns of nodes, at various frequencies. Given the many and multiple pieces of equipment – generators, diesel extraction rigs, light plants, compressors, pumps, screens, cyclone, etc., **it will not be possible for the extraction sites to meet the 83 dBA mandated Workplace Safety and Health maximum for a 12-hour shift.**

- In SRTER (#11), the reviewer notes: "Quantitative analysis are [sic] required to confirm the Proponent's conclusions that the Project will not result in significant noise impacts. These analysis [sic] should include baseline noise assessments of the study area, noise modelling and monitoring." The proponent responds: "it is our opinion that the quantitative analysis proposed by Arcadis to confirm our assessment of noise impacts is not warranted."

- Further in TAC (#13, also SRTER #11): "Prior to commencement of drilling activities, CanWhitewill test the noise-generating equipment used during the extraction process and collect sound measurements at multiple points at 100 m distance from the extraction site (or at the nearest residence) to confirm that sound levels meet the 60 dBA limit at these monitoring points. Ambient sound levels (background noise) will also be collected at each location. Noise generated from extraction equipment shall not exceed 60 dBA at these monitoring locations, unless the ambient noise level exceeds the 60 dBA limit. Mitigation will be applied in all cases where noise exceeds the 60 dBA limit. Mitigation measures

may include engineered controls such as soundproofing material or insulation around noise-generating equipment, portable noise barriers, and equipment maintenance. Operation controls can also be applied, including limited operating hours, minimizing acceleration and deceleration of motors, and limiting activities that create noise (e.g. hammering pipe; limiting the use of vehicle back-up alarms). Any noise complaints will be investigated and addressed as quickly as possible."(Also RPCR #82, #164; SRTER #11).

"Additional noise mitigation measures will be applied (e.g. portable noise barriers) as required" (EAP1, p. viii).

The following observations arise:

1. Any noise data will be collected **after** project approval.

2. Since each site will have different acoustic characteristics, will noise measurements be conducted **for each case, i.e. for each residence**? There may be several residences in the vicinity of a well cluster. Furthermore, if several clusters are present, the noise impinging on a given residence will vary, depending on the respective cluster involved. Due to lift, curvature, and bounce, the noise may show paradoxical behavior in some situations, where farther residences experience greater noise intensity.

3. "**Prior to commencement of drilling activities**, CanWhite will test the noise-generating equipment used during the extraction process": since each site will be unique, how can noise testing of the *extraction* equipment occur BEFORE *drilling* activities commence? This implies that all of the extraction equipment will be on site even before drilling, yet drilling will occur year-round (EAP1, p.11), and a considerable lag period may intervene between drilling and extraction. Furthermore, not all of the noise-generating equipment, or even most of it, can be dry-tested, for example cyclones, screens, slurry line pumps and equipment, turbidity treatment and disinfection, etc. etc.

The site will have already been cleared: can we believe that will it be abandoned because of an unfavorable noise test? The damage is done, the money spent.

4. Who will conduct and verify the measurements? Will a qualified independent party do this? Or will the company do its own readings (if indeed), and the results will be "*proprietary*"?

Will the homeowner have the right to be present to witness the readings?

5. Will the decibel meter be **properly calibrated**? In the field, **an acoustic calibrator must be used before and after each measurement** (CR, 2022). According to the latter source, "If there's any variation between what the calibrator is outputting and what the microphone is receiving, the sound level meter can offset the difference to ensure your measurements are consistent and accurate against a consistent noise source." Besides

the foregoing, because components age, users must *also* send the "sound level meter and acoustic calibrator back to the original manufacturer for them to calibrate and verify the instruments"; this occurs every 1-2 years, depending on amount of use. There are dedicated acoustic tech labs which accept all brands for the necessary recalibrations as well.

Accurate measurement is important not just for the homeowner, but also for the workers. Measurements should be taken at the work site on a regular basis, and whenever more equipment is switched on.

6. **When** will homeowners' measurements be taken? Sound travel, perception and adverse effects of noise are more pronounced at night. In the present case, there will also be **more noise-generating equipment at night** (e.g. light plants). According to EAP1 (p. 26), each of the *eight* light plants will have its own power generator. Will both daytime and nighttime measurements be obtained? For each site and residence?

7. Noise is greater at the second storey of the residence, where the bedrooms are located, due to overtopping of near-ground barriers, and refraction, curvature and lift.

8. Will measurement times at the extraction sites (if undertaken) be **unannounced**? Or will measurements occur after advance notice, or when only some equipment is operating?

9. "Limited operating hours" conflict with the 24/7 operation plans, and requirements for continuous flow in the slurry pipes and disinfection apparatus will render this option unlikely.

10. "Limiting activities that create noise (e.g. hammering pipe; limiting the use of vehicle back-up alarms)": what needs to be done, needs to be done, and isn't optional. By law, vehicle back-up alarms cannot be modified or disabled, as they fall under the category of "safety equipment". The only way to mitigate these noises for neighbors is not to have the site in that location.

- What sort of "portable noise barriers" are envisioned, and where would they be deployed? As discussed above, noise barriers between the source and the recipient may be ineffective, as sound does not necessarily travel in straight lines. The best mitigation is at the point of origin, such as the use of **acoustic blankets and enclosures** that muffle the sound **at the source, on the sides as well as the top**. There are many suppliers of these items, and in many cases manufacturers of generators and compressors can provide options that are designed for the acoustic profile of the particular equipment. **Will such noise suppressors be used on the various pieces of equipment?** The EAP is silent on this issue.

Of course, no approaches can cancel sound escape entirely, other than operation of the equipment underground, or in a bunker or a vacuum.

- Who will determine when noise mitigation is required? Does the resident have to complain? To whom? How long will it take to get a response? Will it be taken seriously? Does a provincial mining inspector have to be involved?

  TAC Comment (#14) states: "ECE recommends the proponent develop and maintain a complaint management plan to track and respond to public complaints regarding the operation of the Development."

  The proponent responds: "CanWhite will develop a Noise Mitigation Plan for the Project that will include a strategy for addressing community concerns in discussion with the Environmental Compliance and Enforcement (ECE) Branch to confirm the recommended scope for the plan. The draft plan will be submitted to ECE for review and will be finalized prior to the initiation of Project operations." (TAC #14). **Where is this Noise Mitigation Plan?**

  "Any noise complaints will be investigated and addressed as quickly as possible." (TAC #14), (also RPCR #219). The company will be investigating itself, whenever it is ready. What is wrong with this picture?

  It is dispiriting that the public will have to deal with the company, and not with an impartial third party with powers of enforcement. This direct engagement may be distasteful and intimidating for some, and will encourage hostility and conflict, or cow others into silence. Will the above-mentioned Environmental Compliance and Enforcement Branch monitor and track this "complaint management plan"? Will mitigation measures be enforced? Will complaints and their resolution be on public record? Who will arbitrate disputes? Will weeks pass between complaint and response, assuming there will be a response, by which time the project will have moved on? Where can people lodge a complaint to a higher authority without resorting to legal channels? In other words, where is the accountability?

  It is disheartening that no plan or strategy exists even in its embryonic stages, yet approval is being sought. Without a response plan **in place,** how can operations be approved?

- It is difficult to obtain the services of a mining inspector, yet even this achievement is not a guarantee that the resident will obtain relief or justice.

  As a real-life illustration, one case involved an aggregate extraction operation, with houses nearby, in Brokenhead Municipality, run by a Springfield mining operator, which was set up with no municipal Conditional Use hearing. After a great deal of resistance and wading through bureaucracy, assisted by the services of a lawyer, the service of a Mines inspector was finally procured months after a neighbor's ongoing noise complaint. At the neighbor's residence, the inspector measured the decibel level of a rock crusher, screens, conveyor, excavators, loaders, dredge, truck weigh scale and other equipment operating 200 m away. Although the inspector tried to prevent the neighbor from seeing

the reading on the decibel meter by physically shoving her away, she was able to see the high reading. However the inspector's ensuing report claimed there was no concern. The neighbor obtained a calibrated decibel meter, and recorded the readings. When the Mines Branch was approached again by the lawyer, and a direct appeal was made by the lawyer to the Minister of Mines of the day, this same inspector was sent out again. Each time he alerted the operators beforehand that he was going to take readings in 15 minutes, allowing them to shut down the crusher and other equipment, and leave only one Caterpillar running in the background. Once the readings were taken and he had left, all of the equipment started up again. The operators laughed about this partnership openly and publicly in a local restaurant, several people witnessed it, and the neighbor's lawyer apprised his client that this was going on. The operators made cruel fun of the neighbor's powerlessness in the face of such insuperable collusion. This same inspector shortly afterwards moved to a lucrative company job with a large aggregate mining operation on Garven Road.

I can personally attest to the veracity of this account. The lesson here is that: our laws, inadequate and unjust and permissive as they already are, are further held in contempt and treated as a joke by those very same public servants who are paid to uphold them. We do not know if this instance was an excrescence of individual initiative, or was conducted with benediction from above. As with most government malfeasance, we will never know. But it destroys the public's confidence and trust in the regulators and their retinues just the same.

- Throughout the proposal documentation, the **human and social aspects** of the distress of noise and impacts of other disturbance have been **ignored, minimized, dismissed**. They have even been degraded to the most unseemly and inappropriate level, by introducing the proponent's sick child into the public ad campaign (The Clipper, January 12, 2023, p. 10):

But I get it, some will say there's still risks, despite anything we could say or do, or how good the technology is. Here's what I would say about that.

My seven-year-old daughter had double kidney failure when she was five years old (there's a photo of us below). After two years of dialysis and three attempts at a transplant we had a successful kidney transplant last January. An adult kidney was placed in a tiny child successfully. I have learned directly the value of technological advances and research. The world we live in today is so because we have used our imaginations to solve problems and create better things.

While we are sorry for the child and her situation, she has been pulled into this fray through no fault of her own, and her right to privacy and medical confidentiality has been so unfairly paraded and exposed for the sake of a crass commercial ad. However we are forced into questions that are distasteful, base, and pitiful in the extreme, yet unavoidably necessary and obvious: **what about other people's children? What if a child in such or a similar situation is awaiting surgery or recuperating in a home that is 100 m away from the proponent's 24/7 extraction site?** Or even 500 m away? What if this same child has to endure unremitting noise, subsist on trucked water? Breathing the stench of diesel exhaust? Would he allow his child to be treated thus? Why would **any child** be subjected to such affliction at her/his own home, for the sake of somebody's industrial profit?

What is the message here? It is heartless and has no place in civil and decent discourse. Shame!

There is also talk of "technological advances and research", and "how good the technology is". Yet the proponent himself admits that the technological advances in this project have not yet materialized and that the project will constitute the research. How are we grandly 'creating better things' here: how does this intrusive and odious mining

method save children's lives - we are mining and selling silica sand, which is amply and widely available elsewhere, in places that don't carry such a burden of grief.

Despite all of this, in the same ad the proponent encourages us to take "comfort and confidence in the activity happening around your home" (The Clipper, January 12, 2023, p. 10). *Comfort*? It is offensive and demeaning. Perhaps some folks won't enjoy the comforting activity of a battlefield around their homes – this is why they live where they do in the first place.

In another ad (The Clipper, January 19, 2023, p. 24), "Every update we make is designed to protect the environment and improve the experience of the people living close to an active operating site." The experience of the people living close would be much improved by **not allowing an active mining site where people live**. Just an outlandish idea, which seems not to have occurred to our regulators.

Farm animals and pets

- Noise has been shown to have **adverse effects on farm animals,** including cattle, pigs, chickens and horses (Broucek, 2014). "Animals have a different spectrum of audible sounds with maximum sensitivity at frequencies that are inaudible to humans" (Voipio, 1997 *in* Broucek, 2014). These frequencies may extend above and below the human acoustic range (Figure 102). Dog whistles and electronic barking deterrents utilize this principle. "Dogs in general can hear as high as 45 khz, while cats and bats can hear frequencies as high as 75 - 100 khz" (Colwell, 2022), in some cases even higher. Cattle and pigs also hear high-frequency sounds much better than people (Heffner, 1998 *in* Broucek, 2014), with discomfort in cattle starting at ≈ 90 dB (Phillips, 2009 *in* Broucek, 2014). Noise stress includes impacts on reproductive performance, feeding, milk yield, egg laying and brooding, hormonal cycles, blood cell counts, heart rate and behavior (Broucek, 2014). Continuous noise at 90-95 dB induces immobility and convulsive behaviors in chickens (Algers et al., 1978 *in* Broucek, 2014).

  In the present situation, sustained round-the-clock noise could impact farm livestock and poultry, especially animals housed outdoors, as well as pet animals owned by rural residents. For example dogs exposed to noise experience disruptions in digestion (Gue et al,, 1987 *in* Kight and Swaddle, 2011). Setbacks of 100 m from animal enclosures will be inadequate because of greater hearing sensitivity of animals. How will this issue be addressed?

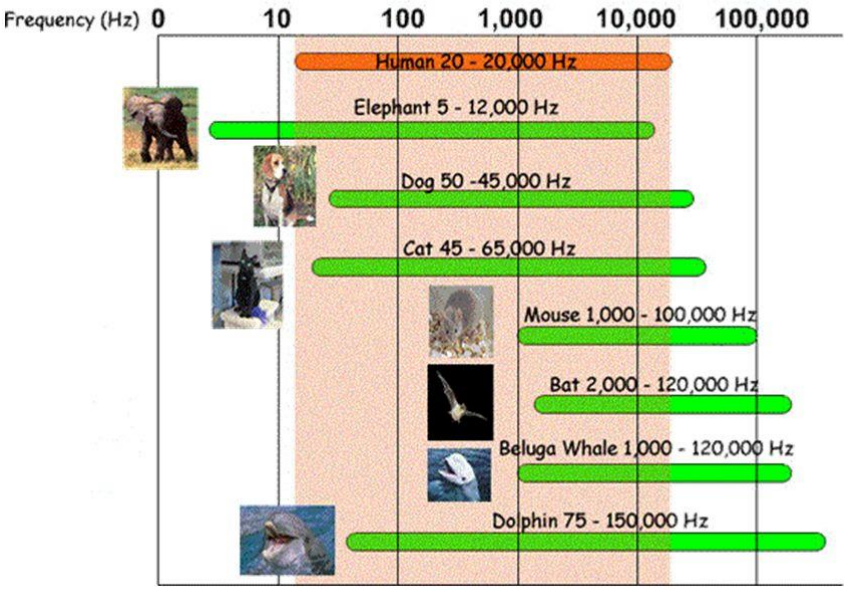


Figure 102. Sound frequency spectrum, showing range of animal and human acoustic hearing. Note Hertz scale is exponential. Source: https://www.google.com/url?sa=i&url=https%3A%2F%2Fslideplayer.com%2Fslide%2F7610822%2F&psig=AOvVaw1N7exJOoqQXbETNABfrOy8&ust=1645627196086000&source=images&cd=vfe&ved=0CAgQjRxqFwoTCMCs95zFk_YCFQAAAAAdAAAAABAU

Wildlife

- "Section 6.5.2 of the EAP concluded that there would be **negligible effects** of the Project on regional Wildlife populations. Factors included in the assessment of potential Project effects on wildlife included Expected presence of specific wildlife in the region, existing local and regional landcover, natural annual variation of wildlife populations, influences on wildlife from local and regional factors (such as predator-prey cycles; human activities such as hunting), the availability of nearby alternative habitat for wildlife and mitigation measures that will be applied to minimize effects on naturally vegetated areas" (RPCR #109)(Emphases are mine.)

  Where is this extensive Wildlife Assessment Report, aside from the species of conservation concern in section 4.4.3 in EAP2?

- The EAP takes pains to reiterate and emphasize that clearing activities will proceed in winter to minimize adverse effects on birds. "Clearing of natural vegetation to accommodate the establishment of sand extraction well cluster sites, temporary access trails, temporary trails for slurry lines and water return lines and area for pumping stations will occur outside of the peak breeding bird season for the Project area (i.e. April 25 – August 15) to avoid contravening the federal Migratory Birds Convention Act, 1994." (EAP1, p. 13).

This statement seems laudable but is in fact disingenuous. While clearing activities are traumatic enough, they do not compare in terms of noise levels and disturbance duration with the extraction sites, which latter will **operate during breeding and nesting times of all bird species**. Furthermore, unlike clearing activities, extraction sites will operate continuously, and be of several weeks+ duration, as likely operation of wells at a site will be staggered over a period of time. Sites will also generate other additional nuisances that will affect birds (see below).

Just as one example, continuous 24/7 **compressor noise** at the extraction sites will affect birds in the area. Ortega and Francis (2012) found that the detection threshold where no birds were found within 60 m was approximately 45 decibels(A) of compressor noise. Although 45 decibels seems not very much in itself, it is the **type of noise** (amplitude, frequency, pitch, continuity, etc.) that is also important. The extraction sites will generate far greater decibel levels.

The federal Migratory Birds Convention Act, 1994 cited by the proponent is only one of the material documents which pertain to bird protection, and others ought to have been consulted. The above Act relates only to selected *migratory* birds, and **does not address non-migratory species** that occupy the region year-round. Additional species of concern are listed in the Manitoba Wildlife Act C.C.S.M. c. W13. Nesting times of the birds in the region can be found by using the Birds Canada Nesting Calendar Query Tool (https://www.birdscanada.org/apps/rnest/index.jsp?lang=EN). It can be seen from this Tool that a number of relevant species **start to nest earlier than April 25** (see p. 445).

- Noise has been shown to elicit physiological effects in birds. For example, "In the myocardial tissue of birds exposed to loud noise an increase of HPS70 [a heat-shock protein] has been found (Hoekstra et al., 1998 *in* Spreng, 2000). These proteins are present in many organs, including heart, kidney and reproductive systems, and are involved in physiological response to cortisol secreted on exposure to environmental stress.

- Bats occur in the project area (personal observation). According to He et al. (2021), "Bats exposed to chronic noise pollution have weakened immune functions, increased viral shedding, and declined immunity during pregnancy, lactation, and vulnerable periods due to noised-induced stress."

- Noise pollution has also been found to negatively affect a **majority of wildlife taxa**, both vertebrate and invertebrate (Kunc and Schmidt, 2019). Noise avoidance (negative phonotaxis) is a primary coping mechanism. "Wildlife species present in the vicinity of the Project are anticipated to be accustomed (habituated) to some level of noise due to the presence of existing developments (e.g. agriculture activities, residential areas, roads and aggregate quarries)." (EAP1, p. ix).

"most sites that have been selected for Project activities are on previously disturbed sites such as gravel quarries or open fields" (RPCR #108).

None of these listed settings are associated with diversity and abundance of wildlife, *because* of the existing disruption and noise. Additional activity will depopulate these places further. Aside from agricultural land, for entirely different reasons extraction sites will hopefully not be located in "residential areas, roads and aggregate quarries"……..But sadly in gravel pits, where noise is particularly enabled, extraction/injection well activities have already proceeded (Figure 103), and will continue to do so.

In response to the question: "Will CWS record and report noise levels of such quarry operations", the proponent blithely states "Please note that there are **no quarries** associated with this Project." (RPCR #141).
In RPCR (#145), the proponent states: "The extraction sites selected for the first few years are in a **gravel quarry** that is already accessible from PR 302", and in RPCR (#150): "Most of the land that will be used for the footprint of Project operations is previously disturbed (e.g. agriculture; **gravel quarry**)." (Emphasis is mine). These are the proponent's own words.

Noise levels in quarries, i.e. extraction sites located in quarries, are problematic because of their acoustic characteristics and various resonating surfaces which enhance noise and reflect it in multiple directions. Sound travels in these exposed settings and is intensified by echoes and reverberations. The behavior and propagation of noise in such conditions are irrespective of the kind of mining being carried out, the differences being in the numbers and types of equipment that are used, and therefore in the sound frequencies and vibration. Thus monitoring of noise levels emanating from these wastelands is important. Residents have already complained of the noise from the PR 302 quarry referenced above, despite the thus far limited extraction well operation (personal communication).

- A further point to consider is whether normal quarry operations will be ongoing at the same time that extraction wells are operating **in the same quarry**. In such situations, the **noise from both activities will be combined**.

  According to Bauer and Spencer (2008), in gravel pits, "(crane, suction pumps and diesel engines) … sound levels greater than 90 dB(A) are present. In addition, crushers and screens used in the processing of the sand and gravel also generate sound levels greater than 90 dB(A).". Further, "Sound levels as high as 112 dB(A) were recorded near crushers, 108 dB(A) near screens".

- Significant noise invasion of woodlands and other natural areas, which constitute

refuges for wildlife, will also occur. **Extraction activities will be concentrated during breeding seasons of all wildlife.** Operation will be continuous 24/7. Noise will be just one stressor of many, which will work together to exert a combined synergistic effect.

Figure 103. Silica sand extraction operating in a Springfield gravel pit, April, 2021.
Source: https://ourlineinthesandmanitoba.ca/about/

- "Amphibian surveys were conducted within the Regional Project Area during May 14 to 18, 2018." (EAP2, section 4.4.2). Where is this report? Surely this information cannot be 'proprietary'?

  Amphibians are one of the most critically endangered animal groups on the planet, and their abundance has noticeably declined in Manitoba. Amphibians have been shown to perceive a wide variety of sound frequencies, including ultrasound in some species, and modify their chorusing behavior in response to anthropogenic noise such as airplanes or engine noise (Narins, 2013), potentially affecting breeding success (Parris et al., 2009). Eigenbrod et al. (2009) found that decreases in species diversity and relative abundance of frogs extended hundreds of meters away from sources of traffic noise on a highway in Ontario.

- Section 4.4.7 of the Canadian federal Environmental Code of Practice for Metal Mines (2009) recognizes the need to protect wildlife to the same noise level as people:

Ambient Noise from Mining Operations

R 419: In residential areas adjacent to mine sites, the equilibrium sound pressure level (L_{eq}) from mining activities should not exceed 55 dBA during the day and 45 dBA at night. Ambient noise can also affect wildlife, so sites in remote locations should also work to meet these objectives for off-site ambient noise levels.

- "Project-generated noise is not expected to be substantial beyond the Project Site and adjacent Local Project Area" (EAP2, section 6.5.2). "Project activities in any one location will be temporary" (RPCR #84).

  Even if this were true, **the site will not remain in the same place**, it will move from site to adjacent site, hence it will affect a wider area. Animals that have been scared away from their dens or territorial ground may not return for some time, as the region is still affected. Impacts may be more complex, for example their food may have been scared away. In addition, what may not seem" substantial" to us may be perceived differently by species with more acute hearing.

- The proponent responds to my noise concern thus: "Section 6.5.2 (Wildlife) of the EAP has assessed the potential for Project impacts on regional wildlife populations related to noise. Noise generated during Project activities is expected to influence wildlife behaviour (e.g. area avoidance) to varying degrees within the Project Site and Local Project Area depending on the type of wildlife (U.S. National Parks Service, 2018). However, Project generated noise is not expected to be of a magnitude that would measurably affect wildlife populations in the Regional Project Area.
  An example study cited by the U.S. National Parks Service (2018) is an article by Shannon et al. (2015) indicating that terrestrial wildlife responses begin at noise levels of approximately 40 dBA. Human-generated noise sources regularly occurring adjacent to the Project Site, such as existing noise from traffic, are currently influencing wildlife behaviour. Traffic noise can be as high as 69 dBA up to 60 m from highways (Rochat 2016). Project activities in any one location will be temporary as each well cluster is decommissioned and drilling activities move on to another well cluster site. Additionally, noise levels will be attenuated (decreased) by landscape characteristics such as forested areas with increasing distance from Project activities (e.g. Yip et al. 2017; Albert 2004)" (RPCR #84).

  I would like to make the following comments:

  1. "Project generated noise is not expected to be of a magnitude that would measurably affect wildlife populations in the Regional Project Area." Where are the data: has project noise actually been measured?

2. The characteristics of traffic noise are not comparable to the noise expected from machinery and activities emanating from the project site. There are significant differences in acoustic attributes (see above discussion), in addition to loud bangs and shouting. Traffic noise in the area is intermittent and not continuous, and is much less frequent at night (personal observation). The relevant paved roads are not multi-lane highways. There seem to be no actual measurements for traffic in the area.

   In any case, one noise will not be replacing another. If existing traffic noise is already influencing wildlife, as the proponent contends, then would not **any <u>additional</u> noise have to be much lesser** in order for the **total** critical noise level to be reached?

3. Where is the report that "has assessed the potential for Project impacts on regional wildlife populations related to noise." ?

4. Standard decibel meters measure only the frequencies in the human audible range of ~20 – 20,000 Hz. Thus **additional frequencies that may affect wildlife are excluded**.

5. The Rochat (2016) reference is missing from the EAP citations; it should be Rochat and Reiter (2016), and is here provided for the reader's reference:
   Rochat, J.L. and D. Reiter. 2016. Highway traffic noise. Acoustics Today 12: 38-47.

   The Shannon (2015) reference is missing from the EAP citations, and is here provided for the reader's reference:
   Shannon, G.; McKenna, M.F., and 10 others. 2015. A synthesis of two decades of research documenting the effects of noise on wildlife. Biological Reviews 91: 982-1005.

Pumping stations

- In Table 2-1 (EAP1), we learn that there will be water pumps and "slurry pumps (varying sizes depending on location)". The **multiple pumping stations will generate noise:** aside from the two pumps at each station, the generators that might at times run them (as backup) will produce additional noise. The pump noise will occur 24/7, be continuous, and prolonged over weeks or months, depending on how often the slurry system is moved, during the April through November extraction window. Presumably the 100 m setback from residences will apply (?) to the pumping stations as well, but this is inadequate for continuous, prolonged, round the-clock, intrusive, oppressive nuisance. The slurry lines might only be moved infrequently, therefore the duration of the nuisance will substantially exceed that of the operation of individual well clusters.

Pumping stations will be positioned "approximately every 450 m to 550 m along the length of slurry line."(EAP1, p. 18), or roughly every 0.5 km. The pairs of pumps at the respective loci may create overlap zones along the line, such that noise attenuation with increasing distance from one station will be cancelled by increasing noise emanating from another. **Why have no noise studies been conducted on pumping stations?**

Figure 2-5 of EAP1 indicates that the slurry pipes, with attendant pumping stations, will often be routed through normally undisturbed forested lands, which traditionally provide cover and breeding habitat for birds. Ample research has shown that birds are adversely impacted by chronic noise, resulting in reduced reproduction and impeded chick development (e.g. Schroeder et al. 2012). Birds and frogs are particularly sensitive to generator noise, resulting in negative patterns of distribution relative to these sources (Slabbekoorn, 2019). **Therefore pumping stations are expected to be disruptive for wildlife**.

The EAP1 (p. 24) indicates that pumping stations "will be buffered by sound barriers for noise suppression if required". Therefore they will not all be buffered as a matter of course, but only "if required". Again, the same questions arise as above for extraction sites: Who will determine if this is required? What will the criteria for action be? What sort of suppression methods will be used? Evidently the stations will not be housed in acoustic enclosures automatically. The wildlife will have no ability to complain and nobody to intercede on their behalf.

Drilling

- Drilling will occur year round, therefore noise from this activity will occur even in winter. When extraction sites are operating, additional drilling noise may be occurring nearby on the same or adjacent parcel. The drilling will involve multiple wells in the clusters and blocks, and will not be comparable to the lesser disturbance associated with drilling a single water well.

  According to Reinke (2005), "water well drillers are exposed to levels above 85dB(A) while performing certain tasks during a typical drilling job." According to this author, "Various parts of a drill rig create noise besides the drilling rod…Some of the loudest parts of the drill rig include the compressor, engine, and cooling fan."

  While the workers are at greatest risk of hazardous noise exposure, the sound will disturb residents and animals. **Drilling noise will be more apparent in winter**, and will disturb more residents than in warm weather. While sound travels more slowly in colder air, **sound intensity is greater due to refraction** (https://bikehike.org/why-does-sound-travel-further-in-cold-weather/), and **it travels farther** (https://www.discovery.com/science/Sound-Carries-Farther-Cold-Days).

Cooler air is also part of the reason why sound travels farther at night. Further adding to noise propagation in winter is the absence of leaf canopy/understory, and reflection due to snow cover.

No noise studies have been conducted by the proponent on drilling noise.

Light pollution

- On p. 26 of EAP1, we see a reference to a "light plant" for the first time: no further elaboration is provided. Does this refer to mobile industrial light towers with banks of excruciatingly powerful lamps? How much lighting will there be? Whatever this item is, Table 2-1 (EAP1, p. 27) indicates there will be an alarming eight of them, for which Table 6-3 (EAP2) estimates a total usage of 24,000 hours per year. This translates to 3000 hours of operation for the combined eight. Apparently each will be powered by its own diesel unit.

  The nuisance of **light pollution** is mentioned only in passing with respect to wildlife, but no reference is made to human health: "Light pollution emanating from the well cluster/work areas within the Project Site can also disturb wildlife and alter natural wildlife behaviour for wildlife that may be present within the zone of influence of site lighting" (EAP2, section 6.5.2). Since activities will occur round the clock, and drilling year-round, January through December, need for substantial lighting is anticipated.

  Light pollution is a recognized adverse impact on human health (Holker et al., 2010), where it may enable cancers (especially breast cancer (Chepesiuk, 2009)), may interfere with hormonal regulatory mechanisms and chronobiology (circadian rhythms), and create stress and psychological/behavioral issues. Not just the intensity of artificial light is important, but also its quality (primary wavelengths). According to Bauerle et al. (2022) "Blue light at night can suppress melatonin and this has been linked to negative health consequences." Health effects can occur not just within the lit area itself, but also from peripheral unwanted glare and light bleeding around the lamp (Figure 104).

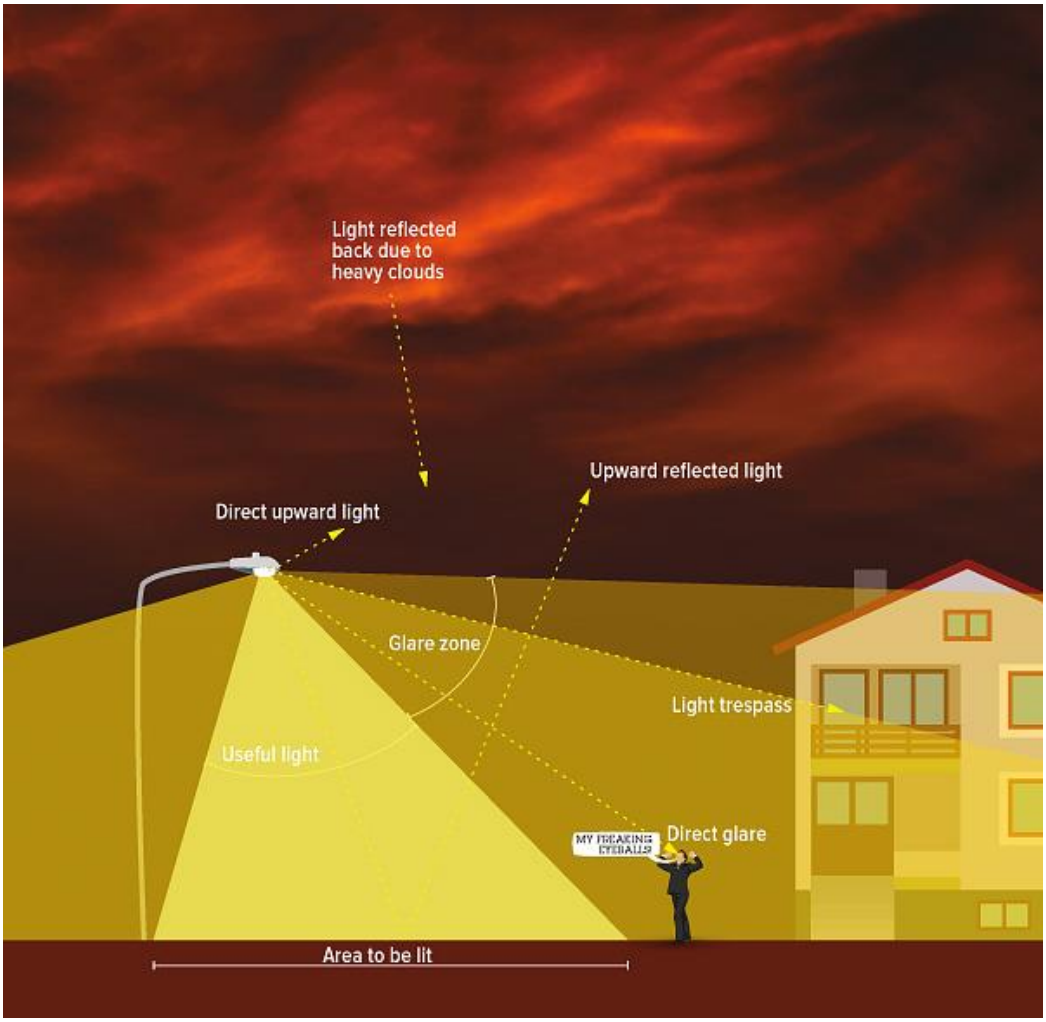


Figure 104. Zones of light pollution from an artificial light source. Source: https://www.darksky.org/light-pollution/

- Artificial light also affects ecology and environment (Bashiri and Hassan, 2014), and disrupts the behavior of nocturnal wildlife (Chepesiuk, 2009), interfering with mating and feeding behaviors.

  In birds, "light at night can directly suppress sleep", affect hormonal secretion and circadian patterns, and alter a variety of daytime and nighttime behaviors, and may extend to impacts on learning, memory, and problem solving (Aulsebrook et al., 2021). At the extraction sites, activities will overlap the bird breeding season. Chepesiuk (2009) reported that night time illumination causes disorientation, dehydration and exhaustion in hatchlings. Light and noise intrusion may cause nests and young to be abandoned, resulting in wasted reproductive effort.

Nocturnal light pollution may also adversely affect other community components. For example, reproduction of fireflies (Lampyridae: Coleoptera), which occur in the project area, may be impaired by unnatural ambient light (https://www.ctvnews.ca/firefly-spotters-wonder-if-the-species-is-fading-away-1.556480).

As is the case for humans, wildlife sensitivity to light pollution is also dependent on light quality, with outputs weighted in the blue part of the spectrum being the most disturbing (Figure 105). Aulsebrook et al. (2021) reported that lights which emit more blue wavelengths have more intense adverse effects on birds. Low pressure sodium lamps appear to be the most ecologically benign (although still disruptive), while LED lights are the worst choice (Longcore et al., 2018). The EAP ignores this topic entirely.

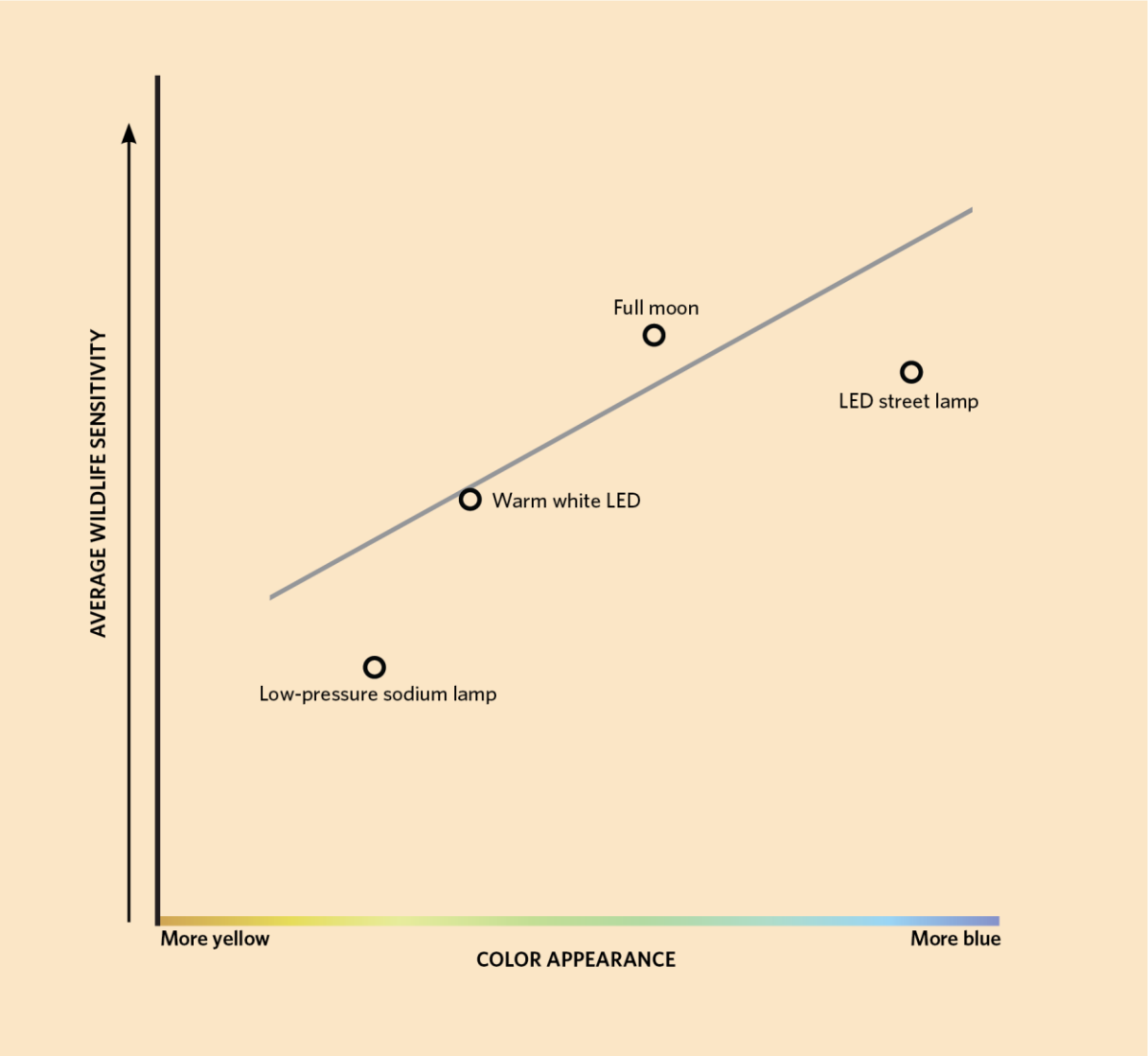


Figure 105. Wildlife sensitivity to nocturnal light increases with proportion of blue light in the output spectrum. Source: https://www.the-scientist.com/features/the-vanishing-night--light-pollution-threatens-ecosystems-64803

- The EAP2 (section 6.5.2) states: "Fully shielded directional lighting fixtures will be used to focus light specifically to work areas to minimize the dispersal of light to the surrounding Project Site."

  From the video at https://www.dropbox.com/s/0hfqzckgv68f61o/img_0623.mov?dl=0 , it is apparent that the light is not shielded (Figure 106). This video was recorded at a silica extraction site in Springfield on 24 August 2021 at 8:45 P.M., at a setback distance of ≈ 130 m. **Eight** such "light plants" are planned (Table 2-1, EAP1, p. 27), but how they will be deployed is unknown.

Figure 106. Springfield silica sand extraction site on 24 August 2021 at 8:45 P.M. at ≈ 130 m setback. Sunset at 8:28 P.M., still twilight. Eight light plants are planned. Is this what the proponent understands as "fully shielded"? Photo Source: https://www.dropbox.com/s/0hfqzckgv68f61o/IMG_0623.mov?dl=0

- "Existing forest cover (45% of the Project Site) is also expected to block or minimize the dispersion of light from Project activities to nearby residences and limit the dispersion of light within the Project Site and adjacent areas." (RPCR #91).

  This will apply only to less than half of the sites, and where present, forest cover will be variable, as will the distance from the forest edge. Within blocks, remaining intervening tree cover will be haphazard, and trunks of deciduous trees will intercept less light than mature conifers . The lights will presumably be simultaneously aimed in different directions in order to cancel shadows, affecting the widest possible surrounding area.

- There is **no further information** on the type, intensity, horizontal arrangement and vertical placement of lighting at the extraction sites. **What kind of lighting will be used and how will it be deployed?**
- **Will pumping stations be illuminated?** The EAP, TAC and RPCR provide no answers.

Fuel and mechanical fluids

- Contamination of groundwater with petroleum products creates a significant health risk. Fuel and lubrication oils contain a large array of organic substances, as well as heavy metals (Bai et al., 2019; Coufalik et al, 2019). Many of these compounds, such as benzene and polyaromatic hydrocarbons, are potent carcinogens (Peters et al., 1999).

- Petroleum organic compounds travel in groundwater and easily contaminate local wells (BRWM, 2002). Figure 107 shows that well contamination risk may be significant at 100 m, i.e. the current proposed project setback distance from residences and domestic wells.

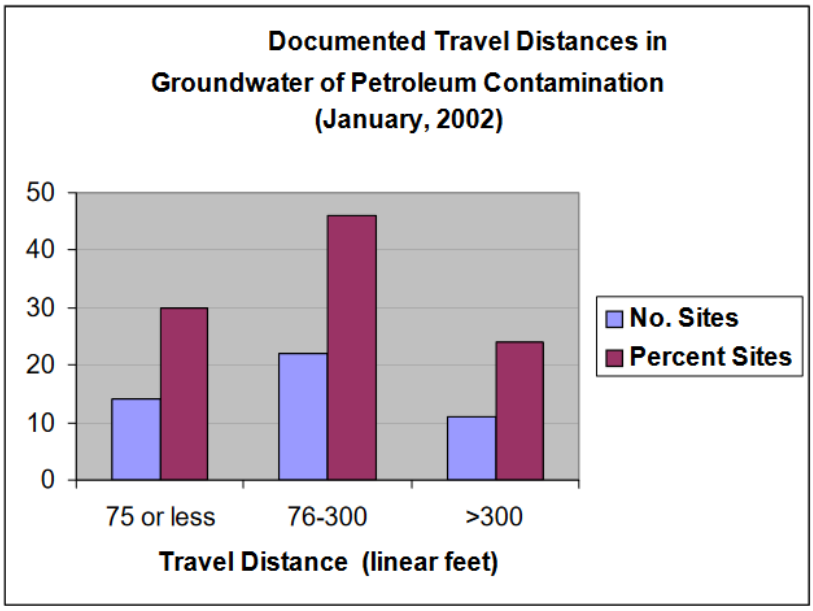


Figure 107. Travel distances of petroleum contamination in bedrock to neighboring water wells (in Maine). Source: BRWM (2002).

The distance of travel from the site of a spill is hard to predict and depends on many factors. According to Duffy et al. (1980), "contaminated groundwater might extend in the direction of flow from less than one meter to several thousand meters from a spill". Derivative organic solvents may travel several kilometers in limestone, as seen in a devastating made-in-Manitoba example:

In the early 1990s in Rockwood Municipality, trichloroethylene (TCE) used as a cleaner/degreaser at a Bristol Aerospace facility entered the excellent Carbonate aquifer and rendered water from local wells unfit for consumption. "An area of TCE contaminated groundwater was found to extend four kilometres to the east and six kilometres to the south of the plant site. A second smaller area of TCE groundwater contamination, separate from the plant site, was also found southeast of Stony Mountain. The areas containing known TCE contaminated groundwater along with an adjacent buffer zone was [sic] designated as the Rockwood Sensitive Area under the Rockwood Sensitive Area Regulation of The Environment Act of Manitoba." (https://www.gov.mb.ca/sd/pubs/water/drinking_water/final_factsheet_tce.pdf). Regulation 121/94 - "Rockwood Sensitive Area Regulation" was issued in 1994.

According to the 2005 Manitoba Auditor General's Report (https://www.oag.mb.ca/wp-content/uploads/2019/10/ENVAUDITS_NOV05.pdf), because of unacceptable solvent levels in well water, "The Regulation was considered necessary to prevent the spread of groundwater contaminated by the solvents.". This regulation forbade the drilling of unauthorized wells in the area; however the Auditor noted: "Staff in the Department of Water Stewardship in Winnipeg, who are responsible for monitoring the well driller's reports and for maintaining the well database **were unaware of the permit requirements** and accordingly **were not monitoring driller's reports for compliance** to the Rockwood Sensitive Area Regulation." (Emphases are mine). This is especially disgraceful, as the contamination was publicly known, and an extraordinary regulation for its attempted containment was in place, ostensibly so it could be enforced. [What do these people actually **do**, in their cushy slumber chairs?]

Protracted and unseemly wrangling occurred among the different levels of government regarding who should pay for treating the water and piping it to residences, while residents subsisted on trucked water. Eventually costs were shared by the federal and provincial governments, and partially by the company. "A groundwater pumping and treatment (pump and treat) system has been operated at the Rockwood plant since 1994 to reduce and contain the highest concentrations of TCE in the aquifer.", but "concentrations of TCE continue to be present in groundwater to the south and east of the Rockwood plant and in an area to the southeast of Stony Mountain" [i.e. in 2019] (https://www.gov.mb.ca/sd/pubs/water/drinking_water/final_factsheet_tce.pdf). According to Lipko (2002), pump-and-treat remediation, where water is pumped to the surface, treated, and returned to the aquifer, requires at least 30 years and is often largely ineffective.

But, have we learned anything? Maybe some timely independent provincial monitoring and oversight would have prevented this obscene ruin of a premium water supply source? But prevention and timely action are not always at hand. For example, in Brokenhead Municipality, local residents near a gravel pit, who were worried about their nearby wells, complained about an ongoing oil leak directly into the adjacent pit pond from a large abandoned dredging crane. They were astounded when the Environment Officer reported not seeing (or smelling) the contamination. The leakage continued; residents tried to address it themselves. ***Semper non videns*** seems to be our eternal enforcement motto: this is what scares us *now*.

- Over time, the contamination spreads, but plumes are attracted to pumping wells (see Figure 28, p. 125). Travel may be assisted or diverted by fractures and discontinuities in the host bedrock; according to BRWM (2002), "Measuring travel distance from the contamination source in linear distance…does not reflect actual travel paths and distances in the field, especially in bedrock." Thus contamination of wells cannot be predicted solely by horizontal distance from the spill, and more distant wells may show greater contamination than some closer ones, depending on direction and path of hydraulic flows.

- Gravel pits seem to be especially favored for the current project (e.g. EAP2, Section 6.8; TAC #25, RPCR #145, #150; SSCRIR1 #CEC-IR-002). This is unfortunate, as removal of soil and overburden significantly reduces interception of contaminants and protection for the aquifer beneath (John and Rose, 2005; FD, 2019), and shorter, or even direct, pathways to the Carbonate are enabled.

  Nonetheless, where surficial deposits are present, petroleum contamination still persists for a long time: Duffy et al. (1980) found that "Analysis of core samples from spill sites of various ages and locations indicated that biodegradation of oil is extremely slow in the anaerobic zone of the soil." Degradation of the various organic molecular species proceeds at different rates, but is very slow at low temperatures and in the absence of hydrocarbonoclastic bacteria (Mariano et al., 2008), i.e. in aquifers.

While overburden may provide some temporary protection by detaining petroleum compounds, "Over time, even [oil] pollutants trapped in the vadose zone will migrate vertically into an aquifer under the effect of leaching" (Bai et al., 2019). Thus these substances "have the potential to pose long term threats to groundwater quality" (Duffy et al., 1980).

- Besides the many organic compounds of petroleum products, heavy metals also pose a contamination risk. Numerous heavy metals and rare earths are present in petroleum (and combustion exhaust), including antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium, and others (https://www.intertek.com/petroleum/trace-metals/). In a study of groundwater oil contamination, Bai et al. (2019) found that "the order of pollution significance was organic pollutant > heavy metal pollutant > inorganic pollutant."

- Diesel oil is a complex fluid that is composed of 2000 – 4000 different hydrocarbons (Mariano et al., 2008). Both diesel and biodiesel are environmentally toxic (Hawrot-Paw et al., 2020), and present a **high risk for groundwater contamination** potential (Peters et al., 1999). According to Lipko (2002), "Due to its "lighter than water" character, diesel may be transported in ground and surface waters over long distances".

- In the current proposal, the *entirety* of Section 2.4.4 Propane Tanks/Fuel Storage (EAP1, p. 24) states:
  "Diesel fuel will be stored **at the extraction site** area in a central location for fuelling of the extraction rigs in accordance with regulatory requirements for the transportation, storage and handling of hazardous materials." (Emphasis is mine). That is all there is.

  A number of questions arise:

  1. Is diesel the only fuel that will used, or will propane and/or gasoline also be stored on site?

  2. Why will diesel "be stored at the extraction site area in a central location", in such close proximity to the open wells, i.e. not even on the outskirts of the area?
  "Fuels, oils or other hazardous materials will be stored in designated areas." (EAP2, Section 6.9.2). Where in the cluster will the designated area for fuel storage (and other hazardous materials) be located? What is "a central location"? There is a well at the center.

3. **How much diesel fuel will be stored on site?** The amount of fuel used *daily* will be substantial. For example the OFD1550 compressor (see p. 58) utilizes 93.2 L/hour of diesel fuel per hour at full load, amounting to 2237 L/day or ~ 590 US gallons per day. This is just one piece of equipment; we do not know if there will be two of these items, as is hinted at in Table 6-3 (EAP2), in which case they alone would account for >1000 US gallons per day. Then there is everything else, except for the electric dewatering station (Table 2-1, EAP1). The grand total will easily amount to thousands of gallons per day.

A **single spill** of even a portion of this magnitude would be catastrophic. Even if it does not directly enter a borehole, percolation into the overburden could lead to eventual tainting of the aquifer(s).

4. What sort of tank(s) will be used for diesel storage? In EAP2 (section 6.9.2) we learn that "Diesel tanks used on-site will be self-contained aboveground storage tank(s)." We hope so, since they will move from site to site. But what are they? Metal or plastic? And are they double-walled? According to the Manitoba Storage and Handling of Petroleum Products and Allied Products Regulation (MR188/2001), tanks of >230 L should have secondary containment, particularly where risk to surface or groundwater is possible (Clause 9). Suppliers recommend: "only fill the container up to 85% to allow room for expansion, to avoid any spillages." (https://www.speedyfuels.co.uk/guides/fuel-storage-regulations/).

5. The plural (tanks(s)) is hinted at: will there be more than one tank?

6. The statement in EAP1 (p. 28): "Some services such as mechanic or fuel will provide deliveries to the extraction sites." seems to indicate that fuel will be delivered to the extraction sites. This is a concern, as refuelling of the tanks will occur in the midst of the open wells, and spills during refuelling are very common. The heavy fuel truck will add to the traffic and disturbance. It will travel on the bumpy access trails. How often will fuel delivery be required? Since the fuel tanks are mobile, why is refuelling not done off site at the fuel supplier's bulk depot? Perhaps the volumes are too great?

- Spills from operations on agricultural fields may poison cropland (Figure 107). Hawrot-Paw et al. (2020) reported that both diesel and biodiesel had "a significant negative impact of contamination level on plant growth and development." Similarly Grifoni et al. (2020) found that "The main effect of the spillage of petroleum products in agricultural soil was a drastic reduction of plant growth." This effect may extend over a number of years. Tilling will spread it over a wider area.

Will the farmer be compensated? Of course, she has to prove where the spill came from, and she isn't allowed on the site until it is vacated…and the decommissioning caterpillar has obscured and spread the evidence….The answer is probably no.

Photo: E. Pip

Figure107. Contaminated soil from a previous year's spill in the midst of an agricultural field.

- Will ***other*** **machine fluids** be stored and used at the sites: engine oil, lubricants, hydraulic fluid, transmission fluid, antifreeze, fuel additives? What about cleaners and detergents? Will oil changes, for example, be performed at the extraction sites, in close proximity to the wells, instead of at the processing facility?

  Spills are a significant concern, since "Environmental effects may occur due to fuel and chemical spills from diesel fuel, lubricants, oils and hydraulic fluids. An accidental release of hazardous materials and/or equipment fluids could occur from improper storage and handling procedures." (EAP2, Section 6.9.2). Given the thousands of eventual sites, and the anticipated longevity of the project, spills are certain.

  Will spills be reported, in view of allegations in media reports:
  https://www.winnipegfreepress.com/the-carillon/local/Former-CanWhite-employee-alleges--well-contamination-lax-site-safety-575758671.html?fbclid=IwAR0_3_MXoo3we8hCYt2g_tHrzXI2tG_tI1rxWPOsKX8guTaHCFAm4jsE7uM
  Why was the affected well not pumped out <u>immediately</u>, even if there was only a *suspicion* of contamination?

- Presumably equipment will need to be washed and cleaned. What cleaning products (detergents, degreasers, descalers, etc.) will be used on site? What is their collection, containment and disposal protocol?

In response to a similar question in SSCRIR1 (#DLN-IR-007), "maintenance and cleaning standards have not been developed yet."

- Petroleum-contaminated soil must be handled and disposed of according to the Manitoba Guideline 96-05 on Treatment and Disposal of Petroleum Contaminated Soil (revised 2010) (https://www.gov.mb.ca/sd/envprograms/contams/pdf/guideline_96_05_treat_pet_cont_soil.pdf).

Air quality

Exhaust fumes

- The EAP is extraordinarily dismissive and indifferent to the environmental and health effects of project activities on air quality. **"**The measures that will be applied to minimize adverse effects on air quality and noise …….are expected to adequately mitigate adverse effects on human health both on and off the Project site." and "Therefore, the risk of adverse impacts on human health is determined to be **negligible**." (EAP1, p. x). (Emphasis is mine.) The health effects of air quality have not even been acknowledged in the EAP.

- Activities will occur 24/7, many pieces of equipment will be operating simultaneously, and fuel exhaust will be a nuisance for workers and adjacent residents. It will be more unfortunate when the source direction coincides with the prevailing wind. On these days, residents will keep windows closed and remain indoors, and a primary reason why they live in the country will be tainted. Nuisance will be especially annoying in warm weather, when windows are normally open.

- **Diesel exhaust** is especially noxious: "It contains more than several hundred different organic and inorganic components, including many chemicals that have been designated as toxic air pollutants." (Kagawa, 2002). These include gaseous carbon monoxide, ammonia, nitrogen oxide, nitrogen dioxide, sulphur dioxide, various alcohols, aldehydes and ketones, benzene, toluene, and others (CCOHS, 2022), many of which are carcinogens. Breathing diesel vapors for extended periods of time has been linked to kidney damage, hypertension, and reduced clotting ability of the blood (https://www.atsdr.cdc.gov/ToxProfiles/tp75-c1.pdf).

  In addition, "Diesel particulate matter (DPM) is primarily made up of soot particles, carbon, ash, polycyclic aromatic hydrocarbons (PAHs), metallic abrasion particles, sulfates, and silicates. Almost all particulate emitted by diesel engines is respirable (PM <10 micron), with the majority of the particulates have diameters less than 1.0 micron." (CCOHS, 2022). Therefore all of these materials can be inhaled.

A recent study by Gawryluk et al. (2023) evaluated the physiological effects of two hours of exposure to diesel exhaust. These researchers found that even such short term exposure in healthy adults was associated with measurable changes in neurocognitive brain function. This has implications for workers that are employed in jobs which require alertness and decision making; in the present circumstances, 12-hour shifts are planned.

Besides short term effects, in the long term, diesel particulates are **carcinogenic**, and are associated with lung as well as bladder cancer (CCOHS, 2022). Fine particulates can lodge deep in tissue and initiate tumors, often after a long time has passed after exposure. Diesel particulates have been shown to have adverse effects on human alveolar macrophages which provide major defences in the lungs by phagocytizing pathogen and particulate threats. In a study of diesel exhaust particulates, Lundborg et al. (2006) reported "significant impairment of phagocytosis of silica particles and microorganisms. The inhibitory effect on particle phagocytosis mediated by four different receptors suggests that air pollution particles cause a general inhibition of macrophage phagocytosis. Such an effect may contribute to increased susceptibility to infections and, for example, result in more exacerbations of asthma and chronic obstructive pulmonary disease." We may here point out that risks posed by **inhalation of ultrafine silica particles will be aggravated by the inhalation of diesel particulates**, especially for on site workers and residences downwind.

In any case, it is established fact that diesel emissions aggravate asthma, allergies and inflammatory respiratory conditions (Kagawa, 2002; CCOHS, 2022).

This will pose a particular nuisance for families with children, the elderly, and persons with health challenges. The meager 100 m setback will not be adequate when these emissions can travel more than 1 km (diesel exhaust can readily be smelled at this distance when the source is upwind (personal observation)). This will be particularly bothersome and unhealthy with the great number of diesel engines that will be operating at the production sites.

- **"**Project activities are expected to have a negligible effect on air quality… due to exhaust emissions including nitrogen dioxide (NO2), carbon monoxide (CO) and sulfur dioxide (SO2)**"** (EAP1, p. vii).

  Thus toxic gases "including nitrogen dioxide (NO2), carbon monoxide (CO) and sulfur dioxide (SO2)" are dismissed as "negligible". Where are the data to support this? What would be the estimates of annual output of these contaminants? Not only will the workers breathe this every day, but surrounding residents and environment must also be considered.

Carbon monoxide output depends on combustion efficiency, which can vary enormously. Both gasoline and diesel engines produce this toxic gas, however engines such as generators and water pumps with simple carburetor systems are highly polluting, with exhaust carbon monoxide concentrations "typically 30,000 ppm or more" (https://www.abe.iastate.edu/extension-and-outreach/carbon-monoxide-poisoning-operating-fossil-fuel-engines-inside-buildings-aen-206/).

- In TAC (#28), the reviewer asks: "Has any air quality impact assessment/dispersion modeling study been done for this project?"

  The dismissive reply in TAC (#28) declares: "Air quality dispersion modeling was completed for the CanWhite Vivian Sand Facility Project", and **"**the need for air dispersion modeling to **support the conclusion of minor to negligible effect** on air quality is **not considered necessary**/warranted. For these reasons, the need for an ambient air monitoring program is also not considered necessary/warranted." (also SSCRIR1 #MBEN/OLS-IR-001; SSCRIR2 #MSSAC-IR-007)(Emphases are mine).

  The proponent argues that air dispersion modeling has been done for the Processing Facility, and that this should suffice. That modeling dealt largely with silica sand dust, which is very different from exhaust emissions, that are comprised of gases as well as diesel particulates (although at times also combined with dust). Components of this type of emission can travel considerably farther, are associated with odor, and have very different dispersion properties. The two situations are not interchangeable, or even comparable. The proponent's response makes it clear that nobody will monitor air quality during operations.

- **Setback from homes is only 100 m, unlike the Processing Facility.** Therefore modelling for the latter cannot apply, as the sources may be closer to people's houses. Furthermore, dispersion will differ for open and forest-enclosed sites, with much greater travel distances in the case of the former, but with greater potential for stagnation and higher concentrations at the work sites in the case of the latter.

- Air quality at the work sites will surely be of interest for the workers during their 12-hour shifts.

- "Idling of motorized equipment will be minimized to the extent feasible" (section 6.3.1, EAP2). Does the proponent commit to not continuously idling diesel equipment, such as bulldozers, especially in winter?

- In SRTER (#9), the reviewer states: "Quantitative analysis are [sic] required to confirm the Proponent's conclusion that the project will not result in significant air quality

impacts. These analysis [sic] should include baseline air quality measurements,… atmospheric dispersion modelling and air quality monitoring".

The proponent doesn't see any need or value in such distractions: "Sio concluded that this equipment and activity would not cause significant air quality impacts." (SRTER #9). Without providing evidence or data, we might add. It's just easier that way.

Dust

- Dust will be generated at extraction sites and on trails from all project components, including clearing activities, movement of heavy equipment, installation of infrastructure, site operations, slurry line monitoring, decommissioning activities, worker traffic, especially at shift changes twice a day, and other potential travel, for example delivery trucks, visitors, sludge and 'overs' trucks and a sludge drying bed drainage water tanker. Additional dust will be generated regionally on municipal and other gravelled roads; the proponent undertakes to water gravel roads (see summary in GTTR, p. 19). Will this occur only in response to complaints?

- Silica dust is a concern at the processing facility, but deemed by the proponent to be of minor importance. According to GTTR (p. 20), "That conclusion is based on normal operating conditions and may not apply to situations involving the inadvertent release of large quantities of silica sand to the environment (e.g., from a large release of sand from the slurry line). However, impacts from such releases would be partially mitigated by the fact the sand would be wet, thereby limiting the potential for atmospheric dispersion."

  We can here comment that spilled wet sand does eventually dry sooner or later.

- We have no information on the operation of the sludge "drying beds" (SUPPL4, p. 20), that is, if they will be used? Will dust be generated while the sludge is drying, or while it is being removed and handled for transport for disposal?

- Bentonite grouts, sealants and drilling muds may be used in the present project in sealing wells and in horizontal directional drilling to route slurry pipes under roadways. In horizontal directional drilling, bentonite drilling mud spills are especially apparent at the entrance and exits of bore span sections (Figure 108). Such materials may generate dust on drying, and often contain substantial amounts of silica, resulting in inhalation hazards. Some bentonite products may also contain various additives, such as polyacrylamide (see p. 236). Materials safety data sheets state that bentonite "Should not be released into the environment"

(https://www.fishersci.com/store/msds?partNumber=B235500&productDescription=BENTONITE+POWDER+PURIF+500G&vendorId=VN00033897&countryCode=US&language=en). In Manitoba this precaution appears not to be followed (Figure 108).

Photo: E. Pip

Figure 108. One of numerous serial bentonite spills left behind without further attention after horizontal directional drilling to install water supply pipe in a Brokenhead municipal drainage ditch (2022). The exposed material has dried and cracked over time, and is open to the wind. The MSDS and manufacturer's directions for this product indicate that spills must be cleaned up, and may not enter water. This work was passed by the provincial project manager.

Incineration of debris

Besides generation of greenhouse gases, undeniably impacts air quality. Smoke contains particulates as well as gases such as carbon monoxide and numerous organic substances, some of which are carcinogens, for example polyaromatic hydrocarbons. Respiratory conditions such as asthma and chronic obstructive pulmonary disease are substantially aggravated by smoke.

The EAP (p. 9) states: "Burning permits to dispose of woody debris will be sought."

In TAC (#8), the reviewer comments: "ECE recommends CanWhite investigate alternative disposal or end-use options for woody debris from site clearing."
The proponent responds: "CanWhite will endeavour to find alternate markets for the woody debris as was done for the Facility Project area. For the Facility Project area, salvageable timber was taken to a mill to go to market, and all remaining wood debris was chipped and taken to a local community to use as biofuel."

This suggests that burning will not occur, although RPCR (#81 below) does not agree. The wood from private land is the property of the landowner. As for chipping, a few logistical observations arise:

1. Clearing will be conducted for creation of extraction sites, access and slurry trails, site interconnecting trails, hydro lines, ditches, and possibly clearings for pumping stations. In vegetated areas, this will generate significant mangled vegetation that will require relocation or disposal. "Approximately 20% the vegetation is burned and approximately 80% is mulched and/or salvaged" (RPCR #81).

   For either chipping/shredding or burning, **where will these activities occur**?
   Will they be conducted at the already cleared extraction sites, as these appear to be the only areas that are large enough for chippers/shredders (which presumably are truck-mounted), or (for burning) present sufficient setback from the wooded boundary to not start a forest fire? Truck-mounted chippers will be problematic on slurry line trails that are 2 m wide.

2. How will the destroyed trees and other remains be marshalled to the disposition locations for chipping or burning? By bulldozer, skid steer? Trees will have to be cut up into manageable pieces and firewood. Who will operate the chain saws? Since the wood belongs to the landowner, will she/he be left with the job of chain saw operator for trees that have been pushed and piled aside?

3. When will the disposition of woody debris occur? For burning, it must have dried (cured) sufficiently to reduce excessive smoke. For chipping, it cannot be too wet because gumming and mold will be problems.

4. It is illegal to possess, store or transport elm wood in Manitoba because of Dutch Elm Disease (see p. 469). American Elm is present in the project area. This material cannot be chipped and must be burned.

5. Wood of ash trees, which are present in the project area, may also not be moved because of Emerald Ash Borer, which is already present in Manitoba (https://www.gov.mb.ca/stopthespread/fis/eab/stop-spread.html).

Radon, hydrogen sulphide, and aeration

- Toxic environmental gases are not discussed in the EAP.

- Decay of uranium gives rise to a chain of daughters including the radionuclides thorium, radium and radon gas, eventually terminating in different isotopes of lead, depending on the initial respective isotope of uranium. Table 4-8 (AppA4) shows that uranium is present at measurable quantities in the groundwater, although the uranium isotope(s) is/are not specified. In this Table, thorium is understandably at levels below detection limits due to its insolubility (Campbell and Kane, 2021).

  We can however conclude that **radon gas is certainly present** in the project area. "Of all the radioisotopes that contribute to natural background radiation, radon presents the largest risk to human health." (Hopke et al., 2000). According to Health Canada (2021), 16% of lung cancer deaths (≈ 3300/year) in Canada are caused by radon gas, and it is the leading cause of lung cancer in non-smokers. According to CCS (2012), Manitoba homes are almost 3 times more likely to exceed the guideline of 200 Bq/m3 compared to the Canadian average. Distribution of hazardous levels of radon in Manitoba homes is shown in Figure 109. While presence of uranium is acknowledged in RPCR (#11), radon is not mentioned, even though the nature of the extraction activities will unavoidably involve it.

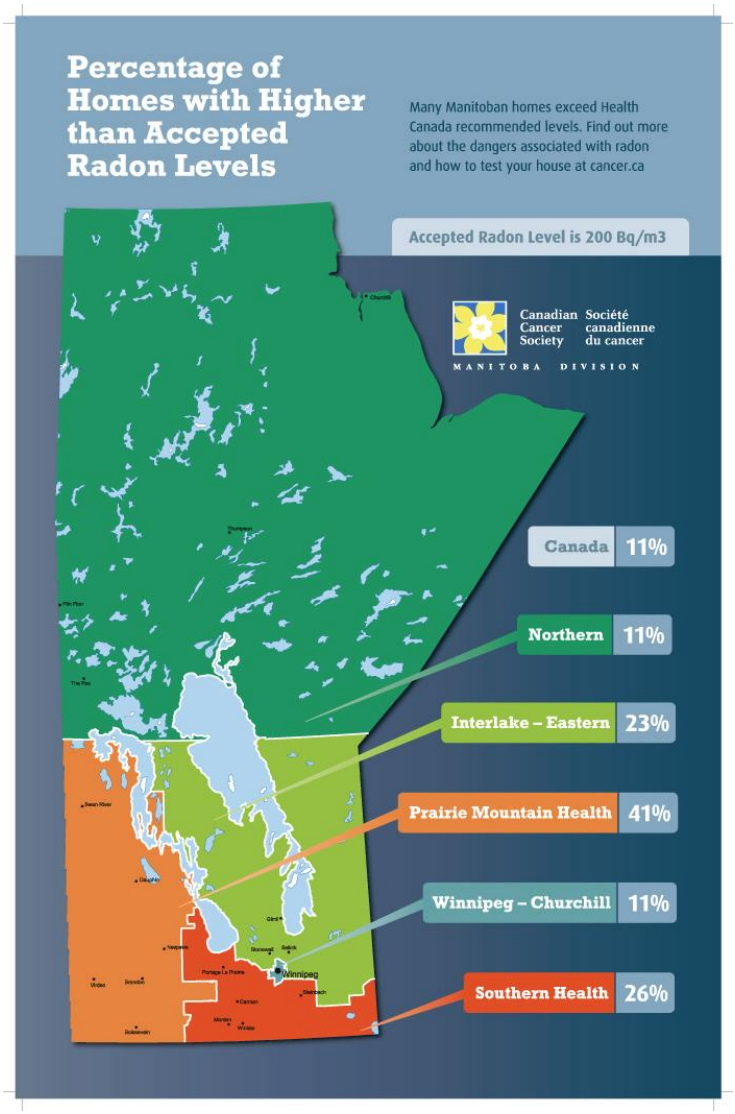


Figure 109. Frequency of hazardous radon levels in Manitoba homes. Source: https://www.manitobacooperator.ca/news-opinion/news/local/manitobans-urged-to-test-homes-for-cancer-causing-radon-gas/

- Elemental sulphur, sulphides, sulphate, and **hydrogen sulphide** are all present sporadically in the project area (AppA4, Table 4-8). Redox reactions among these chemical species are often mediated in water by a variety of sulphur bacteria (Lochrane, 1977; Hose et al., 2000). According to Metcalf and Eddy (1972 *in* Lochrane, 1977) "Hydrogen Sulfide, H_2S, is found in ground water sources primarily as a result of the decomposition of organic matter containing sulfur and from the reduction of sulfites and sulfates." Dissolved organic matter is present in project area groundwater (Table 4-8, AppA4).

Hydrogen sulphide gas is easily noticeable because its 'rotten egg' odor can be detected at very low concentrations (0.01 – 1.5 ppm (OSHA, 2021)), below toxic levels, and therefore at low levels it is an aesthetic concern associated with well water. The Canadian drinking water guideline is 0.05 ppm (ppm = mg/L)(CWQG, 2014). However gradually increasing concentrations are not detected by smell due to olfactory fatigue, which can lead to unawareness of dangerous levels, causing sudden unconsciousness ('knockdown') and death.

According to OSHA (2021), in inhalation exposure, "Effects range from mild, headaches or eye irritation, to very serious, unconsciousness and death." Symptoms start above 2 ppm, but people with asthma or other respiratory problems are more sensitive. Hydrogen sulphide is flammable and explosive; explosion hazard starts at 4.5% (OSHA, 2021). Its combustion produces other toxic gases such as sulphur dioxide, which has been a primary culprit in acid rain and acidification of water and soils.

Although sample numbers were small, H_2S was reported in both Red River Carbonate and Winnipeg Sandstone (Table 4-8, AppA4). All reported values above the detection limit were at levels sufficient for human olfactory perception. One Red River Carbonate sample (BRU 95-5) that was below the analytical threshold of 0.019 ppm at pre-test increased to 0.083 ppm post-test, exceeding the CWQG level. Observations reported elsewhere indicate that **turbulence and aeration promote release of H_2S**, and this effect may further be enhanced by changes in pressure and temperature when well water is brought to the surface (Lochrane, 1977). In the present situation, **neighboring wells may experience greater nuisance odor levels** during and after extraction operations. This effect is not mentioned in the EAP.

It should further be noted that the reported values in the EAP may have been underestimates, as it is not clear how diligently sampling methodology, handling and transport preserved dissolved gases (especially the <u>tapwater</u> samples!). Disturbance, warming, and agitation promote off-gassing. (There is also an error in decimal places that was not corrected, and indeed was replicated (BRU 95-9) in both Table 4-8 and 4-10 (AppA4)). It can be concluded, however, that H_2S occurs frequently enough to be considered in air quality evaluations.

Incidentally, the H_2S produced by sulphur-reducing bacteria at low oxygen levels may reoxidize in the presence of oxygen, and form sulphuric acid (Edstrom, 2004 *in* Artiola et al., 2013), thus constituting another source of acidification, in addition to pyrite oxidation (see p. 274).

- Both H_2S and radon are heavy gases and tend to accumulate in low-lying areas such as basements, but can be distributed throughout the house by furnaces or air conditioners. Outdoors, during calm weather or in areas sheltered from wind, the gases can pool near the ground (Bell, 2005).

- According to ICMC (2008), "Gases likely to be found in an underground mining reservoir have very different characteristics of water solubility." This water may carry large amounts of hydrogen sulphide, carbon dioxide, and radon under the low temperatures and hydrostatic pressure. Methane may also occur where dissolved or particulate organic matter is present. When water is brought to the surface, "the temperature of the water may rise and its pressure may fall steeply", releasing the gases (ICMC, 2008).

- Aside from the release of gases attendant on changes in temperature and pressure, **aeration of water displaces dissolved gases within it**. Bubble aeration is one of the most effective displacement methods of gases from water (Dixon et al., 1991).

  The air lift apparatus will bubble vast quantities of air into the water, and there may be additional pressurized bursts of air (CPA). The water and gases will be brought to the surface, where release of displaced radon and hydrogen sulphide into the air will occur. Any increase in water temperature (and decreased pressure) at the surface will further promote dissolved gas release due to decreased solubility. Workers will be continuously exposed to unknown amounts, in their 12-hour shifts, depending on amount of ventilation from wind and degree of sheltering conditions. These exposures will be in addition to the cumulative exhaust emissions from all of the operating machinery. Adjacent downwind residents may inhale some of these gases.

  According to the CPA, the air lift apparatus is also capable of horizontal incursion beyond the borehole axis, where pressurized air bursts and escaped air can pool under the shale ceiling, or penetrate through fractures into the Carbonate aquifer. Displacement of radon and hydrogen sulphide from the water will enrich the air pockets. Displaced gases may subsequently percolate upwards to soils around foundations and emerge inside the basements of homes, or enter nearby domestic wells, affecting indoor air quality and presenting health risks.

  There is no mention in the EAP of monitoring for this issue at any time, nor is any contemplated: "Please note that although uranium is included in the list of metals that typically are analyzed in water, radon (which is a gas) is not analyzed in water samples." (RPCR #57).

My own note: the above statement is not accurate, as dissolved gases in water are not excluded from measurement. Dissolved oxygen ought to have been measured in the return water and is a routine procedure easily performed *in situ*; in another example the proponents reported H_2S in their water samples (Table 4-8, AppA4). However proper protocols must be followed to prevent offgassing in the course of sample collection, handling and storage when samples are to be analyzed in the lab, to avoid losses and underestimation.

I further beg to differ that "radon (which is a gas) is not analyzed in water samples". If this is true, how is it that the European Union countries, the U.S., and the World Health Organization have all established **radon thresholds for drinking water**? (See Jobbagy et al., 2017 for a review of analytical methods and regulatory guidance summaries).

Although Canada lags behind other countries in establishing a Guideline, the current Canadian federal technical document relating to *measurement* of radon in drinking water is found in: https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-radiological-parameters/page-5-guidelines-canadian-drinking-water-quality-guideline-technical-document-radiological-parameters.html#a68

Pathogenic soil fungi and blastomycosis

- Mold spores may present a health hazard when pathogenic fungal spores in organic soils become airborne and have the potential to be inhaled. While many soil fungi have the potential to cause illness, **blastomycosis** is of particular note: a number of cases have been reported in **southeastern Manitoba** (Figure 110), and severe cases have been lethal (https://www.cbc.ca/news/canada/manitoba/health-officials-keep-close-eye-on-blastomycosis-cases-1.683838). "Spores are more likely to be airborne after contaminated soil is disturbed by activities such as excavation, construction, digging, or wood clearing." (MDH, 2020). Workers in occupations such as forestry or **any activity in a forested area** are more at risk. According to Crampton et al. (2002), "the number of cases of blastomycosis diagnosed per year in Manitoba has increased."

  The fungus causes lung infection which can spread to other organs including bones and the central nervous system. Spores may also enter via skin wounds. Domestic animals are affected as well. Alerts have been issued by Manitoba Health, and it is a reportable disease in Manitoba (Crampton et al., 2002; MHHLS, 2015).

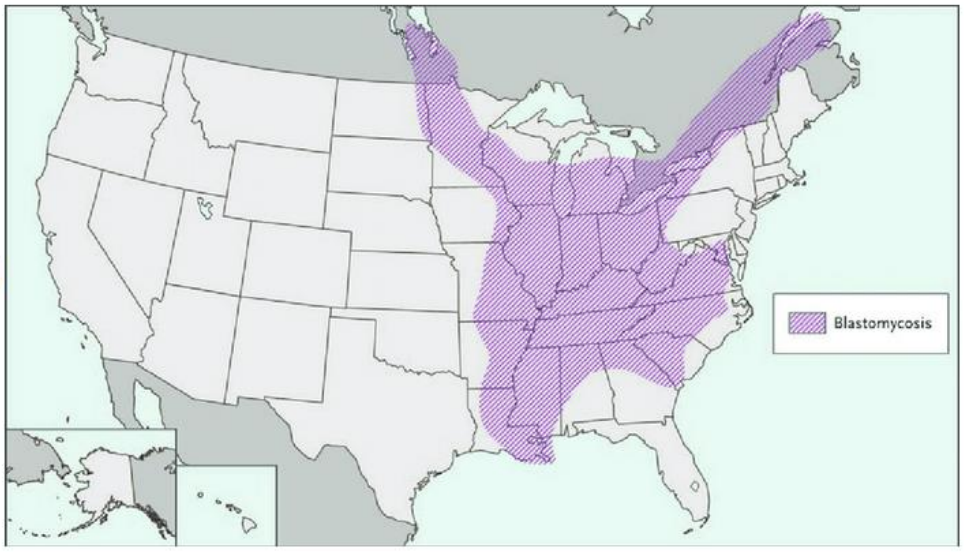


Figure 110. Areas where blastomycosis is endemic. Source: https://www.researchgate.net/figure/Areas-of-the-United-States-and-Canada-in-Which-Blastomycosis-Is-Endemic_fig5_6413281

- Since blastomycosis is known to occur in the region, care must be exercised when disturbing and exposing soils, for example clearing and levelling. Workers should be made aware of this issue.

Greenhouse gases (GHG)

- The EAP significantly underestimates greenhouse gas production, and dismisses the contributions as "negligible" (section 6.3.2, EAP2).

  In RPCR (#75, #79): "The annual calculations reflect the **full numbers** of diesel equipment types, expected engine Tier (i.e. age of equipment), hours of operation (detailed in the EAP, Table 6-3) and fuel consumption during extraction operations. The calculation also includes all electrical power consumed for extraction activities." (Emphasis is mine).

  This statement implies that all fuel-powered equipment will be diesel, or that only diesel powered items were considered in the calculations (aside from electrical). Will any equipment be powered by gasoline (e.g. worker vehicles), or propane?

- "The calculation also includes all electrical power consumed for extraction activities." (RPCR #75, #79; SRTER #9).
  In contrast, "the pump stations will be electric with power drawn from the grid and therefore **will not generate any GHGs**" (RPCR #80) (Emphasis is mine).

The above two statements do not agree. Note that **hydroelectricity is not carbon free.** This is rectified on questioning in SSCRIR1 (MBEN/OLS-IR-016): "According to ECCC (2021), the emission factor for electricity grid in the province of Manitoba is 1.3 g CO2 eq/kWh for the year 2018."

Since the slurry line pump stations will have backup in the event of power failure, will they not have non-electric emergency generators that use fossil fuel?

- We notice the 20 water pumps, the 16 slurry pumps, the 8 cyclones, the 4 dewatering screens listed in Table 2-1 (EAP1) have disappeared from Table 6-3 (EAP2), among other things. These two tables are reproduced for comparison below:

Table 2-1: Project Heavy Equipment Use

Equipment	Units*
Construction Phase (Site Set-up and Well Drilling)	
Excavator	1
4 x 4 pick-up trucks	1
Drill rigs	2
Water Truck	2
Grouting System	2
Operation Phase (Extraction)	
HDPE Tubing Welding machine	1
Extraction Rigs - Diesel	10
4 x 4 pick-up trucks	2
Compressor - Diesel	2
Excavator	2
Light plant	8
Flat Deck Truck	2
Zoom boom/Telescopic handler	2
Welding Truck	1
Mechanical Service Truck	1
Vac Truck	1
Collection Sump with Scalping screen	5
Slurry Pumps (varying sizes depending on location)	16
Water pumps	20
Diesel Generator	2
Cyclone	8
Dewatering Screen	4
Real-time Extraction Control Office	1
Compartment Collection Sump	2
Decommissioning (Well Sealing and Site Clean-up / Rehabilitation)	
Drilling Rig	1
Picker Truck	1
Excavator	1
4 x 4 pick-up truck	1

* Not all operating simultaneously during any given phase.

Table 6-3: Greenhouse Gas Annual Emissions (CO_2e)

Emission Sources	Total Utilization (hours/year)	CO_2e GHG Emission (kg CO2e/year)
DIRECT EMISSIONS		
EXTRACTION		
10 x Extraction Rigs @ 200,000 each - Off-Road	60,000	2,445,719
Compressor trailer for extraction / OFD1550 Tier 4 Final Oil Free Rotary Screw Air Compressor	12,000	934,060
Excavator per pad	6,000	318,505
Light Plant x 8	24,000	385,998
Flat Deck Truck (2015 F650 XLT Super Duty w/ 17' bed)	6,000	303,487
Zoom Boom / Manitou MT 5519 Telescopic Handler	6,000	239,291
DRILLING		
TH60 for drilling Earth Drilling	6,000	489,898
DR24 for Drilling Earth Drilling	6,000	491,784
2022 Ford F750 Water Truck Heavy Duty	6,000	212,886
Grouting System	700	11,295
SEALING		
DR24 for Abandonment	3,000	250,513
Picker Truck On-Road	1,000	72,915
SUPPORT		
Welding Truck F350 Light Duty	750	46,332
Mechanical Service Truck F350 Light Duty	750	46,332
SLURRY HANDLING		
CAT C18 Diesel Generator Set	6,000	394,712
HDPE Tube Welding Machine	1,000	68,475
Vac Truck	1,000	72,777
INDIRECT EMISSIONS		
POWER CONSUMPTION		
Pump Station	8,784	12,432
	Total (kg CO2e/year)	**6,797,411**

Note: Table 6-3 lists the F350 as a Light Duty truck. A Light Duty truck is a half-ton truck. The one-ton Ford F350 is rated as a Medium Duty truck (https://www.cjponyparts.com/resources/truck-sizes), although the manufacturer calls it Super-Duty (https://www.ford.com/trucks/super-duty/models/f350-xlt/): its emissions are not those of a Light Duty truck.

It is not clear why the single pump station (i.e. dewatering station) has extra hours (8784) above the 6,000 for other annual units.

Strangely missing from Table 6-3 (EAP2) are:

- The 16 slurry line pumps (Table 2-1, EAP1)
- The 20 water pumps (Table 2-1, EAP1)
- The 8 cyclones

Also missing from both Tables 2-1 (EAP1) and 6-3 (EAP2) are such additional project elements as, in no particular order:

- **Mobile office** (transport, heaters, light, air conditioning, electronic monitoring and control equipment, computers, fridge, microwave, fan, video games etc.)
- The UV station would consume a lot of power, yet it is strangely not mentioned, even though not feasible for its purpose
- Machinery used for hydro pole installation and removal, power line installation
- Feller bunchers, chippers/shredders (TAC #25)
- Chainsaws (notorious emitters of carbon monoxide and nitrogen oxides (Dimou et al., 2019)

- Transport of drilling and other heavy equipment, mobile office etc. to and from sites
- Fuel transport/delivery
- Water truck operation
- Vehicles/machinery for installation, removal and relocation of slurry pipes and pumping stations
- Disposal of used oil, filters, tires
- Worker personal vehicle travel to and from home, 2 shifts per 24-hours: is this included in the "52,000 kg CO2e/year is due to vehicle emissions" (RPCR #81), or are these just the company vehicles?
- Other traffic, e.g. machine parts deliveries, fuel, supplies, visitors, delivery and removal of portapotties, traffic between processing facility and sites, etc.
- Transportation, and handling, disposal of 'overs' to/by a 'licensed facility'
- The many components of treatment for turbidity (SUPPL4)
- Management of sludge beds resulting from turbidity treatment (SUPPL4) if used, transport of sludge; transport of drainage water from sludge drying fields to water treatment (or maybe just a sludge cake press)
- Management of fines (i.e. particles, not charges)
- Daily patrol of slurry trails and pumping stations
- Significant GHG footprints for HDPE pipe production, transport and disposal (see Nguyen et al., 2019)
- Power washer (since of course they will be keeping their equipment clean), even if they are washing off site
- Post-closure revegetation monitoring, seeding, mitigation
- Other mitigation/remediation required (erosion control, garbage removal, etc.)
- Other ancillary activities: e.g. horizontal drilling under roads to install and remove slurry line crossings, visiting the well owners, well monitoring, drones, etc.
- The processing facility must be considered since it is an integral part of the whole.

The above list is far from complete. Some items are unclear, for example, will any propane (or electric) heaters be used? While there is allowance for general miscellaneous consumption, the latter should be itemized, because contributions add up, and may include some large items. "Pump station" (singular) in Table 6-3 presumably refers to the dewatering station?

- In response to the reviewer's comments (SRTER #9) that air quality "analysis should include baseline air quality measurements, the preparation of emission inventories, atmospheric dispersion modelling and air quality monitoring", the proponent responds:

  "The vehicles and equipment used for Project activities (listed in Table 2-1 of the EAP) would not all be operating simultaneously and will move around the Project Site as extraction wells are drilled and progressively decommissioned. This equipment is also

not all concentrated in one small location, nor is there a large volume of equipment." (also SSCRIR1 DLN-IR-001 and MSSAC-IR-007).

Whether the pieces of equipment are operating simultaneously or not, or whether they are concentrated in one location or not, is immaterial: they still generate GHG when and wherever they *are* operating and their hours must be properly accounted for in emissions inventory. They might be distributed all over Africa, for all we know, yet GHG emissions are a PLANETARY problem, as the earth's atmosphere is communal: what happens in Brazil affects us in Churchill. This is why inventories are important.

The (Arcadis) reviewer's concerns in SRTER (#9) are: "**Quantitative analysis are** [sic] **required** to confirm the Proponent's conclusion that the project will not result in significant air quality impacts. These analysis [sic] should include baseline air quality measurements, the **preparation of emission inventories**, atmospheric dispersion modelling and air quality monitoring".

But in (#10): "Arcadis has no material concerns with the Proponent's assessment of climate/greenhouse gas impacts." (Emphases are mine). Written by two different people, perhaps? Or maybe one amnesiac?

- In response to my question regarding the carbon cost of the destroyed trees and vegetation, and the burning of debris, we learn the following information (RPCR #81):

" To estimate the GHG contribution related to vegetation clearing for a 'worst case scenario', the following assumptions were made:
• Approximately 13 ha of natural vegetation (forest) requiring clearing for extraction in year 2025 which is the annual extraction area with the most naturally vegetated landcover that would need clearing (noting that the current Environment Act Licence application is for activities up to and including 2025);
• The forest is as dense as the forest in Fort McMurry, [sic] AB which the Canadian Forest Service has estimated emitted 170,000 kg CO2e/ha during major forest fires in that area (Werner Kurz, CFS, quoted in the Edmonton Journal article "Carbon release in wake of Fort McMurray wildfire spikes greenhouse gasses", May 11, 2016);
• Approximately 20% the vegetation is burned and approximately 80% is mulched and/or salvaged; and
• Two 220 hp pieces of clearing equipment operate 24/7 for full two weeks.

With these assumptions, the total emissions from vegetation clearing activities is approximately 494,000 kg CO2e/year; or 7.3% of the total 6,797,411 kg CO2e/year provided in Table 6-3 in the EAP, of which 442,000 kg CO2e/year is due to burning vegetation and 52,000 kg CO2e/year is due to vehicle emissions."

[Note: People from Alberta should know how to spell Fort McMurray.]

The following comments arise:

1. "the annual **extraction** area with the most naturally vegetated landcover that would need clearing": this wording appears to refer only to the **extraction** sites, but it must also include all of the sundry trails and hydro corridors. Sludge drying beds, if used?

2. The above response considers only up to 2025 for an annual clearing area of 13 ha. However we cannot divorce ourselves from the *24 year projected lifespan* which is continually harped on in the EAP; indeed it may even be "multi-generational" (The Clipper: February 22, 2022, p. 5; January 12, 2023, p. 10). If the 13 ha value is reasonably realistic, and not deflated (i.e. are the various trails, etc. included), this amounts to *at least* 312 ha or 1.2+ sections of natural cover that will have been denuded over 24 years, on private land, assuming the same proportion of cover. It will not all be in one place, therefore the effects will spill over onto extensive tracts of remaining cover (see below).

3. Do the numbers include the area already cleared for the processing facility?

4. "Two 220 hp pieces of clearing equipment operate 24/7 for full two weeks.": does this include clearing of the trails and hydro line corridors? The wording suggests the two pieces of equipment will be identical. Will the same equipment clear the extraction sites as well as the 2m wide slurry line trails?

4. **What data were used** to determine that "The forest is as dense as the forest in Fort McMurry [sic]"?

First of all, the species composition is different: according to the wildfire article cited by the proponent, the forest was largely black spruce. Although there is some black spruce in the Vivian area, there are also a number of other species, such as tamarack and Jack pine, as well as deciduous trees, particularly poplar (aspen and Balsam poplar). **Different species have different carbon sequestering characteristics**. For this reason, specific gravity of wood is included in the calculations to reflect the denseness of their carbon content (Smith et al. 2006).

- Age of stands is also important. Smith et al. (2006) provides reference tables for these metrics.
- The two cases being compared are also at different latitudes, with different climate profiles, and length of photoperiod and growing season, and therefore different carbon assimilation/emission profiles.
- The composition of the understory (woody shrubs) is also different and less pronounced in black spruce forest compared to deciduous forest. In the latter, shrubs and small tree species comprise significantly more of the total carbon, and must be considered in addition to the canopy trees, as they too will be destroyed.

5. **The cited article refers only to the estimated GHG <u>released</u> in the fires**, **not to the total actual GHG potential.** The value used in the proponent's calculations is an **underestimate** for several reasons.

Combustion in the forest fires was not complete, because unconsumed material remained.

Figures 111 and 112 show images of the Fort McMurray forest after the fire, including a severely burned area. Note the amount of unconsumed material still left: the bulk of the tree trunks, which form the majority of forest biomass, has remained. The thick smoke also contained vast amounts of incompletely combusted particulates (Figure 113). Obviously **the GHGs in this unburned material would not have been included in the GHGs released during the fire.** These missing GHGs will be emitted over time as the dead wood and other matter decay.

In contrast to the fire, in the present project, the tree trunks, which constitute a major part of the carbon reservoir, will be removed during clearing.

Figure 111. Fort McMurray forest after the 2016 fire. Note extent of unburned material. Source: https://www.thestar.com/news/canada/2016/06/14/rcmp-investigating-if-fort-mcmurray-wildfire-was-caused-by-humans.html

Figure 112. A severely burned area of Fort McMurray forest after the 2016 fire. Even here, significant material still remains. Source: https://www.theatlantic.com/photo/2017/05/after-the-fire-recovery-in-fort-mcmurray/525249/

Figure 113. Fort McMurray fire. Note the ash and particulates that will eventually add to the GHG emissions totals as CO_2. Source: https://www.kamloopsbcnow.com/watercooler/news/news/Wildfire/The_Fort_McMurray_wildfire_is_finally_out_after_458days/

6. Conversely, the released greenhouse gas value used above does not, nor is it possible to, factor out **the non-forest components** that were burned in the fire, for example people's houses, apartments, and contents (1595 residential and commercial buildings (https://www.fortmcmurraytoday.com/news/local-news/four-years-later-74-per-cent-of-homes-destroyed-in-2016-wildfire-rebuilt)), miscellaneous other structures, vehicles, fuel, machinery, etc. This is another reason why it is **inappropriate to use the GHG release value to infer the carbon content of project area forest**.

7. There are many components contributing to carbon pools in forests (Table 9). For example, roots typically are not burned in forest fires. However when the trees are killed, whether in a fire, or in cutting or clearing, the dead roots continue to exude carbon to the atmosphere as they decompose over time. This carbon must be factored in as well.

Table 9. Carbon components in forest ecosystems. From: Smith et al., 2006.

—Classification of carbon in forest ecosystems

Forest ecosystem carbon pools	
Live trees	Live trees with diameter at breast height (d.b.h.) of at least 2.5 cm (1 inch), including carbon mass of coarse roots (greater than 0.2 to 0.5 cm, published distinctions between fine and coarse roots are not always clear), stems, branches, and foliage.
Standing dead trees	Standing dead trees with d.b.h. of at least 2.5 cm, including carbon mass of coarse roots, stems, and branches.
Understory vegetation	Live vegetation that includes the roots, stems, branches, and foliage of seedlings (trees less than 2.5 cm d.b.h.), shrubs, and bushes.
Down dead wood	Woody material that includes logging residue and other coarse dead wood on the ground and larger than 7.5 cm in diameter, and stumps and coarse roots of stumps.
Forest floor	Organic material on the floor of the forest that includes fine woody debris up to 7.5 cm in diameter, tree litter, humus, and fine roots in the organic forest floor layer above mineral soil.
Soil organic carbon	Belowground carbon without coarse roots but including fine roots and all other organic carbon not included in other pools, to a depth of 1 meter.

8. Table 4-1 (EAP2) gives an estimated/assumed breakdown of cover types in the project area. Actual forest composition, age, and standing crop for these categories could have been easily determined using standard forestry techniques during the vegetation survey, which is missing from the EAP. (Oops we forgot – the vegetation survey was a "desktop review" (RPCR #114)).

   Smith et al. (2006) provide carbon **calculation methods** that can be consulted, instead of using smoke and mirrors.

9. It must be noted that the destroyed vegetation will not recover for several years. In the case of trees, decades will elapse before original standing crop biomass is restored. According to Birdsey et al. (2000), "There is a time lag between tree planting and significant increases in C storage. Seedlings take several years to become established, and accumulation of biomass is low until trees reach sufficient size (leaf area) to fully utilize the "growth potential" of the site."

   Kurz et al. (2002) describe this lag: "At age zero, immediately following disturbance, large quantities of slash and other dead organic matter (DOM) are left on site. For some time after disturbance, C releases from decomposition of DOM exceed C accumulation in biomass: the stand is a net C source".

Therefore the reduction in carbon sequestration will not be limited just to the year when the vegetation was destroyed. This is why the **TOTAL losses** must be taken into account in the carbon budget.

Ecological damage

Extent of clearing

- Deforestation is a major global crisis, for it attacks the most basic foundation of our planetary life support system. More forest is lost each hour of every day. In our blinkered and distorted tunnel vision, we do not see the impending collapse. In our self-serving pursuit of instant wealth and gratification, we do not consider or even pause to look at what we step on and destroy en route, in a race to "get it before someone else does". That is our universal creed. The human race is the only species that consumes and destroys far more than it needs, and that kills for pleasure. We are all guilty: selfishness and greed and colossal waste are ingrained and ineradicable traits of our race. We justify our insatiability with the dismissive canard of: what difference can this little bit, or that little bit, make? What value does it have? We do not see that when we add up the millions of little bits, they amount to something monstrous.

  Deforestation of public lands is at the whim of politicians and those with influence, who see short term profit as the only objective. Deforestation of private lands is an entirely different matter: ethical landowners have the right to exercise responsible stewardship over their own lands, make their own "little bit" count. However our unjust legislation allows these fundamental rights, in a supposedly "free" society, to be overridden by the interests of others.

  Most of us yield and remain silent. Those who see and feel and speak, they are the ants confronting the semi on the road: they stand for their values, and for our battered Earth, and they stand as long as they are able.

- An overarching attribute of the present problem that lies before us, is that there will not only be clearing, on private lands, but that it will also **not be all in one place**. It will be scattered and dispersed throughout a comprehensive area, thus magnifying and spreading the extent of its influence and impact, and unavoidably affecting the adjacent portions that remain.

- "Information from the Manitoba Forest Resource Inventory, and on-site general reconnaissance in select locations within the Project Site area indicate that less than half (45%) of the Project Site is forested" (EAP2, p. 39). According to Table 4-1 (EAP2), this

value does not include the additional natural areas of willow/alder and meadow in the project site area.

Note: Despite the claim, "on-site general reconnaissance" was actually not done, and there were evidently no "select locations" (SSCRIR1 #CEC-IR-005)(see p. 438+).

According to EAP1 (p. ix), 56% of the project area is neither agricultural nor developed. However this figure does not consider natural vegetation/trees on residential land which is deemed "developed", nor on pastureland, which latter would be deemed agricultural, nor on other "developed" categories of land use. According to Figure 4-6 in EAP2, the project area is blessed with woodland cover in various phases of maturity. Thus it is anticipated that many trees, that are private property, will be in the way.

We need to consider here that, for some landowners, 100% or nearly, of their own land may be forested. This makes their land all the more precious. For them, the argument does not hold that "well, almost half of the region is already trashed, so what is a little more?" Yet this seems to be the subtext that is presented in the EAP.

Further, in some cases, trees will have been planted and cared for by landowners or preceding family generations in efforts to restore and rehabilitate their land.

- The setting of the project in southeastern Manitoba needs to be considered. Stands of **intact old-growth forest** are becoming scarce, as logging and clearing eat into more forested lands each year. This type of forest is a self-sustaining community of climax vegetation where nutrients are retained and continuously recycled, and which supports characteristic stable and balanced ecosystems that have evolved over a long time. It has experienced no selective logging or other consumptive human disturbance or adverse intrusion. Once damaged, it cannot be classed as old-growth again, regardless of how much we revegetate and rebuild it. In agricultural, developed, and logged areas of Manitoba, surviving parcels of old growth forest are rare and extremely ecologically valuable (https://thegreenpages.ca/2007/01/24/rare_old_growth_forest_protect/).

  The EAP provides no information on how much of this type of forest may be in the path of the proposed project. What are the ethical and moral justifications for destroying and mangling ecosystems which may have taken centuries to develop, for the sake of a few days of sand extraction? How can restitution be possible?

- Are there any trees in the project region that need to be brought to the attention of the Manitoba Heritage Tree Program, so that they can have protected status before they are destroyed (www.gov.mb.ca/sd/forestry/)?

- "The mining plan specifically focuses extraction activities on previously disturbed land such as gravel quarries or **areas allocated by landowners on private land**."(SSCRIR1, #CEC-IR-002). In an ad in The Clipper (January 19, 2023, p. 24), "Locations are determined in consultation with the property owner in the access agreement."

  These statements imply that landowners will designate which areas will be given over for mining. Yet in AppH(AppA6), the planned well production schedule and well locations are already specifically laid out. Did the landowners select those locations? What if the landowner does not wish to have the wells in those locations?

- Well cluster sites will be stripped completely. With the vast numbers of proposed wells, this will in many cases necessitate the destruction of trees and vegetation. In addition, trails will be cleared for transport of equipment, materials and personnel, and for slurry pipes. Hydro poles and power lines will be required.

  According to EAP1 (Figure 2-3), each cluster of 50-60 m diameter, amended to 60 m in SUPPL1, p. 1) will encompass 0.20 - 0.28 ha, and clusters will be 60 m apart. The clusters will be arranged in blocks; it is not known whether there will be a maximum block size. However the latter may be substantial, judging from the statement that: "Annual Project site activities will generally be concentrated on one or two properties and this area will be extracted for a season." (SSCRIR1 # CEC-IR-007). It is thus expected that some parcels will be subject to significant deforestation.

  The latest revision in NREP suggests that clusters may consist of <6 wells, some might only have one or two. However, even where there are fewer wells, the area cleared for an extraction site will still have to accommodate all of the extraction equipment, parking and storage.

- **"**Vegetation clearing will take place outside of the spring and summer months to the maximum extent feasible" (EAP1, p. ix and Table 6-4); "clearing will be scheduled during seasons (e.g., winter, later summer/fall)" (SSCRIR1 #CEC-IR-005); "necessary vegetation clearing each year will occur **during winter months**." (SSCRIR1 #CEC-IR-006)(Emphasis is mine).

  "Two 220 hp pieces of clearing equipment operate 24/7 for full two weeks." (RPCR #81). Is this a solid two week period, with no other addenda? When will these two weeks occur? Will residents be notified in advance?

- We note that **clearing will occur at night (i.e. 24/7) as well** (RPCR #81). Why? This operation is dangerous enough for the operators in daytime. Is this safe? And in winter? How will attention to marked areas or items of special concern be handled at night, in

the limited and unreliable (i.e. wavering shadows) illumination of the equipment lights, especially since precision is required? Will other workers act as forerunners to guide the operators and assist in the event of an accident or machine breakdown? Effects of noise and disturbance will also be enhanced at night.

- Will cleanup of slash and debris occur at the same time as clearing, or will this be left until spring?? Will mulchers and chainsaws be used? Note that chainsaw 2-cycle engines are notorious emitters of noise as well as disproportionately high amounts of toxic and greenhouse gases (Dimou et al., 2019). Where will chipping, shredding and burning be located (see p. 403)? At the extraction sites?

- Nowhere in the welter of documentation and correspondence does there seem to be a **map of a cluster <u>clearing</u>**, i.e. not just the arrangement of the wells, but the footprints and layout within a cluster of **all of the other gear** – compressors, pumps, dewatering station, generators, slurry line terminals, overs tank, turbidity treatment tank(s) and associated paraphernalia, disinfection station, sludge tank, filter cake press, light plants, diesel fuel storage tanks, propane tank (?), mobile office, portapotties, employees' and company vehicle parking, truck and equipment turnaround, laydown, room for delivery trucks, canteen trucks, maybe a caterpillar or backhoe, ATVs for patrolling, etc.

  How will a site area of 0.20 - 0.28 ha accommodate all of these components, for they cannot be all jammed together but require safe work space and room for movement between and among them, and safe distances from potential contamination around the several wells?

  We can do a very simple calculation:

  0.20 - 0.28 ha = <u>2000 – 2800 m^2</u> = stated site area (EAP2, section 6.5.1)

  <u>Cluster diameter is given as 60 m</u> (SUPPL1, p.1)(the 50 m value in EAP2, section 6.5.1 has apparently been discarded, although it is still retained in a caption of Figure 1-1 in SUPPL1.).
  Area of circle = πr^2
  60 m cluster diameter (30 m radius) = <u>2827 m^2</u> cluster area
  Therefore, the proponent indicates that **the well cluster area will be equivalent to the total working area at each site,** and the two will be congruent within the same space.

  This in turn means that all of the above equipment, and mobile office, and *fuel storage,* and parking, and sanitary facility and slurry line terminals **shall be distributed directly among and around the boreholes, in intimate proximity to them**. Recall for example

that **"**Diesel fuel will be stored **at the extraction site area** in a central location for fuelling of the extraction rigs" (EAP1, p. 24)(Emphasis is mine). (see p. 395).

Recall also that the boreholes are only 18 m apart: four located on the 36 m diameter wells' circumference, AND one in the center (i.e. the 5-well plan in SUPPL1, p.1), or reverting back to 6 +1 (according to RMSF-IR-004 and -006). (There is also a "confidential" cluster layout version (SSCRIR1 #MSSAC-IR-009, also RMSF-IR-006)). This leaves a 12 m wide belt on the outside of the 36 m diameter circle of wells. It is obvious that some ergonomic planning will be required, especially since there is also a well in the center, and adequate space is required for 13-20 workers (EAP1, p. 28) to move around the various pieces.

Figure 114 shows an experimental (single) sand well site in Springfield. The congestion that is evident represents only a portion of the clutter that will occur at a multiple operating well cluster, with all of the additional attendant dewatering, screening, 'overs' storage, slurry pumping, sedimentation and sludge tanks, disinfection stations, mobile office, fuel storage, multiple light plants, parking, etc. crammed around the wells. Each cluster location will be an intensive 24/7 industrial site.

Photo used with permission (OLS)

Figure 114. Experimental sand well site (Springfield)(April, 2021). Note congestion, even though only a single well is being tested, other components of extraction, processing, disinfection, administration, and full worker contingent are absent.

Is this safe? If an accident or spill occurs, there will not be any setback or buffer from the boreholes. The diesel fuel storage will be "in a central location", conveniently and dangerously within close reach of all of the wells. Spills and leaks from machinery and vehicles will also be inadvisably near: the next rainstorm will wash toxic materials into the holes (see p. 392). What about room for emergency vehicles in the event of a fire or mishap?

"During extraction operations, a small mobile office unit will move around with the extraction equipment" (EAP1, p. 24). What is a "small" unit? Is it an ATCO trailer: the smallest mobile office available is 2.4 x 6.1 m (https://try.atcosl.com/office-trailer-rentals-canada/?gclid=EAIaIQobChMIjKfbvr35-wIVp8iUCR1yfQ1bEAAYASAAEgKWW_D_BwE). However with all of the promised monitoring equipment, and furniture and other items, this may be too small.

And then there is poor Bru 92, for which the entire parcel area is 0.3 ha (EAP1, AppC). If any operations overflow should happen, it would be onto adjacent parcels.

If the site areas turn out to be larger, they and their voids will start to impinge on each other, since distances between well clusters are only 60 m apart. How rigid are the 60 m surface dimensions, and will they be adhered to, or are they just a hypothetical estimate?

- "Most employees will be traveling directly to the extraction site for their shift where they may park their personal vehicles. However, some employees will travel to the facility first to collect a maintenance vehicle or a water well rig, then will travel to the extraction site for their shift. Employees driving company vehicles located at the Processing Facility, will park their personal vehicles at the facility in a designated employee parking area." (EAP1, pp. 27-28). There will be "13-20 employees arriving twice per day" (EAP1, p. 28).

  Presumably most employees will arrive at the extraction site in their own separate vehicles. The workers that park at the processing facility will bring a company vehicle to park at the extraction site; it is unclear whether any will ride-share. Questions regarding parking and vehicle numbers are asked in SSCRIR1 (#CEC-IR-004), but in the response we are edified about "only a minor increase to regional traffic volumes and [it] does not warrant an additional traffic impact study".

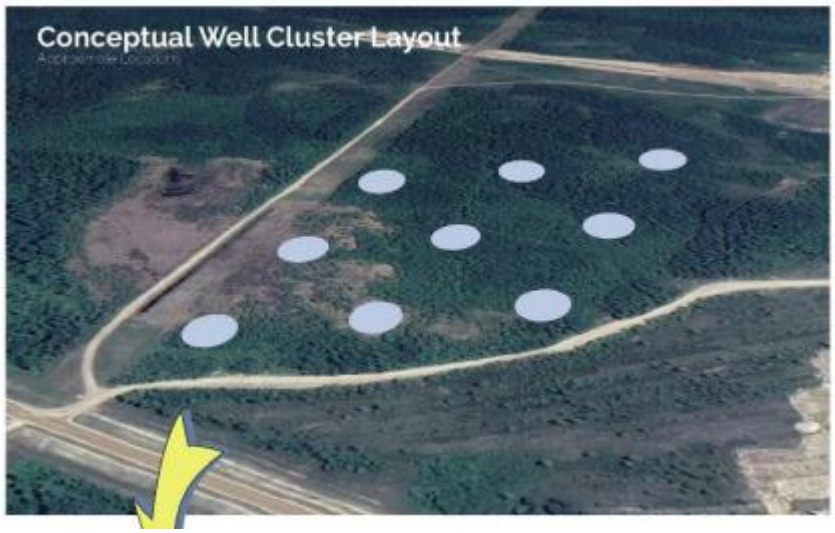
  In any case, **up to 20 parking spaces may be required within the well cluster**. Some or most of them will be trucks. We assume parking will be located in the outer 12 m zone around the outer wells. Based on Canadian parking spot size (https://www.parkingindustry.ca/construction-maintenance/the-average-size-of-parking-spaces-in-

canada), employee parking alone may occupy more than 13% of the site area at 60 m cluster diameter size. Access to the parking area(s) will also be required. What is the traffic impact of this on the extraction site?

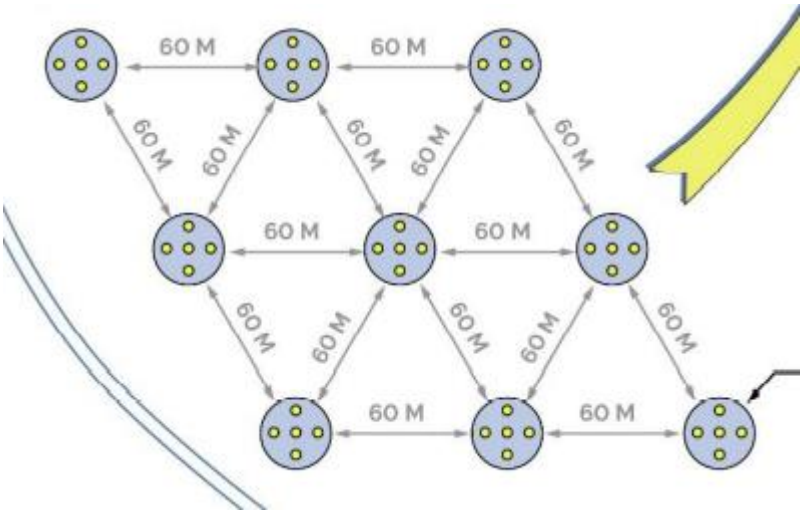
Why can't the workers park at the facility, and ride-share in a few company vehicles to and from the work site? This would reduce (but not eliminate) leaks from vehicles next to the wells, would reduce traffic noise, vehicle exhaust, and disturbance for the homeowner, and would cut down somewhat on the problematic speed limit issue for the would-be vroomers on private land (see p. 344+).

Bonus technical question: Why are workers collecting a water well rig at the processing facility before their shift? Aren't the wells, and presumably rigs, operating 24/7 at the extraction site?

- The layout shown in Figure 1-1 of SUPPL1 (as well as in the EAP) is misleading and does not represent the true magnitude or density of the disturbed areas (reproduced as Figure 115 A and B below):



A



B

Figure 115 A and B. Two images reproduced from Figure 1-1 of SUPPL1. Note: arrangement reverts to 7 wells per cluster again in RMSF-IR-004 and -006, then to <6 in NREP.

The diameters of the well clusters are 60 m, and the distances between clusters are also 60 m, therefore the **sizes of the clusters should equal the distances between them**. But in fact the distances between them are portrayed 2.1 x larger than they should be. Since the circumference of each cluster in Figure 115 B does not touch the wells, it is clear that the clusters purportedly represent the full 60 m diameter.

A similar inaccuracy is propagated in Figure 116 (from Figure 6-5, AppA3), reproduced below:

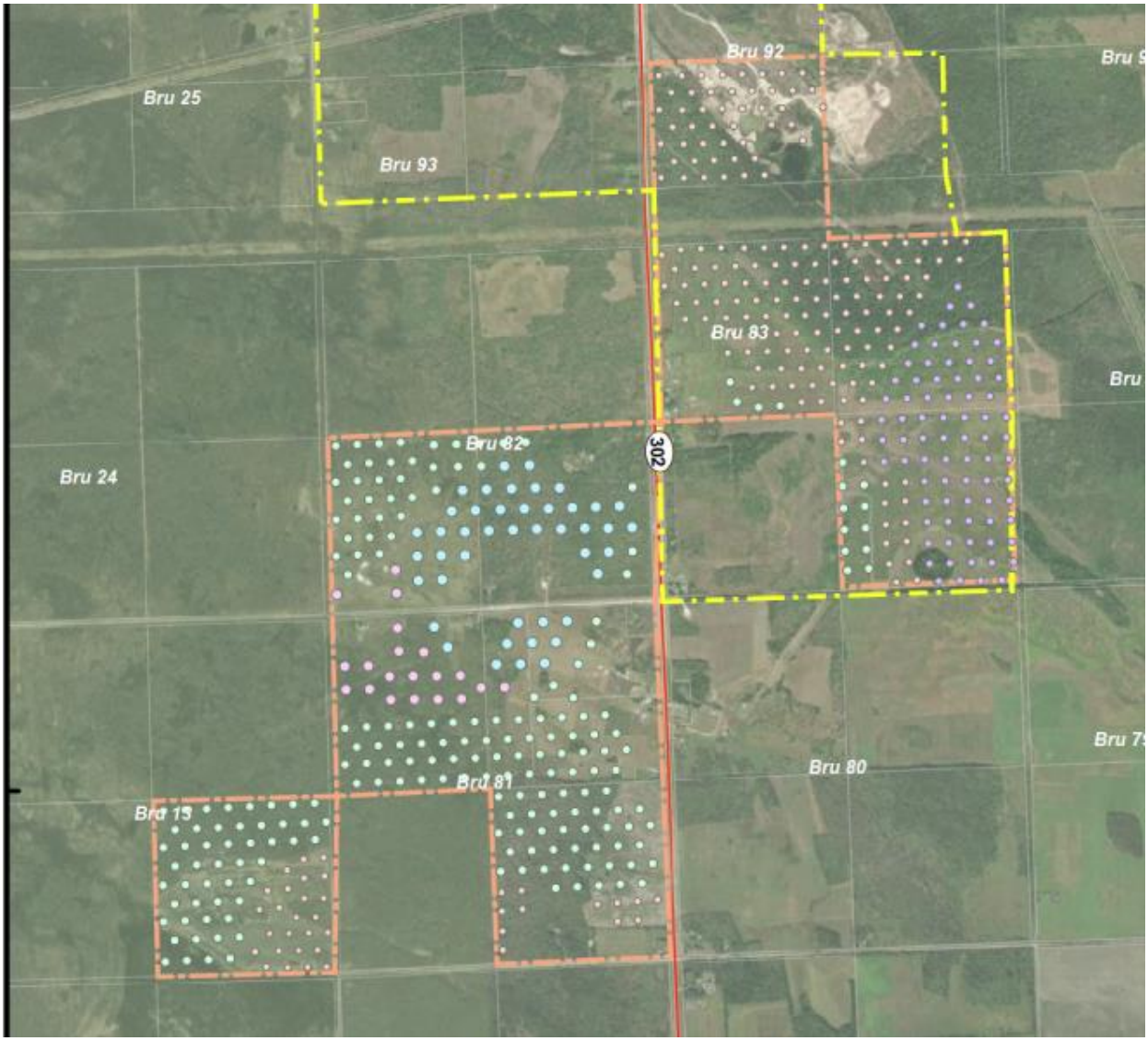


Figure 116. Revised proposed well cluster block arrangement (January 24, 2023)(NREP). Note that site sizes are represented as disproportionately small relative to remaining forest and unoccupied area. No trails are indicated.

Consequently, the relative amount of destroyed vegetation in the clusters has been grossly underrepresented. Why? Surely somebody could have been consulted who could assemble a more realistic and truthful diagram? But then the optics must be considered, and if the sites need to be further enlarged, it might not be advisable to have a diagram at all.

- Access trails are required to reach the clusters, none of which are shown on any of the diagrams or maps. In SUPPL3 the proponent still maintains the previously stated widths of 4-8 m for access trails, to accommodate large and bulky equipment. This scale

renders them comparable to public roadways, "similar to the widths recommended by U.S and Canadian design guides for highways and expressways (3.6 m to 3.7 m)", i.e. for one traffic lane (https://www.ncchpp.ca/docs/2014_EnvBati_LaneWidth_En.pdf). Thus the maximum 8 m width is in excess of two highway lanes, a not insignificant imposition on private property, especially in a forested area.

- On parcels with multiple well clusters, besides clearing of the primary access trails and the cluster sites themselves, and widening of possible existing trails, further additional pathways will be needed to interconnect individual clusters for the movement of workers and equipment among them. Presumably the same widths apply for interconnecting trails as for access trails, to accommodate the same equipment, amounting to more damage and scarring, and providing multiple corridors for weed and disease spread (p. 468). In none of Figures 115 and 116 are any of these additional trails portrayed.

  In TAC (#26): "**minor clearing between up to two adjacent active well clusters** may be required to accommodate temporary drill rig access trails" (Emphasis is mine). Perusing the arrangement of the proposed extraction sites in Figure 116, as well as Figure 1 in the Traffic Projections Memo (TAC), the sites are arranged in blocks, each containing multiple rows and columns. It is difficult to envision how the interior sites could be accessed without connecting **more than two** well clusters. Only drill rig access is mentioned; is not this access needed for *everything* and *everybody* for the entire extraction and decommission cycle? The above quote also refers to "active" well clusters, however all trails will remain as cleared trails whether clusters are active or not. ["up to two": there can be less than two?]

- Slurry trails, on the other hand, are purported as 2 m wide (section 6.5.1, EAP2). How will such narrow trails be cleared in wooded areas? A large frame but narrow skid steer model with a forestry cutter and stump grinder attachments and a mulcher, perhaps? On such a narrow trail, where will the debris be deposited? The trails will need to be relatively smooth and level to accommodate the technical requirements of the HDPE slurry pipes (see p. 211).

  If large trees are cleared with chainsaws, this will be a noisy and protracted task in wooded areas. How will the wood be extracted? As a frame of reference, average pickup truck width is 2.04 m, so this will scrape by, but larger testosterone-display trucks will be a challenge (https://tailhand.com/blogs/news/average-pickup-truck-weight-height-width-length)(see p. 211).

- Each cluster must be accessed by workers and machinery. The EAP and associated documents provide no clue regarding the **disposition of the various trail systems** that will be required.

  Having nothing to go on in any of the documentation, we think up two possible options, neither of which may be the correct one, but we use them as illustrations to make our point: these are shown in Figure 117, where the red lines represent the interconnecting access trails. We base our configurations on the basic dictum that, for access trails, the use of "skidders in the boreal forest generally involves the use of clear, *roughly parallel trails* where 100 per cent of trees are systematically removed, just to provide passage for the machinery." (Bose et al., 2014). Therefore we have ergonomically straight, cleared passages with a minimum of curvy, scenic undulations.

  The least amount of clearing for cluster interconnection would be to run the access trails down the center of the line of clusters as shown, transecting the 60 m of intervening forest between them. However machinery and traffic would have to navigate around the wells in the decommissioned clusters en route to the next operating clusters in each row. If these trails do not run down the centers, concomitantly more clearing would be needed.

  The EAP unequivocably states that slurry line trails will be separate from the access trails (e.g. EAP1, p. 18). Two possible options are shown in Figure 117. In Option A, the branch slurry lines that connect to the main slurry line along the side of the block, run along the edges of the rows of clusters. Each row has its own branch line, which must be cleared. The branch line pipes have to be relocated to the next row each time a row is complete.

  In Option B, branch slurry lines run between alternating rows. There is a trail in every second aisle (Figure 117). Lateral branchlets service the clusters on either side of the trail. These need to be cleared as well. While there are half as much branch trails compared to Option A, this difference is made up by the branchlets. In this option, the branch line pipe is relocated only half as frequently as in Option A.

  In either (or whatever) case, there is substantial clearing and disturbance in addition to the clusters themselves. Note also that the branch **pipes will be relocated multiple times during a season**, regardless of the option used. Frequency will depend on block sizes and configurations.

  But we are not done yet. **Where are the pumping stations?** EAP1 (p. 18) indicates that pumping stations will be deployed at intervals of 450-550 m. Blocks of the sizes shown in Figure 116 will have rows that exceed this distance from the main line once the farther wells are accessed. Theoretically, this will require a pumping station on the

branch line, with additional clearing. Or perhaps additional main access trails will be cleared along other sides of the block to shorten branch access to the interior, but also involving more destruction?

And then, **where are the hydro corridors/poles?** Presumably they will not be on the access trails or slurry trails. As extraction moves along, mainline power will need to accommodate the moves. Besides the dewatering station, mainline power will also service the pumping stations, which are somewhere on the slurry trails, possibly even on the branches. See further discussion of this problem below.

And yet again, we learn of the numerous additional monitoring wells that will be distributed within and around the operational areas (see pp. 530-531). Their sites will need clearing, if only to make drilling possible, and they will require their own access trails, which may need to be usable for five or more years during the post-extraction monitoring period (see p. 529).

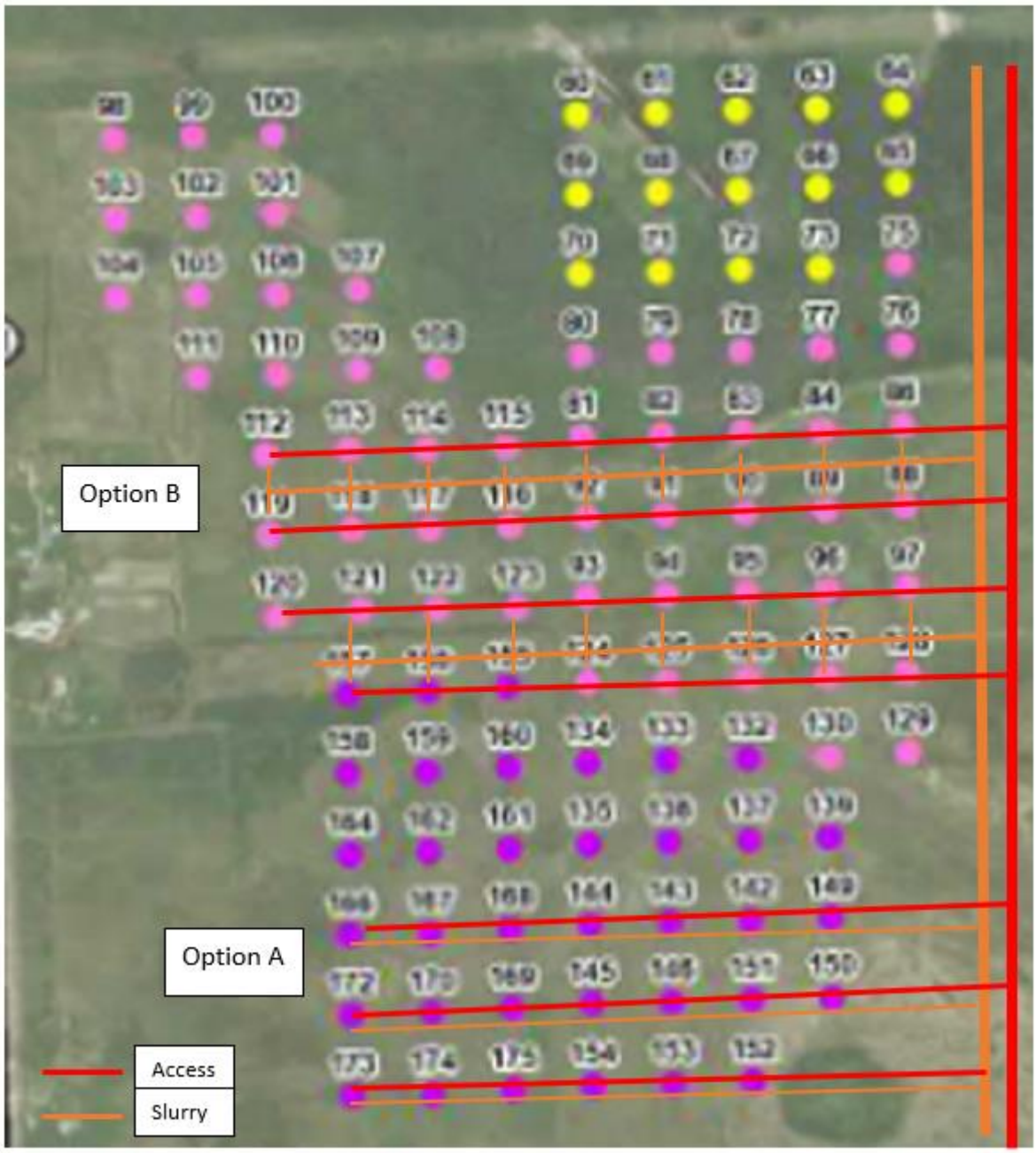


Figure 117. Two possible options for disposition of access and slurry trails within a block of clusters. Red = access, orange = slurry. Modified from Figure 6-5 in AppA3.

- While the proposal states: "Effects on topography will be minimized by using existing roads, trails and other previously disturbed areas to the extent feasible to minimize disturbance to the natural topography." (EAP1, p. v), in the majority of cases, it is unlikely that locations and numbers of existing corridors on private property will happen to conveniently coincide with access to the extraction sites without significant further damage (e.g. Figures 116 and 117). If some do, they will still require adjustment and

enlargement for heavy equipment width and turning radius. Existing hydro pole rights-of-way on the property cannot be used.

- "Areas to be cleared of vegetation will be minimized to the extent feasible and will be clearly marked to avoid clearing more than required." (EAP2, Table 6-4). No information is given regarding how the areas to be cleared will be selected and marked.

- How will the 60 m diameter extraction circles be surveyed? Will transits be used to survey the required locations and dimensions? This may be difficult in forest. Maybe GPS?

- Will nontoxic tree marker paint be used? Or perhaps yellow plastic "police tape"?

- Will bulldozed trees be pushed onto trees that are still standing, thus injuring or killing them as well? Similarly will rocks and stumps be pushed or dumped onto adjacent trees and vegetation? Where will bulldozed rocks be piled?

  According to Bose et al. (2014), **remaining or residual trees may be injured** by felling and hauling: "harvested trees can break branches and peel lengths of bark and sub-bark tissue of residual stems within the felling line. Machinery or felled trees can also cause severe damage to lower trunks and root systems of trees situated adjacent to hauling corridors….these injuries provide vectors for fungal infections and other pathogens that can cause decay…While such injuries do not generally cause immediate mortality, they can affect the health, growth rate, wood quality and lifespan of affected trees." This is particularly relevant for the trails, especially the 2 m wide slurry trails, where damage to adjacent trees will be unavoidable. **This must be factored into the total eventual losses**.

- How will site locations be adjusted in the event of some impediment (e.g. large rock, exceptional tree, surface water pool or seep, old homestead, old landfill, etc.) at the designated spot? What is the policy allowing for flexibility of site location?

- Who will be the arbiter and enforcer that will ensure excessive clearing does not occur? Is the burden of vigilance placed on the landowner, who will survey the wreckage with measuring tape? Once trees are destroyed, they cannot be stuck back in their holes.

- The word "minimize" is used gratuitously and cloyingly throughout all of the documentation, yet its meaning has already been rendered worthless by the first actions that belie the word, in the destruction at the processing facility site, for nothing was "minimized" there. In their ad in The Clipper (13 January 2022, p. 6), in response to public outrage, the proponents admitted: "The blunder we caused by clearing trees on our private land could've been handled better. We knew we wanted to commit to

replanting what was removed. Unfortunately, at the time, the tree supply wasn't available. We've since ordered container-grown trees and will offer them to Anola residents this spring."

A number of observations arise:

-The feeling cannot be helped: If this is how they treat their own "private land", will they treat somebody else's "private land" in the same disgraceful, rapacious way?

- Why was the clearing not "minimized" at the outset? Instead of committing to "replanting what was removed", why remove it in the first place? What was removed were mature trees. Replanted trees will take decades to mature (see p. 460). Many older residents will not live to see them.

-That "the tree supply wasn't available" is no excuse and underlines the lack of responsibility, planning, and care. It's somebody else's fault. Too bad.

- What species are the "container-grown trees"? Are they the same species that were destroyed? How big/old are these trees? Where exactly will they be replanted? There is no hint of any replanting on the actual "private property" where they were destroyed, and are needed most.

- Anola residents have to plant the trees they get themselves, wherever they want to. How difficult will this be by hand shovel? Will the company executives plant the trees in the case of people who may be elderly, ill or disabled and who are unable to do this themselves? Or do residents have to hire somebody?

- Will there be a 1:1 replacement ratio, for trees destroyed vs. trees replanted? I would confidently wager that nobody knows what this number was, since no pre-destruction inventory or survey was done, and that the "350+" number already offered to Anola residents (The Clipper, May19, 2022, p. 15) was nowhere near the actual number destroyed.

- In SIO (p. 22) we see the unsettling statement: "To bridge the area **between the forest and the cleared land**, and to encourage the habitat of the recognized golden winged warbler species, there is allowance of bushes to grow up along the edges of the cleared lands." (Emphasis is mine).

  What is this bridge area "between the forest and the cleared land"? Either it is forest, or it is cleared. Does this mean that there will be additional destruction, i.e. an "allowance", around what will be considered as all-out, full-blown "cleared land"? How wide is this "allowance"? This would further reduce the amount of intervening remaining forest. Why is this missing from the already skewed cluster maps (Figure 1-1, SUPPL1), and why is it not mentioned in the EAP or supplementary information?

Will this "allowance" also apply to trails? Are trails also "cleared lands"? The bushes along the edges will be in the shimmering future and will not have enough time to be 'growing up' during the window that the site is in actual use, so why is this "allowance of bushes to grow up" only "along the edges of the cleared lands.", and not also encompassing the cleared lands themselves?

- In any case, a substantial portion of the area occupied by a block will be denuded, churned up, and compacted in a patchwork pattern, joined together by the noxious web of various corridors and trails. Estimating the amount of area taken up by the round clusters themselves removes approximately one quarter of the vegetation from within a block of clusters (provided the cluster dimensions are adhered to); adding in suppositional estimates of trails increases the amount of clearing in a block to a third or more. However it is possible/probable that some dimensions, for example the slurry line trails, provided in the EAP may be underestimated, and collateral damage is also likely/expected, especially with clearing at night.

  We ask the question: How much intervening vegetation can possibly remain ecologically meaningful or sustainable in such circumstances? The various disturbances will emanate and encroach onto the pathetic remaining tree stands/groves/fringes from the embedded clearings and trails, and drive out remaining wildlife (see also edge effects on p. 446). In practical environmental terms, the entire area can be considered severely damaged. As the project encroaches and expands, this will amount to major intrusion affecting large areas, will substantially alter structure and balance of existing communities, and will degrade habitat quality and integrity for some time to come.

- Despite all of the above, the proponent maintains that "**Most of the Project Site will remain undisturbed**" (EAP2, section 6.8)(Emphasis is mine). In SUPPL3: "Direct impacts on vegetation through annual clearing activities will be **restricted to the Project Site** in consideration of setback distances" (Emphasis is mine).

  What has happened to the clearing of access trails, interconnecting trails, slurry trails, hydro lines? We still remain unenlightened whether pumping stations will require widened clearings, although they will each occupy 63 m^2 of unknown dimensions. On wooded properties, all of this (plus the 0.20-0.28 ha project sites)(EAP2, section 6.5.1) may amount to loss of large numbers of trees on a single parcel. Does Figure 117 above seem undisturbed, albeit under-portrayed and underrepresented though it is?

  [An ethical, and unfortunately rhetorical, question bothers us. While we are grateful that not *all* of the area will be stripped, we cannot help but to wonder why *any* of it should be molested, since after all it is somebody's private land. The fault lies with our legislation, which takes away landowner rights, for the benefit and profit of a third party private enterprise, that has little stake in the preservation of the landowner's interests. It is a step towards autocracy.]

- As mentioned above, the proposal indicates that the onsite "dewatering and pump station will be powered via direct mainline from Manitoba Hydro" (EAP1, p. 26). Since mainline power will be required at the extraction sites and pumping stations, and since power lines cannot be laid on the ground, this will necessitate the **installation of hydro poles** to service this equipment. A number of issues arise:
  - Mainline power will presumably be tapped from the hydro service lines (if present) running along the property frontage, and metered accordingly. In cases where there is no hydro line at the frontage, hydro lines will need to be extended along the municipal allowance from the nearest point of service. If the allowance is forested, corridors will have to be cleared on municipal land to the parcel; this is the responsibility of the party requesting the line extension.
  - **Rights-of-way for Manitoba Hydro (MH) poles and lines will have to be cleared** on private property to bring them to the extraction sites and the pumping stations.
  - Access trails for extraction sites will likely not be suitable for running hydro poles and power lines unless they are very wide and meet MH specifications, and caution will be needed for the transportation of large and heavy equipment to prevent accidental contact with power lines.
  - In agricultural fields, hydro poles and power lines would inconvenience the farmer; for example modern farm equipment is guided by GPS, and these obstacles would create additional annoyance and loss of usable acreage. Special care would be required for operating large farm equipment nearby.
  - Power for the pumping stations will be problematic as the slurry trails will be only 2 m wide and thus hydro poles cannot be installed, unless these trails as well are greatly widened, adding to the amount of property damage.
  - As we envision from the EAP, when the operation proceeds from cluster to cluster and block to block, additional extensions and poles will be needed to extend the power line, requiring additional clearing. At some point, a new corridor for poles will be required.
  - The rights-of-way for hydro lines on private property would require temporary easements.
  - Will these extensions cross neighboring parcels, some of which may not be participating in landowner agreements, or be public lands? Again easements will be required. What if the landowner refuses?
  - What is the maximum distance that will be achieved before a new hydro pole corridor needs to be established?

- Since there is usually a wait time of at least several months for MH hookups, the schedules would have to be firmed up well in advance. Should there be a delay or other unforeseen issue at an extraction site, this would create a problem for the MH schedule.
- All power infrastructure is owned by MH and **can only be handled by MH staff**.
- Hydro poles, transformers, and all related infrastructure will need to be removed by MH staff when no longer required, and moved to the next location.
- This project would place an ongoing operational burden on MH for 24 years. Load requirements at local substations would have to be met.

  The proponent responds: "Manitoba Hydro is conducting a Load Interconnection Evaluation to determine the best option to supply CanWhite with the power required for the Project operations while not impacting local users. Manitoba Hydro was supplied with the electrical loading requirements for the Project for consideration in the evaluation." (RPCR #126).

  The burden would be not just the power requirements, but also the recurrent use of MH personnel, time and equipment, which have become increasingly scarce as MH has attempted to implement greater corporate efficiency, has closed local rural MH offices, and reduced or discontinued ancillary services in order to reduce costs.

The results of consultation with MH cannot be found anywhere in the EAP proposal.

The proponent responds: "CanWhite is in discussions with Manitoba Hydro on logistics and power requirements for the extraction dewatering and pumping station to be powered. The design of the **dewatering and pumping station provides for it to be relocated only once per year.**" (RPCR #122) (Emphasis is mine). That would amount to 24 times in the proposed lifetime of the project. This statement also seems to suggest that, of the extraction site equipment, only the dewatering/pumping station will be electrically powered.

A gigantic logistics question arises from this revelation: as *each well cluster,* and each row of clusters (Figure 117) is brought into production, we have understood that the dewatering/pumping station will move as well, as it is assumed that, as a critical piece of equipment, it will inhabit each respective extraction site where it is needed. There will be many well clusters, and many moves, in one season. So how can it "be relocated only once per year"? Can the dewatering station operate remotely from another location? How would that work?

- The above statement (RPCR #122) also only addresses the dewatering and pumping station and does not seem to address the slurry line pumping stations (plural). "The

pumping station will be powered by an extension of a local power line" (EAP1, p. 24). There seems to be confusion between the "dewatering and pumping station", and the slurry line pumping stations. We assume they are all electrically powered, but will be a challenge on the 2 m wide slurry trails.

- "Burning permits to dispose of woody debris will be sought" (EAP1, p. 9). Burning is nowhere elsewhere indicated in the EAP.

  In TAC (#25), we see a different answer: "Remaining timber/brush will be chipped or mulched". Chipping and shredding of unseasoned woody debris rather than burning is far more environmentally responsible as it creates much less air pollution and immediate greenhouse gases, and provides useful mulch for gardening, landscaping and other uses, where it can be used as soil covering to deter weeds. However care should be exercised if mulch is left at the site, for it makes "an extremely poor germination bed, [and] it constitutes a major physical barrier for any seed and seedling penetration." (Bose et al., 2014), thus deterring revegetation. Care must also be taken not to chip or mulch diseased wood: in this case, burning is the only option (see pp. 404, 469).

  Presumably the bulldozed trees and bushes will be cut up with chainsaws, which will be accompanied by noise and disturbance. As mentioned previously, these 2-cycle engines are notorious emitters of toxic greenhouse gases (carbon monoxide and NO_2) (Dimou et al., 2019).

- Lost trees will be associated with concomitant reduction in property and esthetic/spiritual values, increased runoff and erosion, reduced nutrient sequestration and air and water cleaning, reduced shelter from wind exposure, and tainted enjoyment of one's property. The proponent does not have the right to sell or dispose of wood or shredded mulch without consent of the landowner. The landowner is entitled to fair compensation, which may be estimated by an experienced third-party forestry person (wood), or landscape professional (mulch).

- Section 4.3.7, R 337 of the Canadian federal Environmental Code of Practice for Metal Mines (2009) states: "Clearing of vegetation in preparation for construction should be carried out in such a way that: … the time between clearing of an area and subsequent development is minimized." The purpose of minimizing the interim time interval is to limit the period when the site is disturbed and unreclaimed, and to limit weed growth.

- Clearing of access and other trails will make the property vulnerable to trespassing: ATVs, dirt bikes, snowmobiles, hunters, woodcutters, berry and mushroom pickers, free Christmas tree shoppers, miscellaneous "tourists" of unknown intent. Will

decommissioning include closing the entrances to trails at property boundaries, or will this be left to the landowner?

Vegetation and habitat damage

- A significant part of the biodiversity in southern Manitoba is held on private lands. Landowners are tasked with the responsibility of holding these resources in trust for future generations. They honor these responsibilities in varying degrees. It can be safely said that many residents who own naturally vegetated lands also understand their value and the necessity for their preservation and maintenance. Landowners may also have a strong emotional and spiritual attachment to their land and the plants and creatures which inhabit it, and which are safe from human depradation through the care and expense (e.g. taxes, land donation, conservation easements) that owners exercise on their behalf. It must be recognized that invasion and destruction, which the landowner is powerless to avert, may be profoundly traumatizing to some individuals and families. Some may have kept their land in trust for generations. For thoughtful, cognizant people, desecration of their land may compare to tearing out one's heart. There is absolutely no recognition or acknowledgement of the human context in the EAP or any other documents. For many, the effects of clearing are not "minor" or "temporary" as constantly claimed and dismissed, but they will last for years.

- Where are the results of the "on-site general reconnaissance **in select locations** within the Project Site area" (EAP2, p. 39)? (Emphasis is mine). Where are these "select locations"? How were they selected, and which standard methods were used to sample and enumerate: quadrat sampling, relevé, plot-less method, transects, nearest neighbor method, etc., with which every ecology student is familiar? (http://www.sci.sdsu.edu/serg/techniques/mfps.html).

  However on inquiry, in SSCRIR1 (#CEC-IR-005), this has shrunk to "**Pre-development surveys of ground cover have not been proposed** because the mitigation measures described in the EAP…to minimize adverse effects on vegetation, including species of conservation concern **if present**, are assessed as being sufficient to avoid significant adverse effects on regional vegetation species populations, including plant species of conservation concern **if present**." (Emphases are mine).

  <u>If it wasn't done, why claim it was</u> in the EAP, and done "in select locations within the Project Site area", no less? (See also pp. 419-420). How can it be concluded that the (not yet articulated) "mitigation measures" will be "sufficient" when we do not even know what vegetation is actually present, and what may need to be mitigated. And "if present"? We don't know? Will we ever know, if they get destroyed? We can always say that they *likely* weren't there.

- Table 4-1 (EAP2) gives a breakdown of (*literature*) cover types for different phases of the project. The cumulative estimated value is 67% for forested, meadow and willow/alder combined, i.e. two thirds of the land area. There is no explanation why for the "regional project area" there are concrete values for marsh/muskeg (substantial), treed muskeg, shelter belts, water and mapping gaps, but these values are zero for the 24-year life of the project area, the latter interpreted as the total land area that the project will have encompassed after 24 years. The value for meadows has also declined for the 24-year regional column. Why this vast difference? The time frame of the plain "regional project area" column is not given.

  If the 24-year values are future projected values, how were they derived? Where are these values within the referenced Manitoba Land Initiative (2017), presumably/possibly https://mli2.gov.mb.ca/landuse/index.html (The actual link is not given in the EAP.)?

- "No land cover considered rare for the regional area **was observed** in the Project site **during terrestrial reconnaissance of the Project site**. Vegetation species at risk are **not expected** to occur within the Project site." (EAP1, p. ix)(Emphases are mine). This statement is contradicted in EAP2 which does identify "Plant 'Species at Risk' that may occur within which [sic] the Project Site" (EAP2, pp. 44-45, and AppE).

  Again, where are the results "observed" in this "terrestrial reconnaissance of the Project site"?

  The truth busts out, as it is wont to do. In answer to the question (RPCR #114) regarding the "terrestrial reconnaissance of the Project site", it turns out that actual "Surveys **were not conducted** at the Project Site because our desktop review indicated that the probability of occurrence at the Project Site of the three potential plant Species at Risk is **generally** low." (Emphases are mine).

  So how was it that nothing rare "was observed"? Technically true though, since actually, nothing was observed.

  Somehow however, RPCR (#103) decides definitively that "The Project Site does not have rare or unique vegetation communities."

  Furthermore, contrary to the information presented in EAP2 and AppE, the proponent states that species at risk **are not expected.** "Expected" and "actual" are different things. The RPCR (#103) is even more emphatic and final: "does not have".

  Species at risk and rare species are designated thus because they are, well, **rare.** By definition, they are unlikely to be identified in a cursory distant eyeballing of the general area, especially when they are not in flower, and even less likely to be detected from behind a desk in Winnipeg. **Assumptions do not equate to actual assessment (by qualified botanists) of the actual places where disturbance and destruction will occur**.

Photo: E. Pip

Figure 118. Indian Pipe or Ghost Plant (*Monotropa uniflora*) in bloom. This amazing rare and delicate forest plant occurs sporadically in southeastern Manitoba (including the project area), and requires shade and undisturbed moist soil to survive. It is one of the few known flowering plants that has no chlorophyll and is a saprophyte. It is sacred in Indigenous medicine. Poet Emily Dickinson called it "the preferred flower of life", due to its improbable existence. But, what dollar value does it have for us, you ask?

Furthermore, what about other rare species, not just those At Risk? I have (actually) observed for example, that there are several (I encountered five) species of rare native orchids, rare herbaceous species such as Indian Pipe (*Monotropa*)(Figure 118), rare ferns and clubmosses (*Lycopodium*) and liverworts within the project area, yet the "reconnaissance", actual or otherwise, apparently did not identify any "land cover considered rare for the regional area". Treasures such as these will not, and cannot, be successfully reseeded or transplanted.

Mandatory ground-truthing was not carried out. Desktop review and theoretical probability, with a coffee mug in one's hand, are one thing, but leaving one's comfy chair, donning klompy, non-Manolo-Blahnik-designed boots, and shlepping out into the gucky field with its ticks and mosquitoes and scary garter snakes, is another……and what if you break a nail, or snag your cashmere sweater on a twig? Then what?

In SSCRIR1 (#CEC-IR-005), the proponent has an excuse: "clearing will be scheduled during seasons (e.g., winter, later summer/fall) when plant surveys are not feasible, or when plant species of conservation concern may not be detectable should they be present." But, plant surveys **are** feasible in **summer**: just a crazy idea, but how about doing it then? Unlike animals, plants are more limited in their mobility, and are more likely to still be there when clearing rolls around a few months later. One does not do surveys while walking in front of the bulldozer, people. Duh.

Note: Trees and shrubs can be identified year-round, surprising though it seems.

But then again, what about the "**Fall** vegetation survey (September and October 2018) with additional emphasis on wetland areas and the Project Site" referenced in Section 4 (EAP1, p. 32)? Do YOU, dear reader, not interpret this as a description of actual, *bona fide* field work? Even the season is specified, in contradiction to SSCRIR1 (#CEC-IR-005) above, where they said that fall time is a no-go. If this too was "desktop" according to RPCR (#114), how was it a "fall vegetation survey": perhaps the desktop review was carried out in the fall? Or maybe there is some *vernissage* which we do not care to pursue? In any case, this report is not available either, although it sounds like it would be good.

Despite all of the above word-play and deception, the public ad face is reassuring 'spit and polish': "Through **vegetation, wetland and wildlife studies**, **we determined** that the site is not home to fish habitat, **rare vegetation** or uncommon wildlife habitat." (SIO2) (Emphases are mine). What can we say?

- The proponent does not answer the reviewer's question: "What will be the procedure if a species of concern is identified?" (SSCRIR1 #CEC-IR-005), although this is easy to answer:

  A. There is no interest in identifying any species.
  B. Since we will not be identifying anything, we don't need any procedure.

- In the event that a landowner undertakes the initiative and expense of obtaining her own pre-destruction survey, will the company honor issues of concern? What recourse does the landowner have in the event of a dispute?

- "progressive annual rehabilitation/revegetation of Project activity sites will minimize the long-term effects on vegetation by returning the temporarily disturbed areas to a more natural condition thereby **facilitating the future establishment** of plant species of conservation concern should they occur in the Project Site." (SSCRIR1, CEC-IR-005). (Emphasis is mine).

1. "should they occur in the Project Site": We don't KNOW if they occur? Nope.

2. Rare species are rare because they require very particular microhabitat conditions, which are the opposite of disturbed conditions. These may include diverse factors such as soil particulate and chemical composition, amount and type of organic matter, texture, moisture and microbiota, degree of **shade** (which will not be replicated at the cleared sites), other companion species, symbionts, and other elements that will not be the same as before. Mangling the habitat will not 'facilitate' or improve it: this is why areas where species of concern are found are **strictly left alone**.

3. Because the species were already rare before they were destroyed, even if the habitat is somehow replicated, chances are slim that they will be able to reestablish spontaneously without an adequate viable soil seed bank or an external seed source.

- Since apparently only armchair exercises were done, we surmise that nobody knows what has already been pillaged in the razing of the Processing Facility parcel. If we close our eyes, we can truthfully say we don't see any problem.

- Clearing may occur in winter, under snow cover, including at night, when the bulldozer operators/assistants will be unable to identify circumstances of special concern, and notable features to avoid. **Will a detailed recce of the <u>exact routes</u> be conducted and marked during the previous year**? During the much-needed vegetation survey, perhaps? The documentation dithers, evades and dissembles: it seems the answer here is no as well.

  Otherwise, how responsible is it to go onto somebody's private property, and proceed to blindly flatten and demolish **without even knowing what exactly is being destroyed**? Is the landowner of so little consequence and worth that she does not deserve some respect and accountability for her own property? Does the landowner not deserve some **consideration** for features of personal value, and **compensation and reparation** commensurate with the amount and level of damage?

- Broader ecological consequences must also be considered. In the significant proportion of forested area within the project region, the proposed clearing of extraction sites and various access and operational trails will result in substantial **habitat fragmentation and population segmentation and isolation of rare species**.

- The many kilometers of forest/disturbed boundaries will create **edge effects**, where plant species requiring shade or dappled light are disadvantaged, resulting in altered community composition and structure. (See also p. 446).

Remaining trees along the exposed edges are also more susceptible to windthrow (i.e. toppling in windstorms (e.g. Bose et al., 2014). Increased wind penetration into remaining stands may induce increased tree sway, and higher evapotranspiration rates that "produce die-back symptoms including loss of foliage and tree vigour" (see literature review in Bose et al., 2014). According to the latter author, trees are "dependent on the protection and support of neighbouring trees for their mechanical strength against wind." Conifers, such as black spruce with their shallow root systems, are particularly affected: in intact stands, their root systems interlock and the trees support each other.

- The closest comparisons to the kind of damage that will be inflicted is the practice of "patch-cutting", used in forestry harvesting. In this practice, patches or clearings of timber are harvested, leaving residual stands. There are a number of consequences: "numerous studies have reported elevated mortality rates of residual stems following partial cutting, initial growth stagnation of residual trees, problems related to recruitment of desirable species and, on certain flat or lowland sites, risks of long-term decline in site and stand productivity" (Bose et al., 2014). Thus for several years after the damage, remaining trees may do poorly and die, thus the zone of injury may expand.

- It must be kept in mind that "patch-cutting" studies such as mentioned above, refer to tree cutting only, and the soil is relatively undisturbed. In the present project, this will not be the case: the soil will be disturbed by machinery of various sorts, and levelling during decommissioning. Roots will be compacted or injured and destroyed. It may incorporate leaks and spills. All of these factors will further delay reestablishment of vegetation.

- Regenerated areas differ in composition from the original. They must progress through the stages of succession, which require time, and the resulting climax community may not replicate the pre-destruction species and age cohort structures.

- In considering biodiversity of an area, other components of the community must be considered, as they are essential for the integrated functioning of the whole, and will be directly impacted by habitat destruction. Southeastern Manitoba hosts the largest diversity of native fungi in the province; some have known food, medicinal and indigenous ceremonial (e.g. hallucinogenic, spiritual) uses. The diversity is so vast and complex that these organisms have not been inventoried in the region. I have personally observed a substantial array of both edible and toxic basidiomycetes (gilled mushrooms and their relatives), clavarioids (coral fungi), polypores (bracket fungi), hydnoids (tooth fungi); ascomycetes (morels), gastromycetes (puffballs (especially *Lycoperdon*, used in indigenous medicine to treat wounds), bird's nest fungi and earthstars; and

heterobasidiomycetes (jelly fungi), to name a few. They need shady, moist environments, and in many cases, very specific substrates; clearings will not be hospitable places. In the course of indiscriminate clearing, we do not even know what we are destroying. The proponent is free to include the above information in their 'surveys' of the area.

The area is also extremely rich in populations of foliose, fruticose, and crustose lichens. A list of pertinent known lichen species may be accessed through the University of Manitoba Herbarium portal (https://winherbarium.weebly.com/).

Wildlife

- As for the effects of clearing and physical disturbance on wildlife, "Project impacts to the Regional Project Area wildlife populations are assessed as negligible." (section 6.5.2, EAP2). Since **no actual physical onsite surveys** were done to identify the wildlife species present, conclusions regarding impacts are highly speculative.

  In fact, clearing and the associated disturbance will affect not just the extraction sites and the sundry trails, it will **depopulate the entire cluster blocks and surrounding areas of wildlife** that are mobile and can get away. The intervening vegetation that remains between the cluster sites and other disturbed places cannot be considered as viable habitat for most of the original inhabitants. Desolation of the area will be further entrenched once extraction activities and traffic commence, and these will assault the area day and night for a prolonged time, as operations slowly work through the cluster block, and adjacent blocks.

- "Clearing of natural vegetation to accommodate the establishment of sand extraction well cluster sites, temporary access trails, temporary trails for slurry lines and water return lines and area for pumping stations will occur outside of the peak breeding bird season for the Project area (i.e. April 25 – August 15) to avoid contravening the federal Migratory Birds Convention Act, 1994." (EAP1, p. 13; also SSCRIR1 #CEC-IR-005).

  The proponent admits that "breeding bird surveys throughout the Project Site were not conducted" (SSCRIR1 # CEC-IR-006). An actual bird survey should have been undertaken to identify **not just the migratory species, but year-round residents as well** (see also p. 382). Approximately 50 species are present in winter in Manitoba (https://www.oakhammockmarsh.ca/winter-birds/). These birds will be disturbed by winter clearing activities, and their winter food and shelter may be impacted. The reduced cover may make them more vulnerable to predators.

Note that the Great Horned Owl, which occurs in the project area for example, is a very early nester, "with egg laying and incubation underway well before the snow disappears.", and adults remain within the same area where they were born (https://www.hww.ca/en/wildlife/birds/great-horned-owl.html). Disturbance could be devastating for this species in the project area. Since they utilize different hollow trees or old nests of other birds each year, clearing could impact their breeding habitat for a number of years.

I have encountered Bald Eagles in the project region. They may be found throughout the year in Manitoba, but are more usually seen during migration starting in February or March, and again ending in November (https://www.birdadvisors.com/eagles-manitoba/; https://www.birdatlas.mb.ca/accounts/speciesaccount.jsp?sp=BAEA&lang=en). Eagle nests are normally reused and enlarged for many years/decades, and nests and territory are the possession of the female; the young have to make their own way, wherever that might be. Clearing activities should be preceded by a check for nests in trees. Subsequent noise of extraction activities will make the birds leave the area, which can result in permanent abandonment.

It must be noted that the reduced breeding habitat, food availability, and habitat fragmentation, **will impact all species**, not just migratory birds. Destruction of standing trees and snags may directly deprive woodpeckers of food and nesting places. Several species are present year-round in the area, for example the large, and now quite rare, Pileated Woodpecker requires "large, mature forests with many dead and fallen trees." (https://birdwatchinghq.com/woodpeckers-in-manitoba/). Of particular concern is the Red-headed Woodpecker, which has severely declined due to deforestation. As woodland continues to disappear, the remaining forested lands become all the more precious, and every effort must be made to conserve their integrity.

It seems rather feckless to focus so much attention on the fact that clearing will avoid (most) bird breeding periods, when all of the **extraction and associated activities**, with their massive noise, disturbance and light infliction **will fall squarely upon these very times.**

- Once disturbed, the parents will not return to an abandoned nest. Furthermore some species use the same nest each year, therefore disturbance may have longer term consequences. There will also be associated reduced opportunities for food and cover because of the injured landscape. The problem is exacerbated by the fact that the disturbance will not be confined to one location, but the entire vicinity will be riddled with pockets and corridors of disturbance and destruction, resulting in longer term habitat fragmentation.

- Clearing will reduce the amount of breeding habitat available for ground-nesting birds. A number of species, both indigenous and migratory, require the cover of vegetation to conceal nests from avian and mammalian nest robbers. According to Angelstam (1986), much research has focused on "how patterns of predation become altered as the size of patches of pristine environments are reduced as a consequence of human influence". This worker found that edge effects between disturbed and intact environments are particularly important with regard to nest predation rates.

- Ruffed grouse are present in the project area (personal observation). These ground-dwellers spend their entire lives within only a few hectares of home territory; their winter food of buds and catkins of poplar, birch and alder will be directly impacted by clearing in the area (https://www.hww.ca/en/wildlife/birds/ruffed-grouse.html). Because they are restricted year-round to small home ranges, forest destruction will deprive them of their homes.

- The plan is that "clearing equipment [will] operate **24/7** for full two weeks." (RPCR #81); and "clearing will be scheduled during seasons (e.g., winter, later summer/fall)" SSCRIR1 (#CEC-IR-005); "necessary vegetation clearing each year will occur **during winter months**" (SSCRIR1 #CEC-IR-006)(Emphases are mine).

  It should be pointed out that the noise and disturbance from clearing at night will **startle roosting birds**, that can be injured or killed by flying blindly into trees or other objects, and be unable to find appropriate alternate shelter, which can be disastrous in winter. I have observed dead birds that had frozen to death after being startled at night in winter. I have also seen mass bird kills after nocturnal fireworks displays, apparently of heart attacks; such phenomena have been much reported elsewhere (e.g. https://www.trtworld.com/life/scores-of-birds-killed-after-new-year-s-eve-fireworks-show-in-rome-42890).

  Why must clearing occur at night? Sure, with the reduced available daylight hours in winter, clearing would take three times as long. But can't at least this aspect of the brutality of clearing be given up for some mercy and compassion on behalf of these poorest of the poor? Perhaps a difficult ask: there seems to be little enough compassion for human beings: indeed the proponent has had no compunction in exploiting his own sick child in a tawdry company ad (The Clipper, January 12, 2023, p. 10).

- Other animals may also be abruptly displaced by clearing. Furthermore, a number of animals present in the area hibernate in winter. Deep heterothermic mammalian hibernators as well as ectothermic animals in diapause (reptiles, amphibians, invertebrates) will perish if they are in the path of clearing. Another concern in the project area is the black bear, which hibernates from late November to mid April;

however they are not deep hibernators and are easily roused (https://www.fllt.org/black-bear-hibernation-bearing-the-cold-of-winter), even if the disturbance is only nearby (personal experience). Females may have very small young with them. What immediate protocols will be followed if a bear den in the vicinity is disturbed while clearing? Will there be any shooting and killing? What will happen to the very small young when they are orphaned, will they be left to die because nobody wants to bother, and time is money?

- Habitat fragmentation must also be considered, especially for smaller species and those with limited home ranges. In TAC (#18) we read: "Although AECOM agrees that the evaluation of existing disturbance and fragmentation alone would not be suitable in assessing impacts to all species, **other environmental factors have also been considered in our assessment** that are useful in assessing potential impacts on a broad range of wildlife **in the Project Area and Project Region**. These factors included **expected** presence of specific wildlife in the region, existing local and regional landcover, natural **annual variation of wildlife populations**, influences on wildlife from local and regional factors (such as predator-prey cycles; human activities such as hunting), and available mitigation measures that will be applied to minimize effects on naturally vegetated areas. The assessment also takes into account the temporary nature of the Project." (Emphases are mine**).**

1. **Where is this assessment?** From the elaborate description, this is a sizeable and comprehensive report. A study of local wildlife cannot possibly be "proprietary", and no competing company can possibly gain from its 'trade secrets'. Why is it suppressed?

2. "expected presence", i.e. another 'desktop' survey, no actual site specific data were collected.

3. "annual variation of wildlife populations": since no actual site specific data seem to exist on which wildlife populations are present, how could there be data on their "annual variation"?

4. "predator-prey cycles": which ones? Again, do we even know which species are present?

5. "hunting": how and where were hunting data for the area obtained?

6. "human activities such as": what other human activities were considered?

7. **How** were these factors incorporated into the (apparently nonexistent) "evaluation"?

8. How was the "temporary nature of the Project" factored in? Damage to habitat may take decades to recover, and may not replicate the original quality or composition.

While the proponent will likely and predictably respond that this information is not required for the EAP, the fact that it is mentioned as the foundation upon which decisions and conclusions are based, requires that it be accessible and available for reference and review**. If it does not exist, do not say that it does.**

- Habitat fragmentation is a major cause of loss of amphibian populations in Canada (CARCNET, 2003).
  "Amphibian surveys were conducted within the Regional Project Area during May 14 to 18, 2018" (EAP2, p. 44), and reference is made to a "Spring auditory amphibian survey (May 2018) focused in wetland areas" (Section 4, EAP2), presumably recordings of amphibian calls. Was this also an armchair study (see p. 439)? If it was "desktop", how was it carried out in the Winnipeg office – remote transmitting microphones and recorders, maybe? What about the "Baseline noise data" – remote mic + rec again? Where exactly were the amphibian and noise data obtained? Was there good LTE coverage in these places to transmit the information?

- A reptile survey is not mentioned. Two species of turtles occur in the area: the Painted Turtle, and the Snapping Turtle. The latter has Vulnerable status conservation rating in Manitoba and is a Species-At-Risk. I have had numerous sightings of the former species in the region over the years, but have only once encountered the latter, which is deemed to be the largest freshwater turtle species in the world (https://www.allturtles.com/turtles-in-manitoba/). While road mortality is a major threat for both species, the Snapping Turtle is harder to see due to its camouflage colors and non-fleeing behavior. It has a lifespan of up to 70 years (https://ontarionature.org/programs/community-science/reptile-amphibian-atlas/snapping-turtle/).

  With respect to snakes, "The red-sided garter snake is the reptile species **most likely** to occur in the Project Site" (EAP2, p. 44) (Emphasis is mine). I can confirm that it certainly does, but the rarer Smooth Greensnake has also been known to be present.

  Awareness of reptiles is particularly important because they may not be readily visible and can easily be run over by all of the traffic on the trails, especially during low-light conditions, when shift changes will often occur. This is why low speeds are necessary.

- Bat populations are catastrophically declining due to disease, disturbance, pesticides and habitat loss. I have personally seen the Little Brown Bat (*Myotis lucifugus*) (Endangered) in the target area. As its name implies (*lucifugus* = fleeing from light), it is bothered by light pollution. Other chiropteran species whose range includes the project area are: Big Brown Bat (*Eptesicus fuscus*), Hoary Bat (*Lasiurus cinereus*), Silver-haired

Bat (*Lasionycteris noctivagans*), Eastern Red Bat (*Lasiurus borealis*), and Northern Long-eared Bat (*Myotis septentrionalis*)(Endangered) (https://birdwatchinghq.com/bats-in-manitoba/).

Three of the six bat species found in Manitoba hibernate in winter in hibernacula, which can be destroyed by winter clearing. In summer, they can "roost inside holes in live or dead trees, or under tree bark", and therefore clearing and logging can destroy their shelters (https://canadiankraftpaper.com/wp-content/uploads/2018/05/CKP-Sustainability-Communities-Newsletter2016.pdf).

- I have sighted bobcats southeast of Vivian in 1970, 1989, and 2015. This rare and shy animal will certainly not be compatible with clearing and extraction activities.

- On request, I can supply a list of terrestrial molluscs (excluding slugs), that I found in the region during my surveys over several decades (actual boots-on-the-ground ones). Some rare species were documented in this area. (Molluscs are a particular interest of mine, and I have published on this topic extensively).

- Insect surveys, especially bees and lepidopterans, ought to have been undertaken, as the project will directly impact habitat, food and breeding opportunities. Native bee populations (both solitary bees and bumblebees) have been catastrophically declining in Manitoba, due to numerous factors, including ectoparasites such as *Varroa* and *Acarapis* mites, predators such as bee-eating crab spiders, and imported viral, bacterial and fungal diseases (https://extension.psu.edu/a-quick-reference-guide-to-honey-bee-parasites-pests-predators-and-diseases). In recent years, bee populations have been decimated by the widespread use of neonicotinoids as agricultural pesticides; the chemicals may appear in pollen and nectar, rendering these toxic to bees (https://www.ipswichma.gov/DocumentCenter/View/11328/How-Neonics-Can-Kill-Bees). Canada has had a dismal record in restricting these chemicals compared to other developed countries. In the present project, clearing may affect plant species which are food sources for bees, and ground nesting bees including bumblebees, leaf-cutter bees and sweat bees will be directly affected by soil disturbance. Bee diseases and parasites may also be imported or spread on vehicles and equipment.

  A number of lepidoptera are vulnerable to disturbance and habitat fragmentation. I have twice seen the Cecropia Moth, and the Luna Moth once, in the region.
  The Monarch Butterfly is present in the region, and so are some of its milkweed hosts that are essential for its reproduction: *Asclepias syriaca, A. speciosa, A. incarnata, A. verticillata.* Indiscriminate clearing may destroy these plants and reduce available breeding hosts.

Fireflies (Lampyridae: Coleoptera) are also declining (https://www.ctvnews.ca/firefly-spotters-wonder-if-the-species-is-fading-away-1.556480). Our species require decaying logs and moist shady woods. Several species occur sporadically in the region, but are not common, and may be affected by the clearing activities, destruction of old deadfall, as well as light pollution associated with the project. Their habitats should be conserved as they are a valuable aesthetic and ecological resource, which is fragile and easily extinguished.

Drainage

- "Drainage ditching will be constructed along Project access trails and at disturbed areas, as required, to assist in directing runoff flow from rain and snow and maintaining natural drainage pathways through low areas." (EAP1, p. viii). In addition to clearing, there will be digging, resulting in extensive damage to tree roots, and altered soil moisture cnditions.

  The TAC reviewer (#1) notes: "The Water Use Licensing Section, within the Drainage and Water Rights Licensing Branch, requires that CanWhite Sands Corp. submit an application for a Water Rights Licence for "other-mining" purposes to capture well drilling and groundwater extraction activities as described in the proposal."

  As we see above, the EAP information "as described in the proposal" is less than minimal, "hinted at" is more accurate. This licensing will all be internally handled between the regulator and proponent, with no opportunity for outside input and review. The TAC reviewer has omitted any reference to landowner consent: will Section 4(2)(c) of the Water Rights Act not apply (see further below)? Indeed, in view of the reviewer's comment, will the broader Water Rights Act apply"?

  Under Section 3(1) of the Water Rights Act C.C.S.M. c. W80:

  "Except as otherwise provided in this Act or the regulations, no person shall

  (a) in any manner whatsoever use or divert water, unless he or she holds a valid and subsisting licence to do so; or

  (b) construct, establish, operate or maintain any works, unless he or she holds a valid and subsisting licence to do so; or

  (c) control water or construct, establish, operate or maintain any water control works, unless he or she holds a valid and subsisting licence to do so."

  - A license is required to construct or control surface water flows. This applies to all manipulation of water in Manitoba, regardless of ownership of the land. The only exception is when the construction is the **subject** of an Environmental Act License (Section 5(1)(a) of the Act), for example if the latter License is for a water control project, e.g. a large dam.

Under Section 4(2) of the Water Rights Regulation 126/87 under the Act,
"In the case of an application for a licence for water control works, the application must be accompanied by (a) an aerial photograph of the site of the proposed water control works that shows the specific location of each proposed water control work and their drainage area and which also contains a legal description of the parcel of land on which the water control works are to be located; (b) a detailed plan that describes the proposed project and includes design specifications of all water control works associated with the project".

Thus there cannot be any indiscriminate, informal, or spur-of-the-moment drainage ditch digging.

-Regulations require that a "permit be obtained **for every land title** in the province where some drainage is needed" (https://www.drainagecontractor.com/manitobas-drainage-landscape-changing-621/).

- Will any water be drained onto, from, or affect neighboring properties? **The landowner must consent** in writing. Section 4(2)(c) of the Regulation stipulates:
"if the applicant is not the owner of the land on which the proposed water control works are to be located, written approval from the owner on a form approved by the director."
Section 4(2)(d) of the Regulation requires "written approval from all landowners whom the applicant has determined may be significantly affected by the proposed water control works".

-In addition to "along Project access trails and at disturbed areas", where these latter trails are not conveniently situated, will additional corridors be cleared (and licensed) to provide straight lines for drainage ditches?

-**Where will the water be drained to**? Municipal ditches? This requires licensing under the Act.

- How long might these ditches be, since in many cases the extraction sites will be some distance, sometimes considerable distance, from the road and municipal ditch? This would entail substantial damage.

-The ditches that are "along Project access trails" **will require additional widening of the trail corridors** to accommodate them. Note that ditch construction requires not only the width allocation for the ditch channel, but **also the space alongside where the excavated earth is piled**.

-"low areas" are mentioned. Will these natural areas be drained? This will require deep and significant drains and will disrupt these habitats. These ditches might not be registered as minor Class A works under the Regulation (Section 11) which only apply

to "Construction of surface drains with a depth not exceeding 12 inches below natural prairie level."

-According to Section 10(3)(b) of the Regulation, drainage cannot be undertaken if it "would result in the drainage of Class 6 or 7 soils or unimproved organic soils". Such soils are present in the area (see WDR).

- Will these ditches be necessary to divert uncontrolled artesian flows?

- There is no mention in section 6.4.1 (EAP2) of **filling in the ditches afterwards**. Will this be left to the landowner?

- Will these areas be revegetated, or abandoned (i.e. so-called 'natural revegetation')?

-The latter two concerns are items that the landowner may wish to enshrine in the landowner agreement (see Appendix).

Additional comments

- The proponents estimate that 31% of the impacted area consists of agricultural lands (EAP1, p. ix). On cropland, how will the company compensate farmers for loss of crop at the cluster sites and access routes? Will sites of abandoned well clusters be suitable for future tilling, fertilizing and other farm practices? There is no mention of loss compensation due to operations or spills. The latter may taint soil for years after the spill has occurred (Figure 107, p. 397).

  The proponent responds: "Cropland will still be suitable for tilling following reclamation of the sites" (RPCR #136). How will abandoned and concealed well clusters be marked and protected from damage? Is the proponent claiming that it is fine to roll heavy equipment and conduct deep tilling overtop the buried PVC casings? To apply fertilizers, manure and pesticides?

- Regarding sites situated within pastures and paddocks, how will livestock owners be compensated if they require alternate arrangements for pastured livestock? Will damage/destruction of enclosure fences be repaired? Will dugouts destroyed or impacted by the operations be replaced? These are items to consider in the landowner agreements (see Appendix). What about manure contamination that may travel along well casings and into deteriorating seals of the *multiple* wells (we have learned nothing from Walkerton, see p. 301).

- The beginning of Section 4 (EAP1, p. 32) lists a number of environmental studies and surveys that are relevant to the project area: why are these links not included? Except

for fish, there are no references or literature citations, or indication of who conducted this work, so that it is not possible to access or trace it.

Completely ignoring the thrust of the question about referenced reports, in RPCR (#106), the proponent responds: "The introduction of Section 4 (Existing Environment) of the EAP **lists** the environmental surveys that were completed and overlapped with the Project Local and Regional areas from 2018 to 2020." (Emphasis is mine).

Obediently looping back to Section 4 (EAP2), all that we see is:

"Environmental studies that overlapped with Project Local and Regional Areas from 2018 to 2020;
o Spring auditory amphibian survey (May 2018) focused in wetland areas
o Baseline noise data (May and August 2018)
o Summer vegetation survey (June 2018) in representative vegetation communities
o Fall vegetation survey (September and October 2018) with additional emphasis on wetland areas and the Project Site
o Fish and fish habitat survey (Milani, 2013)"

Yes, Section 4 does list the mythical documents, but that is all, there is no further information. The question stands: except for the Milani reference, **where are these secret reports**? But we are reassured that "**the information was considered in the assessment of Project effects**" (RPCR #106). **Since it was considered, why is it suppressed?** Maybe all of this is "proprietary" as well, which seems to be a repeating euphemism for "who knows"?

- The whole point of conducting all of these studies **before** any disturbance begins is to provide baseline data that will serve as the comparison standard for all future monitoring, which in turn is conducted to identify **changes that have occurred**.

  Baseline data cannot be obtained once operation has begun. This is explained in Section 4.1.2 of the Canadian federal Environmental Code of Practice for Metal Mines (2009):

> **R 103:** Water quality, aquatic ecosystems, air quality, soil quality, terrestrial ecosystems, groundwater and other environmental data collected as part of pre-operational baseline studies associated with environmental impact assessments should be collected so that it is comparable with monitoring data collected later in the mine life cycle. Data should be collected and analyzed so that it will be possible to identify long-term trends, periodic change and fluctuations in rates of change.

Revegetation

- To begin this segment, we cite Section 2 of the **Manitoba Mine Closure Regulation 67/99 General Closure Plan Guidelines** (https://www.manitoba.ca/iem/mines/acts/closureguidelines.html)**:**

  "All areas affected by mining activities (building sites, tailings ponds, sedimentation ponds, waste rock piles, etc.) must be revegetated to control erosion and restore the site's natural condition. However, if all or part of the mining site, particularly former mine rock piles and mine rock piles in use, cannot be revegetated, the proponent must prove that it is nevertheless in "satisfactory condition".

  In general, grass and bushes should be planted in areas prone to erosion. Other areas should be fertilized to promote natural encroachment, or may be seeded. The characteristics of this vegetation should resemble that of the natural environment except for the early growth, which may be a protective cover crop of non-seeding annuals.

  Before revegetation, the land must be properly prepared. Where applicable, organic soil that had been saved during original site development must be spread.

  Vegetation must be self-sufficient six years after planting and require no fertilization or maintenance."

- The EAP provides no adequate Mine Closure or Revegetation Plan. The 2022 SUPPL3 document provides almost no additional information; we are still left without any Plan.

- The proposal indicates that the decommissioning process will "minimize soil erosion" (EAP1, p. vi). In the BMP for the Erosion and Sediment Control Plan (EAP2, section 8.5), soil replacement is mentioned. Will this soil consist of **restored topsoil**, which has been **saved**, or simply be a mashup of the bulldozed material and other waste left over from the drilling and extraction? If the area is to be reseeded with native species, they must have appropriate soil and be sufficiently loose to expect much success. They will not grow in graded and compacted sand and gravel.

  Section 56 of The Surface Rights Act states: "The operator shall remove, **preserve and replace** all top soil affected by its operations in the manner prescribed by the regulations." (Emphasis is mine). The proponent responds that topsoil will be saved (RPCR #263). **Where will the topsoil be placed and stored**? There is already much congestion within the cluster circle (see p. 422+).

  The topsoil will contain a great deal of tangled roots, stumps and debris. How will this material be separated/homogenized, since the soil cannot be levelled in this condition?

Note that imported soil is not used because, since it is not sterilized, it may contain non-native seeds and plant diseases and pests (Section 4.5.9, R534, Environmental Code of Practice for Metal Mines (2009)).

- Even with carefully replaced topsoil, the entire microhabitat consisting of decades/centuries of humus and leaf litter, containing invertebrates and microorganisms specific to this environment, cannot be replicated and must be rebuilt over a long time. These organisms cannot recolonize bare soil. The surface organic layer is a critical link in the broader ecosystem in that organic compounds are decomposed here, nutrients are recycled back to the soil through leaching and bioturbation, moisture is retained, weed growth is suppressed, and food is provided for birds and burrowing animals which in turn provide aeration for the resident biota. This component will be absent from rehabilitation efforts.

- Further (EAP1, p.vi), "disturbed areas will be revegetated as quickly as feasible, and will be augmented using an approved native seed mixture and native plantings if required." (EAP1, p. ix). Who will determine if it is "required"? What does "as quickly as feasible" mean – within the month, the year, never?

  In TAC (#24) the reviewer asks: "What revegetation monitoring protocols will be followed, and what will trigger progressive actions like reseeding and replanting?"

  The proponent evasively responds: "Revegetation monitoring protocols, including progressive actions such as reseeding and replanting, will be developed prior to initiation of Project construction. … The triggers for progressive actions will be specified in the Revegetation Monitoring Program (Section 8.7)."

  There is no "Revegetation Monitoring Program". What criteria, if any, will trigger reseeding indeed? Will we be pulling the trigger with the safety on? The question is unanswerable, as all of the cleared wastelands will look more or less the same.

- In RPCR (#258), "The areas to be reclaimed will include temporary drilling rig access trails, equipment laydown areas, slurry line trails and return water line trails." Hydro line trails? Ditches? Who will approve and conduct the reseeding process? Will there be dedicated staff in charge of the rehabilitation process?

- What is an "approved native seed mixture" – is it native **to the specific area/ecozone**, or a generic commercial mixture from outside the province or even the country? Who approves it?

  In SIO (p. 22), we see "the site seeded with a grass mix matching that of the original." So in this version, only grass will be used. The original community would have been far more diverse than just grass. Who will determine the species composition of "the original", **which will differ for each site**, **even just for grass**, and where will these seeds

be sourced, since there will be some rare species that are not commercially available? Will seeds first be collected at the site before clearing begins, which would be in the previous fall? However the proponents and their consultants are averse to exposing themselves to the outdoor elements in the fall (p. 441). On the other hand, commercial grass mixes are designed to be aggressive and to outcompete other species, and thus are not suitable for restoration and rehabilitation projects.

To confuse the matter even more, the proponent's BMP for the Erosion and Sediment Control Plan (EAP2, section 8.5) states that restoration will occur "using an appropriate seed mix or fast-growing cereal crops for late fall or spring germination." Why and where would cereal crops be planted – certainly not in natural areas, and not in agricultural fields where it would conflict with the existing crop? And this would enable weed proliferation in the following years. Cereal crops are not rehabilitation.

The proponent responds (RPCR #264): "for the most part, the land to be revegetated is privately held (not Crown land) and details of rehabilitation will be determined through discussions with the landowners prior to operations." The specific expectations for the revegetation should be set out in the landowner agreement (see Appendix below). But how would it be enforced? We get the impression that the proponent has no intention of seriously carrying any of this out, and that the relevant sections of the proposal are just cursory fillers that will be discarded as soon as approval is granted.

- Some residents may be affected by destruction of wild foraging foods such as berries, mushrooms, edible roots and herbs, and traditional medicinal and ceremonial plants, which are important resources for many residents and Indigenous harvesters. These items seem not be included in the restoration plans, although of course, there are no plans. Indigenous elders could be consulted for help with sourcing, also some Manitoba nurseries specialize in native plants. But unfortunately, since no actual surveys have been (and likely will not be) done, the pre-destruction information needed does not exist, so how can anything be replaced?

- "Revegetation of each annual extraction site will begin immediately upon completion of extraction activities" (TAC, #18), also RPCR (#109). We are reminded that "Sand extraction activities will occur 24/7 from April through November (and winter, weather dependant)" (EAP1, p. 11). Thus "immediately" would not always be practical. The success of seeding would depend on what is seeded: if seeded too late, seedlings could be killed by frost soon after germinating before they can become established and hardened. Seeds that require vernalization, on the other hand, would benefit from a period of cold temperature induction in order to germinate in the spring, but would not germinate if seeded in the spring. One has to know what one is doing. The EAP has

provided no information on this putative "native seed mixture." But then, as pointed out above, it may be nothing more than grass, if that.

In SIO (p. 22), "Extraction sites that are no longer active will be **fully reclaimed the following year** …the ground being leveled, and the site seeded with a **grass mix** matching that of the original". (Emphases are mine). Thus "immediately" is not accurate, and seems to be an elastic term. Also "fully reclaimed" is not going to happen, as a 'grass mix' is not anywhere near what 'fully reclaimed' means. We suspect these words are meant to appease for the time being, and then the whole notion will be quietly dropped.

- An issue which has been drawing increasing awareness worldwide is the fact that reseeding programs using native seed mixtures that have originated elsewhere introduce extrinsic genetics into local populations, which latter may have evolved local gene pools that maintain certain alleles that may not be prevalent or even present in other areas. Thus introduction of new genetic combinations, as well as novel dominant alleles, may breach genetic integrity of these populations, and lead to loss of overall species genotypic diversity. For these reasons, it is important that seeds and plants used in rehabilitation are locally sourced.

- However "native seed mixtures", even with the most conscientious local sourcing, will not replicate original community composition, because it will not be possible to reseed rare species with exacting germination and growth requirements, or duplicate symbiont needs, nor will seedless (spore-producing) plants be replaced (e.g. bryophytes, lycopodiophytes, ferns).

  It should be noted that soil disturbance will destroy the delicate gametophyte generation (prothallus) of diplohaplontic plants such as *Lycopodium* and ferns embedded in the soil. Both the gametophyte and sporophyte alternating generations are essential for completion of the life cycle.

- In contradiction to the above reseeding scheme, "disturbed areas [will be] allowed to revegetate naturally" (EAP1, p. ix), i.e. "walk away". In RPCR (#258), "The areas to be reclaimed will include temporary drilling rig access trails, equipment laydown areas, slurry line trails and return water line trails. Disturbed areas will be allowed to **revegetate naturally**, but revegetation may be augmented using an approved native seed mixture and/or native plants". (Emphasis is mine). This implies that the primary policy will be to do nothing, and replanting may not materialize. If the hapless property owners want something more, they will likely undertake the expense and travail of replanting trees and other vegetation themselves.

Natural reseeding of trees in clearings is challenged by the limitation that "seed viability for all boreal tree species is very short", less than one year for all boreal tree species (except possibly white birch)(Bose et al., 2014). Therefore soil seed banks cannot be depended upon to re-establish trees.

In contradiction again, in the later SSCRIR1 (#MSSAC-IR-003), Sio Silica "will be rehabilitating and revegetating the disturbed areas annually." In the proponent's ad in The Clipper (January 19, 2023, p. 24), "Surfaces will be revegetated with native species and monitored for regrowth."

So, will they, or won't they? What do *you* think?

- The EAP1 dismisses the vegetation impacts as "minor and temporary" (EAP1, p. ix), and "it is expected that most natural vegetation will be very well established after approximately four years, with reestablishment of trees and shrubs expecting to be evident within five to 10 years following closure" (EAP1, p. ix). Also RPCR (#108).

  The reestablishment of trees is expected to be only "**evident**", not complete, nor even advanced, after these many "temporary" years: unless the landowners are very young, they may not live to see those trees mature. In the meantime, they just have to put up with it. Greene et al. (1999) have compiled an extensive review of regeneration of boreal tree species such as are found in the project area, and factors that contribute to regeneration failure in disturbed areas.

  A drawback of both natural revegetation and tree replanting of clearcut areas is that the resulting forest will be composed of trees of the same age, unlike the original stands, which have developed and staggered their growth over a long period of time (FPB, 2021). Thus the ecosystem which will replace the original will not be the same.

A

Figure 119 A-C. Natural poplar forest regeneration with no supplemental planting or seeding. Beausejour area, 20 km North of Vivian project area.

Left (A): Mature**, undisturbed** forest, with thick shrub understory and tall tree canopy.

Next page, two pictures (B and C): **Immediately adjacent disturbed areas after 30 years** with no intervention, facing North. The trees are 2-3 m tall. Understory is absent. The limited shade swath from the edge of the undisturbed forest boundary is evident.

Photos: E. Pip


B


C

- Natural, unassisted regeneration rates of woodland can be very slow. Figures 119 A-C show natural regeneration of a poplar forest 20 km North of the Vivian project area on private registered conservation land in the Beausejour region. The site had been cleared, and tree roots were destroyed by tilling. The area was adjacent and contiguous with mature, undisturbed forest. The site was allowed to revegetate by itself without any replanting, reseeding, or other intervention. Human traffic was excluded.

  Figure 119 A shows undisturbed forest immediately adjacent; note the thick impassable shrub understory and high tree canopy. Figures 119 B and C show the immediately contiguous disturbed area within 20 m of the undisturbed boundary edge, **30 years later**. The trees are 2-3 m tall and understory is still absent. It is obvious that in situations such as these, **spontaneous revegetation can occur very slowly**. Thus we cannot be overly optimistic about how quickly damaged sites recover: it depends on a variety of site-specific factors, as well as the plant species involved.

- SUPPL3 (p. 1) introduces the idea of "utilizing a tree spade to move established trees to another area either temporarily or permanently".

  The practicality of this attempt to salvage trees has not been adequately considered for the following reasons:

  - The proponent has reiterated that **clearing will occur in winter, when the ground is frozen**. This creates substantial added challenges and expense for digging and blade cutting.

  - Sand extraction activities will not commence immediately after clearing, many months may pass. Trees destined to be returned to their original location would need to be wrapped, watered, and properly stored at low temperatures to maintain dormancy. Where would this occur? The chances of good outcomes drastically decline with increased time intervals between digging and replanting. Therefore trees would need to be moved and promptly replanted elsewhere: where? "Temporarily" would require the tree to be moved *twice,* which would severely curtail its chances of survival.

  - A tree spade (Figure 120) can only plant ONE TREE AT A TIME (see Cool, 1975). Since a number, possibly many, or even hundreds, of trees may be involved on a property, this approach will obviously be limited by time, labor and budget to the point of not being feasible.

Figure 120. Tree spade. Source: https://baumalight.com/tree-spades/img/gallery/Baumalight-50-inch-root-ball-diameter-tree-spade.jpg

- Tree spades are available in different sizes and are rated according to tree caliper size, (i.e. trunk diameter 30 cm above the ground for diameters > 4 cm, and 15 cm above the ground for diameters <4 cm)(Sagaser, 2005). According to the latter author, "generally, the tree spade diameter should be 10 times the trunk caliper". It is important to use a large enough size for each tree.

- Prognosis for survival depends on many factors, including type of tree and the depth of its root system, soil type, time of year, weather, and whether it is nursery grown as root-pruned stock, or is growing in the wild – the latter is much more difficult (Sagaser, 2005). Use of a tree spade is not recommended in hot weather (Cool, 1975).

- The time of relocation depends on the type of tree. Conifers must be moved from mid-summer to early fall, but must not be moved during the spring. Deciduous trees are best moved in spring or fall when they are not in foliage.

- Utilization of a tree spade is limited by suitable access for the spade equipment (Cool, 1975). It is conceivable that the heavy truck or tractor may do damage to the site, particularly in wet or muddy conditions, or injure neighboring trees.

- According to Watson and Himelick (1982), "Tree spades, commonly used to transplant nursery trees, reduce the root system by up to 98 percent Therefore larger, more established trees suffer more severe setback and have poorer outcomes, as they are deprived of a greater proportion of their roots.

- Transplanting success depends critically on the after-care the tree receives. Strapping, cables and anchors are installed to prevent tipping, and cables are gradually slackened during the first year of adaptation (Sagaser, 2005). Adequate watering is critical, once or twice a week during the first growing season, depending on soil type (sandy soil requires more frequent watering), and frequency is gradually scaled back through the **second to fifth seasons** (Sagaser, 2005). **EACH tree will require this attention.** Will it be the landowner's responsibility to haul water for the trees and perform all of the required maintenance during this 5-year period?

- Assuming the tree survives, "A rule-of-thumb regarding the time for reestablishment is that each inch of trunk caliper requires a growing season to get a tree back to its original vigor. For example, a 4-inch caliper tree will probably take four years before it recovers from a move." (Sagaser, 2005). The latter is a fairly small tree. Even with professional transplanting and attention, the outlook for larger trees is poorer.

The whole point of the above tedious exposition is to demonstrate that, **in the present circumstances, tree spade utilization will not be practical or economically possible.** However, in the case of a beloved tree, for example planted by, or in memory of, a deceased loved one, who will pay for the relocation? Moving a single larger tree can cost thousands of dollars. In the case of trees which the property owner has previously planted, survival and recovery will be especially challenging since the tree will have already suffered stress from previous transplanting.

- Contradictory to the above discussions regarding slow natural recovery rates, a company official was quoted in the media as having said, at the CanWhite virtual open house on August 24, 2021: "Most of the areas we work in, within 30 days you can't tell we'd even been there." (The Clipper, September 2, 2021, p. 5). Similarly in a September 11, 2020 letter to the IAAC, a top CanWhite official writes: "the site returns to its natural state **within weeks** of CWS harvest completion." (https://www.ernstversusencana.ca/vivian-silica-sands-extraction-wells-manitoba/)(Emphasis is mine).

  And in an ad in The Clipper (January 19, 2023, p. 24) we see a most stunning and incendiary statement: "Sio is committed to leaving sites in **equivalent or better condition** than prior to extracting."(Emphasis is mine). The desecrated forest, for example, will be in *better* condition? What condition is that?

  The quoted statements are dismissive and uninformed, deeply insulting to the public. The officials obviously had not read their own EAP report. Any landowner who has ever planted and cared for trees knows how slowly trees grow. Similarly natural revegetation takes many years. Seeding with native plant mixtures will show only **some limited germination** after 30 days; many native herbaceous species take months or even years

to germinate. Some places never recover, and the scars are still evident decades later: look at any abandoned gravel pit.

We are consoled, though, that "The residual environmental impact of the Project on vegetation **beyond** the Project Site is assessed to be negligible" (NREP)(Emphasis is mine). Thus we are grateful that negligible residual effects will occur **outside the Project site**. As for inside the Project site……..NREP seems to have nothing for us there.

- The issue of **soil compaction** on the trails and damaged areas by the passage of heavy industrial equipment and other traffic will set back revegetation and regeneration rates, and reduce plant diversity. **Soft track vehicles**, such as those used by Manitoba Hydro for clearing vegetation on transmission corridors (MH, 2021) minimize damage.

- Similarly **compaction of living tree roots** by vehicles is an important factor that results in poor performance and regeneration failure of boreal tree species, particularly those which produce suckers (e.g. poplar)(Greene et al., 1999).

- The proponent states: "A Revegetation Monitoring Program will be implemented to determine the success of the revegetation program and determine if follow-up reseeding or replanting is required. " (EAP1, p. ix). Also, "A Revegetation Monitoring Program will be developed during the Project construction phase prior to clearing of naturally vegetated areas" (TAC, #21).

  "Revegetation monitoring protocols, including progressive actions such as reseeding and replanting, will be developed **prior to initiation of Project construction**." (TAC # 24). "A Revegetation Monitoring Program will be developed **during the Project construction** phase" (TAC #21). (Highlights are mine). Prior, during,…..? This is too late, given the complexity involved. **Why does no plan exist already**? What assurance is there that there will ever be one?

  In this program (EAP2, section 8.7), "The revegetation monitoring program will include monitoring during the growing season until the seedlings appear to be established." "Sio Silica will also be implementing monitoring studies and follow-up actions as described in the EAP (e.g., Revegetation Monitoring Program)" SSCRIR1 (#MSSAC-IR-003). Can we expect any *independent* monitoring and enforcement for these claims? The thus far *non-existent* program? What will the monitoring and follow-up consist of, and who will administer it?

  In Section 2 of Manitoba Mine Closure Regulation 67/99 General Closure Plan Guidelines: "**Vegetation must be self-sufficient six years after planting and require no fertilization or maintenance.**" Therefore monitoring of respective sites must continue until **six years after planting**. In the 24-year lifetime of the project, this means 30 years

of staggered monitoring and commitment. There is no indication that this will be undertaken, or enforced. If it is, what measures will be available in the event that the vegetation is not performing as required?

- According to TAC (#21), "Details that will be incorporated into the Program include:
  -What will be monitored (plant abundance, height, or other measures of success) and at what frequency (e.g. monthly, annually);
  -Monitor qualifications, roles, and responsibilities;
  -Revegetation schedule, including a review of potential conflicts (e.g. migratory bird nesting season conflicts);
  -Reseeding and replanting methods (appropriate seed mixes, plant species, plant source and quality control, seeding and planting methods, including rates and spacing);
  -Erosion-control methods employed;
  -Use of existing infrastructure such as roads, trails or natural features;
  -Measures for the control of weeds and invasive species;
  -List of corrective actions in the event of poor vegetative success; and
  -Recordkeeping and reporting requirements" (Also RPCR #103).

  It would have been very interesting and prudent to see and evaluate these details. However at this point, they are only wishful and embryonic glimmers. There is no assurance that they will materialize or be satisfactory, after the license will have been issued, and given the fact that they will be plastic-elastic non-binding internal "living documents" (Section 8, EAP2) to be altered and modified or disregarded as inclinations suit. There is no mention of rehabilitation of access or slurry trails or hydro corridors, or the ditches that were dug.

  What actual criteria will be used to determine success or failure? Who will determine if additional measures are required? Who will run this program? Will qualified local botanists be employed? Who will enforce it? Will there be a mechanism in place for appeal?

- While section 4.4.4 of EAP2 identifies **public** ecological reserves and wildlife management areas in the surrounding region, **how will lands that are legally designated as conservation or ecological reserves but are in private ownership** be handled? Even if there might not be any now (**do we know?**), there well might be within the next 24 years. Have inquiries been made of agencies such as the Manitoba Habitat Heritage Corporation, which enters into **legally binding agreements** via Conservation Easements with private landowners? (I have such a permanent land title caveat myself). According to the Manitoba Land Access Action Plan for mining, **ecological reserves are protected** (https://www.manitoba.ca/iem/mines/sustain/index.html).

- The EAP and associated documentation, and all of the reviewers' assessments show a yawning lack of interest and care, indeed disdain, for the entire topic of site and trail revegetation and rehabilitation. Yet this is of material interest to the landowners who will be left to live with the result for years and decades afterwards. We suspect that once the license has been issued, the topic will be quietly erased in the many "Notices of Alteration" and the so-called "living documents", and that proper rehabilitation will become the landowner's problem and may take many years. The proponent touts the mining project as "multi-generational" (e.g The Clipper, February 22, 2022, p. 5): yes, for the landowner, this may be dismally true, whether the company continues to exist or not. In any case, who would enforce *any* of this?

Invasive plant species

- In TAC (#20), the proponent indicates that "Developed/disturbed areas that currently occur within the Project Site and the surrounding Regional Project Area are known to contain numerous invasive plant species." No reference is made to how this is known, where this information comes from, or what the species are. Different species have different modes of spreading, and require different control measures and precautions.

  Further in TAC (#20), "the mitigation measures set out in section 6.5.1 (Vegetation) will mitigate the propagation of invasive species to the extent feasible. For example, areas to be cleared of vegetation will be clearly marked to avoid clearing more than is required. As stated in Section 2.1, Project activities will occur on previously disturbed areas to the maximum extent feasible to minimize Project effects on vegetation and associated wildlife. These mitigation measures are expected to control the spread of invasive plant species to the extent feasible."

  The proponents recognize that invasive species occur in disturbed areas, and they then indicate that "Project activities will occur on previously disturbed areas to the maximum extent feasible", i.e. **activities will be concentrated in disturbed areas where invasive species are present.** They reiterate this again in SSCRIR1 (#CEC-IR-007). Therefore when they do work in undisturbed areas, **carry-over potential** of invasive species propagules will be possible, for example on unwashed vehicles, equipment and machinery, drilling rigs, pumping stations, slurry pipes and associated impedimenta…the mobile office…….workers' boots….mud on clothing……..

- Section 6.5.1 (EAP2), to which the proponent refers the inquiring reviewer in TAC (#20), does not mention invasive species. How does clearly marking areas to be cleared, and clearing no more than is required, mitigate invasive species spread? Often all it takes is 1-2 seeds, regardless of area size. In other words, no answer has been provided.

- "It is important to note that Sio will not be moving Project equipment large distances often… Therefore, equipment will not be travelling extensive distances to many different sites in the local Project area over the course of any given growing season" (SSCRIR1 # CEC-IR-007).
  What about clearing and drilling equipment, delivery trucks, portapotty service, etc. ?
  What about **slurry lines**:
  The maximum reach of the slurry system from the processing facility is reported as 3.5 km (EAP1, p. 23; RPCR #113). However eventually the slurry lines may be very long indeed: "the distance between the extraction sites and the processing facility is between 1 and 4 km, growing to approximately 15km in the latter years of the project."(SIO, p. 19).

Will vehicles and equipment travel to and from Alberta?

- Note that seed viability of many weeds is not limited to one growing season and may persist over several years. For example Canada thistle seeds may survive in the environment up to 21 years (https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/weeds/canada-thistle).

- Should revegetation really occur, an "approved native seed mixture" is proposed (EAP1, p. vi). It should not contain any invasive or exotic species. To illustrate, Purple Loosestrife, a highly invasive species in Manitoba, was at one time a component of some native seed mixtures because of the ease with which it revegetated barren soils. To avoid introducing extraneous species, the seed mixture should consist of the species that are growing in that particular area and in that particular soil. How will these seeds be sourced and reviewed?

  According to the Canadian federal Environmental Code of Practice for Metal Mines (2009), Section 4.5.9, R535, "Species native to the area around the mine site should be used for this purpose, and **invasive species should never be used**." (Emphasis is mine).

- While the native species of *Asclepias* milkweeds are acceptable, note that the "native seed mixtures" **must not contain *Asclepias curassavica*.** This showy alien milkweed is very harmful to Monarch butterflies because it interferes with reproduction and migration, and hosts a protozoan parasite which causes deformed and crumpled wings (https://birdwatchinghq.com/milkweed-in-manitoba/).

Plant diseases and pests

- The issue of plant diseases and pests is an important topic that is nowhere recognized in the EAP or TAC. Destructive organisms can be introduced or spread in an area by clearing and construction equipment, tools, recreational vehicles, and any human activity.

- Numerous serious diseases and pests of native trees and shrubs are becoming established in southeastern Manitoba. These include fungi, viruses and bacteria. In addition, two species of highly contagious parasitic dwarf mistletoe (Figure 123 A and B) infect conifers in the province. Spruce trees are also highly vulnerable to *Sirococcus* and *Cytospora,* both of which are present in southeastern Manitoba. Besides native spruce, *Cytospora* has destroyed numerous Colorado blue spruce plantings in the Anola/Vivian/Beausejour area (personal observation), as this cultivar is especially susceptible. Pine gall rust attacks pines. A number of juniper diseases, especially rusts, occur in the area as well (personal observation).

  Poplars in Manitoba are vulnerable to a number of diseases, including two species of *Venturia* (https://www.gov.mb.ca/agriculture/crops/plant-diseases/venturia-leaf-shoot-blight.html), a fungus which is especially problematic in young growth, and can substantially hamper rehabilitation efforts. Poplar canker diseases are also present in the area.

  In southeastern Manitoba, witch's broom fungi now infect saskatoons (Figure 121), and other species such as willows: some properties are highly infested (personal observation). Saskatoons are also susceptible to fireblight, rust fungi, *Entomosporium*, fruit rot, mildew, as well *Cytospora* (https://www.gov.mb.ca/agriculture/crops/crop-management/fruit-crops/saskatoon-berries.html#diseases): these contagious diseases affect wild saskatoons but can ravage commercial crops. Chokecherries and plums are being devastated by black knot (Figure 122) and other contagious diseases for which there are no treatments other than burning (https://www.gov.mb.ca/agriculture/crops/crop-management/fruit-crops/chokecherry-production.html). Many other examples could be cited.

- Both alien and native insects that are a potential concern include: Dutch Elm Bark Beetle, European Gypsy Moth, Emerald Ash Borer, Mountain Pine Beetle, Eastern Larch Beetle, Spruce Budworm, Jack Pine Budworm, Forest Tent Caterpillar (https://www.gov.mb.ca/nrnd/forest/pubs/forest_lands/5yr_report.pdf). Such pests can decimate entire areas and affect every tree of the relevant species.

- Diseases and pests are much slower to spread in healthy, intact forest. Trails create corridors that facilitate invasion. The extensive proposed patchwork of site clearings, access trails, connecting trails, slurry line trails, and hydro pole corridors present ample

opportunities for diseases and pests to spread. Furthermore plants that are stressed by disturbance, injured by machinery, or that suffer root compaction are much more vulnerable to infection.

- "Usable trees/wood will be cut and stacked at the Project Site for local use as firewood for no longer than one year or disposed of in accordance with applicable regulations." (section 6.5.1, EAP2).

  Will diseased/infected wood be identified? For example, there is some **American Elm** in the region (personal observation). It is illegal to possess, store or transport in Manitoba (The Dutch Elm Disease Act S.M. 1998, c. 17, https://web2.gov.mb.ca/laws/statutes/1998/c01798e.php).

  Similarly **ash** wood cannot be transported (https://www.gov.mb.ca/stopthespread/fis/eab/stop-spread.html)

  Firewood may not be removed and/or sold without the owner's permission.

- According to RPCR (#81), "Approximately 20% the vegetation is burned and approximately 80% is mulched and/or salvaged" (RPCR #81). Similarly in TAC (#25): "Remaining timber/brush will be chipped or mulched".

  It cannot be overstated how critical it is to clean equipment and gear when moving from one location to another, even within the same woodland, to reduce the spread of disease. In Manitoba, land clearing and logging equipment has been an inadvertent vector of disease (personal observation).

  Chipping and shredding may pulverize diseased material, rendering the product a vector of disease or pests. **Infected slash and wood cannot be shredded, chipped or mulched and must be burned**, and must not be transported through the bush. Care must be taken regarding exportation of mulch outside the area; only clean mulch can be used for landscaping and gardening.

  It should also be kept in mind that the shredder itself may convey spores or insect eggs from site to site.

- Will any equipment to be used for this project be imported from Alberta? A number of potential threats could be introduced via undisinfected machinery. One example is the Mountain Pine Beetle, which has devastated a number of different pine species in Alberta and presents the potential for invading Manitoba (http://albertaforestproducts.ca/our-industry/forestry/mountain-pine-beetle/)

- Care must be taken that replantings (most likely by individual property owners) do not source infected seedlings and saplings which may imperil native stands.

- **Injured areas should be monitored post-closure for evidence of infection or invasion**, with prompt control and eradication, and trails should be closed to discourage trespassers and recreational vehicle traffic.

Figure 121 . Witch's Broom on saskatoon. Source: https://www.flickr.com/photos/dougcwaylett/155629272

Figure 122 . Black knot on chokecherry. Source: https://extension.umn.edu/plant-diseases/black-knot#pruning-out-galls-117031. Infection rates of 100% are now seen in some woodlands in southeastern Manitoba. In some cases infections appeared after brush clearing nearby.

A

Figure 123 A. American dwarf mistletoe (*Arceuthobium americanum*) on jack pine. Source: https://www.gov.mb.ca/forest/pubs/forest_lands/health/dwarf_mistletoe_brochure.pdf

B

Figure 123 B. Eastern dwarf mistletoe (*Arceuthobium pusillum*) on black spruce. Shown is one excessively branched green limb which is the focus of the infection, while the rest of the tree is dying. Eventually the entire tree succumbs.

Photo: E. Pip

Where are the testimonials

- This is newer technology, or rather methodology, that still requires development. There is a complete absence of any reference to other places where this method has been tried/used and what environmental impacts it has had. "This method for sand extraction is not currently used elsewhere in the country that CanWhite is aware of." (RPCR #181). Other countries are not mentioned.

  The underlying theme running through the proponent's documentation is, on the one hand, the novelty and singularity of the procedure, such that it even requires a patent (CPA), but on the other hand, "Unlike traditional sand mines, Sio Silica is using a **proven method** to remove sand from the Winnipeg Sandstone aquifer" (SIO2) (Emphasis is mine).

  "The extraction method at this time is **proven and repeatable** as tests have been conducted and successfully carried out." (RPCR #185)(Emphasis is mine). From the information provided, the few tests were all within a small target area. Apparently not even one cluster has been tested. This hardly constitutes "proven and repeatable". Therefore **the project itself shall be the test** in order to be able to substantiate such grandiose claims.

  In SRTER (#2), the proponent claims that "Combining all of the collected information, pilot testing results, modelling and design, the **environmental effects associated with the proposed extraction methods are generally well-understood.**" (Emphasis is mine).

  If this method "is not currently used elsewhere in the country", and the current "collected information", as we have seen, has such a long way to go, and the proponents themselves claim it needs 'refinements' and 'upgrades' and 'advancements' (see below), how can the effects be "generally well-understood"? How many hundreds/thousands of wells around the world have provided the necessary data, and how many years/decades of monitoring have contributed to the "well-understood" environmental effects?

  "CanWhite is currently applying for an Environment Act Licence for extraction activities up to and including 2025 because advancements in extraction methods and operations are expected to increase efficiency and reduce overall footprint after 2025. This will be explained in a subsequent Environment Act Proposal for the future potential extraction years." (EAP1, p.2).

  On p. 13 of EAP1 we see: "The first four years of sand extraction activities are expected to result in improvements and efficiencies to this proposed new sand extraction method." These statements are disheartening because they acknowledge that extraction methods and operations still need to be worked out after more learning

experience and experimentation. The project area will be the practice ground. Some things probably won't work out. The project will move on, leaving its *essais infructueux* behind.

The first four years (perhaps/likely more) will be trial and error of a "proprietary" procedure, for which environmental and industry operational parameters have not been standardized, safety protocols do not exist, and for which specific and necessary regulation/legislation has not been enacted. Based on the content of the EAP, its contradictions, and its incomplete, uncertain, and contradictory planning and design, licensing is here sought for a project that apparently will in large part be made up as it goes along. How can such an endeavor proceed **without fully defined and accepted methodologies**, and without fully developed and committed associated strategies in place for accountability, response, mitigation, rehabilitation, compensation, and long-term responsibility?

- As justification for the sea of missing Plans and documents, the proponent states in RPCR (#234): "it is essential that such plans and operating procedures be handled as 'living documents' to ensure that they will be subject to ongoing and periodic revisions to capture operational refinements that are acquired through experience, monitoring and inspection, compliance review, equipment upgrades, and follow-up assessments". …"Maintaining current plans and procedures will allow for continuous operational improvement and **further** protection of the environment." (also SRTER #16)(Emphasis is mine). "Further"? Is there any now?

  In other words, what is approved based on the EAP will be endlessly changed and altered and remodelled and reformed once the approval is obtained, bringing into question why these initial documents would even be considered as sincerely representing the project, and the outcomes and impacts to be expected from it. The proponent hereby admits to lack of experience, information, optimal equipment, and design at the present time, and concedes the need for 'refinements', but the public are asked to trust that these 'minor' details will/may be rectified at some future time, but only after initial blunders have been made. This project will be a needed learning experience for the proponent, but what of the permanent mementoes left behind in the countryside in the course of this experimentation?

  "It is best and common practice for mitigation and monitoring plans, and operating procedures, to be prepared in association with **or on completion of detailed design** of the Project, and for these plans to be reviewed and updated periodically. In this manner, continual environmental planning is built into both the commencement and on-going operation of the Project, and environmental management reflects current operational, legislative and permitting requirements. Thus, it is essential that such plans and operating procedures be handled as 'living documents'" (SSCRIR1 #MSSAC-IR-004) (Emphasis is mine).

Aren't we facing the wrong way here? Should not the *detailed design* (which doesn't yet exist) be mindful of what the environmental issues are, of what the monitoring would require: is it doable and affordable, and of what mitigation plans would be needed or even possible? For example, at the most basic and embryonic level, should we not have already ruled out inappropriate designs that are already being discarded (e.g. the inutile 'sludge drying fields' as just one example), before even contemplating seeking approval?

"**Where required** revisions to these documents will be prepared with the cooperation of the applicable regulatory authority and will be provided for regulator review." (RPCR #234). (Emphasis is mine).
"Where required"? Sadly, we already know the answer. Only regulators will see it. But will they SEE it?

- If approved, further instalments of this project will occur through serial Notices of Alteration, which are expected to appear at 4-5 year intervals:
  "Notices of Alteration will be submitted to the Environmental Assessment Branch for each subsequent four-year block of future proposed extraction activities for the 24-year life of the Project."(SSCR #25).
  "Separating the Project into 4-5 year groupings, with Notices of Alteration to be filed as needed, will allow for improvements in methodology as well as any changes in environmental impact that might arise from relocating the specific sites of extraction activities. Improvements could include, for example, potential efficiencies in the extraction method" (RPCR #185, also #63, #73, #280).

  Indeed, the project is planned to stretch into the murky and depressing future, with no horizon in sight: in ads in The Clipper (February 22, 2022, p. 5; January 12, 2023, p. 10), it is described as "multi-generational." Therefore not only is it with us until the ends of our lives, but also those of our successors. Maybe this is important?

  These Notices of Alteration will not be subjected to the same requirements and scrutiny as the initial proposal. Since the latter lacks many components that are material to the proper evaluation of the project, e.g. Plans and supporting reports that are promised to materialize later, or denied outright, the initial **approval represents a point of no return,** and is likely based on something that will be different anyway.

- It is deeply troubling throughout the presented documentation that the response to concerns regarding the pervasive insufficiency of data is to reiterate a promise of future ongoing data collection, with the proviso that it shall occur *after* the license is issued.

  Its purpose shall be to "**confirm**" the narrative, rather than "**ascertain**" the unbiased facts. The number of times "confirm" is used in this way is too numerous to count (example SSCR #10).

Thus the results are predetermined. Will nonconforming data be rejected? Naturally, these data will be "proprietary", only for the holy eyes of the anointed. Will ANYBODY independently oversee these data? But, even if a regulator should somehow spy them, so what? Tough noogies, people.

- Another question arises: since at some point the workable extraction area within slurry line reach of the processing facility will be exhausted, will a new facility or series of facilities be built in the same or other municipalities? A veritable cornucopia of franchises, perhaps? The future reach of the project is expected to be very wide (see Figure 1, p. 29), even this is underestimated). In such a case, will a new EAP process be required each time, since it will involve new hydrogeological challenges and impacts, or will it simply be a routine 'extension' or 'alteration'?

- If this extraction method is proven to be sound and safe, other jurisdictions will be using it, and we can learn from them and their mistakes and successes, rather than being the disposable ground zero that gambles with very high and permanent stakes, indeed with the future. Our already battered environment is just too sorely in need of our stewardship, vigilance, and care.

- The proponent publicly touts this project as an "Environmental Revolution" (The Clipper, February 22, 2022, p. 5). "The Environmental Revolution is the process of switching from pollution-causing technology to efficient and clean technology. Sio Silica provides the source material to make this possible." One must ask:

  - A significant portion of the sand will be marketed to the "oil and gas industry" (EAPPF Appendix I, #44, 46)(see p. 33+). This is no "Environmental Revolution".
  - How does this project itself avoid or minimize the use of fossil fuels? Greenhouse gases will be spewing 24 hours a day, including exceptionally dirty diesel. The future electrification suggested by the proponent may not materialize in the time frame or sufficiency that is much hoped for, or be profitable or logistically possible.
  - Does this project provide the "source material" for alternative fuels?
  - How does this project eliminate other pollution-causing technology that uses heavy metals, plastics, toxic synthetic organics, and generates all of the greenhouse gases that are emitted in manufacturing and disposal of these things?

[Author's Note. The same ad in The Clipper, as well as the company site at https://www.siosilica.com/company inexplicably include a picture of the Canadian Museum for Human Rights. For me, this is personally deeply offensive and inappropriate. The Dr. E. Pip Collection of my parents' WWII documents and their personal concentration and forced labor camp artifacts is housed there. How does this project promote, or support, or **even respect** Human Rights? The juxtaposition is repulsive and revolting. What contributions have the proponents made to this Museum or to its programs?]

Additional remarks

- The severing of this project into two separate *initial* applications is frustrating and redundant, as each is dependent on the other. Many objections raised for the current application are relevant to the other as well, but the other has already been approved. This seems most hasty and irregular, and faith in the objectivity of the present review process is tarnished. We are asked to pretend that the two are hanging in space by themselves, but they are not.

- The further segregation of the first four years from a project that will span at least twenty-four, perhaps even more, smacks of a "foot-in-the-door" strategy to make the project seem small and innocent enough taken on its own. We are shown the toenail of the elephant and asked on that basis whether we want to admit it into our home.

  The piecemeal strategy also prevents the evaluation of the total picture and its full environmental impact. The information gets doled out like breadcrumbs so that it is impossible to gauge the size of the entire loaf, and we discover that there is more than one loaf. Some of the breadcrumbs are inedible styrofoam. But hey, this carving up into separate, more palatable servings has been eminently successful with the Processing Plant, as it did get approved. What would be the usefulness of that approval, in the remotely possible event that access to the material resource should now be denied?

  We also learn that there are secret versions of the proposal (e.g. SSCRIR1 #MSSAC-IR-009, also RMSF-IR-006) submitted to the regulators, while in the meantime the irrelevant public are appeased and distracted by figurative coloring books, for that is what their contributions, including the present submission, really are. What, then, is the point of the public "participation", when an unknown but probably significant portion of the publicly scrutinized material will be immaterial anyway?

- On the one hand, the text document of the EAP, subsequent addenda, and responses to inquiries are endlessly and mechanically repetitive, cut-and-paste swatches, while on the other hand, inconsistent and clashing information is presented in different sections. Apparently the EAP was prepared by various people who did not consult or coordinate with each other. This is also pointed out by the peer reviewers: "It is evident that multiple authors have prepared the various sections of the report, as there are some internal inconsistencies throughout the text." (AppB #FRIESEN-13).

- Although there is a complete Table of Contents, it is useless after page 63, for subsequent pages are not numbered (EAP2), nor do they match the pagination of the digital document reader on the computer. There are TWO *different* Appendices G: one (Heritage Resources) is where we expect to find it – after Appendix F, the *other* Appendix G, containing well data, is hidden within Appendix A, Part 6. Similarly

Appendix H is inserted inside Appendix A, Part 6 as well. Nobody seems to have been in charge at the organizational level.

- The EAP is frustratingly nebulous, uncertain, even obfuscating on numerous technical aspects of the proposed operation, with disconcerting gaps in information. There are numerous outright contradictory statements, both within the same document, and in different iterations of the supplemental material and reviewer questioning rounds. This makes it difficult to respond cogently to the proposal when we do not know what it actually is.

- There are no statistical analyses of data presented: even basic metrics such as standard error and standard deviation are unknown concepts, and no data sets have been subjected to the rigors of statistical null hypothesis tests or determination of confidence levels. Assertions are made which have no basis in objective mathematical interpretation. Despite the meager amounts of data, numerous reported values are obviously corrupted, leading us to question the possibility of other not-so-obvious possible breaches. Even so, no efforts have been made to mine the information from the databases using more advanced univariate and multivariate statistical techniques, which would have greatly improved understanding of the meaning and significance of the results.

- Such additional evaluations and reports that have been commissioned, for example by the Clean Environment Commission, have been restricted to geotechnical and hydrogeological aspects of the proposed project. On the other hand, ecological and human health impacts have not been favored with any comparable – indeed any – incisive critical attention. This is regrettable, as these impacts are also relevant, in fact immediately so, and extend within and beyond the operation and timeline of the project, but they have been relegated to low priority status as tangential afterthoughts and tiresome obligatory *pro forma* requirements of the proposal application process. There is clearly no interest in them, nor will they attract any once the project is underway. Yet these are the most important and visible interfaces of the project with the public. Given the sacrifice that they are required to make, should not their interests and wellbeing occupy a prominent position within the evaluation process?

- Simulation models are beset with problems of inadequate data and unrealistic assumptions, complicated by suppression of necessary information. This makes the reader question the validity or even pertinence of commenting at such a disorganized and muddled stage.

- Many wordings in the proponent consultant's texts suggest a bias in favor of, and promotion of, the proponent's application, leading the reader to question the objectivity and completeness of the documentation presented.

On the other hand, AECOM is to be commended for the valiant effort in trying to acknowledge the Public Comments in RPCR, in an era when identical impersonal form letters are used to fob off members of the public who have taken the time to articulate their unread questions and concerns. Thank you for at least reading the comments.

Unfortunately, swift disappointment follows: the RPCR responses tend to loop questions from the public back to the original EAP, which gave rise to the questions in the first place, or provide completely irrelevant answers that ignore or pretend to misunderstand the original question. Many responses unfairly refer questions to the dead end wasteland of documents which are inaccessible (e.g. multiple alleged Stantec reports), untraceable, or are nonexistent (e.g. numerous promised-but-unforthcoming Plans and Programs). Thus we tread an endless Möbius path where, much like the slurry fluid, we keep arriving at our starting point again and again.

- In multiple places, inconvenient or taboo topics, even though seemingly innocuous, are firmly stonewalled and suppressed as "proprietary", thus silencing any further inquiries, scrutiny, or discussion. This constitutes a serious withholding of pertinent, even essential, information, to the point of being unreasonable. For example, the Stantec 2022 report, according to the reviewer in GTTR (p. 27), "contains information that is necessary to evaluate whether the Project is likely to result in significant environmental impacts. Despite the importance of this information, the document is currently classified as confidential by the Proponent. We are unaware of any reasons for withholding this or any other document that has been provided to date from the Public Registry. In the opinion of Arcadis, doing so has the potential to limit the use of the information as evidence during the EA decision-making process. It also has the potential to unnecessarily erode public trust that the EA process is open and transparent."

  Similarly a reviewer in SRTER (#17) is frustrated that "The Proponent has provided some information on the condition that it be kept confidential and withheld from the Public Record. None of the information provided to Arcadis to date would normally be classified as confidential. This has the potential to limit the use of critically important information during EA decisionmaking and to erode public trust."

  The proponent's response: "The redacted information in the Geotechnical Assessment is commercially sensitive information that could be used by Sio's competitors to gain a competitive advantage over, and therefore prejudice, Sio Silica." This is an awful lot of 'proprietary' information that has been withheld throughout, including on topics such as vegetation and wildlife. Do the proponents plan to exploit these items commercially (on private land) as well? Is noise proprietary? Is water or air?

  In SSCRIR2 (#MSSAC-IR-015c), another reviewer articulates bluntly: "Why does SIO continually deflect the sharing of critical, key geotechnical modeling information and

analysis that is the basis of the entirety of this project, by imposing an unnecessary NDA to view the materials?" The response again is: "commercially sensitive".

In SRTER (#17), "Nonetheless, Sio has provided the full unredacted report to the regulator, CEC Commission and the Technical Experts hired by the CEC. Sio has also offered to provide the unredacted version of the report to hearing participants if they sign a Non-Disclosure Agreement. Therefore, the full, unredacted, report will be considered in the EA decision-making process."
Critically relevant information will never materialize for others who wish to make a submission, and whose questions and opinions might be useful and thoughtful contributions "in the EA decision-making process". The latter process is uncomfortably in the hands of a very few decision makers, and therefore fraught with uncertainties in a number of capacities, for example the narrow focus of highly selected professional specialties and expertise, with the diminishment or exclusion of other important facets of environmental impact that also ought to factor into the 'decision-making process.'

This excessive, compulsive secretiveness makes us question the objectivity and completeness of data and information that ARE presented. It is not possible to fairly evaluate a project that is beset with blind spots, vital gaps, and strategic omissions.

In SSCRIR2 (#MSSAC-IR-015c), the reviewer advances the same conclusion: "It is impossible to evaluate and assess the geotechnical work in the redacted geotechnical report. The model results must be shared for assessment and proper evaluation. Without the sharing of these results, the work cannot be properly evaluated, and without sharing of these results, the licensing process will be flawed."

Should not the current 'review process' have been stopped at a much earlier stage, and should not the proponents have been instructed to come back when they are ready and serious, and **actually have something to present that can actually be evaluated**?

- Besides the "proprietary" angle, the other major vehicle of evasion in subsequent response documentation is the excuse that questions from the CEC, other agencies and the public need not be answered on the grounds that the information is not required by the EAP (for example see any random page of responses in SSCRIR1 DLN). The review process specifically allows for questions to be asked and clarification to be provided, for the very reason that an **EAP gives rise to a need** for expansion and explanation of certain vague, nonspecific, contradicting, incorrect, inapplicable, misleading, misrepresented, incomplete, inaccessible, misplaced, muddled, or unsupported information.

- The proposal seems very dismissive and trivializing in the tone of its treatment of a very serious issue. For example: "The potential risks to groundwater are assessed to be minor, seasonal in duration and reversible." (EAP1, p. vi). Groundwater impacts unfold over long periods of time, contamination cannot be reversed, mistakes can affect large numbers of people, into future generations, and risks will persist long after the company is gone. Not minor, seasonal, reversible. Even their own EAP acknowledges that aquifer changes will be permanent.

- With respect to previous historical silica sand mining in Manitoba, particularly Black Island, "There have been no significant environmental impacts attributed to silica sand presence or mining at any of these locations." (AppA1, p. 14). Similarly, the following peer reviewer's statement is presented in AppB (p.2) "This background is very important, as it presents silica mining as a concept that has previously occurred in Manitoba, without any significant environmental effects." (AppB, p. 2).

  Previous silica mining, using an additional example (not mentioned in the EAP) at the old glass factory in Beausejour, did not involve the invasive subterranean methodology currently proposed, and was largely open pit mining of shallow near-surface deposits, confined to the same limited circumscribed locations. Of course environmental impacts would have been lesser and very different, as they did not implicate and invade aquifers. They did not involve subsidence risks, people's lives and drinking water, and property values. The two mining methods and spatial scope are not comparable.

- One of the peer reviewers (AppB) has been employed by the proponent (see WDR), and is placed in the position of reviewing some of their own work as well as participating in the report (e.g. drilling and sealing wells, provision of data), with more future work likely. In their review (AppB), they provide helpful advice on public optics, for example in their first comment on the draft:
  "In the initial sentence in the introductory section it might be a better approach to suggest that AECOM has been retained to assess the hydrogeology and geochemistry of the proposed silica sandextraction/mining program. Suggesting that the assessment is simply there to support the application leaves the reader with the impression at the onset that the results of the assessment are a foregone conclusion. Providing more of a balanced approach will be **beneficial** [to] **the members of the public** reading this section." (Highlight is mine). I.e. we don't want people to get the wrong idea right away.

  There is an aroma of bias, even rancor, on the part of the peer reviewers against the meddlesome and imaginative public, for example: "If a defined radius of influence is not stated, the public will often invent their own radius of influence." (AppB, Comment #6), i.e. stupid, ignorant public. Foolishly inventing radii all the time. What next – corrections to the Kantorovich-Akilov hyperspace equation?

The quoted statements are the thoughts admitted in the public version of the review, so what will we, the excitable public, *invent* as the private exchanges between the parties……..

This reviewer is also the author of FD (2019) for Springfield Municipality, and is thus placed in the incongruous position of commenting on a project, and carrying out activities associated with it, that clash monumentally with the recommendations of a report which the same reviewer has previously and recently issued and endorsed (i.e. FD, 2019). A case of *facere sicut ego dico sed non sicut ego facio*?

- "It is **recommended** that mitigation measures, follow-up plans, and monitoring programs described in this report be implemented to avoid or minimize potential environmental effects and/or identify any unanticipated adverse effects **early** so that appropriate adaptive management action can be undertaken." (EAP1, p. xi)(Emphases are mine). Recommended, not required?

  How can adverse effects be identified "early", when the "mitigation measures, follow-up plans, and monitoring programs described in this report" DO NOT EXIST?

  How can effects be identified when **baseline data, essential for any comparison, DO NOT EXIST**, and neither have any plans been formulated to obtain these data, BEFORE the project commences?

  Of what use are monitoring programs, instituted AFTER the fact? There will be nothing to disprove that the data thus obtained are only manifestations of ***post hoc, ergo propter hoc***, i.e. if this is happening AFTER, it must have also existed BEFORE, and nobody can prove any different.

- "The follow-up plans and programs developed for this Project are intended to be 'living documents' that will be updated periodically, as needed, and will be available on-site as reference documents for Project staff and contractors." (Section 8, EAP2).

  This seems to be *carte blanche*. Available just to staff and contractors? What about outside input, consultation, and transparency? What about independent OVERSIGHT?

  It is deeply unsettling that, even before the project is underway, changes and alterations to the original EAP have already streamed in, even before the CEC hearings have commenced. It appears that the project keeps, and will keep, endlessly morphing like an indecisive amoeba, putting forth new pseudopodia while continually retracting old ones.

We have to resign ourselves to the reality that **approval of the project will/can only sanctify the version that happens to exist at that particular time**. It is troubling that what actually eventually occurs will likely be quite different, promulgated through serial Notices of Alteration, or materialized within the cosy *chez nous* miasma of 'living documents'.

- In TAC (#12), "ECE recommends copies of the following plans be submitted to EAB for distribution for review and comment by the appropriate branches/departments prior to licence issuance:
  o Waste Characterization and Management Plan
  o Water Management Plan
  o Groundwater Monitoring and Impact Mitigation Plan
  o Progressive Well Abandonment Plan"

  The proponent responds: "CanWhite commits to preparing and implementing all of these Plans. CanWhite will submit them to the Director prior to commencing operations." (also RPCR #234, #235). In other words, not now.

  Additional plans are also missing. Where are the:

  Water Sampling Program Plan
  Limestone Competency Testing Plan
  Noise Mitigation Plan
  Environmental Emergency Response Plan
  Air Quality Plan
  Revegetation and Monitoring Plan
  Stakeholder and Indigenous Engagement Plan
  Closure Plan
  Trigger Action Response Plan

  The proponent is not submitting, nor formulating, these Plans until they are ready to start operations, **following licensing**. And they say so, for example: "The approach to monitoring groundwater quality before, during and after operations will be fully described in the Groundwater Monitoring and Impact Mitigation Plan **following licensing**." (TAC #41, also RPCR #235, #239, #240, #269). Requisite data to inform and construct these Plans are similarly missing: "Additional data outputs can be evaluated as part of future modelling efforts **after the issuance of an Environment Act Licence.**" (SSCR #23)(Highlights are mine). There is no opportunity to evaluate them beforehand. How can any of this be approved "on a hope and a promise"? What assurance is there against non-compliance, or getting fobbed off with inadequate empty confections?

- Numerous reports referenced in the EAP are also missing, for example:

  Homeowner Water Well Survey
  Mineralogy of Winnipeg Sandstone reports (2017 and 2019 reports)
  Noise Impact Assessment for Wildlife
  Stantec Reports (2019, 2020, 2021)(aside from one redacted fragment in RPCR).
  Stantec 2022 Report has not been posted to the Registry website.
  Wildlife Assessment Report
  Vegetation Reconnaissance Study

  Also those in Section 4, EAP1 (p. 32):
  o Spring auditory amphibian survey (May 2018) focused in wetland areas
  o Baseline noise data (May and August 2018)
  o Summer vegetation survey (June 2018) in representative vegetation communities
  o Fall vegetation survey (September and October 2018) with additional emphasis on wetland areas and the Project Site

  The proponents admit there is no Noise Impact Assessment for extraction operations, and there seems to be no program planned for monitoring injection water.

  In particular, all roads throughout the documentation seem to lead to the pivotal, but cloaked and shielded Stantec reports, which apparently contain all of the answers nestled within their golden pages. But for the uninitiated plebeians, this "public consultation" process can be described thus:

  1. Somebody asks an intelligent question.
  2. In response, the proponent blows a giant soap bubble.
  3. Captivated, we pursue its alluring play of colors.
  4. Just as we are about to close in, and get a better view…….**Boop**!.....It turns out to be yet another reference to a Stantec report.
  5. We are left to contemplate a handful of nothing at all.
  6. We feel cheated, insulted, and laughed at.
  7. Disheartened and defeated, we lose confidence in the entire proceedings.

- As for design and details of the systems: not now. "Sio's detailed designs are still being finalized, Sio **declines** to release any additional details of its designs at this time." Further, "Sio also maintains that details of technical components that have not yet been finalized are **not relevant** to the CEC's review of the extraction proposal" (SSCRIR1 #DLN-IR-004)(Emphases are mine). Not relevant? How is it possible that the application has proceeded to such a stage, when there are no blueprints on the table? Basically, 'we want to do this and this and maybe this, but we don't know for sure or how yet.'

"Many of the technical components of the extraction proposal are being negotiated with arm's length third parties and disclosure of additional information could prejudice Sio's negotiations with these parties." (SSCRIR1 #DLN-IR-004). What if negotiations fail? Should not all of this housekeeping and planning have been worked out *before* application? What if Manitoba Hydro cannot supply power on the proponent's terms, for example?

- Indigenous engagement and input are lacking. However Indigenous Rights are bragged about on p. 11 of SIO, while on p. 26, we see promised "education and training for Sio staff and contractors on the history of Indigenous people, intercultural competency, human rights, and anti-racism.", and "Sio is developing a Stakeholder and Indigenous Engagement Plan" (screenshot):

Components of the plan may include:

- Stakeholder and Indigenous Engagement Commitment Statement
- Stakeholder and Indigenous Community Mapping
- Engagement Plan
- Issues, Values and Interests Assessment
- Local and Indigenous Inclusion Plan (expansion of Sio's current Local Workforce Commitment)

This looks so special, but **where is this "Stakeholder and Indigenous Engagement Plan"?** The "Components of the plan may include" – 'MAY', not 'SHALL'? Is this not also their environment and health that could be impacted? What is "intercultural competency"? This seems to be a derogatory term, implying a degree of **in**competency.

This Truth and Reconciliation logo is emblazoned on page 4 of SIO:

Can the proponent explain to us exactly how this project supports and advances Truth and Reconciliation? By displaying this logo, are the proponents publicly pledging to donate a portion of their proceeds to this cause? Or maybe they are committing to hiring mostly indigenous workers?

In the end, this all seems moot, as there is not even a whiff of any of this in the EAP or any associated documents. Despite the shiny socially-conscious politically-correct us-too public advertising, in RPCR (#151) the whole idea is discarded: "**the Project is not expected to adversely impact the exercise of Indigenous or treaty rights**". A primary excuse is that project activities will occur on private land, discounting the fact that there are some treaty rights, such as hunting and gathering, which do apply, and which have been known to occur in the project area. Portions of the area are settled by Métis, for example the Ste. Rita, Ostenfeld and other areas. The proponent dismisses any effects as "negligible". But, after all, we must be cognizant of the fact that technically all land is Treaty Land, and we all share in the responsibility for its stewardship.

However when pressed on this issue in SSCRIR2 (#MSSAC-IR-006), "The specific feedback that has been provided by Indigenous groups to Sio to date was provided on a **confidential** and without prejudice basis. As such, Sio is **unable to disclose any details** beyond what was provided in the response to CEC-IR-001" (Emphases are mine.) Ah, the catch-all "confidential" skirt to hide behind again. If such consultations do exist, the proponent ought to have been proud and eager to provide evidence of them. Or maybe it was another "desk-top survey", *à la* the confections on p. 439?

- There is gnawing uneasiness with respect to the variation between the information submitted in the Public Registry and its appendages, particolored as it is, and the public messaging in Open Houses and media like The Clipper and the corporate website, where factoids are air-brushed and tarted up for the public to consume. All the public want is the simple unembellished truth and the **actual consistent real information**. After all that we have been through, we still don't know the real story here, because it is clouded by so much ever-shifting

malarkey noun

Save Word

ma·lar·key | \ mə-ˈlär-kē \

variants: *or less commonly* **malarky**

Definition of *malarkey*

: insincere or foolish talk **:** BUNKUM

// He thinks that everything politicians say is a bunch of *malarkey*.

Merriam-Webster

- Long-term accountability is absent. In the future, a company may no longer exist, it may declare bankruptcy, reorganize under another name and structure, or be sold to foreign interests. There are many such mining legacies in Manitoba, where the taxpayer is left to deal with the problem, which is at that stage irreparable. Consider the extreme case of thousands (around 170,000 (AER, 2021)) of abandoned and orphaned oil wells in

Alberta, and stranded landowners, many of whom have waited decades for restoration of their land, that has, and never will, come in their lifetimes, if at all. This is what comes when we place greater value on the quick profit over the enduring reality.

- There is a disturbing and highly uncomfortable feeling of lack of independent oversight and the indolent and lackadaisical *laissez-faire* attitude of our provincial authorities towards projects which may permanently and irreversibly affect the environment and the lives of present and future Manitobans. Forgive us our jaded and jaundiced cynicism, but all we need to do is look around our battered and neglected province and the unfortunate legacy of generations of environmental abuses and neglect, and the unwillingness/inability of the province to take its share of responsibility for its poor decisions. Its officers are insulated and absolved by law from any legal accountabiity or consequences:

  Section 84 of the Manitoba Groundwater and Well Act C.C.S.M. c. G110 expressly states: "No action or proceeding may be brought against the minister, a director, a well drilling officer or any other person acting under the authority of this Act for anything done or omitted to be done, in good faith, in the exercise or intended exercise of a power or duty under this Act."

  In the present case, the pervasive impression is that disaffected citizens will be left on their own to deal primarily or exclusively with the company - a bleak and discouraging prospect, with questionable expectation of fair and impartial treatment.

  In a memorandum from Environmental Compliance and Enforcement, "ECE recommends the proponent develop and maintain a complaint management plan to track and respond to public complaints regarding the operation of the Development." (Item #9, p. 6, https://www.gov.mb.ca/sd/eal/registries/6119/tac_comments_for_public_registry.pdf). The proponent responds: "CanWhite will provide local residents with contact information to file any complaint or concern." (RPCR #214).

  This smacks of the farmer who wants the chickens to take their fox-related complaints to the fox, rather than to him, even though his are the power and moral duty to protect them. This is reminiscent of our provincial autocratic power allocation: a single Project Manager handles public comments, makes decisions, oversees project implementation, and privately receives all associated public complaints and concerns. It is all a one-stop-shop, nobody else knows about the problems, and most importantly, nobody knows that poor decisions and inept management may have occurred. Complaints and appeals to the Minister are automatically shunted back to the same Project Manager, even though they have already been there, the Carnival House-of-Mirrors model. The public are left walking up on the down escalator, and their hearts have been sucked out of them (personal experiences).

In the present situation, will the regulators impose this on the community, then wash their hands of it? **Where is the contact information for ECE?** Why are they not the complaint and response hub, given that they are supposed to, theoretically at least, represent "Compliance and Enforcement"? Are we, as citizens, so deluded and addled that we still naively expect a strong, steady and reassuring hand of our government, whose mandate, or at least some interest, should **FIRST be the long-term welfare and sustainability of our citizens and environment?**

- The regulators ought to refrain from garlanding the otherwise skeletal permits that have been issued so far, with metaphorical psyllium-fibre clauses that look nice, but have not and will not be enforced. (As in the Injection Well Permits or the Processing Facility License for example).

- It must be recognized that the entire intrusion will be highly stressful and disruptive for many landowners and families, and that this stress will have to be endured over an extended period of time. For many, it has already started with anxiety regarding what the future will hold, and a feeling of injustice, powerlessness and violation. There will be, and already is, **a need for support**. What solace does the Province intend to provide for these (i.e. *its*) **citizens**?

- The present project must be considered within the **context** of other human enterprises which have already affected, and continue to affect, these same aquifers in adverse and increasing ways. Notable impacts have included aggregate extraction, intensive hog and other livestock production, inappropriately dense and/or regrettably sited residential developments, deforestation, peat moss extraction, and rigorous drainage. Existing wells, including industrial users, have resulted in hydrological changes in both quantity and quality of water. **It is important to remember that all of these activities are additive, in some cases synergistic**. It is also important to consider the **future growth** of these burdens in the face of accelerating climate change. The EAP completely omits any consideration or even awareness of where the proposed project would fit into the existing fabric of environmental stresses and what, if any, mitigation measures could be possible to avoid exacerbating issues that are already extant.

  This lack of integration has also been pointed out by the reviewer in SRTER (#13): "The Project Proposal and supporting documents do not include an assessment of cumulative effects. Given the wide range of land uses in the vicinity of the Project and the importance of the groundwater resource, this represents a substantive deficiency in the Project Proposal."

  The proponent responds in part: "residual adverse Project impacts combined with effects of past, present and reasonably foreseeable future physical activities are not expected to result in **an exceedance of regulatory thresholds** or other threshold of acceptable change on these other environmental and socioeconomic valued components. This is because Project activities will be limited to small and

temporary footprint areas of disturbance on a local and regional landscape that is largely previously disturbed or developed (e.g., agriculture activities)." (Emphasis is mine).

"Sio maintains that the environmental assessments conducted for the extraction proposal meet or exceed **applicable regulatory requirements**, and allow the CEC and interested parties to **reasonably** understand and assess the potential environmental effects of the proposal." (SSCRIR2 #MBEN-IR-034) (Emphasis is mine).

That is the sticking point. There are very few "applicable regulatory requirements" here, and such as there are, are outdated and irrelevant. Whose fault is that? What will it take to finally convince our regulatory authorities to break out of the *status quo* cocoon?

Thus we cannot conclude without identifying the blighted root which makes such situations possible: our regressive, unjust, and archaic mining legislation. Much is permitted under the gray schmutz of our provincial Mineral Exploration laws, and much is permitted for all of the other phases of operation and abandonment. The dismal legacy of hundreds of unremediated/irremediable places in Manitoba proves it: this is our bequest for those who will follow us.

- According to Section 18(1) of The Mines and Minerals Act (C.C.S.M. c. M162), Mine Closure Regulation from 1999: "A closure plan must include a schedule of the estimated capital costs and operating costs of carrying out, in accordance with the plan, closure of the project site, rehabilitation of the site and programs to monitor and manage the site after closure."; the subsequent Section 19 requires **filing of Security** (https://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=67/99). It is painfully apparent that these regulations have been winked at in far too many cases, and that too many mining companies have been practised virtuosos in the arts of dodge-and-escape that would put Houdini to shame. This shortcoming is complicated by the passage of time after closure, grandfathering, the 'unanticipated' size and extent of the problem left behind, and the inflation of costs over time which dwarf the original security projections.

  Manitoba Mine Closure Regulation 67/99, Mine Closure Guidelines Financial Assurance (https://www.manitoba.ca/iem/mines/acts/financialassurance.html) seems to have been well-intentioned, but regrettably the requirements for Financial Assurance and the Corporate Financial Test therein are guidelines only, *after more than 20 years*. In March 2001, the committee that wrote this document expressed the timid hope that it "shall be reviewed and revised by a similar committee in the event of changes to *The Mines and Minerals Act*", but that, as it stands, it has "no legislative sanction".

  The 2020 Clean Environment Commission review of Manitoba legislation pertaining to mining and contaminated sites staggers, blunders and weaves through the morass of omissions, gaps, blurry regulations, open-ended guidelines, and slippery loopholes which sorely and embarrassingly need updating. We quote: "The Contaminated Sites

and Remediation Act excludes sites regulated by The Mines and Minerals Act. However, under a regulation making provision of The Contaminated Sites Remediation Act, it is possible to apply the act to mine sites although **the panel understands this has never been done**." (https://meia.mb.ca/wp-content/uploads/2021/09/CEC-Legislation-Review-Report.pdf) (Emphasis is mine).

Here is one of the Commission's ideas (unfortunately, that is all it is): "The commission recommends a formal process for care of mine sites post closure be included in regulation referencing implemented policies, procedures or guidelines and that these documents be made available to the public."

And here is another of their ideas: "The commission recommends legislation require financial commitments from mine owners to address on-going maintenance and unforeseen events for closed mines." But in this particular case, who will own the wells after abandonment and the company is long gone? It is the landowner.

- We also need to point out that the 2005 Manitoba Auditor's environmental audits report on contaminated sites and protection of well water quality (https://www.oag.mb.ca/wp-content/uploads/2019/10/ENVAUDITS_NOV05.pdf) pointed out the fragmented nature of applicable legislation and issued a number of recommendations, many of which have still not been implemented. Had they been brought into force, many would have been useful now.

- For decades, with tiresome regularity and fanfare, the same federal and provincial announcements have been trotted out regarding the planned cleanup of contaminated mine sites, with the latest hopeful proclamation in the Manitoba 2022 Budget for situations "where the owner cannot be found or is financially unable to carry out site rehabilitation and remediation" (https://globalnews.ca/news/8769522/manitoba-orphaned-abandoned-mines/). As of 2015, rehabilitation plans have been outlined for 149 sites in Manitoba, and >$200 million of public money have been spent (https://www.manitoba.ca/iem/mines/noami_nugget_may_2015_article.pdf). The vast majority of these sites have yet to be remediated, and will certainly not happen in my lifetime, if ever. In the meantime, the problems spread and become more entrenched and intractable over time. In the end, sites that do win the clean-up lottery and are fortunate to be blessed with eventual remediation efforts are often only partially successful (e.g. https://www.winnipegfreepress.com/local/contamination-concerns-bubble-up-at-manitoba-lakes-575606812.html).

- Most glaringly evident here, the type of mining proposed in the present project is not identified in the regulations that do exist, and those that do exist, are in practice indifferently and grudgingly acknowledged. In a rational world, a credible foundation of rules and procedures would be in place to anchor, safeguard, and anticipate the interests and needs of environment and community, and a reliable fabric of monitoring

and enforcement would exist. We can only hope for a more responsible and aware administration in the distant future, but of course it will be too late for us in our present dilemma. But we can still always hope, regardless of how many times those hopes are dashed.

So, where do we proceed from here? Where do our *successors* proceed from here?

Closing statement

The environment is worth fighting for, on every front, while we still can. It is our life support system. Less of it remains every day. Our descendants will grieve for what we have foolishly squandered and lost, and cannot ever get back again. Perhaps one day we will see the value of things differently, when those things are no longer there.

https://blossombariatrics.com/wp-content/uploads/2017/08/34389048_m-e1453832993683.jpg

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APPENDIX

Respect for the property owner's rights

- There is virtually no information or even acknowledgement in the EAP regarding the central role of the landowners. What are their rights, and how shall the company deal with these stressed human beings throughout the entire and often prolonged process? Throughout the report there is a disheartening disregard of potential human impacts and concerns, which are either not mentioned, or summarily dismissed as "minimal" and "negligible" and "minor", without supporting data.

- A major shortcoming in the mineral rights permitting system is its complete disregard for the property owners, who obviously have an interest in their land. Mineral rights to a property may be acquired surreptitiously by outside parties without the landowner's knowledge: "reports in south-eastern Manitoba have drawn attention to the fact that this may occur **without notice to the owner of the surface rights**." (Teichroew, 2017). One wonders why landowners are not notified, and have no say in what happens on and to their land.

- An inquiry in RPCR (#279) pertains to the "Expiry date for all listed mining claims: 2021-12-03". The proponents respond that they plan to renew claims.

  "Claims are valid for a certain time period based on the date of their assignment to CanWhite. To maintain these claims, CanWhite must file reports to the Mines and Minerals Branch every 1 to 3 years demonstrating work completed and expenditures on those claims. The Mines and Minerals Branch reviews and approves those reports and extends them based on the allocated expenditures."

  Therefore a claim may be clapped onto a property for an extended period of time. Evidently the landowner is superfluous.

- "Land agreements will be **issued** in advance of any work occurring on private property." (EAP1, p. 3).

  "CanWhite will have private landowner agreements with landowners in the area for sand extraction on their property. The details of the individual landowner agreements are private. The sand removed will be subject to a royalty paid to the landowner **and/or** the provincial government." (RPCR #131, also #136, #187).

  "landowners will be compensated fairly for extraction to occur on their property. Landowner agreements are generated for each property that contain the details of each property and landowner **preferences**. CanWhite and the landowner will agree upon access points, reclamation and compensation prior to any access to the property. CanWhite will return fences and access points to original locations should they need to be temporarily moved. All of these items are subject to agreements with the landowner entered into prior to the initiation of Project activities." (RPCR, #137).(Emphases are mine).

  - According to this information, will these private agreements differ (**per unit basis,** i.e. per well cluster, per meter of trail clearing, royalties) among individual landowners? Or will a set uniform rate be established per unit?

  - Individual wells may have different sand yields, or none at all (e.g. monitoring, exploratory, or just disappointing), yet the amount of environmental damage per well may be similar on a given property. Royalties would not be fair compensation in such cases.

  - Royalties for sand removal will be "paid to the landowner and/or the provincial government." A legal interpretation of who owns what and who is owed what (i.e. landowner vs. Province) needs to be clarified. The "and/or" raises the possibility that only the province may get paid.

  - Will the landowners be subject to a confidentiality clause, so they cannot compare the terms amongst themselves, or publicly reveal the arrangements?

- **Who will monitor and verify how much sand is actually extracted from each property?** This is an especially cloudy question, as the sand will disappear immediately into the slurry lines, and the sand content will not be constant, but will greatly vary over the production timeline of each well, and also for different wells and well clusters. Therefore the total volumes extracted do not relate to the amount of sand. Who will independently ensure there is no creative accounting?

- A curtain is drawn over what happens if a landowner refuses to agree/sign, yet the company has the mineral rights. The only inkling we get is: "Mineral rights permit use and occupation of the land for the purpose of prospecting, exploring for, developing, mining or production of minerals on, in, or under the land." (EAP1, p. 3). No landowner's

rights are mentioned. Why? This is not good public relations and sets the stage for many unhappy situations. The RPCR and other documents are silent on these concerns. This in itself constitutes an answer. We are left to find out for ourselves.

- For the edification of the reader/landowner/tenant regarding **landowner's rights** and items to consider, here are some brief gleanings from SRM, 2019. The complete legislation is found in **The Surface Rights Act** (https://web2.gov.mb.ca/laws/statutes/ccsm/s235e.php). All emphasis is mine.

1. "Under The Surface Rights Act, whoever holds the mineral rights is entitled to access the land, to work and remove the minerals. To gain access, **operators must enter into a leasing agreement with the owner who holds title to the land and with the occupant who leases the land. If the negotiation of a leasing agreement is not achieved the operator may apply to The Surface Rights Board for an order permitting access to the land.**" (SRM, 2019).

Section 16(1) of the Surface Rights Act states: "Unless expressly authorized under an order of the board, no operator has a right to enter upon, use, occupy or take the surface of any land, until the operator has obtained a lease of the rights specified therein granted by the owner and occupant".

-Thus an agreement must be negotiated with *both* the landowner and the tenant (if the latter exists).

-The Surface Rights Board may overrule the landowner/tenant, and issue an Order allowing the operation to proceed.

2. "The lease agreed upon legally secures for the operator the surface of the land for extracting minerals. In return, the operator will compensate the owner or occupant for loss of the **land used in connection** with mineral extraction. Compensation will be in the form of a "first year payment" and subsequent "annual payments" for the balance of the lease." (SRM, 2019).

Compensation ought to include not just the extraction sites *solum*, but all trails and corridors and any other footprints: access, slurry pipe, interconnecting, hydro. Even if these are existing trails, or trails that will be established but which do not need to be cleared, the property owner will still be denied their use, or the land which they occupy, and is entitled to compensation. In other words, any "land used in connection" with the operation. Some properties will involve much more intensive environmental damage, such as forest clearing, than others. Premium compensation, on a per meter or areal basis, would be appropriate in these cases.

3. "An employee or agent of the company holding the mineral rights will approach the landowner with a surface lease. This will include a sketch or map indicating the area the company wishes to lease and compensation the company is prepared to pay for surface rights. Landowners **should take sufficient time** to review the lease to ensure terms and conditions are fully understood, and to **identify areas for negotiation**." Note that "THE ACT SPECIFICALLY REQUIRES **A MINIMUM OF THREE (3) DAYS** BEFORE A SURFACE LEASE CAN BE SIGNED BY THE OWNER/OCCUPANT. THE PURPOSE IS TO HELP ENSURE THE

LANDOWNER HAS TIME TO CONSIDER THE OFFER MADE AND TO OBTAIN ADVICE, IF NECESSARY." (SRM, 2019).

-The map will include accurate locations and sizes of extraction sites, and all trails and ditches.

-The owner is allowed **at least** three days to consider, and cannot be stampeded or intimidated into making an immediate decision.

-The owner can negotiate. However it is not clear whether extraction site locations, trails, or setbacks will be negotiable.

- RPCR (#137) refers to "landowner preferences" in connection with the agreement. What are these presumably negotiable "preferences"? Can they include major issues of concern such as hours of operation, noise and light levels, completion deadlines, as well as worker behavior (e.g. loud music from trucks, speed limits, etc.)?

-What immediate recourse does the landowner have when any of these terms are breached? The company's 'complaint line'? But it is the company who is the subject of the complaint. *Pollice naribus tuis*? Who will arbitrate?

4. According to the Act, if all activities will be concluded within one year, the landowner receives just the one payment. If any activities on the parcel extend to two or more years, the landowner receives an additional (but smaller) payment for each additional year.

Subsequent annual payments ought to cover **any extended continued entrance** onto the property **for any purpose** in the following years after extraction has concluded: e.g. site cleanup, monitoring, remediation, restoration, revegetation, etc., including drone monitoring.

5. "An on-site inspection of the land in question is advised to show the operator any areas of special concern such as fences or gates, livestock or wells. All concerns with the operator should be discussed and an agreement made which can be formally included in the lease." (SRM, 2019).

Many landowners have complex and deep attachments to their land, which may have been in the family for generations, and which may often contain areas of particular aesthetic, spiritual or sentimental value. The property is ***home***. There may be places which are used for picnics, recreation, family gatherings, or meditation and prayer; there may be dedicated memorial areas for buried pets, or spots frequented in life by departed loved ones. There may be scattered ashes of cremated family members. Will

property owners be able to require the company to leave such areas alone? Who will enforce these wishes?

6. "All concerns should be addressed by the company prior to signing the lease agreement, since a contract with the operator is binding once the property owner/occupant has signed the lease."

This implies that the contract is immutable and cannot be changed at a later time, nor can the property owner reconsider. This seems to be unfair to the landowner, especially since the company in the present case reserves the right to alter their operations endlessly via mercurial "living documents" (Section 8, EAP2; RPCR #234; SRTER #16). Thus operations or activities may occur to which the landowner has not agreed in the initial contract. Possibly the landowner may have to appeal to the Surface Rights Board (see below), which takes time, while the activities proceed in the meantime.

7. A **set timeline** should be required and adhered to within which decommissioning, site levelling, grading and revegetation shall occur. Property owners must be notified of a firm time within which the work will be completed, so they are not subjected to the stress of waiting indefinite periods of uncertainty and delay, for a conclusion which may or may not ever arrive. Any need for repeat subsequent visits for any purpose must also be specified. If total interaction extends beyond the initial year, relevant compensation should be stipulated. If operations have to be extended due to delays, compensation should be provided.

8. The SRM (2019) advises another item to consider: "Who is responsible for weed control during drilling and production phases?" According to The Surface Rights Act, Section 55(1): "Unless the operator and the owner and occupant, if any, otherwise agree, every operator shall cut down or otherwise control all weeds growing on the land on which the operations of the operator are being carried on and the operator shall cut down or root out and destroy the weeds each year before they have matured to seed."

Thus the operator is responsible for weed control. The proponent has not indicated in the EAP what mode(s) of weed control will be used for the sites, trails and around pumping stations. However the proponent warrants that "CanWhite will not be using herbicides." (RPCR #104)(presumably this applies to Sio as well). To prevent misunderstanding, landowners may wish to include this item in their agreement.

9. Details of the **restoration** to be carried out, including the specifics of **how** and **when** it is carried out, should be included in the agreement: i.e. a guarantee of restoration of damaged property and structures, removal of ditches, and revegetation (i.e. ***details*** of revegetation).

According to RPCR (#137), "CanWhite will return fences… to original locations should they need to be temporarily moved." Will fences also be *repaired*, for example damaged posts, cut stretched barbed wire or electric fencing?

According to The Surface Rights Act, Part V Liability for Tortious Acts, Section 44(2): "The operator is liable to the owner or occupant, as the case may be, for any tortious act committed as provided in subsection (1) notwithstanding that the operator has assigned or transferred the surface rights to any other person." Therefore if repairs to damaged property are not carried out, compensation for the costs of the repairs must be provided, by the operator who did the damage.

10. "If a party to the lease at any time feels the terms of a lease are in violation, the parties should make every attempt to resolve any differences. If this approach is not successful, application to The Surface Rights Board can take place." (SRM, 2019).

-It is advisable for the landowner to keep written or digital records of all dealings and negotiations.

-"Mediation services are available prior to holding any hearing to settle any or all matters under dispute" (SRM, 2019). If mediation is not successful, a formal Surface Rights Board hearing is the ultimate recourse.

The Surface Rights Board is appointed by the Province and is a quasi-judicial panel, therefore proceedings are similar to those in Court. Many people will find this intimidating, time-consuming and expensive, and may be unable to face this hulking bureaucratic machinery on their own. The landowner can represent herself, or hire a lawyer.

The Board deals with disputes concerning rights of access to the property, compensation of the landowner for lease of the land, loss of use of land, noise, inconvenience and tortious (i.e. harmful) matters. Compensation also includes "Increased costs to the owner/occupant, if any, by reason of the works and operations of the operator." (SRM, 2019). Some examples might be: alternate housing for animals, having to buy feed, hotel accommodation, having to purchase and transport water, a medical certificate attesting to health costs, loss of business (home-based), and many dozens of other possibilities.

According to Section 26(1) of the Act:

"In determining the compensation to be paid for surface rights acquired by an operator, the board shall consider the following matters:

(a) the value of the land having regard to its present use before allowance of surface rights;

(b) the loss of use of the land or of an interest therein as a result of granting surface rights;

(c) the area of land that is or may be permanently or temporarily damaged by the operations of the operator;

(d) the increased costs to the owner and occupant, if any, by reason of the works and operations of the operator;

(e) the adverse effect caused by the right of entry to the remaining land by reason of severance, if any;

(f) the nuisance, inconvenience, disturbance or noise, to the owner and occupant, if any, or to the remaining land, that might be caused by, arise from or is likely to arise from or in connection with the operations of the operator, and the damage, if any, to any adjoining land of the owner, including damage to or loss of crop, pasture, fence or livestock and like or similar matters;

(g) where applicable in the opinion of the board, the application of interest payable in addition to the amount awarded as compensation; and

(h) any other relevant matter that may be peculiar to each case"

On farmland, in addition to the extraction sites, the access and other trails may be located on fields. The compensation includes "The adverse effect caused by the right of entry to the remaining land by reason of severance, if any; Compensation should equal the value of the extra time and costs needed to farm two units or to farm around several additional corners. Owners/occupants may be compensated for extra costs in time, material, machinery wear and tear, etc., when facts are offered as evidence at the hearing." (SRM, 2019).

-Compensation ought also to be due where losses to income are incurred as a result of damage to land or trees. For example, in the case of Christmas trees, loss of income will extend for 7-10 years, which is the time required for new plants to reach marketable size.

-Compensation is also included for the "cost of time spent in surface lease negotiations" (SRM, 2019).

-Compensation should be considered where entry onto the property will be made post-closure, possibly for years (e.g. monitoring).

-Neighbors may claim for damages as well.

- The Board hearings will involve considerable passage of time, during which the violation may persist. "The Board however, will generally hold a hearing within 30 days of receipt of any application." and "The Board will render a decision on the application not more than 30 days after the conclusion of the hearing" (SRM, 2019).

  -Therefore up to two months may elapse before the decision is rendered.

  -In the end, satisfactory resolution in the landowner's favor might not occur.

- A copy of The Surface Rights Act, and contact information for Mediation and the Surface Rights Board **should be made available to all landowners** at the time they are first approached for an agreement. This information should also be available at all times at the Municipal Office to all ratepayers, as well as posted on the municipal website.

- Other comments on this topic include:
  - Will access points to properties perforce need to utilize parts of people's driveways, as new access created across municipal rights-of-way and municipal drainage ditches (and installation of temporary culverts) will require municipal and provincial approval. If so, how much will the activities of movement of heavy machinery and 24-hour traffic interfere with people's use of their driveways? Landowners may wish to consider these items for negotiation and compensation.
  - "Use of the land for other purposes will not be available in the locations of annual Project activities." (EAP1, p. x), also RPCR (#128, #136, #138). Will the property owner be excluded from entering the site, even with a hard hat? The proponent's answer is yes: "only authorized personnel will be permitted on the active worksites." (RPCR #137, #256).
  - Further, "**parcels** of land used for Project activities during any given year of Project operation will be available for other uses the following year or once the activities are complete."(EAP1, p. x)(Emphasis is mine). According to this statement, does this mean that the **entire parcel** will be unavailable to the property owner while the proponent is occupying it? The RPCR does not provide a response. Further, how are "activities" defined? Clearing and extraction only, or including subsequent monitoring, etc.?

    The answer to this question is legally 'no'. According to SRM, 2019, "The landowner is permitted by the operator to farm the lease area it is not using." Therefore the proponents cannot exclude the landowner from portions they are not actually occupying.
  - Are separate legal agreements required to manipulate private wells, e.g. levels of pumps? Also to monitor private wells? These questions are particularly relevant, as these wells may be on surrounding properties where extraction is not/will not occur, and are not covered by the above landowner agreements. Well owners are entitled to compensation for intrusion, inconvenience and time, even though they might not be actual leasees. The legal question also arises regarding the rights of property owners who do not wish to be involved in these activities.
  - What will the role of the Province be in monitoring and oversight? If complaint-driven, how will this occur when citizens are encouraged to deal with the company themselves, and the company retains the complaint records? Apparently there is an enormous vacuum here. *Semper non videns*…..

The provincial legislation needs to be urgently updated to include this type of mining. If projects such as this are approved without appropriate governing regulations in place, this creates A) precedent, and B) grandfathering and immunity/impunity for already approved operations.

Addendum

Review of late draft documents

A few days before the CEC Submission deadline of February 13, 2023, a series of additional documents were released by the proponent, when the present Submission was already completed. These items were publicly posted to the Registry on February 9, 2023. The proponent has had years to prepare this documentation. We protest that a reasonable and sufficient timeline has not been provided by the CEC to allow for the proper examination and evaluation of this new documentation. Accordingly, this Addendum constitutes a very harried and incomplete response to the new materials.

We further note that the submitted documents are only skeletal Drafts, with no commitments to any of the recommendations therein. They are not Plans, as much fundamental content is missing, nothing has been finalized, and nothing is binding.

Acronyms

GMIMP = Draft Groundwater Monitoring and Impact Mitigation Plan February 6, 2023
http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/gwmimp-2023-02-06-rpt.pdf

PWAP = Draft Progressive Well Abandonment Plan February 3, 2023
http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/pwap-2023-02-06-rpt.pdf

WCMP = Draft Waste Characterization and Management Plan February 6, 2023
http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/wcmp-2023-02-06-rpt.pdf

Progressive Well Abandonment Plan (PWAP)

- The "Progressive Well Abandonment Plan (the Plan) is a **core mitigation measure** that is required to meet regulatory requirements and protect the groundwater resource." (p. 1) (Emphasis is mine). We thus expect substantive mitigation procedures to be detailed.

- "Boreholes will be advanced during the project to investigate geotechnical and hydrogeological conditions in advance of extraction activities." Further, "Some boreholes will be completed as monitoring wells to allow for hydrogeological testing, and monitoring of groundwater levels and groundwater quality prior to, during and following extraction activities as described in the Groundwater Monitoring and Mitigation Plan. Boreholes not completed as monitoring wells will be backfilled with cement/bentonite grout" (p. 2).

  We understand from the above that boreholes for prior investigation and for monitoring will be drilled in addition to the vast numbers of extraction wells.

  - **How many of these additional punctures will there be?**
    Figure 4-2 in GMIMP indicates 11 proposed new monitoring well locations in the initial extraction area. Further, GMIMP (p.13) indicates there will be ***three* boreholes of varying depth at each monitoring location**. Boreholes not used as monitoring wells are not indicated. Over the course of the project, these additional totals will be significant.
  - How many of these additional punctures will be interconnecting boreholes between the Carbonate and Sandstone aquifers?
  - Where will these boreholes be situated in relation to the clusters/cluster blocks?
  - Since the boreholes will be drilled in advance of extraction activities, this means that a **site and access trails will have to be cleared for the drilling to occur, regardless of whether extraction wells will subsequently occupy that site**. This will involve **additional ecological destruction**.
  - Access trails will have to be maintained to the monitoring wells for an extended period of time. On p. 6, "post-extraction groundwater monitoring, which is estimated to be five years or more following the end of sand extraction." How will this access maintenance occur?
  - How will the testing and borehole cleared sites be rehabilitated, even when the sites might not be used for subsequent extraction?

- "A locked protective steel surface monument will be installed to maintain the integrity of monitoring wells to allow for groundwater monitoring" (p. 2).

  - There is no representation or description of the size and appearance of this "steel surface monument".
  - How much will these monuments interfere with farming of cropland?
  - Will the monuments be permanent (in perpetuity), or will they be in place only for the duration of monitoring?
  - Are these monuments only for monitoring wells? Extraction wells will not be marked in any way?

- From p. 5 of PWAP:

2.4 Responsibility for Well Sealing and Abandonment

Well sealing must be performed by the owner or licensed well drilling contractor. Well drilling contractors are required to seal wells of the following categories:

- Flowing artesian well
- Injection wells
- Contaminated wells
- Saline wells
- Wells with remining equipment, pumps, or debris.

In some instances, the proper sealing of an abandoned well can be accomplished by the owner using appropriate techniques and materials to fill and seal the well.

There is a disturbing undercurrent here: could the responsibility for sealing descend onto the owner for boreholes and wells that are *not* in any of these four categories?

- "Boreholes and Sand Extraction Wells: Boreholes and extraction wells will be sealed within one year of installation to satisfy the requirements of the Borehole License after they are no longer required for operations. Efforts will be made to seal wells in a timely manner following extraction." (p. 5).

  - A maximum of a year is a long time. How will the boreholes be protected from contamination and misadventure in the meantime?
  - How will the boreholes be monitored until they are sealed?
  - "Sealing of boreholes by staff with experience installing well seals" (p. 8). Will these be Sio staff? What training and experience will they have?

- In Section 4.2 Sealing Materials (p. 6), no commitment is made to the use of non-polyacrylamide materials. This is a pertinent question, as testing and monitoring boreholes, sand extraction wells, shallow wells, small diameter wells, and deep and large diameter wells, are not water supply wells, where these materials are precluded.

  "Utilization of grout mixtures and sealing materials that have been confirmed to meet regulatory requirements." (p. 8). As discussed on p. 238 of the present Submission, the regulatory requirements are quite dim regarding additives in sealant materials.

- For Deep and Large Diameter Wells, "It is **recommended** to remove an upper portion of the casing to a depth of 2 m (6 ft) below ground surface)." (p. 7)(Emphasis is mine). This operation appears **only for this category of wells**, and is absent from the protocols of all the other wells. Does this mean that for those other wells, casings will not be severed, or

maybe severed at ground level? This would seriously exacerbate the environmental risks, as well as expose the abandoned wells to all manner of additional future damage and threat. Furthermore, even this item is "recommended" only.

- While PWAP is described as a "core mitigation measure" (p. 1):

  - There are no mitigation strategies whatsoever to address failed or flawed seals and casings.
  - There are no measures whatsoever to address the monitoring of abandoned wells.
  - There is no clarity how and whether *all wells* will be marked.
  - Will locations of abandoned wells be recorded on the land titles?
  - There are no mitigation strategies to address subsequent breakthrough or hydraulic fracturing of artesian wells.
  - There are no measures to address accidentally excavated casings, or sinkholes.

Waste Characterization and Management Plan (WCMP)

- **"**The project involves extraction of silica sand from the Carman Sand Member of the Winnipeg Formation using a series of boreholes (extraction wells) over a period of five years." (p. 6). The entirety of the EAP and supplemental documents identify a four year period for the current application. Where has this now been **amended to five years**? Has the project site boundary also changed (again)?

- "Approximately 330 extraction wells will be drilled per year and used to extract the sand." (p. 8). This number has progressively changed with time from the original numbers in EAP. What will be the final, actual number? How many additional testing and monitoring boreholes will there be?

- Table A (p. 9), provides a value of **<u>13 m</u> assumed thickness for Red River Carbonate** (Highlight is mine)**:**

Table A. Estimated Waste Material Production by Waste Type During First 5 years

Lithology[1]	Assumed Thickness		Borehole Diameter		Extraction Wells	Estimated Volume of Waste[2,3]		
	(ft)	(m)	(inches)	(m)	(Total number)	(m^3/well)	(m^3)	(tonnes)
Quaternary Sediments	118	36	16	0.406	1,680	4.66	7,830	15,660
Red River Carbonate	43	13	10	0.254	1,680	0.66	1,107	2,878
Winnipeg Shale	10	3	10	0.254	1,680	0.15	255	689

- How and where was this value obtained?
- This value **disqualifies** the Carbonate from the Stantec 15 m minimum thickness competent limestone model (see p. 148+ in this Submission).
- Will extraction still proceed regardless, or has the model been 'adjusted' now to accommodate the thinner limestone?

- Only three samples of each of the Carbonate and Sandstone were analyzed: "The Red River Carbonate and Winnipeg Sandstone formation did not contain any sulphide minerals and had low potential for acid generation." (p. 9). In view of the discussion on p. 275 of the present Submission, it is respectfully suggested that a more representative sample number is required.

- Personnel will be trained to "Visually identify and **estimate** sulphide and carbonate minerals contents." (p. 10). Materials will be "**visually** examined to confirm the waste rock type and determine the presence and **percentage** of sulphide and carbonates minerals." (p. 11) (Emphases are mine).

  How reliable and accurate will this visual assessment be:

  1. When the sulphides might be small granules that may need magnification.
  2. The sulphides may be oxidized and difficult to distinguish in the wet material.
  3. Assessment will also be occurring at night, where lighting may be a factor.
  4. How can *percentage* of minerals possibly be visually determined?
  5. How finely ground, or chunky, will the rock fragments be? Visual identification is restricted to what is apparent on the surface of the rock.
  6. Sampling frequency will be based on tonnage of the rock and overburden layers. How will tonnage be measured/estimated?
  7. Will dedicated personnel be tasked with this job, one worker per shift, in order to maintain consistency? Will alternate workers be available in the event of absenteeism?
  8. How much time will elapse between sample collection and availability of laboratory results?

- One of the control methods mentioned for metal leaching potential is "Treat contact water and other effluents using passive or active treatment methods" (p. 14). **What *exactly* are these methods?** Why are they not specified? **Will they occur on site?** Will any chemical waste result?

  Will this water be reinjected? The WCMP proposes "collecting the drainages before they reach the receiving environment and ensuring that they meet discharge criteria before release" (p. 14). What is the "receiving environment"? Where this water will be discharged/released? A ditch? The wells?

- Reporting will be only for the privileged "relevant authorities" (p. 14):

Annual monitoring reports outlining the characterization work carried out during the year, material classification, and management will be prepared and provided to relevant authorities in accordance with reporting requirements or upon request. The reports will summarize the results of geochemical testing and provide the volumes and types of waste generated per year. Recommendations for changes or improvements to the waste characterization, testing, classification, management, and monitoring programs will also be discussed in the report. The report will be prepared under the direction of a professional geoscientist with expertise and experience in the evaluation of ARD/ML.

  Why is reporting annual only? Is that not too late if there are problems?
  Why is there no public transparency? If these materials do constitute hazards, the public are entitled to know.

Groundwater Monitoring and Impact Mitigation Plan (GMIMP)

- Further to the discussion on p. 76 of the present Submission, regarding depths of domestic well pumps, the proponent admits that "The location of pumps within each water supply well is not known." (p. 8).
  "Well owners who agree to participate in the water well survey will undergo an in-person interview to discuss the history and demand of the well." (p. 12).

  The information required will be (p. 12):

- Location of the well
- Age of the well
- Depth of the well
- Well yield
- Number of users serviced by the well
- Type of use (i.e. domestic, commercial, livestock watering, irrigation, municipal, etc.)
- Pump installation depth
- Pump age and condition
- Current water quality information
- Historical taste/odour issues
- The presence of water treatment (e.g. water softener, etc.) and type of plumbing (i.e. copper, PVC, etc.) will be documented to aid in interpretation of water quality results.

1. The homeowner may not know the location, age, depth, or pump information. She may not be the original homeowner, or may be tenant. Even if the well was installed during the current owner's residency, most owners do not know this information. Some might think they do, but are mistaken. I do not believe that anybody will know the well yield, or current water quality information: most homeowners have never submitted their water samples for analysis if there have been no problems because it is very costly. In my own case, I analyzed my own well water every week in my lab for nearly 30 years (it has changed considerably), but I do not believe anybody else can provide much useful relevant data.

2. Many well owners might not agree to participate. How will these cases be handled if there is a subsequent problem?

3. Information regarding the presence of "water softeners, etc." is alarming and disheartening: do the proponents intend to continue their water softener sampling program (see p. 285+ in this Submission) and infer groundwater quality from these sources? They also want to know the type of plumbing, "to aid in interpretation of water quality results, "so we can conclude that **tapwater will be erroneously and inappropriately sampled**. Indeed, "If a sample can not be collected directly from the well due to existing pump infrastructure, **a sample will be collected from a hose bib or indoor tap**." (p. 13) (Emphasis is mine). The following is copied from p. 13:

4.1 Standard Operating Procedures

Groundwater monitoring will be conducted in accordance with the accepted procedures for collecting groundwater levels, collecting groundwater samples, collecting field measurements, recording field notes, and maintaining quality assurance/ quality control measures. The methodology is described in detail in the following reference documents:

- ASTM Standard D4448-01: Standard Guide for Sampling Groundwater Monitoring Wells
- ASTM Standard D6452-99: Guide for Purging Methods Used for Groundwater Quality Investigations
- British Columbia Field Sampling Manual (2003 Edition)

None of these sources endorses collection of water samples from a water softener. If water treatment equipment can be bypassed, the upstream portion of the system still needs complete purging, but results will be overestimated for metals due to contamination from casing and plumbing (see pp. 285-288 in this Submission).

Since there is no intention of avoiding water treatment equipment, why, then, not simply take samples from the output of the Anola water treatment plant, and pretend that it represents water in the wells of the region? Or, even better, do one of those popular "desktop surveys", at which the authors are so proficient?

4. "Historical taste/odour issues" ought also to include *appearance*.

- "The groundwater monitoring wells will be located at the corner of each section of land where sand extraction wells are proposed." (p. 13). There will be **three boreholes** of varying depths **at each location** (p. 13).

1. Surveyors' monuments are usually embedded at the section corners, and other parcel corners. The monuments cannot be disturbed. What is the setback of boreholes from survey monuments?

2. According to Figure 4-2 in GMIMP, in some cases considerable lengths of wide access trails will be required in order to allow the passage of drilling rigs and other vehicles/equipment. If the monitoring wells remain active for five or more years (PWAP, p. 6), this is a long time for these trails to remain in use. They will not revegetate for a considerable time afterwards. How large will the clearings be for these monitoring wells?

Over this period of years, personnel will continue to enter the properties with their vehicles. The landowners are entitled to compensation for the continued disturbance.

3. How far apart will the three boreholes at each monitoring location be?

4. Will installation require the landowner's consent? What if consent is denied? What authority will the proponent have to force the wells onto the property?

- "Proposed project activities will be evaluated **in advance** of each operational year to determine the zone of influence and water supply wells that may be impacted by project operations. The completeness of the monitoring well network will be reviewed each year following the Water Well inventory **in advance** of project operations to **confirm** it is adequate and able to monitor the impacts of sand extraction on all private water supply wells." (p. 13)(Emphases are mine).

  1. How will zone of influence be determined in advance? Conceivably, the actual zone may not coincide with the simulation zone. Operations have not yet started, therefore effects in monitoring wells are not evident. Will there have to be fallback on relying on complaints once operations are underway?

  2. What is the plan when the monitoring network is NOT adequate? When domestic well issues are unpredictable due to heterogeneous preferential flows as a result of secondary porosity (see p. 79), and homeowners' wells do not conform to the observations of monitoring wells (see p. 106)? Field conditions will seldom reflect the uniform and simplistic assumptions of models.

- "**At least** one monitoring well will be installed in between extraction wells and any private water supply wells (i.e. Operational Performance Monitoring Zone) to allow for early detection of impacts to groundwater quantity or quality for each year of operations and adjustment of operational procedures to **avoid** water supply well impacts." (p. 13) (Emphases are mine).

  1. At what distances will the monitoring wells be installed relative to operations/private wells? The proponent indicates monitoring wells will be located "100-250 m around the footprint of sand extraction activities" (p. 14). In cases where private well setback is only 100 m, will the private well become the monitoring well? In such cases, there will be **no early detection to avoid water supply well impacts**.

  2. "**At least** one monitoring well": how many might there be? Will each of these monitoring wells actually be three boreholes, i.e. the same as the monitoring triplets at the section corners (p. 13)?

  3. How many **additional boreholes** would this entail in total, i.e. in addition to the testing wells and the *three* monitoring wells at each corner of a land section (Figure 4-2, GMIMP)?

4. These further **additional boreholes** would require **access trails and clearing of each site** to allow access for drill rigs and vehicles and monitoring visits. In the end, with all of the well clusters, all of the testing and monitoring and extra monitoring boreholes, plus all of the various trails, the whole area will be trashed – we may as well just clear cut the entire landscape. We may as well also admit that most of the shale will be gone in the area. The company will move on to the next area, and the next…

5. "Early detection of impacts" and "adjustment of operational procedures" can only happen **AFTER operations are already happening,** and only **AFTER effects are already evident**. Therefore by that time, impacts cannot be **avoided**. Even if all operations instantaneously cease, the impacts do not instantaneously respond; there will be a lag period until equilibrium can be established, which will occur over a period of time.

6. As discussed on pp. 94+ in this Submission, monitoring wells in line with a private well may not necessarily reflect conditions in the latter because **hydraulic flow patterns between them might not be linear** due to fractures, joints and channels. These disordered flows may be **aggravated by the subterranean voids already previously created** in the cluster blocks. Thus a private well might be affected, without a corresponding change detected in the monitoring well.

- And then, as though the land has not been ravaged enough, there will be **further additional wells**: "additional monitoring wells will be installed to satisfy any data gaps in the regional and local groundwater monitoring well network, following the completion of a water well survey" (p. 14).

  It seems that there will be no limit to the number of various boreholes that the area can sustain. Truly unprecedented and unimaginable damage – the clearing of sites, the trails, the aquifers, the shale. The years of intrusion and disturbance. The people's lives and properties. Why not designate the region as one gigantic mine, and banish the residents from the wasteland? After all, Canadian mining companies are renowned for such tactics throughout the world (e.g. https://readpassage.com/canadian-mining-companies-are-destroying-guatemala/).

- "**All** groundwater monitoring wells, private water supply wells and sand extraction wells will be surveyed to determine their northing, easting and the geodetic elevation of ground surface." (p. 14)(Emphasis is mine).
  The term "all" means 'without exception'. This includes properties which do not have landowner agreements. What is the legal standing of the company, and the landowner, in the event access to the property or the well is denied by the property owner? Whose

rights supersede? Further, can the landowner deny access to company drones (see pp. 347+)?

- "Sio Silica will re-inject majority of water removed during extraction back into the aquifer under the proposed operational condition, and therefore the overall lower net withdrawal rates will reduce the depth and spatial extent of drawdown impacts." (p. 14).

  1. The extracted material may be as high as 90% sand and 10% water (SSCRIR1 #DLN-IR-007, see p. 64 of this Submission). Although the reinjection modelling has used a value of 50%, how representative is this of the entire extraction cycle? Further, water losses in the processing continuum (see p. 64 of this Submission) are not fully known because the complete process has neither been designed nor tested.

  2. How rapidly will reinjected water enter the aquifer? Will difficulty be encountered in reintroducing the water at the same rate that it is processed, without applying pressure?

- The Regional Groundwater Monitoring Zone was devised by applying a radius **around** the Local Groundwater Monitoring Zone: 2000 m for Sandstone, and 1000 m for Carbonate (p. 14). We understand this to mean that, in addition to the area of the Local Zone, a further 4 km diametrical span of areal impacts will be assumed for Sandstone, and 2 km for Carbonate. Beyond this span, impacts are "**anticipated** to be negligible" (p. 15) (Emphasis is mine). This will impact a large number of users. Furthermore, the area of impact will travel as operations shift to new clusters.

- "The electronic water level meter will be decontaminated between each monitoring well using Alconox detergent and de-ionized water." (p. 15).

  1. While Alconox is an effective cleaner, residues can interfere with phosphate, carbonate, sulphate and conductivity measurements. Liquinox omits the phosphate and is associated with less residue (https://technotes.alconox.com/industry/medical-device/differences-alconox-liquinox/). **All tools** that will be used in wells should be decontaminated and then rinsed with de-ionized water to avoid cross-contamination potential.

  2. Why are only monitoring wells favored with decontamination protocol? This care should be extended to all wells, especially private wells, that will be subjected to intrusive manipulations.

- The proposed frequency of water quality sampling is given in Table B (p. 16):

Table B. Summary of Groundwater Quality Monitoring Frequency

Groundwater Monitoring Zone	Frequency Prior to Operations	Frequency During Operations	Frequency for Year 1 Post-Operations	Frequency for Years 2-5 Post-Operations
Background Groundwater Monitoring Zone	Twice	Once Per Quarter	Once Per Quarter	Once Per Quarter
Operational Performance Monitoring Zone	Twice	Once Per Month	Once Per Month	Once Per Quarter
Local Groundwater Monitoring Zone	Twice	Once Per Quarter	Once Per Quarter	Once Per Quarter
Regional Groundwater Monitoring Zone	Twice	Once Per Quarter	Twice Per Year	Once Per Year

1. When and how far apart will the two Prior-to-operations samplings occur? Different months, seasons, years?

2. Is the Operational Performance Monitoring Zone within a well cluster, or otherwise? How is the Local Zone exactly defined? Why is it only sampled every 3 months? On p. 17, a primary purpose of data collection will be to "evaluate the impacts of project operations on …groundwater quality" and "Inform the need for implementation of any mitigation measures". Surely prompt reaction would be required, but if the samples were collected months ago….plus the lab turnaround time…plus the data review….

3. At what times of the year are the two 1-Year-Post-operation samples collected? Will this be consistent for all wells? Similarly at what time of year will the 2-5 post-operation sample be collected, and will this be consistent?

- "YSI-556 or YSI Professional Plus that is calibrated at least once daily throughout the duration of the sampling program" (pp. 16-17). Personal experience has shown that these instruments should be recalibrated/re-zeroed *each time before they are used*. If they are moved or transported in the interim, they may drift from their previous settings.

  Dissolved oxygen values may be overestimated due to the agitation from purging, and the three 'stabilization' values are likely to differ. Field measurements will be considered to be stable when the three readings are "within tolerance limits". How are tolerance limits defined?

The GMIMP refers to "Stabilized field measurements" for parameters including temperature and dissolved oxygen that may be measured in a container of water at the surface (p. 17). If one waits for these parameters to stabilize, they will stabilize at the **ambient surface temperature and oxygen saturation** values, and will not represent the original downhole values. Such parameters (also pH) must be measured as nearly *in situ* as possible. Field measurements for turbidity will apparently not be conducted, except possibly in wells where sensors may be installed.

The GMIMP also mentions that some real-time monitoring of basic water quality may occur (p. 17). In a contemporaneous ad in The Clipper (February 2, 2023, p. 14), the proponent goes further, with "Independent third-party oversite [sic]": "our advanced multi-data sensor monitoring equipment will track key parameters which **may** include the following **24/7**: Conductivity, Temperature, pH, Water level, Pressures, Turbidity, Oxygen, Flow" (Emphases are mine).

1.These parameters **may** include…? We don't know yet?
2. What "advanced" instrumentation will be used? How will it be periodically checked and recalibrated?
3. *How many* wells will be monitored at the same time? How long will the instruments remain in the same well, i.e. how frequently will they be redeployed?
4. Will some of these sensors be in private wells? How will constant usage of these wells affect the data (e.g. water level, pressures, flow)?

- According to GMIMP, samples will be analyzed as follows (p. 17):

  - Physical and Conventional Parameters (pH, specific conductivity, alkalinity, hardness, acidity, total suspended solids)
  - Nutrients (nitrate, nitrate and ammonia)
  - Dissolved Organic Carbon
  - Major Anions
  - Dissolved Metals
  - Total Metals

1. Measurement of pH should be conducted in the field because it is contingent on factors such as temperature and dissolved CO_2, which offgasses at the warmer temperatures and lower pressures at the surface (see p. 292 in this Submission).

2. Presumably nitrite is meant as one of the redundant nitrates in the above list.

3. What "major anions" and "dissolved metals" will be included? Will any hydrocarbons be monitored?

- The water quality parameters that will be the focus of attention are: selenium, arsenic and uranium, and pH, alkalinity, conductivity, sulphate, aluminum, iron and manganese (p. 21). Turbidity does not seem to be included, nor hydrogen sulphide nor radon, even though these parameters would be primary subjects of public concern. Mercury would be essential after UV lamp breakage (see p. 306 in this Submission). If any more bleach will be poured down wells (see pp. 329+ in this Submission), trihalomethanes for example would need to be monitored.

  Why are there no microbiological parameters?

- Who will administer this program? "We're in negotiations to establish an independent monitoring company that will provide oversite [sic], transparency, and authority to act on well data." (The Clipper, February 2, 2023, p. 14). This seems to imply that the proponent will *establish* their own monitoring company, yet it will somehow be "independent' at the same time. In short, no outside arms-length involvement. The "transparency", if any, will be curated and selective, as it has thus far been with the EAP documentation. Data can become "proprietary" at any time.

  What is "authority to act on well data"? Review the data? Issue warnings? Alert homeowners? Order the company to cease and desist operations in the area, or face a fine? Engage the 'mitigation make-up water truck' to bring water pronto? Report non-compliance to the regulators (not that this would be useful)?

- Table E (p. 23) shows the putative "response stages", presumably only for the above listed parameters:

Table E. Water Quality Thresholds in Stages 1, 2 and 3

Response Stage	Description	Threshold
Stage 1	Water quality meets CDWQ MAC and MWQSOG MAC or is similar to baseline groundwater quality	Concentrations of Primary and Secondary Indicators continue to increase during two consecutive sampling events; OR All samples report results for indicators that are less than 10% higher than pre-operation maxima
Stage 2	Water quality meets CDWQ MAC and MWQSOG MAC or is similar to baseline groundwater quality	Two consecutive samples report results for any indicator that are more than 50% higher than pre-operation maxima OR Concentrations of primary indicators in one sample greater than 75% CDWQ MAC or MWQSOG MAC
Stage 3	Water quality exceeds CDWQ MAC and MWQSOG MAC	Two consecutive samples reporting concentrations of any primary indicator parameter that exceeds 100% CDWQ MAC or MWQSOG MAC

1. Much of the existing water quality in this region is amply below the CWQG levels for drinking water, which makes it so valuable and sought after. It has already been harmed in many areas of Springfield by development, and industrial activities such as aggregate and livestock operations, which makes the remaining pockets all the more in need of conservation and protection. It is not morally or ethically responsible to allow it to rise up to the Guideline levels, when it is presently below those levels, as original quality cannot be reprised again. We have learned nothing from Shoal Lake, which was once arguably one of the best water sources in the world, but now sadly requires a treatment plant, because we abused it and allowed it to degrade (Pip, 2016).

2. More than 50% higher than pre-operation *maxima* is truly an unconscionable level of pollution – and even >75% in one sample? And further, two samples could exceed by 100% as in "Stage 3"? This would amount to environmental vandalism. People are drinking this water. Why should there be **any** adverse change?

- The mitigation measures are given in Table F (pp, 23+):

Degraded Groundwater Quality in Regional Observation Well Network	Water quality in Regional Observation Well Network significantly degraded relative to measured water quality prior to operations. Newly identified exceedances of applicable regulatory criteria based on water use.	Stage 1: Water quality evaluated quarterly by qualified hydrogeologist and/or geochemist, with results shared publicly. Stage 2: Conduct follow up sampling. Private Well Owners notified in the event there are deemed to be risks to water quality in private wells. Implement increased monitoring frequency. Stage 3: In extreme cases, provide potable water and/or water treatment system to the affected party via certified water purveyor until the situation is assessed and rectified if impacts deemed related to Project operations. Alternatively, cease sand extraction from that well.
Degraded Groundwater Quality in Private Water Wells	Water quality in Regional Observation Well Network significantly degraded relative to measured water quality prior to operations. Newly identified exceedances of applicable regulatory criteria based on water use. Public complaints specific to changes in water quality, taste or odour of well water.	Stage 1: Water quality information from monitored private wells evaluated following each sampling event by qualified hydrogeologist and/or geochemist, with results shared directly with well owner. Stage 2: Conduct follow up sampling. Nearby Private Well Owners notified in the event there are deemed to be risks to water quality in private wells. Implement increased monitoring frequency. Stage 3: In extreme cases, provide potable water and/or water treatment system to the affected party via certified water purveyor until the situation is assessed and rectified if impacts deemed related to Project operations. Alternatively, cease sand extraction from that well.

1. What does "significantly degraded" mean? The standard statistical significance level is 0.05, i.e. 5%.

2. "Newly identified exceedances": They are not so new if the samples were collected a month or 3 months ago. The qualified professional will evaluate results 'quarterly', according to Table F.

Further, why are only "newly" discovered exceedances included in Table F? What about 'older exceedances'? There is no mention of how or if those continue to be addressed.

3. Follow up sampling: how promptly does follow up sampling occur? After the above delay and deliberation, and now more delay, for response, and more lab turnaround time. The homeowner is drinking this water. He may be notified if some unknown entity 'deems': "there are deemed to be risks to water quality", but he has been drinking it for possibly months. What does he do now? Whatever he wants.

4. Now we get public complaints. Maybe we get a water truck or even some sort of unspecified "water treatment system". Who installs it? The last alternative and last resort is "cease sand extraction from **that** well". Since months may have passed since the problem was even noticed in the quarterly reviews, and further time has passed on all of the follow up sampling and analyzing and waiting and discussions and decisions by the upper echelons – the operation has long long since moved on. It seems rather silly to advocate ceasing extraction from THAT well at this point in time, when it ceased long long ago. Nobody seems to have advocated ceasing operations *in the area*.

5. In an ad in The Clipper (February 2, 2023, p. 14), "Sio will have independent oversite [sic], the ability to instigate operational stop and mitigation protocols should monitoring show an issue."

1. How independent will this 'oversite", i.e. oversight, be (see p. 535 above)?
2. By the time monitoring has shown a problem, there is a problem.
3. Mitigation protocols are essentially nonexistent.
4. Even if, in the unlikely event, operations stop, there will be a lag period before static water levels recover, and an even longer lag before water quality in the afflicted well improves.

6. Will hot water be provided? Will seniors, disabled or otherwise challenged people get help to carry the water into their house several times a day (see p. 100 in this Submission)?

7. Turbidity and discoloration may persist for some time afterwards due to deposition and resuspension of particulates within the plumbing system (see. p. 266 in this Submission).

8. A similar disappointing playlist is given in Table F (pp. 23+) for problems with water quantity.

9. We note that the extensive list of job openings advertised in The Clipper (February 9, 2023, p. 12) does not include a 24/7 job description for public liaisons for responding and dealing with enraged and frightened members of the public, and tracking and resolving complaints.

- In Table F above, Regional Observation Well Network data are evaluated quarterly. However on p. 25, "Groundwater quality results will be reviewed for all monitoring stations on a monthly basis." We refer back to Table B (p. 16), where times are various. In any case, it appears that only exceedances will be "flagged", and "Sio Silica will discuss and implement the required mitigation measures", i.e. resampling and delays and discussions. Nowhere are regulators or the Province apparently included.

  1. Exceedances are already in themselves *de trop*. Should not any upward changes merit notice and concern?

  2. The mitigation measures described by the proponent are not very helpful. Basically: wait, and maybe get some trucked water at a later time if approved and *in extremis*. Not a very palatable outlook. However the lowering of well pumps option from the EAP seems to have been (appropriately) abandoned (e.g. p. 99 in the present Submission). There is no mention of compensation for affected homeowners, or of payment for alternate living accommodation.

  Annual reviews will examine "increasing or decreasing trends in concentrations", and this information will be used "in development of appropriate threshold values" (p. 25). The proponents will make up their own "appropriate threshold values"? Without independent oversight and regulation? Without basic background and knowledge of public health? There are no 'do not cross' thresholds to start with, until they might be developed at some future time?

- We conclude that the GMIMP is inadequate and lacking in multiple ways:

  -many additional boreholes will be drilled for monitoring
  -these boreholes will require additional clearing of access trails and drill sites, adding to the already comprehensive destruction
  -monitoring wells may not identify problems in advance of operations
  -lengthy periods of domestic well surveillance will be intrusive
  -field measurement procedures need to be adjusted
  -the proponent intends to pursue further water softener sampling, and infer groundwater quality from these samples
  -water quality parameters that will be analyzed need to be itemized and expanded
  -**no microbiological parameters will be monitored and are not acknowledged**
  -water quality thresholds for 'response' stages are too high
  -water quality data need more frequent review
  -the homeowner is not protected in a timely way in the event of risks to water quality or quantity
  -mitigation measures are basically resample and wait, and perhaps a water truck in extreme cases: this is unacceptable
  -**no mention is made of monitoring quality of reinjection water**