MEMO

To:	Brian Zeman and James Newlands
From:	Garry T. Hunter, M.A.Sc., P.Eng.
Date:	July 30, 2024
File:	21-407
Subject	Preliminary Phasing Extraction Plan – Possible Alternative for Consideration

Brian and James,

Thank you for sharing the April 30, 2024 proposed Strada Quarry Preliminary Phasing Extraction Plan for advance Peer Review comment. These preliminary comments address hydrogeological components of the proposed Site Plan and offers an alternative quarry dewatering, extraction, and ongoing mitigation approach within the context of the MHPC Preliminary Phasing Extraction Plan (Fig H.3 enclosed).

1.0 Base Line Monitoring History Report

I have been somewhat delayed in replying due to the necessity of comprehensive updating of the Strada Baseline Monitoring History and the preparation of multi year integrated site hydraulics for the Epikarst /Upper Bedrock and the Gasport Formation Aquifers separated by the intervening Goat Island Aquitard. Our current knowledge of the site monitoring is summarized in the enclosed spreadsheet Table H.1 and related Figures H.1 and H.2. The latest groundwater monitoring data we have from Strada is for March 2024.

The last Strada consolidated Baseline Monitoring History Report is now more than one year old. This updated report is required to consolidate the myriad of monitoring communications (a recipe for errors) and to efficiently inform the groundwater modeling and conceptual site plan development as well as this Peer Review. The Impact Assessment Report presumably follows or is part of the Groundwater Modeling and is not part of the Baseline Monitoring History Report. The Impact Assessment Report should not be required until further development of the Site Plan Mining and Dewatering / Recharge Mitigation concept is completed.

Furthermore the availability of the Baseline Monitoring Report will permit further addressing and closing of Matrix issue items.

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2.0 Site Groundwater Monitoring and Aquifers

2.1 Site Monitoring Deficiencies

This enclosed spreadsheet demonstrates that there are now about 50 active groundwater monitors remaining from an original 74 monitors constructed (one third destroyed or inactive). These 50 active remaining monitors are not optimally distributed for multi-level water level interpolation between the monitor locations. Furthermore the Strada monitor well A,B, C depth classifications have required revision based on the site hydraulics and hydrostratigraphy representative of the proposed Strada Quarry lifts.

2.2 Overburden 'Perched' Aquifers

This Peer Review does not currently assign Quarry significance to the overburden wetland 'perched' aquifers which occur on Lot 11, 12 and part of Lot 13 to the west of and along the 4th Line extending onto the Strada site. These perched water levels were incorporated into the Strada 2023 Compliance Report groundwater contour mapping.

2.3 Epikarst / Upper Bedrock Aquifers

This Peer Review Epikarst / Upper Bedrock 'B1 Monitors' water levels (Fig H.1) have been constructed from 2008 to 2023 Strada and Duivenvoorden December 2018 site monitoring data supplemented by LiDAR DTM pond and wetland elevations as shown. Fig H.1 demonstrates a groundwater flow convergence zone in the south western Prince Pit and in the eastern Melancthon Pit No 1 area. This groundwater flow convergence zone is also reflected in the Melancthon Pit No 1 Site Plan depth extraction limit and rehabilitation contours.

There remain 'no static water level data' areas along the eastern half township lot boundary and insufficient active 2023 water level data along the 4th Line in Lots 12 and 13. Only the W½ Lot 11 Melancthon Pit # 2 discharges to Boyne River tributaries.

Fig H.1 is still open to challenge because of insufficient and poorly distributed monitor locations especially as required to define the local groundwater flow convergence zone. This flow convergence zone may reflect a narrower vertical karstic fracture (underwater stream) zone than may be defined by the existing monitors.

2.4 Gasport Aquifers

This Peer Review Gasport Aquifer Groundwater Level Contours 'D1 Monitors' piezometric water levels (Fig H.2) have been constructed from December 2023 water levels supplemented by open hole legacy December data and hydraulic push downs (anomalous low water levels in upper bedrock monitors). With the exception of the southwest Prince Pit area at 4th Line and the designated 'no monitor data' areas, Fig H.2

provides relatively smooth contours, smoother than the Epikarst contours indicating a more complete monitoring data set.

Fig H.2 also shows a groundwater flow convergence zone in the south western Prince Pit and the Melancthon Pit # No 1 area. Given sufficient multilevel site monitoring data these groundwater flow zones are likely horizontally and vertically coincident. The lowest groundwater levels and greatest quantity of groundwater flow on site is therefore at the eastern side of the Melancthon Pit # 1 in the area of prior Strada groundwater takings (PW1 and OW1).

Fig H.2 is also open to challenge because of an insufficient number of monitor locations especially as required to define the local site flow convergence zone.

2.5 Multilevel Groundwater Monitors

Based on the above hydraulic plots, we have now determined that there are the equivalent of five active and one open hole multi-level data sets available on the existing Strada Pits site. Five of these equivalent multi level monitors demonstrate downward gradients and one an upward gradient across the Goat Island Aquitard / Chert Zone. Upward gradients occur in the Melancthon Pit No 2 (W½ Lot 11) area.

Table H.2: Epikarst – Upper Bedrock / Gasport Aquifer Multi-Level Monitor Equivalents

Multi Level Monitors			
(1)	OW23A-B1	496.21	
	OW27C-D1	494.66	
		1.55	
(2)	**OW24A-OHB1**	492.88	Open Hole
	OW24C-OHD1	484.94	Open Hole
		7.94	
(3)	OW28A-B1	486.74	
	OW28C-D1	483.66	
		3.08	
(4)	OW25A-B1	484.35	
	OW25C-D1	479.48	
		4.87	
(5)	OW6A-B1	491.12	
	OW30C-D1	490.37	
		0.75	
(6)	OW4C-B1	490.15	
	OW29C-D1	492.27	
		(2.12)	

This is a sparse dataset for evaluation of site wide vertical gradients.

2.6 Water Quality Gasport Aquifer

No analytical water quality data has been presented for the Gasport Site Aquifers. Is the water quality similar or different from the Upper Bedrock Aquifers**?**

3.0 Revised Preliminary Quarry Concept

Based on the above hydrogeological interpretations of site Baseline groundwater monitoring data we have prepared, for Strada consideration, a revised quarrying concept (Fig H.3) to that proposed in the MHBC May 21, 2024 Memo. This revised concept has a similar upper extraction footprint area (64.4 ha) to the MHBC proposal (65.9 ha).

3.1 Pit / Quarry Lifts

The enclosed Peer Review Figure shows the proposed conceptual pit / quarry lifts.

Lift 1	Overburden (Glacial Till, Sand and Gravel)
Lift 2	Guelph / Eramosa
Lift 3	Goat Island Chert Aquitard
Lift 4	Gasport

The enclosed Fig H.3 illustrates a maximum 25 m maximum operating quarry face with a 25 m setback (1:1 slope). This 25 m horizontal operating face setback occurs within Lift 3.

The Figure H.3 schematic cross section also shows the Epikarst / Upper Bedrock water levels and the piezometric surface of the Gasport Aquifer demonstrating an approximate 5 m hydraulic head loss across the Goat Island Aquitard at this location.

3.2 East Quarry Extraction Boundary

The east Quarry extraction limit has been revised on Fig H.3 to follow the dominant woodland trend with proposed constructed wetlands as compensation for minor tree and wetland removal as may be required to define a more or less straight line eastern quarry extraction boundary.

The eastern Part of the W½ Lot 11 pit area has been extracted below the water table. This area is proposed for wetland / woodland removal compensation as may be desirable.

3.3 Designation of Downgradient Clean Water Infiltration / Injection Areas

The objective is to recharge clean aquifer water to both the Epikarst / Upper Bedrock and Deep Gasport Aquifers along the groundwater depleted downgradient eastern Township Lot setback of the expanding quarry excavation. Injection wells will likely be required to recharge the deep Gasport Aquifers downgradient of the quarry.

Designation of a 'no quarry' buffer Infiltration area in the groundwater flow convergence zone on the east side of the overburden extracted Melancthon Pit #1 (Lot 13) and possibly secondary areas and at mid Prince Pit Lot 14 will be required.

An aggressive pumptest is required in this designated clean water infiltration area to provide design information.

Designation of injection well areas may be required along the east ½ Township licence boundary in both pit extraction and woodland areas.

3.4 Clean Water Extraction Wells

Phased construction of Clean Water extraction wells along the south, west and north sides of the quarry excavation are proposed. Construction of a clean water pipeline to clean water injection wells located along the east quarry boundary is proposed.

An adaptive water management plan will be required.

Note: Quarry sump water will be turbid with quarry fines and contain AN/FO residuals.

3.5 Phase 1, 2, 3, and 4 Lift 2 Upper Bedrock Extraction Area

Upper bedrock Phase 1 Lift 2 extraction is proposed to be initiated adjacent to the 4th Line in N½ Lot 12. The quarry sump to be located down dip in the south west corner of the excavation. Upper bedrock Lift 2 Phases 2, 3 and 4 to progressively follow.

Based on legacy pump tests, the Phase 1 starting location has very tight rock and should have minimal groundwater inflow. A settlement pond has been designated for discharge of turbid water from the southwest corner quarry sump.

If the Lift 2 Upper bedrock excavation is too extensive in area (Fig H.3) , and the Gasport Aquifer is not depressurized, the hyrogeological conditions are favorable for a Goat Island aquitard floor rupture and uncontrolled quarry floor flooding (i.e., Woods Quarry west of Kingston).

3.6 Phase 1 Lift 4 Lower Bedrock Extraction

Strada will likely want early access to the higher economic value Gasport Aggregate resource. This access will require removal of not only Lift 1 and 2 but also the Lift 3 Goat Island Chert Aquitard and exposure of the Lift 4 Gasport Aquifer with higher dewatering rates required. Initial access is recommended in the Phase 1 Lift 2 area.

Phase 1 Lift 4 Lower Bedrock (Gasport) extraction will require dewatering to about 50 m depth, deeper than any other Dolostone Quarry in Ontario. Alternatively underwater extraction of the Gasport may be proposed (James Dick Hidden Quarry Rockwood).

As extraction approaches the Melancthon # 1 eastern Quarry boundary, slurry walls may be required across the groundwater flow convergence zone to control back flow from groundwater infiltration / injection areas.

3.7 Alternative Phase 1 Quarry Initiation

There is also tight bedrock in the north east corner of the Prince Pit. However initiation of quarrying in this area would require significant removal of Lift 1 Sand and Gravel resources prior to quarry extraction.

3.8 Water Balance

No water balance has yet been presented to guide water management planning. Will water surplus be in excess or deficit compared to the existing pits during proposed Quarry operational and rehabilitation phases.

3.9 Time to Fill Quarry Excavations

No estimate of time to fill quarry excavations and related mitigation has yet been presented. Will quarry filling be part of progressive rehabilitation?

3.10 Perpetual Groundwater Mitigation

Will perpetual groundwater mitigation be required?

4.0 MHBC April 30, 2024 Preliminary Phasing and Quarry Extraction Limit - Hydrogeological Disadvantages

- The proposed MHBC Extraction Plan appears to be based on initiation of mining in the lowest water table and least overburden depth pit area.
- The proposed initial Phase 1 A and 2 A are located in the local site groundwater flow convergence zone and will require maximum groundwater pumping and management throughout the entire life of the quarry and beyond.

- Furthermore, the MHBC proposed extraction plan does not provide for infiltration / injection of dewatering within the existing karstic groundwater flow convergence zones on the downgradient area of Melancthon Pit No 1. How will these groundwater levels and flows be maintained? This existing groundwater convergence zone may be able to accommodate excess groundwater recharge with minimal adverse or even positive downgradient effects.
- The proposed Prince Pit northeast water mitigation / infiltration area is underlain by tight bedrock as confirmed by local Upper Bedrock groundwater contours. There is a danger that infiltration water will flow in greater quantities in the Epikarst / Upper Bedrock Aquifers to the northeast increasing farm field groundwater discharge zones west and east of the 3rd Line in Township Lot 15. How will the deep Gasport Aquifers be recharged?
- The proposed S½ of Lot 11 east boundary is likely underlain by low permeability fine textured Tavistock Till as indicated by the presence of nearby wetlands (see NRSI reports). This area appears to have low natural infiltration capability.
- The proposed W½ Lot 11 Infiltration Area is located in an area of upward groundwater gradients (Gasport to Guelph / Eramosa). Groundwater recharge should not be expected at this location except were influenced by quarry drawdowns (flow back into quarry). An elevated higher hydraulic head infiltration reservoir, with water pumped from the Pine catchment, will simply seep or spill over into the Boyne River tributaries and increase the general wetness of downgradient farmers fields. Groundwater flow will be reduced to the Pine River headwater tributaries.

5.0 Conclusion

There are obviously many other considerations leading to development of an optimal efficient quarry plan. This communication is intended to constructively address an optimal quarry development framework from a hydrogeological point of view and advance the process. This communication should not be construed as Peer Review support for a Quarry licence approval.