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January 18, 2018

R.J. Burnside & Associates Limited
292 Speedvale Avenue West Unit 20
Guelph ON
N1H 1C4

Subject: Greenwood Aggregates Pit Violet Hill Licence Application
Response to the Combined Level 1 and Level 2 Hydrogeological Assessment Peer Review

Attention: Gord Feniak, Vice President, Technical Services

Dear Mr. Feniak:

Whitewater Hydrogeology Ltd. (Whitewater) is pleased to respond to the R.J. Burnside & Associates Limited (Burnside) technical peer review comments completed on the Combined Level 1 and 2 Hydrogeological Assessment. (prepared for Greenwood Aggregates for the proposed Violet Hill Pit: memorandum dated December 18th, 2017).

It is noted that as part of the technical review, two versions the Existing Features page of the Site Plans (dated July 13 and July 7, 2017, respectively) were reviewed. It is felt that the Site Plans should have been studied in their entirety in order to provide the techncial reviewer with a comprehensive understanding of the proposed operations for which the hydrogeological assessment was based on. Furthermore, it is noted that that Burnside received a copy of the Combined Level 1 and 2 Hydrogeological Assessment which contained poor reproductions of Figure 1 and Figure 4. Clean copies of these figures were not requested prior to moving forward, which would have resulted in a more comprehensive the peer review.

Burnside comments have been copied from the original memorandum and pasted into the appended table. Whitewater responses fall within the ajacent cells and have been provided in the same sequential order as the format of the technical review.

If you have any questions or concerns, please do not hesitate to call at any time.

Yours truly,

Tecia White, M.Sc. P.Geo.
Senior Hydrogeologist
Whitewater Hydrogeology Ltd

Burnside Comments		Whitewater Responses	
Section	**Comment/Question**	**Section**	**Response**
Borehole Drilling and Monitoring Well Construction			
2	The unavailability of water level data from these locations [dry wells] has restricted the analysis of groundwater flow conditions especially in the north east sector of the site.	6.1.3, 7.4	Topography often is used by hydrogeologist as a preliminary method to identify local groundwater flow patterns within the upper-most saturated interval. This approach can be applied in designing shallow monitoring networks at properties or in areas where little to no site-specific hydrogeologic data are available (W. Dean, S & Blauvelt, Robert & Fullmer, David, 2011). The primary groundwater flow direction is eastward, with a minor westerly and southerly component towards Sheldon Creek. The seven monitoring wells that allow for the establishment of the water table elevation support this conclusion. MW14, MW13, MW9, and MW3 all report water levels higher than wells to the east of them (MW5, MW2, and MW11). This includes the dry elevations reported at MW8 and MW12.
		3.1	As seen on the regional DEM (Figure 1) and Figure 3 (Site Drainage) and discussed in report text, the topographic high at the site is found along the northern property boundary, suggesting shallow groundwater flow is not northward. Furthermore, the highest water level at the site was reported along the northern property boundary at an elevation of 413.5 masl (MW9). Immediately east of MW9, the water level at MW10 is below an elevation of 408.6 masl, indicating an easterly flow direction (supported by regional flow reported by Burnside in their 2001 groundwater assessment of the area).
			The absence of water level data in this area does not restrict the analysis of the groundwater flow conditions.
2	The MOECC database indicates that the depth at which water was struck in this well was approximately 64 m as compared to the 20 m completion depth for MW7. Review of water well records for domestic wells located in the vicinity of MW6 (completed at 16 m) indicate that groundwater was hit in the region of 60 m below grade in this area.		Burnside noted that the local domestic water wells may be used to supplement the on-site data. Specifically, the domestic water wells in proximity to dry groundwater monitoring wells (i.e., MW7 and MW6). Caution needs to be taken when relying on domestic water well information to map the water table. Specifically, the reported depth to which water was found. Depth to water reported by a water well driller is the depth below ground level at which the driller reported the occurrence of water, which may be suitable for a domestic supply. Burnside has noted that the water well record for DW3 (MOECC No.: 17-04612) indicates that water was found at a depth of approximately 64 m (Section 41 of the Water Well Record). However, this does not represent the static water level depth that could be used to map the shallow unconfined aquifer and its flow direction. The static water depth at the time of drilling is provided under Section 71 of the Water Well Record and is reported to be 38 m. It can be further argued that this water level is not the water table, but the potentiometric surface of a lower confined aquifer (based on the lithology encountered). Water levels reported at the time of drilling are often used to assess the water table elevation and regional groundwater flow direction. This can be completed only when assessing a large area that has a sufficient database of water well records, which allows for general patterns in the water table elevations to be interpreted. However, on a local scale, water levels reported on drillers records should not be relied upon to determine local flow conditions. These water levels are typically taken immediately after drilling when the well contains drilling fluids, or after well development when true static conditions have yet to be reached.

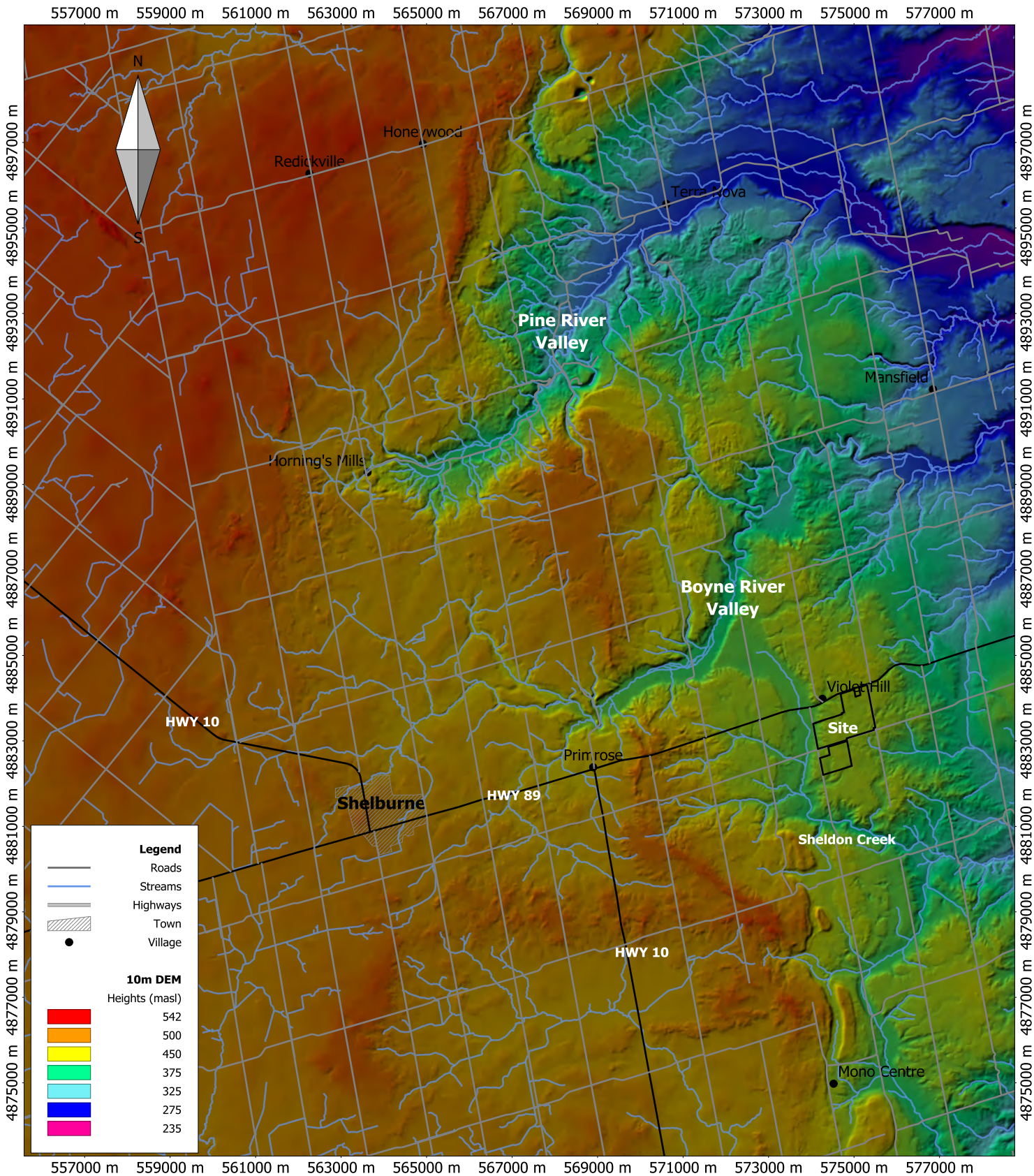
Burnside Comments		Whitewater Responses	
Aquifer / Hydraulic Testing Program			
Section	**Comment/Question**	**Section**	**Response**
3	It is indicated that three slug tests were completed at the site in Section 2.4 of the report. Section 6.1.1 provides results for two tests.	2.4, 6.1.1	The report of three slug tests was a typographical error. Two slugs tests were completed (MW9 and MW11). This is correctly noted in Section 6.1.1 and in Table 3.
	It is uncertain if the results presented refer to MW11 or MW1. The well included in the testing needs to be clarified as MW1 is completed to depth of 10 m while MW11 is completed to 24 m (approximately).	6.1.1	An instantaneous change in head (slug) test is conducted to determine the hydraulic conductivity/transmissivity of a water-bearing zone. No testing was completed on MW1, which is dry. It is documented at the tests were completed on MW9 and MW11 (see above comment). The reference to MW1 is a typographical error and should read MW11.
Physiography and Drainage			
4	The report indicates that approximately 60% of the proposed extraction area is defined by closed drainage basins. It is uncertain as to what was basis for this determination. The topographic contours presented in this report along with those in the Rollings Hyland Consulting Site Plan do not support the closed depressions as delineated. The Rollings Hyland Consulting Site Plan does suggest the presence of closed depressions however they seem to be of much more limited extent than suggested in the Whitewater report	3	The contours (1 m intervals) provided in both Figure 3 and the Site Plans were obtained from First Base Solutions. The catchment mapping provided in Figure 3 was generated in Manifold GIS and then reviewed by Whitewater. Manifold's Surface Tool extension includes the Watershed Computation Tool, which works with a drawing/surface to find watersheds in the surface (regions sharing a common drainage) as well as streams in the surface or upstream areas in the surface from points in a specified drawing. After running this tool, Whitewater reviewed the results confirmed the interpretation (boundaries and size) of the closed drainage areas. Whitewater does not agree that these catchment areas should "much more" limited in extent.
	Based on the Rollings Hyland Consulting Site Plan there seems to be a surface water flow divide that crosses the site in a north to south direction. This divide roughly approximates to the location of the west edge of the closed depressions. It is anticipated that this surface water divide will impact groundwater flow directions on the site	3.1, 7.4	A surface water (or catchment) divide marks were there is a divide in the flow direction (separates area where the water flows in one direction from areas where it flows in another). Surface water catchment areas are defined in Figure 3. Burnside notes that it is anticipated that any surface water divide will impact the groundwater flow direction at the site. This statement is confirming the findings presented in Section 3,1 which states "*Outside of these closed basins; surface water drainage is primarily towards Sheldon Creek to the west*" and in Section 7.4 which states "*The primary groundwater flow direction is eastward, with a minor westerly and southerly component towards Sheldon Creek."* The catchment areas are defined by the surface water flow divides in Figure 3.
Quaternary Geology			
5	The report uses the regional data to support a claim that the floor of the proposed extraction will remain above the base of Sheldon Creek. It is noted that due to the regional (coarse) nature of this data this is not a sufficient basis on which to make this claim. The elevation of the floor of the extraction should be compared to the base of Sheldon Creek based on locally derived survey data.	3.1, Figure 3	Burnside suggests that the regional (coarse) data was used to support the claim that the floor elevation of the proposed Violet Hill Pit will remain above the base of Sheldon Creek. This is an an incorrect statement. Figure 3 shows the local topography based on the 1 m contours. In Section 3.1 it is noted that the elevations on-site range between a high of 442 masl along the northern property boundary to a low of 405 masl along the western property boundary, where the ground surface falls toward the valley floor (Sheldon Creek). Based on the 1 m contours Sheldon Creek sits at an elevation of 400 masl in this location. The Site Plans (July 7, 2017) and Figure 6 (Local Geological Cross-Section) show that the proposed floor elevation will remain at approximately 415 masl.

Burnside Comments		Whitewater Responses	
Quaternary Geology			
Section	**Comment/Question**	**Section**	**Response**
5	Using the Rollings Hyland Consulting Site Plan as reference, it seems that the locations of cross sections were not chosen to optimize the use of monitoring well logs on the sections as slight modifications of cross section orientations may have resulted in more wells being suitable for use on the sections. Additionally on the current sections, wells that are a similar distance offset from the line of section are not all used to construct the section. The rationale for this omission should be discussed. It is noted that numerous private wells are available in the vicinity of the site and these well records could be used to augment the interpretations of the onsite wells.		The cross-section locations chosen by Rollings Hyland Consulting for the Site Plans bisect both the northern and southern portions of the Violet Hill property. For both consistency and representativeness, Whitewater used the same locations. It is felt that based on the geological and hydrogeological conditions the cross sections provide representative cross-sectional views of the site. Whitewater used the four sections to plot most of the wells. Some wells were not plotted due to either the fact they were shallow/dry (providing no additional information) or fell near on the section line to another well. Professional judgment was used on what wells to plot and which ones provided limited information in cross-sectional view.
	We note that the cross section interpretation is not consistent as on section SN1, monitoring well MW2 is shown as terminating in a silt formation while on section WE2 the same monitoring well (MW2) does not show a slit layer termination. Additionally section SN2 shows a well labelled MW2 in the north end of the site close to Highway 89. Based on the information provided MW2 is located in the south of the site, the potential wells in this area (near Highway 89) are MW9 and MW10.		Cross-section SN1 and WE2 both have MW2 identified. Burnside has noted that an isolated silt layer is found within in the southern section of SN1. This silt layer represents the geological conditions at MW11 (Borehole Logs: Appendix A), which is noted to be offset from the section line). The extents of this layer are unknown as identified on the cross-section. The silt is not representative of the geological conditions encountered at MW2 (Borehole Logs: Appendix A). Cross-section SN2 contains a typographical error. M2 should read MW9.
	The cross sections also contain an estimated seasonal groundwater table high. It is not specified what date this seasonal high is based on. The date associated with the estimation is important in order to compare other groundwater elevations with the indicated high.		The water used to estimate the water table elevations plotted on Figure 6 were measured on May 28, 2014. As noted in Section 6.1.2., groundwater elevations remain relatively stable over the year (less than 1 m, except for MW2, which fluctuated 1.45 m). At the scale of the cross sections presented in Figure 6, the small seasonal difference in water level elevations would not be captured.
	As presented on Section WE1 there is a groundwater divide (groundwater mound) near the west edge of the site. Groundwater west of the divide therefore must flow westward towards the Violet Hill Wetland and groundwater east of the divide is interpreted to flow eastward.		Burnside comment suggests agreement with the findings of the Combined Level 1 and 2 Hydrogeological Assessment. The water table present in Figure 6 (WE1) shows a groundwater divide near the west of the property. This mound was included on the cross-section to show that there is a groundwater flow component to Sheldon Creek (Violet Hill Wetland). This is discussed throughout the report.
	The cross-section also suggests that the Violet Hill Wetland is supported by groundwater discharge from the site as the groundwater table intersects the ground surface. The report does not discuss this interpretation or the potential impacts to the wetlands from the proposed extraction	7.6	Burnside claims that an impact assessment was not completed on the wetland and creek. However, in Section 7.4 (Potential Interference with Surface Water Features), a discussion is provided, which includes a summary of the water balance analysis. It is stated that *"local surface water features include Sheldon Creek and the Violet Hill Wetland located immediately to the west of the proposed Violet Hill Pit. The water balance analysis concluded that the majority of the water surplus from within the proposed extraction area (are to be disturbed) entered the groundwater system either as direct recharge (internally drained basins) or infiltrated along the runoff flow path. This is supported by the observation that there are no surface water features on-site (intermittent streams, creeks, springs, or wetlands).* *Infiltration across the subject property recharges the overburden aquifer and becomes a part of the local groundwater flow system. The primary groundwater flow direction is eastward, with a minor westerly and southerly component towards Sheldon Creek. Based on the findings of the water balance assessment, groundwater recharge may increase by approximately 14%."* This summary indicates that the increase in groundwater recharge will be incorporated into the groundwater flow regime, which is dominantly east. The small portion of the 14% increase in infiltration will likely have no measurable influence on the creek or wetland. Therefore, Whitewater disagrees that the groundwater flow contribution and potential impacts to the wetland are not addressed in the hydrogeological assessment.

Burnside Comments		Whitewater Responses	
Private Domestic Water Use			
Section	**Comment/Question**	**Section**	**Response**
6	The report provides a value for aquifer transmissivity based on a calculated Specific Capacity. The methodology for this computation of transmissivity should be provided.		Whitewater used the AqTesolv Calculator which relies on Driscoll's (1986) unconfined formula which is based on the Cooper and Jacob Solution (1946).
	The report's conclusions suggest that there will be no impact to domestic wells from the proposed extraction. The report notes that there will be a slight increase in recharge at the site due to the extraction. This increase in recharge should allow for the maintenance of the groundwater flow systems and hence a reduction in groundwater quantity is not expected.		Burnside agrees with findings presented in the hydrogeological assessment. No response required
	The increased vulnerability will require the use of spill management protocols on the site. In addition to the measures outlined in the Hydrogeology report it is recommended that the following measures be included a spill management plan should be in place for the facility. All spills should be reported to the MOECC Spill Centre.		As noted in Section 8, Greenwood Aggregates has a corporate Spill Contingency Plan. Additional details are provided on Page 2 of 5 of the Site Plans (Operations Plan) Spills will be handled in compliance with Ontario Regulation 675/98 under the Environmental Protection Act Part X.
	The report also recommends that a well survey be completed for all domestic wells within 500 m of the site and that a monitoring program be developed for wells within this area. It is further recommended that at least one monitor well be selected from wells up gradient of the site and at least one well from down gradient of the site as part of the monitoring system. The report recommends that an annual monitoring report on the findings of the groundwater monitoring system be submitted to the MNRF. It is further recommended that a copy of this report be provided to the municipality		Whitewater agrees with these recommendations.
Source Water Protection and the Aggregate Industry			
7	Whether an activity is considered a threat to groundwater is based on the combination of the nature of the activity and the nature of the vulnerable area (vulnerability score) that it falls into. Based on current MOECC approved methodologies the nature of highly vulnerable aquifers and significant groundwater recharge areas (maximum vulnerability score of 6) does not allow for drinking water threats (as defined by the province) to develop in these areas. It is noted however that in accordance with provincial guidelines, the removal of overburden layers as in gravel pits results in an increase in vulnerability		Burnside agrees with findings presented in the hydrogeological assessment. A similar discussion is provided in Section 5.1 of the Whitewater report
Groundwater Elevations			
8	A groundwater flow map is presented in Figure 8 that uses data from June 5, 2015 to determine flow directions. It is unknown if this is the data that is used on the cross sections to illustrate the seasonal groundwater high. My review of the data presented in Table 4 indicates that the data for June 5, 2015 does not represent the highest groundwater table recorded. The information provided suggests that data for the period June to July of 2014 has groundwater elevations that are up to 1.2 m above the June 5, 2015 level (see data for MW2 – June 4, 2014). It is important to consider a conservative value for seasonal groundwater high and for the base of the excavation to be determined based on a reasonable estimate of this value.		As noted in the response under Item 5 – Quaternary Geology, the groundwater elevations used in the cross-sections and to compare to the proposed pit floor elevation were the reported high level measured on May 28, 2014.

	Burnside Comments		Whitewater Responses
Groundwater Elevations			
8	The hydrographs for the various monitoring wells were reviewed and small scale fluctuations were noted to occur in association with precipitation events. Although these events result in small fluctuations in water table the duration of these events is expected to be small and hence their impact of long term water level elevations are expected to be minimal		Burnside agrees with findings presented in the hydrogeological assessment. No comment required
Groundwater Flow			
9	The data presented, the cross section and topographic data suggest that there is a surface water divide on the west side of the site. It is also likely that this serves as a groundwater divide as well. The groundwater flow presented in Figure 8 does not acknowledge flow to the west from the site even though this is acknowledged in the text. It is important to acknowledge flow to the west as this acknowledgement indicates that impacts to Violet Hill Wetland are possible due to excavations on the site.		The surface water divide is not suggested; it is shown on Figure 3. The groundwater divide in this area is also well documented throughout the report (see response to Items 2, 4, and 5 above) Whitewater feels that the groundwater flow component to the Violet Hill Wetland has been sufficiently addressed throughout the text. A small arrow could be added to Figure 8 to show a minor flow component in relation to the dominant flow directions. Regardless, the description/interpretation of the local flow conditions are provided in detail throughout the Combined Level 1 and 2 Hydrogeological Assessment.
	The surface water catchments associated with watercourses that drain to Violet Hill wetland should be determined along with the nature of surface water support for this feature. The nature of support for the wetland is important as this will need to be maintained during and after the excavations on site.		Surface water catchment areas and water balances were not completed for areas outside of the proposed operation. For an above water aggregate operation, where there is no water taking or diversion, off-site impacts are highly unlikely. The results of the water balance suggests a small increase in groundwater recharge. This increase would likely be dissipated within the groundwater regime and no measurable impact to surface water features would occur.
Background Groundwater Quality			
10	Elevated nitrate in monitoring wells indicates the potential for the aquifer to be impacted by land use. It is important to note this potential especially in the post-extraction phase when vulnerability is increased on land is returned to agricultural use.	6.1.4	Burnside agrees with findings presented in the hydrogeological assessment. A discussion on the elevated nitrate in the monitoring wells is provided in Section 6.1.4 of the Whitewater report
Water Balance			
11	The water balance has been completed in the pre-excavation phase based on the delineation of internally drained areas. As outlined in Section 4.0 above, the delineations do not seem to match the site topography. That being noted, the conclusion that the post-development recharge is likely higher than pre-development recharge is still valid as adjustments to the size of the internally drained areas will result in reductions to overall pre-development recharge		Whitewater's delineation of the internally drained catchments presented in the report are considered to be accurate. Further information is required to assess Burnsides interpretation of the contour data.
	It should be noted however that there is potential for impacts to surface water features and this impact should also be evaluated in order to support the conclusion that no impact is likely.		It is unclear how Burnside feels that a small increase in groundwater recharge could impact a surface water feature. As noted in the Tier Three Water Budget & Local Area Risk Assessment; Orangeville, Mono and Amaranth Final Report (May 2011), it should be ensured that any future land developments do not have a negative impact on groundwater recharge and, where possible, attempt to enhance groundwater recharge. This enhanced recharge may increase groundwater discharge to some local streams and wetlands and may offset some baseflow reductions that may occur with future increased pumping or groundwater recharge reduction activities.
	It is recommended that the water balance analysis be completed for the entire site and not only for the area of excavation so the full impact of the proposal is understood. For example it is my understanding that berms are to be built on the site the water balance should incorporate these features along with an allowance for roadways and other areas where compaction may impact infiltration rates.		It is unclear how the request to include small changes to the water balance area will change the results and findings. Incorporating permeable berms and roads will have little to no impact on the overall water balance since it they will not change the drainage pattern (this is not comparable to a development site that will result in a reduction in groundwater recharge, such as a large residential and commercial developments). Berms will direct surface water run-off away from the pit and onto undisturbed lands. Whitewater has 19 years of experience in monitoring the water levels at above water pits. During this time there have been no signs or measurable decrease in infiltration across the pit floor as a result of site operation compacting the floor materials.

	Burnside Comments		Whitewater Responses
Conclusions			
12a	Water level elevations have not been determined in the north east of the site. There is therefore insufficient information to determine the seasonal groundwater high across the entire site. In order to have this number as a target for excavation, additional information on groundwater levels in the north east will need to be provided		The water level in the north-east corner of the site is below the elevation of 408.6 masl (MW10). The proposed pit floor elevation in this area is 415 masl. This proposed floor elevation is therefore at least 5 m higher than the water table. Additional information is not required to ensure that the pit floor remains the required 1.5 m above the water table.
b	Groundwater table should be provided as groundwater contours in order to understand the variation and spatial distribution of groundwater across the site. Spot elevations as provided on Figure 8 do not provide enough information on expected spatial variations		Spot groundwater elevations where provided on Figure 8 along with the elevations of the base of the dry wells. The water table is found below these base elevations. Accurate flow nets cannot be generated without spot groundwater level elevations as referenced spatial locations. For this study, a detailed a flow net of the shallow groundwater system was not necessary. As discussed, the water levels have been used to determine the general groundwater flow directions and pit floor elevation.
c	Topographic and groundwater table data suggests that there is a water table divide on the site and that some groundwater as well as surface water supports the Violet Hill Wetland. No analysis of these contributions has been undertaken. It is important to know what these contributions are in order to ensure that they are maintained in the post-development phase.		The statement that no analysis has been completed is an incorrect statement. The responses provided in this document support that the Combined Level 1 and 2 Hydrogeological Assessment has discussed both the groundwater and surface water flow to Sheldon Creek and the Violet Hill Wetland (see response to Items 2, 4, and 5 above). The impact assessment is provided in Section 7.4 (Potential Interference with Surface Water Features) of the hydrogeological report. It was concluded that the slight increase in groundwater recharge at the site as a result of the aggregate operation will have no measurable impact to the surface water features. It was further noted in this response that, where possible changes in land use should attempt to enhance groundwater recharge
d	Geologic cross sections provided are not adequate and do not provide sufficient information to adequately determine the seasonal groundwater table high. Information providing confirmation of seasonal groundwater table high for the entire site should be provided.		As discussed, the seasonal groundwater fluctuation is less than 1 m and no more than 1.45 m (range between 0.3 m and 1.45 m). This minor change would not be captured on a cross-section that depicts the proposed site boundaries and pit depth.
e	Potential impacts to surface water features should be examined in order to understand the full nature of these impacts and to determine appropriate mitigation measures for these impacts		See response to Item 12 c
f	A more comprehensive water balance should be completed in order to understand the full impact of the proposal and not be limited to the impacts within the excavation areas		Seee response to Item 11
g	As recommended a groundwater monitoring system should be established with annual reports to be provided to the MNRF and the municipality		Agreed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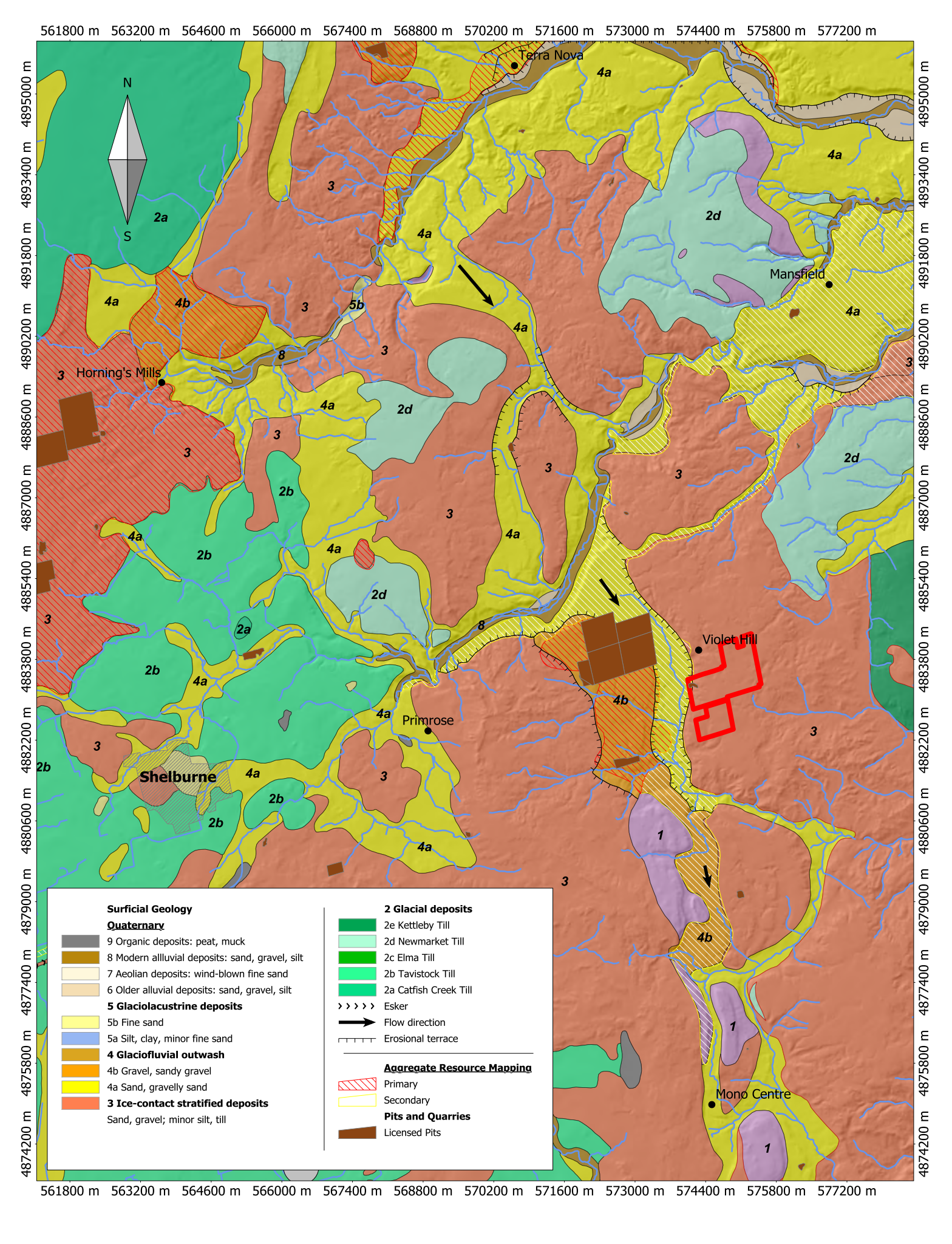
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N
S
Terra Nova
Mansfield
Horning's Mills
Violet Hill
Primrose
Shelburne
Mono Centre
Surficial Geology
Quaternary
9 Organic deposits: peat, muck
8 Modern allluvial deposits: sand, gravel, silt
7 Aeolian deposits: wind-blown fine sand
6 Older alluvial deposits: sand, gravel, silt
5 Glaciolacustrine deposits
5b Fine sand
5a Silt, clay, minor fine sand
4 Glaciofluvial outwash
4b Gravel, sandy gravel
4a Sand, gravelly sand
3 Ice-contact stratified deposits
Sand, gravel; minor silt, till
2 Glacial deposits
2e Kettleby Till
2d Newmarket Till
2c Elma Till
2b Tavistock Till
2a Catfish Creek Till
Esker
Flow direction
Erosional terrace
Aggregate Resource Mapping
Primary
Secondary
Pits and Quarries
Licensed Pits