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August 4, 2017

Hastings County
Department of Planning & Development
235 Pinnacle St., P.O. Bag 4400
Belleville, ON
K8N 3A9

Attn: Cristal Heintzman, M.Sc., Planner

RE: Proposed Category 2, Class A Quarry
2287 Bay Lake Road, Part of Lots 51 and 52
Concession WHR, Township of Faraday, County of Hastings
GGG Project # 1738211

Dear Ms. Heintzman,

The Greer Galloway Group Inc. has been retained by the County of Hastings to carry out a peer review of the above report provided by you and prepared by MTE Consultants Inc, of Kitchener Ontario, dated December 1, 2016, entitled:

Proposed Freymond Quarry, Final Level 1 and Level 2 Hydrogeological Investigation Report.

This letter presents the findings of our review.

Description of the Property

Freymond Lumber Ltd. is applying for a licence to develop a quarry to be located south of the Town of Bancroft, on Lot 51 and 52, Concession W.H.R., Faraday Township, Hastings County. The application is to develop a Class 2, Category A Quarry Below Water, with an extraction area of 27.5 hectares.

The property is located within metasediments of Grenville age, with limited soil cover, with bedrock forming a topographic high sloping to the east towards Highway 62, and to the north and south to streams draining to the east into the York River.

Purpose and Objectives

The report states that its purpose "*is to assess the geological, hydrogeological, and hydrological conditions at the Site and to identify any potential adverse effects on water resources, water uses, and the natural environment that the proposed quarry may have on these systems.*

Additionally, this Level 1/2 Report provides technical data to support applications for:

1. *Permits to Take Water (PTTW) as part of the proposed quarry; and*
2. *Environmental Compliance Approvals (ECA) for periodic discharge of water to watercourses.*

The objectives of this Level 1/2 Report are to:
Establish baseline groundwater and surface water conditions;
Establish a baseline water budget for the proposed licence area;
Provide input for the operation of a quarry and rehabilitation, including water management, use, storage. and drainage;
Identify potential effects of a quarry and end use operations on the quantity, quality, and function of groundwater and surface water resources; and
Provide a monitoring program framework that will include an assessment process that will enable transparency and allow for on-going assessment of compliance with the Site Plan commitments."

Review:

As described in: *Aggregate Resources Provincial Standards (1997) for the preparation of a Level 1 and 2 Hydrogeological Assessment, Section 2.2 Technical Reports,* the following information must be provided:

Hydrogeological Level 1: Preliminary hydrogeologic evaluation to determine the final extraction elevation relative to the established groundwater table, and the potential for adverse effects to groundwater and surface water resources and their uses.

The report determines the final extraction elevation, however the report indicates very slow recovery to a static level for some of the boreholes making the establishment of a groundwater table difficult. In addition, the report indicates that one of the boreholes (MW4) demonstrates confining conditions with a piezometric surface above the existing ground surface.

The report states that there will be limited diversion of net discharge to streams to the north and south of the proposed extraction area from drainage from the quarry. A review of the water balance data suggests a net diversion of approximately 50 m^3/day from the North to the South Streams with an increase of 121 m^3/day to the

South Stream (indicated in Section 7.4 of the report), but that both streams join the York River directly and within a kilometre of each other.

The report discusses the impact of residual ammonia from blasting on water quality and indicates that this will be mitigated through retention ponds within the quarry before discharge to surface water. The report describes the presence of secondary sulphides within a borehole (MW7), and presents a geology map suggesting some extraction may take place within a unit of graphitic schist with pyrite. The report does not address the potential impact to groundwater or surface water from the weathering of these sulphides. (A response to this concern was provided by MTE in an email dated 22JUN17 attached).

Hydrogeological Level 2: Where the results of Level 1 have identified a potential for adverse effects of the operation on ground water and surface water resources and their uses, an impact assessment is required to determine the significance of the effect and feasibility of mitigation. The assessment should address the potential effects of the operation on the following features if located within the zone of influence for extraction below the groundwater table, where applicable;

The technical report must be prepared by a person with appropriate training and / or experience in hydrogeology to include the following items:

(a) *Waterwells:* Waterwells are located and documented.

(b) *Springs:* Presence or absence of springs is discussed.

(c) *Groundwater aquifers:* More interpretation in relation to lithology of aquifers would assist in predicting non-stormwater discharge from the quarry. The report describes slow static level recovery in some boreholes but with artesian conditions in one borehole.

(d) *Surface water courses and bodies:* Existing surface water is thoroughly addressed.

(e) *Discharge to surface water:* The report presents a model showing the interpreted discharge to the North and South Streams. "Precipitation and groundwater collected in the quarry are to be directed to a SWM facility where fines and other potential contaminants introduced during blasting and quarrying will be allowed to settle or be removed." However the Technical Memorandum – Stormwater Management Facility (Appendix E) states that groundwater contribution to the facility is assumed to be negligible. The report does not fully address the impact of extraction below the water table in proximity to the South Stream. (A response to this concern was provided by MTE in an email dated 22JUN17 – attached).

(f) *Proposed water diversion, storage, and drainage facilities on site:* The report provides a plan for water diversion, storage, and drainage facilities, however these facilities may not reflect the potential diversion of groundwater flows during and following extraction.

(g) *Methodology:* The methodology of the Investigation effectively identifies wells, surface water features and flows, topography, and drainage. Seven boreholes (Monitor Wells) are constructed within the proposed extraction area. The monitor well in the centre of the property was constructed by diamond drill coring, and the core logged. Cuttings from the other boreholes were not logged. Groundwater conditions in the monitor wells are documented. Groundwater flows are modelled using published values for typical bedrock materials and not from values determined on site.

(h) *Description of the physical setting including local geology, hydrogeology, and surface water systems:* A description of the local geology is provided based on published large scale government mapping only. Borehole cuttings are not logged. Surface water systems are well described.

(i) *Water budget:* A water budget is presented which models impacts to groundwater and surface water discharge throughout the extraction period.

(j) *Impact assessment:* An impact assessment is provided. Impacts to the South Stream require additional modelling to demonstrate any potential interaction with extraction to 30 metres below the water table. Assessment of impacts on domestic wells directly to the north of the site should use drawdown of water table following extraction, and use site data from boreholes. The potential for impact on surface water from oxidation of exposed sulphides is not addressed. (A response to this concern was provided by MTE in an email dated 22JUN17 – attached).

(k) *Mitigation measures including trigger mechanisms:* The report describes mitigation measures including retention ponds to improve discharge water quality. More description of sampling protocols and additional water quality parameters to reflect additional potential chemical impacts from oxidation of exposed bedrock during extraction should be included.

(l) *Contingency plan:* Section 7.3 Spills Plan of the report states that "As per Condition 3.5 of the Aggregate Resources Act Provincial Standards, a spills plan will be prepared".

Contingency plans should also be prepared to deal with potential: 1. Impacts to neighbouring wells – flow; 2. Impacts to neighbouring wells – water quality; 3. Impact to South Stream – flow; 4. Impact to South Stream – water quality; 5. Increased or unanticipated flow of groundwater into quarry.

(m) *Monitoring plan:* A program is presented for monitoring groundwater, private wells, and SWM (storm water management). The groundwater monitoring plan does not provide information on sampling protocols or parameters to be tested. The private well monitoring does not provide information on sampling protocols or parameters to be tested. Consideration should be given to use of automated levelloggers with barometric control, to be coupled with blasting records. The SWM monitoring plan consists of a recommendation to apply for an ECA for the

construction of a SWM facility. The Technical Memorandum included as Appendix E to the report, does not address groundwater discharge resulting from extraction below the water table in the calculation for design of the facility.

(n) *Technical support data in the form of tables, graphs and figures:* Sufficient data were presented to allow assessment of the conclusions presented in the report.

A review of the Curricula Vitae of the authors indicates that they have the required education, qualifications, and experience to carry out the Investigation.

Section 3: Geology and Hydrogeology

Soil Cover:
Section 3.1 indicates that "Specifically, the Site is mapped by the Ontario Geological Survey as predominantly bedrock at surface…" This information is taken from the literature. Photographs provided with the report show mixed tree cover suggesting some soil cover, and with ponds (pans) suggesting an accumulation of organic material..

Bedrock:
The report includes the following information on geology:

3.2 Precambrian geology: "rusty weathering, graphitic, pyrite and pyrrhotite-bearing schist" about 30 percent of the property, and medium to high metamorphic grade calcareous mudstone and sandstone and diopside-amphibole-plagioclase gneiss locally containing phases rich in potassium feldspar, quartz, biotite, scapolite, epidote, carbonate, titanite, pyrite and iron-titanium minerals, and minor dolomitic marble which does not appear to be within the area proposed for extraction.

3.3 One section and one longitudinal provided.

Boreholes: The log of the monitor well MW7 indicates the presence of pyrite confirming the geological mapping, however the other boreholes were not logged for lithology or mineralogy.

Data Interpretation

More use could be made of sections to represent information from all boreholes to help with interpretation. Seven boreholes have been constructed, but not all were used in determining hydraulic conductivity. MW4 was not used in the interpretation due to flowing conditions. This is a significant anomalous situation which should be addressed through inclusion into the interpretation of groundwater conditions.

Section 3.3: More cross-sections would be helpful, especially in the west portion of the proposed quarry where impacts on groundwater would be greater, to help with interpretation of potential impacts to the South Stream.
Six of the seven boreholes were not logged for lithology. MW1 and MW5 may be collared in the graphite schist represented on the geological mapping. This material would have very low transmissivity, and the metamorphism and lithology would promote sealing of fractures (secondary permeability). This might explain the slow recoveries.

Section 4.2: groundwater levels: MW1 and MW5 exhibit low flow in comparison to the other wells. This may be related to lithology and general competence of the rock (stress relief in graphite schist?). MW4: the static level is reported as above casing. The data from this well have not been represented on a section. This well, located in the southwest corner of the proposed extraction area, is very close to the South Stream (Figure 2). A review of the topography presented in Figure 3 suggests the collar elevation for this well to be very close to the stream elevation immediately to the south. It is possible, as suggested in the report, that confining conditions may occur. However this raises concerns that the flow generated through these confining conditions may be supported by the South Stream.

Section 4.5: groundwater vertical hydraulic gradients: These have been calculated from all wells with exception of MW4 and 7. MW1 and MW5 are reported to have not yet achieved equilibrium. MW4 is a flowing well (discharge). It is possible that hydrogeologic conditions are more variable across the site than can be represented by these wells.

Section 4.6.1: Pumping Test of MW7: A discharge rate of 52 L/min X 1440 = 74,000 litres per day achieved steady state at approximately 6 metres above the proposed quarry floor. Hydrograph 2 shows steady state being achieved twice during the flow testing, Opening fractures and reducing confining pressure may increase the flow above what has been envisaged in the water management plans, requiring additional diversion to the South Stream.

Section 4.7: Private Wells: There are two wells of concern to the north of the proposed extraction area: PW2 and PW13. The PW11 static level is directly linkable to the North Stream and is not a concern. PW3 and PW4 will be of concern if diversion or impacts to the South Stream occur upgradient of the wells. (Section B-B' shows static level for PW3 below bed of South Stream and below proposed quarry floor).

Section 5.2: Proposed Water Diversion, Storage, and Drainage Facilities: Based on flow testing of MW7 it is possible that a combination of pumping and diversion of over 50,000 litres per day of groundwater may be required to allow extraction below the water table. In addition, interaction of the South Stream flow with the quarry may require additional surface water diversion beyond that envisaged in the report.

Section 5.3 Stormwater Management Facility: The report provides some information on dealing with quantity and quality issues related to quarry drainage, but recommends a Stormwater Management Report including a Water Management Plan as part of an ECA. This should be prepared. It appears the Stormwater Management Facility is to be used to deal with routine groundwater discharge quality issues. This approach to permitting needs to be clarified.

Section 6.0 Impact Assessment: The Technical Memorandum (Appendix F) states: *"recharge into the Precambrian bedrock groundwater surface is expected to be controlled by the secondary porosity (i.e. fractures). The secondary porosity of crystalline bedrock is on the order of 2-5%".* Given the grade and type of metamorphism, this porosity may not have a strong relationship to permeability or hydraulic conductivity on this site. The hydraulic conductivity data from the slug tests would be more useful than an estimate based on generalized porosity values applied to metamorphic rocks. The Drainage Analysis suggests a reduction in North Catchment runoff by an average of $100m^3$/day (annualized) and an increase in the South Catchment of $150m^3$/day which may result in a net increase in discharge of $50m^3$/day to the South Stream. Although this volume is not a significant amount on an annualized basis, it may have an impact on the stream at certain times of the year, and on any fish habitat. A PTTW for this diversion may be required.

6.2 Groundwater Drawdown and Zone of Influence (Appendix G): The geometric mean for hydraulic conductivity is based on the results from 7 monitor wells, which show a wide variability. A worst case scenario should also be evaluated, since opening the quarry will possibly increase the flow and near surface (of the quarry floor) hydraulic conductivity.

6.3 Aquifers: The report suggests that PW2 and PW13 be monitored *"to ensure these wells are within historical (pre-quarry) levels (Hydrographs 3-12)."* PW3 and PW4 may be accessing the water table which may be supported by the South Stream drainage. Impacts to this drainage flow and quality are anticipated in the report and these wells may be impacted, depending on the effectiveness of the resultant South Stream as a groundwater/surface water divide.

The report states that: *"MTE surmised that the depth of water found was similar to the total depth of the well. As noted above, the driller would have drilled deep enough to encounter a water bearing fracture(s) capable of supplying the needs of a domestic well."* This is not always the case, since sometimes a well is extended below the water-found depth to provide a sump or reservoir and protect the pump.

The report states that *"...PW3 (I assume this is an editing error and PW2 is meant) and PW13 are located within close proximity to the quarry (Figure 23) but measured groundwater elevations (Hydrograph 3) indicate that groundwater levels in these wells are below that of the proposed quarry floor and therefore will not be affected by quarry activities."* Presently, the report identifies a groundwater

gradient towards the north from the proposed quarry property and towards PW2 and PW13. Following extraction, this groundwater gradient will change, and this change may impact these wells. In the case of PW2 specifically, its proximity to the proposed operation may result in water quality impacts from blasting opening fractures above the reported Water Found depth. Some discussion of the possible variation between vertical and horizontal hydraulic conductivity would assist in prediction of impacts to this well.

Section 6.4 Bedrock Groundwater Flow: The report presents a hydraulic conductivity (K) geometric mean to represent the site of 7.9×10^{-10} metres per second. The report assumes a decrease in K with depth, and discounts data from MW4. MW7: *"had a relatively higher hydraulic conductivity than the bedrock at other monitoring wells (10^{-6}m/s vs 10^{-10}m/s). During the pumping test [of MW7] a decrease in water level was also noted in MW3d which is located 180m away from MW7, likely because it is screened across the same water bearing zone or fracture. MW3d is the only well that showed a response to the testing conducted on MW7. This lack of response at other monitoring wells highlights the discontinuous and random nature of the fractures within the bedrock."* A representation could be made that opening the quarry is equivalent to completing a giant well which will link fractures and homogenize the flow. Therefore the highest K should be used instead of the mean. This section concludes that *"it is apparent that the rate of flow into the quarry will be very slow, particularly in the vertical direction, when extraction occurs."* If there is a differential between vertical and horizontal conductivity, then this should be quantified. Horizontal conductivity on the west, south, and north faces will be a factor, affecting gradient to PW2 and PW13, and gradient and impact on the South Stream. Blasting may increase the horizontal conductivity.

Section 6.6: Blasting: It is agreed that water quality could be impacted by blasting, both on-site to surface water and in the groundwater. These impacts should be addressed in a water discharge treatment program to include monitoring of critical water quality parameters. The report suggests that this water quality will be dealt with in the storm water management plan, but limited information is presented to demonstrate this. In addition, the discharge quality management may not be suitable for incorporation in to the stormwater management plan, and should be treated as a separate issue.

Section 6.7 Streams, Rivers, Lakes, and Ponds: Macro-Drainage Analysis: A review of the Technical Memorandum (Appendix F) stated: *"recharge into the Precambrian bedrock groundwater surface is expected to be controlled by the secondary porosity (i.e. fractures). The secondary porosity of crystalline bedrock is on the order of 2-5%."* Given the grade and type of metamorphism, this porosity may not have a strong relationship to permeability or hydraulic conductivity on this site. The hydraulic conductivity data from the slug tests would be more useful than an estimate based on generalized porosity values applied to metamorphic rocks.

The Drainage Analysis suggests a reduction in North Catchment runoff by an average of 100m^3/day (annualized) and an increase in the South Catchment of 150m^3/day which may result in a net increase in discharge of 50m^3/day to the South Stream. Section 7.4 states that there will be an increase in flows to the South Stream of approximately 1.4L/s (121m^3/day). This may have an impact on the stream at certain times of the year, and on any fish habitat. A PTTW for this diversion may be required.

The report states: *"There will be no discharges of quarry water to the North Stream. As such, there is no potential for the proposed quarry to affect the water quality or quantity of the North Stream."* The proposed quarry straddles the watershed divide between the North Stream and South Stream. The report states that the area provides weak recharge to groundwater. Figures 12 and 13 display an interpretation of shallow and deep groundwater gradient to the North Stream over a large portion of the quarry site. Figure 23 presents an estimation of the zone of influence post extraction which shows a reversal of the groundwater gradient over a significant portion of the North and South Streams catchment areas. This latter gradient is consistent with the values for groundwater gradients presented in Figures 12 and 13. The post extraction zone of influence intersects the South Stream and the flood plain of the North Stream.
The proponent should demonstrate what effect these changes in groundwater gradient will have on the South Stream as a result of the groundwater volumes diverted to the quarry floor.

Mitigative Measures

Well Interference: Well owners experiencing disruption or quality problems normally contact their municipality or regulatory agencies before contacting the operator. A more detailed response procedure possibly including a flow chart should be presented and approved by the municipality. To protect the quarry operator from possibly unfounded complaints regarding water quantity, consideration should be given to the use of automated levelloggers in selected wells closest to the operation, to include barometric control. This would provide more direct correlation of blasting activities with water levels.

Bedrock Groundwater and Quarry Operations: The zone of influence shown in Figure 23 suggests an extensive area of influence which may have an effect on flow regimes in both the North and South Streams. PW13 and PW2 are within the zone of influence, and changes to flow regimes in the streams may affect the streams' support of the groundwater in the vicinity of PW3 and PW4. Monitoring of all participating private wells should include use of automated levelloggers, set to a suitable frequency. Blasting records should be maintained and be readily available for use in addressing any complaints from neighbouring well owners.

SWM Monitoring: An Environmental Compliance Assessment should be prepared, as indicated.

Water quality from groundwater discharge should be addressed as a separate item from stormwater management.

Required Permits

The report (Section 8.0) states that *"Given the current mining plan, which incorporates dewatering the Site via gravity drainage without active pumping, a PTTW will not be required to maintain dry working conditions in the proposed quarry."*

Written confirmation should be obtained from the Ministry of the Environment and Climate Change that a Permit to Take Water is not required for this operation.

Section 7.5 states that an ECA (Environmental Compliance Assessment) will be required prior to the construction of the SWM (Storm Water Management) facility. The report proposes using the SWM facility to control and monitor discharge water quality from the quarry operation. However, limited information is provided on how this facility will provide the two functions. A completed plan for management of water discharge from the quarry operation should be prepared as part of this investigation, as this is a critical part of quarry operations. The flow reported in Section 7.4 of the report: *"Flows to the South Stream are expected to increase by approximately 1.4L/s (121 m^3/day) due to increase in runoff from the Site."* should be considered separately from stormwater management. The Stormwater Management Facility – Technical Memorandum included as Appendix E of the report, states that "*Additional flow due to groundwater seepage from the excavation was assumed to be negligible."* (p2).

Recommendations for additional information to support the Level 1 and Level 2 Hydrogeological Investigation Report:

1. Address additional information requirements in *Aggregate Resources Provincial Standards* checklist above.
2. Present more detailed modeling on groundwater flow in the western portion of the proposed quarry to include all applicable well flow data, through a section to include the South Stream and the private wells PW2 and PW13 to the north. Assess impacts on flow regime of South Stream from quarrying in the western portion of the site, to demonstrate any potential change in groundwater movement to stream in relation to quarry floor.
3. Assess the potential for changes to pH in discharge to South Stream from oxidation of sulphides by exposure of fresh bedrock during extraction (acid

mine drainage). Provide more information on how a lower pH might be mitigated on site before discharge.

4. Develop a monitoring program for groundwater quality before discharge to South Stream, to address potential impacts from ammonia and acidity.
5. Develop a response plan to neighbouring well owner complaints for approval by the municipality.
6. Develop contingency plans for unexpected increased discharge of groundwater using maximum flow data from testing.
7. Obtain written confirmation from the Ministry of the Environment and Climate Change that a permit to take water is not required for this operation.

Sincerely,

THE GREER GALLOWAY GROUP INC.
CONSULTING ENGINEERS

John Porritt, B. Sc., M. Ed., P. Geo.,
Senior Hydrogeologist
APGO Reg. #90266, August 2017

Attached: Email response to preliminary comments