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October 10, 2017

Friends of Grass Lake
c/o Mr. Doug McClure
Conlin, McKenney & Philbrick, P.C.
350 S. Main Street
Ann Arbor, Michigan 48104

Re: Hydrogeologic Review
Proposed Norvell Road Quarry
Grass Lake, MI
Atwell LLC Project No.: 17002715

Dear Mr. McClure:

Atwell, LLC (Atwell) was retained by the Friends of Grass Lake to review the "Environmental Assessment, Norvell Road Quarry" (EA) prepared by ASTI Environmental dated August 10, 2017 in regard to potential impacts to local groundwater associated with the proposed mining operation (site). As part of our review Atwell also reviewed the supplemental information provided by Pepper Hamilton in their letter dated August 21, 2017.

The surface elevations in the proposed mining area range from approximately 992' to 1016' based on Jackson County GIS, which derived the elevation data from LIDAR surveys and has an accuracy of +/- 2 feet. The proposed mining operation plans to remove unconsolidated material to a proposed bottom elevation of 956'. According to the EA, the mining method will not include pumping and therefore will not cause an impact to drinking water supplies.

The report does not provide any specific data to support the conclusion that drinking water supply wells will not be effected, nor does it address the potential impact to the shallow unconfined aquifer other than to state that the stream and wetland on the western portion of the site will not be impacted. The report draws on broad assumptions about the stratigraphy of the site and existing groundwater elevations. It is not known how the approximate water table elevations depicted in Figure 2 were determined. While the intention is to mine to an elevation of 956', there is no indication that minable material extends to this depth.

Atwell obtained the water well logs for the surrounding area including the logs of properties that adjoin or closely adjoin the proposed site. A review of the logs indicates that the site likely consists of 25' to 30' of sand with trace gravel and some clays. This sand is underlain by a brown clay that grades to a grey clay that extends to approximately 60' to 65'. Underlying this clay is shale, limestone, and sandstone of varying thicknesses with the majority of water wells being completed at between 100' and 150' in sandstone. The upper confining clay acts as an impermeable barrier isolating the upper unconfined aquifer from a lower bedrock aquifer, which is the source of drinking water in the area.

Based on our review of the water well logs and elevation data of surface features, Atwell believes that the site lithology most likely consists of 30 feet of sand with trace (5-10%) gravel to an elevation of approximately 980'. Underlying the sand is a brown to grey clay that extends up to 30 to 35 feet in thickness or an elevation of between 945' to 950'. It is unlikely that mining activity will be able to occur below 980' given the presence of the underlying clay.

Atwell believes that the upper unconfined aquifer is perched above the regional clay and that creating a lake and mining in close proximity to both the wetland and stream will cause an impact to the shallow aquifer. Given the estimated high value of the hydraulic conductivity (K_{sat}) as noted in the "Custom Soil Resource Report for Jackson County, MI" included as Appendix E of the EA, the area of influence for a lake with an area of 14 acres could extend over 200'. The EA indicates that the likely elevation of the proposed lake is 980', which is approximately the same elevation of the wetland to the west. If the wetland is a discharge point for groundwater, then the lake will certainly have an effect on the wetland. Additionally, the overburden soil will hold water in pore spaces and the more likely elevation of the lake is 990'. If the excavation extends to 956' and if the clay varies in thickness the mining operation could disrupt the lower confining layer which could impact the water quality in the lower aquifer as well as causing a greater effect in the upper unconfined aquifer.

Atwell's review of the EA is based on reasonable assumptions about the local geology determined from a review of over 100 water well logs for the surrounding area. The EA also draws heavily on assumptions about the local geology and the hydrogeologic conditions. Without actual site data it is not possible to accurately determine the potential effect on the upper unconfined aquifer. This data would include multiple borings to determine the site specific characteristics of the lithology including the presence of a lower confining layer such as the suspected clay in the area. A pump test using a fully penetrating well and a minimum of two observation wells. The results of the pump test will be necessary in completing a lake permit for mining.

In regard to the requirements of the Planning Commission to issue a permit in accordance with Section 14.07HH of the Township Zoning Ordinance, without a pump test it is not possible to make the following statement in regard to item 9 in the letter drafted by Pepper Hamilton that the mining activity will not "alter the drainage pattern of surface or subsurface waters on adjacent property." In fact the EA states on page 5 in the second paragraph that "one mine did alter the direction of groundwater flow by opening differential pathways". This statement in the report was used to argue that because the mining did not include pumping there would not be an effect in the surrounding area. The Pepper Hamilton letter in regard to the Special Use Permit on page 5, Number 5 indicates that there will not be any impact to the quality or quantity of nearby residential wells or adverse impacts to surface water resources and that additional information is included in the EA, however no specific information regarding groundwater impact is included in the EA as no site specific testing has been conducted.

Based on a review of the EA, the letter from Pepper Hamilton, and the requirements for issuing conditional use permits, Atwell concludes the following:

- The mining operation likely will not be able to proceed as indicated given the anticipated lithology, including the presence of clay at approximately 980'. Disruption of this lower confining layer could pose an impact to both the upper unconfined groundwater aquifer as well as the lower confined aquifer.

- Insufficient data is included in the EA to support the statement that no impact to groundwater or surface water will occur as the applicant has not conducted any Hydrogeologic testing to support this claim. In fact the EA offers an example of this type of impact at another mine.

Atwell recommends that borings be conducted to determine the nature and extent of the sand deposit along with the underlying clay confining layer. In addition, a pump test should be conducted to determine actual hydrogeologic conditions at the property including the hydraulic conductivity of the aquifer, the groundwater gradient, the size of the cone of depression, and a calculation of the radius of influence of the proposed 14-acre lake. The pump test should include a pumping well that is fully penetrating and set near the bottom of the upper unconfined aquifer and two to three observation wells.

Please feel free to contact me if you have any concerns or questions.

Sincerely,
ATWELL, LLC

Trevor I. Woollatt
Project Manager
Atwell, LLC