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To: Zoning Board of Appeals, Town of Weston Massachusetts

Attn: Mr. John Field, PE
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From: J. Matthew Davis, PhD

Date: January 14, 2022

Subject: Peer review of groundwater mounding analysis for 518 South Ave project

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This memo provides a summary of my comments on the groundwater mounding analysis as reported by Sanborn Head and Associates in the Groundwater Model Report, dated November 22, 2021, hereafter referred to as the SHA report. The ZBA has also requested that I review the report of McDonald Morrissey Associates dated January 3, 2022, hereafter referred to as the MMA report.

My review has also included the Hanover Weston Comprehensive Permit Package, dated November 22, 2021, hereafter referred to as the CPP. I have relied to a limited extent upon the electronic modeling files provided by SHA but have not done any additional modeling simulations for this report.

My review will begin with some general observations about the modeling results followed by a discussion of issues that, in my opinion, should be addressed further.

General Observations

A total of six groundwater model simulations were performed to assess the groundwater mounding associated with the planned development. Three of the models focus on establishing the model as being representative of the pre-development site conditions and the other three simulations focus on mounding under different recharge scenarios involving the stormwater infiltration and wastewater leachfields.

The pre-development simulations each use a different sets of observed water levels to assess model performance. The "Calibration" model is a steady state model and uses the heads measured on July 23,2021 as the calibration targets. A single recharge rate is applied to the entire model domain and equal to 50% of the average annual precipitation. The Calibration model helps to establish the ambient recharge rate and hydraulic conductivity values for zones representing different geologic materials. The two other pre-development models are transient (time varying) simulations and use data from precipitation events in late June to early July 2021 and then Tropical Storm Ida in early September 2021. In each of these transient simulations, the comparison of model-calculated heads to observed heads involves a 'correction' to provide better agreement. For the "June to July Verification" model, the initial model heads were corrected to remove the residuals from the "Calibration" model. For the "Ida Verification" model, the model observations were corrected to match the first field measurement.

The SHA reports states, on page 12: "It is Sanborn Head's opinion that given the scale of the model, limited off-Site data and the purpose of the model, the numerical groundwater model provides a reasonable representation of groundwater flow conditions at the Site."

Given the various corrections of the observations to fit the model ("June to July Verification") and corrections of the model to fit the data ("Ida Verification"), it is difficult for me to agree or disagree with this statement. On the one hand, the corrections could be cosmetic and have no substantive impact on the interpretation while, on the other hand, they could be masking more significant problems with the model.

The post-development mounding simulations use the same groundwater model construction while accounting for differences in recharge rates and locations due to stormwater and wastewater infiltration. These will be discussed further below.

In regard to the MMA report, I generally agree with the main Observation points and the Summary statement. Several of my concerns noted below are also raised in the MMA report. As the MMA report notes, some of the details on the limitations of the model, such as the modeling of vertical gradients in the wetland, are probably more of a distraction at this point. I am happy to provide further commentary on these issues if the ZBA is interested.

I call your attention to three main issues that are of concern.

Issue #1: Use of ESHGW Data in Analysis

While the SHA report cites the Massachusetts guideline for using the highest estimated groundwater levels as a basis for mounding analysis[1], they choose to use 80 percent of the highest observed ground water levels ins summer 2021 instead of the reported Estimated Seasonal High Ground Water (ESHGW) elevations obtained as part of the hydrogeologic site investigation (SHA report, Appendices B and C).

The SHA report prefers to interpret the Mass DEP guideline for the 80th percentile elevation to be 80 percent of the difference between the lowest and highest observed water levels during the summer of 2021. While the summer of 2021 may have been the wettest on record, no analysis is

[1] "Ground water mound calculations shall be performed based upon the starting groundwater elevation of the 80th percentile of the highest estimated groundwater level. A simple desktop calculation or analytical model should utilize data collected from the site investigations." Commonwealth of Massachusetts Department of Environmental Protection, Division of Watershed Permitting, 2018. *Guidelines for the Design, Construction, Operation, and Maintenance of Small Wastewater Treatment Facilities with Land Disposal*, Revised July 2018, page 41

presented to demonstrate that the summertime water levels in 2021 are representative of the seasonal high condition. Seasonal high conditions typically occur during the spring, when snowmelt is combined with rainfall during a period of very low evapotranspiration.

An analysis of observed ESHGW elevations in the vicinity of the stormwater and wastewater infiltration areas (obtained from Appendices B and C of the SHA report), suggests that the 80th percentile is approximately 215 ft (Table 1).

Table 1. Estimated Seasonal High Ground Water (ESHGW) reported from Test Pits in vicinity of Stormwater Infiltration Areas and Leach Fields.

Test Pit (ranked by ESHGW)	Ground Elevation [ft]	Depth to ESHGW [in]	ESHGW Elevation [ft]	Percentile
SH-TP-102	218.0	84	211.0	0.08
SH-TP-502	220.0	90	212.5	0.17
SH-TP-307	218.0	60	213.0	0.25
SH-TP-501	223.0	120	213.0	0.25
SH-TP-506	217.5	45	213.8	0.42
DTH-8	217.9	48	213.9	0.50
DTH-7	217.3	40	214.0	0.58
SH-TP-504	219.0	54	214.5	0.67
SH-TP-505	219.5	60	214.5	0.67
SH-TP-503	220.0	56	215.3	0.83
DTH-3	225.5	60	220.5	0.92
DTH-4	225.1	30	222.6	1.00

Instead of using the 80th percentile of the ESHGW, the SHA report either uses values calculated from summertime observations or spot ESHGW elevations from select test pits (see SHA report Exhibit J).

The observed ESHGW elevations recorded are for pre-development conditions. The simulation of post-development "Normal Groundwater Conditions" shows a post-development groundwater mound ranging from 0.5 to 1 foot. When using pre-development ESHGW observations to assess post-development mounding, it may be prudent to adjust the pre-development ESHGW for post-development normal conditions.

Issue #2: Disconnect between Pre-development vs. Post-development

If the model is indeed a reasonable representation of the conditions at the Site, as stated on page 12 of the SHA report, this would be limited to the pre-development conditions. The planned development will significantly alter the hydrologic conditions at the site in two ways. First, the post-development model will need to account for spatially varying recharge conditions due to the addition of impermeable surfaces and infiltration basins for both stormwater and wastewater. The post-development models presented by SHA have recognized this change by adding five additional recharge zones, for a total of six.

The second significant post-development site alteration is the additional of physical structures that may interact with the groundwater mound and impede groundwater flow. As noted by MMA, the Massachusetts DEP requires and an evaluation of these potential impacts[2]. Results of the mounding analysis models presented in the SHA report suggest that these structures may indeed impact the ability of the groundwater mound to dissipate horizontally, as depicted in the model.

For example, the Comprehensive Permit Package (CPP) notes the base of the retaining wall to the east of SIA 3 will have an elevation of 217.5 ft (CPP Sheet C-7). This location is very close to Test Pit D.T.H.-8 that has a recorded ESHGW elevation of 213.9. The simulated mound for the 10-year storm at the location of D.T.H.-8 is approximately 5.5 ft. When the simulated mound height is added to the documented ESHGW, the simulated mound height for seasonal high conditions and a 10-year storm event is 219.4 feet, approximately 2 feet higher than the base of the planned wall. Based on the materials provided by the applicant, ***it appears that the retaining walls will impact the groundwater flow, though these effects have not yet been accounted for.***

Another concern regarding the post-development structures is the potential interference of the mound with the stormwater system. Again, adding the simulated mound height of approximately 10 feet (SHA Figure 11) to the 80th percentile of the ESHGW elevations recorded in the test pits near the infiltration areas of 215 feet results in a mound elevation of approximately 225 ft, which is approximately equal to the top of SRA #3 (Top of Stone = 224.6). In addition to the very important point raised by MMA regarding the stormwater designs assuming that the groundwater mound will remain below the bottom of the chambers (220.5 ft), the simulation of the mound height to the top of chambers also neglects the hydrologic impact the chambers may have on groundwater flow. The details of construction of the infiltration chambers are unclear, but reference to a "Vent Hole" in the side of the chambers (CCP Sheet C-15, SC 4-3 Elevation), suggests that the walls are impermeable. As with the retaining walls, ***the hydrologic effects of the stormwater infiltration chambers on the groundwater mound are not accounted for in the current analysis.***

The third impermeable boundary that may affect the groundwater mound is the building foundation that intersects the 6-foot mound height contour (SHA figure 11). Again, if the ESHGW elevation is 215 ft, this suggests that the building foundation would need be higher than 221 ft, which is just one foot below grade (see CPP Sheet C-11). Again, ***the hydrologic effects***

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[2] "Evaluation must include (if applicable) the effect of impermeable or semi-permeable barriers within the potential groundwater mound. These would include but not limited to foundations and retaining walls.", Commonwealth of Massachusetts Department of Environmental Protection, Division of Watershed Permitting, 2018. *Guidelines for the Design, Construction, Operation, and Maintenance of Small Wastewater Treatment Facilities with Land Disposal*, Revised July 2018, page 21.

of the building foundation on the groundwater mound are not accounted for in the current analysis.

Issue #3: Lacking Breakout Analysis

An important aspect of the groundwater mounding analysis is to assess breakout of groundwater to the ground surface under different scenarios. It is common to produce maps showing where simulated head values exceed the ground surface elevation (areas of breakout). However, the SHA report does not provide an assessment of breakout for the scenarios considered. The MMA report does provide a breakout map (MMA Figure 1) showing significant breakout both in the vicinity of stormwater infiltration areas and just outside the wetland boundary. While the breakout illustrated in the vicinity of the stormwater infiltration areas does not account for the planned fill, it is based on the information in the SHA model and further illustrates the disconnection between the SHA models for pre- and post-development conditions. ***It is recommended that the applicant assess breakout in the areas that will be filled, using post-development design elevations.***

The breakout just outside of the wetland (MMA, Figure 1) is significant as this area is not planned for additional fill and the materials have been described as a sandy material. Any breakout along the slope could lead to higher pore pressures and destabilize the sandy material. As materials are washed away due to higher pore pressures, the problem may worsen as erosion further lowers the surface elevation, exacerbating the problem. This could result in headward erosion towards the retaining wall. ***It is recommended that the applicant assess the potential for groundwater seepage between the retaining wall to the east of the Primary Leach Field and the wetland boundary.***