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July 13, 2022

Ms. Sarah Mellish, Chair
Manchester Zoning Board of Appeals
Manchester Town Hall
10 Central Street
Manchester-by-the-Sea, MA 01944-1399

Re: Application for Comprehensive Permit, The Sanctuary, School Street, Manchester, MA

Dear Chair Mellish:

On behalf of the Manchester Essex Conservation Trust ("METC"), I am writing to provide comments on the hydrologic impacts of the proposed "Sanctuary" project on the certified vernal pools.

A significant portion of the project site drains to vernal pools. The proposed site development will change drainage patterns due to the construction of impervious surfaces and stormwater routing to various infiltration and rain garden structures.

Vernal pools are highly sensitive to hydrologic alterations. More specifically, their habitat is impacted by alterations to hydroperiod – changes in water depth and associated duration. Hydroperiods are directly related to groundwater recharge rates. The Spring months of March, April, and May are particularly critical.

To evaluate the impacts of the proposed project, I developed hydrologic budgets for the northern vernal pool under both existing and post-development conditions. These hydrologic budgets are based upon groundwater recharge and discharge rates that are largely responsible for water levels within the vernal pool. I plan to conduct similar analyses for the other vernal pools on and surrounding the site.

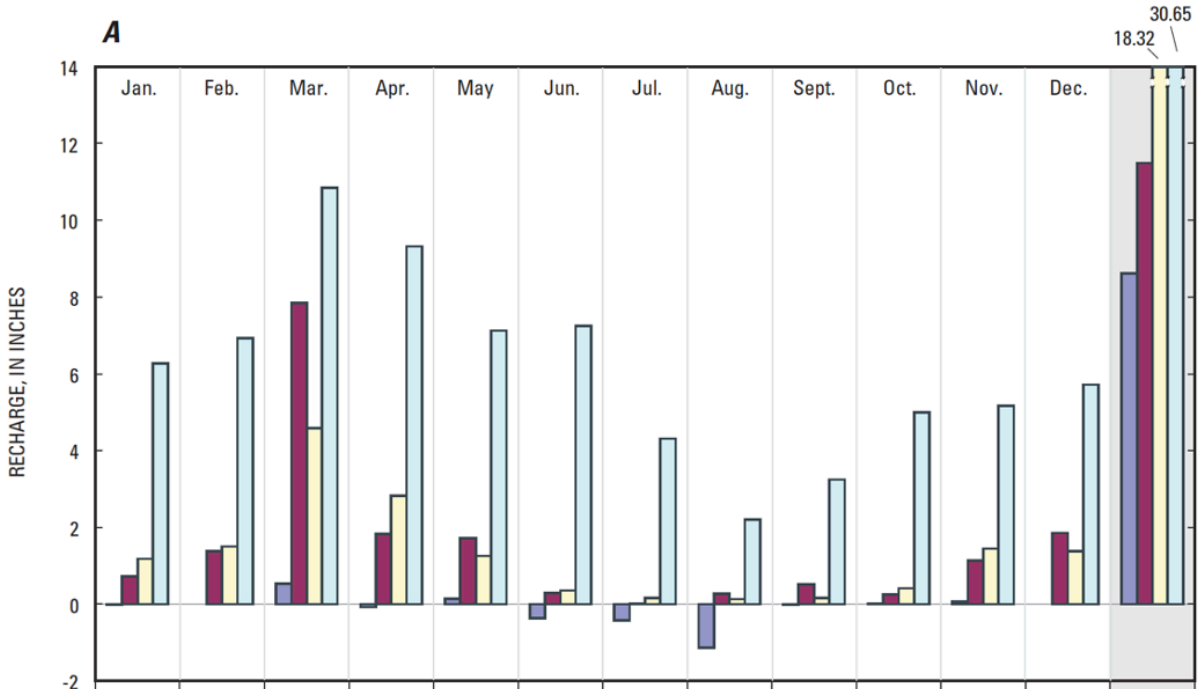
**Existing Conditions:** The northern vernal pool is identified on the site plans with the notations CVPQ2…. This vernal pool is within the drainage area identified in the Stormwater Report as E-1 that drains to northern wetlands (Wetlands D) that includes the vernal pool but also areas of other adjacent wetlands. I delineated a more specific drainage area to the vernal pool using the "Existing Conditions" plan that shows the vernal pool boundary and site topography (see figure 1). The drainage area to the northern vernal pool measures 127,968 square feet.


*Figure 1 - Watershed to Northern Vernal Pool (Base Map Existing Conditions, Allen & Major)*

To determine the existing hydrologic budget, I applied monthly groundwater recharge rates during the critical Spring period (March – May). Under existing conditions, recharge during this period is high because of snowmelt and minimal transpiration by plants. This period of high recharge provides "wet season" hydrologic conditions that support standing water within the vernal pools that support the required wildlife habitat conditions necessary for vernal pool dependent species.

Monthly groundwater recharge rates were estimated based the USGS report, Assessment of Ground-Water Resources in the Seacoast Region of New Hampshire, Scientific Investigations 2008-5222 (see figure 2). The USGS study area has similar precipitation rates (45 inches/year) and hydrogeologic characteristics (crystalline bedrock overlain by glacial surficial deposits) as the project site.

Although precipitation is consistent throughout the year, a combination of spring snowmelt and low evapotranspiration rates result in high groundwater recharge rates and water levels during the spring months. Figure 2 shows that the mean monthly groundwater recharge rates for the months of March, April, and May are reported as 7.85, 1.82, and 1.71 inches respectively. The average monthly recharge rate over the entire year is 0.96 inches. Applying these recharge rates to the vernal pool watershed yields the estimated monthly volumes of groundwater recharge (see Table 1).




| | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | -0.01 | 0.00 | 0.53 | -0.08 | 0.14 | -0.37 | -0.42 | -1.14 | -0.01 | 0.02 | 0.07 | 0.00 | 8.61 |
| MEAN | 0.72 | 1.38 | 7.85 | 1.82 | 1.71 | 0.29 | 0.02 | 0.26 | 0.51 | 0.25 | 1.13 | 1.85 | 11.49 |
| MEDIAN | 1.18 | 1.50 | 4.59 | 2.82 | 1.25 | 0.35 | 0.15 | 0.13 | 0.15 | 0.41 | 1.44 | 1.38 | 18.32 |
| MAXIMUM | 6.27 | 6.93 | 10.85 | 9.32 | 7.12 | 7.25 | 4.31 | 2.20 | 3.24 | 5.00 | 5.16 | 5.72 | 30.65 |

*Figure 2 - Monthly Groundwater Recharge Rates (USGS, 2009)*

*Table 1 - Monthly Groundwater Recharge Rates and Volumes*

| | Recharge rate (inches) | Recharge volume (cubic feet) |
|---|---|---|
| March | 7.85 | 83,712 |
| April | 1.82 | 19,408 |
| May | 1.71 | 18,235 |
| Total (Spring) | 11.38 | 121,356 |

**Post-Development Conditions:**

To evaluate post-development conditions, GIS assistance was provided by the Manchester-Essex Conservation Trust (MECT). The northern vernal pool watershed map was overlaid on the Applicant's Post-Development, "Proposed Watershed Plan PWS-1", prepared by Allen & Major and included in the Drainage Report dated May 8, 2022 (see figure 3).

The proposed project includes approximately 60,056 square feet of impervious area within the vernal pool watershed. This represents nearly 50% of the 127,968 square foot watershed. The proposed routing of stormwater runoff was calculated in accordance with the Applicant's Drainage Report Recharge Calculations (see Table 2 below).

*Table 2 - Proposed Stormwater Routing (Drainage Report, Allen & Major, page 306)*

| |
|---|
| ***BMP 1 - 96" CMP Underground Infiltration System (P-8, P-9, P-10, P-11, & P-14)*** |
| ***BMP 2 - MC-3500 Underground Infiltration System (P-12 & P-13)*** |
| ***BMP 3 - Bioretention Area/Rain Garden #1 (P-7, P-15, P-16 & P-17)*** |
| ***BMP 4 - Bioretention Area/Rain Garden #2 (P-5, P-6) (NO RECHARGE CREDIT)*** |

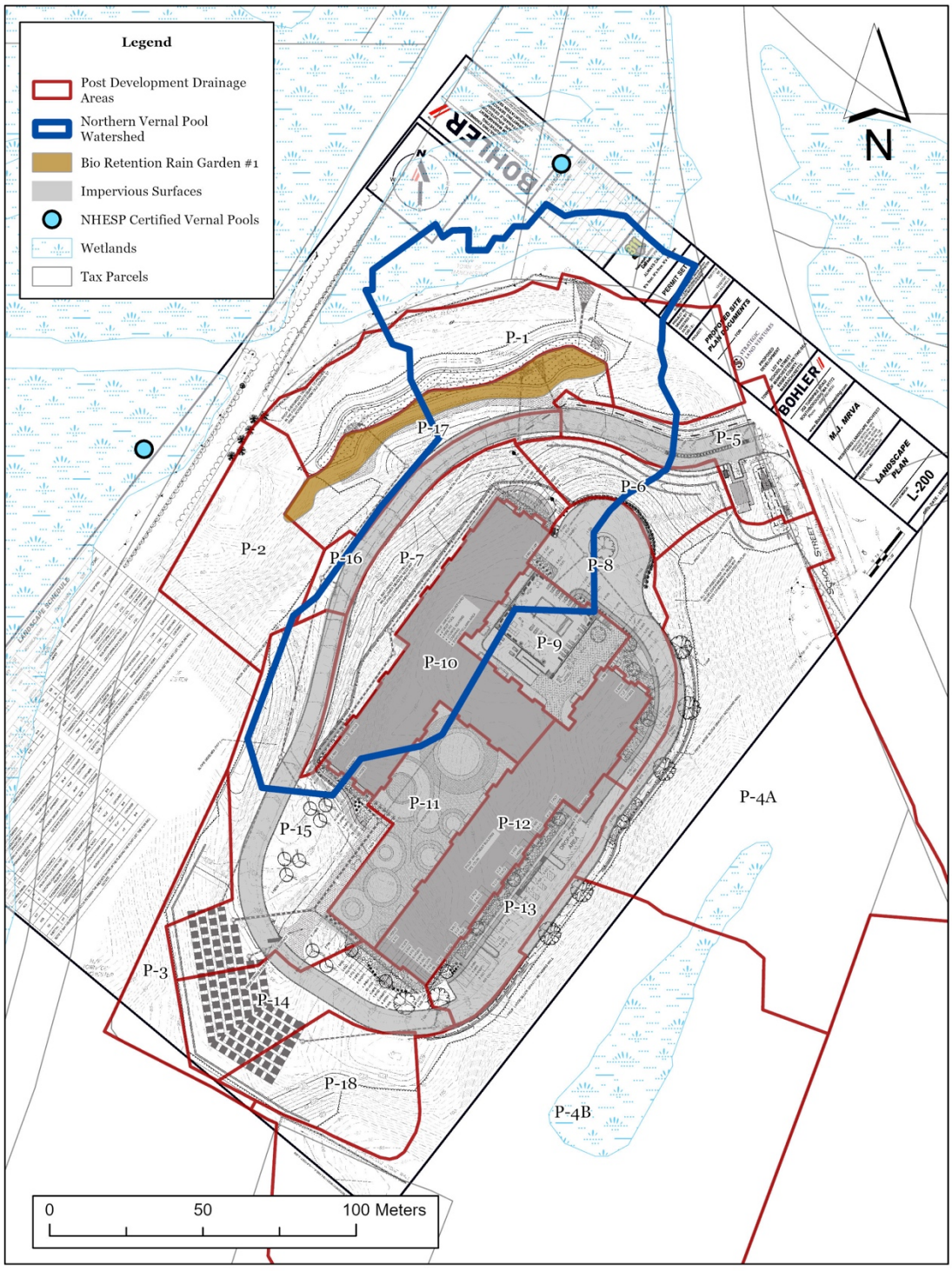



*Figure 3 - Watershed Overlay on Drainage Design*

Post development, the majority of the proposed impervious areas within the existing vernal pool watershed will be routed outside of the vernal pool watershed to the two underground

infiltration systems (shown within the P-14 and P-18 subcatchments on the plan). This system is designed to infiltrate the majority of annual runoff from the contributing impervious surfaces at these locations (outside of the vernal pool watershed). This represents a significant transfer of water outside of the hydrologic budget of the vernal pool.

The drainage from the proposed impervious areas (P-5 and P-6) are also routed outside of the vernal pool watershed to Bio-Retention Area/Rain Garden #2 located near the entrance on School Street. A smaller portion of the impervious area within the vernal pool watershed is routed to Bio-Retention/Rain Garden #1. However only about half of this rain garden is within the vernal pool watershed.

The post-development hydrologic budget is shown in Table 2. This analysis indicates that significant reductions in groundwater recharge of 40 – 50% will result from the proposed development during the critical Spring season. This will result in lowered water levels and impairment of the wildlife habitat conditions in the northern vernal pool.

In addition, runoff from impervious surfaces in close proximity to the northern vernal pool, including road runoff containing salt and sand, polyaromatic hydrocarbons (PAHCs), benzopyrene, and heavy metals associated with tire rubber and vehicle emissions, will alter the water quality of the northern vernal pool, impairing wildlife habitat. There are no proposed BMPs to mitigate these impacts.

I also concur with Patrick Garner's July 12, 2022 comments on the Wildlife Study, which note that "changes to VPs from nearby development typically include higher saline measurements, lower Biological Oxygen Demand (BOD) and higher pH values, which are all detrimental to the fauna of vernal pools," and that "changes to stormwater may increase pool temperatures, because short-circuited flows off lawns and unshaded areas are hotter than stormwater from wooded areas." These changes from the proposed project will negatively impact the water quality of the northern vernal pool.

Please contact me with any questions that you have.

Sincerely,

Scott W. Horsley
Water Resources Consultant

*Table 3 - Comparative Groundwater Recharge (Post-Development versus Pre-Development) - Northern Vernal Pool*

| Subcatchment | Area in Watershed | Stormwater Routing | Groundwater Recharge (cubic feet) | | |
|---|---|---|---|---|---|
| | (square feet) | | March | April | May |
| P-1 | 25,733 | existing conditions | 16834 | 3903 | 3667 |
| P-5 | 5,530 | rain garden 2 | 0 | 0 | 0 |
| P-6 | 6,771 | rain garden 2 | 0 | 0 | 0 |
| P-7 | 24,166 | rain garden 1 (north/in) | 15809 | 3665 | 3444 |
| P-8 | 5,572 | CMP Infiltration | 0 | 0 | 0 |
| P-9 | 3,914 | CMP Infiltration | 0 | 0 | 0 |
| P-10 | 22,803 | CMP Infiltration | 0 | 0 | 0 |
| P-11 | 814 | CMP Infiltration | 0 | 0 | 0 |
| P-15 | 12,757 | rain garden 1 (south/out) | 0 | 0 | 0 |
| P-16 | 9,134 | rain garden 1 (north/in) | 2284 | 2284 | 2284 |
| P-17 | 10,651 | rain garden 1 (north/in) | 6968 | 1615 | 1518 |
| | | | | | |
| Total Proposed | 127,845 | | 41,893 | 11,467 | 10,912 |
| Existing Conditions | 127,845 | | 83,632 | 19,390 | 18,218 |
| | | Change (Volume) | -41,739 | -7,923 | -7,306 |
| | | **Change (Percent)** | **-50%** | **-41%** | **-40%** |