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May 16, 2024

Mr. Charles Tirone, Chairperson
Town of Arlington
Conservation Commission
730 Massachusetts Avenue
Arlington, MA 02476

RE: Thorndike Place

Dear Chairperson Tirone and Conservation Commissioners:

I have reviewed the recent update report prepared by BSC, dated April 24, 2024 and offer the following comments. We continue to disagree with the suggested use of 4.0 feet as an appropriate seasonal high groundwater level and believe that the on-site measurements provided by BSC need to be supplemented with a comparison with USGS index wells as recommended in the MADEP Stormwater Handbook.
]
We also disagree with the groundwater mounding method utilized by BSC and believe that it significantly underestimates the impacts associated with the project. As stated previously, they have expanded the analysis period to 24 hours but are not evaluating the actual proposed volume of infiltration. We have conferred with MADEP on this matter and have attached correspondence which we believe indicates that our concerns are warranted (see attachments to letter).

1. Seasonal High Groundwater

The MADEP Stormwater Handbook requires that a minimum of two (2) feet vertical separation exists beneath the stormwater infiltration system and the seasonal high groundwater elevation. There are two accepted methods discussed in the Handbook to determine the seasonal high groundwater elevation (see Figure 1). Redoxymorphic features, otherwise known as "redox" are visible staining of soils that are generally considered to be representive of a high groundwater condition. However, no reliable redox features were observed in the area of the large infiltration system by BSC. In areas where redox features are not available such as the proposed infiltration system the MADEP Stormwater Handbook recommends the installation of wells, measurement of water levels in the spring months, and comparison to nearby USGS monitoring wells (see excerpt below). Note also that the Handbook defines seasonal high groundwater as the "highest" groundwater elevation.

Determining Seasonal High Groundwater

Seasonal high groundwater represents the highest groundwater elevation. Depth to seasonal high groundwater may be identified based on redox features in the soil (see Fletcher and Venneman listed in References). When redox features are not available, installation of temporary push point wells or piezometers should be considered. Ideally, such wells should be monitored in the spring when groundwater is highest and results compared to nearby groundwater wells monitored by the USGS to estimate whether regional groundwater is below normal, normal or above normal (see: http://ma.water.usgs.gov).

Figure 1 – Excerpt from MADEP Stormwater Handbook, Volume 3, Chapter 1

According to the recent BSC report (April 24, 2024) a groundwater elevation of 3.78 feet was recorded at the TP-9 location on April 24 (see Table 1).

Table 1 – Water Level Measurements (BSC, April 24, 2024)

Test Pit/Well	Groundwater Elevation		
	April 1, 2024	April 17, 2024	April 24, 2024
TP-1	2.94	3.01	2.87
TP-6	3.00	2.95	2.68
TP-7	3.41	3.47	3.30
TP-9	n/a	n/a	3.78

In accordance with the MADEP Stormwater Handbook we have compared this groundwater level measurement with the USGS Lexington well (see figure 2)[1]. The records for this USGS well indicate that the water level on April 24, 2024 was 1.84 lower than the highest recording in 2009.

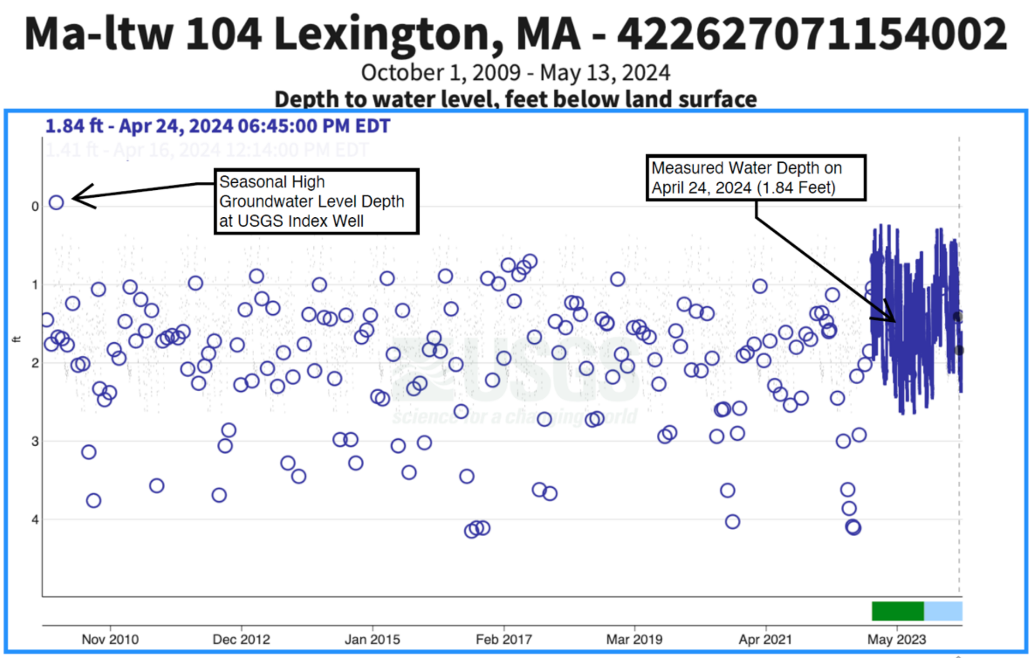

Figure 2 – USGS Index Well Lexington (2009 – Present)

[1] The USGS Lexington well was measured manually until the beginning of 2022 when a pressure transducer was installed to make continuous measurements (every 15 minutes). The open circles on the graph represent discrete manual measurements. The solid line represents the more recent continuous measurements.

The shorter-term water level records at the USGS Lexington well provide a comparison between the BSC measurement on April 24, 2024 that indicates that it is approximately 1.4 feet lower than measurements just a month earlier in March 2024 (see figure 3). This comparison shows that groundwater levels peaked in late March and early April but then declined by 1.4 feet to April 24 (the date that BSC did the measurement).

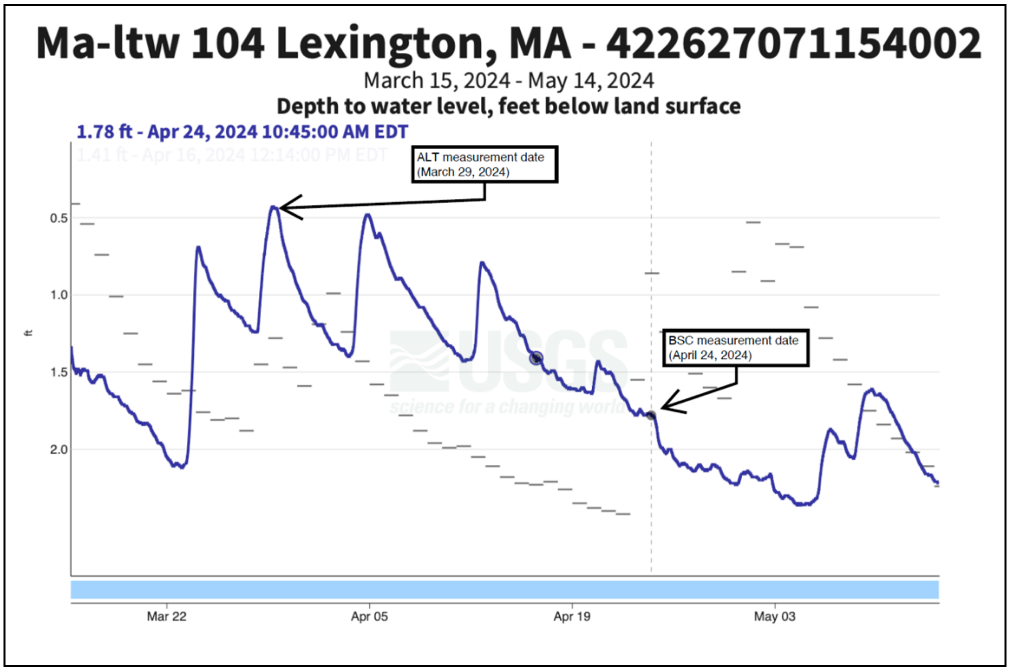

Figure 3 – USGS Lexington Well March – May 2024

This same decline in groundwater levels is further corroborated with our own water level measurements at the Arlington Land Trust well located on Dorothy Road which showed a peak elevation on March 29, 2024 and a similar decline throughout much of April to a level of approximately 1.2 feet lower on April 24 (see figure 4)[2]. This suggests that the relative groundwater level fluctuations over this period are consistent with the USGS Lexington well (which showed a 1.4-foot decline during this same period).

[2] The water level measurements in the ALT wells were made using a calibrated pressure transducer which take measurements every 15 minutes.

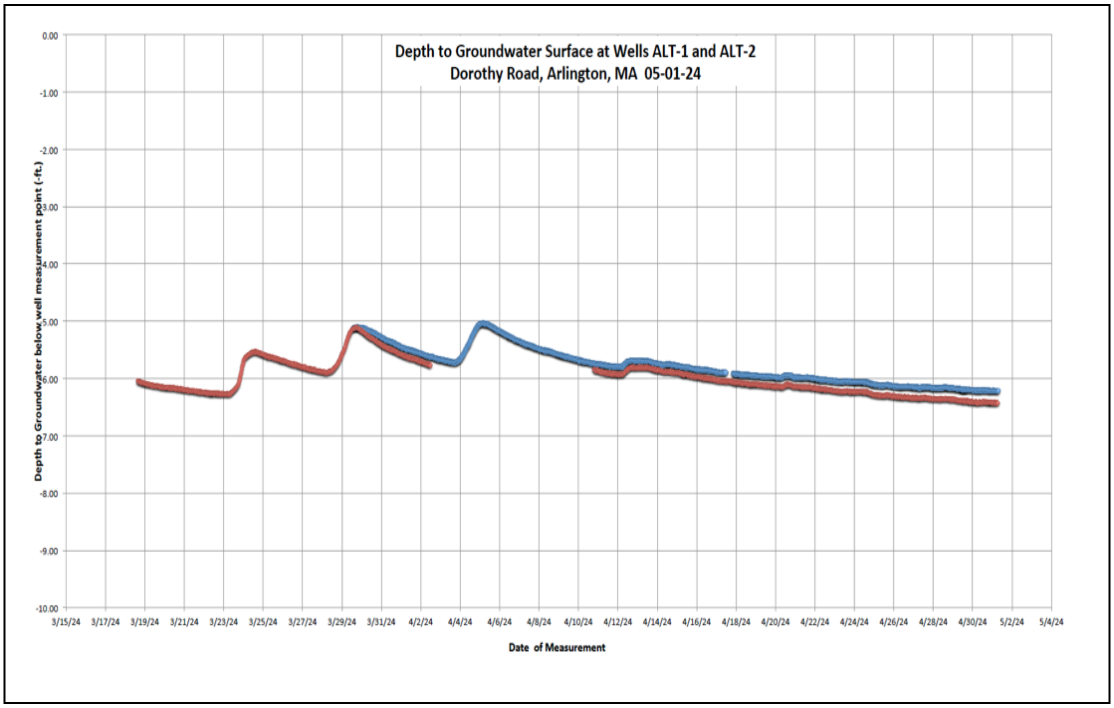

Figure 4 – Groundwater Levels at Arlington Land Trust Wells at Dorothy Road

Another method that is commonly used to evaluate and adjust measured groundwater levels to estimate the required "seasonal high groundwater" condition is the Frimpter Method developed by the United States Geological Survey (USGS). Dr. Michael Mobile has performed the Frimpter method calculations using the BSC water level measurements[3].

In summary, we have evaluated three methods to estimate seasonal high groundwater elevations at the project site. These methods are summarized in Table 2. The first method estimates the "highest" groundwater level based upon the long-term observations in the USGS Lexington well (2009 – 2024). The second method applies the documented short-term water level changes (March to April 2024) and provides a minimal adjustment value representative of this year only. The third method applies the "Frimpter Method" which provides a statistical method to integrate seasonal water level changes at the USGS Lexington well over the period of record.

Table 2 – Estimated Seasonal High Groundwater Calculations

Groundwater Adjustment Method	TP-9 groundwater level on April 24, 2024 (BSC)	Adjustment (feet)	Estimated Seasonal High Groundwater Elevation (feet)
USGS Lexington well (2009 - Present)	3.78	1.84	5.62
USGS Lexington well (spring 2024)	3.78	1.4	5.18
USGS Frimpter Method	3.78	3.48	7.26

[3] Letter from Dr. Michael Mobile, McDonald Morrissey Associates, dated May 16,2024

2. Groundwater Mounding

We have reviewed the revised groundwater mounding report. They have agreed to extend the analysis period to 24 hours to match the design storm duration (as we recommended). However, they are limiting the analysis to a smaller volume of stormwater than they actually propose to infiltrate. This analysis significantly underestimates the impacts of the project.

The purpose of the groundwater mounding analysis is two-fold: 1) to determine if the infiltration system can function hydraulically (and does not become inundated during the storm events) and 2) to avoid impacts (including water level changes) to adjacent wetlands/water bodies and to neighboring properties.

The MADEP Stormwater Standards require a minimum amount of stormwater infiltration. This is referred to as the "required volume". The minimum, based upon the soil type in this case, is 0.25 inches. In this project the Applicant is proposing to infiltrate 1.5 inches[4]. This is six times greater than the minimum (required) volume.

However, BSC is limiting the groundwater mounding analysis to the minimum "required volume" (for example 0.25 inches x impervious surfaces for "C" soils) even though the proposed design for the project is to infiltrate a significantly greater volume (for example 1.5 inches x impervious surfaces).

In my opinion limiting the groundwater mounding analysis to the smaller (minimum required) volume will underestimate the groundwater mounding impacts associated with the actual proposed infiltration volume.

There are several problems with limiting the analysis to the smaller, minimum required volume (rather than what is actually designed and proposed) as follows:

1. the analysis will not determine actual groundwater mounding rises beneath the infiltration system to see if the system is inundated during the design storms.

2. if the system does become inundated, it will increase overflows that are not accounted for in the Stormwater Standard 2 (peak flows analysis).

3. the analysis will underestimate water level changes in adjacent wetlands and at neighboring properties.

Thank you for the opportunity to provide these comments. Please contact me directly with any questions that you might have.

Sincerely,

Scott W. Horsley
Water Resources Consultant

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[4] The BSC Stormwater Report provides calculation for the "required" and "provided" infiltration volumes. To determine the physical size of the infiltration structures the "required" value of 0.25 inches is multiplied by the impervious area (78,629 square feet) which yields a value of 1638 cubic feet (see attachment to this letter). The Report indicates the "provided" volume is 9747 cubic feet. This "provided" or proposed volume is 5.95 larger than the "required volume. This is a significantly higher volume of stormwater going into the ground compared to existing conditions and will result in substantially higher groundwater levels beneath and adjacent to the infiltration systems.

Clark, Elizabeth (DEP) Mon, May 6, 8:09 AM (10 days ago)
to me, Michael

Good Morning Scott and Mike,

The mounding analysis for stormwater recharge is required when there is less than 4 feet of vertical separation AND the recharge system is being proposed to attenuate the peak discharge from a 10-year or higher 24-hour storm. If those conditions exist, then the mounding analysis should be based on the return period of the specific storm the recharge system is designed to attenuate (i.e. if the recharge system is being designed to attenuate runoff from the 100-year storm and there is less than 4 feet of vertical separation, the 100-year storm should be used to evaluate the mounding potential). This is to evaluate if the groundwater mound could impact the infiltration structure's capacity and ability to dewater within 72-hours.

You are also correct that by underrepresenting the volume of infiltration limits that analysis' ability to evaluate the impacts that may occur to nearby wetlands, slopes, or structures.

This email is only intended to respond to your question generally. If there is a Notice of Intent already filed in connection with this question pursuant to the Massachusetts Wetlands Protection Act and regulations, please be advised that the Wetlands Protection Act provides that the municipal Conservation Commission issues the decisions, and that if there is an appeal, appeals are processed and issued by the MassDEP regional offices, and not the MassDEP Boston office.

Feel free to reach out with any further questions.

Take Care,

Liz Clark, PE
Stormwater Coordinator
C: 857-278-9084

Scott horsley <scotthorsley208@gmail.com> May 4, 2024, 10:33 AM (12 days ago)
to Elizabeth, Michael

Liz: Thanks for speaking on the telephone yesterday. I am writing this follow-up email to clarify and summarize my question regarding groundwater mounding analyses for stormwater infiltration systems in reference to Stormwater Handbook, Volume 3, Chapter 1 (excerpt provided below). As I mentioned to you I am providing peer review services to towns and citizen groups on multiple projects.

It is my understanding that for typical development projects the intent of groundwater mounding analysis is two-fold: 1) to determine if the infiltration system can function hydraulically and 2) to avoid impacts to adjacent wetlands/water bodies.

We are seeing that in some cases consulting engineers are limiting the groundwater mounding analysis to the minimum "required volume" (for example 0.25 inches x impervious surfaces for "C" soils) even though the proposed design for the project is to infiltrate a significantly greater volume (for example 1.25 inches x impervious surfaces).

In my opinion limiting the groundwater mounding analysis to the smaller (minimum required) volume will underestimate the groundwater mounding impacts associated with the actual proposed infiltration volume during the design storm events.

Shouldn't the groundwater mounding analysis analyze the actual proposed volume during these design storm events.

There are several problematic implications with limiting the analysis to the smaller, minimum required volume as follows:

1. the analysis will not determine actual groundwater mounding rises beneath the infiltration system to see if the system is inundated during the design storms.

2. if the system does become inundated, it will increase overflows that are not accounted for in the Stormwater Standard 2 (peak flows analysis).

3. the analysis will underestimate water level changes in adjacent wetlands.

Your clarification on this would be most helpful. Thank you in advance. Please feel free to call me with any questions. Scott

P.S. I am copying my colleague, Dr. Micheal Mobile as I know that he has also contacted you on this same issue.

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Required Recharge Volume

Rv = F x Impervious Area

Where:

Rv = Recharge Volume

F=Target Depth Factor associated with each Hydrologic Soil Group

(F=0.25-inch for Soil Type C)

Impervious Area = Proposed Pavement and Rooftop area on-site

$$Rv = \left(\frac{0.25in}{12}\right)(78{,}629sft) =$$

Rv = 1,638 cf (required recharge volume)

As not all impervious surfaces are directed to an infiltration BMP, an adjusted Required Volume mus be provided. The adjusted Required Volume (Rva) is calculated as:

$$Rva = \frac{Total\ Imp.Area}{Imp.Area\ to\ BMP}(\mathrm{Rv}) =$$

$$Rva = \left(\frac{78{,}629sft}{62{,}920sft}\right)(1{,}638cf) =$$

$$Rva = 2{,}047\ cf$$

Storage Provided

- Underground Infiltration System = 9,747 cubic feet provided.
  Rain garden & duplex infiltration systems not required to meet volume, but provide additional infiltration above and beyond that required.
  Refer to the HydroCAD storage table provided for more information.