Preliminary Septic Capacity and Well Water Quality for Properties Surrounding Map 7, Parcel 49

As an abutting neighbor to the Greenwood Homes/Washington Street Homes proposals, I wanted to examine historic baseline groundwater quality in the surrounding area. The region of Sherborn where the proposed developments would be located is zoned RB[1] for single family homes on 2+ acre lots. Like nearly all of Sherborn, homes near the proposed developments rely entirely on well water and septic systems (given no broad town water or sewer systems) – we essentially "live off the land" with regard to water and waste management. RB zoning effectively sets the maximum septic density for residential development for the area and also curbs excessive well water draw. Additionally, there are large areas of protected wetlands and the ecosystems they support in the immediate vicinity and directly dependent on local water quality. It seems logical to A) calculate the average area septic density for existing developed lots (expressed as gallons per day per acre, gpd/acre) and B) determine if this septic density appears to be sparse enough to maintain groundwater quality over time. If groundwater quality appears to have stayed consistent, this could provide a benchmark for determining the septic capacity that Map 7, parcel 49 could reasonably accommodate were it to be developed. If groundwater quality appears to be degrading or is already noticeably degraded, this information could lead to important, more general discussions related to future development within the RB zone.

To help calculate average septic density and determine trends in groundwater quality for the area surrounding Map 7 parcel 49, data on file from the Sherborn Board of Health (BOH) office were collected from septic as-built plans and water testing reports in property files for nearby homes. These plans and reports are typically submitted to the BOH as part of the septic system and well completion approval processes for new construction, well relocations/repairs or septic system replacements or upgrades for existing homes, and occasionally during home sales. Additionally, a smaller collection of water testing reports was submitted to the author directly by homeowners who have had their well water tested by Mass DEP-certified labs over the years and for reasons unrelated to BOH oversight. To date, 34 current septic plans and 73 water quality reports (dating from 1969 to April 2024), have been collected and analyzed for properties surrounding Map 7, parcel 49 (more properties and reports will be added to the database over the coming weeks and additional reports from Mass DEP-certified labs are welcome). Drinking water nitrate concentrations >5 mg/L are considered a health risk (linked to conditions such as infant methemoglobinemia[2], preterm-birth and colorectal cancer[3]), and nitrate is also used as an indicator of effective septic effluent treatment.[4] Well water nitrate concentration (mg/L) was used as an indicator of groundwater quality for this report.

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[1] https://sherbornma.org/DocumentCenter/View/889/33-Sherborn-Zoning-Districts-PDF
[2] Example report: https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract_id/5379/report/F
[3] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9851889/
[4] https://doh.wa.gov/sites/default/files/legacy/Documents/4450//337-142-Nitrogen-Removal-from-OSS-FactSheet.pdf

What is the average septic density for developed properties surrounding Map 7, parcel 49?

Septic system capacities (in gallons per day or gpd) and lot sizes (in acres) were collected for 34 properties surrounding Map 7, parcel 49 (Fig. 1). The average septic capacity for these properties was calculated to be 208.5 gpd/acre. ***If Map 7 parcel 49 were developed to carry the same septic density as the surrounding properties, the entire parcel would have a total septic capacity of 3857 gpd*** (208.5 gpd/acre * 18.5 acre = 3857 gpd), ***or 35 total bedrooms between both proposed developments.*** This value is consistent with a seven-house development proposal submitted in 2019 by a different developer (and whose schematic plan is currently posted as the "by-right" document[5] for the Greenwood Homes proposal).

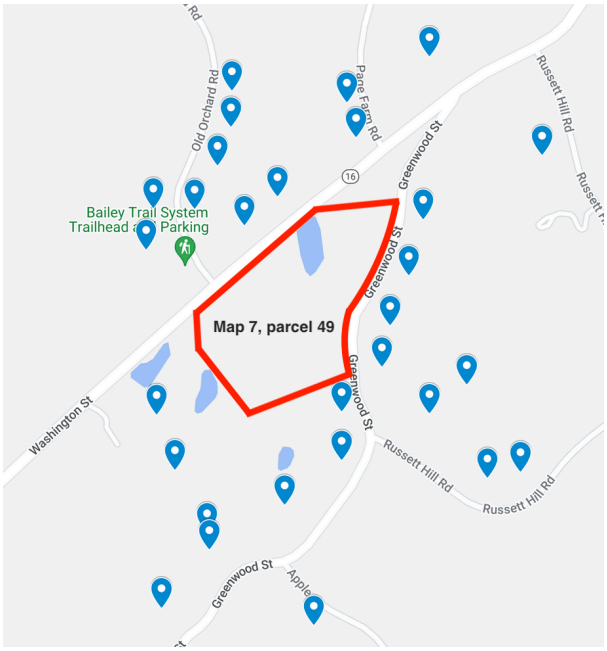

Figure 1: Google-Maps generated locations of properties used to determine average septic capacity per acre, which was calculated to be 208.5 gpd/acre.

The original (2019) development proposal for seven 100% market-rate homes (Fig. 2, left) appears to have been abandoned as it could not meet the Sherborn BOH zoning by-laws related to depth-to-groundwater (the plan is assumed to have not met the 5' minimum depth-to-groundwater regulation for areas tested as potential septic system locations, as the developer had requested variances from the BOH to this rule). This BOH depth-to-groundwater regulation helps ensure that septic effluent is sufficiently treated via percolation through at least 5' of soil before reaching groundwater. (Note: *310 Massachusetts Reg. 15.212* requires that depth-to-groundwater be at least 4' for soils similar to those located on Map 7, parcel 49. It is unknown if even a 4' depth was found at any of the original plan sites, as septic design plans were never submitted to the BOH by the original developer).

[5] https://www.sherbornma.org/DocumentCenter/View/1159/Greenwood-By-Right-Plan-PDF

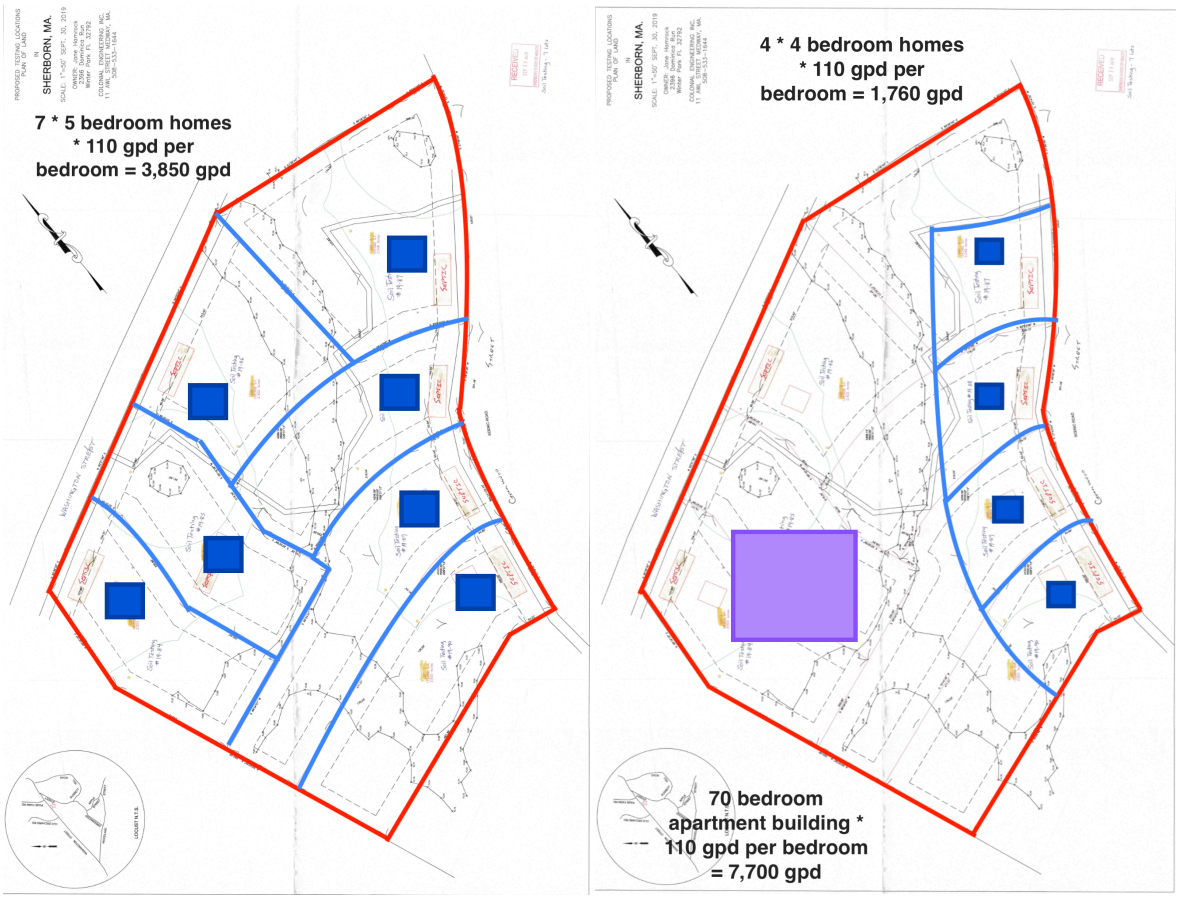

Figure 2: Comparison of the septic sizes for the original 2019 proposal (left), which would have likely had a septic flow design of 3,850 gpd; and the current Greenwood Homes/Washington Homes projects (right), with a total septic flow design of 9,460 gpd.

Four of the original seven lot plans now effectively comprise the current Greenwood Homes proposal, with the home sizes reduced to 4 bedrooms and backyards significantly truncated.[6] Greenwood Homes, with a 1,760 gpd combined septic flow, sits on only 3.64 acres of Map 7, parcel 49 (18.53 acres total), or 19.3% of the lot. This reflects a significantly greater septic density than the surrounding area, with the as-proposed Greenwood Homes development surpassing the average area septic density by 2.3-fold (1,760 gpd/3.64 acres = 483.5 gpd/acre, or 230% of the 208.5 gpd area average).

It should be noted that the remaining three lots from the original 2019 plan were combined to house a proposed 70 bedroom apartment complex known as Washington Street Sherborn Homes. This development would further increase the planned septic density of Map 7, parcel 49 to 510.5 gpd/acre (7,700 gpd + 1,760 gpd)/18.53 acres = 510.5 gpd/acre), or nearly 2.5 times the surrounding septic density.

[6] https://www.sherbornma.org/DocumentCenter/View/1857/Updated-Title-V-Septic-Plans-for-Lots-1-2-3-and-4-December-21-2023

What is the historic average baseline nitrate level (mg/L) based on available water quality data from BOH files and homeowner records?

To address questions related to groundwater quality in the area, as many water test reports as could be located during ~8 visits to the BOH office for the area surrounding Map 7, parcel 49 and its abutting wetlands were collected from the BOH and local homeowners (this collection process is still on-going, and additional data for an increased area will be added to future reports). A map of properties with water quality reports collected to date is below (Fig. 3), as well as several graphs analyzing well water nitrate concentrations from these reports.

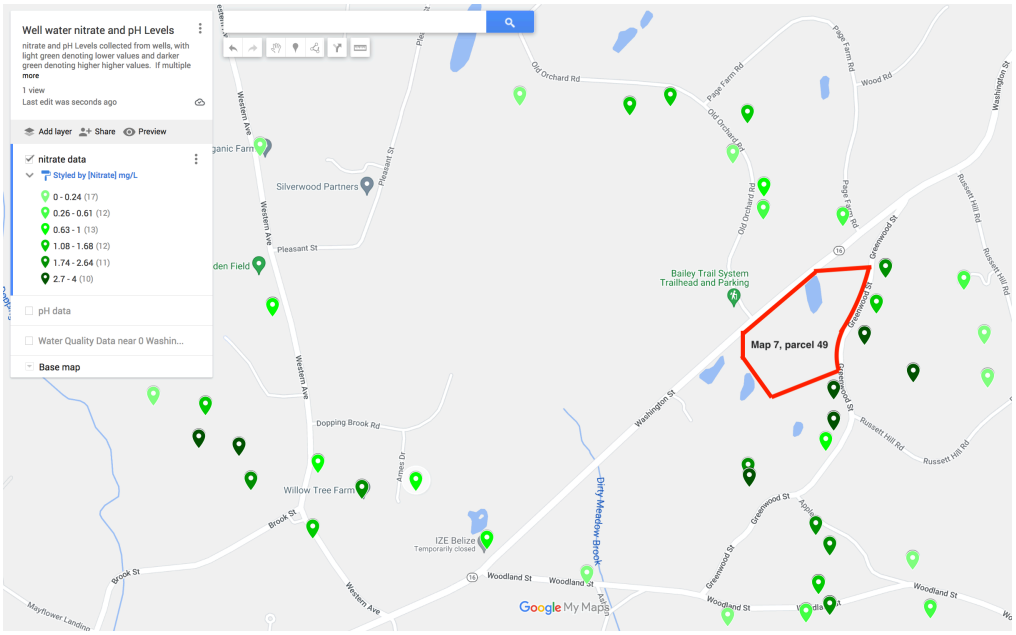

Figure 3: Google-Maps generated locations of surrounding developed properties (green markers) with one or more collected water quality reports. Note that the area directly west of Map 7, parcel 49 includes MassDEP-designated protected wetlands & Town forest and is largely undeveloped. The shade of green reflects the highest detected nitrate level, darkening with increasing mg/L.

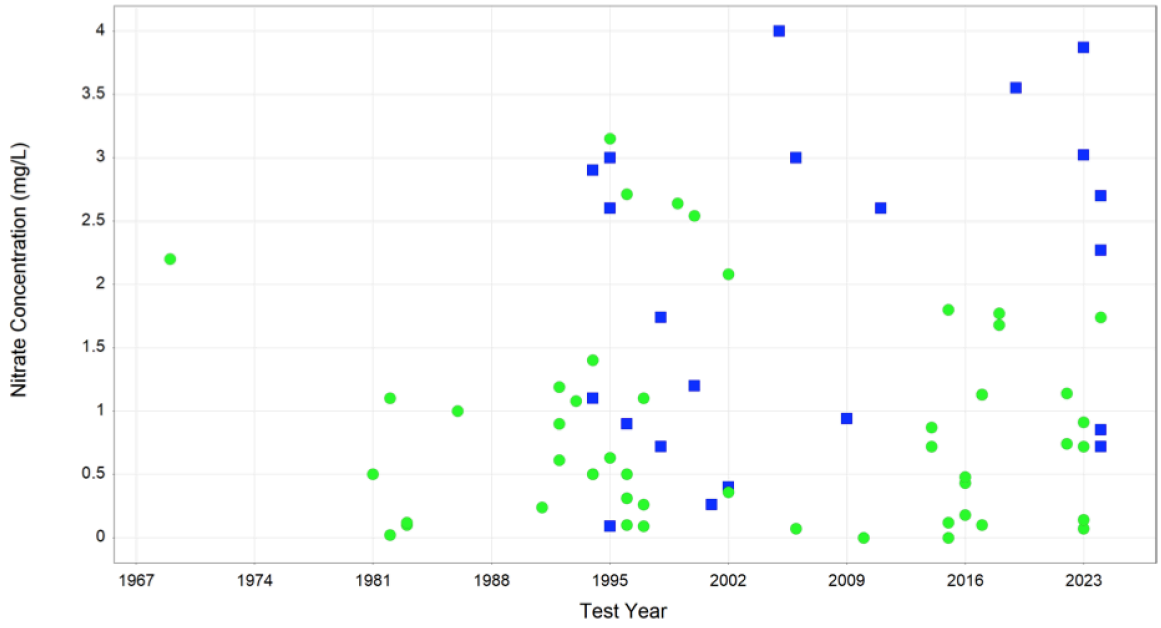

Figure 4: Historic, reported well water nitrate concentrations (mg/L) are plotted against test year for those properties mapped in Fig. 3. Data from selected properties on Greenwood St. are plotted in blue and described below, while data from all other properties are plotted in green.

Based on 73 water quality reports tested over 55 years, ***the average reported well water nitrate level for all properties was 1.2 mg/L***, with a range from "not detected" to 4.0 mg/L and a standard deviation of 1.1 mg/L.

Although data collection and analysis are not yet complete, one unexpected observation was made: **existing homes on Greenwood St. most proximate to Map 7, parcel 49 (19-64 Greenwood St.) reflect a higher average reported well water nitrate level (1.9 mg/L[7]) when compared to the surrounding vicinity.** This represents a nearly 60%-greater nitrate concentration when compared with the average area results. Nitrate concentrations detected at or above 3 mg/L for these addresses (see Figure 5 for map) date back as far as 1995, which is the first test date on record for these homes, and was the first year homes with addresses between 19-34 were built (the last being completed in 2005).

The reasons for this ~60% difference in groundwater nitrate levels are not yet understood but will be looked into further. At present, possible influences include groundwater pH (which is notably lower than average for these homes, with pH being important factor in the removal of nitrogen from septic effluent[8]) and site-specific soil characteristics (these homes are unique for the area in that they sit on a swath of 103C, Charlton-Hollis-Rock outcrop, as does much of Map 7, parcel 49, see Fig. 6). More investigation is required to better understand and characterize this observation.

[7] with a range of 0.09 to 4.0 mg/L and standard deviation of 1.2 mg/L
[8] https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=ebafe4ec398686838fb894cf9edf120d477889d3

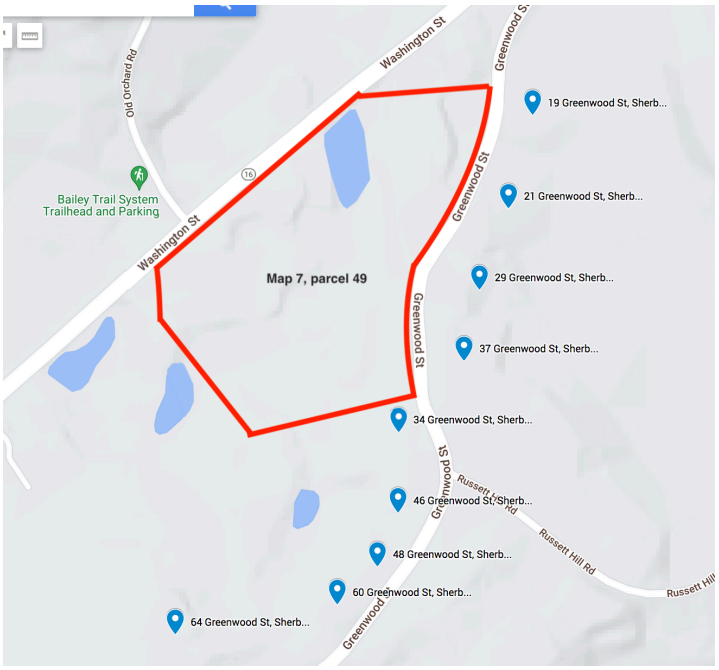

Figure 5: Select addresses on Greenwood St. with a detected average nitrate level of 1.9 mg/L.

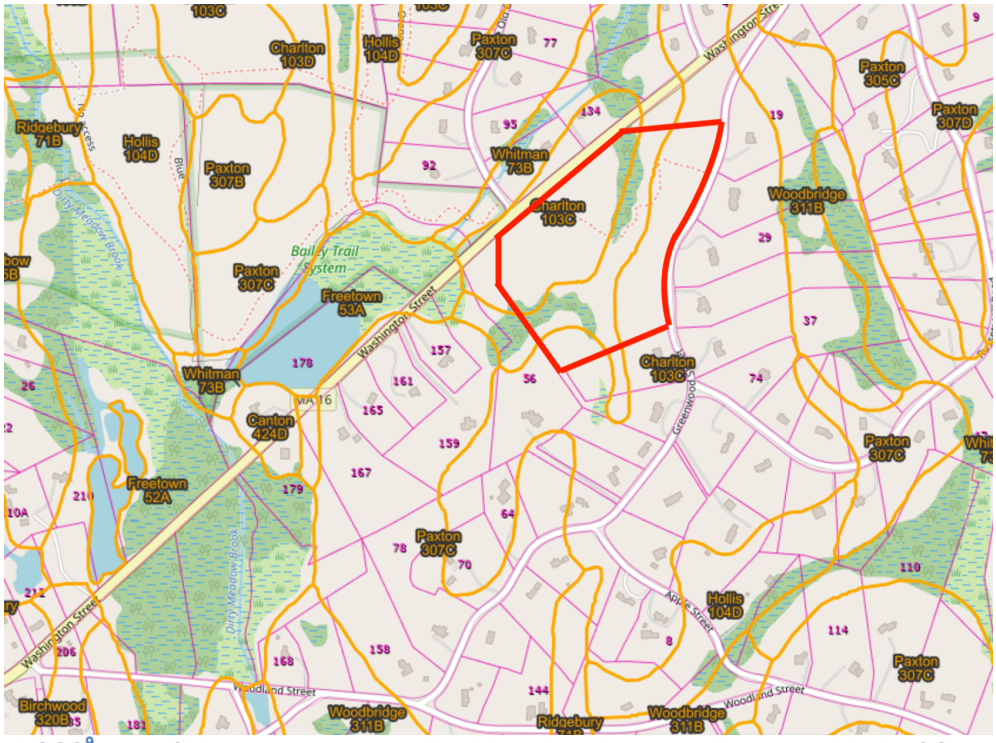

Figure 6: USGS[9] map of Map 7, parcel 49 (outlined in red) and surrounding area. Much of Greenwood St, as well as Map 7, parcel 49, is on Charlton-Hollis-Rock outcrop (103C) as the top 20" of soil. This layer of soil is considered the most relevant for denitrification of septic effluent[10]. This map also shows the large areas of wetland ecosystems found nearby.

[9] https://www.mass.gov/info-details/massgis-data-soils-ssurgo-certified-nrcs
[10] https://www.bio-sol.ca/en/soils-types-impact-on-septic-systems/

Below are additional graphs further analyzing and highlighting those specific to Greenwood St. groundwater nitrate levels.

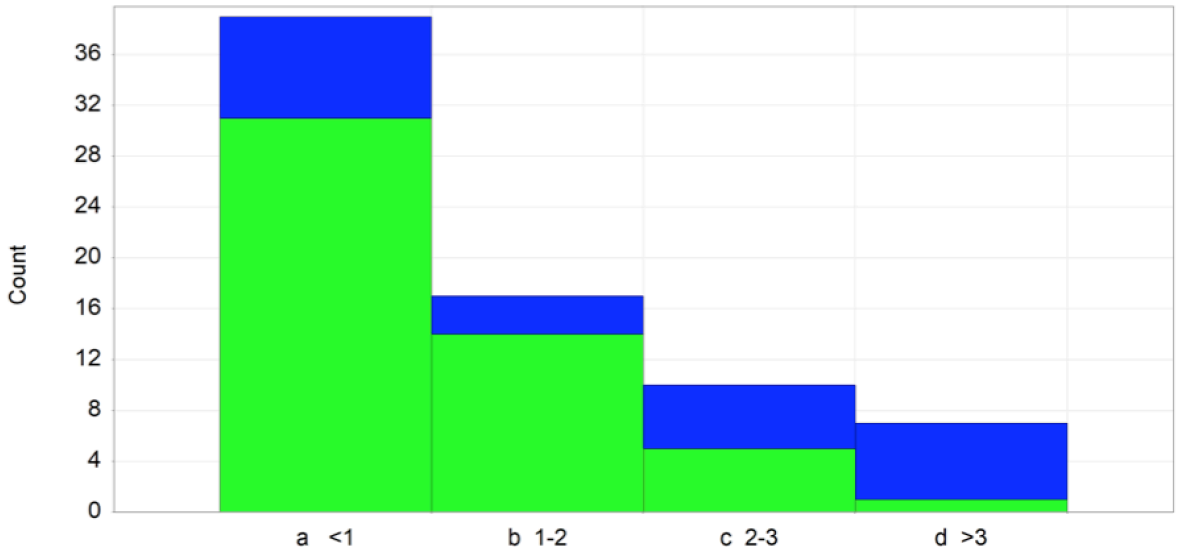

Figure 7: Bar chart showing raw counts of detected nitrate levels that were a) less than 1 mg/L, b) 1-2 mg/L, c) 2-3 mg/L or d) greater than 3 mg/L for area data. Data from selected Greenwood addresses are shown in blue, while data from all other addresses are shown in green.

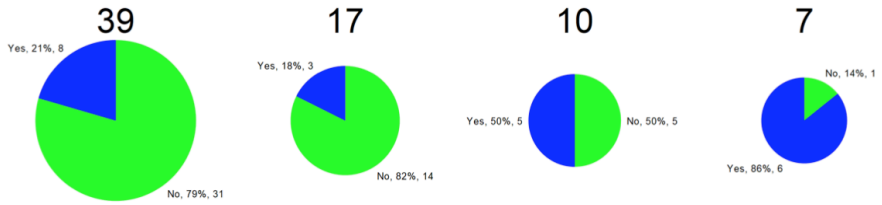

Figure 8: Pie charts showing relative proportions of data falling within each detected nitrate range color-coded by address grouping, and paralleling Fig. 7, a, b, c and d (above). Again, data from the selected Greenwood addresses are blue and those from the remaining addresses are green. As the detected nitrate range increases over 2 mg/L, the selected Greenwood addresses constitute an increasing proportion of data points in each nitrate concentration range.

A review of EPA drinking water guidelines suggests that groundwater nitrate levels above 1 mg/L are indicative of human activity, and those over 3 mg/L suggest contamination.[11] As some water quality data included in the above graphs were from well completion reports for new construction on previously undeveloped land and had results at or above 3 mg/L, it can be assume EPA-designated nitrate contamination is occurring but is due to a wider issue with the local groundwater supply than simply a point source (such as a nearby failed septic field). This highlights concerns related to nitrogen loading for any future development in the area, including Map 7, parcel 49, and underscores why a comprehensive nitrogen-loading study, as requested by the Town of Sherborn and reiterated in the project eligibility letter for the Greenwood Homes project,[12] was and still is a reasonable request. A broader investigation describing the area's

[11] https://www.epa.gov/nutrientpollution/estimated-nitrate-concentrations-groundwater-used-drinking
[12] https://www.sherbornma.org/DocumentCenter/View/1169/Project-Eligibility-Letter-from-Mass-Housing-January-9-2023-PDF

water quality, possible causes of apparent groundwater degradation, as well as potential inferences related to septic density and development will be submitted in the coming weeks.

Submitted respectfully by Meredith C Wesolowski, 34 Greenwood St., Sherborn, MA 01770