From: Jim Vernon <jvernon@nobis-group.com>
Sent: Wednesday, May 5, 2021 10:50 PM
To: Gino Carlucci <planning@sherbornma.org>
Subject: Nobis Phase 1 Hydrogeo Preliminary Results, The Pines and Apple Hill

5/5/21

Hi Gino,

This email constitutes Nobis' preliminary results report under our current (April 2021) contract with the Town of Sherborn. We have been asked to perform the first steps of a hydrogeologic assessment of proposed housing developments known as The Pines Residences (41 North Main Street, Tax Map 11, Lots 41 and 43) and Apple Hill Estates (31 Hunting Lane, Tax Map 11, Lot 3C) in Sherborn. Please pass this preliminary email report to the appropriate Town officials and Boards.

BACKGROUND

The project's Applicant team consists of Barsky Estate Realty Trust (owner/developer), Allen & Major (engineer/surveyor), LDS Consulting Group (40B consultant), Dream Collaborative (Architect), Vanasse & Associates (traffic), and Onsite Engineering (water and wastewater system designer). This team is herein collectively referred to as the "Applicant". Nobis understands that The Pines and Apple Hill will share a new public water system (PWS) and a new wastewater system.

Nobis understands that The Pines will consist of 60 apartments and Apple Hill will consist of 27 new houses in addition to one existing house, and that the projects will fall under the Massachusetts statute Chapter 40B affordable housing developments program. Nobis understands that the PWS is to be served by two wells, to be located between The Pines and Apple Hill on Tax Map 11, Lots 2 and 3B (well site). Railroad tracks separate The Pines from the well site. (See Draft Figure 1.) The wastewater system will include a wastewater treatment plant in the northern portion of Lot 3C, with a leachfield in the western portion of Lot 3C.

Nobis further understands that the proposed, shared water system is above the threshold requirements for a PWS, which means that permitting by the Massachusetts Department of Environmental Protection (MADEP) will be required for the PWS; the same is true for the wastewater system. The Town of Sherborn expects to participate in the permitting process through review of the development application and providing questions, comments, etc. to MADEP and the Applicant. The Town is also concerned about potential effects of the proposed PWS and wastewater system on existing private wells that serve nearby homes.

The proposed properties for The Pines, Apple Hill, and the PWS wells are hereinafter referred to as the Site. Collectively, these properties consist of Tax Map 11, Lots 41, 43, 2, 3B, and 3C, as outlined in red and purple on Draft Figure 1.

HYDROGEOLOGIC PROJECT OBJECTIVES

The objectives of Nobis' proposed hydrogeologic services may evolve as the project progresses. The objectives presently include:

1. Assess the probable adequacy of the proposed wells to serve The Pines and Apple Hill;

2. Assess the potential impact of the new wells on existing domestic wells that serve homes in the area;

3. Assess the potential impact of the proposed wastewater system on existing domestic wells that serve homes in the area; and

4. Provide hydrogeologic support at Zoning Board of Appeals (ZBA) and other meetings or public hearings.

INFORMATION REVIEWED FOR PHASE 1

As of May 5, 2021, Nobis has received and reviewed the following items from the Town of Sherborn. Nobis thanks Gino Carlucci for providing the information to us.

- Development Plans for The Pines Residences, dated October 1, 2020;
- Development Plans for Apple Hill Estates, dated March 1, 2021;
- Presentation materials by Onsight Engineering from March 31, 2021 on Water Supply and Wastewater Treatment for Apple Hill and The Pines;
- Well records:
    - 11 Unity Lane/17 North Main Street,
    - 24 Hunting Lane,
    - 31 Hunting Lane (1994),
    - 31 Hunting Lane (2007),
    - 33 Hunting Lane,
    - 36 Hunting Lane,
    - 41 North Main Street (2004),
    - 49 North Main Street, and
    - 51 Huntington (Hunting?) Lane;
- Soil Suitability Assessment for 31 Hunting Lane;
- Creative Land & Water letter report dated April 23, 2021; and
- Onsight Engineering, Inc. response letter dated April 29, 2021.

Please note that Nobis is not scoped to perform a peer review of the last two items listed above (but could do so upon request). The present review was conducted to obtain any additional hydrogeologic information to meet our objectives.

Additionally, Nobis obtained information from the Massachusetts GIS database, the Massachusetts wells database, and information in our files from previous Sherborn projects.

HYDROGEOLOGIC SETTING

Soils and Overburden Geology

Soils underlying the Site are shown on Draft Figure 2 (with separate key attached to this email) and range from rock outcrop units (103C, 103D, and 104C on Draft Figure 2) to various fine sandy loams (all very stony or extremely stony), to Merrimac urban land complex (probably fill and/or disturbed materials; 626B, southern portion of The Pines). The mapped areas for rock outcrop include the central portion of the proposed site for The Pines and the western and central portions of the proposed site for Apple Hill.

Logs of two test pits (TP-4 and TP-7) dug on October 4, 2019 at 31 Hunting Lane were provided to Nobis, and these are located in the western portion of the lot, where the leachfield is proposed. These test pit logs indicate boulders at the surface with loam underlain by sandy loam to depths of 9 feet and 11 feet respectively. Water table was at depths of 43 and 24 inches for TP-4 and TP-7, respectively, and percolation tests "passed."

Geologic surficial (overburden) deposits at the Site (Mass GIS) are shown on Draft Figure 3. Swamp deposits are mapped in the eastern portion of the Public Wells Lot. The Applicant's plans show wetlands mapped in this area, and Nobis understands that directional drilling will be used to install water main beneath the wetland to connect The Pines with the water supply wells. Areas of outcrop or shallow bedrock are also shown in the central portion of The Pines lot and in the eastern and northern portions of the Apple Hill lot. The former area is consistent with soils mapping, but the latter area is inconsistent with the soil mapping data set from Mass GIS, which shows rocky outcrop in the western and central sections of the lot. Nobis notes that such discrepancies are not surprising at this scale, for statewide data layers. Site specific information obtained from test pits, test borings, or direct observation is crucial for resolving this question and its implications for project feasibility.

Mapped surficial geologic deposits for the remaining portions of the Site are shown as thin glacial till. Glacial material can include a wide range of deposits from boulders, to gravel, to sand, to silt, to clay. Such deposits may or may not be suitable for storing groundwater to replenish deeper aquifers and may or may not be suitable for siting a leachfield. Site specific studies will be needed to make these determinations.

Bedrock Geology

Bedrock underlying the Site is labeled as mafic rock of Avalon age by Mass GIS (Draft Figure 3) and as metamorphosed mafic to felsic volcanic and intrusive rocks of the

Blackstone Group on the Bedrock Geologic Map of Massachusetts (USGS, 1983). These are crystalline rocks, often dark in color, which can be expected to have no effective porosity. This means that groundwater can only be stored in or transported through these rocks by fractures, cracks, or open structures in the rock.

Aquifers and Groundwater

In eastern and central Massachusetts, there are generally two types of aquifers:

- Overburden (surficial), unconsolidated aquifers – These aquifers are most productive where there is saturated sand or gravel, most commonly formed in Massachusetts from glacial meltwater streams formed as the last ice age was retreating. These are also known as stratified drift aquifers, and most high-yielding municipal wells are sited in these aquifers. Such an aquifer is mapped at least 3000 feet to the northeast of the Site (shown in blue on Draft Figure 4). In these aquifers, large amounts of water can be stored in pore spaces between the grains of sand and gravel.
- Fractured bedrock aquifers – Because bedrock in eastern and central Massachusetts is crystalline (igneous or metamorphic), it has no pore spaces in which to store and transmit water. Water can only be stored in fractures or other cracks or openings in the rocks. Drilling a successful well, especially to produce more water than needed for a single home depends on at least two factors. First, open fractures in the rock must be encountered. Second, the fractures must be connected to a source of recharge from above. Thus, sandy soils, even if too thin for overburden wells, are important for storing groundwater and recharging bedrock fractures below. The bedrock aquifer type appears to be the only type of aquifer available at the Site, and the proposed wells for the project, in addition to all the wells known to Nobis in the immediate surroundings, are bedrock wells. See below.

INFORMATION ON NEARBY WELLS

The Town of Sherborn provided Nobis with records for the wells listed in the "Information Reviewed" section, above. The records include Well Drilling Permits, Well Completion Reports (WCRs), results of 4-hour pumping tests, and water quality results, but most of the wells have only some of this information available. Nobis also queried the Massachusetts Energy and Environmental Affairs (EEA) data portal and found 10 additional wells, drilled since 2000, in the general area. Nobis proposes a detailed analysis of these wells in Phase 2.

The Town has informed Nobis that the Applicant drilled two wells in the proposed well site (Tax map 11, Lots 2 and 3B). The Onsite Engineering presentation (March 31, 2021) indicates that each well is 820 feet deep and that the yields are rated at 25 and 7 gallons per minute (gpm). Nobis has not received further well records on these wells from the Town nor did Nobis find WCRs on the EEA data portal. Until WCRs, drilling logs, and pumping test results are available, it is not possible to assess the adequacy of these wells to provide sufficient, sustainable water for the project. Nobis does not know whether the reported yield are from driller's airlift, 4-hour pumping tests, or longer

sustained pumping tests. It is also unknown if the two wells can be pumped together to obtain a combined yield or if the wells will interfere with each other. Also, Nobis has not seen any water quality data for these wells.

Information on the wells for which the Town provided reports to Nobis is summarized on the attached Table. For the wells shown, the average depth is 551 feet, with a range from 200 feet to 1005 feet. All are tapping the bedrock aquifer. While significant quantities of water can sometimes be found very deep, this is not the norm. The relatively great depth of several of these wells, including the wells drilled by the Applicant (not included in the Table) is concerning because it indicates that drilling to several hundred feet was required to obtain enough water for a single home. One advantage of a very deep well is that the wellbore provides storage. However, wellbore storage is not sufficient to sustain a PWS. An adequate sustainable yield, as well as storage tanks will be required by Mass DEP in order to permit the water system.

The attached table also shows that depth to bedrock for these wells ranges from 1 foot to 28 feet, with an average depth of 15 feet. With all other factors equal, sites with thicker overburden are more favorable, as the soils and overburden deposits can store groundwater that can recharge bedrock fractures below. It is interesting to note that the well with only 1 foot of overburden (elsewhere in the well record it shows 4 feet) is an irrigation well drilled at 31 Hunting Lane, the site for Apple Hill. If this well is located in or near the proposed leachfield, the shallow bedrock would be a serious concern.

Reported yields for the existing wells range from 7.5 gpm to 12 gpm, with an average of 9.4 gpm. However, these are drillers' initial estimates, based on either initial airlift tests upon completing the drilling or on 4-5 hour pumping tests. Such initial tests are sufficient for a homeowner well but almost always over-estimate the sustainable yield that could be obtained if a well is pumped over the long term and intended to serve a PWS. Many factors influence a well's sustainable yield, and an extended pumping test of 48 hours or more is needed to estimate the sustainable yield. Nobis does not know if such a test has been done on the two new wells for the project or how the estimates of 25 gpm and 7 gpm were obtained.

Another general concern to be considered is the number of bedrock wells that are already present in this bedrock aquifer with generally thin overburden. Whether existing and new wells will interfere with each other is a concern; there is not yet enough information to evaluate this.

The limited water quality information reviewed so far is generally good (see Table 1), though moderate alkalinity has been noted in a few wells. This is not a health concern but could lead to some hardness in the water. The sampling that has been done for the existing private homeowner wells covers far fewer parameters than will be required (by Mass DEP) for the two new wells proposed to serve the PWS. Also, PFAS is a current and growing concern for drinking water supplies. Nobis is unaware of any PFAS testing results for the proposed new PWS wells or any of the existing wells in the vicinity. Mass DEP may require PFAS testing for the new wells.

SUMMARY AND RECOMMENDATIONS

Based on the information reviewed to date, here is a summary of Nobis' preliminary opinions on the objectives listed above:

1. Adequacy of the new wells drilled to serve the proposed PWS for The Pines and Apple Hill – There is not yet enough information to assess this objective, but there is reason for caution. Relatively thin overburden, great well depths, and modest yield for existing wells are causes for concern, but not necessarily fatal flaws.
2. Possible impact of new wells on existing wells – There is not yet enough information to assess this objective, but the same concerns listed for item 1 pertain. Also, investigations such as a photolineament analysis and monitoring neighboring wells during required pumping tests of the new wells will be needed to answer this question.
3. Possible impact of proposed wastewater system on existing (and new) wells – Additional investigations such as groundwater level and flow direction mapping, photolineament analysis, mounding calculations, etc. will be needed to assess this possibility.
4. Provide support at ZBA and other Town hearings or meetings – Nobis believes that the information described above and to be obtained during Phase 2 will provide initial help to the ZBA and other Town boards to assess the potential impacts of the project, focus additional questions and investigations, and ultimately help the ZBA and other Town boards to make informed decisions.

Nobis offers the following recommendations:

- If information on the new wells intended to serve the proposed PWS is not already available at the Sherborn BOH, Nobis recommends that the Town request this information from the Applicant ASAP.
- Nobis should continue the investigations begun in Phase 1 and do the following for Phase 2:
    - Review information on the new PWS wells for the project, including driller's logs, WCRs, results of any pumping or airlift tests, and results of any water quality sampling performed to date.
    - Expand the Table of existing well information to include the new wells and WCRs available from the EEA database.
    - Add abutter well information to a site map such as Figure 1 or Figure 4.
    - Conduct a photolineament (fracture trace) analysis using a range of available air photos.
    - Visit the site for reconnaissance and to measure orientations of bedrock fractures in nearby outcrops.
- Nobis should then prepare a Phase 2 written report summarizing the information described above and in this Phase 1 email report.
- Regardless of Mass DEP requirements and timing, Nobis recommends that a sustained pumping test be conducted on the new wells soon. If sustainable quantities of potable groundwater cannot be obtained from these wells, the project will not be feasible as designed.

Thank you for the opportunity to participate in this project. Please contact me if you or ZBA members have questions on our work so far.

Sincerely,

Jim Vernon

James H. Vernon, PhD, PG
Director of Water Supply Services | Senior Hydrogeologist

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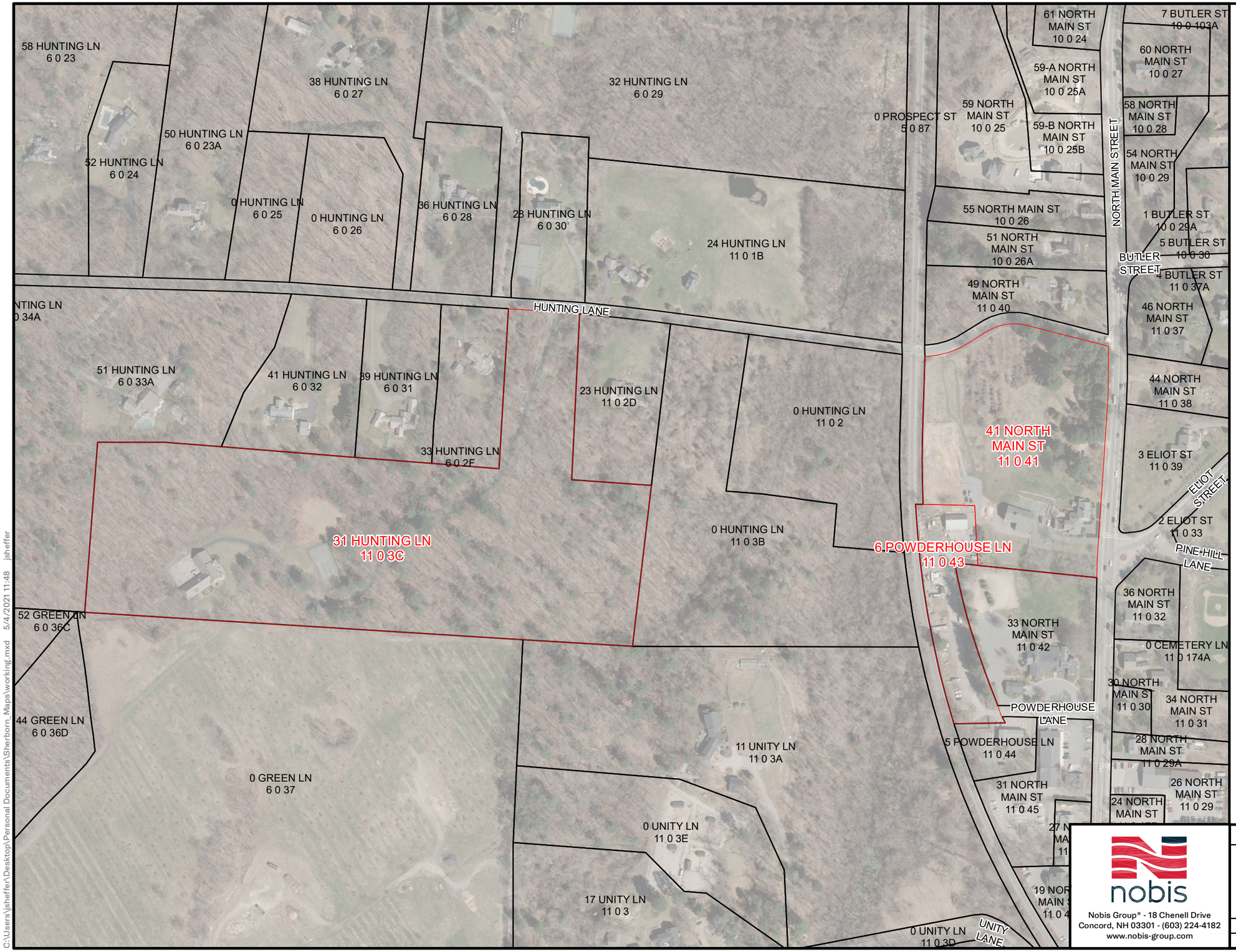

Notes:

1. Assessor's parcels, addresses, and street names are from MassGIS. Aerial photography provided by ESRI.

2. Locations of site features depicted hereon are approximate and given for illustrative purposes only.

Legend

- Site Properties
- Other Property Lines

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FIGURE 1

PROPERTY MAP
THE PINES AND APPLE HILL
SHERBORN, MASSACHUSETTS

PREPARED BY: JTS	CHECKED BY: JV
PROJECT NO. 100137.000	DATE: MAY 2021

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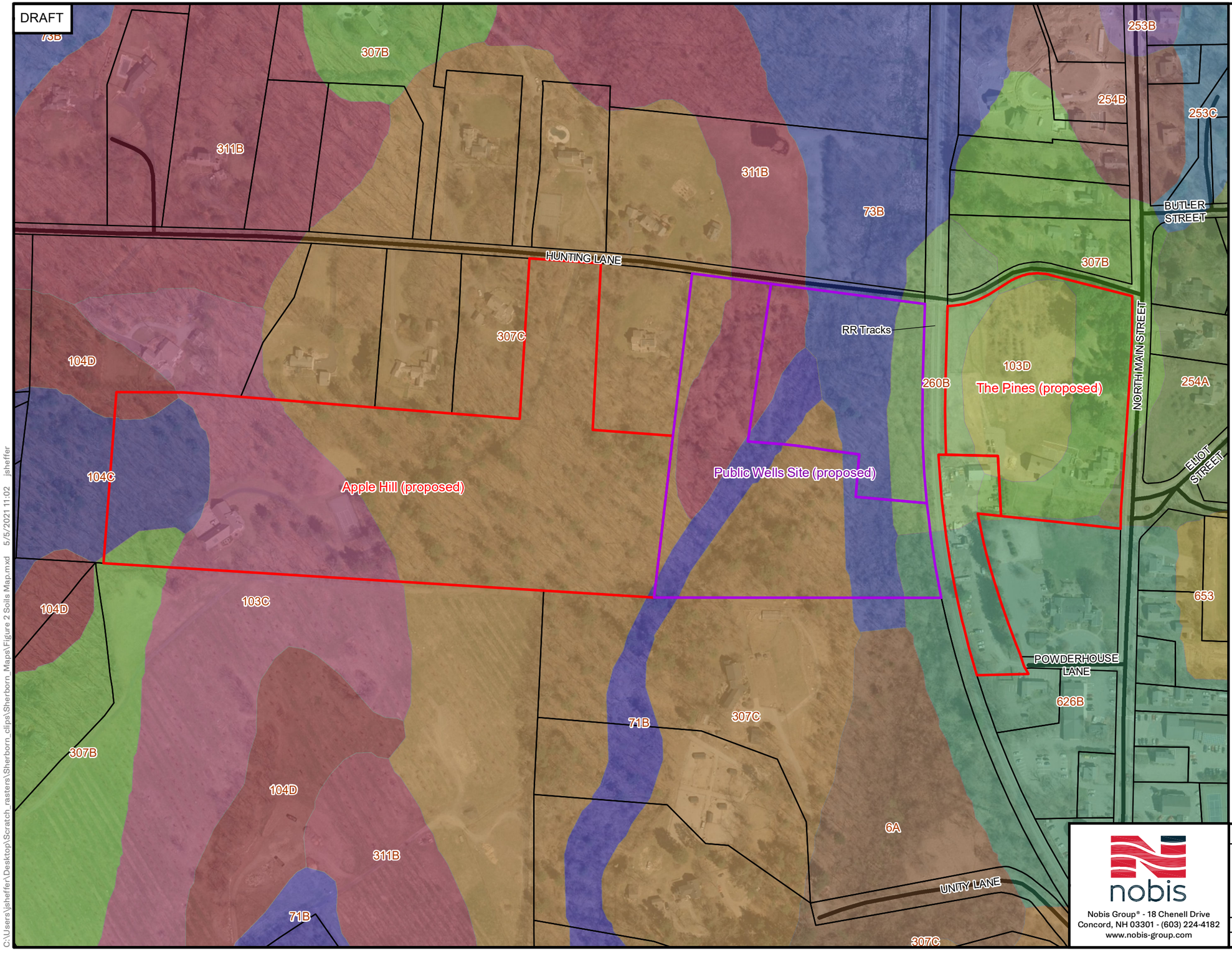

Notes:

1. Soil polygons, types, assessor's parcels and street names are from MassGIS. Aerial photography provided by ESRI.

2. Locations of site features depicted hereon are approximate and given for illustrative purposes only.

- Site Properties
- Public Wells Site
- Other Property Lines
- Charlton-Hollis-Rock outcrop complex, 15 to 25 percent slopes
- Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes
- Hinckley loamy sand, 3 to 8 percent slopes
- Hinckley loamy sand, 8 to 15 percent slopes
- Hollis-Rock outcrop-Charlton complex, 15 to 25 percent slopes
- Hollis-Rock outcrop-Charlton complex, 3 to 15 percent slopes
- Merrimac fine sandy loam, 0 to 3 percent slopes
- Merrimac fine sandy loam, 3 to 8 percent slopes
- Merrimac-Urban land complex, 0 to 8 percent slopes
- Paxton fine sandy loam, 3 to 8 percent slopes, extremely stony
- Paxton fine sandy loam, 8 to 15 percent slopes, extremely stony
- Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony
- Scarboro mucky fine sandy loam, 0 to 3 percent slopes
- Sudbury fine sandy loam, 3 to 8 percent slopes
- Udorthents, sandy
- Whitman fine sandy loam, 0 to 5 percent slopes, extremely stony
- Woodbridge fine sandy loam, 3 to 8 percent slopes, very stony

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0 125 250 500

Feet
1 inch = 250 feet

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FIGURE 2

SOILS MAP
THE PINES AND APPLE HILL
SHERBORN, MASSACHUSETTS

PREPARED BY: JTS	CHECKED BY: JV
PROJECT NO. 100137.000	DATE: MAY 2021

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Map Unit Number	Soil Type
653	Udorthents, sandy
656	Udorthents-Urban land complex
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes
103D	Charlton-Hollis-Rock outcrop complex, 15 to 25 percent slopes
104C	Hollis-Rock outcrop-Charlton complex, 3 to 15 percent slopes
104D	Hollis-Rock outcrop-Charlton complex, 15 to 25 percent slopes
253B	Hinckley loamy sand, 3 to 8 percent slopes
253C	Hinckley loamy sand, 8 to 15 percent slopes
254A	Merrimac fine sandy loam, 0 to 3 percent slopes
254B	Merrimac fine sandy loam, 3 to 8 percent slopes
256A	Deerfield loamy sand, 0 to 3 percent slopes
260B	Sudbury fine sandy loam, 3 to 8 percent slopes
305C	Paxton fine sandy loam, 8 to 15 percent slopes
307B	Paxton fine sandy loam, 3 to 8 percent slopes, extremely stony
307C	Paxton fine sandy loam, 8 to 15 percent slopes, extremely stony
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes
311B	Woodbridge fine sandy loam, 3 to 8 percent slopes, very stony
311C	Woodbridge fine sandy loam, 8 to 15 percent slopes, very stony
312B	Woodbridge fine sandy loam, 3 to 8 percent slopes, extremely stony
335B	Rainbow silt loam, 3 to 8 percent slopes
407B	Charlton fine sandy loam, 3 to 8 percent slopes, extremely stony
420B	Canton fine sandy loam, 3 to 8 percent slopes
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony
51A	Swansea muck, 0 to 1 percent slopes
52A	Freetown muck, 0 to 1 percent slopes
626B	Merrimac-Urban land complex, 0 to 8 percent slopes
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony
73B	Whitman fine sandy loam, 0 to 5 percent slopes, extremely stony

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HUNTING LANE

BUTLER STREET

NORTH MAIN STREET

RR Tracks

The Pines (proposed)

Public Wells Site (proposed)

Apple Hill (proposed)

ELIOT STREET

PINE HILL LANE

POWDERHOUSE LANE

UNITY LANE

Notes:

1. Surficial geology polygons, types, assessor's parcels, and street names are from MassGIS. Aerial photography provided by ESRI.

2. Areas not shown as abundant outcrop and shallow bedrock or swamp deposits are thin glacial till.

3. The bedrock lithology for the area shown is classified as mafic rock in the Avalon Belt.

4. Locations of site features depicted hereon are approximate and given for illustrative purposes only.

Legend

- Site Properties
- Public Wells Site
- Other Property Lines
- Areas of abundant outcrop and shallow bedrock
- Swamp deposits

Wellhead Protection Areas

- DEP Protection Zone I
- DEP Protection Zone II

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0 125 250 500

Feet
1 inch = 250 feet

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FIGURE 3

SURFICIAL GEOLOGY/
BEDROCK LITHOLOGY MAP
THE PINES AND APPLE HILL
SHERBORN, MASSACHUSETTS

PREPARED BY: JTS	CHECKED BY: JV
PROJECT NO. 100137.000	DATE: MAY 2021

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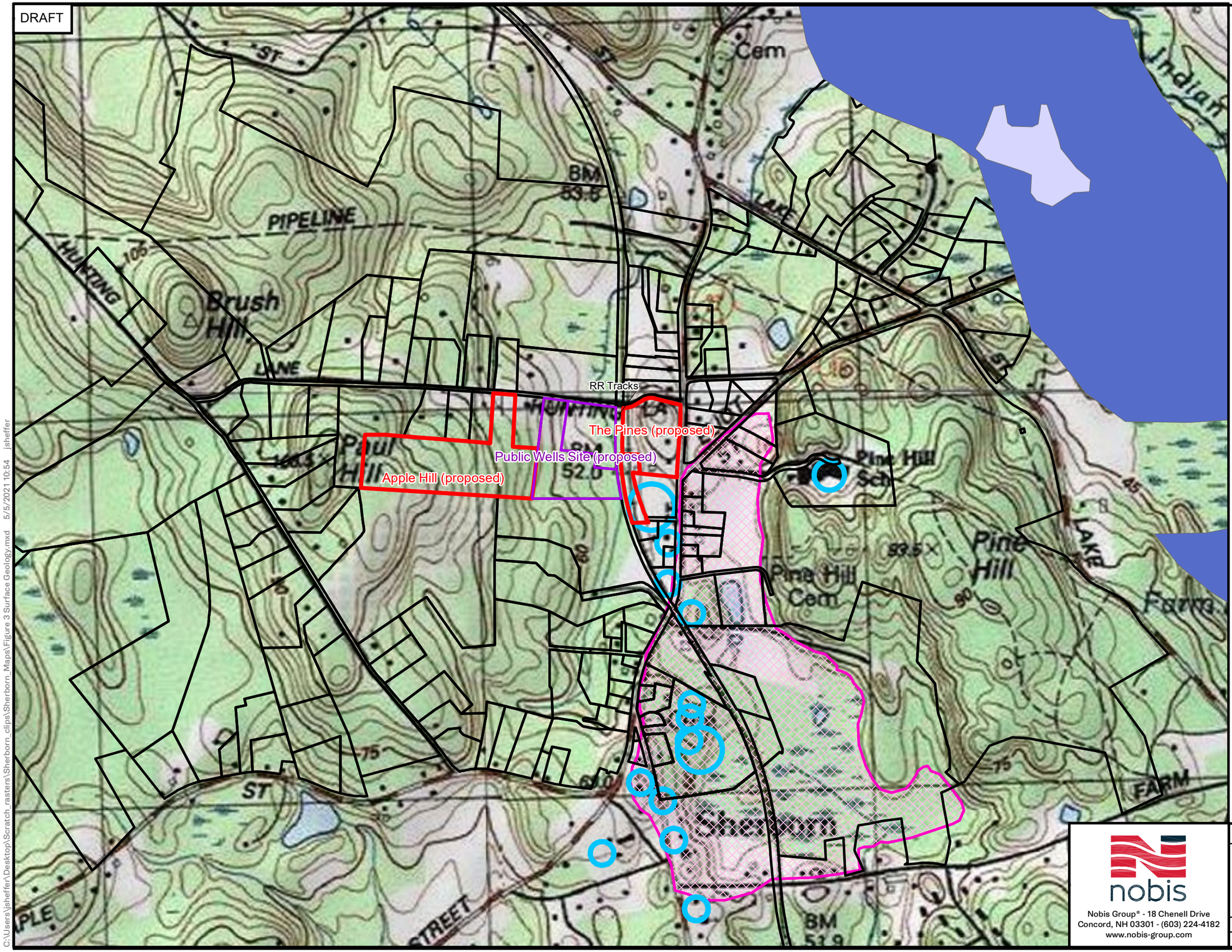

Notes:

1. Wellhead protection zones, aquifer polygons, assessor's parcels and street names are from MassGIS. Aerial photography provided by ESRI.

2. Locations of site features depicted hereon are approximate and given for illustrative purposes only.

Legend

- Site Properties
- Public Wells Site
- Other Property Lines
- Surface Water
- Aquifer, Med Yield: 50-250 gpm

Wellhead Protection Areas

- DEP Protection Zone I
- DEP Protection Zone II

N

0 400 800 1,600

Feet
1 inch = 800 feet

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FIGURE 4

AQUIFER MAP
THE PINES AND APPLE HILL
SHERBORN, MASSACHUSETTS

PREPARED BY: JTS	CHECKED BY: JV
PROJECT NO. 100137.000	DATE: MAY 2021

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