Section 9.3

Surface Water and Groundwater Summary

9.3 SURFACE WATER AND GROUNDWATER SUMMARY

This section provides a summary of surface water and groundwater conditions in the vicinity of the GSL project site and includes the following sections:

- **Section 9.3.1** provides an overview of site setting and hydrology. An overview of features in the vicinity of the project site is shown on Figure 9-3.1.
- **Section 9.3.2** summarizes an evaluation of impaired waters in the GSL project site and vicinity based on NHDES' 2020/2022 305(b)/303(d) CALM information. Figure 9-3.2 depicts impaired waters near the project site based on information maintained by NHDES.
- **Section 9.3.3** provides an overview of site hydrogeology based on drilling and groundwater and surface water monitoring activities performed at the project site between 2018 and 2023. This section also includes an assessment of groundwater levels relative to wetlands. In general, the pattern of depth to groundwater in wetland features is consistent with anticipated distribution of hydrologic features in a topographically-driven "Tóth-style" groundwater basin. Water levels are shallower in topographically-low areas south and east of Douglas Drive, which is consistent with the presence of a groundwater discharge zone within the basin and the presence of larger and more contiguous wetland features, compared to topographically higher areas north and east of Douglas Drive in the vicinity of the proposed footprint. A discussion of seasonal changes observed in a representative wetland instrumented with shallow piezometers and a monitoring well is included, and a summary of observations from staff gauges installed in an intermittent stream is provided. Section 9.3.3 includes the following figures:
  - Figure 9-3.3a and 9-3.3b show groundwater elevation contours and inferred groundwater flow directions within and near the project site in May 2023 and September 2022, respectively. May 2023 is intended to represent general high-water level conditions, while September 2022 is intended to represent general low-water level conditions.
  - Figures 9-3.4a and 9-3.4b show a cross-section alignment plan and cross sections that identify the location of wetlands. These figures depict a comparison of interpolated depths to water in wetland features to ground surface elevation.
  - Figure 9-3.5 shows stratified drift mapped in the vicinity of the project area (also referenced in Section 9.3.4).
- **Section 9.3.4** provides an evaluation of water supplies at the GSL project site. Figure 9-3.6 shows water supplies in the vicinity of the project site.

9.3.1 Setting and Site Hydrology

The site is located near the eastern limit of the Alder Brook/Hatch Brook watershed. This drainage catchment is bordered topographically as follows:

- To the north by the Dalton Mountain Range;
- To the east by a topographic high separating drainage to the Bog Brook/Forest Lake watershed;
- To the south/southeast a topographic high separating drainage near West Forest Lake Road and areas draining south beneath NH Route 116; and

- To the west by the Mann Hill/Hedgehog Hill ridge.

Hatch Brook and Alder Brook converge north of NH Route 116 and then flow south beneath the highway to discharge to the Ammonoosuc River. The Alder Brook/Hatch Brook watershed (approximately 2,900 acres in total) was delineated from LiDAR data of ground surface topography obtained from NH GRANIT[1] for the region. Using the Hydrology toolset in ArcGIS and general methods from USEPA's 2017 Manual "Procedures for Delineating and Characterizing Watersheds for Stream and River Monitoring Programs"[2] , the watershed was delineated and compared to U.S. Geological Survey (USGS) maps and site observations as a check. Agreement between the datasets (which used different methods) was good (see Figure 9-3.2) and the delineation performed using LiDAR is considered representative of site conditions. The Alder Brook/Hatch Brook watershed is shown on Figure 9-3.1.

9.3.2 Evaluation of Impaired Waters

NHDES maintains online information for "impaired waters"[3,4] within the State, which was used to identify areas in the Alder Brook/Hatch Brook watershed within 1-mile upstream of an impaired waterbody. As cited by the ACOE Appendix B - Corps Secondary Impacts Checklist, NHDES' information was evaluated to identify the potential for impaired waterbodies to be present within the Alder Brook/Hatch Brook watershed, as well as impaired waterbodies in other watersheds near the project site.

NHDES released the 2020/2022 305(b)/303(d) Comprehensive Assessment and Listing Methodology (CALM) on February 18, 2022[5]. USEPA approved New Hampshire's 2020-2022 303(d) list on March 14, 2022[6]. Figure 9-3.2 indicates NHDES' February 2022 draft surface water quality assessment information regarding impaired waters in watersheds surrounding the Hatch Brook/Alder Brook watershed.

The streams with impairment classifications indicated on Figure 9-3.2 are classified as "Marginal" impairments by NHDES. Also shown on Figure 9-3.2 are 1-mile radii around each of the impaired stream reaches, with the radii extended to the watershed boundaries for each reach. Watershed boundaries are the USGS Hydrologic Unit Code (HUC) 12 watersheds[7], except for the boundary to the Hatch Brook/Alder Brook watershed, where the HUC 12 watershed was refined based on publicly available LiDAR data.

As indicated on Figure 9-3.2, several reaches of the Ammonoosuc River have marginal impairments indicated for pH and aluminum for aquatic life, and E. coli for primary contact recreation (swimming). We understand all waterbodies in the state have been designated as impaired for fish/shellfish consumption due to mercury, and hence, these impairments are not shown individually on Figure 9-3.2.

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1 LiDAR-derived Bare Earth DEM available at http://lidar.unh.edu/
2 https://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=533925 (Section 3.2)
3 https://www.des.nh.gov/water/rivers-and-lakes/water-quality-assessment
4 https://www.des.nh.gov/water/rivers-and-lakes/water-quality-assessment/swqa-publications#faq38801
5 https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-20-20.pdf
6 https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/epa-approval-2020-2022.pdf
7 https://water.usgs.gov/GIS/huc.html

No impairments were identified on stream reaches in the Hatch/Alder Brook watershed. Only one stream reach (Ammonoosuc River AUID NHRIV801030403-07 with impairments indicated for pH for aquatic life) has a 1-mile buffer that extends into the Hatch Brook/Alder Brook watershed; however, the buffer area does not extend into the proposed landfill area of the Hatch Brook watershed. No stream reaches within the Hatch Brook/Alder Brook watershed are indicated as impaired based on NHDES' 2020/2022 305(b)/303(d) CALM information.

The following table summarizes the marginally impaired waters depicted on Figure 9-3.2:

Assessment Unit Name (ID)	Parameter	NHDES Parameter Level	TMDL Priority	Last Sample	Last Exceedance
Aquatic Life Integrity – Marginal Impairments					
Forest Lake (NHLAK801030101-02-01)	pH	5-M	LOW	2019	2017
Burns Pond (NHLAK801030101-01-01)	pH	5-M	LOW	2019	2019
Unnamed Brooks from Forest Lake to Burns Pond (NHRIV801030101-02)	pH	5-M	LOW	2019	2019
Johns River - Chase Brook (NHRIV801030102-08)	Phosphorus (Total)	4B-T	—	2014	NLV
	Total Suspended Solids (TSS)	4B-T	—	—	—
	pH	5-M	LOW	2017	2015
Cushman Brook (NHRIV801030201-01)	Fishes Bioassessments (Streams)	5-M	LOW	2006	2006
Ammonoosuc River (NHRIV801030403-03)	pH	5-M	LOW	2010	2010
Ammonoosuc River (NHRIV801030403-07)	pH	5-M	LOW	2010	2010
Ammonoosuc River (NHRIV801030403-11)	Aluminum	5-M	LOW	2006	2006
	pH	5-M	LOW	2019	2016
Primary Contact Recreation – Marginal Impairments					
Ammonoosuc River (NHRIV801030403-11)	Escherichia coli (E. coli)	4A-M	—	2019	2015

Notes:
1. This table is modified from NHDES' 2020/2022 Tabular Summary of Assessment Units: https://www.des.nh.gov//sites/g/files/ehbemt341/files/documents/status-of-each-assessment-unit-2020-2022.xlsx
2. "4A-M" indicates: There is an impairment per the CALM by a parameter which is a pollutant and an EPA-approved TMDL has been completed. However, the impairment is relatively slight or marginal.
3. "4B-T" indicates: "There is a parameter which is considered a pollutant that is threatening impairment as per the CALM but a TMDL is not necessary since other controls are expected to attain water quality standards within a reasonable time."

4. “5-M” indicates: “there is an impairment per the CALM by a parameter which is a pollutant that requires a TMDL. The impairment is marginal as defined in DES sub-category 4A-M above.”“—"indicates no information provided in the table accessed via NHDES’ website.
5. Statewide impairments for fish/shellfish consumption due to mercury are not included in this table.

Impairment for aquatic life integrity for pH is the most common impairment identified near the site, except for the statewide mercury impairment mentioned above. According to the 2020/2022 Section 305(b) Surface Water Quality Report prepared by NHDES dated August 19, 2022[8], acidic conditions are widespread in the state because of historical acid rain, modern nitrogen emissions from transportation sources, the loss of acid-neutralizing minerals from soil, and long-term accumulation of sulfur and nitrogen in soils. Therefore, acidic conditions are inferred to be representative of current background conditions in the site vicinity.

In addition to impaired waters described above, there are several water bodies in the vicinity of the site classified within NHDES Category 3-Potentially Not Supporting ("3-PNS”)[9]. These include Forest Lake and Forest Lake State Park Beach, Cushman Brook and the Ammonoosuc River (Reach 11) for Potential Drinking Water Supply E. coli, and Forest Lake for Aquatic Life Integrity for alkalinity and dissolved oxygen saturation. These waters are not currently part of the NHDES impaired water list, but the NHDES category “3-PNS” suggests that further sampling could indicate exceedances of surface water standards.

9.3.3 Site Hydrogeologic Evaluation

In order to assess baseline groundwater conditions in the area of the landfill footprint, a series of groundwater monitoring wells and piezometers (shallow, manually-installed well screens) were installed to monitor groundwater levels, groundwater flow direction, and groundwater quality. These monitoring wells are supplemented by borings installed for geotechnical assessment purposes. In addition, surface water gauging stations were established to characterize surface water elevation and water quality in conjunction with the groundwater monitoring program. Additional surface water stations were installed for aquatic resource/Clean Water Act (CWA) Section 401 permitting purposes that are discussed in the 401 Water Quality Certification Application, submitted separately. In total, the existing monitoring network near the proposed landfill footprint includes: 61 groundwater monitoring wells, 36 piezometers, and 22 surface water gauging stations (12 stations on flowing surface water courses, one spring, and nine on an intermittent stream course[10]). Refer to Figures 9-3.3a and 9-3.3b for monitoring locations.

The results of drilling at the site indicate that generally thin (typically 15 feet or less) glacial till consisting of silty sand and clay with large boulders overlies bedrock within the project area. At five locations bedrock was encountered at depths between 34 and 63 feet (MW-21U/L, MW-38R and MW-39R southwest of Douglas Drive outside of the footprint, MW-28R near the top of the ridgeline east and uphill of the proposed landfill, and MW-32R located outside the Alder Brook catchment southeast of the quarry). At these locations, in addition to till, sand and gravel

8 https:/www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-22-11.pdf
9 “3-PNS” category indicates: “There is some but insufficient data to assess per the CALM, however, the data that is available suggests that the parameter is Potentially Not Supporting (PNS) water quality standards (e.g., there is one exceedance).”
10 Totals do not include surface water monitoring locations installed as part of CWA Section 401 permitting purposes.

was encountered, primarily at depths above the groundwater table, with the exception of MW-21L which had several feet of sand and silty sand beneath the water table in between silty clay till layers. The USGS mapped[11] an isolated, discontinuous area of stratified drift several hundred feet in diameter adjacent to Alder Brook and its associated wetlands west of the proposed landfill. The USGS designated the transmissivity of this area less than 2,000 feet^2 per day. Stratified drift was not encountered at the site as part of drilling. Refer to Figure 9-3.5 for locations of stratified drift and sand and gravel deposits.

Depths to groundwater in and near the project area are typically less than 25 feet; within the proposed landfill footprint, maximum depths to water in overburden monitoring wells ranged from 0.9 to 7.3 feet. Based on groundwater elevation measurements, groundwater is recharged by precipitation in topographically high areas on the hillslope where the proposed footprint is situated, and along the ridgeline to the east. The groundwater within the proposed footprint generally flows to the southwest, towards tributaries and the main branch of Alder Brook and its associated wetlands, in the same general direction as surface water flow.

Groundwater elevations have been measured periodically at the site between 2018 and 2023. Figure 9-3.3a depicts water level contours developed based on measurements collected in May 2023, and Figure 9-3.3b depicts updated water level contours developed based on measurements collected in September 2022, which are generally inferred to be representative of seasonal high and low conditions, respectively. The water level contours depicted in Figures 3-3.3a and 3-3.3b were developed using an ArcGIS model that first interpolates a surface based on known water level measurement points (smooth lines), and then adjusts the surface to be equal to LiDAR ground surface in areas where the interpolation results would have projected groundwater levels above ground. The method indirectly serves to help identify areas between known measurement points with the potential for groundwater to be at or near ground surface.

In addition to manual water level measurements, 25 pressure transducers were installed in groundwater monitoring wells and piezometers in the landfill footprint and vicinity to provide a nearly continuous record of groundwater elevation. Approximately four years of groundwater elevation measurements confirm a stable groundwater divide associated with the topographic divide east of the proposed landfill footprint. Seasonal high water levels and seasonal low water levels were recorded in several rounds (e.g., annual highs in May 2021, March 2022 and May 2023, and annual lows in September 2021 and September 2022), but generally the seasonal highs were recorded in spring and seasonal lows were recorded in fall. Seasonal variations in groundwater levels do not materially change overall groundwater flow direction across the site (i.e., horizontal and vertical gradients do not appear to reverse seasonally).

Groundwater head measurements and observations of several groundwater seeps indicate groundwater discharge to the wetlands, including primarily the relatively low-lying Alder Brook wetland complex located west/southwest of the landfill footprint. Based on measured depths

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[11] Flanagan, S.M. 1996. Geohydrology and water quality of stratified-drift aquifers in the middle Connecticut River basin, west-central New Hampshire. U.S.G.S. Water-Resources Investigations Report 94-4181.

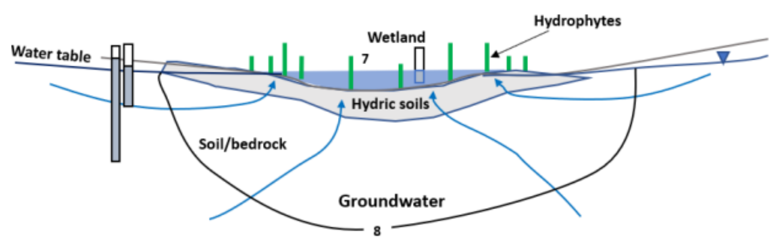
to groundwater and an assumed topographically-controlled groundwater flow system similar to that described by Tóth (1963)[12,13], the generally small-scale wetlands east of Douglas Drive are inferred to represent areas of shallow groundwater along the hillslope. Given the forested nature of the slopes east of Douglas Drive and absence of surface water features, discharge of shallow groundwater in the area east of Douglas Drive is inferred to largely take the form of evapotranspiration. Due to their topographically low setting and position relative to overall groundwater flow direction, wetlands near the main stem of Alder Brook (west of the Douglas Drive) are inferred to receive a proportionally higher amount of groundwater discharge from deeper flow paths than wetlands east of Douglas Drive.

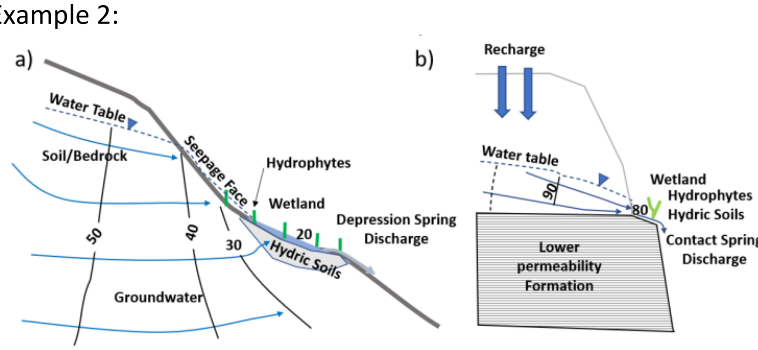
9.3.3.1 Groundwater – Wetland Interaction

The following section describes an assessment of groundwater and wetland interaction within the proposed landfill footprint and vicinity. This section focuses on wetland features; however, intermittent and perennial streams are also discussed.

The general relationship between groundwater and wetlands may be categorized in several ways summarized in the following exhibit:

Exhibit 9.3.3.1
General Summary of Types of Groundwater – Surface Water Interactions in Wetlands

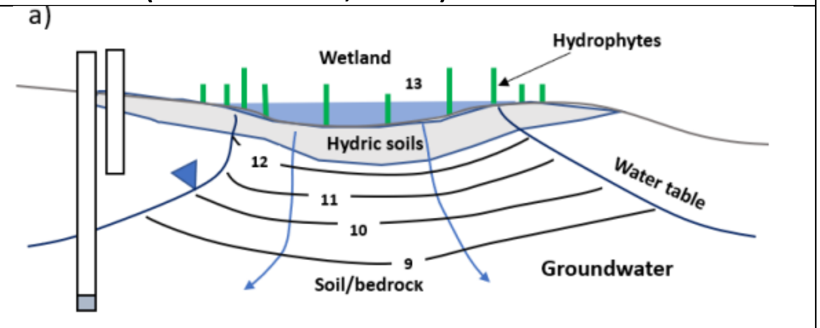
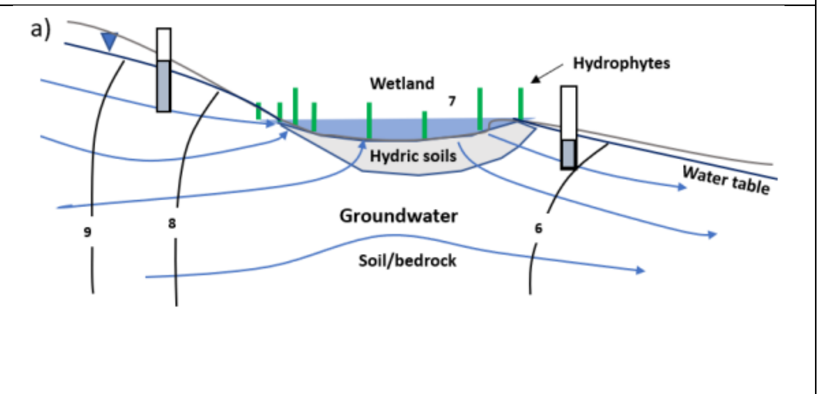
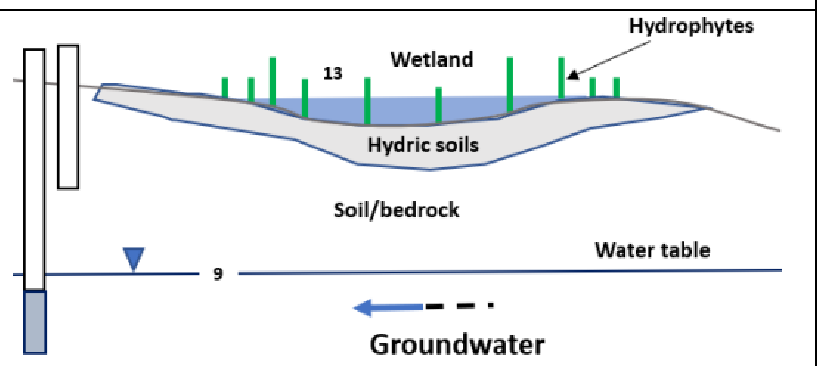
<table>
<tr><th>Description</th><th>Schematic (From Woessner, 2020[14])</th></tr>
<tr><td>Gaining:
Groundwater discharges to surface water; may continue flowing downgradient as surface water in the case of perennial streams, or remain in the surface water feature and eventually leave the system through evapotranspiration and sometimes through ephemeral or intermittent flow</td><td>Example 1:


Example 2:

</td></tr>
</table>

[12] Tóth, J. 1963. A theoretical analysis of groundwater flow in small drainage basins. Journal of Geophysical Research. Vol. 68, Issue 16, p. 4795-4812, https://doi.org/10.1029/JZ068i016p04795

[13] Tóth, J. 2009. Gravitational Systems of Groundwater Flow: Theory, Evaluation, Utilization. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511576546

[14] Woessner, W. W., Groundwater-Surface Water Exchange, The Groundwater Project, Guelph, Ontario, Canada, 2020.

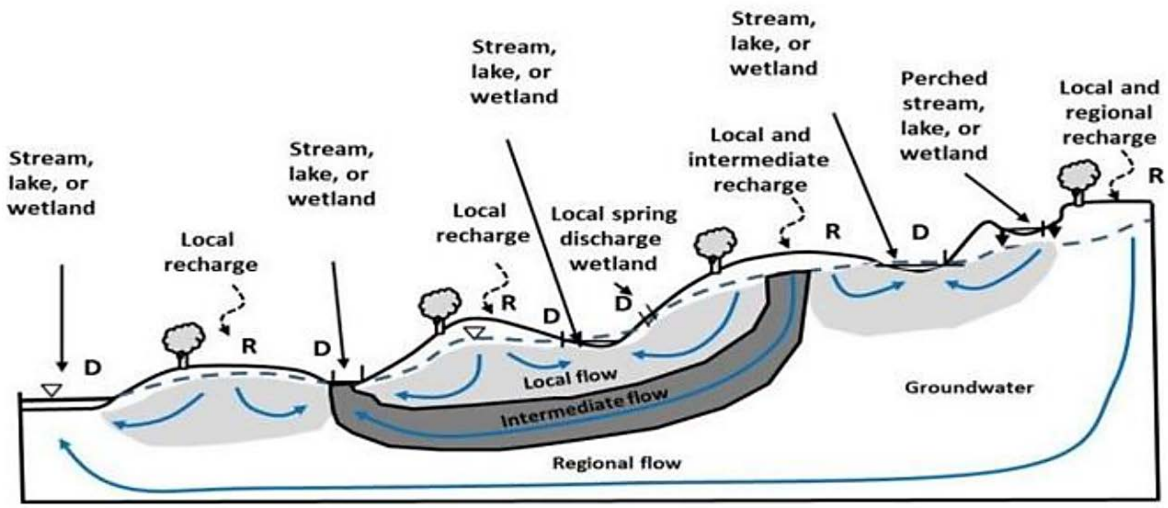
Description	**Schematic (From Woessner, 2020[14])**
Losing: Surface water heads are higher than surrounding groundwater heads; surface water infiltrates into groundwater. May occur locally in wetlands with no streamflow, but occurs naturally less commonly for extended distances along most streams in New England	
Flow-through: Vertical gradients are generally low and groundwater temporarily flows above ground as surface water. If heads are lower beneath the wetland area, groundwater may flow into the wetlands laterally and out through the bottom of the wetlands in a "mixed" condition of gaining and losing zones.	
Separated (perched): surface water is perched above groundwater and separated by a vadose zone. Perching may be a function of low permeability soil conditions beneath wetlands and a relatively deeper water table	

Notes:
1. Schematics depict conceptual cross-sections of wetlands.
2. Groundwater equipotential lines are shown in black. Groundwater flow lines are in blue.
3. Monitoring wells/piezometers are open at the bottom, and the blue bars indicate water level in the monitoring wells/piezometers.
4. Types and descriptions of wetlands are based on Woessner, 2020.

The diagrams above are intended to be generalized depictions. The relationship between groundwater and surface water is influenced by a number of factors such as topography, precipitation and evapotranspiration (water balances), position within the topographic watershed, subsurface transmissivity, the presence of frozen ground during winter, and localized surface water feature bottom conditions (e.g., presence of low permeability leaf litter/muck or presence of macropores). Small scale variability in ground topography, precipitation, soil permeability, and subsurface features may locally influence hydraulic gradients between surface water and groundwater.

In topographically-driven groundwater flow systems typical of the northeastern US, the pattern of groundwater-surface water interaction in wetland features often varies spatially within a watershed and seasonally in response to changes in precipitation. For instance, separated (perched) wetlands more commonly occur in groundwater recharge zones in topographically higher portions of the watershed where depth to water is often greater than lower in the watershed. Gaining wetlands more commonly occur in groundwater discharge zones with shallower depths to water in topographically lower portions of the watershed. Gaining wetlands may receive discharge from groundwater flow paths of varying lengths depending on position along the slope. The following schematic diagram from Woessner (2020) summarizes occurrence of wetlands in relation to groundwater discharge and recharge zones along a topographic gradient. Exhibit 9.3.3.2 is a generalized depiction which includes cases where streams or lakes may be present on the hillslope. At the GSL project site where surface water features are primarily present in topographically low areas, the majority of shallow groundwater discharge on the forested hillslope is inferred to occur through evapotranspiration, rather than discharge to surface water depicted in the generalized schematic.

Exhibit 9.3.3.2 – Schematic Diagram of Groundwater Flow Systems Related to Surface Water Features Based on Topography



Note: Schematic excerpted from Woessner, 2020.

As discussed below, the connection between groundwater and surface water features in the site and vicinity was assessed using three different methods: (1) comparing interpolated water levels to ground surface elevations; (2) comparing water levels recorded by pressure transducers in an overburden monitoring well (MW-13) to two nearby shallow piezometers (P-15 and P-16) within the proposed footprint, and (3) gauging water levels at a network of eight staff gauges installed in the intermittent stream.

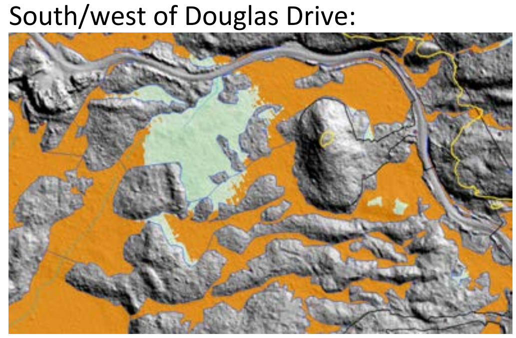
Water Level Contour Comparison to Ground Surface

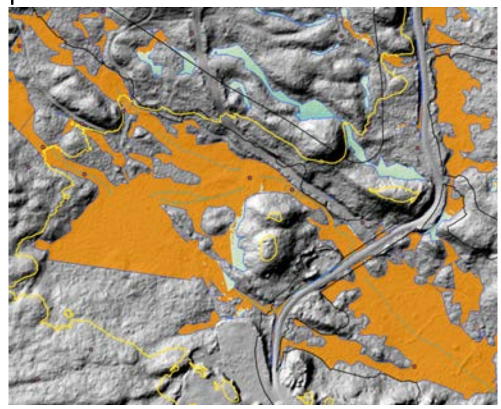
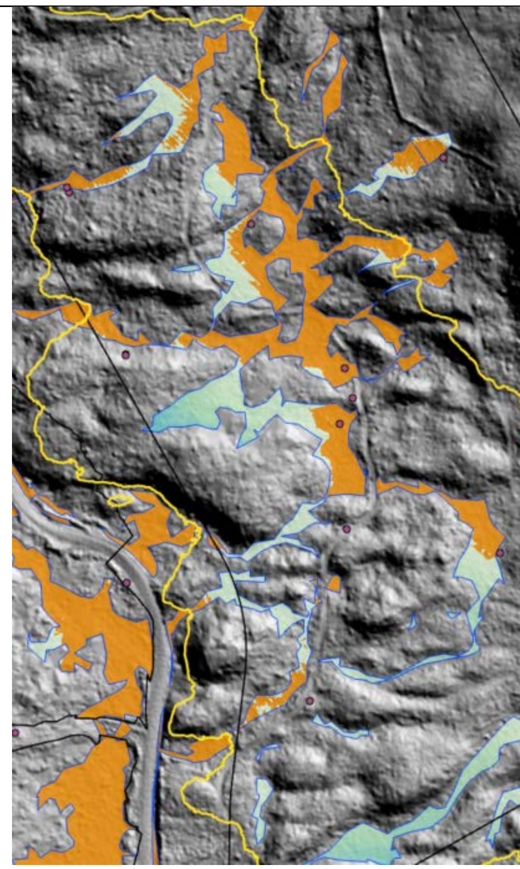
Depth to water within wetland features in the proposed landfill and vicinity were assessed by comparing interpolated water level and ground surfaces during seasonally high (May 2023) and low (September 2022) groundwater level conditions. Refer to Figures 9-3.3a and 9-3.3b for water level contour plans that also depict water level depth below ground surface (derived from LiDAR) at delineated wetlands. These figures were developed based on the GIS methods described in the preceding section. Note that the surfaces were interpolated based on water level measurements from monitoring wells, piezometers, and staff gauges only, and then adjusted to be equal to the LiDAR-derived ground surface in areas where the interpolation otherwise would have projected water levels above ground. The interpolation is more constrained in areas closer to monitoring points, and there is more uncertainty in the interpolation in areas where monitoring points are more widely spaced and in areas of greater topographic relief. In general, the position of mapped wetlands coincides with areas where modeled water levels are within 2 feet of ground surface (orange shading). Figure 9-3.4a shows the position of wetlands and depths to water on a LiDAR-hillshade basemap, and also indicates the locations of cross-sections presented in Figure 9-3.4b.

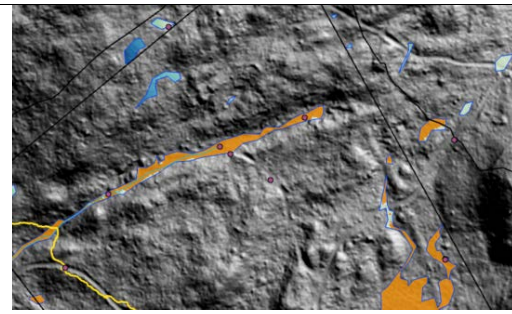
In general, the pattern of depth to groundwater in wetland features is consistent with anticipated distribution of hydrologic features in a topographically-driven Tóth-style groundwater basin described above. Water levels are shallower in topographically-low areas south and east of Douglas Drive, which is consistent with the presence of a groundwater discharge zone within the basin and the presence of larger and more contiguous wetland features, compared to topographically higher areas north and east of Douglas Drive in the vicinity of the proposed footprint. Within the proposed footprint, some wetland features correspond to areas of groundwater inferred to be within 2 feet below ground surface (ft bgs; orange shading), while others are located in areas where interpolated water levels are deeper than 2 ft bgs (green/blue shading).

Based on depth to water depicted in Figures 9-3.3a/b, the following observations and interpretations can be made regarding groundwater/surface water interactions in wetland features:

Exhibit 9.3.3.3 – Description of general wetland features based on interpolated depth to water (grouped by ground elevation)

Approximate Elevation (ft amsl)	Description of Typical Wetland Features	Example Wetland Features (refer to Figures 9-3.4a and 9-3.4b for additional information)
<1,160	**Depth to Water:** <2 ft bgs in both May 2023 and September 2022 **Distribution:** Large (>1 acre) and contiguous. **Location:** South and west of Douglas Drive, and also connected to the perennial stream east of Douglas Drive (south of the proposed landfill footprint) **Physical connection to surface water:** Most wetland polygons are connected to tributaries of Alder Brook. Some altered wetlands near Douglas Drive	South/west of Douglas Drive:  See wetland labels C through G on cross section C-C’ (Figure 9-3.4b)

	have a physical connection to seasonal drainage ditches and/or culverts. **Inferred GW-SW Relationship:** Gaining and connected to perennial streams. Some wetlands may also be flow-through.	East of Douglas Drive – connected to perennial stream:  See wetland labels J and K on cross section C-C’
1,160 to 1,220	**Depth to Water:** Often <2 ft bgs in the uphill portion of the wetland, transitioning to >2 ft bgs downslope. Consistently >2 ft bgs in some wetlands further south in the proposed footprint. More seasonal variability than wetlands further downhill in the watershed. **Distribution:** Commonly large (0.2 to 5+ acres) and occur in topographically low features. Many have a long/narrow geometry that reflects topography. **Location:** North and east of Douglas Drive **Physical connection to surface water:** No direct physical connection, except for those associated with an intermittent stream (see subsequent sections) **Inferred GW-SW Relationship:** Likely gaining in the uphill portion and losing/flow-through further downhill, or seasonally.	 See wetlands labeled D on cross section D-D’ (Figure 9-3.4b)

>1,220 ft	**Depth to Water:** >2 ft bgs in both May 2023 and September 2022 in smaller features, and <2 ft bgs in larger features **Distribution:** Many are small (<0.2 acres) and isolated. Several are >0.2 acres, typically in localized topographic valley features. **Location:** North and east of Douglas Drive **Physical connection to surface water:** No direct physical connection, except for those associated with an intermittent stream (see subsequent sections) **Inferred GW-SW Relationship:** Likely perched and losing. Factors other than the groundwater table are likely responsible for their presence (e.g., soil type, vegetation, topography, etc.). If surface water is present in these wetlands seasonally, the relationship between surface water and groundwater in these wetlands is likely to be losing.	 See wetlands labeled A to C on cross section D-D' (Figure 9-3.4b)

Legend for example images:
Depth to Water (ft bgs)
Orange = <2 ft
Orange/green transition = 2 ft
Blue = 30 ft
Color gradient on a 1 ft interval

Wetland
Stream (intermittent or perennial)
Proposed limit of disturbance, anchor trench
Ground elevation contour (1,160 and 1,220 ft)

Background = LiDAR Hillshade (2022) from NH GRANIT via ArcGIS online.
Scale varies between images

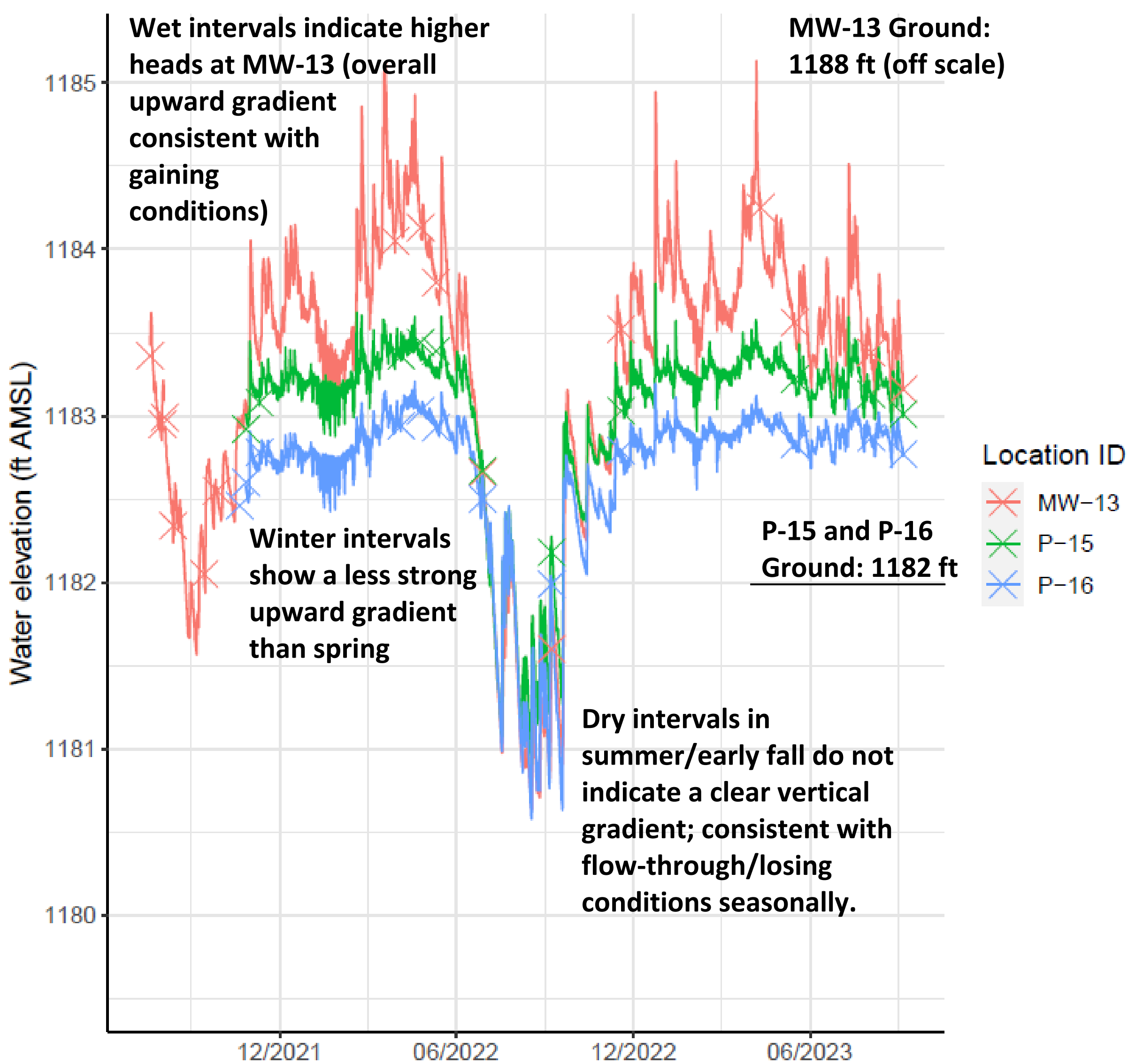
Notes:
The groundwater to surface water (GW-SW) relationship described in this exhibit assumes that surface water is present. If no surface water is present in the wetland, this description is not applicable.
This table is intended to describe the overall pattern of water levels in wetlands.
Images depict May 2023 interpolated depths to water.

Transducer Assessment of Wetland Groundwater Levels within the Proposed Footprint

To evaluate wetland relationships to groundwater, water levels at two wetland piezometers and one monitoring well were measured at a representative wetland in the central portion of the proposed landfill footprint. Water level data were collected using Solinst non-vented pressure transducers. Crosses indicate manual water level measurements, which showed generally good agreement with transducer readings. P-15 and P-16 are manually-driven shallow piezometers with screens set from approximately 3 to 5 feet below ground surface (ft bgs) within delineated wetlands. MW-13 is a 2-inch diameter PVC monitoring well with screen set from approximately 11 to 21 ft bgs. P-15 and P-16 are each located approximately 60-70 ft away from the centrally located MW-13, and are approximately 120 ft away from each other.

As indicated in Exhibit 9.3.3.4, based on approximately 1.5 years of transducer water level measurements from an overburden monitoring well (MW-13) and two nearby piezometers (P-15 and P16), the vertical gradient within shallow overburden groundwater near wetlands varied seasonally. During the summer and early fall, water levels did not indicate a clear vertical gradient. During other times of year that are typically wetter (late fall through early summer), upward vertical gradients were observed between the overburden monitoring well and nearby piezometers, suggesting groundwater discharge to wetlands. Apparent frozen ground conditions in January and February did not materially change the direction of the vertical gradient, but did lessen its magnitude.

Exhibit 9-3.3.4 – MW-13, P-15, and P-16 Water Level Elevations



Given the seasonal influences on vertical gradients and the groundwater table, wetlands within the footprint near MW-13, P-15 and P-16 are influenced by relatively shallow groundwater flow paths, which is consistent with the position within the watershed. During wet times the groundwater level is above ground surface at P-15 and P-16. During dry times, the water table drops below the ground surface.

Intermittent Stream Staff Gauge Measurements
An intermittent stream is located in the northern portion of the proposed footprint. Eight staff gauges (ISG-1 to ISG-8) were installed in Spring 2022 for the purposes of monitoring water levels along the intermittent channel and assessing periods of surface water. Based on water level measurements staff gages ISG-1 to ISG-8 were typically dry in June and September 2022, variably saturated between locations in November 2022, and surface water was present at each location in May 2022 and May 2023. Only the uppermost gage (ISG-8) indicated water in the intermittent stream in each gauging event in 2022 and 2023.

Exhibit 9-3.3.5 – ISG-1 to ISG-8 Water Level Elevations

Note: Closed circles represent water was present at staff on date indicated. Open triangles indicate dry measurement (ground elevation depicted).

In addition to flowing only intermittently, the stream is discontinuous with the lower portion of the drainage (area west of Douglas Drive, downstream of surface water gauging location SP-01). Rather than flowing contiguously to the lower, perennial tributaries of Alder Brook west of Douglas Drive, the surface water in the intermittent stream has been observed to infiltrate into the subsurface approximately near staff gage location ISG-1. Nearby surface water staff gage SG-6 is located in a small ponded area, and similarly does not have a surface flow connection to the upper reaches of the intermittent channel, nor to the streams west of Douglas Drive. Refer to Exhibit 9-3.3.5 for a timeseries plot depicting water elevations and dry measurements at ISG-1 to ISG-8.

9.3.4 Evaluation of Water Supplies

Based on information maintained by NHDES and site visits and "windshield surveys" of the surrounding area performed by Sanborn Head most recently in October 2023, no water supply wells are located within or immediately adjacent to the project area, nor are surface water drinking water supplies known to exist within the portion of the Alder Brook/Hatch Brook watershed near the proposed landfill footprint. The locations of water supplies are shown on Figure 9-3.6, with annotations based on site observations. The nearest public water supply well (PWS ID 0567010) is located at the Forest Lake State Park beach, >½-mile east of the proposed landfill footprint, and on the other side of the identified groundwater flow divide in the Forest Lake/Johns Brook watershed. The sole known private water supply well located on the site property serves the property owner's residence (>3,000 feet south of the proposed landfill footprint). The nearest known off-property private water supply wells are: residential wells on West Forest Lake Road and Forest Lake Road/Hennessey Lane (approximately ¼- to >½-mile east of the proposed footprint on the other side of the identified groundwater flow divide), associated with commercial and residential properties located on Route 116 (>1 mile south of the proposed footprint, on the other side of the topographic divide from Alder Brook/Hatch Brook), and residential wells on Manns Hill Road and Wilkins Farm Road (>1 mile west of the proposed footprint, on the opposite side of Alder and Hatch Brooks from the proposed project).

Note the NHDES' online records include several monitoring wells (not supply wells) installed for the GSL project site characterization in the water well inventory. These monitoring wells are noted on Figure 9-3.6.

Attachments

Figure 9-3.1	Site Vicinity Plan
Figure 9-3.2	Evaluation of Nearby Impaired Waters
Figure 9-3.3a	Groundwater Elevation Contour Plan – May 2023
Figure 9-3.3b	Groundwater Elevation Contour Plan – September 2022
Figure 9-3.4a	Cross Section Alignment Plan
Figure 9-3.4b	Cross Sections C to C' and D to D'
Figure 9-3.5	Stratified Drift
Figure 9-3.6	Evaluation of Nearby Water Supplies

Last Edited By: ewright

Path: P:\1000s\1003.16\Graphics Files\Arcfiles\Figures\Wetland App\SiteVicinityPlan.mxd

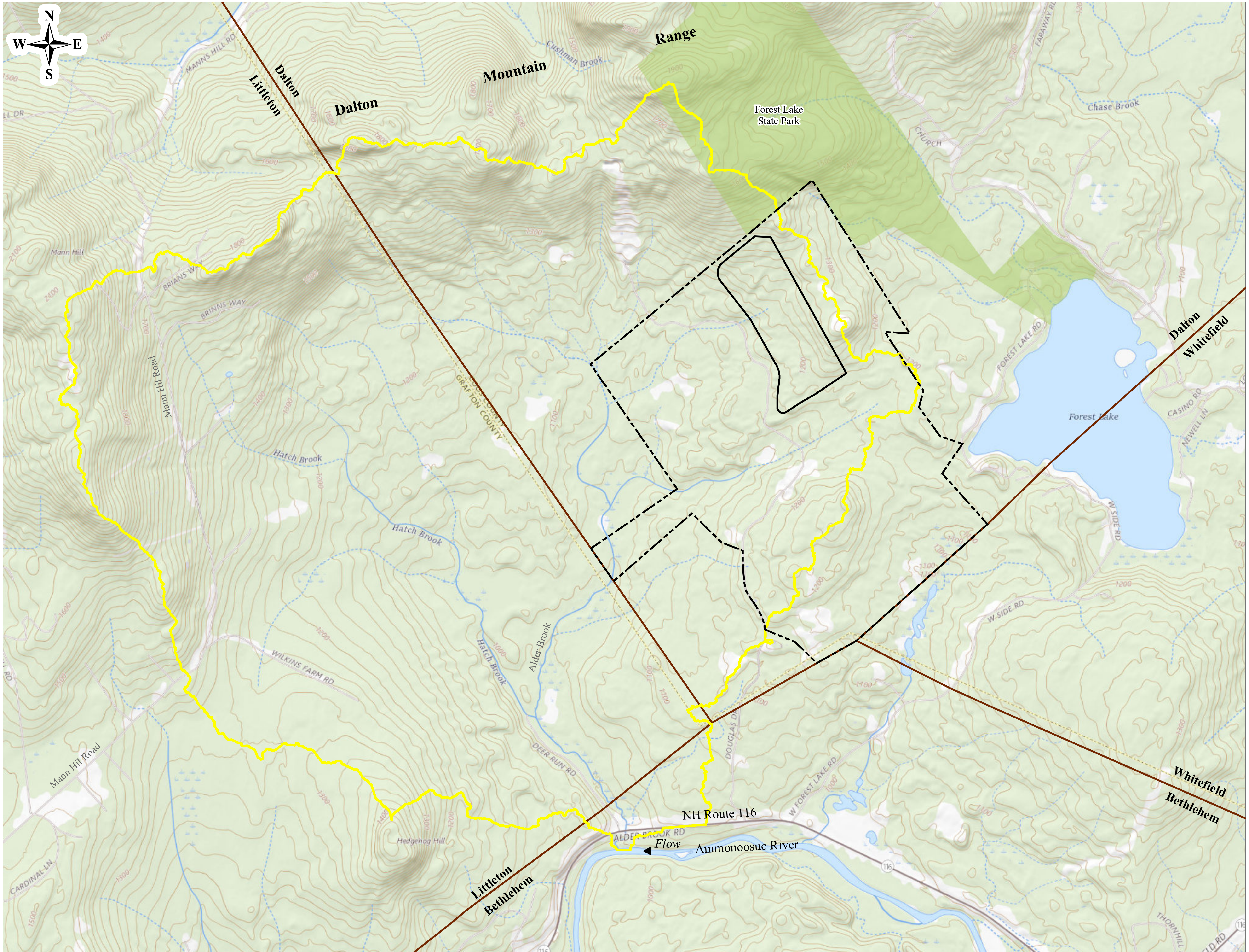


Figure 9-3.1

Site Vicinity Plan

Granite State Landfill

Dalton, New Hampshire

Drawn By:	E. Wright
Designed By:	L. Corenthal
Reviewed By:	T. White
Project No:	1003.24
Date:	November 2023

Figure Narrative

This figure depicts features in the vicinity of the proposed Granite State Landfill project site. The Alder Brook/Hatch Brook catchment shown on the plan was delineated using LIDAR data available from NHGRANIT. Hatch Brook and Alder Brook converge north of NH Route 116 and then flow south beneath NH Route 116 to discharge to the Ammonoosuc River.

Notes

1. Minor differences have been noted between town/county lines shown on the USGS topographic map and surveyed property lines for the area shown on this plan. Surveyed property lines are considered more accurate than the town/county lines shown on the topographic map. For a depiction of surveyed property lines relative to town lines, refer to project design plans included elsewhere in this application package.

2. Intermittent stream features on the USGS 7.5-minute (1:24,000 scale) topographic map show minor differences with the topographic contours and LiDAR data collected in the area, including south of the proposed landfill limit. The locations of water features depicted on the USGS topographic map should be considered approximate, especially at scales larger than 1:24,000.

3. USGS Topo Map provided by ESRI through ArcGIS Online.

Legend

- Project Property Line
- Proposed Landfill Limit
- Alder Brook/Hatch Brook catchment

Feet: 800 400 0 800 1,600

SANBORN HEAD

Figure 9-3.2

Evaluation of Nearby Impaired Waters

Granite State Landfill
Dalton, New Hampshire

Drawn By: E. Wright
Designed By: L. Corenthal
Reviewed By: T. White
Project No: 1003.24
Date: November 2023

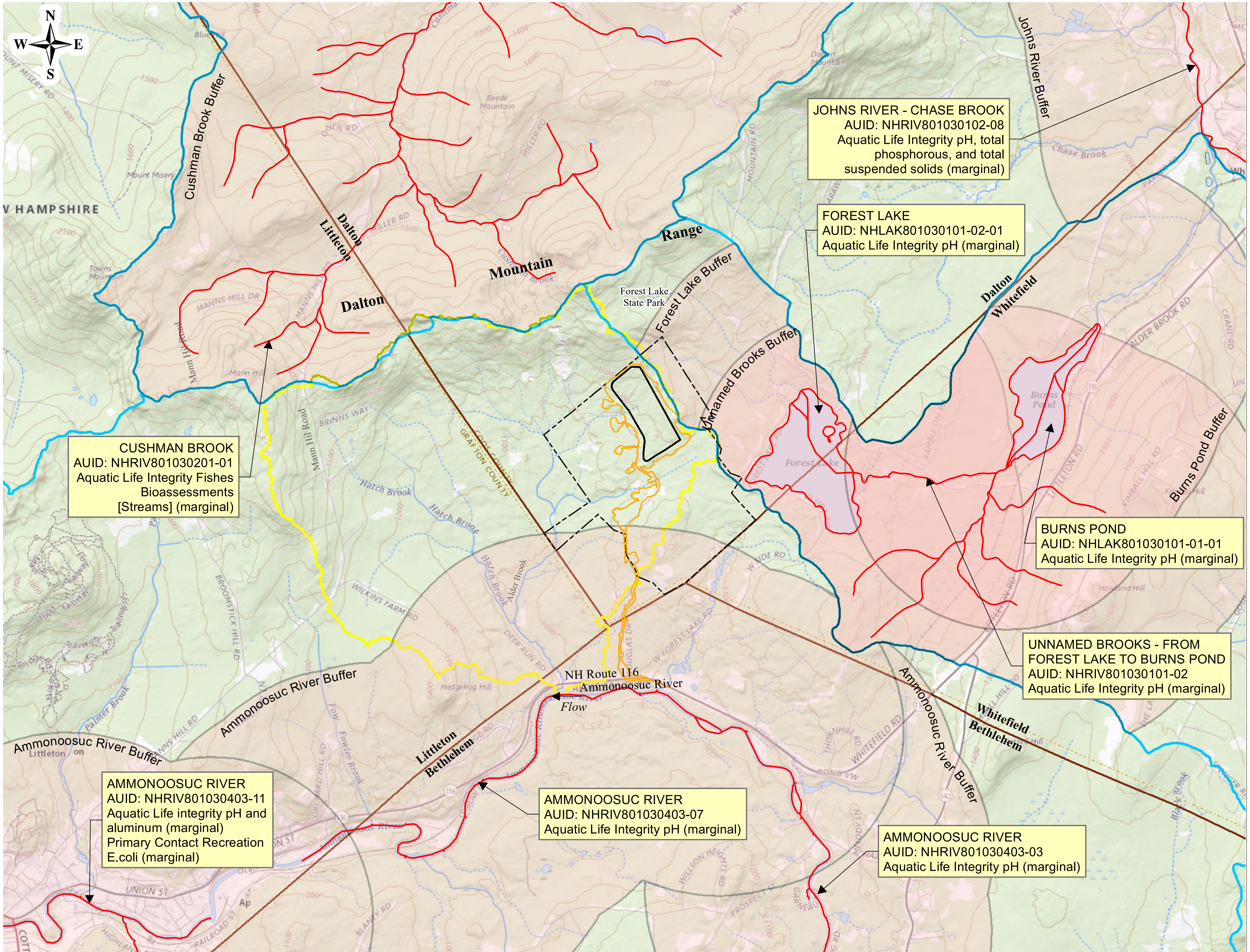


Figure Narrative

This figure depicts "impaired waters" designated by NHDES near the project site. No impaired waters were identified within the Alder Brook/Hatch Brook catchment. The 1-mile buffer for Ammonoosuc River reach NHRIV801030403-07 extends into the Alder Brook/Hatch Brook catchment.

The Forest Lake/Burns Pond/Johns River drainage and the Cushman Brook drainainage are separated from the project site by a topographic high and associated stable groundwater divide.

Notes

1. Information from NHDES' 2022 assessment was obtained from: https://nh-department-of-environmental-services-open-data-nhdes.hub.arcgis.com/apps/nhdes-2020-2022-surface-water-quality-assessment-viewer/explore. We understand all waterbodies in New Hampshire have been designated as impaired for fish/shellfish consumption due to mercury, and therefore these mercury impairments are not shown individually on this figure.

2. Refer to design plans prepared by CMA Engineers and included elsewhere in this application package regarding the detailed proposed limit of disturbance.

3. Where encountered, 1-mile buffers were trimmed to watershed boundaries delineated by USGS HUC 12 designations, with the exception of the Hatch Brook/Alder Brook watershed, which was delineated using LiDAR data. Both HUC 12 and LiDAR delineations are shown.

Legend

- Alder Brook/Hatch Brook Catchment
- NHDES 2022 Impaired Water
- HUC 12 (GRANIT)
- Proposed Landfill Limit
- Proposed Limit of Disturbance
- One Mile Buffer on Impaired Water

1,500 750 0 1,500 3,000 Feet

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Last Edited By: ewright

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Last Edited By: ewright

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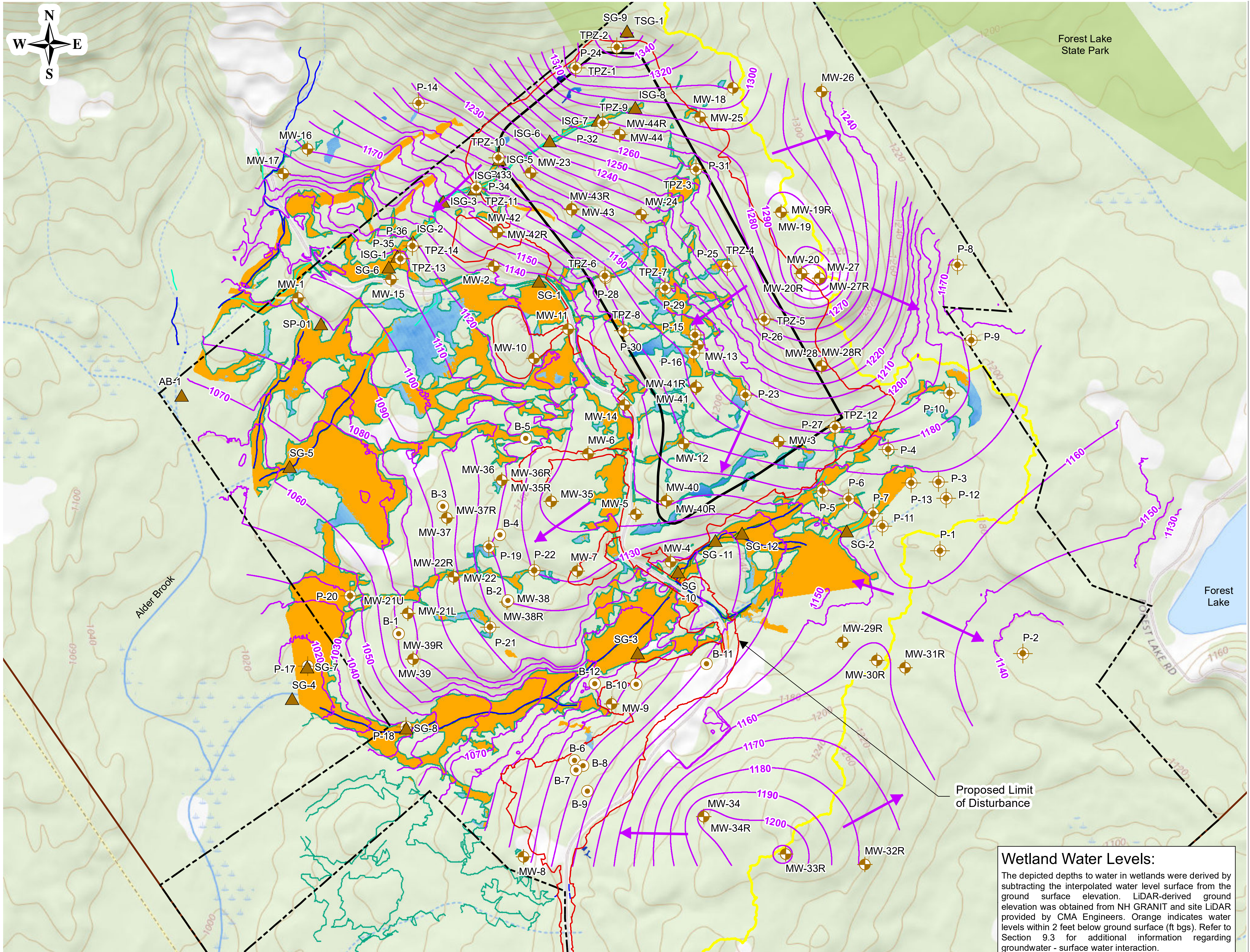


Wetland Water Levels:

The depicted depths to water in wetlands were derived by subtracting the interpolated water level surface from the ground surface elevation. LiDAR-derived ground elevation was obtained from NH GRANIT and site LiDAR provided by CMA Engineers. Orange indicates water levels within 2 feet below ground surface (ft bgs). Refer to Section 9.3 for additional information regarding groundwater - surface water interaction.

Figure 9-3.3a

Groundwater Elevation Contour Plan May 2023

Granite State Landfill
Dalton, New Hampshire

Drawn By:	E. Wright
Designed By:	L. Corenthal
Reviewed By:	T. White
Project No:	1003.24
Date:	November 2023

Figure Narrative

This figure depicts groundwater elevation contours based on water level measurements by Sanborn Head personnel on May 16 & 17, 2023. The groundwater elevation contours indicated on the plan are based on wells screened in the overburden, generally with screens set to span the water table. The contours were derived using an ArcGIS model that first interpolates a surface water on measured water levels (smooth lines) and then adjusts the surface to be equal to the LiDAR ground surface in areas where the interpolation was above ground (less smooth lines that generally coincide with wetlands).

Notes

1. Variations in groundwater elevations are expected to occur due to changes in precipitation, temperature, and other factors not evident at the time water level measurements were obtained. The groundwater elevation contours were developed using generally-accepted hydrogeologic practices, and are intended to depict inferred trends in groundwater levels consistent with the available information. Actual conditions may vary from those shown and other interpretations are possible.

2. Geotechnical borings are displayed for reference purposes only (no water level measurement available). Groundwater elevations in wells screened in bedrock were not used in developing the contours.

3. Refer to wetland plans included elsewhere in the application package for additional information regarding wetland type, etc.

Legend

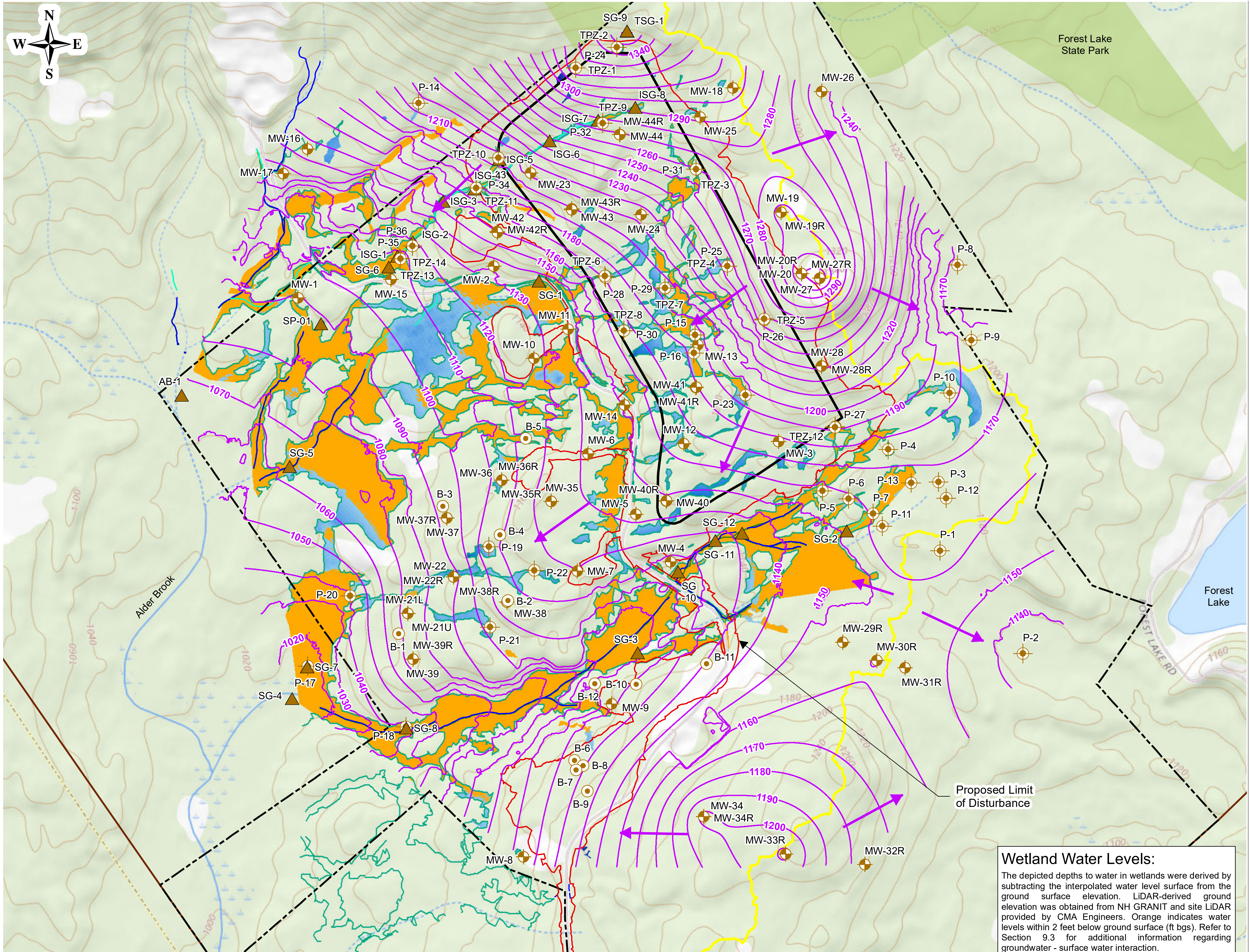
- Project property line
- Proposed landfill limit
- Wetland
- Perennial stream
- Intermittent stream
- Alder Brook/Hatch Brook catchment
- Monitoring well
- Surface water staff gauge/sampling location
- Piezometer
- Geotechnical boring
- Inferred groundwater elevation contour (ft)
- Groundwater flow direction
- Water level is <2 ft below ground surface
- >2 ft bgs
- <31 ft bgs

300 150 0 300 600 Feet

SANBORN HEAD

Last Edited By: ewright

Path: P:\1000s\1003.16\Graphics Files\ArcFiles\Figures\Wetland App\GW_ContourPlanSept2022.mxd



Wetland Water Levels:

The depicted depths to water in wetlands were derived by subtracting the interpolated water level surface from the ground surface elevation. LiDAR-derived ground elevation was obtained from NH GRANIT and site LiDAR provided by CMA Engineers. Orange indicates water levels within 2 feet below ground surface (ft bgs). Refer to Section 9.3 for additional information regarding groundwater - surface water interaction.

Figure 9-3.3b

Groundwater Elevation Contour Plan September 2022

Granite State Landfill
Dalton, New Hampshire

Drawn By:	E. Wright
Designed By:	L. Corenthal
Reviewed By:	T. White
Project No:	1003.24
Date:	November 2023

Figure Narrative

This figure depicts groundwater elevation contours based on water level measurements by Sanborn Head personnel on September 7 & 8, 2022. The groundwater elevation contours indicated on the plan are based on wells screened in the overburden, generally with screens set to span the water table. The contours were derived using an ArcGIS model that first interpolates a surface water on measured water levels (smooth lines) and then adjusts the surface to be equal to the LiDAR ground surface in areas where the interpolation was above ground (less smooth lines that generally coincide with wetlands).

Notes

1. Variations in groundwater elevations are expected to occur due to changes in precipitation, temperature, and other factors not evident at the time water level measurements were obtained. The groundwater elevation contours were developed using generally-accepted hydrogeologic practices, and are intended to depict inferred trends in groundwater levels consistent with the available information. Actual conditions may vary from those shown and other interpretations are possible.

2. Geotechnical borings are displayed for reference purposes only (no water level measurement available). Groundwater elevations in wells screened in bedrock were not used in developing the contours.

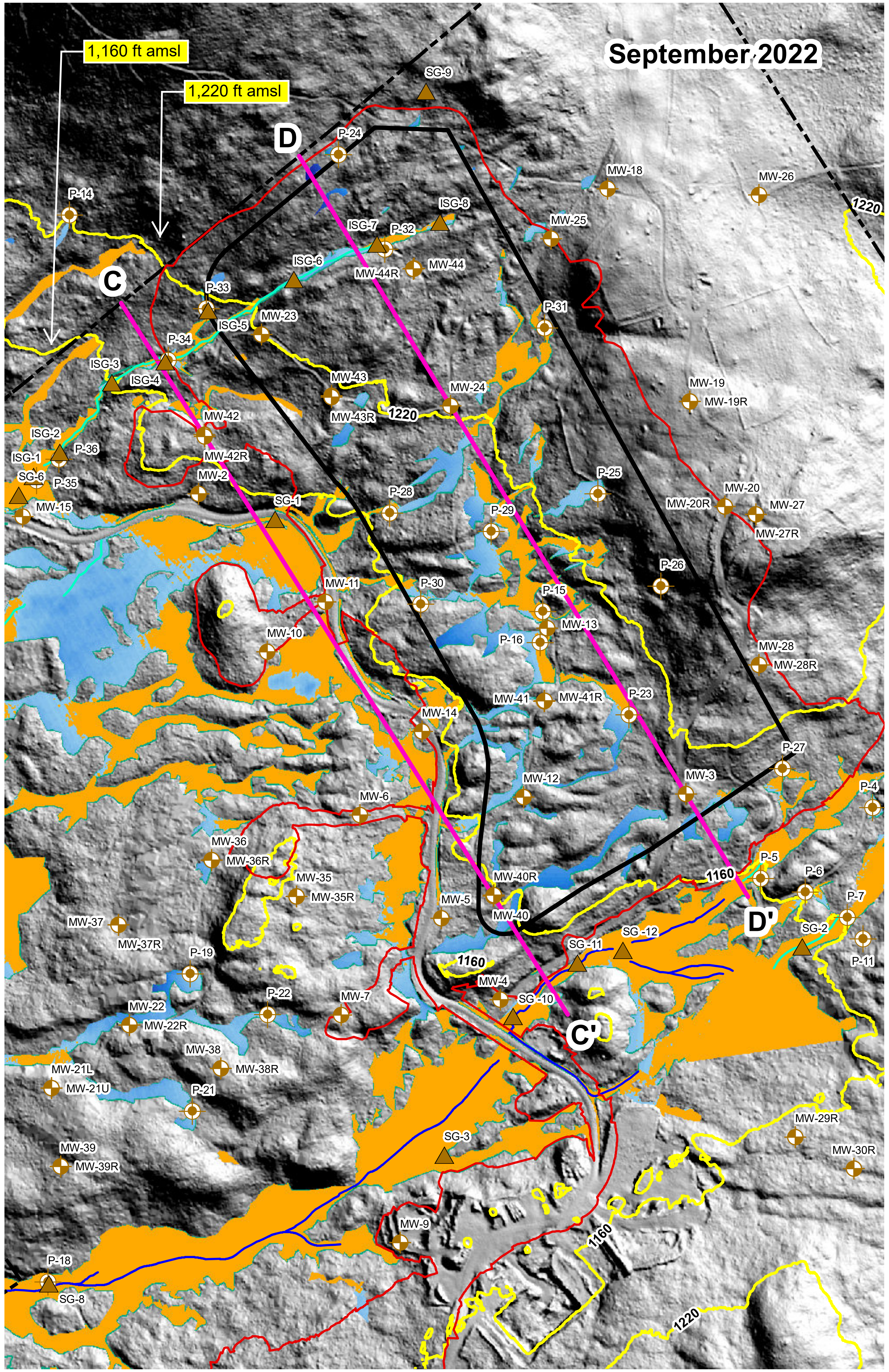
3. Refer to wetland plans included elsewhere in the application package for additional information regarding wetland type, etc.

Legend

- Project property line
- Proposed landfill limit
- Wetland
- Perennial stream
- Intermittent stream
- Alder Brook/Hatch Brook catchment
- Monitoring well
- Surface water staff gauge/sampling location
- Piezometer
- Geotechnical boring
- Inferred groundwater elevation contour (ft)
- Groundwater flow direction
- Water level is <2 ft below ground surface
- >2 ft bgs
- <31 ft bgs

300 150 0 300 600 Feet

SANBORN HEAD



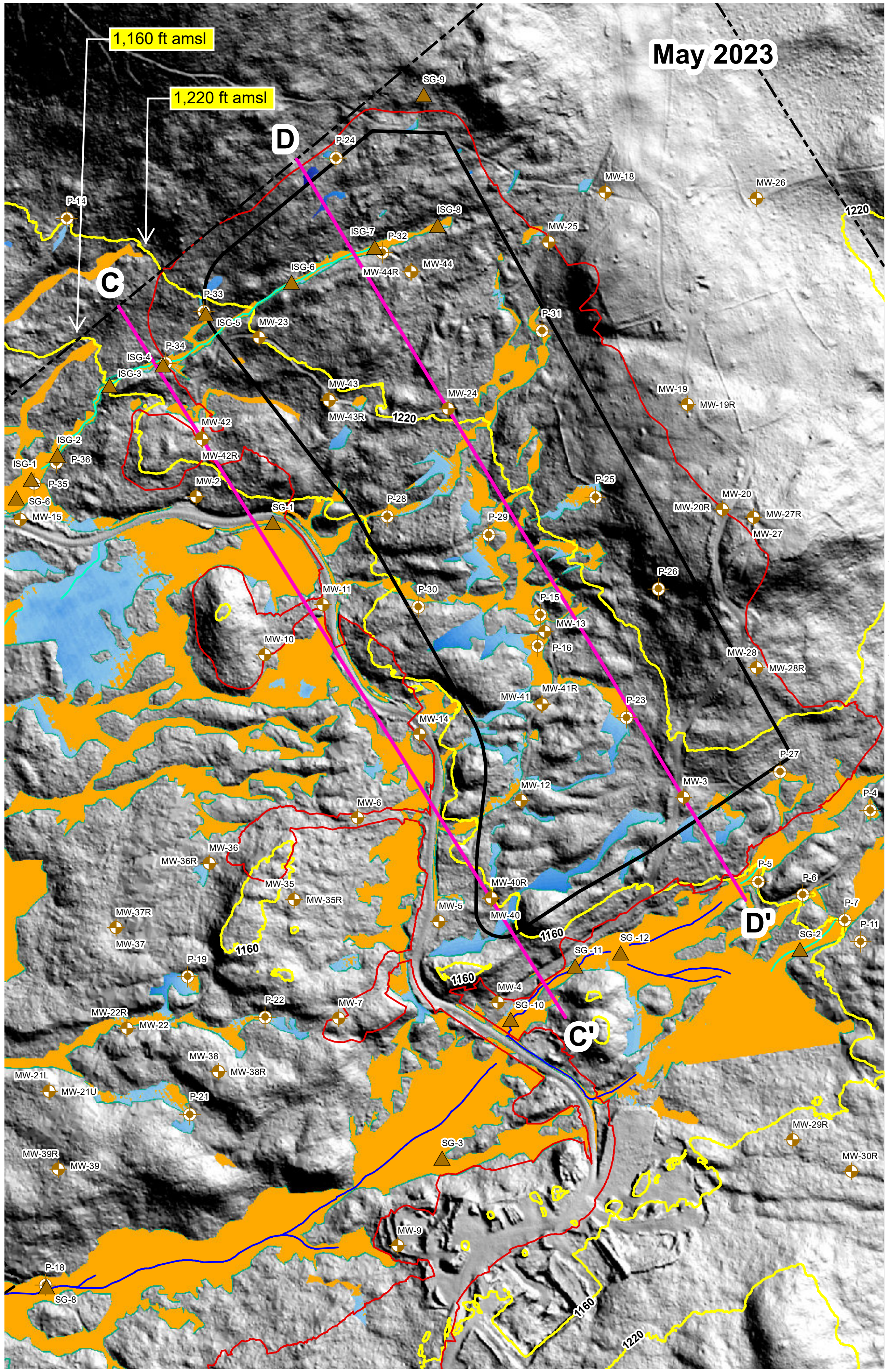


Figure 9-3.4a

Cross Section Location Plan

Granite State Landfill
Dalton, New Hampshire

Drawn By:	E. Wright
Designed By:	L. Corenthal
Reviewed By:	T. White
Project No:	1003.24
Date:	November 2023

Figure Narrative

This figure depicts the locations of cross sections C to C' and D to D' shown on Figure 9-3.4b. Interpolated depth to water within wetland features in September 2022 and May 2023 are also depicted.

Notes

1. Publicly-available LiDAR-derived bare earth hillshade imagery (2022) is from NH GRANIT via ArcGIS Online, obtained in October 2023.

2. The depicted depths to water in wetlands were derived by subtracting the interpolated water level surface from the LiDAR-derived ground surface elevation. Orange indicates water levels within 2 feet below ground surface (ft bgs).

3. Refer to previous figures for additional notes and legend. Refer to wetland plans included elsewhere in the application package for additional information regarding wetland type, etc.

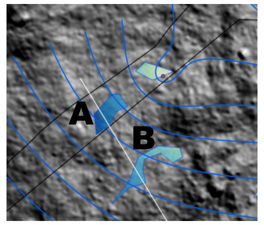
Legend

- Project property line
- Proposed landfill limit
- Proposed limit of disturbance
- Cross section alignment
- Wetland
- Perennial stream
- Intermittent stream
- Ground surface contour
- Monitoring well
- Surface water staff gauge/sampling location
- Piezometer
- Water level is <2 ft below ground surface
- >2 ft bgs
- <31 ft bgs

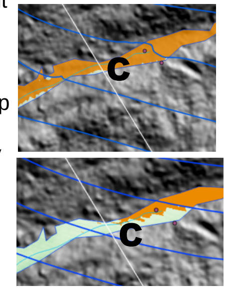
250 125 0 250 500 Feet

SANBORN HEAD

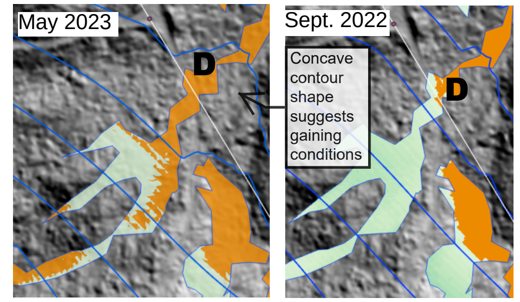
Separated, disconnected wetlands, perched (>2 ft) above water table in both May and September

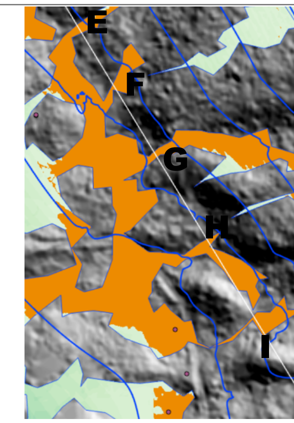


Intermittent stream; gaining/ losing relationship varies seasonally and with position



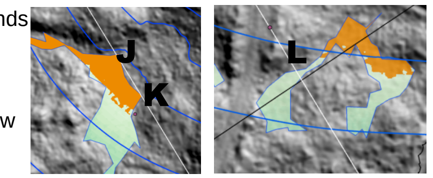
Depth to water <2 ft bgs uphill, transitions to >2 ft bgs downhill, and pattern varies seasonally



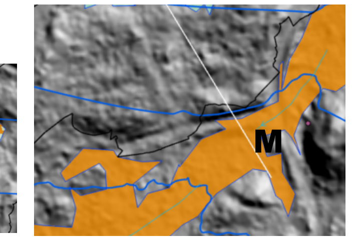


Depth to water <2 ft bgs in May and September; wetlands located in topographic lows; relatively small extent suggests wetlands supported by predominantly shallow groundwater flow paths

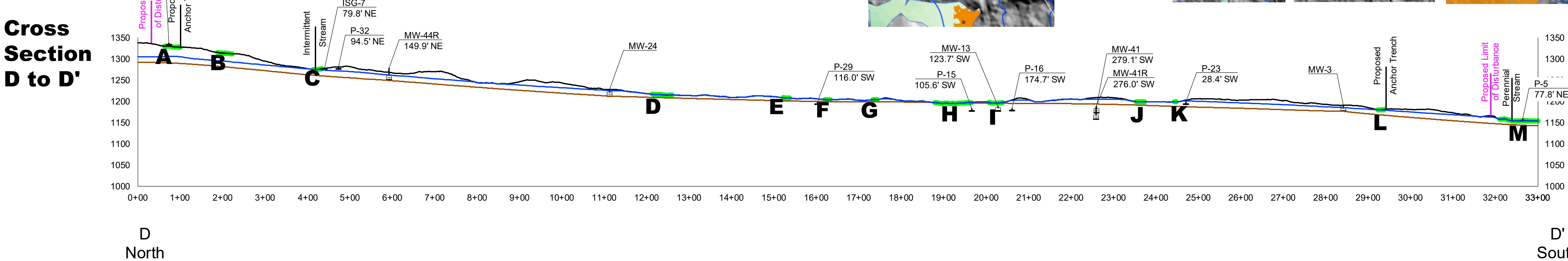
Depth to water <2 ft bgs uphill, transitions to >2 ft bgs downhill, and pattern varies seasonally (May 2023 surfaces are shown)



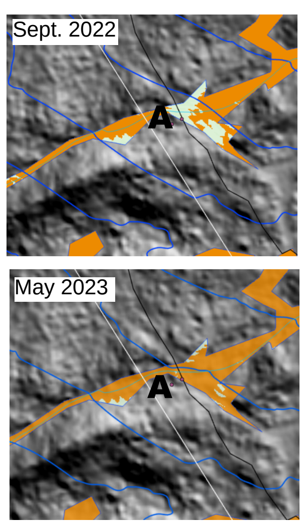
Wetlands connected to a perennial stream; depth to water <2 ft bgs; concave contours suggest gaining conditions, which is typical of perennial streams in the northeastern US



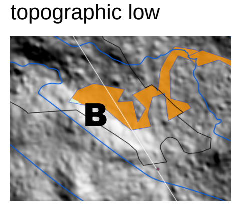
Cross Section D to D'



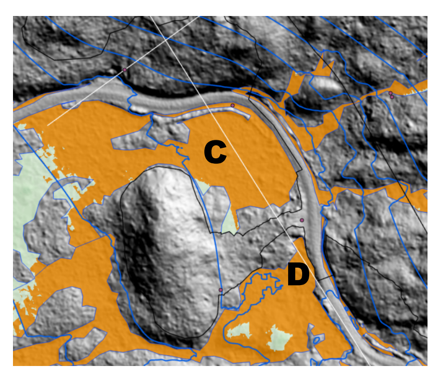
Intermittent stream; gaining/ losing relationship varies seasonally and with position

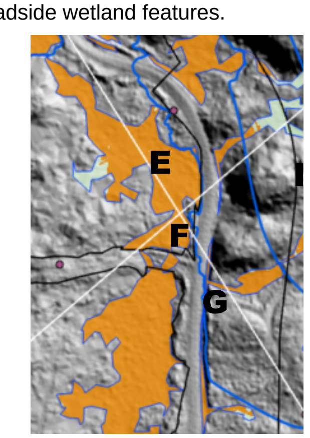


Depth to water <2 ft bgs in September and May; wetland situated in local topographic low

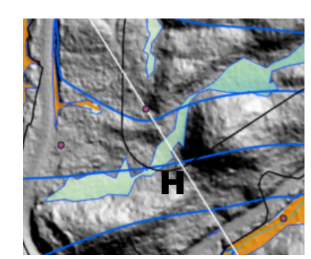


Depth to water <2 ft bgs in September and May; Wetlands located south/east of Douglas Drive are relatively large and connected, with shallow depths to water, which is consistent groundwater discharge from groundwater flow paths originating further upslope in the watershed. Concave groundwater contours further suggest groundwater discharge to surface water. Also includes modified roadside wetland features.

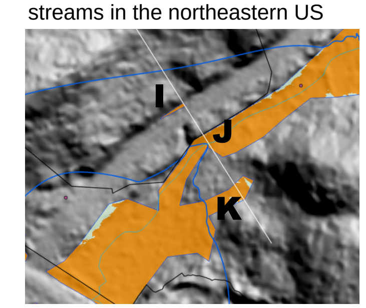




Wetland with depth to water >2 ft bgs in May and September. Wetland coincides with a topographically lower features.



I: Isolated wetland associated with a roadway.
J and K: Wetlands connected to a perennial stream; depth to water <2 ft bgs; concave water level contours suggest gaining conditions, which is typical of perennial streams in the northeastern US



Cross Section C to C'

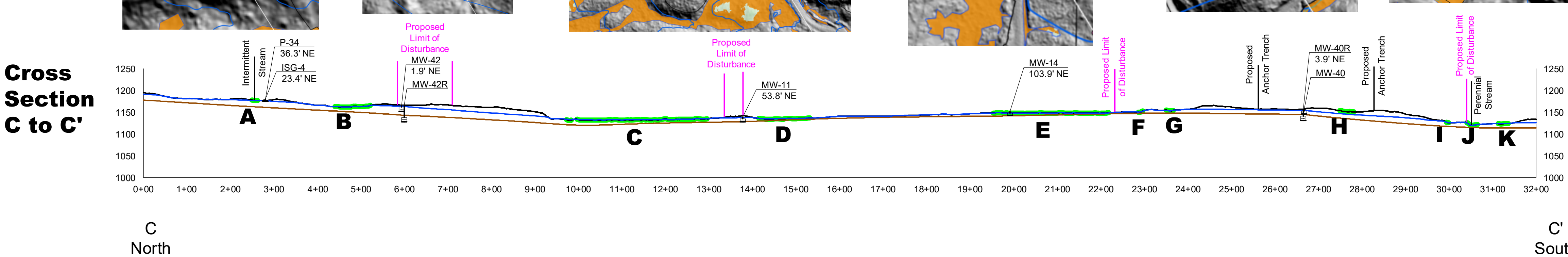


Figure 9-3.4b

Cross Sections C-C' and D-D'

Granite State Landfill
Dalton, New Hampshire

Drawn By: E. Wright
Designed By: L. Corenthal
Reviewed By: T. White
Project No: 1003.24
Date: November 2023

Figure Narrative

This figure depicts the ground surface topography, inferred bedrock surface and groundwater table elevations, the locations of existing monitoring points, and the extents of the proposed landfill limit. Locations of the ground surface along the cross section alignment within the mapped wetland area are indicated. Images depicting depth to water within each wetland, May 2023 groundwater contours, and LiDAR-derived hillshade imagery along the alignment are also included.

Notes

1. Ground topography is based on LiDAR data obtained from CMA in January 2023. LiDAR-derived bare earth hillshade imagery was obtained from NH GRANIT via ArcGIS online.

2. Refer to the Hydrogeologic Report included in the Solid Waste Permit Application for a discussion of how seasonal high groundwater values depicted on the cross sections were identified.

3. Some features have been projected onto the cross-section from adjacent areas, and as such, differences in elevations of the ground surface, groundwater table, and/or top of bedrock surface between values measured at the points and along the alignment may be indicated.

4. Images are shown at various scales. Refer to Figure 9-3.4a for additional information.

Legend

MW-13
158.2' NW
Monitoring well designation
Distance and direction off alignment
(no offset if located on the alignment)

Ground surface (green highlighting indicates ground surface is within the mapped wetland area - shown on Figure 9-3.4a)

Well screen

Estimated seasonal high groundwater elevation

Bedrock surface elevation

Bottom of well

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File:P:\1000s\1003.16\Graphics Files\CAD\Hydrogeo Report\CrossSections.dwg Plot Date: 10-10-23

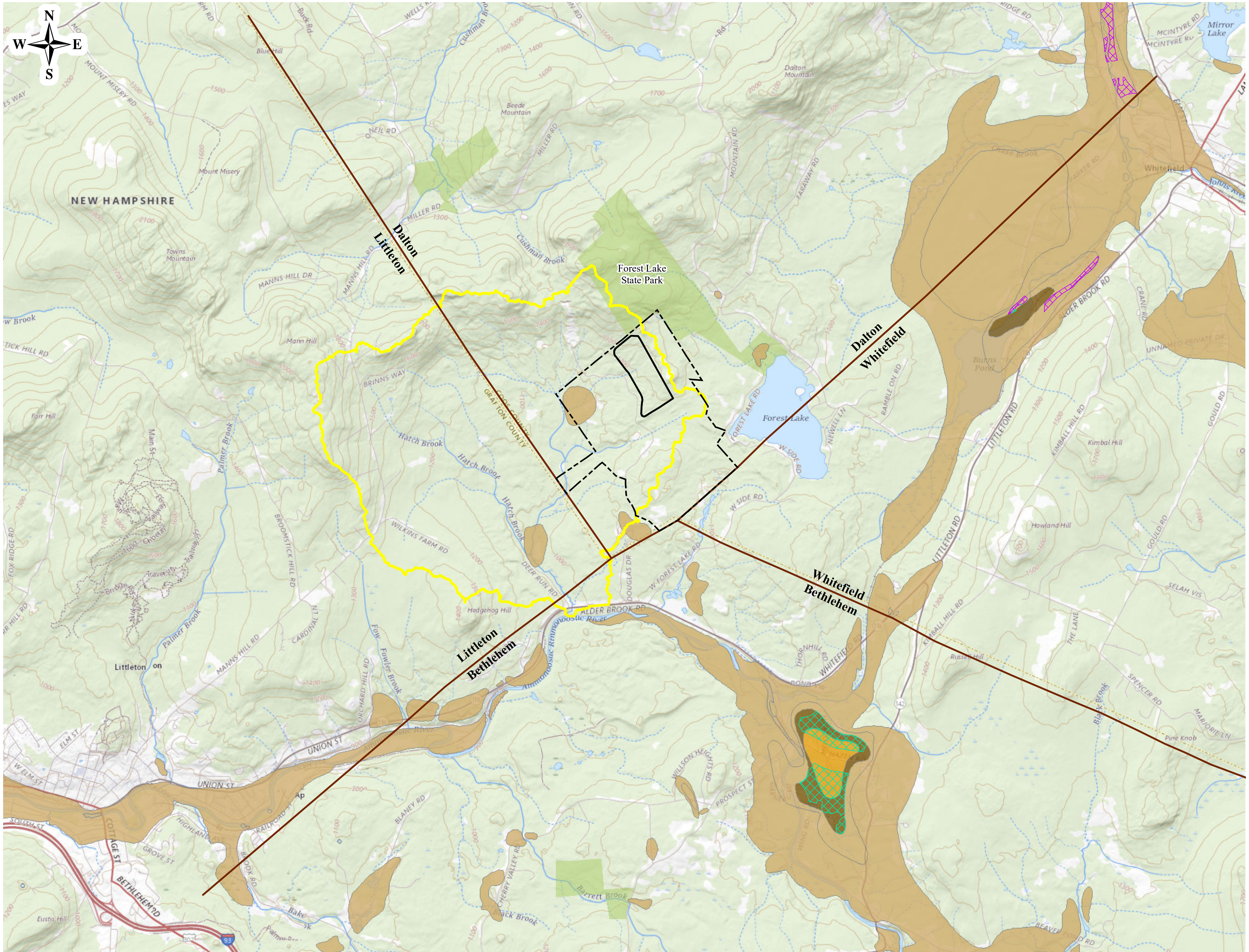

Figure 9-3.5

Stratified Drift

Granite State Landfill

Dalton, New Hampshire

Drawn By:	E. Wright
Designed By:	L. Corenthal
Reviewed By:	T. White
Project No:	1003.24
Date:	November 2023

Figure Narrative

This figure depicts aquifer transmissivity and favorable gravel well analysis (FGWA) layers provided by NHDES. The aquifer transmissivity layer is applicable to stratified drift and sand and gravel deposits.

Notes

1. Refer to wetland plans included elsewhere in this application package for additional information regarding wetland type, etc.

2. Refer to previous figures for additional notes and legend.

Legend

- Project Property Line
- Proposed Landfill Limit
- Alder Brook/Hatch Brook catchment
- Favorable Gravel Wells Analysis - Wells producing at least 150 gpm
  T max= 4,000 (feet sq./day)
  T min=2,000 (feet sq./day)
- Favorable Gravel Wells Analysis - Wells producing at least 75 gpm
  T max= 2,000 (feet sq./day)
  T min=1,000 (feet sq./day)

Aquifer Transmissivity

- Less than 2,000 feet sq./day
- 2,000-4,000 feet sq./day
- Greater than 4,000 feet sq./day

1,750 875 0 1,750 3,500 Feet

SANBORN HEAD

Last Edited By: ewright

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Figure 9-3.6

Evaluation of Nearby Water Supplies

Granite State Landfill
Dalton, New Hampshire

Drawn By: E. Wright
Designed By: L. Corenthal
Reviewed By: T. White
Project No: 1003.24
Date: November 2023

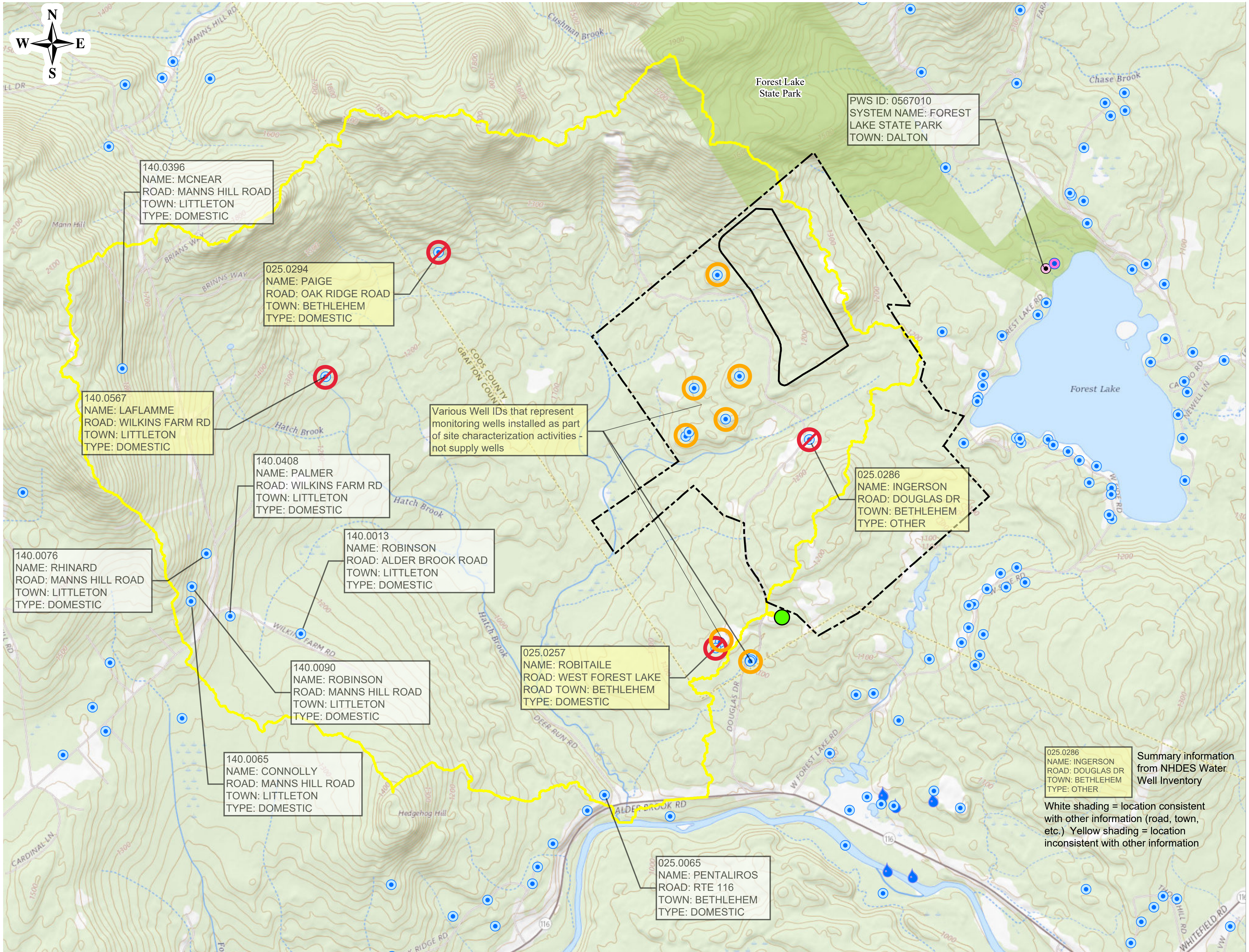

Figure Narrative

This figure depicts the approximate locations of water supply wells in the vicinity of the project site based on information maintained by NHDES and a windshield survey of the area performed by Sanborn Head in October 2023. No water supply wells are located within or immediately adjacent to the project area, nor are surface water drinking water supplies known to exist within the catchment area. Locations of NHDES' water supply wells should be considered approximate. The NHDES Water Well Inventory indicated several private wells located within the Alder Brook catchment that appear to be mis-located. These locations have been annotated to be consistent with site observations regarding actual well locations.

Notes

1. Water supply information was obtained from http://des.nh.gov in October 2023.

2. Other private supply wells may be present along public roads/highways (e.g., Manns Hill Road, Wilkins Farm Road, Hatch Brook Lane, and Brinns Way) but not included in NHDES online information.

3. USGS Topo Map provided by ESRI through ArcGIS Online.

Legend

- Public Water Supply Entities
- Public Water Supply Wells
- Registered Water Users
- Water Well Inventory
- Approximate Location of Ingerson Well (property owner)
- Well inferred to be mis located in online DataMapper based on site observations and/or well record address information
- Monitoring well installed as part of site characterization activities - not a supply well

Feet
800 400 0 800 1,600

SANBORN HEAD

Last Edited By: ewright

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