Grafton Wastewater Preliminary Engineering Report

Town of Grafton, VT

90% Report

August 2024

Tighe&Bond

100% Recyclable

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Executive Summary

Tighe & Bond has identified various wastewater collection, recovery, and return options as well as a cluster system option which are potential solutions for the Town. This report summarizes our 90% evaluation including an alternative analysis, recommended alternative, and anticipated project costs.

Alternatives Analysis

Based on the review of previous studies and evaluations, results of wastewater surveys, discussions with the Town, and a desktop analysis, the proposed service area includes the Village Center and select parcels within the 0.25 mile radius planning buffer. The report also discusses a phased service area approach. The proposed service area is shown in Figure A.7 (Appendix A). The alternatives identified in this report are based on the service area and the estimated average day design flow discussed in Section 4.1.

As you are aware, finding a suitable parcel for the wastewater system close to the village center has been extremely challenging. Therefore, one of the alternatives presented in this report is for a "Theoretical Parcel" should the Town identify another suitable parcel in the future or if one of the parcels already identified becomes available (see Section 9.1.1 for parameters of a suitable parcel). We have also included an alternative for a cluster system approach. The three action alternatives in this report are summarized below:

- Alternative No. 1:
    - Grafton Village Sewer District at a Theoretical Parcel:
        - Septic Tank Effluent Collection System to Theoretical Parcel
        - Recirculating Sand Filter Water Resource Recovery System
        - Drip Dispersal Return System
- Alternative No. 2:
    - Grafton Village Sewer District at the Village Park:
        - Septic Tank Effluent Collection System to Village Park Site
        - Recirculating Sand Filter Water Resource Recovery System
        - Drip Dispersal Return System
    - Grafton Village Drinking Water System:
        - Water Supply Wells near Grafton Pond
        - Ductile Iron Water Distribution System
        - Water Storage Tank near Fire Pond
        - POET Systems
    - Stormwater Improvements at Village Park/Fire Pond
- Alternative No. 3:
    - Grafton Village Cluster System:
        - Abandon Existing Septic Systems, Install New Tanks & Sewers

- 22 Cluster Treatment/Disposal Systems
- Drinking Water Improvements

Recommended Alternative

A no-action alternative was also considered (Alternative No. 4) but was not recommended because it would not address issues with existing septic systems and it would fail to promote growth of business development in the Village. Therefore, a life cycle cost analysis was performed for Alternative No. 1, Alternative No. 2, and Alternative No. 3. The results of the life cycle cost analysis are summarized in Table E.1, below.

TABLE E.1
Alternative Life Cycle Cost Analysis

Item	Alt. No. 1	Alt. No. 2	Alt. No. 3
Capital Cost	$8,782,900	$21,005,900	$14,076,000
Annual O&M Cost	$116,800	$277,400	$137,200
Present Day O&M	$2,837,000	$6,737,000	$3,332,000
Present Day Salvage Value	$759,000	$1,180,000	$2,358,000
Net Present Value	**$10,860,900**	**$26,562,900**	**$15,050,000**
		Planning Period	20 years
		Inflation Rate	2.30%
		Discount Rate	0.30%

Although the theoretical parcel has not yet been identified, the life cycle cost analysis and most of the non-monetary factors discussed in Section 9.3 favor Alternative No. 1 and therefore, Alternative No. 1 is the recommended alternative.

The basis for selection of Alternative No. 1 is as follows:

- Lowest capital cost
- Lowest life cycle cost
- Has potential for future expansion
- Less complex project scope with less constructability and project challenges
- Less challenging to fund
- Regulator familiarity with the proposed system
- Will allow growth of businesses within the Village

Opinion of Probable Costs

There are several financial grant or low-interest loan programs available which may assist the Town with funding this project such as the Clean Water State Revolving Fund (CWSRF) or the USDA Rural Development Program. This engineering report has been prepared in anticipation of pursuit of a low-interest loan or grant. Table E.2 provides the conceptual opinion of probable cost for implementation of Alternative No. 1 in a format that is consistent with funding agency requirements. Note that a yearly 3% escalation has been applied to the construction, engineering, and contingency costs. The escalation accounts for inflation and increases in costs from the time this OPC was developed until the time the design and construction will take place, estimated to be 2 and 3 years, respectively.

TABLE E.2
Recommended Project Costs

Item	Cost
1. Construction Costs[1]	$6,661,000
2. Engineering Costs	
a. Design[2]	$518,000
b. Construction[1]	$800,000
3. Other Expenses	
a. Local Counsel (0.75%)	$50,000
b. Bond Counsel (1.25%)	$83,000
c. Work Force	$0
d. Financial Services	$0
e. Miscellaneous	$0
4. Equipment	$0
5. Land Acquisition	$250,000
6. Project Contingency (20%)[1]	$1,333,000
7. Total Project Costs	$9,695,000
8. Less Other Sources of Financing[3]	$3,968,000
9. Project Costs to be Financed	$5,727,000
10. Financing Insurance Costs	
a. Direct Expense (1%)	$58,000
b. State Bond Issuance Charge (0.84%)	$49,000
c. Administrative Fee (1.1%)	$63,000
Total Project Cost to be Financed	**$5,897,000**

[1]Includes an escalation of 3%/year for 3 years
[2]Includes an escalation of 3%/year for 2 years
[3]ARPA funds appropriated to Grafton for Village Wastewater Project

In accordance with US Environmental Protection Agency (EPA) guidance, sewer use rates are considered affordable if the annual cost for a single-family user (1 ERU) is less than 2% of the Median Household Income (MHI). For the Town of Grafton (MHI = $68,125), this equates to a single-family user fee of $1,363.

Section 10 of this report presents an approach for user fees based on an Equivalent Residential Unit (ERU) approach and an assessment and flow based user fee approach. However, neither approach achieves an affordable user fee without significant grant funding. This is discussed in greater detail in Section 10.3.

Next Steps

We understand that installation of a wastewater system is a complex and costly undertaking, but we hope that this report will meet the Town's goal of understanding the options available for implementing a wastewater system.

Section 1
Project Planning

1.1 Introduction

This report presents a wastewater feasibility preliminary engineering report performed for the Town of Grafton, Vermont. This evaluation has been performed to determine the appropriate delineation of a wastewater service area and the most appropriate and cost-effective means of providing wastewater service for the proposed service area.

The need for community wastewater collection and treatment systems is constantly evolving. Historically, initial efforts were focused on collection and disposal and were driven by the need to reduce human disease. That era was followed by a focus on the elimination of water pollution effects, allowing native marine organisms to return to normal growth patterns and allowing full human recreational use. Currently, community wastewater collection and treatment systems have begun to redefine wastewater as a valuable resource. As such, when proposing alternatives for addressing wastewater needs this document uses the term "water resource recovery and return systems". This modern terminology embraces the concept that water is the most valuable resource in the world.

The Town of Grafton is currently served by individual subsurface wastewater disposal systems and is un-sewered. The Town also does not have a public water supply system. The focus area for this study is the Village of Grafton and parcels surrounding the center of the Village. The study area is shown in Figure A.1 (Appendix A).

The following tasks were performed as part of this evaluation and are described in the Sections that follow:

1. Service Area Delineation
2. Wastewater Flow Estimates
3. Evaluation of Alternatives
4. Cost Estimates for the Developed Alternatives
5. Recommendations & Implementation Procedures

Tighe & Bond has been engaged by the Town of Grafton (Town) to prepare this Preliminary Engineering Report (PER) in a format consistent with the Vermont Department of Environmental Conservation (VT DEC) Preliminary Engineering Report (PER) format consistent with the USDA Rural Development PER as described in RUS Bulletin 1780-2.

1.2 Previous Planning Efforts

The availability of prior planning efforts for the Town of Grafton was investigated as part of this evaluation to obtain background information regarding any previous approaches or studies that were conducted. The following reports and plans were reviewed and are summarized below.

Grafton Capacity Study, An Analysis of Sewer and Water Capacity in the Village of Grafton (1992)

The 1992 capacity study documents existing conditions of the wastewater systems in Grafton, VT and proposes solutions to issues that were experienced in the Village at that time. The most prevalent concerns noted in the 1992 survey and study include:

1. Approximately 70% of the Village septic systems have been constructed before 1970 or have unknown dates of construction.
2. 70% of the Village parcels are less than one acre and 43% are less than one-half acre. Parcel lot sizes could cause issues with meeting current design standards.
3. Soils in Grafton are generally highly permeable.
4. 83% of the Village water supplies are drilled wells and 16% of the wells are shallow wells (less than 100 feet deep).

The report suggested high level solutions to the problems that were identified. Considerations included providing education to residents and businesses owners on maintenance of their existing septic systems; adopting a septic or health ordinance; establishing a community water system should wells have contaminants and if the Saxton River tested as Class B; forming a community septic system if the wells do not show septage contamination and the Saxton River does; and constructing a sewage treatment plant if it is determined that the Saxton River could receive discharge permitting. The report did not recommend which of the alternatives should be pursued.

Village of Grafton, Sewer Feasibility Study (2001)

The August 2001 report by Tighe & Bond states wastewater flow estimates of 47,000 gpd for the existing development and 51,000 gpd for future flow without the Grafton Village Cheese Co. facility. After a discussion of alternatives, the report recommends a village-wide wastewater collection system that pumps to a leachfield at Alpine Field and at Upper Howland Mill Field. The cost of the proposed system was estimated to be approximately $4,000,000 at the time.

The report also acknowledged that a Sewage Disposal Ordinance and a Septic Pumping Ordinance were adopted in 1999. The Septic Pumping Ordinance requires building owners to have their septic tanks pumped every four years and the Sewage Disposal Ordinance requires a town permit be obtained and site inspections be performed when a homeowner is modifying a current septic system or installing a new septic system.

Survey results discussed in the report show that many parcels in the Village do not conform to setback distance requirements. In addition, the survey results showed that 60% of parcels contained at least one potential critical condition i.e., septic system within Class 1 soil, septic system was installed more than 25 years ago, unknown when the septic system was installed, depth of the well is less than 100 feet, or the depth of the well is unknown. According to the report, 70% of survey respondents at the time indicated that they believed a community sewer system was needed but 97% of respondents reported having no problems with their own septic system.

Town of Grafton, Phase II Wastewater and Water System Feasibility Study (2007)

The February 2007 report by Otter Creek Engineering builds upon the 2001 Tighe & Bond report and further evaluates a community water and/or wastewater system. The recommendation in the report with respect to wastewater is to create a community wastewater collection and disposal system that utilizes the Howland Mill site to service a smaller area within the Village that would produce less than 30,000 gpd of flow. The report did not recommend smaller decentralized systems throughout the Village and stated that upgrades to the existing individual septic systems would not solve most of the isolation from water supply issues.

A community water system alternative is explored in the report and is the favorable option over a community wastewater system in terms of cost. The report states that the community water system could utilize the existing fire protection system piping and would require the addition of a well in the valley south of the Grafton Village Cheese Co., a small pump house near the well, a 350,000 gallon prestressed concrete water storage tank above fire pond, water main extensions where required throughout the Village, possible treatment system depending on water quality, water services to buildings within the district, and water meters at each building connected to the system.

Grafton Village Sewer Feasibility Study Addendum (2021)

The 2021 Grafton Village Sewer Feasibility Study addendum by Tighe & Bond evaluates the Village Park site as a potential subsurface disposal site. Site investigation work performed as part of this effort showed that the site could permit a 29,500 gpd disposal system. The report mentions a potential collection system consisting of a septic tank effluent pumped system (STEP) and about 5,000 linear feet of 1.5-inch HDPE forcemain and appurtenances. The report addendum recommends that the flow estimate of the district be revisited in future studies. The report addendum escalated the cost of alternatives to prices reflecting May 2021 prices. According to the report, the Village Park Site alternative had the highest first year operations and maintenance cost but a relatively low capital cost.

Supplemental Site Investigation Report Grafton Elementary School (2022)

The 2022 report was developed by Atlas Technical Consultants, LLC as a supplemental site investigation of Per- and polyfluoroalkyl substances (PFAS) at the Grafton Elementary School. As summarized in the report, PFAS was previously identified in the well serving the school with the suspected source being the school leachfield and the potential PFAS source identified as floor wax and cleaning supplies used at the school and disposed of in wash water to the leachfield. It is suspected that the PFAS then migrated or continues to migrate through the leachfield and into the underlying overburden and bedrock aquifers. The objective of the site investigation was to further delineate the PFAS contamination around the school.

As part of this effort, six groundwater monitoring wells were installed and sampled. Existing wells were also sampled as part of this effort. PFAS was detected at several wells around the school including cross-gradient and upgradient locations as compared to the school leachfield which suggests there may be other sources contributing PFAS to the groundwater in the area according to the report.

Grafton, VT 2021 – 2029 Town Plan

The Grafton, VT 2021 – 2029 Town Plan (Town Plan) summarizes the 2007 report mentioned above. The Town Plan also recognizes that there is limited capability of existing septic systems in the Town to handle additional capacity and that this will restrict future growth in the Village area and force development into the surrounding rural areas. The Town Plan states that consideration of a water supply and/or a centralized wastewater disposal system for the Village may still be necessary in the future.

1.3 Site Information

1.3.1 Location & Population Trends

The Town of Grafton is in the north-central part of Windham County, Vermont, see Figure 1.1. The Grafton census-designated place (CDP) is centered around the Village of Grafton and includes most of the Study area shown in Figure A.1 (Appendix A).

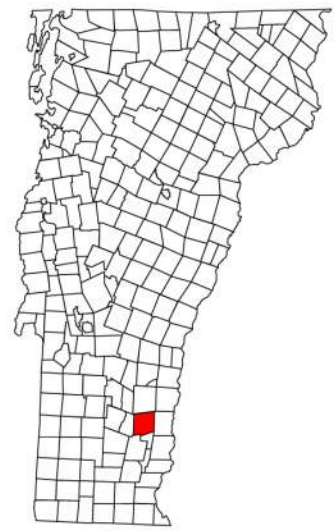


FIGURE 1.1
Town of Grafton, Vermont

The Town of Grafton had a total population of 645 at the time of the 2020 census and the Grafton CDP had a population of 49 according to the 2020 census. Using the 2020 census data, the CDP represents approximately 8% of the Town population. The population for the Town was reported as 679 in 2010. Although the population decreased slightly from 2010 to 2020, the population in the Town has been slowly increasing since the 1940s. Given the overall positive population growth rate, it can be expected that the population of Grafton will continue to increase in the future. The Vermont Population Projections for 2010-2030 produced by the Vermont Agency of Commerce and Community Development predict an increase in population to 744 in Grafton, VT by 2030. The Town of Grafton has also noticed a significant increase in the number of part time residents over the last few years, however, there is no data available regarding full time versus seasonal/part time residents in Grafton.

1.3.2 Environmentally Vulnerable Populations

Vermont's first environmental justice policy was signed into law in May 2022. The new law states that no Vermonter, because of racial, cultural, or economic status should bear a disproportionate share of environmental burdens or be denied environmental benefits. The law ensures that policies and practices of state agencies do not unfairly burden low-income populations and communities of color. The law also established a mapping tool called the Vermont Environmental Disparity Index to identify communities where environmental risks have disproportionate impacts on residents.

According to the Vermont Environmental Disparity Index tool, Grafton is in an area that has an Average Environmental Exposure value of 39.0, an Average Social Vulnerability Percentile of 55.4, an Average Health Risk value of 44.5, and an overall VT Environmental Disparity Index (VTEDI) value of 46.1.

1.3.3 Geologic & Topographic Conditions

The Village is composed largely of Colton, Monadnock and Berkshire, Ondawa, Tunbridge-Lyman, and Marlow soil types. Colton soils are categorized in Hydrologic Soil Group (HSG) Type A. HSG Type A soils are defined as sand, loamy sand, or sandy loam type soils that have low runoff potential and high infiltration rates even when thoroughly wetted. Tunbridge-Lyman and Marlow soils are categorized in HSG Type C and have moderately high runoff potential when thoroughly wet and somewhat restricted water transmission through soil. Monadnock, Berkshire and Ondawa soils are categorized in HSG Type B. Type B soils have moderately low runoff potential when thoroughly wet and water transmission through the soil is unimpeded.

Figure 1.2 below shows the soil types around the Village. Figure A.2 in Appendix A identifies all soil types around the Village as well as those with reported depth to a restrictive layer of less than 4 feet and depth to the water table of less than 3 feet as reported by the National Resource Conservation Service (NRCS) soils report for the area.

The main rock types in the study area are schist, gneiss and granite. From Northwest to Southeast of the study area, the bedrock transitions from gneiss, schist, granofels, granite and back to gneiss. Generally, the depth to a restrictive layer in the center of the Village is greater than 5 feet, however the potential for encountering a shallow depth to a restrictive layer increases around the Village as the topography increases.

The topography in the valley slopes to the east along Route 121 and the Saxton River. The topography steepens in nearly every direction outside the Village. Topography around Grafton is shown in Figure A.3.

FIGURE 1.2
Grafton Soil Map

A brief description of each of the primary soil types found in the area based on NRCS descriptions is below:

50B, 50D – Colton gravelly sandy loam consists of very deep, excessively drained soils formed in glacio-fluvial deposits. They are on terraces, kames, eskers, and outwash plains. Slope ranges from 0 to 70 percent. Estimated saturated hydraulic conductivity is high or very high in the solum and very high in the substratum. The capacity of the most limiting layer to transmit water is moderately high to high and the depth to the water table is more than 80 inches. The depth to a restrictive feature is more than 80 inches.

46E – The Monadnock series consists of very deep, well drained soils that formed in loamy over sandy melt-out till on hills and mountains in glaciated uplands. Estimated saturated hydraulic conductivity is moderately high or high in the mineral solum and high or very high in the substratum. The Berkshire series consists of very deep, well drained soils formed in loamy melt-out till on hills and mountains in glaciated uplands. Estimated saturated hydraulic conductivity is moderately high or high. Slope ranges from 0 to 80 percent. The capacity of the most limiting layer to transmit water is moderately low to high and the depth to the water table is more than 80 inches. The depth to a restrictive feature is 15 to 30 inches to strongly contrasting textural stratification.

20C, 20D, 20E – The Tunbridge series consists of moderately deep, well drained soils on glaciated uplands. They formed in loamy supraglacial till. Saturated hydraulic conductivity is moderately high or high throughout the mineral soil. The Lyman series consists of shallow, somewhat excessively drained soils on glaciated uplands. They formed in loamy supraglacial till. Estimated saturated hydraulic conductivity is moderately high or high throughout the mineral soil. Slope ranges from 0 to 80 percent. The capacity of the most limiting layer to transmit water is very low to high and the depth to the water table is more than 80 inches. The depth to a restrictive feature is 20 to 40 inches to lithic bedrock.

23 – Ondawa fine sandy loam consists of very deep, well drained soils formed in recent alluvium on floodplains. Saturated hydraulic conductivity is moderately high or high in the solum and high or very high in the substratum. Slope ranges from 0 to 3 percent. The capacity of the most limiting layer to transmit water is moderately low to high and the depth to the water table is more than 80 inches. The depth to a restrictive feature is more than 80 inches.

21B, 21C, 21D, 22C, 22D, 22E – Marlow fine sandy loam consists of well drained soils that formed in loamy lodgment till on hills and mountains in glaciated uplands. They are moderately deep to a dense substratum and very deep to bedrock. Estimated saturated hydraulic conductivity is moderately high or high in the solum, and moderately high or moderately low in the dense substratum. Slope ranges from 0 to 60 percent. The capacity of the most limiting layer to transmit water is moderately low to moderately high and the depth to the water table is reported as more than 80 inches. The depth to a restrictive feature is reported as 20 to 39 inches.

1.3.4 Environmental Resources & Floodplain

Grafton was not found to be within the Vermont Agency of Natural Resources rare, threatened, and endangered species area as shown on the Vermont Agency of Natural Resources GIS system, Figure 1.3, below.

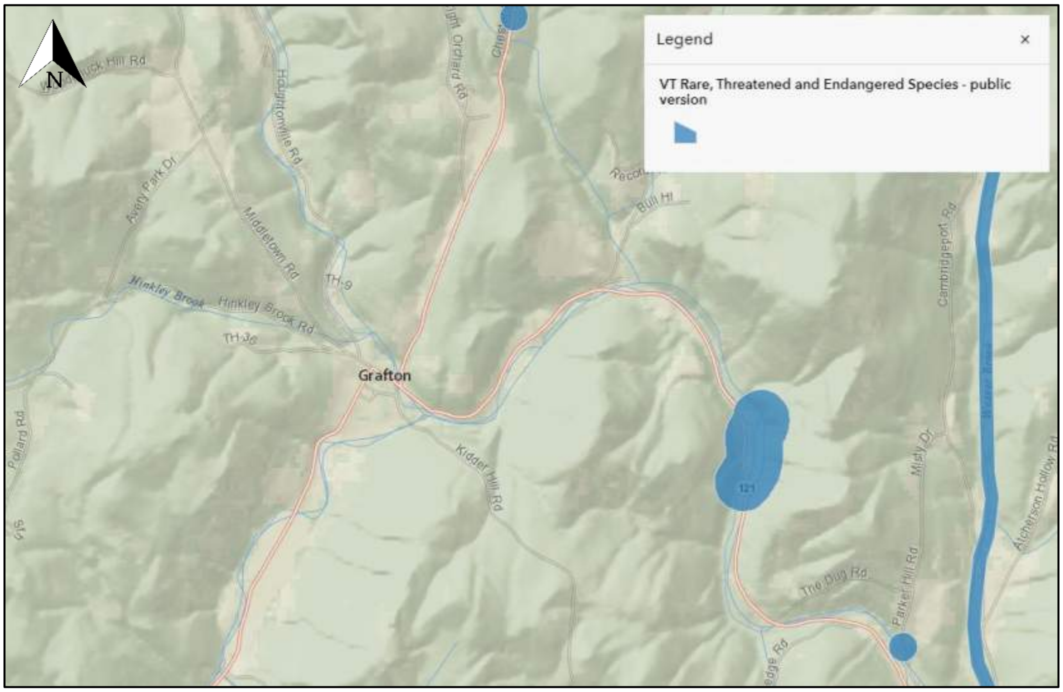


FIGURE 1.3
Rare, Threatened, & Endangered Species in the Vicinity of Grafton

The Vermont Fish and Wildlife Department's National Heritage Inventory (NHI) utilizes Element Occurrences (EO), an area of land or water in which a species or natural community is or was present, to maintain a database of rare, threatened, and endangered species and natural (plant) communities in Vermont. No significant natural communities were noted within the vicinity of the study area in Grafton, as shown in Figure 1.4, below.

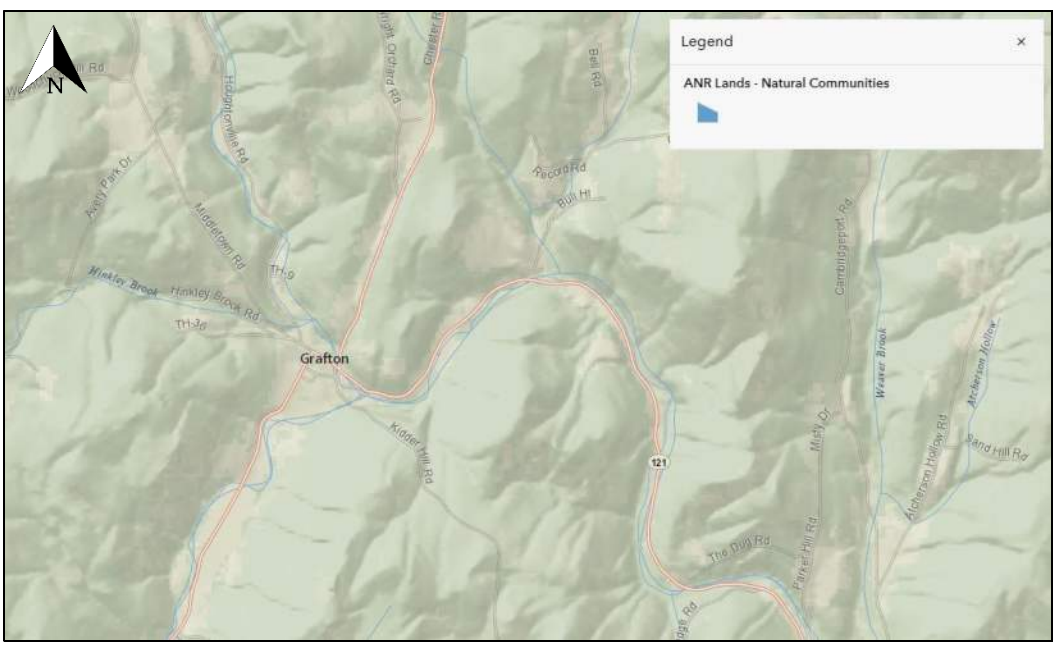


FIGURE 1.4
Significant Natural Communities in the Vicinity of Grafton

As shown on Figure 1.5, there are a few Significant Wetlands identified by the Vermont's Significant Wetlands Inventory (VSWI) scattered throughout Grafton, VT. Figure A.4 in Appendix A identifies the U.S. Fish and Wildlife National Wetlands Inventory (NWI) wetlands around Grafton; much of which overlap with the VSWI wetlands as shown on Figure 1.5 and Figure A.4.

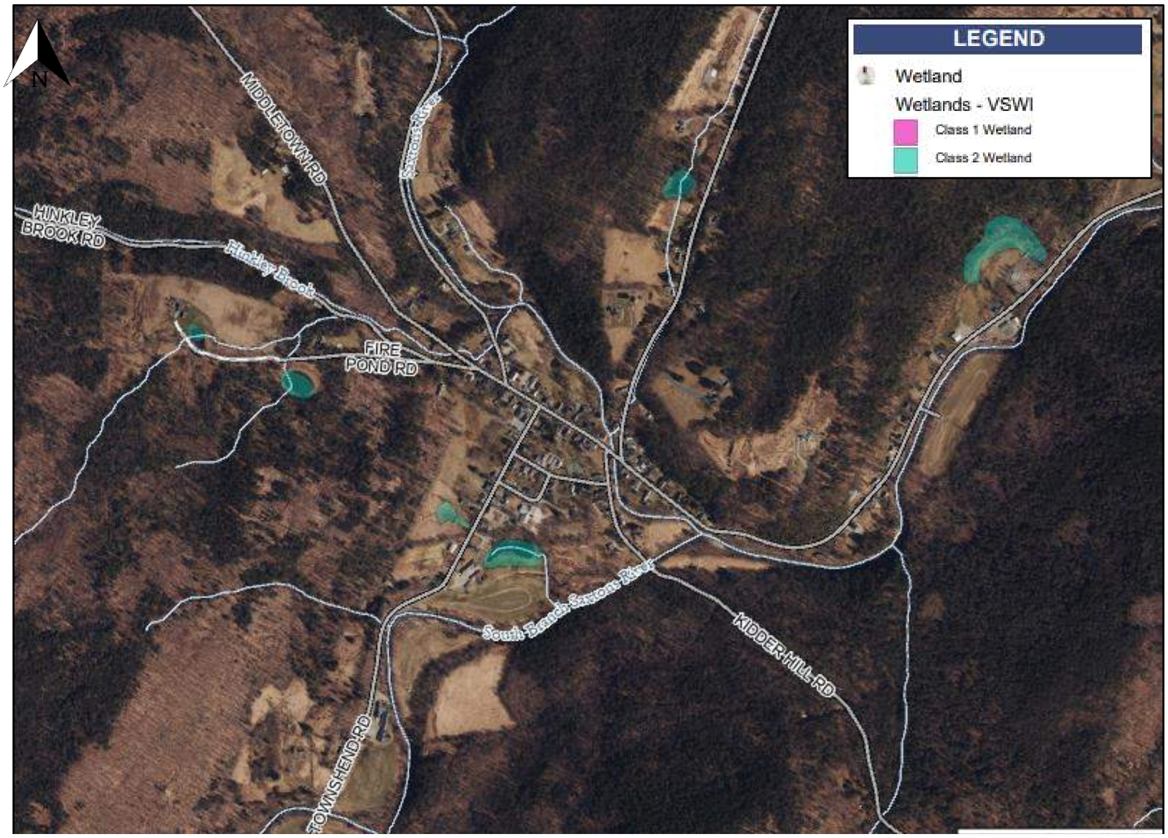


FIGURE 1.5
VSWI Wetlands in the Vicinity of Grafton

The South Branch of the Saxtons River joins the Saxtons River in the Village of Grafton. The Saxton River flows east out of the Village along Route 121. Small, unnamed ponds and waterbodies are scatted throughout the Village. The Fire Pond is located at the Grafton Village Park property along Fire Pond Road on the west side of the Village.

The FEMA 100-year flood zone in the Village of Grafton is also shown on Figure A.4. The mapped flood zones are adjacent to the Saxtons River, the South Branch of the Saxtons River, and unnamed tributaries to the Saxton River. As shown on Figure A.4, several parcels and buildings within the study area are within or adjacent to the 100-year flood zone.

1.3.5 Land Use & Zoning

The Town of Grafton has not yet adopted zoning laws aside from those in the flood plains. A Proposed Land Use Map was developed due to interest in incorporating zoning regulations related to wastewater stemming from the 2007 Phase II Water and Wastewater Feasibility Report. The five zoning categories used in Grafton's Proposed Land Use Map include:

Villages

- Villages are less densely populated and smaller than Regional Centers, but offer many of the same residential, civic, commercial, and light industrial uses.

Critical Resource Areas

- Critical Resource Areas are key sites that are particularly sensitive and should be given maximum consideration for protection. Although there are no specific zoning regulations or ordinances prohibiting development on private land, it is the expressed desire of the Town that no development occurs in Critical Resource Areas.

Resource Lands

- Resource Lands are dominated by lands requiring special protection or consideration due to their uniqueness, irreplaceable or fragile nature, or important ecological function. Resource Lands can be actively worked and used, but future development should be weighed against the desire to preserve the area.

Rural Residential

- Rural Residential is characterized by low and very low density housing, includes areas that are already committed to residential development or are in proximity to already developed lands.

Productive Rural Lands

- Productive Rural Lands include forestlands, active agricultural lands, sand/gravel/mineral deposits, and high-value forest and agricultural soils that, when in productive use, contribute to the working landscape and have significant economic value.

The Town of Grafton Flood Hazard Prevention Regulations outline requirements related to development and use of buildings within the Flood Zone. The proposed zoning districts are shown on the Grafton Proposed Land Use Map attached to this report in Appendix B.

1.3.6 Village Center & Planning Buffer

The State of Vermont, through its Agency of Commerce & Community Development, recognizes the importance of the continued health of historic centers through its Village Center Designation program. Village Centers throughout Vermont are delineated through this program. The designation process was most recently completed in August 2020 for the Village of Grafton when the Grafton Village Center map was passed by the selectboard.

The Village Center delineation is shown in Figure 1.6, below. Figure 1.6 also shows the Village Center planning buffer. The planning buffer is a 0.25 mile radius around the Village Center. The planning buffer is an important consideration for project planning as parcels within the 0.25 mile buffer are eligible for certain funding.

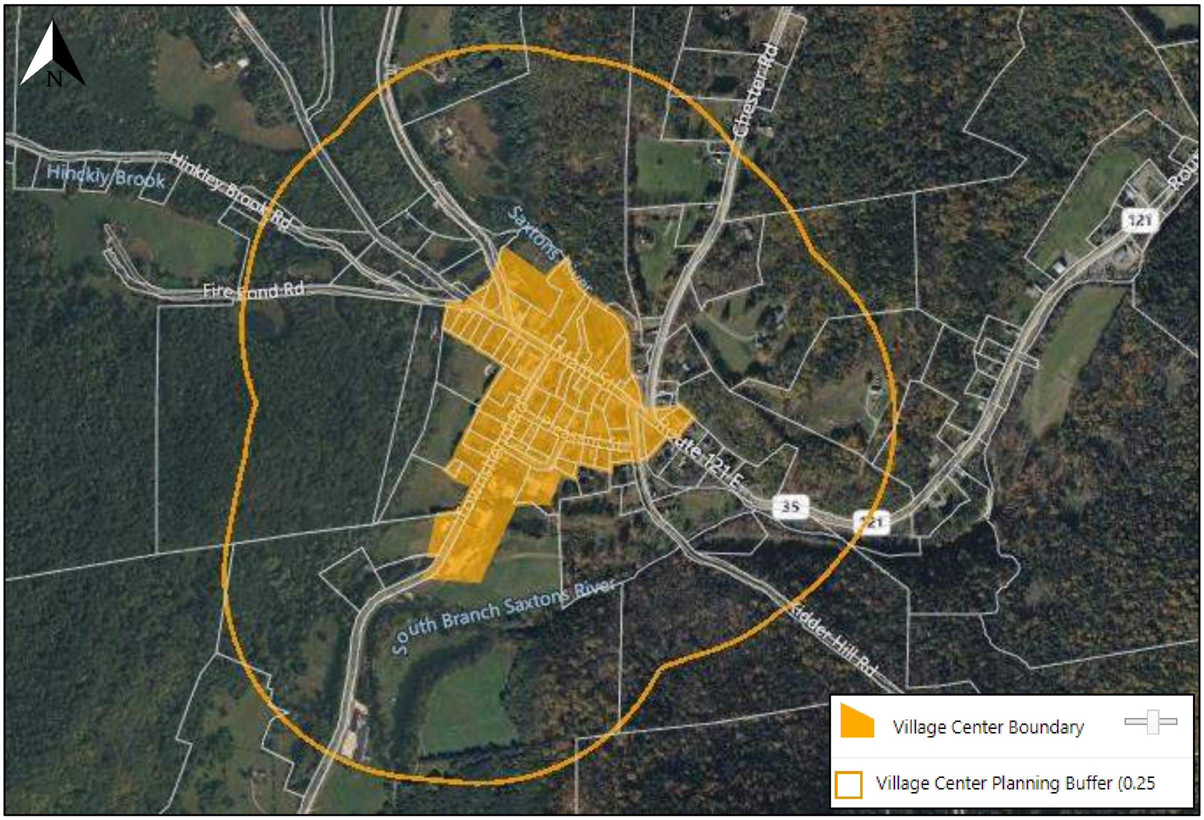


FIGURE 1.6
Grafton Village Center Map and Planning Buffer

The Town of Grafton selectboard recognized the importance of the Grafton Village as a historic center and a mixed-use area that serves the surrounding population with goods and services, civic and religious functions, jobs, and residences. The Village Center is important to the community as the continued social and economic viability of the Grafton Village is critical to the Town of Grafton's future growth and prosperity.

1.4 Community Engagement

The Town of Grafton has been investigating the need for a centralized sewer system or water system for the study area for approximately three decades. The Town has taken several steps to engage the community regarding the need for and feasibility of a new sewer district or public drinking water system. Below is a timeline which illustrates the actions already taken, as well as the planned approach to continuously involve the community and encourage civic participation throughout the next phases of the project.

- 1992 – A capacity study was completed by Windham Regional Commission. The Planning Commission sent surveys to the residents and property owners in the Village of Grafton. The survey was aimed at collecting information regarding existing private septic and water systems.
- 1999 – The Town of Grafton adopted septic pumping ordinance in 1999. The purpose of the ordinance was to preserve the public health, prevent pollution, and to secure the sanitary protection of waters within the Special Assessment District which is defined as the village boundaries as outlined in the Town Plan.

- 2001 – A feasibility study was completed by Tighe & Bond. The 2001 study recommended a centralized wastewater system to address issues seen throughout the study area. A survey was sent to property owners who fell into the Septic Pumping Ordinance district defined by the Town.
- 2007 - A feasibility study was completed by Otter Creek Engineering. The 2007 report recommended a centralized water system over a wastewater system due to financial feasibility. The 2007 report did, however, recommend a smaller service area for a centralized wastewater system.
- 2020 – The Town of Grafton sent out a wastewater survey to residential and commercial property owners. The survey received a 93% response rate. The intent of the survey was to provide useful information for the new feasibility study and continue the process of informing the community about current conditions and the potential need for a resolution.
- 2021 – An addendum to the 2001 feasibility study was developed which investigated the potential for wastewater disposal at the Village Park site. Town of Grafton also selects Tighe & Bond to develop this preliminary engineering report and a public outreach program.
- 2022 – Tighe & Bond and the Town of Grafton began the feasibility study and public outreach program. A 30% public meeting was held in September 2022. Public comment and feedback were received.
- October 2022 – The Town of Grafton was notified by the Clean Water State Revolving Fund Program (CWSRF) that the Grafton Village Wastewater Project in the amount of $5,941,452 was ranked within the fundable range on the SFY2023 CWSRF Project Priority list. The Town of Grafton was also notified in October 2022 that $3,968,331 was appropriated for the Grafton Village Wastewater Project in American Rescue Plan Act (ARPA) funds.
- 2023 – Tighe & Bond and the Town of Grafton investigated additional sites for the potential sewer system and continued with the feasibility study and public outreach program. The Town of Grafton also solicited the Windham Regional Commission to assist with the public outreach component of the project in 2023.
- September 2023 - A 60% public meeting was held in September 2023. Public comment and feedback were received.
- Planned in 2024 – Tighe & Bond and the Town of Grafton will address public comments and feedback from the 60% report and advance the 90% report. Comments and feedback from the 90% report will be incorporated and the final preliminary engineering report will be developed.

Section 2
Need for Project

As discussed, the Village of Grafton has been considering a centralized sewer system for nearly three decades. Grafton does not currently have a public wastewater collection or treatment system although there is relatively dense development in the Village Center. Most parcels in Grafton are served by individual subsurface septic tanks and leachfields, many of which were installed earlier than the 1970s according to the results of the prior wastewater surveys. Some of these older systems are outdated and no longer considered best practices.

The 2001 and 2007 feasibility studies note that the parcel size, location, and soil conditions of many of the parcels in the Village precludes the ability to reconstruct adequate on-site systems. These parcel restrictions can create economic hardship on the property owners if they need to replace their septic system or wish to expand the use of their property. Local conditions that could cause septic system failures may also create a potential environmental and public health concern.

Septic system limitations have restricted numerous businesses from expanding or forming in the Village such as a dentist office and a cafe. In addition to business expansion limitations, property owners are finding it difficult to expand residential spaces including apartments due to septic system restrictions.

The Critical Need Analysis section of the 2001 Engineering Report identifies the issues in the Village based on the survey results received. The report states that about half of the parcels in the Village do not meet at least one of the setback distance requirements and nearly every water supply well within the Village is within the minimum regulatory isolation distance.

The 2020-2028 Grafton Town Plan lists water supply and wastewater issues as an area of priority that requires action in the future to correct. The Grafton Town Plan recommends that a Grafton Village wastewater treatment system is considered to resolve water and wastewater issues that are currently inhibiting small business growth and jeopardizing Village resident health and safety.

A central sewer system would make it easier and more attractive for businesses to expand and would allow lot sizes to be smaller in the service area which would allow for greater density and number of businesses. It would also allow for mixed-uses such as apartments to be built above storefronts which may otherwise be futile without providing a public wastewater system as the small existing lots in the Village are not able to support the larger flow demands of mixed-use buildings. A central sewer system could provide several benefits to Grafton, including:

- Replace outdated septic systems
- Allow existing businesses to reach their full capacity
- Encourage additional growth, multi-use buildings, and new businesses in the Village
- Provide environmental protection by replacing failing or outdated septic systems
- Promote sustainable community development that benefits all town residents
- Encourage in-village capital investments instead of rural areas outside the Village

Section 3
Service Area Delineation

The first task of this study is to delineate the service area. The greatest focus is on parcels that have failing septic systems, small lot sizes, site constraints such as high groundwater or shallow depth to a restrictive layer, or parcels that provided critical services or businesses that have high demands. Intelligent service area delineation is imperative to ensure that all parcels which need to be included are captured, and that parcels which do have enough space for an on-site septic system are not included and thus they do not bare any unnecessary expense. This evaluation utilized several steps to determine the correct delineation of a sewer service area, including:

- Review responses to the wastewater surveys;
- Evaluation of site conditions that may limit the effectiveness of individual onsite wastewater disposal systems including soil type, shallow depth to groundwater or a restrictive layer, parcel size, and parcel density;
- Review of isolation distance requirements and existing conditions
- Assessment of existing and proposed land use, zoning districts, and the Village Center planning buffer;
- Review of comprehensive plan goals and priorities which may impact the need for wastewater treatment improvements, and;
- Input from the Town regarding specific parcels.

3.1 Wastewater Surveys

Surveys were sent to residents within the study area in 2000 by Tighe & Bond for the 2001 Village of Grafton Sewer Feasibility Study, in 1992 by Windham Regional Commission for the 1992 Grafton Capacity Study, and most recently in 2020 by the Town. Information from the 1992 study was used in the 2001 report for those parcels that did not respond to the survey in 2000. In 1992, 117 surveys were sent, and 110 surveys were returned, representing a 94% response rate. In 2001, a 70% response rate was experienced and in 2020 a 93% response rate was achieved.

The 2001 report analyzes the survey results. In summary, the surveys showed:

- The study area was comprised of 64.8% single-family homes; 13.9% business; 3.3% combination of businesses and dwellings; 2.5% apartments; 3.3% recreation; 5.7% undeveloped land; and 6.6% other.
- Approximately half of the parcels within the Village do not meet at least one of the setback distance requirements; half of those parcels do not meet two of the setback distance requirements.
- 60% of parcels contained at least one of the potential critical conditions from the following list: septic system within Class 1 soils; septic system was installed more than 25 years ago; unknown septic system age; depth of well less than 100 feet; or depth of well unknown. Of the 60% of parcels that contained at least one of the potential critical conditions, 58% contained two or more.
- Approximately 13.5% of parcels were smaller than 0.25 acres and 42.5% of parcels are smaller than 0.5 acres.

- Most parcels utilized drilled wells as their water source.
- About 16% of respondents had wells shallower than 100' and 34% did not know the depth of their well.
- Most parcels had standard septic systems. 45% of parcels did not know when their system was installed and 23.5% of parcels had systems that were installed prior to 1970.
- 21% of respondents had sump pumps in their basement.

Questionnaire surveys were mailed by the Town to residential and commercial property owners in 2020. A total of 48 residential surveys and 24 commercial surveys were sent out. The surveys requested information about each property owner's on-site septic system and related property information. The survey was intended to evaluate the homeowners' and business owner's experiences and the perceived need for a wastewater system in the Village. The survey also asked if they have problems with their existing system and if their septic/wastewater capacity/function has limited what they want to do with their property.

Summary tables of the 2020 wastewater survey responses are attached to this report in Appendix C. In total, 67 of the 72 surveys that were sent out were returned, representing a 93% overall response rate. Of the 67 responses, 43 were residential (representing a 90% residential response rate) and 24 were commercial (representing a 100% commercial response rate).

Of the 67 responses, only one residence reported issues with their septic system noting an issue with wetness. A total of 3 residential and 3 commercial property owners responded that their septic system has limited what they want to do with their property.

They survey also asked for general comments which varied in opinion, from supporting a central sewer system to those not in favor of a central sewer system, and several comments regarding who would be responsible for financing the system. Below are a few comments from the 2020 survey respondents.

"I am very much in favor of a village septic system. I hope there is a way to make it affordable."

"With the exorbitant current tax bills – one more thing will make us all sell to out-of-staters."

"Septic anywhere is not viable for our community with wells. However, the question going forward is cost and who pays: Village or all Grafton residents."

"Given the proximity of septic and wells it seems like it would be beneficial to have a town sewer system and potentially town water as well."

The takeaways from the 2020 survey are:

- There were few reported issues with septic system and only about 8% of properties reported property use limitations due to their septic system
- The survey comments indicate that some property owners see the potential benefit of a central sewer system and are open-minded about continuing the discussion but have concerns regarding cost of the system

- The response comments indicate that some property owners are concerned with the proximity of septic systems in relation to drinking water wells

3.2 Site Conditions

Several site conditions can contribute to poor wastewater disposal systems, including:

- Poor Soil Conditions
- Shallow Depth to Groundwater
- Shallow Depth to a Restrictive Layer
- Parcel Size and Density

Poor Soil Conditions

When soils are 'tight' and have percolation rates greater than 60 minutes/inch, wastewater disposal fields are much more likely to fail and create surface ponding or clogging problems. As discussed in Section 1.3.3, the soils in the village vary, but generally consist of different sandy loams, most of which are reportedly well drained.

Depending on the percolation rates and whether they are in accordance with Vermont DEC Standards, some of the soils in the Village may not be appropriate for on-site absorption fields. Or, if percolation rates are slow, it will require the on-site absorption fields to have a larger footprint which may not be feasible for some of the smaller parcels in the village.

The Colton gravelly sandy loam (50B) soils in the center of the Village and extending south-west along Route 121 and Grafton Road are reported as excessively drained HSG Type A soils (see Figure A.2). These areas may have better soils than the Tunbridge and Marlow loamy soils which generally extend along the higher slopes surrounding the Village Center. The soil types in and around the Village are shown on Figure A.2.

High Groundwater or Shallow Depth to Restrictive Layer

The vertical separation to seasonal high ground water is an important requirement in siting subsurface disposal systems. A minimum separation of 3 feet from the bottom of the leachfield to the seasonal high groundwater level is required by the Vermont DEC. There are portions of the Village where the depth to groundwater is expected to be less than 3 feet as reported by the NRCS. These areas are mainly around Fire Pond, south of the Elementary School, and along the Saxton River.

In addition to ground water levels, the vertical separation to a restrictive layer such as bedrock is an important requirement in siting subsurface disposal systems. A minimum depth to a restrictive layer of 3 feet and minimum depth to bedrock of 4 feet is required per Vermont DEC regulations. There are portions of the Village where a restrictive layer or bedrock is expected to be less than 3 or 4 feet according to the NRCS. Nearly the entire areas surrounding the Village have a potential shallow depth to a restrictive layer as shown in Figure A.2. The deeper soils in the valley are not expected to have a shallow depth to a restrictive layer.

Parcel Size and Density

To provide adequate space for a septic tank, soil absorption system, and replacement area, as well as sufficient room for a building and setback requirements, a minimum lot size is typically required.

In the Village, separation distances between wells and septic systems are a concern as stated in previous studies. Parcels less than 0.5 acres may have difficulty conforming to the Vermont DEC setback requirements. The Vermont DEC isolation requirements are stated in Table #21 of the Indirect Discharge Rules (IDR), a copy of which is presented below in Figure 3.1.

	Minimum Horizontal Isolation Distance (feet)			
ITEM	SEWER	SEPTIC TANK	DISPOSAL FIELD	SPRAY FIELD
Drinking Water Supply Source			see (a)	see (a)
Drilled Well		50	200 [see (b)]	200 [see (b)]
Gravel Pack Well, Shallow Well or Spring	75	75	200 [see (b)]	200 [see (b)]
Standing Water (Lake or Pond)	25	25	200	100
Streams and Rivers (includes groundwater seeps)	10	25	150	100
Drainage Swales / Roadway Ditches	C	C	25	100
Main or Municipal Water Lines	see (c)	50	50	200
Service Water Lines	see (c)	25	25	200
Roads, Driveways, Parking Lots	see (d)	5	10	200
Top of Bank or to Slope Greater than 30%	C	10	50	see (e)
Property Line	10	10	25 [see (f)]	200
Trees	10	10	10	---
Other Disposal Field	C	C	10	200
Foundations, Footing Drains or Curtain Drains	C	10	35 [see (g)]	200
Public Community Water System	see (h)	see (h)	see (h)	see (h)
Suction Water Line	50	50	100	200

FIGURE 3.1
Table #21: Isolation Distances taken from the Indirect Discharge Rules

For many parcels in the Village, the building takes up a significant portion of the parcel, leaving very little area for an adequate wastewater disposal system. Figure A.5 shows the parcels in the hamlet which are less than 0.25 acres, parcels that are between 0.25 and 0.5 acres, parcels that are between 0.5 acres and 1 acre, and parcels between 1 and 2 acres.

As shown in Figure A.5, most of the parcels in the center of the Village are less than 1 acre with several less than 0.5 acres and less than 0.25 acres. There are also a few parcels along Route 121 that are less than 1 acre.

Parcel size is typically related to parcel density. Highly developed areas usually have small lot sizes spaced closely together. These areas are not well suited for onsite disposal systems simply due to limited space. The greatest parcel density is the area between Route 121 and School Street.

3.3 Isolation Distances

As discussed above, the Vermont DEC has isolation distance requirements for various components of septic systems from other features such as wells, property lines, streams, etc. The purpose of these isolation distances is to protect drinking water supplies and the environment and ensure proper operation of the septic system.

The 2001 report provided a map of the parcels which did not meet isolation distance requirements (Figure 3 and Figure 4 in the 2001 report). However, several of the isolation distance requirements have increased since the 2001 report. For example, the isolation distance between a return field and a drilled well has increased from 100 feet to 200 feet (see Figure 3.1). The isolation distance between streams and rivers and return fields has also increased from 50 to 150 feet since 2001.

Tighe & Bond has created an updated map (Figure A.6) to reflect current VT DEC isolation distance requirements. This map is based on the approximate location of the wells and leachfields documented in the 2001 report and updated to the best of our ability if additional information regarding the location of septic systems were provided by the respondent as part of the 2020 survey. A GIS dataset of private well locations hosted by the Vermont Agency of Natural Resources was also added to the map. The locations of the wells and leachfields are approximate and therefore it should be expected that there is a margin of error in Figure A.6 since the locations of the wells and leachfields have not been field verified at this time.

As shown in Figure A.6, nearly all of the septic systems in the Village Center fall within one or more of the buffer zones from wells, streams, or water bodies. There are also isolation distance requirements from property lines, houses, drainage ditches, and other features which are not shown on Figure A.6 to provide clarity. The isolation distance between wells and septic systems is the largest contributing factor to non-conforming systems.

3.4 Land Use & Zoning

The land use and zoning districts in the Town of Grafton are discussed in Section 1.3.5 and the proposed districts are shown in Appendix B. The Town does not currently have zoning regulations that define minimum lot size requirements for lots with a connection to a central sewer system or lots which are not served by a central sewer system. Development of zoning regulations and boundaries may be completed in the future.

3.5 Village Center Planning & Town Plan

As discussed in Section 1.3.6, the Village Center delineation and corresponding 0.25 mile planning buffer are important considerations for service area delineation since parcels in the Village Center are most likely to benefit from a sewer system and parcels within the 0.25 mile buffer are eligible for funding.

The 2020-2029 Grafton Town Plan recommends investigating solutions for the potential water supply and wastewater issues within the Village. The Town Plan also suggests investigating "a Grafton Village wastewater treatment center to enable the growth of small businesses and to ensure the health and safety of Village residents."

3.6 Proposed Service Area

Considering the historic wastewater survey responses, the local site conditions, isolation distance requirements, town plan goals, and the Village Center planning buffer; it is recommended that the proposed service area includes the Village Center and those parcels within the 0.25 mile radius planning buffer which are small and within a reasonable distance from the Village Center. The service area delineation is shown on Figure A.7 in Appendix A and on Figure 3.2.

The service area is recommended for the following reasons:

1. A significant number of parcels in the Village Center do not meet isolation distance requirements between leachfields and drinking water wells.
2. The parcels in the Village Center are relatively small which presents challenges for wastewater disposal and limits the expansion of businesses.
3. Most of the businesses are within the Village Center and some businesses in the Village Center have experienced challenges with expanding their business due to limitations of their existing septic systems, lot sizes, and isolation distance requirements.
4. A sewer system serving the Village Center will help achieve the goals of the Grafton Town Plan.

The service area delineation shown in Figure A.7 and Figure 3.2 does not currently include the Grafton Cheese Factory since the Cheese Factory is relatively far from the Village Center and outside the planning buffer. A summary of the service area delineation is as follows:

- The service area includes all parcels within the Village Center designation.
- The service area extends north to include the parcels between Main Street and the Saxtons River and along Chester Road to 103 Chester Road. There are six parcels further north along Chester Road which do fall within the planning buffer, however, these parcels are relatively large and should have enough room for a private septic system.
- The service area extends east along Main Street to 145 Route 121 and along Kidder Hill Road to the South Branch of the Saxtons River. There is one other parcel on Kidder Hill Road which is within the planning buffer but has been excluded from the proposed service area due to its location on the opposite side of the Saxtons River.

- The service area extends south along Townshend Road and includes the Windham Foundation offices and maintenance facilities. There are four other parcels south on Townshend Road which are within the planning buffer, however, they have not been included in the proposed service area due to the isolation and size.
- The service area extends west to the parcel at the intersection of Fire Pond Road and Hinkley Brook Road. The service area also extends west along Middletown Road and Houghtonville Road to the parcels behind the cemetery.

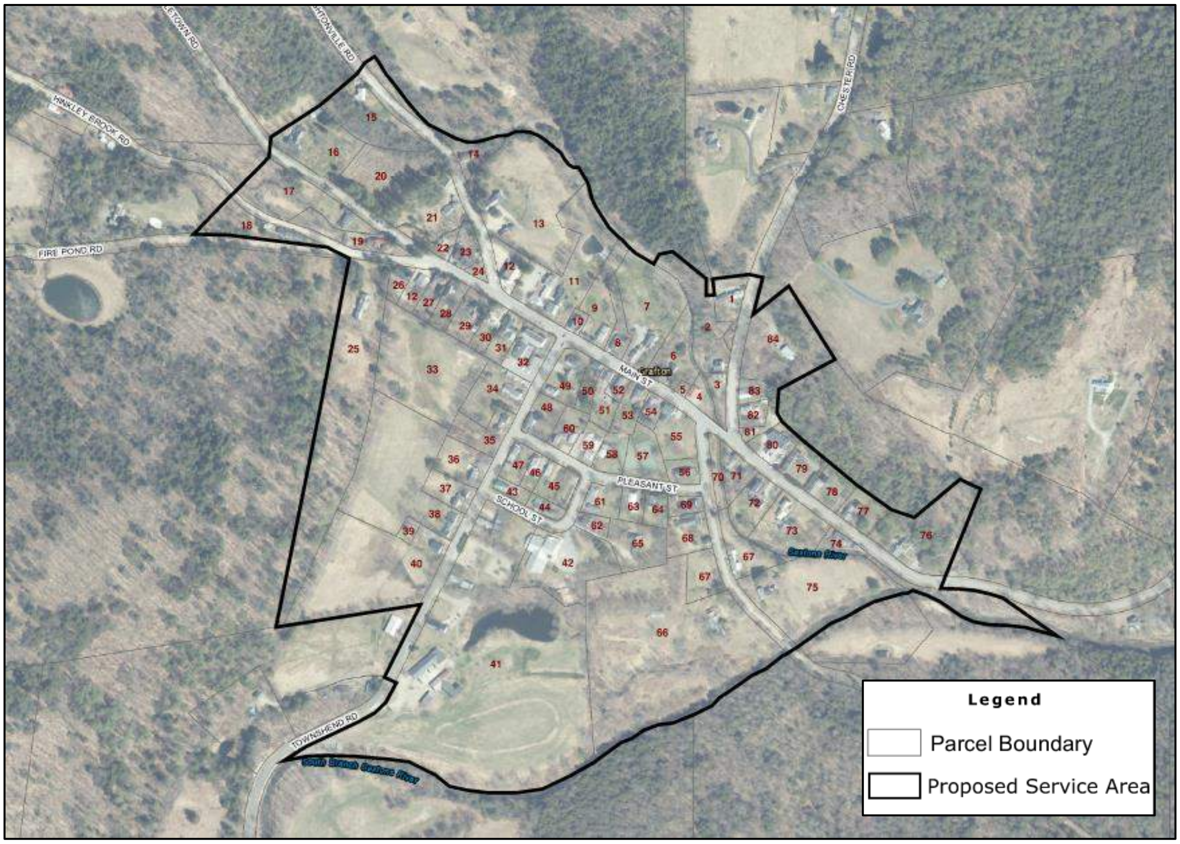


FIGURE 3.2
Proposed Service Area

Note that the proposed service area shown in Figure 3.2 and Figure A.7 does not include all of the parcels under consideration for the proposed water resource recovery system and/or return fields. Refer to Section 5 for discussion of the water resource recovery system and return field locations under consideration. The selected water resource recovery system parcel(s) will be included in the final service area delineation.

There is a total of 84 parcels in the proposed service area. Table 3.1 provides a breakdown of the number of residential, commercial, and vacant parcels in the proposed service area. The parcels have been numbered sequentially for reference purposes as shown on Figure A.7.

TABLE 3.1
Service Area Parcel Summary

Parcel Type	No.
No. of Residential Parcels	56
No. of Commercial Parcels	23
No. of Vacant Parcels	5
Total No. of Parcels	**84**

3.6.1 Potential Phased Service Area Approach

For planning purposes, it is sometime beneficial to consider a phased approach for service area delineation. For instance, certain parcels with VTDEC permitted repair or alternative treatment systems, or larger parcels on the outskirts of the Village Center may be able to remain on their current septic systems or are lower priority and thus could be included in a second phase. Tighe & Bond worked with the Town of Grafton to identify the lower priority parcels which could potentially be included in a second phase of the service area.

Table 3.2 summarizes the parcels that were identified for potential exclusion from Phase 1 and inclusion in Phase 2 of the service area.

TABLE 3.2
Potential Phase 2 Service Area Parcels

Parcel No.	Name/Address
11	Cricketers (part of Grafton Inn)
13	White Gates House (part of Grafton Inn)
25	33 Hinkley Brook Road
32	Grafton Inn & Phelps Barn Pub
40	Grafton Museum
41	Windham Foundation Facilities
51	Crawford House
52	Grafton Village Store
66	136 Kidder Hill Road
75	135 Kidder Hill Road
76	145 Route 121 East

The phased approach is generally not preferred when it can be avoided. However, as discussed, it can be beneficial in certain scenarios during the planning process and has therefore been discussed. The phased approach is referenced later in this report as Phase 1 (all parcels in the proposed service area minus the eleven parcels included in Table 3.2) and Phase 2 (parcels included in Table 3.2).

Section 4
Design Parameters

4.1 Flow Estimates

Historical water meter data was not available to develop the flow estimate for the proposed service area since there is no public water system in Grafton. Therefore, grand list parcel information provided by the Town was used to estimate flow for each parcel based on the VT DEC Environmental Protection Rules Chapter 1 Section 1-803. The grand list parcel information was supplemented by and checked against the 2020 survey responses. If there was a conflict between the grand list parcel information and the survey responses, the more conservative of the two were used. Input from the Windham Foundation was also used regarding the various Windham Foundation properties.

Using the VT DEC flow estimate methodology discussed above, the total average day flow for the proposed service area was estimated to be 38,600 gpd. A 10% factor has been applied to the base flow to account for future expansion and growth within the service area. The 10% factor would cover the additional sanitary flow from the Grafton Cheese Factory if it were added to the service area in the future. Therefore, the total average day design flow for the proposed service area, including the 10% expansion factor is **42,500 gpd**. Table 4.1 provides a summary of the flow estimate for the proposed service area.

TABLE 4.1
Service Area Design Flow Summary

	Flow (gpd)
Base Design Flow	38,600
Future Expansion (10%)	3,900
TOTAL	**42,500**

Sewer districts commonly use the term Equivalent Residential Units (ERUs) for comparing the flow from individual parcels. A single ERU represents the flow from a typical single-family household in the service area. There are 55 single family residential units in the proposed service area. The average day flow estimate for the 55 single family residential parcels using the VT DEC Environmental Protection Rules Chapter 1 Section 1-803 methodology is 451 gpd. Therefore, one ERU has been equated to a flow rate of 450 gpd.

The number of ERUs associated with each parcel in the study area was calculated based on the design flow rate of each parcel. A minimum of 1 ERU was assigned for each single-family residential parcel, 2 ERUs for each two-family residential parcel, etc. even if the estimated flow rate was below 450 gpd. The same was done for commercial parcels with a minimum of 1 ERU per commercial parcel. ERU assignments for each parcel were rounded to the nearest whole number. Table 4.2 summarizes the number of ERUs in the proposed service area. A table summarizing the flow estimate for each parcel and the associated number of ERUs is provided in Appendix D.

TABLE 4.2
Service Area ERU Summary

	No. of ERUs
Residential	59
Commercial	38
TOTAL	**97**

Based on Tighe & Bond's experience and flow meter data from other communities of similar size, we anticipate an average day flow rate for a single-family household to be approximately 200 – 250 gpd. Therefore, we expect that the flow estimate method used above which results in an average single family flow rate of approximately 450 gpd to be conservative compared to the actual flow rate that may be experienced when the system is installed. For example, if the flow rate from the 55 single family residential households averaged 225 gpd instead of 450 gpd, then the base flow estimate for the service area would be reduced by approximately 12,400 gpd (excluding the 10% expansion factor).

Table 4.3 provides a summary of the flow if the service area was split between two phases as discussed in Section 3.6.1.

TABLE 4.3
Design Flow Summary - Phased Approach

	Flow (gpd)
Phase 1 Base Design Flow	26,800
Phase 1 Future Expansion (10%)	2,700
Phase 1 Subtotal	**29,500**
Phase 2 Base Design Flow	11,800
Phase 2 Future Expansion (10%)	1,200
Phase 2 Subtotal	**13,000**
TOTAL	**42,500**

Peak Flow Considerations

Several peak flows should also be considered when discussing the design flows of water resource recovery systems including the anticipated peak daily flow and the anticipated peak hourly flow. Since daily flow meter data is unavailable, Figure 4.1 provides the American Society of Civil Engineers (ASCE) Manual of Practice No. 9 Sewer Design and Construction (MOP 9) daily peaking factor curves taken from the TR-16 Guides for the Design of Wastewater Treatment Works. Using the estimated average daily flow for the service area of 42,500 gpd produces a maximum day peaking factor of approximately 3.0, which results in a peak daily flow of 127,500 gpd for the service area.

It should be noted that, in accordance with TR-16, this method for estimating peak daily flows is primarily for residential areas and that commercial, institutional, and industrial flows will generally have a different, lower peaking factor, depending on locations in a system and hours of operation. In addition, this method is for conventional wastewater collection systems, and not septic tank effluent systems which have some attenuation of peak flows at each septic tank.

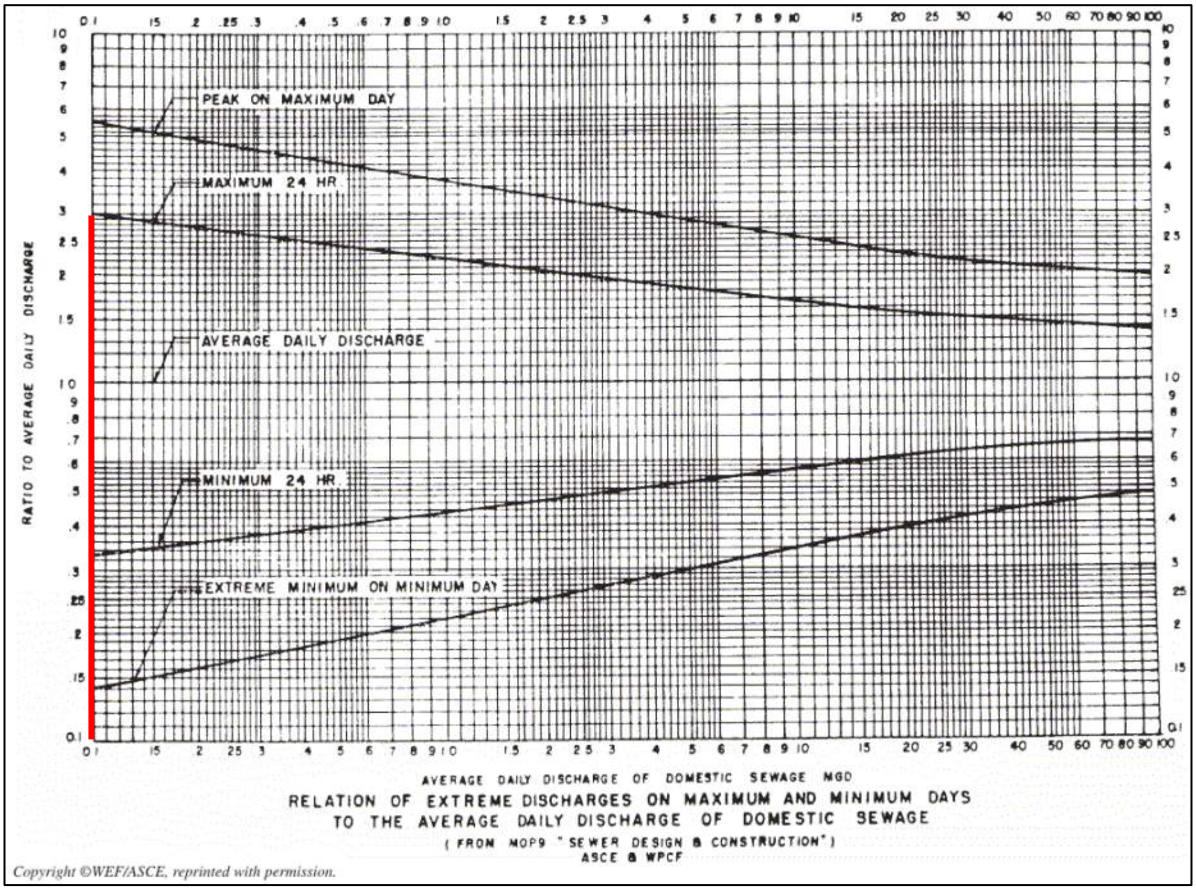


FIGURE 4.1
MOP 9 Daily Peaking Factor Calculation

Figure 4.2 shows the 10 States Standards (10 SS) peak hour peaking factor computational methodology. Assuming the service area serves 50% more people than the population of the Grafton CDP (74 people) based on the delineation of the CDP compared to the study area delineation, the peak hour peaking factor is 4.3. Applying the total estimated average daily flow for the service area of 42,500 gpd produces a peak hourly flow of up to 182,800 gpd. Note that as the service area increases, the peaking factor is predicted to decrease. In accordance with 10 SS, the peaking factor and resulting peak hourly flow account for normal inflow and infiltration (I&I) for systems built with modern construction techniques.

It should be noted that this method is also intended for estimating flows from residential areas and conventional collection systems and therefore it may be conservative for estimating peak hourly flows from service areas that have many commercial users, for alternative septic tank effluent systems, and for new “tight” collection systems.

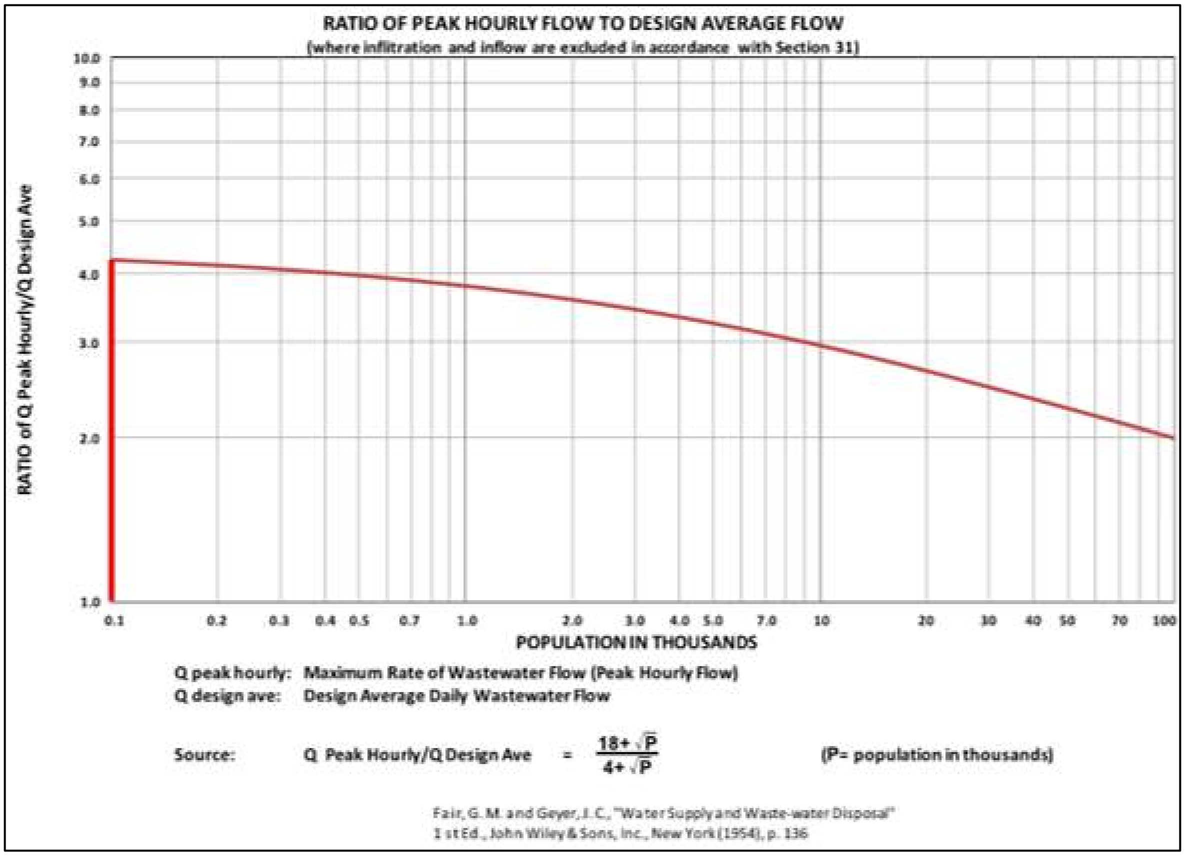


FIGURE 4.2
Ten States Standards Peak Hour Factor Calculation

A summary of the anticipated design flows for the service area is provided in Table 4.4. The same peaking factors could be applied to the phase approach to determine the peak flows from each phase.

TABLE 4.4
Anticipated Wastewater Design Flows

Average Daily Flow (gpd)	42,500
Peak Daily Flow (gpd)	127,500
Peak Hourly Flow (gpd)	182,800

Future Flows

The design wastewater constituents should be based upon the service area at its full potential. Additional residential and commercial development and high demand businesses such as restaurants in the service area may increase the daily average flows. For this application, and as discussed above, a 10% factor has been applied to the base flow to account for future expansion and growth within the service area. The 10% expansion factor, in conjunction with the anticipated conservative flow estimate (as discussed above) should be suitable for future growth and expansion within the Village of Grafton.

4.2 Influent Loading

Treatment efficiency for small systems is generally characterized by their efficiency at removal of organic constituents and solids. The most commonly used parameter to define the organic strength of municipal wastewater is biochemical oxygen demand (BOD). BOD is the quantity of dissolved oxygen utilized by microorganisms in the aerobic oxidation of organic matter in wastewater over a period of time. The depletion of dissolved oxygen in wastewater is directly related to the amount of organic matter present in the wastewater.

The quantity of solids in wastewater is typically expressed as total suspended solids (TSS). Suspended solids are those removable by filtration or settling. Wastewater may also have quantities of dissolved solids, which require additional treatment for removal.

Another parameter used to gauge the strength of wastewater is nitrogen. Common forms of nitrogen are ammonia, nitrite, and nitrate. Large quantities of nitrogen in wastewater returned to a water body can cause growth of algae. Ammonia is considered a serious water pollutant as it is toxic to fish. Nitrate can easily pass through the soil to the groundwater, where it can accumulate to high levels over time, potentially contaminating drinking water sources.

Individual absorption fields remove little or no nitrogen from the septic tank effluent. Primary treatment by a traditional septic tank is effective at removing quantities of BOD and TSS and some nitrogen species. Table 4.5 provides typical influent loading concentrations for a conventional water resource recovery system and for an alternative water resource recovery system (septic tank effluent). These influent loading concentrations have been used for the preliminary design.

TABLE 4.5
Typical Influent Loading Concentrations

Parameter	Conventional Treatment System	Alternative Treatment System (Septic Tank Effluent)
BOD	350 mg/L	150 mg/L
TSS	400 mg/L	60 mg/L
TKN	300 mg/L	60 mg/L
NH_3-N	70 mg/L	50 mg/L
FOG	150 mg/L	20 mg/L
TP	20 mg/L	12 mg/L

4.3 Return Limits & Compliance Monitoring

The return limits of a new water resource recovery system depend on the level of treatment required. Table #12 of the Environmental Protection Rules, Chapter 14, Indirect Discharge Rules dictates the level of treatment required based on the design capacity and disposal method. A copy of Table #12 from the IDR is shown on the following page as Figure 4.3. As shown in Figure 4.3, secondary + treatment is required for design flows above 30,000 gpd and tertiary treatment is required for flows above 50,000 gpd when utilizing a leachfield disposal method. Secondary treatment is required for systems with flows above 6,500 gpd when utilizing a sprayfield disposal method.

TABLE #12: MINIMUM SEWAGE TREATMENT REQUIREMENTS BASED ON DESIGN CAPACITY AND DISPOSAL METHOD

Design Capacity (gallons per day)	Disposal Method	Minimum Treatment Level Required
6,500 - 30,000	Leachfield	Primary (Septic tank)
30,001 - 50,000	Leachfield	Secondary + (1)
50,001 and greater	Leachfield	Tertiary
6,500 and greater	Sprayfield	Secondary

(1) Secondary 'plus' treatment level from recirculating sand / textile filters. See Table #13.

FIGURE 4.3
Table #12 from IDR

TABLE #13: EFFLUENT LIMITATIONS FOR EACH TREATMENT LEVEL

	Effluent Limitation (in mg/L) by Treatment Level			
Parameter	**Septic Tank**	**Secondary**	**Secondary + (1)**	**Tertiary**
Biochemical Oxygen Demand (5-Day)	**N/A**	**30 (2)**	**15 (3)**	**10 (4)**
Total Suspended Solids	**N/A**	**30 (2)**	**15 (3)**	**10 (4)**
Total Dissolved Phosphorus	**N/A**	**N/A**	**N/A**	**0.5 (5)**
Total Kjeldahl Nitrogen	**N/A**	**N/A**	**N/A**	**5 (6)**
Ammonia (as N)	**N/A**	**N/A**	**N/A**	**1 (7)**
Nitrate nitrogen	**N/A**	**N/A**	**N/A**	**5 (8)**
Total Nitrogen (as N)	**N/A**	**N/A**	**N/A**	**N/A**

(1) Secondary 'plus' treatment level from recirculating sand/textile filters.
(2) Daily maximum.
(3) Monthly average.
(4) Monthly average; daily maximum is 18 mg/L
(5) Monthly average; daily maximum is 1.0 mg/L
(6) Monthly average; daily maximum is 10 mg/L
(7) Monthly average; daily maximum is 2.0 mg/L
(8) Monthly average; daily maximum is 10 mg/L

FIGURE 4.4
Table #13 from IDR

Table #13 in the IDR lists the return limits to be included in permits based on the treatment level required per Table #12 of the IDR. A copy of Table #13 from the IDR is shown above as Figure 4.4. As shown in Figure 4.4, there are no effluent limits for systems requiring only primary treatment (< 30,000 gpd). Systems requiring secondary and secondary + treatment have limits for BOD and TSS which vary based on the disposal method. Tertiary treatment systems (> 50,000 gpd) have the most stringent effluent requirements.

In Vermont, a new water resource recovery system associated to a soil-based disposal system with design flow larger than 6,500 gpd will be subject to an indirect discharge permit. Depending on the compliance method, compliance monitoring requirements for indirect discharge permits may require sampling and analysis for the effluent and groundwater and/or receiving stream with regular reporting.

All applicants proposing new indirect discharges of sewage are also required to demonstrate compliance with the Aquatic Permitting Criteria. The Aquatic Permitting Criteria are numerical permitting limits, which are allowable in-stream concentrations for nutrient and non-nutrient parameters. The Aquatic Permitting Criteria pertains to site-specific limits for Total Dissolved Phosphorus, Nitrogen-Nitrate, and pH. Additionally, compliance with the Groundwater Protection Rule and Strategy should be demonstrated. The latter Rule includes checking other parameters, such as Total Phosphorus, *E. Coli,* and Chlorides. All applicants for new indirect discharges of sewage are required to demonstrate compliance with the Aquatic Permitting Criteria and shall use one of the five methods listed in Table #1 of the IDR, a copy of which is shown below as Figure 4.5.

TABLE #1: METHODS FOR DETERMINING COMPLIANCE WITH THE AQUATIC PERMITTING CRITERIA

Compliance Method	Applicability (Maximum Design Capacity)	Stream Sampling Required ?	Renovated Effluent Sampling Required?	Section of Indirect Discharge Rules
Dilution	20,000 gpd	No	No	14-902
Treatment Index	20,000 gpd	No	No	14-903
Modified Site Specific	30,000 gpd	Yes	No	14-908
Site Specific (1)	No Limit	Yes	Yes	14-904
Alternative Demonstration	No Limit	Yes	Yes	14-914
(1) Site Specific includes In-Situ In-Ground Testing, Soil Extraction and Laboratory Testing, and Alternative In-Situ Testing				

FIGURE 4.5
Table #1 from IDR

As shown in Figure 4.5, the dilution method and treatment index method can be used for systems with a maximum design capacity of 20,000 gpd. The modified site-specific method can be used for systems with a maximum design capacity of 30,000 gpd. The site specific or alternative demonstration methods must be used for systems with design capacities greater than 30,000 gpd. Each of the five compliance methods are described in Section 14-902, 14-903, 14-908, 14-904, and 14-914 of the IDR, respectively.

The treatment requirements, return limits, and compliance monitoring requirements of the IDR have been used for the alternative analysis presented herein. The final return (effluent) limits are dependent on the size, type of system, and required level of treatment.

Section 5
Resource Recovery/Return Sites

Determining the correct site for a new water resource recovery system and return location is very important. This section discusses the water resource recovery sites that were considered for the Town of Grafton.

5.1 Initial Parcel Screening

Three potential locations were identified in the 2001 Village of Grafton Sewer Feasibility Study. The three sites identified as part of the 2001 study are referred to as the Alpine Field, the Howland Mill Field site, and the Upper Howland Mill site. The 2021 Grafton Village Sewer Feasibility Study Addendum by Tighe & Bond identified a fourth location referred to as the Village Park site. Several additional sites were identified and investigated as part of this study. The potential locations are shown in Figure A.8 and are summarized below in Table 5.1.

TABLE 5.1
Potential Locations and Initial Parcel Screenings

Parcel	Name	Status - Reason	Tax Parcel ID No.
1	Alpine Field	Consider	008177.
2	Howland Mill Field	Eliminated – flooding	009045.
3	Upper Howland Mill	Consider	009045.
4	Village Park	Consider	008057.
5	Green Hollow	Eliminated – public trails	009043.
6	Windham Foundation	Eliminated – very wet	008177.
7	Montecalvo Property	Eliminated – no interest	008010.
8	680 Houghtonville Road*	Consider*	005082.1
9	Jardine Property	Eliminated – no interest	005088.
10	Mandel Property	Eliminated – no interest	006053.
11	Gregory Property	Eliminated – no interest	009001.8
12	Westclark Property	Eliminated – house const.	009001.9
13	Idyll Acres	Eliminated – cow pasture	009045.
14	Yuspeh Property	Eliminated – no interest	008019.

***The 680 Houghtonville Road parcel owner originally granted approval for initial investigation. The results of the parcel evaluation have been included in this report should the parcel become available for use. However, the parcel owner has since decided that they are not interested in selling or leasing their parcel.

Tighe & Bond completed a desktop analysis of the potential locations listed in Table 5.1. The desktop analysis indicated that four of the parcels should be considered in greater detail. The remaining sites were eliminated during the desktop analysis because they were within the floodplain (flooding), had public trails that would restrict the use of the site (public trails), were too wet (very wet), the property owner was not interested in selling or leasing the parcel (no interest), or the parcel was used as a cow pasture (cow pasture). The status of each parcel based on the desktop review is shown in Table 5.1.

The following paragraphs provide a summary of the four sites that were determined to be worthy of further investigation. Parcel considerations and preliminary soil investigations at each of the four sites are discussed in Sections 5.2 and 5.3, respectively.

Alpine Field

The Alpine Field is approximately 7.5 acres and is part of the Windham Foundation property. The field is located east of the Grafton Cheese Factory on the east side of the South Branch of the Saxtons River. The field is approximately 40-80 feet higher than the South Branch of the Saxtons River. The site is currently used for the land application of whey from the Grafton Village Cheese Factory. The field slopes down from southeast to northwest at approximately 8-11%. Access to the field is via a farm road and covered bridge over the South Branch of the Saxtons River. The covered bridge is adjacent to the Grafton Cheese Factory. There is also an access road near Grafton Ponds.

The land immediately to the south, to the east, and across Townshend Road are also part of the same parcel. The structures on the approximately 822-acre parcel include a water storage tank, the Grafton Village Cheese Factory, Windham Foundation Offices, recreational facilities, and a barn. All the structures are a considerable distance away from Alpine Field.

Upper Howland Mill

Although this site was once referred to as a field, the field has been abandoned and has since grown up with young saplings. The vegetation in the abandoned field is now relatively dense. We were told that the area was once gravel/sand pit. Based on aerial images, the old field area is approximately 2.3 acres. The property is owned by the Windham Foundation and the entire parcel is approximately 255 acres. The site is on the south side of the Saxtons River and approximately 90 feet higher than the Saxtons River. The area slopes from east to west at approximately 15%. Access to the site is via a steep logging road at the base of the slope along the edge of the lower field. The access road is currently in poor condition.

The land immediately to the south and to the east are forested and the topography around the old field is steep in all directions. The are no structures on the parcel near the Upper Howland Mill site.

Village Park

The Village Park parcel is approximately 56 acres in total and is owned by the Town of Grafton. The parcel is used as the Grafton Village Park and includes a small park area with a gazebo and hiking trails throughout the property. The Fire Pond is also located on the property. The Fire Pond is a man-made pond that the Village uses as their water source for firefighting. According to previous reports, the pond has a capacity of approximately 2.5 million gallons. An access road and parking area were installed in 2021 uphill of the Village Park area. Dead ash trees were removed from the site in 2021.

The parcel is mostly wooded and generally slopes down from west to east at various slopes. Most of the parcel is too steep for a disposal field (> 20% slope according to IDR Section 14-1203). The northeast corner of the parcel between the access road and the small park area with the gazebo appears to be the most suitable portion of the parcel for a subsurface return system. The slope in this part of the parcel varies from approximately 12 - 18%. The area that has suitable slopes is approximately 3.1 acres.

There are no structures on the parcel besides the gazebo. The neighboring parcels to the east and north are residential and the parcels to the west and south are heavily wooded vacant areas. Fire Pond Road is located along the northern border of the parcel.

680 Houghtonville Road (Eliminated)***

The 680 Houghtonville Road site is an approximately 37 acre parcel. The property is currently used as a farm. The farm includes christmas trees, apples, peaches, and blueberries. The apple and peach trees are in a fenced area. The remainder of the field which is not planted with trees is a mowed grass field. Access to the farm is via a gravel access road which rises approximately 200 feet from Houghtonville Road to the top of the farm field.

There is one equipment shed on the property near the top of the farm field and a garage building near the driveway entrance at the base of the hill. There is a drilled well near the garage. A small brook runs along the eastern edge of the property. The field has a ridge which runs approximately down the center of the field. The slope in the field varies from 10 - 16%. The wooded areas surrounding the field generally have a higher slope, however, there is a flatter section in the woods to the west of the field. The land immediately to the east, south, and west are also forested.

*** While initial investigation of this parcel was permitted and are discussed herein, the parcel owner has since removed it from consideration.

5.2 Parcel Considerations

The Vermont Department of Environmental Conservation outlines considerations in selecting sites for water resource recovery systems to minimize potential adverse impacts to the public. These criteria are important to consider when selecting a water resource recovery or return system location.

Isolation Distances

The IDR Section 14-1015 requires all components of the sewage treatment systems, aside from pump stations and sewer lines, to be located no closer than 300 feet to any property line, habitation, or area frequented by the public to provide attenuation of airborne nuisances such as aerosols, pathogens, odors, and noise. The isolation distance may be decreased to 100 feet if the applicant demonstrates that all components will be enclosed and have operating mechanical equipment as necessary to prevent odors and health hazards from aerosols escaping the facility (IDR Section 14-1015-b).

The Upper Howland Mill site should not have an issue meeting the 300-foot isolation distance. However, the Village Park site and the Alpine Field site are frequented by the public and therefore would not meet this requirement. The eliminated 680 Houghtonville Road site may be unable to meet the 300 foot setback requirement from the property line since the most suitable locations are relatively close to the property line, however, the farm is not open to the public.

There are also isolation requirements to water bodies. A disposal field would need to be kept at least 200 feet from standing water and at least 150 feet from any stream or river. The water separation distances also apply to groundwater seeps. Groundwater seeps were observed near the Upper Howland Mill site which could limit the amount of useable area for that site. Separation to standing water or streams and rivers is not expected to be an issue for any of the other sites.

Zoning and Other Land Use Restrictions

As mentioned, the Town of Grafton does not currently have zoning restrictions pertaining to Public Utilities. Therefore, zoning restrictions at each location are not expected to be a problem.

Topography

Sites with slopes greater than 20% are not well suited for subsurface return systems. The wetted area for a spray field can have a maximum slope of 30% and the maximum slope for a mound system is 15% according to the IDR. The Alpine field site slopes at approximately 8-11% and therefore topography should not be an issue at this site. The Upper Howland Mill site slopes at approximately 15% but it should be noted that only a small portion of the parcel has acceptable slopes.

The slope in the portion of the Village Park site that appears suitable for a return field varies from approximately 12 - 18%. Other portions of the parcel have slopes greater than 20%.

The eliminated 680 Houghtonville Road site has a relatively uniform slope on the west side of the field which slopes at approximately 10% - 16%.

Area for Future Expansion

A larger parcel is preferable to allow for expansion should the service area be expanded in the future. The Alpine Field site is the largest and has the most potential for future expansion. The 680 Houghtonville Road site (eliminated) has the second most room while the Village Park and Upper Howland Mill sites have less room for future expansion. Refer to Section 6.3 regarding the amount of area required for a subsurface return system.

Direction of Prevailing Wind

Prevailing winds in the Town are generally from the west. The Alpine Field, Upper Howland Mill, and 680 Houghtonville Road site (eliminated) do not have any residential neighbors directly to the east. The Village Park site, on the other hand, is west of the Village and the neighboring residential parcels are to the east. However, prevailing wind direction is a more significant consideration for larger traditional wastewater treatment plants with open tanks and sludge and septage processing. It is assumed that odors will be minimal for the proposed water resource recovery technologies and/or return systems and therefore odors are not expected to be an issue at any of the locations under consideration.

Flood Considerations and Accessibility

Water resource recovery systems and return fields should be located three feet above the 100-year flood plain in accordance with design standards. All locations under consideration are well above the 100-year flood zone and therefore flooding is not expected to be an issue at any of the locations.

Members of the community have expressed concern with using the Village Park site as a return system location because of historic stormwater issues associated with Fire Pond and the localized drainage area. Members of the community have shared personal experiences of stormwater events particularly for events in 1996, 2003, and 2011 in which surface runoff from the Fire Pond drainage area has run down Fire Pond Road and the surrounding areas and caused significant erosion along the road and at nearby residential properties. Therefore, stormwater improvements at Fire Pond and along Fire Pond Road may be required to improve drainage in the area and to protect a potential return system downhill of Fire Pond if one were to be installed in this location.

Geologic Considerations

The geology of the area is shown on Figure A.2. The soil at the Alpine Field site and the 680 Houghtonville Road site (eliminated) is reported as a Marlow fine sandy loam which is a HSG Type C soil with a reported depth to the water table of more than 80 inches and a depth to densic material of 20 to 40 inches.

Densic materials are relatively unaltered materials that have a noncemented rupture-resistant class. The bulk density or the organization is such that roots cannot enter, except in cracks. These are mostly earth materials, such as till. Some noncemented rocks can be densic materials if they are dense or resistant enough to keep roots from entering, except in cracks. A densic material is considered a restrictive layer.

The area of the Village Park site that is under consideration consists of the same Marlow complex as the Alpine Field site and a Tunbridge-Lyman complex which is HSG Type C soil with a reported depth to the water table of more than 80 inches and depth to lithic bedrock of 20 to 40 inches.

The area of the Upper Howland Mill site that is under consideration consists of a Monadnock and Berkshire Soil which is HSG Type B soil with a reported depth to the water table of more than 80 inches and depth to a restrictive feature of more than 80 inches. Further discussion of field investigations at each site are provided in Section 5.3.

Protection of Groundwater

As a regulatory minimum, subsurface return systems are required to be located 200 feet from groundwater wells. This is not expected to be a problem at the Alpine Field, Upper Howland Mill, or 680 Houghtonville Road site (eliminated). The residential property immediately to the east of the Village Park site may impact the extent of a disposal field at the Village Park site depending on the location of their well.

The separation to seasonal high ground water is also an important requirement in siting subsurface disposal systems. As mentioned in Section 3.2, the Vermont DEC requires a minimum separation of 3 feet from the bottom of the leachfield to the seasonal high groundwater level, a minimum depth to a restrictive layer of 3 feet, and a minimum depth to bedrock of 4 feet. The Alpine Field site and 680 Houghtonville Road site (eliminated) may have potential shallow depth to a restrictive layer according to the NRCS soil maps and the Village Park site may have both shallow depths to the water table and to a restrictive layer, as can be seen in Figure A.2. Additional discussion related to the depth to groundwater and restrictive layers based on site investigations can be found in Section 5.3.

Conveyance Distance

The cost of installing sewers from the collection system to the water resource recovery system or return fields is directly related to the length of sewer lines required. Sites which require longer conveyance distances are less favorable than sites which are closer to the center of the sewer district as long as those sites are not in disagreement with the items discussed above. The Village Park site is closest to the center of Grafton. The Alpine Field site is the second closest site and the Upper Howland Mill and 680 Houghtonville Road (eliminated) sites are both far from the center of the Village. The 680 Houghtonville Road site (eliminated) is the furthest which will result in additional piping and cost.

Two-Year Time of Travel Requirement

In accordance with Section 14-2101 of the IDR, any downgradient water supply wells must be located outside the two-year time of travel path for the effluent plume. The two-year time of travel requirement should be achievable at the Alpine Field site since the site is isolated from nearby wells to the best of our knowledge and the downgradient flow path is presumably intersected by the Saxtons River before reaching any private drinking water wells.

The Upper Howland Mill site is also isolated by the Saxtons River except for two wells near the west end of the lower Howland Mill Field. However, further investigations of the hydrogeologic conditions would need to be performed to determine if these wells are within the two-year time of travel path of the Upper Howland Mill site and to determine if there are any other wells that may be impacted.

There is one well on the eliminated 680 Houghtonville Road Parcel that is likely within the two-year time of travel path of the 680 Houghtonville Road site. Based on the slope of the site, and for the purpose of the alternative analysis, it has been assumed that this water supply well would need to be relocated if a system were installed at the 680 Houghtonville Road site. We do not know of any other wells downgrade and between the 680 Houghtonville Road site and the Saxtons River.

Based on preliminary time of travel calculations and several conservative assumptions for the Village Park site, we do not believe the two-year time of travel requirement can be achieved given the proximity of the downgradient residential households. This means that all wells within the two-year time of travel zone will need to be relocated or a public water supply system be provided if the Village Park site is to be considered. See Section 7.4 for further discussion regarding two-year time of travel requirements.

5.3 Site Investigations

Soils suitable for subsurface return systems must be sufficiently permeable to allow effluent to be returned to groundwater. The commonly used empirical measure is the percolation test that measures the rate of water drop in minutes per inch (mpi) in a small percolation test hole.

For subsurface return, soils must have a percolation rate of less than 120 minutes/inch and preferably less than 60 minutes per inch; especially for larger systems. Vermont DEC tabulates the maximum loading rates for leachfields in gallons per day per square foot for a range of soil classes and percolation rates. The required system size and cost is therefore proportional to the soil class and percolation rate.

Soils with a percolation rate of over 60 minutes per inch need to be approximately 3 times larger than systems with a soil percolation rate of 1 minute per inch. Very coarse sands and gravels may have percolation rates of less than 1 minute per inch. According to the Vermont DEC, sites with soils having a percolation rate between 1 and 60 minutes per inch and depths of unsaturated soils between the infiltration surface and seasonal high groundwater of at least three feet are suitable for a conventional leachfield return system while other sites can be considered with appropriate site modification, mound system designs, or spray fields.

A subsurface return system must also meet separation requirements to the seasonal high groundwater level and the depth to the nearest restrictive layer or bedrock. The separation to the seasonal high groundwater level must also consider induced groundwater mounding. In each case, the separation requirements are dictated by the Vermont DEC. The requirements are summarized in Table 5.2.

TABLE 5.2
Trench Separation Requirements

Regulator	Minimum Separation Distance from Bottom of Trench to Seasonal High Groundwater Level	Minimum Separation Distance from Bottom of Trench to Restrictive Layer	Minimum Separation Distance from Bottom of Trench to Bedrock
Vermont DEC	3 feet	3 feet	4 feet

The following sections describe investigations completed at each of the four sites under consideration.

5.3.1 Alpine Field Site

Tighe & Bond, with assistance from the Town and approval from the Windham Foundation, performed five test pits at the Alpine Field site on November 7, 2022. Test pits were performed at this site as it appeared to be the most favorable site for a subsurface return system based on a desktop analysis. However, the test pits revealed that seasonal high groundwater table at the site was only 12-inches to 28-inches below grade.

The soils at each test hole were very similar and generally consisted of a shallow topsoil layer above fine sandy loam. The density and moisture content of the soil increased with depth and redoximorphic (redox) features were observed in each test pit. Groundwater seeps were also discovered in some of the test pits. Based on the test pits, the soil at the Alpine Field site could be classified as Soil Class 4 with a maximum wastewater loading rate of 0.5 gpd/sqft in accordance with Table #19 of the IDR. Test pit logs and a sketch of the test pit locations are attached as Appendix E.

Based on the observed high groundwater condition, a conventional trench system, mound system, or drip dispersal system is not recommended for the Alpine Field site. A large quantity of fill could be brought to the site to create a mounded system; however, this would impact the land applied waste operations currently performed by the Windham Foundation at this site. Spray fields require a minimum of one foot of separation between the average ground surface and the resulting water table to be maintained during all spray disposal episodes, which could be obtainable at the Alpine

Field site. However, only forested sites can be used for winter spray disposal. Therefore, the Alpine Field has been removed for further consideration as a subsurface return location.

5.3.2 Upper Howland Mill Site

Tighe & Bond, with assistance from the Town and approval from the Windham Foundation, performed six test pits at the Upper Howland Mill site on May 17, 2023. Test pits were performed along the portion of the site which has acceptable slopes. The test pits revealed that the seasonal high groundwater table at the site was only 12-inches to 14-inches below grade at nearly all the test pit locations. Groundwater seeps were observed at four of the six test pits and at varying depths ranging from 33-inches to 55-inches.

The soils at each test hole were similar and generally consisted of a shallow organic layer above fine sandy loam. Most test pits had a firm fine sandy loam layer that started anywhere from 10-inches to 37-inches below grade. Redox features were as high as 12-inches below grade. Generally, gravel content increased with depth in each test pit and the gravel content generally increased in the test pits on the northern side of the site. Bedrock was encountered in one test pit at 42-inches below grade.

Based on the test pits, the soil at the Upper Howland Mill site could be classified as Soil Class 5a with a maximum wastewater loading rate of 0.35 gpd/sqft in accordance with Table #19 of the IDR. Test pit logs and a sketch of the test pit locations are attached as Appendix E.

Due to the observed high groundwater condition, this site would require a mounded system to satisfy the 3-foot separation requirement from the bottom of the trench to the seasonal high groundwater level. This site would not be appropriate for a sprayfield since there are hiking/biking trails on the property that are used by the public.

A desktop analysis was performed to approximate the amount of suitable area available for a mound system at the Upper Howland Mill Field site. The desktop analysis considered the slope of the site and isolation distance requirements from property lines, streams, top of banks, etc. Based on the desktop analysis, there are approximately 2.3 acres of suitable area for a mound system at the Upper Howland Mill site. Please refer to Section 6.3.2 regarding the feasibility of a mound system at the Upper Howland Mill site.

5.3.3 Village Park Site

Tighe & Bond and the Town performed test pits at the Village Park site in 2021. The test pits at the Village Park site were documented in the 2021 Grafton Village Sewer Feasibility Study Addendum. The results of the 2021 test pits at the Village Park site have also been summarized below, for reference.

The test pits were excavated in the area between the new access road and the existing Village Park space. Test pits results indicate that the area appears to be appropriate for a leachfield. The soils were found to be a sandy loam material with a dense confining layer encountered at 26-inches to 43-inches below grade, creating a perched groundwater table. The soil under the confining layer was generally dry and presented an increased sand and gravel content.

A subsurface drain upgradient of the potential leachfield area would be required to redirect the shallow groundwater flow. Additionally, surface drainage would need to be provided to redirect surface run-off away from the leachfield area. This drainage would require stormwater conveyance improvements from the Village Park site, on Fire Pond Road, and in the impacted section of Hinkley Brook before its confluence with the Saxtons River. Currently both Fire Pond Road and Hinkley Brook experience washout and erosion during heavy precipitation events and do not contain the existing capacity to convey additional stormwater flow.

Leachfield trenches would need to penetrate the low permeability layer. Based on the test pits, the soil at the Village Park site could be classified as Soil Class 3b with a maximum wastewater loading rate of 0.7 gpd/sqft in accordance with Table #19 of the IDR. Test pit logs are attached as Appendix E. This site would not be appropriate for a sprayfield since the site is frequented by the public.

A desktop analysis was performed to approximate the amount of suitable area available for a subsurface return system at the Village Park site. The desktop analysis considered the slope of the site and isolation distance requirements from property lines, streams, top of banks, etc. Based on the desktop analysis, there are approximately 3.1 acres of suitable area at the Village Park site. Please refer to Section 6.3.3 regarding the feasibility of a subsurface return system at the Village Park site.

5.3.4 680 Houghtonville Road Site (Eliminated)***

Tighe & Bond, with assistance from the Town and approval from the property owner, performed eight test pits at the 680 Houghtonville Road site on May 10, 2023. Test pits were performed on the western and southern ends of the field area. The test pits revealed that the seasonal high groundwater table at the site was approximately 26-inches to 36-inches at many of the test pit locations. Groundwater seeps were observed at five of the eight test pits and at varying depths ranging from 28-inches to 63-inches. Some of the test pits, particularly those at higher elevations, did not have groundwater seeps or clear redox features.

The soils at each test hole were very similar and generally consisted of a shallow topsoil layer above fine sandy loam. Redox features were as high as 26-inches below grade. Generally, gravel content increased with depth in each test pit. Bedrock or refusal was not encountered in any of the test pits. Based on the test pits, the soil at the 680 Houghtonville Road site could be classified as Soil Class 4 with a maximum wastewater loading rate of 0.5 gpd/sqft in accordance with Table #19 of the IDR. Test pit logs and a sketch of the test pit locations are attached as Appendix E.

Due to the observed high groundwater condition, this site would require a partial mounded system to satisfy the 3-foot separation requirement from the bottom of the trench to the seasonal high groundwater level. This site would not be appropriate for a sprayfield since it is not wooded and is near active farming.

It should be noted that there are other portions of the site which have acceptable slopes that could also be considered for a subsurface return system including the partially cleared area north of the access drive/parking area, and a portion of the woods to the west of the field. Test pits were not completed in these areas due to time constraints but have been assumed to have similar soils for the purpose of this report.

A desktop analysis was performed to approximate the amount of suitable area available for a mound system at the 680 Houghtonville Road site. The desktop analysis considered the slope of the site and isolation distance requirements from property lines, streams, top of banks, etc. Based on the desktop analysis, there are approximately 3.4 acres of suitable area for a mound system in the field area, another 1.0 acres in the area north of the access drive/parking area, and approximately 0.9 acres in the wooded area west of the field. Please refer to Section 6.3.4 regarding the feasibility of a mound system at the 680 Houghtonville Road site.

*** The parcel owner initially permitted investigation of the 680 Houghtonville Road site, which was later removed from consideration based upon the owner's lack of interest. The information is presented here should the parcel ever become available in the future.

5.4 Summary of Potential Sites

Table 5.3 provides a summary of the four sites where soil investigations have been performed. Table 5.3 indicates which type of return system could be appropriate at each site and whether a mound system would be required.

TABLE 5.3
Summary of Potential Recovery/Return Sites

Site Name	Mound	Subsurface	Sprayfield	Notes
Alpine Field	✓	✓	✗	Eliminated – existing use
Upper Howland Mill	✓	✓	✗	Consider
Village Park	✗	✓	✗	Consider
680 Houghtonville Road*	✓	✓	✗	Eliminated – no interest*

*The 680 Houghtonville Road parcel owner originally granted approval for initial investigation. However, the parcel owner has since decided that they are not interested in selling or leasing their parcel. Although the parcel owner is no longer interested in leasing or selling their property, the potential for a wastewater system at this site has been discussed in Section 6 should the parcel become available for use in the future.

As shown in Table 5.3, the Alpine Field site will no longer be considered for a subsurface return system since a mound system would be required but ultimately not feasible due to the sites current use for disposal of whey from the Grafton Village Cheese Factory. A mound system at this site would significantly limit the area that the Windham Foundation would be able to drive a tractor over for spreading of the whey, which would not be beneficial for the owner of the property.

This leaves three sites worth further consideration including Upper Howland Mill, Village Park, and the 680 Houghtonville Road site (eliminated). The Upper Howland Mill and 680 Houghtonville Road (eliminated) sites could be considered for a subsurface mound system and the Village Park site could be considered for a subsurface return system without the need to import fill. A sprayfield system is not recommended for any of the sites.

Section 6
Wastewater Alternatives

A water resource recovery system consists of three components: collection, recovery, and return. Each component has several different methods and technologies available. This section compares alternatives for each component to determine which is the most appropriate for the proposed service area.

6.1 Collection Systems

There are two types of collection systems to be considered:

1. Conventional Gravity and Pumped Systems
2. Septic Tank Effluent Systems

6.1.1 Conventional Gravity and Pumped Collection Systems

General Description

A conventional collection system consists of PVC piping installed by an open trench method. This involves removing pavement or sod on the ground surface, excavating to depths of 5 – 12 feet (typically, but can be deeper) installing crushed stone bedding, installing rigid PVC pipe, and backfilling and repairing the disturbed surface. Gravity piping must be installed carefully to maintain a constant downward slope. Access for inspection and cleaning is by pre-cast concrete manholes spaced approximately 250 feet. Generally, the smallest gravity main is no less than 8-inches with a minimum slope of 0.4%.

Gravity systems are appropriate when there is enough grade to ensure required pipe slopes. However, since maintaining slope is vital to these systems, open trench construction is necessary. Open trench construction in shallow cross-country routes with enough space and only requiring loaming and seeding for repair can be very cost effective. However, open trench construction through well trafficked paved areas can have expensive restoration costs.

Where site conditions and topography do not allow for conveyance to the treatment site, gravity piping will discharge to a pump station. Conventional pump stations typically consist of a pre-cast concrete wet well with two submersible wastewater pumps. Pump stations discharge to a smaller diameter forcemain. The minimum sanitary forcemain diameter is typically 4-inches and the pumps must maintain a flow velocity of 2 fps. Sanitary forcemains must have clean out structures every 400 – 500 feet and may require air release structures at high points.

Rather than pumping stations, grinder pumps may be used to convey untreated wastewater directly from a buildings sewer into the collection system. This option requires a grinder pump at each household but is often a good option if site conditions and topography do not allow for gravity lines or for isolated parcels which are at slightly lower elevations as compared to nearby areas.

Conventional Collection System Layout

The topography and treatment system location dictate the layout of a conventional collection system. Direct gravity flow to any of the potential sites will not be possible given that the topography across the proposed service area generally slopes downhill from west and east and the fact that the potential treatment locations are at higher elevations compared to the collection system.

Pump stations and long forcemains will be required if a conventional collection system were installed for the proposed service area with a treatment system and/or leachfield at either the Village Park or 680 Houghtonville Road (eliminated) sites. The Upper Howland Mill site is more advantageous for a conventional collection system since it is generally down grade of the proposed service area and would involve shorter forcemains. It should also be noted that certain parcels may need grinder pumps based on local topography.

If a conventional collection system were used in conjunction with a water resource recovery system, a large influent tank would be required to capture the solids prior to the recovery system. This tank would essentially serve as a large septic tank in place of the individual septic tanks and provide primary treatment before the sewage entered the water resource recovery system. The tank would be located at the water resource recovery system site.

Figure A.9a, Figure A.9b, and Figure A.9c show the preliminary layout for a conventional collection system with the water resource recovery/return system located at the Upper Howland Mill, Village Park, and 680 Houghtonville Road (eliminated) sites, respectively.

6.1.2 Septic Tank Effluent Collection Systems

General Description

Alternative type collection systems such as septic tank effluent gravity (STEG) and septic tank effluent pumped (STEP) differ from conventional collection systems because both utilize septic tanks. Septic tanks are typically plastic or concrete tanks which detain raw wastewater discharge from a building service. The tank is baffled which allows solids to settle to the bottom of the tank, and floatable material to form a scum layer at the top of the tank. Waste in the tank are decomposed by aerobic digestion.

Wastewater leaving the tank (septic tank effluent) is of improved quality as solids remain within the septic tank. Septic tanks must be pumped regularly (typically every 3 – 7 years) or solids will build up in the tank and discharge in the effluent. A schematic of STEG and STEP systems is shown in Figure 6.1.

STEG systems use small diameter gravity collector lines to convey septic tank effluent to a treatment location. These gravity lines have a minimum diameter of 4-inches and no minimum slope but typically have a minimum velocity of 0.5 fps. STEG lines can be installed by horizontal direction drilling as long as the area has sufficient slope.

Cleanouts are typically preferred over manholes for STEG collection systems since septic tank effluent is anaerobic and prone to odors and corrosion from turbulence in concrete manholes. Air release valves or ventilated cleanouts are required at high points in STEG systems. The STEG tanks have septic tank effluent filters to prevent solids from leaving the septic tanks.

STEG systems offer a few advantages including reduced excavation and disturbance compared to conventional systems and STEG systems have the advantage of not requiring any power to operate and will continue to provide appropriate wastewater service even in cases of electricity outages.

FIGURE 6.1
Typical STEG and STEP System Schematic

Low pressure STEP sewers consist of smaller diameter forcemains through which sewage is pumped. Septic tank effluent pumps force wastewater through the main regardless of pipe slope. Low pressure sewers can be installed by conventional open trench methods, but smaller diameter piping can also be installed by horizontal directional drilling.

Horizontal directional drilling utilizes exit and entry pits, and access for service connections, but does not disturb the ground surface over the entire pipe length, significantly reducing restoration costs. The minimum diameter for low pressure sewer piping is 2-inches and there are no minimum slope requirements. Individual effluent service lateral lines may be as small as 1.25” in diameter. Similar to conventional sanitary sewer forcemains, low pressure sewers must have regular clean out structures every 500 to 1,000 feet and will require air release valves at high points.

Typical STEG/STEP systems have an easement which allows the utility to maintain the septic tanks and periodically pump out the tanks. A control panel will be located near each tank for STEP systems. Easements will also be necessary for the sewer forcemains located in the streets and/or on individual parcels.

One of the basic concerns for STEP collection systems is that the pumps at each parcel will not work if there is a power outage. Frequently, if a home has municipal water service (Grafton does not), the water service often remains unaffected by the power outage and therefore the homeowner can continue to use water, but the wastewater pump cannot turn on and thus the septic tank begins to fill and will eventually cause a back-up if the power outage is prolonged. This is not an issue if the facility has a back-up generator, but if it does not, water usage will need to be reduced during the power outage. Septic tanks for STEP systems are typically sized to have 24 hours of additional storage for these scenarios.

However, if a sustained power outage lasted for several days, the municipality would need to pump each septic tank into the collection system. For a conventional collection system, this would simply require providing emergency power at a central pump station, rather than requiring service at many individual systems. Both conventional and alternative systems that utilize gravity collection avoid these problems. All water resource recovery systems, conventional and alternative, require emergency power at the main recovery system location.

STEG/STEP Collection System Layout

A benefit of effluent sewer systems is that they can be constructed within an easement instead of directly in roadways or under road surfaces, avoiding expensive surface restorations. For example, many of the buildings within the proposed service area are at the front of the parcel and thus the existing septic tanks are most likely located in the rear of the parcel. Since many of these parcels would have minimal room on the side or in front of the building for a new STEG or STEP tank, it would present construction challenges for installing new service laterals from the rear of the building to the street.

There are pros and cons for routing the sewers on the backside of parcels instead of in the street. Routing them behind the houses typically reduces the length of lateral service connections and reduces construction complexities with installation of sewer lines in roadways. However, it also requires easements through each parcel, the sewer mains may be harder to access in emergency situations in winter months, and residential backyards will be disturbed when future repairs to the sewer mains are needed. It should be noted that easements for each parcel will be required regardless, and that constructing useable easements is important since the utility will own tanks and equipment on private property and will require access from time to time to provide operation and maintenance (O&M).

The location of the sewer mains for the preliminary septic tank effluent collection system were based on the assumed location of septic tanks relative to the buildings and parcel boundaries. The location of each septic tank and other underground utilities would be surveyed as part of the final design of a septic tank effluent collection system. At that time, it may be determined that it would be more beneficial and cost effective to run the sewer mains under the roads and have the service laterals go from the septic tanks to the sewer main in the street rather than to a sewer main on the backside of the parcels.

Figure A.10a, Figure A.10b, and Figure A.10c show the preliminary layout for a septic tank effluent collection system with the water resource recovery/return system located at the Upper Howland Mill, Village Park, and 680 Houghtonville Road (eliminated) sites, respectively. The preliminary layout for each septic tank effluent collection system has been assumed to be a STEP system. We recognize that a STEG system could be utilized for most of the collection system if treatment were provided at the Upper Howland Mill site. However, a pump station would be required to pump the wastewater up to the Upper Howland Mill site and several parcels would require STEP tanks. Therefore, we have assumed a STEP system for the preliminary layout.

An intermediate pump station at the base of the hill at the 680 Houghtonville Road site (eliminated) will be required due to the significant elevation gain from the lowest point in the collection system to the top of the 680 Houghtonville Road site (approximately 300 feet of static head). Typical septic tank effluent pumps are capable of pumping to a maximum of 200 feet total dynamic head. This pump station could be sized to have equalization instead of providing equalization at the head of the treatment system.

6.2 Water Resource Recovery Systems

Many larger communities have "conventional" wastewater treatment systems which generally consist of the following components:

- Primary treatment for the removal of solids
- Secondary treatment which typically consists of biological treatment for the removal of additional contaminates
- Tertiary treatment for further removal of contaminants by biological, chemical, or physical means
- Disinfection by chemical treatment or by UV light
- Return to a surface water body

FIGURE 6.2
Conventional Water Resource Recovery System

Since most conventional wastewater treatment systems were built for large municipalities, extensive centralized systems were justifiable due to the significant flows requiring treatment and the site constraints faced by densely developed communities. However, a conventional system may not be the best match for a smaller, rural community such as Grafton.

There is strong interest in many smaller communities about alternative technologies for water resource recovery; however, considering the significant cost burden it takes a small community to implement any wastewater system, there is a tendency to utilize the 'tried and true' approach of a conventional system. Unfortunately, a conventional system has energy, economic, and environmental impacts that place additional cost burdens on small communities.

One of the most significant disadvantages of a conventional system for small communities is solids handling. Conventional systems typically consist of screening for large solids removal, comminutors, large above ground settling basins to remove the remaining solids, pumps to remove the collected solids, digesters to further break down sludge or mechanical dewatering devices and then loading facilities for trucking to conventional landfills.

Solids removal components are generally expensive to build and operate especially at a small scale. From a technical standpoint, sludge removal, collection, and disposal are one of the most significant challenges to any wastewater system. When considering the economic scale of small community systems, successfully addressing sludge management is vital.

In general, conventional treatment systems are treating higher flows and have more complex treatment components due to onsite sludge management. For proper operation, conventional facilities require a full-time licensed operator and generally at least one other trained staff member. Alternative water resource recovery systems typically treat smaller flows and have simpler treatment systems; thus, staffing is usually part time.

Due to the rural character and size of the proposed Grafton service area, associated costs, and staffing requirements of a conventional wastewater treatment system, it is recommended that the Town of Grafton focus on an alternative water resource recovery systems instead of a conventional system.

An alternative water resource recovery system accomplishes treatment in two locations; primary treatment occurs in the onsite septic tanks, and secondary/tertiary treatment which occurs at a site where the flow has been collected. There are several differences between conventional systems and alternative systems. The significant differences include:

- Sludge Management
- Piping Costs
- Operation & Maintenance

With many alternative systems, solids removal occurs at each parcel or a combination of a few parcels. This allows typical residential septic tank pumpers and haulers to handle solids removal and disposal. Typically, the sewer district is responsible for all maintenance of septic tanks, ensuring that efficient solids removal is occurring. Piping costs are lower due to smaller pipe sizes and less infrastructure such as manholes and operations and maintenance is generally less due to the simplicity of the systems.

There are many suitable alternative technologies available for water resource recovery. However, there are minimum criteria that each system must meet including the ability to meet regulatory effluent limits and Vermont DEC should be familiar with the system. Water resource recovery system technologies that have not been previously approved by the Vermont DEC for a community application will have a much longer review period and have a significant chance of delaying project schedule.

There are several types of water resource recovery systems that could be considered for Grafton including membrane bioreactors (MBR), moving bed biofilm reactors (MBBR), fixed bed bio-reactors (FBBR), packed bed media filters (PBF), recirculating sand filters

(RSF), and several others. For this analysis, re-circulating sand filters, PBFs, and FBBRs have been considered. The level of treatment required from each of these systems is Secondary + since the flow from the proposed service area is greater than 30,000 gpd but less than 50,000 gpd. As shown in Figure 4.4, the Secondary + effluent limits will be 15 mg/L BOD and 15 mg/L total suspended solids.

Recirculating sand filters are discussed in Section 6.2.1, PBF systems are discussed in Section 6.2.2, and FBBR systems are discussed in Section 6.2.3.

6.2.1 Recirculating Sand Filters (RSF)

General Description

A recirculating sand filter (RSF) system is a modified version of a conventional, single-pass sand filter. RSF systems were designed to alleviate the odor problems associated with single-pass open sand filters. Recirculation increases the oxygen content in the effluent that is distributed on the filter bed which helps to reduce noxious odors.

RSF systems remove contaminants in wastewater through physical, chemical, and biological processes, although the biological process plays the most important role in sand filters. RSF systems generally consist of two components including a recirculation tank and the sand filter. The partially clarified effluent from the pretreatment tank(s) flows into the recirculation tank. Raw effluent from the collection system is combined with filtrate from the sand filter inside the recirculation tank where it is mixed and pumped to the sand filter bed for treatment. Treatment in the sand filter is achieved by physical removal of particles and biologically by naturally occurring microorganisms in the sand media.

In Vermont, the recirculating sand filters must be contained within a watertight container, either concrete or a flexible membrane liner to prevent groundwater from infiltrating into the filter and to prevent effluent exfiltration from the filter. An illustration of a typical recirculating sand filter is shown in Figure 6.3.

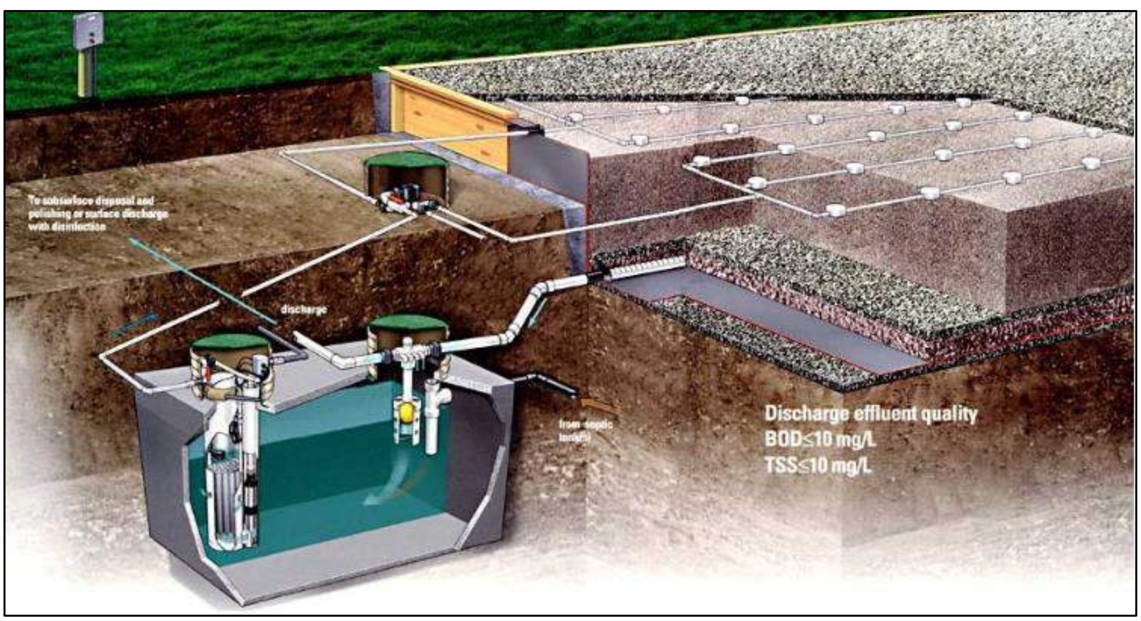


FIGURE 6.3
Typical Recirculating Sand Filter

Preliminary Recirculating Sand Filter Design

A preliminary recirculating sand filter design was completed for the Grafton service area with an average day design flow rate of 42,500 gpd and the secondary + effluent limits discussed in Section 4.3.

The preliminary design is based on the requirements of IDR Section 14-1010. The primary components included in the preliminary design of the recirculating sand filter system include the following:

- 76,500 Gallons Cast-in-Place Concrete EQ/Recirculation Tank with Dosing Pumps
- Two Parallel Sand Filters, Membrane Lined, approximately 4,400 sq ft each
- Recirculation/Effluent Splitter Box

The recirculation tank will be sized to also provide flow equalization to provide stability by leveling out peaks in flow and allowing consistent loading of the treatment system. Dosing pumps are installed in this tank which distribute the flow to the sand filters. There will be a filter system on the dosing pumps to prevent solids from being dosed to the filter beds.

The sand filter distribution system will be pressurized and consist of 2-inch piping spaced at 24-inches on center to provide even loading of the sand filter beds. Two sand filter beds would be provided, each capable of handling approximately 50% of the average day design flow. The sand filters will be membrane lined instead of concrete and covered with a non-woven geotextile fabric and topsoil. Four-inch perforated PVC underdrain pipes will collect the filtered effluent after passing through the sand filters.

Other components which will be installed as part of the recirculating sand filter system include:

- Influent flow meter in a buried vault
- Effluent and recirculation flow meters and check valve in buried vault
- Telemetry controls
- Control building on a concrete slab (approximately 12' x 15')
- Electrical service and back-up generator
- Buried process piping

6.2.2 Packed Bed Media Filters (PBF)

General Description

The basic principle of packed bed media filters is the biodegradation of pollutants carried out by micro-organisms attached on the filter media. Bacterial masses attached onto the media (called biofilm) oxidize most of the organic matter. Packed bed media filter processes are usually aerobic, which means that microorganisms require oxygen which can be supplied to the biofilm either passively or by a forced air supply.

There are several different packed bed media filter systems available. The Orenco AdvanTex packed bed media filter has been used as the basis for this report and alternative analysis since it is approved by the Vermont DEC as an innovative and alternative wastewater technology (Approval No. 2001-01-R12). The Orenco AdvanTex system is a packed bed media filter that uses lightweight synthetic textile to treat septic tank effluent. The textile media has a high porosity and large surface area for microbial attachment and high loading rates. The septic tank effluent is sprayed onto the textile media and percolates down where it is filtered and treated by microorganisms that populate the textile.

There are several AdvanTex models available, which range in size and flow capacity. An image of an operational Orenco AdvanTex PBF system in Hyde Park, NY is shown in Figure 6.4. There are several residential Orenco systems in the Village of Grafton.

FIGURE 6.4
Orenco Advantex PBF System in Hyde Park, NY

Preliminary PBF Design

A preliminary Orenco PBF system design was completed for the Grafton service area with an average day design flow rate of 42,500 gpd and the secondary + effluent limits discussed in Section 4.3. The primary components included in the preliminary design of an Orenco AdvanTex PBF system include the following:

- 40,000 Gallon Flow EQ Tank w/ Pumps (1)
- AX-Max300-42 Treatment Units (5)
- AX-Max200-42 Treatment Unit (1)

The flow equalization tank is installed to provide stability by leveling out peaks in flow and allowing consistent loading of the treatment system. Time-dose-controlled pumps are installed in this tank which distribute the flow to the PBF treatment units. In the treatment tanks, the flow percolates down through the media where it is filtered, cleaned, and nitrified by the naturally occurring microorganisms on the media. The treated wastewater leaves and goes to the dosing tank for the subsurface return system.

Other components which will be installed as part of the PBF treatment system include:

- Influent flow meter in a buried vault
- Telemetry controls
- Control building on a concrete slab (approximately 15’ x 20’)
- Electrical service and back-up generator
- Buried process piping

6.2.3 Fixed Bed Bio-Reactors (FBBR)

General Description

Fixed bed bioreactors (FBBR) are an advanced biological wastewater treatment technology used for efficiently treating wastewater with high organic contamination levels. Among biological treatment systems, FBBRs can hold a large number of microbes in a small area which allows them to save space and be energy efficient and are ideal for treating wastewater with medium to high BOD. FBBRs consist of multi-chambered tanks which are packed with a porous media. There are many different types of media, but all are designed to encourage the formation of a biofilm while also allowing the wastewater to flow through the system. The chambers can be both anoxic and aerated to achieve denitrification. FBBRs typically have a low tolerance for suspended solids, however, this is not an issue for septic tank effluent systems as influent suspended solids concentrations will be low since TSS is reduced at the individual septic tanks.

There are many different manufacturers of packaged FBBR systems. However, the ECOPOD system by Delta Treatment Systems, LLC has been used as the basis for this report and alternative analysis since it is approved by the Vermont DEC as an innovative and alternative wastewater technology (Approval No. 2015-03-R5). These systems are designed to be used with septic tank effluent systems and are commonly paired with subsurface return systems.

The ECOPOD wastewater treatment system is a submerged fixed film system that uses an engineered plastic media. Wastewater enters a pretreatment tank where any remaining debris and settleable solids settle to the bottom and are decomposed by anaerobic bacteria. The effluent moves from the pretreatment tank to the ECOPOD where it is oxygenated via an external air blower. The wastewater moves into the reactor and through the plastic media which is designed to act as a growth medium for naturally occurring bacteria. The media is completely submerged in the reactor tank which works as a recirculating zone. Ammonia is reduced in addition to BOD removal as nitrification of the ammonia and denitrification of nitrates occurs in the bacterial masses. Figure 6.5 shows an overview of a typical ECOPOD unit.

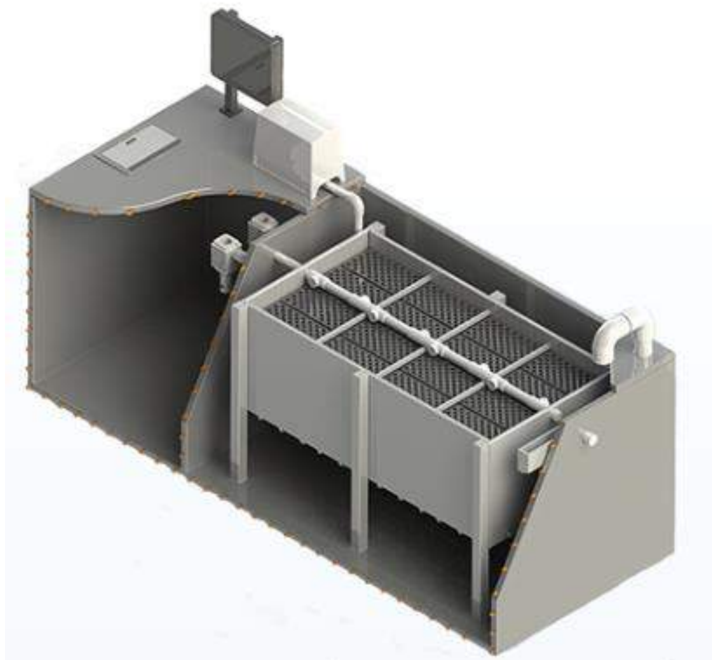


FIGURE 6.5
Delta's Typical ECOPOD Treatment Unit

Preliminary FBBR Design

A preliminary ECOPOD FBBR system design was completed for the Grafton service area with an average day design flow rate of 42,500 gpd and the secondary + effluent limits discussed in Section 4.3. The primary components included in the preliminary design of an ECOPOD FBBR system include the following:

- 40,000 Gallon Flow EQ Tank w/ Pumps (1)
- Parallel ECOPOD Treatment Trains in Cast-in-Place Concrete Tanks
- Duplex Blower System

The flow equalization tank is installed to provide stability by leveling out peaks in flow and allowing consistent loading of the treatment system. Duplex submersible pumps with float and controls are installed in this tank which distribute the flow to the FBBR treatment units. In the treatment tanks, the flow percolates down through the media where it is filtered, cleaned, and nitrified by the naturally occurring microorganisms on the media. Blowers force air into each of the treatment tanks. The treated wastewater leaves and goes to the dosing tank for the subsurface return system.

Other components which will be installed as part of the FBBR treatment system include:

- Influent flow meter in a buried vault
- Telemetry controls
- Control building on a concrete slab (approximately 18' x 20')
- Electrical service and back-up generator
- Buried process piping

6.3 Return Systems

Two options typically exist for return of wastewater: return to surface water (direct) and return to subsurface (indirect). Direct return of wastewater to a surface water body was not considered for the Grafton system. There are many different types of subsurface return systems, both conventional and alternative systems such as gravelless technologies or drip dispersal systems. The alternative type systems fall under the "Experimental Disposal System" category in Vermont which requires additional review and approval by the Secretary in advance of any application for an indirect discharge permit. For this reason, only conventional absorption fields and technologies that have been previously approved by the VT DEC have been considered for Grafton.

When absorption fields are used for treatment (such as with conventional septic tanks and leachfields), it is anticipated that microorganisms in the soil assist in removal of any remaining organic matter, solids, and nutrients. When absorption fields are used after treatment, they are primarily intended for return of the treated effluent into the ground since they are not relying on the soil for treatment. In this case, increases in loading rates can be obtained. In accordance with IDR Section 14-1303-C, the loading rate following a secondary treatment system can be two times the rate allowed under Table #19 in the IDR, three times the rate allowed following a secondary + treatment system, and five times the rate allowed following a tertiary treatment system. Therefore, for preliminary sizing of the subsurface return systems, the application rate for the subsurface return systems have been calculated using the application rate increases discussed above.

There are many options for subsurface return; both conventional and alternative. The types of subsurface disposal systems that were analyzed for Grafton include:

1. Conventional Absorption Fields
2. Gravelless Geotextile Sand Filters (GGSF)
3. Drip Dispersal

The subsurface return potential for each of the three technologies at each of the three viable sites (Upper Howland Mill, Village Park, and 680 Houghtonville Road (eliminated)) is discussed in the following Sections.

6.3.1 Conventional Absorption Fields

There are two configurations of absorption fields including absorption trenches and absorption beds. The trench is the most common and preferred of the two options (absorption beds are not allowed in Vermont) and consists of a trench or series of trenches in which perforated PVC pipe is placed in a bed of gravel or synthetic aggregate. Sewage is delivered to the PVC pipes by gravity, pressure, or by dosing and seeps slowly out of the perforated PVC pipe, into the aggregate, and finally into the soil (only pressure distribution is allowed in Vermont for systems over 6,500 gpd). A typical trench absorption field utilizing perforated PVC pipe and gravel aggregate is shown in Figure 6.6.

FIGURE 6.6
Conventional Trench Absorption Field Under Construction

Table 6.1 presents the preliminary sizing criteria and field size for a conventional absorption disposal system at each of the three feasible sites. The field size calculations have been completed using the soil information from on-site soil investigations as discussed in Section 5.3, sizing criteria in accordance with the IDR Section 14-1401, an average day design flow rate of 42,500 gpd, and assuming secondary + treatment upstream of the disposal field.

TABLE 6.1
Conventional Absorption Field System Sizing

	Upper Howland Mill	Village Park
Soil Class	5a	3b
Application Rate (gpd/sqft)[1]	0.35	0.70
Application Rate Increase[2]	3X	3X
Adjusted Application Rate (gpd/sqft)	1.05	2.10
Average Day Design Flow (gpd)	42,500	42,500
Required Absorption Area (sqft)	40,571	20,286
Total Length of Trench Required (ft)	10,150	5,080
Approximate Field Size (acres)	1.9	1.0
Total Area Required (acres)[3]	3.9	2.0
Mound System	✓	**X**

[1]From IDR Table #19

[2]Application rate increase with Secondary + Treatment, IDR Section 14-1303-C

[3]Includes 100% alternating field area, does not include area for mound fill extension

As shown in Table 6.1, the Upper Howland Mill site would require a mound system and approximately 3.9 acres. Area for a treatment system and future expansion would also be required. However, as discussed in Section 5.3.2, there is only 2.3 acres of suitable area available at the Upper Howland Mill site. In addition, the seasonal high water table is only about 12-inches to 14-inches below grade. In accordance with IDR Section 14-1501-a-1-I, 12-inches of unsaturated native soil must be maintained at all points under and 25 feet downgradient of a mound at all times, taking into account groundwater mounding induced by wastewater effluent. This requirement may be difficult to maintain at the Upper Howland Mill site given the shallow depth to the seasonal high water table. Given the size limitations and shallow water table concerns, the Upper Howland Mill site is not suitable for a conventional absorption field.

Approximately 2.0 acres will be required for a conventional absorption system at the Village Park site. Area for a treatment system and future expansion would also be required. As discussed in Section 5.3.3, there are approximately 3.1 acres of suitable area available at the Village Park site which should be enough room for a conventional absorption field and a treatment system. Stormwater improvements upgradient of the absorption field are anticipated to re-direct the shallow groundwater flow and surface flow around the leachfield. It is assumed that the leachfield trenches will penetrate the confining layer.

Approximately 2.8 acres will be required for a conventional absorption system at the 680 Houghtonville Road site (eliminated). Area for a treatment system and future expansion would also be required. As discussed in Section 5.3.4, there are up to 5.3 acres of suitable area available at the 680 Houghtonville Road site (eliminated) which should be enough room for a conventional absorption field, treatment system, and future expansion.

6.3.2 Gravelless Geotextile Sand Filters

The use of gravelless absorption systems is becoming more common as the technology provides distinct advantages at certain sites. There are several types of gravelless absorption systems including open-bottom gravelless chambers, gravelless media-wrapped corrugated pipe sand-lined systems, and gravelless geotextile sand filters.

Gravelless geotextile sand filters (GGSF) are similar to conventional absorption trench systems but consist of a geotextile wrapped "nit" surrounded by system sand instead of a single pipe surrounded by gravel aggregate. There are several manufacturers of GGSF products which vary slightly from one manufacturer to the next, but each generally consists of a perforated pipe surrounded by or placed on top of a synthetic aggregate or media which is then contained around the diameter of the pipe or covered by a geotextile fabric. The unit(s) are surrounded by system sand below and on the sides of the unit(s).

GGSF systems are considered an innovative and alternative (I/A) wastewater technology in Vermont. Therefore, we have used the Advanced Enviro-Septic (AES) system by Presby Environmental, Inc. as the basis for the preliminary sizing of a GGSF system. The AES system has been approved as an I/A dispersal technology by the Vermont DEC (Approval No. 2004-02-R10). In accordance with the approval letter, the design of these systems is based on the approved design and installation manual published by the manufacturer.

Per the design and installation manual, the AES GGSF systems are allowed a 50% maximum reduction in bed area. However, we have assumed that the 3-times application rate increase for secondary + treatment cannot be compounded to further increase the application rate. For preliminary sizing of the GGSF system, we have assumed that the 3-times application rate increase for secondary + treatment will be used since it is more favorable from a sizing perspective as compared to the 50% reduction in bed area.

Table 6.2 presents the preliminary sizing criteria for the GGSF system at each of the three feasible sites. The field size calculations have been completed using the soil information from on-site soil investigations as discussed in Section 5.3, sizing criteria in accordance with the AES design manual & IDR, and an average day design flow rate of 42,500 gpd.

TABLE 6.2
GGSF System Sizing

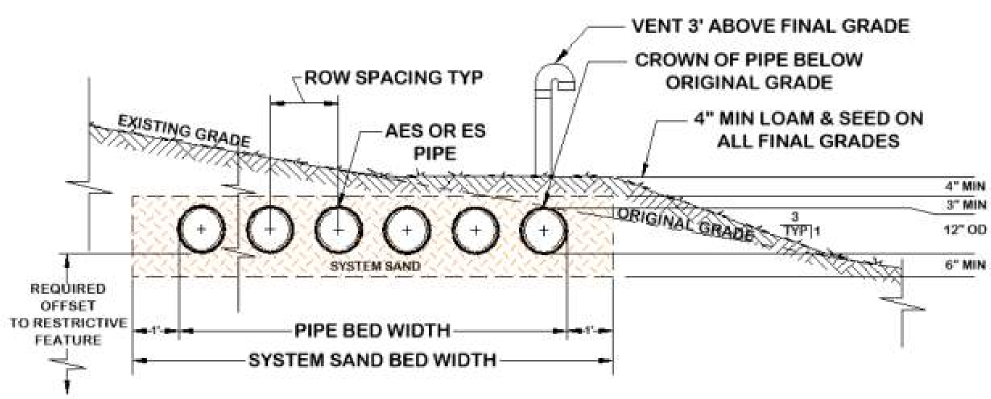
	Upper Howland Mill	Village Park
Soil Class	5a	3b
Application Rate (gpd/sqft)[1]	0.35	0.70
Application Rate Increase[2]	3X	3X
Adjusted Application Rate (gpd/sqft)	1.05	2.10
Average Day Design Flow (gpd)	42,500	42,500
Required Absorption Area (sqft)	40,500	20,300
Approximate Field Size (acres)	0.9	0.5
Total Area Required (acres)[3]	1.9	0.9
Mound System	✓	**X**

[1]From IDR Table #19

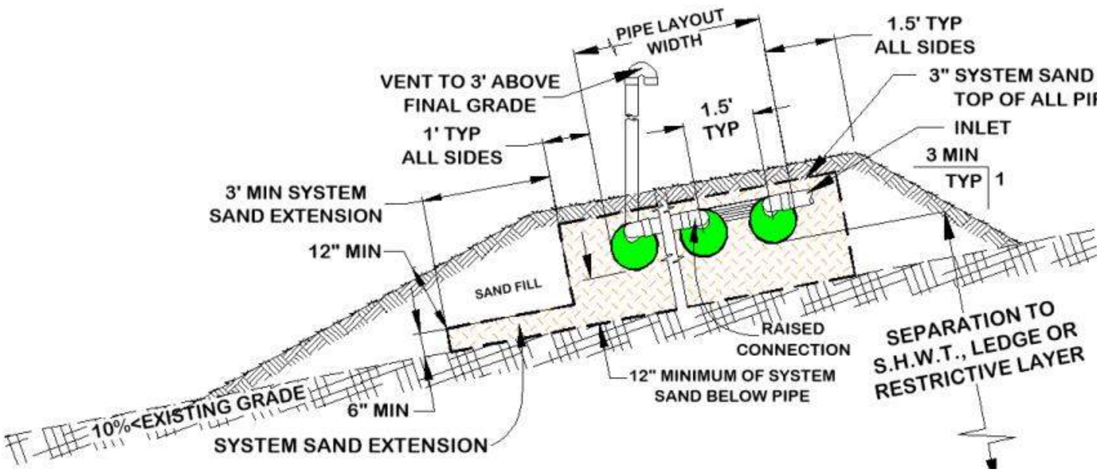
[2]Application rate increase with Secondary + Treatment, IDR Section 14-1303-C

[3]Includes 100% alternating field area, does not include area for mound fill extension

The AES GGSF systems are designed to be installed in a bed application with an in-ground bed configuration or an elevated bed system (i.e., mound system). A stepped in-ground configuration could be used at the Village Park site. However, due to the high groundwater condition, the Upper Howland Mill site and the 680 Houghtonville Road site (eliminated) would both require a mound system. An example of an in-ground system at a sloping site and a mound system at a sloping site are shown in Figure 6.7.



In-Ground GGSF System on Sloping Site



Mound GGSF System on Sloping Site

FIGURE 6.7
Typical Advanced Enviro-Septic GGSF System Configurations

The AES systems are designed to be gravity fed through distribution boxes and cannot use pressure distribution lines. Due to the gravity distribution, the maximum row length for these systems is 100 feet and the minimum row length is 30 feet. Fill extensions for mound systems are required based on the site specific configuration.

There is not enough room for a GGSF system at the Upper Howland Mill site when considering area for treatment and future expansion but there is enough room at the Village Park site and the 680 Houghtonville Road site (eliminated). Stormwater improvements upgradient of the absorption field are anticipated to re-direct the shallow groundwater flow and surface flow around the leachfield at the Village Park site.

6.3.3 Drip Dispersal

Subsurface drip dispersal technologies apply water to the root zone using perforated small diameter piping or porous diffusers, typically placed 6 to 24 inches below the soil surface. This technology has been successfully used in the northeast for many years and has been accepted as a reliable method for subsurface wastewater return. Drip dispersal systems are often used in areas where marginal or shallow soils are found. Figure 6.8 shows a typical drip dispersal system under construction.

Drip tubing is typically placed 2-feet apart so emitters are on a grid pattern within the existing landscape. Drip lines are buried relatively shallow so the soil can provide treatment, plants can use the nutrients and water, and the system can maximize evaporation.

A benefit of drip dispersal systems is that they require minimal backfill compared to traditional leachfields thus cutting down on excavation costs for installation. Drip dispersal systems also have controls which allow for monitoring of the system performance. Drip dispersal systems allow the water to disperse into the ground slowly over a larger area and do not require gravel placement.

FIGURE 6.8
Typical Drip Dispersal System Before Backfill

Drip dispersal systems are considered an innovative and alternative (I/A) wastewater technology in Vermont. Therefore, we have used the Perc-Rite drip dispersal system as the basis for the preliminary sizing of a drip dispersal system. The Perc-Rite system has been approved as an I/A dispersal technology by the Vermont DEC (Approval No. 2014-01-R3). In accordance with the approval letter, the design of these systems is based on the approved design and installation manual published by the manufacturer.

Table 6.3 presents the preliminary sizing criteria for the drip dispersal system at each of the three feasible sites. The field size calculations have been completed using the soil information from on-site soil investigations as discussed in Section 5.3, sizing criteria in accordance with the Per-Rite Drip Dispersal Design Manual, and an average day design flow rate of 42,500 gpd.

TABLE 6.3
Drip Dispersal System Sizing

	Upper Howland Mill	Village Park
Soil Class	5a	3b
Application Rate (gpd/sqft)[1]	0.35	0.70
Application Rate Increase[2]	3X	3X
Adjusted Application Rate (gpd/sqft)	1.05	2.10
Average Day Design Flow (gpd)	42,500	42,500
Required Absorption Area (sqft)	81,000	40,500
Total Area Required (acres)[3]	1.9	0.9
Mound System	✓	X

[1]From IDR Table #19

[2]Application rate increase with Secondary + Treatment, IDR Section 14-1303-C

[3]Does not include area for mound fill extension

As shown in Table 6.3, the Upper Howland Mill site would require approximately 1.9 acres, not including the area needed for mound fill extensions. Given the area requirement and understanding that additional area would be required for a treatment system and future expansion, the Upper Howland Mill site does not appear to have enough room for a drip dispersal system. However, the Village Park site and the 680 Houghtonville Road site (eliminated) both appear to be feasible for a drip dispersal system.

The Village Park site would require four zones, three of the zones would be approximately 300-feet by 36-feet and one of the zones would be approximately 100-feet by 108-feet. The zones would be located between the new access road/parking area and extend down into the existing Village Park space. Drip dispersal systems must be installed no deeper than 24-inches below grade to keep the drip dispersal piping within the oxygenated soil zone. Since the confining layer is approximately 26-inches to 43-inches below grade at the Village Park site, some of the existing soil will need to be stripped from the site. Stormwater improvements upgradient of the absorption field are anticipated to re-direct the shallow groundwater flow and surface flow around the leachfield at the Village Park site.

The 680 Houghtonville Road site would require six zones. Based on the site configuration, each zone would be broken up into two sub-zones approximately 100-feet by 48-feet each. The zones would be located on the west side and south side of the existing fencing.

The drip dispersal system will require a dosing chamber with a usable dosing volume of approximately 28,000 gallons. A small building approximately 12-feet by 15-feet will also be required for the hydraulic unit. The building will need to be heated. The hydraulic unit could also be located inside the treatment system building provided that the building is sized appropriately.

6.4 Cluster Systems

A cluster system is a type of wastewater system that collects wastewater from two or more dwellings or buildings (a cluster) and conveys the wastewater to a nearby suitable location for treatment and disposal. The treatment and disposal location are typically on one of the parcels in the cluster. A cluster system typically consists of multiple clusters and can be advantageous for small communities or rural developments where the houses and buildings are close together and/or there is lack of suitable areas large enough to treat the wastewater from all of the houses and buildings within the service area.

In a cluster system, it is common for each of the buildings in the cluster to share a drinking water supply. Cluster systems also have some form of common ownership. Figure 6.9 shows a schematic of a typical single cluster septic system.

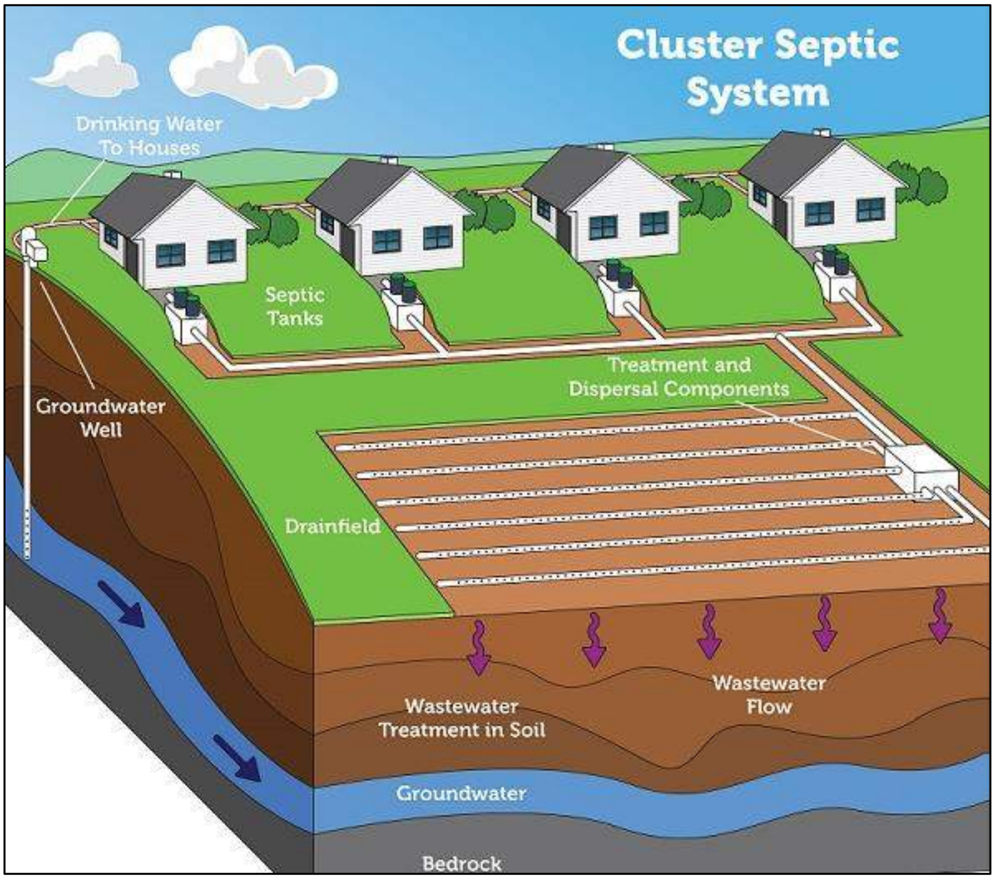


FIGURE 6.9
Typical Cluster System

Tighe & Bond completed a preliminary cluster system layout for the proposed service area. The cluster system layout considered stream buffers, wetland/standing water buffers, flood zones, areas with insufficient slope (>20%), and buffers around private drinking wells. Please note that the following assumptions and considerations have been made in developing the preliminary cluster system layout for the proposed service area:

- Parcels are grouped into clusters of 1 – 5 parcels.
- The parcels are grouped into clusters such that the combined flow estimate for each cluster is less than 6,500 gpd. Clusters with design flows of less than 6,500 gpd are not subject to the Indirect Discharge Rules (Chapter 14) but are instead subject to the Wastewater System and Potable Water Supply Rules (Chapter 1). This is an important consideration for the cluster systems in Grafton as the setback requirements are different between the two rules and systems less than 6,500 gpd are not subject to the two-year time of travel requirements according to conversations with the Vermont DEC.
- Soil investigations for each cluster have not been completed and therefore we are assuming there is sufficient room within each cluster for the septic tank and leachfield.
- Assumptions for the type of septic system (conventional trench system, mound system, or alternative system) have been made for each cluster based on soil maps, topographic maps, proximity to water features, and available area within

the cluster for a septic system. Mound systems were assumed for clusters which are expected to have shallow depth to groundwater and alternative systems were assumed for clusters that appear to have limited room for a septic system.

- One of the wells within the cluster will serve all of the parcels within the cluster and all other wells will be abandoned. This assumes that one of the wells has sufficient capacity to supply all of the parcels within the cluster and that sufficient separation distance between the well and the septic systems can be maintained. The parcel with the well will need a larger pressure tank.

Figure A.11 shows the preliminary cluster system layout for the proposed service area. As shown in Figure A.11, the preliminary cluster system layout consists of 22 clusters. Potential locations for the leachfields for each cluster and the well that would potentially remain are also shown in the preliminary cluster system layout. Table 6.4 provides a summary of the preliminary cluster system layout and anticipated septic type for each parcel.

TABLE 6.4
Preliminary Cluster System Summary

Cluster No.	No. of Parcels	Parcel No's	Total Flow (gpd)	Assumed System Type
1	3	1,2,3	1,050	Mound
2	5	4,5,6,7,8	1,160	Mound
3	3	9,10,11	2,590	Mound
4	3	12,13,14	1,285	Mound
5	5	15,16,17,20,21	2,030	Mound
6	3	22,23,24	1,050	Alternative
7	1	18	420	Alternative
8	5	19,25,26,12,27	1,610	Mound
9	4	28,29,30,33	1,680	Mound
10	4	31,32,24,35	5,360	Mound
11	5	36,37,38,39,40	1,493	Mound
12	3	41,42,62	2,835	Mound
13	5	43,44,45,46,47	1,540	Alternative
14	4	48,49,59,60	1,405	Alternative
15	5	50,51,52,53,54	2,258	Alternative
16	4	55,56,57,58	910	Alternative
17	4	61,63,64,65	1,750	Mound
18	3	67,68,69	1,050	Mound
19	4	66,67,70,75	1,540	Mound
20	4	71,72,73,74	1,680	Mound
21	5	76,77,78,79,80	2,249	Mound
22	4	81,82,83,84	1,680	Alternative

Should the Town decide to move forward with the cluster system approach, a design phase will need to be completed that would involve much more detailed work to locate, size, and design appropriate clusters. The design phase will include soil investigations, survey, coordination with property owners, and confirmation of well capacity to provide a more detailed cluster system design.

Section 7
Drinking Water Alternative

As discussed in Section 5.2, a public drinking water system will be required if the Village Park site is to be used as a site for a return field since the two-year time of travel requirement cannot be achieved due to the proximity of the downgradient residential households. Therefore, this section discusses one possible option for a drinking water system. However, there are several other drinking water options that could be considered, and a formal Drinking Water Preliminary Engineering Report must be completed before the Town can consider a stand-alone drinking water alternative.

A public drinking water system consists of three components: supply, distribution, and storage. This section discusses one feasible option for each component to better understand the infrastructure required for a public drinking water system serving the Village of Grafton. It has been assumed that the same service area as discussed in Section 3.6 would be served by the public drinking water system and that the average daily demand for the system is approximately the same, 50,000 gpd (rounded up from estimated wastewater flow estimate of 42,500 gpd, see Section 4.1).

7.1 Water Supply

The 2007 Phase II report by Otter Creek Engineering discusses the groundwater geology and potential in Grafton. The 2007 report reviewed publicly available well log information for private water supply wells in and around the Village of Grafton. The 2007 Report investigation stated that the well log data in the vicinity of the Grafton Village and in the South Branch valley indicate that the area generally consists of a surficial sand and gravel sediment layer providing approximately 40-feet or greater of saturated thickness atop bedrock which forms a shallow groundwater aquifer that has the potential for providing abundant quantities of groundwater for a public water supply system.

The 2007 report identified a well on the Windham Foundation property near Grafton Ponds that has a 40 gpm yield, is 240 feet deep, and encountered 50-feet of surficial sand and gravel sediments atop bedrock. The report recommended this area for a large diameter gravel-packed public water supply well.

The 2007 Report also included a desktop lineament analysis for bedrock well potential. Several existing bedrock wells with good yield (up to 50 gpm) were found to be in or around the Village of Grafton. The 2007 Report stated that the data reviewed indicates that there is potential for the siting, drilling, and development of one or more bedrock water supply sources that could serve the Village of Grafton. However, the 2007 report recommended the gravel well near Grafton Ponds as the best option.

Tighe & Bond also reviewed updated well log data which is publicly available through the Vermont Natural Resources Atlas. In addition to the well near Grafton Ponds, Tighe & Bond also identified another area along Route 121 before Fisher Hill Road where there are two wells near each other with reported capacities of 50 and 60 gpm. The depth of these wells are 120-feet and 175-feet. These wells are owned by Wilson & Lawrence, Inc. and the Grafton Fire Department. Another private well on the property at the end of Fire Pond Road has a reported capacity of 50 gpm and was drilled to a depth of 195-feet.

Based on the 2007 Report and well log information, Tighe & Bond believes there are three potential areas worth exploring for the siting of public water supply wells:

1. Well(s) at the Windham Foundation Property near Grafton Ponds
2. Well(s) near Fisher Hill Road
3. Well(s) at the Town owned Fire Pond Site

For the alternative analysis presented further in this report, it has been assumed that two drilled wells will be installed near Grafton Ponds and that these wells would be used as the primary source of drinking water supply. It has also been assumed that a small well house building would be constructed for well pump controls, disinfection, and basic water treatment (if needed depending on water quality).

7.2 Water Distribution

The 2007 Phase II report by Otter Creek Engineering explored a potential municipal water supply system for the Village of Grafton. As discussed in the 2007 Report, the Windham Foundations constructed a fire protection system in 1974. The source water for the Fire Protection System is Fire Pond, which is a 2.5 million gallon open reservoir according to the 2007 Report. A 10-inch asbestos cement water main extends approximately 2,000-feet and carries the water from Fire Pond to the Grafton Inn. The fire protection system consists of an additional 2,200 feet of 8-inch asbestos cement water main and 13 fire hydrants throughout the Village area.

The Fire Pond is approximately 160 feet above the Village center and provides 65-80 psi throughout the Village. The 2007 Report states that the fire protection system was tested by the Insurance Services Office (ISO) in 1975 and 1992. According to the 2007 Report, the fire protection system meets the needed fire flows in 4 of the 6 locations. Available fire flows did not meet the ISO fire flows at the Elementary School or the Grafton Cheese Factory. Otter Creek Engineering also completed a simple leakage test of the 8-inch diameter portion of the fire protection system as part of the 2007 Report effort and determined that the 8-inch portion of the fire protection system had no major leakage at the time.

Concerns regarding the use of asbestos cement (AC) water mains for drinking water supplies are discussed in the 2007 Report. The primary concerns discussed in the 2007 Report are asbestos fibers and deterioration of a vinyl coating of the asbestos cement pipe if the AC pipe was supplied with a vinyl coating. Grab samples for asbestos cement fibers and tetrachloroethylene (TCE) were collected from the fire protection system as part of the 2007 effort. The samples indicated no detectable AC fibers or TCE at the time.

The 2007 Report states that a discussion with the Vermont Agency of Natural Resources, Water Supply Division was held regarding the potential to convert the existing fire protection system into a drinking water system. According to the 2007 report, the Water Supply Division stated that the existing piping system could be approved for drinking water use if:

1. It is shown to have integrity similar to a typical 30-year old municipal water system (no significant leakage, etc.)
2. There are no measured contamination issues related to the pipe material.

3. There is evidence the system was designed by a professional engineering firm, and construction under the guidance and observation of that firm.
4. The Town has a set of accurate plans of what was constructed with locations of pipe and valves.

In the 2007 Report, Otter Creek concluded that the four items listed above could be satisfied and therefore the existing fire protection system could be considered for conversion to a public drinking water distribution system.

The estimated life span for AC pipe varies anywhere from 50 – 70 years depending on conditions and usage. The existing fire protection AC piping is approximately 49 years old at the time of this report. Therefore, due to its age and the potential health issues associated with AC pipe, this report assumes that the existing fire protection system piping will not be used, and that new ductile iron water distribution piping would be installed for the public water supply system. It has also been assumed that the existing fire protection system will remain in service and thus the new water supply system will be sized for drinking water service only.

7.3 Water Storage

The 2007 Phase II report by Otter Creek Engineering recommended a 300,000 - 350,000 gallon water storage volume based on a 2,500 gpm fire flow for 2 hours. Ten States Recommended Standards for Water Works (Ten State Standards) indicates that water storage facilities should have sufficient capacity, as determined from engineering studies, to meet domestic demands and where fire protection is provided, fire flow demands. Regarding finished water storage tank sizing, Ten State Standards states that:

- The minimum storage capacity for a system not providing fire protection shall be equal to the average daily consumption. This requirement may be reduced when the source and treatment facilities have sufficient capacity with standby power to supplement peak demands of the system.
- Excessive storage capacity should be avoided to prevent potential water quality deterioration problems.
- Fire flow requirements established by the appropriate state Insurance Services Office should be satisfied where fire protection is provided.

Three components typically determine the size of a new water storage tank:

1. Equalization Storage
2. General Emergency Storage
3. Fire Protection Storage

Equalization storage should meet the demand variations of the system and should be approximately 25% of the maximum daily demand, 20% of the total tank volume, or the system's peak hour demand minus the well supply capacity for 6 hours. General emergency storage is typically equivalent to 2 times the average daily demand, or 60% of the maximum daily demand. Overall emergency storage is typically the larger of general emergency storage and fire protection storage.

Fire protection requirements are provided by the National Fire Protection Association (NFPA) and by the ISO. Municipalities are not required to provide fire flow to residents. However, fire flow requirements established by the NFPA should be satisfied where fire protection is provided. Since fire protection is provided by the existing fire protection system, the potable water storage system only needs to meet domestic demands.

Tighe & Bond completed a preliminary water storage tank sizing calculation shown below in Table 7.1 assuming a 50,000 gpd average day demand (ADD) which was rounded up from the wastewater flow estimate of 42,500 gpd (see Section 4.1), an estimated maximum day demand (MDD) of 100,000 gpd (2.0 x ADD), and an estimated peak hour demand (PHD) of 200,000 gpd (4.0 x ADD). As shown in Table 7.1, a usable water storage volume of approximately 125,000 gallons is appropriate for the Village of Grafton.

TABLE 7.1
Usable Water Storage Volume

Item	Storage Volume (gpd)
Equalization - 25% of MDD[1]	25,000
Equalization - 20% of Tank Volume[2]	25,000
Equalization - PHD (-) Well Supply Capacity for 6 hours[3]	25,000
Selected Equalization Storage Component	25,000
Emergency - 60% of MDD	60,000
Emergency - 2x ADD	100,000
Selected Emergency Storage Component	100,000
Total Usable Storage Tank Volume	**125,000**

[1]Water Resource Engineering, 2nd Ed., Prentice-Hall, 2006

[2]If equalization storage volume is 20% of total tank volume as sized for emergency storage volume then the tank should turn over completely every five days on average

[3]Well Supply Capacity of 120,000 gpd was used

The 2007 Report compared several different types of storage tanks including:

- Poured-in-Place Concrete
- Pre-Stressed Concrete
- Glass-Fused-to-Steel
- Welded, Painted Steel

The 2007 Report also compared the advantages and disadvantages of each type of water storage tank. Ultimately, the 2007 Report recommended a concrete storage tank that would be partially or entirely buried to mitigate freezing concerns and aesthetic issues.

Tighe & Bond would recommend that a glass-fused-to-steel tank be reconsidered based on their long useful life. Potential for freezing is a concern for all tank types, including partially buried concrete tanks. Freezing concerns can be mitigated with appropriate tank mixing and aesthetic issues could potentially be addressed with appropriate tank siting. A full tank design and analysis should be completed during the preliminary design phase. For the alternative analysis presented further in this report, it has been assumed that a 125,000 gallon glass-fused-to-steel tank would be installed at the Village Park site near the Fire Pond.

Figure A.12 shows the preliminary layout for the drinking water supply, distribution, and storage systems.

7.4 PFAS Treatment

As discussed in Section 1.2, Per- and Polyfluoroalkyl Substances (PFAS) have previously been identified in the well serving the Grafton Elementary School with levels exceeding the State Maximum Contaminant Levels (MCLs) of 20 parts per trillion (ppt). According to the DEC, sampling has also been collected at 12 residences surrounding the school and of the twelve residences tested, 6 have detections and only 1 is above the current State MCL.

On April 10, 2024, the EPA announced the final National Primary Drinking Water Regulation for six per- and polyfluoroalkyl substances (PFAS). The new rule set a MCL for PFOS and PFOA of 4 ppt and a MCL for PFHxS, PFNA, and HFPO-DA (commonly known as GenX Chemicals) of 10 ppt. In addition, mixtures containing two or more of PFHxS, PFNA, HFPO-DA, and PFBS will be regulated by a calculated *Hazard Index* (HI) value of 1 (unitless) based on the sum of individual compound's concentrations relative to their reference dose.

Two other residences are above the new MCL of 4 ppt. As discussed in Section 1.2, some of the wells where PFAS was detected are cross-gradient and upgradient as compared to the school leachfield which suggests there may be other sources contributing PFAS to the groundwater in the area according to the 2022 Supplemental Site Investigation Report. Therefore, additional sampling may find that some wells have levels above the MCL of 4 ppt.

For these reasons, and for the alternative analysis presented further in this report, we have assumed that 25% of the parcels in the proposed service area (approximately 20 parcels) will require a PFAS treatment system. We have assumed that 10 of the parcels are single family residences and that 10 are small businesses. We have also assumed that Point of Entry Treatment systems (POETs) will be installed.

POET systems will be custom tailored to the individual application, but generally consist of a pre-filter and at least two activated carbon adsorbers. They may also contain water softeners, acid neutralizers, UV lights, pre-filtration, flow totalizers, and ancillary interconnecting piping. A typical residential POET system is shown below in Figure 7.1.

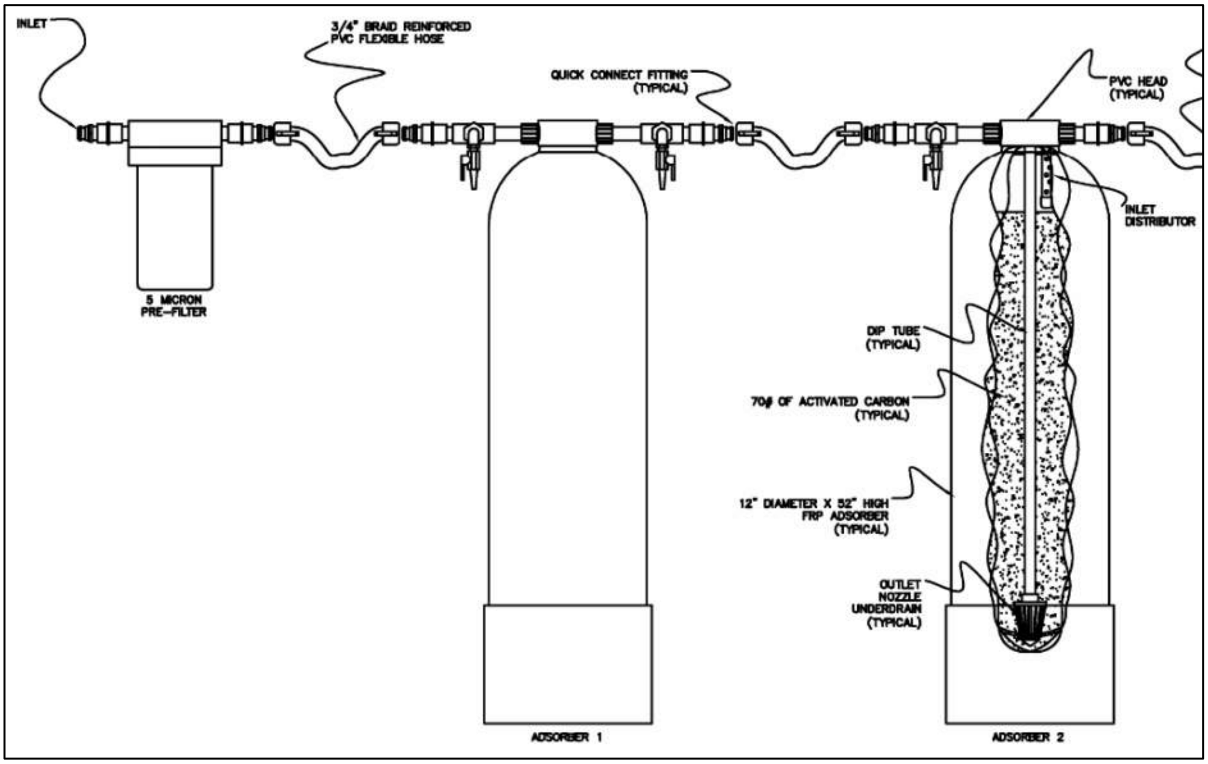


FIGURE 7.1
Typical POET System

7.5 Two-Year Time of Travel Water Service Area

As discussed in Section 5.2, a public drinking water system will be required if the Village Park site is to be used as a site for a return field since the two-year time of travel requirement cannot be achieved due to the proximity of the downgradient residential households. This means that all wells within the two-year time of travel zone will need to be relocated or a public water supply system be provided for the parcels within the two-year travel zone.

The two year travel time is based on the reasonable assurance of pathogen attenuation. Calculations of travel time must consider hydraulic gradient, porosity, saturated hydraulic conductivities, the cone of influence of production wells or the recharge area of springs being considered and mounding of the water table due to groundwater recharge by discharge of the sewage effluent.

Tighe & Bond performed preliminary calculations and an approximate delineation of the two-year time of travel zone for the effluent plume. The preliminary calculations and delineation are based on conservative hydraulic conductivity (0.0003 ft/s for silty sand), effective porosity (0.25 for sandy loam), and hydraulic gradient assumptions. The hydraulic gradient is typically measured in the field by measuring the elevation of the groundwater table at multiple monitoring wells a known distance apart and dividing the difference in elevation by the distance between the wells. However, for the preliminary calculations, the hydraulic gradient was assumed to be equivalent to the slope of the surface topography immediately down gradient of the Village Park Site. The preliminary two year time of travel delineation also assumes that the groundwater generally follows the surface contours.

The preliminary delineation of the two year time of travel zones is shown in Figure 7.2, in yellow. It is estimated that approximately 64 of the 84 parcels from the proposed Village service area fall within the two year time of travel zone of the Village Park site. Field work should be conducted to confirm the local soil and groundwater conditions and verify the two year time of travel calculations and delineation.

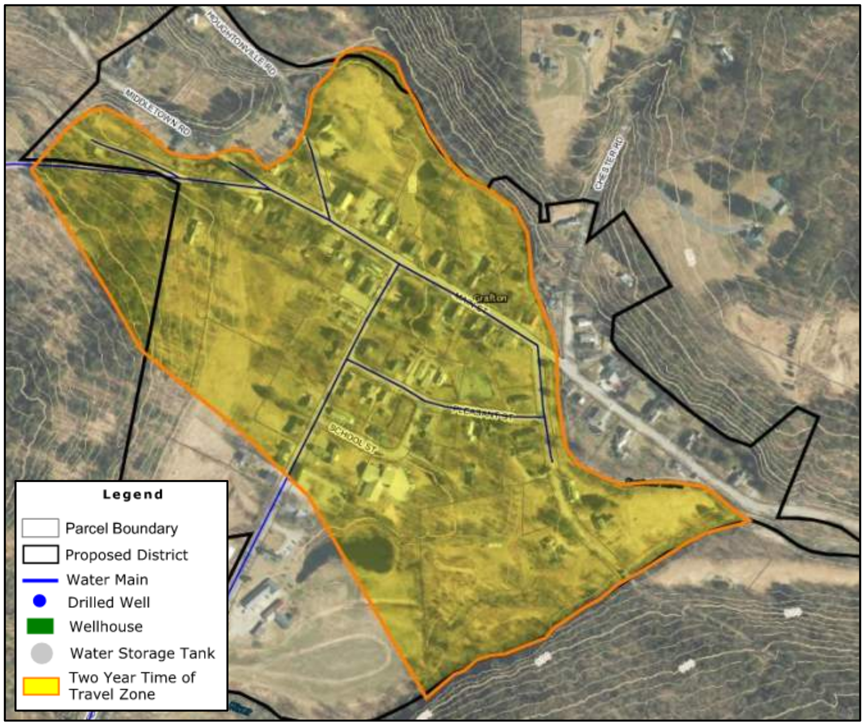


FIGURE 7.2
Two-Year Time of Travel Zone

Since the approximated two-year time of travel area covers 76% of the proposed service area, and given the existing PFAS issues in the Village, we believe it is appropriate to assume that the entire service area is provided drinking water service if a wastewater system were considered at the Village Park site. Therefore, for the purpose of the alternative evaluation, the water service area shown in Figure A.12 will be assumed.

7.6 Community Water System Capacity & Funding Requirements

7.6.1 Capacity Requirements

Section 1420(a) of the Safe Drinking Water Act (SDWA) requires the state to ensure that all new Community Water Systems (CWS) demonstrate the capacity to comply with regulations. The Water Supply Rules (WSR) (Environmental Protection Rules, Chapter 21) prohibit a new CWS from operating before demonstrating that it has adequate Technical, Managerial, and Financial capacity (TMF). The Vermont Agency of Natural Resources (ANR), Drinking Water and Groundwater Protection Division's (DWGWPD) makes a formal determination as to whether a system has adequate capacity at two junctures – before issuing the construction permit and before issuing the operating permit. The determination is completed through a process called a Capacity Determination.

The Capacity Determination involves several steps to provide proof of TMF before being approved to serve water as a public community water system. A copy of the capacity checklist is attached as Appendix F, for reference. The following tasks would also need to be completed as part of the Capacity Determination process:

1. Implement a plan to gauge local interest in connecting to a CWS
2. Develop capital estimates for construction of the CWS
3. Develop water rate estimates for users of the CWS
4. Complete a Long Range Plan

The Town of Grafton would need to successfully complete the Capacity Determination process and tasks listed above as part of implementing a drinking water alternative discussed in the sections above.

Tighe & Bond and the Town of Grafton have had discussions with the Drinking Water and Groundwater Protection Division, and the Drinking Water and Groundwater Protection Division have many concerns that because of Grafton's small size and low population density, the Town of Grafton may not be able to successfully prove TMF for a CWS, and therefore, may not be permitted to move forward with a CWS.

7.6.2 Funding Requirements

New CWS projects are not eligible for funding through the Drinking Water State Revolving Fund (DWSRF) unless they are addressing "widespread" water quality issues that have a public health concern. As discussed in Section 1.2 and 7.4, PFAS have previously been identified in the well serving the Grafton Elementary School as well as 6 other detections in nearby wells. However, based on preliminary conversations with the DWGWPD, unless further PFAS exceedances are presented, DWSRF funding for the Grafton CWS is not likely.

The Town of Grafton adopted a Sewage Disposal Ordinance and a Septic Pumping Ordinance in 1999. The Town considers this an important component of maintaining groundwater quality in the Village. To the best of our knowledge, besides the PFAS sampling efforts, there have been no other Village-wide water quality sampling efforts and there are no other known widespread water quality issues in the Village. For these reasons, it is assumed that a CWS would not be fundable through the DWSRF at this time.

Section 8
Opinion of Probable Cost

8.1 Cost Estimate Approach

Conceptual opinions of probable costs (OPC) have been prepared for the wastewater collection system approaches, water resource recovery system approaches, return system approaches, and cluster system discussed in Section 6. The opinion of probable cost includes the following components:

1. **Construction Cost:** The budgetary cost estimates are based on Class 4 level construction cost estimates, as defined by the Association for the Advancement of Cost Engineering (AACE) International Recommended Practices and Standards. According to AACE International Recommended Practices and Standards, the estimate class designators are labeled Class 1, 2, 3, 4, and 5, where a Class 5 estimate is based on the lowest level of project definition and a Class 1 estimate is closest to full project definition and maturity. The end usage for a Class 4 estimate is a conceptual study. The expected accuracy range of a Class 4 estimate is between +40% and -25%. The level of project definition for a Class 4 estimate is between 1% and 15%. The costs include overhead and profit, equipment costs, demolition/removal of existing equipment (if applicable), temporary provisions (if applicable), facilities and bypasses (if necessary, to complete the work), property acquisition (if applicable), easements, and costs regarding installation and start-up of improvements. The cost also includes a contractor's general conditions cost factor of 10% of the construction subtotal to cover contractors' costs for traffic control, mobilization and demobilization, bonds, insurance, etc. The costs are based upon recently completed project bid forms, quotes from equipment manufacturers/vendors, and data contained in R.S. Means Construction Cost Data.
2. **Engineering (20%):** A 20% contingency has been applied to the estimated construction costs for the engineering fees. The 20% for engineering fees can generally be broken down further as: Engineering Design (8%) and Construction Administration/Observation (12%).
3. **Contingency (20%):** A 20% general contingency has been applied to the estimated construction costs. This contingency is in-line with the current level of project definition.
4. **Total Project Costs:** The total project costs are the sum of the construction costs, engineering costs, and the contingency.

8.2 Cost Comparison

Table 8.1 summarizes the opinion of probable construction cost (OPCC) for the different wastewater collection system approaches as discussed in Section 6.1. The costs for the collection system are slightly different depending on the location of the water resource recovery/return site. We have included the cost of a collection system to a "theoretical" parcel approximately 1 mile from the center of Grafton should the Town find another suitable parcel in the future. The costs presented in Table 8.1 are construction costs only and do not include the engineering and contingency costs. The detailed opinion of probable costs are provided in Appendix G.

TABLE 8.1
Collection System Opinion of Probable Construction Cost

Collection System Type	Treatment Location	OPCC
Conventional	Upper Howland Mill (G-1)	$7,158,800
	Village Park (G-2)	$7,535,700
	Theoretical Parcel (G-3)	$8,813,800
Septic Tank Effluent	Upper Howland Mill (G-4)	$3,163,700
	Village Park (G-5)	$2,954,200
	Theoretical Parcel (G-6)	$3,736,900

Table 8.2 summarizes the OPPC for each of the water resource recovery systems discussed in Section 6.2. The capital construction costs for each type of water resource recovery system are for the most part independent on the system location and therefore the costs presented in Table 8.2 do not include site specific costs including site work, access roads, electric utilities, and property acquisition. The costs associated with site work and property acquisition are presented in the alternative cost analysis (Section 9). In addition, the costs presented in Table 8.2 do not include engineering or contingency. The detailed opinion of probable costs are provided in Appendix G.

TABLE 8.2
Water Resource Recovery System Opinion of Probable Construction Costs

Water Resource Recovery Type	OPCC
Recirculating Sand Filter (RSF) (G-7)	$1,225,400
Packed Bed Media Filter (PBF) (G-8)	$2,990,000
Fixed Bed Bio-Reactor (FBBR) (G-9)	$1,893,200

Table 8.3 summarizes the OPCC for the wastewater return systems discussed in Section 6.3. As discussed in Section 6.3, the Upper Howland Mill site does not have enough room and therefore the cost for a system at the Upper Howland Mill site is not provided in Table 8.3. We have included the cost of a return system to a "theoretical" parcel with assumed soil conditions (see Section 9) should the Town find another suitable parcel in the future. The costs presented in Table 8.3 are construction costs only and do not include the engineering and contingency costs. The detailed opinion of probable costs are provided in Appendix G.

TABLE 8.3
Return System Opinion of Probable Construction Cost

Return System Type	Return Location	OPCC
Conventional Absorption Field	Village Park (G-10)	$822,100
	Theoretical Parcel (G-11)	$2,145,300
Gravelless Geotextile Sand Filter (GGSF)	Village Park (G-12)	$1,873,300
	Theoretical Parcel (G-13)	$2,314,100
Drip Dispersal	Village Park (G-14)	$782,200
	Theoretical Parcel (G-15)	$1,036,800

Table 8.4 summarizes the OPCC for the cluster system discussed in Section 6.4. As discussed in Section 6.4, there are several assumptions regarding the preliminary cluster system layout. In addition to the assumptions discussed in Section 6.4, we have assumed that 25% of the clusters have wells with insufficient capacity to support the entire cluster and therefore new wells will need to be drilled for six of the clusters.

We have also assumed that POET systems will be required at 25% of the clusters (6 total) for PFAS treatment. The costs presented in Table 8.3 are construction costs only and do not include the engineering and contingency costs. The detailed opinion of probable costs are provided in Appendix G.

TABLE 8.4
Cluster System Opinion of Probable Construction Cost (G-16)

Component	OPCC
Abandon Existing Systems, Install New Tanks & Sewers	$1,518,700
Cluster Treatment/Disposal	$4,681,000
Drinking Water Improvements	$3,854,500
Opinion of Probable Construction Cost	**$10,054,200**

Table 8.5 summarizes the OPCC for the drinking water supply system serving the entire service area as discussed in Section 7. The costs presented in Table 8.5 are construction costs only and do not include the engineering and contingency costs. The detailed opinion of probable costs are provided in Appendix G.

TABLE 8.5
Drinking Water System Opinion of Probable Construction Cost (G-17)

Component	OPCC
Water Supply	$530,800
Water Distribution	$7,138,100
Water Storage	$1,117,400
POET Systems	$224,300
Opinion of Probable Construction Cost	**$9,010,600**

Section 9 Alternatives Analysis

9.1 Identification of Alternatives

Two types of wastewater collection systems were discussed in Section 6.1 including conventional collection systems and alternative septic tank effluent systems. As shown in Table 8.1, the septic tank effluent collection systems are expected to have a lower capital construction cost compared to conventional collection systems. Therefore, only septic tank effluent collection systems have been included in the final comparison of alternatives.

Three types of water resource recovery systems were discussed in Section 6.2 including recirculating sand filters, packed bed media filters, and fixed bed bio-reactors. As shown in Table 8.2, the recirculating sand filters are expected to have the lowest capital construction costs and therefore a recirculating sand filter system has been included in the final comparison of alternatives.

Three types of wastewater return systems were discussed in Section 6.3 including conventional absorption fields, gravelless geotextile sand filters, and drip dispersal systems. As shown in Table 8.3, the drip dispersal system is expected to have the lowest capital construction costs and therefore a drip dispersal system has been included in the final comparison of alternatives.

Since the Village Park site is the only feasibly location at this time, it has been included as an alternative along with an alternative at a theoretical parcel should the Town identify another suitable location in the future. A cluster system has also been considered. A summary of the alternatives to consider include:

- <u>Alternative No. 1:</u>
  - Grafton Village Sewer District at a Theoretical Parcel:
    - Septic Tank Effluent Collection System to Theoretical Parcel
    - Recirculating Sand Filter Water Resource Recovery System
    - Drip Dispersal Return System
- <u>Alternative No. 2:</u>
  - Grafton Village Sewer District at the Village Park:
    - Septic Tank Effluent Collection System to Village Park Site
    - Recirculating Sand Filter Water Resource Recovery System
    - Drip Dispersal Return System
  - Grafton Village Drinking Water System:
    - Water Supply Wells near Grafton Pond
    - Ductile Iron Water Distribution System
    - Water Storage Tank near Fire Pond
    - POET Systems
  - Stormwater Improvements at Village Park/Fire Pond

- Alternative No. 3:
    - Grafton Village Cluster System:
        - Abandon Existing Septic Systems, Install New Tanks & Sewers
        - 22 Cluster Treatment/Disposal Systems
        - Drinking Water Improvements
- Alternative No. 4:
    - Do Nothing

9.1.1 Alternative No. 1

Alternative No. 1 consists of the following:

1. Construction of a septic tank effluent sewer collection system for the proposed sewer district with conveyance to a theoretical parcel.
2. Construction of a recirculating sand filter water resource recovery system for secondary + treatment at a theoretical parcel.
3. Construction of a drip dispersal return system at a theoretical parcel.

This alternative involves a "theoretical parcel" should the Town identify another suitable parcel in the future or if one of the parcels already identified (see Section 5.1) becomes available. A summary of the parameters for a suitable parcel is below:

- 1 acre of suitable area available for a sand filter treatment system, tanks, etc.
    - Preferred slope less than 15%
- 2 acres of suitable area for a drip dispersal field
    - Slope less than 20%
    - Suitable separation distance from water bodies (200') and streams (150')
    - Not within the floodplain
    - No drinking water wells within the two-year time of travel zone
    - Soil Class 5a or less
- 1 acre of suitable area for future expansion

We have assumed a STEP collection system that is approximately 1 mile away from the center of Grafton. Due to the significant topography change for many of the potential sites compared to the elevation of the Village center, we have assumed that the STEP collection system will require an intermediate pump station. Equalization storage could be provided at the pump station instead of at the recirculation/dosing tank. The wastewater will be sent from the intermediate pump station to the recirculation/dosing tank. Flow will be sent from the recirculation/dosing tank to parallel recirculating sand filter beds. The recirculating sand filters will be membrane lined and covered; each bed sized for 50% of the average day design flow.

The treated wastewater will flow from the recirculating sand filters to an effluent/recirculation splitter box. A portion of the flow will be sent back to the re-circulation tank and the remainder of the flow will be sent to the dosing tank for the drip dispersal system. The flow will be periodically dosed to the various drip dispersal zones for return to the groundwater. There will be a small building for the recirculation/dosing tank pump controls and for the drip dispersal dosing pumps and controls.

Anticipated site improvements will include an electric service and a gravel access drive and parking area. We have assumed that up to one well will need to be relocated. It has been assumed that the property will need to be purchased by the Town and we have assumed an acquisition price of $250,000.

9.1.2 Alternative No. 2

Alternative No. 2 consists of the following:

1. Grafton Village Sewer District at the Village Park:
    a. Construction of a septic tank effluent sewer collection system for the proposed sewer district with conveyance to the Village Park site.
    b. Construction of a recirculating sand filter water resource recovery system for secondary + treatment at the Village Park site.
    c. Construction of a drip dispersal return system at the Village Park site.
2. Grafton Village Drinking Water System:
    a. Construction of water supply wells, site access, and a small wellhouse building near Grafton Ponds.
    b. Ductile iron water main distribution system and service connections for the entire service area.
    c. Construction of a 125,000 gallon glass-fused-to-steel water storage tank and site improvements near Fire Pond at the Village Park site.
    d. POET systems for PFAS treatment at 20 parcels
3. Stormwater improvements at the Village Park site, Fire Pond, and the surrounding areas.

The STEP sewer collection system for this Alternative will be as shown in Figure A.10b. The wastewater will be sent from the STEP collection system to the EQ/Recirculation tank at the Village Park site. Flow will be sent from the EQ/Recirculation tank to parallel recirculating sand filter beds. The recirculating sand filters will be membrane lined and covered; each bed sized for 50% of the average day design flow.

The treated wastewater will flow from the recirculating sand filters to an effluent/recirculation splitter box. A portion of the flow will be sent back to the re-circulation tank and the remainder of the flow will be sent to the dosing tank for the drip dispersal system. The flow will be periodically dosed to the various drip dispersal zones for return to the groundwater. The preliminary layout of the drip dispersal field includes 4 zones, three of which will be approximately 36-feet by 300-feet each and one which will be approximately 100-feet by 108-feet, running parallel to the site contours. There will be a small building for the EQ/recirculating pump controls and for the drip dispersal dosing pumps and controls.

This area for the water resource recovery system and for the drip dispersal system will need to be cleared. Additionally, the grade will need to be stripped such that the drip dispersal tubing penetrates the confining layer and is still shallow enough to be within the oxygenated soil layer. After installation of the drip dispersal system, the area would be covered with topsoil and planted with grass. A preliminary layout of the sewer system and drinking water infrastructure for Alternative No. 2 at the Village Park site is shown in Figure A.13. See Figure A.10b for the collection system layout.

The drinking water system is required for this alternative since the Village Park site will be utilized for the sewer disposal field and since many wells are within the down-gradient two-year time of travel zone as discussed in Section 7.5.

The drinking water supply system is assumed to consist of one wellfield with two drilled wells near Grafton Ponds as discussed in Section 7.1. The wellfield will have a small wellhouse building for pump controls and chlorination equipment. Site improvements such as an access road and electrical service will also be required at the wellfield.

The preliminary design of the water distribution system assumes new 8-inch ductile iron water mains as discussed in Section 7.2. As discussed in Section 7.3, the preliminary design of the water storage tank includes a 125,000 gallon glass-fused-to-steel water storage tank near Fire Pond. Assumptions regarding the foundation for the water storage tank have been made. The area for the water storage tank would need to be cleared and an access road and electrical service installed. See Figure A.12 for a preliminary layout of the Alternative No. 2 drinking water system.

We have assumed that 20 parcels will require a POET system as discussed in Section 7.4. We have assumed that 10 of the parcels are single family residences and that 10 are small businesses.

In addition to needing the drinking water system when utilizing the Village Park site, there are documented issues with stormwater associated with Fire Pond and drainage along Fire Pond Road and surrounding areas. The necessary stormwater improvements have not been investigated in detail as part of this preliminary engineering report. However, this alternative includes a budgetary price of $1,000,000 to address stormwater issues related to the Fire Pond drainage area.

The Village Park site is already owned by the Town of Grafton. However, it has been assumed that approximately 1 acre will be required for the wellfield near Grafton Ponds and that the property owner would be compensated $20,000 for acquisition or a lease to use the property for the wellfield.

9.1.3 Alternative No. 3

Alternative No. 3 consists of the following:

1. Abandonment of existing septic systems, installation of new tanks and sewer lines connecting each of the buildings to the cluster system
2. 22 new cluster treatment/disposal systems
3. Abandonment existing wells (besides one well that will remain for each cluster)
4. New pressure tanks for each cluster and water services from one well to each of the buildings within the cluster
5. POET systems for PFAS treatment at 6 clusters

The preliminary cluster system layout is shown in Figure A.11. Should the Town decide to move forward with the cluster system approach, a design phase will need to be completed that would involve much more detailed work to locate, size, and design appropriate clusters. The design phase will include soil investigations, survey, coordination with property owners, and confirmation of well capacity to provide a more detailed cluster system design.

We have assumed that no property will need to be acquired for the cluster system alternative and that an agreement will need to be made between property owners and the Town for operation and maintenance of the cluster systems.

9.1.4 Alternative No. 4

The "no action" alternative means that no sewer system or public drinking water system will be installed for the Village. In this scenario, the existing individual sewer systems and private drinking water wells would remain in use. This option does not address the isolated sewer issues and PFAS water quality issues experienced by some in the Village and leaves the responsibility of fixing these issues on the homeowners. In addition, the no action alternative will not address issues that businesses in the Village are experiencing with limited expansion due to restrictions of their existing septic systems. This will prevent certain facilities such as restaurants and multi-use buildings from being able to expand due to limited wastewater capacity.

9.2 Life Cycle Cost Analysis

Capital Costs

The opinion of probable cost for each of the three alternatives are summarized in Table 9.1, Table 9.2, and Table 9.3, respectively. The costs in these tables include the construction costs as well as engineering, contingency, and property acquisition.

TABLE 9.1
Alternative No. 1 Opinion of Probable Cost

Item	Cost
Septic Tank Effluent Collection System (G-6)	$3,736,900
Recirculating Sand Filter Water Resource Recovery System (G-7)	$1,225,400
Drip Dispersal Return System (G-15)	$1,036,800
Site Work (G-18)	$95,800
Subtotal Construction Costs	$6,094,900
Engineering (20%)	$1,219,000
Contingency (20%)	$1,219,000
Property Acquisition	$250,000
Opinion of Probable Cost	**$8,782,900**

TABLE 9.2
Alternative No. 2 Opinion of Probable Cost

Item		Cost
Septic Tank Effluent Collection System (G-5)		$2,954,200
Recirculating Sand Filter Water Resource Recovery System (G-7)		$1,225,400
Drip Dispersal Return System (G-14)		$782,200
Site Work (G-19)		$17,500
Drinking Water System (G-17)		$9,010,600
Stormwater Improvements		$1,000,000
	Subtotal Construction Costs	$14,989,900
	Engineering (20%)	$2,998,000
	Contingency (20%)	$2,998,000
	Property Acquisition	$20,000
	Opinion of Probable Cost	**$21,005,900**

TABLE 9.3
Alternative No. 3 Opinion of Probable Cost

Item		Cost
Cluster System (G-16)		$10,054,200
	Subtotal Construction Costs	$10,054,200
	Engineering (20%)	$2,010,900
	Contingency (20%)	$2,010,900
	Property Acquisition	$0
	Opinion of Probable Cost	**$14,076,000**

Operation and Maintenance Costs

If Alternative No. 4 is selected, costs for maintenance and repairs of existing septic systems and private drinking water wells will remain the cost of the individual property owners including costs for repair or replacement of failing systems. Table 9.4 presents a summary of the anticipated annual operation and maintenance (O&M) costs for Alternative No. 1, Alternative No. 2, and Alternative No. 3. The opinion of probable O&M costs includes the annual operation and maintenance costs for the sewer collection, recovery, and return systems, drinking water system(s), as well as administrative costs, short-term assets, and a 20% contingency. The detailed opinion of probable O&M costs for each alternative are provided in Appendix G.

TABLE 9.4
Annual O&M Costs for Each Alternative

Alternative	Annual O&M
Alternative No. 1 (G-20)	$116,800
Alternative No. 2 (G-21)	$277,400
Alternative No. 3 (G-22)	$137,200

A life cycle cost analysis was utilized to better compare the three alternatives to determine the most cost-effective alternative, rather than just the alternative with the lowest capital construction cost. The net present value was calculated for each alternative as the capital cost (which includes construction and non-construction costs such as land acquisition and engineering) plus the present worth of the uniform series of annual O&M, minus the present worth of the salvage value of the system.

The life cycle costs were calculated for a planning period of 20 years with a 2.3% inflation rate and a 0.3% discount rate taken from Appendix C of OMB Circular A-94. The net present value for each alternative is presented in Table 9.5.

TABLE 9.5
Alternative Life Cycle Cost Analysis

Item	Alt. No. 1	Alt. No. 2	Alt. No. 3
Capital Cost	$8,782,900	$21,005,900	$14,076,000
Annual O&M Cost	$116,800	$277,400	$137,200
Present Day O&M	$2,837,000	$6,737,000	$3,332,000
Present Day Salvage Value	$759,000	$1,180,000	$2,358,000
Net Present Value	**$10,860,900**	**$26,562,900**	**$15,050,000**
		Planning Period	20 years
		Inflation Rate	2.30%
		Discount Rate	0.30%

9.3 Non-Monetary Considerations

Non-monetary factors such as environmental impacts, land requirements, constructability/project concerns, sustainability considerations, potential for service interruptions, future expansion, public perception, operation & maintenance, regulator familiarity, public health, fundability, and indirect benefits.

Environmental Impacts

Implementing a new sewer system is expected to reduce potential environmental impacts from failing or outdated septic tanks and leachfields. For all of the alternatives wastewater would be treated to meet VT DEC discharge limits. The no-action alternative (Alternative No. 4) may have negative environmental impacts if existing septic systems are to remain and are not functioning properly, including impacts on private drinking water supplies.

Land Requirements

Each alternative (besides the no action alternative) requires land for the water resource recovery system and return field. Alternative No. 1 requires land that is not owned by the Town of Grafton, which could cause a challenge and potentially even prevent the project from moving forward if a suitable property cannot be found. This is the single largest challenge for Alternative No. 1.

As of writing this report, no locations have been identified but the Town continues to search for a suitable location. Alternative No. 2 requires a lease or property acquisition for the wellfield. Alternative No. 3 requires space for approximately 22 cluster systems (see Constructability/Project Challenges for more discussion regarding Alternative No. 3).

Constructability/Project Concerns

Each of the alternatives have unique challenges. Alternative No. 1 may require an intermediate pump station due to the significant elevation difference between the collection system and the anticipated water resource recovery site. Alternative No. 1 also requires installation of a sewer main across a long distance.

Alternative No. 2 has the constructability challenges of stripping soil from the site to provide proper depth such that the drip dispersal field is below the confining layer. This will provide some minor grading challenges where the proposed grade blends with the existing grade. Alternative No. 2 also has the challenge of performing a significant construction project in an active Village Park that is relatively close to residential areas. Alternative No. 2 also has a significant construction challenge associated with stormwater improvements. Alternative No. 2 may also have constructability challenges with construction of the water storage tank foundation, depending on soil conditions at the site.

The cluster system alternative is expected to have many project challenges including:

- All property owners must agree to be part of the cluster system and be agreeable to the location of the proposed system.
- One or more of the property owners will have a new septic system installed on their property. This will be larger than their existing system so they will likely lose some usable area of their property while other parcels in the cluster gain usable area on the property since their existing leachfields will be abandoned.
- There will be a large disturbance to the property(s) with the septic system during construction of the cluster system.
- Existing wells may not have enough capacity to supply all parcels within the cluster (requires further investigation).
- The pressure tank for the well that will remain for each cluster will need to be installed at one of the parcels within the cluster. The pressure tank will be bigger than their existing pressure tank and therefore they will likely lose some space in their basement.
- Some of the cluster systems are anticipated to have pumps and other equipment that require electricity. The electrical service for this equipment will need to come from one of the parcels. An agreement between will need to be made such that the cost for the electricity is not born solely on the property owner who is providing the electricity for the cluster system. The same applies for the parcel that will have the well pump.
- The water for all parcels in the cluster will be supplied by a single well. Therefore, if an equipment failure occurs all parcels in the cluster will lose water. If there is a power outage and the property with the well does not have a backup generator then all parcels in the cluster will not have access to water until the electrical service is restored.
- Operation and maintenance easements/agreements need to be developed for each of the cluster systems and POETS.

Sustainability Considerations

Sustainable utility management practices are important to consider when creating a new sewer district and/or water district. The alternatives all incorporate septic tank effluent collection systems which are a closed system and thus there is much less chance for inflow and infiltration compared to a conventional collection system. All alternatives also include indirect discharges which are more energy efficient than direct discharges.

Alternative No. 2 includes a public drinking water system in addition to the wastewater system and Alternative No. 3 consists of multiple clusters instead of a single system. Therefore, Alternative No. 2 and Alternative No. 3 will use more electricity as compared to Alternative No. 1. Alternative No. 2 will also require more labor for the operation of a wastewater system and drinking water system as compared to just a wastewater system. Although minimal, Alternative No. 2 will require more operator visits, time and fuel driving, sending samples to the lab, etc., which all increase the carbon footprint of Alternative No. 2 as compared to Alternative No. 1 and Alternative No. 3.

There is minimal installation of non-porous surfaces for each alternative and thus stormwater management for construction of the new infrastructure should be easily obtained. Green infrastructure can be incorporated where practical during the final design of the selected alternative.

Potential for Service Interruption

As discussed in Section 6.1.2, STEG systems have the advantage of not requiring any power to operate and will continue to provide appropriate serve even in cases of electricity outages. However, STEP systems present concerns during power outages as discussed in Section 6.1.2. Power failure events for parcels with STEP systems will mean temporary service interruptions for those parcels until electrical service is restored. STEP tanks are included in all of the alternatives. The treatment system and intermediate pump stations will have emergency generators in case of power outages.

The drinking water system wellfield will have an emergency generator to prevent service interruptions for the drinking water system (Alternative No. 2). It is anticipated that the public drinking water system will have less service interruptions due to electricity outages as compared to a typica residential household utilizing a private well.

Availability for Future Expansion

Having area available for expansion of the sewer system is one of the most important non-monetary considerations. All the alternatives have STEP collection systems which can be easily expanded if the service area were to increase, but Alternative No. 3 is expected to have more limited area for future expansion since the clusters will be on relatively small parcels.

Alternative No. 1 utilizes a "theoretical parcel". The theoretical parcel should have at least 1 acre of suitable land for future expansion. Alternative No. 2 at the Village Park site has very limited room for future expansion of the sewer disposal field due to the topography of the site. Future expansion of the drinking water system is not anticipated to be a major concern since the water mains can be extended (Alternative No. 2).

Public Perception

Nuisances such as odors and noise are commonly associated with water resource recovery systems. However, very limited noise or odor concerns are expected for the proposed water resource recovery systems or cluster systems.

We anticipate that the public will look more favorably (from a septage perspective) at a theoretical parcel that is isolated from the Village as compared to the Village Park site which is upgradient and very close to the center of Grafton. It may be perceived that Alternative No. 2 will impact the quality of the drinking water wells since it is upgradient of nearly the entire proposed sewer district.

Residents have also voiced their concern with stormwater issues associated with the Village Park site. Residents have explained how heavy rainfall events have caused erosion along Fire Pond Road and the surrounding properties. Residents have stated that the surface runoff also impacts the Village Park site, and they are concerned how the stormwater runoff would impact the proposed wastewater system at the site. In addition, some residents have brought up concerns with the integrity of the man-made Fire Pond which is located uphill of the proposed treatment system. They fear that failure of the Fire Pond could wash out the wastewater treatment system below.

Alternative No. 3 will likely have varying public perception depending on the final design of the cluster systems.

Operation and Maintenance Requirements

The proposed wastewater system for Alternative No. 1 and Alternative No. 2 are the same and therefore require the same degree of operation and maintenance. However, Alternative No. 2 also requires a public drinking water system which increases the amount of operation and maintenance. Alternative No. 3 is expected to have more operation and maintenance since there is a greater number of systems as compared to Alternative No. 1.

Regulator Familiarity

Regulator familiarity with the water resource recovery system will help expedite regulatory review of the project. Water resource recovery system technologies that have not previously been approved by the Vermont DEC will have a much longer review period and have a significant chance of delaying project schedule. The proposed recirculating sand filter and drip dispersal technologies are both accepted technologies. Therefore, no regulator familiarity issues are anticipated for the proposed wastewater systems (Alternative No. 1 and Alternative No. 2).

The type of cluster systems needs to be finalized during the next design phase, but we do not anticipate and regulator familiarity issues with Alternative No. 3. However, there will be additional steps for regulatory review and approval for Alternative No. 2 and Alternative No. 3 since both alternatives include a drinking water component.

Public Health

Installation of a village wastewater system may indirectly improve drinking water quality for private drinking water wells by eliminating any failing systems. Construction of a public drinking water system may directly improve drinking water quality, especially for those parcels whose wells have poor water quality or have been impacted by PFAS.

Fundability & Permitting

It is anticipated that Alternative No. 1 will be fundable through CWSRF if a suitable location can be identified. However, as discussed, it is anticipated that the public drinking water system for Alternative No. 2 will have funding challenges.

The wastewater system for Alternative No. 1 and the wastewater component of Alternative No. 2 should be permittable. However, the drinking water component for Alternative No. 2 is subject to the Town of Grafton demonstrating TMF capacity as discussed in Section 7.6.1 which could limit the feasibility. Alternative No. 3 is not expected to have funding or permitting challenges at this time although challenges may arise during the next design phase.

Indirect Benefits

Alternative No. 2 is expected to have several indirect benefits including improved stormwater management in the Fire Pond drainage area, and increased park space at the Village Park. Alternative No. 1 may have indirect benefits if a property can be found that also has enough room for other public use such as a park, graveyard, etc. Alternative No. 3 is not expected to have any indirect advantages.

A summary of the non-monetary considerations is provided in Table 9.6.

TABLE 9.6
Summary of Non-Monetary Considerations

Item	Alt No. 1	Alt. No. 2	Alt. No. 3
Environmental Impacts	- Minimal	- Minimal	- Minimal
Land Requirements	- Still need to find suitable parcel	- Wellfield site needed	- Multiple locations required
Constructability/ Project Concerns	- Topography challenges - Others TBD	- Grading challenges - Stormwater challenges - Active park	- Property owners need to agree - Some property owners will lose usable property space - Disturbance during construction - Potential well capacity issues - Electricity costs
Sustainability Considerations	- None	- Two systems – use more energy	- Multiple clusters – use more energy
Potential for Service Interruption	- Service interruptions for STEP tanks	- Service interruptions for STEP tanks - Water main breaks	- Service interruptions at individual parcel impact other parcels
Availability for Future Expansion	- Need to find parcel with room for expansion	- Very limited room for expansion	- Limited room for expansion
Public Perception	- Potentially favorable if isolated location is found	- Very close to Village Center - Stormwater concerns - Water system may be favorable	- Likely to have variable perception depending on cluster location

TABLE 9.6 Continued
Summary of Non-Monetary Considerations

Item	Alt No. 1	Alt. No. 2	Alt. No. 3
Operation and Maintenance Requirements	- Least O&M	- Most O&M	- Moderate O&M
Regulator Familiarity	- Familiar	- Familiar	- Familiar
Public Health	- Addresses some concerns	- Addresses all concerns	- Addresses most concerns
Fundability & Permitting	- Fundable - No permit challenges	- Funding challenges - TMF challenge	- No challenges anticipated at this time
Indirect Benefits	- Potential for other use on property depending on parcel that is found	- Stormwater Imp. - Village Park area	- None

Section 10
Proposed Project

10.1 Basis of Selection

Although the parcel has not yet been identified, the life cycle cost analysis and a most of the non-monetary factors discussed in Section 9.3 favor Alternative No. 1 in comparison to Alternative 2 & 3 and therefore, Alternative No. 1 is the recommended alternative.

The basis for selection of Alternative No. 1 is as follows:

- Lowest capital cost
- Lowest life cycle cost
- Has potential for future expansion
- Less complex project scope with less constructability and project challenges
- Less challenging to fund
- Regulator familiarity with the proposed system
- Will allow growth of businesses within the Village

10.2 Project Costs

There are several financial grant or low-interest loan programs available which may assist the Town with funding this project such as the Clean Water State Revolving Fund (CWSRF) or the USDA Rural Development program.

This engineering report has been prepared in anticipation of pursuit of a low-interest loan or grant. Table 10.1 provides the conceptual opinion of probable cost for implementation of Alternative No. 1 in a format that is consistent with funding agency requirements. Note that a yearly 3% escalation has been applied to the construction, engineering, and contingency costs. The escalation accounts for inflation and increases in costs from the time this OPC was developed until the time the design and construction will take place, estimated to be 2 and 3 years, respectively.

We would like to note that over the last couple of years there has been unusually high inflation and significant increases in construction material pricing. The price increases are a result of multiple, complex factors. The costs presented here are based on 2024 pricing and have been escalated at 3% per year as discussed above (the average historic ENR cost index is approximately 2.5% per year).

TABLE 10.1
Recommended Project Costs

Item	Cost
1. Construction Costs[1]	$6,661,000
2. Engineering Costs	
a. Design[2]	$518,000
b. Construction[1]	$800,000
3. Other Expenses	
a. Local Counsel (0.75%)	$50,000
b. Bond Counsel (1.25%)	$83,000
c. Work Force	$0
d. Financial Services	$0
e. Miscellaneous	$0
4. Equipment	$0
5. Land Acquisition	$250,000
6. Project Contingency (20%)[1]	$1,333,000
7. Total Project Costs	$9,695,000
8. Less Other Sources of Financing[3]	$3,968,000
9. Project Costs to be Financed	$5,727,000
10. Financing Insurance Costs	
a. Direct Expense (1%)	$58,000
b. State Bond Issuance Charge (0.84%)	$49,000
c. Administrative Fee (1.1%)	$63,000
Total Project Cost to be Financed	**$5,897,000**

[1]Includes an escalation of 3%/year for 3 years
[2]Includes an escalation of 3%/year for 2 years
[3]ARPA funds appropriated to Grafton for Village Wastewater Project

10.3 Anticipated Rates

The Clean Water State Revolving Fund (CWSRF) loan program can provide either low-interest or interest-free loans for project financing. The types of loans available include:

- Planning Loans: Terms of 5 to 15 years with 0% interest
- Final Design Loans: Terms of 5 to 15 years with 0% interest
- Municipal Construction Loans: Terms of 20 to 30 years with 2% administrative fee, annually. Terms need to be less than or equal to asset life.
- Natural Infrastructure Project Loans

Eligible projects include wastewater collection system and treatment facility construction, upgrades, or refurbishment projects and community decentralized wastewater disposal systems. Given the scope of the proposed project, it is likely that the Town would meet financing criteria and could assume a municipal construction loan with 2% administrative fee. Note that it has been assumed that the planning and final design loans would be rolled into the construction loan at closing, and administrative fees would apply then. For estimating user rates, we have assumed a 30% loan with 2% interest.

Table 10.2 develops potential sewer use fees based upon the equivalent residential unit (ERU) calculation method. This method is very simple; parcels with greater ERU assignments (and theoretically higher flow) will pay a greater portion of the costs than those with lower ERU assignments. Annual O&M costs would also be proportional to the ERU assignments. One ERU represents a typical single-family residence.

TABLE 10.2
ERU Based User Fees

Item	Cost
Total Project Cost to be Financed	$5,897,000
Annual Dept Service Payment, 30 years @ 2%	$263,301
Number of ERUs in Proposed Sewer District	97
Annual Cost Per ERU	$2,714
Annual O&M Costs	$116,800
Number of ERUs in Proposed Sewer District	97
Annual O&M Cost per ERU	$1,204
Total Annual Cost per ERU	**$3,919**

In accordance with US Environmental Protection Agency (EPA) guidance, sewer use rates are considered affordable if the annual cost for a single-family user (1 ERU) is less than 2% of the Median Household Income (MHI). For the Town of Grafton (MHI = $68,125), this equates to a single-family user fee of $1,363. Therefore, the ERU based methodology for Alternative No. 1 will not result in an affordable user fee.

Another very common billing method is to address capital costs based on a cost per $1,000 of assessed parcel value per user and an operation and maintenance fee based upon a usage rate so users with higher flows pay a greater portion of the annual O&M cost then users with lower flows. An example using this scenario is provided in Table 10.3.

TABLE 10.3
Assessment and Flow Based User Fees

Item	Cost
Total Project Cost to be Financed	$5,897,000
Annual Dept Service Payment, 30 years @ 2%	$263,301
Proposed Sewer District Total Assessed Value	$35,032,100
Annual Cost per $1,000 Assessed Value	$7.52
Annual Cost Per Single Family Residence[1]	$2,837
Annual O&M Costs	$116,800
Annual O&M Flat Rate ($40/quarter)	$160
Annual O&M Cost (per 1,000 gallons > 40,000 gallons)	$8.43
Annual Usage per Single Family (gallons)[2]	164,250
Annual O&M Usage Cost per Single Family	$1,208
Total Annual Cost per Single Family	**$4,045**

[1]Based on an average assessed value of $377,500 per single family residence

[2]Based on 450 gpd per single family residence

In many circumstances, the assessed value methodology provides a reduction for single family costs compared to the EDU methodology. However, in this case, it increases the annual cost per single family residence and therefore it also does not achieve EPA designated affordability levels.

To reduce costs to achieve the EPA designated affordability levels with the ERU user fee method, approximately $9,350,000 in total grant funding will be needed for Alternative No. 1. Therefore, grant funding in addition to the $3,968,000 in ARPA funds will need to be secured to meet the EPA affordability criteria.

10.4 Project Implementation Plan

The following are the next steps for project implementation of the recommended alternative through the state revolving fund program:

1. Find a Suitable Parcel – The Town of Grafton will continue searching for a suitable parcel that meets the criteria outlined in Section 9.1.1. A suitable parcel must be identified before proceeding to the next steps.
2. Grant Funding – The Town shall explore additional grant funding opportunities to make the project affordable. This task should be completed concurrently with Step 1/Step 2.
3. Step 1: Planning and Preliminary Engineering – The Town of Grafton and their consultant shall update the PER once an acceptable parcel has been identified and complete the remaining tasks (through Task 15c) as part of Step 1: State Revolving Fund – Planning and Preliminary Engineering.
4. Step 2: Final Design – The Town of Grafton and their consultant shall complete all tasks (Tasks 1-12) of Step 2: State Revolving Fund – Final Design. This step of the project generally includes the following:
    a. Engineering – The Town should hire an engineering consultant to design and oversee construction of the collection system, water resource recovery system, and return system.
    b. Site Survey - A topographic and boundary survey of the water resource recovery and return site will be conducted by the engineering consultant. The engineer will utilize the survey during the design.
    c. Parcel Investigations – A parcel by parcel survey will be required to determine the type and location of the existing septic systems to determine the appropriate connection points and locations for the new STEP tanks.
    d. Collection System Survey – A survey of the collection system will be completed to locate existing utilities and avoid conflicts with the utilities during construction of the new collection system.
    e. Soil Testing – Geotechnical information will be collected at the site and will be used for final design of the treatment system and return system components.
    f. Design Phases– Design of the collection, water resource recovery, and return systems will advance in stages including 30%, 60%, 90% (permit set), and 100% (bid set) design phases.

g. Permitting - Permits will be required for construction of the wastewater system. Permit applications will be submitted, reviewed, and issued during this step.

h. Regulatory Review – It is anticipated that the State will need to review and approve the design deliverables before issuing a permit. The State will review the final submittal and send final design approval letter, permit to construct, and approval to advertise for bids.

i. Bidding – The project will go out to public bid after receiving approval.

5. Step 3: Construction – The Town of Grafton and their consultant will complete Step 3: State Revolving Fund - Construction (Tasks 1 – 10). This step also includes bidding. Construction will be awarded and commence following receipt of reasonable bids. The sequence of construction would likely start with installation of the water resource recovery and return system, return field, installation of the sewer mains, and then making the service connections to each user. Easements must be obtained for sewer mains and STEP systems. Permanent easements for system maintenance will be required at each parcel in the proposed district and it is anticipated that the easements will be mapped and described by a licensed surveyor based on as-built locations.

10.5 Project Implementation Schedule

Figure 10.2 on the following page presents an estimated project schedule for the proposed project. We have assumed one year to find a suitable parcel. Please note that the ARPA funding has certain deadlines that are not represented in this schedule.

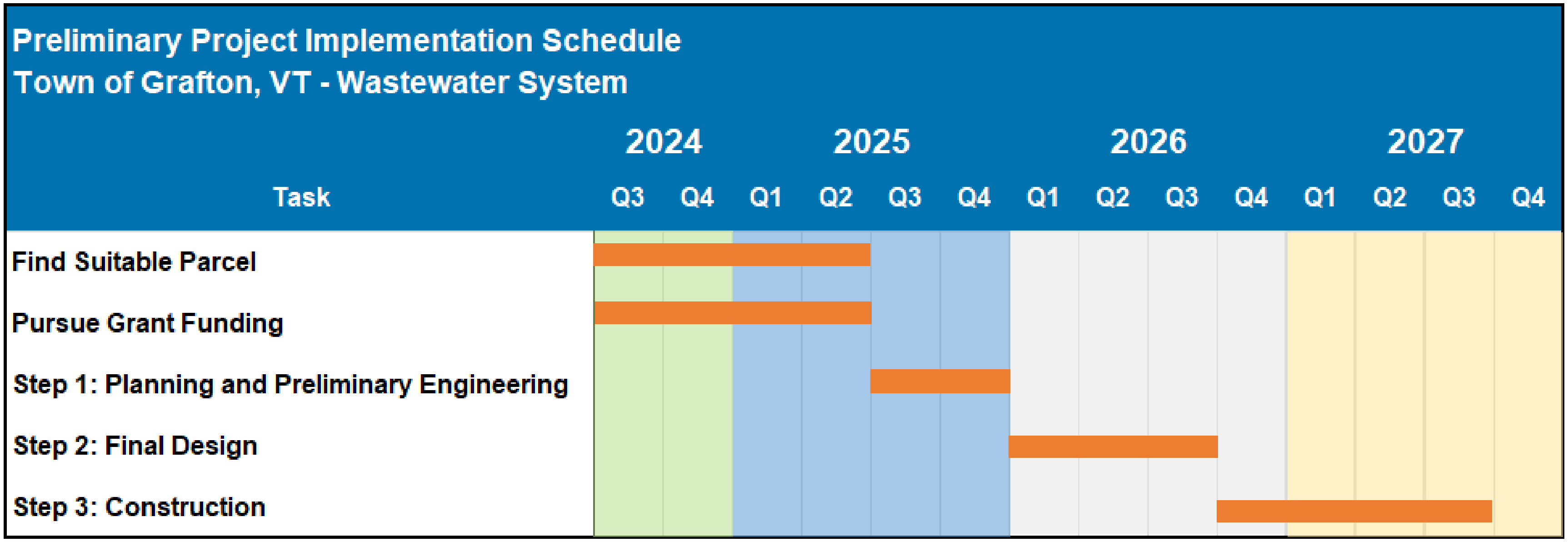
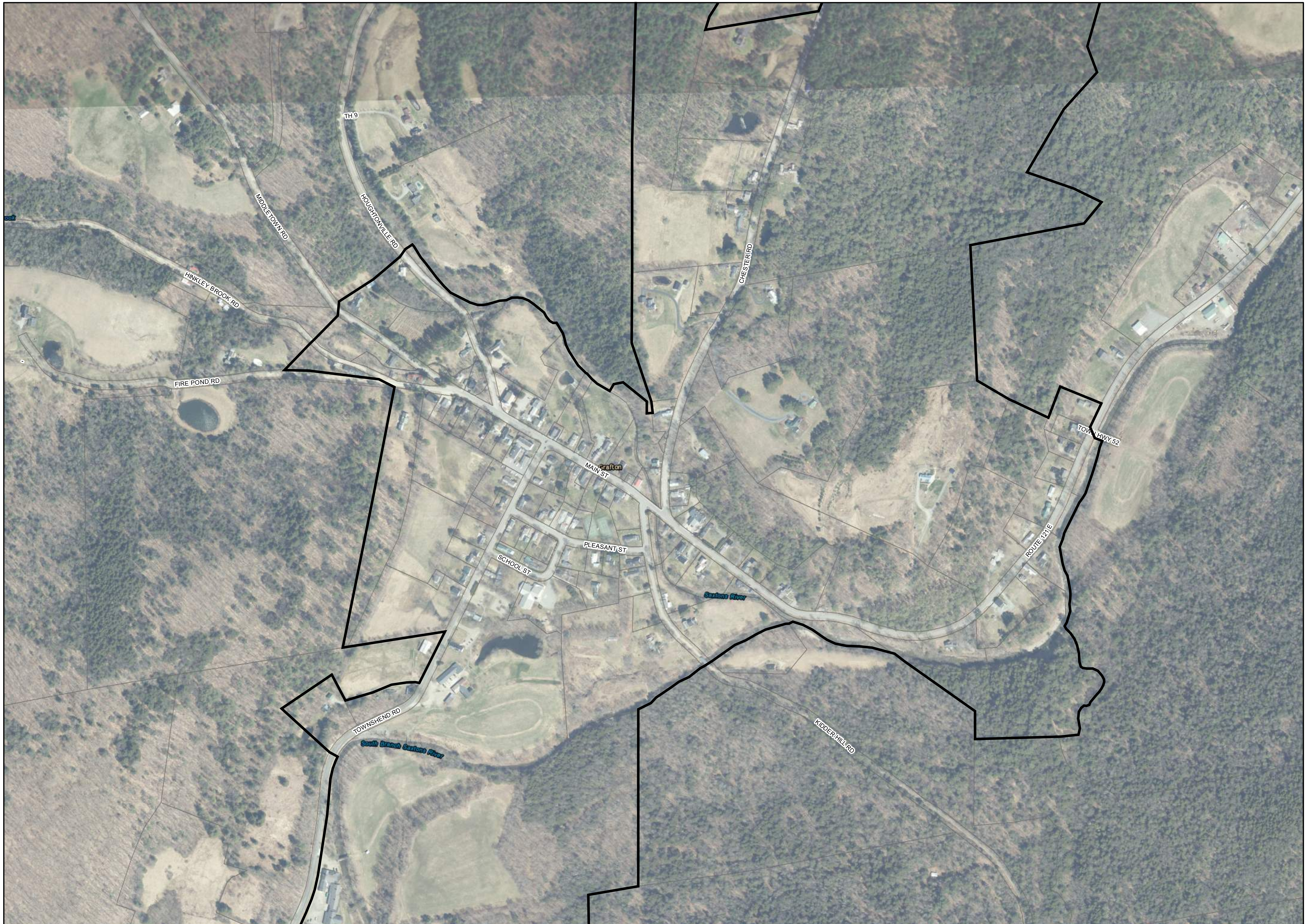


FIGURE 10.2
Project Implementation Schedule

APPENDIX A

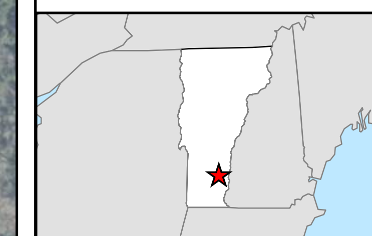
FIGURE A.1
STUDY AREA



Legend

- Parcel Boundary
- Study Area Boundary

LOCUS MAP



N

0 250 500

Feet

1 in = 500 ft

NOTES

1. Ortho imagery based on ESRI World Imagery.
2. Tax parcel boundaries provided by State of Vermont Geodata Portal.
3. Soil data provided by USDA Natural Resource Conservation Service.
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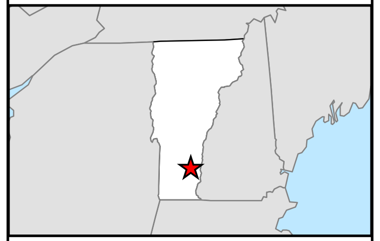
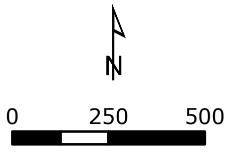
FIGURE A.2
SOIL TYPES & RESTRICTIVE LAYERS

Legend

- Parcel Boundary
- Soil Group
- Potential Shallow Depth to Water Table
- Potential Shallow Depth to Restrictive Layer
- Potential Shallow Depth to Both

LOCUS MAP





1 in = 500 ft

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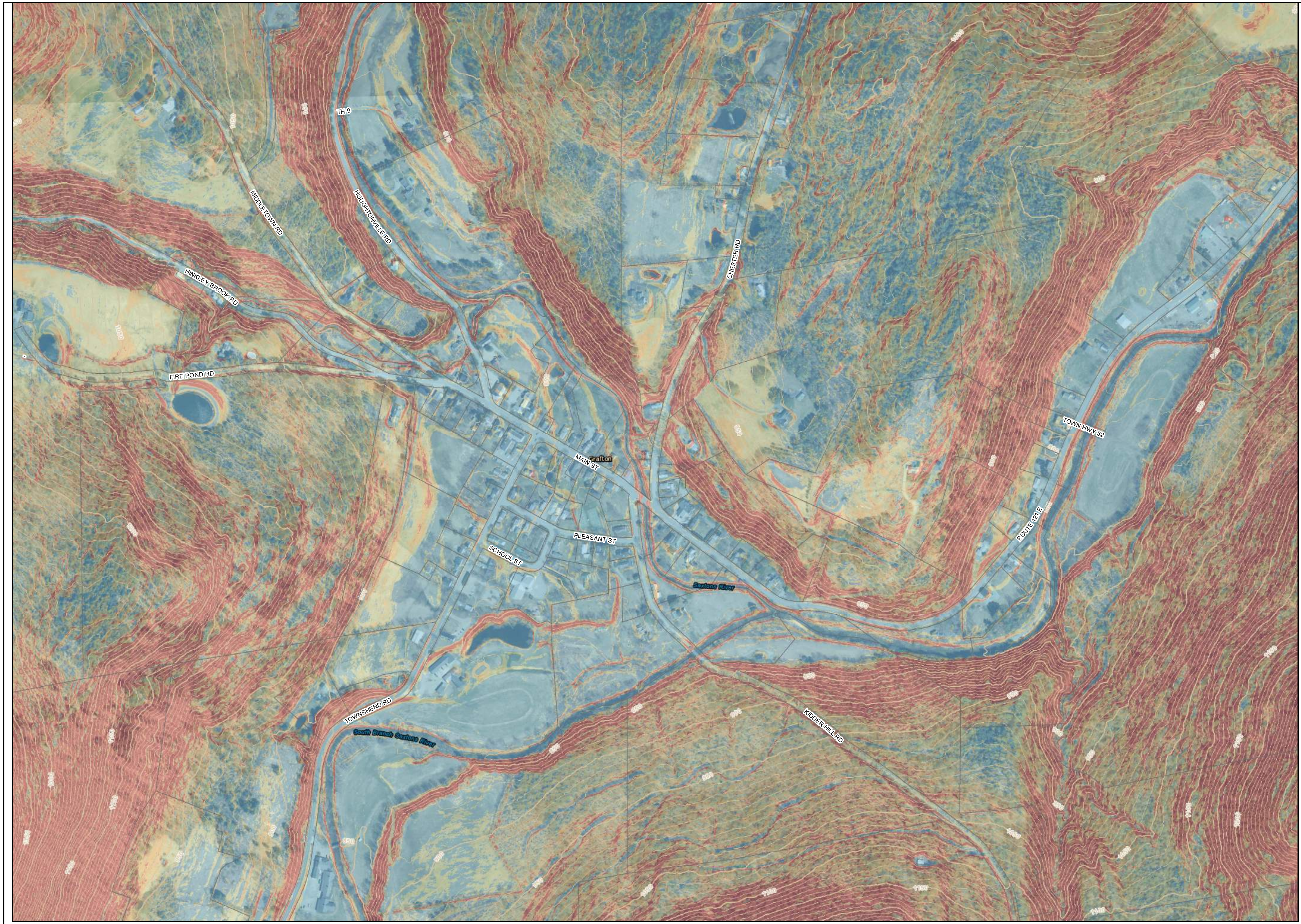
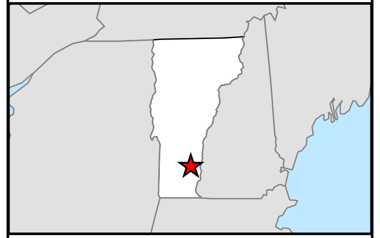


FIGURE A.3
TOPOGRAPHY

Legend

- Parcel Boundary
- 0% - 10% Slope
- 10% - 20% Slope
- 20% - 30% Slope
- > 30% Slope

LOCUS MAP



N

0 250 500
Feet
1 in = 500 ft

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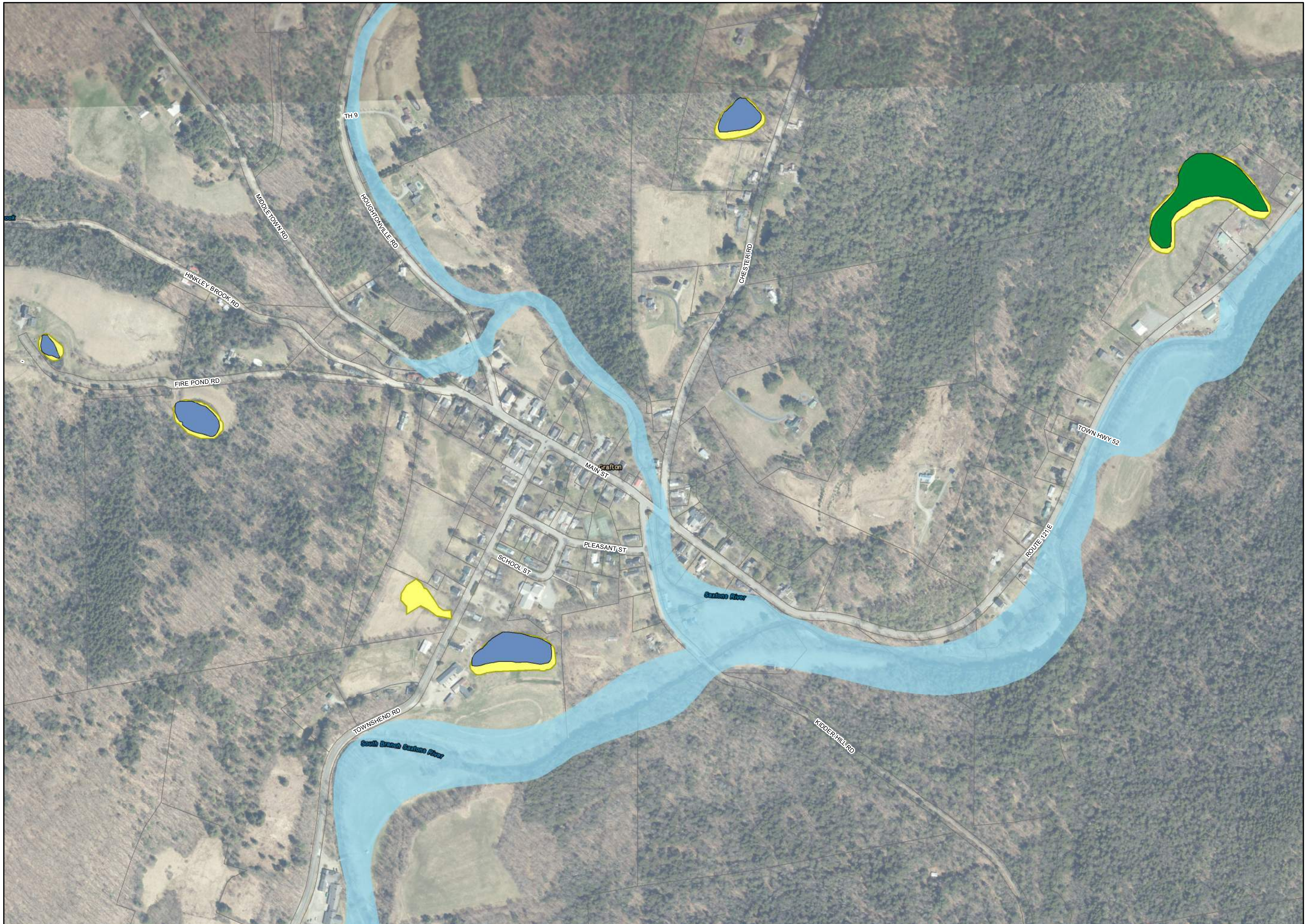
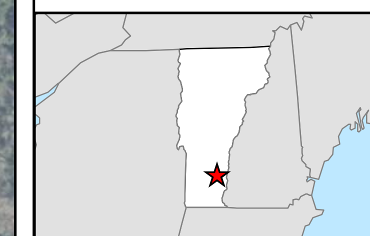
FIGURE A.4
HYDROGRAPHY

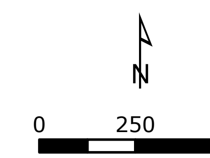


Legend

- Parcel Boundary
- 100-Year Flood Zone
- NWI - Freshwater Forested/Shrub Wetland
- NWI - Freshwater Pond
- VSWI - Class 1 Wetland
- VSWI - Class 2 Wetland

LOCUS MAP





1 in = 500 ft

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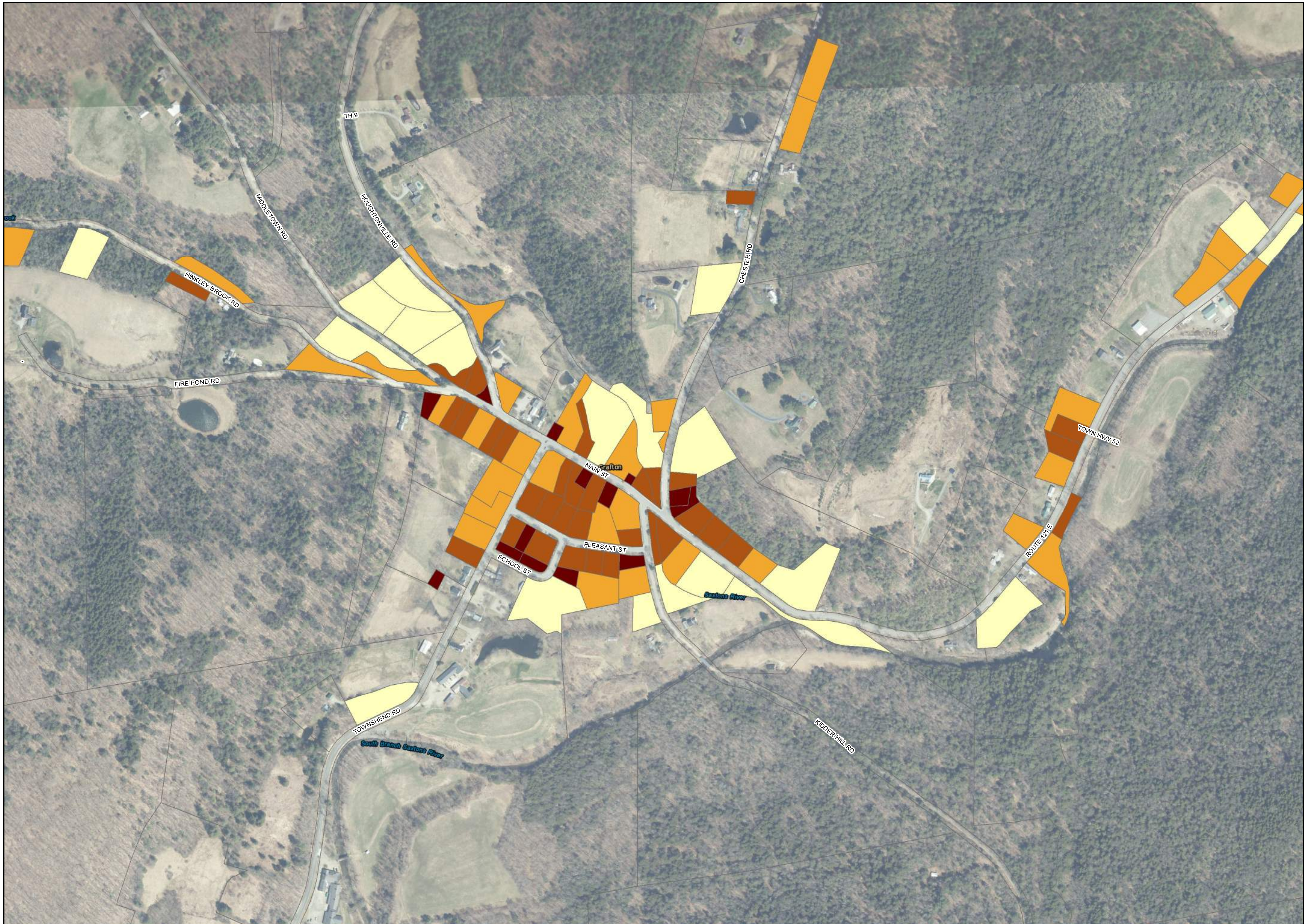
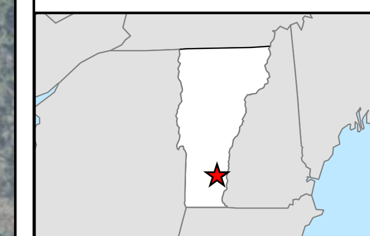


FIGURE A.5
PARCEL SIZES

Legend

- < 0.25 Acres
- 0.25 - 0.50 Acres
- 0.50 - 1.00 Acres
- 1.00 - 2.00 Acres
- > 2.00 Acres

LOCUS MAP



N

0 250 500
Feet
1 in = 500 ft

NOTES

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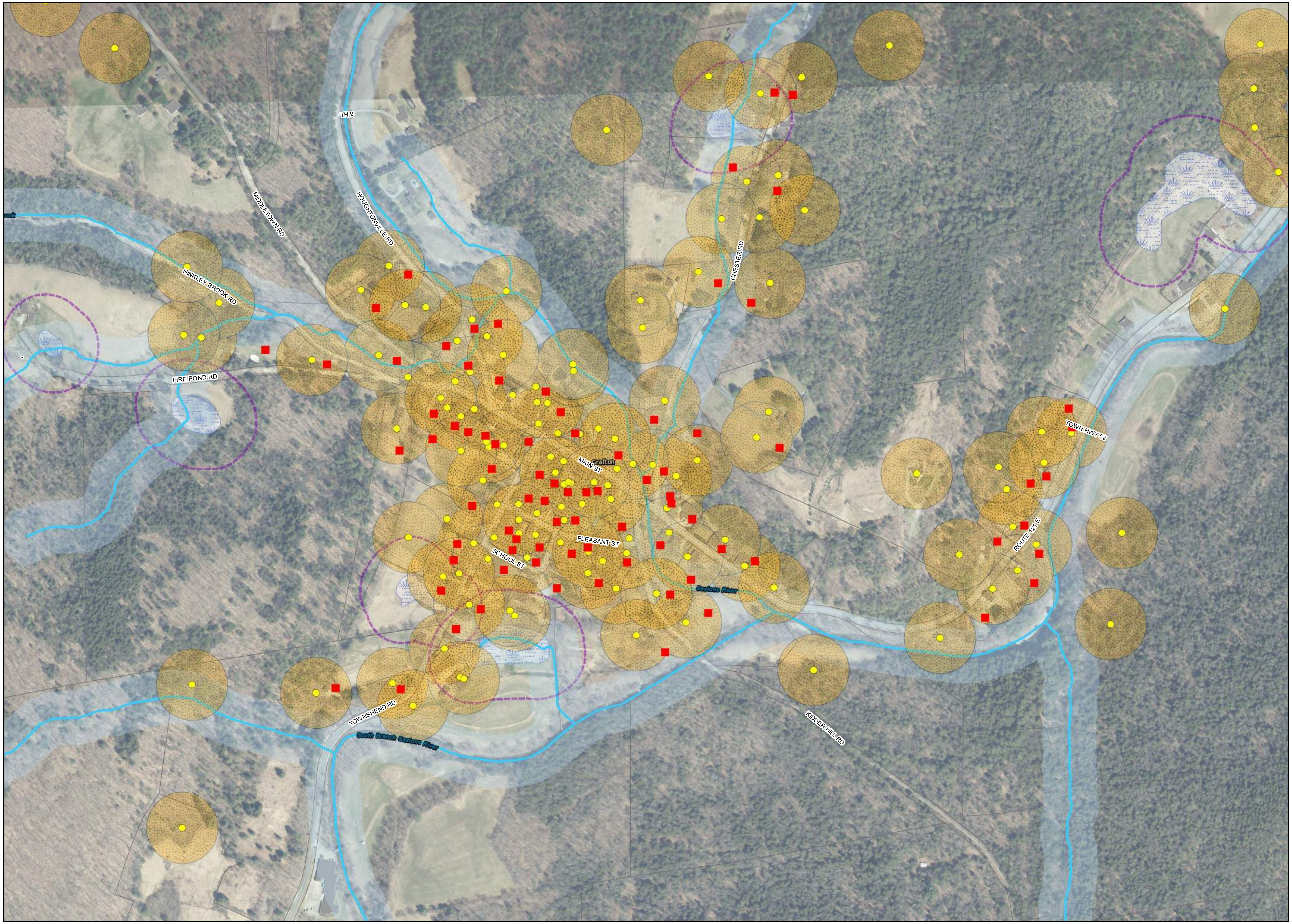
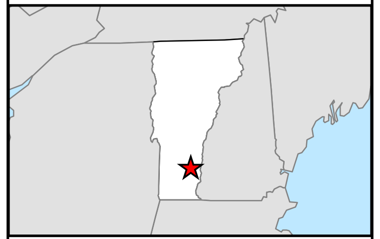


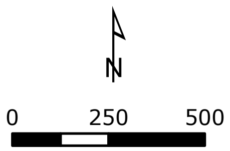
FIGURE A.6
ISOLATION DISTANCES

Legend

- Parcel Boundary
- Septic Systems
- Private Wells
- 200' Well Buffer
- Stream/River
- 150' Stream Buffer
- Wetland/Standing Water
- 200' Wetland Buffer

LOCUS MAP





1 in = 500 ft

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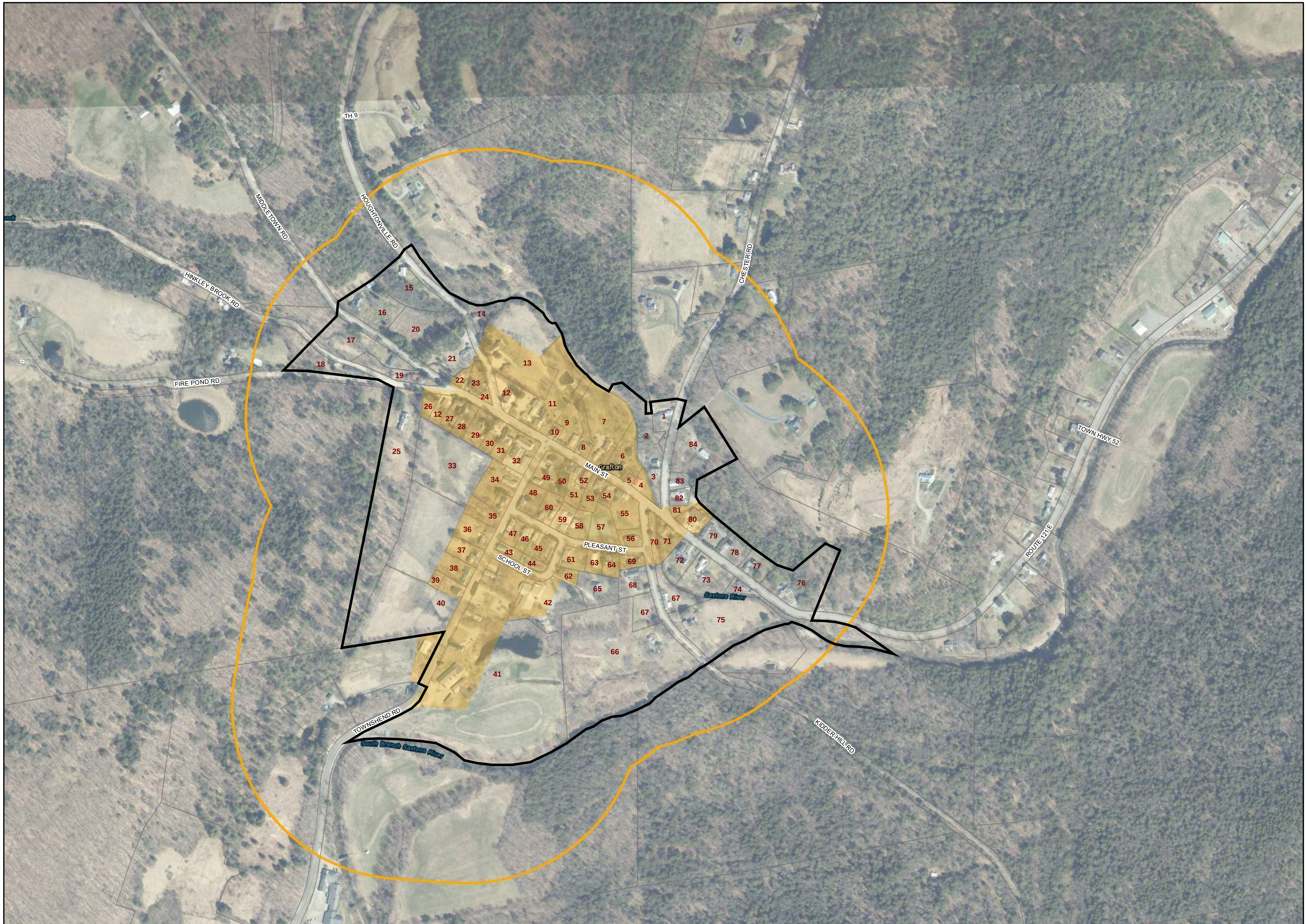
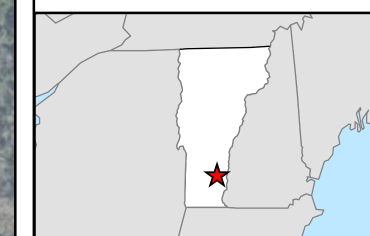


FIGURE A.7
PROPOSED DISTRICT

Legend

- Parcel Boundary
- Village Center
- Neighb. Planning Area
- Service Area

LOCUS MAP



N

0 250 500
Feet
1 in = 500 ft

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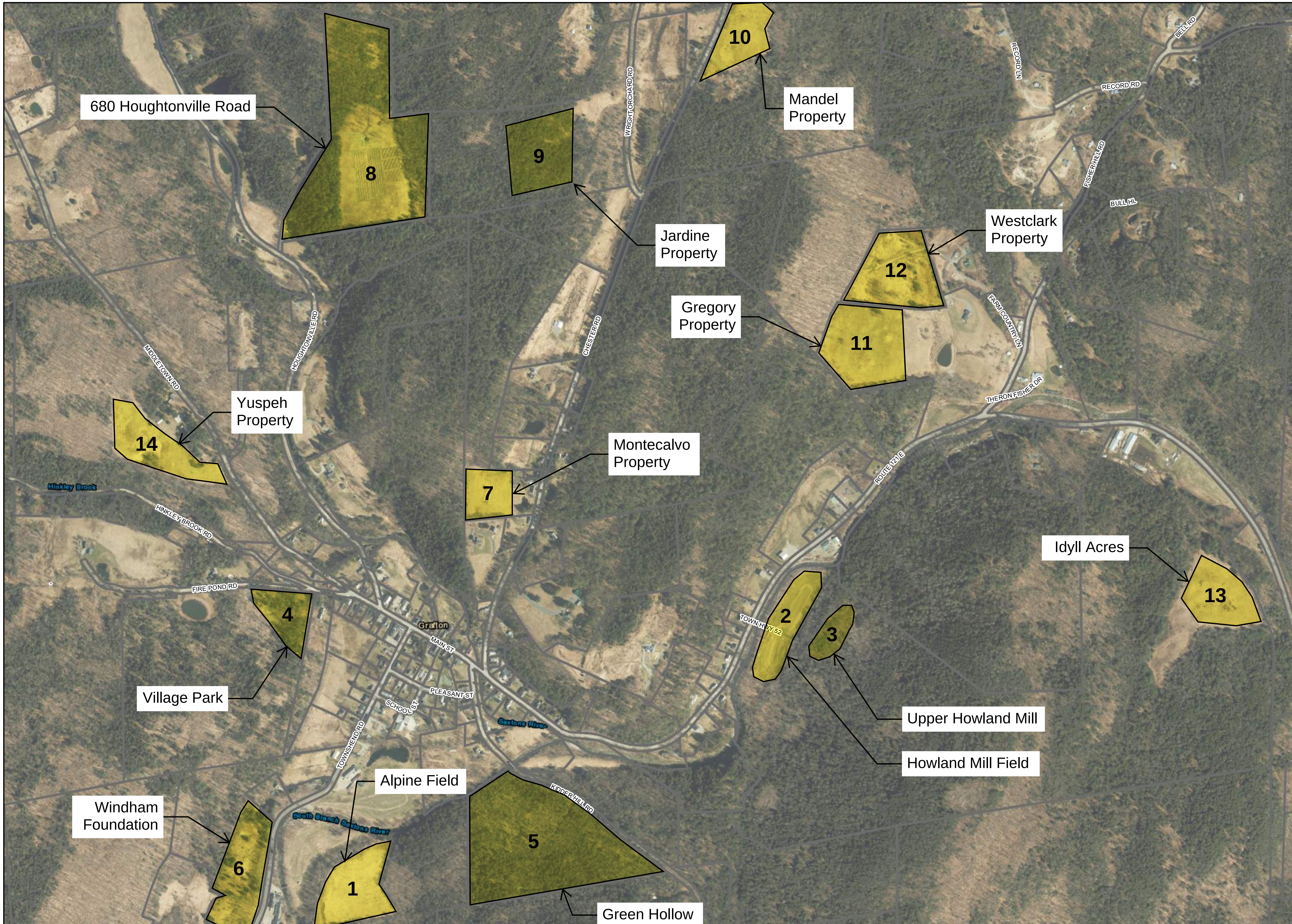
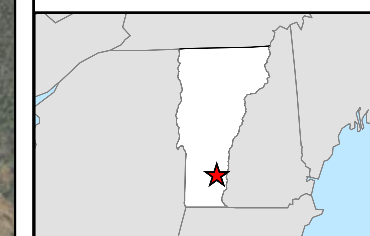
FIGURE A.8
POTENTIAL SITES



Legend

- Parcel Boundary
- Potential Site

LOCUS MAP



N

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Feet
1 in = 800 ft

NOTES

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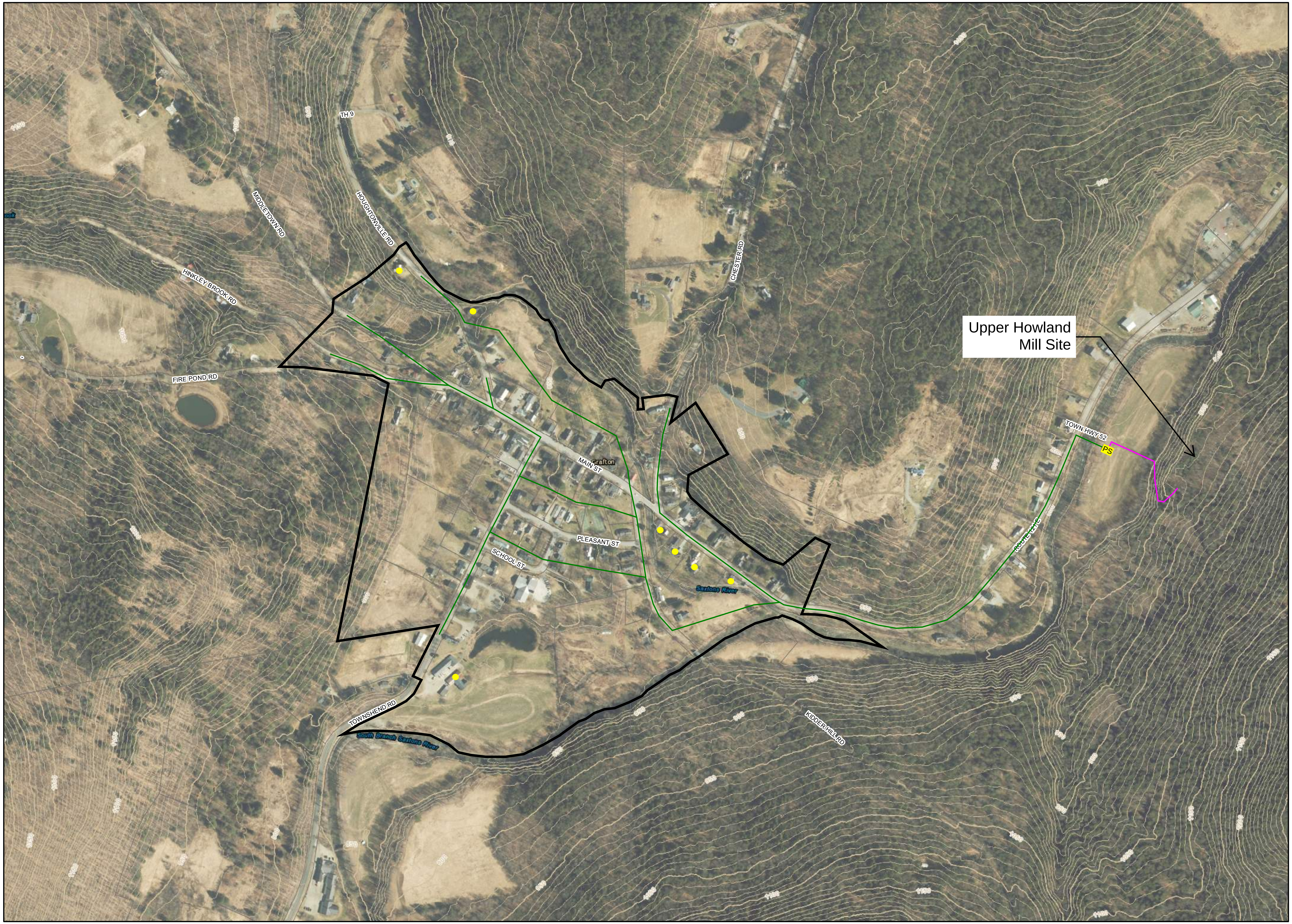
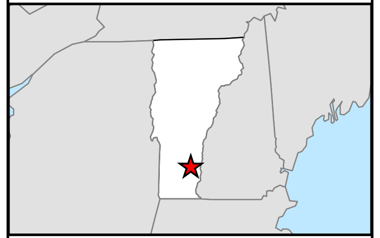


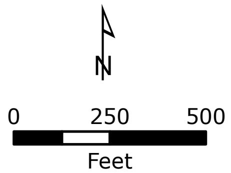
FIGURE A.9a PRELIMINARY COLLECTION SYSTEM LAYOUT

Legend

- Parcel Boundary
- Proposed District
- Gravity Sewer
- Pressure Sewer
- Grinder Pump
- PS Pump Station

LOCUS MAP





1 in = 500 ft

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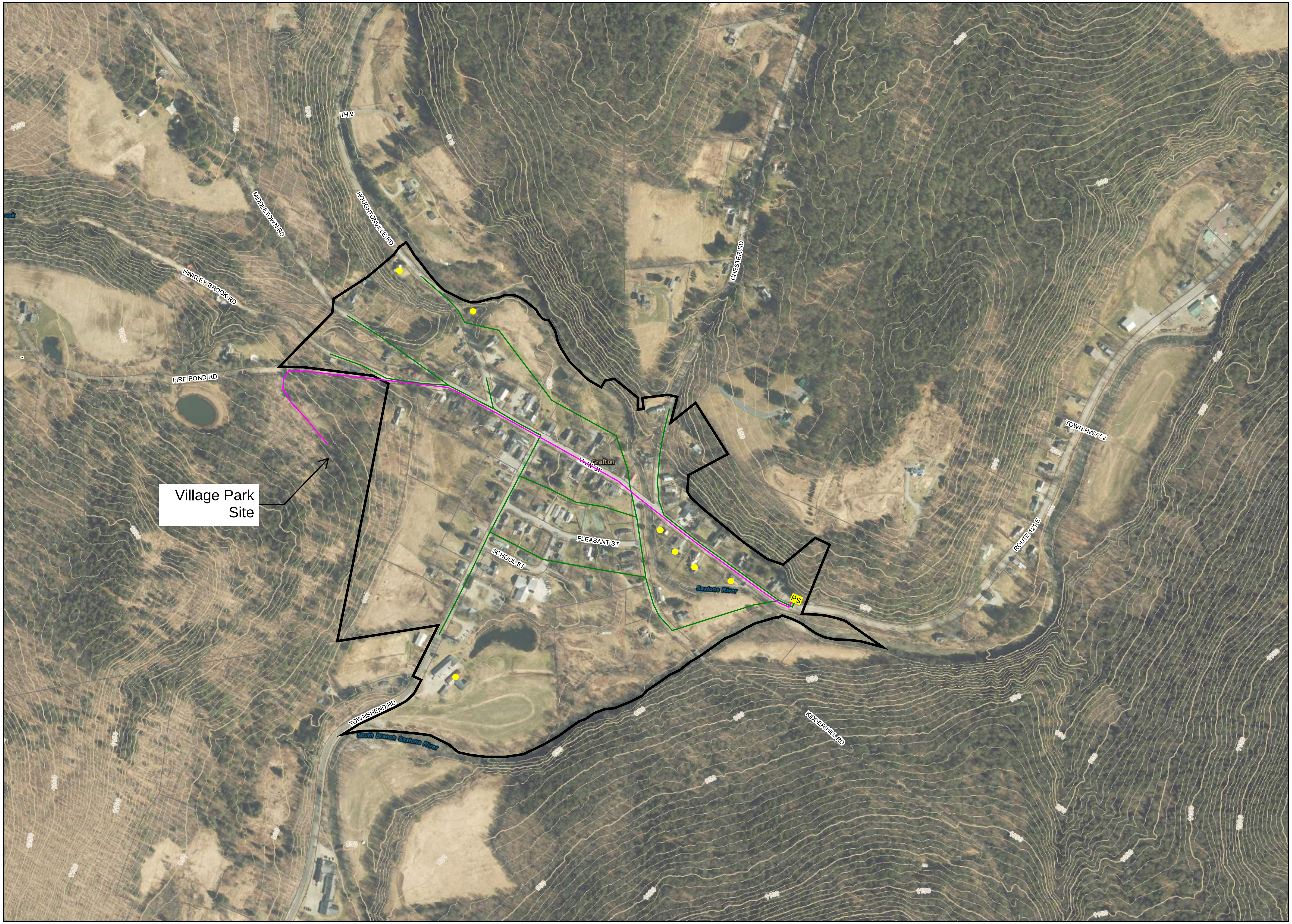
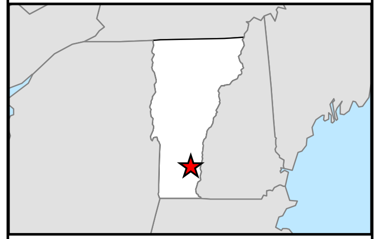


FIGURE A.9b PRELIMINARY COLLECTION SYSTEM LAYOUT

Legend

- Parcel Boundary
- Proposed District
- Gravity Sewer
- Pressure Sewer
- Grinder Pump
- PS Pump Station

LOCUS MAP



N

0 250 500

Feet

1 in = 500 ft

NOTES

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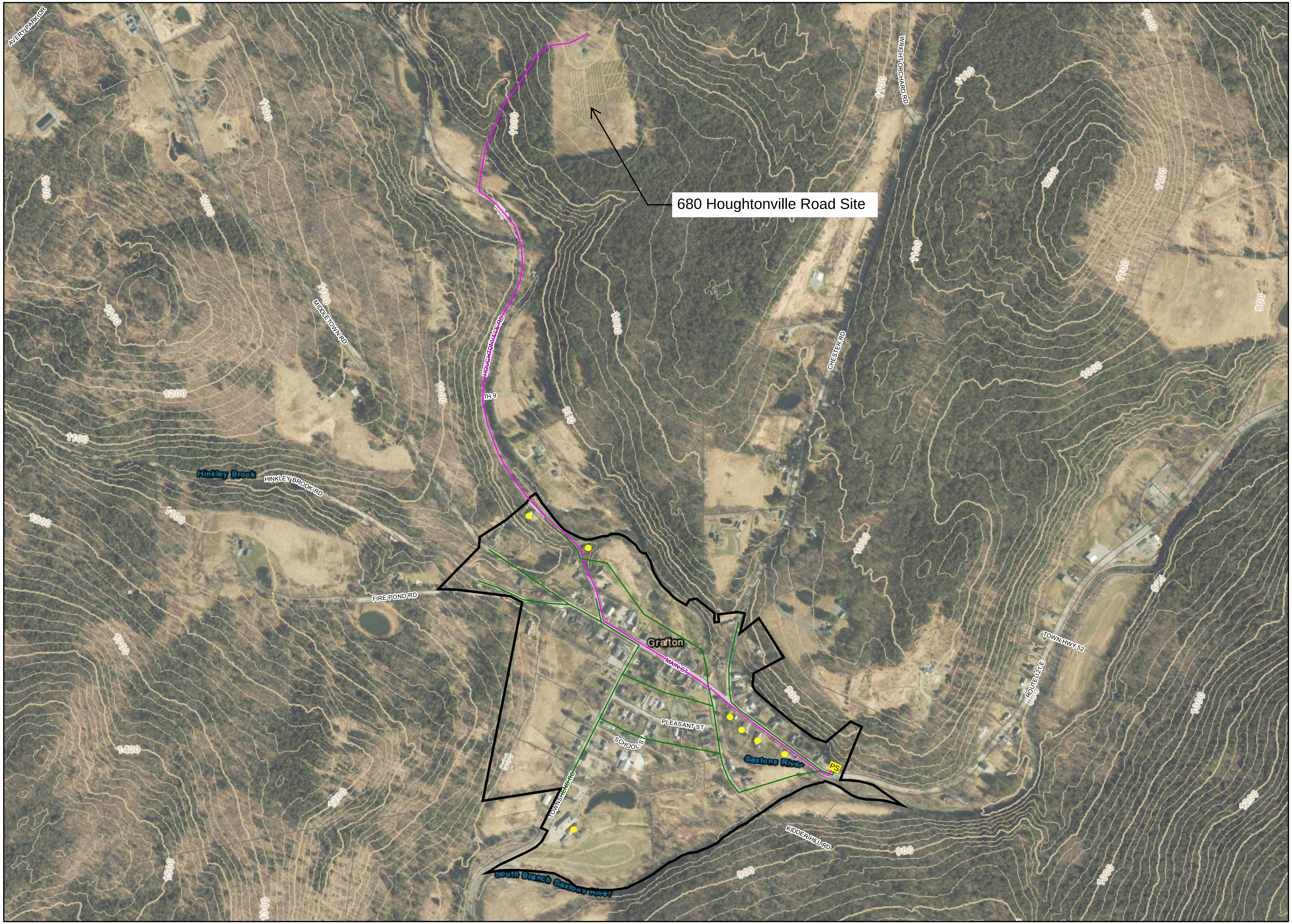
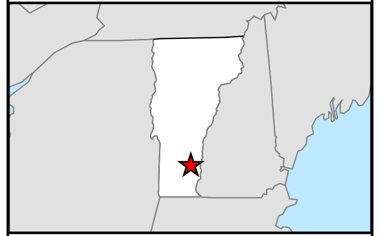
FIGURE A.9c PRELIMINARY COLLECTION SYSTEM LAYOUT



Legend

- Parcel Boundary
- Proposed District
- Gravity Sewer
- Pressure Sewer
- Grinder Pump
- PS Pump Station

LOCUS MAP



N

0 325 650

Feet

1 in = 650 ft

NOTES

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2. Tax parcel boundaries provided by State of Vermont Geodata Portal.
3. Soil data provided by USDA Natural Resource Conservation Service.
4. Hydrography data provided by USGS.
5. Wetland data provided by US Fish and Wildlife Service and CUGIR.
6. Flood zone data provided by the Federal Emergency Management Agency.
7. Topography data provided by State of Vermont Geodata Portal.

Town of Grafton
Water & Wastewater Study
Grafton, Vermont

July 2024

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G0348-002

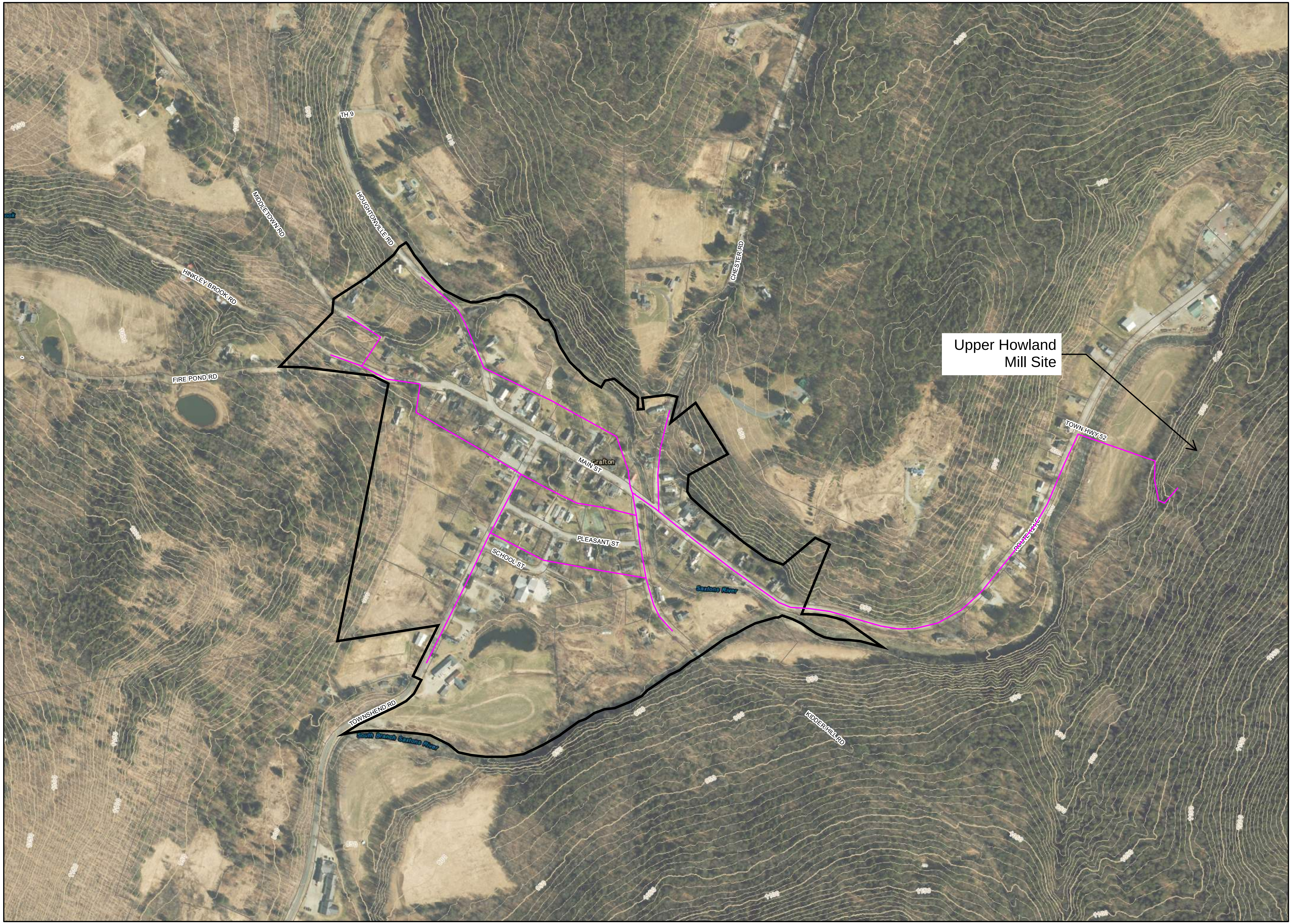
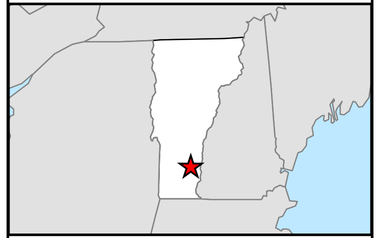


FIGURE A.10a PRELIMINARY COLLECTION SYSTEM LAYOUT

Legend

- Parcel Boundary
- Proposed District
- Pressure Sewer

LOCUS MAP



N

0 250 500

Feet

1 in = 500 ft

NOTES

1. Ortho imagery based on ESRI World Imagery.
2. Tax parcel boundaries provided by State of Vermont Geodata Portal.
3. Soil data provided by USDA Natural Resource Conservation Service.
4. Hydrography data provided by USGS.
5. Wetland data provided by US Fish and Wildlife Service and CUGIR.
6. Flood zone data provided by the Federal Emergency Management Agency.
7. Topography data provided by State of Vermont Geodata Portal.

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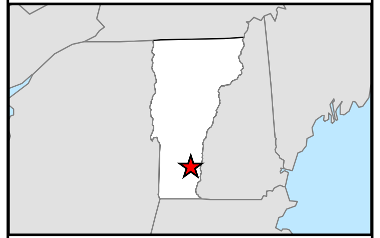
G0348-002

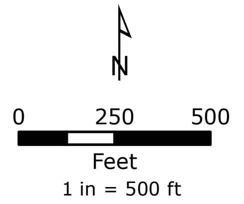
FIGURE A.10b PRELIMINARY COLLECTION SYSTEM LAYOUT

Legend

- Parcel Boundary
- Proposed District
- Pressure Sewer

LOCUS MAP





NOTES

1. Ortho imagery based on ESRI World Imagery.
2. Tax parcel boundaries provided by State of Vermont Geodata Portal.
3. Soil data provided by USDA Natural Resource Conservation Service.
4. Hydrography data provided by USGS.
5. Wetland data provided by US Fish and Wildlife Service and CUGIR.
6. Flood zone data provided by the Federal Emergency Management Agency.
7. Topography data provided by State of Vermont Geodata Portal.

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G0348-002

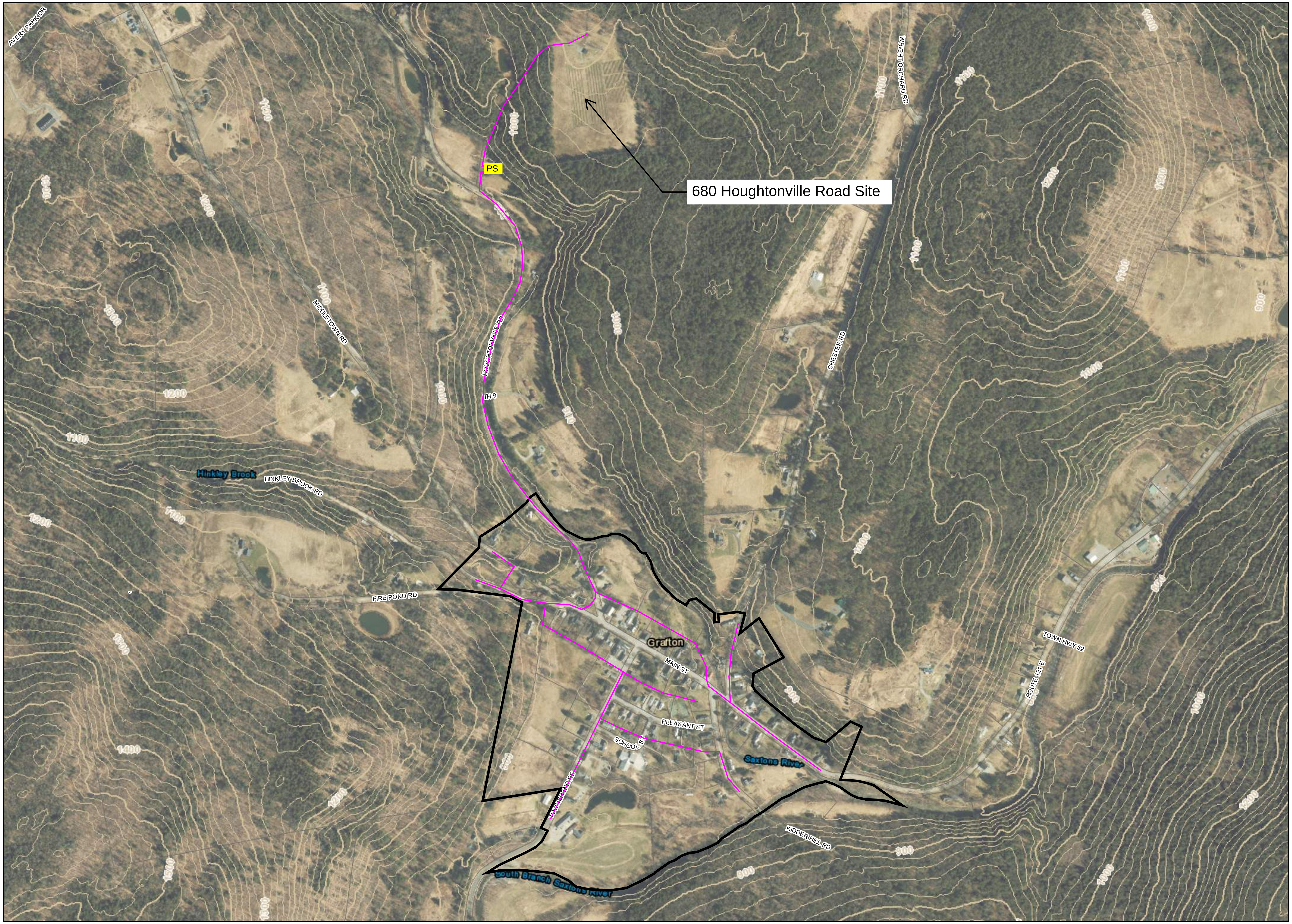
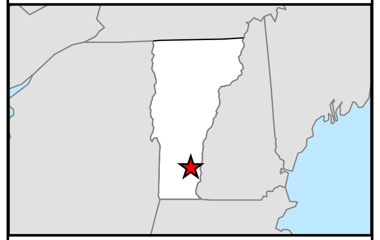


FIGURE A.10c PRELIMINARY COLLECTION SYSTEM LAYOUT

Legend

- Parcel Boundary
- Proposed District
- Pressure Sewer
- PS Pump Station

LOCUS MAP



N

0 325 650

Feet

1 in = 650 ft

NOTES

1. Ortho imagery based on ESRI World Imagery.
2. Tax parcel boundaries provided by State of Vermont Geodata Portal.
3. Soil data provided by USDA Natural Resource Conservation Service.
4. Hydrography data provided by USGS.
5. Wetland data provided by US Fish and Wildlife Service and CUGIR.
6. Flood zone data provided by the Federal Emergency Management Agency.
7. Topography data provided by State of Vermont Geodata Portal.

Town of Grafton
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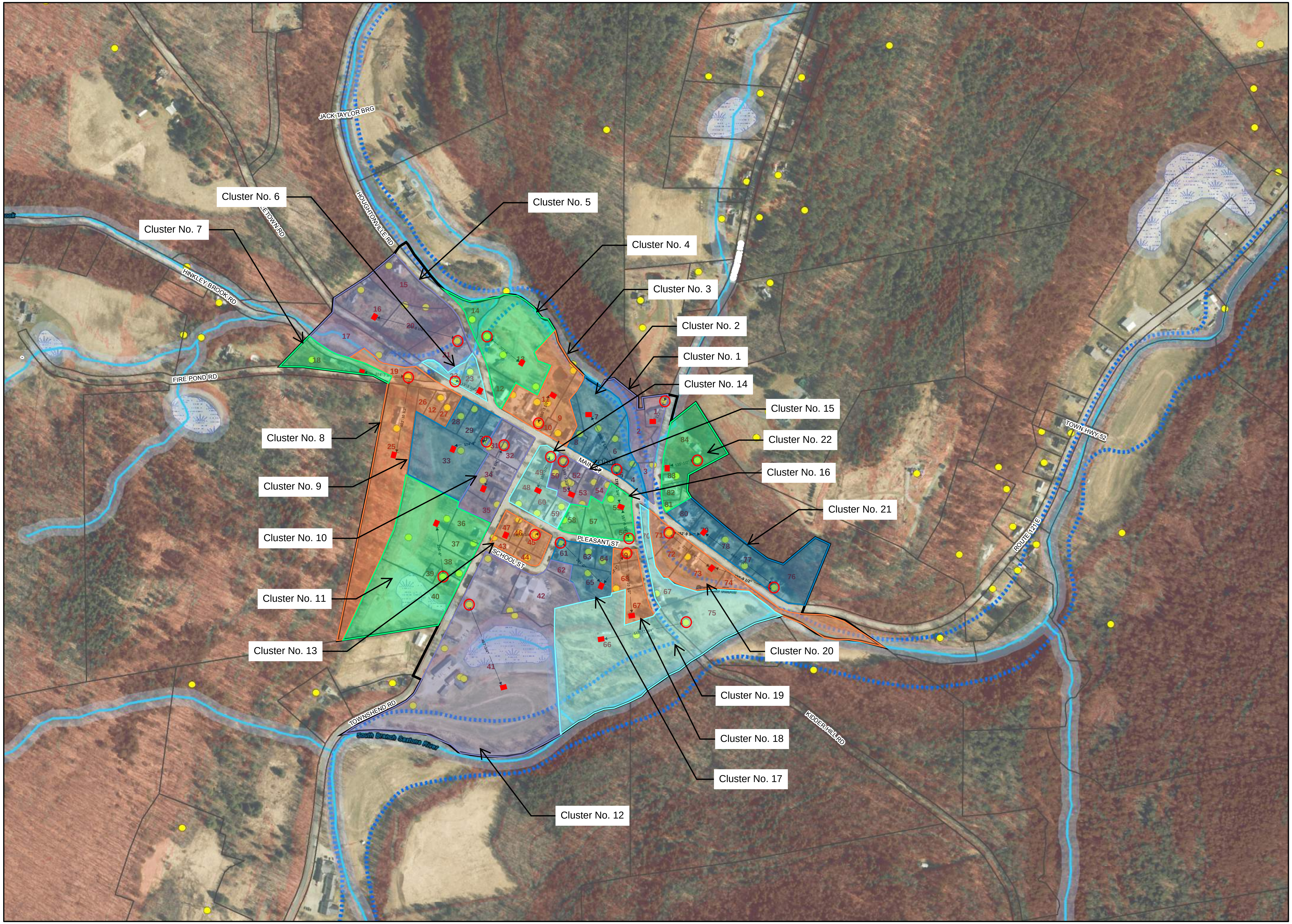
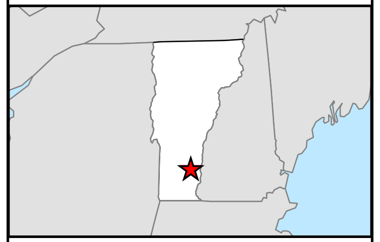
FIGURE A.11 PRELIMINARY CLUSTER SYSTEM LAYOUT



Legend

- Parcel Boundary
- Private Wells
- Stream/River
- Wetland/Surface Water
- 50' SW Buffer
- Flood Zone
- > 20% Slope
- Service Area
- Cluster System
- Well to Remain
- Potential Septic Locat.

LOCUS MAP



N

0 250 500

Feet

1 in = 500 ft

NOTES

1. Ortho imagery based on ESRI World Imagery.
2. Tax parcel boundaries provided by State of Vermont Geodata Portal.
3. Soil data provided by USDA Natural Resource Conservation Service.
4. Hydrography data provided by USGS.
5. Wetland data provided by US Fish and Wildlife Service and CUGIR.
6. Flood zone data provided by the Federal Emergency Management Agency.
7. Topography data provided by State of Vermont Geodata Portal.

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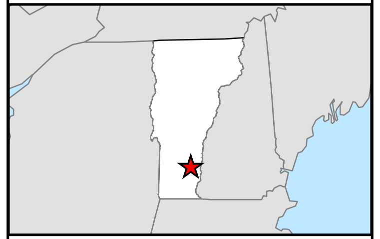
G0348-002

FIGURE A.12 PRELIMINARY DRINKING WATER SYSTEM LAYOUT

Legend

- Parcel Boundary
- Proposed District
- Water Main
- Drilled Well
- Wellhouse
- Water Storage Tank

LOCUS MAP



0 250 500
Feet
1 in = 500 ft

NOTES

1. Ortho imagery based on ESRI World Imagery.
2. Tax parcel boundaries provided by State of Vermont Geodata Portal.
3. Soil data provided by USDA Natural Resource Conservation Service.
4. Hydrography data provided by USGS.
5. Wetland data provided by US Fish and Wildlife Service and CUGIR.
6. Flood zone data provided by the Federal Emergency Management Agency.
7. Topography data provided by State of Vermont Geodata Portal.

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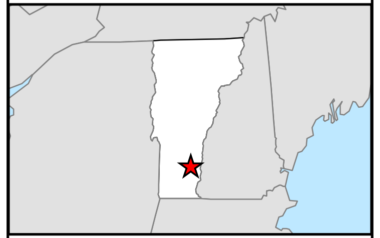
G0348-002

FIGURE A.13
ALTERNATIVE NO. 2
PRELIMINARY LAYOUT

Legend

- Parcel Boundary
- Stream/River/Brook
- 150' Stream Buffer
- Standing Water
- 200' Buffer
- Wells
- 200' Buffer
- Water Main
- Sewer Main
- Process Tank/Unit
- Building
- Drip Dispersal Zone
- Water Storage Tank

LOCUS MAP



N

0 50 100
Feet
1 in = 100 ft

NOTES

1. Ortho imagery based on ESRI World Imagery.
2. Tax parcel boundaries provided by State of Vermont Geodata Portal.
3. Soil data provided by USDA Natural Resource Conservation Service.
4. Hydrography data provided by USGS.
5. Wetland data provided by US Fish and Wildlife Service and CUGIR.
6. Flood zone data provided by the Federal Emergency Management Agency.
7. Topography data provided by State of Vermont Geodata Portal.

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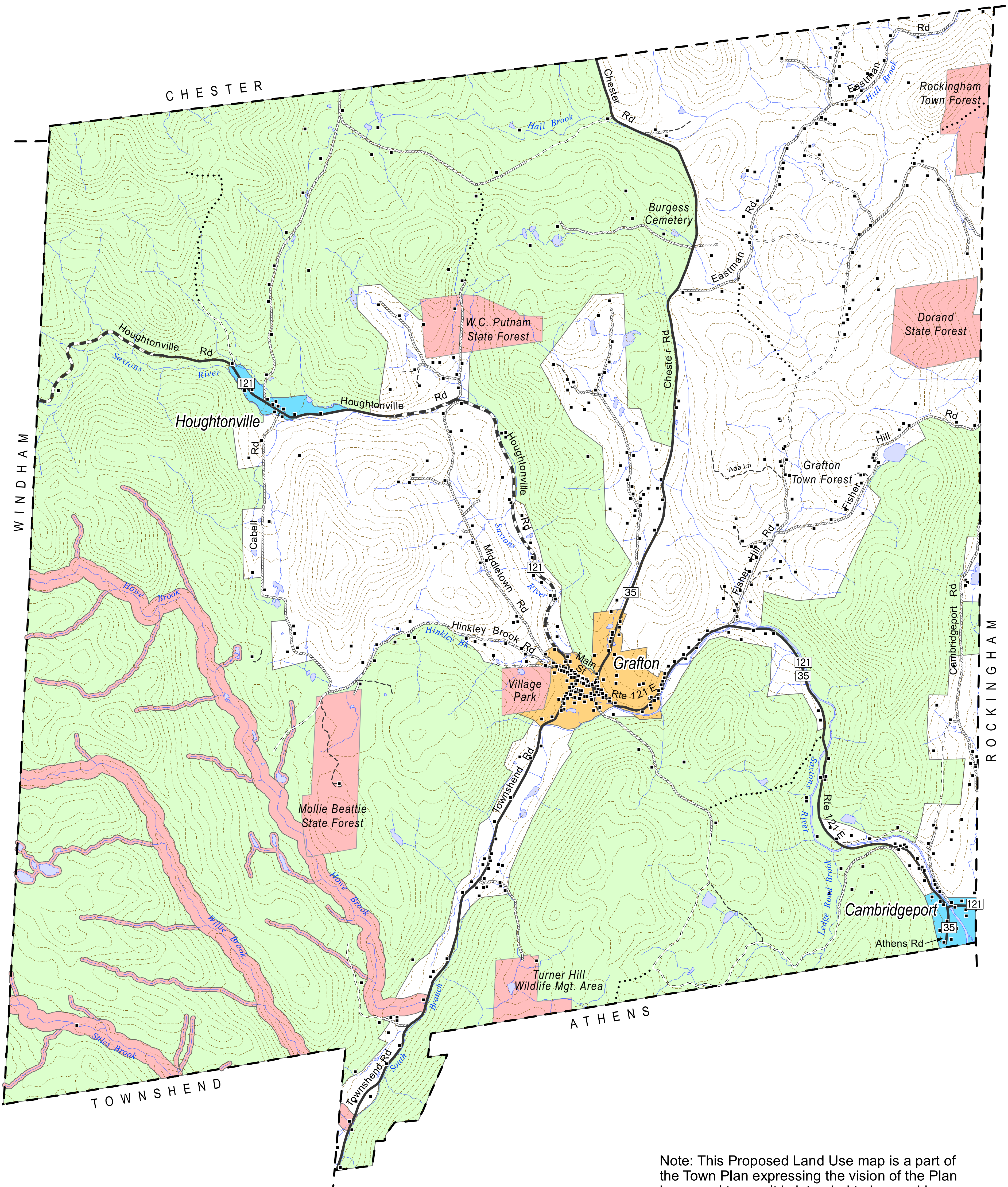
G0348-002

APPENDIX B



Note: This Proposed Land Use map is a part of the Town Plan expressing the vision of the Plan in general terms. It is intended to be used in concert with the Plan's policies to articulate the desired future for the town. This map is for planning purposes and general reference only.

Proposed Land Use
Town of Grafton, Vt.
November 2018

Critical resource area
Resource lands
Rural residential
Village
Productive rural
50-foot contour
structure

paved roads
unpaved roads
Stream
Pond or river

Vermont Geographic Information System
WINDHAM REGIONAL COMMISSION
139 Main St • Suite 505 • Brattleboro, VT 05301
(802) 257-4547 www.windhamregional.org

0.5 0 0.5 1 1.5 Miles
1:42,000

November 2018; u:\GIS\Towns\Grafton\TP2019_PLU.mxd

Tighe&Bond

APPENDIX C

2020 Residential Survey Summary

	Survey Data - Residential					Page 1				Question 1		Question 2		Question 3 - use an "x" if survey box is checked									Question 4 - use an "x" if box is checked									Q5	Q6		Q7	Q. 8	Q1	Q2	Any other notes?	
	Plot #	Location	Name	Pumping Year	Team	Residency / Property Type	How Long? Yrs.	Full / Part time	total bedrooms?	Existing System Installed around	or Specific Year	Size	Material	Leach Field	Drywell	Mound System	Grease Trap	Garbage Disposal	Alternative	Other	Alt. /other? Describe	Don't Know/None	Sewage on Ground?	Wetness?	Back-up in Basement?	Sump Pump?	Sump Pump to Septic?	Sewage smells?	Sink holes?	Resolved? Yes / No	None	Last Pumped	Other Routine Maintenance?	Additives / Filter?	Entirely On Property?	Shared System?	Capacity limited you?	Thoughts / ideas?	Use this box to make any other notes about the survey	Permit #
1	62	94 Houghtonville Rd.	Holyoak	2023	Paul	Grafton Residence	5	Part Time	3	2000-2020		1000	concrete	1																		2020							Plan to replace failed leach field	
2	63	77 Houghtonville Rd.	Wiske	2023	Paul	Grafton Residence	<1	Part Time	4	2000-2020		1000	concrete	1	1											no						2019	no		yes	no	no		Perhaps add 1BR/1Bath apartment ; not sure current septic will accommodate	
3	64	3 Main St.	Watson	2023	Paul	Grafton Residence	20	Full Time	3	don't know	2014	1000	concrete		1						800 gallon					no						2019	no		yes	no	no			
4	65	Main Street 17	Alford	2022	Meg	Grafton Residence	10	Full Time	3	2000-2020	2014	don't know										Don't know									no	2018	no		yes	no	no	no		
5	71	Main St. 133	Kastner	2021	Meg	Grafton Residence	<1	Full Time	3	2000-2020		1000	concrete	1											no	yes	no					2020	no		DK	yes	no		shared with Town Hall	
6	73	169 Main St	Boswell		Chris	Grafton Residence	12	Part-Time	3	1980-2000	1988	don't know	concrete	1				1								yes	no					2017	no		yes	yes	no			
7	74	Main St 185	Cooley	2022	Meg	Grafton Residence	1.5	Part Time	>4	2000-2020	2019	don't know	don't know	1												no	no					2019	yes	additives	yes	no	no		Replace leach bed	
8	81	Chester Rd. 103	Rettaliata	2020	Paul																											2020								
9	85	Chester Rd. 30	Wallace	2022	Paul	Grafton Residence	19	Full Time	4	1980-2000	1985	1000	concrete	1																		2018	yes	additives	yes	no				
10	86	24 Chester Rd	Durand	2023	Meg	Grafton Residence	17	Part Time	3	2019		1000	fiberglass / plastic	1										yes						yes		2019	no		yes	no	no		Replaced failed septic system	
11	87.1	Route 121 E 21 ME Jones (Garage/Lee)	Windham Foundation (Lee)	2022	Chris	Long Term Rental		Full Time	4	2000-2020	2002	1000	concrete							yes	advantex					yes	no					2018	yes	filter	yes	no	no		Replaced failed septic system with Advantex	
12	88	Route 121 E 43	Rowley	2022	Paul	Grafton Residence	38	Part Time	2	1980-2000		don't know	don't know	1												no	no					2020	yes	additives			no			
13	89	Rte 121 East 67	Moulton	2020	Paul																											2022								
14	90	Rt. 121 E 101	Mass	2020	Paul	Grafton Residence	20	Part-Time	3	2000-2020		don't know	don't know																			2020			yes	no	no			
15	92	108 Rt. 121 E	Schemm	2023	Paul	Grafton Residence	20	Full Time	>4	<1980	1971	1000	concrete	1	1											no						2019	no		yes	no	no			
16	93	58 Route 121 E.	Hard	2023	Paul	Grafton Residence + Short-Term Rental	10	Part Time	4	don't know		don't know	don't know									None										2019	No		yes	no	no			
17	94	Kidder Hill Rd 105	Ellis	2022	Meg	Grafton Residence	14	Full Time	>4	2000-2020	2011	1000	concrete	1						1	pump station										no	2019	no		yes	no	no			
18	95	Rt. 121 E 30	James	2021	Meg	Grafton Residence	7	Full Time	3	<1980	1974	1000	concrete	1	1			1													no	2020	no		yes	no	no			
19	97	Rt. 121 E Clark House - 12	Wolfe/Smith	2020	Chris	Grafton Residence	6	Part Time	2	don't know		don't know	don't know																			2020					no			
20	99	Kidder Hill Rd. 72	Martin	2020	Meg	Grafton Residence	17	Full Time	3	1980-2000	1994	1000	concrete	1																		2020	no		yes	no	no		How many residential properties in the village have a sweage issue? How many of those are owned by WF? If a vote was taken - whole town? Village? Property-taxed people? Who pays? Whole town or village? Can you opt out of hookup? With the exorbitant current tax bills - one more thing will make all of us sell to out-of-staters. If this is primarily to satisfy the businesses (including WF), then they should fund it.	
21	100	Pleasant St. 130	Mandel	2021	Paul	Grafton Residence	2	Part Time	>4	<1980		1000	concrete								behind house	don't know				yes	no					2017	no		yes	no	no			
22	103	Townshend Rd. 193 Grace	WF (Ethan)	2021	Chris	Long Term Rental		Full Time	2	don't know		1000	concrete	1												no						2017	no		yes	no	no			
23	104	Townshend Rd. 151 Gallery North Star	WF (North Star Gallery)	2022	Chris	Recently Sold			4	1986		1000	concrete	1												no						2018	no		yes	no	no		Septic failure in 1986	
24	105	15 School Street	Daigle	2023	Meg																											2019								
25	106	47 School Street	Pape	2023	Paul																											2022								
26	107.1	70 School Street	Bonin	2023	Meg	Grafton Residence	9	Part Time	3	2000-2020		1000	don't know	1												yes	no					2018	no		yes	no	yes	yes		
27	108	108 Pleasant Street	Otis	2022	Paul	Grafton Residence		Part Time		2009		500	concrete							yes						yes	no					2018	yes		yes	no	yes		Replaced failed wastewater system; annual inspection required	
28	109	94 Pleasant Street	Conklin/McLean	2020	Paul	Grafton Residence	<1	Full Time	3	don't know		1000	concrete													yes						2020	no		yrs	no	no			
29	110	66 Pleasant St.	Feder	2020	Meg	Grafton Residence + Short-Term Rental	5	Full Time	>4	<1980		1000	concrete			1		1		1	Composter					yes	no				no	2020	no		yes	no	no	yes		
30	111	30 Pleasant Street Elrick (Campion)	WF (Campion)	2022	Chris	Long Term Rental		Full Time	1	<1980		1000	concrete	1												yes	no					2018	no		yes	no	no			
31	112	18 Pleasant Street	Welch	2023	Paul	Grafton Residence	5	Full Time	2	1980-2000		1000	concrete	1	1			1								no						2019	yes	filter	yes	no	no			
32	114	Townshend Rd. 69	Stewart	2020	Paul	Grafton Residence	15	Full Time	4																							2020			yes	no	no			
33	117	67 Pleasant St Allard (Middleton)	WF (Middleton)	2021	Chris	Long Term Rental		Full Time	2	2012		1000	concrete	1												yes	no					2017	no		yes	no	no		Replacement wastewater system	
34	119	123 Pleasant Street	Baldwin	2020	Meg	Grafton Residence	19	Part Time	4	1980-2000	2001	1000	concrete	1																	no	2020	no		no	yes	no	no		
35	122	Main Street 194	Bason Trust	2022	Meg	Grafton Residence	6	Part Time	3	don't know		500	don't know	1																		2018	no		yes	no	no			
36	123	Main Street 188 (Lake) (Meg and Mariano)	WF (Meg and Mariano)	2021	Chris	Grafton Residence		Full Time	3	don't know		1000	concrete	1																		2017	no		yes	no	no			
37	125	Main Street 152 Crawford (Aaron)	WF ((Aaron)	2020	Chris	Long Term Rental		Full Time	3	1980-2000		1000	concrete						1		Advantex					yes	no					2020	yes		yes	no	no		Onsite services yearly	
38	126	Main St. 138	Goodfellow	2021	Paul	Grafton Residence	50	Part Time	3	2000-2020		1000	concrete	1							Pump system					yes	no					2017	no		yes	no	no			
39	130	Townshend Road 148	Xander	2020	Chris	Grafton Residence	6	Full Time	3	2000-2020		1000	concrete	1													no					2020	yes	add	yes	no	no		Ridex additive	
40	131	Townshend Rd. 128	Williams	2022	Paul	Grafton Residence	2	Part Time	3	1980-2000		1000	concrete	1																		2018	no		yes	no	no			
41	132	Townshend Rd. 80	Bolton	2021	Meg	Grafton Residence	30	Part Time	3	1980-2000		1000	concrete	1												no						2017	no		yes	no	no			
42	135	Main Street 72 Gilbert (Robinson) (2 apartments)	WF (Robinson 2 Apts)	2021	Chris	Long Term Rental		Full Time	3	don't know		1000	concrete	1												no						2017	no		yes	no	no			
43	136	Main Street 54	Soyster	2022	Paul	Grafton Residence	21	Part Time		don't know		1000	concrete	1												no						2018	no		d/k	no	no			
44	137	Main Street 40	Park	2022	Meg																											2019								
45	138	Main Street 16	Humes	2021	Paul	Grafton Residence	14	Part Time	3	1980-2000		1000	concrete	1											no							2017			yes	no	no			
46	139	Main St. 6	Hartmann	2021	Paul	Grafton Residence + Short-Term Rental	22	Part Time	2	2017		1000	concrete	1													no					2017	yes	additives	yes	no	no		Rid Ex; New leach field 2019; Village as "road salt free zone"	
47	142	Hinkley Brook Rd. 30	Cooperman	2022	Meg	Grafton Residence	33	Full Time	>4	<1980					1																no	2020	no		no	no	yes	yes		
48	143	Middletown Road 67	Cannon	2022	Meg	Grafton Residence		Full Time	4	1980-2000		1500	concrete	1												no						2018	no		yes	no	no	yes		

2020 Commercial Survey Summary

	Survey Data - Commercial / Non-profit					Page 1							Page 2		Question 1			Question 2		estion 3 - use an "x" if survey box is chec									Question 4 - use an "x" if box is checked									Q5	Q6		Q7	Q8	Q1	Q2	Any other notes?		
	Plot #	Location	Name	Pumping Year	Team	Type of Use	If "retail w/ dining"... seating for how many?	If lodging...how many bedrooms?	If "dining w/ lodging"... seating for how many?	2. Number of private bathrooms?	3. Number of public bathrooms?	4. Commercial Kitchen?	5. Kitchenette?	6. Number of staff (empl. and volunteers)	(For school) how many students + staff in a typical year?	Existing System Installed around	or Specific Year	Size	Material	Leach Field	Drywell	Mound System	Grease Trap	Garbage Disposal	Alternative	Other	Alt. /other? Describe	Don't Know / None checked	Sewage on Ground	Wetness	Back-up in Basement	Sump Pump in basement	Sump Pump to Septic?	Sewage smells	Sink holes	Resolved? Yes / No	Don't Know / None checked	Last Pumped	Other Routine Maintenance?	Additives / Filter?	Entirely On Property?	Shared System?	Has capacity limited you?	Thoughts / ideas?	Use this box to make any other notes about the survey, or to record responses to Q1 and Q2 on last page	Permits	Name on Permit
1			Brick Meeting House	N/A	Chris	Non-profit				0	0	no	no	10																															no septic system		
2	140	Main Street 55 - Chapel	Grafton Chapel	2021	Chris	Non-profit	75			0	1	yes	no	10		don't know			don't know	1																		2017	yes	filter	yes	no	yes		have 2 bathrooms		
3	67	Main Street 55 White Church	Grafton Church	2021	Chris	Non-profit				0	2	no	yes	3		don't know		750	concrete																			2017	no		yes	no	no				
4	102	School Sreet 58	Grafton Elementary School	2022	Chris	School				7	2	no	yes		61	1980-2000	1988	3000	concrete	1						1			1									2018			yes	no	no		Septic system includes pump station w/3000 gallon tank. (In addition to the 3000 gallon septic tank).		
5	75	205 Main St	Grafton Historic Post Office	N/A	Chris																																								no septic system		
6	72	147 Main Street	Grafton Historical Society	2020	Chris	Non-profit				1	0	no	no			don't know		1000																				2020									
7	121	204 Main Street	Grafton Library	2020	Chris	Non-Profit				0	1	no	no	9		don't know		don't know	don't know	1												yes	no					2020	no		yes	no	yes		Add to size of footprint		
8	128	Townshend Rd. 186	Grafton Nature Museum	2022	Chris	Non-Profit										specific yr =>	1998	1000	don't know	1																		2018			yes	no	yes		Future plans may be to expand building; add multi-purpose room		
9	70	Main Street 117 Town Hall	Town of Grafton	2022	Chris	Business / Office				1	0	no	yes	2		<1980		1000	concrete	1																		2018			no	no	no				
10	118	Townshend Rd. Laundry/Barn	WF (Laundry/Barn)	2022	Chris	Business / Office				2	2	no	no	6		1980-2000		1250	concrete			1										no	no					2018	no		yes	no	no		Laundry gray water into septic; blueprint?		
11	127	Townshend Rd 17 Barrett	WF (Barrett)	2021	Chris	Lodging				4		no	no			don't know		1000	concrete	1												no	no					2017	no		yes	no	no		septic located in back near Lawyer's Office		
12	107	Blacksmith - 72 School Street	WF (Blacksmith)	2020	Chris	Retail				0	0	no	no			no water																						2020									
13	114	Cricketers	WF (Cricketeers)	2021	Chris	Lodging		3		3	0	no	no			<1980		1000	concrete	1												no	no					2017	no		yes	no	no		Septic located off corner of patio		
14	103	Townshend Rd. 193 Grace	WF (Foundation Office)	2021	Chris	Business / Office				3.5		no	yes	4		<1980		1000	concrete	1												no	no					2017	no		yes	no	no		Septic located to right of front door		
15	87		WF (Garage)			Business / Office					1	no	no	3		<1980		1000	concrete	1	2											no	no						no		yes	no	no		2 drywells tied together		
16	69	Main St. 79 Homestead	WF (Homestead)	2022	Chris	Lodging				20			yes			1980-2000	1981	1500	concrete			1										no	no					2018	yes		yes	no	no		pump 2x a year; mound system at Whitegates		
17	133	Townshend Road 56 (Mercantile/Cheese Store	WF (Mercantile/Cheese Store)	2021	Chris	Retail				2	1	no	no	2		<1980		1000	concrete	1												no	no					2017	no		yes	no	no		off side of patio		
18	124	Store - 162 Main Street	WF (MKT)	2023	Chris	Retail with Dining	20			1	1	yes		6		1980-2000		1000	concrete			1	1						1			yes	no					2019	yes		yes	no	no		Grease Trap; Advantex. Clean filters.	WW-2-0517-2	WF/MKT
19	116	Pleasant St 55 Nursery	WF (Nursery)	2022	Chris	Retail				1		no	no	1		<1980		other	concrete	1												yes	no					2018	no		yes	no	no		750 gal septic in Middleton's driveway		
20	76	Old Firehouse - 217 Main Street	WF (Old Firehouse)	2020	Chris	Retail				0																												2020									
21	134	Main Street 92 Tavern	WF (Tavern)	2022	Chris	Dining with Lodging				16		yes				1980-2000	1999	other	concrete			1	1									no	no					2020	yes		yes	no	no		4,700G, 1,000G, 3,000G pumping station; GT side of patio		
22	115	Tuttle - 26 Pleasant St	WF (Tuttle)	2023	Chris	Lodging		4		4		no	yes			<1980		1000	concrete	1												no	no					2019	no		yes	no	no		behind house		
23	66	White Gates - 62 Houghtonville Rd	WF (White Gate)	2023	Chris	Lodging		5		6			yes			don't know		1000	concrete	1												no	no					2019			yes	no	no				
24	113	Woodard - 87 Townshend Rd	WF (Woodard)	2023	Chris	Lodging		3		3	0	no	yes			<1980		1000	concrete	1												no	no					2019	no		yes	no	no		septic back of house left side		

APPENDIX D

Town of Grafton, VT
Service Area Parcel Summary Table
Updated - July 2024

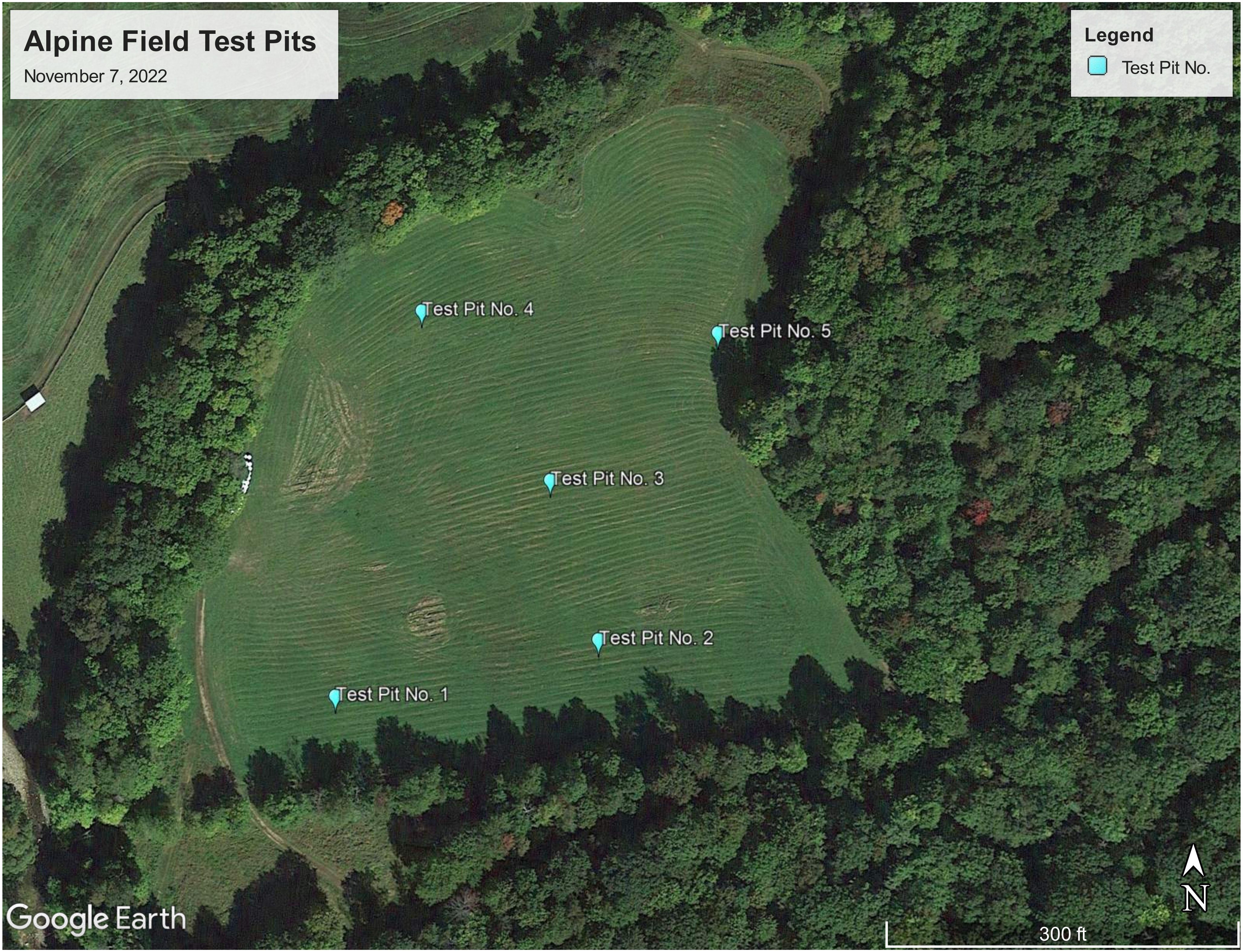
Map ID No.	Parcel ID No.	Parcel Address	Primary Owner Name	Lot Size (Ac)	Land Use Type	Category	Total Assessed Value	Base Design Flow	No. Residential ERUs	No. of Commercial ERUs
1	008081.	103 Chester Rd	Rettaliata, Mary A	0.25	1 Family Res	Residential	$290,200	490	1	0
2	008079.	63 Chester Road	Brianne Grady	1.25	1 Family Res	Residential	$309,100	280	1	0
3	008078.	47 Chester Road	Robert N Grady	0.20	1 Family Res	Residential	$283,900	280	1	0
4	008076.	217 Main Street	The Windham Foundation inc	0.25	Comm	Commercial	$152,000	0	0	1
5	008075.	205 Main Street	Thomas Evans Jr Foundation	0.02	Comm	Commercial	$37,900	0	0	1
6	008074.	185 Main Street	Eaglebrook VT Trust	0.54	1 Family Res	Residential	$677,700	630	1	0
7	008073.	169 Main Street	Fredric R Boswell	2.00	1 Family Res	Residential	$816,600	420	1	0
8	008072.	147 Main Street	Grafton Historical Society	0.25	Comm	Commercial	$256,000	110	0	1
9	008071.	133 Main Street	Igor Alexander	1.00	1 Family Res	Residential	$403,300	490	1	0
10	008070.	117 Main Street	Town of Grafton	0.25	Ex-Town	Commercial	$363,000	120	0	1
11	008068.	91 Main Street	The Windham Foundation inc	1.25	Comm	Commercial	$1,226,600	1,980	0	4
12	008067.	55 Main Street	Grafton Church Corp	0.73	Ex-Oth	Commercial	$706,000	425	0	1
13	008066.	62 Houghtonville Road	The Windham Foundation inc	4.00	Comm	Commercial	$627,000	440	0	1
14	008062.	94 Houghtonville Road	James A Holyoak	0.50	1 Family Res	Residential	$334,900	420	1	0
15	008060.	191 Houghtonville Road	Robert Kellogg	1.00	1 Family Res	Residential	$328,900	490	1	0
16	008059.	146 Middletown Road	Richard Warren	1.30	1 Family Res	Residential	$518,700	490	1	0
17	008143.	67 Middletown Road	Dorothy Cannon	2.00	1 Family Res	Residential	$448,000	490	1	0
18	008058.	111 Hinkley Brook Road	Asok Patnaik	0.86	1 Family Res	Residential	$423,000	420	1	0
19	008142.	30 Hinkley Brook Road	Patrick M Cooperman	1.00	1 Family Res	Residential	$318,400	840	2	0
20	NA	NA	Town of Grafton	NA	#N/A	Vacant	NA	0	0	0
21	008063.	77 Houghtonville Road	Gregory J Wiske	2.00	1 Family Res	Residential	$551,000	560	1	0
22	008064.	3 Main Street	Williak D Watson	0.38	1 Family Res	Residential	$244,200	420	1	0
23	008065.	17 Main Street	Frances H Alford	0.29	1 Family Res	Residential	$665,000	630	1	0
24	NA	NA	NA	NA	#N/A	Vacant	NA	0	0	0
25	008145.	33 Hinkley Brook Road	Stephen Keegan	5.00	1 Family Res	Residential	$429,200	490	1	0
26	008141.	2 Main Street	Grafton Historical Society	0.75	Ex-Oth	Commercial	$489,300	0	0	1
27	008139.	6 Main Street	Jud Hartman	0.25	1 Family Res	Residential	$361,300	280	1	0
28	008138.	16 Main Street	Jud Hartman	0.25	1 Family Res	Residential	$340,300	420	1	0
29	008137.	40 Main Street	Arthur Park	0.50	1 Family Res	Residential	$380,700	770	2	0
30	008136.	54 Main Street	Trustee Thomas Soyster	0.25	1 Family Res	Residential	$413,500	490	1	0
31	008135.	72 Main Street	The Windham Foundation inc	0.50	Comm	Commercial	$464,100	500	0	1
32	008134.	92 Main Street	The Windham Foundation inc	0.50	Comm	Commercial	$1,154,100	4,210	0	9
33	008144.	Main Street	Grafton Improvement Assoc	3.10	Woodlnd	Vacant	$7,700	0	0	0
34	008133.	56 Townshend Road	The Windham Foundation inc	1.00	Comm	Commercial	$370,400	230	0	1
35	008132.	80 Townshend Road	Robert B Bolton Trustee	0.78	1 Family Res	Residential	$333,200	420	1	0
36	008131.	128 Townshend Road	Robert B Williams	0.50	1 Family Res	Residential	$394,200	420	1	0
37	008130.	148 Townshend Road	Brian Xander	0.50	1 Family Res	Residential	$342,900	420	1	0
38	008147.	170 Townshend Road	Trustee Joseph Pollio Jr	5.50	1 Family Res	Residential	$494,800	490	1	0
39	008128.1	178 Townshend Road	Vermont Telephone Co Inc	0.25	Comm	Commercial	$139,200	13	0	1
40	008128.	186 Townshend Road	Grafton Museum Natural History	4.03	Comm	Commercial	$351,300	150	0	1
41	008177.	533 Townshend Road	The Windham Foundation inc	828.20	Comm	Commercial	$3,332,400	1,920	0	4
42	008102.	58 School Street	Town of Grafton	1.00	Ex-Town	Commercial	$1,516,000	915	0	2
43	008105.	15 School Street	Jocelyn P Brown	0.50	1 Family Res	Residential	$328,100	280	1	0
44	008106.	47 School Street	Samuel F Provo Jr	0.50	1 Family Res	Residential	$382,800	420	1	0
45	008111.	30 Pleasant Street	The Windham Foundation inc	0.75	1 Family Res	Residential	$206,000	140	1	0
46	008112.	18 Pleasant Street	Suzanne Welch	0.25	1 Family Res	Residential	$339,900	280	1	0
47	008113.	87 Townshend Road	The Windham Foundation inc	0.25	Comm	Commercial	$269,200	420	0	1
48	008114.	69 Townshend Road	Trust Margaret N Stewart	0.44	1 Family Res	Residential	$320,000	490	1	0
49	008127.	17 Townshend Road	The Windham Foundation inc	0.50	Comm	Commercial	$536,700	330	0	1
50	008126.	138 Main Street	Charles C Goodfellow III	0.50	1 Family Res	Residential	$230,700	420	1	0
51	008125.	152 Main Street	The Windham Foundation inc	0.50	1 Family Res	Residential	$264,000	420	1	0
52	008124.	162 Main Street	162 Main Street LLC	0.23	Comm	Commercial	$389,900	578	0	1
53	008123.	188 Main Street	The Windham Foundation inc	0.37	1 Family Res	Residential	$292,800	420	1	0
54	008122.	194 Main Street	Trustee Robert and Carol Bason	0.25	1 Family Res	Residential	$345,700	420	1	0
55	008121.	204 Main Street	Grafton Public Library	0.75	Ex-Town	Commercial	$515,000	140	0	1
56	008119.	123 Pleasant Street	Prouty House LLC	0.25	1 Family Res	Residential	$308,500	490	1	0
57	008118.	Pleasant Street	The Windham Foundation inc	0.52	Misc LND	Vacant	$40,100	0	0	0
58	008117.	67 Pleasant Street	The Windham Foundation inc	0.25	1 Family Res	Residential	$240,500	280	1	0

Town of Grafton, VT
Service Area Parcel Summary Table
Updated - July 2024

Map ID No.	Parcel ID No.	Parcel Address	Primary Owner Name	Lot Size (Ac)	Land Use Type	Category	Total Assessed Value	Base Design Flow	No. Residential ERUs	No. of Commercial ERUs
59	008116.	55 Pleasant Street	The Windham Foundation inc	0.31	Comm	Commercial	$195,300	95	0	1
60	008115.	26 Pleasant Street	The Windham Foundation inc	0.38	Comm	Commercial	$386,500	490	0	1
61	008110	66 Pleasant Street	Mary Feder	0.45	1 Family Res	Residential	$502,800	630	1	0
62	008107.	72 School Street	The Windham Foundation inc	0.16	Comm	Commercial	$77,700	0	0	1
63	008109.	94 Pleasant Street	Katherine C Conklin	0.25	1 Family Res	Residential	$248,200	420	1	0
64	008108.	108 Pleasant Street	Kim Otis	0.26	1 Family Res	Residential	$331,100	280	1	0
65	008107.1	70 School Street	Charles Bonin	2.40	1 Family Res	Residential	$403,600	420	1	0
66	008182.	136 Kidder Hill Road	S Neil Brailsford	6.10	2 Family Res	Residential	$264,200	490	2	0
67	008094.	105 Kidder Hill Road	Patricia Ellis	1.50	1 Family Res	Residential	$437,100	560	1	0
68	008099.	72 Kidder Road	Denise C Martin	0.75	1 Family Res	Residential	$435,000	490	1	0
69	008100.	130 Pleasant Street	Robert Mandel	0.25	1 Family Res	Residential	$492,700	560	1	0
70	008098	NA	Town of Grafton	0.50	#N/A	Vacant	$4,500	0	0	0
71	008097.	12 Route 121 East	Kevin Wolfe	0.25	1 Family Res	Residential	$261,100	280	1	0
72	008095.	30 Route 121 East	Michele Kramer	0.50	1 Family Res	Residential	$511,000	420	1	0
73	008093.	58 Route 121 East	Douglas Hard	1.00	1 Family Res	Residential	$449,400	490	1	0
74	008092.	108 Route 121 East	Christopher Schemm Life Estate	0.25	1 Family Res	Residential	$236,200	490	1	0
75	009036.1	135 Kidder Hill Road	Neil S Brailsford	2.50	1 Family Res	Residential	$404,200	490	1	0
76	008091.	145 Route 121 East	Gravelle, Leonard	3.00	1 Family Res	Residential	$479,800	630	1	0
77	008090.	101 Route 121 East	Mass, Rosa W	1.00	1 Family Res	Residential	$371,800	490	1	0
78	008089.	67 Route 121 East	Moulton, Bruce	0.50	1 Family Res	Residential	$362,700	560	1	0
79	008088.	43 Route 121 East	Rowley, Judith	0.50	1 Family Res	Residential	$367,100	280	1	0
80	008087.	21A Route 121 East	The Windham Foundation inc	2.00	Comm	Commercial	$398,000	289	0	1
81	008087.1	8 Chester Road	The Windham Foundation inc	0.50	1 Family Res	Residential	$277,800	490	1	0
82	008086.	24 Chester Road	Durand, Raymond J	0.25	1 Family Res	Residential	$318,100	420	1	0
83	008085.	30 Chester Road	Revocable Trust Christopher Wallace	0.25	1 Family Res	Residential	$297,300	490	1	0
84	008084.	112 Chester Road	Tammy Bonk	2.20	1 Family Res	Residential	$213,000	280	1	0
							$35,032,100	**38,625**	**59**	**38**

APPENDIX E

Alpine Field Test Pit Logs


Alpine Field Test Pits
November 7, 2022
Legend
Test Pit No.
Test Pit No. 4
Test Pit No. 5
Test Pit No. 3
Test Pit No. 2
Test Pit No. 1
Google Earth
N
300 ft

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

Alpine Field Site
Grafton, Vermont

Test Pit No.	**TP-1**
Page No.	1 of 5
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	11/07/22
		Operator	Cody			Ground Elev.	905 ft
Weather	Sunny, 65 degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 12" Topsoil, Brown Color			M	A	1
1'	12" - 78" Loam, Some Sand, Gray Color			M	A	
2'	Redox at 28"			M	A	2
3'	Groundwater seep at 40".			M		3
4'	Soil moisture increasing with depth.			M		
5'				D		
6'	Total Depth = 6'-6" (78")			D		4
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. 6" - 18" boulders found in approximately first three feet.
2. Redox features were as high as 28".
3. Groundwater seep at 40". Multiple seeps around this depth on the uphill side of the test pit began forming as the test pit remained open.
4. Bedrock was not encountered.

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(X) Encountered
(   ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

Alpine Field Site
Grafton, Vermont

Test Pit No.	**TP-2**
Page No.	2 of 5
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW	Date	11/07/22
		Operator	Cody	Ground Elev.	920 ft
Weather	Sunny, 65 degrees	Make	John D. Model 410J	Time Started	NA
		Capacity	Reach 10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 6" Topsoil, Brown Color			M		
1'	6" - 14" Loam and Sand, Brown Color			M		
2'	Redox at 24".			M		1
3'	14" - 78" Sand, Little Gravel, Grey Color			M		
4'				M		
5'	Soil moisture and gravel content increasing with depth.			M		2
6'				M		3
7'	Total Depth = 6'-6" (78")					
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Redox features were as high as 24".
2. Bedrock was not encountered.
3. Groundwater was not encountered.

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used

TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

J:\G\G0348 Grafton, VT\002 WW PER\Design\Return Systems\Alpine Field Test Pits\[Alpine Field Test Log.xls]TP-2

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

Alpine Field Site
Grafton, Vermont

Test Pit No.	**TP-3**
Page No.	3 of 5
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	11/07/22
		Operator	Cody			Ground Elev.	900 ft
Weather	Sunny, 65 degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 12" Topsoil, Brown Color			M		
1'	12" - 48" Loam, Some Sand, Trace Gravel, Gray Color			M		1
2'	Redox at 18"-20".			M		2
3'	Less sand and more silt than previous test pits Increasing gravel content with depth Total Depth = 4'-0" (48")			M		3
4'						
5'						
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Redox features were as high as 18".
2. Bedrock was not encountered.
3. Groundwater was not encountered.

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used

TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

J:\G\G0348 Grafton, VT\002 WW PER\Design\Return Systems\Alpine Field Test Pits\[Alpine Field Test Log.xls]TP-3

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

Alpine Field Site
Grafton, Vermont

Test Pit No.	**TP-4**
Page No.	4 of 5
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	11/07/22
		Operator	Cody			Ground Elev.	885 ft
Weather	Sunny, 65 degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 12" Topsoil, Some Clay, Brown Color			E		
1'	12" - 48" Loam and Sand, Gray Color Very Moist			E		1
2'	Redox at 18".			E		2
3'	Loam/sand layer is relatively compacted			E		3
4'	Total Depth = 4'-0" (48")					
5'						
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Redox features were as high as 18".
2. Bedrock was not encountered.
3. Groundwater was not encountered.

Test Pit Plan

Volume = ______ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

Alpine Field Site
Grafton, Vermont

Test Pit No.	**TP-5**
Page No.	5 of 5
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	11/07/22
		Operator	Cody			Ground Elev.	895 ft
Weather	Sunny, 65 degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 8" Topsoil, Some Clay, Brown Color 8" - 24" Loam and Sand, Gray Color			M		1
1'	Redox at 12" - 14". Densely compact below redox.			M		2
2'	Total Depth = 2'-0" (24")			M		3
3'						
4'						
5'						
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Redox features were as high as 12".
2. Bedrock was not encountered.
3. Groundwater was not encountered.

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

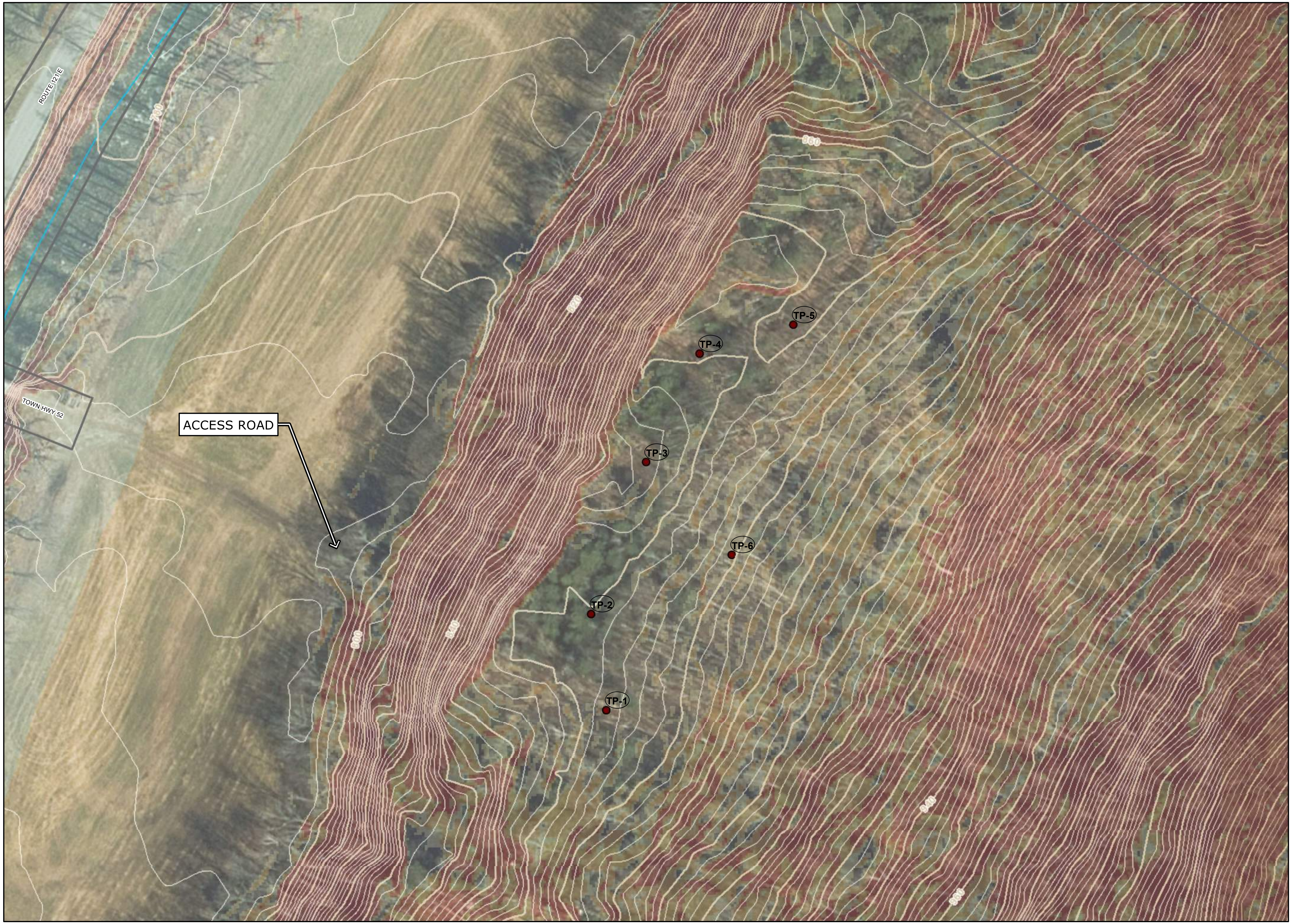
Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Upper Howland Mill Test Pit Logs

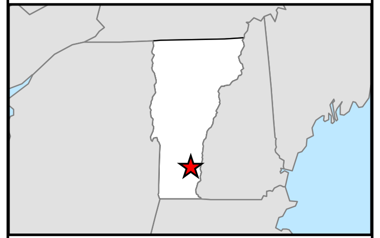


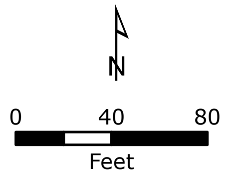
Upper Howland Mill Test Pit Map

Legend

- Parcel Boundary
- Stream/River/Brook
- 150' Stream Buffer
- Test Pit
- < 15% Slope
- 15% - 20% Slope
- 20% - 30% Slope
- > 30% Slope

LOCUS MAP





1 in = 80 ft

NOTES

1. Ortho imagery based on ESRI World Imagery.
2. Tax parcel boundaries provided by State of Vermont Geodata Portal.
3. Soil data provided by USDA Natural Resource Conservation Service.
4. Hydrography data provided by USGS.
5. Wetland data provided by US Fish and Wildlife Service and CUGIR.
6. Flood zone data provided by the Federal Emergency Management Agency.
7. Topography data provided by State of Vermont Geodata Portal.

Town of Grafton
Water & Wastewater Study
Grafton, Vermont

July 2023

Tighe&Bond

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G0348-002

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

Upper Howland Mill Field Site
Grafton, Vermont

Test Pit No.	**TP-1**
Page No.	1 of 6
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/17/23
		Operator	Colby Record			Ground Elev.	873
Weather	Sunny, 40 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	Cobbles in first two feet			D	A/B	
1'	Groundwater seep at 36"			D		
2'				D		
3'	Bedrock at 42". Stopped test pit at this depth and abandoned test pit			D	C	1
4'						
5'						
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Refusal at 42". Moved test pit over a few feet and also encountered refusal. Abandoned test pit.

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(X) Encountered
(   ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

Upper Howland Mill Field Site
Grafton, Vermont

Test Pit No.	**TP-2**
Page No.	2 of 6
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/17/23
		Operator	Colby Record			Ground Elev.	870
Weather	Sunny, 40 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 4" - Horizon O, Decomposed Organics 4" - 10" - Horizon A, Fine Sandy Loam			E		
1'	10" - 44" - Horizon B1, Fine Sandy Loam, Firm Redox at 12"			E		
2'				M		
3'	44" - 50" - Horizon B2, Coarse Sandy Loam			M		
4'	50" - 68" - Horizon B3, Fine Sandy Loam			M		
5'	68" - 80" - Horizon B4, Silty Sand			M		
6'	Total Depth = 6'-8" (80")			D		1
7'	Refusal at 80"					
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Refusal to bedrock at 80". No observed water seeps.

Test Pit Plan

Volume = ______ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

Upper Howland Mill Field Site
Grafton, Vermont

Test Pit No.	**TP-3**
Page No.	3 of 6
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/17/23
		Operator	Colby Record			Ground Elev.	865
Weather	Sunny, 40 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 3" - Horizon O, Decomposed Organics 3" - 9" - Horizon A, Fine Sandy Loam			E		
1'	9" - 19" - Horizon B1, Medium Sandy Loam Redox at 14"			E		
2'	19" - 42" - Horizon B2, Fine Sandy Loam, Firm			M		
3'	42" - 84" - Horizon B3, Gravelly Sandy Loam, Firm			M		
4'	Gravel content increases with depth Groundwater seep at 43"			M		
5'				M		
6'	Total Depth = 7'-0" (84")			M		
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:

Test Pit Plan

Volume = ______ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(X) Encountered
( ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

J:\G\G0348 Grafton, VT\002 WW PER\Design\Return Systems\Upper Howland Mill Field Test Pits\[Upper Howland Mill Field Test Pit Logs.xls]TP-3

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

Upper Howland Mill Field Site
Grafton, Vermont

Test Pit No.	**TP-4**
Page No.	4 of 6
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/17/23
		Operator	Colby Record			Ground Elev.	870
Weather	Sunny, 40 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 4" - Horizon O, Decomposed Organics 4" - 21" - Horizon A, Fine Sandy Loam			E		
1'	21" - 37" - Horizon B1, Medium Sandy Loam Redox at 14"			E		
2'	37" - 54" - Horizon B2, Fine Sandy Loam, Firm			M		
3'	54" - 77" - Horizon B3, Gravelly Sandy Loam, Firm			M		
4'	Gravel content increases with depth Groundwater seep at 43"			M		
5'	Groundwater seep at 55"			M		
6'	Total Depth = 6'-5" (77")			M		
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(X) Encountered
( ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

Upper Howland Mill Field Site
Grafton, Vermont

Test Pit No.	**TP-5**
Page No.	5 of 6
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/17/23
		Operator	Colby Record			Ground Elev.	871
Weather	Sunny, 40 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 4" - Horizon O, Decomposed Organics 4" - 14" - Horizon A, Fine Sandy Loam			E		
1'	14" - 32" - Horizon B1, Medium Sandy Loam Redox at 14"			E		
2'	32" - 50" - Horizon B2, Gravelly Sandy Loam, Firm Gravel content increases with depth			M		
3'	Groundwater seep at 40"			M		
4'	Total Depth = 4'-2" (50")			M		
5'						
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used

TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(X) Encountered
(   ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

Upper Howland Mill Field Site
Grafton, Vermont

Test Pit No.	**TP-6**
Page No.	6 of 6
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/17/23
		Operator	Colby Record			Ground Elev.	880
Weather	Sunny, 40 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 4" - Horizon O, Decomposed Organics 4" - 8" - Horizon A, Fine Sandy Loam			M	A	
1'	8" - 28" - Horizon B1, Fine Sandy Loam Redox at 28"			M		
2'	28" - 84" - Horizon B2, Gravelly Sandy Loam, Firm Gravel content increases with depth			M	A	
3'				M		
4'				M		
5'				M		
6'				M		
7'	Total Depth = 7'-0" (84")			M		1
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. No refusal encountered, no groundwater encountered.

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used

TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(   ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Village Park Test Pit Logs

Soil Test Pit Map
29-Apr-21
Fire Pond Road, Grafton, VT

Soil Test Pit Log

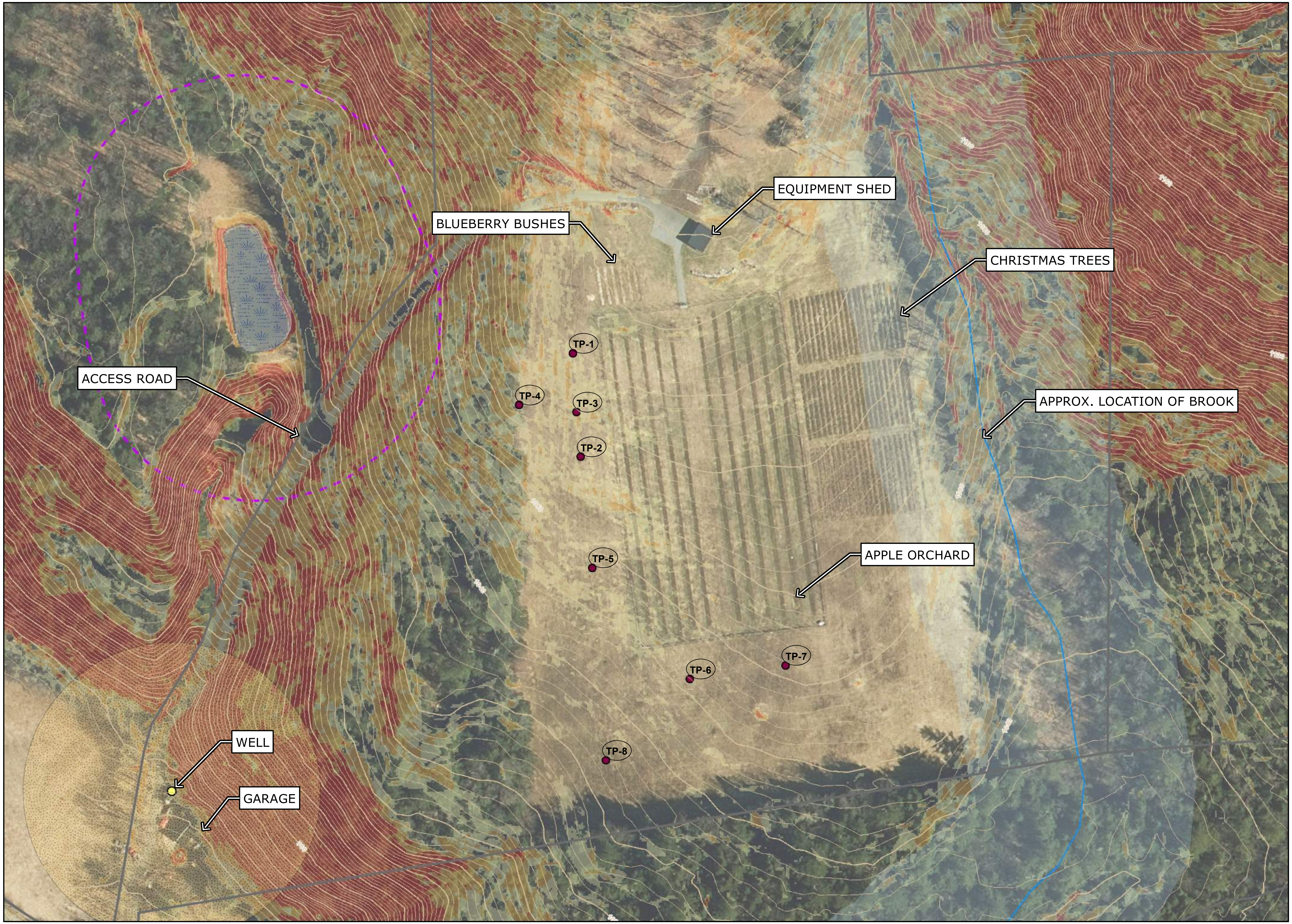
Site: Fire Pond Road, Grafton, VT **Date:** 4/29/2021

Conducted By: Erin Moore, PE **Weather:** Raining

Test Pit #	Depth	Color	Soil Description	Consistency	Groundwater
1	0 - 8"	7.5 YR 3/2	Sandy loam with high organics	Friable, granular structure	No groundwater nor redox features
	8" - 32"	10 YR 4/4	Sandy loam	Friable, granular structure	GW seep observed at 32"
	32" - 34"	6/5GY	Sandy loam	Granular structure, very firm	Thin, dense lens with redox features
	34" - 64"	10 YR 4/3	Sandy Loam with 20% gravel, gravel increasing with depth	Friable, granular structure	Very dry, no groundwater nor redox features
2	0 - 6"	7.5 YR 3/1	Sandy loam with high organics	Friable, granular structure	No groundwater nor redox features
	6" - 28"	10 YR 4/4	Sandy loam	Friable, granular structure	GW seep observed at 28"
	28" - 29"	6/5GY	Sandy loam	Granular structure, very firm,	Thin, dense lens with redox features
	29" - 63"	10 YR 5/2	Sandy Loam with 20% gravel, gravel increasing with depth	Friable, granular structure	Very dry, no groundwater nor redox features
3	0-5"	7.5 YR 3/1	Sandy loam with high organics	Friable, granular structure	No groundwater nor redox features
	5" - 14"	7.5 YR 4/4	Sandy loam	Friable, granular structure	No groundwater nor redox features
	14" - 26"	10 YR 3/4	Sandy loam	Friable, granular structure	GW seep observed at 26"
	26" - 27"	6/5GY	Sandy loam	Granular structure, very firm,	Thin, dense lens with redox features
	27" - 43"	10 YR 5/2	Sandy Loam with 20% gravel, gravel increasing with depth	Friable, granular structure	Large bolder stopped progress @43" (Bedrock not encountered)
4	0-3"	7.5 YR 3/1	Sandy loam with high organics	Friable, granular structure	No groundwater nor redox features
	3" - 43"	7.5 YR 4/4	Sandy loam	Friable, granular structure	GW seep observed at 43"
	43" - 60"	7.5 YR 6/1	Sandy loam, gravel increasing with depth, boulders encountered at 60"	Friable, granular structure	Several GW seeps and redox features throughout this layer

680 Houghtonville Road Test Pit Logs

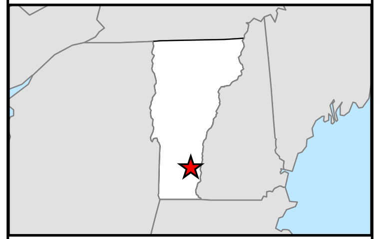
680 Houghtonville Road Test Pit Map



Legend

- Parcel Boundary
- Stream/River/Brook
- 150' Stream Buffer
- Standing Water
- 200' Buffer
- Wells
- 200' Buffer
- Test Pit
- < 15% Slope
- 15% - 20% Slope
- 20% - 30% Slope
- >30% Slope

LOCUS MAP



0 60 120
Feet
1 in = 120 ft

NOTES

1. Ortho imagery based on ESRI World Imagery.
2. Tax parcel boundaries provided by State of Vermont Geodata Portal.
3. Soil data provided by USDA Natural Resource Conservation Service.
4. Hydrography data provided by USGS.
5. Wetland data provided by US Fish and Wildlife Service and CUGIR.
6. Flood zone data provided by the Federal Emergency Management Agency.
7. Topography data provided by State of Vermont Geodata Portal.

Town of Grafton
Water & Wastewater Study
Grafton, Vermont

July 2023

Tighe&Bond

J:\G\G0348 Grafton, VT\002 WW PER\Drawings_Figures\GIS\Spring Hill Farm Site Map.mxd

G0348-002

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

680 Houghtonville Road Site
Grafton, Vermont

Test Pit No.	**TP-1**
Page No.	1 of 8
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/10/23
		Operator	Colby Record			Ground Elev.	1089
Weather	Sunny, 60 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 11" - Horizon O, Fine Sandy Loam			M	A	1
1'	11" - 18" - Horizon A, Fine Sandy Loam			M		
2'	18" - 28" - Horizon B1, Fine Sandy Loam			M		
3'	28" - 62" - Horizon B2, Gravelly Fine Sandy Loam, Firm Gravel content increases with depth			M		
4'	Soil moisture increasing with depth.			D	A	2,3
5'	Total Depth = 5'-2" (62")					
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. 6" - 18" boulders found in test pit.
2. No observed groundwater seeps or redox.
3. Did not encounter refusal.

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

680 Houghtonville Road Site
Grafton, Vermont

Test Pit No.	**TP-2**
Page No.	2 of 8
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/10/23
		Operator	Colby Record			Ground Elev.	1075
Weather	Sunny, 60 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 8" - Horizon O, Fine Sandy Loam			M		
1'	8" - 16" - Horizon A, Fine Sandy Loam			M		
2'	16" - 28" - Horizon B1, Fine Sandy Loam Redox at 28"			M		
3'	28" - 62" - Horizon B2, Gravelly Fine Sandy Loam, Firm Groundwater seep at 28"			M		
4'	Groundwater seep at 48" Total Depth = 4'-10" (62")			M		1
5'						
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Did not encounter refusal.

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(X) Encountered
( ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

680 Houghtonville Road Site
Grafton, Vermont

Test Pit No.	**TP-3**
Page No.	3 of 8
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/10/23
		Operator	Colby Record			Ground Elev.	1081
Weather	Sunny, 60 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 6" - Horizon O, Fine Sandy Loam			M		
1'	6" - 18" - Horizon A, Fine Sandy Loam			M		
2'	18" - 32" - Horizon B1, Fine Sandy Loam Redox at 32", boulder at 34"			D	B	
3'	32" - 60" - Horizon B2, Gravelly Fine Sandy Loam, Firm Gravel content and moisture increase with depth			M		
4'	Groundwater seep at 54" Total Depth = 5'-0" (60")			M		1
5'						
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Did not encounter refusal.

Test Pit Plan

Volume = ______ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

	Proportions Used
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(X) Encountered
( ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

680 Houghtonville Road Site
Grafton, Vermont

Test Pit No.	**TP-4**
Page No.	4 of 8
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/10/23
		Operator	Colby Record			Ground Elev.	1075
Weather	Sunny, 60 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 15" - Horizon O, Fine Sandy Loam			M		
1'	15" - 26" - Horizon A, Fine Sandy Loam			M		
2'	26" - 36" - Horizon B1, Fine Sandy Loam Redox at 36"			M		
3'	36" - 68" - Horizon B2, Gravelly Fine Sandy Loam, Firm Gravel content and moisture increase with depth			M		
4'				M		
5'	Total Depth = 5'-8" (68")			M		1,2
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Did not encounter refusal.
2. No observed groundwater seeps.

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(   ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

J:\G\G0348 Grafton, VT\002 WW PER\Design\Return Systems\Spring Hill Farm Test Pits\[Spring Hill Farm Test Pit Logs.xls]TP-4

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

680 Houghtonville Road Site
Grafton, Vermont

Test Pit No.	**TP-5**
Page No.	5 of 8
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/10/23
		Operator	Colby Record			Ground Elev.	1057
Weather	Sunny, 60 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 6" - Horizon O, Fine Sandy Loam			M		
1'	6" - 12" - Horizon A, Fine Sandy Loam			D	A	
2'	12" - 23" - Horizon B1, Fine Sandy Loam Redox at 26"			M		
3'	23" - 60" - Horizon B2, Gravelly Fine Sandy Loam, Firm			M		
4'				M		
5'	Total Depth = 5'-0" (60")			D	A	1,2
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Did not encounter refusal.
2. No observed groundwater seeps or standing water in test pit after left alone.

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

680 Houghtonville Road Site
Grafton, Vermont

Test Pit No.	**TP-6**
Page No.	6 of 8
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/10/23
		Operator	Colby Record			Ground Elev.	1052
Weather	Sunny, 60 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 12" - Horizon O, Fine Sandy Loam			M		
1'	12" - 16" - Horizon A, Fine Sandy Loam			M		
2'	16" - 32" - Horizon B1, Fine Sandy Loam Redox at 28"			M		
3'	32" - 75" - Horizon B2, Fine Sandy Loam, Firm Groundwater seep at 33"			M		2
4'	Coarse sand seam at 56" down from top, approximately 2"-4" thick Groundwater seep at 48" and 56"			M		
5'				D	A	1
6'	Total Depth = 6'-3" (75")					
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Did not encounter refusal.
2. Generally, cleaner fine sandy loam compared to previous test pits, less gravel. Shallower A Horizon than TP-1 through TP-5

Test Pit Plan

Volume = ______ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(X) Encountered
(   ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

680 Houghtonville Road Site
Grafton, Vermont

Test Pit No.	**TP-7**
Page No.	7 of 8
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/10/23
		Operator	Colby Record			Ground Elev.	1062
Weather	Sunny, 60 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 4" - Horizon O, Fine Sandy Loam			M		
1'	4" - 51" - Horizon A, Fine Sandy Loam			D	A	
2'				M		
3'				M		
4'	51" - 87" - Horizon B1, Fine Sandy Loam			M		
5'				M		
6'	Groundwater seep at 63" and 69"			M		
7'	Total Depth = 7'-3" (87")			M		1
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Did not encounter refusal.

Test Pit Plan

Volume = ________ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used

TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(X) Encountered
(   ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

Tighe&Bond

Project/Site Information
G0348-002 Water & WW Study

680 Houghtonville Road Site
Grafton, Vermont

Test Pit No.	**TP-8**
Page No.	8 of 8
File No.	
Checked By:	

T&B Rep.	K. Kortright	Contractor	Town of Grafton DPW			Date	05/10/23
		Operator	Colby Record			Ground Elev.	1033
Weather	Sunny, 60 Degrees	Make	John D.	Model	410J	Time Started	NA
		Capacity		Reach	10 ft.	Time Completed	NA

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulder Count/ Class	Note No.
0	0" - 7" - Horizon O, Fine Sandy Loam			M		
1'	7" - 22" - Horizon A, Fine Sandy Loam			M		
2'	22" - 44" - Horizon B1, Fine Sandy Loam Groundwater seep at 32"			M		
3'	44" - 80" - Horizon B2, Gravelly Fine Sandy Loam, Firm			M		
4'				M		
5'	Groundwater seep at 67" and 72"			M		
6'	Total Depth = 6'-8" (80")			M		1
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Did not encounter refusal.

Test Pit Plan

Volume = ______ cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" +

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(X) Encountered
( ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
	"
	"

APPENDIX F

VERMONT
ENVIRONMENTAL CONSERVATION
Drinking Water & Groundwater Protection Division

Capacity Checklist

Proposed System Checklist

New Community Water Systems (CWSs)

Proposed New Water System:	**WSID #VT**

Date:

☐ Pre-Application Meeting with DWGPD Capacity Program (Date:)

Capacity Approval (must be completed **before** Source Permit is issued)**:**

☐ 5 year Property Owner Budget - must include: all incomes and major expenses, including water system expenses – system installation cost(s), operator costs, sampling costs, etc.
☐ Verbal agreement with VT certified operator
☐ Submit Officials Contact form (excluding designated operator)
☐ Capacity Approval Letter issued (Date:)

Source Permit (must be **issued** before Construction Permit will be **issued**)

☐ Source Permit Application submitted (Date submitted:)
☐ Source Testing Review Application submitted
☐ Source Evaluation Report submitted
☐ Water Quality Results submitted
☐ Source Permit issued (Date:)

Construction Permit

☐ Construction Permit Application submitted (Date:)
☐ Construction Plans & Specifications submitted
☐ Engineering Report submitted
☐ Construction Permit issued (Date:)

Operating Permit Criteria (all must be completed prior to receiving a Permit to Operate)

☐ Compliance with Appendix A source water and infrastructure requirements
☐ Approved Operation and Maintenance manual
☐ Retention of a VT certified operator (detailed owner/operator contract)
☐ Approved as-built/record drawings
☐ Submit updated Officials Contact form
☐ Approved Long Range Plan in accordance with Appendix B submitted
☐ Operating Permit Application submitted by water system Owner
☐ Bacteriological Sampling Plan submitted
☐ Lead and Copper Sampling Plan submitted
☐ Disinfection By-Product (if applicable) Sampling Plan submitted
☐ Operating Permit issued

Note: ☒ Indicates that the item has been completed.

APPENDIX G

Construction Costs

Tighe&Bond

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Conventional Collection System - Treatment at Upper Howland Mill Site
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Pump out Existing Septic Tanks and Abandon in Place	$500	EA	75	$37,500
Clearing and Grubbing in Easements	$20,000	Acre	0.25	$5,000
8" PVC Gravity Sewer Main Installation (In Paved Road)	$310	LF	8450	$2,619,500
8" PVC Gravity Sewer Main Installation (Cross Country)	$230	LF	3730	$857,900
8" HDPE Forcemain (Cross Country)	$270	LF	690	$186,300
Manholes	$8,750	EA	54	$472,500
Forcemain Cleanouts	$5,200	EA	2	$10,400
Air Releases	$7,250	EA	1	$7,300
Stream Crossings	$10,000	EA	4	$40,000
Gravity Service Lateral Installation	$11,900	EA	68	$809,200
Grinder Pump and Service Lateral Installation	$16,900	EA	7	$118,300
Pump Station	$640,000	EA	1	$640,000
Primary Treatment Tank Inc. Installation	$273,500	EA	1	$273,500
Culvert Crossings	$4,400	EA	17	$75,600
Rock Excavation	$400	CY	180	$72,000
Contractor General Conditions	15%	LS	1	$933,800
Opinion of Probable Construction Cost				**$7,158,800**

NOTES: This is an engineer's Opinion of Probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of the Probable Construction Cost.

Tighe&Bond

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Conventional Collection System - Treatment at Village Park Site
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Pump out Existing Septic Tanks and Abandon in Place	$500	EA	75	$37,500
Clearing and Grubbing in Easements	$20,000	Acre	0.50	$10,000
8" PVC Gravity Sewer Main Installation (In Paved Road)	$310	LF	6250	$1,937,500
8" PVC Gravity Sewer Main Installation (Cross Country)	$230	LF	3575	$822,300
8" HDPE Forcemain (In Gravel Road)	$310	LF	980	$303,800
8" HDPE Forcemain (In Paved Road)	$350	LF	2715	$950,300
8" HDPE Forcemain (Cross Country)	$270	LF	50	$13,500
Manholes	$8,750	EA	44	$385,000
Forcemain Cleanouts	$5,200	EA	8	$41,600
Air Releases	$7,250	EA	2	$14,500
Stream Crossings	$10,000	EA	4	$40,000
Gravity Service Lateral Installation	$11,900	EA	68	$809,200
Grinder Pump and Service Lateral Installation	$16,900	EA	7	$118,300
Pump Station	$640,000	EA	1	$640,000
Primary Treatment Tank Inc. Installation	$273,500	EA	1	$273,500
Culvert Crossings	$4,400	EA	18	$79,700
Rock Excavation	$400	CY	190	$76,000
Contractor General Conditions	15%	LS	1	$983,000
Opinion of Probable Construction Cost				**$7,535,700**

NOTES: This is an engineer's Opinion of Probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of the Probable Construction Cost.

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Conventional Collection System - Treatment at Theoretical Parcel
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Pump out Existing Septic Tanks and Abandon in Place	$500	EA	75	$37,500
Clearing and Grubbing in Easements	$20,000	Acre	0.75	$15,000
8" PVC Gravity Sewer Main Installation (In Paved Road)	$310	LF	6250	$1,937,500
8" PVC Gravity Sewer Main Installation (Cross Country)	$230	LF	3575	$822,300
8" HDPE Forcemain (In Gravel Road)	$310	LF	4420	$1,370,200
8" HDPE Forcemain (In Paved Road)	$350	LF	2575	$901,300
8" HDPE Forcemain (Cross Country)	$270	LF	50	$13,500
Manholes	$8,750	EA	44	$385,000
Forcemain Cleanouts	$5,200	EA	15	$78,000
Air Releases	$7,250	EA	3	$21,800
Stream Crossings	$10,000	EA	5	$50,000
Gravity Service Lateral Installation	$11,900	EA	68	$809,200
Grinder Pump and Service Lateral Installation	$16,900	EA	7	$118,300
Pump Station	$640,000	EA	1	$640,000
Primary Treatment Tank Inc. Installation	$273,500	EA	1	$273,500
Culvert Crossings	$4,400	EA	22	$99,000
Rock Excavation	$400	CY	230	$92,000
Contractor General Conditions	15%	LS	1	$1,149,700
Opinion of Probable Construction Cost				**$8,813,800**

NOTES: This is an engineer's Opinion of Probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of the Probable Construction Cost.

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Septic Tank Effluent Collection System - Treatment at Upper Howland Mill Site
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Pump out Existing Septic Tanks and Abandon in Place	$500	EA	75	$37,500
Clearing and Grubbing in Easements	$20,000	Acre	0.25	$5,000
1,000 Gallon STEP Tank Inc. Installation	$7,700	EA	70	$539,000
1,500 Gallon STEP Tank Inc. Installation	$8,500	EA	2	$17,000
3,000 Gallon STEP Tank Inc. Installation	$15,000	EA	2	$30,000
6,500 Gallon STEP Tank Inc. Installation	$20,700	EA	1	$20,700
STEP Service Lateral Installation (1-1/2" HDPE) Inc. Restoration	$7,600	EA	75	$570,000
3" HDPE Forcemain Material and Installation (Directional Drilling)	$70	LF	11600	$812,000
Excavation and Connection at Drill Sites and at Junctions	$6,000	EA	49	$294,000
Directional Drill Restoration	$55	SY	2730	$150,200
Air Releases	$6,200	EA	2	$12,400
Cleanouts	$3,650	EA	24	$87,600
Stream Crossings	$10,000	EA	4	$40,000
Culvert Crossings	$4,400	EA	15	$68,100
Directional Drilling through Rock	$225	LF	300	$67,500
Contractor General Conditions	15%	LS	1	$412,700
Opinion of Probable Construction Cost				**$3,163,700**

NOTES: This is an engineer's Opinion of Probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of the Probable Construction Cost.

Tighe&Bond

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

Septic Tank Effluent Collection System - Treatment at Village Park Site

Town of Grafton, VT

Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Pump out Existing Septic Tanks and Abandon in Place	$500	EA	75	$37,500
Clearing and Grubbing in Easements	$20,000	Acre	1.00	$20,000
1,000 Gallon STEP Tank Inc. Installation	$7,700	EA	70	$539,000
1,500 Gallon STEP Tank Inc. Installation	$8,500	EA	2	$17,000
3,000 Gallon STEP Tank Inc. Installation	$15,000	EA	2	$30,000
6,500 Gallon STEP Tank Inc. Installation	$20,700	EA	1	$20,700
STEP Service Lateral Installation (1-1/2" HDPE) Inc. Restoration	$7,600	EA	75	$570,000
3" HDPE Forcemain Material and Installation (Directional Drilling)	$70	LF	9860	$690,200
Excavation and Connection at Drill Sites and at Junctions	$6,000	EA	47	$282,000
Directional Drill Restoration	$55	SY	2620	$144,100
Air Releases	$6,200	EA	2	$12,400
Cleanouts	$3,650	EA	20	$73,000
Stream Crossings	$10,000	EA	3	$30,000
Culvert Crossings	$4,400	EA	13	$57,900
Directional Drilling through Rock	$225	LF	200	$45,000
Contractor General Conditions	15%	LS	1	$385,400
Opinion of Probable Construction Cost				**$2,954,200**

NOTES: This is an engineer's Opinion of Probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of the Probable Construction Cost.

Tighe&Bond

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Septic Tank Effluent Collection System - Treatment at Theoretical Parcel
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Pump out Existing Septic Tanks and Abandon in Place	$500	EA	75	$37,500
Clearing and Grubbing in Easements	$20,000	Acre	1.00	$20,000
1,000 Gallon STEP Tank Inc. Installation	$7,700	EA	70	$539,000
1,500 Gallon STEP Tank Inc. Installation	$8,500	EA	2	$17,000
3,000 Gallon STEP Tank Inc. Installation	$15,000	EA	2	$30,000
6,500 Gallon STEP Tank Inc. Installation	$20,700	EA	1	$20,700
STEP Service Lateral Installation (1-1/2" HDPE) Inc. Restoration	$7,600	EA	75	$570,000
3" HDPE Forcemain Material and Installation (Directional Drilling)	$70	LF	11375	$796,300
Pump Station	$350,000	LS	1	$350,000
3" HDPE Forcemain from Pump Station (Directional Drilling)	$70	LF	1325	$92,800
Excavation and Connection at Drill Sites and at Junctions	$6,000	EA	55	$330,000
Directional Drill Restoration	$55	SY	3060	$168,300
Air Releases	$6,200	EA	3	$18,600
Cleanouts	$3,650	EA	26	$94,900
Stream Crossings	$10,000	EA	3	$30,000
Culvert Crossings	$4,400	EA	15	$66,800
Directional Drilling through Rock	$225	LF	300	$67,500
Contractor General Conditions	15%	LS	1	$487,500
			Opinion of Probable Construction Cost	**$3,736,900**

NOTES: This is an engineer's Opinion of Probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of the Probable Construction Cost.

Tighe&Bond

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Recirculating Sand Filter Water Resource Recovery System
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Influent Flow Meter in Buried Vault Inc. Installation	$15,500	LS	1	$15,500
Excavation and Backfill for EQ/Recirculation Tank	$40	CY	900	$36,000
Cast-in-Place Concrete EQ/Recirculation Tank	$1,800	CY	180	$324,000
Hatch, Steps, Vent for EQ/Recirculation Tank	$8,500	EA	1	$8,500
Submersible EQ/Recir. Pumps, Piping, Valves, Controls, Etc.	$60,000	LS	1	$60,000
Installation of Submersible EQ/Recirculation Pump Equipment	$36,000	LS	1	$36,000
Excavation and Backfill for Sand Filters	$40	CY	2400	$96,000
30 Mil PVC Membrane Liner for Sand Filters	$1.5	SF	12500	$18,800
Underdrain Piping	$2.5	LF	1600	$4,000
12" Washed Clean Stone Media Inc. Delivery	$43	CY	360	$15,500
36" Sand Media Inc. Delivery	$54	CY	1070	$57,800
6" Washed Clean Stone Media Inc. Delivery	$43	CY	180	$7,800
Non-Woven Geotextile Fabric	$0.4	SF	9600	$3,900
6" Topsoil Inc. Delivery	$62	CY	180	$11,200
Distribution Piping	$2.5	LF	4800	$12,000
Liner, Underdrain, Media, and Distribution Piping Installation	$78,600	LS	1	$78,600
Recirculation/Effluent Splitter Box Inc. Installation	$12,500	LS	1	$12,500
Recirculation/Effluent Flow Meters & Check Valve Vault	$23,300	LS	1	$23,300
Buried Process Piping	$125	LF	200	$25,000
Concrete Slab for Control Building	$45	SF	180	$8,100
Control Building	$200	SF	180	$36,000
HVAC for Control Building	$10,800	LS	1	$10,800
Backup Generator	$50,000	LS	1	$50,000
Electrical & Control Work	$30,500	LS	1	$30,500
Sampling Station and Equipment	$7,500	LS	1	$7,500
Site Grading and Restoration	$1.6	SF	15100	$24,200
Fencing	$70	LF	600	$42,000
Landscaping	$10,000	LS	1	$10,000
Contractor General Conditions	15%	LS	1	$159,900
Opinion of Probable Construction Cost				**$1,225,400**

NOTES: This is an engineer's Opinion of Probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of the Probable Construction Cost.

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Packed Bed Media Filter Water Resource Recovery System
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Influent Flow Meter in Buried Vault Inc. Installation	$15,500	LS	1	$15,500
40,000 Gallon Flow EQ Tank Inc. Installation	$273,500	LS	1	$273,500
Submersible EQ Pumps, Piping, Valves, Controls, Etc.	$60,000	LS	1	$60,000
Installation of Submersible EQ Pump Equipment	$36,000	LS	1	$36,000
Orenco Packaged PBF System	$1,296,000	LS	1	$1,296,000
PBF System Installation	$518,400	LS	1	$518,400
Buried Process Piping	$125	LF	300	$37,500
Concrete Slab for Control Building	$45	SF	300	$13,500
Control Building	$200	SF	300	$60,000
HVAC for Control Building	$18,000	LS	1	$18,000
Backup Generator	$50,000	LS	1	$50,000
Electrical & Control Work	$166,100	LS	1	$166,100
Sampling Station and Equipment	$7,500	LS	1	$7,500
Site Grading and Restoration	$1.6	SF	7100	$11,400
Fencing	$70	LF	380	$26,600
Landscaping	$10,000	LS	1	$10,000
Contractor General Conditions	15%	LS	1	$390,000
Opinion of Probable Construction Cost				**$2,990,000**

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ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Fixed Bed Bio-Reactor Water Resource Recovery System
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Influent Flow Meter in Buried Vault Inc. Installation	$15,500	LS	1	$15,500
40,000 Gallon Flow EQ Tank Inc. Installation	$273,500	LS	1	$273,500
Submersible EQ Pumps, Piping, Valves, Controls, Etc.	$60,000	LS	1	$60,000
Installation of Submersible EQ Pump Equipment	$36,000	LS	1	$36,000
Excavation and Backfill for FBBR Tanks	$40	CY	1000	$40,000
Cast-in-Place Concrete FBBR Tanks	$1,800	CY	160	$288,000
Hatch, Steps, Vent for FBBR Tanks	$8,500	EA	4	$34,000
ECOPOD FBBR Packaged System	$345,600	LS	1	$345,600
FBBR System Installation	$207,400	LS	1	$207,400
Buried Process Piping	$125	LF	400	$50,000
Effluent Splitter Box Inc. Installation	$5,000	LS	1	$5,000
Air Process Piping and Valves	$75	LF	60	$4,500
Concrete Slab for Control Building	$45	SF	360	$16,200
Control Building	$200	SF	360	$72,000
HVAC for Control Building	$21,600	LS	1	$21,600
Backup Generator	$50,000	LS	1	$50,000
Electrical & Control Work	$91,400	LS	1	$91,400
Sampling Station and Equipment	$7,500	LS	1	$7,500
Site Grading and Restoration	$1.6	SF	2500	$4,000
Fencing	$70	LF	200	$14,000
Landscaping	$10,000	LS	1	$10,000
Contractor General Conditions	15%	LS	1	$247,000
Opinion of Probable Construction Cost				**$1,893,200**

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Tighe&Bond

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Conventional Absorption Field - Village Park Site
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Clearing and Grubbing	$20,000	Acre	2.50	$50,000
25,000 Gallon Effluent Dosing Tank Inc. Installation	$170,900	LS	1	$170,900
Dosing Pumps and Appurtenances Inc. Installation	$35,000	LS	1	$35,000
Electrical & Control Work for Dosing System	$8,800	LS	1	$8,800
Strip & Stockpile Topsoil	$2	SY	9680	$19,400
Strip Upper Layer of Soil (approximately 1-foot)	$20	CY	3230	$64,600
Absorption Field Trenching and Backfill	$11	LF	5060	$55,700
Pipe Bedding for Distribution Piping Inc. Delivery	$43	CY	1300	$55,900
Absorption Field Distribution Piping	$2.5	LF	5060	$12,700
Non-Woven Geotextile Fabric	$0.4	SF	22300	$9,000
Installation of Distribution Piping, Bedding, Geotextile	$46,600	LS	1	$46,600
Trenching and Backfill for Tight Pipes	$11	LF	1000	$11,000
Pipe Bedding for Tight Pipes	$43	CY	90	$3,900
Absorption Field Tight Pipes	$2.5	LF	1000	$2,500
Installation of Tight Pipes and Bedding	$3,900	LS	1	$3,900
Curtain Drain	$14	LF	850	$11,500
Site Grading and Restoration	$1.6	SF	87120	$139,400
Landscaping	$10,000	LS	1	$10,000
Monitoring Wells	$1,000	EA	4	$4,000
Contractor General Conditions	15%	LS	1	$107,300
Opinion of Probable Construction Cost				**$822,100**

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ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Conventional Absorption Field - Theoretical Parcel
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
25,000 Gallon Effluent Dosing Tank Inc. Installation	$170,900	LS	1	$170,900
Dosing Pumps and Appurtenances Inc. Installation	$35,000	LS	1	$35,000
Electrical & Control Work for Dosing System	$8,800	LS	1	$8,800
Till Absorption Area	$10	MSF	122	$1,300
Mound Sand Fill Inc. Delivery	$54	CY	9870	$533,000
Installation of Mound Sand	$213,200	LS	1	$213,200
Absorption Field Trenching and Backfill	$11	LF	7090	$78,000
Pipe Bedding for Distribution Piping Inc. Delivery	$43	CY	1800	$77,400
Absorption Field Distribution Piping	$2.5	LF	7090	$17,800
Non-Woven Geotextile Fabric	$0.4	SF	146400	$58,600
Installation of Distribution Piping, Bedding, Geotextile	$92,300	LS	1	$92,300
Trenching and Backfill for Tight Pipes	$11	LF	1400	$15,400
Pipe Bedding for Tight Pipes	$43	CY	120	$5,200
Absorption Field Tight Pipes	$2.5	LF	1400	$3,500
Installation of Tight Pipes and Bedding	$5,300	LS	1	$5,300
General Fill Inc. Delivery & Installation	$35	CY	5400	$189,000
Topsoil Inc. Delivery	$62	CY	1800	$111,600
Curtain Drain	$14	LF	800	$10,800
Site Grading and Restoration	$1.6	SF	146400	$234,300
Monitoring Wells	$1,000	EA	4	$4,000
Contractor General Conditions	15%	LS	1	$279,900
			Opinion of Probable Construction Cost	**$2,145,300**

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Tighe&Bond

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Gravelless Geotextile Sand Filter - Village Park Site
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Clearing and Grubbing	$20,000	Acre	2.10	$42,000
25,000 Gallon Effluent Dosing Tank Inc. Installation	$170,900	LS	1	$170,900
Dosing Pumps and Appurtenances Inc. Installation	$35,000	LS	1	$35,000
Electrical & Control Work for Dosing System	$8,800	LS	1	$8,800
Strip & Stockpile Topsoil	$2	SY	4356	$8,800
Excavation for Absorption Beds	$20	CY	5700	$114,000
Absorption Field Trenching and Backfill	$11	LF	24000	$264,000
System Sand Inc. Delivery	$54	CY	2300	$124,200
Presby AES Piping	$14	LF	24000	$336,000
Non-Woven Geotextile Fabric	$0.4	SF	45400	$18,200
Installation of AES Piping, System Sand, Geotextile	$287,100	LS	1	$287,100
Trenching and Backfill for Tight Pipes	$11	LF	4800	$52,800
Pipe Bedding for Tight Pipes	$43	CY	400	$17,200
Absorption Field Tight Pipes	$2.5	LF	4800	$12,000
Distribution Boxes	$5,000	EA	4	$20,000
Installation of Tight Pipes and Bedding	$29,600	LS	1	$29,600
Curtain Drain	$14	LF	850	$11,500
Site Grading and Restoration	$1.6	SF	39210	$62,800
Landscaping	$10,000	LS	1	$10,000
Monitoring Wells	$1,000	EA	4	$4,000
Contractor General Conditions	15%	LS	1	$244,400
Opinion of Probable Construction Cost				**$1,873,300**

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ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Gravelless Geotextile Sand Filter - Theoretical Parcel
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
25,000 Gallon Effluent Dosing Tank Inc. Installation	$170,900	LS	1	$170,900
Dosing Pumps and Appurtenances Inc. Installation	$35,000	LS	1	$35,000
Electrical & Control Work for Dosing System	$8,800	LS	1	$8,800
Till Absorption Area	$10	MSF	57	$600
Mound Sand Fill Inc. Delivery	$54	CY	3600	$194,400
Installation of Mound Sand	$77,800	LS	1	$77,800
Absorption Field Trenching and Backfill	$11	LF	33600	$369,600
Presby AES Piping	$14	LF	33600	$470,400
Non-Woven Geotextile Fabric	$0.4	SF	63600	$25,500
Installation of AES Piping and Geotextile	$297,600	LS	1	$297,600
Trenching and Backfill for Tight Pipes	$11	LF	6700	$73,700
Pipe Bedding for Tight Pipes	$43	CY	550	$23,700
Absorption Field Tight Pipes	$2.5	LF	6700	$16,800
Distribution Boxes	$5,000	EA	5	$25,000
Installation of Tight Pipes and Bedding	$39,300	LS	1	$39,300
General Fill Inc. Delivery & Installation	$35	CY	800	$28,000
Topsoil Inc. Delivery	$62	CY	800	$49,600
Curtain Drain	$14	LF	800	$10,800
Site Grading and Restoration	$1.6	SF	56630	$90,700
Monitoring Wells	$1,000	EA	4	$4,000
Contractor General Conditions	15%	LS	1	$301,900
			Opinion of Probable Construction Cost	**$2,314,100**

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Tighe&Bond

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Drip Dispersal System Field - Village Park Site
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Clearing and Grubbing	$20,000	Acre	1.40	$28,000
25,000 Gallon Effluent Dosing Tank Inc. Installation	$205,100	LS	1	$205,100
5' Diameter Wet Well for Dosing Pump Suction Inc. Installation	$8,500	LS	1	$8,500
Concrete Slab for Control Building	$45	SF	180	$8,100
Dosing Pump Building	$200	SF	180	$36,000
HVAC for Dosing Pump Building	$10,800	LS	1	$10,800
Drip Dispersal Package System Including Installation	$162,200	LS	1	$162,200
Electrical & Control Work for Dosing System & Building	$49,600	LS	1	$49,600
Strip & Stockpile Topsoil	$2	SY	4360	$8,800
Strip Upper Layer of Soil (approximately 1-foot)	$20	CY	1460	$29,200
Trenching and Backfill for Tight Pipes	$11	LF	2200	$24,200
Pipe Bedding for Tight Pipes	$43	CY	180	$7,800
Absorption Field Tight Pipes	$2.5	LF	2200	$5,500
Installation of Tight Pipes and Bedding	$8,000	LS	1	$8,000
Curtain Drain	$14	LF	850	$11,500
Site Grading and Restoration	$1.6	SF	39210	$62,800
Landscaping	$10,000	LS	1	$10,000
Monitoring Wells	$1,000	EA	4	$4,000
Contractor General Conditions	15%	LS	1	$102,100
Opinion of Probable Construction Cost				**$782,200**

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Tighe&Bond

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

Drip Dispersal System Field - Theoretical Parcel

Town of Grafton, VT

Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
25,000 Gallon Effluent Dosing Tank Inc. Installation	$205,100	LS	1	$205,100
5' Diameter Wet Well for Dosing Pump Suction Inc. Installation	$8,500	LS	1	$8,500
Concrete Slab for Control Building	$45	SF	180	$8,100
Dosing Pump Building	$200	SF	180	$36,000
HVAC for Dosing Pump Building	$10,800	LS	1	$10,800
Drip Dispersal Package System Including Installation	$177,100	LS	1	$177,100
Electrical & Control Work for Dosing System & Building	$53,300	LS	1	$53,300
Till Absorption Area	$10	MSF	57	$600
Mound Sand Fill Inc. Delivery	$54	CY	2040	$110,200
Installation of Mound Sand	$44,100	LS	1	$44,100
Trenching and Backfill for Tight Pipes	$11	LF	2900	$31,900
Pipe Bedding for Tight Pipes	$43	CY	240	$10,400
Absorption Field Tight Pipes	$2.5	LF	2900	$7,300
Installation of Tight Pipes and Bedding	$10,700	LS	1	$10,700
Topsoil Inc. Delivery	$62	CY	1320	$81,900
Curtain Drain	$14	LF	800	$10,800
Site Grading and Restoration	$1.6	SF	56630	$90,700
Monitoring Wells	$1,000	EA	4	$4,000
Contractor General Conditions	15%	LS	1	$135,300
Opinion of Probable Construction Cost				**$1,036,800**

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Tighe&Bond

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Cluster System
Town of Grafton, VT
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Pump out Existing Septic Tanks and Abandon in Place	$500	EA	75	$37,500
Clearing and Grubbing	$14,000	Acre	0.5	$7,000
1,000 Gallon STEP Tank Inc. Installation	$7,700	EA	70	$539,000
1,500 Gallon STEP Tank Inc. Installation	$8,500	EA	2	$17,000
3,000 Gallon STEP Tank Inc. Installation	$15,000	EA	2	$30,000
6,500 Gallon STEP Tank Inc. Installation	$20,700	EA	1	$20,700
STEP Service Lateral Installation (1-1/2" HDPE) Inc. Restoration	$10,100	EA	75	$757,500
Stream Crossings	$10,000	EA	2	$20,000
Rock Excavation (HDD for sewer laterals and water services)	$225	LF	400	$90,000
Cluster No. 1 Treatment/Disposal System	$107,100	LS	1	$107,100
Cluster No. 2 Treatment/Disposal System	$118,300	LS	1	$118,300
Cluster No. 3 Treatment/Disposal System	$264,200	LS	1	$264,200
Cluster No. 4 Treatment/Disposal System	$131,100	LS	1	$131,100
Cluster No. 5 Treatment/Disposal System	$207,100	LS	1	$207,100
Cluster No. 6 Treatment/Disposal System	$191,100	LS	1	$191,100
Cluster No. 7 Treatment/Disposal System	$76,400	LS	1	$76,400
Cluster No. 8 Treatment/Disposal System	$164,200	LS	1	$164,200
Cluster No. 9 Treatment/Disposal System	$171,400	LS	1	$171,400
Cluster No. 10 Treatment/Disposal System	$546,700	LS	1	$546,700
Cluster No. 11 Treatment/Disposal System	$152,300	LS	1	$152,300
Cluster No. 12 Treatment/Disposal System	$289,200	LS	1	$289,200
Cluster No. 13 Treatment/Disposal System	$280,300	LS	1	$280,300
Cluster No. 14 Treatment/Disposal System	$255,700	LS	1	$255,700
Cluster No. 15 Treatment/Disposal System	$411,000	LS	1	$411,000
Cluster No. 16 Treatment/Disposal System	$165,600	LS	1	$165,600
Cluster No. 17 Treatment/Disposal System	$178,500	LS	1	$178,500
Cluster No. 18 Treatment/Disposal System	$107,100	LS	1	$107,100
Cluster No. 19 Treatment/Disposal System	$157,100	LS	1	$157,100
Cluster No. 20 Treatment/Disposal System	$171,400	LS	1	$171,400
Cluster No. 21 Treatment/Disposal System	$229,400	LS	1	$229,400
Cluster No. 22 Treatment/Disposal System	$305,800	LS	1	$305,800
Abandon Wells	$9,500	EA	68	$646,000
Drill New Wells (assume 6 new wells)	$37,500	EA	6	$225,000
Pressure Tank and Piping Modifications for each Cluster	$8,500	EA	22	$187,000
POET Systems	$19,500	EA	6	$117,000
Water Services Connections Inc. Water Meters	$12,000	EA	84	$1,008,000
Service Connection Restoration	$3,500	EA	84	$294,000
Flushing, Testing, & Disinfecting new Water Services	$66,000	LS	1	$66,000
Contractor General Conditions	15%	LS	1	$1,311,500
Opinion of Probable Construction Cost				**$10,054,200**

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Tighe&Bond

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

Drinking Water System

Town of Grafton, NY

Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Water Supply				**$530,800**
Wellfield Site Access Drive	$6	SF	12000	$72,000
Electrical Service for Wellfield	$25,000	LS	1	$25,000
Drilled Water Supply Wells	$50,000	EA	2	$100,000
Electrical for Wells	$15,000	LS	1	$15,000
Concrete Slab for Wellhouse	$45	SF	320	$14,400
Wellhouse Building	$200	SF	320	$64,000
HVAC for Wellhouse	$19,200	LS	1	$19,200
Plumbing for Wellhouse	$12,800	LS	1	$12,800
Wellhouse Process Piping, Valve, Fittings, Etc.	$20,000	EA	1	$20,000
Chlorination System Equipment & Installation	$17,500	EA	1	$17,500
Backup Generator	$50,000	LS	1	$50,000
Electrical & Control Work	$32,900	LS	1	$32,900
Lab/Sampling Equipment	$7,500	LS	1	$7,500
Security Fencing	$70	LF	160	$11,200
Contractor General Conditions	15%	LS	1	$69,300
Water Distribution				**$7,138,100**
8-inch Ductile Iron Water Main Installation (In Gravel Road)	$300	LF	1210	$363,000
8-inch Ductile Iron Water Main Installation (In Paved Road)	$340	LF	12500	$4,250,000
8-inch Ductile Iron Water Main Installation (Cross Country)	$260	LF	700	$182,000
8-inch Gate Valves with Boxes	$4,000	EA	30	$120,000
Rock Excavation	$400	CY	190	$76,000
Bridge Crossings	$65,000	EA	1	$65,000
Stream Crossings	$10,000	EA	4	$40,000
Culvert Crossings	$4,400	EA	20	$88,000
Water Services Connections Inc. Water Meters	$9,500	EA	84	$798,000
Service Connection Restoration	$2,500	EA	84	$210,000
Flushing, Testing, & Disinfecting	$15,000	LS	1	$15,000
Contractor General Conditions	15%	LS	1	$931,100
Water Storage				**$1,117,400**
Clearing and Grubbing	$20,000	Acre	1.00	$20,000
Site Access Drive	$6	SF	9600	$57,600
Electrical Service	$25,000	LS	1	$25,000
8-inch Ductile Iron Water Main Installation (Cross Country)	$260	LF	250	$65,000
Valve Vault Inc. Pipe, Fitting, Valves, and Appurtenances	$120,000	LS	1	$120,000
General Contractor Site Preparation for Water Storage Tank	$138,000	LS	1	$138,000
Water Storage Tank & Foundation	$345,000	LS	1	$345,000
Tank Mixing System	$30,000	LS	1	$30,000
Electrical & Controls	$150,000	LS	1	$150,000
Security Fencing	$70	LF	300	$21,000
Contractor General Conditions	15%	LS	1	$145,800
POET Systems				**$224,300**
Residential POET System	$6,500	EA	10	$65,000
Small Commercial POET System	$13,000	EA	10	$130,000
Contractor General Conditions	15%	LS	1	$29,300
			Opinion of Probable Construction Cost	**$9,010,600**

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ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Alternative No. 1 Site Work
Town of Grafton, NY
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Gravel Access Road	$6	SF	2400	$14,400
Trenching for Underground Electrical Utilities	$5	LF	1500	$7,500
Bedding for Underground Electrical Conduits	$7	LF	1500	$10,500
Direct Burial of PVC Conduits	$7	LF	1500	$10,500
Utility Fee/Service Entrance	$5,000	LS	1	$5,000
Well Relocation	$15,000	LS	1	$15,000
Trenching for Water Service	$6	LF	1700	$10,200
Bedding for Water Service	$3	LF	1700	$5,100
1" Polyethylene Water Service	$3	LF	1700	$5,100
Contractor General Conditions	15%	LS	1	$12,500
Opinion of Probable Construction Cost				**$95,800**

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ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
Alternative No. 2 Site Work
Town of Grafton, NY
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Gravel Access Road	$6	SF	1200	$7,200
Trenching for Underground Electrical Utilities	$5	LF	150	$800
Bedding for Underground Electrical Conduits	$7	LF	150	$1,100
Direct Burial of PVC Conduits	$7	LF	150	$1,100
Utility Fee/Service Entrance	$5,000	LS	1	$5,000
Contractor General Conditions	15%	LS	1	$2,300
Opinion of Probable Construction Cost				**$17,500**

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Annual O&M Costs

ENGINEER'S OPINION OF PROBABLE ANNUAL O&M COST
Alternative No. 1
Town of Grafton, NY
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Septic Tank Effluent Collection System				
Proactive System Maintenance	$75	Hour	208	$15,600
Reactive System Maintenance	$75	Hour	24	$1,800
Septic Tank Pumping (1,000 gal)	$500	EA	14	$7,000
Septic Tank Pumping (1,500 gal)	$750	EA	1	$800
Septic Tank Pumping (> 1,500 gal)	$1,500	EA	1	$1,500
STEP Equipment Repair and Replacement	$3,800	Year	1	$3,800
Pump Station Energy Consumption	$0.10	kWh	38200	$3,900
Pump Station Pump & Appurtenances Repair and Replacement	$2,000	Year	1	$2,000
Pump Station Misc. Maintenance	$1,000	Year	1	$1,000
Pump Station Cellular Service for Communication	$80	Month	12	$1,000
Recirculating Sand Filter System				
Proactive System Maintenance	$75	Hour	104	$7,800
Reactive System Maintenance	$75	Hour	26	$2,000
Energy Consumption	$0.10	kWh	70800	$7,100
Cellular Service for Communication	$80	Month	12	$1,000
EQ Tank Cleaning	$750	Year	1	$800
EQ/Recirculation Pump & Appurtenances Repair & Replacement	$2,000	Year	1	$2,000
Media Replacement - UEAC	$9,400	Year	1	$9,400
Flow Meter Calibration	$800	Year	1	$800
Sampling Supplies	$1,500	Year	1	$1,500
Misc. Building Maintenance	$500	Year	1	$500
Mowing around Sand Filters	$75	Hour	12	$900
Misc. Site/Access Road Maintenance	$500	Year	1	$500
Drip Dispersal System				
Dosing Tank Cleaning	$500	Year	1	$500
Dosing Pump & Appurtenances Repair and Replacement	$2,000	Year	1	$2,000
Energy Consumption	$0.10	kWh	15800	$1,600
Mowing Dispersal Field	$75	Hour	6	$500
Dosing System Maintenance	$500	Year	1	$500
Subtotal Annual O&M Costs				$77,800
Contingency (20%)				$15,600
Administrative, Billing, & Accounting (30%)				$23,400
Opinion of Probable Annual O&M Cost				**$116,800**

NOTES: This is an engineer's Opinion of Probable Annual O&M Cost. Tighe & Bond has no control over the cost or availability of labor, equipment or materials, or over market conditions and that the estimates of probable annual O&M costs are made on the basis of Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the actual annula O&M costs will not vary from this estimate of the Probable Annual O&M Cost.

ENGINEER'S OPINION OF PROBABLE ANNUAL O&M COST
Alternative No. 2
Town of Grafton, NY
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Septic Tank Effluent Collection System				
Proactive System Maintenance	$75	Hour	208	$15,600
Reactive System Maintenance	$75	Hour	24	$1,800
Septic Tank Pumping (1,000 gal)	$500	EA	14	$7,000
Septic Tank Pumping (1,500 gal)	$750	EA	1	$800
Septic Tank Pumping (> 1,500 gal)	$1,500	EA	1	$1,500
STEP Equipment Repair and Replacement	$3,800	Year	1	$3,800
Recirculating Sand Filter System				
Proactive System Maintenance	$75	Hour	104	$7,800
Reactive System Maintenance	$75	Hour	26	$2,000
Energy Consumption	$0.10	kWh	70800	$7,100
Cellular Service for Communication	$80	Month	12	$1,000
EQ Tank Cleaning	$750	Year	1	$800
EQ/Recirculation Pump & Appurtenances Repair & Replacement	$2,000	Year	1	$2,000
Media Replacement - UEAC	$11,800	Year	1	$11,800
Flow Meter Calibration	$800	Year	1	$800
Sampling Supplies	$1,500	Year	1	$1,500
Misc. Building Maintenance	$500	Year	1	$500
Mowing around Sand Filters	$75	Hour	12	$900
Misc. Site/Access Road Maintenance	$500	Year	1	$500
Drip Dispersal System				
Dosing Tank Cleaning	$500	Year	1	$500
Dosing Pump & Appurtenances Repair and Replacement	$2,000	Year	1	$2,000
Energy Consumption	$0.10	kWh	15800	$1,600
Mowing Dispersal Field	$75	Hour	6	$500
Dosing System Maintenance	$500	Year	1	$500
Drinking Water System				
Proactive System Maintenance & Operation	$75	Hour	728	$54,600
Reactive System Maintenance	$75	Hour	104	$7,800
Well Pump Repair and Replacement	$5,000	Year	1	$5,000
Misc. Wellhouse Building Maintenance	$500	Year	1	$500
Chlorination System Repair and Replacement	$1,200	Year	1	$1,200
Sodium Hypochlorite	$2,200	Year	1	$2,200
Sampling Supplies	$3,000	Year	1	$3,000
Laboratory Sampling	$300	Month	12	$3,600
Misc. Wellfield Site/Access Road Maintenance	$500	Year	1	$500
Emergency Distribution Repairs (Water Main Breaks, etc.)	$10,000	Year	1	$10,000
Water Storage Tank Mixer Repair & Replacement	$2,000	Year	1	$2,000
Water Storage Tank Replacement - UEAC	$3,500	Year	1	$3,500
Well Pump/Water Tank Controls Repair & Replacement	$600	Year	1	$600
Energy Consumption	$0.10	kWh	75200	$7,600
POET System Maintenance	$950	EA	10	$9,500
Cellular Service for Communication	$80	Month	12	$1,000
Subtotal Annual O&M Costs				$184,900
Contingency (20%)				$37,000
Administrative, Billing, & Accounting (30%)				$55,500
Opinion of Probable Annual O&M Cost				**$277,400**

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ENGINEER'S OPINION OF PROBABLE ANNUAL O&M COST
Alternative No. 3
Town of Grafton, NY
Water & Wastewater Feasibility Study

Item Description	Unit Cost	Units	Quantity	Cost
Septic Tank Effluent Collection System				
Proactive System Maintenance	$75	Hour	208	$15,600
Reactive System Maintenance	$75	Hour	24	$1,800
Septic Tank Pumping (1,000 gal)	$500	EA	14	$7,000
Septic Tank Pumping (1,500 gal)	$750	EA	1	$800
Septic Tank Pumping (> 1,500 gal)	$1,500	EA	1	$1,500
STEP Equipment Repair and Replacement	$3,800	Year	1	$3,800
Cluster Systems				
Proactive System Maintenance	$75	Hour	52	$3,900
Reactive System Maintenance	$75	Hour	26	$2,000
Energy Consumption	$0.10	kWh	95900	$9,600
Cluster System Tank Cleaning	$750	EA	6	$4,500
Cluster System Pump & Appurtenances Repair & Replacement	$6,000	Year	1	$6,000
Dispersal Field System Maintenance	$8,500	Year	1	$8,500
Drinking Water System				
Proactive System Maintenance & Operation	$75	Hour	52	$3,900
Reactive System Maintenance	$75	Hour	26	$2,000
Well Pump Repair and Replacement	$5,000	Year	1	$5,000
Pressure Tank Repair/Replacement	$1,500	Year	2	$3,000
Energy Consumption	$0.10	kWh	95900	$9,600
POET System Maintenance	$950	EA	3	$2,900
Subtotal Annual O&M Costs				$91,400
Contingency (20%)				$18,300
Administrative, Billing, & Accounting (30%)				$27,500
Opinion of Probable Annual O&M Cost				**$137,200**

NOTES: This is an engineer's Opinion of Probable Annual O&M Cost. Tighe & Bond has no control over the cost or availability of labor, equipment or materials, or over market conditions and that the estimates of probable annual O&M costs are made on the basis of Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the actual annula O&M costs will not vary from this estimate of the Probable Annual O&M Cost.