March 2023

Londonderry Environmental Risk Assessment

Prepared for:

Town of Londonderry
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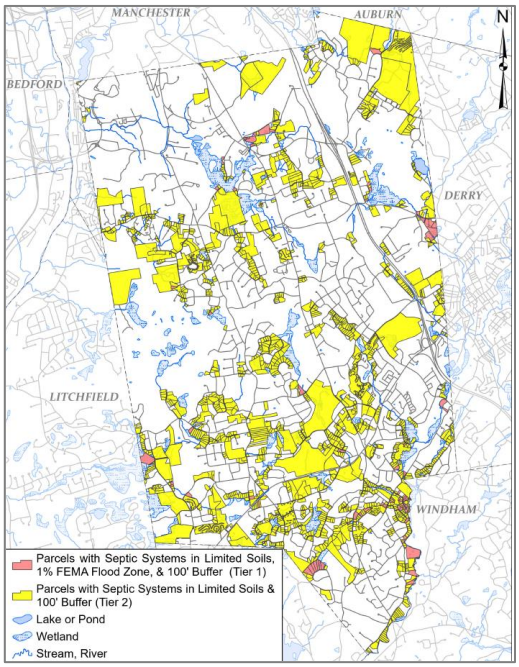
Executive Summary

In 2021, the Town of Londonderry applied for and received a Source Water Protection (SWP) grant from the New Hampshire Department of Environmental Services (NHDES). The SWP grant provided funds for the Town of Londonderry to create an electronic tracking system for septic systems, review septic system records, and develop an outreach and education program. In addition to the SWP grant, the Town of Londonderry funded an Environmental Risk Assessment to identify areas of the town at higher risk for septic system malfunction or failure based on soil and environmental factors.



Environmental Risk Assessment for the Town of Londonderry, NH

Key Findings

- The Environmental Risk Assessment (ERA) assessed soil and environmental conditions that may limit septic system function.
    - 70 properties in Londonderry were identified as "Tier 1" properties. Tier 1 indicates the property is located in limited soils, within a FEMA flood zone, and within a 100-foot buffer of a waterbody or wetland.
    - 1,300 properties are considered "Tier 2," properties as they are located in limited soils and within a 100-foot buffer of a waterbody or wetland.
- Of the 1,370 properties identified as Tier 1 or Tier 2, 736 of them are located within a Source Water Protection Area. Per the SWP Grant, state and town septic system records were reviewed for these properties.
- Approximately 78% of the 736 properties assessed had septic system replacement records that were dated over twenty years ago. Conventional septic systems are designed to work effectively for 20-30 years and need to be replaced to ensure they are removing pollutants effectively.

Recommended Next Steps

More information is needed to fully assess the state of septic systems in the Town of Londonderry. With the information available, it is likely that many of these systems are not functioning effectively based on the age and/or location of the system and are a potential source of pollutants to groundwater and surface waters in Londonderry. Specific recommendations for addressing septic systems in Londonderry include:

1. Develop an education and outreach program targeted to homeowners in Tier 1 and Tier 2 categories (information on town website, mailings to homeowners, education workshops, etc.);
2. Consider regulatory changes to include mandatory septic system pump out and inspection or requiring advanced treatment systems upon replacement;
3. Explore possibility of zero or low interest loan or grant programs to assist homeowners with septic system replacement; and
4. Complete the septic system inventory for all other parcels on septic in Londonderry.

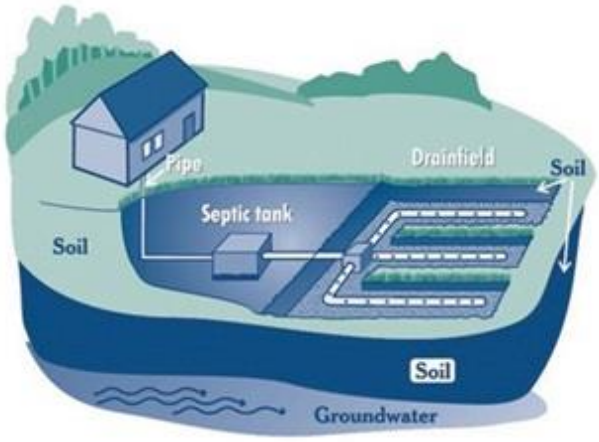
1 Introduction

Over 90% of the homes in Londonderry rely on septic systems to treat their wastewater as they do not have access to a public sewer system. The 2019 Londonderry Water Resource Management Protection Plan identified septic systems as a potential threat to Londonderry's drinking water supplies. In 2021, the Town of Londonderry applied for and received a Source Water Protection (SWP) grant from the New Hampshire Department of Environmental Services (NHDES). The SWP grant provided funds for the Town of Londonderry to create an electronic tracking system for septic systems, review septic system records, and develop an outreach and education program. In addition to the SWP grant, the Town of Londonderry funded an Environmental Risk Assessment to identify areas of the town at higher risk for septic system malfunction or failure based on soil and environmental factors.

1.1 Conventional Septic Systems

Septic systems are the primary method for treating wastewater in areas without a sewer system. If properly installed and maintained, septic systems remove many of the pollutants that could cause water quality problems. However, if systems are not working properly, nutrients and bacteria could enter nearby waterbodies and groundwater.

Conventional septic systems consist of a septic tank, a distribution box and a soil absorption system, all connected by pipes (called conveyance lines). A conventional septic system is capable of removal of suspended solids, biodegradable organic compounds, and pathogens if properly designed, sited, operated and maintained.



Conventional Septic System and Leachfield

Septic systems treat household wastewater by temporarily holding it in the septic tank where heavy solids and lighter scum separate from the wastewater. This separation process is known as primary treatment. Solids stored in the tank are decomposed by bacteria and later removed, along with the lighter scum, by a septic tank pumper.

After partially treated wastewater leaves the tank, it flows into a distribution box and then into a network of soil absorption system trenches or chambers. Drainage holes at the bottom of each line allow the wastewater to drain into trenches for temporary storage. These trenches are commonly filled with aggregate (gravel/crushed stone), or use other approved materials such as molded polyethylene. This effluent then slowly seeps into the subsurface soil where it is further treated and purified (secondary treatment).

1.2 Limitations to Conventional Septic System Treatment

In environments with adequate soil and hydrological conditions, conventional septic systems are appropriate for wastewater treatment. However, in areas that are not considered adequate (as described below), conventional septic systems may provide incomplete treatment of effluent, resulting in pollutants such as phosphorus reaching nearby waterbodies. Incomplete treatment may occur in the following instances:

1. **Depth to water table/bedrock -** Multiple studies have shown a clear link between the vertical separation of the septic system from the water table or impermeable layer (bedrock). The United States Environmental Protection Agency (USEPA) recommends that the soil available for treatment

be at least three feet thick but ideally up to five feet thick for adequate treatment. Temporary reduction in the vertical separation (due to seasonal changes, rain storms) is enough to reduce the effectiveness of the soil to treat pollutants.[1]

2. **Soil type** – The type of soil available for treatment is important to determine the effectiveness of the soil to absorb pollutants. For instance, sandy soils or other rapidly draining soils generally allow water to pass to rapidly to absorb pollutants effectively. At the other extreme, poorly draining soils such as clay soils may result in surface ponding. Ideal soils lie between the two extremes, delaying effluent from the septic system long enough to provide good treatment, but not so long as to not accept all of the effluent.[1]

3. **Proximity to surface waters and wetlands** – Proximity to the shoreline increases the risk of incomplete treatment. Many studies have been conducted to determine the appropriate distance between the leachfield and nearby water and wetlands. These studies showed the average plume length was approximately 80 feet with a range from 30 to 300 feet depending on factors such as soil type and septic system use.[2,3]

4. **The number of septic systems in a watershed** – Too many septic systems in an area may overwhelm the area's carrying capacity for treatment because individual septic system plumes may intermingle and pollute large areas of groundwater. The density of septic systems in an area has been shown to be potentially problematic for surface water quality. The USEPA defines high density as forty septic systems per square mile. [4,5]

5. **Improper maintenance** – As with any type of system, improper maintenance will prevent a conventional septic system from operating as it was designed. For conventional septic systems, general maintenance includes regular inspection and pumping of the primary tank. This maintenance typically occurs every three to five years, but may need to occur more often in certain environmental conditions. In addition, septic systems are only designed to work effectively for 20-30 years and need to be replaced to ensure they are removing pollutants effectively.

6. **Overuse/Incorrectly sized** – If a septic system is not sized correctly for the property, it is at risk of failure or malfunction. If it is too small, the tank will not be able to handle the amount of wastewater coming from the house. If this happens, wastewater can flood the leach field and could come back into the home as the system becomes overloaded. The tank size is generally dictated by the number of bedrooms or square footage of the home. A typical tank size for a three-bedroom home is 1,000 gallons. For each additional bedroom, the tank must hold an additional 250-gallons.

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1 Mallin, M.A., 2004. Septic Systems in the Coastal Environment: Multiple Water Quality Problems in Many Areas. Chapter 4. University of North Carolina Wilmington Center for Marine Science.

2 MPCA, 1999. Effects of Septic Systems on Ground Water Quality. Ground Water Monitoring and Assessment Program, Minnesota Pollution Agency, St. Paul, Minnesota. May 1999.

3 Schneeberger, C. L, M.A. O'Driscoll, C. P Humphrey, K.A. Henry, N. Deal, K.L. Seiber, V.R. Hill, and M.A. Zarate-Bermudez, 2015.Fate and Transport of Enteric Microbes from Septic Systems. *Journal of Environmental Health.* Vol. 77, No. 9, Pg. 22-30. May 2015.

4 Anderson, John R. II, "The Effects of High Density Septic Systems on Surface Water Quality in Gwinnett County, Georgia." Thesis, Georgia State University, 2010.

5 Yates, M.V., 1985. Septic tank density and groundwater contamination. *Ground Water*., Vol23, No. 5, Pg. 586-591. Sept-Oct 1985.

2 Local and State Regulations

The installation of new septic systems and the replacement of old septic systems are regulated by both the State of New Hampshire and the Town of Londonderry. A review of these regulations is summarized below.

2.1 New Hampshire Septic System Regulations

Currently, septic systems are regulated by the State of New Hampshire under Chapter Env-Wq 1000 Subdivision; Individual Sewage Disposal Systems in the New Hampshire Code of Administrative Rules and promulgated under the authority of Statute Title 50, Water Management and Protection, Chapter 485A, Water Pollution and Waste Disposal. These regulations outline all aspects of septic system installation and maintenance. Some key regulations are summarized below.

- **Setbacks -** Chapter Env-Wq 1008 addresses setbacks for septic tanks and leachfields. These regulations require a setback of 75 feet from all surface waters (for both tank and leachfield) and a setback of 50 to 75 feet from all wetlands depending on the type of wetland soils.
- **Leachfields** - Chapter Env-Wq 1014 addresses the requirements for the leachfield including the requirements for the receiving soil layer. Chapter 1014.07 requires at least two feet of permeable soil above any impermeable sub-soil and four feet of soil above bedrock. The regulations do not specify the nature of the "permeable" soil although "impermeable" soil is defined as having a percolation rate of greater than 60 minutes per inch. Chapter 1014.08 addresses the distance above the seasonal high water table (SHWT) which is defined under Env-Wq 1002.61 as the level at which the uppermost soil horizon contains 2% or more distinct or prominent redoximorphic features that increase in percentage with increasing depth. The state requires the bottom of the Effluent Disposal Area (EDA) to be at least four feet above the SHWT and in no case less than two feet above the SHWT if a conventional system is used.
- **Maintenance -** NH State Statute RSA-A:37 Maintenance and Operation of Subsurface Septic Systems requires that all subsurface septic systems must be operated and maintained to prevent a nuisance or potential health hazard due to a failing system. Further, the state and its agents may enter properties for the purpose of inspecting and evaluating the maintenance and operating conditions of all septic systems, and where appropriate, issue compliance orders.
- **Failure -** Chapter Env-Wq 1004.20: Replacement of Systems in Failure cites NH State Statute RSA 485-A:2, IV. Failure is defined as "the condition produced when a subsurface sewage or waste disposal system does not properly contain or treat sewage or causes the discharge of sewage on the ground surface or directly into surface waters, or the effluent disposal area is located in the seasonal high groundwater table. If a system is identified as failing, the use of the current septic system and leachfield must be stopped, and efforts to pump out and install a replacement system.

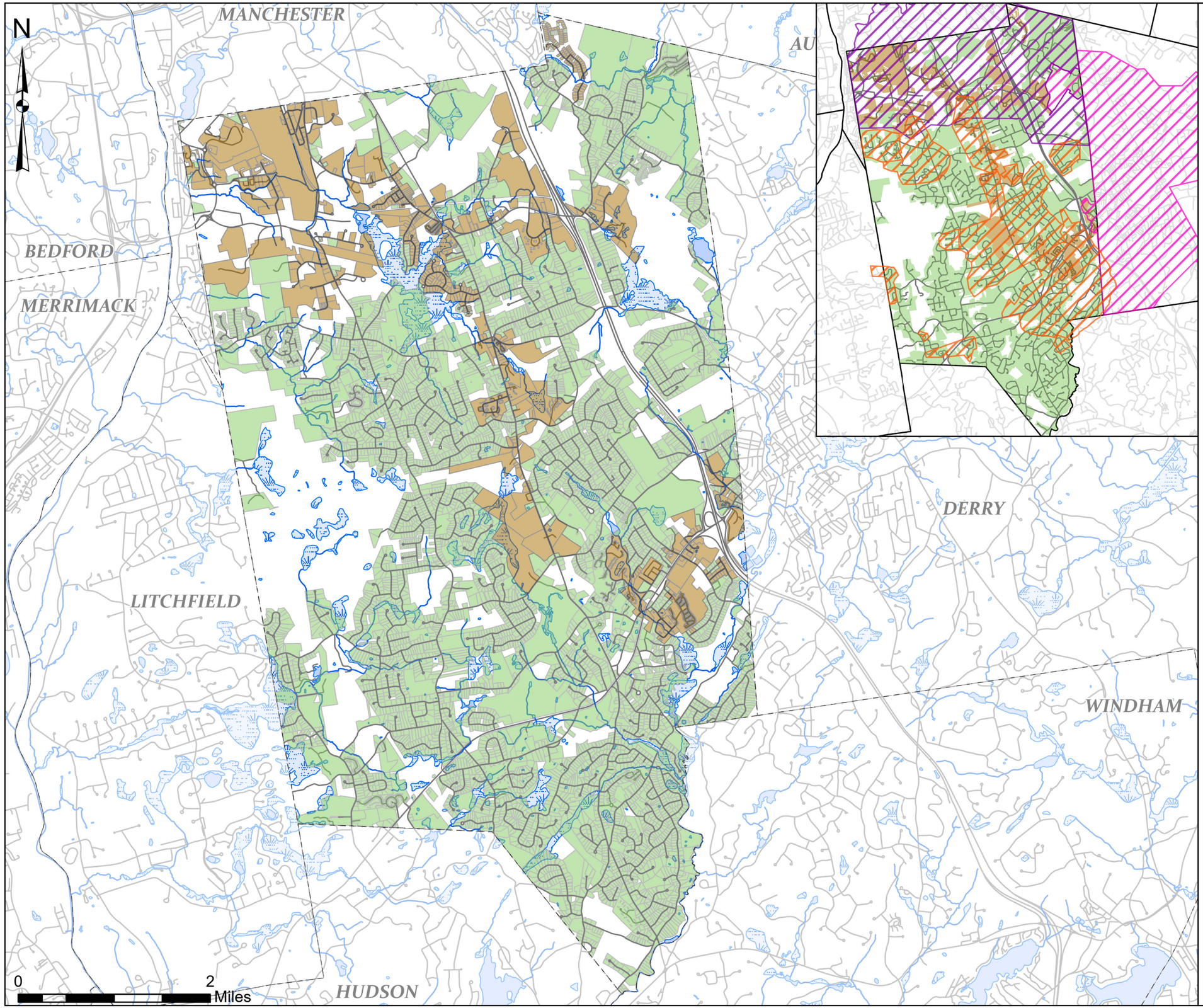
In Londonderry, over 90% of homes are estimated to rely on septic systems to treat their wastewater as they do not have access to public/private sewer. The remainder of properties have access to public/private sewer for treatment at the City of Manchester's Treatment Facility (northern portion of town) and with the Town of Derry's Wastewater Treatment Facility (southeastern portion of town). The majority of parcels that have access to public/private sewer are located in the northern portion of the town between Interstate 93 and the airport. Parcels near the town center on Mammoth Road and in the developed area near Nashua Road and Interstate 93 also rely on public sewer.

2.2 Town of Londonderry Regulations

Many New Hampshire town regulations regarding septic systems reference and follow the state regulations. However, in an effort to protect water quality, some towns impose stricter requirements on some aspects of the septic systems than the state regulations. A review of local ordinances and regulations for the Town of Londonderry is provided below. The town does not have any specific regulations regarding septic systems that are different than state regulations:

- **Zoning Ordinance, As Amended through June 6. 2022** –
    - Section 2.3.1.7 Accessory Dwellings Section J. If the accessory dwelling is not on public water and sewer, then well and septic provisions shall comply with New Hampshire Department of Environmental Services.
- **Subdivision Regulations, Amended November 2021 -**
    - Section 3.07 Sanitary Sewer System. Section B. Individual Disposal System. When a project is to be served by an individual septic system, certification from the Town of Londonderry Health Officer and the New Hampshire Department of Environmental Services shall be submitted. The State subdivision approval number shall be shown on all plans. Individual disposal systems shall be designed and constructed in accordance with the New Hampshire Department of Environmental Services and the Town of Londonderry Regulations.
- **Site Plan Regulations**, **Amended November 2021 -**
    - Section 3.06 Sanitary Sewer System. Section B. Individual Disposal System. When a project is to be served by an individual septic system, certification from the Town of Londonderry Health Officer and the New Hampshire Department of Environmental Services shall be submitted. The State subdivision approval number shall be shown on all plans. Individual disposal systems shall be designed and constructed in accordance with the New Hampshire Department of Environmental Services and the Town of Londonderry Regulations.

Figure 1: Septic Systems and Drinking Water Suppliers in the Town of Londonderry, NH



Legend

- Parcels on Septic
- Parcels on Sewer
- Pennichuck Water Works Service Area
- Manchester Water Works Service Area
- Derry Water Works Service Area
- Lake or Pond
- Wetland
- Stream, River

Comprehensive Environmental Incorporated

Data Sources: GRANIT, Town of Londonderry, CEI

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3 Septic Systems in the Town of Londonderry

The Town of Londonderry has over 5,500 parcels relying on septic systems to treat their wastewater. The remainder of properties have access to public/private sewer for treatment at the City of Manchester's Treatment Facility (northern portion of town) and with the Town of Derry's Wastewater Treatment Facility (southeastern portion of town). The majority of parcels that have access to public/private sewer are located in the northern portion of the town between Interstate 93 and the airport. Parcels near the town center on Mammoth Road and in the developed area near Nashua Road and Interstate 93 also rely on public sewer (Figure 1).

Drinking water for these properties is provided by both public and private water supplies. Public water supplies serving properties in Londonderry include Derry Water Works, Pennichuck Water Works, Manchester Water Works, and community/public wells (Figure 1). Though the installation of new and replacement systems is regulated by both the state and the town, information on older systems is often unknown. The Town of Londonderry does not currently have systems in place to manage this potential pollutant source. To address this need, an Environmental Risk Assessment was developed to identify parcels with soil and environmental conditions. Based on the results of this assessment, parcels could be prioritized and an initial septic system inventory could be developed. The process is described in the sections below.

3.1 Environmental Risk Assessment

An Environmental Risk Assessment was conducted **to** identify areas at higher risk for septic system malfunction or failure based on soil limitations such as filtering capacity, flooding, depth to bedrock, depth to saturated zone, slope, and restricted permeability. Environmental factors such as the proximity of wetlands, 100-foot stream buffer, and flood potential were also considered.

In addition to the location of parcels with septic systems within the Town of Londonderry, the following factors were analyzed to determine areas of the watershed potentially unsuitable for this type of wastewater treatment.

1. **Septic Tank Adsorption Rating (NRCS):** The Natural Resources Conservation Service Soils Data layer in GIS provides a Septic Tank Adsorption Rating for parcels within a watershed based on the following soil and environmental factors (as defined by NRCS) that may limit the effectiveness of conventional septic systems:

    - **Filtering capacity**: The saturated hydraulic conductivity of soil, known as KSat, is an important physical property that influences the capacity of the soil to retain and transport water. The soil horizon with the maximum Ksat governs the leaching and seepage potential (or filtering capacity) of the soil. When this rate is high, transmission of fluids through the soil is unimpeded, and leaching and seepage may become an environmental, health, and performance concern.
    - **Flooding**: Flooding has the potential to transport agricultural waste off site and pollute surface waters. Flooding also limits building, recreational, and sanitary facility use and management of these soils.
    - **Ponding**: Ponding is the condition where standing water is on the soil surface for a given period of time. Soils that pond have restrictions that limit the installation and function of most land use applications. Soil features considered are ponding duration and frequency.

- **Depth to bedrock**: The depth to bedrock restricts the construction, installation, and functioning of septic tank adsorption fields and other site applications. Shallow soils have limited adsorptive capacity and biologically active zones through which waste materials can percolate. These soils may pose environmental and health risks when used as filter fields.
- **Slope**: Absorption fields cannot be located too close to cuts or on steep slopes as there is a danger that sewage can seep laterally out of the slope or cut before it has a chance to be fully treated. Septic systems can also cause slope failures if located in unstable slopes.
- **Depth to saturated zone**: Soils with shallow depth to a water table may become waterlogged during periods of heavy precipitation and are slow to drain. These soils have the potential to contaminate groundwater, which may create health and environmental hazards.
- **Seepage**: The soil's bottom layer Ksat (saturated hydraulic conductivity) governs the leaching and seepage potential of the soil. When this rate is high, transmission of fluids through the soil and underlying materials is unimpeded, and leaching and seepage may become an environmental, health, and performance concern.
- **Restricted permeability**: The soil horizon with the minimum Ksat governs the rate of water movement through the whole soil. When this rate is low, transmission of fluids into and through the soil is impeded, and runoff, infiltration, and percolation of pollutants may result in environmental, health, and performance concerns.
- **Too Steep**: For non-rated “rock outcrop” soil types, a risk score of five (which was the highest score among all soil types) was manually assigned on the basis that rock outcrops are extremely unsuitable for septic systems. For non-rated “urban land” soil types, the risk factor similar to surrounding rated soils was chosen. Generally, the highest score was chosen if there were multiple surrounding soil units (excluding waterbodies). The reason for choosing the highest of the scores is the proximity to properties and people, which elevates risk of harm if there is a wastewater failure.

2. **Proximity to Wetlands and Surface Waters:** The National Hydrography Dataset provides the location of all wetland and surface water areas in the watershed. All septic systems located within the 100-foot buffer to wetlands or surface water bodies were identified.
3. **Flood Zones:** Flood zones are geographic areas that the Federal Emergency Management Agency (FEMA) has defined according to varying levels of flood risk. Each zone reflects the severity or type of flooding that would be expected in the area. For this analysis, areas of Londonderry with the highest risk of flooding as determined by FEMA were identified. These areas, or Flood Zone A, have a 1% chance of flooding and a 26% chance of clouding over the life of a 30-year mortgage. The potential for the land to flood increases the likelihood of septic system failure or transfer of effluent to nearby waterbodies or wetlands.

These soil and environmental factors were then combined with town parcel and sewer data and each parcel was assigned a specific “Tier” or septic system category as described below:

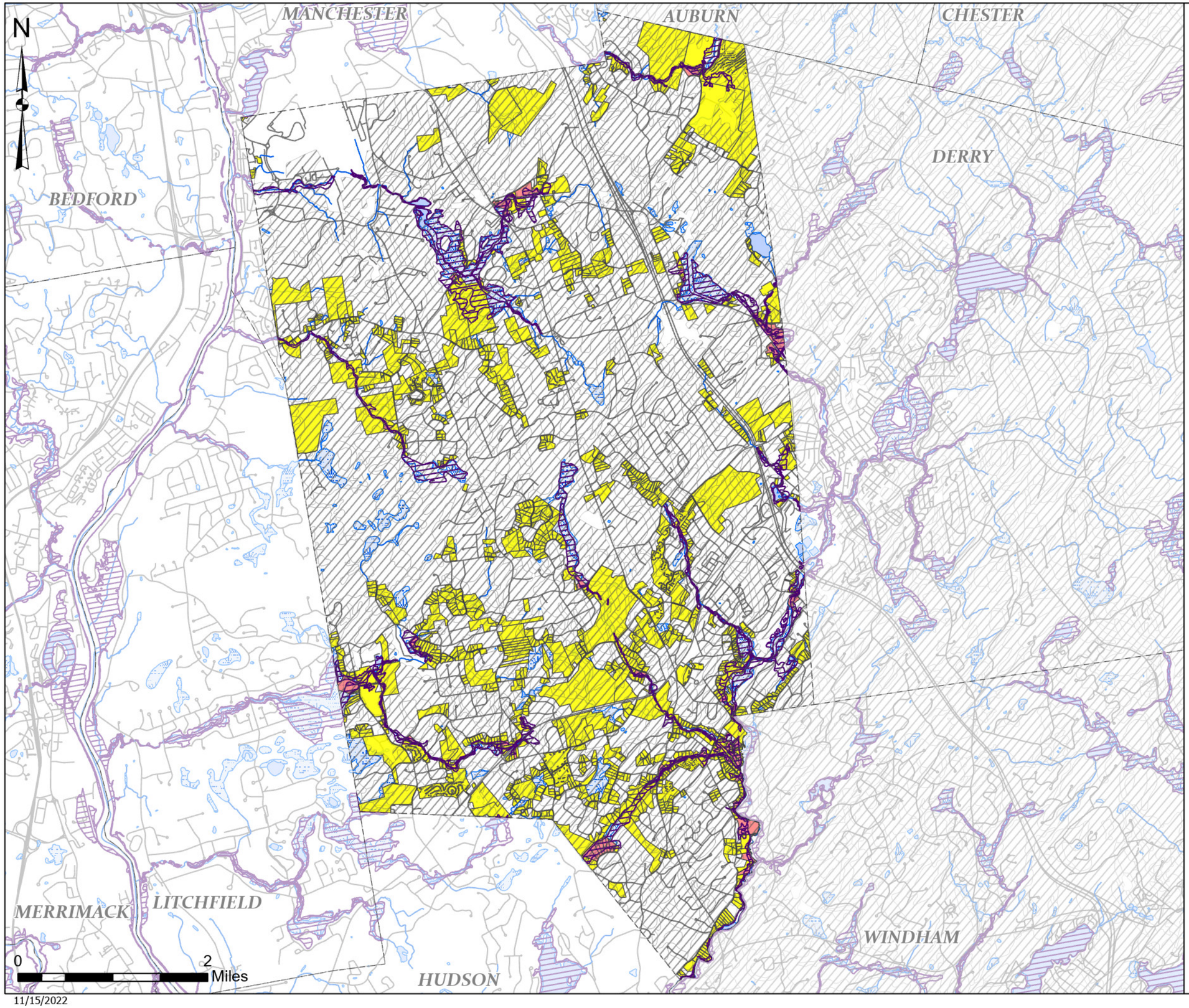
- **Tier 1**: Parcels on septic systems in limited soils, 1% FEMA Flood Zone, and within the 100-foot buffer of a waterbody or wetland.
- **Tier 2**: Parcels on septic systems in limited soils and within the 100-foot buffer of a waterbody or wetland.
- **Tier 3**: Parcels on septic systems not considered Tier 1 or Tier 2.

Table 1. Environmental Risk Asessement and Drinking Water Sources for Londonderry

Category	Total Properties	Drinking Water Source				
		Derry WW	Pennichuck WW	Manchester WW	Community/ Public Well	Private Well
Tier 1	70	0	23	13	0	34
Tier 2	1300	6	538	147	9	600
Tier 3	4410	3	2025	16	20	2346
Sewer	693	10	317	343	12	11
Totals	**6473**	**19**	**2903**	**519**	**41**	**2991**

As shown in Table 1 and Figure 1, there are 6,473 parcels in the Town of Londonderry of which 5,780 do not have access to the public sewer system and are assumed to rely on private septic systems. Drinking water to these properties are supplied by Derry Water Works, Pennichuck Water Works, Manchester Water Works, community and public wells, or private wells. In total, 70 properties in Londonderry are considered "Tier 1" properties. These properties are most "at risk" for septic system malfunction or failure based on soil and environmental conditions. An additional 1,300 properties are considered "Tier 2," properties that are located in limited soils and within a 100-foot buffer of a waterbody or wetland (Figure 2).

Figure 2: Environmental Risk Assessment for Septic Systems in the Town of Londonderry, NH



Legend

- Parcels with Septic Systems in Limited Soils, 1% FEMA Flood Zone, & 100' Buffer (Tier 1)
- Parcels with Septic Systems in Limited Soils & 100' Buffer (Tier 2)

FEMA Flood Hazard

- 1% Annual Chance Flood Hazard

Septic Tank Absorption Rating

- Very limited
- Lake or Pond
- Wetland
- Stream, River

Comprehensive Environmental Incorporated

Data Sources: GRANIT, Town of Londonderry, CEI

11/15/2022

3.2 Septic System Inventory

As a next step for providing the Town of Londonderry with a method for tracking septic system installation and replacement, an inventory of septic systems classified as Tier 1 and Tier 2 within the Source Water Protection Areas (SWPAs) was developed. As defined by the USEPA, A SWPA is the land area that contributes water to the drinking water supply and where pollution from human activities or natural sources poses the greatest threat to source water quality. Though only parcels within the SWPAs were assessed due to funding, the inventory provides the town with the framework for a tracking system for septic systems throughout the town.

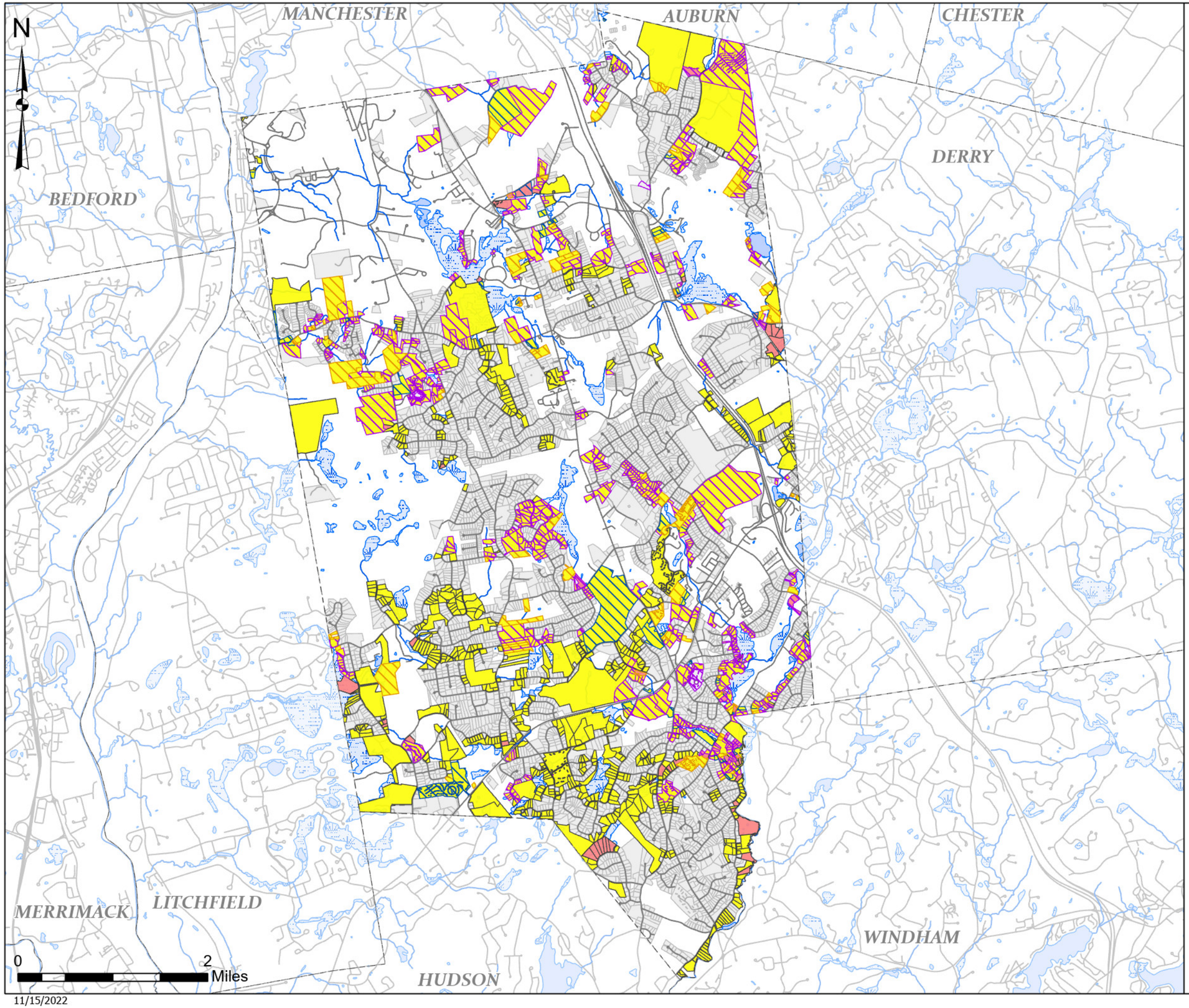
This inventory was developed by reviewing town records and the state permitting database for all homes within these categories. Based on this review, there are 36 developed parcels classified as Tier 1 located in one of the SWPAs. Information about septic systems was available for 31 of these properties. Of the 1,300 parcels classified as Tier 2, there are 700 located within a SWPA. Information was available for 671 of these properties. A summary of findings is provided in Table 2 and Figure 3. An inventory of the developed parcels in the watershed is provided separately in Excel.

Table 2. Tier 1 and Tier 2 parcels within Source Water Protection Areas in Londonderry

Category	Total Properties	Parcels with Record of Replacement	Replacement Date		
			>20 Years Ago	10-20 Years Ago	<10 Years Ago
Tier 1	36	31	23	5	3
Tier 2	700	671	524	103	44
Totals	**736**	**702**	**547**	**108**	**47**

As shown in Table 2, approximately 78% of properties assessed had septic system replacement records that were dated over twenty years ago. As noted in Section 1.1.1, septic systems are only designed to work effectively for 20-30 years and need to be replaced to ensure they are removing pollutants effectively. There is currently no method for tracking septic system maintenance. As noted, for conventional septic systems, general maintenance includes regular inspection and pumping of the septic tank. This maintenance typically occurs every three to five years, but may need to occur more often in certain environmental conditions.

Figure 3: Septic System Inventory for the Town of Londonderry, NH



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Septic Replacement Date:

- >20 Years Old
- 10-20 Years Old
- <10 Years Old
- Parcels with Septic Systems in Limited Soils, 1% FEMA Flood Zone, & 100' Buffer (Tier 1)
- Parcels with Septic Systems in Limited Soils & 100' Buffer (Tier 2)
- All Parcels on Septic not Considered Tier 1 and Tier 2 (Tier 3)
- Lake or Pond
- Wetland
- Stream, River

Comprehensive Environmental Incorporated

Data Sources: GRANIT, Town of Londonderry, CEI

11/15/2022

4 Addressing Septic Systems

Management strategies associated with septic systems are anticipated to be an important part of the long-term approach to protecting Londonderry's water resources. Septic systems are currently regulated at the State level and alternative treatment practices have not yet been approved. Therefore, regulatory changes at the State level are needed to allow for implementation of alternative treatment practices. However, there are many steps municipalities can take to address septic systems.

4.1 Regulatory Changes

The construction and operation of septic systems are regulated by a comprehensive set of state regulations. Local municipalities are free to enforce local regulations or ordinances with stricter, but never more lenient requirements. Many municipalities in New Hampshire have adopted stricter ordinances and regulations regarding septic systems.

Health Division Regulations may be enacted where existing state laws are determined to be insufficient for the protection of public health. For example, Boards of Health can regulate septic systems more stringently than required under state law, and can further regulate the use, storage and handling of fuel and other hazardous materials in specified areas. Some communities have adopted septic system pump out regulations, requiring residents to pump their septic systems regularly (typically once every three years) and provide documentation to the town.

Town of Meredith, NH: Health Ordinance for Inspection

The Town of Meredith, NH enacted a health ordinance that requires the evaluation of all septic systems within 250 feet of Lake Waukewan that do not have an approved operational permit. In addition, the health ordinance requires that septic systems are replaced under certain conditions such as for those properties lacking a valid subsurface system design approval and a proposed expansion is submitted to the Planning Board.

Town of Rye, NH: Design Criteria and Pump-out Ordinance

Septic systems are regulated by the Town of Rye under the Section 7.9 of the Building Code most recently revised in March 2017. Many town regulations regarding septic systems follow the state regulations. However, in an effort to protect water quality, the town requires additional design criteria such as requiring the bottom of the leachfield to be a minimum of six feet above an impermeable layer and a minimum of four feet above the water table. In addition, septic systems are prohibited in areas with the following conditions (Section 7.9.4):

- All lands within 100 feet of protected wetlands (as indicated in Section 301.7 of the Zoning Ordinance)
- Soils with a water table at or within 24 inches of the surface.
- Soils with bedrock or impervious substratum within 36 inches of the surface.
- Any land having a natural slope of 15% or greater.
- Soils with a percolation rate greater than 60 minutes per inch.

Septic systems can be installed in areas meeting these prohibited conditions with a town-approved waiver. In addition to stricter design criteria, the Town of Rye recently adopted an ordinance requiring that all septic tanks are pumped out once every three years in specific areas of town.

4.2 Alternative Treatment Systems

In areas where conventional septic systems are not appropriate due to soil or environmental conditions, alternative systems may provide adequate treatment. Alternative systems are typically upgraded from traditional septic systems by adding a component that reduces phosphorus concentrations from the effluent before it is discharged to the ground. They are installed at an individual home, or cluster of homes, and usually cost more to operate and maintain than a traditional septic system. The increased maintenance costs are due to power needs for the system (e.g., pumps, aerators), required water quality sampling, and other elements that are not needed for a traditional onsite system.

4.2.1 Advanced Onsite Treatment

Alternative treatment components can be added to a conventional system, often between the septic tank and the leachfield, to provide advanced treatment of phosphorus (Figure 4). Reactive media filters, such as sand or gravel filters, are often used as advanced treatment in septic systems. For phosphorus removal specifically, additional media such as iron, aluminum, or calcium compounds, are added to these systems with the goal of immobilizing phosphorus. These systems have been shown to reduce phosphorus by up to 90 percent.

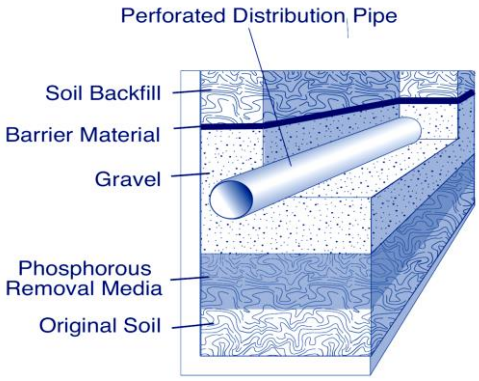


Figure 4. Alternative Onsite System with Phosphorus Treatment (Source: EPA, 2013)[6]

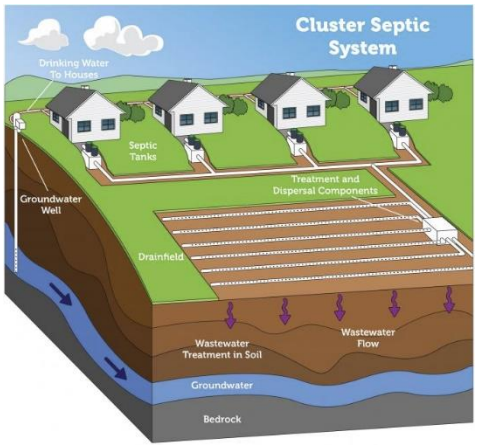
4.2.2 Alternative Toilets

Approximately 60 to 75 percent of phosphorus Is contained in toiled wastewater, also referred to as blackwater. Removing the blackwater from the septic tank influent will greatly reduce the amount of phosphorus in the effluent. Composting toilet systems offer a different solution to wastewater by eliminating much of the liquid waste. On a basic level, composting toilets retain solid and liquid excrement in a contained unit that facilitates the natural breakdown of material, or composting. Whether done completely within the eco-toilet unit, or transported and completed offsite, this process results in 'finished' compost free of pathogens and disease, with the potential to serve as a soil amendment. There are many different types of composting systems that range in cost, size, and maintenance requirements.

The cost of upgrading a residential property to alternative toilets varies greatly and is based on a number of factors including: number of bathrooms, extent of remodeling work required, greywater management (i.e., hand and dish washing, showers, laundry, etc.), permitting requirements, and the type of system.

6 EPA. 2013. A Model Program for Onsite Management in the Chesapeake Bay Watershed. Office of Wastewater Management. June 2013.

4.2.3 Cluster or Neighborhood Treatment Systems



Cluster or shared systems provide an opportunity for cost savings in both the construction and operation of the system. Building and operating one larger system is often less expensive than operating many small individual systems unless the homes using the system are far apart and the costs to connect them by sewer are high. Cluster systems also provide an opportunity to offset nitrogen discharges from other systems where upgrades are less feasible.

While cluster systems can be easily implemented for new development, retrofitting an existing area to a cluster system may pose both financial and engineering challenges. For example, the cost of piping the wastewater from each individual property to the cluster system could be a significant expense, particularly in low density areas. The construction of new collection systems and the availability of land for cluster systems also pose engineering challenges. Dense areas or areas with historical failures might provide the most opportunities for retrofitting conventional systems to cluster systems.

4.3 Detection of Failing Septic Systems

Failing septic systems have been identified in many watershed-based plans as potential sources of bacteria and nutrients to impaired waters. However, identifying the location of failing and malfunctioning septic systems is often difficult as little information is known about private systems, failure is generally only noted when there is an odor or surface outbreak, and access to private property may prevent the discovery of failing systems.

Many municipalities have worked to identify areas of their community most at risk for septic failure based on factors including soil type, proximity to surface water, age of home, and slope. This information is often paired with obtaining local pump-out records, municipal records involving septic system replacement, and other information to begin to develop a septic system database. However, these records are often incomplete and do not positively identify failing or malfunctioning systems.

Though identification of failing septic systems may be difficult, characteristics of a failing system have been documented in other studies. Failing systems are characterized by dead or stressed vegetation, high soil moisture, and surface effluent as the partially treated or untreated wastewater moves toward the ground surface. If the plume is located near or at the ground surface, temperature differentials may occur.

Examples of failing leachfields. The majority of failing systems are identified by surface effluent (middle and far right). However, the majority of failing systems are not evident to the naked eye and may appear as a green lawn (left)

4.3.1 On-Site Investigations

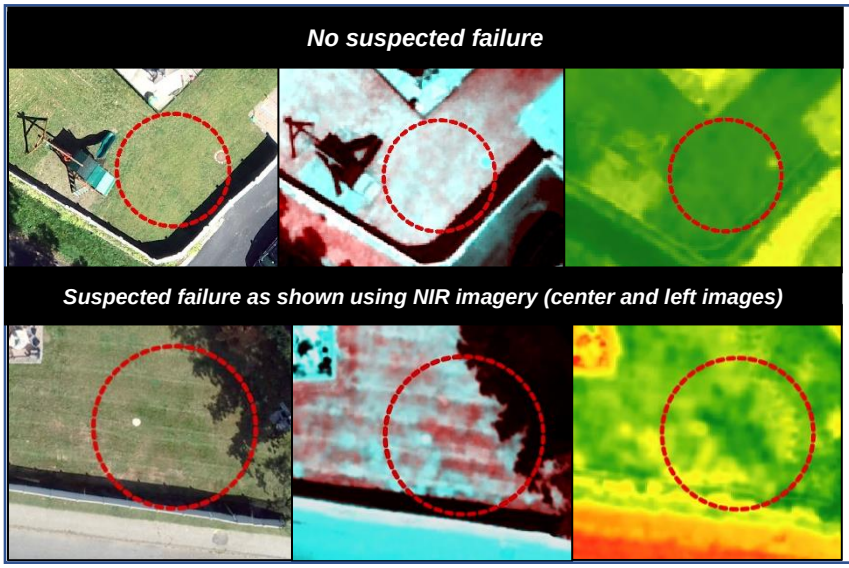
The most effective method of detecting a failing septic system is to have the system inspected by a licensed septic inspector. Septic inspectors generally discuss with the homeowner the history of the system, review any permits for the system, and conduct a thorough tank, distribution box, leachfield, and house inspection to ensure all parts of the system are operating properly. Tanks are inspected for obvious leaks or cracks and to ensure water is flowing from the house as it should. During the tank inspection, the inspector will determine if it needs to be pumped. The inspector will dig test pits to determine if the leachfield is draining properly. All mechanical equipment, including pumps, aerators, and alarms will be tested.

Inspectors can use a fluorescent dye solution to visually identify any problems with the septic system. The dye can be flushed down the toilet to determine connection with the septic tank. Water can then be added to the tank to flush the dye into the leachfield. Once the leachfield is saturated to capacity with dyed water, any broken or disconnected pipes can be identified as the dye solution will be visible at the surface. Generally, dye should make it through the system within a few hours.

4.3.1.1 Drone Investigations

Watershed surveys using unmanned aerial drones can be effective at identifying failing septic sytems. By combining the use of drones, readily available information on septic systems, and color (CIR) and near-infrared (NIR) imagery, failure signatures such as vegetation stressors, soil moisture, and others that are not visible to the naked eye can be identified. This type of imaging has been successful in identifying failing systems in other studies.[7,8]

As shown in the example images below, CIR and NIR can be combined with site information (i.e., septic leachfield location) to identify potentially failing systems that may be contributing to surface water impairments. Drones are able to screen large areas very efficiently for potential problem sites, allowing staff and financial resources to focus on the highest priority areas for follow-up investigations and improvements.



*Example of imagery collected using **Drones**.*

Location of septic systems identified from site plans (in red circles).

Left images: Typical camera images

Center and right images: NIR images (deeper red color (center) and dark green (right) indicates more productive vegetation)

Top panel: No suspected failure as NIR images do not indicate stressed vegetation.

Bottom panel: "Signature" of septic failure can be seen faintly with drone imagery from a standard image and is significantly improved through the use of NIR imagery.

7 Huron River Watershed Council, 2012. Identification of Failing Septic Systems. https://www.hrwc.org/wp-content/uploads/HRWC20Septic20System20ID20Report20Final20v1.pdf

8 Roper, W.E., 2008. Color Infrared Survey for Identification of Failing Onsite Treatment Systems, George Mason University.

4.4 Developing Septic System Programs

In addition to regulatory changes, other programs can be developed to address septic systems. Other communities in New Hampshire have developed public education, septic system inspection and/or replacement, and group maintenance programs.

4.4.1 Public Education

Public education is vital to prevent septic system malfunction and failure. Many of the problems associated with septic system malfunction may be attributed to a lack of homeowner knowledge on proper operation and maintenance of their systems. Educational materials for homeowners regarding the need to pump out their systems regularly and the linkage between septic systems and water quality are effective. The Town of Londonderry provides a link to a NHDES fact sheet regarding septic systems on their Health Division webpage. In addition to this fact sheet, there are many resources for existing public education brochures and flyers:

- EPA Septic Systems Outreach Toolkit
- Winnipesaukee Environmental and Community Action Network
- Massachusetts Clean Water Toolkit

4.4.2 Inspection and Replacement Programs

Once a septic system has been identified as needing replacement, the cost of replacement can be prohibitive for homeowners. To address nutrient loading from failing septic systems in the Lake Waukewan Watershed, the Lake Waukewan Watershed Septic System Improvement Initiative was developed to provide cost share incentives to property owners for the evaluation of septic systems and the repair or replacement of the system if necessary. As Lake Waukewan is the municipal drinking water source for the Town of Meredith, the Lake Winnipesaukee Association (LWA) was awarded a Source Water Protection grant to provide cost sharing incentives to property owners located within 250 feet of Lake Waukewan to conduct septic system evaluations. Grants provided 50% of the cost of each evaluation, or $250. Sixteen evaluations were completed through LWA's Evaluation program.

A second part of the Waukewan Watershed Septic System Improvement Initiative provided cost sharing grants to property owners whose septic systems were found to be in failure through the evaluation program or were documented in failure. A NHDES Watershed Assistance Grant provided funds for the improvement of ten septic systems found in or near failure; cost share grants covered one third of the cost toward repair, upgrade, or replacement of an existing system, up to a maximum of $4,000. Priority was given to properties with septic systems identified as high risk located within 250 feet of Lake Waukewan and Lake Winona as nutrient loading in these critical areas poses a threat to public health. Through the cost share program, nine septic systems were replaced with new systems. In addition, because of Meredith's health regulation, five more properties had their septic systems replaced, for a total of 14 new systems installed. The estimated reduction in phosphorus loading to Lake Waukewan from the installment of new septic systems is 5.3 kg.

5 Recommendations for the Town of Londonderry

More information is needed to fully assess the state of septic systems in the Town of Londonderry. With the information available, it is likely that many of these systems are not functioning effectively based on the age and/or location of the system and are a source of pollutants to groundwater and surface waters in Londonderry. Specific recommendations for addressing septic systems in Londonderry include:

1. Develop an education and outreach program targeted to homeowners in Tier 1 and Tier 2 categories (information on town website, mailings to homeowners, education workshops, etc.);
2. Consider regulatory changes to include mandatory septic system pump out and inspection or requiring advanced treatment systems upon replacement;
3. Explore possibility of zero or low interest loan or grant programs to assist homeowners with septic system replacement; and
4. Complete the septic system inventory for all other parcels on septic in Londonderry.