Engineering Study of Wastewater Issues and Solutions Around Truesdale Lake

Town of Lewisboro, Westchester County, New York

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Town of Lewisboro, Westchester County, NY

Engineering Report

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Table of Contents

Table of Tables

Table of Figures

Executive Summary

The Town of Lewisboro is evaluating solutions for managing wastewaters generated in the Truesdale Lake watershed that are contributing to impaired lake water quality, specifically regarding the nutrient loading to the Lake resulting from Onsite Septic Disposal Systems (OSDSs). This report is an initial step toward identifying potential solutions and implementation scenarios to reduce nutrient loading.

Truesdale Lake (the Lake) is a small, developed lake located in the Lower Hudson River basin in the Hamlet of South Salem, New York. Located in the Town of Lewisboro, the Lake is approximately 83 acres in area, with the Lake's watershed spanning more than 2,000 acres, reaching upstream into western Connecticut. The Lake drains into the Waccabuc River as it enters the Cross River as part of New York City's Croton water supply system, and specifically the New York City Department of Environmental Protection (NYCDEP) CDEP unfiltered surface water supply system of the Cross River Reservoir.

There are approximately 70 waterfront residences surrounding the shore of the Lake and approximately 419 residences within the study area serviced by OSDSs, otherwise known as Onsite Wastewater Treatment Systems (OWTSs) by Westchester County Health Department or Subsurface Sewage Treatment Systems (SSTS) by NYCDEP. Soils within Lewisboro and the study area are reportedly limited or extremely limited in their suitability for use of OSDSs due to the steep slopes, shallow rock, and high-water tables. These sub-par conditions have resulted in OSDSs that are operating inefficiently and yielding increased point and nonpoint source loadings, resulting in high levels of nutrients within the Lake.

Lake Truesdale is classified by the New York State Department of Environmental Conservation (NYSDEC) as a Class B waterbody, whose best uses are listed as recreational including fishing, swimming, and boating activities. These uses are considered by the NYSDEC as impaired due to bacterial and algal growth resulting in low water transparency caused by elevated nutrient (phosphorus) loads. The primary causes in reduction of water quality are nutrient loading from OSDSs, stormwater runoff from urban land, and residential wildlife. The Lake has been a part of a volunteer lake monitoring and education program from 1999 to 2015 as part of the NYCDEC Citizen Statewide Lake Assessment Program (CSLAP). EcoLogic LLC conducted a study on the Lake in August 2008 and found the concentrations of soluble reactive phosphorus, nitrate + nitrite N, and TKN to be greater than the established limits (EcoLogic LLC, 2009). The same was reported again in 2015 by the SUNY Oneonta report.

As the surrounding OSDSs are the main contributors of nutrient loading to the watershed, causing bacterial and algal growth and Lake impairment due to poor water quality, this high-level study was commissioned. The objective was to identify and evaluate wastewater collection and treatment management alternatives, specifically public sanitary sewers and treatment, that can be implemented on a cost-effective basis to reduce nutrient levels in Truesdale Lake and bring the Lake into compliance with water quality standards. This would allow the Lake to meet its intended best uses. Similar studies were also conducted across several lakes in the area, as a preventative measure against increased nutrients in the NYC drinking water reservoirs.

Ramboll partnered with Insite Engineering, Surveying & Landscape Architecture, P.C. (Insite) to implement a variety of desktop evaluation tools supplemented with field visits to estimate wastewater flows and loads and confirm existing conditions surrounding the Lake. A Geographic Information System (GIS) model was prepared for the study area, enabling visual representation of the flow paths, soil types, slopes, wetlands, water bodies, and wastewater generated within the Truesdale Lake study area.

Given the size and span of the Truesdale Lake study area, the study area was divided into two (2) major zones of influence, Zone 1 and Zone 2. Zone 1 includes the area immediately surrounding the Lake and consists of approximately 2/3 of the OSDSs within the study area, most of which are on small lots and within 800 feet of the lakeshore. Zone 2 includes the remaining 1/3 of the OSDSs which are located on larger parcels, further from the Lake, where residences are more dispersed. These zones are further described and depicted in the following sections. Using publicly available data obtained from the Town of Lewisboro, NYCDEP and Westchester County, the developed GIS database, regional knowledge, and frequent site visits, cost-effective approaches for identifying solutions to improve the water quality of the Lake and implementation scenarios were evaluated.

Potential alternatives for wastewater collection and conveyance for the study area surrounding the Lake included:

- Gravity collection system
- Low pressure sewer system/residential grinder pumps
- Vacuum sewer collection system
- Effluent sewer collection system
    - Septic tank effluent pump (STEP) system
    - Septic tank effluent gravity (STEG) system

Potential alternatives for wastewater treatment include:

- Upgraded residential onsite septic systems for advanced nutrient removal
- Cluster collection/treatment system with subsurface discharge
- Treatment at an existing local surface discharging WWTP
- Construction of new/expanded surface discharging WWTP with required variance(s)

Based on the technical analysis and discussions with the Town, construction of a low-pressure sewer collection system and the expansion of the WWTP at Lewisboro Elementary School is the recommended proposed alternative for Zone 1 surrounding the Lake. Upgraded residential OSDSs with improved treatment as part of a septic remediation program is the recommended proposed alternative for the areas not immediately in the vicinity of the Lake (Zone 2). Implementation of this sewage collection and treatment program for the areas surrounding the Lake is recommended to address the TMDL requirements and reduce the amount of non-point source nutrient loading into the Lake.

The preliminary cost estimate for the construction of a low-pressure sewer collection system, and an expanded WWTP to serve the customer base of Zone 1, approximately 274 developed parcels, is estimated to cost $31.2M in 2021 dollars. The following additional steps are recommended to advance the preliminary phase of this project:

- Complete a preliminary design to further define the scope of the project including high level mapping of the collection system and development of a basis of design report for the proposed WWTP that includes desktop and field investigations to site and number the required pumping stations.
- Prepare a Map and Plan Report necessary to define the limits and anticipated user cost for developing a sewer district.

- Evaluate the shoreline and surrounding water courses for potential improvements that could assist in nutrient removal in conjunction with the sewer management district and the septic remediation program.
- Discuss variance and permitting concerns with NYCDEP and NYSDEC.

Project Background and History

Ramboll Americas Engineering Solutions, Inc. (Ramboll) was retained by the Town of Lewisboro and teamed with Insite Engineering, Surveying and Landscape Architecture, P.C. to prepare an engineering report evaluating the impacts on Truesdale Lake water quality resulting from Onsite Septic Disposal Systems (OSDSs), otherwise known as Onsite Wastewater Treatment Systems (OWTSs) or septic tanks, that are contributing high levels of nutrients to the Lake. Historical sampling events and studies have shown that the nutrient concentrations within the Lake are steadily increasing, rendering it an impaired waterbody. Major concerns regarding the water quality of the Lake have arisen because the Lake is part of the NYCDEP water supply. Increasing nutrients in the Lake, and surrounding lakes create a significant impact on the treatment of the drinking water supply downstream. To address the increasing nutrient loading into the Lake, the Town of Lewisboro will be evaluating the various wastewater management solutions presented in this report, along with associated costs, as a step to better manage nutrient loadings and increase water quality.

As part of the report, a variety of desktop evaluation tools, supplemented with field visits, were utilized to estimate wastewater flows and confirm existing conditions surrounding the Lake. This report provides an extensive review of alternatives evaluated to improve the water quality of the Lake by mitigating nutrient loading and outlines available wastewater management alternatives that would improve the water quality. The report will follow New York State Environmental Facilities Corporation (NYSEFC), New York City Department of Environmental Protection (NYCDEP), and New England Interstate Water Pollution Control Commission (NEIWPCC) guidance for municipal wastewater infrastructure projects.

Truesdale Lake is an 83-acre man-made lake created in 1927 by the construction of an 18-foot-tall dam, impounding the flow from a variety of sources including Pumping Station Swamp on the New York Connecticut border, on the northeastern side of the Lake. Along with small creeks and water courses, precipitation (precipitation that is not readily absorbed by the ground and runs overland as runoff) accounts for a significant portion of flow into the Lake, estimated to be 1.6 billion gallons a year. The Lake is approximately 25-feet wide at the mouth of the lake and has a maximum depth of 14-feet. The Lake discharges via a 200-foot-long dam with an 18-foot spillway located at the northern end of the Lake, under Indian Lane, where flow then enters Waccabuc River. The Lake is managed by several associations, including Truesdale Lake Estates Association (TEA) and Truesdale Property Owners Association (TLPOA). These two associations include the majority of the homeowners in the area.

Several studies conducted within the Truesdale Lake watershed were reviewed and used as part of this study. They include the following:

- Town-wide Comprehensive Lakes Management Plan (February 2009)
- Lake Evaluation and Enhancement Plan (September 2001)
- Wetlands Survey (December 2007)
- The State of Truesdale Lake & Truesdale Lake Management Plan (est. 2016)

These historic studies identify the increasing eutrophication trend within Truesdale Lake, where the presence of nutrients within the Lake provide a food source for the micro flora and fauna in the water causing bacterial and algal growth, decreased dissolved oxygen and an causing an overall decrease in water quality. While there is no public access to the Lake, only residents and locals can use the Lake recreationally and power boats are prohibited. The Lake has been classified as a Class B fresh surface water body whose best uses are listed as public swimming and contact recreation activities. However, given historic eutrophication levels, the Lake has been listed on the NYSDEC Section 303(d) list of impaired water bodies as a result of high levels of phosphorus. Phosphorus is most often transported into aquatic systems by the runoff of phosphorus absorbed sediments. The main sources of phosphorus include urban stormwater runoff, septic runoff, fertilizers, and wildlife like waterfowl and land-dwelling animals. The high levels of phosphorus in the Lake have resulted in seasonal algal blooms and an abundance of aquatic plants.

The population in the Town of Lewisboro was 12,324 in 2000, 12,411 in 2010, and 12,265 in 2020 per the US Census data. However, the scope of this study only pertains to the town population that is within the Lake area, which includes 419 single-family homes with an average family size of 2.7 residences, according to the US Census. Therefore, the estimated population within the study area is 1,131, as shown in Table 1 below. Note that there are two ways to calculate average family size; either through bedroom count or through Census Data. Census data suggests an average family size of 2.7, while Westchester County bedroom count suggests 3.25. Ultimately, 2.7 was used to calculate the population following a national standard.

Table 1: Study Area Estimated Present Population

Number of Homes	419
Persons per Household	2.7
Total Population	1,131

The area surrounding the Lake is densely developed, and any remaining undeveloped parcels of land are undeveloped for a reason – i.e., the land is not suitable or is challenging for development. Based on the Census data provided, the population within the Town and study area is anticipated to remain constant over time, experiencing little to no growth and development.

There are no municipally owned sewer utilities available in the Town of Lewisboro or within the study area and residences use onsite water treatment systems (OSDSs) to treat their wastewater. Potable water is supplied for parcels by either privately owned water supplies, public supply wells, or by drinking water wells. There are a few local wastewater treatment facilities in the area; however, they were designed to treat small flows (under 10,000 gpd) from standalone facilities such as schools and country clubs. The closest treatment facility is Lewisboro Elementary School, with a rated capacity of 8,000 gpd.

Nearly all the soils in the watershed and Study Area are considered to be limited or extremely limited in their suitability for supporting an OSDS. These substandard soil conditions have done little to help prevent OSDS leachate from reaching the Lake, especially since the majority of systems have not been properly pumped out and maintained following installation. As the Lake has been limited in its recreational activities due to its high level of productivity, this study has been tasked with evaluating wastewater collection and treatment alternatives that can be implemented to reduce wastewater loadings to the Lake to abate contraventions to water quality standards and allow to the Lake to meet its best usage.

This study provides a desk top evaluation of alternatives, including the replacement of existing OSDSs, construction of community septic systems, public sewer collection and wastewater treatment alternatives that could be implemented to improve the water quality of Truesdale Lake.

Environmental Settings

This study focuses on the areas within New York which are tributary to Lake Truesdale, located in the Hamlet of South Salem, part of the Town of Lewisboro, within Westchester County, New York. The limits of the study area were selected by the NYCDEP, as shown on the Proposed Study Area Map, Figure A, and consists of residential developments and several undeveloped parcels. All developed parcels are currently served by subsurface sewage treatment systems (OSDSs). Existing and future flows for the study area are presented in Figures B and C.

The Lake Truesdale study area is primarily used and zoned as residential. With R-1/4A and R-1/2A zoned areas clustered around Lake Truesdale and R-2A and R-4A zoned areas farther away from the Lake within the study area.

All developed properties within the Lake Truesdale study area are currently serviced by individual OSDSs. The Lake Truesdale Property Owners Association Public Water Supply services 149 residences with three (3) wells to the north end of the Lake. It is unknown how many residences are serviced by the Twin Lakes Water Supply. The water is treated and conveyed through a water main distribution system. The remaining residences within the study area are serviced individually by private wells.

Several factors impacting OSDSs in the project area, as discussed below, limit the area's ability to support the existing development and limit the potential for expansion and new development. These limitations include parcel size, shallow groundwater, surface water, steep slopes, ledge rock, age, and size/condition of existing facilities. These are discussed in greater detail in the following sections relative to their impact on the water quality and OSDS sustainability.

OSDSs that are deficient in one or more of the areas listed above will lead to reduced water quality within the watershed. Suitable areas for installation of OSDSs for new development, expansion of development, or repair of existing systems are severely limited in the Town and the study area. These factors impact the area’s ability to sustain the current level of development and potential expansion, or new development with an individual residence OSDS.

Figure A: Proposed Study Area

Figure B: Existing Flows

Figure C: Future Flows

Description of Wastewater Management Alternative Technologies

Wastewater Management Alternatives (On-site Collection and Treatment):

Several wastewater management alternatives were considered for this effort and range from continued on-site treatment to construction of a new centralized collection and treatment system located in the Town of Lewisboro. Alternatives considered are described below and may include one or more of the systems proposed for this study in a combined fashion. Information has been obtained from the United States Environmental Protection Agency and the Water Environment Research Foundation.

Residential Onsite Sewage Disposal System

Residential on-site treatment systems (generally known as septic tanks with absorption fields or OSDSs) utilize an anaerobic process followed by absorption to treat wastewater. Septic systems are the most common residential on-site treatment system and commonly used in rural areas where centralized collection and treatment systems are not available.

Modern septic systems consist of two components: an enclosed below-grade tank and an absorption field located at grade or, in some cases, elevated to provide adequate separation above groundwater. The elevated systems use imported granular fill when native material is unsuitable. Older systems could have a cesspool providing the tank and absorption in one component. In most cases, wastewater flows by gravity from the residence to the septic tank and then through the absorption field. If the system includes a raised absorption field, a small dosing pump is required.

A majority of the waste treatment occurs in the main tank of the OSDS, where floatables rise to the top of the tank, solids are settled by gravity and bacteria is used to reduce solids and nutrients through anaerobic processes. Liquid leaving the septic tank (effluent) flows through the absorption fields where the remaining contaminants are absorbed by the soils and micro fauna that inhabit the soils. Septic systems, installed in optimal locations and operating efficiently are able to remove a portion of residential pollutants; however, systems not operating efficiently and in poor soils are not able to effectively remove nutrients like phosphorus.

While the longevity of properly installed residential on-site systems varies, typical lifespan for a septic tank and/or absorption field is 15-50 years.

Elements of a properly installed and functioning septic tank and absorption area, according to the Westchester County Health Department's Green book (2002) include:

- Septic tanks must be watertight, constructed of durable materials and not subject to excessive corrosion, decay, frost damage or cracking with a minimum cover of 6-12 inches and a maximum cover of 2 feet.
- Absorption areas should be located a minimum of 5 feet above groundwater, rock, or impervious soils.
- Absorption areas should be a minimum of 100 feet from any water body and a minimum of 100 feet (200 feet if well is in direct line of drainage) from any drinking water well.
- A minimum of three (3) percolation tests, with uniform results, site specific.

The Westchester County Department of Health and NYSDEC recommends pumping of the septic tank by a licensed septic hauler every three (3) years or when the sludge depth reaches 1/3 of the liquid level. The Town of Lewisboro requires that the septic tank be pumped, and the system be inspected every 5 years.

OSDSs that are not installed according to the WCDOH design guidelines or improperly maintained are at risk for surface and subsurface failures. These failures cause untreated sewage to be released from the system and transported to undesirable areas. The sewage may rise to the surface of the ground around the tank or leach field or to back up in the pipes of the buildings or residences. Sewage can also find its way into groundwater, surface water or marine water without ever being noticed. The raw and untreated sewage contains high levels of nutrients like phosphorus, pathogens, and other dangerous contaminants. They contaminate water sources, including private wells, and make them unsafe for consumption and recreational uses, among other things.

Enhanced Treatment Units

Removal of readily available phosphorus in a residential on-site system can be enhanced through the addition of an aeration process after the anaerobic process. Typical installations consist of a three-compartment tank (anaerobic, aerobic, and final settling) and the center compartment is outfitted with a small air pump and diffuser assembly. The air requirement is low and can be provided by a 120v air pump that can easily be installed in a new or existing system. While adding a second tank adjacent to an existing septic tank is possible, installation of an entirely new watertight system provides the most benefit.

The estimated installed cost for the aeration system installed as part of an existing OSDS is approximately $25,000 for a residential system. These enhanced treatment units provide upgraded septage treatment and nutrient reduction by further treating the wastewater before it is discharged to the soil absorption field. The improved treatment reduces the amount of total suspended solids (TSS), biochemical oxygen demand (BOD), nutrients and stabilizes the wastewater. This improved treatment is vital to reducing the nutrient loading to surrounding waters.

Proper operation of the advanced treatment unit is dependent on the homeowner maintaining the aeration system and hiring a licensed septic hauler to pump out the septic tank on a regular basis. When coupled with properly constructed absorption fields for subsurface disposal of effluent, this alternative is a good strategy for treatment in areas not directly adjacent to a waterbody. Quantitative results will vary with soil type, loading and condition of existing system.

Wastewater Management Alternatives (Off-Site Collection and Conveyance)

Gravity Collection System

A gravity sewer system is used to collect wastewater from multiple sources and convey it by gravity to a central location where it can be treated. Wastewater from each source is conveyed through a lateral sewer from the residence to a collection line. Centralized collection (sewer) lines are typically 8-inch or larger diameter pipe with pipe sizes increasing with the volume of water being transported. Pipes of sufficient size and slope are installed to keep the suspended solids moving through the system and to maintain an adequate velocity, so as not to surcharge the system or allow solids to settle out in the line and create a clogging issue. If gravity flow is not possible throughout the system, lift (pumping) stations are employed. Lift stations are installed at low points of the network to pump the sewage via a force main up to another gravity line, to convey wastewater over hills, and/or up to a treatment facility. Manholes are installed at regular intervals to provide maintenance access to collection lines. Pipe depth is another important design parameter; which depends on the lowest connection point, the depth of the water table, topography, and the frost line; that could greatly affect costs, depending on the amount of necessary excavation.

In its purest form (i.e., uniform slope from service connections to treatment components) gravity is an inexpensive means to convey water. However, the topography is rarely conducive to purely gravity flow, and lift stations must often be included. The cost of gravity sewers is prohibitive unless there is sufficient population density to justify the installation.

There are several advantages of gravity collection systems, including:

- Gravity pipes are the simplest and most common and established types of sewer systems.
- Gravity pipes are large enough pipes to handle grit and solids.
- Gravity pipes are sized to maintain velocities, which reduces hydrogen sulfide production and odor problems.
- Operation and maintenance costs are typically lower than other alternatives.

There are also disadvantages of gravity systems, including:

- Allowable slopes for maintaining acceptable flow, which could require deep excavations in less than desirable terrain, increasing capital construction costs.
- Excavations are deeper and wider than for pressure sewers resulting in substantial additional costs in difficult or rocky soils or with high groundwater conditions.
- The need for lift stations to pump wastewater from low points ultimately to a treatment plant, increasing costs considerably.
- Inflow and infiltration, resulting from manholes and deteriorated piping, increasing the volume of sewage, resulting in larger pipes and lift stations, which will increase costs.

Grinder Pump / Low Pressure Sewer Collection System

Pressure sewers are a means of collecting wastewater from multiple sources and conveying it to a central location for treatment by using pressure instead of gravity. Pressurized sewers eliminate the slope requirements of gravity sewer systems and are instead able to follow the contour of the terrain and maintain a relatively constant depth below the soil surface. A typical arrangement is for each connection (or small cluster of connections) to flow to a centralized pump pit. When the pump pit fills to a set point, a grinder pump within the basin pumps the wastewater into the pressurized sewer. Grinder pumps utilize a unique rotating assembly that reduces the size of solids and stringy matter that could otherwise plug a pipe and allow for small diameter pipes to be used for conveyance. As various grinder pumps along the length of the sewer inject sewage into the line, the wastewater is progressively moved toward the treatment facility.

Pressurized sewer systems have higher maintenance and energy demands than traditional gravity sewer systems, since each grinder pump must be connected to a power source. The pumps do not work when there are power outages, and the size of the pump basin provides some detention time to allow for connection to a backup power system.

One method for addressing backup power during a power outage is to install a common electric drop for a series of several grinder pumps. With this approach, a single portable generator can be employed to operate grinder pumps serving a group of homes. The generator(s) can be rotated between the groups of homes such that each group of pumps is operated every few hours to coincide with available detention time within the grinder pump basin.

As an alternate to this approach, grinder pumps could be powered from the residence and the homeowner responsible for temporary electric as needed.

Grinder pumps are low maintenance but require annual inspections. While pumps reportedly will last 8-10 years, replacement can be planned or take place when the equipment fails. Maintenance could be the responsibility of the residence or set up to be the responsibility of the sewer district. If the responsibility of the district, an agreement would have to be in place to allow the sewer district staff to enter private property for maintenance of the equipment.

There are several advantages of low-pressure sewers, including:

- The ability to sewer areas with undulating terrain, rocky soil conditions, and high bedrock or groundwater tables.
- Reduced material and installation costs, resulting from shallower placement, reduction of manholes and lift stations, and longer sections of smaller diameter piping.
- The pump basin can be located such that the existing house lateral can remain in place and interior plumbing modifications won't be required.
- The ability to handle low flow situations.

Low pressure sewer systems also have disadvantages, including:

- Operation and maintenance costs.
- Systems are often located on private property requiring access agreements for sewer district staff to maintain the systems as needed.
- The lifespan of a grinder pump system is typically 8-10 years requiring replacement when they fail.

Vacuum Sewer Collection System

A vacuum sewer system is used to collect wastewater from multiple sources and convey it to a central location for treatment. As the name suggests, a vacuum (negative pressure) is drawn on the collection system. When a service line is opened to atmospheric pressure, wastewater and air are pulled into the system. The wastewater that enters with the air forms a "plug" in the line, and air pressure pushes the wastes toward the vacuum station. This differential pressure comes from a central vacuum station. Vacuum sewers can take advantage of available slope in the terrain but are most economical in flat terrain. Vacuum sewers have a limited capacity to pull water uphill with a maximum expected lift is between 30 and 40 feet. Vacuum sewers are designed to be watertight since any air leakage into the system reduces the available vacuum.

However, vacuum sewers do not require a septic tank, however a valve pit with a pneumatic pressure valve is used to separate gravity flow from a residence or commercial establishment. Often, a common valve pit will serve multiple locations. Each valve pit is fitted with a pneumatic pressure-controlled vacuum valve which automatically opens after a predetermined volume of sewage has entered the sump. The difference in pressure between the valve pit (at atmospheric pressure) and the main vacuum line (under negative pressure) pulls wastewater and air through the service line. When the vacuum valves close, atmospheric pressure is restored inside the valve pit. The sewage travels in the vacuum main as far as its initial energy allows, eventually coming to rest. As other valve pits in the network open, more sewage and air enter the system. Each input of energy moves the sewage toward the central vacuum station. The violent action in the pipe tends to break up the larger suspended solids during transport.

Vacuum systems typically consist of one (or few) vacuum pumping stations resulting in a centralized location for the bulk of the maintenance activities. Many successful vacuum sewer systems are located in warmer areas with flat topography and less impact from freezing temperatures however, there are a few systems located in the northern part of the United States. Other than the vacuum pumps, the only other item that requires regular maintenance is the valve pit located at each residence or commercial establishment. Typically, the sewer district will have responsibility for all components in the system up to the customer connection to the valve pit. As the valve pits are often located on private property, agreements will need to be in place for the sewer district staff to access the valve pit.

Vacuum pump stations include two or more vacuum pumps and a large vacuum tank. The vacuum pumps run on short cycles that are sufficient for creating an adequate vacuum in the system. The large vacuum tank at the station maintains the vacuum on the collection system and keeps the vacuum pumps from having to operate at all times. There is a loss in negative pressure as the valve pits are actuated. The vacuum pumps turn back on when this negative pressure reaches a certain set point. Sewage flows into a collection tank when it gets to the vacuum station and traditional sewage pumps then convey the collected wastewater via a force main to the treatment facility.

Advantages of vacuum sewer systems include:

- Being conducive to flat and hilly terrain, rocky soils, dense communities in rural areas, and high groundwater tables and bedrock.
- Less disruptive installation, resulting from the small diameter pipes (typically 4-inches) and shallow excavations.
- The ability to locate vacuum sewer mains outside of and adjacent to the edge of pavement.
- Less disturbance than gravity sewers, including no need for manholes.
- Typically, the need for only one vacuum station, instead of multiple lift stations, reduces energy costs.
- Reduced odors and hydrogen sulfide production in the collection system because of a sealed system with short detention times.

Disadvantages of vacuum sewers include:

- The maximum expected capacity to draw wastewater uphill is between 30 and 40 feet.
- Low population densities with few connections result in poor performance because the movement of wastewater depends on the differential pressure created when valves open.
- Large and expensive vacuum stations.
- Noise and odor created by the vacuum station.
- The need to regularly inspect system components by staff or remote monitoring via telemetry.

- Regular maintenance, including changing oil and oil filters on vacuum pumps, removing and cleaning inlet filters on vacuum pumps, testing alarm systems, checking motor couplings, and checking operation of the vacuum station shutoff and isolation valves.
- Rebuilding controllers every 3 to 6 years and rebuilding valves every 8 to 12 years.
- Wastewater backup when valves fail to open.
- Several mechanical components in the system at risk of failure.

Effluent Sewer Collection

An effluent sewer is used to collect wastewater from multiple sources that have undergone liquid/solid separation or primary treatment and convey it to a central location for final treatment. Septic Tank Effluent Pump and Septic Tank Effluent Gravity sewers (commonly referred to as STEP or STEG) use on-lot septic tanks to provide liquid/solid separation. Clarified effluent then moves into the watertight collection system using either a pump (STEP) or gravity (STEG). STEP and STEG configurations can also be combined within a gravity or pressure collection system.

Septic Tank Effluent Pump (STEP)

In a STEP system each wastewater source or group of sources flows into a conventional, watertight septic tank to capture solids and provide primary treatment. However, in this case, an effluent pump (typically capable of pumping 3 or more gallons per minute) is installed either in the outlet end of the septic tank or in a separate holding tank or vault. The pump injects the clarified effluent into a pressure or gravity sewer system. As each STEP pump in the collection systems operates, effluent is progressively moved toward the wastewater treatment facility.

Retrofitting existing septic tanks can sometimes be a means of cost savings, however, if many must be replaced because of insufficient capacity, deterioration of concrete, or leaking, costs for a STEP system will increase significantly.

Advantages of STEP systems include:

- The ability to handle low flow conditions.
- Opportunities for cost savings by potentially reusing some existing septic tanks.
- The ability to sewer areas with undulating terrain, rocky soil conditions, and high bedrock or groundwater tables.
- Reduced material and installation costs, resulting from shallower placement, lack of manholes and lift stations, and longer sections of smaller diameter piping.
- Modifications to existing plumbing within homes and businesses are not necessary.

Disadvantages of STEP systems include:

- STEP systems require temporary power during extended power outages (more than 1 day).
- Reduced excess capacity typical of conventional gravity systems.
- There are several mechanical components located within the service area.
- O&M costs are typically higher than they are for gravity systems, due to the number of pumps.
- Power outages can result in overflows, but generators can prevent this.
- Additional infrastructure and wastewater storage could result in an increased potential for leaks and contamination.

Septic Tank Effluent Gravity (STEG)

In a STEG system, each source or group of sources has a watertight septic tank with an effluent screen and an access riser. Effluent flows out of the tank and into a collection sewer by gravity. The collection sewer is typically plastic pipe 4 to 8-inches in diameter. The piping from the tank to the collection line includes an accessible cleanout. STEG systems operate via gravity to a low point in the system where a lift station can be utilized to transfer the liquid downstream to a gravity or larger pumped system.

There are several advantages of STEG systems, including:

- The septic tank provides primary treatment of wastewater and captures debris, grease and grit that could impact downstream treatment processes.
- Septic tanks that are watertight and in good condition can remain in place and be converted to effluent transfer by pumping or gravity.
- Suitable for cluster systems.
- The ability to handle low flow conditions.
- Opportunities for cost savings by potentially reusing some existing septic tanks.
- Reduced material and installation costs, resulting from shallower placement, lack of manholes and lift stations, and longer sections of smaller diameter piping.
- Modifications to existing plumbing within homes and businesses are not necessary.

STEG systems also have disadvantages, including:

- Most existing septic tanks may not be watertight enough to work for a STEP/STEG system and will require replacement.
- Existing house laterals or septic tanks may not be optimally located to support a STEG system or easy access for sewer district employees.
- Requires that septic tanks be pumped out on a routine basis, usually every 3-5 years.
- Pumps and discharge piping are often located on private property requiring access agreements for sewer district staff to maintain the systems as needed.
- Allowable slopes for maintaining acceptable flow, which could require deep excavations in less than desirable terrain, increasing capital construction costs.
- The need for lift stations to pump wastewater from low points to a treatment plant, increasing costs considerably.
- Reduced large excess capacity typical of conventional gravity systems.

Cluster Collection / Treatment System

Cluster / Decentralized collection systems treat wastewater from several homes (aka. cluster) and are typically designed to treat 1,000 to as much as 20,000 gallons per day. Most systems consist of one or more larger septic tanks followed by an appropriately sized absorption field.

Under this alternative, flow currently treated by individual septic systems would be conveyed to a common septic system sized to treat the quantity of homes connected. Discharge from each new septic tank would be conveyed by gravity or pumped to a subsurface discharge point located at a distance of 800 feet or more from the Lake or other watercourse. It is assumed that the wastewater treatment system would be designed so that nutrient loading to the Lake from each system would be minimized due to the distance from the absorption field to the Lake. Key features of this alternative include:

- Construction of gravity collection sewers to convey sewage to a common location for treatment.
- Installation of a residential sewer lateral from each residence to a collection sewer. Installation, as well as maintenance of the sewer lateral, would be the responsibility of the homeowner.
- Installation of a wastewater treatment system to serve each cluster of homes. Operation and maintenance of the wastewater treatment system would be the responsibility of the group of homes that it serves. Identification of a responsible entity for O&M, as well as reporting to the NYSDEC would be necessary.
- It is expected that design flows for each wastewater treatment system is estimated to be between 1,000 GPD and 10,000 GPD, with subsurface discharge, therefore, the systems would be designed to comply with New York State Design Standards for Intermediate sized Wastewater Treatment Systems (NYSDEC, 2014). A General Permit GP 0-15-001 may be required.
- Location of the absorption field would require at least five (5) feet of appropriate soil type between the bottom of the absorption bed and the highest groundwater level, bedrock or impermeable strata, as well as meeting minimum distances from water wells (100 to 200 feet), in accordance with the Residential On-site Wastewater Treatment Systems Design Handbook and the Westchester County Health Department Green Book.

The concept of cluster systems was evaluated in the 2009 Ecologic report and based on site and geological conditions, would result in minimal reduction of nutrients.

Treatment at an Existing Local WWTP

Treatment at an existing WWTP has a number of advantages. The cost to site, design and permit a new facility can all be avoided, which can be a significant undertaking as well as a time-consuming task. From a cost standpoint, facilities are often constructed with excess capacity either throughout the entire facility or in individual processes, allowing for treatment of imported flows with focused capital improvements. Cost structures for treatment vary and can consist of purchasing capacity outright with flow-based contribution to O&M costs or capital and O&M costs combined into a flow-based user fee.

In this scenario, capital costs consist primarily of the collection system capacity purchase arrangements for the facility. However, directing the septic flows to an existing facility, especially one out of state, while potentially deemed most favorable in terms of cost, could result in permitting and logistical challenges.

New York City DEP Required Variance(s)

The Rules and Regulations for the Protection from Contamination, Degradation and Pollution of the New York City Water Supply and its Sources prohibit the construction of new wastewater treatment plants or expansion of existing wastewater treatment plants, within coliform and phosphorus restricted basins, which includes the Cross River Reservoir Basin. The NYCDEP may grant a variance if it determines that conditions in the area to be served by the new or expanded wastewater treatment plant are resulting in the release or discharge of inadequately treated sewage into the water supply, and that there is no other feasible method of correcting such release or discharge of inadequately treated sewage except to provide a variance from such prohibition. Flows deemed inadequately treated can be granted a variance for the expansion or construction of a new WWTP where subsurface discharge is impossible and every one-kilogram projected increase in phosphorus load is offset by a two-kilogram reduction in phosphorus via enhanced treatment or stormwater retrofits. As discussed herein, the existing flows are contributing to water quality concern and should be considered for a WWTP variance without a phosphorus offset, acknowledging that any flows resulting from future development would require the offset.

Environmental Conditions

Residences

As provided by the Town of Lewisboro Assessor's office, approximately 88% of residences within the Lake Truesdale study area were constructed prior to 1980 and 8% constructed between 1980-1989. The remaining 4% of residences were constructed between 1990 and present day 2021. Based on the high percentage of residences aged more than 40 years, most of the existing and original septic systems are nearing the end of their effective operational life expectancy, following the assumption that the OSDSs were installed in conjunction with construction of the residences.

Infrastructure

Septic Systems

As stated above, most of the septic systems within the study area have or will soon exceed their useful design life of approximately 40 years. The useful age of septic systems ranges from 15-50 years, depending on a variety of factors that will be discussed in detail in sections below. Structural components themselves limit the useful life, even under optimal operational and maintenance conditions.

Tables and figures below illustrate the number of septic systems that have been pumped out and that have been repaired.

Wastewater Conveyance

There is no existing wastewater infrastructure within the Lake Truesdale Study Area. However, Lewisboro has two existing sewer districts servicing the Oakridge and Wilk Oaks areas. The nearest sewer collection system is Ridgefield, Connecticut.

Drinking Water Supply

There are two public water suppliers within the study area, which include Twin Lakes Water Works and the Lake Truesdale Property Owners Association (LTPOA) Water System. The LTPOA system serves 149 parcels in the study area. It is unknown the number of residences serviced by the Twin Lakes Water Works supplier. The remainder of the residences are served by private wells.

Existing Treatment Facility

The closest wastewater treatment facility serves Lewisboro Elementary School and is located approximately 0.6 miles west of the Lake at the intersection of Bouton Road, Scotts Lane, and Captain Lawrence Drive. The facility is permitted to Katonah-Lewisboro School District in Katonah, New York, constructed circa 2000 with a rated treatment capacity of 8,000 gal/day according to the SPDES and discharges into an unnamed perennial watercourse. It currently treats on average 4,000 gpd. The most recent permit available via the NYSDEC info locator was issued in 2000 and expired in 2005. The existing facility was upgraded in 2007 to the latest NYCDEP and NYSDEC standards as part of the NYCDEP WWTP upgrade program.

Flow estimates

Wastewater flows for single family residences served by OSDSs are based on guidelines in Appendix 75-A Wastewater Treatment Standards – Residential Onsite Systems published by the New York State Department of Health (App 75-A). Wastewater flows for wastewater systems serving multiple properties are sized using New York State Design Standards for Intermediate Sized Water Treatment Systems provided by the NYSDEC (DEC 14). Both documents base the flow rates on bedroom count and have a range of flows based on the age of the plumbing fixtures. Plumbing fixtures manufactured pre 1980 contribute a design flow of 150 gpd per bedroom, plumbing fixtures manufactured from 1980 – 1993 contribute a design flow of 130 gpd per bedroom, and plumbing fixtures manufactured from post 1994 contribute a design flow of 110 gpd per bedroom. Although a large majority of the residences were constructed prior to 1980, it is assumed that through home renovations and remodels, water saving initiatives, and plumbing fixture failures, most of the plumbing fixtures have been installed post 1980. As such, a design flow rate of 130 gpd per bedroom was used in calculating existing wastewater flow estimates for the Lake Truesdale study area. An estimate of the flows, if all residences are updated with modern plumbing fixtures (110 gpd/bedroom), is presented for informational purposes and flow comparison only.

The Lake Truesdale study area includes 513 parcels. Data for these parcels for bedroom count was received from the Town Assessor which provided there are 94 undeveloped parcels and 419 developed parcels. The developed parcels consist of residences with a total bedroom count of 1,370 bedrooms. There are 6 one-bedroom residences, 53 two-bedroom residences, 222 three-bedroom residences, 106 four-bedroom residences, 24 five-bedroom residences, and 8 six-bedroom residences within the Lake Truesdale study area. It is estimated that the developed study area would have a total design flow of 178,100 gpd based on the above design flow of 130 gpd per bedroom, as outlined below in Table 2.

Table 2: Assessor's Office Data for the Study Area

Truesdale Lake Study Area Parcels	513	
Developed Parcels	419	
Undeveloped Parcels	94	
1-Bedroom Residences	6	
2-Bedroom Residences	53	
3-Bedroom Residences	222	
4-Bedroom Residences	106	
5-Bedroom Residences	24	
6-Bedroom Residences	8	
Total Bedrooms	1,370	
Average flow per bedroom*	130 gpd	110 gpd
Estimated flow in study area	178,100 gpd	150,700 gpd

*With upgraded plumbing fixtures, flows can be reduced to 110 gpd, but dated fixtures results in flows if 150 gpd. As there is no proof each residence has upgraded every fixture, flows were assumed to be 130 gpd.

As mentioned previously, due to the size and span of the Truesdale Lake study area, the study area was broken into two zones: Zone 1 and Zone 2, with Zone 1 encompassing the area within 0-feet to 800-feet of the lake, and Zone 2 encompassing the rest of the study area. Zone 1 consists of approximately 2/3 of the residences of the study area, while Zone 2 contains the remaining 1/3. By dividing the study area into

Zone 1 and Zone 2, a resulting existing design flow of 110,110 gpd for Zone 1 (274 developed parcels) and an existing design flow of 67,990 gpd for Zone 2 (145 developed parcels) can be calculated. Design flows for Zone 1 will be further analyzed in later sections of this report. Zone 2 will continue to be treated by individual OSDS and not consolidated into a single design flow.

Currently there are 94 undeveloped parcels generating zero flow within the Lake Truesdale study area. 74 of the undeveloped parcels are within Zone 1 and 20 are within Zone 2, as presented in Table 3. It is anticipated that should these lots be developed, they would be developed with a 3- or 4-bedroom home. To calculate potential future flows an average of 3.5 bedrooms per parcel was assumed equating to 329 bedrooms. As current standards require water saving fixtures, 110 gpd will be used. These 74 undeveloped parcels from Zone 1 would then generate an additional 28,490 gpd, resulting in a total proposed Zone 1 design flow of 138,600 gpd. Future development of the 20 undeveloped parcels within Zone 2 are anticipated to be treated by individual onsite OSDS and would not contribute to a single consolidated total design flow.

Table 3: Zonal Flow Estimates

Developed Parcels	# Bedrooms	Exhibiting Flow (130 gpd/BR)	Undeveloped Parcels	# Bedrooms (average 3.5/parcel)	Future Flow (110 gpd/BR)	Total Flow (existing and future)
Zone 1: 274	847	110,110 gpd	74	259	28,490 gpd	138,600
Zone 2: 145	523	67,790 gpd	20	70	7,700 gpd	75,690
Total: 419	1,370	178,100 gpd	94	329	36,190 gpd	214,290

If all residences were upgraded to current plumbing fixtures, a reduction in flows of 27,400 gpd (20gpd/exhibiting bedroom) would be achieved. A total flow of 186,890 gpd is calculated with this upgrade.

A review of the water usage by The Lake Truesdale Property Owners Association Water System was completed. The 149 parcels within the water district used an average of 23,300 gpd for the period of September 2020 to September 2021. This equates to 156 gpd/parcel on an average yearly flow basis. The ratio of average day to maximum day is typically between 1.5 to 1.0, or 2.0 to 1.0. These numbers may also reflect that some homes are used as weekend houses or may have smaller families. Though on average, the wastewater flows will be less than those predicted by DEC 14, typical planning and sizing of components is done using the unit values of DEC 14. For the purposes of this reports, the flows are based on 130 gpd/bedroom for existing houses and 110 gpd/bedroom (assuming average of 3.5 bedrooms/parcel) for future development.

Septic Systems Suitability

Various factors can impact an OSDS in its ability to effectively treat wastewater, support existing development and allow for future development. These factors primarily consist of parcel size, proximity to surface waters, depth to groundwater, age of existing faculties, depth to ledge rock, steep slopes, soil type, and required separation distances. An OSDS, which is substandard in one or more of these factors, can lead to reduced surface water quality and groundwater quality. The impact of these factors on the Lake Truesdale study area are discussed in more detail below.

Parcel Size - There are 513 parcels within the study area for Lake Truesdale ranging in size from a 1/4 acre to 60 acres. Within the study area 341 parcels are within 0-1 acres (326 in Zone 1), 95 parcels between 1-acre and 4 acres, and 77 parcels over 4 acres. Figure D separates parcels above and below the 1-acre threshold. Most of the parcels in Zone 1 are less than 1 acre with some between 1/4 acre and 1/2 acre in size. This suggests many of the existing OSDS's are likely substandard per current regulations. Designing new OSDS's or providing code conforming repairs meeting current regulations on such small parcels with individual wells and OSDS's is often not possible or practical.

Surface Waters – Several national wetlands, NYSDEC regulated wetlands, local wetlands, streams, lakes, and waterbodies are present in the study area as shown on Figure E. The New York State Department of Health and Department of Environmental Conservation does not allow OSDS absorption fields within 100' of surface water. The presence of surface waters can also indicate a shallow depth to ground water in the area.

Depth to Groundwater – A shallow depth to groundwater limits a parcels available area to properly treat wastewater. Based on review of the USDA web soil survey in regard to depth to ground water as seen in Figure F, many of the parcels in the proposed service area are subject to a shallow depth to saturation, meaning many existing systems likely do not meet the regulated vertical separation between OSDS and groundwater. The OSDS being in close contact with the groundwater will affect the lifetime of the tank as well as prevent the tank effluent from being properly treated by the absorption fields.

Age of Existing Facilities – Approximately 88% of residences within the Lake Truesdale study area were constructed prior to 1980 as provided by the Town Assessor. Due to the high percentage of residences constructed more than 40 years ago it is anticipated that most of the existing and original septic systems are nearing the end of their effective operational life expectancy.

Depth to Ledge Rock – The shallow depth of ledge rock in some areas of the study area makes conventional OSDSs less effective in properly treating sewage effluent. Shallow depth to ledge rock does not allow for proper permeation of OSDS effluent, increasing the nutrient loading to the Lake. Due to the age of the residences within the study area it is probable that many OSDSs were not designed with this shallow depth in mind and are today considered substandard in the critical separation distance from absorption trench to ledge rock. Exposed ledge rock is evident on multiple parcels in the study area. Locations identified by the USDA web soil survey for shallow depth to ledge rock are shown on Figure G.

Steep Slopes – Slopes within the study area vary significantly with proximity to the Lake. Steeper slopes have decreased time of concentrations and result in increased runoff and peak flow conditions. Portions of the study area contain steep slopes in excess of 15% and 20% are shown on Figure H. OSDS's are prohibited on slopes in excess of 15% for single family residential or 20% for commercial/community septics, per the WCDOH and NYCDEP regulations. OSDS placed on steep slopes can result in premature system failures, reduced treatment capabilities, and increased nutrient loading to surface waters.

Soil Type – Soil types and subsequent hydrologic soil groups can significantly impact the effectiveness of an OSDS. Areas within the study area with D soils were considered undesirable as D soils have the potential to percolate very slowly which will hold effluent and prohibit the proper growth of aerobic bacteria to break down waste. For the purposes of this study D soils were considered not suitable for OSDS. Soil types are shown on Figure I, and hydrologic soil groups (HSG) shown on Figure K and tabulated below in Table 4.

Table 4: Hydrologic Soil Groups

HSG	Acres in Study Area	Percent (%) of Study Area
A	48	4%
B	487	41%
C	249	21%
D	404	34%

Required Separation Distances – In addition to the previously discussed separation distances to groundwater, surface water, and ledge rock, OSDS need to maintain a require well separation distance ranging from 100 feet to 200 feet per current WCDOH regulations. Due to the small parcel sizes, it can be deduced that, many existing OSDSs in the area are located with significantly reduced horizontal separation distances from wells. This reduced separation has likely contributed to the decline in groundwater and surface water quality.

Recent studies have all commented that the majority of the Truesdale Lake watershed is made up of soils that are limited in their suitability for septic systems because of the shallow depth of the water table, steep slopes, and soil composition that promote runoff rather than retention. Each parcel within the study area is impacted by at least one of these constraints as noted in Figure J Septic Constraints.

As can be seen in Figure L based on Westchester County Department of Health (WCDOH) records, many of the septic tanks immediately surrounding the Lake have been pumped out between 0 and 1 times in the last 5 years. Lewisboro Town law requires pumping and inspection of septic systems every five (5) years, however, there is no enforcement to this action. According to a 2015 stakeholder survey, the average septic system was last inspected around 1999 (Jenne, 2016). It should be noted that there could be some variation to the data, as a Connecticut company could have been contracted to pump and haul the waste and not reported it, as only septage haulers certified by Westchester County are obligated to report pump out data to the County, and many may not do so. Table 5 shows the number of septic pump outs per developed parcel over the last 5 years per WCDOH records.

Table 5: OSDS Pump Outs

Pump Outs	Parcels
0	89
1	155
2	97
3	47
4	18
5	7
6	4
7	1
8	1

Based on records reviewed from the WCDOH over a 13-year span, 10 septic systems have required repair or remediation within the study area. Of these parcels 9 were located within Zone 1, Figure M. It is assumed that these repairs were based on a noted surface failure of the OSDS, as subsurface failures are nearly impossible to identify.

Figure D: Parcels Less than 1 Acre

Figure E: Wetlands and Waterbodies

Figure F: Depth to Groundwater

Figure G: Depth to Bedrock

Figure H: Steep Slopes

Figure I: Soil Types

Figure J: Septic Constraints

Figure K: Soil Groups

Figure L: Pump Out Records

Figure M: Septic Repairs

Floodplains

A floodplain is defined as a nearly flat area in close proximity to a body of water that is naturally subjected to flooding. These areas have increased potential for nutrient infiltration into the watershed. No flood plains exist within the Lake Truesdale study area, per the Federal Emergency Management Agency Flood Map Service Center.

Water Quality Management Action

To date, several studies have been conducted on the Lake and used to compile a Lake Management Plan. As of the time of writing this report, a recent improvement consisted of paving of a hill near the Lake inlet (east of the Lake) to reduce erosion resulting in sediment flow into the Lake. Additional implemented plans include the purchase of a vacuum truck to clean storm inlets, the spraying of drain inlets to prevent mosquito breeding, and duckweed remediation. It has also been mentioned in recent meetings with the Town that several additional holistic water quality improvements have been made, but it is unknown at this time what measures those include.

Water Quality Measurement Criteria

The NYSDEC has set state standards for the water bodies of New York based on thresholds for a variety of water quality measurements, including but not limited to total phosphorus, chlorophyl *a*, and water transparency. Additional indicators include dissolved oxygen and biological water quality. Based off these eutrophic indicators and several rounds of sampling during lake monitoring events, the NYSDEC has classified the Lake as eutrophic, or highly productive, based on low water transparency and high nutrient (primarily phosphorus) and algae levels. Phosphorus levels consistently and often significantly exceed the state phosphorus guidance and transparency measurements, and rarely meet what is recommended for swimming beaches. The Lake is moderately to highly colored and may influence transparency when algae levels are low. The pH of the Lake falls within the state water quality range of 6.5 to 8.5; occasionally high pH does not appear to impact aquatic life in the Lake (no data was given).

Nutrient Loads

Elevated nutrient levels are a primary cause of algal blooms within the Lake and the primary nutrients that impact water quality are phosphorus and nitrogen in soluble form. Previous studies collaborated through this effort identified that the majority of the phosphorus contribution into Truesdale Lake comes from OSDS effluent and urban stormwater runoff surrounding the Lake and within the local watershed.

Phosphorus is prevalent in wastewater and is difficult to remove in a conventional anaerobic septic tank as the form of treatment is limited to settling with a removal efficiency of approximately 20-30% (USEPA 2002). Flows leaving the septic tank typically contain a phosphorus concentration of 13 mg/L (Lowe, et al., 2007) and pass through the absorption field with minimal removal. Outside of the absorption field, phosphorus can be utilized by soil microbes and/or converted to inorganic phosphorus which is then taken up by plants (McCray et al., 2005), but the adsorption rate is highly dependent on soil characteristics, ground water, and landscaping (Brady and Weil, 2008). Excess phosphorus is then available to infiltrate into the local watershed either through subsurface means or through surface breakouts on steep slopes or where the soil layer is thin. Studies have reported that phosphorus concentrations decrease linearly with distance from the absorption fields, as more plants have the opportunity to use the nutrients rendering fewer available nutrients to enter the watershed (Robertson and Harmon, 1999). Properly maintained OSDSs designed and installed following the WCDOH guidelines (outlined above) will filter suspended solids and nutrients from sewage such that they have a minimal impact on water quality.

Additional phosphorus loading comes from the individual property owners in the Town of Lewisboro and surrounding areas upstream, as a result of landscaping activities including fertilizer applications. However, the use of phosphorus-based fertilizers for residential properties has been banned in Westchester County and Connecticut as of 2011 and 2012 respectively, therefore the land application contribution should be on the decline. As of 2013 phosphorus-based detergents have also been banned in New York.

As Figure N below shows, 65% of phosphorus loading is estimated to come from septic systems, approximately 774 lb./year or 2lb./day (Ecologic, 2009). While the EcoLogic report determined the phosphorus loading into the Lake via lake monitoring and sample evaluation, the report is dated, and the Town has made several nutrient management and holistic improvements since then. This report was also published before the bans on phosphorus-based fertilizer and detergents went into effect. To best approximate the current nutrient loading, a range of septic conditions were evaluated using new software to enable the best planning approach for the study area. This data is presented in Table 6.

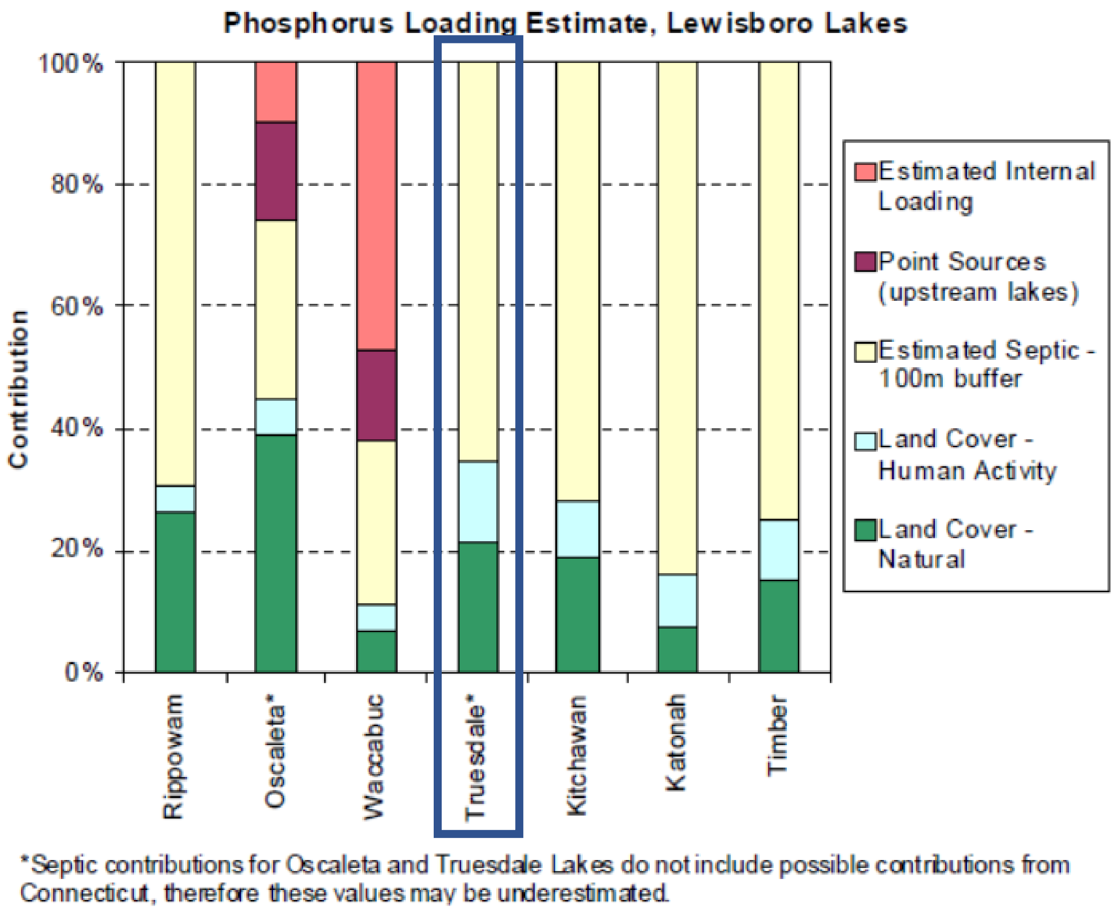

Figure N: Phosphorus Loading Estimate for Lewisboro Lakes

Without a comprehensive evaluation of each OSDS within Zones 1 and 2 to determine existing conditions and treatment effectiveness, phosphorus loadings were estimated using several potential failure scenarios typical of the physical conditions at the Lake. As noted above, most of the OSDSs within the service area have not been pumped out or inspected in several years and age, soil type, depth to bedrock, slope, and proximity to other systems all influence the effectiveness of an OSDS. To estimate nutrient loading resulting from various treatment challenges, the team developed the following scenarios for model development:

A. Two failures/zone/year, following septic repairs reported to the WCDOH
B. 200 failures in Zone 1, 25 failures in Zone 2 annually, following the WCDOH Green Book guidelines
C. 15% failures annually, following EPA documented typical 10-20% septic failures
D. Zero failures/zone/year, establishing baseline loading for the Lake and study area

The modeling software implemented here to predict the nutrient loading, utilizes data and inputs based on total population, not total number of OSDS, assuming that multiple persons are contributing to the same OSDSs and therefore impacting the flow and nutrient loading. Table 6 below presents the number of operational OSDSs and the assumed number of OSDS surface and subsurface failures for each zone for each evaluated scenario outlined above. The number of OSDSs was then converted to per capita, using the 2.7 persons per residence conversion established by the Census, and input into the model to generate the total phosphorus results.

Table 6: Total Phosphorus Loading Scenarios, Per Residence

	Zone 1		Zone 2	
	Operational OSDSs	Surface/Subsurface Failures	Operational OSDSs	Surface/Subsurface Failures
A. Scenario A	272	2	143	2
B. Scenario B	74	200	126	19
C. Scenario C	233	42	124	21
D. Scenario D	274	0	145	0

**Consists of OSDSs located 200’ from a water source (lake, river, stream, well) and located in a shallow water table where the OSDS does not adhere to WCDOH installation guidelines

These scenarios were evaluated using Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) to estimate the nutrient and sediment loading into the Lake. BASINS provides plug-ins to set up watershed and water quality simulation models based on information in the BASINS project, which is sourced from the USEPA. By using plug-ins, specifically the Map My Watershed plug-in, BASINS aids the user in setting up powerful external, yet linked, simulation models. The Generalized Watershed Loading Function model extension (GWLF-E) (formerly known as MapShed) plug-in, included with BASINS, is a GIS-based watershed modeling tool that estimates monthly nutrient and sediment loads within a watershed. This plug-in provides a link between BASINS and the newest version of the GWLF watershed model (now called GWLF-E). The model has also been endorsed by the USEPA as a good “mid-level” model that contains algorithms for simulating most of the key mechanisms controlling nutrient and sediment fluxes within a watershed (USEPA 1999).

The results from the BASINS software run for Truesdale Lake illustrating the 30-year average annual nutrient loading rates are presented below in Table 7 and Table 8. It is important to note that the software does not automatically calculate septic data for phosphorus, as the data is based off septic surface and subsurface failures. To model the loading from each zone, assumed failures (outlined above) were input into the model based on population using the 2.7 factor implemented per OSDS for these calculations.

Note that the annual phosphorus loading for Zone 1 and Zone 2 was calculated by BASINS ranging 230 lb/year (Scenario C) to 1,000 lb/year (Scenario B) for Zone 1 and 170 lb/year (Scenario B) to 180 lb/year (Scenario C) for Zone 2. As a reminder, Zone 1 encompasses the area within 800 feet of the lake, with reduced separation to groundwater that dramatically affects phosphorus treatment. Zone 2 is the remainder of the study area, roughly 2/3 the area and 1/3 the population. This zone consists of larger parcels of land with more wooded areas than Zone 1, resulting in higher non-septic phosphorus loading. For more information, please see Appendix D for the BASINS Nutrient Loading Information and data.

Scenarios B and C were selected to provide a phosphorus loading range for this high-level study for the following reasons:

- The 10 reported surface failures per the WCDOH (Scenario A) is an underestimation of the number of OSDSs in failure because it does not account for any subsurface failures.
- The OSDSs not properly installed or maintained according to the WCDOH guidelines are in failure or disrepair, especially regarding those in shallow water tables (Scenario B), where leach fields and the septic tank are not functioning optimally, will result in significant subsurface failures that can remain undetected for long periods of time.
- Using the EcoLogic report as a base, assuming notable water quality improvements implemented by the Town, the USEPA range of cited failures between 10 – 20% (Scenario C) is a more applicable number.
- The assumption that not a single OSDS was in failure (Scenario D) is inaccurate and supported by the repairs submitted to the WCDOH.

Table 9 below shows the combined loading to the Lake under Scenarios A, B, C and D. As noted above, Scenarios A and D would not be representative of the study area and will not be evaluated further; however, the data is presented to show the result variations.

Total modeled phosphorus loading into the Lake ranges from 400 lb/year (Scenario C) to 1,200 lb/year (Scenario B). According to the model, the study area is estimated to contribute approximately 1,200 lbs/year of total phosphorus to the Lake from external loading, accounting for approximately 92% of the total modeled external annual phosphorus load to Truesdale Lake. Figure O shows a pie chart of the combined phosphorus loading as a percentage of the total load into the Lake relative to Scenario B, which was deemed the worst-case scenario. Similar pie charts were developed for all alternatives and can be found in the appendix. The purpose of this study was to evaluate the opportunities for nutrient loading reduction within the study area of Truesdale Lake, therefore additional watersheds were not evaluated or modeled.

Table 7: Average Annual Loads from 30-Years of Daily Fluxes – Zone 1

Zone 1 Scenario:	A	B	C	D
Loading Rates (lb/ac)				
Sediment	191.7	191.7	191.7	191.7
Total Nitrogen	3.9	22.5	7.7	3.7
Total Phosphorus	0.3	10.1	2.3	0.2
Mean Annual Concentration (mg/L)				
Sediment	35.9	35.9	35.9	35.9
Total Nitrogen	0.7	4.2	1.4	0.69
Total Phosphorus	0.1	1.9	0.4	0.1
Mean Low-Flow Concentration (mg/L)				
Sediment	53.0	53.0	53.0	53.0
Total Nitrogen	1.3	12.8	3.6	1.2
Total Phosphorus	0.2	6.2	1.4	0.1
Total Loads (lb)				
Sediment	19,400	19,400	19,400	19,400
Total Nitrogen	400	2,300	800	400
Total Phosphorus	30	1,000	200	20

Table 8: Average Annual Loads from 30-Years of Daily Fluxes – Zone 2

Zone 2 Scenario:	A	B	C	D
Loading Rates (lb/ac)				
Sediment	24.2	24.2	24.2	24.2
Total Nitrogen	1.5	1.8	1.8	1.5
Total Phosphorus	0.1	0.2	0.2	0.1
Mean Annual Concentration (mg/L)				
Sediment	6.4	6.4	6.4	6.4
Total Nitrogen	0.4	0.5	0.5	0.4
Total Phosphorus	0.0	0.1	0.1	0.0
Mean Low-Flow Concentration (mg/L)				
Sediment	34.6	34.6	34.6	34.6
Total Nitrogen	0.7	0.9	1.0	0.6
Total Phosphorus	0.1	0.3	0.3	0.1
Total Loads (lb)				
Sediment	19,000	19,000	19,000	19,000
Total Nitrogen	1,200	1,400	1,400	1,200
Total Phosphorus	90	170	180	80

Table 9: Average Annual Loads from 30-Years of Daily Fluxes – Combined Lake Loading

Lake Loading Scenario:	A	B	C	D
Loading Rates (lb/ac)				
Sediment	37.9	37.9	37.9	37.9
Total Nitrogen	1.8	4.1	2.4	1.7
Total Phosphorus	0.1	1.4	0.5	0.1
Mean Annual Concentration (mg/L)				
Sediment	9.2	9.2	9.2	9.2
Total Nitrogen	0.4	1.0	0.6	0.4
Total Phosphorus	0.0	0.3	0.1	0.1
Mean Low-Flow Concentration (mg/L)				
Sediment	27.5	27.5	27.5	27.5
Total Nitrogen	0.7	3.1	1.4	0.6
Total Phosphorus	0.1	1.4	0.5	0.1
Total Loads (lb)				
Sediment	38,000	38,000	38,000	38,000
Total Nitrogen	1,600	3,700	2,200	1,600
Total Phosphorus	120	1,200	400	100

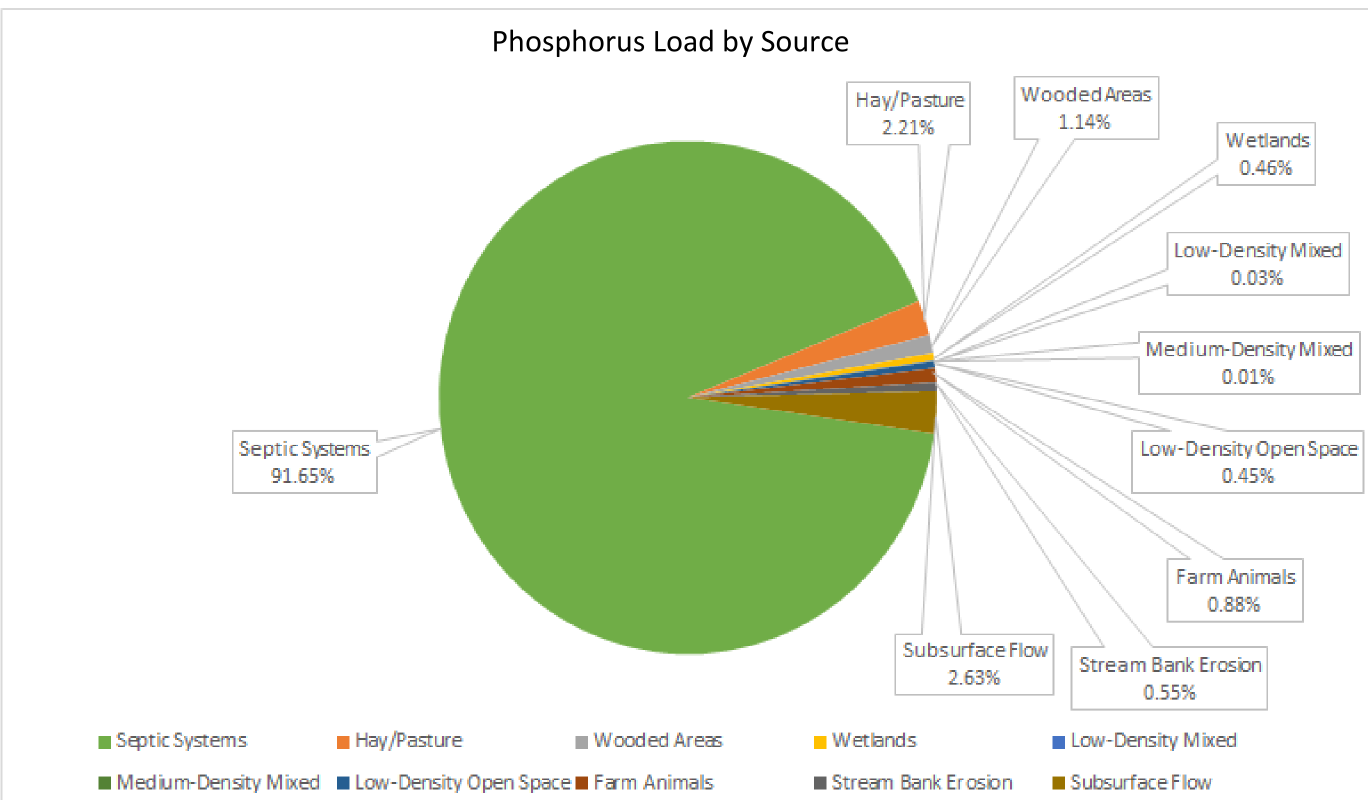

Figure O: Combined Zone 1 and 2 OSDS Loading, Scenario B

Water Budget

A water budget is a method of calculating or estimating the amount of natural inputs and outputs in a water system. They are developed to determine water availability and usage and are used to examine the natural changes in water availability throughout a year by comparing water that enters the system to water that exits the system. Water that enters the system is most commonly in the form of precipitation and runoff, while water existing the system is primarily evaporation or evapotranspiration.

The Truesdale Lake water budget includes inflow into the Lake, Lake volume, flushing rate, and retention time, as shown in Table 10. While the water budget is from 2009 from the study by EcoLogic, it was used in consideration of the development of wastewater infrastructure and treatment improvements to ensure a minimal impact on the existing water balance or hydrologic system within the study area. As the water budget does not account for human impacts, i.e., OSDSs, none of the proposed alternatives will result in a significant impact to the water budget.

Table 10: Truesdale Lake 2009 Water Budget

Inflow to Lake [R+(P-ET)]	1,756 Mgal/year
Lake Volume	180 Mgal
Flushing Rate	10 times/year
Residence Time	0.10 years

The recommended improvements described in the following sections outline a wastewater management approach consisting of treatment and discharge through a new outfall into the Waccabuc River and would result in no significant change to the Truesdale Lake, the Cross River or Croton water budgets. As the Truesdale Lake budget does not inherently account for septic runoff but flows into the Cross River basin via the Waccabuc River and into the Croton Basin, discharge of treated flows into the Waccabuc River will end up at the original destination.

Evaluation of Treatment Options

Zone Breakdown

The boundary of the study area was determined by the NYCDEP with the area of study being bordered to the north, west, and south by residentially zoned property, and to the east by the border between New York and Connecticut. As presented earlier in this report, the study area was divided into two distinct Zones. For this section, we define these zones as follows: Zone 1 (Sewer District) and Zone 2 (Septic Management District). The division of the service area zones was primarily determined by three criteria:

- Parcels potential for contributing nutrient loading to Lake Truesdale.
- The size of the parcel and its ability to accommodate an effective OSDS.
- The practicality of providing a collection system for parcels to connect to.

The potential for a parcel and associated OSDS to contribute nutrient loading to Lake Truesdale is primarily established by its proximity to a water course and the environmental factors influencing the OSDS. The closer an OSDSs proximity is to the Lake, stream, or water table, the higher its potential to contributing nutrient loading. Parcels in close proximity with high nutrient loading to the Lake would benefit the most from being connected to a collection sewer.

The ability of a parcel to accommodate a WCDOH code compliant OSDS is driven by the parcel's use, size, slopes, and soil characteristics. The boundary of the proposed service areas is delineated in Figure P below. A total of 348 parcels are proposed to be included in Zone 1 and 165 parcels in Zone 2. These include 274 developed parcels and 74 undeveloped parcels in Zone 1 and 145 developed parcels and 20 undeveloped parcels in Zone 2, refer to Table 3.

Figure P: Sewer District and Septic Maintenance Districts

Local WWTPs

As previously discussed, all the developed properties within the proposed service area (Zone 1) are served by OSDSs, where the existing flows vary greatly based on parcel use and occupancy – i.e., vacation homes and residential homes ranging from 3-6 bedrooms. As the area solely utilizes OSDSs, there is no existing public sewer. However, there are a variety of local and nearby wastewater facilities.

A total of 52 publicly owned WWTPs, along with several privately owned or operated facilities, were identified within a 40-mile radius of the Town for potential connection of the newly sewered Zone 1. The list of facilities was narrowed down to those facilities within a 15-mile radius of the Town (as the crow flies), due to pipeline construction costs. These facilities are presented in Table 11. The facilities were then evaluated based on the following criteria: a maximum pipeline length of 10 miles and more than 50% remaining facility treatment capacity available. This was to ensure the facility had enough capacity to accept wastewater from Zone 1. A total of four (4) facilities met this criterion, and were approached for connection discussions: Danbury, Ridgefield, Heritage Hills, and Peach Lake, these facilities are bolded in the table. Note that although Danbury did not meet the pipeline length criteria, it was approached due to its high remaining treatment capacity.

Out of the listed facilities, only Heritage Hills gave a positive response. See Table 12 for a summary of Facility responses.

Table 11: Wastewater Treatment Plants Located in a 15 Mile Radius of Lewisboro

Community	Permit Design Flow (MGD)	Average 2021 Flow (MGD)	Percent Remaining Capacity (Theoretical)	Est. Distance from Truesdale Lake (Miles)
Lewisboro Elementary School	0.01	0.004	60%	0.7
Waccabuc Country Club	0.008	0.0031	61%	3.1
Ridgefield Water Pollution Control Facility	1.0	0.85	15%	3.8
Ridgefield Water Pollution Control Facility	0.12	0.0307	74%	5.6
Oakridge STP	0.08	0.0595	26%	6.0
Increase Miller Elementary School WWTP	0.01	0.0011	89%	6.2
Wild Oaks SD	0.06	0.04	33%	7.5
Redding Wastewater Treatment Facility	0.075	0.0353	53%	8.1
Peach Lake Sewer District WWTP	0.17	0.05	71%	8.4
Bedford Hills Correctional Facility WWTP	0.5	0.1304	74%	9.4
Heritage Hills STP	0.702	0.265	62.3%	10.1
Brewster (V) STP	0.24	N/A	N/A	10.1

Southeast Brewster Heights SD 1	0.15	0.1018	32.1%	11.1
Blackberry Hill San SD STP	0.0747	N/A	N/A	11.5
New Canaan Wastewater Treatment Plant	1.7	0.835	50.9%	11.9
Yorktown Heights SD WWTP	1.5	1.12	25.5%	13.4
Danbury Water Pollution Control Facility	15.5	8.87	42.8%	13.8
Mahopac (V) STP	0.3	N/A	N/A	14.2
Carmel Sewer District #2 WWTP	1.1	N/A	N/A	14.3

*Facility names in bold were contacted for potential connection and treatment. Results are detailed in Table 12 below.

Table 12: Summary of Contacted Facilities

Facility	Permitted Flow	Average Flow	Notes / Reason for dismissal
Danbury WPCF	15.5 MGD (being reduced to 12 MGD)	8.87 MGD	Facility recently received a new phosphorus limit and is thus obtaining a lower permit and not accepting additional water inflow.
Ridgefield Water Pollution Control Facility	1.0 MGD (being increased to 1.12 MGD)	0.85 MGD	Initially contacted because the facility was being upgraded. However, the upgrade is only enough to accept the flow from a nearby Ridgefield facility that is being decommissioned.
Heritage Hills STP	0.702 MGD	0.265 MGD	Positive response. See Description of Alternatives section for more information.
Peach Lake Sewer District WWTP	0.17 MGD	0.05 MGD	Facility would only be able to accept around 0.05 MGD from Lake Truesdale, which is very unlikely to justify the piping cost.

Description of Alternatives

Wastewater Collection & Conveyance

The existing conditions surrounding the Lake were evaluated with consideration for the collection technologies that are most suitable for Truesdale Lake. Due to the density of residences and the septic system constraints adjacent to the Lake, technologies that involve continued use of on-site treatment systems and/or cluster systems that require substantial area were dropped from further consideration. Vacuum sewers were also dropped from additional consideration due to inherent problems with the systems in difficult soils, northern climates, and topography.

Different systems were analyzed for use as the Lake Truesdale study area collection system. A traditional gravity sewer system and low-pressure sewer system were selected and further evaluated for practicality and cost effectiveness within the study area.

A conventional gravity sewer system would have low points due to the variations in topography around Lake Truesdale and would require several large pump stations positioned around the Lake to move the wastewater to a dedicated treatment area. The topography would also indicate that sections of the gravity sewer would be 10 feet to 15 feet deep. Combined with the presence of shallow depth to rock and ground water around Lake Truesdale, constructability would be challenging requiring deep excavations and increased cost. The gravity system would also need to meet minimum separation distance to all wells and water mains, which is outside the scope of the current study. With a gravity system, approximately 25% of the parcels within the study area would require individual pump stations, as they are positioned downhill of the adjoining street and flow would need to be lifted up to then flow by gravity. Considering the above, a conventional gravity sewer system would prove to be cost prohibitive in the study area.

A Low-Pressure Sewer (LPS) system can follow topography to limit the depth of excavation required and every other residence, sharing where possible, will have a pump pit that contains a semi positive displacement grinder pump. The LPS system is pressurized which allows it to overcome moderate changes in elevation eliminating the need for larger dedicated pump stations at low points in the topography. Town ownership of pump pits would allow shared pump pits between adjoining parcels within the study area. These pump pits are designed to store several days of waste in the event of a power outage. When compared to a gravity system, the LPS system would on average use much smaller diameter pipes to convey the wastewater. The LPS system, like the gravity system, would need to meet separation distance to all wells and water mains. The most cost-effective collection system within the study area was determined to be the LPS system. The LPS system was selected for use as the Lake Truesdale Collection system within the study area Zone 1.

The area surrounding the Lake has been separated into two project areas as identified above and the limits of Zones 1 and 2 are shown in detail in Figure O. It should be noted that for this study, residences located more than 800 feet from the Lake were assumed to contribute a fractional amount of phosphorus loading to the Lake relative to the entire study area. The BASINS modeled data supports this assumption, revealing a 10-fold decrease contribution for septic failures. However, this assumption should be further investigated as the values input into the model were assumptions and subsurface discharges contribute significant phosphorus loading that goes undetected without frequent inspection. Inclusion of these areas in the long-term plan may have ancillary economic and health related benefits to the community.

Zone 1 – Low-Pressure Sewer Alternatives

The low-pressure sewer district (as well as other proposed piping) is anticipated to be constructed with High Density Polyethylene (HDPE) pipe by a combination of open trench installation and directional drilling. This material and construction method result in a cost-efficient and durable system. For the initial identification of areas that should be included in the sewer district with flow to an upgraded WWTP, the following criteria were used: (These criteria were developed using soils data, parcel size, and septic maintenance data, and may require updating and re-evaluation as additional data becomes available.)

The initial criteria for areas suggested to be sewered and conveyed to a WWTP include the following:

- Areas where the ground elevation is less than five (5) feet above high Lake water level as groundwater depth is too shallow for conventional soil absorption beds and trenches allowing for proper nutrient removal.
- Small parcel size (less than 1-acre) identifies clusters of septic systems and increased volumes of nutrient loadings.
- Areas within 800-feet of Lake Truesdale

Parcels adjacent to roads where collection and conveyance are proposed per criteria above. The following paragraphs describe each alternative considered for evaluation. Potential facilities for each alternative are estimated for Zones 1 and 2. However, figures of proposed infrastructure were developed for Zone 1 improvements only as these will provide the most benefit to the Lake relative to removal of readily available phosphorus.

Zone 1 Alternative 1: Low Pressure Sewer Connection to Expanded WWTP

Alternative 1, applicable for Zone 1 only (within 800 feet of the Lake), due to parcel density includes decommissioning/abandoning existing individual septic systems and diverting flows to a low-pressure sewer collection system for collective treatment at an expanded wastewater treatment plant located at the Lewisboro Elementary School.

In this alternative, the property owner and Town would share responsibility for the installation of the sewer lateral from the house to the grinder pump station as well as decommissioning the existing septic tank. Routine maintenance would likely consist of replacing the grinder pump every 5 to 10 years. For planning purposes, connection costs (sewer lateral from the house to the grinder-pit) are estimated at $2,500. A new sewer district will be formed to support the installation, upgrade, operation, and maintenance of the collection system.

Expanded WWTP

The expanded wastewater treatment plant will provide treatment for a max daily flow of 140,000 gpd, with a peak daily flow of 280,000 gpd for Zone 1, with a Phase 2 option to provide treatment for an increase of flow to encompass the entire study area, should the Town decide to gradually tie in Zone 2. Recommended design flows, biological loading and nutrient loads are presented in Table 13.

Table 13: Estimated Flows and Nutrient Loads – Zone 1

Parameter	Design Capacity
Flow (gpd)	
Annual Average	140,000
Max Day[1]	280,000
Peak Hour[2]	560,000
BOD_5 (lb./day)	
Average[3]	191
Max Day[1]	382
TSS (lb./day)	
Average[4]	217
Max Day[1]	434
Total Phosphorus (lb/d)	
Average	3.25

1. Calculated as average value with 2-fold peaking factor
2. Calculated as average value with 4-fold peaking factor
3. Calculated based on 0.22 lb. BOD5 per capita-day, 2014 Ten States Standards
4. Calculated based on 0.25 lb. TSS per capita-day, 2014 Ten States Standards

New or expanded wastewater treatment facilities within the NYCDEP watershed are required to meet high effluent standards and a variance is required from the NYCDEP for these facilities. Further, flows from new development would require a phosphorus offset. To achieve a high level of treatment, the NYCDEP has allowed the use of membrane bioreactor (MBR) treatment systems in lieu of conventional tertiary treatment facilities. For this reason, a membrane treatment facility is recommended for this study and is evaluated further as described below. The proposed MBR system will be constructed at Lewisboro Elementary School as an expansion to the existing facility with the predicted discharge limits presented in Table 14 below. A new NPDES permit will need to be issued as the outfall is being relocated to Waccabuc River.

Table 14: Proposed WWTP Discharge Limits

Parameter	Limit	Units
BOD	< 5	mg/L
TSS	< 5	mg/L
NH_3	< 1	mg/L
Total Nitrogen	< 5	mg/L
Total Phosphorus	< 0.5	mg/L

A fabricated package plant (Ovivo MicroBlox MBR) was considered for this evaluation due to the simplicity of design and installation, coupled with sole source procurement and warranty. Package plants do have some drawbacks and may not be applicable for this project and a custom designed and constructed facility may be better suited when financial and regulatory factors are considered. The Ovivo proposal for the MicroBlox MBR package treatment system is included in Appendix B.

The design influent flows and water quality, developed using Ten State Standards (2014) and New York State Design Standards for Intermediate-Sized Wastewater Treatment Systems (2014), are contained in Table 15.

Table 15: Design Influent Hydraulic and Water Quality Loads

Influent Parameter	Units	Value
Annual average flow rate	gpd	140,000
Design rated capacity	gpd	280,000
Average BOD load	lb/d	191
Peak hour BOD load	lb/d	762
Average TSS load	lb/d	217
Average TKN load	lb/d	18
Peak hour TKN load	lb/d	72
Average phosphorus load[1]	lb/d	3.25

[1]Intermediate-sized Facilities Wastewater Treatment Systems states that a phosphorus concentration of 7 mg/L is typical, while research has provided a wide range of phosphorus in OSDSs with the median being 13 mg/L, translating to 8 lb/d and 16 lb/d respectively. However, based off the BASINS modeling, the maximum phosphorus loading is projected to be 3.25 lb/d (combined Alternative B). This value will be used when estimating phosphorus savings.

The projected discharge permit requirements (Table 16) were assumed to be equal to that of the existing Lewisboro Elementary School SPDES Permit NY0036684, which were confirmed with the operator. Some values were then adjusted to meet the New York State Design Standards for Intermediate-Sized Wastewater Treatment Systems (2014). Additional parameters that will likely be included in the SPDES permit include an annual phosphorus loading and phosphorus offset (for flows from new development) as well as 3-log removal of Giardia Lamblia cysts and Enteric viruses.

Table 16: Projected SPDES Permit Criteria

Parameter	Type	Limit	Units
Flow	Monthly average	150,000	gpd
BOD	Daily maximum	5	mg/L
TSS	Daily maximum	5	mg/L
Settleable solids	Daily maximum	0.1	mg/L
pH	Range	6.5 - 8.5	SU
Ammonia - summer	Daily maximum	1.5	mg/L as NH_3
Ammonia - winter	Daily maximum	2.2	mg/L as NH_3
Phosphorus	30-day arithmetic mean	0.5	mg/L as P
Dissolved oxygen	Daily maximum	7	mg/L

The MBR process can produce phosphorus effluent in the range of 0.1 mg/L which is well within potential effluent limits, including the 2:1 required offset. If ultra-low phosphorus limits are required, an additional and separate treatment step of chemical addition will be necessary. See Table 17 below for the estimated phosphorus removal from the expanded WWTP. See Appendix A for a more detailed description of the design criteria.

Table 17: WWTP Phosphorus Removal Estimate

Phosphorus Load and Benefit to Lake	Annual Loading (lb/yr)
Estimated phosphorus influent	230 – 1,000
Estimated phosphorus effluent (0.5 mg/L)	213
Phosphorus reduction	7 – 79% (up to 787 lbs/year)

Wastewater Solids Management

The process is expected to produce 1-2% solids based on weight of the influent flow. Assuming 2% solids to be conservative, and a total flow of 140,000 gal/day, the resulting solids to be stored and hauled is approximately 40,000 gallons in a two-week period. The solids would be hauled by the Town and disposed of at a regional WWTP.

WWTP Location

The Town, local HOA members and the Ramboll team reviewed potential sites for a new WWTP based on available useable land, objectively targeting a central location with a favorable discharge that met the NYSDEC locational recommendations (an intermediate-sized facility may be no less than 150 feet from a property line and 200 feet from a drinking water supply well, WCDOH GreenBook). While several identified, undeveloped parcels were evaluated, they were each deemed unacceptable by the Town and local HOA members. Upon further review, the Town identified the Lewisboro Elementary School property as the preferred location for the wastewater treatment facility.

When evaluating the placement of a new building for the expanded facility on school property, following the recommended guidelines established by the NYSDEC, the school playing field was considered for the unit but dismissed upon discovering that the field was the location of a drinking water well servicing the school. There are two potential locations for the WWTP at the campus, Alternative A being north of the existing facility, between the facility and the parking lot. Although there is no development in that area and it is large enough to house the facility, the area is a stormwater management practice, and developing that land would require dedicating new land for stormwater management. Alternative B is in the north-east part of the parking lot, this location would not cause stormwater issues, but the campus would have to sacrifice some of its parking space to house the facility. Both options have an associated disadvantage and would need to be decided at a later date if this alternative for Zone 1 moves forward. These alternatives are presented in Figure Q.

Both locations would be able to support the estimated 3,600 square foot (65’ x 55’) WWTP building. The existing facility would remain, while portions would be repurposed as needed. The new process units would be sized to treat the existing flows (approximately 4,000 gpd) and the existing equalization basin would be expanded to serve the increased flows. Due to the size and configuration of the property, it would not be possible to build a facility that maintains 150 feet from property lines in accordance with NYSDEC guidelines without demolishing parts of the existing school building. It should be noted that the existing WWTP is located less than 150 feet from the property boundary of the school. The proposed WWTP would be enclosed within a newly constructed building, therefore the structure will not be aesthetically intrusive as the treatment process will not be visible.

Should this location be deemed unacceptable, another alternative is to demolish a section of the existing school building and construct the WWTP there. This will result in a substantial increase in the cost due to demolition. Lastly, the school property is owned by the Katonah-Lewisboro School District and will come with some challenges. It is understood that despite renting out the property, the school district plans to hold on to the property for the time being. Therefore, the school district may resist the construction of an expanded facility on site and/or demolishing school infrastructure.

Figure Q: Proposed Sewer System layout

Figure R: Proposed Site Plan

Figure S: WWTP Process Flow Diagram

Ramboll has discussed with the Lake Waccabuc study team the potential of using the expanded facility at the school as a regional WWTP with the capacity to receive flow from both Lake Waccabuc and Truesdale Lake areas. This would ultimately double the influent flow for the proposed facility. As of now, Ramboll has not explored this further, but it may be economical if both communities wish to pursue the construction of an expanded WWTP and shared pipeline.

Alternative 1 Pipeline

For Alternative 1, Truesdale Lake Zone 1 collection system and effluent discharge, the following would be required:

- Low pressure sewer:
    - Approximately 18,000 LF of 1.25-inch diameter low pressure sewer (sewer laterals)
    - Approximately 12,600 LF of 2-inch diameter low pressure sewer
    - Approximately 9,100 LF of 3-inch diameter low pressure sewer
    - Approximately 6,700 LF of 4-inch diameter low pressure sewer
    - Approximately 2,600 LF of parallel 4-inch diameter low pressure sewer
    - Approximately 180 on lot grinder pumping stations (*assuming 1/3 of residences share)
    - Disconnect and decommission each residential OSDS, approximately 274
- Effluent Forcemain:
    - Pumping station
    - Approximately 2,640 LF of 4-inch diameter force main

New Effluent Discharge Location

NYCDEP regulations generally prohibit the construction of new surface discharge facilities unless a septic emergency is determined and requires substantial permitting, a variance from NYCDEP and studies to advance the project. The proposed WWTP effluent discharge point is the Waccabuc River. Note that water discharged from the expanded facility will not flow back to Truesdale Lake; however, it will still reach the Cross River Reservoir via the Waccabuc River, contributing an estimated 213 lb/year of phosphorus to the reservoir, as well as 52.7 Mgal/yr of flow. However, as mentioned earlier, since both Lake Truesdale and the Waccabuc River are upstream of the Cross River Reservoir, the watershed water budget will balance out. Ramboll is unable to evaluate the effect this would have on Lake Truesdale without more detailed water budget information, as the present budget does not account for any water contribution resulting from the surrounding OSDSs.

Effluent from the WWTP will be pumped an estimated half mile through a directionally drilled 4-inch HDPE force main from the elementary school down Bouton Road where the outfall will discharge into the Waccabuc River before crossing State Route 35. The exact location of the Waccabuc River outfall is flexible but illustrated in Figure T. This location will require the Town to obtain an easement, as the pipeline crosses private property, but the proposed location deposits the effluent in the mixing zone of the river and the pond. Routing the force main to the river without crossing private property would require following Bouton Rd and crossing State Route 35 before discharging. This alternative would double the effluent piping length, significantly increasing cost. Note that the proposed effluent piping path is based off a high-level study, and further planning during the design phase of the project would determine the final force main path and discharge location.

Figure T: Proposed Effluent Force Main Path

Zone 1 Alternative 2: Low Pressure Sewer Connection to an Existing WWTP

Alternative 2, applicable for Zone 1 only, includes decommissioning/abandoning existing individual septic systems and construction of a low-pressure collection system to convey flows to an existing WWTP, Heritage Hills.

Heritage Hills has the capacity to accept all of Zone 1 flow. The facility is located 7.8 miles north-west of Truesdale Lake, with the most direct pipeline path constructed in roads is approximately 10 miles. Heritage Hills presently receives 0.3 MGD average daily flow and has a permitted flow capacity of 0.702 MGD. Note that the Lake Waccabuc project team is also considering conveying flows generated in the service area to the Heritage Hills STP. If both communities were to convey wastewater to Heritage Hills STP, it is unclear if the facility would be able to handle the increased loading.

Alternative 2 Pipeline

For this alternative, the following would be required:

- Low pressure sewer:
  - Approximately 18,000 LF of 1.25-inch diameter low pressure sewer (sewer laterals)
  - Approximately 12,600 LF of 2-inch diameter low pressure sewer
  - Approximately 9,100 LF of 3-inch diameter low pressure sewer
  - Approximately 6,700 LF of 4-inch diameter low pressure sewer
  - Approximately 180 on lot grinder pumping stations (*assuming 1/3 of residences share)
  - Disconnect and decommission each residential OSDS, approximately 274
- Forcemain System:
  - Submersible pumping station
  - Approximately 55,000 LF of 8-inch diameter force main

Under Alternative 2, flows collected through the low-pressure system would terminate in a centrally located pump station and be conveyed directly to Heritage Hills STP. The proposed pumping station/junction chamber consists of a wet well, valve vault, submersible pumping system, odor control and small support building (electrical, standby power and controls). The proposed force main to Heritage Hills STP consists of 55,000 feet of 8-inch HDPE pipe with appropriately spaced clean outs and air release stations, Figure U.

Zone 1 Alternative 3: Community Septic

Due to the large number of residences needed to be serviced in Zone 1 by a community septic, only vacant parcels greater than four (4) acres and within an acceptable distance to the Lake were considered. A total of seven (7) vacant parcels fit these criteria, see Figure V, and were analyzed for their viability to accommodate a community septic, based on surface and subsurface characteristics.

First the presence of wetlands on each parcel was evaluated, Figure W, and a 100-foot buffer zone was implemented around each wetland to preclude septic placement. Then steep slopes were examined for each parcel, and areas with slopes greater than 20% were eliminated. Next, soil information was reviewed for depth to groundwater and hydraulic soil group composition was evaluated within each parcel. Areas with D soils were considered unsuitable, as they have the potential to percolate very slowly, holding effluent and prohibiting the proper growth of aerobic bacteria to break down waste. Finally, the depth to bedrock was evaluated. Adequate separation to bedrock is required for proper treatment and must be provided to have a permittable community septic.

After careful analysis of the seven identified parcels and field verification of the mentioned constraints, it was determined that an area required to support a community septic was not available. A community septic was determined to not be a viable option for treating wastewater from the Zone 1 study area.

Figure U: Connection to Heritage Hills Wastewater Treatment Plant

Zone 2 – Septic Maintenance District

Alternative 1 – Septic Maintenance and Enhanced Treatment

The evaluation of septic management options is limited in Zone 2 due to the large area that Zone 2 covers and the spacing of residences on parcels. The initial criteria for areas suggested for the septic maintenance district include the following:

- Far reaching areas of the study area, where length of pipeline and cost of installation outweigh the benefits of a sewer collection district; and
- Large parcel size denoting scattered septic systems with reduced nutrient loading density

The Septic Maintenance District would enact user fees to cover system upgrades and maintenance of all the OSDSs within Zone 2. All systems would require assessment to determine the extent of improvements essential to the OSDS and surrounding leach field. The assessment would involve a septic contractor opening the tanks and uncovering portions of the absorption system for inspection by a Professional Engineer (PE). Systems not in disrepair/failure (no surface discharge or standing water in trenches/ no excessive bio mat/sludge build up in gravel) would be modified with the installation of an Enhanced treatment Unit (ETU). The improvement would need to be designed by a PE and approved by the WCDOH. Systems in failure would receive an ETU and absorption field replacement. This repair would be designed by a PE and need to be approved by the WCDOH.

This alternative includes utilizing improved technology for OSDS nutrient removal for the replacement of existing, dated OSDSs. ETUs shall have a label indicating compliance with the standards for Class I unit as described in the National Sanitation Foundation (NSF) International Standard 40 or equivalent testing. The minimum rated daily capacity of these units shall be equal to or greater than the daily design flow. ETUs shall have an effluent filtering mechanism as part of the manufactured product or an effluent filter with a label indicating compliance with NFS Standard 46 or equivalent installed on the system outlet prior to discharging to the absorption area. The maintenance district would be in charge of the coordination, design, construction, and maintenance of the upgrade to each system.

Recommended Treatment Practice

Zone 1

Recommendation

Because there is no viable option for a community septic system in Zone 1, the recommended course of action for nutrient reduction is the construction of a low-pressure sewer and a new/expanded WWTP located at the Lewisboro Elementary School with collected solids hauled to a regional WWTP for treatment and disposal. This option is more economical and feasible than constructing a pipeline to Heritage Hills for treatment of Zone 1 collected wastewater. The estimated overall lifetime cost for Alternative 1 is $67,530,864, while the estimated lifetime cost for Alternative 2 is $76,638,991, supporting that the newly constructed facility is the most cost-effective alternative. See Table 18 in the section "Estimated Cost of Zone 1 Treatment Practices" for a more in-depth analysis of the estimated cost of this course of action.

Zone 2

Due to the large parcel size and the distribution of the residences in Zone 2, implementation of a septic maintenance district is the recommended course of action. This management practice will require upgrades, as outlined previously in the report, for improved nutrient reduction for all existing OSDSs along with regular pump outs, to be established by the Town.

Estimated Phosphorus Loading Reduction

By implementing the recommended alternatives (sewering Zone 1 with treatment at Lewisboro Elementary and establishing a Septic Maintenance District for Zone 2), the phosphorus loading to Truesdale Lake attributed to OSDSs discharge (human waste contribution) is estimated to decrease from 1200 lb./year to 140 lb./year resulting in approximately 87% loading reduction. This is based off the targeted WWTP effluent discharge limit of 0.5 mg/L for Zone 1 and the implementation of upgraded OSDSs for Zone 2. Note that this does not include nonpoint source loading, which does not originate from OSDSs and accounts for approximately 7.5% of the Lake's phosphorus loading.

Table 18 – Phosphorus Removal Estimates

Phosphorus Load and Benefit to Lake	Zone 1 Loading (lb/yr)	Zone 2 Loading (lb/yr)	Total Lake Loading (lb/yr)
Septic phosphorus loading	1000	100	1100
Nonpoint source loading	20	80	100
Estimated phosphorus loading (septic and nonpoint source)	1020	180	1200
Estimated phosphorus WWTP effluent loading*	220	N/A	N/A
Estimated OSDS upgrade effluent loading**	N/A	40	N/A
Total estimated reduction of TP	800	60	N/A
Total Lake Loading	**20**	**120**	**140**
20-year Cost per lb TP removed	**$2,470**	**$11,670**	

* For the removal estimates, the anticipated permit level of 0.5mg/L was used for reduction calculations

** Effluent concentration based off a low-end projected reduction of 60% with targeted phosphorus treatment.

Estimated costs to remove TP from Truesdale Lake on an annual basis are based on capital and O&M costs over a 20-year period assuming simple payback on capital. Capital costs for Zone 1 and 2 of $31.2M and $9.4M respectively and annual O&M costs of $413K and $228K for Zones 1 and 2 respectively were utilized as the cost basis and are presented in detail in subsequent sections.

Figure V: Community Septic Parcels

Figure W: Wetland Waterbodies Intersection

Project Considerations

Permits

Ramboll permitting experts reviewed the proposed project and prepared a summary of potential permits that may be required for implementation of this project. In addition to permits a variance from the NYCDEP will be required from the prohibition of new or expansion of surface discharging WWTP. The applicability of these programs will be reviewed and confirmed as the project advances through construction. See Appendix E for the summary of potential required permits, required agency approvals and relative comments per permit.

Feasibility

The project components recommended in previous sections are proven solutions with a long track record of success. While not all challenges have been identified to date, the following are items for further consideration as this project advances:

- Availability of Lewisboro Elementary School campus for construction of the WWTP expansion
- Viability of effluent discharge into the Waccabuc River
- Feasibility of wastewater or solids disposal at Heritage Hills STP
- Determination of permitting issues that could prohibit some or all of the project

Zone 1

The area proposed for the expanded WWTP is currently owned by the Katonah-Lewisboro school district. However, the facility is not currently being used as a school, instead sections are being rented as offices. A business agreement or land sale would need to be agreed to between the Town and the school district in order for the Town to be allowed to locate the WWTP on this property.

Noise and odors from the WWTP would need to be considered in the design of the facility.

Environmental features such as wetlands and waterbodies would also need to be taken into account during the design of the facility. Reuse of existing facilities and sighting the plant in previously disturbed areas would be recommended to minimize impacts. A stormwater pollution prevention plan would be required for any new impervious surfaces.

The required improvements to the existing facilities for the repurposing of the existing WWTP include but are not limited to the following:

- Resizing and reuse of the EQ tank
- Reuse of the wet well for sludge storage
- Retaining the existing building for chemical addition, mechanical, electrical, maintenance and administration

Additional modifications will require further capacity evaluations and applicability.

Seasonal Limitations, Challenges, and Requirements

No seasonal limitations to the solutions recommended were identified. Construction of the improvements will account for seasonal conditions and will likely take two construction seasons for full implementation.

Public Support

The primary benefit to completing this project is improved water quality within the Lake and reduced stress on residential water wells due to short circuiting or failing OSDSs. Enhanced water quality (lake and drinking water) may lead to increased property values as the Truesdale Lake area becomes a more desirable place to live. Additionally, by improving the water quality of Truesdale Lake, subsequent water quality improvements will benefit downstream watersheds.

The primary source of public support and outreach is through the homeowner associations surrounding the Lake as each of these associations has been integral in advocating for activities that advance water quality.

Financial Status

As the project area is primarily residential and there is no income producing potential, the project will be funded through loans and grants with the remaining principal to be paid down by the ratepayers. With an estimated capital cost well over $20 million and a limited population of rate payers, this project will need substantial grants to be viable. Funding sources are explored in greater detail in the next section and are subject to change as new funding opportunities become available.

Estimated Cost of Zone 1 Treatment Practices

Cost Estimate

Zone 1 – Alternatives 1 and 2

An opinion of probable construction cost for Alternatives 1 and 2 was developed assuming a 20-year lifespan and a 3% annual interest rate, as presented in Table 19 below. Costs utilized in developing the overall estimates are a combination of data presented in previous engineering reports and updated based on current bid tabs and standards to reflect present day values. These costs are suitable for consideration in this high-level study only and are subject to change in refined stages of design. A summary of common unit prices is included as Appendix C.

Both the present worth and lifetime costs for the alternatives show that the lower O&M cost for Alternative 2 does not offset the overall cost of the alternative, and that constructing a low-pressure sewer connected to an upgraded WWTP is the most cost-effective option.

Table 19: Cost for Alternative Options for Zone 1

Alternative	Capital Cost (2021)	Annual O&M Cost	20-Year Present Worth	20-Year Lifetime Cost
Alternative 1 - Low Pressure Sewer Connection to Upgraded WWTP	$31,246,400	$412,960	$37,390,202	$67,530,864
Alternative 2 - Low Pressure Sewer Connection and Force Main to Heritage Hills	$40,023,000	$162,000	$42,433,151	$76,638,991

Zone 1 – Alternative 1 - Low Pressure Collection Sewer to Expanded WWTP

See the table below for a breakdown of the estimated costs of the proposed WWTP expansion. Note that cost estimates of these items may be refined as the project progresses. Most item estimates are based off values from similar projects, but neither capital or O&M costs have been approved by the DEP and will only be finalized during the design phase of this project.

Table 20: Zone 1 Alternative 1 Lewisboro Elementary School WWTP Construction Cost Estimate

Item	Units	Unit Cost	Quantity	Cost
On-lot 1.25-inch low pressure sewer force main	LF	$90	18000	$1,620,000
2-Inch low pressure sewer force main	LF	$110	12600	$1,386,000
3-Inch low pressure sewer force main	LF	$115	9100	$1,046,500
4-Inch low pressure sewer force main	LF	$125	6700	$837,500
On-lot grinder pump pit[1]	EA	$20,000	180	$3,600,000
On-lot grinder pump electric service	EA	$4,000	180	$720,000
WW conveyance pump station	EA	$250,000	1	$250,000
4-Inch parallel influent force main	LF	$160	2600	$416,000
Directional drill through ledge rock	EA	$100,000	1	$100,000
Cleanout/ARV station	EA	$8,000	3	$24,000
Effluent pump station	EA	$250,000	1	$250,000
4-Inch effluent force main	LF	$125	2640	$330,000
Subtotal: Infrastructure				**$10,580,000**
Wastewater treatment process equipment	LS	$3,000,000	1	$3,000,000
Installation	LS	$1,000,000	1	$1,000,000
New treatment building	SF	$350	3000	$1,050,000
Equalization tank and pumping	LS	$200,000	1	$200,000
Electrical and instrumentation	LS	$700,000	1	$700,000
HVAC and plumbing	LS	$400,000	1	$400,000
Subtotal: Processes + Installation[2]				**$6,350,000**
Interior valves & piping	LS	$400,000	1	$400,000
Site/civil/miscellaneous	LS	$750,000	1	$750,000
Building modifications to existing WWTP	LS	$250,000	1	$250,000
Yard piping	LS	$150,000	1	$150,000
Subtotal				**$1,550,000**
Contingency	EA	40%	1	$7,392,000
Engineering and admin	EA	20%	1	$5,174,400
Property acquisition	LS	$200,000	1	$200,000
Subtotal				**$12,766,400**
Total				**$31,246,400**

1. On-lot grinder pump pit unit price is based on an E/One grinder. Competitive bidding with additional manufacturers and sizeable scope will likely reduce the unit cost by as much as 25%.
2. Cost estimate assumes that the existing WWTP infrastructure will be repurposed to the greatest extent possible.

Table 21: Zone 1 Alternative 1 Lewisboro Elementary School WWTP O&M Cost Estimate

Item	Estimated Annual cost	Cost per Gallon
Labor	$135,000	$0.0026
Electricity	$35,000	$0.0007
Propane	$15,000	$0.0003
Chemicals	$7,000	$0.0001
Certified lab testing	$6,000	$0.0001
Equipment maintenance	$15,000	$0.0003
Sludge disposal	$156,000	$0.0030
Miscellaneous	$10,000	$0.0002
Building maintenance supplies	$4,000	< $0.0001
Internet/telephone	$1,800	< $0.0001
Insurance	$8,000	$0.0002
On-lot grinder station	$12,960	$0.0002
On-lot grinder station electric	$7,200	$0.0001
Total	**$412,960**	**$0.0077**

Table 22: Zone 1 Alternative 1 Funding Analysis

Low Pressure Collection Sewer to New WWTP	
Capital Cost	$31,246,400
NYCDEP Capital Cost Subsidy[1]	-
Total Local Capital Cost	$31,246,400
NYSEFC Financing[2] (Annual)	$1,367,793
O&M (Annual)	$412,960
NYCDEP O&M Subsidy[3]	-
Total Local O&M Cost	$412,960
Annual Cost Subtotal	$1,780,753
No. of Users	280
Annual Cost/ User w/o Grants	$6,360
Annual O&M Per User[4]	**$1,475**
Annual Capital Cost Repayment Per User	**$4,885**

1. NYCDEP subsidy for tertiary treatment capital cost.
2. Based on 30-year loan at 2% financing.
3. NYCDEP subsidy for tertiary treatment O&M.
4. O&M Costs for primary and secondary treatment are not grant eligible.

The above cost analysis includes the assumption that there will be no grant funding to reduce the project capital cost. Under this scenario, an annual user fee of $6,360 is unrealistic and not sustainable. While typical user fees vary across New York a threshold of $1,000 annually is often used as a starting point for discussion and targeting for a financing program. In order to reach a total annual user fee of $1,000 (summation of capital cost and O&M annual fee), approximately $27 million in capital grant funding and approximately $265,000 annually in O&M subsidies or reduced O&M costs would be required.

Zone 1 – Alternative 2 – Conveyance to Regional WWTP

The Heritage Hills STP is located approximately 10 miles northwest of Lake Truesdale, requiring a new pumping station and an extensive force main. As with Alternative 1, neither the capital or O&M costs have been approved by the DEP, these estimates are subject to change and will only be finalized during the design phase of the project.

Table 23: Zone 1 Alternative 2 Cost Estimate

Item	Units	Unit Cost	Quantity	Cost
On-lot 1.25-inch low pressure sewer force main	LF	$90	18,000	$1,620,000
2-Inch low pressure sewer force main	LF	$100	12,600	$1,386,000
3-Inch low pressure sewer force main	LF	$115	9,100	$1,046,500
4-Inch low pressure sewer force main	LF	$125	6,700	$837,500
On-lot grinder pump pit	EA	$20,000	180	$3,600,000
On-lot grinder pump electric service	EA	$4,000	180	$720,000
Force Main pump station	EA	$250,000	1	$500,000
8-Inch force main to Heritage Hills	LF	$220	55,000	$12,100,000
Cleanout/airvac station	EA	$8,000	30	$240,000
Subtotal: Infrastructure				**$22,050,000**
Contingency	EA	40%	1	$8,820,000
Engineering and admin	EA	20%	1	$4,774,000
Purchase WWTP capacity at Heritage Hills	EA	$2,979,000	1	$2,979,000
Subtotal				**$14,573,000**
Total				**$40,023,000**

1. On-lot grinder pump pit unit price is based on an E/One grinder. Competitive bidding with additional manufacturers and sizeable scope will likely reduce the unit cost by as much as 25%.

Table 24: Zone 1 Alternative 2 O&M Cost Estimate

Item	Estimated Annual Cost	Cost per Gallon
Labor	$30,000	$0.0006
O&M User fee (assumed $1.5/1,000 gal)[1]	$78,840	$0.0015
Electricity (pump station)	$12,000	$0.0002
Diesel (pump station emergency power)	$3,000	< $0.0001
Chemicals (odor control)	$3,000	< $0.0001
Equipment maintenance	$5,000	$0.0001
Miscellaneous	$10,000	$0.0002
On lot Grinder station	$12,960	$0.0002
On lot Grinder station electric	$7,200	$0.0001
Total	**$162,000**	**$0.0029**

1. Sewage user rates are estimates and will need to be confirmed with the operator of Heritage Hills STP if this alternative is pursued further.

Table 25: Zone 1 Alternative 2 Funding Analysis

Low Pressure Collection Sewer and Force Main to Heritage Hills STP	
Capital Cost	$40,023,000
NYCDEP Capital Cost Subsidy[1]	-
Total Local Capital Cost	$40,023,000
NYSEFC Financing[2] (Annual)	$1,751,984
O&M (Annual)	$162,000
NYCDEP O&M Subsidy[3]	-
Total Local O&M Cost	$162,000
Annual Cost Subtotal	$1,913,984
No. of Users	280
Annual Cost/ User w/o Grants	$6,836
Annual O&M Per User	**$579**
Annual Capital Cost Repayment Per User	**$6,257**

1. NYCDEP subsidy for tertiary treatment capital cost.
2. Based on 30-year loan at 2% annual interest rate.
3. This project would not be eligible for a tertiary treatment O&M subsidy.

The above cost analysis includes the assumption that there will be no grant funding to reduce the project capital cost. Under this scenario, an annual user fee of $6,257 is unrealistic and not sustainable. While typical user fees vary across New York a threshold of $1,000 annually is often used as a starting point for discussion and targeting for a financing program. In order to reach a total annual user fee of $1,000 (summation of capital cost and O&M annual fee), approximately $35.8 million in capital grant funding would be required.

Zone 2 – Alternative 1 – Septic Maintenance District

There are 145 currently developed parcels in Zone 2. The cost estimate below is for the installation of an ETU on each system and assumes that 1/3 of the parcels may also require a septic repair.

Table 26: Zone 2 Alternative 1 Cost Estimate

Item	Unit	Unit Cost	Quantity	Cost
Open System Inspection by Professional Engineer	EA	$3,500	145	$507,500
ETU Installation	EA	$27,000	145	$3,915,000
OSDS Repair	EA	$25,000	48	$1,200,000
Subtotal: Infrastructure				**$5,622,500**
Contingency	EA	40%	1	$2,249,000
Engineering and Admin	EA	20%	1	$1,574,300
Subtotal				**$3,823,300**
Total				**$9,445,800**

Table 27: Zone 2 Alternative 1 O&M Yearly Cost Estimate

Item	Units	Unit Cost	Quantity	Estimated Cost Per Year
Pump Out	EA	$500	73	$36,500
System Inspection	EA	$1,000	29	$29,000
Equipment maintenance (twice annually)	EA	$300	290	$87,000
Labor/Repair/Maintenance	LS	$50,000	1	$50,000
Program Manager	LS	$25,000	1	$25,000
Total				**$227,500**

Power costs for the ETUs would be the responsibility of the homeowner and anticipated to be minimal. Costs for the remaining activities would be combined into the program and managed by the Town or other entity assigned to manage the Septic Maintenance District (SMD). Similar to a Sewer District, the SMD would be administered by the Town and each parcel within the SMD assessed an annual O&M cost and if capital costs are borne by the SMD, these will be assessed to each user as well.

Table 28: Zone 2 Alternative 1 Funding Analysis

Septic Maintenance District	
Capital Cost	$445,800
NYSEFC Financing[1] (Annual)	-
O&M (Annual)	$227,500
NYCDEP O&M Subsidy[2]	-
Total Local O&M Cost	$227,500
Annual Cost Subtotal	-
No. of Users	145
Annual Cost/ User w/o Grants	$4,421
Annual O&M Per User	$1,569
Capital Cost Repayment	$2,852

1. Based on 30-year loan at 2% annual interest rate.
2. This project would not be eligible for a tertiary treatment O&M subsidy.

The above cost analysis includes the assumption that there will be no grant funding to reduce the project capital cost. One philosophy on user fees within an SMP is to compare the annual user fee for participation in an SMP with the cost of owning and maintaining an OSDS for the long term. For example, if the 25-year cost to construct and maintain an OSDS with a lifespan of 25 years is $40,000 the annual cost for the homeowner to go “alone” equates to $1,600/year. This value then becomes the target user fee after grant funding and O&M costs optimized. In this example, to reach a total annual user fee of $1,600 (summation of capital cost and O&M annual fee), approximately $2.2 million in capital grant funding would be required and O&M costs optimized and/or subsidized such that each user supports a fair share of the program and individual repairs as needed.

Potential Funding Sources

Clean Water State Revolving Fund

The Clean Water State Revolving Fund (CWSRF), administered by the Environmental Facilities Corporation (EFC), provides interest-free or low-interest rate financing for wastewater and water quality improvement projects to municipalities throughout New York State. The Federal Environmental Protection Agency (EPA) annually provides a grant to the state to capitalize the CWSRF program. EFC uses this federal money, along with the required State match funds, equal to 20% to fund projects, for the purpose of preserving, protecting, or improving water quality. As borrowers repay their loans, repayments of principal and interest earnings are recycled back into the CWSRF program to finance new projects and allow the funds to "revolve" over time.

There are several different types of financing available to CWSRF applicants. Interest-free financing, known as “hardship financing,” is available to municipalities that meet the eligibility requirements. Hardship eligibility is generally based on municipal population, median household income (“MHI”) and percentage of families below the poverty level (“Poverty”). For purposes of this policy, population, MHI and Poverty are based on the 2017 American Community Survey’s 5-year estimates published by the U.S. Census Bureau.

Hardship Financing Eligibility

EFC evaluates a municipality’s eligibility for hardship financing based on two sets of criteria: first, on criteria specific to the municipality, and second, on criteria specific to the project. As significant savings can be achieved through hardship financing, it is recommended that Lewisboro review eligibility with EFC.

New York State Administered Grant Opportunities

In past years, the primary grant programs available for municipal wastewater infrastructure projects consisted of the following:

Water Infrastructure Improvements Act (WIIA) administered by NYSEFC

In tandem with financing, the EFC administers the WIIA programs which in 2021 will be awarding $600 million in grants for water infrastructure and resiliency. Under the WIIA grant program, grant awards will fund up to 25% of an eligible wastewater project up to $25 million.

Water Quality Improvement Program (WQIP) administered by NYSDEC

Competitive statewide reimbursement grant programs are open to local governments. For 2021, up to $65 million was available for distribution with a maximum award of $10 million.

Recommended Alternative

As discussed previously, the recommended alternative for Zone 1 is Alternative 1 - to install a low-pressure sewer collection system and convey flows to an expanded WWTP located at the Lewisboro Elementary School and discharge effluent via a forcemain into the Waccabuc River.

The recommended alternative for Zone 2 is Alternative 1 - to establish a Septic Maintenance District and establish frequent septic pump out and repairs that include upgrades to advanced nutrient removal technologies.

Appendix A: Flow, Loading, and Treatment Calculations

APPENDIX C - WASTEWATER TREATMENT CALCULATIONS

Proposed Membrane Treatment System Design Criteria

Lake Truesdale Service Area

Raw Water Influent Characteristics			
Influent Parameter	**Units**	**Area**	
Annual average flow rate (present + future)	gpd	140,000	
Design rated capacity	gpd	280,000	
Peak hourly flow	gpd	560,000	
Per capita equivalent (present + future)	people	868	((274 developed + 74 undeveloped zones) * 2.7 bedrooms per household)
BOD	lb/d	191	
TSS	lb/d	217	
TKN	lb/d	18	
Phosphorus	lb/d	3.25	

Basis		
Influent		
Flow Peaking Factors		
Max mo: Avg mo		2
Peak hour : Avg annual		4
Per Capita Water Quality Loads		
Per Ten State Standards Para 11.253		
BOD	0.22	lb/capita
TSS	0.25	lb/capita
TKN	0.021	lb/capita
Phosphorus concentration		
NYSDEC Intermediate-sized Facilities		
	2.79	mg/L
*Determined through BASINS analysis		

Projected SPDES Permit Requirements (assumes surface water discharge, based off of old 1999 permit)				
BOD	mg/L	5	Daily Maximimum	
TSS	mg/L	5	Daily Maximimum	
Settleable solids	mg/L	0.1		
Ammonia - Summer	mg/L	1.5	Daily Maximim	Jun 1-Oct 31
Ammonia Winter	mg/L	2.2		Nov 1-May 31
Phophorus	mg/L	0.5	30-day average	
Dissolved oxygen	mg/L	7		

SPDES Permit Basis

Lewisboro Elementary School SPDES Permit

Additional Conditions

3 log removal of Giardia Lamblia cysts
3 log removal of Enteric viruses
Turbidity level fo less than 0.5 NTU in 95% of measurements
Turbidity instantenous maximum of 5.0 NTU
If chlorine is used for disinfection, a minimum of 0.2 mg/L shall be kept in tank for dechlorination (this sytem is UV)

Proposed Membrane Treatment System Design Criteria

Lake Truesdale Service Area

Membrane Process Design Criteria

Water Quality Peaking factors (Peak hour : Average)		**Return stream loads**	
BOD	2	BOD	2%
TKN	2	TKN	20%

Design Influent Loads to Membrane Process

	Area	
	BOD	**TKN**
Average	191	18
Return Stream	3	4
Influent peak hour	382	36
Return + influent peak hour	385	40

WAS generated

per TR-16 para 11.1.2: 1 dry ton of solids per 1 mgd typical. So, ratio is 1 mgd = 2000 lb

Given the stricter discharge limits, assume solids generated increases by 20%

1 mgd : 2,400 lb/d dry solids

So for design average flow rate of

Area 0.140 mgd

The estimated WAS would be:

Area 336 lb/d

Aeration Needs

Amount of oxygen needed for BOD and TKN:	**Area**	
Average Membrane influent BOD load =	191	lb/d
Return +Peak hour Membrane influent BOD load =	385	lb/d
The COD Demand from BOD is	1.1	times BOD load, Ten States para 92.331
COD demand at avg BOD load =	**210**	lb/d
COD demand at peak hour BOD load =	**423**	lb/d

Proposed Membrane Treatment System Design Criteria			
Lake Truesdale Service Area			
		Area	
Average influent TKN load =		18	lb/d
Return +Peak hour influent TKN load =		40	lb/d
The amount of TKN used for cellular synthesis is assumed at		5%	BOD load
	at average BOD =	**1**	lb/d
	at peak hour BOD =	**2**	lb/d
TKN load adjusted for synthesis =	avg	**17**	lb/d
	peak hr	**38**	lb/d
The COD demand from TKN 4.6 lb O2/lb TKN - Ten States para 92.331			
COD demand at avg TKN load =		**80**	lb/d
COD demand at peak hour TKN load =		**175**	lb/d
Influent COD demand:	average	**290**	lb/d
	peak hr	**599**	lb/d
COD leaving in effluent: assumed negligible - conservative assumption			
COD leaving as WAS: (see 7-Solids Handling)			
	sludge produced =	336	lb/d
	% VSS =	70%	Metcalf & Eddy, 2003, Table 14-4
The COD demand from VSS is		1.2	lb O2/lb VSS
COD demand leaving as WAS =		**285**	lb/d
To be conservative - use average WAS value for average conditions			
Oxygen returned to system from denitrification			
Assume this is negligible since denitrification is not optimized			
Actual Oxygen Required (AOR) = COD Demand In - COD demand leaving as WAS			
		Area	
	at average load:	5	lb/d
	at peak hour load:	314	lb/d

Proposed Membrane Treatment System Design Criteria

Lake Truesdale Service Area

SOR (Standard oxygen required)

SOR with Fine Bubble Diffusers

alpha	0.55		Typ fine bubble diffuser. (Sanitaire Design Guide)
beta	0.95		typ. sat'n factor (Metcalf & Eddy, p 429)
DO field	**8.0**	mg/L	working DO concentration, SPDES Permit + 1 mg/L
AOR/SOR =		**0.33**	

AOR/SOR value used is typical for fine bubble diffuser Sanitaire design guide. To be calculated once permit established.

Fine bubble	Area	
Loading	Average	Peak Hr
SOR (in lb O2/d)=	16	952

Phosphorus Loads & Benefit to Lake	Area
Current P load - calculated, this report	1180
Projected P Load - rated capacity	220
P load reduction to lake	974

Appendix B: Ovivo MicroBLOX MBR System Proposal

Ovivo
microBLOX® MBR System

PRELIMINARY PROPOSAL

#072621-1-MCS-R1

LOCATION:

LAKE TRUESDALE

SOUTH SALEM, NY

PREPARED FOR:

CHRISSIE SWAN, PE

ENGINEER 3

RAMBOLL

DATE PREPARED:

08/10/2021

VALID UNTIL:

09/10/2021

PREPARED BY:

Ovivo USA, LLC.

MBR Systems

2300 Greenhill Drive, #100, Round Rock TX 78664

515.834.6000

www.ovivowater.com | www.mbrcentral.com

Worldwide Experts in Water Treatment

SUMMARY

For smaller flows, true Ready-to-Operate systems are available. These systems are **delivered to the site factory assembled with little or no interconnecting piping or ancillary equipment to install**.

Branded as microBLOX®, the facility design and layout of an Ovivo® microBLOX MBR system is intended to provide **low constructed cost, low O&M, process stability, flexible design, simplified piping, operational ease** and requires less automation. The biggest advantage to end-users, however, may ultimately be reduced installation costs. Contractor estimates indicate that single-stage systems may cost as much as 25-50% less to construct due to the Ready-to-Operate design, reduced footprint, reduced concrete and overall process simplicity.

This proposal will demonstrate technology advancements, lessons learned and innovations that are continually assessed and implemented in-order to provide maximum uptime. One size does NOT fit all. Each BLOX® solution should be **unique and tailored to the specific application through the use of modular subsystem blocks**.

Respectfully submitted,

Martin Swanson

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TC Tech LLC
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Enclosure

CONSIDERATIONS

Ovivo's proposal address' the commercial and technical requirements of the planned MBR project. Ovivo and the Owners team will collaborate to execute a technological advanced and sustainable facility.

Years of lessons learned have evolved our microBLOX® MBR systems to provide a safe, smart and operator friendly system. Many items are now standard with each microBLOX® System. For comparison and evaluation, Table 1 below, demonstrates some of the unique items now included as standard.

TABLE 1 – STANDARD EQUIPMENT AND COMPLIANCE STANDARDS

Item	Comment
Tank	
American Iron & Steel Act	Tanks are AIS compliant, with American Steel documentation
Seismic Rating	Designed to Category D
Tank Drain	Provides connection point for tank drain
Access Stairs	Safe stair access to upper porch and tank
Disconnects & Lockouts	Safe equipment service conditions, locking out equipment power
Porch Lights	Lights assist in maintenance during low ambiente light conditions
Convenience Outlets	Convenience outlet for power tools
Grating and Rail System	Safe direct tank & equipment access
Headworks	
Coarse & Fine Screens	Coarse Screen optimizes uptime of fine screen
Rescreen System	Rescreen reduces the risk of hair and fiber build-up
Membrane Zone	
Silicon Carbide Membranes	SiC membranes give a wider operational window and longer life
Lily Pad	Additional safe membrane access platform and lifting tool
Rotating Equipment	
Rotary Lobe Pumps	Common pump model for all service applications and ease of repair
Blower VFDs	Optimizes air and oxygen requirements
Anodized Blowers	Optimizes and extends blower operation
Analytics	
TSS Probe	Measures the level of TSS in the MBs and manages MC and WAS
WaterExpert™	Cloud Based Asset Management Program
Maintenance Clean (MC)	
Automated MC System	Automatically provides a MC based on analytical conditions
Automated Backwash	Automatically provides backwash based on analytical conditions
WAS	
WAS Pumps	Pumps provide sludge removal from membrane tanks
Automated Wasting	Automatically wastes based on analytical conditions

INFLUENT FLOW DATA

Ovivo's design values are summarized in the Table 2 below.

TABLE 2 – INFLUENT FLOW DATA

Parameter	Flow	Min Temp	Event Duration
Phase 1			
Annual Day Flow (AAF)	0.108 MGD[1]	10° C[1]	30 consecutive days up to 12 months/yr
Maximum Day Flow (MMF)	0.140 MGD	10° C	30 consecutive days up to 12 months/yr
N-1 Maximum Day Flow (MMF)	0.210 MGD	10° C	7 consecutive days[3]
Peak Day Flow (PDF)	0.280 MGD	10° C	24 hours non-consecutive
Peak Hour Flow (PHF)	0.315 MGD[1,2]	10° C	4 consecutive hours
Phase 2			
Annual Day Flow (AAF)	0.162 MGD[1]	10° C[1]	30 consecutive days up to 12 months/yr
Maximum Day Flow (MMF)	0.210 MGD	10° C	30 consecutive days up to 12 months/yr
N-1 Maximum Day Flow (MMF)	0.210 MGD	10° C	7 consecutive days[3]
Peak Day Flow (PDF)	0.420 MGD	10° C	24 hours non-consecutive
Peak Hour Flow (PHF)	0.473 MGD[1,2]	10° C	4 consecutive hours

Notes:
1. Values assumed by Ovivo, to be verified by Consulting Engineer.
2. Peak Values assumed to occur during PDF, to be verified by Consulting Engineer.
3. Multiple back to back weeks extended with automated MC between events.

INFLUENT / EFFLUENT CHARACTERISTICS

Influent wastewater flows or loads are summarized in Table 3 below. In the event that the influent exceeds the specifications used in engineering this proposal, or the source of influent changes, the ability of the treatment system to produce the designed treated water quality and/or quantity may be impaired. Ovivo will provide guidance to overcome characteristic variations, however, if the Owner chooses to continue to operate the system, they assume the risk or any additional costs associated with biological upset, increased consumable use or membrane damage.

TABLE 3 – INFLUENT FLOW DATA

Parameter	Influent	Effluent	Remarks
BOD	250 mg/L[1]	< 5 mg/L[1]	
TSS	250 mg/L[1]	< 5 mg/L[1]	
TKN	45 mg/L[1]	--	
NH_3	32 mg/L[1]	< 2.0 mg/L[1]	
TN	45mg/L[1]	--	
TP	8 mg/L[1]	< 0.1 mg/L	
Fecal Coliform	--	< 2.2 CFU[1]	
Alkalinity	300 mg/L[1]	--	
Coarse Suspended Solids (CSS)	< 200 mg/L[3]		Maximum limit in MBR basins
Screen Capture Efficiencies	90%		
Maximum Temperature	25° C		
Elevation	495 ft[1]		

Notes:
1 Values assumed by Ovivo, to be verified by Consulting Engineer.
2 Particles having a specific gravity > 1.6 and unable to pass through a 65-meshc (0.21 mm) screen.
3 May be accomplished with a rescreen if headworks is insufficient.

SYSTEM CONFIGURATION

Each microBLOX® solution is **unique and tailored to the specific application through the use of modular subsystem blocks.** Technology advancements, lessons learned and innovations that are continually assessed and implemented in-order to provide maximum uptime. The following Tables 4, 5 & 6 and Figures 1, 2 & 3 provide specific configuration and specifications for your application.

TABLE 4 – SYSTEM DESIGN

Parameter	Description	≈ Total Volume
System Selection		
Model	XL-I microBLOX® with Supplemental Tanks	--

Phase 1 Configuration Design				
Zone 1	MBR	SiC Membrane	Eight (8) M8	7,536 gallons
Zone 2	MBR	SiC Membrane	Eight (8) M8	7,536 gallons
Supplemental Tank #1	AX | PA1	Mixer | Fine Bubble	Aerostrip	12,976 | 13,848 gallons
Supplemental Tank #2	PA1a & PA1b	Fine Bubble	Aerostrip	27,696 gallons

Parameter	Value	Units	Comment
Phase 1 Process Design			
Total AOR	545	lbs. O2/day	140,000 gpd
AOR Supplied by MBR Scour	261	lbs. O2/day	
AOR Supplied By PA	284	lbs. O2/day	
MBR MLSS	12,500	mg/L	
SRT	22	days	

Phase 2 Configuration Design				
Zone 1	MBR	SiC Membrane	Eight (8) M11	7,536 gallons
Zone 2	MBR	SiC Membrane	Eight (8) M11	7,536 gallons
Supplemental Tank #1	AX 1 | AX 2	Mixer	--	25,952 gallons
Supplemental Tank #2	PA1a & PA1b	Fine Bubble	Aerostrip	28,325 gallons
Supplemental Tank #3	PA2a & PA2b	Fine Bubble	Aerostrip	28,325 gallons

Parameter	Value	Units	Comment
Phase 2 Process Design			
Total AOR	735	lbs. O2/day	210,000 gpd
AOR Supplied by MBR Scour	279	lbs. O2/day	
AOR Supplied By PA	456	lbs. O2/day	
MBR MLSS	12,500	mg/L	
SRT	17	days	

FIGURE 1 PHASE 1

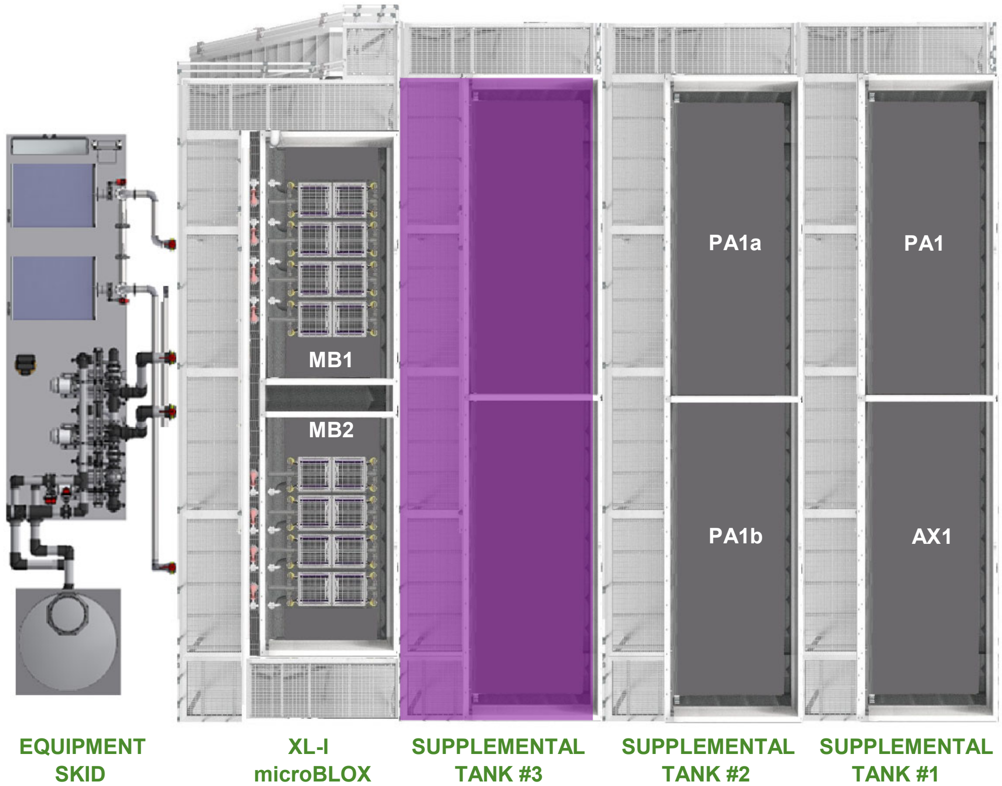


FIGURE 2 PHASE 2

Phase 2 adds Supplemental Tank #3 and a PA blower, converts PA1 to AX2 and adds membrane modules to each membrane stack.

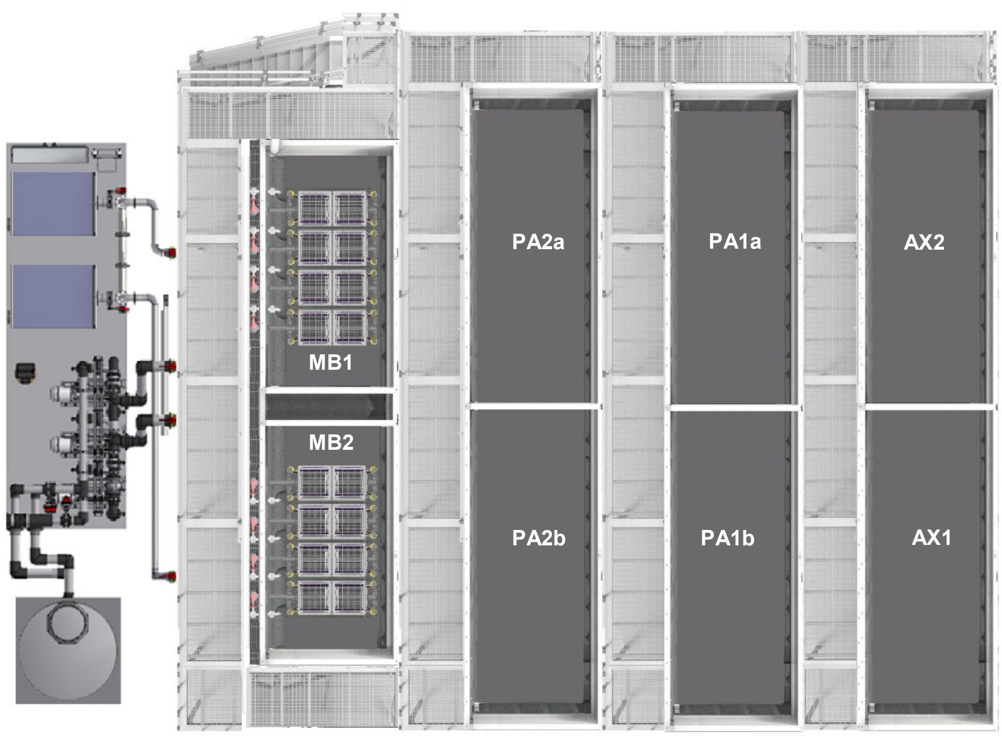


TABLE 5 – SPECIFICATIONS

Parameter	Value	Comment
Site Requirements		
Power	480VAC/3PH/60Hz	
Service Amps	200	
Connectivity	5G Cellular	
Ambient Temp	33°F to 103°F	Climate control required outside of temperatures listed.
Minimum Temp	20°F	w/ Optional Heat Trace
Water Service	40 gpm @ 40 psi	
Elevation	490’	
System Ratings		
Area Classification	NFPA C1D1 & C1D2	Headworks C1D1 | System C1D2 Envelope
Seismic Rating	Category D	SIF:1.5, Occupancy Cat: II,
US Steel	American Iron & Steel Act	Tanks are AIS compliant, with American Steel documentation
Quality Standard	ISO 9001:2015	Applicable to design, manufacturing, supply, installation & servicing of WWTP & WTP, associated equipment & systems.
NSF	NSF/ANSI	Membrane Plate
Panel Electrical	UL	
Maximum Deflection	½”	Max deflection on any single member
Welding	ANSI/AWWA D100-05	All welds are continuous seam welded.
System		
microBLOX® Footprint	35’ l x 8.2’ w x 12’ h	
Sup Tank Footprint	45’l x 8.2’ w x 12’ h	
System Footprint	62.5’ l x 49’ w x 12’	Includes stairs
Ceiling Clearance	9.5’	Minimum clearance
Service Clearance	4’	Distance from system
microBLOX® Weight (Dry)	50,000 lbs.	
microBLOX® Weight (Wet)	192,000 lbs	
Sup Tank Weight (Dry)	32,000 lbs.	
Sup Tank Weight (Wet)	208,000 lbs.	

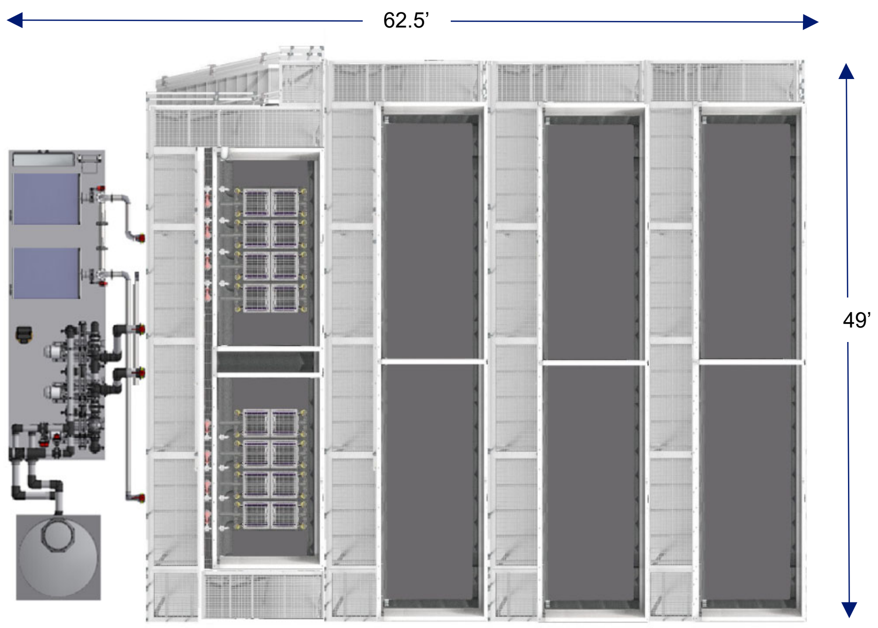


FIGURE 3 – TYPICAL PLAN VIEW

TABLE 6 – BUILD SHEET

XL	V1	H1	D4	D4	AX	PA	B2	T3	P2	U6	S1	MC	W1	FB	--	--

Base	
3Z	Three (3) Zone
4Z	Four (4) Zone
XL	XL

Voltage	
V1	480VAC/3PH/60Hz
V2	208VAC/3PH/60Hz

Headworks	
H1	Dual Fine Screen (Auto + Static)
H2	Single Coarse, Triple Fine Screen

Zone 1	
D1	Single Membrane
D2	Dual Membranes
D3	Triple Membranes
D4	Dual Stack Membranes

Zone 2	
D1	Single Membrane
D2	Dual Membranes
D3	Triple Membranes
D4	Dual Stack Membranes

Supplemental Tank #1	
00	None
PA	Aeration
AX	Anoxic
SW	Swing
WA	Sludge Storage
EQ	Equalization

Supplemental Tank #2	
00	None
PA	Aeration
AX	Anoxic
SW	Swing
WA	Sludge Storage
EQ	Equalization

Supplemental Tank #3	
00	None
EQ	Equalization
WA	Sludge Storage
FB	Aeration
AX	Anoxic
SW	Swing

WAS Pump	
W1	Single WAS Pump

Maintenance Clean	
MC	Fully Automated

Oxygen Delivery	
S0	None
S1	Fine Bubble
S2	O2 + Reactor

UV Disinfection	
U0	None
U1	Single Ultraviolet
U2	Dual Ultraviolet
U3	Triple Ultraviolet
U4	Quad Ultraviolet
U5	Quint Ultraviolet
U6	Six Ultraviolet

Permeate Collection	
P2	Dual Permeate Pumps

Transfer Pumps	
T1	Single Transfer Pump
T2	Dual Transfer Pump
T3	Triple Transfer Pump

Blowers	
B1	Single Blower
B2	Dual Blower
B3	Triple Blower

Analytics		
Yes-1	No-2	Dissolved Oxygen
Yes-1	No-2	Turbidity
Yes-1	No-2	Total Suspended Solids
Yes-1	No-2	WaterExpert™

Chemical Addition System		
Yes-1	No-2	Carbon
Yes-1	No-2	Flux Enhancer
Yes-1	No-2	Phosphorus Reduction
Yes-1	No-2	pH Adjustment

Adders
PA Blowers

Options		
Yes-1	No-2	Cover & Rails
Yes-1	No-2	Grate & Rails
Yes-1	No-2	Heat Tracing
Yes-1	No-2	Porch Lights
Yes-1	No-2	Conv Outlets
Yes-1	No-2	Disconnects
Yes-1	No-2	Stairs

Colors	
G	Grey (standard)
D	Desert
F	Forest
B	Beach

A	1	1	2	2	1	1	1	1	2	1	2	2	1	1	1	G

SYSTEM COST

Ovivo is pleased to offer the Membrane Bioreactor System equipment and services as detailed in this proposal. Unless specifically and expressly included in this proposal, pricing provided is limited to the Services, Goods, quantities, materials, and model numbers as per Ovivo's Scope of Supply. The estimated cost of this proposal constitutes a non-binding estimate for certain goods and/or services and is exclusive of applicable local sales tax or bonds. Any contractual offer shall be conveyed in the form of Ovivo's standard proposal document which includes, but is no limited to, its standard terms and conditions of sale.

TABLE 7 – PRICE TABLE

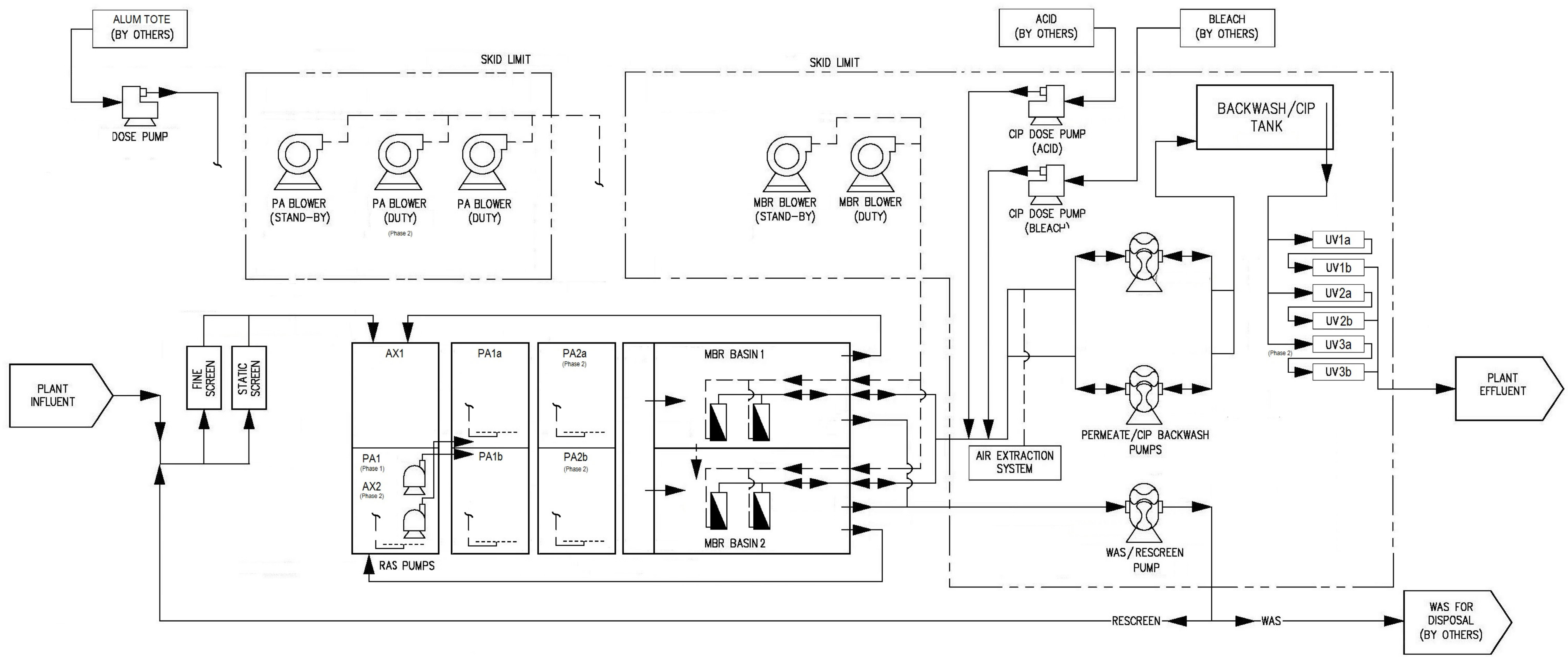
Item	QTY	Price
Price microBLOX® System Phase 1		
Ovivo® MBR System	1	$1,775,000
WaterExpert™	1-yr	Included
Membrane Warranty	12-yr	Included
System Perform Warranty	1-yr	Included
Ancillary Equip Warranty	2-yr	Included
On-site Support	14 days	Included
	microBLOX® Sub Total	$1,775,000
Phase 2 Adders		
System Expansion	1	$615,000
Membrane Modules (M8 to M11)	48	Included
Supplemental Tank w/Diffusers and Walkay	1	Included
Aeration Blower	1	Included
Controls	1	Included
Membrane Warranty	12-yr	Included
System Perform Warranty	1-yr	Included
Ancillary Equip Warranty	2-yr	Included
On-site Support	5 days	Included
	Adder Sub Total	$615,000[1]
Miscellaneous		
Shipping	1	Included
Tax	TBD[1]	$TBD[1]
	Miscellaneous Sub Total	$TBD[1]

[1] To Be Determined and Added

ENCLOSURES

The following enclosed documents are provided to further support Ovivo's supply of goods and services.

- PFD
- MBR Brochure
- SiC Brochure
- WaterExpert™ Brochure



INITIAL RELEASE				
REVISION	EN	BY	CHECK'D	DATE

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OVIVO
Worldwide Experts in Water Treatment

microBLOX XL I

PFD

DATE	02/18/2021	BY	MKS	CHECK'D	
DWG SCALE	NONE				
JOB NUMBER					
SHEET	1	OF	1		

microBLOX® MBR SYSTEMS

True ready-to-operate MBR Systems are available. These systems are delivered to the site and factory assembled with little or no interconnecting piping or ancillary equipment to install.

Branded as microBLOX, the facility design and layout is intended to provide low construction costs, low O&M, process stability, flexible design and operational ease. Contractor estimates indicate that systems may cost as much as 25-50% less due to the ready-to-operate design, reduced footprint, reduced concrete, reduced building, and overall simplicity.

However, one size does not fit all. For every project, we begin the design process by understanding client needs and identifying scope before ultimately tailoring a solution specific to the application through the use of modular building blox.

microBLOX® MBR SYSTEMS

3Z microBLOX®

< 75,000 GPD

4Z microBLOX®

15,000 GPD to 150,000 GPD

XL microBLOX®

150,000 GPD to 500,000 GPD

STANDARD FEATURES

- **SiC Ceramic Membranes**
- **6mm Coarse & 2mm Fine Screen**
- **Automated Re-screen**
- **Automated WAS**
- **Automated Maintenance Clean**
- **Access Stairs**
- **Grating or Sealed Covers with Access Points**
- **Walkway and Rails**
- **VFDs for Blowers and Pumps**
- **Portable Crane & Davits**
- **Disconnects and Lockouts**
- **Convience Outlets**
- **TSS, Turbity and DO Instrumentation**
- **Porch Lights**
- **Optional UV System**
- **Multiple Paint Colors**

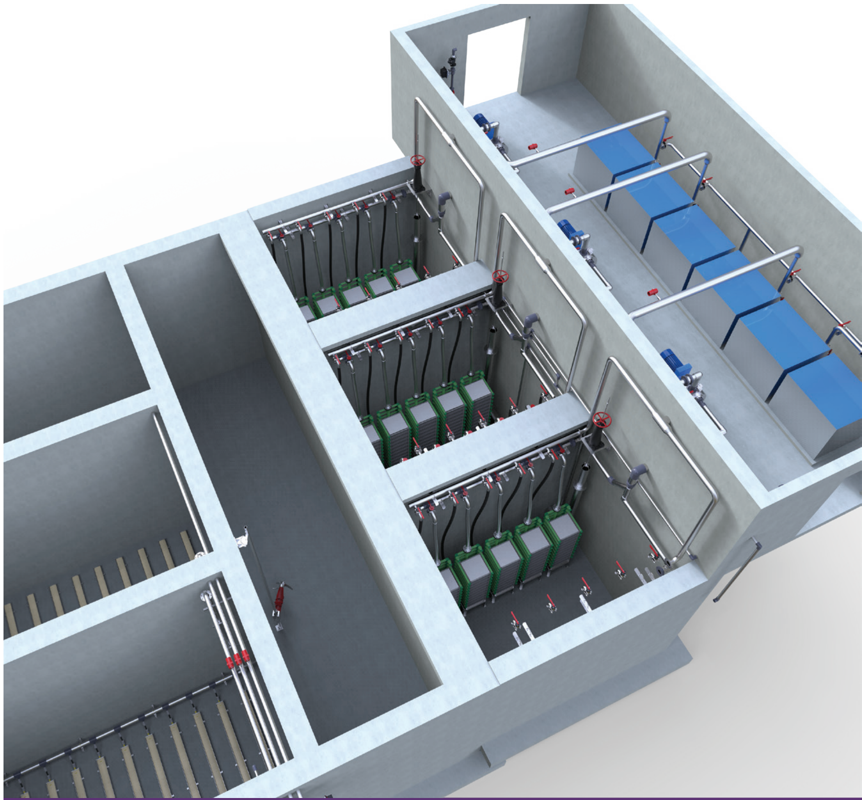
COMPLIANCE

- **American Iron and Steel Act**
- **Siesmic Rated to Category D**
- **NFPA 820**
- **UL Panel**

INTEGRATED MBR SYSTEMS

Since 2001, Ovivo MBR has played a pivotal role in establishing and innovating submerged MBR technology in North America. Continuing on our technology and market advancement, Ovivo MBR is 100% dedicated to integrating Silicon Carbide (SiC) membrane technology into our MBR Systems.

The heart of the system is Ovivo's Ceramic Membrane Technology, comprised of hydrophilic Silicon Carbide UF/MF (0.1μ) flat plate membranes which provides unmatched flux rate while also repelling negatively charged particles. The chemically inert membrane can operate in extreme environments such as a pH range from 1-14 and high sludge concentrations of 4% organic waste. The plates have a high resistance to chemicals, oxidants, and even ozone. The hydrophilic nature of the membranes allows the membrane basins to be shut down and drained without the addition of preservatives.



100% INTEGRATION WITH SILICON CARBIDE MEMBRANES

Life Cycle Commitment

Solid Design Practices
Early collaboration offers a solid, risk free, customized design

Seamless Project Execution
On time, on budget are key to the bottom line

Technical Serivces Obligation
When all others have moved on, Ovivo's services endure

THE **SiC** DIFFERENCE

WIDE OPERATIONAL WINDOWS • EXTENDED MEMBRANE LIFE

OPERATING LIMITS/CAPABILITIES

Operating Parameter	Units	Silicon Carbide
TSS	mg/l	< 45, 000
Oil & Grease	mg/l	< 500
Free Oil	mg/l	< 500
pH	-	1 - 14
Temperature	°C	1 - 80
Backwash Pressure	psi	< 30
Chlorine Tolerance	ppm hours	5,000,000

MEMBRANE TECHNOLOGY CONVERSION

SiC REPLACES POLYMERIC

PE

PES

HOLLOW-FIBER

FLAT PLATE

PAN

FLAT SHEET

PS

HOLLOW-SHEET

FIBER-PLATE

PTFE

PVDF

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ALL OF YOUR MANUALS,
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ALL IN ONE PLACE.

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Create and manage service logs and maintenance schedules.

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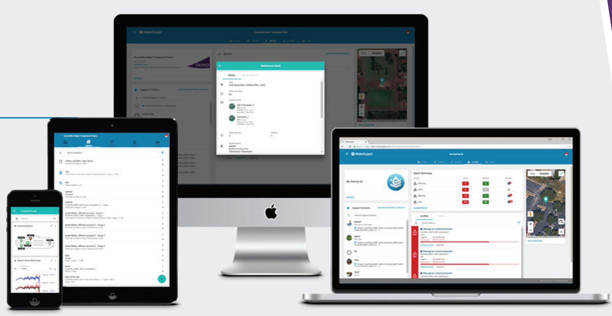

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Ovivo® Silicon Carbide Membrane Technology

Worldwide Experts in Water Treatment

ALL THE WATER WE HAVE
IS ALL THE WATER WE WILL HAVE.

It is our responsibility to treat, recover, and reuse it wisely.

Ovivo's mission is to provide sustainable and efficient water treatment solutions to our customers through expertise and innovation.

LIMITLESS POSSIBILITIES

CHANGING THE LANDSCAPE OF MEMBRANE SYSTEMS

Silicon Carbide (SiC) represents a dramatic shift in membrane technology. With a unique, set of material properties, SiC changes the perception of what a membrane is capable of doing.

SiC naturally draws water in while polymeric membranes have the tendency to repel water. Such a high affinity for water allows SiC to repel the most aggressive substances and materials, resulting in the highest sustainable flux rates.

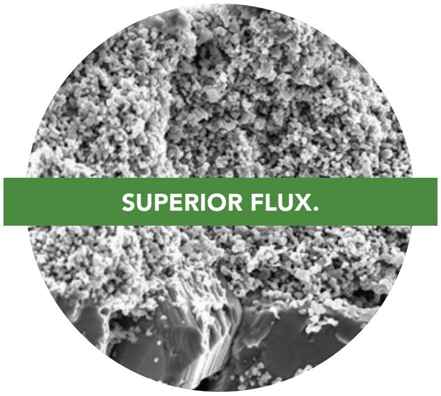
SiC membranes allow water and wastewater treatment plants to achieve levels of performance previously thought impossible.

UNIQUE PROPERTIES

All of SiC's key properties work together to provide a technology that is 100% recoverable.

HYDROPHILIC

Natural and permanent hydrophilic properties ensure less chemical cleaning and indefinite dry storage.

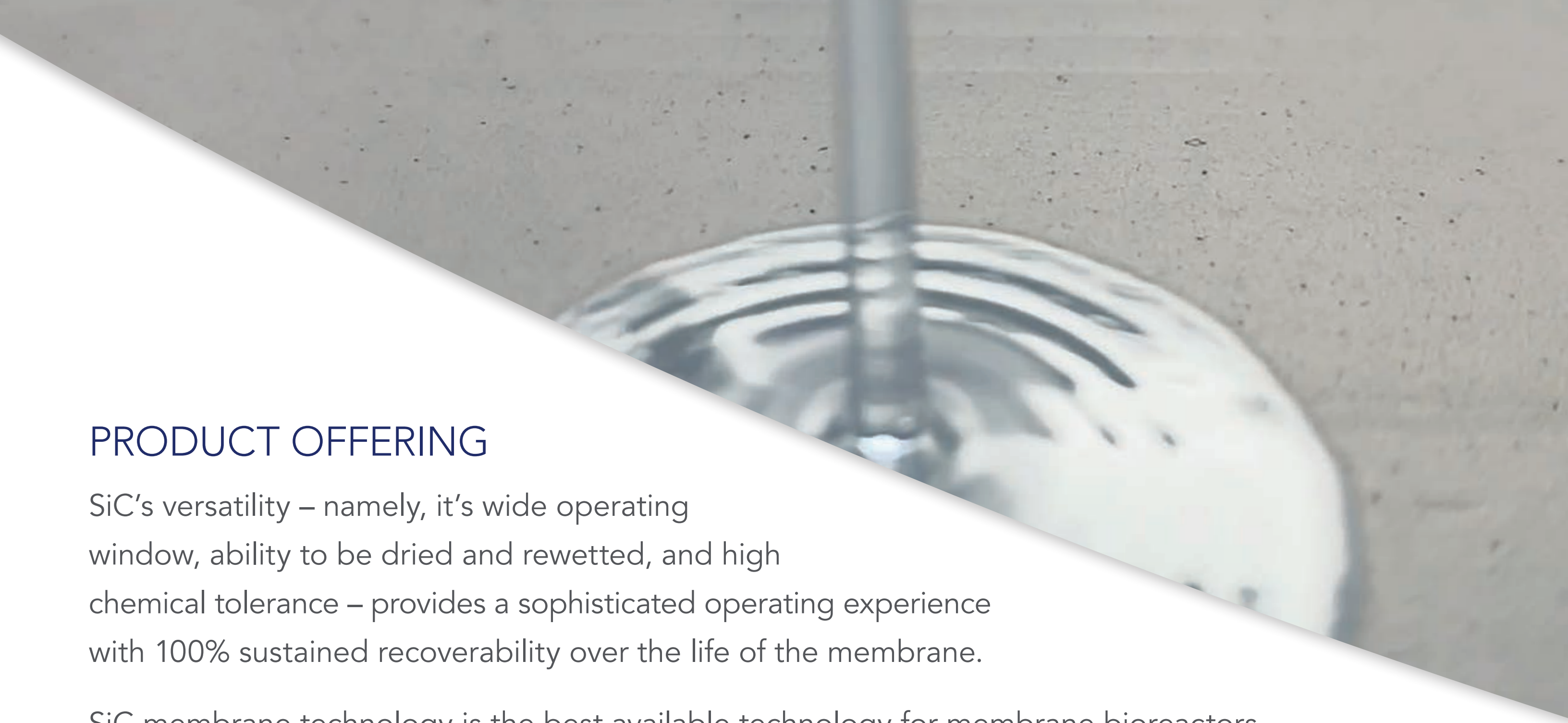


POROSITY

Operate at higher sustainable flux rates and solids concentration compared to other membrane formats.

MATERIAL STRENGTH

Both extremely hard and chemically inert material, SiC allows for aggressive cleaning methods.



PRODUCT OFFERING

SiC's versatility – namely, it's wide operating window, ability to be dried and rewetted, and high chemical tolerance – provides a sophisticated operating experience with 100% sustained recoverability over the life of the membrane.

SiC membrane technology is the best available technology for membrane bioreactors (MBR), sludge thickening applications, wet weather treatment, and tertiary treatment systems.

	MBR	WET WEATHER TREATMENT	TERTIARY TREATMENT	SLUDGE THICKENING
PACKAGED PLANT OFFERING	●	●	●	●
CONVENTIONAL PLANT UPGRADES	●	●	●	●
REUSE QUALITY EFFLUENT	●	●	●	●
CSO/SSO TREATMENT		●		
HIGH MLSS	●			●
NITROGEN REMOVAL	●			●
REDUCED SLUDGE HAULING AND SOLIDS DISPOSAL	●			●
TSS & TURBIDITY REMOVAL	●	●	●	●
PATHOGEN REMOVAL	●	●	●	●
ULTRA-LOW PHOSPHORUS REMOVAL	●		●	
SMALL FOOTPRINT	●	●	●	●
REMOTE MONITORING CAPABILITIES	●	●	●	●

MBR SYSTEMS

Revolutionizing MBR systems with unmatched performance, easier operation, and reuse quality effluent.

PRODUCTS

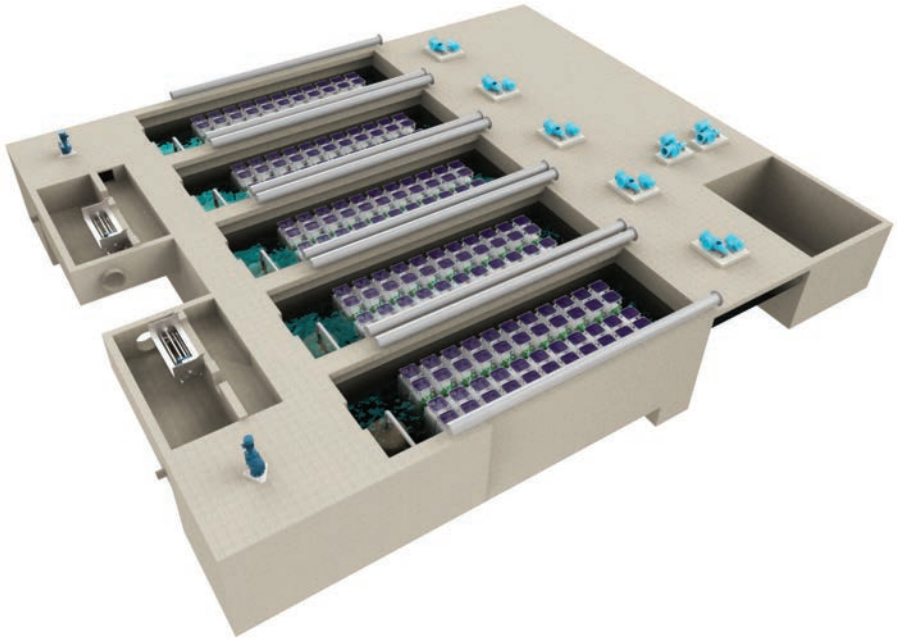
- Ovivo® MBR System
- microBLOX® Package Plant

ADVANTAGES

- Wide operational window allows systems to perform well under a broad range of harsh conditions.
- Extended membrane life: Durable, resistance to fatigue and chemicals, which sets up a long sustainable lifespan

WET WEATHER TREATMENT

Prevent pollutants being discharge into sensitive waterways with rapid treatment of CSO and SSO flows.



PRODUCTS

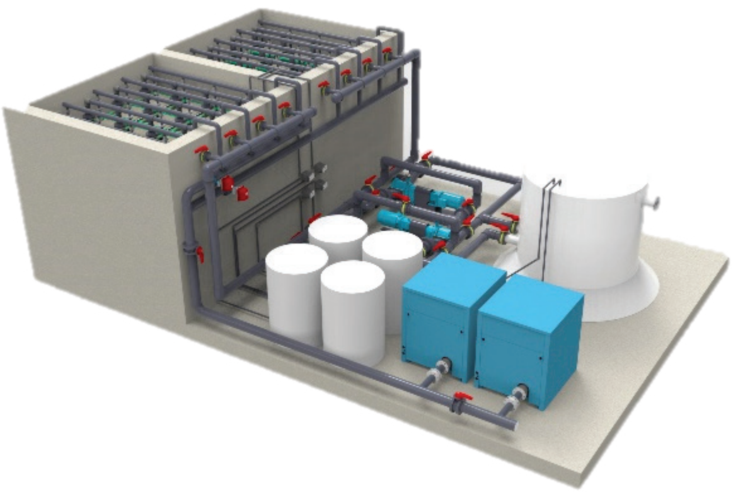
- Ovivo® RapidStorm™ Treatment
- stormBLOX™ Package Plant

ADVANTAGES

- Rapid treatment with instant high quality effluent
- Ground-breaking disinfection advantages with 6 Log fecal coliform removal
- Ideal for tight footprints

TERTIARY MEMBRANE FILTRATION

Advanced treatment to meet tight permit limits and for water reuse applications with completely new disinfection capabilities.



PRODUCTS

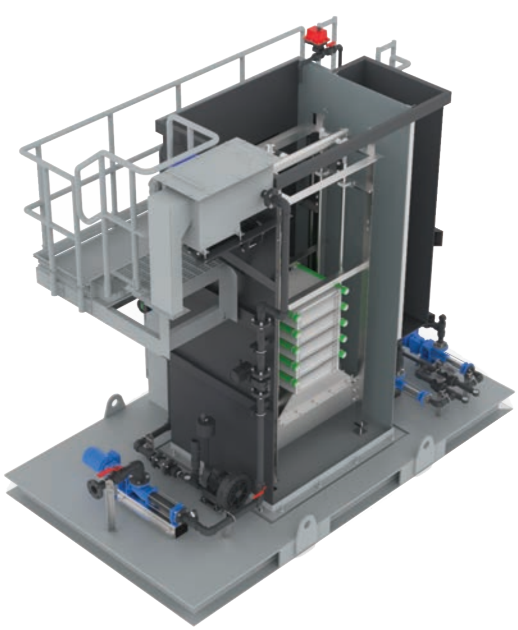
- Ovivo® Tertiary Treatment System
- ultraBLOX™ Package Plant

ADVANTAGES

- Ultra-low phosphorus removal
- Reuse
- Retrofit existing chlorine contact chambers

SLUDGE THICKENING SYSTEMS

Reduce hauling costs and polymer usage in a smaller footprint.



PRODUCT

- solidBLOX™ Package Plant

ADVANTAGES

- Easy to install & quick start-up
- Can thicken WAS up to 3% solids without polymers
- Reliable performance & reduced O & M

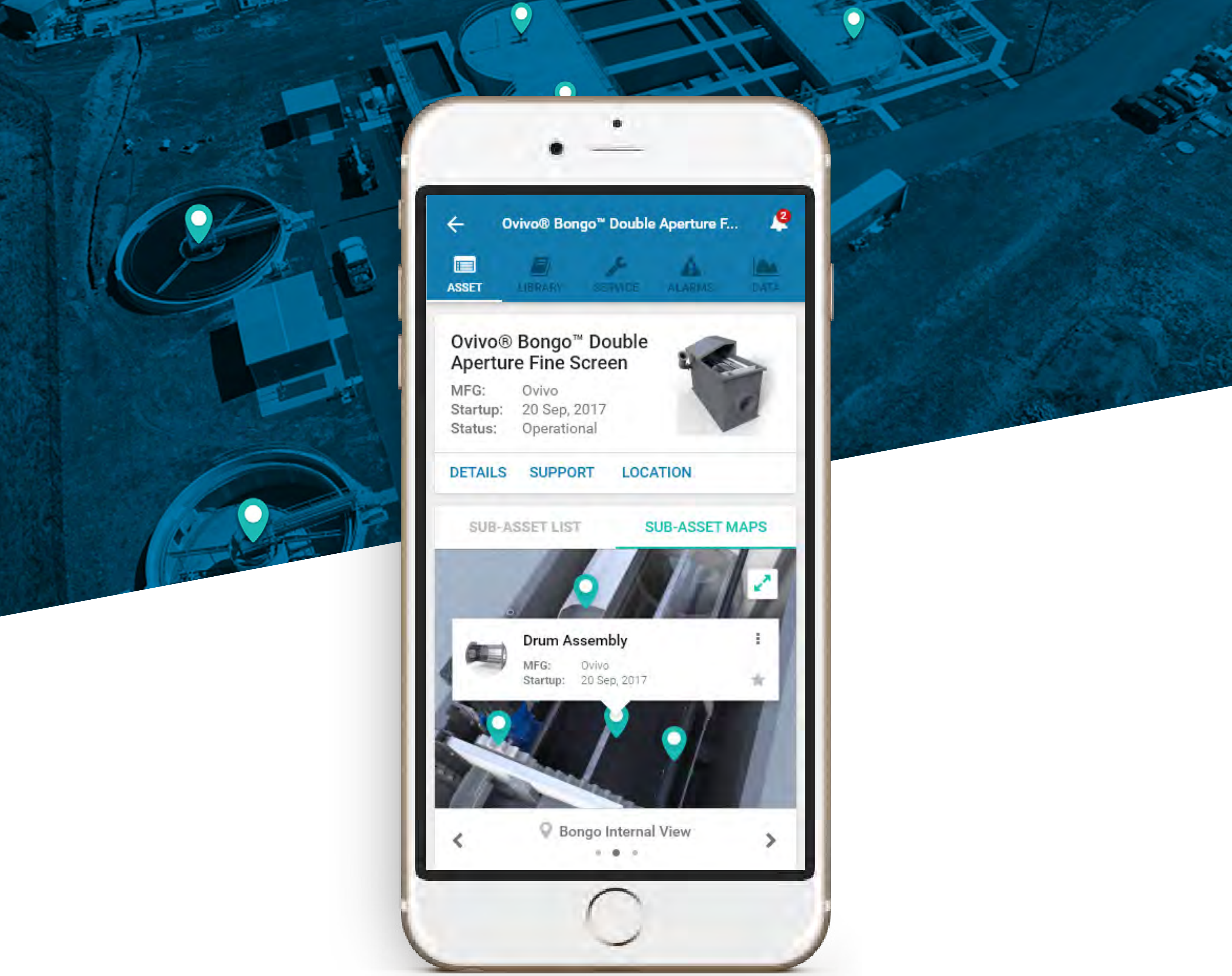
WHEREVER OVIVO TOUCHES WATER, WE SEEK TO ADD VALUE.

Ovivo was born from the need for clean water. We believe in challenging our people to learn, to grow, so we can provide the best experience for those seeking clean water. It's our stability combined with our fierce energy to do good that keeps us looking ahead. We want to do good work, with good people, and have fun while we're doing it.

To learn more about Silicon Carbide technology, visit us at ovivowater.com/sic

ovivowater.com

Your All-in-One Solution for Digitizing Your Plant



WaterExpert™

WHAT WE OFFER

WaterExpert™ is an all-in-one solution for digitizing your plant. Combining asset management, maintenance management, alarm management and real-time data monitoring into one easy to use platform. Login to your account from your own device and keep your whole team connected in the office and in the field.

Asset Management

Track the valuable information and predict life-cycles of your important plant assets. Prolong the life of your aging assets and plan for future capital expenses. Map out your plant and remote sites.

Knowledge Capture & Library

Digitize your O&M manuals and SOP documentation. Use your existing smartphone or tablet to record processes, then upload to the app for all users to access across all devices. Videos are linked to specific equipment, so the right video is always with the right equipment.

Maintenance Management

Automate tasks required for managing and reporting maintenance and work orders.
Give your technicians convenient and timely access to the appropriate O&M info and/or videos.
Implement an effective preventive maintenance program to extend the life of your equipment.

NEW Operator Rounds

Create operator rounds forms, then assign them to your team. Users can check off tasks, enter readings directly in the app, attach photos, trend recorded readings in charts and more. Multiple people can collaborate on rounds sheets and logs are created automatically upon completion.

Alarm Management

Get immediate notifications of problems and quickly make informed decisions based on your knowledge library. Set custom alarm notifications with detailed resolution instructions.
Start building compliance for alarm industry standards such as ANSI / ISA 18.2

Data Monitoring

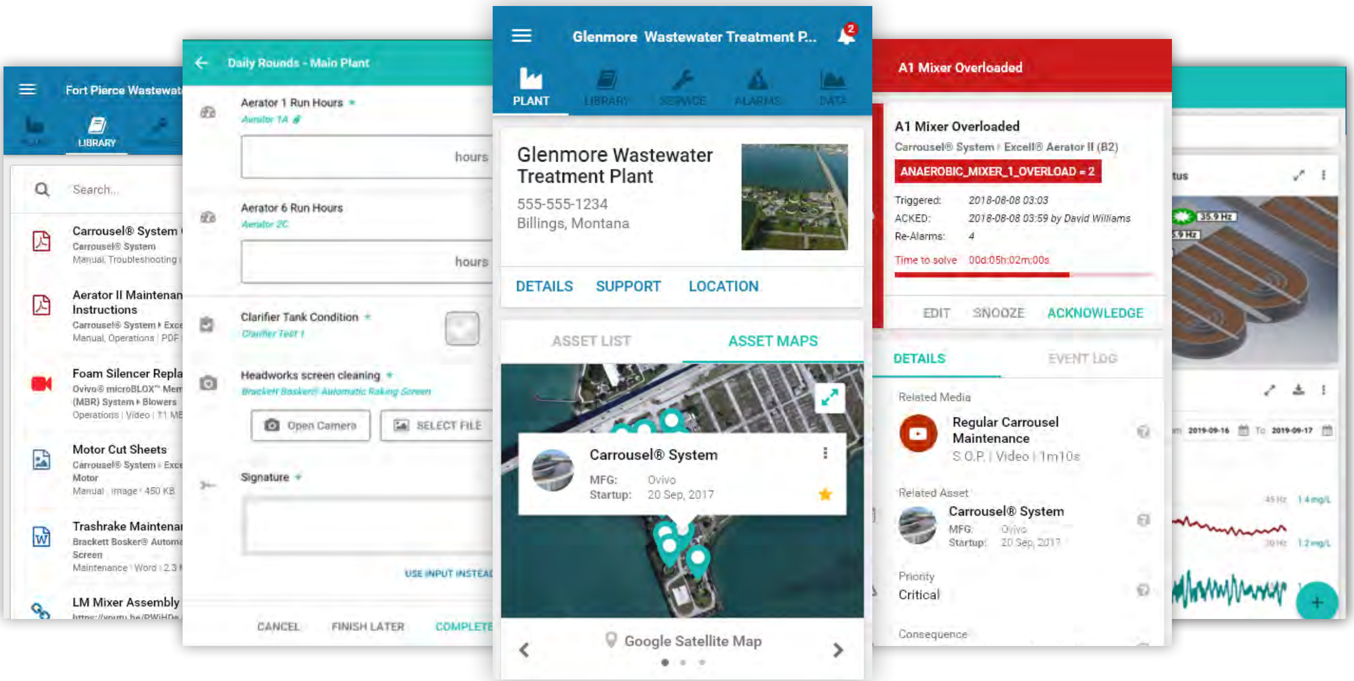
Know what is happening in real-time. Simply create customized HMI widgets to provide live machine monitoring or water quality monitoring for any part of your plant. See historical trend charts to analyze performance or build reports.

Archive and secure your team's knowledge, forever.

Simply record procedures with your phone and link them to your equipment.

USER-FRIENDLY DESIGN

Built by water experts, for water experts. This software is designed to be fast and accessible for everyone on your team. Whether you are in the office or in the field, on a desktop, laptop, tablet or smartphone, you have complete visibility over your entire plant and operations.



YOUR PLANT'S SECURITY IS OUR PRIORITY

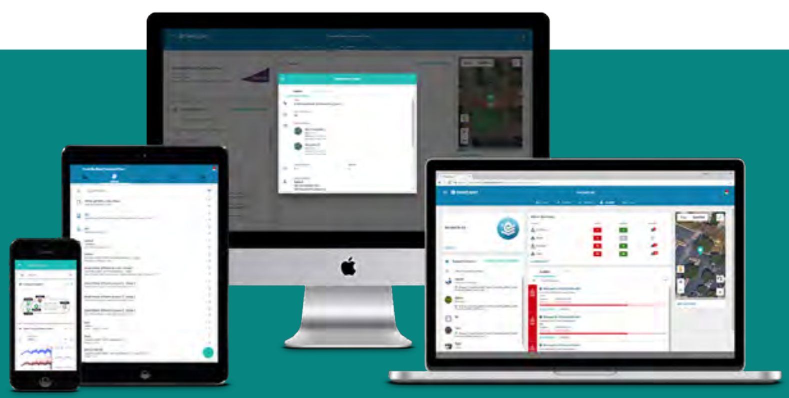
Our industrial hardware platform tools are ISO27001 Certified and ISECOM STAR Certified. ISO27001, an internationally recognized security standard, and STAR (Security Test Audit Report) ensure a high security level. Our hardware employs industrial strength security for it's cloud connectivity platform.

Access your account from anywhere, on any device.

WaterExpert is a single integrated system optimized for desktop, Apple & Android.

Download on the App Store

GET IT ON Google Play



Book your demo and discover how you can quickly digitize your plant operations

The WaterExpert™ digital solution can be as simple or robust as you need it to be. Select the features your plant needs and avoid unnecessary confusion or excessive costly integration. WaterExpert combines multiple digital solutions into one easy-to-use package.

See it in action at
www.waterexpert.com

- Asset Management
- Knowledge Capture & Library
- Maintenance Management
- Alarm Management
- Data Monitoring

Call **1-801-931-3135**
or visit **waterexpert.com**
to schedule a demo

Learn how WaterExpert can help you:

- Implement a preventative maintenance program
- Monitor plant performance remotely
- Reduce knowledge loss & improve knowledge transfer
- Minimze repetitive paperwork/busywork
- Improve communication accross your team

Appendix C: BASINS Nutrient Loading Rates

Sewer - Zone 1

1. Assume 2 failures per year per zone

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	19,374.40	393.8	30.2
Loading Rates (lb/ac)	191.7	3.9	0.3
Mean Annual Concentration (mg/L)	35.92	0.73	0.06
Mean Low-Flow Concentration (mg/L)	52.96	1.29	0.18

Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0	0	0
Cropland	0	0	0
Wooded Areas	646.3	17.2	1.5
Wetlands	0	0	0
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	130.3	2.8	0.3
Medium-Density Mixed	63.5	1.1	0.1
High-Density Mixed	0	0	0
Low-Density Open Space	1,170.00	24.7	2.7
Farm Animals	0	9.9	2.5
Stream Bank Erosion	18,534.30	33.1	6.6
Subsurface Flow	0	305.2	8
Point Sources	0	0	0
Septic Systems	0	24.6	11.1
			32.8

Lake Truesdale - Tech Memo - A | Lake Truesdale - BASINS GWLF-E | Model My Watershed

https://modelmywatershed.org/project/36492/scenario/66188

ADP | Rydoo - Expense | Workday | SharePoint | Resilient NJ Region... | AWS Technical DD | Future Flow Explore... | StreamStats | FEMA FIRMs | NYS GIS Clearingho...

Model My Watershed

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Sewer (Zone 1) - Waters... | Details | Analyze | Monitor | **Model** | Share | New Project

Scenario #1: 2 Failures | + New scenario | Export GMS | Compare | Weather Data | Land Cover | Conservation Practice | Settings

Hydrology | **Water Quality**

Average annual loads from 30-years of daily fluxes

Related Layer: Weather Stations used in this model. ✔ Turn on

Weather Source: USEPA National Climate Data

Simulated by the GWLF-E (MapShed) model

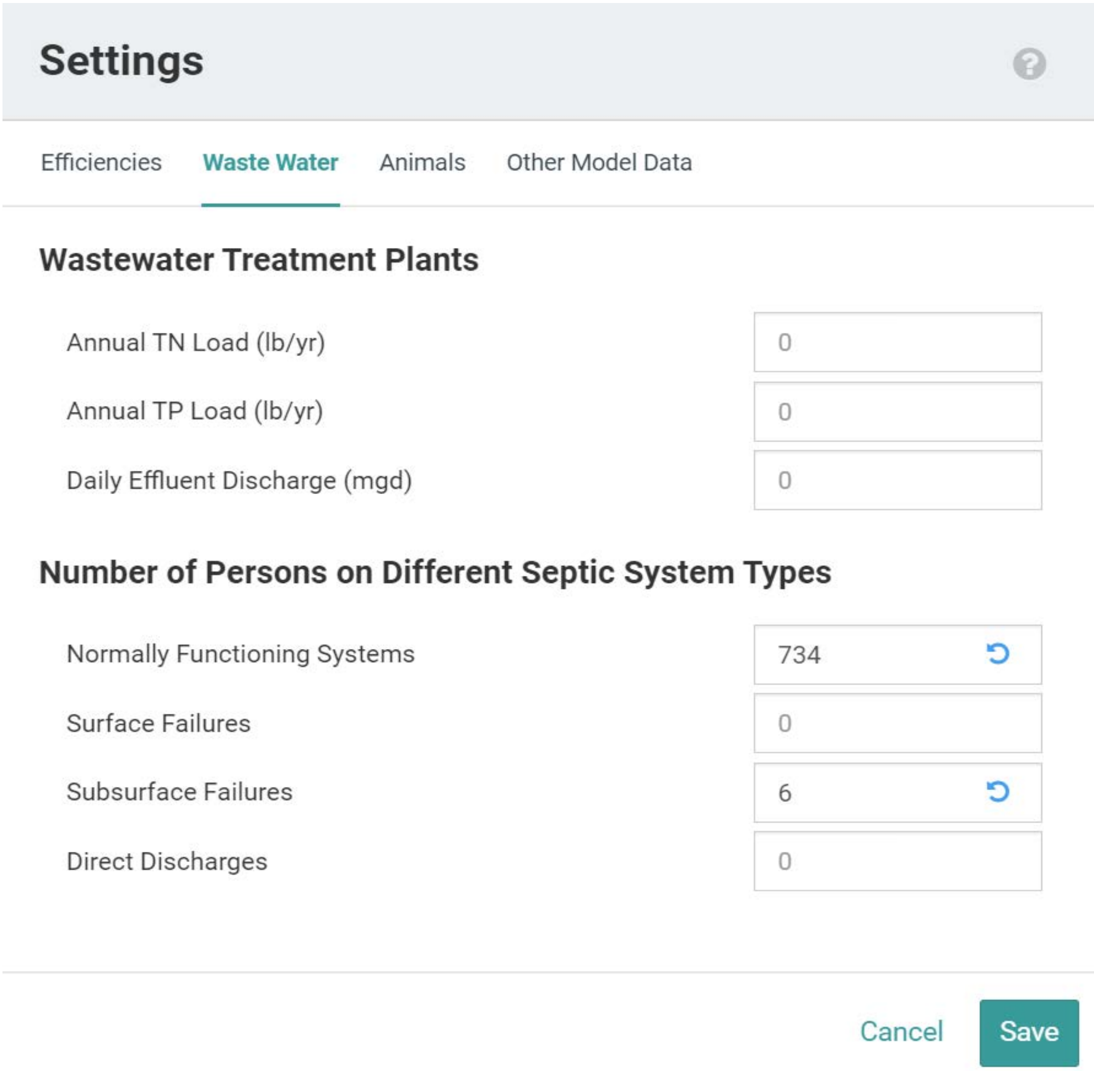
Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	19,374.4	393.8	30.2
Loading Rates (lb/ac)	191.70	3.90	0.30
Mean Annual Concentration (mg/L)	35.92	0.73	0.06
Mean Low-Flow Concentration (mg/L)	52.96	1.29	0.18

Mean Flow: 8,638,934 (ft^3/year) and 0.27 (ft^3/s)

Download this data

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0.0	0.0	0.0
Cropland	0.0	0.0	0.0
Wooded Areas	646.3	17.2	1.5
Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	130.3	2.8	0.3
Medium-Density Mixed	63.5	1.1	0.1
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	1,170.0	24.7	2.7
Farm Animals	0.0	9.9	2.5
Stream Bank Erosion	18,534.3	33.1	6.6
Subsurface Flow	0.0	305.2	8.0
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	24.6	11.1

Download this data


Settings
Efficiencies
Waste Water
Animals
Other Model Data
Wastewater Treatment Plants
Annual TN Load (lb/yr)
0
Annual TP Load (lb/yr)
0
Daily Effluent Discharge (mgd)
0
Number of Persons on Different Septic System Types
Normally Functioning Systems
734
Surface Failures
0
Subsurface Failures
6
Direct Discharges
0
Cancel
Save

Sewer - Zone 1

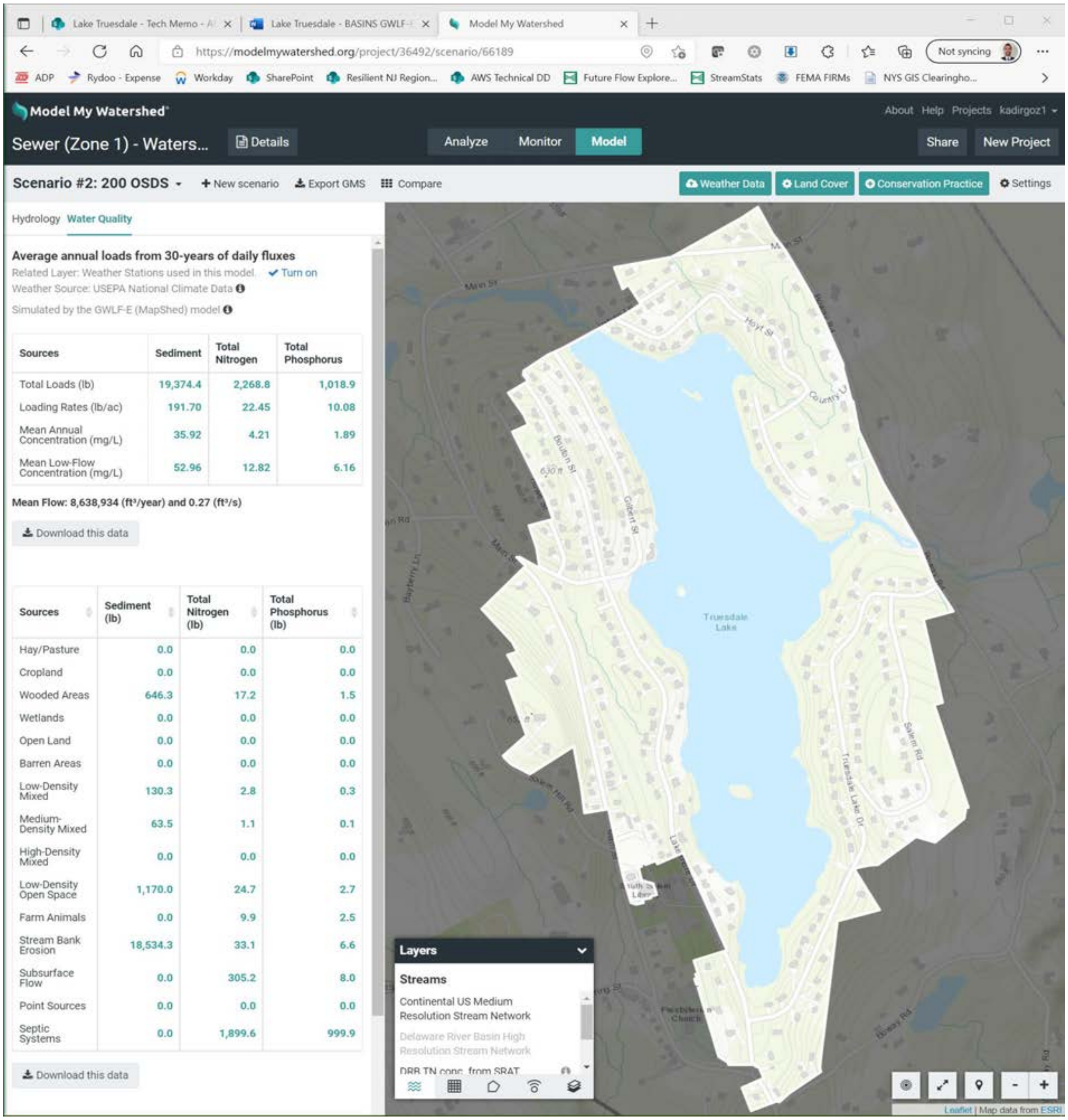
2. Assume that all septic systems within 200' of lake shore in shallow water tables are failing (approximately 200 OSDSs)

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	19,374.40	2,268.80	1,018.90
Loading Rates (lb/ac)	191.7	22.45	10.08
Mean Annual Concentration (mg/L)	35.92	4.21	1.89
Mean Low-Flow Concentration (mg/L)	52.96	12.82	6.16

Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0	0	0
Cropland	0	0	0
Wooded Areas	646.3	17.2	1.5
Wetlands	0	0	0
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	130.3	2.8	0.3
Medium-Density Mixed	63.5	1.1	0.1
High-Density Mixed	0	0	0
Low-Density Open Space	1,170.00	24.7	2.7
Farm Animals	0	9.9	2.5
Stream Bank Erosion	18,534.30	33.1	6.6
Subsurface Flow	0	305.2	8
Point Sources	0	0	0
Septic Systems	0	1,899.60	999.9
			1021.6



Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	19,374.4	2,268.8	1,018.9
Loading Rates (lb/ac)	191.70	22.45	10.08
Mean Annual Concentration (mg/L)	35.92	4.21	1.89
Mean Low-Flow Concentration (mg/L)	52.96	12.82	6.16

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0.0	0.0	0.0
Cropland	0.0	0.0	0.0
Wooded Areas	646.3	17.2	1.5
Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	130.3	2.8	0.3
Medium-Density Mixed	63.5	1.1	0.1
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	1,170.0	24.7	2.7
Farm Animals	0.0	9.9	2.5
Stream Bank Erosion	18,534.3	33.1	6.6
Subsurface Flow	0.0	305.2	8.0
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	1,899.6	999.9

Settings

Efficiencies | **Waste Water** | Animals | Other Model Data

Wastewater Treatment Plants

Annual TN Load (lb/yr)	0
Annual TP Load (lb/yr)	0
Daily Effluent Discharge (mgd)	0

Number of Persons on Different Septic System Types

Normally Functioning Systems	194
Surface Failures	0
Subsurface Failures	540
Direct Discharges	0

Cancel | Save

Sewer - Zone 1

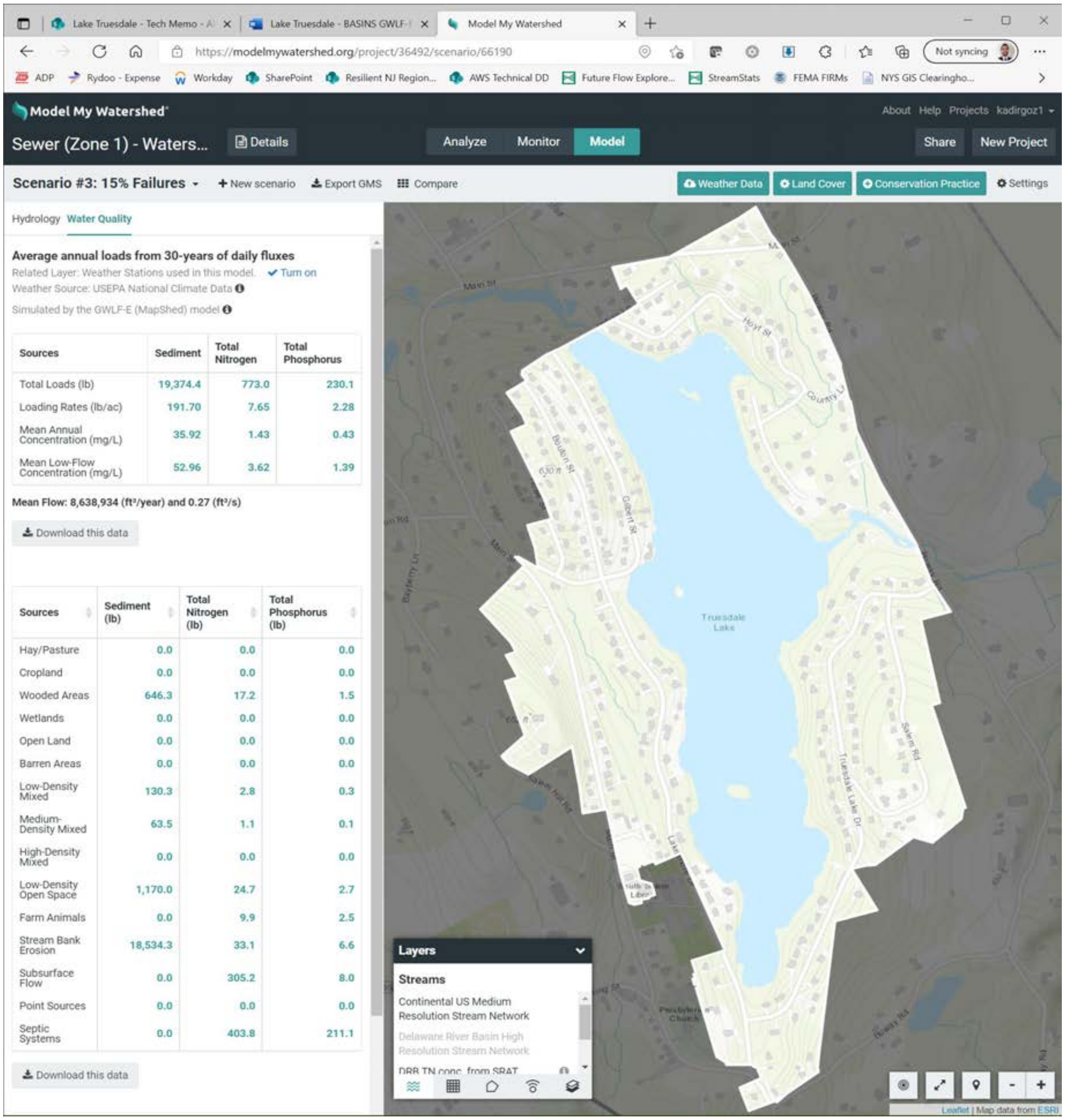
3. Assume at 15% failure in both zones

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	19,374.40	773	230.1
Loading Rates (lb/ac)	191.7	7.65	2.28
Mean Annual Concentration (mg/L)	35.92	1.43	0.43
Mean Low-Flow Concentration (mg/L)	52.96	3.62	1.39

Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0	0	0
Cropland	0	0	0
Wooded Areas	646.3	17.2	1.5
Wetlands	0	0	0
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	130.3	2.8	0.3
Medium-Density Mixed	63.5	1.1	0.1
High-Density Mixed	0	0	0
Low-Density Open Space	1,170.00	24.7	2.7
Farm Animals	0	9.9	2.5
Stream Bank Erosion	18,534.30	33.1	6.6
Subsurface Flow	0	305.2	8
Point Sources	0	0	0
Septic Systems	0	403.8	211.1



Model My Watershed

Sewer (Zone 1) - Waters...

Scenario #3: 15% Failures

Hydrology Water Quality

Average annual loads from 30-years of daily fluxes

Related Layer: Weather Stations used in this model. Turn on

Weather Source: USEPA National Climate Data

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	19,374.4	773.0	230.1
Loading Rates (lb/ac)	191.70	7.65	2.28
Mean Annual Concentration (mg/L)	35.92	1.43	0.43
Mean Low-Flow Concentration (mg/L)	52.96	3.62	1.39

Mean Flow: 8,638,934 (ft³/year) and 0.27 (ft³/s)

Download this data

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0.0	0.0	0.0
Cropland	0.0	0.0	0.0
Wooded Areas	646.3	17.2	1.5
Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	130.3	2.8	0.3
Medium-Density Mixed	63.5	1.1	0.1
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	1,170.0	24.7	2.7
Farm Animals	0.0	9.9	2.5
Stream Bank Erosion	18,534.3	33.1	6.6
Subsurface Flow	0.0	305.2	8.0
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	403.8	211.1

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Settings

Efficiencies | **Waste Water** | Animals | Other Model Data

Wastewater Treatment Plants

Annual TN Load (lb/yr)	0
Annual TP Load (lb/yr)	0
Daily Effluent Discharge (mgd)	0

Number of Persons on Different Septic System Types

Normally Functioning Systems	626
Surface Failures	0
Subsurface Failures	114
Direct Discharges	0

Cancel Save

Sewer - Zone 1

4. Assume no failures (all systems working)

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	19,374.40	372.7	19
Loading Rates (lb/ac)	191.7	3.69	0.19
Mean Annual Concentration (mg/L)	35.92	0.69	0.04
Mean Low-Flow Concentration (mg/L)	52.96	1.16	0.12

Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0	0	0
Cropland	0	0	0
Wooded Areas	646.3	17.2	1.5
Wetlands	0	0	0
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	130.3	2.8	0.3
Medium-Density Mixed	63.5	1.1	0.1
High-Density Mixed	0	0	0
Low-Density Open Space	1,170.00	24.7	2.7
Farm Animals	0	9.9	2.5
Stream Bank Erosion	18,534.30	33.1	6.6
Subsurface Flow	0	305.2	8
Point Sources	0	0	0
Septic Systems	0	3.5	0

Model My Watershed

Sewer (Zone 1) - Waters... Details | Analyze | Monitor | Model | Share | New Project

Current Conditions + New scenario | Export GMS | Compare

Hydrology | Water Quality

Average annual loads from 30-years of daily fluxes

Related Layer: Weather Stations used in this model. ✔ Turn on

Weather Source: USEPA National Climate Data

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	19,374.4	372.7	19.0
Loading Rates (lb/ac)	191.70	3.69	0.19
Mean Annual Concentration (mg/L)	35.92	0.69	0.04
Mean Low-Flow Concentration (mg/L)	52.96	1.16	0.12

Mean Flow: 8,638,934 (ft³/year) and 0.27 (ft³/s)

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Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0.0	0.0	0.0
Cropland	0.0	0.0	0.0
Wooded Areas	646.3	17.2	1.5
Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	130.3	2.8	0.3
Medium-Density Mixed	63.5	1.1	0.1
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	1,170.0	24.7	2.7
Farm Animals	0.0	9.9	2.5
Stream Bank Erosion	18,534.3	33.1	6.6
Subsurface Flow	0.0	305.2	8.0
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	3.5	0.0

Download this data

Septic - Zone 2

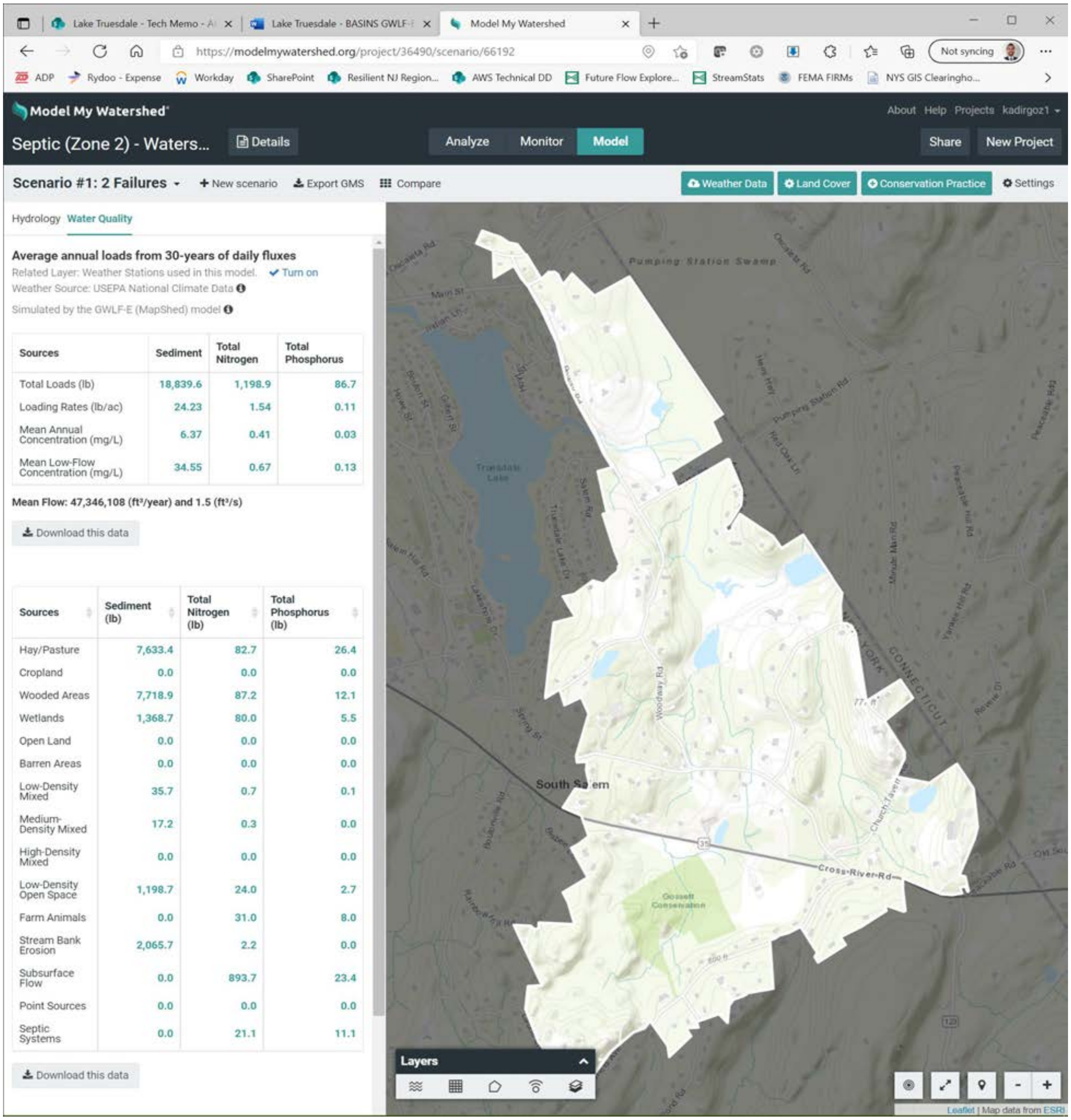
1. Assume 2 failures per year per zone

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	18,839.60	1,198.90	86.7
Loading Rates (lb/ac)	24.23	1.54	0.11
Mean Annual Concentration (mg/L)	6.37	0.41	0.03
Mean Low-Flow Concentration (mg/L)	34.55	0.67	0.13

Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.40	82.7	26.4
Cropland	0	0	0
Wooded Areas	7,718.90	87.2	12.1
Wetlands	1,368.70	80	5.5
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	35.7	0.7	0.1
Medium-Density Mixed	17.2	0.3	0
High-Density Mixed	0	0	0
Low-Density Open Space	1,198.70	24	2.7
Farm Animals	0	31	8
Stream Bank Erosion	2,065.70	2.2	0
Subsurface Flow	0	893.7	23.4
Point Sources	0	0	0
Septic Systems	0	21.1	11.1



Average annual loads from 30-years of daily fluxes

Related Layer: Weather Stations used in this model. Turn on

Weather Source: USEPA National Climate Data

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	18,839.6	1,198.9	86.7
Loading Rates (lb/ac)	24.23	1.54	0.11
Mean Annual Concentration (mg/L)	6.37	0.41	0.03
Mean Low-Flow Concentration (mg/L)	34.55	0.67	0.13

Mean Flow: 47,346,108 (ft^3/year) and 1.5 (ft^3/s)

Download this data

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.4	82.7	26.4
Cropland	0.0	0.0	0.0
Wooded Areas	7,718.9	87.2	12.1
Wetlands	1,368.7	80.0	5.5
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	35.7	0.7	0.1
Medium-Density Mixed	17.2	0.3	0.0
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	1,198.7	24.0	2.7
Farm Animals	0.0	31.0	8.0
Stream Bank Erosion	2,065.7	2.2	0.0
Subsurface Flow	0.0	893.7	23.4
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	21.1	11.1

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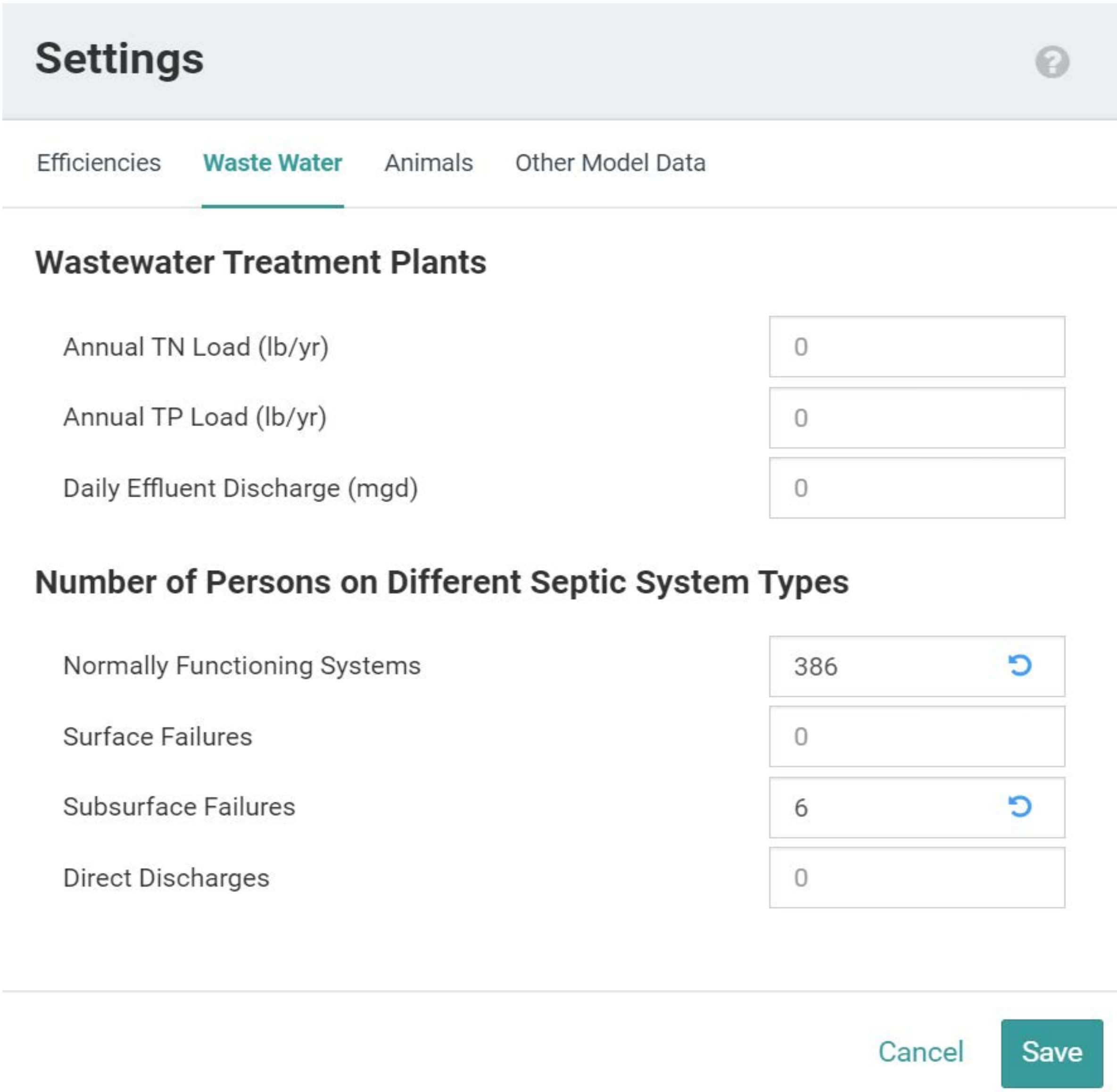
Settings
Efficiencies
Waste Water
Animals
Other Model Data
Wastewater Treatment Plants
Annual TN Load (lb/yr)
0
Annual TP Load (lb/yr)
0
Daily Effluent Discharge (mgd)
0
Number of Persons on Different Septic System Types
Normally Functioning Systems
386
Surface Failures
0
Subsurface Failures
6
Direct Discharges
0
Cancel
Save

Septic - Zone 2

2. Assume that all septic systems within 200' of lake shore in shallow water tables are failing (approximately 200 OSDSs)

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	18,839.60	1,360.40	171.80
Loading Rates (lb/ac)	24.23	1.75	0.22
Mean Annual Concentration (mg/L)	6.37	0.46	0.06
Mean Low-Flow Concentration (mg/L)	34.55	0.93	0.26

Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.40	82.7	26.4
Cropland	0	0	0
Wooded Areas	7,718.90	87.2	12.1
Wetlands	1,368.70	80	5.5
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	35.7	0.7	0.1
Medium-Density Mixed	17.2	0.3	0
High-Density Mixed	0	0	0
Low-Density Open Space	1,198.70	24	2.7
Farm Animals	0	31	8
Stream Bank Erosion	2,065.70	2.2	0
Subsurface Flow	0	893.7	23.4
Point Sources	0	0	0
Septic Systems	0	182.60	96.3

Lake Truesdale - Tech Memo - A | Lake Truesdale - BASINS GWLF-E | Model My Watershed

https://modelmywatershed.org/project/36490/scenario/66193

ADP | Rydoo - Expense | Workday | SharePoint | Resilient NJ Region... | AWS Technical DD | Future Flow Explore... | StreamStats | FEMA FIRMs | NYS GIS Clearingho...

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Septic (Zone 2) - Waters...

Details | Analyze | Monitor | **Model** | Share | New Project

Scenario #2: 200 OSDS | + New scenario | Export GMS | Compare | Weather Data | Land Cover | Conservation Practice | Settings

Hydrology | **Water Quality**

Average annual loads from 30-years of daily fluxes

Related Layer: Weather Stations used in this model. ✔ Turn on

Weather Source: USEPA National Climate Data

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	18,839.6	1,360.4	171.8
Loading Rates (lb/ac)	24.23	1.75	0.22
Mean Annual Concentration (mg/L)	6.37	0.46	0.06
Mean Low-Flow Concentration (mg/L)	34.55	0.93	0.26

Mean Flow: 47,346,108 (ft³/year) and 1.5 (ft³/s)

Download this data

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.4	82.7	26.4
Cropland	0.0	0.0	0.0
Wooded Areas	7,718.9	87.2	12.1
Wetlands	1,368.7	80.0	5.5
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	35.7	0.7	0.1
Medium-Density Mixed	17.2	0.3	0.0
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	1,198.7	24.0	2.7
Farm Animals	0.0	31.0	8.0
Stream Bank Erosion	2,065.7	2.2	0.0
Subsurface Flow	0.0	893.7	23.4
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	182.6	96.3

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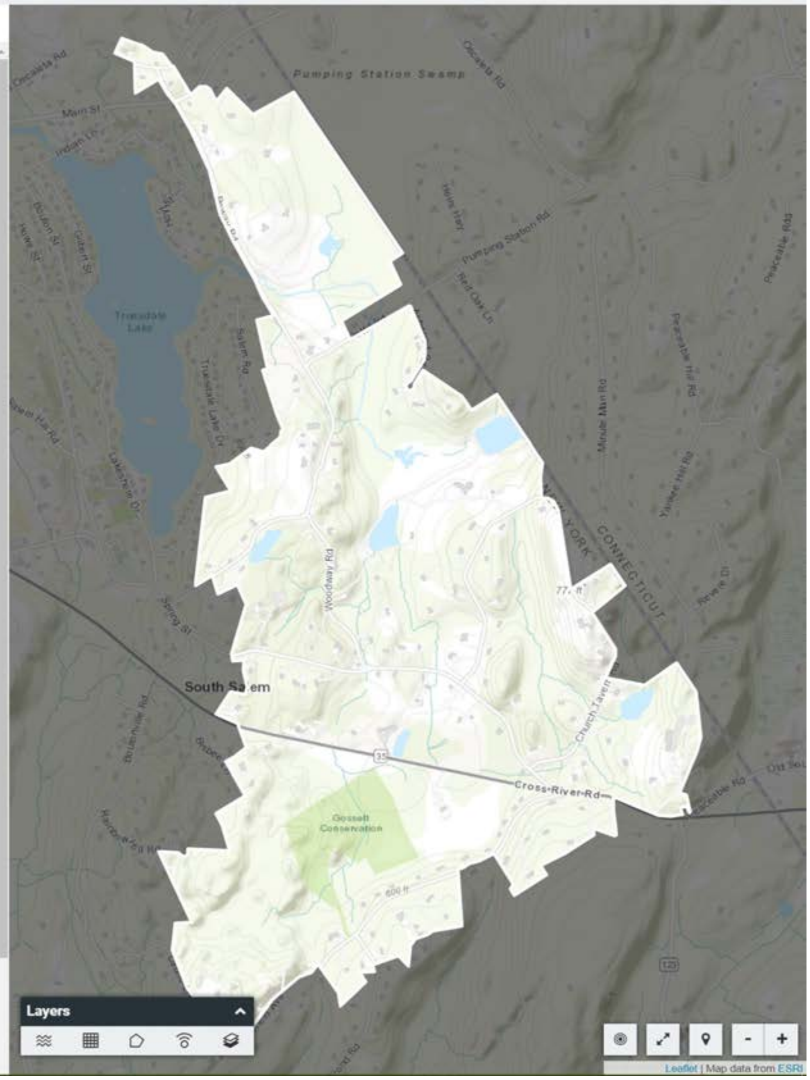
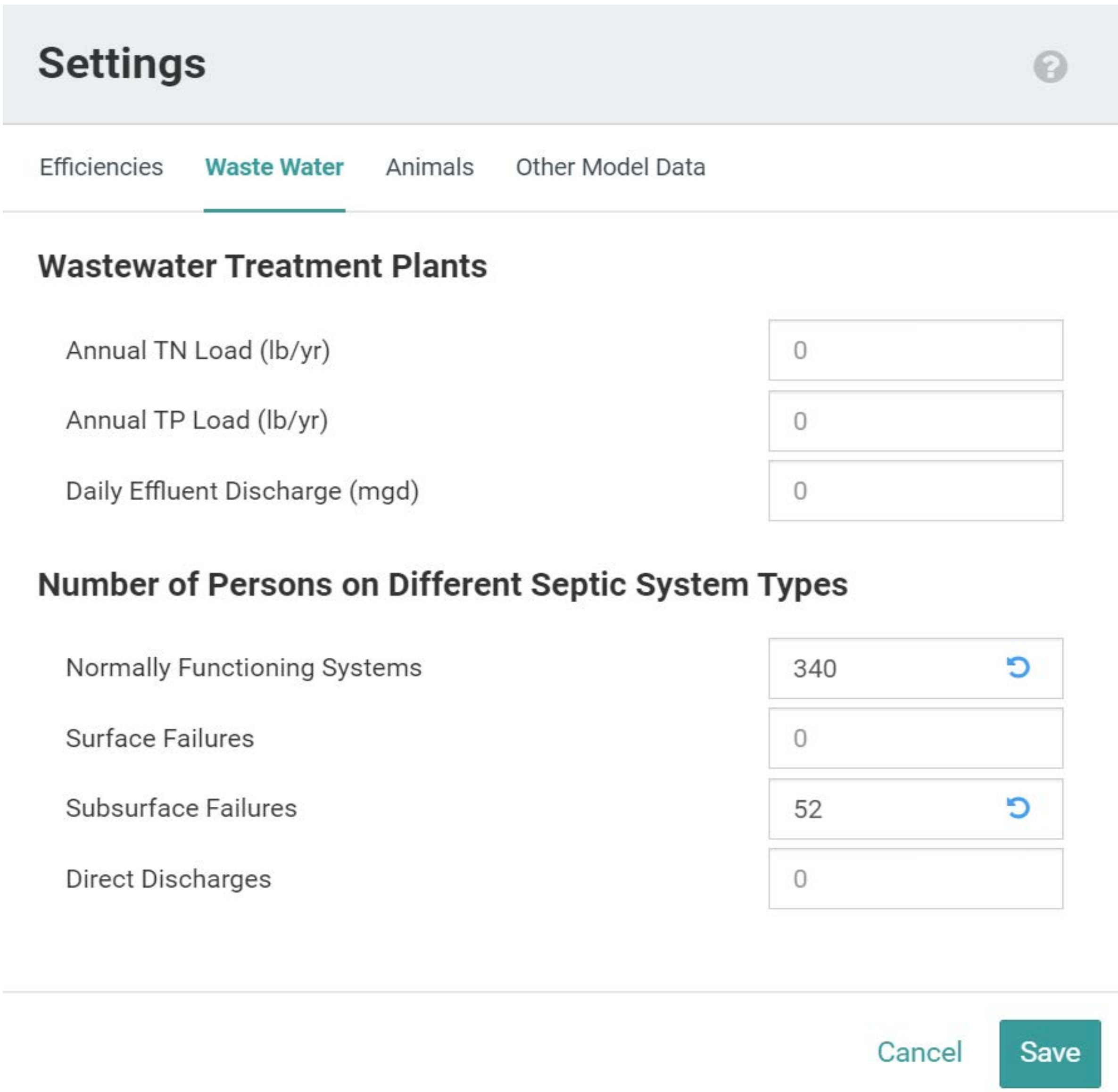



Settings
Efficiencies
Waste Water
Animals
Other Model Data
Wastewater Treatment Plants
Annual TN Load (lb/yr)
0
Annual TP Load (lb/yr)
0
Daily Effluent Discharge (mgd)
0
Number of Persons on Different Septic System Types
Normally Functioning Systems
340
Surface Failures
0
Subsurface Failures
52
Direct Discharges
0
Cancel
Save

Septic - Zone 2

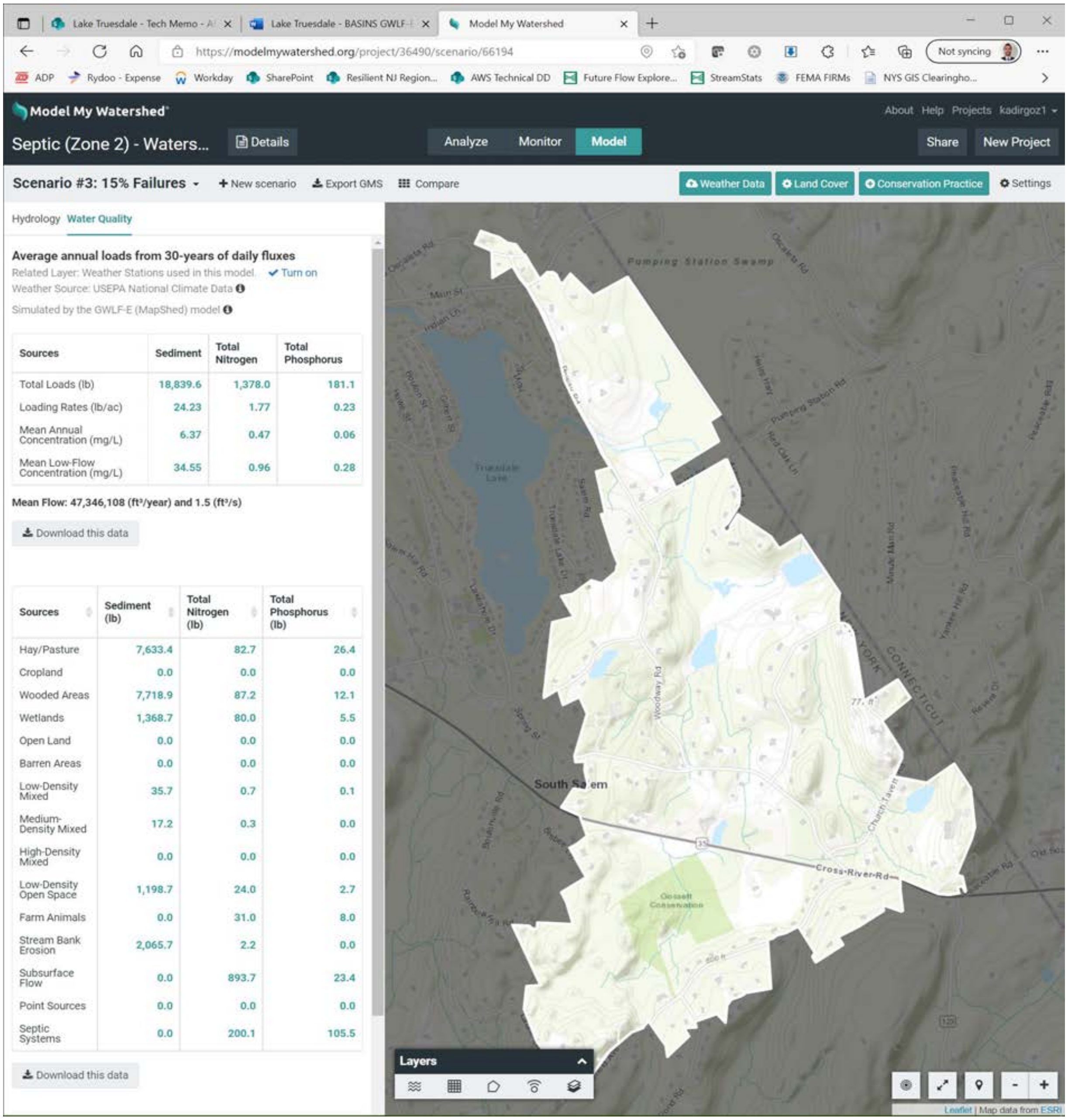
3. Assume at 15% failure in both zones

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	18,839.60	1,378.00	181.1
Loading Rates (lb/ac)	24.23	1.77	0.23
Mean Annual Concentration (mg/L)	6.37	0.47	0.06
Mean Low-Flow Concentration (mg/L)	34.55	0.96	0.28

Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.40	82.7	26.4
Cropland	0	0	0
Wooded Areas	7,718.90	87.2	12.1
Wetlands	1,368.70	80	5.5
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	35.7	0.7	0.1
Medium-Density Mixed	17.2	0.3	0
High-Density Mixed	0	0	0
Low-Density Open Space	1,198.70	24	2.7
Farm Animals	0	31	8
Stream Bank Erosion	2,065.70	2.2	0
Subsurface Flow	0	893.7	23.4
Point Sources	0	0	0
Septic Systems	0	200.1	105.5



Average annual loads from 30-years of daily fluxes

Related Layer: Weather Stations used in this model. Turn on

Weather Source: USEPA National Climate Data

Simulated by the GWLF-E (MapShed) model

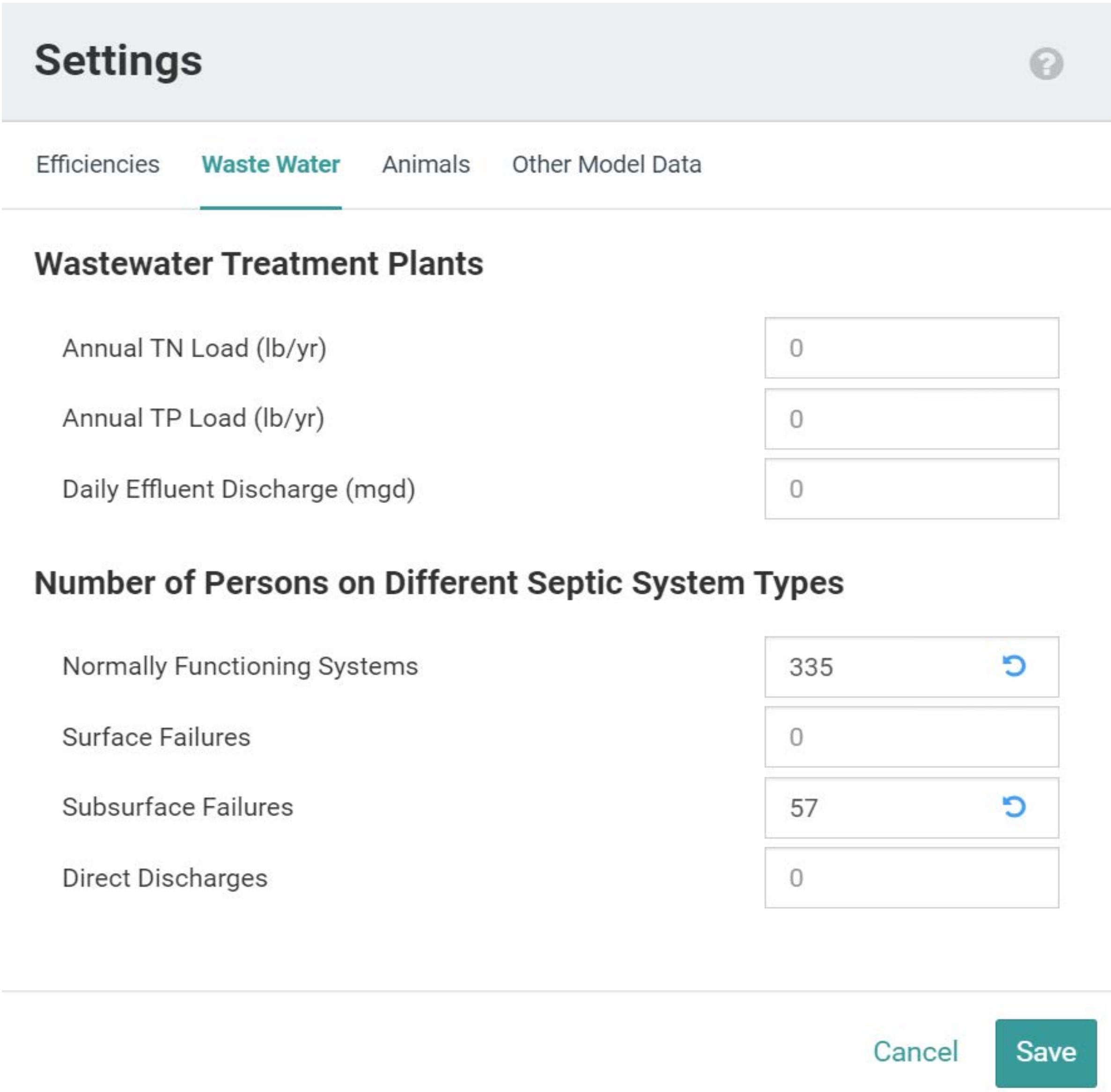
Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	18,839.6	1,378.0	181.1
Loading Rates (lb/ac)	24.23	1.77	0.23
Mean Annual Concentration (mg/L)	6.37	0.47	0.06
Mean Low-Flow Concentration (mg/L)	34.55	0.96	0.28

Mean Flow: 47,346,108 (ft³/year) and 1.5 (ft³/s)

Download this data

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.4	82.7	26.4
Cropland	0.0	0.0	0.0
Wooded Areas	7,718.9	87.2	12.1
Wetlands	1,368.7	80.0	5.5
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	35.7	0.7	0.1
Medium-Density Mixed	17.2	0.3	0.0
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	1,198.7	24.0	2.7
Farm Animals	0.0	31.0	8.0
Stream Bank Erosion	2,065.7	2.2	0.0
Subsurface Flow	0.0	893.7	23.4
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	200.1	105.5

Download this data


Settings
Efficiencies
Waste Water
Animals
Other Model Data
Wastewater Treatment Plants
Annual TN Load (lb/yr)
0
Annual TP Load (lb/yr)
0
Daily Effluent Discharge (mgd)
0
Number of Persons on Different Septic System Types
Normally Functioning Systems
335
Surface Failures
0
Subsurface Failures
57
Direct Discharges
0
Cancel
Save

Septic - Zone 2

4. Assume no failures (all systems working)

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	18,839.60	1,177.90	75.5
Loading Rates (lb/ac)	24.23	1.52	0.1
Mean Annual Concentration (mg/L)	6.37	0.4	0.03
Mean Low-Flow Concentration (mg/L)	34.55	0.63	0.11

Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.40	82.7	26.4
Cropland	0	0	0
Wooded Areas	7,718.90	87.2	12.1
Wetlands	1,368.70	80	5.5
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	35.7	0.7	0.1
Medium-Density Mixed	17.2	0.3	0
High-Density Mixed	0	0	0
Low-Density Open Space	1,198.70	24	2.7
Farm Animals	0	31	8
Stream Bank Erosion	2,065.70	2.2	0
Subsurface Flow	0	893.7	23.4
Point Sources	0	0	0
Septic Systems	0	0	0

Model My Watershed

Septic (Zone 2) - Waters...   Details   Analyze   Monitor   Model   Share   New Project

Current Conditions   + New scenario   Export GMS   Compare

Hydrology   Water Quality

Average annual loads from 30-years of daily fluxes

Related Layer: Weather Stations used in this model. ✓ Turn on

Weather Source: USEPA National Climate Data

Simulated by the GWLF-E (MapShed) model

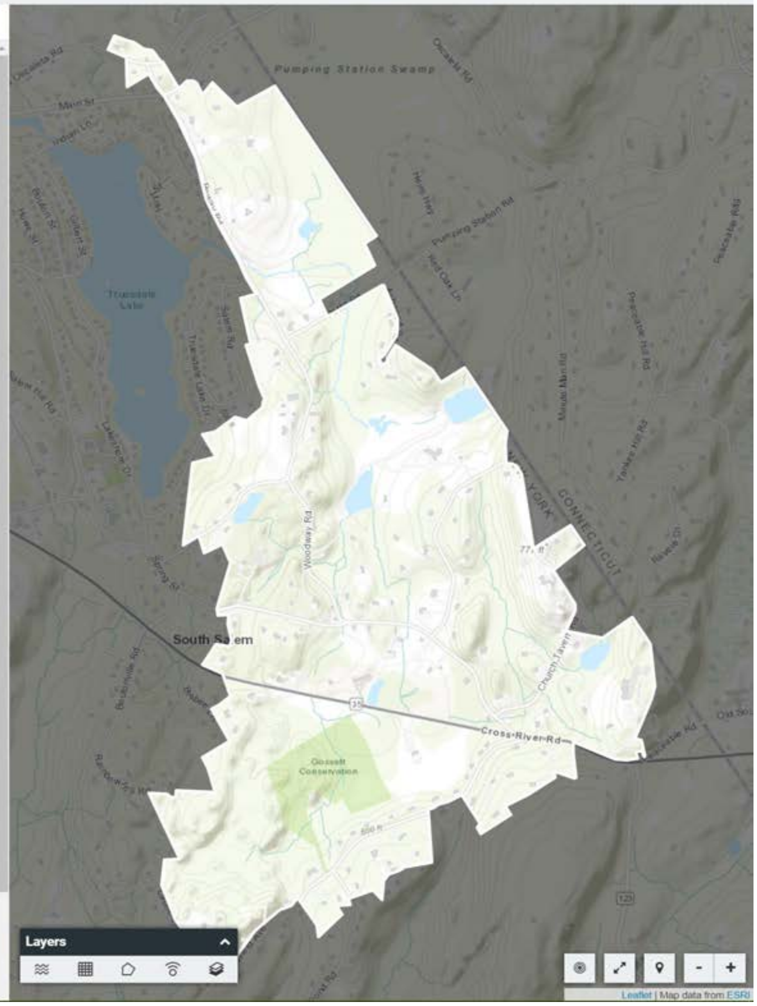
Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	18,839.6	1,177.9	75.5
Loading Rates (lb/ac)	24.23	1.52	0.10
Mean Annual Concentration (mg/L)	6.37	0.40	0.03
Mean Low-Flow Concentration (mg/L)	34.55	0.63	0.11

Mean Flow: 47,346,108 (ft³/year) and 1.5 (ft³/s)

Download this data

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.4	82.7	26.4
Cropland	0.0	0.0	0.0
Wooded Areas	7,718.9	87.2	12.1
Wetlands	1,368.7	80.0	5.5
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	35.7	0.7	0.1
Medium-Density Mixed	17.2	0.3	0.0
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	1,198.7	24.0	2.7
Farm Animals	0.0	31.0	8.0
Stream Bank Erosion	2,065.7	2.2	0.0
Subsurface Flow	0.0	893.7	23.4
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	0.0	0.0

Download this data



Combined - Zone 1 & 2

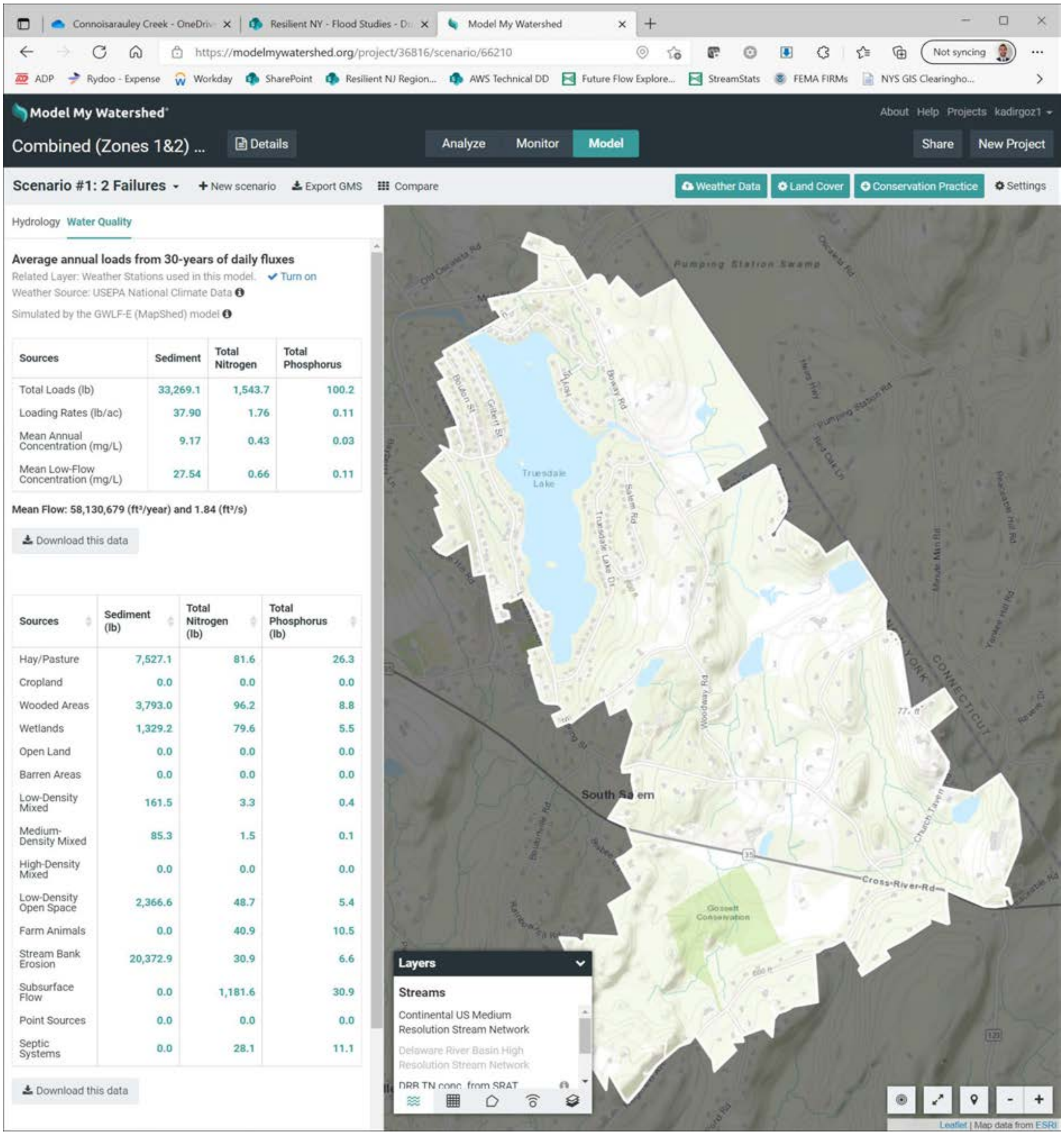
1. Assume 2 failures per year per zone

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	38,214.00	1,592.70	116.90
Loading Rates (lb/ac)	37.9	1.76	0.11
Mean Annual Concentration (mg/L)	9.17	0.43	0.03
Mean Low-Flow Concentration (mg/L)	27.54	0.66	0.11

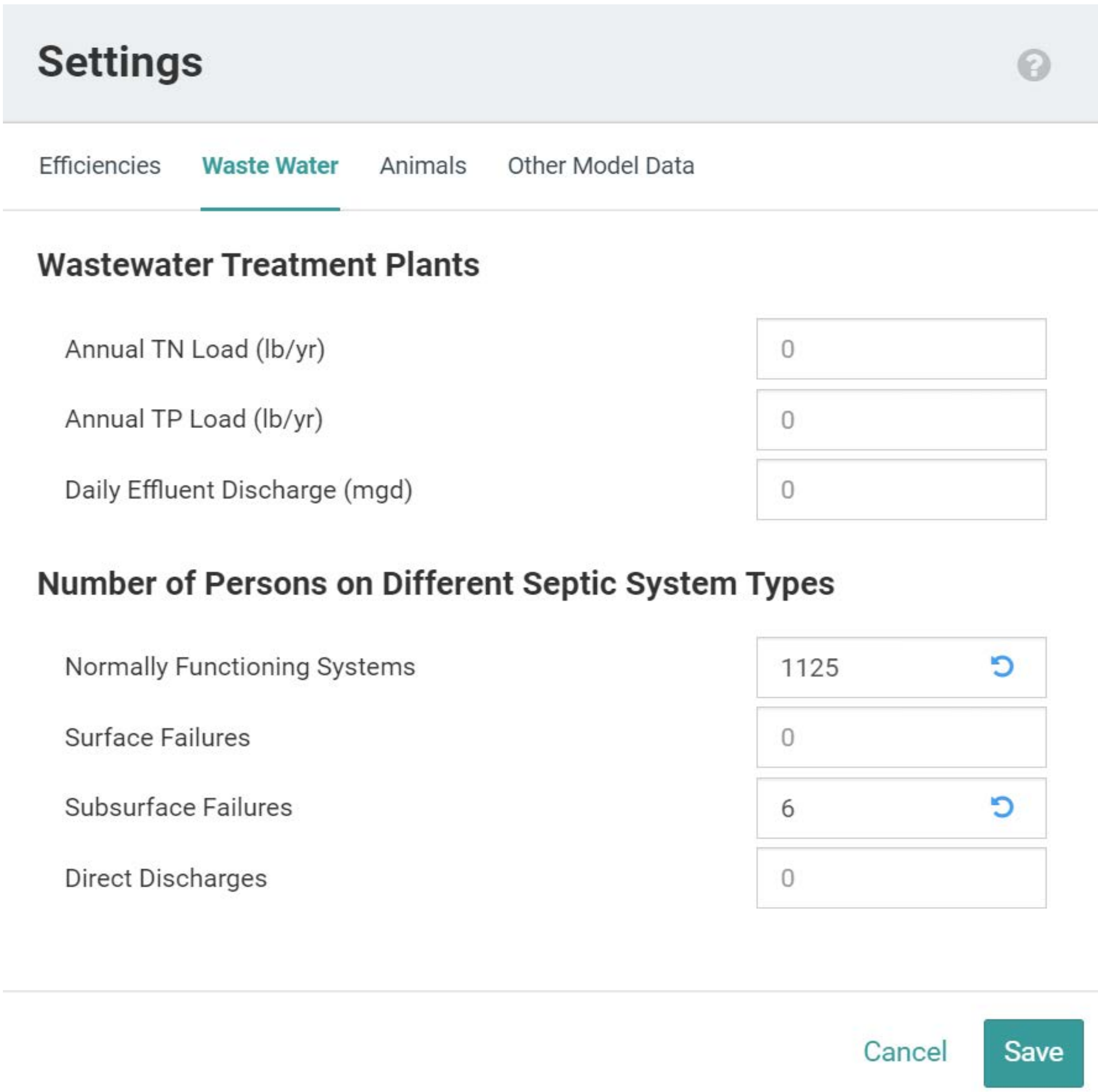
Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.40	82.7	26.4
Cropland	0	0	0
Wooded Areas	8,365.20	104.4	13.6
Wetlands	1,368.70	80	5.5
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	166	3.5	0.4
Medium-Density Mixed	80.7	1.4	0.1
High-Density Mixed	0	0	0
Low-Density Open Space	2,368.70	48.7	5.4
Farm Animals	0	40.9	10.5
Stream Bank Erosion	20,600.00	35.3	6.6
Subsurface Flow	0	1,198.90	31.4
Point Sources	0	0	0
Septic Systems	0	45.7	22.2



Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	33,269.1	1,543.7	100.2
Loading Rates (lb/ac)	37.90	1.76	0.11
Mean Annual Concentration (mg/L)	9.17	0.43	0.03
Mean Low-Flow Concentration (mg/L)	27.54	0.66	0.11

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,527.1	81.6	26.3
Cropland	0.0	0.0	0.0
Wooded Areas	3,793.0	96.2	8.8
Wetlands	1,329.2	79.6	5.5
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	161.5	3.3	0.4
Medium-Density Mixed	85.3	1.5	0.1
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	2,366.6	48.7	5.4
Farm Animals	0.0	40.9	10.5
Stream Bank Erosion	20,372.9	30.9	6.6
Subsurface Flow	0.0	1,181.6	30.9
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	28.1	11.1


Settings
Efficiencies
Waste Water
Animals
Other Model Data
Wastewater Treatment Plants
Annual TN Load (lb/yr)
0
Annual TP Load (lb/yr)
0
Daily Effluent Discharge (mgd)
0
Number of Persons on Different Septic System Types
Normally Functioning Systems
1125
Surface Failures
0
Subsurface Failures
6
Direct Discharges
0
Cancel
Save

Combined - Zone 1 & 2

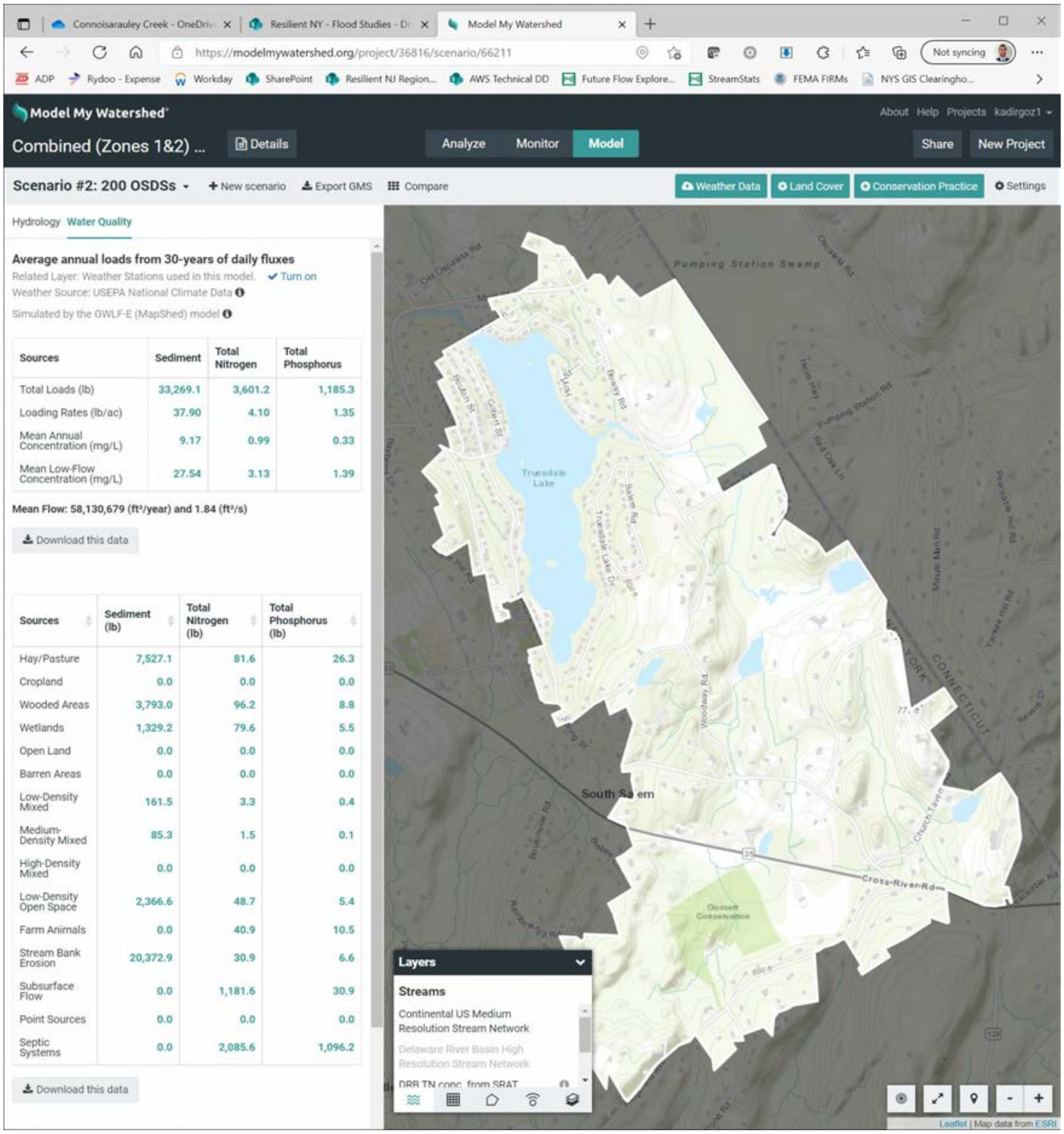
2. Assume that all septic systems within 200’ of lake shore in shallow water tables are failing (approximately 200 OSDSs)

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	38,214.00	3,629.20	1,190.70
Loading Rates (lb/ac)	37.9	4.1	1.35
Mean Annual Concentration (mg/L)	9.17	0.99	0.33
Mean Low-Flow Concentration (mg/L)	27.54	3.13	1.39

Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.40	82.7	26.4
Cropland	0	0	0
Wooded Areas	8,365.20	104.4	13.6
Wetlands	1,368.70	80	5.5
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	166	3.5	0.4
Medium-Density Mixed	80.7	1.4	0.1
High-Density Mixed	0	0	0
Low-Density Open Space	2,368.70	48.7	5.4
Farm Animals	0	40.9	10.5
Stream Bank Erosion	20,600.00	35.3	6.6
Subsurface Flow	0	1,198.90	31.4
Point Sources	0	0	0
Septic Systems	0	2,082.20	1,096.20



Average annual loads from 30-years of daily fluxes

Related Layer: Weather Stations used in this model. ✔ Turn on

Weather Source: USEPA National Climate Data

Simulated by the GWLF-E (MapShed) model

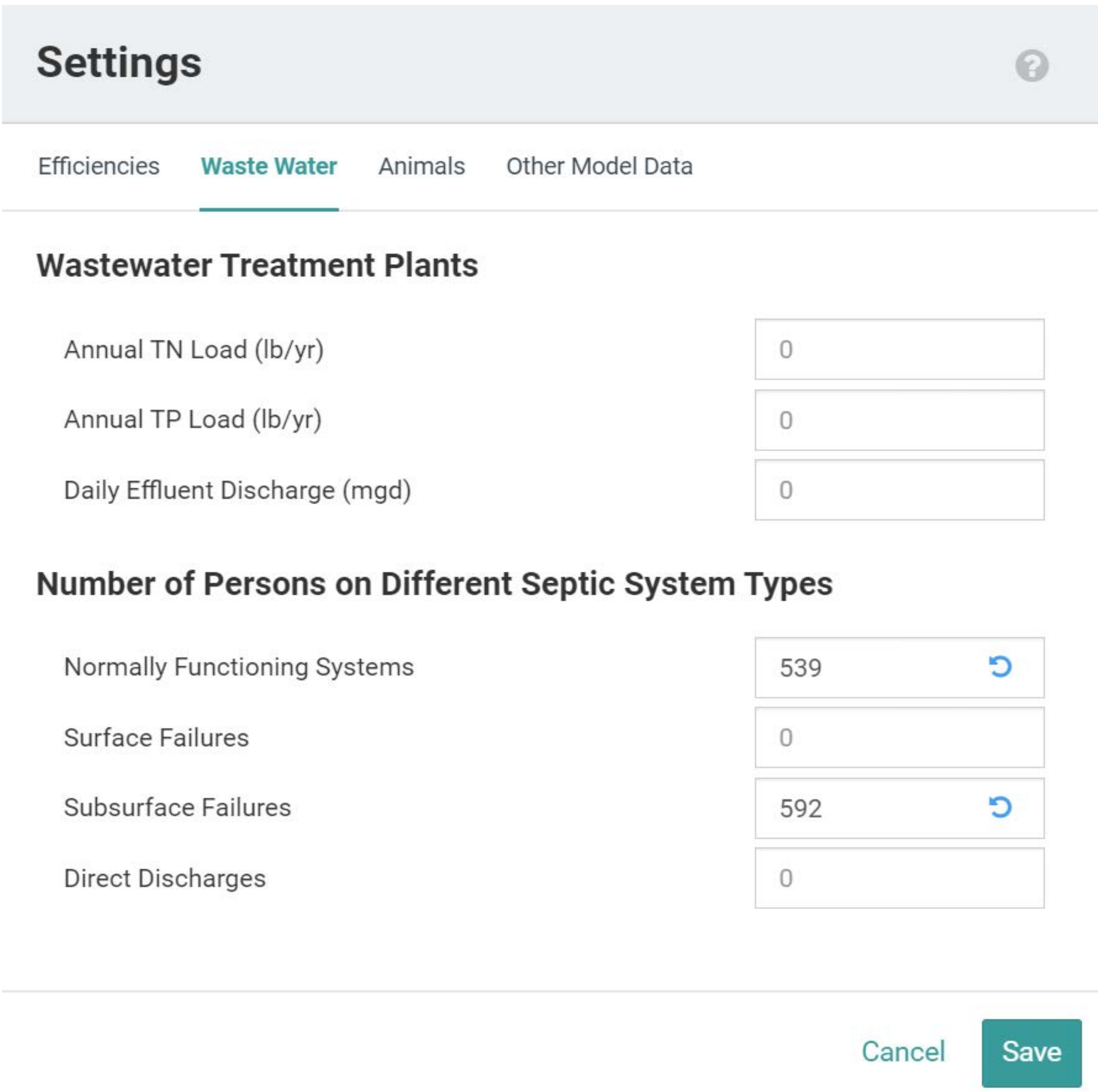
Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	33,269.1	3,601.2	1,185.3
Loading Rates (lb/ac)	37.90	4.10	1.35
Mean Annual Concentration (mg/L)	9.17	0.99	0.33
Mean Low-Flow Concentration (mg/L)	27.54	3.13	1.39

Mean Flow: 58,130,679 (ft³/year) and 1.84 (ft³/s)

Download this data

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,527.1	81.6	26.3
Cropland	0.0	0.0	0.0
Wooded Areas	3,793.0	96.2	8.8
Wetlands	1,329.2	79.6	5.5
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	161.5	3.3	0.4
Medium-Density Mixed	85.3	1.5	0.1
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	2,366.6	48.7	5.4
Farm Animals	0.0	40.9	10.5
Stream Bank Erosion	20,372.9	30.9	6.6
Subsurface Flow	0.0	1,181.6	30.9
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	2,085.6	1,096.2

Download this data


Settings
Efficiencies
Waste Water
Animals
Other Model Data
Wastewater Treatment Plants
Annual TN Load (lb/yr)
0
Annual TP Load (lb/yr)
0
Daily Effluent Discharge (mgd)
0
Number of Persons on Different Septic System Types
Normally Functioning Systems
539
Surface Failures
0
Subsurface Failures
592
Direct Discharges
0
Cancel
Save

Combined - Zone 1 & 2

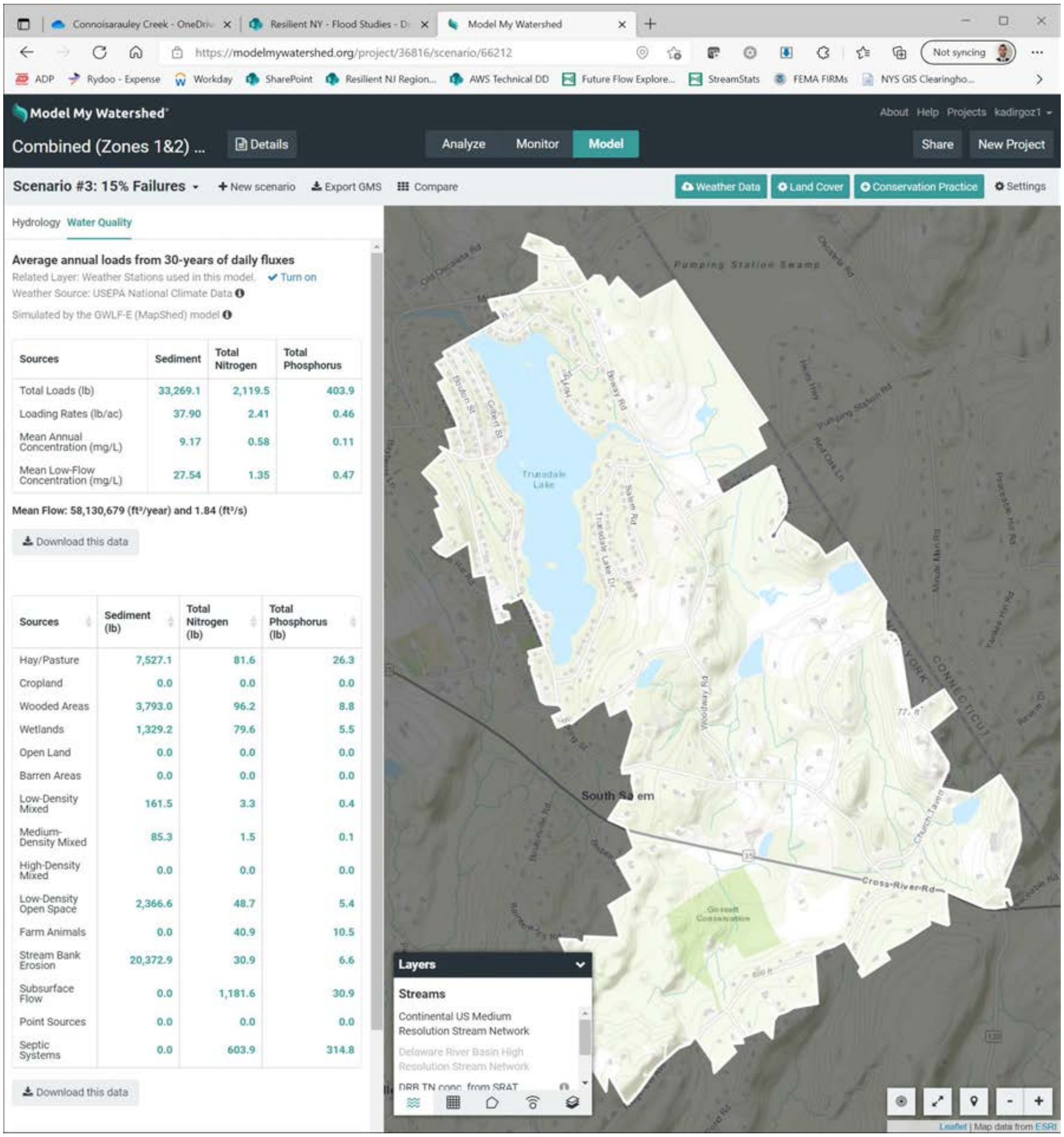
3. Assume at 15% failure in both zones

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	38,214.00	2,151.00	411.20
Loading Rates (lb/ac)	37.9	2.41	0.46
Mean Annual Concentration (mg/L)	9.17	0.58	0.11
Mean Low-Flow Concentration (mg/L)	27.54	1.35	0.47

Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.40	82.7	26.4
Cropland	0	0	0
Wooded Areas	8,365.20	104.4	13.6
Wetlands	1,368.70	80	5.5
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	166	3.5	0.4
Medium-Density Mixed	80.7	1.4	0.1
High-Density Mixed	0	0	0
Low-Density Open Space	2,368.70	48.7	5.4
Farm Animals	0	40.9	10.5
Stream Bank Erosion	20,600.00	35.3	6.6
Subsurface Flow	0	1,198.90	31.4
Point Sources	0	0	0
Septic Systems	0	603.9	316.6



Average annual loads from 30-years of daily fluxes

Related Layer: Weather Stations used in this model. ✓ Turn on

Weather Source: USEPA National Climate Data

Simulated by the GWLF-E (MapShed) model

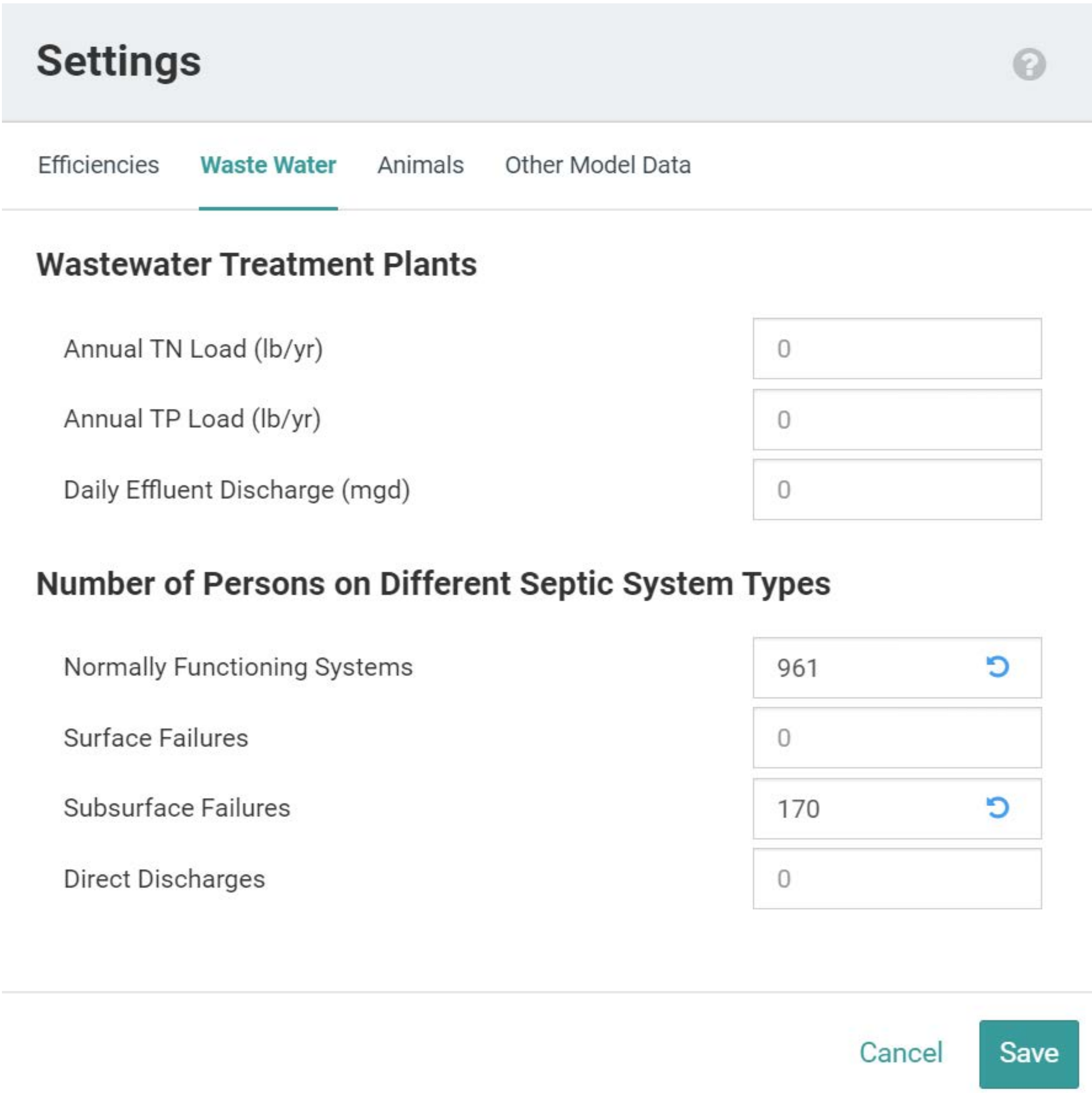
Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	33,269.1	2,119.5	403.9
Loading Rates (lb/ac)	37.90	2.41	0.46
Mean Annual Concentration (mg/L)	9.17	0.58	0.11
Mean Low-Flow Concentration (mg/L)	27.54	1.35	0.47

Mean Flow: 58,130,679 (ft³/year) and 1.84 (ft³/s)

Download this data

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,527.1	81.6	26.3
Cropland	0.0	0.0	0.0
Wooded Areas	3,793.0	96.2	8.8
Wetlands	1,329.2	79.6	5.5
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	161.5	3.3	0.4
Medium-Density Mixed	85.3	1.5	0.1
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	2,366.6	48.7	5.4
Farm Animals	0.0	40.9	10.5
Stream Bank Erosion	20,372.9	30.9	6.6
Subsurface Flow	0.0	1,181.6	30.9
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	603.9	314.8

Download this data


Settings
Efficiencies
Waste Water
Animals
Other Model Data
Wastewater Treatment Plants
Annual TN Load (lb/yr)
0
Annual TP Load (lb/yr)
0
Daily Effluent Discharge (mgd)
0
Number of Persons on Different Septic System Types
Normally Functioning Systems
961
Surface Failures
0
Subsurface Failures
170
Direct Discharges
0
Cancel
Save

Combined - Zone 1 & 2

4. Assume no failures (all systems working)

Average annual loads from 30-years of daily fluxes

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	38,214.00	1,550.60	94.50
Loading Rates (lb/ac)	37.9	1.73	0.1
Mean Annual Concentration (mg/L)	9.17	0.42	0.02
Mean Low-Flow Concentration (mg/L)	27.54	0.63	0.09

Average annual loads from 30-years of daily fluxes by land type

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,633.40	82.7	26.4
Cropland	0	0	0
Wooded Areas	8,365.20	104.4	13.6
Wetlands	1,368.70	80	5.5
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	166	3.5	0.4
Medium-Density Mixed	80.7	1.4	0.1
High-Density Mixed	0	0	0
Low-Density Open Space	2,368.70	48.7	5.4
Farm Animals	0	40.9	10.5
Stream Bank Erosion	20,600.00	35.3	6.6
Subsurface Flow	0	1,198.90	31.4
Point Sources	0	0	0
Septic Systems	0	3.5	0

Model My Watershed

https://modelmywatershed.org/project/36816/scenario/66209

Combined (Zones 1&2) ... Details | Analyze | Monitor | Model | Share | New Project

Current Conditions

Export GMS

Hydrology | Water Quality

Average annual loads from 30-years of daily fluxes

Related Layer: Weather Stations used in this model. Turn on

Weather Source: USEPA National Climate Data

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	33,269.1	1,522.6	89.1
Loading Rates (lb/ac)	37.90	1.73	0.10
Mean Annual Concentration (mg/L)	9.17	0.42	0.02
Mean Low-Flow Concentration (mg/L)	27.54	0.63	0.09

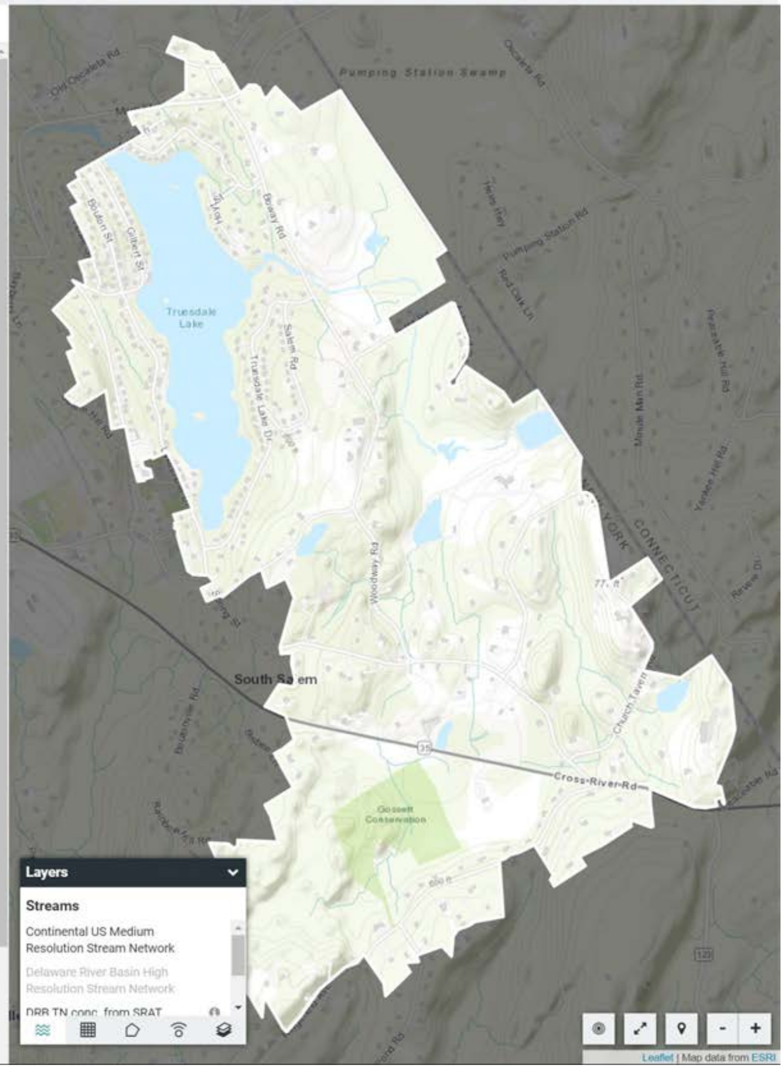
Mean Flow: 58,130,679 (ft³/year) and 1.84 (ft³/s)

Download this data

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	7,527.1	81.6	26.3
Cropland	0.0	0.0	0.0
Wooded Areas	3,793.0	96.2	8.8
Wetlands	1,329.2	79.6	5.5
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	161.5	3.3	0.4
Medium-Density Mixed	85.3	1.5	0.1
High-Density Mixed	0.0	0.0	0.0
Low-Density Open Space	2,366.6	48.7	5.4
Farm Animals	0.0	40.9	10.5
Stream Bank Erosion	20,372.9	30.9	6.6
Subsurface Flow	0.0	1,181.6	30.9
Point Sources	0.0	0.0	0.0
Septic Systems	0.0	7.0	0.0

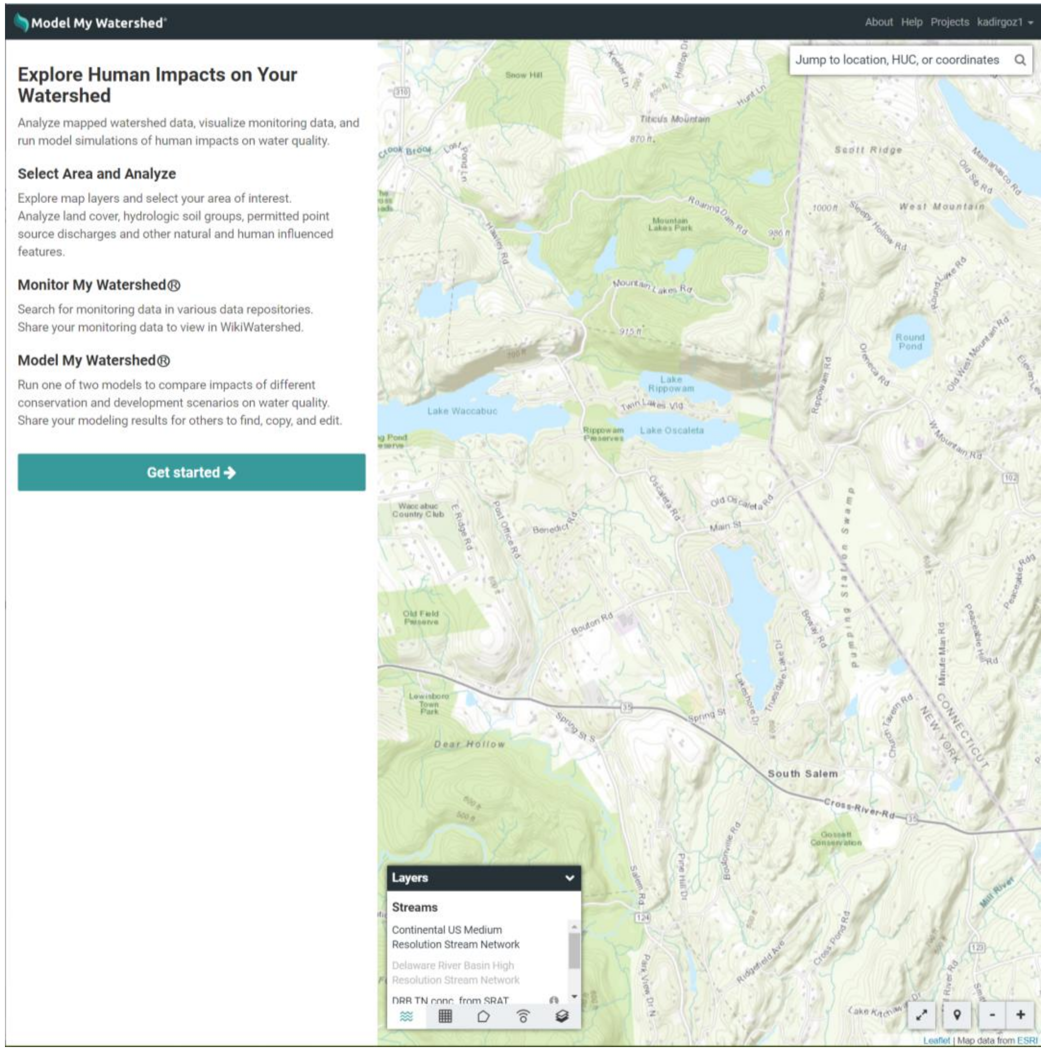
Download this data

Add changes to this area



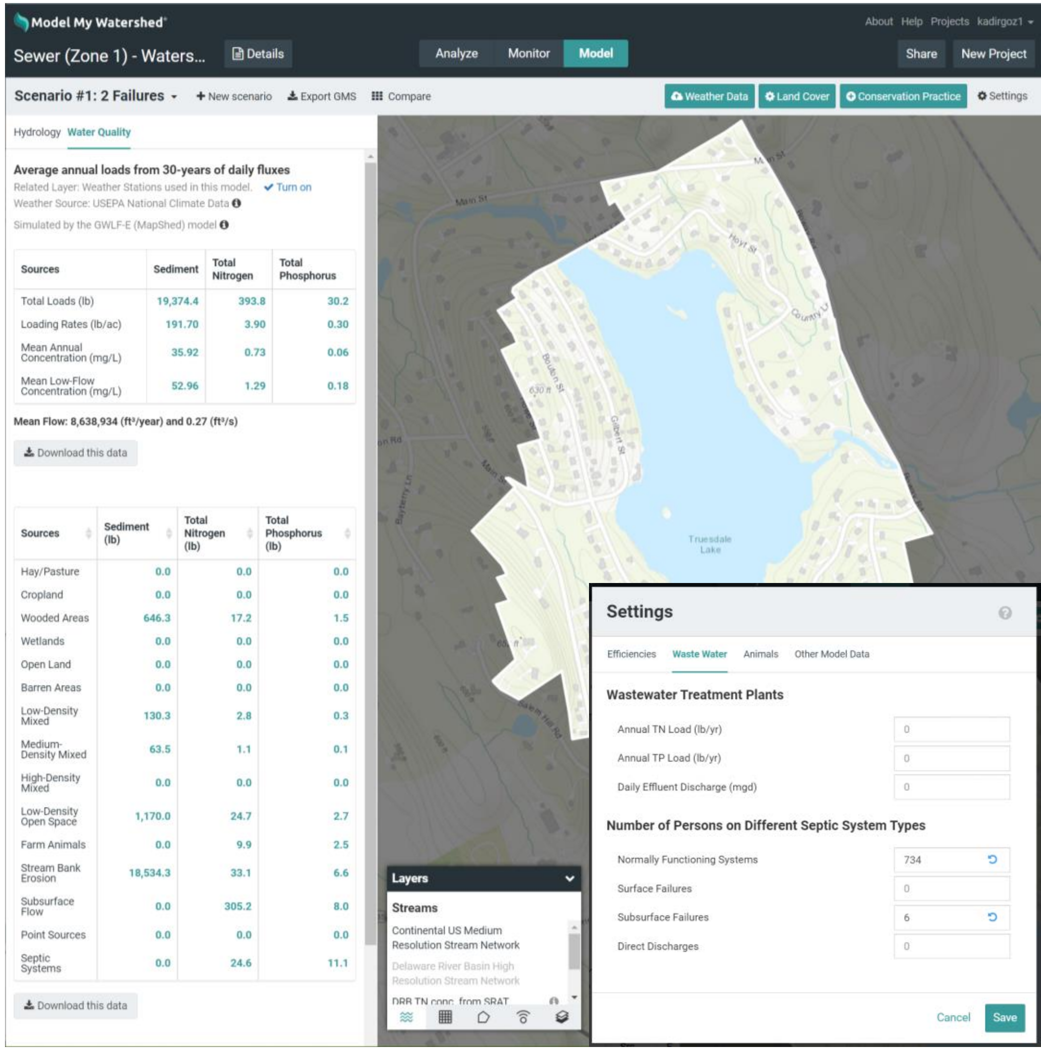
Model My Watershed (MMW)

- Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) is a multipurpose environmental analysis system developed by the USEPA
- BASINS provides plug-ins to set up watershed and water quality simulation models:
  - Generalized Watershed Loading Function model extension (GWLF-E) MapShed - The GWLF-E Plug-in included with BASINS is a GIS-based watershed modeling tool that estimates monthly nutrient and sediment loads within a watershed
- The GWLF-E MapShed watershed modeling tool has been integrated into Model My Watershed as the Watershed Multi-Year Model



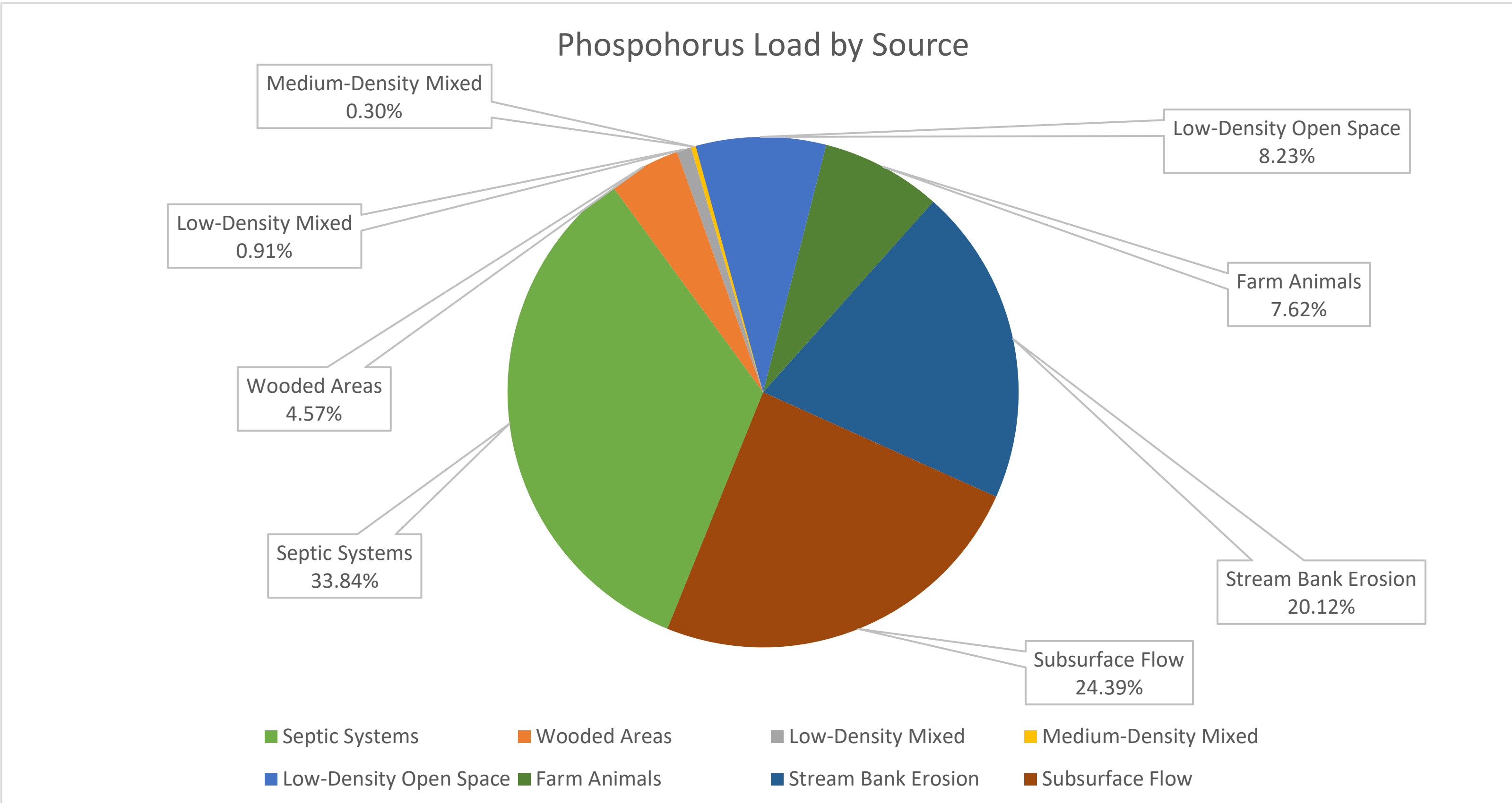
Model My Watershed (MMW)

- Model Input Data and Parameters
  - <u>Number of Persons on Different Septic System Types</u> –
    - Normally Functioning Systems - homes assumed to be connected to “normally functioning” systems
    - Surface Failures – surface breakouts
    - Subsurface Failures - short-circuiting to underlying groundwater
    - Direct Discharges - direct conduits to nearby water bodies
- The values pertaining to any system type were adjusted based on local information
- Four (4) scenarios were modeled:
  1. No system failures
  2. Two (2) failures per year per zone
  3. 15% failures in both zones
  4. All septic systems within 200’ of lake shore in shallow water tables fail (approximately 200 OSDSs)



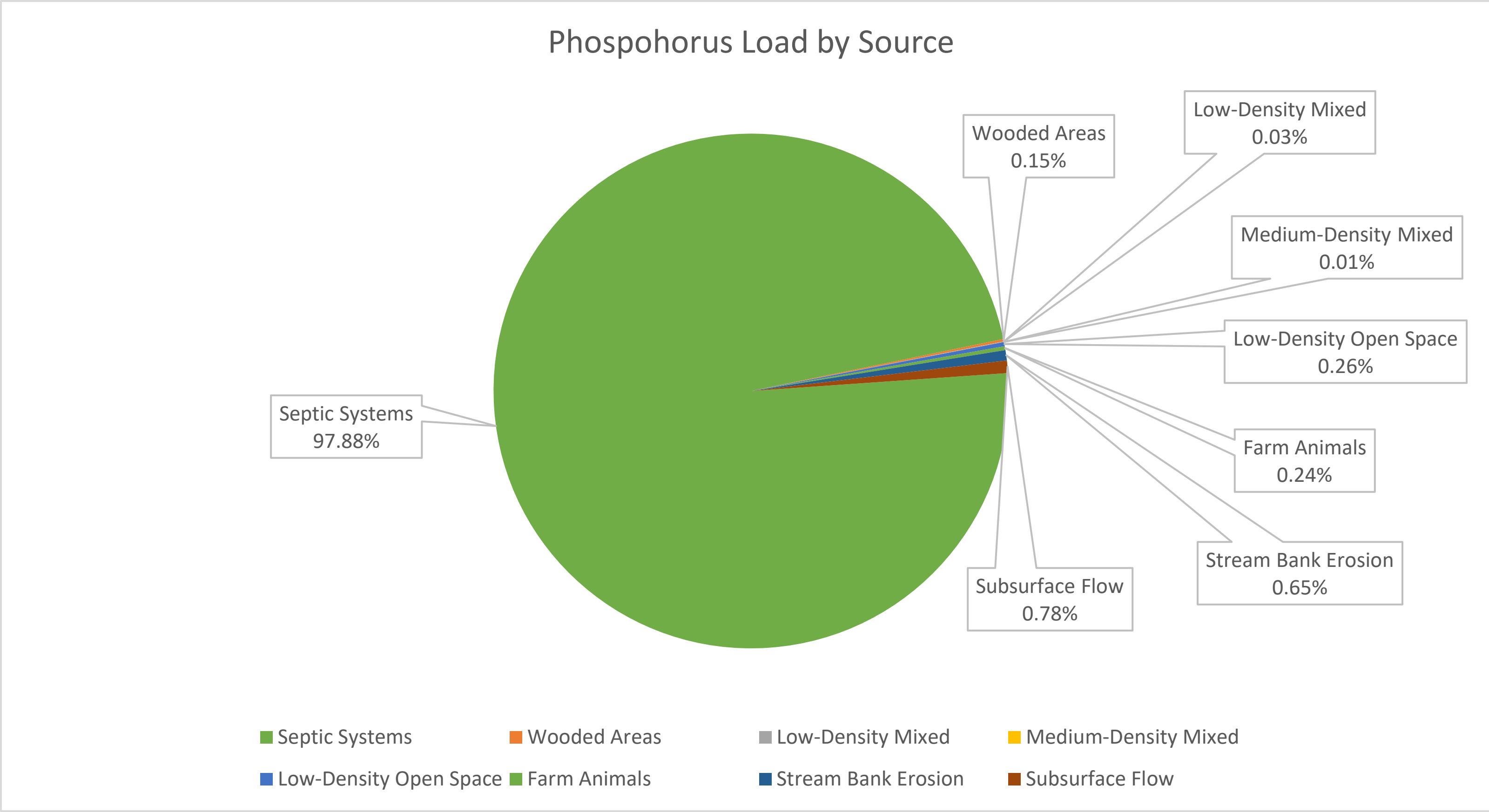
Zone 1

1. Assume 2 failures per year per zone



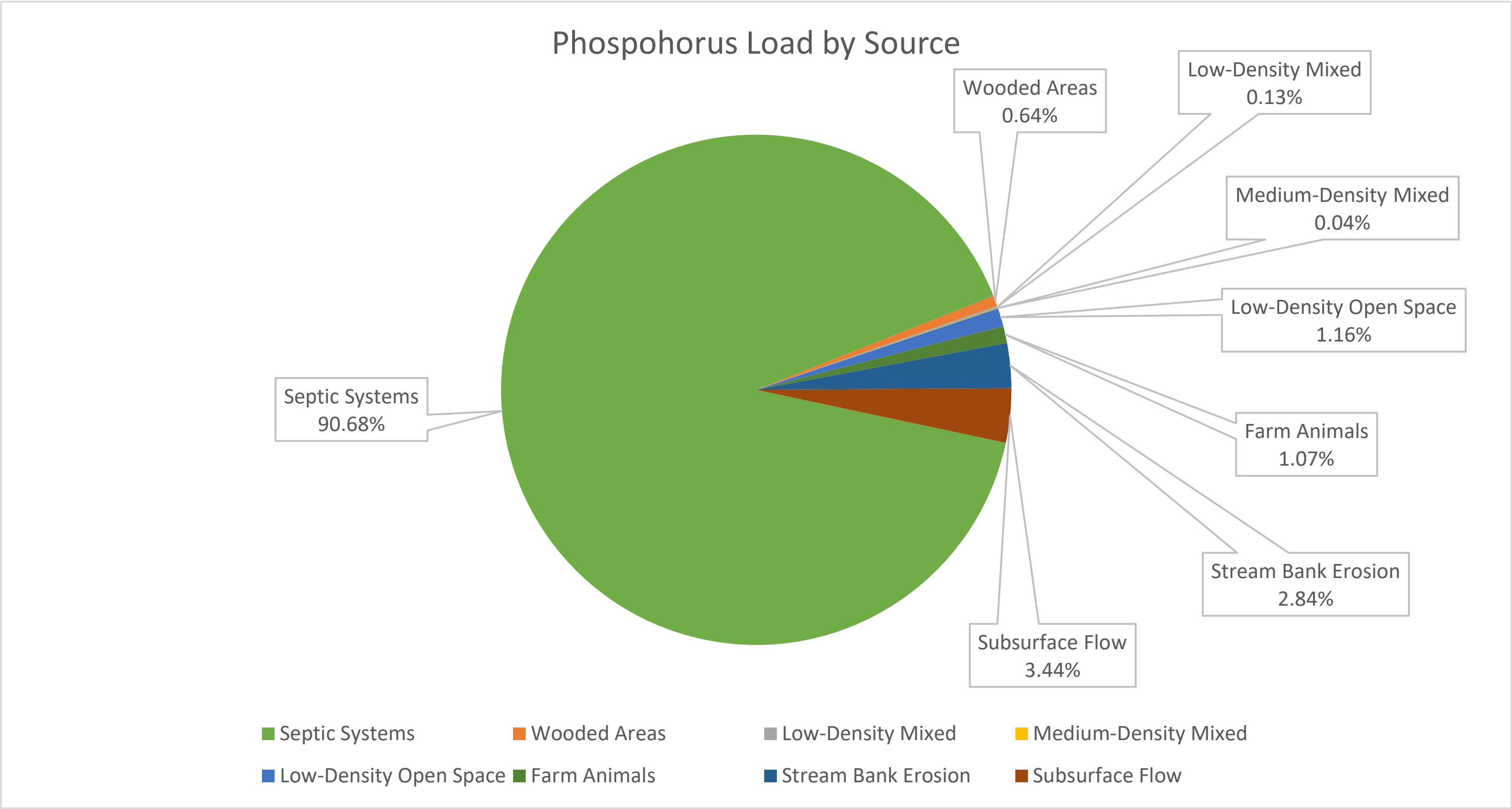
Zone 1

2. Assume that all septic systems within 200’ of lake shore in shallow water tables are failing (approximately 200 OSDSs)



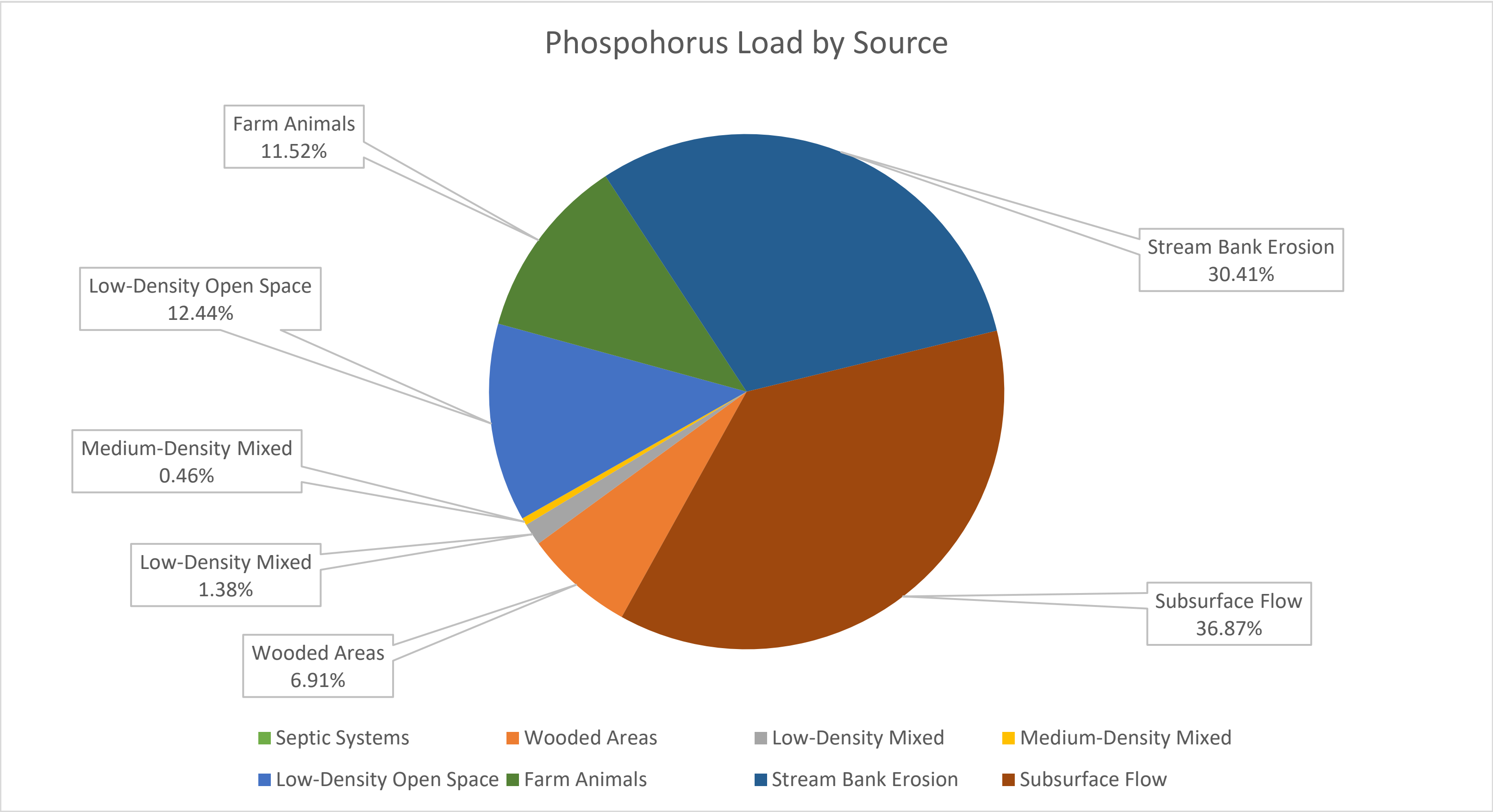
Zone 1

3. Assume at 15% failure in both zones



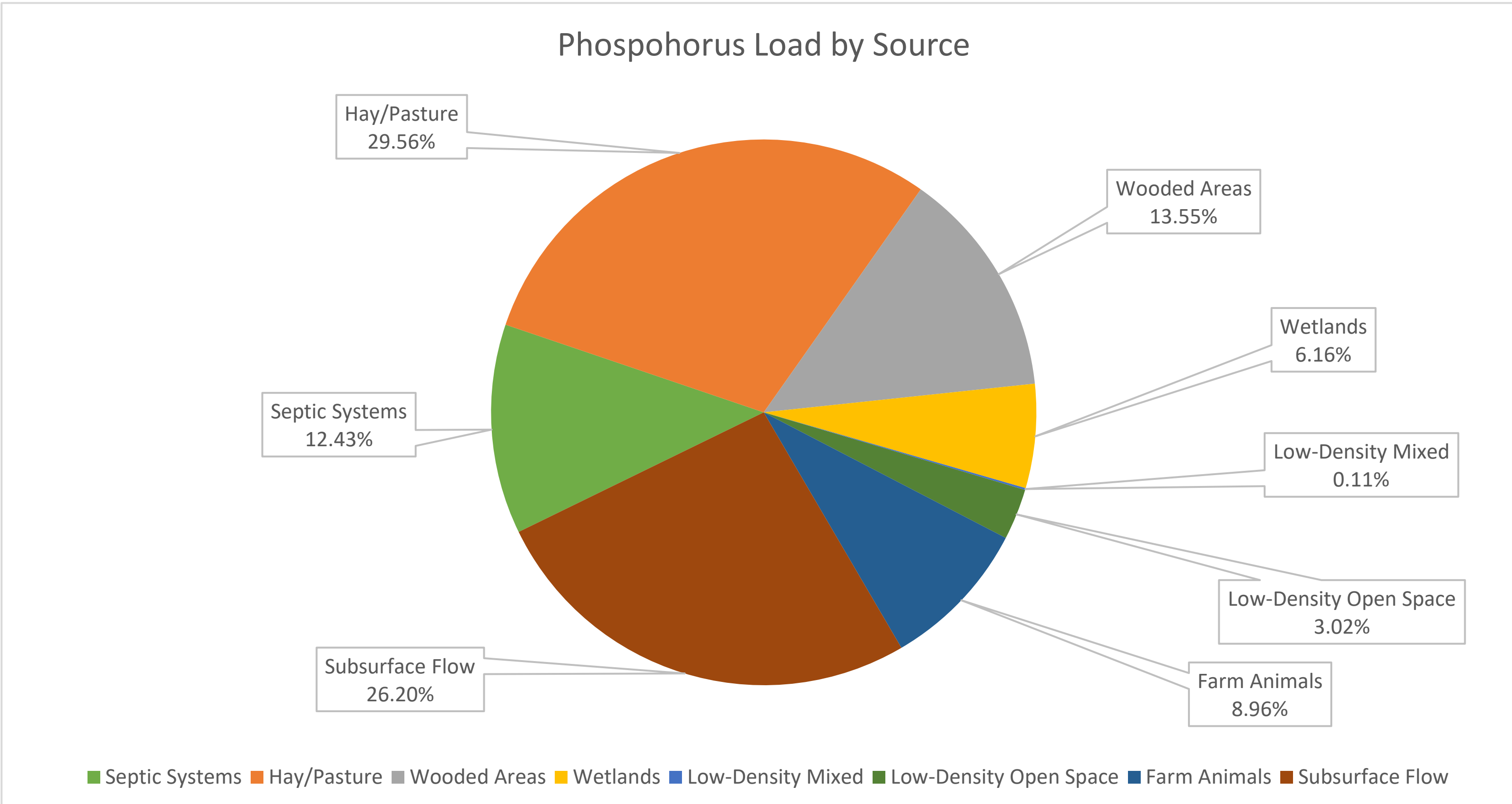
Zone 1

4. Assume no failures



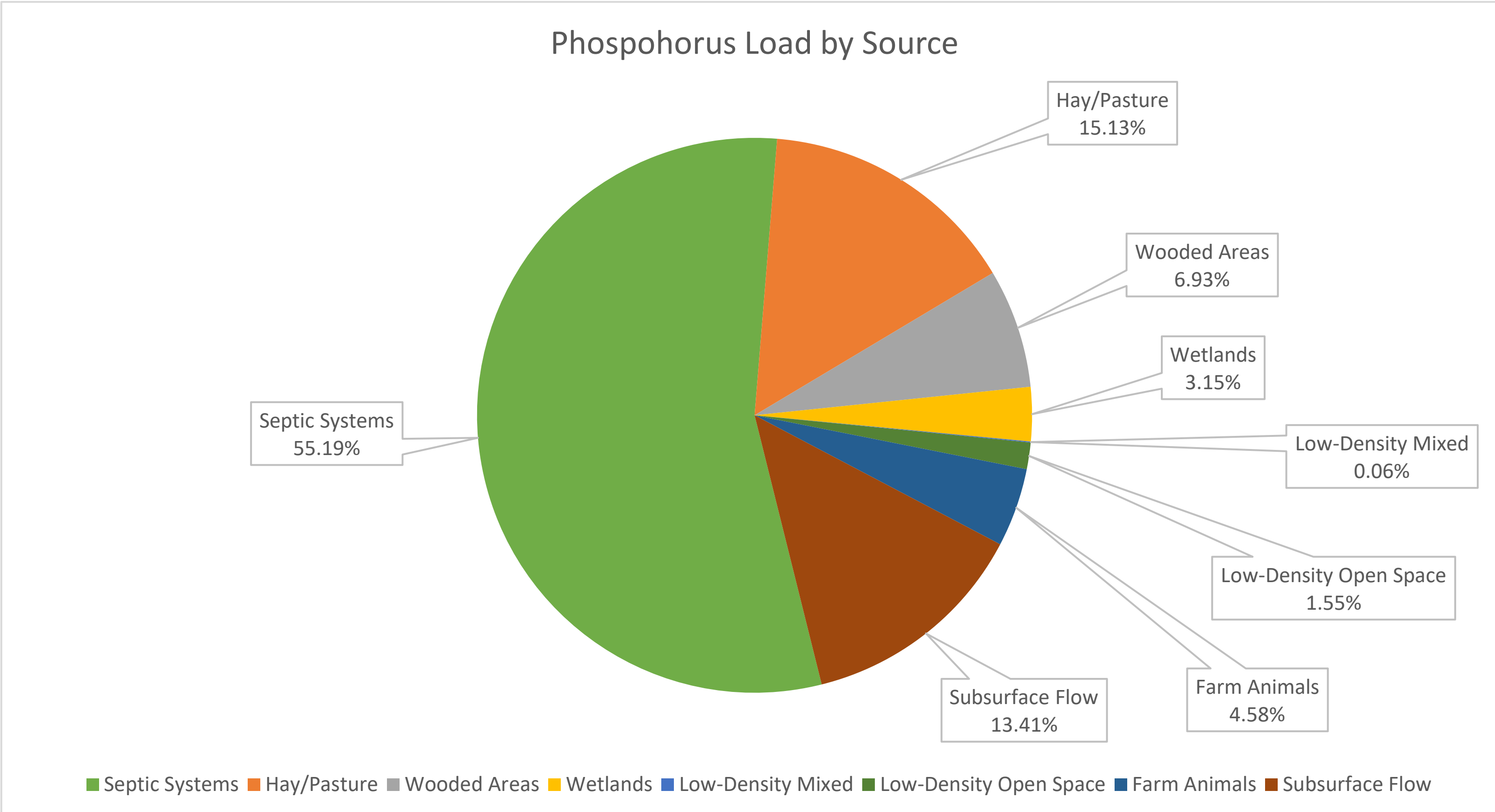
Zone 2

1. Assume 2 failures per year per zone



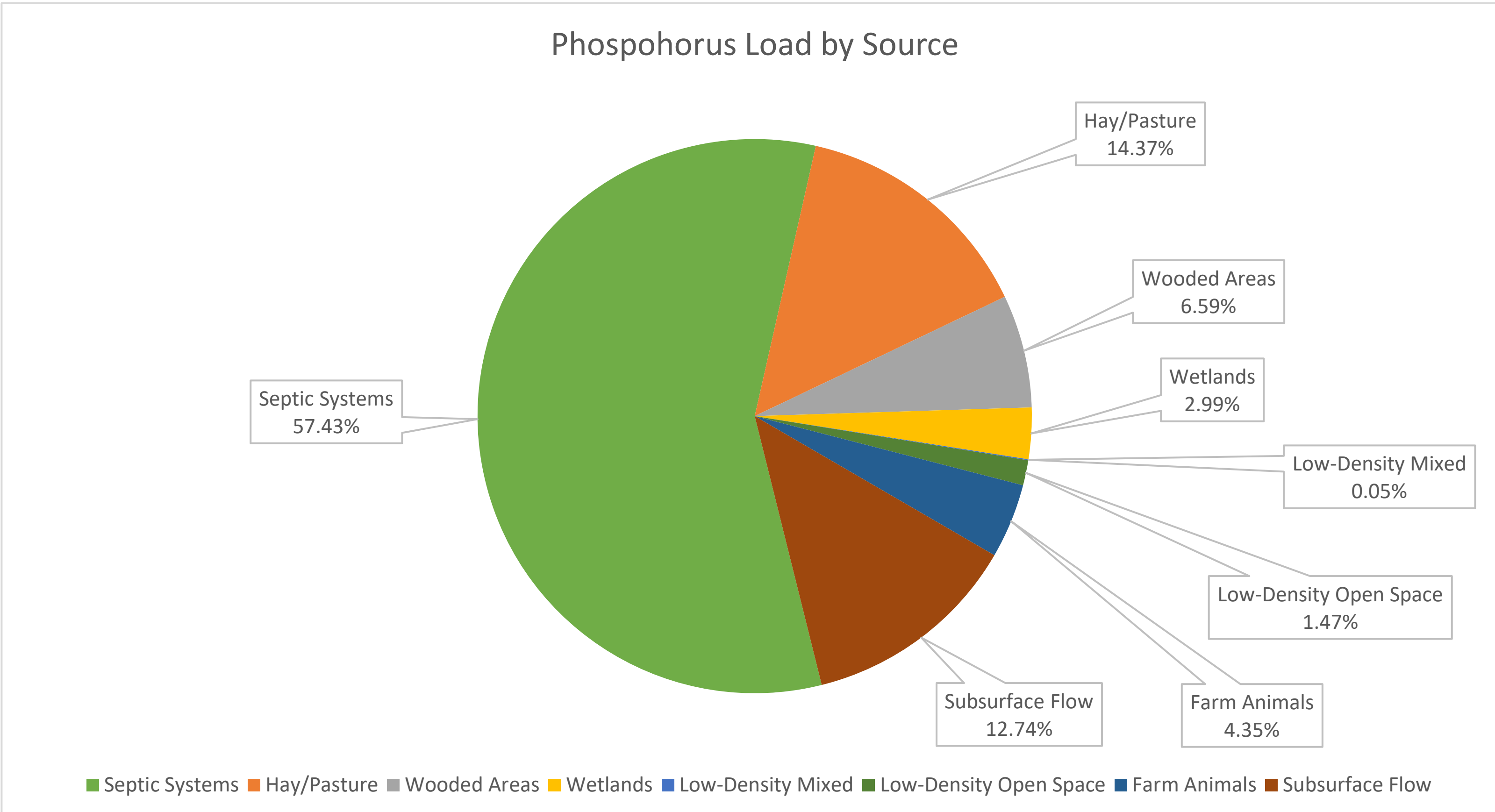
Zone 2

2. Assume that all septic systems within 200’ of lake shore in shallow water tables are failing (approximately 200 OSDSs)



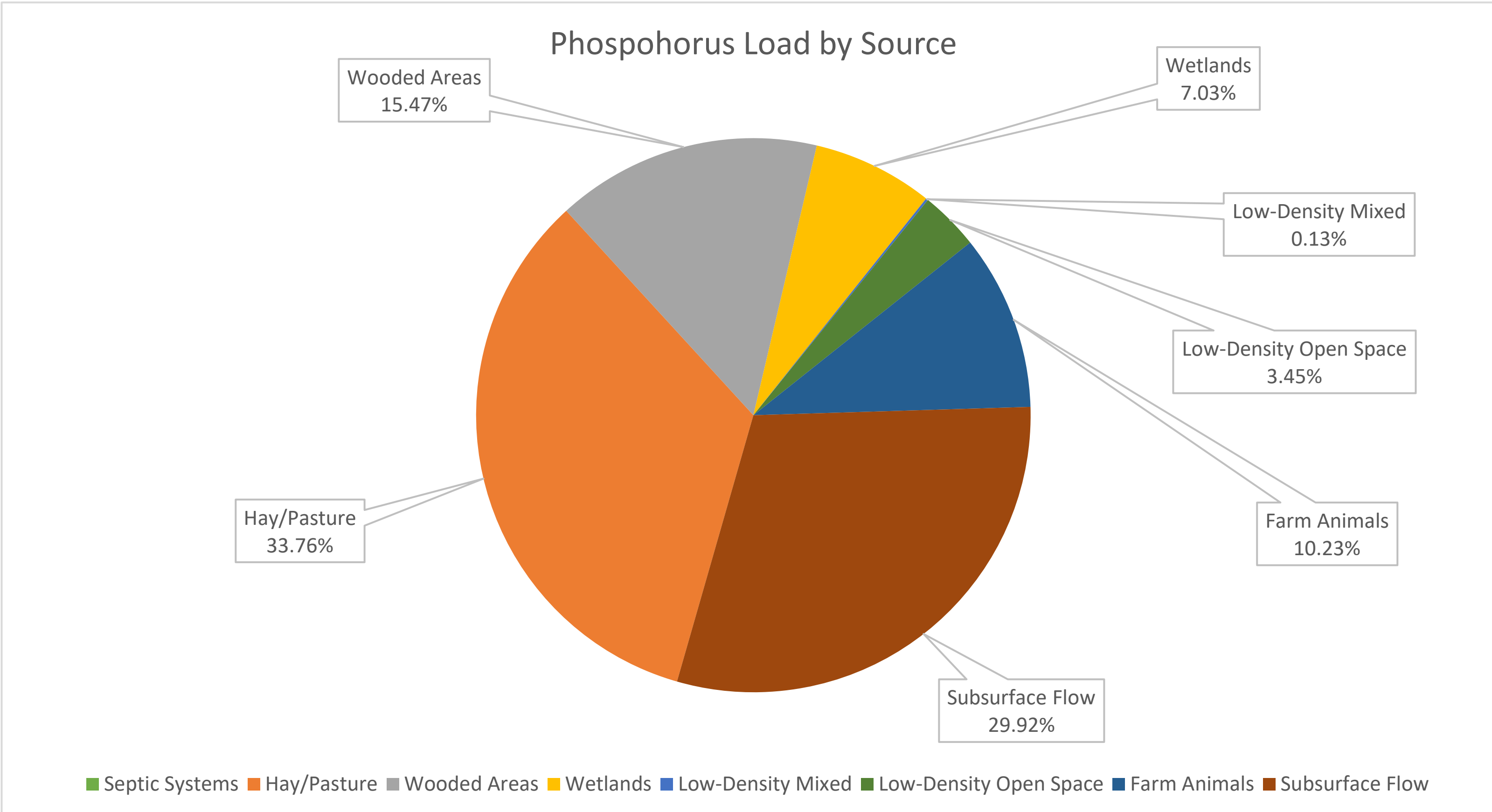
Zone 2

3. Assume at 15% failure in both zones



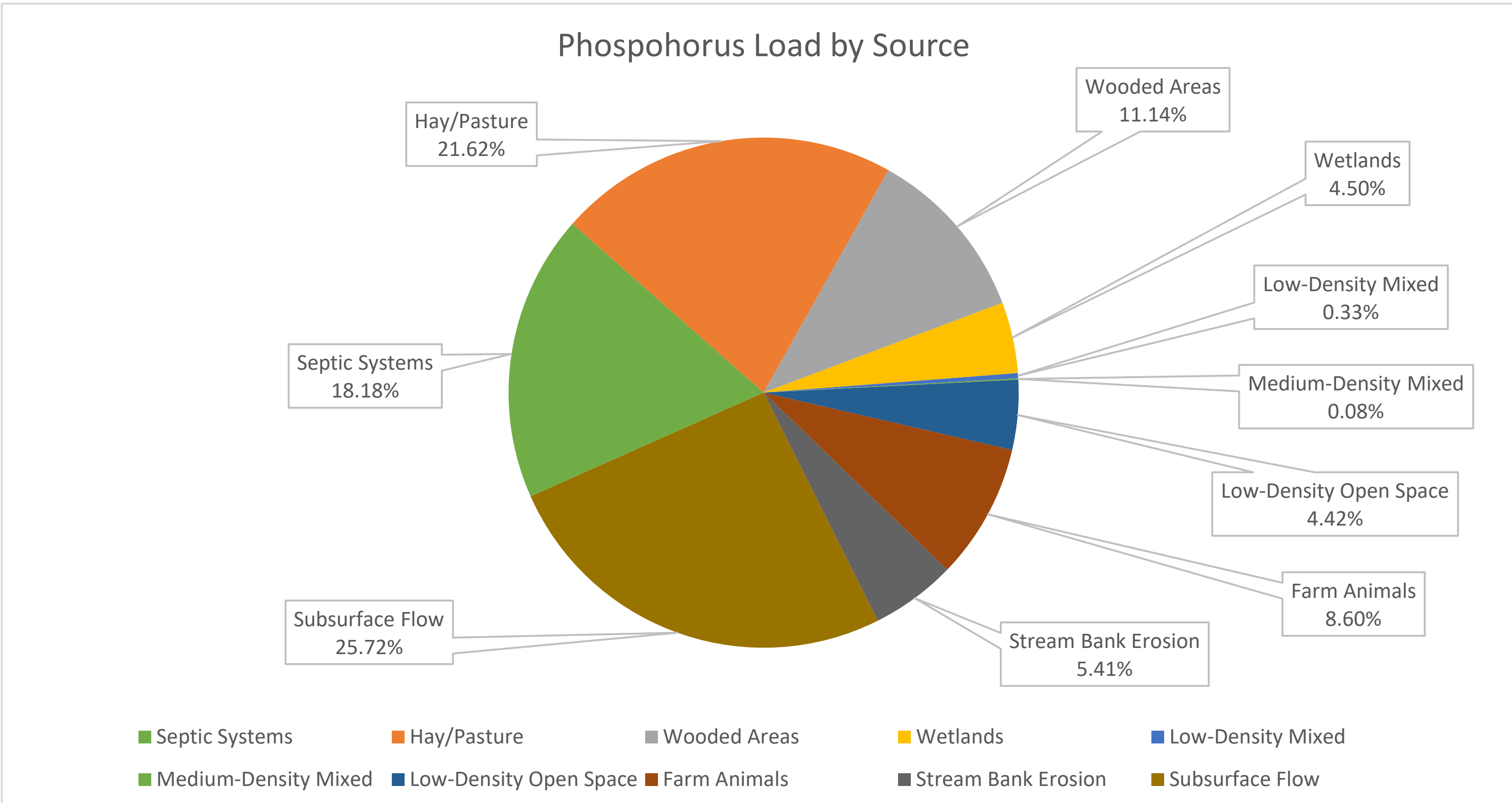
Zone 2

4. Assume no failures



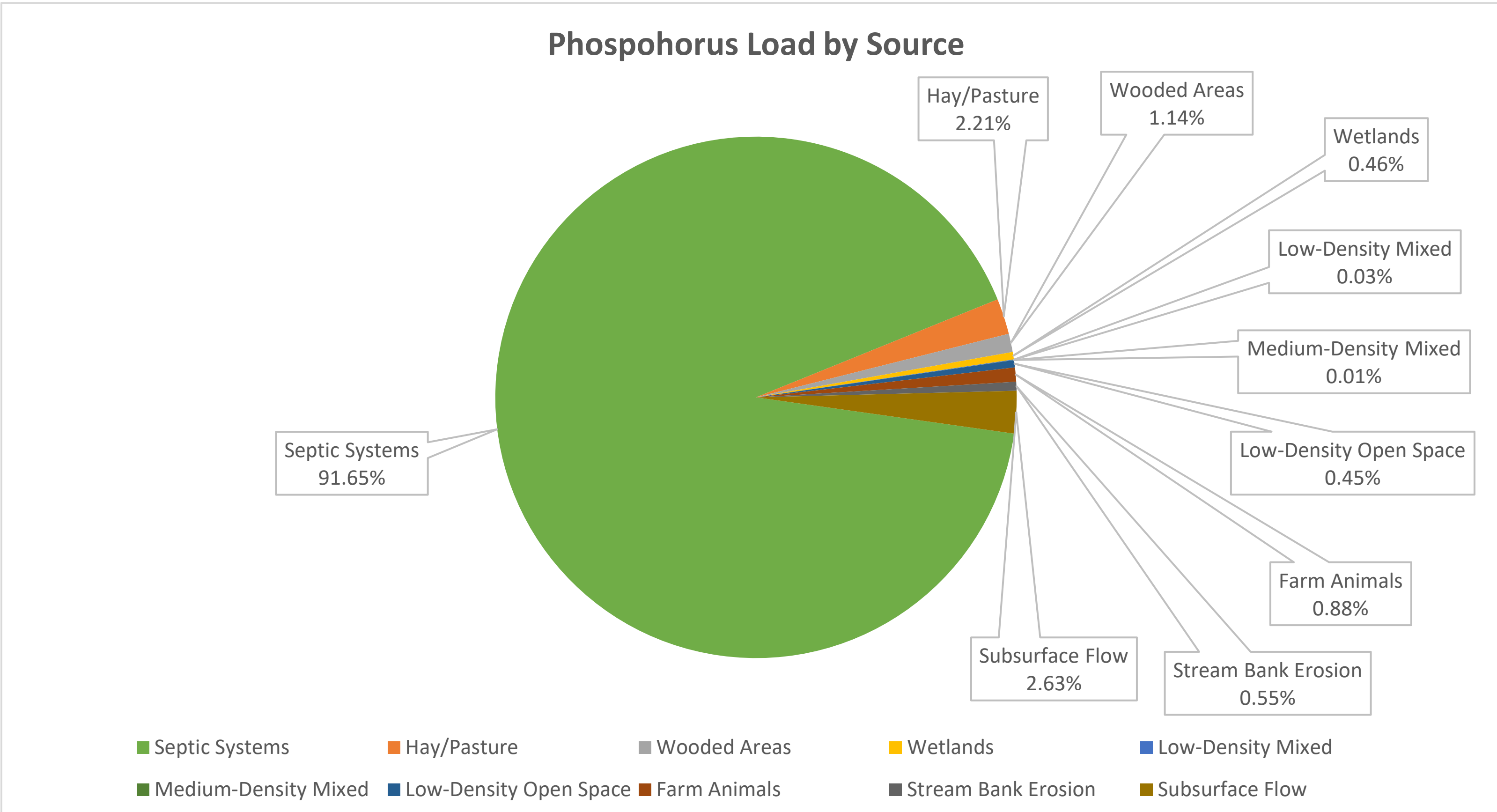
Combined (Zone 1 & 2)

1. Assume 2 failures per year per zone



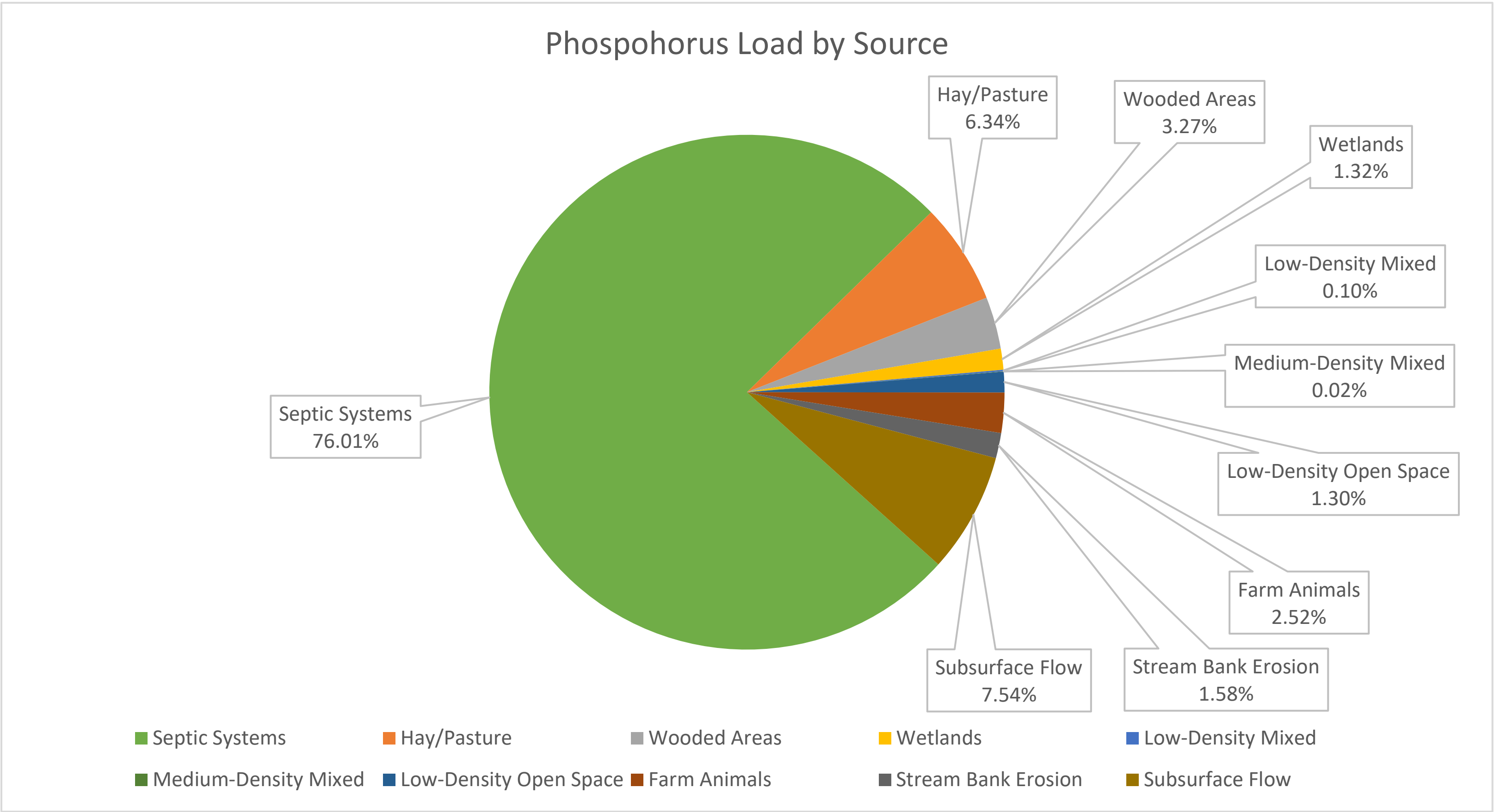
Combined (Zone 1 & 2)

2. Assume that all septic systems within 200’ of lake shore in shallow water tables are failing (approximately 200 OSDSs)



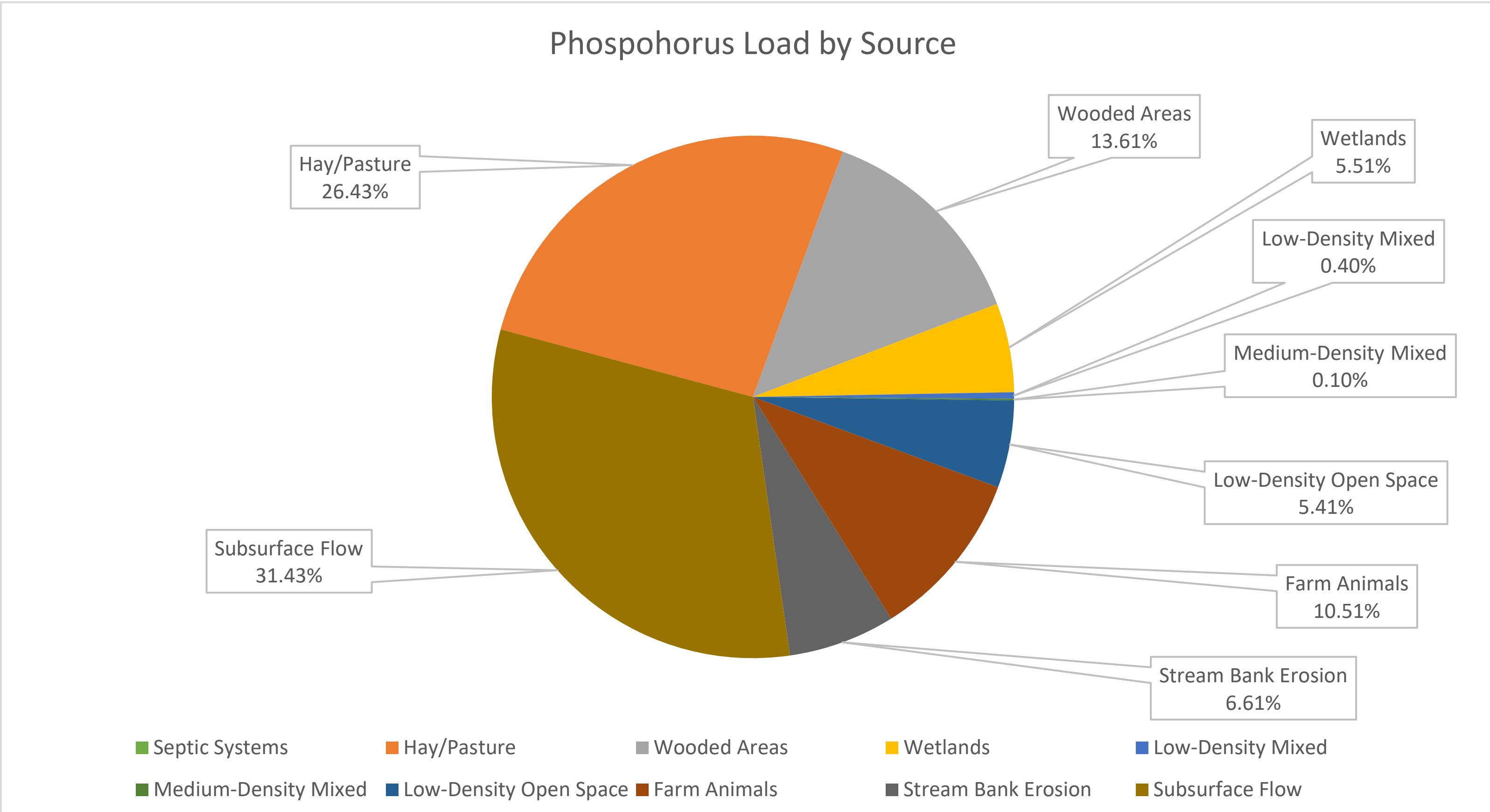
Combined (Zone 1 & 2)

3. Assume at 15% failure in both zones



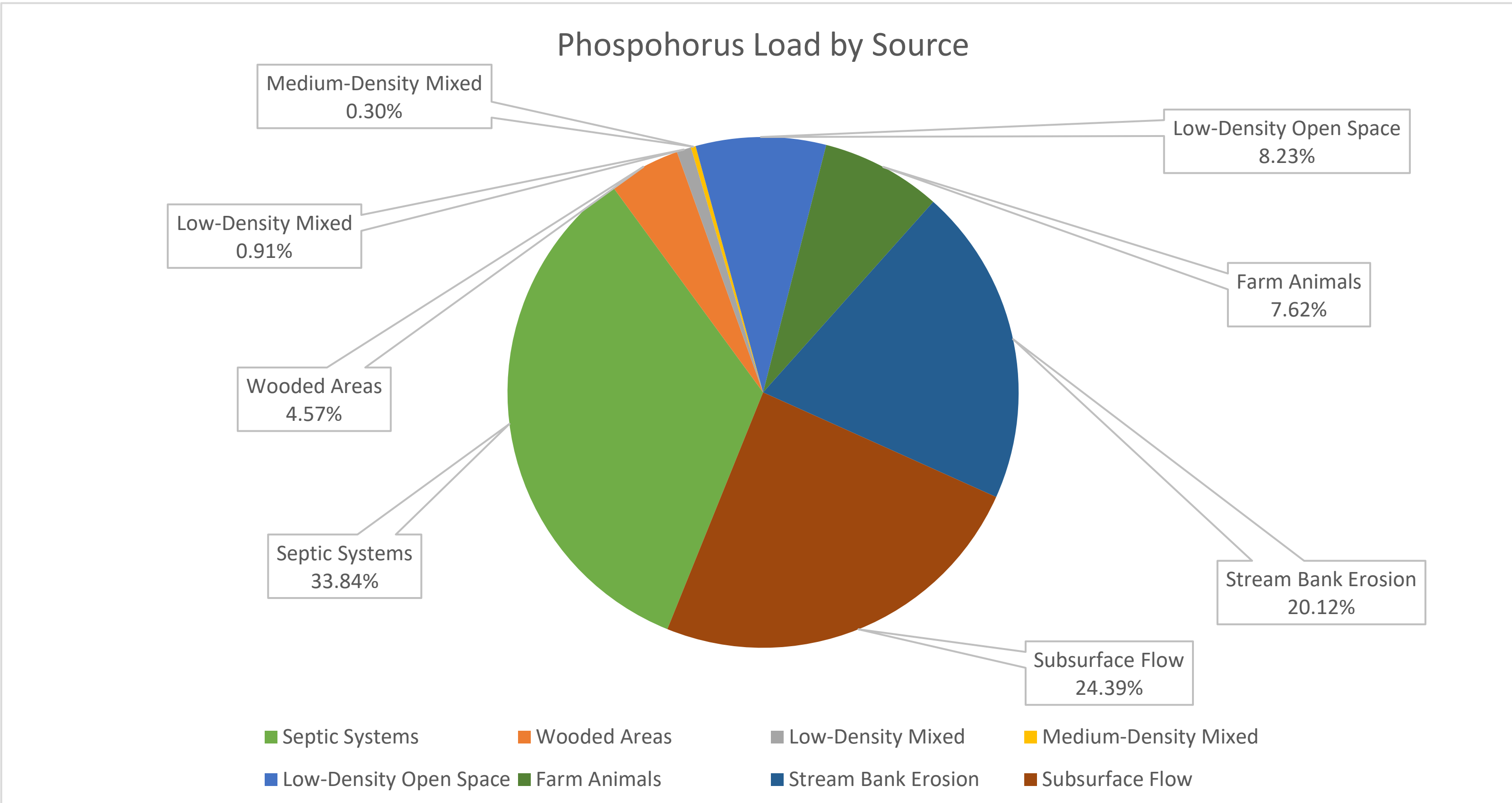
Combined (Zone 1 & 2)

4. Assume no failures



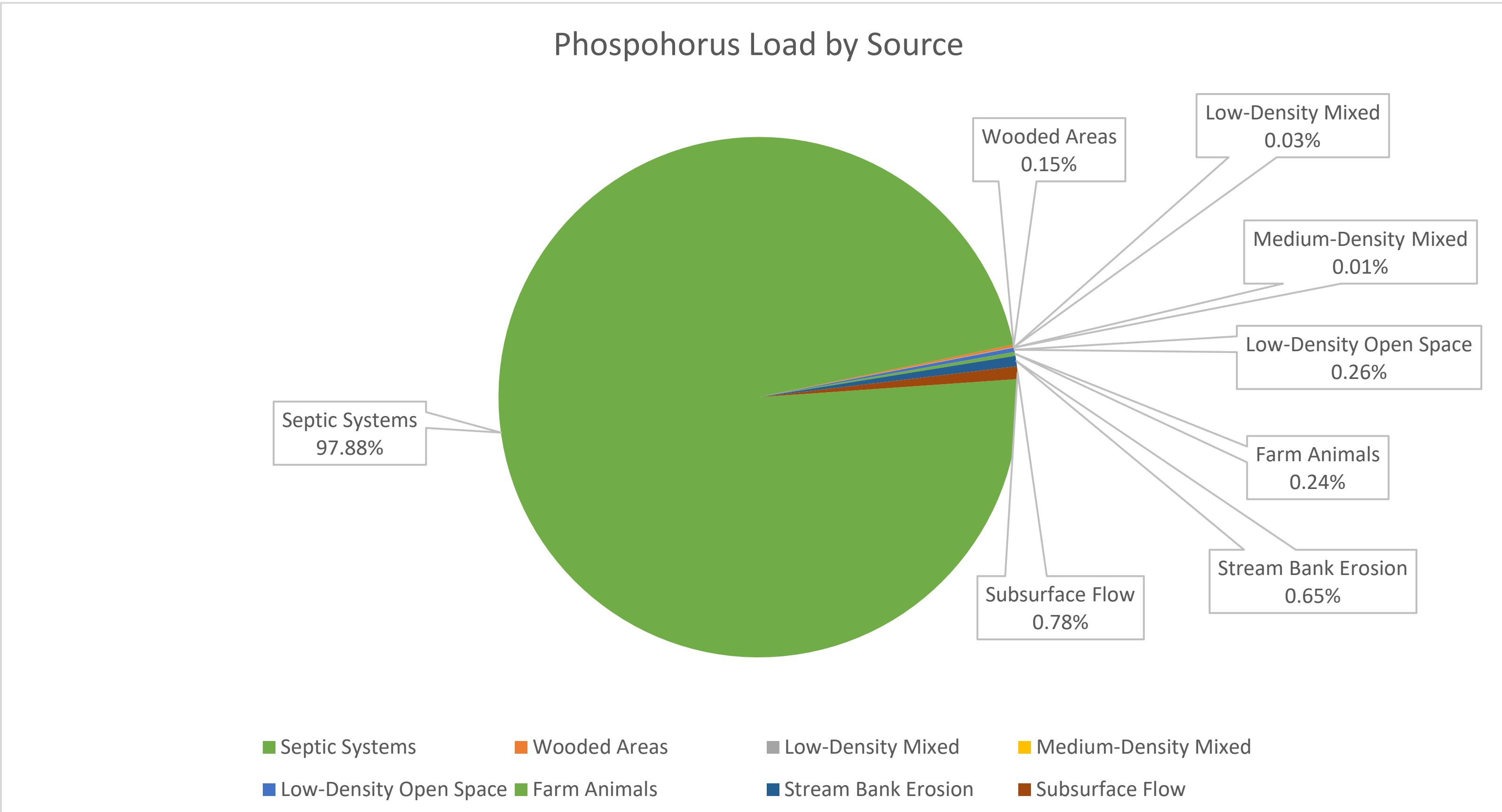
Zone 1

1. Assume 2 failures per year per zone



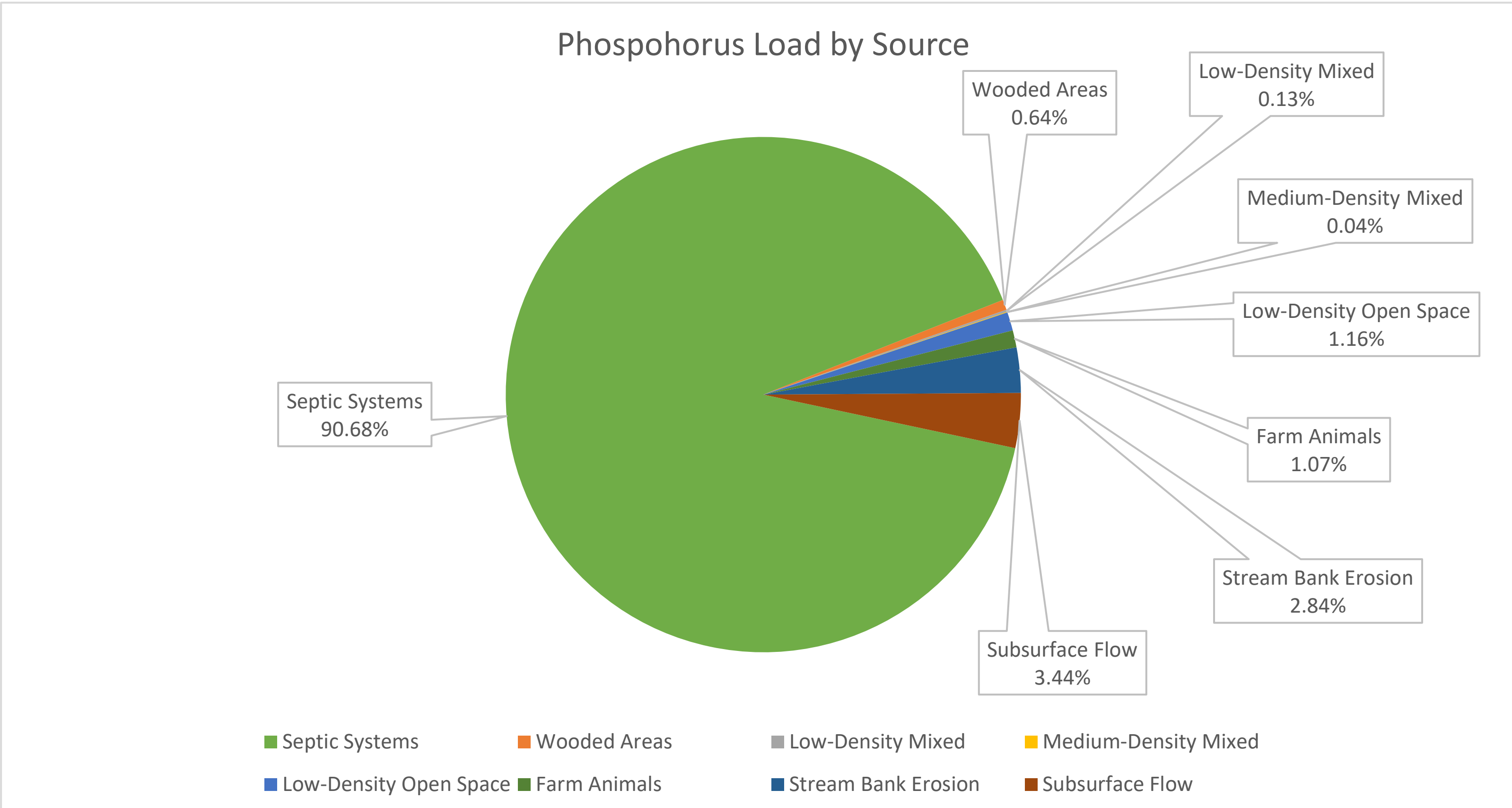
Zone 1

2. Assume that all septic systems within 200' of lake shore in shallow water tables are failing (approximately 200 OSDSs)



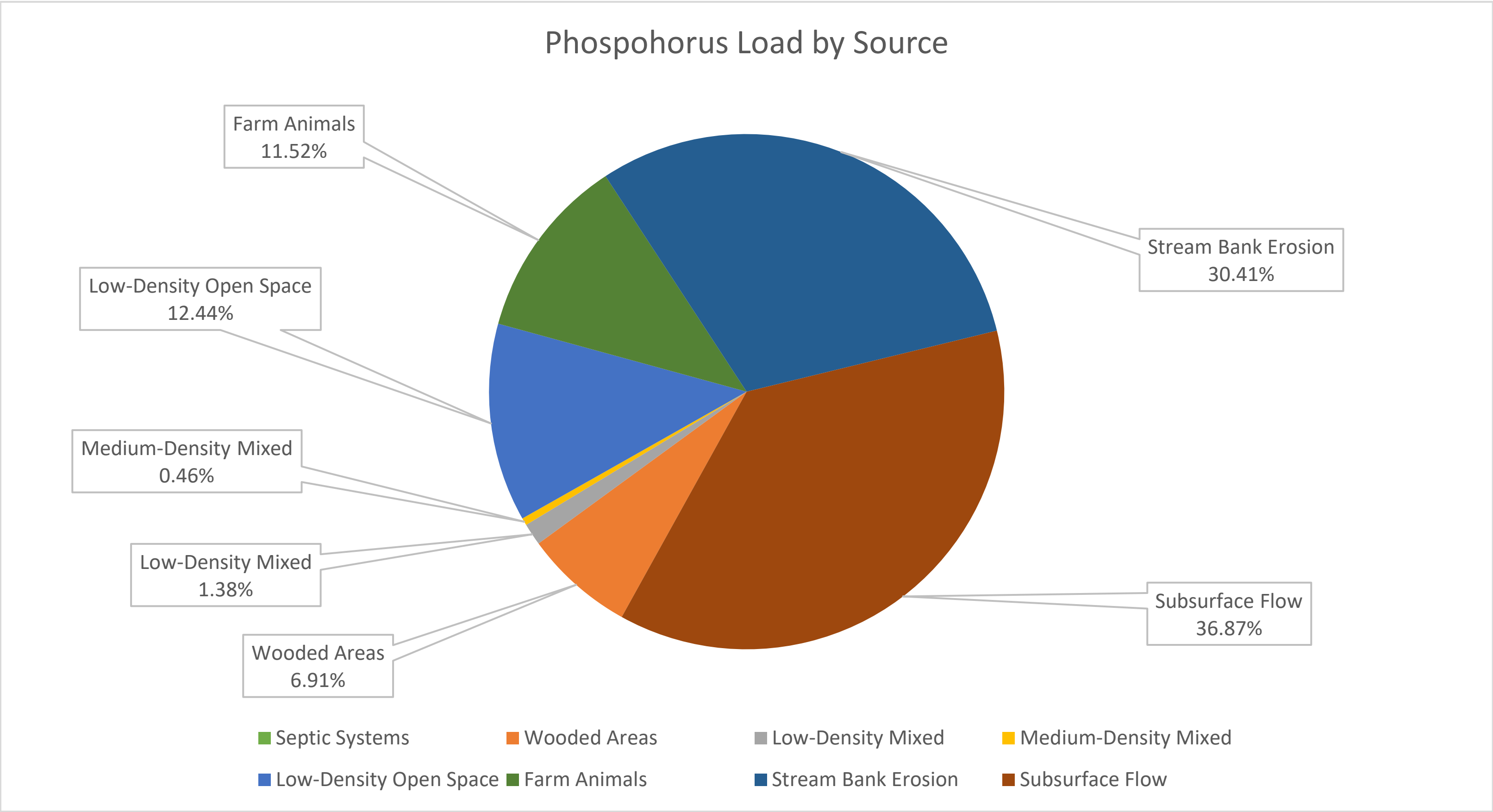
Zone 1

3. Assume at 15% failure in both zones



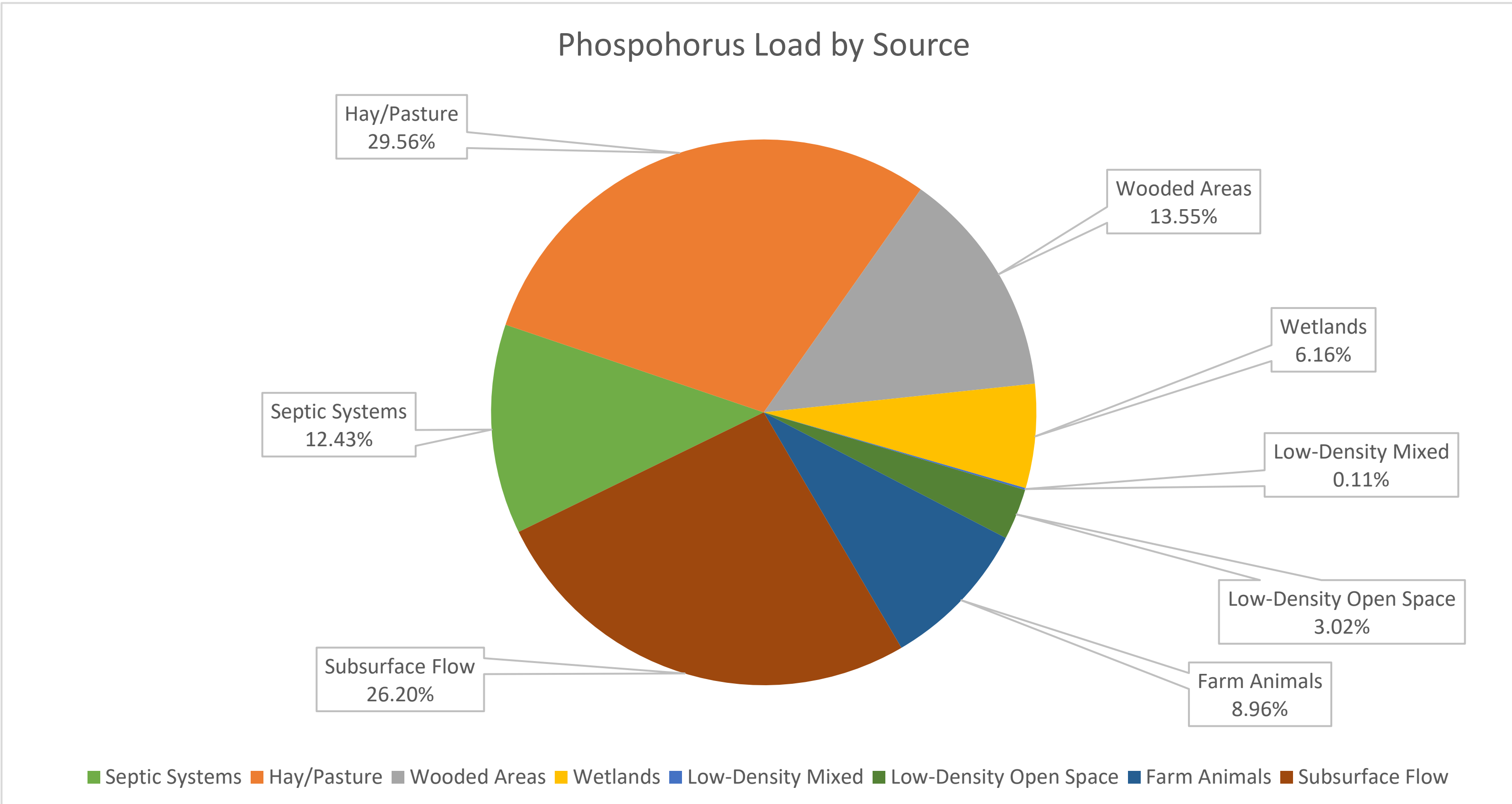
Zone 1

4. Assume no failures



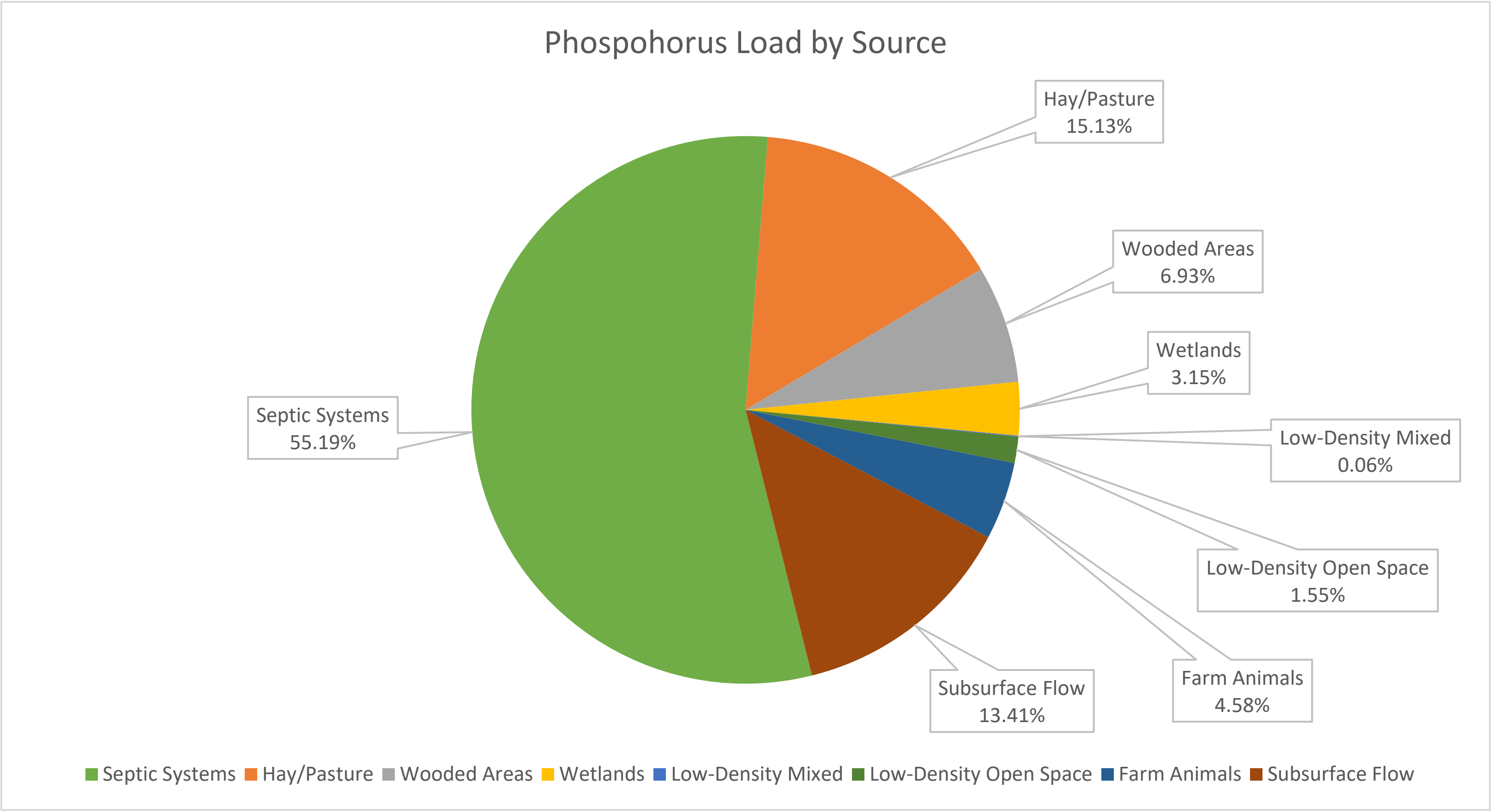
Zone 2

1. Assume 2 failures per year per zone



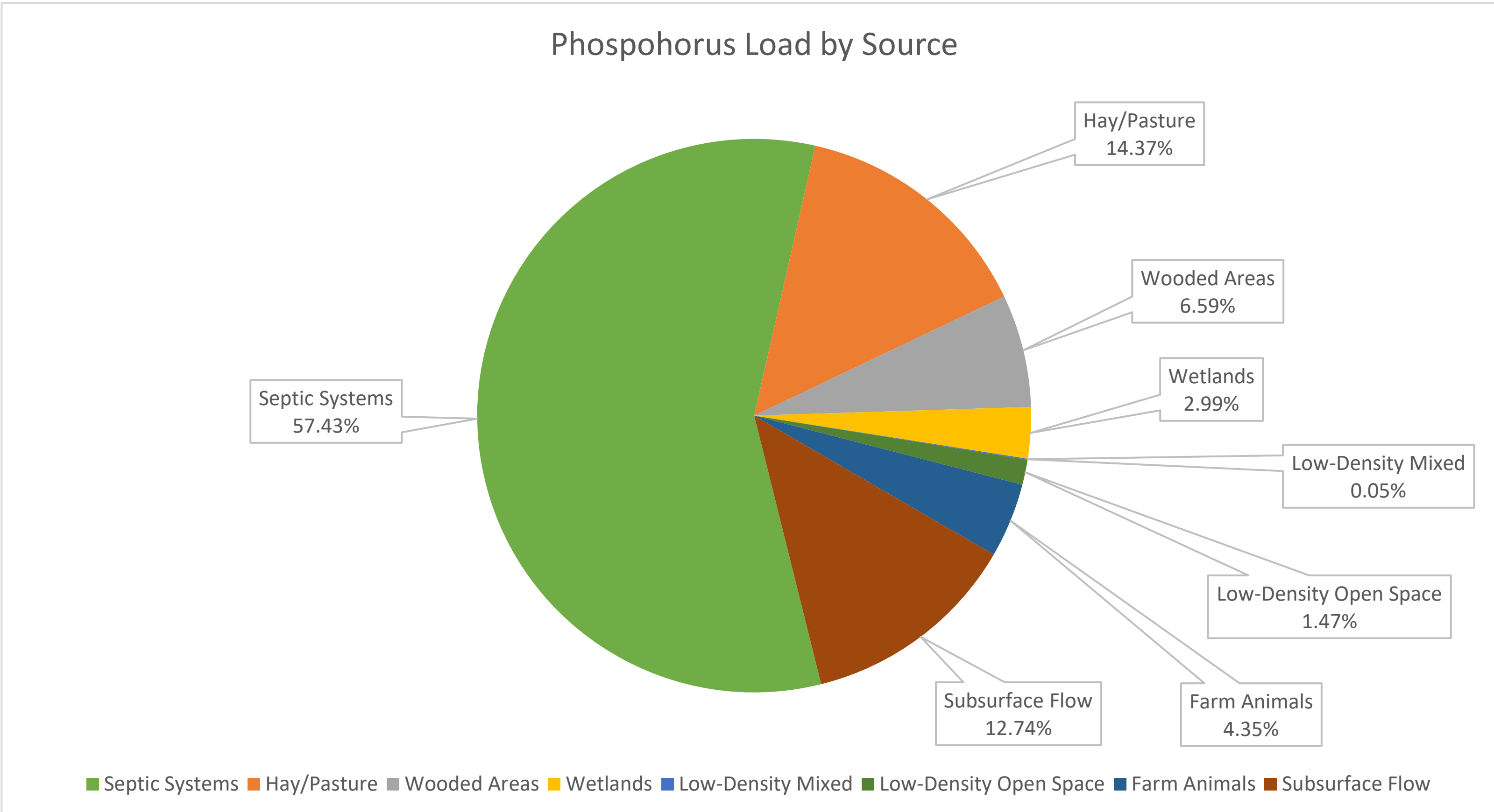
Zone 2

2. Assume that all septic systems within 200’ of lake shore in shallow water tables are failing (approximately 200 OSDSs)



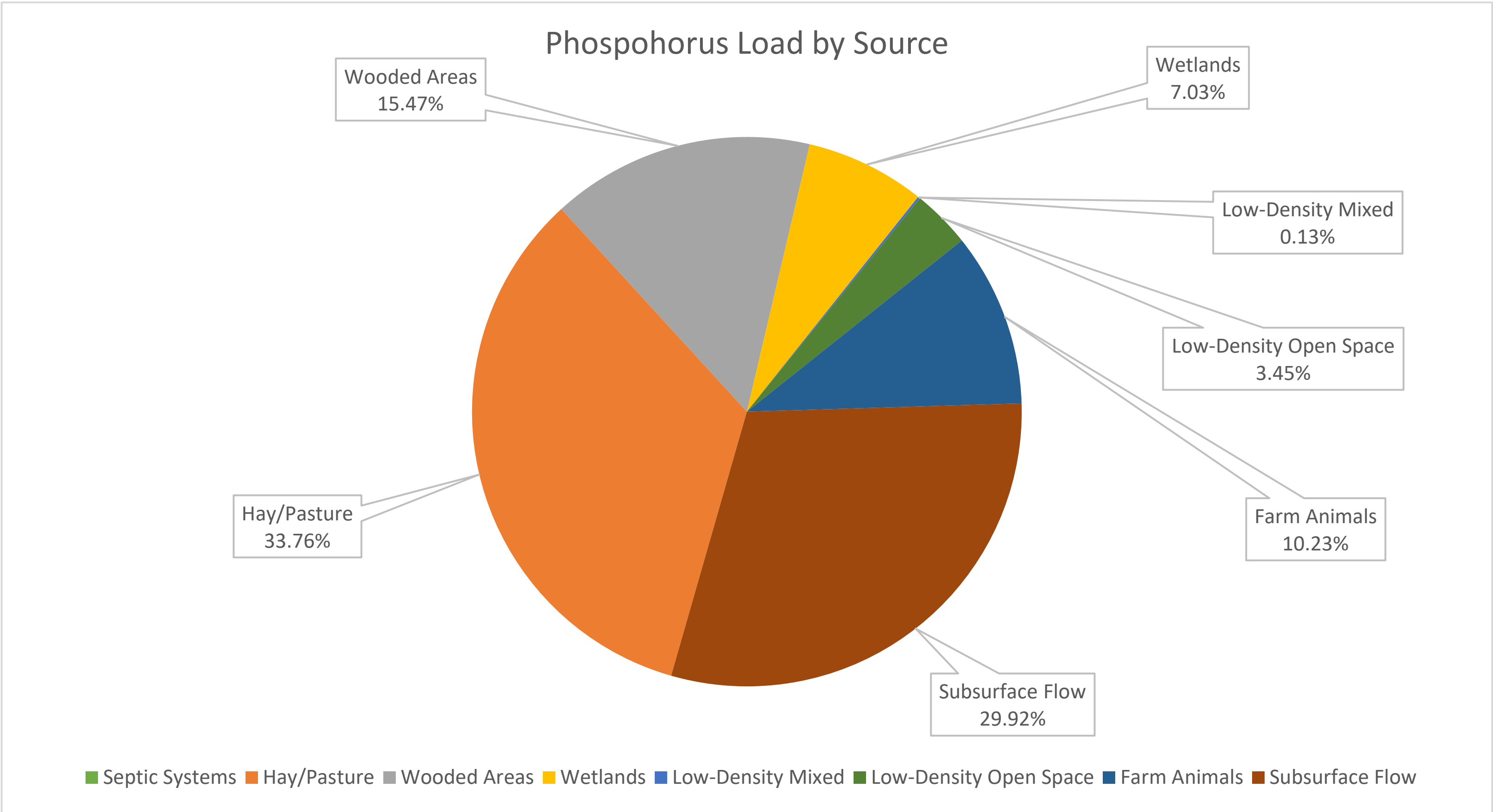
Zone 2

3. Assume at 15% failure in both zones



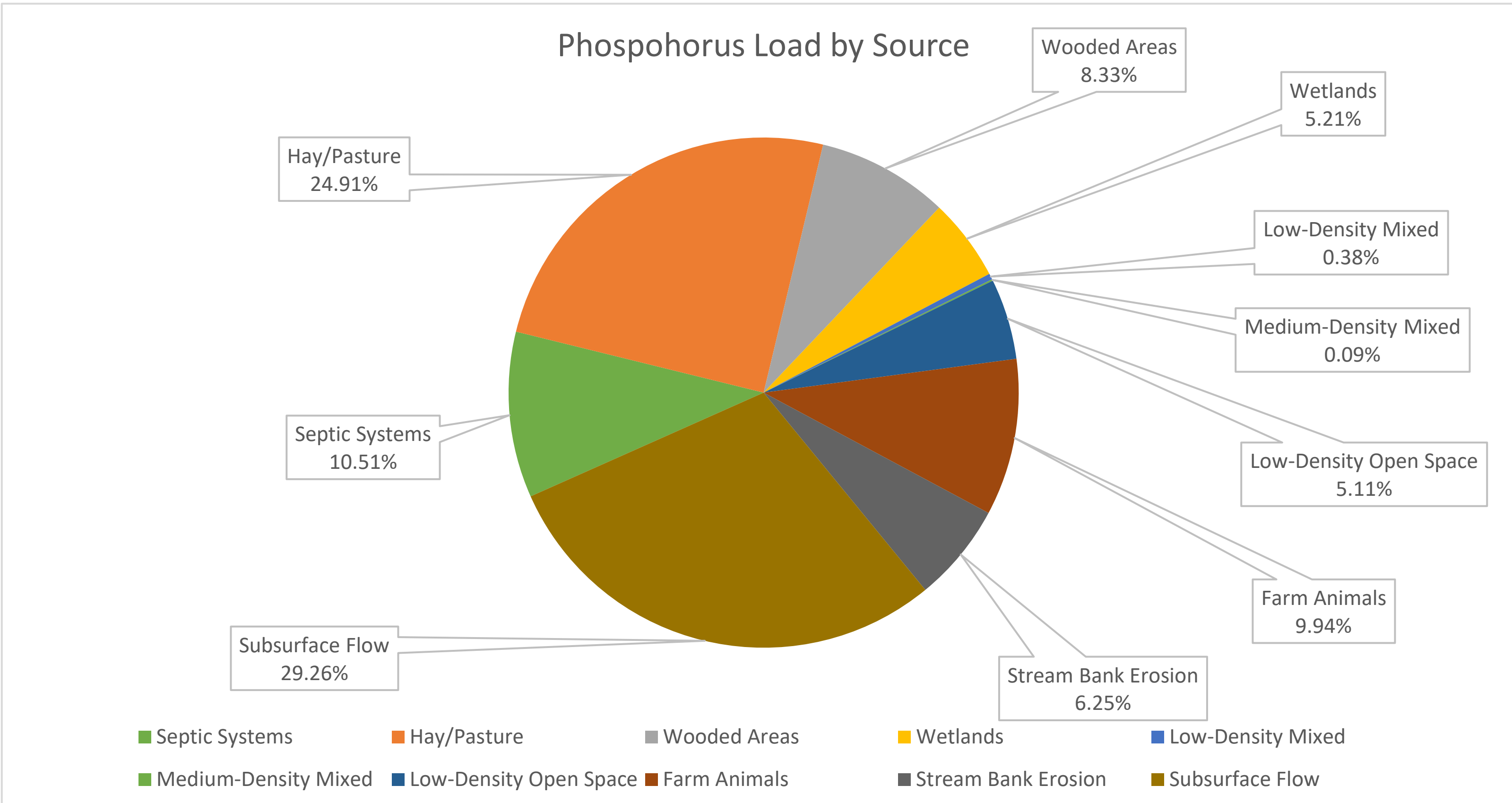
Zone 2

4. Assume no failures



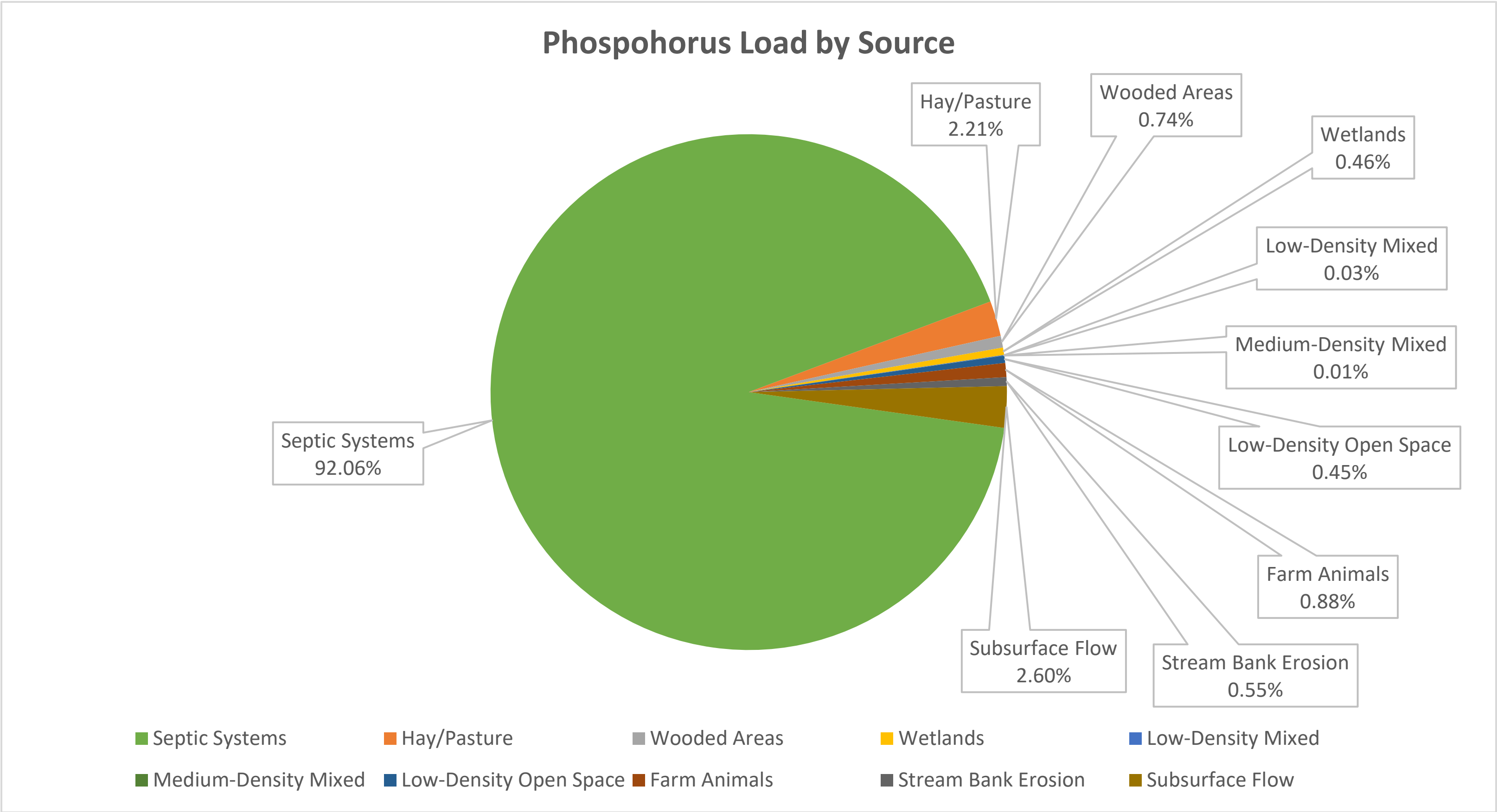
Combined (Zone 1 & 2)

1. Assume 2 failures per year per zone



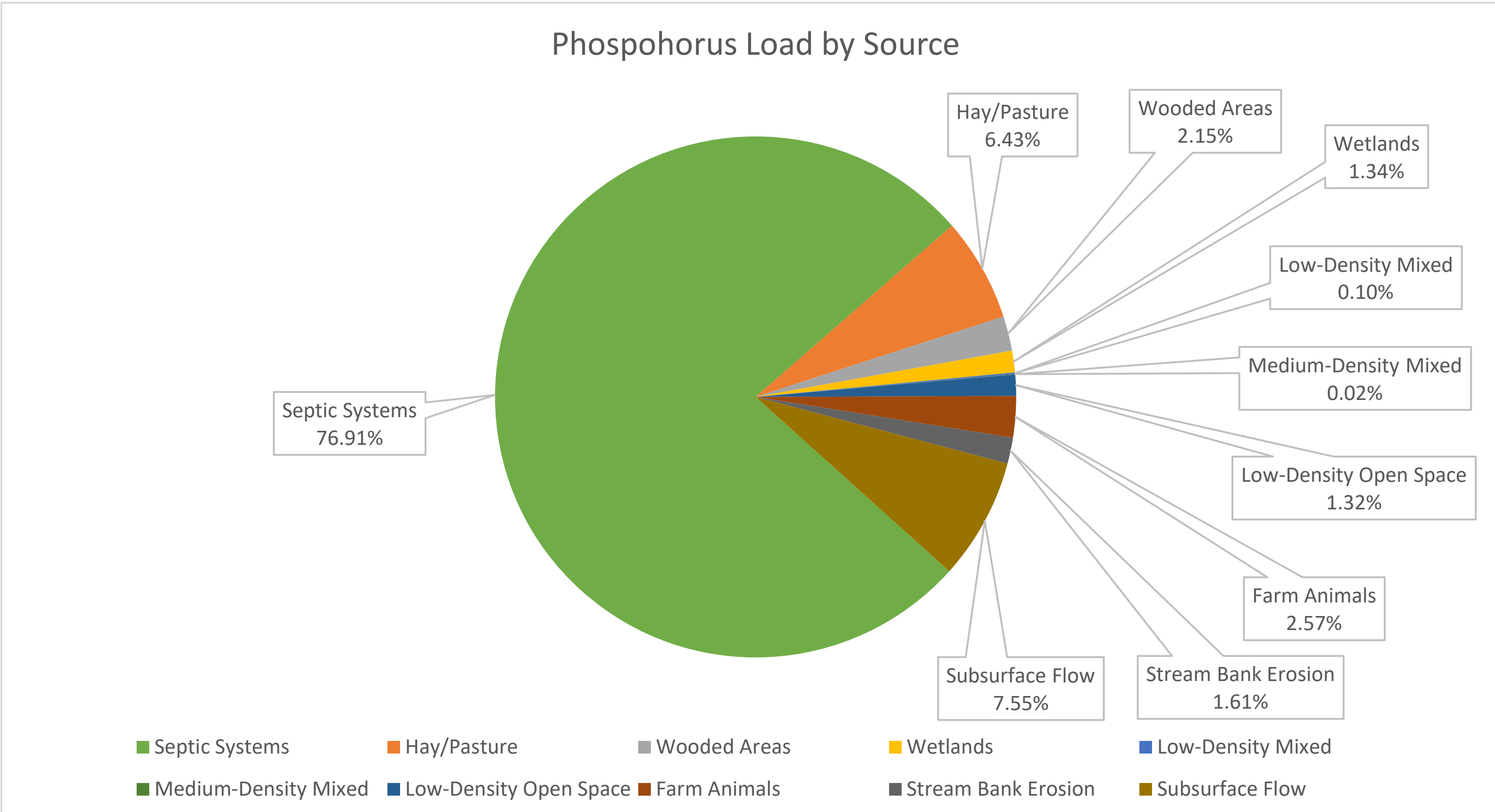
Combined (Zone 1 & 2)

2. Assume that all septic systems within 200’ of lake shore in shallow water tables are failing (approximately 200 OSDSs)



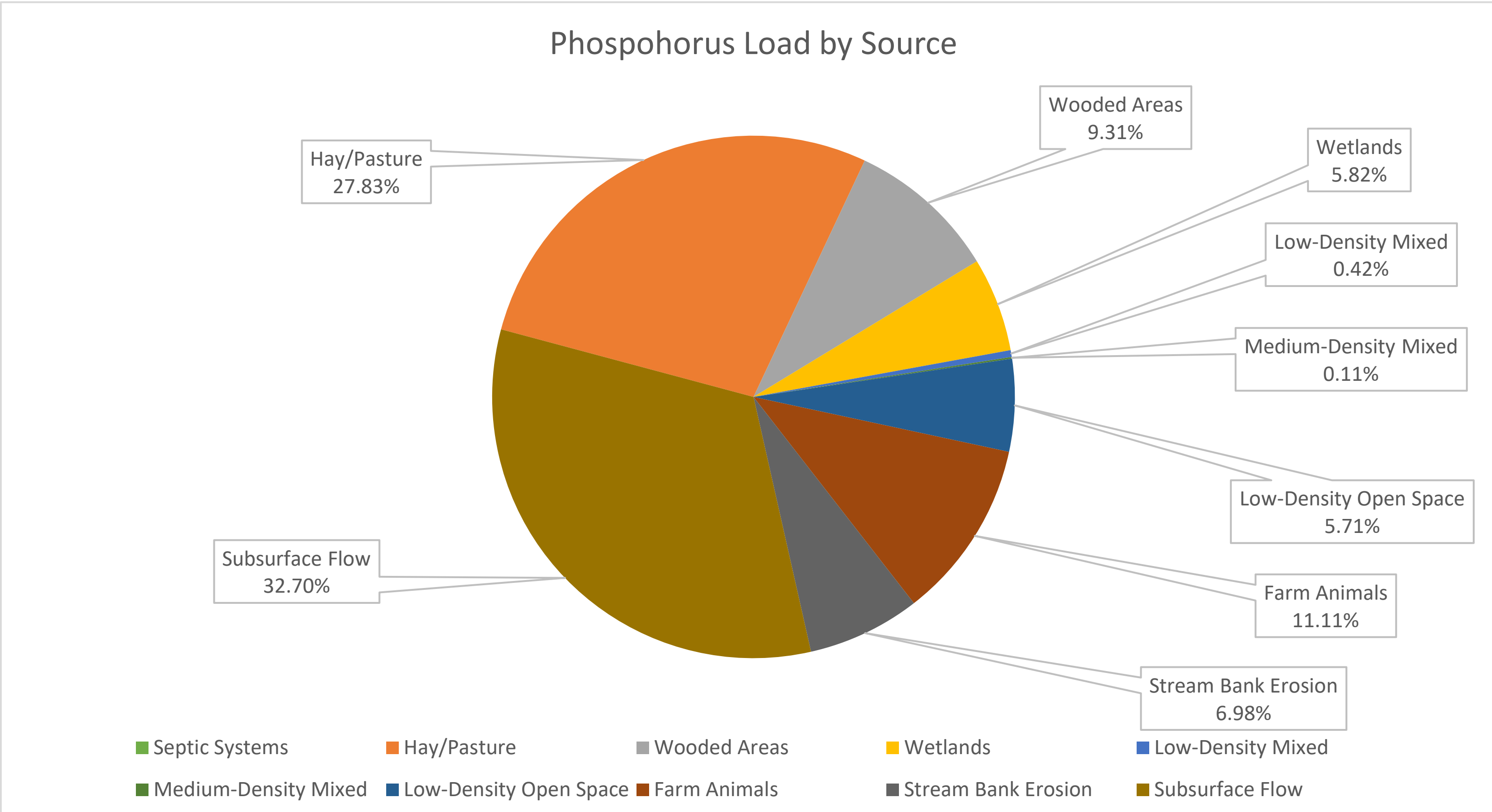
Combined (Zone 1 & 2)

3. Assume at 15% failure in both zones



Combined (Zone 1 & 2)

4. Assume no failures



Appendix D: Potential Required Permits and Approvals

New York State

	Permit	Activity	Agency	Comments
	Federal			
1	Section 404 of the Clean Water Act (Joint Application)	Discharge of dredged or fill material into waters of the United States (including non-isolated wetlands; delineation required for application). Nationwide Permits vs. Project-Specific Permit.	USACE	
	State			
2	Section 401 of the Clean Water Act (401 Water Quality Certification) (Pre-filing Meeting Request Form and Joint Application)	Certification is used to ensure that federal agencies issuing permits or carrying out direct actions, which may result in a discharge to waters of the United States do not violate New York State's water quality standards or impair designated uses.	NYSDEC	Pre-filing Meeting Request to be submitted 30 days prior to Joint Application
3	Protection of Waters (6 NYCRR Part 608; Article 15 of the ECL) (Joint Application)	Work within protected water bodies (bed and banks)	NYSDEC	
4	Freshwater Wetlands (6 NYCRR Parts 663 – 664; Article 24 of the ECL) (Joint Application)	Activities within State-regulated wetlands and buffer areas (mapped by NYSDEC). May include development of mitigation plan.	NYSDEC	NYSDEC-mapped wetlands identified proximal to the lake.

	Permit	Activity	Agency	Comments
5	Permit to Construct an Air Emission Source (Article 19 of ECL; 6 NYCRR Part 201)	Permit to construct and operate an air emission source. (**Note**: Construction, as defined below and excluding site clearing and excavation, is not permitted until the air permit is issued. Pursuant to 6 NYCRR 201-2.1(b)(9), "Construction" is defined as the "initiation of physical on-site construction activities which are of a permanent nature excluding site clearing and excavation. Such activities include, but are not limited to, installation of building supports and foundations, laying underground pipework and construction of permanent storage structures.")	NYSDEC	Potential need for air permit or registration certificate for wastewater treatment plant operations.
6	Hazardous Substance (Chemical) Bulk Storage & Petroleum Bulk Storage (Articles 17, 37 & 40 of the ECL; 6 NYCRR Parts 596-599, 613)	Tank registrations (including construction-related) (SPR and/or SPCC Plan may be necessary depending upon quantities)	NYSDEC	Potential need for PBS certificate for petroleum storage needed for emergency power and/or CBS certificate for chemical storage.

	Permit	Activity	Agency	Comments
7	SPDES General Permit for Storm Water Discharges from Construction Activity (GP-0-20-001)	Stormwater discharges from construction phase activities disturbing one-acre or greater. Includes preparation and implementation of Stormwater Pollution Prevention Plan (SWPPP).	NYSDEC	• Notice of Intent (NOI) submitted at least 5-days before construction start-up. • Notice of Termination (NOT) submitted after site restoration completed. • Up to 60-day review of SWPPP by NYSDEC if SWPPP not in conformance with General Permit. • Potential review of SWPPP by municipality in MS4 communities.
8	SPDES Permit for the Discharge of Industrial Wastewater (and Stormwater) (6 NYCRR Part 750)	Combined SPDES Permit (process wastewater from pre-treatment facility and site stormwater discharges). See local permits below if wastewater from pre-treatment facility is discharged to local POTW.	NYSDEC	Must also adhere to NYCDEP MS4 SWPPP Requirements
9	Wastewater Disposal System (Approval of Plans & Specifications)	Approval of wastewater facility designs.	NYSDEC (tie-in to public sewer may also require local approval)	
10	Highway Work Permit	Work within highway rights-of-way (highway and utility improvements).	NYSDOT and/or local DOT	
11	NOI to Undertake an Action within an Agricultural District (1 NYCRR Part 370)	Assessment of potential agricultural impacts for projects sponsored by State agencies, public benefit corporations, or local government, and occurring within an agricultural district.	NYSDAM	

	Permit	Activity	Agency	Comments
		(Some municipalities also require private developers to complete agricultural data statements.)		
12	Federal Coastal Zone Management Act & NYS Coastal Management Program (6 NYCRR Part 600) (Federal or State Coastal Consistency Assessment Form)	Any person who is considering an activity in, or affecting, the State's coastal area that requires approval from a federal, State or local agency (in a city, town, or village with an adopted Local Waterfront Revitalization Plan, LWRP) may be required to comply with certain consistency requirements or have their action subject to state agency consistency requirements.	NYSDOS, Permitting State Agency and/or municipality (with approved LWRP)	No current LWPR; however, potential exists for future program.
13	SEQRA (Article 8 of the ECL; 6 NYCRR Part 617)	Environmental impact assessment. Preparation of Short or Full EAF. May also involve "Environmental Justice"-related public participation activities. Federal funding/permits may require NEPA review.	Lead & Involved Agencies (coordinated vs. uncoordinated review)	
14	Federal & State Preservation Laws (36 CFR 800; 9 NYCRR Part 428; Sections 3.09 and 14.09 of the NYS Parks, Recreation and Historic	Activities affecting historic, architectural, archaeological and cultural resources. Involved State agency determines need for consultation with SHPO. Consultation via SHPO's Cultural Resource Information System (CRIS). Initial	NYSOPRHP – Field Services Bureau (SHPO)	

	Permit	Activity	Agency	Comments
	Preservation Law)	consultation includes submission of project description and location, photographs, and documentation of prior disturbance and/or cultural resource investigation. Goal is to obtain "No Effect" letter from SHPO.		
15	State Lands Permit (Section 233 of NYS Education Law)	Required for activities that will appropriate, excavate, injure, or destroy any object of archeological or paleontological interest, situated on or under lands owned by the State of New York. Required prior to performing archeological reconnaissance investigations on state lands.	New York State Museum and State Agency which owns the land	
16	ESA (Section 7 of ESA)	Consultation process to identify whether a Federally- or State-listed, proposed or candidate species and/or critical habitat may occur within the proposed project area.	USFWS NYSDEC NHP	
17	Notice of Petition for Grant or Easement for Underwater Lands	Installation of cables, conduits, pipelines and other facilities in State owned lands underwater.	NYSOGS	Truesdale Estates Association, Inc. owns the lake bottom. Verify authorization requirements in order to undertake activities.

	Permit	Activity	Agency	Comments
18	Pre-Demolition Asbestos Survey (12 NYCRR Part 56 – Industrial Code Rule 56 and 40 CFR Part 61, Subpart M – NESHAP)	Pre-Demolition Asbestos Survey Pre-Demolition Notification Pre-Removal Notification (if demolition involved).	NYSDOL USEPA	
19	Lead in Construction Rules (29 CFR 1926.62)	Removal of Lead Based Paint.	OSHA	
	Regional			
20	NYC Watershed Rules & Regulations	Consultation with NYCDEP regarding potential impacts on NYC watershed (NYC's water supply source); typically coordinated with SPDES storm water permitting processes.	NYCDEP	
21	Approval of Wastewater Collection and Conveyance	Review and approval of the design of the new sewer lines and conveyance facilities.	NYCDEP	
22	Variance from Prohibition of New or Expanded WWTP	Consultation with NYCDEP regarding required variance.	NYCDEP	
23	Approval of WWTP	Review and acceptance of design.	NYCDEP	
	Local (Municipal, at the discretion of the Town)			
24	Rezone	Rezone to allow proposed land use (if necessary).	Municipal Board (typical)	
25	Site Plan Approval	Approval of site modifications. (May not be necessary if no major site modifications [*i.e.*, Building Permit only] – coordinate with	Municipal Planning Board (typical)	

	Permit	Activity	Agency	Comments
		municipal Code Enforcement Officer to identify process).		
26	Subdivision Approval	Consolidation or breakout of parcels.	Municipal Planning Board (typical)	
27	Variances (or Special Use Permits)	Approval of area (*i.e.*, encroachment on setbacks) and/or use variances.	Municipality (ZBA) (typical)	
28	GML 239-m	County Planning Board review of activities located within 500-feet of State or County highway, municipal boundary or park.	County Planning Board	
29	Water and Wastewater System Improvements Approval of Plans	Approval of water and wastewater infrastructure improvements and connections.	Westchester County DOH	
30	Building & Demolition Permits	Building code compliance.	Local Code Enforcement Office	
31	Certificate of Occupancy	Approval to occupy building.	Local Code Enforcement Office	
Source: Ramboll				

Appendix E: List of Sources Referenced for Lake Truesdale GIS File and Figures

List of Sources referenced for Lake Truesdale GIS file and Figures

- Westchester County Department of Health
  - Approved Remediation Permits
  - Septic Repairs Completed between 1-1-2008 and 1-1-2021
  - Septic System Pump outs
- Westchester County GIS
  - Steep Slopes
  - Hydric Soils
- Town of Lewisboro
  - Tax Map Section-Block-Lot
  - Tax Map Property Lines
  - Year Built (house)
  - Number of Bedrooms per Parcel
  - Digitized Section-Block-Lot
  - Property Owner Name
  - Property Owner Mailing Address
  - Year Remodeled (house)
  - Parcel Acreage
- United States Department of Agriculture Web Soil Survey
  - Soil Type
  - Hydrologic Soil Group
  - Depth to Bedrock
  - Depth to Water Table
  - Suitability of Soil for Septic Systems
- New York City Department of Environmental Protection
  - 2’ Contours
  - NYC Watershed Basins
  - Bedrock Geology
  - Parcel Address
  - NWI Wetlands
  - FEMA Floodplains
  - Land Use
  - Land Cover
  - USGS National Hydrography Dataset (Wetlands, Streams, Lakes)
- New York State GIS Clearinghouse
  - Tax Map Parcels
  - Municipal Boundaries
  - State Boundaries
  - Orthoimagery (Aerial Photo Background)
  - New York State Department of Environmental Conservation Wetland Boundaries