LRN: 03D102I

Project Number: BJS-LQ02 4l

The Impact of Title 5 on Lake Quinsigamond

An Interactive Qualifying Project Report

Submitted to the Faculty of

WORCESTER POLYTECHNIC INSTITUTE

In partial fulfillment of the requirements for the

Degree of Bachelor of Science

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Date: April 30, 2003

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Abstract

By understanding lake characteristics and subsurface sewage disposal systems it was determined that a regulation system was needed to protect the environment and the health of the population. The rules and regulations of Title 5 were viewed and the effectiveness was found by comparing the amounts of phosphorus and nitrogen that enters the lake with and without the regulations of Title 5. This allowed for the determination that without Title 5 Lake Quinsigamond would eutrophy at a higher rate.

Table of Content

Table of Content Continued

Table of Contents Continued

Table of Contents Continued

Authorship Page

Authorship Page Continued

**All revisions done by all three parties

Glossary

Amictic Lake: a lake that are permanently covered by ice, and the waters remain at temperatures well below 4°C

Bacteria: any of a group of microscopic organisms that are prokaryotic, i.e., that lack a membrane-bound nucleus and organelles

Biomat: a black, jelly-like mat that forms along the bottom and sides of the drain field trench. It is home to anaerobic microorganisms that consume the organic matter in the wastewater.

Board of Health: A town organization that is responsible for activities that related to health and the environment.

Carcinogens: a substance or agent producing or inciting cancer

Cesspool: underground tank that stores sewage until it can be disposed of.

Chlorine: disinfectant in water purification

Cold Monomictic Lake: A lake whose water never rises above 4°C in the summer. It is during the winter months where cold monomictic lakes are temporarily amictic and experience inverse thermal stratification

Contaminate: to make impure or unclean.

Department of Environmental Management (DEM): The organization where Massachusetts' land management and resource planning is completed. There are two major bureaus the Division of Forest and Parks, and the Division of Resource Conservation.

Department of Environmental Protection (DEP): The organization that oversees the growth and execution of Massachusetts DEP policies and programs. There are three major bureaus within the DEP; Resource Protection, Waste Prevention, and Waste Site Clean up.

Dimictic Temperature Lakes: A lake that have complete circulation in the spring, stratify during the summer, mix again in autumn and inversely stratified in winter. (Lake Quinsigamond.)

Distribution Box: Box is a small tank that has one inlet and multiple outlets that uniformly disperse the flow of the effluent to several lines of a disposal field.

E. coli: a straight rod-shaped gram-negative that are used in public health as indicators of fecal pollution (as of water or food), or produce a toxin causing intestinal illness

Epilimnion: the region of temperature gradient between the surface and the Thermocline during Stratification.

Equity: the money value of a property or of an interest in a property in excess of claims or liens against it

Eutrophic: Having waters rich in mineral and organic nutrients that promote a proliferation of plant life, especially algae, which reduces the dissolved oxygen content and often causes the extinction of other organisms.

Eutrophication: process by which bodies of water become enriched hence more productive.

Greywater: water from sinks, washing machines, showers and other plumbing fixtures except toilets.

Greywater Garden: a patented specially engineered system to evaporate and grow away graywater.

Hemolytic Uremic Syndrome: A syndrome where a large number of the red blood cells are destroyed and the kidneys fail.

Glossary Continued

Hydrologic Cycle: The cycle of evaporation and condensation that controls the distribution of the earth's water as it evaporates from bodies of water, condenses, precipitates, and returns to those bodies of water.

Hypolimnion: the region of temperature gradient between the Thermocline and the bottom during Stratification.

Igneous rock: rock formed by the solidification of molten magma

Innovative Technologies: additional aspects or alternatives to septic systems that provides an equal or greater degree of effectiveness.

Inorganic Matter: being or composed of matter other than plant or animal

Lake: an inland body of standing water

Limnetic Zone: The region in which photosynthesis is most likely to occur.

Limnology: the scientific study of bodies of freshwater

Littoral Zone: The shallow water that are subjected to fluctuating temperatures and home to rooted plants.

Nitrate: NO_3^-, a salt or ester of nitric acid, commonly found in human waste

Nitrite: NO_2^-, a salt or ester of nitrous acid, commonly found in human waste

Nitrogen: A nonmetallic element occurs as a colorless, odorless, almost inert diatomic gas, N_2, in various minerals and in all proteins and used in a wide variety of important manufactures, including ammonia, nitric acid, TNT, and fertilizers

Oligomictic Lakes: Lakes that are found in very warm areas. The water temperature of these lakes is always above 4°C.

Organic Matter: derived from living organisms

Percolation: to flow or pass slowly through fine pores or small openings (Soil)

Permeability: the rate of flow of a liquid through a porous material

Phosphorus: highly reactive, poisonous, nonmetallic element occurring naturally in phosphates, used in fertilizers, and to protect metal surfaces from corrosion

Photosynthesis: carbon dioxide is removed from the environment and oxygen is released. Plants do this, thus removing the carbon dioxide from the water (bicarbonate), and replenishing the oxygen.

Profundal Zone: The region near the bottom of the lake where sunlight is reduced, the temperature is nearly uniform, and decomposition occurs.

Promulgate: to make known or public the terms of (a proposed law)

Public Sewage System: is a system of pipes that take wastewater from homes and bring it to a wastewater treatment facility.

Runoff: Rainfall not absorbed by the soil.

Septic Systems: the entire system that disposes wastewater.

Septic Tank: A sewage-disposal tank where solids that are separated from the wastewater are stored until removal.

Stratification: differences in density created by the differential heating of the water.

Thermocline: the region of temperature gradient between Epilimnion and Hypolimnion during Stratification.

Tight Tank: watertight container used in places where a cesspool or septic system can not be place and when public sewage hook up is not possible

Glossary Continued

Title 5: part of the Massachusetts Environmental Code (310 CMR 15.00). It regulates the siting, constructions, inspection and maintenance of on-site septic systems
Tributary: a stream feeding a larger stream or a lake
Vernal Pool: are temporary bodies of fresh water created during spring rains and snow melts.
Virus: the causative agent of an infectious disease
Warm Monomictic Lake: A lake that is thermally stratified during summer, but whose temperature never falls below 4°C at other times of the year when there is complete circulation
Wastewater: waste matter carried off by sewers
Well: a pit or hole sunk into the earth to reach a supply of water

List of Tables

List of Figures

Section 1: Introduction

The purpose of this report is to illustrate that the implementation of The State Environmental code Title 5 is beneficial to Massachusetts in general, and specifically to Lake Quinsigamond. Lake Quinsigamond has greatly benefited from Title 5, and if it were not in effect, the lake would be even more eutrophied than it is today. Title 5 has made a significant impact on the water quality of Lake Quinsigamond, the health of the population, and the environment. This is accomplished by limiting the amount of nutrients that enter the lake through septic systems. With the continuation of Title 5, the overall quality of Lake Quinsigamond will only increase. Overall, the benefits of Title 5 outweigh the cost to the general population.

We are also going to attempt to find a DEP or DEM cost/benefit analysis, if one exists, and apply it to our thesis. From this, we may be able to put a definitive dollar figure on environmental protection.

We feel that in order to better prove our thesis, other topics besides Title 5 have to be considered. It is important to understand the workings and characteristics of lakes such as cycling, development, regions, and eutrophication. From this knowledge, a better understanding of Lake Quinsigamond functions would be gained. It was also important to ascertain information regarding the inner workings of septic systems, cesspools and city sewers. Learning the cost of installing and repairing these systems was also imperative.

Based upon the knowledge of sewage disposal systems and lakes, it would be possible to provide a quantitative analysis of key eutrophying elements entering Lake Quinsigamond. The prevention of eutrophication in lakes is, and long has been considered a primary goal for many environmental planners.

Along with understanding lakes and sewage disposal systems, Title 5 and its stipulations have to be considered. Understanding how it was generated, what it regulates, and who is in charge of inspections are key to understanding Title 5. It is essential to contact the Department of Environmental Protection, the Department of Environmental Management, and both the Shrewsbury and Worcester Boards of Health, in order to establish who is responsible for the various aspects of Title 5.

Appreciating the effects that Title 5 has on the general population of Massachusetts would allow us to better understand the impact that the cost has on consumers. Title 5 affects both buyers and sellers of homes, homeowners, real estate agents, and many other workers throughout the State of Massachusetts.

Finally, we will research if there are any other new technologies being developed to further the level of treatment that wastewater receives from an individual subsurface sewage disposal unit.

After understanding all of the above, we will be able to give a quantitative analysis of the effects of septic systems and Title 5 on the Massachusetts community.

Section 2: Lakes

2.1: How Lakes Were Created

Lakes are defined as "landlocked bodies of water of sufficient size and volume to generate waves and create at least a partially barren shoreline."[1] Lakes were created in eleven different ways: tectonic activity, volcanic activity, landslides, glaciations, groundwater, streams, coastal processes, meteorites, organic processes and construction.[2]

Earthquakes and mountain building are the two major forms of tectonic activity. These both create changes in land dynamics that allow for areas to flood and create lakes. Volcanic activity occurs when volcanic craters collapse and create a basin that eventually fills to create a lake. The deepest lakes are normally created by collapsing craters. Volcanic dams, produced by lava, are also ideal lake basins.

The third way lakes are built is when landslides occur and block streams. The lakes that are formed by landslides have brief existence because landslides are made up of loosely packed materials which are easily eroded.

Glaciations, which occurred 10,000 to 20,000 years ago, created the greatest number of lakes. Lake basins were formed when glaciers slid across the land removing the loose soil which would then be deposited across stream beds, flood the area and create a lake. Another way glaciers can create lakes is when a large chunk of ice is left behind and buried. These ice chunks would then melt, creating lake basins.[3] Lake Quinsigamond was created by this process.

Many limestone deposits are dissolved by ground water. Over time, this creates limestone caves and underground lakes. When the limestone roof collapses, a deep lake basin is

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[1] The Encyclopedia Americana International Edition. "Lakes". Vol. 16. Pages 672-676. 2001 by Grolier Incorporated. 673

[2] The Encyclopedia Americana International Edition. "Lakes". Vol. 16. Pages 672-676. 2001 by Grolier Incorporated. 673

[3] The Washington Lake Book. http://www.ecy.wa.gov/programs/wq/plants/lakes/characteristics.html

created. Streams can create lakes if the course of the stream changes. Many pools are formed within a stream when the water loosens the soft rock which is carried away by the current. Streams can also create lakes is when soft rock is deposited within a stream. This can create dams which change the direction of the stream or even stop the stream from flowing.

The eighth way lakes are formed is by coastal processes. Wave action and currents are the two most common coastal processes. They both form barrier bars which restrict the flow of rivers, thus creating lake basins.

Lake basins that are formed by meteorites are extremely rare. These lake basins were formed when meteorites struck earth, creating indentations which filled with water over time.

Organic processes such as vegetation growth can form lakes. The growth of vegetation can slow rivers and streams, creating lakes.

The final way that lakes are created is by mammals. Humans, as well as beavers, can dam all types of flowing water. Bodies of water made by beavers typically have a short life and are often shallow, thus making them ponds rather than lakes. Since humans have more tools, and the ability to dam larger areas of water, the lakes are more controlled and last longer. Humans use dammed lakes for hydro-electric power, flood control, irrigation, recreation, and navigation.

2.2: Lake Categorization

One common way that lakes are classified is by the type of lake basin. There are three types of lake basins: rock basins, barrier basins and organic basins[4]. Rock basins are created by tectonic activity, volcanic activity, glaciations, groundwater, and meteorites. If the rock-basin was formed by glaciers, volcanic or tectonic activity, there are few nutrients found in the lake. "Such lakes are often poorly colonized by organisms, and are considered to be the unevolved,

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[4] Maitland, Peter S. Biology of Fresh Waters. 1978. Halsted Press, New York NY. Pg 63

classical, oligotrophic type."[5] An oligotrophic lake lacks large quantities of plant nutrients and has a large amount of dissolved oxygen throughout the lake. These lakes are also considered a nonproductive waterway, which allows for excellent water quality. Rock basins with shallower waters have rich bottom sediments. These lakes "are very suitable for habitation by man, and for his agricultural and industrial activities."[6] These lakes are classified as eutrophic lakes. Eutrophic lakes have waters rich in mineral and organic nutrients which promote a proliferation of plant life, especially algae, which reduce the dissolved oxygen content and often cause the extinction of other organisms. Lake Quinsigamond has a rock basin and is classified as a eutrophic lake.

Barrier basins are formed by damming pre-existing valleys to form the lake basin. The material that is used for damming the area can range from debris that was carried either by wind or water current, to cement and other man-made materials.

Organic basins are created by the activity of living organisms. These can range from beavers building dams, to vegetation overgrowth to excavated reservoirs created by humans.

Another way lakes are classified is by their annual circulation patterns. However, because lake behaviors vary from year to year it is difficult to classify many lakes using this method. The five different classifications of lakes are amictic, oligomictic, cold monomictic, warm monomictic, and dimictic lakes.

Amictic lakes are permanently covered by ice, and the waters remain at temperatures well below 4°C.[7] Ice thickness can range from 1.8 to 4 meters, capping water that attains a maximum

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[5] Maitland, Peter S. Biology of Fresh Waters. 1978. Halsted Press, New York NY. Pg 65
[6] Maitland, Peter S. Biology of Fresh Waters. 1978. Halsted Press, New York NY. Pg. 65
[7] Maitland, Peter S. Biology of Fresh Waters. 1978. Halsted Press, New York NY. Pg. 67

depth of 187 meters.[8] These lakes are found outside the 80° latitude lines, which include Antarctica, and the northern parts of Canada, Greenland and Russia.

The second type of lake is an oligomictic lake. Oligomictic lakes are found in very warm areas. The water temperature of these lakes is always above 4°C. These lakes are not subjected to seasonal changes therefore are permanently stratified.[9] A permanently stratified lake has many layers of water which differ by temperature, and do not mix unless there are strong winds.

Cold monomictic lakes are lakes whose water never rises above 4°C in the summer. It is during the winter months where cold monomictic lakes are temporarily amictic and experience inverse thermal stratification. Inverse thermal stratification is when the temperature of the surface water is colder than the temperature of the bottom water.[10] A complete circulation of water occurs while the ice is melting and the temperature rises.

The fourth type of lake is a warm monomictic lake. These lakes "are those which are thermally stratified during summer, but whose temperature never falls below 4°C at other times of the year when there is complete circulation."[11] These lakes can be found in a variety of locations, including south of the 40° latitude in North America.

The fifth and final type of lake is a dimictic lake. These lakes have two mixing periods; one during the spring when the water rises above 4°C, and the other in autumn when the lake begins to cool. Dimictic lakes, such as Lake Quinsigamond, experience stratification during the warmer months which is destroyed by surface cooling. Once enough heat is released into the atmosphere, the lake freezes which prevents circulation by wind. Dimictic lakes are the most

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[8] Cole, Gerald A. Textbook of Limnology. 1975. C.V. Mosby Company. Saint Louis. Missouri. Pg 130
[9] Cole, Gerald A. Textbook of Limnology. 1975. C.V. Mosby Company. Saint Louis. Missouri. Pg 131
[10] Maitland, Peter S. Biology of Fresh Waters. 1978. Halsted Press, New York NY. Pg. 67
[11] Maitland, Peter S. Biology of Fresh Waters. 1978. Halsted Press, New York NY. Pg. 67

complex systems because of the dual mixing periods, the stratification, and amictic characteristics.

2.3: Hydrologic Cycle

Lakes are fresh water resources. In order to understand where the water comes from, the hydrologic cycle, shown in Figure 2.1, must be understood. The hydrologic cycle occurs in the hydrosphere[12], the region that contains all of the water in the atmosphere and on the earth's surface. The hydrologic cycle is divided into five parts; condensation, infiltration, runoff, evaporation, and precipitation.

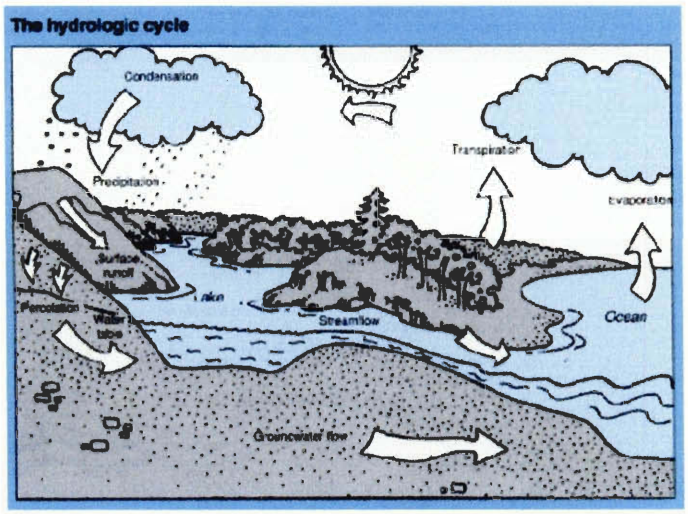

Figure 2.1: The Hydrologic Cycle

The hydrologic cycle begins with condensation. Here the water vapor condenses to create clouds. Condensation occurs when the temperature cools and the gas particles start to move slower. When the particles move slower, the intermolecular forces are strong enough to pull the particles together to form water droplets.

Wind moves these clouds across the globe. As the cloud moves it gathers more water particles. Each cloud is limited to the amount of water it is capable of holding. When the water holding limit it reached, the water particles are released in the form of precipitation, such as snow, rain, or hail.

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[12] Hydrologic Cycle.http://www.und.nodak.edu/instruct/eng/fkarner/pages/cycle.htm

Infiltration, runoff, and evaporation occur simultaneously. Infiltration occurs when precipitation enters the ground, the rate of which is known as permeability. The higher the permeability, the more precipitation can be absorbed by the ground. If precipitation occurs at a faster rate than it can enter the ground, it becomes runoff. The runoff remains on the earth's surface and flows downhill into streams, rivers, lakes or oceans. If the runoff reaches a place in which it can not flow downhill, it creates small bodies of water, called puddles. These puddles remain until the water can infiltrate into the ground or be evaporated into the air. Infiltrated water moves through the soil until it reaches streams, rivers, lakes or oceans.

As infiltration and runoff occur, the sun evaporates the water. During evaporation the sun light raises the temperature of the liquid in oceans and lakes. The molecules gain more energy and speed up, thus separating from one another. When the particles separate from each other they change phase, from liquid to gas. This warm vapor rises into the atmosphere then becomes the vapor that is later condenses, and the process begins again.

The hydrologic cycle controls the level of the lake. These levels will vary from season to season and year to year. Precipitation is the major contributor to the fluctuation in the lake level. When the rainfall decreases, the lake level falls, however when the rainfall increases, the lake level rises. The time between precipitations varies, thus varying the lake level. Dams are used to control the fluctuations, although fluctuating lake levels are normal.

2.4: Stratification

Stratification, occurring in lakes that are located in temperate regions, is the layering of the water within a lake. The degree of stratification "depends on a number of factors: the shape and depth of the lake, the amount of wind and the orientation of the lake (lakes that are oriented east-west are more affected than lakes oriented north-south)."[13] Stratification occurs during the summer months because the density of water changes with temperature. Water is most dense at 3.8°C; at temperatures above and below 3.8°C, water expands, becoming less dense. Stratification also occurs during the winter months. The ice acts as a wind barrier protecting the lake from circulation due to wind.

It is during the summer months that the layers become more distinct. Stratification creates three different layers: epilimnion, thermocline and hypolimnion (See Figure 2.2).

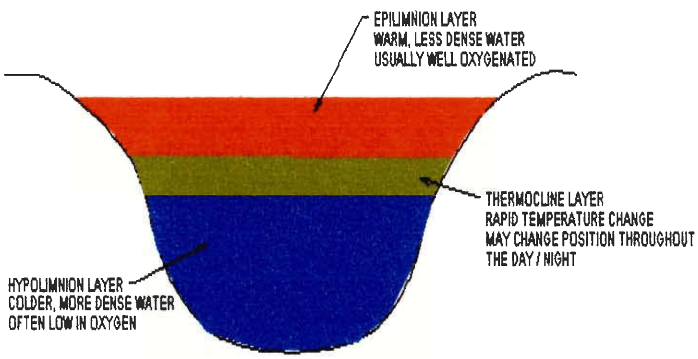

Figure 2.2: Cross Section of Lake Water Layers

The epilimnion is the first layer that extends from the surface to the thermocline. Here the temperature ranges from 18.3°C to 23.9 ° C. This is the layer that is warmest and least dense. Here, sunlight can penetrate well, allowing for productivity and biological growth.

The thermocline is the next layer. The temperature of the thermocline layer ranges from 7.2 ° C to 18.3 ° C. This layer is a narrow band that prevents mixing between the epilimnion and the hypolimnion layers. It is in the thermocline where "there is a rapid rate of decrease in temperature with depth; a minimum of one degree Centigrade per meter in depth."[14]

The hypolimnion is the bottom layer which extends from the thermocline to the bottom of the lake. Here the water is much colder than it is in the epilimnion but the temperature is virtually uniform.[15] The temperature ranges between 3.8 ° C and 7.2 ° C.

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[13] Rowe, Jon. Teaching About Thermal Stratification. http://wow.nrri.umn.edu/wow/teacher/thermal/teaching.html

[14] Veatch, Jethro Otto. Water and Water Use Terminology. 1966. Thomas Printing and Publishing Co. Kaukauna, Wisconsin.

[15] The Washington Lake Book. http://www.ecy.wa.gov/programs/wq/plants/lakes/characteristics.html

Lake Quinsigamond experiences these conditions year in and year out.

2.5: Lake Regions

A lake is divided into three zones: littoral, limnetic, and profundal. These are the three regions in which animals and plants live, regenerate, and grow, where photosynthesis takes place and where the decomposition matter occurs.

The littoral zone is affected by the shore and is subjected to fluctuating temperatures. It is here where plants are rooted to the bottom and algae grow. The littoral zone is home to many small vertebrae and invertebrates including tiny crustaceans, flatworms, insect larvae, snails, frogs, fish and turtles.[16]

Next, is the limnetic or open-water zone. This is the region where photosynthesis can occur. The amount of light present in the water decreases with depth. "The amount of light decreases until a depth is reached where the rate of photosynthesis becomes equal to the rate of respiration."[17] The limnetic zone is home to floating microorganisms, swimming animals such as fish and insects, planktonic algae, and zooplankton.

Finally, there is the profundal zone. This is where the decomposition of matter occurs. Since sunlight can not penetrate to these depths, the temperature is nearly uniform. The profundal zone is home to bacteria and fungi which decomposes the organic matter. There is limited oxygen and an abundance of carbon dioxide because of this decomposition.[18]

Oxygen is as important to water habitats just as it is to habitats on land. The presence of oxygen determines where organisms are found. During spring, the water mixed with oxygen is

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[16] Freshwater Ecosystems http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/F/Freshwater.html 13 December 2001

[17] Freshwater Ecosystems http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/F/Freshwater.html 13 December 2001

[18] Freshwater Ecosystems http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/F/Freshwater.html 13 December 2001

found throughout the lake, allowing organisms to live everywhere in the lake. As the summer months come and stratification occurs, little or no oxygen is found in the hypolimnion. The small amount of oxygen that is found here is used to decompose organic material. When the oxygen level becomes too low, the organisms that require more oxygen to survive must relocate to other areas of the lake. If the oxygen levels throughout the lake become too low, the aquatic life may die.[19]

During the fall, the top layers cool and the lake layers mix. When this occurs, the oxygen gets replenished. It is important that the oxygen gets replenished in the fall because, when the winter comes, ice covers the surface which does not allow for the layers to mix via wind. If there is not a sufficient amount of oxygen in the fall the lake may "die" during the winter since the oxygen can not be replenished due to the ice.

2.6: Photosynthesis

Oxygen is an important element which is needed for life. In lakes it is important to produce enough oxygen so that the plants and animals can survive. As noted before when organic material decays it releases gases like carbon dioxide and methane. It is important for a lake to remove these gases in order to survive.

Oxygen is added and carbon dioxide is removed from the lakes through a process called photosynthesis. Photosynthesis is a complex process which is carried out by green plants, blue-green algae, and certain bacteria. Photosynthesis can only occur in the areas of lakes that sunlight can reach. The organisms take the energy created by sunlight and transfers carbon dioxide and water into sugar and oxygen.[20] The chemical equation is:

$$6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$$

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[19] The Washington Lake Book. http://www.ecy.wa.gov/programs/wq/plants/lakes/characteristics.html

This is a process that removes CO_2 from the water and supplies the water with O_2, in addition to the O_2 that is supplied by the atmosphere.

2.7: <u>Phosphorus and Nitrogen</u>

Phosphorus was originally found in igneous rock which was formed by the solidification of molten magma. Over time, weathering released the phosphorus and it was deposited elsewhere. This is how phosphates (PO_4^{-3}) are formed. There are three different forms of phosphates: orthophosphate, metaphosphate, and organically bound phosphate. Orthophosphates are formed by natural processes but are influenced by partially treated and untreated sewage, runoff from agricultural sites and from some fertilizers. Organic phosphates are found in plant tissues, waste solids and other organic material. As decomposition occurs organic phosphates convert to orthophosphate.

Phosphates are added to water supplies to prevent corrosion. It is used extensively in the treatment of boiler water. Large quantities of phosphates are found in laundering and commercial cleaning fluids, while orthophosphates are applied to agricultural and residential lands as fertilizers which are then carried away from these locations by rain. The phosphate enters the groundwater, and whatever is not absorbed through natural ground filtration consequently enters lakes.[21]

Approximately eighty percent of air is nitrogen. The two types of nitrogen are inorganic, which includes the gas (N_2), nitrate (NO_3^-), nitrite (NO_2^-), and ammonia (NH_3^+), and organic which is found in proteins and is recycled by organisms. In lakes, nitrogen acts as a nutrient. Nitrogen combines with oxygen in the water to create Nitrate (NO_3^-) and Nitrite (NO_2^-), therefore, reducing the supply of oxygen within lakes. Nitrogen enters the lake through

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[20] <u>Photosynthesis</u> http://library.kcc.hawaii.edu/external/chemistry/everyday_photosyn.html
[21] Cole, Gerald A. <u>Textbook of Limnology.</u> 1975. C.V. Mosby Company. Saint Louis. Missouri. Pg. 240.

wastewater, septic tanks, feed lot discharges, animal wastes and car exhaust. It is the bacteria in the water that are responsible for converting nitrites to nitrates.[22]

Nitrogen and phosphorus are the major cause of Eutrophication.

2.8 E. Coli

Escherichia Coli (E. coli) is a fecal coliform bacterium normally found in the gastrointestinal tract of warm blooded mammals. It becomes problematic when a person ingests a large quantity of the bacteria. A person ingests this bacterium through various means, such as drinking contaminated water, bathing in contaminated water when they have open wounds, or by touching items that are contaminated and touching food which is then consumed. The populations that are most effected by E. coli are young children, the elderly, and individuals with impaired immune systems.

Once the bacterium is within the body, it makes its way into the large intestine where it affixes itself. The intestinal wall then inflames due to the toxins that are secreted by the bacteria. This is the major cause of hemorrhagic colitis, the sudden onset of abdominal pain and severe cramps, followed by watery diarrhea that may become bloody. Vomiting may also occur, but there is normally no fever. The normal duration of illness is typically somewhere between three and nine days. Most infected individuals are cured within a week and without any long term problems. Since there is no treatment, infected individuals are advised to keep hydrated and not to use antidiarrhea agents.[23]

An E. coli infection can cause hemolytic uremic syndrome, which causes the kidney to fail, and destroys red blood cells. "About 2%-7% of infections lead to this complication… [It] is

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[22] Cole, Gerald A. Textbook of Limnology. 1975. C.V. Mosby Company. Saint Louis. Missouri. Pg. 243.
[23] Escherichia coli http://www.cdc.gov/ncidod/dbmd/diseaseinfo/escherichiacoli_g.htm

a life-threatening condition... [where] blood transfusions and kidney dialysis are often required."[24]

Massachusetts public beaches remain open as long as the E. coli count is less than 126 E. coli per 100 milliliter of water. In non-public areas, Massachusetts relies "on the 1968 200 FC/100 mL water standard as their primary indicator for recreational waters."[25] Both numbers are the geometric mean of all the samples taken in an area. Once the E. coli count is over the regulation amount, beaches and other recreational areas are closed to the public. However, since most water conditions are not optimal for the continuous growth of E. coli. The amount of E. coli eventually dies and allows for beaches to be reopened.

E. coli leaves the human in the form of feces. The fecal matter enters the septic system and separates from the liquid. E. coli, like other infectious bacteria, leaves the septic system without being treated. Treatment of infectious bacteria occurs by ground filtration in the leaching field. If there is enough unsaturated soil, the bacteria die since it is not a moist place where the bacteria can grow. If there is a sufficient amount of saturated soil, the bacteria continue to live. With rainfall and other precipitation the bacteria move from the leaching field to groundwater, and eventually into the lake. Septic systems that are located on lakes impact the E. coli count because typically the leaching field is sufficiently saturated to keep the E. coli alive.

E. coli outbreaks are not caused by the amount of bacteria that enters the lake from inadequate leaching fields. The amount of E. coli that enters from septic systems is small compared to the amount of fecal matter placed directly in the lake from ducks, deer and other wildlife. These animals migrate back to the lake during the spring and are natural carriers of the E. coli bacteria. The amount of E. coli in the fecal matter is not reduced since it is typically

[24] Escherichia coli http://www.cdc.gov/ncidod/dbmd/diseaseinfo/escherichiacoli_g.htm

deposited directly near or within the lake; therefore the entire amount of E. coli enters the lake. Throughout the summer, the wildlife population increases along with the quantity of fecal matter and E. coli counts. Even in saturated areas, the E. coli from septic system origin is filtered more than the non-filtered animal fecal matter. The amount of E. coli that comes from septic systems is minuscule compared to the amount that comes from animal life. For this reason a quantitative analysis for E. coli coming from septic systems is unnecessary. Although the leaching fields adjacent to Lake Quinsigamond can often be small and the ground can often be saturated the majority of the E. coli is still filtered out.

2.9: Eutrophication

Plants require phosphorus and nitrogen for growth. It is the concentration of both elements that controls the amount of plant matter that can grow within the lake. Phosphorus controls the growth of algae. The amount of phosphorus that enters the lake is proportional to the amount of algae growth. When there is an abundance of algae, the depth of light penetration is decreased drastically, the water appears dark and cloudy, and oxygen in the hypolimnion is limited. [26]

Over time, these lakes become eutrophic, or nutrient enriched. This is the start of the eutrophication process. The phosphorus and nitrogen fertilize the water and encourage algae and plants growth. As the plants and animals die, they decompose on the bottom of the lake where they remain as organic sediments. Over hundreds of years the organic sediments accumulate, and the level of the water drops. The lake loses its lake characteristics and begins to take on the characteristics of a marsh or a bog.

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[25] Bacterial Water Quality Standards for Recreational Waters (Freshwater and Marine Waters) http://www.epa.gov/waterscience/beaches/local/sum2.html

[26] The Washington Lake Book.http://www.ecy.wa.gov/programs/wq/plants/lakes/characteristics.html

In 1840, Justus Liebig formulated the idea that "growth of a plant is dependent on the amount of foodstuff that is presented to it in a minimum quantity." Also known as Leibig's law of the minimum, this philosophy governs the growth of all plant matter, both aquatic and land dwelling. From this principle, it is possible to deduct that the simplest way to control eutrophication is to identify the limiting nutrient and reduce its concentration.[27]

The Redfield Ratio, which dictates the ratio of the amounts of carbon, nitrogen, and phosphorus necessary for plant growth, is 106:16:1. This ratio is derived from the chemical representation equation for typical algae:

$$106\ CO_2 + 16NO_3^- + HPO_4^{2-} + 122H_2O + 18H^+ \rightarrow C_{106}H_{263}O_{110}N_{16}P + 138O_2$$

The N:P ratio is often used in lieu of the C:N:P ratio due to the abundance of carbon found in lake environments. Even with an unlimited amount of carbon and nitrogen, growth of algae and other aquatic plant life is still limited by the presence of phosphorus. Likewise, if there were an unlimited amount of phosphorus and carbon, then nitrogen would be the limiting factor.

Using a stoichiometric analysis it can be shown that it takes approximately seven times the amount of nitrogen as it does phosphorus to generate a certain amount of algae growth. Incorporating the atomic weights of nitrogen and phosphorus (14 and 31, respectively) with the Redfield Ratio, we can prove this:

$$\frac{N}{P} = \frac{16 * 14}{1 * 31} = 7.2$$

From this, we can conclude that phosphorus, with a relatively large amount of nitrogen, as is the case in Lake Quinsigamond, is the limiting factor.

Eutrophication can be accelerated by human activities. When this occurs it is called cultural eutrophication. The lakes receive "nutrients from agricultural areas, storm water runoff,

[27] Introduction to Environmental Engineering and Science, Gilbert M. Masters, 1991 pg 136

urban development, fertilized yards and gardens, failing septic systems, land clearing, municipal and industrial wastewater, runoff from construction projects, and recreational activities."[28] It is these activities that are detrimental to the lakes. Unless these activities are monitored carefully the lake transforms into a marsh or bog and eventually a meadow.

[28] The Washington Lake Book. http://www.ecy.wa.gov/programs/wq/plants/lakes/characteristics.html

Section 3: Septic Systems

3.1: What is a Septic System

A septic system includes both the septic tank and the subsurface soil absorption system. The purpose of a septic system "is to receive raw household wastewater from the plumbing system, separate solids from the liquid portion, and discharge the clarified liquid to a soil absorption leach field for treatment and disposal."[29] Currently, septic systems are the standard when it comes to subsurface sewage disposal.

3.2: Wastewater

Sewage, or wastewater, is anything that is flushed down a toilet or a sink in a home, office, or facility. Septic systems are needed to dispose of wastewater where homes are too far apart from each other in a rural area where sewer systems would be too expensive to install. Rural areas would include many towns in central Massachusetts such as Princeton, Hubbardston, and Sterling.

There are three major reasons why septic systems are needed. The first reason is that wastewater has a foul odor. Over time this odor can mask the natural smells of an area making it an unpleasant place to live in.

The second reason is that wastewater contains harmful bacteria. Human waste naturally contains coliform (E. coli) bacteria and other bacteria that are capable of causing disease. (See Section 2.8) It becomes a health hazard when both drinking and recreational waters are infected with the bacteria. For example, an E. coli infection causes severe diarrhea and abdominal cramps. These symptoms occur for five to ten days. This infection can cause hemolytic uremic

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[29] Training Manual For the State Environmental Code Title 5. March 1995. Pg. 3.3

syndrome in children under the age of five and elderly people. This causes a large number of the red blood cells to be destroyed and the kidneys to fail.[30]

The third reason that septic systems are needed is because wastewater contains suspended solids and chemicals that affect the environment. The two major chemicals include nitrogen and phosphorus. The chemicals and there affects are discussed in greater detail in Section 2.7 and 2.8. The wastewater contains organic material that bacteria will decompose. The oxygen that is normally used by fish and other organisms is used by the bacteria to decompose the organic material. The suspended solids make the water look murky and will affect the fish's ability to breathe; killing them due to the lack of oxygen. Overall, waste water will reduce the lake's ability to support wildlife and the lake will eutrophy.[31]

Septic Systems are an important aspect in keeping the environment clean and to protect the health and the safety of the surrounding communities.

3.3: <u>How does a Septic System Work</u>

The wastewater that is created is drained out of the house either through toilets, sinks or showers. The plumbing system in a home, shown in Figure 3.1, is very important because it protects the family from the gases that are created during decomposition. The bacterium that decomposes the organic material in wastewater produces a foul odor. If the pipes are not connected properly, the odor can enter the home, creating an unpleasant environment. In order for the gases to escape the septic tank and not enter the home sinks and other drains, the piping system

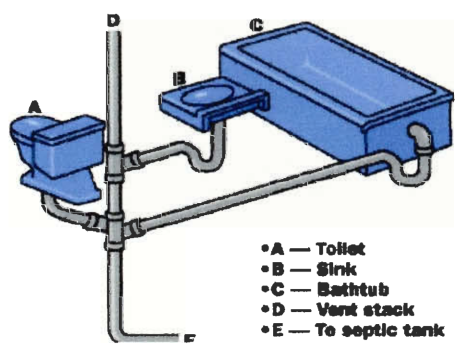

Figure 3.1: Pipe System

[30] <u>Escherichia coli O157:</u>H7 http://www.cdc.gov/ncidod/dbmd/diseaseinfo/escherichiacoli_g.htm. June 2001.

has P-traps or loops in the pipe. These loops are designed so that water remains in the loop thus acting as a barrier to keep the gases from entering the home. The vent pipe opens to the atmosphere above the roof of the home to allow the gases to escape from the system.[32] All of the plumbing throughout the house is connected to a main pipe which leaves the home.

Once the wastewater leaves the home it enters the septic tank via a main pipe that is connected to the home and the septic tank. The septic tank is a buried, water-tight receptacle usually made out of solid concrete, fiberglass, or plastic and can hold 1,500 gallons of water or more. Scum, grease and suspended solids are removed from the liquid in the tank by gravity separation. Materials that float such as grease, scum and hair, will be found on the top layer called the scum layer while the materials that sink, like sludge and dirt, will be found in the bottom layer called the sludge layer. The layer between these two is mainly water but it does contain chemicals like phosphorous and nitrogen. (See Figure 3.2)

The separation of the solids from the liquid is considered the primary treatment. Aerobic bacteria digest the floating solids while anaerobic bacteria consume the organic materials in the sludge. The byproducts of the anaerobic bacteria are water soluble, and leave the septic tank with the wastewater.

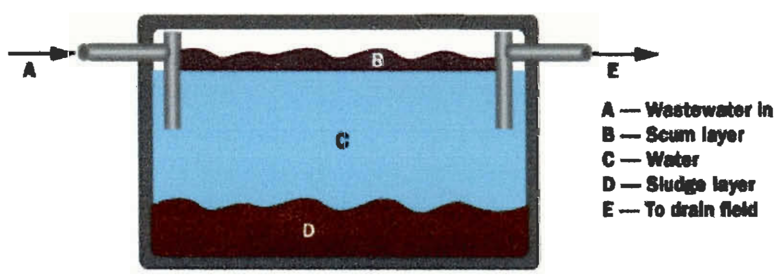

Figure 3.2: Cross-Sectional View of a Septic Tank

This new wastewater displaces the wastewater that is already contained within the tank. The liquid layer leaves the tank though the outlet tee. Since the outlet tee extends below the scum layer the scum layer

[31] Brain, Marshall. How Sewer and Septic Systems Work. http://people.howstuffworks.com/sewer.htm/printable. 2003.

[32] Brain, Marshall. How Sewer and Septic Systems Work. http://people.howstuffworks.com/sewer.htm/printable. 2003.

is prevented from leaving the septic tank. Some solids decompose during this retention period in the septic tank. These materials eventually leave the tank through the outlet tee.[33]

Wastewater should be retained in the septic tank for a minimum of twenty-four hours when one half to two thirds of the tank is filled with sludge. This allows proper time for the solids to settle from the liquid. If the tank is filled with more sludge than the system can handle, the sludge enters the distribution box and leaching field. This results in clogged pipes and gravel, which is the leading cause of septic system failure.

After the wastewater leaves the septic tank it enters the distribution box. (See Figure 3.3) The distribution box is located in or just before the leaching field. It is a small tank that has one inlet and multiple outlets and is made out of concrete or some other durable material. The multiple outlets distribute the wastewater to several pipes within the leaching field. A layer of insulation placed over distribution boxes that are located in colder climate, to prevent freezing during the winter months.[34]

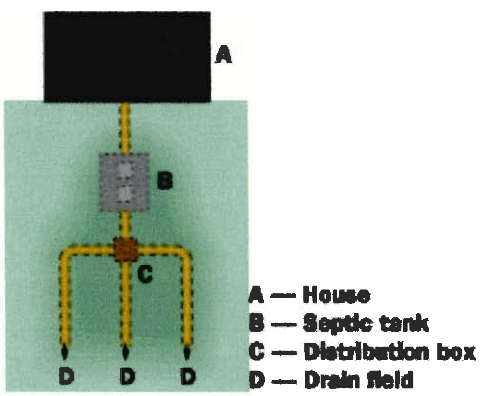

Figure 3.3: Top View of a Septic

The wastewater leaves the distribution box and enters the leaching field. The leaching field is made up of perforated pipes that `are buried in trenches. These trenches are four to six feet deep and approximately two feet wide. The pipes are four inches in diameter and have perforated holes to allow the wastewater to leave the pipe. Gravel

[33] Brain, Marshall. How Sewer and Septic Systems Work. http://people.howstuffworks.com/sewer.htm/printable. 2003.
[34] Training Manual For the State Environmental Code Title 5. March 1995. Pg. 3.5

fills the bottom three feet of the trenches and retains the sewage until it dissolves and enters the soil.[35] The sewage is absorbed and filtered by the ground in the leaching field. The size of this field is directly dependent on the percolation rate, the rate that water enters the ground.

The final treatment of the wastewater occurs in the leaching field. When the wastewater infiltrates the soil it has to pass through a biomat. A biomat is a black, jelly-like mat that forms along the bottom and sides of the drain field trench. Anaerobic microorganisms anchor themselves to the soil and gravel. They consume the organic matter in the wastewater.

Due to its inherently low permeability, wastewater pools on the biomat. The biomat removes viruses, and filters out pathogenic bacteria and parasites. After the wastewater is filtered through the biomat, it percolates through the soil.

[35] Training Manual For the State Environmental Code Title 5. March 1995. Pg. 3.10

Section 4: Cesspool

4.1: <u>What is a Cesspool</u>

The legal definition of a cesspool includes septic tanks; however a cesspool is an underground tank that stores sewage until it can be disposed of. Cesspools, like septic systems, are used in areas where there is no access to public sewers. The more recent cesspools are made out of glass-reinforced plastics, polythene or steel.[36] These materials were chosen because they are capable of withstanding corrosion and strong enough to support the stresses acting on it. The older cesspools were made out of bricks or concrete. Cesspools have an open bottom or holes in the sides of the wall to allow the wastewater to seep through. The solid sewage would stay inside the cesspool until it is removed. Cesspools were designed with the idea that the soil would filter out the contaminants. (See Figure 4.1)

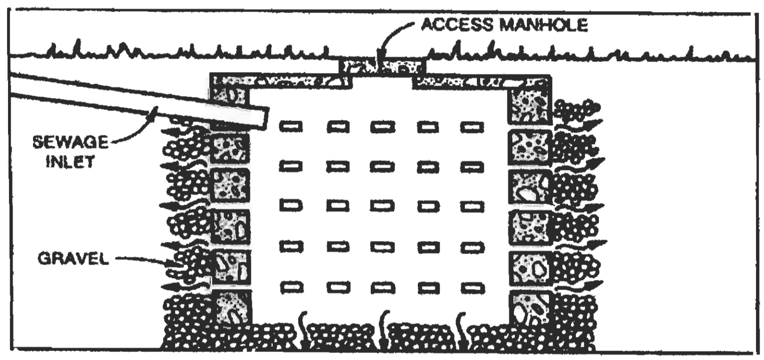

Figure 4.1: Cross Section of a Cesspool

The holes may become clogged because of detergents and other material that slows the natural bacteria process. Over use of the cesspool will also cause the cesspool to clog up. Pumping the cesspool is a temporarily solution; however the clogged holes remain clogged and slows the rate of percolation.[37]

The older types of cesspools are surrounded by porous materials that filter the wastewater before it reaches groundwater. Cesspools are constructed six to ten feet in diameter and fifteen to twenty feet deep. They are placed in the ground above groundwater and therefore are also considered dry wells.

36 Cesspools. http://www.winchester.gov.uk/enviro_health/issues/cesspools.shtml Winchester City Council 12/16/02

37 The Care and Feeding of Your Septic System http://www.gemechanical.com/septic101.html

4.2: How Cesspools Work

A single pipe enters the cesspool from the home or building. The pipe must have tight joints to prevent the wastewater from leaking into the ground, and possibly contaminating ground water. The cesspool has an opening at the top to allow for the removal of solid wastes. Since the cover is buried under soil it has to be strong enough to support the soil and the extra weight that passes over the cesspool such as humans and small animals.

Once the waste material enters the cesspool it remains there until the natural bacteria decomposes the material. The waste water leaves the cesspool via holes in the side walls and through the open bottom. The porous material that surrounds the cesspool acts as a filter. When the wastewater leaves the porous material the polluting material is removed.

4.3: How a Cesspool Effects the Environment

Cesspools can effect the environment by contaminating water supplies. The best position for a cesspool is downhill and as far away as possible from a water supply, such as a lake, pond or well.

Another way cesspools can affect water supplies is if there is fractured limestone or rock beneath the cesspool. Fracture limestone does not provide adequate filtrating of the pollutants thus contaminates the water supply. However, a few feet of added sand and gravel can provide enough filtration to protect the water supplies.[38]

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[38] The Encyclopedia Americana International Edition. "Cesspool." Vol. 6 pg. 206 Grolier Inc. Danbury, CT. 2001.

Section 5: Public Sewer Systems

5.1: What are Public Sewer Systems

To maximize living space, residential areas build homes on smaller lot sizes. These smaller lot sizes do not allow for the use of septic systems since there is not enough land to accommodate a septic tank and leaching field for each home. To solve this problem public sewer systems were created. A public sewer system is a system of pipes that take wastewater from homes and bring it to a wastewater treatment facility.

When a public sewer system is placed in an area there are two types of hook up lists: mandatory and non-mandatory. The homes that are on the non-mandatory hook up lists are those homes in which the septic system they are currently using has failed or those home owners that want public sanitary. Homes in areas where septic systems can not be upgraded because of the number of homes around them or the layout of their land, like those around lakes, are on the mandatory list and are required to hook up to the public sewer system.[39]

5.2: How Public Sewer Systems Work

There are two types of public sewer systems; gravity-powered and grinder-pump. A gravity-powered system is the ideal system because it does not require a grinder-pump or a lift station. A grinder-pump or a lift station is used when there are hills that the wastewater has to go over in order to get to the treatment plant. The grinder-pump takes the wastewater and turns it into slurry, and then it pumps it to the wastewater treatment plant under pressure. A grinder-pump station is more expensive then a gravity-powered system. It also requires more maintenance because the pumps only have a life expectancy of five to ten years. The home

[39] Wilkshire/Pebble Hill III Public Sewage Project http://www.buckswater-sewer.org/bc-projects-pebblehill.html#public

owners can not put foreign matter into the drains because it would cause problems with the plumbing and pumping system.[40]

In either case, pipes leave the house or building and carry the wastewater to the sewer main. The sewer main is a large pipe usually three to five feet in diameter. Along the sewer main there are vertical pipes that run to the main surface where they are covered by a manhole. By placing the manholes throughout the system the city can find a problem and fix it without destroying the roads.[41]

As the sewer mains get closer to the wastewater treatment plant they converge into larger pipes. The wastewater treatment plants are located in low-lying areas and sewer mains are placed to follow creek beds because they naturally flow downhill.

Depending on the ability of the plant the wastewater can undergo three treatments. The primary treatment allows the solids and the scum to separate from each other. The system then removes the solids and disposes them in a landfill or an incinerator. If this is the only stage that the wastewater goes though, the water is chlorinated to kill the remaining bacteria and then released from the plant. If not, the water undergoes a secondary treatment which occurs when the water goes into aerated tanks and with the help of bacteria the organic material and the nutrients are removed from the water. The water then flows into settling tanks where the bacteria is removed.

The tertiary treatment is when the use of chemicals, filter beds and other treatments, remove the phosphorous and nitrogen from the water. Chlorine is added to destroy any remaining bacteria, and then the water is released from the plant.

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[40] Wilkshire/Pebble Hill III Public Sewage Project http://www.buckswater-sewer.org/bc-projects-pebblehill.html#public

[41] Brian, Marshall. How Sewer and Septic Systems Work. "Urban Wastewater Systems." http://people.howstuffworks.com/sewer3.htm

5.3: <u>How Public Sewage Systems Effects the Environment</u>

Public sewage does a good job in protecting the environment once the system is in place. However, major construction is needed to put a public sewage system in. Many areas have to be dug up so that the pipes can be laid down. This damages many of the ecosystems that have been naturally created.

When the water leaves the wastewater treatment plant it is chlorinated. Chlorine is not naturally found in water therefore the amount of chlorine that is used has to be monitored carefully so that it does not damage the environment.

The process to install a public sewage system is more time consuming than the process for installing septic systems capable of handling the same load. Sewer mains and house lines have to be installed in order to have a successful public sewage system. A wastewater treatment plant also has to be built. The wastewater treatment plant must be able to handle the influx from the connected homes. If new homes are built and connected to the public sewage system, the wastewater treatment plant has to be able to accommodate the increase in influx. Public sewer systems take time and a lot of money but are more effective in treating wastewater than cesspools.

Section 6: Title 5

6.1: History of Title 5[42]

In 1937, legislation in Massachusetts gave the Boards of Health responsibility for making and enforcing regulations regarding house drainage. This was an extreme change from the complete lack of regulation prior in some towns. Rules and regulations under this section varied widely from one town to another. Some towns adopted very simple rules, and left discretion to the inspector, while others were tremendously comprehensive. The public, as well as engineers, builders, and contractors were confused by the considerable differences in the regulations of adjacent towns. This was often the case when dealing with lots on the same street, but addressed in different towns.

This situation became the basis for the creation of the State Sanitary Code, as well as the State Environmental Code.

Under Massachusetts General Law, (MGL) Chap.11, Sec 17, The Massachusetts Department of Public Health has responsibility to consult with and advise local Boards of Health on matters of water supplies, drainage, and sewage. In 1962, the Department of Public Health distributed rules and regulations for the control of individual sewage disposal systems, which was known as Article XI of the State Sanitary Code. This also gave power to a new Department of Environmental Quality Engineering, who then promulgated Title 5, or as it is officially entitled, "Title 5 – Minimum Requirements for the Subsurface Disposal of Sanitary Sewage," in 1977. Title 5 of the State Environmental Code replaced Article XI of the State Sanitary Code, and became the official regulation for the control of sewage disposal systems statewide. Title 5 was revised in 1978 and again in 1994.

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[42] Training Manual for the State Environmental Code Title 5, March 1995 pg 1.5

6.2: Purpose of Title 5

The Training Manual for Title 5 states the purpose of Title 5 is to "provide a comprehensive body of standards, which if fairly administered and strictly enforced, will provide protection of the public health and the environment in all cities and towns of the Commonwealth where circumstances require the use of individual systems for the disposal of sanitary sewage."[43] Title 5, if properly enforced, will bring uniformity in the design, construction, and inspection of subsurface sewage disposal systems in the Commonwealth of Massachusetts.

Title 5 is based on proven scientific principles and tested methods for the construction, maintenance, and design of individual subsurface sewage disposals systems, for a wide range of conditions likely to be found in Massachusetts. If followed, and properly regulated, Title 5 will assure the proper protection of public health in the State.

Title 5 also gives the local Boards of Health the authority to apply stricter regulations if deemed necessary, in addition to the regulations stipulated by Title 5 itself. Local Boards of Health have the authority and the legal responsibility to enforce Title 5. Board members may delegate the authority to independent agents to enforce Title 5, but the ultimate responsibility lies with the board.

The primary reason for safe disposal of sewage is to prevent the spread of infection and disease, but there are important environmental, economic, and aesthetic reasons for its control as well. Untreated or improperly treated sewage will:

a) Contaminate groundwater and other water supplies with inorganic matter to make it unsuitable, not only for drinking water, but for commercial, industrial, and recreational purposes at great economic loss.

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[43] Training Manual for the State Environmental Code Title 5, March 1995 pg 1.6

b) Pollute harbors, rivers, lakes, ponds, streams, resulting in economic detriment to fishing and shellfish industries

c) Upset biological balance between plants and animals in our lakes, ponds, rivers, and streams resulting in overgrowth of algae and odorous matter

d) Foul our coastline and the shores of rivers, ponds and lakes to rob them of their beauty and sources or inspiration, recreating, and habitation. [44]

Therefore, without proper disposal of wastes, the environment and the population are at great risk for disease and pollution.

6.3: <u>Title 5 Code Specifics</u>[45]

The new rules from the revision of Title 5 revised in 1994 took effect on March 31, 1995. There are exceptions to these rules; any applications filed for a Disposal System Construction Permit before March 31, 1995 are subjected to the 1978 code with a few exceptions for extremely large systems.

Under the new rules of Title 5, there must be a certified soil evaluator on site when the soil and groundwater elevations are determined, or there is a deep observation hole test. The soil evaluator may be from the Board of Heath, or may be hired by the applicant but they must have past the soil evaluator test and licensed in Massachusetts. A partial list of local soil evaluators can be found in Appendix A. This was implemented due to the fact that it was realized that all soils were not the same, and system design must be changed depending on the soil characteristics.

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[44] <u>Training Manual for the State Environmental Code Title 5</u>, March 1995 pg 1.8
[45] <u>Training Manual for the State Environmental Code Title 5</u>, March 1995 pg 2.3

Four classes of soil are identified, based on the new rules, considering many factors, including percolation rate. For some soils, these classes allow for much smaller leaching fields than the 1978 code; for others, larger areas will be required.

In the updated Title 5, the setback distance from water supply reservoirs and other bodies of water was increased. The leaching field of the septic system must be at least 400 feet from a body of water, and at least 200 feet from any tributary thereof. In some areas of Lake Quinsigamond it is not possible for a septic system to be at least 400 feet away from the lake. This has required Shrewsbury and Worcester to invest money and time to attach the residents to the public sewer system. Attachment to public sewer system may also be required for areas in which it is impossible to place construction vehicles on the land in order to upgrade the current septic system.

Title 5 also regulates distances from vernal pools, a depressed basin that fills with water during spring melting and rain and generally dries by end of summer. A new section of Title 5 states that a setback of at least 100 feet from certified vernal pools is required unless the system is downhill from the vernal pool, in which case only 50 feet of setback is required.

In 1978, the maximum allowable percolation rate was 30 minutes per inch. Presently the rate is the same, with the exception of systems with a percolation rate between 30 and 60 minutes per inch, which potentially may be allowable if there are no other sewage disposal alternatives. The Massachusetts Department of Health has the authority to allow up to twenty of the 30-60 minute per inch systems each year. Under the new Title 5, it is stipulated that all the percolation rate requirements must be reviewed within three years.

The new rules establish nitrogen loading limits for new systems located in nitrogen-sensitive areas, such as zones containing drinking water wells. The new rules require for a four bedroom house to be built on an acre of land. A larger house or smaller lot may be allowed if there is a higher level of treatment provided, like sewer systems.

Innovative technologies (See also Section 11) is a subject that is very important to the new Title 5. If enough information is provided about a new, innovative technology, the Board of Health will consider reviewing the technology based upon the level of information available. Recirculating sand filters are conditionally approved for general use. Humus or composting toilet is already approved where a conventional system could not be used. In addition, the Board of Health is required to use at least two additional alternative systems with costs comparable to that of conventional systems. The Board of Health is also required to publish a list of those approved alternatives as well as those technologies undergoing review.

The revised version of Title 5 allows for more than one home to share a common leaching field or system. This is only allowable in new construction if the leaching field can handle the additional load from the two or more separate systems.

Overall, the new rules attempt to bring "greater clarity and consistency to permitting and enforcement provisions, most of which are carried without substantial change from the 1978 code."[46] In addition, the new code prohibits a septic system from being installed within 100 feet of a well.

The updated Title 5 requires the Department to review several key issues and propose additional changes every three years, namely the change of percolation rate in soils from 30 to 60 minutes per inch, increasing the use of soil analysis and pollutant loading determination in systems, and the effectiveness of the rules in protecting critical resources and upgrading failing systems. An advisory committee was assigned to work with the Department of Health to establish and enforce new rules.

6.4: **Maintenance and Inspection**

The biggest stipulation that the revised version of Title 5 makes is the Inspection at Time of Transfer clause. "The goal of the inspection is to provide sufficient information to make a determination as to whether or not the system is adequate to protect public health and the environment."[47] The completed System Inspection Form[48] must be submitted by the inspector within 30 days of the inspection, and approved by the Board of Health. Inspections of septic systems are required within the nine months prior to the transfer of property to the new owner. The only exception to this law is when weather conditions prevent inspection due to frozen ground or other natural occurrences. If this is the case, the inspection may be delayed up to six months after the transfer of property.

All inspections are conducted by certified Title 5 system inspectors. A list of local Title 5 inspectors can be found in Appendix A. "Professional engineers, sanitarians, or health officers have been designated as being previously qualified because of their backgrounds and experience."[49] Other people such as Board of Health members or agents, home inspectors, licensed sewage haulers or installers may also perform the inspection; however they must first take a training course and pass an exam.

The new rules contain specific definitions on failing systems to protect the environment and public health. Typically failing items include hydraulic systems, such as broken or backed up septic lines, or systems found to be a specific environmental threat. When an inspector comes across one of these, or any other catastrophic problems, the system must be upgraded or replaced within one year from the date of discovery. The Board of Health may require a quicker upgrade

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[46] Training Manual for the State Environmental Code Title 5, March 1995 pg 2.4
[47] Guidance for the Inspection of Subsurface Sewage Disposal Systems January 13, 1995 pg 1
[48] See Appendix B
[49] Training Manual for the State Environmental Code Title 5, March 1995 pg 2.7

if the problem is deemed imminent danger or health hazard to the community. Likewise, the Board of Health may choose to increase the allotted time in extenuating circumstances. The Board is more opt to provide an extended time frame if the one year does not provide adequate time to come up with a satisfactory solution.

If a system is deemed failing, the inspector must clearly identify the reason for failure. Upon arrival at the property, he/she must note the general conditions of the property to look for obvious signs of failure. These include but not limited to backup of sewage to the property, broken pipes, effluent ponding, and breakout to the surface of the ground to surface waters. The inspector must also inspect all components preceding the leach field. In a typical system, this means locating and exposing the septic tank and distribution box. If the system is a cesspool, it must be exposed for inspection.

Larger systems greater than 10,000 gallons per day must be inspected every two years due to the high failure rate of these larger systems. All systems greater than 10,000 gallons per day, which are located within 400 feet of a water supply reservoir or within 200 feet of their tributaries, must be replaced by a water sewage treatment plant within five years even if they are not considered a failing system. If the owner of the property can prove that the system does not adversely affect the water quality of the reservoir or cause a health hazard, then he/she would not be required to have the system replaced with a treatment plant. The Board of Health may also grant the owner a longer period of time for the same reasons discussed above.

The pumping of septic systems is not required by law, but is highly recommended at least once every three years, or once every year for homes with a garbage disposal grinder. Frequent pumping of septic systems is said to increase their longevity. Most septic systems should be pumped on average every two or three years, although there are exceptions. In certain instances, such as when there is not enough room to hook up to city sewer, or install a proper working septic system, including leaching field, the installation of a tight tank may be necessary. A tight tank is a watertight container, similar to those found in airplanes, buses, and motor homes, which must be pumped on a regular basis. A tight tank is only a temporary solution, lasting only until other solutions are available, such as connecting to city sewer, on-site sewage treatment, depending on circumstances. The average tight tank for a three to four bedroom home requires pumping every three to six weeks, depending on the size of the tight tank. At approximately $150 per pumping, the cost can add up quickly for the consumer.

Section 7: Enforcement:

7.1: **Department of Environmental Protection**:[50]

The Department of Environmental Protection (DEP) oversees the growth and execution of Massachusetts DEP policies and programs. There are three major bureaus within the DEP; Resource Protection, Waste Prevention, and Waste Site Clean up.

The Bureau of Resource Protection is responsible for protecting and preserving inland and coastal water resources. They protect the public drinking water and give grants to cities and towns to improve their infrastructure. There are three divisions within the Bureau of Resource Protection: Municipal Services Division, Watershed Management Division, and Evaluation and Planning Group.

The Bureau of Waste Prevention consists of four divisions: Business Compliance Division, Consumer and Transportation Compliance Division, Evaluation and Planning Division, and Program Support. Together they reduce pollution and encourage the "Reduce, Reuse and Recycle" programs in residents and businesses.

The Bureau of Waste Site Cleanup is in charge of cleaning up environmental emergencies in a timely fashion. Environmental emergencies include chemical fires, oil spills, and hazardous wastes. There are three divisions that are associated with the Bureau of Waste Site Cleanup, they include, Policy and Program Development Division, Response and Remediation Division, and Technical and Financial Support Division.

Massachusetts is divided into four regions; Western Region, Central Region, Metro Boston/Northeast Region and Southeast Region. Each region has an office in a city within their respected region, Springfield, Worcester, Wilmington and Lakeville, respectively. Each office

[50] Massachusetts Department of Environmental Protection http://www.state.ma.us/dep/

contains all three of the bureaus and together they help protect the environment of Massachusetts.

The DEP is in charge of some items dealing with Title 5. System inspector and soil evaluator training is controlled by the DEP. The center for training is Millbury. These training sessions are run by the DEP so that all evaluators and inspectors have the same training and the same rules are enforced throughout Massachusetts. The application process for items such as failing systems, permits, and alternative systems are all regulated by the DEP.

7.2: <u>Board of Health:</u>[51]

Every town has a Board of Health. They are responsible for activities that related to health and the environment. Some activities include the collection and disposal of solid waste, recycling, housing, hazardous materials, and sanitation.

Permits for items such as restaurants, clubs, churches, soil testing, septage haulers, tanning salons, and massage therapists are governed by the Board of Health. Since each town has their own Board of Health and their own needs, these permits can vary depending on what they will and will not allow, how much they will cost, and how long they will last.

Each town can create their own regulations in addition to the state laws. Like the variations in permits, these regulations vary from town to town. Depending on the need of the town rules can be stricter, more expensive, and more time consuming. For example, if a town has an excessive amount of garbage, the town can impose rules to reduce the garbage amount. They can require residents to recycle recyclable materials, only use one city bag per week, and only allow trash pick up bi-monthly.

All the technical questions regarding Title 5 such as how often a system has to be pumped, when the system has to be inspected, and what alternative systems are allowed are all answered by the local Board of Health. This allows the DEP to take care of greater problems while the questions from residents are answered by their local representatives.

7.3: Department of Environmental Management:[52]

The majority of Massachusetts' land management and resource planning is completed by the Massachusetts Department of Environmental Management (DEM). There are two major divisions within the DEM. They include the Division of Forest and Parks, and the Division of Resource Conservation.

The Division of Forest and Parks include five sub-divisions which are the Bureau of Recreation, the Bureau of Forestry, the Bureau of Fire Control, the Bureau of Ranger Services and the Bureau of Interpretive Services. Together these groups are responsible for every day operation and resource management.

The Division of Resource Conservation is divided into nine subdivisions. The nine subdivisions include the Bureau of Resource Protection, the Office of Natural Resources, the Office of Water Resources, the Office of Historic Resources, the Office of Project Management, Bureau of Engineering, the Office of Waterways, the Office of Dam Safety and the Office of Park Improvements. These nine groups are responsible for resource assessment, planning, design, construction and scientific services.

7.4: Lake Quinsigamond Commission and Lake Quinsigamond Watershed Association: [53]

Lake Quinsigamond is the only lake in Massachusetts that has its own regulatory council. In 1916, the Lake Quinsigamond Commission was created. It was ineffective since it was just an advisory board. In 1936, Amendment Chapter 181 was created. Shortly following other

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[51] Shrewsbury Board of Health http://www.shrewsbury-ma.gov/health/index.asp
[52] Massachusetts Department of Environmental Management. http://www.state.ma.us/dem/index.htm
[53] Lake Quinsigamond Watershed Association http://www.lqwa.org/index.html 4/17/03.

amendments were imposed helping to create the Lake Quinsigamond Lake Commission. Today, the Lake Commission has the power to cover any issues that directly or indirectly affect Lake Quinsigamond.

The Lake Commission has a list of rules and regulations that they enforce year round with the help from Worcester and Shrewsbury Police Departments. Both departments have launches that allow them to patrol the waters during the summer. Regatta Point Park is Worcester's Police Department's launch site while 125 South Quinsigamond Avenue is Shrewsbury's launch site. Chapter 294 of the Special Acts of the Legislature of Massachusetts allows the Lake Commission to create rules and regulations for Lake Quinsigamond. Rule 2 states "No person shall illegally discharge sewage, thermal pollution, siltation, or any substance which itself or in combination with any substance might tend to create a public nuisance, into Lake Quinsigamond."[54] A complete rules and regulation list is shown in Figure 7.1.

[54] Chapter 294 of the Special Acts of the Legislature of Massachusetts.

Figure 7.1: Chapter 294 of the Special Acts of the Legislature of Massachusetts

The Lake Quinsigamond Commission acting under the authority of Chapter 294 of the Special Acts of the Legislature of Massachusetts of the year 1916, as amended by Chapter 357 of the Acts of 1973 and other amendments thereto, adopted the following Rules and Regulations pertaining to Lake Quinsigamond.

By order of the Lake Quinsigamond Commission

Wayne Sampson, Chairman	John Wilson	Nicholas Pepper
Edward Ashe	Tristan Lundgren	Michael Paika
Melvin Gordon	Arthur LeDoux	Kenneth Polito

Rule 1. Any power boat operated on Lake Quinsigamond must meet the statutory requirements of the General Laws of the Commonwealth of Massachusetts. All operations of water craft on the waters of Lake Quinsigamond shall be in strict compliance with the U.S. Coast Guard Rules and Regulations, the General Laws of the Commonwealth of Massachusetts and Rules and Regulations of the Lake Quinsigamond Commission, as ordered.

Rule 2. No person shall illegally discharge sewage, thermal pollution, siltation, or any other substance which by itself or in combination with any other substance might tend to create a public nuisance, into Lake Quinsigamond or into Flint Pond or Hovey Pond, or tributaries thereto, or all of them, in the county of Worcester. Nor shall any person illegally fill in said lake or said ponds or illegally obstruct the flow into or from said lake or ponds, or illegally obstruct the flow into or from said lake or ponds, including all waste or refuse from any dwelling, building, factory or other establishment. No person shall litter the lake or its shoreline or its tributaries.

Rule 3. All boats or any water craft must, if equipped with toilet facilities, have a marine approved holding tank. Boats or any water craft having toilet facilities equipped to discharge effluent overboard will not be permitted on the waters of Lake Quinsigamond unless the thru hull fitting for discharge is plugged from the outside of the boat or craft.

Rule 4. No person shall annoy another person or utter any profane, indecent, threatening or abusive language or loud outcry, or play any game of chance, or have possession of any instrument of gambling or do any obscene or indecent act, or use, for the purpose of annoying another person, a flashlight or any light or horn or other device, in or upon the waters of Lake Quinsigamond.

Rule 5. No person shall operate any boat at a speed greater than 40 m.p.h., or a safe and reasonable speed depending on existing conditions, except during an official supervised race for which the Quinsigamond Commission has issued a permit in writing. The operator of any boat shall reduce boat to headway speed where operator's vision is obscured by bridges, curves or bends. Speed at all times must be reasonable and proper for existing conditions.

Rule 6. All persons using the waters of Lake Quinsigamond must obey official marker buoys and signs. Craft shall not be tied to buoys.

Rule 7. No person shall post, paint, affix or display any sign, notice, placard or advertising device on any part of the waters of said lake up to the high water mark, except with the written authority of the Lake Quinsigamond Commission.

Rule 8. No person shall moor any vessel, boat, canoe, raft, buoy or float or erect a wharf, wharves or other structures in the waters of Lake Quinsigamond which presents any hazard, or is not consistent with the reasonable and safe use of the lake as determined by the Lake Quinsigamond Commission. The Commission may order the removal of any such item which it deems hazardous.

Rule 9. No person shall abandon a boat or power-propelled boat or canoe or other craft, or leave the same unfixed, or allow boats, wharves, floats and barrels to go adrift upon the waters of Lake Quinsigamond. All wharves and unregistered craft must bear the first initial and surname of the owner in letters at least three inches high. Wharves shall be lettered at the end facing the water; boats shall be lettered as near as possible to the bow on the outside of the hull.

Rule 10. Swimming is prohibited at any point in the lake more than 50 feet from land, and in those areas officially marked "No Swimming". Swimming across the lake is prohibited in all cases.

Rule 11. Jumping and diving off bridges, buildings or other structures into the lake is prohibited, except wharves and designated diving structures. Jumping or diving from ropes or lines attached to trees or structures is also prohibited.

Rule 12. Ski-Kites are permitted only with written authorization from the Lake Quinsigamond Commission.

Rule 13. No person shall use the waters of Lake Quinsigamond for the taking off or landing of aircraft, except in case of emergency or authorization from the Lake Quinsigamond Commission.

Rule 14. No person shall conduct a powerboat rental agency or carrying of passengers for hire on the waters of Lake Quinsigamond except as prescribed by and specified in a permit to be issued by the Lake Quinsigamond Commission.

Rule 15. No person shall at any time make an opening in the ice of Lake Quinsigamond exceeding ten inches in diameter, unless in case of emergency, except by permission of the Lake Quinsigamond Commission.

Rule 16. All powerboat racing and waterski competition, snowmobile races, iceboat races, canoe races and regattas are prohibited without the written permission of the Lake Quinsigamond Commission.

Rule 17. Snowmobiles, motorcycles, iceboats and other winter recreational vehicles shall exercise reasonable caution and shall follow the laws of the Commonwealth of Massachusetts and shall keep a reasonable distance from all persons, structures and cleared skating areas. Automobiles and trucks are not permitted on the ice. All ice racing must be with the written permission of the Lake Quinsigamond Commission. The race course must be clearly marked to ensure the safety of the general public.

Rule 18. Racing by ice boats, whether propelled by motors or otherwise, motorcycles, skimobiles or other recreational vehicles, powerboats or sailboats must be held on the portion of the lake that is north of the Lake Quinsigamond Bridge, Route 9, and only on a special permit that will be issued by this Commission. The race course must be marked and protected so as to ensure the safety of the general public.

Rule 19. All craft not covered by state or federal regulations must carry and display appropriate lighting from sunset to sunrise, including at least one portable flashlight.

Rule 20. Racing shells, canoes, row boats shall have the right-of-way over sailboats on Lake Quinsigamond.

Rule 21. The Rules and Regulations of the Lake Quinsigamond Commission shall be enforced by any state or municipal officer empowered to enforce the State Boating Laws of Massachusetts. Each such officer shall have jurisdiction over all waters of Lake Quinsigamond and its adjoining shores and may in the performance of his duties cross over or through public or private lands and property whether covered by water or not.

Whoever shall violate any of the above rules and regulations shall be subject to a fine not exceeding $200 for each offense. Any person having law enforcement powers or a member of the sworn police service of the Commonwealth of Massachusetts, upon observing any violation of these rules may, if the person committing the violation is unknown to him, arrest without a warrant and bring such person before the appropriate court. This power of arrest is in addition to any powers of arrest granted under existing laws.

The Quinsigamond Lake Commission consists of one person appointed by county commissioners, The Worcester Chief of Police, The Shrewsbury Chief of Police, one member of the Worcester Conservation Commission, one member of the Shrewsbury Conservation Commission, one member of the Grafton Conservation Commission, and three members from within Worcester, Grafton and Shrewsbury who are residential landowning abutters on the lake.

In 1984, one hundred volunteers created the Lake Quinsigamond Watershed Association (LQWA). The goal of this group was to enhance the quality of life in and around Lake Quinsigamond for all living species. There were three major reasons for starting the LQWA. These are restoring, preserving and maintaining the water quality and recreational quality of the watershed area. LQWA keeps the public informed through web sites, newsletters regarding the actions taken and the steps used to minimize the actions that impact the lake and the watershed area.

Both of these groups, Lake Quinsigamond Commission and LQWA main objective is to protect Lake Quinsigamond and its watershed from issues that will directly and indirectly affect it. With the help of the DEP, the DEM and the local Board of Health, Lake Quinsigamond can be safe for all living species.

Section 8: Inspections:

8.1 Types of Inspections

There are four major inspections that arise because of Title 5: Soil Suitability for On-site Sewage Disposal, Greywater Disposal Systems Piloting, Variance to Percolation Rate Projects and Subsurface Sewage Disposal System. Each of these are responsible for making sure that residents, business and other facilities are following the rules and regulations set forth by Title 5. Complete copies of these inspection reports are found in Appendix C.

8.2: The Soil Suitability for On-site Sewage Disposal

The Soil Suitability for On-site Sewage Disposal is a seven page inspection process. Two holes are dug on the proposed site and both are inspected. There is information gathered regarding each site such as wetland area, current conditions, flood rate, distances from open water, drainage ways and drinking wells. Another part of the inspection includes observation of each ground hole. These include topics such as soil texture, percentage of coarse fragments, soil consistence and soil horizon layer. The last section of this inspection includes determination of high groundwater elevation, depth of pervious material and the signature of a qualified soil evaluator.

8.3: Greywater Disposal Systems Piloting

Greywater Disposal Systems Piloting is a three page inspection process. Greywater is the water that comes from everything but toilets. In a greywater disposal system, Figure 8.1, greywater is treated similarly to wastewater in a septic tank. However, the greywater leaves the pre-treatment tank and enters the greywater garden or soil-box planter

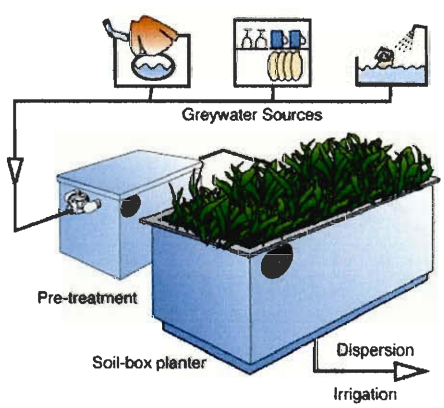


Figure 8.1: Greywater Garden

where it is filtered into the soil. The inspection includes information on the facility and system such as when it was installed, the dates of inspections and what it is used for. The next section includes a list of system components inspected and the conclusions made. The final few sections of the inspection include where the Greywater Garden is located, the general information about the system such as gallons of water, maintenance performed and number of days since last inspection. Also, either an influent or effluent sample is taken. These are sent to a laboratory for testing on various components such as, but not limited to pH, BOD, oil and grease, E. coli, and Fecal Coli form. Just like the Soil Suitability for On-site Sewage Disposal this form has to be signed by a registered professional engineer or sanitarian.

8.4: <u>The Variance to Percolation Rate Projects</u>

The Variance to Percolation Rate Projects is also a three page inspection process. It is an inspection for septic systems with greater than thirty to sixty minutes per inch percolation rates. It includes information on the depth of sludge/scum layers, the determination of need for pumping, if the distribution box has back up or solids, and the water meter readings at the time of inspection. The last two parts include what the well looks like and a signature from the certified Title 5 Inspector. This inspection has to be turned into the DEP and local board of health by January 31st for the pervious calendar year.

8.5: <u>The Subsurface Sewage Disposal System</u>

The Subsurface Sewage Disposal System is an eleven page inspection process. This inspection tells whether or not a septic has passed the Title 5 requirements. The system can pass, fail, conditionally pass or need further evaluation by the Board of Health. If the system conditionally passes, the parts that are described within this section will have to be replaced or repaired. Once this is completed the system will pass. Further evaluation by the Board of Health is deemed necessary when the cesspool or privy is within fifty feet of wetlands, or when the septic tank is within Zone I of a public well or within fifty feet from a private well. Another part of the inspection process is the flow conditions of the septic tank. Flow conditions include, but are not limited to: the number of bedrooms, the use of the system, and the water meter readings. The general information for the septic system is also included. General information includes the type of system, age, sewage odors, and pumping records. Measurements are taken from each part of the system, building sewer, septic tank, grease trap, holding tank, distribution box, pipe chamber, soil absorption systems, cesspool and privy. Depending on the part the measurements can include but are not limited to dimensions, depth of layers, materials of construction, and configuration. Also included in the inspection is a sketch of the sewage disposal system. This inspection form has to be signed and completed by a certified Title 5 inspector. The inspection form has to be returned to the DEP and the local board of health within thirty days of inspection. If a resident fails the Subsurface Sewage Disposal System inspection Title 5 allows for up to two years for the completion of repairs or an upgrade.

Section 9: Analysis

9.1: Analysis

Taking into account all the research in the previous chapters, the IQP group will attempt to show that Title 5 makes a considerable impact on the flow of nutrients into Lake Quinsigamond. Knowing that currently, only about 10% of tested systems fail Title 5 inspections, we can assume that 10% of systems in general are failing-caliber systems. Based on research, nitrogen and phosphorus are the two essential elements leading to eutrophication. It will be revealed that the flow rates of phosphorus and nitrogen from working and non-working systems, combined with several other factors, will show that Title 5 is beneficial to Lake Quinsigamond's well-being.

9.2: Phosphorus

With a working, Title 5 compliant septic system, in perfect conditions, 20% of the influent phosphorus will be removed before the wastewater is expelled from the system. Taking into account that the concentration of phosphorus in a septic tank at any given point is around 4.0 mg/L, this results in approximately 3.2 mg/L entering the ground water, and consequently a nearby lake. With an average flow rate of 225 gallons per day (1020 liters per day), based on a typical three or four family house, that works out to 3270 mg/day entering the lake, from each house with a working septic system.

Assuming that a failing septic system removes no influent phosphorus, we can figure the rate of phosphorus entry into the lake to be 4.0 mg/L x 1020 L/day = 4090 mg/day enter the lake from each house with a failing septic system.

With Title 5 in effect, the amount of in-lake phosphorus is reduced. Take for instance that there are 1590 houses on Lake Quinsigamond, and 90% of those homes pass Title 5 inspection.

From this, we can deduct the daily total influent phosphorus as:

Working system discharged phosphorus * number of houses * percent passing
+
Failing system discharged phosphorus * number of houses * percent failing
=
Daily total influent phosphorus into Lake Quinsigamond.

With the aforementioned numbers, this works out to:

3270mg/day * 1590 homes * 90% = 4680000 mg/day = 4.7 kg/day
+
4090 mg/day * 1590 homes * 10% = 650000 mg/day = 0.65 kg/day
=
5330000 mg/day = 5.35 kg/day phosphorus

Currently, with Title 5 in effect, there are 5.35 kilograms per day of phosphorus entering the ground adjacent to the lake. In an inland system, this number would be further reduced due to the presence of a leaching field, and the miles of ground for the nutrients to filter through. As mentioned above, the homes on Lake Quinsigamond have extremely small yards which do not allow for properly sized leaching fields. There is even less land between the septic system and the lake to adequately filter contaminants exiting the system.

If Title 5 and its stipulations were not in effect today, over time it could be assumed that there would be drastically fewer compliant systems. At an absolute maximum, with no regulatory commission, it is to be assumed that 50% of all systems would be Title 5 compliant, as Massachusetts knows it today.

From the previously stated information, we can deduct the daily influent phosphorus, if there were no Title 5 could be determined as:

3270mg/day * 1590 homes * 50% = 2600000 mg/day = 2.6 kg/day
+
4090 mg/day * 1590 homes * 50% = 3250000 mg/day = 3.2 kg/day
=
5850000 mg/day = 5.8 kg/day

There is a difference of 520,000 mg/day (approximately one-half of a kilogram per day) phosphorus between a Title 5 – implemented environment, and an environment with no Title 5. This number may not seem like much, but seeing how Lake Quinsigamond property is no longer seasonal, the yearly influent totals are calculated, and arrived at 190,000,000 mg phosphorus more per year. That is 190 kilograms of phosphorus being introduced to the water of Lake Quinsigamond each year.

9.3: <u>Nitrogen</u>

With a working, Title 5 compliant septic system, in ideal conditions, 12.5% of the influent nitrogen will be removed before the wastewater is expelled from the system. Taking into account that the concentration of nitrogen in a septic tank at any given point is around 40.0 mg/L, this results in approximately 35.0 mg/L entering the ground water, and consequently a nearby lake. With an average flow rate of 225 gallons per day (1020 liters per day), based on a typical three or four bedroom house, that works out to 35800 mg/day

Assuming that a failing septic system removes no influent nitrogen, we can figure the rate of nitrogen entry into the lake to be 40.0 mg/L x 1020 L/day = 40900 mg/day entering the lake from each house with a failing septic system.

With Title 5 in effect, the amount of in-lake nitrogen is reduced. Take for instance that there are 1590 houses on Lake Quinsigamond, and 90% of those homes pass Title 5 inspection. From this, we can deduct the daily total influent nitrogen as:

Working system discharged nitrogen * number of houses * percent passing
+
Failing system discharged nitrogen * number of houses * percent failing
=
Daily total influent nitrogen into Lake Quinsigamond.

With the aforementioned numbers, this works out to:

35800 mg/day * 1590 homes * 90% = 51,200,000 mg/day = 51 kg/day
+
40900 mg/day * 1590 homes * 10% = 6,500,000 mg/day = 6.5 kg/day
=
57,700,000 mg/day = 58.0 kg/day influent nitrogen

Presently, with Title 5 in effect, there are 57,700,000 mg of nitrogen entering the ground adjacent to Lake Quinsigamond each day. Using the same percentages of compliant versus non-compliant systems as above, disregarding Title 5, then the total influx of nitrogen into Lake Quinsigamond is:

35800mg/day * 1590 homes * 50% = 28,400,000 mg/day = 28 kg/day
+
40900 mg/day * 1590 homes * 50% = 32,500,000 mg/day = 32 kg/day
=
60,900,000 mg/day = 60 kg/day influent nitrogen

There is a difference of 3,250,000 mg/day of nitrogen going into the ground adjacent to Lake Quinsigamond between situations where Title 5 is in effect, and where Title 5 is not in effect. Taking this number over the course of a year, there is a difference of 1,190,000,000 mg (1,190 kilograms) of nitrogen entering the ground bordering Lake Quinsigamond with little or no filtration.

9.4: <u>Quantitative Conclusion:</u>

We are comparing two distinct situations: one being where Title 5 is in effect, with a 90% rate of compliance, and two, if there were no Title 5; assuming half of all systems are failing systems as Massachusetts defines it today. Based on the difference of the daily rates of influx of nitrogen and phosphorus, 3.3 kg and 0.5 kg respectively, it can be concluded that Title 5 is slowing the rate of the eutrophication of Lake Quinsigamond.

Although these numbers may seem small, only 5.6% and 9.6% for nitrogen and phosphorus, respectively, when projected over the course of two decades, the percentages, although small, become a substantial number. Taking the daily difference of nitrogen influx, over a longer time span, we arrive at:

3.3 kg/day nitrogen difference * 365 days/year * 20 years = **24,000 kg**

The same calculation can be done for phosphorus:

0.5 kg/day phosphorus difference * 365 days/year * 20 years = **3,700 kg**

We show this calculation because over the period of one day, Lake Quinsigamond is only seeing an additional 3.3 kg of nitrogen. Although the percentage is small, the number is considerable. To put it in terms of a simple analogy, if one professor makes $50 a week more than another professor, the percentage is relatively small. However, over the span of a 10 year tenure, the difference is $26,000. How can it be said that the $50 difference is minimal, knowing the long-term summation?

Another substantial contributor of nitrogen and phosphorus to the waters of Lake Quinsigamond is runoff. Urban runoff consists of rainwater and melting snow washing road debris downstream into the lake. Some of this matter is lost through the natural ground filtration, however most of the nutrients eventually make it into the lake. The following is a table containing data gathered by the Nationwide Urban Runoff Program (NURP) for an urban and rural runoff from a Rouge River, Wayne County, Michigan study. Although the data is from Michigan, it is still applicable to Lake Quinsigamond, due to the large number of sources from which their information was gathered, which includes the Lake Quinsigamond area, shown in the following figure.

Figure 9.1: Location of Nationwide Urban Runoff Program Sites

EPA Region	NURP Code	Project Name/Location	EPA Region	NURP Code	Project Name/Location
I	MA1	Lake Quinsigamond (Boston Area)	V	IL1	Champaign-Urbana, Illinois
	MA2	Upper Mystic (Boston Area)		IL2	Lake Ellyn (Chicago Area)
	NH1	Durham, New Hampshire		MI1	Lansing, Michigan
II	NY1	Long Island (Nassau and Suffolk Counties)		MI2	SEMCOG (Detroit Area)
	NY2	Lake George		MI3	Ann Arbor, Michigan
	NY3	Irondequoit Bay (Rochester Area)		WI1	Milwaukee, Wisconsin
III	DC1	WASHCOG (Washington, D.C. Metropolitan Area)	VI	AR1	Little Rock, Arkansas
	MD1	Baltimore, Maryland		TX1	Austin, Texas
IV	FL1	Tampa, Florida	VII	KS1	Kansas City
	NC1	Winston-Salem, North Carolina	VIII	CO1	Denver, Colorado
	SC1	Myrtle Beach, South Carolina		SD1	Rapid City, South Dakota
	TN1	Knoxville, Tennessee		UT1	Salt Lake City, Utah
			IX	CA1	Coyote Creek (San Francisco Area)
				CA2	Fresno, California
			X	OR1	Springfield-Eugene, Oregon
				WA1	Bellevue (Seattle Area)

Figure 2-1. Locations of Nationwide Urban Runoff Program Sites

Source: USEPA, *Results of the Nationwide Urban Runoff Program, Volume I: Final Report*, Water Planning Division, Washington, D.C. December, 1983

Table 9.1: Event Mean Concentrations

Constituent	Coefficient of Variation		Site Mediation Event Mean Concentration (EMC)			
			Median Site		90th percentile site	
	Urban	Rural	Urban	Rural	Urban	Rural
Total Phosphorus (mg/l)	0.89	1.02	0.40	0.16	1.07	0.48
Nitrate + Nitrite Nitrogen (mg/l)	0.56	0.57	0.76	0.46	1.48	0.91

From this data, we can calculate the nitrogen and phosphorus entering Lake Quinsigamond from runoff. The NURP study monitored 2,300 storm events nationwide during the testing period, which corresponds to an average of 28 storms per site per year. Our estimate will be based on an area equal to the area containing the septic systems from which our previous calculations were made. Lake Quinsigamond is approximately five miles long. We are going to assume that the majority of nitrogen and phosphorus containing rain runoff that enters Lake Quinsigamond from the adjacent lots. Using an width two lots deep, 100 ft, we arrive at a total area of 5.3×10^6 ft^2 per side of the lake.

From this data, we can deduct yearly influent runoff nitrogen and phosphorus into Lake Quinsigamond by:

Urban site EMC * area * yearly rainfall = yearly influent nutrient

Phosphorus:

0.40×10^{-6} kg/l * (5.3×10^6 ft^2) * 2 sides * 4 feet = **490 kg/year**

Nitrogen:

0.76×10^{-6} kg/l * (5.3×10^6 ft^2) * 2 sides * 4 feet = **920 kg/year**

Comparing these numbers to those coming from the septic system, we can show how runoff and septic systems contribute to the nitrogen and phosphorus totals in Lake Quinsigamond:

Table 9.2: Runoff vs. Septic Systems

	Runoff	**Septic Systems**
Nitrogen (kg/year)	920	21,000
Phosphorus (kg/year)	490	2,000

From our analysis on runoff, we can conclude that runoff is a major contributing factor, as is septic systems. By tackling the septic system contributions, which contributes 60% of the yearly phosphorus, it is possible to make a significant impact on the amount of the algae produced. As previously discussed, the N:P ratio in Lake Quinsigamond dictates that the amount of phosphorus present controls the eutrophication of the lake.

As of now, only four percent[55] of Lake Quinsigamond is heavily feeling the effects of eutrophication. Since the rate of eutrophication will increase proportionally with the increase in the presence of available nutrients, namely phosphorus, it is essential that the Department of Environmental Protection, Department of Environmental Management, and the town Boards of Health do everything in their power to limit the presence of nitrogen and phosphorus in bodies of water statewide both by controlling septic system discharge and controlling runoff.

[55] Massachusetts Department of Environmental Management. http://www.state.ma.us/dem/index.htm

Section 10: Effects on People on Lake Quinsigamond

In the month of February, 2003, we contacted 20 different real estate offices at random, and polled them on several aspects of Title 5. We asked questions such as, "Has Title 5 affected your sales in general?," "What is the average consumer spending on Title 5 related issues, such as upgrading/replacing failing systems, or connecting to city sewer?," and "What information do you give to customers explaining Title 5 and what has to be done?" The vast majority of people we spoke with were happy to speak with us, and give us any information we requested. A complete list of the realtors' responses and the questionnaire is located in Appendix B.

In response to the sales question, all but one realtor said Title 5 does not affect their sales at all. Realtor 4 in Worcester said that of the [approximate] 10% of customers who have a failing system, 10% choose not to sell their home because of it. On the other hand, Realtor 16 said that because of the booming real estate market, most people selling their homes choose to sell regardless of Title 5 expenses because there is so much equity in the home. This seemed to be the mentality of the vast majority of the realtors.

Replies to the average consumer spending on Title 5 related issues question varied widely. We received answers as low as $2,000 (Realtor 13), to as high as $40,000. (Realtor 6) The average of all responses is a mean of approximately $10,500 in costs to the consumer. This includes Title 5 inspection, pump inspection, distribution box digging, design costs, labor, and parts. The cost for a consumer to connect to city sewer, if applicable, is usually somewhere in the $2,000-$5,000 range.

Realtor 14 referred us to Realtor 15, the so-called "Title 5 Guru," and one of the most knowledgeable real estate agents in Massachusetts when it comes to Title 5. In Realtor 15's opinion, the fact that local boards of health can promulgate regulations that are more stringent than those required by Title 5 is unfair. Local regulations often change with the appointment of a new Board of Health official, which can be as often as every year.

Realtor 15 had some very strong views on the Board of Health's inadequacies in promoting new technologies. Realtor 15 feels that even though there are several innovative new systems to aide in subsurface sewage disposal, the Board of Health does not give sufficient consideration and funding to the promulgation of these technologies. If the upcoming technologies would be recognized and approved faster, it would help solve many of the state's sewage problems.

Title 5 requires that every home be inspected when it is either bought or sold; therefore every homeowner, be it buyer or seller, has been affected by Title 5. An inspection costs approximately $500. When the new Title 5 was implemented many realtors saw a drop in their sales because people were not willing sacrifice the several thousand dollars to make the changes necessary for their system to pass a Title 5 inspection. However, over the years the sales have increased back to where they were before Title 5 was implemented. Sales have increased for two major reasons: the first reason is that once Title 5 was implemented, many systems were upgraded. These newer systems have a longer life, approximately twenty years, so today fewer systems are failing. Another reason is that the economy and the real estate markets are doing well, and home values have risen. This leads to more equity in the property for the seller, so that the cost of the system does not significantly affect the profit from the sale.

Today, 10-20% of homes fail a Title 5 inspection. On average, one spends between $2,000 and $10,000 to fix or replace a failing system. Depending on the reasons for failure, the cost to the homeowner may be as low as $2,000 or as high as $40,000. The more expensive costs are incurred when the homeowner has to completely replace the system.

Title 5 requires that the septic system is inspected, and failed systems are replaced; it does not say who is required to fix it. Many sellers and buyers make an agreement stating that the buyer will fix the system within the required time as long as the seller compensates the buyer. For example, the seller can add a holdback to the closing, of 1.5 times the lowest appraisal, to fix the system.

Section 11: Innovative Technologies

11.1 New and Innovative Technology

The Department of Environmental Protection (DEP) is dedicated to the development and implementation of new and innovated technologies. The DEP has developed a network of services regarding innovative technology expansion and applications.

The DEP defines an Innovative Technology (IT) as "an entirely new technology; one that has been proven effective in certain fields but not yet applied to problems; or one that is accepted and commonly used in other states or countries but is new to Massachusetts."[56] While a conventional system consists of a septic tank, distribution box, and leaching field, an IT system provides additional aspects or alternatives to one of the above, while providing an equal or greater degree of effectiveness. ITs are mainly focusing on the upgrades of failing systems, places that are sensitive to nitrogen and phosphorus (such as lake-front property) and locations where the current system is not compliant with Title 5.

Title 5 mandates a three step approach for the approval of an innovative technology: piloting, provisional, and general use.

A piloting approval is the first stage to acceptance for a new technology. The applicant must prove that their system can provide an equivalent degree of environmental protection as a convention Title 5 compliant system. The DEP is not able to approve more than 15 facilities for testing of a piloting approved technology each year.

For a company to obtain provisional use, they must show that their system can provide an equivalent degree of environmental protection as a conventional Title 5 compliant system. "The applicant must have a minimum of 50 systems installed for three years and evaluated under

[56] Massachusetts Department of Environmental Protection Fact Sheet, Innovative Technologies.

Provisional Approval prior to moving on to General Use Certification."[57] A provisional use system may be installed only in upgrade situations, or in new construction, where a conventional Title 5 system would not be a problem

For a company to receive a certification for general use of their product, they must demonstrate that the technology provides an equal level of environmental protection to a conventional Title 5 complying system.

There is also approving remedial use systems, for operation at sites with failing or non-compliant systems.

11.2: Approved Technologies

The following tables show a list of all Innovative Technologies approved by the DEP as of December 21, 2002. [58]

Table 11.1: Approved for Piloting	
Technology and Model Numbers	**Technology Proponent**
WWT System CA-5D, CA-12D, CA-25D, CA-30D, CA-50D, CA-60D, CA-100D, CA-120D, and CA-150D	Cromaglass Corporation
MicroSeptec EnviroServer 600, 1200, and 1500	MicroSeptec, Inc.
RUCK CFT	North Coast Technologies, LLC
SeptiTech models 400N, 550N, 750N, 1200N, 1500N & 3000N	SeptiTech, Inc.
Norweco Singulair Model 960 DN	Siegmund Environmental Services, Inc.
Nitrex Filters and Nitrex Plus	Wastewater Science, Inc.
Waterloo Biofilter	Waterloo Biofilter System, Inc.

[57] Massachusetts Department of Environmental Protection Innovative and Alternative Subsurface Sewage Disposal Technologies Approved for use in Massachusetts. December 21, 2002.

[58] Charts from Massachusetts Department of Environmental Protection Innovative and Alternative Subsurface Sewage Disposal Technologies Approved for use in Massachusetts. December 21, 2002.

Table 11.2: Approved for Provisional Use	
Technology and Model Numbers	**Technology Proponent**
Bioclere 16, 22, 24, and 30 series units	AWT Aquapoint
Micro FAST Model 23-001-750	Bio-Microbics, Inc.
Amphidrome Process	F. R. Mahony & Associates, Inc.
Single Home FAST and Modular FAST	Smith & Loveless, Inc.
Waterloo Biofilter	Waterloo Biofilter Systems, Inc.
ZenoGem/Cycle-Let	Zenon Municipal Systems

Table 11.3: Certified for General Use	
Technology and Model Numbers	**Technology Proponent**
Composting Toilets that comply with Title 5	(Generic)
Recirculating Sand Filter that complies with Title 5	(Generic)
BioDiffuser High Capacity, Standard, and Bio 2 Chambers Model Number: Standard	Advanced Drainage Systems, Inc.
Bioclere 16, 22, 24, and 30 series units	AWT Aquapoint
Biolet XL Composting Toilet	Biolet USA
MicroFAST, High Strength FAST, NitriFAST	Bio-Microbics, Inc.
WWT System CA-5, CA-12, CA-25, CA-30, CA-50, CA-60, CA-100, CA-120, and CA-150	Cromaglass Corporation
Contactor 75, 100, 125 and EZ-24; and Recharger 180, 280, 330, and 400; Contactor Field Drain C1, C2, C3, and C4	Cultec, Inc.
Eljen In-Drain Systems: Model Number: Type B43	Eljen Corporation
Enviro Chamber Standard and High Capacity and Narrow Enviro Chamber	Hancor, Inc.
High Capacity and Standard Chambers, Infiltrator 3050, and Equalizer 24	Infiltrator Systems, Inc.
RUCK System (less than 2000 gpd)	Innovative RUCK Systems, Inc.
Low-Rate Intermittent Sand Filter by Orenco Systems, Inc.	Saneco, Inc.
Modular FAST	Smith & Loveless, Inc.
Singulair Model 960 and 960 DN	Seigmund Environmental Services, Inc.
Waterloo Biofilter	Waterloo Biofilter Systems, Inc.

Table 11.4: Approved for Remedial Use	
Technology and Model Numbers	**Technology Proponent**
Composting Toilets that comply with Title 5	(Generic)
Recirculating Sand Filter that complies with Title 5	(Generic)
Bioclere 16, 22, 24, and 30 series units	AWT Aquapoint
Puraflo Peat Fiber Biofilter	Bord na Mona Environmental Products U.S. Inc.
Biocycle 525	Biocycle, Inc.
Biolet XL Composting Toilet	Biolet, Inc.
MicroFAST, High Strength FAST, NitriFAST, models	Bio-Microbics, Inc.

0.5 to 9.0	
WWT System CA-5, CA-12, CA-25, CA-30, CA-50, CA-60, CA-100, CA-120, and CA-150	Cromaglass Corporation
Jet Models J-335 Tertiary Sand Filter	Clearwater Recovery (Stephen B. Nelson)
Jet Models J-500, J-750, J-1000, J-1250, and Jet J-1500	Clearwater Recovery (Stephen B. Nelson)
Amphidrome Process	F.R. Mahony & Associates, Inc.
Ecoflo Biofilter	Premier Tech
High-Rate and Low-Rate Intermittent Sand Filter by Orenco Systems, Inc.	Saneco, Inc.
SeptiTech Models 300, 400, 500, 750, 1200, and 3000	SeptiTech, Inc.
Singulair Models 960N, 960/750, 960/1000, 960/1250, and 960/1500	Siegmund Environmental Services, Inc.
Modular FAST	Smith & Loveless, Inc.
Waterloo Biofilter	Waterloo Biofilter System, Inc.

There are many new and innovative technologies and ideas, currently not in widespread use, that could make a dramatic impact on the quantity of nitrogen and phosphorus that enter the soil, and consequently enter groundwater and lakes. Although the DEP does not endorse specific IT products, there are several, including the Waterloo Biofilter, that the DEP looks upon highly. Currently approved for General Use, Piloting Use, Provisional Use, as well as Remedial Use, the Waterloo Biofilter has several unique characteristics. With such recommended options as Phosphorus Removal Modules for homes on lakefront property, it is the leader in the IT industry.

As mentioned previously, by reducing the amount of the limiting factor (phosphorus) that each septic system produces, it is possible to reduce the amount of algae that is produced in a lake.

11.3: Waterloo Biofilter

According to the Waterloo website, "The Waterloo Biofilter ® system is a single-pass aerobic biofilter designed for the biological treatment of wastewater. The patented process utilizes an absorbent synthetic filter medium designed to optimize the biological degradation of wastewater. Natural microbial action in the filter medium is enhanced by its high porosity, large available surface area, excellent air flow characteristics and ease of microbial attachment"[59] The Waterloo has separate flow paths for wastewater and air, allowing for effective treatment and high loading rates. Figure 11.1 shows the basic schematic sectional workings of the Waterloo Biofilter installed on lakefront property. Figure 11.2 shows the overhead proposed plan for a Waterloo Biofilter installed on lakefront property.

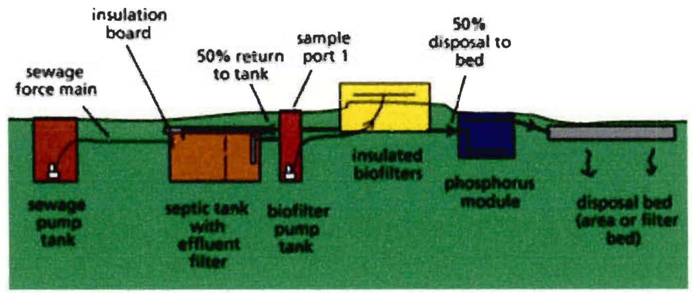


Figure 11.1: Waterloo Biofilter Cross Section

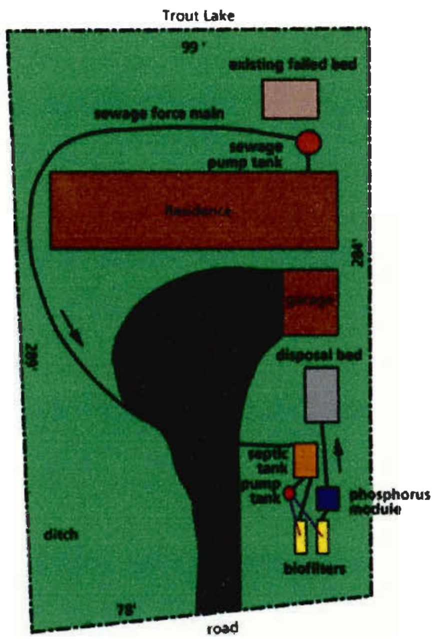


Figure 11.2: Waterloo Biofilter Top View

The Waterloo Biofilter is excellent at removing nitrogen and phosphorus from wastewater. The septic tank used in the Waterloo system contains a starting concentration of nitrogen of 40.0 mg/L. Based on three years of trials, the nitrogen output value from Waterloo systems averaged 20.0 mg/L. This is a nitrogen reduction of 50%, compared with a standard, properly working septic system (including proper leaching area, and distribution box) only reducing nitrogen 12.5%.

[59] How Waterloo Biofilter Works. www.waterloo-biofilter.com/HowitWorks.htm

Septic tanks contain approximately 4.0 mg/L phosphorus, and with the Waterloo Biofilter, phosphorus concentration was reduced between 31% and 86%, depending on the soil type and quality. Compared to a standard septic system removing only 20% of phosphorus, this is an exceptional number. The IQP group would like to stress, that the removal rates for standard septic systems is for a system that is in perfect working condition, with ideal physical properties.

The rates of removal for Nitrogen (TN) and Phosphorus (TP), and other contaminates from the Waterloo system are found in Table 11.5.

Table 11.5: Removal Rates for Substances in a Waterloo Biofilter

n = number of samples.

Parameter	Jan 98 – Jun 98 red earth in upflow				Jul 98 – Dec 98 Filtralite in upflow				Jan 99 – Aug 99 Filtralite in upflow			
mg/L	n	IN*	OUT	%	n	IN*	OUT	%	n	IN*	OUT	%
BOD_5 (initial est. at 100 mg/L)	6	46	<5	~95	4	48	<5	~95	3	34	7	~95
TSS	6	31	<2	>94	4	57	~5	>91	3	106	2	>95
$NO_{2,3}$-N	6	0.1	7	-	4	0.5	16	-	3	3.2		-
TKN (initial est. at ~40 mg/L)	6	20 (40)	12	-	4	21 (40)	2	-	3	23 (40)	3	-
TN (initial est. at 40 mg/L)	6	40*	19	~50	4	40*	18	~50	3	40*	23	~50
TP	13	3.9	2.7	31	12	4.1	0.6	86	15	4.3	2.8	36
E.Coli (CFU/100 mL)	4	>58k	660	>99	4	>320k	<75	99.98	14	>86k	<16	99.98

*note recirculation tank is mixed sewage and Biofilter® effluent, and not the starting point for BOD or nitrogen species (estimated at 40 mg/L), but is for starting point phosphorus and possibly for TSS and E.Coli

11.4: <u>Conclusions on Innovative Technologies:</u>

The Waterloo Biofilter System is just one of many new and innovative technologies. If we compare the reduction of nitrogen and phosphorus of the Waterloo Biofilter with the average septic system:

Table 11.6: Biofilter vs. Septic System

	Waterloo Biofilter	Average Septic System
% Reduction Nitrogen	50	12.5
% Reduction Phosphorus	51 (With Phosphorus Removal Module)	20

From this data we can conclude that if perfected and widely implemented, the Waterloo Biofilter would make a significant impact on the amount of contaminants and nutrients entering groundwater, and consequently nearby lakes, drinking water wells, and reservoirs. Through the DEP programs assisting IT developing companies we will see many drastic improvements in the near future. These innovative systems are evolving from theoretical ideas to working models that eventually may become the norm.

Section 12: Conclusions

Based on the analysis, Title 5 has proven to be effective in controlling the efficacy of septic systems. From the report, it has been shown that Lake Quinsigamond is more environmentally sound because that that Title 5 is in effect. Title 5 has also made a substantial impact on the health of the population surrounding Lake Quinsigamond by limiting the presence of nutrients and contaminants entering the lake. We found a cost benefit analysis on Title 5, located in appendix E. However, after carefully consulting the analysis, and DEP officials, we found that the numbers contained in it were inconclusive. For this reason, and because no other cost benefit analyses were found, they were not used in this report.

The analysis shows that in the absence of Title 5, the influx of nitrogen and phosphorus into Lake Quinsigamond would be substantially increased. With the presence of the additional nitrogen and phosphorus acting as nutrients, the eutrophication of Lake Quinsigamond would proportionally escalate. Not only is eutrophication greatly increased, there also would be a significant detriment to the ecosystem in general.

Lake Quinsigamond once was a prime destination for summer vacationers. These seasonal homes have become year round homes, and multiplied in number. This densely population area surrounding Lake Quinsigamond leaves little room for adequate space for a proper working septic system. A possible solution to this would be to have the city install public sewers for the homes on the lake. This solution proves to be not only time consuming, but is also increasingly expensive. A more probable solution would be to develop and implement various innovative technologies discussed in the report, such as the Waterloo Biofilter System. If the Waterloo System, or countless others like it, were widely implemented, there would be a considerable impact on the health on the Lake Quinsigamond watershed.

In conclusion, we feel that Title 5 is a step in the right direction. The State of Massachusetts cannot be content with the results of Title 5 produced to date. Although the results are promising thus far, the Department of Environmental Protection, the Department of Environmental Management, and local Boards of Health must continue to conduct studies and inform the public of the problems that arise, and take deliberate action. With the DEP, DEM, and local Boards of Health doing their jobs and engineers continuing to develop new and innovative technology, the situation of Lake Quinsigamond and subsurface sewage disposal systems will only improve.

As of now, only four percent[60] of Lake Quinsigamond is heavily feeling the effects of eutrophication. Since the rate of eutrophication will increase proportionally with the increase in the presence of available nutrients, namely phosphorus, it is essential that the Department of Environmental Protection, Department of Environmental Management, and the town Boards of Health do everything in their power to limit the presence of nitrogen and phosphorus in bodies of water statewide both by controlling septic system discharge and controlling runoff.

Appendix A

[60] Massachusetts Department of Environmental Management. http://www.state.ma.us/dem/index.htm

Soil Evaluators by Town:

Name	Association	Address	Town	State	Zip	Phone Number
Michael Berberian		5 Old Colony Rd.	Auburn	MA	01501-	508-478-7966
Robert J. Duff	Cullinan Engineering	300 Auburn St.	Auburn	MA	01501-	508-832-5811
Tom Healey		27 Old Meetinghouse Rd	Auburn	MA	01501-	508-721-0040
Kenneth W. Hodgson, Jr.	Cullinan Engineering Co., Inc.	200 Auburn St.	Auburn	MA	01501-	508-832-5811
Leo Lessard		157 Southbridge St.	Auburn	MA	01501-	508-754-2789
Michael F. Loin	Bertin Engineering Assoc.	7 Midstate Dr.	Auburn	MA	01501	508-721-0040
James F. Malley, Jr.	Sutton/Millbury BOH	23 Winchester Ave	Auburn	MA	01501-	508-799-6114
Joanne Petterson	Auburn BOH	104 Central St.	Auburn	MA	01501-	508-832-7703
William J. Richard	Cullinan Engineering	200 Auburn St.	Auburn	MA	01501-	508-832-5811
Steven P. Roix		15 Midstate Dr., Ste 204	Auburn	MA	01501	508-721-7680
Dennis M. Costello	Board of Health	221 Main St.	Boylston	MA	01505-	508-869-6828
Andrew B. Liston	Thompson-Liston Assoc., Inc.	P.O. Box 570	Boylston	MA	01505-	508-869-6151
James L. Tetreault	Thompson-Liston Assoc., Inc.	51 Main St., Box 570	Boylston	MA	01505-	508-869-6151
Jeffrey M. Walsh		35 Glazier Rd	Boylston	MA	01505-	508-869-2239
Ralph E. Wegener	On-Line Engineering	12 Kendall Rd.	Boylston	MA	01505-	508-869-6418
Gary Dulmaine		14 Alana Dr.	Grafton	MA	01519-	508-792-7650
John H. Goodhall, Jr.		49 Sunrise Ave.	Grafton	MA	01519-	508-366-3076
Norman Hill	Land Planning	214 Worcester St.	Grafton	MA	01519-	508-839-9526
Mark M. Santora	Town of Grafton	30 Providence Rd.	Grafton	MA	01519-	508-839-8506
Robert S. Shanks	Shanks & Assoc.	6 Kaye Ciorcle	Grafton	MA	01536-	508-839-9485
Dennis R. Dunn	DEP 157 Holden St		Holden	MA	01520-	617-556-1130
Lewis Reed		27 Holden St.	Holden	MA	01520	508-853-1234
Jennifer Carlino		59 School St a-3	Northboro	MA	01532-	508-393-7539
Bryant Firmin		14 Edmunds Way	Northboro	MA	01532-	508-393-3754
Richard F. Gorman	Land Planning Inc.	11 Saint James Dr.	Northboro	MA	01532-	508-839-9526
Beth A. Koch	Hopkinton BOH	33 Washburn St	Northboro	MA	01532-	508-497-9725
Larry Sabean	Northboro Engineering	276 West Main St	Northboro	MA	01532-	508-393-9727
Ning Chen	DEP/CRO	18 Stratton Way	Northborough	MA	01532-	- -
Tim Paris	Connorstone Engineering	276 W. Main St.	Northborough	MA	01532-	508-393-9727
Michael J. Sullivan	Connorstone Engineering	276 W. Main St.	Northborough	MA	01532-	508-393-9727
John P. Wallace	Town of Northborough	63 Main St.	Northborough	MA	01532-	508-393-5009
Stephen Balcewicz	B. C. Survey & Engineering, Inc.	1 Major Moore Circle	Paxton	MA	01612-	508-987-8000
Christopher Keenan		397 Pleasant St.	Paxton	MA	01612	508-277-9433
William A. Coyle	Mass Highway	339 River St	Leicester	MA	01524-	508-754-7204
Robert McNeill, III		21 Cricklewood Dr	Leicester	MA	01524-	
James D. Perrone	J.P. Engineering	21 Burncoat Lane	Leicester	MA	01524-	508-892-9693
Nancy E. Allen	Town of Shrewsbury	100 Maple Ave.	Shrewsbury	MA	01545-	508-841-8512
Mahmood Azizi		715 Main St.	Shrewsbury	MA	01545-	508-852-5285
Mark Beaudry		45 Thomas Farm Cir	Shrewsbury	MA	01545-	
Mark E. Godfrey		21 Park ST.	Shrewsbury	MA	01545	508-842-4773
Gennaro J. Groccia		261 Old Mill Rd.	Shrewsbury	MA	01545-	508-752-2143
Mark P. Johnson		82 Harriet Ave.	Shrewsbury	MA	01545-	508-842-7286
Robert G. Moore	Town of Shrewsbury	100 Maple Ave.	Shrewsbury	MA	01545-	508-841-8512
John J. Ostrosky		16 Colton Lane	Shrewsbury	MA	01545-	508-842-2184
Jason Benoit	Metropolitan Dist. Comm.	180 Beamon St.	West Boylston	MA	01583-	508-368-0026

Name	Association	Address	Town	State	Zip	Phone Number
Robert Bishop	Metropolitan Dist. Commission	180 Beamon St.	West Boylston	MA	01583-	508-792-7423
Michael J. Burke	Town of Boylston	Mixters Bldg.	West Boylston	MA		
Scott Campbell	Metropolitan Dist. Commission	180 Beamon St.	West Boylston	MA	01583-	508-792-7423
Stanley Szczurko, Jr.		24 Woodlands Heights Dr.	West Boylston	MA	01583-	
Vincent P. Vignaly		50 Newton St.	West Boylston	MA	01583-	508-835-9084
Steven Baccari	Westboro BOH	45 W. Main St Rm 25	Westboro	MA	01581-	508-366-3045
David Boyer		20 Haskell St.	Westboro	MA	01581-	508-754-7204
Gerard T. Cushing		12 Edmund Drigham Way	Westboro	MA	01581-	508-366-6137
Gerald J. Topping		7 Jacob Amsden Rd	Westboro	MA	01581-	508-366-2289
Yu T. Chen		33 Mountain View Dr.	Westborough	MA	01581-	617-241-6321
Mark J. Guerard	Guerard Survey Co. & Assoc.	11 Summer St.	Westborough	MA	01581-	508-928-5467
Paul R. McNulty	Town of Westborough	45 W. Main St. - Rm. 25	Westborough	MA	01581-	508-366-3045
Michael A. Baer	Millbury BOH	60 Eustis St Ext.	Worcester	MA	01606-	508-443-9566
William M. Clougherty	City of Worcester	25 Meade St.	Worcester	MA	01610-	508-799-8576
Sean Collins		199 Coburn Ave.	Worcester	MA	01604	508-839-5335
Alan Cooperman	DEP	PO Box 721 Westside Station	Worcester	MA	01602-	508-682-5237
William J. Cotter	W. Boylston BOH	9 Westbrook Rd	Worcester	MA	01602-	508-835-4820
Wayne J. Curran	City of Worcester	25 Meade St.	Worcester	MA	01610-	508-799-8576
Chris Evasius	Guertin & Assoc.	753 Pleasant St.	Worcester	MA	01601	617-279-2288
Ronald J. Ferraiuolo, Jr.		256 Lake Ave.	Worcester	MA	01604	978-263-8585
Maureen Finlay		446 Chandler St	Worcester	MA	01602-	508-791-9355
John E. Finlay II	Finlay Engineering Services	14 N. Bend Rd.	Worcester	MA	01602-	508-799-4493
Walter G. Irvine, Jr.	Town of Sterling	62 Wilbur St.	Worcester	MA	01606-	508-852-5919
Philip J. Jakubosky	Worcester BOH	25 Meade St	Worcester	MA	01610-	508-799-8540
Jospeh Mikielian		19 Cataract St.	Worcester	MA	01602-	508-799-1210
Claudio Polselli	US Coast Guard	8 Benson St.	Worcester	MA	01604-	401-736-1713
Kevin J. Quinn	Graves Engineering	27 West Mountian St.	Worcester	MA	01606-	508-856-0321
Michael S. Santora		90 Angelo St.	Worcester	MA	01604-	508-755-8743
Philip J. Sheridan	P.J. Sheridan Construction	665 Grove St.	Worcester	MA	01605-	508-852-4177
Elizabeth Sidoti		DEP - CERO	Worcester	MA		508-792-7683
Brian E. Thorne		24 Tiverton Parkway	Worcester	MA	01602-	508-753-5859
Margo Webber		DEP - CERO	Worcester	MA	-	508-792-7650

Full In-State Soil Evaluators List: http://www.state.ma.us/dep/brp/wwm/files/SoilEvIn.pdf

Title 5 System Inspectors by Town

Name	Association	Address	Town	State	Zip	Phone Number
Michael Berberian		5 Old Colony Rd.	Auburn	MA	01501-	508-478-7966
Robert J. Duff	Mendon/Uxbridge Board of Health	200 Auburn St.	Auburn	MA	01501-	508-832-5811
Leo Lessard		157 Southbridge St.	Auburn	MA	01501-	508-754-2789
Michael F. Loin	Bertin Engineering Assoc.	7 Midstate Dr.	Auburn	MA	01501	508-721-0040
Bill Richard	Cullinan Engin,	200 Auburn St.	Auburn	MA	01508-	508-832-5811
Dennis M. Costello	Board of Health	221 Main St.	Boylston	MA	01505-	508-869-6828
Kenneth R. Engvall		P.O. Box 570 - 571 Main St.	Boylston	MA	01505-	508-869-6151
Andrew B. Liston	Thompson-Liston Assoc., Inc.	P.O. Box 570	Boylston	MA	01505-	508-869-6151
James L. Tetreault	Thompson-Liston Assoc., Inc.	51 Main St., Box 570	Boylston	MA	01505-	508-869-6151
Nancy E. VonHone	Boylston BOH	616 Edgebrook Dr	Boylston	MA	01505-	508-853-1070
Jeffrey M. Walsh		35 Glazier Rd	Boylston	MA	01505-	508-869-2239
Ralph E. Wegener	On-Line Engineering	12 Kendall Rd.	Boylston	MA	01505-	508-869-6418
Robert G. Caldwell	Realty Inspection Services, Inc.	87 George Hill Rd.	Grafton	MA	01519-	508-839-9085
Ronald C. Chase	Chase-Harris Co.	108 North Main St.	Grafton	MA	01536-	508-865-2007
Robert G. Chenette	Down-Home Inspection	38 Elmwood St.	Grafton	MA	01560-	508-839-7355
Michael P. Chouinard		39 Ferry St.	Grafton	MA	01560-	508-754-7204
Daniel L. Harris	The Chase - Harris Co.	108 North Main St.	Grafton	MA	01536-	508-865-2007
David A. Harris	The Chase-Harris Co	108 North Main St.	Grafton	MA	01536-	508-865-2007
Norman Hill	Land Planning	214 Worcester St.	Grafton	MA	01519-	508-839-9526
John J. Jonasch		18 Hovey Pond Rd	Grafton	MA	01536-	508-756-7281
Ronald L. Knapik	Knapik Builders	70 George Hill Rd	Grafton	MA	01519-	508-839-4668
John Magill, Jr.	Magill Assoc.	19 Greany Dr.	Grafton	MA	01536-	508-839-9810
George McGuirk	The Chase-Harris Co.	108 North Main St.	Grafton	MA	01536-	508-865-2007
Mark M. Santora	Town of Grafton	30 Providence Rd.	Grafton	MA	01519-	508-839-8506
Lawrence D. Thuot	Northboro Septic	55 Orchard St	Grafton	MA	01560-	508-393-7234
Alan R. Berg		205 Highland St.	Holden	MA	01520-	508-829-5212
Richard J. Contonio	Amerispec Home Inspection	672 Main St., Suite 21	Holden	MA	01520-	508-829-5809
Lawrence H. Galkowski		70 Wyndhurst Dr.	Holden	MA	01520-2715	508-829-6066
Russell A. Gibson	Gibson Sanitation	PO Box 433	Holden	MA	01520-	508-829-2514
Brianna Kopp	Board of Health	1196 Main St.	Holden	MA	01520	508-829-0254
Edward C. Leahy	Leahy Excavating Co., Inc.	1403 Wachusett St.	Holden	MA	01522-	508-829-2180
Kevin J. LeGacy	Holden Sanitation	516 Wachusett St.	Holden	MA	01520-	508-829-3793
James J. Litwinowich		58 Cimarron Lane	Holden	MA	01520-	508-829-6977
Donald W. MacKay	Town of Holden	1196 Main St.	Holden	MA	01520-	508-829-0254
Chirstopher McClure		716 Salisbury St.	Holden	MA	01520	508-829-5662
Daniel T. Migdelany	Holden Sand & Gravel	789 Wachusett St.	Holden	MA	01520-	508-829-3725
Bruce J. Pennino		35 Woodridge Rd	Holden	MA	01520-	
Herbert W. Pope	Holden Sanitation	516 Wachusett St.	Holden	MA	01520-	508-829-3793
Lewis T. Reed	Norfolk Ram Group	27 Holden St.	Holden	MA	01520	508-853-1234
Francis Santom		5 Fairchild Dr.	Holden	MA	01520-	508-853-2159
Winslow M. Spofford		34 Scenic Dr.	Holden	MA	01520-	508-829-4079
Peter J. Thurston	Holden Sanitation	516 Wachusett St.	Holden	MA	01520-	508-829-3793
Lawrence P. Chaponis	CPS - Chaponis Property Services	PO Box 314	Holden (Jefferson)	MA	01520-	508-829-5322
Earl Bernier		251 Auburn St.	Leicester	MA	01611-	508-892-9165
Joanne P. Bernier		251 Auburn St.	Leicester	MA	01611-	508-892-9165
Steven Borgerson	RH White Construction	29 Fairview Dr	Leicester	MA	01524-	508-832-3295

Name	*Association*	*Address*	*Town*	*State*	*Zip*	*Phone Number*
William A. Coyle	Mass Highway	339 River St	Leicester	MA	01524-	508-754-7204
Robert McNeill, III		21 Cricklewood Dr	Leicester	MA	01524-	
Paul R. Morris	Morris Excavating	50 Peter Salem Rd.	Leicester	MA	01524-	508-892-4048
R. P. Williamson		15 Salminen Dr.	Leicester	MA	01524-	508-892-8545
Paul Anderson	Anderson construction	402 Greenwood St	Millbury	MA	01527-	508-865-9377
John E. Daly	JE Daly Construction	107 Riverlin St	Millbury	MA	01527-	508-865-3835
Carl Froment		126 Wheelock Ave.	Millbury	MA	01527-	508-795-1007
Anthony Kowszik, Jr.	Valley Corp.	26 Tainter Hill Rd.	Millbury	MA	01527	508-865-8911
Charles J. Kupper, Jr.	Stockbridge Const.	68 So. Oxford Rd	Millbury	MA	01527-	508-865-3042
Richard Palinski		7 Waters Court	Millbury	MA	01527-	508-865-9206
John R. Rock	Mid State Sewerage	8 Jacques Park Rd.	Millbury	MA	01527	508-865-1343
Thomas M. Stratford	Mid State Sewerage	42 Burbank St	Millbury	MA	01527-	508-865-6989
Robert D. Cormier	Northboro Septic Service	192 South St	Northboro	MA	01532-	508-393-7234
Henry G. Dickinson Jr.		385 Main St.	Northboro	MA	01532-	508-393-8985
Bryant Firmin		14 Edmunds Way	Northboro	MA	01532-	508-393-3754
Kenneth J. Maclean	Advance Management co	2 Scott Ln	Northboro	MA	01532-	508-393-9164
John Benedetti	John Benedetti Contr.	21 Southwest Cutoff	Northborough	MA	01532-	508-393-7351
Paul S. Casey	Seltec Engineering Inc.	265 Main St #8	Northborough	MA	01532-	508-393-9868
Andrew J. Curtis	Northboro Septic	192 South St.	Northborough	MA	01532-	508-393-7234
Sean P. Durkin	Up Right Construction Inc.	P.O. Box 754	Northborough	MA	01532-	508-393-6849
Wallace Hack		21 Palter Circle	Northborough	MA	01532-	
William Henries		45 Summer St.	Northborough	MA	01532-	508-393-8554
William J. Maloney	Connorstone, Inc.	276 W. Main St.	Northborough	MA	01532-	508-393-9727
Michael J. Marian		21 Wiles Farm Rd.	Northborough	MA	01532-	508-393-6677
Bernard Wood		PO Box 196	Northborough	MA	01532-	508-393-3558
George Carlson		32 Crystal St.	Paxton	MA	01612-	508-799-5864
Mark R. Johnson		108 Howard St.	Paxton	MA	01612	508-752-9550
David G. Parent		12 Pond St	Paxton	MA	01612-	508-757-6100
Gennaro J. Groccia		261 Old Mill Rd.	Shrewsbury	MA	01545-	508-752-2143
Joseph McCarthy		26 Fox Hill Rd.	Shrewsbury	MA	01545-	508-845-1034
John J. Ostrosky		16 Colton Lane	Shrewsbury	MA	01545	508-842-2184
John J. Ostrosky		16 Colton Lane	Shrewsbury	MA	01545-	508-842-2184
Purnachander Rao		9 Shearson Dr.	Shrewsbury	MA	01545-	508-842-9398
Richard Record	Richard Record and son	709 South St	Shrewsbury	MA	01545-	508-842-8230
Joseph M. Record	Richard Record and Sons	709 South St	Shrewsbury	MA	01545-	508-842-8230
Richard E. Wall	Wall Trucking	22 School St	Shrewsbury	MA	01545-	508-757-0940
Valmore H. Pruneau	West Boylston BOH	Town Hall, 560 Prospect St.	West Boylston	MA	01583-	508-856-9162
Stanley Szczurko, Jr.		24 Woodlands Heights Dr.	West Boylston	MA	01583-	
Vincent P. Vignaly		50 Newton St.	West Boylston	MA	01583-	508-835-9084
David Boyer		20 Haskell St.	Westboro	MA	01581-	508-754-7204
Jennifer T. Lord	Beals and Thomas	2 Westboro Bus. Park - 200 Friberg Pkw	Westboro	MA	01581-	508-366-0560
Harry F. Angevine	Angevine Development and Const.	134 Flanders Rd.	Westborough	MA	01521	508-836-1945
Paul D. Ciesluk	Guerard Survey Co. & Associates	P.O. Box 364, 11 Summer St.	Westborough	MA	01581-	508-366-8800
Zachary Esper		29 Hundreds Rd.	Westborough	MA	01581-	508-366-4659
Mark J. Guerard	Guerard Survey Co. & Assoc.	11 Summer St.	Westborough	MA	01581-	508-928-5467
William McCarthy		130 Milk St.	Westborough	MA	01581-	508-366-7810
Timothy D. Paris		18 Shepherd Rd.	Westborough	MA	01581-	508-366-0584
Michael E. Rook	New England Electric	25 Research Dr.	Westborough	MA	01581-	508-366-9011
Alexander B. Trakimas	Tyree Consulting Co.	9 Otis St.	Westborough	MA	01581-	508-871-8400

Peter J. Wright	D&P Wright construction	15 Blake St	Westborough	MA	01581-	508-836-4479
Patricia E. Austin		23 Dell Ave.	Worcester	MA	01605-	508-752-6732
Roland E. Barrows, Jr.	RE Barrows Septic Service	22 Barrows Rd	Worcester	MA	01609-	508-754-4942
John J. Bechard		49 Alanta St.	Worcester	MA	01604-	617-924-1770
Dolores M. Branco	Environmental Management Associates, Inc.	14 Tatman St.	Worcester	MA	01607-	508-755-3067
Michael J. Burke		299 Salisbury St.	Worcester	MA	01609-	508-795-7795
William M. Clougherty	City of Worcester	25 Meade St.	Worcester	MA	01610-	508-799-8576
Wayne Curran		34 Sherbrook Ave.	Worcester	MA	01604-	508-754-1688
John E. Finlay II	Finlay Engineering Services	14 N. Bend Rd.	Worcester	MA	01602-	508-799-4493
John A. Gagliastro		64 Dunkirk Ave.	Worcester	MA	01604-	508-753-3056
John Gallagher		6 Perrot St.	Worcester	MA	01602-	508-756-9521
James M. Galvin		6 Hickory Dr.	Worcester	MA	01609-	508-798-2015
Donald J. Graves	Graves Engineering, Inc.	27 West Mountain St.	Worcester	MA	01606-	508-856-0321
Fred Koza	GK Assoc.	892 R Main St	Worcester	MA	01610-	508-799-7300
David A. Leidel		5 Berwick Lane	Worcester	MA	01602-	508-756-8442
Joseph D. Marino	RH White Construction	3 Farrington St	Worcester	MA	01604-	508-757-7847
Peter Morano		414 Plantation St.	Worcester	MA	01605-	508-791-8212
George Netch		15 Ivanhoe Rd.	Worcester	MA	01602-2618	508-755-8098
Thomas O'Connell		11 Dunbar St.	Worcester	MA	01603-	508-754-6624
Kevin J. Quinn	Graves Engineering	27 West Mountian St.	Worcester	MA	01606-	508-856-0321
Ronald A. Rice		107 East Mountain St (rear)	Worcester	MA	01606-	508-595-9397
George Rigney	Jim Brown Septic Service	7 Elmwood St.	Worcester	MA	01609	508-798-1809
Ronald Sampson	Allstate Home Inspection	3 Waucantuck Rd	Worcester	MA	01606-	508-852-4778
Michael S. Santora		90 Angelo St.	Worcester	MA	01604-	508-755-8743
Amjad T. Shadid	Chase Precast	72 High ridge Rd	Worcester	MA	01602-	508-791-4056
Elizabeth Sidoti		DEP - CERO	Worcester	MA		508-792-7683
Richard Vigliotts		22 Alvarada Ave.	Worcester	MA	01604-	508-831-7365
Donald S. Williamson		65 Moreland Green Dr.	Worcester	MA	01609-	508-752-8107

Full In-State Title 5 System Inspectors List: http://www.state.ma.us/dep/brp/wwm/files/T5SysIns.pdf

Appendix B

Realtors Contacted	What They Said
Realtor 1	"You have reached a number that has been disconnected…"etc
Realtor 2	Left message
Realtor 3	Left message…called back.
Realtor 4	10 % of people affected by title 5, Sales effected by title 5 10% of title 5 applicable instances. Average spending, $2-20K. Info to customers, nothing, just tell the customer need to know info.
Realtor 5	– left message…called back. Doesn't really affect sales. 'Quite a few' customers are affected by title 5, 2 most recent cost 15-16K. pump, inspection cost ~$500, if need be, dig up D-Box, $450-550. if need be, design costs ~$1200. Just explains title 5 to customers.
Realtor 6	Message…called back…Not that many systems fail, probably 10%. Typical Cost, 7-40K. Doesn't affect sales, customers that need to sell characteristically fix the system, and sell anyway.
Realtor 7	Don't do anything around Worcester
Realtor 8	100 % of people affected by title 5, testing for everyone when they buy/sell. 5-40K price range. The state went overboard on regulatory matters, instead of providing money to extend sewer systems out to the countryside. MDC has bought up 30% of the property in Sterling, 40% in Rutland, and 35% in W. Boylston. Instead of spending money on sewer systems, so future generations of his children could live there, they will not be able to, because of the huge price of real estate. Originally, Title 5 banned cesspools, because of the belief that old-timers dug them until they hit water, which based on the principles that cesspools were designed for, having water in them, so the solid fecal matter would dissolve. Then later, they allowed them, because the realized that the design was also to have the cesspool far enough away from houses and water supplies that it would not affect them.
Realtor 9	Left Message…called back, lady who answered only deals with rentals, husband who knows about title 5 will call back. Called back…said he is in rental business, and title 5 does not affect him at all.
Realtor 10	Left message…got back saying over 50% fail…usually 15-25K, less if connecting to sewer sys. Can still sell home if fails, just must add holdback to closing, typically 1.5 x of the lowest appraisal. Will mail us brochure that they give to customers about title 5.
Realtor 11	Message
Realtor 12	Only Build new homes…n/a for us

Realtors Contacted Continued	**What They Said Continued**
Realtor 13	Not many customers are dramatically affected…doesn't effect sales much. Usually 2-3K, rarely 10-15 K. Lesbian.
Realtor 14	Referred us to realtor 15; she specializes in residential homes, and also does seminars and training on title 5.
Realtor 15	Spoke with secretary, will call tomorrow morning. Returned call, left message. Now that real estate value has gone up, people don't mind title 5 It is more equitiable in the market Lenny Gangle the only person that knows more about title 5 than maria 508 864-4509 Builder in Rutland Is/was President of builders association More involved that any builder Maria knows No uniform title 5, locals can go more stringent Inequitable, for person-to person BOH person, one official vs. another She thinks it should be fair Alternative things, that could be approved, such **as new technology**. Enclosed systems that can go in the ground for high perk-sites 10G hasn't gone forward More new stuff, the more they deal with (BOH) Talk to Lenny Not being approved or recognized fast enough
Realtor 16	Sales – couple years ago, maybe, in this market with so much equity in homes, doesn't affect sales at all. Approx 15K to replace system
Realtor 17	Left message
Realtor 18	Left message
Realtor 19	left message

Construction Companies Called	What They Said
Construction Company 1	Amy - 1000, 1500 gallon tanks, $101.05, $133.30 title 5 inspection – $275 labor exposure fee 130/hr
Construction Company 2	Left message
Construction Company 3	Cheryl . Up to 1000g, 145, newer tanks, 1500-2000, 175. New system…standard, good perk, 1500g tank, avg leech field, 7500-9500. worst case scenario, in Wrentham, 30,000. pump up system, 11G. Small area, mandate that on a lake side, they have to put in a tight tank. Doesn't leech out, pump often, 3 weeks – 6, 7 weeks. Same price as regular pump. 40 years expertise. Very helpful.
Construction Company 3	Talked to someone, Peter will call back about Title 5 inspection – Tight tanks get pumped
Construction Company 4	Left message
Construction Company 5	Title 5- $300 800-20k engineer, variances neo-tribuatarys differs in every situation tight tank pumping, varies depending on size, water usage
Construction Company 6	Left message
Construction Company 7	Steve - Title 5 inspection – 300-600, pumping, inspection Find more than 1 cover, most tanks have 3 covers If on lake, need engineer. If on lake, limited land area…no public 1/10 is cesspool…mostly in older homes type of plumbing in home makes difference too all they do is pump & maintain
Construction Company 8	Tammy - Title 5, 1500 gallon, 10 years old, 350 + pumping ($100) If never been pumped, solid build up, 100 bucks more 10-50K

Realtors Questionnaire

1) Does your real-estate company deal with property on Lake Quinsigamond?____________

   a) If not do you know who does?____________________

2) Has Title V decreased the amount of sales around:

   a) Lake Quinsigamond?________ by what percent?_________

   b) Worcester?___________ by what percent?________

   c) Shrewsbury?__________ by what percent?_________

   d) Massachusetts?_________ by what percent?________

3) What is the average spending on Title V related issues? Ie: changing cesspool to septic system or connecting to city sewage? ______________

4) What information do you give to customers explaining Title V and what has to be done? ____

Record of Service

Date	Work Done	Contractor

For More Information

A videotape version of this brochure, also entitled *"Your Septic System: A Guide for Homeowners,"* is available through the EPA Small Flows Clearinghouse. Call 1-800-624-8301.

For more information about maintenance or inspection of your septic system, contact your local board of health or the Department of Environmental Protection:

Central Regional Office:
(508) 792-7650

Northeast Regional Office:
(617) 932-7600

Southeast Regional Office
(508) 946-2700

Western Regional Office:
(413) 784-1100

Boston Office:
(617) 292-5673

*Published 1990 by the **Northern Virginia Planning District Commission** with assistance from Virginia Water Control Board, National Small Flows Clearinghouse, and the Northern Virginia Health Departments. Reprinted 1994 by the Division of Water Pollution Control of the Massachusetts Department of Environmental Protection.*

Printed on Recycled Paper

A Reference Guide

YOUR SEPTIC SYSTEM

for Homeowners

DEP

Commonwealth of Massachusetts
Department of Environmental Protection

Caring for Your Septic System

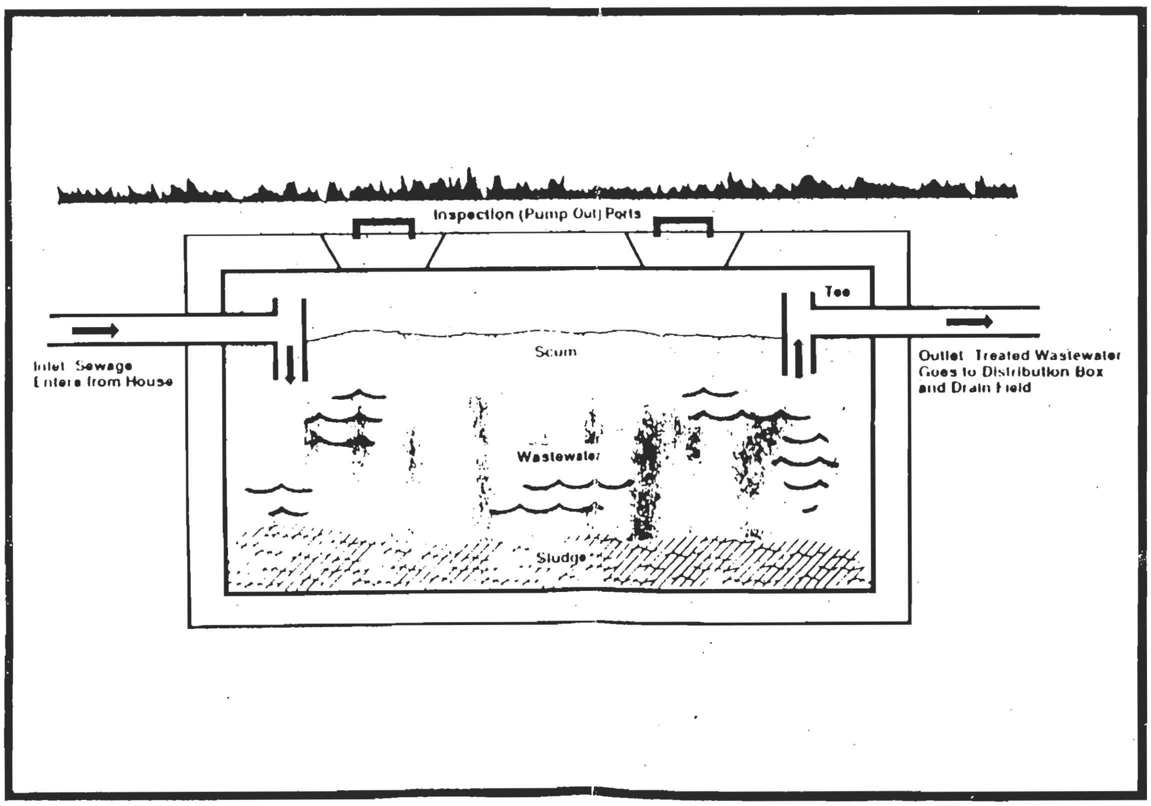
The accumulated solids in the bottom of the septic tank should be pumped out **every three to five years** to prolong the life of your system. Septic systems must be maintained regularly to stay working.

Neglect or abuse of your septic system can cause it to fail. Failing septic systems can

- cause a serious health threat to your family and neighbors,
- degrade the environment, especially lakes, streams and groundwater,
- reduce the value of your property,
- be very expensive to repair,
- and, put thousands of water supply users at risk if you live in a public water supply watershed and fail to maintain your system.

Be alert to these warning signs of a failing system:

- sewage surfacing over the drainfield (especially after storms),
- sewage back-ups in the house,
- lush, green growth over the drainfield,
- slow draining toilets or drains,
- sewage odors.



Tips to Avoid Trouble

- **DO** have your tank pumped out and system inspected every 3 to 5 years by a licensed septic contractor (listed in the yellow pages).

- **DO** keep a record of pumping, inspections, and other maintenance. Use the back page of this brochure to record maintenance dates.

- **DO** practice water conservation. Repair dripping faucets and leaking toilets, run washing machines and dishwashers only when full, avoid long showers, and use water saving features in faucets, shower heads and toilets.

- **DO** learn the location of your septic system and drainfield. Keep a sketch of it handy for service visits. If your system has a flow diversion valve, learn its location, and turn it once a year. Flow diverters can add many years to the life of your system.

- **DO** divert roof drains and surface water from driveways and hillsides away from the septic system. Keep sump pumps and house footing drains away from the septic system as well.

- **DO** take leftover hazardous household chemicals to your approved hazardous waste collection center for disposal. Use bleach, disinfectants, and drain and toilet bowl cleaners sparingly and in accordance with product labels.

- **DON'T** allow anyone to drive or park over any part of the system. The area over the drainfield should be left undisturbed with only a mowed grass cover. Roots from nearby trees or shrubs may clog and damage your drain lines.

- **DON'T** make or allow repairs to your septic system without obtaining the required health department permit. Use professional licensed septic contractors when needed.

- **DON'T** use commercial septic tank additives. These products usually do not help and some may hurt your system in the long run.

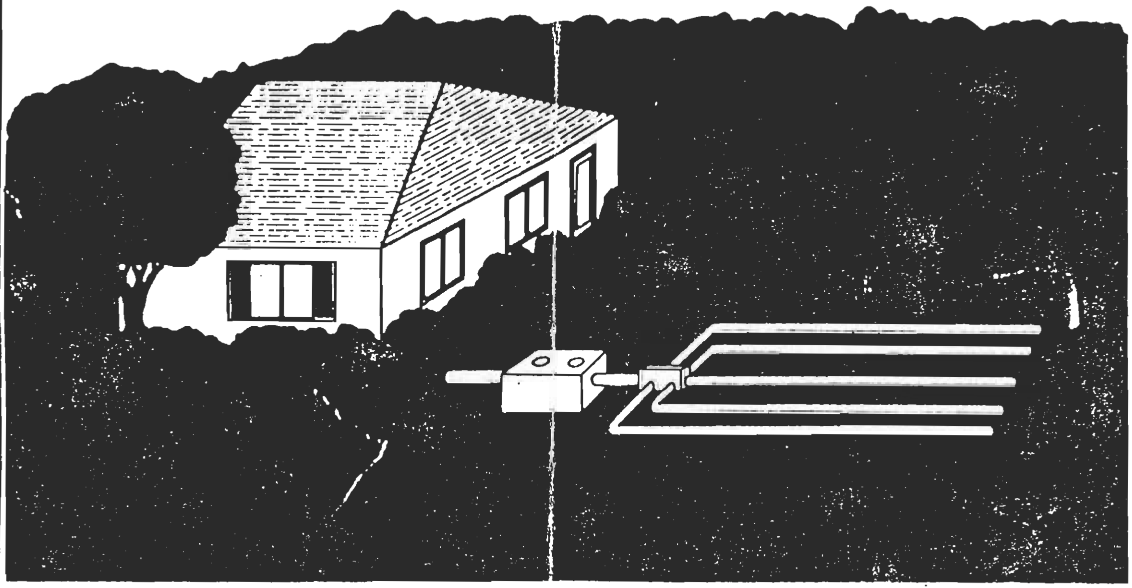
- **DON'T** use your toilet as a trash can by dumping nondegradables down your toilet or drains. Also, don't poison your septic system and the groundwater by pouring harmful chemicals down the drain. They can kill the beneficial bacteria that treat your wastewater. Keep the following materials out of your septic system:

Septic Systems Explained

Septic systems are individual wastewater treatment systems that use the soil to treat small wastewater flows, usually from individual homes. They are typically used in rural or large lot settings where centralized wastewater treatment is impractical.

There are many types of septic systems in use today. While all septic systems are individually designed for each site, most septic systems are based on the same principles.

A Conventional Septic System



A **septic system** consists of a **septic tank**, a **distribution box** and a **drainfield**, all connected by pipes, called **conveyance lines**.

Your septic system treats your household wastewater by temporarily holding it in the ***septic tank*** *where heavy solids and lighter scum are allowed to separate from the wastewater. This separation process is known as* ***primary treatment.*** *The solids stored in the tank are decomposed by bacteria and later removed, along with the lighter scum, by a professional septic tank pumper.*

After the partially treated wastewater leaves the tank, it flows into a ***distribution box****, which separates this flow evenly into a network of* ***drainfield trenches****. Drainage holes at the bottom of each line allow the wastewater to drain into gravel trenches for temporary storage. This* ***effluent*** *then slowly seeps into the subsurface soil where it is further treated and purified (****secondary treatment****). A properly functioning septic system does not pollute the groundwater.*

in mind if you are planning to sell your home. You may find during negotiations that the prospective buyer is willing to assume some or all of the costs. Just be sure to consult with a lawyer or mortgage lender who is familiar with Title 5 before shaking hands on the deal.

Even if you have no plans to move, you may qualify for one or more programs designed to help homeowners pay for septic system or cesspool repair or replacement:

- Many cities and towns either have in place now or are working to establish "betterment" loan programs to provide homeowners with long-term, low-cost financing;
- The Massachusetts Housing Finance Agency (MHFA) and federal Farmers Home Administration (FHA) offer low-cost financing to those who qualify.
- Pending state legislation would provide for septic system repair tax credits of up to $2,500 per homeowner.

For additional information, contact your local board of health; MHFA at (617) 451-3480; FHA at U.S. Department of Agriculture, Washington, DC 20250; or your state legislator.

Protect Your Investment

One of the best ways to ensure that your septic system or cesspool will pass inspection is to keep it on a routine maintenance schedule. At a minimum, you should have it pumped out every three years. If you use a garbage disposal, annual pumping is a must.

And a word about septic system additives: There isn't one on the market that can make a failing system pass inspection. DEP approves septic system additives, but only to ensure that they will not harm your system or the environment. DEP does not evaluate the accuracy of claims manufacturers make about the effects their products will have on system performance.

Remember that even the best-maintained system in the world cannot last forever. Like anything else, it will wear out over time, stop working properly and need to be repaired or replaced.

Need More Information?

If you still have questions about getting your septic system or cesspool inspected, repaired or upgraded, please contact DEP's Title 5 Hotline at (617) 292-5886 or 1-800-266-1122.

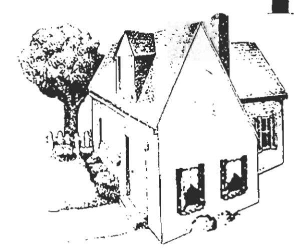
DEP

Prepared by the Massachusetts Department of Environmental Protection, Public Affairs Office, One Winter Street, Boston, MA 02108. September 1995. Printed on recycled paper.

T I T L E 5

Consumer Protection Tips

Septic System Inspections and Repairs



Brought to you by the Massachusetts Department of Environmental Protection

Across the Commonwealth of Massachusetts, failing septic systems and cesspools are a major cause of contaminated drinking water, tainted shellfish beds and polluted beaches. Title 5 of the State Environmental Code protects you, your family and your neighbors from these public health threats by requiring inspection of private sewage disposal systems before the sale, expansion or change in use of properties where they are present. Inspection results are reported to local boards of health. Most systems will pass inspection. Systems that fail must be repaired or upgraded.

If you own a home with a septic system or cesspool and have plans to put it up for sale, add a bedroom or convert it to a different use, you will need to have your system inspected – and possibly fixed or replaced. This brochure is intended to help you make the right decisions about who to hire and how to finance repairs if they are necessary.

You'd Better Shop Around

When you need to hire a system inspector, there are two important things you need to bear in mind. First, inspection fees are not regulated by the Department of Environmental Protection or anyone else. Inspectors can charge whatever their customers are willing to pay. The fee also may vary depending on the complexity of the inspection. Second, only certain professionals are qualified to perform Title 5 system inspections:

- Professionals who meet experience requirements and have passed a DEP-administered exam;
- Registered Sanitarians;
- Certified Health Officers; and
- Registered Professional Engineers who specialize in civil, environmental or sanitary engineering.

For a list of qualified system inspectors in your area, contact your local board of health or call DEP's Title 5 Hotline at (617) 292-5886 or 1-800-266-1122.

But before hiring anyone, do some comparison shopping:

✓ Get written estimates from several inspectors. One key question to ask is whether the price of the inspection includes pumping the system; often it does not.

✓ Ask for and check each inspector's identification and references.

✓ Before signing any contract, be absolutely certain that it spells out precisely what work is going to be done, how much it is going to cost, what the payment terms are, and what, if any, guarantees the inspector is willing to provide.

✓ And, once the inspection is complete, make sure the person who signs the form is the same person who conducted the inspection.

What To Do If Your System Fails

If your septic system or cesspool fails inspection, Title 5 allows up to two years for the completion of repairs or an upgrade. The first thing you should do is contact your local board of health, which needs to approve all upgrades and most repairs, and can tell you what will be required.

Again, shop around. Get written estimates, check qualifications and references. Remember that you are under no obligation to have the person who inspects your system perform any other work on it. In fact, you may want to hire separate contractors. While most septic system professionals are honest business people, as in any other profession there may be a few "bad apples" who try to take advantage of the consumer. If you ever believe you have been treated unfairly by a system inspector, soil evaluator, engineer, or system installer, call the Massachusetts Environmental Strike Force at (617) 556-1000.

Options for Financing Repairs

Repair or upgrade costs will vary depending on the nature of the problem, soil conditions, proximity of the system to water supplies, and the size of the lot. Title 5 does not specify who must pay for system inspections, repairs or upgrades. Keep that

Appendix C

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – Wastewater Permitting Program

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

____
Site Address or Map/Lot Number

A. Facility Information

1. Facility Information

____
Owner Name

______________________________ Map/Lot______________
Street Address

______________________ ______________ ______________
City State Zip Code

B. Site Information

1. (Check one) New Construction ☐ Upgrade ☐ Repair ☐
2. Published Soil Survey available? Yes ☐ No ☐ If yes: ______________ Year Published ______________ Publication Scale ______________ Soil Map Unit

   ______________ Soil Name ______________ Soil limitations
3. Surficial Geological Report available? Yes ☐ No ☐ If yes: ______________ Year Published ______________ Publication Scale ______________ Map Unit

   ______________ Geologic Material ______________ Landform
4. Flood Rate Insurance Map:

   Above the 500 year flood boundary? Yes ☐ No ☐ Within the 100 year flood boundary? Yes ☐ No ☐

   Within the 500 year flood boundary Yes ☐ No ☐ Within a Velocity Zone? Yes ☐ No ☐
5. Wetland Area: National Wetland Inventory Map ______________ Map Unit ______________ Name

   Wetlands Conservancy Program Map ______________ Map Unit ______________ Name
6. Current Water Resource Conditions (USGS) ______________ Month/Year Range: Above Normal ☐ Normal ☐ Below Normal ☐
7. Other references reviewed:

   ____

____
Site Address or Map/Lot Number

C. On-Site Review

(minimum of two holes required at every proposed disposal area)

Deep Observation Hole A:

__________ Date
__________ Time
__________ Weather

1. Deep Observation Hole Logs

   Deep Hole Number _________ Ground Elevation at Surface of Hole _________

   Location (Identify on Plan) ______________________________

2. Land Use: ______________________________ (e.g. woodland, agricultural field, vacant lot, etc.)

   ______________ Surface Stones

   ______________ Slope (%)

   ______________ Vegetation

   ______________ Landform

   ______________ Position on landscape (attach sheet)

3. Distances from: Open Water Body _______ feet Drainage Way _______ feet Possible Wet Area _______ feet

   Property Line _______ feet Drinking Water Well _______ feet Other ___________

4. Parent Material: ______________________ Unsuitable Materials Present: Yes ☐ No ☐

   If Yes: Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock ☐

5. Groundwater Observed: Yes ☐ No ☐

   If Yes: Depth Weeping from Pit _________ Depth Standing Water in Hole _________

   Estimated Depth to High Groundwater: __________ inches __________ elevation

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – Wastewater Permitting Program

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

____
Site Address or Map/Lot Number

Deep Observation Hole A: Deep Hole Number:__________________

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	*Other*
			Depth	Color	Percent		Gravel	Cobbles & Stones			

Additional Notes

____

____

____

C. On-Site Review (Cont.)

Deep Observation Hole B: ____________ Date ____________ Time ____________ Weather

1. Deep Observation Hole Logs

   Deep Hole Number ________ Ground Elevation at Surface of Hole ________

   Location (Identify on Plan) ______________________________

2. Land Use: ______________________________ (e.g. woodland, agricultural field, vacant lot, etc.)

   ____________ Surface Stones ____________ Slope (%)

   ____________ Vegetation ____________ Landform ____________ Position on landscape (attach sheet)

3. Distances from: Open Water Body ______ feet Drainage Way ______ feet Possible Wet Area ______ feet

   Property Line ______ feet Drinking Water Well ______ feet Other ____________

4. Parent Material: ______________________________ Unsuitable Materials Present: Yes ☐ No ☐

   If Yes: Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock ☐

5. Groundwater Observed: Yes ☐ No ☐

   If Yes: Depth Weeping from Pit ________ Depth Standing Water in Hole ________

   Estimated Depth to High Groundwater: ____________ inches ____________ elevation

Massachusetts Department of Environmental Protection
Bureau of Resource Protection – Wastewater Permitting Program
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

____
Site Address or Map/Lot Number

Deep Observation Hole B: Deep Hole Number:__________________

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	*Other*
			Depth	Color	Percent		Gravel	Cobbles & Stones			

Additional Notes
____
____
____

D. Determination of High Groundwater Elevation

1. Method used:

☐	Depth observed standing water in observation hole	A. _____ inches	B. _____ inches
☐	Depth weeping from side of observation hole	A. _____ inches	B. _____ inches
☐	Depth to soil redoximorphic features (mottles)	A. _____ inches	B. _____ inches
☐	Groundwater adjustment (USGS methodology)	A. _____ inches	B. _____ inches

2. Index Well Number __________ Reading Date __________ Index Well Level __________

Adjustment Factor __________ Adjusted Groundwater Level __________

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the
   soil absorption system? Yes ☐ No ☐

   b. If yes, at what depth was it observed? Upper boundary: __________ inches Lower boundary: __________ inches

F. Certification

I certify that I have passed the soil evaluator examination* approved by the Department of Environmental Protection and that the above analysis was performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017.

____
Signature of Soil Evaluator

____
Date

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Site Address or Map/Lot Number

Typed or Printed Name of Soil Evaluator

*Date of Soil Evaluator Exam

Name of Board of Health Witness

Board of Health

Note: This form must be submitted to the approving authority with Percolation Test Form 12

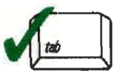
Use this sheet for field diagrams:

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Title 5

DEP Inspection and O&M Form and Checklist for Title 5 Greywater Disposal Systems Piloting

A. Installation:

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



____
Owner

____
Facility Street Address

______________________________ ______________
City Zip

Mailing address of owner, if different:

____
Facility Street Address

______________________________ ______________ ______________
City State Zip

( ) - ext.
Telephone Number

B. Authorized Provider

____
O & M Firm

____
Facility Street Address

______________________________ ______________ ______________
City State Zip

( ) - ext.
Telephone Number

Inspector: ______________________________ PE☐ RS☐

C. Facility/System Information

DEP Transmittal no. __________ Greywater Project ID no.: GW

Installation Date: ___/___/___ Start of Operation: ___/___/___

Date of Inspection: ___/___/___ Previous Inspection Date: ___/___/___

System is: Remedial ☐ New construction ☐

System facility is occupied? ☐Yes ☐No Seasonal Residence: used less than 6 mo./year: ☐Yes ☐No

Pumping Recommended ☐ Yes ☐ No

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Title 5

DEP Inspection and O&M Form and Checklist for Title 5 Greywater Disposal Systems Piloting

D. Indicate whether the following items have been inspected:

Inspection of absorption system:
SAS _____ Modified SAS _____ Greywater garden _____ Other

Condition of soil absorption system: ______________________________

Ponding anywhere in system? ☐Yes ☐No
Location ______________________________

Pressure distribution _____ Gravity distribution
If pressure distribution, has system been inspected in accordance with 310 CMR 15.254? ☐Yes ☐No

E. System components inspected:

Septic tank: ☐Yes ☐No ☐N/A
Condition of septic tank ______________________________

Pump chamber: ☐Yes ☐No ☐N/A
Condition of pump chamber ______________________________

Recirculation tank: ☐Yes ☐No ☐N/A
Condition of recirculation tank ______________________________

Overflow/storage tank: ☐Yes ☐No ☐N/A
Condition of overflow/storage tank ______________________________

System alarms: ☐Yes ☐No ☐N/A
Condition of alarms ______________________________

Level controls: ☐Yes ☐No ☐N/A
Condition of level controls ______________________________

Pump(s) inspected: ☐Yes ☐No ☐N/A Number

Distribution laterals: ☐Yes ☐No ☐N/A Cleaned: ☐Yes ☐No

Effluent tee filter: ☐Yes ☐No ☐N/A Cleaned: ☐Yes ☐No
Located ____________________

Lint filter: ☐Yes ☐No ☐N/A Cleaned: ☐Yes ☐No
Located ____________________

Grease trap: ☐Yes ☐No ☐N/A Cleaned: ☐Yes ☐No
Located ____________________

F. Greywater Garden:

If a GW garden, is it: Indoors _____ Outdoors

GW garden components inspected:
- Humidistat ☐Yes ☐No
- Thermostat ☐Yes ☐No
- Other controls: ☐Yes ☐No
  - Describe:____
- Aerator ☐Yes ☐No
- Planting bed media: Wet? ☐Yes ☐No
- Planting bed liner: Watertight? ☐Yes ☐No

Comments on GW garden components:____
____

Condition of plants used for transpiration: _______________________________________
____

G. General

System facility is occupied? ☐Yes ☐No

Water use metered in gallons: _____ gallons

Number of people using facility regularly: _____

Number of days since last inspection:

Gallons in overflow tank (Last Inspection): _____ gallons

Gallons in overflow tank (Current Inspection): _____ gallons

Maintenance Performed:
____
____

Comments/Deficiencies:
____
____

H. Sampling Information

Samples Taken: ☐ Influent ☐ Effluent ☐ None

Parameters sampled: ☐ pH ☐ BOD ☐ TSS ☐ Oil & Grease ☐Surfactants ☐ Ammonia ☐ Nitrate ☐ TKN ☐ Fecal coliform ☐ E. coli ☐ Enterococci ☐ Water Use ☐ No. of Users
☐ Other - List ____________________________________

Please attach laboratory test results

F. Certification

I certify: I have inspected the greywater disposal system at the address above, have completed this report and the attached technology operation and maintenance checklist, and the information reported is true, accurate, and complete as of the time of the inspection. I am a Massachusetts Registered Professional Engineer or Massachusetts Registered Sanitarian.

P.E or R.S. Signature:____ Date:_______________

System owner must submit this report and any required sampling results to the local board of health and DEP for Greywater Piloting Use within 30 days of inspection **date**.

Mail To: Department of Environmental Protection Title 5 Greywater Program, One Winter Street,
Boston, Massachusetts 02108

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Title 5

DEP Approved Inspection and O&M Form for Title 5- Variance to Percolation Rate Projects (septic systems with >30 to 60 minutes per inch percolation rates)

A. Facility Information

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

Current Owner

Facility Street Address

City Zip

Mailing address of owner, if different:

Street Address/PO Box:

City State Zip

( ) - ext.
Telephone Number

B. Authorized Service Provider / Facility Inspector

O&M Firm

Street Address

City State Zip

( ) - ext.
Telephone Number

Title 5 Inspector Name

C. Facility/System Information

DEP ID Installation Date

Certification of Compliance date

This is the ☐ 1st / ☐ 2nd / ☐ 3rd / ☐ 4th / ☐ 5th / ☐ 6th / ☐ 7th annual ☐ Spring or ☐ Fall inspection report for this facility.

DEP Approved Inspection and O&M Form for Title 5-Variance to Percolation Rate Projects
(septic systems with >30 to 60 minutes per inch percolation rates)

D. Inspection Results

If problems are found, please provide explanation or cause of problem and whether correction was made.

Identify as a Spring or Fall Inspection:

Spring Inspection | **Fall Inspection**

Inspection date (April 15 – May 15) | Inspection date (September 15 – October 15)

Septic Tank (*once per year*)

Condition of inlet and outlet tees

Evidence of exfiltration and backup of sewage

Depth of sludge/scum layers

Determination of need for pumping

Recommendations for maintenance, if required

Distribution Box and/or Pump Chamber (at each inspection)

☐ Yes ☐ No Evidence of backup of sewage into the facility served by the system or any system component.

☐ Yes ☐ No Evidence of solids, floatables from septic tank.

Soil Absorption System and Surrounding Area (at each inspection)

☐ Yes
☐ No
Any signs of discharge of effluent directly or indirectly to the surface of the ground through ponding, surface breakout or damp soil above the SAS or to a surface water of the Commonwealth?

Water Meter Readings (at each inspection)

Water meter reading at the time of inspection

Water meter reading previous read

Average daily water use current period

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Title 5

DEP Approved Inspection and O&M Form for Title 5-Variance to Percolation Rate Projects (septic systems with >30 to 60 minutes per inch percolation rates)

Monitoring Well (at each inspection)

Groundwater level in the well or piezometer at the time of Inspection. Note: If the separation between the groundwater and the bottom of the SAS is three feet or less provide additional monthly recordings as required in Approval.

Groundwater elevation from monitoring well

Groundwater separation to bottom of SAS

E. Certification

I certify: I have inspected the sewage treatment and disposal system at the address above, have completed this report, and the information reported is true, accurate, and complete as of the time of the inspection. I am a Massachusetts certified Title 5 Inspector in accordance with 310 CMR 15.340.

T5 System Inspector Signature

Date

System owner must submit the Spring and Fall reports and any additional data, if required, to the DEP and local board of health by January 31st for the previous calendar year.

Submit to:

Department of Environmental Protection
Attention: Title 5 Program
One Winter Street, 6th Floor
Boston, MA 02108

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Title 5

DEP Approved Inspection and O&M Form for Title 5-Variance to Percolation Rate Projects (septic systems with >30 to 60 minutes per inch percolation rates)

TITLE 5
OFFICIAL INSPECTION FORM – NOT FOR VOLUNTARY ASSESSMENTS
SUBSURFACE SEWAGE DISPOSAL SYSTEM FORM
PART A

CERTIFICATION

Property Address: ____________________________
____

Owner's Name: ____________________________
Owner's Address: ____________________________
____

Date of Inspection: ____________________________

Name of Inspector: (please print) ______________________
Company Name: ______________________
Mailing Address: ______________________
____

Telephone Number: ______________________

CERTIFICATION STATEMENT

I certify that I have personally inspected the sewage disposal system at this address and that the information reported below is true, accurate and complete as of the time of the inspection. The inspection was performed based on my training and experience in the proper function and maintenance of on site sewage disposal systems. **I am a DEP approved system inspector pursuant to Section 15.340 of Title 5 (310 CMR 15.000).** The system:

____ Passes
____ Conditionally Passes
____ Needs Further Evaluation by the Local Approving Authority
____ Fails

Inspector's Signature: ________________________ ***Date:*** ____________

The system inspector shall submit a copy of this inspection report to the Approving Authority (Board of Health or DEP) within 30 days of completing this inspection. If the system is a shared system or has a design flow of 10,000 gpd or greater, the inspector and the system owner shall submit the report to the appropriate regional office of the DEP. The original should be sent to the system owner and copies sent to the buyer, if applicable, and the approving authority.

Notes and Comments

TITLE 5
OFFICIAL INSPECTION FORM – NOT FOR VOLUNTARY ASSESSMENTS
SUBSURFACE SEWAGE DISPOSAL SYSTEM FORM
PART A

CERTIFICATION

Property Address: ______________________________
____

Owner's Name: ______________________________
Owner's Address: ______________________________
____

Date of Inspection: ______________________________

Name of Inspector: (please print) ______________________
Company Name: ______________________
Mailing Address: ______________________
____

Telephone Number: ______________________

CERTIFICATION STATEMENT

I certify that I have personally inspected the sewage disposal system at this address and that the information reported below is true, accurate and complete as of the time of the inspection. The inspection was performed based on my training and experience in the proper function and maintenance of on site sewage disposal systems. **I am a DEP approved system inspector pursuant to Section 15.340 of Title 5 (310 CMR 15.000).** The system:

____ Passes
____ Conditionally Passes
____ Needs Further Evaluation by the Local Approving Authority
____ Fails

Inspector's Signature: ______________________ ***Date:*** ____________

The system inspector shall submit a copy of this inspection report to the Approving Authority (Board of Health or DEP) within 30 days of completing this inspection. If the system is a shared system or has a design flow of 10,000 gpd or greater, the inspector and the system owner shall submit the report to the appropriate regional office of the DEP. The original should be sent to the system owner and copies sent to the buyer, if applicable, and the approving authority.

Notes and Comments

******This report only describes conditions at the time of inspection and under the conditions of use at that time. This inspection does not address how the system will perform in the future under the same or different conditions of use.**

OFFICIAL INSPECTION FORM – NOT FOR VOLUNTARY ASSESSMENTS
SUBSURFACE SEWAGE DISPOSAL SYSTEM INSPECTION FORM
PART A
CERTIFICATION (continued)

Property Address: ________________________________

____

Owner: ___________________________
Date of Inspection: ________________________

Inspection Summary: Check A,B,C,D or E / ALWAYS complete all of Section D

A. System Passes:

_____ I have not found any information which indicates that any of the failure criteria described in 310 CMR 15.303 or in 310 CMR 15.304 exist. Any failure criteria not evaluated are indicated below.

Comments:

____

____

B. System Conditionally Passes:

_____ One or more system components as described in the "Conditional Pass" section need to be replaced or repaired. The system, upon completion of the replacement or repair, as approved by the Board of Health, will pass.

Answer yes, no or not determined (Y,N,ND) in the ____ for the following statements. If "not determined" please explain.

_____ The septic tank is metal and over 20 years old* **or** the septic tank (whether metal or not) is structurally unsound, exhibits substantial infiltration or exfiltration or tank failure is imminent. System will pass inspection if the existing tank is replaced with a complying septic tank as approved by the Board of Health.
*A metal septic tank will pass inspection if it is structurally sound, not leaking and if a Certificate of Compliance indicating that the tank is less than 20 years old is available.

ND explain:

_____ Observation of sewage backup or break out or high static water level in the distribution box due to broken or obstructed pipe(s) or due to a broken, settled or uneven distribution box. System will pass inspection if (with approval of Board of Health):

____ broken pipe(s) are replaced
____ obstruction is removed
____ distribution box is leveled or replaced

ND explain:

_____ The system required pumping more than 4 times a year due to broken or obstructed pipe(s). The system will pass inspection if (with approval of the Board of Health):

____ broken pipe(s) are replaced
____ obstruction is removed

ND explain:

OFFICIAL INSPECTION FORM - NOT FOR VOLUNTARY ASSESSMENTS

SUBSURFACE SEWAGE DISPOSAL SYSTEM INSPECTION FORM
PART A
CERTIFICATION (continued)

Property Address: ______________________________

____

Owner: __________________________
Date of Inspection: _________________________

C. Further Evaluation is Required by the Board of Health:

_____ Conditions exist which require further evaluation by the Board of Health in order to determine if the system is failing to protect public health, safety or the environment.

1. **System will pass unless Board of Health determines in accordance with 310 CMR 15.303(1)(b) that the system is not functioning in a manner which will protect public health, safety and the environment:**

   ___ Cesspool or privy is within 50 feet of a surface water
   ___ Cesspool or privy is within 50 feet of a bordering vegetated wetland or a salt marsh

2. **System will fail unless the Board of Health (and Public Water Supplier, if any) determines that the system is functioning in a manner that protects the public health, safety and environment:**

   ___ The system has a septic tank and soil absorption system (SAS) and the SAS is within 100 feet of a surface water supply or tributary to a surface water supply.

   ___ The system has a septic tank and SAS and the SAS is within a Zone 1 of a public water supply.

   ___ The system has a septic tank and SAS and the SAS is within 50 feet of a private water supply well.

   ___ The system has a septic tank and SAS and the SAS is less than 100 feet but 50 feet or more from a private water supply well**. Method used to determine distance ________________________________

   **This system passes if the well water analysis, performed at a DEP certified laboratory, for coliform bacteria and volatile organic compounds indicates that the well is free from pollution from that facility and the presence of ammonia nitrogen and nitrate nitrogen is equal to or less than 5 ppm, provided that no other failure criteria are triggered. A copy of the analysis must be attached to this form.

3. **Other:**

   ____
   ____
   ____

OFFICIAL INSPECTION FORM – NOT FOR VOLUNTARY ASSESSMENTS

SUBSURFACE SEWAGE DISPOSAL SYSTEM INSPECTION FORM

PART A

CERTIFICATION (continued)

Property Address: ____________________
____

Owner: ____________________

Date of Inspection: ____________

D. System Failure Criteria applicable to all systems:

You **must** indicate "yes" or "no" to each of the following for **all** inspections:

Yes No

___ ___ Backup of sewage into facility or system component due to overloaded or clogged SAS or cesspool

___ ___ Discharge or ponding of effluent to the surface of the ground or surface waters due to an overloaded or clogged SAS or cesspool

___ ___ Static liquid level in the distribution box above outlet invert due to an overloaded or clogged SAS or cesspool

___ ___ Liquid depth in cesspool is less than 6" below invert or available volume is less than ½ day flow

___ ___ Required pumping more than 4 times in the last year **NOT** due to clogged or obstructed pipe(s). Number of times pumped ____.

___ ___ Any portion of the SAS, cesspool or privy is below high ground water elevation.

___ ___ Any portion of cesspool or privy is within 100 feet of a surface water supply or tributary to a surface water supply.

___ ___ Any portion of a cesspool or privy is within a Zone 1 of a public well.

___ ___ Any portion of a cesspool or privy is within 50 feet of a private water supply well.

___ ___ Any portion of a cesspool or privy is less than 100 feet but greater than 50 feet from a private water supply well with no acceptable water quality analysis. **[This system passes if the well water analysis, performed at a DEP certified laboratory, for coliform bacteria and volatile organic compounds indicates that the well is free from pollution from that facility and the presence of ammonia nitrogen and nitrate nitrogen is equal to or less than 5 ppm, provided that no other failure criteria are triggered. A copy of the analysis must be attached to this form.]**

______ (Yes/No) **The system fails.** I have determined that one or more of the above failure criteria exist as described in 310 CMR 15.303, therefore the system fails. The system owner should contact the Board of Health to determine what will be necessary to correct the failure.

E. Large Systems:

To be considered a large system the system must serve a facility with a design flow of 10,000 gpd to 15,000 gpd.

You must indicate either "yes" or "no" to each of the following:

(The following criteria apply to large systems in addition to the criteria above)

yes no

___ ___ the system is within 400 feet of a surface drinking water supply

___ ___ the system is within 200 feet of a tributary to a surface drinking water supply

___ ___ the system is located in a nitrogen sensitive area (Interim Wellhead Protection Area – IWPA) or a mapped Zone II of a public water supply well

If you have answered "yes" to any question in Section E the system is considered a significant threat, or answered "yes" in Section D above the large system has failed. The owner or operator of any large system considered a significant threat under Section E or failed under Section D shall upgrade the system in accordance with 310 CMR 15.304. The system owner should contact the appropriate regional office of the Department.

OFFICIAL INSPECTION FORM – NOT FOR VOLUNTARY ASSESSMENTS

SUBSURFACE SEWAGE DISPOSAL SYSTEM INSPECTION FORM

PART B

CHECKLIST

Property Address: ________________________

____

Owner: ___________________

Date of Inspection: ________________________

Check if the following have been done. You **must** indicate "yes" or "no" as to each of the following:

Yes No

___ ___ Pumping information was provided by the owner, occupant, or Board of Health

___ ___ Were any of the system components pumped out in the previous two weeks ?

___ ___ Has the system received normal flows in the previous two week period ?

___ ___ Have large volumes of water been introduced to the system recently or as part of this inspection ?

___ ___ Were as built plans of the system obtained and examined? (If they were not available note as N/A)

___ ___ Was the facility or dwelling inspected for signs of sewage back up ?

___ ___ Was the site inspected for signs of break out ?

___ ___ Were all system components, excluding the SAS, located on site ?

___ ___ Were the septic tank manholes uncovered, opened, and the interior of the tank inspected for the condition of the baffles or tees, material of construction, dimensions, depth of liquid, depth of sludge and depth of scum ?

___ ___ Was the facility owner (and occupants if different from owner) provided with information on the proper maintenance of subsurface sewage disposal systems ?

The **size and location of the Soil Absorption System (SAS)** on the site has been determined based on:

Yes no

___ ___ Existing information. For example, a plan at the Board of Health.

___ ___ Determined in the field (if any of the failure criteria related to Part C is at issue approximation of distance is unacceptable) [310 CMR 15.302(3)(b)]

OFFICIAL INSPECTION FORM – NOT FOR VOLUNTARY ASSESSMENTS

SUBSURFACE SEWAGE DISPOSAL SYSTEM INSPECTION FORM
PART C
SYSTEM INFORMATION

Property Address: ________________________
____
Owner: ________________________
Date of Inspection: ________________________

FLOW CONDITIONS

RESIDENTIAL

Number of bedrooms (design): ____ Number of bedrooms (actual): _____
DESIGN flow based on 310 CMR 15.203 (for example: 110 gpd x # of bedrooms): _______
Number of current residents: ______
Does residence have a garbage grinder (yes or no): ___
Is laundry on a separate sewage system (yes or no): ___ [if **yes** separate inspection required]
Laundry system inspected (yes or no): ___
Seasonal use: (yes or no): ___
Water meter readings, if available (last 2 years usage (gpd)): __________________
Sump pump (yes or no): ___
Last date of occupancy: _________

COMMERCIAL/INDUSTRIAL

Type of establishment: ________________________
Design flow (based on 310 CMR 15.203): ____________gpd
Basis of design flow (seats/persons/sqft,etc.): ___________________________________
Grease trap present (yes or no): ___
Industrial waste holding tank present (yes or no): ___
Non-sanitary waste discharged to the Title 5 system (yes or no): ___
Water meter readings, if available: ____________________
Last date of occupancy/use: ___________

OTHER (describe): ____

GENERAL INFORMATION

Pumping Records

Source of information: ____
Was system pumped as part of the inspection (yes or no): ___
If yes, volume pumped: ______gallons -- How was quantity pumped determined? ________________
Reason for pumping: ____

TYPE OF SYSTEM

___ Septic tank, distribution box, soil absorption system
___ Single cesspool
___ Overflow cesspool
___ Privy
___ Shared system (yes or no) (if yes, attach previous inspection records, if any)
___ Innovative/Alternative technology. Attach a copy of the current operation and maintenance contract (to be obtained from system owner)
___ Tight tank ___ Attach a copy of the DEP approval

___ Other (describe): ____

Approximate age of all components, date installed (if known) and source of information:

____

Were sewage odors detected when arriving at the site (yes or no): ___

OFFICIAL INSPECTION FORM – NOT FOR VOLUNTARY ASSESSMENTS

SUBSURFACE SEWAGE DISPOSAL SYSTEM INSPECTION FORM
PART C
SYSTEM INFORMATION (continued)

Property Address: ______________________

____

Owner: ____________________
Date of Inspection: ______________________

BUILDING SEWER (locate on site plan)

Depth below grade: __________
Materials of construction: ___cast iron ___40 PVC ___other (explain): ____________________
Distance from private water supply well or suction line: ______________
Comments (on condition of joints, venting, evidence of leakage, etc.):

____

SEPTIC TANK: ___ (locate on site plan)

Depth below grade: ______
Material of construction: ___concrete ___metal ___fiberglass ___polyethylene
___other(explain)____
If tank is metal list age: ___ Is age confirmed by a Certificate of Compliance (yes or no): ___ (attach a copy of certificate)
Dimensions: ____________________________
Sludge depth: ____________________________
Distance from top of sludge to bottom of outlet tee or baffle: _________
Scum thickness: _________
Distance from top of scum to top of outlet tee or baffle: _________
Distance from bottom of scum to bottom of outlet tee or baffle: ______
How were dimensions determined: ____________________________________
Comments (on pumping recommendations, inlet and outlet tee or baffle condition, structural integrity, liquid levels as related to outlet invert, evidence of leakage, etc.):

____
____

GREASE TRAP: ___(locate on site plan)

Depth below grade: ___
Material of construction: ___concrete ___metal ___fiberglass ___polyethylene ___other (explain):____
Dimensions: _____________
Scum thickness: __________
Distance from top of scum to top of outlet tee or baffle: __________
Distance from bottom of scum to bottom of outlet tee or baffle: _________
Date of last pumping: ________

Comments (on pumping recommendations, inlet and outlet tee or baffle condition, structural integrity, liquid levels as related to outlet invert, evidence of leakage, etc.):

____

____

OFFICIAL INSPECTION FORM – NOT FOR VOLUNTARY ASSESSMENTS

SUBSURFACE SEWAGE DISPOSAL SYSTEM INSPECTION FORM

PART C

SYSTEM INFORMATION (continued)

Property Address: ____________________

Owner: __________________________

Date of Inspection: __________________

TIGHT or HOLDING TANK: ____ (tank must be pumped at time of inspection)(locate on site plan)

Depth below grade: _____

Material of construction: ____concrete ____metal ____fiberglass ____polyethylene ____other(explain):

____

Dimensions: __________________

Capacity: ___________________gallons

Design Flow: _________________gallons/day

Alarm present (yes or no): _____

Alarm level: ______ Alarm in working order (yes or no): ____

Date of last pumping: ______

Comments (condition of alarm and float switches, etc.):

____

____

DISTRIBUTION BOX: ____ (if present must be opened)(locate on site plan)

Depth of liquid level above outlet invert: _____

Comments (note if box is level and distribution to outlets equal, any evidence of solids carryover, any evidence of leakage into or out of box, etc.):

____

____

PUMP CHAMBER: ____ (locate on site plan)

Pumps in working order (yes or no): ____

Alarms in working order (yes or no): ____

Comments (note condition of pump chamber, condition of pumps and appurtenances, etc.):

____

____

OFFICIAL INSPECTION FORM – NOT FOR VOLUNTARY ASSESSMENTS

SUBSURFACE SEWAGE DISPOSAL SYSTEM INSPECTION FORM

PART C

SYSTEM INFORMATION (continued)

Property Address: ______________________

____

Owner: ________________

Date of Inspection: ________________

SOIL ABSORPTION SYSTEM (SAS): (locate on site plan, excavation not required)

If SAS not located explain why:

____

____

Type

____ leaching pits, number: ___

____ leaching chambers, number: ____

____ leaching galleries, number: ____

____ leaching trenches, number, length: ____________________

____ leaching fields, number, dimensions: __________________

____ overflow cesspool, number: ____

____ innovative/alternative system Type/name of technology: ____________________________

Comments (note condition of soil, signs of hydraulic failure, level of ponding, damp soil, condition of vegetation, etc.):

____

____

CESSPOOLS: ____ (cesspool must be pumped as part of inspection)(locate on site plan)

Number and configuration: ______________________

Depth – top of liquid to inlet invert: __________________

Depth of solids layer: ______________

Depth of scum layer: ________________

Dimensions of cesspool: ______________

Materials of construction: ____________________________

Indication of groundwater inflow (yes or no): ____

Comments (note condition of soil, signs of hydraulic failure, level of ponding, condition of vegetation, etc.):

____

____

PRIVY: ____ (locate on site plan)

Materials of construction: ____________________________________

Dimensions: ____________

Depth of solids: ________________
Comments (note condition of soil, signs of hydraulic failure, level of ponding, condition of vegetation, etc.):

____

____

OFFICIAL INSPECTION FORM – NOT FOR VOLUNTARY ASSESSMENTS

SUBSURFACE SEWAGE DISPOSAL SYSTEM INSPECTION FORM
PART C
SYSTEM INFORMATION (continued)

Property Address: ______________________
____

Owner: ________________
Date of Inspection: ______________

SKETCH OF SEWAGE DISPOSAL SYSTEM

Provide a sketch of the sewage disposal system including ties to at least two permanent reference landmarks or benchmarks. Locate all wells within 100 feet. Locate where public water supply enters the building.

OFFICIAL INSPECTION FORM – NOT FOR VOLUNTARY ASSESSMENTS

SUBSURFACE SEWAGE DISPOSAL SYSTEM INSPECTION FORM
PART C
SYSTEM INFORMATION (continued)

Property Address: ______________________
____

Owner: ____________________
Date of Inspection: ___________________

SITE EXAM
Slope
Surface water
Check cellar
Shallow wells

Estimated depth to ground water _____ feet

Please indicate (check) all methods used to determine the high ground water elevation:

____ Obtained from system design plans on record - If checked, date of design plan reviewed: _________
____ Observed site (abutting property/observation hole within 150 feet of SAS)
____ Checked with local Board of Health-explain: ___________________________
____ Checked with local excavators, installers- (attach documentation)
____ Accessed USGS database-explain: ________________________

You **must** describe how you established the **high ground water elevation**:
____
____
____
____

Appendix D

Contacts

Department of Environmental Protection

Main Office	Central Region	Service Center
(617) 292-5500	(508) 792-7650	(508) 792-7683

www.state.ma.us/dep

Department of Environmental Management
Main Office
(617) 626-1250
www.state.ma.us/dem/index.htm

Lake Commission: Shrewsbury Chief of Police
(508) 845-4681

Lake Quinsigamond State Park
(508) 755-6880

Shrewsbury Board of Health
(508) 841-8512

Worcester Board of Health
(508) 799-1121

12/4/02
Contact:
Nancy Allen
Director of Public Health
Email: nallen@th.ci.shrewsbury.ma.us
Phone: 508-841-8512

Tim, Jeremy and I met with Nancy. She gave us 11-page Inspection Report, Title 5 Training Manual, and Title 5. She discussed with us Title 5, what Shrewsbury is doing and has done. Including the grant from the government, which is being used for a phosphorous study and draining pipes. This money is given until 2005. The phosphorous and nitrogen is coming from higher grounds where the water runs into drainage pipes and dumps into Lake Quinsigamond. Shrewsbury paid $5.5 million for 683 homes to be put on public sewage because they could not fix their septic systems because of ground conditions. (Southeast side of the lake). This money would be paid back by property pay betterment and fees for each home to access sewage.

Group conclusion: Got way too much general information. When we go back we should have a better idea of what we are looking for, and better questions to get answered.

From: Tim Downing [mailto:tdowning@WPI.EDU]
Sent: Wednesday, January 22, 2003 3:51 PM
To: nallen@th.ci.shrewsbury.ma.us
Subject:

Nancy,

We were hoping that you could help us find a few numbers regarding TItle 5 compliant systems in either the massachusetts area, and/or the shrewsbury area.

I have no numbers to report. Approximately 65 - 70% of the buildings in Shrewsbury are connected to municipal sewer. There are about 12,500 residential dwellings including apartments and condos. Except for the few businesses on Route 70 and some on Route 20 all of the businesses (commercial, industrial and retail) are connected to municipal sewer.

When a Title 5 inspection is conducted, a sewage disposal system is classified as a pass (compliant) if it does not meet any of the 13 failure criteria listed in Title 5 (15.303) and it was built as required by the Title 5 that was in effect when the system was constructed. The same is true statewide.

Another question that we have for you is what is the percentage of pollution in the lake coming from sewage vs non-source point runoff? We do not know. Neither has ever been measured. Would you be willing to design criteria for a study that would measure and differentiate between pollution from sewage disposal systems and pollution from non-source point run-off? Would you compare bacterial loading to phosphorus loading? Where would you measure/sample bacteria if the waste water passed through the soil and entered the water body subsurface? How about bacteria from animal waste, etc that gets washed into catch basins and ultimately into the lake? How about bacteria from water fowl? Also, what is the total expended cost on Sewage control as well as any funds used to evaluate or control runoff? The sewer department budget for this year is $2,354,186.00. Only a small % of the grant money will be spent on run-off.

We're in the process of coming up with a thesis statement for our project, and the answers to these questions would help us very much. Thanks again for all of your help. The Title 5 training manual we borrowed is proving to be a very good resource for the project. Keep asking the questions. This is just starting to get good.

Tim, Becki, & Jeremy

From: Tim Downing [mailto:tdowning@WPI.EDU]
Sent: Monday, February 03, 2003 8:34 PM
To: nallen@th.ci.shrewsbury.ma.us
Cc: Jeremy Rouleau; Becki Duhaime; bjs@WPI.EDU
Subject: more q&a regarding title 5

Nancy,

Tim, Becki, & Jeremy here...your last email was very helpufl to us, and we appreciate the fact that you replied so quickly. A few more questions for you, if you don't mind.

first off, we have narrowed down our thesis search, and would like your opinion on it.

"In the long run, the benefits of Title 5 will out-weigh the costs by making a significant impact on the water quality of Lake Quinsigamond, the health of the population, and the environment, by liimiting the amount of contaminants which enter the lake through septic systems."

I think it will be very difficult to measure or quantify the effect of Title 5 on the lake and on public health. If you are just giving your opinion, that's easy. If you have to prove the statement and show findings, that's not going to be easy. Questions to consider: What factual information do you have (bacterial testing results) prior to 1995? That is the background information. Will you be able to repeat that testing and show that conditions have improved? Testing is expensive. Towns have changed their testing protocol since 1995.

If conditions have improved, how will you show that it is because Title 5 was enacted? What changes within the Lake Quinsigamond watershed were brought about by the enactment of Title 5? On the Shrewsbury side a major sewer extension project was built, but so far only 300 (approximately) homes out of the eligible 830 homes have connected to sewer and abandoned their septic systems.

To have a valid discussion on the health of the population you would have to consider how many people use the lake for swimming, fishing, boating, etc. What information would show that their health has improved? Were there more reports of illness prior to Title 5 than after in lake users? Earaches, vomiting, diarrhea often go unreported.

Secondly, we have obtained a document entitled, "Title 5, 'What we have accomplished and What's Ahead," published by the DEP, and complied by Commissioner David Struhs in January 1996. There are several charts and figure within this document, that we would like to varify. Do you have, or is there any way that you could obtain, the document, and the appendix, from which this was assembled. It seems this paper is written largely in laymans terms, and it would be nice if we had the actual data.

I do not have access to that. Do you want to FAX it to me? 508-841-8414.

Lastly, if there is any sort of DEP cost/benefit analysis of Title 5, it would be great if we could take a look at, or get a copy of that. You should call John Higgins, the DEP Title 5 answer man. 508-756-7281.

Thank you again for all of your help.

I do not mean for this to sound negative. You are doing a good job of thinking it out. Just be sure you can answer the questions you raise and prove your answers.

Tim, Jeremy, & Becki.

From: Nancy Allen
To: 'Tim Downing'
Sent: Thursday, February 20, 2003 9:20 AM
Subject: RE: Title 5 and more

Hi: I am just back from vacation and settling in. A quantitative analysis of Title 5 would be excellent. I do not think it has ever been done. Please send me the attachment/analysis and I will try to answer your question.

-----Original Message-----
From: Tim Downing [mailto:tdowning@WPI.EDU]
Sent: Wednesday, February 19, 2003 4:57 PM
To: Nancy Allen
Cc: Jeremy Rouleau; Becki Duhaime; bjs@WPI.EDU
Subject: Title 5 and more

Nancy,

We appologize for the wording of our last email, in retrospect, we realized it was pretty confusing. What we really wanted was a confirmation from you that you had received our fax.

Secondly, we have come up with a tentative quantitative analysis of title 5, which we would like to prove. If you don't mind, we would not only like your opinion on it, but also there is a question in there regarding the output of e-coli, nitrogen and phosphorous of passing vs. failing systems. If you know these numbers, or know of a place where we could find them, that would be great. A simple outline of our analysis is attached.

As always, thank you again for your help. We really appreciate you going out of your way for us.

Tim, Jeremy, Becki

From: Nancy Allen
To: 'Timothy Michael Downing'
Sent: Thursday, April 03, 2003 5:06 PM
Subject: RE: Lake Q

That is wastewater that has been "treated" only in the sense that it has passed through the septic tank and soil absorption system.

-----Original Message-----
From: Timothy Michael Downing [mailto:tdowning@WPI.EDU]
Sent: Wednesday, April 02, 2003 10:19 PM
To: Nancy Allen
Cc: Jeremy Rouleau; Becki Duhaime
Subject: Lake Q

Nancy,

We wrote up a bit on nitrogen loading in Lake Q, and were stumped at one aspect. In the Title 5 training manual, it gave some numbers on nitrogen due to wastewater, but didn't mention whether or not that was treated wastewater. If you have any way of finding that out, that'd be great.

We estimated the number of homes on lake Q by finding the perimeter, and multiplying by the number of homes per mile, which we counted ourselves. It is a pretty rough estimate, but solid nonetheless. We plan on multiplying this by the mass flux of nitrogen and phosphorus to get the flow of the substances into the lake.

Attached is our nitrogen findings, hopefully you can give us some insight on it.

Thanks again.

Tim, Becki & Jeremy

Appendix E

TITLE 5

What We Have Accomplished and What's Ahead

Commonwealth of Massachusetts
Department of Environmental Protection

Across Massachusetts, failing cesspools and septic systems are a leading cause of contaminated drinking water, tainted shellfish beds, weed-choked lakes and ponds and polluted beaches. Three years ago, the Department of Environmental Protection began working with key stakeholders to revise the state's septic system rules for the first time since 1978. The revised Title 5 of the State Environmental Code protects the health of Massachusetts citizens and the state's natural resources by requiring inspection of private on-site sewage disposal systems before properties using them are sold, expanded or undergo a change in use.

This report reviews the first nine months of implementation of the 1995 revised Code and previews future plans and expectations. A more detailed quantitative analysis of the costs and benefits of Title 5 will be released as an appendix to this report in February, 1996.

TITLE 5 BENEFITS OUTWEIGH COSTS

DEP's cost-benefit analysis of the new Title 5 rules concludes that the accrued public health and environmental benefits outweigh the costs by a margin of better than five to one. In preparing this analysis, DEP has taken a highly conservative approach, in that the department has not quantified or assigned a dollar value to all of these benefits. *If the full economic value of clean water resources plus avoided illness and health care costs were included, the benefits of the new rules would outweigh the costs by an even larger margin than the figures provided here indicate.* But even with this conservative approach, DEP estimates the benefits of Title 5 total at least $135.5 million per year, compared to an average annual cost of $26.3 million.

The cost of Title 5 repairs and upgrades also compares favorably to the cost of sewers. Amortized over 20 years, the total costs associated with the typical Title 5 upgrade are lower than the average sewer bill. In almost every instance, even homeowners who install new septic systems will pay less, on an annualized basis, than most residential sewer ratepayers. And since more than three out of four septic systems *pass* inspection, the only costs for most homeowners are inspection fees and regular maintenance — clearly far more affordable than a sewer bill.

Estimated Costs

Since the Title 5 revisions took effect in March 1995, approximately 26,000 private septic systems and cesspools have been inspected across the state, nearly four times as many inspections as were occurring annually under the old Code. Fewer than one-quarter (6,500) have needed upgrades, and half of the repairs have involved inexpensive replacement of broken parts. An independent survey of local health boards, financial institutions and system inspectors found that the average cost of a Title 5 upgrade — factoring in all regions of the state and all types of upgrades, from repair of broken parts to replacement of an entire system — has been about $6,200.

DEP estimates that the 6,500 septic systems repaired, upgraded or replaced since Title 5 took effect handle more than 522 million gallons of household wastewater annually. This wastewater is now being treated at levels that are protective of public health and the environment at an estimated first-year cost, including inspection fees and repair costs, of approximately $50 million. Amortized over 20 years, the average expected lifespan of a septic system, that works out to less than a penny a gallon. But that cost will go down considerably in subsequent years; the total number of repairs needed each year will decrease as the most troublesome areas are sewered and the backlog of failed systems is reduced. DEP estimates that the total average annual costs over the next ten years will be approximately $30.4 million per year. Subtracting from that figure the comparable long-term yearly cost of the old Code, estimated at approximately $4.1 million, yields an average annual cost of the new Title 5 of approximately $26.3 million per year over the next ten years.

Estimated Costs of Title 5 Regulations (in millions)

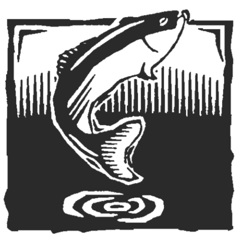
	First Year of Implementation	Annual Average 1996 - 2005
Estimated Cost of 1995 Code	$49.9 (range $44.6-$66.0)	$30.4
Estimated Cost of 1978 Code	$6.7 (range: $4.9-$9.6)	$4.1
New Cost Attributable to the Revised Code	$43.2 (range $39.7-$56.4)	$26.3

Estimated Benefits: Reduced Pollution, Avoided Costs, and Job Creation

Commercial Shellfishing: A total of 170,643 acres of shellfish beds are closed to harvesting in Massachusetts. Of these, DEP estimates that 55,685 acres are contaminated to some degree by septic systems.

The potential future benefits associated with reopening these 52,503 acres of shellfish beds are estimated at $2.6 million per year for additional shellfish landings, and $28,000 in additional permit revenues. Potential costs avoided due to prevention of future bed closures that might have occurred in the absence of Title 5 are estimated to be of a similar magnitude, yielding an estimated overall benefit of $5.3 million.

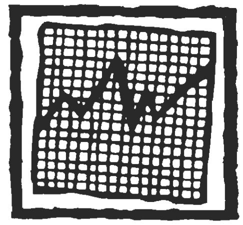
Lakes and Ponds: DEP estimates that 72 percent of the Commonwealth's lakes are affected by eutrophication (depleted oxygen and/or excessive algae and weed growth). This condition, caused largely by excess nutrients, significantly reduces the recreational and aesthetic value of the affected waterbodies. It is estimated that septic system discharges account for at least 14 percent of the nutrient inputs to lakes and ponds statewide, and substantially more in many specific cases. An indirect estimate of the potential benefits associated with better lake and pond water quality attributable to Title 5 was derived using known costs to treat or restore affected lakes. These remediation costs provide an indirect valuation of the potential benefits associated with protecting these water resources. Based on the estimated costs for a mix of maintenance and restoration projects that would be needed to address the impact of septic system discharges on Massachusetts lakes and ponds, DEP estimates $10.8 million per year in avoided costs due to the new Title 5.



Recreation: Improvements in recreational freshwater fishing and shellfishing in Massachusetts as a result of the new Title 5 will provide an estimated benefit of $8.1 million per year in increased revenues and avoidance of future costs. Because of a lack of data, the economic benefits associated with other forms of recreational activities, such as swimming, boating, and saltwater fishing, could not be quantified.

Jobs: The upgrading of septic systems and cesspools will generate significant economic activity and jobs. Although technically not a direct benefit, the money spent will benefit the local economy in two ways: the regulations have already stimulated the development and sale of innovative technologies by companies based in Massachusetts, spurring the growth of "green" businesses; and, the dollars spent on system upgrades are spent in Massachusetts, even by those selling their homes and moving out of state. In these cases, the Commonwealth benefits twice; the dollars spent provide local jobs, and the upgraded septic systems improve the overall quality of our environment.

The revised Title 5 will continue to create jobs for system designers, system installers, soil evaluators, inspectors, and workers involved with supplying materials such as concrete septic tanks. DEP estimates that approximately 442 new jobs will be created, generating total wages of approximately $15.9 million dollars annually.



Public Health: Based on data from the U.S. Food and Drug Administration, DEP estimates that 253 people in Massachusetts become sick every year after eating sewage-contaminated shellfish. Additional illnesses caused by contaminated ground and surface drinking water supplies undoubtedly also occur, but there simply is not enough data available to estimate the numbers. *Nationally, septic leachate is the most commonly reported cause of contaminated groundwater drinking water supplies.* The consumption of untreated groundwater was responsible for almost half of all cases of water-borne disease in the U.S. from 1971 to 1979. A similar situation is likely to exist here. Thus, although there is not enough public health data to accurately estimate the number of sewage-related diseases in our state, the number is likely to be significant. Contamination of groundwater by chemicals associated with septage, most notably nitrates, is well documented across Massachusetts, with nitrate levels on the increase in public water supplies serving tens of thousands of people. Less well-documented are nitrate levels in private drinking water wells that serve many thousands more.

While it is difficult to accurately estimate the potential avoided costs of decreased pollution of drinking water, it is clear that the benefit will be substantial. For example, the cost of a filtration plant for the Wachusett Reservoir alone would be some $400 million — or about $20 million per year over 20 years. The technical appendix to this report to be released next month will examine these costs more closely.

Sewering: As stated earlier, the cost of upgrading and maintaining a conforming Title 5 system is far less than the cost of sewers. Based on the cost of sewering neighborhoods with failed septic systems around the Wachusett Reservoir, DEP estimates that the cost of replacing failed septic systems with sewers statewide would be a minimum of $75 million dollars per year.

Rivers: Septic systems are believed to directly contribute to the contamination of approximately 926 Massachusetts river miles, reducing the recreational and aesthetic value of these waterways. The dollar value of these impacts cannot be quantitatively determined and are not included in this cost-benefit analysis. The technical appendix to this report to be released next month will further consider these values.

Failed Systems Threaten Public Health

- High levels of nitrates in drinking water can be toxic to babies. At least 61 public water supply sources in Massachusetts report nitrate levels that already exceed 5 parts per million (ppm), more than half the public health standard of 10 ppm. The cost of building and operating treatment facilities for all these wells would be approximately $495 million over twenty years.

- The town of Weymouth suspects leaking septic tanks and cesspools contributed to recent bacterial contamination in town water supplies, and has urged 28 property owners to connect to the municipal sewer system.

- In Westfield, contamination from failing septic systems was identified as the cause of contamination in the Hampton Ponds, a popular swimming area. The city is now working to extend sewer lines to the neighborhood.

Comparison of Benefits To Costs

The considerable uncertainty in the benefit estimates and the time frames over which those benefits will accrue, and the inability to accurately place dollar values on several important benefits, make a comprehensive comparison of Title 5 costs and benefits difficult. The estimates that DEP has been able to derive, however, suggest that long-term benefits potentially attributable to Title 5 significantly outweigh the costs involved.

The best estimate for total average yearly costs associated with Title 5 (averaged over ten years) is approximately $30.4 million. Approximately $4.1 million of this total can be attributed to expenditures that were occurring before the revised code took effect (i.e. they had to be made even under the 1978 code), yielding a new cost of $26.3 million per year attributable to the 1995 revisions. Expenditures are up chiefly because a greater percentage of polluting septic systems are being identified and repaired.

The best estimate of quantifiable potential future benefits attributable to the new Title 5 equals approximately $135.5 million per year — more than five times the estimated annual cost. As these benefits will not occur immediately but will accrue over an extended period, *and will continue beyond the ten-year time-frame considered in the cost estimations,* this longer-term comparison is the most appropriate. DEP's positive benefit ratio is highly conservative because many important benefits could not be quantified in dollar terms and because the yearly costs of implementing Title 5 in the future are likely to be less than those estimated. Another long-term economic benefit is the fact that many of the inexpensive repairs happening now will head off more expensive repairs later.

Sharing the Solution

- In Rowley, seven failed residential cesspools will be replaced by a shared septic system operated by the town — a solution that is available as a direct result of the Title 5 revisions. All of the homes to be served are owned by low- or moderate-income families who could not afford individual replacement systems. The shared system will also enable the town to reclaim a municipal building that was closed due to a septic system failure. The building will probably be used as a senior center or library.

- In Duxbury, a wastewater district is being formed to build a town-operated shared system to serve approximately 30 commercial establishments in Snug Harbor, all of which currently have failing septic systems. A smaller shared system that would serve three properties in the Bluefish River section of town is also under consideration.

MASSACHUSETTS TAKES A LEADERSHIP ROLE IN INNOVATIVE AND ALTERNATIVE TECHNOLOGIES

One of the biggest successes of Title 5 is its new streamlined approval process for innovative and alternative technologies for on-site wastewater treatment. These systems provide substitutes for, or alternatives to, one or more of the components that make up a conventional system, while providing equal or better environmental and public health protection. These can be used for cost-effective upgrades on sites that cannot accommodate conventional systems, in environmentally sensitive areas, or where conventional systems simply don't work. More than 20 alternative systems have been approved in Massachusetts, and at least 20 more are currently under review. *No other state in the nation has approved more innovative technologies.*

Estimates of Title 5 Benefits (Including Annual Avoided Costs)[1]

	Best Estimate**	Range
Shellfish Landings: potential opening of beds currently closed and prevention of future deterioration	$5,330,800	$287,000 - $10,661,600
Shellfish Permits	$27,900	$3,200 - $55,800
Impacts to Lakes and Ponds	$10,810,000	$52,200 - $73,865,100
Additional Sportfishing Expenditure Impacts	$8,063,400	$7,701,200 - $98,760,580
Employment Impacts	$15,940,000	NI - $21,083,000
Other Recreational Impacts: boating swimming, etc.	N/A (moderately significant)	N/A
Drinking Water Benefits associated with preventing water supply contamination and resulting need to treat	$20,000,000 (minimum)	$20,000,000 +
Pubic Health Impacts	N/A (approximately 253 cases per year of shellfish poisoning and a significant but unquantifiable number due to drinking water contamination are likely to be prevented)	N/A
"Existence Value"*** of Clean Water	N/A (very significant)	N/A
Avoided Cost of Sewering	$75,400,000	$75,400,000 +
Total	$135,572,100 (a conservative estimate due to large number of unquantifiable categories)	$103,443,600 - $204,426,100

NI = Not included. Although employment impacts clearly create jobs which provide a benefit to the Commonwealth, the appropriateness of considering these as a benefit is open to debate and they were not included in the lower bound estimate. It is important to note though, that *local benefits* which most economists would consider as appropriate to include in this analysis will almost certainly occur including the development of MA based companies to provide innovative and alternative treatment technologies that are saleable out-of-state and the "retention" of funds spent in MA for upgrades and inspections that would otherwise not have occurred; depending upon the apportionment of these costs between buyer and seller, a significant fraction of these monies would otherwise have left the Commonwealth to ultimately be spent elsewhere, due to people moving out of state.

NA = Data not available to allow for dollar values to be assigned to likely benefits. Thus, total benefits are highly conservative and significantly underestimate benefits.

[1] Average Yearly Rate. Due to uncertainties in temporal accrual of benefits, values were not discounted nor adjusted for inflation.

** Values rounded off to nearest $100.

*** Value placed by people on the existence of something of value even though they may not directly use it.

Because of its leadership status, Massachusetts is becoming a prime location for the development of these technologies. Massachusetts is developing plans for a technology testing and certification center, and encouraging the U.S. Environmental Protection Agency and other New England states to develop a region-wide uniform approval process. If the latter becomes a reality, alternative systems developed in Massachusetts could be certified for use elsewhere in the region without having to go through duplicative regulatory reviews. This will provide an important boost for the Massachusetts enviro-technology industry while providing more cost-effective choices for Massachusetts consumers.

Plumbing Board

An obstacle to the use of innovative technologies was overcome when DEP collaborated with the state plumbing board to revise sections of the plumbing code that previously had prohibited the use of many alternatives to conventional septic systems. David Del Porto of Sustainable Strategies, a company in the business of developing and marketing alternative systems, offers this assessment: "Harmonizing the requirements of Title 5 with those of the Board of Examiners of Plumbers and Gas Fitters has a far reaching impact for the future of pollution avoidance. It will ensure that these viable alternatives to conventional subsurface disposal technologies can be selected with confidence by home owners ... [and] enhance the credibility of these technologies and so encourage innovation through research and development here in Massachusetts."

TRAINING AND MUNICIPAL ASSISTANCE EASE THE TRANSITION

In 1995, DEP provided technical training to some 1,200 health board members, health agents and septic system designers. The agency also trained more than 3,500 system inspectors and some 1,000 soil evaluators. In early June, DEP established a toll-free hotline to provide information, help and referrals to homeowners, municipal officials, system inspectors and others with questions about Title 5 implementation. That hotline has served more than 5,300 callers to date.

In cooperation with the Executive Office of Communities and Development, DEP conducted eight training sessions for the 97 communities that have received grants under an initial $10 million dollar Title 5 financial assistance program. These workshops taught local officials how to implement successful community betterment or loan programs for homeowners needing financial assistance with septic system repairs and upgrades.

Next year, training will be expanded to serve all Massachusetts towns and cities, and will include training on how to establish septage management districts. The Administration will also continue seeking additional financial assistance for municipal governments through the Open Space Bond Bill, which includes $30 million to help homeowners pay for Title 5 repairs and upgrades.

SEWER FINANCING PLAYS A ROLE

In many cases, on-site wastewater treatment offers important economic and environmental advantages and is preferable over conventional sewer systems. In other cases, however, sewer systems are clearly the best alternative.

For example, many neighborhoods in Massachusetts are built in areas with ledge, high groundwater and poor soil conditions, not conducive for traditional septic systems. As a result, a large percentage of these homes have failing systems today. Municipal sewers are often the most cost-effective solution for the long term in neighborhoods like these, and the State Revolving Fund (SRF) provides towns and cities with subsidized loans to finance sewer construction. SRF loans supported $15 million in municipal sewer projects during the last year. Another $15 million in loans will be issued by the end of June 1996. These investments will eliminate the need to replace an estimated 1,900 failing or potentially failing Title 5 systems.

Efforts to protect the Wachusett Reservoir offer a prime example of how state financing can help. The Metropolitan District Commission estimates that half of the 11,000 septic systems in the Wachusett watershed are failing, posing a major threat to the drinking water supply for 2.1 million Bay State residents. Fifty-eight million dollars will be spent over the next six years to extend sewers in West Boylston and Holden. This is a key component of a larger strategy for Massachusetts to avoid the expense of building a federally-mandated $400 million water filtration plant.

The SRF Trust is currently refinancing some of its existing projects to make an additional $20 million available for priority sewer needs in neighborhoods where Title 5 systems are failing.

Also, DEP is developing a proposal that would expand the state's ability to use the financial resources of the SRF to address non-point sources of water pollution, such as failing Title 5 systems, with new management approaches and technological alternatives to conventional sewering. The specifics of this regulatory change will be unveiled in January 1996, with public hearings to follow.

LEGISLATIVE SUPPORT IS CRUCIAL

Members of the Legislature, and particularly the Joint Committee on Natural Resources and Agriculture, have provided DEP with valuable assistance in identifying Title 5 implementation challenges. State lawmakers also have adopted changes to the betterment law and appropriated $10 million, enabling many municipalities to help their citizens pay for septic system repairs.

Title 5 Encourages Alternative Technologies

- A homeowner in Haverhill was quoted a price of $15,000 to replace his failed system. But that was under the old Title 5. Under the new rules, he was able to build a smaller leach field. Total installed cost: $6,800, a savings of more than $8,000.

- A single-family home in Needham had an existing cesspool, sitting in the groundwater and located only 21 feet from a lake, on a small lot with no room for a conventional system. Under the old rules, the only solution would have been a costly tight tank. But the new rules allowed the homeowner to install an innovative technology which solved the problem.

- More than 300 people attended an alternative technology workshop in western Massachusetts last September. The Tri-Town Health Department reports that since then, at least half a dozen homeowners in Lee, Lenox and Stockbridge have opted to install technological alternatives which cost less than conventional septic systems on their lots and work at least as well, if not better.

Continued support is needed to complete the successful implementation of this program. Specifically, the Legislature must enact the proposals submitted by the Administration in early August:

- House Bill 5393, to provide a $2,500 tax credit to homeowners making repairs to comply with Title 5; and

- House Bill 5392, to establish a uniform statewide code for septic system repairs and upgrades.

In addition, passage of the Open Space Bond Bill is critical to provide an additional $30 million dollars to supplement existing Title 5 loan programs and get them going in more cities and towns.

LOOKING TO THE FUTURE

Much progress has been made, but additional challenges still lie ahead.

- Systems that treat more than 10,000 gallons per day (gpd) must be inspected by December 1, 1996. Between now and then, DEP will develop an extensive outreach campaign to communicate with the owners of these large systems about the inspection requirements and how to comply. This will include a substantial effort to identify the hundreds of systems that fall into this category. Because DEP in the past did not issue permits for systems under 15,000 gpd, there is no existing database.

- In February 1996, DEP will release a computerized nitrogen loading model that can assess how proposed land uses within the zones of contribution to public water supply wells (Zone IIs) will affect nitrate concentrations in the drinking water. This will give communities a valuable tool for evaluating the impacts of development and zoning decisions on drinking water quality. And in some cases, its use may provide the information necessary to allow DEP to relax septic system density requirements.

- The Administration will continue to seek financial resources from the Legislature for assistance to municipal governments.

- DEP will continue to provide technical assistance to local governments. That assistance will help communities determine which treatment system, or combination of systems, make the most sense. DEP is particularly interested in helping communities develop long-term waste management programs.

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