# UNDERSTANDING THE ROLE OF SOILS IN DECISION MAKING: URBAN AGRICULTURE AND SEPTIC SYSTEMS

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**Title**

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

**MASTER OF SCIENCE**

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**ABSTRACT**

Rural and urban dwellers frequently face decisions relating to human health. Among these are issues pertaining to water quality, and the availability of safe and nutritious food. Rural septic systems treat household wastewater which could contaminate surface and near surface waters if left untreated. In urban areas and food deserts the quality of the locally sourced food may be of concern. Many of these issues can be resolved with access to current soils information and interpretations, and an understanding of how the soil functions in the user's area of interest. From planting a community garden to replacing a failing septic system, decisions can be made with the help of experts in their respective fields. Agencies like the Natural Resources Conservation Service, Minnesota Pollution Control Agency, and local professionals can assist stakeholders in making the best-informed decisions when it comes to mitigating potentially harmful water and producing safe food.

## ACKNOWLEDGMENTS

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Thank you to the Becker County Zoning Staff, for the continual assistance and cooperation with my research. Additionally, my sister, Olivia Ohm for your help in research, writing, and knowledge along the way. I appreciate the lessons we pass back and forth more than you will ever know.

To my family, thank you for your love, guidance, and always supporting me. My parents, Chris and Jackie Ohm, your encouragement to follow my dreams have shaped me into the person I am today. To my fiancé, Joseph Olson, for having an unwavering belief in me and for supporting our family during this time. To our three kids; Eliza, Ryker, and Oaklyn who motivate me, to be the best version of myself. Finally, to all the friends and special people in my life who have made this journey possible, thank you. With your support, this experience means more to me knowing I have a group behind me.

## DEDICATION

This paper is dedicated to my grandparents Bob and Gloria Levos, and my grandpa Grant Ohm, for instilling the love of agriculture and soils in my life. Thank you for sharing your wisdom, support, encouragement, and love.

*“Grandparents hold our hands*

*for just a little while*

*but our hearts forever”*

TABLE OF CONTENTS

## LIST OF FIGURES

Figure | Page

## GENERAL INTRODUCTION

Soils information is utilized throughout the country to make everyday decisions. From large scale operations to individual stakeholders, soil interpretations can aid in making the most informed choices. A soil property of concern in rural areas, such as Becker County, Minnesota is redoximorphic features. These features are looked for in areas where someone has an individual sewage treatment system and defined as (7080.1110 Definitions) “A color pattern in soil, formed by oxidation and reduction of iron or manganese in saturated soil coupled with their removal, translocation, or accrual.” These features, when present are an indication that the soils may not be able to process the effluent thoroughly, risking entry to the water table. The Minnesota Pollution Control Agency has recognized the importance of soils, in being able to understand how an area is functioning in relation to environmental impacts. This recognition has resulted in laws and regulations to be updated in regard to septic system compliance and training to be expanded to give county offices and local septic professionals guidance on how to best preserve the natural resources Minnesota has to offer. Agencies like the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) provide technical assistance addressing the impact of soil properties on the issues stakeholders face. As the understanding that local markets have become community centerpieces and critical to our nation’s economy (Alonzo, 2017), knowledge and understanding of the urban soils that produce local foods has become a necessity (U.S. EPA, 2011). Traditionally, urban soils have not been a focus of the USDA NRCS Soil and Plant Science Division when it comes to soil surveying and supporting constituents. This knowledge and understanding, originally intended for America’s rural farmlands, is also beneficial for small scale urban agriculture.

This thesis is composed of two chapters and is organized in manuscript format. The first chapter is a septic system decision case study to be utilized by individuals to develop a reasonable solution to the ongoing concern of individual treatment systems by employing a multidisciplinary approach. The second chapter is a commentary on the role of the United States Department of Agriculture agencies in supporting urban stakeholders in food production. These papers provide insight into the decisions stakeholders make with the help of experts in their respective fields.

## CHAPTER 1. A BECKER COUNTY, MINNESOTA SEPTIC SYSTEM DECISION: A CASE STUDY

### Abstract

In the late 1980's, Becker County, Minnesota (MN) took its first steps in mitigating the environmental impacts that individual sewage treatment systems have on their watersheds. This area, popular with tourists and home to seasonal lake cabins, was becoming increasingly aware of the public health implications of human waste entering the surface and groundwater. The lakes, typically used for swimming, fishing, and boating were becoming contaminated with human waste after being discharged by failing sewage treatment systems. By 2007, compliance standards were put in place to protect Becker County's waterbodies by setting guidelines for individual shoreland sewage treatment. Due to the codes put in place, many homeowners had to decide what their plan of action would be upon seeing the results of the sewage treatment compliance inspection. The intent of this case study is to be utilized by individuals to develop a reasonable solution to the ongoing concern of individual treatment systems by employing a multidisciplinary approach.

### Introduction

This case focuses on an individual's sewage treatment system (ISTS) decision. The case is designed to be used for high school or college level students, landowners facing decisions for sewage treatment systems on their own properties, and individuals in introductory training courses for ISTS certification. This decision-based problem encourages students to use their knowledge on pollution, soils, and watersheds to determine the most environmentally sound and cost-effective method to bring an ISTS into compliance. This case study is based upon a situation that occurred in Becker County, Minnesota in 2019 when a property owner's system failed its compliance inspection, causing the homeowner to decide on the best option for their property.

### The Case

On March 29, 2019, Mr. Fawcett lost his father to a heart attack. After the passing of his father, he inherited a lakeshore property on Bijou Lake in Becker County, MN. When Mr. Fawcett went out to his newly inherited property, he found a letter from Becker County. The letter from the county stated, "In 2007, the Becker County Board of Commissioners implemented the Shoreland Individual Sewage Treatment Compliance Program and amended this program in 2011… The goal is to abate all non-conforming septic systems on lakeshore property in an effort to keep our lakes clean… Properties on selected lakes will be inventoried for valid certificates of compliance within the last 10 years… Our records indicate the sewage treatment system (standard system, holding tank or privy) serving your property has not had a valid certificate of compliance within the last 10 years. Under the guidelines of this program, you are required to submit a new Certificate of Compliance to the Becker County Zoning Office by September 30, 2019…" (Appendix A).

Mr. Fawcett knew that his father had paid to have the current septic system installed in 2006 but was unfamiliar with the process of having a septic inspection, so he called the phone number of a local inspector with questions on what his next steps were. His conversation with the inspector, Mr. Grant, was an outline of what he was to do by September 30, 2019. Mr. Grant also explained that he was fully certified in inspections, installations, design, and maintenance in Minnesota and had been working in Becker County for over 40 years. Mr. Fawcett asked Mr. Grant to explain the process of an inspection because he was unsure what it would entail. Mr. Grant explained that he would visit the site and look at both the septic tank and the soils in the treatment area. Initially, he would pump out the concrete septic tank and insert a camera to look for any cracks or leakages. Next, he would bore two to three holes alongside the soil treatment area to determine if the soil was filtering the effluent as expected. Mr. Grant would look for redoximorphic concentrations and depletions in the soil, which indicate a fluctuating water table. When these features are found, systems are required to have 92 cm (36 in) of separation between the features and bottom of the soil treatment area to be able to properly filter the effluent to prevent entry into the ground water. Finally, Mr. Grant would submit a form with his findings to Becker County regarding the compliance of the system. Mr. Fawcett felt comfortable with this inspection as his father had installed the system just 13 years prior and they had never had any issues in that time. Mr. Grant agreed to inspect his system one week later.

While waiting for his inspection, Mr. Fawcett spoke to some of his new lake neighbors to see if they had received the same letter from the county. He learned about the issue arising from the new regulations regarding the soil properties suitable for different system designs. He discovered that many of his neighbors' systems had failed their inspections over the past month due to something called "redox." Many of his neighbors were being forced to put in mound systems on their lake properties due to this redox they spoke of, and these mounds were to be one m (3 ft) tall or even taller in some cases. Still, Mr. Fawcett felt he would be okay due to the fact he had never had issues with his system.

A week later, Mr. Grant came out to perform the inspection. Things looked positive. The tank was constructed of concrete, was free from cracks, and was the correct size for his home, but the findings soon took a turn for the worst. In the three soil borings, Mr. Grant found the soil had redoximorphic concentrations and depletions (collectively known as redox) at 86 cm (34 in). Mr. Grant explained that there needs to be 92 cm (36 in) between the bottom of the soil treatment area and any restrictive features such as redox (Appendix B). Mr. Grant stated that the bottom of Mr. Fawcett's drainfield was 61 cm (24 in) from the surface, and with the soils exhibiting saturation at 86 cm (34 in), he did not have the required separation. Mr. Grant stated that when redox features are present that the soils may not be able to process the effluent thoroughly, risking entry to the water table. Mr. Fawcett was confused, saying, "My dad never had issues with the system and never even had to have it pumped." Mr. Grant told him that even if it appears to be working normally, all homeowners should have their tank pumped at least once every three years to help the system function properly and ensure the proper bacteria are present. Mr. Fawcett was distraught; he had lost his father a few months prior and now had a working but a county-failing sewage treatment system that he knew nothing about or the cost to bring it up to code.

After discussing the characteristics of his home, the number of bedrooms he had (three), and his lot size and shape (sloped), Mr. Fawcett was informed that he had two options. The first option was to add a second holding tank and abandon the existing soil treatment area. The other option was to add a lift station and install a mound soil treatment area, and not lose the benefits of an on-site treatment system. Both options had their positives and negatives, but Mr. Fawcett wanted to know what Mr. Grant recommended. Mr. Grant stated the cost of installing a second tank was the least costly option up front ($4,500), but he would need to have it pumped ($150-$200 per pumping) more frequently depending on the amount of water the home used. Mr. Grant explained that water use is different for each home. In some cases, he would pump out holding tanks every other month for seasonal dwellers. For more full-time homes, he pumped as often as every other week. Mr. Fawcett was informed that having holding tanks are also almost completely invisible as you would only see two small 15 cm (6 in) pipes rising above the soil surface and a manual float system is also visible to show the level of sewage in the tanks alerting the homeowner to the depth of sewage in the tanks.

The other option, a mound soil treatment area, would cost more upfront ($12,000), but the pumping would be far less frequent. Pumping a single 5,700 L (1,500 gallon) tank costs less, about $125-$175 every three years, rather than pumping two 5,700 L (1,500 gallon) holding tanks which costs the same ($125-$175 total) but has to be done at least once a year, if not multiple times a year. The downside many homeowners face with a mound system is the amount of space required and the aesthetics. Mr. Fawcett's mound system would need to be 1 m (3.5 ft) tall. The top of the mound would be 3 m (10 ft) wide by 12 m (38 ft) long, and at the bottom of the mound would be 12 m (38 ft) wide by 18 m (59 ft) long. The systems are made to slope with the existing landscape so that they look more pleasing to the eye. Although the soils would be treating the effluent, Mr. Fawcett would still need to pump his concrete tank at least every three years to ensure that the tank structure stays intact and prolong the lifetime of the system. Mr. Fawcett took some time to determine what he wanted to do but needed to decide quickly since he only had ten months to bring his system into compliance.

Mr. Fawcett received the inspection form which included Mr. Grant's findings and the soil observation logs from the county (Appendix C and D). He took the next five months to do research on ISTS and to assess his options moving forward. There was a lot of information, but he decided to first look at the soil logs as that was the main reason that his compliance inspection failed. The soils were reported as horizons (layers) and Mr. Fawcett focused on the depth, texture, colors, and redox features (i.e., color and kind of the features) (Appendix D).

The first step was to research further on redox. Mr. Fawcett found that redox is short for redoximorphic features and defined as (7080.1110 Definitions) "A color pattern in soil, formed by oxidation and reduction of iron or manganese in saturated soil coupled with their removal, translocation, or accrual, which results in the loss (depletion) or gain (concentration) of mineral compounds compared to the matrix color; or a soil matrix color controlled by the presence of ferrous iron." He found that redox features are common in soils that have a fluctuating water table and reduced infiltration rates, such as clayey soils. Redox features are also an indicator that the soil is not properly treating the ISTS effluent, both of which would result in a non-compliant system due to a threat to public safety. He knew he had clayey soils on this land from trying to plant a garden with his mother as a child. Mr. Fawcett continued to research the soils that are native to his new lake property. He used Web Soil Survey and found that the soils on his property were named Forman and Buse (Soil Survey Staff, 2021). According to the Forman Official Series Description, last updated October of 1998, the soil has redox below 112 cm (44 in). The Buse Official Series Description, which was last updated September of 2011, states that redox occurs between 56 cm (22 in) and 102 cm (40 in). He wondered why, if the soils naturally have redox, would it disqualify him continuing to use his current system?

Mr. Fawcett then contacted the Becker County Zoning Office to inquire further on redox. When Mr. Fawcett spoke to the Zoning Office, he was told that redoximorphic features have always been something soil scientists have been aware of, but it was not until recently that their implications in septic systems were widely understood. He learned that although it was in the code, it was not as easy to distinguish, and the code was lenient. Septic installation professionals would oversize a soil treatment system in these types of soils to add more area for proper filtration based upon percolation tests (tests to determine how fast water moves into soil). However, with so many in ground systems installed, the rate at which redox was formed rapidly increased due to the frequency of saturation. To pass the inspection there could not be any limiting factors (i.e., redox or saturation) within 92 cm (36 in) of the base of the soil treatment area. In some circumstances, systems are installed deeper in the ground, requiring the redox to be even further below the soil surface.

Mr. Fawcett's next question was why a mound would treat the effluent better than his current in ground system? He first researched the composition of a mound and found that a mound is made up of a layer of sand, topped with rock, and covered with a black soil. The perforated pipes that push the effluent through the soil treatment area lay within the rock that acts as a distribution media. The Environmental Protection Agency (2022) states that mound systems are an option in areas of shallow soil depth, high water table, or shallow bedrock. Treatment of the effluent occurs as it discharges to the distribution media (rock), then filters through the sand, and finally disperses into the native soil. With the knowledge that a mound is mostly comprised of sand and rock, which have a much higher infiltration rate, he went on to research how clayey soils react when inundated with water. He found that clayey soils require more time to absorb water. When water infiltrates into clayey soils the wet conditions may, in the area where Mr.

Fawcett lives, cause the soil to expand, which in turn reduces the pore space. This reduced pore space results in a lessened ability for the soil to absorb effluent thus causing the drainfield to be less able to process the sewage efficiently.

Mr. Fawcett’s final question was the fate of the sewage once it is pumped out of a septic tank, regardless of the use of a mound system or two holding tanks. Mr. Grant told him that after the tank is pumped, septic maintainers typically have contracts with landowners where the waste can be land applied at a certain rate following health and safety guidelines. Lime is added to human waste to adjust pH levels to ensure the safety of the general public during land application. If he had two holding tanks, Mr. Grant would be removing roughly 11,300 L (3,000 gallons) from the two tanks; whereas with a mound system, 5,700 L (1,500 gallons) would be removed from the septic tank.

## Context

Individual sewage treatment systems for maintaining clean waters are a growing concern as tourism and seasonal lake homes are common in many lake-rich areas, such as in Minnesota. With influxes in population during the frost-free seasons, properly maintained ISTS are key to protecting human health, communities, and the environment. Areas like Becker County use ISTS as the dominant way to treat sewage in rural or low-population areas.

Human health can be directly impacted by ISTS that do not properly treat sewage. Bacteria, viruses, and disease-causing pathogens (hepatitis and dysentery) can enter surface and ground waters when not properly treated (USEPA, 2002 and OSTP, 2020). Potentially harmful insects that breed in wet areas (e.g., mosquitoes), specifically where sewage reaches the surface, directly impacts communal spread. When not properly treated, sewage can raise nitrate levels within the ground water. Nitrate, at high concentrations, can be of risk to adults with compromised immune systems and pregnant women. When high nitrate water is consumed by infants, they can develop methemoglobinemia (blue-baby syndrome), where nitrate affects the ability of their blood to carry oxygen. Lastly, odorous and or toxic gasses such as hydrogen sulfide, carbon dioxide, and methane may be released into a home when ISTS are inadequately vented (USEPA, 2002 and OSTP, 2020). Toxic gasses can also be in the air around an overflowing sewage treatment system. In 2006, roughly one-third of all ISTS in Minnesota were found to pose a threat to public health or are failing to protect the local ground water (MPCA, 2006).

Along with human health, protecting the natural environment can be done through properly functioning ISTS. Nutrients like phosphorus and nitrogen can reach nearby lakes and streams when an ISTS does not fully treat the sewage. Excess nutrients promote algae and plant growth resulting in algal blooms and abundant weeds, which may cause waters to be unpleasant for swimming, boating, and water-based activities. Excess plant growth can directly impact water quality for fish and wildlife habitat by eventually settling to the lake bottom and increasing the lake’s biological oxygen demand upon decomposition.

## Background Information

Over 25 percent of Minnesota’s households use ISTS to treat sewage and are commonly installed in rural areas where centralized sewage and wastewater treatment collection systems are not accessible (OSTP, 2017). Historically, ISTS were installed where there was a concern for sewage disposal. Before ISTS were required sewage was often disposed into ditches, low areas on the landscape, local bodies of water, agricultural drain tiles, or directly into ground water via deep cesspools and seepage pits (USEPA, 2002). As laws and regulations changed, the concern has also changed to focus first on treatment, and then on disposal. In the state of Minnesota, ISTS are designed and installed by licensed professionals, whereas operation and scheduling maintenance are typically the responsibility of the homeowners. Most commonly, ISTS have three basic components: plumbing, septic tank, and a soil treatment area (Figure 1). These three components may vary from household to household. (Appendix E).

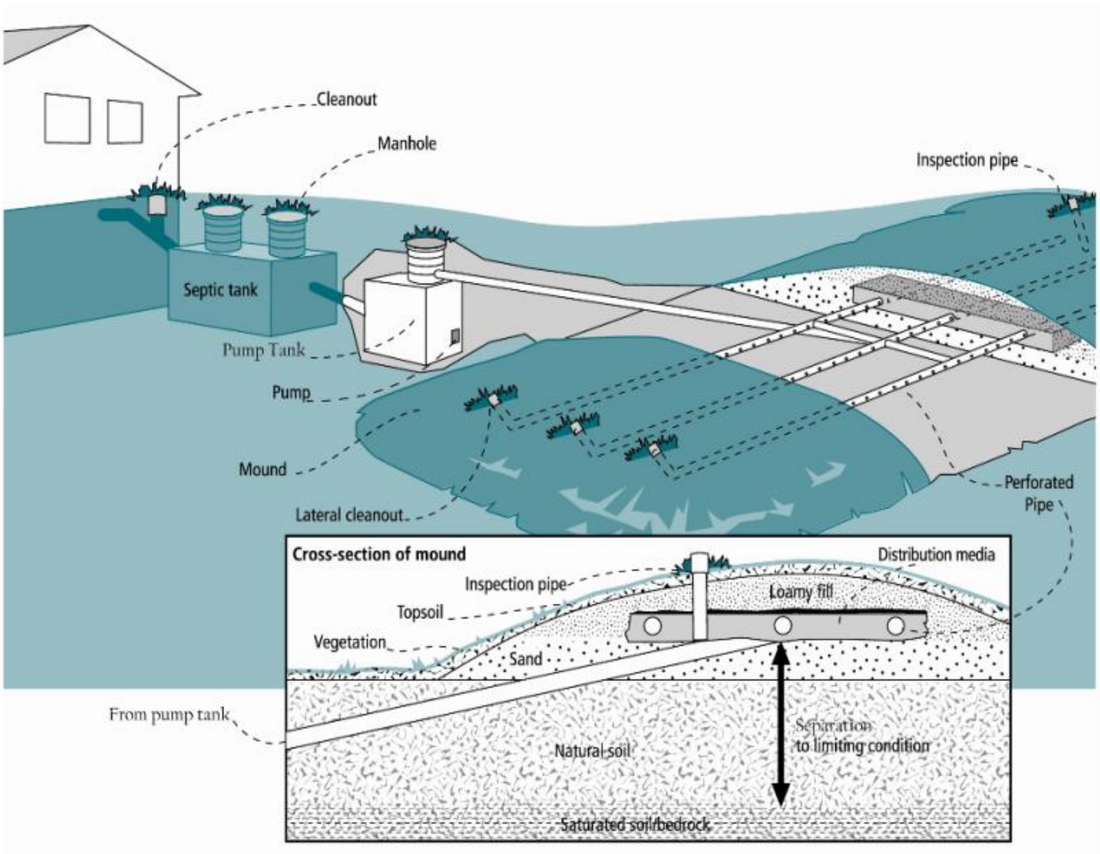


Figure 1. Septic system diagram depicting a mound treatment area (OSTP, 2020)

In 1945, Minnesota took its first step in mitigating raw sewage that was being disposed of into its lakes and rivers. Since 1945, laws, regulations, associations, and programs have been further developed and updated in Minnesota and Becker County (Figure 2).

**1945 – Water Pollution Control Agency formed**

**1967 – Minnesota Pollution Control Agency formed**

**– Minnesota Shoreland Act implemented**

1987 – Program Developed to target seepage pits on lake properties

**1994 – Individual Sewage Treatment Systems (ISTS) Act enacted**

2007 – Shoreland Individual Sewage Treatment Compliance Program implemented

2010 – Clean Water Fund grant awarded

2011 – Lakes were ranked and prioritized based on wastewater susceptibility

2019 – Bijou Lake chosen for septic compliance inspections

Figure 2. Timeline of Minnesota's and Becker County, Minnesota's advancements in individual sewage treatment (MPCA, 2019 and Becker County, Minnesota Planning and Zoning Staff, personal communication, 2020). Minnesota's steps are bolded, and Becker County's are not.

The MPCA (2011) lays out design and compliance criteria for ISTS, establishing local program requirements, providing certification and training for individuals and licensing businesses, and registering treatment products. The local programs review individualized plans, approves permits and inspections, and ensures compliance when a notice of noncompliance is issued. The counties adopt the ordinances set out by the MPCA and cover all but the city or town ordinances. Cities and towns may regulate ISTS, but if they choose not to, the minimum ordinances are at the county level (MPCA, 2011).

Beginning in 2011 the lakes in Becker Co. were ranked and prioritized by susceptibility to sewage contamination. Data used to complete this ranking included reviewing water clarity trends, observing inlets, shoreline development indices, and trophic state index levels. This data is still being used today to create lake studies in the county.

Lakes in Becker County are chosen based on a ten-year rotation and additional lakes are added as homes are built on their shorelines. Each year at least one lake is chosen based on its prioritization by susceptibility to sewage contamination, area in the county, and occasionally at the request of a Lake Association. All property owners within 81 m (267 ft) of the lake shore are identified utilizing Geographic Information Systems (GIS) and are required to participate in the lake study and receive a letter explaining the purpose of the program, how it works, and the status of their septic system. Educational material is given to the property owners, such as septic system operation and maintenance, improving septic performance by being conscious of water use in each room of a home, and how often maintenance needs to be completed. If their file includes a certificate of compliance that is 10 years old or newer, no letter is required. If no compliance certificate is present or if the compliance is greater than 10 years old, a letter is sent to the individual stating that a compliance inspection, performed by a private-licensed inspector, is required to be completed by a given date. Figure 3 and Figure 4 outline the simplified lake study process in Becker County. These flow charts are not the complete process, and more information can be obtained by contacting Becker County Zoning.

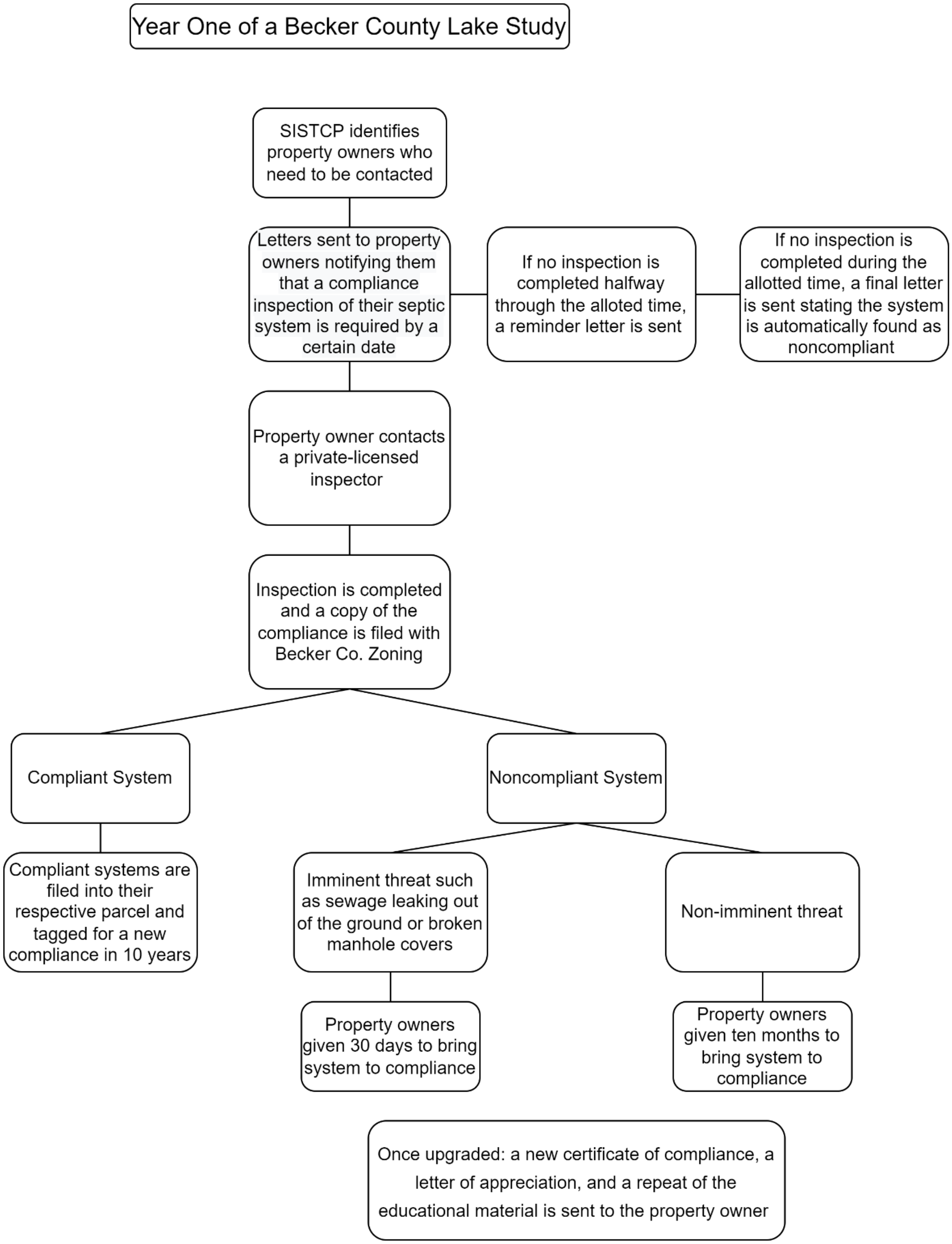


Figure 3. The first year of a lake study in Becker County, Minnesota by the Shoreland Individual Sewage Treatment Compliance Program (SISTCP) (Becker County, Minnesota Planning and Zoning Staff, personal communication, 2020). Once a system is compliant or upgraded, the process ends for that property owner.

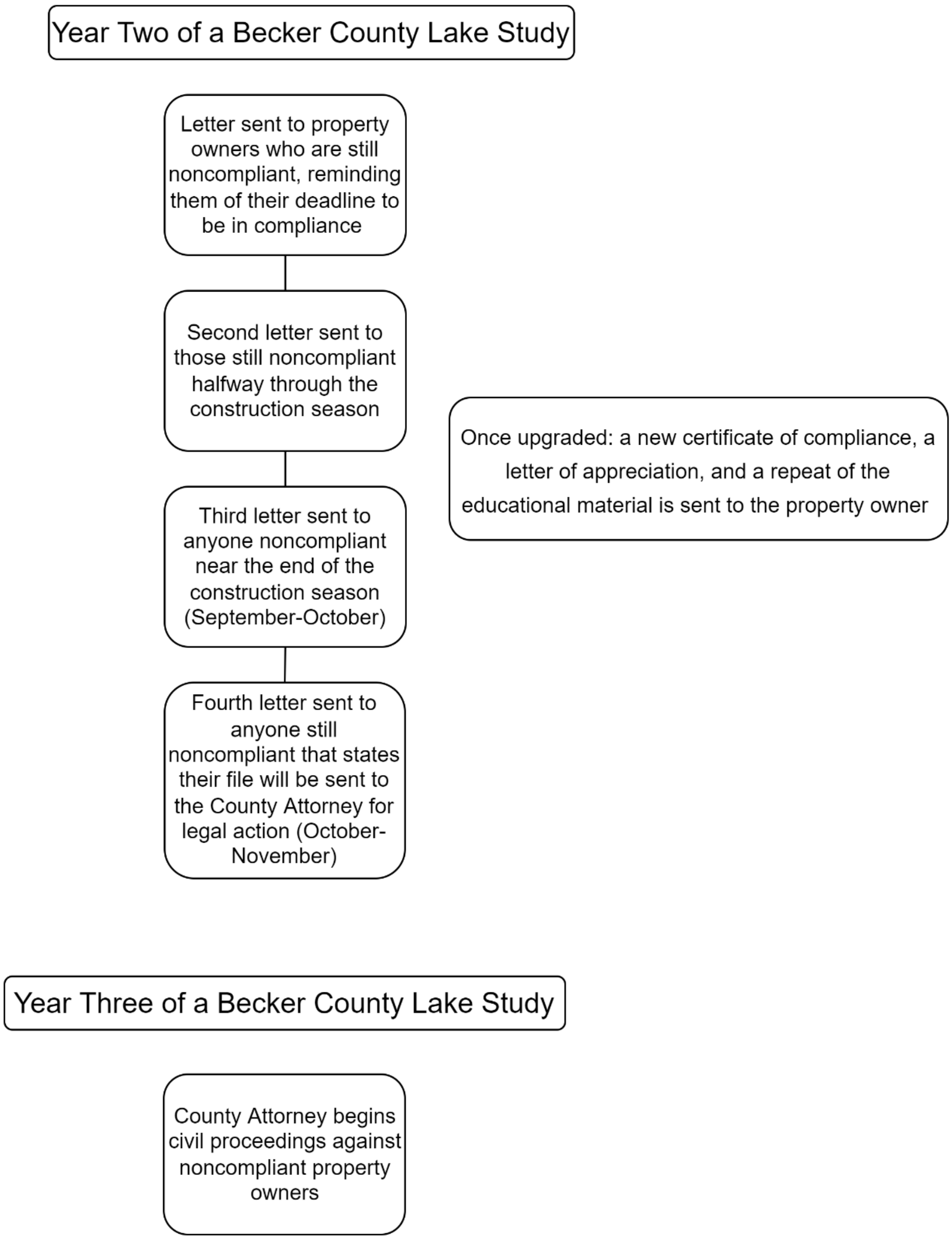


Figure 4. Years two and three of a Becker County, Minnesota lake study (Becker County, Minnesota Planning and Zoning Staff, personal communication, 2020). Once a system is compliant or upgraded, the process ends for that property owner.

In 2019, three lakes were added to the Becker County Lake Study rotation: Bijou, Acorn, and Cotton (Becker County, Minnesota Planning and Zoning Staff, personal communication, 2020). A total of 495 properties were reviewed in which 80 were found compliant, 396 noncompliant, and 19 undeveloped. A total of 396 letters were sent to those who were non-compliant. In addition to the new lakes added, those who were still termed non-complaint from the previous 20 lake studies were again contacted by county officials. From the previous lake studies, there were 135 properties deemed non-compliant, and these owners were also sent letters from county officials (Becker County, Minnesota Planning and Zoning Staff, personal communication, 2020).

Bijou Lake is located in the southwest corner of Becker Co. and is surrounded by clay loam soils and silty clay loam soils. The first individual sewage treatment systems on Bijou Lake were primarily in-ground and the concern of redox was not fully understood. The rule of vertical restrictive feature separation was changed in many counties from 61 cm (24 in) to 92 cm (36 in) in 1996. With the Bijou Lake area having more restrictive conditions such as soils with a higher clay content and fluctuating water tables, ISTS designers and installers may assume most systems will need to be mounds to have the required 92 cm (36 in) of soil separation between any limiting feature, but an in-person inspection must first be completed. In 2019, 106 properties were inspected on Bijou Lake, with 27 parcels found to be compliant, 4 were undeveloped, and 75 were non-compliant (Becker County, Minnesota Planning and Zoning Staff, personal communication, 2020).

## Questions to Consider

What should Mr. Fawcett, as a new property owner on Bijou Lake, do to bring his ISTS into compliance with Becker County, MN? What are his options in the next 10 months? How does each choice impact the environment and his personal cost-benefit analysis? Mr. Fawcett only has 10 months from the date of the inspection to have his compliant system in place, so decisions must be finalized to avoid further action by the county.

## Teaching Notes

### Case Objectives

Upon completion of this case study, students should be able to:

1. Describe how an individual sewage treatment system works to treat household waste.

2. Identify the advantages and disadvantages of a mound soil treatment area system versus holding tanks.
3. Explain the human health and environmental impacts that non-compliant systems have in Minnesota.
4. Identify how soils filter effluent to keep groundwater clean.
5. Describe why in-ground systems are less effective in soils with a high clay content.

**Uses of the Case**

This case is based upon environmental concerns that are rising across the country. The case is built to develop students' problem-solving skills in an area that many individuals face including rural landowners, seasonal lake dwellers, and those who work in this industry. Students in environmental high school courses or students in college undergraduate and graduate level courses studying soil science, natural resource management, wastewater/sewage, or environmental science can benefit from this case. No prior knowledge or prerequisites are required to complete this case study. Students will use this case to develop a reasonable solution to the ongoing concern of individual treatment systems utilizing a multidisciplinary approach. During the investigative process, students will examine the health impacts that occur with the mistreatment of sewage, the environmental impacts on sewage in waterways, different individual treatment systems, and the way different soil particle sizes filter effluent.

This case can also be used for property owners who are facing a similar situation of a non-compliant system or installing a new system. It can educate those who want to better understand how different treatment systems can vary in cost both short term and long term, and the impacts on the environment. This case can help aid in understanding how redoximorphic features are formed and why they are a restrictive feature in many soils for ISTS installation.

Lastly, this case can be utilized by individuals in introductory training courses for ISTS certification. The case allows these individuals to begin the problem-solving process that they will face in their career. This problem gives those individuals seeking certification a real-world example that they must work through and promotes thinking through the process of being the inspector and also provides a homeowner's perspective.

**Implementation of the Case**

There are many ways to implement this case study in a classroom setting such as a one-hour class or a weeklong discussion. In addition to the case at hand, there are five supplemental materials: 1) an example lake study letter, 2) an overview of redoximorphic features, 3) compliance inspection from the true story, 4) soil logs from the true story, 5) and an overview of septic systems. This decision-based case can be used as a discussion piece or take-home assignment. As a discussion piece, have each student read the case individually and come up with answers to “The Decision” questions. Next, form groups of three to four students and create a discussion on their answers and why. Have the group come up with a solution and give a two-minute presentation on their decision for Mr. Fawcett, including the environmental impacts. If this case is to be used for a week-long course, lectures can be spent looking at health risks of sewage contamination in lakes, soil infiltration and filtering rates, environmental impacts on individual sewage treatment programs and end the week with the case study bringing all the learned information together to make an informed decision. The discussion leader can conclude with the outcome of the path the property owner chose. Students will better understand how soils, environmental quality, and human health all are intertwined with wastewater/sewage. They can also understand how a decision that many urban homeowners with city sewer systems never have to face, can have major impacts on their lake properties.

**Discussion Questions**

1. What are the concerns to human health with sewage contamination in waterways?
    a. Bacteria, viruses, and disease-causing pathogens (hepatitis and dysentery) can enter surface and ground waters
    b. Potentially harmful insects (e.g., mosquitoes) that breed in wet areas, specifically where sewage reaches the surface, directly impacts communal spread.
    c. Sewage can raise nitrate levels of the ground water. Nitrate, at high concentrations, can be of risk to adults with compromised immune systems and pregnant women. Also, infants can develop methemoglobinemia (blue-baby syndrome), where nitrate affects the ability of their blood to carry oxygen.

   d. Odorous and or toxic gasses (e.g., hydrogen sulfide) may be released into a home when ISTS are inadequately vented.

2. What are the concerns to the natural environment with sewage treatment systems?
   a. Nutrients like phosphorus and nitrogen can reach nearby lakes and streams when an ISTS does not fully treat its sewage.
   b. Excess nutrients promote algae and plant growth resulting in algal blooms and abundant weeds.
   c. Excess plant growth can directly impact water quality for fish and wildlife habitat by breaking down, settling to the bottom of the body of water, and breaking down, utilizing the oxygen that fish also require to survive.
   d. Individuals may feel that the lakes do not look safe or aesthetically pleasing due to excess plants and algal blooms thus moving to other lakes, not swimming and boating, and reduced seasonal tourism.
   e. Replacing old systems and installing new systems requires large holes to be dug in the soil resulting in degradation of natural soil. When old tanks and drain fields are abandoned, they are filled in and left in the soil where most of the material cannot break down.
3. What are redoximorphic features?
   a. A color pattern in soil, formed by oxidation and reduction of iron or manganese in saturated soil coupled with their removal, translocation, or accrual, which results in the loss (depletion) or gain (concentration) of mineral compounds compared to the matrix color; or a soil matrix color controlled by the presence of ferrous iron.
4. How do redoximorphic features influence system design, and why is this important?
   a. The presence of redoximorphic features determines the vertical separation needed when designing a system. In Becker County, MN, as an example, there must be 92 cm (36 in) of separation from the bottom of the drainfield to the limiting feature. In many cases redoximorphic features are the limiting feature because it indicates the ground has been saturated or inundated with water for a period of time. Thus, the

onsite soils may not be able to properly treat the effluent resulting in a direct pathway to ground water.

5. When holding tanks are pumped and contents land applied, should these contents be applied to all types of soils?
    a. Determining sand and clay percentage determines land application rates. Soils with a higher clay content may infiltrate more slowly, while soils with a higher sand percentage tend to infiltrate more rapidly. Land application is regulated by MPCA with strict regulations. Loading rates are determined by soil texture, previous crop, and time of year. Soils can work equally well due to the regulations set forth by the MPCA, though not all soils are suitable.
        i. Why does the MPCA have strict regulations on land application?
            1. To reduce human waste contamination to waterbodies
            2. Sandy soils have higher infiltration rates than that of clay soils. Soils that infiltrate too fast risk ground water contamination as the soil does not have time to filter the contaminants such as disease-causing pathogens and excess nutrients.
            3. If the soil infiltrates too slowly, such as in soils that are higher in clay content, ponding can occur and result in anaerobic conditions in the upper part of the soil surface. Soils that cannot infiltrate as quickly could also result in the applied sewage running off and contaminating waterbodies.
                **a.** Volumes and rates of application may have to be altered based on soil texture.
6. What is an onsite environmental impact typically not considered by the property owner?
    a. Many homeowners are unaware that their sewage treatment system could affect their well water.
        i. Example Question to Promote Discussion: A homeowner has an ISTS inspector visit, and they find that the soil treatment area is not in compliance.

The homeowner states they have never had any issues with their system, the only problem they have in their home is that they are unable to drink the water from the faucet because it looks and tastes really bad. What could be occurring?

1. If a home has a shallow well (depth of less than 15 m (50 ft)) and a soil treatment area that is over saturated, the effluent overflow from the soil treatment area could be affecting the same water the shallow well is pumping from. It could also be impacting neighbors who also have a shallow well. The impact is not always visible such as sewage backing up or exiting the soil surface. Sometimes it is the secondary impacts that homeowners do not realize.

7. What are the advantages and disadvantages for Mr. Fawcett to add an additional holding tank and not having a soil treatment area?
   a. Disadvantages: The upfront cost is much smaller adding a second holding tank, but maintenance cost could be higher in the long term. Holding tanks do not have any effluent running into a soil treatment area and thus fill up much faster and must be pumped more frequently. Holding tanks do have a greater amount of sewage being land applied (twice as much or more in some cases of a larger home) rather than filtering through a soil treatment area. So, pumping can sometimes cost more than a single tank.
   b. Advantages: Pumping may be beneficial to the land to which it is applied as it provides nutrients and therefore may reduce the cost of inorganic fertilizers. Finally, aesthetically, holding tanks are almost invisible to the onlooker as there are only two small 15 cm (6 in) pipes and a float system. The two pipes would rise over time to tell Mr. Fawcett that he needed to get his tanks pumped soon.
8. What are the advantages and disadvantages of a mound system for Mr. Fawcett?
   a. Disadvantages: The greatest disadvantage to a mound system is the amount of space it requires. Although the soils would be treating the sewage, Mr. Fawcett would

still want to pump his tank at least every three years to ensure the system remained healthy and to extend the life expectancy of the system.

   b. Advantages: The systems are made to slope into the ground so that they look more aesthetically pleasing to the eye. If done correctly mound systems can be almost hidden to the onlooker and hidden on the landscape, provided they are not in a frequent walking space. Mound systems are also built above the ground to keep any waste products away from ground water. Finally, mound systems have to be pumped less frequently, at least once every three years.

9. What is the major goal of the Minnesota Pollution Control Agency?
   a. To protect Minnesota's air, land, and water resources.
10. What option should Mr. Fawcett choose? Why?
   a. There are no right or wrong answers. Students only need to explain why they chose the answer they did and be able to defend their reasoning. Both options of a holding tank or mound have their advantages and disadvantages, and both are considered in compliance with the county.

**What Really Happened**

The homeowner ultimately chose to put in a mound system. This decision was based on the amount of time being spent at the cabin and frequency of pumping. The mound system cost more upfront but with multiple people frequenting the cabin on a weekly basis it was determined that holding tanks would fill faster between the shower, toilets, dishwasher, sinks, and laundry. The homeowner was able to put the mound in the back of the property and thus it was mostly hidden from sight and not in the main "useable" space in the yard. In Becker County it is very common to find lake properties that are very narrow, have large homes, or have unsuitable soils, and thus many individuals are encountering this problem of not having room for a soil treatment area. Over time, this issue of lack of space may become more and more prevalent as laws change and the MPCA and Becker County strive to protect its air, land, and water resources.

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# CHAPTER 2. THE ROLE OF USDA AGENCIES IN SUPPORTING URBAN FOOD PRODUCTION


## Abstract

Urban agriculture is gaining popularity across the United States due to its benefits, including but not limited to increased access to affordable healthy food, bringing communities together for a common goal, and improving food security. However, a review of the existing literature indicates a disconnect between the Natural Resources Conservation Service (NRCS) and urban communities as well as an inconsistency in the information available to urban dwellers on soil-related topics. To bridge the gap between rural and urban agriculture, the NRCS and other United States Department of Agriculture agencies should expand upon the programs and services already established for rural communities and restructure them to develop assistance to those participating in urban agriculture. Achieving full integration of the NRCS into urban communities will require continued research and education to provide knowledge and tools to give personalized advice to urban stakeholders to assist in making the best-informed decisions.


## Introduction

Historically, those living in urban areas have been perceived as the consumers, and the rural population as the producers (Nugent, 1999). However, recent literature discusses urban agriculture's social, economic, and environmental sustainability (De Zeeuw et al., 2011; Nunget, 1999; Hodgson et al., 2011). Using Minnesota, North Dakota, and South Dakota as examples, less than one percent of its land is considered urban while over 60 percent of its population lives in these areas (U.S. Census Bureau, 2021) (Figure 5). In addition, according to Feeding America (2022) this region has over 400 thousand food insecure people with the highest percentage located within counties having Native American communities.

Although government programs exist to supplement food needs (FNS, 2022) the introduction of urban agriculture (UA) is another option for providing food to oneself. Urban agriculture is defined by the United States Department of Agriculture (USDA) as including the cultivation, processing, and distribution of agricultural products in urban areas. The concept of a food desert should also be considered, rural communities without easy access to affordable, healthy foods (Hodgson et al, 2011). Examples of agriculture in urban settings include gardens (both communal and individual), high tunnels, raised beds, greenhouses, and vertical production (USDA, 2022). The benefits of UA can include agricultural production, economic benefits, social and psychological benefits, and ecological benefits (Nugent, 1999). Each of these, however, depends on the function of the soil to support these benefits. As interest grows in UA (Hodgson et al, 2011), so does the need for improved information on how urban soils, those not traditionally mapped and described by the USDA Natural Resources Conservation Service (NRCS), can help provide healthy and sustainable foodstuffs. Therefore, serving the needs of this non-traditional agricultural population through education and outreach, either by state or federal entities, is needed. The objective of this commentary is to raise awareness to needs of the urban population in their quest to produce locally grown food and will focus on how federal agencies can provide support through technical assistance, expanded outreach efforts, trace element testing, and financial assistance.

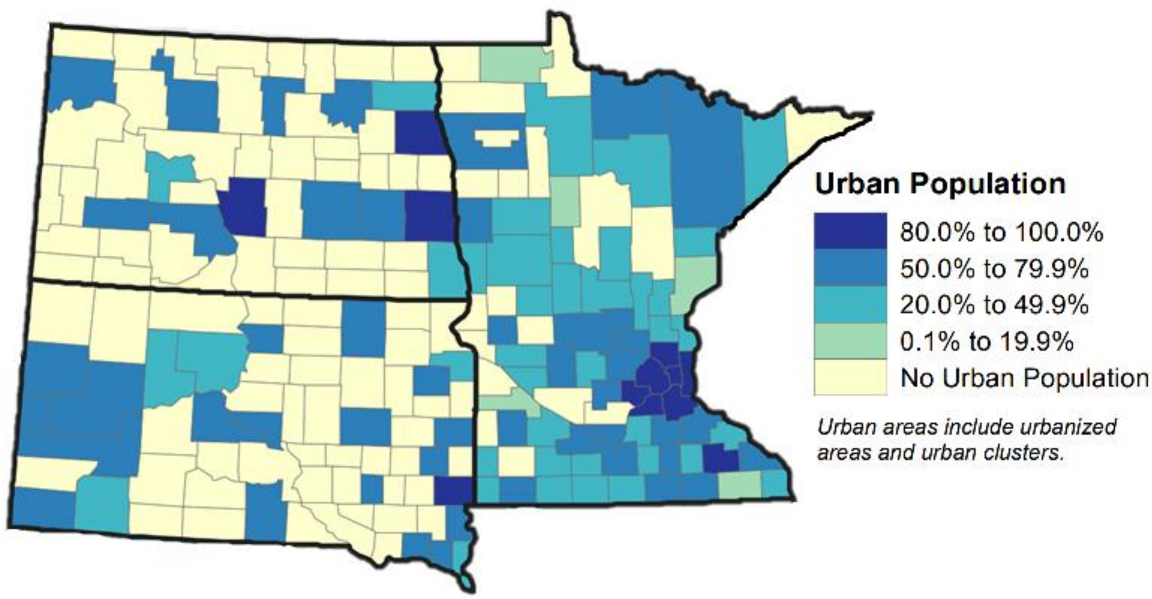


Figure 5. Percent population residing in urban areas by county in Minnesota, North Dakota, and South Dakota (US Census Bureau, 2021).

**Urban Soils and Their Implications**

As the understanding that local markets have become community centerpieces and critical to our nation's economy (Alonzo, 2017), knowledge and understanding of the urban soils that produce local foods has become a necessity (U.S. EPA, 2011). Traditionally, urban soils have not been a focus of the USDA NRCS Soil and Plant Science Division when it comes to soil surveying and supporting constituents. For example, boundaries have been drawn around urban areas and within these boundaries then named "Urban Land" or "Udorthents" on soil maps. An example of this would be the Fargo-

Moorhead-West Fargo area located along the Red River of the North in North Dakota and Minnesota (Figure 6). Urban soils, also known as human-altered and human-transported (HAHT) soils, form from human-affected parent materials and cannot be mapped using the traditional soil survey methods (USDA, 2018). Soils with HAHT materials are characterized by artificial landforms or microfeatures that are either constructional or destructional, and may or may not include artifacts (e.g., concrete, paper, plastic) (Soil Survey Staff, 2014). Other factors needing consideration when mapping urban soils include elevated levels of trace elements, heterogeneous parent materials, and multiple land use and cover types (USDA, 2018). These considerations create a need for soil mapping to be at greater detail than what has been produced for rural settings.

In 2017, the USDA formed an “urban soils” focus team (14 NRCS members and 3 university partners) to address soils within urban environments. This team has proposed the Artesols soil order to provide more specific information on HAHT soils in which the dominant soil forming factor is human activity. Artesols would include any soils meeting 1 of more of the following 5 criteria: 50 cm or more of excavation followed by replacement, 50 cm or more of transported material, significant artifact content, a continuous manufactured layer, or a sealed layer (Galbraith, 2022). Some soils are excluded from the Artesols proposal as they can be better classified with the current subgroups already outlined in the 12$^{th}$ edition of the *Keys to Soil Taxonomy* (Soil Survey Staff, 2014). Both physical and chemical properties should be observed when mapping soils within an urban landscape so that implications such as trace element contaminants can be identified.

Trace elements such as arsenic (As), chromium (Cr), copper (Cu), lead (Pb), manganese (Mn), and zinc (Zn) are naturally occurring in soils, though elevated levels are found in urban settings due to anthropogenic activities (USDA, 2018). This increase can be attributed to activities such as Pb paint and gasoline usage, which have contributed to harmful Pb levels in soils (Mielke and Reagan, 1998; Ryan et al., 2004). In addition to lead, anthropogenic depositions of arsenic have occurred through use of pesticides and chromated arsenical (CCA) treated wood, which contains Cr, Cu, and As (U.S. EPA, 2022).

When analyzing urban soils Pb and As are the primary focus regarding human health in more populous urban areas though other contaminants may be present and should be evaluated when historical data indicates a concern (i.e., smaller urban areas that once had manure applications, could contain elevated levels of Cu and Zn if salts were added to the animal feed) (USDA, 2018; U.S. EPA, 2011). Though very small amounts of Pb and As are transported from the soil into garden fruits and seeds (e.g., edible berries and gourds), the main concern is the exposure and accidental ingestion of the soil itself as this can have lasting effects on the health of children (i.e., elevated blood Pb levels) (Ferguson et al., 2018; ATSDR, 1988; U.S. EPA, 1991; CDC, 1991; HUD, 1990).

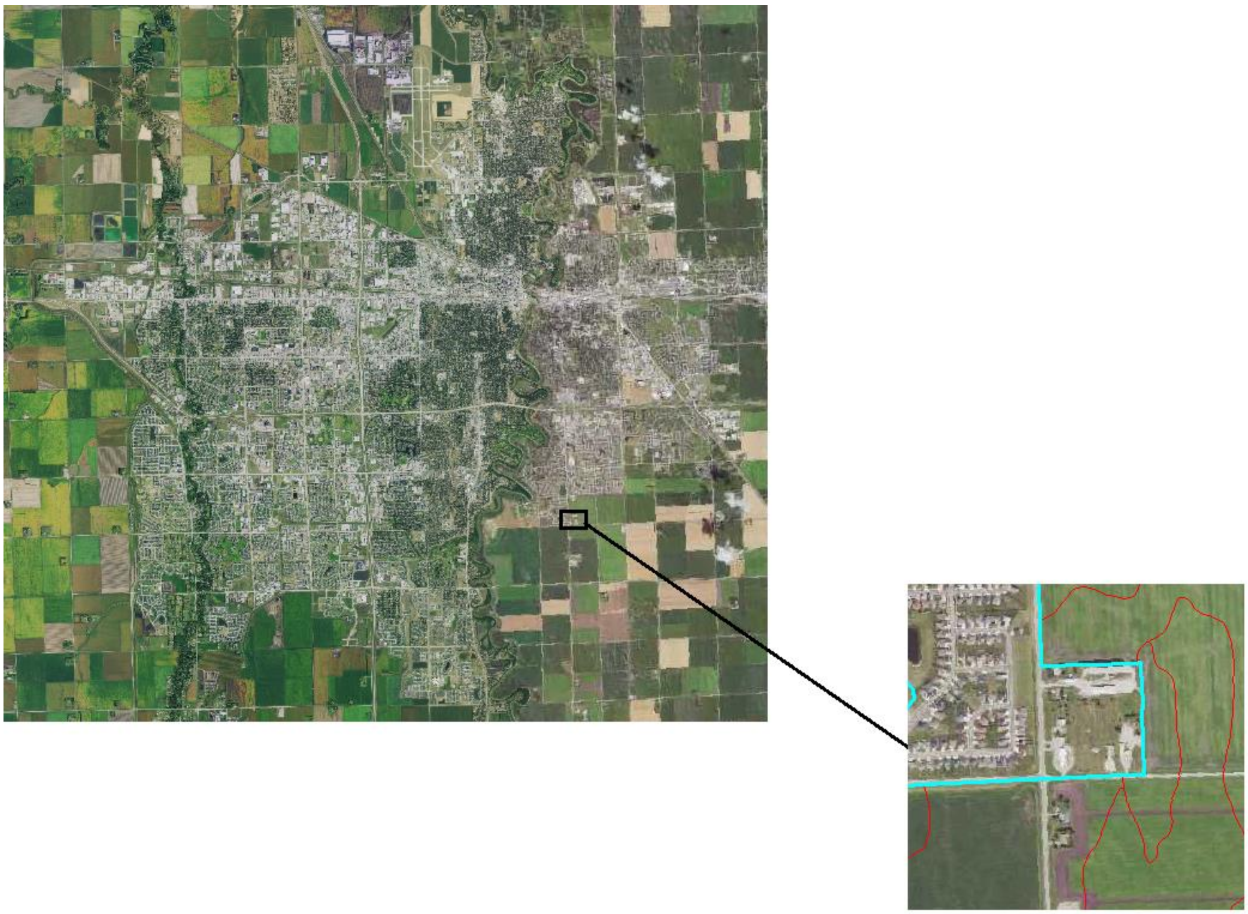

Figure 6. Fargo-Moorhead-West Fargo area. The inset displays the lines drawn around developed land to remove previous soil survey delineations. Areas within the blue lines are mapped as “Urban Land” and areas within the red lines are traditional soil survey map units.

## Serving Communities

With over 80 percent of the population living in urban areas (U.S. Census Bureau, 2021), the need is increasing for the Natural Resources Conservation Service (NRCS) to assist in supporting UA, along with partnering United States Department of Agriculture (USDA) agencies such as the Farm Service Agency (FSA). The NRCS has conservation field offices located throughout the country to assist individuals with their natural resource questions. Traditional assistance in urban settings is supplied through outreach and literature distribution but to expand NRCS efforts in Minnesota, North Dakota, and South Dakota, as examples, programs and assistance must be expanded upon and developed.

In the last 35 years, UA has been a topic in many debates including the Farm Bill, which has resulted in new acts being developed and committees being formed. These advancements were established to focus on UA and expand upon the assistance already provided to rural farmers. Funding provided through programs such as Environmental Quality Incentives Programs (EQIP), Regional Conservation Partnership Programs (RCPP), or Conservation Innovation Grants (CIG) are established through the NRCS and some in collaboration with the FSA (such as EQIP). These programs are available to rural farmers who want to conserve and protect their natural resources, while improving their environment and commercial viability (NRCS, n.d.). The Farm Bill debates in both 1985 and 1990 considered whether to include goals of agricultural stability into the legislation (Gottlieb, 1995). In 1996 the Federal Agriculture Improvement and Reform Act (FAIR) established federal grants to support the establishment and development of community food projects under Section 25 of the Food Stamp Act of 1977. This program was re-authorized by the Farm Security and Rural Investment Act of 2002 and then amended by the Food and Nutrition Act of 2008 and Section 4402 of the Food, Conservation, and Energy Act of 2008. The current program was set up to increase access to more nutritious food supplies, increase self-sustainable communal food needs, create marketing activities for producers and consumers, and meet state, local, or communal needs for agricultural infrastructure development/improvement (USDA, n.d.). In the 2018 Farm Bill the Office of Urban Agriculture and Innovative Production (OUAIP) was developed to better meet the needs of farming in urban settings. The OUAIP provides guidance for States and recommends that each state establish a new State Technical Committee subcommittee. The focus of this subcommittee is to implement UA and to assist with innovative production issues that may emerge as the Farm Bill is implemented. The aforementioned area of Minnesota, North Dakota, and South Dakota has or is in the process of forming their urban ag subcommittee.

To expand upon assistance already established and answer the questions of UA participants, the NRCS and partner agencies could participate in four main objectives to support UA (Figure 7): technical assistance, expanding outreach/extension efforts, trace element testing, and financial assistance.


Figure 7. A concept map to show questions urban agriculture participants may ask and what resources could be available.

1) Technical Assistance between the NRCS and Urban Agriculture Stakeholders

Providing technical assistance is the first step in creating a working relationship between the NRCS and UA stakeholders. The main goal of technical assistance is to provide the knowledge and tools to give personalized advice to assist in making the best-informed decisions. To be able to establish technical assistance to UA stakeholders, cooperation between soil scientists, field offices, and county districts must be established. Technical assistance can be provided through face-to-face interactions and other forms of communication. Providing assistance at state, city, and local levels establishes a clear point of contact for information with regard to UA.

2) Expanding Outreach/Extension Efforts in Urban Communities

Currently, local universities within the example region, such as the University of Minnesota, North Dakota State University, and South Dakota State University offer Master Gardener classes that train individuals on techniques in horticulture to make them experts in their area (AHS, 2022). The NRCS can aid in training the public through participation in local events and educating the public on UA. Examples could include agriculture days at farmers markets or existing community gardens, Earth Day activities, and community outreach events. By utilizing events that already occur, the NRCS can provide education on gardening techniques, soil-specific information, food storage techniques, and the benefits that UA can provide. Other information like fertilizer requirements would require a soil test and utilizing local agronomists or university extension rate recommendations. Through face-to-face interactions with the public, individuals and groups can learn about the programming the USDA has in place to assist in their community food security efforts.

3) Trace element testing

As the NRCS becomes more involved in UA, it is important to verify that the soils are suitable for crop production, resulting in foods that are safe for human consumption. A major concern in urban soils and UA is trace element contamination. Though trace elements are naturally occurring in soil, studies have proven their levels are elevated in urban settings (Mielke and Reagan, 1998; Ryan et al., 2004, U.S. EPA, 2022). Soil sampling and lab analysis for trace elements could be completed by NRCS soil scientists through onsite investigations with portable, handheld X-Ray Fluorescence (XRF) analyzers or completed by commercial soil testing laboratories. To understand trace element contaminants or other pollution concerns, investigating the history of the land use should be partnered with the soil analysis. Local data analysis and evaluation would enhance urban soil mapping concepts and improve information used by planners and land managers.

4) Financial Assistance

The USDA currently has 17 FSA county office committees that are set up to only work on urban agriculture. In Minnesota, North Dakota, and South Dakota only one committee exists, located in Minneapolis-St. Paul, MN. To expand UA across all three states, an initial office should be set up in ND and in SD to provide assistance to urban farmers in those states. Granting financial assistance for the design and installation of roof top gardens, community gardens, and small scale seasonal high tunnels would provide increased food security in urban areas but cost share programs for UA would need to be designed to allow participation by individuals, community groups, or entities on small scales that don't require land ownership. Allowing participation by municipalities and other government entities would also expand the availability of land resources for gardens in public green spaces.

Financial assistance could be provided through programs similar to rural farming. These programs could include EQIP for urban farmers who want to conserve the resources in their urban garden, RCPP with partners who want to address natural resource concerns in an urban setting, or CIG to address challenges in an urban setting while improving UA operations, though other programs may also be available dependent upon operational needs (i.e., Conservation Stewardship Program for those who want to increase their conservation activities) (USDA, 2021). Other states around the country have already begun implementing some of these programs and have had successful community gardens established through their assistance (Wright, 2018; NRCS NJ, 2020).

## Conclusion

Urban agriculture has the potential to provide sustainable foodstuffs to aid in decreasing food insecurities that select groups encounter. As human altered and human transported soils are further studied, management practices can be developed to benefit areas that were once not viewed as food producing. By involving the NRCS and FSA in UA, additional assistance will become available to those who once did not have access to this resource. Ultimately, the NRCS's goal is to conserve the nation's soil, water, air, and other natural resources but this goal should be further expanded to urban farmers to reduce food insecurities in urban and rural communities.

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## APPENDIX A. BECKER COUNTY, MINNESOTA COMPLIANCE LETTER

# COUNTY OF BECKER


***Planning and Zoning***

*915 Lake Ave, Detroit Lakes, MN 56501*

*Phone: 218-846-7314 ~ Fax: 218-846-7266*


Dear Property Owner,

In 2007, the Becker County Board of Commissioners implemented the **Shoreland Individual Sewage Treatment Compliance Program** and amended this program in 2011. The purpose is to assure that all individual sewage treatment systems meet or exceed the Minnesota Pollution Control standards of MN Chapter 7080. The goal is to abate all non-conforming septic systems on lakeshore property in an effort to keep our lakes clean. Lakes chosen for inventory are lakes that have been prioritized based upon shoreline development index, inlets, water clarity trends, and the oligotrophic trophic state index. This program looks at lake properties within the first tier of development or within 267 ft of lakeshore. Properties on selected lakes will be inventoried for valid certificates of compliance within the last 10 years. This is an ongoing program. Property owners will need to submit a valid certificate of compliance every ten years. ***Bijou Lake*** falls into this category.

Our records indicate the sewage treatment system (standard system, holding tank or privy) serving your property has not had a valid certificate of compliance within the last ten years. Under the guidelines of this program, you are required to submit a new Certificate of Compliance to the Becker County Zoning Office by **September 30, 2019.**

A Certificate of Compliance can be obtained by contacting a septic contractor licensed as a Designer I to perform an inspection on your existing system. If you have more than one system on your property, a compliance inspection must be done on each system. If the system(s) meets the compliance criteria, the contractor may issue a new certificate of compliance. If the system is found to be non-compliant (failing) you will be required to have a new design (may involve a new tank, drainfield or combination of both) completed by a septic professional and the update installed by September 30, 2019. A list of area contractors has been included with this letter for your convenience.

Although the sewage may appear to leave your home effectively, it does not mean that it is being treated safely. If one of the above issues is present, your septic system could be contaminating both the lake and the ground/drinking water and has the potential for further negative environmental effects. A failing system may be due to an underground pit into which sewage tank discharges effluent and from which the liquid seeps into the surrounding soil through the bottom and openings in the side of the pit, a tank that obviously leaks below the designated operating depth, or any system with less than the required vertical separation.

If the septic system is not utilized and there is no plumbing or running water on the property, you may also choose to have the system abandoned by a septic professional rather than updated. The abandonment needs to be completed by a professional with the corresponding abandonment paper work submitted to our office.

If you do not have a septic system, holding tank, or privy on your property, please complete the attached form and return it to our office.

Minnesota Pollution Control Agency | www.pca.state.mn.us

# Vertical separation distance for existing subsurface sewage treatment systems

This fact sheet provides information for homeowners, Subsurface Sewage Treatment Systems (SSTS) inspectors, and Local Government Units (LGUs) on the vertical separation requirements for SSTS.

## What is vertical separation distance and why is it required?

Minn. R. 7080.1100, subp. 91, defines vertical separation as the vertical measurement of unsaturated soil or sand between the bottom of the distribution medium and the periodically saturated soil level or bedrock. For an SSTS to properly treat wastewater, this zone of unsaturated soil must be present in order for beneficial bacteria and microbes in the soil to remove harmful bacteria and viruses from the wastewater. The periodically saturated soil level is commonly identified by the presence of redoximorphic features.

## What are redoximorphic features?

Redoximorphic features, commonly referred to as 'redox features', and previously referred to as "mottles" or "mottling" are color patterns formed in the soil by the process of reduction, translocation and oxidation of iron or manganese compounds. They are used to determine compliance for existing systems and to determine the type of new or replacement system for a site. Redoximorphic features are further defined in Minn. R. 7080.1720, subp. 5. E.

## What is the required vertical separation distance?

Minn. R. 7080.1500 allows two different vertical separations for SSTS, depending on when and where the system was constructed.

For SSTS constructed after March 31, 1996, or in a Shoreland area, Wellhead protection area, or Food, beverage, or lodging establishment (SWF), at least three feet of vertical separation distance is required. The LGU may allow up to a 15 percent reduction in this distance; however, this reduction must be specified in the local SSTS ordinance.

For SSTS constructed before April 1, 1996, in areas that are not SWF, at least two feet of vertical separation distance is required. There is **no** allowance for an additional reduction of 15 percent in the vertical separation for these systems.

Systems that use a registered pretreatment device to assist in the treatment of sewage may be able to decrease the required vertical separation distance for their system. The required separation distance for systems that use registered treatment products varies with each product and components; the required separation ranges from one to three feet of suitable, unsaturated soil. Please refer to the Minnesota Pollution Control Agency SSTS product registration webpage and their requirements at: http://www.pca.state.mn.us/publications/wq-wwists4-32.pdf.

The required vertical separation distance for systems designed under the "performance" section of previous rule versions (Minn. R. 7080.0179; 1999 to 2006), shall be based on the design approved by the local unit of government.

## Can a local ordinance be more restrictive?

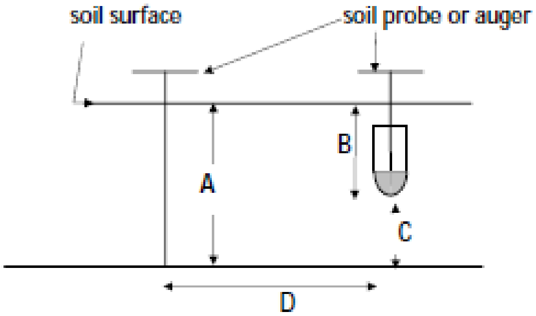
A LGU **can** require greater than three feet of vertical separation distance for systems constructed after March 31, 1996. However, LGUs **cannot** require systems to be replaced if they have at least two feet of vertical separation for systems constructed before April 1, 1996, for systems located outside of SWF areas (per Minnesota Stat. 115.55, subd. 5a).

## How is the vertical separation distance determined?

The separation distance is measured outside the area of system influence in an area of similar soil. Therefore, the measurement is taken:

- in an area adjacent to the system, but not affected by the system's use
- on the same contour and landscape position of similar soil

When a compliance inspection is conducted, the certified inspectors make soil borings based on the requirements above. This can be depicted graphically as:




Where:

A = depth from surface to periodically saturated soil or bedrock

B = depth from surface to bottom of distribution media

C = vertical separation distance

D = location on same contour and landscape position, but not in the soil dispersal system itself

Once the depths A and B have been determined, vertical separation is calculated as:

$A - B = C$

Depending upon when and where the SSTS was constructed, the value obtained in C must equal two feet or more for system compliance.

As soil conditions can vary considerably across the location of an onsite system, SSTS inspectors are encouraged to conduct more than one soil boring to get the best possible representation of soil conditions at the site.

## Where can I find more information?

For additional SSTS information, please visit our website at www.pca.state.mn.us/programs/ists or call us at 651-296-6300, or toll free at 800-657-3864.

**APPENDIX C. COMPLIANCE INSPECTION**

180284000

Becker County Planning & Zoning
915 Lake Ave
Detroit Lakes, MN 56501
(218) 846-7314
www.co.becker.mn.us

# Certificate of Compliance

## Inspection Report - Permit #:

## Owner & Property Information

Owner Name:

Mailing Address:

Parcel #:

Secondary Parcel #:

Site Address:

Township - Sec/Twp/Rng:

Legal Description:

Designer:

Installer:

## Inspector Verified Specifications

| | |
|---|---|
| Insp- Effluent Screen Installed: | No |
| Insp- Alarm Required: | Yes |
| Insp- Lift Pump In System: | Yes |
| Insp- Number of Bedrooms: | 3 |
| Insp- Tank Nbr/Size: | 0/existing |
| Insp- Drainfield Type: | Mound |
| Insp- Drainfield Size: | 10' X 38' rock bed and 26' X 38' soil absorption area |
| Insp- Soil Verification: | #1:attached #2:N/A #3:N/A |

## Inspector Verified Setbacks

| | |
|---|---|
| Insp- Tank Dist to Road | |
| Insp- Tank Dist to Nearest Prop Line | |
| Insp- Tank Dist to Nearest Structure | |
| Insp- Tank Dist to Well | |
| Insp- Tank Dist to OHW | |
| Insp- Tank Dist to Pond/Wetland | |
| Insp- Tank Dist to Pressure Line | |
| Insp- Drainfield Dist to Road | 25+ |
| Insp- Drainfield Dist to Nearest Prop Line | 10+ |
| Insp- Drainfield Dist to Nearest Structure | 90 |
| Insp- Drainfield Dist to Well | 150+ |
| Insp- Drainfield Dist to OHW | 150+ |
| Insp- Drainfield Dist to Pond/Wetland | |
| Insp- Drainfield Dist to Pressure Line | |

## Certificate of Compliance

(Yes) Certificate is hereby granted based upon the application, addendum from, plans, specifications and all other supporting data. With proper maintenance, this system can be expected to function satisfactory, however this is not a guarantee.

Certification Date: 9/8/2020

Zoning Office Signature:

* Certificate of Compliance is not valid unless signed by a Registered Qualified Employee *

# Field Review Form

**Permit #**

## Property and Owner

| | |
|---|---|
| | Parcel Number: |
| | Secondary Parcel: |

## Home Information

| | Designer submitted | Inspector verified |
|---|---|---|
| Does the structure contain any of the following elements? | Garbage disposal: No<br>Dishwasher: Invalid Field<br>Grinder pump: Invalid Field<br>Lift pump in bsmt: Invalid Field | Garbage disposal? Y N<br>Dishwasher? Y N<br>Grinder pump? Y N<br>Lift pump in basement? Y N |
| Number of bedrooms: **3** | Review - Number of bedrooms: 3 | |
| Effluent screen | Effluent screen installed? Y N Mfr: | |
| Alarm: **No** Type: | Review - Alarm? Y N Type & Mfr: [illegible] | |
| Lift pump in system: **Yes** | Review - Lift pump in system? Y N Mfr: Goulds PE51 | |

## Component Information

| | |
|---|---|
| Tank size: **1000 gallon** | Review - Tank nbr: 0 size: [illegible] Mfr: |
| Drainfield type: **Mound** | Review - Drainfield type: Mound |
| Drainfield size: Full size **- 375**<br>Reduced/warr. size - | Review - Drainfield status: none / installed / next spring<br>Review - Drainfield size: 10' x 36' rock bed |
| Absorption area size: **12 inches** | Review - Absorption area size: 26' x 36' SAA |
| Chamber type/num:<br>Trench sqft/chamber - | Review - Chamber type: Num:<br>Review - Trench sqft/chamber: |
| Drainfield rock depth: **12 inches** | Review - Rock depth: 12" + 1' Sand Wt |

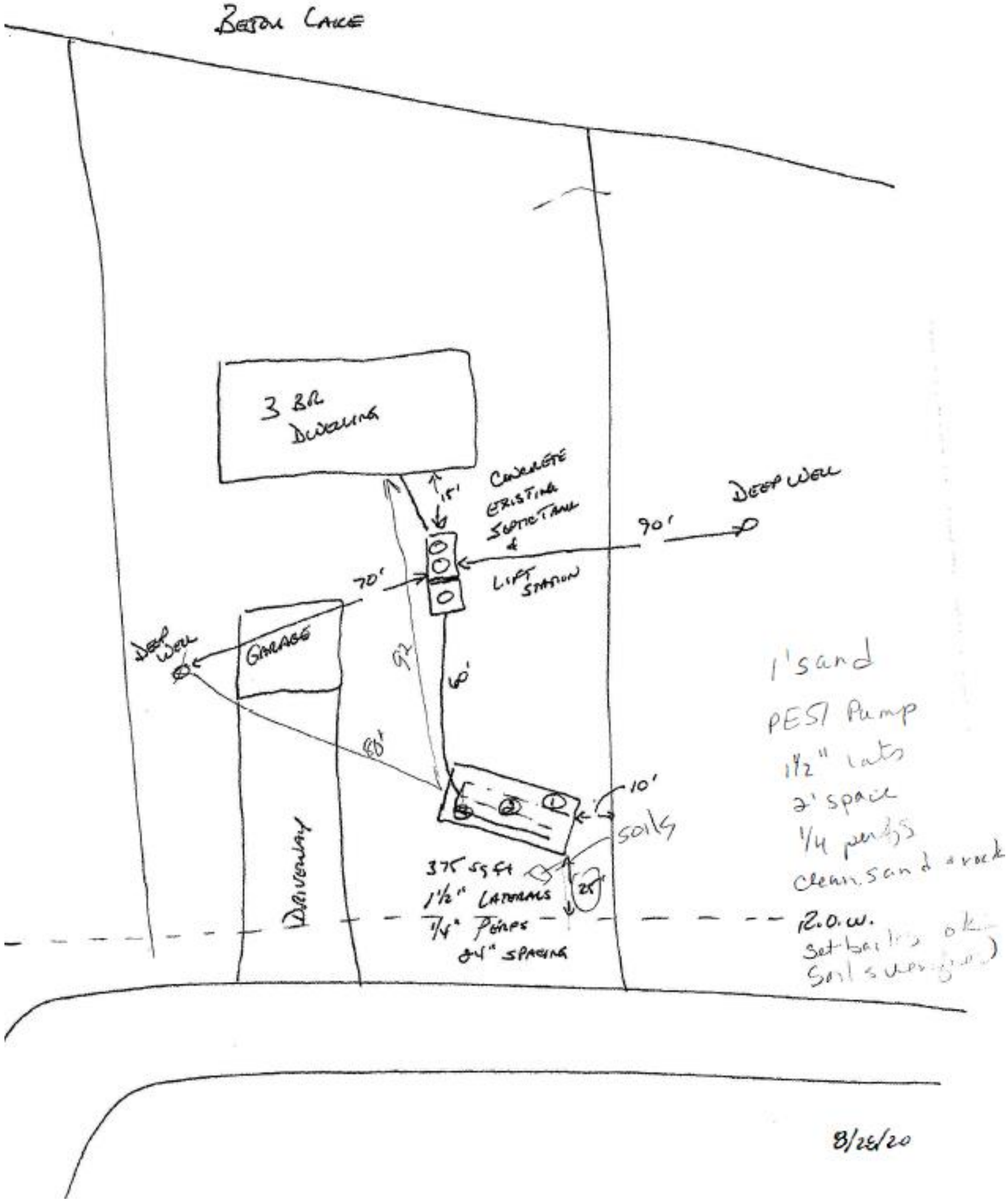
## Soil Verification

| | |
|---|---|
| Vertical separation verified | Boring #1:<br>Boring #2: attached<br>Boring #3: |

## Setback Verification

| Distance to... | Designer submitted | | Inspector verified | |
|---|---|---|---|---|
| | Tank | Drainfield | Tank | Drainfield |
| Road | 100+ feet | 40 ft | | 25+ |
| Nearest prop line | 25 ft | 10 ft | | 10+ |
| Nearest structure | 15 ft | 30 ft | | 90 to dwelling |
| Well | 70 ft | 90 ft | existing | 90 |
| OHW | 100+ ft | 160+ ft | | 150+ |
| Pond/Wetland | N/A | N/A | | |
| Pressure line | N/A | N/A | | |

Date System Installed: 9/9/2020 Installer: Inspector:


3 BR
DWELLING
CONCRETE
EXISTING
SEPTIC TANK
&
LIFT
STATION
15'
90'
DEEP WELL
70'
GARAGE
DEEP
WELL
92'
60'
80'
10'
soils
375 sq ft
1½" LATERALS
¼" PERFS
24" SPACING
25'
DRIVEWAY
R.O.W.
1' sand
PESI Pump
1½" lats
2' space
¼ perfs
clean sand & rock
8/25/20

# Becker County Restrictive Layer Verification

| | | |
|---|---|---|
| Client: | Parcel: | Date: 9-8-2020 |
| Address: | | |

Vegetation: Lawn

Weather Conditions/Time of Day: Cloudy 1:30 Observation#/Location/Method: Pit

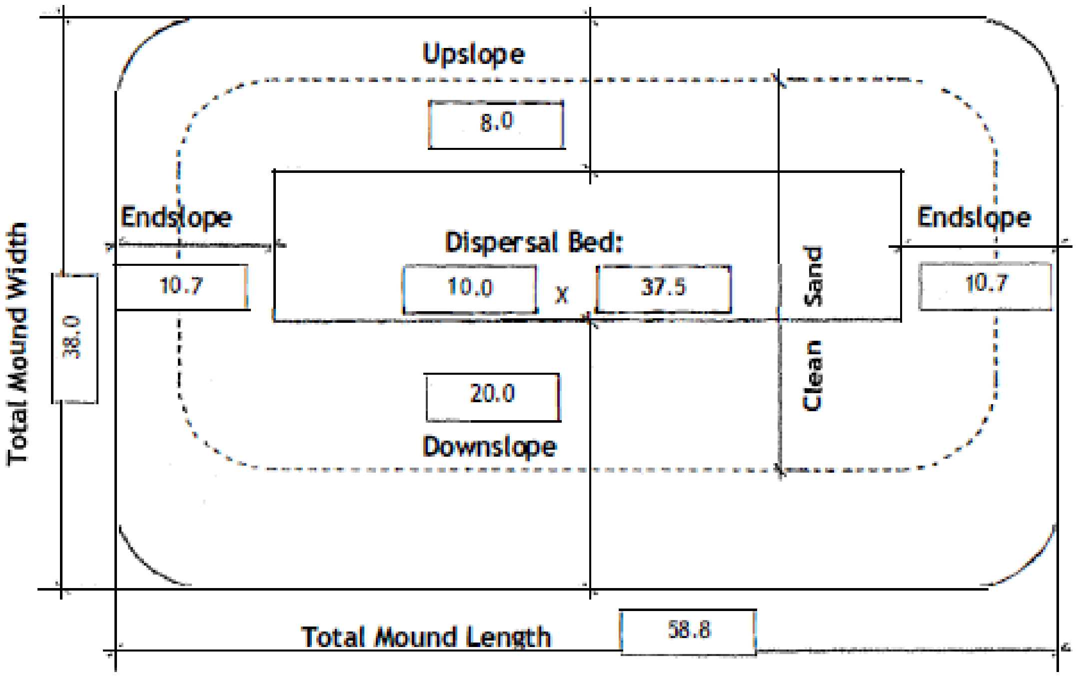
| Depth (in) | Texture | Matrix Color(s) | Mottle Color(s) |
|---|---|---|---|
| 34" | CL | 10yr 6/4 | 10yr 7/2, 7.5yr 5/6 |

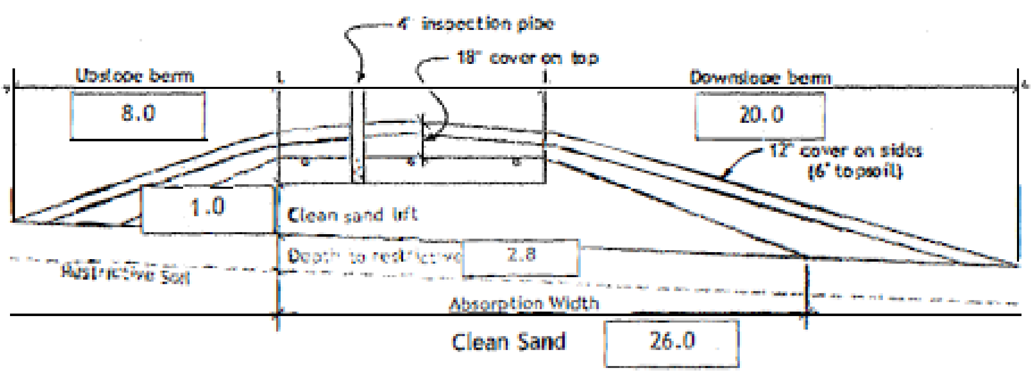
Comments/Notes:

34" - Restrictive Layer - Redox concentrations & depletions

| Certified Statement: I hereby certify that I have completed this work in accordance with all applicable ordinace, rules and laws. | | | |
|---|---|---|---|
| (Designer) | (Inspector) | (License #) | (Date) 7-8 |

7. **MOUND DIMENSIONS** Project ID:




Comments:

Becker County Planning & Zoning
915 Lake Ave
Detroit Lakes, MN 56501
(218) 846-7314
www.co.becker.mn.us

# Septic Permit
**Permit #:**

## Owner & Property Information

| | | | |
|---|---|---|---|
| **Owner Name:** | | **Parcel #:** | |
| | | **Secondary Parcel #:** | |
| **Mailing Address:** | | **Site Address:** | |
| **Phone #:** | | **Township - Sec/Twp/Rng:** | |
| **Lake/River(1000/300):** | Yes | **Designer:** | |
| **Lake/River Name:** | Bijou (Lake Park) [RD] | | |
| **Pond/Wetland(50):** | No | **Installer:** | |

## Specifications

| | | | |
|---|---|---|---|
| **Tank to be Installed:** | Existing Tank | **Type of Drainfield:** | Mound |
| **Total # Tanks Installed:** | 0 | **Full Size of Drainfield:** | 375 |
| **System Status:** | Replacement System | **Reduced/Warrantied Size:** | |
| **System Serves:** | Seasonal Dwelling | **Absorbtion Area Size:** | 26 ft Wide |
| **Number of Bedrooms:** | 3 | **Rock Depth:** | 12 inches |
| **Design Flow/GPD:** | 450 | **Chamber Type and Number:** | |
| **Garbage Disposal?** | No | **Chamber Trench SqFt/Chamber:** | |
| **Size of Lift Pump:** | 1/2 HP | **Is System Pressurized?** | Yes |
| **Size of Lift Line:** | 2 inch | **Alarm?** | No |
| **Soil Sizing Factor:** | 0.45 | **Type of Alarm:** | |

## Setbacks

| | | | |
|---|---|---|---|
| **Road Type:** | Public / Township | **Right of Way Marked:** | Yes |
| **Tank Dist to Road:** | 100+ feet | **Drainfied Dist to Road:** | 40 ft |
| **Tank Dist to Closest Prop Line:** | 25 ft | **Drainfied Dist to Closest Prop Line:** | 25 ft |
| **Tank Dist to Nearest Structure:** | 15 ft | **Drainfield Dist to Nearest Structure:** | 30 ft |
| **Tank Dist to Well:** | 70 ft | **Drainfield Dist to Well:** | 90 ft |
| **Tank Dist to OHW:** | 100+ ft | **Drainfield Dist to OHW:** | 160+ ft |
| **Tank Dist to Pond/Wetland:** | N/A | **Drainfield Dist to Pond/Wetland:** | N/A |
| **Tank Dist to Pressure Line:** | N/A | **Drainfield Dist to Pressure Line:** | N/A |

## Other Information

| | | |
|---|---|---|
| **Date Approved:** | 9/1/2020 | **Zoning Office Signature:** |
| **Permit Fee:** | | |
| **Receipt Number:** | | |
| **Date Paid:** | 9/2/2020 | |

**Notes:** Utilize existing septic/lift tank. Install a mound system with a 1' sand lift, a 10' X 38' rock bed and a 26' X 38' soil absorption area

**PERMIT MUST BE POSTED AT JOB SITE. PERMIT EXPIRES ONE YEAR FROM DATE PAID.**
**** Please schedule for inspection prior to installation! ****

## APPENDIX D. SOIL LOGS

ONSITE SEWAGE TREATMENT PROGRAM

# Soil Observation Log

Project ID:

v 04.01.2020

Client:

Location / Address:

Soil parent material(s): (Check all that apply) ☐ Outwash ☐ Lacustrine ☐ Loess ☑ Till ☐ Alluvium ☐ Bedrock ☐ Organic Matter

| | | | | | | |
|---|---|---|---|---|---|---|
| Landscape Position: (select one) | Back/Side Slope | Slope %: 3.0 | Slope shape | Linear, Linear | Elevation-relative to benchmark: | |
| Vegetation: | Lawn | Soil survey map units: | | | Limiting Layer Elevation: | |
| Weather Conditions/Time of Day: | Sunny | | Morning | | Date | 08/27/20 |
| Observation #/Location: | 1 | South End of STA | | | Observation Type: | Auger |

| Depth (in) | Texture | Rock Frag. % | Matrix Color(s) | Mottle Color(s) | Redox Kind(s) | Indicator(s) | Structure: Shape | Structure: Grade | Structure: Consistence |
|---|---|---|---|---|---|---|---|---|---|
| 0-11 | Clay Loam | <35% | 10YR 2/2 | | | | Blocky | Weak | Friable |
| 11-13 | Clay Loam | <35% | 10YR 3/3 | | | | Blocky | Weak | Friable |
| 13-22 | Clay Loam | <35% | 10YR 5/4 | | | | Blocky | Weak | Friable |
| 22-39 | Clay Loam | <35% | 10YR 6/4 | | | | Blocky | Weak | Friable |
| 39+ | Clay Loam | <35% | 10YR 6/4 | 10YR 5/8 | Concentrations | S2 | Blocky | Weak | Friable |
| | | | | | | | | | |
| | | | | | | | | | |

Comments

I hereby certify that I have completed this work in accordance with all applicable ordinances, rules and laws.

(Designer/Inspector) (Signature) (License #) 8/27/2020 (Date)

Onsite Sewage Treatment Program

# Soil Observation Log

Project ID:

v 04.01.2020

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Client: | | | | | Location / Address: | | | | |
| Soil parent material(s): (Check all that apply) | | | ☐ Outwash ☐ Lacustrine | | ☐ Loess ☐ Till | ☐ Alluvium | ☐ Bedrock | ☐ Organic Matter | |
| Landscape Position: (select one) | | | Back/Side Slope | Slope %: 5.0 | Slope shape | Linear, Linear | | Elevation-relative to benchmark: | |
| Vegetation: | Lawn | | Soil survey map units: | | | | | Limiting Layer Elevation: | |
| Weather Conditions/Time of Day: | | | Sunny | | Morning | | Date | 08/27/20 | |
| Observation #/Location: | | 2 | Center of STA | | | Observation Type: | | Auger | |

| Depth (in) | Texture | Rock Frag. % | Matrix Color(s) | Mottle Color(s) | Redox Kind(s) | Indicator(s) | Structure: Shape | Structure: Grade | Structure: Consistence |
|---|---|---|---|---|---|---|---|---|---|
| 0-7 | Clay Loam | <35% | 10YR 2/2 | | | | Blocky | Weak | Friable |
| 7-9 | Clay Loam | <35% | 10YR 3/3 | | | | Blocky | Weak | Friable |
| 9-17 | Clay Loam | <35% | 10YR 4/3 | | | | Blocky | Weak | Friable |
| 17-24 | Clay Loam | <35% | 10YR 5/4 | | | | Blocky | Weak | Friable |
| 24-34 | Clay Loam | <35% | 10YR 6/4 | | | | Blocky | Weak | Friable |
| 34+ | Clay Loam | <35% | 10YR 6/4 | 10YR 5/8 | Concentrations | S2 | Blocky | Weak | Friable |
| | | | | | | | | | |

Comments:

I hereby certify that I have completed this work in accordance with all applicable ordinances, rules and laws.

| (Designer/Inspector) | (Signature) | (License #) | 8/27/2020 (Date) |
|---|---|---|---|

Onsite Sewage Treatment Program

# Soil Observation Log

Project ID: v 04.01.2020

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Client: | | | | | Location / Address: | | | | |
| Soil parent material(s): (Check all that apply) | | | ☐ Outwash ☐ Lacustrine | | ☐ Loess ☐ Till | ☐ Alluvium | ☐ Bedrock | ☐ Organic Matter | |
| Landscape Position: (select one) | | Back/Side Slope | Slope %: 5.0 | | Slope shape | Linear, Linear | | Elevation-relative to benchmark: | |
| Vegetation: | Lawn | | Soil survey map units: | | | | | Limiting Layer Elevation: | |
| Weather Conditions/Time of Day: | | Sunny | | Morning | | Date | | 08/27/20 | |
| **Observation #/Location:** | 3 | | North End of STA | | | Observation Type: | | Auger | |

| Depth (in) | Texture | Rock Frag. % | Matrix Color(s) | Mottle Color(s) | Redox Kind(s) | Indicator(s) | Structure: Shape | Structure: Grade | Structure: Consistence |
|---|---|---|---|---|---|---|---|---|---|
| 0-7 | Clay Loam | <35% | 10YR 2/2 | | | | Blocky | Weak | Friable |
| 7-11 | Clay Loam | <35% | 10YR 3/3 | | | | Blocky | Weak | Friable |
| 11-17 | Clay Loam | <35% | 10YR 4/3 | | | | Blocky | Weak | Friable |
| 17-24 | Clay Loam | <35% | 10YR 5/4 | | | | Blocky | Weak | Friable |
| 24-37 | Clay Loam | <35% | 10YR 6/4 | | | | Blocky | Weak | Friable |
| 37+ | Clay Loam | <35% | 10YR 6/4 | 10YR 5/8 | Concentrations | S2 | Blocky | Weak | Friable |
| | | | | | | | | | |

Comments

I hereby certify that I have completed this work in accordance with all applicable ordinances, rules and laws.

| | | | |
|---|---|---|---|
| | | | 8/27/2020 |
| (Designer/Inspector) | (Signature) | (License #) | (Date) |

**Textures:**
c-clay
sic-silty clay
sc-sandy clay
cl-clay loam
sicl-silty clay loam
scl-sandy clay loam
si-silt
sil-silt loam
l-loam
sl-sandy loam*
ls-loamy sand*
s-sand*

**Subsoil Indicator(s) of Saturation:**
S1. Distinct gray or red redox features
S2. Depleted matrix (value >/=4 and chroma </=2)
S3. 5Y chroma </= 3
S4. 7.5 YR or redder faint redox concentrations or redox depleti

**If yes to one of the above indicators then:**
**Topsoil Indicator(s) of Saturation:**
T1. Wetland Vegetation
T2. Depressional Landscape
T3. Organic texture or organic modifiers
T4. N 2.5/ 0 color
T5. Redox features in topsoil
T6. Hydraulic indicators

***Sand Modifiers**
co-coarse
m-medium
f-fine
vf-very fine

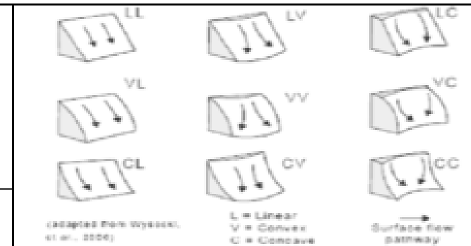
**Consistence:**

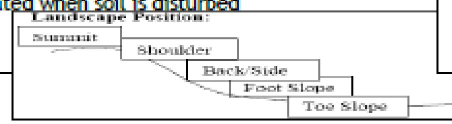
| | |
|---|---|
| Loose- | Intact specimen not available |
| Friable- | Slight force between fingers |
| Firm- | Moderate force between fingers |
| Extremely firm- | Moderate force between hands or slight foot pressure |
| Rigid- | Foot pressure |

**Slope Shape:**
Slope shape is described in two directions: up and down slope (perpendicular to the contour), and across slope (along the horizontal contour); e.g. Linear, Convex or LV'.

**Soil Structure Grade:**

| | |
|---|---|
| Massive- | No observable aggregates, or no orderly arrangement of natural lines of weakness |
| Weak- | Poorly formed, indistinct peds, barely observable in place |
| Moderate- | Well formed, distinct peds, moderately durable and evident, but not distinct in |
| Strong- | Durable peds that are quite evident in un-displaced soil, adhere weakly to one another, withstand displacement, and become separated when soil is disturbed |
| Loose- | No peds, sandy soil |




**Soil Structure Shape:**

| | |
|---|---|
| Granular- | The peds are approximately spherical or polyhedral and are commonly found in topsoil. These are the small, rounded peds that hang onto roots |
| Platy- | The peds are flat and plate like. They are oriented horizontally and are usually overlapping. Platy structure is commonly found in forested |
| Blocky- | The peds are block-like or polyhedral, and are bounded by flat or slightly rounded surface that are casting of the faces of surrounding peds. |
| Prismatic- | Flat or slightly rounded vertical faces bound the individual peds. Peds are distinctly longer vertically, and faces are typically cast or molds of |
| Single Grain- | The structure found in a sandy soil. The individual particles are not held together. |

MINNESOTA POLLUTION CONTROL AGENCY

www.pca.state.mn.us

# Septic systems 101

## Facts about subsurface sewage treatment systems

Subsurface sewage treatment systems (SSTS), commonly known as septic systems, are soil-based treatment systems used by homes and businesses that are not connected to municipal sewers. The systems treat and dispose of wastewater generated on-site. More than 500,000 septic systems are in use in Minnesota, which includes 30% of the state's households. Septic systems treat approximately 25% of wastewater generated in the state.

Wastewater contains sewage, which includes bacteria, viruses, parasites, nutrients, and some chemicals. Correctly treating and disposing of wastewater is critical to protecting public health and the environment. More than two-thirds of Minnesotans get their drinking water from groundwater, and poorly built or ill-functioning septic systems can contaminate groundwater and other water resources. When constructed and maintained properly, septic systems are highly effective at treating sewage and keeping Minnesota's groundwater, lakes, and rivers safe and clean.

## How septic systems work

SSTS treat sewage with a combination of biological, physical, and chemical processes. A system's design must account for several factors:

- The amount of daily wastewater generated on site
- Using gravity or a pump for distribution
- The site's soil conditions
- The need for developing a biological layer (biomat)

A typical SSTS includes a septic tank and a soil-based treatment system where liquid waste can come in contact with soils.

### The septic tank

Sewage is piped from a home or business into a buried, watertight septic tank, which is sized to retain wastewater for 24 to 36 hours. The time allows the wastewater to separate into three layers in the tank:

- Solids sink to the bottom
- Greases, fats, and soaps float to the top
- The remaining liquid (effluent) flows out to the drainfield for final treatment

Baffles in the tank at the inlet and outlet help prevent the top and bottom layers from moving to the drainfield, where they can clog distribution pipes and cause premature drainfield failure. Over time, these layers will accumulate, and must be pumped out of the tank at regular intervals.

Anaerobic bacteria (bacteria that doesn't need oxygen) in the tank begin the process of breaking down organic matter in the sewage. But microorganisms and pathogens remain. Research shows that effluent leaving the septic tank contains high counts of bacteria (about 1,000,000 colonies per 100 ml) that must be further treated in the soil.

Minnesota Pollution Control Agency
651-296-6300 | 800-657-3864 or use your preferred relay service | Info.pca@state.mn.us

June 2019 | wq-wwists1-10
Available in alternative formats

### The drainfield/soil treatment system

The effluent from the septic tank moves to the soil treatment system, such as a mound, trench, or at-grade drainfield. A trained SSTS professional must take soil types and other factors into account when designing the correct type of septic system for a specific site.

The effluent moves either by gravity or using a pump, through distribution pipes in the soil treatment system, and down through the distribution medium to its base where the distribution medium meets the underlying soil. That's where a sticky biological layer (biomat) forms. The biomat slows the infiltration of effluent into the underlying unsaturated soil, and further filters out pathogens and solids. The biomat can slow effluent movement to as much as 100 times less than its normal flow rate; this helps maximize the contact time between the effluent and the surrounding soil particles.

Soil particles are negatively charged. Through a process called adsorption, they attract and hold the positively charged pathogens in the effluent. Once held, the pathogens are easily available to the aerobic bacteria in the air pockets between the soil particles. The aerobic bacteria, which are much more efficient than the anaerobic bacteria in the septic tank, continue treatment. Other forms of bacteria also begin to grow, producing slimy films over the soil particles, which act as additional filters to "grab" pathogens.

It is important to properly site the SSTS with the existing soil conditions to ensure maximum treatment occurs. If the site is not optimal for treatment (e.g., it has a high seasonal water table), it won't offer effective soil treatment and the risk of contamination increases.

## SSTS regulations in Minnesota

The 1968 Minnesota Shoreland Act required septic systems to be evaluated and managed properly within shoreland areas to better control their impact on water quality. But the first state law specifically addressing septic systems wasn't enacted until 1994: the Individual Sewage Treatment Systems (ISTS) Act (Minn. Stat. §§ 115.55 and 115.56). It requires all new construction and replacement septic systems to meet minimum standards. It also enacted a system to upgrade failing existing SSTS before construction of an additional bedroom, and methods to replace failing SSTS within certain timeframes. The 1994 act has been amended in recent years, with major changes in 1996 and 2008. Regulations will continue to be amended as the SSTS industry advances.

### More information

Visit the Minnesota Pollution Control Agency website at http://www.pca.state.mn.us.