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# Stark County Failing Home Sewage Treatment Systems Prioritization Analysis

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# Summary

The Stark County Health Department (SCHD) and the Stark County Metropolitan Sewer District (SCMSD) requested that the Northeast Ohio Four County Regional Planning and Development Organization (NEFCO), as an unbiased entity, assist in creating a project to determine a priority for extending sewers to areas the Health Department has determined to have above average failure rates for home sewage treatment systems (HSTSs). These high failure rates are common in areas with dense housing stock, small lot sizes, and poor soils for a properly functioning HSTS. These areas are a concern due to the potential threat to public health and local water quality. NEFCO worked closely with the Health Department and the Sewer District to conduct this study and prepared this report as a tool to help Stark County prioritize which areas should be serviced with sewers. The criteria included HSTS age weighted risks, housing density risks, soil suitability, surface water potential pollution, drinking water supply source, and E coli qualifiers levels. Other qualifying indicators included percent E coli, odor scores, estimated flow of sewage, and groundwater pollution potential. NEFCO suggests that the priority of extending sewers to these areas, based on environmental and health concerns, is as listed below (higher priority at the top):

Limaville
Harmon
States
Moreland
East Tuscarawas
Justus
East Greenville
North Lawrence
Nellabrook
Lynnette
Uniontown

# Scoring Disclaimer

The statistical accuracy required to determine the true degree of failure between individual sites using the critical factor criteria would demand a much more involved study in data retrieval, time and budget. The intent of this study was to determine the general order of HSTS failure and the health impacts of the sites investigated and not a specific and scientifically defendable list of individual sites prioritized by degree of failure. The goal is not to resolve the health issues at each site in the exact order as dictated by the composite score, but to insure that the higher scores have priority when planning for rehabilitation projects. This way, when planning and financial opportunities present themselves, the resources can be directed to the higher priority sites for the best cost/benefit outcome.

# Introduction

An average of 30 percent of all households within the United States are treated by on-site septic systems (USEPA, 1999). These home sewage treatment systems tend to last fifteen to twenty years before they start to fail (USEPA, 1999). This is because the majority of HSTS are not well-maintained. If the system is maintained properly, it could last for more than twenty years. According to the Ohio Department of Health (ODH, 2013), the average failure rate of septic systems in Ohio is 31 percent. When HSTSs fail, they can cause a variety of problems. The most severe problem is wastewater seeping into surface drinking waters. This can then cause a variety of health problems in both humans and animals, along with adding nutrients to the water, which may cause a harmful algal bloom. Other unwanted symptoms of failing septic systems include, but are not limited to: strong odor, backup of sewage into the house, ponding of wastewater, and degradation of the environment (USEPA, 1999).

The majority of septic systems rely on the natural soil and the microorganisms within it to filter the wastewater before it reaches surface or groundwater. Roughly half of the HSTSs in Ohio rely on the soil to filter the wastewater (ODH, 2013). As a result, the soil that the septic system is placed in is extremely important to the functionality of the system. However, many soils within Stark County are limited for septic systems. Soil limitations include shallow water table, permeability, drainage issues, or inadequate thickness of soil for proper filtering (ODH, 2013). Septic systems that do not rely on the soil for filtering are called discharging or off-site systems. These systems discharge the wastewater outside of the property. As a result, these types of septic systems require a National Pollutant Discharge Elimination System (NPDES) permit.

The Ohio Revised Code (ORC) states that if there is a complaint of unsanitary conditions, and investigation reveals that the conditions are indeed unsanitary, then sanitary sewers must be installed within that area (ORC 6117.34). Water samples that exceed 576 *Escherichia coli* (*E. coli*) colonies per 100 milliliters in two or more samples are considered to be evidence of unsanitary conditions (OAC 3745-1-04 (1B)). Then, when sanitary sewers are accessible (within 400 feet per county policy), the HSTS must be abandoned and it is required that the property owner tie into the sewer (OAC 3701-29-06 (I)). A replacement sewage treatment system is ineligible for a NPDES General Permit if any part of the property is within 400 feet of a public sewer, and if that sewer has capacity to accept the household's flow.

When nutrients are added to surface waters, it can result in an algal bloom. Some algal blooms can cause adverse health effects; these are called harmful algal blooms (HABs). Cyanobacteria are the most common cause of HABs, and are known for producing chemicals that are toxic to humans and animals. These chemicals are referred to as cyanotoxins, of which there are four major types that impact human and animal health. These can cause many health issues, such as headaches, vomiting and diarrhea, fevers, pneumonia, kidney failure, and affect liver function (USEPA, 2012). One type tends to cause neurological damage and respiratory problems. Exposure to cyanotoxins can occur through direct contact (e.g., swimming) or through ingestion. In addition to producing toxins, cyanobacteria can also produce odorous chemicals within their cells that are released during their life or decomposition. Geosmin and MIB (2-Methylisborneol) are common chemicals that create an earthy/musty odor in water bodies containing cyanobacteria. Although not harmful to human health, Geosmin and MIB cause taste and odor problems for water treatment facilities. See Appendix 1 for more information on HABs.

For this report, several criteria were examined by the three agencies in order to establish prioritization for sewer service. These criteria included:

- Estimate of HSTS Failure due to system age
- Soil suitability for HSTS
- Density and estimated volume of sewage flow from households
- Pollution potential
  - Adjacent land use
  - Travel time of water flow
  - Surface water pollution potential
  - Groundwater pollution potential
  - TMDLs (Total Maximum Daily Loads)
- Sampling results for *Escherichia coli* (*E. coli*)
- Logistics
  - Costs of connecting to sewers versus replacing septic systems
  - Average income

## Methodology and Criteria

NEFCO, SCHD, and SCMSD collaborated to determine the areas of interest and methods used throughout this study. In all of the qualifier rankings in this study, the higher the score, the greater the priority should be for the area should to receive sewers. For each individual criteria, the study areas with the highest numbers are listed at the top.

## Study Sites

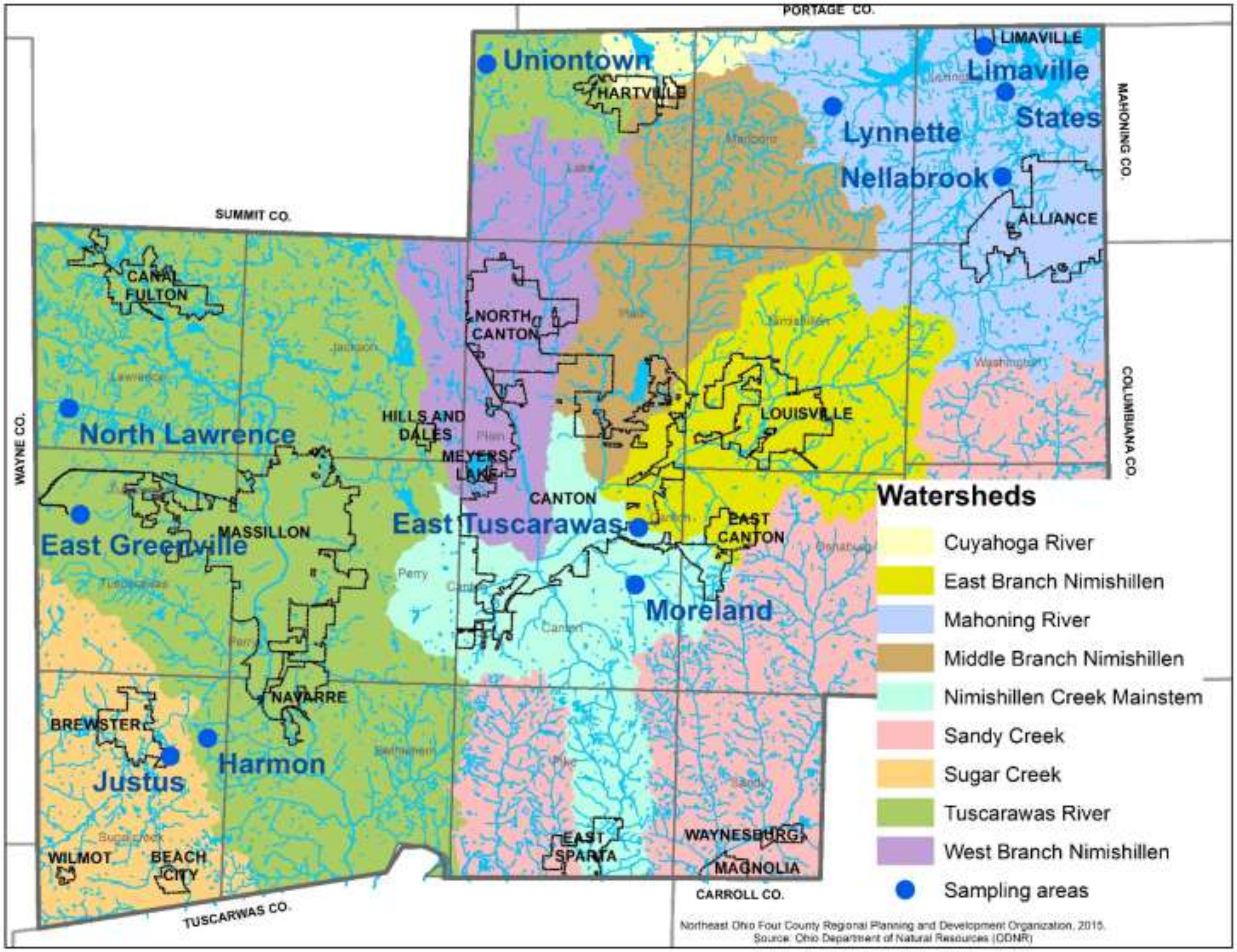
There were eleven sites identified by the Health Department that had above average failure rates for HSTSs. These eleven areas are located in four major watersheds across Stark County (Map 1).

<u>Mahoning River</u>
Lynnette (Marlboro Twp.)
Village of Limaville
Florida, Pennsylvania, Maryland, Indiana, Michigan and Illinois Streets (Lexington Twp.; henceforth called States)
Nellabrook Allotment (Lexington Twp.)

<u>Nimishillen Creek</u>
East Tuscarawas (Canton Twp.)
Moreland Allotment (Canton Twp.)

<u>Tuscarawas River</u>
Uniontown (Lake Twp.)
North Lawrence (Lawrence Twp.)
East Greenville (Tuscarawas Twp.)
Harmon (Sugarcreek Twp.)

<u>Sugar Creek</u>
Justus (Sugarcreek Twp.)




*Map 1: The watersheds and sampling areas within Stark County, Ohio*

# Assessment of Records

## *Estimate of HSTS failure*

An estimate of the percentage of failing home sewage treatment systems in each study area was one risk factor evaluated in this study. The average life expectancy of a HSTS is approximately 20 years. The Stark County Health Department supplied NEFCO employees with information regarding the year each system was installed. If no records were found, the age of the house was used. For each age range, the number of systems was counted in each sampling area. Systems less than 20 years old (1995 or younger) were considered to be least likely to fail, while systems 20 years or older had a higher likelihood of failing, which increases with age. (It should be noted that there are many variables that may cause a system to fail and age alone is only one.) (Table 1). To represent this risk proportionate to the percentage of systems in each age bracket (10 year increments), a risk value of 1, 2 or 3 was used to give heavier weight to areas with proportionately older systems. This was then multiplied by the percentage in each bracket to create the weighted age risk (table 2). All estimated failure rates in the eleven areas were above the state-wide average (31%) for failure rate of septic systems (ODH, 2013).

*Table 1: Percent Estimates of HSTS failure based on age ranges for septic systems in the sampling areas. (The Older Systems Relate to a Higher Failure Rate)*

| **Site** | **< 20 years** | **20-30 years** | **30-40 years** | **> 40 years** | **Total Systems > 20 Yr. Old** |
|---|---|---|---|---|---|
| North Lawrence | 4.5 | 2.2 | 1.1 | 92.1 | 95.4 |
| East Greenville | 6.8 | 2.7 | 2.7 | 87.7 | 93.1 |
| Harmon | 8.6 | 2.9 | 0 | 88.6 | 91.5 |
| Nellabrook | 15.3 | 2.4 | 0 | 82.4 | 84.8 |
| Limaville | 16.9 | 1.5 | 1.5 | 80.0 | 83.0 |
| East Tuscarawas | 10.8 | 9.7 | 5.4 | 74.2 | 89.3 |
| Moreland | 8.5 | 11.6 | 10.1 | 69.8 | 91.5 |
| Uniontown | 13.5 | 7.2 | 4.2 | 75.1 | 86.5 |
| Justus | 20.0 | 0 | 0 | 80.0 | 80.0 |
| States | 17.6 | 4.1 | 5.4 | 73.0 | 82.5 |
| Lynnette | 20.0 | 14.3 | 2.9 | 62.9 | 80.1 |

*Table 2: Percent Failure Ranking Based on Age of Risk*

| Site | % < 20 years | Age risk of 0 | % 20-30 years | Age risk of 1 | % 30-40 years | Age risk of 2 | % >40 years | Age risk of 3 | Total % >20 years | Weighted Age Risk |
|---|---|---|---|---|---|---|---|---|---|---|
| North Lawrence | 4.5 | 0 | 2.2 | 0.022 | 1.1 | 0.022 | 92.1 | 2.763 | 95.4 | 2.81 |
| East Greenville | 6.8 | 0 | 2.7 | 0.027 | 2.7 | 0.054 | 87.7 | 2.631 | 93.1 | 2.71 |
| Harmon | 8.6 | 0 | 2.9 | 0.029 | 0 | 0 | 88.6 | 2.658 | 91.5 | 2.69 |
| Nellabrook | 15.3 | 0 | 2.4 | 0.024 | 0 | 0 | 82.4 | 2.472 | 84.8 | 2.50 |
| Limaville | 16.9 | 0 | 1.5 | 0.015 | 1.5 | 0.03 | 80 | 2.4 | 83 | 2.45 |
| East Tuscarawas | 10.8 | 0 | 9.7 | 0.097 | 5.4 | 0.108 | 74.2 | 2.226 | 89.3 | 2.43 |
| Moreland | 8.5 | 0 | 11.6 | 0.116 | 10.1 | 0.202 | 69.8 | 2.094 | 91.5 | 2.41 |
| Uniontown | 13.5 | 0 | 7.2 | 0.072 | 4.2 | 0.084 | 75.1 | 2.253 | 86.5 | 2.41 |
| Justus | 20 | 0 | 0 | 0 | 0 | 0 | 80 | 2.4 | 80 | 2.4 |
| States | 17.6 | 0 | 4.1 | 0.041 | 5.4 | 0.108 | 73 | 2.19 | 82.5 | 2.34 |
| Lynnette | 20 | 0 | 14.3 | 0.143 | 2.9 | 0.058 | 62.9 | 1.887 | 80.1 | 2.09 |

## *Soil data*

<u>Methods</u>

Soil data was collected for each sampling area from the Web Soil Survey (USDA). The types of soils, drainage types, depth to water table, capacity to transmit water, and the ratings for septic system types were collected for each sampling area. The soil parameter assigned to a ranking scale is the rating for septic system types. This rating was given to NEFCO staff by the SCHD, and indicates if the soils are acceptable for septic system use. "No to minor limitations" means that those soils are suitable for septic systems, while "moderate or worse limitations" indicates that septic systems will not work properly in those soils. The ratings are listed below:

No to minor limitations = 1
Minor to moderate limitations = 2
Moderate to severe limitations = 3
Severe to very severe limitations = 4

The average of each soil type per site was then computed.

<u>Results</u>

The majority of soils in Stark County are not recommended for septic system use. Most of the soils in the sampling areas are silt loams, which consist of more silt than sand or clay. Despite the fact that silt loams tend to have medium to low permeability, all of the areas have some soils that are well drained or moderately well drained. When averaged across all of the sampling areas, the drainage types were as follows: well drained soils (43.3%), moderately well drained (20.8%), somewhat poorly drained (22.3%), poorly drained (9.9%), and very poorly drained (3.6%).

The recommended distance between the bottom of a septic system tile field and the water table is 24 to 48 inches. The soils that are classified as well drained tend to have a depth of 48 or more inches to the water table. However, the majority of the other drainage classes fall well below this recommended range. This indicates that some of the wastewater is reaching the water table before it is fully treated.

The recommended rate for water transmissivity is different for various soils types. For silt loams, the recommended permeability rate for septic system use is 0.5–2.0 inches per hour. The well drained soils tend to be greater than this recommended range. The other drainage classes are at or below this recommended range. This indicates that wastewater is not draining as fast as it could through the soil, which could lead to backups or poorly treated wastewater if it pools on the ground surface.

The majority of soils in Stark County have moderate or worse limitations for septic systems. The breakdown of limitations for all septic types when averaged across all sampling areas is as follows: no to minor limitations (15%), minor to moderate limitations (32.5%), moderate to severe limitations (29.8%), and severe to very severe limitations (22.7%).

When examining the soil parameters for the eleven sampling areas, Nellabrook had the worst soils for septic systems, while North Lawrence had the best. The order of sampling areas from worst to best soils is as follows (Appendix 3):

*Table 3: Soil Suitability Score*

| Site | Soil Suitability |
|---|---|
| Nellabrook | 3 |
| States | 3 |
| Limaville | 2.75 |
| East Tuscarawas | 2.5 |
| East Greenville | 2.5 |
| Harmon | 2 |
| Moreland | 2 |
| Lynnette | 2 |
| Justus | 2 |
| Uniontown | 2 |
| North Lawrence | 1.5 |

To view percentages for the soil parameters for each sampling area, consult Appendix 3.

### *Facilities Planning Areas (FPA)* http://www.nefcoplanning.org/CWP.html

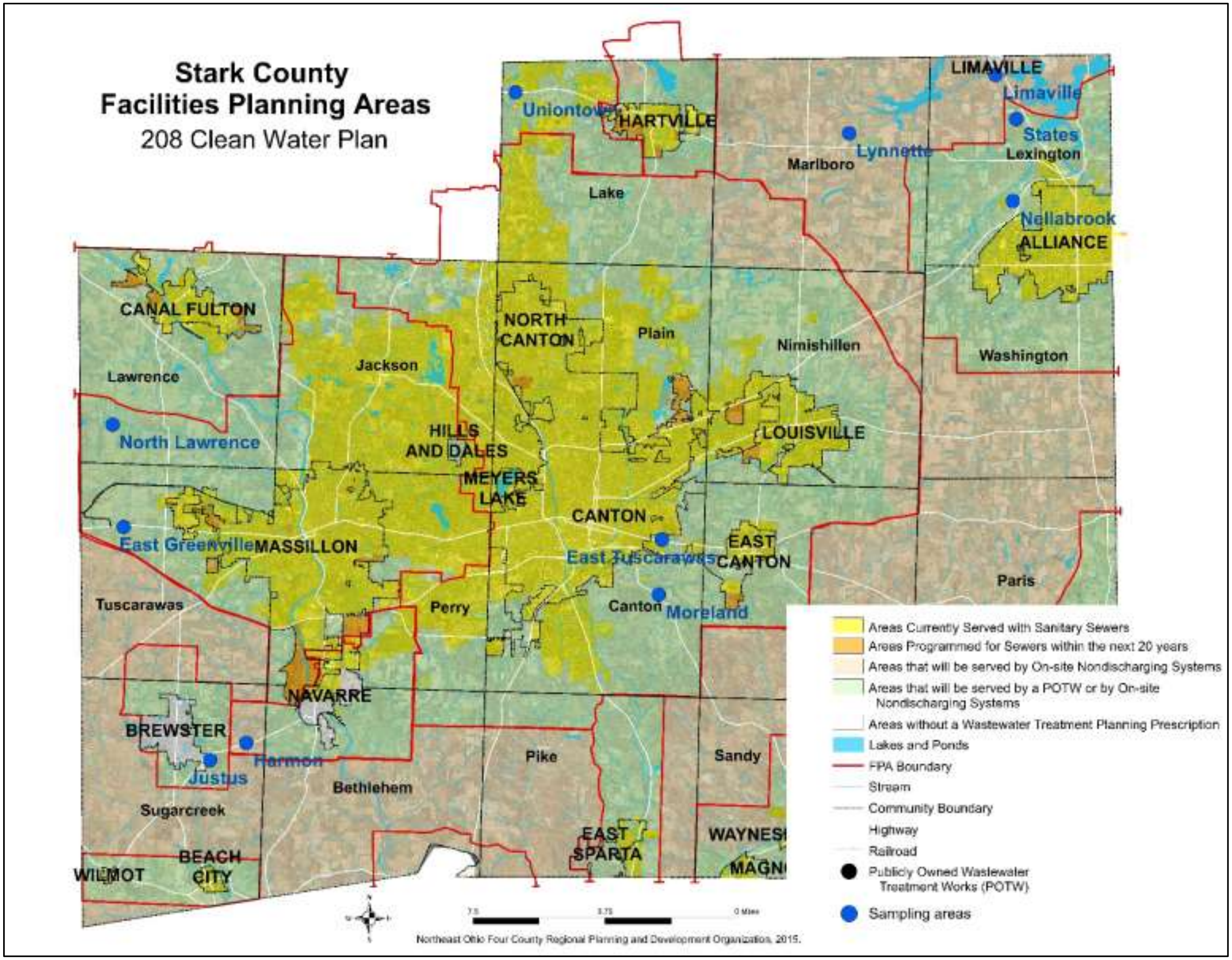
The Clean Water Act specifies water quality planning requirements in Sections 205(j), 208, and 303. Section 208 was meant to establish integrated and coordinated facility planning for wastewater management. Areawide planning agencies, which were designated by a state's Governor, were given the task of creating 208 water quality management plans for their jurisdictions. NEFCO is one such agency, and is the agency for Portage, Stark, Summit, and Wayne Counties. Chapter 3 of NEFCO's 208 plan deals with Wastewater Management Facilities Planning (Appendix 4). One of the objectives of the 208 plan is to establish Facilities Planning Areas (FPAs). An FPA is a designated geographical area that has the ability to treat wastewater in various ways. There is a designated management agency (DMA) within each FPA. A DMA is an entity that has adequate authority to carry out specific water quality programs and responsibilities. The DMAs identified areas that were:

1) currently served with sanitary sewers;
2) expected to be served with sanitary sewers in the next twenty years;
3) served with a publicly-owned treatment works (POTW), home sewage treatment systems (HSTSs), or semi-public sewage disposal systems (SPSDSs)/private wastewater treatment systems (PWTSs);
4) served by non-discharging HSTSs, PWTSs, and SPSDSs;
5) without a wastewater treatment planning prescription.

In counties where a countywide sewer district exists, the county's sanitary engineering office serves as the DMA for the unincorporated areas, including the townships. On-site discharging systems will only be approved if the Ohio EPA does not mandate sewers due to a demonstrated water quality problem, as stated by ORC 6117.34 (Appendix 4, Policy 3-3; ORC 6117.34).

The FPA boundaries were used in this study to determine the wastewater planning prescription for the eleven sampling areas. Wastewater planning prescriptions are options that represent current judgments about where sewers will be extended and where areas will remain unsewered over the next 20 years. The designated management agencies in Stark County that have sampling areas within their jurisdiction are the City of Alliance, the City of Canton, the City of Massillon, the Village of Brewster, the Village of Navarre, and the Stark County Metropolitan Sewer District (SCMSD). Uniontown is under the jurisdiction of the Summit County Metropolitan Sewer District Map 2, Appendix 5). The Alliance FPA has the Nellabrook Allotment and the States streets. The Canton-Nimishillen FPA has East Tuscarawas and the Moreland Allotment. North Lawrence and East Greenville are within the Massillon FPA. Justus is in the Brewster FPA, while Harmon is part of Navarre's FPA. Uniontown is in the Springfield #91 FPA from Summit County. Limaville and Lynnette are included in the Stark County MSD's area.

Limaville does not have a wastewater treatment planning prescription. Lynnette and Harmon are in areas that are programmed to be served by on-site non-discharging systems. The majority of the areas (States, Nellabrook, Uniontown, East Tuscarawas, Moreland, North Lawrence, and East Greenville) are prescribed to be treated in one of three ways. They can be treated by a publicly-owned treatment works for wastewater (POTW), a semi-public sewage disposal system, or by a home sewage treatment system (HSTS). The Village of Brewster within the Justus sampling area does not have a wastewater treatment planning prescription (the schools), and half is in the area that is prescribed to be treated by a POTW or an HSTS (single family homes). Half of Uniontown, Nellabrook, and East Tuscarawas are already served by sewers, so the areas in which samples were taken are not serviced by sewers.




*Map 2: Stark County FPAs with sampling areas*

# Risk Assessment

## *Volume*

The number of bedrooms in a house is a good indicator of how large a septic system should be, and how frequently it should be pumped. For each sampling area, census data were used to determine the number of bedrooms for each house with a home sewage treatment system. The number of bedrooms per sampling area was then averaged. This average did not include commercial or institutional sites such as businesses or nursing homes. The average number of bedrooms for each site ranged from two to three bedrooms. This indicates that the majority of dwellings in these sampling areas were single-family homes.

The number of bedrooms was also used to determine an estimate of sewage flow for each area. The Ohio EPA suggests using a rate of 120 gallons per day (gpd) per bedroom as an estimate for sewage flow from a single family dwelling (OEPA, 2013). For each individual dwelling in each area, the estimated sewage flow was calculated, and then summed for the entire area. For the majority of the areas, the sewage flow estimates were not calculated for businesses /institutions, as staff were unable to find the proper information necessary for these calculations. The estimated sewage flow for each area can be found in Appendix 2. It should be noted that Uniontown had a much higher estimated sewage flow rate (86,940 gpd) than the next highest estimation (≤ 44,430 gpd).

*Table 4: Sewage Flow Rate*

| Site | Gallons per day |
|---|---|
| Uniontown | 86,940 gpd |
| Moreland | 44,430 gpd |
| East Greenville | 43,140 gpd |
| Justus | 42,000 gpd |
| East Tuscarawas | 31,392 gpd |
| Nellabrook | 30,720 gpd |
| North Lawrence | 30,470 gpd |
| Harmon | 25,680 gpd |
| States | 25,080 gpd |
| Limaville | 23,730 gpd |
| Lynnette | 14,160 gpd |

## *Density*

The density of failing systems in an area is another indicator that was used to prioritize failing systems. The density was calculated per area as can be seen in Table 5. Risk Weights were assigned. The areas where there are 1-2 acres per home were given a score of 1. Densities of 0.51-0.99 were given a 2, and 0.50-0.1 scored a 3

*Table 5: Site Density*

| Site | Housing Acres Per Home | Risk Weight |
|---|---|---|
| Moreland | 0.5 | 3 |
| Justus | 0.5 | 3 |
| Harmon | 0.8 | 2 |
| Limaville | 0.7 | 2 |
| North Lawrence | 0.8 | 2 |
| East Tuscarawas | 0.8 | 2 |
| East Greenville | 0.9 | 2 |
| Uniontown | 0.6 | 2 |
| States | 1.8 | 1 |
| Lynnette | 1.0 | 1 |
| Nellabrook | 1.0 | 1 |

Risk Weights
*1-2 per acres =1*
*0.51-0.99 per acres = 2*
*0.50-0.1 per acre=3*

## *Pollution Potential*

Land Cover

Land cover data for each of the eleven areas was determined using GIS (Geographical Information System). For each sampling area, a separate layer was created that included all parcels (properties) within that area. The land cover layer was then modified to only include data within the parcel layer. This was to make sure the calculation only included the houses within the sampling area. The count of the different types of land cover were summed, and then converted to percentages.

There were six major types of land cover found within the eleven sampling areas. They were water, developed areas, agriculture, forest, shrub/grasslands, and wetlands. Open water, shrub/grasslands, and wetlands were less than 5% of the land cover in any of the areas. Developed areas, agriculture, and forest were the most common type of land cover. The percentage of these three types are shown below for each of the sampling areas (Table 6).

*Table 6: Percentage of developed areas, agriculture, and forests for each of the sampling areas*

| Sampling Area | Developed areas | Agriculture | Forest |
|---|---|---|---|
| East Greenville | 21.1 | 77.3 | 1.0 |
| East Tuscarawas | 86.9 | 0.0 | 10.7 |
| Harmon | 56.0 | 32.0 | 9.5 |
| Justus | 39.0 | 29.0 | 31.5 |
| Limaville | 31.8 | 35.8 | 25.6 |
| Lynnette | 26.8 | 71.7 | 1.5 |
| Moreland | 65.7 | 23.3 | 10.4 |
| Nellabrook | 73.9 | 11.6 | 9.7 |
| North Lawrence | 73.2 | 23.5 | 3.3 |
| States | 34.0 | 9.4 | 52.7 |
| Uniontown | 85.0 | 0.4 | 11.8 |

Knowing the major types of land cover in an area is useful for assessing pollution potential. In developed areas, water and sewage are likely to flow faster due to impervious surfaces. Therefore, pollution of the waterways can happen faster and in higher quantities since there is less vegetation to filter out the pollutants. A high presence of agriculture in an area can contribute other pollutants besides sewage to the waterways (e.g., manure and nitrogen and phosphorous run-off). Having a forest or riparian corridor present can reduce the flow rate of runoff entering the waterway and remove pollutants before they reach the stream or other water body.

<u>Travel time</u>

Travel time describes the amount of time it takes for wastewater to travel to the nearest body of water. The formula for travel time was given to NEFCO from the SCMSD. This formula only accounts for water traveling over the surface; it does not take into account water flowing through pipes. The formula is:

$$Tf = L/60V$$

*Tf* = travel time in minutes
*L* = flow length in feet
*V* = velocity (ft./sec)

Where: $V = wSo^{1/2}$

*So* = slope (ft./ft.)
*w* = 16.1 for unpaved areas, and 20.3 for paved surfaces

The travel time was calculated for a central location within each area. A central point was chosen in order to get an average distance for each sampling area to the nearest body of water. Flow length was measured in feet using GIS. Slope was determined using GIS soil data from the

United States Geological Survey. For the central point, *w* was determined by whether the flow would travel over more paved or unpaved areas to get to the nearest water source.

Travel times over land for a central point to the nearest body of water can be found in Appendix 5. These numbers were compared to wastewater traveling through storm lines to show how quickly area flows travel to the streams. To see the numbers used for determining velocity through pipes, see Appendix 6 (provided by the SCMSD). These velocities were then used to determine the potential travel time of wastewater through storm sewers flowing to streams or other water sources.

Surface Water Pollution Potential

Surface water pollution potential takes into account if there are storm sewers discharging directly into surface water, whether the areas affect a nearby surface drinking water source, and if there is a riparian corridor present to filter out wastewater pollutants. Pipes that discharge directly into surface water mean that the wastewater is not being filtered at all before entering the water. The presence of riparian corridors was determined by GIS. Limaville, Lynnette, and the States streets are all within the Deer Creek watershed (subwatershed of the Mahoning River). The Deer Creek watershed drains into the Deer Creek and Walborn reservoirs. These two reservoirs are the only sources of surface drinking water in Stark County (Table 7). The rest of the county's drinking water is supplied by groundwater. Further information on the Deer Creek watershed can be found in a separate NEFCO study (NEFCO Deer Creek and Walborn Reservoir Watershed Study, Unpublished Draft Report).

*Table 7: Surface pollution potential factors for the individual sampling areas*

| Site | Surface drinking water source? | Riparian corridor? | Storm water Pipes present? | Pipe travel time (minutes) | Overland travel time (minutes) |
|---|---|---|---|---|---|
| Limaville | Yes | Yes | Yes | 0.6 | 355 |
| Lynnette | Yes | No | Yes | 1.05 | 54 |
| States | Yes | No | Yes | 1.26 | 129 |
| Nellabrook | No | No | Yes | 1.0 | 51 |
| Uniontown | No | No | Yes | 5.57 | 1077 |
| East Tuscarawas | No | No | Yes | 2.1 | 845 |
| Moreland | No | Yes | Yes | 2.98 | 576 |
| North Lawrence | No | Yes | Yes | 1.88 | 601 |
| East Greenville | No | No | Yes | 2.06 | 422 |
| Justus | No | No | Yes | 0.83 | 169 |
| Harmon | No | No | Yes | 1.86 | 379 |

Each of these factors were then given a ranking scale. All areas were found to have storm sewers discharging directly into a waterbody. These received a +1 due to the direct discharge. If there was no riparian corridor present in the areas or downstream, the areas received another +1. Areas that had a riparian corridor of 30 feet or wider received a 0. The rating from all of these factors was then combined to rank the areas from most likely to contaminate surface waters, to least likely

If the sampling area affected a surface drinking water source, it received a +1.

*Table 8: Surface Pollution Potential Ranking*

| Site | Surface Pollution Potential Score |
|---|---|
| Lynnette | 3 |
| States | 3 |
| Limaville | 2 |
| Nellabrook | 2 |
| Uniontown | 2 |
| East Tuscarawas | 2 |
| East Greenville | 2 |
| Justus | 2 |
| Harmon | 2 |
| Moreland | 1 |
| North Lawrence | 1 |

Overland pipe travel time as well as the overall surface water pollution potential are difficult to quantify. There is often not enough data, and it is difficult to get precise numbers without spending a large amount of time and resources. These parameters were included in this study because they are related to environmental and health concerns and should be accounted for. A further study of travel time and surface water pollution could reveal more detailed information regarding pollution via septic systems.

Groundwater pollution potential

Groundwater pollution potential was determined using DRASTIC (Appendix 7). DRASTIC is a methodology used to determine the potential for groundwater pollution by using hydrogeologic parameters. These parameters and their respective weights (in parentheses) are as follows:

**D** – Depth to water (5)
**R** – (Net) Recharge (4)
**A** – Aquifer media (3)
**S** – Soil media (2)
**T**– Topography (slope) (1)
**I** – Impact of Vadose Zone media (5)
**C** – (Hydraulic) Conductivity of the aquifer (3)

For each sampling area, these parameters were found using the Web Soil Survey (USDA). The formula for DRASTIC was then calculated for each area:

$$D_R D_W + R_R R_W + A_R A_W + S_R S_W + T_R T_W + I_R I_W + C_R C_W = \text{Pollution Potential}$$

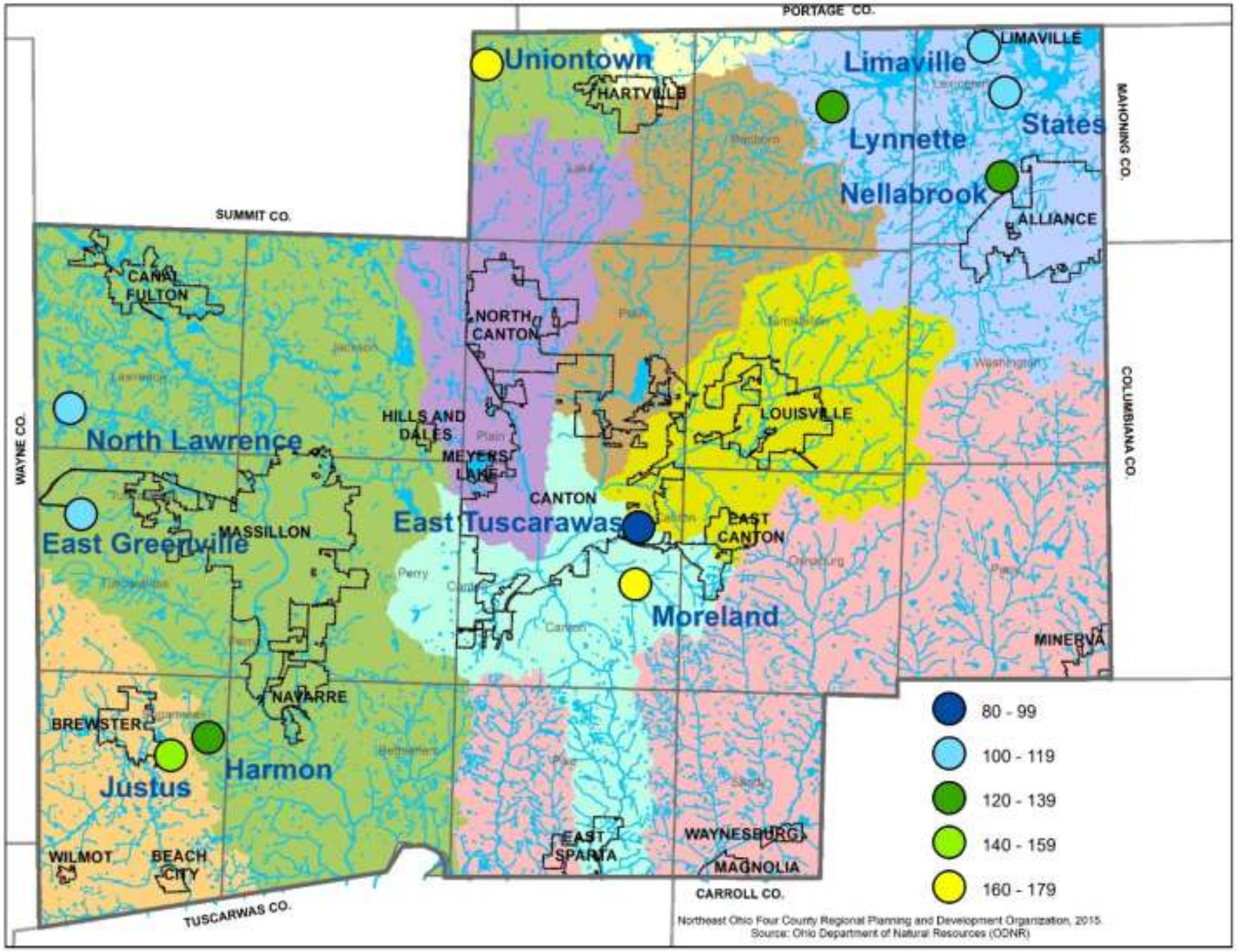
*R* = rating
*W* = weight

When the DRASTIC rating is a higher number, there is a greater risk of groundwater pollution. The Ohio Department of Natural Resources used DRASTIC to determine the groundwater pollution potential for Stark County (ODNR, 1991). NEFCO decided to use the pollution potential determined by the ODNR, rather than the numbers calculated, to save time and to keep from repeating work and results already generated. The information from the ODNR was gathered from a map that broke down the county into generalized ranges of DRASTIC (Appendix 8). Since these results are generalized per area, caution should be used when looking at individual properties, and a soil test for each property should be conducted.

The groundwater pollution potential for the sampling areas is shown below, from the highest chance of groundwater pollution to the lowest (Appendix 2; Table 9; Map 3). In this case the greater the number the higher the risk.

*Table 9: Groundwater pollution potential factors for the individual sampling areas*

| Site | GW pollution potential |
|---|---|
| Uniontown | 160-179 |
| Moreland | 160-179 |
| Justus | 140-159 |
| Harmon | 120-139 |
| Lynnette | 120-139 |
| Nellabrook | 120-139 |
| Limaville | 100-119 |
| North Lawrence | 100-199 |
| East Greenville | 100-119 |
| States | 100-119 |
| East Tuscarawas | 80-99 |




*Map 3: The groundwater pollution potential for the eleven sampling areas.*

*The DRASTIC rating is shown in the legend. A higher rating indicates higher pollution potential.*

<u>Total Maximum Daily Loads</u>

Watersheds can be assigned TMDLs (total maximum daily loads) for pollutants by the Environmental Protection Agency. A TMDL is the amount of pollutant that can be assimilated by a water body without a violation of water quality standards, and includes wasteload allocations for point sources, load allocations for nonpoint sources, and a margin of safety. The Northeast Ohio Stormwater Training Council (NEOSWTC) compiled TMDL information for many watersheds in the Northeast Ohio region. NEFCO used the TMDL community identifier table from NEOSWTC to determine the TMDLs for the Mahoning River, Nimishillen Creek, and Tuscarawas River watersheds (NEOSWTC, 2015). The Sugar Creek watershed was not covered in the TMDL community identifier table, so NEFCO found the TMDLs for Sugar Creek via the Ohio EPA website (2002).

Each of the four watersheds had several TMDLs (Table 10). The Ohio EPA also thinks there should be a TMDL for bacteria in the Sugar Creek Watershed, but there was insufficient data to conclude the need for this TMDL.

*Table 10: TMDLs for the four watersheds included in this study.*

| TMDL | Upper Mahoning | Tuscarawas | Nimishillen | Sugar Creek |
|---|---|---|---|---|
| Bacteria | X | X | X | |
| Phosphorous | X | X | X | X |
| Nitrogen | | | | X |
| TSS | X | X | | X |
| Habitat | X | X | X | X |

*The X's indicate that a TMDL is in place for that pollutant within the listed watershed.*

Bacteria is possibly the most important TMDL for this study. A TMDL for bacteria means that there is an excessive amount of fecal coliform and *E. coli* in the water (Appendix 9). These two types of bacteria are associated with fecal waste from warm-blooded animals (e.g., humans, livestock, pets, and wildlife). As a result, the biggest contributors of fecal bacteria to the water are failing septic systems, treated wastewater effluent, stormwater runoff, and agriculture. These are indicators of the potential presence of disease-causing bacteria in the water.

Phosphorous and nitrogen are also important nutrient TMDLs for this study (Appendix 10). An excessive amount of nutrients in the water can lead to many problems, such as harmful algal blooms and public health warnings. The harmful algal blooms can then affect drinking water or recreational use of surface water resources. For further information on harmful algal blooms, consult the Ohio EPA website or Appendix 1. The biggest contributors to nutrient loading in aquatic ecosystems are failing septic systems, treated wastewater effluent, stormwater runoff, and agriculture.

Total suspended solids (TSS) are solids found in water that can be trapped by a filter (Appendix 11). This can include a wide variety of materials, such as sewage, soil, decaying plant and animal matter, and industrial wastes. A high amount of TSS in the water leads to a decrease in the quality of life for many aquatic organisms, but also can indicate a high amount of nutrients or bacteria in the water. TSS can be caused by high water flow rates, erosion, stormwater runoff, failing septic systems, treated wastewater effluent,, and organic matter.

Habitat degradation (Appendix 12) refers to the decreasing health of aquatic ecosystems. This includes less suitable habitat for aquatic organisms, along with a decreasing riparian corridor. The riparian corridor consists of vegetation that can filter and decrease the travel time of water entering the aquatic ecosystem. As a result, the riparian corridor can help filter water than may contain sewage before it reaches the water body. Though habitat degradation is not directly related to failing septic systems, it is a factor that affects the health of all aquatic ecosystems.

## Escherichia Coli

### *Methods*

The sampling protocol used for *Escherichia coli* (*E. coli*) was as determined by OAC Rule 3745-1-04 (F) & (G) (Appendix 13). Samples were taken by NEFCO and SCHD employees twice at each site. Sampling occurred after 72 hours of dry weather, as suggested by the Ohio EPA. While out in the field, odor level and any visual manifestations of septic system failure were documented. Samples were stored on ice until delivered to the laboratory at the Stark County Metropolitan Sewer District that same day. Staff at SCMSD then performed laboratory analyses to determine the number of *E. coli* colonies per 100 milliliters. A typical Chain of Custody protocol was followed

According to the OAC Rule 3745-1-04 (F) (1) (b), a public health nuisance exists when the number of *E. coli* colonies exceeds 576 colonies per 100 milliliters (OAC 3745). Samples for each site were ranked on a scale from zero to four (Map 4):

0–576 colonies = 0
577–1,152 colonies = 1
1,153–5,760 colonies = 2
5,761–62,000 colonies = 3
111,000+ colonies = 4

1,152 was chosen as an end point of the “1” score because it is twice the Public Health Nuisance Level or allowable limit. Similarly, 5,760 was chosen as an end point to “2” because it is ten times the allowable limit. NEFCO chose to split the scale between 62,000 (over 100 times the limit) and 111,000 (under 100 times the limit) colonies, because those were outlying data found at sampling. The sum of the ranks for each site was calculated, and then divided by the number of samples for that site. This number for the two dates was then averaged, and used as a “qualifier” to rank the areas from worst to best.

In Limaville, in the first round of the six samples taken, five were over the E.coli available limit with the total percentage exceeding the Public Health Nuisance Level at 71.4 percent. The highest count was 141,000, well over the 576 limit. In the second round of sampling, again five out of six were above the E.coli limit with the same 71.4 percent over the limit of which the highest count was 2,000. During both rounds sewage fungus was observed.

| | |
|---|---|
| 0 – 25% = 1 | 51 – 75% = 3 |
| 26 – 50% = 2 | 76 – 100% = 4 |

Maps showing each sampling site within the sampling areas were created in GIS. The shapes depict the types of sampling sites (e.g., storm drain versus open ditch). The colors show the average *E. coli* ranking over the two sampling rounds. See Appendix 14 for the individual maps of each sampling area.

It should be noted that these *E. coli* sampling numbers can change based on many variables. It was not feasible to sample all the areas on the same day. As a result, there could be differences in *E. coli* numbers due to different weather, varying amounts of dilution of the sewage, and varying levels of sewage flow, to name a few variables.

## *Results*

### Bacteria Levels

Every sampling area, except for Uniontown, had samples that were over the *E. coli* allowable limit. When looking at the *E. coli* qualifiers for each sampling area, Harmon had the worst samples overall (Appendix 2 and 14). The ranking of the areas from worst to best is as follows:

*Table 11: Bacteria Results*

| Site | Bacteria Results |
|---|---|
| Harmon | 2.75 |
| North Lawrence | 2.67 |
| Moreland | 2.5 |
| Limaville | 2.17 |
| States | 2 |
| East Tuscarawas | 1.86 |
| Lynnette | 1.085 |
| Justus | 1.08 |
| Nellabrook | 1 |
| East Greenville | 0.875 |
| Uniontown | 0.6 |

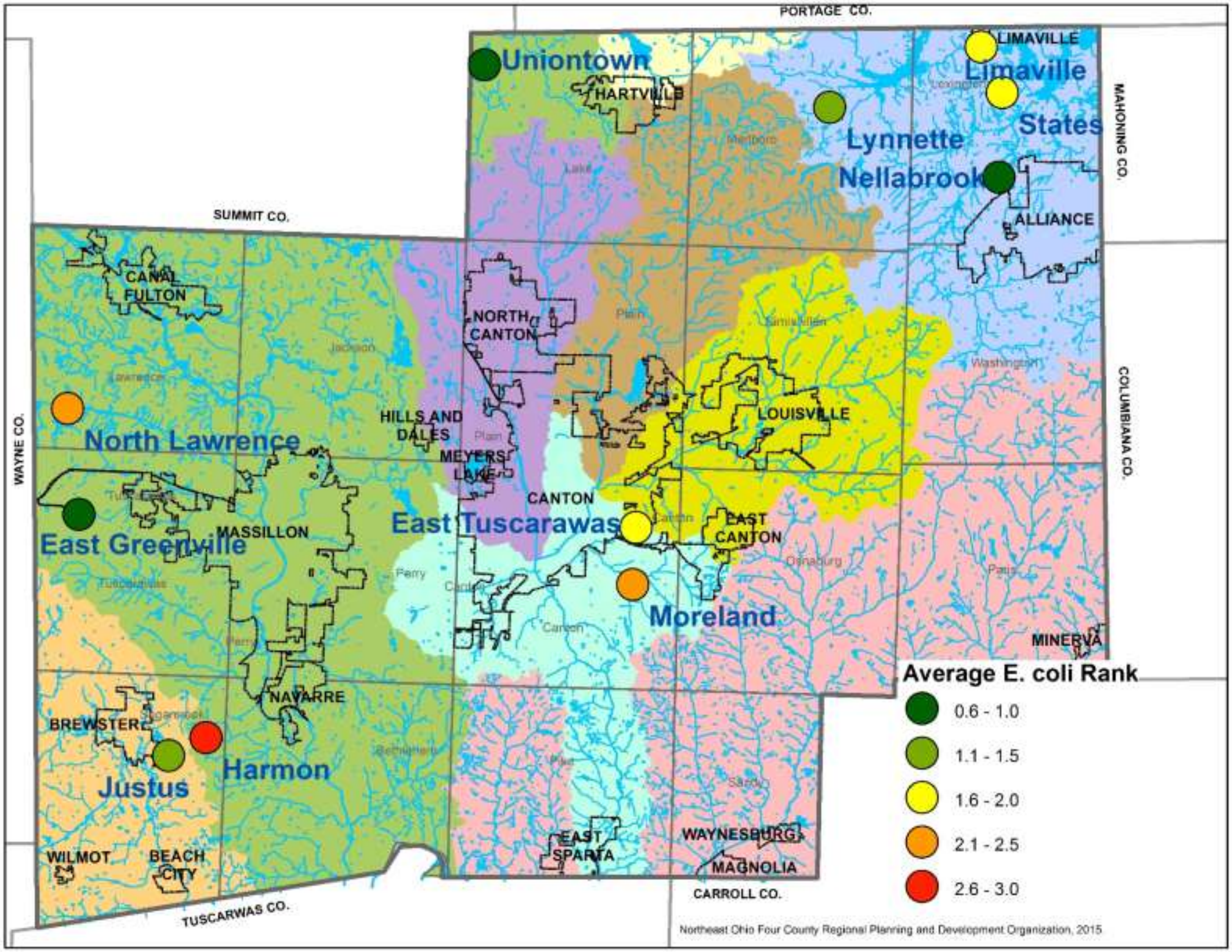
When looking at the average percent of samples over the limit for each sampling area, Harmon had the highest percent of samples over the *E. coli* limit (100%), and Uniontown had the lowest (0%). The sampling areas and the average percent of their samples over the limit is below (Table 12):

*Table 12: Percent of samples over the limit:*

| Site | % |
|---|---|
| Harmon | 100 |
| Moreland | 83.3 |
| States | 80 |
| Limaville | 71.4 |
| North Lawrence | 71.4 |
| East Tuscarawas | 57.1 |
| Lynnette | 57.1 |
| Nellabrook | 50 |
| Justus | 41.7 |
| East Greenville | 30 |
| Uniontown | 0 |

*(576 E Coli colonies per 100 milliliters)*

For the areas where a stream traversed through the development, an upstream and downstream sample was taken. For three of the areas (States, North Lawrence, and East Greenville), the downstream sample had much higher *E. coli* than the upstream sample, which indicates that these systems are failing and polluting the streams. In Lynnette and Nellabrook, the upstream sample was higher for one of the two sampling dates. For Nellabrook and Limaville, the upstream and downstream samples were about the same for both dates. These upstream samples were not included when examining the percentage of samples over the limit or the *E. coli* qualifiers.




*Map 4: The average rank of each area based on E. coli colonies in the samples.*

<u>Visual Observances</u>

There were several types of visual observations found at the sampling areas over the two sampling dates. Raw sewage was seen at several of the sampling areas. Sewage fungus and algae can grow as a result of sewage in waterways, and were seen in a few of the areas (Fig. 3).

Raw sewage can appear as white, black, or any shade of gray in between, in surface waters (Fig. 1; Appendix 13). There also may be a film on the surface of the water as a result of organic oils reflecting light (Fig. 5). Residues from sewage effluent, such as degrading toilet paper, were also seen at several sampling sites. At a couple of sites, sewage was seen flowing over the surface of the ground (Fig. 2), which indicated that the septic system or one nearby was failing.

*Figure 1: Raw sewage found in a ditch in North Lawrence*

*Figure 2: Water flowing over the ground as a result of flushing in a nearby house*

Sewage fungus is a mass of filamentous fungi and bacteria (mostly *Sphaerotilus*) that grows in water affected by organic matter (Hynes, 1960). It can appear as wool-like plumes that are white, gray, or brown in color (Fig. 3). Sewage fungus can grow within two to three days of the water receiving fecal matter, and will persist until the effluent stops. It is unsightly, and can lead to the deoxygenation of the aquatic habitat in large quantities. Sewage fungus was seen in streams and stormwater drains at several of the sampling areas.

*Figure 3: Sewage fungus growing in a stormwater pipe in Moreland*

Algal growth can result in ditches and streams that are receiving sewage effluent (Figs. 4 & 5). Fecal matter is high in nutrients, specifically nitrogen and phosphorous. Nitrogen and phosphorus are important nutrients for plant and algal growth. When an excess amount of nutrients are added to an aquatic ecosystem, it can cause unchecked algal growth. Sometimes this just results in a visible algal film or colony in the stream or lake, but sometimes it can cause harmful algal blooms. As a result, a large amount of algae in a stream or ditch could indicate that sewage effluent is entering the water body. However, we also must keep in mind that agricultural runoff can also contribute to algal growth in water bodies.

*Figure 4: Ditch full of algae behind houses in Justus with failing septic systems.*

*Figure 5: Oils and algae in a ditch in Justus*

Odor Ranking

Odor can be an indication of septic system failure, even when no visual evidence can be found. The odor from septic systems and sewage can be described as a “rotten egg” smell. These odors can have adverse health effects, such as headaches and nausea, and altering appetites, sleep, and breathing (Appendix 13). An odor level of two or above from sewage is considered a violation of OAC rule 3745-1-04 (F) (1). The SCHD received odor complaints from residents in almost all of the sampling areas. The average odor for each of the areas (both sampling dates) is ranked below, from worst to best (Table 13).

Odor level was documented at each sampling site during sample collection. The odor level was assigned a number based on the following scale, as suggested by the Ohio EPA:

No odor = 0
Odor threshold (very slight) = 1
Slight odor = 2
Moderate odor = 3
Strong odor = 4

The odor level was then averaged for each sampling area, and ranked based on the average.

*Table 13. Average Odor (as Discovered during Sampling Events)*

| Site | Average Odor |
|---|---|
| Moreland | 2.67 |
| North Lawrence | 1.79 |
| East Tuscarawas | 1.65 |
| Limaville | 1.43 |
| East Greenville | 1.3 |
| Harmon | 1 |
| States | 0.9 |
| Justus | 0 |
| Nellabrook | 0.8 |
| Lynnette | 0.73 |
| Uniontown | 0.2 |

# Cost Analysis

The criteria discussed in this section were included for logistical considerations. These factors were not included in the final ranking. However, having this data available for the SCHD, SCMSD, and other entities can help those departments make final decisions regarding the installation of sewers in the various areas.

## *Proximity and Costs of Sewers*

The SCMSD analyzed the costs of implementing sewers in each of the areas, and gave this information to NEFCO. NEFCO then organized the data and determined in which areas it would be the most economically feasible to construct sewers. The SCMSD also provided information regarding where each area would connect to pre-existing sewer lines, if possible.

The cost of building sewers in each of the areas included any potential wastewater treatment plants (WWTP) or pump/lift stations. When looking at the total cost of construction, the areas are ranked from least to most expensive. Even though the areas are ranked, the cost for the majority of the areas are in the same range, so some of the differences in cost are negligible (Appendix 14).

Three of the sampling areas already have sewers in place for a portion of the area. These three are Uniontown (serviced by Summit County), Nellabrook (serviced by Alliance), and East Tuscarawas (serviced by Canton). North Lawrence is too far away from other areas to connect to pre-existing sewer lines. As a result, this area would require that a new WWTP be built in order to service their residents with sewers. This new WWTP would then need a NPDES permit to discharge its wastewater. All of the other study areas have the capability to connect to pre-existing sewers through sanitary pump and lift stations. Limaville will most likely be served using a combination of gravity sewers and low pressure grinder pumps, which ultimately discharge into a central pump station south of Limaville. The pump station will pump the wastewater south along SR 183 into the City of Alliance where it will discharge into one of the City's trunk sewers to be treated at the Alliance WWTP. Both the States and the remaining homes in Nellabrook would also connect to the Alliance WWTP via sanitary lift stations. Lynnette would connect to the new sewage treatment plant in Marlboro Township. In Uniontown, the homes that are currently serviced by HSTSs would be connected to the other sewers within Uniontown. The wastewater would then be pumped to Summit County, as the current wastewater is. In East Tuscarawas, new sewers would be connected to the pre-existing sewers already in place, and then pumped to Canton's WWTP. Moreland's sewers would be pumped through Waco to Canton's WWTP via a sanitary lift station. East Greenville would connect to Massillon's WWTP through a sanitary lift station. Harmon would be connected to Justus along US 62 via a sanitary lift station. Justus would then connect to Brewster through another sanitary lift station.

Limaville already has some funds available in order to build sewers. The Army Corps of Engineers has contributed funds to finance a portion of the project. Grants and loans may be available to fund more of the sewer construction costs in Limaville; some of these are available from the Ohio Water Development Authority (OWDA). A number of residents in this area may have some assistance in paying the assessment fee. The estimate for Limaville listed in Table 14 is the SCMSD's expense without the Army Corps of Engineer's funding.

*Table 14: Estimated Costs to Provide Sewers to the Identified Unsewered Areas**

| PROJECT AREA | OPINION OF PROBABLE CONSTRUCTION COSTS | EXISITNG STRUCTURE CONNECTIONS | AVERAGE COST/ CONNECTIONS |
|---|---|---|---|
| UNIONTOWN | $2,600,103 | 200 | $13,001 |
| JUSTUS | $1,752,109 | 120 | $14,601 |
| MORELAND ALLOTMENT | $2,479,721 | 151 | $16,422 |
| EAST GREENVILLE | $2,343,000 | 122 | $19,205 |
| LINCOLN ST. EAST, WEST OF TRUMP | $2,411,962 | 98 | $24,612 |
| HARMON AREA | $1,178,719 | 50 | $23,574 |
| NELLABROOK ALLOTMENT | $2,369,414 | 84 | $28,207 |
| LYNNETT ST. | $1,412,378 | 47 | $30,051 |
| FLORIDA,PENNSLYVANIA,INDIANA ST. | $2,918,212 | 92 | $31,720 |
| LIMAVILLE VILLAGE | $2,500,000 | 62 | $40,323 |
| NORTH LAWRENCE | $4,151,279 | 101 | $41,102 |

* - Costs do not include connection fees, lateral construction costs or the cost of septic tank abandonment

## *Sewer vs. replacement cost*

The costs for connecting to sewers was provided by the SCMSD. Costs for pumping and replacing septic systems was provided by the SCHD.

### Sewers

The costs for connecting to sewers can vary based on the property. As a result, the numbers provided by the SCMSD are for a yard with a front footage of 100 feet. Most residences would be close to this number. For Stark County, the connecting and permit fees for existing sewers is about $2,050. If the sewer project includes a property assessment, which most do, the assessment fee, historically, is about $6,960 without extra grant money. Assessments may vary based on County Commissioners funding availability and commitment level. Each resident is then responsible for abandoning the existing septic tank, costs of which can vary based on the type of septic system. The resident would also pay for tying the lateral to the main sewer line. The overall estimated cost of connecting to sewers would be expected to be between $10,000 and $12,000 for the property owner. However, some of the areas will have funding available to help residents and lower the cost for each individual property owner. All estimates are based on an average across Stark County; each individual property might have higher or lower costs based on the site assessment.

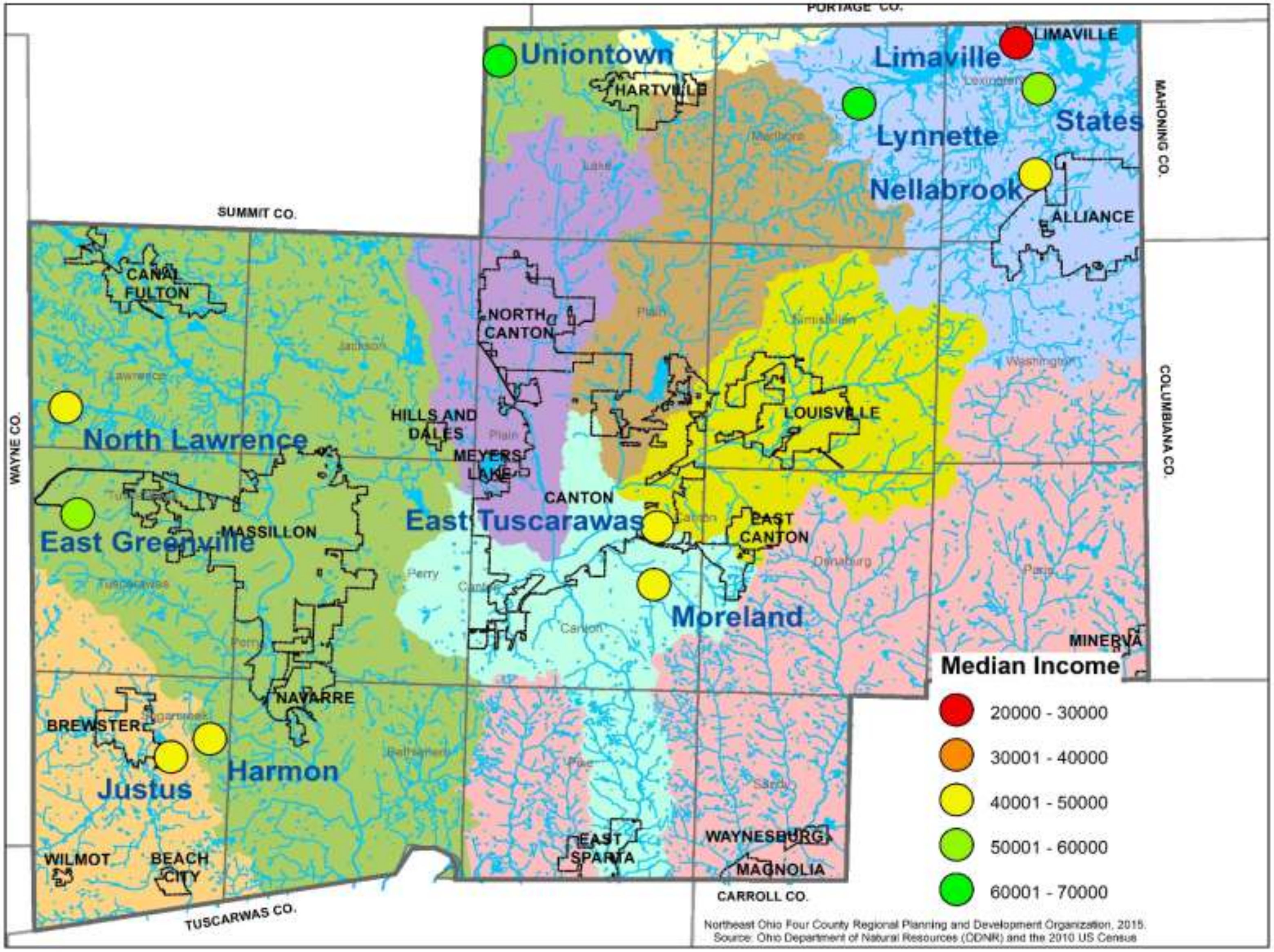
Septic Systems

The costs of septic systems vary, based on the size and type of system needed. Pumping out the system should occur every 1–3 years, depending on tank size and frequency of use. As a result, pumping cost can vary based on tank size and use, but usually range from $170-$200 for a 1,000 gallon tank. The average cost for replacement of septic systems within Stark County is $9,616 (January 2013 to present). Many replacement systems in Stark County are aerobic treatment systems, which require a maintenance contract, electric use, periodic pump/compressor/component replacement and, if discharging, yearly sampling. The cost for this is $70 a month over a period of five years. Leach field systems tend to be cheaper to operate, but many of the soils in Stark County are limited for this type of system.

Connecting to sewers would be expensive for the homeowner, but would be less expensive over time than septic systems. Once put in place, the only cost for sewers would be the bi-monthly fee of $53.00. Maintenance of the sewers is the responsibility of the SCMSD. Septic systems require maintenance by the homeowner, and thus the cost of upkeep fall on the homeowner.

### *Median Household Income*

Median household income information was gathered from the 2010 United States Census. The census block group for each sampling area was found, and the median household income was recorded. The sampling areas are ranked from highest median income to the lowest (Appendix 15; Map 5). This is under the assumption that those areas with higher incomes would be better able to afford the cost of connecting to sewers. This ranking does not take into account the potential additional assistance available for Limaville.




*Map 5: Median income for the eleven sampling areas (based on 2010 census data).*

# Conclusion/Recommendations

After review of these criteria, NEFCO worked with the SCHD and SCMSD and presented these finding to NEFCO's Environmental Resources Technical Advisory Committee (ERTAC) for review and comment. The final criteria selected for prioritization included age weighted risks, density housing risks, soil suitability risks, surface water potential pollution, drinking water supply source, and E coli qualifier levels. Additional qualifying indicators not included in the overall composite score but, nonetheless important, included percent E coli, odor scores, estimated flow of sewage, and groundwater pollution potential. NEFCO suggests that the priority of extending sewers to these areas based on environmental and health concerns is as listed in Table 15. The Stark County Sewer Technical Advisory Committee developed an approach to ranking the areas based on the NEFCO criteria but modified to include other logistics (see Appendix 15). (5-12-2016)

*Table 15 Environmental Scores and Ranking*

| | CRITICAL FACTORS | | | | | | OTHER INDICATORS | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site | Age Weighted Risk | Soil Suitability Risk | Housing Density Risk | Surface Pollution Potential | E Coli Level Qualifiers | SCORE COMPOSITE (Sum) | Estimated Sewage Flow | Groundwater Pollution Potential | Percent E Coli | Odor Score |
| Harmon | 2.69 | 2 | 2 | 2 | 2.75 | **11.44** | 25,680 | 120-139 | 100 | 1 |
| Limaville | 2.45 | 2.75 | 2 | 2 | 2.17 | **11.37** | 14,160 | 100-119 | 71.4 | 1.43 |
| States | 2.34 | 3 | 1 | 3 | 2 | **11.34** | 25,080 | 100-119 | 80 | 0.9 |
| Moreland | 2.41 | 2 | 3 | 1 | 2.5 | **10.91** | 44,430 | 160-179 | 83.3 | 2.67 |
| East Tuscarawas | 2.43 | 2.5 | 2 | 2 | 1.86 | **10.79** | 31,392 | 80-99 | 57.1 | 1.65 |
| Justus | 2.40 | 2 | 3 | 2 | 1.08 | **10.48** | 42,000 | 140-159 | 41.7 | 0 |
| East Greenville | 2.71 | 2.5 | 2 | 2 | 0.875 | **10.99** | 43,140 | 100-119 | 30 | 1.3 |
| North Lawrence | 2.81 | 1.5 | 2 | 1 | 2.67 | **9.98** | 30,470 | 100-119 | 71.4 | 1.79 |
| Nellabrook | 2.5 | 3 | 1 | 2 | 1 | **9.5** | 30,720 | 120-139 | 50 | 0.8 |
| Lynnette | 2.09 | 2 | 1 | 3 | 1.085 | **9.18** | 14,160 | 120-139 | 57.1 | 0.73 |
| Uniontown | 2.41 | 2 | 2 | 2 | 0.6 | **9.01** | 86,940 | 160-179 | 0 | 0.2 |

According to the ranking, Limaville should receive sewers second. Limaville already has some funds in place courtesy of the Army Corps of Engineers

If Stark County decides to install sewers in Harmon which ranked first, it ought to consider installing sewers in Justus, despite it being less of an environmental and health concern than some other areas. The design of the Harmon project has the sewers connecting to Brewster through Justus. As a result, it may be ideal to install sewers in both areas at the same time.

Those areas that already have sewers in place for half of the homes include, East Tuscarawas (ranked 5th), Nellabrook (ranked 9th), and Uniontown (ranked 11th). Since there are sewers present nearby, it might be easier to install sewers for the remaining homes.

North Lawrence (ranked 8th) has some environmental and health concerns, including a ditch full of raw sewage. However, when looking at logistics, it would be expensive to install sewers and a waste water treatment plant (WWTP) in this area. Unless extra funding becomes available, it is unlikely that this area will receive sewers in the near future.

In addition to the criteria used for this ranking, the other environmental qualifiers can be used as well as economic factors to make better informed decision about the installation of sewage systems.

Stark County should take these results as suggestions for areas that should receive sewers first, not as a definitive ranking. The final recommendation regarding prioritization resides in the hands of the SCHD and SCMSD. If funding becomes available for any individual area, then it is possible that area will become a higher priority. Other factors that could affect the final decision that NEFCO did not take into account include the willingness of the individual communities to pay for the improvements and the number of complaints received in each area.

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# Appendices

Appendix 1: Harmful Algal Blooms fact sheet

Appendix 2: Table with soil properties

Appendix 3: Chapter 3 of NEFCO 208 plan.

Appendix 4: All individual FPA boundaries with sampling areas outlined

Appendix 5: Slope flow spreadsheet from the SCMSD

Appendix 6: DRASTIC

Appendix 7: DRASTIC for Stark County

Appendix 8: TMDL fact sheet for bacteria

Appendix 9: TMDL fact sheet for nutrients (P and N)

Appendix 10: TMDL fact sheet for TSS

Appendix 11: TMDL fact sheet for habitat

Appendix 12: Sampling Methods for Documentation of a Public Health Nuisance Under OAC Rule 3745-1-04 (F) & (G)

Appendix 13: Maps of *E.coli* levels and sample type for each sampling area

Appendix 14: Rankings of economic criteria examined in this study

Appendix 15: Stark County Sewer Technical Advisory Committee Plan

# Glossary

- DMA: Designated Management Agency. An existing or newly created local, regional, or state agency or political subdivision designated by the governor having adequate authority to carry out specific water quality programs and responsibilities.
- FPA: Facilities Planning Area. This is a discrete geographical planning area of sufficient scope to allow for an analysis of various alternatives for the treatment and disposal of wastewater.
- HAB: Harmful Algal Bloom. Overgrowth of algae, usually but not always visible. Usually caused by high amounts of phosphorous in the water, and are usually dominated by toxic cyanobacteria. Algal blooms are a global problem.
- HSTS: Home Sewage Treatment System. Devices for the treatment and disposal of domestic wastewater, usually from a single household.
- NEFCO: Northeast Ohio Four County Regional Planning and Development Organization
- NPDES: National Pollutant Discharge Elimination System. A permit required for point sources of pollution that limits the amount of pollutant that can be discharged
- OAC: Ohio Administrative Code. The interpretation of the ORC as determined by individual agencies (e.g., Ohio Department of Health).
- ORC: Ohio Revised Code. The laws of the state of Ohio as determined by the legislature of the state.
- On-site system: Uses soil located on the property to filter wastewater before reaching any surface or groundwater.
- Off-site system: Also called discharging systems. These require a NPDES permit, since they discharge the sewage effluent from a point source.
- POTW: Publicly-Owned Treatment Works. Publicly-owned facilities to treat sanitary and combined sewerage in accordance with requirements of an NPDES permit.
- SCHD: Stark County Health Department
- SCMSD: Stark County Metropolitan Sewer District
- TMDL: Total Maximum Daily Load. This is the maximum amount of a pollutant that a water body can receive from all sources, and still meet water quality standards.