LANCASTER COUNTY STUDY OF MUNICIPAL WASTEWATER DISPOSAL OPTIONS

INFRASTRUCTURE ANALYSIS PROJECT

September 2009

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ACKNOWLEDGEMENTS

In 2005, the United States Department of Defense (DOD) made public its recommendations for Base Realignment and Closures (BRAC) involving more than 800 installations, including the Aberdeen Proving Ground (APG) in Harford County, Maryland. The APG will experience significant net gains in personnel with approximately 8,200 jobs transferred to APG from other installations by 2011. Overall, the DOD is projecting between 21,000 and 35,000 direct and indirect new positions added to the region by 2017. A portion of the new households that will be created are projected be located in Lancaster County.

Lancaster County received a $34,000 grant from the federal Office of Economic Adjustment (OEA), administered through the Chesapeake Science and Security Corridor (CSSC) Consortium, to assist with planning and preparing for this projected growth. Using these funds, Lancaster County Planning Commission contracted with F.X. Browne, Inc. or Lansdale, Pennsylvania to prepare this study for use by municipalities and developers to evaluate feasible, environmentally sound wastewater management alternatives to large public systems that will meet the goals of the county and local comprehensive plans. LCPC also partnered with Colerain Township to serve as a model community, completing a study that comprehensively examined existing conditions in the township, including geology and topography, and evaluated the potential for failed on lot sewage disposal systems.

This Project would not have been possible without the help of many dedicated project partners, town board members, committee members, and community leaders, including the following:

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EXECUTIVE SUMMARY

With the potential influx of approximately 1,025 people and 379 households as a result of the Aberdeen Proving Ground (APG) expansion plus normal projected population growth, wastewater disposal will become an important factor in maintaining the quality of life in Lancaster County. *Balance: the Growth Management Element of the Lancaster County Comprehensive Plan* (2006) establishes a framework for future land use and development in the County and its municipalities. The Plan sets new residential density targets of net average of 7.5 dwelling units per acre in Urban Growth Areas, and net average of 2.5 dwelling units per acre in Village Growth Areas. These growth targets and density guidelines can only be achieved by using the proper mix of wastewater collection and treatment technologies.

The Rural Strategy of *Balance, the Growth Management Element of the Lancaster County Comprehensive Plan*, does not support the provision of public sewer service to rural areas outside of existing villages. This policy means that public sewer service may be provided to targeted growth areas and could consist of a variety of collection and treatment alternatives, but that rural areas will be limited to non-community sewers. Both rural neighborhoods and many of the County's historic villages have small lot sizes and would best be served by cluster or innovative on-site systems.

The Lancaster County Planning Commission (LCPC) partnered with Colerain Township to examine existing conditions in the Township, including geology, topography, soils, and streams in order to evaluate the potential for implementing a variety of wastewater management systems that will meet the goals of the comprehensive plan. The study was performed using the land uses and characteristics of Colerain Township; however, a major goal of this study was to develop a wastewater evaluation process that could be used throughout Lancaster County by municipalities and developers to evaluate feasible, environmentally sound wastewater management alternatives that will meet the goals of the comprehensive plan.

This study was performed to provide a comprehensive evaluation and analysis of wastewater management alternatives suited to the specified areas of Colerain Township. The study addressed the following:

1. The need for and feasibility of providing wastewater disposal system alternatives to specified geographic areas, based on soils, slopes and other physical attributes,

2. The feasibility of serving existing developed areas as well as future development using current county and municipal policies,

3. The applicability of the identified wastewater management options in this study for use throughout Lancaster County.

In addition, this study:

1. Identified site-specific environmental constraints that limited or eliminated the use of certain wastewater management system alternatives. The constraints evaluated included soils (distance to limiting zone, percolation rate), slopes (limiting use of certain on-site approaches such as mound and drip systems), water quality and flow of streams (many of the County streams are impaired; small, sluggish streams which may not assimilate sufficient wastewater effluent), and land use and ownership.

2. Identified regulatory constraints related to wastewater management system alternatives. The analysis focused on regulatory constraints imposed by the Pennsylvania Department of Environmental Protection (DEP) and the Chesapeake Bay Program.

3. Evaluated population projections and wastewater flows for various density scenarios.

4. Identified wastewater treatment and disposal alternatives that would meet the goals of the Township's and County's Comprehensive Plan.

5. Analyzed land area needs for various wastewater treatment and disposal alternatives.

6. Developed cost estimates for various wastewater management system alternatives.

The cost analysis included engineering design, permitting, and construction costs.

7. Identified potential sources of funding for the design and construction of wastewater management facilities.

8. Explored alternative management structures for the long-term operation and maintenance of the wastewater management alternatives.

Wastewater Planning Approach

The first step in any wastewater planning and feasibility study is to analyze any and all constraints within the planning service area. Such constraints may include the suitability of the soils, slopes, water quality criteria, and the availability of land. If an area has 60 inches of good soils and appropriate slopes, a conventional septic system can be installed and will function so that the soil treats the wastewater effluent from the septic tank and does not contaminate the groundwater. If an area has between 10 and 60 inches of good soils and appropriate slopes, other land disposal systems can be considered, depending on the overall site conditions. Nitrate contamination tends to be the biggest concern with land-based systems, and sometimes nitrogen removal may be necessary before the water is discharged to the soil. The nitrate nitrogen limit for groundwater is 10 mg/L. If a site has less than 10 inches of good soil, only a stream discharge can be considered.

Most of Lancaster County is located within the Susquehanna River Watershed, which is part of the Chesapeake Bay Watershed. The Chesapeake Bay Tributary Strategy is a set of guidelines designed to help states within the Chesapeake Bay Watershed fulfill their legal obligations under the Chesapeake 2000 Agreement in a cost effective manner. According to Pennsylvania's Chesapeake Bay Tributary Strategy Implementation Plan for NPDES Permitting (2007), dischargers such as wastewater treatment facilities will be allocated a cap loading rate of 6.0 mg/L total nitrogen (TN) and 0.8 mg/L total phosphorus (TP) at the design annual average daily flow. These loading rate caps are being phased in over the next several years for existing wastewater treatment facilities. New treatment plants with stream discharges would require tertiary wastewater treatment to meet these effluent requirements. Smaller wastewater treatment facilities have less stringent loading rates, and nutrient trading credits may be employed to achieve the allocated cap load.

The amount of land that is needed for a land-based wastewater treatment and disposal system is ultimately determined from detailed soil testing and land availability. The ultimate amount of land required for a particular method depends on the amount of wastewater generated and the characteristics of the land where wastewater is applied plus the land where pre-treatment facilities are located.

Ownership of wastewater treatment facilities is also a consideration, especially when the facility is a community treatment facility. The most common forms of community treatment facility ownership include the following:

1. Municipal Ownership

2. Municipal Wastewater Authority Ownership

3. Homeowners Association Ownership

4. New Wastewater Utility Ownership

5. Existing Public Utility Ownership

The municipality (Township Board of Supervisors or Borough Council) can own, operate and maintain the facilities. The municipality would be required to perform daily operation activities, on-going maintenance, meet all permit requirements, and bill all customers that are connected to the system. The municipality may also decide to form a Municipal Authority or new Wastewater Utility to perform all of these duties.

Funding sources for municipally-owned wastewater disposal systems that are applicable to Lancaster County can include municipal bonds, bank loans, PENNVEST grants and low interest loans, Rural Development Program grants, and loans administered by the US Department of Agriculture. Other options for funding can include developer contributions. Developers can be required to construct internal sewer lines in accordance with municipal specifications and then dedicate the sewer lines to the municipality.

PENNVEST offers 20-year, and sometimes 30-year loans to municipalities or authorities, and some private entities, at interest rates below those which they would receive on the open market (generally between one and four percent depending upon the borrower's financial conditions). These loans are very valuable to all communities, especially those that may lack the financial backing to undertake a project on their own.

Colerain Township Case Study

Colerain Township is located approximately 30 miles from Aberdeen, Maryland. Land use in the township consists primarily of agricultural use with residential use consisting of individual rural homes and small villages. The proximity of Colerain Township to Aberdeen is significant because ongoing development in Aberdeen Proving Grounds will likely cause a surge of new residential development in Colerain Township and other areas in Lancaster County within commuting distance to the Aberdeen Proving Ground. Lancaster County's growth management practices attempt to reduce rural sprawl by providing options for public or community wastewater management facilities within designated growth areas and avoiding central sewer systems in rural areas unless it is necessary to sustain existing development.

This study evaluated individual on-lot systems and community systems, such as spray irrigation and stream discharge, for potential units in select undeveloped areas of Kirkwood Village, Black Rock Estates, and Octoraro Pines/Mount Vernon Estates that may be suitable for future development of these undeveloped areas. In order to address issues that may arise in other townships in Lancaster County, especially townships that might not have the excellent soils that Colerain Township has, the study evaluated several "what-if" scenarios including what if some soils were unsuitable for some of the disposal methods, what if a few septic systems failed in an area, and what if many or all septic systems failed in an area. These scenarios provide an approach for addressing these situations.

Almost all of the soils in Colerain Township are suitable for most of the soil-based disposal systems including septic systems, mound systems, drip irrigation systems, and spray irrigation systems. Most of the unsuitable soils for on-site wastewater disposal are located primarily in areas along streams and Octoraro Lake, where slopes exceed 25% and where Hydric (wetland) soils such as Baile silt loam are more prevalent.

Approximately 113 acres in Kirkwood Village, 240 acres in Black Rock Estates, and 194 acres in Octoraro Pines and Mount Vernon Estates may potentially be available for development. The likely potential build-out scenarios for increased wastewater flow from these areas include approximately 216,000 gpd at Black Rock Estates and 198,000 gpd at Octoraro Pines and Mount Vernon Estates, based on likely build-out EDUs.

Three higher density areas were identified on which community wastewater disposal systems could potentially be applicable. One 80-acre parcel and portions of two smaller parcels in the northern area of Kirkwood Village are prime candidates for a community wastewater disposal system. The developable portions of these parcels make up a contiguous 93.5-acre tract of developable land. One 19-acre parcel and one 10-acre parcel in the eastern portion of Black Rock Estates are prime candidates for a community system. The developable portions of these parcels make up a contiguous 24.5-acre tract of developable land. One 35-acre parcel in the north-central portion of Octoraro Pines is a prime candidate for a community system. The entire 35 acre tract is developable, although it is land-locked and would require a right-of-way.

Each site was analyzed to determine the optimal type of community wastewater system, with respect to site constraints, logistics and cost.

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1.0 INTRODUCTION

1.1 Lancaster County

Lancaster County has a total area of 984 square miles; 35 square miles of this is water, consisting of 3.5 percent of the county. Most of the area of Lancaster County is located in the Chesapeake Bay drainage area; one unnamed tributary flows into Brandywine Creek which is in the Delaware River drainage area. The major streams in the county are: Conestoga River and Little Conestoga Creek, Pequea Creek, Chiques Creek, Cocalico Creek, Octoraro Creek, and Conowingo Creek.

Lancaster County forms the Lancaster Metropolitan Statistical Area (MSA), which is the 99th largest of 361 MSAs in the United States. It has one city (Lancaster), 18 boroughs, 41 townships, and 51 communities, such as Kirkwood in Colerain Township. Major highways in the county include the Pennsylvania turnpike, Route 30 (Lincoln Highway), and Routes 222 and 322. The County library system, established in 1987, consists of 14 member libraries, three branches, and a bookmobile. There are 16 public school systems in Lancaster County and one charter school, the LaAcademia Charter School. Lancaster County has many state-protected areas including Susquehannock State Park, located on 224 acres overlooking the Susquehanna River, and six Pennsylvania State Game Lands for hunting, trapping, and fishing.

Agriculture is an important part of Lancaster County due to having some of the most fertile soils in the country. Almost half of the land in Lancaster County is zoned for agriculture, and about 276,000 acres of the agriculturally-zoned land require at least 20 acres per residence. Lancaster County's farms are responsible for nearly 20 percent of the agricultural output of Pennsylvania. Livestock-raising is responsible for over 80 percent of the agricultural output of Lancaster County and consists of dairy farming, poultry and eggs, cattle and swine. Lancaster County is known as the Garden Spot of America.

1.2 Growth Management and Wastewater Management

The key message of *Balance: the Growth Management Element of the Lancaster County Comprehensive Plan* is "to help achieve and sustain Lancastrians' Vision of a balanced community where urban centers prosper, natural landscapes flourish, and farming is strengthened as an integral component of our diverse economy and cultural heritage (2006)." According to the Center for Opinion Research, 24 percent of respondents identified development and sprawl as the main issue impacting the quality of life in Lancaster County. Development and sprawl are directly related to the availability of transportation and wastewater facilities. With the potential influx of approximately 1,025 people and 379 households as a result of the Aberdeen Proving Ground (APG) expansion plus normal projected population growth, wastewater disposal will become an important factor in maintaining the quality of life in Lancaster County.

Balance: the Growth Management Element of the Lancaster County Comprehensive Plan establishes a framework for future land use and development in the County and its municipalities. Looking 25 years into the future, it identifies areas that are appropriate for urban growth and reinvestment, areas that should be maintained in agriculture, natural resources, and similar uses, and strategies that municipalities and the County can use to shape growth to achieve the desired patterns of development and preservation. New growth targets provided in *Balance, the Growth Management Element of the Lancaster County Comprehensive Plan* encourage and direct 85 percent of new growth to Urban Growth Areas, and limit new growth in Rural Areas to 15 percent of the countywide total. The Plan sets new residential density targets of net average of 7.5 dwelling units per acre in Urban Growth Areas, and net average of 2.5 dwelling units per acre in Village Growth Areas. These growth targets and density guidelines can only be achieved by using the proper mix of wastewater collection and treatment technologies.

The Rural Strategy of *Balance: the Growth Management Element of the Lancaster County Comprehensive Plan*, states that "Wastewater disposal is a critical issue for the Rural Strategy because of 1) the role played by public collection and disposal systems in shaping development patterns and 2) the environmental and planning implications of on-lot systems." The Rural Strategy does not support the provision of public sewer service to rural areas outside of existing villages. This policy means that public sewer service may be provided to targeted growth areas and could consist of a variety of collection and treatment alternatives (conventional sewers, small diameter pressure sewers, treatment plants with stream discharges, spray or drip irrigation, constructed wetlands, etc.). It means that rural areas will be limited to non-public sewers; however, rural areas could be serviced by septic systems, mound systems, cluster systems, spray and drip irrigation systems, decentralized systems, and innovative on-site systems. A further complication to this process is that a number of the County's historic villages and rural neighborhoods are experiencing on-lot failing septic systems, and many of these properties have relatively small lot sizes, severely limiting the installation of replacement disposal systems. This is where innovative systems or cluster systems may be required.

1.3 Wastewater Feasibility Study Goals

The Lancaster County Planning Commission (LCPC) partnered with Colerain Township to examine existing conditions in the Township, including geology, topography, soils, and streams in order to evaluate the potential for implementing a variety of wastewater management systems that will meet the goals of the comprehensive plan. The study was performed using the land uses and characteristics of Colerain Township; however, a major goal of this study was to develop a wastewater evaluation process that could be used throughout Lancaster County by municipalities and developers to evaluate feasible, environmentally sound wastewater management alternatives that will meet the goals of the comprehensive plan.

The village of Kirkwood is the only Designated Village Growth Area in Colerain Township. The Octoraro Region Joint Strategic Comprehensive Plan (Lancaster County Planning Commission 2004) and Balance: the Growth Management Element of the Lancaster County Comprehensive Plan (Lancaster County Planning Commission 2006) call for future growth to be directed into this area. This study evaluated potential areas for additional future development in existing rural development areas, based on data and policies from the county and local comprehensive plans. There are several of these rural areas in the township.

1.4 Study Elements

This study was performed to provide a comprehensive evaluation and analysis of wastewater management alternatives suited to the specified areas of Colerain Township. The study addressed the following:

1. The need for and feasibility of providing wastewater disposal system alternatives to specified geographic areas, based on soils, slopes and other physical attributes,
2. The feasibility of serving existing developed areas as well as future development using current county and municipal policies,
3. The applicability of the identified wastewater management options in this study for use throughout Lancaster County.
4. In addition, this study:
5. Identified site-specific environmental constraints that limited or eliminated the use of certain wastewater management system alternatives. The constraints evaluated included soils (distance to limiting zone, percolation rate), slopes (limiting use of certain on-site approaches such as mound and drip systems), water quality and flow of streams (many of the County streams are impaired; small, sluggish streams which may not assimilate sufficient wastewater effluent), and land use and ownership.
6. Identified regulatory constraints related to wastewater management system alternatives. The analysis focused on regulatory constraints imposed by the Pennsylvania Department of Environmental Protection (DEP) and the Chesapeake Bay Program.
7. Evaluated population projections and wastewater flows for various density scenarios.
8. Identified wastewater treatment and disposal alternatives that would meet the goals of the Comprehensive Plan.
9. Analyzed land area needs for various

wastewater treatment and disposal alternatives.

10. Developed cost estimates for various wastewater management system alternatives. The cost analysis included engineering design, permitting, and construction costs.

11. Identified potential sources of funding for the design and construction of wastewater management facilities.

12. Explored alternative management structures for the long-term operation and maintenance of the wastewater management alternatives.

1.5 Organization of the Report

This report is organized to provide sufficient information and direction to municipalities and developers so that they can understand the proper approach that should be followed in evaluating wastewater management alternatives that meet the goals of the comprehensive plan. Section 2 provides a wastewater management primer which clearly explains the primary collection and treatment alternatives available for rural and non-rural areas of Lancaster County.

Section 3 describes the basic wastewater planning approach that should be followed to properly evaluate wastewater collection and treatment alternatives that are economically feasible, environmentally sound, and meet the goals of the comprehensive plan. Section 4 illustrates how the wastewater evaluation approach was applied to Colerain Township. It provides specific examples of how population and wastewater flow estimates were calculated, and how various wastewater management alternatives were evaluated. Section 5 discusses how the methodology provided in Sections 3 and 4 can be applied to other municipalities in Lancaster County. Section 6 provides a list of references that was used to prepare this report.

2.0 WASTEWATER MANAGEMENT PRIMER

Wastewater management is a primary planning concern for most Pennsylvania communities. Wastewater disposal requires not only land area, but also suitable soils and adequate setbacks from water supplies and other wastewater systems. The availability of centralized and community wastewater systems can be a major factor in the growth and development of a town. According to a 1995 American Housing Survey by the U. S. Census Bureau, approximately one quarter of housing units in the United States are served by septic systems or cesspools.

Septic systems are also known as on-lot wastewater disposal systems. An on-lot system is a system that serves one individual house on one lot. Many different types of on-lot systems exist, including conventional septic systems, elevated sand mounds, and spray or drip irrigation on-lot systems. Wastewater systems that serve more than one residence are called community systems. Community systems that serve fewer than 50 properties are referred to as cluster systems, while those that serve from 50 to as many as several thousand properties are known as small centralized community systems. Discharge type and location, soil conditions, slopes, and space considerations must be evaluated before constructing a community wastewater system. For some community systems, the wastewater is collected from a group of homes and discharged into a large absorption field. Other systems involve advanced treatment and disinfection before being directly discharged to a waterway (lake, stream, or river) or a drip or spray irrigation field. The means of collecting wastewater from individual homes can include gravity sewers (both conventional and small diameter), pressure sewers with grinder pumps, pressure sewers with septic tank effluent pumping (STEP system), and vacuum sewers. Treatment options can include treatment lagoons, wastewater treatment plants, and constructed treatment wetlands.

On-lot wastewater systems must be designed by a licensed engineer working closely with the township’s Sewage Enforcement Officer (SEO). If septic systems are not maintained properly, or if they are installed in an area of unsuitable soils, both public health and environmental problems can occur. In areas where high concentrations of failing systems are identified, connection to an existing centralized wastewater collection and treatment facility may be preferred and may be justified by a cost-benefit analysis. Or, construction of smaller community wastewater treatment facilities or package treatment plants may be an option.

Descriptions of many of the more common types of wastewater systems are provided below.

2.1 Conventional Septic System

A conventional septic system is an on-lot wastewater system designed to separate household wastewater into a solid and liquid phase, and then treat the waste prior to disposal. A typical septic system, shown in Figure 1, consists of two main parts: a septic tank and an absorption field, also known as a leach field. Water leaving the house first enters the septic tank, where the solids settle out on the bottom of the tank in the form of sludge. The liquid (effluent) then leaves the septic tank and enters the absorption field. A conventional absorption field consists of lengths of perforated pipe buried in gravel-filled trenches. The effluent passes through the holes in the pipe, trickles through the gravel, and is absorbed by the soil. Under ideal conditions, the soil particles filter out pathogens and nutrients before the treated

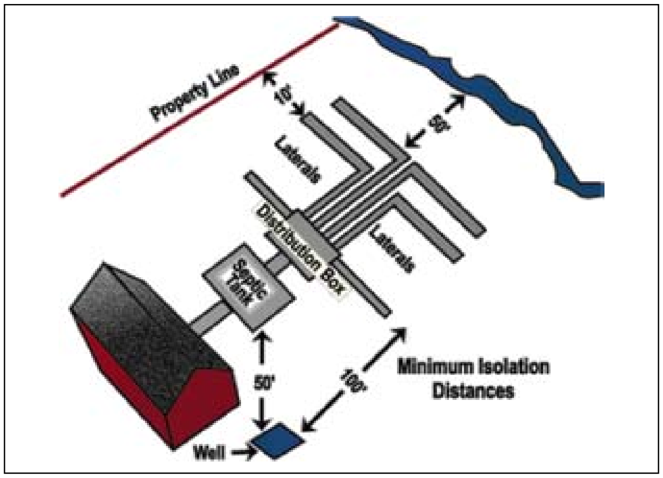


Figure 1: Required Setback and Isolation Distances for On-Lot Septic Systems. Source: Tobyhanna/ Tunkhannock Creek WA

effluent reaches the underlying groundwater. However, if a septic system is not properly installed or maintained, the effluent may not be treated properly. Most septic systems will eventually fail. On-lot systems typically have a design life of 15 to 25 years even when properly maintained. Eventually, the soil in the absorption field becomes clogged with organic material, and percolation will no longer occur.

In rural areas where the closest centralized wastewater treatment facility is located at a considerable distance, replacement of the existing on-lot septic system or construction of a new community system may be necessary. When designing a new or replacement wastewater system, the most important factor to consider is the soil characteristics in the absorption area. For a single family home, the absorption area is sized based on a design flow of 400 gallons per day and the percolation (or "perc") rate of the soil. The perc rate is the time it takes for water to percolate down through the soil. If the soil in the absorption area is sandy, the perc rate will be higher, meaning the soil will absorb effluent faster. Conversely, if the soil has a high clay content, the perc rate will be slower, sometimes prohibitively so.

Just as important as the perc test when designing a wastewater system is the deep hole, or deep probe test. A deep hole test is performed by using a backhoe to dig a six- to seven-foot deep hole in or near the proposed absorption area. The hole is examined by a Sewage Enforcement Officer, licensed engineer, or soil scientist to determine the existence of any limiting zone. A limiting zone is defined as the upper limit of any zone, or soil layer that may limit the soil's ability to percolate and treat wastewater. There are three types of limiting zones:

1. A soil layer that contains a permanent or seasonally high water table (a seasonally high water table is usually evident as a mottled soil layer),
2. A soil or rock layer that has such slow permeability that the effluent will not be able to penetrate this layer at a rate that will permit the proper treatment of the wastewater, or
3. A soil layer such as a gravel or shattered stone layer that does not contain sufficient fines to provide sufficient contact between the effluent and the soil particles to properly treat the effluent.

When replacing or repairing an on-lot wastewater system, it is important to take into account setback and isolation distances. As shown in Figure 1, the distribution box and absorption field must be located at least 100 feet from any water well – either the homeowner's or a neighbor's. The system must be located at least 50 feet from any seasonal or perennial water body or wetland. Ideally, a 100 percent reserve area should be designated for a replacement system in the event of a future system failure.

Limitations of a conventional septic system include the following:

- Slopes must be less than 25 percent. For slopes between 15 percent and 25 percent, detailed design in relationship to elevation must be provided.
- Systems may not be sited within a Federal Flood Insurance flood zone or in an area with sinkholes.
- Systems may not be placed in fill unless the fill has been in place for at least four years.
- Percolation rates must be between six and 90 minutes per inch.
- The depth of undisturbed soil to the top of the limiting zone must be 60 inches or greater. The system must then be installed so that the bottom of the system is a minimum of 4 feet above the limiting zone.

The primary advantage of a conventional septic system is construction and operating costs. A conventional gravity-fed septic system costs about $5,000 to $10,000. Costs could increase by $1,000 or more if an effluent pump is required due to site topography. Conventional systems are relatively simple to install and require little permitting and time for construction. The disadvantages of a conventional septic system are potential poor soil suitability or other site constraints, and the relatively large amount of space required per system for installation. Isolation distances for property lines, water bodies, and drinking water wells may make site of these systems difficult, if not impossible, on smaller lots (less than one acre).

2.2 Elevated Sand Mound Systems

Elevated sand mounds are on-lot septic systems that are similar to conventional septic systems except the absorption field is installed within a raised sand mound. All of the same setbacks and design considerations for a conventional septic system apply to an elevated sand mound system in terms of the septic tank and distribution box. However, an elevated sand mound system may be installed where soil depths are insufficient, or where conventional septic leach fields have failed and are in need of replacement. For an elevated sand mound, the distribution pipes in gravel trenches in the absorption system are situated within a mound of sand and topsoil that is placed on top of the original soil, as shown in Figure 2. A properly designed and maintained sand mound has a design life of over 20 years; therefore, both conventional and raised sand mound systems are considered long-term wastewater disposal methods.

Limitations of an elevated sand mound septic system include the following:

- Slopes must be less than 12 percent. Elevated sand mounds installed on slopes between 8-12 percent have additional design requirements.
- Systems may not be sited within a Federal Flood Insurance flood zone or in an area with sinkholes.

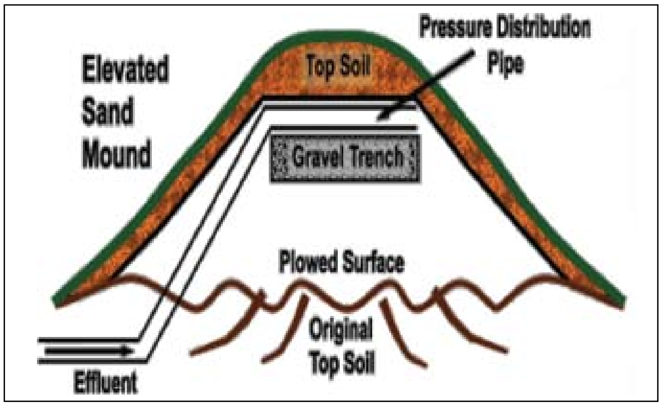


Figure 2: Typical Cross Section of an Elevated Sand Mound System. Source: Tobyhanna/Tunkhannock Creek Watershed Assoc.

- Systems may not be placed in fill unless the fill has been in place for at least four years.
- Percolation rates must be between three and 180 minutes per inch.
- The depth of undisturbed soil to the top of the limiting zone must be 20 inches or greater, and the existing soil must be used as part of the system.
- The system must then be installed so that the bottom of the system is a minimum of 4 feet above the limiting zone.

The main advantage of a mound system is the less restrictive site requirements compared to a conventional septic system. An elevated sand mound wastewater system costs between $15,000 - $20,000. Because elevated sand mounds can be constructed on sites with only 20 inches of useable soil, they can be installed in more places than conventional on-lot systems. Like septic systems, elevated sand mounds are relatively simple to install and require little permitting and time for construction. The disadvantages of an elevated sand mound septic system are the relatively large amount of space required per system for installation, and the fact that an elevated sand mound is less attractive in a backyard than a conventional system.

2.3 Spray Irrigation System

Spray irrigation is a wastewater disposal method that involves spraying treated wastewater effluent directly onto vegetated land, as shown in Figure 3. The wastewater evaporates, infiltrates through the soil, or is taken up by plant material. Properly designed, maintained, and operated spray irrigation systems provide highly effective treatment of residential wastewater and allows for maximum recharge of groundwater, a benefit that is completely lost by small package and large community wastewater treatment facilities that use stream discharge for treated effluent.

The spray irrigation system is a conventional disposal method for on-lot sewage that can be used for sites with certain restrictive soil conditions such as high water tables or shallow bedrock. However, spray irrigation systems require the availability of a relatively large parcel of suitable land for

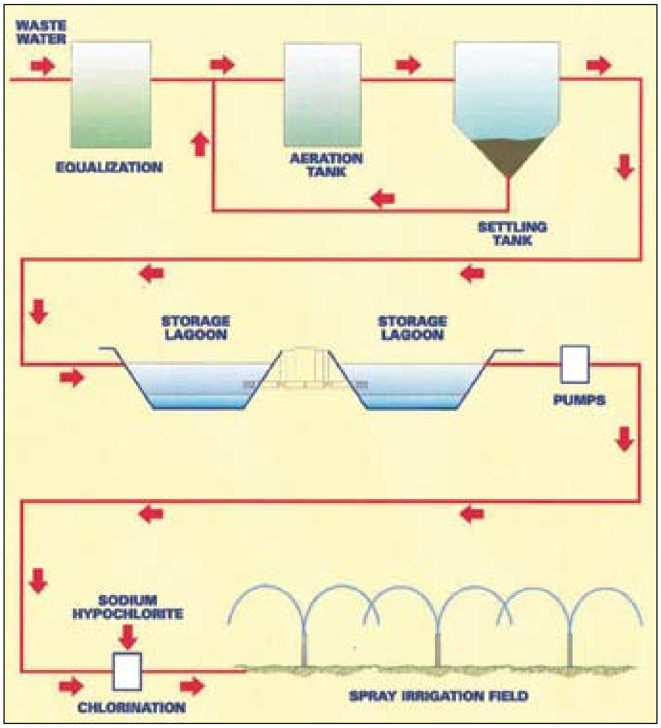


Figure 3: Community Spray Irrigation Wastewater Disposal System. Source: F. X. Browne, Inc.

wastewater storage (lagoons) and disposal (spray field). Therefore, this disposal method is most applicable as a community wastewater treatment method rather than an on-lot method, and will be discussed as such in this report. The typical spray irrigation system, as shown in Figure 3, consists of secondary wastewater treatment (using a wastewater treatment plant or aerated lagoons), storage in lined storage lagoons, disinfection, and spray irrigation fields where the treated effluent is spray onto the land.

The design considerations for a community spray irrigation wastewater disposal system include:

- Spray fields can be placed on soils with seasonally high water tables greater than 10 inches from the soil surface and bedrock greater than 16 inches from the soil surface.
- Spray fields have maximum slope requirements:
  - » Agricultural areas (not utilized for human food consumption) are limited to 4 percent slopes.
  - » Grass areas are limited to 12 percent slopes.
  - » Forested areas are limited to 25 percent slopes.
- Spray fields cannot be located in the following locations:
  - » Soils with seasonally high water tables less than 10 inches from the soil surface.
  - » Soils with bedrock at less than 16 inches from the soil surface.
  - » Floodplain soils or floodplain areas (without appropriate permits).
  - » Agricultural areas for human food consumption.
- Spray field sizing is based on the amount of sewage and soil types. A typical 3 bedroom home typically requires approximately 10,000 to 80,000 square feet of spray field area (depending on soil characteristics and slope).

A community spray irrigation wastewater disposal system has several advantages, including groundwater recharge, improved water quality of surrounding surface waters, easier siting and permitting since spray fields may be located in more restrictive soil conditions than conventional systems

such as in-ground septic and sand mounds, and the preservation of existing trees since the flexible pipes within the spray field allow for installation around trees.

The primary disadvantage to a spray irrigation system is cost, since a typical community spray irrigation wastewater disposal system costs from $40 to $60 per gallon, depending on land availability, number of connections, amount of sewage, and site constraints. Other disadvantages include the requirement of a large land area, potential spray cycle interruptions during inclement weather (heavy rain, snow, etc), and maintenance costs for the system once installed.

Spray fields are not to be located on “Agricultural areas in active production of food for human consumption” per 25 PA Code Chapter 73. Spray fields can be used for crop production for livestock feed or can be maintained in grasslands/meadows and harvested for hay. There are restrictions on the active and recreational uses of spray fields, as aerosols from the spray field are a concern. Golf courses and often times irrigated with treated wastewater at night when there is minimal chance of exposure by the general public. Oftentimes a 150 +/- buffer zone is required between the spray field and athletic fields; however, this determination can be site specific and should be discussed with the DEP during the planning stages of a project.

2.4 Drip Irrigation System

Drip irrigation systems apply treated wastewater to soil absorption fields slowly and uniformly from a network of narrow plastic, polyethylene or polyvinylchloride (pvc) tubing. The tubing is placed at shallow depths of usually six to 12 inches, in the plant root zone (Figure 4). The wastewater is pumped through the drip lines under pressure but drips slowly from a series of evenly spaced openings called “emitters.” Wastewater must be pretreated and filtered prior to subsurface drip irrigation dispersal. The principal difference between drip irrigation systems and conventional on-lot wastewater systems is that irrigation systems are specifically designed to allow the water and nutrients to be used by plants. The nutrients from the wastewater effluent provide excellent fertilizer for plants and flowers, and often these systems are installed under attractive gardens.

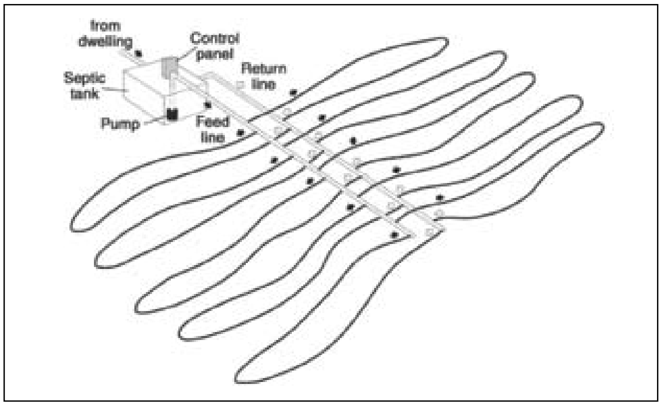


Figure 4: Drip irrigation wastewater system.
Source: Gustafson et. al.

One advantage to these systems is the minimal site disturbance required due to the flexible tubing that can be placed around trees and shrubs. Thus, these systems are more aesthetically pleasing than an elevated mound or spray irrigation system. Drip irrigation wastewater systems are useful on sites with soils that are unsuitable for conventional absorption systems. Because initial capital costs are relatively high as compared with other on-lot disposal options, and because regular maintenance of these systems is necessary, these systems are most applicable as community systems where more than one home is served by the same drip irrigation system. In addition, many system components supplied from local commercial sources are proprietary and therefore must be ordered from specific manufacturers. The cost for an individual drip irrigation system runs approximately $15,000-$25,000 (Community Environmental Services, Inc. 2001a). The cost for a community system is approximately $20 to $30 per gallon, depending on the permit requirements, number of connections, amount of wastewater treated, and the type of collection system required (Gover).

The design considerations for a community drip irrigation wastewater disposal system include:

- Soils must be classified morphologically as either well drained or moderately well drained.
- Slopes at the project site must be less than 25 percent.
- The depth to limiting zone must be greater than or equal to 20 inches. A vertical isolation

distance between the depth of tubing and the limiting zone must be at least 20 inches of soil.

- Isolation distances as specified in Chapter 73, Section 73.13 must be maintained, with the distance measured from two feet beyond the outermost drip tubing in the drip irrigation zone.

- At least two drip irrigation absorption zones must be installed, and dosing alternated between the two (PA DEP, 2004).

2.5 Wastewater Treatment Plants

When large clusters of failing septic systems exist or when large tracts of land in a town are found to be unsuitable for wastewater disposal, a centralized wastewater treatment facility may be warranted. Small communities often worry that if a large wastewater collection and treatment system is developed in their town at a reasonable cost, the town will become a more desirable place to live and rapid community growth may result. This is a valid concern, but the phenomenon most frequently applies to areas connecting to large central wastewater treatment plants. In circumstances where municipal growth is desired, especially commercial or industrial growth, or where large numbers of failing septic systems are causing problems, a centralized wastewater treatment plant (Figure 5) may be the best option. If sewage capacity exists at a nearby wastewater treatment plant, it is usually preferable to connect to the existing plant rather than to construct a new plant. Expansion of an existing plant is also an option. Sometimes new treatment plant connections require the establishment of sewer authorities to manage the facility.

"Package" Wastewater Treatment Plants are small, pre-fabricated plants that treat wastewater via activated sludge processes. According to manufacturers, package plants can be designed to treat flows as low as 22000 gallons per day (gpd) or as high as 500,000 gpd, although they more commonly treat flows between 0.01 and 0.25 MGD (US EPA, 2000). They are usually operated by a contractor and are permitted under federal NPDES regulations. Typically these small treatment plants operate in a similar manner to large centralized treatment plants, just on a smaller scale.

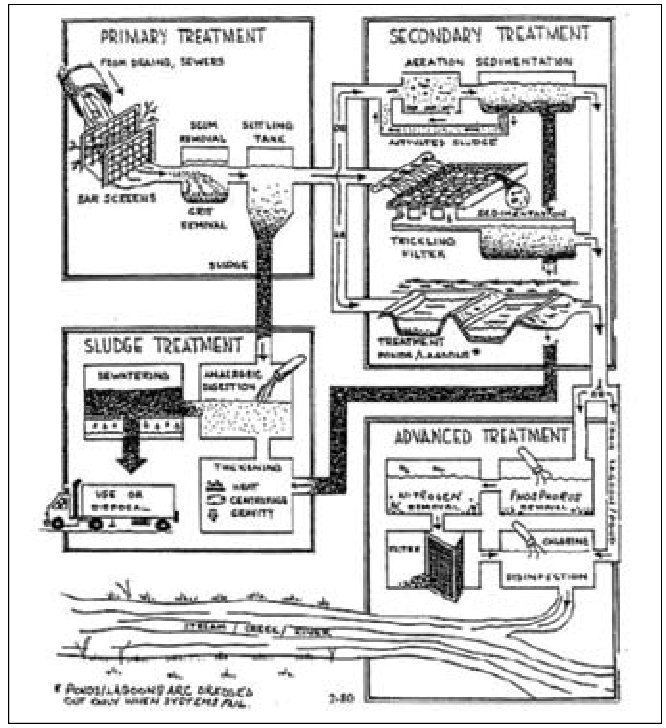


Figure 5: Typical Wastewater Treatment Plant. Source: Team Pennsylvania Foundation

The major and most obvious disadvantage to centralized wastewater treatment is cost. Centralized wastewater treatment facilities can cost anywhere from $20-$40 per gallon or more, depending on the size, the level of treatment required, the economy, and whether the project is a private job or a government job. Another disadvantage is permitting. Centralized wastewater treatment facilities typically discharge to streams, as shown in Figure 5 above. Pennsylvania Code Title 25 Chapter 93 establishes general and specific water quality criteria, and defines protected and statewide water uses, that must be protected in surface water. In addition, stream discharges require a National Pollutant Discharge Elimination System (NPDES) Permit, which involves complicated environmental testing and justification that the wastewater disposal system is the best possible option for the site or township in question.

Lancaster County is located within the Susquehanna River Watershed, which is part of the Chesapeake Bay Watershed. The Chesapeake Bay Tributary Strategy is a set of guidelines designed to help states within the Chesapeake Bay Watershed fulfill their legal obligations under the Chesapeake 2000

Agreement in a cost effective manner. According to Pennsylvania's Chesapeake Bay Tributary Strategy Implementation Plan for NPDES Permitting (2007), dischargers such as wastewater treatment facilities will be allocated a cap loading rate of 6.0 mg/L total nitrogen (TN) and 0.8 mg/L total phosphorus (TP) at design annual average daily flow. These loading rate caps are being phased in over the next several years for existing wastewater treatment facilities. Non-significant wastewater treatment facilities (design annual average daily flow on August 29, 2005, greater than or equal to 0.2 million gallons per day (MGD) but less than 0.4 MGD) will have the same loading rate caps, but have a different timeline for implementation. Small wastewater treatment facilities (design annual average daily flow on August 29, 2005 less than 0.2 MGD and greater than 0.002 MGD) will not be required to meet the loading rate caps, but will not be allowed to exceed loads of 7306 pounds of TN and 974 pounds of TP annually. Alternatively, centralized wastewater treatment facilities may choose to purchase nutrient trading credits or generate an offset to achieve the allocated cap load (PA DEP 2007).

Along with the state and federal water quality permit requirements, in Pennsylvania an Act 537 Sewage Facilities Plan must be prepared or updated for any wastewater treatment plant construction or expansion. Local municipalities are largely responsible for administering the Act 537 sewage facilities program, with technical assistance, financial assistance, and oversight provided by the PA DEP. The Act 537 Plan determines the wastewater needs of the township and evaluates alternatives to address those needs. Each township's Plan must be updated every 5-10 years, and individual planning modules must be prepared whenever new land development projects are implemented in a township.

2.6 Wastewater Collection Systems

Centralized wastewater treatment facilities treat wastewater from multiple homes and buildings, but the wastewater must be delivered to the facility via a collection system. According to the US EPA, in the year 2000 approximately 208 million people in the U.S. were served by centralized collection systems (2004). In the past, both municipal stormwater and municipal wastewater typically used the same collection systems, called combined sewer outflows (CSOs). However, with the Clean Water Act and Phase I and Phase II EPA Stormwater NPDES regulations, larger municipalities are required to separate their collection systems so that wastewater and stormwater are collected and treated separately, which drastically reduces the loadings to wastewater treatment facilities and decreases wastewater pollution in waterways from overflows during heavy precipitation events. NPDES Phase II stormwater regulations require municipalities with Municipal Separate Storm Sewer Systems (MS4s) to monitor stormwater quality and to periodically monitor their collection systems for Inflow and Infiltration of wastewater.

Wastewater collection systems consist of a series of pipes running underground connecting individual homes or buildings to the wastewater treatment facility (Figure 6). Two different kinds of wastewater collection systems exist: gravity sewers and pressure sewers. Gravity sewers utilize the natural topography of the land in a developed area to allow wastewater to travel via gravity through the collection system to the wastewater treatment facility (or to a pump at a certain collection point in the system). Pressure sewers are necessary where the topography is flat; they require each individual home or building to have its own pump to force the wastewater through the collection system.

Gravity sewers are preferable to pressure sewers because they don't require the initial expense

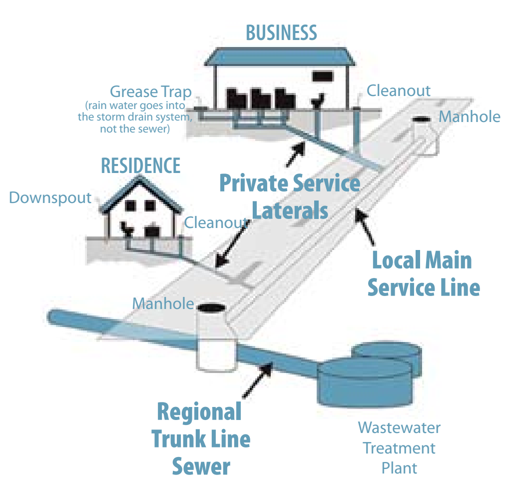


Figure 6: Typical wastewater collection system.
Source: Fulton County DPW

Fig 7: Septic Tank Effluent Pump. Source: Orenco Systems, Inc.

or maintenance costs of a pump. However, pressure sewers are often necessary, or else some combination of gravity and pressure sewers can be implemented to take advantage of the topography wherever possible. Some municipalities require individual homeowners to pay for the pressure pumps and some municipalities purchase the pumps and charge higher sewer rates to consumers. A cost-benefit analysis would determine the best method of funding for a new collection system.

Septic Tank Effluent Pump (STEP) systems are a form of wastewater pretreatment that reduces the pollutant loads to wastewater treatment facilities. With a STEP system, each home or building has its own septic tank, which allows separation of liquids and solids (Figure 7). The liquid effluent is then pumped from the septic tank to the municipal wastewater collection system. As with standard pressure sewer pumps, each municipality must determine the best type of pump and the rate scheme that is most beneficial for them via a cost-benefit analysis.

2.7 Decentralized Systems

When the majority of the soils or site conditions in a township are not generally suitable for conventional septic systems, there are two potential solutions for correcting this problem. One is to construct a centralized sewer system with one or more large wastewater treatment facilities to treat the wastewater and discharge the effluent to a stream. This approach has several disadvantages. It is expensive; it depletes the groundwater; and it may encourage new development in areas where development is not desired. Another approach is

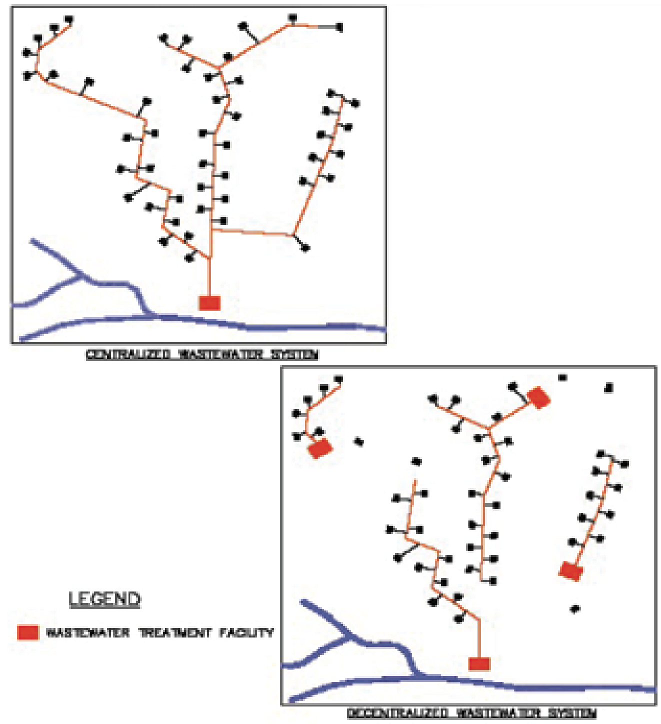


Figure 8: Centralized vs. Decentralized wastewater systems. Source: F.X. Browne, Inc.

to install decentralized wastewater management systems where they are needed to treat and dispose of wastewater. This approach has several advantages, which are discussed below.

A decentralized wastewater system is defined by the US EPA as "An onsite or cluster wastewater system that is used to treat and dispose of relatively small volumes of wastewater, generally from individual or groups of dwellings and businesses (2005)." A comparison of a centralized vs. decentralized system is presented in Figure 8. A centralized wastewater system uses gravity or pressure sewers to transport all of the wastewater in the area to one location for treatment and disposal, usually to a stream discharge.

Decentralized wastewater disposal consists of a system of clusters. Wastewater from each cluster is transported to a smaller wastewater system for treatment and disposal. Instead of one centralized treatment facility, there are two or more smaller, decentralized wastewater treatment facilities. The cluster treatment systems, being smaller due to the reduced cluster wastewater flow, may be on-site systems such as mound, drip irrigation, or spray irrigation systems. They could also be small package treatment plants that discharge to streams.

There are several advantages to decentralized wastewater systems:

1. Decentralized systems usually do not promote uncontrolled growth as centralized systems often do.

2. Decentralized systems often are less expensive to construct and operate. They reduce the length of sewers needed and do not sewer unpopulated areas.

3. Decentralized systems, consisting of a series of smaller wastewater flows, have a greater potential for on-site disposal. Most centralized wastewater systems require a wastewater treatment plant with stream discharge because of the larger wastewater flows being treated.

4. If on-site treatment and disposal is feasible, decentralized systems, by using on-site soil disposal, provide better treatment, better meet EPA and DEP water quality antidegradation requirements, and recharge groundwater.

There are, however, several disadvantages to decentralized wastewater systems. They usually require more up-front soils testing to locate suitable sites. They may also require slightly higher engineering design fees. Although system maintenance is typically lower than a centralized system, it could be more complicated for multiple cluster systems.

EPA recently released a Program Strategy for decentralized wastewater treatment systems (EPA 2005). This strategy presents EPA's vision, mission, and actions to improve the performance of decentralized wastewater treatment systems, thereby providing better protection of public health and water resources.

2.8 Alternative Systems

In some areas where soils are not suitable for conventional on-lot septic systems, alternative on-lot wastewater systems may be feasible. As with any conventional septic system installation, soil testing is critical to determining the practicality of installing a specific wastewater system. Depending on the site conditions, alternative designs such as infiltration chamber systems, trenchless absorption systems, low-pressure pipe systems, or constructed wastewater treatment wetland systems may be used. Refer to 25 PaCode Chapter 73 Sections 73.71 and 73.72 or PA DEP's Alternate Systems Guidance (2004) for information about experimental and alternative wastewater system design. In addition, several technologies exist that may help accelerate the wastewater treatment process and result in better pretreatment. These alternatives to conventional septic systems are discussed below.

Alternative on-lot wastewater alternatives may require special approvals. Alternative wastewater systems require maintenance just like conventional septic systems, and they tend to have a higher failure rate due to improper maintenance and installation. Composting toilets and low-flow fixtures can be used to reduce the amount of wastewater entering a septic system, but should not be used in lieu of a functioning wastewater treatment system.

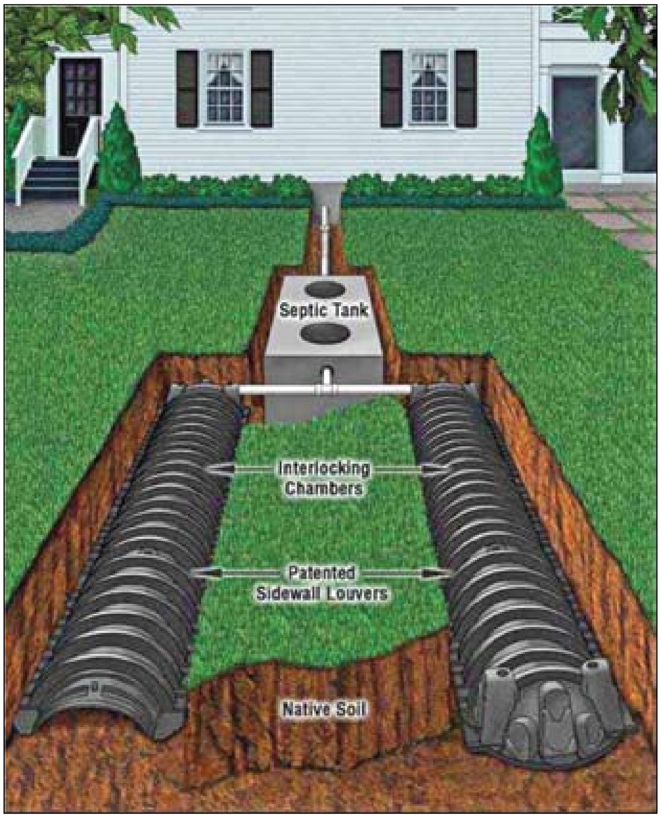


Fig 9: Infiltrator Chamber Distribution System.
Source: Infiltrator System, Inc.

Infiltration Chamber Distribution Systems

Infiltration Chamber Distribution Systems are similar to conventional systems in that pretreated effluent flows from a septic tank into the leach field and eventually percolates into the ground. The difference is that instead of perforated pipe and gravel, the leach field consists of specialized chambers that are designed to increase the surface area for wastewater treatment. Therefore, these systems typically afford greater design flexibility due to the smaller footprint required (up to a 50 percent smaller leach field area). A number of U.S. manufacturers and suppliers of proprietary leaching chamber distribution systems exist. The infiltration chambers are typically placed over either native soil or specified fill soil in the disposal trench(es) as shown in Figure 9.

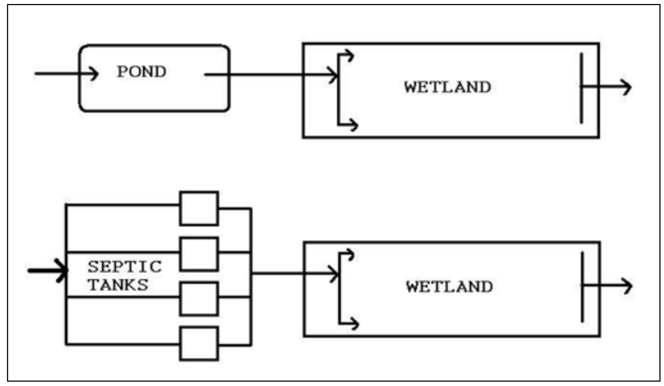


Figure 10 - Constructed Wetland Configuration Options for Community Systems (Discharge is to either a land-based system (spray or drip irrigation) or a stream or other surface waterbody)

Low Pressure Pipe Systems

Low pressure pipe (LPP) wastewater systems use one to two inch diameter plastic pipes with orifices (small spray holes) spaced 2.5 to 7.5 feet apart to deliver wastewater to the soil. A pump delivers effluent throughout the system on a regular basis as determined by a timer or the pump tank capacity. With this technology, absorption fields can be located upslope of the septic tank, or on uneven terrain that would otherwise be unsuitable for gravity flow systems.

Wastewater Treatment Wetlands

Constructed wastewater treatment wetlands use the nutrient-absorbing abilities of natural vegetation to treat wastewater. When properly constructed, wastewater wetlands are both attractive and effective. Constructed wetlands can offer an affordable solution to wastewater disposal in sites with failed conventional absorption fields, narrow or oddly-shaped lots, high water tables, and/or low soil percolation rates. Constructed wetlands are considered a type of treatment system, but not a method of disposal. Methods of disposal of the treated discharge from constructed wetlands could include subsurface absorption areas (a conventional trench system of an elevated mound system), land application (spray or drip irrigation), or direct discharge to a surface water.

Two types of constructed wetlands exist: “free water surface” (FWS) wetlands, where wastewater runs through dense vegetation over a generally impervious soil surface and “subsurface flow” (SSF) wetlands, in which the effluent runs beneath a coarse substrate such as a gravel bed matrix. Subsurface flow wetlands work better than free water surface wetlands in colder climates such as Pennsylvania. Wastewater treatment wetlands may be less costly to construct and are usually less costly to maintain than traditional wastewater treatment systems, depending on the price of land and the ultimate disposal option selected. The estimated cost for subsurface flow wetlands is $87,000/acre and $22,000/acre for free water surface wetlands.

The wetland system is actually only part of an overall treatment system. Pretreatment of the wastewater is required. Pretreatment may consist of septic tanks or lagoons. Vegetation that is adapted to saturated conditions is grown in the wetland bed, removing nutrients, organic matter, suspended solids, and pathogens from the effluent. The pretreated effluent from the wetland bed can be discharged to a land application system or be discharged to a stream with a Part I NPDES discharge permit. A typical wetland treatment system, therefore, might consist of pretreatment lagoons, the wetlands, disinfection, and discharge to a stream or to a land-based disposal system. Constructed wetlands have not been commonly used in Pennsylvania in the past; it is also doubtful whether the effluent from constructed wetlands will meet the proposed nutrient criteria of the Chesapeake Bay.

Geotextile Sand Filter Wastewater Absorption Systems (Eljen In-Drain)

Geotextile Sand Filter (GSF) absorption systems such as the Eljen In-Drain system, offer an alternative to the conventional trench and aggregate wastewater absorption system. The major advantage to these systems is that they require less area for the absorption field than a conventional trench on-lot absorption field or elevated sand mound. The GSF system is a sand filter covered with a geotextile biofabric (Figure 11), which is designed to create multiple vertical infiltration layers, increasing the surface area for infiltration. This helps to promote the formation of a biomat on the biofabric rather than at the system-soil interface, thus increasing the life of the system. Although GSF systems cost slightly more than a conventional on-site wastewater absorption system, it is often a good alternative for replacement systems that have severe space constraints.

On-Lot Pretreatment Technologies

In Pennsylvania, septic tank effluent filters and aerobic treatment units are approved for general use with certain conditions. Aerobic treatment units (ATUs) pretreat wastewater by adding air to break down organic matter, reduce pathogens, and transform nutrients. Compared to conventional septic tanks, ATUs break down organic matter more efficiently, achieve quicker decomposition of organic solids, and reduce the concentration of pathogens in the wastewater.

Various septic tank effluent filter types and designs have been extensively tested and used in the United States. Some wastewater treatment filters use peat, pea gravel, crushed glass, shredded recycled tires, or other experimental media, but sand is the best understood and the most predictable media. Peat filters pretreat septic tank effluent by filtering it through a two-foot-thick layer of sphagnum peat before sending it to the soil treatment system. Peat is partially decomposed organic material with a high water-holding capacity, large surface area, and chemical and biological properties that make it very effective in treating wastewater. Unsterilized peat is also home to a number of different microorganisms, including bacteria, fungi, and tiny plants. All of these characteristics make peat a reactive and effective filter.

Fig 11: Eljen In-Drain system. Source: Eljen Website

Many other pretreatment technologies exist for wastewater systems. Denitrification devices such as Recirculating Sand Filters (RSF) utilize an additional treatment chamber between the septic tank and the leach field as a means of discharging cleaner effluent with a lower nitrogen concentration. Effluent from the septic tank is pressurized and sprayed on a volume of sand in the filter chamber. Microorganisms in the sand break down organic matter and convert ammonia into nitrate as the effluent filters through the filter. When the effluent reaches the under drain, a portion of the water enters the leach field and the rest re-circulates through the septic tank, where the nitrates are converted into nitrogen gas, an inert gas that can be vented to the atmosphere (Obropta and Berry 2005).

3.0 WASTEWATER PLANNING APPROACH

The Pennsylvania Department of Environmental Protection (DEP) requires that all municipalities within the Commonwealth of Pennsylvania prepare an Official Act 537 Wastewater Management Plan, or Sewage Facilities Plan, to address the wastewater needs of the municipality. The Act 537 Plan typically includes an evaluation of the entire municipality and provides guidance for how each area of the municipality will handle wastewater treatment and disposal. For example, the plan may indicate that less populated areas of a municipality be served by on-site wastewater disposal systems while more populated areas, such as villages and towns, be served by a central wastewater collection, treatment and disposal system. All wastewater planning activities conducted by a municipality should be coordinated with the DEP so that the municipality is eligible for 50 percent matching funds for this work, as allowed by Act 537.

In most cases, on-lot and on-site land-based wastewater disposal options are preferred, especially for rural and low density residential areas, due to lower costs. In fact, in high-quality and exceptional value watersheds and in special protection areas like the Chesapeake Bay watershed, land-based wastewater treatment and disposal alternatives are required to be evaluated and installed before the construction of a new treatment plant with a stream discharge will even be considered.

The first step in any wastewater planning study is to identify the study area and consider land use, zoning, and land development restrictions or requirements that may affect general planning decisions. Are there areas that need to be protected? Are there areas where concentrated development is desired or areas where low density or no development is desired? In Colerain Township and in Lancaster County in general, preservation of agricultural land is an important land planning and wastewater planning consideration. Based on these types of questions, areas where concentrated land development is desired should be evaluated for community systems. In most cases, these areas will be village or town areas where there are concentrated numbers of residential and commercial buildings. These areas are the areas where detailed studies need to be conducted to determine what types of wastewater disposal options are feasible to meet the wastewater needs of these more densely developed areas.

3.1 Analysis of Constraints

The first step in any wastewater planning and feasibility study is to analyze any and all constraints within the planning service area. Such constraints may include the suitability of the soils, slopes, water quality criteria, and the availability of land. Each of these constraints is described in detail in the following sections.

SITE REQUIREMENTS FOR ON-SITE SYSTEMS IN PENNSYLVANIA			
Type of System	***Soil Limiting Zone***	***Allowable Slopes***	***Other***
Conventional Trench	60 inches	25%	
Elevated Sand Mound	20 inches	12%	
Drip Irrigation	20 inches	25%	
Spray Irrigation	10 inches	25%	
Stream Discharge	N/A	N/A	Access to stream and nutrient concentration limits

Table 1

Soils and Slopes

The DEP has established regulations for on-site wastewater disposal systems with regards to soils and slopes. These regulations are found in 25 PA Code Chapter 73 and are summarized in Table 1.

The first step in evaluating the soils and slopes in the study area is obtain the County Soil Survey prepared by the USDA Soil Conservation Service or to obtain digital GIS soil layers and determine the soils and soil characteristics of the soils in the service area. The Soil Survey is typically available at the County Conservation District. Once each soil type in the service area has been identified, an evaluation of the associated limiting zone must be made based on the description of each soil type. Sometimes this is an easy determination if the typical limiting zone for a soil type is the same as the regulatory requirement. For example, if the soil survey indicates that there is a seasonal high ground water table and/or bedrock at 18 inches, then it can be assumed that that soil type is not acceptable for a conventional system, an elevated sand mound, or a drip system. In this example the soil type would most likely be acceptable for spray irrigation. Sometimes it is difficult to determine what type of wastewater system would be acceptable in a specific soil type since the Soil Survey many indicate a limiting zone ranging from 18 inches to 24 inches. In this case, an elevated sand mound or a drip irrigation system may be acceptable, but, depending on the actual measured limiting zone, may not be acceptable. Since the soil maps usually provide a range of limiting zone depths, the types of suitable disposal methods can only be estimated.

Once each soil type is evaluated with respect to limiting zones and after taking into consideration slope information, an estimate can be made of the suitable disposal methods for each soil type. Based on this information, a soil suitability map can be made showing areas within the service area that appear, based on the soil map, to be suitable for the various disposal methods including septic systems, elevated sand mounds, drip irrigation systems, and spray irrigation systems. If the limiting zone of the soils is less than 10 inches, the only acceptable disposal alternative is a treatment plant with a stream discharge.

This approach is a good first step in evaluating the service area based on soil suitability. Soils information needs to be verified based on field investigations for any detailed design work.

Site Setbacks

Wastewater planning must take into account regulatory setbacks for wastewater treatment facilities on a given site. Regulatory setback requirements for land-based wastewater disposal systems are provided in 25 PA Code Chapter 73.13. Setbacks for community spray and drip irrigation systems are variable and depend on slope and adjacent land uses.

Water Quality Criteria

Water quality impacts from wastewater treatment and disposal must be considered for most types of wastewater systems. Treated effluent that is applied to the land has the potential for contaminating the groundwater. The soil requirements provided in 25 PA Code Chapter 73 of the DEP regulations have been established based on years of research. Therefore, if an area has 60 inches of good soils and appropriate slopes, a conventional septic system can be installed and will function so that the soil treats the wastewater effluent from the septic tank and does not contaminate the groundwater. Nitrate contamination tends to be the biggest concern with land-based systems, and sometimes nitrogen removal may be necessary before the water is discharged to the soil. The nitrate nitrogen limit for groundwater is 10 mg/L.

The quality of wastewater that is discharged to a stream from a wastewater treatment plant is regulated by the Pennsylvania DEP under 25 PA Code Chapter 93 which establishes general and specific water quality criteria, and defines protected and statewide water uses, that must be protected in surface water. In addition, stream discharges require a National Pollutant Discharge Elimination System (NPDES) Permit. These effluent limits are typically determined by the DEP and are either based on effluent quality or on the stream water quality.

Most of Lancaster County is located within the Susquehanna River Watershed, which is part of the Chesapeake Bay Watershed. The Chesapeake Bay Tributary Strategy is a set of guidelines designed to help states within the Chesapeake Bay Watershed fulfill their legal obligations under the Chesapeake 2000 Agreement in a cost effective manner. According to Pennsylvania's Chesapeake Bay Tributary Strategy Implementation Plan for NPDES Permitting (2007), dischargers such as wastewater treatment facilities will be allocated a cap loading rate of 6.0 mg/L total nitrogen (TN) and 0.8 mg/L total phosphorus (TP) at the design annual average daily flow. These loading rate caps are being phased in over the next several years for existing wastewater treatment facilities. New treatment plants with stream discharges would require tertiary wastewater treatment to meet these effluent requirements.

Non-significant wastewater treatment facilities (design annual average daily flow on August 29, 2005, greater than or equal to 0.2 million gallons per day (MGD) but less than 0.4 MGD) will have the same loading rate caps, but have a different timeline for implementation. Small wastewater treatment facilities (design annual average daily flow on August 29, 2005 less than 0.2 MGD and greater than 0.002 MGD) will not be required to meet the loading rate caps, but will not be allowed to exceed loads of 7306 pounds of TN and 974 pounds of TP annually. Alternatively, centralized wastewater treatment facilities may choose to purchase nutrient trading credits or generate an offset to achieve the allocated cap load (PA DEP 2007). The DEP is currently working on new statewide nutrient criteria that may make required effluent limits more stringent.

Land Availability

The amount of land that is available for wastewater treatment and disposal can be estimated once the areas of suitable soils are identified. The land requirements, discussed in Section 3.3 below, include the land where wastewater is applied and the land where pre-treatment facilities are located. Each disposal method has different land area requirements. The amount of available land, therefore, can limit which disposal method is feasible.

3.2 Service Area Flow Projections

On-lot wastewater systems that serve a single family dwelling must be sized based on design flows provided in 25 PA Code Chapter 73. A three bedroom home should be designed for a flow of 400 gallons per day. The design flow should be increased by 100 gallons per day for each additional bedroom over three. Flows for community systems that serve a larger area are calculated using a per capita flow of 90 gpd/person times the average number of people per household for the township or municipality that the service area is located in, based on the most recent version of the US Census. The resulting flow per home is then multiplied by the number of homes that need to be served. If an area contains commercial development, each establishment must be looked at individually to estimate a wastewater flow based on the flow tables provided in 25 PA Code Chapter 73.

3.3 Land Area Needs

The amount of land that is needed for a land-based wastewater treatment and disposal system is ultimately determined from detailed soil testing. It should be noted that the suitability of a particular site for various disposal methods is based on soil type, soil limiting zone depth, and slope. The amount of suitable land required for a particular disposal method is based on the disposal method and the percolation rate of the soil. In general, therefore, the amount of land needed for the application of wastewater is determined by performing a percolation test for septic systems and by performing a hydroconductivity test for mound, drip, and spray systems. The percolation test measures the horizontal and vertical percolation of wastewater, while the hydroconductivity test measures only the vertical percolation of wastewater.

The ultimate land required for a particular method includes the land where wastewater is applied and the land where pre-treatment facilities are located. For example, a spray irrigation system requires a treatment plant (or aerated lagoon), a storage lagoon, a disinfection system, and a spray field.

For a planning study, information in the Soil Survey can provide sufficient information to estimate an application rate which can be used to estimate the area required for the drip or spray field. Most small to medium sized wastewater treatment plants can be constructed on an acre of land, while larger treatment plant can require 2 or more acres.

The area required for individual on-site wastewater systems, including conventional trench systems,

Soil Type	Application Rate
Deep, well-drained soils	2.0 inches/week/acre
Moderately deep, well-drained soils	1.5 inches/week/acre
Deep, moderately well-drained soils	1.0 inches/week/acre
Moderately deep, moderately well-drained soils	0.5 inches/week/acre
Shallow, moderately well-drained soils	Not typically acceptable
Deep, somewhat poorly-drained soils	0.5 inches/week/acre (growing season only)

elevated sand mounds, and individual residential spray irrigation systems, can be calculated based on tables found in 25 PA Code Chapter 73.16. Community spray irrigation systems can be generally sized based on guidelines for maximum allowable application rates found in the Manual for Land Application of Treated Sewage and Industrial Wastewater (Pennsylvania DEP 2009), as listed above. Detailed soil testing is required to accurately size the spray field.

Soils must be classified morphologically as either well drained or moderately well drained for drip irrigation. The loading rate for drip irrigation systems must not exceed 0.34 gallons per day per linear foot of tubing. Based on this loading limitation and the actual design flow, an estimated drip field area can be calculated (Pennsylvania DEP 2000).

3.4 Cost Estimates

For planning purposes, cost estimates for the various types of wastewater disposal systems can be obtained from the literature and from local sources. The following guidelines can be used to estimate the cost of wastewater systems:

Conventional Septic System	$5,000 to $10,000
Elevated Sand Mounds	$15,000 to $20,000
Drip Irrigation Systems	
Individual	$15,000 to $25,000
Community	$20/gal to $30/gal
Spray Irrigation Systems	$40/gal to $60/gal
Wastewater Treatment Plants	$20/gal to $40/gal

(depending on level of required treatment)

3.5 Institutional Structure

On-lot wastewater disposal systems for a single family home are owned and maintained by individual property owners. When clusters of homes or many homes are served by a community land-based wastewater treatment facility or a wastewater treatment plant the following questions come into play:

1. Who owns the wastewater facilities?
2. Who is the Permittee?
3. Who operates and maintains the facilities?

The most common forms of community treatment facility ownership include the following:

1. Municipal Ownership
2. Municipal Utilities Authority Ownership
3. Homeowners Association Ownership
4. New Wastewater Utility Ownership
5. Existing Public Utility Ownership

The municipality (Township Board of Supervisors or Borough Council) can own, operate and maintain the facilities. The municipality would be required to perform daily operation activities, on-going maintenance, meet all permit requirements, and bill all customers that are connected to the system.

The municipality may decide to form a Municipal Utilities Authority or Wastewater Authority to perform all of these duties. This is a good idea if the municipality does not want to be in the "wastewater business", and it allows the municipality to focus on typical municipal business while allowing the Municipal Authority to handle all of the wastewater business.

If the service area consists of a large development that has a Homeowners Association, the HOA can own and operate the wastewater facilities for the service area. The HOA would manage the wastewater facilities, hire an operator, and be responsible for all permitting requirements. Some DEP regions do not like HOAs to be responsible for wastewater facilities because they feel that these entities may not operate the systems properly when economic conditions are not favorable. There are many HOA owned and operated wastewater systems in Pennsylvania. The HOA does have a vested interest in ensuring the proper operation of the system since they do not want a "smelly", poorly operated system in their back yard. If, however, an HOA should go bankrupt or refuse to maintain the wastewater facilities, the municipality is ultimately responsible for managing wastewater and would probably have to take control of the wastewater facilities.

A new Wastewater Utility can be established to operate the treatment facilities. This type of Utility is licensed by the Pennsylvania Public Utilities Commission and has legal responsibilities to operate the wastewater treatment facilities according to DEP and PUC regulations and to charge fair prices to all customers for their services.

Some existing Wastewater Utilities like AquaPA and American Water, will purchase wastewater treatment facilities (either new or existing systems), become the permittee of the system, and operate and maintain the facilities. They send out bills for their services to all customers connected to the system. These utilities, however, are selective in the treatment systems they purchase and often have size requirements.

3.6 Funding Sources

Funding sources for municipally-owned wastewater disposal systems that are applicable to Lancaster County can include municipal bonds, bank loans, PENNVEST grants and low interest loans, Rural Development Program grants, loans administered by the US Department of Agriculture, and developer funding. The most common method of funding a municipal wastewater system is by obtaining municipal bonds. The most common method of funding a wastewater system for a private community is for the developer to pay for all engineering and construction costs.

When a wastewater system is to be used by both a municipality and a developer, the costs are shared based on a proportion of the wastewater being generated by each user. The developer, however, usually pays for all internal sewers and pump stations. One public-private option often used is for the developer to pay all upfront costs for engineering and construction of the wastewater system. The municipality then either purchases capacity in the wastewater system and the developer, HOA, or public utility operates the facility, or the municipality purchases the entire wastewater facility and operates the facility, and the developer maintains use of a portion of the wastewater treatment capacity.

If there is an existing wastewater facility and new users want to tie into the existing system, there are a wide variety of funding options depending are whether it is a private or public system and whether there is existing capacity in the facility. If new users want to discharge wastewater to an existing private facility, they must first obtain approval from the owner of the facility. They must also obtain planning approval from the municipality and maybe DEP, depending on a number of factors. The new users would usually pay a proportional share of the capital and operating costs of the wastewater facility. The new users would also pay for the capital and operating costs of sewers and pump stations to transport the wastewater to the private facility. Basically, the new users would pay an upfront capital fee (usually referred to as a tapping fee) upon connection to the private facility to pay their share of the capital cost of the facility, and they would also pay an annual operating fee for their share of the operating costs of the facility.

If there is an existing public wastewater facility and there is available capacity in the facility, new users would usually pay the same tapping fee and user fee that other citizens have or are paying. However, if providing wastewater services to new users would cost the municipality more money than the tapping and user fees, the municipality has the option to create a special wastewater district with higher tapping and user fees to pay the additional costs for providing wastewater service.

Besides the funding methods described above, private and public entities may request PENNVEST funding. PENNVEST is a funding option that offers 20-year, and sometimes 30-year loans to municipalities or authorities, and some private entities, at interest rates below those which they would receive on the open market (generally between one and four percent depending upon the borrower's financial conditions). These loans are very valuable to all communities, especially those that may lack the financial backing to undertake a project on their own. For communities that are financially distressed, PENNVEST also offers limited grants.

PENNVEST was established as a revolving loan fund and is funded by nearly $2 billion from state general fund appropriations, state general obligation bond sales, PENNVEST revenue bond sales, and federal grants. Advance funding from PENNVEST for feasibility analysis, design and permitting is available. This funding is especially advantageous for small systems (systems with fewer than 1000 connections) and financially distressed systems. The funding allows high quality planning and engineering studies necessary to successfully complete and support a PENNVEST construction loan application.

Another source of funding for wastewater treatment systems in rural areas is through the United States Department of Agriculture, Rural Development Program. USDS-RUS administers financial and technical assistance programs to help rural communities develop safe and affordable sewage treatment and waste disposal systems. The programs that target wastewater treatment needs are run by the Water Programs Division of the Rural Utilities Service (RUS). The Water and Waste Disposal Loans and Grants Program provides loans, guaranteed loans, and grants for water, sewer, storm water, and solid waste disposal facilities. Public bodies (e.g., municipalities, counties, Indian Tribes, nonprofit organizations) serving rural areas may be eligible for loans or grants from the water and waste disposal program. The program makes assistance available only to rural areas with 10,000 or fewer people.

4.0 COLERAIN TOWNSHIP CASE STUDY

4.1 Description of Study Area

Colerain Township is situated in the southeastern portion of Lancaster County as shown in Figure 12, inset. Land use in the township consists primarily of agricultural use with residential use consisting of individual rural homes and small villages.

The township is located approximately 30 miles from Aberdeen, Maryland. The proximity of Colerain Township to Aberdeen is significant because ongoing development in Aberdeen Proving Grounds will likely cause a surge of new residential development in Colerain Township and other areas in Lancaster County within commuting distance to the Aberdeen Proving Ground.

As discussed in Section 1, the Rural Strategy of *Balance: the Growth Management Element of the Lancaster County Comprehensive Plan*, states that "Wastewater disposal is a critical issue for the Rural Strategy because of 1) the role played by public collection and disposal systems in shaping development patterns and 2) the environmental and planning implications of on-lot systems." The Rural Strategy does not support the provision of public sewer service to rural areas outside of existing villages. This policy means that public sewer service may be provided to targeted growth areas and could consist of a variety of collection and treatment alternatives (conventional sewers, small diameter pressure sewers, treatment plants with stream discharges, spray or drip irrigation, constructed wetlands, etc.). It means that rural areas will be limited to non-public sewers; however, rural areas could be serviced by septic systems, mound systems, cluster systems, spray and drip irrigation systems, decentralized systems, and

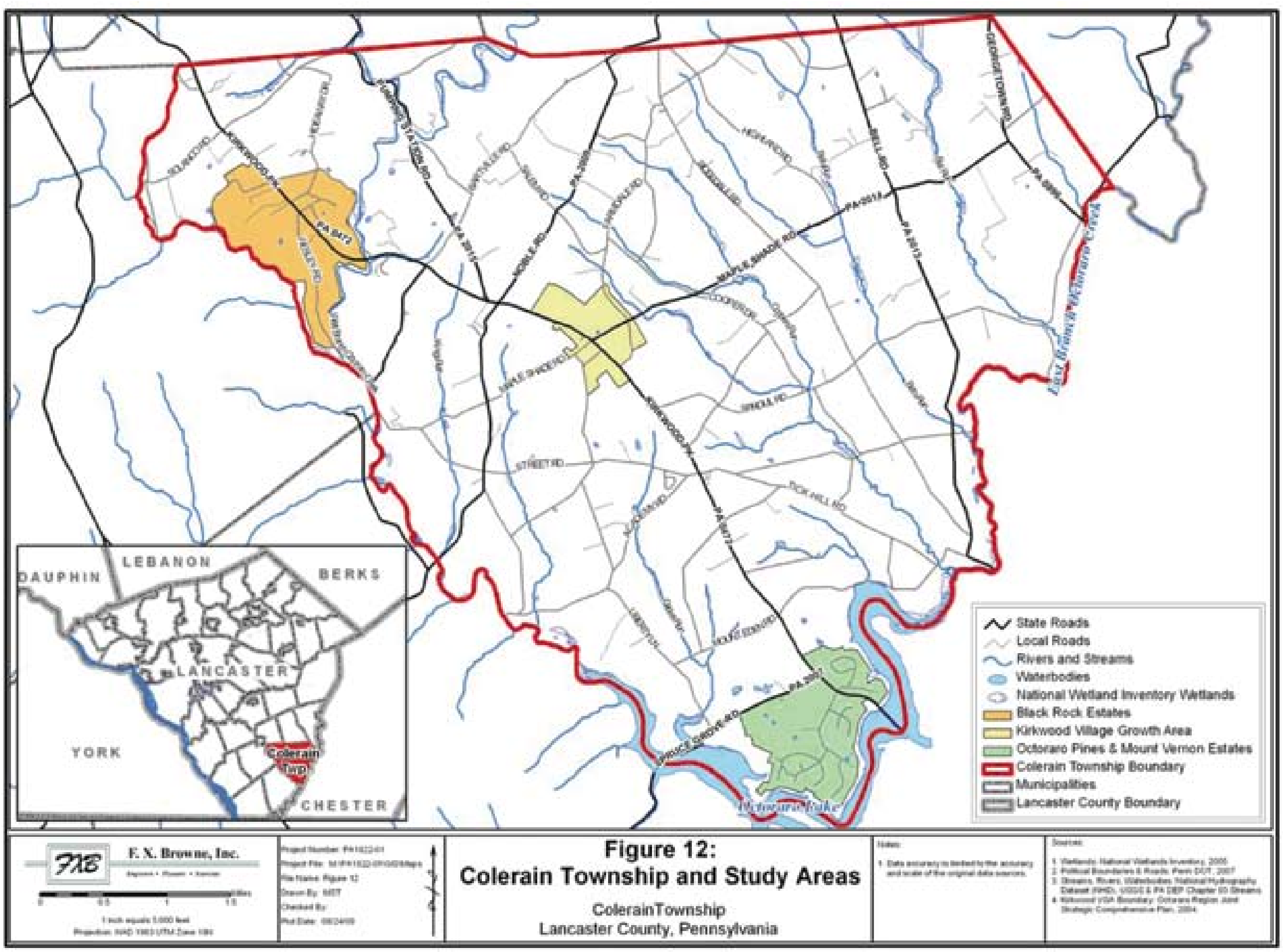


Figure 12: Colerain Township and Study Areas

innovative on-site systems. A further complication to this process is that a number of the County's historic villages and rural neighborhoods are experiencing on-lot failing septic systems, and many of these properties have relatively small lot sizes, severely limiting the installation of replacement disposal systems. This is where innovative systems or cluster systems may be required.

Therefore, in order to preserve the existing agricultural nature of Lancaster County and Colerain Township, the Lancaster County Comprehensive Plan aims to preserve farmland and satisfy growth with infill and within designated urban and village growth areas. Lancaster County's growth management practices attempt to reduce rural sprawl by providing options for public or community wastewater management facilities within designated growth areas and avoiding central sewer systems in rural areas unless it is necessary to sustain existing development.

Kirkwood Village is the only village growth area within Colerain Township and, as shown in Figure 12, is located at the crossroads of Kirkwood Pike (PA 472) and Maple Shade Road. Existing residential and commercial development are served by on-lot septic systems. A single, large 80-acre parcel in the northern portion of Kirkwood Village presents the potential for over 150 new housing units; there are other smaller, undeveloped parcels in Kirkwood that also have the potential for infill development.

Black Rock Estates, Octoraro Pines, and Mount Vernon Estates are three residential areas that were developed prior to the County's adoption of *Balance, the Growth Management Element of the Lancaster County Comprehensive Plan,* and are not considered growth areas. Black Rock Estates is located in the northwest portion of the township along Kirkwood Pike and currently consists of approximately 84 homes, all served by on-lot septic. Additional development of several large parcels and infill development is possible within Black Rock Estates and has the potential to contribute additional 200 or more homes to the area without expanding into the surrounding agricultural land.

Octoraro Pines and Mount Vernon Estates are located in the southern tip of the Township, bordered on three sides by Octoraro Lake. Octoraro Pines and Mount Vernon Estates are currently home to approximately 155 homes, a gas station with mini-market, a church and a Christmas Shoppe, all served by on-lot septic. Several twenty to thirty-acre parcels and infill development may provide additional 150 or more homes to the area without expanding into the surrounding agricultural land to the north.

This study did not evaluate the construction of an area-wide central sewer system for all existing and potential units in each of the study areas because the soils are suitable for septic systems and mound systems. It would not be economically feasible to have existing homeowners abandon on-lot systems that are working properly. This study, however, did evaluate individual on-lot systems and community systems, such as spray irrigation and stream discharge, for potential units in select undeveloped areas of Kirkwood Village, Black Rock Estates, and Octoraro Pines/Mount Vernon Estates that may be suitable for future development of these undeveloped areas. In order to address issues that may arise in other townships in Lancaster County, especially townships that might not have the excellent soils that Colerain Township has, the study evaluated several "what-if" scenarios including what if some soils were unsuitable for some of the disposal methods, what if a few septic systems failed in an area, and what if many or all septic systems failed in an area. These scenarios provide an approach for addressing these situations.

4.2 Analysis of Constraints

Soils and Slopes

25 PA Code Chapter 73 specifies certain site requirements for on-site wastewater disposal systems including minimum soil limiting zone and maximum allowable slopes. In Pennsylvania, the minimum depth to a limiting zone varies from 10 to 60 inches. The depth to the limiting zone determines the general suitability of the site and indicates which systems might be suitable for the site. A limiting zone is defined as a soil horizon or condition in the soil profile or underlying strata which includes one or more of the following:

1. A seasonal high water table determined by direct observation of the water table or by the presence of soil mottling. Before it can be properly treated, wastewater flows into the groundwater, polluting the groundwater.

SITE REQUIREMENTS FOR ON-SITE SYSTEMS IN PENNSYLVANIA			
Type of System	***Soil Limiting Zone***	***Allowable Slopes***	***Other***
Conventional Trench	60 inches	25%	
Elevated Sand Mound	20 inches	12%	
Drip Irrigation	20 inches	25%	
Spray Irrigation	10 inches	25%	
Stream Discharge	N/A	N/A	Access to stream and nutrient concentration limits

Table 2

2. Rock strata that contains open joints, fractures, solution channels, or loose rock fragments which do not provide sufficient renovation of the wastewater. Wastewater flows too quickly through these areas to be treated properly.

3. A rock formation, other stratum or soil condition which reduces the permeability of the soil and limits downward movement of the wastewater. These limiting formations include fragipan, duripan or other restrictive layers.

The limiting zone of a particular soil is usually the depth to the evidence of a seasonal high groundwater, or the depth to bedrock. The depth to the seasonal high groundwater can be directed observed during wet conditions by observing the depth of water in a pit. During dry weather conditions, the seasonal high groundwater depth is determined by observing soil mottling. According to DEP, soil mottling is a contrasting or "blotchy" color pattern within the dominant soil color. It is formed when the seasonal high water table rises into aerobic soils changing the conditions in the soils from aerobic (oxygen rich) to anoxic (without oxygen). The types of bacteria that can live under these two conditions are different. Bacteria living under aerobic conditions die when the water table rises because the oxygen in the soil is replaced by water. Anoxic bacteria begin to thrive because they can use certain oxides (oxygen bonded to iron and manganese) in the soil to survive. When the bacteria use the oxygen bonded to the iron and manganese, these minerals change color and dissolve into the water around them. When the water level begins to drop, these dissolved minerals stick to the surface of soil particles as yellow, red, orange, brown, blue or black coatings or a combination of these colors. Areas from which all of these minerals were removed because of long saturation periods become gray in color.

The soil limiting zone and slope criteria for a variety of on-site wastewater disposal options are shown in Table 2.

Lancaster County is known for its fertile farmland and exceptional soils and Colerain Township soils support this reputation. Table 2 illustrates the soil types within Colerain Township and the key factors that contribute to soil suitability for wastewater disposal options. It's important to note that the depth to the seasonal high water table, the depth to the restrictive layer, the hydric (wetland) soil, and the limiting zone characteristics are based on average soils of this type throughout Pennsylvania and may vary significantly for a specific soil in a specific area. The information contained in Table 3 should only be used for planning purposes. For the final selection and design of a particular soil-based wastewater system, such as a mound or spray irrigation system, in-depth soils testing should be performed on the site being considered. The site testing should, as a minimum, include the digging of a test pit with a backhoe, identifying the limiting zone of the soil horizon, and observing the characteristics of the soils. Ultimately, if the soils appear to be suitable for a specific wastewater disposal method, either percolation tests (for septic systems) or hydroconductivity tests (for mound, drip and spray systems) should be performed to determine the infiltration rate of the wastewater.

SOIL LIMITATIONS FOR ON-LOT SEWAGE DISPOSAL IN COLERAIN TOWNSHIP							
Soil Symbol	***Soil Name***	***Description***	***Hydrologic Group***	***Depth to Seasonal High Water Table (inches) (*1)***	***Depth to Restrictive Layer (inches) (*2)***	***Hydric Soil (H) with % of map unit***	***Limiting Zone (inches) (*3)***
Ba	Baile	silt loam	D	0-6	60+	H - 85%	0
CbA	Chester	silt loam	B	80+	72+		72
CbB	Chester	silt loam	B	80+	72+		72
CbC	Chester	silt loam	B	80+	72+		72
Cm	Comus	silt loam	B	80+	72+	H - 8% (fldpln)	72
EcB	Elk	silt loam	B	80+	60+		60
GbB	Glenelg	silt loam	B	80+	60+		60
GbC	Glenelg	silt loam	B	80+	60+		60
GbD	Glenelg	silt loam	B	80+	60+		60
GdB	Glenville	silt loam	C	6-36	60+ 15-30 (fragipan)	H - 5%	20 * soil test required
LaB	Lansdale	loam	B	80+	42-60		42
LaC	Lansdale	loam	B	80+	42-60		42
MaB	Manor	silt loam	B	80+	72+		72
MaC	Manor	silt loam	B	80+	72+		72
MaD	Manor	silt loam	B	80+	72+		72
MbB	Manor	very stony silt loam	B	80+	72+		72
MbD	Manor	very stony silt loam	B	80+	72+		72
MbF	Manor	very stony silt loam	B	80+	72+		72
Nd	Newark	silt loam, schist substratum	C	6-18	60+	H - 12% (fldpln)	6
W	Water	-	-	-	-	-	-
*(*1) Based on the Soil Survey of Lancaster County, Pennsylvania Water Features Table*							
*(*2) Based on the Soil Survey of Lancaster County, Pennsylvania Soil Features Table. Restrictive layer is bedrock unless noted otherwise.*							
*(*3) Limiting zone is the shallower of depth to bedrock or depth ot seasonal high water table*							

Table 3

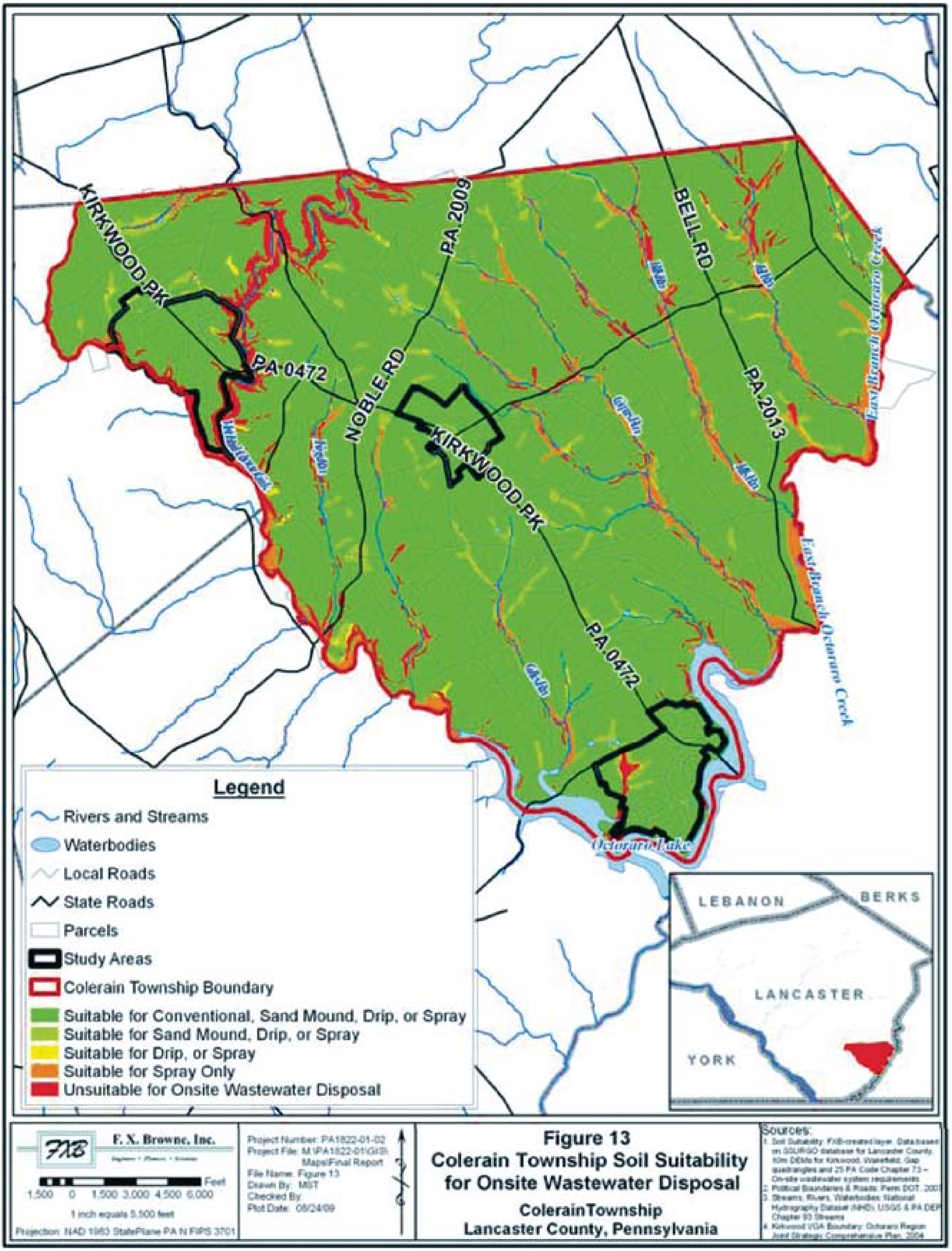
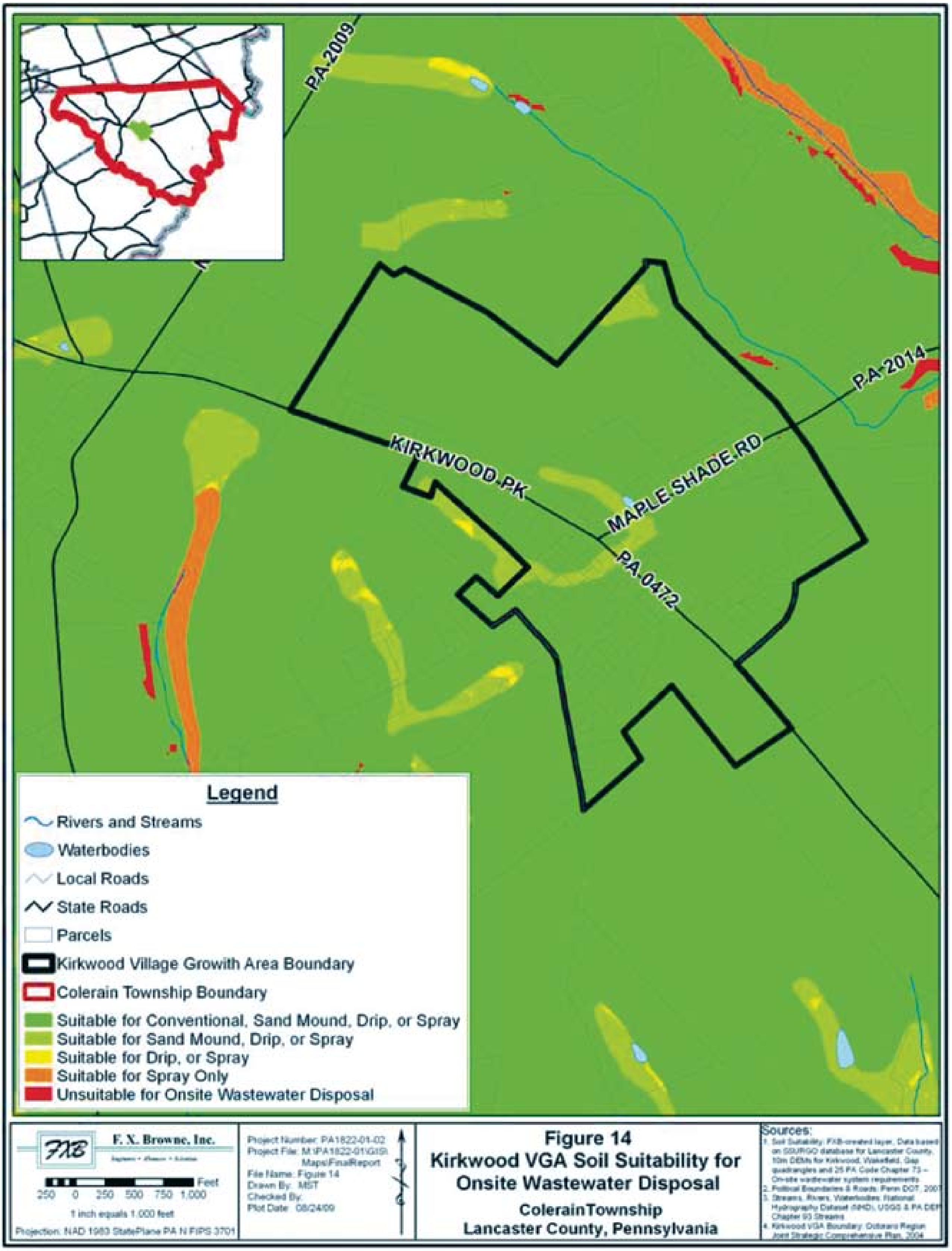


Figure 13
Colerain Township Soil Suitability for Onsite Wastewater Disposal
ColerainTownship
Lancaster County, Pennsylvania


PA-2009
PA-2014
KIRKWOOD PK
MAPLE SHADE RD
PA-0472
Legend
Rivers and Streams
Waterbodies
Local Roads
State Roads
Parcels
Kirkwood Village Growith Area Boundary
Colerain Township Boundary
Suitable for Conventional, Sand Mound, Drip, or Spray
Suitable for Sand Mound, Drip, or Spray
Suitable for Drip, or Spray
Suitable for Spray Only
Unsuitable for Onsite Wastewater Disposal
FXB
F. X. Browne, Inc.
Feet
250 0 250 500 750 1,000
1 inch equals 1,000 feet
Projection: NAD 1983 StatePlane PA N FIPS 3701
Project Number: PA1822-01-02
Project File: M:\PA1822-01\GIS\Maps\FinalReport
File Name: Figure 14
Drawn By: MST
Checked By:
Plot Date: 08/24/09
Figure 14
Kirkwood VGA Soil Suitability for Onsite Wastewater Disposal
ColerainTownship
Lancaster County, Pennsylvania
Sources:
1. Soil Suitability: FXB-created layer. Data based on SSURGO database for Lancaster County, 10m DEMs for Kirkwood, Wakefield, Gap quadrangles and 25 PA Code Chapter 73 – On-site wastewater system requirements
2. Political Boundaries & Roads: Penn DOT, 2007
3. Streams, Rivers, Waterbodies: National Hydrography Dataset (NHD), USGS & PA DEP Chapter 93 Streams
4. Kirkwood VGA Boundary: Octoraro Region Joint Strategic Comprehensive Plan, 2004

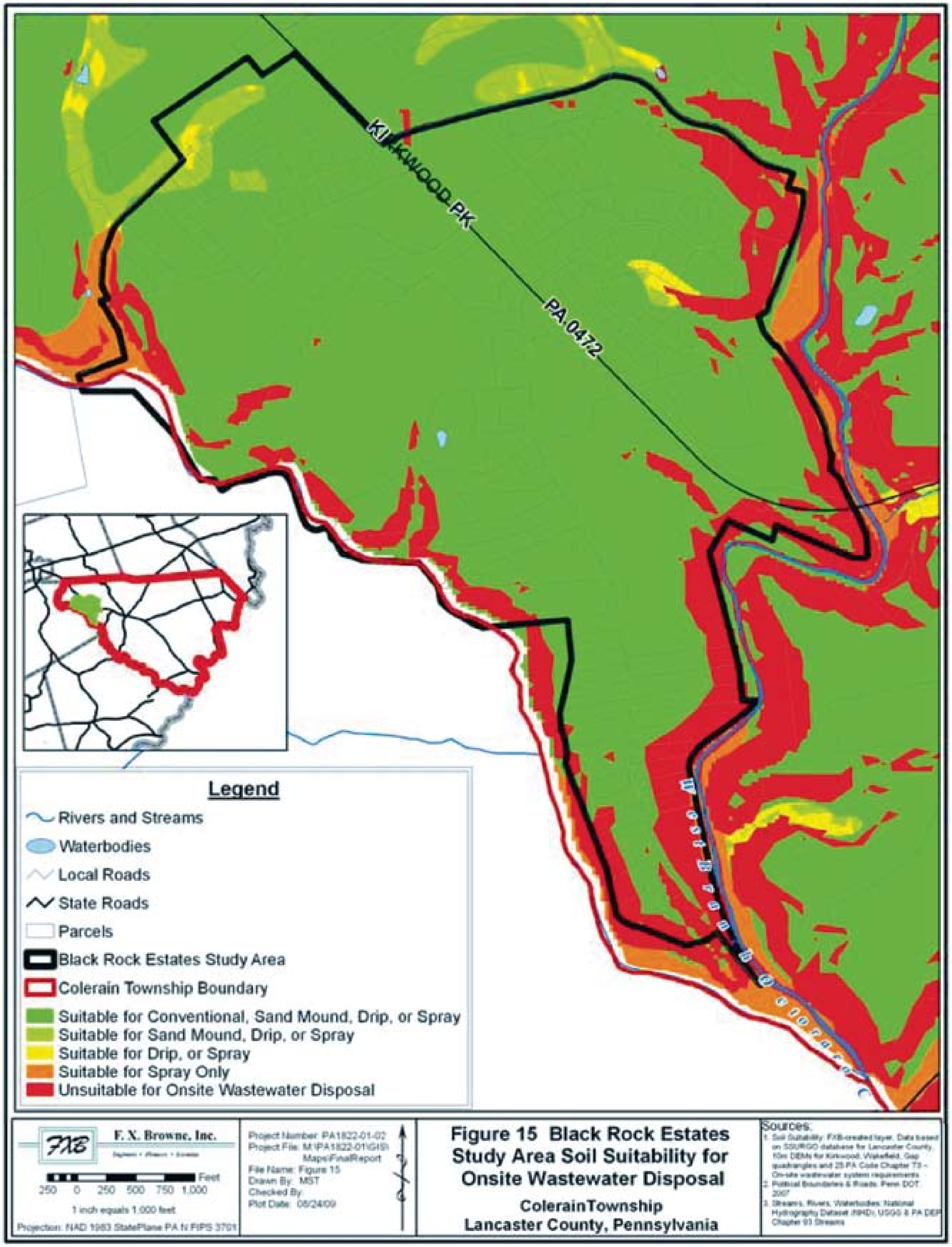


Figure 15 Black Rock Estates Study Area Soil Suitability for Onsite Wastewater Disposal

Colerain Township
Lancaster County, Pennsylvania

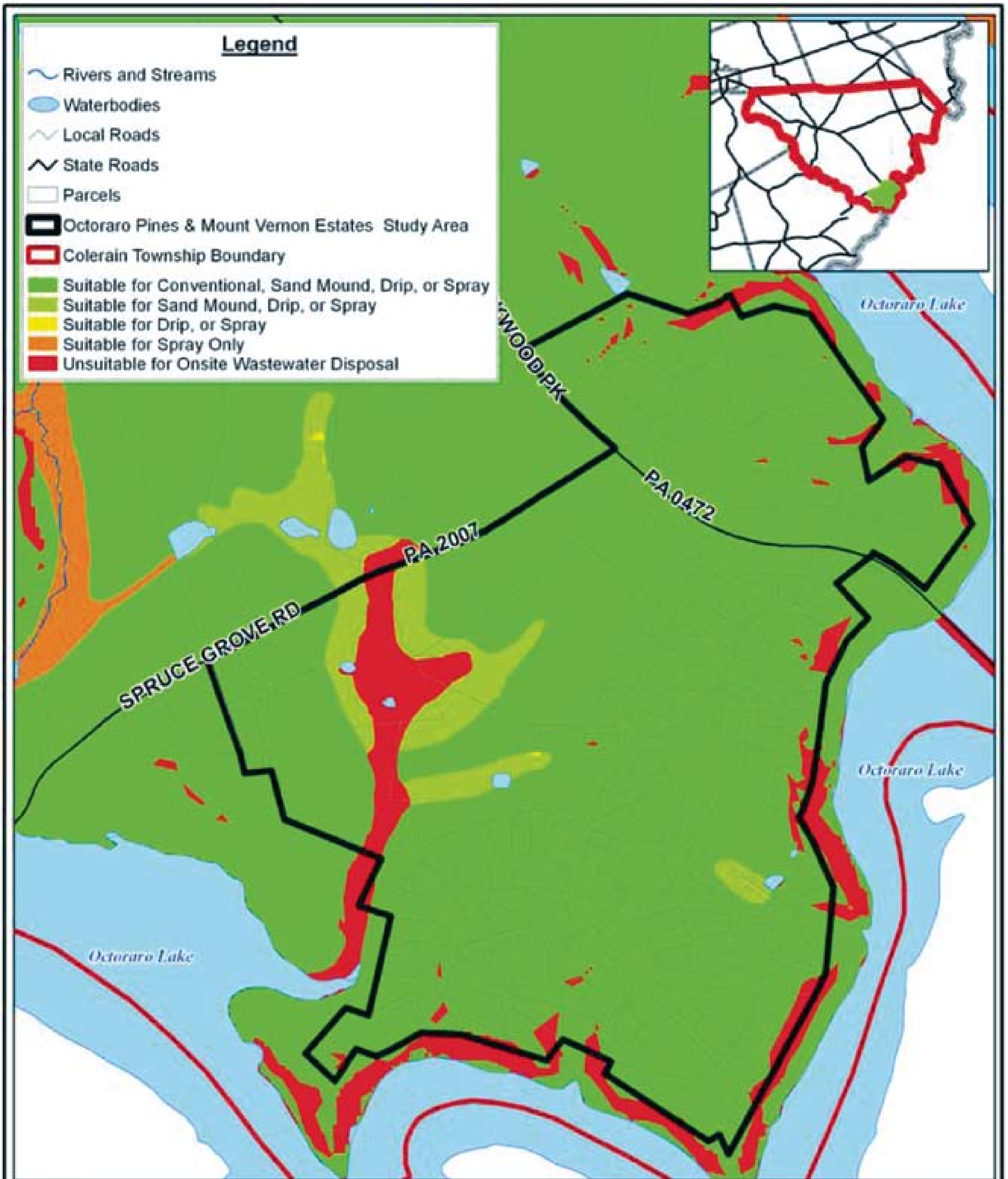


Figure 16 Octoraro Pines Study Area Soil Suitability for Onsite Wastewater Disposal

ColerainTownship
Lancaster County, Pennsylvania

This information is needed to design the size of the required wastewater disposal system.

Since slope maps were not available, slopes were determined using 10-meter resolution Digital Elevation Models in GIS. Colerain Township is generally flat and slopes exceeded 25% only along the banks of streams and Octoraro Lake. A combination of the soil suitability factors and GIS-derived slopes were used to estimate the overall soil suitability for the Township. The soils suitability map for Colerain Township is presented in Figure 13. As shown in Figure 13, almost all of the soils in Colerain Township are suitable for most of the soil-based disposal systems including septic systems, mound systems, drip irrigation systems, and spray irrigation systems. Most of the unsuitable soils for on-site wastewater disposal are located primarily in areas along streams and Octoraro Lake, where slopes exceed 25% and where Hydric (wetland) soils such as Baile silt loam are more prevalent. Figures 14, 15, and 16 provide a detailed look at the soil suitability within each study area.

Land Availability

Balance, the Growth Management Element of the Lancaster County Comprehensive Plan seeks to limit additional development in Colerain Township to within the village growth area of Kirkwood Village and to a lesser extent, within the rural settlements of Black Rock Estates, Octoraro Pines and Mount Vernon Estates. The land availability information described below is based on existing zoning and land use and not the potential need projected by either the *Octoraro Region Joint Strategic Comprehensive Plan* or the Lancaster County Comprehensive Plan.

Kirkwood Village has a large 80 acre parcel and two smaller, adjacent parcels that have the potential to provide a combined 95 acres of land that could be developed by a single developer. Additional infill development and smaller parcels may contribute an additional 18 acres of developable land in Kirkwood Village.

Black Rock Estates contains several residentially-zoned, undeveloped parcels currently in agricultural use ranging in size from 10 acres to 68 acres. These undeveloped parcels have the potential to provide an additional 240 acres of land for development[1].

Octoraro Pines and Mount Vernon Estates also contain several residentially-zoned, undeveloped parcels currently in agricultural use. These parcels range in size from 3 acres to 35 acres and have the potential to contribute an additional 194 acres of developable land to the area.

4.3 Services Area Flow Projections

Service area flow projections were calculated for each study area by determining the number of

[1] Land available for development includes only the portion of the parcels zoned for residential use and does not include any portion of the parcel zoned as Open Space.

SUMMARY OF EQUIVALENT DWELLING UNITS BY SERVICE AREA

Study Area	*EDUs without Central Sewer*	*EDUs with Central Sewer (likely build-outs)*	*EDUs with Central Sewer (maximum build-out)*
Kirkwood Village	241	-	658
Black Rock Estates	278	706	816
Octoraro Pines and Mount Vernon Estates	326	648	824

Residential EDUs for Black Rock Estates and Octoraro Pines/Mount Vernon Estates were calculated based on existing zoning (Rettew Associates 1993), land use codes, acreage, and GIS frontage distances, not by the potential need projected by either the Octoraro Region Joint Strategic Comprehensive Plan or the Lancaster County Comprehensive Plan. Residential EDUs for Kirkwood Village were based on the 2007 analysis conducted by Lancaster County, and thus, do not include a “likely build-out” scenario.

Table 4

SUMMARY OF WASTEWATER FLOW BY SERVICE AREA			
Study Area	***EDUs without Central Sewer (gpd)***	***EDUs with Central Sewer (likely build-outs) (gpd)***	***EDUs with Central Sewer (maximum build-out) (gpd)***
Kirkwood Village	96,400	-	200,164
Black Rock Estates	113,235	216,412	249,874
Octoraro Pines and Mount Vernon Estates	132,000	198,338	264,645

Residential wastewater flows for Black Rock Estates and Octoraro Pines/Mount Vernon Estates were calculated based on existing zoning (Rettew Associates 1993), land use codes, acreage, and GIS frontage distances, not by the potential need projected by either the Octoraro Region Joint Strategic Comprehensive Plan or the Lancaster County Comprehensive Plan. Residential flows for Kirkwood Village were based on the 2007 analysis conducted by Lancaster County, and thus, do not include a "likely build-out" scenario.

Table 5

equivalent dwelling units (EDUs) for each study area and multiplying by the flow per EDU.

Table 4 illustrates the estimated EDUs in each service area for three potential build-out scenarios. Each of the scenarios includes already developed parcels in the EDU estimate and assumes that 80% of each parcel, not including area zoned Open Space, is available for development. The "EDUs without Central Sewer" scenario is based on a minimum lot size of 40,000 square-feet (0.92 acres) and a minimum lot width of 150 feet. The "EDUs with Central Sewer (likely build-out) is based on a minimum lot size of 18,000 square-feet (0.41 acre) and considers only the likely redevelopment of already developed parcels; parcels greater than 3 acres with suitable geometry were considered likely to allow for potential redevelopment. The "EDUs with Central Sewer (maximum build-out)" is also based on a minimum lot size of 18,000 square-feet (0.41 acre) but considers redevelopment of any parcel larger than twice the minimum lot size.

As discussed above, this study did not evaluate the construction of an area-wide central sewer system for all existing and potential units in each of the study areas because the soils are suitable for septic systems and mound systems. This study, however, did evaluate individual on-lot systems and community systems for potential units in select undeveloped areas of Kirkwood Village, Black Rock Estates, and Octoraro Pines/Mount Vernon Estates that may be suitable for future development of these undeveloped areas.

Kirkwood Village Proposed Village Growth Area

One 80-acre parcel and portions of two smaller parcels in the northern area of Kirkwood Village are prime candidates for a community wastewater disposal system. The developable portions of these parcels make up a contiguous 93.5-acre tract of developable land. Figure 17 shows the location of this tract of land as well as zoning, parcel ID numbers, and the acreage of each section.

Four wastewater disposal scenarios were evaluated for this tract of land:

1. Use on on-lot septic and mound systems, using a low density development
2. Community system with Spray Irrigation, options for disposal on-site or off-site
3. Community system with Drip Irrigation, options for disposal on-site or off-site
4. Community system with a Treatment Plant with Stream Discharge

The community system scenarios for spray irrigation and drip irrigation were evaluated in two ways: placing the treatment system on the land being developed, and placing the treatment system on land adjacent to the land being developed. Placing the treatment system on adjacent land outside of the area to be developed would require the purchase of the land or a conservation easement.

SUMMARY OF EDUs BY WASTEWATER DISPOSAL SCENARIO					
Parcel ID	**Acres**	**EDUs without Central Sewer**	**EDUs with Spray or Drip Irrigation and On-Site Disposal**	**EDUs with Spray or Drip Irrigation and Off-Site Disposal**	**EDUs with Treatment Plant with Stream Discharge**
175027	79.15	68	115	165	163
175106	3.73	3	7	7	7
175275	10.70	8	21	21	21
TOTAL	**93.58**	**79**	**143**	**193**	**191**

Table 6

The potential development of this tract for each wastewater disposal scenario is provided in Table 6.

Black Rock Estates Proposed Village Growth Area

One 19-acre parcel and one 10-acre parcel in the eastern portion of Black Rock Estates are prime candidates for a community system. The developable portions of these parcels make up a contiguous 24.5-acre tract of developable land. Figure 18 shows the location of this tract of land as well as zoning, parcel ID numbers, and the acreage of each section.

Four wastewater disposal scenarios were evaluated for this tract of land:

1. Use on on-lot septic and mound systems, using a low density development
2. Community system with Spray Irrigation, options for disposal on-site or off-site
3. Community system with Drip Irrigation, options for disposal on-site or off-site
4. Community system with a Treatment Plant with Stream Discharge

Table 7 illustrates the potential development of this tract for each wastewater disposal scenario.

"EDUs without Central Sewer" scenario is based on a minimum lot size of 40,000 square-feet (0.92 acres). The EDUs for all community system scenarios are based on a minimum lot size of 18,000 square-feet (0.41 acre), excluding any land area that may be required for on-site wastewater disposal, treatment plants, or lagoons.

Octoraro Pines Proposed Study Area

One 35-acre parcel in the north-central portion of Octoraro Pines is a prime candidate for a community system. The entire 35 acre tract is developable, although it is land-locked and would require a right-of-way. Figure 19 shows the location of this tract of land as well as zoning, parcel ID number, and acreage. Four wastewater disposal scenarios were evaluated for this tract of land:

SUMMARY OF EDUs BY WASTEWATER DISPOSAL SCENARIO					
Parcel ID	**Acres**	**EDUs without Central Sewer**	**EDUs with Spray or Drip Irrigation and On-Site Disposal**	**EDUs with Spray or Drip Irrigation and Off-Site Disposal**	**EDUs with Treatment Plant with Stream Discharge**
174654	10.39	9	20	20	20
174638	14.10	12	16	27	25
TOTAL	**24.49**	**21**	**36**	**47**	**45**

Table 7

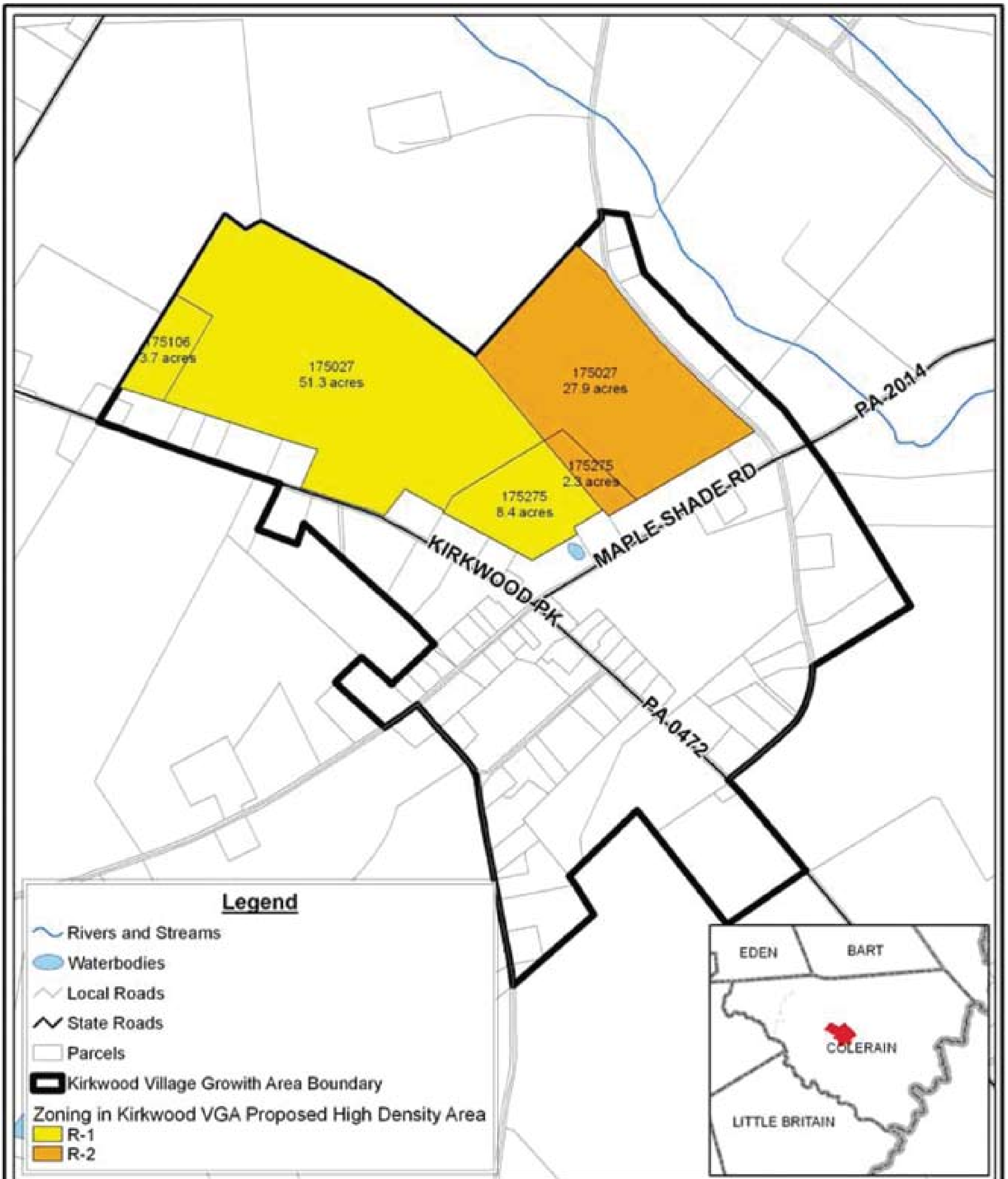


Figure 17
Kirkwood VGA Proposed Higher Density Area with Zoning
ColerainTownship
Lancaster County, Pennsylvania

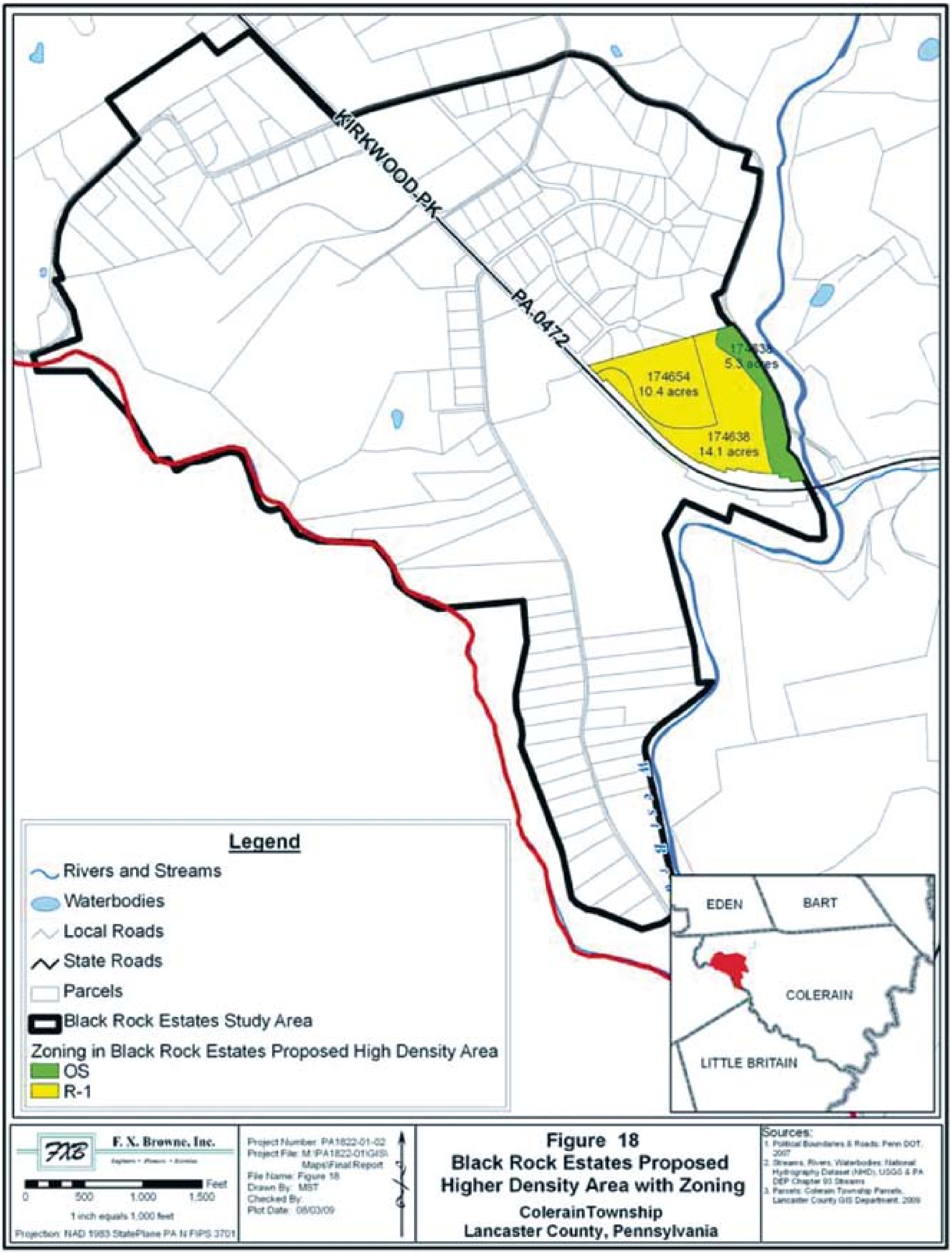


Figure 18
Black Rock Estates Proposed Higher Density Area with Zoning
Colerain Township
Lancaster County, Pennsylvania

SUMMARY OF EDUs BY WASTEWATER DISPOSAL SCENARIO					
Parcel ID	**Acres**	**EDUs without Central Sewer**	**EDUs with Spray or Drip Irrigation and On-Site Disposal**	**EDUs with Spray or Drip Irrigation and Off-Site Disposal**	**EDUs with Treatment Plant with Stream Discharge**
177602	35.4	30	53	69	67

Table 8

1. Use on on-lot septic and mound systems, using a low density development
2. Community system with Spray Irrigation, options for disposal on-site or off-site
3. Community system with Drip Irrigation, options for disposal on-site or off-site
4. Community system with a Treatment Plant with Stream Discharge

Table 8 illustrates the potential development of this tract for each wastewater disposal scenario.

"EDUs without Central Sewer" scenario is based on a minimum lot size of 40,000 square-feet (0.92 acres). The EDUs for all community system scenarios are based on a minimum lot size of 18,000 square-feet (0.41 acre), excluding any land area that may be required for on-site wastewater disposal, treatment plants, or lagoons.

4.4 Land Area Needs

As discussed in Section 3.3, the amount of land that is needed for a land-based wastewater treatment and disposal system is ultimately determined from detailed soil testing. For this planning study, information from the Lancaster County Soil Survey was used to determine an estimate of application rate. Spray irrigation systems typically require greater land area than drip irrigation systems due to a lower application rate and larger lagoons. However, considering the small community systems evaluated in this report that result in little difference of application area and the rough estimates of lagoon requirements for a planning level study, the land area estimates for drip and spray were averaged for a more concise representation. General sizing guidelines provided in Section 3.3 were used to estimate the area required for spray and drip irrigation.

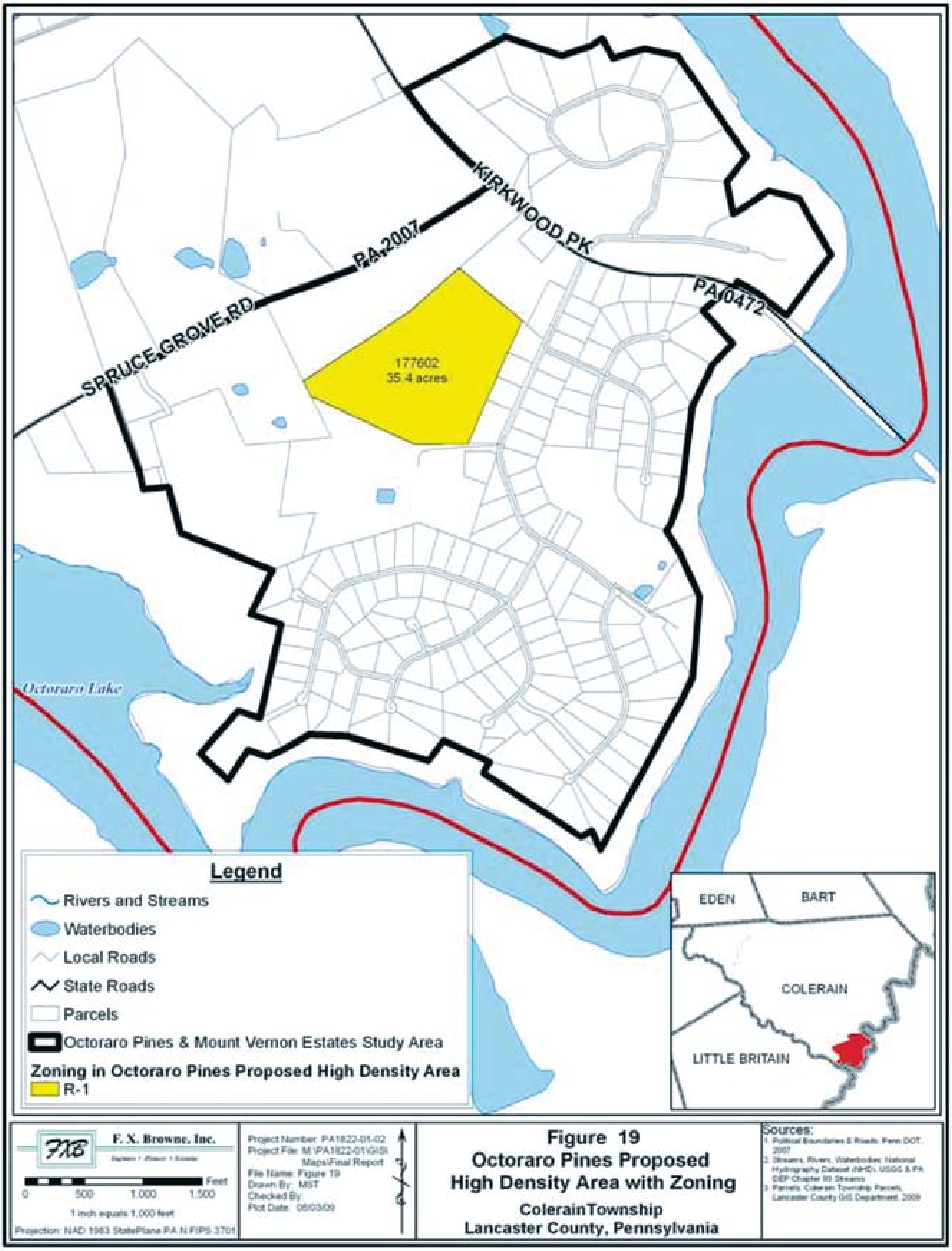
Kirkwood Village Proposed Village Growth Area

Table 9 describes the land area needed for wastewater treatment and disposal for on-site systems, spray or drip irrigation with on-site disposal, spray or drip irrigation with off-site disposal, and a treatment plant with stream discharge. Figure 20 shows the location and extent of these land areas in graphical format. More land is required for the off-site disposal option because more land will be available for development within the service area if that land is not being used for spray or drip irrigation.

Off-site disposal for spray or drip irrigation will require a conservation easement or land purchase of the specified acreage outside of Kirkwood Village. A treatment plant with stream discharge would discharge across Farmdale Road and discharge into an unnamed tributary to Cooper's Run, an easement would be required for the distance from Farmdale Road to the stream.

LAND AREA NEEDS BY WASTEWATER DISPOSAL SCENARIO				
	EDUs without Central Sewer	**EDUs with Spray or Drip Irrigation and On-Site Disposal**	**EDUs with Spray or Drip Irrigation and Off-Site Disposal**	**EDUs with Treatment Plant with Stream Discharge**
Land Area (acres)	0	21.4	28.6	1

Table 9


KIRKWOOD PK
PA 2007
SPRUCE GROVE RD
PA 0472
177602
35.4 acres
Octoraro Lake
Legend
Rivers and Streams
Waterbodies
Local Roads
State Roads
Parcels
Octoraro Pines & Mount Vernon Estates Study Area
Zoning in Octoraro Pines Proposed High Density Area
R-1
EDEN
BART
COLERAIN
LITTLE BRITAIN
F. X. Browne, Inc.
Feet
0 500 1,000 1,500
1 inch equals 1,000 feet
Projection: NAD 1983 StatePlane PA N FIPS 3701
Project Number: PA1822-01-02
Project File: M:\PA1822-01\GIS\Maps\Final Report
File Name: Figure 19
Drawn By: MST
Checked By:
Plot Date: 08/03/09
Figure 19
Octoraro Pines Proposed
High Density Area with Zoning
ColerainTownship
Lancaster County, Pennsylvania
Sources:

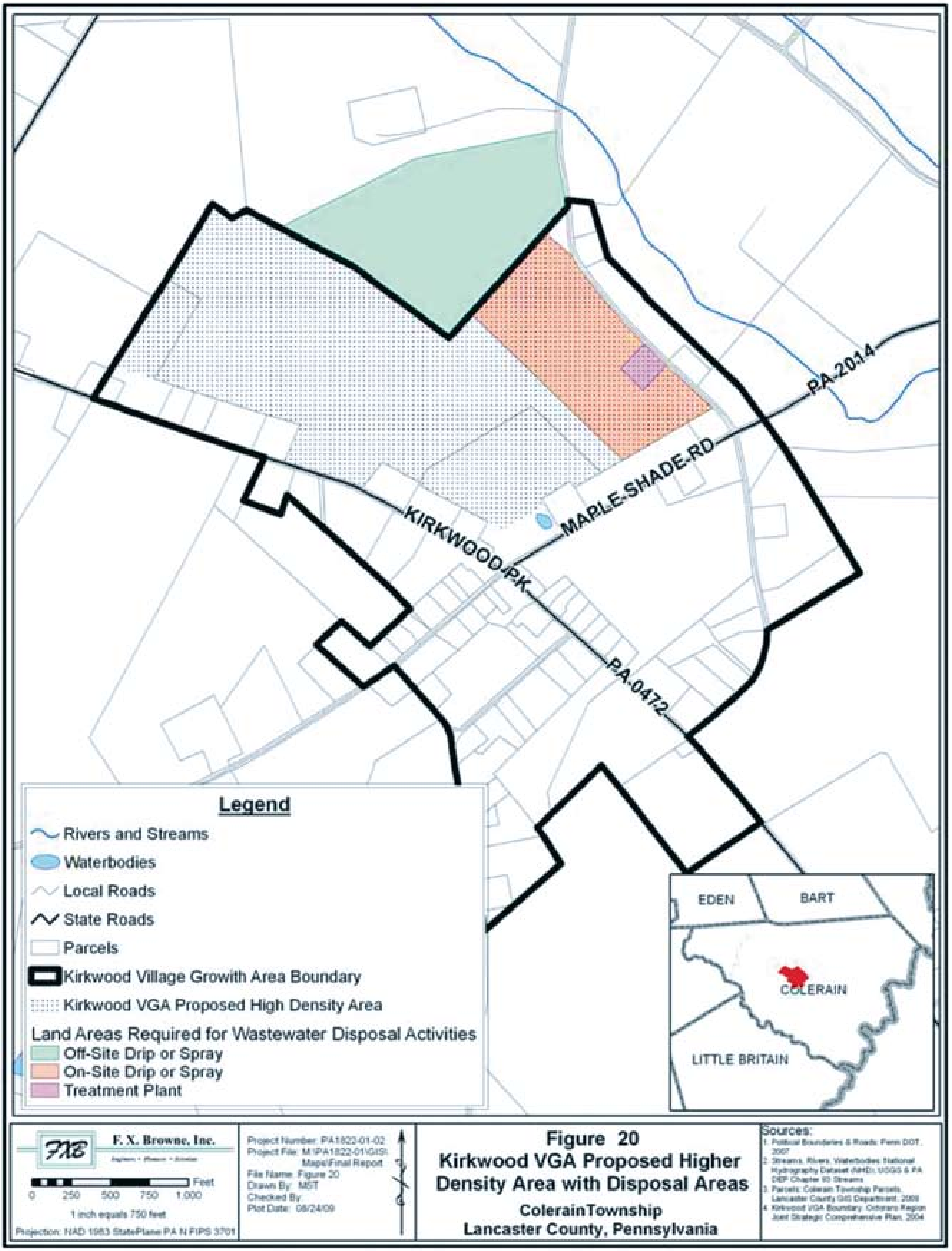


Figure 20
Kirkwood VGA Proposed Higher Density Area with Disposal Areas
Colerain Township
Lancaster County, Pennsylvania

LAND AREA NEEDS BY WASTEWATER DISPOSAL SCENARIO				
	EDUs without Central Sewer	**EDUs with Spray or Drip Irrigation and On-Site Disposal**	**EDUs with Spray or Drip Irrigation and Off-Site Disposal**	**EDUs with Treatment Plant with Stream Discharge**
Land Area (acres)	0	5.8	7.3	1

Table 10

Black Rock Estates Proposed Study Areas

Table 10 describes the land area needed for wastewater treatment and disposal for on-site systems, spray or drip irrigation with on-site disposal, spray or drip irrigation with off-site disposal, and a treatment plant with stream discharge. Figure 21 shows the location and extent of these land areas in graphical format.

Off-site disposal for spray or drip irrigation will require a conservation easement or land purchase of the specified acreage outside of Black Rock Estates and also would require a road crossing at Kirkwood Pike. A treatment plant with stream discharge would discharge into the West Branch Octoraro Creek at the southern corner of the property where a road crossing would not be necessary.

Octoraro Pines Proposed Study Areas

Table 11 describes the land area needed for wastewater treatment and disposal for on-site systems, spray or drip irrigation with on-site disposal, spray or drip irrigation with off-site disposal, and a treatment plant with stream discharge. Figure 22 shows the location and extent of these land area is graphical format.

Off-site disposal would require a conservation easement or land purchase for spray or drip application. A treatment plant with stream discharge may discharge into the Octoraro Lake; additional investigation of local regulations would be required to determine viability of lake discharge. If this option is found to be viable, the discharge pipe would cross under Long Lane and follow Pine Drive toward the lake, an additional easement would be necessary between Long Lane and Octoraro Lake.

4.5 Cost Estimates

Multiple cost estimates were compiled for the proposed higher density areas, each with differing treatment options and considering treatment locations both inside and outside of the areas. Treatment options evaluated include spray irrigation, drip irrigation, wastewater treatment facilities with stream discharge, and on-site treatment. Each of these treatment options yields different total EDU counts for a given proposed area. For instance, on-site treatment systems require large lots and therefore yield far less total EDUs than if a centralized wastewater treatment facility was constructed for an area. Alternately, drip irrigation allows for a slightly larger allowable loading rate than spray irrigation, and therefore yields more EDUs for a given area.

The following sections and tables discuss in detail the construction cost per EDU for each treatment option for the proposed village growth areas within the Kirkwood Village, Black Rock Estates and Octoraro Pines growth areas. EDU counts are based

LAND AREA NEEDS BY WASTEWATER DISPOSAL SCENARIO				
	EDUs without Central Sewer	**EDUs with Spray or Drip Irrigation and On-Site Disposal**	**EDUs with Spray or Drip Irrigation and Off-Site Disposal**	**EDUs with Treatment Plant with Stream Discharge**
Land Area (acres)	0	8.1	10.2	1

Table 11

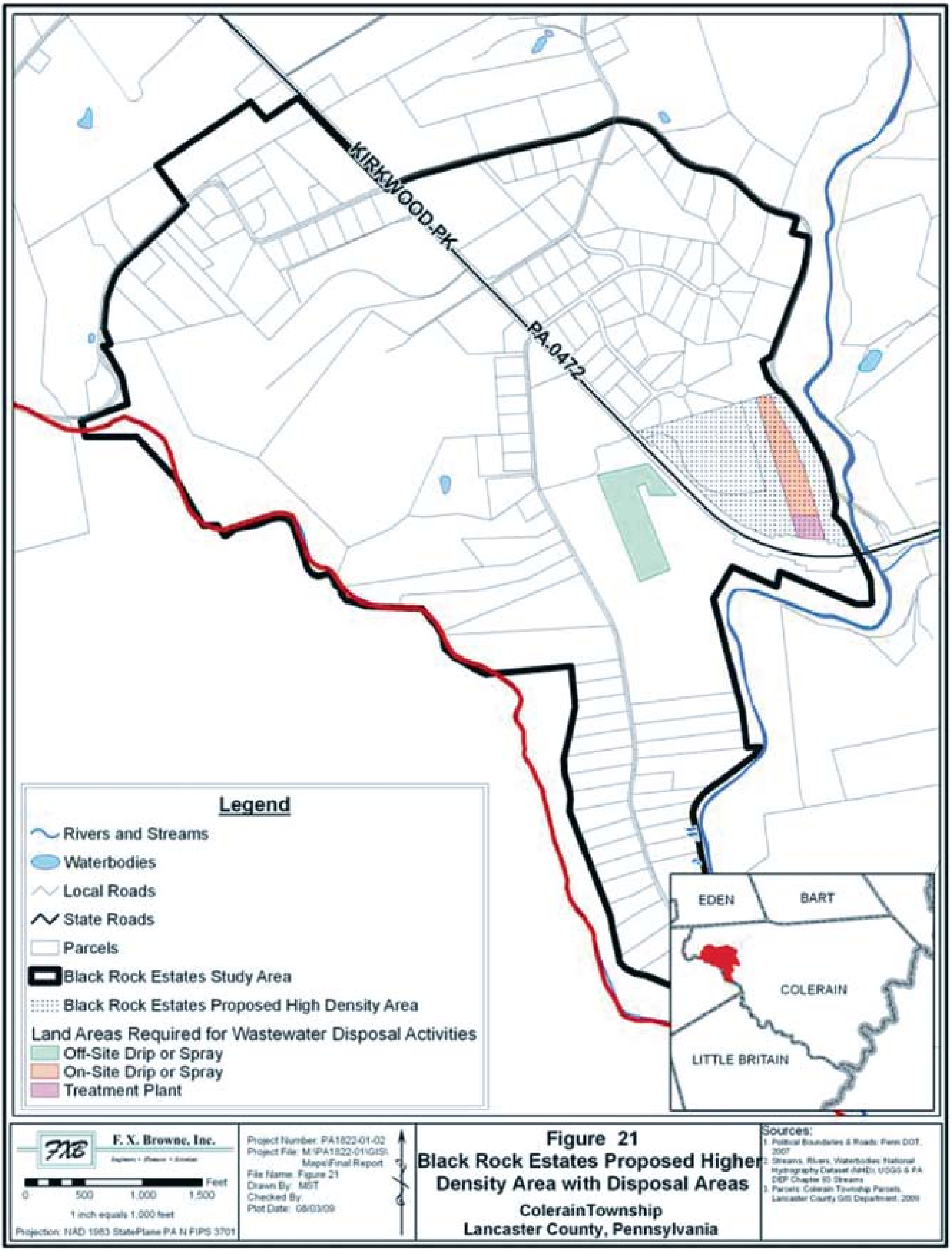
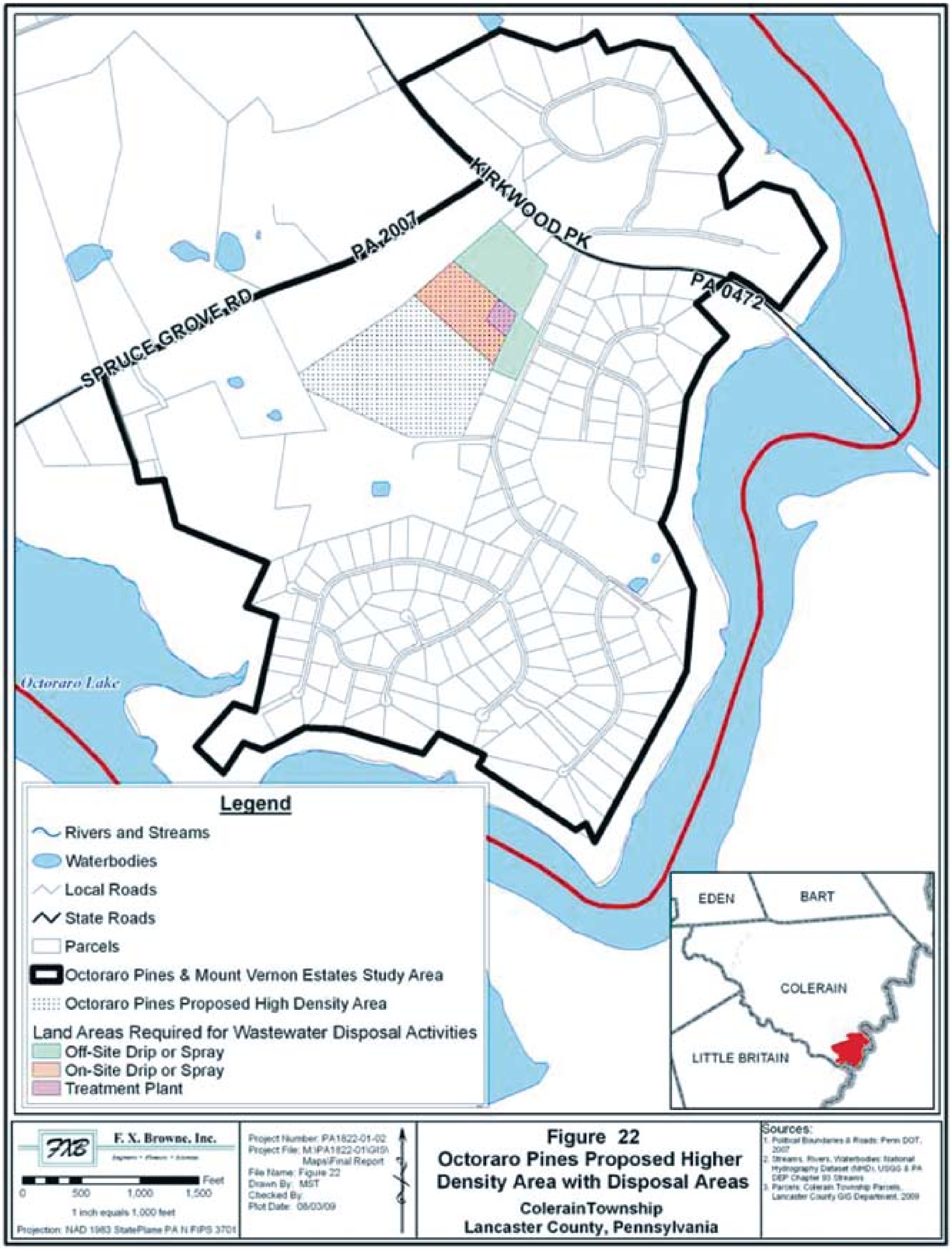


Figure 21
Black Rock Estates Proposed Higher Density Area with Disposal Areas
Colerain Township
Lancaster County, Pennsylvania


KIRKWOOD PK
PA 2007
SPRUCE GROVE RD
PA 0472
Octoraro Lake
Legend
Rivers and Streams
Waterbodies
Local Roads
State Roads
Parcels
Octoraro Pines & Mount Vernon Estates Study Area
Octoraro Pines Proposed High Density Area
Land Areas Required for Wastewater Disposal Activities
Off-Site Drip or Spray
On-Site Drip or Spray
Treatment Plant
EDEN
BART
COLERAIN
LITTLE BRITAIN
F. X. Browne, Inc.
Feet
0 500 1,000 1,500
1 inch equals 1,000 feet
Projection: NAD 1983 StatePlane PA N FIPS 3701
Project Number: PA1822-01-02
Project File: M:\PA1822-01\GIS\Maps\Final Report
File Name: Figure 22
Drawn By: MST
Checked By:
Plot Date: 08/03/09
Figure 22
Octoraro Pines Proposed Higher Density Area with Disposal Areas
ColerainTownship
Lancaster County, Pennsylvania
Sources:

on the methodology discussed above. Total costs are based on costs as discussed in Section 2.0.

Kirkwood Village Proposed Village Growth Areas

Within the Kirkwood Village growth area, as delineated in the Octoraro Region Joint Strategic Comprehensive Plan (Lancaster County Planning Commission 2004), a contiguous 93.5-acre tract of developable land was identified as a prime candidate for a community treatment system. Tables 12 and 13 illustrate the total cost of constructing each treatment alternative and the equivalent number of EDUs the treatment alternative will yield within the Kirkwood Village proposed growth areas. The proposed wastewater treatment areas contain a combination of Glenelg and Chester soil types, which are suitable for both spray and drip irrigation.

KIRKWOOD VILLAGE PROPOSED VILLAGE GROWTH AREAS WASTEWATER SYSTEM COSTS (PARCELS 175027, 175106, and 175275) (Systems Located Inside Service Area)

Wastewater Option Description	Total Cost	Number of EDUs	Cost per EDU
SPRAY IRRIGATION			
Gravity Collection System/ Small Pump Station	$2,671,099	143	$18,679
Pressure Collection System (Developers pay for Grinder Pumps)	$2,733,441	143	$19,115
Pressure Collection System (Homeowners pay for Grinder Pumps)	$2,315,881	143	$16,195
DRIP IRRIGATION			
Gravity Collection System/ Small Pump Station	$1,483,652	143	$10,375
Pressure Collection System (Developers pay for Grinder Pumps)	$1,545,994	143	$10,811
Pressure Collection System (Homeowners pay for Grinder Pumps)	$1,128,434	143	$7,891
WWTF WITH STREAM DISCHARGE			
Gravity Collection System/ Small Pump Station	$3,120,116	191	$16,336
Pressure Collection System (Developers pay for Grinder Pumps)	$3,322,618	191	$17,396
Pressure Collection System (Homeowners pay for Grinder Pumps)	$2,764,898	191	$14,476
ON-SITE SYSTEMS	$632,000	79	$8,000

Kirkwood Proposed Village Growth Areas dileneated in the Octoraro Region Joint Strategic Comprehensive Plan (Lancaster County Planning Commission 2004)

Table 12

KIRKWOOD VILLAGE PROPOSED VILLAGE GROWTH AREAS WASTEWATER SYSTEM COSTS (PARCELS 175027, 175106, and 175275) (Systems Located Outside Service Area)			
Wastewater Option Description	***Total Cost ****	***Number of EDUs***	***Cost per EDU***
SPRAY IRRIGATION			
Gravity Collection System/ Small Pump Station	$3,491,517	193	$18,091
Pressure Collection System (Developers pay for Grinder Pumps)	$3,660,439	193	$18,966
Pressure Collection System (Homeowners pay for Grinder Pumps)	$3,096,879	193	$16,046
DRIP IRRIGATION			
Gravity Collection System/ Small Pump Station	$1,646,588	193	$8,532
Pressure Collection System (Developers pay for Grinder Pumps)	$1,838,140	193	$9,509
Pressure Collection System (Homeowners pay for Grinder Pumps)	$1,236,912	193	$6,409
Kirkwood Village Growth Areas delineated in the Octoraro Region Joint Strategic Comprehensive Plan (Lancaster County Planning Commission 2004)			

Table 13

Black Rock Estates Proposed Study Area

Within the Black Rock Estates growth area, a contiguous 24.5-acre tract of developable land was identified as a prime candidate for a community treatment system. Tables 14 and 15 illustrate the total cost of constructing each treatment alternative and the equivalent number of EDUs the treatment alternative will yield within the Black Rock Estates proposed study area. The proposed wastewater treatment areas contain a combination of Glenelg and Manor soil types, which are generally suitable for both spray and drip irrigation.

BLACK ROCK ESTATES PROPOSED STUDY AREA WASTEWATER SYSTEM COSTS (PARCELS 174638, 174639, AND 174654) (Systems Located Inside Service Area)			
Wastewater Option Description	***Total Cost***	***Number of EDUs***	***Cost per EDU***
SPRAY IRRIGATION			
Gravity Collection System/ Small Pump Station	$784,589	36	$21,794
Pressure Collection System (Developers pay for Grinder Pumps)	$680,929	36	$18,915
Pressure Collection System (Homeowners pay for Grinder Pumps)	$575,809	36	$15,995
DRIP IRRIGATION			
Gravity Collection System/ Small Pump Station	$1,165,372	36	$32,371
Pressure Collection System (Developers pay for Grinder Pumps)	$1,061,712	36	$29,492
Pressure Collection System (Homeowners pay for Grinder Pumps)	$956,592	36	$26,572
WWTF WITH STREAM DISCHARGE			
Gravity Collection System/ Small Pump Station	$856,538	45	$19,034
Pressure Collection System (Developers pay for Grinder Pumps)	$779,158	45	$17,315
Pressure Collection System (Homeowners pay for Grinder Pumps)	$647,758	45	$14,395
ON-SITE SYSTEMS	$168,000	21	$8,000

Table 14

BLACK ROCK ESTATES PROPOSED STUDY AREA WASTEWATER SYSTEM COSTS (PARCELS 174638, 174639, AND 174654) (Systems Located Outside Service Area)			
Wastewater Option Description	***Total Cost***	***Number of EDUs***	***Cost per EDU***
SPRAY IRRIGATION			
Gravity Collection System/ Small Pump Station	$1,033,409	47	$21,987
Pressure Collection System (Developers pay for Grinder Pumps)	$922,449	47	$19,627
Pressure Collection System (Homeowners pay for Grinder Pumps)	$785,209	47	$16,707
DRIP IRRIGATION			
Gravity Collection System/ Small Pump Station	$1,302,028	47	$27,703
Pressure Collection System (Developers pay for Grinder Pumps)	$1,222,604	47	$26,013
Pressure Collection System (Homeowners pay for Grinder Pumps)	$1,050,616	47	$22,354

Table 15

Octoraro Pines Proposed Study Area

Within the Octoraro Pines growth area, a contiguous 35-acre tract of developable land was identified as a prime candidate for a community treatment system. Tables 16 and 17 illustrate the total cost of constructing each treatment alternative and the equivalent number of EDUs the treatment alternative will yield within the Octoraro Pines proposed study area. The proposed wastewater treatment area contains primarily Chester soil types. This soil type is generally suitable for both spray and drip irrigation.

OCTORARO PINES PROPOSED STUDY AREA WASTEWATER SYSTEM COSTS (PARCEL 177602) (Systems Located Inside Service Area)			
Wastewater Option Description	***Total Cost***	***Number of EDUs***	***Cost per EDU***
SPRAY IRRIGATION			
Gravity Collection System/ Small Pump Station	$1,089,227	53	$20,551
Pressure Collection System (Developers pay for Grinder Pumps)	$1,088,635	53	$19,031
Pressure Collection System (Homeowners pay for Grinder Pumps)	$853,875	53	$16,111
DRIP IRRIGATION			
Gravity Collection System/ Small Pump Station	$1,220,852	53	$23,035
Pressure Collection System (Developers pay for Grinder Pumps)	$1,140,260	53	$21,514
Pressure Collection System (Homeowners pay for Grinder Pumps)	$985,500	53	$18,594
WWTF WITH STREAM DISCHARGE			
Gravity Collection System/ Small Pump Station	$1,205,145	67	$17,987
Pressure Collection System (Developers pay for Grinder Pumps)	$1,165,433	67	$17,395
Pressure Collection System (Homeowners pay for Grinder Pumps)	$969,793	67	$14,475
ON-SITE SYSTEMS	$240,000	30	$8,000

Table 16

OCTORARO PINES PROPOSED STUDY AREA WASTEWATER SYSTEM COSTS (PARCEL 177602) (Systems Located Outside Service Area)			
Wastewater Option Description	**Total Cost**	**Number of EDUs**	**Cost per EDU**
SPRAY IRRIGATION			
Gravity Collection System/ Small Pump Station	$1,367,529	69	$19,819
Pressure Collection System (Developers pay for Grinder Pumps)	$1,313,947	69	$19,043
Pressure Collection System (Homeowners pay for Grinder Pumps)	$1,112,467	69	$16,123
DRIP IRRIGATION			
Gravity Collection System/ Small Pump Station	$1,360,428	69	$19,716
Pressure Collection System (Developers pay for Grinder Pumps)	$1,317,358	69	$19,092
Pressure Collection System (Homeowners pay for Grinder Pumps)	$1,018,130	69	$15,669

Table 17

4.6 Institutional

The institutional options for the wastewater scenarios described above are described in Section 3.5.

4.7 Funding Sources

The potential funding sources are described in Section 3.6

5.0 APPLYING METHODOLOGY TO LANCASTER COUNTY

This report presents a methodology to evaluate wastewater options that can be used throughout Lancaster County. A case study of Colerain Township is provided as an example of how to use the methodology to develop wastewater options for a relatively large planning area. A wastewater primer with definitions is provided in Section 2 of this report. Definitions in this chapter help to clarify wastewater terminology used throughout this report for the reader. A standard approach for evaluating wastewater treatment and disposal options is provided in Section 3. The methodology in Section 3, along with the flow chart in Appendix A, can be used to evaluate the feasibility of wastewater alternatives for all municipalities in Lancaster County and also throughout Pennsylvania. The wastewater methodology provided in Section 3 is applied to Colerain Township, and the results are provided in Section 4.

Because Colerain Township has excellent soils, almost all wastewater disposal options are suitable for large areas within the growth areas of the Township. In the following sections, different scenarios are discussed to give the user an idea of how the standard methodology can be applied if an area has limited or unsuitable soils or failing septic systems.

5.1 Scenario #1 - Some Soils in an Area Are Unsuitable

What if some of the soils in a municipality are unsuitable for certain disposal methods? The approach to evaluating wastewater disposal systems is to evaluate feasible methods in the following order: septic systems, mound systems, drip irrigation, and spray irrigation. As shown in Table 2, the requirements are more restrictive for septic systems based on limiting zone and maximum allowable slope and are least restrictive for spray irrigation. Therefore, if soil conditions do not allow septic systems or mound systems, you then evaluate drip irrigation. If that does not work, you evaluate spray irrigation. Because of the less restrictive nature of spray irrigation, this method usually works for most sites.

If the site soils are not suitable for any of these land-based disposal methods, off-site land-based disposal or construction of a wastewater treatment plant with stream discharge should be evaluated. Off-site land-based disposal systems would require purchasing land and/or obtaining easements for the disposal systems. The stream discharge option obviously requires a nearby stream. If a stream is not located on the site, an easement to install a discharge sewer would be required. A stream discharge would be subject to the effluent requirements of DEP and the Chesapeake Bay Program. A stream discharge would require the following approvals and permits: planning approval via a planning module, an NPDES permit to discharge to a waterway of the Commonwealth of Pennsylvania, and a Water Quality Management Permit to construct the treatment facilities and discharge sewer. Land-based disposal options, such as septic systems, mound systems, drip systems and spray irrigation systems, do not require an NPDES Permit, but may require planning approval and a Water Quality Management Permit.

5.2 Scenario #2 - Some Septic Systems Fail

If a few septic systems fail in an area, there are several corrective options: find a new site on the property to install a new system, try to install an innovative on-lot system or an individual spray irrigation system on the property, or develop a cluster treatment system. Finding a site on the property is the easiest solution if land is available and if the site soils are suitable. Use of an individual spray irrigation system is a viable solution if sufficient land is available and the soils and slopes are suitable for spray irrigation. If on-site disposal is not feasible, one option is to partner with other nearby homes with failing septic systems to find a nearby site where wastewater from several homes can be pumped using a low pressure, small diameter sewer. The wastewater would then be treated using a mound, spray or drip system. The most cost-effective approach would be to use a STEP (septic tank effluent pump) system at each house. A STEP system uses the existing septic tank by adding a sump pump next to the septic tank. The failing septic system field is disconnected and the supernatant (top water) from the septic tank is pumped to a site where it is treated by a new or existing community mound system, drip irrigation system, spray irrigation system, wetlands treatment system, or wastewater treatment plant. See Section 2.6 above for a more detailed description of a STEP system.

The most cost-effective approach for failing septic systems is to discharge the wastewater from the failing septic systems to an existing community or municipal wastewater disposal system. The first step in this option would be to determine whether the existing system is located within a reasonable distance from the failing systems. Sewers are expensive therefore the existing wastewater facility must be located within a reasonable distance. The next step is to determine whether the existing wastewater facility has excess capacity to accept the additional wastewater. If it does not have excess capacity, the next step is to evaluate whether the wastewater system can be expanded. This evaluation should include the evaluation of whether sufficient land is available and whether is it cost-effective to expand the facility. It is often not technically or economically feasible to expand a community wastewater facility, especially for a small number of homes or failing septic systems.

If a community or municipal system is not available and the failing systems cannot be replaced on site, the only other option is to find an off-site location for the disposal of the wastewater using a community disposal field, a mound system, a drip or spray irrigation system, a constructed wetland or a treatment plant. In planning the size of a community wastewater disposal system, it is a good idea to plan ahead and size the system to handle additional failing systems.

5.3 Scenario #3 - Many or All Septic Systems Fail

If many or all septic systems in an area fail, the options include development of a cluster system or connection to a community wastewater disposal sys as described in Section 5.2. In Kirkwood Village, for example, the residents would have the option of trying to find a nearby area with suitable soils to develop a cluster system. If this is not feasible, the residents could connect to a central community system if one exists. The main advantage of multiple septic system failures over just a few system failures is in the economics of scale. Installing a community sewer and disposal system can be relatively expensive, depending on the distance from the failing systems to the disposal area, and the kind of treatment system used. The planning, engineering, and permitting costs are almost the same for a small system as for a large system. And the cost per gallon of wastewater treated is much higher for small systems compared to medium to large systems. Thus, there is a significant difference in the economics of scale. Large systems, for example, cost more than small systems but ultimately are more cost effective because all of the costs (design, permitting and construction) are less per gallon of treated wastewater than small systems. And the costs are shared by a larger number of users.

5.4 Scenario #4 – Integrating Failing Systems with New Development

One scenario that often occurs is that new development is planned for an area that also has failing septic systems. In a way this is a combination of all of the above scenarios. The solution is to follow the wastewater management procedures provided in Section 3.0 to determine the best, most cost-effective method for wastewater disposal. In the process of evaluating the various methods of disposal, consideration should be given to the location and number of failing septic systems. The procedures described in the above scenarios should be followed to try to develop a comprehensive wastewater management plan that integrates the conditions and constraints of both the proposed new development and the failing systems. As discussed above, one option is to use the existing septic tanks and a STEP system to transport the pre-treated, settled wastewater to a new community system that will serve both the new development and the failing systems.

Integration of a wastewater system for new development and failing systems, however, may not be physically or economically feasible if the two are separated by a long distance, wetlands, or other physical or institutional constraints. In this case, each should be addressed separately using the procedures described in Sections 3.0 and 5.0.

5.5 Epilogue

The purpose of this report was to provide guidance for the evaluation and selection of wastewater treatment and disposal options that would protect the environment and natural characteristics of Lancaster County, and meet the goals of the County and municipal comprehensive plans. This report provides procedures and approaches to meet these objectives. And it describes a variety of scenarios. However, wastewater management is a complicated issue, and it is not possible to describe every situation or scenario that may arise. It was the goal, therefore, to provide an understanding of wastewater basics: what are the various wastewater methods, what procedures should be followed in evaluating and selecting a wastewater management system, and how to address various scenarios. This information can be extremely helpful to municipal officials, planners, and engineers. It can be used to understand the available wastewater disposal methods; it can be used to identify potential wastewater disposal options; it can be used to understand what has to be done to develop a wastewater management plan. It is not, however, a substitute for professional advice from someone educated and experienced in wastewater management.

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APPENDIX A

PROCEDURE FOR EVALUATING AND SELECTING WASTEWATER DISPOSAL OPTIONS

Desk Top Evaluation

1. Determine what soils are available from the Soil Survey (what soils are on the proposed property to be developed or what soils are on nearby parcels that may be available for wastewater disposal).

2. Determine limiting zones for the soil types from the soil survey.

3. Determine slopes from USGS 10-meter digital elevation models using GIS.

4. Based on the Soil Requirements Table, select acceptable disposal option(s).

Field Verification

1. Conduct soil testing to verify limiting zones provided in soil survey (test pits and/or soil probes)

2. Verify that slopes are within acceptable ranges for wastewater disposal options

Evaluate Soil Limiting Zones and Select Options

Greater than 60 inches ➔ Conventional Trench, Sand Mound, Spray or Drip is acceptable

Do you want to maximize density?

NO If Density is 1 EDU per acre or less --à Conventional Trench (least expensive), low density

YES If Density is 2 or more EDUs/acre --à Community System is required with common area for disposal

> If total Flow is less than or equal to 10,000 gpd, a community sand mound, spray irrigation or drip irrigation is acceptable
>
> If total flow is greater than 10,000 gpd, spray irrigation or drip irrigation is recommended.

Greater than 20 and less than 60 inches ➔ Sand Mound, Spray or Drip is acceptable

Do you want to maximize density?

NO If Density is 1 EDU per acre or less--à Sand mound, individual residential spray irrigation system (IRSIS), or individual drip system is acceptable.

YES If Density is 2 or more EDUs/acre --à Community System is required with common area for disposal

> If total Flow is less than or equal to 10,000 gpd, a community sand mound, spray irrigation or drip irrigation is acceptable
>
> If total flow is greater than 10,000 gpd, spray irrigation or drip irrigation is recommended.

Greater than 10 and less than 20 inches ➔ Spray irrigation is acceptable

Do you want to maximize density?

NO If Density is 1 EDU per acre or less ➔ Individual Residential Spray Irrigation System is only available option.

YES If Density is 2 or more EDUs/acre ➔ Community spray irrigation system is required on common area dedicated for disposal.

Less than 10 inches ➔ No options are acceptable, stream discharge is only viable method.

Is a stream discharge location available?

YES Wastewater treatment facility with a stream discharge is only available option.

NO Project is not feasible.

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LANCASTER COUNTY STUDY OF MUNICIPAL WASTEWATER DISPOSAL OPTIONS
INFRASTRUCTURE ANALYSIS PROJECT

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