VOLUME I OF IV

ENGINEER'S REVIEW REPORT

THE NEW SEWAGE TREATMENT INFRASTRUCTURE PROGRAM

FOR THE

HAMLET OF PHOENICIA

TOWN OF SHANDAKEN
ULSTER COUNTY, NEW YORK

New York City Watershed Memorandum of Agreement (MOA)
Identified Community No. 6

October 2011

Catskill Watershed Corporation

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EXECUTIVE SUMMARY

This Engineering Review Report is an evaluation of the work that has been performed to date for the Hamlet of Phoenicia under the New Sewage Treatment Infrastructure Facilities Program (NIP) as well as a new and updated evaluation of the wastewater management alternatives available to Phoenicia. The primary objectives of this Report are (1) to evaluate the Hamlet of Phoenicia's existing wastewater needs, (2) to consider various alternative methods for managing those needs, (3) to estimate the costs involved with each alternative method, (4) to identify which alternative methods will have project costs consistent with available funding, and (5) to recommend the best alternative that can be completed within the remaining block grant amount of $15.8 million.

The Original Proposed Sewer District was confirmed to be the area where further consideration of wastewater needs was warranted based on review of existing engineering, planning, GIS mapping, USGS quadrangle topographic mapping and tax mapping as well as the delineation of the proposed district by LaBerge Engineering and Consulting Group, LTD in the late 1990's. The topographic mapping originally obtained by Delaware Engineering during the original design phase of the project in the mid 2000's was acquired.

In the proposed district, existing wastewater problems were reviewed through identification of potential wastewater problems including small lot sizes, flooding areas, proximity to waterways, high groundwater table, steep slopes, records of existing wastewater system failures, and poor soils. A windshield survey was also performed.

In addition to the Original Proposed Sewer District, another smaller sub-district was identified. This Alternative Service Area is a sub-area of the Original Proposed Sewer District where the development density is the highest. Wastewater load estimates were developed for both areas.

Wastewater Management Options were identified and reviewed, including a Septic Maintenance District (SMD), Community Septic System, Conveyance to an Existing Wastewater Treatment Plant (WWTP), and a Wastewater Treatment Plant.

The Original Proposed Sewer District is comprised of properties with significant limitations to constructing and maintaining functional on-site septic systems. Due to lot size, soil types, steep slopes, and proximity to water bodies, only 51 of 345 total properties (15 % of total) could maintain an individual on-site septic system with the required 100% leach field reserve area available. Therefore a septic maintenance district is not recommended, and a community system must be pursued.

The two types of community systems are a community septic system and a wastewater treatment plant. A Community Septic System consists of a collection system to individual properties, septic tanks, and a leach field for all the wastes. It requires large parcel of suitable undeveloped land for the leach field. There are no large parcels of undeveloped land in or in reasonable proximity to the Hamlet of Phoenicia with suitable soils, out of the 100-year flood plain and not on steep slopes. Therefore a wastewater treatment plant is recommended.

Wastewater Collection System alternatives were reviewed including conventional gravity sewers, small diameter gravity sewers (SDGS), septic tank effluent pump (STEP) systems, grinder pump pressure sewers, and vacuum sewers. However, a large diameter conventional gravity sewer system was already designed and developed as part of the original project by Delaware Engineering. The review of that design indicates that only minor revisions need to be made, so the existing collection system design was recommended as the preferred alternative.

Wastewater Treatment Alternatives were evaluated including:

Original Proposed Sewer District

- Option 1 - Existing Sequencing Batch Reactor (SBR) WWTP Design (162,000 gpd)
- Option 2 - Membrane Bioreactor (MBR) WWTP (162,000 gpd)
- Option 3 - SeptiTech WWTP (162,000 gpd)
- Option 4 - Orenco WWTP (162,000 gpd)
- Option 5 – Pump to Pine Hill WWTP (162,000 gpd)

Alternative Service Area

- Option 6 – Membrane Bioreactor (MBR) WWTP (100,000 gpd)
- Option 7 – SeptiTech WWTP (100,000 gpd)
- Option 8 – Orenco WWTP (100,000 gpd)

Other Service Area Options

- Option 9 – Membrane Bioreactor (MBR) WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections)
- Option 10 – Phoenicia, Chichester and Shandaken Pump to Pine Hill WWTP (200,000 gpd)
- Option 11 - Membrane Bioreactor (MBR) WWTP (130,000 gpd) with Reduced Collection System (127 Lateral Connections)

WWTP Additive Alternates

- Option 6A and Option 9A – Innovative WWTP

The advantages and disadvantages of the various systems were identified. The anticipated total project costs and the operation and maintenance costs of the Wastewater Treatment Alternatives are as follows:

Summary of Wastewater Treatment Alternatives with Total Project Costs and O&M Costs				
	Capital Cost	Full Flow O&M Cost ($/Year)	Present Day Worth	Regulatory Indication
Option 1 – Ex. SBR WWTP Design (162,000 gpd)	$25.0M	$590,000	$42.7M	Approvable
Option 2 – MBR WWTP (162,000 gpd)	$24.6M	$590,000	$42.7M	Approvable
Option 3 – SeptiTech WWTP (162,000 gpd)	$26.9M	$580,000	$44.3M	Approvable
Option 4 – Orenco WWTP (162,000 gpd)	$30.8M	$550,000	$47.3M	Approvable
Option 5* - Pump to Pine Hill WWTP (162,000 gpd)	$29.7M*	$410,000 **	$42.0M	Not Approvable
Option 6 – MBR WWTP (100,000 gpd)	$15.8M	$520,000	$31.4M	Approvable
Option 7 – SeptiTech WWTP (100,000 gpd)	$16.9M	$520,000	$32.5M	Approvable
Option 8 – Orenco WWTP (100,000 gpd)	$19.0M	$500,000	$34.0M	Approvable
Option 9 – MBR WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections)	$15.8M	$510,000	$31.1M	Approvable
Option 10* - Phoenicia, Chichester and Shandaken Pump to Pine Hill WWTP (200,000 gpd)	$33.7M*	$430,000 **	$46.6M	Not Approvable
Option 11 – MBR WWTP (130,000 gpd) with Reduced Collection System (127 Lateral Connections)	$15.8M	$520,000	$31.4M	Approvable

* Pump to Pine Hill Options do not include the capital cost to remediate infiltration and inflow issues at the Pine Hill WWTP or the cost of increasing the flow capacity of Pine Hill

** Pump to Pine Hill Options O&M Cost Estimate do not include yearly fee to Pine Hill for accepting flow from Phoenicia

The three options with the lowest present day worth and the only three options that come within the remaining block grant amount of $15.8M are Options 6, 9 and 11.

Option 11 - Membrane Bioreactor (MBR) WWTP (130,000 gpd) with Reduced Collection System (127 Lateral Connections) is the recommended option because it satisfies the requirement by the Town that the WWTP is sized to treat the flow from the entire Original Proposed Sewer District and keeps the yearly commercial operation and maintenance costs down by servicing as many residential users as possible with the funds remaining after construction of the WWTP.

INTRODUCTION

As part of the Watershed Protection and Partnership Programs of the 1997 New York City Watershed Memorandum of Agreement (MOA), and as required by the 1997 Water Supply Permit issued by New York State and the 1997 Filtration Avoidance Determination (FAD) issued by the United States Environmental Protection Agency, New York City provided funding for the New Sewage Treatment Infrastructure Facilities Program (NIP) to assist in the development of new sewage collection and treatment facilities in up to 22 selected villages and hamlets in the NYC Watershed. The MOA also notes that no community is required to accept such funding and no community is required by the MOA to build a new wastewater treatment project. The Town of Shandaken, Ulster County contains one of those hamlets, Identified Community No. 6, the Hamlet of Phoenicia.

In 1998, the Town of Shandaken hired LaBerge Engineering and Consulting Group, LTD (LaBerge), to evaluate the alternative technologies, to develop a program for a community sewer system, and to develop the preliminary engineering reports and environmental compliance work needed to define a wastewater management project for Phoenicia. These reports were called the Task 1 through Task 6 Study Phase reports. These reports were completed in the year 2000. Shortly before the Town completed the study phase, the project was suspended due to lack of funding for communities numbered 6 and 7.

As a condition of the 2002 FAD, the City provided additional funding for communities numbers 6 and 7. The Town then resumed the study phase process. After a competitive selection process, the Town Board of Shandaken hired Delaware Engineering to complete the study phase and the preconstruction design phase.

Delaware Engineering proposed a gravity sewer collection system and a Sequencing Batch Reactor Wastewater Treatment Plant. This project subsequently went out to bid, and contracts were awarded to the lowest responsible bidders subject to a contingency that the sewer district was formed within 6 months from the effective date of the contracts. Based on received construction bids, there was apparently sufficient contingency (approximately $1,000,000) for all construction costs for laterals to each building in the hamlet. The pre-construction phase was to be concluded with the act of creation of the sewer district, an act subject to permissive referendum. A petition for a permissive referendum was received by the Town and a referendum was held on February 3, 2007. The proposal was defeated by a vote of 156 to 123. At that time, the town terminated the construction contracts and stayed any further pursuit of the project.

In June 2007, the Town requested and the City agreed to provide the Town additional time to June 2008 to form a sewer district. In June 2008, the City agreed, again at the Town's request, to extend the time under the contract with the Town until January

2009. The City also agreed to the Town's request allow a portion of block grant funds to be used for to study the alternative of a constructed wetlands WWTP. A preliminary engineer's report was competed by NEWS-USA/Rennia Engineering based on a constructed wetlands concept. Ultimately, the Town's new consultants were unable to prove to the satisfaction of NYCDEP engineers that a constructed wetlands could provide adequate wastewater treatment to meet discharge permit limits for ammonia and total phosphorus. In 2010, DEP approved for use within the watershed, Membrane BioReactor (MBR) WWTP, without being followed by the sand filtration and micro-filtration which had been previously required in the Watershed for NYCDEP approval of MBRs.

In April, 2010, the Town formally requested by resolution CWC's assistance in determining an appropriate project for the Hamlet. In July 2010, the City approved the Town using block grant funds to hire CWC so long as the Town meets certain deadlines to ensure continued availability of the block grant. Subsequently, the Town contracted with CWC to reevaluate the selected technology and collection system in order to propose a project (or project alternatives) within the remaining block grant amount. CWC has overseen the selection, design, permitting, and construction of six new community sewer systems within the Watershed since 2004. Each of those projects were successfully completed within budget, and well received by the communities.

This effort is called the Engineering Review Phase and is the subject of the current report.

The purpose of the Engineering Review Phase is to examine the feasibility, technical work, cost, planning, and implementation issues for the Hamlet of Phoenicia NIP utilizing all the work completed previously, exploring new alternatives that may not have been considered before and reexamining technologies that were previously rejected based on technological advancements, including a Septic Maintenance District(s) (SMD), a Community Septic System(s), and a Membrane Bioreactor (MBR) WWTP. The goal is to attempt to identify a project within the remaining block grant amount that best meets the needs of the community and addresses the community's concerns.

The Engineering Review Phase includes a review of all the work that has been done to date. This includes all the work performed by the Town of Shandaken's previous engineers, LaBerge Engineering and Consulting Group, LTD, Delaware Engineering, and Rennia Engineering, consisting of, but not limited to the Task 1 through 6 reports, the Facility Plan, final design plans, and specifications that were issued for bidding and all supporting design information, low bidder bid forms, SPDES permit, the Final Environmental Impact Statement, and SEQRA findings, cultural resource reports, soil boring reports, easements, Sewer Use Law, operation and maintenance budget, and associated commercial fees. The Review Phase also includes

investigation of possible cost savings alternatives. These alternatives include evaluating the feasibility of providing an SMD(s) and/or Community Septic System(s) for all or a portion of the proposed Sewer District, evaluating the existing collection system for technical and cost adequacy and efficiency, determining if redesigning the system could reduce costs, identifying any areas of the collection system that could be eliminated, and evaluating the feasibility and cost of a Membrane Bioreactor (MBR) wastewater treatment plant. Additionally, this report reviews the wetlands option study and makes comments and recommendations.

To save on costs, information and data from the previous work has been used wherever possible.

SECTION 1
Overview of Hamlet of Phoenicia

1.1. Description of Area

The Hamlet of Phoenicia is located a half mile north of the intersection between NYS Route 214 and NYS Route 28 within the Town of Shandaken in Ulster County, NY. The Hamlet of Phoenicia was identified by the New York City Watershed Memorandum of Agreement (MOA) as Identified Community No. 6. The entire Town is located within the New York City Watershed. The majority of the development in the Town of Shandaken is along NYS Route 28, NYS Route 214 and NYS Route 42. The primary land uses found within the Town are Wild/Forested, Low Density Residential, and Vacant land.

The Hamlet of Phoenicia is the largest Hamlet area in the Town of Shandaken. Phoenicia is approximately 8 miles north of the Ashokan Reservoir. See Exhibit 1.1.A for the Location Maps of the area.

The Hamlet of Phoenicia has approximately 51 commercial and institutional establishments, including restaurants, motels, inns, cabins, delis/markets, retail stores, banks, churches, a realty agency, an insurance broker, a salon, a drugstore, campground, funeral home, elementary school, post office, doctor's office, and an auto body repair shop. A large majority of these businesses are along or are close to Main Street in Phoenicia.

1.2. Population

The Hamlet of Phoenicia is identified in the 2000 Census as a Census Designated Place (CDP), meaning there is detailed information about the Hamlet of Phoenicia as defined by the Census Bureau. This CDP leaves out the Woodland Valley Road section of the Hamlet and the area of the Hamlet north of School Road, but includes the area between Old NYS Route 28 and NYS Route 28 down to Kinsey Road. According to the 2000 Census, the population of this boundary defined as the Hamlet of Phoenicia is 381 persons. The Population of the Town of Shandaken is 3,235 persons.

See Exhibit 1.2.A for the 2000 U.S. Census Information for the Hamlet of Phoenicia Census Designated Place and Town of Shandaken.

1.3. Housing

The 2000 Census reports a total of 246 housing units within the Hamlet of Phoenicia (194 occupied units and 52 vacant units). In the Hamlet of Phoenicia, approximately 59% of the units were built prior to 1939 and 18% were built between the years of

1980 to 2000. Roughly 11% of the total number of housing units has four or more bedrooms. Based on 381 persons in 194 occupied units, the average number of persons per household in 2000 was 1.96.

The 2000 Census reports a total of 2,666 housing units within the Town of Shandaken (1,406 occupied units and 1,203 vacant units). In the Town of Shandaken, approximately 41% of the units were built prior to 1939 and 20% were built between the years of 1980 to 2000. Roughly 16% of the total number of housing units has four or more bedrooms. Based on 3,235 persons in 1,406 occupied units, the average number of persons per household in 2000 was 2.3.

The Town population primarily uses on-site wells for drinking water. The Hamlet of Phoenicia is served by a public water system. Most areas in the Town, including the Hamlet of Phoencia dispose of wastewater on-site. There is a NYCDEP owned WWTP in the Hamlet of Pine Hill, also located in the Town of Shandaken, about 10 miles north of Phoenicia. There is also a NYCDEP owned community subsurface wastewater disposal system servicing an area of the Hamlet of Chichester.

1.4. Local Economy

The median household income in the Hamlet of Phoencia was $22,159 (1999 dollars), compared to the state median household income of $43,393. The median household income in the Town of Shandaken was $31,566.

1.5. Land Use

The Hamlet of Phoenicia developed around the intersection of NYS Route 214 and the Old NYS Route 28, now called Main Street.

The total land area of the Town of Shandaken is estimated to be approximately 79,200 acres (123.8 square miles). The predominant land use is overwhelmingly Wild, Forested, Conservation Lands & Public (75%), followed by residential (12%) and vacant land (8%).

The following table breaks down the area by land use category found within the Town of Shandaken, as calculated by the Ulster County GIS Department.

Land Use	Acres	Percentage
Residential	9,829.59	12.41%
Commercial	732.89	0.93%
Community Services	760.73	0.96%
Entertainment & Recreation	737.50	0.93%
Industrial	8.35	0.01%
Public Services	170.30	0.21%
Vacant Land	5,985.11	7.56%
Wild, Forested, Conservation Lands & Public	59,719.37	75.38%
no match with rps data (149 parcels)	1,275.37	1.61%
	79,219.21	100.00%

1.6. Local Planning

The Town of Shandaken has a Comprehensive Plan and a Zoning Law. Shandaken also has its own codes enforcement officer, who administers the NYS Building Code.

SECTION 2
Planning Area

Aerial photographs and basemaps for the Hamlet of Phoenicia were performed by LaFave, White and McGivern during Task 1 through 4 reports done by LaBerge Engineering and Consulting Group, LTD, (LaBerge). LaFave, White and McGivern provided Lamont Engineers with the basemap as well as a limit of photography map. The extent of this mapping extends from the northwestern most intersection of Old Route 28 and NYS Route 28 to the intersection of Lower High Street and NYS Route 28, to the Chichester Wastewater Treatment Facility on NYS Route 214. The Limit of Photography Map is presented in Exhibit 2.A.

The date of the mapping is April 13, 1998 and was produced with 2' contour intervals at a 1" = 40' scale. 2' contour intervals indicate the mapping has a ground elevation accuracy of ± 1'. This is the minimum accuracy with which a detailed sewer collection system and WWTP should be designed. 1' contour intervals are preferable but not required.

The mapping company stated that based on the elevation of the original photos used to produce the mapping (2,400' AMT), it would be possible to produce 1' contours from this photography. However the photo elevation is at the maximum height acceptable to create 1' contour intervals. Therefore creating 1' contours from this photography may require some additional photo control.

The basemap for the area south of the Hamlet, along NYS Route 28 to the proposed WWTP was created using Light Detection and Ranging (LIDAR). This mapping was obtained by Delaware Engineering from NYCDEP during their design phase work which began in 2005. The date of this mapping is unknown. This mapping was also created at 2' contour intervals.

Delaware Engineering supplemented the mapping from LaFave, White and McGivern and the LIDAR mapping with additional survey work. The surveying work included a ground elevation check on the aerial survey, location of features, location and elevation of utilities and a ground survey of the proposed WWTP site. The Topographic Map is presented in Exhibit 2.B.

Because the mapping is between 6 and 13 years old it is recommended that during the design phase of the project, a supplemental ground survey be performed to pick up any features that have changed.

Based on this aerial base mapping and the Original Proposed Sewer District Boundary for the Hamlet of Phoenicia as defined in the previous Task 1 through 4 reports done by LaBerge an area for GIS mapping was selected. The area selected was chosen in an attempt to include all properties that might ultimately be placed

within a septic maintenance district or a sewer district plus possible community septic or wastewater treatment facility sites within a reasonable distance from the Hamlet area. This GIS mapping area was therefore inclusive of most areas of relatively higher population density and smaller lot size and areas that might have significant wastewater disposal needs. The GIS mapping area was selected using information obtained from existing available large scale aerial photography and the USGS Quadrangle map for the area. The GIS mapping area is considered the Planning Area.

The GIS mapping was provided by the Ulster County Information Services Department. This mapping information includes aerial photography, the MOA designated Hamlet Area, sewer districts, water districts, agricultural districts, aquifers, flood plain information, 100' offset from streams, watercourses, roads, stormwater facilities, National Wetland Inventory information, tax map information, land use, USGS information and NRCS soils classification. See Exhibit 2.C for the GIS Mapping.

The above mapping was reviewed, particularly in regard to lot size, to ensure that no populated areas or potential facility sites had been inadvertently excluded from the Original Proposed Sewer District Boundary for the Hamlet of Phoenicia.

SECTION 3
Identify, Assess and Plan for Wastewater Needs

3.1. Identify Existing Wastewater Problems

After review of the site information through site visits, tax map and Ulster County GIS information, the potential for adequate on-site wastewater systems was determined based on size and other constraints such as proximity to streams, wetlands, steep slopes, property line setbacks, etc. as required by the New York State Department of Health Individual Residential Wastewater Treatment Systems Design Handbook (NYSDOH Design Handbook), which is based on Chapter 10 of the New York Codes, Rules and Regulations, Appendix 75-A (10NYCRR Appendix 75-A), the New York State Department of Environmental Conservation Design Standards for Wastewater Treatment Works, 1988 (1988 NYSDEC Standards) and the Rules and Regulations for the Protection from the Contamination, Degradation and Pollution of the New York City Water Supply and its Resources, 2010 (WRR).

3.1.a. Identify Soils and Limiting Property Lot Size

The most fundamental feature of a property relative to establishing an up-to-standard, adequate on-site leach field is the available area. The smaller the area available for construction of a leach field, the less likely that an up-to-standard, adequate leach field can be constructed on the property in the event of a septic failure. The size of the lot required is in part directly related to the soil type and its associated permeability.

There are several different soil types found in the Hamlet of Phoenicia and the surrounding areas. The large majority of the soils found in the Hamlet are Tunkhannock gravelly loam, Barbour loam, and Suncook loamy fine sand. These soils are similar in that they are deep soils and generally suitable for on-site septic systems. The areas immediately adjacent to the Esopus Creek and the Stony Clove Creek are Alluvial soils. There are two small areas of Wellsboro and Wurtsboro soils, one along NYS Route 214 in the Chichester area and one in the very eastern section of the Hamlet, on the north side of Herdman Road. There is also one area of Schoharie soils, in the vicinity of School Lane/Christie Court. None of these soils are suitable for on-site septic systems. (Note: The soils on the very steep areas around the Hamlet (those soil types that are proceeded with a D, E or an F, indicating very steep soils with a percent grade of 15% or greater) are automatically not suitable for on-site septic systems because of the slope. Therefore they were not reviewed in the soils analysis).

The range of soil permeability is given in the soil survey information in units of micrometers per sec. This can be converted to percolation rate in minutes per inch by dividing 423.3 by the permeability. A summary of the permeability, percolation and the corresponding application rate for sewage as given in 1988 NYSDEC Standards, Table 10 – Recommended Sewage Application Rates, is shown in the table on the sixth page of Exhibit 3.2.b.A.

Based on a typical parcel, a layout of a single family residence with 3 bedrooms, a garage, a driveway and miscellaneous landscaping will occupy an area of approximately 8,000 square feet without the septic system. Since most of the Original Proposed Sewer District is serviced by a municipal water system, an area for a private well on each lot was not considered in this square footage. For those parcels outside the water district boundaries, the on-site private wells requires an additional 5,000 sf in order to provide the 100' separation distance between the well and the leach field, for a total square footage of 13,000 sf.

The areas required for on-site septic systems, inclusive of the required 100% reserve area, and the resulting required lot size, derived from the sample septic system designs shown in Exhibit 3.1.a.A, Sample Conventional Septic System Layout and Design (0.6 gal/day/sf) are summarized in the table below.

Location in Hamlet	Primary Soil Type	Per-meability, µm/sec	Percolation Rate, min/in	Application Rate, gal/day/sf	Septic System Size, Sf	Required Lot Size in Water District, sf (acres)	Required Lot Size w/ On-Site Well, sf (acres)
Center of Hamlet	Tunk-Hannock (TkA, TkB, TkC, TuC)/ Barbour (Ba)	14	30	0.6	10,000	18,000 sf (0.41 acres)	23,000 sf (0.53 acres)
Center of Hamlet	Suncook (Su)	42	30 imported (10 actual)	0.6 imported (0.9 actual)	10,000 imported	18,000 sf (0.41 acres)	23,000 sf (0.53 acres)
Along the Esopus Creek	Alluvial (AA)	0.42	1008	Not Suitable	---	---	---
NYS Route 214 (Chichester)	Wellsboro/ Wurtsboro (WLB, WOB)	0.42	1008	Not Suitable	---	---	---
School Lane/Christie Court	Schoharie (SaC)	0.42	1008	Not Suitable	---	---	---

The slower percolation rate in the range was used to be conservative in the evaluation. However, even the slow range for the Suncook soils is very fast and is likely to have areas of excessive permeability, thereby warranting importing fill to slow down the permeability of the soil and provide better treatment and significantly increasing the cost of the septic system. The permeability of that fill will have a maximum percolation rate of 30 minutes/inch. While the permeability of Tunkhannok and Barbour soils is fast enough for a subsurface system, there may be cases within this soil type where excessive permeability could be a problem as well. However, the size of the septic system and resulting lot size would not change since the imported fill would have a minimum percolation rate of 30 min/in. For the Alluvial, Wellsboro, Westboro, and Schoharie soils, even the faster percolation rates in the range were unsuitable (too slow).

Depending on site specifics, it may or may not be possible to site a properly functioning leach field on a smaller site than listed in the table above. However, for purposes of identifying which parcels may have issues siting a properly functioning conventional septic system, all parcels located within the Planning Area not meeting the required area within their respective soil types have been identified as being limited for on-site subsurface wastewater disposal. Additionally, properties whose lot sizes are larger than the areas listed in the table above but whose useable area (i.e. not encumbered by steep slopes, water way buffers, unsuitable soils, and the 100 year flood plain) is less than the areas listed in the table above have also been identified as being limited for on-site subsurface wastewater disposal. See Exhibit 3.1.a.B, Septic Limitations Map.

3.1.b. Identify Areas Susceptible to Flooding and High Groundwater Table

Based upon the recent flood events as well as the floodplain mapping obtained from FEMA for the Hamlet of Phoenicia, the area along the Esopus Creek and the Stony Clove Creek are susceptible to flooding. The properties on both sides of Main Street in the Hamlet area are completely in the 100-year flood plain. See Flood Insurance Study, Exhibit 3.1.b.A. Refer to mapping titled Septic Limitation Map in Exhibit 3.1.a.C to view the 100-year flood plain boundaries and 100 foot buffer boundaries from waterways.

3.1.c. Identify Areas on 15% Slope or Greater

The 1988 NYSDEC Standards states that trenches for absorption fields should not be placed on slopes greater than 20 percent. The NYSDOH Design Handbook prohibits construction of leach fields on slopes greater than 15%. Therefore, a slope of 15 percent or greater will be considered a limiting factor for on-site subsurface wastewater disposal for this wastewater study.

Using the topographic mapping, in conjunction with functions of AutoCAD software that identify slopes chosen by the user, areas with slopes greater than 15 percent were identified.

These identified slopes were located predominately on the east and west sides of NYS Route 214 and on both sides of NYS Route 28. The Hamlet area, the narrow corridor along NYS Route 214 and the corridor along NYS Route 28 and the Esopus Creek generally consist of slopes of 5% or less. See Exhibit 3.1.a.C, Septic Limitation Map for areas identified with slopes over 15%.

3.2. Assess Potential Wastewater Disposal Issues

3.2.a. Existing Wastewater System Information

Since Phoenicia has no centrally managed sewer system, wastewater system records are scarce. The NYCDEP, the CWC and Ulster County Department of Health (UCDOH) were contacted to obtain any information on past or current reports of failures of septic systems in the Hamlet of Phoenicia. Also, a map produced by LaBerge, dated November 16, 1998 indicated that there were additional failures or recently replaced systems known at the time the Task 1-4 Report was being completed. 47 properties compiled from these sources have replaced septic systems due to failure. Most of the replacements so not meet current standards.

See Exhibit 3.2.a.A, Septic Failures Map for a map indicating the lots in the Hamlet of Phoenicia with current or previously failing septic systems.

3.2.b. Soil Data

Soils information was obtained from the information published on the Natural Resources Conservation Service, United States Department of Agriculture, Web Soil Survey, available online at *http://websoilsurvey.nrcs.usda.gov/*.

The Soil Survey data indicates that the majority of the soil unit types situated within the more populated portions of the Planning Area are generally suited for septic systems, except for the potential of excessive permeability in the subsoil. This can be corrected by bringing in imported fill that has a slower percolation rate than the soil in situ.

See Exhibit 3.2.b.A, Soils Mapping and Soils Descriptions for the information gathered from the Natural Resources Conservation Service, United States Department of Agriculture Web Soil Survey.

3.2.c. Septic System Windshield Survey

A windshield survey was conducted to assess the properties based on site-specific factors that influence the performance of existing septic systems. The windshield survey was conducted along public streets and roads. Observations of properties in the Hamlet of Phoenicia were made from a motor vehicle or while on foot. Conversations with numerous residents explained the purpose of the windshield survey and gathered pertinent information from them.
The windshield survey is helpful because observations can be made on visible site-specific factors that can affect the treatment performance of existing septic systems. The windshield survey focused on the acceptability of individual parcels to incorporate properly designed septic systems based on known soil conditions, groundwater conditions, type of parcel use and occupancy, and the availability of space for septic systems versus approximate size of the parcel.

The following characteristics pertinent to wastewater needs were noted wherever possible: land use, occupancy type, topography, land slopes, flooding potential, wetlands, groundwater seepage, and basement sump pump discharge locations. The field observations were recorded on data sheets shown in Exhibit 3.2.c.A, Septic System Windshield Inspection Survey.

In general, septic systems were not directly observed, nor their exact locations ascertained; however, through conversations with some residents the general location of some septic systems was noted. Sump pump discharge locations were observed where possible. These items are noted on the drawings in Exhibit 3.2.c.A.

The Hamlet of Phoenicia consists of many single-family dwellings and a dense commercial district along Main Street, in which some of the buildings are both commercial as well as residential. There are also a few properties that have two or more residences. Several campgrounds are located in the Hamlet, and there are also two relatively large apartment complexes (located on Mt. Ava Maria Rd). Most dwellings and businesses in the Hamlet are located close together on very small lots. The character and makeup of the Hamlet is similar to the larger rural villages and hamlets found in the region.

It was observed that many lots in the Hamlet of Phoenicia are small and are in close proximity to either Stony Clove Creek or Esopus Creek. Many of these lots are not large enough to support up-to-standard septic systems.

3.2.d. Stormwater Disposal

Stormwater runoff from the Hamlet of Phoenicia flows to the Stony Clove and Esopus Creeks. The stormwater system in the downtown business district is comprised mainly of catch basins along Main Street that collect stormwater and convey it to the Stony Clove Creek. The catch basin locations are shown on the GIS Maps provided by Ulster County GIS in Exhibit 2.C.

3.2.e. Water System

The Hamlet of Phoenicia has a public water system. The Water District covers the entire area of the Original Proposed Sewer District except for a few properties on the northern end of the district along NYS Route 214. According to the Annual Drinking Water Quality Report 2010, Phoenicia Water District, the water supply for the water system is ground water under the direct influence of surface water. The water has a very high susceptibility to microbials and nitrates, a high susceptibility to industrial solvents, and a medium-high susceptibility to other industrial solvents. These high ratings are due to the proximity of a permitted wastewater discharge facility into the environment and low intensity residential activities in the area. The ground water used for the water supply is from a shallow sand and gravel aquifer, whose overlying soils do not provide adequate protection from potential contamination. The water filtration building is located south of the Hamlet on County Route 160 and is within the Original Proposed Sewer District.

3.3. Summary of Wastewater Disposal Issues

Based on the reviewed materials, it is clear that developing up-to-standard, properly functioning on-site individual septic systems would be difficult to do, if not impossible, especially within the more densely populated areas of the Hamlet of Phoenicia. Many of the inadequate septic systems will lead to failures in the future. The Service Area delineation in Section 4 is based on the compilation of the observations on existing wastewater needs as discussed above.

SECTION 4
Delineate Proposed Wastewater Service Area

Based on our review of the information presented in Section 3, all the parcels included in the Original Proposed Sewer District, if and when a septic failure occurs, would greatly benefit from a centralized sewage treatment system because a majority of the lots in the Original Proposed Sewer District have at least one, if not multiple constraints that prevent the development of a properly functioning on-site septic system. No additional properties are proposed to be added to the Original Proposed Sewer District.

However, since the block grant for the Town is limited and, since, due to inflation, the block grant that was enough to construct a project for the Original Proposed Sewer District in 2006, may not be enough to construct a project for the same area in the next 1-3 years, an Alternative Service Area was developed to include only the densest portion of the Hamlet. That area includes the business area along Main Street and the surrounding residences. This area has the most potential issues when considering subsurface sewage disposal because of the small lot sizes located within the flood plain, some of which have higher wastewater flows, such as restaurants.

See Exhibit 4.A for the Potential Service Areas Map and Table Summary of Parcels for both the Original Proposed Sewer District and the Alternative Service Area.

SECTION 5
Determine Wastewater Flows for Service Area

5.1. Equivalent Dwelling Units and Population Equivalents

The concepts of equivalent dwelling units (EDU's) and population equivalents are commonly used to simplify wastewater generation estimating. Non-residential units are converted to equivalent dwelling units (EDU's) based on the amount of wastewater generated. The EDU concept converts all wastewater usage proportionally to the equivalent of a typical single family residence. Then an engineering estimate of the wastewater generation per population equivalent is used to calculate an estimated wastewater load or flow.

During the septic system windshield inspection survey, an EDU count was completed within the study area for the Hamlet of Phoenicia. Each parcel was evaluated to determine its current use (Residential Single Family, Residential Two Family, Residential Apartment, Commercial, Commercial with Apartment, Institutional, Institutional with Apartment, Municipal, or Vacant). If a parcel was determined residential, it was then given an EDU count depending on how many housing units were located on the parcel, based on the number of utility meters, number of mailboxes, etc.

When a parcel was determined to be used other than for residential use, an attempt was made to contact the property owner. The vast majority were contacted. In some cases an adjacent property owner or a Town official was questioned about the subject property. In all cases, an evaluation of the site and its sewage flow generating characteristics was performed to the extent possible with the information obtained. See Exhibit 3.2.c.A to review the septic system windshield inspection survey conducted for the Hamlet of Phoenicia.

5.2. Estimate Wastewater Flow for Service Area

The MOA states "Upon agreement of the City and an Identified Community, the maximum permitted flow may be adjusted to equal the existing flow within the agreed-upon service area plus ten percent (10%)." The Hamlet of Phoenicia's maximum permitted flow as estimated in the MOA was 94,000 gpd (30-day average).

The March 1999 report, "Wastewater Flow Projection, Town of Shandaken, Hamlet of Phoenicia," prepared by Laberge Engineering & Consulting Group estimated the Hamlet of Phoenicia wastewater flow at 185,000 gpd, including 10% for growth. The flow calculation was reviewed and errors were discovered in the original flow estimate. These errors included multiple flow allotments for the same property and inclusion of flow from properties not in the Original Proposed Sewer District.. Furthermore, the study was completed 12 years ago and property usage is likely to

have changed since then. Therefore, the Hamlet of Phoenicia's wastewater flow was recalculated.

The Recommended Standards for Wastewater Facilities – 2004 Edition (Ten States Standards) requires that the sizing of wastewater facilities receiving flows from new wastewater collection systems is based on an average daily flow of 100 gallons per capita plus wastewater flow from industrial plants and major institutional and commercial facilities unless water use data or other justification upon which to better estimate flow is provided. The 100 gallons per capita is intended to include normal infiltration for systems built with modern construction techniques, as would be the case for Phoenicia.

According to the U.S Census Bureau, 2010 Census, the average number of persons per household is 2.05 in the Town of Shandaken and 2.57 in Ulster County. Also according to the U.S Census Bureau, 2005-2009 American Community Survey, the average number of persons per household in New York State was 2.64 and the United States is 2.60. Using 2.64 persons per household multiplied by 100 gallons per capita, results in 264 gallons per residence (or EDU) per day. See Exhibit 5.2.A for the U.S. Census Bureau 2005-2009 American Community Survey for New York State and the United States.

However, a flow of 291 gpd per EDU was previously used in the Sewer Use Law, Local Law No. 4 of year 2005, adopted by the Town of Shandaken on September 12, 2005 and filed on October 6, 2005 with the Department of State. Therefore, 291 gpd per EDU was used to estimate flow in this report. Observations made during the site evaluations conducted during the windshield survey were used to determine the flows of all potentially large users.

For non-residential properties, New York State Department of Environmental Conservation Design Standards for Wastewater Treatment Works, 1988 (1988 NYSDEC Standards), Table 3, Expected Hydraulic Loading Rates, was used to determine the estimated flow rates for a particular facility.

A description of the properties within the Original Proposed Sewer District and the Alternative Service Area is given in Exhibit 4.A. The inventory of the properties in the Original Proposed Sewer District suggests that the existing wastewater flow for the Service Area for Phoenicia is approximately 147,200 gpd and the wastewater flow for the Alternative Service Area is 88,400 gpd. The estimated residential EDU count for the Original Proposed Sewer District is 344 EDU's plus commercial flows and 186 EDU's for the Alternative Service Area plus commercial flows. See Exhibit 5.2.B for the Hamlet of Phoenicia Wastewater Flow Estimate for the Original Proposed Sewer District and the Alternative Service Area.

SECTION 6
Proposed Hydraulic and Organic Loading

6.1. Original Proposed Sewer District Hydraulic and Organic Loadings

6.1.a. Design Maximum Month (SPDES Permitted) Wastewater Flow

Providing for the 10% growth allowed by the MOA, the Maximum Month Wastewater Flow (MMF) is calculated as follows:

Wastewater Flow Estimate for the Hamlet of Phoenicia	
Original Proposed Sewer District =	147,200 gpd
Add 10% for growth	+ 14,720 gpd
	161,920 gpd

Rounding, the Proposed Maximum Month Wastewater Flow for the Original Proposed Sewer District for the Hamlet of Phoenicia is 162,000 gpd.

6.1.b. Design Average Day and Maximum Day Wastewater Flow

Average Day Wastewater Flow (ADF) was estimated from water usage records in Phoenicia. The Phoenicia Water District closely follows the boundaries of the Original Proposed Sewer District, as shown in Exhibit 2.C, GIS Information Mapping. Phoenicia Water District monthly water system operation reports with flow monitoring readings from 2009 and 2010 were obtained from Ulster County Department of Health. Operational reports for the months of 9/10, 8/10, 7/09, 6/09, and 4/09 could not be located by Ulster County Department of Health. One consecutive year's worth of reports were identified, from 8/09 to 7/10 and used to estimate Average Day and Maximum Day Wastewater Flow (MDF). The average daily demand in the Hamlet of Phoenicia from 8/09 to 7/10 was approximately 100,000 gallons. Providing 10% growth allowed by the MOA and 20% for inflow and infiltration, the Average Day Wastewater Flow is calculated as follows:

Original Proposed Sewer District Average Day Wastewater Flow	
Average Daily Water Demand for the Hamlet of Phoenicia =	100,000 gpd
Add 10% for growth	+ 10,000 gpd
Add 20% for I&I	+ 20,000 gpd
	130,000 gpd

The water district's single highest day usage from 8/09 to 7/10 was approximately 136,000 gallons, yielding a maximum day to average day ratio of 1.4 to 1. Alternatively, the Phoenicia Water District "Annual Drinking Water Quality Report for 2010" states an average daily water demand of 90,000 gallons

and a single highest day usage of 145,000 gallons, yielding a maximum day to average day ratio of 1.6 to 1. To be conservative, Maximum Month Flow was multiplied by 1.6 to determine Maximum Day Wastewater Flow as follows:

Original Proposed Sewer District Maximum Day Wastewater Flow
MMF x 1.6 = MDF
162,000 x 1.6 = 260,000 gpd

In the 2006 WWTP design by Delaware Engineering a ratio of 2 to 1 was used, and hamlets of this size usually have a ratio of maximum day usage to average day usage of about 2 to 1. Therefore, Average Day Flow could be multiplied by 2 to determine Maximum Day Flow as follows:

Original Proposed Sewer District Maximum Day Wastewater Flow
ADF x 2.0 = MDF
130,000 x 2.0 = 260,000 gpd

Both methods yield a Maximum Day Wastewater Flow for the Hamlet of Phoenicia equal to 260,000 gpd.

See Exhibit 6.1.b.A, Phoenicia Water System Reports and Annual Drinking Water Quality Reports for the Phoenicia Water District.

6.1.c. Design Peak Hour Wastewater Flow

Original Proposed Sewer District Design Peak Hour Wastewater Flow

The proposed Maximum Month Wastewater Flow for the Hamlet of Phoenicia Original Proposed Sewer District indicates a population equivalent of 1,620 (162,000 gpd maximum month flow ÷ 100 gallons per capita per day). Per Ten States Standards, Chapter 10, Figure 1, the expected ratio of peak hourly flow to design average flow for a population equivalent of 1,620 persons is 3.66. Thus the proposed design Peak Hour Wastewater Flow (PHF) is:

162,000 gpd x 3.66 = 592,900 gpd or 412 gallons per min (gpm).

6.1.d. Organic, Solids and Nutrient Loadings

In a rural, predominately residential, non-industrial community like Phoenicia, only normal household wastewater is typically produced, so standard municipal wastewater organic and solids loadings are expected, as follows:

6.1.d.i. Design Maximum Month, Maximum Day and Peak Hour BOD_5

Per Ten States Standards, Section 11.253, domestic waste treatment design shall be on the basis of at least 0.17 lbs BOD_5 per capita per day.

Original Proposed Sewer District Design BOD_5

The population equivalent for the Original Proposed Sewer District is 1,620 persons, therefore:

Proposed Design Maximum Month BOD_5 =
0.17 lbs BOD_5/capita/day x 1,620 person-equivalents
= 275 lbs BOD_5/day

Proposed Design Maximum Day BOD_5 =
Proposed Design Max. Month BOD_5 x 1.6 = 440 lbs BOD_5 /day

Proposed Design Peak Hourly BOD_5 =
Proposed Design Max. Month BOD_5 x 3.66 = 1,007 lbs BOD_5 /day

6.1.d.ii. Design Maximum Month, Maximum Day and Peak Hour Total Suspended Solids (TSS).

Per Ten States Standards, Section 11.253, domestic waste treatment design shall be on the basis of at least 0.20 lbs of suspended solids per capita per day.

Original Proposed Sewer District Design TSS

The population equivalent for the Original Proposed Sewer District is 1,620 persons, therefore:

Proposed Maximum Month Total Suspended Solids (TSS) =
0.20 lbs TSS/capita/day x 1,620 person-equivalents
= 324 lbs TSS/day

Proposed Design Maximum Day Total Suspended Solids (TSS) =
Proposed Design Max. Month TSS x 1.6 = 518 lbs TSS/day

Proposed Design Peak Hour Total Suspended Solids (TSS) =
Proposed Design Max. Month TSS x 3.66 = 1,186 lbs TSS/day

6.1.d.iii. Design Maximum Month Ammonia and Nitrogen

From Ten States Standards Appendix, Table No. 2, the estimates of the Design Maximum Month ammonia and nitrogen using concentrations of 25 ppm of NH_3-N (ammonia nitrogen) and 40 ppm of TKN (Total Kjeldahl Nitrogen) are as follows:

Original Proposed Sewer District Design Maximum Month NH_3-N and TKN

The Design Maximum Month Wastewater Flow for the Original Proposed Sewer District is 162,000 gpd (0.162 MGD, where 1 MGD equals 1,000,000 gpd), therefore:

Proposed Design Maximum Month Ammonia Nitrogen (NH_3-N)
25 ppm x 8.34 lbs/gallon x 0.162 MGD = 34 lbs/day of NH_3-N

Proposed Design Maximum Month Total Kjeldahl Nitrogen (TKN)
40 ppm x 8.34 lbs/gallon x 0.162 MGD = 54 lbs/day of TKN

6.1.d.iv. Design Maximum Month Phosphorus

From Ten States Standards Appendix, Table No. 2, the estimate of the design maximum month phosphorus is 7 ppm; we will use a concentration of 10 ppm of phosphorus to be conservative:

Original Proposed Sewer District Design Maximum Month Phosphorus

Proposed Design Maximum Month Phosphorus
10 ppm x 8.34 lbs/gallon x 0.162 MGD = 14 lbs/day of Phosphorus

6.1.e. Seasonal Loading Considerations

Most of the residences and apartments in the Original Proposed Sewer District appear to be occupied all year, so no correction for seasonal, part-time or weekend occupancy is needed.

6.2. Alternative Service Area Hydraulic and Organic Loadings

6.2.a. Maximum Month (SPDES Permitted) Wastewater Flow

Providing for the 10% growth allowed by the MOA, the Maximum Month Wastewater Flow is calculated as follows:

Wastewater Flow Estimate for the Hamlet of Phoenicia Alternative Service Area =	88,400 gpd
Add 10% for growth	+ 8,840 gpd
	97,240 gpd

With rounding, the Alternative Service Area flow would be 98,000 gpd. However the Average Daily Water Demand for the entire Hamlet is 100,000 gpd. If a wastewater treatment facility was designed for this flow, it is possible that the community could expand the collection system to almost the full extent as designed for the Original Proposed Sewer District and not have to increase the capacity of the facility. Therefore, the estimated flow that will be used for the Alternative Service Area will be rounded up to 100,000 gpd.

6.2.b. Design Average Day and Maximum Day Wastewater Flow

Based on the information presented above in Section 6.1.b, the ratio of Maximum Day to Average Day is 2:1 and the ratio of Maximum Month to Maximum Day is 1:1.6, therefore:

Alternative Service Area Maximum Day Wastewater Flow
100,000 gpd x 1.6 = 160,000 gpd

Alternative Service Area Average Day Wastewater Flow
160,000 gpd ÷ 2.0 = 80,000 gpd

6.2.c. Design Peak Hour Wastewater Flow

The proposed Maximum Month Wastewater Flow for the Hamlet of Phoenicia Alternative Service Area indicates a population equivalent of 1,000 (100,000 gpd maximum month flow ÷ 100 gallons per capita per day). Per Ten States Standards, Chapter 10, Figure 1, the expected ratio of peak hourly flow to design average flow for a population equivalent of 100 persons is 3.8. Thus the proposed design peak hour wastewater flow is:

Alternative Service Area Design Peak Hour Wastewater Flow
100,000 gpd x 3.8 = 380,000 gpd or 264 gallons per min (gpm).

6.2.d. Organic, Solids and Nutrient Loadings

In a rural, predominately residential, non-industrial community like Phoenicia, only normal household wastewater is typically produced, so standard municipal wastewater organic and solids loadings are expected, as follows:

6.2.d.i. Design Maximum Month, Maximum Day and Peak Hour BOD_5

Per Ten States Standards, Section 11.253, domestic waste treatment design shall be on the basis of at least 0.17 lbs BOD_5 per capita per day.

Alternative Service Area Design BOD_5

The population equivalent for the Alternative Service Area is 1,000 persons, therefore:

Proposed Design Maximum Month BOD_5 =
0.17 lbs BOD_5/capita/day x 1,000 person-equivalents
= 170 lbs BOD_5/day

Proposed Design Maximum Day BOD_5 =
Proposed Design Max. Month BOD_5 x 1.6 = 272 lbs BOD_5 /day

Proposed Design Peak Hourly BOD_5 =
Proposed Design Max. Month BOD_5 x 3.8 = 646 lbs BOD_5 /day

6.2.d.ii. Design Maximum Month, Maximum Day and Peak Hour Total Suspended Solids (TSS).

Per Ten States Standards, Section 11.253, domestic waste treatment design shall be on the basis of at least 0.20 lbs of suspended solids per capita per day.

Alternative Service Area Design TSS

The population equivalent for the Alternative Service Area is 1,000 persons, therefore:

Proposed Maximum Month Total Suspended Solids (TSS) =
0.20 lbs TSS/capita/day x 1,000 person-equivalents
= 200 lbs TSS/day

Proposed Design Maximum Day Total Suspended Solids (TSS) =
Proposed Design Max. Month TSS x 1.6 = 320 lbs TSS/day

Proposed Design Peak Hour Total Suspended Solids (TSS) =
Proposed Design Max. Month TSS x 3.8 = 760lbs TSS/day

6.2.d.iii. Design Maximum Month Ammonia and Nitrogen

From Ten States Standards Appendix, Table No. 2, the estimates of the Design Maximum Month ammonia and nitrogen using concentrations of 25 ppm of NH_3-N (ammonia nitrogen) and 40 ppm of TKN (Total Kjeldahl Nitrogen) are as follows:

Alternative Service Area Design Maximum Month NH_3-N and TKN

The Design Maximum Month Wastewater Flow for the Alternative Service Area is 100,000 gpd, (0.100 MGD, where 1 MGD equals 1,000,000 gpd), therefore::

Proposed Design Maximum Month Ammonia Nitrogen (NH_3-N)
25 ppm x 8.34 lbs/gallon x 0.100 MGD = 21 lbs/day of NH_3-N

Proposed Design Maximum Month Total Kjeldahl Nitrogen (TKN)
40 ppm x 8.34 lbs/gallon x 0.100 MGD = 33 lbs/day of TKN

6.2.d.iv. Design Maximum Month Phosphorus

From Ten States Standards Appendix, Table No. 2, the estimate of the design maximum month phosphorus is 7 ppm; we will use a concentration of 10 ppm of phosphorus to be conservative:

Alternative Service Area Design Maximum Month Phosphorus

Proposed Design Maximum Month Phosphorus
10 ppm x 8.34 lbs/gallon x 0.100 MGD = 8 lbs/day of Phosphorus

6.2.e. Seasonal Loading Considerations

Most of the residences and apartments in the Alternative Service Area appear to be occupied all year, so no correction for seasonal, part-time or weekend occupancy is needed.

6.3. Wastewater Load Summary

RAW WASTEWATER LOAD SUMMARY	
Phoenicia Community Wastewater System Original Proposed Sewer District	
Hydraulic Loads:	
Design Average Flow	130,000 gpd
Design Max. Month Flow	162,000 gpd
Design Maximum Day Flow	260,000 gpd
Design Peak Hourly Flow	412 gpm (592,900 gpd)
Organic and Solids Loads:	
Design Max. Month BOD_5	275 lbs BOD_5/day (203 mg/L)
Design Maximum Day BOD_5	440 lbs BOD_5/day
Design Peak Hour BOD_5	1,007 lbs BOD_5/day
Design Max. Month Total Suspended Solids	324 lbs TSS/day (240 mg/L)
Design Maximum Day Total Suspended Solids	518 lbs TSS/day
Design Peak Hour Total Suspended Solids	1,186 lbs TSS/day
Nutrient Loads:	
Design Max. Month NH_3-N	34 lbs/day of NH_3-N
Design Max. Month TKN	54 lbs/day of TKN
Design Max. Month Phosphorus	14 lbs/day Phosphorus

RAW WASTEWATER LOAD SUMMARY	
Phoenicia Community Wastewater System Alternative Service Area	
Hydraulic Loads:	
Design Average Flow	80,000 gpd
Design Max. Month Flow	100,000 gpd
Design Maximum Day Flow	160,000 gpd
Design Peak Hourly Flow	264 gpm (380,000 gpd)
Organic and Solids Loads:	
Design Max. Month BOD_5	170 lbs BOD_5/day (203 mg/L)
Design Maximum Day BOD_5	272 lbs BOD_5/day
Design Peak Hour BOD_5	646 lbs BOD_5/day
Design Max. Month Total Suspended Solids	200 lbs TSS/day (240 mg/L)
Design Maximum Day Total Suspended Solids	320 lbs TSS/day
Design Peak Hour Total Suspended Solids	760 lbs TSS/day
Nutrient Loads:	
Design Max. Month NH_3-N	21 lbs/day of NH_3-N
Design Max. Month TKN	33 lbs/day of TKN
Design Max. Month Phosphorus	8 lbs/day Phosphorus

6.4. Septic Tank Effluent Loadings versus Raw Sewage Loadings

The organic, solids and nutrient loadings as presented above represent loadings as would be expected of raw sewage, as would be conveyed through conventional, grinder pump or vacuum sewers (see Sections 9.1.a, 9.1.c and 9.1.d, respectively). However, in the case of an on-site septic system or a small diameter gravity sewer (see Section 9.1.b.), solids are settled out before entering the on-site subsurface system or collection system, thereby removing some of the organics and solids from the wastewater. The Septic Tank Effluent Loadings for the Original Proposed Sewer District and the Alternative Service Area are as follows:

SEPTIC TANK EFFLUENT WASTEWATER LOAD SUMMARY	
Phoenicia Community Wastewater System Alternative Service Area	
Original Proposed Sewer District:	
Design Max. Month Flow	162,000 gpd
Design Max. Month BOD_5	149 lbs BOD_5/day (110 mg/L)
Design Max. Month Total Suspended Solids	108 lbs TSS/day (80 mg/L)
Alternative Service Area:	
Design Max. Month Flow	100,000 gpd
Design Max. Month BOD_5	92 lbs BOD_5/day (110 mg/L)
Design Max. Month Total Suspended Solids	67 lbs TSS/day (80 mg/L)

SECTION 7
Identification and Review of Wastewater Management Options

7.1. Septic Maintenance District

When soil conditions are favorable and lot sizes are adequate, rather than implement some form of centralized sewage disposal, a town can form a district to take responsibility for individual septic systems serving private property. This is called a Wastewater Disposal District or Septic Maintenance District. The town board is authorized to exercise all powers with respect to Wastewater Disposal Districts, which are provided for Sewer Districts, to the extent that such powers are consistent with the purposes of a Wastewater Disposal District. The charges for all Wastewater Disposal District services shall be sufficient to pay all estimated annual costs of operation and maintenance and all annual installments of principal and interest on obligations issued on behalf of the Wastewater Disposal District. To the extent that revenue in any year is insufficient, the excess cost over the revenues may be assessed against the real property of the district in the following year. A Wastewater Disposal District cannot include any portion of a Sewer District. However, a Sewer District can include the maintenance of individual on-site septic systems (from Guide to Developing a Municipal Wastewater Project by Lamont Engineers, P.C. and Young, Sommer…LLC (Guidance Manual), Chapter 5, Paragraph 5.12)

The services of a Septic Maintenance District are defined locally. The services can be as basic as a town providing awareness and information about how to properly maintain a private septic system, inventorying the systems, and reminding homeowners of maintenance at the appropriate intervals. However, services of a Septic Maintenance District can also be as involved as the town operating and maintaining the on-site system still owned by the private individual, including providing repairs to the system or even full replacement by construction of entirely new on-site septic systems.

On-site septic tank and subsurface treatment and disposal systems, if properly applied to adequate site(s), and if properly operated and maintained, are effective, and these systems are the least costly wastewater management option in initial capital costs, on-going operation and maintenance costs and future replacement or rehabilitation costs.

The key issue is whether the individual lots are adequate in size, hydrogeologic and physical characteristics. The sites must be evaluated with caution. If a significantly large majority of the community sites can support an adequate, properly sized and designed system meeting current regulatory requirements including the 100% reserve requirement, and if the balance of the community's sites can support specially engineered systems, then the community can pursue the development of this option with reasonable confidence. If a significant number of sites are insufficient, then the septic maintenance district option should be rejected in favor of an option with more

potential for full and long-term success (from Alternatives for Municipal Wastewater Management Systems, by Lamont Engineers, P.C., Chapter 10, Paragraph 1).

7.2. Sewer District

A district is an area of a town that receives a service from the town that benefits only the properties within the district. A Sewer District is a legal formation of properties within a town that are benefited by and pay for sewage treatment and disposal. The district ensures that households within the municipality that are not benefited by the sewer system are not unfairly burdened with its cost. Different types of Sewer Districts may be comprised of a portion of a town or a portion of a town and village within the same town, with the village's approval. A Sewer District may not cross town lines. Sewer districts do not have to be contiguous; sewer districts can have separate sections or areas that are not contiguous (from Guidance Manual, Chapter 5, Paragraph 5.11). The typical Sewer District is served by a sewage collection system, a wastewater treatment plant, and a permitted surface discharge to a stream.

Sewer Districts can be developed that implement alternative approaches to the wastewater collection and treatment systems typical of larger municipalities. A district may be comprised of properties joined to one community septic system or to multiple cluster systems, or a district may be a combination of a community septic system and one or more cluster systems. In these cases, the charges imposed within the sewer district can vary in direct proportion to the benefit of the service provided.

7.2.a. Community Septic System

The flow strength and volume of a small rural community is typically lower than that of a city and therefore simpler methods of treating and discharging of the wastewater may be implemented. A community septic system is a wastewater collection and treatment system that is intermediate in scale and complexity. A community septic system may have a collection system that collects raw sewage and conveys it to a central location. Solids are collected in a tank, and liquid is discharged to a large leach field, where it is treated and discharged. The treated effluent is discharged below the ground, as opposed to a wastewater treatment plant where the discharge is usually to surface waters. The extent and complexity of treatment of the wastewater in a community septic system is typically less than in a wastewater treatment plant.

7.2.a.i. Cluster System

Cluster systems are a method of wastewater treatment and disposal where two or more homes may be connected to a common septic tank and disposal system. These systems may be located on public or private property. This

type of multi-home septic system is more suitable for small rural communities than for large, densely populated areas.

7.2.b. Wastewater Treatment Plant System

A wastewater treatment plant system refers to the type of sewage treatment and disposal typical of larger municipalities, villages and cities. A wastewater treatment plant may be necessary even in a small community if adequate subsurface treatment and disposal sites are unavailable. Typically large diameter gravity collection system pipes carry raw sewage directly from the homes and businesses to pump stations, where necessary, but ultimately to a central location where the sewage is treated and disposed of directly to a stream as a surface discharge. Wastewater treatment plants treat the sewage through biological, mechanical and chemical processes in order to prepare the wastewater to be legally discharged to a body of water (i.e. without posing a health threat to the public or creating an environmental problem).

7.2.c. Conveyance to Existing Wastewater Treatment Plant

Some communities are located relatively near a neighboring community's existing wastewater collection and treatment system. If that neighbor is willing to sell some of its excess capacity at a reasonable price and if that neighbor is willing to take on the responsibility for treating the wastewater for a reasonable cost or for other considerations, such as annexation in the case of a town, hamlet, and a village, then pumping wastewater to the existing system could prove to be the best option. When a community proposes such a deal to its neighbor, it must remember that the neighbor has no legal or moral obligation to provide the service requested and that therefore the proposal must be financially advantageous to the neighbor. Indeed, if the deal were not in the interest of the neighbor, then the neighbor would have an obligation to its citizens to reject the idea.

One disadvantage to the option of pumping to a neighboring community's wastewater system is that the availability of future additional wastewater treatment capacity is entirely within the power of the neighbor to grant or deny.

7.3. Practical Wastewater Management Options for the Hamlet of Phoenicia

7.3.a. Septic Maintenance District for Service Area

The Original Proposed Sewer District for the Hamlet of Phoenicia contains 345 properties as shown in Exhibit 4.A. Site features inhibiting or prohibiting the development of adequate conventional, on-site septic systems were found

on many of these properties. As shown on the Septic Limitation Map in Exhibit 3.1.a.C, these features are:

1. location too close to waterways (minimum 100' setback)
2. location within the FEMA 100-year flood zone boundary
3. too steep (>15% slopes)
4. insufficient lot size
5. unsuitable soils

The properties located within the Original Proposed Sewer District were reviewed to determine if an individual on-site septic system meeting Chapter 10 of the New York Codes, Rules and Regulations, Appendix 75-A (10NYCRR Appendix 75-A) could be sited on the property while avoiding the limiting septic system site features.

To do this, the Sample Conventional Septic System Layout and Design in Exhibits 3.1.a.A, was used as described in Chapter 3. The sample conventional septic system was based on a flow rate of 400 gpd, per the New York State Department of Environmental Conservation Design Standards for Wastewater Treatment Works, 1988 (1988 NYSDEC Standards), Table 3 – Expected Hydraulic Loading Rates, for a 3 bedroom housing unit.

Based on this review, it was determined that only 51 of 345 properties (15% of total) could maintain an individual on-site septic system with the required 100 percent leach field reserve area available. Of the remaining 294 (85% of total) properties, 192 (56%) would not be able to meet requirements due to insufficient lot size, 60 (17%) are within the 100-year flood plain, 12 (3%) would not meet the 10NYCRR Appendix 75-A requirement avoiding slopes greater than 15%, 3 (1%) were significantly encumbered by both slopes greater than 15% and the 100-year flood plain, 10 (3%) would not meet the 100' offset from streams and 17 (5%) had predominantly unsuitable soils. Many of the 294 properties had overlapping issues such as insufficient lot size coupled with steep slopes, flood plain, poor soils and/or being within limiting distances of watercourses. See Exhibit 7.3.a.A for the Septic Limitation Map Summary.

The Hamlet of Phoenicia was also evaluated to see how many properties would be able to have an individual on-site septic system without the required 100% reserve area. It was determined that only 78 of 345 properties (23% of total) could maintain an individual on-site septic system without the required 100 percent leach field reserve area available. Of the remaining 267 (77% of total) properties, 152 (44%) would not be able to meet requirements due to insufficient lot size, 69 (20%) are within the 100-year flood plain, 10 (3%) would not meet the 10NYCRR Appendix 75-A requirement avoiding slopes greater than 15%, 3 (1%) were significantly encumbered by both slopes

greater than 15% and the 100-year flood plain, 12 (3%) would not meet the 100' offset from streams and 21 (6%) had predominantly unsuitable soils. Many of the 267 properties had overlapping issues such as insufficient lot size coupled with steep slopes, flood plain, poor soils and/or being within limiting distances of watercourses.

The 267 properties identified as having inadequate space for a conventional leach field system without the 100% reserve area may be able to site a specially engineered system utilizing advanced treatment systems. An engineered system would include some type of advanced treatment system ahead of the subsurface system, like a peat biofilter, sand filter, trickling filter, or aerobic treatment unit. Because the effluent from these advanced treatment systems is cleaner than the effluent from a septic tank, the subsurface system size could be reduced if subsurface disposal area was limited, thereby possibly allowing these smaller lots with site constraints to support their own treatment systems. A potential Hamlet of Phoenicia Septic Maintenance District for the Service Area would require extensive site testing and analysis of each property during a pre-design phase.

Due to the lot sizes in the proposed wastewater service area for the Hamlet of Phoenicia, the fast soils typical throughout the Hamlet, the location of many properties in the Hamlet in the 100-year flood plain and close proximity of many properties in the Hamlet to water courses and the significant slopes on properties surrounding the Hamlet, the majority (85%) of the properties in the Hamlet of Phoenicia are not able to support a properly functioning, up-to-standards septic system. Therefore, a Septic Maintenance District cannot be recommended for the Hamlet of Phoenicia.

7.3.b. Community Septic System / Subsurface Disposal

The Hamlet requires some form of centralized wastewater treatment and disposal system. The simplest and least expensive form of this is a community septic system.

7.3.b.i. Identify Potential Sites

Site Selection Criteria were developed to assist in the process of identifying, screening, and selecting potentially suitable sites for subsurface disposal of wastewater for cluster systems and to identify where a Community Septic System could be sited in the vicinity of the Planning Area. The Site Selection Criteria are broken up into five different phases. Each phase moves progressively closer toward final site selection while eliminating more problematic sites along the way. See Exhibit 7.3.b.i.A for the Site Selection Criteria for Subsurface Disposal.

As part of the Phase I investigations, a cursory review of the parcels in the Planning Area was initiated to develop a list of potentially suitable sites for a community or cluster subsurface system.

Based on previous projects of this nature and size, it was determined that a minimum subsurface treatment site to serve the entire flow of the service area would need to be very large, larger than any one site previously used for a subsurface site on other projects completed in the NYCDEP Watershed. Therefore we looked for smaller cluster sites, approximately 15 acres in size, which, depending on the percolation rate of the soil, would be large enough to treat approximately 25,000 gpd to 35,000 gpd. No sites of that size or even as small as 5 acres in size were found in or near the Planning Area that were suitable for subsurface systems. Considering this and the large flow from the community, the search for subsurface sites was abandoned and therefore a subsurface system for Phoenicia is not a viable alternative.

7.3.c. Wastewater Treatment Plant with Surface Discharge

Because of the small property lots throughout the Hamlet and a lack of sites large enough and suitable for community subsurface systems, a Septic Maintenance District or a Community Septic System(s) are not viable alternatives for the Hamlet of Phoenicia. However, a wastewater treatment plant can be built on poorer soils and/or in a floodplain if floodproofed, and requires much less property than a community septic system. The previous engineering solution recommended by Laberge and designed by Delaware Engineering for the Hamlet of Phoenicia was a wastewater treatment plant. It is recommended that this solution be reevaluated and new wastewater treatment technologies be further investigated.

7.3.d. Conveyance to Existing Wastewater Treatment Facilities

In some cases a viable option for community wastewater management is to pump the wastewater to an existing facility for treatment and discharge. The downside of this option is the loss of municipal control to approve additional users to the district as well as local approval for changes of use of existing users. This solution was used for the Roxbury New Sewage Infrastructure Project (NIP) in neighboring Delaware County. The Hamlet of Roxbury Sewer District utilizes a gravity sewer system to collect its wastewater and convey it to a pump station at the downstream end of the Hamlet. This pump station transports the wastewater to the NYC-owned wastewater treatment plant at Grand Gorge, NY. The Town of Roxbury and NYCDEP signed a contract for the treatment of Roxbury's wastewater including provisions for a fee for the service, a ceiling on the flow that the Hamlet can convey to NYCDEP's Grand Gorge WWTP, a restriction on hook-ups along the 9+ mile force main route from Roxbury to Grand Gorge WWTP, and a boundary

around the Grand Gorge sewer service area. All users in Roxbury pay an operation and maintenance fee. In addition, the Roxbury Sewer District is responsible for maintenance of the collection system, pump stations, and force main.

The neighboring Hamlet of Pine Hill, located 10 miles north of Phoenicia, in the Town of Shandaken and the neighboring Hamlet of Boiceville, located 5 miles south of Phoenicia, in the Town of Olive have existing wastewater treatment plants. The Hamlet of Boiceville Wastewater Treatment Plant was recently constructed and completed under the Catskill Watershed Corporation Community Wastewater Management Program, and the Hamlet of Pine Hill has a NYCDEP owned and operated Wastewater Treatment Plant.

Although the Hamlet of Boiceville WWTP is within relatively close proximity to the Hamlet of Phoenicia, the Boiceville WWTP does not have the capacity to accept the flows from the Hamlet of Phoenicia. In addition, there is not enough area to expand the Hamlet of Boiceville system for the capacity needed for the Hamlet of Phoenicia. Therefore, pumping to Boiceville is not a feasible option.

On the other hand, and based solely upon SPDES limit and current flows, the Pine Hill WWTP may have the capacity to accept wastewater from the Hamlet of Phoenicia. As in Roxbury, the WWTP is city owned and located within the same Town and County as the NIP hamlet, Phoenicia. Therefore, it is evaluated in more detail in Sections 9 2.f and 10.1.e.

SECTION 8
Screening and Selection of Potentially Suitable WWTP Sites

8.1. Surface Disposal

8.1.a. Review of Existing WWTP Site

During the design phase of the originally proposed project completed by Delaware Engineering a parcel of land located approximately 1 mile south of the Hamlet on the west side of NYS Route 28, near Kinsey Road, was purchased with project funds for the location of the proposed WWTP. This parcel is approximately 4.3 acres in size. An unnamed tributary of the Esopus Creek runs through the center of the property and divides the property approximately in half. There is also a small stream located along the western property boundary, which discharges into the unnamed tributary at a location south of the property.

An existing 15 foot wide gravel drive that provides access from Route 28 to a NYSDEC parking area and to several homes was the proposed WWTP entrance. The May 2006 Bid Set Drawings prepared by Delaware Engineering shows the WWTP located on the western half of the property, bordered to the east by the unnamed tributary of the Esopus Creek running through the center of the property and bordered to the west by the small stream located along the western property boundary. Topography on the originally proposed WWTP site is generally level with elevations ranging from 758 feet above sea level to 762 feet above sea level. According to the May 2006 Facility Plan prepared by Delaware Engineering, stormwater runoff from the property flows east and southeast to the stream running through the center of the property. See Exhibit 8.1.a.A, Original Proposed Wastewater Treatment Plant Site Map.

Soil conditions of the previously proposed WWTP site were described in the February 2006 Facility Plan prepared by Delaware Engineering. According to the Facility Plan, the Ulster County Soil and Water Conservation District Map indicated that there are primarily two soil types located within the WWTP site; the Tunkhannock series TkA and Barbour loam (Ba). Tunkhannock soils are a gravelly loam, very deep, and well to somewhat excessively drained. Barbour loam soils are very deep and well drained. Ba soils are located on floodplains and are occasionally flooded, but not ponded. The TkA soil and the Ba soil are classified as hydrological group A and B, respectively (group A soils have low runoff potential and high infiltration rates; group B soils have moderate infiltration rate, slightly less than group A soils). The soil survey lists the depth to bedrock as being greater than 60”.

Lamont Engineers developed a set of site selection criteria to assist in evaluating the suitability of the site and as guidance for potential further searches for wastewater treatment plant sites. See Exhibit 8.1.a.B, Site Selection Criteria for Surface Discharge WWTP. The site meets almost all of the criteria. It is distant from public water supply reservoirs and wells, distant from active private wells, down gradient from the Hamlet, the land is relatively flat and therefore will require little grading, it is in close proximity to a stream, yet is not in the 100-year flood plain, there are no indications that bedrock is shallow at the site and it is relatively distant from the homes near the property (the closest home is approximately 300' away). According to Town officials, it did not flood during Tropical Storm Irene on that hit the area on August 28, 2010. The only notable negative aspect of the site is that it is very distant (approximately 1 mile) from the Original Proposed Sewer District. However, in consideration of all the characteristics of the site, the site is a good site for a WWTP. Furthermore, it is currently already owned by the Town. Therefore, it is not recommended that a search for another WWTP be pursued.

Soil borings were performed in 2005 by Soil Material and Testing, Inc. for Delaware Engineering at the originally proposed WWTP site. The soil boring log sheets indicate that the soils contain silty sand and gravel to a depth of approximately 15 to 20 feet. Some areas (SB 60, SB-61, SB-65) also contain silty clay below 15 feet. Borings were 20 feet deep, except in one location where refusal, most likely rock, was encountered at 15.5 feet. Ground water is approximately 9 feet on the east side of Route 28, 10 feet on the west side of Route 28, and 19 feet around the proposed WWTP site.

A review of the soil borings by a geotechnical engineer was not included in the bidding documents and was not found in any of the Town's files provided to Lamont Engineers. It is recommended that review of the soil borings be performed by a Geotechnical Engineer. Even though the soil borings show the silt and clay layers as being relatively compact (Standard Penetration Test (SPT) N values done during the soil borings are 20 and higher), the soil borings were not very deep and there is the potential for deeper softer clay layers to exist. If so, the instability of potentially softer clay subsoil could have a significant impact on the design of the tanks and building foundations. Furthermore, it is our experience that one deep, 100' boring will be needed to evaluate and confirm the seismic classification of the site, as required by the New York State Building Code, in order to verify that the structural design of the building is adequate.

SECTION 9
Wastewater System Alternatives and Discussion

9.1. Collection Options for Service Area

9.1.a. Conventional Gravity Sewers

Conventional collection systems collect and convey raw wastewater from the homes and businesses it serves to a centralized location for treatment and disposal. Conventional collection systems are typically constructed of gravity flow sewer pipe of 8-inch diameter or larger. Polyvinyl chloride (PVC) pipe is typically used under normal service conditions while ductile iron pipe is used where additional pipe strength is needed, or where the collection system will be within 50' horizontally from a private well. Conventional sewers must be installed at slopes sufficient to maintain the flow velocities necessary to transport solids. For maintenance purposes, conventional sewers must be installed in straight horizontal and vertical alignment between manholes no farther than 400 feet apart. The critical alignment of conventional sewers increases installation costs by requiring installation accuracy and by requiring deeper sewer installation in areas where the ground surface rises between manholes and where the additional depth is necessary in order to service the lowest house laterals.

Conventional collection systems are designed for gravity flow wherever possible. However, in some flat terrain, due to minimum sewer grade requirements or excessive sewer depth, pumping or lift stations may be necessary or more economical.

Advantages to conventional collection systems include applicability to all types of treatment processes, flexibility for expansion, reliability of service, and minimal operating and maintenance costs.

A disadvantage of conventional collection systems is significant construction and restoration cost when deep sewers (greater than 10 feet) are required.

9.1.b. Small Diameter Gravity Sewers

A Small Diameter Gravity Sewer (SDGS) system consists of septic tanks for each service connection and small diameter (4 and 6-inch) HDPE collection sewers. The collection sewers are installed at varying (and sometimes uphill) grades at or just below the frost line. Smaller diameter pipe can be used because the septic tanks trap solids and greases which tend to clog sewers, leaving only septic tank effluent (liquid) to be transported in the pipes. Cleanouts and flush connections are used instead of manholes for maintenance purposes.

Where services are too low for connecting to the mainline sewer by gravity, small effluent pump stations may be required. These can either be for single or multiple services. When several effluent pump stations are connected to a common pressure pipe, a septic tank effluent pump (STEP) system is created. Where entire service areas are too low for connection to the rest of the sewer system, larger effluent pump stations are required.

Advantages to such a system include a potential reduction in construction and restoration costs, reduction of waste loading, and elimination of primary settling at the wastewater treatment facility due to the use of on-site septic tanks. Construction and restoration costs are reduced because alignments of SDGS systems can be easily routed around above- and below-ground obstacles and/or directional drilled, thereby further reducing installation and restoration costs.

Disadvantages to such a system include potential limited flexibility for future expansion, due to small diameter piping, if expansion needs are not considered during the design of the system, and the maintenance requirements and sludge disposal costs required for the septic tanks at each service connection. Also, when collection systems which carry only septic tank effluent are used in conjunction with other types of collection systems which require primary settling, the advantage of the septic tanks is lost. Additionally, measures to control odors must be taken since septic tank effluent when aerated by flowing through pipes or dropping into pump stations can be odorous.

9.1.c. Grinder Pump Pressure Sewers

Grinder pump pressure sewers can be used for entire collection systems or just for lower elevation service areas where connection to the collection system is not feasible by gravity. However, since grinder pumps only grind up solids and do not remove them from the sewage, as does a septic tank, such systems are typically only used when connected to conventional sewers or a complete system of pressure sewers. They should not be pumped into a SDGS system. By eliminating the need for a septic tank (as required with effluent pumping systems), grinder pump systems may be cost effective in some applications.

Advantages to grinder pump pressure sewers include applicability to all types of treatment processes, the cost and maintenance advantages of eliminating septic tanks, and a potential reduction in construction and restoration costs.

Disadvantages include the operation costs and maintenance of a solids-handling pump at each home or group of homes.

9.1.d. Vacuum Sewers

Like grinder pump pressure sewers, vacuum sewers can be used for an entire collection system or just for lower elevation service areas. Vacuum sewers consist of one or more central vacuum sources and 4-inch or greater vacuum lines, which are capable of handling all solids in normal wastewater. "Wet well" wastewater collectors are located such that they serve from 1 to 4 homes. When the waste in the wet well reaches a certain level, a valve in the wet well is actuated and the wastewater in the wet well is ejected to the central vacuum station. Wastewater from the central vacuum station either flows by gravity or is pumped to the treatment location.

As with grinder pump pressure sewers, the advantages to vacuum sewers include the applicability to all types of treatment processes and the maintenance advantages of eliminating septic tanks.

Disadvantages include the cost and maintenance of the central vacuum station(s) and the mechanical valve units at each of the collection wells. Also, the available 'lift' provided by vacuum sewers is limited to about 20 feet.

9.1.e. Review of Existing Collection System Design and Selection of Collection System Alternative

The original proposed collection system for the Hamlet of Phoenicia was conventional gravity sewer, augmented with pump stations to service low lying properties.

The collection system consists of approximately 36,200 LF of 8” PVC gravity sewer, approximately 3,200 LF of force main, and 4,200 LF of PVC lateral stubs. The sewage collection system piping is 8” SDR 26 PVC. Changing the pipe material to SDR 35 PVC, which is a thinner walled pipe than SDR 26 PVC, but commonly used for sewage collection systems, should be considered since using SDR 35 PVC pipe would likely provide a cost savings to the project. The majority of the collection system sewage piping is located in the road, except for along Main Street and NYS Route 28 south of the Hamlet down to the WWTP site, where the piping is located behind the properties or in the railroad right-of-way. The large majority of the gravity sewage collection system piping is generally between 5’ and 10’ deep, although some of the sewage collection system piping is as deep as 16’.

There are twelve (12) simplex pump stations serving individual properties and two (2) main pump stations to pump sewage from areas of low lying properties to the main trunk sewer to the wastewater treatment plant. The bidding documents also identify one (1) residential duplex pump station, but the location

of this pump station was not identified on the drawings. Therefore, it is unclear as to what this line item is for.

For the twelve (12) simplex pump stations serving individual properties, the pump station equipment was scheduled to be purchased by the sewer district as part of the construction bid and to be installed by the home owner. Therefore, there were no easements to be obtained or property to be acquired. The two (2) main pump stations are the Esopus Creek Pump Station and the Old Route 28 Pump Station. They were included in the construction bid to be purchased and installed by the sewer contractor. The property for the two (2) main pump stations was to be acquired by the Town.

The Esopus Creek Pump Station is located behind the properties along the west side of Bridge Street. The design occupies lands now currently owned by Harry Jameson (tax map parcel number 14.13-3-43) and Michael Ricciardella (tax map parcel number 14.13-3-41). At the time of the bidding of the project, the acquisition of the property had not been secured, and still has not been secured. At the time of bidding, it is our understanding that Harry Jameson had agreed to provide the project with an easement. However, Mike Ricciardella refused. If the project proceeds, the Esopus Creek Pump Station will either need to be relocated or the Town would need to exercise eminent domain. It is our recommendation that another pump station site be obtained where eminent domain is not necessary.

Lateral construction was not included as part of the bidding documents. If there was money remaining in the block grant after the sewer mains and wastewater treatment plant were constructed, that money was going to be used to assist the homeowners with the installation of their laterals, including the individual pump stations.

Because the existing collection system design is adequate, with only minor issues to be resolved, the existing collection system design with the improvements discussed above is the recommended collection system alternative.

See Exhibit 9.1.e.A for the General Plan – Existing Collection System Design by Delaware Engineering

9.1.f. Subsurface Conditions Along Proposed Collection Route

As part of the collection system design prepared by Delaware Engineering, soil borings were performed in February of ’06 to determine the subsurface conditions along the route, including but not limited to identifying the depth to groundwater and areas where rock may be encountered during construction of the collection system (the majority of the collection system designed by

Delaware Engineering is between 6' and 10' deep). A Geotechnical Engineering report was not completed at that time.

North of Main Street
The soil borings on the north side of Main Street, including along NYS Route 214 revealed brown silty sand and gravel in the upper layers (less than 10') with a brown silty clay below that. In some areas, specifically in the areas of Church Street, Mt Ava Maria Drive, Newton Avenue the silty sand and gravel layers were generally very dense and rock when encountered was deeper than 10'. Shallow rock was encountered along School Street at a depth of 6'-9'. Groundwater was typically not encountered, and when encountered was generally deep (deeper than 10').

Lower High Street/Station Road Area
The soil borings along Lower High Street and Station Road revealed silty sand and gravel, typically to a depth greater than 15'. Groundwater, when encountered, was generally deep (greater than 10'). Some silty clay was encountered along Station Road at approximately 15'. Rock, when encountered, was greater than 16' deep, except for SB-52 and SB-52a, which encountered boulders at 4'.

Old Route 28 Area
The soil borings along the eastern end of Main Street and along and to the east of Old Route 28 (along Waterworks Road and Rawson Road) revealed brown silty sand and gravel in the upper levels (less than 12') with a brown silty clay below that. Groundwater was typically not encountered, except in SB-77b, at a depth of approximately 11'. Boulders were encountered in SB-77 and SB-77a at 5' and 8', respectively. (Soil Boring, SB-77b, adjacent to the other two borings, did not encounter rock, so therefore that the auger refusal in SB-77 and SB-77a is assumed to be a result of boulders and not bedrock).

NYS Route 28 and Woodland Valley Area
This area includes NYS Route 28 and Old Route 28 (west of Main Street) and the side streets off of Old Route 28, referred to as the Woodland Valley Area. Most borings revealed brown silty sand and gravel soils (and some clay at depths greater than 12'). However 9 out of 15 encountered rock at a depth of less than 10'. Rock was encountered along Route 28 in three (3) borings between 8' and 9'. Four (4) borings along Woodland Valley Road indicated rock between 3.5'-10'. The boring on West Street encountered Rock at 9', and one boring on Old Route 28 also encountered rock at 9'. Groundwater, when encountered was typically deeper than 10'; however, groundwater was encountered between 5' and 6' at two locations (east end of Route 28, and Woodland Valley Road).

High Street Area
The soil borings along High Street, including Lane Street, revealed silty sand and gravel soils. Some glacial till was also encountered along the eastern end of High Street. Silty clay was encountered below 13' along the western end of High Street. The only area indicating shallow rock was the end of Lane Street, with rock at 8'. Groundwater was encountered at 5'-7' at some locations, otherwise groundwater was not encountered.

NYS Route 28, South of Hamlet
The soil borings along NYS Route 28, south of the Hamlet, as far as the location of the originally proposed wastewater treatment plant (WWTP) site revealed silty sand and gravel soils. Groundwater, when encountered, was at depths of 14'-19'. Silty sand was encountered at approximately 15' at the two southern most borings, and silty clay was encountered at approximately 18' at the boring across from the originally proposed WWTP site. Rock was encountered at 8.5 feet at one boring halfway along NYS Route 28 between the Hamlet and the originally proposed WWTP site; otherwise, rock was not encountered.

South of Main Street (North of Esopus Creek)
The soil borings on the south side of Main Street and north of the Esopus Creek revealed brown silty sand and gravel in the upper layers, and brown silty clay or rock below that. Several borings revealed shallow rock (less than 6'). This included SB-24 (Black Bear Campground), SB-25 (Bridge Street), SB-31 and SB-31a (near Stony Clove Creek), and SB-35 and SB35a (west of Bridge Street). Groundwater, when encountered, was at depths typically between 7'-12.' When shallow rock was not encountered, rock was typically eventually encountered by 10'-18'.

In conclusion, rock and boulders were encountered infrequently in the Original Proposed Sewer District area. Therefore, it is assumed that some rock removal will be required to complete the construction of the collection system. Groundwater was also generally deeper than the depth of the proposed sewer installation, so well points or significant dewatering will not be necessary in order to install the sewage collection system. However, the presence of silty and clayey material in the subsoil could make deep excavations more difficult and trenches that are not properly shored are likely to be very unsafe. The contractor will be required to follow all OSHA guidelines for safe excavations.

See Exhibit 9.1.f.A for the Soil Boring Location Map and Soil Boring Logs.

9.2. Wastewater Treatment Plant Options

A wastewater treatment plant (WWTP) can be designed to treat wastewater from both the residences and businesses in the Hamlet of Phoenicia. A WWTP can discharge either to the subsurface through exfiltration ponds or absorption fields or to a surface water through an outfall. Although the NYCDEP Watershed Rules and Regs allow up to a 25% reduction in leach field size for WWTP's discharging to subsurface, there are still no sites in the community that are large enough to accommodate discharging the volume of flow estimated for a WWTP in Phoenicia, as indicated through our investigations for the Community Septic System. Therefore, a surface water discharge is the only alternative for disposal of the wastewater from a WWTP.

As part of the design of the previously proposed WWTP completed by Delaware Engineering, NYSDEC issued Draft State Pollutant Discharge Elimination System (SPDES) Discharge limits. The draft permit was obtained and is included in Exhibit 9.2.A, Original Draft State Pollutant Discharge Elimination System (SPDES) Discharge Permit. These limits were for a discharge to the tributary of the Esopus Creek that runs through the center of the original proposed WWTP site. Draft SPDES limits were also requested from NYSDEC for a possible direct discharge to the Esopus, since larger streams may have less stringent limits because of their size. However the response from NYSDEC was that the limits would be the same as the original draft limits. They are summarized as follows:

Parameter	***Limit***
Flow	185,000 gpd
$CBOD_5$	5 mg/L[(1)]
TSS	10 mg/L[(1)]
Settleable Solids	0.1 mg/L
pH	6.5 – 8.5
Ammonia (NH_3)	1.1 mg/L (June 1 to October 31) 2.2 mg/L (November 1 to May 31)
Total Phosphorus (P)	0.5 mg/L
Temperature	70° (June 1 to October 31) Monitor (November 1 to May 31)
Dissolved Oxygen	7.0 mg/L
Effluent Disinfection Fecal Coliform	All Year 200 no./100 ml (30 Day Mean) 400 no. /100 ml (7 Day Mean)

[(1)] Effluent $CBOD_5$ and TSS shall not exceed 15% of the influent concentration values of $CBOD_5$ and TSS.

A discharge to the Esopus Creek would involve a longer outfall installed under NYS Route 28, thereby costing more than the original design. However, since NYSDEC

has stated that the limits would be the same whether the discharge is to the tributary to the Esopus Creek or the Esopus Creek itself, it is not recommended to change the outfall location. The outfall location will remain the same as the original design. A final SPDES Permit will be applied for and obtained before bidding of the project.

Section 6 describes the characteristics of the wastewater that the proposed WWTP will treat. The WWTP system will consist of secondary treatment to remove BOD, and TSS (and most of the phosphorus), sludge separation, and UV disinfection. The NYCDEP Watershed Rules and Regulations (WRR) also require tertiary treatment (chemical precipitation to remove residual phosphorus (limit of 0.5 mg/L), sand filtration or approved equivalent technology to remove the residual TSS, and microfiltration or approved equivalent technology to remove the giardia lamblia cysts and enteric viruses, and disinfection).

As discussed above, the WWTP system would consist of primary, secondary and tertiary treatment systems. The WWTP options considered for the Hamlet of Phoenicia were to rebid the Existing Sequencing Batch Reactor (SBR) WWTP, a Membrane Bioreactor (MBR) WWTP, a SeptiTech WWTP, an Orenco System WWTP, and a Wetland WWTP. See Exhibit 9.2.a.A, Drawing PR-1 Process Schematic by Delaware Engineering, for the existing SBR WWTP process flow schematic, Exhibit 9.2.c.i.A Membrane Bioreactor (MBR) WWTP Process Flow Schematic, and Exhibit 9.2.c.ii.A Packaged WWTP Process Flow Schematic for the SeptiTech and Orenco WWTP process flow schematic. The operations of these systems are discussed below.

9.2.a. Existing Sequencing Batch Reactor (SBR) WWTP

The original proposed WWTP design for the Hamlet of Phoenicia is for an extended air, activated sludge process followed by dual stage tertiary sand filtration and ultraviolet disinfection with a Design Maximum Month Flow of 185,000 gallon per day (gpd). (See Section 5 for an explanation of why the current Design Maximum Month Design Flow as developed as part of this Engineer's Review Report is 162,000 gpd). The proposed facilities would be located just south of the Hamlet along the West side of NYS Route 28 on lands owned by the Town of Shandaken (See Section 8 for a description of the Original Proposed WWTP Site). Treated effluent from the WWTP discharges into the unnamed tributary of the Esopus Creek that runs through the center of the property. The main process components of the WWTP consist of the following:

- Influent Wet Well adjacent to the WWTP
- Duplex Pump Station
- Headworks channels with mechanical and manual screening

- Influent Splitter Box (manual)
- Dual Intermittent Cycle Sequencing Batch Reactors (SBRs) with fine bubble aeration and waste activated sludge pumps
- Equalization tank and submersible filter influent pumps
- Continuous Backwashing Upflow Dual Sand Filters (CBUDSF)
- Ultraviolet (UV) Disinfection
- Sludge dewatering belt press and conveyance systems
- Post aeration system
- SCADA system
- Emergency Generator
- Microfiltration Units as an ***Alternate to CBUDSF system***

The Sequencing Batch Reactor (SBR) is a form of a packaged secondary treatment system designed to biologically remove nutrients in the wastewater. SBRs operate on the "fill and draw" principal, i.e., filling the reactor with waste, treating it biologically, settling it, and decanting the supernatant (treated clarified wastewater), usually over a four to five hour cycle. Excess sludge that accumulates in the reactor is drawn off periodically. Since the concrete reactors are buried and usually covered, temperature effects are minimized. The fact that the waste is treated in batches allows the flexibility for additional treatment, i.e., holding the waste in the reactor for a longer period before discharge in order to meet treatment objectives.

If the waste contains high nitrate content from the conversion of ammonia to nitrate, an anoxic (presence of little oxygen) phase is added during the fill period. While batches of waste are added to the reactor, the waste is allowed to mix but no dissolved oxygen (DO) is added. The microorganisms in the wastewater use all the DO in the waste quickly and must resort to using the oxygen molecules in the nitrate as their oxygen source, thereby breaking the nitrates down. This process, known as denitrification, results in nitrogen gas being released to the atmosphere.

During the aeration period, oxygen is usually added to the waste through coarse bubble diffusers to create an aerobic environment. In this phase BOD5 and chemical oxygen demand (COD) removal occurs in the same way as all aerobic processes, i.e., organic constituents are metabolized and ammonia nitrogen is oxidized.

Since no waste is entering the reactor during the settling phase, quiescent conditions are maintained and settling is optimized. Decanting is accomplished using an adjustable weir.

Because SBR's only provide a level of treatment equivalent to secondary treatment limits and the New York City Rules and Regulations (NYC Rules and Regs) require that tertiary sand filtration or a department approved equivalent and microfiltration or department approved equivalent be provided, the original proposed design included Continuously Backwashing Upflow Dual Sand Filtration to meet the tertiary sand filtration and microfiltration requirements of the Rules and Regs.

The SBR process chosen by Delaware Engineering consisted of four steps:

1. Aeration – Wastewater from the Headworks flows into the basin and mixes with the mixed liquor in the pre-react zone. Filling and biological oxidation take place at the same time as the basin is aerated.
2. Mix – aeration is shut off and mechanical mixing is continued to enhance denitrification. Residual dissolved oxygen is depleted and conditions become anoxic in this phase. Denitrification and phosphorus release are accomplished.
3. Settle – Aeration and mechanical mixing are shut off and solids settle to the bottom of the basin. The basin continuously receives wastewater from the Headworks.
4. Decant – Clearwater is discharged from the top of the basin and sludge is wasted. The basin continues to receive wastewater from the Headworks.

The proposed plant would have two (2) SBR basins. Each basin would contain 164 fine bubble disc diffusers. Also, a weir decanter mechanism and drive unit would be installed in each basin. The SBR treatment system would include positive displacement blowers with VFDs, and a submersible waste activated sludge pump in each basin. The manufacturer would provide controls, programmable logic controller (PLC), supervisory control and data acquisition (SCADA), and a motor control center (MCC) for the SBR system.

Based on a limited review of the facility plan, design drawings and specifications, the design appears to be workable and constructable. If this option was chosen, a full engineering review of the drawings and specifications would need to be completed, as well as a complete NYS Building Code Review. Items noted during the cursory review, that could be considered during the pre-construction phase of the project include, but are not limited to, possible relocation of the main pump station wetwell to allow

for less complicated construction, limiting the paved driveway and parking areas as a project cost savings, and adding components to the SBR design to allow for better operator flexibility.

See Exhibit 9.2.a.A, Drawing PR-1 Process Schematic by Delaware Engineering, PC.

(A review of other alternatives follows with a section on Preliminary and Primary Treatment, a section on Secondary Treatment, and a section on Tertiary Treatment.)

9.2.b. Preliminary Treatment and Primary Treatment

With a conventional gravity sewer collection system, preliminary treatment consists of a combination bar screen/communitor unit to remove the trash and large debris from the wastewater to protect pumps and other equipment. The unit would include a bar screen bypass at its entry point. A six inch deep gravel pit would be constructed upstream to protect the bar screen/comminutor unit from grit. The bar screens prevent the large debris from entering the wastewater plant, and the communitor grinds the material that passes through the bar screen into smaller particles so that it can pass through the remainder of the treatment system.

The prefabricated steel bar screens and comminutor are sized based on the design peak hourly flow. In case of a major blockage of the main bar screen channel, an overflow trough would be provided to allow bypassing to an inclined bar screen. The clear openings between bars would not exceed 1-3/4 in., and the screen channel invert would be 3 to 6 in. below the invert of the influent piping. The comminutor would be supplied with an automatic reversing feature for mechanical cleaning. Guard rails and removable deck gratings would be provided to protect personnel from accidental contact with moving parts.

For the Orenco and SeptiTech Options, a septic tank like structure will be installed instead of the bar screen/comminutor and grit removal chamber. For the MBR System, an additional fine screen will be installed to protect the membranes. These systems are described in their respective sections below.

9.2.c. Secondary Treatment

9.2.c.i. Membrane Bioreactors (MBR)

A Membrane Bioreactor (MBR) is a high mixed liquor suspended solids (MLSS) activated sludge process equipped with an integral solid-liquid separation mechanism. The high mixed liquor suspended solids (MLSS) levels

lead to high removal of BOD_5 and ammonia. MBR plants typically operate at a MLSS of 8,000 to 15,000 mg/L. Operating at a higher MLSS allows for a smaller footprint of the tanks to achieve a similar sludge retention time (SRT) as other traditional activated sludge processes. The integral solid-liquid separation mechanism is a membrane through which the treated water passes, leaving the solids behind. There are two membrane types: hollow fiber and flat sheet.

Hollow fiber membranes consist of many individual spaghetti-like membrane fibers. Membrane fibers are grouped to form a module, and the modules are aligned to form a cassette. Each cassette has a permeate header that applies a low pressure vacuum on the hollow membrane fibers. Permeate is drawn through the pores of each membrane fiber into its hollow center to the permeate header.

Alternatively, flat sheet membranes consist of a number of sheets over which the membrane is attached. The membrane sheets are aligned with a small space between each sheet to form a cassette (also referred to as an element or a unit). Similarly, each cassette has a manifold that draws permeate through the pores of each flat sheet membrane.

Coarse bubble diffusers located under the membrane cassettes supply air to scour the membranes and provide additional oxygen for BOD removal. GE Water and Process Technologies manufacture hollow fiber MBR systems with a porosity of 0.04 microns, Kruger manufactures a flat sheet MBR system with a porosity of 0.08 microns and Ovivo (formerly Enviroquip) manufactures a flat sheet MBR system with a porosity of 0.2 microns, but with an effective porosity of less than that when the biofilm is considered. See Exhibit 9.2.c.i.A, Membrane Bioreactor (MBR) WWTP Process Flow Schematic.

Fine Screen and Splitter Box: Two fine screens, one operating and one on standby, is provided to remove particles larger than 2-3 mm from the waste stream as it flows to the anoxic tanks (GE requires a 2 mm screen; Kruger and Ovivo allow a 3 mm screen). The screenings are automatically cleaned and dumped into a receptacle for proper disposal. After the fine screen, the splitter box splits the flow between the MBR treatment trains.

Anoxic Tank/Swing Tank. The biological treatment portion of the MBR system consists of both anoxic (without oxygen) and aeration (with oxygen) zones. However, the anoxic tanks are fitted with fine bubble air diffusers and can be utilized as an additional pre-aeration zone. Therefore anoxic tanks are also referred to as swing tanks because they can operate either with or without aeration. When used as anoxic tanks, they convert nitrate nitrogen to atmospheric nitrogen via the biological process known as denitrification.

Along with converting the nitrate nitrogen to atmospheric nitrogen, the denitrification process provides pH stabilization, because the denitrification process produces alkalinity that is later lost to the nitrification process. Denitrification occurs when there is insufficient oxygen available for the aerobic bacteria to convert carbonaceous BOD to carbon dioxide and water. Under this condition, bacteria use oxygen from nitrates to convert the BOD. The end product is the release of elemental nitrogen to the atmosphere.

Recirculation pumps are used to transfer mixed liquor from the membrane tanks to the anoxic tanks at a rate of approximately four times the influent flow. In addition to the diffusers, bottom mixers will also be installed to keep the MLSS in suspension when the tank is being used strictly as an anoxic zone. Aluminum sulfate (Alum) is added to the anoxic tanks to remove phosphorus from the wastewater. Alum reacts with phosphorus to form an insoluble precipitate that will be discharged along with the excess solids to the sludge holding tank. Alum will be added to the anoxic tanks using two chemical feed pumps, one operating and one on standby.

Pre-Aeration Tanks. Two pre-aeration tanks are provided to reduce BOD and to oxidize ammonia nitrogen in the wastewater to nitrate nitrogen. Two blowers, one operating and one on standby, are provided to supply the air to the fine bubble diffused aeration system that supplies the required oxygen and the mixing needed.

Membrane Tanks. Two membrane tanks are provided, adjacent to the pre-aeration tanks, to house the membrane cassettes. The treated wastewater is pulled through the membranes via two permeate pumps; the membranes separate the solids from the liquid in the wastewater resulting in a TSS concentration of 5 mg/L or less. Two blowers, one operating and one on standby, provide coarse bubble aeration that periodically scrubs the solids from outside of the membranes to reduce plugging.

The MLSS are retained in the system for a sufficiently long time to allow for growth of the nitrifying bacteria that reduce the ammonia to nitrate. The nitrification process uses alkalinity in the wastewater, thus reducing the pH. This is counterbalanced by the denitrification process that produces alkalinity and raises the pH. Solids, including organics, bacteria and most viruses are rejected by the membrane system and retained in the mixed liquor, which is then returned to the splitter box and fed back into the anoxic tank.

Membrane Cleaning. Membrane cleaning is accomplished differently for hollow fiber and flat plate membranes.

Flat sheet membranes are continuously scoured by the air bubbles from coarse diffusers. Periodically, a chemical clean in place (CIP) is required to prevent

organic and inorganic fouling of the membranes. This procedure is automated and is operator adjustable. A CIP is conducted approximately two times per year by injecting, a dilute solution of sodium hypochlorite onto the membranes. The cleaning solution remains in the membranes for one to three hours. Permeate is then sent to the head of the plant, the cycle is repeated approximately two more times, and then normal operation is resumed. One to two times per year, the membranes are also cleaned using dilute oxalic acid or citric acid in the same manner as the sodium hypochlorite is used. The sodium hypochlorite removes the organic matter and the oxalic acid or citric acid removes the inorganic matter, e.g., calcium, on the membranes. Changes in the trans-membrane pressure (TMP) are monitored over time by the operator to determine if an additional CIP is needed.

Hollow fiber membranes are also continuously scoured with coarse bubble diffusers, and require periodic CIP. Additionally, maintenance cleaning is required two times per week and allows for a steadier TMP. This process takes approximately 40 minutes. Additionally, hollow fiber membranes can backpulse, i.e. force flow in the reverse direction through the membrane pores to aid in cleaning.

Permeate Collection System. Flow through the plant is regulated using variable frequency drive (VFD) permeate pumps. Permeate pump speeds are changed to match variations in flow. This control strategy allows the membranes to operate at lower flux rates during low-flow conditions, overcome fouling in between CIP cleanings, and also handle peak flows. Control of the pumps is carried out using a programmable logic controller (PLC). The PLC is programed to adjust the permeate pumps motor speeds up or down based on influent flow rate.

The MBR system would consist of two treatment trains each designed to treat 100% of the maximum day flow, including the peak hour flow for 4 hours out of the 24 hours in a day. The MBR's are designed in this manner to match the NYCDEP requirements for microfiltration units (see Section 9.2.d.ii below). Thus the MBR system provides all filtration required and no further filtration units are needed.

See Exhibit 9.2.c.i.A, Membrane Bioreactor (MBR) WWTP Process Flow Schematic and Exhibit 9.2.c.i.B, Membrane Bioreactor (MBR) Manufacturer's Information

9.2.c.ii. SeptiTech System

The SeptiTech treatment system consists of multiple treatment trains of SeptiTech's Processing Tanks oriented in a series configuration. Each SeptiTech Processing Tank can treat up to 5,000 gpd of wastewater flow. The

processing modules and all associated tankage are precast concrete tanks that are delivered to the site for installation. The tanks are installed below grade, eliminating the need for a building to cover the treatment system.

Primary Collection Tank: Wastewater from the collection system flows to a primary collection tank. The primary collection tank provides primary settling of the raw sewage and equalization of peak flows.

Flow Splitter: Wastewater from the Primary Collection tank flows into a flow splitter to evenly split the wastewater between the processing trains. Gate valves or weir plates are provided on each feed line to allow for isolation of any trains in order to allow for flow fluctuations or to put a system offline for maintenance purposes. The flow splitter should be accessible in order to allow for adjustments to be made in the case of unbalanced flow to each train.

Septic Tanks: Wastewater from the flow splitter is directed to septic tanks at the head of each treatment train to remove solids and provide a biosolids pump-back vessel for the processing train. Each septic tank is sized at 15,000 gallons.

SeptiTech Processor Tanks: Wastewater from each septic tank flows to each processing system. The wastewater is treated using a trickling filter technology. The treatment process is aerobic and requires that multiple air intake snorkels be installed above grade to allow oxygen to enter the system. Sludge that sloughs off the trickling filter media is automatically pumped back to the septic tank for settling by sludge collection pumps located on the bottom of the SeptiTech processor tanks. The final processer in each train pumps the treated wastewater to downstream treatment systems.

Because the treatment system is aerobic and requires that outside air be drawn into the system, any air that is drawn in must also be displaced out. Therefore, designated air vents are installed on the first processor of each train to allow for venting of the system. In addition, a designated vent is also recommended coming off of each septic tank.

Controls: The SeptiTech treatment system is operated using multiple control panels. The control panel is equipped with a telemetry system in order to allow for offsite diagnostics and for alarm notification.

For the Original Proposed Sewer District Maximum Month Flow of 162,000 gpd, the treatment system would be comprised of twelve (12) treatment trains with each train consisting of one (1) septic tank and three (3) treatment modules. The SeptiTech treatment system is designed to treat Maximum Month Flow utilizing eleven (11) treatment trains, allowing for one (1) train at a time to be taken off line for service. For the Alternative Service Area

Maximum Month Flow of 100,000 gpd, the treatment system would be comprised of eight (8) treatment trains, allowing any one (1) train to be taken out of service.

See Exhibit 9.2.c.ii.A, Packaged WWTP Process Flow Schematic and Exhibit 9.2.c.ii.B, SeptiTech Treatment System Manufacturer's Information

9.2.c.iii. Orenco System

Orenco's Advantex-MAX treatment is a multiple-pass attached-growth packed bed filter system. The Advantex-MAX is a fiberglass basin filled with an engineered textile material. The process is similar to a recirculating sand filter (RSF), except that instead of a sand bed, the wastewater trickles over strips of synthetic textile media that hang vertically in the fiberglass enclosure. The textile media has a large surface area and void volume (for free flow of oxygen). Because of this, application rate over the media is approximately 25 gpd/sf, making the foot print of the system small when compared to an RSF. Wastewater percolates both through and between the textile media. The synthetic fabric supports more biomass per cubic foot than a sand filter, and because the fabric is suspended in air, more oxygen is available to the aerobic micro-organisms. Ventilation fans are used to keep fresh air moving through the treatment pods. Within the filter, aerobic conditions exist that allow for microbes to convert ammonia to nitrate (nitrification). BOD and TSS reductions occur as the wastewater trickles over the media. A visible biological film normally develops on the filter media within a few days of system start-up. The fiberglass enclosures are installed below grade, eliminating the need for a building to cover the treatment system.

The Orenco Advantex-MAX treatment system is designed to treat the Maximum Month Flow utilizing multiple treatment units. The treatment system design includes redundancy, allowing for one first stage and one second stage unit at one time to be taken off line for service while diverting flow to the remaining units.

Processing Tank: Influent wastewater from the collection system flows into a processing tank. The processing tank functions as a septic tank and collects solids. Flow from the processing tank enters two recirculation tanks connected in series. These tanks serve as recirculation and dilution tanks for the Advantex units.

Recirculation Tanks: The recirculation/dilution tanks contain diluted wastewater, which has already passed through the Advantex units. The recirculation ratio is the ratio of the flow returned to the recirculation tank to the influent wastewater flow. Recirculation establishes equilibrium with respect to the desired endogenous respiration rate by maintaining food-to-

microorganism (F/M) ratios relative to influent hydraulic and biological loads. A usual design recirculation ratio is between 3:1 and 5:1.

Stage 1 Advantex-MAX Units: Pumps in the recirculation tanks transport wastewater onto the textile media in the Advantex-MAX treatment tanks. Several Advantex units are required. As the wastewater percolates through the textile media in the units, bacteria colonizing on the media digest organic material contained in the wastewater and trap inorganic solids. Small doses of effluent ensure that the void spaces between the fibers are not filled with water to allow for passive oxygen transfer. Some flow from the first stage Advantex units is returned to the recirculation/dilution tanks and some flow is pumped to the second stage Advantex units for additional treatment.

Stage 2 Advantex-MAX Units: Effluent from the first stage Advantex-MAX units is pumped onto the textile media in the second stage Advantex-MAX units. Multiple second stage units are required. Effluent from the second stage is returned to the recirculation tank from where it is discharged to downstream treatment processes.

For the Original Proposed Sewer District Maximum Month Flow of 162,000 gpd, the treatment system would be comprised of three (3) upfront recirculation tanks in series, followed by sixteen (16) Stage 1 Adventex-MAX units in parallel, followed by four (4) Stage 2 Adventex-Max units in parallel. For the Alternative Service Area Maximum Month Flow of 100,000 gpd, the treatment system would be comprised of three (3) upfront recirculation tanks in series, followed by twelve (12) Stage 1 Adventex-MAX units in parallel, followed by three (3) Stage 2 Adventex-Max units in parallel.

See Exhibit 9.2.c.ii.A, Packaged WWTP Process Flow Schematic and Exhibit 9.2.c.iii.A, Orenco Treatment System Manufacturer's Information

9.2.c.iv. Constructed Wetlands

As early as 2003, the Town of Shandaken expressed interest in the option of utilizing constructed wetlands as the secondary biological treatment process in its wastewater treatment system. NYCDEP responded on November 20, 2003 with a letter outlining its requirements for constructed wetlands within its watershed. See Exhibit 9.2.c.iv.A, NYCDEP Letter on Constructed Wetlands, 11/20/2003. The NYCDEP requirements are outlined below:

1. Primary settling prior to constructed wetlands bioreactor even if septic tanks serve each property
2. Flow equalization either prior to or within roughing cells of the wetlands
3. Microfiltration or equivalent after the secondary treatment

4. Phosphorus removal to 0.5 mg/l whether preceding surface or subsurface discharge
5. UV disinfection
6. Sludge treatment
7. Constructed reed bed wetlands need 50% redundancy but would meet sand filtration requirement because of the similarity in construction to open intermittent sand filters with enhanced treatment
8. The maximum hydraulic application rates will be 2 gpd/ft^2 total where secondary treatment is intended or will be 1 gpd/ft^2 total where nitrification is intended, but NYCDEP would be open to proof of successful higher loading rates from similar constructed wetlands
9. Downstream units must be sized to include provision for infiltration into and precipitation onto the wetlands
10. Ulster County Department of Health (UCDOH) and New York State Department of Environmental Conservation must also approve.

After the property owners within the proposed sewer district defeated sewer district creation in the permissive referendum of February 2, 2007, the Town of Shandaken requested permission from NYCDEP to use project funds to engage an engineering consultant to complete a Preliminary Engineering Report on the feasibility of a Vegetated Sand Bed (VSB) constructed wetlands wastewater treatment plant. NYCDEP confirmed its approval of this request and indicated that its review of the preliminary report was underway in a letter dated November 7, 2008.

Subsequently, the Preliminary Design Report, Vegetated Sand Bed (VSB) (Top Loading Vertical Flow Submerged Bed Wetland) Wastewater Treatment for the Hamlet of Phoenicia dated October 23, 2008 and revised January 29, 2009, was developed by New England Waste Systems (NEWS-USA), Inc. and Rennia Engineering Design, PLLC. The NEWS-USA/Rennia proposal was based on an average daily design flow of 150,000 gpd and a peak hourly flow of 550,000 gpd. Their design included primary clarification tanks which would also double as digesters in a batching mode, 12 wetlands cells with a total of 151,000 ft^2 (3.5 acres) surface area, a 2-foot effective depth, a 3-day "treatment time" (or "hydraulic retention time"), an effective hydraulic loading rate of 2 gpd/ft^2, and providing 100% redundancy, followed by upflow sand filters for microfiltration equivalence, and disinfection by ultraviolet light (UV) and post aeration. The predicted effluent quality was:

BOD_5	$\leq$5 mg/l
TSS	$\leq$ 5 mg/l
Dissolved O_2	$\geq$ 7 mg/l
Phosphate	0.1 mg/l
Ammonia	<1 mg/l

The report included a descriptive discussion of the science of wetlands treatment biology and cited several books and papers as well as results from existing constructed wetlands wastewater treatment systems. The report predicted that the WWTP construction and additional land would cost about $5.7M or nearly equivalent to a conventional system. Soft costs such as administration, legal, and engineering were not presented. The Operation and Maintenance costs were estimated at $177,330 per year or about half that of the conventional system.

NYCDEP engineering review of the report went through several cycles of written comments followed by resubmissions by NEWS-USA/Rennia during the period of October 2008 through June 10, 2009 when NYCDEP wrote to the Town of Shandaken to indicate its concerns about the proposal and its decision not to "support further expenditures in researching this technology." See attached Exhibit 9.2.c.iv.B, NYCDEP Letter Withdrawing Support of Constructed Wetlands Option, 6/1/2009.

NYCDEP's primary concerns were:

1. The lack of documentation from suitably comparable VSBs operating in similar climates
2. The use of hydraulic retention time as a design basis versus the surface area requirements established by NYCDEP in its November 10, 2003 letter of 2 gpd/ft^2 for secondary treatment and 1 gpd/ft^2 for nitrogen removal (the NEWS-USA/Rennia deign based on HRT was equivalent to 2 gpd/ft^2 but indicated significant and adequate ammonia and phosphorus removals).
3. The innovative use of common tanks for primary clarification and digesting with no documentation from other facilities using that configuration.

(The NYCDEP letter of 6/1/2009 also expressed support for Membrane Bio-Reactor (MBR) technology for the Phoenicia WWTP based in part on a change in NYCDEP policy for MBR wastewater treatment plants. Since the MBR is a membrane filter technology, NYCDEP no longer requires sand filtration and membrane filtration following an MBR. This policy change significantly reduces the capital cost of an MBR WWTP in the NYC Watershed).

The Lloyd, NY documentation given by NEWS-USA/Rennia actually did show failures by that constructed wetland to consistently meet the proposed Phoenicia permit limitations for ammonia and nitrogen (1.1 mg/l June through October and 2.2 mg/l November through May for ammonia, 0.5 mg/l for Total Phosphorus), and were from a plant designed for 10,000 gpd and receiving only 2,000 gpd. According to the design engineer, that facility is now being expanded and rehabilitated to treat new sources of wastewater but with different design concepts.

Clearly, interest in the constructed wetlands technology is based primarily on the significant potential for lower operation and maintenance costs associated with a much lower energy use.

Because of the Town's interest in constructed wetlands and reducing Operations and Maintenance costs, Lamont Engineers has attempted to find documentation of performance from suitably comparable constructed wetlands operating in similar climates. Utilizing the NYSDEC database on municipal wastewater plants, only nine (9) were found that utilize artificial wetlands. One of those was the plant in Lloyd (T) that NYCDEP had already visited and reviewed as part of their review of the NEWS-USA/Rennia proposal for Phoenicia. Of the other eight (8) municipal facilities in NYS utilizing artificial wetland, only one (1) is using artificial wetlands as a major secondary treatment bioreactor. This is the Village of Minoa, NY Facility. The others use them in various ancillary, mostly tertiary, treatment roles.

Lamont Engineers visited the Village of Minoa Wastewater Treatment Facility on March 31, 2011 to get information on a constructed wetlands plant that reportedly is achieving very good treatment results. See Exhibit 9.2.c.iv.C, Minoa Wetlands Visit E-mail Report, for a report on the site visit.

Effluent data from the wetlands in Minoa is attached as Exhibit 9.2.c.iv.D, Wastewater Treatment Data Minoa (V) Constructed Wetlands. This data demonstrates the definite secondary treatment level achieved by the Minoa constructed wetlands bioreactor. However, though the wetlands achieve significant removals of ammonia and total phosphorus, the ammonia and phosphorus concentrations in the effluent would not meet the discharge limits for Phoenicia, and therefore a facility incorporating constructed wetland as its secondary treatment option would need additional unit processes for ammonia and phosphorus removal.

As NYCDEP observed in its review of the earlier Phoenicia wetlands proposal, proof of consistent tertiary treatment levels of nutrient removals for constructed wetlands has not been offered or found.

Lamont Engineers presented the preliminary conclusions outlined above at a Town of Shandaken Board meeting on May 2, 2011. Members of the public continued to express support for a constructed WWTP and specifically asked that the system at the Omega Institute and wetland systems outside New York State be researched, presumably to find examples of wetlands that could meet the needs of Phoenicia. Whether or not an example of a successful wetland would constitute proof that a wetlands could succeed in Phoenicia, despite the examples in New York State to the contrary, was not mentioned or addressed at the meeting, but of course is critical, especially to regulatory approvals.

Nonetheless, Lamont reviewed website information on the Eco-Machine at Omega Institute, and contacted Stantec Engineering, a large consulting firm who is now the owner of North American Wetlands Engineering (NAWE), a company with extensive experience in engineered wetland design and construction, about constructed wetlands for sanitary wastewater treatment outside of NYS.

The Omega Institute uses a 52,000 gpd Eco Machine when the campus is open from April to October. In the off season the flow to the Eco-Machine wetlands is 5,000 gpd. On the Eco-Machine Answers link FAQ sheet, the company clearly state that the systems need to be kept at about 50°F (10°C) to work properly. The systems are housed in greenhouses. For the wetlands proposed for Phoenicia by NEWS-USA/Rennia, capital costs were judged to be equivalent to conventional treatment. The addition of green houses would add to the capital cost and heating would add to the O&M cost. Phoenicia wastewater is anticipated to reach temperatures as low as 6°C to 7°C (43°F to 45°F) during the winter months. The Eco-Machine cannot be seriously recommended for Phoenicia in lieu of a simple stone or sand media submerged wetlands like that proposed by NEWS-USA/Rennia and rejected by NYCDEP.

Lamont Engineers contacted Rick Wagner, formerly of NAWE and now a Principal with Stantec Engineering for information on constructed engineered wetlands. See Exhibit 9.2.c.iv.E, Forced Bed Aeration™ by North American Wetlands Engineering (NAWE) for the information provided by Rick Wagner. In response to our further inquiries, regarding Phoenicia, Rick Wagner stated as follows:

> *"I have reviewed the effluent limits for the hamlet. These limits are not possible out of a wetland. Consistent BOD's out of a wetland are typically in the 10-15 range, fecals less than 200 can only be achieved with disinfection (UV or chlorine) and a phosphorus of 0.5 is not achievable. An MBR is really the only way to get these results."*

See Exhibit 9.2.c.iv.F, Email Communications from Rick Wagner, Principal at Stantec Engineering.

Given the large wetlands that would be required for Phoenicia's design flow, the attendant need for more land, and the need for additional unit processes for primary clarification, phosphorus removal, ammonia removal, and microfiltration or equivalent, the constructed wetlands option is highly unlikely to be preferable to a MBR WWTP in terms of capital cost, land requirements or treatment performance. Constructed wetlands would at this point in time represent an innovative and experimental design with more risk of problems and failure than a more conventional design. Furthermore, based on all of the above information, a constructed wetland WWTP for Phoenicia would clearly not be approvable.

Therefore, a constructed wetlands wastewater treatment plant cannot be recommended for Phoenicia. However, constructed wetlands may have a place in an innovative and experimental wastewater treatment plant as discussed in section 9.2.g of this report.

9.2.d. Tertiary Treatment

9.2.d.i. Tertiary Sand Filters

In most conventional treatment plants located in the NYCDEP Watershed, effluent from the secondary treatment system would flow to the sand filter lift station for distribution to the Tertiary Sand Filters. However, in the case of MBR's, tertiary sand filtration is not proposed. This is because the membrane cartridges have an porosity of 0.2 microns or less depending on the manufacturer, as described in Section 9.2.c.i above, much smaller than the porosity of tertiary sand filters. In an MBR system, aluminum sulfate (Alum) is added to the anoxic tank to remove the phosphorus from the wastewater.

Rapid Sand Filters will be required for the Orenco WWTP option and the SeptiTech WWTP option. Effluent from the secondary treatment system will flow to the sand filter lift station. Two sand filter pumps, one operating and one on standby, will pump the wastewater to the sand filters. The filters will be sized to meet the 1988 NYSDEC Standards loading rate limit of 3 gpm/ft^2 at the peak hourly flow; in this case, the peak hourly flow will be the Maximum Day Flow due to equalization.

For the Orenco and SeptiTech Options, effluent from the rapid sand filters will be discharged to a clearwell. Two backwash pumps in the clearwell will use the clean water to backwash the sand filters as necessary. Two pumps, one operating and one on standby, will pump the filtered wastewater to the microfiltration system. Alternatively, if continuous backwash upflow filters

(CBUFs) are used the effluent will flow directly to the microfiltration system feed tank.

9.2.d.ii. Microfiltration

One of the primary directives of the Watershed Rules and Regulations mandates the use of microfiltration prior to any surface water discharge to act as a barrier to giardia lamblia cysts, cryptosporidium oocysts, and enteric viruses. Microfiltration is defined by the Watershed Rules and Regulations as a filtration media or membrane having a maximum nominal pore size of 0.2 microns. The microfiltration unit proposed would have a membrane size of 0.1 microns. The general requirements of membrane filtration include the following:

- The system shall be provided in modules and shall consist of a minimum of two identical units
- The system shall be able to handle peak hydraulic flow with one unit out of service (if equalization is not provided)
- The filtrate quality shall remain constant irrespective of variable feed characteristics
- Reject materials and backwash shall be returned to the plant for further treatment
- The additional hydraulic load due to reject and backwash water returned to the plant shall not affect the performance of the treatment processes
- The system shall be provided with integrity testing capability
- The process shall not elevate the wastewater temperature

The microfiltration membranes contain pores small enough to retain fats, oil, grease, suspended solids, some surfactants, bacteria, enteric viruses, cysts, colloids, pigments, metal hydroxides, and other sub-micron materials. Water, low molecular weight dissolved solids, and particulate matter less than 1 micron in size (the “permeate”) pass through the membrane.

In a traditional microfiltration system, a film will build up on the membranes. To help alleviate this problem, the microfiltration system is set to automatically backwash at a pre-set operating interval (typically every 20-30 min.). The reverse filtration feed water is stored in a pressurized storage tank and upon the signal to backwash, the feed pumps shut down for about 90 seconds and the water from the reverse filtration tank flows in the reverse direction through the microfiltration modules, removing the surface contamination.

In addition, the micro-filter units will incorporate an air scrub sequence that periodically (every 20 to 30 minutes) agitates the fibers and dislodges solids. The feed flow is shut off and air is introduced through the feed line to the outside of the membranes. When air flow is stopped, feed water is used to flush the outside surface of the fibers and remove debris that was loosened from the membrane surface. The air scrub occurs simultaneously with the reverse filtration phase. The backwash and air scrub solids are discharged to the head of the plant for treatment. Periodically, the membranes are cleaned with sodium hypochlorite and citric acid to remove both organic and inorganic deposits. The clean-in-place (CIP) waste is discharged to a CIP waste holding tank. The plant operator uses this tank to neutralize the CIP waste before discharging to the head of the plant.

While the unit is backwashing, no wastewater can flow through the system; therefore, the microfiltration pumps would be interlocked to shut off while the unit is backwashing.

In the case of MBR's, a subsequent microfiltration system is not proposed. This is because the membrane cartridges have an porosity of 0.2 microns or less depending on the manufacturer, as described in Section 9.2.c.i above, thereby meeting the requirements of microfiltration as defined by the Watershed Rules and Regulations. The MBR system would be designed to handle peak hour flow for 4 hours out of a 24 hour period.

For the Orenco WWTP and the SeptiTech WWTP options, the microfiltration units will either be pumped to from a post sand filtration clearwell, or in the case of continuously backwashing upflow sand filters (CBUF), will be fed by gravity directly from the sand filters.

9.2.d.iii. Disinfection/Dechlorination

After microfiltration, the effluent must be disinfected to destroy any remaining coliform bacteria in the wastewater. If chlorine is used for disinfection, the wastewater must be dechlorinated to reduce the residual chlorine to acceptable permit limits. Chlorination/dechlorination requires two chemical feed pumps each and the controls for each plus the chemical storage area and chlorine contact tank.

Given the complications attendant with using chlorination/dechlorination, ultraviolet (UV) irradiation is recommended. UV disinfects by destroying the ability of microorganisms to reproduce, i.e. the microorganisms are rendered inactive and therefore unable to cause disease.

To satisfy the redundancy requirement, two units in series would be installed. The unit comes with a monitoring system that provides instantaneous readings

of the UV intensity and the elapsed time of the actual hours of operation. The system would be installed inside the treatment building.

9.2.d.iv. Post Aeration

Post-aeration is needed to meet the SPDES discharge limit of 7 mg/L of DO in the effluent. Air would be provided by two blowers, one operating and one on standby, to a coarse bubble diffuser located in the post-aeration tank, which provides 20 SCFM/1,000 gal of capacity. The detention time provided in the post-aeration tank would be greater than 30 minutes required at maximum day flow.

9.2.e. Solids Handling

Solids management will depend on the selected secondary treatment process. For SBR, MBR, and constructed wetland treatment, solids handling is similar. SBR and MBR treatment entails handling secondary waste activated sludge (WAS); wetland treatment entails handling primary sludge from the primary clarifier. For these three treatment options, sludge would be wasted to a digester. For Orenco and SeptiTech treatment, no aerobic digestion or dewatering equipment would be provided. These two options entail pumping septic tank solids from the upfront processor tank (for Orenco) or septic tanks (for SeptiTech) and transporting to a septage receiving station at a nearby WWTP. A pump and haul schedule would be developed over time with operation of the WWTP.

9.2.e.i. Anaerobic Digestion

In some cases, anaerobic digestion can be an alternative to aerobic digestion. As with aerobic digestion, anaerobic digestion involves biological degradation of organic material, however, in the absence of oxygen.

Biochemically, anaerobic digestion is a relatively complex process. Three types of chemical and biochemical reactions occur in anaerobic digestion: hydrolysis, fermentation, and methanogenesis. During hydrolysis, complex organics are broken down into soluble organics; fermentation converts soluble organics to organic acids, and methanogenesis converts organic acids to methane gas and carbon dioxide. Each step involves several biochemical reactions producing intermediate compounds.

The typical operating temperature for most anaerobic digesters is 95 degrees Fahrenheit. Heating is most often accomplished by circulating sludge through external heating systems. Adequate mixing is important to ensure that temperature is relatively consistent throughout the reactor. Mixing can be accomplished by recirculating biogas into the digester, mechanical mixing, or

recirculating sludge into the digester. The hydraulic and solids retention time in an anaerobic digester is based on desired volatile solids destruction and design organic loading rates. Typical organic loading rates are in the range of 0.12 to 0.16 lb volatile solids / cu ft / d, and solids retention time is typically at least 15 days. Anaerobic digestion produces an effluent containing between 4-7% solids. The solids from the anaerobic digester would be pumped to a filter press for daily dewatering. The anaerobic digestion process produces biogas containing approximately 65% methane and 25% carbon dioxide. Methane gas can be used for heating the digester, and excess biogas can be used for other heating requirements or to produce electricity at the WWTP.

Preliminary anaerobic digester sizing and biogas production calculations were performed to determine if anaerobic digestion would be economical compared to aerobic digestion. It was determined that the yearly average heating requirements of the anaerobic digester alone were greater than the heating value from the produced biogas. This is due to the relatively small scale of the system compared to systems at larger WWTPs. The mass of the sludge at large 5-10 MGD (1 MGD equals 1,000,000 gpd) WWTP's works in their favor to maintain the required heat. A much larger quantity of sludge than would be produced at the Phoenicia WWTP would need to be fed to the reactor for the system to produce enough biogas to heat boilers or produce electricity at the plant. Given the lack of biogas available for beneficial re-use coupled with the higher capital cost and complexity of the system, anaerobic digestion at this scale is not recommended.

9.2.e.ii. Aerobic Digestion

Aerobic digestion serves to stabilize and thicken the sludge, reduce odor, reduce the amount of biodegradable solids, and improve the sludge dewaterability. The process involves the removal of the residual BOD by the organisms and the oxidation of the microbial cellular material itself. The latter process is called endogenous respiration, the principal process of aerobic digestion. Stabilization is not complete until an extended period of endogenous respiration has occurred, usually 15 to 20 days. The covered aerobic digester is fitted with a mixer and diffusers to supply sufficient air and mixing to keep the solids in suspension. An aerobic digester is relatively simple to operate and construction is less expensive than anaerobic digestion. Alum can be added to the digester using a chemical feed pump to ensure that the phosphorus in the solids that may be released during the digestion process is removed as alum sludge, rather than being decanted back to the head of the plant. The digestion process reduces the volume of solids by approximately 40%. Decant from the digester is removed using telescoping valves and piped to the head of the plant. Digested sludge is pumped to the filter press for daily dewatering.

9.2.e.iii. Pump and Haul Liquid Sludge vs. Onsite Sludge Dewatering

An alternative to sludge dewatering on-site is hauling liquid sludge. Sludge would be pumped from an aerated sludge holding tank and hauled to a nearby WWTP. Costs to haul liquid sludge are currently $0.15 to $0.20 per gallon of sludge. This equates to approximately $0.50 / gpd design flow / year.

For sludge dewatering on-site, digested sludge would be pumped from a digester to a plate and frame or belt filter press for daily dewatering. The press would be sized for one or two batches of sludge to be processed per day. Processed sludge (cake) would be discharged to a roll-off container that is hauled away by a refuse hauler and land-filled. Landfills typically require a minimum 20% solids content in the cake. Operation and maintenance cost of a plate and frame filter press (including chemical usage, electricity, sludge cake disposal, and spare parts) is approximately $0.22 / gpd design flow / year. Since this is less than half the liquid sludge hauling cost calculated above, on-site dewatering is recommended.

9.2.e.iv. Selection of Sludge Processing and Handling Facilities

Based on the above, it is recommended that the MBR WWTP alternatives be designed with an aerobic digester. Aerobically digested sludge would be pumped to a plate and frame filter press for dewatering. Plate and frame presses are preferred over belt presses because they can produce a sludge cake with a much higher solids content than a belt filter press. A sludge cake with a higher solids content will reduce the operation and maintenance cost of hauling. Dewatered solids would be hauled to a landfill that accepts dewatered sludge.

9.2.f. Conveyance to Existing Wastewater Treatment Plant

An alternative to treating the Hamlet of Phoenicia's wastewater is to pipe it to an existing treatment plant nearby. This option would require a sewer district and collection system as previously described in Section 7.3.d. In addition, it would require a large pumping station, an equalization tank and several miles of piping to convey the sewage to the neighboring WWTP.

As discussed in Section 7.3.d. above, a possible option for conveyance to a neighboring community's wastewater system is to convey the Hamlet of Phoenicia's wastewater to the NYCDEP owned Pine Hill Wastewater Treatment Plant (WWTP).

The Pine Hill WWTP is located about 10 miles upstream of the Hamlet of Phoenicia and sits approximately 500' higher in elevation. Because of the significant elevation difference, a large pumping station and a booster pump

station will be required to pump the sewage from Phoenicia to Pine Hill. The booster pump station would need to be located at a point approximately ½ the elevation difference between the inlet and discharge points from the force main. Conveniently, the Hamlet of Shandaken is equidistant, both horizontally and vertically between the Hamlet of Phoenicia and the Pine Hill WWTP. Each pumping station would be provided with storage tanks so that flow could be diverted to the storage tank during repairs and maintenance of the force main or in times when high flows at the Pine Hill WWTP would dictate that flow from Phoenicia would need to be halted until flows recede at the Pine Hill WWTP.

See Exhibit 9.2.f.A, Preliminary Hydraulic Calculations and Pump Manufacturer Information.

The 10 miles of force main from Phoenicia to Pine Hill would generally follow the NYS Route 28/railroad ROW corridor. Additional work would be necessary to determine the availability of the railroad ROW. The pipe material would be high density polyethylene (HDPE). HDPE pipe can handle the working pressures that will exist within the force main and which can be installed with a trenching machine or by directional drilling in almost any soil or rock.

However, an evaluation of the Pine Hill WWTP shows that it currently does not have the capacity to accept wastewater from the Hamlet of Phoenicia. The Pine Hill WWTP has a SPDES permit limit of 500,000 gpd. The flows being received currently or that NYCDEP has agreed to accept at Pine Hill WWTP in the future are as follows:

Hamlet of Pine Hill (current flow)	160,000 gpd
Pine Hill Sewer Extension (design flow)	11,575 gpd
Belleayre Mountain Ski Resort (current flow plus future obligations)	60,000 gpd
Crossroads (future obligation)	195,000 gpd
Total Flow Obligations =	426,575 gpd

In an Agreement in Principal signed by NYSDEC, Crossroads, and numerous other parties, NYCDEP agreed to accept a wastewater flow of 195,000 gpd from the Crossroads Development and additional flow from a proposed Belleayre Ski Center Expansion, should they be constructed. DEP has indicated in writing their intention to abide by the Agreement in Principle when reviewing available capacity at the Pine Hill WWTP. See Exhibit 9.2.f.B, letter from Jeff Graf, NYCDEP Chief, Watershed Lands and Community Planning to Alan Rosa, Executive Director of the Catskill Watershed Corporation.

Comparing the Total Flow Obligations to the SPDES permit of 500,000 gpd, there is only an excess capacity at the Pine Hill WWTP of approximately 73,000 gpd, not enough for either the Original Proposed Sewer District, whose Maximum Month Flow is 162,000 gpd or the Alternative Service Area, whose Maximum Month Flow is 100,000 gpd. There is known infiltration and inflow of groundwater and stormwater in the collection system that serves the Hamlet of Pine Hill. If the problems were corrected, the flow of the Hamlet of Pine Hill would probably be closer to 90,000 gpd, thereby increasing the excess capacity at the WWTP to 143,000 gpd, enough to accommodate the Alternative Service Area.

Furthermore, the Pump to Pine Hill Option for either the Original Proposed Sewer District or Alternative Service Area cannot be completed within the remaining block grant. Therefore, a Pump to Pine Hill Option for the Hamlet of Phoenicia that included the Hamlet of Shandaken (which is Community Number 18 in the Memorandum of Agreement's list of 22 priority communities in need of some form of wastewater treatment and also happens to be next in line to receive funding) and the Hamlet of Chichester (a NYCDEP owned facility located just north of the Hamlet of Phoenicia on NYS Route 214 that currently has subsurface treatment system to treat their flows) was considered, given the possibility of additional NYCDEP funds for inclusion of flows from the hamlet of Shandaken and possibly Chichester.

However, the additional flow from the Hamlet of Shandaken of approximately 26,000 gpd, per the NYSEFC Study completed in 2000 and the flow from the Hamlet of Chichester of 9,900 gpd only make the lack capacity issue at the Pine Hill WWTP even more difficult to overcome.

Given the Town's interest in a Pump to Pine Hill Option, cost estimates and operation and maintenance costs will be explored further in Chapter 10. However, this estimate does not resolve issues of funding and treatment plant capacity for this option.

9.2.g. Innovative WWTP Alternative – Combined MBR and Wetland WWTP

At several Town of Shandaken Town Board meetings over the past year, Shandaken and Phoenicia citizens consistently expressed their very significant concerns about the potential cost of the operation and maintenance (O&M) of any proposed wastewater collection and treatment system. In addition to their general concern about O&M costs of a community wastewater system, some citizens fear the consequences to residents and businesses should New York City's obligations to fund tertiary treatment, as required by the O&M contracts between New York City and the Town and the MOA, ever end.

Many of these citizens have expressed an interest in using innovative approaches to reduce operations and maintenance costs, especially an interest in a constructed wetlands wastewater treatment facility. Yet as indicated in section 9.2.c.iv above, a wetlands WWTP is not approvable by the regulating agencies, partly because data supporting wastewater wetlands may not be available.

In response to the concerned citizens, Lamont Engineers has researched and developed an alternative that incorporates constructed wetlands and Membrane Biological Reactor (MBR) wastewater treatment technology to create an approvable wastewater treatment plant along with treatment options that will provide opportunities for the study and optimization of a constructed wetlands as a secondary treatment system alongside a full capacity MBR wastewater treatment plant. In addition, the innovative plant would incorporate the concept of a biologically enhanced tertiary filtration system (BETFS) i.e. a nitrifying MBR following secondary treatment. This idea is based on a pilot study in the Windham NIP wastewater treatment plant performed by Delaware Operations, Inc. and funded by the New York State Energy Research and Development Authority (NYSERDA). This pilot study indicates a 40% savings in energy use by utilizing a primary clarifier and an upflow sand filter ahead of an MBR that operates as a tertiary nitrifying bioreactor and a microfilter. For Phoenicia, a constructed wetlands would be substituted for the upflow sand filter in the Windham pilot.

A copy of the report funded by NYSERDA can be found in Exhibit 9.2.9.A, Alternative Treatment and Energy Management System Town of Windham Wastewater Treatment Plant, December 2009. See also Exhibit 9.2.9.B, Tertiary Nitrifying MBR Studies for 3 papers describing the use of MBR's as nitrifying MBR's (as the MBR would be used in the Innovative WWTP, when receiving flow from the wetlands).

The engineered wetlands that would be constructed alongside the MBR for the Innovative WWTP Alternative would consist of a primary clarifier, the constructed wetlands and piping configurations to allow flexibility in

operating, studying, and optimizing treatment performance and energy management. The Innovative WWTP Alternative could operate as a conventional MBR plant with capacity for the full design flow by bypassing the primary clarifier and constructed wetlands. The Innovative Alternative could operate as a constructed wetlands wastewater treatment plant with microfiltration by placing the same MBR in a microfiltration status. The Innovative Alternative could operate as a nitrifying MBR like the Windham pilot. And the Innovative Alternative could split flows and operate simultaneously in all three configurations by careful flow splitting so long as the combined effluent meets the SPDES permit limits. This would allow a comparative study of three distinct design and operational approaches. Finally, should NYC obligations to fund tertiary treatment ever end, the wetland would also be there as an alternative to using the MBR. The wetlands would provide the necessary secondary treatment and the system would be setup so that the MBR could be bypassed.

See Exhibit 9.2.g.C, Innovative WWTP Process Flow Schematic.

Stantec Engineering, the company who bought out North American Wetland Engineering, was hired as a sub-consultant by Lamont Engineers to evaluate the engineered wetland treatment component of the Innovative WWTP. Stantec proposed a sub-surface flow (SSF) engineered wetland, consisting of vertically fed wetland cells followed by horizontally fed wetland cells, with the ability to provide aeration to the cells by use of blowers and distribution perforated piping. Adding air to wetlands increases oxidation reactions such as nitrification. Given the stringent discharge standards for the Hamlet of Phoenicia WWTP, Stantec's opinion is that aeration will be necessary to achieve the desired treatment results. However, since the wetlands is a side treatment train to the MBR's in the Innovative WWTP Alternative, the operator of the WWTP could adjust and experiment with the amount of air delivered to the wetlands and MBR systems in order to find the optimal point at which the desired treatment results are achieved with the least amount of electrical power use.

Sub-surface flow (SSF) wetlands treat wastewater as it flows just under the surface of porous materials (substrates) consisting of gravel, sand, rock, or other granular material. Wetland vegetation grows out of the substrate surfaces of the wetland cells. There are two types of SSF wetlands, horizontally fed and vertically fed. As their names imply, with horizontally fed wetlands, wastewater flows horizontally through the substrate; with vertically fed wetlands wastewater flows vertically through the substrate (either downward or upward depending on location of influent and effluent collection pipes).

Wastewater from the primary clarifier is collected in a recirculation tank. Wastewater is pumped from the recirculation tank to the aerated vertical flow wetland cells. These cells provide primary and secondary treatment. Effluent from the vertical flow wetland cells can be recycled back to the recirculation tank or directed to the horizontal flow wetland cells for secondary BOD removal and nitrification. Both the vertical and horizontal flow constructed wetlands has been designed with a hydraulic loading of 3 gpd/ft^2. After passing through the horizontal flow cells, effluent from the system is directed to the MBR for microfiltration as shown in Exhibit 9.2.g.C, Innovative WWTP Process Flow Schematic.

See Exhibit 9.2.g.D, Constructed Wetland Wastewater Treatment Evaluation by Stantec Engineering.

SECTION 10
Evaluate Options

10.1. Summary of Options

Capital costs and Operation and Maintenance budgets reflecting the cost of operation and maintenance of the treatment facility at full flow were developed for eleven (11) different options. A present day worth for each option was also calculated so that the options could be compared based on the cost of the option over the lifetime of the facility and ensure that an option that had a higher capital cost, but lower lifetime cost was not disregarded based on the higher initial capital cost. The following is a list of the options:

Original Proposed Sewer District Options

- Option 1 - Existing Sequencing Batch Reactor (SBR) WWTP Design (162,000 gpd)
- Option 2 - Membrane Bioreactor (MBR) WWTP (162,000 gpd)
- Option 3 - SeptiTech WWTP (162,000 gpd)
- Option 4 - Orenco WWTP (162,000 gpd)
- Option 5 – Pump to Pine Hill WWTP (162,000 gpd)

Alternative Service Area Options

- Option 6 – Membrane Bioreactor (MBR) WWTP (100,000 gpd)
- Option 7 – SeptiTech WWTP (100,000 gpd)
- Option 8 – Orenco WWTP (100,000 gpd)

Other Service Area Options

- Option 9 – Membrane Bioreactor (MBR) WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections)
- Option 10 – Phoenicia, Chichester and Shandaken Pump to Pine Hill WWTP (300,000 gpd)

WWTP Additive Alternates

- Option 6A and Option 9A – Innovative WWTP

Operation and Maintenance budgets and the resulting commercial fees were then developed for the start-up flow conditions for Options 6 and 9. The start-up flow conditions are the conditions at which the sewer plant is expected to operate once all connections are made. Operation and maintenance budgets and commercial fees were developed for Options 6 and 9 only because they are the two Options that can be done for $15.8M, which is the amount of money remaining in Phoenicia's NIP block grant.

10.1.a. Option 1 – Existing Sequencing Batch Reactor (SBR) WWTP Design (162,000 gpd)

Option 1 involves servicing the Original Proposed Sewer District with a large diameter conventional collection system, as originally designed by Delaware Engineering. The collection system consists of approximately 36,000 LF of gravity sewers, approximately 3,250 LF force main and 4,250 LF of lateral stubs, twelve (12) individual grinder pump stations, 1 duplex pump station, and 2 main pump stations (Old Route 28 Pump Station and Esopus Creek Pump Station). The system will also include approximately 290 lateral connections. The treatment system is a sequencing batch reactor (SBR) system with tertiary dual sand filtration, ultraviolet disinfection system, post aeration system and sludge dewatering facilities, as designed by Delaware Engineering.

See Exhibit 10.1.a.A, Opinion of Probable Cost Estimate Breakdown – Option 1 - Existing Sequencing Batch Reactor (SBR) WWTP Design.

Capital Cost – Option 1 Existing Sequencing Batch Reactor (SBR) WWTP Design	
	Option 1
Capital Cost – Construction	
Original Proposed SBR WWTP	$ 8,300,000
Original Proposed Collection System	$ 13,500,000
TOTAL CONSTRUCTION =	$ 21,800,000
TOTAL NON-CONSTRUCTION =	$ 3,200,000
TOTAL COST =	**$ 25,000,000**
Full Flow O&M Cost (Yearly) =	$ 590,000
Present Day Worth (30-year) =	$ 42,700,000

10.1.b. Option 2 – Membrane Bioreactor (MBR) WWTP (162,000 gpd)

Option 2 involves servicing the Original Proposed Sewer District with a large diameter conventional collection system, as originally designed by Delaware Engineering and described above for Option 1. The treatment system is a membrane bioreactor (MBR) system for a SPDES Permit design flow of 162,000 gpd, with a ultraviolet disinfection system, post aeration system and sludge dewatering facilities.

See Exhibit 10.1.b.A, Opinion of Probable Cost Estimate Breakdown – Option 2 - Membrane Bioreactor (MBR) WWTP (162,000 gpd).

Capital Cost – Option 2 Membrane Bioreactor (MBR) WWTP (162,000 gpd)	
	Option 2
Capital Cost – Construction	
MBR WWTP (162,000 gpd)	$ 7,000,000
Original Proposed Collection System	$ 13,500,000
TOTAL CONSTRUCTION =	$ 20,500,000
TOTAL NON-CONSTRUCTION =	$ 4,100,000
TOTAL COST =	**$ 24,600,000**
Full Flow O&M Cost (Yearly) =	$ 590,000
Present Day Worth (30-year) =	$ 42,700,000

10.1.c. Option 3 – SeptiTech WWTP (162,000 gpd)

Option 3 involves servicing the Original Proposed Sewer District with a large diameter conventional collection system, as originally designed by Delaware Engineering and described above for Option 1. The treatment system is the SeptiTech treatment system for a SPDES Permit design flow of 162,000 gpd, with tertiary sand filtration, microfiltration, ultraviolet disinfection system, post aeration system and sludge dewatering facilities.

See Exhibit 10.1.c.A, Opinion of Probable Cost Estimate Breakdown – Option 3 - SeptiTech WWTP (162,000 gpd).

Capital Cost – Option 3 SeptiTech WWTP (162,000 gpd)	
	Option 3
Capital Cost – Construction	
SeptiTech WWTP (162,000 gpd)	$ 9,300,000
Original Proposed Collection System	$ 13,500,000
TOTAL CONSTRUCTION =	$ 22,800,000
TOTAL NON-CONSTRUCTION =	$ 4,100,000
TOTAL COST =	**$ 26,900,000**
Full Flow O&M Cost (Yearly) =	$ 580,000
Present Day Worth (30-year) =	$ 44,300,000

10.1.d. Option 4 – Orenco WWTP (162,000 gpd)

Option 4 involves servicing the Original Proposed Sewer District with a large diameter conventional collection system, as originally designed by Delaware Engineering and described above for Option 1. The treatment system is the Orenco system for a SPDES Permit design flow of 162,000 gpd, with tertiary sand filtration, microfiltration, ultraviolet disinfection system, post aeration system and sludge dewatering facilities.

See Exhibit 10.1.d.A, Opinion of Probable Cost Estimate Breakdown – Option 4 - Orenco WWTP (162,000 gpd).

Capital Cost – Option 4 Orenco WWTP (162,000 gpd)	
	Option 4
Capital Cost – Construction	
Orenco WWTP (162,000 gpd)	$ 13,200,000
Original Proposed Collection System	$ 13,500,000
TOTAL CONSTRUCTION =	$ 26,700,000
TOTAL NON-CONSTRUCTION =	$ 4,100,000
TOTAL COST =	**$ 30,800,000**
Full Flow O&M Cost (Yearly) =	$ 550,000
Present Day Worth (30-year) =	$ 47,300,000

10.1.e. Option 5 - Pump to Pine Hill WWTP (162,000 gpd)

Option 5 involves servicing the Original Proposed Sewer District with a large diameter conventional collection system, as originally designed by Delaware Engineering and described above for Option 1. The wastewater would be pumped to Pine Hill WWTP for treatment and disposal at the NYCDEP facility. A large pump station and storage tank equal to two day's flow would be built in Phoenicia with an equal sized booster pump station constructed in Shandaken. The SPDES Permit design flow is 162,000 gpd,

See Exhibit 10.1.e.A, Opinion of Probable Cost Estimate Breakdown – Option 5 - Pump to Pine Hill WWTP (162,000 gpd).

*Capital Cost – Option 5 Pump to Pine Hill (162,000 gpd)	
	Option 5
Capital Cost – Construction	
Pump to Pine Hill Pump Stations	$ 10,700,000
Original Proposed Collection System	$ 13,500,000
TOTAL CONSTRUCTION =	$ 24,200,000
TOTAL NON-CONSTRUCTION =	$ 5,500,000
TOTAL COST =	**$ 29,700,000**
Full Flow O&M Cost (Yearly) =	$ 410,000
Present Day Worth (30-year) =	$ 42,000,000

* This estimate does not include necessary costs to increase capacity at the Pine Hill WWTP, either through inflow and infiltration correction and/or capital upgrades. Also, the O&M Cost (Yearly) does not include a yearly fee that would be charged by the Pine Hill WWTP to accept the flow from Phoenicia.

10.1.f. Option 6 – Membrane Bioreactor (MBR) WWTP (100,000 gpd)

Option 6 involves servicing the Alternative Service Area only with a large diameter conventional collection system, as originally designed by Delaware Engineering. The collection system consists of approximately 18,500 LF of gravity sewers, approximately 740 LF force main and 2,000 LF of lateral stubs, two (2) individual grinder pump stations, and 1 main pump stations (Esopus Creek Pump Station). The system will also include approximately 141 lateral connections. The treatment system is a membrane bioreactor (MBR) system for a SPDES Permit design flow of 100,000 gpd, with a ultraviolet disinfection system, post aeration system and sludge dewatering facilities.

See Exhibit 10.1.f.A, Opinion of Probable Cost Estimate Breakdown – Option 6 - Membrane Bioreactor (MBR) WWTP (100,000 gpd).

Capital Cost – Option 6 Membrane Bioreactor (MBR) WWTP (100,000 gpd)	
	Option 6
Capital Cost – Construction	
MBR WWTP (100,000 gpd)	$ 6,200,000
Alternative Service Area Collection System	$ 6,400,000
TOTAL CONSTRUCTION =	$ 12,600,000
TOTAL NON-CONSTRUCTION =	$ 3,200,000
TOTAL COST =	**$ 15,800,000**
Full Flow O&M Cost (Yearly) =	$ 520,000
Present Day Worth (30-year) =	$ 31,400,000

10.1.g. Option 7 – SeptiTech WWTP (100,000 gpd)

Option 7 involves servicing the Alternative Service Area with a large diameter conventional collection system, as originally designed by Delaware Engineering and described above for Option 6. The treatment system is the SeptiTech treatment system for a SPDES Permit design flow of 100,000 gpd, with tertiary sand filtration, microfiltration, ultraviolet disinfection system, post aeration system and sludge dewatering facilities.

See Exhibit 10.1.g.A, Opinion of Probable Cost Estimate Breakdown – Option 7 - SeptiTech WWTP (100,000 gpd).

Capital Cost – Option 7 SeptiTech WWTP (100,000 gpd)	
	Option 7
Capital Cost – Construction	
SeptiTech WWTP (100,000 gpd)	$ 7,300,000
Alternative Service Area Collection System	$ 6,400,000
TOTAL CONSTRUCTION=	$ 13,700,000
TOTAL NON-CONSTRUCTION =	$ 3,200,000
TOTAL COST =	**$ 16,900,000**
Full Flow O&M Cost (Yearly) =	$ 520,000
Present Day Worth (30-year) =	$ 32,500,000

10.1.h. Option 8 – Orenco WWTP (100,000 gpd)

Option 8 involves servicing the Alternative Service Area with a large diameter conventional collection system, as originally designed by Delaware Engineering and described above for Option 6. The treatment system is the Orenco system for a SPDES Permit design flow of 100,000 gpd, with tertiary sand filtration, microfiltration, ultraviolet disinfection system, post aeration system and sludge dewatering facilities.

See Exhibit 10.1.h.A, Opinion of Probable Cost Estimate Breakdown – Option 8 - Orenco WWTP (100,000 gpd).

Capital Cost – Option 8 Orenco WWTP (100,000 gpd)	
	Option 8
Capital Cost – Construction	
Orenco WWTP (100,000 gpd)	$ 9,400,000
Alternative Service Area Collection System	$ 6,400,000
TOTAL CONSTRUCTION=	$ 15,800,000
TOTAL NON-CONSTRUCTION =	$ 3,200,000
TOTAL COST =	**$ 19,000,000**
Full Flow O&M Cost (Yearly) =	$ 500,000
Present Day Worth (30-year) =	$ 34,000,000

10.1.i. Option 9 – Membrane Bioreactor (MBR) WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections)

Town Supervisor, Robert Stanley, has expressed his opinion that the only acceptable alternative will be to build the treatment facility large enough to service the entire Original Proposed Sewer District. Therefore, in order to keep the project cost within the $15.8M remaining block grant (and keep the WWTP large enough to service the entire Original Proposed Sewer District) the area to be served by the collection system would need to be even smaller than the Alternative Service Area. As discussed in Section 6 above, the estimated Design Maximum Month SPDES Permit design flow for the Original Proposed Sewer District is 162,000 gpd.

Option 9 involves construction of an MBR WWTP for 162,000 gpd, which is the Maximum Month SPDES Permit design flow as calculated using 1988 NYSDEC Standards and is more than enough capacity to serve the Original Proposed Sewer District. The MBR WWTP will be provided with an ultraviolet disinfection system, post aeration system and sludge dewatering facilities. The collection system will be a large diameter conventional collection system, as originally designed by Delaware Engineering. The extent of the collection system installed is limited by the amount of money remaining in the block grant, but is anticipated to be at least approximately 16,200 LF of gravity sewers 625 LF force main, 1,850 LF of lateral stubs and one (1) main pump stations (Esopus Creek Pump Station). The system will also include approximately 116 lateral connections. The remaining portions of

the collection system for the Original Proposed Sewer District will be bid as Additive Alternates so that if there is money left over after the construction of the Base Bid is complete, the collection system can be extended until the block grant is completely depleted.

See Exhibit 10.1.i.A, Opinion of Probable Cost Estimate Breakdown – Option 9 - Membrane Bioreactor (MBR) WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections).

Capital Cost – Option 9 Membrane Bioreactor (MBR) WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections)	
	Option 9
Capital Cost – Construction	
MBR WWTP (162,000 gpd)	$ 7,000,000
Reduced Collection System (116 Lateral Connections)	$ 5,600,000
TOTAL CONSTRUCTION=	$ 12,600,000
TOTAL NON-CONSTRUCTION =	$ 3,200,000
TOTAL COST =	**$ 15,800,000**
Full Flow O&M Cost (Yearly) =	$ 510,000
Present Day Worth (30-year) =	$ 31,100,000

See Exhibit 10.1.i.B, Reduced Collection System Service Area (116 Lateral Connections) for Membrane Bioreactor MBR WWTP (162,000) gpd WWTP and Table Summary of Parcels and Wastewater Flow Estimate.

10.1.j. Option 10 – Phoenicia, Shandaken and Chichester Pump to Pine Hill WWTP (200,000 gpd)

Option 10 involves design and construction of a Pump to Pine Hill WWTP pumping station to service the Hamlet of Phoenicia's Original Proposed Sewer District, the Hamlet of Shandaken and the Hamlet of Chichester. A large diameter conventional collection system, as originally designed by Delaware Engineering and described above for Option 1 would be installed for the Hamlet of Phoenicia. That collection system would be extended up to Chichester to allow for Chichester to connect to the Pump Station in Phoenicia. The pump station in Phoenicia would be designed and constructed to handle the flow of the Hamlet of Phoenicia and the Hamlet of Chichester and would be provided with a storage tank equal to two day's flow of the two communities combined. In Shandaken, a large diameter collection system

would be designed and constructed for the Hamlet of Shandaken service area, as identified in the 2000 NYSEFC Study. A booster pump station would be designed and constructed in Shandaken to handle the flow from all three communities and would be provided with a storage tank equal to two day's flow of the Hamlet of Shandaken. The wastewater would be treated and disposed of at the NYCDEP owned and operated Pine Hill WWTP. The SPDES Permit design flow would be 200,000 gpd for Phoenicia, Chichester and Shandaken combined.

See Exhibit 10.1.j.A, Opinion of Probable Cost Estimate Breakdown – Option 10 – Phoenicia, Chichester and Shandaken Pump to Pine Hill WWTP (200,000 gpd).

*Capital Cost – Option 10 Phoenicia, Shandaken and Chichester Pump to Pine Hill WWTP (200,000 gpd)		
		Option 10
Capital Cost – Construction		
	Pump to Pine Hill Pump Stations	$ 10,900,000
	Collection Systems for Phoenicia and Shandaken and a Collection System Extension from Phoenicia to Chichester	$ 16,300,000
	TOTAL CONSTRUCTION=	$ 27,200,000
	TOTAL NON-CONSTRUCTION=	$ 6,525,000
	TOTAL COST =	**$ 33,725,000**
	Full Flow O&M Cost (Yearly) =	$ 430,000
	Present Day Worth (30-year) =	$ 46,625,000

* This estimate does not include necessary costs to increase capacity at the Pine Hill WWTP, either through inflow and infiltration correction and/or capital upgrades. Also, the O&M Cost (Yearly) does not include a yearly fee that would be charged by the Pine Hill WWTP to accept the flow from Phoenicia.

10.1.k. Innovative WWTP – Option 6A and Option 9A

The Innovative WWTP was evaluated as an additive to both Option 6 – Membrane Bioreactor (MBR) WWTP (100,000 gpd) and Option 9 - Membrane Bioreactor (MBR) WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections). The Innovative WWTP includes flow splitting structures, primary clarifier tank and equipment, vertical and horizontal wetland treatment systems, aeration equipment and an equalization tank for a 100-year storm, in addition to the completely functional MBR WWTP for either 100,000 gpd (Option 6A) or 162,000 gpd (Option 9A) and the associated collection systems as described for Options 6 and 9 above, respectively.

See Exhibit 10.1.k.A, Opinion of Probable Cost Estimate Breakdown – Option 6A - Innovate WWTP (100,000 gpd) Cost Addition to Option 6 and Exhibit 10.1.k.B, Opinion of Probable Cost Estimate Breakdown – Option 9A - Innovate WWTP (162,000 gpd) Cost Addition to Option 9.

Capital Cost – Option 6A Innovative WWTP with Membrane Bioreactor (MBR) WWTP (100,000 gpd)	
INNOVATIVE WWTP (100,000 gpd) CONSTRUCTION =	$ 2,150,000
NON-CONSTRUCTION =	$ 740,000
TOTAL INNOVATIVE WWTP =	$ 2,890,000
TOTAL MBR WWTP (100,000 gpd) (141 Lateral Connections) =	$ 15,800,000
TOTAL COST =	**$ 18,690,000**
Full Flow O&M Cost (Yearly) =	$ 510,000
Present Day Worth (30-year) =	$ 33,990,000

Capital Cost – Option 9A Innovative WWTP with Membrane Bioreactor (MBR) WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections)	
INNOVATIVE WWTP (162,000 gpd) CONSTRUCTION =	$ 3,330,000
NON-CONSTRUCTION =	$ 1,030,000
TOTAL INNOVATIVE WWTP =	$ 4,360,000
TOTAL MBR WWTP (162,000 gpd) w/ REDUCED COLLECTION SYSTEM (116 Lateral Connections) =	$ 15,800,000
TOTAL COST =	**$ 20,160,000**
Full Flow O&M Cost (Yearly) =	$ 490,000
Present Day Worth (30-year) =	$ 34,860,000

10.2. Operation and Maintenance (O&M) Costs to Users

The full flow operation and maintenance budgets presented in Section 10.1.a through Section 10.1.k for each of the Options was estimated and used for the purpose of evaluating the present day worth of each of the Options. However, the WWTP is not expected to operate at full flow conditions until some point at which a considerable change in the number or types of users in the district occurs. Therefore, operation and maintenance budgets for start-up flow conditions and the resulting commercial fees were calculated for the Options 6 and 9 which are the Options that can be completed with the remaining block grant funds of $15.8M.

O&M commercial fees were calculated as follows. The O&M budget for Options 6 and 9 was developed for start-up flow conditions and then divided into two parts: the portion of the budget responsible by the Phoenicia Sewer District and the portion of the budget 100% paid for by NYCDEP because of New York State Public Health Law, Article 11, Title 1, Section 1104 (Public Health Law).

The State law requires that NYCDEP pay for the full operation, maintenance, capital and replacement costs associated with any piece of equipment that is required as a result of the Watershed Rules and Regulations. For a Membrane Bioreactor (MBR) WWTP, this includes all costs associated with the microfiltration aspect of the

treatment system, including the portion of the operator's time for operating and maintaining the equipment, the electrical costs to operate the equipment, a portion of the building operation and maintenance line items for housing the equipment, and the increased operating cost for downstream or sidestream equipment to treat the additional sludge volume captured by the microfiltration equipment. The portion of the budget to be paid for by NYCDEP as a result of the Public Health Law was calculated by estimating the percentage responsible by NYCDEP for each budget line item and then summing all the line items. Approximately 29% of the budget is paid for as a result of the Public Health Law.

The remaining portion of the O&M budget responsible to be paid for by the residential and commercial users is then split based on the percentage of the residential flow to the total flow and the percentage of the commercial flow to the total flow. The flow for each residence is estimated to be 291 gallons/day/EDU and the commercial flow is based on actual metered water flow. The O&M Agreement the Town will enter into with NYCDEP caps the cost to the residential users at $100 per year for the first three years, at which point the cost per year would increase by inflation for each year following. NYCDEP pays for any costs for treating the flow from the residential users that are above that amount. The commercial users will receive a maximum of a $10,000 subsidy from NYCDEP and the Town's existing Sewer Use Law states that each commercial will be charged a minimum fee of $200/year. The subsidy and the minimum commercial fee are deducted from the overall commercial portion of the budget and the remaining amount is then divided between each of the commercial users based on the actual water meter flow at each business. Commercial water meter usage data for each business was obtained from the Town and used to calculate the fee for each business.

Mixed use commercials (those commercials that have a residence or apartment in them in addition to the business) pay the $100 fee for each residence in addition to the $200 minimum commercial fee. However, the flow of 291 gallons/EDU is deducted from their total water meter flow to determine the amount of commercial flow on which they are charged.

Therefore the formula for how commercial fees are determined is as follows:

$200 + CF(gpd) x $/gpd + No. of Apts. x $100/Apt.

Where:

$200 = the minimum commercial fee
CF = Average Commercial Flow based on Water Meter Data =
Average Water Meter Flow – 291gpd x No. of Apts
No. of Apts = Number of residential units (EDU's) in the commercial
$100 = Cost per EDU

As a result of the Public Health Law requirements and all the subsidies provided by NYCDEP, approximately 91% of the total O&M Budget is paid for by NYCDEP.

See Exhibit 10.2.A, Start-up Flow Operation and Maintenance Budget and Estimated Yearly Cost for Commercials – Option 6 - Membrane Bioreactor (MBR) WWTP (100,000 gpd) and Exhibit 10.2.B, Start-up Flow Operation and Maintenance Budget and Estimated Yearly Cost for Commercials – Option 9 - Membrane Bioreactor (MBR) WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections).

10.3. Permits and Approvals Needed

As typical with a project of this size, many different regulatory and approval agencies would be involved in the project. The State Environmental Quality Review process (also known as SEQR) is required to be completed. SEQR was completed for the Original Proposed Project, but may need to be updated depending on the project that is eventually chosen by the Town. A community wastewater management system in general should be viewed as a net environmental benefit to the community and should avoid, wherever possible, permanent negative impacts on the environment. A final design that takes these issues into consideration would likely shorten the SEQR review and updating and permitting process.

Most permits for the Original Proposed Project were applied for and obtained at the time that project was bid. However, the permits have since expired and will need to be reapplied for the specific project that is eventually undertaken by the Town. Permits from the Army Corps of Engineers (ACOE), NYSDEC, NYSDOT, NYCDEP, the County and Town are required. Design approvals are required from NYSDEC, NYSDOH, NYCDEP, the Town and CWC. See Exhibit 10.3.A, Permits and Approval Inventory, for the anticipated required permit and approvals and the list of associated agencies.

10.4. Identify Additional Funding Sources

There are multiple funding sources for grants and loans for wastewater projects outside of the NYCDEP Watershed. In Phoenicia, the additional funding sources could be applied to for additional capital either to extend the sewage collection system beyond that of Option 9 or to construct the Innovative WWTP Additive Alternative discussed in Section 9.2.g. Some of those funding sources and the applicable programs are as follows:

- New York State Environmental Facilities Corporation (NYSEFC), Clean Water State Revolving Fund (CWSRF)
- United States Department of Agriculture - Rural Development (USDA RD), Water and Wastewater Grants and Loans program

- New York State Division of Housing and Community Renewal (NYSDHCR), New York State Community Development Block Grant (CDBG)
- New York State Environmental Facilities Corporation (NYSEFC), Green Infrastructure Grant Program (GIGP)
- New York State Energy Research and Development Authority (NYSERDA), Program Opportunity Notice (PON)
- New York State Energy Research and Development Authority (NYSERDA), Focus on Local Government Program

Because the service charge to the Phoenicia residents of $100 is well below the target service charge for the CWSRF and the USDA RD Water and Wastewater Grants and Loans programs, Phoenicia is not eligible for grant or 0% loans to install more sewage collection system or the Innovative WWTP. Rather any money possibly provided by those programs for that work would be a subsidized loan with a low interest rate.

The CDBG funding program is available for low to moderate income service areas for community improvements, which construction of wastewater treatment facilities is considered. If a service area is comprised of a majority of low to moderate income eligible property owners, then the municipality may apply for a grant to assist with the capital costs of the project. In order to prove that the majority of the service area is low to moderate income, an income survey would need to be completed before application is made. This is a competitive grant program with an annual funding round and the maximum requested amount for a single focus application is $400,000.

The upcoming GIGP round of funding, for which applications are due on October 31, 2011, is for stormwater projects only. Previous rounds of GIGP funding have been available for wastewater projects, and future rounds maybe available for wastewater projects again. Typically these funding rounds are yearly, so another funding round is not anticipated until the Fall of 2012.

NYSERDA's funding programs are focused on projects that will result in energy savings. The Innovative WWTP is anticipated to save energy and may be eligible for funding through NYSERDA. NYSERDA is regularly adding PONs for specific types of projects. However there are currently no PONs that are available for wastewater projects at this time. The Innovative WWTP appears to meet the requirements of The Focus on Local Governments Program. However at this time, repeated phone discussions have not resulted yet in any definite funding.

The project cost estimates developed in Chapter 10 do set aside money for the construction of laterals (the portion of the sewer main to within 5' of the building foundation). However, the CDBG grant program could be applied for to assist homeowners with the installation of their laterals. If money could be obtained from CDBG to assist homeowners with the installation of their laterals, then the NYCDEP

block grant could be used for the installation of more sewage collection system. If the money was applied for the entire service area, then the majority of households in the service area would need to be of low to moderate income. However, even if the service area does not meet this requirement, a municipality may still apply for the CDBG to assist individual homeowners who are eligible with the cost of the installation of their laterals. Again, this is a competitive grant program with an annual funding round and the maximum requested amount for a single focus application is $400,000.

Lastly, the USDA RD also has loans available for income-eligible senior citizens. These are individual applications to be completed and submitted directly by the homeowner to assist with any costs associated with the installation of their lateral.

10.5. Timeframe to Complete

It is anticipated that final design engineering and project development would take one and a half years to complete. This includes facility planning and final design, applying for and obtaining updated permitting, completing the remaining property and easement acquisitions, design approval from NYCDEP and NYSDEC, and the development of construction drawings and documents for bidding. The bidding and contract agreement period is estimated to take 6 to 8 months to complete, and construction of the system, including final restoration, startup and closeout would take two (2) years from the date construction contracts are executed. The costs presented in this section are based on that schedule. Therefore, any significant delays could cause these costs to escalate due to inflation.

SECTION 11
Recommendations and Conclusions

A Septic Maintenance District is not recommended for Phoenicia for the following reason:

- There is an overwhelming predominance in the number of small and otherwise problematic lots in the Original Proposed Sewer District that could not meet design standards for individual on-site septic systems.

In addition, there are these disadvantages with a Septic Maintenance District (SMD) for Phoenicia:

- Due to the overwhelming number of lots in the Original Proposed Sewer District not capable of meeting the current standard, the Town may be taking on a significant liability arising from its responsibility in an SMD to provide adequate wastewater treatment, unless the SMD were developed as a reimbursement program in which the individual on-site systems would remain the property and responsibility of the individual lot owner.

- Unless the SMD could be delineated and budgeted to include vacant lots, no provisions for community growth could be incorporated.

- Vacant lots may prove unbuildable under an SMD.

- Change of use for properties may prove impossible or impractical under an SMD.

A Community Septic System for the Original Proposed Sewer District is not feasible because there is no site, or combination of sites large enough to discharge the volume of flow generated by the Original Proposed Sewer District through a subsurface system.

The Pump to a Neighboring WWTP alternative is not feasible, because neither the Pine Hill WWTP nor the Boiceville WWTP have enough capacity to accept the flow from Phoenicia. Furthermore, even if NYCDEP agreed to accept the flow from Phoenicia at the Pine Hill WWTP, the capital cost for such a system is much greater than the remaining block grant amount. While combining the Phoenicia Pump to Pine Hill WWTP with Shandaken and Chichester may provide funds designated for those communities, the overall cost for Phoenicia alone is still more than the remaining block grant amount and only serves to worsen the issues about the lack of capacity to accept the flow from all three communities at the Pine Hill WWTP.

Therefore, a WWTP in Phoenicia is recommended.

The preferred service area is the Original Proposed Sewer District because of the overwhelming predominance of small and otherwise problematic lots.

The Membrane Bioreactor (MBR) WWTP is a proven technology with a lower capital cost and smaller footprint, and results in a cleaner, more reliable effluent than other treatment technologies due to the state of the art design and operational flexibility. Because it combines secondary and tertiary treatment processes and microfiltration into one process, it results in a lower capital cost than a Sequencing Batch Reactor (SBR) WWTP or other Pre-packaged WWTPs, where the secondary and tertiary treatment systems are separate, as evident by the difference in capital costs between Options 1 through 4 and Options 6 through 9.

Furthermore, there have been concerns among some Phoenicia residents over the presence of trace organic compounds (TOrC) in wastewater, water supplies, and the receiving environment (July 11, 2011 Town Board Meeting). Over the past decade a number of studies have brought increasing awareness on this topic. In 2008 the Water Environment Research Foundation (WERF) prepared "Technical Brief: Trace Organic Compounds and Implications for Wastewater Treatment" summarizing available scientific data on TOrC in wastewater and the receiving environment and putting concerns into prospective. According to the Technical Brief, data collected to date did not indicate that TOrC present in municipal wastewater treatment plant effluent causes harm to human health or the environment. However, there was data suggesting that these compounds did have the potential to be harmful to aquatic wildlife.

Research has shown that longer solids retention times (SRT) in Waste Water Treatment Plants (WWTP) increases the removal of TOrC. Membrane Biological Reactor (MBR) treatment plants operate at longer SRTs than conventional activated sludge treatment plants. It has been demonstrated that MBR plants show better removal of TOrC than conventional treatment plants. Research papers supporting these statements can be found in Exhibit 11.A, Technical Briefs on Pharmaceuticals in Wastewater.

The preferred treatment type is a Membrane Bioreactor (MBR) WWTP.

The potential treatment alternatives discussed throughout the report focus mainly on the two potential service areas described in Section 4 and their associated flows as described in Section 5 and 6; the Original Proposed Sewer District and the Alternative Service Area. During the development of Section 4 it was anticipated that the current project funds would not be enough funds to complete a project of the original scope. (This assumption was proven in Section 10, with Option 1 – Existing Sequencing Batch Reactor (SBR) WWTP Design estimated to cost $25M). As a

result, the Alternate Service Area was developed, which reduced the service area and the WWTP design flows. Option 6 – Membrane Bioreactor (MBR) WWTP (100,000 gpd) which would service the Alternative Service Area is one of the Options constructable for the remaining block grant of $15.8M.

Subsequently, based on conversations with Town Supervisor, Robert Stanley, Option 9 – Membrane Bioreactor (MBR) WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections) was developed to address the concern that potentially the only project that would be acceptable to the Town would be to construct a WWTP that would be large enough to service the Original Proposed Sewer District, even if that meant only being able to install an even smaller collection system than would be constructed to serve the Alternative Service Area. Even though the collection system would serve fewer users, the construction of a WWTP large enough to service the Original Proposed Sewer District would allow expansion of the collection system at a later date, perhaps if additional money from NYCDEP became available or if other funding sources could be obtained, without the complication of also needing to expand the newly constructed WWTP.

In the case of Phoenicia, the specific problem with serving fewer users, as is the case with Option 9, is that the core district that would be served under Option 9 is mostly commercial users and when the collection system size is reduced many more residential users (i.e. flow) are removed from the service area than commercial users. As a result, the proportion of the total flow that is considered residential flow goes down. When this occurs, the portion of the O&M budget subsidized by the NYCDEP residential subsidy is also reduced and results in the cost to the commercial properties going up. Therefore, from an O&M standpoint, Option 6 will result in lower commercial O&M fees.

In order to accomplish the goals of both serving the most residential users and constructing a treatment facility that is large enough to serve the full Original Proposed Sewer District, the Maximum Month (SPDES Permit) Design Flow of the WWTP should be as close as possible to the actual flow of the Original Proposed Sewer District with an adequate allotment for growth added. An adequately but also moderately sized facility will ensure that funds are available to serve as many users as possible, instead of those funds being wasted on facility capacity that most likely will never be used. Therefore, a review of the Maximum Month (SPDES Permit) Flow calculation was conducted to determine if the flow of the Original Proposed Sewer District could be reduced.

In Section 3, a windshield survey performed by Lamont Engineers evaluated each property within the Original Proposed Sewer District and categorized the properties by their current use. In Section 5, an estimated flow was assigned to each property based on the use of each property as determined during the windshield survey. Section 5 explained how The Recommended Standards for Wastewater Facilities – 2004 Edition (Ten States Standards), one of the design standards used by NYSDEC

for the design of Wastewater Treatment Facilities, requires that the sizing of wastewater facilities receiving flows from new wastewater collection systems shall be based on an average daily flow of 100 gallons per capita plus wastewater flow from industrial plants and major institutional and commercial facilities unless water use data or other justification upon which to better estimate flow is provided.

As was done in previous NYCDEP watershed projects, the flow from residences was based on 100 gallons per person per day and an estimated number of people per residential unit (i.e. an EDU). For non-residential properties, the New York State Department of Environmental Conservation Design Standards for Wastewater Treatment Works, 1988 (1988 NYSDEC Standards), Table 3, Expected Hydraulic Loading Rates, was used to determine the estimated flow rates for a particular facility. In previous projects the average persons per household used was 2.6, as that was the average reported in the census data for the entire United States, resulting in an estimated flow of 260 gallons per day per household. However, in Phoenicia, an average of 2.91 people per household was used to develop the design flow of the WWTP because that is what was used during the development of the project under LaBerge and Delaware Engineering and a higher estimated residential flow reduces the O&M fees for the commercial properties.

In Section 6, the hydraulic and organic loadings, including a 10% growth allotment, were developed based on all the data gathered and reviewed in Sections 3, 4 and 5. The design flow for the WWTP for the Original Proposed Sewer District based on the above described methodology was calculated to be 162,000 gpd. And, although it was calculated in accordance with all applicable standards, as have many other approved and constructed projects in the NYCDEP Watershed, once all the connections are made the actual flow treated at the WWTP will be much less than 162,000 gpd.

Previous experience in other NYCDEP watershed communities where treatment facilities were built under the New Sewage Treatment Infrastructure Program (NIP) or the Community Wastewater Management Program (CWMP) demonstrates that flows developed using these estimating standards are consistently higher than what the facility actually treats once all connections to the WWTP are made. For instance, the following chart lists the Maximum Month SPDES Permit design flows and actual flows of the treatment facilities Lamont Engineers has designed and constructed in the watershed using the exact same standards as was used in Section 6 for Phoenicia.

Community Name	Max. Month SPDES Permit Design Flow	Actual Flow	Percentage of Actual Flow to Design Flow
Roxbury Pump Station	91,000 gpd	35,000 gpd	38%
Prattsville WWTP	86,000 gpd	19,500 gpd	23%
Boiceville WWTP	75,000 gpd	25,000 gpd	33%
Bloomville WWTF	30,000 gpd	17,000 gpd	57%
Hamden WWTF	26,000 gpd	8,000 gpd	31%
Bovina WWTF	20,000 gpd	8,000 gpd	40%

In addition the following is a list of the other NYCDEP Watershed communities where WWTP projects were completed under the NIP and whose Maximum Month SPDES Permit design flows were also estimated using 1988 NYSDEC Standards:

Community Name	Max. Month SPDES Permit Design Flow	Actual Flow	Percentage of Actual Flow to Design Flow
Andes WWTP*	62,000 gpd	72,000 gpd	N/A*
Fleischmanns WWTP	160,000 gpd	37,000 gpd	23%
Hunter WWTP	338,400 gpd	135,000 gpd	40%
Windham WWTP	373,000 gpd	126,000 gpd	34%

*Andes WWTP *Andes WWTP has significant I/I problems that are causing their actual flow to exceed their Maximum Month SPDES Permit Design Flow. Andes is currently in the process of correcting the I/I problems. Therefore it is not possible to determine how the Max. Month SPDES Permit compares to the actual sewage flow, less I/I.

The above tables reveal that for all the projects in the NYCDEP Watershed constructed under the NIP and CWMP, (with the exception of the Andes WWTP because it is indeterminable at this time), the 1988 NYSDEC Standards is conservatively high for estimating sewer design flows. Since this reference is used by all of New York State, it must be conservative because it is used for the design of wastewater treatment facilities for commercial establishments in densely populated, as well as less densely populated areas alike. Therefore we conclude that the Maximum Month (SPDES Permit) Flow developed for the Original Proposed Sewer District for Phoenicia based on the 1988 NYSDEC Standards is much higher than any flow that would ever be generated by the current residents and businesses in that service area, just as has been the case in the other NYCDEP Watershed communities in the Catskills shown in the tables above.

In addition to the conservatively high estimate of the sewer flows generated from the commercial establishments, the flow from the residential units in Phoenicia was estimated to be 291 gallons per day per EDU, which is even higher than the standard average of 260 gallons per day per EDU used for all the NYCDEP watershed projects in the above table.

The argument that the design flow calculated in Section 6 for the Original Proposed Sewer District is much higher than the flows that will be treated by the WWTP is further supported by the water system records. The water system reports for the Phoenicia Water District, whose boundaries are similar to the Original Proposed Sewer District, as shown in Exhibit 2.C, GIS Information Mapping, indicate that the average daily water demand of the water system is between 90,000 gpd and 100,000 gpd, with a highest day demand between 136,000 gallons and 145,000 gallons, as described in Section 6.1.b above. Also, see Exhibit 6.1.b.A, Phoenicia Water System Reports and Annual Drinking Water Quality Reports for the Phoenicia Water District.

Furthermore, a Preliminary Engineering Report for the Town of Shandaken Phoenicia Water District, May 2011 completed by the MRB Group, calculated that the actual average daily water flow based on the sum of each of the individual water meters in the system for the years 2008, 2009 and 2010 was approximately 40,000 gpd, or 40% of the flow of 100,000 gpd that is treated at the water filtration plant. The discrepancy in the treated flow compared to the individual meter flow is likely due largely in part to leaks in system, in combination with the lack of individual meter calibration, and flows lost due to firefighting or system flushing.

Considering the above, the design flow of the WWTP for the Original Proposed Sewer District could be reduced from the originally developed 162,000 gpd while still allowing for growth within the Original Proposed Sewer District.

As stated in the Ten States Standards, water use data, or other justification upon which to better estimate flow may be used to develop the design flow of wastewater treatment facilities. Since the Phoenicia Water District closely follows the Original Proposed Sewer District Boundary, it is proposed that the Phoenicia water system records be used as the basis for the calculation of the Maximum Month (SPDES Permit) Flow of the WWTP to serve the Original Proposed Sewer District. As described in Section 6, a 20% allotment for infiltration and inflow (I/I) and a 10% growth factor as allowed by the MOA will be added to the average water flow of 100,000 gallons per day, resulting in a Maximum Month Flow (SPDES Permit Flow) for the Original Proposed Sewer District of 130,000 gpd. Therefore, the Wastewater Load Summary for the Original Proposed Sewer District, using the concentrations described in Section 6 (BOD5= 0.17 lbs/day, TSS = 0.20 lbs/day, NH3 = 25 ppm, TKN = 40 ppm and Phosphorus = 10 ppm), and a Maximum Day Factor and Peak Hour Factor of 1.6 and 3.72, respectively, would be as follows:

RAW WASTEWATER LOAD SUMMARY	
Phoenicia Community Wastewater System Original Proposed Sewer District	
Hydraulic Loads:	
Design Average Flow	100,000 gpd
Design Max. Month Flow	130,000 gpd
Design Maximum Day Flow	208,000 gpd
Design Peak Hourly Flow	336 gpm (484,000 gpd)
Organic and Solids Loads:	
Design Max. Month BOD_5	221 lbs BOD_5/day (203 mg/L)
Design Maximum Day BOD_5	354 lbs BOD_5/day
Design Peak Hour BOD_5	822 lbs BOD_5/day
Design Max. Month Total Suspended Solids	260 lbs TSS/day (240 mg/L)
Design Maximum Day Total Suspended Solids	416 lbs TSS/day
Design Peak Hour Total Suspended Solids	967 lbs TSS/day
Nutrient Loads:	
Design Max. Month NH_3-N	27 lbs/day of NH_3-N
Design Max. Month TKN	43 lbs/day of TKN
Design Max. Month Phosphorus	11 lbs/day Phosphorus

Capital costs and O&M costs for both full flow and start-up flow conditions were then developed for this option (Option 11), in which the MBR WWTP would be constructed for the more realistic yet still conservative Maximum Month SPDES Permit flow of the Original Proposed Sewer District of 130,000 gpd. The MBR WWTP will be provided with an ultraviolet disinfection system, post aeration system and sludge dewatering facilities. The collection system will be a large diameter conventional collection system, as originally designed by Delaware Engineering. The extent of the collection system installed is limited by the amount of money remaining in the block grant, but is anticipated to be at least approximately 17,000 LF of gravity sewers, 625 LF force main, 1,970 LF of lateral stubs and one (1) main pump station (Esopus Creek Pump Station). The system will also include approximately 127 lateral connections. The remaining portions of the collection system for the Original Proposed Sewer District will be bid as Additive Alternates so that if there is money left over after the construction of the Base Bid is complete, the collection system can be extended until the block grant is completely depleted.

See Exhibit 11.B, Opinion of Probable Cost Estimate Breakdown – Option 11 - Membrane Bioreactor (MBR) WWTP (130,000 gpd) with Reduced Collection System (127 Lateral Connections).

Capital Cost – Option 11 Membrane Bioreactor (MBR) WWTP (130,000 gpd) with Reduced Collection System (127 Lateral Connections)	
	Option 11
Capital Cost – Construction	
MBR WWTP (130,000 gpd)	$ 6,700,000
Reduced Collection System (127 Lateral Connections)	$ 5,900,000
TOTAL CONSTRUCTION =	$ 12,600,000
TOTAL NON-CONSTRUCTION =	$ 3,200,000
TOTAL COST =	**$ 15,800,000**
Full Flow O&M Cost (Yearly) =	$ 520,000
Present Day Worth (30-year) =	$ 31,400,000

See also Exhibit 11.C, Start-up Flow Operation and Maintenance Budget and Estimated Yearly Cost for Commercials – Option 11 - Membrane Bioreactor (MBR) WWTP (130,000 gpd) with Reduced Collection System (127 Lateral Connections).

A map of the proposed collection system service area for Option 11 can be found in Exhibit 11.D, Reduced Collection System Service Area (127 Lateral Connections) for Membrane Bioreactor MBR WWTP (130,000) gpd WWTP and Table Summary of Parcels and Wastewater Flow Estimate.

Because of the Town's continued expression of interest in pursuing alternative treatment options, the Innovative WWTP was also considered for Option 11.

The Innovative WWTP includes flow splitting structures, primary clarifier tank and equipment, vertical and horizontal wetland treatment systems, aeration equipment and an equalization tank for a 100-year storm, in addition to the completely functional MBR WWTP for 130,000 (Option 11A) and the associated collection systems as described for Option 11 above.

Capital Cost – Option 11A Innovative WWTP with Membrane Bioreactor (MBR) WWTP (130,000 gpd) with Reduced Collection System (127 Lateral Connections)	
INNOVATIVE WWTP (130,000 gpd) CONSTRUCTION =	$ 2,680,000
NON-CONSTRUCTION =	$ 870,000
TOTAL INNOVATIVE WWTP =	$ 3,550,000
TOTAL MBR WWTP (130,000 gpd) w/ REDUCED COLLECTION SYSTEM (127 Lateral Connections) =	$ 15,800,000
TOTAL COST =	**$ 19,350,000**
Full Flow O&M Cost (Yearly) =	$ 500,000
Present Day Worth (30-year) =	$ 34,350,000

The Innovative WWTP alternative costs are not eligible to be paid for with the NYCDEP block grant. Alternative funding sources would need to be pursued. Those potential funding sources are described in Section 10.4. Because there are no grant programs that the Hamlet of Phoenicia is currently eligible for, the only potential available money would be low interest loans.

A Summary of Costs can be found in Exhibit 11.F and is further summarized below.

Summary of Wastewater Treatment Alternatives with Total Project Costs and O&M Costs				
	Capital Cost	Full Flow O&M Cost ($/Year)	Present Day Worth	Regulatory Indication
Option 1 – Ex. SBR WWTP Design (162,000 gpd)	$25.0M	$590,000	$42.7M	Approvable
Option 2 – MBR WWTP (162,000 gpd)	$24.6M	$590,000	$42.7M	Approvable
Option 3 – SeptiTech WWTP (162,000 gpd)	$26.9M	$580,000	$44.3M	Approvable
Option 4 – Orenco WWTP (162,000 gpd)	$30.8M	$550,000	$47.3M	Approvable
Option 5* - Pump to Pine Hill WWTP (162,000 gpd)	$29.7M*	$410,000 **	$42.0M	Not Approvable
Option 6 – MBR WWTP (100,000 gpd)	$15.8M	$520,000	$31.4M	Approvable
Option 7 – SeptiTech WWTP (100,000 gpd)	$16.9M	$520,000	$32.5M	Approvable
Option 8 – Orenco WWTP (100,000 gpd)	$19.0M	$500,000	$34.0M	Approvable
Option 9 – MBR WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections)	$15.8M	$510,000	$31.1M	Approvable
Option 10* - Phoenicia, Chichester and Shandaken Pump to Pine Hill WWTP (200,000 gpd)	$33.7M*	$430,000 **	$46.6M	Not Approvable
Option 11 – MBR WWTP (130,000 gpd) with Reduced Collection System (127 Lateral Connections)	$15.8M	$520,000	$31.4M	Approvable

* Pump to Pine Hill Options do not include the capital cost to remediate infiltration and inflow issues at the Pine Hill WWTP or the cost of increasing the flow capacity of Pine Hill

** Pump to Pine Hill Options O&M Cost Estimate do not include yearly fee to Pine Hill for accepting flow from Phoenicia

Option 2 - Membrane Bioreactor (MBR) WWTP (162,000 gpd) for the Original Proposed Sewer District is the preferred option. However, at a cost of $24.6M, this Option is $8.8M more than the $15.8M remaining in Phoenicia's block grant funded by NYCDEP's NIP. NYCDEP has not, to date, agreed to increase the money in Phoenicia's block grant. The Options whose project costs are within the remaining block grant of $15.8M and whose 30-year present day worth were also the lowest are as follows:

Summary of Wastewater Treatment with Total Project Costs and O&M Costs			
Option	Capital Cost	Start-up Flow O&M Cost	Regulatory Indication
Option 6 – Membrane Bioreactor (MBR) WWTP (100,000 gpd)	$15.8 M	$450,000 per year $2.05/gallon per day per year Commercial*	Approvable
Option 9 – Membrane Bioreactor (MBR) WWTP (162,000 gpd) with Reduced Collection System (116 Lateral Connections)	$15.8 M	$440,000 per year $3.58/gallon per day per year Commercial*	Approvable
Option 11 – Membrane Bioreactor (MBR) WWTP (130,000 gpd) with Reduced Collection System (127 Lateral Connections)	$15.8 M	$450,000 per year $2.43/gallon per day per year Commercial*	Approvable

* NYCDEP O&M subsidies included in O&M commercial rate calculation.

Option 6, 9 and 11, are all acceptable alternatives for the Town to pursue. Option 6 was developed to serve the Alternative Service Area. If additional funding later through grants or bonding becomes available to extend the collection system, a majority but not all of the Original Proposed Sewer District could be served by the 100,000 gpd WWTP. Either Option 9 or Option 11 will need to be selected as the preferred alternative because of the desire of the Town to construct a WWTP definitively large enough to serve the entire Original Proposed Sewer District.

Option 11 is the preferred option for the Hamlet of Phoenicia because of lower O&M costs for commercial users and a higher number of residential users served. The 162,000 gpd WWTP proposed in Option 9 is larger than necessary. Furthermore, the commercial fees are lower for Option 11 because more residential users are served than under Option 9.

If the Town desires to proceed with the design and construction of a wastewater project, a Sewer District will need to be created. A Sewer District can be formed by permissive referendum, mandatory referendum, or by a property owner petition process.

Under the property owner petition process, a petition must be signed by the owners of taxable real property located within the proposed district, owning in the aggregate at least ½ of the assessed valuation of all of the taxable real property in the proposed district. The petition must also include the following:

1) A description of the boundaries of the proposed district in a manner sufficient to identify the lands included therein as a deed of conveyance (See Town Law § 191);
2) A map and plan prepared by a duly licensed engineer showing the boundaries of the proposed district and a general plan of the proposed sewer district. The map must show all outlets and the terminus and course of each proposed sewer main together with the location and a general description of all sewage disposal plants (See Town Law § 192);
3) The maximum amount proposed to construct the waste water treatment plant (See Town Law § 191);
4) The maximum amount to be expended annually for the services provided by the district (See Town Law § 191);
5) Signatures of the petitioners, and acknowledged or proved in a manner provided by election law for the authentication of nominating petitions. See Town Law § 191.

Assuming the petition complies with State law and after it is presented to the Town Board, the Town Board would adopt an order and hold a public hearing. Following that public hearing, the Town Board would adopt a resolution establishing the district if it determines that the petition was signed, and acknowledged or proved as required by law, that all the property and property owners within the proposed district are benefitted thereby, that all the property and property owners benefitted are included within the limits of the proposed district, and that it is in public interest to grant the relief sought.

The Town Clerk would then file a certified copy of the resolution establishing the sewer district with the County Clerk's office and file a certified copy with the State Comptroller's office. Upon the filing of the resolution with the County Clerk, the determination shall be presumptive evidence of the regularity of the proceedings establishing the district.

For the permissive or mandatory referendum procedure, the Town Board would, pass a resolution to form the district, which would be subject to either a permissive referendum, or the Town opts for a mandatory referendum. Under the permissive referendum procedure, after a public hearing, if the Town Board determines all properties in the district are benefited and the district formation is in the public interest, the Board then adopts a resolution establishing the district and noting that it is subject to a permissive referendum. Permissive referendums are governed by Article 7 of the Town Law. A petition for a permissive referendum must be submitted within 30 days after the Town Board resolution. To require a referendum, the petition must contain the authenticated signatures of at least 5% of the property owners or a 100 property owners within the district, whichever is less.

The Town Board also has the option of requiring a referendum vote when it passes the resolution to establish the district ("mandatory referendum".) Under either permissive or mandatory referendum, the vote process and requirements are the same under New York State law.

Once a referendum is determined to be held, either by the Town Board or a petition, approval of the district requires the affirmative vote of the owners of a majority of taxable real property in the district. A referendum is either conducted in a special election or, depending on the timing, as part of the normal annual election.

Prior to any referendum vote, it is recommended that the Town Board schedule several informational sessions to ensure an informed vote. The sessions could focus on property owner participation in voting, why the Town Board believes the district is in the public interests, and financial aspects, especially operation and maintenance fees, and what the project would mean to a property owner in the proposed district. Town Board members and/or interested community members may also desire to go door to door within the district to supply information that was also provided to attendees at these sessions.

One of the concerns that will likely arise during the Sewer District formation is the cost to the commercial users as a result of the new WWTP system. Option 11 keeps the O&M commercial fees at a reasonable level for all except for the 2 or 3 highest water users. The Town may want to consider amending the current sewer use law and exempting certain property owners from a new connection fee. Currently, the Sewer Use Law requires all property owners to connect within 90 days. The Town Sewer Use Law also allows properties with adequately functioning septic systems to appear before the Town Board and request an exemption from that requirement. Under a different section of the Town's Sewer Use Law, new users to the plant (those not connected within 90 days of startup) are subject to a sewer connection fee. The Sewer Use Law further provides that all such fees with be placed in a dedicated capital reserve account. The Town could amend the sewer use law to provide that any properties that are granted an opt-out by the Town Board will not be subject to the new connection fee.

In summary, the recommendations of this Engineer's report are:

1. Proceed with the project, pursuing Option 11 – Membrane Bioreactor (MBR) WWTP (130,000 gpd) with Reduced Collection System (127 Lateral Connections).

2. Modify the Town's Sewer Use Law to wave connection fees for any existing residences or commercials, if those property owners apply to the Town Board for a variance from the Mandatory Hookup Requirement and are approved. To get a variance, the property owner has to show that they have a functioning septic

system and, as a result, so choose to connect up to the sewer system after the allotted time for connections pass.

3. Form the Sewer District by mandatory referendum.

4. Complete the design, obtain the permits and remaining easements and put project to bid.