Orient, New York
Decentralized
Wastewater Collection & Treatment
Feasibility Study

PHASE 1
Potential Site Identification

for:

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December 23, 2013

Project No. 3941302

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SECTION 1 BACKGROUND

1.1 INTRODUCTION

This report presents the initial phase of a wastewater feasibility study performed for Orient. This phase identifies suitable sites within the hamlet for subsurface wastewater disposal. Additional phases will determine the most appropriate and cost-effective means of wastewater collection, treatment and disposal using the potential sites identified during this phase.

1.2 WASTEWATER NEEDS

The January 2011 Suffolk County Comprehensive Water Resources Management Plan is an extensive document which provides valuable information on the impact of human activities on groundwater sources. One of the most significant contaminates of concern is nitrate. Sources of nitrate include on-site sanitary wastewater disposal in un-sewered areas, sewerage treatment plant discharges to groundwater, as well as the application of fertilizers to agricultural and manicured lands. Nitrate from these sources has resulted in contamination of drinking water supplies. Nitrate is also an important factor in eutrophication.

Wastewater has high levels of nitrogen and phosphorus. Both of these components are known as good fertilizers. Once introduced into a body of water, they cause increased plant growth, specifically of algae, which will bloom, then die and fall to the bottom of the water body and decompose. The decomposition of algae fuels bacterial growth, which consumes oxygen. Aquatic life needs oxygen and without it the water becomes “dead” which means unsuitable to sustain life. Algal blooms not only harm animals, but also block sunlight from reaching plants, which stunts or stops plant growth, destroying habitat.

The Comprehensive Water Resources Management Plan presents data which shows improved wastewater treatment is effective at lowering environmental nitrate levels. The goal of wastewater improvements in Orient will be effective treatment to preserve drinking water and environmental quality while providing a treatment system that would be compatible with the character and concerns of the community.

1.3 WASTEWATER BACKGROUND

Orient is currently served by individual subsurface wastewater disposal systems (primarily cesspools) and is un-sewered. The proposed service areas for the future wastewater system are comprised of 7 different areas and are shown on Figure 1.1.

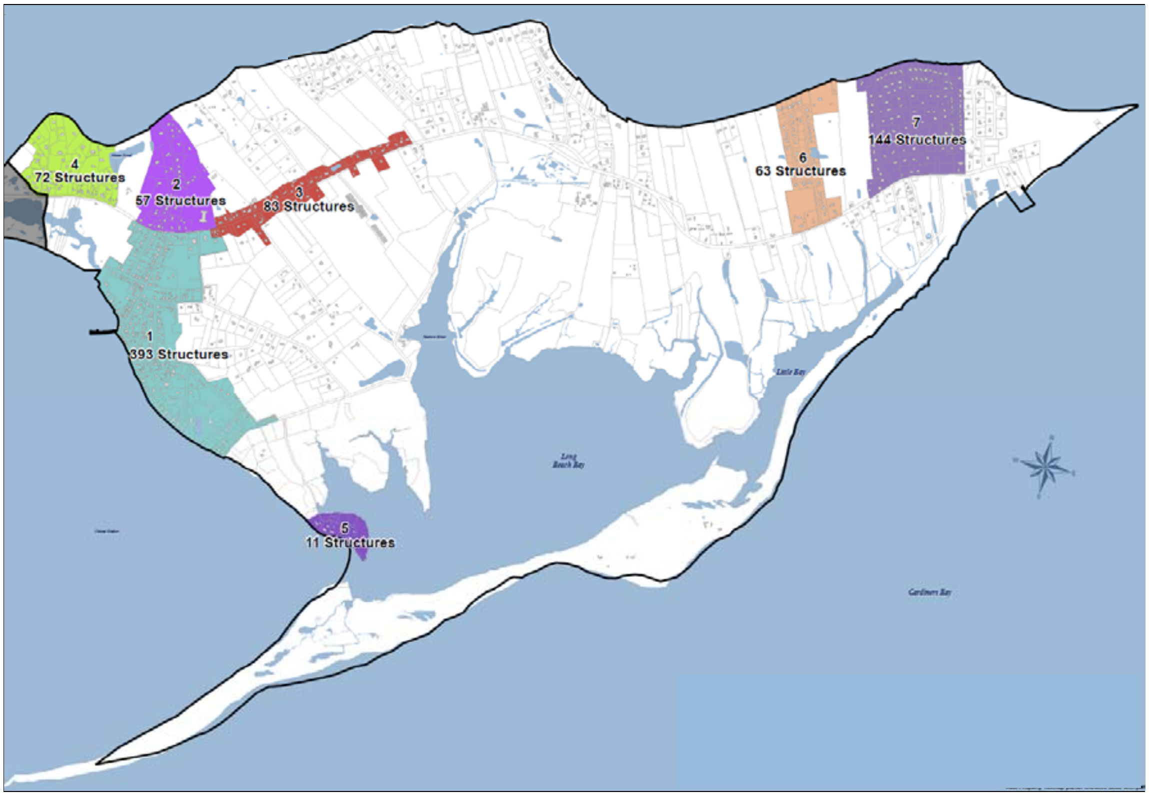

Figure 1.1 Proposed Service Area

Peconic Green Growth (PGG), a not-for-profit organization, has expended significant effort on developing the wastewater system needs and scope. The proposed sewer service areas shown on Figure 1.1 were developed by PGG.

1.3.1 Service Area and Flows

Preliminary mapping by PPG shows seven potential wastewater districts. The final district boundaries and number of districts will most likely be adjusted based on public feedback and technical analysis going forward. These districts range in size from 11 to 393 structures with estimated flows of between 2,100 and 72,582 gallons per day (gpd). With the exception of one district (District 1), these are primarily residential areas. District 1 contains the commercial center of the hamlet of Orient and therefore a higher number of commercial and institutional properties. The table below provides the characteristics and flows of each district upon which this proposal is based.

Project Understanding – RFP District Characteristics				
District	Area (acres)	Buildings	Dwellings	Flow (gpd)
1	169	393	230	72,582
2	64	57	48	19,996
3	43	63	44	13,500
4	58	72	48	14,400
5	15	11	7	2,100
6	56	63	51	15,300
7	110	144	144	43,200

1.3.2 Proposed Treatment System

PGG has indicated that the study should focus on alternative treatment technologies and collection systems. This phase of study will focus on acceptable areas for subsurface disposal.

1.4 PROJECT AREA CHARACTERISTICS

1.4.1 Location & Population

Orient is located at the very eastern end of Suffolk County on Long Island within the Town of Southold. Orient comprised of approximately 6.1 square miles including residential and commercial uses.

The population in the hamlet has increased by 4.8% from 2000 to 2010, from 709 to 743. The summer population of the hamlet is estimated to be over 1,000.

1.4.2 Environmental Resources

Of the 6.1 square mile area, one square mile is water. The majority of this is Hallock Bay (Long Beach Bay), but there are also many tidal streams (NYSDEC Class SA & SC Saline Surface Waters) and wetlands. Many of the wetlands areas are designated as either federal or NYS DEC wetlands. Both of these features are shown on Figure 1.2.

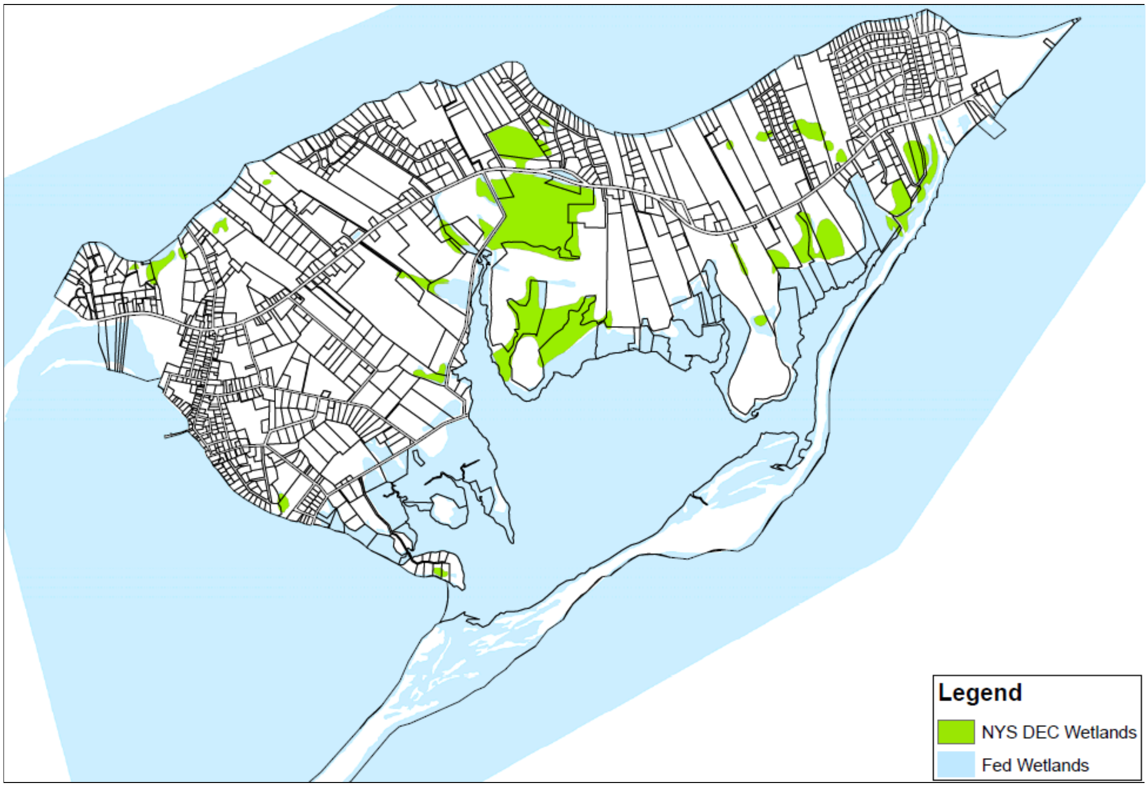

Figure 1.2 Orient Hamlet Wetlands

Source: GIS Data from Southampton GIS Department

The hamlet is located on the Nassau-Suffolk sole source Aquifer. A sole source aquifer is one that has been identified by the EPA as one which supplies at least fifty percent (50%) of the drinking water consumed in the area overlying the aquifer.

Orient is considered a Water Supply Sensitive Area under 760-706 of the Suffolk County Sanitary Code. This is defined by the code as a groundwater area separated from a larger regional groundwater system where salty groundwater may occur within the Upper Glacial aquifer. Discharge of industrial wastes in Waste Supply Sensitive Areas is restricted.

Orient also contains two estuaries of national importance, the Long Island Sound and the Peconic Estuary. An estuary is a partially enclosed body of water along the coast where freshwater from rivers and streams meets and mixes with salt water from the ocean.

1.4.3 Flood Zones

The FEMA 100 year flood plain boundary is present in the proposed service area as well as Sea, Lake and Overland Surges from Hurricanes (SLOSH) zones. SLOSH zones indicate the areas of flooding that could be anticipated from category 1 – 4 storms. Both of these features are shown on Figure 1.3.

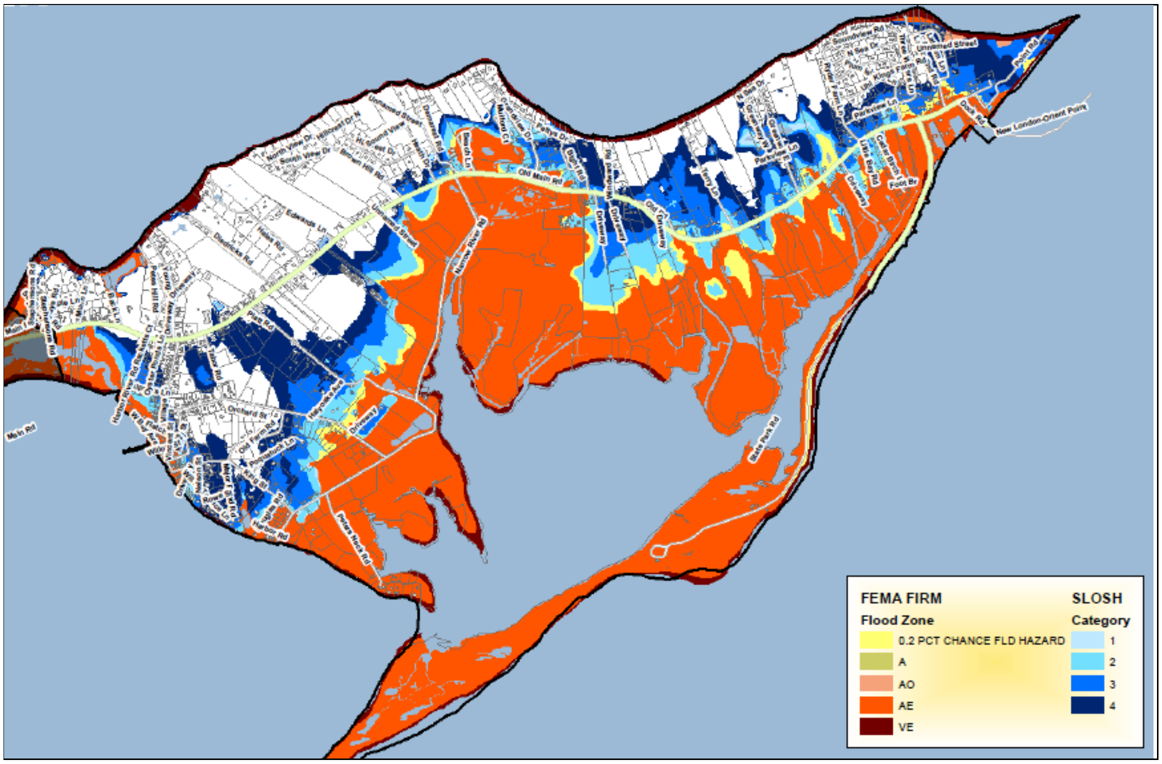

Figure 1.3 Orient Hamlet Floodplain & SLOSH Zones

Source: PGG with support from Southampton GIS Department

1.4.4 Geology/Topography/Soils

A soil map of the hamlet is shown in Figure 1.3. There are many soil types in and around the hamlet, the most prominent being: Haven, Montauk, Plymouth, Raynham, Riverhead, and Scio. A significant percentage of soils, approximately 15%, are classified as beaches (Bc)or tidal marsh (Tm). The following descriptions are based upon the USDA Natural Resources Conservation Service soil descriptions. Exact soil composition and extents requires field confirmation.

HaA, HaB, HaC – Haven loam is very deep, moderately well drained soil formed in glacial outwash plains. It consists of loamy glaciofluvial deposits over sandy and gravelly glaciofluvial deposits. This soil belongs to Hydrologic Soil Group B. Slope ranges from 0 to 12 percent.

MfB, MfC– Montauk fine sandy loam is somewhat shallow well drained soil formed in glacial moraines. It consists of loamy till over firm sandy till derived from crystalline rock. This soil belongs to Hydrologic Group B. Dense material is typically encountered at 18 to 38 inches. Groundwater is typically encountered at 16 to 36 inches. Slope ranges from 3 to 15 percent.

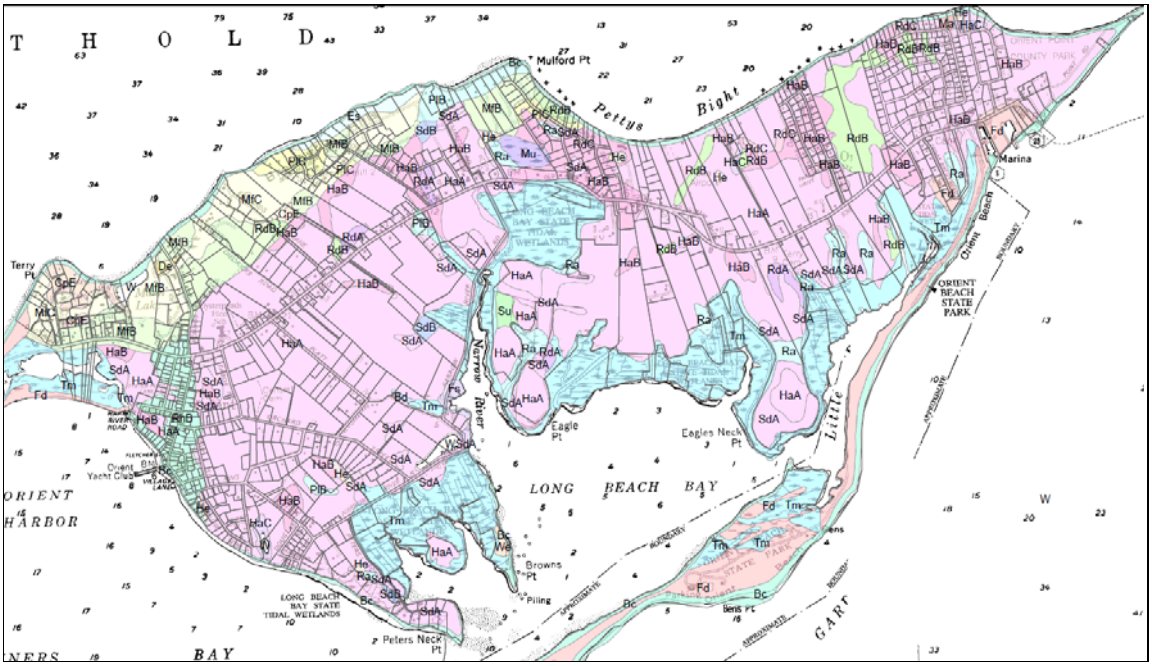

Figure 1.3 Orient Hamlet Soils **Source: GIS Data from Southampton GIS Department**

PlB, PlC- Plymouth loamy sand is deep, excessively drained soil formed in glacial outwash plains and moraines. It consists of acid sand glaciofluvial or deltaic deposits. This soil belongsHA to Hydrologic Group A.

Ra – Raynham Loam is deep, somewhat poorly drained soil formed in glaciolacustrian, eolian or old alluvial deposits comprised mainly of silt and fine sand. This soil belongs to Hydrologic Group B – D. Depth to water table is typically 6 to 12 inches.

RdA, RdB, RdC, RhB – Riverhead sandy loam is deep, well drained soil formed in glacial outwash plains and moraines. It consists of loamy glaciofluvial deposits overlying stratified sand and gravel. This soil belongs to Hydrogeologicl Group A.

SdA, SdB – Scio silt loam is somewhat deep, moderately well drained soils formed in lake plains. It consists of glaciolacustrian deposits, eolian deposits, or old alluvium, comprised mainly of silt and very fine sand. This soil belongs to Hydrologic Group B/D. Depth to water table is typically 18 to 24 inches.

Other than in areas of the North shore, topography is relatively level. Topography is shown in Figure 1.5.

Figure 1.5 Orient Hamlet Topography **Source: US Geological Survey Topographical Maps**

1.4.5 Groundwater

The depth to groundwater in the hamlet generally decreases from North to South as shown in Figure 1.6.

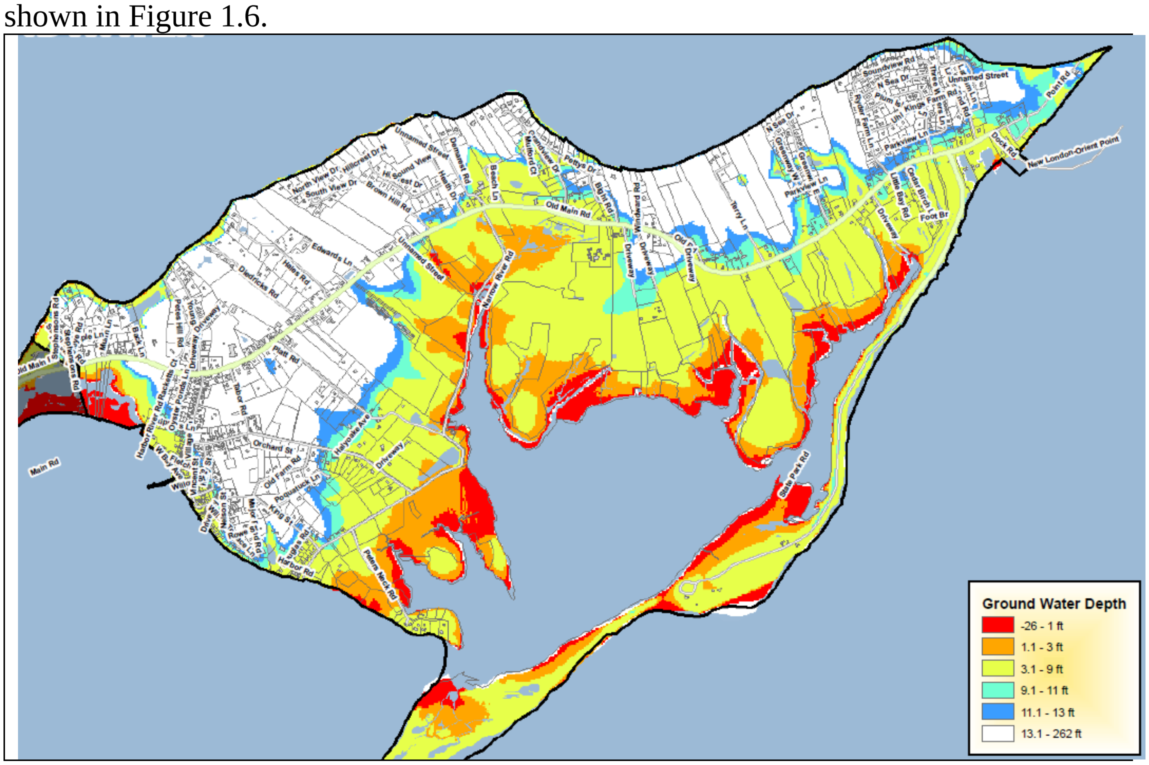

Figure 1.6 Depth to groundwater **Source: PGG with support from Southampton GIS Department**

It is important to note that groundwater elevations provided in Figure 1.6 have been modified to address impacts by septic system design, but regardless, show the general trend of increasing depths.

1.4.6 Land Use/Zoning

Orient is within the Town of Southold. Southold's zoning laws enable the Town to regulate specific types of development. The zoning districts present in the hamlet are described below:

Residential Low Density District (R40)

- Several residential areas throughout Orient.
- Minimum 1 acre lot

Residential Low Density District (R80)

- Several residential areas throughout Orient.
- Minimum two acre lot

Residential Low Density District (R200)

- Area south of Route 25, eastern end of Orient.
- Minimum lot size of 5 acres

Residential Low Density District (R400)

- Orient Beach State Park
- Minimum lot size of 10 acres

Hamlet Density Residential District (HD)

- One lot north of Route 25, near Orient.
- No specified minimum lot size

Resort Residential (RR)

- One parcel on Main Street, near the center of Orient.
- Zoning to provide opportunity for resort development in waterfront areas or other appropriate areas

Hamlet Business District (HB)

- Parcels at the center of Orient.
- Zoning to provide for business development in Orient central business areas

General Business District (B)

- Parcels near the center of Orient.
- Zoning to provide for retail and commercial business development

Marine I District (MI)

- Two coastal parcels in the western portion of Orient.
- Zoning to provide a waterfront location for water related uses on Town creeks and coves

Marine II District (MII)

- One coastal parcel in the eastern portion of Orient.
- Zoning to provide a waterfront location for water related uses on major waterways.

The Town zoning indicates that municipal uses are permitted by right in most areas, except Hamlet Density Residential where the specific use is not indicated as in all other areas. Figure 1.7 provides the zoning districts in and around the service area.

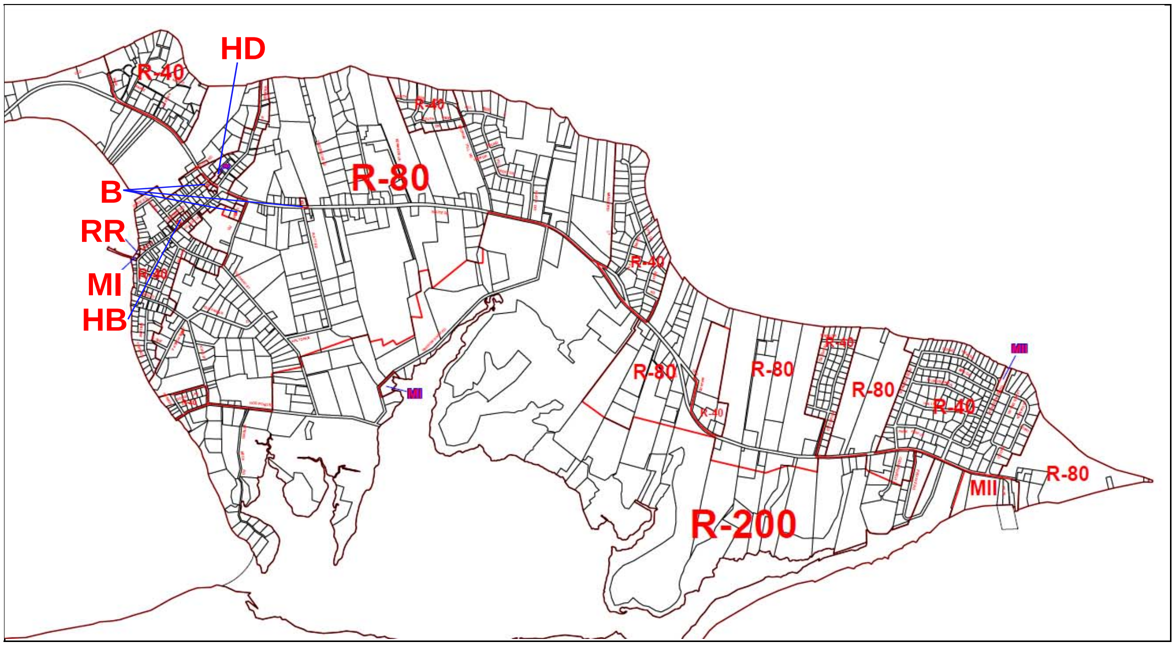

Figure 1. 6 Orient Hamlet Zoning Source: Town of Southold Zoning Map

SECTION 2 WASTEWATER SYSTEM ALTERNATIVES

2.1 INDIVIDUAL DISPOSAL SYSTEMS

In many portions of Orient continued use of individual homeowner on-site systems may be appropriate and cost-effective. For parcels in areas with low development density, suitable soils, and a deep depth to groundwater may have conditions that can support continued use of properly designed and constructed individual septic systems.

Smaller lots in areas with dense development would require alternative technologies to provide an acceptable level of treatment to protect drinking water and environmental quality. Several alternative treatment systems discussed in the upcoming Section 2.4 are manufactured in sizes appropriate for use by individual homeowners. Please refer to Section 2.4 for more information on these units.

Alternative treatment systems require mechanical equipment (blowers and/or pumps) in order to operate effectively and, as a result, require more periodic maintenance than a conventional septic system. Typically a licensed operator will need to perform annual or biannual maintenance.

On parcels with very small, non-conforming lot sizes which have no remaining room for an appropriate treatment or disposal areas, upgrades to septic systems will not be effective in correcting current wastewater effluent quality deficiencies. Because upgrades to individual septic systems alone are not expected to be sufficient for all of Orient, other wastewater disposal improvements have been described in the following sections.

2.2 WASTEWATER COLLECTION SYSTEMS

There are generally two different types of wastewater collection systems: conventional and alternative.

2.2.1 Conventional Collection System

A conventional collection system consists of gravity piping, typically PVC, installed by an open trench method. This involves removing paving or sod on the ground surface, excavating to depths of 5 – 12 feet (typically, can be deeper) installing crushed stone bedding, installing rigid PVC pipe, backfilling and repairing the disturbed surface. Gravity piping must be installed carefully to maintain a constant downward slope. Access for inspection and cleaning is by pre-cast concrete manholes. Generally the smallest gravity main is 8-inches with a minimum slope of 0.4%.

Gravity systems are appropriate when there is sufficient grade to ensure required pipe slopes. However, since maintaining slope is vital to these systems, open trench construction is necessary. Open trench construction in shallow cross-country routes with sufficient space and only requiring loaming and seeding for repair can be very cost effective. Open trench construction through congested paved areas can have expensive restoration costs.

If gravity collection systems do not allow for conveyance to the treatment site, gravity piping will discharge to a pump station. Conventional pump stations typically consist of a pre-cast concrete wet well with two submersible wastewater pumps. Pump stations discharge to a smaller diameter forcemain. Minimum sanitary forcemain diameter is 4-inches. Pumps must maintain a flow velocity of 2 fps. Sanitary forcemain must have clean out structures every 400 – 500 feet and may require air release structures at high points.

2.2.2 Alternative Collection Systems

A significant difference between conventional and alternative collection systems is the use of septic tanks. Septic tanks are typically plastic or concrete tanks which detain raw wastewater discharge from a building service. The tank is baffled which allows solids to settle to the bottom of the tank, and floatable material to form a scum layer at the top of the tank. Wastes in the tank are decomposed by aerobic digestion. Wastewater water leaving the tank, septic tank effluent, is of improved quality as solids remain with the septic tank. Septic tanks must be pumped regularly (typically every 3 – 7 years) or solids will build up in the tank and discharge in the effluent.

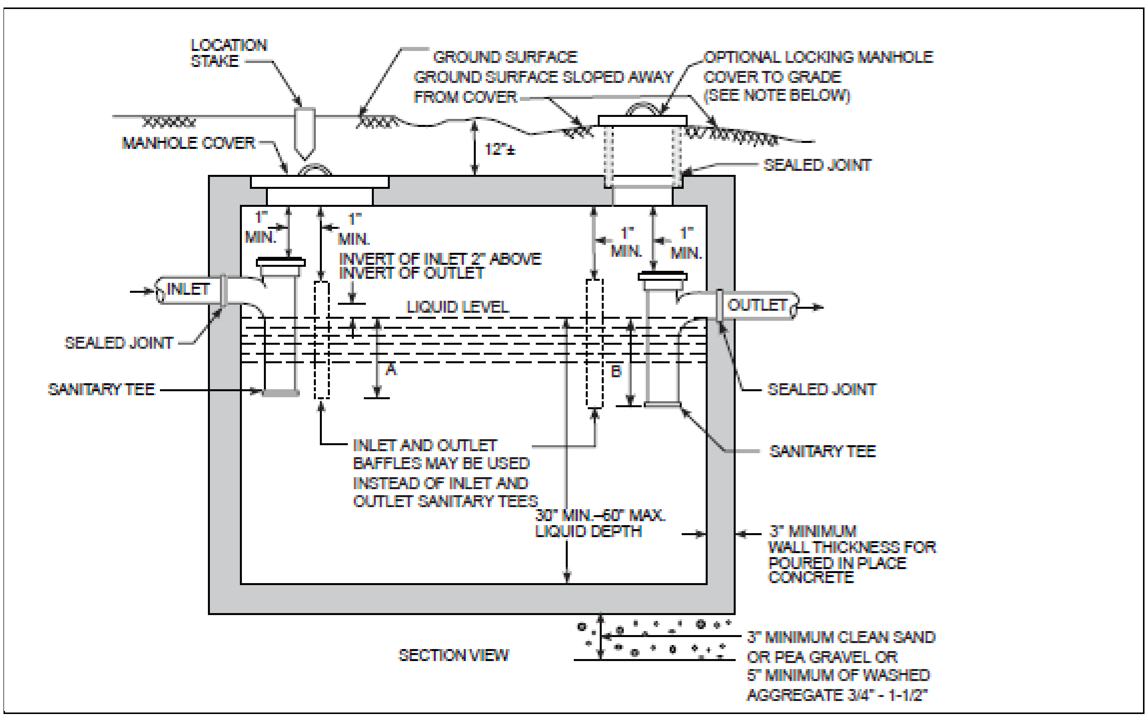

Figure 2.1 Typical Septic Tank **Source: NYS Department of Health**

While conventional wastewater collection systems convey raw wastewater, alternative collection systems typically convey septic tank effluent.

There are alternative gravity and pressure collection systems. Septic tank effluent gravity (STEG) systems use small diameter gravity collector lines to convey septic tank effluent to a treatment location. These gravity lines have a minimum diameter of 4-inches and no minimum slope but typically have a minimum velocity of 0.5 fps. Gravity lines have the advantage of not requiring any power to operate, and will continue to provide appropriate wastewater service even in cases of electricity outages.

Low pressure sewers consist of smaller diameter force main through which sewer flow is pumped. Septic tank effluent pumps (STEP) or grinder pumps force wastewater through the main regardless of pipe slope. Low pressure sewers can be installed by conventional open trench methods, but smaller diameter piping can also be installed by directional drilling. Directional drilling utilizes exit and entry pits, and access for service connections, but does not disturb the ground surface over the entire pipe length, significantly reducing restoration costs. The minimum diameter for low pressure sewer piping is 2-inches and there are no minimum slope requirements. Similar to conventional sanitary forcemain, low pressure sewers must have regular clean out structures and may require air release valves at high points.

2.3 WASTEWATER TREATMENT SYSTEMS

Consistent with collections systems, wastewater treatment systems can be divided into two categories; conventional and alternative systems.

2.3.1 Conventional Treatment System Description

Many communities have 'conventional' treatment systems which generally consist of the following components:

- Primary treatment for the removal of solids
- Secondary treatment which typically consists of biological treatment for the removal of additional contaminates
- Tertiary treatment for further removal of contaminants by biological, chemical or physical means
- Disinfection by chemical treatment or by UV light, and
- Discharge to a surface water body or groundwater.

According to the 2012 Report on the Sewage Treatment Plants of Suffolk County, there are 43 municipal plants, 34 of which are considered tertiary plants due to nitrogen removal in their treatment processes. Of these municipal plants, 16 discharge to surface waters.

The largest municipal operator is the Southwest Sewer District which operates 21 municipal treatment plants in Islip, Babylon and Huntington with sizes ranging from 0.035 to 30.5 million gallons per day (mgd).

Figure 2.2 Bergen Point WWTP, West Babylon, NY **Source: Bing Maps**

2.3.2 Alternative Treatment System

Alternative treatment systems typically include:

- Use of individual septic tanks for solids removal and primary treatment,
- Use of several treatment locations for one community,
- Packaged modular secondary/tertiary biological treatment units located at a regional locations near denser development/neighborhoods
- Subsurface discharge

Figure 2.3 Alternative Treatment, Dix Hills, NY **Source: Newsday**

2.3.3 Treatment System Comparison

There are several differences between the two treatment plant types. Significant differences include:

- Sludge Management
- Piping Costs
- Operation & Maintenance

One of the most challenging aspects of a conventional wastewater treatment system is solids handling. Conventional wastewater treatment systems typically consist of screening for large solids removal, comminutors, large above ground settling basins to remove the remaining solids, pumps to remove the collected solids, digesters to further break down sludge or mechanical dewatering devices and then loading facilities for trucking to conventional landfills. These components are generally expensive to build and operate especially at a small scale.

With many alternative treatment systems, solids removal occurs at each parcel or a combination of a few parcels. This allows typical residential septic tank pumpers and haulers to handle solids removal and disposal. Typically the community is responsible for all maintenance of septic tanks, ensuring that efficient solids removal is occurring. However, this does require the community to obtain easements from the parcel owner to be able to access and maintain the septic tanks. In Suffolk County there are several wastewater treatment plants which accept wastewater from pumped septic tanks from licensed septic haulers.

By removing solids before the wastewater is conveyed to a treatment location, a wastewater collection system can be sized at a smaller diameter, lowering installation costs. For instance gravity lines can be reduced to 4-inches where an 8-inch diameter is normally required. Pressure lines can be reduced to 2-inches where 4-inches would normally be required.

However, septic tank effluent systems that utilize pumping may be difficult to manage during power outages. Frequently, a home with no municipal wastewater services has no municipal water service either. Thus if a power outage occurs, the well is without power, as well as the wastewater system pump. If a home has a generator, it typically will be sized to accommodate the well pump, as well as the wastewater pump, also avoiding a conflict. However, if a home with municipal water service, which typically remains unaffected by power outage also, has septic wastewater pumps as part of an alternative collection system, there may be a continued source of wastewater, with no means of pumping. If a sustained power outage lasted for several days, the municipality would need to pump each septic tank into the collection system. For a conventional collection system, this would require simply providing emergency power at a central pump station, rather than requiring service at many individual systems. Both conventional and alternative systems that utilize gravity collection avoid these problems. All treatment systems, conventional and alternative, require emergency power at the main treatment location.

In general, conventional wastewater treatment facilities are treating higher flows, and have more complex treatment systems due to on-site sludge management. For proper operation, conventional wastewater treatment facilities require a full time licensed operator and generally at least one other trained staff member. Alternative treatment systems typically have smaller flows and simpler treatment systems, thus staff is usually part time.

Due to Orient's the rural nature, and the style of development which includes several densely populated areas separated by large areas of much smaller population, further consideration of decentralized treatment is appropriate. Additional information on alternative treatment technologies has been presented in the following section.

2.4 ALTERNATIVE TREATMENT TECHNOLOGIES

An alternative treatment system accomplishes treatment in two locations; primary treatment occurs in the on-site septic tanks, and secondary/tertiary treatment which occurs at a site where all the flow has been collected.

Treatment efficiency for small systems is generally characterized by their efficiency at removal of organic constituents and solids. The most commonly used parameter to define the organic strength of municipal wastewater is biochemical oxygen demand (BOD). BOD is the quantity of dissolved oxygen utilized by microorganisms in the aerobic oxidation of the organic matter in wastewater over a period of time. The depletion of dissolved oxygen in wastewater is directly related to the amount of organic matter present in the wastewater.

The quantity of solids in wastewater is typically expressed as total suspended solids (TSS). Suspended solids are those removable by filtration of settling. Wastewater may also have quantities of dissolved solids, which require additional treatment for removal.

Another parameter used to gauge the strength of wastewater is nitrogen. Common forms of nitrogen are ammonia, nitrite, and nitrate. Nitrogen is used by plants for photosynthesis, and is an important component in fertilizer. Large quantities of nitrogen in wastewater discharged to a water body can cause growth of algae. Ammonia is considered a serious water pollutant as it is toxic to fish. Nitrate can easily pass through the soil to the groundwater, where it can accumulate to high levels over time, potentially contaminating drinking water sources. Typically a permit for subsurface wastewater discharge will have limitations set on ammonia (NH_3). Typical individual disposal system absorption fields remove little or no nitrogen from the septic tank effluent.

Primary treatment by septic tank is effective at removing quantities of BOD and TSS and some nitrogen species. Table 2.1 below provides typical septic tank influent and effluent concentrations.

Table 2.1
Septic Tank Influent & Effluent Concentrations

Parameter	Influent Concentration	Effluent Concentration
BOD	350 mg/l	150 mg/l
TSS	400 mg/l	40 mg/l
NH_3-N	70 mg/l	50 mg/l
FOG	150 mg/l	20 mg/l

There are many suitable technologies available for wastewater treatment. However there are minimum criteria that each system must meet:

- Ability to meet regulatory effluent limits
- Suffolk County Department of Health Services familiarity with the system

Suffolk County has formally evaluated many innovation/alternative onsite sewage disposal system capable of denitrification, ranging from individual home systems to small plants with capacities of 30,000 gpd (approximately 100 homes). A summary of their evaluation is included in Appendix A. The following systems are approved for use in Suffolk County.

- Advantex by Orenco followed by Nitrex

- BESST by Purestream
- Bioclere by Aquapoint
- Commercial Treatment Unit by Waterloo Biofilter followed by Nitrex
- Cromaglass SBR Systems
- SeptiTech Commercial Unit followed by Lombardo Assc. Nitrex
- STM Aerotor by WesTech

Further phases of this study will evaluate the available technologies and recommend which may best meet the needs of the hamlet.

2.5 WASTEWATER DISPOSAL SYSTEMS

Several alternatives exist for disposal of the treated wastewater effluent to the ground water;

- Seepage Pits/Subsurface Leaching Pools
- Open Recharge Beds
- Absorption Beds and Fields
- Shallow Narrow Drainfields
- Subsurface Drip Irrigation

2.5.1 Seepage Pits

The most common form of wastewater disposal in the hamlet is seepage pits. Seepage pits are typically used in Suffolk County as they are the smallest foot print of available wastewater disposal systems. Large portions of the hamlet also have a significant depth to groundwater, which is required for seepage pit usage. Groundwater depths are provided in Figure 1.6 in the previous Section. Seepage pits are perforated circular concrete structures which receive septic tank effluent. If sufficient distance between the seepage pit and groundwater exists, then microorganisms in the soil sufficiently treat wastewater effluent before it enters the groundwater. According to the Suffolk County Department of Public Works/Cornell Cooperative Extension of Suffolk County Stormwater Management Program failing seepage pits are the primary cause of nitrate contamination in the groundwater in high density residential areas.

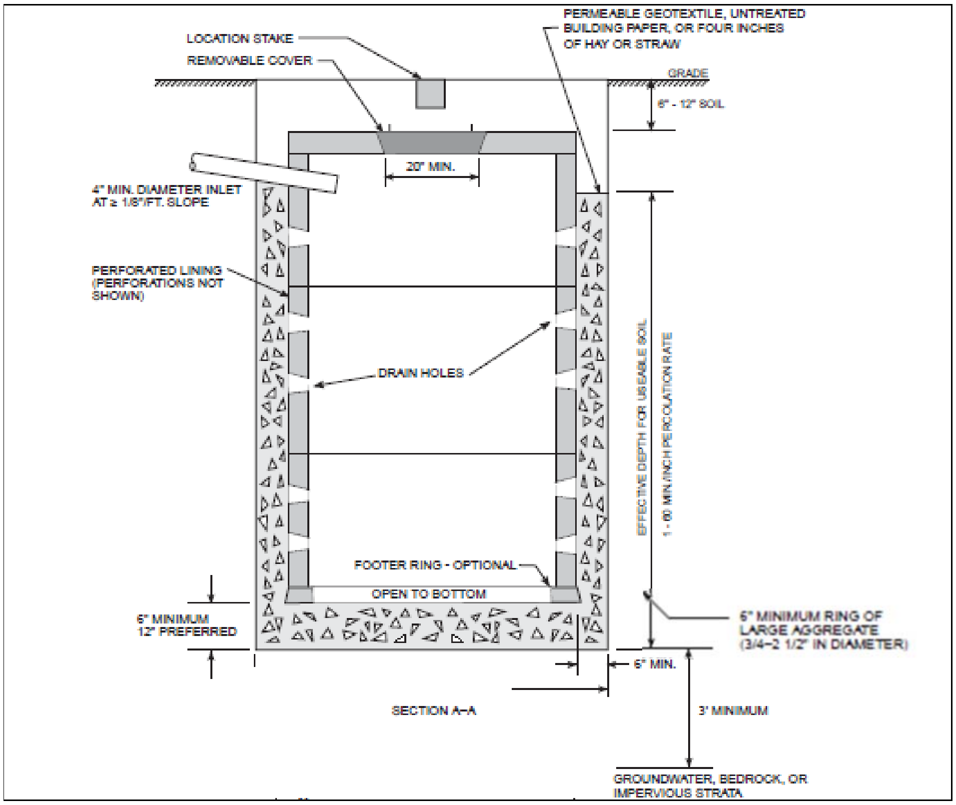

Figure 2.2 Seepage Pit **Source: NYS Department of Health**

Seepage pits are also indicated as acceptable by the Suffolk County Department of Public Works Division of Sanitation's Standards for Recharge of WWTP effluent as part of shallow and deep subsurface disposal methodologies.

2.5.2 Open Recharge Beds

Open recharge beds are included in the Suffolk County Department of Health Services – Appendix B "Standards for Approval and Construction of Sewage Collection System and Treatment Works" and noted in the Suffolk County Department of Public Works Division of Sanitation's Standards for Recharge of WWTP effluent as the preferred methodology. However utilization of this disposal method has been a contentious and arduous process for other facilities in Suffolk County, such as the propped usage on the SUNY Stony Brook Campus. The setbacks for these facilities are significant; 400' to buildings and 300' to property lines. There is poor public perception of these facilities in regard to the potential for odors and visual impact from the exposed pool of wastewater.

2.5.3 Absorption Fields and Beds

An alternative method for subsurface disposal is through the use of absorption fields or beds. Wastewater effluent is discharged by gravity or pressure into buried perforated PVC pipes which are surrounded by gravel. Absorption fields or beds are used to treat wastewater similarly to seepage pits, except the closer proximity to the ground surface makes the system more aerobic, and the wastewater is dispersed over a much larger soil surface area.

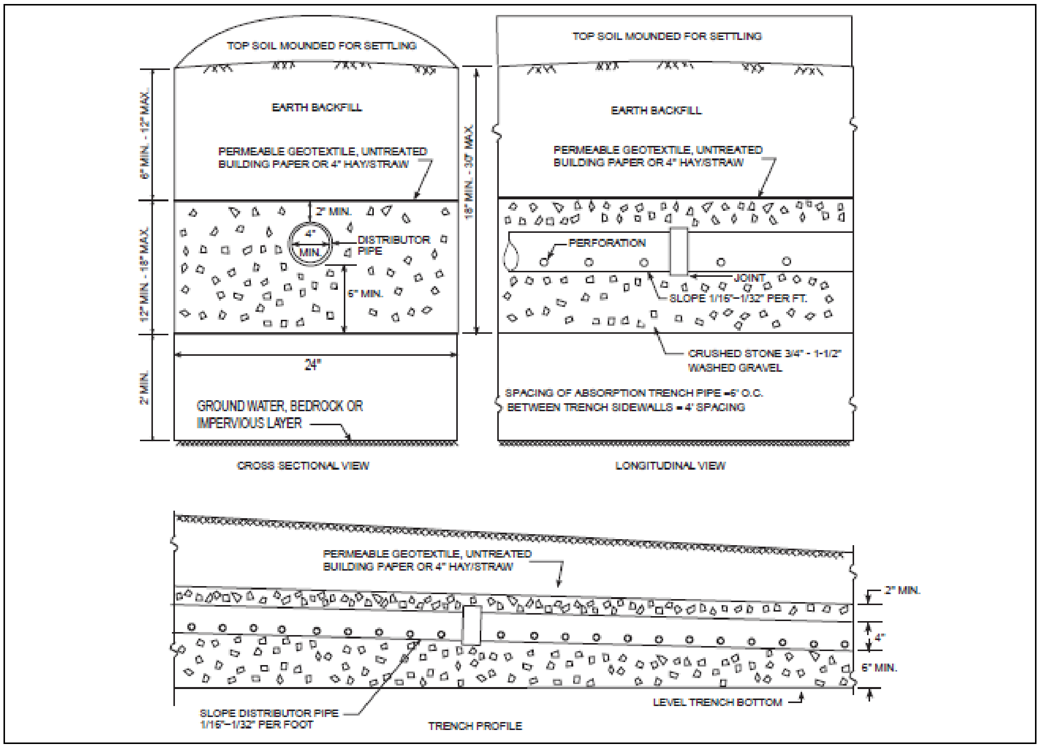

Figure 2.3 Absorption Field **Source: NYS Department of Health**

2.5.4 Absorption Fields and Beds

When any of the previously discussed absorption methodologies are used after secondary treatment, they are primarily intended for discharge of the treated effluent into the groundwater. However, there a dispersal method heavily researched by the University of Rhode Island and the Rhode Island Department of Environmental Management, Shallow Narrow Drainfields (SND), have been shown to effectively reduce nitrogen in effluent. SNDs have been studied in coastal regions of Rhode Island to evaluate their nitrogen reduction capabilities. This is important, as Rhode Island's coastal areas were formed geologically in the same fashion as long island, and typically have the same progressions of sandy areas, sandy loam, loam and silt loam. Additional information on SNDs is provided in Appendix B. In general, a 33% - 73% reduction in nitrogen is anticipated utilizing the SND.

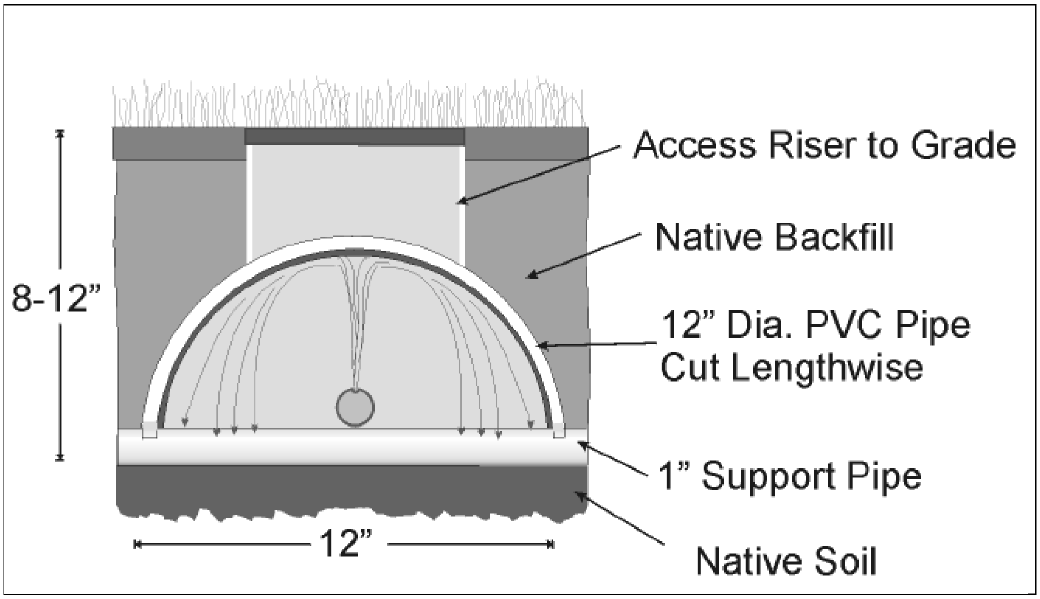

Figure 2.4 Shallow Narrow Drainfield Cross Section **Source: RI Dept. of Env. Management**

2.5.5 Irrigation Wastewater Reuse

Another potential methodology for disposing of treated wastewater effluent is subsurface drip irrigation. Subsurface drip irrigation technologies apply water to the root zone using perforated small diameter piping or porous diffusers, placed 6 to 12 inches below the soil surface.

Disposal of recycled water through subsurface drip irrigation will provide a valuable source of nitrogen for nursery stock, and an efficient water reuse method. Once the needs of the facility are better determined, a design could be completed that utilizes this appropriate technology.

Additionally, reclaimed wastewater can be utilized for spray or surface drip applications. Treatment would need to include UV disinfection.

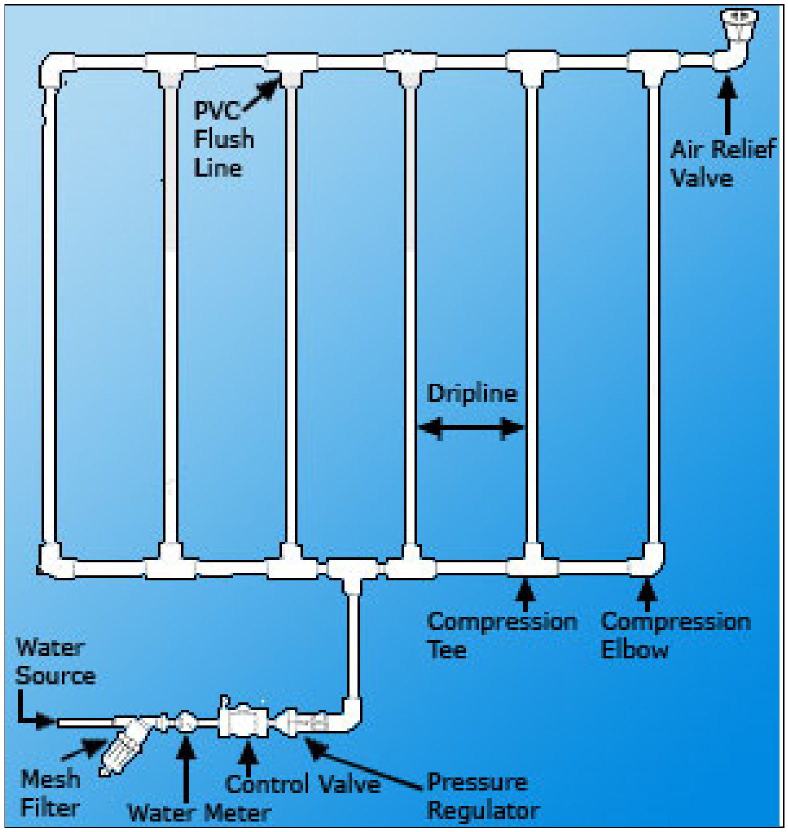

Figure 3.7 Drip Irrigation System **Source: Geoflow, Inc.**

2.6 WASTEWATER DISPOSAL QUALITY

Based upon data from the Suffolk County Department of Health, and the NYS Code of Regulations Part 703: Surface Water and Groundwater Effluent Limitations for community systems, the following discharge limits are presumed:

Table 2.2
Effluent Characteristics

Wastewater Component	Effluent
BOD_5	< 30 mg/l
TSS	< 30 mg/l
TDS	1,000 mg/l
pH	6.5 – 8.5
Nitrogen	< 10 mg/l

SECTION 3 TREATMENT SITE IDENTIFICATION

3.1 TREATMENT SYSTEM SITING CONSTRAINTS

Determining the correct siting for a wastewater treatment facility is challenging, however the use of alternative treatment technologies, with their low visual, audio and odor impact, allow for a much greater number of sites to be considered. Preliminary potential sites were identified by preliminary map review using the criteria provided in Table 3.1.

Table 3.1
Treatment Site Initial Screening

Criteria	Initial Screening
Vacant parcels with usable land less than 3 acres	Excluded
Occupied Parcels with less than 5 acres	Excluded. Assumes 5 acres needed to buffer existing house lot
100 year flood plains and SLOSH areas	Excluded
State and Federal Wetlands	Excluded
Streams, wetlands or protected water bodies	Excluded areas within 100’
Steeply sloped areas (>15%)	Excluded

Mapping showing each of the application of these criteria is found in Figure 3.1.

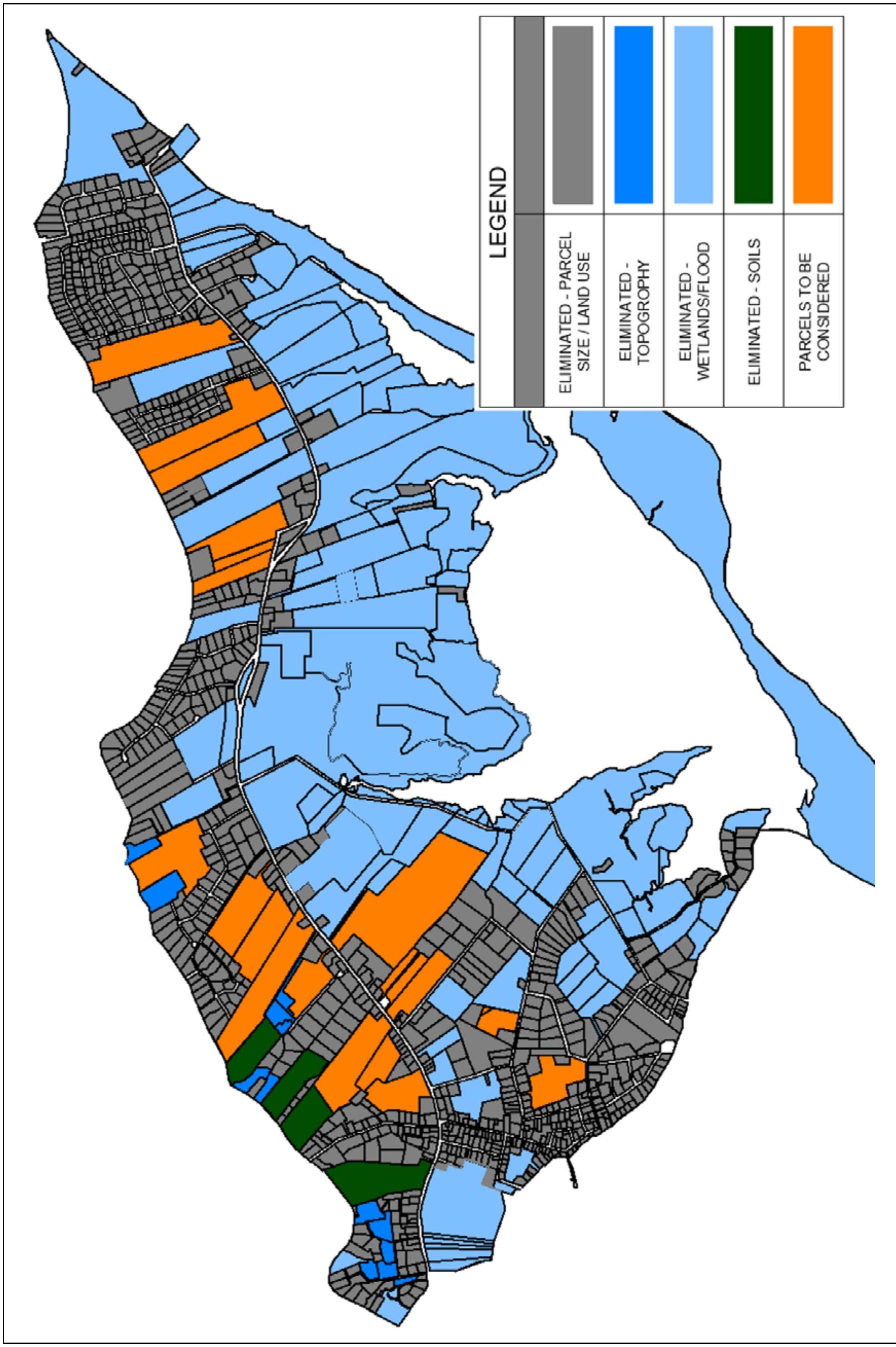

Figure 3.1 – Parcel Suitability for Wastewater Disposal

Based upon the parcels eliminated by the criteria presented in Table 3.1, twenty sites acceptable for wastewater treatment, based upon land review only, were determined and are presented on Table 3.2, from West to East.

Table 3.2
Potential Wastewater Treatment Sites

Parcel #	Tax Map #	Property Owner	Property Location	Acres	Comment
1	2500.400.11009	Morton	Orchard St.	13.5	Nursery in Ag district, parcel in SLOSH, may have subdivision plans
2	2700.100.2003	Guadagno	Orchard St.	6.0	Farmed field in Ag. District, small portion of parcel in SLOSH, may have subdivision plans
3	1800.200.23001	Oysterponds School District	Route 25	12.9	School playing fields behind school building
4	1800.200.33000	C&P Healy Corp	Route 25	8.0	One large structure
5	1800.200.34000	Boyle	Route 25	22.3	Several large structures
6	1800.600.4001	Latham	Platt Road	11.7	Ag District, garage, farmed fields, portion of parcel in SLOSH
7	1800.600.5002	Apostle Trust	Route 25	4.2	Ag District, farmed fields, Suffolk County owns development rights
8	1800.600.5003	Apostle Trust	Route 25	3.1	Ag District, farmed fields, Suffolk County owns development rights
9	1800.600.14009	Khedouri Ezair Corp.	Route 25	62.4	Ag District, farmed/fallow fields, southern half of parcel in SLOSH, Town of Southold owns development rights
10	1800.300.9009	Caslenova	Route 25	11.3	Ag District, farmed/fallow fields, Suffolk County owns development rights
11	1800.300.30003	N. Brown LLC	Route 25	28.5	Ag District, farmed fields
12	1800.400.1003	Oysterponds Corp.	Route 25	16.8	Ag District, farmed fields, Peconic Land Trust Preservation Easement
13	1800.400.7007	Sepenoski Family Farm LLC	Route 25	18.8	Ag District, farmed fields, Town of Southold owns development rights
14	1300.200.8002	Benjamin	Heath Drive	22.8	Ag District, farmed fields
15	1400.200.29003	Orient West LLC	Old Road	8.7	Farmed field, southern portion of parcel in SLOSH
16	1400.200.29004	Orient Point LLC	Old Road	4.6	Farmed field with barn, southern portion of parcel in SLOSH

Table 3.2 (cont.)
Potential Wastewater Treatment Sites

Parcel #	Tax Map #	Property Owner	Property Location	Acres	Comment
17	1900.200.12002	Orient East LLC	Old Road	16.8	Fallow field, landing strip, southern portion of parcel in SLOSH
18	2000.100.2002	Whitsit	Terry Lane	19.2	Ag District, farmed fields, portion of parcel in SLOSH, Protected Town of Southold open space
19	2000.100.3007	Egan	Route 25	30.6	Ag District, farmed fields, wooded area, portion of parcel in SLOSH, Protected Town of Southold open space
20	1500.200.17006	Amelias Sound Properties Inc.	Route 25	32.3	Fallow field, southern portion of parcel in SLOSH

These sites are shown on Figure 3.2.

Figure 3.2 Potential Wastewater Treatment Sites

3.2 PRELIMINARY PARCEL SCREENING

After the parcels identified by the matrix constraints were determined, additional review of the parcels was completed. Based upon more detailed review of land use and other constraints, additional parcels were excluded from further review.

The most common cause for exclusion was active farming of food crops. Food crops are annual planting which require plowing and replanting every year. This would be a high potential for disturbance of any wastewater disposal system. Also, utilizing wastewater for irrigation of edible products requires additional treatment including filtration and disinfection which would significantly impact treatment costs.

Table 3.3
Preliminary Wastewater Treatment Site Screening

Parcel #	Property Owner	Comment	Action
1	Morton	Nursery use may be compatible with wastewater disposal, parcel in Ag. District, 4.8 acres of parcel in SLOSH leaving 8.7 acres.	Include in further study
2	Guadagno	Fallow field or pasture Ag. District, <0.5 acre parcel in SLOSH leaving 5.5 acres available for disposal, Ag district requirements must be adhered to	Include in further study
3	Oysterponds School District	Elementary School playing fields behind school building, wastewater disposal in playing field is compatible use. Advantage of not being in Ag. District.	Include in further study
4	C&P Healy Corp	This parcel appears to be a horse farm.	Include in further study
5	Boyle	This parcel appears to be a horse farm.	Include in further study
6	Latham	This parcel appears to be a vegetable farm.	Exclude from further analysis
7	Apostle Trust	This parcel appears to be a berry farm.	Exclude from further analysis
8	Apostle Trust	This parcel appears to be a berry farm	Exclude from further analysis
9	Khedouri Ezair Corp.	Over 20 acres are not in SLOSH. Town development rights.	Include in further study
10	Caslenova	Ag District, County development rights.	Include in further study
11	N. Brown LLC	The southern portion of this is a plowed farm field. Plowing would be incompatible with effluent disposal. The northern portion of this parcel is mature trees.	Exclude from further analysis
12	Oysterponds Corp.	This parcel is a plowed farm field. Plowing is incompatible with effluent disposal.	Exclude from further analysis
13	Sepenoski Family Farm LLC	This parcel is a plowed farm field. Plowing is incompatible with effluent disposal.	Exclude from further analysis
14	Benjamin	This parcel appears to be a vineyard.	Exclude from further analysis
15	Orient West LLC	This parcel is a plowed farm field. Plowing is incompatible with effluent disposal.	Exclude from further analysis

16	Orient Point LLC	This parcel appears to be a fallow field. If no longer used regularly for agriculture, maybe available for disposal. This parcel is not in the Ag. District.	Include in further study
17	Orient East LLC	This parcel appears to contain brush to mature trees. This parcel is not in the Ag. District.	Include in further study
18	Whitsit	Parcel is a plowed field in the Ag. District, Town protected open space.	Exclude from further analysis
19	Egan	The southern portion of this is a plowed farm field in SLOSH zone. The northern portion is mature trees. Town protected open space.	Exclude from further analysis
20	Amelias Sound Properties	Fallow field with southern portion in SLOSH.	Include in further study

As provided in the Suffolk County Department of Health Services – Appendix B "Standards for Approval and Construction of Sewage Collection System and Treatment Works", the following assumptions were made in regard to the treated wastewater effluent disposal:

- 2.3 gpd/sq ft application rate. Per Suffolk County guidance a 5 gpd/sq ft application rate is permissible (10 gpd/sqft is permitted with filtered wastewater), but without detailed treatment process analysis, we are recommending use of a use more conservative number)
- a 100% reserve/expansion area
- a minimum 25' setback to property lines
- a minimum 100' setback to surface waters or wetlands
- a minimum 200' setback from surrounding wells (assumed 200' from property line on small adjacent parcels and assumed to be in general area of building on large buildings on adjacent parcels)
- A field efficiency of 30% was assumed. This means that of the available area, it was assumed that 30% was actually used as disposal area, and the remaining was separation between disposal practices, areas where manifold piping was, and other spacing.

Table 3.3 provides the estimated wastewater disposal capability of each parcel.

Table 3.4
Preliminary Wastewater Disposal Capacity

Parcel ID	Total Area (acres)	Useable Area (acres)	Field Area (acres)	Absorption Area (sf)	Disposal Capacity (gpd)
1	13.5	0.70	0.35	4,590	10,557
2	6	3.72	1.86	24,300	55,890

3	12.9	2.11	1.06	13,800	31,740
4	8	4.41	2.20	28,800	66,240
5	22.3	9.11	4.56	59,550	136,965
9	62.4	17.93	8.96	117,150	269,445
10	11.3	3.97	1.99	25,950	59,685
16	4.6	1.49	0.75	9,750	22,425
17	16.8	2.55	1.27	16,650	38,295
20	32.3	4.06	2.03	26,550	61,065

Each of the considered parcels is presented in the following Figures 3.3 – 3.9.

Figure 3.3 –Parcels 1 & 2

Figure 3.4 Parcels 3, 4 & 5

Figure 3.5 – Parcel 9

Figure 3.6 – Parcel 10

Figure 3.7 – Parcel 16 & 17

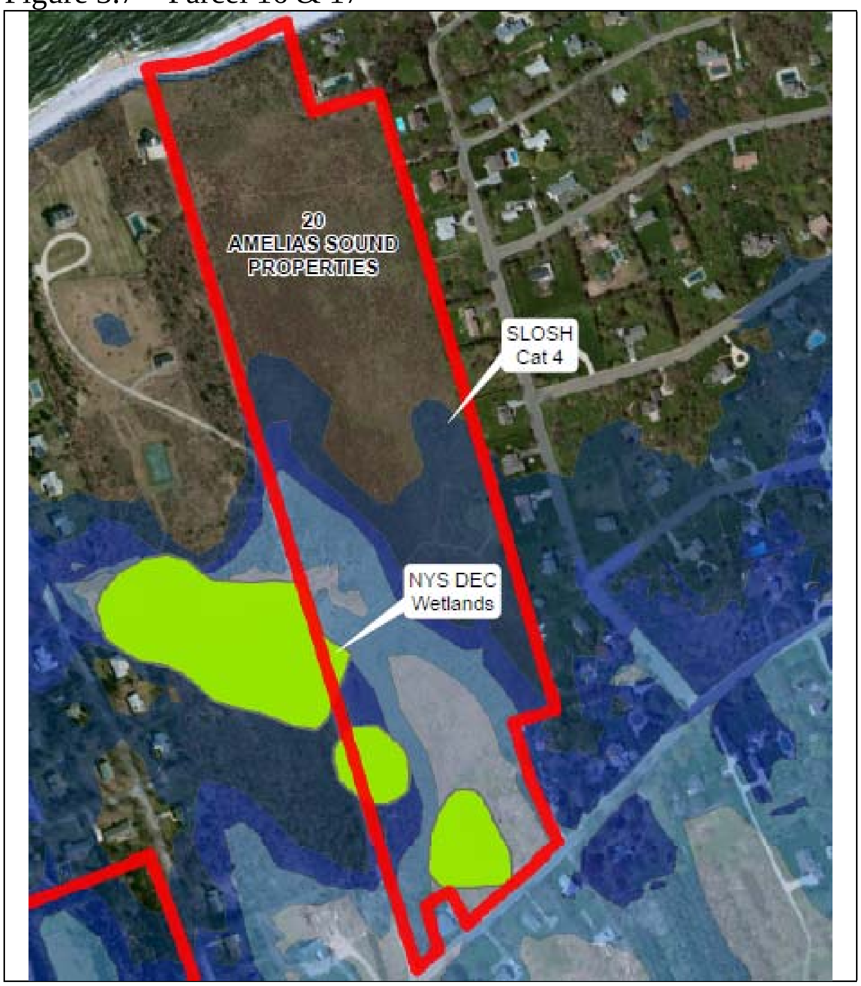

Figure 3.8 – Parcel 20

3.3 ADDITIONAL PARCEL CONSIDERATIONS

There are restrictions of working on certain types of properties, especially those classified as parks or agricultural districts. These restrictions are described below:

3.3.1 Park Land

As explained in the New York State Office of Parks, Recreation and Historic Preservation's Handbook on the Alienation and Conversion of Municipal Parkland in New York, "Once land has been dedicated to use as a park, it cannot be diverted for uses other than recreation, in whole or in part, temporarily or permanently, even for another public purpose, without legislative approval." The handbook specifically recommends that municipality should obtain alienation legislation for "The granting of temporary or permanent easements for the installation of underground facilities such as water and sewer pipelines even when the surface of the land will be restored and continue to be used for park and recreational purposes". The New York State Legislature routinely passes underground easement related alienation bills, and this fact would give a court a basis for finding such an easement to be an alienation. The New York State Attorney General's Office has the ability to bring action against a municipality that does not comply with proper legislative procedures.

Legal counsel should be sought to advise on this matter.

3.3.2 Agricultural Districts

Parcels located within Agricultural District No. 1 must comply with Agriculture and Markets Law Section 305, Subdivision 4 as required by 1 NYCRR Part 371. These regulations specify that a preliminary and final notice of intent must be filed with the Commissioner of Agriculture and Markets of NYS and county agricultural and farmland protection board before initiating an action, with "action" specifically defined as "The construction by a State agency, public benefit corporation or local government, within an agricultural district, of dwellings, commercial or industrial facilities, or water or sewer facilities to serve non-farm structures." The notice of intent contents include important information about the parcel in the agricultural district and the proposed usage which is specifically identified in Part 371. It must be filed at least 65 days before any action is commenced. The Commissioner will determine if alternatives are available that avoid impacts to the farmland and can propose alternative actions. It is also possible for the Owner of the parcel to sign a document waiving the requirement for notice of intent filing which provides the commissioner the name of the purchasing parties, the address and specifically states the intent of the waiver. It is recommended that legal counsel research the required steps needed to use a portion of a parcel in an Agricultural District for wastewater treatment and disposal.

3.3.3 Development Rights

In a purchase of development rights program, a landowner voluntarily sells the parcels development rights to a governmental agency or land trust. In the case of farmland, the agency typically pays the farmer the difference between the agricultural value of the land, and the land's potential development value. When the property is sold, an easement which restricts the use of the land for agricultural uses incorporated in the title. Private ownership of the parcel is maintained.

There are several parcels where development rights of the parcel have been purchased by the Town or County. Easements on development rights are not consistent from parcel to parcel, but most easements limit use of property to agricultural production. While certainly it seems that some form of agricultural production could be maintained while also using the property for wastewater disposal, it is likely to be a challenging process to utilize parcels with development right easements for wastewater disposal purposes. These parcels include: parcel #9, Khedouri Ezair Corp., and parcel #10, Caslenova. While these parcels have been included on the list for further study, legal review of the specifics of the easements for these two parcels should be completed to determine siting feasibility.

SECTION 4 PROJECT ADVANCEMENT

4.1 ADDITIONAL STUDY PHASES

To complete the Wastewater Feasibility Report, the following additional phases are recommended.

4.1.1 Treatment Site Identification

The effort to identify appropriate treatment sites should continue with onsite soils review of each of the feasible sites needs to be completed to confirm the NRCS soil data. A biologist may need to complete the wetlands delineation.

4.1.2 Collection and Treatment Alternative Evaluation

In concert with continuing to refine acceptable treatment sites, a complete analysis on the collection and treatment methodologies presented in this report needs to be completed and a preferred treatment alternative identified. The analysis should be based upon costs, regulatory compliance, and appropriateness for the community and expandability. As there are significant difference in space requirements, identifying the preferred technology will impact capacity of feasible disposal parcels, thus both aspects need to be considered together.

4.1.3 System Recommendations

Combining the results of the parcel identification, and the collection and treatment system analysis a comprehensive wastewater approach for the 7 districts should be completed, and project phasing should be recommended.

4.1.4 Costs & Funding

The engineering report should include:

- An estimate of probable construction and operation and maintenance costs for the recommended alternative.
- An estimate of sewer use rates for each parcel using the Equivalent Dwelling Unit (EDU) methodology.
- The funding required to reach the maximum rate of $500 per EDU will be calculated.

4.1.5 Implementation

The report should present any additional tasks that will need to be completed before design could begin. These could include: regulatory agency concurrence, wetlands delineation, additional subsurface exploration, easement procurement, and SEQR preparation and submission.

SECTION 5 REFERENCES

Standards for Approval of Plans and Construction for Sewage Disposal Systems for Other than Single-Family Residences, Suffolk County Department of Health Services Division of Environmental Quality, 2008.

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APPENDIX A
ALTERNATIVE ON-SITE SEWAGE DISPOSAL SYSTEMS – EXECUTIVE SUMMARY

SUFFOLK COUNTY, NEW YORK
DEPARTMENT OF HEALTH SERVICES
OFFICE OF WASTEWATER MANAGEMENT

ALTERNATIVE ON-SITE SEWAGE DISPOSAL SYSTEMS

TASK IX–SUMMARY REPORT

H2M Project No.: SCHS 09-01

Draft: August 2012

Final: February 2013

Prepared by:
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EXECUTIVE SUMMARY

The Suffolk County Department of Health Services (SCDHS) retained the services of Holzmacher, McLendon and Murrell, P.C. (H2M) to determine the feasibility of instituting alternative on-site wastewater treatment systems into decentralized sewered communities or in single family residential properties that could better manage total nitrogen discharged to groundwater. The project objective, as stated in the County's Request for Proposal, is to investigate the performance, installation and design costs, economic benefits, and operation and maintenance requirements for alternative on-site sewage disposal systems for projects generating a flow less than 30,000 gpd. The investigation was broken down into two different treatment categories. The first category was defined as single-family residential dwellings with flows from 300 to 1,000 gallons per day (GPD); the second category was defined as other than single-family comprised of commercial, industrial, or high-density residential properties, with flows from 1,000 GPD to 30,000 GPD. For the purposes of this report, the first flow category will be referred to as residential applications, while the second flow category will be referred to as commercial applications.

The investigation was broken down into the following nine (9) tasks composed of reports and progress meetings with the Department.

- Task I, III, V, VI – Progress meetings to discuss previously submitted Task Reports
- Task II – Review of Standards, Codes, and Regulations for On-Site System Technologies
- Task IV A and B – Selection, Sampling, and Evaluation of AOSSDS
- Task IV C – System Assessment and Acceptance using SCDHS Requirements
- Task VI – Cost and Benefit Analysis
- Task VIII – Evaluations of Conditions and Restrictions Under Which AOSSDS are Permitted for use in Massachusetts, Rhode Island, New Jersey, and Maryland
- Task IX – Study Summary, Findings and Recommendations

Overall study conclusions and recommendations for the individual residential applications:

- The Nitrex^{TM} System was the only on-site treatment system that consistently met the 10 mg/l total nitrogen discharge requirement.
- Suffolk County currently utilizes the practice of limiting the building density in order to protect both the drinking and surface water supplies in addition to conventional sanitary systems.
- At this point in time, further study and modeling are necessary to determine if additional nitrogen controls are required and to what extent. This companion study is currently in the planning stage.
- There are numerous policy concerns with the proposed use of treatment systems for individual residences. These deal not only with potential public health nuisances, but also with various

social and economic concerns that transcend the purview of Department of Environmental Quality (DEQ) – especially since the goal is generally surface water protection, rather than strictly public health and drinking water.

- Ultimately, once DEQ is able to provide facts grounded in science, issues can be fully vetted by policymakers in an informed manner to support a reasoned and systematic regional approach to treatment on individual residences, with the goal of garnering public support and implementation funding.

Overall study conclusion and recommendations for commercial projects:

- The Nitrex™ System, Aqua Point – Bioclere®, WesTech's STM-Aerotors™, and BESST technologies were added to the list of technologies that the Department would approve.
- Cromaglass, SBR, and MBR technologies are currently approvable technologies.
- For larger communal systems (i.e. commercial property or small housing clusters), the owners could propose to install an alternative system as a demonstration system providing that the project is within the sanitary density permitted under Article 6 of the Suffolk County Sanitary Code and that the proposed system is in conformance with separation distances as specified in Appendix A of the Commercial Standards.

APPENDIX B
PRESSURIZED SHALLOW NARROW DRAINFIELDS

SEASONAL VARIATION IN NITROGEN LEACHING FROM SHALLOW-NARROW DRAINFIELDS

S.A. Holden[1], M.H. Stolt[2], G.W. Loomis[3], and A.J. Gold[4]

ABSTRACT

Nitrogen removal from septic tank effluent is one of the most pressing issues in coastal areas undergoing growth and development. Seven home-sites using onsite wastewater treatment systems were monitored in coastal Rhode Island to examine N treatment and leaching. The primary treatment units at these sites include: geo-textile filters; recirculating sand filters; single pass sand filters; a fixed activated sludge treatment system; and a modular peat filter. The final treatment step of all of these systems is a pressure-dosed shallow-narrow drainfield (SND). This paper focuses on N-removal by the SND serving these sites (treatment performance of the secondary treatment units will be delivered in a separate paper). Sites vary in age from four to six years. Five suction-cup lysimeters were installed at each site, three within the SND and two within a control plot (i.e., outside the drainfield area). In the SND, lysimeters were installed in the undisturbed soils adjacent to each trench at a depth of 30 cm below the drainfield lines. Control lysimeters were placed at 70 cm below the soil surface. Soil porewater samples were collected through the lysimeters twice seasonally from the winter of 2001 until the summer of 2003 and analyzed for total N. Average concentrations of N entering the groundwater for these seven sites ranged from 2 to 41 mg/L (ppm). Six of the seven sites showed a 33 to 73% overall reduction in N levels as a result of treatment in the SND. Seasonal effects were recognized for inputs of N into the groundwater for two of the sites. There were no observed seasonal effects on the amount that N levels were reduced as a result of treatment in the SND. Porewater samples collected from the control area of two sites had considerably higher levels of total nitrogen (TN) than those below the SND. The higher N levels outside the SND are likely the result of excess fertilizer additions to the lawns.

KEYWORDS. Alternative onsite wastewater treatment, Nitrogen reduction, Shallow-narrow drainfield, Low pressure distribution.

INTRODUCTION

The major pollutants to ground and surface waters from onsite wastewater disposal systems (OSWDS) are N, P, and pathogens (Reneau et al., 1989). Nitrogen is generally considered the most mobile of the three, thus assessment of N concentrations in pore and groundwaters below an OSWDS can be used to estimate the potential for pollution from the system (Loomis, 1999). The main sources of N in domestic wastewater are feces, urine, food, and chemical wastes (Siegrist and Jenssen, 1989). The N found in wastewater is mostly organic nitrogen (NH_3-R), nitrate (NO_3^-), nitrite (NO_2^-), ammonium (NH_4^+), and nitrogen gas (Burks and Minnis, 1994). Under aerobic conditions organic nitrogen and ammonium (the most abundant forms of N) are oxidized to nitrate (Walker et al, 1973; Lance, 1975). Nitrate is not adsorbed to the negatively charged soil particles, therefore it leaches easily, and may reach the groundwater resulting in contaminated drinking water and eutrophication of surrounding coastal waters (Stolt and Reneau, 1991; Peterson and Simpson, 1992; Burks and Minnis, 1994; Brady and Weil, 2002; Loomis et al., 2001). Most OSWDS rely on denitrification to convert nitrate to N_2 gas, which is then released to the atmosphere (Siegrist and Jenssen, 1989; Reneau et al., 1989; Stolt and Reneau,

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1991). In order for denitrification to occur certain conditions; such as an available carbon source, anaerobic conditions, and a favorable soil temperature and pH (Brady and Weil, 2002); must exist. Conventional OSWDS, however, are designed for aerobic treatment of effluent and will remove little N through denitrification.

Numerous studies have focused on the effectiveness of alternative OSWDS to remove N from domestic wastewater (Stolt and Reneau, 1991; Peterson and Simpson, 1992; Loomis et al., 2001). Most of these studies have focused on the effectiveness of secondary treatment units, such as sand filters and aeration treatment units, to remove N and have not evaluated final treatment of the wastewater. One commonly used final treatment step used for alternative systems is a shallow narrow drainfield (SND), sometimes referred to as a low pressure distribution system (Carlisle, 1980; Simon and Reneau, 1985; Stewart and Reneau, 1988). A SND consists of a series drainfield lines, placed 25-45 cm below the soil surface, that are pressure dosed with effluent from a secondary treatment unit. The SND offers many potential advantages over a conventional drainfield. By being closer to the surface, a SND creates a larger aerobic treatment zone for the effluent before it reaches the ground water or a limiting layer. Another advantage is that the system is pressure dosed and will disperse the effluent equally over the drainfield preventing overloading. Microbial and root biomass greatly decreases at a depth below 50 cm (Brady and Weil, 2002), thus by having the drainfield lines in the upper 25 to 45 cm of soil the effluent is released in a zone where roots and soil microbes are most active (Stewart and Reneau, 1988). This allows for the increased uptake and transformation of N in the wastewater. The objectives of this study were to examine the amount of N potentially entering the groundwater below SND in Rhode Island and to determine if time of year affects the groundwater inputs. Our hypothesis was that reduced biological activity would occur in the SND during winter and late fall and result in an increase in the amount of N entering the groundwater from these systems. We assumed that soil porewaters collected 30 cm below the SND lines would represent N concentrations entering the shallow groundwater in these coastal settings.

METHODOLOGY

Seven home-sites located in coastal resource areas of Rhode Island were chosen for study. The sites vary in the type of secondary treatment, age (four to six years old), placement of the drainfield lines, and loading rates (Table 1). Each site has a SND as the final treatment step for waste disposal.

Ceramic cup lysimeters were installed at each site: three directly adjacent to the trenches in the SND and two in a control area. A push probe (diameter equal to lysimeter) was used to install the lysimeters and reduce disturbance of the natural soil during installation. The base of the lysimeters was located 30 cm below the trench bottom (depth was measured from the middle of the ceramic cup). Lysimeters within the control were placed 70 cm below the soil surface at all the sites. The top of each lysimeter was 5-10 cm below the soil surface. A bucket auger (10 cm diameter) was used to excavate a space to allow access to the lysimeter. These access ports were stabilized with an appropriate sized section of PVC pipe. The PVC pipe was sealed with a #11 rubber stopper or a plastic cover. A screened PVC well was placed 90 cm from the outside of the SND at a depth of 60 cm below the trench bottom to monitor the water table level at each site. The purpose of the well was to confirm that the water table was not approaching the treatment zone of the SND and that we were collecting porewater samples (i.e. not collecting samples below the water table). Redox potential was measured at selected sites using six redox probes (electrodes) inserted along the drainfield to a depth equal to the trench bottom. Potentials were also measured at the same depth in the control area. Values were corrected by adding the standard potential of a saturated calomel reference electrode at a pH = 7 (244 mV). The soil redox potential measurements were made to determine if Eh levels were low enough in the SND for denitrification to occur (Mohn et al., 2000).

Soil-porewater samples were collected from the lysimeters on consecutive days each season from the winter of 2002 until summer 2003: a total of 14 samplings over the seven seasons. To collect the samples, a vacuum was established within each lysimeter using a field pump and portable power source. The following day the soil porewater was extracted from the lysimeter by extending a tube to the bottom and pumping the water into a labeled 120 ml bottle. Effluent was sampled from the secondary treatment unit of every system. Effluent from the LON, LIN, and MCG sites (Table 1) were collected 15 times between August 1997 and February 1999 (Sykes et al., 1999; Sykes, 2001). Effluent from the HAZ, TAR, TWE, and SIS secondary units were collected seasonally from the winter of 2002 until summer 2003. Soil porewater and effluent samples were stored in 120 ml econoware brown-glass bottles at 4^0 C until analyzed.

Soil-porewater and effluent samples were prepared for analysis by filtering them through a #2 Whatman filter using a Buchner funnel connected to a vacuum. One mL of sample was diluted by a factor of 20 and added to a 40 mL glass vial. A 5 mL liquid digestion reagent, consisting of recrystallized potassium persulfate ($K_2S_2O_8$), boric acid (H_3BO_3), and 1N sodium hydoxide (NaOH), was added to the samples. The samples were boiled in a water bath for 15 minutes and left overnight (American Public Health Association, 1995). Standards, created using potassium nitrate (KNO_3), were also digested following the same procedure. The following day the samples were analyzed for total N using a rapid flow analyzer (RFA-300, ALPKEM Corp.).

RESULTS AND DISCUSSION

Nitrogen Entering the Groundwater

Average N levels in the soil porewaters, based on seasonal sampling over a 20-month period, ranged from 2 to 42 mg/L (Figs. 1-7). Nitrogen levels from individual lysimeters ranged from 0 to 121 mg/L. Because of dry conditions during the summer of 2002, no soil-porewater samples could be obtained from the control areas of the MCG, HAZ, TAR, and LON sites and the SND from the LIN site (Figs. 1, 2, 3, 6, and 7). Concentrations of N entering the groundwater from the LIN and TAR sites were below drinking water standards (10 mg/L N) for nearly every season (Figs. 2 and 7). At the other 5 sites, N levels entering the groundwater were mostly well above the drinking water standard.

Two of the sites, LON and MCG, showed a trend suggesting seasonal effects on the amount of N entering the groundwater (Figs. 1 and 2). At these two sites porewater collected in the winter had the highest N concentrations, spring and summer months showed lower levels, and the levels increased in the fall. Although this trend was not strong, it was recognized for both years. We suspect that lower soil temperatures in the winter and fall resulted in reduced biological activity (plant growth, nutrient uptake, and microbial activity) in the SND such that more N was entering the groundwater during this time of year. Seasonal effects on the amount of N entering the groundwater were not apparent at the LIN, TAR, HAZ, SIS, and TWE sites (Figs. 3-7). Variations in the soil types within the SND, effluent N concentrations, or loading rates may have masked any seasonal patterns for these sites and contributed to the amount of variability seen in the MCG and LON sites.

Reductions in Nitrogen Levels within the SND

Reduction in N concentrations, based on seasonal effluent levels and N concentrations in the porewater samples, for the TWE, SIS, HAZ, and TAR sites range from 0 to 97%. No seasonal effect on N removal was observed. Average N concentration reductions for the entire sampling period were 53, 43, 40, and 33% for TWE, SIS, HAZ, and TAR sites, respectively. Reduced concentration levels in N can be attributed to plant uptake, denitrification, and dilution. Since our porewater samples were collected above the water table, we expect little dilution to occur within the 30 cm of soil between the disposal points in the SND and where the lysimeters were located. Lush green grass was observed in all the sites at times during the spring, fall, and summer at each site. These observations suggest that the grassroots had access to both water and nutrients over the SND and may potentially remove N during the growing season. Over time, however, N mineralization will reach some equilibrium with N uptake by the grass and this effect will likely be inconsequential. Our redox potential measurements were lower in the SND than the control and at or below potentials reported for denitrification to occur. Therefore, we expect that denitrification may be the leading factor in the reduction of N concentrations in these four sites.

Effluent levels dosed on the SND at the LON, LIN, and MCG sites were measured in 1997 through 1999 (Sykes et al., 1999; Sykes, 2001). Since, the data reported here represent N levels reaching the groundwater for 2002 and 2003, examining seasonal effects was not possible. Based on average N levels for the effluent, and our seasonal porewater measurements, reduction of N due to treatment in the SND of these three systems is estimated to range from 0 to 99%. This range in values is similar to the range for the four sites where both effluent and porewater samples were collected seasonally. The average reduction for the entire sampling period, however, was much different. Nitrogen levels in four of the seven porewater samples collected from the LON site were higher than average effluent levels recorded for an 18 month period from 1997 to 1999. At the LIN site, there was a much higher percent of reduction (73%) than observed at any of the other sites. These data suggest that effluent N levels leaving the secondary treatment unit may have increased between 1999 and 2002 at the LON site and decreased at the LIN site during the same period. These differences in N levels in the effluent are likely due to changes in water usage or occupancy by the homeowner, resulting in higher or lower levels of contaminants entering the SND.

Control Plot N Levels

Ratios of N in porewaters below the SND to N concentrations below the control plots ranged from 0.2 to 18.4. The LIN and TAR sites had ratios of less than one, meaning more N was present in porewater samples collected below the control plots than porewater extracted below the SND (Figs. 2 and 7). For the LIN site, five of the six seasonal measurements show this trend (Fig. 2). Similarly in the TAR site, levels of N in the control exceeded the SND in all cases where porewater samples could be extracted (Fig. 7). In both of these cases, the porewater entering the groundwater from the control plots was much higher than drinking water standards. This is significant, since the alternative systems at these locations have greatly reduced N additions coming from disposal of domestic wastewater to less than 10 mg/L. The lawns at these locations are plush and green suggesting the likely source of the elevated N concentrations in the control plots is excess fertilizer.

SUMMARY AND CONCLUSIONS

Alternative OSWDS are called upon in areas where soils are marginal with respect to their treatment capacity or resources are such that special requirements are in place to minimize development impacts on water quality. Numerous studies have evaluated the effectiveness of the secondary units that define the alternative OSWDS to treat wastewater. Few studies, however, have addressed the effectiveness of SND as the final treatment step in an alternative OSWDS. In our study we found that on average as much as 73% of the N leaving a secondary unit can be removed by a SND, and that between 33 and 53% of the N is commonly removed. We expected considerable seasonal variations in the N removal. These effects, however, were only observed in two of the seven sites we studied. The lack of consistent evidence of seasonal effects on N removal may be the result of variations in soil type, N concentrations in the effluent, and loading rates. Variations in water usage by the homeowner may also make seasonal effects less evident. Although as much as 73% of the N disposed of in a SND may be removed, we found that N concentrations reaching the groundwater below these systems were well above drinking water standards. These data suggest that although alternative measures were taken in these critical coastal resource areas of Rhode Island to control N additions to the groundwater from onsite waste disposal, more work needs to be done to control N entering our ground and surface waters.

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Citations for this report:
Holden, S.A., M.H. Stolt, G.W. Loomis, and A.J. Gold, 2004. Seasonal Variation in Nitrogen Leaching from Shallow- Narrow Drainfields. In *Proceedings of 10th National Symposium on Individual and Small Community Sewage Systems*. 432-440. ASAE, St. Joseph, MI.

Table 1: Study sites characteristics.

Site	System Installation Date	Drainfield Line Depth (cm)	Secondary Treatment Unit	Average Loading Rate (gpd)
LON	Spring 1997	36 - 46	Above-Grade Recirculating Sand Filter	165
LIN	Spring 1997	23 - 35	At-Grade Recirculating Sand Filter	131
MCG	Spring 1997	28 - 38	Single-Pass Sand Filter	249
TWE	Winter 1998	25 - 30	Recircualting Geo-Textile Filter	66
SIS	Spring 1999	41 - 70	Peat Filter / UV Unit	130
HAZ	Spring 1999	29 - 56	Single-Pass Sand Filter	155
TAR	Summer1999	28 - 38	Fast Activated Sludge Unit / UV Unit	236

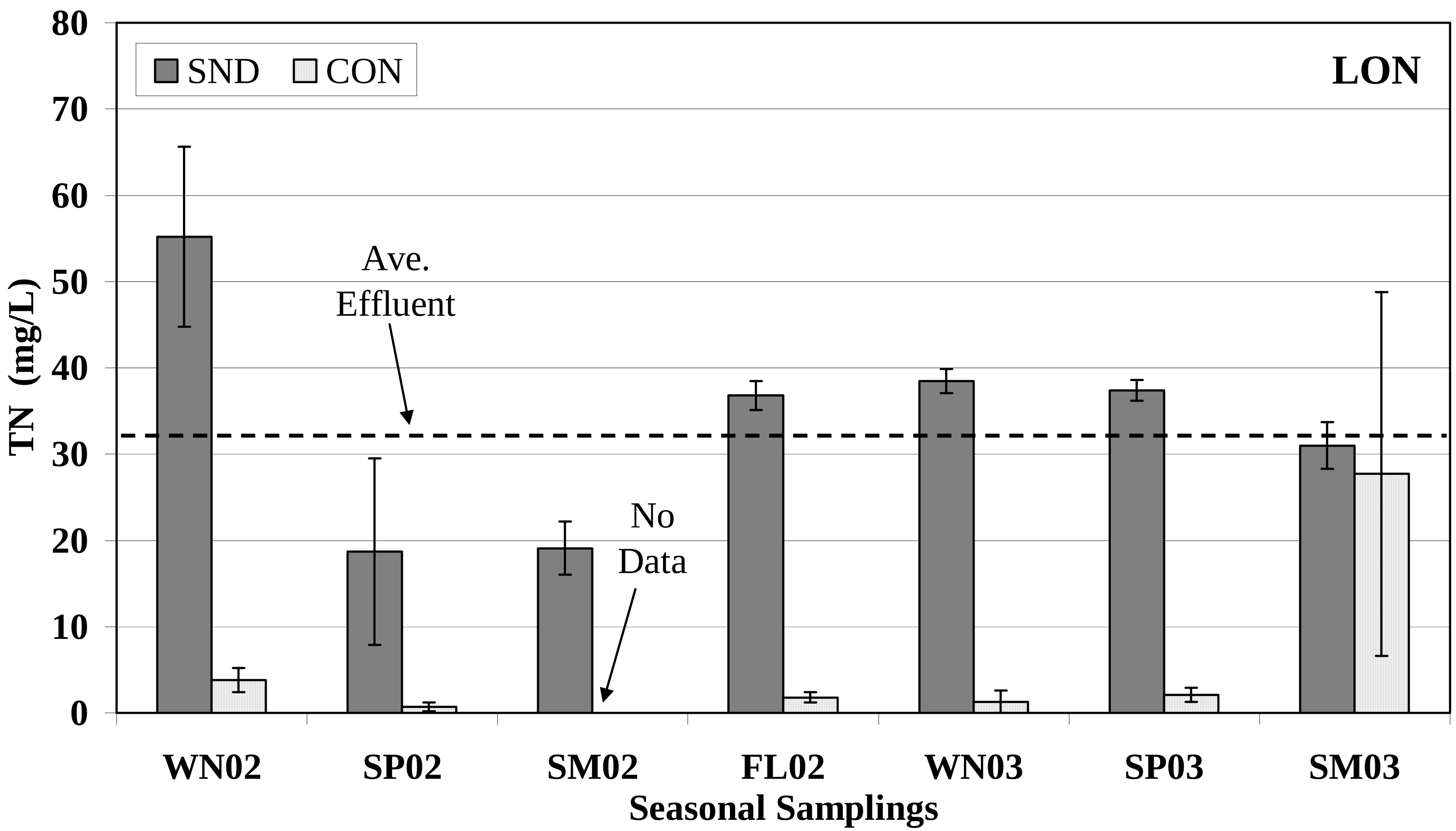

Figure 1: Total N concentrations in the porewater from the LON site. Samples were collected twice seasonally by multiple lysimeters placed 30 cm below the shallow-narrow drainfield (SND) and at a depth of 70 cm in the control area (CON). Effluent level represents average input of N from 7 samplings over 20 months (Sykes et al., 1999; Sykes 2001). Error bars represent +/- one standard deviation.

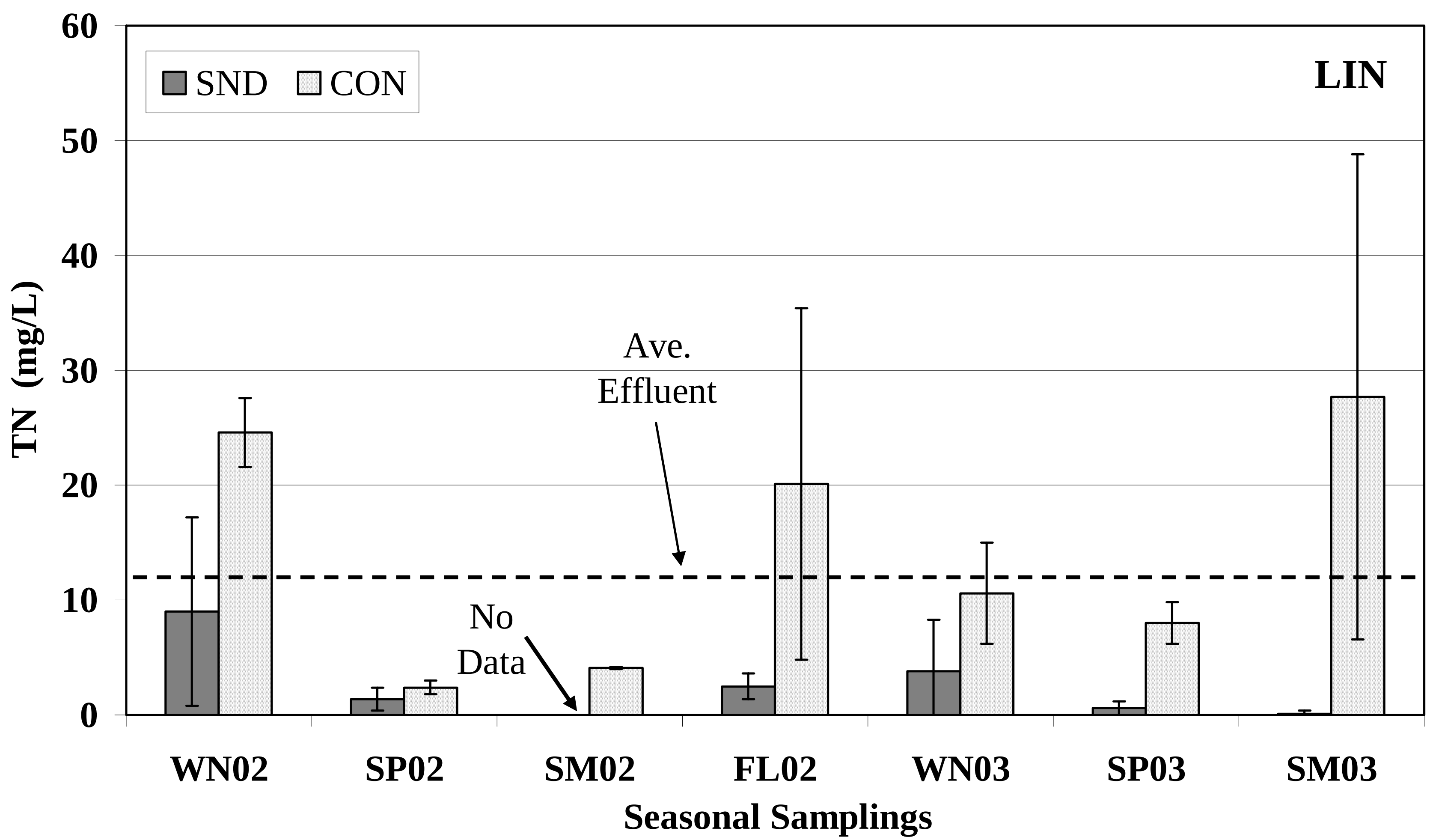

Figure 2: Total N concentrations in the porewater from the LIN site. Samples were collected twice seasonally by multiple lysimeters placed 30 cm below the shallow-narrow drainfield (SND) and at a depth of 70 cm in the control area (CON). Effluent level represents average input of N from 7 samplings over 20 months (Sykes et al., 1999, Sykes 2001). Error bars represent +/- one standard deviation.

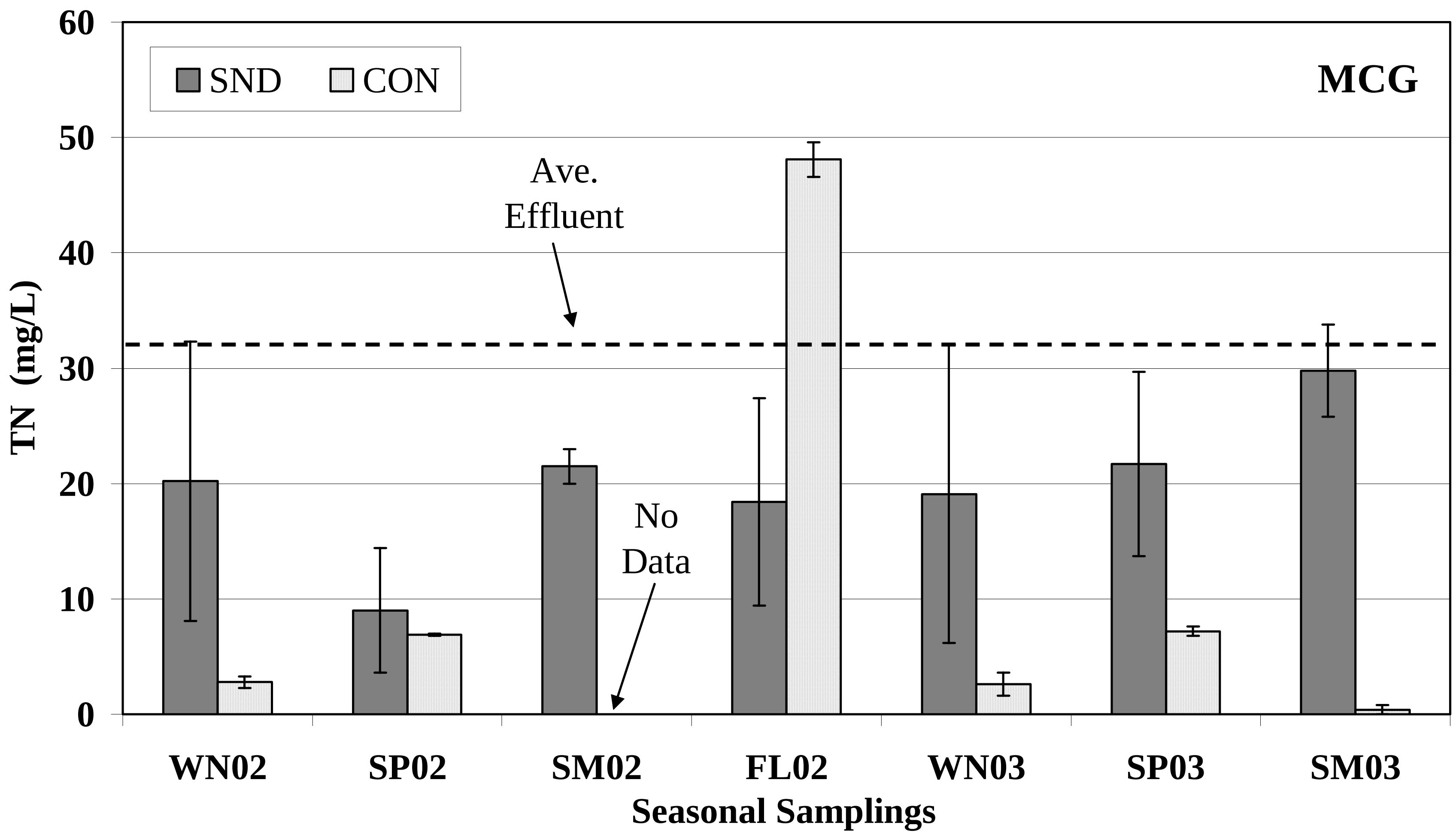

Figure 3: Total N concentrations in the porewater from the MCG site. Samples were collected twice seasonally by multiple lysimeters placed 30 cm below the shallow-narrow drainfield (SND) and at a depth of 70 cm in the control area (CON). Effluent level represents average input of N from 7 samplings over 20 months (Sykes et al., 1999; Sykes 2001). Error bars represent +/- one standard deviation.

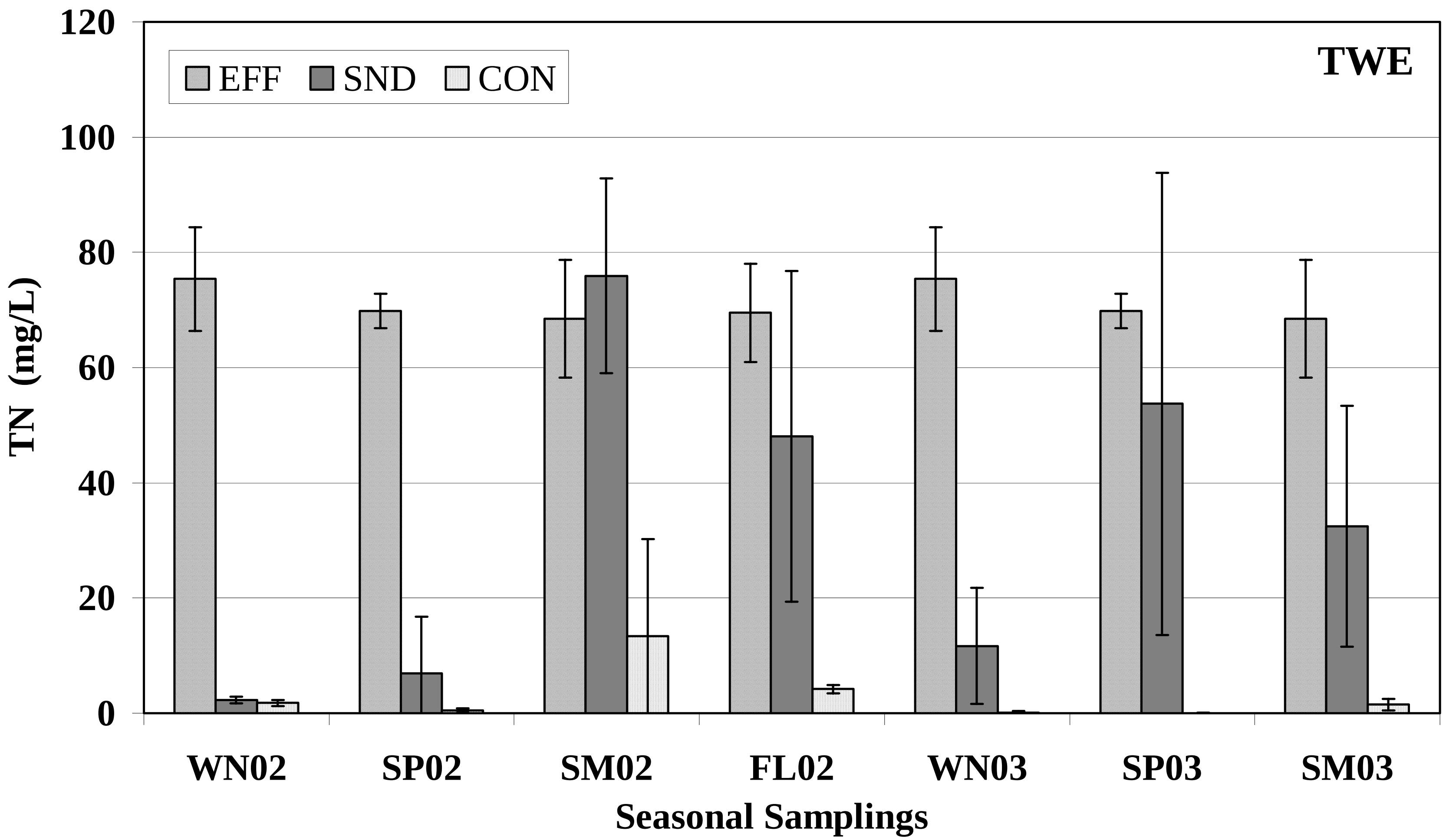

Figure 4: Total N concentrations in the porewater from the TWE site. Samples were collected twice seasonally from multiple lysimeters placed 30 cm below the shallow-narrow drainfield (SND) and at a depth of 70 cm in the control area (CON). Effluent levels (EFF) represent average seasonal input of N from 32 samplings over 41 months. Error bars represent +/- one standard deviation.

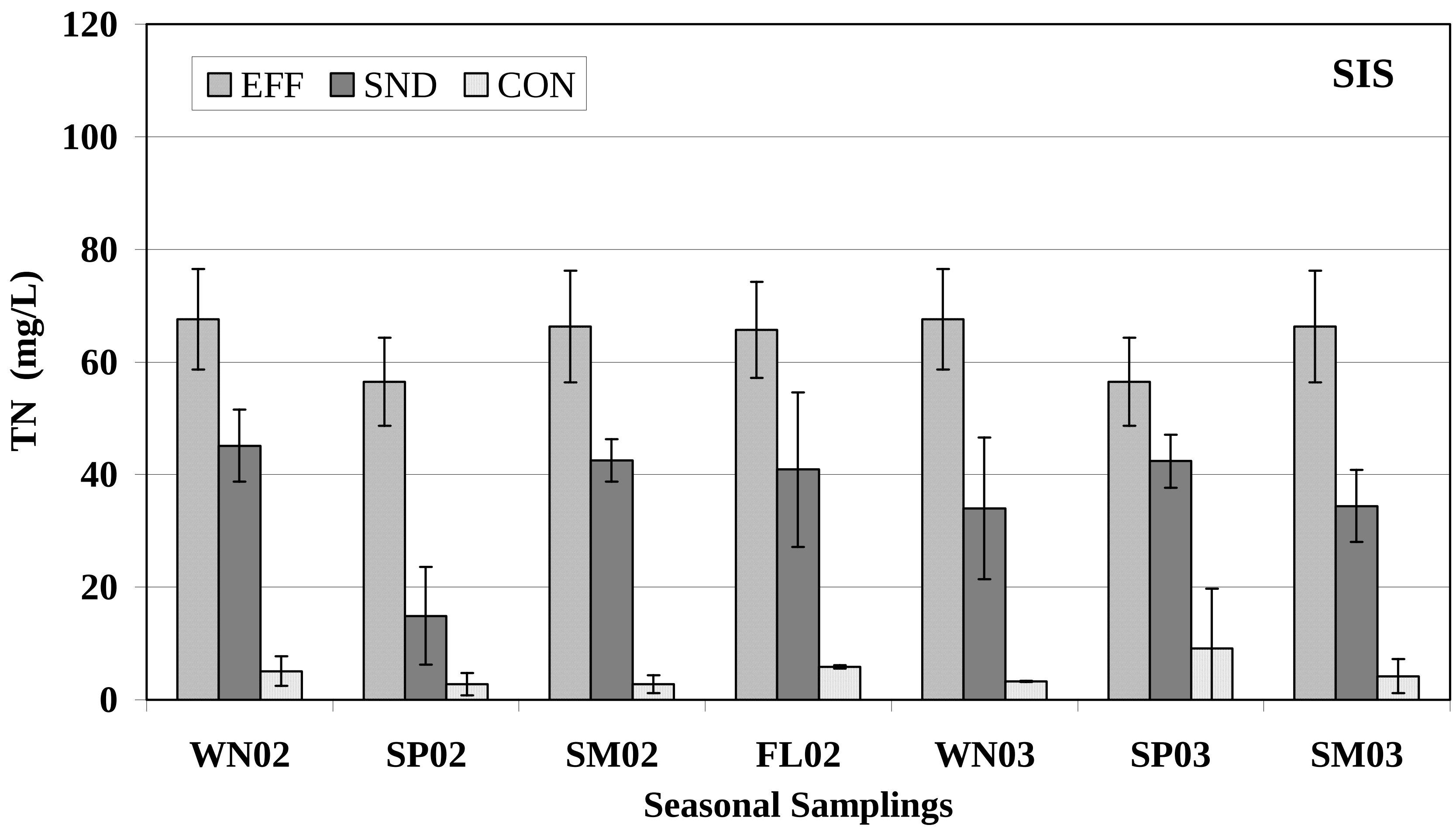

Figure 5: Total N concentrations in the porewater from the SIS site. Samples were collected twice seasonally from multiple lysimeters placed 30 cm below the shallow-narrow drainfield (SND) and at a depth of 70 cm in the control area (CON). Effluent levels (EFF) represent average seasonal input of N from 32 samplings over 41 months. Error bars represent +/- one standard deviation.

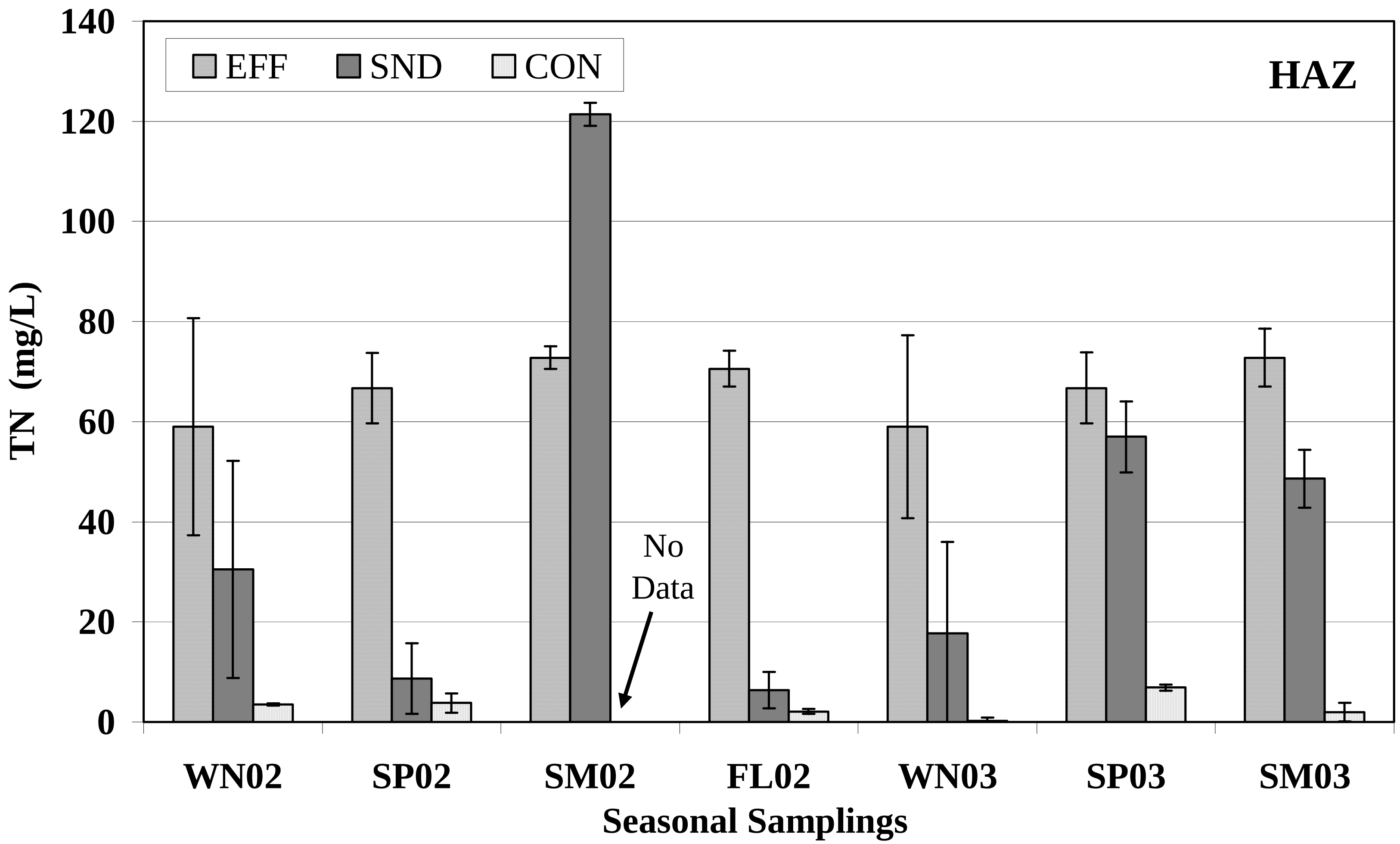

Figure 6: Total N concentrations in the porewater from the HAZ site. Samples were collected twice seasonally from multiple lysimeters placed 30 cm below the shallow-narrow drainfield (SND) and at a depth of 70 cm in the control area (CON). Effluent levels (EFF) represent average seasonal input of N from 32 samplings over 41 months. Error bars represent +/- one standard deviation.

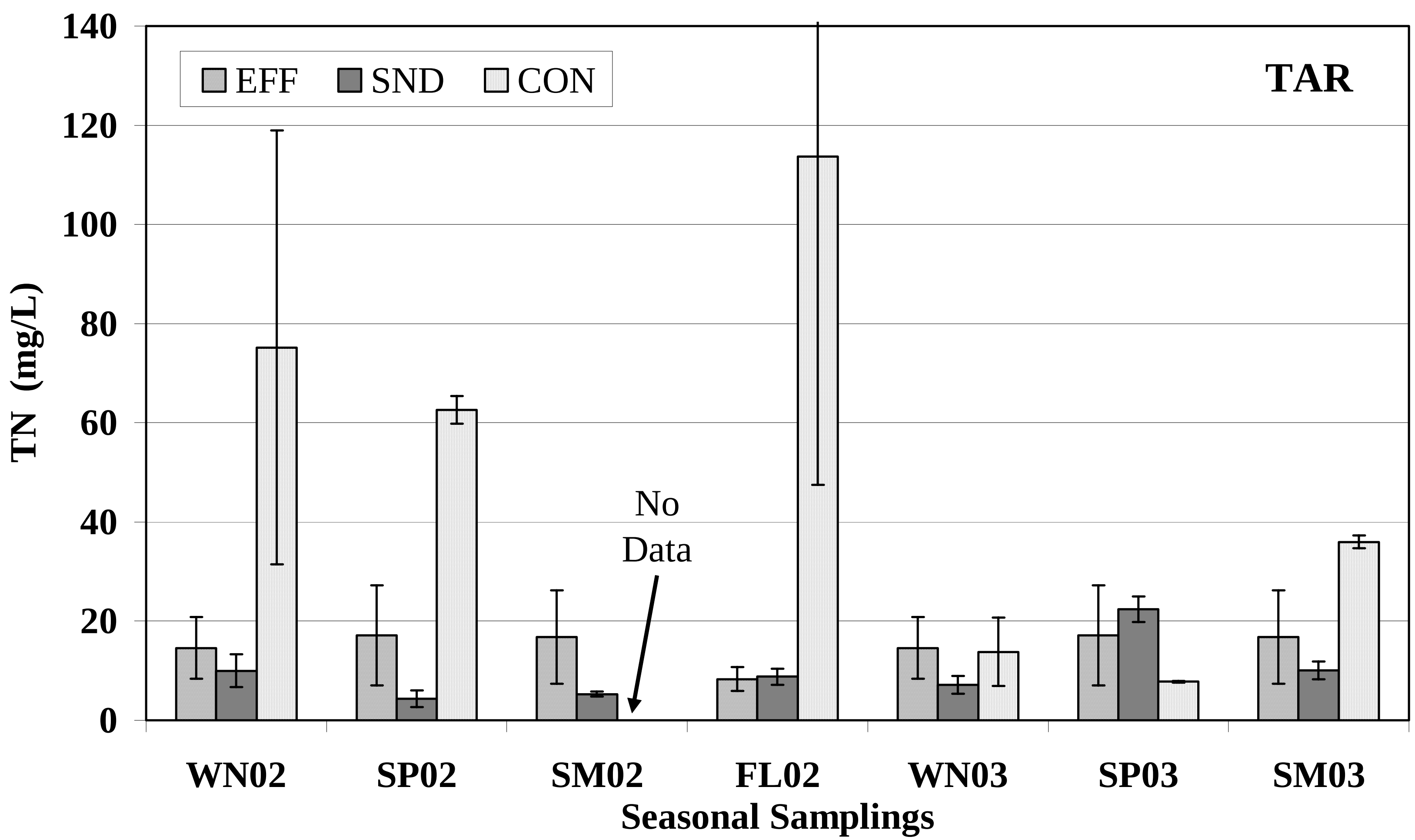

Figure 7: Total N concentrations in the porewater from the TAR site. Samples were collected twice seasonally from multiple lysimeters placed 30 cm below the shallow-narrow drainfield (SND) and at a depth of 70 cm in the control area (CON). Effluent levels (EFF) represent average seasonal input of N from 32 samplings over 41 months. Error bars represent +/- one standard deviation.