ONSITE ENGINEERING PLLC

January 5, 2015

Ridge 29 LLC
Attn: Mr. Anthony Sblendorio, President
3055 Valley Road
Basking Ridge, NJ 07920

Re: Ridge 29 LLC
Onsite Wastewater Treatment System Project Summary

Dear Mr. Sblendorio:

Onsite Engineering, PLLC. has prepared this project summary for the Onsite Wastewater Treatment System being proposed for the Ridge 29 LLC project. This letter presents the basis of design including design flow calculation. A summary of the results from site characterization that was conducted during August 2014 is provided. We also discuss the method/technologies used in the collection, treatment, and dispersal of the onsite wastewater.

I. Basis of Design:

The Ridge 29 project includes building forty-three 3-bedroom dwelling units in a neighborhood residential development. Each building will have two dwellings. The property is currently identified as Block 9230, Lot 28 (086.15-1-24) in the Town of Pound Ridge and is comprised of 29.08 acres.

The onsite wastewater treatment system (OWTS) design will be reviewed for approval by the Westchester County Health Department (WCHD) following the design parameters outlined in the New York State Department of Environmental Conservation (NYSDEC) document entitled "Design Standards for Intermediate Sized Wastewater Treatment Systems" dated March 5, 2014.

Onsite Engineering used the following Design Standard reference documents throughout the design process:

1. NYSDEC, Design Standards for Intermediate Sized Wastewater Treatment Systems, 2014
2. National Onsite Wastewater Association (NOWRA), Recommended Guidance for the Design of Wastewater Drip Dispersal Systems, 2006
3. USEPA, Onsite Wastewater Treatment Systems Design Manual, 2002
4. 10 States Standards, Recommended Standards for Wastewater Facilities, 2004

Design Flow:

Since Ridge 29 is a community OWTS that employs time equalized dosing with peak flows controlled by flow equalization, we used the USEPA 2002 Design Manual data as follows: US Census Bureau 1998 2.7 people per household; Table 3-1 estimates average daily wastewater flow 50-70 gallons per person per day (we use 70 gpd); EPACT 1994 average daily wastewater flow 40-60 gallons per person per day;

Use 2.7 * 70 gpd/per person for 43 units = 8,127 gallons per day water saving fixtures.

Site Characterization

The Ridge 29 OWTS design team completed site characterization activities on August 18-19, 2014. Deep test holes and percolation testing were completed while the Westchester County Health Department were on site to observe the work.

The findings of the site characterization activities revealed a good depth of useable soil. A lot of boulders are located at the property but bedrock was not encountered within 6' of the surface. The boulders located within the dispersal field area will be removed during construction. Many of the small trees located in the dispersal area will also be removed. An effort will be made to keep the larger trees.

Percolation testing was completed at ten locations throughout the area designated for the dispersal field. The results from the soil percolation testing revealed fairly permeable soil with rates ranging from 3 to 7 minutes per inch (mpi).

Hydraulic Loading Rate

The results from the site characterization activities are favorable to placement of the proposed subsurface drip dispersal field. According to one of the drip manufactures, soils with a percolation rate of 8-10 mpi would use a soil loading rate of 1.2 gallons per day/square foot (gpd/SF). The NYSDEC Design Guidelines suggest an application rate of 0.9 gpd/SF in soil with a similar percolation rate. The Ridge 29 design will use the more conservative soil application rate of approximately 0.9 gpd/SF.

II. Overview & Highlights of OWTS Design Component Technologies:

The Ridge 29 community OWTS design components consist of proven innovative technologies that deliver high levels of treatment performance while fitting within the character of the Ridge 29 property. Each of the buildings (which serve two 3-bedroom units) at the Ridge 29 property will be connected to a 2,000 gallon 2-compartment septic tank with an effluent filter on the outlet baffle to provide primary settling. A gravity sewer will be used to convey the filtered septic tank effluent to a Constructed Treated Wetland (CTW) inlet control structure. The CTW will provide secondary treatment of the effluent. Final subsurface dispersal of the treated effluent will be accomplished using drip dispersal.

The following sections provide a description of the technologies used for collection, treatment and subsurface dispersal:

STEG Collection System: Septic Tank Effluent Gravity (STEG) Systems have been in use in the United States since the 1970's. STEG technology has been endorsed by the USEPA, the Electric Power Research Institute (EPRI) and the Water Environment Federation (WEF), and others as a viable, sustainable and economical alternative to conventional sewer collection systems.

STEG systems are referenced in nearly every text or manual related to OWTS. Removing solids as early as possible in the treatment process reduces the infrastructure footprint, costs and improves treatment performance.

The collection equipment used in the Ridge 29 STEG systems will include a 2,000 gallon 2-compartment concrete septic tank to serve each building (two 3-bedroom homes per building) with each septic tank equipped with a 1/16" effluent filter on the septic tank outlet baffle to trap solids. All septic tanks will be on a maintenance schedule to have solids removed as needed.

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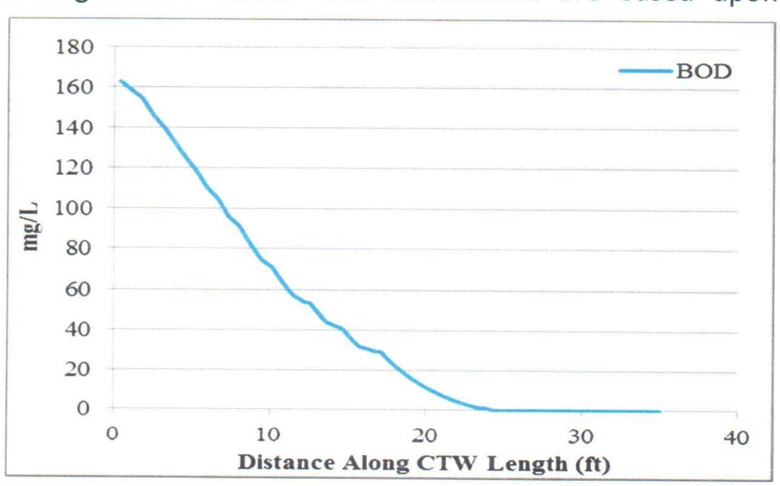
Constructed Treated Wetland (CTW) Treatment System: The Ridge 29 OWTS design will utilize a Roux Associates patented Enhanced Subsurface Flow CTW to provide secondary levels of treatment. CTW have been in use in the United States and recognized by the USEPA as highly effective treatment systems for more than 40 years. A Roux Associates Enhanced Subsurface Flow CTW has been installed in Kingston, New York with excellent treatment performance results since late 2012. A comprehensive description of the proposed Roux CTW is provided below.

Roux CTW Basis of Design:

The CTW system has been designed to treat the primary settled effluent to secondary treatment levels (i.e., total suspended solids, biochemical oxygen demand, nitrogen, and fecal coliform) while also ensuring compliance NYSDEC and Westchester Count discharge standards (TSS < 30 mg/L; BOD < 30 mg/L; and TKN < 20 mg/L). The following sections provide an overview of the proposed treatment mechanisms within the CTW.

Biochemical Oxygen Demand

The primary treatment mechanism for $CBOD_5$ within the CTW environment is aerobic microbial degradation. In aerobic microbial degradation, organic material is consumed by microbes for both energy and as a carbon source. Some $CBOD_5$ removal occurs in the septic tanks; however, the bulk of the $CBOD_5$ removal will occur in the CTW cells. Other treatment mechanisms in the CTW include sedimentation, filtration and adsorption. The CTW system is designed to treat an average daily flow rate 8,127 gpd over a 2.25-day HRT. The 2.25-day HRT was determined by the BOD and nitrogen loading and degradation rates. The calculations are based upon reference documented rates provided both by USEPA (2000a) and standard wastewater treatment design guidance (Metcalf and Eddy, 1991).



Treatment efficiency is further improved through incorporation of supplemental aeration methods, such as the system design. Supplemental aeration was developed in the late 1990s (Patent No. 5893975, 6200469, 6406627, 6576130, and 6652743) to support microbial populations in treatment wetlands during winter operations in northern climates and ensure the aerobic conditions are available in the subsurface for microbial degradation of BOD and nitrification. In fact, similar to aeration utilized in conventional sanitary wastewater treatment design, adding air in wetland designs ensures an aerobic environment for reliable treatment performance. In the 2006 publication, *Small Scale Constructed Wetland Treatment Systems*, Wallace and Knight state: "*The limited oxygen transfer availability in standard VSB (vegetated submerged bed) systems has led to the development of enhanced processes that retain the advantages of conventional VSB systems (no pathogen exposure, cold climate operation, small footprint area), but which are also capable of providing sufficient oxygen transfer for nitrification and aerobic BOD removal*" (p. 7-19). In a separate publication, Wallace and Knight (2006) reviewed 17 full scale aerated CTWs and 22 full-scale CTWs with no aeration treating domestic wastewater. The study found that "*aeration resulted in significant improvements in the reduction of both BOD_5 and TSS*" (Treatment Wetlands by Kadlec and Wallace, 2nd edition, 2009. p. 825).

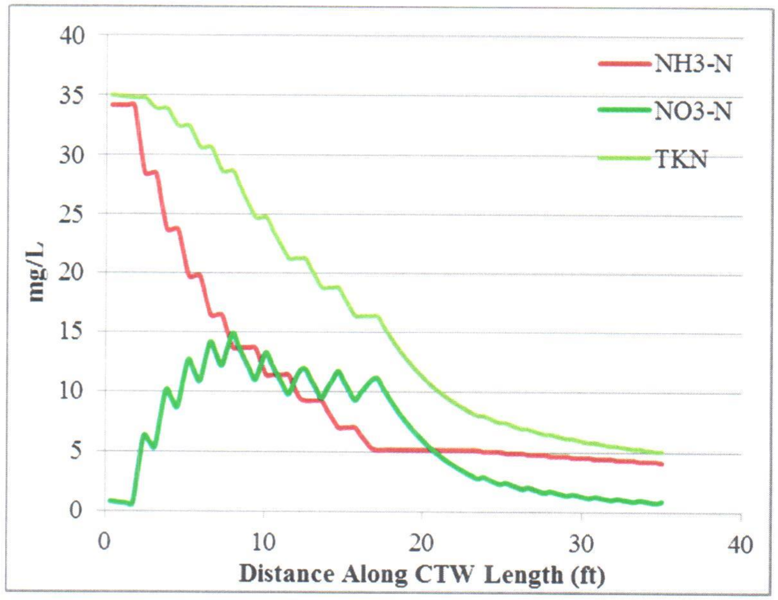
Total Suspended Solids

Gross TSS removal will occur within the existing septic tank through sedimentation. Effluent from the septic tanks, and influent to each CTW cell, is assumed to range between 44 and 54 mg/L TSS (USEPA Onsite Wastewater Treatment Systems Manual, February 2002). Any remaining suspended solids will be removed through the gravel within the treatment wetland. Residual TSS will primarily be comprised of organic matter, and thus microbial degradation is the principal treatment mechanism. Microbial degradation will occur within the CTW cells in addition to filtration in the root biomass matrix and settling. In addition, TSS will be removed through flocculation and settling from the presence of natural flocculants generated during the degradation of organic matter by microorganisms because of relatively low flow velocities and a high amount of media surface area (USEPA, 2000).

Nitrogen

The 2.25-day HRT was determined by the BOD and nitrogen loading and degradation rates. The calculations reference documented rates provided both by USEPA (2000a) and standard wastewater treatment design guidance (Metcalf and Eddy, 1991).

Removal of ammonia nitrogen in a CTW system is a two-step process. First, ammonia is oxidized to nitrate via a microbially mediated process termed nitrification. Nitrification is an aerobic process in which ammonia converted to nitrate by *Nitrosomonas* bacteria during microbial respiration. The supplemental aeration incorporated into the first half of each CTW cell will ensure sufficient oxygen is available for microbes and thus year round nitrification processes and ammonia degradation. After the ammonia has been nitrified, it will then be denitrified in the second half of each CTW cell through anaerobic microbial respiration processes involving *Nitrobacter* sp.



Roux Proposed CTW System:

The proposed CTW system has been designed to treat an average wastewater flow rate of 8,127 gpd over a 2.25-day hydraulic residence time (HRT). The CTW unit will be comprised of three parallel enhanced subsurface flow CTW cells. Each CTW cell will be approximately 37 ft (width) by 42 ft (length). Each cell will be lined with an HDPE liner to maintain proper HRT. The cells will be composed of 3 ft of gravel substrate, 4-inches of planting substrate and a diverse array of native wetland plants to enhance microbial degradation. An additional 1 foot of dry freeboard is provided above the planting substrate for a total cell depth of 4.5 feet.

Each CTW cell will also be equipped with a supplemental subsurface oxygen delivery system to optimize treatment and provide supplemental oxygen for microbial degradation during colder months. Treated effluent from the CTW cells will be conveyed to the drip dispersion fields for subsurface discharge. Influent and effluent hydraulic control structures (HCS) incorporating weirs and valves will be used to passively convey and distribute water evenly between the CTW cells as well maintain water levels (and thus HRT) within each cell.

The primary treatment media in the CTW cells is nominal 1to 2-inch (ASTM D 448 Varies No. 3 stone) non-carbonate gravel supplemented by wetlands vegetation species. Gravel media was selected to maintain permeability and function as a substrate for microbial attachment. Gravel has been used as the predominant media choice in subsurface flow treatment wetlands since the 1980s (Treatment Wetlands by Kadlec and Wallace, 2nd edition, 2009). The 1 to 2-inch stone size is standard practice for use in subsurface flow CTWs (USEPA, 2000). The surface of the treatment media will contain 4-inches of pea gravel (ASTM D 448 Varies No. 6 stone; ⅜" to ¾"), as a planting substrate for the emergent wetland plants (USEPA, 2000).

Proposed wetlands plantings for the CTW system may include *Sagittaria latifolia*, *Carex lurida*, *Pontederia cordata*, *Peltandra virginica*, and *Iris versicolor*. Plants were selected based upon their ability to form dense root masses to serve as microbial substrate, obligate emergent wetland classification (USFWS Region 1) to tolerate saturated conditions, and finally previous application in a treatment wetland environment (USEPA Handbook of Constructed Wetlands, 1995; USEPA Design Manual Constructed Wetlands Treatment of Municipal Wastewater, 2000; ITRC Technical and Regulatory Guidance Document for Constructed Treatment Wetlands, 2003; North American Treatment Wetland Database, 1998; Treatment Wetlands by Kadlec and Wallace, 2nd edition, 2009). Plants will be installed on 1 foot centers in the pea gravel planting substrate.

A supplemental oxygen delivery system is included as part of the CTW system design to provide adequate oxygen within the subsurface for aerobic microbial degradation during winter operation when the plants are dormant and not able to produce sufficient oxygen requirements for BOD and ammonia degradation to occur. The supplemental oxygen delivery system will include air blowers that will convey oxygen to the subsurface gravel cells via air lines fitted with high volume/low pressure diffusers installed within contactor chambers. The air lines and diffusers will be protected within the CTW cells by HDPE contactor chambers. The arrangement of contactor chambers and diffusers is designed to provide the most intensive oxygen delivery across the first half of each CTW cell.

<u>Drip Dispersal System:</u> Drip dispersal is a method that uses ½ inch diameter tubing with emitters spaced every two feet to uniformly distribute the secondary treated effluent to subsurface soils. A pump is used to pressurize the drip tubing and the secondary treated effluent is dispersed through the emitters. Drip dispersal has several key advantages for this

project. The small diameter tubing is typically placed near the surface which maximizes the vertical separation to the limiting condition. A small volume of effluent is emitted evenly along the drip lines which decreases the soil loading requirement per square foot.

Drip dispersal has been in use for more than 50 years for agricultural irrigation purposes and is well adapted for use at sites with steep slopes and non-uniform layouts such as the Ridge 29 property. The drip tubing can be installed in irregular formations which can traverse around existing features such as trees and rock formations. There will be an 8,000 gallon dosing tank with pumps and a backup generator to ensure an uninterrupted power supply. The dosing tank will be designed to provide time-equalized dosing whereby a small volume of effluent is dispersed on an hourly basis to the drip dispersal system. Evenly dispersing effluent consistently throughout the full 24 hours of the day further takes stress off of the receiving soils. The NYSDEC's recently updated Design Guidelines (March 2014) include drip dispersal as a commonly excepted method of dispersal.

The Ridge 29 project will use drip technology as the method of dispersing the secondary treated effluent from the CTW to the subsurface soils at the site. Three equal size drip fields will be used. Each field will be sized to accommodate 50% of the daily design flow (4,064 gpd for each field). Daily operation will typically only use two fields. This built in redundancy will allow for one field to always be off line and available for maintenance. Each field will be connected through a manifold that has isolation valves which allow it to be turned off.

The dispersal lines will be placed 12-18 inches below finished grade, parallel to topographic contours. The cover over the system may be divided between in-situ soil burial depth and cover by soil fill. Dense vegetation cover over the drip field will be maintained.

The pump controls for the drip system will integrate continuous data recording and will enable the operator to readily determine dosing and flushing pressures & flows in each of the fields. The panel will data log pump run cycles, pump run times, and will count flushing cycles and alarm events. The panel will have a manual override which will give the operator full control to turn on/off pumps.

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Summary

The advanced OWTS proven technology components chosen by Onsite Engineering will provide high levels of treatment including the necessary nitrogen reduction while requiring the least amount of change to the Ridge 29 property. The STEG collection system provides for the localized capture of solids in the individual septic tanks. The remaining effluent is sent via gravity to the patented Roux Associates Enhanced Subsurface Flow CTW which meets and exceeds the treatment standards of < 30 mg/L BOD; < 30 mg/L TSS; and <20 mg/L Total Nitrogen as required by WC-DOH and NYSDEC. The Roux Enhanced Subsurface Flow CTW is primarily a natural treatment system that operates year-round with no freezing or noticeable odor based on its self-contained, fully lined subsurface design. The drip dispersal system allows for placement on steeper slopes and the ability to work around larger trees and boulders. The Ridge 29 advanced OWTS provides high levels of treatment, minimal disruption to the Ridge 29 property while recharging the groundwater with highly treated effluent.

Please call if you have any questions.

Sincerely;

Eric E. Murdock, P.E.

CC: Mr. Bryan Waisnor, P.E., Langan Associates
Mr. Bob Eichinger, Onsite Engineering

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