NUTRIENT LOADING ANALYSIS FOR THE PROPOSED PRESERVE AT ROLLING GREENS

NORTH KINGSTOWN, RHODE ISLAND

Prepared for:

JAMM Golf, LLC
P.O. Box 675
Exeter, Rhode Island 02822

Prepared by:

Paul B. Aldinger & Associates, Inc.
860A Waterman Avenue, Suite 9
East Providence, Rhode Island 02914

PBA No. 10035
May 2010

PAUL B. ALDINGER & ASSOCIATES, INC.
Consulting in Geotechnical Engineering & Groundwater Hydrology
860A Waterman Avenue Suite 9 East Providence, Rhode Island 02914 (401) 435-5570

May 27, 2010

Mr. Mark Hawkins
JAMM Golf, LLC
P.O. Box 675
Exeter, Rhode Island 02822

Re: Nitrate Loading Study
The Preserve at Rolling Greens
A.P. Plat 110 Lots 3, 4, 5, 6, 7, 9, 10, & 11
Ten Rod Road
North Kingstown, Rhode Island.

Dear Mr. Hawkins:

Paul B. Aldinger & Associates, Inc. (PBA) is please to provide JAMM Golf, LLC with the following preliminary report, which presents the results of our preliminary analysis of the anticipated nitrate loading resulting from the proposed development, in accordance with your request.

1.00 PROJECT LIMITS

The subject site is located along Ten Rod Road in North Kingstown, Rhode Island. Figure 1 indicated the general vicinity of the site. The property consists of a total of 131.16 acres of land and is located within a Zone 2 Groundwater Protection Area, as indicated on the map entitled, *Town of North Kingstown, Groundwater Protection*, dated September 2008. Currently the property consists of several residences, a restaurant, a 9-hole golf course with a clubhouse and parking area, and undeveloped land which is largely wooded. A gravel access drive extends along the eastern edge of the property from Ten Rod Road to the Narragansett Bow Hunters Club.

According to the North Kingstown Zoning Ordinance Section No. 21-186, Groundwater Recharge and Wellhead Protection Overlay Districts, an analysis of nutrient loading is required as part of the permit application for development of the parcel.

The objective of PBA's services was to provide a preliminary nitrate loading study of the groundwater as it is anticipated to be affected by the development. Figure 2 indicates the concept plan for the development.

2.00 EXISTING CONDITIONS

We reviewed the available geologic publications for the vicinity of the site in order to gain an understanding of the subsurface conditions. Based upon the *Soil Survey of Rhode Island,* developed by the United States Department of Agriculture (USDA) Soil Conservation Service, undisturbed soils which underlie the project site consist of soils from the Bridgehampton series, Enfield series, Hinckley series, and Raypol series. Some disturbed Urban Land is also indicated within the limits of the proposed project. The location of each soil series is indicated on Figure 3. The NRCS Hydrologic Soil Class is indicated in the Soil Survey for each soil series. Using an overlay of the Soil Survey map on the proposed development plan, we determined the percentage by area of each NRCS Soil Class underlying the site. The site is underlain by 61 percent Class B soils, 25.6 percent Class A soils, and 13.4 percent Class C soils.

We also reviewed the *Groundwater Map of the Slocum Quadrangle, Rhode Island*, developed by the United States Geologic Survey (USGS), the subsurface soils consist of a mixture of Glacial Outwash and Glacial Till deposits. The Glacial Outwash is described as medium to coarse sand and gravel interbedded with fine sand, silt, and clay. The deposit is reportedly as much as 122 feet in thickness within this quadrangle. The Glacial Till is described as a poorly sorted and unstratified mixture of boulders, gravel, sand, silt, and clay. The deposit has an average thickness of 20 feet and is immediately underlain by the bedrock. It is anticipated that the glacial outwash would be underlain by the glacial till and bedrock. The mixed deposits are reported to grade into one another in varying proportions and reach a maximum known thickness of 125 feet. The average depth to water in this deposit is reportedly 22 feet.

3.00 BACKGROUND

Invariably the development of a site will change the conditions and often modes of recharge to the underlying groundwater. The subject of this analysis is the potential input of nitrates to the groundwater. At this stage of the project development, our analysis will be based upon assumptions which we develop based upon our understanding of the project development. As the project design progresses and the plans become more definitive, our analysis may need to be revised and/or the plans modified to be consistent with the assumptions utilized.

Recharge To Groundwater

The quantification of the input of nitrates to the groundwater is directly related to the hydrological cycle and the quantity of water recharged to the groundwater from precipitation, irrigation and septic loadings. Briefly, water falling on the land as precipitation or irrigation water will evaporate, be taken up by the vegetation, flow overland (surface water runoff) or percolate into the ground (groundwater runoff or groundwater recharge). Septic loadings are infiltrated at the leaching field. That water which percolates into the ground carries with it dissolved substances, such as nitrate, to

the groundwater.

There are several factors which determine whether this precipitation or irrigation water will percolate into the ground and become groundwater. These factors include the regional climate, site cover (pavement, grass or vegetation, etc.), slope and topography, and soil type. We have utilized the prescribed groundwater recharge values indicated within the North Kingstown Zoning Ordinance which requires the nutrient analysis to be completed. These recharge values are based upon soil classifications by NRCS Hydrologic Group.

Nitrate Nitrogen

Nitrates are found naturally occurring in groundwater. We have assumed that rainwater contains a small amount of nitrates within it. Other sources of nitrogen to be considered in this development are from the ISDS systems, and also from the fertilizer placed on the landscaped areas. These nitrates, which are not lost to the atmosphere as gas or not taken up by the plants as a nutrient will travel downward to the groundwater and remain in the groundwater system, moving down-gradient with the ambient flow.

Our analysis has assumed that part of the landscaped area would be fertilized and some surrounding areas, such as undeveloped woodlands, would not be fertilized. It should be noted that the magnitude of "wasted" fertilizer or fertilizer which is not taken up by the plants should be minimized. As a result, care should be taken to apply it only when needed and only when there is no rain forecast so that the probability of erosion from storm water flows is unlikely. By careful management, only a small percentage, perhaps only 2% of the nitrate nitrogen applied to landscaping, is not taken up by the plants and thus is "lost" from its intended purpose of fertilizing plants. We have been conservative in our analysis and in keeping with the requirements of the Zoning Ordinance, we have assumed a much higher percentage, 25%, is leached to the groundwater.

The objective of our analysis is to estimate the average concentration of nitrates input to the groundwater by the planned development. The Town of North Kingstown has set a criteria for net nitrates to groundwater of 5 mg/l. The Town Ordinance also does not allow for a reduction in the wastewater concentration during the nitrate analysis due to the proposed use of advanced treatment systems for commercial development. Although advanced treatment has been proposed for use at this development for both residential and commercial facilities, we have assumed a conventional nitrate loading of 35 ppm for wastewater from the commercial portion of the development. Use of the advanced treatment will significantly reduce the net nitrates to groundwater from the residential and commercial facilities.

4.00 PROPOSED CONDITIONS AT DEVELOPMENT

The proposed development of the site will result in changes in the nitrate loading of the groundwater.

However, the design as anticipated will minimize the introduction of undesirable chemicals to the groundwater. Utilizing the site development plan and in order to develop an estimate of the anticipated nitrates which will be introduced, we utilized the following parameters:

Area Description	Area (SF)	Area (Acres)
Total Area	5,713,350	131.16
Area w/Pavement	321,040	7.37
Total Landscaped Area	3,546,230	81.41
Area Landscaped with irrigation & fertilizer application	1,160,880	26.65
Area Landscaped with no fertilizer applied	2,385,350	54.76
Wooded - Undeveloped Area	1,568,170	36.00
Pond Area	47,000	1.08
Building Area	230,870	5.30

To perform the nitrate loading estimate, we have utilized a mass balance type of procedure. This analysis accounts for all water infiltration onsite and estimates nitrate concentration of each. The average concentration of nitrates and average yearly value of all these sources of input is then calculated. The procedure then aggregates these imports to develop an "average" value for the entire development. Our analysis uses the required nitrate loading input indicated in the Town Zoning Ordinance, such as groundwater recharge rates, concentration of nitrates in wastewater, fertilizer application rates and nitrate concentrations for collected water. Appendix B presents calculations we performed to develop our estimate of nitrate loading for the proposed development.

Our analysis has assumed that approximately 90% of the surface water runoff from impervious surfaces (pavement and buildings) will be captured and that the remaining water will run off site. The proposed development incorporates numerous diversion, collection, and storage measures designed to allow infiltration of surface water and we have therefore been able to assume approximately 25% of the surface water runoff from pervious surfaces (landscaped areas) will be captured and that the remaining water will run off site. We believe this is a conservative estimate as long as the site is developed with this in mind. Our analysis has also assumed that the captured water, calculated as surface water runoff, will enter the groundwater system through diversion and infiltration. At this time we have not attempted to account for any treatment of this captured water in a wet basin. We have assumed some irrigation water is being utilized, however this is only a nominal amount at this time and may be adjusted after your plans are more completely developed.

We have developed our analysis based on septic loadings, provided by Gary Lamond, for the development:

Source	Sewage Flow, gallons per day
Residential Development 174 total bedrooms at 115 gpd/bedroom	20,010
Clubhouse at Golf Course 50 seats at 40 gpd/seat	2,000
Mixed-Use Retail Facility 43,100 SF at 0.1 gpd/SF	4,310
Full-service Restaurant 150 seats at 40 gpd/seat	6,000

5.00 SUMMARY AND CONCLUSIONS

We have completed an analysis of the water which will contribute to the groundwater beneath the site utilizing the general assumptions and the techniques employed in this Town as well as others for the intended purpose. The results of our preliminary calculations indicate that the potential nitrate loading of the groundwater recharge from this proposed development should be approximately 4.8 mg/l. Our analysis indicates that approximately 68% of this nitrate comes from the septic systems and the remaining nitrates from fertilizers (24%), pet wastes (4%) and rainwater (4%). We believe that this estimate is relatively conservative. The level is lower than the allowable level in State and Federal drinking water standards of 10 mg/l and meets the requirements of town ordinances of 5 mg/l.

We trust that the information contained in this report is adequate for your needs at this time. If any of the assumptions cited herein are not correct, if there are questions on these recommendations or if you need additional information, please do not hesitate to contact the writer.

Very truly yours,

PAUL B. ALDINGER & ASSOCIATES, INC.

Mary M. Caouette, P.E.
Senior Geotechnical Engineer

Paul B. Aldinger, Ph.D., P.E.
Chief Engineer

FIGURES

APPENDIX A

LIMITATIONS

A. Use of Report

1. This preliminary report has been prepared for the exclusive use of JAMM Golf, LLC for specific application to the proposed Preserve at Rolling Greens development on Ten Rod Road, in North Kingstown, Rhode Island, in accordance with generally accepted engineering practices. No other warranty, express or implied, is made.

APPENDIX B

CALCULATIONS

CALCULATION OF NITRATE LOADING TO THE AQUIFER

Project: The Preserve at Rolling Greens Development North Kingstown, Rhode Island

Run: Preliminary Analysis - Preserve at Rolling Greens: 72 Duplex, 10 Live/Work, 10 Single Family Development (174 total bedrooms) with Golf Course

Date: 5/27/10

Job: 10035

ITEM		VALUE	From Precipitation Runoff Quantity (kcf/yr)	From Precipitation GW Quantity (kcf/yr)	From Irrigation Runoff Quantity (kcf/yr)	From Irrigation GW Quantity (kcf/yr)	Nitrate (lb/yr)	Nitrate % of Total
General	Acreage	square feet						
Total Area (SF)	131.16	5,713,351.9						
Area of Roads/Driveways (SF)	7.37	321,038.5						
Total Landscaped Area (SF)	81.41	3,546,233.4						
Area Landscaped with fertilizer application (SF)	26.65	1,160,878.5						
Area Landscaped with no fertilizer applied (SF)	54.76	2,385,354.9						
Area of Detention Pond (SF)	1.08	47,045.0						
Wooded Area - Total (SF)	36.00	1,568,166.1						
Area of Buildings (SF)	5.30	230,868.9						
Wetland Area - Total (SF)	0.00	0.0						
Area Landscaped off property contributing to basin (SF)		0.0						
Area Landscaped off property contributing to trenches (SF)		0.0						
Area Pavement off property contributing to basin (SF)		0.0						
Area Pavement off property contributing to trenches (SF)		0.0						
Nitrate concentration in Rainwater (mg/l)		0.05						
Nitrate concentration in Runoff from Pavement (mg/l)		1.5						
Nitrate concentration in Runoff from Roof Drains (mg/l)		0.5						
Average Sewage Loading to all ISDS systems(GPD)	57.5 GPD/person	20,010						
Residential Effluent Nitrate Loading (ppm)	DENITRIFICATION	19						
Wastewater Loading - Commercial Devl (GPD)		12310						
Commercial Devl Effluent Nitrate Loading (ppm)	ORDINANCE	35						
Fertilizer Application Rate (lb/1000SF)		3						
Pet Waste (kg/person/yr)		0.19						
Estimated residents 2 people per planned bedroom		348						
RAINFALL								
Average Annual Rainfall, in/yr		48						
Irrigation Water (Average Year), in/yr	NOT INCLUDED	0						
Total		48						
Total Runoff Coefficients								
From Precipitation								
On Impervious Surfaces		90.0%						
On Gravel Roadways - Combined		90.0%						
Surface Water Runoff		45.0%						
Groundwater Recharge		45.0%						
On Pervious Surfaces - Combined		52.0%						
Surface Water Runoff		19.0%						
Groundwater Recharge Type A soils (25.6% of area)		50.0%						
Groundwater Recharge Type B soils (61% of area)		37.5%						
Groundwater Recharge Type C soils (13.4% of area)		20.8%						
From Irrigation								
On Impervious Surfaces	NA							
On Pervious Surfaces - Combined		35.0%						
Surface Water Runoff		20.0%						
Groundwater Recharge		15.0%						
Area of Road/Driveways (SF)		321,038.5						
SW Runoff Quantity, in/yr		43.2						
SW Runoff Quantity, kcf/yr		1,155.7	1,155.7					
Ground Water (GW) Recharge Coefficient		0						
GW Quantity, in/yr		0						
GW Quantity, kcf/yr		0		0.0				

ITEM	VALUE	From Precipitation Runoff Quantity (kcf/yr)	From Precipitation GW Quantity (kcf/yr)	From Irrigation Runoff Quantity (kcf/yr)	From Irrigation GW Quantity (kcf/yr)	Nitrate (lb/yr)	Nitrate % of Total
Area Landscaped with irrigation & fertilizer application (SF)	1,160,878.5						
Portion of Landscaped Area with Type A soils	297,184.9						
Portion of Landscaped Area with Type B soils	708,135.9						
Portion of Landscaped Area with Type C soils	155,557.7						
SW Runoff Qty (Irr.), in/yr	0.00						
SW Runoff Qty (Irr.), kcf/yr	0.0			0.0			
GW Quantity (Irr.), in/yr	0.00						
GW Quantity (Irr.), kcf/yr	0.0				0.0		
SW Runoff Qty (Precip.), in/yr	9.12						
SW Runoff Quantity (Precip.), kcf/yr	882.3	882.3					
GW Quantity from Type A soils (Precip.), in/yr	24.00						
GW Quantity from Type B soils (Precip.), in/yr	18.00						
GW Quantity from Type C soils (Precip.), in/yr	10.00						
GW Quantity (Precip.), kcf/yr	1786.2		1,786.2				
Fertilizer Application Rate (lb/1000SF)	3						
Fraction Leached to Groundwater	0.25						
Total Nitrate to GW (lb/yr)	870.66					870.7	24.0%
Area of Open Space with no fertilizer applied (SF)	2,385,354.9						
Portion of Open Space Area with Type A soils	610,650.9						
Portion of Open Space Area with Type B soils	1,455,066.5						
Portion of Open Space Area with Type C soils	319,637.6						
SW Runoff Qty (Irr.), in/yr	0.00						
SW Runoff Qty (Irr.), kcf/yr	0.0			0.0			
GW Quantity (Irr.), in/yr	0.00						
GW Quantity (Irr.), kcf/yr	0.0				0.0		
SW Runoff Qty (Precip), in/yr	9.12						
SW Runoff Qty (Precip), kcf/yr	1,812.9	1,812.9					
GW Quantity from Type A soils (Precip.), in/yr	24.00						
GW Quantity from Type B soils (Precip.), in/yr	18.00						
GW Quantity from Type C soils (Precip.), in/yr	10.00						
GW Quantity (Precip), kcf/yr	3670.2		3,670.2				
Area with Detention Pond (SF)	47,045.0						
Precipitation on Pond, in/yr	48.00						
Precipitation Quantity, kcf/yr	188.2						
Evaporation of Pond, in/yr	27.45						
Evaporation Quantity, kcf/yr	107.6						
Wooded Area (SF)	1,568,166.1						
Portion of Wooded Area with Type A soils	401,450.5						
Portion of Wooded Area with Type B soils	956,581.3						
Portion of Wooded Area with Type C soils	210,134.3						
SW Runoff Quantity, in/yr	9.12						
SW Runoff Quantity, kcf/yr	1,191.8	1,191.8					
GW Quantity from Type A soils (Precip.), in/yr	24.00						
GW Quantity from Type B soils (Precip.), in/yr	18.00						
GW Quantity from Type C soils (Precip.), in/yr	10.00						
GW Quantity, kcf/yr	2412.9		2,412.9				
Wetland Area (SF)	0.0						
SW Runoff Quantity, in/yr	9.12						
SW Runoff Quantity, kcf/yr	0.0	0.0					
GW Quantity, in/yr	0.00						
GW Quantity, kcf/yr	0.0		0.0				
Area with Buildings (SF)	230,868.9						
SW Runoff Quantity, in/yr	43.20						
SW Runoff Quantity, kcf/yr	831.1	831.1					
GW Quantity, in/yr	0.00						
GW Quantity, kcf/yr	0.0		0.0				

ITEM		VALUE	From Precipitation Runoff Quantity (kcf/yr)	From Precipitation GW Quantity (kcf/yr)	From Irrigation Runoff Quantity (kcf/yr)	From Irrigation GW Quantity (kcf/yr)	Nitrate (lb/yr)	Nitrate % of Total
Total Precipitation Runoff, kcf/yr			5,873.8					
% Runoff Captured fromRoad/Driveway Area (Total) =	1,155.7	90.0%	1040.2	1,040.2				
% Runoff Captured from Building Area (Total) =	831.1	90.0%	748.0	748.0				
% Runoff Captured from Vegetated Area	3,886.9	25.0%	971.7	971.7				
Total captured Runoff Diverted to Infiltration, kcf/yr			2,759.9	2,759.9				
Total Irrigation Runoff, kcf/yr					0.0			
% Runoff Captured from Vegetated Area	0.0	25.0%						
Total captured Runoff Diverted to Infiltration, kcf/yr					0.0	0.0		
Summation of GW Recharge								
Total GW Recharge from Precipitation on Vegetation, kcf/yr				8,841.0				
Total nitrate in Rainwater, ppm		0.05						
Fraction lost in Wetlands		0						
Total nitrate in Rainwater, lb/yr		27.6					27.6	0.8%
Total GW Recharge from Irrigation, kcf/yr						0.0		
Total GW Recharge from Pavement Runoff Infiltration kcf/yr				1,040.2				
Total nitrate in Rainwater from Pavement Runoff, ppm		1.5						
raction lost in Wetlands		0						
otal nitrate in Rainwater, lb/yr		97.4					97.4	2.7%
otal GW Recharge from Roof Drain Infiltration kcf/yr				748.0				
otal nitrate in Rainwater from Roof Drain, ppm		0.5						
action lost in Wetlands		0						
otal nitrate in Rainwater, lb/yr		23.3					23.3	0.6%
fluent From All ISDS Systems								
verage Residential Devl Sewage Loading (gal/day)		20,010						
erage Residential Devl Sewage Loading, kcf/yr		976		976.4				
rate Loading in Residential Wastewater, ppm		19						
tal Nitrate in Residential Wastewater, lb/yr		1157.6						
erage Commercial Devl Sewage Loading (gal/day)		12,310						
erage Commercial Devl Sewage Loading, kcf/yr		601		600.7				
rate Loading in Commercial Devl Wastewater, ppm		35						
al Nitrate in Commercial Devl Wastewater, lb/yr		1311.9						
ction of Nitrogen Lost as Gas		0						
al Nitrate Leached to Ground Water, lb/yr		0.0						
ate from Pet Wastes							2,469.6	68.0%
al Pet Waste (kg/yr)		66.1						
							145.5	4.0%
MMARY								
l GW Recharge, kcf/yr				12,206.3				
l Nitrate to GW, lb/yr							3,634.0	100.0%
age Nitrate Conc, lb/cf		0.000298						
age Nitrate Conc, mg/l or ppm		4.77						100.0%