Otis
Environmental
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TECHNICAL MEMORANDUM

TO:	Eberhard Roeder Elke Ursin
FROM:	Dick Otis
DATE:	January 25, 2007
RE:	Quantification Strategy for Assessing Nitrogen Contributions from OWTS

Background

I have decided to try a different approach to construction the nitrogen contribution quantification from OWTS in the Wekiva Study Area. The reason is that the available data seem to be too few and too insensitive to be able to show significant differences between condition variables. Therefore, I am proposing that we consider the fate of nitrogen in and under OWTS looking at how the various variables to be considered regarding use, type of system, and site characteristics might impact the fate on nitrogen. I am hopeful that this might open other data sources that may be helpful in establishing more credible estimates of nitrogen contributions. I have tried to outline this approach in this memorandum.

Raw Wastewater Characteristics

There are numerous wastewater constituents that can impact the contributions of nitrogen to groundwater from OWTS. I am proposing the following wastewater parameters be considered as part of this study:

- Average daily flow
- Nitrogen concentration (or mass determined from an appropriate unit equivalent)
- cBOD concentration
- Alkalinity concentration

There are numerous organic and inorganic inhibitors to which nitrifying bacteria are sensitive. I propose that these be ignored for this study unless a particular wastewater type is known to typically contain such inhibitors.

The Water Environment Research Foundation is currently nearing completion of a wastewater characterization study that will update much of what we know about various categories of wastewater. I expect this study will be the best source for identifying wastewater constituents for this study and therefore, have not yet researched this area.

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Nitrogen Removal through Septic Tanks

If we use raw wastewater data to determine the mass of nitrogen that is discharged to a system, we will need to estimate the amount of nitrogen removed in the septic tank. Removal will occur through biological denitrification of most, if not all, of any nitrate nitrogen entering the septic tank or through retention of organic or other forms of insoluble or retained nitrogen in the sludge. The mass of nitrogen removed will be estimated from available per capita septage generation rates and measured nitrogen concentrations in septage.

Nitrogen Removal through Advanced Treatment

Two generic types of advanced treatment processes will be considered. The first will be nitrification using an extended aeration or fixed film process. Nearly complete nitrification with 2-3 mg-N/L of refractory organic nitrogen will be assumed unless the source water in the area has insufficient alkalinity to achieve complete nitrification. The second treatment type will be biological denitrification assuming a “single sludge” process such as an extended air or fixed film unit with recycle back to a septic tank. Again, alkalinity could be a limiting factor and must be considered.

Nitrogen Removal through Soil Infiltration

Estimating nitrogen removal in the soil will be more complex. System installations in two soil types will be evaluated; well to excessively drained sands (e.g. Candler, Millhopper, Other?) and poorly drained loamy soils (e.g. Chobee, Felda, Other?). The fate of nitrogen in these two soil types will differ and the amount of nitrogen removed in each will depend, in part, on the species of nitrogen applied to the soils.

For example, if septic tank effluent is applied to the soils, the well drained sandy soil will nitrify the TKN, which in the nitrate form, will easily leach deeper into the soil profile or groundwater. Denitrification will be minimal unless an anoxic zone is encountered containing some organic matter for the denitrifying heterotrophs. (I am not anticipating any autotrophic denitrification, which requires elemental sulfur or hydrogen gas for the electron donor) In a poorly drained wet, loamy soil, the ammonium cation, will be adsorbed by the clay minerals in the soil and retained or leach to the groundwater depending on the available adsorptive capacity of the soil material. However, it could be released through nitrification and leach deeper into the soil profile if aerobic conditions are created during seasonal drainage.

Where a nitrified effluent is applied to each soil type, the mass of nitrate reaching the groundwater in the well drained sandy soil should not differ substantially from the mass leached when septic tank effluent is applied. However, in the poorly drained soils, a nitrified effluent has a better chance of being denitrified in the shallow horizons where organic matter and anoxic conditions are more likely to occur since nitrification has already been completed in the pre-treatment step.

Treatment beyond the System Boundary

Estimating the removal of nitrogen in the soil and groundwater beyond the system boundaries is not within the scope of this task, but it must be estimated if this study is to be complete. The capacity of the environment to denitrify is huge. USGS has shown that denitrification occurs within hours when nitrate enters an anoxic zone of groundwater. Similar results have been found in Holland. The karst geology of the study area may limit the conditions where this would occur however. Also, it has been demonstrated by several that where nitrate is forced to leach through bottom sediments in lakes and streams that nearly complete denitrification occurs. Again, the karst geology could limit this opportunity, but in the floodplains it may be significant. In any event, potential removals considering travel distance and/or residence time in unconsolidated sediments and discharge areas where organic rich sediments would be encountered should be estimated.

Summary

Currently, I am gathering data for each of these conditions. This should make it easier to construct a useful table for estimating nitrogen contributions to groundwater below various onsite systems. This approach will only work well if we can assign percent removals to each condition. This too, may be difficult. I would appreciate your comments on this approach. I also hope that we have time to meet after the RRAC meeting February 6th.