

Phase I Report Wekiva River Basin Nitrate Sourcing Study

Prepared for:



St. Johns River Water
Management District
4049 Reid Street
Palatka, Florida 32177

and



Florida Department of
Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399

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MACTEC Project No.: 6063060079

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List of Acronyms and Abbreviations

ac	acre
Basin	Wekiva Basin
BMP	Best Management Practice
CAFO	concentrated animal feeding operations
CASTNET	Clean Air Status and Trends Network
cfs	cubic feet per second
DPT	direct push technology
EMC	event mean concentration
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
ha	hectare
GW	groundwater
IRL	Indian River Lagoon
IFAS Extension	Institute of Food and Agricultural Sciences Florida Cooperative Extension Service
lb	pound
LU	Land Use
MACTEC	MACTEC Engineering and Consulting, Inc.
MT/yr	metric tons per year
N	Nitrogen
N ₂	nitrogen gas
NO ₃	nitrate
NO ₃ -N	the nitrogen mass (or concentration) present as nitrate (often stated as nitrate expressed as N or as nitrate nitrogen)
NO _x	nitrogen oxides
OAWP	Office of Agricultural Water Policy
RIB	rapid infiltration basin
SJRWMD	St. Johns River Water Management District
SOW	Statement of Work
TMDL	Total Maximum Daily Load
UF	University of Florida
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
WAVA	Wekiva Aquifer Vulnerability Assessment
WMM	Watershed Management Model
WSA	Wekiva Study Area
yr	year

Acknowledgement

MACTEC and the District wish to thank Del Bottcher, Ph.D., P.E., President of Soil and Water Engineering Technology, Inc., and Wendy Graham, Ph.D., Director of the University of Florida's Water Institute for their valuable guidance and technical input during this project.

Executive Summary

The Wekiva Parkway and Protection Act of 2004 (Chapter 369, Part III, FS) established the legislative framework for construction of a limited-access expressway across the Wekiva River Basin in parts of Seminole, Orange and Lake counties, while providing enhanced protection to the Wekiva River ecosystem. Additional legislation passed in 2006 authorized funds to the Florida Department of Environmental Protection (FDEP) for "Identification and Quantification of Nitrogen Sources in the Wekiva River Basin Area".

The Nitrogen Sourcing Study is being performed in two Phases. This report covers only Phase I, in which existing information was collected and synthesized to produce a preliminary understanding of nitrate sources and loadings in the Wekiva River basin.

If deemed necessary, Phase II will follow and will consist of detailed field data collection and analyses to further identify and quantify nitrate sources and loadings in the Wekiva River basin.

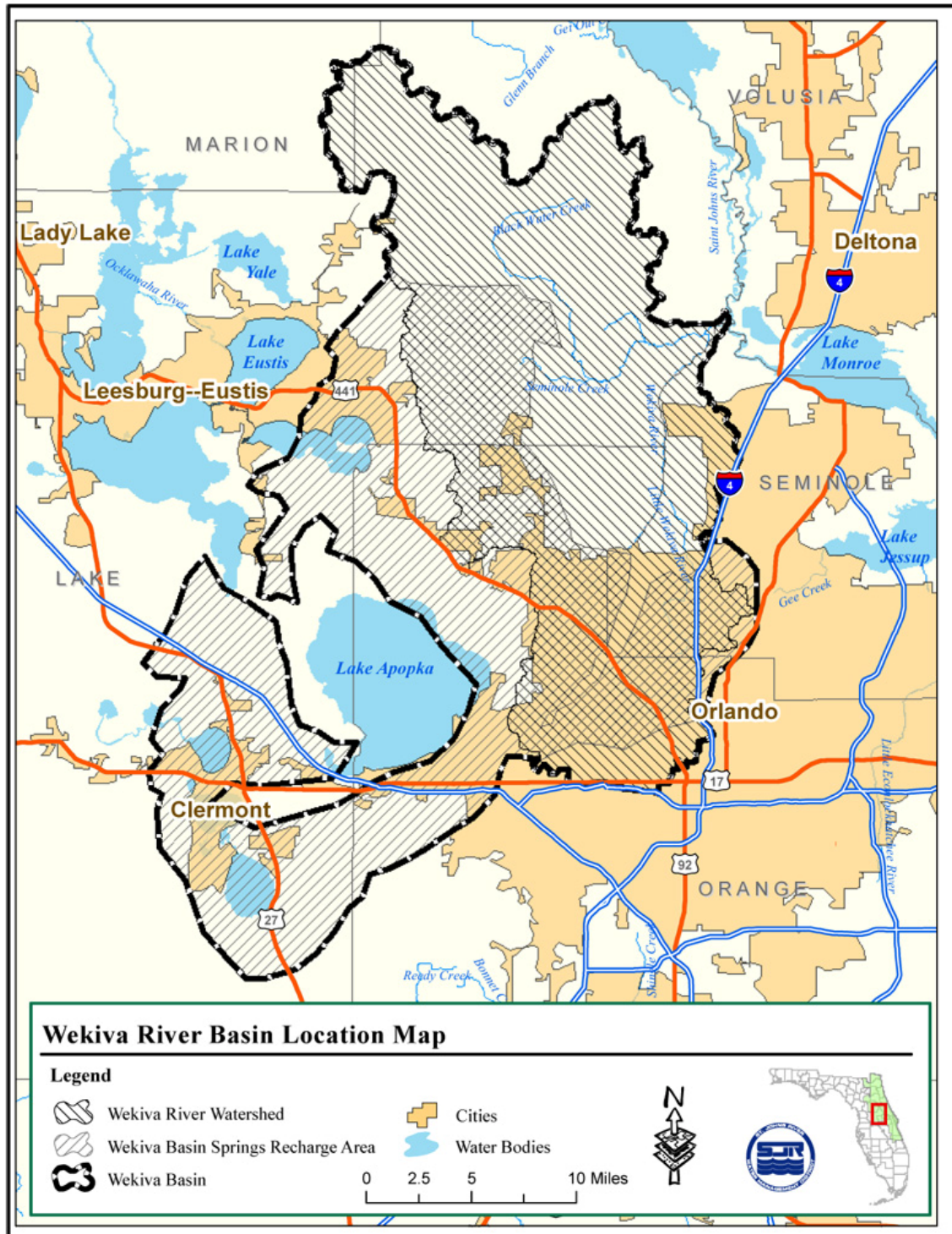
Description of Project Area

For purposes of this project, "Wekiva Basin" refers to (a) the area contributing groundwater recharge¹ to the Wekiva River and its tributaries as delineated by the SJRWMD Division of Groundwater Programs; and (b) the surface water catchments or watershed of the Wekiva River (Figure ES-1).

The Wekiva Basin as shown in Figure ES-1 is generally consistent with the Wekiva Study Area (WSA) as defined by F.S. Chapter 369.316, but not identical. The Wekiva Basin, which includes portions of Lake, Orange, Seminole, and Marion Counties, has an area of 415,000 acres (648 mi²), which is 37% larger in area than the WSA (303,000 acres or 473 mi²). The portion of the Wekiva Basin that is not part of the WSA is generally to the west and southwest of the WSA, in Lake County, and in areas that are less densely populated. Figure ES-2 summarizes the land use in the Wekiva Basin.

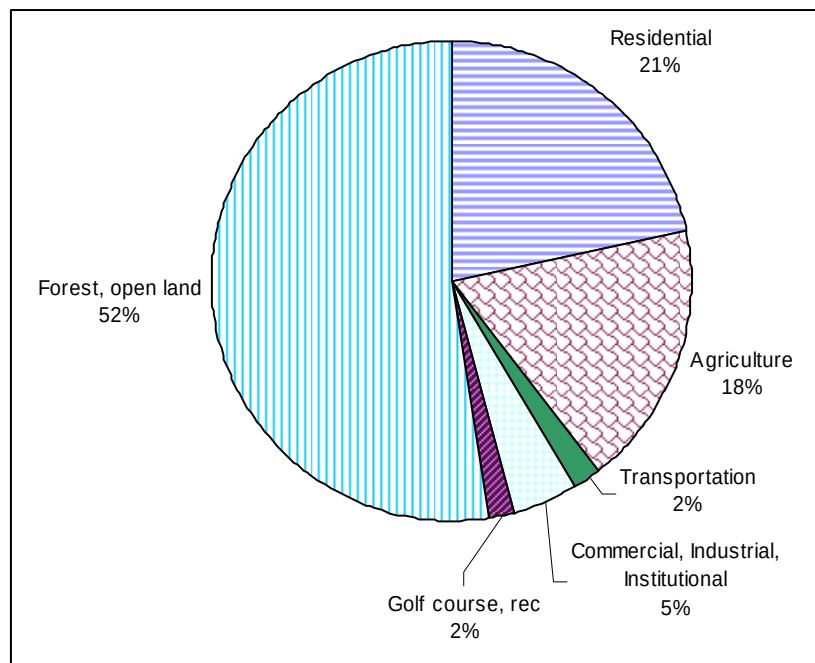
¹ Recharge is the downward flow of water to a subsurface groundwater aquifer.

Figure ES-1. Project Location



Source: MACTEC and SJRWMD
Created by: NMG Checked by: WAT

Figure ES-2. Land Use in 2004, Wekiva Basin



Source: MACTEC and SJRWMD
Created by: SAR Checked by: WAT

Sources of Nitrate

Nitrogen is an important plant nutrient, and a major ingredient in commercial fertilizers. Nitrogen is also associated with human and other animal waste, and is found in raw sewage. Nitrate is a negatively charged ion consisting of nitrogen and oxygen. In the environment, nitrogen exists in several chemical forms, and biochemical processes can change the chemical form of the nitrogen in environmental media. Other forms include ammonia and organic nitrogen compounds, such as amino acids and proteins. Nitrogen gas is the predominant compound that comprises the atmosphere. Nitrate, however, is probably the most problematical form as a water pollutant. Nitrate is highly soluble in water, so it migrates readily into and with groundwater. In drinking water, high concentrations of nitrate can be fatal to infants. In surface waters, nitrate is a nutrient that can be used as food by algae and other plants, and excessive growth of such plants may cause nuisance conditions in springs, lakes, and rivers, often referred to as eutrophication.

The following source types were identified as potentially important sources of nitrate, and their contribution to loadings in the Wekiva Basin was estimated:

- Industrial Wastewater
- Domestic Wastewater
- Septic Tanks
- Fertilizer – Agriculture
- Fertilizer – Residential
- Fertilizer – Golf Course
- Fertilizer – Other

- Livestock
- Atmospheric Deposition

For each of these sources, the annual rate of nitrate (or Total Nitrogen, see Section 2.2.1)² released to the environment within the Wekiva Basin (inputs) was estimated using the best available information.

Nitrate from these sources is delivered to ground or surface waters of the Wekiva Basin by the following transport mechanisms:

- Direct discharge to surface waters (e.g., a wastewater outfall pipe that discharges to a river);
- Generation of stormwater runoff that flows to surface waters (stormwater-direct);
- Generation of stormwater in closed basins, or other stormwater that percolates to groundwater (stormwater-diffuse); and
- Infiltration to groundwater (e.g., the leaching process in which fertilizer applied in excess of crop or turfgrass requirements is carried by infiltrating rainwater to a groundwater aquifer).

Each of these transport mechanisms was quantified using best available information (literature, available models, etc). The delivery of nitrate to waters of the Basin by these transport mechanisms is referred to as “loading” in this report.

Inputs and loadings per area are presented in this report in metric units of kilograms of nitrogen per hectare per year (kg/ha/yr). Results for the entire Wekiva Basin are presented in metric tons of nitrogen per year (MT/yr).³ One metric ton is equal to one thousand kilograms (2,205 pounds).

Inputs

Fertilizer Use

The general procedure for estimating fertilizer use was to assume fertilizer is applied at rates recommended by the University of Florida Institute of Food and Agricultural Sciences Florida Cooperative Extension Service (UF/IFAS Extension), with limited modifications if there is evidence that actual usage differs from UF/IFAS Extension recommendations. Fertilizer use was estimated for the following land uses:

- Residential,
- Commercial, institutional, recreational, and transportation
- Agricultural, subdivided in the following types of agriculture
 - Row crops
 - Field crops

² Nitrate mass and concentrations are generally expressed as the mass of nitrogen present as nitrate, which is customarily labeled NO₃-N. Total nitrogen is the combination of all forms of nitrogen, whether dissolved or in solid form

³ One kilogram equals 2.205 pounds (lb); one hectare equals 2.472 acres (ac); and one metric ton equals 2,205 lb or 1.102 tons. To convert from metric to English units, multiply the loading rate in (kg/ha/yr) by 0.8920 to yield a loading rate in (lb/ac/yr).

- Tree crops (citrus), nurseries, and ornamentals, and
- Pasture
- Golf courses

For each of these land uses, an estimate of fertilizer use per hectare was multiplied by the total area in that land use in the Wekiva Basin.

Livestock

In addition to fertilizer use on improved pasture, nitrogen in livestock (cattle) waste was also estimated, by multiplying the estimated number of cattle in the Basin by the waste produced per head.

Domestic and Industrial Wastewater Discharges

Wastewater discharges of nitrate to surface water and groundwater were estimated using actual monitored discharge rates and effluent concentrations as reported by permittees to FDEP. The permits were used to determine the amount of effluent (a) discharged to groundwater via Rapid Infiltration Basins and other rapid rate land applications systems; (b) discharged directly to surface water by a permitted outfall, or (c) reclaimed / reused in slow rate public access reuse systems; and these were accounted for separately.

Septic Tanks

Florida Department of Health (FDOH) data were used as the primary basis for the estimate of the number of septic tanks in the Wekiva Basin. FDOH provided the location of all septic tanks in the WSA. This information was used to estimate the density of septic tanks in relevant land uses (primarily residential), and the septic tank density by land use in the WSA was used to estimate the number of septic tanks in the remaining portions of the Wekiva Basin. The number of septic tanks in the Wekiva Basin was estimated to be approximately 65,000. Each tank was estimated to discharge approximately 20 pounds of nitrogen per year.

Atmospheric Deposition

Measured rates of atmospheric deposition of nitrate from four locations in Florida were evaluated to estimate atmospheric deposition of nitrate in the Wekiva Basin. The average deposition rate observed at a site near Sebastian Inlet was assumed to be representative of rural areas within the Basin, while average values from the Tampa metropolitan area were assumed to be representative of urban areas within the Basin.

Loadings

Loadings represent a portion of the inputs that actually reach surface waters or groundwater in the Basin. To understand the difference between inputs and loadings, as the terms are used in this report, consider fertilizer use. Inputs represent the best estimate of the total amount of fertilizer nitrogen applied on the land. Some of this fertilizer nitrogen is taken up by plants and

incorporated into plant biomass. However not all the fertilizer nitrogen is taken up, some is lost during application, and some escapes the root zone, etc. The portion of the applied nitrogen that is excess to plant requirements and dissolves in runoff or infiltrates with percolating rainwater to the water table is a loading.

Fertilizer Use

Loadings to groundwater, and attributable to fertilizer use, were estimated by reviewing representative research studies where concentrations of nitrate were measured in groundwater or leachate from specific land uses. This information was used to estimate a representative groundwater concentration associated with that land use. This representative groundwater concentration was assumed to represent the impact of fertilizer applications on groundwater within each land use. The resultant groundwater concentrations were overlaid on a map showing groundwater recharge rates to estimate the rate of nitrate loading to groundwater. The land use and recharge rate maps were developed by the St. Johns River Water Management District (SJRWMD).

Loadings attributable to fertilizer use were estimated for each of the land use categories associated with fertilizer use listed above in the discussion of Inputs.

The same procedure was used to estimate loading from livestock waste, using measured groundwater concentrations under pasture land and feedlots.

Domestic and Industrial Wastewater

All effluent from domestic and industrial wastewater facilities were assumed to represent loadings, i.e., assumed to reach surface or groundwater. This assumption is conservative, and limitations of this assumption are discussed in the report.

Septic Tanks

Approximately 70% of the waste nitrogen discharged from septic tanks was assumed to reach groundwater as nitrate. Research papers indicate the actual percentage may range from 50 to 90%.

Stormwater Loadings

Stormwater loadings were estimated using information used to support development of the WSA Master Stormwater Management Plan. Stormwater loadings were attributed to specific land uses and source types by application of the Watershed Management Model (WMM) originally applied in support of that Plan.

Phase I Results

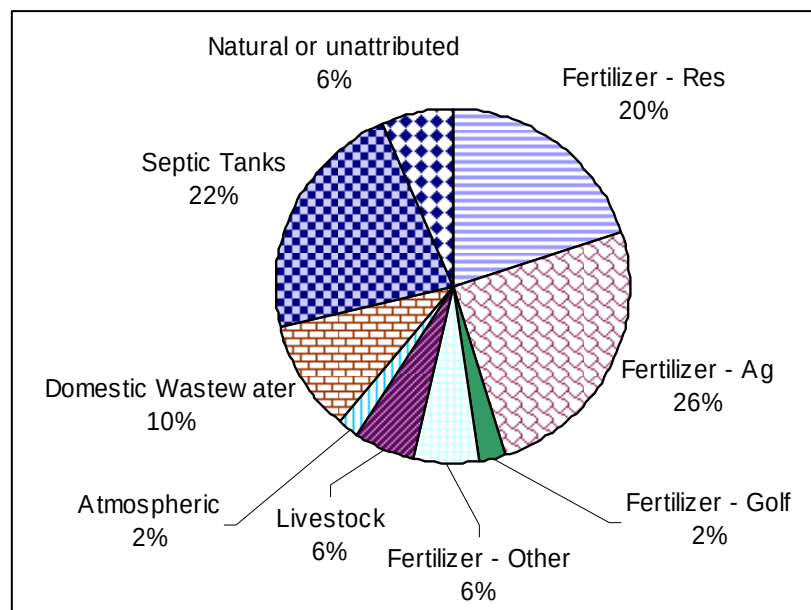
It was estimated that in 2004, the rate of nitrate loading to groundwater and surface water in the Wekiva Basin was 1,800 metric tons of nitrogen as nitrate (NO₃-N) per year. Most of this NO₃-N

(about 93%) initially affects groundwater, with only a small amount discharged directly to surface waters. The groundwater loading (1,700 metric tons per year) substantially exceeds the amount that is estimated to be discharged by springs in the Wekiva Basin, which is estimated to be approximately 230 metric tons of $\text{NO}_3\text{-N}$ per year. Estimated loadings may exceed current spring discharges for several reasons, including:

- Loadings may have been overestimated.
- Discharges from springs reflect the result of loadings some time in the past. Loadings may have increased during the past 20 years. If so, nitrate concentrations in the springs may increase in the future.
- Chemical processes occurring in the aquifer may reduce the mass of nitrate nitrogen as the groundwater moves from the source areas to the springs.
- Not all of the groundwater in the Basin discharges at springs. Some nitrate in groundwater may underflow the springs, eventually discharging to the St. Johns River.

Figure ES-3 illustrates the apportionment of the total estimated loadings by source type.

Figure ES-3. Nitrate Loadings to the Wekiva Basin, Partitioned by Source



Source: MACTEC

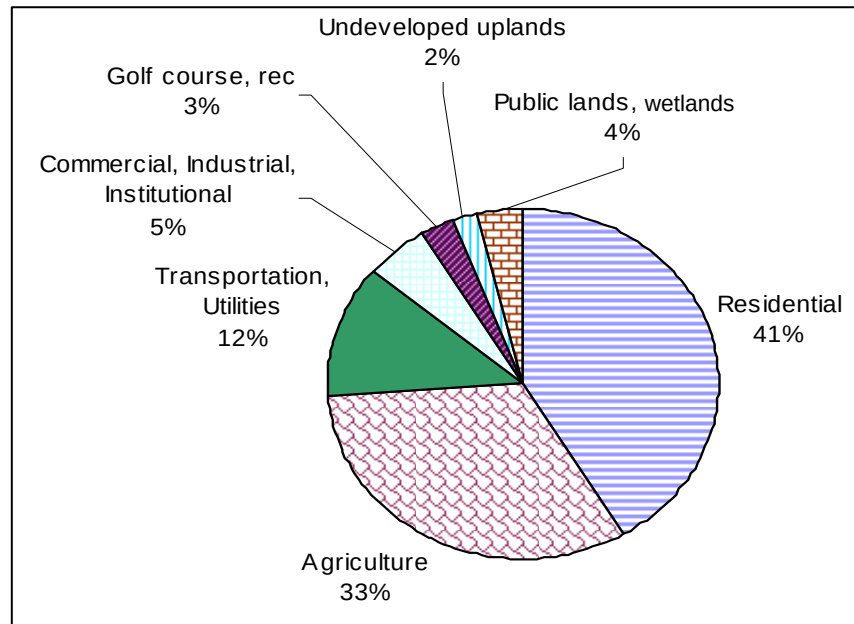
Created by: SAR Checked by: WAT

Fertilizer use by agriculture and for residential turfgrass are major contributors to total Basin loading, as are septic tanks. Fertilizer use on all land uses comprises more than half of total loadings. Domestic wastewater and livestock waste add 10 and 6%, respectively. Approximately 6% of the total loading is apparently natural, that is it cannot be attributed to identified sources. This amount consists of the groundwater recharge and stormwater loadings that would be expected to occur if all land in the Basin were undeveloped.

The portion of nitrogen inputs applied as fertilizer that reaches groundwater or surface waters of the Basin as nitrate is the result of two essentially independent calculations. Nitrogen inputs are based on estimated fertilizer use, while loadings are based on estimated groundwater concentrations and recharge rates and application of a stormwater loading model (WMM). Although there is significant potential for errors in both the loadings and the inputs, the portion of fertilizer applied that is estimated to reach groundwater and surface water is consistent with other research.

Figure ES-4 illustrates the partitioning of $\text{NO}_3\text{-N}$ loadings by land use. Residential land uses, which are affected by both fertilizer use and septic tanks, account for 42% of total loading, while agricultural land uses contribute 33%. Wastewater effluents are the predominant contributor to the transportation, communications, and utilities land uses, which combined contribute 12% of total loadings of $\text{NO}_3\text{-N}$.

Figure ES-4. Nitrate Loading to the Wekiva Basin, Partitioned by Land Use



Source: MACTEC
Created by: SAR Checked by: WAT

Residential land uses are major contributors to $\text{NO}_3\text{-N}$ loadings (42%), in part, because they comprise a large portion (21%) of the Wekiva Basin. Similarly transportation, utilities, commercial, industrial, institutional, and golf course land uses contribute a greater proportion of the $\text{NO}_3\text{-N}$ loadings than their proportion of the acreage, while undeveloped land uses that make up more than 50% of the area of the Basin contribute only 6% of the $\text{NO}_3\text{-N}$ loading.

Uncertainties in Phase I Results

Several of the factors used to estimate inputs and loadings are uncertain, and the procedures themselves do not represent all factors that affect nitrate loadings. Sources of uncertainties are

characterized in detail in the report, and were considered in developing recommendations for further investigations in Phase II.

Recommendations

Potential strategies for reducing loading of $\text{NO}_3\text{-N}$ to waters of the Wekiva Basin were identified and, where possible, the potential effectiveness of these strategies was estimated. The feasibility and cost-effectiveness of potential strategies were not evaluated, although issues of feasibility were considered in identifying promising strategies. The potential effectiveness of attractive strategies was estimated. From a practical standpoint it will be difficult to realize the potential reductions available from most of the strategies considered, due to their high cost and the necessity for significant changes in behavior of residents.

Recommendations were also made for follow up Phase II studies. Recommendations include additional investigations and further development of available information to reduce uncertainties identified in Phase I.

Load Reduction Strategies

Provisional Pollutant Load Reduction Goals have been established for the Wekiva River by the SJRWMD. They determined that $\text{NO}_3\text{-N}$ loads need to be reduced by 36% for the Lower Wekiva River up to 85% for Rock Spring. These load reduction targets were determined to meet water quality target concentrations of $\text{NO}_3\text{-N}$ for these water bodies. They were developed with large safety margins to ensure that the load reduction goals would be protective.

Figures ES-3 and ES-4 suggest that residential and agricultural land uses, specifically fertilizer use by homeowners and farmers, and septic tank and domestic wastewater effluents contribute the bulk of the loading, and would therefore represent the primary targets for load reduction.

Domestic Wastewater Management

Options for reducing loadings from domestic wastewater include upgrading septic tanks, upgrading centralized wastewater treatment facilities, increasing reclamation/reuse of domestic wastewaters, expanding footprints of central sewer systems, and/or requiring hookups where central sewer systems are already available.

In April 2006 FDEP promulgated F.A.C. 62-600.550 establishing specific wastewater management requirements for the WSA. Existing domestic wastewater facilities discharging within the Wekiva Study Area are to comply with requirements of the rule by April 2011. The approach adopted by FDEP is to target more stringent requirements in portions of the WSA where the Floridan Aquifer is particularly vulnerable to contamination.

This report presents an estimate of the effluent load reduction that will occur upon implementation of F.A.C. 62-600.550. Within the WSA, total domestic wastewater effluent

NO₃-N loads are estimated to be reduced by 65%. Since there are a number of wastewater facilities in the Wekiva Basin that are not within the WSA, and therefore not subject to the requirements of F.A.C. 62-600.550, the overall effect of the required upgrades on NO₃-N effluent loads in the Basin would be a 21% reduction. Since domestic wastewater facilities represent only 10% of the baseline NO₃-N loading (see Figure ES-3), the effect of the rule will be a 2% NO₃-N load reduction across the entire Basin, all source types.

In 2004 FDOH developed recommended load reduction strategies to reduce the impact of septic tanks in the WSA. FDOH determined that advanced septic systems are commercially available that can reduce nitrogen loading from septic tanks by approximately 75%. FDOH recommended that new, modified, and replacement tanks in the Primary and Secondary Protection Zones within the WSA be upgraded. FDOH concluded that similar levels of environmental protection are afforded by advanced septic systems as by central sewer, but recognizes that extension of and/or connection to central sewer is a lower cost alternative to septic tank replacement/upgrade in high density land uses; while septic tank upgrade would be the lower cost alternative in areas with a low density of development. Since similar levels of environmental protection are afforded, the lower cost alternative (central sewer hookup or upgrade to advanced septic systems) should be selected, by location.

Recognizing that septic system malfunction is an important ongoing problem, and that advanced septic systems may require an even higher level of maintenance than conventional septic tanks, FDOH also recommended the establishment of regional wastewater management entities to oversee the maintenance of all septic systems in the WSA. The wastewater management entities would be a part of county or city governments, or a special taxing district. The governmental wastewater management entity would oversee inspection and maintenance services. Funding for the maintenance program would be generated through user service fees.

The potential load reductions afforded by the FDOH recommendations were estimated. A scenario was developed that could be evaluated within the context of available information for the Wekiva Basin and procedures used to estimate loadings in this report. Specifically, if all septic tanks in high density residential land use within the WSA Primary and Secondary Protection Zones were replaced by central sewerage (approximately 5,000 tanks hooked up), and NO₃-N loadings from all other septic tanks in Primary and Secondary Protection Zones in the WSA were reduced by 75% (approximately 43,000 tanks upgraded), the total loading of NO₃-N (entire Basin, all source types) would be reduced by 12%.

If the FDOH recommendations were implemented throughout the Wekiva Basin (and not just within the WSA), the total NO₃-N loading would be reduced by 14% (6,000 tanks hooked up, 50,000 upgraded).

Strategies to reduce impacts from septic systems must address funding mechanisms, since costs to individual septic system owners are substantial and may be perceived to be inequitable.

Loadings from fertilizer use may be reduced by improved management of both fertilizer use and irrigation. An important element of any strategy to reduce fertilizer impacts on waters of the Wekiva Basin must be education because so many citizens make individual decisions regarding fertilization and irrigation. The public agency with the clearest charge to educate fertilizer users is the UF/IFAS Extension Service. Other public agencies and industry associations also play a role, including the Florida Department of Agriculture and Consumer Services (FDACS), FDEP, and the SJRWMD. The best approaches to encourage use of BMPs may differ depending on the types of fertilizer users. Turfgrass is maintained by homeowners, commercial lawn care service providers, golf course maintenance supervisors, and parks maintenance personnel (e.g., City and County). Farmers and citrus growers also apply fertilizer. Each group of fertilizer user may be educated or influenced using different methods. UF/IFAS Extension Service conducts research on the best methods to communicate with and influence various fertilizer users, and then implements their findings to the extent feasible. It may be appropriate to allocate additional resources to such educational programs. Alternative approaches discussed in the report included regulatory and incentive based approaches. It is estimated that effective implementation of residential fertilizer use BMPs could reduce $\text{NO}_3\text{-N}$ loadings from this source by approximately 33%, which would equate to about 6% of the total Basin $\text{NO}_3\text{-N}$ loading from all sources.

Recommended Activities for Phase II of this Study

Significant uncertainties have been identified throughout this report, and studies targeted at reducing these uncertainties are recommended. Phase II should include:

1. a recharging groundwater quality assessment emphasizing locations and land uses likely to have the greatest impact on springs feeding the Wekiva River, and
2. integration and interpretation of the available information using an integrated watershed water quality model with potential to simulate $\text{NO}_3\text{-N}$ transformations and transport in runoff, shallow and deep groundwater compartments, and discharge of groundwater to springs and streams.

Several other attractive, but lower priority, topics are identified as potential elements of Phase II in the report.

1.0 Introduction and Background

The Wekiva Parkway and Protection Act of 2004 (Chapter 369, Part III, FS) established the legislative framework for construction of a limited-access expressway across the Wekiva River Basin in parts of Seminole, Orange and Lake counties, while providing enhanced protection to the Wekiva River ecosystem. Additional legislation passed in 2006 authorized funds to the Florida Department of Environmental Protection (FDEP) for "Identification and Quantification of Nitrogen Sources in the Wekiva River Basin Area".

The FDEP contracted with the St. Johns River Water Management District (SJRWMD) to perform this nitrogen sourcing work. SJRWMD chose to focus on one form of nitrogen, nitrate (NO_3), because that has been identified as a problem pollutant in springs and spring-run streams in Florida, including the Wekiva River and its main tributary, Rock Springs Run.

In Phase I of this project, existing information was collected and synthesized to produce a preliminary understanding of nitrate sources and loadings in the Wekiva River basin and identify additional data and analyses needed to adequately characterize nitrate sources and loadings. This report covers only Phase I.

If deemed necessary, a Phase II will follow under a separate contract and will consist of detailed field data collection and analyses as recommended in Phase I to further identify and quantify nitrate sources and loadings in the Wekiva River basin. Phase II might include activities such as sampling at new surface and groundwater monitoring locations, refinement of existing models, or additional new modeling.

1.1 Description of Project Area

For purposes of this project, "Wekiva Basin" refers to (a) the area contributing groundwater recharge⁴ to the Wekiva River and its tributaries as delineated by the SJRWMD Division of Groundwater Programs, and (b) the surface water catchments or watershed of the Wekiva River (Figure 1-1).

The Wekiva Basin as shown in Figure 1-1 is generally consistent with the Wekiva Study Area (WSA) as defined by F.S. Chapter 369.316, but not identical. The Wekiva Basin, which includes portions of Lake, Orange, Seminole, and Marion Counties, has an area of 415,000 acres (648 mi^2), which is 37% larger in area than the WSA (303,000 acres or 473 mi^2). The population of the Wekiva Basin was approximately 423,000 in 2000, or 9% greater than the population of the

⁴ Recharge is the downward flow of water to a subsurface groundwater aquifer.

WSA (388,000 in 2000)⁵. The portion of the Wekiva Basin that is not part of the WSA is generally to the west and southwest of the WSA, in Lake County, and in areas that are less densely populated. The additional area included within the Wekiva Basin for the purpose of this study is somewhat more rural and agricultural than the portion of the Basin included within the WSA (see Figures 1-2 and 1-3).

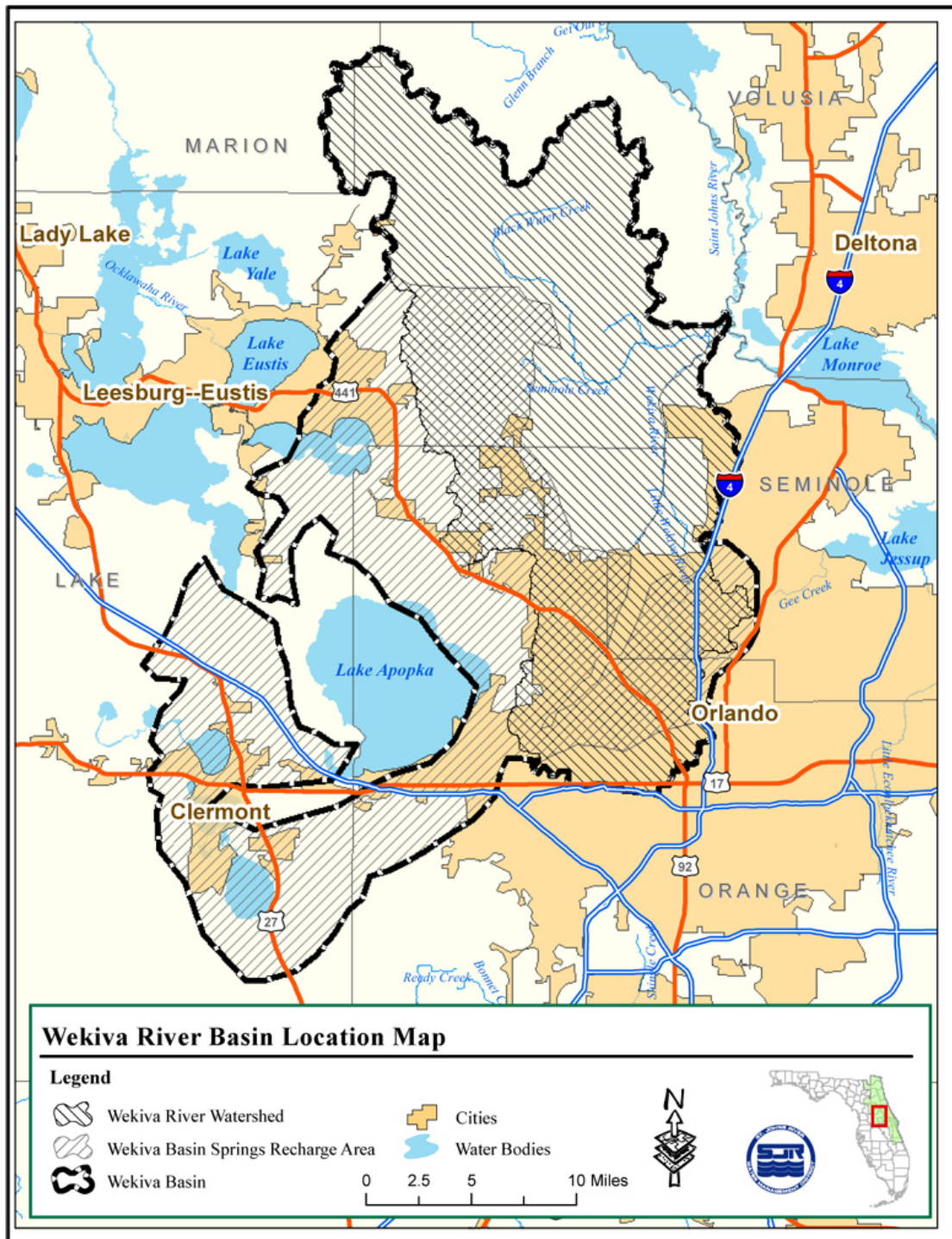
1.2 Objectives of Project

The objectives of this project include:

- Obtain, review and integrate existing land-use data and models of surface water and groundwater for the Wekiva River basin;
- Conduct a “desktop” inventory of all potential sources of nitrate loading to surface and groundwaters in the Wekiva River basin;
- Review and summarize the literature on nitrate loading to surface and groundwater from various land uses in the Wekiva River basin;
- Develop a preliminary nitrate budget for the Wekiva River basin;
- Develop preliminary recommendations for nitrate load reduction strategies and methods;
- Develop recommendations for additional data and analyses needed to adequately identify and loading to the Wekiva River basin; and
- Prepare a comprehensive report that summarizes the above.

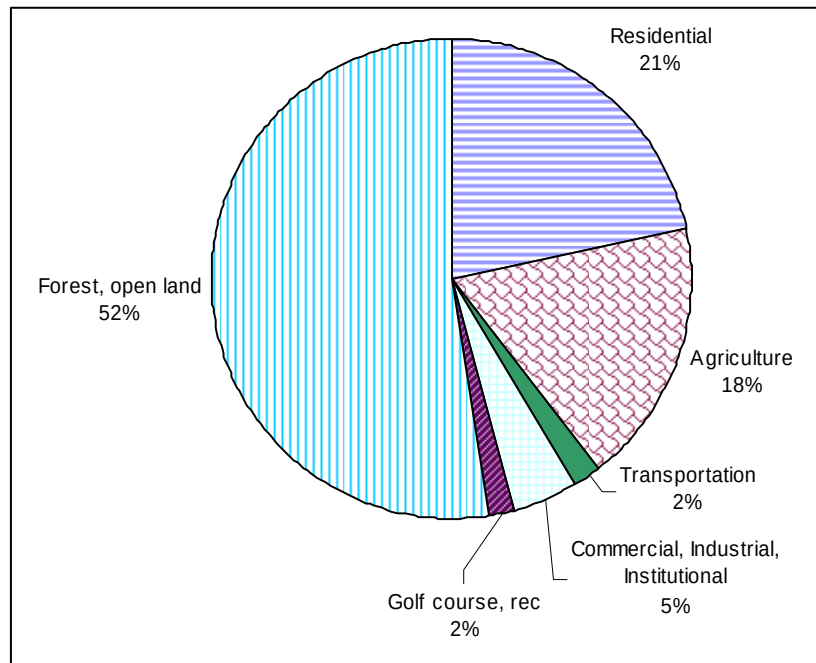
⁵ Note: Various statistics presented in this report are based on land use in 2004, while these population statistics are based on the 2000 U.S. census. Population is increasing rapidly in the Basin – acreage in residential land use increased by 10% from 1999 to 2004.

Figure 1-1. Project Location



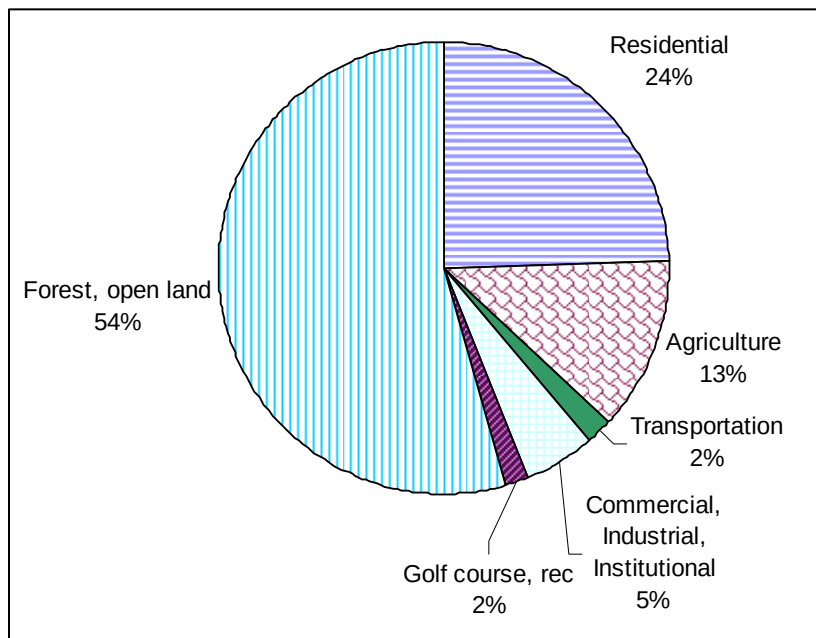
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Figure 1-2. Land Use in 2004, Wekiva Basin



Source: MACTEC and SJRWMD
Created by: SAR Checked by: WAT

Figure 1-3. Land Use in 2004, Wekiva Study Area (WSA)



Source: MACTEC and SJRWMD
Created by: SAR Checked by: WAT

2.0 Approach to Nitrate Loading and Partitioning

Existing information and models were collected and synthesized to produce a preliminary understanding of nitrate sources and loadings in the Wekiva Basin.

2.1 Review of Available Information

Information sources specified in the SOW were reviewed. The SJRWMD provided MACTEC Engineering and Consulting, Inc. (MACTEC) with two bibliographic searches conducted by others, and MACTEC identified additional references by review of reference lists of publications reviewed and by keyword search of multiple web-based databases. References identified were then further reviewed for relevance to the project and copies of technical publications were acquired. The acquired publications were then reviewed by the project team to determine their value to the study. In all, approximately 250 technical publications were acquired and reviewed for relevance. The entire list of references consulted appears in Appendix A. Publications actually cited in the report are in Section 5.0. References.

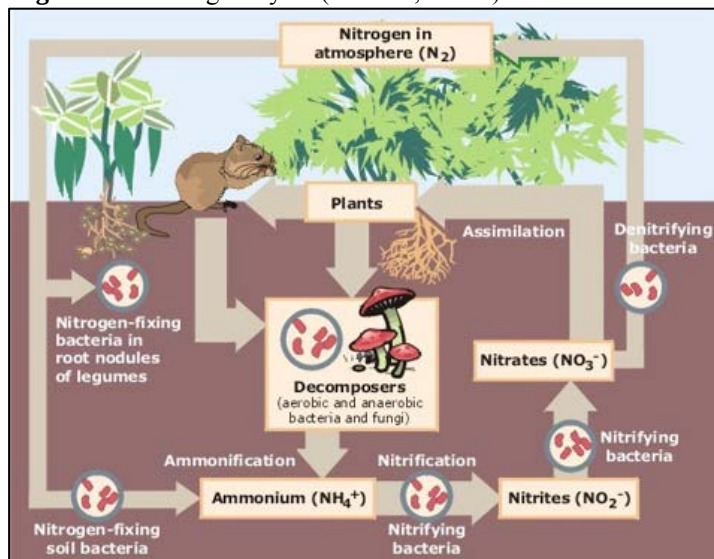
2.2 Conceptual Model of Nitrate Loading to Waters of the Wekiva Basin

2.2.1 The Nitrogen Cycle

Nitrate (NO_3^-) is an anion that participates in the complex nitrogen cycle (Figure 2-1) in the earth's biosphere (see, for example, Loreti, 1988; the nitrogen cycle is also described on a variety of websites). Nitrate may be either created or destroyed in the biochemically active root zone, in surface water and groundwater.

Nitrogen gas (N_2) comprises about 78% of the atmosphere. Nitrogen is essential for many biological processes, but is not readily available to plants or animals in the N_2 form. In nature, N_2 is converted to biologically usable forms (ammonium, nitrate or nitrite ions) by some algae and bacteria, a process called fixation. These anionic forms can be taken up by plants, which convert them to amino acids and proteins, a process known as assimilation; while the reverse decomposition reaction is known as mineralization. Decomposition in anaerobic environments generally yields ammonia or ammonium ions, a process called ammonification. Nitrification is the process whereby microorganisms convert organic nitrogen⁶

Figure 2-1. Nitrogen Cycle (USEPA, 2006a)



⁶ Organic nitrogen, such as proteins, amino acids, and urea, includes nitrogen in organic compounds found within living organisms and decaying plant and animal tissues.

to nitrate and nitrite. Nitrification is favored in aerobic environments, while ammonification is more likely to occur in reducing environments⁷. Finally, denitrification is a biochemical process that converts nitrate or nitrite ions back to nitrogen gas, completing the nitrogen cycle (Cohen, 2006). Denitrification depends on the availability of electron donors used by autotrophic bacteria. The electron donors, typically pyrite or ferrous silicates, are rare in the Florida environment. Additionally, when calcium, pH, alkalinity and/or specific conductance are high, denitrification is less likely to occur. All of these parameters are characteristically high in Florida's groundwater. Consequently, denitrification is generally negligible in groundwater in Florida (Cohen, 2006). Denitrification has been shown to occur in shallow groundwater in Florida where the water table is near the surface (McNeal, *et al.*, 1995; Crandall, 2000).

In soils, organic nitrogen and ammonia are more likely to be associated with solids than nitrate, which is highly soluble and not sorbed to any significant extent (Loreti, 1988). Although ammonium ion is soluble, it is more readily sorbed to soils, and thus not as leachable as nitrate (Cohen, 2006). This is one reason that nitrate represents a more significant water quality concern than other forms of nitrogen.

Based on the importance of these processes in the environment, nitrate cannot be considered a conservative (never changing) constituent. Nitrate applied as fertilizer may be assimilated by plants, or denitrified and returned to the atmosphere. Ammonium in fertilizers or in animal waste may be converted to nitrate in soil or water, and so on.

This Phase I project does not attempt to quantify these processes in the Wekiva Basin. Further consideration of the importance of these processes may be worthwhile in Phase II. In Phase I, however, certain simplifying assumptions and/or conventions have been adopted that partially account for some features of the nitrogen cycle. The target constituent for this study is nitrate. Where information regarding loadings of nitrate is readily available, that information was used. For some source types, however, the most reliable loading information was reported as Total Nitrogen (N)⁸ (e.g., fertilizer use, animal wastes). For such categories of information, Total N information was used. Effectively this means that for some sources, Total N was assumed to be readily converted to nitrate in the environment.

Although it was not feasible in this Phase I project to account for all the complex biochemistry of the nitrogen cycle, a limited attempt was made to account for assimilation by plants and other processes that occur in the root zone. Specifically it was not assumed that all fertilizer N applied to the land surface would reach ground and/or surface water of the Wekiva Basin as nitrate.

⁷ A reducing environment is one characterized by little or no free oxygen. In soils, reducing environments are more common in wetlands and where soils are rich in organic matter.

⁸ Total N is the combination of all forms of inorganic and organic nitrogen, whether dissolved or in solid form.

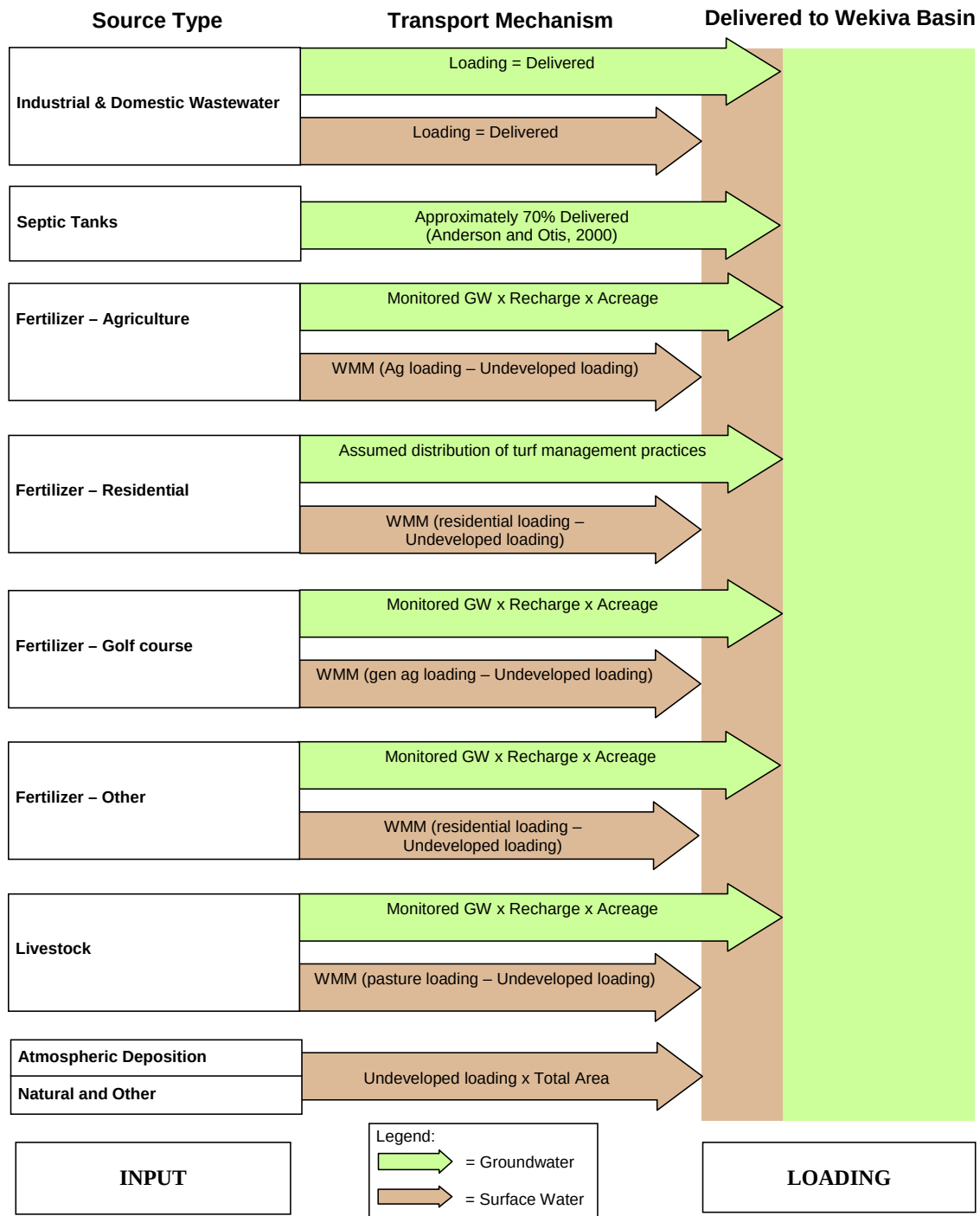
Specific procedures were adopted that were intended to more realistically account for the water quality impacts of fertilizer use, as described in the following sections.

2.2.2 Conceptual Model

Figure 2-2 presents a conceptual model of nitrate movement from sources to waters of the Wekiva Basin. The model, developed as an organizing concept for this study, defines terms in the nitrate budget of the Wekiva Basin to be quantified in this Phase I project.

In Figure 2-2, source types of nitrate are on the left, while the arrows represent transport mechanisms that deliver nitrate to either ground or surface waters of the Wekiva Basin. The text summarizes key principals or assumptions that guided the quantification of each term in the nitrate budget.

Figure 2-2. Conceptual Model of Nitrate Inputs to the Wekiva Basin



Note: Ag = Agriculture
 DOH = Florida Department of Health
 EMC = Event Mean Concentration
 GW = groundwater; recharge is the downward flow of water to a subsurface groundwater aquifer
 WMM = Watershed Management Model (used to estimate stormwater loadings)

Source: MACTEC
 Created by: WAT Checked by: SAR

The following source types were quantified:

- Industrial Wastewater
- Domestic Wastewater
- Septic Tanks
- Fertilizer – Agriculture
- Fertilizer – Residential
- Fertilizer – Golf Course
- Fertilizer – Other
- Livestock
- Atmospheric Deposition

For each of these sources, the annual rate of nitrate (or Total N, see Section 2.2.1) released to the environment within the Wekiva Basin (inputs) was estimated. Specifically, it was feasible to estimate the release of nitrate from permitted wastewater facilities and from atmospheric deposition. For the other sources, release of Total N to the environment was estimated.

Nitrate from these sources is delivered to ground or surface waters of the Wekiva Basin by the following transport mechanisms:

- Direct discharge to surface waters (e.g., a wastewater outfall pipe that discharges to a river);
- Generation of stormwater runoff that flows to surface waters (stormwater-direct);
- Generation of stormwater in closed basins, or other stormwater that percolates to groundwater (stormwater-diffuse); and
- Infiltration to groundwater (e.g., the leaching process in which fertilizer applied in excess of crop requirements is carried by infiltrating rainwater to a groundwater aquifer).

Each of these transport mechanisms was quantified. The delivery of nitrate to waters of the Basin is referred to as “loading” in the remainder of this report. Loadings consistently represent $\text{NO}_3\text{-N}^9$ loading, not Total N. Procedures for each mechanism are described below. Procedures were developed to partition loadings in two ways – by source type and by land use.

2.3 Procedures – Inputs to the Basin

Inputs to the Basin include direct application (use) of fertilizer; animal waste production, which is assumed to be released to the environment; atmospheric deposition (wet and dry) of total nitrate (nitrate + nitric acid); domestic and industrial wastewater effluents; and discharges from septic tanks.

⁹ $\text{NO}_3\text{-N}$ is the amount of nitrogen present as nitrate, often referred to as “ NO_3 expressed as N” or “nitrate nitrogen”. Chemical analyses of nitrate are customarily presented in this form. Although the NO_3 ion has an ionic weight of 62, only 23% of the ionic weight is comprised of nitrogen. Expressing NO_3 mass or concentration in this way permits ready comparison with the mass of other nitrogen containing chemicals, which are customarily also expressed “as N”.

Inputs and loadings per area are presented in this report in metric units of kilogram per hectare per year (kg/ha/yr). Results for the entire Wekiva Basin are presented in metric tons per year (MT/yr).¹⁰ One metric ton is equal to one thousand kilograms (2,205 pounds).

Appendix D contains a summary of inputs by land use and source type.

2.3.1 Fertilizer Use

The general procedure for estimating fertilizer use was to assume fertilizer is applied at rates recommended by the University of Florida Institute of Food and Agricultural Sciences Florida Cooperative Extension Service (UF/IFAS Extension), with limited modifications if there is evidence that actual usage differs from UF/IFAS Extension recommendations.

2.3.1.1 Residential, Commercial, Institutional and Transportation

Fertilizer use for residential, commercial, institutional, and transportation land uses was estimated using the following equation:

$$Fertilizer\ Use_{LU} = \frac{Pervious\ Fraction_{LU} \times Application\ Rate_{LU} \times Area_{LU}}{CF}$$

Where $Fertilizer\ Use_{LU}$ = Total Nitrogen contained in fertilizer applied for a specific land use (LU), totaled for that land use over the entire Wekiva Basin;(MT/yr)
 $Pervious\ Fraction_{LU}$ = Fraction of the land use area that is not paved or under roof;
 $Application\ Rate_{LU}$ = Application rate of Total Nitrogen in fertilizer (kg/ha/yr);
 $Area_{LU}$ = Area within a given land use classification totaled over the entire Wekiva Basin (ha); and
 CF = conversion factor to achieve desired units of measurement, 1000 (kg/MT).

Harper (1994) was used to estimate pervious fraction for each land use. The basis for application rate for each land use follows.

Residential

UF/IFAS Extension recommends 49 to 293 kg/ha/yr depending on the variety of turfgrass (Sartain, 2000). Hipp, *et al.* (1993) and Morton, *et al.* (1988) provide survey and/or anecdotal information that suggests a range from 122 to 450 kg/ha/yr. Of course some homeowners do not fertilize at all, therefore, the lower end of the range is zero. Hodges, *et al.* (1994) surveyed Florida residents and found that 39% do not fertilize. Knox, *et al.* (1995) found that 82% fertilize, averaging three applications per year. Assuming each application at 50 kg/ha/yr, Knox *et al.*'s (1995) findings indicate that most homeowners apply about 150 kg/ha/yr.

¹⁰ One kilogram equals 2.205 pounds (lb); one hectare equals 2.472 acres (ac); and one metric ton equals 2,205 lb or 1.102 tons. To convert from metric to English units, multiply the loading rate in (kg/ha/yr) by 0.8920 to yield a loading rate in (lb/ac/yr).

It is reasonable to assume that approximately 25% of homeowners apply 293 kg/ha/yr or more, the upper end of UF/IFAS Extension recommended rates. Commercial lawn care service providers are presumed to apply fertilizer at the high end of the UF/IFAS Extension recommended range, and 24% of Florida homeowners use professional lawn care services. It is further assumed that 50% apply 150 kg/ha/yr; and that 25% do not fertilize. Under this assumption, average residential use would be 148 kg/ha/yr on pervious surfaces. Although not all residential pervious surfaces are maintained in turfgrass, other residential landscapes include ornamentals which are also likely to be fertilized.

Commercial, Institutional, Recreational, Transportation

It is assumed that these land uses apply fertilizer at a rate in the upper half of the range of UF/IFAS Extension recommended rates for turfgrass, specifically 200 kg/pervious ha/yr.

2.3.1.2 Agricultural

Pervious fraction was assumed to be 1.00 for all agricultural land uses. Therefore, fertilizer use for all agricultural land uses was estimated using the following equation:

$$Fertilizer\ Use_{LU} = \frac{Application\ Rate_{LU} \times Area_{LU}}{CF}$$

The basis for application rates for various agricultural land uses are summarized below.

Row Crops

Principal vegetables produced in the Wekiva Basin are cabbage, cucumbers, greens, spinach, sweet corn, eggplant, and peppers (USDA, 2005). The U.S. Environmental Protection Agency (USEPA) (1999) provides average fertilizer use and ranges for each of these crops except greens. The average of these is 180 kg/ha/crop, ranging from 70 to 360 kg/ha/crop. UF/IFAS Extension (Hochmuth and Hanlon, 2000) recommendations for the same vegetables in Florida average 192 kg/ha/crop and range from 100 to 225 kg/ha/crop. Assuming the higher of the USEPA actuals and IFAS recommendations for each vegetable yields 210 kg/ha/crop (average of the seven crops). Kraft and Stites (2003) report that typical application to sweet corn exceeds Extension recommendations in Wisconsin. McNeal, *et al.* (1995) report that typical application rates to peppers, potatoes, and tomatoes substantially exceed UF/IFAS Extension recommendations (300-400 kg/ha/yr typical; 227 kg/ha/yr recommended). These anecdotal reports support using the higher of USEPA actuals or UF/IFAS Extension recommendations.

It is customary to produce two or three vegetable crops per year in central Florida. Therefore, fertilizer application rate per year may be two to three times higher than the application rate per crop. Although it is unlikely that fields consistently produce three crops per year, the anecdotal evidence that actual application rates exceeds UF/IFAS Extension recommendations supports the

assumption that three times the fertilizer that would be applied to each crop is applied per year, with the resultant row crop application rate of 630 kg/ha/yr (3 crops/yr x 210 kg/ha/crop).

Field Crops

UF/IFAS Extension recommended fertilization rates for hay are 150 to 180 kg/ha/yr (Mylavarapu, *et al.*, 2002). No anecdotal information was found indicating actual use differs. An application rate of 150 kg/ha/yr was assumed for field crops. This rate was also applied to land uses designated “cropland and pastureland.”

Tree Crops, Nurseries, and Ornamentals

In Florida, most land designated as “tree crops” are used for citrus. UF/IFAS Extension (Zekri, *et al.*, 2005) recommends 138 to 227 kg/ha/yr for established orange groves. Florida Department of Agriculture and Consumer Services (FDACS) has established 227 kg/ha/yr as a Best Management Practice (BMP) for oranges, and 238 kg/ha/yr for grapefruit. Since these rates represent a recent reduction in IFAS recommendations, MACTEC assumed the upper bound of IFAS recommendations and BMP will be actual.

This application rate (227 kg/ha/yr) was also assumed for nurseries and ornamentals.

Pasture

UF/IFAS Extension (Mylavarapu, *et al.*, 2002) recommends between 56 and 179 kg/ha/yr depending on cattle product pricing, fertilizer pricing, and intensity of use. Sumner, *et al.* (1992) conducted a survey of nine ranches in Florida and found that actual application rates averaged 69 kg/ha/yr. Two of the nine ranches did not fertilize at all. The average of the minimum IFAS recommendation and the nine ranch average, or 63 kg/ha/yr, was assumed to be applied on improved pasture.

2.3.1.3 Golf Courses

UF/IFAS Extension (Sartain and Miller, 2002) recommends application rates for various golf course landscapes:

- Greens – 588 kg/ha/yr;
- Tees – 441 kg/ha/yr;
- Fairways – 294 kg/ha/yr; and
- Rough – 98 kg/ha/yr.

USEPA (2006b) has estimated the portion of golf courses in each of these conditions as:

- Greens – 2.4%;
- Tees – 2.6%;
- Fairways – 28.6%; and
- Rough and other – 66.4%.

Applying these percentages to the recommended application rates indicates that the average application rate on golf courses is 175 kg/ha/yr. No reliable information was identified that actual use differed from UF/IFAS Extension recommendations, so this average recommended application rate was applied to lands used as golf course.

2.3.2 Livestock

Anderson and Cabana (2006) estimate that cattle (including calves) produce on average 56 kg N/yr. Sumner, *et al.* (1992) and Arthington, *et al.* (2003) indicate that pasture stocking rates in Florida range from 0.27 to 0.40 cattle/acre. U.S. Department of Agriculture (USDA) (2006) provides a cattle census by county. Given the acreage of pasture and feedlots in Lake, Marion, Orange, and Seminole counties, it appears that the average pasture stocking rate in the Wekiva Basin is approximately 0.3 cattle/acre (approximately 30 cattle/acre in feedlot land uses). The inferred stocking rates are consistent with industry practice, and produce total head of cattle in the counties comprising the Wekiva Basin within 2% of the USDA 1999 cattle census statistics. The inferred number of cattle in the Wekiva Basin is approximately 18,600.

At 0.3 cattle/acre (0.7 cattle/ha) times 56 kg/cattle/yr, livestock waste on pasture land is 41 kg/ha/yr. With 30 head per acre on feedlot land uses, waste production would be 4100 kg/ha/yr. Therefore, animal waste production of N is:

$$\text{Livestock Waste, Pasture (MT / yr)} = \frac{41 \text{ (kg / ha / yr)} \times \text{Area (ha)}}{1000 \text{ (kg / MT)}}$$

$$\text{Livestock Waste, Feedlots (MT / yr)} = \frac{4100 \text{ (kg / ha / yr)} \times \text{Area (ha)}}{1000 \text{ (kg / MT)}}$$

In 2004, approximately 46,000 acres in the Wekiva Basin were used for pasture, while only 160 acres were used for feeding operations. As a result, feeding operations represent a relatively small contribution to inputs of total N in the Basin.

2.3.3 Domestic and Industrial Wastewater Discharges

Wastewater discharges of NO₃-N to surface water and groundwater were estimated using monitored discharge rates and NO₃-N effluent concentrations obtained from FDEP.

Permitted domestic and industrial wastewater discharge facilities within the Wekiva Basin were obtained from the FDEP Wastewater website (FDEP, 2006). Facilities were segregated into industrial and domestic effluents. Within the Basin there were three (3) industrial dischargers with the potential to emit NO₃ and 53 permitted domestic discharges. Permits were obtained from FDEP for the industrial dischargers. Due to the large number of domestic dischargers, the permitted facilities were sorted by permitted capacity, and the largest 26 facilities were selected

for NO₃ loading quantification. These 26 facilities encompassed 99% of the total permitted capacity within the Wekiva Basin. Permits were obtained from FDEP for these 26 facilities.

Permits for the 3 industrial and 26 domestic wastewater facilities were reviewed. Eleven of the 29 facilities are either not required to monitor for NO₃-N in effluent, have no available nitrate monitoring data, or have no discharges. The remaining 18 are required to monitor NO₃-N concentrations in effluent. For these 18 facilities effluent NO₃-N concentrations and actual discharge rates during the period 2004-2006 were obtained from FDEP (Sudano, 2006).

Effluents were segregated by disposal type (e.g., sprayfield, percolation basins, rapid infiltration basins (RIBs), surface water discharge), and subsequently separated into two categories, discharge to surface water or groundwater. In addition, several facilities have a reclamation/reuse disposal system. Inputs of wastewater effluents to groundwater, surface water, and reclaimed/reused were estimated by:

$$\text{Input} = \frac{\text{Actual Discharge} \times \text{Concentration (NO}_3 - \text{N)}}{\text{CF}}$$

Where

<i>Input</i>	=	Wastewater facility effluent (MT/yr);
<i>Actual Discharge</i>	=	Total annual discharge (L/yr);
<i>Concentration (NO₃-N)</i>	=	Average effluent concentration of NO ₃ -N during 2004 through 2006 (mg/L); and
<i>CF</i>	=	Conversion Factor to achieve desired units of measurement (1 x 10 ⁹ mg/MT).

Total NO₃-N discharged to groundwater from permitted facilities was estimated at 180 MT/yr. Direct discharges to surface water were 9 MT/yr. The amount of NO₃-N that is reclaimed/reused was estimated at 109 MT/yr (see Appendix D).

Effluent that was reclaimed/reused was assumed to replace or reduce fertilizer use. For the purpose of this study, the total of 109 MT/yr associated with reclaimed/reused domestic wastewater facility effluents is included in the fertilizer use totals for the Basin. It was assumed that total N applied to the various land uses that received reclaimed water would be the same, whether the N was from reclaimed water or purchase of commercial fertilizers. The need to adopt this assumption is tied intrinsically to the procedure used to estimate fertilizer use, wherein fertilizer requirements (UF/IFAS Extension recommendations) were multiplied by acreage in various land uses. It is MACTEC's judgment that users of reclaimed water would purchase and use less commercial fertilizer than if they were using "clean" water. It is assumed that golf course greenskeepers and agricultural users of reclaimed water are aware of the nutrient content of the reclaimed water they apply, and would adjust downward their fertilizer purchases and applications to improve the profitability of their business. We assume that if reclaimed water is

applied to turfgrass, and the grass is greener as a result, lawn maintenance personnel would not apply as much commercial fertilizer. On the other hand, it is possible that some, or many, entities that receive reclaimed water use the same amount of fertilizer they would use if they were irrigating with “clean” well water or other water supplies. If so, this assumption would underestimate total N applied to lands that are irrigated by reclaimed water.

Industrial wastewater contributes a negligible amount of $\text{NO}_3\text{-N}$ to the Wekiva Basin, at 0.04 MT/yr.

Appendix E contains a summary of the wastewater treatment facilities that were evaluated during this study, and their estimated nitrate loadings.

2.3.4 Septic Tanks

Florida Department of Health (FDOH) (Roeder, 2006) provided MACTEC with a GIS map layer identifying the location of all septic tanks in the WSA. The FDOH septic tank inventory was developed from 1990 US Census data, FDOH permit files, and consideration of areas served by sewer systems (Roeder, 2006). The primary basis of the DOH septic tank inventory was the identification of improved parcels that are not paying for sewer service.

Although there is substantial overlap in the footprint of the Wekiva Basin as defined for this study and the WSA, they are not identical. Therefore, it was necessary to estimate the number of septic tanks in portions of the Wekiva Basin that are not included in the WSA. An estimate was developed under the assumption that the density of septic tanks (tanks/acre) was a function of land use. The density of tanks by land use was determined for the WSA, using the FDOH data, and then this same density was assumed in portions of the Wekiva Basin outside the WSA. By this procedure, the number of septic tanks in the Wekiva Basin was estimated to be approximately 65,000. Within the WSA, the FDOH data were used directly. Approximately 85% of the tanks are within residential land use categories, with the largest number in the medium density (2 to 6 dwelling units per acre) residential land use category.

The accuracy of the extrapolation procedure used to estimate the number of tanks in the Basin, but not in the WSA, was evaluated using the same septic tank densities by land use to estimate the total number of septic tanks in Lake and Orange Counties, and these results were compared with FDOH estimates of the total number of tanks in each county (using 1999 data for both land use and number of tanks) (FDOH, 2007). This test indicated extrapolation errors of 13% and 4% for Lake and Orange Counties, respectively. Considering these two alternate extrapolation error tests, it appears that the septic tank density by land use procedure is accurate to about 10%. Since only about 20% of the tanks in the Basin were estimated by the extrapolation method (the rest within the WSA are directly from the FDOH data), the estimate of 65,000 tanks in the Wekiva Basin is expected to be accurate to within about 2%.

Each tank was assumed to release 20 lb N/yr to the environment (Roeder, 2006; Anderson, 2006).

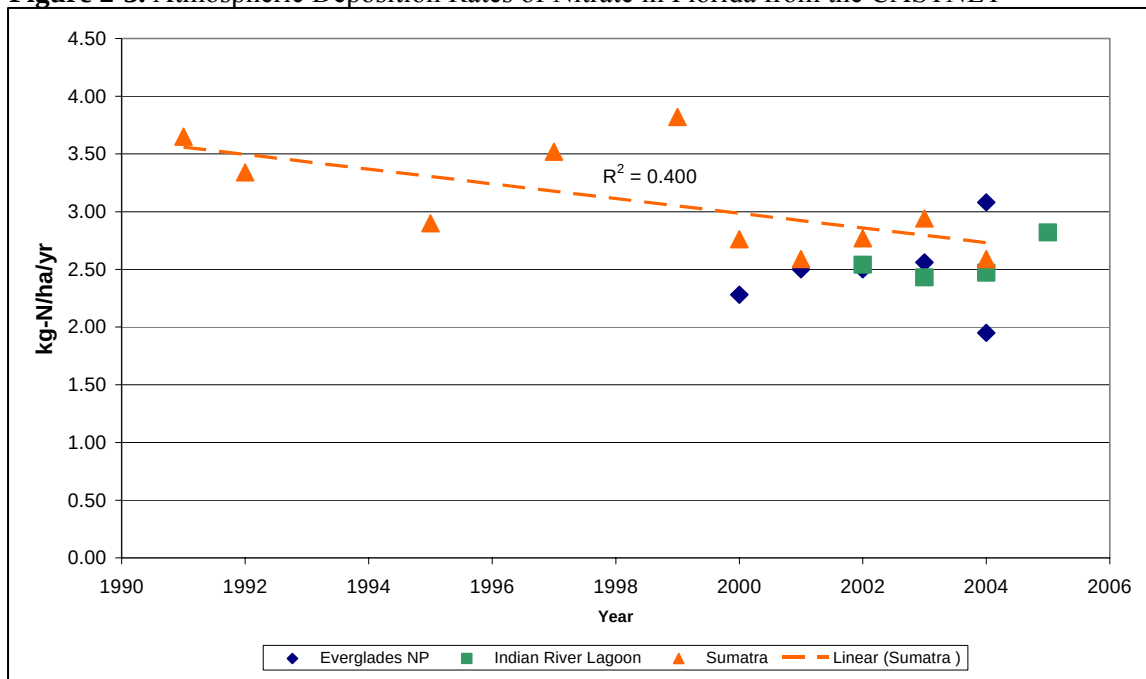
2.3.5 Atmospheric Deposition

USEPA's Clean Air Status and Trends Network (CASTNET) monitors deposition of nitrate at stations in rural areas throughout the United States. CASTNET includes three monitoring sites in Florida, one in the panhandle region (Sumatra), one near the Indian River lagoon (IRL), and one in Everglades National Park. Of these, the IRL site would be expected to be most representative of the Wekiva Basin. The IRL site is at Coconut Point near Sebastian Inlet in northern Indian River County, and is 87 miles southeast of Wekiva Springs. The Sumatra site, however, has a longer data record than the IRL site. Sumatra has reported nitrate deposition rates since 1991, while the IRL station was established in 2002. Figure 2-3 presents all available annual deposition totals for these three stations in Florida. Nitrate deposition rates at Sumatra have declined significantly from 3.65 (kg/ha/yr) in 1992 to 2.59 (kg/ha/yr) in 2004. Since 2000, all of the Florida sites have reported similar deposition rates, ranging from 1.95 to 3.08 (kg/ha/yr), and deposition rates have been very similar at Sumatra, IRL, and Everglades. The average deposition rate at the IRL site (2.57 ± 0.09 kg/ha/yr) was assumed to be representative for rural areas in the Wekiva Basin.

Nitrate deposition rates are expected to be higher in urban areas. Nationwide, approximately half of nitrogen oxide emissions are from mobile sources, e.g., automobiles. Dixon and Murray (1999) reported Total N deposition in the urbanized Tampa Bay watershed of 6.48 (kg/ha/yr). At Florida CASTNET sites, NO_3 deposition consistently averages 65% of Total N deposition. Assuming this ratio applies in urban areas, urban NO_3 deposition is assumed to average 4.18 (kg/ha/yr). This higher rate of nitrate deposition was assumed to occur in the following urban land uses: medium and high density residential; transportation, communication, and utilities; and commercial and services.

Nitrate deposition rates could also be higher in agricultural areas where fertilizers are routinely applied, but fertilizer use has been accounted as total N applied, without accounting explicitly for volatile or other application losses. Therefore, if atmospheric deposition rates are higher in and downwind of agricultural areas due to application/volatile losses of applied fertilizer, this amount is already included in the fertilizer application totals.

Figure 2-3. Atmospheric Deposition Rates of Nitrate in Florida from the CASTNET



Source: MACTEC

Created by: WAT Checked by: MOS

2.4 Loadings to Waters of the Basin

A portion of the nitrate released to the environment actually reaches groundwater or surface waters of the Basin. In particular, a significant portion of nitrate applied to the land as fertilizer is used by plants in the root zone. Denitrification processes also convert NO_3 to N_2 , which is released to the atmosphere. A portion of Total N in fertilizers and in wastewater effluents is volatilized as ammonia. Consequently, only a portion of the nitrate input to the Basin will reach ground and surface waters. The nitrate delivered to waters of the Basin will be referred to here as loading.

Available information was sufficient to support estimation and partitioning of loads to groundwater at the water table (generally to the surficial aquifer) and to surface water. The portion of the groundwater load (at the water table) that eventually reaches the Floridan aquifer is expected to be significant (Cohen, 2006), but that portion cannot be quantified in this Phase of the study. Additional evaluation of loads that actually reach the Floridan aquifer may be useful in Phase II of this study.

The following subsections summarize the procedures and information sources used to estimate loadings, which are primarily based on land use, as well as procedures used to partition those loadings to specific source types.

The primary basis for estimating loadings to waters of the Basin was distinct for the following loading or delivery categories:

- Groundwater recharge as a function of land use,
- Stormwater loadings as a function of land use,
- Domestic and Industrial wastewater discharges, and
- Septic tank discharges.

Appendix F contains a summary of estimated nitrate loadings by land use and source type.

2.4.1 Groundwater Recharge

Loadings to groundwater associated with various land uses were estimated by multiplying shallow groundwater concentrations (CGW) representative for each land use by the recharge rate (by location) using the following equation:

$$\text{Groundwater Loading}_{LU} = \frac{\text{Recharge} \times \text{CGW}_{LU} \times \text{Area}_{LU}}{CF}$$

Where $\text{Groundwater Loading}_{LU}$ = Amount of NO₃-N reaching the water table from a specific land use (MT/yr);

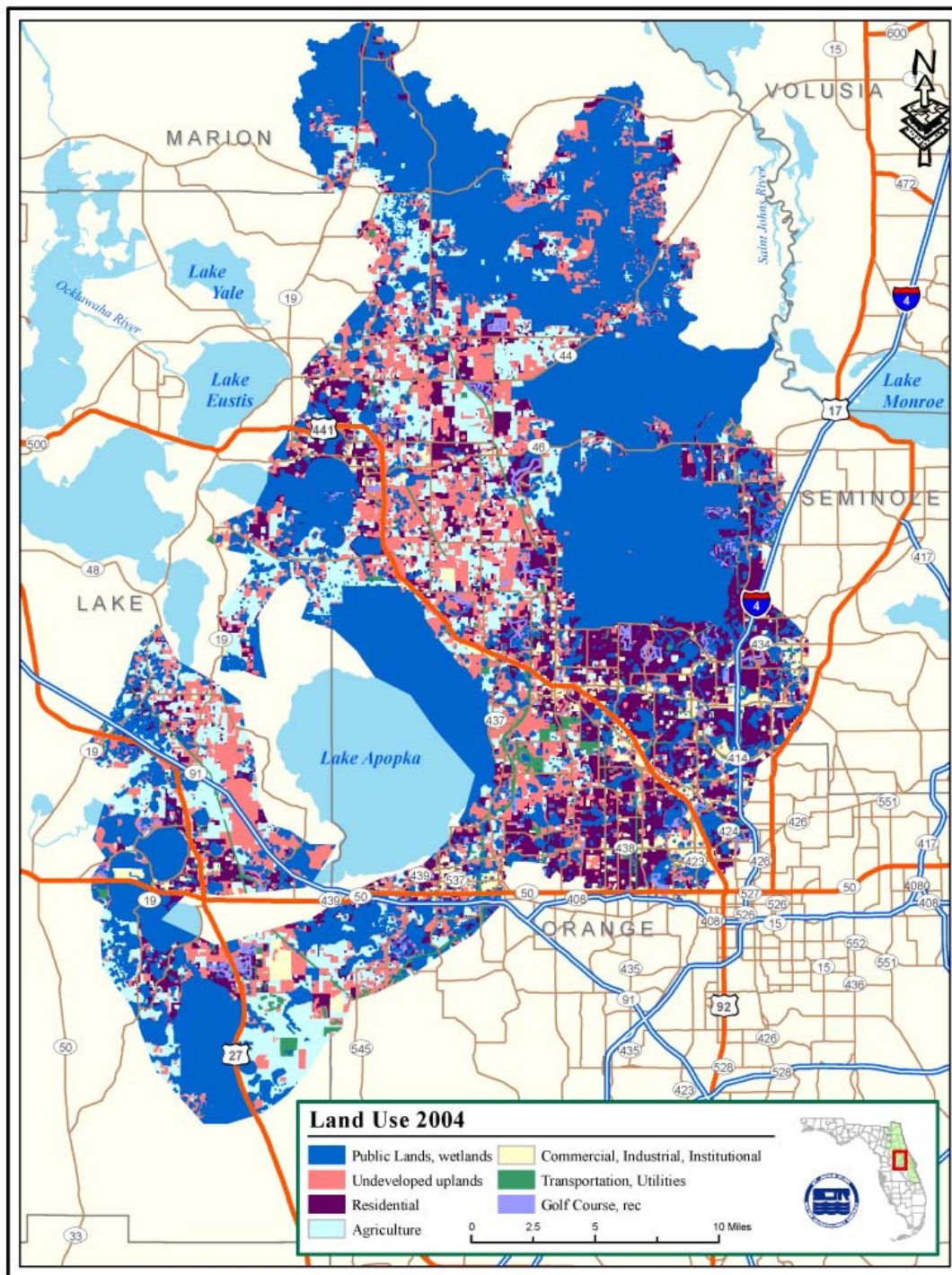
Recharge = downward flow of water to the Floridan aquifer (inch/yr);

CGW_{LU} = Concentration of NO₃-N in recharging groundwater, estimated here from concentrations near the water table (mg/L); and

CF = Conversion Factor to achieve desired units of measurement, 3937 (mg inch ha/kg L).

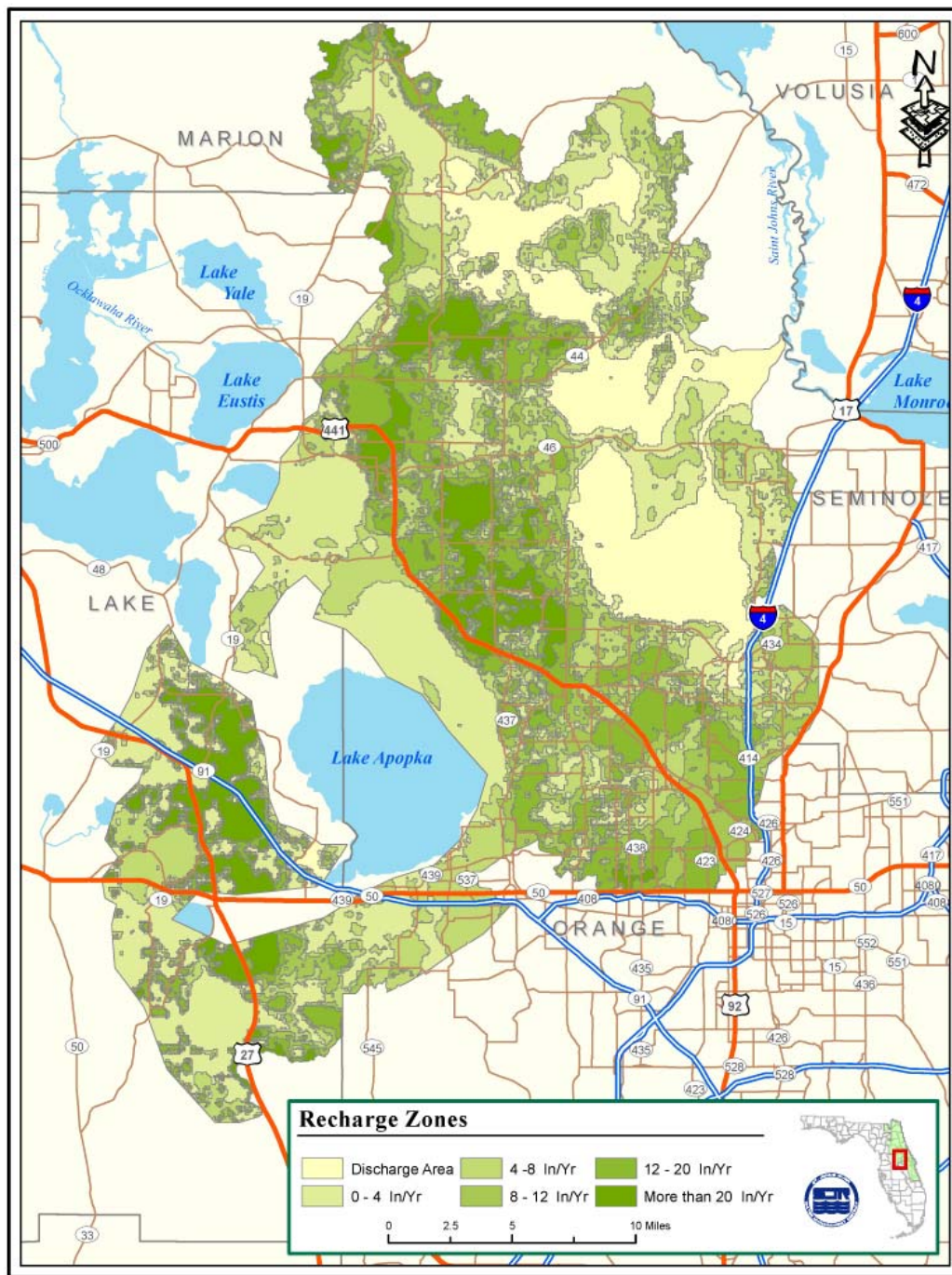
The calculation is performed for each land use category and recharge rate (after overlaying land use and recharge rate using GIS software), then summed across the entire Basin, by land use. Figures 2-4 through 2-6 illustrate the application of this procedure. Figure 2-4 shows land use in the Basin, and Figure 2-5 shows recharge rates. When the two maps are overlaid, using ArcGIS™, a matrix of area by land use and recharge rate was developed, as illustrated in Figure 2-6.

Figure 2-4. Land Use



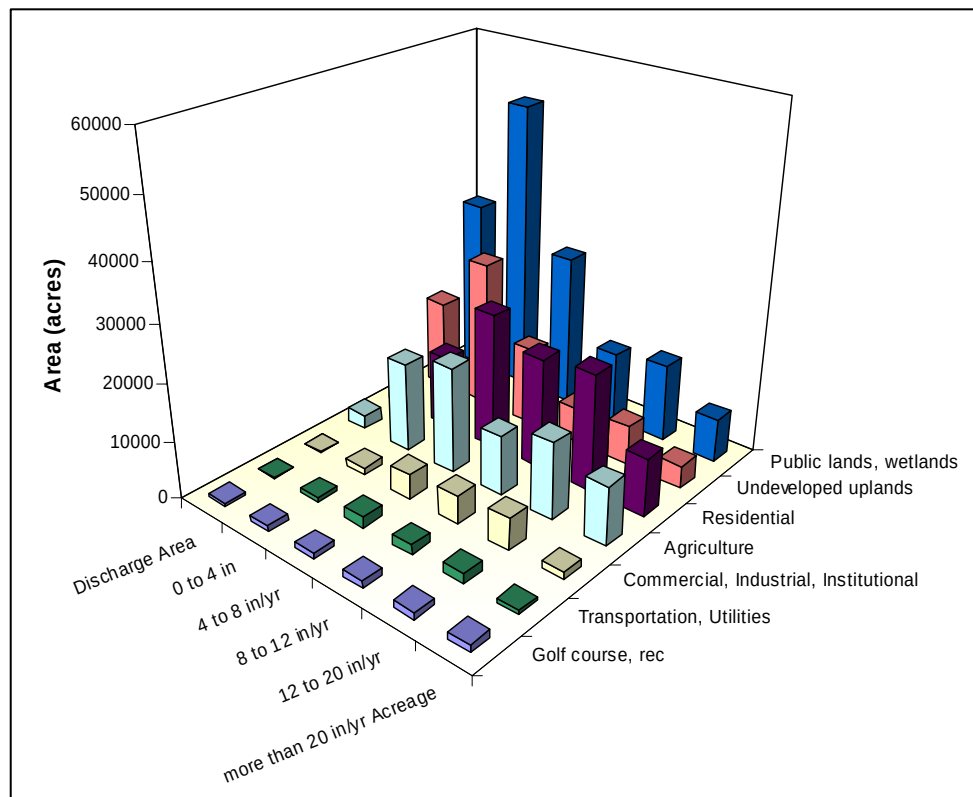
Source: MACTEC and SJRWMD
Created by: NMG Checked by: WAT

Figure 2-5. Recharge Rates



Source: MACTEC and SJRWMD
Created by: NMG Checked by: WAT

Figure 2-6. Acreage by Land Use and Recharge Rate



Source: MACTEC and SJRWMD
 Created by: SAR Checked by: WAT

Groundwater recharge rates used as input to the East Central Florida MODFLOW model (McGurk and Presley, 2002) within the Wekiva Basin were acquired from SJRWMD (<http://sjr.state.fl.us/programs/index.html>). The recharge rate map indicates total recharge within the Basin of approximately 400 cubic feet per second (cfs). This recharge rate compares reasonably with the estimated discharge rate from springs in the Wekiva Basin of approximately 230 cfs, since not all groundwater flowing through the Basin is expected to discharge via springs.

Representative groundwater concentrations for all land uses were estimated from relevant technical literature as discussed in the following subsections. Estimated groundwater concentrations are intended to represent area sources of contamination associated with the land use, not point source contamination due to such sources as septic tanks or wastewater disposal facilities. This approach was used to characterize loadings associated with fertilizer use and livestock waste, and is not intended to represent groundwater concentrations associated with point sources such as septic tanks or domestic wastewater disposal facilities, such as RIBs.

Whereas the primary load estimation calculation for groundwater was based on land use, attribution (partitioning) to specific source types was specified according to the primary source presumed to be contributing $\text{NO}_3\text{-N}$ to groundwater for each land use. For undeveloped land, the

source type was identified as “Natural or Unattributed”. For most land uses, the source type was assumed to be fertilizer use. For pasture, groundwater loadings were proportionately assigned to livestock waste and fertilizer use.

2.4.1.1 Residential

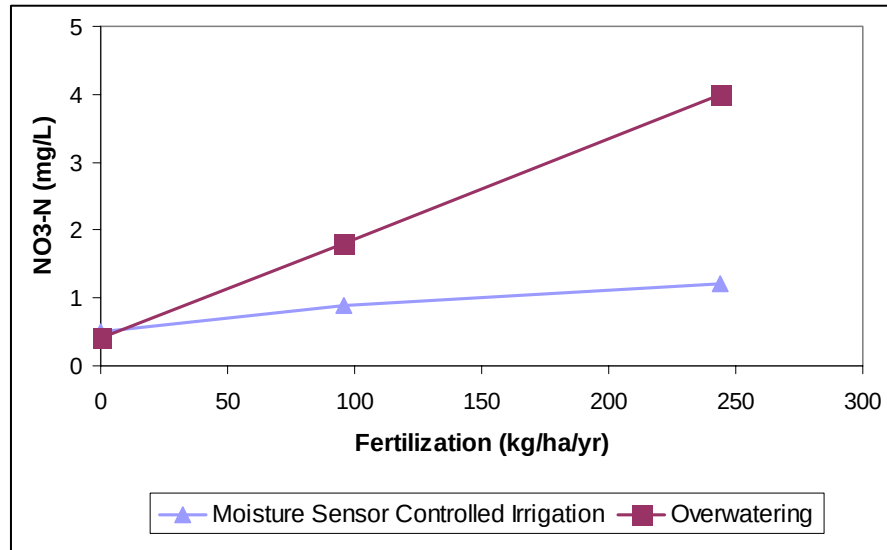
The objective of this section is to present procedures used to estimate groundwater concentrations associated with the use of fertilizer for residential turfgrass maintenance. Loadings derived using these estimates are attributed to fertilizer use. The residential land use may also be associated with loadings from septic tanks, but these loading are estimated separately (see Section 2.4.4).

No definitive field scale monitoring studies were identified that could be used to estimate representative groundwater concentrations associated with residential fertilizer use. Available information is from experimental plots, which were fertilized at rates chosen by the researchers, which the individual researchers believed to be representative of the range of fertilizer applications by homeowners. Often data is reported during the period of lawn establishment, when recommended fertilization rates are higher, above-average irrigation is required, and the lack of established roots increases leaching¹¹. Several of the experimental studies reviewed appear to be biased high for these reasons.

Two similar experimental studies, Morton, *et al.* (1988) and Snyder *et al.* (1984), were used to estimate groundwater concentrations. Morton, *et al.* (1988) varied irrigation rate and fertilizer application rate, spanning the application rate ranges of a cross-section of residents and landscape maintenance professionals. Experimental conditions were application of 0, 97, and 244 kg/ha/yr. Two irrigation regimes were investigated – moisture sensor controlled and 1.5 inches per week in three 0.5 inch applications. Concentrations in leachate averaged 0.4 mg/L for the control, 1.3 mg/L for low fertilization rate, and 2.6 mg/L for high fertilization rate. Concentrations were strongly affected by irrigation rate, as high as 4 mg/L for high fertilizer and overwatering compared with 1.2 mg/L for high fertilizer and sensor-controlled irrigation. Lower fertilization and sensor-controlled irrigation produced 0.9 mg/L, but with overwatering 1.8 mg/L. Morton, *et al.*’s (1988) results are illustrated in Figure 2-7, which indicates that overwatering has a greater impact than the fertilization rate.

¹¹ Leaching is the process by which infiltrating rainfall removes soluble chemicals as it passes through soil prior to reaching the water table. Leaching results from desorption and dissolving of chemical constituents in the soil, chemical reactions, and other chemical processes that take place in soil. Leachate is the potentially contaminated water that infiltrates to the water table as a result of these processes.

Figure 2-7. Effect of fertilization and irrigation on nitrate leaching from turfgrass [from Morton, *et al.* (1988)]



Source: MACTEC

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Snyder, *et al.* (1984) compared moisture sensor controlled irrigation with daily irrigation using three fertilizer types: ammonium nitrate (soluble), sulfur-coated urea (slow release), and fertigation (soluble fertilizer in the irrigation water). Fertilization rate was 300 kg N/ha/yr in all cases. Each plot had similar turfgrass quality (color and growth). Snyder's results are summarized in Table 2-1.

Table 2-1. Impacts of Fertilizer type and irrigation rate on leaching of NO₃ from residential turfgrass (Snyder, *et al.*, 1984)

Irrigation	Fertilizer	Leached (% applied)	Leaching Rate (kg/ha/yr)	Leachate Concentration (mg/L)
Daily	Soluble	44	132	10
	Slow release	19	58	4.2
	Fertigation	9	26	1.5
Moisture sensor controlled	Soluble	17	51	7.8
	Slow release	4	13	1.9
	Fertigation	2	7	1.1

These results indicate major improvements by any of three potential BMPs (slow release fertilization, moisture sensor controlled irrigation, or fertigation). Leachate concentrations ranged from 0.4 mg/L (no fertilizer and overwatering) to 10 mg/L (high fertilization and overwatering) in these studies. Both studies are consistent in showing that overwatering is just as important a factor as either fertilization rate or fertilizer type (soluble or slow release) in affecting leaching to groundwater.

Applying their results across a range of lawn care practices (25% overwater and/or overfertilize, 50% apply recommended rates, 25% do not fertilize) yields a weighted average concentration of 3 mg/L. Note that the water measured in these studies was leachate, not groundwater. Groundwater concentrations may be different (and presumably lower) due to mixing of the leachate with underflowing groundwater. Groundwater concentrations used to estimate loadings for other land uses in this study were based on samples from wells. The lack of field scale monitoring studies that could be used to define representative groundwater concentrations in residential areas affected by residential use necessitated this modified approach for this land use.

Due to a lack of information on groundwater concentrations for commercial and services, institutional, recreational, and transportation, communication, and utilities land uses, these land uses were assumed to have similar groundwater concentration to those occurring in residential land uses because significant portions of these land uses are maintained in turfgrass. These combined land uses comprise only 4% of the total area of the Wekiva Basin, while residential land use makes up about 19%. Therefore, errors in estimation of groundwater concentrations under these land uses would not contribute significantly to total uncertainty in nitrate loadings.

2.4.1.2 Agricultural

Representative groundwater concentrations associated with row and vegetable crops, tree crops (citrus), nurseries, pasture, and concentrated animal feeding operations (CAFOs) were estimated from field scale monitoring studies of groundwater concentrations associated with these land uses. Available monitoring studies were reviewed, and well designed studies specific to a given land use from Florida or the Southeastern U.S. were selected to represent the groundwater impacts of these land uses.

Loadings for all agricultural land uses were attributed to fertilizer use, with the exception of pasture and concentrated animal feeding operations. For pasture, approximately 1/3 of the loading was attributed to animal waste and 2/3 to fertilizer use, based on the Total N inputs of these two source types to pastureland as detailed in sections 2.3.1.2 and 2.3.2. All groundwater loadings determined for the feeding operations land use were attributed to livestock waste.

Row and Vegetable Crops

Within the Wekiva Basin, most row and field crop production is in Lake and Orange Counties. About half of the field and row crop production is in hay and other forage, mostly in Lake County; and about half in vegetables (more concentrated in Orange County). Principal vegetables produced are cabbage, cucumbers, greens, spinach, sweet corn, eggplant, and peppers (USDA, 2005).

McNeal, *et al.* (1995) measured shallow groundwater concentrations under vegetable fields and at the downgradient edge of fields in Manatee County. Average monitored groundwater concentrations under fields and at their downgradient edge were 1.3 mg/L for tomato, 1.9 mg/L

for pepper, and 1.4 mg/L for all vegetables monitored by McNeal, *et al.* (1995). These concentrations are much lower than those reported for impacts from potatoes and sweet corn in Suwannee County (UF/IFAS and Suwannee River Water Management District, 2006) where concentrations averaged 26 mg/L; cropland in a review of literature on nitrate contamination in the southeastern coastal plain by Hubbard and Sheridan (1989; average of 20 mg/L) and by Kraft and Stites (2003) under sweet corn in Wisconsin (20 mg/L). The Manatee County farms investigated by McNeal *et al.* (1995) were maintained under a high water table condition (about 1 ft below land surface) with irrigation by shallow ditches throughout the fields. These conditions would favor denitrification of applied NO_3 .

To evaluate whether denitrification processes are likely to be important in association with row crop agriculture impacts in the Wekiva Basin, soil types in areas with row crop agriculture land use were assessed. The primary soil characteristic considered was whether the soils were hydric. Such soils occur in wetlands and areas of high water table, and reducing conditions that would favor denitrification are a signal characteristic of hydric soils. It was found that only 12% of row crop agriculture land use occurs in hydric soils within the Wekiva Basin. Consequently, it is assumed that denitrification would not be an important process in fields used for row crop agriculture in the Wekiva Basin, and the results of McNeal, *et al.* (1995) in Manatee County are probably not representative of conditions in row crop land use in the Wekiva Basin. Concentrations observed by UF/IFAS and Suwannee River Water Management District (2006) in Suwannee County and by Hubbard and Sheridan (1989) in the southeastern coastal plain are considered representative, and an average concentration of 23 mg/L $\text{NO}_3\text{-N}$ is assumed under row crops.

Although limited information was identified regarding concentrations under field crops, leaching rates that have been reported from wheat (15 kg/ha/yr; Riley, *et al.*, 2001) and alfalfa (7 kg/ha/yr; Randall and Mulla, 2001) are substantially less than those associated with row crops and are consistent with groundwater concentrations of approximately 4 mg/L.

Tree Crops (Citrus)

In the Wekiva Basin, virtually all land used for tree crops is in citrus. Crandall (2000), Lamb, *et al.* (1999) and McNeal, *et al.* (1995) provide the most thorough and representative data on groundwater concentrations under citrus. Crandall (2000) monitored six groves in Indian River, Martin, and St. Lucie Counties. Lamb, *et al.* (1999) monitored five groves in Highlands County. McNeal, *et al.* (1995) monitored two groves in Manatee County. Each study observed significant NO_3 levels in groundwater collected near the water table and as deep as 10 ft below the water table. In this shallow interval, Crandall (2000) observed an average concentration of 5 mg/L $\text{NO}_3\text{-N}$ in the Indian River groves; Lamb, *et al.* (1999) an average of 11 mg/L; while McNeal, *et al.* (1995) observed an average concentration of 16 mg/L in the Manatee County groves.

Although concentrations observed by Crandall (2000) and McNeal, *et al.* (1995) were similar in groundwater near the water table, the two studies observed distinctly different concentrations at greater depths in the groundwater. McNeal, *et al.* (1995) observed a gradual decline in NO₃-N with depth, from 16 mg/L at 10 ft to about 8 mg/L at 19 ft depth. In the Indian River groves, on the other hand, Crandall (2000) observed a marked reduction with depth, declining from an average of 5 mg/L at a depth of 5 ft to 0.8 mg/L at 10 ft and undetectable (<0.02 mg/L) at 20 ft. Crandall (2000) also demonstrated that the process primarily responsible for the reduction was denitrification as evidenced by elevated levels of N₂ gas in shallow groundwater. Apparently conditions favoring denitrification were not in place at the Manatee County groves studied by McNeal, *et al.* (1995). Lamb, *et al.* (1999) monitored one grove on a flatwoods site with concentrations similar to the low lying Indian River groves, three groves on ridge sands (uplands) with concentrations similar to those observed in Manatee County, and one grove that was probably not representative because it had been recently established.

Within the Wekiva Basin, 99% of tree crop land use is on uplands (non-hydric soils). Therefore, the denitrification processes observed by Crandall (2000) are not likely to be important in the Wekiva Basin, so the average concentrations observed by McNeal, *et al.* (1995) and at the three established upland sites monitored by Lamb, *et al.* (1999) were assumed to be representative of tree crop land use in the Wekiva Basin. The grove-weighted average concentration in shallow groundwater at these five groves was 15 mg/L, NO₃-N.

It is noted that these studies were conducted prior to the current FDACS BMP for citrus fertilization, and therefore may represent the effect of fertilization at rates greater than the current BMP.

Nurseries

Although very high concentrations (20 to 100 mg/L) of nitrates have been observed in nursery leachates under controlled experimental conditions (McAvoy, *et al.*, 1992; Yeager and Cashion, 1993), a comprehensive monitoring survey of 29 container nurseries in six states, including Florida (Yeager, *et al.*, 1993), found groundwater concentrations on and downgradient of nurseries consistently in the range of 5 to 7 mg/L. It was assumed that a representative groundwater concentration associated with nurseries is 6 mg/L.

Pasture

Limited data are available to estimate groundwater nitrate concentrations under pasture in Florida. Ator and Ferrari (1996) compiled and analyzed groundwater concentrations of NO₃-N from more than 850 sites in the Mid-Atlantic Region (including parts of Delaware, Maryland, New Jersey, New York, North Carolina, Pennsylvania, Virginia, and West Virginia) and categorized the sites by land use. The median concentration in pasture lands was 5.5 mg/L, and not significantly different from areas in row or field crops. They concluded that field rotation or

the close proximity of crops and pastures within agricultural areas leads to a mixed-agricultural effect on groundwater quality.

The groundwater concentration associated with pasture for the Wekiva Basin was assumed to be 5.5 mg/L.

Concentrated Animal Feeding Operations (CAFOs)

This represents a very limited land use within the Wekiva Basin (< 0.05%), but may have disproportionate nitrate loadings.

Hatzell (1995) monitored groundwater near poultry (broiler) farms in North Central Florida and found that concentrations averaged 13 mg/L.

Woodard, *et al.* (2002) monitored a dairy in the panhandle region of Florida (near Bell) for four years. Dairy effluent was applied to forage crops onsite. Forage crop rotations and application rates were varied in separate plots. Concentration of NO₃-N was measured in soil moisture (by lysimeters) and loading rates (kg/ha/yr) were estimated. Soil moisture concentrations are expected to be higher than concentrations in groundwater, which were not monitored. Soil moisture concentrations ranged from about 1 mg/L to 68 mg/L, and averaged 18 mg/L. A bermudagrass-rye rotation was more efficient in N uptake, with an average soil moisture concentration of approximately 6 mg/L, while a corn-sorghum-rye rotation yielded an average leachate concentration of 30 mg/L.

Collins (1995) monitored groundwater at four swine farms in Jackson County, FL. Concentrations ranged from 0.04 to 11 mg/L, averaging 2.8 mg/L.

Although groundwater impacts of these three distinct CAFOs are similar, cattle are the predominant livestock in the Wekiva Basin, so the results of Woodard, *et al.* (2002) for a dairy were assumed to be most representative of CAFOs in the Wekiva Basin, with an average groundwater concentration of 18 mg/L.

2.4.1.3 Golf Courses

All groundwater loadings from golf courses were attributed to fertilizer use.

Groundwater concentrations have been monitored at a number of golf courses nationwide, and leachate quality has been monitored from experimental turfgrass plots designed to simulate golf course landscape management practices. Of the variety of monitoring studies available, the study by Swancar (1996) a U.S. Geological Survey (USGS) study of groundwater impacts of nine central Florida golf courses was used. Swancar's results are generally consistent with results reported outside of Florida (e.g. Flipse and Bonner, 1985; Petrovic, 1995; Branham, *et al.*, 1995; Rufty and Bowman, 2004). Concentrations ranged from not detected (< 0.02 mg/L) to 26 mg/L

in 228 groundwater samples, averaging 2.6 mg/L. The distribution of concentrations appeared to be lognormal, so the more conservative Land procedure (Gilbert, 1987) was used to estimate the mean concentration. Only data from permanent monitor wells, rather than direct push technology (DPT) samples that were only collected near tees and greens, were used. The conservative estimate of the mean concentration is 8 mg/L.

2.4.2 Stormwater Loadings

The stormwater pollutant loading model developed by CDM (2005) using the Watershed Management Model (WMM) and used to support the WSA Stormwater Master Plan was the primary basis for estimation of stormwater loadings to the Wekiva Basin. The appendix to the WSA Stormwater Master Plan that describes the application of WMM by CDM (2005) is reproduced as Appendix B.

WMM estimates stormwater runoff volumes and pollutant loadings within basins. Inputs include Event Mean Concentrations (EMCs)¹² by land use, land use, annual precipitation, and descriptions of structural stormwater treatment systems or Best Management Practices (BMPs). CDM modified basin boundaries and mapped BMPs following field investigations. EMCs were identified after a comprehensive literature review and consideration of inputs from Basin stakeholders (e.g., state and local governments). WMM is capable of estimating loads from groundwater (referred to as baseflow), but CDM's (2005) application to the WSA did not account for loadings by baseflow. Their report does not discuss any attempt to calibrate the runoff volumes or loadings.

A number of ancillary calculations were performed using the CDM (2005) WMM application to achieve the objectives of this study to:

- Update the loading estimates to the 2004 land use baseline used for this study (the WMM model used to develop the WSA Stormwater Master Plan was based on 1999 land use);
- Extend the WSA results to portions of the Wekiva Basin outside the WSA;
- Partition loadings by land use and source type; and
- Distinguish between direct stormwater loadings to surface waters and diffuse stormwater loadings to groundwater.

The basic approach used in these ancillary calculations was to assume that loadings by land use as determined by the CDM (2005) WMM application were valid. The approach retains the detailed evaluation of WSA hydrology represented by the CDM (2005) WMM application. Sub-basin boundaries, rainfall/runoff relationships, and EMCs by land use were not modified. Acreage in each land use was (a) extended to the Wekiva Basin, and (b) updated to 2004 land use.

¹² Event Mean Concentration (EMC) is the average of individual measurements of storm pollutant mass loading divided by the storm runoff volume taken over a storm event (CDM, 2005).

WMM does not automatically output totals by land use. Rather it reports total loadings by sub-basin. To determine the loadings by land use, the WSA WMM model was rerun, sequentially “turning on” each land use while turning off all others. These simulations produced results for each land use within the WSA. Next, by a simple ratio, the loading for the Wekiva Basin (2004 land use) could be estimated. These calculations were performed outside the WMM software, in EXCEL™ spreadsheets.

Finally, the sub-basins in the Wekiva Basin were identified as either closed or open. A closed basin is one with no outlet. Closed basins are assumed to deliver their stormwater loadings to groundwater. Open basins are assumed to deliver their loadings to surface waters. Total annual runoff from open basins within the Wekiva River watershed was estimated to be 340 cfs. This flow may be compared with the average discharge of the Wekiva River, which is about 300 cfs. Spring flow to the river is about 230 cfs.

This procedure produced untreated loading (prior to effect of BMPs) and BMP-treated loading by land use for both open and closed sub-basins in the Wekiva Basin. Loading to surface water (stormwater direct) by land use was defined as BMP-treated load from open basins. Loading to groundwater (stormwater diffuse) by land use is untreated load in the entire Wekiva Basin minus loading to surface water. Inherent in this calculation is an assumption that treatment by BMPs reduces the direct loading to surface water, but that all the $\text{NO}_3\text{-N}$ removed by the BMP goes to groundwater. This assumption is conservative. In fact, some portion of the $\text{NO}_3\text{-N}$ load treated by BMPs does not reach groundwater. For example, in wetlands used as BMPs, a portion of the $\text{NO}_3\text{-N}$ treatment efficiency represents a true recycling of $\text{NO}_3\text{-N}$ into plant biomass. Harper (1988) found that $\text{NO}_3\text{-N}$ concentrations in groundwater below detention ponds was similar to concentrations in the ponds (indicating limited treatment effectiveness). Bahk and Kehoe (1997) studied effectiveness of agricultural retention ponds, but their study was not designed to address the question of whether $\text{NO}_3\text{-N}$ mass is removed by the ponds. Generally it is found that structural BMPs have limited effectiveness in removal of $\text{NO}_3\text{-N}$ mass (e.g., Barber and Molash, 1999; Rea, 2004). Estimation of the ultimate treatment efficiency of BMPs, i.e., their ability to eliminate nitrate loading to groundwater, may be an appropriate topic for further investigation in Phase II of this study. In this Phase I investigation, the conservative assumption was made that BMPs do not eliminate $\text{NO}_3\text{-N}$, but rather reroute it from surface water to groundwater.

To partition stormwater loadings by source type, it was assumed that $\text{NO}_3\text{-N}$ loading from undeveloped lands (e.g., forest, wetlands, and open land) was natural, attributable to atmospheric deposition, or otherwise unattributable. The load from each land use that could be attributed to specific source types is given by [Loading (land use) – Loading (Forest / Open Land)]. WMM was used to estimate the loading from each land use if its land use were changed to Forest / Open Land. The difference between the actual loading and the undeveloped loading was attributed to the most relevant source, e.g., fertilizer use associated with the land use.

2.4.3 Domestic and Industrial Wastewater Facilities

All discharges, as estimated according to Section 2.3.3, were assumed to reach waters of the Basin. Although some $\text{NO}_3\text{-N}$ associated with wastewater may be assimilated or denitrified in systems such as artificial wetlands, sprayfields or RIBs, the concentrated nature of wastewater disposal facilities suggests that losses are small, and they were not quantified. Sumner and Bradner (1996) found that denitrification losses were minimal from a RIB in Orange County, FL. Merritt and Toth (2006) intensively studied recharge of domestic effluent meeting reclaimed water standards at the Water Conserv II RIB systems in Orange County, FL, which are within the Wekiva Basin. Their study did not specifically quantify denitrification losses, but they performed a variety of dilution and mixing calculations that were based on the assumption that denitrification losses were minimal, and that $\text{NO}_3\text{-N}$ could be used as a conservative tracer of effluent impacts. Their results are generally supportive of the assumption used in this study that essentially all effluent $\text{NO}_3\text{-N}$ discharged to groundwater via RIBs reaches groundwater. At the Conserv II site, essentially all $\text{NO}_3\text{-N}$ also reached the Floridan aquifer.

York (2007), however, commented on the draft version of this report indicating his opinion, based on various published reports and limited site-specific data, that approximately 50% of total N discharged to RIBs is lost, primarily by nitrification/denitrification processes and does not reach groundwater. Dr. York's comments are included as Appendix C.

Reclaimed or reused effluent was not included in the total discharge or loadings associated with domestic wastewater facilities. The $\text{NO}_3\text{-N}$ associated with reclaimed or reused water is assumed to replace/reduce fertilizer use. Additional discussion of this concept is presented in Section 2.3.3. Effectively, within the conceptual approach to this project, $\text{NO}_3\text{-N}$ in reclaimed or reused water is accounted in the fertilizer totals.

Domestic wastewater loadings were all assigned to the land use category of Transportation, Communication, and Utilities (Sewage Treatment).

2.4.4 Septic Tanks

See Section 2.3.3 for the procedure for estimating the number of septic tanks, their distribution by land use in the Wekiva Basin, and the N released per tank. According to Anderson and Otis (2000), 50 to 90% of the N released from septic tanks reaches the water table. In this study it was assumed that 70% of the N released by septic tanks is delivered to groundwater as $\text{NO}_3\text{-N}$, i.e., 14 lb/yr.

3.0 Estimated Nitrate Loadings

Procedures described in Section 2.0 were applied to estimate nitrogen inputs to the Wekiva Basin and NO₃-N loadings to groundwater and surface waters of the Basin.

Nitrogen inputs include:

- Application of fertilizer;
- Discharges from domestic and industrial wastewater treatment facilities;
- Discharges from septic systems;
- Livestock waste; and
- Atmospheric deposition.

Based on availability of information, discharges from domestic and industrial wastewater treatment facilities, and atmospheric deposition were quantified as NO₃-N. Fertilizer use, discharges from septic systems, and livestock waste were quantified as Total N.

Nitrate (NO₃-N) loadings represent the portion of these inputs that are delivered to groundwater and surface water in the Basin. Loadings are consistently expressed as NO₃-N. Loadings were attributed (partitioned) by land use and by source type as described in Section 2.4.

The portion of nitrogen inputs applied as fertilizer that reaches groundwater or surface waters of the Basin as NO₃-N is the result of two essentially independent calculations. Nitrogen inputs are based on estimated fertilizer use, while loadings are based on estimated groundwater concentrations and recharge rates (loadings to groundwater) and the results of application of a stormwater loading model (modification of the WMM model application developed by CDM, 2005).

Results of input and loading estimates are presented in the following sections.

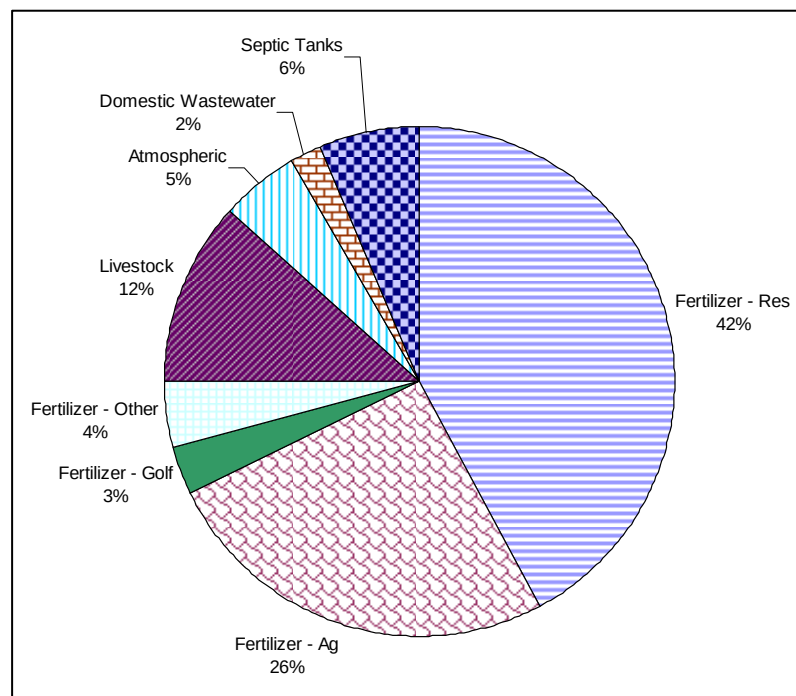
3.1 Inputs of Nitrate to the Wekiva Basin

The total amount of nitrogen input to the Wekiva Basin is estimated at approximately 9,400 MT/yr. Partitioning of these inputs by source is illustrated in Figure 3-1, which shows approximately 42% of Total N input to the Basin results from the application of fertilizer in residential areas; 26% is fertilizer applied in agriculture; 3% fertilizer used on golf courses and 4% other fertilizer use. In all 7,000 MT of Total N is applied as fertilizer within the Wekiva Basin annually, accounting for about $\frac{3}{4}$ of the Total N input to the Basin.

Livestock waste contributes approximately 1,100 MT Total N to the Basin annually, or 12% of the total input. Remaining sources are septic tanks, contributing approximately 6% of Total N input to the Basin; domestic wastewater, 2%, and atmospheric deposition, 5%.

Some nitrogen inputs have a greater impact on water quality than others. For example, a direct discharge of $\text{NO}_3\text{-N}$ to surface water is likely to have a greater impact than an equivalent amount of nitrogen applied as fertilizer on uplands far from streams or springs. Nitrogen applied as fertilizer is used by plants. Nitrogen as ammonia in septic effluents may volatilize to the atmosphere. The next section on loadings provides additional information regarding the contribution of each of these sources to $\text{NO}_3\text{-N}$ in groundwater and surface water of the Basin.

Figure 3-1. Nitrate Inputs to the Wekiva Basin, Partitioned by Source Type



Source: MACTEC

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3.2 Loadings to Waters of the Wekiva Basin

Procedures described in Section 2.0 were applied to estimate $\text{NO}_3\text{-N}$ loadings to groundwater and surface waters of the Basin. Total loading of $\text{NO}_3\text{-N}$ to waters of the Basin is estimated to be 1,800 MT/yr. Contrasting this estimate with the nitrogen input to the Basin of 9,400 MT/yr indicates that only 19% of the Total N input to the Basin reaches groundwater and surface water as $\text{NO}_3\text{-N}$. Although the importance of removal processes has not been evaluated quantitatively, it appears that a significant portion of nitrogen input is lost by assimilation (plant uptake), storage as soil organic nitrogen, denitrification, and volatilization to the atmosphere as N_2 or ammonia. Only about 130 MT/yr is discharged directly to surface water in the Wekiva River watershed. The remainder of the loading, i.e., approximately 1,700 MT/yr is a load to groundwater resources.

This amount may be compared with the estimated discharge of $\text{NO}_3\text{-N}$ from springs in the Wekiva Basin, which has been estimated to be approximately 230 MT/yr.

There are several possible explanations for this discrepancy between estimated groundwater loading and spring discharge. A portion of the $\text{NO}_3\text{-N}$ initially discharged to groundwater may be lost by denitrification or other chemical processes, while a portion of the loading may underflow the springs, perhaps eventually discharging to the St. Johns River. Toth (1999, 2003) and Toth and Fortich (2002) showed that water discharging to springs in the Basin reflects impacts from past activities in the Basin. On average the water discharging from springs reflects land use activities (e.g., fertilizer use) that happened 20 years ago, when the Basin was less developed, more agricultural, and prior to implementation of structural and non-structural BMP programs. Discharges from springs are the result of historical loadings, not those occurring today. Therefore the estimated loadings in 2004, higher than spring discharges, may indicate that water quality in springs could deteriorate in the future. It is also possible that the groundwater loadings may be overestimated.

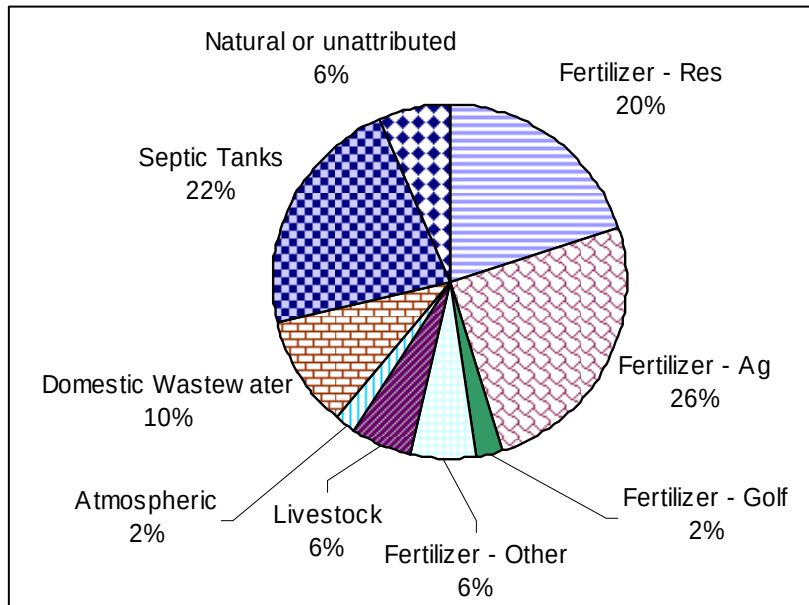
Figure 3-2 illustrates the sources of $\text{NO}_3\text{-N}$ loadings. Fertilizer use by agriculture (26% of total loading) and for residential turfgrass (20%) are major contributors, as are septic tanks (22%). Fertilizer use on all land uses comprises 54% of total loadings. Domestic wastewater and livestock waste add 10 and 6%, respectively. Approximately 6% of the total loading is apparently natural, that is it cannot be attributed to identified sources. This amount consists of the groundwater recharge and stormwater loadings that would be expected to occur if all land in the Basin were undeveloped. This “natural or unattributed” amount was calculated by setting all groundwater concentrations to 0.1 mg/L, representative of values generally observed in undeveloped areas, and generating stormwater loadings using WMM in a separate application by changing all upland land uses to an undeveloped classification. Combining this amount with atmospheric deposition (2%, a portion of which is natural) suggests that anthropogenic loadings are about 92% of the total, or that pre-cultural loadings would have been about 1/12th of current loading rates.

Figure 3-3 shows the portion of nitrogen inputs that are delivered to waters of the Basin by source type. It was assumed that all effluent nitrate from permitted wastewater facilities, excluding effluent that is reclaimed or reused, is discharged to waters of the Basin. Effluent that is reclaimed or reused was assumed to replace or reduce fertilizer use. In fact, approximately 37% of wastewater effluent $\text{NO}_3\text{-N}$ is reclaimed or reused in the Wekiva Basin. Approximately 70% of septic tank effluent nitrogen was assumed to reach groundwater as $\text{NO}_3\text{-N}$ (Anderson and Otis, 2000). The remainder is presumed to be volatilized as ammonia or denitrified and volatilized as N_2 during transport from the leachfield to the water table.

The portion of nitrogen inputs applied as fertilizer that reaches groundwater or surface waters of the Basin as $\text{NO}_3\text{-N}$ is the result of two essentially independent calculations. Nitrogen inputs are

based on estimated fertilizer use, while loadings are based on estimated groundwater concentrations and recharge rates (loadings to groundwater) and the results of application of a stormwater loading model (modification of the WMM model application developed by CDM, 2005). Although there is significant potential for errors in both the loadings and the inputs estimated in accordance with Section 2.0, the portion of fertilizer applied that actually reaches groundwater and surface water is consistent with the literature. For example, leachate and/or runoff losses of $\text{NO}_3\text{-N}$ have been reported to range from 1 to 44% (most results less than 15%) of Total N applied as fertilizer to residential turfgrass by Hipp, *et al.* (1993), Morton, *et al.* (1988), Raulerson, *et al.* (2002), and Snyder, *et al.* (1984). This range compares favorably with the portions estimated for residential turfgrass and golf courses in the Wekiva Basin of 9 and 14% respectively. Bottcher and Rhue (2000) estimate $\text{NO}_3\text{-N}$ losses by runoff and leaching of 5 to 30% in agricultural applications, which compares with 18% estimated in the Wekiva Basin.

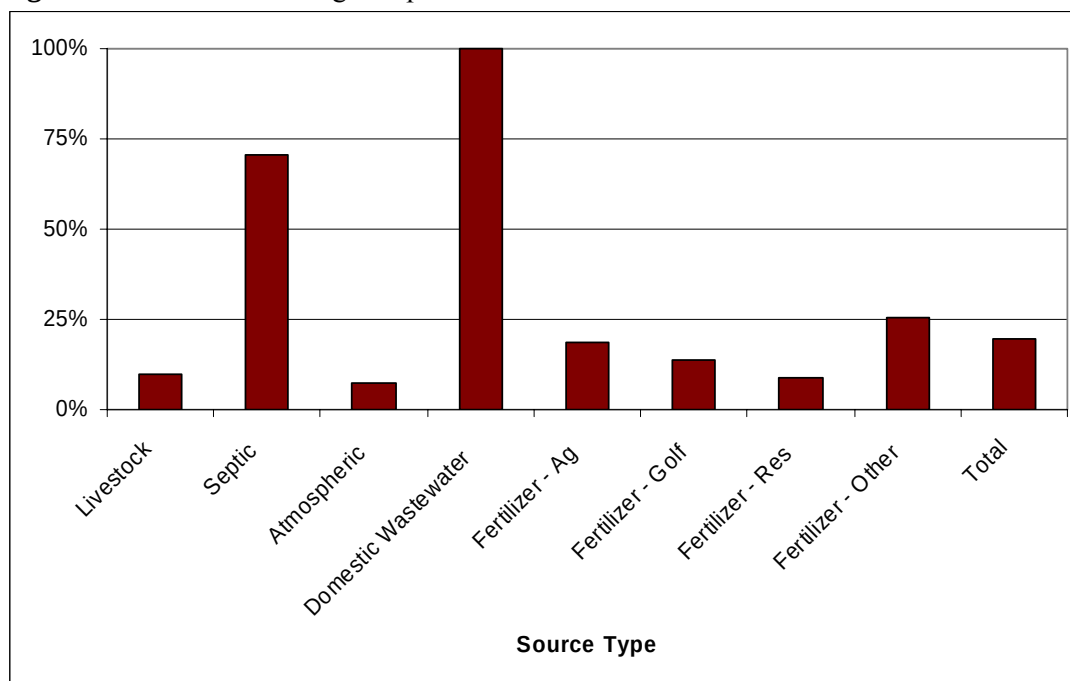
Figure 3-2. Nitrate Loadings to the Wekiva Basin, Partitioned by Source



Source: MACTEC

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Figure 3-3. Portion of Nitrogen Input Delivered to Waters of the Wekiva Basin



Note: 37% of domestic wastewater is reclaimed or reused, but this amount is not included or represented in the domestic wastewater totals presented in Figure 3-3.

Source: MACTEC
 Created by: SAR Checked by: WAT

Figure 3-4 illustrates the partitioning of $\text{NO}_3\text{-N}$ loadings by land use. Residential land uses, which are affected by both fertilizer use and septic tanks, account for 41% of total loading, while agricultural land uses contribute 33%. Wastewater effluents are the predominant contributor to the transportation, communications, and utilities land use which contributes 12% of total loadings of $\text{NO}_3\text{-N}$. In Figure 3-4 the undeveloped sector (as depicted in Figure 2-1) has been disaggregated into two parts, undeveloped uplands (which may be presumed to be developable in the future, and currently contribute 2% to total loading) and those undeveloped lands that are protected from future development, including publicly owned conservation lands, wetlands, and water bodies, which contribute 4% of total Basin loading.

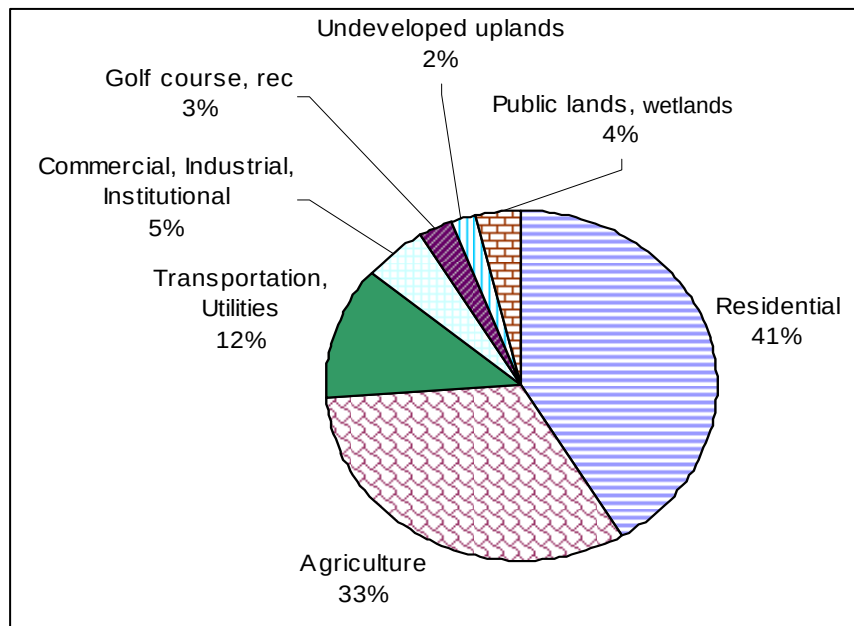
Residential land uses are major contributors to loadings, in part, because they comprise a large portion of the Wekiva Basin (21%, see Figure 1-2). Figure 3-5 presents information on land use acreage from Figure 1-2, and partitioning of $\text{NO}_3\text{-N}$ loadings by land use from Figure 3-4 in a stacked bar chart format. This illustration shows, for example, that although residential land uses comprise 21% of the total area of the Basin, they contribute 41% of the $\text{NO}_3\text{-N}$ loadings. Similarly transportation, utilities, commercial, industrial, institutional, and golf course land uses contribute a greater proportion of the $\text{NO}_3\text{-N}$ loadings than their proportion of the acreage, while undeveloped land uses that make up more than 50% of the area of the Basin contribute only 6% of the $\text{NO}_3\text{-N}$ loading.

Information presented on Figure 3-4 can also be presented in terms of loading rates per area. Residential land uses, in aggregate, yield about 21 kg/ha/yr, while agricultural land uses yield about 19 kg/ha/yr. The loading from specific residential parcels, however, depends primarily on whether they are served by a central sewer system or septic tanks. About half of the aggregate residential loading is from septic tanks, but less than half of residences are on septic systems in the Wekiva Basin, so residential parcels with septic systems have much higher loading rates. Loading rates from undeveloped lands, on the other hand, were estimated to average about 1 kg/ha/yr.

Considering the number of septic systems (65,000), the average number of people served by each tank (approximately 2.5), and the actual discharge rate from domestic wastewater facilities in the Basin (about 48 MGD), it is estimated that about 160,000 people are served by septic, and 265,000 by central sewer systems. Loadings from septic systems are estimated at 415 MT/yr, or about 2.6 kg NO₃-N/person/yr. Loadings from central sewer (discounting reused effluents, which displace fertilizer use) average 0.7 kg/person/yr. Therefore, central wastewater treatment facilities reduce 73% more NO₃-N loading than septic systems.

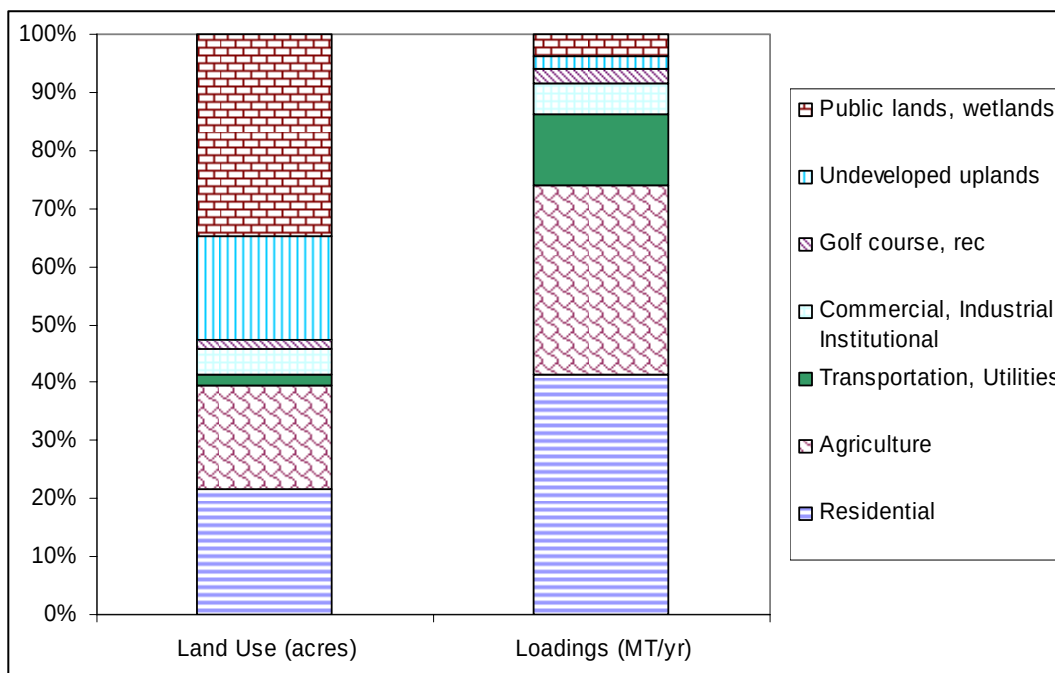
These loading rates represent conditions in the Basin in 2004. Projections of future loadings were not one of the objectives of this study. Nonetheless, some trends are apparent. From 1999 to 2004, residential land use (and correspondingly the number of dwelling units) increased by about 10% (an increase of about 10,000 acres). During the same five year period, acreage in row crops decreased by 40% (losing 600 acres) and acreage in citrus decreased by 28% (a loss of 5,000 acres). Assuming these trends continue, the percent contribution of residential land uses to NO₃-N loadings would be expected to increase in the future, with a decrease in the importance of agricultural land uses.

Figure 3-4. Nitrate Loading to the Wekiva Basin, Partitioned by Land Use



Source: MACTEC
 Created by: SAR Checked by: WAT

Figure 3-5. Loadings by Land Use compared with Proportionate Acreage in Each Land Use



Source: MACTEC
 Created by: SAR Checked by: WAT

3.3 Uncertainties in Loading Estimates and Limitations of the Selected Procedures

Several of the factors used to estimate inputs and loadings are uncertain, and the procedures themselves do not represent all factors that affect nitrate loadings. Procedures were selected, in part, because available information supported estimation of all quantities specified in the SOW (partitioning by specific source types and partitioning by specific land uses) using those procedures consistently across all source types and land uses.

In the following two subsections limitations of the selected procedures are identified, and uncertainties in input parameters are discussed qualitatively or semi-quantitatively.

3.3.1 Procedural Issues

Procedural issues identified include:

- Definition of the springshed – There are at least three published maps depicting the Wekiva Groundwater Basin and/or the springshed (Toth and Fortich, 2002, Wekiva River Basin Coordinating Committee, 2004). The District has determined that the map used to define the scope of this project is the most reliable. Boundaries of the springshed may change with season, or from year to year. The relative importance of predominantly agricultural areas in the western portion of the springshed would be affected if different assumptions had been made regarding the boundary of the springshed.
- Relative importance of loadings near springs versus loadings far from springs – Although this factor would not affect the estimate of loadings within the Wekiva Basin as defined by this study, not all loadings to the Floridan Aquifer will have an equivalent impact on springs and Wekiva River water quality. Loadings to the Floridan Aquifer that occur near a spring probably have a disproportionately greater impact, and certainly the effects of loading changes in areas near a spring will have a more immediate effect on spring water quality. These factors have not been addressed in this Phase I study, but may be addressed during Phase II.
- Use of shallow groundwater concentrations and/or leachate concentrations as representative of the quality of recharge to the Floridan Aquifer – By the selected procedure for estimating groundwater loadings (multiplying shallow groundwater concentrations times recharge rates) the ideal groundwater concentration input would be deeper groundwater, the water actually recharging the Floridan. Unfortunately these data are not as readily available as shallow groundwater concentrations, nor could deeper concentrations be attributed to specific sources and land uses. In order to attribute loadings to specific sources and land uses, it was important that the concentrations used as characteristic of a source should clearly reflect the source type. By the time groundwater has recharged to the top of Floridan, in many locations, its concentration represents the combined impacts of multiple land uses, multiple sources, with some dilution and/or other chemical transformations. In this study shallow groundwater concentrations, generally within 20 ft of the water table, were used to estimate concentrations in water recharging the Floridan. For one source type (residential fertilizer use) representative groundwater concentrations were not found in the technical literature, and leachate concentrations from experimental plots were used in lieu of groundwater data. Leachate concentrations would likely be higher than groundwater concentrations, due to dilution, and this could lead to overestimation of the importance of residential fertilizer source type, compared with agricultural sources.

- Primary reliance on UF/IFAS Extension recommended fertilization rates rather than actual fertilizer use – Most researchers and Extension agents generally believe that most farmers apply more fertilizer than the amounts recommended by UF/IFAS Extension. In some cases “over fertilization” has been documented in published reports. For the most part, however, such assertions are not well documented. An alternative approach that was considered was to use fertilizer sales (e.g., by County) as the primary method for estimating fertilizer use. This approach was rejected, however, for several reasons, including (a) difficulty of assigning County-wide fertilizer sales to source types and land uses of interest; (b) recognition that the Wekiva Basin includes small portions of several Counties such that it would be difficult to assign a portion of County-wide sales to the Basin; (c) concern that fertilizer is not necessarily used in the County where it is purchased (one example – large agricultural concerns may use significant quantities of fertilizer purchased elsewhere by corporate purchasing systems).
- Reclamation/reuse of domestic wastewater effluents not tracked – The amount of $\text{NO}_3\text{-N}$ in reclaimed/reused effluents was estimated, but not included in totals for the wastewater effluent source type. Rather it was assumed these $\text{NO}_3\text{-N}$ loadings replace/reduce fertilizer use. Given the procedure used to estimate fertilizer inputs and loadings, addition of the $\text{NO}_3\text{-N}$ contained in reclaimed/reused effluent would have amounted to “double-counting”. The most significant effect of this error is the assignment of loadings to the wrong source type, rather than an error in the total loading estimated. In addition, disposal of wastewater treatment residuals was not tracked or accounted for.
- Assumption that structural BMPs (e.g., stormwater detention ponds) simply reroute nitrate from surface water to groundwater, without reducing total Basin loading – Clearly structural BMPs effect some treatment of nitrate, although structural BMPs are less effective for soluble $\text{NO}_3\text{-N}$ than for constituents strongly associated with suspended solids, including Total Suspended Solids, Biochemical Oxygen Demand, and Total Phosphate. This assumption is conservative and was made primarily for simplification, and may be reviewed and modified during Phase II of this study.

3.3.2 Uncertainties in Input Parameters

All inputs used in estimation of inputs and loadings are uncertain to some extent. Land use designations may not be accurate on a parcel by parcel basis, but the aggregate (total acres by land use through the entire Basin) is probably relatively accurate and not a significant source of uncertainty.

Stormwater loadings (per acre of land use) are the product of stormwater flow for a climatically average year and an Event Mean Concentration (EMC, representative concentration of $\text{NO}_3\text{-N}$ in stormwater). Stormwater flow can vary widely from year to year, depending on rainfall rates, but the climatological average is assumed to be reasonably reliable, and not a significant source of uncertainty in this analysis.

EMCs used in this study were developed by CDM (2005) and represent a consensus estimate based on the literature and the input of stakeholders. Information on the uncertainty in EMCs

presented by CDM (2005)¹³ indicate that the uncertainty in EMCs for the land uses contributing significantly to NO₃-N loadings in the Wekiva Basin is roughly a factor of 2. The consensus value selected by CDM (2005) was usually near the high end of the range of reported values, suggesting that stormwater loadings are unlikely to be underestimated, but may be overestimated by as much as a factor of 2. Considering that stormwater represents 14% of total NO₃-N loading in the Basin, the effect of this potential error is that total loadings may be overestimated by 5 to 10%.

The concentrations of NO₃-N in recharging groundwater assigned as representative of specific land uses are uncertain. For most land uses these estimates are based on published studies from locations outside the Wekiva Basin, and, in some cases, from outside the state of Florida. Representative data from Florida locations were used if available. Different monitoring studies generally yield fairly consistent results for given land uses, but limitations and variability observed in the data suggest that each land use estimate may not be reliable to much better than $\pm 50\%$. Given the large percentage of the Basin that is in residential land uses, and the lack of reliable field scale studies for residential land use, the uncertainty in the estimated concentration recharging from residential land uses is believed to represent one of the more significant sources of uncertainty.

¹³ The information referred to here has been reproduced in an appendix to this report, and can be found in CDM's table E-6. In that table it is shown that CDM (2005) considered a variety of sources of information on EMCs and selected a value based on technical evaluation and a process of consensus building among stakeholders. The values used by CDM (2005) may differ by roughly a factor of 2 from values that have been reported in the technical literature considered by CDM in developing their consensus EMCs.

4.0 Recommendations

Potential strategies for reducing loading of $\text{NO}_3\text{-N}$ to waters of the Wekiva Basin are identified in this section, and, where possible, the potential effectiveness of these strategies was estimated. The feasibility and cost-effectiveness of potential strategies were not evaluated, although issues of feasibility were considered in identifying promising strategies. Rather, the potential effectiveness of apparently attractive strategies was estimated in terms of their potential for reducing loadings. From a practical standpoint it will be difficult to realize the potential reductions available from most of the strategies considered. Nonetheless an estimate of the potential reductions available from various strategies is believed to be useful as a means of prioritizing strategies for further evaluation of their cost and feasibility. By and large the strategies that are evaluated are approaches recommended by others. The specific evaluations presented here place available information on effectiveness in the context of the basin-specific relative contribution of various source types to total $\text{NO}_3\text{-N}$ loading.

In the second part of this section, recommendations are made for follow up studies in Phase II of this study. Recommendations include additional investigations and further development of available information to reduce uncertainties identified in Phase I.

4.1 Load Reduction Strategies

Mattson, *et al.* (2006) recommended provisional NO_3 load reduction goals for surface waters of the Wekiva Basin ranging from 36% for the Lower Wekiva River to 85% for Rock Spring. These load reduction targets were determined to be needed to meet water quality target concentrations for these water bodies. They were developed with large safety margins to ensure that the load reduction goals would be protective. Additional data or research may eventually show that somewhat lesser loading reductions will be sufficient to achieve water quality standards. The magnitude of reductions recommended by Mattson, *et al.* (2006) broadly indicate the percentage reductions in $\text{NO}_3\text{-N}$ loadings that should be sought in this early stage of evaluation of actions required to improve water quality in the major springs and streams of the Basin.

Figures 3-2 and 3-4 suggest that residential and agricultural land uses, specifically fertilizer use by homeowners and farmers, and septic tank and domestic wastewater effluents contribute the bulk of the loading, and would therefore represent the primary targets for load reduction. Although future loadings were not projected, the recent trend of increasing acreage in residential land use, and decreasing acreage in agricultural land use indicates that residential fertilizer use and domestic wastewater (whether from septic systems or central sewer systems) will continue to represent the dominant source of $\text{NO}_3\text{-N}$ loading to the basin. These source types (residential fertilizer use, septic tanks, and domestic wastewater), whose impact is most closely correlated with population, currently comprise 52% of total $\text{NO}_3\text{-N}$ loadings, while agricultural sources comprise about 30% of total load. Combining sources in a slightly different way (fertilizer use

versus sewage), it is seen that about half of the load is associated with fertilizer use, across all land uses, while 33% is associated with sewage.

4.1.1 Domestic Wastewater Management

Options for reducing loadings from domestic wastewater include upgrading septic tanks to reduce Total N and NO₃-N concentrations in septic tank effluents, upgrading centralized wastewater treatment facilities to reduce NO₃-N concentrations in effluents, increasing reclamation/reuse of domestic wastewaters thereby displacing fertilizer use, expanding footprints of central sewer systems and/or requiring hookups where central sewer systems are already available. Advanced septic tank systems that reduce NO₃-N loadings (e.g., with denitrification process components) are also known as performance-based treatment systems (PBTS). Upgrading to PBTS affords similar loading reductions (about 75%) as would occur if the waste stream were discharged to central sewer and treated in a centralized wastewater treatment facility. For this reason, decisions as to whether to expand central sewer service (extending sewer lines, requiring hookups) or upgrade septic tanks should primarily be based on which alternative is lower cost. In densely developed areas, expansion of central sewer service is likely to be less expensive; but in areas with a low density of septic tanks, tank upgrade to PBTS is likely to be the more economical approach. Additional discussion and estimated benefits are presented in the following two sections.

4.1.1.1 Sewered Domestic Wastewater

In April 2006 FDEP promulgated F.A.C. 62-600.550 establishing specific wastewater management requirements for the WSA. The purpose of the rule is to reduce NO₃-N discharges to protect surface and groundwater quality in the WSA. Existing domestic wastewater facilities discharging within the WSA are to comply with requirements of the rule by April 2011. New facilities are to comply immediately.

The approach adopted in F.A.C. 62-600.550 is to target more stringent requirements in portions of the WSA where the Floridan Aquifer is particularly vulnerable to contamination, as defined by the Wekiva Aquifer Vulnerability Assessment (WAVA; Cichon, *et al.*, 2005). Cichon, *et al.* (2005) found that the Floridan Aquifer is vulnerable to surface contamination throughout the entire WSA, but further identified areas with relatively greater vulnerability. Areas where the Floridan Aquifer is most vulnerable to contamination are designated the Primary Protection Zone. The Floridan Aquifer is relatively vulnerable in the Secondary Protection Zone as well, and least vulnerable in the Tertiary Protection Zone. F.A.C. 62-600.550 requires the most stringent discharge requirements in the Primary Protection Zone, relatively stringent requirements in the Secondary Protection Zone, and less stringent requirements in the Tertiary Protection Zone.

Specifically, in the Primary Protection Zone:

- Expanded rapid-rate or restricted access slow-rate land application systems are prohibited;

- Facilities with a permitted capacity exceeding 0.1 MGD must achieve effluent concentration of 3 mg/L Total N in water discharged to rapid rate land applications systems (e.g., RIBs) unless the RIB is used only as backup (<30% of total discharge) to a public access reuse system for which the effluent concentration shall not exceed 10 mg/L Total N; and
- Smaller facilities must achieve effluent concentration of 10 mg/L, regardless of disposal method.

In the Secondary Protection Zone:

- Larger facilities (permitted capacity > 0.1 MGD) must achieve effluent concentration of 6 mg/L Total N in water discharged to RIBs unless the RIB is used only as backup to a public access reuse system; and
- Other requirements similar to those for facilities in the Primary Protection Zone, except that small facilities have until 2016 to comply.

Facilities do not have to meet these requirements if their effluent contains less than 0.2 mg/L NO₃-N. Discharge to surface waters is prohibited except as backup to a public access reuse system. In both the Primary and Secondary Protection Zones, the concentration in effluent supplied to slow rate public access reuse systems must not exceed 10 mg/L Total N.

To meet these requirements, several facilities will have to upgrade their treatment systems and/or change their effluent disposal system(s). The need to reduce discharge or modify effluent disposal systems was evaluated by review of effluent concentrations from 2004 through mid-2006. It was assumed that if more than 20% of the historical sample results exceed the revised effluent concentration limits, the facility would upgrade. Further it was assumed the design criterion for upgrades would be that fewer than 20% of discharge measurements would exceed the revised limits, with 95% confidence. Results of this analysis are summarized in Appendix E. Within the WSA, where F.A.C. 62-600.550 is applicable, the effect of the rule is estimated to be a 65% reduction in NO₃-N wastewater facility effluent loading. Since there are a number of wastewater facilities in the Wekiva Basin that are not within the WSA, and therefore not subject to the requirements of F.A.C. 62-600.550, the overall effect of the required upgrades on effluent loads in the Basin would be a 21% reduction (from 189 MT/yr to 149). The estimated load reduction is relatively uncertain, based on the analyses performed. The largest discharger in the Basin is not in the WSA and therefore not subject to the new rule. The effect on total loading (entire Basin, all source types) would be a reduction of 2%.

4.1.1.2 Septic Tanks

FDOH (2004) developed recommended load reduction strategies to reduce the impact of septic tanks in the WSA. FDOH (2004) determined that PBTS are commercially available that can reduce Total N loading from septic tanks by approximately 75%. Based, in part, on this finding, FDOH recommended that new, modified, and replacement tanks in the Primary and Secondary Protection Zones within the WSA be upgraded to PBTS systems. In addition they recommend further enhancement of such systems by discharging tank effluents to shallow drip irrigation drainfields to maximize plant uptake of nitrogen and reduce lawn fertilization and irrigation

needs. FDOH (2004) found that similar levels of environmental protection are afforded by PBTS as by central sewer¹⁴, but recognizes that extension of and/or connection to central sewer is a lower cost alternative to septic tank replacement/upgrade in high density land uses (e.g., high density residential); while septic tank upgrade would be the lower cost alternative in areas with a low density of development. Since similar levels of environmental protection are afforded, the lower cost alternative (central sewer hookup or upgrade to PBTS) should be selected, by location.

Recognizing that septic system malfunction is an important ongoing problem, and that PBTS may require an even higher level of maintenance than conventional septic tanks, FDOH also recommended the establishment of regional wastewater management entities to oversee the maintenance of all septic systems in the WSA. The wastewater management entities would be a part of county or city governments, or a special taxing district. The governmental wastewater management entity would contract with existing registered septic tank contractors, licensed plumbers, or licensed wastewater treatment plant operators for inspection and maintenance services. The management entity would be responsible for assuring that required inspections and maintenance are conducted and that the discharge limits specified by the operating permits issued by FDOH are met. Funding for the maintenance program would be generated through user service fees.

Strategies to reduce impacts from septic systems must address funding mechanisms, since costs to individual septic system owners are substantial and may be perceived to be inequitable. FDOH (2004) addresses these concerns, in part, by recommending the establishment of regional wastewater management entities to administer maintenance of septic systems. The objective of the regional wastewater management entities recommended by FDOH (2004), however, is to ensure that upgraded PBTS systems operate as designed, and does not address the high capital cost of upgrades and/or extension of central sewer systems.

The potential load reductions afforded by the FDOH recommendations were estimated approximately. A scenario was developed that could be evaluated within the context of available information for the Wekiva Basin and procedures used to estimate loadings in this report. Specifically, if all septic tanks in high density residential land use within the WSA Primary and Secondary Protection Zones (approximately 5,000 tanks) were replaced by central sewerage, and loadings from all other septic tanks in Primary and Secondary Protection Zones in the WSA (approximately 43,000 tanks) were reduced by 75%, the total loading of NO₃-N would be reduced by 226 MT/yr, which would represent a 12% reduction in total NO₃-N loading in the Wekiva Basin.

¹⁴ This finding is supported by analyses performed during this study and discussed in Section 3.3. It appears that loadings from domestic wastewater facilities are about 73% of the loadings from septic systems on a per capita basis. Upgrading to PBTS results in a similar reduction of about 75%.

If the FDOH recommendations were implemented throughout the Wekiva Basin (and not just within the WSA), the total loading would be reduced by 263 MT/yr, a 14% reduction in total loading. This estimate is consistent with looking up 6,000 tanks to sewer and upgrading approximately 50,000 tanks to PBTS.

Finally, an even more aggressive scenario was evaluated, to gain better insight into the maximum potential reduction under existing septic tank technologies. In this scenario, all medium and high density residential septic tanks (49,000 tanks) were assumed to be hooked up to sewer, and all remaining septic tanks (16,000 tanks) were assumed to be upgrade to PBTS systems, regardless of WAVA Protection Zone. In this hypothetical scenario, which is intended to represent the maximum achievable reduction using commercially available technology, loadings from domestic wastewater would be reduced by 328 MT/yr, an 18% reduction in total loading from all sources.

FDOH further recommended that all septic systems in Primary and Secondary Protection Zones be upgraded to PBTS by 2010. If tanks were only upgraded when they failed, benefits would accrue more gradually. Based on practical service life of individual tanks, it would take approximately 25 years to upgrade a large portion of the tank inventory and achieve these estimated benefits.

The state administers three funding programs to assist local governments with the construction of centralized wastewater treatment and collection projects. These are the State Revolving Fund loan program, administered by DEP, the State Pollution Control Bond program, administered by the State Board of Administration and DEP, and Community Development Block Grants, administered by the Department of Community Affairs. Dennis and Glaser (1998) provide several recommendations to enhance state funding programs and additional information on the existing funding mechanisms. The State Revolving Fund program appears to be the more widely used of these three approaches [Walker, *et al.* (1999)]. Alternative mechanisms should be evaluated that could be used to:

- Equitably share costs across the region and all parties who would benefit from water quality improvements,
- Amortize capital costs for homeowners and local governments, and
- Provide additional funds to low and moderate income neighborhoods that are required to upgrade.

4.1.1.3 Domestic Wastewater Summary

Combining both types of domestic wastewater management systems (central sewer and septic tanks), domestic wastewater contributes 604 MT/yr or 32% of the NO₃-N loading to waters of the Basin. Implementation of (a) FDEP's new rule for permitted wastewater facilities in the WSA (F.A.C. 62-600.550) and (b) FDOH (2004) recommendations for reducing loadings from septic systems is defined as one alternative scenario (Scenario 1). This scenario is estimated to cause a 14% reduction in total loading for the Wekiva Basin.

If this strategy were extended to cover the entire Wekiva Basin (Scenario 2), rather than only the statutory WSA, then a 16% reduction in loading could be achieved.

The FDOH and FDEP approaches emphasize more stringent requirements within the Primary and Secondary Protection Zones. By current statutory authority, they would affect only the WSA. This is a balance between cost and effectiveness because the Primary and Secondary Protection Zones within the WSA represent the portion of the Basin with the greatest rates of recharge, and the greatest potential for impacting the springs and river. If similar requirements were established consistently throughout the entire Wekiva Basin, and if septic tank upgrades were required regardless of Protection Zone (a more stringent requirement) loadings could be reduced further, with a potential reduction up to 20% of the total NO₃-N loading using best available technologies for domestic wastewater treatment. Scenario 3 represents the resultant load reduction if these actions were combined with load reductions achievable from implementation of residential turfgrass BMPs (discussed in following Section 4.1.2). Scenario 3 results in a 25% load reduction through the entire Basins (466 MT/yr).

4.1.2 Reducing Loadings from Fertilizer Use

Loadings from fertilizer use may be reduced by improved management of both fertilizer use and irrigation. Structural BMPs (e.g., stormwater detention, artificial wetlands) may also play a role in some watersheds.

It is probably possible for most fertilizer users to reduce their total annual rate of fertilizer use without experiencing a significant reduction in the benefits of fertilizer, such as turfgrass quality and agricultural productivity. It appears, however, that very meaningful water quality improvements could be achieved by more efficiently managing the rate and timing of fertilization and irrigation, even without significantly reducing total fertilizer use. For example, studies (Morton, *et al.*, 1988; Snyder, *et al.*, 1984) show that unnecessary irrigation (too much or at the wrong time) has a greater effect on NO₃-N leaching from turfgrass than excessive fertilization. Recently developed BMPs for citrus recommend more frequent fertilization in smaller doses than past standard practices, but do not recommend a significant reduction in total annual fertilizer use.

An important element of any strategy to reduce fertilizer impacts on waters of the Wekiva Basin must be education because so many citizens make individual decisions regarding fertilization and irrigation. The public agency with the clearest charge to educate fertilizer users is the UF/IFAS Extension Service. Other public agencies and industry associations also play a role, including the FDACS, FDEP, and the SJRWMD. The best approaches to encourage use of BMPs may differ depending on the types of fertilizer users. Turfgrass is maintained by homeowners, commercial lawn care service providers, golf course maintenance supervisors, parks maintenance personnel (e.g., City and County). Farmers and citrus growers apply fertilizer. Each group of fertilizer user may be educated or influenced using different methods. UF/IFAS Extension Service conducts

research on the best methods to communicate with and influence various fertilizer users, and then implements their findings to the extent feasible. It may be appropriate to allocate additional resources to such educational programs.

Alternative approaches may be:

- Regulatory, e.g.,
 - Prohibit sales of soluble fertilizers,
 - Regulate practices of the commercial lawn care service industry; or
- Incentive-based, e.g.,
 - Surcharge tax on fertilizer sales which may provide dedicated funding for other programs;
 - Relief from such a tax if the buyer has completed appropriate UF/IFAS Extension certified training;
 - Public funding to install and maintain sensor-controlled irrigation systems.

4.1.2.1 Residential Fertilizer Use

A wide range of BMPs are available as guidelines for homeowners and others involved in turfgrass maintenance. Exemplary BMP information is available from:

- The Florida Yards & Neighborhoods (FYN) program, an educational outreach program of UF/IFAS Extension (<http://hort.ufl.edu/fyn/>); see for example the FYN Handbook (FYN, 2003); and
- FDEP's Non-Point Source Management website and specifically the Florida Green Industries: BMPs for Protection of Water Resources in Florida developed jointly by the Florida Green Industries, FDEP, FDACS, DCA, water management districts, and UF (Florida Green Industries, 2002). <http://www.dep.state.fl.us/water/nonpoint/pubs.htm>.

Information for professional lawn care service providers is also available from diverse sources including industry associations such as the Florida Turfgrass Association (<http://www.ftga.org/index.html>).

Still, many homeowners are not aware of or do not use these resources. The primary sources of guidance used by most residential fertilizer users are package labels; advice by family, friends and neighbors; and information from retail sources of the product (see Israel and Knox, 2001). More effective public education programs should be implemented to increase citizens' understanding of the FYN Program, residential turfgrass BMPs, and their importance to Florida's environment. A potential funding source for enhanced community awareness programs could include a dedicated tax on fertilizer sales. Completion of UF/IFAS certified training could be a criterion for exempting the fertilizer purchaser from the fertilizer tax.

Detailed information was provided In Section 2.4.1.1 on the importance of appropriate rates and timing of lawn watering as a potential method to reduce NO₃-N leaching while maintaining turfgrass quality. Both rain sensors and soil moisture sensors, if used properly, can facilitate irrigation management, conserve water, and prevent excessive chemical leaching by overriding automatic operation of a sprinkler system. Furthermore, Florida is the only state in the nation

with an overall rain sensor statute. Beginning in 1991, this statute applies to all new automatic sprinkler systems: "Any person who purchases and installs an automatic lawn sprinkler system after May 1, 1991, shall install, and must maintain and operate, a rain sensor device or switch that will override the irrigation cycle of the sprinkler system when adequate rainfall has occurred" (Florida Statute 373.662). This requirement was intended to conserve water. However, avoiding overwatering clearly will have additional benefits in preventing NO₃-N runoff and leaching to groundwater. Consequently enhancements of the state and/or District's approach to encouraging sensor-controlled irrigation may be warranted. One potential enhancement could be the provision of state funds for operation of a program to install and maintain sensor-controlled irrigation systems. For example, water supply utilities could administer a state-funded program to install and maintain sensor-controlled irrigation systems, targeting large users of irrigation water, regardless of the applicability of the rain sensor statute to that user. Based on industry experience with such systems, providing for routine maintenance would be an important part of such a program.

State and local initiatives to restrict types of fertilizers sold (e.g., formulations, percent of active ingredients) have not proven popular, and consequently are consistently not promulgated when proposed. This approach may not be politically feasible at this time. It may be more feasible (considering probability of implementation as well as enforceability) to regulate the practices of commercial lawn care service providers, stipulating the maximum rate of lawn fertilizer application as a condition of licensing.

UF/IFAS Extension is currently working with residential developers and homeowner associations to modify standard subdivision covenants, which often encourage residential turfgrass landscapes, excessive fertilization and overwatering, to instead encourage implementation of FYN BMPs (Graham, 2007). Such approaches should be encouraged.

Information presented in Section 2.4.1.1 was further evaluated to develop an estimate of the potential benefit of more widespread adoption of residential turfgrass BMPs. Specifically, it was assumed that use of turfgrass BMPs would eliminate specific practices (excess watering, excess fertilization, and/or exclusive use of soluble nitrogen fertilizer formulations) that were studied by Morton, *et al.* (1988) and Snyder, *et al.* (1984). It was still assumed that 25% of residents would not fertilize at all, while 75% would fertilize and irrigate in accordance with BMPs. Under these assumptions, the expected average groundwater concentrations due to fertilizer use in residential land uses is estimated to be reduced from 3 mg/L to 2 mg/L, a 33% reduction. Loadings from residential fertilizer use would then be estimated to be reduced by 124 MT/yr, representing 7% of the total loading (entire Basin, all source types).

4.1.2.2 Agricultural Fertilizer Use

The Office of Agricultural Water Policy (OAWP) was established in 1995 by the Florida Legislature to facilitate communications among federal, state, local agencies, and the agricultural

industry on water quantity and water quality issues involving agriculture. In this effort, the OAWP is actively involved in the development of BMPs, addressing both water quality and water conservation on a site specific, regional, and watershed basis. As a significant part of this effort, the office is directly involved with statewide programs to implement the Federal Clean Water Act's Total Maximum Daily Load (TMDL) requirements for agriculture. The OAWP works cooperatively with agricultural producers and industry groups, the FDEP, the university system, the water management districts, and other interested parties to develop and implement BMP programs that are economically and technically feasible.

BMPs were developed by the Office of Agricultural Water Policy to set minimum standards necessary to protect and maintain Florida's water quality. The BMP program is completely voluntary, but by complying with the BMPs, landowners are protected by the state from cost recovery if the water quality standards are not met. Also, those enrolled in the BMP program are eligible for cost-sharing funds used to implement new BMP practices. To take place in the BPM program, one must:

- Do a full assessment of the property using a Decision Tree Flowchart;
- Submit a Notice of Intent to Implement (Outlined in 5M-8.004);
- Implement all applicable BMPs that were needed from the assessment and listed on the Notice of Intent to Implement; and
- Maintain documentation to verify implementation and maintenance of BMPs.

BMPs have been developed for the following agricultural activities:

- Citrus production (BMPs vary by producing region),
- Silviculture,
- Aquaculture,
- Vegetable and agronomic crops,
- Leather leaf ferns,
- Nurseries,
- Forage grass, and
- Sod farms.

Considering their importance in the Wekiva Basin, the ridge citrus and vegetable and agronomic crops BMPs are discussed further below.

Potential Effect of Vegetable and Agronomic Crop BMP

This BMP was promulgated in February 2006, and therefore its effectiveness cannot be determined at this time. The BMP encourages implementation of UF/IFAS Extension recommended fertilization rates. In this study (see Section 2.3.1.2) the assumed application rate is 210 kg N/ha/crop, while UF/IFAS Extension recommended rates are slightly lower at 192 kg/ha/crop. Therefore implementation of the BMP is expected to represent a 9% reduction in fertilizer use from the baseline condition assumed during this study. Extensive guidance is provided regarding water and fertilizer management to reduce nutrient leaching and runoff.

Implementation of the BMP would be expected to reduce loadings to surface water and groundwater, but there is no basis to estimate the magnitude of the effect at this time.

Potential Effect of Ridge Citrus BMP

The ridge citrus BMP has been in place for approximately four years. The BMP does not require a significant reduction in fertilization rate from the rates assumed as the baseline situation. A consortium of state agencies are conducting research to determine the effectiveness of the BMP.

The primary beneficial effect of the BMP is expected to be the requirement to apply less Total N per application, at a greater frequency, than the standard practice of the industry prior to implementation of the BMPs. More frequent fertilization, in smaller amounts, reduces the potential for excessive runoff or leaching if heavy rains follow closely after fertilization, while maintaining, and perhaps enhancing, agricultural productivity. For example, Lamb, *et al.* (1999) reported an average rate of 257 kg/ha/yr distributed in three applications per year (86 kg/ha/application) on three ridge citrus groves in Highlands County during the period 1988 to 1993. The ridge citrus BMP permits average application rates of 270 kg/ha/yr similar to rates actually used pre-BMP, but stipulates a minimum of 6 applications (average of 45 kg/ha/application). Lamb, *et al.* (1999) evaluated the effectiveness of several alternative BMPs, but all of the potential BMPs evaluated were more stringent than the promulgated BMP. As a result it is not possible to estimate the effect of the promulgated BMP, although it is not expected to reduce groundwater concentrations to less than 10 mg/L, compared with the estimated concentration used in loading estimation in this report of 15 mg/L. Therefore, the effect of the BMP is expected to be less than a 30% reduction in loading rates from the citrus land use.

Although neither of these BMPs represent a substantial reduction of fertilizer use from the assumed baseline condition, the most critical factor in preventing leaching and runoff to springs and streams is the effective utilization of fertilizer applied by the crop. A small percentage reduction in fertilizer use could result in a much larger percentage reduction in loadings so long as the fertilizer that was applied is used more efficiently by the crop. Increasing the efficient utilization of applied fertilizer is, in fact, a primary objective of the promulgated BMPs so their implementation is expected to result in a more effective reduction in loading than might be indicated by any reduction in fertilizer applied. Their effectiveness, however, cannot be quantified using available data.

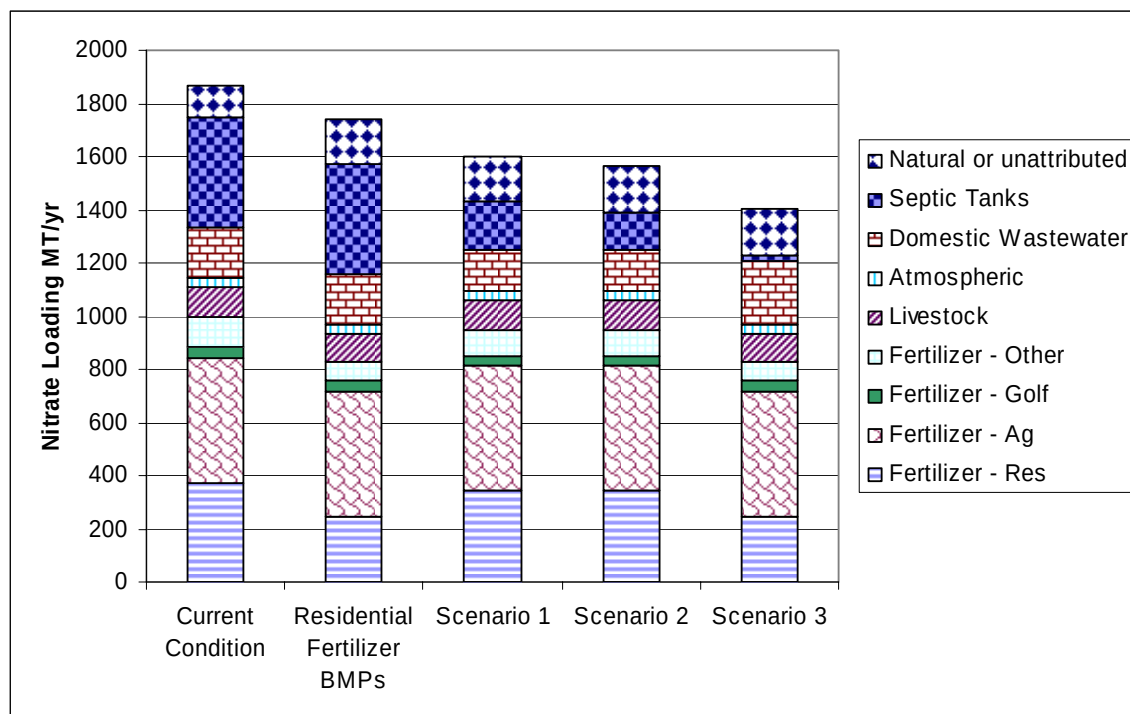
4.1.3 Summary of Load Reduction Alternatives

Figure 4-1 summarizes the estimated effect of various load reduction alternatives discussed in Section 4.1. The first column illustrates current conditions. The second column shows the effect of residential fertilizer BMPs as described in Section 4.1.2.1. Scenario 1 is the combination of effects of F.A.C. 62-600.550 and FDOH (2004) recommendations as described in Section 4.1.1

(entire section, with Scenarios defined in Section 4.1.1.3). In Scenario 1, all actions are within the WSA. Scenario 2 presents the estimated loadings if these actions were also taken throughout the Wekiva Basin. Scenario 3 is the combination of the most aggressive actions discussed throughout this section, including both aggressive septic tank upgrades (see Section 4.1.1) and implementation of residential fertilizer BMPs.

Note that F.A.C. 62-600.550 has been promulgated, and its benefits will be realized during the next 5 years as requirements are phased in. The other strategies considered have not been implemented at this time.

Figure 4-1. Potential Load Reduction Opportunities



Source: MACTEC

Created by: SAR Checked by: WAT

4.2 Groundwater/Spring Treatment Alternatives

Load reduction or pollution prevention approaches discussed in Section 4.1 are clearly preferable to an “end-of-pipe” treatment approach. Insofar as the primary impact of $\text{NO}_3\text{-N}$ is on springs, where groundwater flow becomes more focused and localized, treatment of the water as it discharges may be feasible. Such approaches may be considered as a temporary alternative as basin-wide load reductions are phased in, but may be necessary in the near term to prevent objectionable water quality in these high value water resources. As shown by Toth and Fortich (2002), water currently discharging from Wekiva Springs recharged as rainwater about 17 years ago; while water discharging from other springs in the Wekiva Basin is older. These findings

indicate that actions taken to reduce loadings today will not have an immediate effect on water quality of the springs.

Several “end-of-pipe” approaches for treatment of $\text{NO}_3\text{-N}$ in groundwater were identified during the course of the study that could be considered as potential interim actions. Since identification of groundwater treatment alternatives was not a primary objective of the study, these approaches were not evaluated in detail, but are presented as representative of innovative approaches that have been tested for treating $\text{NO}_3\text{-N}$ in groundwater. In all such approaches the objective is to facilitate denitrification and convert $\text{NO}_3\text{-N}$ to harmless N_2 gas. All such technologies have the potential adverse side effect of creating anaerobic conditions in the groundwater. Approaches in development or application include:

- **Denitrification walls** – In this technology, groundwater must pass through an engineered subsurface zone where a carbon substrate (sawdust has been used successfully) is intermixed with the aquifer formation (Schipper, *et al.*, 2005). The carbon substrate reduces dissolved oxygen in the groundwater and provides a substrate for denitrifying bacteria. In some applications the walls have not been effective because the sawdust lowered hydraulic conductivity and the groundwater simply flowed around or under the wall. Alternative materials have been evaluated to address this limitation, using larger wood chips instead of sawdust in very permeable formations (Robertson, *et al.*, 2005). Where applicable they have been effective in reducing $\text{NO}_3\text{-N}$ concentrations in groundwater by 60 to 90%. Denitrification walls may be useful to treat high concentration source areas (e.g., high density residential areas with septic tanks, feedlots) or as a final treatment of groundwater approaching springs.
- **Injection of liquid substances that serve as electron donors into groundwater:** Injection of formate to serve as an electron donor and carbon substrate has been investigated by the USGS (Smith, *et al.* (2001). Injection of molasses has also been proposed as an ideal carbon substrate which is injected into groundwater to effect denitrification (Suthersan, 1999).
- **Infusion of dissolved hydrogen and carbon dioxide gases** – inVentures Technologies, Inc (Ray, 2006; <http://www.isocinfo.com/bioremediation.aspx>) has developed systems to diffuse high concentrations of dissolved gases into groundwater to stimulate bioremediation. They have successfully reduced $\text{NO}_3\text{-N}$ concentrations in surface water and groundwater using their patented Gas inFusion® technology.

4.3 Recommended Follow Up Investigations – Phase II

Significant uncertainties have been identified throughout this report, and studies targeted at reducing these uncertainties are recommended herein. Phase II should include:

1. A recharging groundwater quality assessment emphasizing locations and land uses likely to have the greatest impact on springs feeding the Wekiva River, and
2. Integration and interpretation of the available information using an integrated watershed water quality model with potential to simulate $\text{NO}_3\text{-N}$ transformations and transport in runoff, shallow and deep groundwater compartments, and discharge of groundwater to springs and streams.

It may not be feasible to complete item 2 within available funding constraints. Item 1 is higher priority. If it is subsequently determined that item 2 cannot be completed within available resource constraints, several alternative tasks, of somewhat lower priority, could be substituted. Potential Phase II activities are presented below in order of priority, with potential alternative task elements discussed in Section 4.3.3.

4.3.1 Recharging Groundwater Quality Assessment

The central element of Phase II would be a recharging groundwater quality assessment. The groundwater quality assessment should be designed to determine the quality of recharging groundwater in those locations and land uses likely to have the greatest impact on springs feeding the Wekiva River. Three critical criteria should be used to design the monitoring program. Monitoring should focus on:

- Land uses whose contribution is relatively large and relatively uncertain;
- Areas with relatively high recharge rates; and
- Locations most likely to affect the springs and Wekiva River over the next 10 to 20 years.

The Phase I Study provides sufficient information to prioritize land uses. Residential land uses should be the focus of Phase II investigations. Residential land uses were estimated to contribute 42% of the total loading (See Figure 3-1) and 19% of total loading was estimated to be due to fertilizer use in residential areas. Yet the basis for this estimate is highly uncertain. As noted in Sections 2.4.1.1 and 2.5, no field scale monitoring studies were identified that could be used to estimate representative groundwater concentrations associated with residential fertilizer use, so the estimates were based on leachate from small scale experimental plots. Furthermore, the actual lawn maintenance practices of residents vary, so it is difficult to determine which experimental case studies are most representative of actual fertilization and irrigation practices.

These uncertainties regarding groundwater impacts from residential fertilizer use are more significant than uncertainties associated with agricultural and golf course land uses, where fertilization and irrigation practices are better understood, and numerous well-designed field scale monitoring studies have been reported in the technical literature.

Although residential land uses should be the focus of the Phase II investigation, limited monitoring in other land uses may be warranted, if only to allow Basin-specific comparison with results of the residential land use groundwater assessment, and to verify that impacts in the Wekiva Basin are consistent with groundwater concentrations observed elsewhere.

The District's recharge rate maps are expected to be sufficient basis to select locations with relatively high recharge rates, an important criterion for site-selection for the recharging groundwater quality assessment recommended for Phase II.

Although the entire Basin (i.e., springshed and watershed) are believed to contribute $\text{NO}_3\text{-N}$ loadings to the Basin's springs and the Wekiva River, areas near the springs and the run of the River are expected to have a proportionately greater effect, especially during near term to intermediate time periods of 10 to 20 years. Toth (1999, 2003) and Toth and Fortich (2002) showed that the age of water discharging to the springs varies from spring to spring, but the typical period of time between when water fell on Basin lands as rainwater and when it discharges at the Basin's springs averages about 20 years. If the average age is 20 years, then some water discharging now is "younger" than 20 years and some is "older". Load reduction actions taken today in areas close to the springs should have an effect in the near to intermediate term of 10 to 20 years, but actions taken far from the springs may not have any effect for many years, and the effect would be relatively smaller. Consequently an adaptive management strategy should target early actions near the springs. Then observations over time can be used to determine if these actions are effective, and whether additional actions need to be taken.

Groundwater models by McGurk and Presley (2002) and Hydrogeologic, Inc. (2005) provide information to identify the areas most likely to contribute groundwater recharge to the springs and Wekiva River over the near to intermediate term (e.g., 10 to 20 years). Such locations, nearer to the springs and River run, should also be prioritized in designing the recharging groundwater water quality assessment program.

The first task recommended for Phase II, then, is to design a recharging groundwater quality assessment model, prioritizing sampling in areas with (a) residential land use; (b) high recharge rates; and (c) areas relatively near the springs and run of the River. Although most sampling points should be sited to characterize residential land use, limited sampling points may be designated to characterize agricultural or other land uses in areas with high recharge rates near the springs and River.

The residential land use sampling program should be designed to characterize a range of dwelling unit densities (i.e., low, medium, and high density residential areas as defined by the Florida Land Use, Cover and Forms Classification System) as well as a range of real estate values, i.e., a robust cross-section of residential properties. Wells in residential land uses should be sited so as to avoid impacts from septic systems and other source types. Ongoing studies by FDOH are designed to determine septic tank impacts on groundwater. The focus of this investigation should be on fertilizer use in residential areas.

Groundwater samples should be collected near the water table so that the quality of the recharging groundwater can be clearly associated with the contributing land use, and to enhance comparability with studies from other land uses that were relied on in this report. At a limited number of locations, well clusters, with one or more wells at greater depths, may be used to assess the role of mixing, denitrification, or other environmental fate processes.

At least two samples (wet season, dry season) should be collected and analyzed for NO₃-N from each well. Well installation and construction techniques for Phase II should reflect the limited objectives of this study. Existing wells may be used if they meet the objectives of the study. A minimum of 20 wells should be sampled, although a larger data set would be desirable.

These data should be evaluated to refine estimates of the impact of residential fertilizer use.

4.3.2 Calibration and Application of a Watershed Water Quality Model

A watershed water quality model capable of routing NO₃-N loadings through major hydrographic compartments of the Basin would be useful as a means of integrating and evaluating sources of NO₃-N and characterizing their impacts on springs and the Wekiva River. The model should be capable of realistically simulating major elements of the Wekiva Basin water and NO₃-N budgets, including runoff, baseflow, recharge and discharge to springs.

The Watershed Assessment Model (WAM) is representative of the type of model that may be useful. The process-based source cell models within WAM can simulate surface and groundwater flows with associated nutrient concentrations for each cell and then dynamically route these flows through the hydrography of the Basin, and thus provide integrated impacts of spatial land activities at any spring or point within the stream network. The process-based structure of the model allows for very specific land management changes or practices, such as fertilization, wastewater treatment and reuse, stormwater retention/detention, landscape management, farm crops, etc., to be evaluated for their impact on nitrate transport. This integrated source cell and watershed routing provides spatial depiction of nitrate sources as well as providing the regional effects on springs and streams throughout the basin. WAM has a number of the more common Best Management Practice (BMPs) built into its interface, but customized BMPs or other land management changes can be added to the model. More information on WAM can be obtained from the EPA or Soil and Water Engineering Technology, Inc. websites (www.epa.gov/athens/wwqtsc/index.html or www.swet.com). WAM has been used successfully in similar applications in Florida, including coastal springs in the Southwest Florida Water Management District and springs in the Suwannee River watershed where both spring flows and the influence of land use activities on the water quality of the springs were characterized.

Once an appropriate model is calibrated and shown to realistically simulate major sources and their effects on NO₃-N loadings, it can be used to evaluate the effects of alternative load reduction strategies.

4.3.3 Potential Additional or Alternative Phase II Topics

FDEP and the District should evaluate the costs and benefits of alternative scope elements in the context of available resources.

Actual Fertilizer Use

Actual use of fertilizers in the Wekiva Basin is uncertain. Actual use may differ substantially from UF/IFAS Extension recommendations, for both agricultural and residential land uses. Alternate approaches that may be effective include:

- Fertilizer user surveys, which may be conducted in coordination with or directly outsourced to UF/IFAS Extension;
- Inventory fertilizer sales in the Basin adjacent areas (e.g., County-wide), by fertilizer type and vendor; such information can be used to better estimate residential fertilizer use.

Evaluate Effectiveness of Non-Structural BMPs

Effectiveness of agricultural and residential fertilizer BMPs is not well known. The portion of the fertilizer user population that has or may adopt BMPs is unknown. The effectiveness of specific BMPs, if implemented, is not well established. Recent research and research in progress by various state or federal entities could be further evaluated. Limited Basin-specific research (e.g., fertilizer user surveys – see previous item) may be effective in identifying the potential benefits of BMP programs currently in development or initial stages of implementation.

Develop Additional GIS Data Sets for the Basin

Evaluation of load reduction strategies would be more cost-effective if all relevant information were available in a common geodatabase. Pertinent information is currently stored in a variety of formats and by different state and local agencies. For example, the footprint of sewerage service areas, the major sewage routing infrastructure, septic tank locations, and developable parcels should be combined in a single geodatabase to facilitate evaluation of potential upgrades to domestic wastewater management.

Assess Legacy Loading of NO₃-N

Phase I represents a best estimate of existing NO₃-N loading rates from readily available information on a 2004 baseline. Toth (1999, 2003) and Toth and Fortich (2002) showed that water discharging to springs in the Basin reflects impacts from past activities in the Basin. On average the water discharging from springs reflects land use activities (e.g., fertilizer use) that happened 20 years ago, when the Basin was less developed, more agricultural, and prior to implementation of structural and non-structural BMP programs. The delay between present day actions and future impacts presents decision-makers with significant challenges.

The uncertainties inherent in estimating loadings today would be magnified several times over in any attempt to estimate historical loadings. Nonetheless, it may be useful to estimate loading conditions in the Basin at some historical date most representative of the age of water discharging from the springs now. Understanding the differences in both magnitudes of loadings and predominant source types, then and now, could be useful for understanding both the nature of the problem, and developing reasonable expectations regarding the magnitude and timing of improvements in water quality that might result from actions taken over the next few years. It may also be possible to gain additional insight by calibrating the integrated watershed water

quality model (see Section 4.3.2) to historical loadings and simulate a time series of conditions to predict rates of change in spring water quality. Any such simulation, however, is likely to be extremely uncertain.

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Appendix A

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Appendix B

Appendix E of Wekiva Parkway and Protection Act Master Stormwater Plan
Support, Final Report, completed by CDM, 2005



Wekiva Parkway and Protection Act

Master Stormwater Management Plan Support

FINAL REPORT

Prepared for:

St. Johns River Water Management District

LAKE COUNTY

City of Eustis

City of Mount Dora

SEMINOLE COUNTY

City of Altamonte Springs

City of Lake Mary

City of Longwood

ORANGE COUNTY

City of Apopka

Town of Eatonville

Town of Oakland

City of Ocoee

City of Orlando

City of Winter Garden



November 2005

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Appendix E

Pollutant Load Analysis

E.1 Introduction

As part of the MSMP, CDM estimated the relative annual pollutant loads for the WSA for existing and future conditions. Nonpoint source pollutant loads were estimated using the CDM Watershed Management Model (WMM), Version 4.21. The WMM was used to conceptually evaluate the 12 USEPA stormwater indicator pollutants (BOD₅, COD, TSS, TDS, TP, DP, TKN, NO₃ and NO₂, Pb, Cu, Zn, and Cd) for each of the subbasins identified in the WSA (see Section 2.6.1). The purpose of the evaluation was to identify relative changes in nonpoint source pollutant loadings due to changes in land use, areas served by septic tank, point sources and existing BMPs. The model provides a basis for planning-level evaluations of the long-term (annual or seasonal) basin pollutant loads and the relative benefits of pollution management strategies to reduce these loads. This conceptual screening allows the Stakeholders to identify areas where water quality retrofit may be a higher priority to address TMDL and water quality issues as well as to focus on those areas where future loads are predicted to be relatively high.

E.2 Watershed Management Model (WMM) Background

WMM uses a database platform to estimate annual or seasonal pollutant nonpoint surface loads within a basin. Data required for the WMM include stormwater event mean concentrations (EMCs) for each pollutant type, land use, and average annual precipitation. In addition, impacts due to failing septic systems, annual baseflow and average baseflow concentrations, point source flows and pollutant concentrations, and average number of combined sewer overflows (CSOs) and concentrations can also be taken into account in the WMM if applicable. The model is a “stand alone” application that runs in Microsoft Windows 95® or greater. The following summarizes some of the features of the WMM:

- Estimates annual stormwater runoff pollution loads and concentrations for nutrients (total phosphorus, dissolved phosphorus, total nitrogen, ammonia plus organic nitrogen), heavy metals (lead, copper, zinc, cadmium), and oxygen demand (BOD₅, COD) and sediment (total suspended solids, total dissolved solids) based upon EMCs, land use, percent impervious, and annual rainfall;
- Estimates stormwater runoff pollution load reduction due to partial or full-scale implementation of onsite or regional BMPs;
- Estimates annual pollution loads from stream baseflow;
- Estimates point source loads for comparison with relative magnitude of other basin pollution loads;
- Estimates pollution loads from failing septic tanks;

- Applies a delivery ratio to account for reduction in runoff pollution load due to settling of particulate matter in stream courses; and,
- Imports data sets from land use data files from the spreadsheet version of WMM 3.30 into the data base version of WMM for Windows, Version 1.0.

Pollution control strategies that may be identified and evaluated using WMM include nonstructural controls (e.g., land use controls, buffer zones, etc.), and structural controls (e.g., onsite and regional detention basins, grassed swales, dry detention ponds, CSO basins, sewer separation, etc.).

The WMM can also evaluate alternative management strategies (combinations of source and treatment stormwater controls) to develop a proposed municipal NPDES stormwater management plan or other basin management plan.

Within a given watershed, multiple subbasins can be evaluated. Subbasins are typically subdivided by tributary areas, outfalls, or other receiving water body within a basin. However, subbasins can be delineated based on non-hydrologic boundaries such as jurisdictional limits. This provides decision makers with information regarding the relative contribution of pollution loadings from various areas within a basin which can be used for targeting control measures to those areas which are responsible for generating the majority of the pollutant load.

The WMM consists of three major computational modules, the import utility, and numerous related database records. WMM was developed using Visual Basic® and Microsoft Access®.

E.2.1 Basins and Pollution Sources

A “basin” is the land area which supplies all of the water that eventually flows into a downstream “receiving water” such as a river, lake, or reservoir. The major sources of water in a basin typically include rainfall runoff from the basin surface and seepage into streams from groundwater sources.

The major sources of pollutants in a basin are typically stormwater runoff pollution from urban and agricultural areas and discharges from wastewater treatment plants (WWTPs) or industrial facilities. Stormwater runoff, traditionally referred to as a nonpoint source (NPS), discharges into streams at many dispersed points. A WWTP discharge or industrial process wastewater discharge, typically referred to as a point source releases pollution into streams at discrete points.

E.2.2 Rainfall/Runoff Relationships

NPS pollution loading factors (lbs/acre/year) for different land use categories are based upon annual runoff volumes and event mean concentrations (EMCs) for different pollutants. The EMC is defined as the average of individual measurements of storm pollutant mass loading divided by the storm runoff volume. One of the keys

to effective transfer of literature values for nonpoint pollution loading factors to a particular study area is to make adjustments for actual runoff volumes in the basin under study. In order to calculate annual runoff volumes for each subbasin, the pervious and impervious fractions of each land use category are used as the basis for determining rainfall/runoff relationships. For rural/agricultural (nonurban) land uses, the pervious fraction represents the major source of runoff or stream flow, while impervious areas are the predominant contributors for most urban land uses.

Annual Runoff Volume

WMM calculates annual runoff volumes for the pervious/impervious areas in each land use category by multiplying the average annual rainfall volume by a runoff coefficient. A runoff coefficient of 0.95 is typically used for impervious areas (i.e., 95% of the rainfall is assumed to be converted to runoff from the impervious fraction of each land use). A pervious area runoff coefficient of 0.20 is typically used. The total average annual surface runoff from land use "L" is calculated by weighting the impervious and pervious area runoff factors for each land use category as follows:

$$R_L = [C_P + (C_I - C_P) IMP_L] * I; \quad (\text{Equation E-1})$$

where:

R_L = total average annual surface runoff from land use L (in/yr);

IMP_L = fractional imperviousness of land use L;

I = long-term average annual precipitation (in/yr);

C_P = pervious area runoff coefficient; and

C_I = impervious area runoff coefficient.

Total runoff in a basin is the area-weighted sum of R_L for all land uses.

E.2.3 Nonpoint Pollution Event Mean Concentrations

The WMM estimates loads from pollutants which are most frequently associated with nonpoint pollution sources, including,

- Oxygen Demand
 - Biochemical Oxygen Demand (BOD₅)
 - Chemical Oxygen Demand (COD)
- Sediment
 - Total Suspended Solids (TSS)

- Total Dissolved Solids (TDS)
- Nutrients
 - Total Phosphorus (TP)
 - Dissolved Phosphorus (DP)
 - Total Kjeldahl Nitrogen (TKN)
 - Nitrate + Nitrite Nitrogen ($\text{NO}_3 + \text{NO}_2$)
- Heavy Metals
 - Lead (Pb)
 - Copper (Cu)
 - Zinc (Zn)
 - Cadmium (Cd)

Estimates of the annual load of most of these pollutants were also specified as part of the Phase I National Pollutant Discharge Elimination System (NPDES) stormwater permitting program. These pollutants and their impacts on water quality and aquatic habitat are described below.

Oxygen Demand: Biochemical Oxygen Demand (BOD_5) is caused by the decomposition of organic material in stormwater which depletes dissolved oxygen (DO) levels in slower moving receiving waters such as lakes and estuaries. Low dissolved oxygen can be the cause of fish kills in streams and reservoirs. The degree of DO depletion is measured by the BOD_5 test that expresses the amount of easily oxidized organic matter present in water.

Sediment: Sediment from nonpoint sources is the most common pollutant of surface waters. Many other toxic contaminants adsorb to sediment particles or solids suspended in the water column. Excessive sediment can lead to the destruction of habitat for fish and aquatic life. Total suspended solids (TSS) is a laboratory measurement of the amount of sediment particles suspended in the water column. Excessive sediment pollution is primarily associated with poor sedimentation controls at construction sites in developing areas or unstable channels throughout river systems.

Nutrients: Nutrients, usually phosphorus and nitrogen, are essential for plant growth. Within a lake, impoundment, or other slow moving receiving water, high concentrations of nutrients, particularly phosphorus, can result in overproduction of algae and other aquatic vegetation. Excessive levels of algae present in a receiving

water is called an algal bloom. Algal blooms typically occur during the summer when sunlight and water temperature are ideal for algal growth. Water quality problems associated with algal blooms range from simple nuisance or unaesthetic conditions, to noxious taste and odor problems, oxygen depletion in the water column, and fish kills. Collectively, the problems associated with excessive levels of nutrients in a receiving water are referred to as eutrophication impacts. Control of nutrients discharged to streams can severely limit algal productivity and minimize the water quality problems associated with eutrophication.

Heavy Metals: Heavy metals are toxic to humans above certain levels and are subject to State and Federal drinking water quality standards. Heavy metals are also toxic to aquatic life and may bioaccumulate in fish. Lead, copper, zinc and cadmium are heavy metals which typically exhibit higher nonpoint pollutant loadings than other metals found in urban runoff. The presence of these heavy metals in streams and reservoirs in the basin may also be indicative of problems with a wide range of other toxic chemicals, like synthetic organics, that have been identified in previous field monitoring studies of urban runoff pollution (USEPA, 1983b).

Event Mean Concentrations

Over the past 20 years, nonpoint pollution monitoring studies throughout the U.S. have shown that annual “per acre” discharges of urban stormwater pollution (e.g., nutrients, metals, BOD₅) are positively related to the amount of imperviousness in the land use (i.e., the more imperviousness the greater the nonpoint pollution load) and that the EMC is fairly consistent for a given land use. The EMC is a flow-weighted average concentration for a storm event and is defined as the sum of individual measurements of stormwater pollution loads divided by the storm runoff volume. The EMC is widely used as the primary statistic for evaluations of stormwater quality data and as the stormwater pollutant loading factor in analyses of pollutant loadings to receiving waters.

Nonpoint pollution loading analyses typically consist of applying land use specific stormwater pollution loading factors to land use scenarios in the basin under study. Runoff volumes are computed for each land use category based on the percent impervious of the land use and the annual rainfall. These runoff volumes are multiplied by land use specific mean EMC load factors (mg/L) to obtain nonpoint pollution loads by land use category. This analysis can be performed on a subarea or basin-wide basis, and the results can be used for performing load allocations or analyzing pollution control alternatives, or for input into a riverine water quality model.

Selection of nonpoint pollution loading factors depends upon the availability and accuracy of local monitoring data as well as the effective transfer of literature values for nonpoint pollution loading factors to a particular study area.

EMC monitoring data collected by the USEPA's Nationwide Urban Runoff Program (NURP) and the Federal Highway Administration (FHWA) were determined to be log normally (base e) distributed. The log normal distribution allows the EMC data to be described by two parameters, the mean or median which is a measure of central tendency, and the standard deviation or coefficient of variation (standard deviation divided by the mean) which is a measure of the dispersion or spread of the data. The median value should be used for comparisons between EMCs for individual sites or groups of sites because it is less influenced by a small number of large values which is typical of lognormally distributed data.

To estimate annual pollutant loads discharged to receiving waters from a municipality, median EMCs are converted to mean values (USEPA, 1983b; Novotny, 1992) by the following relationship:

$$M = T * ((1 + CV^2))^{1/2}; \quad (\text{Equation E-2})$$

where:

M = arithmetic mean;

T = median; and

CV= coefficient of variation = standard deviation/mean.

E.2.4 Nonpoint Pollution Loading Factors

WMM estimates pollutant loadings based upon nonpoint pollution loading factors (expressed as lbs/ac/yr) that vary by land use and the percent imperviousness associated with each land use. The pollution loading factor M_L is computed for each land use L by the following equation:

$$M_L = EMC_L * R_L * K; \quad (\text{Equation E-3})$$

where:

M_L = loading factor for land use L (lbs/ac/yr);

EMC_L = event mean concentration of runoff from land use L (mg/l); EMC_L varies by land use and by pollutant;

R_L = total average annual surface runoff from land use L computed from Equation E-1 (in/yr); and

K = 0.2266, a unit conversion constant.

By multiplying the pollutant loading factor by the acreage in each land use and summing for all land uses, the total annual pollution load from a subbasin can be

computed. The EMC coverage is typically not changed for various land use scenarios within a given study basin, but any number of land use data sets can be created to examine and compare different land use scenarios (e.g., existing versus future) or land use management scenarios.

BMP Pollutant Removal Efficiencies

The WMM applies a constant removal efficiency for each pollutant to all land use types to simulate treatment BMPs. The range of typical pollutant removal efficiencies for swales, extended dry and wet detention ponds, baffle boxes and retention ponds are shown in **Table E-1**.

Calculation of Pollutant Loading Reduction from BMPs

The effectiveness of BMPs in reducing nonpoint source loads is computed for each land use in each subbasin. Up to five BMPs per land use can be specified. The percent reduction in nonpoint pollution per pollutant type in each subbasin of the basin is calculated as:

$$P_{L, SB} = (AC_{1, SB} (REM_1) + (AC_{2, SB} (REM_2) + (AC_{3, SB} (REM_3) + (AC_{4, SB} (REM_4) + (AC_{5, SB} (REM_5) \quad (\text{Equation E-4})$$

where:

$P_{L, SB}$ = percent of annual nonpoint pollution load captured in subbasin SB by application of the five BMP types on land use L;

$AC_{1, SB}$; $AC_{2, SB}$;

$AC_{3, SB}$; $AC_{4, SB}$; = fractional area coverage of BMP types 1 through 5 on subbasin SB;
 $AC_{5, SB}$

REM_1 ; REM_2 = removal efficiency of BMP types 1 through 5 respectively; REM_3 ; REM_4 ; REM_5 varies by pollutant type but not by land use or subbasin.

Equation E-4 enables the user to examine the effectiveness of various BMPs and the degree of BMP coverage within a basin. Coverage might vary depending upon whether the BMP is applied to new development only, existing plus new development, etc. Also, topography may limit the areal coverage of some BMPs.

The nonpoint pollution load from a basin is thus computed by combining Equations E-3 and E-4 and summing over all land uses and all subbasins; i.e.,

$$MASS = \sum_{SB=1}^N \sum_{L=1}^{15} M_{L, SB} (1 - P_{L, SB}); \quad (\text{Equation E-5})$$

Table E-1
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Ranges of BMP Removal Efficiencies (%)

Parameter	Dry Detention ⁽¹⁾	Wet Detention ⁽¹⁾	Retention ⁽¹⁾	Swale ⁽¹⁾	Baffle Boxes ⁽²⁾
BOD ₅	20 - 30	20 - 40	80-99	20 - 40	0
COD	20 - 30	20 - 40	80-99	20 - 40	0
TSS	80-90	80 - 90	80-99	70 - 90	80
TDS	0	30 - 40	80-99	0 - 10	0
Total -P	20 - 30	40-50	80-99	30 - 50	35
Dissolved P	0	60 - 70	80-99	0 - 20	0
TKN	10 - 20	20 - 30	80-99	30 - 50	5
NO ₂ +NO ₃	0	30 - 40	80-99	30 - 50	0
Lead	70 - 80	70 - 80	80-99	60 - 90	75
Copper	50 - 60	60 - 70	80-99	40 - 60	50
Zinc	40 - 50	40 - 50	80-99	40- 50	35
Cadmium	70 - 80	70 - 80	80-99	50 - 80	60

(1) Watershed Management Model Version 4.0 User's Manual. CDM, 1998.

(2) Big Creek Watershed Study, Fulton County, GA. CDM, 2001.

where:

MASS = annual nonpoint pollution load washed off the basin in lbs/yr with BMPs taken into account.

N = number of subbasins

The resultant model is a very versatile yet simple algorithm for examining and comparing nonpoint pollution management alternatives for effectiveness in reducing nonpoint pollution.

E.2.5 Failing Septic Tank Impacts

Many of the residential developments within the U.S. rely on household septic tanks and soil absorption fields for wastewater treatment and disposal. The nonpoint pollution loading factors for low density residential areas, which are typically served by septic tank systems, are based on test basin conditions where the septic systems were in good working order and made no significant contribution to the monitored nonpoint pollution loads. In fact, septic tank systems typically have a limited useful life expectancy and failures are known to occur, causing localized water quality impacts. This section describes the method used for estimating average annual septic tank failure rates and the additional nonpoint pollution loadings from failing septic systems.

To estimate an average annual failure rate, the time series approach proposed in the report entitled *Forecasting Onsite Soil Absorption System Failure Rates* (USEPA, 1986) was used. This approach considers an annual failure rate (percent per year of operation), future population growth estimates, and system replacement rate to forecast future overall failure rates. Annual septic tank failure rates reported for areas across the U.S. range from about 1% to 3%. For average annual conditions, it is conservative to expect that septic tank system failures would be unnoticed or ignored for five years before repair or replacement occurred. Therefore, during an average year, 5% to 15% of the septic tanks system in the basin are estimated to be failing.

This is consistent with the results of a survey conducted in Jacksonville, Florida, by the Department of Health and Rehabilitative Services. Of more than 800 site inspections, about 90 violations (11%) had been detected. Types of violations detected were typically: (1) drain field located below groundwater table, (2) direct connections between the tile field and a stream, and (3) structural failures. The violation rate of 11% is consistent with the average year septic tank failure rate and period of failure before discovery/remediation. The "impact zone" or the "zone of influence" for failing septic tanks can be estimated to be all residential areas that are not served by public sewer.

Pollutant loading rates for failing septic systems were developed from a review of septic tank leachate monitoring studies. The range of concentrations of total-P and total-N based upon literature values are as follows:

	<u>Total-P</u>	<u>Total-N</u>
Low	1.0 mg/L	7.5 mg/L
Medium	2.0 mg/L	15.0 mg/L
High	4.0 mg/L	30.0 mg/L

Annual “per acre” loading rates for septic tank failures from low density residential land uses were then estimated using 50 gallons per capita per day wastewater flows. The loading rates can be applied to the percentage of all non-sewered residential land uses with failing septic tanks. The septic tank loading factors are included in the runoff pollution loading factors. The range of percent increases in annual per acre loadings attributed to failing septic tanks is:

	<u>Total-P</u>	<u>Total-N</u>
Low	130%-180%	120%-150%
Medium	160%-250%	140%-200%
High	220%-400%	180%-310%

To assess the increase in surface runoff load due to failing septic tanks, WMM considers a multiplication factor. This multiplication factor is applied to the phosphorus (dissolved P, total P) and nitrogen (TKN, NO₂+NO₃-N) parameters.

Consequently, the load from a residential area with failing septic tanks is:

(surface runoff load without failing septic tanks) x

((multiplication factor) x (% of area with failing septic tanks/100%) + (1 - (% of area with failing septic tanks)/100%))

Despite the large increase in annual loading rates, septic tank failures typically have only a limited impact on overall nonpoint pollution discharges. This is because the increased annual loading rates are applied only to the fraction of non-sewered residential development that are predicted to have a failing septic tank system during an average year. Based upon this methodology, failing septic tank systems typically would contribute less than 10% of total nonpoint loadings.

However, it should be noted that septic tanks often exist along lakes, streams, and wetlands, therefore a public information program may be beneficial to curtail localized water quality impacts. For example, a pilot septic tank inspection program can be initiated which would include a mail- out questionnaire to each resident in the pilot area, a stream walk to observe for potential septic tank failure, stream sampling for fecal coliform, and onsite inspections to verify the continued use of septic tanks and their maintenance condition. The information can be compiled into a database to develop a systematic inspection and maintenance program based on the findings of the pilot program. The program could require inspections every five years for those homes that lie around wetlands and water bodies.

E.2.6 Point Source Loadings

Pollutant loadings from point source discharges such as package wastewater treatment plants (WWTP), regional WWTPs, and industrial sources can also be estimated to determine the relative contributions of point versus other watershed pollution loadings. An inventory of package plants and industrial discharges within each subbasin are typically developed from utility location maps and discharge permit data. Package plants and industrial dischargers are usually assumed to be discharging effluent at their permit limits where compliance monitoring data are not available. Where data on permit limits are not readily available, package plant discharges can be represented by following effluent concentrations which are based on typical effluent limits for secondary WWTPs:

- Total-P 6.0 mg/L
- Total-N 12.0 mg/L
- Lead 0.0 mg/L
- Zinc 0.0 mg/L

If permit data on industrial discharges are not available, then pollutant loads for each point source discharge are estimated for each subbasin by multiplying the discharge flow rate by the effluent concentration.

E.2.7 Model Limitations

The WMM was developed to estimate the relative changes in nonpoint source pollutant loads (average annual or seasonal) due to changes in land use or from the cumulative effects of alternative basin management decisions (e.g. treatment BMPs). The models should be applied to appropriate spatial (basin-wide) and temporal (average annual or seasonal) scales. It is not appropriate to use these input/output models for analysis of short-term (i.e., daily, weekly) water quality impacts. It is also not appropriate to use WMM to estimate absolute loads for a given outfall system without specific monitoring data for that system.

E.3 WMM Data Analysis

The WSA is made up of 10 major watersheds (previously shown in Figure 2-10). Based on existing delineations available from the Stakeholders, the major watersheds are divided up into 102 subbasins within the WSA (previously shown in Figure 2-11). These subbasins range in size from 85 to 26,783 acres in total area. The following sections describe how each of the input parameters for the WMM (i.e., land use, EMCs, BMPs, septic tank, point source) was obtained and processed to perform the pollutant load analysis for the WSA.

E.3.1 Land Use

The acquisition and modification of existing and future land use data were described in detail in Section 2.4 of the MSMP. Due to the number of land use classifications within the WSA, the categories were consolidated into twenty major categories for the purpose of developing the WMM, as shown in **Table E-2**. Another reason for consolidation was to correlate the twenty land use categories with the land use categories with available EMC data. The percent impervious used for each of the land use categories is also shown in Table E-2. Studies conducted at the University of Florida have indicated that wetlands export about 25% of the annual rainfall to other wetlands or water bodies, due to internal storage within the wetlands. Lakes export a slightly higher value (approximately 30%). For this study, an average of the two was used for the water and wetlands land use category.

E.3.2 BMP Identification and Pollution Removal Efficiencies

The existing BMPs were identified using information provided by some of the Stakeholders, parcel maps, available GIS stormwater structure inventory data, GIS subdivision coverages and inspection of the 2004 DOQQs. The BMP treatment areas identified from these data sources were then digitized as polygon features using ArcMap Version 9.0. Approximately 40,000 acres or 62 square miles within the WSA are served by BMPs as shown in **Figure E-1**. The SJRWMD was also consulted regarding the restoration effort at Lake Apopka. Values of approximate removal efficiencies for phosphorus for the alum treatment system the SJRWMD operates were provided.

In order to account for BMPs that will be incorporated as part of future development it was expected that all future development (i.e., those lands considered developable based on land use) will have treatment by BMPs based on current regulations (the most likely scenario). Therefore, all lands with agricultural and forest/open land use categories under existing conditions that were shown to be developed under future land use conditions (i.e., residential, commercial, industrial, etc.) were estimated as served by wet detention. At this point, it is unknown exactly which types of stormwater treatment BMPs will be incorporated as part of new development as there are various types. Therefore, for the purpose of this analysis, wet detention was used to represent this unknown. This basis is also made to show the pollution reduction benefits of mandating BMPs for all future development. The BMP tributary areas

Table E-2
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
WMM Land Use Categories

FLUCCS Land Use Category	WMM Land Use	% Impervious
Agriculture - Feeding Operations	Agriculture - Feeding Operations	1.0%
Agriculture - Field Crops	Agriculture - Field Crops	1.0%
Agriculture - Nurseries	Agriculture - Nurseries	1.0%
Agriculture - Pasture	Agriculture - Pasture	1.0%
Agriculture - Row Crops	Agriculture - Row Crops	1.0%
Agriculture - Specialty Farms	Agriculture - Specialty Farms	1.0%
Agriculture - Tree Crops	Agriculture - Tree Crops	1.0%
Commercial	Commercial	85.0%
Barren Land	Forest/Open	0.5%
Forest	Forest/Open	0.5%
Transportation*	Forest/Open	0.5%
Open Land	Forest/Open	0.5%
Cemetery	Forest/Open	0.5%
Recreational	Forest/Open	0.5%
Agriculture	General Agriculture	1.0%
Golf Course	Golf Course	17.0%
High Density Residential	High Density Residential	71.0%
Communication & Utilities	Industrial/utility	85.0%
Industrial	Industrial/utility	85.0%
Extractive	Industrial/utility	85.0%
Institutional	Institutional	65.0%
Low Density Residential	Low Density Residential	30.0%
Roads	Major Roads	100.0%
Medium Density Residential	Medium Density Residential	37.0%
Very Low Density Residential	Very Low Density Residential	16.0%
Rural Residential	Very Low Density Residential	16.0%
Water Body	Water Body	27.5%
Wetlands	Wetlands	27.5%

*Inspection of the 2004 DOQQs revealed that the actual land cover for the designated transportation areas were primarily grassed airstrips and therefore were assigned Forest/Open.

under the future land use scenario are shown in **Figure E-2**. **Tables E-3** and **E-4** provide the BMP type, the acreage and percent land use served by each type of BMP under existing and future conditions, respectively.

Five types of BMPs were identified in the WSA: alum treatment (SJRWMD Lake Apopka Restoration), combination of swale and dry detention (treatment train), retention, wet and retention/detention (dual ponds), and wet detention. Dr. Harvey Harper performed a literature search to document the removal efficiencies for various stormwater treatment systems from selected studies throughout the state of Florida. This paper, *Pollutant Removal Efficiencies for Typical Stormwater Management Systems in Florida* (1999) summarizes removal efficiencies for dry retention, wet retention, off-line retention/detention systems (dual pond), wet detention and dry detention. Where available, values for treatment efficiencies documented in Harper's work for the parameters evaluated in the WMM analysis were used. Where values were not available from Harper's work for certain BMPs as well as certain constituents, the literature values shown in Table E-1 were used (i.e., WMM User's Manual, 1998). The BMP removal efficiencies used in the WSA WMM analysis are shown in **Table E-5**. As mentioned previously, the SJRWMD provided approximate removal efficiencies for phosphorus related to the restoration effort at Lake Apopka.

Since some combination BMPs (e.g., swale/dry detention) are not standard default BMPs included in the WMM, it was necessary to create a new BMP type for these treatment trains from their individual treatment efficiencies. These efficiencies are estimated by calculating the "minimum" and "maximum" efficiency of the two BMPs in question. The minimum efficiency would be the maximum of the two BMPs. The equation for "maximum efficiency" is based on that each BMP in series has the same efficiency it would have if it was the only BMP.

For example, a wet detention BMP was expected to have a efficiency of 30 percent for BOD₅, and a swale was expected to have 30 percent removal efficiency for copper. The "minimum efficiency" would be 30 percent. Under the "maximum efficiency" calculation, wet detention would remove 30 percent (e.g., of a 100-pound load, 30 lb would be removed and 70 lb would be discharged) and the second BMP (swale) would remove 30 percent of the BOD₅ discharged by the first BMP (in the example, 70 lb is discharged by the first BMP into the second BMP and of that 70 lb, 21 lb (30%) is removed and 49 lb (70%) is discharged). The maximum efficiency would be 51 percent (100 lb into the BMP series, 51 lb removed and 49 lb discharged).

The equation below performs the calculations described above:

$$\text{Maximum Efficiency} = 100 - \frac{[(100 - \text{BMP1 efficiency})(100 - \text{BMP2 efficiency})]}{100}$$

where:

The BMP efficiencies are in percent removal (e.g., use "50" in the equation for 50% removal). The final removal efficiency of the two BMPs in series is an average of the minimum and maximum efficiencies. For the example of BOD₅, the resulting efficiency would be approximately 40 percent.

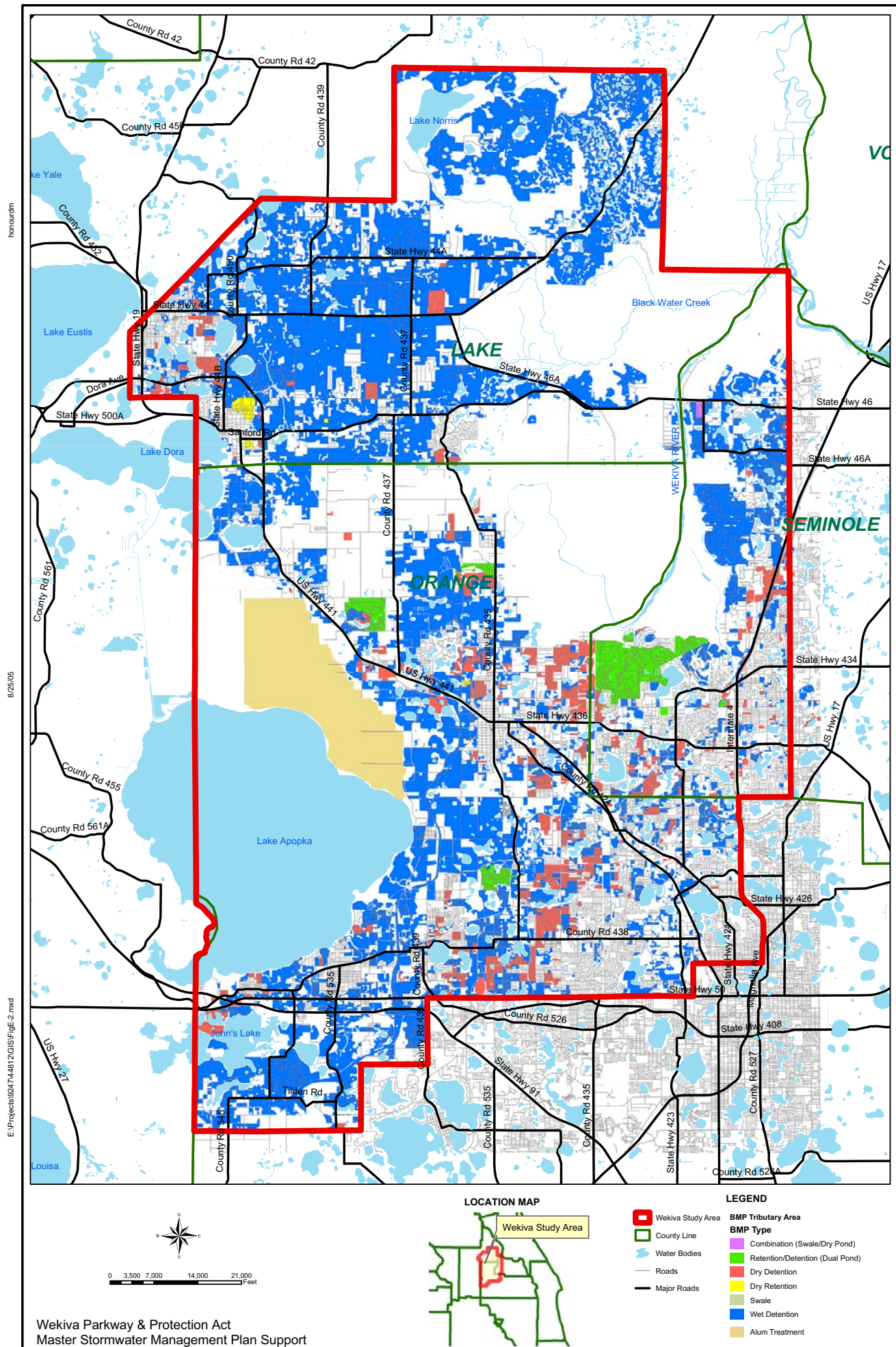


Table E-3
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Existing BMP Tributary Areas

Land Use	BMP Type	Acres Served	% of Land Use
Agriculture - Nurseries	alum treatment	376.43	6.72%
Agriculture - Pasture	alum treatment	5.63	0.03%
Agriculture - Tree Crops	alum treatment	0.03	0.00%
Forest/Open	alum treatment	8,463.36	10.00%
Industrial/utility	alum treatment	33.62	0.69%
Low Density Residential	alum treatment	1.77	0.01%
Major Roads	alum treatment	0.38	0.00%
Water Body	alum treatment	51.50	0.13%
Wetlands	alum treatment	145.57	0.29%
Agriculture - Pasture	Combination (Swale/Dry Pond)	1.23	0.01%
Forest/Open	Combination (Swale/Dry Pond)	1.78	0.00%
Major Roads	Combination (Swale/Dry Pond)	18.25	0.12%
Medium Density Residential	Combination (Swale/Dry Pond)	59.84	0.18%
Agriculture - Field Crops	dry detention	0.26	0.01%
Agriculture - Nurseries	dry detention	164.61	2.94%
Agriculture - Pasture	dry detention	12.93	0.07%
Agriculture - Row Crops	dry detention	6.94	1.06%
Agriculture - Specialty Farms	dry detention	8.84	0.97%
Agriculture - Tree Crops	dry detention	110.99	1.25%
Commercial	dry detention	539.50	8.37%
Forest/Open	dry detention	772.04	0.91%
General Agriculture	dry detention	0.00	0.00%
Golf Course	dry detention	72.28	2.67%
High Density Residential	dry detention	1,146.55	17.93%
Industrial/utility	dry detention	92.81	1.91%
Institutional	dry detention	148.38	5.99%
Low Density Residential	dry detention	724.19	4.55%
Major Roads	dry detention	1,426.06	9.06%
Medium Density Residential	dry detention	3,782.94	11.31%
Very Low Density Residential	dry detention	4.59	0.14%
Water Body	dry detention	42.34	0.11%
Wetlands	dry detention	65.79	0.13%
Agriculture - Tree Crops	retention	35.31	0.40%
Forest/Open	retention	61.98	0.07%
High Density Residential	retention	6.44	0.10%
Industrial/utility	retention	1.19	0.02%
Institutional	retention	19.58	0.79%
Low Density Residential	retention	8.77	0.06%
Major Roads	retention	5.30	0.03%
Medium Density Residential	retention	162.00	0.48%
Water Body	retention	2.61	0.01%
Wetlands	retention	1.13	0.00%

Table E-3
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Existing BMP Tributary Areas

Land Use	BMP Type	Acres Served	% of Land Use
Agriculture - Nurseries	Retention/Detention (Dual Pond)	0.02	0.00%
Agriculture - Specialty Farms	Retention/Detention (Dual Pond)	1.92	0.21%
Agriculture - Tree Crops	Retention/Detention (Dual Pond)	0.14	0.00%
Commercial	Retention/Detention (Dual Pond)	10.87	0.17%
Forest/Open	Retention/Detention (Dual Pond)	256.95	0.30%
Golf Course	Retention/Detention (Dual Pond)	294.87	10.89%
High Density Residential	Retention/Detention (Dual Pond)	49.22	0.77%
Industrial/utility	Retention/Detention (Dual Pond)	37.85	0.78%
Institutional	Retention/Detention (Dual Pond)	64.12	2.59%
Low Density Residential	Retention/Detention (Dual Pond)	362.19	2.28%
Major Roads	Retention/Detention (Dual Pond)	562.05	3.57%
Medium Density Residential	Retention/Detention (Dual Pond)	1,571.79	4.70%
Water Body	Retention/Detention (Dual Pond)	48.77	0.12%
Wetlands	Retention/Detention (Dual Pond)	102.67	0.20%
Agriculture - Tree Crops	swale	0.17	0.00%
Commercial	swale	1.98	0.03%
Forest/Open	swale	1.08	0.00%
High Density Residential	swale	0.44	0.01%
Industrial/utility	swale	0.05	0.00%
Institutional	swale	0.23	0.01%
Low Density Residential	swale	0.77	0.00%
Major Roads	swale	266.08	1.69%
Agriculture - Feeding Operations	wet detention	0.31	0.18%
Agriculture - Field Crops	wet detention	311.34	8.06%
Agriculture - Nurseries	wet detention	287.80	5.14%
Agriculture - Pasture	wet detention	1,071.56	5.44%
Agriculture - Tree Crops	wet detention	854.94	9.66%
Commercial	wet detention	736.33	11.42%
Forest/Open	wet detention	2,107.97	2.49%
General Agriculture	wet detention	21.19	26.91%
Golf Course	wet detention	885.35	32.68%
High Density Residential	wet detention	1,673.67	26.17%
Industrial/utility	wet detention	486.07	10.01%
Institutional	wet detention	148.40	5.99%
Low Density Residential	wet detention	537.41	3.38%
Major Roads	wet detention	2,306.15	14.66%
Medium Density Residential	wet detention	4,945.93	14.78%
Very Low Density Residential	wet detention	53.17	1.68%
Water Body	wet detention	465.52	1.19%
Wetlands	wet detention	793.23	1.58%

Table E-4
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Future BMP Tributary Areas

Land Use	BMP Type	Acres Served	% of Land Use
Agriculture - Nurseries	alum treatment	372.03	17.32%
Agriculture - Pasture	alum treatment	5.63	0.19%
Agriculture - Tree Crops	alum treatment	0.03	0.00%
Commercial	alum treatment	1.27	0.01%
General Agriculture	alum treatment	8422.66	43.39%
Industrial/utility	alum treatment	33.03	0.50%
Institutional	alum treatment	0.44	0.01%
Low Density Residential	alum treatment	1.77	0.00%
Major Roads	alum treatment	0.38	0.00%
Very Low Density Residential	alum treatment	0.05	0.00%
Water Body	alum treatment	43.83	0.10%
Wetlands	alum treatment	197.17	0.45%
Forest/Open	Combination (Swale/Dry Pond)	0.01	0.00%
Major Roads	Combination (Swale/Dry Pond)	18.23	0.11%
Medium Density Residential	Combination (Swale/Dry Pond)	59.80	0.17%
Very Low Density Residential	Combination (Swale/Dry Pond)	2.99	0.01%
Agriculture - Nurseries	dry detention	47.71	2.22%
Agriculture - Pasture	dry detention	0.09	0.00%
Agriculture - Tree Crops	dry detention	0.02	0.00%
Commercial	dry detention	608.76	4.68%
Forest/Open	dry detention	9.73	0.05%
General Agriculture	dry detention	55.83	0.29%
Golf Course	dry detention	72.23	2.67%
High Density Residential	dry detention	1148.34	16.15%
Industrial/utility	dry detention	156.76	2.38%
Institutional	dry detention	156.94	3.00%
Low Density Residential	dry detention	1325.30	3.26%
Major Roads	dry detention	1398.13	8.72%
Medium Density Residential	dry detention	3864.82	10.82%
Very Low Density Residential	dry detention	208.33	0.45%
Water Body	dry detention	40.32	0.09%
Wetlands	dry detention	16.32	0.04%
Commercial	retention	0.14	0.00%
Forest/Open	retention	5.48	0.03%
High Density Residential	retention	6.44	0.09%
Industrial/utility	retention	1.19	0.02%
Institutional	retention	39.74	0.76%
Low Density Residential	retention	81.57	0.20%
Major Roads	retention	5.29	0.03%
Medium Density Residential	retention	161.97	0.45%
Water Body	retention	1.84	0.00%
Wetlands	retention	0.44	0.00%

Table E-4
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Future BMP Tributary Areas

Land Use	BMP Type	Acres Served	% of Land Use
Agriculture - Tree Crops	Retention/Detention (Dual Pond)	0.14	0.01%
Commercial	Retention/Detention (Dual Pond)	10.87	0.08%
Forest/Open	Retention/Detention (Dual Pond)	28.46	0.15%
General Agriculture	Retention/Detention (Dual Pond)	0.00	0.00%
Golf Course	Retention/Detention (Dual Pond)	294.67	10.88%
High Density Residential	Retention/Detention (Dual Pond)	49.18	0.69%
Industrial/utility	Retention/Detention (Dual Pond)	37.68	0.57%
Institutional	Retention/Detention (Dual Pond)	89.41	1.71%
Low Density Residential	Retention/Detention (Dual Pond)	509.71	1.26%
Major Roads	Retention/Detention (Dual Pond)	561.67	3.50%
Medium Density Residential	Retention/Detention (Dual Pond)	1592.42	4.46%
Very Low Density Residential	Retention/Detention (Dual Pond)	46.31	0.10%
Water Body	Retention/Detention (Dual Pond)	29.82	0.07%
Wetlands	Retention/Detention (Dual Pond)	110.78	0.25%
Commercial	swale	2.41	0.02%
Forest/Open	swale	0.00	0.00%
General Agriculture	swale	0.34	0.00%
High Density Residential	swale	0.47	0.01%
Industrial/utility	swale	0.06	0.00%
Institutional	swale	0.33	0.01%
Low Density Residential	swale	1.05	0.00%
Major Roads	swale	265.90	1.66%
Medium Density Residential	swale	0.01	0.00%
Water Body	swale	0.02	0.00%
Agriculture - Field Crops	wet detention	1.14	0.31%
Agriculture - Nurseries	wet detention	0.76	0.04%
Agriculture - Pasture	wet detention	2.01	0.07%
Agriculture - Tree Crops	wet detention	0.63	0.06%
Commercial	wet detention	6656.86	51.21%
Forest/Open	wet detention	93.89	0.49%
General Agriculture	wet detention	62.32	0.32%
Golf Course	wet detention	884.75	32.66%
High Density Residential	wet detention	2247.25	31.60%
Industrial/utility	wet detention	2685.10	40.84%
Institutional	wet detention	2585.14	49.38%
Low Density Residential	wet detention	22985.08	56.60%
Major Roads	wet detention	2471.53	15.42%
Medium Density Residential	wet detention	6878.63	19.26%
Very Low Density Residential	wet detention	40291.52	87.89%
Water Body	wet detention	229.96	0.54%
Wetlands	wet detention	650.55	1.49%

Table E-5
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
BMP Removal Efficiencies (%) Used In WMM

Parameter	Dry Detention	Wet Detention	Retention ⁽⁴⁾	Dual Pond (Off-line Retention/Detention) ⁽⁵⁾	Swale	Swale/Dry Detention ⁽⁶⁾	Alum Treatment
BOD (1)	30	30	90	90	30	45	N/A
BOD (2)	40	55	90	80	N/A	N/A	75
COD (1)	30	30	90	90	30	40	N/A
COD (2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TSS (1)	90	90	90	95	80	85	N/A
TSS (2)	70	85	90	90	N/A	N/A	90
TDS (1)	0	40	90	90	10	10	N/A
TDS (2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total -P (1)	30	50	90	90	40	40	N/A
Total -P (2)	25	65	90	85	N/A	N/A	N/A
Total -P (3)	N/A	N/A	N/A	N/A	N/A	N/A	60
Dissolved P (1)	0	70	90	95	10	10	N/A
Dissolved P (2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dissolved P (3)	N/A	N/A	N/A	N/A	N/A	N/A	88
TKN (1)	20	30	90	90	40	45	N/A
TKN (2)	N/A	37	90	80	N/A	N/A	N/A
NO2+NO3 (1)	0	30	90	90	40	40	N/A
NO2+NO3 (2)	N/A	80	90	90	N/A	N/A	N/A
Total N (1)	N/A	N/A	N/A	90	40*	30	N/A
Total N (2)	15	25	90	60	N/A	N/A	50
Lead (1)	80	80	90	95	75	80	N/A
Lead (2)	60	75	90	75	N/A	N/A	N/A
Copper (1)	60	70	90	90	50	60	N/A
Copper (2)	35	60	90	65	N/A	N/A	80
Zinc (1)	50	50	90	90	50	70	N/A
Zinc (2)	70	85	90	85	N/A	N/A	90
Cadmium (1)	80	80	90	95	65	85	N/A
Cadmium (2)	N/A	N/A	N/A	N/A	N/A	N/A	80

N/A - Not Available

(1) Average of values from Table E-1

(2) Literature Values from "Pollutant Removal Efficiencies for Typical Stormwater Management Systems in Florida", Harper, 1999

(3) SJRWMD measured values for P removal associated with Lake Apopka Restoration

(4) Values cited for retention removal in Harper's 1999 study were for 0.25-in., 0.5-in, 0.75-in, 1.0-in and 1.25-in retention; values shown in table are for 0.75-in retention.

(5) Estimated from efficiencies for a combination of wet detention and retention

(6) Estimated from efficiencies for a combination of swale and dry detention

E.3.3 Event Mean Concentration Values

Due to the large number of local governments included within the WSA, it was necessary to gain consensus on an acceptable set of EMCs for the study area. Additionally, the WPPA (Section 369.318, F.S.) requires the SJRWMD to develop a pollution load reduction goal (PLRG) for the WSA and the information regarding EMCs in this subsection may be useful to the SJRWMD for that effort. CDM performed an extensive literature review and compiled EMC values for the Central Florida area. Studies and reports that were consulted as part of this effort include:

- *Stormwater Loading Rate Parameters for Central and South Florida* (Harper, 1994);
- *Pollutant Load Reduction Goals for Seven Major Lakes in the Upper Ocklawaha River Basin* (Technical Publication SJ2004-5);
- *Draft Nutrient Total Maximum Daily Load For Trout Lake, Lake County, Florida* (FDEP, 2004);
- Pollutant Load Spreadsheet Model Expanded Land Use Parameters, Indian River Lagoon and Lower St. Johns (SJRWMD, date unknown);
- SJRWMD Lake Jesup HSPF Modeling (SJRWMD, date unknown);
- EMC values from the Orange County's NPDES MS4 Part 2 Permit Application (PBS&J, 1993);
- Seminole County EMC values; and
- Southeastern United States Regional EMC database (CDM, 2001).

CDM developed a spreadsheet that shows the land uses where EMC data were available for the 12 USEPA indicator pollutants. As there is variance in reported EMC values depending on the study, CDM worked with the Stakeholders to develop a methodology to assign a set of EMCs for the WSA. The resulting EMC table is provided in **Table E-6**. This table shows the values identified from various studies as well as the selected values used in the WMM analysis based on feedback from the Stakeholders and the methodology described below. A large majority of the EMCs used came from Harper's *Stormwater Loading Rate Parameters for Central and South Florida* (1994). Based on communication with the SJRWMD, it is understood that additional work is on-going and may provide more refined EMCs for this specific application in the future.

Table E-6
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Event Mean Concentrations

	General Agriculture	Study Land Use	BOD mg/l	COD mg/l	TSS mg/l	TDS mg/l	TP mg/l	DP mg/l	TKN mg/l	NO2/NO3 mg/l	TN mg/l	Pb mg/l	Cu mg/l	Zn mg/l	Cd mg/l
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - NPSLAM (1993)		N/A													
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - Sampling Event Data (1993)		N/A													
	Seminole County	Agricultural/Golf Course	3.80	51.00	55.30	100.00	0.34	0.23	1.74	0.58	2.32	0.00	0.00	0.00	0.00
	Harvey Harper, 1994	General Agriculture	3.80		55.30		0.34				2.32	0.00		0.00	
	Other Local Studies (Average)	Agriculture					0.34				2.74				
	Southeast	Agriculture/Pasture*	13.20	70.00	50.00	113.00	0.14	0.12	0.87	0.28	1.15	0.01	0.00	0.02	0.00
		Choice	3.80	51.00	55.30	100.00	0.34	0.23	1.74	0.58	2.32	0.01	0.00	0.02	0.00
	Feeding Operations						6.53				78.23				
	Indian River Lagoon PLRGs (SJRWMD)	Feed Lots			59.40		1.13				3.74				
		Choice	3.80	51.00	59.40	100.00	6.53	0.23	1.74	0.58	78.23	0.01	0.00	0.02	0.00
	Nurseries														
	Indian River Lagoon PLRGs (SJRWMD)	Nurseries			22.00		0.57				2.30				
		Choice	3.80	51.00	22.00	100.00	0.57	0.23	1.74	0.58	2.30	0.01	0.00	0.02	0.00
	Pasture														
	UORB PLRG (SJ 2004-5)	Pasture					0.39				2.48				
	Harvey Harper, 1994	Pasture	5.10		94.30		0.48				2.48				
	Indian River Lagoon PLRGs (SJRWMD)	Improved Pasture			30.10		0.58				2.70				
		Choice	5.10	51.00	94.30	100.00	0.48	0.23	1.74	0.58	2.48	0.01	0.00	0.02	0.00
	Field Crops														
	UORB PLRG (SJ 2004-5)	Cropland					0.67				4.56				
	Harvey Harper, 1994	N/A			15.70		0.27				2.52				
	Indian River Lagoon PLRGs (SJRWMD)	Field Crops													
		Choice	3.80	51.00	15.70	100.00	0.27	0.23	1.74	0.58	2.52	0.01	0.00	0.02	0.00
	Row Crops														
	UORB PLRG (SJ 2004-5)	Cropland					0.67				4.56				
	Harvey Harper, 1994	Row Crops			15.70		0.56				2.68				
	Indian River Lagoon PLRGs (SJRWMD)	Field Crops					0.27				2.52				
	Indian River Lagoon PLRGs (SJRWMD)	Row Crops			55.30		1.00				4.56				
		Choice	3.80	51.00	55.30	100.00	0.56	0.23	1.74	0.58	2.68	0.01	0.00	0.02	0.00
	Specialty Farms														
	Indian River Lagoon PLRGs (SJRWMD)	Stables/Dairy/Aquaculture			40.63		0.49				2.34				
		Choice	3.80	51.00	40.63	100.00	0.49	0.23	1.74	0.58	2.34	0.01	0.00	0.02	0.00
	Tree Crops														
	UORB PLRG (SJ 2004-5)	Tree Crops					0.14				2.05				
	Harvey Harper, 1994	Citrus	2.55		16.30		0.14				2.05				
	Indian River Lagoon PLRGs (SJRWMD)	Citrus			30.50		0.51				1.92				
		Choice	2.55	51.00	16.30	100.00	0.14	0.23	1.74	0.58	2.05	0.01	0.00	0.02	0.00
	Commercial														
	Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - NPSLAM (1993)	Commercial/Office	12.70	55.00	87.65	174.00	0.29	0.18	1.14		0.20	0.18	0.11	0.14	0.03
	Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - Sampling Event Data (1993)	Commercial/Office	2.33	19.67	3.33	93.33	0.05	0.04	0.49		0.06	0.05	0.03	0.04	0.01
		Commercial	7.80	53.00	42.50	141.00	0.20	0.09	1.03	0.67	1.70	0.01	0.02	0.07	0.00
	Seminole County	Low Intensity Commercial	8.20		81.00		0.15				1.18	0.14		0.11	
	Harvey Harper, 1994	High Intensity Commercial	17.20		94.30		0.43				2.83	0.21		0.17	
	Other Local Studies (Average)	Commercial					0.24				1.80				
	Southeast	Commercial	6.60	45.00	54.00	57.50	0.14	0.06	0.83	0.41	1.24	0.01	0.01	0.05	0.00
		Choice	12.70	54.00	87.65	157.50	0.29	0.14	1.08	0.67	2.01	0.18	0.06	0.14	0.02

Table E-6
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Event Mean Concentrations

			BOD mg/l	COD mg/l	TSS mg/l	TDS mg/l	TP mg/l	DP mg/l	TKN mg/l	NO2/NO3 mg/l	TN mg/l	Pb mg/l	Cu mg/l	Zn mg/l	Cd mg/l
Industrial															
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - NPSLAM (1993)	Industrial		9.60	55.00	93.90	174.00	0.31	0.13	1.79		0.27	0.20	0.12	0.12	0.04
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - Sampling Event Data (1993)	N/A														
Seminole County	Industrial/Utility		14.00	83.00	77.00	130.00	0.28	0.20	1.47	0.40	1.87	0.02	0.02	0.13	0.00
Harvey Harper, 1994	Industrial		9.60		93.90		0.31				1.79	0.20		0.12	
Other Local Studies (Average)	Industrial						0.28				1.85				
Southeast	Heavy Industrial		6.50	39.20	60.00	66.50	0.15	0.05	1.00	0.49	1.49	0.01	0.01	0.04	0.00
	Choice		9.60	69.00	93.90	152.00	0.31	0.17	1.63	0.40	1.79	0.20	0.07	0.12	0.02
Institutional															
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - NPSLAM (1993)	N/A														
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - Sampling Event Data (1993)	N/A														
Seminole County	Institutional		7.30	49.90	41.20	114.10	0.15	0.08	1.24	1.05	2.29	0.01	0.02	0.08	0.00
Other Local Studies (Average)	Institutional						0.48				1.80				
Southeast	N/A														
	Choice		7.30	49.90	41.20	114.10	0.15	0.08	1.24	1.05	2.29	0.01	0.02	0.08	0.00
Forest/Open															
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - NPSLAM (1993)	Undeveloped		1.45	55.00	11.10	174.00	0.53	0.00	1.25		0.19	0.03	0.02	0.01	0.01
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - Sampling Event Data (1993)	Undeveloped		3.00	50.00	3.33	95.33	0.07	0.07	1.39		0.11	0.05	0.02	0.01	0.01
Seminole County	Open		1.50	51.00	11.00	100.00	0.05	0.00	0.94	0.31	1.25	0.00	0.00	0.00	0.00
Harvey Harper, 1994	Open		1.45		11.10		0.05				1.25	0.03		0.01	
Other Local Studies (Average)	Open						0.08		0.87	0.17	1.04	0.01	0.01	0.01	0.00
Southeast	Forest/Open		10.30	70.00	25.00	216.00	0.28	0.15	0.87						
	Choice		1.45	53.00	11.10	137.00	0.05	0.00	1.10	0.31	1.25	0.03	0.01	0.01	0.00
Very Low Density Residential															
Harvey Harper, 1994	Low Density Residential*		4.40		19.10		0.18				1.77	0.04		0.03	
	Choice		4.40	54.51	19.10	136.75	0.18	0.15	1.22	0.47	1.77	0.04	0.02	0.03	0.00
*Lot sizes are generally defined as greater than 1 acre or less than 1 DU/acre															
Low Density Residential															
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - NPSLAM (1993)	Low Density Residential		5.60	41.25	29.27	136.50	0.64	0.30	1.33		0.24	0.06	0.04	0.04	0.01
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - Sampling Event Data (1993)	Low Density Residential		4.00	31.67	22.67	92.33	0.33	0.33	1.07		0.26	0.05	0.03	0.04	0.01
Seminole County	Low Density Residential		15.10	70.80	26.60	286.00	0.44	0.33	1.34	0.63	1.97	0.00	0.01	0.05	0.00
Harvey Harper, 1994	Single Family Residential		7.40		27.00		0.30				2.29	0.05		0.06	
Other Local Studies (Average)	Low Density Residential						0.14		0.87	0.28	1.15	0.01	0.00	0.02	0.00
Southeast	Low Density Residential		13.20	70.00	50.00	74.00	0.14	0.03	0.87						
	Choice		7.40	56.03	27.00	136.50	0.30	0.30	1.34	0.63	2.29	0.05	0.02	0.04	0.01
Medium Density Residential															
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - NPSLAM (1993)	N/A														
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - Sampling Event Data (1993)	N/A														
Seminole County	Medium Density Residential		9.20	64.60	58.80	58.80	0.45	0.27	1.77	0.27	2.04	0.01	0.01	0.06	0.00
Harvey Harper, 1994	N/A														
Other Local Studies (Average)	Medium Density Residential						0.26				1.85				
Southeast	Medium Density Residential		9.40	50.00	48.00	70.00	0.27	0.10	1.22	0.46	1.68	0.01	0.01	0.03	0.00
	Choice		9.20	58.45	49.35	157.88	0.40	0.40	1.48	0.65	2.36	0.07	0.03	0.05	0.01

Table E-6
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Event Mean Concentrations

			BOD mg/l	COD mg/l	TSS mg/l	TDS mg/l	TP mg/l	DP mg/l	TKN mg/l	NO2/NO3 mg/l	TN mg/l	Pb mg/l	Cu mg/l	Zn mg/l	Cd mg/l
High Density Residential		Study Land Use													
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - NPSLAM (1993)		High Density Residential	9.30	68.75	48.80	217.50	1.05	0.50	2.22		0.39	0.10	0.06	0.06	0.02
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - Sampling Event Data (1993)		High Density Residential													
Seminole County		High Density Residential	3.33	24.00	3.67	92.33	0.19	0.34	0.60		0.33	0.05	0.03	0.02	0.01
Harvey Harper, 1994		High Density Residential	7.80	53.00	42.50	141.00	0.49	0.09	1.03	0.67	1.70	0.01	0.02	0.07	0.00
Other Local Studies (Average)		Multi-Family Residential	11.00		71.70		0.49				2.42	0.09		0.06	
Southwest		High Density Residential					0.38				2.15				
		High Density Residential	9.60	53.50	38.00	49.50	0.19	0.17	1.01	0.40	1.41	0.01	0.01	0.08	0.00
		Choice	11.00	60.88	71.70	179.25	0.49	0.50	1.63	0.67	2.42	0.09	0.04	0.06	0.01
Highways															
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - NPSLAM (1993)		Major Roads	9.04	55.00	79.13	174.00	0.49	0.18	1.75		0.30	0.15	0.09	0.10	0.03
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - Sampling Event Data (1993)		Major Roads													
Seminole County		Major Roads	3.17	47.67	18.55	179.50	0.48	0.44	1.80		0.14	0.05	0.03	0.02	0.01
Harvey Harper, 1994		Major Roads	14.00	83.00	77.00	130.00	0.28	0.20	1.47	0.40	1.87	0.02	0.02	0.13	0.00
Other Local Studies (Average)		Transportation	5.60		50.30		0.34				2.08	0.19		0.13	
Southwest		Transportation					0.45				2.01				
		Major Highways	14.00	114.00	287.00	57.50	0.44	0.40	1.83	0.76	2.59	0.40	0.05	0.33	0.00
		Choice	5.60	69.00	50.30	152.00	0.34	0.19	1.61	0.40	2.08	0.19	0.06	0.13	0.01
Water															
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - NPSLAM (1993)		N/A													
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - Sampling Event Data (1993)		N/A													
Seminole County		Water/Wetlands	3.20	16.80	6.20	100.00	0.17	0.09	0.60	0.19	0.79	0.01	0.05	0.15	0.00
Harvey Harper, 1994		Water	1.60		3.10		0.11				1.25	0.03		0.03	
Other Local Studies (Average)		Water					0.07				0.66				
Southwest		Water	3.10	22.00	5.00	100.00	0.09	0.02	1.10	0.20	1.30	0.01	0.00	0.01	0.00
		Choice	1.60	16.80	3.10	100.00	0.11	0.02	0.60	0.19	1.25	0.01	0.05	0.03	0.00
Wetlands															
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - NPSLAM (1993)		N/A													
Orange County, Florida Part 2 Joint MS4 Permit Application Regional Data - Sampling Event Data (1993)		N/A													
Seminole County		Water/Wetlands	3.20	16.80	6.20	100.00	0.17	0.09	0.60	0.19	0.79	0.01	0.05	0.15	0.00
Harvey Harper, 1994		Wetlands	4.63		10.20		0.19				1.60	0.03		0.01	
Other Local Studies (Average)		Wetlands					0.24				1.27				
Southwest		Wetlands	5.00	51.00	5.00	100.00	0.10	0.02	1.10	0.40	1.50	0.01	0.00	0.01	0.00
		Choice	4.63	51.00	10.20	100.00	0.19	0.09	1.10	0.40	1.60	0.03	0.05	0.01	0.00

N/A - Not Available

Harper, 1994

The average of Orange (regional values identified in the NPDES Part 2 Permit Application) and Seminole County's EMCs
The values from the southeast regional database were used as the other values reported were 0.000

The choice for General Agriculture

Indian River Lagoon PLRGs (SJRWMD)

Pollutant Load Reduction Goals for Seven Major Lakes in the Upper Ocklawaha River Basin (Technical Publication SJ2004-5)

Average of Harper's values for Low and High Intensity Commercial land uses.

Average of the Open and Low Density Residential choices

Orange County regional values

Average of Orange County (regional) and Seminole County values were used instead of Harper's values

Average of Low Density and High Density Residential choices

Seminole County value was used

The southeast U.S. regional value was used

The methodology for the EMC selection criteria is presented as follows:

- 1) Where values from the *Stormwater Loading Rate Parameters for Central and South Florida* (Harper, 1994) were available, those were used as the recommended choice (highlighted as Light Yellow in Table E-6).
- 2) If Harper's numbers were not available, the average of Orange County's (regional values identified in the NPDES Part 2 Permit Application) and Seminole County's EMCs were used. (highlighted as Light Green in Table E-6).
- 3) In very few cases Harper's numbers were outside the range of all the other reported values, so the average of Orange County (regional) and Seminole County values were used (i.e., Low Density Residential for Zn) (highlighted as Light Blue in Table E-6).
- 4) In some cases where Harper's data were not available and some of the Seminole County EMCs had high variability from Low Density Residential to High Density Residential, then the Orange County values were used (i.e., Low Density Residential for TDS & DP; High Density Residential for DP) (highlighted as Orange in Table E-6).
- 5) For Medium Density Residential, there was only 1 complete dataset available (Seminole County). Therefore, the average of Low Density and High Density Residential choices was used to obtain a value for Medium Density Residential EMCs (highlighted as Pink in Table E-6).
- 6) For metals under General Agriculture, the values from the Southeastern United States Regional EMC database (CDM, 2001) were used as the other values reported were 0.000 (highlighted as Purple in Table E-6).
- 7) For the Water land use for Pb, Harper's values note that the same value used for Wetlands was also applied to the Open Water land use. Therefore, the Seminole County value was used for this constituent (highlighted as Grey in Table E-6).
- 8) For some cases for the Wetlands and Water land uses, where only a value for Seminole County is reported and it is identical for both land uses, the Southeastern United States Regional EMC database (CDM, 2001) value was used (highlighted as Green in Table E-6).
- 9) For Commercial land use, Harper reports values for both Low and High Intensity Commercial land uses. Low Intensity Commercial land uses are defined as "...areas that receive only a moderate amount of traffic volume and areas where cars may be parked during the day.

High Intensity Commercial is defined in Harper's study as "commercial areas with constant traffic moving in and out of area...and are assumed to be represented by typical downtown areas which contain commercial sites, office buildings and associated parking lots." Therefore, since there seems to be a mixture of these two types of commercial land use throughout the study area, the average of the two were used (highlighted as Turquoise in Table E-6).

- 10) A new land use was added for Very Low Density Residential. Very Low Density Residential is generally defined as lot sizes greater than 1-acre or less than one dwelling unit/acre. Based on review of the land use coverages for the study area, large acreages of this type of land use are prevalent, more so in Lake County under future land use conditions. Harper also included this type of land use in his analysis. Since no site specific data were available for this land use, he averaged the values for Open and Low Density Residential land uses to arrive at these values. Where Harper's values were available, these were used as the choice in the accompanying table. Where values were not available, the same methodology of averaging the Open and Low Density Residential choices shown in the table was applied (highlighted as Fuchsia in Table E-6).
- 11) The comment was raised by the Stakeholders that the choice selected for TN should equal the sum of the choices for TKN and NO₂+NO₃. In almost all cases, there was a more complete set of values available for TN versus TKN and NO₂+NO₃. Where Harper's values were available for TN, these were used. There are two cases where Harper's values were not available (Institutional & Medium Density Residential). In the case of Institutional, the TN choice is already equal to the sum of the TKN and NO₂+NO₃ choices. For Medium Density Residential land use criteria 5 above applies.
- 12) Due to the variability in EMCs for different types of agriculture operations, agriculture land uses in addition to "General Agriculture" were taken into consideration. This is especially important in Lake County, as much of the land area is devoted to agriculture. The land use coverages were revisited and the Lake County FLUCCS codes were used to determine each type of agricultural operation (i.e., Feeding Operations, Nurseries, Pasture, Row Crops, Specialty Farms and Tree Crops). As before, Harper's values were used where available. When Harper's values were not available, the EMCs from the *Pollutant Load Reduction Goals for Seven Major Lakes in the Upper Ocklawaha River Basin* (Technical Publication SJ2004-5) were used as this study was specific to the Lake County area (highlighted as Light Orange in Table E-6). When neither of those two was available, the SJRWMD values from the

Indian River Lagoon PLRG work were used (highlighted as Red in Table E-6). These values are largely based on the results of a literature search of studies performed mostly throughout the State of Florida. Where no values were available, the choices for General Agriculture were used (highlighted as Dark Pink in Table E-6).

E.3.4 Rainfall Data

Annual rainfall data for the WSA was discussed in Section 2.7 of the MSMP. CDM summarized historical rainfall data obtained from the National Oceanic & Atmospheric Administration (NOAA) rainfall stations. CDM obtained and reviewed a listing of these stations along with their associated data. This list was then narrowed down to those stations with a long-term period of record (i.e., 15 years and greater) and complete data sets. This list of NOAA stations along with their period of record and long-term monthly average rainfall data was provided in Table 2-3. Based on the values shown in this table, an annual rainfall of 50.3 inches was used in the WMM analysis. As seasonal EMCs were not available for this analysis, CDM estimated the seasonal rainfall to approximate loadings during the wet and dry seasons. From Table 2-3, the average annual rainfall for the wet season (June through September) is 27.9 inches and for the dry season (October through May) it is 22.4 inches.

E.3.5 Septic Tank Usage

Septic tanks are still used in many areas of the WSA for sewage disposal, primarily in older residential areas and rural areas where sanitary sewer services are not readily available. To identify those areas where septic tanks are used, a variety of sources were consulted. Seminole County and the City of Orlando provided a septic tank coverage in GIS format. The majority of the City of Altamonte Springs is served by sanitary sewer based on a wastewater GIS coverage provided by the City. Septic tank information for Orange County was obtained from the Orange County Utility Master Plan (PBS&J, 2001). In this study, it was presumed that all areas currently not served by sanitary sewer are served by septic tanks. The GIS coverage reflecting this was obtained and used as part of the WMM analysis. Additionally, Lake County provided a point coverage of those parcels served by septic tanks within the WSA.

Upon inspection of the GIS data obtained, specifically for Seminole County, there were many subdivisions in the County where only some parcels within the subdivision were shown to be on septic systems. However, these subdivisions were also not served by sanitary sewer based on the GIS coverage provided by the County. CDM reviewed these areas along with the 1990 census data and evaluated the entire subdivision as served by septic systems if no sanitary sewer lines were shown servicing the area. The 1990 census data were used because this type of information was not surveyed for the 2000 census. The 1990 census long form inquired if homes were served by septic tanks or sanitary sewer systems. These data are available by census tract and block group at the U.S. Census web page. By making the

determinations previously described, the resulting changes reflected something closer to the values reported in the census data. Using the data sources previously mentioned, CDM estimated that approximately 51,400 identified parcels within the WSA are served by septic systems. The resulting septic tank coverage with the assumptions incorporated is shown in **Figure E-3**.

E.3.5.1 Septic Tank Failure

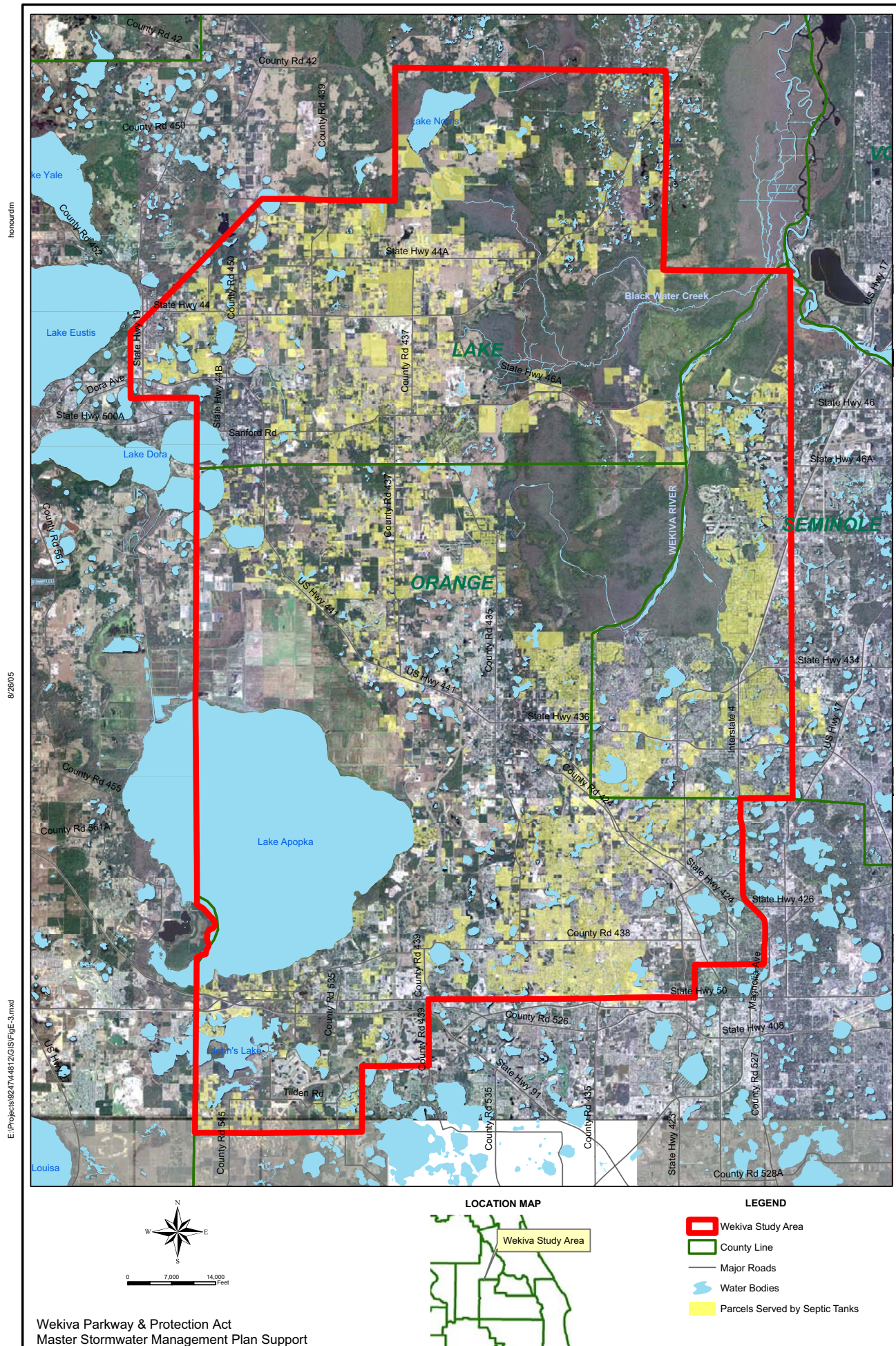
The WMM assesses the impact of failing septic tanks by applying a multiplication factor to the surface runoff load. This multiplication factor was applied only to the phosphorus (dissolved P, total P) and nitrogen (TKN, NO₂+NO₃) parameters. The factor used for the phosphorus and nitrogen parameters was 2.1 and 2.0, respectively (i.e., nitrogen load for a residential area with failing septic tanks is estimated to be 2.0 times the load from a residential area without failing septic tanks).

To assess the increase in surface runoff load due to failing septic tanks, the WMM considers the multiplication factor (discussed above), the percent septic tank coverage, and the percent failure rate. Although the definition of “failure” varies, national failure rates average 19 percent (EPA, 2002) and range from a high of 50-70 percent (Minnesota) to low of 0.4 percent (Wyoming), with Florida reported as 1-2 percent. The Florida Department of Health (DOH) had provided some feedback on failure rates and reported that for Florida it is typically less than the 1-3 percent reported in the *Forecasting Onsite Soil Absorption System Failure Rates* (USEPA, 1986).

Assessing the Densities and Potential Water Quality Impacts Of Septic Tank Systems in the Peace and Myakka River Basins (Charlotte Harbor National Estuary Program, 2003) states that it is unclear if this number represents the total number of failures at any time, or the annual number of repair permits issued. The EPA’s 1986 guidance manual (*Forecasting Onsite Soil Absorption System Failure Rates*) acknowledged that many failures go unreported. Modeling guidelines developed for EPA’s Rouge River demonstration project (CDM, 1998) suggest homeowners ignore signs of failure for 5 years before completing repairs, resulting in a range of 5-10 percent failures for Florida. This value is consistent with a Department of Health study conducted in Jacksonville where site inspections were conducted at 800 facilities and found an 11 percent failure rate.

Based on the information found for failure rates in Florida and feedback from the DOH, a failure rate of 1 percent was used in the WMM analysis. As a wide variation of failure rates have been reported, CDM also did a limited sensitivity analysis to show the impact of varying the failure on the overall pollutant load.

Using a failure rate of 1 percent, the maximum increase in nitrogen loading from a residential area with 100 percent septic tank coverage and a 1 percent failure rate, is 1 percent over the base load:



$(2.0 \times 1\% / 100\%) + (1 - 1\% / 100\%) = 0.2 + 0.9 = 1.01$, or 1% increase over the case without septic tanks)

It is important to emphasize that although the WMM includes a septic routine, it does not address all aspects of septic loading, such as loading estimates from “working” systems.

Based on the septic tank data obtained from the Stakeholders, there was a percentage of the WSA served by septic tanks that was identified as non-residential (i.e., commercial, industrial and institutional). Typically the septic tank routine in WMM has been used to assess the impacts from residential areas. Little to no data were available regarding the use of septic tanks for non-residential areas. It was assumed that these land uses typically have greater disposal rates than those of residential, due to the higher volume of occupants in the facilities associated with these land uses. Therefore, the higher end of the range of percent increases in annual per acre loadings presented in Section 4.2.5 was used for these types of land uses.

The recent study prepared by the Florida DOH for the WSA entitled the *Wekiva Basin Onsite Sewage Treatment and Disposal System Study* (2004) recommended that the highest priority for sewerage should be given to areas with high densities of systems within the WAVA Primary and Secondary Protection Zones. For septic tanks, the study recommends the following: 1) a discharge limit of 10 mg/l of total nitrogen for new systems, systems being modified, and for existing systems within the WAVA Primary and Secondary Protection Zones; 2) state and local planning agencies evaluate the economic feasibility of sewerage versus nutrient removal upgrades to existing onsite sewage treatment and disposal systems (OSTDSs) (areas with high densities of development will be better suited to central sewerage and lower density areas more suitable for nitrogen-removing OSTDSs); 3) failed or modified systems within the WSA be upgraded to meet new system standards; and 4) new regional wastewater management entities be established or that existing ones be modified to oversee the maintenance of all wastewater discharged from OSTDSs in the WSA.

E.3.6 Point Source Discharges

Three point source discharges associated with wastewater treatment plants (WWTPs), were identified in the WSA. One point source exists along the main stem of the Little Wekiva River and is associated with the Swofford WWTP and water reclamation facility operated by the City of Altamonte Springs. The outfall from this plant is located just upstream of this confluence of the Little Wekiva River and tributary from Spring Lake. Monthly discharge monitoring reports (DMRs) from February, 1997 through December, 2003 were obtained from the WWTP. Discharge data were available for flow and concentrations of BOD, TP and TSS. Overall, the average values for the period of record are included below in **Table E-7**. The City of Altamonte Springs is currently pursuing a regional project to remove discharges to the Little Wekiva River in favor of providing reclaimed water to the City of Apopka.

Table E-7
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Average Discharge Monitoring Data from the Swofford WWTP

	Flow (mgd)	CBOD5 (mg/L)	TSS (mg/L)	Phosphorus, Total as P (mg/L as P)
Annual Flow	0.85	1.25	0.58	1.38

The Wekiva Hunt Club WWTP in Seminole County was also identified as a point source discharge. This facility discharges to Sweetwater Creek which eventually discharges to the Wekiva River. Point source loadings from this facility were documented in the *Sweetwater Cove Tributary Surface Water Restoration Project Phase 2 Restoration Plan* (ERD, 2005). Chemical characteristics of discharges from the Wekiva Hunt Club WWTP that were used in the WMM analysis are provided in **Table E-8**.

Table E-8
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Monitoring Data from the Wekiva Hunt Club WWTP

	Flow (mgd)	NO ₃ (mg/L)	TN (mg/L)	TP (mg/l)	TSS (mg/l)	BOD (mg/l)
Annual Flow	1.7	8.7	10.9	0.15	0.98	1.96

Lastly, the City of Winter Garden's WWTP discharges from the underdrain system of and land application system (i.e., percolation pond site) to an unnamed ditch, then through approximately one (1) mile of wetlands and swamp to Lake Apopka. Chemical characteristics of the treated effluent (i.e., annual average of selected constituents) discharged from the percolation pond were obtained from FDEP's Domestic Wastewater Facility Permit issued to the City and are summarized in **Table E-9**.

Table E-9
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Discharge Effluent Levels from the City of Winter Garden WWTP

	Flow (mgd)	TN (mg/L)	TP (mg/l)	DO (mg/l)
Annual Flow	1.05	2.45	0.17	5.81

E.4 WMM Results

The WMM was used to evaluate the major subbasins identified in sub-section 2.6.1 under existing and future land use conditions to estimate both annual and seasonal pollutant loads. The summary of the scenarios evaluated for the 102 major subbasins are listed as follows:

- Existing Land Use – Annual
- Existing Land Use – Dry Season
- Existing Land Use – Wet Season
- Future Land Use – Annual
- Future Land Use – Dry Season
- Future Land Use – Wet Season

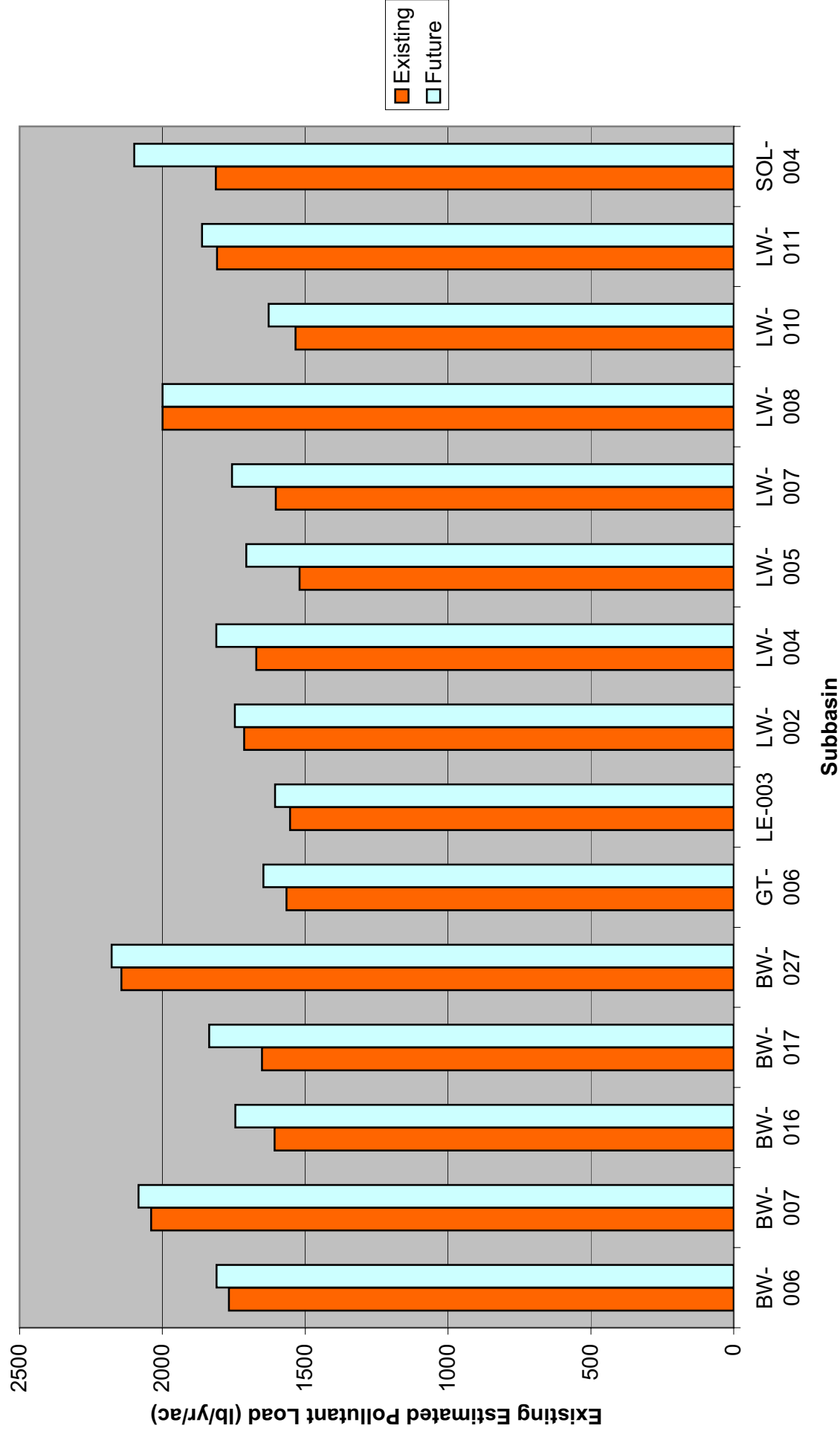
The results of the WMM analysis for both existing and future land use conditions with BMPs considered and a septic tank failure rate of 1 percent under annual rainfall are included in **Tables E-10 through E-15**, which is located at the end of this section. Pollutant loading estimates are calculated in units of lbs/yr. However, when comparing subbasins using these units, the size of the subbasin has a large effect on the estimated load (i.e., one will typically see larger pollutant loads associated with larger subbasins). Therefore, in an effort to normalize the estimates, the loading rate was calculated using the subbasin tributary area (i.e., lb/ac/yr). This provides a better basis for comparison to determine where the generated loads are more concentrated. A discussion of the results is provided in the following subsections.

E.4.1 Existing Land Use

Due to the number of subbasins evaluated, the discussion has been narrowed to the top 15 that are estimated to generate the highest pollutant loads. As mentioned earlier, existing land use conditions with BMPs and a 1 percent failure rate assumed for septic systems was simulated using the WMM. The top 15 estimated annual pollutant loading rates (lb/yr/ac) are shown in **Figure E-4**. For comparison purposes, the estimated loading rate under future conditions is also shown. The watersheds that encompass these subbasins include:

- Big Wekiva River Basin – Subbasins BW-006, BW-007, BW-016, BW-017 and BW-027;
- Golden Triangle Basin – Subbasin GT-006;
- Lake Eustis Basin – Subbasin LE-003;
- Little Wekiva River Basin – Subbasins LW-002, LW-004, LW-005, LW-007, LW-008, LW-010 and LW-011; and,
- Soldiers Creek Basin – Subbasin SOL-004.

Figure E-4
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Subbasins with Largest Estimated Annual Pollutant Load - Existing Conditions



The locations of these subbasins are shown on **Figure E-5**. As can be seen from this figure and Figures E-4, 2-5 and 2-7, most of these subbasins are very close to build-out conditions (i.e., little change between existing and future land use) based on the comparison to future conditions. A complete listing of the subbasins and the resulting annual pollutant loading rate is provided in **Table E-16** located at the end of this section.

E.4.2 Future Land Use

Under future conditions, a comparison was done to show the percent increase from existing to future conditions for each subbasin. Under this scenario, the top 15 estimated percent increases between existing and future conditions are shown in **Figure E-6** and occur in the following subbasins:

- Big Wekiva River Basin – Subbasins BW-001;
- Blackwater Creek Basin – Subbasin BWC-001, BWC-002, BWC-003, BWC-005, BWC-008, BWC-011, BWC-012, BWC-014, BWC-015, and BWC-018; and,
- Lake Eustis Basin – Subbasin LE-001, LE-005, LE-006 and LE-008.

A complete listing of the subbasins and their estimated increase in annual pollutant loading is provided in **Table E-17** located at the end of this section. Based on this table, a total of 28 subbasins had a predicted increase in future loadings by greater than 20 percent. The locations of the 28 subbasins are shown in **Figure E-7**. These subbasins are primarily in areas that are relatively undeveloped or are dominated by agriculture and the future land use map indicates they will be developed over time. Please note that the future loading estimates assumed that all new development was treated by wet detention BMPs (as some type of treatment would be required by permitting agencies). Subbasins BWC-005, LE-001 and BW-001 exhibited the highest estimated increases with 59.7, 45.9 and 39.7 percent, respectively. There are 26 subbasins whose pollutant loading rates are predicted to increase by greater than 10 percent, but less than 20 percent. The pollutant loading rates for 16 subbasins are predicted to increase by greater than 5 percent but less than 10 percent. The pollutant loading for the remaining 32 subbasins is predicted to increase by less than 5 percent between existing and future land use conditions.

E.5 Recommendations

The subbasins identified above in subsection E.4.1 that have the highest estimated pollutant loading rates should consider being given the highest priority for water quality retrofits, as the majority of these subbasins are nearing build-out conditions. The majority of development that has occurred in these subbasins was prior to the SJRWMD regulations for stormwater treatment. The affected jurisdictions should implement water quality retrofit BMPs in the subbasins where practicable, which will help in decreasing existing pollutant loadings. Estimated pollutant loading rates were factored into the ranking methodology described in Section 5.2 used to prioritize

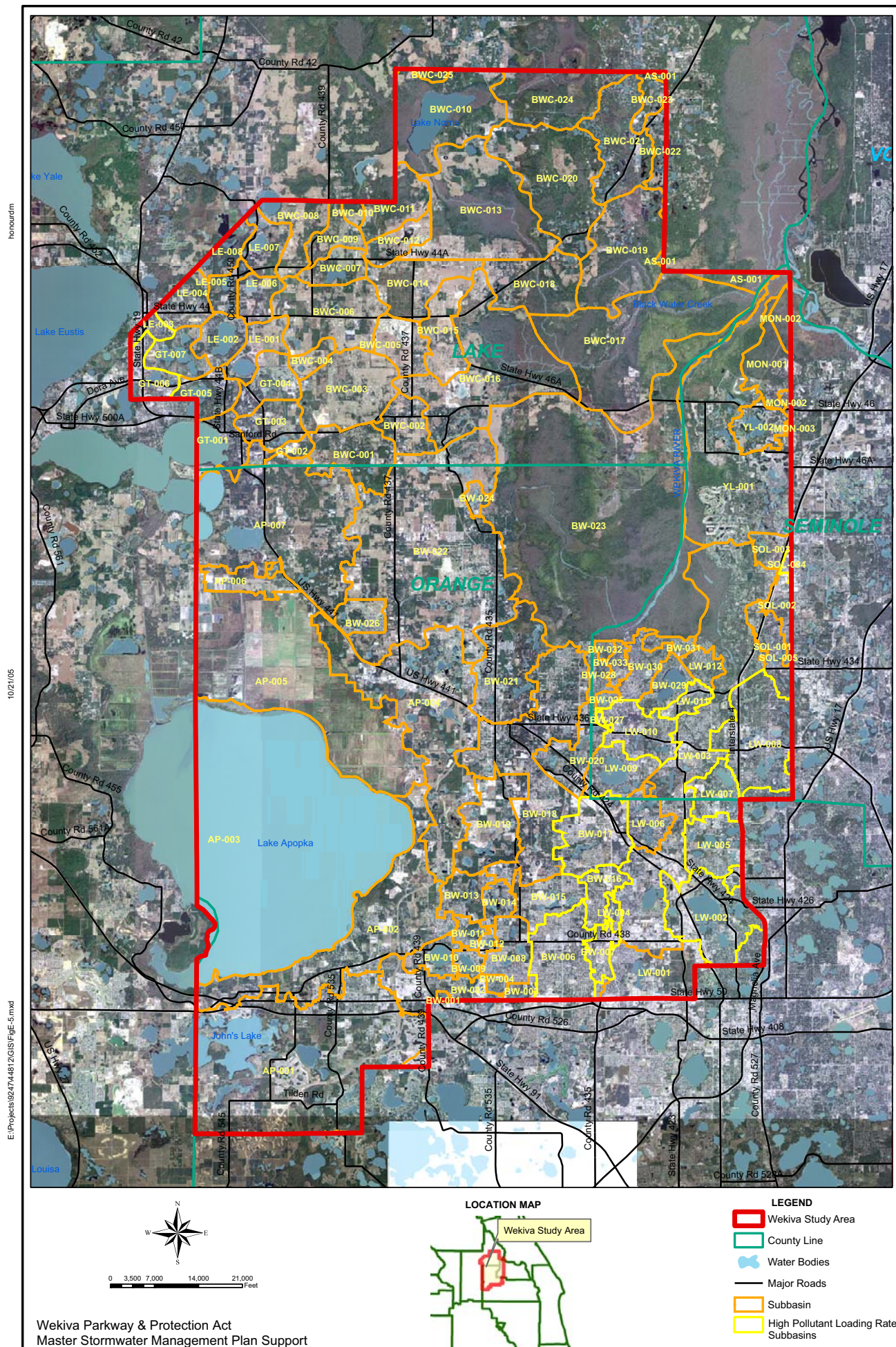
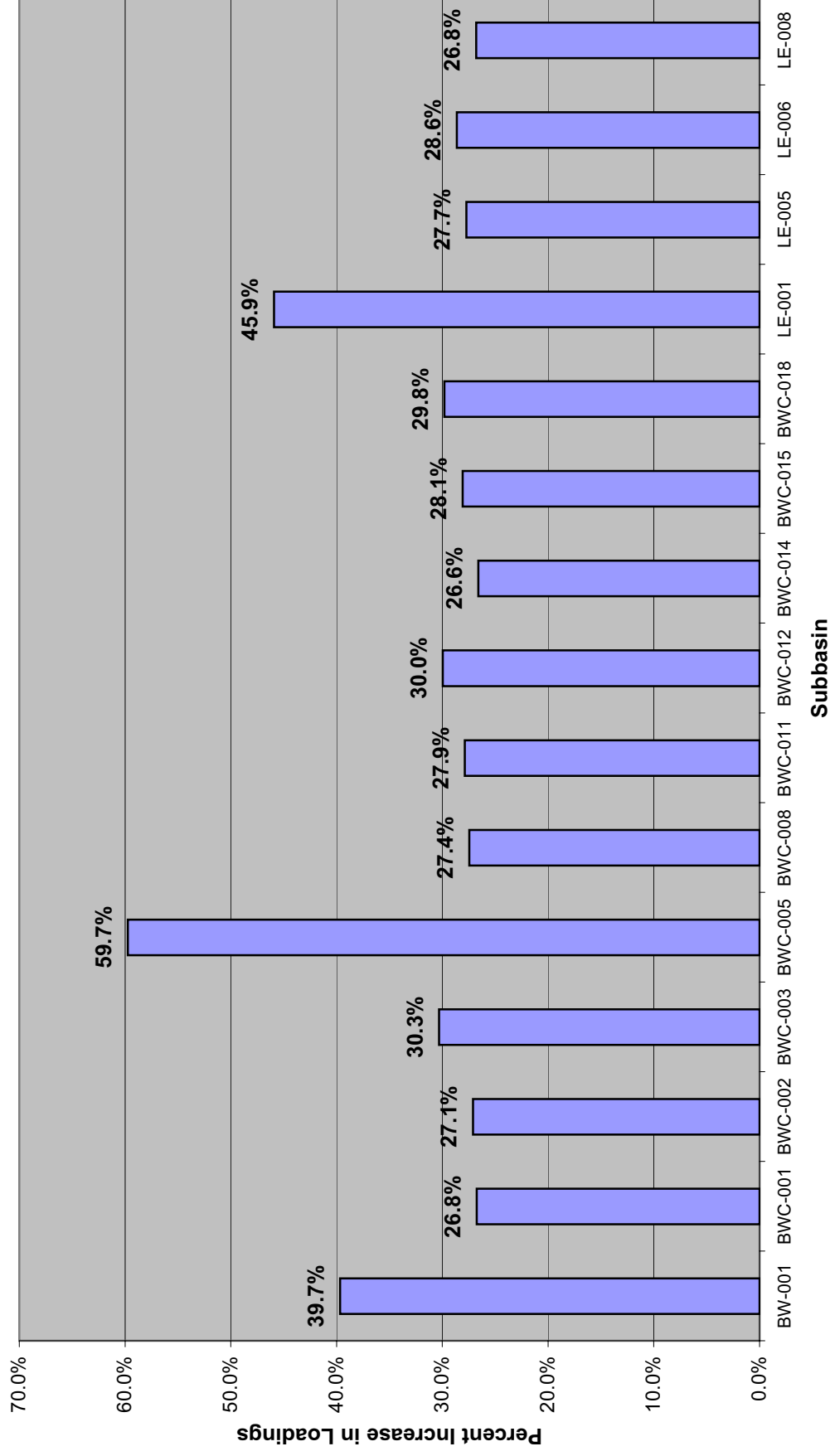


Figure E-6
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Subbasins with Largest Estimated Increase in Pollutant Loadings Between Existing & Future Conditions



subbasins in order to apply long term management strategies. Therefore this is already addressed in the recommendations made in Section 5. Section 5 also includes a detailed list of BMPs for water quality treatment that when implemented will help reduce pollutant loads.

For those subbasins with predicted percent increases in pollutant loads between existing and future land use conditions, the affected jurisdictions should consider requiring controls in addition to what is already required for stormwater treatment by local governments and permitting agencies. Twenty-eight subbasins were identified with estimated percent increase in loads greater than 20 percent are primarily undeveloped or dominated by agriculture. These subbasins should therefore receive a higher priority for evaluation as development takes place. These additional controls will help offset some of the large percent increases in pollutant loads which are forecasted for these subbasins within the WSA. The remaining subbasins should also be evaluated but are somewhat of a less priority than the 28 subbasins previously mentioned. Section 5 also includes a detailed list of BMPs for water quality treatment that when implemented will help reduce pollutant loads.

Table E-10

Wekiva Parkway Protection Act

Master Stormwater Management Plan Support

Annual Pollutant Load Estimates - Existing Land Use with 1% Septic Tank Failure Rate and Existing BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
AP-001	15879	4,583	29	25,352.0	330,000.0	357.0	3,200,000.0	2,359.0	8,552.0	26,366.0	4,142.0	8,100,000.0	77,193.0	120,000.0	13,585.0	1,800,000.0	3,308.0
AP-002	8237	2,528	31	14,832.0	210,000.0	260.0	2,000,000.0	1,275.0	6,789.0	15,546.0	3,002.0	4,800,000.0	48,568.0	77,505.0	9,764.0	1,300,000.0	2,091.0
AP-003	25030	6,871	27	38,778.0	170,000.0	84.0	1,800,000.0	4,740.0	2,185.0	20,254.0	651.0	11,000,000.0	63,806.0	130,000.0	11,679.0	340,000.0	2,930.0
AP-004	9708	2,344	24	13,966.0	180,000.0	211.0	2,000,000.0	1,134.0	5,838.0	14,781.0	2,482.0	4,800,000.0	47,657.0	68,563.0	8,745.0	1,100,000.0	1,780.0
AP-005	13107	482	4	9,859.0	46,938.0	51.0	1,400,000.0	263.0	926.0	9,106.0	518.0	3,600,000.0	31,464.0	29,322.0	2,536.0	320,000.0	371.0
AP-006	1186	230	19	1,517.0	20,941.0	27.0	220,000.0	134.0	706.0	1,652.0	315.0	500,000.0	5,362.0	7,180.0	1,124.0	150,000.0	230.0
AP-007	10494	1,619	15	12,028.0	140,000.0	156.0	1,500,000.0	900.0	4,525.0	12,816.0	1,626.0	4,000,000.0	37,490.0	53,580.0	6,502.0	820,000.0	1,361.0
AS-001	772	89	12	784.0	6,935.0	1.0	100,000.0	59.0	128.0	735.0	32.0	230,000.0	2,185.0	3,009.0	290.0	21,767.0	14.0
BW-001	65	15	24	93.0	821.0	1.0	11,107.0	10.0	26.0	87.0	17.0	30,927.0	288.0	414.0	48.0	5,550.0	14.0
BW-002	1989	1,008	51	4,632.0	74,839.0	91.0	640,000.0	491.0	1,710.0	4,801.0	1,141.0	1,600,000.0	14,471.0	22,185.0	2,741.0	420,000.0	754.0
BW-003	344	124	36	631.0	8,737.0	12.0	88,207.0	64.0	349.0	713.0	145.0	240,000.0	2,207.0	3,236.0	458.0	53,875.0	108.0
BW-004	210	92	44	441.0	5,267.0	3.0	54,529.0	29.0	234.0	480.0	52.0	150,000.0	1,364.0	2,194.0	253.0	19,854.0	36.0
BW-006	2892	1,551	54	7,019.0	140,000.0	164.0	1,100,000.0	746.0	5,345.0	10,822.0	1,839.0	2,900,000.0	26,319.0	40,057.0	6,205.0	870,000.0	1,354.0
BW-007	742	445	60	1,960.0	44,581.0	59.0	320,000.0	242.0	1,445.0	3,002.0	639.0	810,000.0	7,846.0	11,460.0	1,845.0	310,000.0	468.0
BW-008	1416	531	38	2,670.0	33,788.0	33.0	350,000.0	207.0	1,336.0	2,769.0	411.0	930,000.0	8,494.0	13,308.0	1,624.0	160,000.0	298.0
BW-009	434	155	36	794.0	9,923.0	10.0	95,552.0	72.0	352.0	767.0	125.0	270,000.0	2,414.0	3,800.0	464.0	49,224.0	94.0
BW-010	907	387	43	1,868.0	30,177.0	38.0	260,000.0	210.0	1,028.0	2,335.0	432.0	690,000.0	6,506.0	9,761.0	1,380.0	190,000.0	339.0
BW-011	460	214	46	1,006.0	15,531.0	18.0	140,000.0	94.0	557.0	1,163.0	208.0	360,000.0	3,389.0	5,289.0	711.0	84,289.0	154.0
BW-012	237	79	33	414.0	4,862.0	7.0	51,166.0	34.0	136.0	295.0	79.0	120,000.0	1,213.0	1,894.0	209.0	26,689.0	57.0
BW-013	1143	338	30	1,852.0	23,507.0	27.0	250,000.0	164.0	801.0	1,908.0	331.0	610,000.0	5,988.0	8,769.0	1,144.0	130,000.0	228.0
BW-014	668	225	34	1,175.0	12,026.0	13.0	130,000.0	83.0	379.0	824.0	158.0	320,000.0	3,116.0	5,082.0	552.0	55,892.0	110.0
BW-015	1589	585	37	2,961.0	39,901.0	33.0	380,000.0	234.0	1,764.0	3,619.0	417.0	1,100,000.0	9,592.0	15,042.0	1,989.0	180,000.0	306.0
BW-016	1012	478	47	2,238.0	44,835.0	57.0	350,000.0	245.0	1,586.0	3,327.0	626.0	910,000.0	8,599.0	12,687.0	1,948.0	290,000.0	460.0
BW-017	2740	1,412	52	6,458.0	120,000.0	173.0	980,000.0	781.0	3,659.0	8,123.0	1,961.0	2,500,000.0	23,575.0	33,899.0	4,990.0	840,000.0	1,343.0
BW-018	7866	3,356	43	16,201.0	300,000.0	359.0	2,400,000.0	1,626.0	10,836.0	22,479.0	4,009.0	6,300,000.0	58,346.0	89,077.0	13,168.0	1,800,000.0	2,845.0
BW-019	2940	509	17	3,555.0	49,389.0	62.0	500,000.0	294.0	1,462.0	3,994.0	662.0	1,200,000.0	12,064.0	16,477.0	2,178.0	340,000.0	494.0
BW-020	1774	817	46	3,853.0	76,328.0	96.0	560,000.0	450.0	2,205.0	5,294.0	1,061.0	1,500,000.0	13,196.0	20,658.0	3,004.0	470,000.0	797.0
BW-021	3681	1,409	38	7,038.0	120,000.0	127.0	1,000,000.0	660.0	4,454.0	9,614.0	1,383.0	2,700,000.0	24,666.0	37,769.0	5,423.0	700,000.0	1,039.0
BW-022	15208	2,052	13	16,441.0	200,000.0	205.0	2,200,000.0	977.0	7,184.0	18,694.0	2,130.0	5,400,000.0	52,973.0	74,832.0	9,792.0	1,200,000.0	1,621.0
BW-023	26770	4,496	17	31,909.0	340,000.0	88.0	4,300,000.0	2,981.0	7,329.0	33,108.0	1,864.0	9,300,000.0	94,536.0	130,000.0	14,512.0	1,000,000.0	772.0
BW-024	330	91	28	513.0	8,293.0	9.0	74,307.0	46.0	360.0	666.0	96.0	210,000.0	1,868.0	2,630.0	409.0	51,975.0	66.0
BW-025	3949	1,807	46	10,447.0	93,565.0	76.0	590,000.0	562.0	2,726.0	50,726.0	1,115.0	1,600,000.0	16,843.0	88,178.0	4,508.0	430,000.0	735.0
BW-026	913	186	20	1,198.0	7,925.0	4.0	76,361.0	47.0	249.0	685.0	67.0	210,000.0	2,195.0	4,050.0	351.0	33,258.0	51.0
BW-027	84	56	66	240.0	4,990.0	5.0	33,036.0	26.0	213.0	396.0	60.0	110,000.0	864.0	1,325.0	218.0	28,647.0	41.0
BWC-001	2463	211	9	2,256.0	25,955.0	24.0	310,000.0	99.0	851.0	2,600.0	205.0	780,000.0	7,321.0	10,026.0	1,085.0	140,000.0	162.0
BWC-002	1416	220	16	1,628.0	27,744.0	30.0	230,000.0	117.0	874.0	2,191.0	277.0	560,000.0	5,526.0	8,048.0	1,133.0	170,000.0	214.0
BWC-003	3636	355	10	3,477.0	40,653.0	38.0	410,000.0	165.0	1,538.0	3,810.0	341.0	1,000,000.0	10,153.0	14,698.0	1,753.0	220,000.0	269.0
BWC-004	576	15	3	412.0	2,128.0	1.0	47,478.0	7.0	60.0	331.0	6.0	120,000.0	1,120.0	1,428.0	103.0	12,346.0	8.0
BWC-005	1466	69	5	1,152.0	8,482.0	7.0	80,633.0	31.0	339.0	733.0	63.0	200,000.0	2,049.0	5,072.0	555.0	45,398.0	50.0
BWC-006	3839	136	4	2,870.0	19,474.0	12.0	360,000.0	62.0	590.0	2,690.0	99.0	890,000.0	8,266.0	10,667.0	992.0	110,000.0	100.0
BWC-007	1092	99	9	1,019.0	8,898.0	7.0	110,000.0	52.0	299.0	979.0	53.0	290,000.0	2,694.0	3,968.0	425.0	38,538.0	58.0
BWC-008	1700	207	12	1,764.0	18,942.0	14.0	200,000.0	107.0	631.0	1,851.0	121.0	510,000.0	4,849.0	7,311.0	812.0	76,666.0	109.0

Table E-10

Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Annual Pollutant Load Estimates - Existing Land Use with 1% Septic Tank Failure Rate and Existing BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
BWC-009	1043	117	11	1,046.0	12,760.0	9.0	130,000.0	58.0	457.0	1,131.0	81.0	310,000.0	2,930.0	4,309.0	548.0	59,359.0	58.0
BWC-010	5134	840	16	6,044.0	49,150.0	14.0	630,000.0	564.0	945.0	5,065.0	238.0	1,700,000.0	14,822.0	22,580.0	2,226.0	130,000.0	212.0
BWC-011	1647	181	11	1,642.0	15,269.0	5.0	200,000.0	110.0	349.0	1,543.0	78.0	450,000.0	4,346.0	6,117.0	625.0	48,530.0	39.0
BWC-012	1075	106	10	1,031.0	7,709.0	5.0	98,237.0	26.0	273.0	665.0	39.0	230,000.0	2,372.0	3,760.0	322.0	28,451.0	34.0
BWC-013	6768	1,069	16	7,838.0	85,052.0	32.0	980,000.0	629.0	2,143.0	7,906.0	452.0	2,100,000.0	21,867.0	37,921.0	4,011.0	250,000.0	237.0
BWC-014	2397	125	5	1,927.0	16,949.0	12.0	240,000.0	50.0	568.0	1,984.0	96.0	600,000.0	5,568.0	11,258.0	1,132.0	86,191.0	91.0
BWC-015	1945	136	7	1,677.0	14,897.0	9.0	190,000.0	52.0	552.0	1,794.0	78.0	500,000.0	4,566.0	6,460.0	702.0	74,940.0	74.0
BWC-016	7725	1,209	16	8,912.0	110,000.0	54.0	1,100,000.0	713.0	3,031.0	9,633.0	658.0	2,600,000.0	25,295.0	37,754.0	4,547.0	430,000.0	426.0
BWC-017	9563	1,170	12	9,937.0	94,326.0	19.0	1,300,000.0	775.0	1,854.0	9,842.0	447.0	2,900,000.0	28,871.0	39,751.0	3,911.0	280,000.0	167.0
BWC-018	2788	286	10	2,712.0	25,930.0	9.0	340,000.0	173.0	656.0	2,676.0	131.0	750,000.0	7,507.0	12,151.0	1,245.0	87,677.0	70.0
BWC-019	4578	379	8	4,148.0	32,566.0	10.0	500,000.0	232.0	677.0	3,676.0	144.0	1,200,000.0	11,006.0	15,088.0	1,385.0	120,000.0	88.0
BWC-020	5540	632	11	5,602.0	54,349.0	18.0	720,000.0	391.0	1,323.0	5,741.0	265.0	1,700,000.0	16,348.0	24,277.0	2,467.0	180,000.0	160.0
BWC-021	3331	380	11	3,368.0	28,463.0	12.0	410,000.0	230.0	622.0	3,177.0	133.0	1,100,000.0	9,299.0	13,372.0	1,216.0	100,000.0	117.0
BWC-022	755	146	19	963.0	14,896.0	12.0	120,000.0	73.0	561.0	1,232.0	100.0	340,000.0	3,041.0	4,771.0	661.0	70,475.0	82.0
BWC-023	673	74	11	672.0	7,241.0	5.0	79,513.0	38.0	245.0	709.0	41.0	210,000.0	1,900.0	2,831.0	334.0	32,194.0	38.0
BWC-024	3242	448	14	3,540.0	34,948.0	7.0	480,000.0	298.0	647.0	3,548.0	168.0	1,100,000.0	10,374.0	14,319.0	1,421.0	100,000.0	57.0
BWC-025	210	17	8	188.0	1,479.0	0.0	25,146.0	11.0	23.0	172.0	6.0	57,214.0	532.0	690.0	58.0	5,149.0	1.0
GT-001	1551	548	35	2,814.0	48,114.0	47.0	320,000.0	315.0	1,371.0	3,504.0	460.0	990,000.0	8,240.0	13,828.0	1,888.0	270,000.0	409.0
GT-002	593	186	31	997.0	19,488.0	28.0	160,000.0	113.0	547.0	1,236.0	296.0	390,000.0	3,883.0	4,931.0	754.0	160,000.0	196.0
GT-003	1451	342	24	2,058.0	32,973.0	37.0	280,000.0	180.0	1,045.0	2,547.0	383.0	720,000.0	6,736.0	9,714.0	1,336.0	210,000.0	285.0
GT-004	1476	331	22	2,037.0	20,938.0	14.0	200,000.0	80.0	727.0	1,294.0	134.0	510,000.0	5,012.0	7,928.0	875.0	86,168.0	95.0
GT-005	1223	360	29	1,976.0	33,079.0	26.0	250,000.0	166.0	1,090.0	2,694.0	271.0	710,000.0	6,175.0	10,034.0	1,272.0	170,000.0	254.0
GT-006	1090	516	47	2,416.0	54,232.0	58.0	330,000.0	286.0	1,360.0	3,873.0	626.0	960,000.0	7,923.0	12,967.0	1,841.0	330,000.0	512.0
GT-007	1274	323	25	1,885.0	29,972.0	23.0	220,000.0	157.0	1,306.0	2,568.0	201.0	700,000.0	5,992.0	9,758.0	1,389.0	140,000.0	180.0
LE-001	1233	126	10	1,198.0	7,872.0	5.0	86,112.0	68.0	229.0	745.0	54.0	260,000.0	2,249.0	5,175.0	473.0	32,162.0	66.0
LE-002	1216	304	25	1,783.0	23,964.0	16.0	200,000.0	140.0	1,049.0	2,083.0	147.0	630,000.0	5,282.0	8,699.0	1,126.0	100,000.0	137.0
LE-003	422	186	44	889.0	22,520.0	21.0	130,000.0	93.0	677.0	1,636.0	203.0	360,000.0	3,225.0	5,336.0	794.0	130,000.0	174.0
LE-004	1278	319	25	1,873.0	37,147.0	30.0	270,000.0	144.0	1,389.0	2,952.0	283.0	720,000.0	6,577.0	10,258.0	1,493.0	200,000.0	226.0
LE-005	778	107	14	847.0	9,784.0	6.0	99,498.0	56.0	275.0	1,075.0	60.0	260,000.0	2,529.0	3,880.0	381.0	48,591.0	78.0
LE-006	1010	113	11	1,013.0	11,756.0	11.0	120,000.0	61.0	396.0	1,111.0	103.0	300,000.0	3,057.0	4,364.0	495.0	62,691.0	86.0
LE-007	1255	141	11	1,261.0	12,297.0	8.0	150,000.0	72.0	457.0	1,384.0	64.0	400,000.0	3,726.0	5,629.0	556.0	51,103.0	83.0
LE-008	891	132	15	1,003.0	10,245.0	4.0	120,000.0	85.0	299.0	1,050.0	53.0	290,000.0	2,948.0	4,319.0	463.0	34,646.0	41.0
LW-001	2664	1,152	43	5,537.0	110,000.0	155.0	870,000.0	712.0	2,872.0	7,293.0	1,735.0	2,100,000.0	20,232.0	29,091.0	4,328.0	760,000.0	1,238.0
LW-002	3550	1,822	51	8,342.0	170,000.0	237.0	1,300,000.0	1,065.0	4,804.0	11,227.0	2,588.0	3,300,000.0	30,850.0	45,202.0	6,844.0	1,200,000.0	1,939.0
LW-003	11154	5,430	49	26,175.0	470,000.0	547.0	3,700,000.0	2,786.0	15,296.0	31,198.0	6,154.0	9,400,000.0	90,319.0	130,000.0	23,371.0	2,800,000.0	4,173.0
LW-004	240	120	50	552.0	11,636.0	14.0	89,160.0	58.0	400.0	926.0	149.0	220,000.0	2,167.0	3,316.0	496.0	72,164.0	123.0
LW-005	1784	885	50	4,089.0	79,258.0	102.0	590,000.0	480.0	2,068.0	5,012.0	1,122.0	1,500,000.0	13,687.0	21,361.0	3,005.0	490,000.0	828.0
LW-006	1160	540	47	2,540.0	44,821.0	52.0	370,000.0	255.0	1,706.0	3,329.0	583.0	990,000.0	9,061.0	13,913.0	2,043.0	250,000.0	429.0
LW-007	1323	731	55	3,282.0	60,434.0	74.0	470,000.0	362.0	1,754.0	3,708.0	828.0	1,200,000.0	10,992.0	17,012.0	2,401.0	350,000.0	573.0
LW-008	4047	2,413	60	10,636.0	240,000.0	315.0	1,700,000.0	1,330.0	7,582.0	15,722.0	3,424.0	4,400,000.0	39,796.0	60,901.0	9,807.0	1,600,000.0	2,517.0
LW-009	1758	783	45	3,730.0	62,181.0	73.0	500,000.0	386.0	2,302.0	4,778.0	815.0	1,400,000.0	12,630.0	19,823.0	2,844.0	350,000.0	623.0
LW-010	1930	945	49	4,383.0	81,986.0	92.0	640,000.0	442.0	2,806.0	6,210.0	1,028.0	1,700,000.0	15,650.0	24,068.0	3,474.0	480,000.0	788.0

Table E-10
Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Annual Pollutant Load Estimates - Existing Land Use with 1% Septic Tank Failure Rate and Existing BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
LW-011	589	374	64	1,626.0	34,635.0	41.0	220,000.0	186.0	824.0	2,170.0	449.0	580,000.0	5,199.0	8,560.0	1,188.0	210,000.0	345.0
LW-012	629	317	50	1,460.0	23,680.0	21.0	200,000.0	114.0	853.0	1,411.0	235.0	490,000.0	4,980.0	7,780.0	1,049.0	130,000.0	156.0
MON-001	1697	347	20	2,229.0	28,403.0	17.0	320,000.0	220.0	686.0	2,513.0	224.0	700,000.0	7,115.0	10,004.0	1,190.0	110,000.0	120.0
MON-002	655	182	28	1,023.0	14,040.0	8.0	150,000.0	119.0	348.0	1,180.0	115.0	310,000.0	3,292.0	4,745.0	604.0	48,751.0	57.0
MON-003	26	7	28	41.0	620.0	1.0	5,849.0	3.0	29.0	58.0	7.0	15,719.0	147.0	219.0	31.0	3,051.0	5.0
SOL-001	1301	598	46	2,822.0	52,310.0	64.0	430,000.0	301.0	1,948.0	3,882.0	712.0	1,100,000.0	10,528.0	15,912.0	2,416.0	310,000.0	527.0
SOL-002	682	308	45	1,461.0	23,878.0	29.0	200,000.0	151.0	810.0	1,761.0	346.0	570,000.0	4,992.0	7,459.0	1,054.0	140,000.0	234.0
SOL-003	682	272	40	1,342.0	21,028.0	29.0	200,000.0	136.0	802.0	1,572.0	337.0	520,000.0	4,986.0	7,220.0	1,049.0	130,000.0	241.0
SOL-004	122	72	59	319.0	6,600.0	8.0	42,640.0	40.0	110.0	437.0	99.0	130,000.0	931.0	1,545.0	202.0	38,170.0	69.0
SOL-005	76	34	45	160.0	2,584.0	3.0	22,290.0	17.0	97.0	180.0	37.0	59,089.0	553.0	859.0	126.0	15,203.0	28.0
YL-001	9854	2,310	23	13,941.0	160,000.0	121.0	1,800,000.0	975.0	4,516.0	11,689.0	1,409.0	4,200,000.0	40,876.0	63,038.0	6,649.0	670,000.0	960.0
YL-002	1229	325	26	1,861.0	21,165.0	22.0	220,000.0	155.0	641.0	1,655.0	240.0	570,000.0	5,358.0	8,475.0	955.0	97,318.0	192.0

Table E-11
Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Wet Season Pollutant Load Estimates - Existing Land Use with 1% Septic Tank Failure Rate and Existing BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
AP-001	15879	4,583	29	14,062.0	180,000.0	198.0	1,800,000.0	1,309.0	4,743.0	14,625.0	2,298.0	4,500,000.0	42,817.0	65,845.0	7,535.0	1,000,000.0	1,835.0
AP-002	8237	2,528	31	8,751.0	120,000.0	144.0	1,100,000.0	707.0	3,765.0	8,623.0	1,665.0	2,700,000.0	26,939.0	46,481.0	5,658.0	700,000.0	1,160.0
AP-003	25030	6,871	27	21,509.0	95,201.0	47.0	1,000,000.0	2,629.0	1,212.0	11,234.0	361.0	5,900,000.0	35,392.0	73,301.0	6,478.0	190,000.0	1,625.0
AP-004	9708	2,344	24	7,746.0	97,893.0	117.0	1,100,000.0	629.0	3,238.0	8,199.0	1,377.0	2,600,000.0	26,434.0	38,030.0	4,850.0	610,000.0	987.0
AP-005	13107	482	4	5,468.0	26,035.0	28.0	790,000.0	146.0	514.0	5,051.0	287.0	2,000,000.0	17,452.0	16,264.0	1,407.0	180,000.0	206.0
AP-006	1186	230	19	841.0	11,615.0	15.0	120,000.0	75.0	392.0	916.0	175.0	280,000.0	2,974.0	3,983.0	623.0	81,041.0	128.0
AP-007	10494	1,619	15	6,671.0	77,741.0	86.0	850,000.0	499.0	2,510.0	7,109.0	902.0	2,200,000.0	20,795.0	29,719.0	3,606.0	460,000.0	755.0
AS-001	772	89	12	435.0	3,846.0	1.0	55,590.0	33.0	71.0	408.0	18.0	130,000.0	1,212.0	1,669.0	161.0	12,074.0	8.0
BW-001	65	15	24	51.0	455.0	1.0	6,161.0	5.0	14.0	48.0	9.0	17,154.0	159.0	229.0	27.0	3,079.0	8.0
BW-002	1989	1,008	51	2,569.0	41,511.0	51.0	360,000.0	272.0	949.0	2,663.0	633.0	900,000.0	8,027.0	12,305.0	1,520.0	230,000.0	418.0
BW-003	344	124	36	350.0	4,846.0	7.0	48,926.0	36.0	194.0	395.0	80.0	130,000.0	1,224.0	1,795.0	254.0	29,883.0	60.0
BW-004	210	92	44	244.0	2,921.0	2.0	30,246.0	16.0	130.0	266.0	29.0	84,682.0	757.0	1,217.0	140.0	11,012.0	20.0
BW-006	2892	1,551	54	3,893.0	80,118.0	91.0	590,000.0	414.0	2,965.0	6,003.0	1,020.0	1,600,000.0	14,598.0	22,219.0	3,442.0	480,000.0	751.0
BW-007	742	445	60	1,087.0	24,728.0	33.0	180,000.0	134.0	802.0	1,665.0	354.0	450,000.0	4,352.0	6,357.0	1,024.0	170,000.0	260.0
BW-008	1416	531	38	1,481.0	18,741.0	18.0	190,000.0	115.0	741.0	1,536.0	228.0	510,000.0	4,711.0	7,381.0	901.0	86,821.0	165.0
BW-009	434	155	36	440.0	5,504.0	6.0	53,000.0	40.0	195.0	425.0	69.0	150,000.0	1,339.0	2,108.0	257.0	27,303.0	52.0
BW-010	907	387	43	1,036.0	16,738.0	21.0	140,000.0	117.0	570.0	1,295.0	239.0	380,000.0	3,609.0	5,414.0	766.0	110,000.0	188.0
BW-011	460	214	46	558.0	8,614.0	10.0	77,248.0	52.0	309.0	645.0	115.0	200,000.0	1,880.0	2,934.0	395.0	46,753.0	85.0
BW-012	237	79	33	230.0	2,697.0	4.0	28,380.0	19.0	75.0	164.0	44.0	67,757.0	673.0	1,051.0	116.0	14,804.0	31.0
BW-013	1143	338	30	1,027.0	13,039.0	15.0	140,000.0	91.0	444.0	1,058.0	184.0	340,000.0	3,321.0	4,864.0	634.0	74,010.0	126.0
BW-014	668	225	34	651.0	6,671.0	7.0	70,609.0	46.0	210.0	457.0	88.0	170,000.0	1,728.0	2,819.0	306.0	31,002.0	61.0
BW-015	1589	585	37	1,642.0	22,132.0	18.0	210,000.0	130.0	979.0	2,007.0	231.0	600,000.0	5,320.0	8,343.0	1,103.0	99,397.0	170.0
BW-016	1012	478	47	1,241.0	24,869.0	32.0	200,000.0	136.0	880.0	1,845.0	347.0	500,000.0	4,770.0	7,037.0	1,080.0	160,000.0	255.0
BW-017	2740	1,412	52	3,582.0	68,816.0	96.0	540,000.0	433.0	2,029.0	4,505.0	1,088.0	1,400,000.0	13,076.0	18,803.0	2,768.0	470,000.0	745.0
BW-018	7866	3,356	43	8,986.0	170,000.0	199.0	1,300,000.0	902.0	6,010.0	12,469.0	2,223.0	3,500,000.0	32,363.0	49,409.0	7,304.0	980,000.0	1,578.0
BW-019	2940	509	17	1,972.0	27,394.0	34.0	280,000.0	163.0	811.0	2,215.0	367.0	680,000.0	6,686.0	9,139.0	1,208.0	190,000.0	274.0
BW-020	1774	817	46	2,137.0	42,337.0	53.0	310,000.0	250.0	1,223.0	2,936.0	589.0	830,000.0	7,319.0	11,458.0	1,666.0	260,000.0	442.0
BW-021	3681	1,409	38	3,904.0	69,184.0	70.0	560,000.0	366.0	2,470.0	5,332.0	767.0	1,500,000.0	13,682.0	20,949.0	3,008.0	390,000.0	576.0
BW-022	15208	2,052	13	9,119.0	110,000.0	113.0	1,200,000.0	542.0	3,985.0	10,369.0	1,181.0	3,000,000.0	29,383.0	41,507.0	5,431.0	640,000.0	899.0
BW-023	26770	4,496	17	17,699.0	190,000.0	49.0	2,400,000.0	1,653.0	4,065.0	18,364.0	1,034.0	5,200,000.0	52,437.0	74,586.0	8,049.0	560,000.0	428.0
BW-024	330	91	28	285.0	4,600.0	5.0	41,216.0	26.0	199.0	369.0	53.0	120,000.0	1,036.0	1,459.0	227.0	28,829.0	37.0
BW-025	3949	1,807	46	6,643.0	56,428.0	42.0	320,000.0	312.0	1,512.0	48,206.0	618.0	890,000.0	9,342.0	74,055.0	2,846.0	240,000.0	407.0
BW-026	913	186	20	664.0	4,396.0	2.0	42,355.0	26.0	138.0	380.0	37.0	120,000.0	1,218.0	2,246.0	194.0	18,447.0	28.0
BW-027	84	56	66	133.0	2,768.0	3.0	18,324.0	14.0	118.0	220.0	33.0	58,591.0	479.0	735.0	121.0	15,890.0	23.0
BWC-001	2463	211	9	1,251.0	14,396.0	13.0	170,000.0	55.0	472.0	1,442.0	114.0	430,000.0	4,061.0	5,561.0	602.0	79,265.0	90.0
BWC-002	1416	220	16	903.0	15,389.0	16.0	130,000.0	65.0	485.0	1,215.0	154.0	310,000.0	3,065.0	4,464.0	628.0	95,557.0	119.0
BWC-003	3636	355	10	1,929.0	22,549.0	21.0	230,000.0	92.0	853.0	2,114.0	189.0	560,000.0	5,632.0	8,153.0	972.0	120,000.0	149.0
BWC-004	576	15	3	229.0	1,181.0	0.0	26,335.0	4.0	33.0	183.0	3.0	67,695.0	621.0	792.0	57.0	6,848.0	5.0
BWC-005	1466	69	5	639.0	4,705.0	4.0	44,725.0	17.0	188.0	407.0	35.0	110,000.0	1,136.0	2,813.0	308.0	25,181.0	28.0
BWC-006	3839	136	4	1,592.0	10,802.0	7.0	200,000.0	34.0	327.0	1,492.0	55.0	490,000.0	4,585.0	5,917.0	550.0	60,993.0	56.0
BWC-007	1092	99	9	565.0	4,935.0	4.0	60,436.0	29.0	166.0	543.0	30.0	160,000.0	1,494.0	2,201.0	236.0	21,376.0	32.0
BWC-008	1700	207	12	978.0	10,507.0	8.0	110,000.0	60.0	350.0	1,027.0	67.0	280,000.0	2,690.0	4,055.0	450.0	42,524.0	61.0

Table E-11
Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Wet Season Pollutant Load Estimates - Existing Land Use with 1% Septic Tank Failure Rate and Existing BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
BWC-009	1043	117	11	580.0	7,077.0	5.0	69,454.0	32.0	253.0	627.0	45.0	170,000.0	1,625.0	2,390.0	304.0	32,925.0	32.0
BWC-010	5134	840	16	3,353.0	27,262.0	8.0	350,000.0	313.0	524.0	2,810.0	132.0	930,000.0	8,221.0	12,525.0	1,235.0	74,522.0	118.0
BWC-011	1647	181	11	911.0	8,469.0	3.0	110,000.0	61.0	194.0	856.0	43.0	250,000.0	2,411.0	3,393.0	346.0	26,918.0	22.0
BWC-012	1075	106	10	572.0	4,276.0	3.0	54,489.0	15.0	151.0	369.0	21.0	130,000.0	1,316.0	2,085.0	178.0	15,781.0	19.0
BWC-013	6768	1,069	16	4,348.0	47,176.0	18.0	540,000.0	349.0	1,189.0	4,385.0	251.0	1,200,000.0	12,129.0	21,034.0	2,225.0	140,000.0	132.0
BWC-014	2397	125	5	1,069.0	9,401.0	7.0	130,000.0	27.0	315.0	1,100.0	53.0	330,000.0	3,088.0	6,245.0	628.0	47,808.0	50.0
BWC-015	1945	136	7	930.0	8,263.0	5.0	110,000.0	29.0	306.0	995.0	44.0	280,000.0	2,527.0	3,583.0	389.0	41,567.0	41.0
BWC-016	7725	1,209	16	4,943.0	59,301.0	30.0	610,000.0	396.0	1,681.0	5,343.0	365.0	1,400,000.0	14,030.0	20,941.0	2,522.0	240,000.0	237.0
BWC-017	9563	1,170	12	5,512.0	52,320.0	11.0	730,000.0	430.0	1,028.0	5,459.0	248.0	1,600,000.0	16,014.0	22,049.0	2,169.0	160,000.0	93.0
BWC-018	2788	286	10	1,504.0	14,383.0	5.0	190,000.0	96.0	364.0	1,484.0	73.0	410,000.0	4,164.0	6,740.0	691.0	48,632.0	39.0
BWC-019	4578	379	8	2,301.0	18,063.0	5.0	280,000.0	129.0	376.0	2,039.0	80.0	670,000.0	6,105.0	8,369.0	768.0	64,479.0	49.0
BWC-020	5540	632	11	3,107.0	30,146.0	10.0	400,000.0	217.0	734.0	3,184.0	147.0	920,000.0	9,068.0	13,466.0	1,369.0	100,000.0	89.0
BWC-021	3331	380	11	1,868.0	15,788.0	6.0	230,000.0	127.0	345.0	1,762.0	74.0	590,000.0	5,158.0	7,417.0	674.0	56,169.0	65.0
BWC-022	755	146	19	534.0	8,262.0	6.0	68,494.0	40.0	311.0	683.0	55.0	190,000.0	1,687.0	2,646.0	366.0	39,090.0	46.0
BWC-023	673	74	11	373.0	4,016.0	3.0	44,104.0	21.0	136.0	393.0	23.0	120,000.0	1,054.0	1,570.0	185.0	17,857.0	21.0
BWC-024	3242	448	14	1,964.0	19,384.0	4.0	270,000.0	165.0	359.0	1,968.0	93.0	590,000.0	5,754.0	7,942.0	788.0	56,286.0	32.0
BWC-025	210	17	8	104.0	820.0	0.0	13,948.0	6.0	13.0	95.0	3.0	31,735.0	295.0	383.0	32.0	2,856.0	1.0
GT-001	1551	548	35	1,561.0	26,687.0	26.0	180,000.0	175.0	760.0	1,944.0	255.0	550,000.0	4,570.0	7,670.0	1,047.0	150,000.0	227.0
GT-002	593	186	31	553.0	10,809.0	16.0	87,922.0	63.0	303.0	686.0	164.0	210,000.0	2,154.0	2,735.0	418.0	89,871.0	109.0
GT-003	1451	342	24	1,141.0	18,289.0	21.0	150,000.0	100.0	580.0	1,412.0	212.0	400,000.0	3,736.0	5,388.0	741.0	120,000.0	158.0
GT-004	1476	331	22	1,130.0	11,614.0	8.0	110,000.0	45.0	403.0	718.0	74.0	280,000.0	2,780.0	4,397.0	485.0	47,795.0	53.0
GT-005	1223	360	29	1,096.0	18,348.0	15.0	140,000.0	92.0	605.0	1,494.0	150.0	400,000.0	3,425.0	5,566.0	705.0	94,535.0	141.0
GT-006	1090	516	47	1,340.0	30,081.0	32.0	180,000.0	159.0	754.0	2,148.0	347.0	530,000.0	4,395.0	7,187.0	1,021.0	190,000.0	284.0
GT-007	1274	323	25	1,045.0	16,625.0	13.0	120,000.0	87.0	725.0	1,424.0	111.0	390,000.0	3,324.0	5,413.0	770.0	79,066.0	100.0
LE-001	1233	126	10	665.0	4,367.0	3.0	47,764.0	38.0	127.0	413.0	30.0	140,000.0	1,248.0	2,871.0	262.0	17,839.0	37.0
LE-002	1216	304	25	989.0	13,292.0	9.0	110,000.0	78.0	582.0	1,155.0	82.0	350,000.0	2,930.0	4,825.0	624.0	57,517.0	76.0
LE-003	422	186	44	493.0	12,491.0	12.0	74,238.0	52.0	376.0	907.0	113.0	200,000.0	1,789.0	2,960.0	440.0	73,794.0	96.0
LE-004	1278	319	25	1,039.0	20,605.0	17.0	150,000.0	80.0	770.0	1,637.0	157.0	400,000.0	3,648.0	5,690.0	828.0	110,000.0	125.0
LE-005	778	107	14	470.0	5,427.0	3.0	55,189.0	31.0	153.0	596.0	33.0	150,000.0	1,403.0	2,152.0	212.0	26,952.0	43.0
LE-006	1010	113	11	562.0	6,521.0	6.0	68,173.0	34.0	220.0	616.0	57.0	170,000.0	1,696.0	2,421.0	275.0	34,773.0	48.0
LE-007	1255	141	11	699.0	6,821.0	5.0	80,610.0	40.0	253.0	767.0	35.0	220,000.0	2,067.0	3,122.0	308.0	28,346.0	46.0
LE-008	891	132	15	556.0	5,682.0	2.0	66,934.0	47.0	166.0	583.0	29.0	160,000.0	1,635.0	2,395.0	257.0	19,217.0	23.0
LW-001	2664	1,152	43	3,071.0	60,880.0	86.0	480,000.0	395.0	1,593.0	4,045.0	962.0	1,200,000.0	11,222.0	16,136.0	2,401.0	420,000.0	686.0
LW-002	3550	1,822	51	4,627.0	91,961.0	131.0	700,000.0	591.0	2,665.0	6,227.0	1,435.0	1,800,000.0	17,112.0	25,073.0	3,796.0	650,000.0	1,075.0
LW-003	11154	5,430	49	14,943.0	260,000.0	304.0	2,100,000.0	1,545.0	8,484.0	17,305.0	3,413.0	5,200,000.0	50,098.0	74,152.0	14,555.0	1,600,000.0	2,315.0
LW-004	240	120	50	306.0	6,454.0	8.0	49,455.0	32.0	222.0	514.0	83.0	120,000.0	1,202.0	1,839.0	275.0	40,027.0	68.0
LW-005	1784	885	50	2,268.0	43,962.0	57.0	330,000.0	266.0	1,147.0	2,780.0	623.0	850,000.0	7,592.0	11,848.0	1,667.0	270,000.0	459.0
LW-006	1160	540	47	1,409.0	24,861.0	29.0	200,000.0	142.0	947.0	1,846.0	323.0	550,000.0	5,026.0	7,717.0	1,133.0	140,000.0	238.0
LW-007	1323	731	55	1,821.0	33,521.0	41.0	260,000.0	201.0	973.0	2,057.0	459.0	670,000.0	6,097.0	9,436.0	1,332.0	200,000.0	318.0
LW-008	4047	2,413	60	5,900.0	130,000.0	175.0	920,000.0	738.0	4,205.0	8,720.0	1,899.0	2,400,000.0	22,074.0	33,780.0	5,440.0	880,000.0	1,396.0
LW-009	1758	783	45	2,069.0	34,490.0	41.0	280,000.0	214.0	1,277.0	2,650.0	452.0	780,000.0	7,006.0	10,995.0	1,578.0	190,000.0	345.0
LW-010	1930	945	49	2,431.0	45,475.0	51.0	360,000.0	245.0	1,556.0	3,444.0	570.0	930,000.0	8,680.0	13,350.0	1,927.0	270,000.0	437.0

Table E-11
Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Wet Season Pollutant Load Estimates - Existing Land Use with 1% Septic Tank Failure Rate and Existing BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
LW-011	589	374	64	902.0	19,211.0	23.0	120,000.0	103.0	457.0	1,204.0	249.0	320,000.0	2,884.0	4,748.0	659.0	120,000.0	191.0
LW-012	629	317	50	810.0	13,135.0	12.0	110,000.0	63.0	473.0	783.0	131.0	270,000.0	2,762.0	4,316.0	582.0	71,318.0	87.0
MON-001	1697	347	20	1,236.0	15,754.0	9.0	180,000.0	122.0	381.0	1,394.0	124.0	390,000.0	3,946.0	5,549.0	660.0	63,709.0	66.0
MON-002	655	182	28	567.0	7,787.0	4.0	82,084.0	66.0	193.0	655.0	64.0	170,000.0	1,826.0	2,632.0	335.0	27,041.0	32.0
MON-003	26	7	28	23.0	344.0	0.0	3,244.0	2.0	16.0	32.0	4.0	8,719.0	81.0	121.0	17.0	1,692.0	3.0
SOL-001	1301	598	46	1,566.0	29,015.0	36.0	240,000.0	167.0	1,080.0	2,153.0	395.0	610,000.0	5,840.0	8,826.0	1,340.0	170,000.0	292.0
SOL-002	682	308	45	810.0	13,244.0	16.0	110,000.0	84.0	449.0	977.0	192.0	310,000.0	2,769.0	4,137.0	585.0	78,006.0	130.0
SOL-003	682	272	40	744.0	11,664.0	16.0	110,000.0	75.0	445.0	872.0	187.0	290,000.0	2,766.0	4,005.0	582.0	71,952.0	134.0
SOL-004	122	72	59	177.0	3,661.0	4.0	23,651.0	22.0	61.0	242.0	55.0	70,017.0	516.0	857.0	112.0	21,172.0	38.0
SOL-005	76	34	45	89.0	1,433.0	2.0	12,363.0	9.0	54.0	100.0	21.0	32,775.0	307.0	477.0	70.0	8,433.0	16.0
YL-001	9854	2,310	23	7,733.0	87,685.0	67.0	980,000.0	541.0	2,505.0	6,483.0	782.0	2,300,000.0	22,673.0	34,966.0	3,688.0	370,000.0	533.0
YL-002	1229	325	26	1,032.0	11,740.0	12.0	120,000.0	86.0	356.0	918.0	133.0	310,000.0	2,972.0	4,701.0	530.0	53,980.0	106.0

Table E-12

Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Dry Season Pollutant Load Estimates – Existing Land Use with 1% Septic Tank Failure Rate and Existing BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
AP-001	15879	4,583	29	11,290.0	150,000.0	159.0	1,400,000.0	1,051.0	3,808.0	11,742.0	1,845.0	3,600,000.0	34,376.0	52,865.0	6,050.0	800,000.0	1,473.0
AP-002	8237	2,528	31	7,258.0	92,507.0	116.0	910,000.0	568.0	3,023.0	6,923.0	1,337.0	2,200,000.0	21,628.0	38,863.0	4,650.0	560,000.0	931.0
AP-003	25030	6,871	27	17,269.0	76,434.0	38.0	800,000.0	2,111.0	973.0	9,020.0	290.0	4,700,000.0	28,415.0	58,851.0	5,201.0	150,000.0	1,305.0
AP-004	9708	2,344	24	6,219.0	78,595.0	94.0	870,000.0	505.0	2,600.0	6,582.0	1,105.0	2,100,000.0	21,223.0	30,533.0	3,894.0	490,000.0	793.0
AP-005	13107	482	4	4,390.0	20,903.0	23.0	630,000.0	117.0	412.0	4,055.0	231.0	1,600,000.0	14,012.0	13,058.0	1,129.0	140,000.0	165.0
AP-006	1186	230	19	676.0	9,325.0	12.0	97,227.0	60.0	314.0	735.0	140.0	220,000.0	2,388.0	3,198.0	500.0	65,065.0	103.0
AP-007	10494	1,619	15	5,356.0	62,416.0	69.0	680,000.0	401.0	2,015.0	5,707.0	724.0	1,800,000.0	16,695.0	23,861.0	2,895.0	370,000.0	606.0
AS-001	772	89	12	349.0	3,088.0	1.0	44,632.0	26.0	57.0	327.0	14.0	100,000.0	973.0	1,340.0	129.0	9,693.0	6.0
BW-001	65	15	24	41.0	366.0	1.0	4,946.0	4.0	11.0	39.0	7.0	13,773.0	128.0	184.0	21.0	2,472.0	6.0
BW-002	1989	1,008	51	2,063.0	33,328.0	41.0	290,000.0	219.0	762.0	2,138.0	508.0	720,000.0	6,444.0	9,880.0	1,221.0	190,000.0	336.0
BW-003	344	124	36	281.0	3,891.0	5.0	39,281.0	29.0	156.0	317.0	64.0	110,000.0	983.0	1,441.0	204.0	23,992.0	48.0
BW-004	210	92	44	196.0	2,345.0	2.0	24,283.0	13.0	104.0	214.0	23.0	67,988.0	607.0	977.0	113.0	8,841.0	16.0
BW-006	2892	1,551	54	3,126.0	64,324.0	73.0	470,000.0	332.0	2,380.0	4,819.0	819.0	1,300,000.0	11,720.0	17,839.0	2,763.0	390,000.0	603.0
BW-007	742	445	60	873.0	19,853.0	26.0	140,000.0	108.0	644.0	1,337.0	284.0	360,000.0	3,494.0	5,104.0	822.0	140,000.0	209.0
BW-008	1416	531	38	1,189.0	15,047.0	15.0	150,000.0	92.0	595.0	1,233.0	183.0	410,000.0	3,783.0	5,926.0	723.0	69,706.0	133.0
BW-009	434	155	36	353.0	4,419.0	5.0	42,552.0	32.0	157.0	341.0	56.0	120,000.0	1,075.0	1,692.0	206.0	21,921.0	42.0
BW-010	907	387	43	832.0	13,438.0	17.0	110,000.0	94.0	458.0	1,040.0	192.0	310,000.0	2,897.0	4,347.0	615.0	84,438.0	151.0
BW-011	460	214	46	448.0	6,916.0	8.0	62,020.0	42.0	248.0	518.0	93.0	160,000.0	1,509.0	2,355.0	317.0	37,536.0	68.0
BW-012	237	79	33	184.0	2,165.0	3.0	22,786.0	15.0	61.0	132.0	35.0	54,400.0	540.0	844.0	93.0	11,885.0	25.0
BW-013	1143	338	30	825.0	10,468.0	12.0	110,000.0	73.0	357.0	850.0	147.0	270,000.0	2,667.0	3,905.0	509.0	59,420.0	101.0
BW-014	668	225	34	523.0	5,356.0	6.0	56,690.0	37.0	169.0	367.0	70.0	140,000.0	1,388.0	2,263.0	246.0	24,890.0	49.0
BW-015	1589	585	37	1,319.0	17,769.0	15.0	170,000.0	104.0	786.0	1,612.0	186.0	480,000.0	4,271.0	6,699.0	886.0	79,803.0	136.0
BW-016	1012	478	47	997.0	19,966.0	25.0	160,000.0	109.0	706.0	1,481.0	279.0	400,000.0	3,829.0	5,650.0	867.0	130,000.0	205.0
BW-017	2740	1,412	52	2,876.0	55,250.0	77.0	440,000.0	348.0	1,629.0	3,617.0	873.0	1,100,000.0	10,499.0	15,096.0	2,222.0	370,000.0	598.0
BW-018	7866	3,356	43	7,215.0	130,000.0	160.0	1,100,000.0	724.0	4,826.0	10,011.0	1,785.0	2,800,000.0	25,983.0	39,669.0	5,864.0	790,000.0	1,267.0
BW-019	2940	509	17	1,583.0	21,994.0	28.0	220,000.0	131.0	651.0	1,779.0	295.0	550,000.0	5,368.0	7,337.0	970.0	150,000.0	220.0
BW-020	1774	817	46	1,716.0	33,991.0	43.0	250,000.0	200.0	982.0	2,357.0	473.0	670,000.0	5,876.0	9,200.0	1,338.0	210,000.0	355.0
BW-021	3681	1,409	38	3,134.0	55,545.0	56.0	450,000.0	294.0	1,983.0	4,281.0	616.0	1,200,000.0	10,985.0	16,819.0	2,415.0	310,000.0	463.0
BW-022	15208	2,052	13	7,322.0	88,510.0	91.0	960,000.0	435.0	3,199.0	8,325.0	948.0	2,400,000.0	23,590.0	33,325.0	4,361.0	510,000.0	722.0
BW-023	26770	4,496	17	14,210.0	150,000.0	39.0	1,900,000.0	1,327.0	3,264.0	14,744.0	830.0	4,200,000.0	42,100.0	59,883.0	6,463.0	450,000.0	344.0
BW-024	330	91	28	228.0	3,693.0	4.0	33,091.0	21.0	160.0	296.0	43.0	94,396.0	832.0	1,171.0	182.0	23,146.0	30.0
BW-025	3949	1,807	46	5,709.0	47,310.0	34.0	260,000.0	250.0	1,214.0	47,587.0	496.0	710,000.0	7,501.0	70,587.0	2,438.0	200,000.0	327.0
BW-026	913	186	20	533.0	3,529.0	2.0	34,006.0	21.0	111.0	305.0	30.0	93,642.0	978.0	1,804.0	156.0	14,811.0	23.0
BW-027	84	56	66	107.0	2,222.0	2.0	14,712.0	12.0	95.0	176.0	27.0	47,040.0	385.0	590.0	97.0	12,757.0	18.0
BWC-001	2463	211	9	1,005.0	11,558.0	10.0	140,000.0	44.0	379.0	1,158.0	91.0	350,000.0	3,260.0	4,465.0	483.0	63,640.0	72.0
BWC-002	1416	220	16	725.0	12,355.0	13.0	100,000.0	52.0	389.0	976.0	124.0	250,000.0	2,461.0	3,584.0	504.0	76,720.0	95.0
BWC-003	3636	355	10	1,549.0	18,104.0	17.0	180,000.0	73.0	685.0	1,697.0	152.0	450,000.0	4,521.0	6,545.0	780.0	95,833.0	120.0
BWC-004	576	15	3	184.0	948.0	0.0	21,143.0	3.0	27.0	147.0	2.0	54,350.0	499.0	636.0	46.0	5,498.0	4.0
BWC-005	1466	69	5	513.0	3,777.0	3.0	35,908.0	14.0	151.0	326.0	28.0	87,946.0	912.0	2,259.0	247.0	20,217.0	22.0
BWC-006	3839	136	4	1,278.0	8,672.0	5.0	160,000.0	27.0	263.0	1,198.0	44.0	390,000.0	3,681.0	4,750.0	442.0	48,969.0	45.0
BWC-007	1092	99	9	454.0	3,962.0	3.0	48,522.0	23.0	133.0	436.0	24.0	130,000.0	1,200.0	1,767.0	189.0	17,162.0	26.0
BWC-008	1700	207	12	785.0	8,435.0	6.0	89,667.0	48.0	281.0	824.0	54.0	230,000.0	2,159.0	3,256.0	362.0	34,141.0	49.0

Table E-12
Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Dry Season Pollutant Load Estimates – Existing Land Use with 1% Septic Tank Failure Rate and Existing BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
BWC-009	1043	117	11	486.0	5,682.0	4.0	55,762.0	26.0	203.0	504.0	36.0	140,000.0	1,305.0	1,919.0	244.0	26,434.0	26.0
BWC-010	5134	840	16	2,692.0	21,888.0	6.0	280,000.0	251.0	421.0	2,256.0	106.0	740,000.0	6,601.0	10,056.0	991.0	59,831.0	94.0
BWC-011	1647	181	11	731.0	6,800.0	2.0	88,609.0	49.0	155.0	687.0	35.0	200,000.0	1,935.0	2,724.0	278.0	21,612.0	17.0
BWC-012	1075	106	10	459.0	3,433.0	2.0	43,748.0	12.0	122.0	296.0	17.0	100,000.0	1,056.0	1,674.0	143.0	12,670.0	15.0
BWC-013	6768	1,069	16	3,491.0	37,876.0	14.0	440,000.0	280.0	954.0	3,521.0	201.0	950,000.0	9,738.0	16,887.0	1,786.0	110,000.0	106.0
BWC-014	2397	125	5	858.0	7,548.0	5.0	110,000.0	22.0	253.0	883.0	43.0	270,000.0	2,479.0	5,014.0	504.0	38,383.0	40.0
BWC-015	1945	136	7	747.0	6,634.0	4.0	85,251.0	23.0	246.0	799.0	35.0	220,000.0	2,029.0	2,877.0	312.0	33,373.0	33.0
BWC-016	7725	1,209	16	3,969.0	47,611.0	24.0	490,000.0	318.0	1,350.0	4,290.0	293.0	1,100,000.0	11,264.0	16,813.0	2,025.0	190,000.0	190.0
BWC-017	9563	1,170	12	4,425.0	42,006.0	9.0	590,000.0	345.0	826.0	4,383.0	199.0	1,300,000.0	12,857.0	17,702.0	1,742.0	130,000.0	74.0
BWC-018	2788	286	10	1,208.0	11,547.0	4.0	150,000.0	77.0	292.0	1,192.0	58.0	330,000.0	3,343.0	5,411.0	555.0	39,045.0	31.0
BWC-019	4578	379	8	1,847.0	14,502.0	4.0	220,000.0	104.0	302.0	1,637.0	64.0	530,000.0	4,901.0	6,719.0	617.0	51,768.0	39.0
BWC-020	5540	632	11	2,495.0	24,203.0	8.0	320,000.0	174.0	589.0	2,556.0	118.0	740,000.0	7,280.0	10,811.0	1,099.0	81,114.0	71.0
BWC-021	3331	380	11	1,500.0	12,675.0	5.0	180,000.0	102.0	277.0	1,415.0	59.0	480,000.0	4,141.0	5,955.0	541.0	45,096.0	52.0
BWC-022	755	146	19	429.0	6,633.0	5.0	54,992.0	32.0	250.0	548.0	44.0	150,000.0	1,354.0	2,124.0	294.0	31,384.0	37.0
BWC-023	673	74	11	299.0	3,224.0	2.0	35,410.0	17.0	109.0	316.0	18.0	94,538.0	846.0	1,261.0	149.0	14,337.0	17.0
BWC-024	3242	448	14	1,577.0	15,563.0	3.0	210,000.0	133.0	288.0	1,580.0	75.0	470,000.0	4,620.0	6,377.0	633.0	45,190.0	25.0
BWC-025	210	17	8	84.0	659.0	0.0	11,198.0	5.0	10.0	77.0	3.0	25,479.0	237.0	307.0	26.0	2,293.0	1.0
GT-001	1551	548	35	1,253.0	21,426.0	21.0	140,000.0	140.0	610.0	1,561.0	205.0	440,000.0	3,669.0	6,158.0	841.0	120,000.0	182.0
GT-002	593	186	31	444.0	8,678.0	13.0	70,589.0	50.0	244.0	551.0	132.0	170,000.0	1,729.0	2,196.0	336.0	72,154.0	87.0
GT-003	1451	342	24	916.0	14,684.0	17.0	120,000.0	80.0	465.0	1,134.0	170.0	320,000.0	3,000.0	4,326.0	595.0	92,894.0	127.0
GT-004	1476	331	22	907.0	9,324.0	6.0	91,179.0	36.0	324.0	576.0	60.0	230,000.0	2,232.0	3,530.0	390.0	38,373.0	42.0
GT-005	1223	360	29	880.0	14,731.0	12.0	110,000.0	74.0	486.0	1,200.0	121.0	320,000.0	2,750.0	4,469.0	566.0	75,899.0	113.0
GT-006	1090	516	47	1,076.0	24,151.0	26.0	150,000.0	127.0	606.0	1,725.0	279.0	430,000.0	3,528.0	5,770.0	820.0	150,000.0	228.0
GT-007	1274	323	25	839.0	13,347.0	10.0	100,000.0	70.0	582.0	1,143.0	89.0	310,000.0	2,668.0	4,346.0	618.0	63,479.0	80.0
LE-001	1233	126	10	534.0	3,506.0	2.0	38,348.0	30.0	102.0	332.0	24.0	110,000.0	1,002.0	2,305.0	210.0	14,323.0	30.0
LE-002	1216	304	25	794.0	10,672.0	7.0	87,965.0	62.0	467.0	927.0	65.0	280,000.0	2,352.0	3,874.0	501.0	46,179.0	61.0
LE-003	422	186	44	396.0	10,029.0	9.0	59,603.0	41.0	302.0	729.0	91.0	160,000.0	1,436.0	2,376.0	353.0	59,247.0	77.0
LE-004	1278	319	25	834.0	16,543.0	14.0	120,000.0	64.0	619.0	1,315.0	126.0	320,000.0	2,929.0	4,568.0	665.0	89,633.0	101.0
LE-005	778	107	14	377.0	4,357.0	3.0	44,309.0	25.0	123.0	479.0	27.0	120,000.0	1,126.0	1,728.0	170.0	21,639.0	35.0
LE-006	1010	113	11	451.0	5,235.0	5.0	54,734.0	27.0	176.0	495.0	46.0	140,000.0	1,361.0	1,944.0	221.0	27,918.0	38.0
LE-007	1255	141	11	561.0	5,476.0	4.0	64,719.0	32.0	203.0	616.0	28.0	180,000.0	1,659.0	2,507.0	248.0	22,758.0	37.0
LE-008	891	132	15	447.0	4,562.0	2.0	53,739.0	38.0	133.0	468.0	24.0	130,000.0	1,313.0	1,923.0	206.0	15,429.0	18.0
LW-001	2664	1,152	43	2,466.0	48,878.0	69.0	390,000.0	317.0	1,279.0	3,248.0	772.0	960,000.0	9,010.0	12,955.0	1,928.0	340,000.0	551.0
LW-002	3550	1,822	51	3,715.0	73,832.0	105.0	570,000.0	474.0	2,139.0	5,000.0	1,152.0	1,500,000.0	13,738.0	20,130.0	3,048.0	520,000.0	863.0
LW-003	11154	5,430	49	12,185.0	210,000.0	244.0	1,700,000.0	1,241.0	6,812.0	13,893.0	2,740.0	4,200,000.0	40,222.0	59,534.0	12,390.0	1,200,000.0	1,858.0
LW-004	240	120	50	246.0	5,182.0	6.0	39,705.0	26.0	178.0	412.0	67.0	98,946.0	965.0	1,477.0	221.0	32,137.0	55.0
LW-005	1784	885	50	1,821.0	35,296.0	45.0	260,000.0	214.0	921.0	2,232.0	500.0	680,000.0	6,095.0	9,513.0	1,338.0	220,000.0	369.0
LW-006	1160	540	47	1,131.0	19,960.0	23.0	160,000.0	114.0	760.0	1,482.0	259.0	440,000.0	4,035.0	6,196.0	910.0	110,000.0	191.0
LW-007	1323	731	55	1,462.0	26,913.0	33.0	210,000.0	161.0	781.0	1,651.0	369.0	540,000.0	4,895.0	7,576.0	1,069.0	160,000.0	255.0
LW-008	4047	2,413	60	4,737.0	110,000.0	140.0	740,000.0	592.0	3,376.0	7,001.0	1,525.0	2,000,000.0	17,722.0	27,121.0	4,367.0	700,000.0	1,121.0
LW-009	1758	783	45	1,661.0	27,691.0	33.0	220,000.0	172.0	1,025.0	2,128.0	363.0	630,000.0	5,625.0	8,828.0	1,267.0	150,000.0	277.0
LW-010	1930	945	49	1,952.0	36,511.0	41.0	290,000.0	197.0	1,250.0	2,765.0	458.0	750,000.0	6,969.0	10,718.0	1,547.0	210,000.0	351.0

Table E-12
Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Dry Season Pollutant Load Estimates - Existing Land Use with 1% Septic Tank Failure Rate and Existing BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
LW-011	589	374	64	724.0	15,424.0	18.0	99,972.0	83.0	367.0	967.0	200.0	260,000.0	2,315.0	3,812.0	529.0	95,240.0	153.0
LW-012	629	317	50	650.0	10,545.0	10.0	89,174.0	51.0	380.0	628.0	105.0	220,000.0	2,218.0	3,465.0	467.0	57,259.0	70.0
MON-001	1697	347	20	993.0	12,649.0	8.0	140,000.0	98.0	306.0	1,119.0	100.0	310,000.0	3,168.0	4,455.0	530.0	51,150.0	53.0
MON-002	655	182	28	456.0	6,252.0	3.0	65,903.0	53.0	155.0	526.0	51.0	140,000.0	1,466.0	2,113.0	269.0	21,710.0	26.0
MON-003	26	7	28	18.0	276.0	0.0	2,605.0	2.0	13.0	26.0	3.0	7,000.0	65.0	97.0	14.0	1,359.0	2.0
SOL-001	1301	598	46	1,257.0	23,295.0	29.0	190,000.0	134.0	867.0	1,729.0	317.0	490,000.0	4,688.0	7,086.0	1,076.0	140,000.0	235.0
SOL-002	682	308	45	651.0	10,634.0	13.0	91,059.0	67.0	361.0	784.0	154.0	250,000.0	2,223.0	3,322.0	469.0	62,629.0	104.0
SOL-003	682	272	40	598.0	9,364.0	13.0	90,454.0	60.0	357.0	700.0	150.0	230,000.0	2,221.0	3,215.0	467.0	57,768.0	107.0
SOL-004	122	72	59	142.0	2,939.0	3.0	18,989.0	18.0	49.0	195.0	44.0	56,214.0	415.0	688.0	90.0	16,998.0	31.0
SOL-005	76	34	45	71.0	1,151.0	2.0	9,926.0	8.0	43.0	80.0	17.0	26,314.0	246.0	383.0	56.0	6,770.0	13.0
YL-001	9854	2,310	23	6,208.0	70,399.0	54.0	780,000.0	434.0	2,011.0	5,205.0	628.0	1,900,000.0	18,203.0	28,073.0	2,961.0	300,000.0	428.0
YL-002	1229	325	26	829.0	9,426.0	10.0	99,311.0	69.0	285.0	737.0	107.0	250,000.0	2,386.0	3,774.0	425.0	43,338.0	85.0

Table E-13
Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Annual Pollutant Load Estimates - Future Land Use with 1% Septic Tank Failure Rate and Future BMP's

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
AP-001	15878	7.634	48	35,584.0	510,000.0	497.0	4,300,000.0	3,150.0	10,524.0	30,730.0	5,809.0	11,000,000.0	97,090.0	170,000.0	17,343.0	2,300,000.0	4,210.0
AP-002	8237	3.848	47	19,259.0	270,000.0	292.0	2,500,000.0	1,508.0	7,723.0	16,699.0	3,371.0	5,800,000.0	56,767.0	98,820.0	11,217.0	1,400,000.0	2,274.0
AP-003	25011	6.873	27	38,774.0	170,000.0	85.0	1,800,000.0	4,741.0	2,189.0	20,261.0	663.0	11,000,000.0	63,813.0	130,000.0	11,685.0	340,000.0	2,930.0
AP-004	9708	4.518	47	21,255.0	290,000.0	295.0	2,800,000.0	1,714.0	7,647.0	17,413.0	3,518.0	6,400,000.0	64,441.0	100,000.0	11,303.0	1,500,000.0	2,299.0
AP-005	13107	7.21	6	10,660.0	83,247.0	59.0	1,500,000.0	344.0	2,413.0	14,431.0	658.0	3,000,000.0	44,337.0	45,623.0	5,688.0	620,000.0	604.0
AP-006	1186	272	23	1,658.0	25,714.0	35.0	260,000.0	152.0	863.0	3,176.0	394.0	680,000.0	6,713.0	8,227.0	1,412.0	240,000.0	281.0
AP-007	10494	2,265	22	14,192.0	170,000.0	162.0	1,800,000.0	991.0	5,780.0	19,796.0	1,682.0	4,800,000.0	45,068.0	66,518.0	8,455.0	1,100,000.0	1,435.0
AS-001	772	103	13	831.0	7,258.0	2.0	110,000.0	59.0	137.0	722.0	34.0	250,000.0	2,310.0	3,287.0	292.0	21,351.0	15.0
BW-001	63	38	60	167.0	2,223.0	2.0	18,470.0	17.0	36.0	121.0	29.0	50,898.0	407.0	724.0	75.0	8,687.0	20.0
BW-002	1989	1,447	73	6,101.0	110,000.0	119.0	810,000.0	637.0	2,058.0	5,584.0	1,470.0	2,000,000.0	17,685.0	28,997.0	3,395.0	540,000.0	942.0
BW-003	344	188	55	846.0	12,677.0	15.0	110,000.0	78.0	456.0	791.0	168.0	300,000.0	2,755.0	4,374.0	579.0	63,137.0	117.0
BW-004	212	109	51	498.0	6,054.0	4.0	59,715.0	31.0	248.0	509.0	56.0	160,000.0	1,484.0	2,495.0	271.0	21,674.0	40.0
BW-006	2892	1,706	59	7,540.0	150,000.0	166.0	1,100,000.0	763.0	5,642.0	11,119.0	1,854.0	3,000,000.0	27,547.0	43,087.0	6,475.0	880,000.0	1,371.0
BW-007	742	467	63	2,032.0	46,001.0	60.0	330,000.0	246.0	1,487.0	3,036.0	648.0	830,000.0	8,030.0	11,870.0	1,888.0	310,000.0	474.0
BW-008	1418	617	44	2,962.0	37,792.0	36.0	370,000.0	222.0	1,471.0	2,846.0	437.0	980,000.0	9,076.0	14,898.0	1,753.0	160,000.0	316.0
BW-009	433	203	47	953.0	12,576.0	12.0	110,000.0	81.0	386.0	806.0	143.0	300,000.0	2,688.0	4,579.0	520.0	53,998.0	102.0
BW-010	907	455	50	2,095.0	33,877.0	44.0	290,000.0	235.0	1,070.0	2,369.0	490.0	750,000.0	7,106.0	10,672.0	1,480.0	210,000.0	367.0
BW-011	460	233	51	1,070.0	16,758.0	18.0	150,000.0	98.0	599.0	1,205.0	215.0	380,000.0	3,582.0	5,667.0	756.0	87,176.0	157.0
BW-012	228	127	56	570.0	6,812.0	7.0	68,018.0	41.0	150.0	307.0	83.0	160,000.0	1,497.0	2,645.0	242.0	25,036.0	54.0
BW-013	1143	430	38	2,161.0	28,372.0	28.0	280,000.0	182.0	953.0	2,107.0	351.0	680,000.0	6,817.0	10,636.0	1,322.0	150,000.0	245.0
BW-014	668	289	43	1,390.0	15,939.0	15.0	160,000.0	99.0	469.0	949.0	183.0	370,000.0	3,686.0	6,231.0	662.0	64,622.0	118.0
BW-015	1589	673	42	3,254.0	43,967.0	38.0	410,000.0	247.0	1,914.0	3,728.0	457.0	1,100,000.0	10,227.0	16,693.0	2,100.0	190,000.0	335.0
BW-016	1012	578	57	2,576.0	50,570.0	60.0	390,000.0	266.0	1,736.0	3,489.0	659.0	990,000.0	9,445.0	14,490.0	2,117.0	300,000.0	477.0
BW-017	2741	1,679	61	7,353.0	140,000.0	189.0	1,100,000.0	868.0	3,950.0	8,385.0	2,140.0	2,800,000.0	25,973.0	37,889.0	5,411.0	900,000.0	1,439.0
BW-018	7867	3,861	49	17,894.0	320,000.0	370.0	2,500,000.0	1,708.0	11,296.0	22,742.0	4,114.0	6,600,000.0	61,569.0	96,138.0	13,488.0	1,800,000.0	2,895.0
BW-019	2939	913	31	4,908.0	59,978.0	46.0	600,000.0	288.0	1,700.0	4,638.0	494.0	1,400,000.0	14,159.0	23,969.0	2,366.0	280,000.0	454.0
BW-020	1774	978	55	4,396.0	88,322.0	109.0	630,000.0	497.0	2,437.0	5,630.0	1,198.0	1,700,000.0	14,547.0	23,431.0	3,291.0	520,000.0	880.0
BW-021	3681	1,587	43	7,636.0	130,000.0	134.0	1,100,000.0	687.0	4,710.0	10,004.0	1,445.0	2,800,000.0	25,991.0	41,014.0	5,596.0	720,000.0	1,086.0
BW-022	15410	3,325	22	20,840.0	260,000.0	212.0	2,700,000.0	1,145.0	9,786.0	30,464.0	2,224.0	7,000,000.0	68,367.0	100,000.0	13,065.0	1,600,000.0	1,790.0
BW-023	26770	4,451	17	31,757.0	340,000.0	104.0	4,300,000.0	2,844.0	7,387.0	33,286.0	1,875.0	9,600,000.0	95,001.0	130,000.0	14,235.0	1,100,000.0	840.0
BW-024	330	88	27	503.0	8,759.0	8.0	71,704.0	46.0	424.0	737.0	92.0	200,000.0	2,017.0	2,907.0	489.0	63,087.0	70.0
BW-025	3949	1,833	46	10,535.0	94,917.0	77.0	600,000.0	564.0	2,760.0	50,772.0	1,124.0	1,600,000.0	17,023.0	88,591.0	4,523.0	430,000.0	735.0
BW-026	913	260	28	1,445.0	11,029.0	5.0	93,101.0	61.0	324.0	749.0	85.0	240,000.0	2,618.0	5,261.0	458.0	39,483.0	61.0
BW-027	84	60	71	254.0	5,281.0	5.0	34,718.0	27.0	229.0	420.0	62.0	110,000.0	904.0	1,403.0	228.0	29,388.0	42.0
BWC-001	2463	651	26	3,732.0	47,274.0	35.0	470,000.0	174.0	1,561.0	3,134.0	310.0	1,000,000.0	11,083.0	18,874.0	1,873.0	190,000.0	227.0
BWC-002	1416	543	38	2,710.0	42,535.0	37.0	340,000.0	173.0	1,138.0	2,331.0	352.0	800,000.0	7,614.0	13,716.0	1,390.0	170,000.0	244.0
BWC-003	3631	958	26	5,496.0	62,892.0	42.0	660,000.0	224.0	2,121.0	4,101.0	349.0	1,500,000.0	14,705.0	26,505.0	2,335.0	170,000.0	250.0
BWC-004	576	98	17	691.0	4,225.0	2.0	71,949.0	20.0	107.0	228.0	21.0	160,000.0	1,491.0	2,571.0	146.0	8,318.0	14.0
BWC-005	1466	348	24	2,090.0	20,233.0	14.0	230,000.0	76.0	582.0	1,066.0	121.0	530,000.0	5,044.0	9,063.0	692.0	56,838.0	77.0
BWC-006	3839	682	18	4,701.0	33,606.0	22.0	510,000.0	150.0	862.0	2,070.0	190.0	1,200,000.0	10,706.0	18,253.0	1,148.0	75,368.0	128.0
BWC-007	1092	216	20	1,412.0	11,925.0	8.0	150,000.0	68.0	344.0	874.0	69.0	370,000.0	3,371.0	5,793.0	458.0	31,481.0	61.0
BWC-008	1701	448	26	2,570.0	28,715.0	20.0	300,000.0	143.0	865.0	1,938.0	170.0	700,000.0	6,740.0	11,965.0	1,082.0	80,288.0	132.0
BWC-009	1043	223	21	1,402.0	16,334.0	12.0	170,000.0	75.0	551.0	1,155.0	105.0	410,000.0	3,871.0	6,323.0	647.0	60,083.0	70.0
BWC-010	5134	1,183	23	7,196.0	63,192.0	25.0	770,000.0	658.0	1,348.0	5,479.0	344.0	1,900,000.0	17,691.0	28,710.0	2,724.0	150,000.0	272.0
BWC-011	1647	339	21	2,172.0	23,029.0	14.0	280,000.0	153.0	619.0	1,968.0	143.0	620,000.0	6,095.0	9,452.0	914.0	65,485.0	88.0
BWC-012	1075	206	19	1,367.0	11,016.0	7.0	150,000.0	42.0	340.0	700.0	57.0	330,000.0	3,364.0	5,775.0	419.0	29,245.0	42.0
BWC-013	6768	1,532	23	9,393.0	100,000.0	50.0	1,200,000.0	733.0	2,706.0	8,567.0	599.0	2,600,000.0	26,349.0	41,308.0	4,157.0	270,000.0	332.0
BWC-014	2397	483	20	3,128.0	28,479.0	21.0	360,000.0	116.0	759.0	1,782.0	185.0	820,000.0	7,495.0	12,852.0	949.0	79,768.0	126.0
BWC-015	1944	366	19	2,449.0	22,401.0	15.0	290,000.0	95.0	768.0	1,923.0	133.0	700,000.0	6,351.0	10,442.0	866.0	70,765.0	101.0

Table E-13
Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Annual Pollutant Load Estimates - Future Land Use with 1% Septic Tank Failure Rate and Future BMP's

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
BWC-016	7724	1,939	25	11,360.0	140,000.0	85.0	1,500,000.0	899.0	4,095.0	11,428.0	919.0	3,400,000.0	33,135.0	52,630.0	5,734.0	500,000.0	603.0
BWC-017	9527	1,462	15	10,891.0	110,000.0	46.0	1,500,000.0	841.0	2,467.0	10,972.0	622.0	3,300,000.0	32,206.0	45,817.0	4,485.0	340,000.0	318.0
BWC-018	2880	546	19	3,642.0	37,490.0	21.0	470,000.0	254.0	981.0	3,302.0	224.0	1,100,000.0	10,201.0	15,657.0	1,486.0	110,000.0	141.0
BWC-019	4578	625	14	4,974.0	40,715.0	18.0	610,000.0	265.0	934.0	3,787.0	207.0	1,400,000.0	13,203.0	19,800.0	1,591.0	120,000.0	131.0
BWC-020	5537	1,106	20	7,190.0	67,865.0	39.0	870,000.0	439.0	1,798.0	5,408.0	403.0	1,900,000.0	18,793.0	30,085.0	2,646.0	180,000.0	258.0
BWC-021	3330	726	22	4,528.0	40,701.0	21.0	500,000.0	302.0	966.0	3,019.0	234.0	1,200,000.0	10,996.0	18,354.0	1,566.0	99,425.0	166.0
BWC-022	755	197	26	1,136.0	16,635.0	13.0	140,000.0	85.0	605.0	1,236.0	112.0	370,000.0	3,401.0	5,605.0	700.0	69,758.0	86.0
BWC-023	673	143	21	902.0	9,229.0	6.0	100,000.0	50.0	299.0	670.0	55.0	250,000.0	2,324.0	3,910.0	372.0	30,061.0	43.0
BWC-024	3242	678	21	4,311.0	40,469.0	15.0	530,000.0	315.0	909.0	3,205.0	224.0	1,100,000.0	11,237.0	17,590.0	1,582.0	92,312.0	103.0
BWC-025	210	40	19	265.0	2,056.0	1.0	30,624.0	14.0	44.0	142.0	11.0	64,146.0	635.0	1,025.0	76.0	3,997.0	4.0
GT-001	1551	591	38	2,957.0	50,335.0	48.0	340,000.0	323.0	1,429.0	3,552.0	476.0	1,000,000.0	8,537.0	14,561.0	1,952.0	280,000.0	419.0
GT-002	592	292	49	1,352.0	25,944.0	35.0	200,000.0	144.0	737.0	1,467.0	355.0	470,000.0	4,848.0	6,840.0	971.0	180,000.0	231.0
GT-003	1451	570	39	2,824.0	42,508.0	38.0	350,000.0	201.0	1,311.0	2,726.0	379.0	870,000.0	8,220.0	14,043.0	1,590.0	200,000.0	286.0
GT-004	1475	528	36	2,697.0	29,495.0	20.0	280,000.0	115.0	949.0	1,495.0	196.0	660,000.0	6,606.0	11,684.0	1,115.0	98,645.0	129.0
GT-005	1223	482	39	2,385.0	38,322.0	29.0	280,000.0	183.0	1,214.0	2,740.0	297.0	790,000.0	6,807.0	12,004.0	1,420.0	170,000.0	264.0
GT-006	1089	594	55	2,677.0	58,596.0	61.0	360,000.0	304.0	1,419.0	3,929.0	659.0	1,000,000.0	8,350.0	14,178.0	1,930.0	340,000.0	528.0
GT-007	1274	419	33	2,207.0	34,408.0	25.0	260,000.0	171.0	1,439.0	2,658.0	224.0	760,000.0	6,628.0	11,536.0	1,519.0	150,000.0	191.0
LE-001	1232	318	26	1,841.0	16,141.0	10.0	190,000.0	97.0	420.0	961.0	97.0	470,000.0	4,241.0	7,879.0	599.0	40,468.0	85.0
LE-002	1216	405	33	2,122.0	30,753.0	22.0	240,000.0	162.0	1,306.0	2,430.0	188.0	720,000.0	6,187.0	10,845.0	1,375.0	120,000.0	166.0
LE-003	421	192	46	908.0	22,803.0	21.0	140,000.0	94.0	687.0	1,642.0	205.0	370,000.0	3,262.0	5,444.0	803.0	130,000.0	175.0
LE-004	1278	504	39	2,495.0	46,798.0	35.0	340,000.0	171.0	1,661.0	3,392.0	323.0	860,000.0	8,138.0	14,040.0	1,770.0	220,000.0	268.0
LE-005	778	261	34	1,364.0	16,402.0	10.0	150,000.0	76.0	414.0	1,105.0	90.0	360,000.0	3,457.0	6,595.0	546.0	50,643.0	92.0
LE-006	1010	290	29	1,607.0	18,610.0	14.0	190,000.0	80.0	553.0	1,133.0	116.0	430,000.0	4,177.0	7,648.0	666.0	52,951.0	88.0
LE-007	1255	372	30	2,036.0	21,878.0	14.0	220,000.0	103.0	688.0	1,363.0	106.0	540,000.0	5,077.0	9,742.0	830.0	50,721.0	98.0
LE-008	891	261	29	1,435.0	17,117.0	9.0	170,000.0	101.0	502.0	1,203.0	89.0	390,000.0	3,876.0	6,836.0	671.0	43,624.0	64.0
LW-001	2664	1,605	60	7,056.0	140,000.0	189.0	1,100,000.0	858.0	3,409.0	8,199.0	2,104.0	2,600,000.0	24,286.0	36,537.0	5,103.0	910,000.0	1,471.0
LW-002	3550	1,999	56	8,935.0	180,000.0	243.0	1,300,000.0	1,102.0	4,976.0	11,580.0	2,680.0	3,400,000.0	32,404.0	48,204.0	7,075.0	1,200,000.0	1,987.0
LW-003	11154	5,890	53	27,715.0	500,000.0	584.0	4,000,000.0	2,943.0	16,013.0	32,096.0	6,552.0	9,900,000.0	95,090.0	140,000.0	24,306.0	3,000,000.0	4,398.0
LW-004	240	129	54	583.0	12,758.0	15.0	93,903.0	63.0	425.0	1,003.0	161.0	240,000.0	2,282.0	3,528.0	529.0	79,391.0	133.0
LW-005	1774	1,052	59	4,642.0	90,174.0	111.0	650,000.0	533.0	2,219.0	5,236.0	1,233.0	1,700,000.0	14,939.0	23,911.0	3,249.0	530,000.0	887.0
LW-006	1160	592	51	2,714.0	47,603.0	54.0	380,000.0	265.0	1,786.0	3,378.0	601.0	1,000,000.0	9,449.0	14,835.0	2,129.0	260,000.0	439.0
LW-007	1323	830	63	3,616.0	69,043.0	83.0	510,000.0	399.0	1,874.0	4,023.0	925.0	1,300,000.0	11,811.0	18,739.0	2,590.0	400,000.0	640.0
LW-008	4047	2,512	62	10,969.0	240,000.0	315.0	1,700,000.0	1,342.0	7,409.0	15,492.0	3,442.0	4,400,000.0	40,072.0	62,123.0	9,719.0	1,600,000.0	2,513.0
LW-009	1758	864	49	4,002.0	66,539.0	78.0	540,000.0	413.0	2,366.0	4,841.0	870.0	1,500,000.0	13,381.0	20,955.0	2,947.0	360,000.0	646.0
LW-010	1930	1,054	55	4,749.0	88,694.0	95.0	690,000.0	474.0	2,962.0	6,562.0	1,071.0	1,800,000.0	16,629.0	26,144.0	3,670.0	500,000.0	821.0
LW-011	589	378	64	1,638.0	35,437.0	42.0	230,000.0	188.0	842.0	2,211.0	461.0	590,000.0	5,255.0	8,669.0	1,208.0	220,000.0	354.0
LW-012	629	318	51	1,461.0	23,910.0	21.0	200,000.0	114.0	862.0	1,425.0	237.0	490,000.0	5,013.0	7,816.0	1,057.0	130,000.0	156.0
MON-001	1697	546	32	2,898.0	36,735.0	18.0	380,000.0	246.0	774.0	3,041.0	239.0	810,000.0	8,469.0	13,441.0	1,308.0	130,000.0	168.0
MON-002	655	197	30	1,071.0	14,724.0	8.0	150,000.0	123.0	351.0	1,179.0	121.0	320,000.0	3,348.0	4,918.0	610.0	49,624.0	60.0
MON-003	26	8	33	44.0	652.0	1.0	6,122.0	4.0	29.0	56.0	7.0	16,185.0	148.0	231.0	31.0	2,991.0	5.0
SOL-001	1302	629	48	2,928.0	53,966.0	65.0	440,000.0	311.0	1,981.0	3,949.0	721.0	1,100,000.0	10,769.0	16,456.0	2,464.0	320,000.0	532.0
SOL-002	683	381	56	1,707.0	27,596.0	31.0	230,000.0	177.0	894.0	1,913.0	379.0	620,000.0	5,676.0	8,581.0	1,171.0	150,000.0	250.0
SOL-003	681	320	47	1,502.0	23,113.0	30.0	220,000.0	149.0	842.0	1,578.0	350.0	540,000.0	5,253.0	7,901.0	1,111.0	130,000.0	243.0
SOL-004	123	101	82	415.0	8,153.0	9.0	52,761.0	50.0	131.0	478.0	115.0	150,000.0	1,149.0	1,939.0	240.0	42,589.0	77.0
SOL-005	75	34	45	161.0	2,600.0	3.0	22,441.0	17.0	98.0	181.0	37.0	59,143.0	556.0	862.0	126.0	15,244.0	28.0
YL-001	9854	2,879	29	15,851.0	180,000.0	133.0	2,000,000.0	1,109.0	5,048.0	12,655.0	1,563.0	4,600,000.0	45,521.0	73,025.0	7,391.0	720,000.0	1,047.0
YL-002	1228	413	34	2,158.0	25,461.0	24.0	260,000.0	176.0	750.0	1,745.0	262.0	640,000.0	6,137.0	10,121.0	1,085.0	100,000.0	199.0

Table E-14

Wekiva Parkway Protection Act

Master Stormwater Management Plan Support

Wet Season Pollutant Load Estimates - Future Land Use with 1% Septic Tank Failure Rate and Future BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
AP-001	15878	7,634	48	19,738.0	290,000.0	276.0	2,400,000.0	1,747.0	5,837.0	17,045.0	3,222.0	6,000,000.0	53,853.0	92,484.0	9,620.0	1,300,000.0	2,335.0
AP-002	8237	3,848	47	11,206.0	150,000.0	162.0	1,400,000.0	836.0	4,284.0	9,262.0	1,870.0	3,200,000.0	31,487.0	58,303.0	6,464.0	760,000.0	1,261.0
AP-003	25011	6,873	27	21,507.0	95,284.0	47.0	1,000,000.0	2,630.0	1,214.0	11,238.0	362.0	5,800,000.0	35,396.0	73,303.0	6,481.0	190,000.0	1,625.0
AP-004	9708	4,518	47	11,790.0	160,000.0	164.0	1,500,000.0	951.0	4,242.0	9,659.0	1,951.0	3,600,000.0	35,743.0	55,797.0	6,270.0	800,000.0	1,275.0
AP-005	13107	721	6	5,913.0	46,175.0	33.0	810,000.0	191.0	1,338.0	8,005.0	365.0	1,700,000.0	24,593.0	25,306.0	3,155.0	350,000.0	335.0
AP-006	1186	272	23	920.0	14,263.0	19.0	140,000.0	85.0	473.0	1,762.0	219.0	380,000.0	3,724.0	4,563.0	783.0	130,000.0	156.0
AP-007	10494	2,265	22	7,872.0	95,171.0	90.0	980,000.0	550.0	3,206.0	10,980.0	933.0	2,700,000.0	24,998.0	36,896.0	4,690.0	630,000.0	796.0
AS-001	772	103	13	461.0	4,026.0	1.0	59,428.0	33.0	76.0	401.0	19.0	140,000.0	1,281.0	1,823.0	162.0	11,843.0	8.0
BW-001	63	38	60	92.0	1,233.0	1.0	10,245.0	10.0	20.0	67.0	16.0	28,231.0	226.0	402.0	42.0	4,819.0	11.0
BW-002	1989	1,447	73	3,384.0	58,449.0	66.0	450,000.0	353.0	1,141.0	3,097.0	815.0	1,100,000.0	9,809.0	16,084.0	1,883.0	300,000.0	523.0
BW-003	344	188	55	469.0	7,032.0	8.0	62,883.0	43.0	253.0	439.0	93.0	160,000.0	1,528.0	2,426.0	321.0	35,020.0	65.0
BW-004	212	109	51	276.0	3,358.0	2.0	33,122.0	17.0	137.0	282.0	31.0	90,236.0	823.0	1,384.0	150.0	12,022.0	22.0
BW-006	2892	1,706	59	4,182.0	84,838.0	92.0	620,000.0	423.0	3,129.0	6,168.0	1,029.0	1,700,000.0	15,280.0	23,899.0	3,591.0	490,000.0	760.0
BW-007	742	467	63	1,127.0	25,515.0	33.0	180,000.0	136.0	825.0	1,684.0	359.0	460,000.0	4,454.0	6,584.0	1,047.0	170,000.0	263.0
BW-008	1418	617	44	1,643.0	20,962.0	20.0	210,000.0	123.0	816.0	1,579.0	242.0	540,000.0	5,034.0	8,264.0	972.0	89,028.0	175.0
BW-009	433	203	47	528.0	6,976.0	7.0	62,405.0	45.0	214.0	447.0	79.0	170,000.0	1,491.0	2,540.0	288.0	29,951.0	57.0
BW-010	907	455	50	1,162.0	18,790.0	24.0	160,000.0	130.0	593.0	1,314.0	272.0	420,000.0	3,941.0	5,919.0	821.0	120,000.0	204.0
BW-011	460	233	51	594.0	9,295.0	10.0	81,725.0	55.0	332.0	668.0	119.0	210,000.0	1,987.0	3,143.0	419.0	48,354.0	87.0
BW-012	228	127	56	316.0	3,778.0	4.0	37,727.0	23.0	83.0	170.0	46.0	87,929.0	830.0	1,467.0	134.0	13,887.0	30.0
BW-013	1143	430	38	1,199.0	15,737.0	16.0	150,000.0	101.0	528.0	1,169.0	195.0	360,000.0	3,781.0	5,899.0	733.0	83,041.0	136.0
BW-014	668	289	43	771.0	8,841.0	8.0	86,745.0	55.0	260.0	527.0	102.0	200,000.0	2,045.0	3,456.0	367.0	35,844.0	65.0
BW-015	1589	673	42	1,805.0	24,387.0	21.0	230,000.0	137.0	1,062.0	2,068.0	253.0	630,000.0	5,673.0	9,259.0	1,165.0	100,000.0	186.0
BW-016	1012	578	57	1,429.0	28,050.0	33.0	220,000.0	148.0	963.0	1,935.0	365.0	550,000.0	5,239.0	8,037.0	1,174.0	170,000.0	265.0
BW-017	2741	1,679	61	4,079.0	76,966.0	105.0	600,000.0	482.0	2,191.0	4,651.0	1,187.0	1,500,000.0	14,406.0	21,016.0	3,002.0	500,000.0	798.0
BW-018	7867	3,861	49	9,925.0	180,000.0	205.0	1,400,000.0	947.0	6,266.0	12,615.0	2,282.0	3,700,000.0	34,151.0	53,325.0	7,481.0	980,000.0	1,606.0
BW-019	2939	913	31	2,723.0	33,268.0	26.0	330,000.0	160.0	943.0	2,573.0	274.0	770,000.0	7,854.0	13,295.0	1,312.0	150,000.0	252.0
BW-020	1774	978	55	2,438.0	48,990.0	61.0	350,000.0	276.0	1,352.0	3,123.0	665.0	920,000.0	8,069.0	12,997.0	1,826.0	290,000.0	488.0
BW-021	3681	1,587	43	4,236.0	74,308.0	74.0	590,000.0	381.0	2,613.0	5,549.0	802.0	1,600,000.0	14,417.0	22,749.0	3,104.0	400,000.0	602.0
BW-022	15410	3,325	22	11,559.0	150,000.0	117.0	1,500,000.0	635.0	5,428.0	16,898.0	1,234.0	3,900,000.0	37,921.0	57,183.0	7,247.0	890,000.0	993.0
BW-023	26770	4,451	17	17,615.0	190,000.0	58.0	2,400,000.0	1,578.0	4,097.0	18,463.0	1,040.0	5,300,000.0	52,694.0	74,606.0	7,896.0	590,000.0	466.0
BW-024	330	88	27	279.0	4,858.0	5.0	39,772.0	25.0	235.0	409.0	51.0	110,000.0	1,119.0	1,612.0	271.0	34,993.0	39.0
BW-025	3949	1,833	46	6,692.0	57,169.0	43.0	330,000.0	313.0	1,531.0	48,232.0	623.0	890,000.0	9,442.0	74,284.0	2,855.0	240,000.0	408.0
BW-026	913	260	28	802.0	6,118.0	3.0	51,641.0	34.0	180.0	415.0	47.0	130,000.0	1,452.0	2,918.0	254.0	21,900.0	34.0
BW-027	84	60	71	141.0	2,929.0	3.0	19,257.0	15.0	127.0	233.0	34.0	62,208.0	501.0	778.0	126.0	16,301.0	23.0
BWC-001	2463	651	26	2,070.0	26,222.0	19.0	260,000.0	97.0	866.0	1,738.0	172.0	580,000.0	6,147.0	10,469.0	1,039.0	110,000.0	126.0
BWC-002	1416	543	38	1,503.0	23,593.0	21.0	190,000.0	96.0	631.0	1,293.0	196.0	440,000.0	4,223.0	7,608.0	771.0	96,155.0	135.0
BWC-003	3631	958	26	3,049.0	34,879.0	23.0	360,000.0	124.0	1,177.0	2,275.0	193.0	830,000.0	8,157.0	14,702.0	1,295.0	95,489.0	139.0

Table E-14

Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Wet Season Pollutant Load Estimates - Future Land Use with 1% Septic Tank Failure Rate and Future BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
BWC-004	576	98	17	383.0	2,343.0	1.0	39,908.0	11.0	59.0	127.0	12.0	89,481.0	827.0	1,426.0	81.0	4,614.0	8.0
BWC-005	1466	348	24	1,159.0	11,223.0	7.0	130,000.0	42.0	323.0	591.0	67.0	290,000.0	2,798.0	5,027.0	384.0	31,527.0	43.0
BWC-006	3839	682	18	2,607.0	18,640.0	12.0	290,000.0	83.0	478.0	1,148.0	105.0	640,000.0	5,938.0	10,124.0	637.0	41,805.0	71.0
BWC-007	1092	216	20	783.0	6,615.0	5.0	84,779.0	38.0	191.0	485.0	38.0	210,000.0	1,870.0	3,213.0	254.0	17,461.0	34.0
BWC-008	1701	448	26	1,426.0	15,927.0	11.0	170,000.0	79.0	480.0	1,075.0	94.0	390,000.0	3,738.0	6,637.0	600.0	44,534.0	73.0
BWC-009	1043	223	21	778.0	9,060.0	6.0	96,775.0	42.0	306.0	641.0	58.0	230,000.0	2,147.0	3,507.0	359.0	33,327.0	39.0
BWC-010	5134	1,183	23	3,991.0	35,051.0	14.0	430,000.0	365.0	748.0	3,039.0	191.0	1,100,000.0	9,813.0	15,925.0	1,511.0	81,668.0	151.0
BWC-011	1647	339	21	1,205.0	12,774.0	8.0	160,000.0	85.0	343.0	1,092.0	79.0	350,000.0	3,381.0	5,243.0	507.0	36,323.0	49.0
BWC-012	1075	206	19	758.0	6,110.0	4.0	84,250.0	23.0	188.0	388.0	32.0	190,000.0	1,866.0	3,204.0	233.0	16,221.0	23.0
BWC-013	6768	1,532	23	5,210.0	57,651.0	28.0	670,000.0	407.0	1,501.0	4,752.0	332.0	1,400,000.0	14,615.0	22,912.0	2,306.0	150,000.0	184.0
BWC-014	2397	483	20	1,735.0	15,797.0	12.0	200,000.0	65.0	421.0	988.0	103.0	460,000.0	4,157.0	7,129.0	527.0	44,245.0	70.0
BWC-015	1944	366	19	1,358.0	12,425.0	8.0	160,000.0	53.0	426.0	1,067.0	74.0	390,000.0	3,522.0	5,792.0	481.0	39,251.0	56.0
BWC-016	7724	1,939	25	6,301.0	79,994.0	47.0	820,000.0	499.0	2,271.0	6,339.0	510.0	1,900,000.0	18,379.0	29,192.0	3,180.0	280,000.0	334.0
BWC-017	9527	1,462	15	6,041.0	61,548.0	25.0	820,000.0	467.0	1,388.0	6,086.0	345.0	1,900,000.0	17,864.0	25,413.0	2,488.0	190,000.0	176.0
BWC-018	2880	546	19	2,020.0	20,795.0	12.0	260,000.0	141.0	544.0	1,832.0	124.0	590,000.0	5,658.0	8,685.0	830.0	60,355.0	78.0
BWC-019	4578	625	14	2,759.0	22,584.0	10.0	340,000.0	147.0	518.0	2,101.0	115.0	800,000.0	7,323.0	10,983.0	882.0	67,536.0	73.0
BWC-020	5537	1,106	20	3,988.0	37,643.0	22.0	480,000.0	244.0	998.0	3,000.0	223.0	1,100,000.0	10,424.0	16,687.0	1,468.0	99,593.0	143.0
BWC-021	3330	726	22	2,512.0	22,576.0	12.0	280,000.0	168.0	536.0	1,674.0	130.0	660,000.0	6,099.0	10,181.0	868.0	55,149.0	92.0
BWC-022	755	197	26	630.0	9,227.0	7.0	79,451.0	47.0	336.0	686.0	62.0	200,000.0	1,886.0	3,109.0	388.0	38,693.0	48.0
BWC-023	673	143	21	500.0	5,119.0	4.0	57,315.0	28.0	166.0	372.0	31.0	140,000.0	1,289.0	2,169.0	206.0	16,674.0	24.0
BWC-024	3242	678	21	2,391.0	22,447.0	9.0	290,000.0	175.0	504.0	1,778.0	124.0	620,000.0	6,233.0	9,757.0	878.0	51,203.0	57.0
BWC-025	210	40	19	147.0	1,140.0	0.0	16,986.0	8.0	25.0	79.0	6.0	35,580.0	352.0	568.0	42.0	2,217.0	2.0
GT-001	1551	591	38	1,640.0	27,920.0	27.0	190,000.0	179.0	792.0	1,970.0	264.0	570,000.0	4,735.0	8,077.0	1,083.0	150,000.0	232.0
GT-002	592	292	49	750.0	14,391.0	19.0	110,000.0	80.0	409.0	813.0	197.0	260,000.0	2,689.0	3,794.0	538.0	100,000.0	128.0
GT-003	1451	570	39	1,567.0	23,578.0	21.0	190,000.0	112.0	727.0	1,512.0	210.0	480,000.0	4,560.0	7,789.0	882.0	110,000.0	159.0
GT-004	1475	528	36	1,496.0	16,360.0	11.0	160,000.0	64.0	526.0	829.0	109.0	370,000.0	3,664.0	6,481.0	619.0	54,716.0	71.0
GT-005	1223	482	39	1,323.0	21,256.0	16.0	160,000.0	101.0	674.0	1,520.0	165.0	440,000.0	3,776.0	6,659.0	788.0	95,992.0	146.0
GT-006	1089	594	55	1,485.0	32,501.0	34.0	200,000.0	169.0	787.0	2,179.0	366.0	560,000.0	4,631.0	7,864.0	1,071.0	190,000.0	293.0
GT-007	1274	419	33	1,224.0	19,085.0	14.0	140,000.0	95.0	798.0	1,474.0	124.0	420,000.0	3,676.0	6,399.0	842.0	80,887.0	106.0
LE-001	1232	318	26	1,021.0	8,953.0	6.0	100,000.0	54.0	233.0	533.0	54.0	260,000.0	2,352.0	4,370.0	332.0	22,447.0	47.0
LE-002	1216	405	33	1,177.0	17,058.0	12.0	130,000.0	90.0	725.0	1,348.0	104.0	400,000.0	3,432.0	6,015.0	763.0	65,287.0	92.0
LE-003	421	192	46	503.0	12,648.0	12.0	75,146.0	52.0	381.0	911.0	114.0	200,000.0	1,809.0	3,020.0	445.0	73,936.0	97.0
LE-004	1278	504	39	1,384.0	25,958.0	19.0	190,000.0	95.0	921.0	1,881.0	179.0	480,000.0	4,514.0	7,788.0	982.0	120,000.0	149.0
LE-005	778	261	34	757.0	9,098.0	5.0	83,302.0	42.0	230.0	613.0	50.0	200,000.0	1,917.0	3,658.0	303.0	28,090.0	51.0
LE-006	1010	290	29	892.0	10,322.0	8.0	100,000.0	44.0	307.0	629.0	64.0	240,000.0	2,317.0	4,242.0	370.0	29,371.0	49.0
LE-007	1255	372	30	1,129.0	12,135.0	8.0	120,000.0	57.0	381.0	756.0	59.0	300,000.0	2,816.0	5,404.0	460.0	28,134.0	55.0
LE-008	891	261	29	796.0	9,494.0	5.0	94,120.0	56.0	279.0	667.0	50.0	220,000.0	2,150.0	3,792.0	372.0	24,197.0	35.0

Table E-14

Wekiva Parkway Protection Act

Master Stormwater Management Plan Support

Wet Season Pollutant Load Estimates - Future Land Use with 1% Septic Tank Failure Rate and Future BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
LW-001	2664	1,605	60	3,914.0	78,250.0	105.0	580,000.0	476.0	1,891.0	4,548.0	1,167.0	1,400,000.0	13,471.0	20,266.0	2,831.0	510,000.0	816.0
LW-002	3550	1,999	56	4,956.0	97,293.0	135.0	740,000.0	611.0	2,760.0	6,423.0	1,476.0	1,900,000.0	17,974.0	26,737.0	3,924.0	670,000.0	1,102.0
LW-003	11154	5,890	53	15,797.0	280,000.0	324.0	2,200,000.0	1,632.0	8,882.0	17,803.0	3,634.0	5,500,000.0	52,744.0	78,487.0	15,073.0	1,600,000.0	2,440.0
LW-004	240	129	54	323.0	7,077.0	8.0	52,085.0	35.0	236.0	556.0	89.0	130,000.0	1,266.0	1,957.0	293.0	44,036.0	74.0
LW-005	1774	1,052	59	2,575.0	50,017.0	62.0	360,000.0	296.0	1,231.0	2,904.0	684.0	930,000.0	8,286.0	13,263.0	1,802.0	290,000.0	492.0
LW-006	1160	592	51	1,505.0	26,404.0	30.0	210,000.0	147.0	991.0	1,874.0	333.0	570,000.0	5,241.0	8,228.0	1,181.0	140,000.0	243.0
LW-007	1323	830	63	2,006.0	38,296.0	46.0	280,000.0	221.0	1,039.0	2,231.0	513.0	730,000.0	6,551.0	10,394.0	1,437.0	220,000.0	355.0
LW-008	4047	2,512	62	6,084.0	130,000.0	174.0	930,000.0	745.0	4,110.0	8,593.0	1,909.0	2,500,000.0	22,227.0	34,458.0	5,391.0	860,000.0	1,394.0
LW-009	1758	864	49	2,220.0	36,907.0	43.0	300,000.0	229.0	1,312.0	2,685.0	483.0	820,000.0	7,422.0	11,623.0	1,634.0	200,000.0	358.0
LW-010	1930	1,054	55	2,634.0	49,196.0	53.0	380,000.0	263.0	1,637.0	3,640.0	594.0	970,000.0	9,224.0	14,501.0	2,036.0	280,000.0	455.0
LW-011	589	378	64	909.0	19,656.0	23.0	130,000.0	105.0	467.0	1,227.0	256.0	330,000.0	2,915.0	4,808.0	670.0	120,000.0	196.0
LW-012	629	318	51	811.0	13,262.0	12.0	110,000.0	63.0	478.0	791.0	131.0	270,000.0	2,780.0	4,335.0	586.0	71,848.0	87.0
MON-001	1697	546	32	1,607.0	20,376.0	10.0	210,000.0	136.0	430.0	1,687.0	133.0	450,000.0	4,698.0	7,455.0	725.0	72,394.0	93.0
MON-002	655	197	30	594.0	8,167.0	4.0	84,433.0	68.0	195.0	654.0	67.0	180,000.0	1,857.0	2,728.0	339.0	27,525.0	33.0
MON-003	26	8	33	25.0	362.0	0.0	3,396.0	2.0	16.0	31.0	4.0	8,978.0	82.0	128.0	17.0	1,659.0	3.0
SOL-001	1302	629	48	1,624.0	29,933.0	36.0	250,000.0	172.0	1,099.0	2,190.0	400.0	620,000.0	5,973.0	9,127.0	1,367.0	180,000.0	295.0
SOL-002	683	381	56	947.0	15,307.0	17.0	130,000.0	98.0	496.0	1,061.0	210.0	350,000.0	3,148.0	4,760.0	649.0	83,601.0	139.0
SOL-003	681	320	47	833.0	12,820.0	17.0	120,000.0	83.0	467.0	875.0	194.0	300,000.0	2,914.0	4,383.0	616.0	72,295.0	135.0
SOL-004	123	101	82	230.0	4,522.0	5.0	29,265.0	28.0	72.0	265.0	64.0	84,079.0	637.0	1,075.0	133.0	23,623.0	43.0
SOL-005	75	34	45	89.0	1,442.0	2.0	12,448.0	9.0	54.0	100.0	21.0	32,805.0	308.0	478.0	70.0	8,455.0	16.0
YL-001	9854	2,879	29	8,792.0	100,000.0	74.0	1,100,000.0	615.0	2,800.0	7,019.0	867.0	2,500,000.0	25,249.0	40,505.0	4,100.0	400,000.0	581.0
YL-002	1228	413	34	1,197.0	14,123.0	13.0	140,000.0	97.0	416.0	968.0	145.0	360,000.0	3,404.0	5,614.0	602.0	56,562.0	110.0

Table E-15
Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Dry Season Pollutant Load Estimates – Future Land Use with 1% Septic Tank Failure Rate and Future BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
AP-001	15878	7,634	48	15,847.0	230,000.0	222.0	1,900,000.0	1,403.0	4,687.0	13,685.0	2,587.0	4,800,000.0	43,237.0	74,253.0	7,723.0	1,000,000.0	1,875.0
AP-002	8237	3,848	47	9,229.0	120,000.0	130.0	1,100,000.0	671.0	3,439.0	7,437.0	1,501.0	2,600,000.0	25,280.0	48,355.0	5,297.0	610,000.0	1,013.0
AP-003	25011	6,873	27	17,267.0	76,500.0	38.0	800,000.0	2,111.0	975.0	9,023.0	291.0	4,700,000.0	28,418.0	58,853.0	5,204.0	150,000.0	1,305.0
AP-004	9708	4,518	47	9,466.0	130,000.0	132.0	1,200,000.0	763.0	3,405.0	7,755.0	1,567.0	2,900,000.0	28,697.0	44,797.0	5,034.0	650,000.0	1,024.0
AP-005	13107	721	6	4,747.0	37,072.0	26.0	650,000.0	153.0	1,074.0	6,427.0	293.0	1,300,000.0	19,745.0	20,317.0	2,533.0	280,000.0	269.0
AP-006	1186	272	23	738.0	11,451.0	15.0	120,000.0	68.0	380.0	1,414.0	176.0	300,000.0	2,990.0	3,664.0	629.0	110,000.0	125.0
AP-007	10494	2,265	22	6,320.0	76,409.0	72.0	790,000.0	441.0	2,574.0	8,816.0	749.0	2,200,000.0	20,070.0	29,622.0	3,765.0	510,000.0	639.0
AS-001	772	103	13	370.0	3,232.0	1.0	47,713.0	26.0	61.0	322.0	15.0	110,000.0	1,029.0	1,464.0	130.0	9,508.0	7.0
BW-001	63	38	60	74.0	990.0	1.0	8,225.0	8.0	16.0	54.0	13.0	22,666.0	181.0	322.0	33.0	3,869.0	9.0
BW-002	1989	1,447	73	2,717.0	46,927.0	53.0	360,000.0	284.0	916.0	2,487.0	654.0	900,000.0	7,876.0	12,913.0	1,512.0	240,000.0	420.0
BW-003	344	188	55	377.0	5,645.0	6.0	50,487.0	35.0	203.0	352.0	75.0	130,000.0	1,227.0	1,948.0	258.0	28,117.0	52.0
BW-004	212	109	51	222.0	2,696.0	2.0	26,593.0	14.0	110.0	227.0	25.0	72,447.0	661.0	1,111.0	121.0	9,652.0	18.0
BW-006	2892	1,706	59	3,358.0	68,114.0	74.0	500,000.0	340.0	2,512.0	4,952.0	826.0	1,300,000.0	12,268.0	19,188.0	2,883.0	390,000.0	610.0
BW-007	742	467	63	905.0	20,486.0	27.0	150,000.0	110.0	662.0	1,352.0	289.0	370,000.0	3,576.0	5,286.0	841.0	140,000.0	211.0
BW-008	1418	617	44	1,319.0	16,830.0	16.0	170,000.0	99.0	655.0	1,267.0	194.0	430,000.0	4,042.0	6,635.0	780.0	71,478.0	141.0
BW-009	433	203	47	424.0	5,600.0	5.0	50,103.0	36.0	172.0	359.0	64.0	140,000.0	1,197.0	2,039.0	232.0	24,047.0	45.0
BW-010	907	455	50	933.0	15,086.0	19.0	130,000.0	104.0	476.0	1,055.0	218.0	330,000.0	3,164.0	4,753.0	659.0	92,611.0	164.0
BW-011	460	233	51	477.0	7,463.0	8.0	65,614.0	44.0	267.0	537.0	96.0	170,000.0	1,595.0	2,524.0	336.0	38,822.0	70.0
BW-012	228	127	56	254.0	3,033.0	3.0	30,290.0	18.0	67.0	137.0	37.0	70,595.0	667.0	1,178.0	108.0	11,149.0	24.0
BW-013	1143	430	38	962.0	12,635.0	13.0	120,000.0	81.0	424.0	938.0	156.0	290,000.0	3,036.0	4,736.0	589.0	66,671.0	109.0
BW-014	668	289	43	619.0	7,098.0	7.0	69,645.0	44.0	209.0	423.0	82.0	160,000.0	1,642.0	2,775.0	295.0	28,778.0	52.0
BW-015	1589	673	42	1,449.0	19,580.0	17.0	180,000.0	110.0	853.0	1,660.0	203.0	500,000.0	4,554.0	7,434.0	935.0	82,511.0	149.0
BW-016	1012	578	57	1,147.0	22,520.0	27.0	170,000.0	118.0	773.0	1,554.0	293.0	440,000.0	4,206.0	6,453.0	943.0	130,000.0	213.0
BW-017	2741	1,679	61	3,275.0	61,793.0	84.0	490,000.0	387.0	1,759.0	3,734.0	953.0	1,200,000.0	11,566.0	16,873.0	2,410.0	400,000.0	641.0
BW-018	7867	3,861	49	7,969.0	140,000.0	165.0	1,100,000.0	761.0	5,031.0	10,128.0	1,832.0	3,000,000.0	27,419.0	42,813.0	6,006.0	790,000.0	1,289.0
BW-019	2939	913	31	2,186.0	26,710.0	21.0	270,000.0	128.0	757.0	2,066.0	220.0	620,000.0	6,306.0	10,674.0	1,054.0	120,000.0	202.0
BW-020	1774	978	55	1,958.0	39,332.0	49.0	280,000.0	221.0	1,085.0	2,507.0	534.0	740,000.0	6,478.0	10,435.0	1,466.0	230,000.0	392.0
BW-021	3681	1,587	43	3,401.0	59,660.0	60.0	480,000.0	306.0	2,098.0	4,455.0	644.0	1,300,000.0	11,575.0	18,265.0	2,492.0	320,000.0	484.0
BW-022	15410	3,325	22	9,281.0	120,000.0	94.0	1,200,000.0	510.0	4,358.0	13,567.0	990.0	3,100,000.0	30,446.0	45,910.0	5,818.0	710,000.0	797.0
BW-023	26770	4,451	17	14,142.0	150,000.0	46.0	1,900,000.0	1,267.0	3,289.0	14,823.0	835.0	4,300,000.0	42,307.0	59,898.0	6,339.0	470,000.0	374.0
BW-024	330	88	27	224.0	3,900.0	4.0	31,932.0	20.0	189.0	328.0	41.0	87,504.0	898.0	1,295.0	218.0	28,094.0	31.0
BW-025	3949	1,833	46	5,748.0	47,901.0	34.0	270,000.0	251.0	1,229.0	47,608.0	501.0	720,000.0	7,581.0	70,771.0	2,445.0	200,000.0	327.0
BW-026	913	260	28	644.0	4,912.0	2.0	41,461.0	27.0	144.0	333.0	38.0	110,000.0	1,166.0	2,343.0	204.0	17,583.0	27.0
BW-027	84	60	71	113.0	2,352.0	2.0	15,461.0	12.0	102.0	187.0	27.0	49,945.0	403.0	625.0	101.0	13,087.0	19.0
BWC-001	2463	651	26	1,662.0	21,053.0	15.0	210,000.0	78.0	695.0	1,396.0	138.0	460,000.0	4,936.0	8,405.0	834.0	86,072.0	101.0

Table E-15

Wekiva Parkway Protection Act

Master Stormwater Management Plan Support

Dry Season Pollutant Load Estimates – Future Land Use with 1% Septic Tank Failure Rate and Future BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
BWC-002	1416	543	38	1,207.0	18,942.0	16.0	150,000.0	77.0	507.0	1,038.0	157.0	360,000.0	3,391.0	6,108.0	619.0	77,199.0	108.0
BWC-003	3631	958	26	2,448.0	28,003.0	19.0	290,000.0	100.0	945.0	1,826.0	155.0	670,000.0	6,549.0	11,803.0	1,040.0	76,665.0	112.0
BWC-004	576	98	17	308.0	1,882.0	1.0	32,041.0	9.0	47.0	102.0	9.0	71,841.0	664.0	1,145.0	65.0	3,704.0	6.0
BWC-005	1466	348	24	931.0	9,010.0	6.0	100,000.0	34.0	259.0	475.0	54.0	230,000.0	2,246.0	4,036.0	308.0	25,312.0	34.0
BWC-006	3839	682	18	2,093.0	14,966.0	10.0	230,000.0	67.0	384.0	922.0	85.0	510,000.0	4,768.0	8,129.0	511.0	33,563.0	57.0
BWC-007	1092	216	20	629.0	5,311.0	4.0	68,066.0	30.0	153.0	389.0	31.0	170,000.0	1,501.0	2,580.0	204.0	14,019.0	27.0
BWC-008	1701	448	26	1,145.0	12,788.0	9.0	130,000.0	64.0	385.0	863.0	76.0	310,000.0	3,001.0	5,328.0	482.0	35,755.0	59.0
BWC-009	1043	223	21	624.0	7,274.0	5.0	77,697.0	33.0	245.0	514.0	47.0	180,000.0	1,724.0	2,816.0	288.0	26,757.0	31.0
BWC-010	5134	1,183	23	3,205.0	28,141.0	11.0	340,000.0	293.0	600.0	2,440.0	153.0	860,000.0	7,878.0	12,785.0	1,213.0	65,569.0	121.0
BWC-011	1647	339	21	967.0	10,256.0	6.0	120,000.0	68.0	276.0	876.0	64.0	280,000.0	2,714.0	4,209.0	407.0	29,162.0	39.0
BWC-012	1075	206	19	609.0	4,906.0	3.0	67,641.0	19.0	151.0	312.0	26.0	150,000.0	1,498.0	2,572.0	187.0	13,023.0	19.0
BWC-013	6768	1,532	23	4,183.0	46,286.0	22.0	540,000.0	327.0	1,205.0	3,815.0	267.0	1,200,000.0	11,734.0	18,396.0	1,851.0	120,000.0	148.0
BWC-014	2397	483	20	1,393.0	12,683.0	9.0	160,000.0	52.0	338.0	793.0	82.0	370,000.0	3,338.0	5,723.0	423.0	35,523.0	56.0
BWC-015	1944	366	19	1,091.0	9,976.0	7.0	130,000.0	42.0	342.0	856.0	59.0	310,000.0	2,828.0	4,650.0	386.0	31,514.0	45.0
BWC-016	7724	1,939	25	5,059.0	64,225.0	38.0	660,000.0	400.0	1,824.0	5,089.0	409.0	1,500,000.0	14,756.0	23,437.0	2,553.0	220,000.0	268.0
BWC-017	9527	1,462	15	4,850.0	49,415.0	20.0	660,000.0	375.0	1,099.0	4,886.0	277.0	1,500,000.0	14,342.0	20,403.0	1,997.0	150,000.0	142.0
BWC-018	2880	546	19	1,622.0	16,695.0	9.0	210,000.0	113.0	437.0	1,470.0	100.0	470,000.0	4,543.0	6,973.0	666.0	48,457.0	63.0
BWC-019	4578	625	14	2,215.0	18,132.0	8.0	270,000.0	118.0	416.0	1,686.0	92.0	640,000.0	5,880.0	8,817.0	709.0	54,223.0	58.0
BWC-020	5537	1,106	20	3,202.0	30,222.0	17.0	390,000.0	196.0	801.0	2,409.0	179.0	870,000.0	8,369.0	13,398.0	1,178.0	79,960.0	115.0
BWC-021	3330	726	22	2,017.0	18,125.0	9.0	220,000.0	134.0	430.0	1,344.0	104.0	530,000.0	4,897.0	8,174.0	697.0	44,277.0	74.0
BWC-022	755	197	26	506.0	7,408.0	6.0	63,789.0	38.0	269.0	551.0	50.0	160,000.0	1,515.0	2,496.0	312.0	31,065.0	38.0
BWC-023	673	143	21	401.0	4,110.0	3.0	46,016.0	22.0	133.0	299.0	25.0	110,000.0	1,035.0	1,741.0	166.0	13,387.0	19.0
BWC-024	3242	678	21	1,920.0	18,022.0	7.0	230,000.0	140.0	405.0	1,427.0	100.0	500,000.0	5,004.0	7,833.0	705.0	41,109.0	46.0
BWC-025	210	40	19	118.0	915.0	0.0	13,638.0	6.0	20.0	63.0	5.0	28,566.0	283.0	456.0	34.0	1,780.0	2.0
GT-001	1551	591	38	1,317.0	22,416.0	22.0	150,000.0	144.0	636.0	1,582.0	212.0	460,000.0	3,802.0	6,485.0	869.0	120,000.0	187.0
GT-002	592	292	49	602.0	11,554.0	15.0	89,591.0	64.0	328.0	653.0	158.0	210,000.0	2,159.0	3,046.0	432.0	81,114.0	103.0
GT-003	1451	570	39	1,258.0	18,930.0	17.0	160,000.0	90.0	584.0	1,214.0	169.0	390,000.0	3,661.0	6,254.0	708.0	86,847.0	127.0
GT-004	1475	528	36	1,201.0	13,135.0	9.0	130,000.0	51.0	423.0	666.0	87.0	300,000.0	2,942.0	5,203.0	497.0	43,929.0	57.0
GT-005	1223	482	39	1,062.0	17,066.0	13.0	130,000.0	81.0	541.0	1,220.0	132.0	350,000.0	3,031.0	5,346.0	632.0	77,069.0	118.0
GT-006	1089	594	55	1,192.0	26,094.0	27.0	160,000.0	136.0	632.0	1,750.0	294.0	450,000.0	3,718.0	6,314.0	860.0	150,000.0	235.0
GT-007	1274	419	33	983.0	15,323.0	11.0	110,000.0	76.0	641.0	1,184.0	100.0	340,000.0	2,952.0	5,137.0	676.0	64,941.0	85.0
LE-001	1232	318	26	820.0	7,188.0	5.0	83,117.0	43.0	187.0	428.0	43.0	210,000.0	1,889.0	3,509.0	267.0	18,022.0	38.0
LE-002	1216	405	33	945.0	13,695.0	10.0	110,000.0	72.0	582.0	1,082.0	84.0	320,000.0	2,755.0	4,830.0	612.0	52,417.0	74.0
LE-003	421	192	46	404.0	10,155.0	9.0	60,332.0	42.0	306.0	731.0	91.0	160,000.0	1,453.0	2,424.0	358.0	59,361.0	78.0
LE-004	1278	504	39	1,111.0	20,841.0	16.0	150,000.0	76.0	740.0	1,510.0	144.0	380,000.0	3,624.0	6,252.0	788.0	97,601.0	119.0

Table E-15

Wekiva Parkway Protection Act
Master Stormwater Management Plan Support
Dry Season Pollutant Load Estimates – Future Land Use with 1% Septic Tank Failure Rate and Future BMPs

Name	Tributary Area (acres)	DCIA (acres)	DCIA (%)	Flow	BOD	Cd	COD	Cu	DP	NO23	Pb	TDS	TKN	TN	TP	TSS	Zn
LE-005	778	261	34	608.0	7,304.0	4.0	66,880.0	34.0	184.0	492.0	40.0	160,000.0	1,539.0	2,937.0	243.0	22,553.0	41.0
LE-006	1010	290	29	716.0	8,287.0	6.0	82,689.0	36.0	246.0	505.0	51.0	190,000.0	1,860.0	3,406.0	297.0	23,581.0	39.0
LE-007	1255	372	30	907.0	9,743.0	6.0	97,089.0	46.0	306.0	607.0	47.0	240,000.0	2,261.0	4,338.0	369.0	22,588.0	44.0
LE-008	891	261	29	639.0	7,622.0	4.0	75,566.0	45.0	224.0	536.0	40.0	170,000.0	1,726.0	3,044.0	299.0	19,427.0	28.0
LW-001	2664	1,605	60	3,142.0	62,824.0	84.0	470,000.0	382.0	1,518.0	3,651.0	937.0	1,100,000.0	10,815.0	16,271.0	2,273.0	410,000.0	655.0
LW-002	3550	1,999	56	3,979.0	78,114.0	108.0	600,000.0	491.0	2,216.0	5,157.0	1,185.0	1,500,000.0	14,430.0	21,466.0	3,151.0	540,000.0	885.0
LW-003	11154	5,890	53	12,870.0	220,000.0	260.0	1,800,000.0	1,310.0	7,131.0	14,293.0	2,918.0	4,400,000.0	42,346.0	63,015.0	12,807.0	1,300,000.0	1,959.0
LW-004	240	129	54	260.0	5,682.0	7.0	41,817.0	28.0	189.0	447.0	72.0	100,000.0	1,016.0	1,571.0	235.0	35,355.0	59.0
LW-005	1774	1,052	59	2,067.0	40,157.0	50.0	290,000.0	237.0	988.0	2,332.0	549.0	750,000.0	6,653.0	10,648.0	1,447.0	240,000.0	395.0
LW-006	1160	592	51	1,209.0	21,199.0	24.0	170,000.0	118.0	795.0	1,504.0	268.0	460,000.0	4,208.0	6,606.0	948.0	120,000.0	195.0
LW-007	1323	830	63	1,611.0	30,747.0	37.0	230,000.0	178.0	834.0	1,791.0	412.0	590,000.0	5,260.0	8,345.0	1,153.0	180,000.0	285.0
LW-008	4047	2,512	62	4,885.0	110,000.0	140.0	750,000.0	598.0	3,300.0	6,899.0	1,533.0	2,000,000.0	17,845.0	27,665.0	4,328.0	690,000.0	1,119.0
LW-009	1758	864	49	1,782.0	29,632.0	35.0	240,000.0	184.0	1,053.0	2,156.0	387.0	660,000.0	5,959.0	9,332.0	1,312.0	160,000.0	288.0
LW-010	1930	1,054	55	2,115.0	39,498.0	42.0	310,000.0	211.0	1,314.0	2,922.0	477.0	780,000.0	7,405.0	11,643.0	1,634.0	220,000.0	365.0
LW-011	589	378	64	730.0	15,781.0	19.0	100,000.0	84.0	375.0	985.0	205.0	260,000.0	2,340.0	3,861.0	538.0	98,024.0	158.0
LW-012	629	318	51	651.0	10,648.0	10.0	90,026.0	51.0	384.0	635.0	106.0	220,000.0	2,232.0	3,481.0	471.0	57,684.0	69.0
MON-001	1697	546	32	1,290.0	16,359.0	8.0	170,000.0	110.0	345.0	1,354.0	107.0	360,000.0	3,772.0	5,986.0	582.0	58,123.0	75.0
MON-002	655	197	30	477.0	6,557.0	4.0	67,789.0	55.0	156.0	525.0	54.0	140,000.0	1,491.0	2,190.0	272.0	22,099.0	27.0
MON-003	26	8	33	20.0	290.0	0.0	2,726.0	2.0	13.0	25.0	3.0	7,208.0	66.0	103.0	14.0	1,332.0	2.0
SOL-001	1302	629	48	1,304.0	24,032.0	29.0	200,000.0	138.0	882.0	1,759.0	321.0	500,000.0	4,796.0	7,328.0	1,098.0	140,000.0	237.0
SOL-002	683	381	56	760.0	12,289.0	14.0	100,000.0	79.0	398.0	852.0	169.0	280,000.0	2,528.0	3,822.0	521.0	67,120.0	111.0
SOL-003	681	320	47	669.0	10,293.0	13.0	97,611.0	66.0	375.0	703.0	156.0	240,000.0	2,339.0	3,519.0	495.0	58,043.0	108.0
SOL-004	123	101	82	185.0	3,631.0	4.0	23,496.0	22.0	58.0	213.0	51.0	67,504.0	512.0	863.0	107.0	18,966.0	34.0
SOL-005	75	34	45	72.0	1,158.0	2.0	9,994.0	8.0	43.0	80.0	17.0	26,338.0	248.0	384.0	56.0	6,788.0	13.0
YL-001	9854	2,879	29	7,059.0	82,181.0	59.0	890,000.0	494.0	2,248.0	5,636.0	696.0	2,000,000.0	20,272.0	32,520.0	3,291.0	320,000.0	466.0
YL-002	1228	413	34	961.0	11,339.0	11.0	120,000.0	78.0	334.0	777.0	117.0	290,000.0	2,733.0	4,507.0	483.0	45,412.0	88.0

Table E-16
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Estimated Annual Pollutant Loading Rates

Name	Tributary Area (acres)	Total Pollutant Load (lbs/yr)	Loading Rate (lbs/yr/ac)
BW-027	84	180,061	2143.6
BW-007	742	1,513,547	2039.8
LW-008	4,047	8,092,030	1999.5
SOL-004	122	221,170	1812.9
LW-011	589	1,065,223	1808.5
BW-006	2,892	5,109,870	1766.9
LW-002	3,550	6,083,098	1713.5
LW-004	240	401,161	1671.5
BW-017	2,740	4,524,962	1651.4
BW-016	1,012	1,626,608	1607.3
LW-007	1,323	2,121,420	1603.5
GT-006	1,090	1,706,084	1565.2
LE-003	422	655,568	1553.5
LW-010	1,930	2,960,927	1534.2
LW-005	1,784	2,711,012	1519.6
BW-020	1,774	2,656,942	1497.7
LW-003	11,154	16,700,019	1497.2
SOL-001	1,301	1,931,422	1484.6
LW-001	2,664	3,913,193	1468.9
LW-006	1,160	1,688,732	1455.8
BW-002	1,989	2,787,856	1401.6
BW-018	7,866	11,018,946	1400.8
SOL-002	682	952,175	1396.2
LW-012	629	861,739	1370.0
LW-009	1,758	2,360,185	1342.5
SOL-005	76	101,226	1331.9
BW-011	460	612,409	1331.3
BW-010	907	1,194,074	1316.5
SOL-003	682	888,742	1303.1
BW-021	3,681	4,612,173	1253.0
GT-002	593	742,469	1252.1
BW-003	344	398,742	1159.1
BW-004	210	234,736	1117.8
BW-015	1,589	1,735,858	1092.4
GT-001	1,551	1,660,990	1070.9
BW-024	330	351,238	1064.4
BW-008	1,416	1,504,938	1062.8
AP-002	8,237	8,489,632	1030.7
BW-009	434	433,591	999.1
MON-003	26	25,780	991.5
LE-004	1,278	1,252,372	979.9
GT-005	1,223	1,187,037	970.6
BW-013	1,143	1,034,719	905.3
GT-007	1,274	1,113,431	874.0

Table E-16
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Estimated Annual Pollutant Loading Rates

Name	Tributary Area (acres)	Total Pollutant Load (lbs/yr)	Loading Rate (lbs/yr/ac)
BW-012	237	207,055	873.6
GT-003	1,451	1,267,294	873.4
AP-001	15,879	13,711,214	863.5
AP-004	9,708	8,245,157	849.3
MON-002	655	534,282	815.7
LE-002	1,216	974,426	801.3
BW-014	668	529,410	792.5
AP-006	1,186	909,188	766.6
BW-001	65	49,403	760.0
YL-002	1,229	928,037	755.1
BW-025	190	140,824	741.2
BW-033	412	305,069	741.2
BW-028	512	379,261	741.2
BW-029	1,021	756,372	741.2
BW-030	1,155	855,838	741.2
BW-031	426	315,371	741.2
BW-032	185	136,747	741.2
BWC-022	755	556,867	737.6
BW-019	2,940	2,130,621	724.7
BWC-002	1,416	1,007,782	711.7
YL-001	9,854	6,974,174	707.8
MON-001	1,697	1,182,721	696.9
AP-007	10,494	6,590,984	628.1
BW-022	15,208	9,184,849	603.9
BW-023	26,770	15,257,099	569.9
GT-004	1,476	835,302	565.9
BWC-016	7,725	4,331,023	560.7
LE-005	778	427,060	548.9
AP-003	25,030	13,585,107	542.8
BWC-024	3,242	1,749,327	539.6
LE-008	891	465,156	522.1
BWC-001	2,463	1,280,584	519.9
BWC-013	6,768	3,498,088	516.9
BWC-021	3,331	1,670,009	501.4
BWC-009	1,043	522,746	501.2
LE-006	1,010	505,144	500.1
LE-007	1,255	626,640	499.3
BWC-010	5,134	2,561,860	499.0
BWC-023	673	335,761	498.9
BWC-020	5,540	2,710,941	489.3
BWC-017	9,563	4,669,900	488.3
BWC-008	1,700	823,177	484.2
AS-001	772	365,939	474.0
BWC-003	3,636	1,706,895	469.4

Table E-16
Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Estimated Annual Pollutant Loading Rates

Name	Tributary Area (acres)	Total Pollutant Load (lbs/yr)	Loading Rate (lbs/yr/ac)
BWC-011	1,647	728,653	442.4
BWC-018	2,788	1,230,937	441.5
BWC-025	210	90,669	431.8
BWC-007	1,092	456,990	418.5
AP-005	13,107	5,451,354	415.9
BWC-019	4,578	1,889,020	412.6
BWC-015	1,945	795,791	409.1
BWC-014	2,397	965,826	402.9
BW-026	913	336,441	368.5
BWC-006	3,839	1,405,822	366.2
BWC-012	1,075	372,924	346.9
BWC-004	576	185,428	321.9
LE-001	1,233	396,408	321.5
BWC-005	1,466	344,564	235.0

**Wekiva Parkway & Protection Act
Master Stormwater Management Plan Support
Estimated Percent Increase in Pollutant Loads**

Estimated Percent Increase in Pollutant Loads					Jurisdiction Affected													
Name	Tributary Area (acres)	Existing Pollutant Loading Rate (lbs/yr/ac)	Future Pollutant Loading Rate (lbs/yr/ac)	Estimated Percent Increase in Pollutant Load	Lake County	Eustis	Mount Dora	Orange County	Apopka	Eatonville	Oakland	Ocoee	Orlando	Winter Garden	Seminole County	Altamonte Springs	Longwood	Lake Mary
BWC-005	1,466	235	584	59.7%	✓													
LE-001	1,233	321	594	45.9%	✓	✓	✓											
BW-001	65	760	1,260	39.7%				✓			✓							
BWC-003	3,636	469	674	30.3%	✓													
BWC-012	1,075	347	495	30.0%	✓													
BWC-018	2,788	442	629	29.8%	✓													
LE-006	1,010	500	701	28.6%	✓	✓												
BWC-015	1,945	409	569	28.1%	✓													
BWC-011	1,647	442	613	27.9%	✓													
LE-005	778	549	759	27.7%	✓	✓												
BWC-008	1,700	484	667	27.4%	✓													
BWC-002	1,416	712	976	27.1%	✓													
LE-008	891	522	713	26.8%	✓	✓												
BWC-001	2,463	520	710	26.8%	✓			✓										
BWC-014	2,397	403	549	26.6%	✓													
AP-004	9,708	849	1,156	26.5%				✓	✓			✓						
LE-007	1,255	499	679	26.5%	✓													
AP-006	1,186	767	1,036	26.0%				✓										
AP-001	15,879	863	1,164	25.8%				✓			✓	✓		✓				
BWC-004	576	322	434	25.8%	✓		✓											
BWC-006	3,839	366	484	24.3%	✓													
GT-004	1,476	566	741	23.6%	✓		✓											
BWC-016	7,725	561	733	23.5%	✓													
BW-022	15,208	604	776	22.2%	✓			✓	✓									
BWC-009	1,043	501	643	22.1%	✓													
BW-012	237	874	1,120	22.0%				✓				✓						
BW-002	1,989	1,402	1,773	21.0%				✓				✓		✓				
BWC-007	1,092	418	527	20.6%	✓													
BW-003	344	1,159	1,442	19.6%				✓				✓						
LW-001	2,664	1,469	1,817	19.1%				✓					✓					
BWC-013	6,768	517	630	18.0%	✓													
AP-007	10,494	628	766	18.0%	✓		✓	✓										
GT-002	593	1,252	1,506	16.8%	✓		✓	✓										
AP-002	8,237	1,031	1,237	16.7%				✓	✓		✓	✓		✓				
LE-004	1,278	980	1,173	16.5%	✓	✓												
BWC-023	673	499	591	15.6%	✓													
BW-014	668	793	935	15.2%				✓				✓						
GT-003	1,451	873	1,030	15.2%	✓		✓											
BW-026	913	369	432	14.8%				✓	✓									
MON-001	1,697	697	818	14.7%											✓			
BWC-019	4,578	413	484	14.7%	✓													
SOL-004	122	1,813	2,116	14.3%														✓
LE-002	1,216	801	934	14.2%	✓	✓												

Table E-17

Wekiva Parkway & Protection Act

Master Stormwater Management Plan Support

Estimated Percent Increase in Pollutant Loads

Jurisdiction Affected

Name	Tributary Area (acres)	Existing Pollutant Loading Rate (lbs/yr/ac)	Future Pollutant Loading Rate (lbs/yr/ac)	Estimated Percent Increase in Pollutant Load	Lake County	Eustis	Mount Dora	Orange County	Apopka	Eatonville	Oakland	Ocoee	Orlando	Winter Garden	Seminole County	Altamonte Springs	Longwood	Lake Mary
BWC-010	5,134	499	574	13.1%	✓													
BWC-017	9,563	488	560	12.9%	✓										✓			
BWC-020	5,540	489	557	12.1%	✓													
BWC-025	210	432	491	12.0%	✓													
YL-002	1,229	755	853	11.5%											✓			
BW-020	1,774	1,498	1,688	11.3%				✓							✓			
BWC-021	3,331	501	564	11.2%	✓													
BW-019	2,940	725	814	11.0%				✓	✓			✓						
BW-009	434	999	1,122	10.9%				✓				✓						
LW-005	1,784	1,520	1,697	10.4%				✓		✓								
BW-017	2,740	1,651	1,837	10.1%				✓				✓			✓			
GT-007	1,274	874	966	9.6%	✓	✓												
BW-013	1,143	905	1,000	9.5%				✓				✓						
SOL-002	682	1,396	1,537	9.2%											✓		✓	✓
GT-005	1,223	971	1,068	9.1%	✓		✓											
YL-001	9,854	708	778	9.0%	✓			✓							✓			✓
BW-010	907	1,317	1,444	8.8%				✓				✓						
LW-007	1,323	1,603	1,756	8.7%				✓							✓	✓		
BWC-022	755	738	807	8.6%	✓													
BW-016	1,012	1,607	1,745	7.9%				✓				✓						
LW-004	240	1,672	1,812	7.7%				✓					✓					
AS-001	772	474	513	7.7%	✓										✓			
BW-004	210	1,118	1,205	7.2%				✓				✓						
LW-009	1,758	1,343	1,432	6.2%				✓	✓						✓	✓		
LW-003	11,154	1,497	1,591	5.9%				✓					✓		✓	✓	✓	
LW-010	1,930	1,534	1,628	5.8%											✓	✓		
BW-011	460	1,331	1,407	5.4%				✓				✓						
BW-021	3,681	1,253	1,317	4.9%				✓	✓									
BW-008	1,416	1,063	1,117	4.9%				✓				✓						
GT-006	1,090	1,565	1,645	4.8%	✓	✓	✓											
SOL-003	682	1,303	1,367	4.6%											✓			✓
BW-018	7,866	1,401	1,456	3.8%				✓	✓			✓						
LE-003	422	1,553	1,602	3.0%	✓	✓												
BWC-024	3,242	540	556	2.9%	✓													
LW-011	589	1,809	1,861	2.8%											✓	✓		
MON-003	26	992	1,019	2.7%											✓			
BW-015	1,589	1,092	1,122	2.6%				✓				✓						
GT-001	1,551	1,071	1,099	2.6%	✓		✓	✓										
BW-023	26,770	570	585	2.6%	✓			✓							✓			
BW-006	2,892	1,767	1,810	2.4%				✓										
MON-002	655	816	834	2.2%											✓			
BW-007	742	2,040	2,083	2.1%				✓					✓					

Appendix C

Correspondence received from Dr. York

Heinen, Erin

From: Drew, Richard [Richard.Drew@dep.state.fl.us]
Sent: Tuesday, March 06, 2007 11:11 AM
To: Hall, Bonnie
Cc: Ferraro, Chris
Subject: FW: Nitrogen Removal by Reuse Systems
Follow Up Flag: Follow up
Flag Status: Completed

From: York, David
Sent: Tuesday, March 06, 2007 9:10 AM
To: Drew, Richard
Cc: Sawicki, Sharon; Potts, Elsa; Walker-Coleman, Lauren J.; Ferraro, Chris
Subject: Nitrogen Removal by Reuse Systems

Richard --

Per your request, I reviewed available literature related to reductions in total nitrogen (TN) by land application and reuse activities. I focused on published reports, manuals, and other book-length references. A couple of notes:

1. There is a fair amount of variability in the data -- particularly for rapid infiltration basins (RIBs). For irrigation systems, TN reductions are reported to range from 67% to over 85%. For RIBs, the range is much wider -- extending from 0% to 93%.
2. The degree of preapplication treatment (affecting the distribution of TN among the various forms of nitrogen; and the remaining carbon content as needed to support denitrification), cropping system (for irrigation projects), loading rates, operational strategies (particularly wetting/drying cycles for RIBs), the site-specific hydrogeology, and temperature all will affect removal percentages and concentrations being released to ground water.
3. I am presenting my best assessment of average percent removals. I have not selected the absolute "best" (highest percent removals) reported. However, I certainly have not been pessimistic -- I definitely did not select the lowest percent removals reported. Generally, the value I recommend represent somewhat of an approximation of the modal value.
4. For irrigation systems, TN removal occurs primarily by vegetative uptake and by nitrification/denitrification. I have not attempted to account for other fertilizer application, as would be expected in irrigation of a golf course, residential lawns, or some other landscaped areas.

3/19/2007

5. For RIBs, TN removal occurs primarily by nitrification/denitrification. Wetting and drying cycles play a significant role here.

6. My recommended average percent reductions are generally consistent with the limited site specific data that I have seen.

My recommended values for expected reductions in TN:

1. Irrigation systems (slow-rate systems) -- 80%

2. RIBs (and other rapid rate systems) -- 50%

I hope this will be of use. I will be pleased to discuss further, if you would like.

Good luck. -- David

**David York, Ph.D., P.E.
Water Reuse Coordinator
Florida Department of Environmental Protection
2600 Blair Stone Rd. - MS 3540
Tallahassee, FL 32399-2400
850-245-8610
850-245-8621 (fax)
david.york@dep.state.fl.us**

For information about water reuse in Florida,
be sure to check out www.dep.state.fl.us/water/reuse

Appendix D

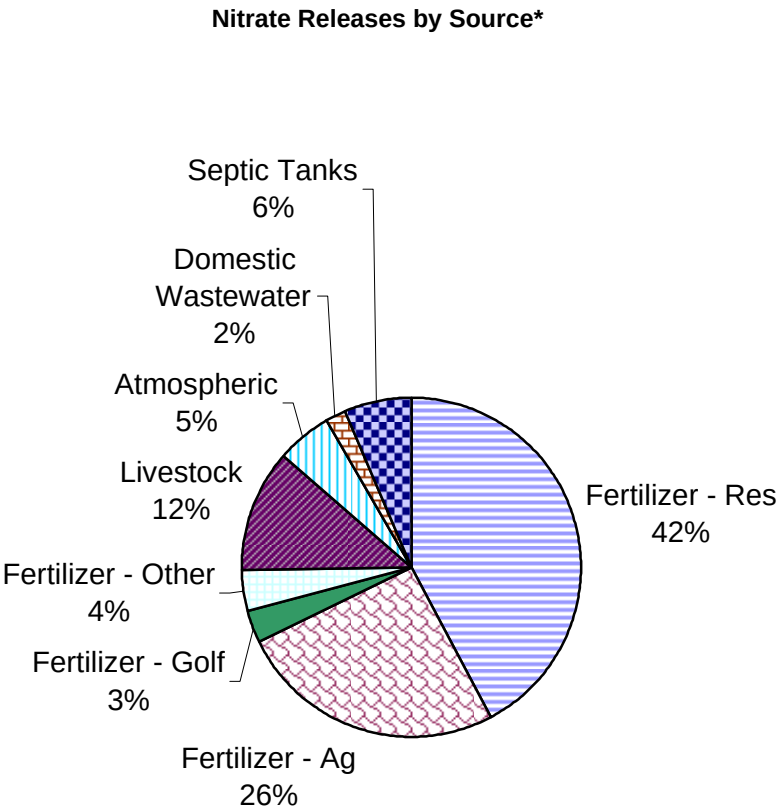
Inputs Summary

Phase I Report
Wekiva River and Basin Nitrate Sourcing Study

APPENDIX D. INPUTS SUMMARY

Table 1. Inputs by Source Type

Fertilizer		
Source (by Land Use)	Land Use Description	Fertilizer kg/ha/year
Residential	Low, medium, high density residential	148
Other	Commercial, institutional, recreation, transportation	200
Agricultural	Cropland, pastureland, field crops	150
	Improved pasture, horse farms	63
	Unimproved pasture, woodland pasture	0
	Row crops	630
	Tree crops	227
	Feeding operations	0
	Sod farms, floriculture, specialty farms	200
Golf Course	Golf courses	175
Source (by Type)		
Septic Tanks		
	Loading Rate lb N/year	20
Livestock Waste		
	Pasture Cattle/acre	0.3
	Feedlots Cattle/acre	30
	Nitrate from Cattle kg/year	56
Atmospheric Deposition		
	Rural Loading Rate kg/ha/year	2.57
	Urban Loading Rate kg/ha/year	4.18
Domestic Wastewater		
	Loading Rate metric tons/year	189



* - same figure as Figure 3.1 in Section 3.1.

Phase I Report
Wekiva River and Basin Nitrate Sourcing Study

APPENDIX D. INPUTS SUMMARY

Table 2. Inputs by Land Use and Source Type

Inputs by Land Use							Inputs by Source Type								Totals	
							Animal Waste		Atmospheric Deposition		Septic Tanks			Domestic Wastewater ^(a)		
Land Use Type	Acres	Hectares	Fertilizer kg/ha/yr (from Table 1)	% Impervious	Fertilizer Subtotal (kg/ha/yr)	Fertilizer Total (kg/yr)	kg/ha/yr	kg/yr	kg/ha/yr	kg/yr	kg/ha/yr	kg/yr	# of Septic Tanks	kg/yr	Total Nitrate (kg/ha/yr)	Total Nitrate (MT/yr)
1100: Residential, low density - less than 2 dwelling units/acre	32,024	12,960	148	14.70%	126	1,636,074	0	0	2.57	33,306	5.33	69,042	7,610		134	1,738
1200: Residential, medium density - 2-5 dwelling units/acre	49,320	19,959	148	27.80%	107	2,132,740	0	0	4.18	83,429	19.50	389,134	42,894		131	2,605
1300: Residential, high density - 6 or more dwelling units/acre	8,929	3,613	148	67.00%	49	176,476	0	0	4.18	15,104	16.23	58,638	6,464		69	250
1400: Commercial and services	9,808	3,969	200	94.25%	12	45,644	0	0	4.18	16,590	3.94	15,654	1,725		20	78
1500: Industrial	3,231	1,307	0		0	0	0	0	2.57	3,360	2.28	2,982	329		5	6
1600: Extractive	2,211	895	0		0	0	0	0	2.57	2,300	0.28	251	28		3	3
1700: Institutional	3,593	1,454	200	91.00%	18	26,175	0	0	2.57	3,737	1.29	1,871	206		22	32
1800: Recreational	2,802	1,134	200	1.50%	197	223,389	0	0	2.57	2,914	0.56	634	70		200	227
1820: Golf courses	4,045	1,637	175	0.00%	175	286,474	0	0	2.57	4,207	0.65	1,072	118		178	292
1900: Open land	3,141	1,271	0	0.00%	0	0	0	0	2.57	3,267	2.81	3,574	394		5	7
2100: Cropland and pastureland	59	24	150	0.00%	150	3,600	0	0	2.57	62	0	0	0		153	4
2110: Improved pastures (monocult, planted forage crops)	28,217	11,419	63	0.00%	63	719,402	41	473,846	2.57	29,347	0.77	8,793	969		108	1,231
2120: Unimproved pastures	12,540	5,075	0	0.00%	0	0	41	210,587	2.57	13,042	0.26	1,325	146		44	225
2130: Woodland pastures	5,025	2,033	0	0.00%	0	0	41	84,377	2.57	5,226	0.45	909	100		45	91
2140: Row crops	821	332	630	0.00%	630	209,328	0	0	2.57	854	0.03	11	1		633	210
2150: Field crops	3,650	1,477	150	0.00%	150	221,536	0	0	2.57	3,796	0.41	608	67		153	226
2200: Tree crops	12,582	5,092	227	0.00%	227	1,155,819	0	0	2.57	13,086	0.56	2,839	313		230	1,172
2300: Feeding operations	162	66	0	0.00%	0	0	4,150	272,135	2.57	169	0.41	27	3		4,153	272
2400: Nurseries and vineyards	157	64	227	0.00%	227	14,421	0	0	2.57	163	1.70	108	12		231	15
2410: Tree nurseries	277	112	227	0.00%	227	25,448	0	0	2.57	288	0.70	78	9		230	26
2420: Sod farms	1,106	448	200	0.00%	200	89,544	0	0	2.57	1,151	0	0	0		203	91
2430: Ornamentals	5,704	2,308	227	0.00%	227	523,957	0	0	2.57	5,932	2.11	4,875	537		232	535
2450: Floriculture	21	9	200	0.00%	200	1,704	0	0	2.57	22	3.20	27	3		206	2
2500: Specialty farms	128	52	200	0.00%	200	10,386	0	0	2.57	133	1.04	54	6		204	11
2510: Horse farms	3,163	1,280	63	0.00%	63	80,650	41	53,121	2.57	3,290	1.13	1,443	159		108	139
2540: Aquaculture	29	12	0	0.00%	0	0	0	0	2.57	30	0.00	0	0		3	0
2600: Other open lands - rural	268	108	0	0.00%	0	0	0	0	2.57	279	0.18	19	2		3	0
3000: Upland Nonforested	21,237	8,594	0	0.00%	0	0	0	0	2.57	22,088	0.49	4,243	468		3	26
4000: Upland Forests (25% forested cover)	75,745	30,653	0	0.00%	0	0	0	0	2.57	78,778	0.42	12,763	1,407		3	92
5000: Water	34,676	14,033	0	0.00%	0	0	0	0	2.57	36,065	0.34	4,829	532		3	41
6000: Wetlands	72,795	29,459	0	0.00%	0	0	0	0	2.57	75,709	0.21	6,148	678		3	82
7000: Barren land	10,291	4,165	0	0.00%	0	0	0	0	2.57	10,703	0.04	151	17		3	11
8000: Transportation, Communication, and Utilities	7,489	3,031	200	85.00%	30	90,925	0	0	4.18	12,669	0.40	1,203	133	189,000	35	105
TOTALS	415,247	168,044	3,983		3,277	7,673,688	4,316	1,094,066	91	481,096	68	593,302	65,399	189,000		9,842

Notes:
(a) - Calculated from data in Appendix E, Table 2.

Appendix E

Wastewater Facilities Summary

Phase I Report
Wekiva River and Basin Nitrate Sourcing Study

APPENDIX E. WASTEWATER FACILITIES SUMMARY

Table 1. Summary of groundwater, surface water, and reuse nitrate discharge.

FACILITY ID	NAME	Current Condition			Implementation of 62-600.550 (WSA only)			Implementation of 62-600.550 (Basin)		
		GW DISCHARGE (MT/YR)	SW DISCHARGE (MT/YR)	REUSE (MT/YR)	GW DISCHARGE (MT/YR)	SW DISCHARGE (MT/YR)	REUSE (MT/YR)	GW DISCHARGE (MT/YR)	SW DISCHARGE (MT/YR)	REUSE (MT/YR)
FLA010795	CONSERV II DISTRIBUTION CENTER	121.4	0.0	81.3	121.4	0.0	81.3	121.4	0.0	81.3
FLA010798	OCUD/NORTHWEST WATER RECLAMATION FACILITY	26.0	1.2	0.0	9.6	1.2	0.0	9.6	1.2	0.0
FLA010818	APOPKA WRF - PROJECT ARROW	15.8	0.0	0.0	5.1	0.0	0.0	5.1	0.0	0.0
FL0036251	WEKIVA HUNT CLUB	1.3	0.0	4.4	0.7	0.0	2.2	0.7	0.0	2.2
FLA010815	OCOEE, CITY OF	5.4	7.7	16.7	1.4	2.0	4.3	1.4	2.0	4.3
FLA010512	CLERMONT/WEST WWTF #1	1.2	0.0	6.2	1.0	0.0	5.2	1.0	0.0	5.2
FLA011105	SHADOW HILLS WWTF	3.7	0.0	0.0	3.7	0.0	0.0	3.7	0.0	0.0
FLA010865	ZELLWOOD STATION MHP	0.8	0.0	0.0	0.8	0.0	0.0	0.5	0.0	0.0
FLA010855	COCA-COLA/APOPKA FACILITY	1.3	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0
FLA295965	EUSTIS - EASTERN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLA010660	LAKE COUNTY CORRECTIONAL	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLA185761	QUAIL VALLEY	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
FLA010656	SUNSHINE PARKWAY WWTF	0.2	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0
FLA010538	CLERBROOK RV RESORTS	0.5	0.0	0.0	0.5	0.0	0.0	0.5	0.0	0.0
FLA010541	WEKIVA FALLS RESORT	0.5	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0
FLA010851	CLARCONA RESORT CONDO	0.3	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0
FLA010833	MONTEREY MUSHROOM FARM (TERRY FARMS)	0.5	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0
FLA010498	SEMINOLE SPRINGS ELEMENTARY SCHOOL WWTF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL DISCHARGE (MT/YR)		180	9	109	146	3	93	145	3	93
GRAND TOTAL DISCHARGE (MT/YR)		298			242			241		

Notes:

MT/YR = metric tons per year

= indicates change in amount of groundwater discharge due to implementation of 62-600.550, FAC.

Created by: SAR 3/19/07

Checked by: WAT 3/26/07

Phase I Report
Wekiva River and Basin Nitrate Sourcing Study
APPENDIX E. WASTEWATER FACILITIES SUMMARY

Table 2. Groundwater, surface water, and reuse nitrate discharge by facility, current condition.

	GW DISCHARGE (MT/YR)	SW DISCHARGE (MT/YR)	REUSE (MT/YR)	FACILITY ID	NAME	CAPACITY (MGD)	GROUNDWATER DISCHARGE	ALLOWABLE DISCHARGE (MGD)	ACTUAL DISCHARGE (MGD)	CONCENTRATION (MG/L)	RELEASE (MT/YR)	SURFACE WATER DISCHARGE	ALLOWABLE DISCHARGE (MGD)	ACTUAL DISCHARGE (MGD)	CONCENTRATION (MG/L)	RELEASE (MT/YR)	RECLAMATION/R EUSE	ALLOWABLE DISCHARGE	ACTUAL DISCHARGE	CONCENTRATION (MG/L)	RELEASE (MT/YR)	WAVA PROTECTION ZONE	WSA											
TOTAL DISCHARGE (MT/YR) GRAND TOTAL DISCHARGE (MT/YR)	121.4	0.0	81.3	FLA010795	CONSERV II DISTRIBUTION CENTER	80.9	RIBS	29.2	19.528	4.5	121.4						slow rate public access reuse system	51.93	13.07	4.5	81.3	TERTIARY	NO											
	26.0	1.2	0.0	FLA010798	OCUD/NORTHWEST WATER RECLAMATION FACILITY	7.9	RIBS	4.5	3.3	5.7	26.0	Effluent to Lake Marden	3		0.3	1.2				5.7	0.0	SECONDARY	YES											
	15.8	0.0	0.0					slow rate restricted public access system (enhanced wetlands)	3	1.762	6.5	15.8											SECONDARY	YES										
	1.3	0.0	4.4	FLA010818	APOPKA WRF - PROJECT ARROW	4	slow rate restricted public access land application system	2	0.6	1.6	1.3						slow rate public access land application system	4.0	1.99	1.6	4.4	SECONDARY	YES											
	5.4	7.7	16.7	FL0036251	WEKIVA HUNT CLUB	2.9	RIBS	0.4	0.423	9.3	5.4	surface water discharge Sweetwater Creek/Cove Lake	2.9	0.599	9.3	7.7	slow rate public access reuse system	2.603	1.298	9.3	16.7	SECONDARY	YES											
	1.2	0.0	6.2	FLA010815	OCOEE, CITY OF	1.6	RIBS	0.35	0.271	3.2	1.2						slow rate public access reuse system	2.25	1.4	3.2	6.2	SECONDARY	YES											
	3.7	0.0	0.0	FLA010512	CLERMONTWEST WWTF #1	0.75	slow rate restricted public access system (sprayfield)	0.75	0.628	4.3	3.7											TERTIARY	NO											
	0.8	0.0	0.0	FLA011105	SHADOW HILLS WWTF	0.47	RIBS	0.47	0.376	1.6	0.8											PRIMARY	NO											
	1.3	0.0	0.0	FLA010865	ZELLWOOD STATION MHP	0.3	RIBS	0.3	0.137	7	1.3											PRIMARY	YES											
	0.02	0.0	0.0	FLA010855	COCA-COLA/APOPKA FACILITY	0.255	land application system (spray irrigation field)	0.117	0.053	0.21	0.02											SECONDARY	YES											
	0.7	0.0	0.0	FLA295965	EUSTIS - EASTERN	0.19	RIBS	0.19	0.022	23	0.7											SECONDARY	YES											
	0.5	0.0	0.0	FLA010660	LAKE COUNTY CORRECTIONAL	0.18	slow rate restricted public access system (sprayfield)	0.18	0.148	2.3	0.5											PRIMARY	NO											
	0.2	0.0	0.0	FLA185761	QUAIL VALLEY	0.16	RIBS	0.16	0.045	2.9	0.2											SECONDARY	NO											
	0.5	0.0	0.0	FLA010656	SUNSHINE PARKWAY WWTF	0.15	RIBS	0.15	0.082	4	0.5											TERTIARY	NO											
	0.5	0.0	0.0	FLA010538	CLERBROOK RV RESORTS	0.12	RIBS	0.12	0.036	10	0.5											SECONDARY	NO											
	0.3	0.0	0.0	FLA010541	WEKIVA FALLS RESORT	0.0990	RIBS	0.099	0.099	2	0.3											SECONDARY	YES											
	0.5	0.0	0.0	FLA010851	CLARCONA RESORT CONDO	0.08	RIBS	0.08	0.06	6	0.5											SECONDARY	YES											
	0.0	0.0	0.0	FLA010833	MONTEREY MUSHROOM FARM (TERRY FARMS)	0.076	perc ponds	0.076	0.061	0.3	0.03											SECONDARY	YES											
	0.0	0.0	0.0	FLA010498	SEMINOLE SPRINGS ELEMENTARY SCHOOL WWTF	0.01	absorption field/drainfield	0.01	0.003	4	0.02											TERTIARY	YES											
	180	9	109	TOTAL ALLOWABLE DISCHARGE			53.9520	42.1520					5.9					0.599					60.783					17.758						
	TOTAL ACTUAL DISCHARGE						45.9910	27.6340																										
	298																																	
	Notes:																																	

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Phase I Report
Wekiva River and Basin Nitrate Sourcing Study

APPENDIX E. WASTEWATER FACILITIES SUMMARY

Table 3. Groundwater, surface water, and reuse nitrate discharge by facility from implementation of 62-600.550, FAC (Wekiva Study Area only).

	GW DISCHARGE (MT/YR)	SW DISCHARGE (MT/YR)	REUSE (MT/YR)	FACILITY ID	NAME	CAPACITY (MGD)	GROUNDWATER DISCHARGE	ALLOWABLE DISCHARGE (MGD)	ACTUAL DISCHARGE (MGD)	CONCENTRATION (MG/L)	RELEASE (MT/YR)	SURFACE WATER DISCHARGE	ALLOWABLE DISCHARGE (MGD)	ACTUAL DISCHARGE (MGD)	CONCENTRATION (MG/L)	RELEASE (MT/YR)	RECLAMATION/RE USE	ALLOWABLE DISCHARGE	ACTUAL DISCHARGE	CONCENTRATION (MG/L)	RELEASE (MT/YR)	WAVA PROTECTION ZONE	WSA																
	121.4	0.0	81.3	FLA010795	CONSERV II DISTRIBUTION CENTER	80.9	RIBS	29.2	19.528	4.5	121.4						slow rate public access reuse system	51.93	13.07	4.5	81.3	TERTIARY	NO																
	9.6	1.2	0.0	FLA010798	OCUD/NORTHWEST WATER RECLAMATION FACILITY	7.9	RIBS	4.5	3.3	2.1	9.6	Effluent to Lake Marden	3		0.3	1.2						SECONDARY	YES																
	5.1	0.0	0.0	FLA010798	OCUD/NORTHWEST WATER RECLAMATION FACILITY	7.9	slow rate restricted public access system (enhanced wetlands)	3	1.762	2.1	5.1											SECONDARY	YES																
	0.7	0.0	2.2	FLA010818	APOPKA WRF - PROJECT ARROW	4	slow rate restricted public access land application system	2	0.6	0.8	0.7						slow rate public access land application system	4	1.99	0.8	2.2	SECONDARY	YES																
	1.4	2.0	4.3	FL0036251	Sanlando Utilities;WEKIVA HUNT CLUB	2.9	RIBS	0.4	0.423	2.4	1.4	surface water discharge Sweetwater Creek/Cove Lake	2.9	0.599	2.4	2.0	slow rate public access reuse system	2.603	1.298	2.4	4.3	SECONDARY	YES																
	1.0	0.0	5.2	FLA010815	OCOEE, CITY OF	1.6	RIBS	0.35	0.271	2.7	1.0						slow rate public access reuse system	2.25	1.4	2.7	5.2	SECONDARY	YES																
	3.7	0.0	0.0	FLA010512	CLERMONT/WEST WWTF #1	0.75	slow rate restricted public access system (sprayfield)	0.75	0.628	4.3	3.7											TERTIARY	NO																
	0.8	0.0	0.0	FLA011105	SHADOW HILLS WWTF	0.47	RIBS	0.47	0.376	1.6	0.8											PRIMARY	NO																
	0.2	0.0	0.0	FLA010865	ZELLWOOD STATION MHP	0.3	RIBS	0.3	0.137	1	0.2											PRIMARY	YES																
	0.0	0.0	0.0	FLA010855	COCA-COLA/APOPKA FACILITY	0.255	land application system (spray irrigation field)	0.117	0.053	0.21	0.0												SECONDARY	YES															
	0.0	0.0	0.0	FLA295965	EUSTIS - EASTERN	0.19	RIBS	0.19	0.022	1.6	0.0												SECONDARY	YES															
	0.5	0.0	0.0	FLA010660	LAKE COUNTY CORRECTIONAL	0.18	slow rate restricted public access system (sprayfield)	0.18	0.148	2.3	0.5												PRIMARY	NO															
	0.2	0.0	0.0	FLA185761	QUAIL VALLEY	0.16	RIBS	0.16	0.045	2.9	0.2												SECONDARY	NO															
	0.5	0.0	0.0	FLA010656	SUNSHINE PARKWAY WWTF	0.15	RIBS	0.15	0.082	4	0.5												TERTIARY	NO															
	0.5	0.0	0.0	FLA010538	CLERBROOK RV RESORTS	0.12	RIBS	0.12	0.036	10	0.5												SECONDARY	NO															
	0.3	0.0	0.0	FLA010541	Wekiva Falls Resort	0.0990	RIBS	0.099	0.099	2	0.3												SECONDARY	YES															
	0.3	0.0	0.0	FLA010851	CLARCONA RESORT CONDO	0.08	RIBS	0.08	0.06	3.3	0.3												SECONDARY	YES															
	0.0	0.0	0.0	FLA010833	MONTEREY MUSHROOM FARM (TERRY FARMS)	0.076	perc ponds	0.076	0.061	0.3	0.03												SECONDARY	YES															
	0.0	0.0	0.0	FLA010498	SEMINOLE SPRINGS ELEMENTARY SCHOOL WWTF	0.01	absorption field/drainfield	0.01	0.003	4	0.02												TERTIARY	YES															
	TOTAL DISCHARGE (MT/YR)	146	3	93	TOTAL ALLOWABLE DISCHARGE		53.9520	42.1520					27.6340					5.9					0.599					60.783					17.758						
	GRAND TOTAL DISCHARGE (MT/YR)	242			TOTAL ACTUAL DISCHARGE		45.9910																																

Notes:
MT/YR = metric tons per year
MGD = million gallons per day
MG/L = milligrams per liter
= change in discharge/concentration from current condition

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Phase I Report
Wekiva River and Basin Nitrate Sourcing Study

APPENDIX E. WASTEWATER FACILITIES SUMMARY

Table 4. Groundwater, surface water, and reuse nitrate discharge by facility from implementation of 62-600.550, FAC (entire Wekiva Basin).

	GW DISCHARGE (MT/YR)	SW DISCHARGE (MT/YR)	REUSE (MT/YR)	FACILITY ID	NAME	CAPACITY (MGD)	GROUNDWATER DISCHARGE	ALLOWABLE DISCHARGE (MGD)	ACTUAL DISCHARGE (MGD)	CONCENTRATION (MG/L)	RELEASE (MT/YR)	SURFACE WATER DISCHARGE	ALLOWABLE DISCHARGE (MGD)	ACTUAL DISCHARGE (MGD)	CONCENTRATION (MG/L)	RELEASE (MT/YR)	RECLAMATION/REU SE	ALLOWABLE DISCHARGE	ACTUAL DISCHARGE	CONCENTRATION (MG/L)	RELEASE (MT/YR)	WAVA PROTECTION ZONE	WSA
	121.4	0.0	81.3	FLA010795	CONSERV II DISTRIBUTION CENTER	80.9	RIBS	29.2	19.528	4.5	121.4						slow rate public access reuse system	51.93	13.07	4.5	81.3	TERTIARY	NO
	9.6	1.2	0.0	FLA010798	OCUD/NORTHWEST WATER RECLAMATION FACILITY	7.9	RIBS	4.5	3.3	2.1	9.6	Effluent to Lake Marden	3		0.3	1.2						SECONDARY	YES
	5.1	0.0	0.0	FLA010798	OCUD/NORTHWEST WATER RECLAMATION FACILITY	7.9	slow rate restricted public access system (enhanced wetlands)	3	1.762	2.1	5.1											SECONDARY	YES
	0.7	0.0	2.2	FLA010818	APOPKA WRF - PROJECT ARROW	4	slow rate restricted public access land application system	2	0.6	0.8	0.7						slow rate public access land application system	4	1.99	0.8	2.2	SECONDARY	YES
	1.4	2.0	4.3	FL0036251	Sanlando Utilities;WEKIVA HUNT CLUB	2.9	RIBS	0.4	0.423	2.4	1.4	surface water discharge Sweetwater Creek/Cove Lake	2.9	0.599	2.4	2.0	slow rate public access reuse system	2.603	1.298	2.4	4.3	SECONDARY	YES
	1.0	0.0	5.2	FLA010815	OCOEE, CITY OF	1.6	RIBS	0.35	0.271	2.7	1.0						slow rate public access reuse system	2.25	1.4	2.7	5.2	SECONDARY	YES
	3.7	0.0	0.0	FLA010512	CLERMONT/WEST WWTF #1	0.75	slow rate restricted public access system (sprayfield)	0.75	0.628	4.3	3.7											TERTIARY	NO
	0.5	0.0	0.0	FLA011105	SHADOW HILLS WWTF	0.47	RIBS	0.47	0.376	1	0.5											PRIMARY	NO
	0.2	0.0	0.0	FLA010865	ZELLWOOD STATION MHP	0.3	RIBS	0.3	0.137	1	0.2											PRIMARY	YES
	0.0	0.0	0.0	FLA010855	COCA-COLA/APOPKA FACILITY	0.255	land application system (spray irrigation field)	0.117	0.053	0.21	0.0											SECONDARY	YES
	0.0	0.0	0.0	FLA295965	EUSTIS - EASTERN	0.19	RIBS	0.19	0.022	1.6	0.0											SECONDARY	YES
	0.0	0.0	0.0	FLA010660	LAKE COUNTY CORRECTIONAL	0.18	slow rate restricted public access system (sprayfield)	0	0	0.9	0.0											PRIMARY	NO
	0.1	0.0	0.0	FLA185761	QUAIL VALLEY	0.16	RIBS	0.16	0.045	1.3	0.1											SECONDARY	NO
	0.5	0.0	0.0	FLA010656	SUNSHINE PARKWAY WWTF	0.15	RIBS	0.15	0.082	4	0.5											TERTIARY	NO
	0.1	0.0	0.0	FLA010538	CLERBROOK RV RESORTS	0.12	RIBS	0.12	0.036	1.1	0.1											SECONDARY	NO
	0.3	0.0	0.0	FLA010541	Wekiva Falls Resort	0.0990	RIBS	0.099	0.099	2	0.3											SECONDARY	YES
	0.3	0.0	0.0	FLA010851	CLARCONA RESORT CONDO	0.08	RIBS	0.08	0.06	3.3	0.3											SECONDARY	YES
	0.0	0.0	0.0	FLA010833	MONTEREY MUSHROOM FARM (TERRY FARMS)	0.076	perc ponds	0.076	0.061	0.3	0.03											SECONDARY	YES
	0.0	0.0	0.0	FLA010498	SEMINOLE SPRINGS ELEMENTARY SCHOOL WWTF	0.01	absorption field/drainfield	0.01	0.003	4	0.02											TERTIARY	YES
TOTAL DISCHARGE (MT/YR)	145	3	93	TOTAL ALLOWABLE DISCHARGE		53.7720																	
GRAND TOTAL DISCHARGE (MT/YR)	241			TOTAL ACTUAL DISCHARGE		45.8430																	

Notes:
MT/YR = metric tons per year
MGD = million gallons per day
MG/L = milligrams per liter
= change in discharge/concentration from actual

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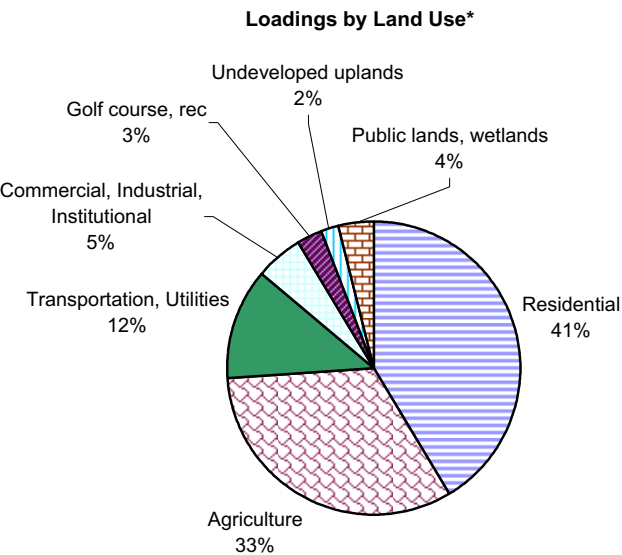
Appendix F

Loadings Summary

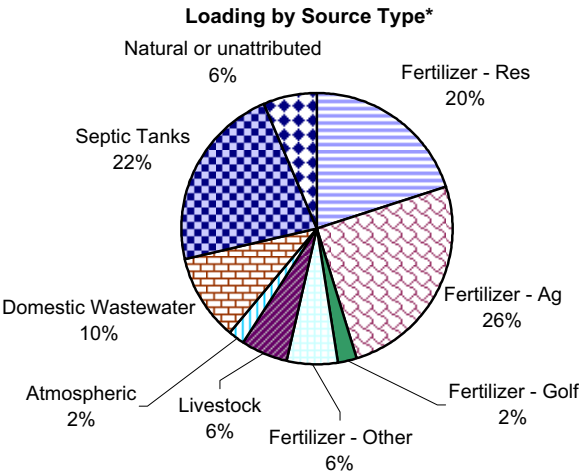
Appendix F. Loading Summary Phase I Report Wekiva River Basin Nitrate Sourcing Study

Table 1. Loadings Inputs by Land Use and Source Type

LAND USE		
Land Use Description		Nitrate in GW mg/L
Feeding operations		18
Row crops		23
Golf courses		8
Improved pastures, unimproved pastures, woodland pastures, horse farms, cropland and pastureland		5.5
Tree crops		15
Nurseries, vineyards, ornamentals, floriculture, specialty farms		6
Field crops, sod farms		4
Low, medium and high density residential, commercial, institutional, recreational, transportation		3
Industrial, open land, rural areas, upland nonforested, upland forests, water, wetlands, barren land, extractive		0.1
SOURCE TYPE		
Septic Tanks	Loading Rate lb N/year	14
Livestock Waste	Pasture Cattle/acre	0.3
	Nitrate from Cattle kg/year	56
Pasture Fertilizer	Loading Rate kg/ha/year	63
Atmospheric Deposition	"Natural" groundwater concentration mg/L	0.1
Domestic Wastewater	Loading Rate metric tons/year	189



* - same figure as Figure 3.4 in Section 3.2.



* - same figure as Figure 3.2 in Section 3.2.

Prepared by: SAR 3/26/07
Checked by: WAT 3/26/07

Appendix F. Loading Summary

Phase I Report
Wekiva River Basin Nitrate Sourcing Study

Table 2. Loadings Results by Land Use and Source Type

Loadings by Land Use																			
Land Use Type	Nitrate in GW (mg/L) (see Table 1)	Recharge Rates (MT/year)							GW Concentration Subtotal (excluding No Data areas)		GW Concentration Total (including No Data areas)		Weighted Average Recharge Rate	Septic Tanks		Domestic Wastewater ^(a) (MT/yr)	Stormwater		GRAND TOTAL (MT/yr)
		No data	Discharge Area	0 to 4 in	4 to 8 in/yr	8 to 12 in/yr	12 to 20 in/yr	more than 20 in/yr	MT/yr	MT/acre/yr	MT/yr	kg/ha/yr	in/yr	# Septic Tanks	Loading from Septic Tank (MT/yr)		Stormwater - Diffuse (MT/yr)	Stormwater - Direct (MT/yr)	
1100: Residential, low density - less than 2 dwelling units/acre	3.0	0.45	0.00	3.47	16.30	17.88	32.62	34.28	104.55	3.28E-03	105.00	8.1	10.6	7,610	48.37		24.57	10.07	188.01
1200: Residential, medium density - 2-5 dwelling units/acre	3.0	1.64	0.00	3.60	23.87	36.97	58.64	32.72	155.80	3.19E-03	157.44	7.9	10.3	42,894	272.63		31.81	28.75	490.64
1300: Residential, high density - 6 or more dwelling units/acre	3.0	0.02	0.00	0.76	4.25	5.91	11.19	7.82	29.94	3.36E-03	29.96	8.3	10.9	6,464	41.08		10.06	8.24	89.34
1400: Commercial and services	3.0	2.57	0.00	0.39	3.98	8.32	14.79	3.79	31.27	3.45E-03	33.84	8.5	11.2	1,725	10.97		6.67	14.28	65.76
1500: Industrial	0.1	0.02	0.00	0.01	0.04	0.08	0.17	0.06	0.36	1.17E-04	0.38	0.3	11.4	329	2.09		1.85	2.11	6.43
1600: Extractive	0.1	0.02	0.00	0.00	0.04	0.06	0.08	0.04	0.22	1.10E-04	0.24	0.3	10.7	28	0.18		2.17	0.00	2.59
1700: Institutional	3.0	0.34	0.00	0.14	1.75	2.68	5.51	2.59	12.67	3.62E-03	13.01	8.9	11.7	206	1.31		4.92	4.94	24.18
1800: Recreational	3.0	0.74	0.00	0.25	1.16	1.97	1.72	2.88	7.98	3.11E-03	8.73	7.7	10.1	70	0.44		0.12	0.30	9.59
1820: Golf courses	8.0	0.00	0.00	1.17	2.43	5.71	11.76	17.81	38.88	9.61E-03	38.88	23.7	11.7	118	0.75		2.02	0.82	42.47
1900: Open land	0.1	0.01	0.00	0.01	0.09	0.06	0.06	0.03	0.25	8.29E-05	0.26	0.2	8.1	394	2.50		2.56	2.08	7.41
2100: Cropland and pastureland	6.0	0.00	0.00	0.00	0.03	0.22	0.14	0.00	0.40	6.67E-03	0.40	16.5	10.8	0	0.00				0.40
2110: Improved pastures (monocult, planted forage crops)	5.5	0.15	0.00	8.48	23.77	25.89	42.62	39.34	140.09	4.97E-03	140.24	12.3	8.8	969	6.16		11.30	5.69	163.39
2120: Unimproved pastures	5.5	5.83	0.00	2.72	9.18	8.11	15.07	42.14	77.22	6.62E-03	83.05	16.4	11.7	146	0.93				83.98
2130: Woodland pastures	5.5	0.64	0.00	1.26	4.92	3.44	7.61	8.39	25.62	5.23E-03	26.26	12.9	9.2	100	0.64				26.90
2140: Row crops	23.0	0.00	0.00	0.66	9.56	0.01	0.00	0.40	10.64	1.30E-02	10.64	32.0	5.5	1	0.01		0.10		10.74
2150: Field crops	4.0	0.15	0.00	0.89	1.81	1.21	5.65	5.39	14.93	4.13E-03	15.08	10.2	10.0	67	0.43		0.97	0.32	16.80
2200: Tree crops	6.0	17.97	0.00	5.19	30.03	30.00	72.64	62.92	200.77	1.74E-02	218.74	42.9	28.2	313	1.99		2.89	0.24	223.86
2300: Feeding operations	18.0	0.00	0.00	0.05	0.63	0.41	1.75	0.20	3.04	1.88E-02	3.04	46.4	10.1	3	0.02		0.04	0.03	3.13
2400: Nurseries and vineyards	6.0	0.00	0.00	0.05	0.03	0.12	0.58	0.41	1.20	7.61E-03	1.20	18.8	12.3	12	0.08		2.17	0.52	3.96
2410: Tree nurseries	6.0	0.02	0.00	0.08	0.19	0.20	0.37	1.21	2.06	7.54E-03	2.09	18.6	12.2	9	0.05				2.14
2420: Sod farms	4.0	0.00	0.00	0.30	1.69	0.24	0.00	0.00	2.23	2.01E-03	2.23	5.0	4.9	0	0.00				2.23
2430: Ornamentals	6.0	0.14	0.00	0.60	4.31	6.33	19.12	15.99	46.34	8.15E-03	46.48	20.1	13.2	537	3.42				49.89
2450: Floriculture	6.0	0.00	0.00	0.01	0.00	0.00	0.10	0.00	0.11	5.36E-03	0.11	13.3	8.7	3	0.02				0.13
2500: Specialty farms	6.0	0.00	0.00	0.01	0.13	0.01	0.31	0.79	1.25	9.73E-03	1.25	24.0	15.8	6	0.04		0.92	0.32	2.52
2510: Horse farms	5.5	0.07	0.00	0.98	2.90	3.28	4.80	4.22	16.18	5.14E-03	16.25	12.7	9.1	159	1.01				17.26
2600: Other open lands - rural	0.1	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.02	8.75E-05	0.02	0.2	8.5	2	0.01				0.04
3000: Upland Nonforested	0.1	0.01	0.00	0.15	0.28	0.25	0.56	0.38	1.62	7.67E-05	1.63	0.2	7.5	468	2.97				4.60
4000: Upland Forests (25% forested cover)	0.1	0.06	0.00	0.32	1.07	1.11	2.25	2.28	7.04	9.38E-05	7.10	0.2	9.1	1407	8.94		6.97	9.41	32.42
5000: Water	0.1	0.03	0.00	0.45	0.40	0.21	0.22	0.03	1.32	3.89E-05	1.35	0.1	3.8	532	3.38		3.07	2.94	10.74
6000: Wetlands	0.1	0.01	0.00	0.48	0.62	0.24	0.27	0.09	1.71	2.36E-05	1.72	0.1	2.3	678	4.31		13.63	32.19	51.85
7000: Barren land	0.1	0.00	0.00	0.17	0.05	0.03	0.07	0.05	0.38	3.70E-05	0.38	0.1	3.6	17	0.11		0.29	0.14	0.92
8000: Transportation, Communication, and Utilities	3.0	1.04	0.00	0.54	3.77	5.34	8.76	5.17	23.58	3.29E-03	24.63	8.1	10.7	133	0.84	189.00	6.56	3.11	224.14
TOTALS											991.62			65,399	415.68	189.00	135.64	126.51	1858.45

Notes:
(a) - Calculated from data in Appendix E, Table 2.

Appendix F. Loading Summary

Phase I Report

Wekiva River Basin Nitrate Sourcing Study

Table 2. Loadings Results by Land Use and Source Type

Land Use Type	Loadings by Source Type									
	Fertilizer				Livestock	Atmospheric Deposition	Domestic Wastewater ^(a)	Septic Tanks	Natural or unattributed	GRAND TOTAL
	Residential (MT/yr)	Agriculture (MT/yr)	Golf Courses (MT/yr)	Other (MT/yr)	(MT/yr)	(MT/yr)	(MT/yr)	(MT/yr)	(MT/yr)	(MT/yr)
1100: Residential, low density - less than 2 dwelling units/acre	129.16					3.50		48.37	6.97	188.01
1200: Residential, medium density - 2-5 dwelling units/acre	200.58					5.25		272.63	12.18	490.64
1300: Residential, high density - 6 or more dwelling units/acre	45.00					1.00		41.08	2.25	89.34
1400: Commercial and services				51.56		1.13		10.97	2.10	65.76
1500: Industrial						0.38		2.09	3.96	6.43
1600: Extractive						0.24		0.18	2.17	2.59
1700: Institutional				21.71		0.43		1.31	0.73	24.18
1800: Recreational				8.43		0.29		0.44	0.42	9.59
1820: Golf courses			39.99			0.49		0.75	1.24	42.47
1900: Open land						0.26		2.50	4.64	7.41
2100: Cropland and pastureland		0.23			0.15	0.01		0.00	0.00	0.40
2110: Improved pastures (monocult, planted forage crops)		90.92			54.68	2.55		6.16	9.08	163.39
2120: Unimproved pastures		49.16			32.38	1.51		0.93	0.00	83.98
2130: Woodland pastures		15.54			10.24	0.48		0.64	0.00	26.90
2140: Row crops		10.64				0.05		0.01	0.05	10.74
2150: Field crops		15.31				0.38		0.43	0.69	16.80
2200: Tree crops		216.55				3.65		1.99	1.67	223.86
2300: Feeding operations					3.03	0.02		0.02	0.07	3.13
2400: Nurseries and vineyards		2.43				0.02		0.08	1.44	3.96
2410: Tree nurseries		2.05				0.03		0.05	0.00	2.14
2420: Sod farms		2.17				0.06		0.00	0.00	2.23
2430: Ornamentals		45.70				0.77		3.42	0.00	49.89
2450: Floriculture		0.11				0.00		0.02	0.00	0.13
2500: Specialty farms		1.80				0.02		0.04	0.66	2.52
2510: Horse farms		9.62			6.34	0.30		1.01	0.00	17.26
2600: Other open lands - rural						0.02		0.01	0.00	0.04
3000: Upland Nonforested						1.63		2.97	0.00	4.60
4000: Upland Forests (25% forested cover)						7.10		8.94	16.38	32.42
5000: Water						1.35		3.38	6.01	10.74
6000: Wetlands						1.72		4.31	45.82	51.85
7000: Barren land						0.38		0.11	0.43	0.92
8000: Transportation, Communication, and Utilities				31.94		0.82		189.00	0.84	224.14
	374.75	470.79	39.99	113.64	106.81	35.82	189.00	415.68	120.50	1866.99

Notes:
(a) - Calculated from data in Appendix E, Table 2.

Prepared by: SAR 3/26/07
Checked by: WAT 3/26/07