Memorandum MIAMI-DADE COUNTY

Date: December 10, 2020

To: Honorable Acting Chairwoman Rebeca Sosa
and Members, Board of County Commissioners

From: Daniella Levine Cava
Mayor

Subject: Plan of Action Report - A Risk-Based Approach to Septic Systems Vulnerable to Sea Level Rise

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The attached Plan of Action Report is provided in response to a request by Commissioners Monestime and Diaz during the January 15, 2019 Infrastructure and Capital Improvements Committee, the second in a series of reports concerning septic systems located within Miami-Dade County. The initial study, titled *Septic Systems Vulnerable to Sea Level Rise*, was commissioned under Resolution No. R-911-16, sponsored by Commissioner Sosa. That report examined the functionality of an estimated 100,000-plus septic systems within Miami-Dade County, primarily through the lens of sea level rise. At the request of multiple Board of County Commissioners, myself included, this second report refined the focus from identifying septic issues relating to sea level rise, to identifying available opportunities for reducing any potential impacts from septic systems on human health and the health of our natural systems, our drinking water aquifer, and Biscayne Bay.

This Plan of Action Report was prepared as a joint effort between the Miami-Dade Water and Sewer Department (WASD) and the Department of Regulatory and Economic Resources (RER). Its primary objective is to inform policymakers of the most effective practices and investments that should be implemented in the near-term to reduce the environmental impact and public health risks of septic tank systems in vulnerable areas. Analyses indicate that wholesale septic tank conversion is a very costly (more than $4 billion) proposition for residents, and the corresponding environmental and human health benefit may be limited in the context of other available beneficial actions to address diverse pollutant sources and the canal systems. This plan introduces a methodical and phased approach that prioritizes solutions for systems that may pose the highest risk to yield the greatest benefits in the shortest time.

The following are the key findings contained within the report:

Septic Tanks within Miami-Dade County	120,000
Septic Tanks Vulnerable to Compromise/Failure by 2020	9,000
Septic Tanks Vulnerable to Compromise/Failure by 2040	13,500
Septic Tanks Abutting Wastewater Infrastructure	12,000
Septic Tanks Vulnerable to Compromise/Failure and currently Abutting Wastewater Infrastructure	1,900
Septic Tanks Registered and Inspected within County	0

Note: Figures within this table are approximate and reflect all septic tanks within Miami-Dade County, including WASD and other utility service areas.

The following are the key recommendations contained within the report:

- **Convert Vulnerable Tanks that Abut Sewer Infrastructure:** Prioritize the conversion of approximately 1,900 tanks to the sewer system that are (or will become) vulnerable to compromise/failure that currently abut sewer infrastructure

- **Convert Remaining Tanks Abutting Sewer Infrastructure:** Begin the conversion of the remaining approximate 10,100 septic systems abutting sewer infrastructure

- **Prioritize Conversion of Tanks Vulnerable to Compromise/Failure:** Prioritize new public infrastructure, or more robust on-site treatment, for approximately 11,600 tanks remaining vulnerable to compromise/failure by 2040

- **Public Laterals Investments:** Implement a program to facilitate the installation of public laterals, as necessary, to support connection to public sewer and abandonment of prioritized septic systems

- **Financing Programs:** Implement financing opportunities for homeowners for the conversion of septic to sewer

- **Septic Tank Registration:** Establish a residential and commercial septic system registration program that focuses on outreach and education and provides for periodic inspections, consistent with the recommendations from the Governor's Blue Green Algae Task Force

- **Improve Water Quality Monitoring Program to Guide Investment Choices:** Improve available data and analysis of water quality through a more comprehensive monitoring program, to better determine the contribution of the various land-based sources of pollutants, including septic systems, on surface waters and ultimately Biscayne Bay, to guide investment decision-making.

Conversion Costs

The conversion from septic to sewer is financially challenging, with anticipated homeowner expenses ranging from approximately $7,500 (when both public sewer and a public lateral are available), to $15,000 (when only public sewer is available), to an average of $40,000 (when no public infrastructure is available). For the prioritized properties identified above that currently have abutting sewer infrastructure, WASD is developing a strategy to provide public laterals, though these investments have historically been the responsibility of developers and homeowners.

Conversion Financing

Several financing opportunities are being developed for homeowners. The Board recently passed a Resolution urging the State Legislature to amend F.S. 163.08, and make septic conversion expenses eligible for financing under the Property Assessed Clean Energy Program (PACE), which would afford long-term, low-interest financing leveraging *non-ad valorem* property assessments.

Additionally, my Administration and I are currently developing a targeted financial assistance tool for lower-income property owners that would be funded by a set-aside of $20 million in Surtax funds. The program will be added as a discrete part of the existing Surtax homeowner's rehabilitation loan program and managed by the County's Public Housing and Community Development Department. The program will be designed to provide loans to homeowners with family annual incomes of up to 140 percent of area median income ($127,960 for a family of four), and can be structured for terms of up to 40 years, at an interest rate of as low as .001 percent. The program may be available as soon as the first quarter of 2021.

WASD is also exploring, in conjunction with its bond counsel, a financing program that would be available to homeowners, independently of income. The findings of this inquiry will be made available under a separate memorandum that I will issue in the near future.

Ongoing Efforts

Since the time of the original preparation of this report, WASD and RER have continued to perform substantial analysis on nutrient pollution issues concerning the Biscayne Aquifer and Biscayne Bay, not only in relation to the contribution of septic tanks, but of the overall fate and transport of nutrients within our extraordinarily sensitive fresh water system. Both departments are actively participating with local universities and federal environmental agencies to share data and to coordinate research efforts and overall recommendations. Information will be shared with the Chief Bay Officer, when appointed, as well as the Board of County Commissioners.

WASD is currently designing a follow-up septic report that will explore a more broad-based conversion program, likely focused on the North Bay watershed. This area has been preliminarily designated, owing to the extraordinary amount of nutrients entering the North Bay through the canal systems, which serves as the primary transportation route for storm water run-off and septic nutrient pollution. The report will contain a specific conversion strategy, as well as options concerning funding.

Implementation of the report recommendations will require considerable coordination across County departments, municipalities, and external governmental agencies, as well as future Board of County Commissioners legislative action. The Administration will continue to work with the Board to identify and pursue additional funding and financing strategies. These initiatives are critical to Miami-Dade County, not only for environmental benefits, but also for social and economic benefits that are realized from having access to reliable, sustainable, and efficient wastewater disposal.

Pursuant to Ordinance No. 14-65, this memorandum shall be placed on the next available Board meeting agenda for review.

If you have any questions regarding this report, please contact Kevin T. Lynskey, Director, Water and Sewer Department, at 786-552-8200.

Attachment

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December 2020

Plan of Action Report

A RISK-BASED APPROACH TO SEPTIC SYSTEMS VULNERABLE TO SEA LEVEL RISE

MIAMI-DADE WATER AND SEWER DEPARTMENT
MIAMI-DADE REGULATORY AND ECONOMIC RESOURCES
MIAMI-DADE OFFICE OF RESILIENCE
DIVISION OF PLANNING
DIVISION OF ENVIROMENTAL RESOURCES MANAGEMENT

MIAMI-DADE COUNTY

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Introduction

A central theme of water resource planning is to protect the public drinking water supply, recreational waters, and the natural resources upon which the County's economy and environment depend. Miami-Dade County has a long history of developing and establishing policy for the protection of environmental and human health. Specifically, portions of the Comprehensive Development Master Plan and Chapter 24 of the Code of Miami-Dade County code are dedicated to the protection of the environment, water supplies, Biscayne Bay, and other natural resources.

As external environmental drivers continue to evolve, it has become clear that important natural areas such as the southern Everglades and Biscayne Bay need better managed clean freshwater deliveries beyond that which the current water management system can provide, and that updates to policies and new approaches are required to monitor and mitigate associated environmental and human health risks.

Sea level rise presents a new challenge that will require updating existing codes and policies. Today's king tides are higher due to sea level rise and they are already flooding some coastal areas with septic systems. Inland areas affected by higher groundwater levels and flooding may have also experienced compromised septic systems. In order to protect public health and the value of these properties it is important to ensure all residents have access to safe, effective, sanitary wastewater disposal. Because these improvements can take decades to implement, proactive planning is necessary to stay ahead of rising water levels.

The report titled *Septic Systems Vulnerable to Sea Level Rise*, commissioned by Resolution R-911-16, was submitted and accepted by the Miami-Dade Board of County Commissioners on December 4, 2018. The report provided an overview of potential impacts to the functionality of septic systems as a result of current and projected groundwater levels.

The following report, which evaluates the anticipated impacts of sea level rise upon existing septic systems within Miami-Dade County and recommends immediate actions, represents only a portion of the comprehensive framework required to make informed policy choices to protect water resources and reduce impacts to personal property and human health.

This report has the objective of recommending the approach and immediate actions to address vulnerable septic systems. It will be followed by further analyses and updates to the Board of County Commissioners, including a prioritization methodology in the context of a comprehensive framework to support impactful and cost-effective solutions for the environment and our community.

Background and Objective

The report titled "Septic Systems Vulnerable to Sea Level Rise", commissioned by Resolution R-911-16, was accepted by the Miami-Dade Board of County Commissioners on December 4, 2018. The report provided an overview of potential impacts to the functionality of septic systems as a result of current and projected groundwater water levels. Subsequently, at the January 2019 meeting of the Infrastructure and Utilities Committee (IUC), committee members requested recommendations from the Department of Regulatory and Economic Resources (RER) and the Miami-Dade Water and Sewer Department (WASD) for immediate actions to mitigate the potential environmental and human health risks posed by projected sea level rise upon the most vulnerable septic systems within Miami-Dade County. The objective of this document is to respond to the request of the IUC.

Key Findings and Recommendations of the Initial Report

The following is a summary of the key findings of the *Septic Systems Vulnerable to Sea Level Rise* report:

- There are approximately 100,000 residential and commercial septic systems in the Miami-Dade Water and Sewer Department's sanitary sewer service area.
- Vulnerable areas are not confined to the coast and are distributed across Miami-Dade County.
- There are septic systems potentially subject to failure under current conditions, the majority of which are residential and within unincorporated Miami-Dade County.
- The number of septic systems periodically compromised due to sea level rise is expected to increase through the 2040 planning horizon.
- The estimated cost of connecting all parcels to the sanitary sewer system is significant ($4 billion+)
- Additional data is required to develop the methodology for applying the most cost-effective, responsible, and impactful solutions to reduce risk from compromised systems.

Additionally, the report included several key recommendations:

- Development of a suite of potential solutions including policy changes to limit the installation of additional septic systems within vulnerable areas, improvements to design standards, and application of new technologies for onsite treatment.
- Comprehensive prioritization methodology for any future sewer infrastructure expansions to meet the objective of serving those areas where growth is encouraged by the future land use element of the County's Comprehensive Development Master Plan (CDMP) and where the provision of water and sewer service would yield definitive environmental or human health benefits. The prioritization methodology should consider land use, environment, health and welfare, and socioeconomic conditions, among others.
- Pursuit and advancement of county-wide and localized funding initiatives including general obligation bonds, special taxing districts, tax increment financing districts, special basin

charges, among others. These initiatives should be supplemented/supported by any available State Revolving Loan financing and other grant programs.

- Additional environmental water quality monitoring and analysis to understand and quantify the contributions of nutrients and pathogens from septic systems is necessary in order to prioritize action.

Results of Multi-Department Analysis and Actions

Due to the nature and complexity of analyzing the vulnerability of septic systems and developing comprehensive solutions for the county-wide environmental protection and safeguard of human health, a collaborative effort between staff from WASD, RER, and the Miami-Dade Department of Transportation and Public Works (DTPW) was undertaken.

A multi-department working group was assembled to consolidate all necessary resources, information, and expertise from throughout Miami-Dade County. Input and recommendations from all program areas were obtained to develop a more comprehensive understanding of septic systems, their vulnerability, potential impact, and solutions for the future. The working group has been successful in achieving the following tasks:

1. Refinement of the non-sewer (septic system) data set
2. Additional septic system vulnerability modeling and scenario development
3. Review of existing infrastructure programs funded by BCC and correlation with septic system data.
4. Identification of septic system parcels currently abutting sanitary sewer infrastructure
5. Developed inventory of county-owned parcels currently served by septic systems
6. Identification of vulnerable parcels within areas experiencing recurrent flooding
7. Development of policy recommendations
8. Preliminary study of existing water quality data to better quantify pollutant sources beyond septic systems.
9. Review of existing case studies in Florida for best practices in prioritization, communication, funding, alternative treatment technologies/systems, policies, among other solutions.
10. Development of a communications plan, coordination with municipalities operating sanitary sewer systems, and review of available grant and other funding opportunities.

A description of each of these tasks and corresponding results are described below:

Refinement of the Non-Sewer Dataset

To arrive at the most accurate estimate possible for parcels not currently served by sanitary sewer infrastructure, staff performed an analysis of all available customer, geospatial, permitting, and other data to identify properties that are not connected to the sanitary sewer system.

The estimates for properties not connected to sanitary sewer in the initial septic system vulnerability report did not include parcels abutting sanitary sewer, but not currently connected, within the totals for active septic systems, and also excluded vacant parcels.

The data layer of parcels considered to be on septic has been enhanced to include these properties. This addition will help develop recommendations to increase compliance with existing regulations that require existing properties to connect to the sanitary sewer system. The data will continue to be updated by coordinating with data owners including WASD, RER, municipalities, and the Department of Health. Additionally, RER-DERM is developing a GIS based layer of "Potential Septic Systems" using customer data sets from sixteen (16) utilities, Department of Health septic system data, and other Department data sets to improve future reviews, assessments and analysis.

Table 1 presents the updated inventory of "non-sewer" parcels within Miami-Dade County, with additional detail indicating the estimated quantity of septic systems (1) within WASD's service area and (2) within/outside the urban development boundary (UDB).

Table 1

Estimated Properties within Miami-Dade County unserved by Sanitary Sewer Infrastructure

Category	Estimated Number of Parcels
Total Parcels on Septic systems within Miami Dade County	120,000
- Parcels on Septic systems Outside of UDB[1]	5,000
- Parcels on Septic systems within Volume Sewer Customer Areas[2]	12,000
Parcels on Septic systems within WASD Service Area	103,000

1. Comprehensive Development Master Plan (CDMP) text regarding the UDB states that "public expenditures for urban service and infrastructure improvements shall be focused on the area within the UDB, and urban infrastructure is discouraged outside the UDB." (CDMP, page I-61).

2 This figure is an approximation. Miami-Dade County does not have high-quality data available to estimate non-sewer parcels outside of its service area. RER-DERM is coordinating with the fifteen (15) municipal utilities to map customer data using Geographical Information Systems (GIS) to better define parcels not currently served by public sewer systems (i.e., served by septic system). To date, thirteen (13) of the fifteen (15) Municipal Utilities have provided customer data.

Vulnerability Modeling and Scenario Development

The vulnerability report provided an important understanding of what systems may be impacted by rising groundwater. Additional analysis was performed to provide insight into degrees of vulnerability and to support a shift to systematically reducing the risks septic systems may pose to human health and the health of our natural resources.

The vulnerability report established that a septic system is vulnerable to failure if groundwater levels were within 24-inches of the surface, and a septic system is vulnerable to compromise if groundwater levels were within 42-inches of the surface.

Two groundwater levels were analyzed for the original report using the U.S. Geological Survey's Surface Groundwater Model. The average October conditions were used to determine current or base-case vulnerability, while groundwater levels following the highest rain event in the 15-year period, including projected sea level rise, were used to identify future vulnerability. The highest rainfall event, or maximum condition, was selected in order to answer the question of which systems are potentially vulnerable. The concept was if the water table reaches 42 inches of the surface of the ground during that maximum rainfall scenario, it has the potential to be impacted and therefore should be considered vulnerable to compromise. The rain event that defined the maximum condition occurred in October 2000 and resulted in approximately 11-inches of rainfall across the County. This was described as the maximum and represents what is often referred to as a 100-year storm. This means there is a 1% chance of the storm occurring in any year, not the often-misunderstood meaning that the event is expected to happen once in 100 years. The analysis at maximum water table conditions, including sea level rise, revealed approximately 67,000 parcels impacted by groundwater levels higher than 42 inches of the surface of the land by 2040. While the use of this rare rain event was helpful in establishing a minimum threshold for vulnerability, it is not the most appropriate standard for planning sewer expansion or other mitigation due to limited funding resources.

An additional analysis of 2040 groundwater levels under average October conditions, also including sea level rise, was performed in order to provide an understanding of degrees of vulnerability, which will help to prioritize cost-effective risk reduction. Approximately 13,500 parcels are projected to be impacted by groundwater levels within 42 inches of the surface of the land by 2040 under average October conditions.

Table 2 provides a summary of the parcels vulnerable to failure (groundwater levels within 24-inches of the surface) and vulnerable to compromise (groundwater levels within 42-inches of the surface)

Table 2
Estimated Properties within Miami-Dade County Vulnerable Under Average October Groundwater Conditions

Category	Estimated Number of Parcels
Vulnerable Septic Systems within Miami-Dade County	
Parcels on Septic systems Currently Vulnerable to Failure	2,000
Parcels on Septic systems Currently Vulnerable to Compromise	7,000
Subtotal of Currently Vulnerable within Miami-Dade County	9,000
Parcels on Septic systems Vulnerable to Failure in 2040 under average October Groundwater Conditions	3,500
Parcels on Septic systems Vulnerable to Compromise in 2040 under average October Groundwater Conditions	10,000
Subtotal of Vulnerable by 2040 within Miami-Dade County	13,500
Vulnerable Septic systems within WASD Service Area	
Parcels on Septic systems Currently Vulnerable to Failure	800
Parcels on Septic systems Currently Vulnerable to Compromise	4,600
Subtotal of Currently Vulnerable within WASD Service Area	5,400
Parcels on Septic systems Vulnerable to Failure in 2040 under average October Groundwater Conditions	1,900
Parcels on Septic systems Vulnerable to Compromise in 2040 under average October Groundwater Conditions	7,300
Subtotal of Vulnerable by 2040 within WASD Service Area	9,200

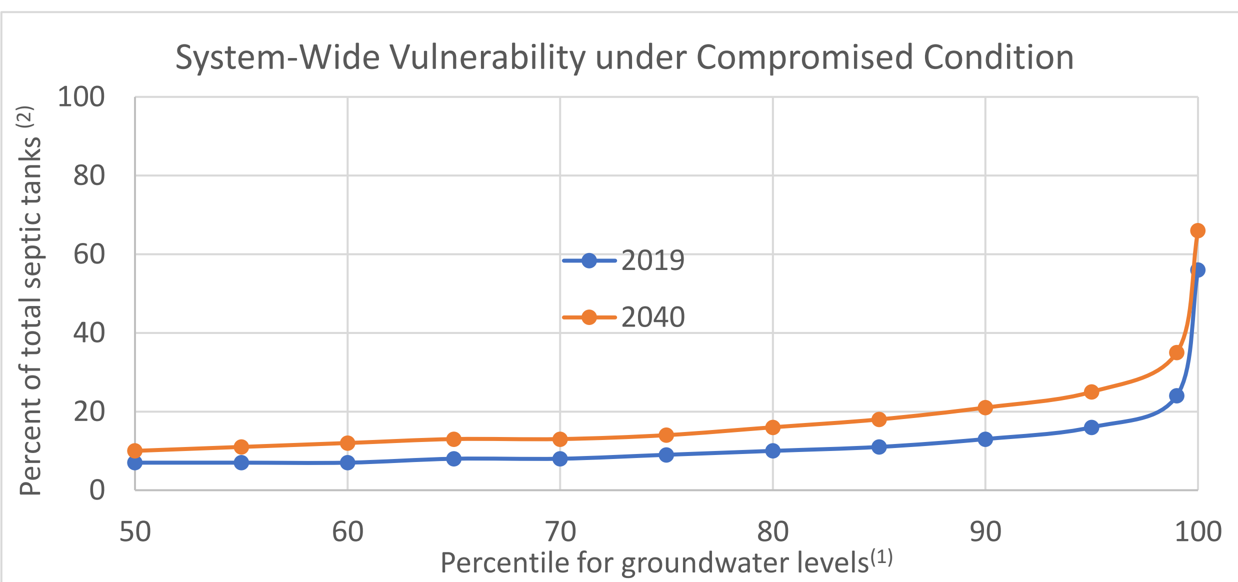
As we shift from identifying vulnerability to taking action to reduce risk, it will be important to understand the likelihood and consequences these vulnerable systems pose. Projected groundwater levels are not sufficient on their own to drive decision-making. However, when used in conjunction with finer resolution stormwater mapping and other criteria, they can assist with effective infrastructure planning.

Considering these systems in their context and taking a risk-based approach to infrastructure planning will increase the effectiveness of these investments and other measures. Compromised and failing systems pose a risk to the effect of saturated soil conditions which allow pollutant-loaded effluent (nutrients, pathogens, and others) to move away from septic systems to soils, groundwater and surface waters. This can pose a risk to the health of surface waters and ultimately the Bay and impacts on human health.

The amount of time saturated soil conditions exist increases the amount of effluent that can travel and the distance that effluent may travel. The longer soils are saturated the higher likelihood of its conveyance and increases the likeliness of risks from exposure events to some bacteria and viruses. According to Dr. Elmir, "Some of the pathogenic human organisms can survive harsh and various environmental conditions (extreme temperatures, various soil moisture conditions, rainfall, salinity, etc.) for a long time from one day to a couple of years."

Another way to think about vulnerability is to understand the percentage of septic systems at risk under different groundwater conditions. For example, Figure 1 below indicates that in 2019, approximately 10% of the septic systems were vulnerable under the 80th percentile of groundwater levels. In other words, 80% of the time, groundwater levels are lower than this level and therefore 90% of septic systems would not be at risk. This finding suggests that addressing 10% of the septic systems at risk in 2019 should address those with the greatest likelihood and frequency of experiencing saturated soil conditions (i.e., highest vulnerability). The vulnerability of septic tanks increases to approximately 17% of systems by 2040, mainly due to sea-level rise.

Figure 1
Percent of Total Septic Tanks in Compromised Condition
(water table is < 42 inches from surface of the ground)



[1] Percentile for groundwater levels – A percentile is a groundwater value below which a certain percentage of groundwater observations lie. Groundwater values were computed with the U.S. Geological Survey's Surface Groundwater Model.

[2] *Percent of total septic tanks - For each percentile, the number of vulnerable septic tanks for the compromised condition is computed for each cell in the model. Then, adding all the vulnerable septic tanks system-wide, the % of total septic tanks is found for that percentile. The compromised case is defined as less than 42 inches from the surface of the ground to the water table.*

Finally, the following table summarizes the criteria, including groundwater levels, that will be the focus of the next steps in prioritizing risk reduction. Table 3 includes criteria set forth in existing County policy for providing improvements to the sanitary sewer collection system (WS-3A of the County Comprehensive Development Master Plan). The criteria in bold font were used in a previous prioritization effort for expanding service to septic systems in commercial corridors. The italicized criteria are under consideration to increase the effectiveness of system expansion and other potential solutions including alternative technologies.

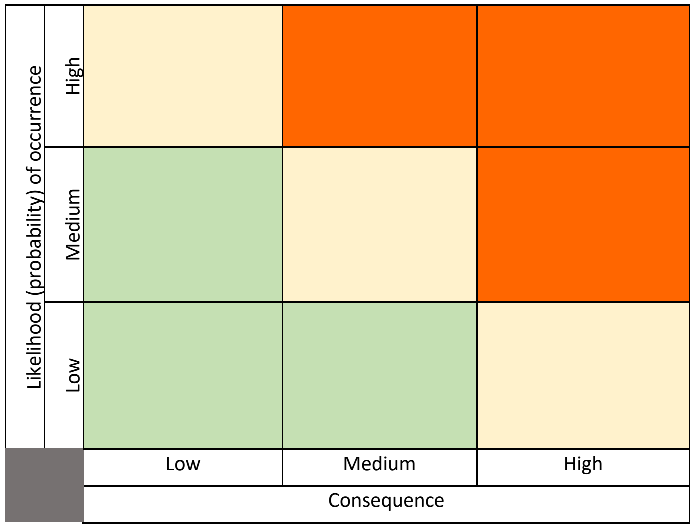
Additional groundwater and surface water monitoring to better understand the dynamics of septic system effluent fluxes to receiving water bodies is required to establish appropriate metrics for some of the criteria in the table. For example, the criteria *proximity to surface water* requires a metric of distance (i.e. number of feet). Sampling and analysis needs are discussed in more detail in the Preliminary Study of Water Quality and Pollutant Sources section starting on Page 14.

Table 3 - Prioritization Criteria

Criteria	Sub-criteria	County Policy
Planning Considerations	**Zoned Urban Centers**	**WS-3A(3)**
	Inside urban infill area	**WS-3A(3)**
	Inside the Urban Development Boundary	**WS-1A**
	Proximity to SMART corridors	**WS-3A(3)**
Environmental and Public Health Impacts	**Wellfield protections area**	**WS-3A(7)(a)**
	Total non-conforming DERM permits (commercial, industrial)	**WS-3A(1)**
	Areas of low land elevation in conjunction with high water table	**WS-3A(7)(e)**
	Area currently lacking water service	**WS-3A(7)(d)**
	Proximity to surface water	**WS-3A(1)**
	Within a priority contaminated basin (TMDL)	**WS-3A(1)**
	Number of septic tank repair permits	**WS-4D**
	Age of septic system	**WS-4H**
	Poor soil conditions	**WS-3A(7)(f)**
	Repetitive Flood Losses	**WS-4H**
	Potential for flooding in the area (Coastal High Hazard Areas, FEMA Flood Zones, and Tidally influenced areas)	**WS-4H**
Land Use	**Commercial, industrial without sewer service (acres)**	**WS-3A(7)(b)**
	Land Use Map designation – more intense than residential	**WS-3A(7)(c)**
Special economic areas	**Community Redevelopment Area**	**WS-3A(3)**
	Enterprise Zone	**WS-3A(3)**
	Targeted Urban Areas	**WS-3A(3)**
	Opportunity Zone	**WS-3A(3)**
Socio-economic conditions	**Individual poverty rate**	
	Median household income	
Cost-effective improvements to expand capacity, maximize operational efficiency, and increase productivity.	*Proximity to existing sewer mains*	**WS-3A(7)(g)**
	Pose a threat to public health	**WS-4D**
	Estimate of pollutant loading generated	**WS-4H**
	Annualized cost per pound of nitrogen removed	**WS-4H**
	Feasibility (cost and time to connect)	**WS-1G**

Prioritization can be performed once the final criteria and associated metrics are developed. These criteria can be weighted and used to rank systems based on potential to reduce risk. The diagram in Figure 2 provides an example matrix of likelihood vs. consequence and can be expanded to include criteria details and used to assist with developing priority system expansions and other measures to reduce the risks to both humans and the natural system.

Figure 2
Risk Matrix



Review of Existing Infrastructure Expansion Programs funded by the Board of County Commissioners and Correlation with Non-Sewer Data

WASD's current bond ordinance and financial mechanisms do not provide for expansion of local water or sewer infrastructure by the Department, thus creating a burden on existing rate payers. Rather, infrastructure expansion is driven by development and costs borne by the new users requiring service. However, current programs authorized and funded by BCC exist that are expanding sanitary sewer service to various areas of the County.

On July 2, 2013, the Miami-Dade BCC adopted Resolution No. 597-13 which directed WASD to perform a comprehensive study of the water and sewer infrastructure needs of the areas inside commercial and industrial corridors to maximize their development and economic potential.

As a result of the study, 29 sanitary sewer improvement projects along major commercial corridors were identified throughout Miami-Dade County. The total cost of the projects was estimated at $233 million. Upon the conclusion of the study, the Planning Division of the Department of Regulatory and Economic Resources (RER) was tasked with developing a methodology for ranking the projects. The objective of the ranking effort was to prioritize investments considering that only approximately $126 million of the estimated $233 million cost for the 29 projects would be available to complete the proposed improvements. The ranking methodology evaluated planning and environmental considerations, special economic areas, land use, current business environment, and socio-economic conditions.

The ranking effort undertaken by RER yielded a subset of projects to be completed with the available funds. The results of the prioritization report were submitted to BCC on April 14, 2014, identifying $126 million in unallocated Building Better Communities General Obligation Bond funds that had been approved by voters for water and sewer improvements. The Commission concluded that extending the sewer system to the identified commercial corridors would have economic benefits for the entire community and would improve job development potential in needed areas as well as enhance environmental quality. The Board of County Commissioners passed Resolution No. 537-14 allocating the $126 million in GOB funds for WASD to undertake the commercial sewer projects identified in the report.

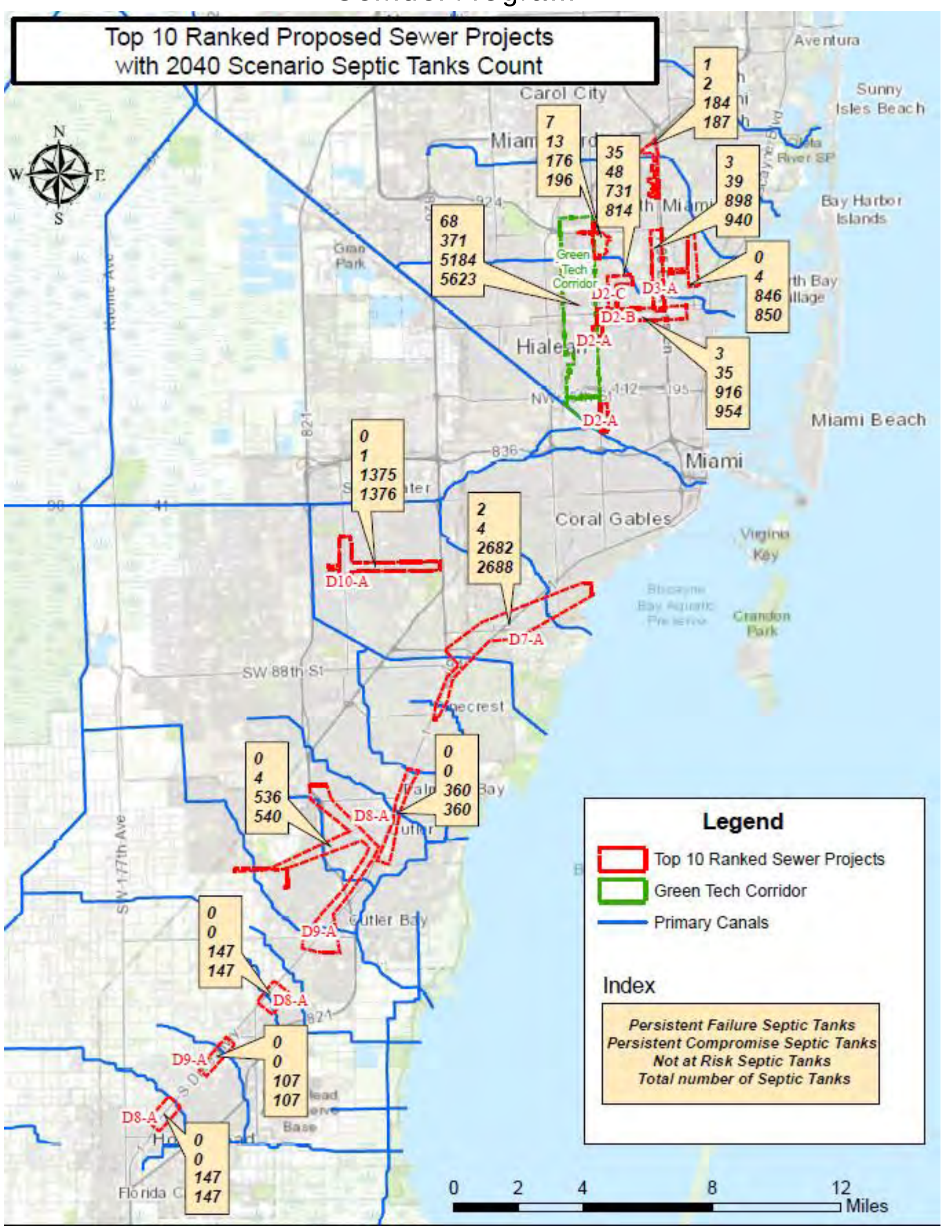
With the intent of identifying overlap between planned sewer extension projects and vulnerable septic systems, the working group analyzed the geographical extent of the projects in relation to the non-sewer parcel data set. Staff also evaluated possible expansion of the infrastructure projects planned within the program to serve vulnerable parcels.

The results of the analysis indicate:

- The 10 highest priority projects in this existing GOB program will serve approximately 15,000 properties currently served by septic systems.
    - Approximately 350 of those captured in the program are projected to be failing or compromised by rising groundwater under current average October conditions.
    - This number increases to approximately 650 by the year 2040.

- Further analysis will be performed to determine the feasibility, cost-benefit, and potential pollutant reduction that would be achieved by expanding the existing corridor projects to include vulnerable parcels in the adjacent areas. The map below includes vulnerable parcels within 1/8-mile radius of pump stations that are planned as part of the GOB program and should be evaluated for inclusion. For example, there are approximately 70 vulnerable septic systems within 1/8-mile radius of the Green Tech Corridor project that could be considered for inclusion. The text boxes in the Figure 3 represent, from top to bottom, number of systems in various categories. The top number represents the number of systems that will be persistently failing by 2040. The next number represents the number that will be persistently compromised by 2040. The next number represents those systems that are not at risk. Finally, the bottom number represents the total systems in project. For example, the Green Tech Corridor extension project will address 68 failing systems and 371 compromised systems. Project D2-C has the potential to address 35 failing systems and 48 compromised systems.

Figure 3
Vulnerable Septic systems within Sanitary Sewer Basin of WASD GOB Sanitary Sewer Commercial Corridor Program



Identification of Septic Systems Parcels Abutting Sanitary Sewer Infrastructure

The multi-department working group, led by DERM, identified parcels within Miami-Dade County that are abutting sanitary sewer infrastructure but not currently connected. The properties are required to connect to the sanitary sewer system, per Chapter 24 of the Miami-Dade County Code, within 90 days of the sewer system being installed. While the Code has provisions for circumstances that would exempt connection, the majority of these properties are currently out of compliance with County requirements to connect. For many of these cases, the lack of a public lateral, connection fees, and repaving the roadway are significant physical and financial impediments to connecting.

In total, it is estimated that there are approximately 12,000 properties with abutting sewer that are not connected to sewer. Of these, a subset is vulnerable under current and future conditions to septic system performance impacts due to sea level rise.

The dynamic is a result of historical development practices that in certain instances led to sanitary sewer infrastructure expansion but did not provide for service laterals to existing properties, thus making connection by the homeowner complex and costly. DERM and WASD have developed policies to ensure that, as infrastructure is extended with development, all existing properties have service laterals installed (for both water and sewer).

Today all new sanitary sewer extension projects installed in the right-of-way are required to include lateral pipes which facilitate service connections to the abutting parcels. This requirement applies to WASD customers as well as those within municipal utilities. For force mains in WASD's service area, the Department reimburses the developer for the installation of laterals to serve existing parcels abutting the gravity main being installed in the right-of-way. When the existing property owner, who is now abutting sewer, connects to the system, the Department recovers the cost of the lateral. The reimbursement amounts are established in WASD's rate and fee schedule authorized annually by the BCC.

Table 4 presents a summary of the estimated number of unconnected parcels abutting sanitary sewer infrastructure that are potentially vulnerable to sea level rise. These are considered to be the "low hanging" fruit, for which connection to sanitary sewer is most immediately feasible.

Table 4
Estimated Number of Properties Abutting Sanitary Sewer Infrastructure Vulnerable to SLR

Category	Estimated Number of Parcels
Parcels on Septic systems abutting Sewer Systems and Currently Vulnerable to Failure	300
Parcels on Septic systems abutting Sewer Systems and Currently Vulnerable to Compromise	1,000
Subtotal of systems abutting sewer and currently vulnerable	1,300
Parcels on Septic systems abutting Sewer Systems and Vulnerable to Failure in 2040 under Average October Groundwater Conditions	600
Parcels on Septic systems abutting Sewer Systems and Vulnerable to Compromise in 2040 under Average October Groundwater Conditions	1,300
Subtotal of systems abutting sewer and vulnerable by 2040	1,900

Inventory of County-Owned Parcels Served by Septic Systems

The multi-department working group analyzed properties owned by Miami-Dade County Parks Recreation and Open Space Department with the intent of identifying those currently served by onsite septic systems. Due to the County's ownership and control over these sites, their connection to the sanitary sewer system or other action to mitigate vulnerability of the respective septic systems is highly feasible.

There are approximately 20 Miami-Dade County park locations currently served by approximately 40 septic systems. Additional analysis is ongoing to identify additional county-owned properties with this condition and determine whether these are in fact served by septic systems with drainage fields. This analysis will be expanded to all Miami-Dade County owned parcels as a next step.

Table 5 presents the approximate number of septic systems within Miami-Dade County owned park properties that are vulnerable under current and future groundwater conditions.

Table 5
Summary of County Park Properties on Septic Systems Vulnerable to Failure/Compromise

Category	Estimated Number of Parcels
County park parcels on septic systems currently vulnerable to failure (2) or (4) compromise	6
County park parcels on septic systems vulnerable to failure (2) or (5) compromise by 2040	7

Identification of Vulnerable Parcels within Areas of Recurring Flooding

In order to better inform the prioritization process and phasing of improvements to mitigate risks associated with vulnerable septic systems, properties that flood during king tide events or properties that have suffered repetitive losses from flooding will be identified. The failure of septic systems at these properties as a result of flooding have a significantly higher relative environmental and human health risk than other vulnerable properties. As such, these will be among the cohort of highest priority for mitigating actions.

Development of Policy Recommendations

Existing policies pertaining to septic systems, sanitary sewer extension requirements, design standards, land use, and other areas were reviewed, and recommendations developed for consideration and advancement by various County departments and adoption by the BCC. These recommendations are presented in Table 7 and are complimentary to the strategies and actions presented within Table 6 of the Plan of Action.

Preliminary Study of Water Quality and Pollutant Sources

This preliminary study, presented within Appendix A, had the objective of consolidating and analyzing all available historical water quality data from Miami-Dade County Departments and their respective monitoring programs (RER-DERM, WASD, etc.) and the South Florida Water Management District, with the intent of identifying relationships and correlations between land uses, septic systems, and other factors on ground and surface water quality.

The preliminary study indicates that there is currently insufficient data to determine whether there is a correlation between groundwater and surface water quality and septic system locations. Water quality data analyses indicated different nutrient source in the South Bay watershed than in the Central and North Bay watersheds. There are an inadequate number and distribution of water quality monitoring locations within septic system areas. Additionally, the frequency of sampling is insufficient to understand the dynamics of septic system impacts to the environment and the extent of septic system contribution to nutrient or other pollutant loading therefore cannot yet be determined. This study concurs with the recommendations of the RER DERM 2019 Seagrass Report to continue and update the County's established Surface Water Quality Monitoring Program, and also recommends the expansion the County's wellfield protection and ambient groundwater monitoring programs to include monitoring in areas with potentially vulnerable septic systems. Further recommendations from the study are as follows:

- Review of previous studies in Florida on septic and wastewater impacts on groundwater and surface water quality and integration of conclusions into design of enhanced monitoring programs.

- Continue analysis of existing water quality and flow data including statistical analyses to better understand correlations of the various components of the watersheds.

- Evaluate and implement into sampling programs evolving technology such as sucralose, microbial DNA fingerprinting, and stable isotopes of 14N and 15N, to better identify and quantify human and animal wastewater related sources

- Identify data gaps in the regional canal system for flow and water quality and develop plan with federal, state and local agencies to address those gaps

- Develop and implement strategically located groundwater and surface water monitoring plan to better understand the dynamics of septic system nutrient fluxes to receiving water bodies. Data will be collected in a manner that can be easily shared amongst stakeholder departments and agencies and that could feed into a public facing report or web-based map of consolidated data.

Review of Existing Florida Case Studies for Best Practices in Prioritization, Communication, Funding, Alternative Treatment Technologies, and Policies

A comprehensive review of case studies and experiences throughout the State of Florida was performed by the Florida Department of Environmental Protection (FDEP), the Florida Water and Environment Federation (FWEA) Utility Council, and Jones Edmunds in 2018. The multi-department working group reviewed this document, along with additional information to identify approaches that could yield success for Miami-Dade County. Appendix B presents excerpts from the Septic to Sewer Guidance Document that could be applicable to Miami-Dade.

Development of a Communications Plan, Coordination with Municipal Sewer Utilities, and Review of Available Grant and Other Funding Opportunities

Staff from RER and WASD are collaborating in the development of a communication plan to educate and guide the public with regards to septic system and sanitary sewer connection. Areas of focus within the communication plan include:

- Outreach material with information for homeowners regarding proper inspection and maintenance of septic systems, with recommended frequencies and resources available.

- Information and guidance for property owners with access to sanitary sewer systems indicating the processes to achieve connection and highlighting the County Departments and resources that can assist residents in this process.

- Information for businesses served by onsite systems to communicate potential environmental hazards, materials prohibited for discharge into septic systems, and recommendations regarding inspection and maintenance of septic systems. Information regarding procedure/options for connecting to sanitary sewers will be incorporated.

In addition to the communication plan in development, staff has coordinated with municipalities which own/operate sanitary sewer utilities. The purpose of these interactions is to improve the quality of septic systems data outside of WASD's service area and inform municipal officials of study results and proposed policy actions which could impact their residents/constituents.

To support the various components of the proposed Plan of Action, the working group has explored various funding opportunities such as Community Development Block Grant (CDBG) Program and others. These programs, particularly when coordinated with multiple County initiatives (housing, transit, etc.), have a higher likelihood of yielding the intended results. Coordination between County departments, including the Miami-Dade County Department of Public Housing & Community Development, is ongoing to advance strategies for securing funding to advance holistic initiatives.

Plan of Action

- A Risk-Based Approach to Septic Systems Vulnerable to Sea Level Rise

There is a clear understanding of how rising groundwater affects the functionality of septic systems. Septic systems can fail in two ways: (1) a hydraulic failure which typically manifests as wastewater surfacing on the ground or a backup in the plumbing, or (2) a treatment failure, where the plumbing continues to operate but the effluent is not retained in an unsaturated condition for a time period long enough to provide adequate treatment and may move relatively unimpeded to ground and surface waters under saturated conditions.

> This plan includes actions that can be taken immediately to advance the reduction of nutrients and pathogen contributions and identifies next steps to guide impactful and cost-effective investment.

These failures pose a variety of risks to human health, our natural environment, and private property. Determining the relative risk in terms of likelihood and consequences on each of these systems is quite complex. For example, it is not possible at this time to determine the precise contribution of septic systems to larger water quality issues due to gaps in the data and monitoring network, as well as the complexity and interconnectivity of our groundwater and surface water system, the influence of the regional system, and the presence of multiple potential pollutant sources. Further research and analysis are needed to improve the certainty that actions such as expanding sewer service will result in impactful and cost-effective reduction of the risks that impacted systems pose to humans and the natural system.

Therefore, this Plan of Action includes a phased approach, including actions that can be taken now to advance the reduction of nutrients, non-nutrient pollutants, and pathogen contributions, such as incentivizing connection to available sewer infrastructure, expanding existing infrastructure programs to capture vulnerable systems, and aligning policies with the goal of reducing risks. It also includes information on data gaps and the next steps needed to define prioritization criteria to guide impactful and cost-effective risk reduction over time.

This plan of action includes nine central actions and six recommended policy related changes, all guided by the following overarching goals:

Overarching Goals

- Facilitate access to functional wastewater disposal
- Achieve impactful reductions in pathogen contributions and exposures
- Achieve impactful reductions in nutrient contributions
- Maximize cost-effective investment
- Minimize financial burdens

The following is a summary of recommended actions for a risk-based approach to addressing vulnerable systems, which are described in detail within Table 6. The Plan of Action has been configured into two phases. Phase 1 consists of immediate actions that can be advanced to mitigate environmental and human health impacts of vulnerable systems, while Phase 2 identifies longer range actions which will address these risks holistically. Many of these items should be advanced in parallel to yield the greatest results.

Phase I

1. Establish a residential and commercial septic system registration program
2. Implement effective public and private investment projects:
    a. Install public laterals to promote the connection of existing parcels abutting sewer infrastructure
    b. Expand existing septic to sewer projects,
    c. Address County-owned septic systems
3. Develop and finalize methodology to prioritize risk-based action and investments
4. Advance a suite of policy changes and requirements described in Table 7.
5. Improve available data, science, and information on water quality through a more comprehensive monitoring program, to better guide investment decision making
6. Develop process to identify vulnerable parcels within areas of planned public projects
7. Develop and implement a proactive public outreach and communications plan
8. Establish internal (County) funding sources and seek external funding

Phase II

1. Continue to identify internal and external funding sources
2. Develop an effective public and private investment program in Phase 2:
    a. Program execution of infrastructure improvements with basis in risk-based prioritization methodology.
    b. Identify areas impacted by rising sea level that require further study beyond septic system impacts for holistic study and potential investment (roadway, stormwater, sanitary sewer, etc.).

The following are areas of recommended changes in standards and procedures, which would require legislative action and are described in more detail in Table 7:

1. Update Feasible Distance Requirements (Chapter 24-5 and 28 of Code)
2. Review Environmental Code Variance Process
3. Revise Septic System Design Standards
4. Setbacks
5. Update Connection Requirements (Chapter 24 and 32 of Code)
6. Update standards for regional and sub-regional public pump stations

Table 6: Next Actions to Address Vulnerable Septic Systems

Strategies and Actions		Lead & Partners
PHASE I		
Establish a Septic System Registration Program		
1	Develop a septic system owner engagement program to: a. Improve inventory data of systems (number, age, condition, etc.) b. Increase awareness of septic system operations, maintenance requirements c. Provide reminders for maintenance • Facilitates baseline for additional outreach and regulatory programs	RER-DERM
Implement Phase 1 of Effective Public and Private Investment Projects		
2	Infrastructure Investment Projects – Phase I a. Implement a Global Opportunity for Abutting Sewer Tie-in (GOFAST) Program[1] to install public laterals to promote the connection of parcels, beyond current Code requirements that mandate connection by property owner. There are existing mechanisms for the County to recover the costs, including assessing the property owners the cost for this connection through a special assessment lien as authorized in Section 32-80 of the Code of Miami-Dade County and policies including special taxing districts. Once the funding mechanism is finalized for this program, lateral installations can be completed based on criteria including: • Current & future vulnerability • Proposed work in the area (e.g., water & sewer utility projects, roadway projects, drainage, community projects, etc.) • Risk factors related to property "use" type b. Evaluate expansion of existing septic to sewer projects to incorporate vulnerable parcels • General Obligation Bond Commercial Corridor Project Program county-owned vulnerable systems c. Analyze Miami-Dade County Parks and other County properties currently on septic systems that can be feasibly connected to the public sanitary sewer system.	WASD, RER
Prioritize Risk-based Action and Investments		
3	Develop and finalize methodology to prioritize risk-based action and investments: • Identify metrics for prioritization criteria that prioritize reducing nutrient and pathogen contribution and exposure events. Examples include systems within X feet of water body receptor, neighborhoods that flood in King Tide or rain events, areas reliant on well water, wellfield protection areas, contaminated basins, etc. • Consider likelihood and consequences from direct (pathogen absorption) and indirect (algal blooms and the toxins they create) impacts • Consider planning implications: do vulnerable areas coincide with enterprise zones, Community Redevelopment Areas (CRA's), Opportunity Zones, Neighborhood Revitalization Strategy Areas (NRSA's), SMART Corridors, etc. [2] • Evaluate clusters and develop phasing plan.	RER, WASD
Establish and Modify Enabling Policies		

<table>
<tr><td>4</td><td>Advance a suite of policy standards and requirements (see Table 7)</td><td>RER, WASD, CAO</td></tr>
<tr><td colspan="3">Enhance Available Data and Science of Improved Decision Making</td></tr>
<tr><td rowspan="2">5</td><td>Enhance water quality data and monitoring network to yield improved scientific basis for decision making and guidance of investments:
a) Review of previous studies in Florida on septic and wastewater impacts on groundwater and surface water quality and integrate conclusions into design of enhanced monitoring programs.
b) Continue analysis of existing water quality and flow data including statistical analyses to better understand correlations of the various components of the watersheds.
c) Evaluate and implement into sampling programs evolving technology such as sucralose, microbial DNA fingerprinting, and stable isotopes of 14N and 15N, to better identify and quantify human and animal wastewater related sources
d) Identify data gaps in the regional canal system for flow and water quality and develop plan with federal, state and local agencies to address those gaps
e) Develop and implement strategically located groundwater and surface water monitoring plan to better understand the dynamics of septic system nutrient fluxes to receiving water bodies.</td><td>RER, WASD, FDOH, FDEP, municipalities, academia</td></tr>
<tr><td>Continue to improve the information on parcels with septic systems by coordinating with data owners including the Department of Health and municipalities. Improve the current septic and private well GIS layers using customer data and electronic atlas from all sixteen (16) utilities. Currently DERM has atlas data for all sixteen utilizes and customer connection data for fourteen of the sixteen utilities (missing Hialeah and Homestead).</td><td>RER, WASD, DOH, municipalities</td></tr>
<tr><td colspan="3">Develop Process to Identify Vulnerable Parcels within Areas of Planned Public Projects</td></tr>
<tr><td>6</td><td>Perform analysis of County-Wide Capital Improvement Program to identify public infrastructure and development projects that create an opportunity to expand sanitary sewer infrastructure as part of the overall initiative, thus reducing project costs and facilitating connection at the time of execution/development. The existing Joint Participation model in use by Miami-Dade County and other external agencies to yield efficiencies in project delivery can be adopted and enhanced to address vulnerable systems.
• Develop a process and information source to identify septic system parcels that coincide with areas planned for major roadway, water, wastewater, or other utility work that would provide an opportunity to address vulnerabilities and reduce disruptions to the right of way.</td><td>RER, WASD, DTPW, PHCD, PROS, & Others</td></tr>
<tr><td colspan="3">Communicate</td></tr>
<tr><td>7</td><td>Develop and implement communications plan.
• Outreach material with information for homeowners regarding proper inspection and maintenance of septic system, with recommended frequencies and resources available.
• Information and guidance for property owners with access to sanitary sewer systems indicating the processes to achieve connection and highlighting the County Departments and resources that can assist residents in this process.
• Information for businesses served by onsite systems to communicate potential environmental hazards, materials prohibited for discharge into septic systems, and recommendations regarding inspection and maintenance of septic system. Information regarding procedure/options for connecting to sanitary sewers will be incorporated.</td><td>RER, WASD</td></tr>
<tr><td colspan="3">PHASE II</td></tr>
</table>

Establish Internal (County) Funding Sources and Pursue External Funding		
1	Development of *Internal* funding sources: • Establish fee mechanisms: o Creation of revenue stream through utility service fee model recognizing environmental resilience, water quality, or public health benefit to all utility rate payers. o Pursuit of special taxing districts or special benefit districts in appropriate areas (i.e. commercial/high density zoned areas). o General Obligation Bond through Board of County Commissioners and citizen referendum. o Explore "Readiness to Serve" charge (City of Jacksonville example – base wastewater fee for available service after 1 year no connection – $21.50/month), and other similar mechanisms. o Establishment of tax increment financing (TIF) districts for infrastructure improvements (sanitary sewer, storm water, roadway, etc.) to align with land use/zoning o Ad-valorem tax program	WASD, RER, CAO
	Next steps for aligning and seeking *external* funding: • Submit proposal for State Water Quality Assistance Grants and Federal 319(h) Grants – annual opportunity • Analyze opportunities for properties with Community Redevelopment or Opportunity Zone designations • Explore Community Development Block Grant funding for infrastructure expansion with PHCD • Analyze opportunities for State and Federal funding associated with repetitive loss properties.	RER, WASD, OMB, PHCD
Implement Phase 2 of Effective Public and Private Investment Projects		
2	Infrastructure Investment Projects – Phase II - Develop phased infrastructure improvement plan for clusters of vulnerable parcels (~13,500) • As part of this process Identify areas experiencing other impacts of rising sea level and groundwater that might require a comprehensive adaptation approach, one that addresses more than wastewater disposal issues. This approach will be essential in ensuring the most effective social, environmental, and economic results.	

[1]The Global Opportunity for Abutting Sewer Tie-in (*GOFAST*) Program is designed to:

- expedite connections using a global approach to assisting properties abutting sewer systems, but without a public lateral, to connect
- coordinates the installation of public laterals with all departments involved in approving work in the right-of-way, leveraging planned future work and prioritizes the installation of laterals based on current & future vulnerability, proposed work in the right-of-way, and risk factors related to property "use" type
- removes the burden from private property owners to coordinate, permit and oversee the installation of public laterals and establishes a predictable and realistic timeline for final connection
- coordinates construction to minimize community and traffic interruptions.
- protects the publicly owned sewer system by assuring consistent and coordinated construction.
- reduces the overall cost of construction for property owners by grouping projects and providing a payment plan.

[2] CDMP Land Use Element LU-2B states: "Priority in the provision of services and facilities and the allocation of financial resources for services and facilities in Miami-Dade County shall be given first to serve the area within the Urban Infill Area and Transportation Concurrency Exception Areas. Second priority shall be given to serve the area between the Urban Infill Area and the Urban Development Boundary. And third priority shall support the staged development of the Urban Expansion Area (UEA)."The prioritization should not be in conflict with any CDMP policy such as the Policy CM-9F which directs public infrastructure from the CHHA, or any other CDMP policies, as outlined in Appendix 4 of the County's November 2018 report Septic Systems Vulnerable to Sea Level Rise.

The multi-department working group recommends the following changes which require legislative action:

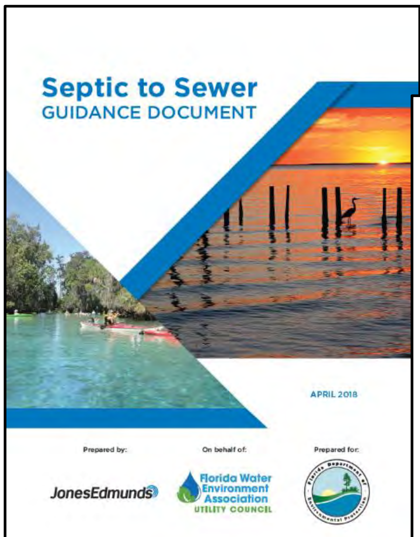
Table 7: Recommended Policy Changes to Address Vulnerable Septic Systems

	Policy Recommendation	Description	Lead / Partners	Implementation Notes
1	Chapter 24 Variances for connection to public sanitary sewer system	Requiring developments that are granted variance for septic systems be required to "offset" the same volume by contributing to expanding the existing sanitary sewer system.	RER-DERM, WASD	Develop a fund based on fees collected by property owners who apply for and obtain a variance from connecting to the public sanitary sewer system. This fund would be used for system expansion. The determination for granting a variance should NOT be based upon paying into the fund. The variance would still need to satisfy Chapter 24 requirements and be subject to approval by the Environmental Quality Control Board.
2a	Requirements to Connect, Existing facilities/buildings	• Review connection requirements for existing County facilities • Establish a "Readiness to Serve" charge for property owners who don't connect after 1 year of system availability	RER-DERM, WASD	• Require county facilities to inventory their systems and make a plan to connect to sewers. Evaluate phasing these with clusters identified for the lateral installation program; • Establish an oversizing reimbursement process • Research the City of Jacksonville example –base wastewater fee for available service after 1 year no connection – $21.50/month
2b	Requirements to Connect, New Construction/Expansion	• Review connection requirements for new/expanding County facilities • Review and modify criteria for determining connection requirements to eliminate exemptions by phasing of the development •	RER-DERM, WASD	• Refer to feasible distance below.
3	Feasible Distance	Review effectiveness of feasible distance requirements (Chapter 24-5 of Code) in protecting public and environmental health.	RER-DERM	RER-DERM is evaluating the development of non-linear standards for calculating feasible distance for connection to public sanitary sewer systems. Currently, feasible distance calculations are linear and only factor total building gross area. RER-DERM is evaluating a non-linear approach that includes a matrix of factors; e.g., gross-area non-linear scale, proximity to surface water bodies, impaired water bodies, and sea level rise. Additionally, since connection to public sanitary sewer mandates connection to public water, evaluating feasible distance to public sanitary sewers is incomplete without addressing feasible distance to public water. Therefore, a synergistic review of feasible distance to water is required and prosed. Like sanitary sewers, a non-leaner matrix approach for calculating feasible distance to water should be evaluated and may include: gross-area non-linear scale, proximity to surface water bodies, impaired water bodies, sea level rise, and saltwater intrusion.

4	Design Standards	Consider using groundwater projection maps for permitting review of septic systems and modifying minimum horizontal and vertical distance from drainage systems	RER-DERM, WASD, Planning	RER-DERM to consider code change to incorporate septic system design criteria in Chapter 24. Design criteria will incorporate future projection maps for groundwater level and setbacks intended to protect surface water bodies and drinking water wells.
5	Regional and Sub-regional Pump Station	Consider sub-regional pump stations	RER-WASD, DERM	Perform an analysis of alternative onsite, neighborhood and sub-regional systems to develop a suite of feasible technology alternatives for a variety of site scenarios
6	Setbacks	Determine if setbacks from waterbodies and drainage systems are protective and revise as necessary.	RER-DERM	Consider the outcomes of the additional water sampling and analysis to inform modifications to these standards.

Learning from Others

There are eleven case studies in Florida to reference for best practices in prioritization, communication, funding, policies, and more. A Septic to Sewer Guidance Document was developed through a partnership of the Florida Department of Environmental Protection, the Florida Water Environment Association, and Jones Edmunds in April 2018, which includes examples of these best practices. The City of Jacksonville and Indian River County for example, used quantitative metrics to prioritize vulnerable systems (see Appendix A). These examples will be considered in the development of final prioritization criteria.



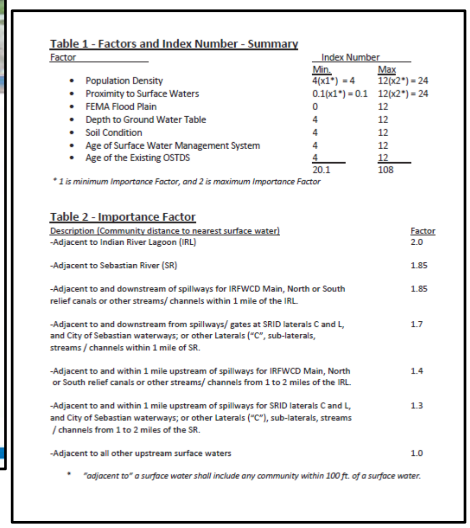


Table 1 - Factors and Index Number - Summary

Factor	Index Number Min.	Index Number Max
• Population Density	4(x1*) = 4	12(x2*) = 24
• Proximity to Surface Waters	0.1(x1*) = 0.1	12(x2*) = 24
• FEMA Flood Plain	0	12
• Depth to Ground Water Table	4	12
• Soil Condition	4	12
• Age of Surface Water Management System	4	12
• Age of the Existing OSTDS	4	12
	20.1	108

** 1 is minimum Importance Factor, and 2 is maximum Importance Factor*

Table 2 - Importance Factor

Description (Community distance to nearest surface water)	Factor
-Adjacent to Indian River Lagoon (IRL)	2.0
-Adjacent to Sebastian River (SR)	1.85
-Adjacent to and downstream of spillways for IRFWCD Main, North or South relief canals or other streams/ channels within 1 mile of the IRL.	1.85
-Adjacent to and downstream from spillways/ gates at SRID laterals C and L, and City of Sebastian waterways; or other Laterals ("C", sub-laterals, streams / channels within 1 mile of SR.	1.7
-Adjacent to and within 1 mile upstream of spillways for IRFWCD Main, North or South relief canals or other streams/ channels from 1 to 2 miles of the IRL.	1.4
-Adjacent to and within 1 mile upstream of spillways for SRID laterals C and L, and City of Sebastian waterways; or other Laterals ("C"), sub-laterals, streams / channels from 1 to 2 miles of the SR.	1.3
-Adjacent to all other upstream surface waters	1.0

* *"adjacent to" a surface water shall include any community within 100 ft. of a surface water.*

Communication Plan

The communications and public information staff of the multiple Departments engaged in this effort will work together to develop and distribute information on the topic of septic system vulnerability, impacts, policies, programs, and other information. Below is an initial list of message components that may be included in fact sheets, websites, or other communications outlets for stakeholders including elected officials, community groups and leaders, legislative representatives, homeowners, municipalities, and others as identified.

Possible Messages
General awareness of septic system operation and their potential impacts on the health of Biscayne Bay, other water bodies and potential public health exposures
Conditions that elevate the need to address this issue – cumulative effect of other area sources on surface water compliance, and groundwater flooding during sunny day flooding events increasing human exposure
Connection to overall water quality issues and needs
Steps individuals can take to reduce contribution of nutrients and pathogens: limiting use of the garbage disposal, use phosphate-free detergents, reduce fertilizer and pesticide use, landscape with native plants, etc.
Information on current policy requirements and anticipated legislation
Components of Plan of Action for addressing vulnerable systems, including policies, actions, and unmet needs
Current regulations and requirements, recommended maintenance schedules, best practices, etc.
Programs to convert to septic as become identified

Resource: EPA's Septic Systems Outreach Toolkit:
https://www.epa.gov/septic/septic-systems-outreach-toolkit

State Legislation

A number of bills were introduced in the House and Senate State legislative sessions in 2019 pertaining to septic systems and several bills merit mention. Notably, Senate Bill (SB) 1758 sought to establish matching grant programs to septic system conversions in areas covered by basin management action plans (BMAP) and expand septic system remediation plans to all BMAP areas. SB 1758 would have required public notification following sewage spills; and required a report on transferring regulation of septic system from the Florida Department of Health to the Department of Environmental Protection. However, SB 1758 failed to garner support, and certain remnant provisions were absorbed into House Bill (HB) 973, which failed to pass. Other bills introduced included House Bill 85 and SB 214 that sought to restore a septic system inspection program, but those bills did not gather support and did not advance. In addition, on February 20, 2019 the Board of County Commissioners (BCC) adopted Resolution No. R-211-19 that supported SB 282, House Bill 63 or similar legislation that would expand the qualifying improvements that may be financed through Property Assessed Clean Energy (PAC) programs to include sewage treatment improvements. While those referenced bills failed to pass, the Florida legislature passed a budget which included $150 million for wastewater treatment upgrades, septic to sewer conversions.

Appendices

Appendix A - Water Quality Technical Memorandum

Appendix B - Septic to Sewer Program Case Study Information

Appendix A

Water Quality Technical Memorandum

Technical Memorandum on Water Quality
Septic Systems Vulnerable to Sea Level Rise
In Support of Resolution No. R-911-16

1. Introduction

This Technical Memorandum (TM) is a preliminary effort towards implementing the recommendations regarding water quality in the report Septic Systems Vulnerable to Sea Level Rise submitted to the Board of County Commissioners in November 2018 in support of Resolution No. R-911-16. The report indicated that in addition to analyzing parcels with systems that are expected to be failing under current conditions, there was an overarching need for a comprehensive understanding of the various sources and quantities of nutrients and other pollutants that are impacting the health of Miami-Dade County groundwater, natural systems and public health. It was recommended to develop a comprehensive water quality and geologic data collection network that would inform the type of analysis called for in the report and aid natural systems management and infrastructure planning and programming. The report recommended evaluating existing sampling programs to identify modifications to collection sites and identify gaps to better characterize and monitor sources, destinations, and impacts of pollutants and nutrients that enter canals, groundwater, lakes, Biscayne Bay and coastal waterways. This TM describes the compilation and analysis of existing groundwater, surface water and canal flow, water quality data, and provides recommendations for further actions. This TM is a collaborative effort of Miami-Dade County's Water and Sewer Department (WASD) and Regulatory and Economic Resources Department of Environmental Resources Management (RER DERM).

On February 5, 2019, the County Board of County Commissioners accepted the Report on the Findings of the County's Study on the Decline of Seagrass and Hardbottom Habitat in Biscayne Bay – Directive No. 171537 (RER DERM, 2019) pursuant to Resolution No, R-876—17. Please refer to this report for a very thorough description of Biscayne Bay, DERM's water quality data, and a review of scientific literature and academic studies for Biscayne Bay, much of which is pertinent to this TM. The report concluded that water quality in Biscayne Bay is largely dependent on land use and influences from the watershed discharging into the Bay. Their findings from peer-reviewed literature indicate that the timing and sources of freshwater delivery into an estuarine system such as Biscayne Bay affects not only the water quality but thereby the health, diversity, and distribution of flora and fauna.

1.1. Objective

For this TM, available canal flow and water quality, and groundwater water quality nutrient measurements were used to determine if a correlation could be established between canal nutrient loading and groundwater and canal surface water quality impacts as a result of septic tank effluent discharges, and to provide directive for future monitoring efforts towards this goal. The results of this TM's flow and nutrient budgets for Biscayne Bay were compared to the previously published study of the nutrient loading budget for Biscayne Bay by Caccia and Boyer (Caccia and Boyer, 2007) to check for consistency of results and indications of temporal and spatial changes in nutrient loadings.

Summary figures and tables are included in the text of this TM. Due to the number and size of the maps and data tables, this report includes in the appendices maps generated from the water quality and flow data (designated in this report as *Appendix A, F1 through F26*), summary of methodology of loading calculations, and summary tables and graphical descriptions of canal flow and groundwater and surface water quality data (designated in this report as *Appendix C, T1 – T5*). The data files for these maps and tables are available upon request from the County.

2. Septic Tank Water Quality Chemistry

A brief and simplified description of septic tank water quality chemistry for nitrogen is included here. The nitrogen cycle is well known for surficial environmental processes (Stumm and Morgan, 1996; Hem, 1985), and can be simplified to be the oxidation of *ammonium* (NH_4^+) to nitrate (NO_3^-) in the presence of oxygen (O_2), in the process known as nitrification (*Figure 1*). Organic nitrogen (*Organic-N*) is composed of nitrogen compounds that have their origin in plants or animals. *Organic-N* can enter the environment through wastes that organisms expel, or by the decay of dead plants and animals. Nitrogen is essential for amino acids, the building blocks of all proteins, and proteins comprise the structural components of organisms such as muscle, tissue and organs, and the enzymes and hormones essential

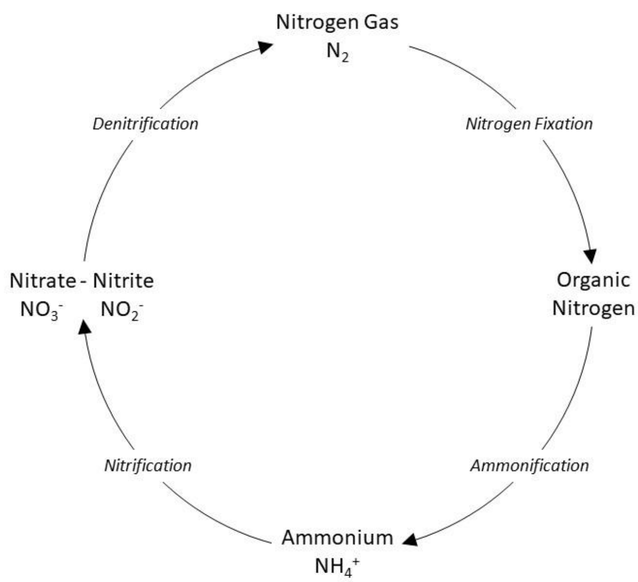


Figure 1. Simplified nitrogen cycle after MBL, University of Chicago.

for the functioning of all living things. Nitrogen is contained in urea, a byproduct of protein digestion. Nitrates are natural chemicals and can be introduced to the environment through runoff or seepage from fertilized agricultural lands, municipal and industrial wastewater, refuse dumps, animal feedlots, septic tanks and private sewage disposal systems, urban drainage, residential, commercial and golf course fertilizer applications, animal waste, and decaying plant debris.

Organic-N enters septic systems as bodily wastes, discarded food material, or as components of cleaning agents. Wastewater that enters the septic tank contains nitrogen that is approximately 75%

organic-N and 25% NH_4^+ (Lowe et al. 2007). Septic tanks in proper repair and operating condition are anaerobic (absence of oxygen). Wastewater into the septic tank is comprised of liquids and solids. Solids retention times in the tank are very long (e.g., years), and this results in a reduction of the solid volume of waste and through microbial action converts much of the *organic-N* found in human waste to NH_4^+ in the process of ammonification (Hazen and Sawyer, 2009). As a result, fluids leaving the septic tank (effluent) discharging into the drain field can be 90% NH_4^+ and 10% *organic-N* (Toor et.al. 2011). Very little NO_3^- is found in wastewater and septic tank effluent.

Once the effluent enters the drain field, NH_4^+ is further transformed in the soil by nitrification and denitrification. Nitrification is a two-step aerobic (oxygen presence) process by which NH_4^+ is converted first to nitrite (NO_2^-) and then to nitrate (NO_3^-) via biological oxidation (*Figure 2*). The conversion of NO_2^- to NO_3^- is relatively rapid. This particular reaction is of importance, as it represents the transformation from the relatively immobile nitrogen form (NH_4^+) to the highly mobile form (NO_3^-). This process occurs within unsaturated soils beneath the drain field and can transform nearly all NH_4^+ if at least 2 feet of unsaturated soils are present (Toor et.al. 2011). Because this is an aerobic process, if the soils become saturated or the depth to the water table is less than 2 feet, then conditions for nitrification become less favorable.

NO_3^- is highly mobile in groundwater and the only significant method of natural attenuation is denitrification. NO_3^- behaves essentially as a conservative solute, with virtually no sorption onto soil as it moves through the subsurface. It is, however, subject to transformative processes. Denitrification is the

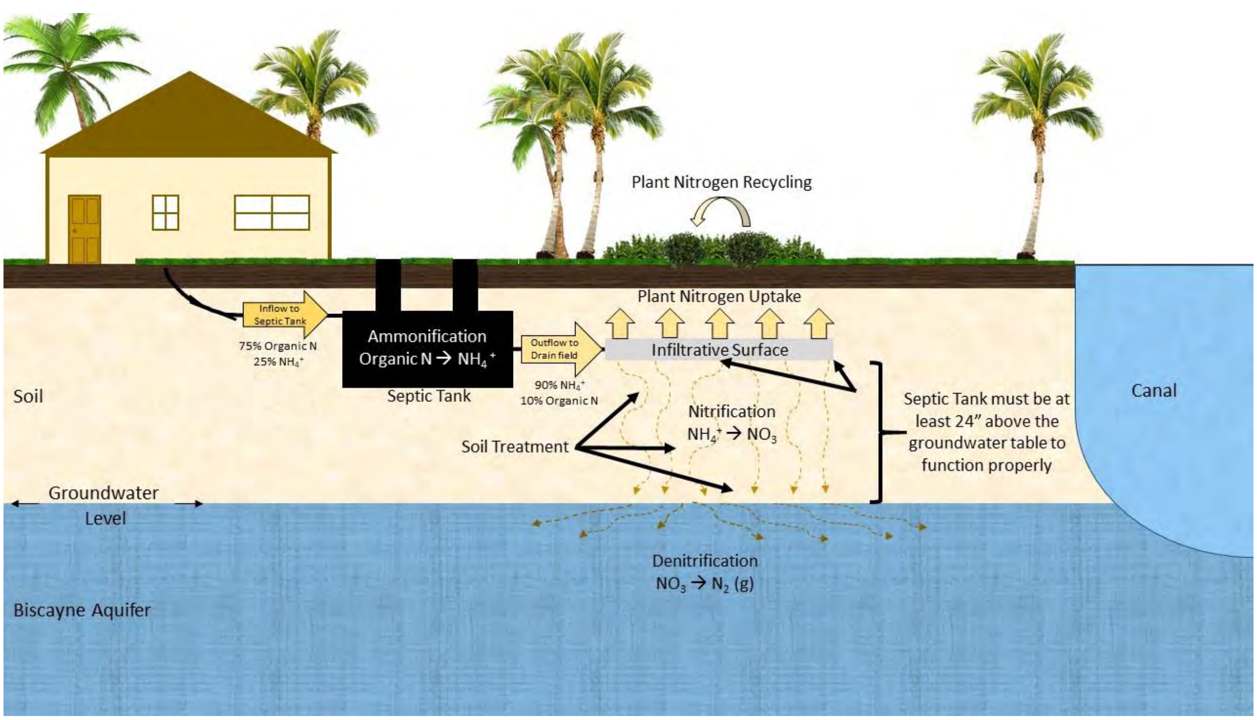


Figure 2. Septic tank waste nitrogen cycle modified after Heatwole and McCray, 2007.

transformation of NO_3^- to nitrogen gas (N_2), under anoxic (low oxygen) conditions, such as when soils are nearly saturated with water. Soil and groundwater temperatures in Florida are near optimum for denitrification, however, this process will only occur if there is nitrification of NH_4^+ and soil conditions allow it (i.e. at least 2 feet of unsaturated soil to the groundwater table).

The three forms of nitrogen that are commonly analyzed for septic system water quality are NH_4^+, NO_3^- and NO_2^- (*NOx*) and total nitrogen (*TN*). *TN* is the sum of total Kjeldahl nitrogen ([*TKN*]; which is *organic-N* and NH_4^+), and *NOx*. *TN* concentrations range typically between 26-171 milligrams Nitrogen per liter (mg-N/L) in septic tank effluent (Canter, 1996; Lowe et al., 2009), with the Florida average *TN* concentration in septic tank effluent at 61 mg-N/L (Lowe et al., 2009). In terms of mass loading to the subsurface, a range of loading was determined to be 10 grams of Total Nitrogen per capita per day (g-N/capita/d) (Lowe et al., 2009) to 11.2 g-N/capita/d (Toor et.al. 2011, FDOH 2013). These loading ranges are consistent with effluent loading of 11.3 g-N/capita/d for WASD wastewater treatment plants (James Ferguson, Miami-Dade WASD, 2019, personal communication).

Total phosphorous (*TP*) occurs in wastewater bound to oxygen to form phosphates. Phosphorous found in septic tank effluent is divided into two categories; inorganic and organic. Inorganic phosphate originates from detergents and household cleaning products, and almost 85% of *TP* in septic tank effluent is in the form of inorganic orthophosphates (Toor et.at., 2011). The remaining 15% exists as organic phosphates in the suspended solids in the effluent. There is little removal of Phosphorous (P) in septic tanks, however, inorganic-P readily adsorbs onto soils. *TP* has been reported at 1 – 2 grams of Phosphorous per capita per day (g-P/capita/d) (U.S. EPA 2002). These loading ranges are consistent with effluent loading of 1 g-P/capita/d for WASD wastewater treatment plants (James Ferguson, Miami-Dade WASD, 2019, personal communication).

3. Methodology

3.1. Data Sources

3.1.1. Septic Tank Vulnerabilities

Locations of septic tanks were determined as parcels without sewer service in Miami-Dade County according to existing WASD sewer lines and customer information system data (Tetra Tech, 2019). This is inclusive of residential and non-residential properties, properties within and outside the Urban Development Boundary, and properties that have abutting sewer but were not connected. These data exclude vacant land. The centroid of these parcels was used to extract land surface elevation (Miami-Dade County, 5-foot DEM, 2015 LiDAR) and to obtain depth to groundwater levels provided by the Urban Miami Dade (UMD) Groundwater Flow Model (Hughes and White, 2016). Please refer to the *Septic Systems Vulnerable to Sea Level Rise* 2018 report for a complete description of the methodology used to identify areas which are likely to be vulnerable due to very high groundwater levels (Miami-Dade County, 2018). Groundwater levels were determined for each model cell of the UMD based on historic climate conditions (1996-2010) excluding October 3-4, 2000 storm event and recession. Septic tanks located in parcels that had a depth to groundwater within 24 inches are considered *persistent failure*; parcels with septic tanks within 42 inches are considered *persistent compromised*. Septic tanks located in model cells with depth to groundwater greater than 42 inches were considered *not at risk* (*Figure 3*).

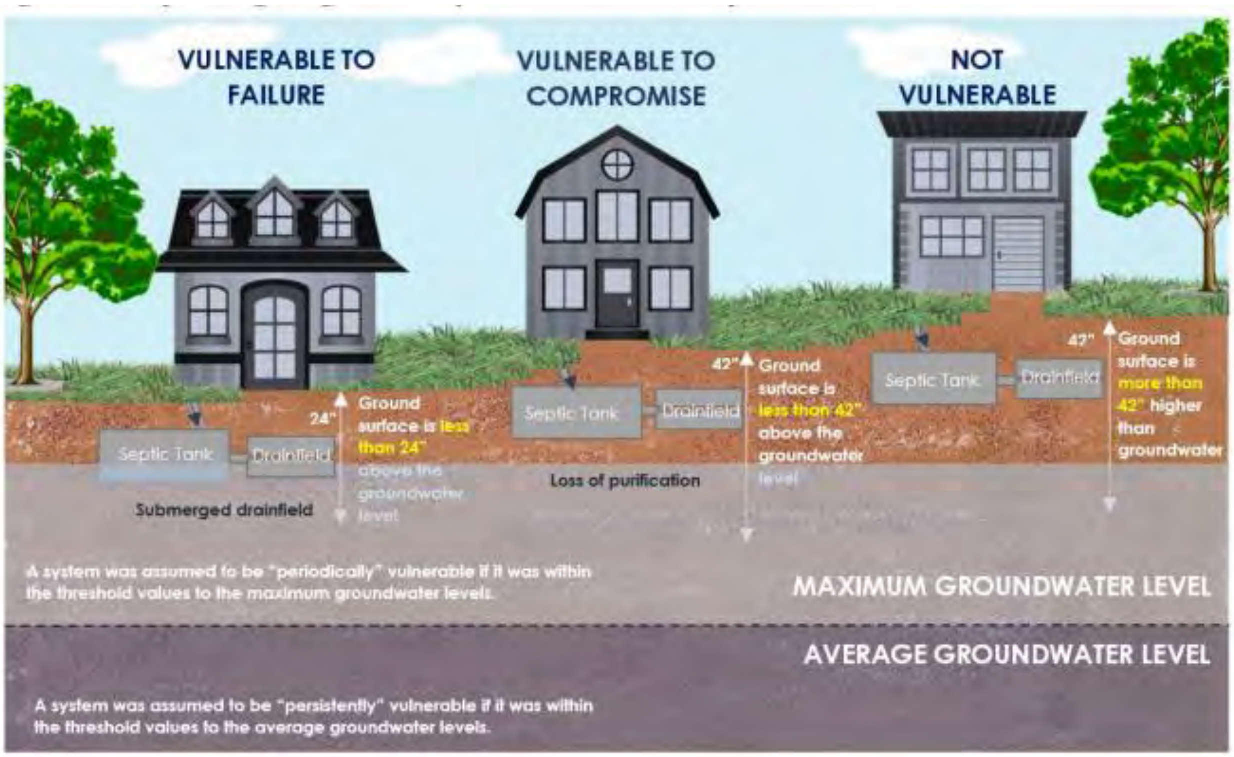


Figure 3. Septic tank vulnerability definitions.

3.1.2. Canal Flow

Canal flow data were obtained from South Florida Water Management District (District). District canals and structures were identified in the study area (*Appendix A-F1*), and flow data was obtained from the District's DBHYDRO website (https://www.sfwmd.gov/science-data/dbhydro). Flow data was obtained for period of record of eleven (11) years from 2008 – 2018 and reported in ft^3 s^{-1} (CFS). Flow data were then converted to million gallons per day (mgd). These data were used to obtain average flows for the period of record and for wet and dry mean seasonal flows, with the wet season defined as May through October, and the dry season November through April. District structures were identified as culverts, spillways, flow meters and pumps to categorize how flow data were calculated by the District and obtained from DBHYDRO.

3.1.3. Surface Water Quality

Surface water quality data were obtained from RER DERM for county surface water monitoring stations (*Appendix A-F1*). The County's surface water quality monitoring program was established in 1979 and collects data that include various physical, chemical and biological water quality parameters within all major canals across the County and throughout Biscayne Bay on a monthly basis (Miami-Dade County RER-DERM, 2019). Water quality data were obtained from three (3) surface water monitoring stations from the District. Data were compiled for the period of record, and included parameters such as NH_3, *TKN*, NO_x *TN* and *TP* with concentrations reported in mg/L. Please note that some *TN* values were calculated from *TKN* and NO_x data, when the *TKN* and NO_x readings were taken simultaneously at the same station. The data were used to obtain the average concentration and number of sampling events for the period of record, and the averages were calculated for the wet and dry seasons within the period of record. Surface water nutrient concentrations were then compared to the Cleanup Target Levels (CTLs) as per Chapter 24-44(2)(f)(v)1 Miami-Dade County Code and 62-302 Florida Administrative Code (FAC) as applicable. *TP* results were compared to the 2004 U.S. Army Corps of Engineers' (USACE) Comprehensive Everglades Restoration Project (CERP) Wastewater Reuse Pilot Project (Class III / Outstanding Florida Water (OFW) Water Quality.

3.1.4. Groundwater Quality

Groundwater Quality was obtained from RER DERM for the period of record for DERM groundwater monitoring wells (*Appendix A-F2*). The wet and dry seasonal average concentrations and sampling counts were compiled for NH_3, NO_X *TN* and *TP* with concentrations reported in mg/L. Some *TN* values were calculated as specified above in Section 3.1.3 – Surface Water Quality. Groundwater nutrient concentrations were compared to the Cleanup Target Levels (CTLs) as per Chapter 24-44(2)(f)(v)1 Miami-Dade County Code. There is no groundwater standard for *TP*, however, concentrations were compared to the range of medians for routinely sampled sites in south Florida (McPherson et.al, 2000).

3.1.5. Canal Nutrient Loading

Canal nutrient loading was calculated using the flow and canal surface water quality data, and calculated for the average period of record, wet, and dry season. Surface water monitoring stations located on the regional canals in this study were selected based on proximity to the flow structures to attempt a more precise water quality concentration with respect to the flow. Canal flows and water quality concentrations were converted to loading as follows:

$$Avg\ Load_{POR}\ US\frac{ton}{yr} = AvgFlow_{POR}\frac{L}{s} * AvgConc_{POR}\frac{mg}{L} * 0.03476(conversion\ factors)$$

Refer to *Appendix B* for complete methodology of canal nutrient loading calculations. *TN* was calculated by the summation of *TKN* and NO_x. *Organic-N* was calculated by subtracting the NH_3 values from the *TKN* values.

4. <u>Results</u>

This report used the same geographical descriptions for basins discharging to Biscayne Bay, following the description of Caccia and Boyer (2007) and used by RER DERM in the 2019 Decline of Seagrass report. North Bay is defined as north of the Rickenbacker Causeway, and canals discharging into North Bay include Snake Creek (C-9), Biscayne Canal (C-8), Little River (C-7) and Miami River (C-6). Central Bay includes the Coral Gables Waterway (C-3), Snapper Creek (C-2) and Cutler Drain (C-100). South Bay includes Black Creek (C-1), Princeton Canal (C-102), Mowry Canal (C-103) and Aerojet Canal (C-111), as seen in *Appendix A -F1*. For a more throughout description of the Canal Names, Codes, and Flow and Water Quality stations used for each Canal, please refer to *Appendix B*.

4.1. Septic Tank Vulnerabilities

Based upon the Tetra Tech 2019 methodology at the time this report was compiled, there are 120,008 septic tank parcels in Miami-Dade County (*Table 1*). Using the average October groundwater levels, of the total, 1,924 or about 1.6% were determined to be *persistent failure*, 6,806 or about 5.7% were *persistent compromised*, with the majority (92.7%) determined to be *not at risk.* Septic tank density per 0.1 square miles was calculated for the total number of parcels (*Appendix A-F3 through F5*). The highest density was 48% in the North Bay watershed, while the lowest was 13% in the South Bay watershed. Most of the 1% *persistent failure* septic tanks were located along the North Bay canals. Although Central Bay has 39% of all septic tanks, only 7% are considered *persistent failure* under current October average conditions, with a similar percentage for *persistent compromise*. Most of the *persistent failure* and *persistent compromise septic tanks* in South Bay are located in the western stretches of the watershed beyond the urbanized areas.

	All Septic Tanks	% of Total by Location	Persistent Failure	% of Persistent Failure	Persistent Compromise	% of Persistent Compromise
North Bay	57,781	48%	1,082	56%	4,530	67%
Central Bay	46,487	39%	141	7%	425	6%
South Bay	15,740	13%	701	36%	1,851	27%
Total	120,008		1,924		6,806	

Table 1. Number and percentage of septic tanks per categories and watershed, Miami-Dade County, FL (average October groundwater levels).

4.2. Regional System Flows and Nutrient Loading

There were few flow and water quality monitoring sites in the regional system, however, data for flow obtained from District structures as well as DERM surface water quality data from stations closest to the above-mentioned District structures were located at the head of canals leading to Biscayne Bay (*Appendix A-F6 and Appendix C-T1*), are provided. No flow or water quality data were available for structures in the head waters of the canals in the Central Bay watershed, since they originate from the Tamiami Canal (as the Coral Gables Canal and Snapper Creek) or do not connect to the Regional System directly (as the Cutler Drain). Miami River had the highest flows recorded for the period of record with an average of 118 mgd, with the expected seasonal differences of higher flows; 148 mgd during the wet season, and lower flows of 89 mgd during the dry season. There was scarce incoming regional flow data available for the other canals in the North Bay watershed, since they originate from the Miami River (as Little River) or do not connect to the Regional System directly (as Biscayne Canal). South Bay had an average of 183 mgd for the incoming regional system flows, with the majority flowing in through the Aerojet and Black Creek canals (83%). South Bay had 59% difference between wet season flows (266 mgd) and dry season flows (98 mgd), whereas North Bay had a 37% difference between seasonal flows (152 and 89 mgd wet and dry flows respectively).

North Bay had an average of 280 tons/year loading of *TN*, with seasonal loads corresponding to wet and dry season flows. Nutrient data were available for Miami River, but little concentration data was available for the other canals in the watershed. South Bay had an average loading of 257 tons/year, with seasonal loads corresponding to wet and dry season flows. 82% of *TN* loading was through the Aerojet and Black Creek Canals.

From the 280 tons/year of *TN* in North Bay, the majority of *TN* flowing from the Regional System is in the form of *TKN*, at 272 tons/year. Only one concentration sampling event data was available for *Ammonia* in the North Bay Miami River, therefore concentration results for *Ammonia* and *Organic-N* may not be reflective of the entire period of record, however, based on that one sample the majority of *TKN* flowing from the regional system is in the form of *organic-N*, at 260 tons/year (*Ammonia* loading was 8 tons/year). The majority of *TN* loading from the regional system in the South Bay watershed was in the form of *organic-N* (200 tons/year), with NH_3 at 42 tons/year. NO_x loading in North Bay was only 4% of *TN*. South Bay watershed regional NO_x loading was a slightly higher percentage at 7% (18 tons/year). North and South Bay had similar *TP* loadings at an average of 2 tons/year from the regional system.

4.3. Biscayne Bay Flows and Nutrient Loading

4.3.1. Canal Flows

Flows were greatest for canals discharging into North Bay for the average period of record (*Figure 4, Appendix A-F6 and Appendix C-T2*). The Miami River (Compromised of the flow data from Miami River, S. Fork Miami River and Tamiami Canal when discharging into the bay) had the highest average flows for the period of record, the wet season and the dry season at 299 mgd, 429 mgd and 168 mgd, respectively. Miami River also had higher flows in the Bay with 173 mgd for the average period of record, 241 mgd for the wet season, and had the highest for dry season flows at 104 mgd. The sum of flows into North Bay was 676 mgd for the average period of record, with higher average flows in the wet season at 976 mgd, and lower in the dry season at 371 mgd. Central Bay had average period of record flows at 173 mgd, wet season flows at 266 mgd, and dry season flows at 79 mgd. Snapper Creek provided the greatest amount of flow to Central Biscayne bay with 145 mgd in the average period of record, and 217 mgd and 72 mgd for the wet and dry season flows respectively. South Bay had average period of record flows at 389 mgd, with wet seasons flows at 533 mgd and dry season flows at 242 mgd. Mowry Canal had the highest average period of record flows at 143 mgd, and the highest dry season flows at 111 mgd, with Black Creek Canal also a main contributor to flows to South Biscayne Bay at 138 mgd for average period of record, and the highest wet season flows at 213 mgd.

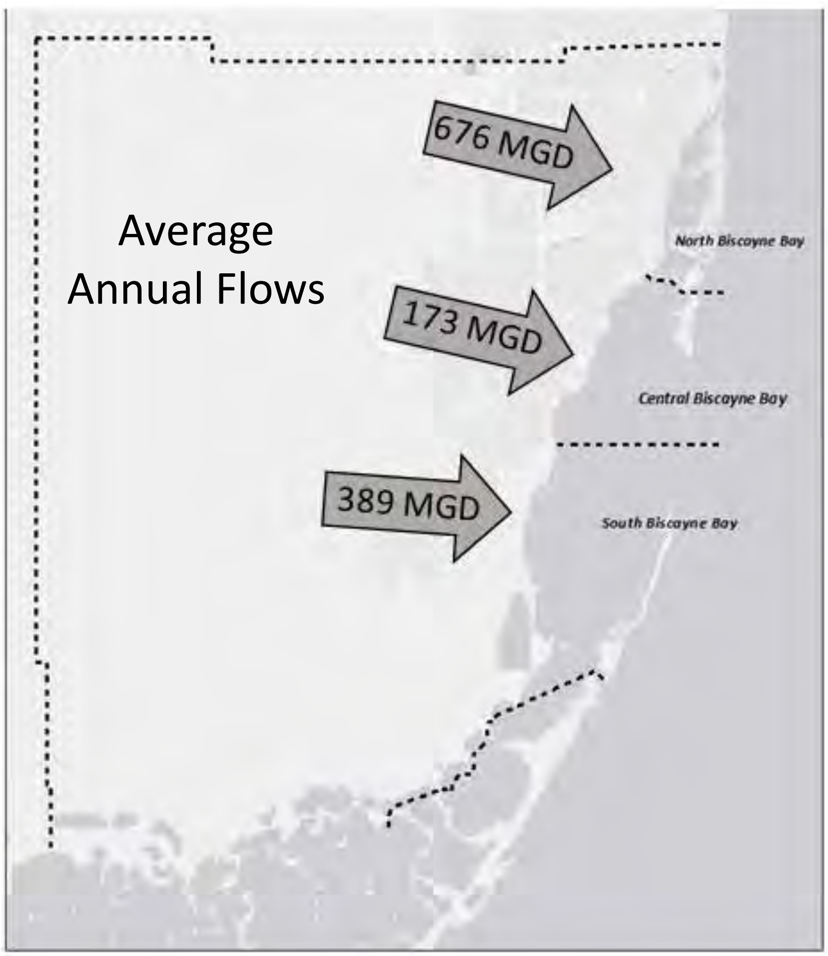


Figure 4. Average annual flows into Biscayne Bay.

4.3.2. Total Nitrogen (*TN*)

North Biscayne Bay had an average *TN* loading of 1,000 tons/year for the period of record, with wet and dry season loadings of 1,424 and 557 tons/year respectively *(Figure 5, Appendix A-F6 and Appendix C-T2)*. The Miami River was the largest contributor to North Bay, with 408 tons/year for the average period of record, 624 tons/year for the wet season, and 212 tons/year for the dry season. Central Bay had a loading of 225 tons/year for the average period of record, with 329 and 111 tons/year for the wet and dry season averages respectively. As with flows, Snapper Creek was the largest contributor to *TN* loading with 201 tons/year for the average period of record, and 286 and 104 tons/year for the wet and dry seasons averages. South Bay had the largest loading of *TN*, with 1,120 tons/year average period of record, and 1,471 and 794 tons/year for wet and dry season averages. The largest contributor South Bay was the Mowry and Princeton Canals, with 420 and 494 tons/year average period of record season average loading at 543 tons/year and dry season loadings at 409 tons/year.

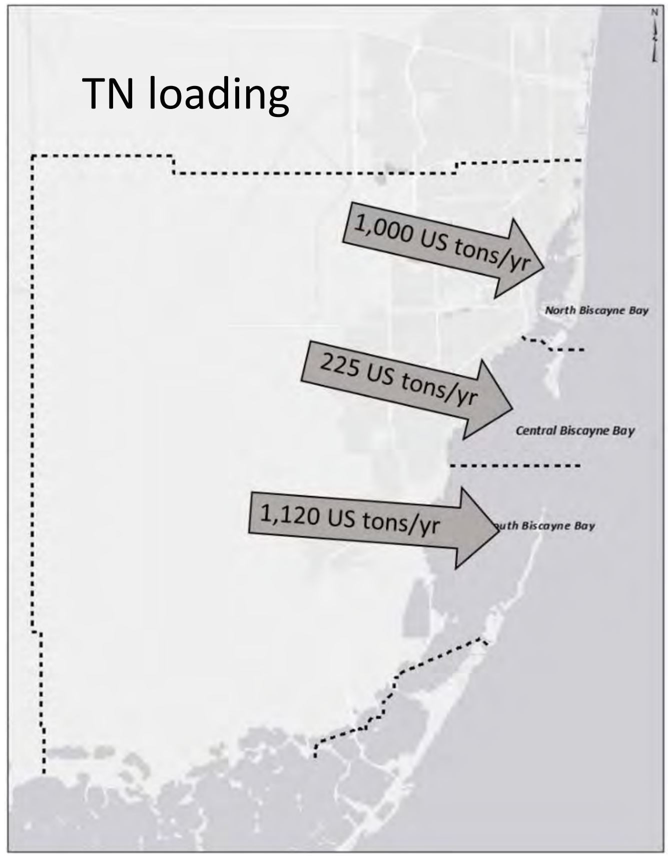


Figure 5. TN loading annual average.

4.3.3. Total Kjeldhal Nitrogen - *TKN – Ammonium* and *Organic-N*

North Bay had the highest *TKN* loading, with the average period of record at 808 tons/year, and wet and dry season loadings of 1,225 and 423 tons/year, respectively (*Figure 6*, *Appendix A-F7, A-F8, and C-T2*). The Miami River was the largest contributor, with 338 tons/year for the average period of record,544 tons/year for the wet season, and 167 tons/year for the dry season. The majority of *TKN* in North Bay is *organic-N*, present at an annual average of 79% of total *TKN*, with NH_3 at 21% of annual average total. Central Bay had a loading of *TKN* of 187 tons/year for the average period of record, with 273 and 93 tons/year for the wet and dry season averages, with Snapper Creek the largest contributor to *TKN* loading, with *organic-N* at 82% of *TKN*. South Bay had *TKN* loadings of 222 tons/year for the average period of record, and 374 and 102 tons/year for the wet and dry season averages. The largest contributor to the South Bay was the Black Creek Canal with 97 tons/year on average period of record

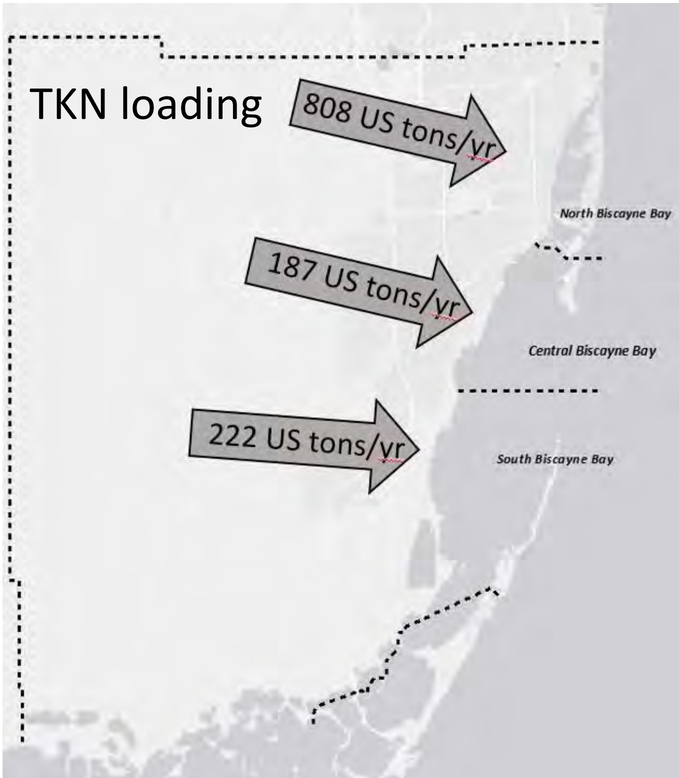


Figure 6. TKN loading annual average.

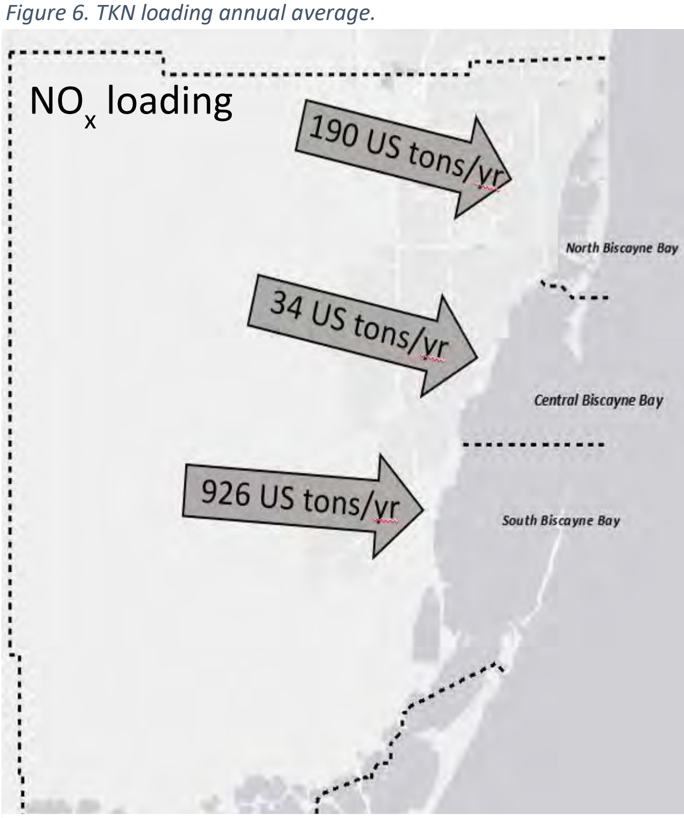


Figure 7. NOx loading annual average.

respectively, and wet season average loading at 177 tons/year, however, Mowry Canal had the highest dry season loadings at 38 tons/year. South Bay had the highest percentage of *organic-N* at 84% of *TKN*.

4.3.4. NO_X

North Biscayne Bay had an average NO_X period of record loading of 190 tons/year, and wet and dry season loadings of 215 and 125 tons/year respectively (*Figure 7*, *Appendix A-F9 and C-T2*). The largest contributor for NO_X was the Miami River with 70 tons /year annual average, 82 tons/year for the wet season average and 45 tons/year for the dry season average. Central Bay had a NO_X loading of 34 tons/year for the annual average, with 42 and 19 tons/year for the wet and dry season averages, and Snapper Creek, the largest contributor to NO_X loading with 26 tons/year annual average. South Bay had the highest NO_X loading of 926 tons/year for the annual average, and 1,124 and 715 tons/year for wet and dry season averages. The largest contributor to South Bay was the Princeton Canal with 459 tons/year for the annual average, and wet season average loading at 498 tons/year and 388 tons/year for dry season average loading, followed closely by the Mowry Canal (C-103) with an average annual loading of 370 tons/year, a wet season annual average of 435 tons/year and a dry season annual average of 296 tons/year.

4.3.5. Total Phosphorus (*TP*)

North Bay had the highest *TP* loading, with the annual average period of record at 14 tons/year, and wet and dry season loadings of 21 and 8 tons/year respectively (*Figure 8*, *Appendix A-F10 and C-T2*). The Miami River was the largest contributors of *TP* with an annual average of 6 tons/year, and wet and dry season averages of 8 and 3 tons/year. Central Bay had a loading of *TP* of 2 tons/year for the annual average, with 4 and 1 tons/year for the wet and dry season averages, and Snapper Creek the largest contributor. South Bay had *TP* loadings of 4 tons/year annual average, and 5 and 2 tons/year for wet and dry season averages. The largest contributor to South Biscayne Bay was the Black Creek Canal with 2 tons/year as the annual average, and wet season average loading at 3 tons/year, while the dry season average loadings was 1 ton/year.

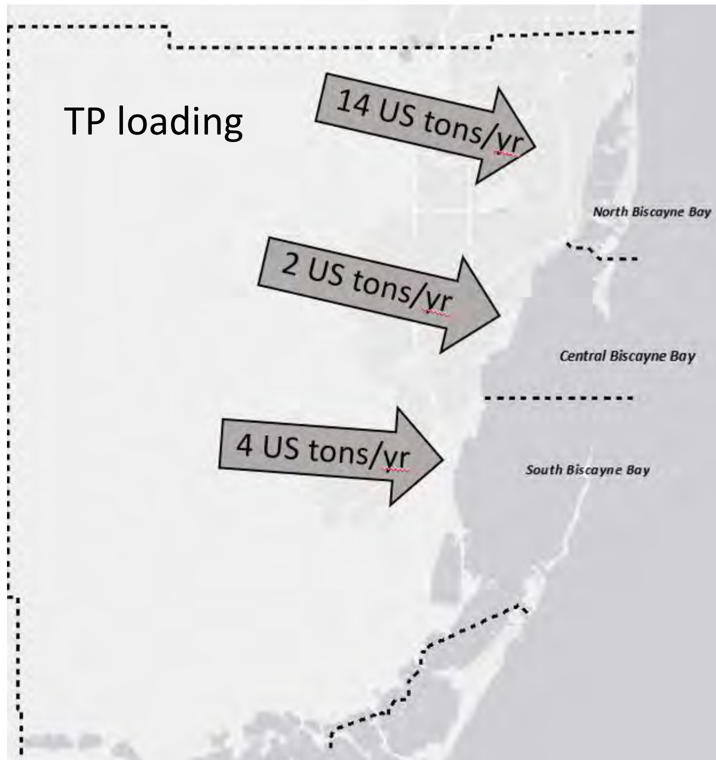


Figure 8. TP loading annual average.

4.3.6. Surface Water Quality

Average NH_3, *TKN*, NO_x and *TP* surface water concentrations were analyzed with respect to *all septic tank parcels* in the County, and those parcels that were determined to be *persistent failure* (*Appendix A-F11 through F18 and Appendix C-T3 through C-T4)*. *TKN* average concentrations were higher in stations along the Miami River, in the upstream stations of the Tamiami Canal (North Bay), Snapper Creek (Central Bay) and Princeton Canal (South Bay), four stations located in the vicinity of landfills and wastewater treatment plants along the coast in the North and South Bay. Stations with the higher average concentrations were not located in areas of high septic tank parcel density. Stations with the highest NH_3 average concentrations were located also in the vicinity of the landfills and regional wastewater treatment plants, with one station along the Miami River of higher concentration. Surface water stations with the higher NO_x concentrations were primarily located in South Bay watershed, in areas of no septic tank parcels or low-density septic tank parcels.

4.3.7. Groundwater Water Quality

NH_3 concentrations in groundwater were consistent throughout the county with a few localized higher concentrations *(Table 2, and Appendix A-F19 through F24).* Monitoring wells located in the North Bay watershed had an average of 0.89 mg/L, Central Bay and South Bay watershed monitoring wells had similar averages of 0.24 mg/L and 0.2 mg/L respectively. *NO_x* concentrations for monitoring wells in the North and Central Bay watersheds had similar averages of 0.04 mg/L and 0.17 mg/L respectively. South Bay watershed monitoring wells had higher *NO_x* average concentrations at 2.45 mg/L. *TP* average concentrations were similar for all watersheds at 0.04 mg/L or less. Average *NH_3, NO_x* and *TP* groundwater concentrations were analyzed with respect to all septic tank parcels in the County, and those parcels that were determined to be *persistent failure.* Only a few groundwater monitoring stations had concentrations above the MCL of 2.8 mg/L, and no spatial pattern was observed with regard to septic parcels. Concentrations of *NO_x* were higher in the South Bay watershed than in the rest of the County, with many of the stations located in areas of low septic tank parcel density. Groundwater monitoring stations with higher *TP* concentrations were located throughout the County, many in areas with few or no septic tank parcels.

DERM Groundwater Well Water Quality Measurements (2008-2018)				
		North Biscayne Bay	Central Biscayne Bay	South Biscayne Bay
NH_3 in mg/L	Minimum	0.01	0.01	0.01
	Average	0.89	0.24	0.2
	Maximum	29.8	7.41	9.27
NOX in mg/L	Minimum	0.01	0.01	0.01
	Average	0.04	0.17	2.45
	Maximum	3.37	9.57	39.2
Total Phosphorus in mg/L	Minimum	0.002	0.002	0.002
	Average	0.04	0.03	0.04
	Maximum	1.97	4.89	1.57

Table 2. Summary groundwater average concentrations in mg/L.

5. Discussion

Canal flows showed the expected wet and dry season variations. Average annual period of record flows was compared to calculated flows from a previous study on nutrient loading budgets for Biscayne Bay (Caccia and Boyer, 2007). Caccia and Boyer calculated average flows for the nine (9) year period of record of 1994 – 2002. While canal flows from different periods of record cannot be directly compared due to climatic variabilities and land use changes, canal flows can be compared for similarities and trends. Caccia and Boyer results showed a total canal flow of 800 mgd for the North Bay, 15% more than this study calculated for the 2008 – 2018 period of record. Caccia and Boyer results of 161 mgd into Central Bay and 387 mgd into South Bay are similar to the average period of record in this study with 8% or less variation. Overall percentage of flows into the North, Central and South Bay in this study are similar to the Caccia and Boyer flows for percentage of flows.

If the majority of *TKN* in surface waters was of septic tank origin, it would be expected in the form of NH_4^+, or even NO_x, as most nitrogen leaves the septic tank into the drain field in the form of NH_4^+ (Toor el.al., 2011). North Bay and Central Bay had NO_x average concentrations of ≤0.23 mg/L for both wet and dry season. Most of the *TN* in the North and Central Bay canals is in the form of *organic-N* and suggests runoff of organic material throughout the watersheds may be the significant contributor of nitrogen to the canals.

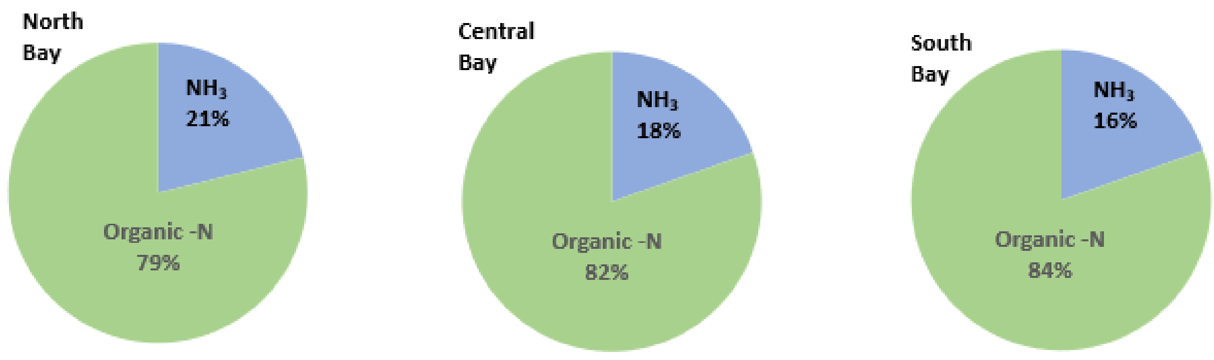


Figure 9. Percentage of organic-N and NH_3 in Biscayne Bay watersheds.

South Bay nitrogen concentrations exhibited different trends than the rest of the County. Unlike North and Central Bay which had minimal seasonal variation in concentrations, concentrations in South Bay had strong seasonal trends. South Bay *TKN* concentrations showed a 44% decrease in average concentration for the dry season. *NOx* average concentrations increased in the dry season. South Bay had the lowest average concentrations for *TKN*, but the highest for *NOx* with Mowry and Princeton Canals concentrations above 1.6 and 4.1 mg/L respectively. South Bay canal concentrations for *NOx* showed higher dry season concentrations except for the Black Creek Canal. Higher dry season *NOx* concentrations have been documented in other surface waters in Florida (Upchurch et.al., 2007), indicative of groundwater contributions to the watershed. Most of the nitrogen into the South Bay watershed canals is *NOx*, and the seasonal variations in the concentrations suggest that the major source of nitrogen loading to South Bay may be of agricultural origin. Nutrient application through fertilizers in agricultural areas is common to enhance crop production. In South Florida, nutrient applications often occur near water bodies and watersheds that feed ground water and surface water. When nutrients are not fully utilized by the growing plants, the excess nitrogen and phosphorus can enter the canals in the watershed during rain events as runoff and can also leach through the soil and into groundwater over time.(U.S.EPA, https://www.epa.gov/nutrientpollution/sources-and-solutions-agriculture).

The highest *TKN* loadings in South Bay were at Black Creek Canal. This canal runs through the South Dade Landfill, a known source of leachate to the ground and surface waters, and adjacent to a regional wastewater treatment plant. *TKN* loadings may be indicative of the leachate plume from the landfill (*Appendix A-F12, F14, F19 and F20*). The highest *TKN* loadings in North Bay were in the Miami

River and the Snake Creek Canal, which is consistent with findings of the Caccia and Boyer study. The Snake Creek is in the vicinity of the Munisport Landfill and a regional wastewater treatment plant and may also be indicative of canal flows intercepting the known landfill groundwater leachate plume in that area.

Nitrogen and phosphorus loadings calculated in this study were compared to the Caccia and Boyer 2007 study and loading results for this study followed similar trends (*Table 5).* Caccia and Boyer calculated nitrogen loading for NO_x, NH_4^+ and dissolved inorganic nitrogen (DIN), which was calculated as the sum of NO_x and NH_4^+. NO_x loadings were very similar with regards to percentage of total loading to the bay, with the majority NO_x loading into South Bay in both studies (79% C&B and 81% TM). The Caccia and Boyer study estimated greater tons per year of loading, but this would be consistent with their results of higher canal flows for their period of record. *TP* loading trends were similar in both studies, with higher loadings in the Caccia and Boyer study, again consistent with higher flows. Caccia and Boyer had loadings of 21 tons per year for North Bay, compared to this TM of 14 tons/year. Central and South Bay were very similar loadings for both studies, between 2 to 6 tons/year for the watershed canals.

Caccia and Boyer compiled NH_4^+ concentrations for loading calculations. This study used NH_3 concentrations as reported by RER-DERM. The two loading calculations were evaluated for comparative purposes. This study had NH_3 loadings of 80% less than the Caccia and Boyer NH_4^+ study, with most of that resulting in the considerably lower North bay NH_3 loading for the 2008 to 2018 period of record. However, overall percentages of NO_x, NH_3/NH_4^+ and *TP* for North, Central and South Bay were similar in both studies (*Table 5*).

This TM had findings consistent to those of previous studies where maximum loadings of NO_X are found discharging from the agricultural areas in South Bay, while *TKN* loadings were higher in the urbanized North Bay.

	Caccia and Boyer 2007 MGD	Caccia and Boyer 2007 % of total	TM MGD	TM % total
North Bay	800	59%	676	55%
Central Bay	161	12%	173	14%
South Bay	387	29%	389	31%
Total	1348		1238	
NO_X	tons/year		tons/year	
North Bay	259	18%	190	17%
Central Bay	43	3%	34	3%
South Bay	1125	79%	926	81%
Total	1427		1150	
NH_3/NH_4^+	tons/year		tons/year	
North Bay	344	80%	171	71%
Central Bay	31	7%	33	14%
South Bay	57	13%	36	15%
Total	432		240	
DIN	tons/year		tons/year	
North Bay	603	32%	361	26%
Central Bay	74	4%	67	5%
South Bay	1183	64%	962	69%
Total	1860		1390	
TP	tons/year		tons/year	
North Bay	21	68%	14	70%
Central Bay	4	12%	2	10%
South Bay	6	20%	4	20%
Total	30		20	

Table 3. Comparison of flows and loadings to Caccia and Boyer 2007.

5.1. Spatial and Temporal Data Constraints

Miami-Dade County's groundwater monitoring network has been developed primarily protect potable municipal drinking water supply of the Biscayne aquifer, and most monitoring stations are in the vicinity of county wellfields and wellfield protection areas, and at seawater/freshwater interface in the Aquifer (*Appendix A-F2*). Groundwater quality sampling events are conducted typically twice or three times per year. There are few groundwater monitoring wells in areas of high-density septic tank locations. Surface water quality collection sites along the County's canals also are not located in high density septic tank areas. This study did not find elevated groundwater or surface water quality concentrations of compounds associated with septic tank effluent, but this may be due to the lack of sampling stations in septic tank areas.

To better understand how urban and agricultural landscapes may impact Biscayne Bay watersheds, the water quality of surface and groundwater flowing into the county needs to be better characterized, and additional data and analysis is required regarding groundwater inflow, atmospheric and ocean source loadings. This TM accessed data that was available through the District DBHYDRO site, and from DERM. Little data were obtained from the regional system inputs into the County. More spatial and temporal for all septic tank pollutant data are needed from the regional system and in the County's secondary canal systems.

6. Conclusions and Recommendations

This preliminary study could not determine correlations between groundwater and surface water quality and septic tank locations. This study did find evidence that there are different sources of nutrients to the North and Central Bay watersheds than in the South Bay watershed. Nutrient loading in the North Bay is suggestive of multiple sources, including runoff from the urban landscapes into the canals. Septic tanks contribute to ground and surface water quality impacts, however, expanding the type, frequency, and resolution of water quality monitoring locations within septic tank areas is needed to fully understand the dynamics of those impacts. Nutrient data in the South Bay watershed is consistent with agricultural origins.

This study concurs with the recommendations of the RER DERM 2019 Seagrass Report to continue and update the County's established Surface Water Quality Monitoring Program, and, recommends expanding the County's wellfield protection and ambient groundwater monitoring programs to include monitoring in areas with high density of persistent failure/compromise septic systems. Recommendations include:

- Review of previous studies in Florida on septic and wastewater impacts on groundwater and surface water quality and integrate conclusions into design of monitoring programs.
- Continued analysis of existing water quality and flow data including statistical analyses to better understand correlations of the various components of the watersheds.
- Evaluate and implement into sampling programs evolving technology such as testing for sucralose, microbial DNA fingerprinting, and stable isotopes of 14N and 15N, to better identify and quantify human and animal wastewater related sources.
- Identify data gaps in the regional canal system for flow and water quality and develop plan with academia, federal, state and local agencies to address those gaps.
- Develop and implement strategically located groundwater and surface water monitoring locations to better characterize and understand the dynamics of septic tank nutrient and pathogen fluxes to receiving water bodies.

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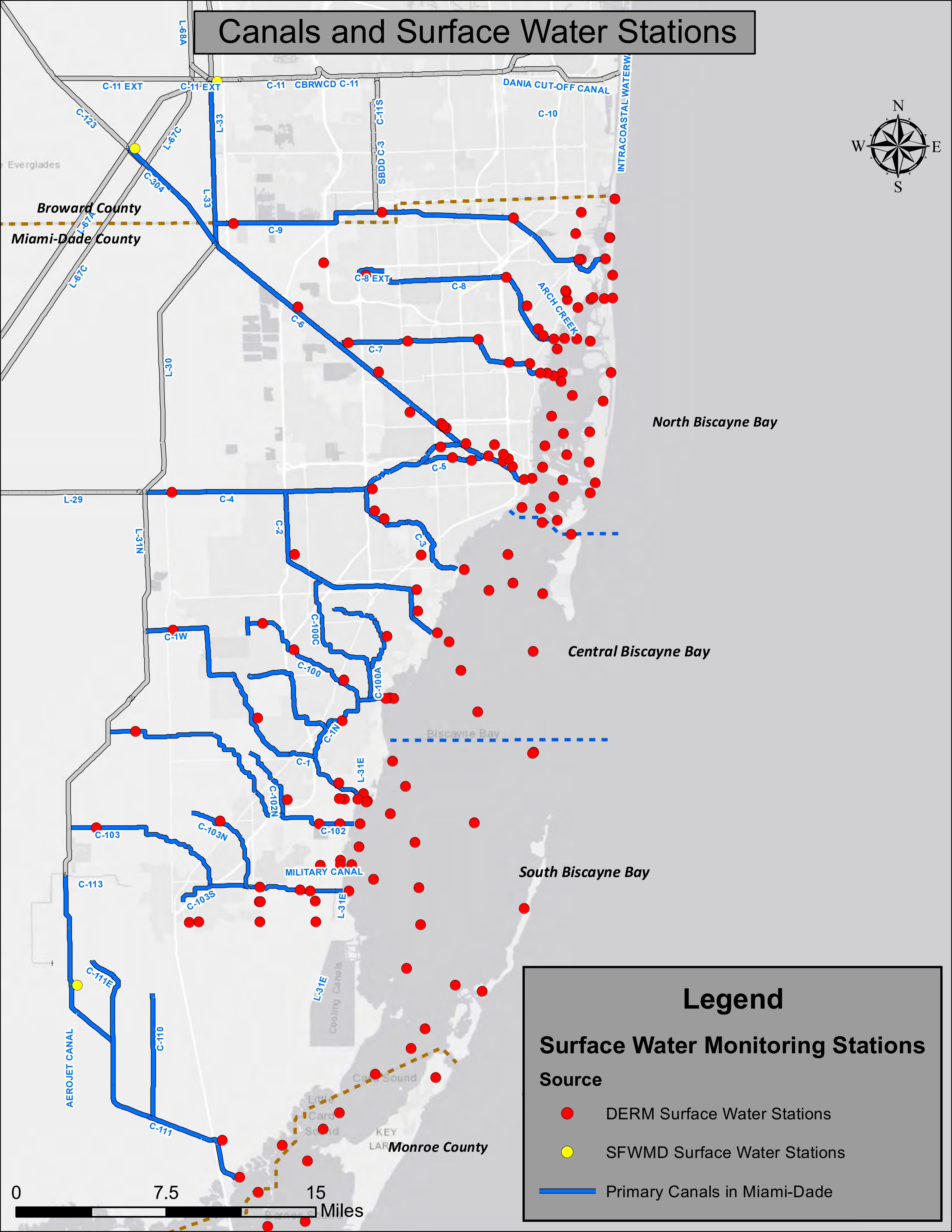
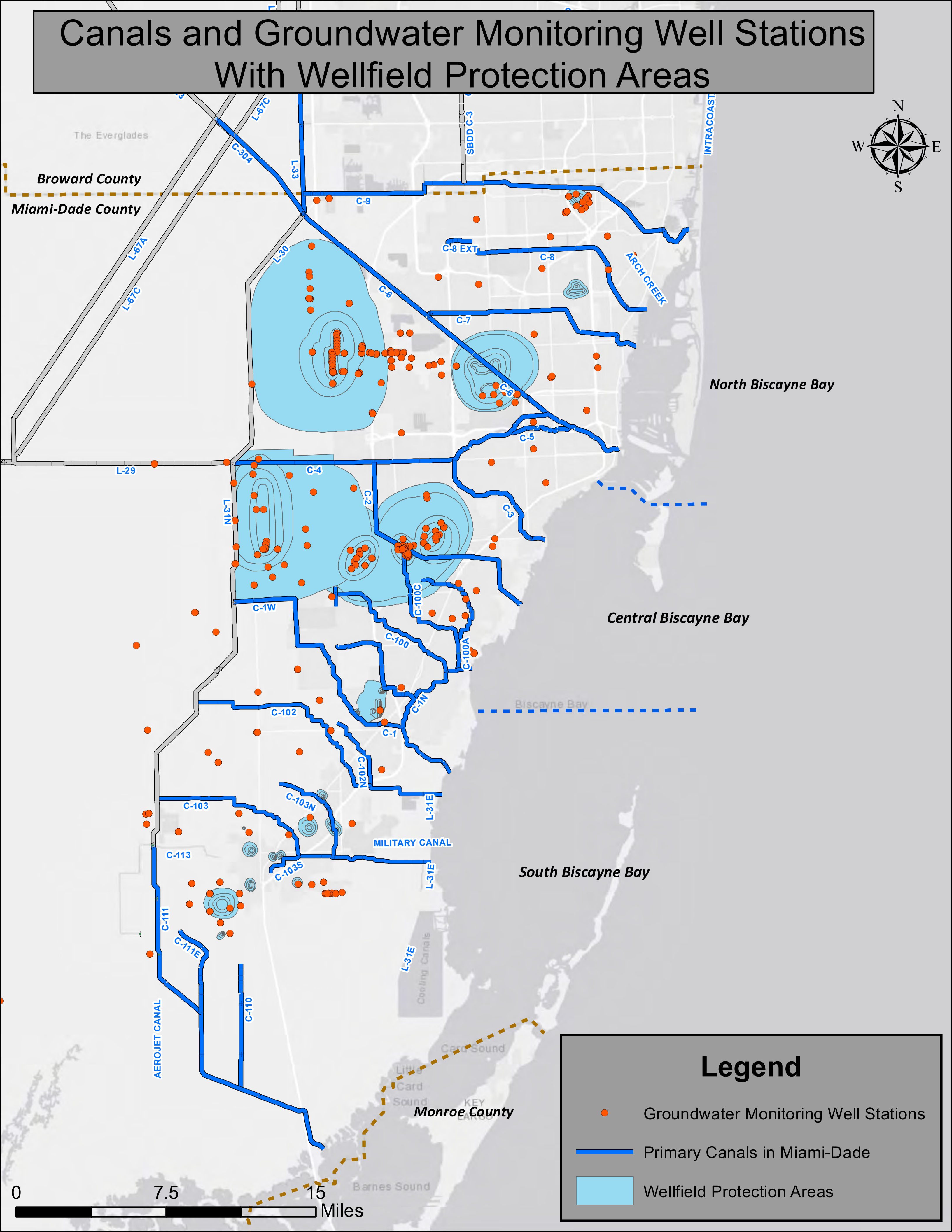
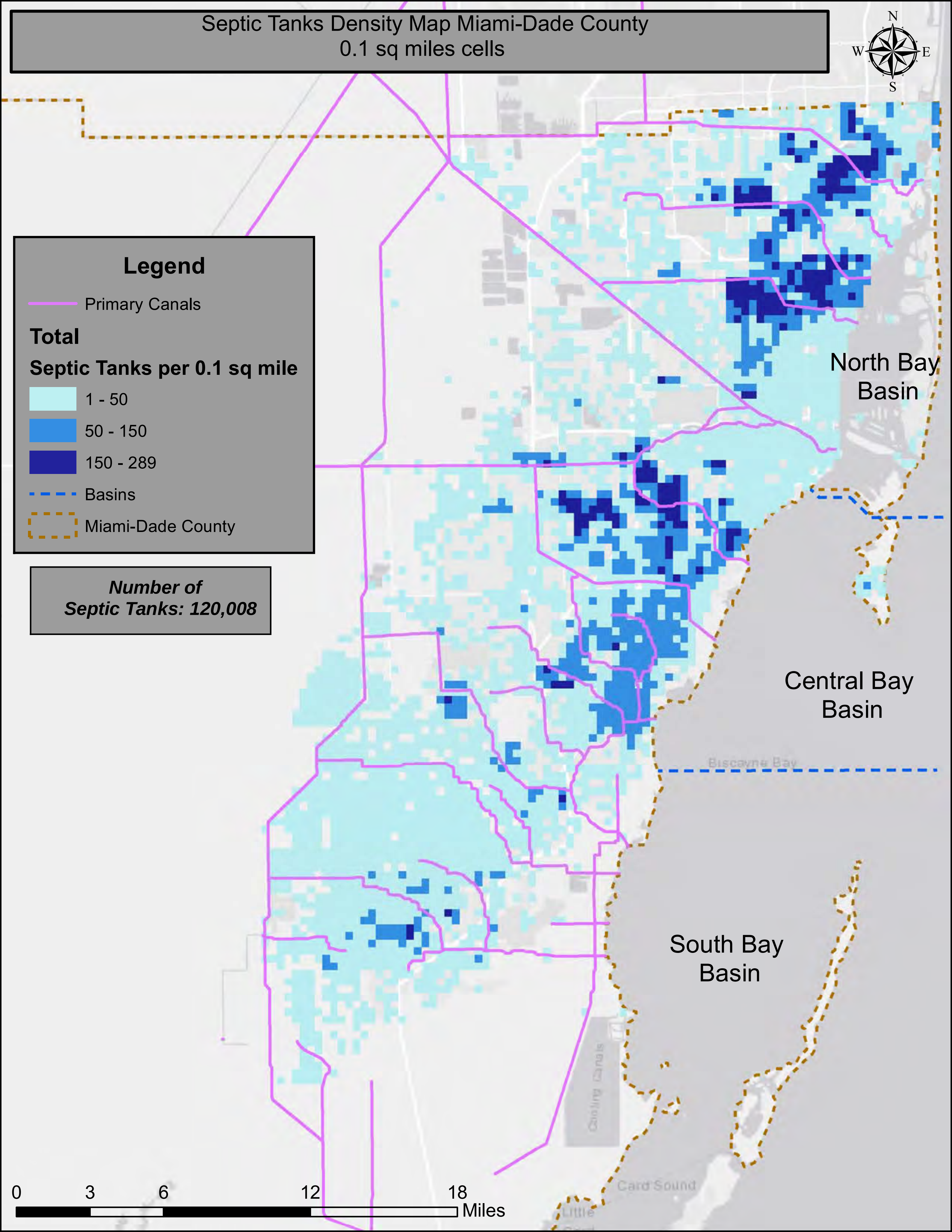
APPENDIX A

of the
Water Quality Technical
Memorandum

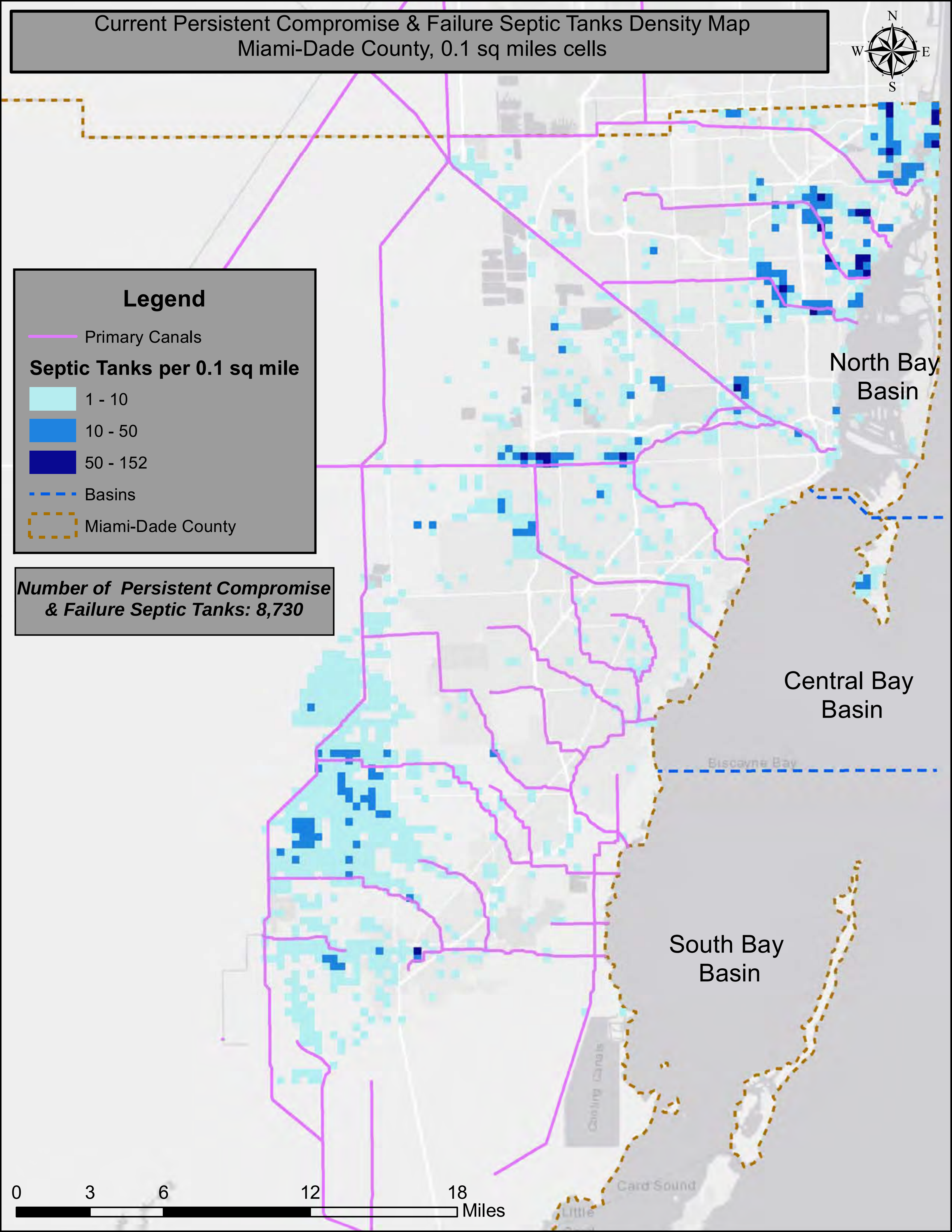

Canals and Surface Water Stations
N
W
E
S
Broward County
Miami-Dade County
North Biscayne Bay
Central Biscayne Bay
South Biscayne Bay
Monroe County
Biscayne Bay
Everglades
C-11 EXT
C-11
CBRWCD C-11
DANIA CUT-OFF CANAL
INTRACOASTAL WATERW
C-10
C-11S
SBDD C-3
C-123
L-67C
L-67A
C-304
L-33
L-68A
C-9
C-8 EXT
C-8
ARCH CREEK
C-6
C-7
L-30
C-5
L-29
C-4
L-31N
C-2
C-3
C-100C
C-1W
C-100
C-100A
C-1N
C-1
C-102N
L-31E
C-102
C-103
C-103N
MILITARY CANAL
C-113
C-103S
C-111E
C-110
AEROJET CANAL
C-111
Cooling Canals
Card Sound
KEY LAR
0
7.5
15
Miles
Legend
Surface Water Monitoring Stations
Source
DERM Surface Water Stations
SFWMD Surface Water Stations
Primary Canals in Miami-Dade

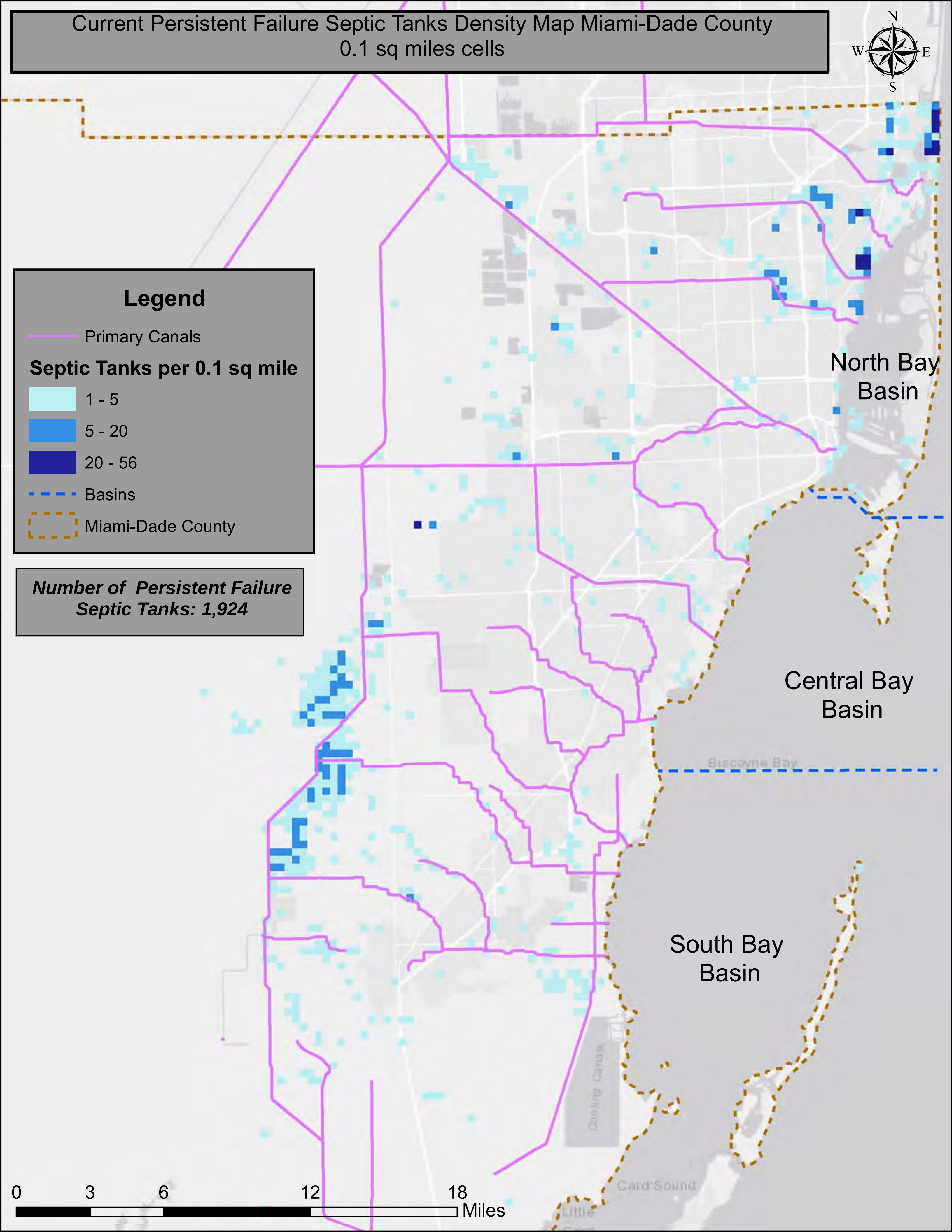
Canals and Groundwater Monitoring Well Stations With Wellfield Protection Areas



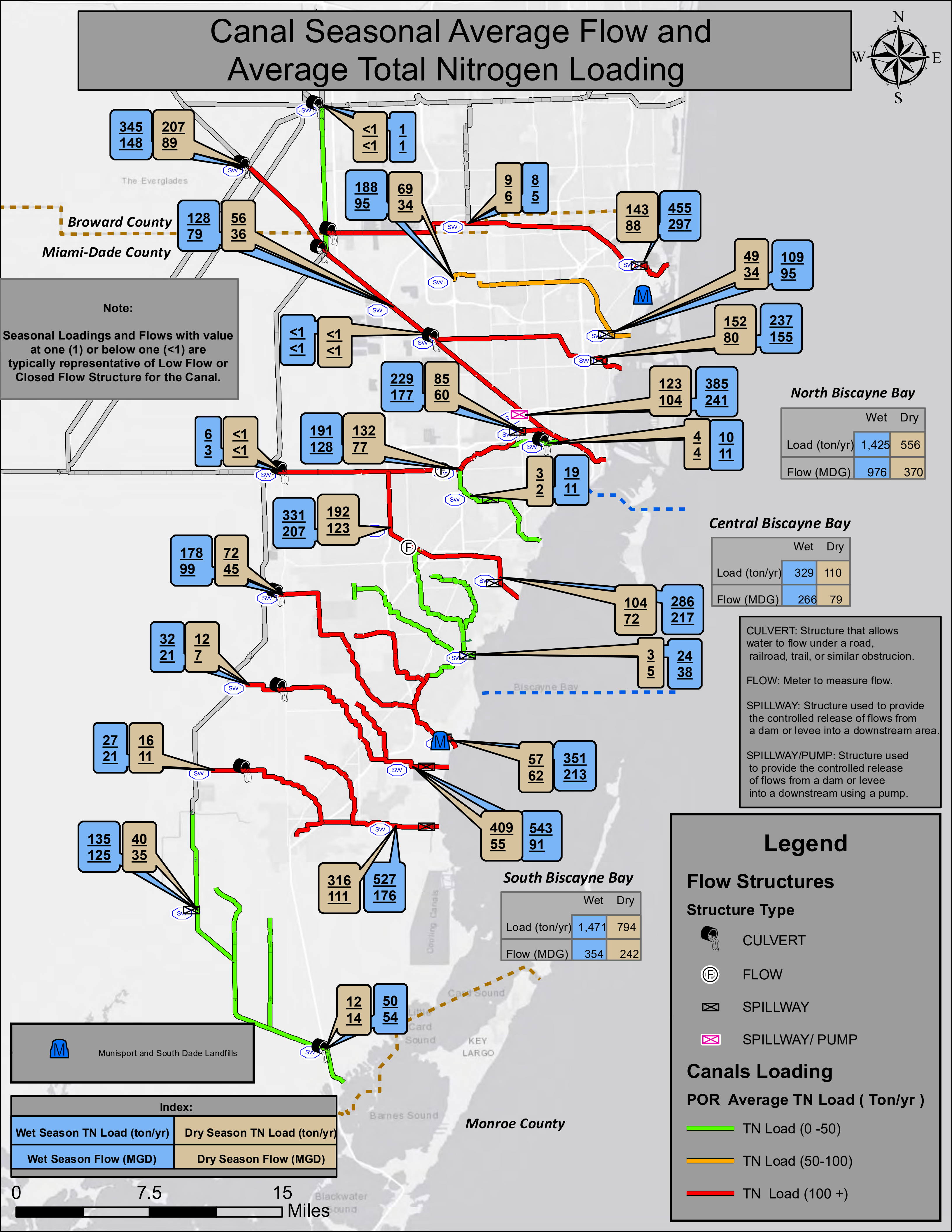


Septic Tanks Density Map Miami-Dade County
0.1 sq miles cells
N
W
E
S
Legend
Primary Canals
Total
Septic Tanks per 0.1 sq mile
1 - 50
50 - 150
150 - 289
Basins
Miami-Dade County
Number of Septic Tanks: 120,008
North Bay Basin
Central Bay Basin
Biscayne Bay
South Bay Basin
Card Sound
0
3
6
12
18
Miles

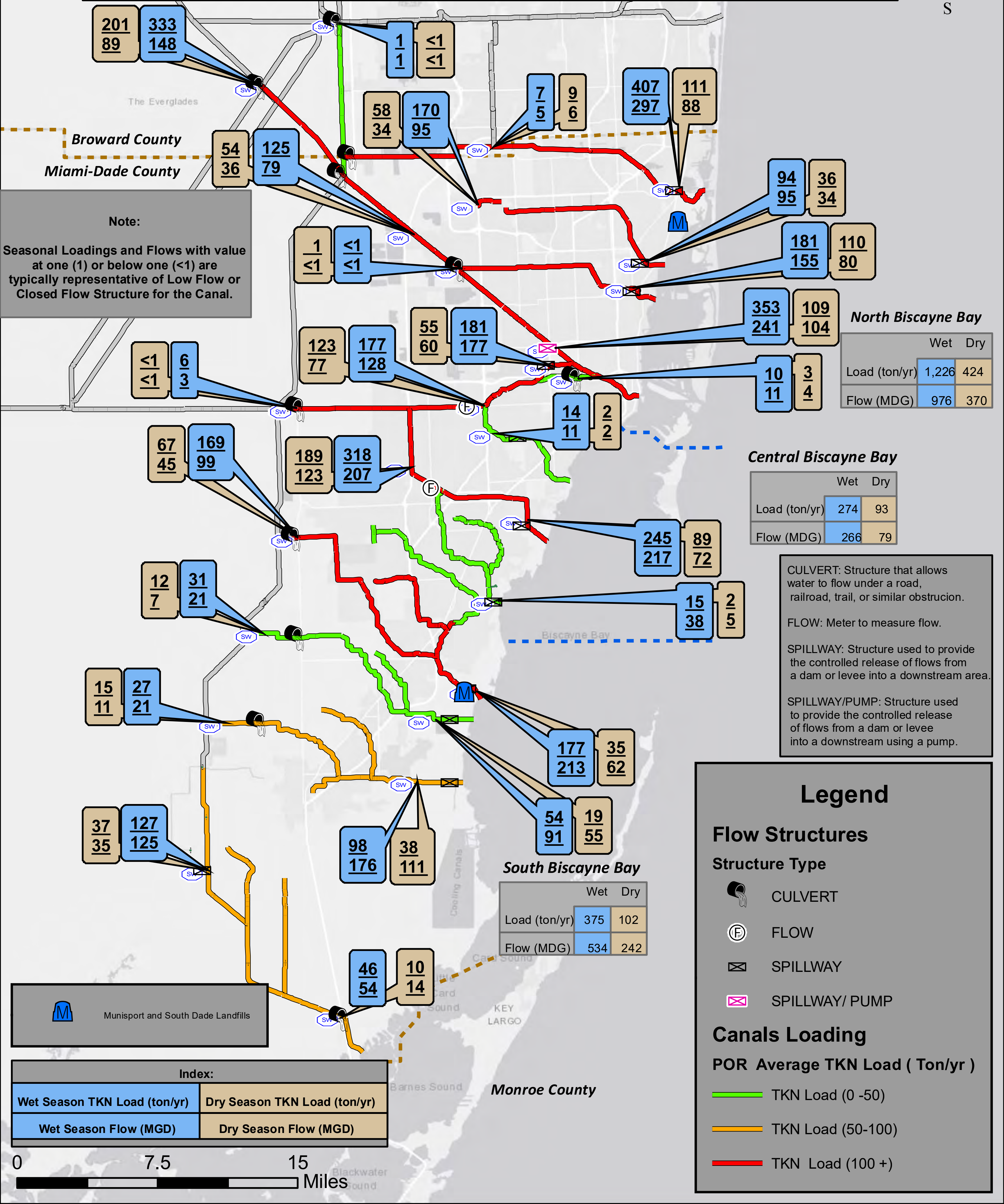

Current Persistent Compromise & Failure Septic Tanks Density Map
Miami-Dade County, 0.1 sq miles cells
N
W
E
S
Legend
Primary Canals
Septic Tanks per 0.1 sq mile
1 - 10
10 - 50
50 - 152
Basins
Miami-Dade County
Number of Persistent Compromise & Failure Septic Tanks: 8,730
North Bay Basin
Central Bay Basin
Biscayne Bay
South Bay Basin
Card Sound
0
3
6
12
18
Miles



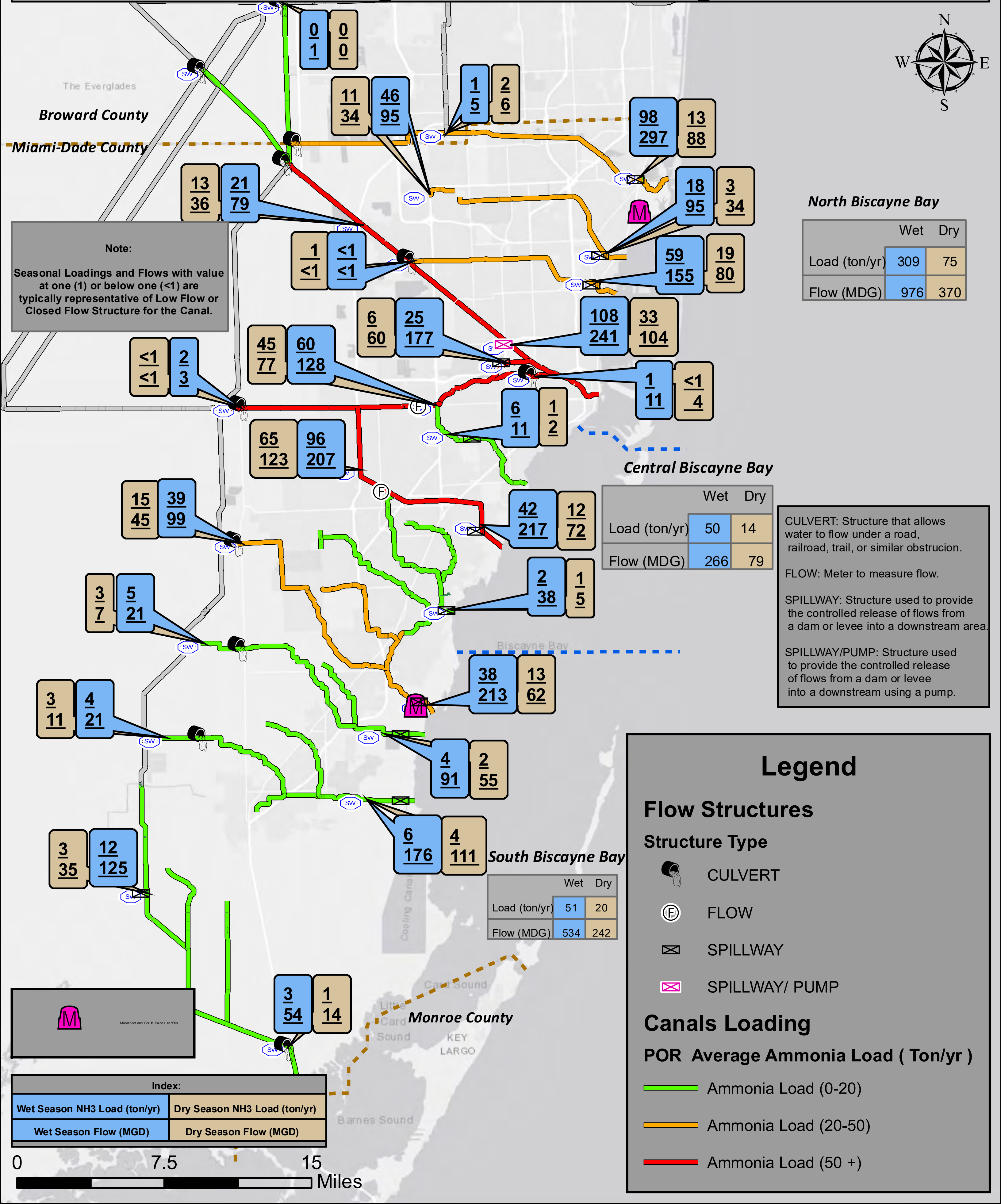
Current Persistent Failure Septic Tanks Density Map Miami-Dade County
0.1 sq miles cells
N
W
E
S
Legend
Primary Canals
Septic Tanks per 0.1 sq mile
1 - 5
5 - 20
20 - 56
Basins
Miami-Dade County
Number of Persistent Failure Septic Tanks: 1,924
North Bay Basin
Central Bay Basin
South Bay Basin
Biscayne Bay
Card Sound
0
3
6
12
18
Miles


Canal Seasonal Average Flow and Average Total Nitrogen Loading
N
E
S
W
Broward County
Miami-Dade County
Monroe County
The Everglades
Biscayne Bay
Card Sound
Barnes Sound
KEY LARGO
Note:
Seasonal Loadings and Flows with value at one (1) or below one (<1) are typically representative of Low Flow or Closed Flow Structure for the Canal.
345 148
207 89
<1 <1
1 1
188 95
69 34
9 6
8 5
143 88
455 297
128 79
56 36
49 34
109 95
152 80
237 155
<1 <1
<1 <1
229 177
85 60
123 104
385 241
6 3
<1 <1
191 128
132 77
4 4
10 11
3 2
19 11
331 207
192 123
178 99
72 45
104 72
286 217
32 21
12 7
3 5
24 38
27 21
16 11
57 62
351 213
409 55
543 91
135 125
40 35
316 111
527 176
12 14
50 54
North Biscayne Bay
Wet Dry
Load (ton/yr) 1,425 556
Flow (MDG) 976 370
Central Biscayne Bay
Wet Dry
Load (ton/yr) 329 110
Flow (MDG) 266 79
South Biscayne Bay
Wet Dry
Load (ton/yr) 1,471 794
Flow (MDG) 354 242
CULVERT: Structure that allows water to flow under a road, railroad, trail, or similar obstrucion.
FLOW: Meter to measure flow.
SPILLWAY: Structure used to provide the controlled release of flows from a dam or levee into a downstream area.
SPILLWAY/PUMP: Structure used to provide the controlled release of flows from a dam or levee into a downstream using a pump.
Munisport and South Dade Landfills
Index:
Wet Season TN Load (ton/yr)
Dry Season TN Load (ton/yr)
Wet Season Flow (MGD)
Dry Season Flow (MGD)
Legend
Flow Structures
Structure Type
CULVERT
FLOW
SPILLWAY
SPILLWAY/ PUMP
Canals Loading
POR Average TN Load (Ton/yr)
TN Load (0 -50)
TN Load (50-100)
TN Load (100 +)
0
7.5
15
Miles

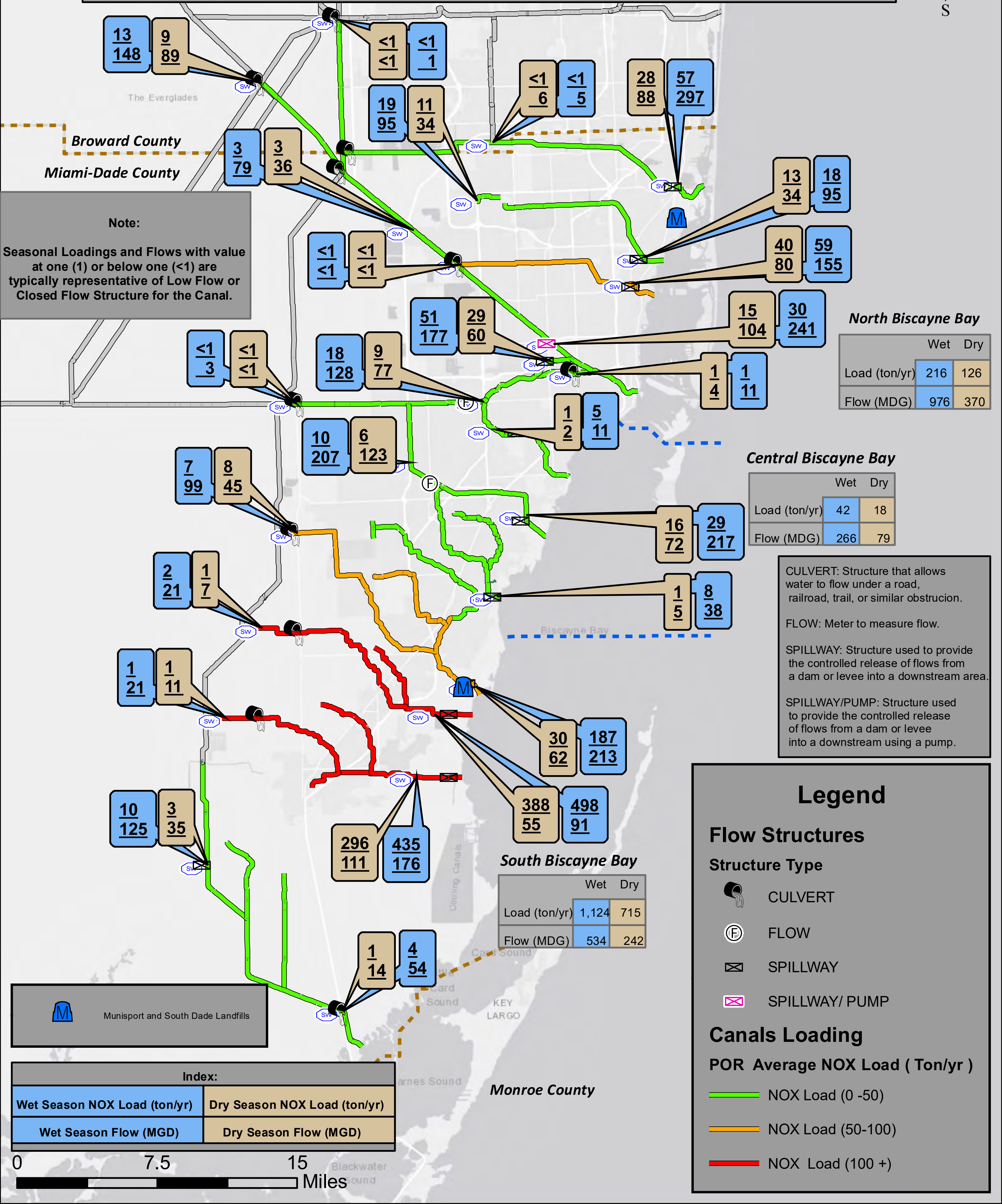
Canal Seasonal Average Flow and Average TKN Loading

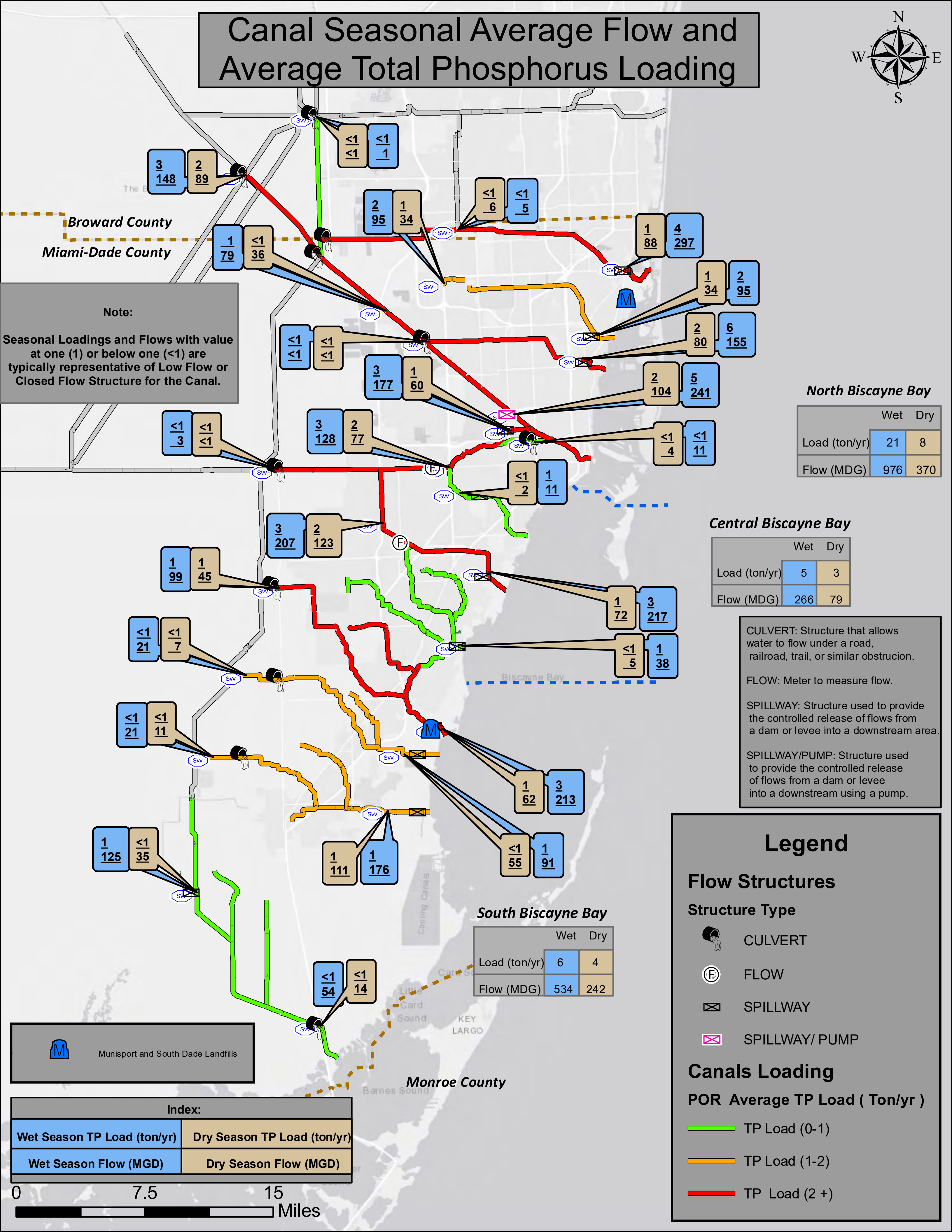


Canal Seasonal Average Flow and Average Ammonia Loading

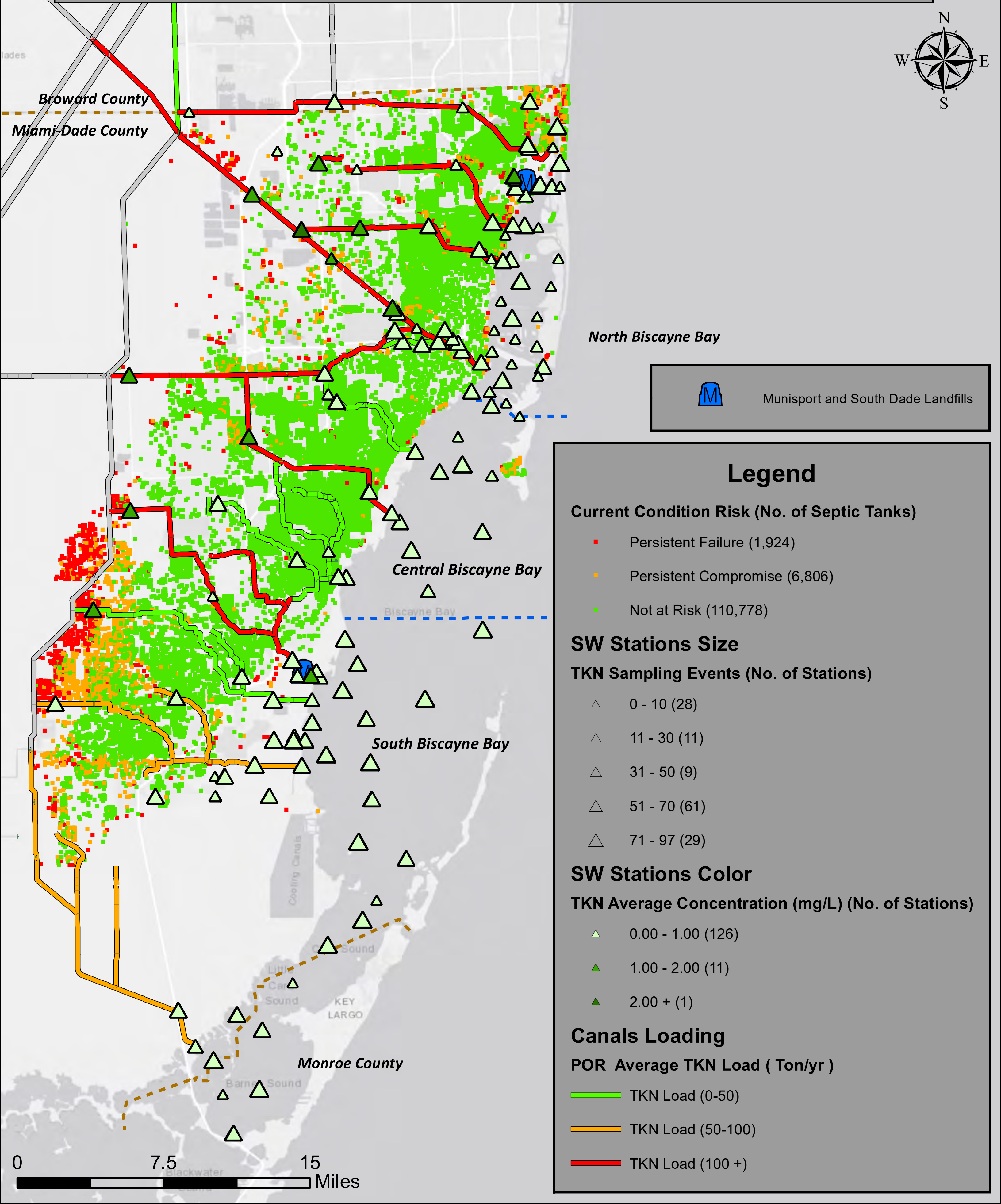


Canal Seasonal Average Flow and Average NOX Loading

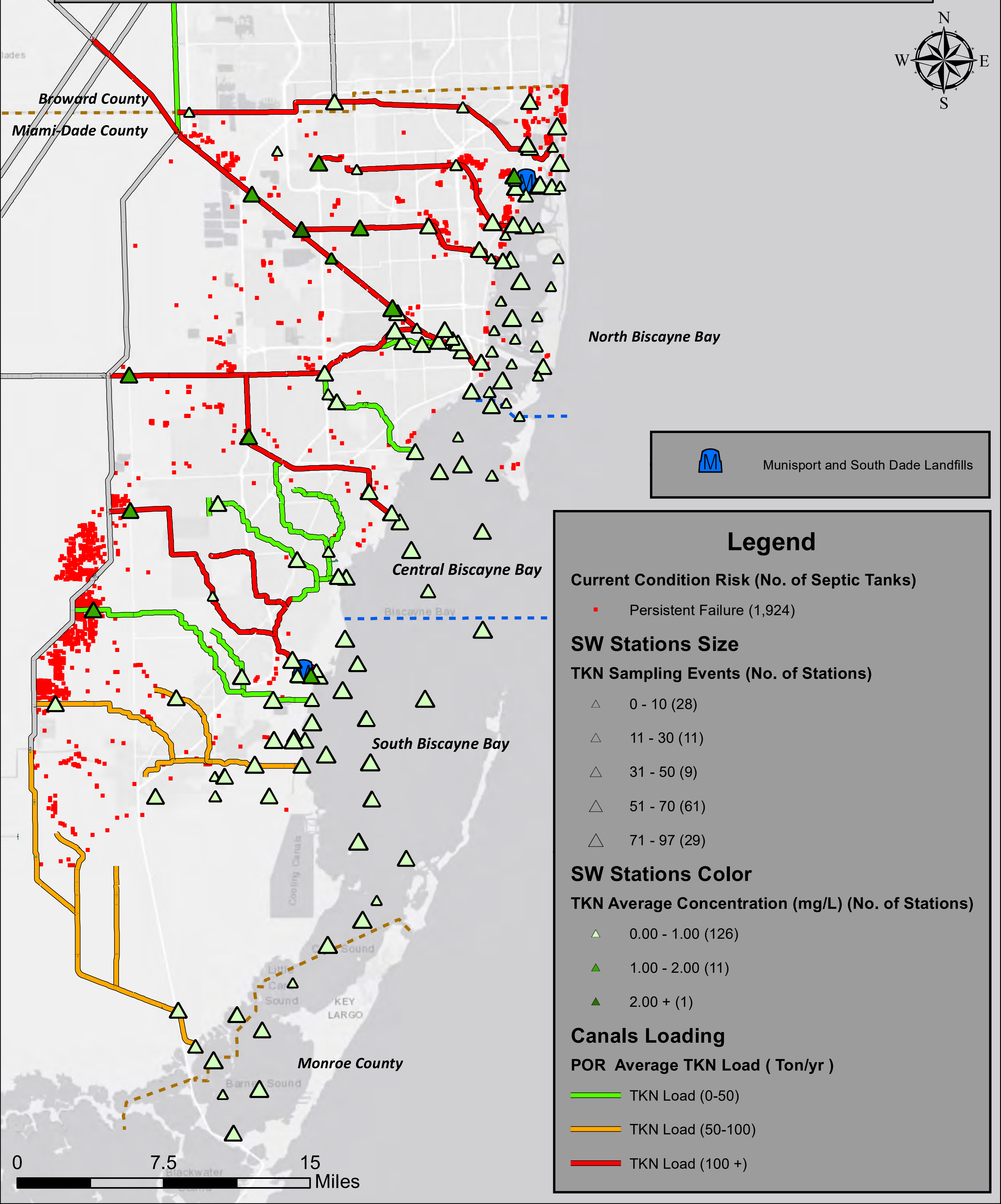


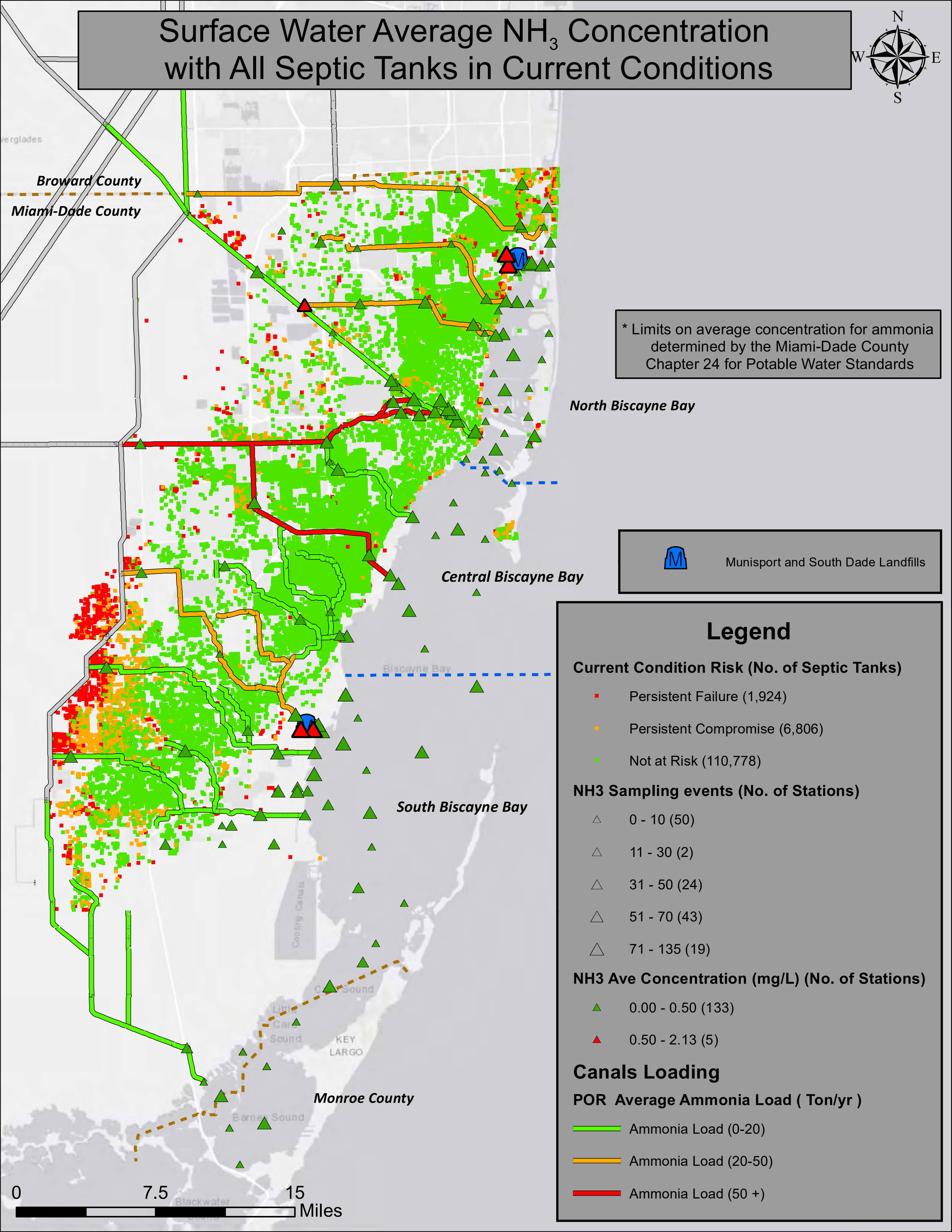

Canal Seasonal Average Flow and Average Total Phosphorus Loading
N
W
E
S
Broward County
Miami-Dade County
Monroe County
Note:
Seasonal Loadings and Flows with value at one (1) or below one (<1) are typically representative of Low Flow or Closed Flow Structure for the Canal.
North Biscayne Bay
Wet Dry
Load (ton/yr) 21 8
Flow (MDG) 976 370
Central Biscayne Bay
Wet Dry
Load (ton/yr) 5 3
Flow (MDG) 266 79
South Biscayne Bay
Wet Dry
Load (ton/yr) 6 4
Flow (MDG) 534 242
CULVERT: Structure that allows water to flow under a road, railroad, trail, or similar obstrucion.
FLOW: Meter to measure flow.
SPILLWAY: Structure used to provide the controlled release of flows from a dam or levee into a downstream area.
SPILLWAY/PUMP: Structure used to provide the controlled release of flows from a dam or levee into a downstream using a pump.
Legend
Flow Structures
Structure Type
CULVERT
FLOW
SPILLWAY
SPILLWAY/ PUMP
Canals Loading
POR Average TP Load (Ton/yr)
TP Load (0-1)
TP Load (1-2)
TP Load (2 +)
Munisport and South Dade Landfills
Index:
Wet Season TP Load (ton/yr)
Dry Season TP Load (ton/yr)
Wet Season Flow (MGD)
Dry Season Flow (MGD)
0 7.5 15
Miles
Biscayne Bay
Cooling Canals
Card Sound
KEY LARGO
Barnes Sound
3 148
2 89
<1 <1
<1 1
2 95
1 34
<1 6
<1 5
1 88
4 297
1 79
<1 36
1 34
2 95
2 80
6 155
<1 <1
<1 <1
3 177
1 60
2 104
5 241
<1 3
<1 <1
3 128
2 77
<1 4
<1 11
<1 2
1 11
3 207
2 123
1 99
1 45
1 72
3 217
<1 21
<1 7
<1 5
1 38
<1 21
<1 11
1 62
3 213
1 125
<1 35
1 111
1 176
<1 55
1 91
<1 54
<1 14

Surface Water Average TKN Concentration with All Septic Tanks in Current Conditions

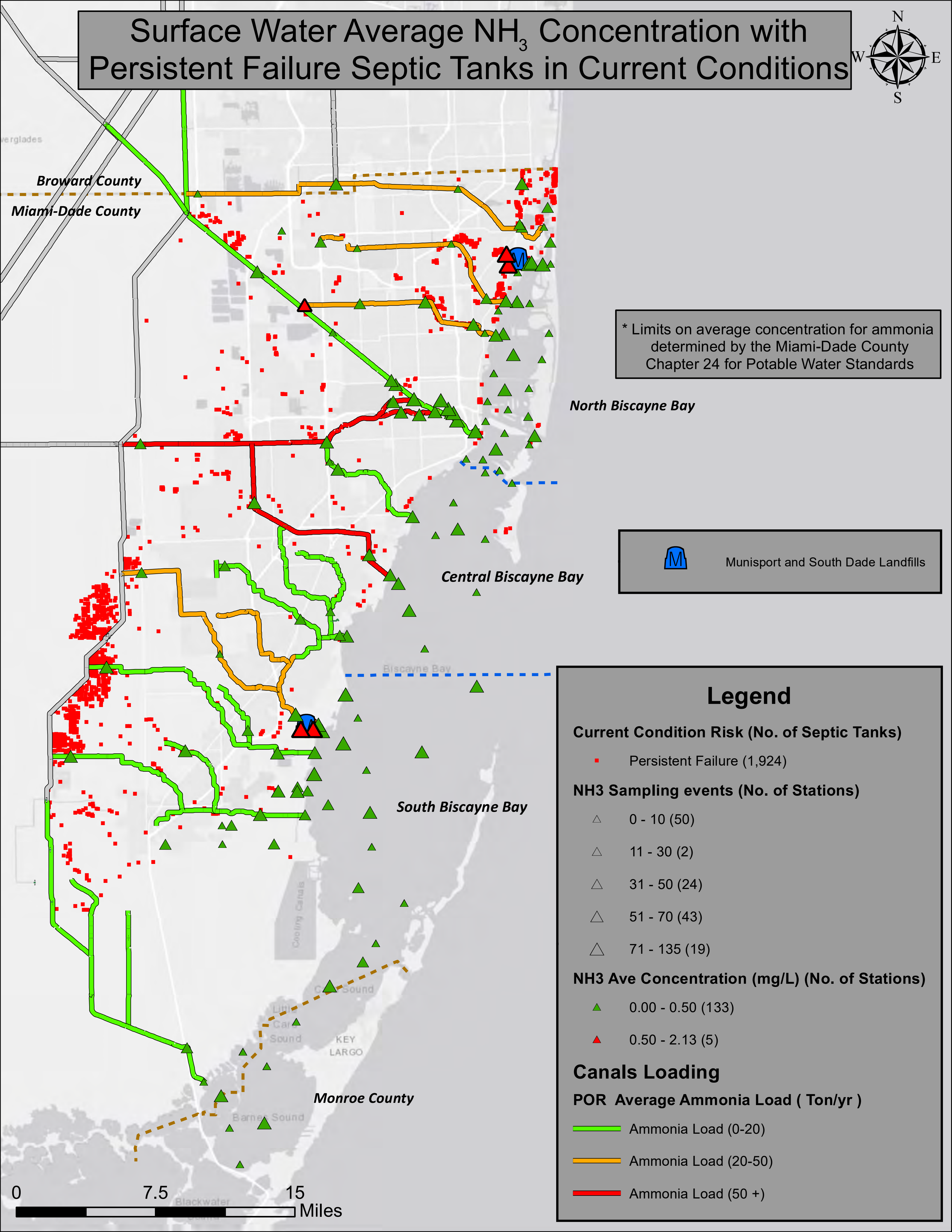


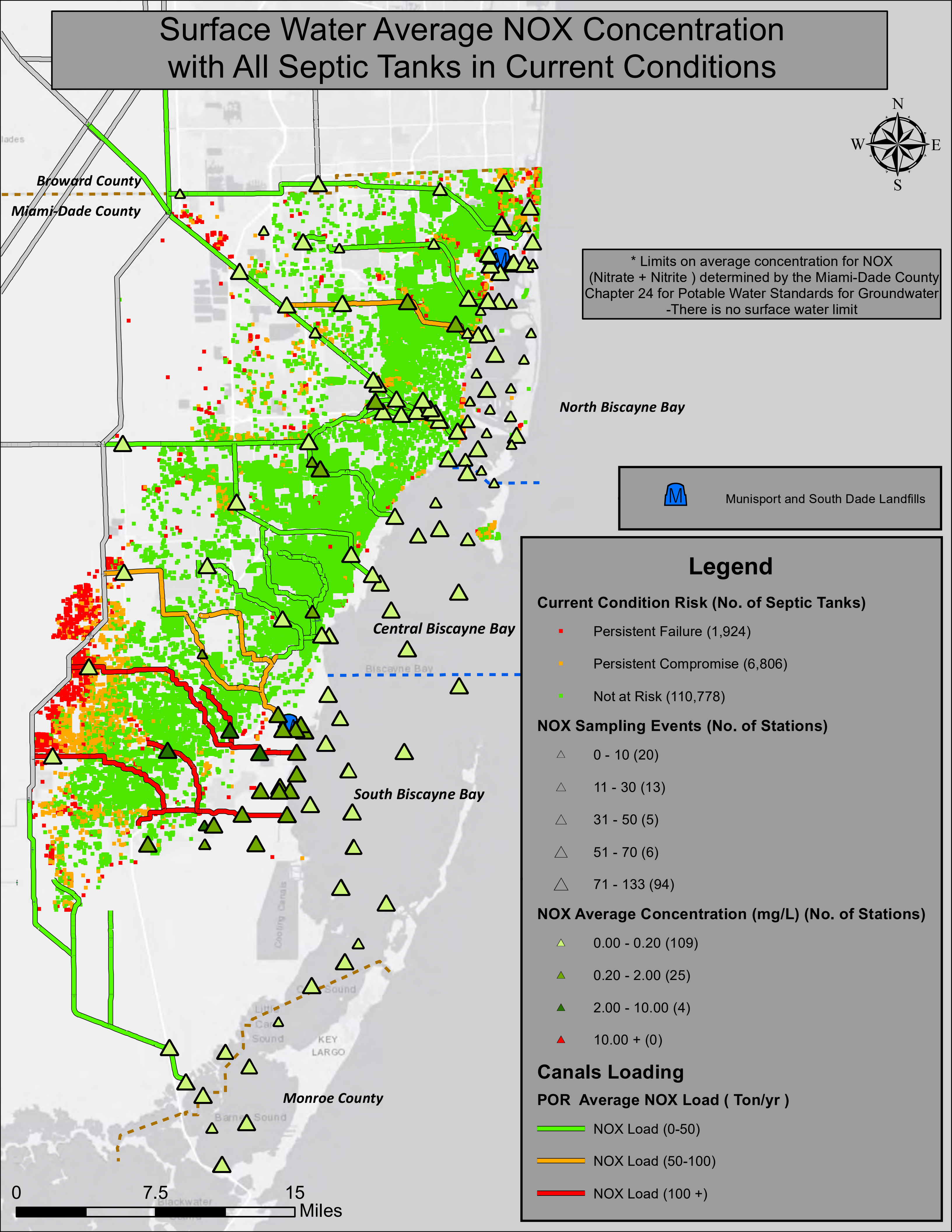
Surface Water Average TKN Concentration with Persistent Failure Septic Tanks in Current Conditions

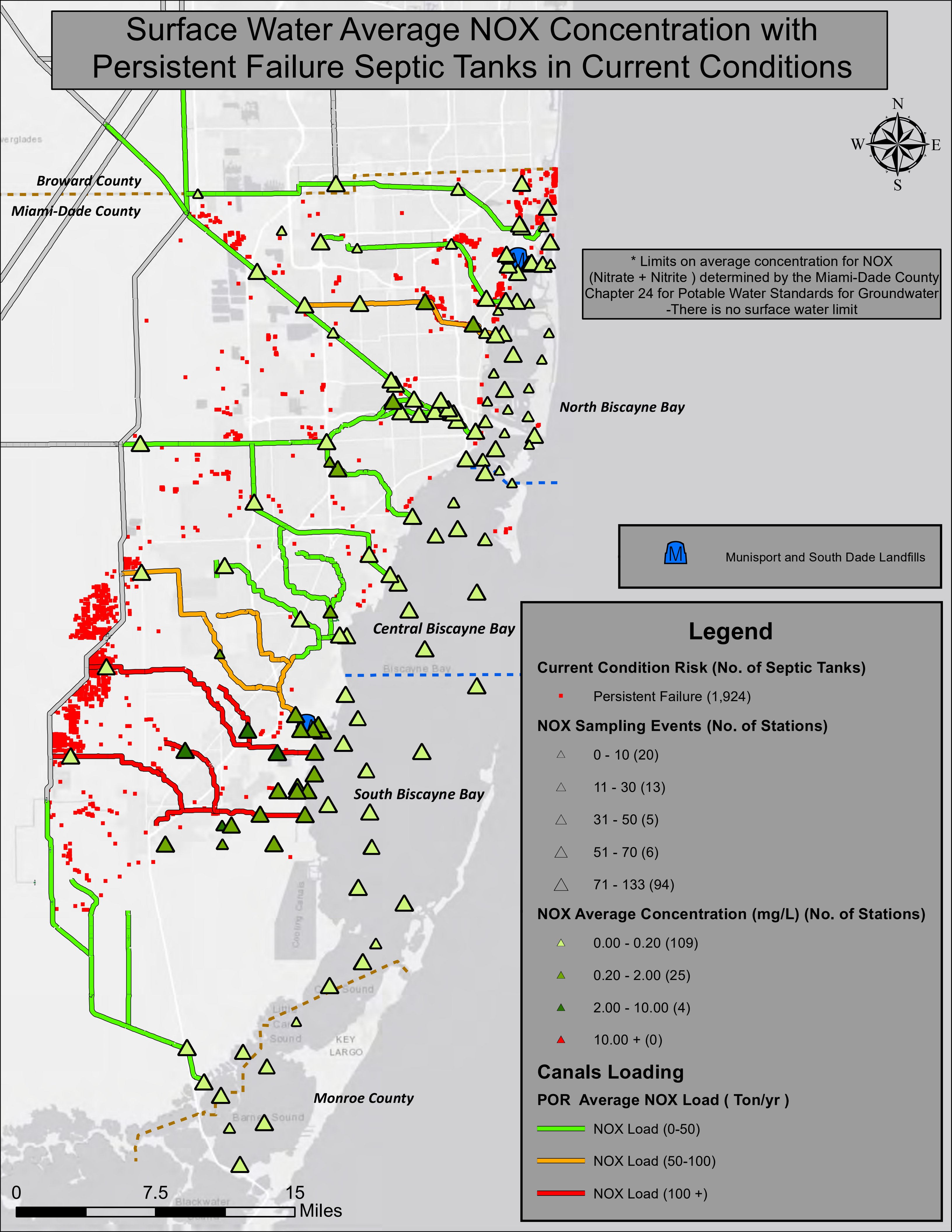




Surface Water Average NH3 Concentration with All Septic Tanks in Current Conditions
N
W
E
S
Broward County
Miami-Dade County
Everglades
* Limits on average concentration for ammonia determined by the Miami-Dade County Chapter 24 for Potable Water Standards
North Biscayne Bay
Central Biscayne Bay
Munisport and South Dade Landfills
Biscayne Bay
South Biscayne Bay
Cooling Canals
Card Sound
Little Card Sound
KEY LARGO
Monroe County
Barnes Sound
Blackwater
0
7.5
15
Miles
Legend
Current Condition Risk (No. of Septic Tanks)
Persistent Failure (1,924)
Persistent Compromise (6,806)
Not at Risk (110,778)
NH3 Sampling events (No. of Stations)
0 - 10 (50)
11 - 30 (2)
31 - 50 (24)
51 - 70 (43)
71 - 135 (19)
NH3 Ave Concentration (mg/L) (No. of Stations)
0.00 - 0.50 (133)
0.50 - 2.13 (5)
Canals Loading
POR Average Ammonia Load (Ton/yr)
Ammonia Load (0-20)
Ammonia Load (20-50)
Ammonia Load (50 +)

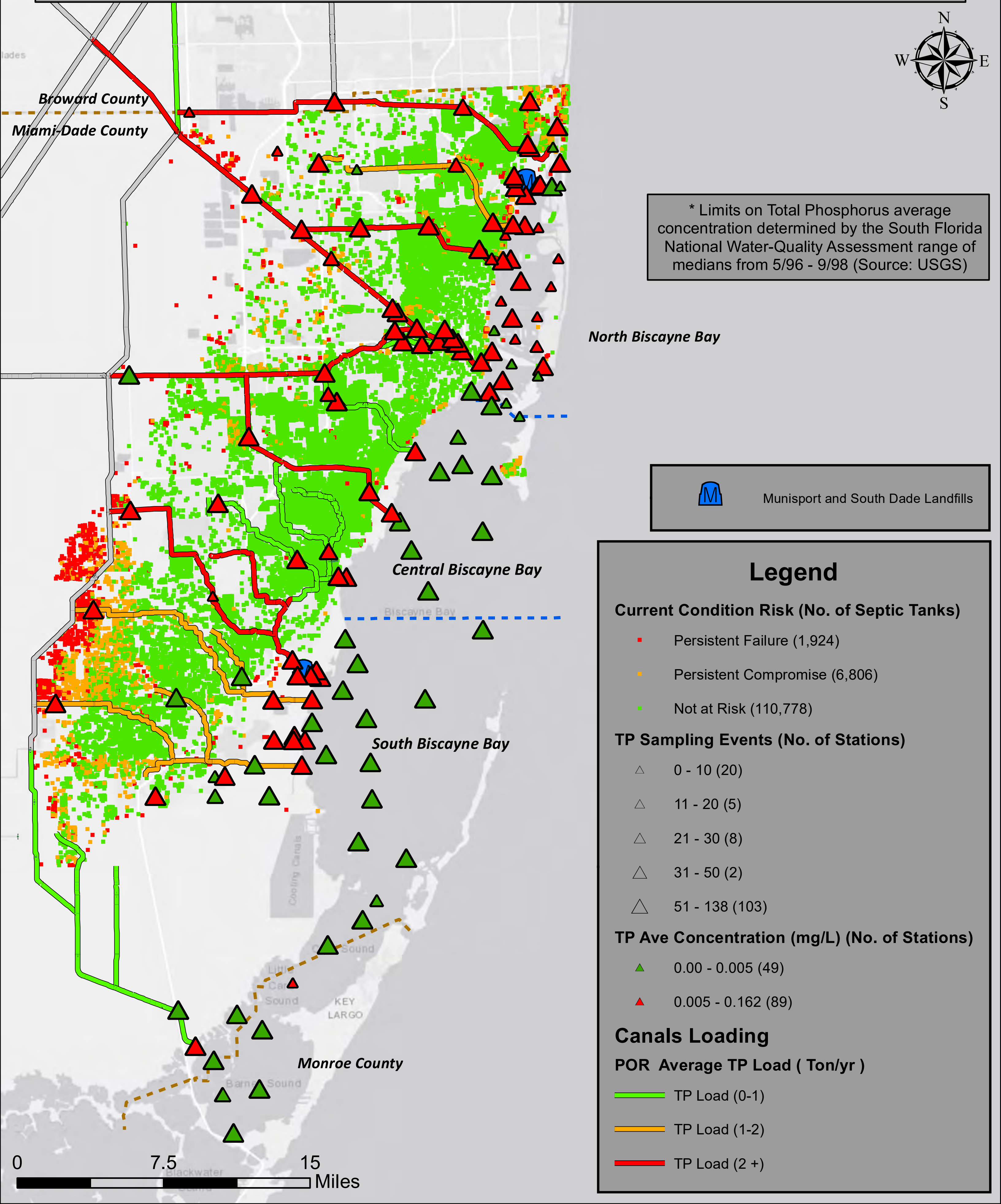

Surface Water Average NH_3 Concentration with Persistent Failure Septic Tanks in Current Conditions
N
W
E
S
Broward County
Miami-Dade County
* Limits on average concentration for ammonia determined by the Miami-Dade County Chapter 24 for Potable Water Standards
North Biscayne Bay
Munisport and South Dade Landfills
Central Biscayne Bay
Biscayne Bay
South Biscayne Bay
KEY LARGO
Monroe County
Legend
Current Condition Risk (No. of Septic Tanks)
Persistent Failure (1,924)
NH3 Sampling events (No. of Stations)
0 - 10 (50)
11 - 30 (2)
31 - 50 (24)
51 - 70 (43)
71 - 135 (19)
NH3 Ave Concentration (mg/L) (No. of Stations)
0.00 - 0.50 (133)
0.50 - 2.13 (5)
Canals Loading
POR Average Ammonia Load (Ton/yr)
Ammonia Load (0-20)
Ammonia Load (20-50)
Ammonia Load (50 +)
0
7.5
15
Miles

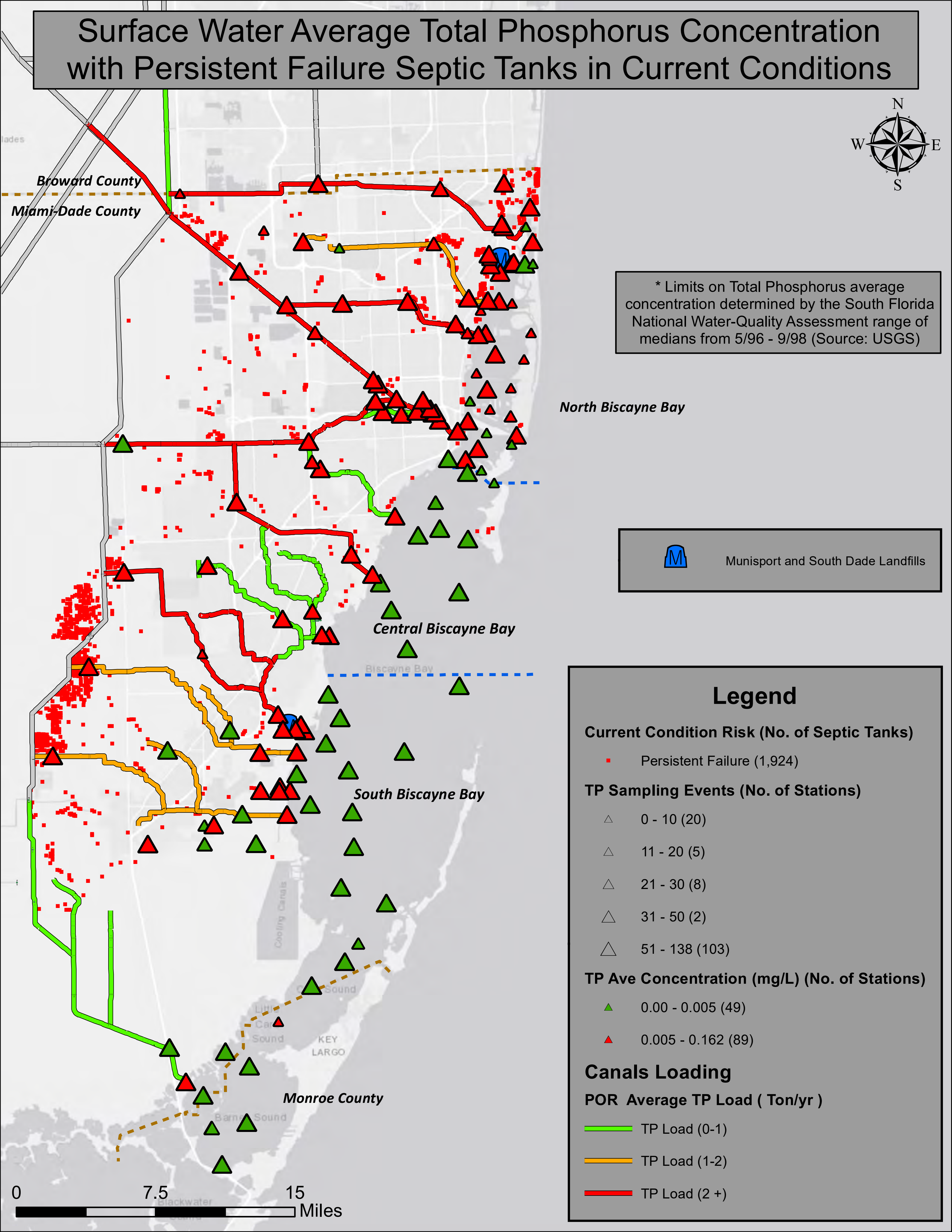

Surface Water Average NOX Concentration
with All Septic Tanks in Current Conditions
Broward County
Miami-Dade County
North Biscayne Bay
Central Biscayne Bay
Biscayne Bay
South Biscayne Bay
Monroe County
KEY LARGO
Barnes Sound
N
S
E
W
* Limits on average concentration for NOX (Nitrate + Nitrite) determined by the Miami-Dade County Chapter 24 for Potable Water Standards for Groundwater
-There is no surface water limit
Munisport and South Dade Landfills
Legend
Current Condition Risk (No. of Septic Tanks)
Persistent Failure (1,924)
Persistent Compromise (6,806)
Not at Risk (110,778)
NOX Sampling Events (No. of Stations)
0 - 10 (20)
11 - 30 (13)
31 - 50 (5)
51 - 70 (6)
71 - 133 (94)
NOX Average Concentration (mg/L) (No. of Stations)
0.00 - 0.20 (109)
0.20 - 2.00 (25)
2.00 - 10.00 (4)
10.00 + (0)
Canals Loading
POR Average NOX Load (Ton/yr)
NOX Load (0-50)
NOX Load (50-100)
NOX Load (100 +)
0
7.5
15
Miles



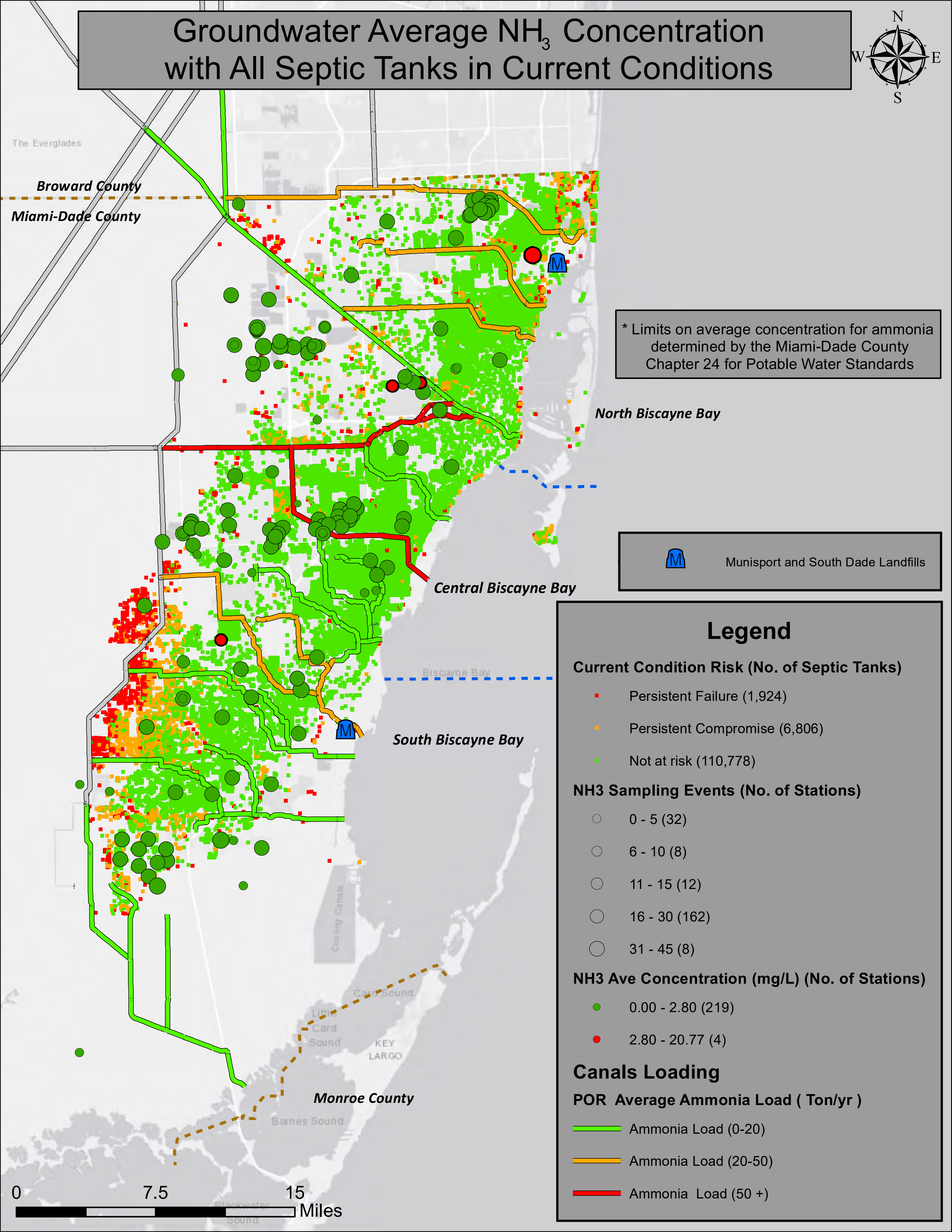
Surface Water Average NOX Concentration with Persistent Failure Septic Tanks in Current Conditions
N
W
E
S
Broward County
Miami-Dade County
North Biscayne Bay
Central Biscayne Bay
South Biscayne Bay
Monroe County
Biscayne Bay
KEY LARGO
Barnes Sound
* Limits on average concentration for NOX (Nitrate + Nitrite) determined by the Miami-Dade County Chapter 24 for Potable Water Standards for Groundwater -There is no surface water limit
Munisport and South Dade Landfills
Legend
Current Condition Risk (No. of Septic Tanks)
Persistent Failure (1,924)
NOX Sampling Events (No. of Stations)
0 - 10 (20)
11 - 30 (13)
31 - 50 (5)
51 - 70 (6)
71 - 133 (94)
NOX Average Concentration (mg/L) (No. of Stations)
0.00 - 0.20 (109)
0.20 - 2.00 (25)
2.00 - 10.00 (4)
10.00 + (0)
Canals Loading
POR Average NOX Load (Ton/yr)
NOX Load (0-50)
NOX Load (50-100)
NOX Load (100 +)
0
7.5
15
Miles

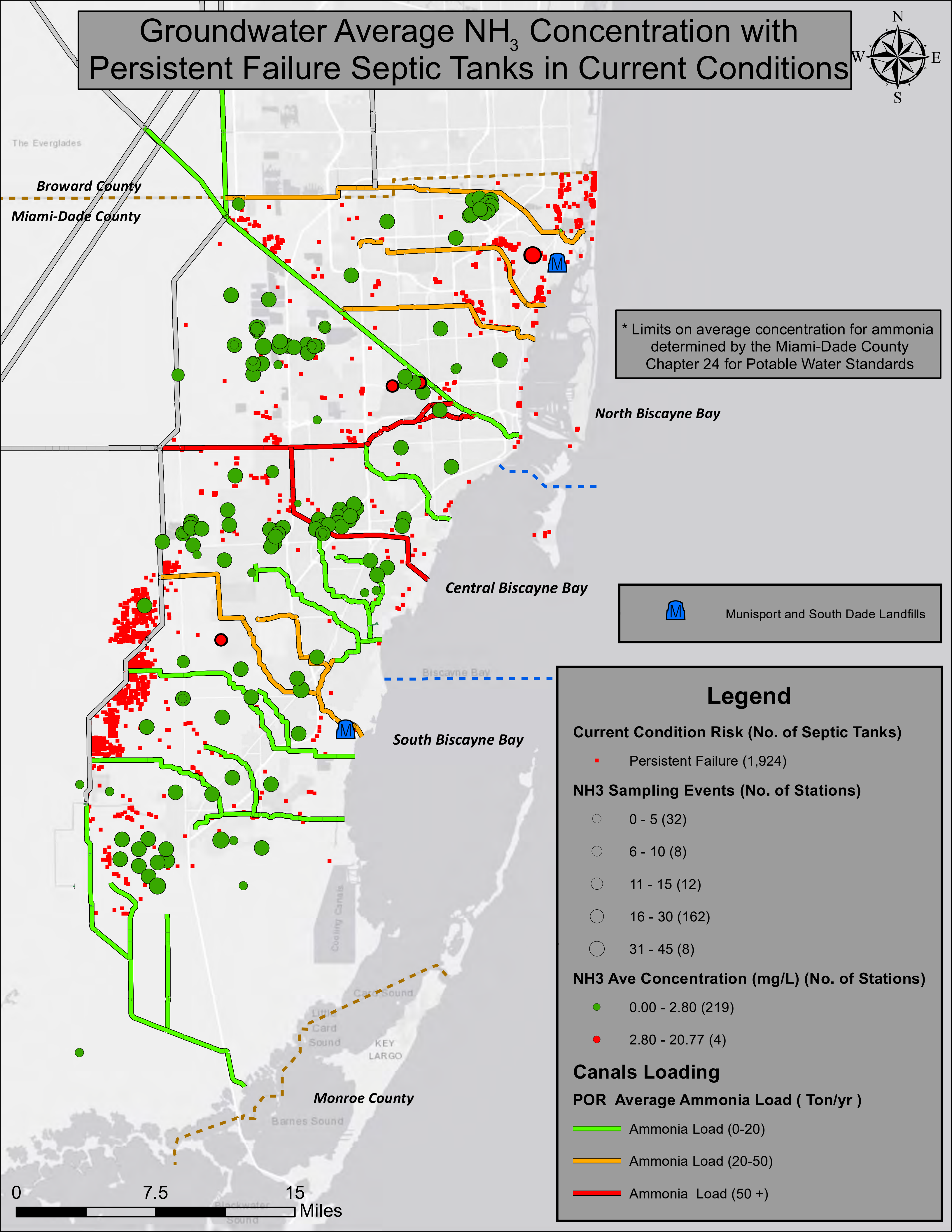
Surface Water Average Total Phosphorus Concentration with All Septic Tanks in Current Conditions



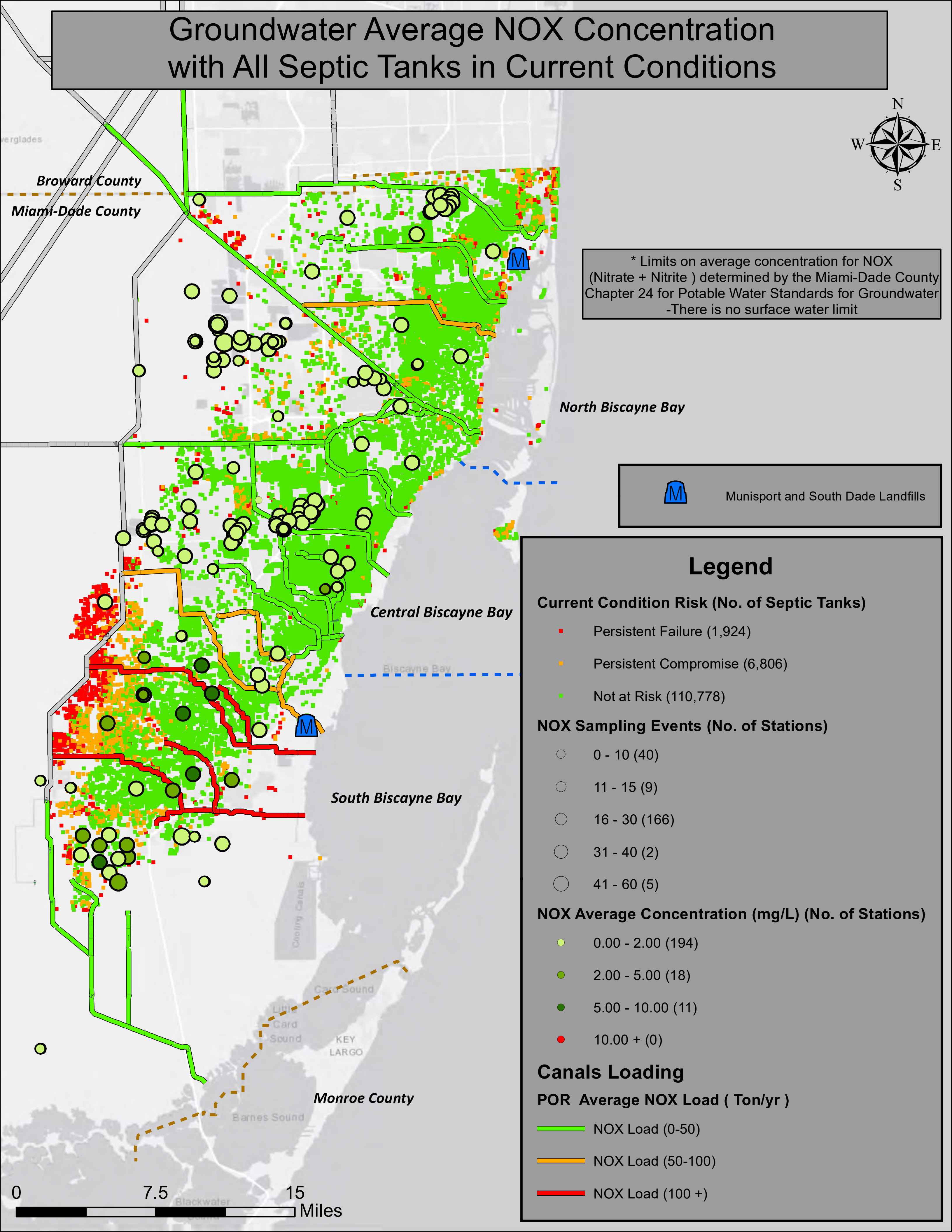


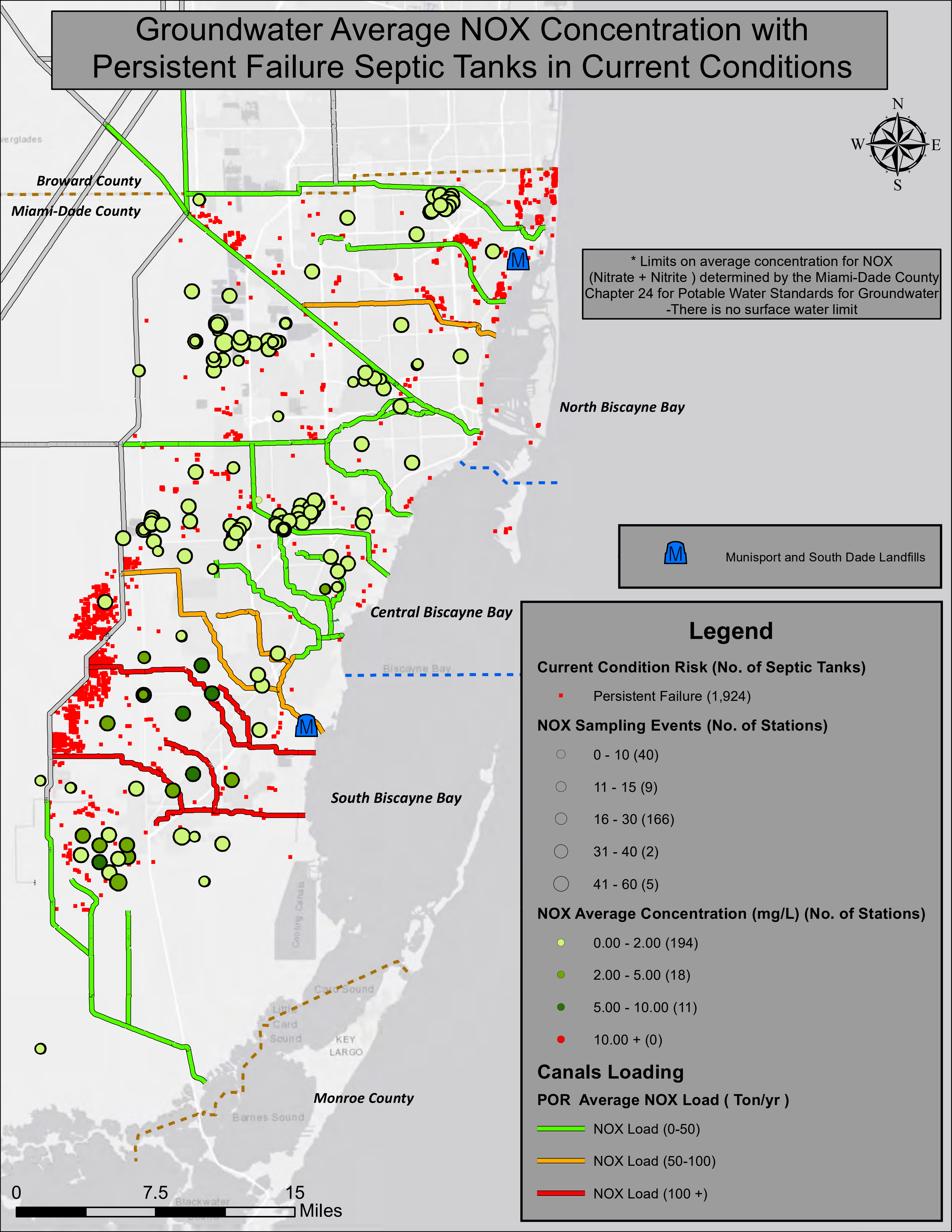
Surface Water Average Total Phosphorus Concentration with Persistent Failure Septic Tanks in Current Conditions
N
W
E
S
Broward County
Miami-Dade County
* Limits on Total Phosphorus average concentration determined by the South Florida National Water-Quality Assessment range of medians from 5/96 - 9/98 (Source: USGS)
North Biscayne Bay
Munisport and South Dade Landfills
Central Biscayne Bay
Biscayne Bay
South Biscayne Bay
Cooling Canals
Card Sound
Little Card Sound
KEY LARGO
Monroe County
Barnes Sound
Blackwater
0
7.5
15
Miles
Legend
Current Condition Risk (No. of Septic Tanks)
Persistent Failure (1,924)
TP Sampling Events (No. of Stations)
0 - 10 (20)
11 - 20 (5)
21 - 30 (8)
31 - 50 (2)
51 - 138 (103)
TP Ave Concentration (mg/L) (No. of Stations)
0.00 - 0.005 (49)
0.005 - 0.162 (89)
Canals Loading
POR Average TP Load (Ton/yr)
TP Load (0-1)
TP Load (1-2)
TP Load (2 +)


Groundwater Average NH3 Concentration with All Septic Tanks in Current Conditions
N
W
E
S
The Everglades
Broward County
Miami-Dade County
* Limits on average concentration for ammonia determined by the Miami-Dade County Chapter 24 for Potable Water Standards
North Biscayne Bay
Munisport and South Dade Landfills
Central Biscayne Bay
Biscayne Bay
South Biscayne Bay
Legend
Current Condition Risk (No. of Septic Tanks)
Persistent Failure (1,924)
Persistent Compromise (6,806)
Not at risk (110,778)
NH3 Sampling Events (No. of Stations)
0 - 5 (32)
6 - 10 (8)
11 - 15 (12)
16 - 30 (162)
31 - 45 (8)
NH3 Ave Concentration (mg/L) (No. of Stations)
0.00 - 2.80 (219)
2.80 - 20.77 (4)
Canals Loading
POR Average Ammonia Load (Ton/yr)
Ammonia Load (0-20)
Ammonia Load (20-50)
Ammonia Load (50 +)
Cooling Canals
Card Sound
Little Card Sound
KEY LARGO
Monroe County
Barnes Sound
0
7.5
15
Miles



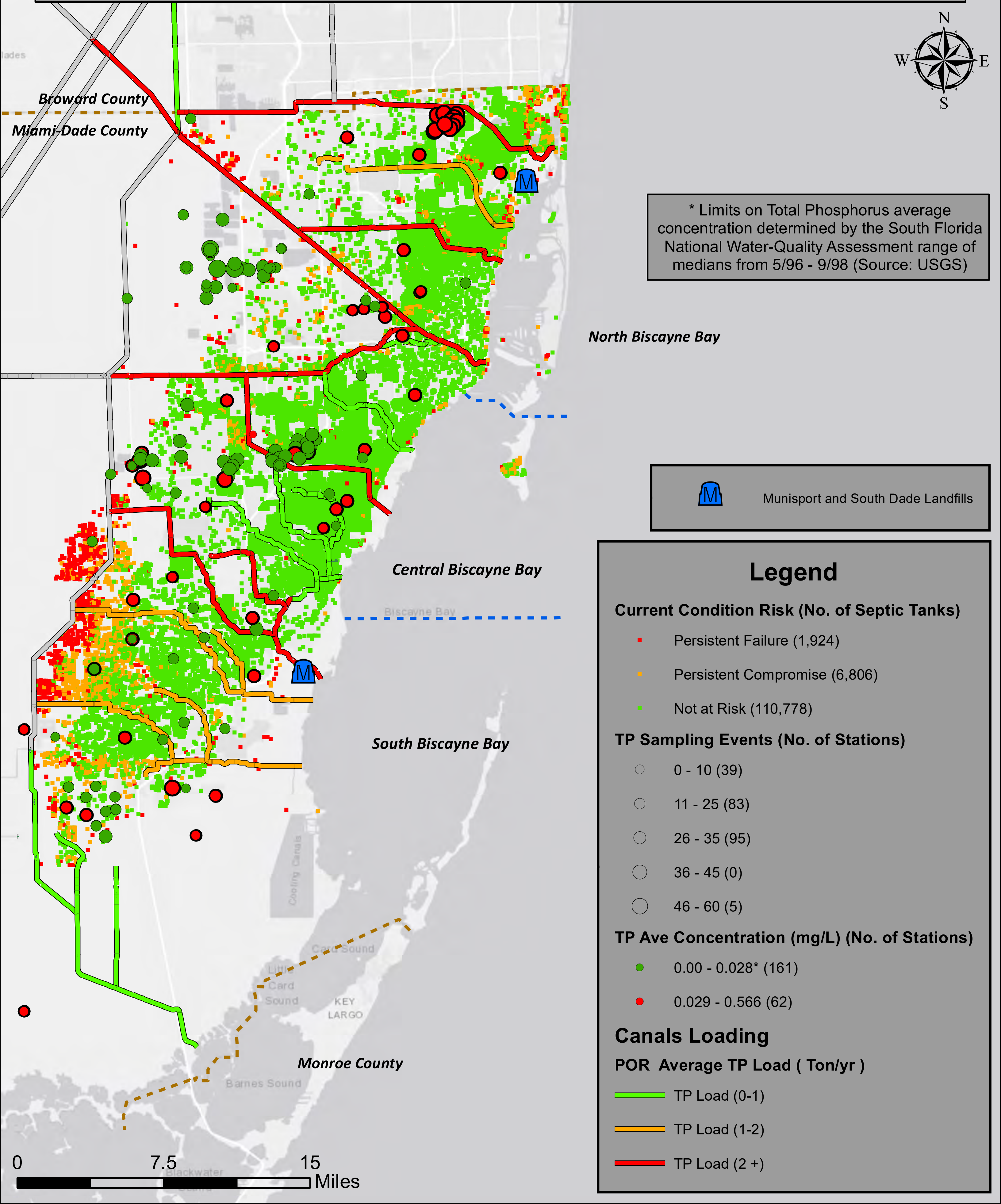
Groundwater Average NH_3 Concentration with Persistent Failure Septic Tanks in Current Conditions
N
W
E
S
The Everglades
Broward County
Miami-Dade County
* Limits on average concentration for ammonia determined by the Miami-Dade County Chapter 24 for Potable Water Standards
North Biscayne Bay
Central Biscayne Bay
Munisport and South Dade Landfills
Biscayne Bay
South Biscayne Bay
Legend
Current Condition Risk (No. of Septic Tanks)
Persistent Failure (1,924)
NH3 Sampling Events (No. of Stations)
0 - 5 (32)
6 - 10 (8)
11 - 15 (12)
16 - 30 (162)
31 - 45 (8)
NH3 Ave Concentration (mg/L) (No. of Stations)
0.00 - 2.80 (219)
2.80 - 20.77 (4)
Canals Loading
POR Average Ammonia Load (Ton/yr)
Ammonia Load (0-20)
Ammonia Load (20-50)
Ammonia Load (50 +)
Cooling Canals
Card Sound
Little Card Sound
KEY LARGO
Monroe County
Barnes Sound
0
7.5
15
Miles


Groundwater Average NOX Concentration
with All Septic Tanks in Current Conditions
N
W
E
S
Broward County
Miami-Dade County
* Limits on average concentration for NOX
(Nitrate + Nitrite) determined by the Miami-Dade County
Chapter 24 for Potable Water Standards for Groundwater
-There is no surface water limit
North Biscayne Bay
Munisport and South Dade Landfills
Central Biscayne Bay
Biscayne Bay
South Biscayne Bay
Card Sound
Little Card Sound
KEY LARGO
Monroe County
Barnes Sound
Legend
Current Condition Risk (No. of Septic Tanks)
Persistent Failure (1,924)
Persistent Compromise (6,806)
Not at Risk (110,778)
NOX Sampling Events (No. of Stations)
0 - 10 (40)
11 - 15 (9)
16 - 30 (166)
31 - 40 (2)
41 - 60 (5)
NOX Average Concentration (mg/L) (No. of Stations)
0.00 - 2.00 (194)
2.00 - 5.00 (18)
5.00 - 10.00 (11)
10.00 + (0)
Canals Loading
POR Average NOX Load (Ton/yr)
NOX Load (0-50)
NOX Load (50-100)
NOX Load (100 +)
0
7.5
15
Miles

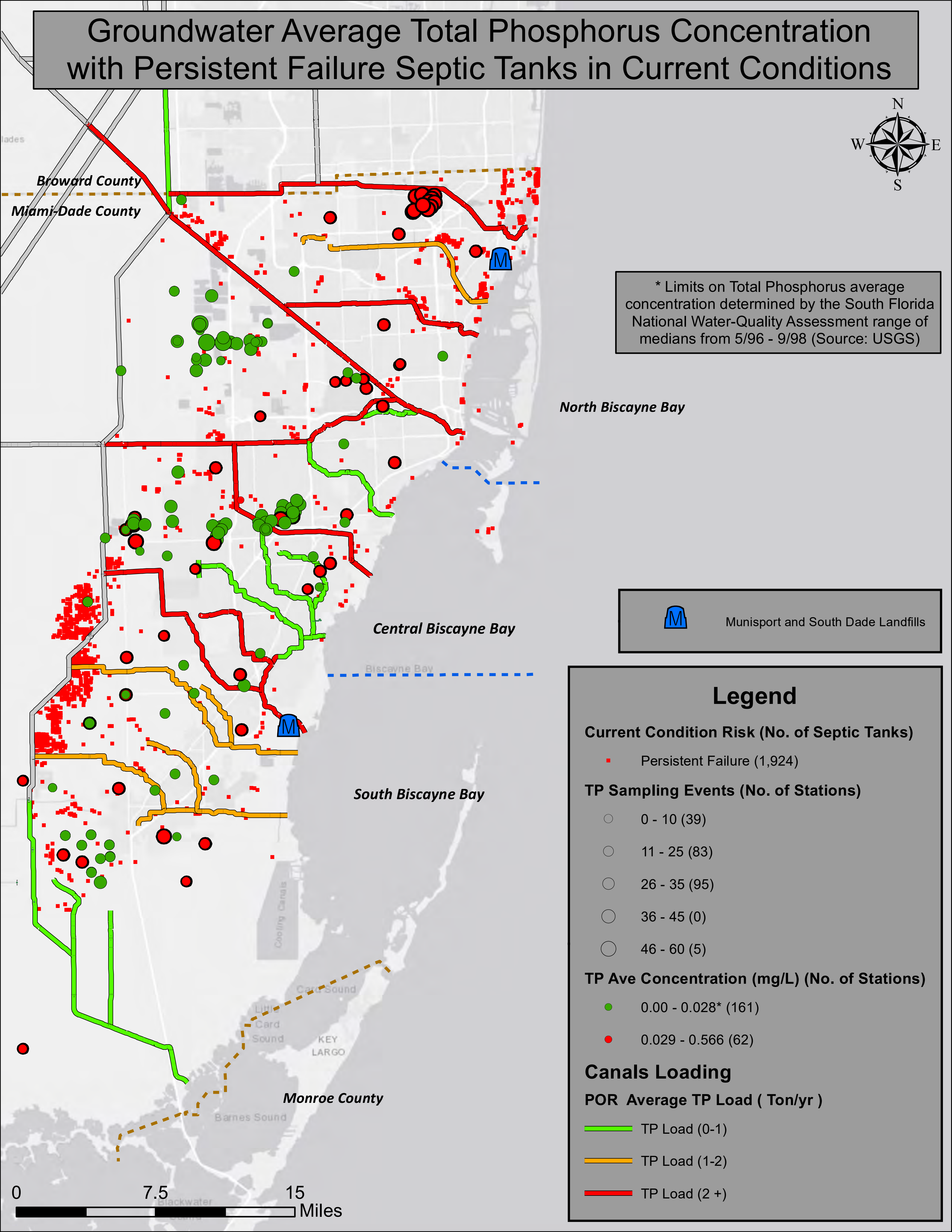


Groundwater Average NOX Concentration with Persistent Failure Septic Tanks in Current Conditions
Broward County
Miami-Dade County
N
W
E
S
* Limits on average concentration for NOX (Nitrate + Nitrite) determined by the Miami-Dade County Chapter 24 for Potable Water Standards for Groundwater
-There is no surface water limit
North Biscayne Bay
Munisport and South Dade Landfills
Central Biscayne Bay
Biscayne Bay
South Biscayne Bay
Cooling Canals
Card Sound
Little Card Sound
KEY LARGO
Monroe County
Barnes Sound
Legend
Current Condition Risk (No. of Septic Tanks)
Persistent Failure (1,924)
NOX Sampling Events (No. of Stations)
0 - 10 (40)
11 - 15 (9)
16 - 30 (166)
31 - 40 (2)
41 - 60 (5)
NOX Average Concentration (mg/L) (No. of Stations)
0.00 - 2.00 (194)
2.00 - 5.00 (18)
5.00 - 10.00 (11)
10.00 + (0)
Canals Loading
POR Average NOX Load (Ton/yr)
NOX Load (0-50)
NOX Load (50-100)
NOX Load (100 +)
0
7.5
15
Miles

Groundwater Average Total Phosphorus Concentration with All Septic Tanks in Current Conditions



Groundwater Average Total Phosphorus Concentration with Persistent Failure Septic Tanks in Current Conditions



* Limits on Total Phosphorus average concentration determined by the South Florida National Water-Quality Assessment range of medians from 5/96 - 9/98 (Source: USGS)

Munisport and South Dade Landfills

Legend

Current Condition Risk (No. of Septic Tanks)

Persistent Failure (1,924)

TP Sampling Events (No. of Stations)

0 - 10 (39)

11 - 25 (83)

26 - 35 (95)

36 - 45 (0)

46 - 60 (5)

TP Ave Concentration (mg/L) (No. of Stations)

0.00 - 0.028* (161)

0.029 - 0.566 (62)

Canals Loading

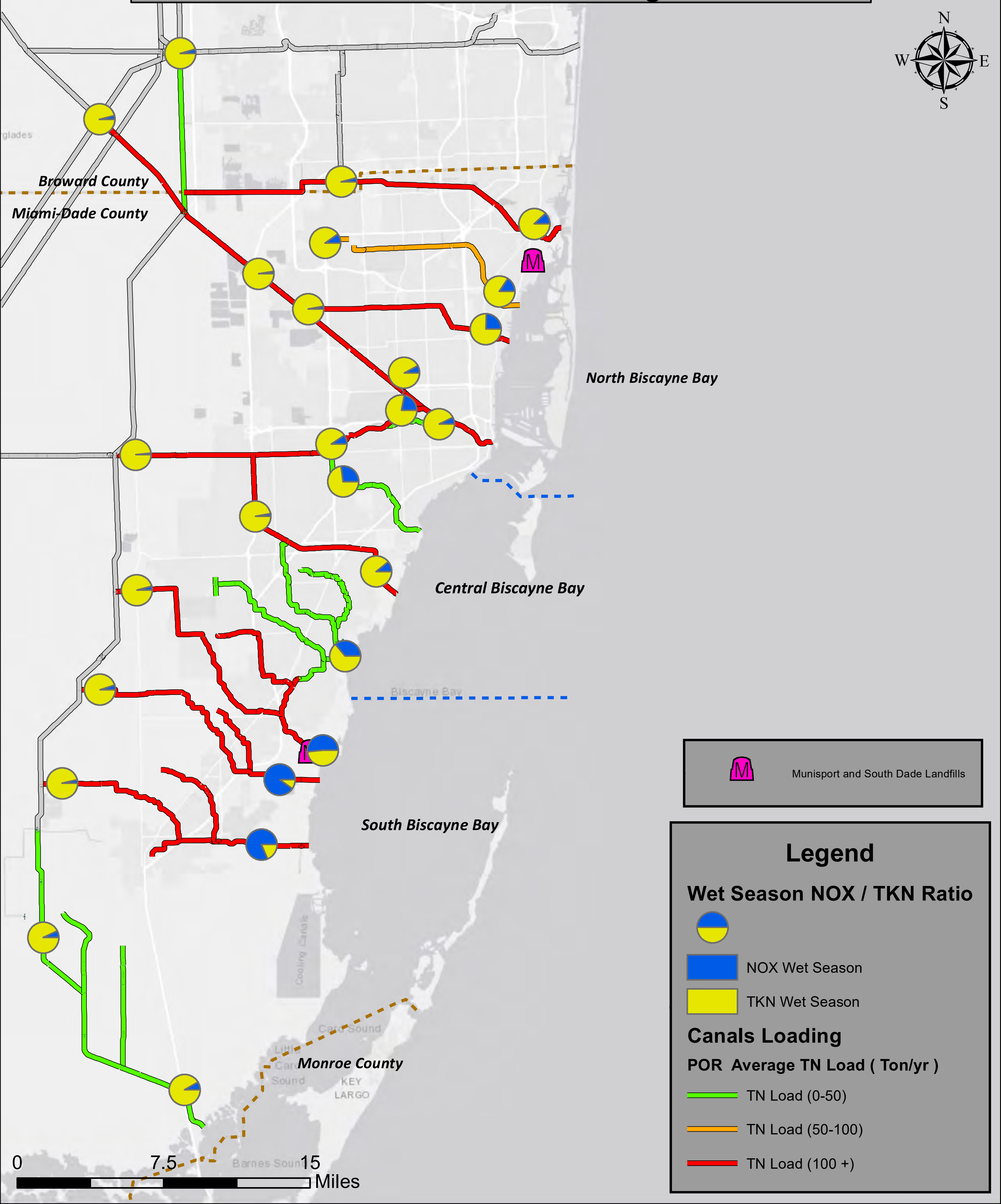
POR Average TP Load (Ton/yr)

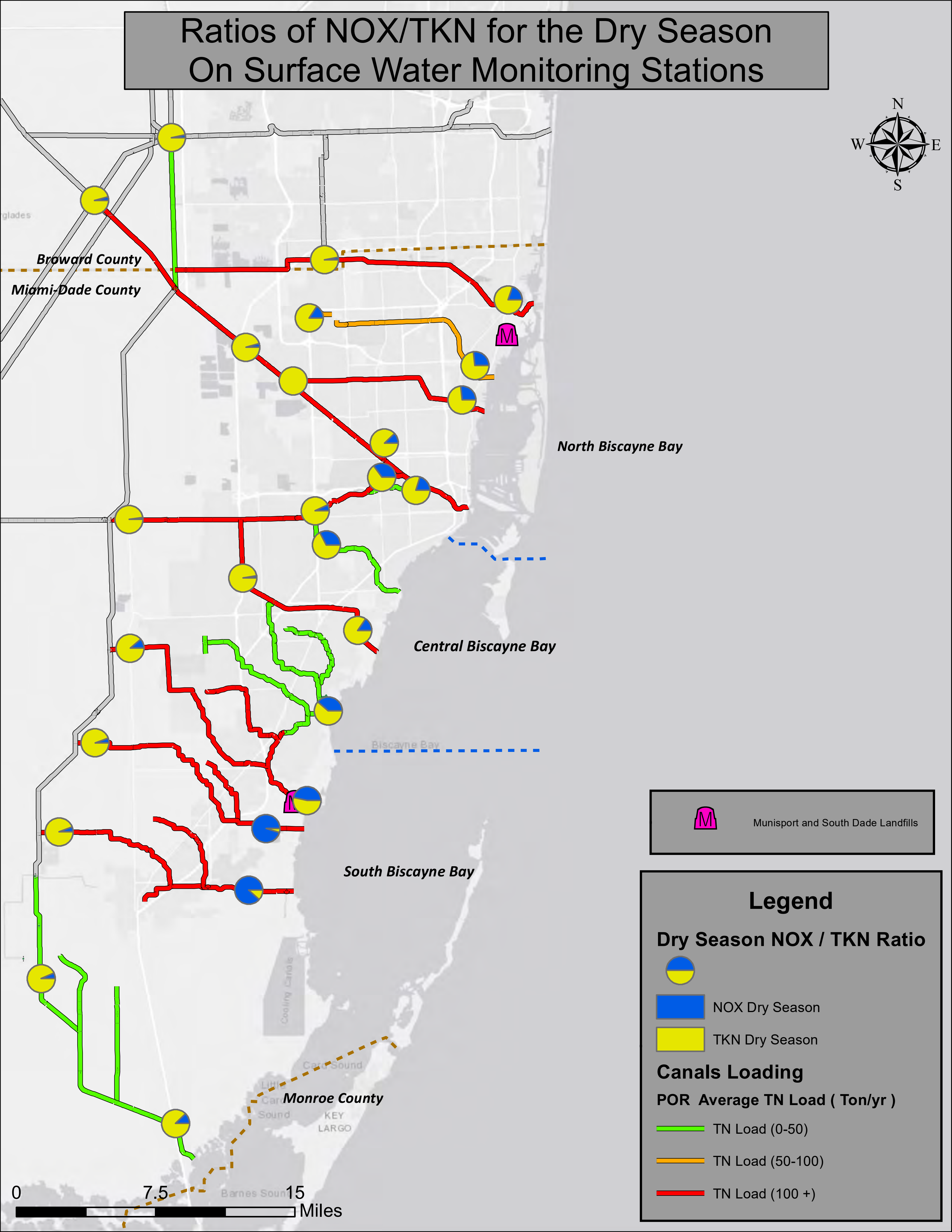
TP Load (0-1)

TP Load (1-2)

TP Load (2 +)

Ratios of NOX/TKN for the Wet Season On Surface Water Monitoring Stations




Ratios of NOX/TKN for the Dry Season
On Surface Water Monitoring Stations
N
W
E
S
Broward County
Miami-Dade County
North Biscayne Bay
Central Biscayne Bay
South Biscayne Bay
Biscayne Bay
Monroe County
Card Sound
KEY LARGO
Cooling Canals
Munisport and South Dade Landfills
Legend
Dry Season NOX / TKN Ratio
NOX Dry Season
TKN Dry Season
Canals Loading
POR Average TN Load (Ton/yr)
TN Load (0-50)
TN Load (50-100)
TN Load (100 +)
0
7.5
15
Miles

APPENDIX B

of the Water Quality Technical Memorandum

Canal Data					
Canal Name	Canal Code	Inflow (Regional) Station ID		Outflow (Into Bay) Station ID	
		Flow	Water Quality	Flow	Water Quality
North Bay					
Snake Creek	C-9	S9XS_S	S9*	S29_S	SK02
Biscayne	C-8	-	-	S28_S	BS04
Little River	C-7	-	-	S27_S	LR06
Miami River	C-6	S151_C	S151*	S26, S26_P	MR07
S. Fork Miami River	C-5	-	-	S25_C	CM02
Tamiami	C-4	G119_C	TM08	S25B_S	TM03A
Central Bay					
Coral Gables	C-3	-	-	G93	CG07
Snapper Creek	C-2	-	-	S123_S	SP04
Cutler Drain	C-100	-	-	S22_S	CD02
South Bay					
Black Creek	C-1	S338_C	BL12	S21_S	BL02
Princeton	C-102	S194_C	PR08	S21A_S	PR03
Mowry	C-103	S196_C	MW13	S20F_S	MW04
Aerojet	C-111	S177_S	S177*	S197_C	AR03

Flow Station data obtained from SFWMD
Water Quality ata obtained from DERM, unless noted otherwise

*Water Quality data obtained from SFWMD for this stations

To calculate the nutrient load in canal water:

Obtain water flow data from the detection station in the South Florida Water Management District (SFWMD) DBHYDRO site in cubic feet per second (cfs). The average is taken for the period of record (POR) -10 years- and multiplied by 28.32 to obtain the flow data in liters per second (L/s).

$$AvgFlow_{POR} in\ cfs * 28.32 = AvgFlow_{POR} \frac{L}{s}$$

To calculate the daily volume in millions of gallons, multiply by 0.002.

$$AvgFlow_{POR} \frac{L}{s} * 0.02 = AvgFlow_{POR} MGD$$

Obtain nutrient data from Miami-Dade Department of Environmental Resources and Management (DERM) and SFWMD in milligrams per liter (mg/L) and average for the POR.

Multiply the average flow of water for the period of record in L/s by the average concentration of the nutrient for the period of record in (mg/L). That equals the average load of the water for the period of record in milligrams per second (mg/s).

$$AvgFlow_{POR} \frac{L}{s} * AvgConc_{POR} \frac{mg}{L} = AvgLoad_{POR} \frac{mg}{s}$$

To obtain the average load in kilograms per day (kg/d) from mg/s, multiply by 0.0864.

$$AvgLoad_{POR} \frac{mg}{s} * 0.0864 = AvgLoad_{POR} \frac{kg}{d}$$

To obtain the average load in US tons per year (US ton/yr) from kg/d, multiply by 0.402344.

$$AvgLoad_{POR} \frac{kg}{d} * 0.402344 = AvgLoad_{POR}\ US\ ton/yr$$

To obtain the values for wet and dry seasons, filter the data for May through October for the wet season and November through April for the dry season and then use the same methods applied for the POR.

APPENDIX C

of the Water Quality Technical Memorandum

Table Appendix C-T1

Regional System Flow and Loading Data

Canal Data			*Average POR Flow*	*Wet Season Flow*	*Dry Season Flow*	*POR TN Load*	*Wet TN Load*	*Dry TN Load*	*POR TKN Load*	*Wet TKN Load*	*Dry TKN Load*	*POR NH_3 Load*	*Wet NH_3 Load*	*Dry NH_3 Load*	*POR Org. N Load*	*Wet Org. N Load*	*Dry Org. Load*	*POR NOx Load*	*Wet NOx Load*	*Dry NOx Load*	*POR TP Load*	*Wet TP Load*	*Dry TP Load*
Canal Name	*Flow Station ID*	*Water Quality Station ID*	*MGD*			*US ton/year*																	
North Bay			**120**	**152**	**89**	**280**	**352**	**208**	**272**	**340**	**201**	**9**	**12**	**6**	**263**	**328**	**195**	**11**	**13**	**9**	**2**	**3**	**2**
Snake Creek	S9XS_C	S9	0.4	0.7	0.2	1	1	0.5	1	1	0.5	0.3	0.3	0.2	0.7	1	0.3	0	0.1	0	0	0	0
Biscayne Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Little River Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Miami River	S151_C	S151	118	148	89	277	345	207	268	333	201	8	10	6	260	323	195	11	13	9	2	3	2
S.Fork Miami River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tamiami Canal	G119_C	TM08	2	3	0	3	6	0	3	6	0	0.9	2	0	2	4	0	0.1	0.1	0	0	0	0
Central Bay			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0**
Coral Gables Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snapper Creek Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cutler Drain Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Bay			**183**	**266**	**98**	**257**	**372**	**140**	**242**	**354**	**130**	**42**	**60**	**24**	**200**	**294**	**106**	**18**	**20**	**13**	**2**	**3**	**1**
Black Creek Canal	S338_C	BL12	72	99	45	123	178	72	115	169	67	26	39	15	89	130	51	9	7	8	0.9	1	0.6
Princeton Canal	S194_C	PR08	15	21	7	23	32	12	22	31	12	5	5	3	18	26	9	1	2	0.7	0.1	0.2	0.1
Mowry Canal	S196_C	MW13	16	21	11	22	27	16	21	27	15	4	4	3	17	23	12	1	1	0.9	0.1	0.2	0.1
Aerojet Canal	S177_S	S177	80	125	35	89	135	40	83	127	37	7	12	2.8	76	115	34	6	10	3	0.7	1	0.3
Grand Total			**303**	**418**	**187**	**538**	**723**	**348**	**514**	**694**	**332**	**51**	**72**	**30**	**462**	**622**	**301**	**29**	**33**	**22**	**4**	**6**	**3**

Red Number = Ammonia Concentration used to calculate Loading came from a 10 year period of record with only 1 sample taken. This number is not reliable.

Table Appendix C-T1

Regional System Flow and Loading Data

Graphical Representation

Flow (MGD) | **Total Nitrogen Loading (ton/yr)** | **TKN Loading (ton/yr)** | **NH_3 Loading (ton/yr)** | **Organic Nitrogen Loading (ton/yr)** | **NOx Loading (ton/yr)** | **Total Phosphorus Loading (ton/yr)**

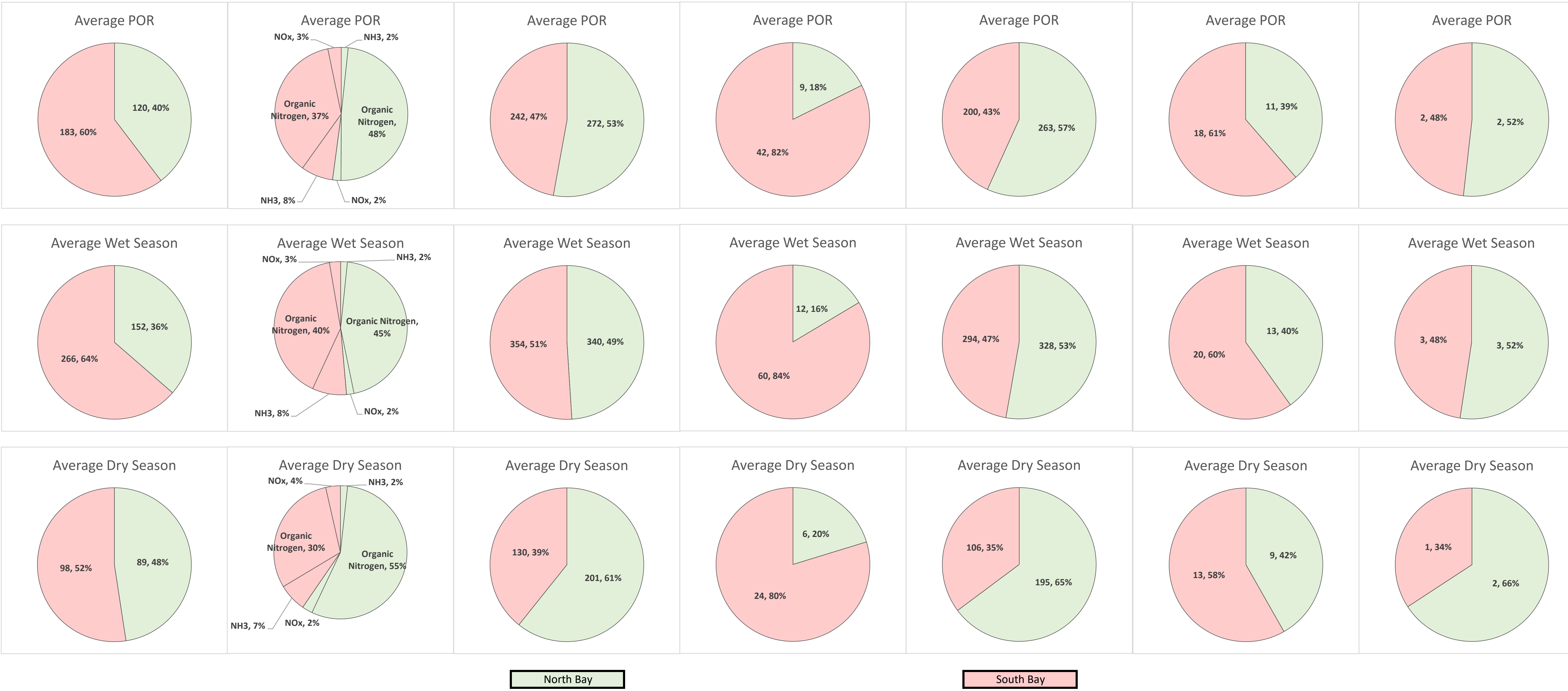


Table Appendix C-T2

Flow and Loading Data into Biscayne Bay

Canal Data			*Average POR Flow*	*Wet Season Flow*	*Dry Season Flow*	*POR TN Load*	*Wet TN Load*	*Dry TN Load*	*POR TKN Load*	*Wet TKN Load*	*Dry TKN Load*	*POR NH_3 Load*	*Wet NH_3 Load*	*Dry NH_3 Load*	*POR Org. N Load*	*Wet Org. N Load*	*Dry Org. Load*	*POR NOx Load*	*Wet NOx Load*	*Dry NOx Load*	*POR TP Load*	*Wet TP Load*	*Dry TP Load*
Canal Name	*Flow Station ID*	*Water Quality Station ID*	*MGD*			*US ton/year*																	
North Bay			**676**	**976**	**371**	**1,000**	**1,424**	**557**	**808**	**1,225**	**423**	**171**	**310**	**75**	**637**	**916**	**349**	**190**	**215**	**125**	**14**	**21**	**8**
Snake Creek	S29_S	CM02	193	297	88	305	455	143	254	407	111	46	98	13	208	308	98	49	57	28	2	4	1
Biscayne Canal	S28_S	SK02	65	95	34	84	109	49	66	94	36	10	18	3	56	76	32	18	18	13	1	2	0.7
Little River Canal	S27_S	BS04	118	155	80	202	237	152	150	181	110	37	59	19	113	121	90	52	59	40	4	6	2
Miami River	S26_, S26_P	LR06	173	241	104	240	385	123	216	353	109	66	108	33	150	245	76	23	30	15	4	5	2
S.Fork Miami River	S25_C	MR07	7	11	4	7	10	4	6	10	3	0.6	1	0.3	6	9	3	1	0.7	0.8	0.3	0.4	0.1
Tamiami Canal	S25B_S	TM03A	119	177	60	161	229	85	116	181	55	12	25	6	104	157	49	46	51	29	2	3	0.9
Central Bay			**173**	**266**	**79**	**225**	**329**	**111**	**187**	**273**	**93**	**33**	**50**	**14**	**154**	**222**	**79**	**34**	**42**	**19**	**2**	**4**	**0.9**
Coral Gables Canal	G93	CG07	7	11	2	10	19	3	7	14	2	3	6	0.6	4	8	1	3	5	1	0.4	0.7	0.1
Snapper Creek Canal	S22_S	CD02	145	217	72	201	286	104	171	245	89	27	42	12	145	203	77	26	29	16	2	3	0.7
Cutler Drain Canal	S123_S	SP04	22	38	5	14	24	3	9	15	2	3	2	1	5	12	0.8	5	8	1	0.3	0.6	0.1
South Bay			**389**	**533**	**242**	**1,120**	**1,470**	**794**	**222**	**374**	**102**	**36**	**51**	**19**	**186**	**323**	**83**	**926**	**1,124**	**715**	**4**	**5**	**2**
Black Creek Canal	S21_S	PR03	138	213	62	179	351	57	97	177	35	26	38	13	70	139	22	94	187	30	2	3	0.8
Princeton Canal	S21A_S	AR03	73	91	55	492	543	409	34	54	19	3	4	2	31	50	17	459	498	388	0.6	0.7	0.5
Aerojet Canal	S197_C	BL02	34	54	14	30	50	12	27	46	10	2	3	0.7	25	43	9	3	4	1	0.2	0.4	0.1
Mowry Canal	S20F_S	MW04	143	176	111	420	527	316	64	98	38	5	6	4	59	92	34	370	435	296	1	1	0.8
Grand Total			**1,238**	**1,775**	**692**	**2,344**	**3,223**	**1,462**	**1,217**	**1,873**	**619**	**239**	**411**	**109**	**977**	**1,462**	**510**	**1,150**	**1,381**	**859**	**20**	**30**	**11**

Table Appendix C-T2
Flow and Loading Data into Biscayne Bay
Graphical Representation

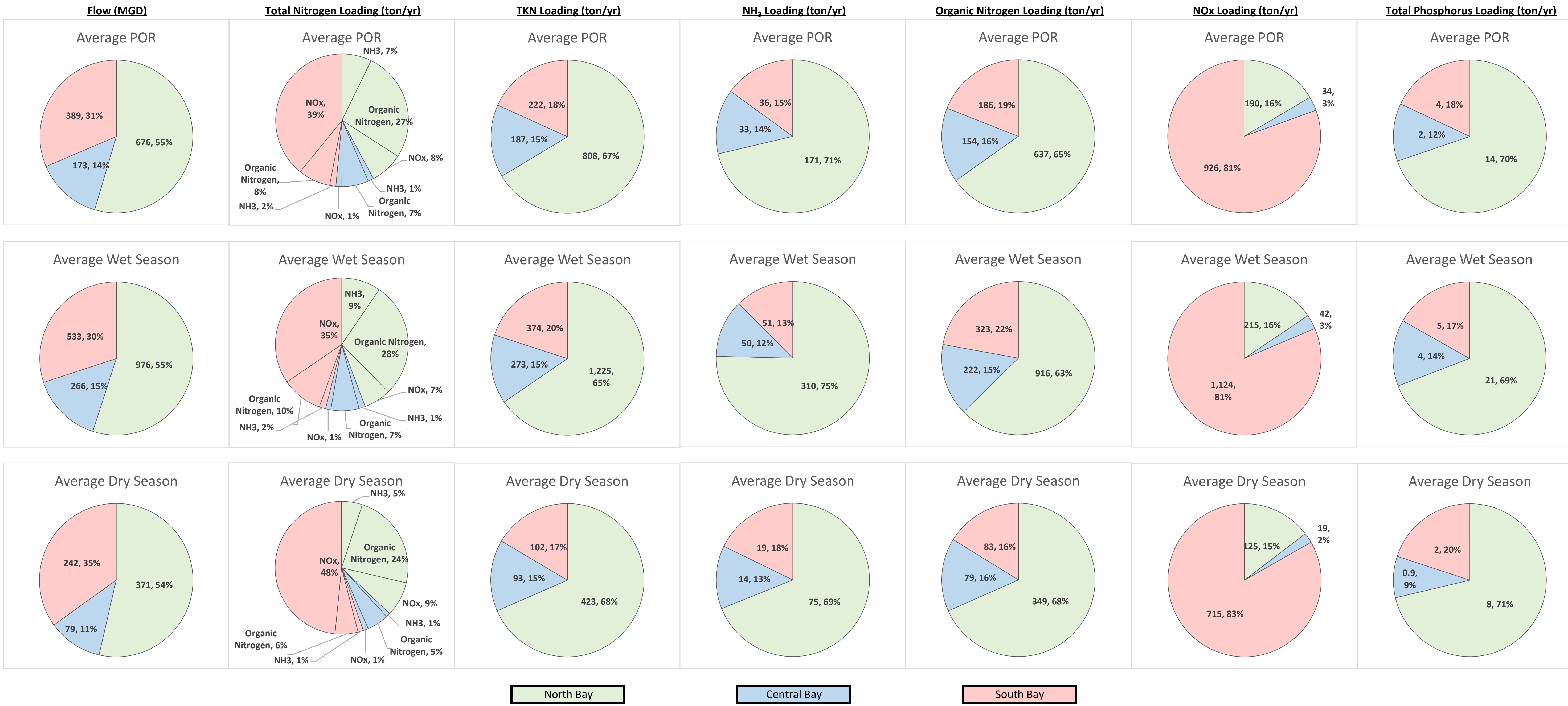


Table Appendix C-T3

Regional System Flow and Concentration Data

Canal Data			*Average POR Flow*	*Wet Season Flow*	*Dry Season Flow*	*POR TN Concentration*	*Wet TN Concentration*	*Dry TN Concentration*	*POR TKN Concentration*	*Wet TKN Concentration*	*Dry TKN Concentration*	*POR NH_3 Concentration*	*Wet NH_3 Concentration*	*Dry NH_3 Concentration*	*POR Org. N Concentration*	*Wet Org. N Concentration*	*Dry Org. Concentration*	*POR NOx Concentration*	*Wet NOx Concentration*	*Dry NOx Concentration*	*POR TP Concentration*	*Wet TP Concentration*	*Dry TP Concentration*
Canal Name	***Flow Station ID***	***Water Quality Station ID***	***MGD***			***US ton/year***																	
North Bay			**120**	**152**	**89**	**1.35**	**1.32**	**1.39**	**1.32**	**1.29**	**1.35**	**0.26**	**0.23**	**0.30**	**1.06**	**1.07**	**1.05**	**0.05**	**0.05**	**0.05**	**0.01**	**0.01**	**0.01**
Snake Creek	S9XS_C	S9	0.4	0.7	0.2	1.46	1.40	1.56	1.42	1.35	1.53	0.40	0.32	0.50	1.03	1.04	1.02	0.06	0.07	0.05	0.01	0.01	0.01
Biscayne Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Little River Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Miami River	S151_C	S151	118	148	89	1.53	1.53	1.53	1.48	1.48	1.49	0.04	0.04	0.04	1.44	1.44	1.45	0.06	0.06	0.07	0.01	0.01	0.01
S.Fork Miami River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tamiami Canal	G119_C	TM08	2	3	0	1.06	1.04	1.08	1.04	1.04	1.04	0.34	0.32	0.36	0.70	0.72	0.68	0.02	0.02	0.02	0.01	0.01	0.00
Central Bay			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Coral Gables Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snapper Creek Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cutler Drain Canal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Bay			**183**	**266**	**98**	**0.95**	**0.93**	**0.97**	**0.90**	**0.90**	**0.91**	**0.17**	**0.15**	**0.18**	**0.74**	**0.75**	**0.73**	**0.06**	**0.04**	**0.07**	**0.01**	**0.01**	**0.01**
Black Creek Canal	S338_C	BL12	72	99	45	1.12	1.18	1.04	1.05	1.12	0.96	0.24	0.26	0.22	0.81	0.86	0.74	0.08	0.05	0.12	0.01	0.01	0.01
Princeton Canal	S194_C	PR08	15	21	7	1.04	0.98	1.10	1.01	0.96	1.08	0.21	0.15	0.26	0.81	0.80	0.82	0.06	0.05	0.06	0.01	0.01	0.01
Mowry Canal	S196_C	MW13	16	21	11	0.91	0.85	0.97	0.88	0.84	0.91	0.16	0.13	0.19	0.71	0.71	0.72	0.04	0.03	0.06	0.01	0.01	0.01
Aerojet Canal	S177_S	S177	80	125	35	0.73	0.71	0.76	0.68	0.67	0.70	0.06	0.07	0.05	0.62	0.60	0.64	0.05	0.05	0.05	0.01	0.01	0.01
Grand Total			**303**	**418**	**187**	**0.77**	**0.75**	**0.79**	**0.74**	**0.73**	**0.75**	**0.14**	**0.13**	**0.16**	**0.60**	**0.60**	**0.59**	**0.04**	**0.03**	**0.04**	**0.01**	**0.01**	**0.01**

Red Number = Ammonia Concentration came from a 10 year period of record with only 1 sample taken. This number is not reliable.

Table Appendix C-T3
Regional System Flow and Concentration Data
Graphical Representation

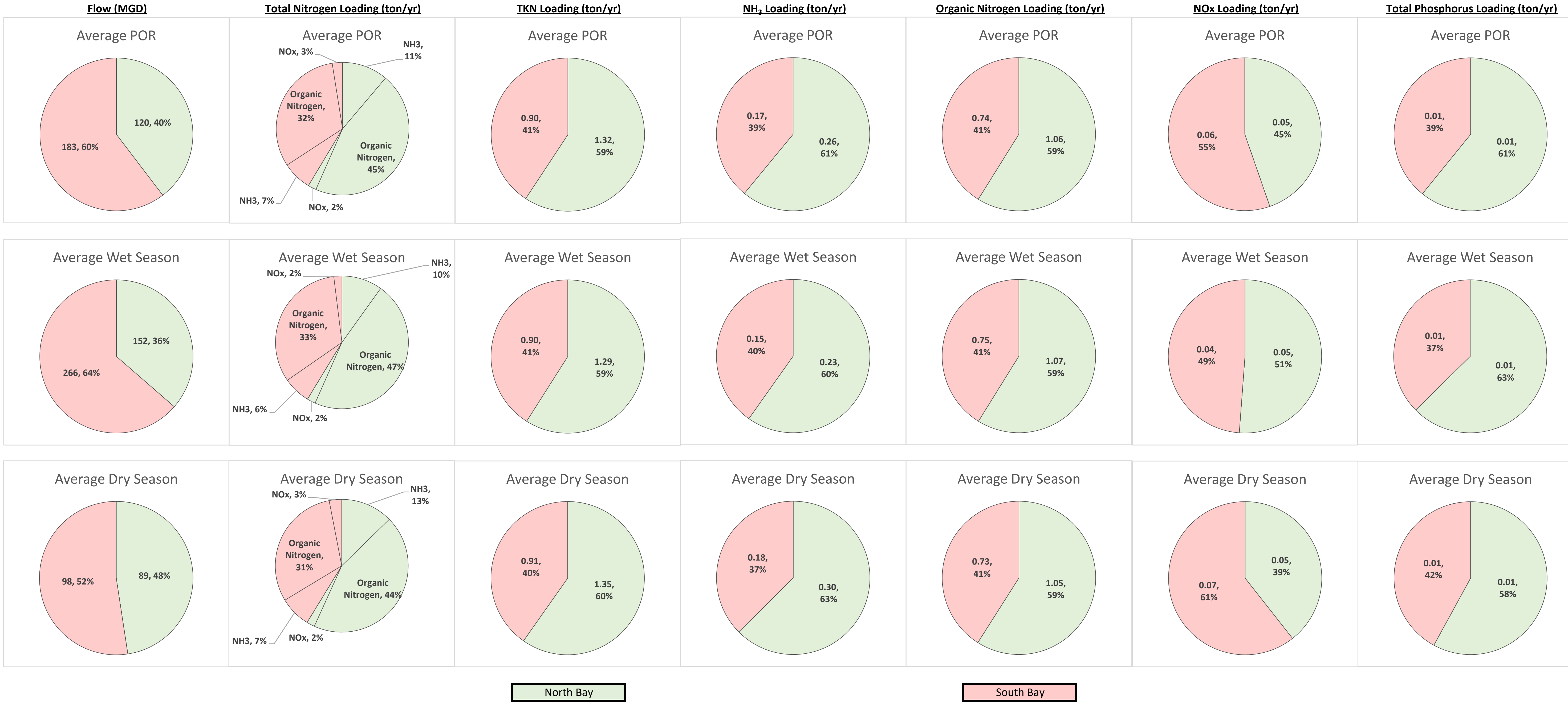
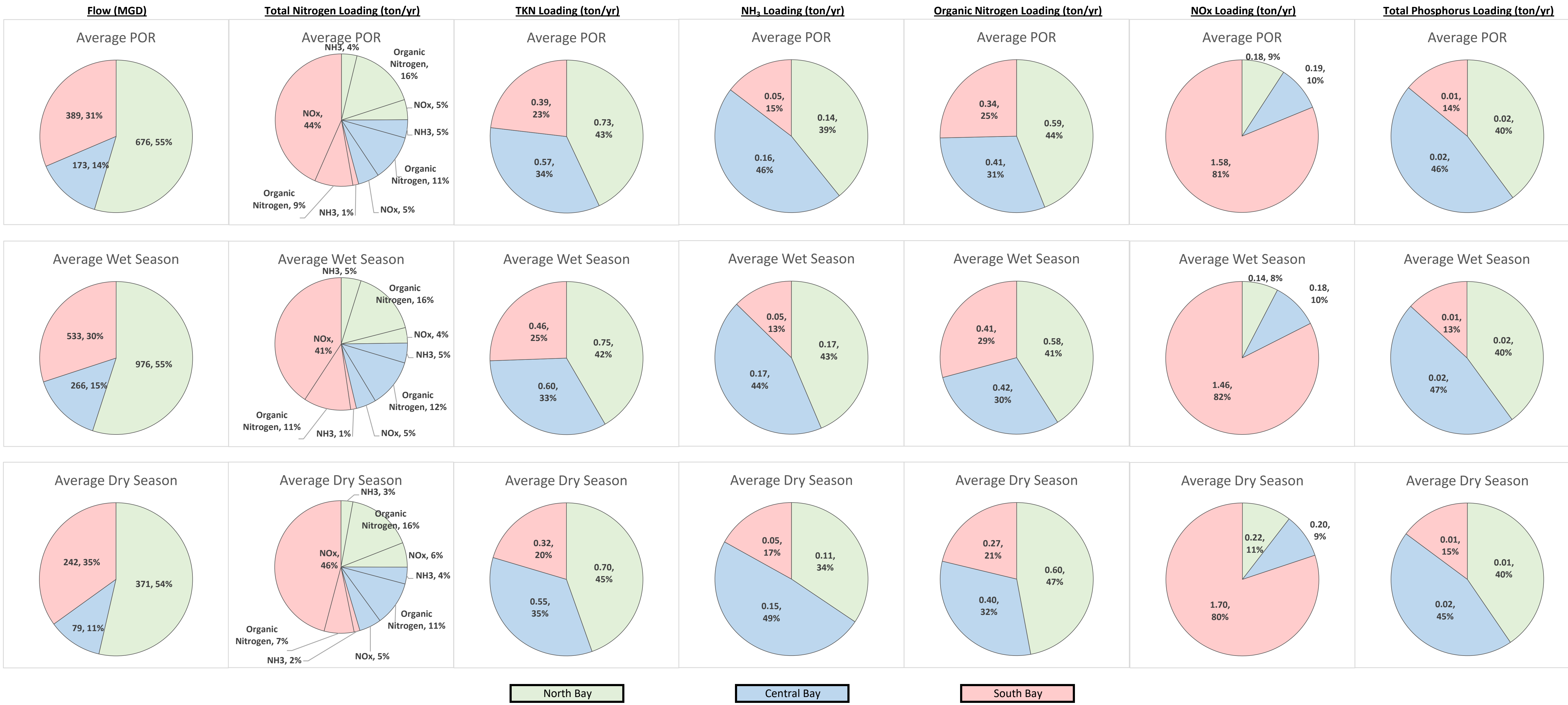


Table Appendix C-T4																							
Flow and Concentrations Data into Biscayne Bay																							
Canal Data			***Average POR Flow***	***Wet Season Flow***	***Dry Season Flow***	***POR TN Concentration***	***Wet TN Concentration***	***Dry TN Concentration***	***POR TKN Concentration***	***Wet TKN Concentration***	***Dry TKN Concentration***	***POR NH_3 Concentration***	***Wet NH_3 Concentration***	***Dry NH_3 Concentration***	***POR Org. N Concentration***	***Wet Org. N Concentration***	***Dry Org. Concentration***	***POR NOx Concentration***	***Wet NOx Concentration***	***Dry NOx Concentration***	***POR TP Concentration***	***Wet TP Concentration***	***Dry TP Concentration***
Canal Name	***Flow Station ID***	***Water Quality Station ID***	***MGD***			***US ton/year***																	
North Bay			**676**	**976**	**371**	**0.91**	**0.88**	**0.94**	**0.73**	**0.75**	**0.70**	**0.14**	**0.17**	**0.11**	**0.59**	**0.58**	**0.60**	**0.18**	**0.14**	**0.22**	**0.02**	**0.02**	**0.01**
Snake Creek	S29_S	SK02	193	297	88	1.04	1.01	1.07	0.86	0.90	0.83	0.16	0.22	0.10	0.71	0.68	0.73	0.17	0.13	0.21	0.01	0.01	0.01
Biscayne Canal	S28_S	BS04	65	95	34	0.85	0.75	0.94	0.66	0.65	0.68	0.10	0.13	0.07	0.57	0.52	0.61	0.19	0.12	0.25	0.02	0.02	0.01
Little River Canal	S27_S	LR06	118	155	80	1.13	1.00	1.25	0.83	0.76	0.90	0.21	0.25	0.16	0.63	0.51	0.74	0.29	0.25	0.33	0.02	0.03	0.02
Miami River	S26_, S26_P	MR07	173	241	104	0.91	1.05	0.78	0.82	0.96	0.68	0.25	0.29	0.21	0.57	0.67	0.48	0.09	0.08	0.09	0.01	0.01	0.02
S.Fork Miami River	S25_C	CM02	7	11	4	0.64	0.62	0.65	0.56	0.58	0.53	0.06	0.06	0.05	0.50	0.52	0.48	0.09	0.05	0.14	0.03	0.03	0.02
Tamiami Canal	S25B_S	TM03A	119	177	60	0.89	0.85	0.93	0.64	0.67	0.60	0.07	0.09	0.07	0.57	0.58	0.54	0.26	0.19	0.32	0.01	0.01	0.01
Central Bay			**173**	**266**	**79**	**0.77**	**0.79**	**0.75**	**0.57**	**0.60**	**0.55**	**0.16**	**0.17**	**0.15**	**0.41**	**0.42**	**0.40**	**0.19**	**0.18**	**0.20**	**0.02**	**0.02**	**0.02**
Coral Gables Canal	G93	CG07	7	11	2	0.98	1.08	0.89	0.69	0.79	0.59	0.27	0.36	0.18	0.42	0.44	0.41	0.29	0.30	0.29	0.04	0.04	0.03
Snapper Creek Canal	S22_S	SP04	145	217	72	0.91	0.87	0.95	0.78	0.74	0.82	0.12	0.13	0.11	0.66	0.61	0.70	0.12	0.09	0.15	0.01	0.01	0.01
Cutler Drain Canal	S123_S	CD02	22	38	5	0.42	0.42	0.41	0.26	0.25	0.26	0.10	0.04	0.17	0.16	0.22	0.10	0.15	0.14	0.16	0.01	0.01	0.01
South Bay			**389**	**533**	**242**	**1.94**	**1.90**	**1.98**	**0.39**	**0.46**	**0.32**	**0.05**	**0.05**	**0.05**	**0.34**	**0.41**	**0.27**	**1.58**	**1.46**	**1.70**	**0.01**	**0.01**	**0.01**
Black Creek Canal	S21_S	BL02	138	213	62	0.85	1.08	0.60	0.46	0.55	0.37	0.13	0.12	0.13	0.33	0.43	0.24	0.45	0.58	0.32	0.01	0.01	0.01
Princeton Canal	S21A_S	PR03	73	91	55	4.43	3.93	4.91	0.30	0.39	0.22	0.02	0.03	0.02	0.28	0.36	0.20	4.14	3.60	4.66	0.01	0.01	0.01
Mowry Canal	S20F_S	MW04	143	176	111	1.92	1.97	1.88	0.30	0.37	0.23	0.02	0.02	0.02	0.27	0.34	0.20	1.69	1.63	1.76	0.01	0.01	0.01
Aerojet Canal	S197_C	AR03	34	54	14	0.57	0.60	0.55	0.51	0.55	0.47	0.03	0.04	0.03	0.48	0.52	0.44	0.06	0.05	0.07	0.00	0.00	0.00
Grand Total			**1,238**	**1,775**	**692**	**1.21**	**1.19**	**1.22**	**0.57**	**0.60**	**0.53**	**0.12**	**0.13**	**0.10**	**0.45**	**0.47**	**0.42**	**0.65**	**0.59**	**0.71**	**0.01**	**0.01**	**0.01**

Table Appendix C-T4
Flow and Concentration Data into Biscayne Bay
Graphical Representation



Appendix B

Septic to Sewer Program Case Study Information

(Excerpts from the ***Septic to Sewer Guidance Document, April 2018***, Jones Edmunds, Florida Water Environment Association, and the Florida Department of Environmental Protection)

CASE STUDIES

Indian River County

October 2017

West Regional Wastewater Treatment Facility Wetlands, Vero Beach

Indian River County is located on the Treasure Coast between St. Lucie and Brevard Counties with the Indian River Lagoon running present from its north to south County lines. The County has a population of approximately 150,000 and five incorporated cities. The County has approximately 30,000 septic systems in 325 subdivisions/communities with about 37 percent of them in the incorporated areas. The County's Utilities Department provides sewage collection for over 28,950 accounts, along with commercial and industrial customers – a major portion of the population. The County has recently initiated a Septic-to-Sewer Program in the County and completed a Septic-to-Sewer Conversion Evaluation (June 2017). The program is in its early stages and details for program implementation are evolving with some that have yet to be defined.

Septic to Sewer Highlights

- An assessment of the septic systems was conducted for the communities across the County. The 2017 report entitled "Septic to Sewer Conversion Evaluation" prepared by Schulke, Bittle & Stoddard, LLC provided Capital Improvement Program prioritization recommendations. A copy of the report is available on the County's website and available as an attachment.
- As part of the initial ranking, the County used the following factors to evaluate the various areas of the County for septic-to-sewer conversation:
    - Population Density
    - Proximity to Surface Waters
    - FEMA Flood Plain
    - Depth to Ground Water Table
    - Soil Condition
    - Age Surface Water Management System
    - Age of Existing OSTDS
- The County has begun implementing priorities starting with the North Sebastian area Phase I Septic-to-Sewer (S2S) Conversion Project. Phase I Construction has been bid and the funding allocated. The notice to proceed was issued in August 2017 with a 1-year construction period. The first phase of the North Sebastian S2S project focuses on the commercial area of Sebastian with the expectation that it will help the Sebastian US Highway 1 commercial corridor.
- Funds for this initial project are coming from several sources and are allocated as follows:
    - Utility reserve funds – 20 percent.
    - Sales Tax – 20 percent.
    - Cost-share Grant – 21.80 percent.
    - Owner portion – 38.20 percent
- North Sebastian S2S Phase II Design is 90-percent complete.

Other Information of Interest

- The County Goals include:
    - Protecting the Indian River Lagoon by working with the regulatory agencies, residents, and other stakeholders to develop and implement the County-wide S2S plan.
    - Provide safe, reliable water and wastewater service.
    - Pursue grant dollars to minimize the overall impact to rate payers and be fair to all County citizens.
- The County's program is evolving. The County will be addressing such issues as:
    - Changes to the County comprehensive plan.
    - Financing options:

- A sign-up incentive program that rewards early converters will help jump-start the S2S residential program in priority areas.
    - Public outreach:
- Effective communications is essential. The Utilities Department has an informative website (weblink below) and is developing an outreach strategy to effectively inform residents.
    - Policies for work to be completed on Owners' properties.
    - How best to serve areas in the County to be developed in the future.
- Foresight and leadership by the Board of County Commissioners was essential to effectively initiate the S2S Conversion Program.

Attachments/Resources

- **Executive Summary from "Septic to Sewer Conversion Evaluation" report including an Aerial Map (Attachment 43, Page 862).**
- **Indian River County's Septic-to-Sewer Program: www.ircutilities.com/S2S which includes documents, maps, and FAQs.**
- **Rate Structure (Attachment 44, Page 920).**

Contact Information

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http://www.ircutilities.com

Indian River Lagoon

CASE STUDIES

City of Jacksonville and JEA

October 2017

Pumpkin Hill Creek, Jacksonville

JEA is located in Jacksonville, Florida, where they serve an estimated 455,000 electric, 337,000 water and 261,000 sewer customers. JEA is the largest community-owned utility in Florida and the eighth largest in the United States. JEA has engaged with multiple Septic to Sewer programs over the past 20 years. During the Better Jacksonville Program, the City of Jacksonville (COJ) and JEA worked together to remove more than 6,000 septic tanks. The current Septic to Sewer program began in the Spring 2016 and has been adjusted to maximize the cost benefit of the financial investment by the City and the Utility.

Program Overview

Under the current program, COJ and JEA are jointly investing $30 million dollars for the Septic to Sewer program. An additional $5 million investment will come from JEA in the form of funding for engineering design and project management and another $600,000 in the form of treatment capacity for removal of septic tanks that are eligible for total maximum daily load (TMDL) credit. The funds for the program will carryover from budget year to budget year and not lapse. Additionally, central water will also be included in the areas where it is currently unavailable. A key feature of the program is that it funds connection costs for water and wastewater connections for projects that achieve required participation levels. This is a huge selling point in moving the program forward.

Some of the elements of JEA's current program include the following:

- A list of 35 neighborhoods monitored by the Duval County Health Department was evaluated and ranked using several additional scoring criteria that includes environmental, health and welfare considerations, and community considerations. The list will be reviewed and updated annually.
- The total wastewater collection system estimate for the 35 neighborhoods (estimated in 2016 dollars) is $708 million.
- Additional provision for the 14 neighborhoods where central water is not fully available and could be added totals $25 million (estimated in 2016 dollars).
- Available joint COJ/JEA funding has been committed to the highest scored priority areas that achieve required participation levels.
- Projects will require 70 percent of the property owners in the priority area to agree to connect and sign an access agreement before project design consultant selection commences (applies to properties improved with houses or businesses).
- The Program provides for a 5-year waiting period for neighborhood project reconsideration if 70 percent is not achieved within the 6-month outreach period.
- The City has eliminated an option to defer connections and requires mandatory connections, absent a valid previously approved deferral.
- The Program will pay for all connection costs for projects funded as priority areas that achieve participation levels as funding allows.
- Connection to existing wastewater lines will be required where available.
- Uses Florida Department of Health Statute guidelines for mandating connections (criteria include property types and distances from existing infrastructure).
- Established a monthly "Readiness to Serve" charge for properties that do not connect within 1 year of availability and proper notice. Applicable to neighborhoods receiving new infrastructure and existing neighborhoods with existing infrastructure.
- The "Readiness to Serve" charge will be collected through a separate billing process where the money will flow to COJ for funding future priority-area projects. This fee is equal to the base sewer bill.

COJ and JEA used a strong outreach program in the initially identified neighborhood that included two "town hall"-style meetings and door-to-door outreach to gain the required percentage of commitment from the property owners within the neighborhoods. The 6-month participation period commences with the second town hall meeting. The required participation was reached in the first neighborhood, and the project is moving to the design phase. Outreach has started on the second priority neighborhood.

Challenges

One of the challenges faced in moving the program forward included connecting with absentee owners in a community that has 51-percent absentee owners.

Attachments

- **Water and Wastewater Infrastructure Review 2016 (Attachment 45, Page 927)**
- **Water Wastewater Review Committee Report and Recommendations (Attachment 46, Page 949)**
- **Water/Wastewater Appropriation Ordinance (Attachment 47, Page 958)**
- **Septic Tank Phaseout Program Information Sheet (Attachment 48, Page 979)**
- **Septic Tank Phaseout Prioritization Spreadsheet (Attachment 49, Page 980)**
- **Biltmore Septic to Sewer Presentation (Attachment 50, Page 983)**
- **Rate Structure (Attachment 51, Page 999)**

Contact Information

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Main Street Bridge, Jacksonville

Executive Summary

To: **Arjuna Weragoda, Capital Projects Manager, Indian River County Department of Utility Services**

From: **Joseph Schulke, PE – Project Manager, SBS**

Date: **June 20, 2017**

Re: **Executive Summary - Septic to Sewer Conversion Evaluation**

The Indian River Lagoon (Lagoon) is North America's most diverse estuary with more than 4,300 species of plants and animals, including 35 that are listed as threatened or endangered, more than any other estuary in North America. The Lagoon varies in width from .5 to 5 miles (0.80 to 8.0 km) and averages 4 feet (1.2 m) in depth. It serves as a spawning and nursery ground for many different species of oceanic and lagoon fish and shellfish. The Lagoon also has one of the most diverse bird populations anywhere in America. Nearly 1/3 of the nation's manatee population lives here or migrates through the Lagoon seasonally. In addition, its ocean beaches provide one of the densest sea turtle nesting areas found in the Western Hemisphere.

The Lagoon has faced challenges and adversity over the years, and has seen the reduction in Fishery populations, the loss of salt marshes and mangrove wetlands, and shellfish harvesting areas are shrinking every year and are being closed. While there are many contributing factors, numerous symposiums on the health of the Lagoon have identified the proliferation of residential septic systems as one of the significant contributors to the degradation of the lagoon.

The Indian River County Board of County Commissioners has recognized that the health of the Lagoon should be one of the county's top priorities. Consequently, it has directed staff to retain Schulke, Bittle & Stoddard, LLC to prepare a County-wide study to evaluate the impact of continued septic system use on the Indian River Lagoon, and consider alternative methods to provide public sewer to communities whose septic systems are causing the most harm to the environment.

The final report prepared by Schulke, Bittle & Stoddard, LLC, titled "Septic to Sewer Conversion Evaluation", was prepared as an objective review of geographic areas in Indian River County that currently utilize on-site sewage treatment and disposal systems (OSTDS). The evaluation in the report provides a relative comparison of the negative environmental impact to the Indian River Lagoon that the various geographic areas (communities) in the County are causing due to the existence and use of septic systems. From this comparison, the communities have been ranked from the most to least impactful to the lagoon eco-system. The results can be used by IRCDUS for the development of a capital improvement program which identifies and prioritizes communities to be converted from OSTDS use to IRCDUS sewer utility system construction, connection and use. Factors considered for the final prioritization to convert communities to IRCDUS sewer utility use are: cost of system construction per

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home site at each community, cost of system construction, cost per pound of pollutant removed at each community, and presence or absence of potable water.

The evaluation is presented in three parts:

Part 1 – Aquatic Health: Evaluation of relative environmental impacts caused by each community (345) and ranking of communities.
Part 2 – Master Wastewater System Data and Estimate of Pollutants Generated by Septic System Use: Evaluation of wastewater data from the top 30 communities from Part 1, including design average daily and peak hour flows generated, and estimate of pollutant loading.
Part 3 - Capital Improvement Program Prioritization. The top 30 ranked communities from Part 1 will be evaluated and re-prioritized based on cost of sewer system construction, cost of pollutant reduction, and presence or absence of potable water.

The Final report, **"Septic to Sewer Conversion Evaluation",** presents in detail, Schulke, Bittle & Stoddard, LLC's methods and results of the study. A summary of the results from the report is attached to this Executive Summary in both a graphic and tabular form:

- Table EX-1: **Summary Results - Priority Sites - Septic to Sewer Conversion**
- Exhibit EX-1: **Map of the top 30 Priority Sites**

Other considerations:

SBS and IRCDUS staff considered the results of the evaluation, and found that the communities identified as the worst contributors to the Indian River Lagoon Eco-system are consistent with our initial expectations. Most communities identified were located close to the primary waterbodies (Indian River Lagoon and Sebastian River), or close to primary tributaries to these water bodies. However, there was at least one outlier that was identified as a priority community in the evaluation, which IRCDUS would not likely consider for conversion. Amos A of E subdivision, which only has two home sites, clearly would not be feasible to expand sewer to, nor would it reduce pollutants significantly. This result is attributed to a rare happenstance – this community received the highest index number for several factors, including "importance factor", proximity to surface waters, flood plain, depth to groundwater, and soil condition, which numbers cumulatively predicted a high relative score. This appears to be one of the only communities inside the top tier of sites that we considered an anomaly in the results. This community, while listed, is struck through and should not be considered.

Upon review of Table EX-1, the reader will find that the table lists 35 communities, while on Exhibit EX-1, the map graphically depicts only 30 communities. This is because, while evaluating factors such as cost to expand public sewer, several communities were not readily separated from other communities. In these cases, communities outside the top 30 are surrounded by communities in the top 30 – and preparing the conceptual design of and cost estimates for the construction of sewer systems was not feasible with-out including these lower ranked communities in the results.

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TABLE EX-1
CAPITAL IMPROVEMENT PROGRAM PRIORITY RECOMMENDATION SUMMARY

Number	*Subdivision Name*	*Initial Ranking*	*New/ Reprioritized Final Ranking*	*Gravity,Low Pressure or Vacuum (most cost effective per lot)*	*Cost per Lot*			*Cost per lb of Pollution Reduction/ YR* n=30 yr; i=3.125%			*IRC Potable Water Available*
					Gravity	*Low Pressure*	*Vacuum*	*Gravity* O&M=$10,000/LS	*Low Pressure* O&M=$450/PS	*Vacuum* O&M=$60,000/LS	
48	Floravon Shores Subdivision	*7*	1	Gravity	$10,531.72	$0.00	$0.00	$31.24	$0.00	$0.00	Yes
52	Sebastian Highlands Unit 02 Collier	*9*	2	Vacuum	$21,344.64	$0.00	$12,669.04	$31.11	$0.00	$19.45	Yes
58	Sebastian Highlands Unit 05	*12*	3	Vacuum	$21,344.64	$0.00	$12,669.04	$39.10	$0.00	$24.45	Yes
138	Hobart Landing Unit 2	*1*	4	Gravity	$26,220.22	$32,331.87	$0.00	$39.22	$57.29	$0.00	Yes
18	Orchid Island No. 2	*3*	5	Low Pressure	$61,902.03	$28,825.33	$33,220.65	$102.48	$57.98	$78.20	No
17	Orchid Island No. 1	*2*	7	Low Pressure	$88,754.76	$29,133.51	$42,629.54	$146.73	$58.01	$107.24	No
1	Ambersand Beach Sub No 1 & 2	*6*	8	Gravity	$25,186.91	$0.00	$29,493.95	$42.71	$0.00	$0.00	Yes
131	Naranja TR Shellmound Bch Replat of POR	*8*	11	Low Pressure	$41,334.29	$29,249.95	$0.00	$102.69	$66.16	$0.00	No
50	Sebastian Highlands Unit 01	*24*	8	Vacuum	$21,344.64	$0.00	$12,669.04	$49.88	$0.00	$31.19	Yes
57	Sebastian Highlands Unit 04	*25*	5	Vacuum	$21,344.64	$0.00	$12,669.04	$49.90	$0.00	$31.21	Yes
19	Orchid Isle Estates Subdivision	*14*	13	Vacuum	$49,749.53	$30,057.06	$21,365.00	$79.39	$55.40	$38.71	No
139	Hobart Landing Unit 3	*4*	14	Low Pressure	$56,318.05	$33,987.79	$0.00	$84.90	$57.31	$0.00	Yes
272	Pine Tree Park Units 1-4	*22*	17	Vacuum	$18,896.51	$0.00	$14,624.42	$85.89	$0.00	$73.63	Yes
320	River Shores Estates Units 1-4	*10*	16	Vacuum	$24,444.12	$0.00	$21,979.98	$97.46	$0.00	$118.30	Yes
291	Indian River Heights Units 1 -9	*18*	17	Vacuum	$19,375.08	$0.00	$13,591.82	$139.86	$0.00	$104.88	Yes
51	Sebastian Highlands Unit 02	*30*	11	Vacuum	$21,344.64	$0.00	$12,669.04	$67.29	$0.00	$42.08	Yes
278	Stevens Park Unit 1 & 2	*21*	24	Vacuum	$18,796.12	$0.00	$15,122.31	$184.15	$0.00	$179.49	Yes
212	Rain Tree Corner Subdivision	*11*	20	Low Pressure	$40,184.62	$29,299.76	$0.00	$97.45	$70.85	$0.00	Yes
53	*Sebastian Highlands Unit 02 Replat PG 2**	*38*	*14*	*Vacuum*	*$21,344.64*	*$0.00*	*$12,669.04*	*$59.41*	*$0.00*	*$37.15*	*Yes*
273	Diana Park Subdivision	*19*	21	Low Pressure	$33,128.36	$28,527.86	$0.00	$78.40	$68.94	$0.00	Yes
49	Dales Landing Subdivision	*20*	24	Low Pressure	$52,887.18	$35,328.90	$0.00	$172.41	$94.32	$0.00	No
207	Tropic Colony Subdivision	*27*	31	Gravity	$21,141.85	$0.00	$22,004.08	$151.54	$0.00	$202.21	Yes
~~275~~	~~Amos (A of E) **~~	~~*15*~~	~~24~~	~~Low Pressure~~	~~$195,601.05~~	~~$41,320.80~~	~~$0.00~~	~~$648.37~~	~~$111.01~~	~~$0.00~~	~~No~~
2	Hallmark Ocean Subdivision	*5*	24	Low Pressure	$130,635.31	$65,670.98	$0.00	$261.82	$99.87	$0.00	Yes
199	Verona Estates Subdivision	*17*	22	Low Pressure	$43,570.90	$28,469.58	$0.00	$329.15	$200.11	$0.00	No
56	*Sebastian Highlands Unit 03**	*31*	*10*	*Vacuum*	*$21,344.64*	*$0.00*	*$12,669.04*	*$41.97*	*$0.00*	*$26.24*	*Yes*
54	*Sebastian Highlands Unit 02 Replat PG 3**	*45*	*17*	*Vacuum*	*$21,344.64*	*$0.00*	*$12,669.04*	*$44.36*	*$0.00*	*$27.74*	*Yes*
137	Hobart Landing Unit 1	*13*	24	Gravity	$26,336.91	$30,618.92	$0.00	$188.51	$197.86	$0.00	Yes
143	Winter Grove Subdivision	*26*	29	Low Pressure	$34,703.42	$28,384.58	$0.00	$89.83	$79.04	$0.00	Yes
213	Kanawah Acres	*16*	29	Low Pressure	$91,971.34	$40,474.04	$0.00	$408.14	$185.68	$0.00	No
32	Halleluiah Acres	*28*	32	Low Pressure	$94,292.08	$51,062.75	$0.00	$169.83	$80.24	$0.00	No
68	Sebastian Highlands Unit 13	*29*	22	Vacuum	$22,483.78	$0.00	$14,124.59	$124.23	$0.00	$85.96	Yes
196	Little Portion Subdivision Replat OF	*23*	33	Low Pressure	$32,734.44	$27,729.70	$0.00	$226.87	$197.05	$0.00	Yes
55	*Sebastian Highlands Unit 02 Replat PG 4**	*69*	*34*	*Vacuum*	*$21,344.64*	*$0.00*	*$12,669.04*	*$71.58*	*$0.00*	*$44.76*	*Yes*
136	*Heritage Trace at Hobart **	*281*	35	*Gravity*	*$23,946.97*	*$27,984.56*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*Yes*

* These communities are included in the evaluation due to their proximity to one or more top 30 ranked communities

**** It is recommended that Amos subdivision not be considered in the capital improvement program. Ranking results are due to an anomaly in the methodology. This site has the highest index numbers assigned for "importance factor", proximity to surface water, flood plain, depth to groundwater and soil condition. As a result, the site is ranked much higher than would otherwise be expected.**

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EXHIBIT C

WATER AND WASTEWATER INFRASTRUCTURE REVIEW 2016

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DRAFT 7-15-16

Section A – Report

Water and Wastewater Infrastructure Review 2016

Purpose:

The purpose of this review is to: 1) develop recommendations for prioritization of new water and wastewater infrastructure, 2) address proliferation of septic tanks, and 3) consider mandatory connection methods where central water and wastewater lines are available. The goals of the program as summarized during the work by the City Council Special Committee on the JEA Agreement are to improve the environment, improve quality of life, ensure public health, and promote economic growth by making public water and wastewater service available throughout developed portions of the City.

Background:

The City Council Special Committee on the JEA Agreement (Council Special Committee) completed its work on February 9, 2016 and the City Council approved related ordinance 2015-764-E on March 8, 2016. An Interagency Agreement (IA) between the City and JEA was approved by the full Council and signed by the Mayor on March 22, 2016. The IA included, among other provisions, an additional contribution from JEA to the City of $15 million, to be utilized by the City toward water and wastewater infrastructure expansion needs and matched over 5 years with an additional $15 million from the City. The IA (Section D) also included a commitment for a working committee to propose policies, procedures, laws and recommendations on water and wastewater infrastructure to the City Council related to deployment of this funding and prioritization of future funding for water and wastewater infrastructure expansion. Themes in the Council Special Committee included future funding, implementation, methods to encourage connection to central systems provided by the City, and reduction in proliferation of septic tanks. In addition, through the IA, JEA agreed to continue additional funding to be used to support environmental credit projects including project outreach, engineering, construction management and certain related wastewater capacity fees, up to the amounts specified in the IA.

Approach:

The working group of City and JEA staff, supported by the Duval County Health Department (DCHD), formed a committee to develop recommendations. This committee was further divided into a System Review subcommittee and a Service Availability subcommittee, whose

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work was aggregated into the recommendations set forth in these materials. With various members participating in both groups, there was ample coordination between the two subcommittees as the recommendations were being developed.

System Review Subcommittee

- Review for septic tank phase out and central water infrastructure
- Criteria and approach to ranking
- Development of prioritization scoring matrix

Service Availability Subcommittee

- Mandatory connection review
- Proliferation of septic tanks
- Review of recommended ordinance changes to achieve goals set forth by the Council Special Committee

Findings:

Rate of connection to available infrastructure:

Part of the charge from the Council Special Committee was a goal to improve connection rates to maximize the number of connections for environmental benefit and justify the City's significant capital investment.

For earlier City funded septic tank phase out projects, property owners generally funded the costs of private side connections. Some grant monies were available through the City's Utility Tap in Program (UTIP) funded by Community Development Block Grant (CDBG) dollars for income-based qualified residents. During the Better Jacksonville Plan (BJP) project, the earlier neighborhoods had higher initial connection rates. In the later projects, connection rates slowed, thought to be attributable to general economic conditions, associated credit tightening and costs of connection.

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The following shows a chart of the BJP project connection rates as of 2014:

Better Jacksonville Plan (BJP)	Potential Connections	Actual Connections	% Connected	Project Construction Completed
Pernecia	211	200	95%	2002
Glynlea	495	474	96%	2003-05
Murray Hill B	1130	1056	93%	2004-06
Oakwood	1726	972	56%	2007-09
Scott Mill	367	292	80%	2008
Lake Forest	887	567	64%	2005-09

For the Lincoln Villas project, funded entirely by state and federal grant monies, a high majority of improved properties connected to the system. Water and wastewater infrastructure was installed in two phases and the project funds paid for connection costs for property owners that agreed to give access. For Phase 1, there were 108 total lots of which 45 lots were improved with a home. For Phase 2, there were 120 total lots of which 48 were improved with a home. There were a series of letters, community meetings and door-to-door contact to gain approval from homeowners for the connections on this project.

Lincoln Villas	Potential Connections (Improved Lots)	Actual Connections	% Connected	Project Construction Completed
Lincoln Villas Phase 1	45	42	93%	2012
Lincoln Villas Phase 2	48	47	97%	2014

For the City's **Lateral Only Connection (LOC)** Project, properties were identified that had existing wastewater infrastructure available but had not yet connected to central systems, and connection would result in Basin Management Action Plan (BMAP) credits for the City to help meet its nitrogen reduction goals. As of May 2016, 352 unique addresses received up to two mailings, followed up by phone calls and property visits. Seventy-six additional follow up letters were sent. Agreements for connection have been received from 156 property owners for a current success rate of 44.32%. Thirty four additional signed agreements were received by owner initiated contacts that were not included in the original mailing to owners and are not included in the success rate. This LOC program paid for connections to existing wastewater systems at no cost to the residential property owner. This program will sunset at the end of July 2016.

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Only 44% of those offered the program took advantage which tells us that even when the City pays for the connection, there are not always good participation rates. We do not recommend making significant capital investments for expanded infrastructure without some form of mandatory connection and commitment to participate from property owners.

Proliferation of septic tanks

Current land use laws allow for septic tanks to be used on existing lots of record as long as the required minimum distances are established between any adjacent wells and septic tanks. Additionally, septic tanks are approved for lots one acre in size or greater. A summary of the current 2030 Comprehensive Plan Septic Tank Construction Policies is included in Addenda Section C.

Data was collected from 2010 through 2015 of new single family building permits issued. The building permits include the type of wastewater system to be used. Of those permits issued, approximately 6% of the total permits indicated use of septic systems.

SINGLE FAMILY PERMITS WITH SEPTIC TANKS (2010-2015)

CALENDER YEAR	# of Single Family Building Permits Issued	# of Septic Tank Per BID	"Calculated" % of New Single Family Homes w/Septic Tanks
2010	1190	85	7%
2011	855	84	10%
2012	1205	67	6%
2013	1827	93	5%
2014	2047	99	5%
2015	2271	132	6%
Average	1566	93	6%
Note:	*532 Single Family Building permits had been issued for 2016 during 1st quarter 2016 utilizing 21 septic tanks per BID.*		

The addresses of the permit data with septic tanks were also plotted graphically. Many of the septic tanks were located in more rural areas – outside the I-295/9A beltway. Several of the new septic tanks were also located within the footprints of septic tank failure neighborhoods that are reviewed by the Health Department and the City annually. That is not surprising since these are the neighborhoods that do not have central infrastructure. A map showing new septic tanks derived from the permit data reported above is included in Addenda Section D.

To implement a ban on any new septic tanks would result in many land owners being penalized and not being able to use their currently existing developable lots of record. Once central wastewater services are in place, there are very limited exceptions where septic tanks can continue to be installed. For these reasons, the working group does not believe proliferation to be a major problem and not one to address at the present time. There will be discussion in the prioritization recommendations to consider benefits from avoiding future proliferation once central services are made available to infill development lots.

To insure proper regulation of new septic tanks, an Administration directive has been issued that requires any development pre-application or other application or development permitting to include either a Water and Sewer Availability Letter from JEA or, if central wastewater is not available, a "Certificate of Eligibility" or septic tank permit from the DCHD.

Decision Factors/Recommendations:

Based on the goals outlined by the Council Special Committee, the working group is making four recommendations to address connections to existing systems in order to improve program effectiveness.

1) Remove the connection deferral option

Florida law generally requires connections to central wastewater systems within one year of availability in F.S. 381.00655. The Jacksonville City Council, through legislation for Chapter 751 (2000-119-E), provided an option for deferral of wastewater connections. The deferral option was until an owner sold, conveyed or otherwise transferred a property with an approved deferral or if the owner's septic system failed and the Duval County Health Department required connection by denying a repair permit. In practice, in order to qualify for a deferral, owners had to make application to the Duval County Health Department along with findings from a licensed plumber or septic tank contractor demonstrating a properly functioning septic tank.

In order to maximize the number of connections to wastewater systems and reduce the number of septic tanks in our area, for new systems funded by the City or in voluntary customer driven projects, this committee recommends removing the deferral option that is currently provided in Chapter 751 for customers that elect not to connect, and instead recommends utilizing the state law requirement to govern connections for our community.

Several community models and methods were considered by the committee to address mandatory connection requirements. Much of the community information was reported during the Special Committee process. Excerpt summaries are included in Addenda Section E. Mandatory connections result in a number of associated issues such as enforcement, affordability (ability to pay for connections), fines or penalties, and process-related issues such as accessibility to private property and legal actions, including courts involvement. While not altogether avoidable, the issues may be lessened by the next decision factors presented below. Payment for connections for City initiated and funded projects would lessen the impact to property owners' requirement to connect. Financing connection costs via special assessment on voluntary customer projects may also lessen connection cost hurdles.

2) Pay for priority project connections

For neighborhoods and projects identified as highest priority through the scoring matrix developed by the committee, the committee recommends that the City fund the full cost of projects, including costs to connect properties to the systems and associated fees, for up to one year from the date on which notices are sent to homeowners regarding system availability. Homeowners who elect not to connect within the specified timeframe would receive enforcement notices from the City and begin paying the service availability charge recommended below. It is recommended that a cap be established for connection costs paid by the City to be established with the program requirements developed by the City Council. For connection costs that exceed the established caps, owners would be asked to pay for the difference. It is expected this would occur only rarely for properties that had extensive connection or post construction restoration requirements.

For neighborhoods electing a voluntary customer paid wastewater project, the City may consider contributing a portion of the project cost to encourage customer funded projects but it is not recommended that the City fund voluntary project connection costs. Voluntary projects and associated connection costs could be financed through a special assessment option initially funded by JEA. This option will require the City Council to adopt an additional special assessment option for water and wastewater projects.

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3) Service availability fees

The committee recommends assessment of service availability or "readiness to serve" charge for properties that do not connect to available central wastewater systems. Charges would be billed initially by JEA on a separate billing statement. Proceeds from the charges could be used to seed additional future water and wastewater projects. The charge would be equivalent to JEA's base monthly charges for wastewater service ($21.15 for ¾" meter), and would be assessed where infrastructure is available but a connection is not made. The separate billing would allow the funds to be passed through to the City, rather than be considered as a JEA service fee and therefore designated as JEA system revenue, which is restricted for other uses. Applicability would be to all properties that have appropriate central service available for connection.

It is recommended that charges could be implemented in a time phased manner. For new projects, the service availability charge would commence after the allowable 12 months connection period. For existing infrastructure neighborhoods (i.e., BJP projects, LOC program customers that have not connected when offered, or any other area where systems are available), billing could begin one year beyond a notice to customers of the requirement to connect and notice of the charge.

Failure to pay the readiness to serve charge could result in liens or final judgments on properties. Separate billing would also avoid utility services from being disconnected and the associated issues with JEA's billing system prioritization of regular utility service payments.

4) Modification of Selection Criteria

The working group recommends modification of the current selection criteria to reflect the criteria factors discussed in the following section.

Project Prioritization and Selection review:

The working group utilized data compiled for the stormwater utility regarding neighborhoods that were on the 2016 Septic Tank Failure Area Ranking list. Chapter 751 specified the criteria to be used to rank septic tank failure areas within the City. The criteria include:

1) Number of septic tank system repair permits issued in the area
2) Average lot size in the area

3) Soil potential in the area
4) Seasonal highwater table in the area
5) Threat to potable water in the area
6) Sanitary conditions in the area
7) Proximity of the area to any surface water body
8) Potential for flooding the area

The above eight criteria are those used to develop the failure neighborhood list as currently published by the Duval County Health Department in consultation with the City's Environmental Quality Division.

Additional criteria and factors were considered during the current working group review and a modified approach is recommended.

Septic Tank Phase-out Prioritization Spreadsheet

Overall:

In order to develop a recommended prioritized list of septic tank failure and needs areas within Duval County, excepting municipal districts 1 through 4, a criteria matrix spreadsheet was developed. From an overall standpoint, the spreadsheet incorporates data in two distinct sections. The first contains environmental, health and welfare parameters. Within this section a maximum of 70 points can be earned. The second section contains community consideration parameters, wherein a maximum of 30 points can be earned. Cost of a project does not factor into the prioritization. The priority project spreadsheet is included in Section B.

Environmental, Health & Welfare:

Areas to be considered for inclusion on the spreadsheet were taken from the 2016 Septic Tank Failure Area Ranking produced by the Florida Department of Health in Duval County (DCHD) and presented to the City of Jacksonville Neighborhoods Department via memorandum dated June 30, 2016. The updated DCHD list was provided in accordance with the guidelines described in Jacksonville Ordinance 751.106 and 751.107. The DCHD list identified thirty-seven (37) areas, which received scores ranging from 30.87 to 60.26, with the higher scores denoting areas of greater concern. The DCHD scores were determined by the eight criteria described above. The DCHD scores were imported directly into the spreadsheet and became the first column of data.

Within the Environmental, Health & Welfare section, other data that was scored included Impaired Tributary Exceedance Factor and the percent of lots within the 150 meter buffer area. The Impaired Tributary Exceedance Factor is a measure of the percentage of samples exceeding

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State standards over a seven and one-half year period, and was supplied by the City of Jacksonville Environmental Quality Division. The percent of lots within the 150 meter buffer was felt to be important because these lots have the highest probability, if failing, to negatively impact receiving water bodies. The total Environmental, Health & Welfare score is the sum of the DCHD score, plus the Impaired Tributary Exceedance Factor, plus the percentage of lots within the 150 meter buffer factor.

Community Considerations:

This second section of the spreadsheet was created to consider quality-of-life (non-environmental) factors. The first column reflects whether the area was developed prior to 1968 (the year in which the City of Jacksonville was consolidated). Ten points were awarded only for areas developed prior to 1968. Date of development was taken from plats, or age of infrastructure information.

The second column addresses home value. Areas with median home values less than $50,000 received five points, while those with median home values over $250,000 received zero points. It is the intent to recognize home value with a progressive 5 to 0 point structure over the $50,000 to $250,000 value range, giving the highest points to the most economically challenged areas. The values used were taken from the Property Appraiser's data base of fair market value before any homestead or exemption deductions and before Save Our Homes accumulations were deducted.

The third column considers the presence or absence of an existing water distribution system in the area. Again, a sliding scale is used, awarding 5 points for areas with no existing water distribution system, 4 points for areas with only 20% water distribution coverage, 3 points for areas with 40% water distribution coverage, down to zero points for areas with 100% existing water distribution coverage. The assessment of existing central water distribution was taken from JEA's databases. Maximum points were awarded to areas with no existing water distribution because of greater potential to affect quality of life.

The fourth scored Community Considerations element is Elimination of Future Proliferation. This column is a factor that considers the percent of undeveloped lots within the area of concern. Undeveloped lots in areas not served by a central waste water collection system will require the construction of new septic tanks; hence future proliferation of septic tanks. Once a new central system is installed, new homes in existing neighborhoods can connect to a central system instead of constructing additional new septic tanks. Again, this column uses a sliding scale of 0 to 5 points. The percentage of undeveloped lots was estimated comparing Property Appraiser information of single family homes and vacant parcels.

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The last scored Community Considerations element is 'Offsite Economic Development Opportunities'. This 0 to 5 point column is included to recognize potential secondary economic development benefits that may result from the offsite infrastructure construction necessary to connect an area of concern to JEA's system. For example, the nearest point of connection to JEA's waste water system may be 2000 feet outside an area of concern. There may be vacant land, or under-developed land along that 2000 foot route. These parcels may have direct frontage or indirect proximity to the new offsite gravity or force main, and therefore would have a possible point of connection to JEA's wastewater system, thereby increasing the likelihood of additional development with access to central systems.

The total Community Concerns score is the sum of the Development Prior to 1968 score, the Median Home Value score, the Water score, the Elimination of Future Proliferation score, and the Offsite Economic Development Opportunity score.

<u>Overall Score:</u>

The Overall Score is simply the sum of the Environmental, Health & Welfare Score and the Community Considerations Score. The spreadsheet has been formatted with the highest scoring area of concern at the top. A group of high-scoring areas of concern has been identified as "Top Tier". These are regarded as the highest areas of concern for septic tank phase-out.

The overall score would include revised criteria as described above.

Environmental, Health & Welfare (maximum 70 points)	
DCHD Annual Score	Maximum 60 points
Factor for Lots within 150 Meter Buffer	Maximum 5 points
Impaired Tributary Exceedance Factor	Maximum 5 points
Community Considerations (maximum 30 points)	
Development prior to 1968	Maximum 10 points
Median home value	Maximum 5 points
Water infrastructure lacking	Maximum 5 points
Elimination of future proliferation	Maximum 5 points
Offsite economic development opportunities	Maximum 5 points

<u>Cost Information:</u>

To the right of the "Overall Total Score", cost information is provided for wastewater as well as water construction. These costs should be regarded as very preliminary, and are <u>not</u> based on topographic survey, soils data, or final construction drawings. The costs include restoring the

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roadway and drainage to pre-construction condition. The costs are inclusive of project management, design and construction engineering inspection (CEI) expenses.

Other Factors for Project Approval - % participation:

Using the neighborhoods identified in the scoring matrix, it is recommended that no project commence until at least 70% of the properties that would benefit from the water or wastewater project sign letters and access agreements (temporary construction easements) for making connections to the system on private property. Since all priority project costs, including paying for connections, are recommended to be funded by the City, the intent is to get prior agreement and approval from the property owners for connections before any work begins, including major planning, design and construction. Preliminary project work will be necessary to identify the properties and owners of record within a neighborhood to develop the notice process. The agreements may include water and wastewater agreements where both central services are contemplated and water or wastewater access agreements where only one utility service is being proposed.

The working group recommends achieving 70% participation approval within six (6) months of official notification for project interest. If 70% participation is not attainable for a particular neighborhood priority project within the designated timeframe, that neighborhood would only be reconsidered for a project after five (5) years, regardless of position on the annual priority project list. The program would then move to the next priority project list neighborhood for consideration.

Funding Allocation Approaches:

The working group considered different approaches to funding allocation. One option is for the current funding pool to be utilized based on the priority project list and any project participation condition requirement (like a required number of property owner commitments before project commencement). Another option is to divide the funding pool into segments for wastewater construction based on priority ranking, additional water construction, and connection only monies for both utility types. It is recommended the majority of the funding be allocated to 1) new project construction that may include wastewater only or wastewater with water where neither central system is available and 2) water only projects where water lines are critical for water quality/health concerns.

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Summary:

The working group recommendations were focused on the Council Special Committee's goals for environment, public health, and economic growth. The recommendations include suggested changes to Chapter 751, payment of full project costs including customer side connection fees for City funded priority projects, and implementation of a readiness to serve charge for properties that elect not to connect to central systems.

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Septic Tank Phase-Out Prioritization

Area Designation	DCHD 2015 Score	No. of Units Within Area	No. of Units Within 150M Buffer [A] (BMAP)	Factor For Lots Within The 150 M Buffer	Potential Annual Water Quality Benefit [B] (Metric Tons)	Impaired Tributary Exceedance Factor [C]	Environ, Health & Welfare Score	Development Prior to 1968 10 pts	Median Home Value 5 pts	Water 5 pts	Drain.	Curb	S/W	Elimination of Future Proliferation 5 pts	Offsite Economic Development Opportunities 5 pts	Community Considerations Score	Total Score	Sewer Capacity Fee Available From JEA (%) of lots	Sewer Cost per House [D] (2016 $'s)	Sewer Cost Area Total	Area Water Cost [E]
	Environmental, Health & Welfare (Max. 70 points)							Community Considerations (Max. 30 points)		Other Infrastructure	FYI						Overall	Sewer Cost			Water Cost
Biltmore C	51.00	173	135	4	0.12	0.00	55.00	10	5	5	x	x	x	2.7	2.0	24.7	79.70	78	$36,000	$6,228,000	$1,384,000
Christobel	49.76	289	62	2	0.06	2.20	53.96	10	5	1	x	x	P	3.8	2.0	21.8	75.76	21	$30,000	$8,670,000	$462,400
Beverly Hills	58.26	695	279	2	0.25	1.35	61.61	10	4	0	x	x	x	0.1	0.0	14.1	75.71	40	$30,000	$20,850,000	$0
Riverview	54.78	1812	612	2	0.56	1.40	58.18	10	4	2	x	x	x	1.5	0.0	17.5	75.68	33	$30,000	$54,360,000	$5,798,400
Emerson	48.66	751	437	3	0.4	4.65	56.31	10	4	0	x	x	x	1.1	2.0	17.1	73.41	58	$30,000	$22,530,000	$0
St. Nicholas	48.69	623	343	3	0.31	4.25	55.94	10	4	0	x	x	P	0.3	3.0	17.3	73.24	55	$36,000	$22,428,000	$0
Westfield	55.00	181	13	1	0.01	4.50	60.50	10	1	0	x	x	x	0.1	0.0	11.1	71.60	7	$30,000	$5,430,000	$0
Eggleston Heights	47.01	3416	1446	3	1.31	4.35	54.36	10	4	0		P	P	0.1	2.7	16.8	71.16	42	$33,000	$112,728,000	$0
Champion Forest	47.64	610	262	3	0.24	0.50	51.14	10	4	3	x	x	x	0.7	1.0	18.7	69.84	43	$33,000	$20,130,000	$2,928,000
Sans Pereil	47.98	211	181	5	0.16	2.15	55.13	0	4	5	x	x	x	5.0	0.0	14.0	69.13	86	$33,000	$6,963,000	$1,688,000
Sub-Totals:		8761			3.42													**Sub-Totals:**		$280,317,000	$10,572,800

TOP TIER (Biltmore C, Christobel, Beverly Hills)

DCHD Determining Criteria

Area Designation	1A Number of Septic Tank Repair Permits	1B Age of Septic Tank System	2 Average Lot Size	3 Soil Potential	4 Seasonal High Water Table	5 Threat to Potable Water	6 Sanitary Conditions	7 Proximity to Surface Water	8 Potential for Flooding	DCHD 2015 Score
Beverly Hills	8		4	9.58	9.68	2	5	10	10	58.26
Julington Creek	10		2	7.06	7.97	6	5	10	10	58.03
Westfield	6		6	10	10	0	3	10	10	55.00
Riverview	10		2	7.16	7.62	6	2	10	10	54.78
Biltmore C	4		0	10	10	10	8	4	5	51.00
Christobel	2		6	8.82	8.94	6	6	7	5	49.76
Julington Hills	10		0	7.21	8.13	4	5	10	5	49.52
St. Nicholas	10		0	7.74	8.95	4	8	10	0	48.69
Emerson	10		6	6.13	7.53	4	8	7	0	48.66
Kinard	0		0	8.2	8.92	6	5	10	10	48.12

Environmental, Health & Welfare Notes

[A] Potential to qualify for water quality benefit credits including JEA payment of plant capacity fee ($2200 +/- per connection) not to exceed $650,000 per year.

[B] Per Septic Tank Phase Out Water Quality Prioritization (by consultant) dated May 11, 2016.

[C] Refers to fecal coliform impairment only, and is the score provided by the Environmental Quality Division divided by 2.

Factor For Lots Within The 150 M Buffer

% Within Buffer	Factor
0	0
1 to 20	1
21 to 40	2
41 to 60	3
61 to 80	4
81 to 100	5

Community Considerations Notes

Home Value[G] Scoring:

5 pts	< $50,000
4 pts	$50,000 to $100,000
3 pts	$100,000 to $150,000
2 pts	$150,000 to $200,000
1 pt	$200,000 to $250,000
0 pts	> $250,000

[G] Value source - Duval Co. Property Appraiser

Water Scoring:
5 = No existing water system in Area
4 = Existing water system in 20% of Area
3 = Existing water system in 40% of Area
2 = Existing water system in 60% of Area
1 = Existing water system in 80% of Area
0 = Existing water system in 100% of Area

Elimination of Proliferation Score: The numerical percentage of undeveloped lots divided by ten. For example:
5.0 = 50% or greater undeveloped
1.0 = 10% undeveloped
0.1 = 1% undeveloped
0 = 0% undeveloped

Other Infrastructure: 'x' denotes infrastructure is not in-place
'P' denotes infrastructure is partially in-place

Legend

(yellow) Denotes columns to be scored
XXXXXXX Denotes numbers subject to verification

Standard Costs per Dwelling (Incl. Connection)[F]

Type	Unit Cost	Units	Sub-Total
Gravity Systems			
Gravity Main (GM) w/ Manholes	$ 175	75 lf	$ 13,125
Real Estate	$ 90,000	1/300 lots	$ 300
Lift Station	$ 300,000	1/300 lots	$ 1,000
Force Main	$ 75	2000 lf/300 lots	$ 500
Septic Tank Removal	$ 1,900	1	$ 1,900
Reversal	$ 6,000	1	$ 6,000
Lateral	$ 430	1	$ 430
Capacity Fee & Main Extension Fee	$ 2,270	1	$ 2,270
Proj. Mgmt, Eng, CEI (20% +/-)	$ 4,475	1	$ 4,475
Baseline Total			**$ 30,000**
Potential Additional Cost:			
Deep GM w/ highline (est 10% of pipe LF) or large lots	$ 500	7.5 lf	$ 3,750
Lift Station (added cost for 150 units)	$ 150,000	1/150 lots	$ 1,000
Proj Mgmt, Eng, CEI (20% +/-) + Misc.	$ 1,250	1	$ 1,250
Additional cost sub-total			**$ 6,000**
Adverse condition total			**$ 36,000**
Low Pressure *			
LP PS	$ 6,700	1	$ 6,700
On-Site 2" FM	$ 25	100 lf	$ 2,500
System FM	$ 35	65 lf	$ 2,275
Septic Tank Removal	$ 1,900	1	$ 1,900
Reversal	$ 4,000	1	$ 4,000
Capacity Fee & Main Extension Fee	$ 2,270	1	$ 2,270
Proj. Mgmt, Eng, CEI (20% +/-)	$ 3,355	1	$ 3,355
Total			**$ 23,000**

* Requires additional owner maintenance costs

Cost Consideration Notes

[D] Includes Plant Capacity Fee and Line Extension Charge.

[E] Water cost est per lot = ($70/ft x 70ft) x 120% + $2100 connection and capacity fee = $8000
$8000 x no. of units x % w/o existing water = Area Water Cost

[F] Costs include restoring road and drainage to pre-construction condition. Road and sod restoration costs are included in pipeline unit costs.

Revision Date: 4/5/2018

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