Brevard COUNTY

AGENDA REPORT
October 9, 2018

Ordinance Replacing the 150-day Conventional Septic Moratorium

SUBJECT:
Ordinance No. 2018-__, Replacing the 150-day Conventional Septic Moratorium, County-Wide

FISCAL IMPACT:
FY 17-18 – No Impact
FY 18-19 – No Impact

DEPT/OFFICE:
Natural Resources Management

REQUESTED ACTION:
It is requested that the Board of County Commissioners:

1. approve the second reading of Ordinance No. 2018-__ codifying amendments to Chapter 46, Article II (Onsite Sewage Treatment And Disposal Systems And Water Well Permitting) and specifically creating Division 4 (Nitrogen Reduction Overlay To Require Alternative Septic Systems Reducing Nitrogen By 65% In An Overlay Area) to the Brevard County Code; and
2. direct staff regarding interest in development of a grant program, funded by the Save Our Indian River Lagoon Half-Cent Surtax and phased out over the life of the Surtax, to assist low income applicants with the potential increased cost of complying with the proposed Nitrogen Reduction Overlay ordinance.

SUMMARY EXPLANATION and BACKGROUND:
At the May 22, 2018, regular meeting, the Board of County Commissioners (BCC) approved Ordinance 2018-13, establishing a county-wide, 150-day moratorium on new conventional septic systems that do not provide a minimum 65% total nitrogen reduction on the Barrier Islands, including Merritt Island, and within 50 meters (m) (~165 feet) of the Indian River Lagoon (IRL) System, including all natural and man-made tributaries.

On September 17, 2018, the Local Planning agency voted in favor of recommending the attached ordinance proposed to replace the 150-Day Conventional Septic Moratorium with a permanent Nitrogen Reducing Overlay Ordinance.

On September 25, 2018, the Board of County Commissioners voted unanimously in favor of proceeding to the second Public Hearing for adopting the attached Nitrogen

Reducing Overlay Ordinance for Onsite Sewage Treatment and Disposal (Septic) Systems.

Nitrogen loading from septic drainfields is a recognized source of pollution in the IRL through ground water pollution migration. It has been estimated that septic drainfields contribute 18.8% of the total nitrogen pollution in the Brevard County portion of the IRL. The County is spending approximately $68 million to remove or upgrade 3,734 of the most polluting septic systems over the 10-year life of the Save Our Indian River Lagoon Half Cent Surtax. During the quarter preceding adoption of the moratorium, the Florida Department of Health permitted 200 new septic systems, indicating that at the current rate, new septic systems will be added at approximately twice the rate that existing systems will be removed or upgraded. However, nitrogen reducing septic systems that provide a minimum 65% total nitrogen reduction, are about twice as effective at nitrogen reduction as properly maintained and fully functioning conventional septic systems.

Prohibiting the installation of more conventional septic systems, but allowing alternative nitrogen-reducing septic systems, provides immediate additional protections to the IRL. While existing scientific studies supported the moratorium in sensitive environmental areas, a study was contracted to quantify in finer spatial detail the nitrogen loading potential of septic systems in different regions of the County. This study used local conditions and soils to refine nitrogen transport estimates through groundwater to the IRL.

Nitrogen loading estimates for existing septic system were used to extrapolate the potential impacts to the IRL from new septic permits. This analysis provides an opportunity to optimize the overlay area to balance maximizing pollution prevention while minimizing the area to be affected by the proposed ordinance. The following findings may be used to guide policy development for septic permitting:

- Septic systems throughout the Barrier Island and Merritt Island contribute substantially more pollution per distance traveled through groundwater compared to most septic systems on the mainland. This is due to risk factors for treatment effectiveness including very porous sandy soils, the presence of floodplains, seasonally wet drainage systems, and low elevation. Systems on the islands as far away as 300 m (~1,000 feet) from an open water connection were found to contribute nitrogen pollution to the IRL System.

- Septic systems within the Melbourne-Tillman Water Control District (MTWCD) contribute substantially less pollutant loading per distance travelled through groundwater compared to most septic systems on the mainland due mostly to soil types and management of water in the MTWCD.

- Septic systems on the mainland outside the MTWCD, but within 60 m (~200 feet) of an open water connection to the IRL, are responsible for the majority of the septic loading from all septic systems on the mainland excluding MTWCD.

The proposed ordinance would replace the 150-day moratorium on conventional septic systems and require that all new septic systems permitted on the entirety of the Barrier Island and Merritt Island be capable of reducing nitrogen load by 65%. The recommended ordinance reduces the width of the overlay district from 50 m (~165 feet) to 40 m (~130 feet) within MTWCD, and expands the overlay from 50 m to 60 m (~200 feet) on the remainder of the mainland.

The proposed Nitrogen Reduction Overlay ordinance requires that a notice be recorded in the property records so that future owners will be made aware of any special operating or maintenance requirements associated with the nitrogen reducing septic system installed on the property. Final approval for any building permit or site plan application within the nitrogen reduction overlay area shall not be granted until the permitting authority confirms that the property owner has executed and recorded in the official property records at the county courthouse, a written notice that informs all subsequent property owners of the type of septic system installed.

The effective date of the Moratorium was May 22, 2018. During public forums held during development of the moratorium and the proposed replacement ordinance, staff received requests that the County Commission consider a delay to the effective date of the replacement ordinance. Due to the overlay of the replacement ordinance being so similar to the area affected by the moratorium, no delay in effective date is included in the proposed Nitrogen Reduction Overlay ordinance.

The proposed Nitrogen Reduction Overlay ordinance does include an additional exemption that was not included in the temporary moratorium. An exemption is added for sites included in a septic to sewer project area scheduled for funding from the Save Our Indian River Lagoon Halt-Cent Surtax, as amended. Properties claiming this exemption would be required to hook up to sewer service within 180 days of sewer service reaching the right of way abutting that property.

During Board consideration of the temporary moratorium in May, staff was asked how the moratorium would impact low income housing and what could be done to address such impacts. Natural Resources staff coordinated with Housing and Human Resources staff on the possibility of a partnership between existing housing assistance programs and the Save Our Indian River Lagoon program. Currently, most low income neighborhood development projects are targeted for areas served by central sewer. This avoids the potential for large unscheduled expenses that occur with septic failure. However, assistance programs also exist to repair and upgrade existing low income housing. A grant program could assist low income housing comply with the ordinance.

If there is Board interest in development of a grant program, funded by the Save Our Indian River Lagoon Half-Cent Surtax, this could be incorporated into the 2019 update of the Save Our Indian River Lagoon Project Plan. Grants could be structured to assist low income applicants, qualified through existing city and county Housing and Human Resources programs, by covering the increased cost of complying with the proposed Nitrogen Reduction Overlay ordinance. The grant amount could be reduced over time to be gradually phased out concurrent with the expiration of the Surtax. During the September 25th Public Hearing, Board members suggested offering a grant program to everyone impacted by the ordinance. Attached is a sheet comparing the potential cost of a phased out grant program for low income applicants or a program open to everyone. Staff requests direction on whether to include a grant program in the next update of the Save Our Indian River Lagoon Project Plan to be funded by the Save Our Indian River Lagoon Trust Fund.

ATTACHMENTS:

Description

- **Financial Assistance Option Costs**
- **Advisory Board Recommendations**
- **Staff Report**
- **CAO Ordinance Approval Sheet**
- **Draft Nitrogen Reduction Overlay Ordinance 2018-__________**
- **Septic Analysis Report**

FLORIDA DEPARTMENT *of* STATE

RICK SCOTT
Governor

KEN DETZNER
Secretary of State

October 15, 2018

Honorable Scott Ellis
Clerk
Board of County Commissioners
Brevard County
Post Office Box 999
Titusville, Florida 32781-0999

Attention: Ms. Deborah Thomas

Dear Mr. Ellis:

Pursuant to the provisions of Section 125.66, Florida Statutes, this will acknowledge receipt of your electronic copy of Brevard County Ordinance No. 2018-23, which was filed in this office on October 11, 2018.

Sincerely,

Ernest L. Reddick
Program Administrator

ELR/lb

BREVARD County
BOARD OF COUNTY COMMISSIONERS

FLORIDA'S SPACE COAST

Tammy Rowe, Clerk to the Board, 400 South Street • P.O. Box 999, Titusville, Florida 32781-0999

Telephone: (321) 637-2001
Fax: (321) 264-6972
Tammy.Rowe@brevardclerk.us

October 10, 2018

MEMORANDUM

TO: Virginia Barker, Natural Resources Management Director

RE: Item H.4., Ordinance Replacing the 150-Day Conventional Septic Moratorium County-Wide

The Board of County Commissioners, in regular session on October 9, 2018, conducted the second public hearing, and adopted Ordinance No. 18-23, codifying amendments to Chapter 46, Article II (Onsite Sewage Treatment and Disposal Systems, and Water Well Permitting), specifically creating Division 4 (Nitrogen Reduction Overlay to Require Alternative Septic Systems Reducing Nitrogen by 65 Percent in an Overlay Area) to the Brevard County Code; and directed staff to forward the Board's recommendations regarding a grant program to assist low income applicants with the potential increased cost of complying with the proposed Nitrogen Reduction Overlay Ordinance, to the Brevard County Save Our Lagoon Citizen Oversight Committee for its review, staff to work with the Committee, and to bring it back to the Board with recommendations. Enclosed is a certified copy of the Ordinance.

Your continued cooperation is always appreciated.

Sincerely,

BOARD OF COUNTY COMMISSIONERS
SCOTT ELLIS, CLERK

Tammy Rowe

Tammy Rowe, Deputy Clerk

Encl. (1)

cc: County Attorney

ORDINANCE 2018-23

AN ORDINANCE OF THE BOARD OF COUNTY COMMISSIONERS OF BREVARD COUNTY, FLORIDA, REGARDING THE INSTALLATION OF ONSITE SEWAGE TREATMENT AND DISPOSAL SYSTEMS (OSTDS), ALSO KNOWN AS SEPTIC SYSTEMS; AMENDING CHAPTER 46, ENVIRONMENT, ARTICLE II. ONSITE SEWAGE TREATMENT AND DISPOSAL SYSTEMS AND WATER WELL PERMITTING, DIVISION 1. GENERALLY; AMENDING SEC. 46-36 DEFINITIONS; SPECIFICALLY CREATING DIVISION 4. NITROGEN REDUCTION OVERLAY TO REQUIRE ALTERNATIVE SEPTIC SYSTEMS REDUCING NITROGEN BY 65% IN AN OVERLAY AREA; SPECIFICALLY CREATING SEC. 46-89 OVERLAY AREA ON THE BARRIER ISLANDS INCLUDING MERRITT ISLAND AND ON THE MAINLAND WITHIN 60 METERS, EXCEPT MELBOURNE TILLMAN DRAINAGE DISTRICT WHICH SHALL HAVE AN OVERLAY OF 40 METERS, OF THE INDIAN RIVER LAGOON SYSTEM INCLUDING ALL NATURAL AND MANMADE TRIBUTARIES; CREATING SEC. 46-90 NITROGEN REDUCTION REQUIREMENT; CREATING SEC. 46-91 NOTICE OF OSTDS OPERATING PERMIT; CREATING SEC. 46-92 EXEMPTIONS; PROVIDING FOR CONFLICTING PROVISIONS; PROVIDING FOR SEVERABILITY; PROVIDING FOR AREA ENCOMPASSED TO BE COUNTYWIDE; PROVIDING FOR INCLUSION IN THE CODE; PROVIDING FOR AN EFFECTIVE DATE.

WHEREAS, the Indian River Lagoon (IRL) is one of the most biologically diverse estuaries in North America, supporting more than 2,000 species of plants, 600 species of fish, 300 species of birds and 53 threatened or endangered species; and

WHEREAS, the annual economic activity generated from IRL-related recreational, tourism and commercial industries in Brevard County was estimated at $1,111,737,960 in 2016[1]; and

WHEREAS, the IRL has a long history of poor water quality and environmental degradation caused by multiple pollution sources; and

WHEREAS, in 1987 the Florida Legislature enacted the Surface Water Improvement and Management Act (SWIM Plan) for the restoration and protection of water quality of waterbodies of statewide significance, including the IRL. Ch. 87-97,

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1 "Indian River Lagoon Economic Valuation Update" Table 9, Final Report 08-26-2016, Prepared by East Central Florida Regional Planning Council Treasure Coast Regional Planning Council

Officially filed with the Secretary of State on October 11, 2018.

Laws of Florida. The SWIM Plan considered multiple pollution sources, including septic tanks; and

WHEREAS, in 1990 the Florida Legislature amended the SWIM Plan to specifically require further study and protection of the IRL. Ch. 90-262, Laws of Florida. Septic tanks were identified as continuing threats to the water quality of the IRL; and

WHEREAS, also in 1990, the entire Indian River Lagoon spanning five (5) counties – Volusia, Brevard, Indian River, St. Lucie and Martin –was incorporated into the U.S. Environmental Protection Agency's (EPA) National Estuary Program for watershed restoration by its designation as an estuary of national significance. A large portion of the entire system, 71% of its area and nearly half its length, is within Brevard County; and

WHEREAS, since 2007, the IRL has been listed on EPA's Verified List of Impaired Waters due to excess levels of both nitrogen and phosphorus and the County is subject to regulations reducing pollution to comply with total maximum daily load (TMDL) levels to comply with the Clean Water Act. TMDLs are established to define the maximum pollutant loadings a waterbody can assimilate without showing signs of impairment[2]; and

WHEREAS, nutrient loading from septic drainfields is a recognized source of pollution in the IRL through groundwater pollution migration[3] through lands upland of the Indian River, the Banana River, Mosquito Lagoon, Newfound Harbor and Sykes Creek, and their natural and manmade tributaries and directly connected surface waterbodies, referred to as the IRL System; and

WHEREAS, pollution from septic systems varies based on many factors including proximity to surface water, soil hydrologic group, depth to groundwater, density of development, age and maintenance history of the septic system, as well as soil organic matter, porosity, and hydraulic conductivity versus dispersity[4]; and

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[2] "TMDL Report – Nutrient and Dissolved Oxygen TMDL's for the Indian River Lagoon and Banana River Lagoon" by Xueqing Gao, Florida Department of Environmental Protection, March 2009; "Draft Integrated Assessment Waster Quality Report, Group 5 Indian River Lagoon Basin" Florida Department of Environmental Protection, September 27, 2017.

[3] "Refining the Indian River Lagoon TMDL Technical Memorandum Report: Assessment and Evaluation of Model Input Parameters Final Report" by Environmental Research and Design, Inc., Revised March 2016

[4] Ye, Ming & Sun, Huaiwei & Hallas, Katie. (2017). Numerical estimation of nitrogen load from septic systems to surface water bodies in St. Lucie River and Estuary Basin, Florida. Environmental Earth Sciences. 76.

WHEREAS, the barrier islands of Brevard County contribute groundwater flow to the IRL System and also exhibit many of the conditions limiting the effectiveness of septic drainfields in removing nitrogen and bacterial contaminants from septic system discharges before reaching groundwater[5]; and

WHEREAS, in 2016, after a five-year series of algal blooms and fish kills in the IRL, the Brevard County Board of County Commissioners enacted Ordinance 2016-15 to authorize a referendum for the imposition of a half-cent sales tax for ten (10) years to fund water quality restoration projects for the IRL; and

WHEREAS, Ordinance 2016-15 also adopted the "Save Our Lagoon Project Plan" prepared by Tetra Tech, Inc. and Closewaters, LLC, July 2016 (SOIRL Plan). The SOIRL Plan compares the contributing sources of pollution, based on available scientific literature, and proposes cost-effective projects to achieve water quality restoration goals; and

WHEREAS, the overall value of the IRL is dependent on successful water quality restoration. Closewaters, LLC, estimates approximately two billion dollars ($2,000,000,000.00) in benefits from restoration and an estimated four billion dollars ($4,000,000,000.00) in damages if the IRL is not brought back to health during the next decade[6]; and

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10.1007/s12665-016-6358-y; Martin County Septic System Elimination Final Report February 2015, prepared by Captec Engineering, Inc for Martin County; Sayemuzzaman, Mohammad and Ming Ye. August 2015. "Estimation of Nitrogen Loading from Converted Septic Systems (2013-14 and 2014-15) to Surface Waterbodies in Port St. Lucie, FL." Department of Scientific Computing, Florida State University. Prepared for the Florida Department of Environmental Protection. Tallahassee, Florida; Florida Department of Health (FDOH). 2015. Florida Onsite Sewage Nitrogen Reduction Strategies Study, Final Report; Wang, Liying, Ming Ye, J. Fernando Rios, and Paul Z Lee (March 2012) Sensitivity Analysis and Uncertainty Assessment for AcrNLET-Estimating Nitrate Load from Septic Systems to Surface Water Bodies Hazen and Sawyer. 2015. Evaluation of Full Scale Prototype Passive Nitrogen Reduction Systems (PNRS) and Recommendations for Future Implementation. Report to the Florida Department of Health. Report:
http://www.floridahealth.gov/environmentalhealth/onsitesewage/research/_documents/rrac/hazensawyervolireportrmall.pdf.
Appendices:http://www.floridahealth.gov/environmentalhealth/onsitesewage/research/_documents/rrac/hazensawyervol0iireportrappend.pdf.

[5] Michael A. Mallin and Matthew R. McIver 2012. "Pollutant impacts to Cape Hatteras National Seashore from urban runoff and septic leachate", Marine Pollution Bulletin 64 (2012) 1356-1366 ; Han Xiao, et al 2016. "Assessing the impacts of sea-level rise and precipitation change on the surficial aquifer in the low-lying coastal alluvial plains and barrier islands, east-central Florida (USA)", Hydrogeology Journal (2016) 24:1791-1806

6 See Section 1.1 Return on Investment and Economic Value, SOIRL Plan July 2016.

WHEREAS, based on all the major sources of pollution quantified in the SOIRL Plan, approximately 18% of total nitrogen (TN) loading in the IRL System is from septic systems, compared to other sources; and

WHEREAS, a recent State-funded study of the impact of septic systems on the IRL conducted in Port St. Lucie found that the average septic system within fifty (50) meters of the IRL contributes twenty-seven pounds (27 lbs) of total nitrogen (TN) per year[7]; and

WHEREAS, the 2018 SOIRL Plan Update includes $68,066,923.00[8] worth of septic-to-sewer and septic enhancement projects that target highest risk neighborhoods and individual systems; and

WHEREAS, based on scientific literature, a properly functioning conventional septic system reduces total nitrogen (TN) from 30-40%.[9] In adverse conditions, reduction has been measured at 0-20%. The best available studies estimate a 10% reduction in nitrogen within a properly maintained tank versus an improperly maintained tank. The remaining 20-30% of nitrogen removal occurs in a properly located and functioning drainfield[10]; and

WHEREAS, there are alternative septic systems specifically designed to provide at least 65% total nitrogen (TN) reduction through multi-stage treatment processes. According to the Brevard County Health Department and the Florida Onsite Wastewater Association, Inc., alternative septic systems, such as NSF 245-certified aerobic treatment units combined with a properly located and functioning drainfield installed with a minimum 24-inch separation from the water table, are capable of reducing total nitrogen (TN) in effluent by at least 65%; performance based treatment systems can

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[7] See Section 4.1.4 SOIRL Plan 2018 Update, April 2018: Sayemuzzaman, Mohammad and Ming Ye. August 2015. "Estimation of Nitrogen Loading from Converted Septic Systems (2013-14 and 2014-15) to Surface Waterbodies in Port St. Lucie, FL." Department of Scientific Computing, Florida State University. Prepared for the Florida Department of Environmental Protection. Tallahassee, Florida.

[8] Table ES-1: Summary of Project Types, Costs and nutrient Reductions in the Save Our Indian River Lagoon Project Plan, SOIRL Plan 2018 Update, April 2018.

[9] "Achieving Nitrogen Loading Reduction through Onsite Wastewater Treatment Technologies." Florida Onsite Wastewater Association, Inc.

10 A Review of Nitrogen Loading and Treatment Performance Recommendation for Onsite Wastewater Treatment Systems in the Wekiva Study Area." Anderson, Damann L. of Hazen and Sawyer, P.C. 2006, Prepared for the Florida Department of Health. Tallahassee, Florida.

also be engineered to reduce total nitrogen (TN) in effluent by at least 65%, and would provide significant nitrogen reduction results in these areas[9]; and

WHEREAS, the Florida Department of Health (FDOH) recently revised Rule 64E-6.009, Florida Administrative Code, entitled Alternative Systems, providing standards for use of nitrogen reducing media in drainfields with any approved septic tank to achieve at least 65% total nitrogen (TN) reduction; and

WHEREAS the barrier island is composed of relic dune sand, of sparse organic and carbon content, through which septic effluent migrates quickly without significant contact time with a denitrifying microbial community before reaching surface waters; and

WHEREAS Merritt Island is composed of relic dune ridges alternating with large swaths of floodplain, where there is a high risk that septic drainfields will flood, allowing untreated effluent to pollute the environment and threaten human health; and

WHEREAS the Melbourne Tillman Water Control District (MTWCD) is composed primarily of soils with low to moderate conductance values. These soils slow down the migration of drainfield leachate to adjacent canals and provides higher than average contact time with denitrifying microbial communities. In addition, an increasing fraction of the MTWCD canal water is pumped away from the lagoon by the C-1 pump system and polished through a treatment marsh, decreasing pollutant impact from septic systems within MTWCD. Furthermore, management of water levels in the MTWCD canal system by the MS-1 control structure increases nutrient detention time in the MTWCD canals, further reducing the amount of septic pollution that reaches the IRL System; and

WHEREAS the mainland of Brevard County, excluding the MTWCD, is composed of a mosaic of low, moderate and high conductance soils located at variable elevations and distances from an open water connection to the IRL, through which septic drainfield effluent migrates at differing speeds and may or may not encounter pockets of denitrifying microbial communities along its flowpath; and

WHEREAS, specific authority for this ordinance includes, but is not limited to Article VIII, Section 1, Florida Constitution of 1968; Chapters 125 and 163 and Section 381.0065(4)(r), Florida Statutes; and

WHEREAS, the Brevard County Board of County Commissioners finds that based on the foregoing reasons, this Ordinance will promote the public health, welfare, safety and economic benefit of the IRL and the County as a whole.

NOW, THEREFORE, BE IT ORDAINED by the Board of County Commissioners of Brevard County, Florida, that:

SECTION 1. **Sec. 46-36. Definitions**. Code of Ordinances of Brevard County, Florida, is hereby amended to revise and include the following definitions:

For the purposes of this article, the following words and phrases shall have the same meaning as defined in F.S. ch. 381, F.S. ch. 373, F.A.C. ch. 64E-6, F.A.C. ch. 64E-8, F.A.C. ch. 40C-2 ~~40-C~~, and F.A.C. ch. 62-555 except as noted below, unless from the context a different meaning is clearly intended. ~~In addition, section 1-2 applies to this article.~~

Alternative or emergency use well means a well, which may be used as a potable water supply that is not the primary water supply.

Alternative system means any approved onsite sewage treatment and disposal system used in lieu of, including modifications to, a standard subsurface system.

Barrier islands means all islands, natural and manmade, between the mainland and the Atlantic Ocean, to include: Merritt Island, Cape Canaveral, Cocoa Beach, Satellite Beach, Indian Harbour Beach, Melbourne, Indialantic, Melbourne Beach and all unincorporated areas on the barrier islands.

Block means a lot or group of lots entirely and immediately surrounded by streets or highways, railroad rights-of-ways, road rights-of-ways, watercourses, drainage easements, subdivision boundaries, multifamily boundaries, or any combination thereof. In the absence of above criteria, a block shall be considered to be 500 feet from the subject property boundaries.

Conventional septic system means the simplest septic system that can be permitted pursuant to state regulations, typically consisting of a septic tank and standard subsurface or mound drainfield system with no enhanced removal function for nitrogen.

~~*County health department* means the county health services section.~~

Department means the county's natural resources management department ~~office or the county health department's, environmental health services section~~.

Drainfield means a system of open-jointed or perforated piping, approved alternative distribution units, or other treatment facilities designed to distribute effluent for filtration, oxidation and absorption by the soil within the zone of aeration.

FDOH means the state agency, the Florida Department of Health in Brevard County.

Health officer means any person appointed by the board of county commissioners or FDOH to carry out the duties and enforce the provisions of this article. The health officer shall include, but not be limited to, employees of the department, FDOH ~~county health department's, the county office of natural resource management,~~ and county code enforcement division.

Indian River Lagoon System (IRL System) means the Indian River, the Banana River, Mosquito Lagoon, Newfound Harbor, Sykes Creek and their natural and manmade tributaries, including directly connected ditches and canals absent of downstream manmade water control structures.

Onsite sewage treatment and disposal system or *OSTDS* includes *conventional septic tank and drainfield systems* and is defined in Section 381.0065(2)(k), Florida Statutes, to mean "a system that contains a standard subsurface, filled, or mound drainfield system; an aerobic treatment unit; a graywater system tank; a laundry wastewater system tank; a septic tank; a grease interceptor; a pump tank; a solids or effluent pump; a waterless, incinerating, or organic waste-composting toilet; or a sanitary pit privy that is installed or proposed to be installed beyond the building sewer on land of the owner or on other land to which the owner has the legal right to install a system. The term includes any item placed within, or intended to be used as a part of or in conjunction with, the system. This term does not include package sewage treatment facilities and other treatment works regulated under chapter 403."

Septic tank means a watertight receptacle constructed to promote separation of solid and liquid components of wastewater, to provide limited digestion of organic matter, to store solids, and to allow clarified liquid to discharge for further treatment and disposal into a drainfield.

Shoreline means the mean annual flood line of the Indian River Lagoon System or top of bank, whichever is preferred by the applicant. The mean annual flood line is defined in Section 381.0065(2)(j), Florida Statutes, to be "the elevation determined by calculating the arithmetic mean of the elevations of the highest yearly flood stage or discharge for the period of record, to include at least the most recent 10-year period. If at least 10 years of data is not available, the mean annual flood line shall be as determined based upon the data available and field verification conducted by a certified professional surveyor and mapper with experience in the determination of flood water elevation lines or, at the option of the applicant, by FDOH personnel. Field verification of the mean annual flood line shall be performed using a combination of those indicators listed below that are present on the site, and that reflect flooding that recurs on an annual basis. In those situations where any one or more of these indicators reflect a rare or aberrant event, such indicator or indicators shall not be utilized in determining the mean annual flood line. The indicators that may be considered are:

1. Water stains on the ground surface, trees, and other fixed objects;
2. Hydric adventitious roots;
3. Drift lines;
4. Rafted debris;
5. Aquatic mosses and liverworts;
6. Moss collars; and
7. Lichen lines.

Standard subsurface drainfield system means an onsite sewage treatment and disposal system drainfield consisting of a distribution box or header pipe and a drain trench or absorption bed with all portions of the drainfield sidewalls installed below the elevation of undisturbed native soil.

Water well means a well as defined in F.S. ch. 373.303(7), which includes any excavation that is drilled, cored, washed, driven, dug, jetted, or otherwise constructed when the intended use of such excavation is for the location, acquisition, development or artificial recharge of groundwater.

SECTION 2. **DIVISION 4. NITROGEN REDUCTION OVERLAY** is hereby created as follows:

DIVISION 4. - NITROGEN REDUCTION OVERLAY

SECTION 3. **Sec. 46-89 Nitrogen reduction overlay area**. is hereby created as follows:

Sec. 46-89. Nitrogen reduction overlay area.

(a) This division shall affect all properties within the unincorporated area and municipalities of Brevard County, County-wide. The nitrogen reduction overlay area is established as follows:

(1) all barrier islands including Merritt Island; and

(2) on the mainland, the overlay shall be 60 meters from the IRL System shoreline; and

(3) within the boundaries of the Melbourne-Tillman Water Control District, as defined in Section 254-98, the overlay shall be 40 meters from the IRL System shoreline.

(b) A map of the nitrogen reduction overlay area is available from the department. In the event of any conflict between the map and shoreline measurement, the shoreline measurement will control.

SECTION 4. **Sec. 46-90. Nitrogen reduction requirement.** is hereby created as follows:

Sec. 46-90. Nitrogen reduction requirement.

(a) No building permits shall be issued or site plans approved after May 22, 2018, for those properties located within the nitrogen reduction overlay area unless the property is being serviced by a central sewage treatment facility or an OSTDS is used satisfying the following requirements:

(1) the proposed OSTDS treatment meets or exceeds a 65% reduction in total nitrogen (TN); and

(2) the proposed OSTDS complies with the standards and provisions of within Section 381.0065, Florida Statutes, Chapter 64E-6, Florida Administrative Code, and Chapter 46 of this Code.

(b) Examples of an OSTDS that meet or exceed the 65% total nitrogen (TN) reduction standard include, but are not limited to, NSF 245-certified aerobic treatment units combined with a properly located and functioning drainfield installed with a minimum 24-inch separation from the water table; performance based treatment systems engineered to reduce total nitrogen (TN) by at least 65%, and alternative systems using nitrogen reducing media in accordance with Rule 64E-6.009, Florida Administrative Code. Other OSTDS treatment that can demonstrate compliance with the nitrogen reduction standard, and as approved for use by FDOH, are acceptable.

SECTION 5. **Sec. 46-91. Notice of OSTDS operating permit** is created as follows:

Sec. 46-91. Notice of OSTDS operating permit.

Final approval for any building permit or site plan application within the nitrogen reduction overlay area shall not be granted until the permitting authority confirms that the property owner has executed and recorded in the official property records at the county courthouse, a written notice, in a format provided by the County, to inform all subsequent property owners of the use of an OSTDS permitted pursuant to Rule 64E-

6.009, Florida Administrative Code, or an OSTDS which requires an operating permit or monitoring from FDOH.

SECTION 6. **Sec. 46-92. Exemptions.** is hereby created as follows:

Sec. 46-92. Exemptions.

The restrictions in this division do not apply to a property within the nitrogen reduction overlay area if:

(a) an OSTDS for which a FDOH or building permit was issued or site plan application was approved prior to May 22, 2018 or a complete FDOH permit, building permit or site plan application was filed with all fees paid before May 22, 2018; or

(b) the property is subject to residential construction contract which was both fully executed and deposit paid prior to May 22, 2018; or

(c) for repairs and maintenance to an existing OSTDS; or

(d) for minor structures or accessory uses that do not require a connection to a public sewer or OSTDS; or

(e) the property is included in a septic-to-sewer project area approved for funding in the Save Our Indian River Lagoon Project Plan, as most recently amended. Final approval for any building permit or site plan application using this exemption shall not be granted until the property owner executes a contract with the county agreeing to hook up to sewer within 180 days of the sewer service reaching the right-of-way abutting the property; or

(f) a portion of the property is located within the nitrogen reduction overlay area but the OSTDS can be installed outside of the overlay area.

SECTION 7. **Conflicting Provisions.** In the case of a direct conflict between any provision of this Ordinance and a portion or provision of any other applicable

Federal, State or County law, rule, code or regulation, the more restrictive shall apply, unless preempted by law.

SECTION 8. **Severability.** If any section, subsection, clause, phrase, word or provision of this Ordinance is for any reason held invalid or unconstitutional by any court of competent jurisdiction, such invalid unconstitutional portion shall be deemed a separate, distinct and independent provision, and such holding shall not affect the validity of the remaining portions of this ordinance, provided the remaining portions effectuate purpose and intent of this ordinance.

SECTION 9. **Area Encompassed.** This Ordinance shall take effect COUNTYWIDE, within the municipal and unincorporated areas of Brevard County, Florida.

SECTION 10. **Effective date.** A certified copy of this ordinance shall be filed with the Office of the Secretary of State, State of Florida within ten (10) days of enactment. This ordinance shall take effect upon adoption and filing as required by law.

DONE, ORDERED AND ADOPTED in Regular Session, this 9 day of OCT., 2018.

Attest:

BOARD OF COUNTY COMMISSIONERS
OF BREVARD COUNTY, FLORIDA

Scott Ellis, Clerk

Rita Pritchett, Chair
(As approved by the Board on October 9, 2018)

Brevard County Attorney
Ordinance Approval Sheet

SECTION I

The following information must be completed on all ordinances submitted to the Board:

Ordinance Name: **Ordinance 2018-___, Amending Sec. 46-36, Creating Secs. 46-89, 46-90, 46-91, and 46-92**		Ordinance Author: **Anthony Gubler**
Division Name: **Natural Resources Management Department**	Review Deadline: **09/04/18 BCAC 09/04/18 LPA**	
Sent by: **Anthony Gubler**		
Dept./Office Director: **Virginia Barker** Asst. Director, Environmental Regulation: **Darcie McGee**		
Meeting Dates: BCAC -- **09/12/18** LPA – **09/17/18**	BCC **09/25/18 & 10/09/18**	Advertising Deadline: **09/04/18**

SECTION II

COUNTY OFFICE	APPROVAL Yes	No	INITIALS	DATE
County Attorney's Office	X	____	CW	9/5/18

SECTION III **Sent for Review**

Land Dev. ____Y ____N __XX__N/A

NRMD ____Y ____N __XX__N/A

Other Dept./Office ____Y ____N __XX__N/A

Comments:

Financial Assistance Options for Compliance with the Proposed Nitrogen Reducting Septic Overlay Ordinance

	Low Income Applicants			All Septic Permits (except Repairs) in Overlay		
	# of Participants*	Eligible Amount	Cost to County	# of Participants**	Eligible Amount	Cost to County
FY 18-19	30	$ 4,000	$ 120,000	480	$ 4,000	$ 1,920,000
FY 19-20	30	$ 4,000	$ 120,000	480	$ 4,000	$ 1,920,000
FY 20-21	30	$ 3,000	$ 90,000	480	$ 3,000	$ 1,440,000
FY 21-22	30	$ 3,000	$ 90,000	480	$ 3,000	$ 1,440,000
FY 22-23	30	$ 2,000	$ 60,000	480	$ 2,000	$ 960,000
FY 23-24	30	$ 2,000	$ 60,000	480	$ 2,000	$ 960,000
FY 24-25	30	$ 1,000	$ 30,000	480	$ 1,000	$ 480,000
FY 25-26	30	$ 1,000	$ 30,000	480	$ 1,000	$ 480,000
Sum			**$ 600,000**			**$ 9,600,000**

*Assumptions: 150 qualified SHIP and HOME applicants county-wide/year, 1/3 on septic, 60% in overlay
**Assumption: 800 septic permits/year, 60% of vacant land in overlay

Cost of the Nitrogen Reduction Overlay Ordinance
(Assuming the 65% Nitrogen Removal adds $4,000 to Septic Cost)

	Loan Amount	Mortgage Payment**	Loan Amount	Mortgage Payment**	Monthly Increase
Median Home Value in Brevard*	$ 204,200	$ 965	$ 208,200	$ 984	$ 19
Median of Bottom Tier Home Values*	$ 132,000	$ 624	$ 136,000	$ 643	$ 19
Median of Top Tier Home Values*	$ 357,000	$ 1,688	$ 341,000	$ 1,707	$ 19

*Source: Zillow.com Home Value Index for Brevard County in August 2018
**Source: Schwab.com Mortgage Calculator, assuming financing 100% of Home Value at 3.92% Interest for 30 Years

Brevard County
BOARD OF COUNTY COMMISSIONERS

Natural Resources Management Department
2725 Judge Fran Jamieson Way
Building A, Room 219
Viera, Florida 32940

COMMUNITY OUTREACH

In August 2018, the Natural Resources Management Department (NRM), the County Attorney's office (CAO), and the Florida Department of Health (DOH) conducted three separate outreach events for:

- Home Builders and Contractors Association (HBCA),
- Environmental stakeholders, and
- County and city Building Officials.

Staff presented information on the current septic moratorium, nutrient loading sources, scientific methods to conduct the septic study (Study) authorized by the Board of County Commissioners (Board), and the most recent findings of the Study. Staff requested community input during each meeting.

ADVISORY BOARD RECOMMENDATIONS

On September 12, 2018, the item was presented to the **Building Construction Advisory Committee (BCAC).**
Motion 1: Recommend approval of the item with two modifications; 1) removal of the exemption for septic repairs, and 2) make the ordinance applicable to all areas of incorporated and unincorporated Brevard County (i.e., no overlay). The motion failed with a vote of 2-2.
Motion 2: Recommend approval of the item as proposed. The motion failed with a vote of 2-2.

On September 17, 2018, the item was presented to the **Local Planning Agency (LPA).**
Motion 1: Recommend approval of the item with two modifications; 1) removal of the exemption for septic repairs, and 2) make the ordinance applicable to all areas of incorporated and unincorporated Brevard County (i.e., no overlay). The motion failed due to the lack of a second.
Motion 2: Recommend approval of the item as proposed. The motion passed 7-1.

ATTACHMENT A

Natural Resources Management Department
2725 Judge Fran Jamieson Way
Building A, Room 219
Viera, Florida 32940

Brevard COUNTY

BOARD OF COUNTY COMMISSIONERS

Staff Report

SUBJECT: **Ordinance to Replace the 150-Day Conventional Septic Moratorium**

DATE: **September 11, 2018**

AUTHORS: **Natural Resources Management Department (NRM)**

On May 22, 2018 the Board of County Commissioners adopted Ordinance No. 18-13, a temporary (150-day) moratorium on the permitting of new conventional septic systems located in areas of the County where septic systems were likely to have significant impacts on water quality in the Indian River Lagoon. The areas of likely harm were selected using data collection and modeling that was performed recently in Martin and St. Lucie Counties. The purpose of the Brevard moratorium was to provide immediate protection from additional harm and reasonable time for staff to contract a geo-spatial analysis of septic impacts in Brevard and draft an ordinance to help ensure that Board policy supports the community's vision of clean, safe water in the Indian River Lagoon (IRL).

Staff contracted with Applied Ecology, Inc. (AEI) to model the impact of existing septic systems in Brevard County on IRL water quality. Impacts of existing septic systems were used to assess the potential risk of permitting additional conventional septic systems. Staff used the results of the AEI modeling to refine the most beneficial regulatory overlay area wherein nitrogen reducing septic systems can be required to benefit Lagoon water quality.

During the County's 150-day moratorium, the State of Florida adopted two significant changes pertinent to septic systems. On July 1, 2018, the Florida Department of Environmental Protection adopted Basin Management Action Plans for many springsheds. These BMAPs have an effective date of January 2019. In areas where septic pollution was estimated to account for over 20% of the nitrogen load, the BMAPs require that new permits for septic systems will only be issued for systems that achieve 65% or better nitrogen reduction. Similar to these springsheds, septic pollution in Brevard is estimated to account for 18.8% of the nitrogen pollution load to the IRL, therefore a 65% or better nitrogen reduction requirement is consistent with the latest state standards for other sensitive waterbodies.

The State of Florida also adopted rule revisions that add another septic system option that provides 65% nitrogen removal. On July 31, 2018, the Florida Department of Health adopted a new rule that allows In-ground Nutrient Reducing Biofilter (INRB) drainfields to be permitted as a passive performance system. These INRB systems, along with previously available NSF 245 certified Aerobic Treatment Units (ATU) systems and some Performance Based Treatment Systems (PBTS), are capable of reducing the nitrogen load from septic systems by 65%. According to the revised state rule, INRB systems, like conventional septic systems, do not require the bi-ennial operating and maintenance permits that contribute to the increased ownership costs of ATUs and PBTS. While INRB systems are not applicable for all areas of Brevard County, in areas where there is sufficient depth to groundwater, INRBs should provide a relatively low cost, low maintenance septic option for providing nitrogen reduction.

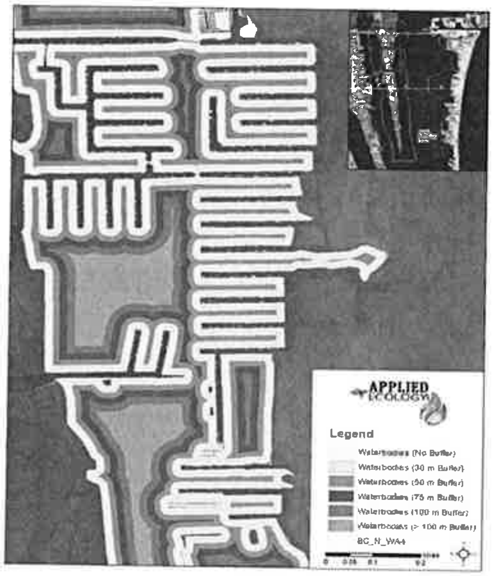
During the moratorium, staff worked with AEI to analyze septic loading in Brevard County using the ArcGIS-based Nitrogen Load Estimating Toolkit (ArcNLET). ArcNLET is a septic loading model commissioned several years ago by the State of Florida. According to the operator's manual and limited sensitivity testing in Brevard, model output for absolute loading is very sensitive to calibration factors. The best calibration data available at this time is in Palm Bay, near Turkey Creek. Better county-wide calibration will be possible next year, after a $1 million state-funded groundwater study is complete, however the uncalibrated or partially calibrated model is currently sufficient for comparing the relative risk of loading from one area to the relative risk of septic loading from another area.

ArcNLET was used to analyze the relative importance of septic loading based on several criteria that account for the largest amount of variation in pollution potential for properly functioning septic systems. Nitrogen loading impact was analyzed by:

a. County Commission direction to consider stronger regulation on the Barrier Island and Merritt Island
b. Board inquiry regarding the relative importance of septic systems located on canals that extend miles from the IRL
c. Distance from an open water connection to the lagoon
d. Soil type and character, provided by the US Department of Agriculture (USDA), US Geological Survey (USGS) and the Natural Resources Soil Conservation Service (NRCS)
e. Floodplain, as designated by the Federal Emergency Management Agency (FEMA)

Soil type, (mostly A, A/D, B/D, C/D and D) and their associated conductance characteristics were found to be the most important factor affecting nitrogen loading to the IRL system. Figure 1 shows soil type distribution in Brevard. Patterns in soil type distribution have distinct impacts on the risk of septic pollution in different areas of the county.

Figure 1: Soil distribution in the northern and southern regions of Brevard County.



Within each soil type, distance was the next most important factor. For statistical analysis, septic system distance to water was measured for approximately 27,000 septic systems and each was then assigned to one of 18 different distance classes (10m, 20m, 30m, 40m, 50m, 60m, 70m, 80m, 90m, 100m, 125m, 150m, 175m, 200m, 225m, 250m, 275m, 300m, 325m, 350m, 375m, 400m, 500m, 600m, and 700m) as illustrated in Figure 2. Elevation gradients accounted for additional variability within soil types and distance classes.

Figure 2: Buffering used to assign distance to water.

Sandy soils, like those on the barrier island (Figure 3) and relic dune ridges on Merritt Island and the mainland, allow drainfield effluent to be transported quickly through the groundwater with little attenuation of nutrients along the way. On average, septic systems located 100-125m from the lagoon or a canal on the barrier island contributed over 5 pounds of nitrogen load each (Figure 4). This distance encompasses nearly the entire island, justifying a requirement for 65% nitrogen reducing systems island-wide.

Figure 3: Coverage of Soil Type A on the Barrier Island.

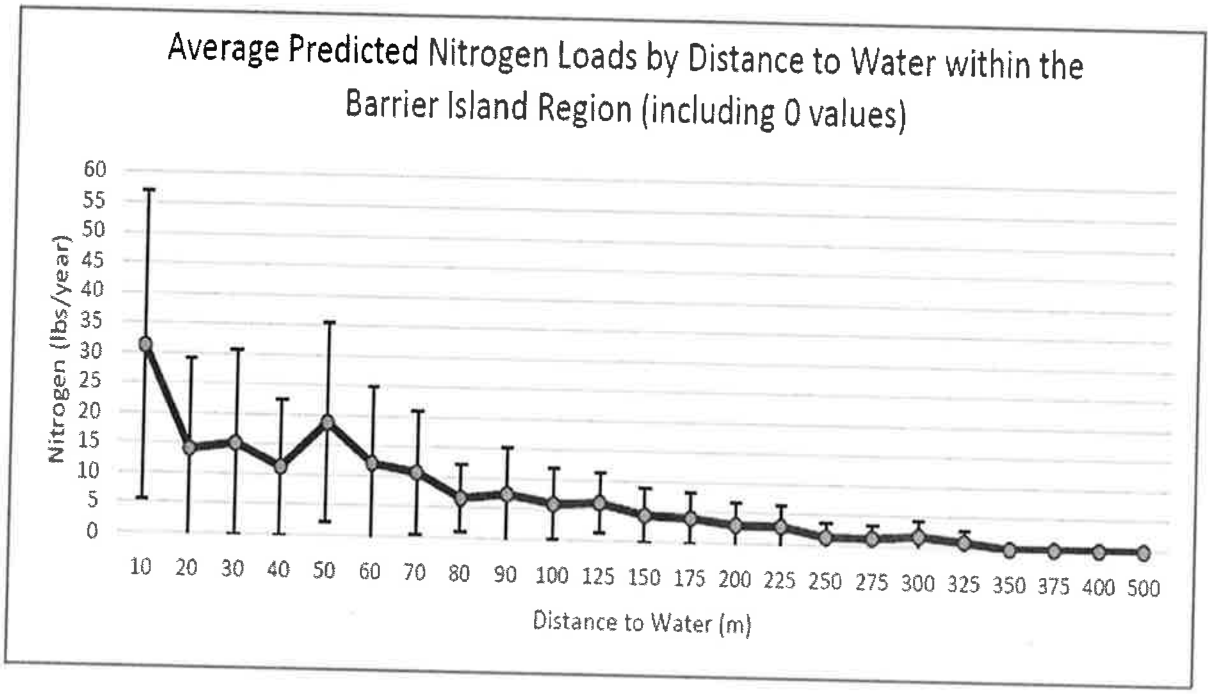


Figure 4: Mean individual septic tank nitrogen load into the nearest waterbody for the Barrier Island in Brevard County.

Floodplains, like those that cover a significant portion of Merritt Island (Figure 5), are a strong indicator of areas where septic drainfields are frequently saturated by floodwaters or rising groundwater tables. When this occurs, human pathogens can be transported from flooded drainfields to wherever floodwaters are present – in waterways, streets, yards, homes and businesses. ATUs reduce both nitrogen pollution and the pathogen load before effluent is dispersed from the septic tank to the drainfield.

Merritt Island is comprised of alternating roughly linear areas of highly conductive sandy dune ridges and flood hazard risk areas mapped by FEMA as floodplain. Conventional septic systems pose a nutrient impact on the ridges and a human health concern in the floodplains. On average, septic systems located 90-100m from the lagoon or a canal on Merritt Island contributed over 6 pounds of nitrogen load each (Figure 6). This combination justifies a requirement for 65% nitrogen reducing systems on all of Merritt Island.

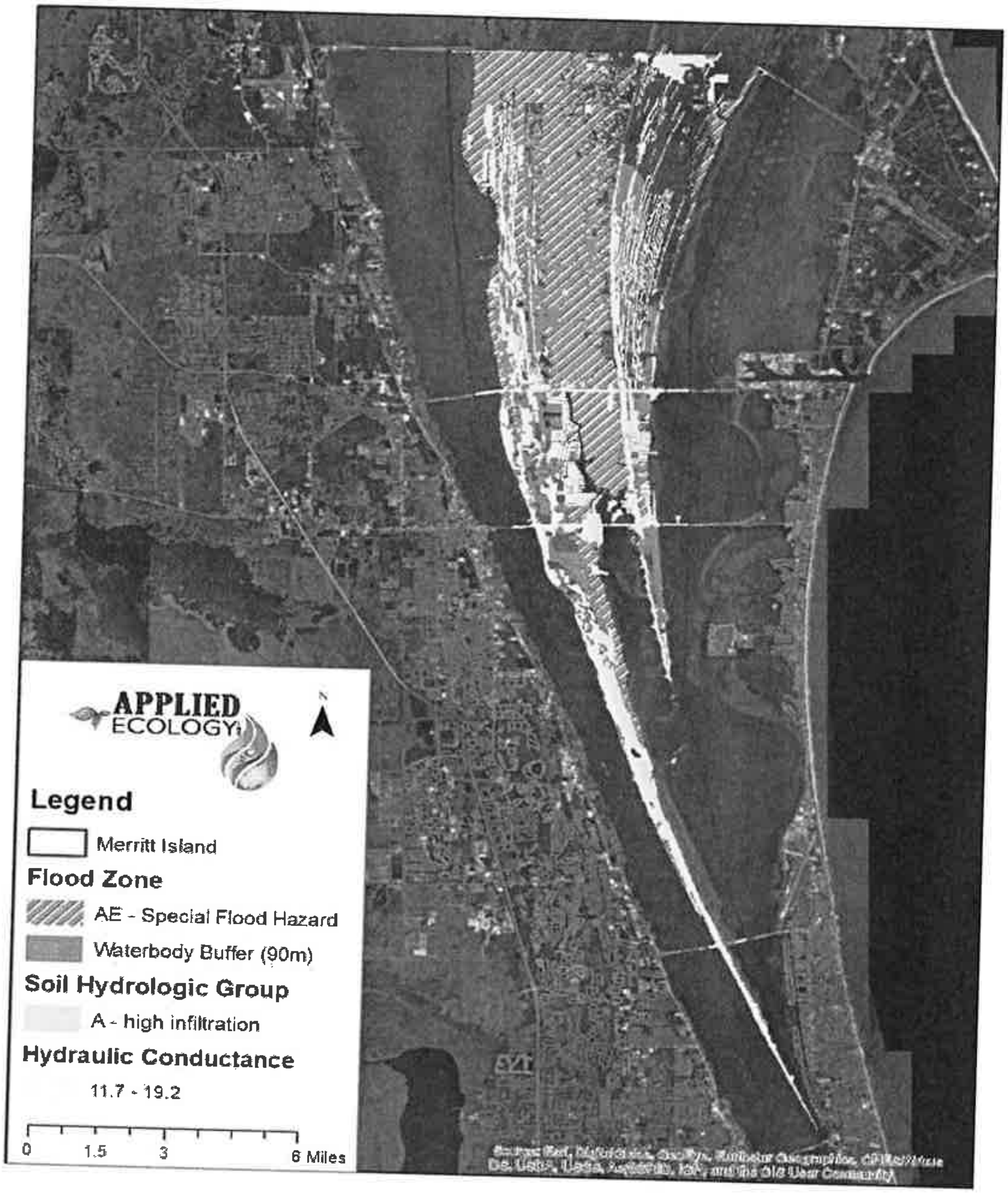


Figure 5: Coverage of Soil Type A, the Special Flood Hazard Area and a 90m Distance to Water.

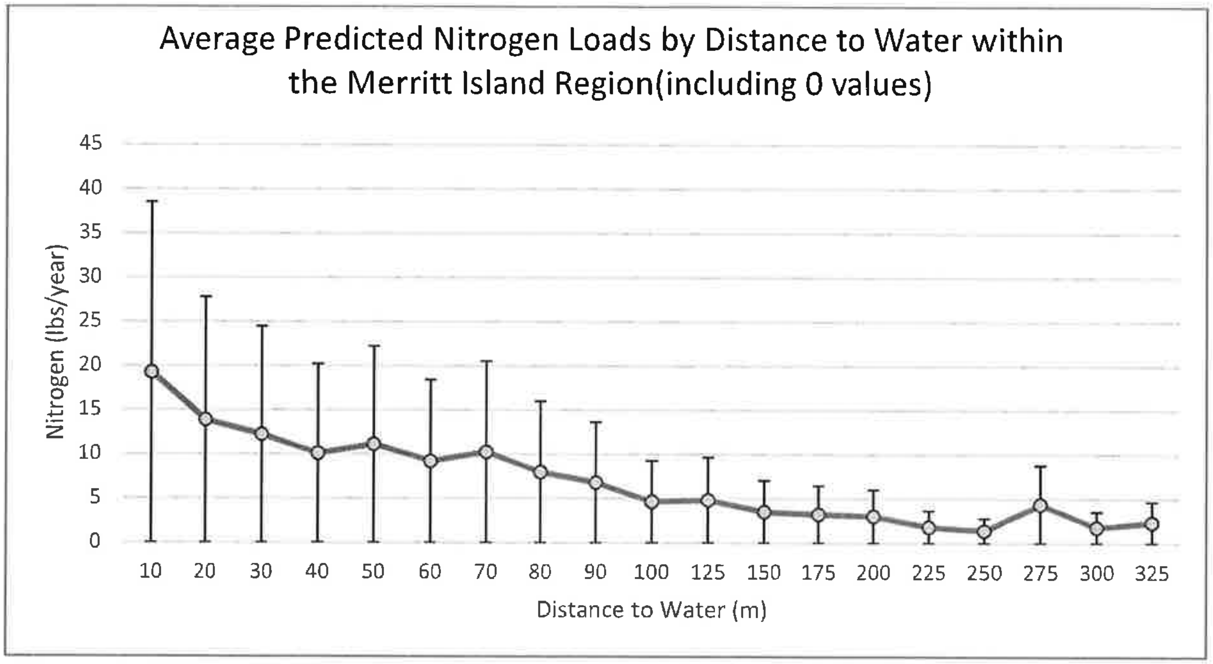


Figure 6: Mean individual septic tank nitrogen load into the nearest waterbody for Merritt Island.

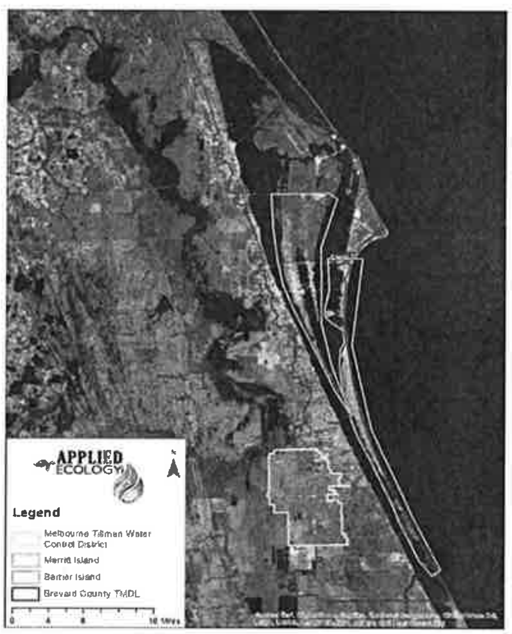


Figure 7: Regions of interest in Brevard County.

Melbourne-Tillman Water Control District (MTWCD) is a large area of mainland Brevard that is drained by over 300 miles of extensive canal network. This canal system collects storm runoff and groundwater discharge to the central C-1 canal which discharges the combined pollutant load to the IRL through Turkey Creek (Figure 7). This discharge is the single largest point of pollutant discharge in Brevard County. Approximately half of the county's existing septic systems (responsible for a third of septic loading from Brevard to the IRL) are located within the MTWCD.

Unlike the sandy soils of the barrier island that move nutrient laden groundwater quickly to the lagoon, most of the area within MTWCD is comprised of soils with medium to low conductance values. These soils retard the flow of groundwater and allow more time for natural attenuation to reduce the nitrogen loading impact of septic systems on the lagoon. Staff looked at the loading potential for septic systems at different distances from MTWCD canals (Figure 8). Due mostly to the frequent occurrence of relatively low conductivity soils, it is recommended that the overlay in this area be reduced from the moratorium width of 50m to a narrower overlay width of 40m.

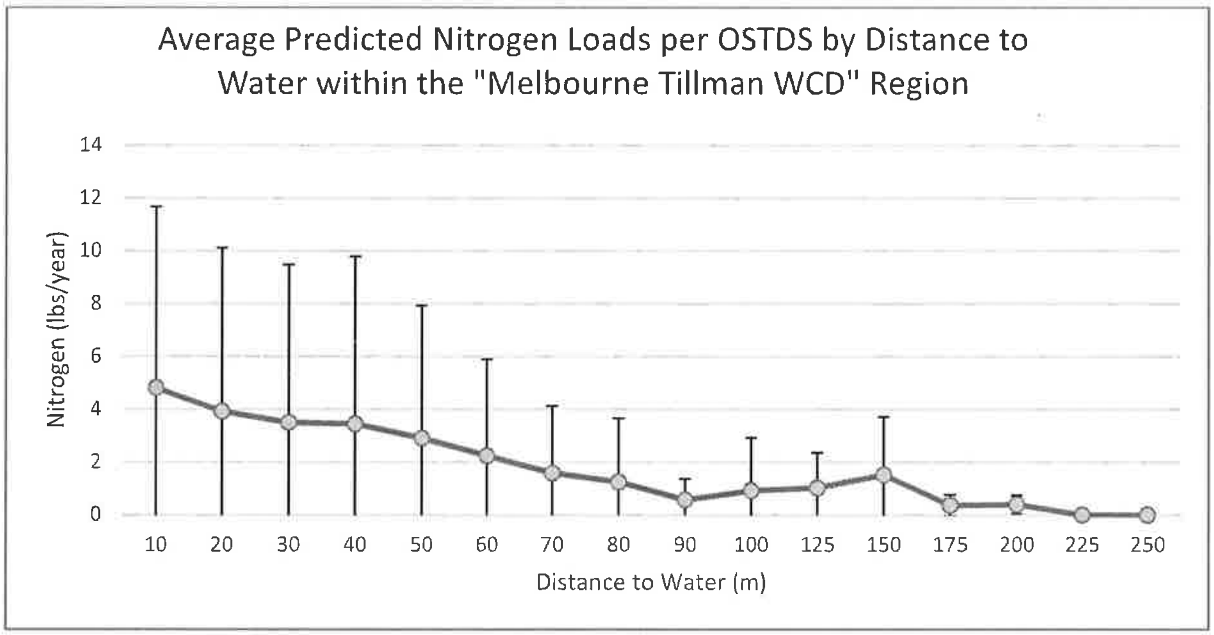


Figure 8: Mean individual septic tank nitrogen load into the nearest waterbody for septic systems loading canals within the Melbourne Tillman Water Control District.

On the remainder of the mainland (excluding MTWCD), there is a complex mosaic of different soil types and nitrogen loading potential. While sandy areas conduct nutrients hundreds of meters, low conductivity soils restrict nutrients from traveling more than a few dozen meters. On average, county-wide, excluding MTWCD, Figure 9 shows that the highest loading occurs within 60m of an open water connection to the lagoon system. At distances beyond 60m, the chances increase substantially that conventional septic systems are not contributing pollution to the lagoon.

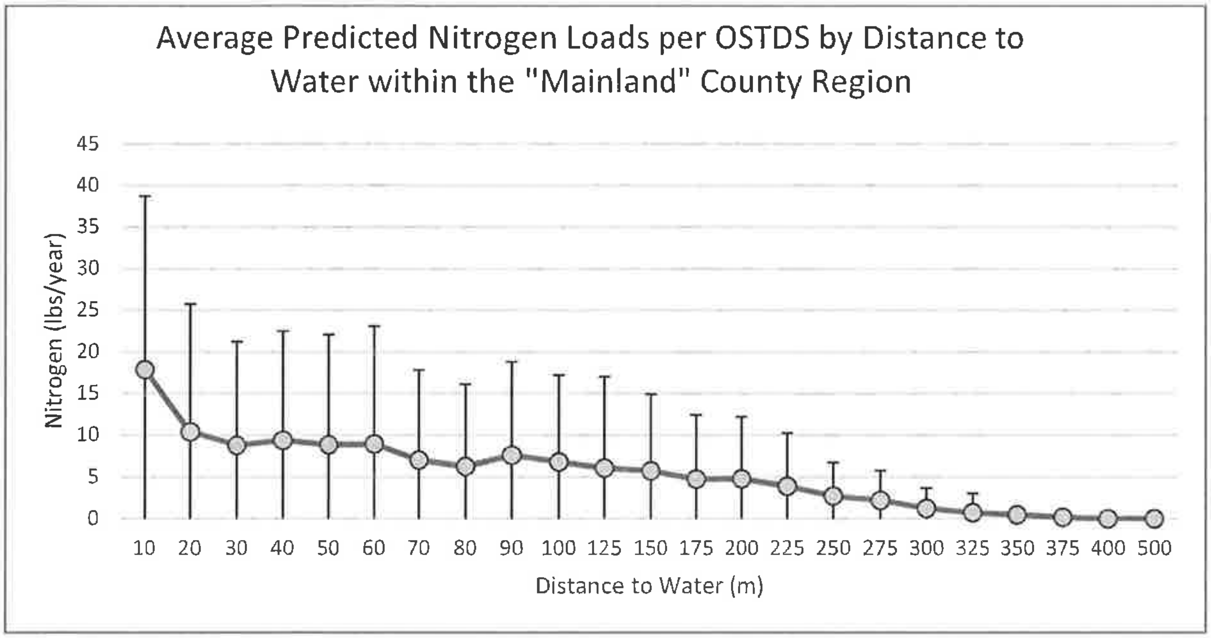


Figure 9: Mean individual septic tank nitrogen load into the nearest waterbody for the mainland of Brevard County, excluding MTWCD.

Summary

The ArcNLET estimates of loading from existing septic systems within Brevard indicate support for the Board's previous direction to include all of the Barrier Island and Merritt Island in a regulatory overlay within which a 65% nitrogen reduction standard applies. The Barrier Island is dominated by high conductance sandy soils and Merritt Island is dominated by alternating areas of high conductance soils and low elevation floodplain.

ArcNLET model results also support a concern from the Board regarding the loading impact of septic systems within the MTWCD. Despite the large number of septic systems located at high densities in this area, an abundance of low and moderate conductance soils retards the travel of nutrients through the groundwater to the canal network. A limited amount of loading is attributable to systems located greater than 40 meters from the canals, therefore a narrower overlay of 40m in this area will capture the majority of lots that pose the greatest risk to lagoon water quality.

The remainder of the mainland is a mosaic of low, moderate and high conductance soils. Fortunately, the majority of high conductivity soils are located within 60m of the IRL system, and the areas of low to moderate conductivity soils do not convey many nutrients beyond 60m, so a 60m overlay in this area captures the majority of land responsible for septic loading and excludes the majority of parcels that do not contribute significant risk of septic loading to the IRL system.

A groundwater monitoring study that began this June collecting monthly samples of groundwater nutrients at 50 wells distributed county-wide, will be highly valuable next year for quantifying the total loading potential of future land use if the County were to continue permitting conventional septic systems instead of requiring systems capable of 65% nitrogen reduction. For the present analysis, uncalibrated and partially calibrated versions of the state model were used to identify areas of greatest and least pollution potential. This analysis allows decision-makers to balance minimizing pollution potential while also minimizing the area to be affected by the proposed septic ordinance.

OSTDS Pollution Potential Analysis: Final Report

Brevard County

Natural Resources Management Office

Task Order #271010-14-001-005

SEPTEMBER 7, 2018

Applied Ecology, Inc.

Authored by: Claudia Listopad, Ph.D.

Background

In response to the deterioration of the health of the Indian River Lagoon (IRL) along Florida's east coast, Brevard County residents approved a sales tax referendum in 2016 to fund the Save our Indian River Lagoon Project Plan for ten years. The plan focuses on reducing nutrient inputs to the lagoon through stormwater and wastewater retrofit projects as well as fertilizer education and restoration efforts. To reduce new sources of groundwater pollution, Brevard County Commissioners recently adopted a temporary ordinance limiting new conventional septic systems within 50 meters of the IRL, connected tributaries, and surrounding barrier islands. This critical distance was selected based on a few available studies in the South Indian River Lagoon watershed. To produce a permanent ordinance that balances protection of water quality with other socio-economic factors, further analysis was needed to better understand which areas of the county are contributing the most septic pollution to the IRL. This information will be also used to prioritize sewer service expansion areas.

In May 2018, Applied Ecology was contracted by Brevard County to assist in the analysis of the potential loading impact of Onsite Wastewater-Treatment and Disposal Systems (OSTDS) to the Indian River Lagoon and Connected Waterways in Brevard County. The analysis is based on extensive predictive modeling using the ArcGIS-based Nitrate Load Estimation Toolkit (ArcNLET). This simplified conceptual model of groundwater flow and transport, developed by Ye and Rios for the FDEP, was customized with County-based input data.

Due to large spatial extent of the analysis (countywide) and the model data processing limitations, the analysis was initially divided into 16 work areas, six located in the northern half of the County (Figure 1) and the remaining 10 in the southern half of the County (Figure 2). Data was examined per work area focusing on the impact of the distance from septic tank to waterbodies variable. The impact on distance on the predicted nitrogen plumes reaching the Lagoon or connected waterways is reported by examining the data distribution of model outputs and statistical analyses. The percentage of total nitrogen (sum of nitrate and ammonia plumes) contribution from of existing modeled OTDS by distance is also included for each work area.

Countywide results were also aggregated from the 16 work areas and examined by soil hydrologic type and floodplain class, both likely indicators of groundwater pollution potential from OSTDS. Keene (2015) used hydrologic group as an important variable in the prioritization process in the Martin County Septic System Elimination Study to convert any remaining septic communities to sanitary sewer (Keene, 2015). Soil hydrologic group provides a general idea of drainage class of the soil type, very important to understand if the aerobic and anaerobic conditions are present at the right time and place to promote nitrification and then denitrification (Mary Lusk, per. communication). Soil hydrological type is typically a key variable in stormwater modeling loading predictions (Harper & Baker, 2007), and likely affects groundwater loading potential. Other soil variables, such as percentage of organics, porosity and hydraulic conductivity, all key inputs in the groundwater nutrient transport models, are often correlated to soil hydrologic group classification. Soil hydrologic group is used in this analysis as a simple surrogate to other more complex soil variables.

Floodplain zone, as designated by the most recent FEMA mapping, is also used in the analysis as a surrogate to mean elevation above sea level (MSL), a good predictor of water table with strong correlation coefficients often above 0.8-0.9 (Rios *et al.* 2011). Often, depth to groundwater is not available at a landscape scale and topography is used as a subdued replica of the water table (Rios *et al.*, 2011; Wang *et al.*, 2012). Chapter 64E-6 of the *Florida Administrative Code* for the Standards for Onsite Sewage Treatment and Disposal Systems has a criterion specifically designating a minimum water table elevation that is used for site evalutation when installing an OSTDS (State of Florida Department of Health, 2013). While elevation and specifically depth to water have a a significant impact on the groundwater pollution potential of OSTDS, the lack of availability and ease of use of these two variables throughout the County, made these difficult to use in a county-wide ordinance. A simpler surrogate might be FEMA's classification of floodplain category throughout the County. Typically, areas located in lower elevations, often with shallow water tables, might be classified as a floodplain zone of higher risk (A, AE, AH, or AO zones).

Several work areas within the County presented similar nutrient loading factors within geographic regions. Typically, these regions are represented by distinct soil types (hydrologic group, soil hydraulic conductance values, etc.), elevations above MSL, and/or density of water features. Four distinct results were examined independently for the impact of OSTDS by distance to water: Barrier Island, Merritt Island, Melbourne Tillman Water Control District Basin (MTWCD), and the Mainland County (excluding the MTWCD).

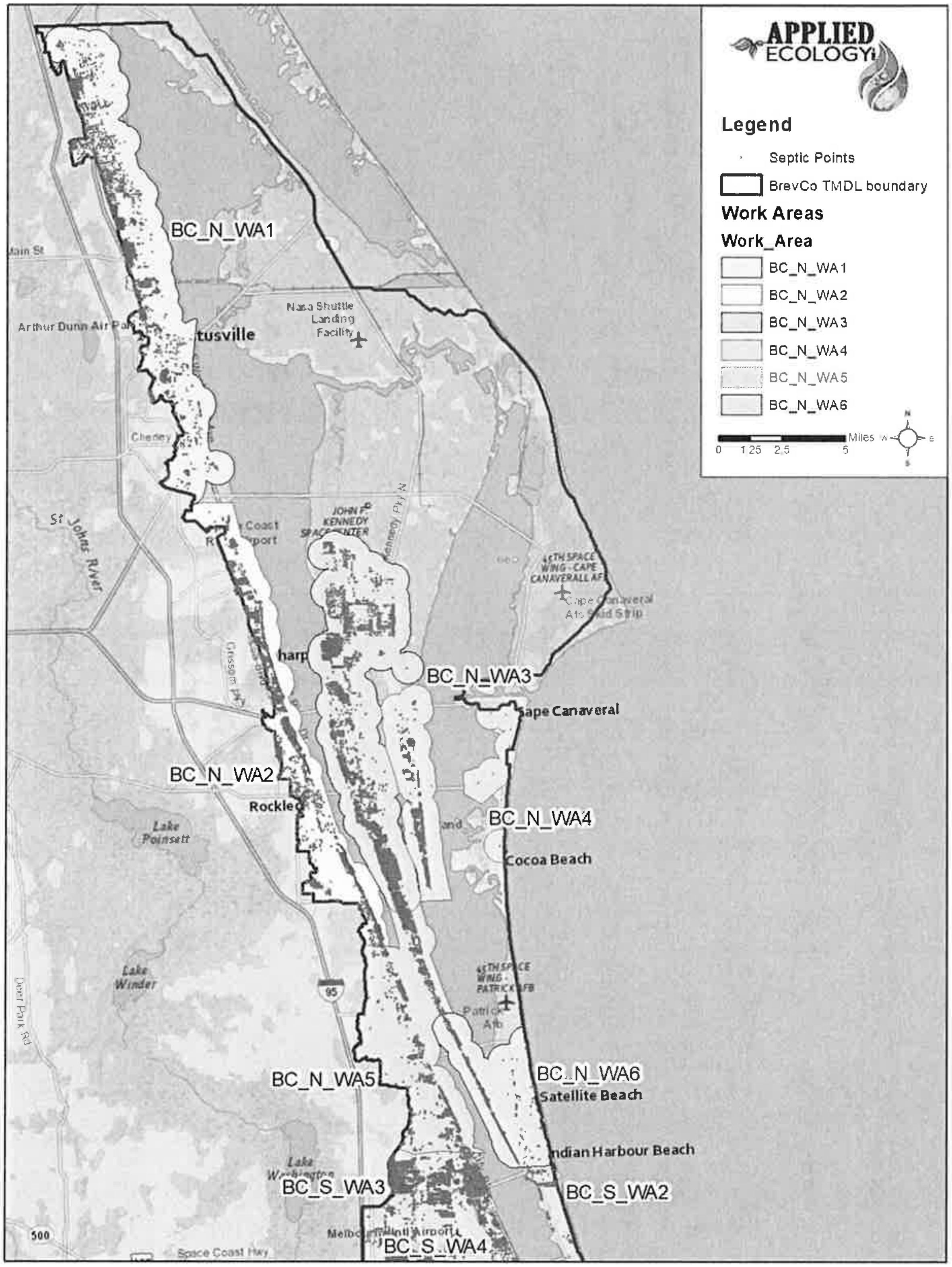


Figure 1. Model and Analysis Work Areas within the northern half of Brevard County.

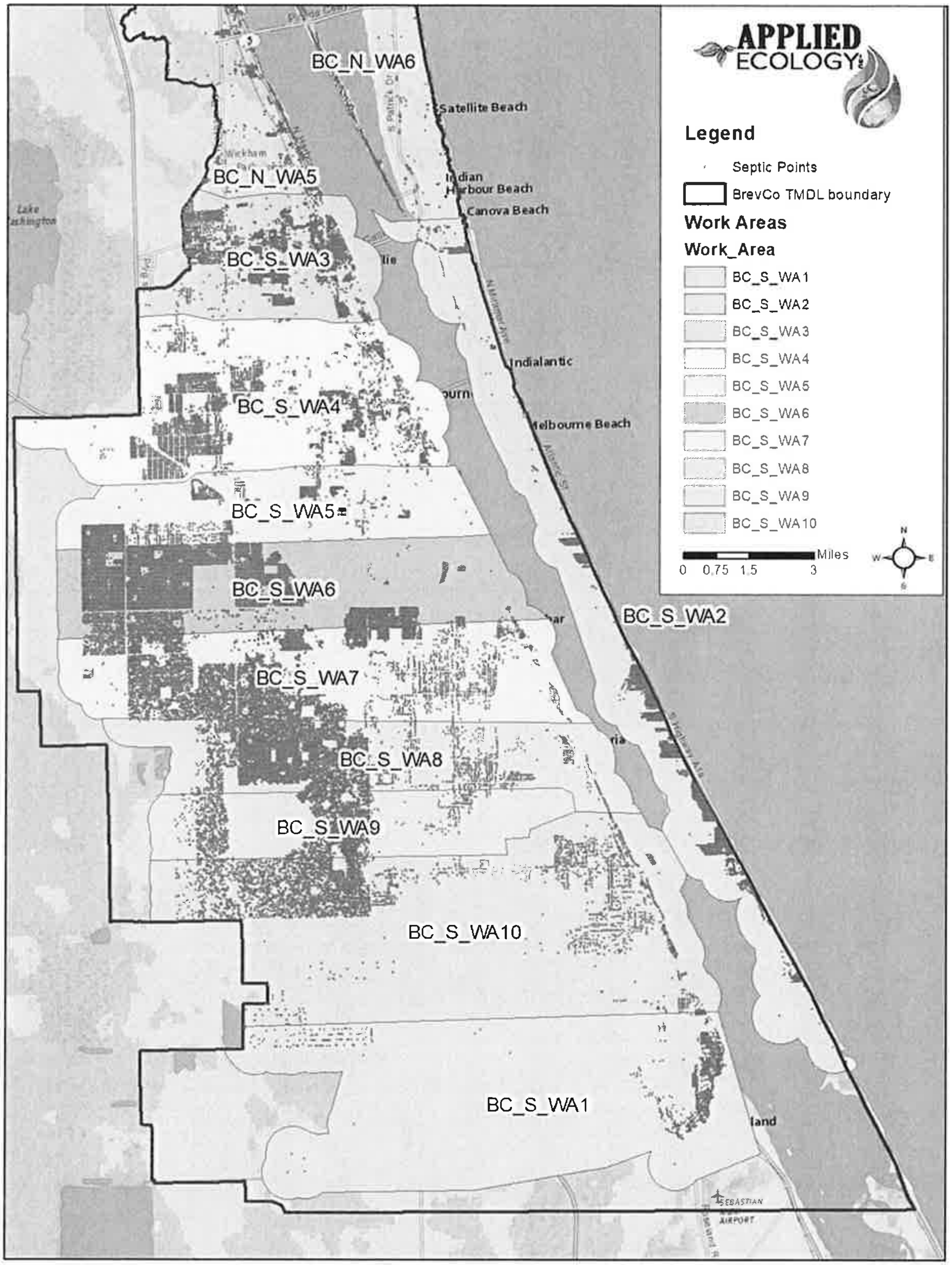


Figure 2. Model and Analysis Work Areas within the southern half of Brevard County.

Methodology

The analysis of the impact of OSTDS by distance and other parameters of interest required intensive modeling using a simplified conceptual model of groundwater flow and solute transport, the ArcNLET (ArcGIS-based Nitrate Load Estimation Toolkit). Data preparation to allow all sixteen work areas to be modeled was extensive and included the determination of input septic tank locations, creation of a complete waterbody polygon layer, modification of available Digital Elevation Models (DEM) for the County, and the creation of porosity and hydraulic conductance spatial input layers. To make the effort more efficient, Applied Ecology Inc. (AEI) developed in-house custom tools to process some of the inputs required for each model run, based on each of the model extents.

Septic tank location information was developed by AEI for a Countywide Groundwater Study effort and was based on compilation and assessment of data the FDOH, FDEP, USDA, USGS, Brevard County, and most of the cities within the County. Extensive effort was dedicated to assign treatment type to every parcel within the County based on development status proximity of sewer laterals connecting each parcel to a nearby gravity or force main. In addition, when available, sewer billing addresses were geocoded and checked against the lateral information. Ancillary datasets used might have included paper maps, CAD drawings, and septic tank locations provided by different municipalities. Level of confidence was assigned based on the data source and professional judgment. Parcels identified by this effort as being on septic were converted to centroid point locations, required for model input. For modeling purposes, only work areas with less dense network of OSTDS used all existing septic point locations as data input (Work Areas N4, N5, N6, S1, S4, S5, and S9). For the remaining 9 work areas, a random seed generator was used to allow a random subset of about 2000 OSTDS point locations to be selected and included in the modeling. Percentages of representation vary by work area OSTDS density but vary between 21% and 70% (described in the work area results).

Porosity and Hydraulic conductivity layers were developed from the latest NRCS soil information for Brevard County. Both inputs are provided with ranges (low, medium, high) for each soil horizon and soil type. As recommended by the ArcNLET developers, medium values for the deepest horizon, which interacts with the groundwater, are a good starting point as modeling inputs unless site-specific soil information are available. Processing porosity and hydraulic conductivity from the original soil data to obtain raster datasets was completed in accordance with the data preparation section of the ArcNLET User's Guide (Rios et al. 2011).

Digital Elevation Model information used to derive the water table replica was derived from 2017 USGS 10x10-m DEM. DEM had to cover the entire Brevard County and raster values converted to floating point data. For each work area, modeling results were carefully examined to determine if filling sinks was necessary to remove DEM artifacts that might trap nutrient transport paths that should otherwise reach a waterbody.

Waterbodies were created by a combination of data processing methods. Available hydrographic datasets from the NHD (flowlines and waterbodies), county-wide open channels, and city obtained infrastructure information (ditches, swales, open channels, etc.) were incorporated in one polygon file. Remote sensing was used to confirm that no open water bodies were missed from the previous layer. Extensive photointerpretation using 2016, 2017, and 2018 aerials allowed the input to be completed and connectivity between these various data sources to be accomplished (Figure 3). Topology and geometry reviews tool place to remove any overlaps, unnecessary gaps, and discrepancies.

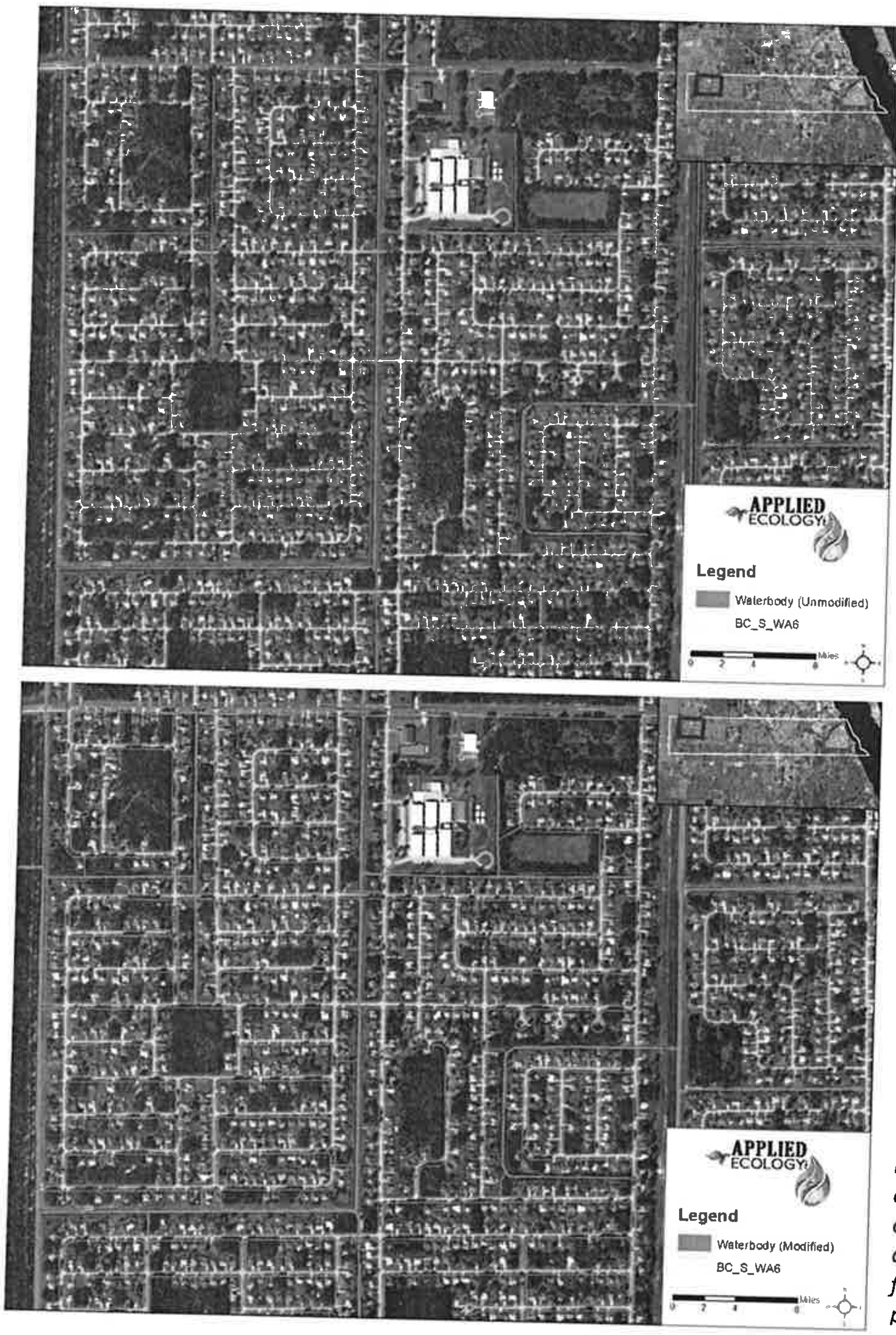


Figure 3. Waterbody layer development effort example. Top frame represented original line features from the NHD open channel layer, while bottom frame the final all-inclusive water conveyances in polygon format.

For analysis, nitrate and ammonia loads were extracted for each OSTDS, summed to provide best total nitrogen loading estimates and then to each original septic point location. Individual OSTDS loading data was assigned to soil hydrologic group, based on NRCS soil information, and floodplain information, based on the latest FEMA floodplain coverage. Regions were delineated by AEI (Barrier Island, Merritt Island, MTWCD, etc.), based on available aerial photography, SJRWMD basin data for the MTWCD, and local knowledge. Loading data was also identified by region and distance to water (from our previously developed waterbodies layer) was calculated to the nearest waterbody (Figure 4).

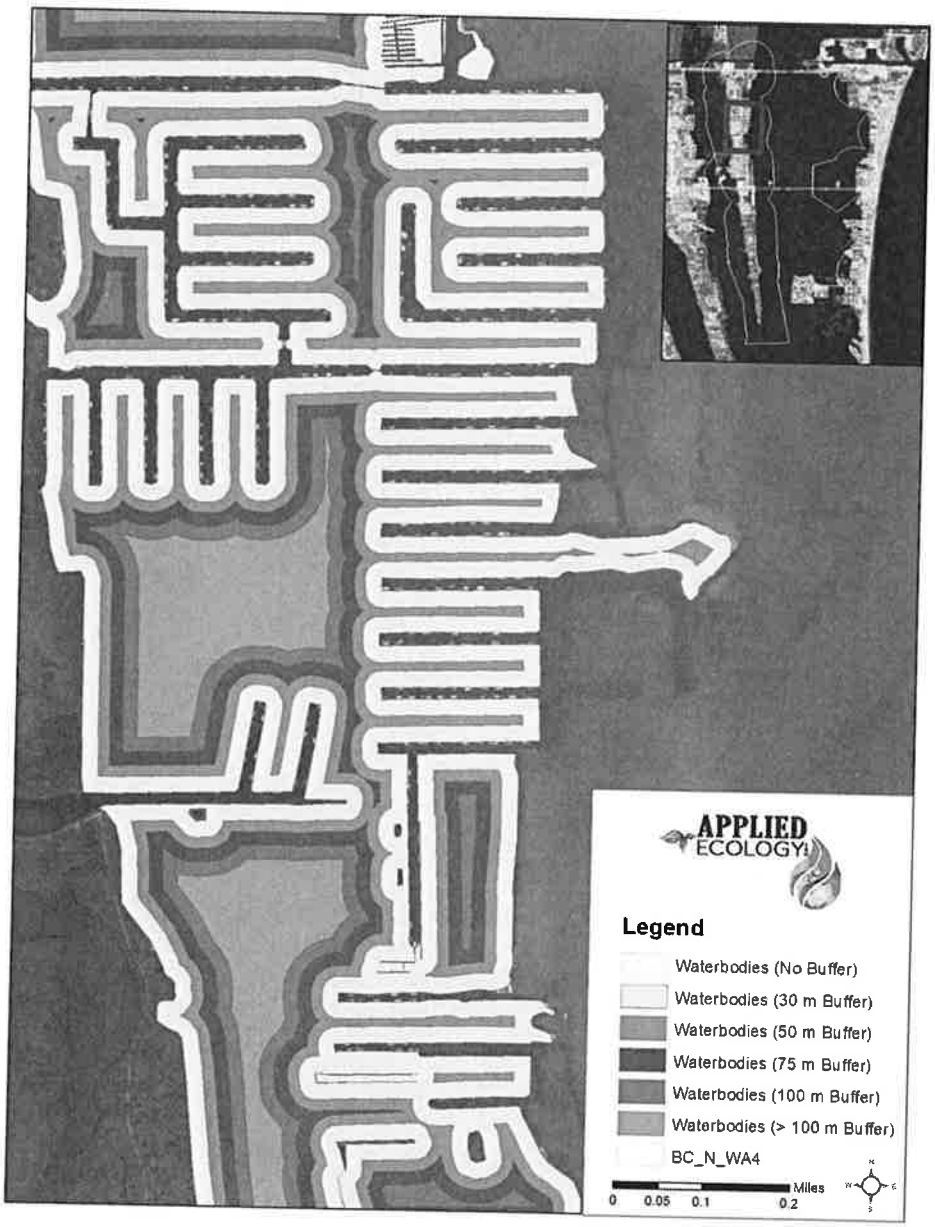


Figure 4. Buffered distance classes to assign distance to water value to every OSTDS in Brevard County.

For statistical analysis, calculated exact distance to water values were assigned to one of 18 distance classes: 10-, 20-, 30-, 40-, 50-, 60-, 70-, 80-, 90, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350, 375, 400, 500, 600, and 700-m (Figure 5). Boxplots of data distribution, summary stats, and mean and standard deviation were plotted by distance for each work area and aggregated by soil hydrologic group, floodplain type, and region. Cumulative loading and percentage representation of existing OSTDS by distance were also plotted regionally.

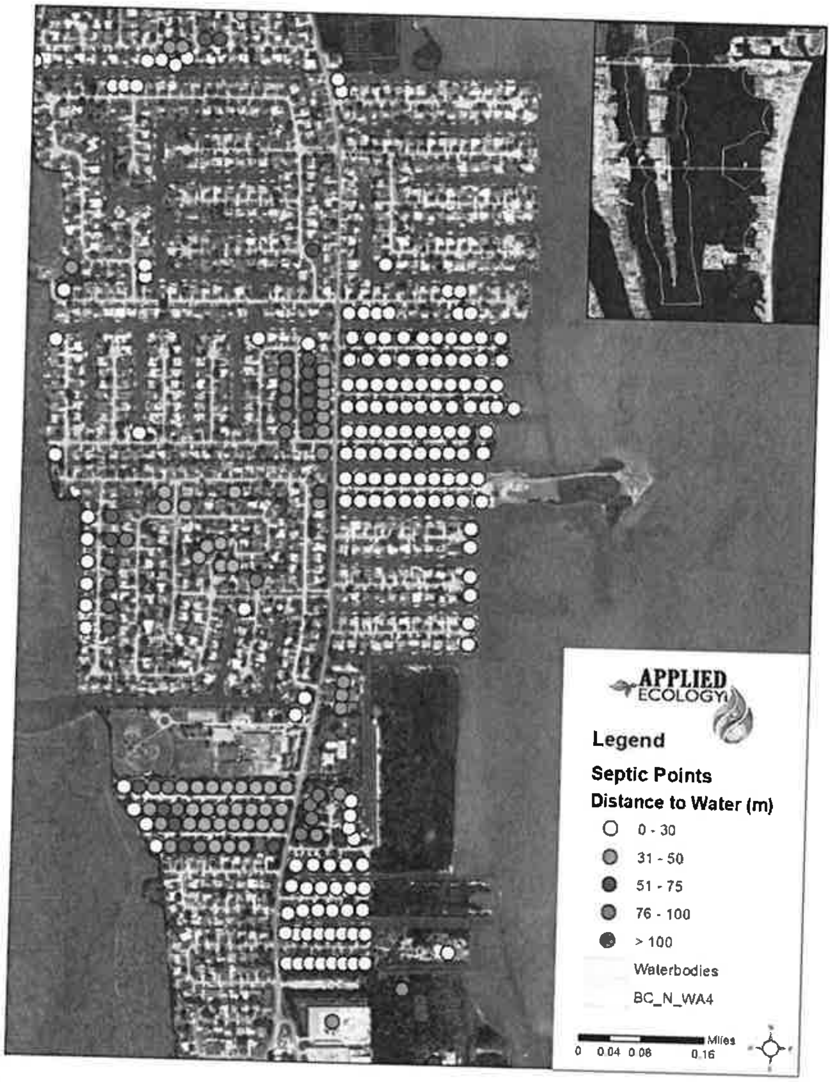


Figure 5. OSTDS model inputs associated to a distance to water value and bin class.

For most of modeling extents, no calibration was possible due to lack of site-specific groundwater level and especially water quality (nitrate and ammonia) datasets. Currently, only one pilot project located in the Turkey Creek basin has enough data (15 monthly events) to be used to calibrate. A comparison between this calibrated model and the closest work area (South Work Area 6) was used to try to adjust the loading data for all other work areas. It is important to note, that calibration is very site-specific and new data currently being collected throughout the County will likely greatly improved total loading estimated for more areas within Brevard County.

Results

Individual Work Area OSTDS Contribution to Loading

Results of OSTDS loading by distance class are provided for each of the sixteen work areas that cover all areas of the county with existing septic tanks. All loading information provided below area uncalibrated and like underestimated by 5.8 to 10x the actual loading for these areas.

Work Area North 1

This work area occupies a large extent of the northern mainland portion of the county from Titusville through Mims. The distribution of soil types is described as almost equal parts A, A/D, and B/D soils, with largest area being occupied by B/D soils type (Figure 6).

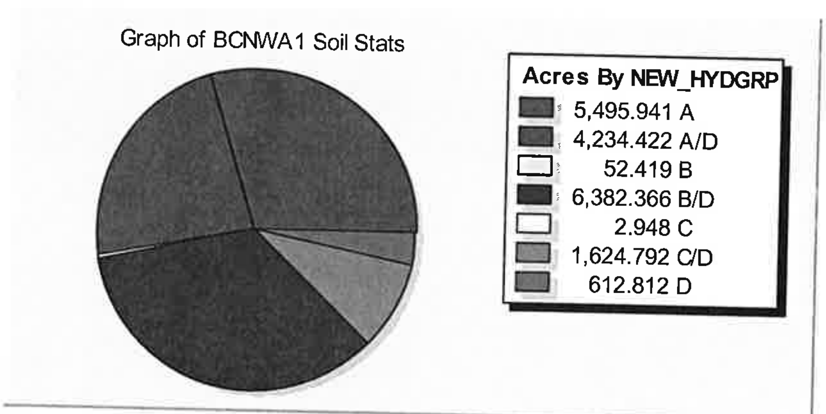


Figure 6. Distribution of the soil coverage by hydrologic group for North WA1.

In this northern work area, 1800 septic tanks were modeled for loading potential to nearby waterways, all within the Indian River Lagoon watershed. This represents 64% of all the OSTDS in this work area (2,801 total), randomly selected using a random seed number generator in the GIS environment. Only 420 septic tanks are located within 50-m of a waterbody in this area, 841 septic tanks within 100m, and almost 1500 (84% of the total) within 250-m (Figure 7).

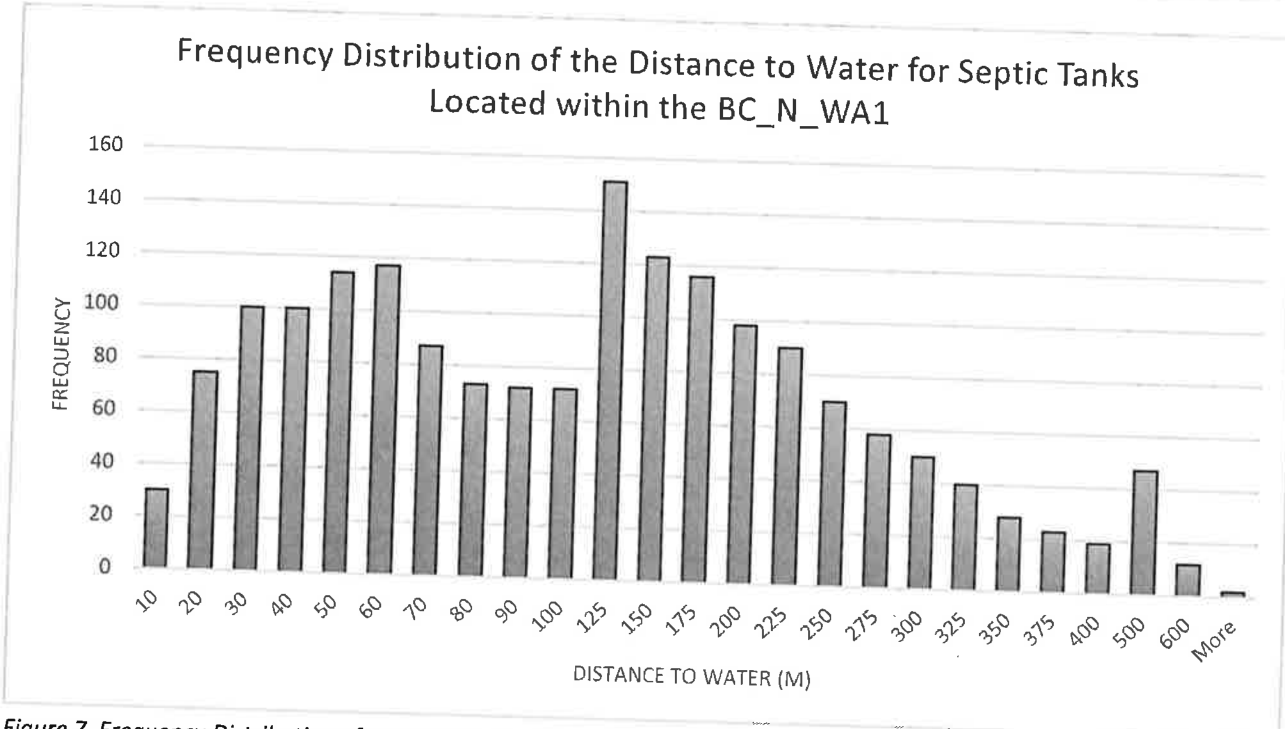


Figure 7. Frequency Distribution of septic tanks by distance to waterbodies within North WA1.

Out of the 1768 septic tanks that generated plume paths, only 30% of these (528 OTDS) generated nitrate or ammonia plumes that loaded into a waterway. Predicted ammonia and nitrate loads were aggregated and total nitrogen loads per year were examined in detail for every distance category: 10-m distance categories between 0-100 m, 25-m distance groups between 100-400, and 100-m categories for distances greater than 400-m. Histograms of the frequency of load distributions by distance category are included for this work area in Appendix A. Load distributions are always represented as the sum of both nitrate and ammonia loads. No discussion of ammonia versus nitrate contributions are included in this preliminary report.

Mean predicted total nitrogen loads reaching waterways (or the Lagoon) for an individual septic tank in this work area are included in Figure 8. Variability of individual septic tank loading impact is quite high, particularly for the shortest distances to water (Figure 9). Highest per septic tank loading is predicted for those septic tanks within 10-m of the waterbodies, followed by those within 30-m distance category. Mean average septic tank loading decreases from 40- to 70-m category, with some higher loading septic tanks located in the 90-125-m distance categories. Individual septic tank loading rapidly declines in this work area after the 175-m distance and was not detected for any septic tank located at distances >375-m from any waterbody.

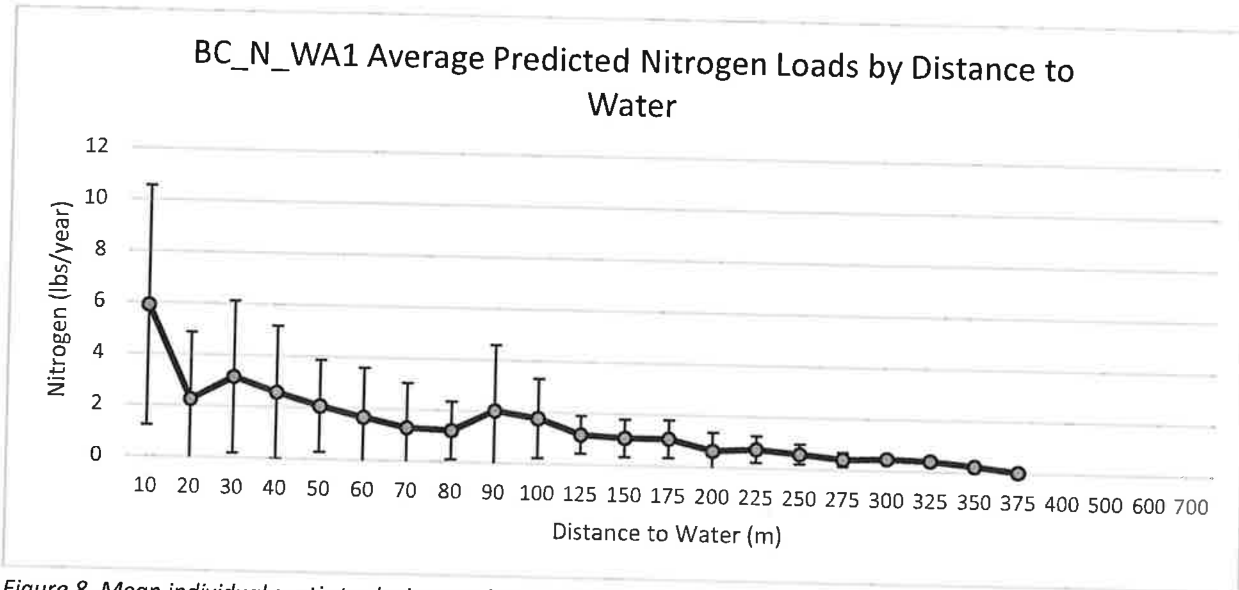


Figure 8. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for North WA1. Standard deviation was included as error bars.

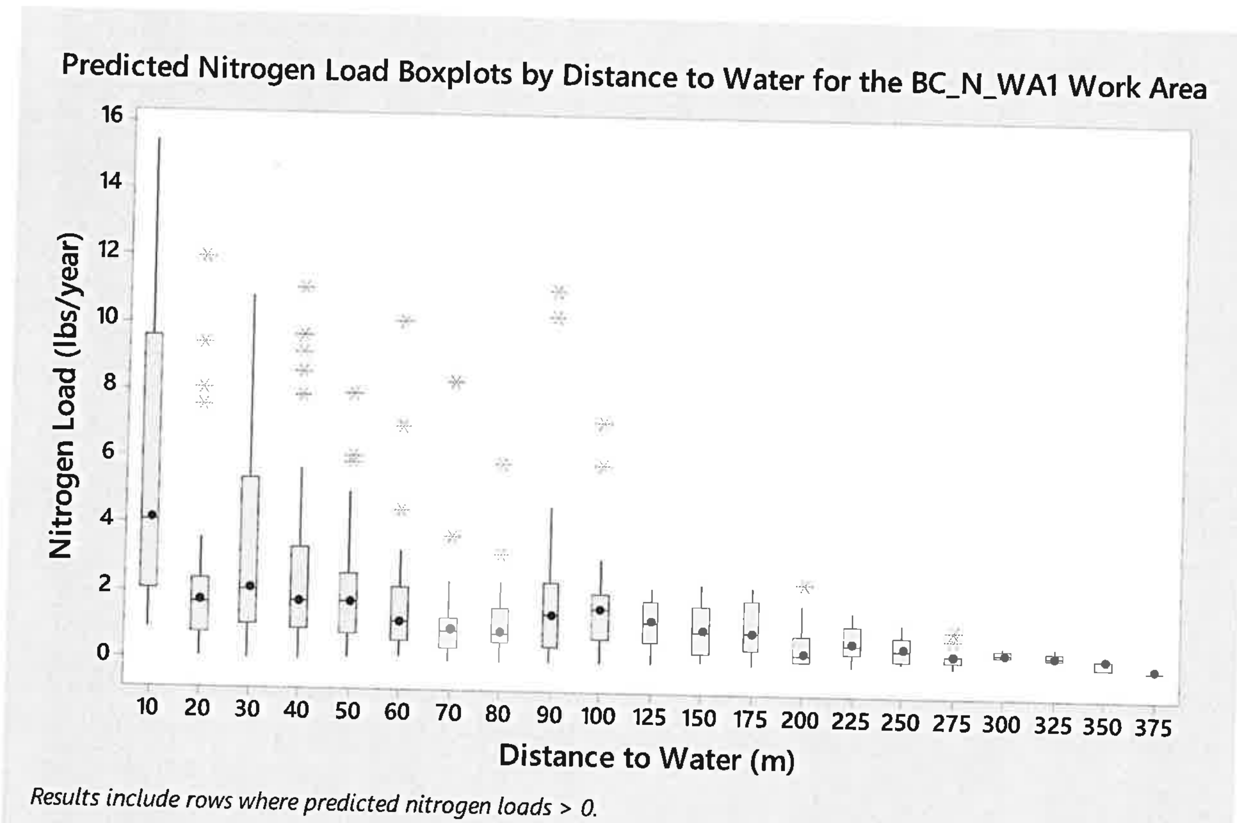


Figure 9. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for North WA1.

Beyond the per septic tank loading data, the percentage distribution of total modeled loading by distance from nearby waterways from this area might provide a more informative global view of the total impact of septic tanks in North Work Area 1. Septic tanks located in the first 50-60 m from a waterway have the greatest impact in the loading, with each 10-m class yielding between 6 and 16% of the total loading from this work area. Cumulatively, even though only 30% of the total OSTDS are located within the first 60 m from waterways, they account for 67% of all the loading (Figure 10). Septic tanks located within 100 m from waterways (about 48% of all OSTDS within this area) contribute to 86% of all the modeled input loading.

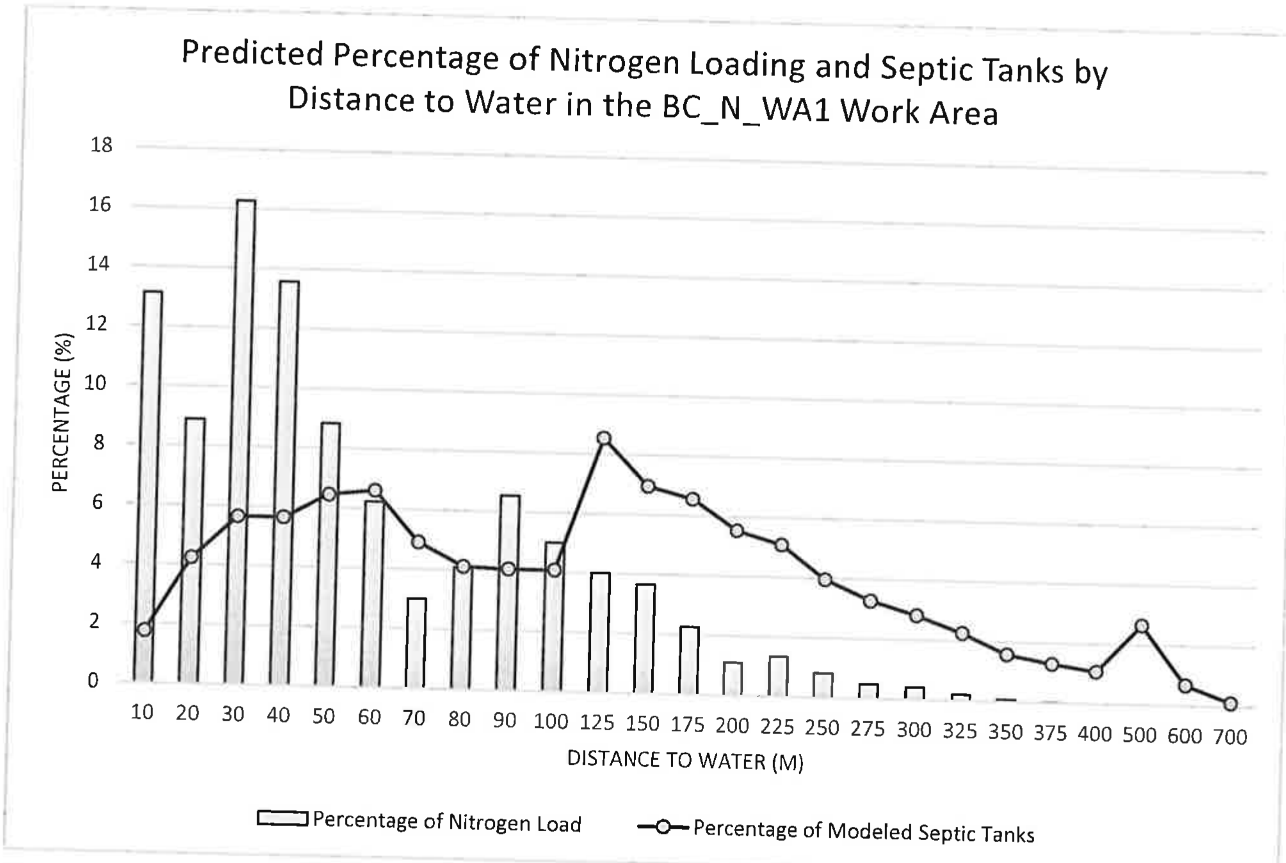


Figure 10. Percentage of total nitrogen loading and OSTDS by distance within North WA1.

Work Area North 2

The North Work Area 2 includes most of the Rockledge and Cocoa areas within the County (Figure 1). The soils in this work area are composed by about half well drained soils (A soils), and the other half by a combination of A/D and B/D soils (dual classes, dependent on drained and natural conditions; Figure 11).

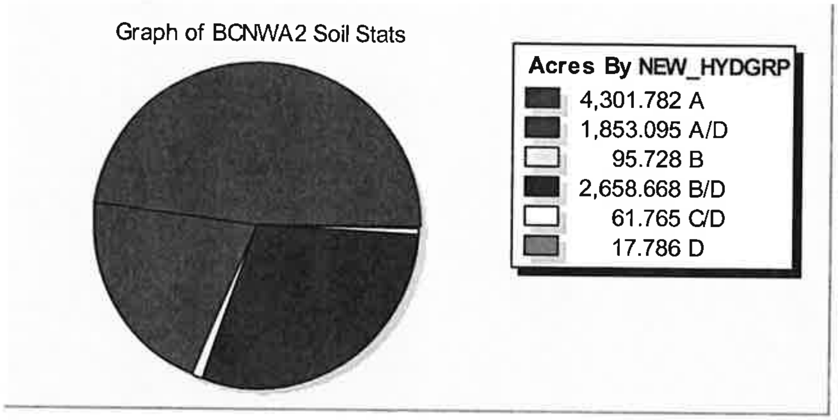


Figure 11. Distribution of the soil coverage by hydrologic group for North WA1.

In the North Work Area 2, 1800 septic tanks were modeled for loading potential to nearby waterways. This represents 51% of all the OSTDS in this work area (3,547 total), randomly selected using a random seed number generator in the GIS environment. Only 562 septic tanks (32% of the total) are located within 50-m of any waterbody/channel, whereas 1028 tanks (59% of the total) are within 100-m of water (Figure 12). This means that 40% of the septic tanks in this mainland section are located at >100-m distances from any waterbody, most of which are within 100-250-m.

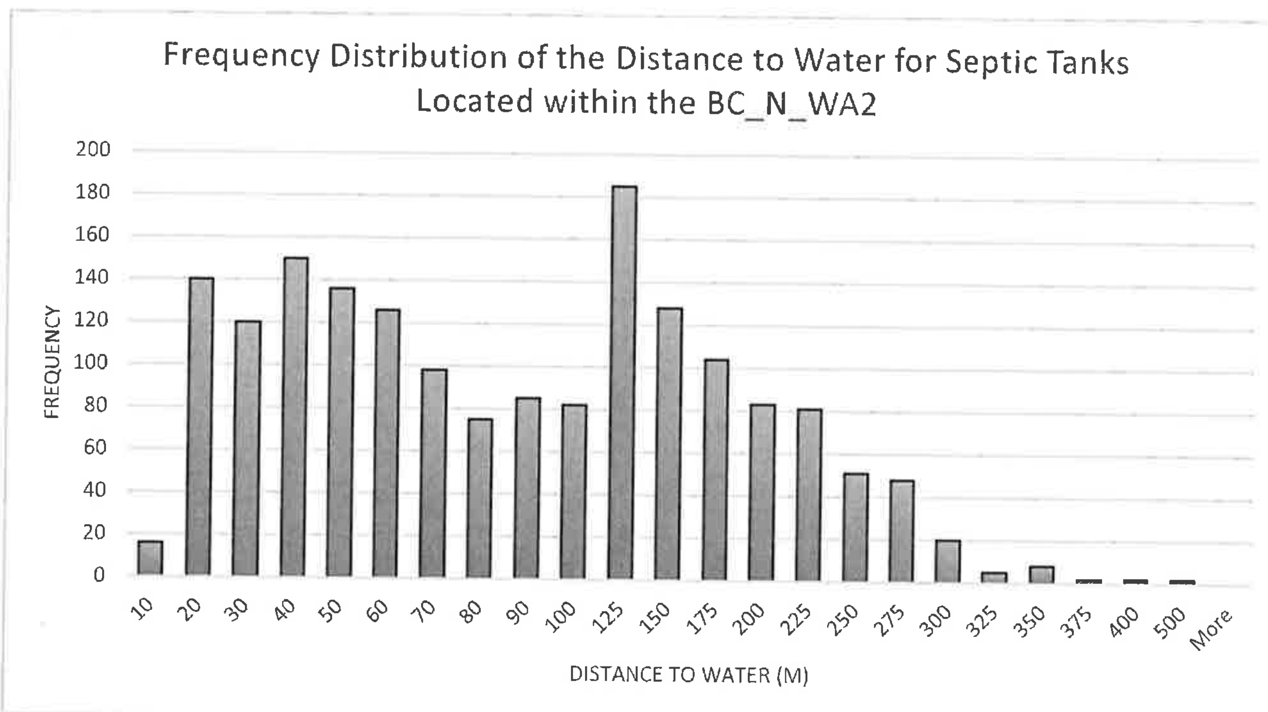


Figure 12. Frequency Distribution of septic tanks by distance to waterbodies within North WA2.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix B. Out of the 1747 septic tanks that generated plume paths, 71% of these (964 OSTDS) were predicted to generate nitrate or ammonia plumes that loaded into a waterway.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are included in Figure 13. Variability of individual septic tank loading contribution to nearby waterbodies is very high, particularly for the 10-60 m distance classes (Figure 14). Highest mean individual septic tank loading is predicted for the 10-60-m distance classes (3.2-5.1 lbs. TN/yr). These values are reduced to <3 lbs N/yr in the 70-200-m distance classes, and further reduced to <2 lbs N/yr at >200-m distances.

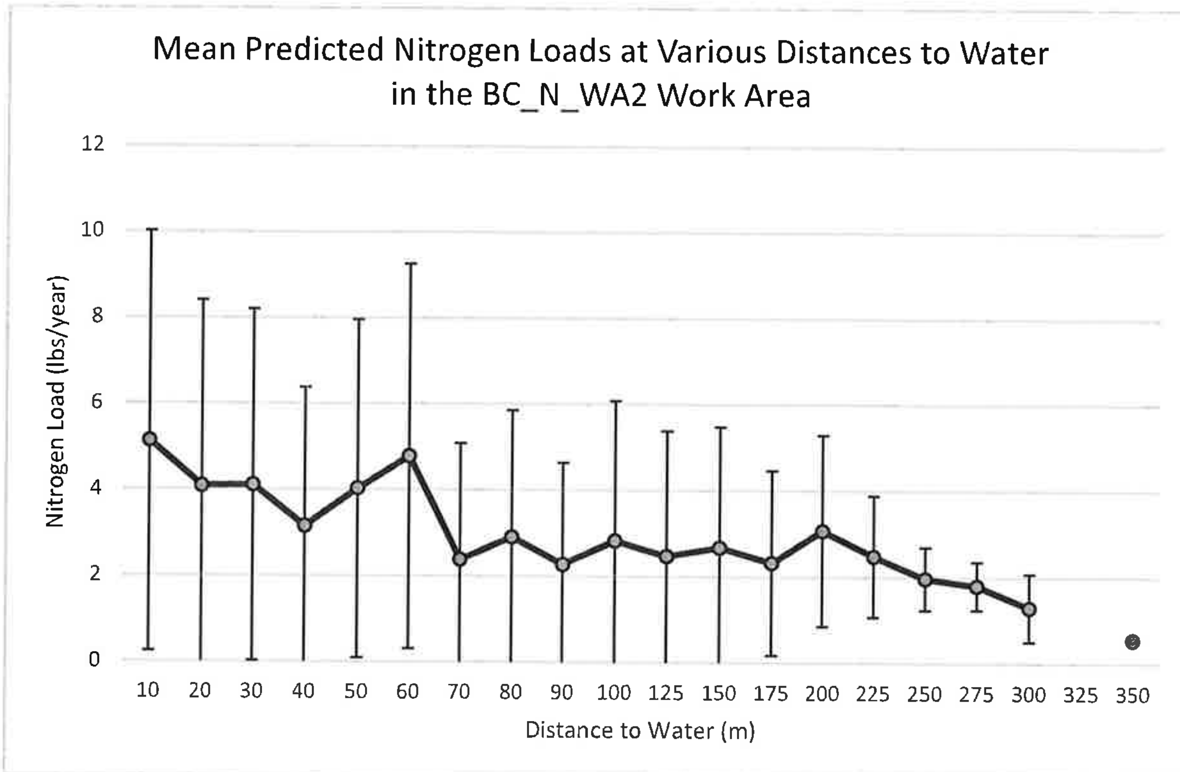


Figure 13. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for North WA2. Standard deviation was included as error bars.

Median nitrogen loading contributions present a subtler reduction with distance, with medians above 2 lbs/year for septic tanks within the first 60-m from a waterbody, and gradually reducing to <2 lbs N/yr >60-m distances. Examining the 75th percentile of the data for each category, the reductions are more noticeable, with values as high as 9 lbs N/yr within the first 60-m and never exceeding 5 lbs N/yr at greater distances (Figure 14).

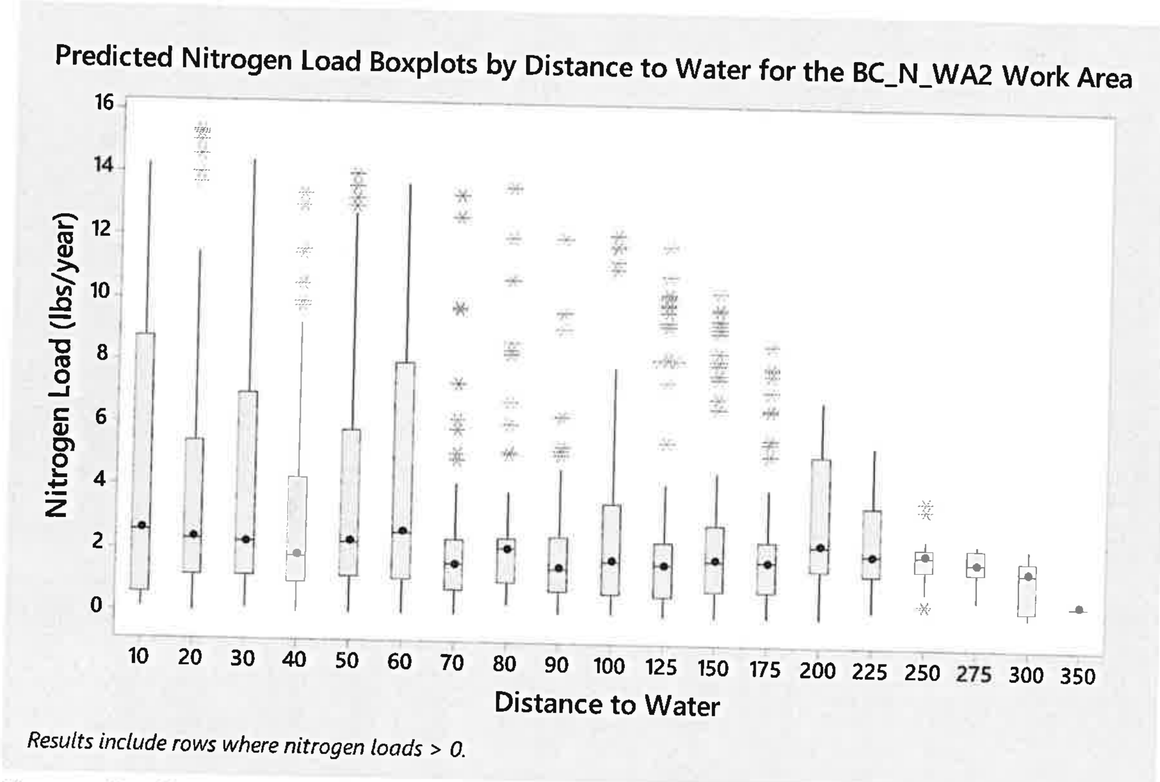


Figure 14. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for North WA2.

Septic tanks located in the first 60 m from a waterway have the greatest impact in the loading, with highest relative contribution to the total loading of this areas of 8% of greater for each of the following distance classes: 10-20m, 20-30m, 30-40m, 40-50m, and 50-60 m. Cumulatively, even though only 39% of the total OSTDS are located within the first 60 m from the water, they account for 54% of all the loading (Figure 15). An uptick in the relative percentage of loading contribution is also visible from the OTDS located within the 100-150 m distance intervals, totaling about 15% of the total loading. Most of this high relative contribution of the loading can be explained by the total number of septic tanks located at these distance intervals as well (267 tanks or 15% of all the modeled OTDS).

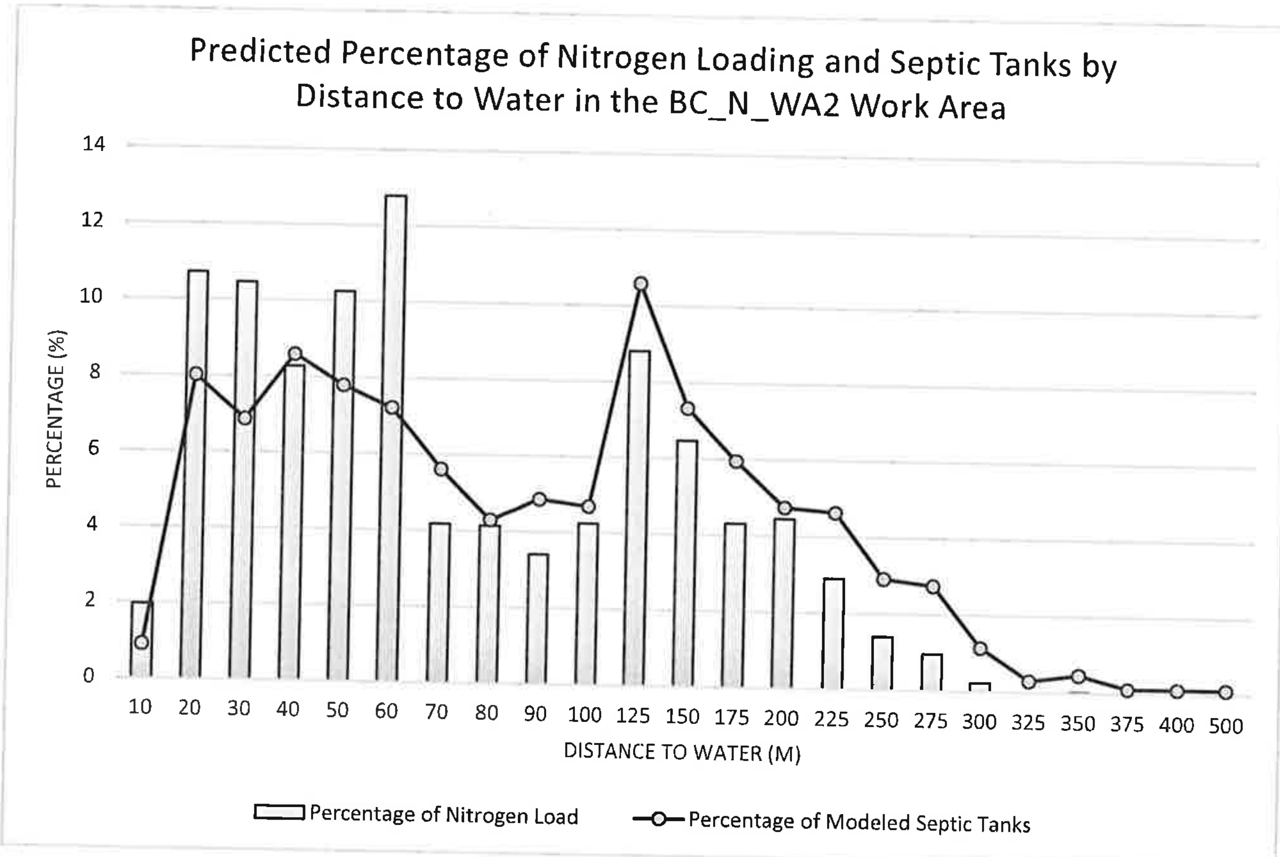


Figure 15. Percentage of total nitrogen loading and OSTDS by distance within North WA2.

Work Area North 3

The North Work Area 3 includes a large portion of Merritt Island (west Merritt Island, see Figure 1), with slightly over 50% of the soils represented by A or A/D soils, and another quarter as B/D soils (Figure 16). This work area has the third largest percentage of D soils (poorly drained) from all 16 work areas representing the county.

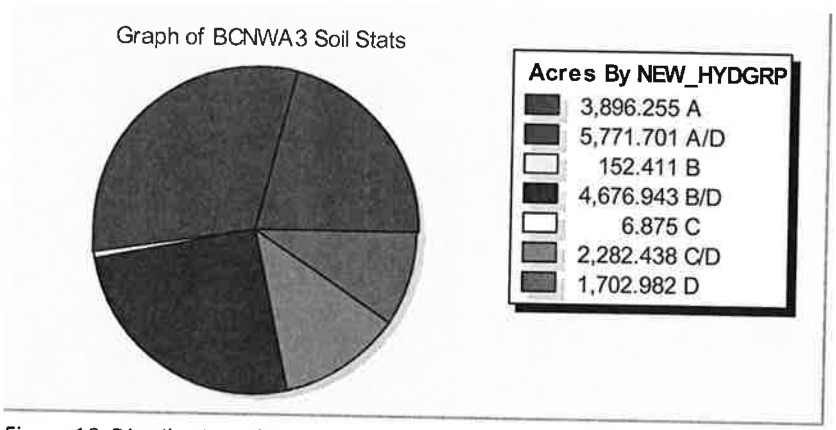


Figure 16. Distribution of the soil coverage by hydrologic group for North WA3.

In this North Work Area 3, 1,800 septic tanks were modeled for loading potential to nearby waterways. This represents 38% of all the OSTDS in this work area (4,733 total), randomly selected using a random seed number generator in the GIS environment. Due to the high channelization of this area, a larger percentage of septic tanks are located within 50-m of a waterbody/channel (883 septic tanks). Over 77% of all the septic tanks (1356) in this work area are located within 100-m of any waterbody (Figure 17). Unlike in previous northern work areas, there were no septic tanks found to be located further than 325-m from a waterbody.

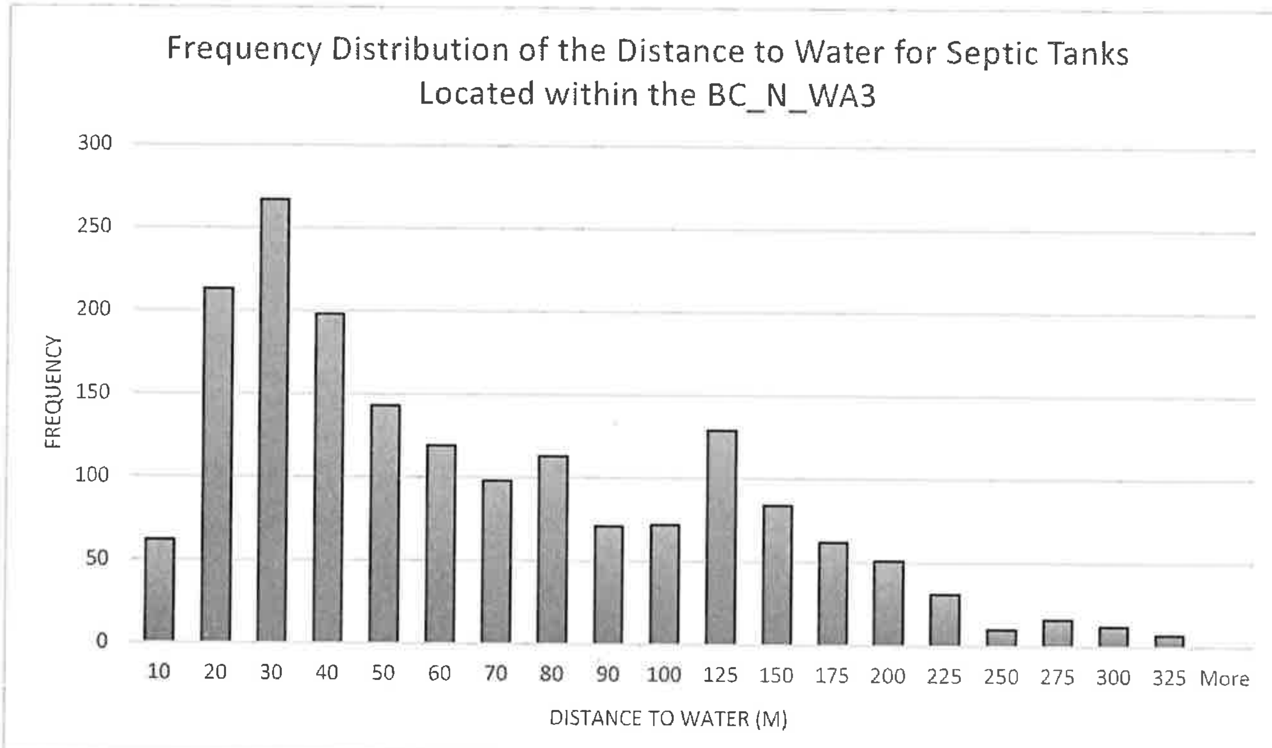


Figure 17. Frequency Distribution of septic tanks by distance to waterbodies within North WA3.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix C. Out of the 1758 septic tanks that generated plume paths, about a 66% of these (1161 OSTDS) generated nitrate or ammonia plumes that loaded into a waterway.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are included in Figure 18. As for previous work areas (maybe even more obvious), variability of individual septic tank loading contribution to nearby waterbodies is very high for the 10-150-m distance categories, with a broader distribution of the dataset around the 0-10-m distance class (Figure 19Figure 18). Highest per septic tank loading is for those tanks within 10-m of the waterbodies (mean of 4 lbs/year), rapidly dropping to half the loading impact by 50-m. Mean per septic tank values are further reduced to around 1.5 lbs/year at the 80-m distance from septic tanks, fluctuating between 1-1.5 lbs/year until distances >200-m. Mean septic tank loadings were detected for all distance classes in this work area.

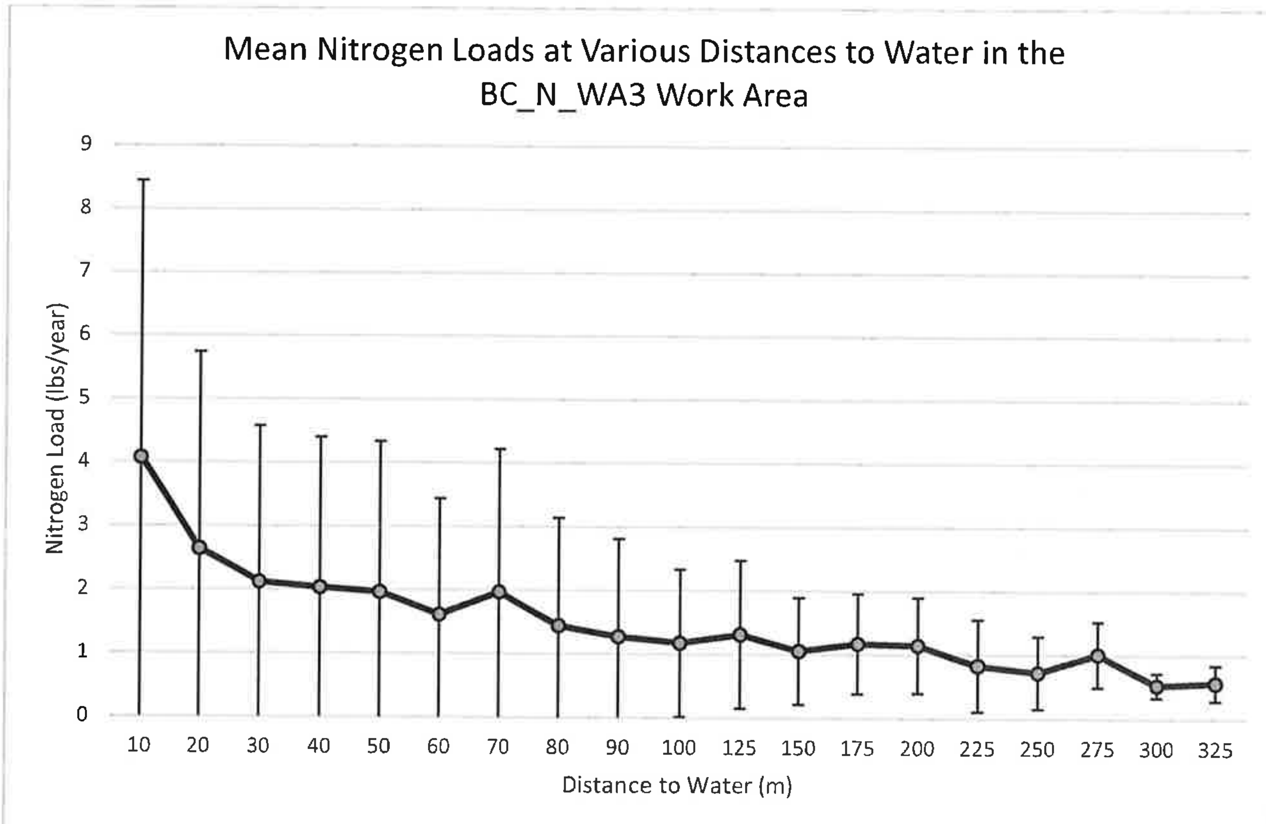
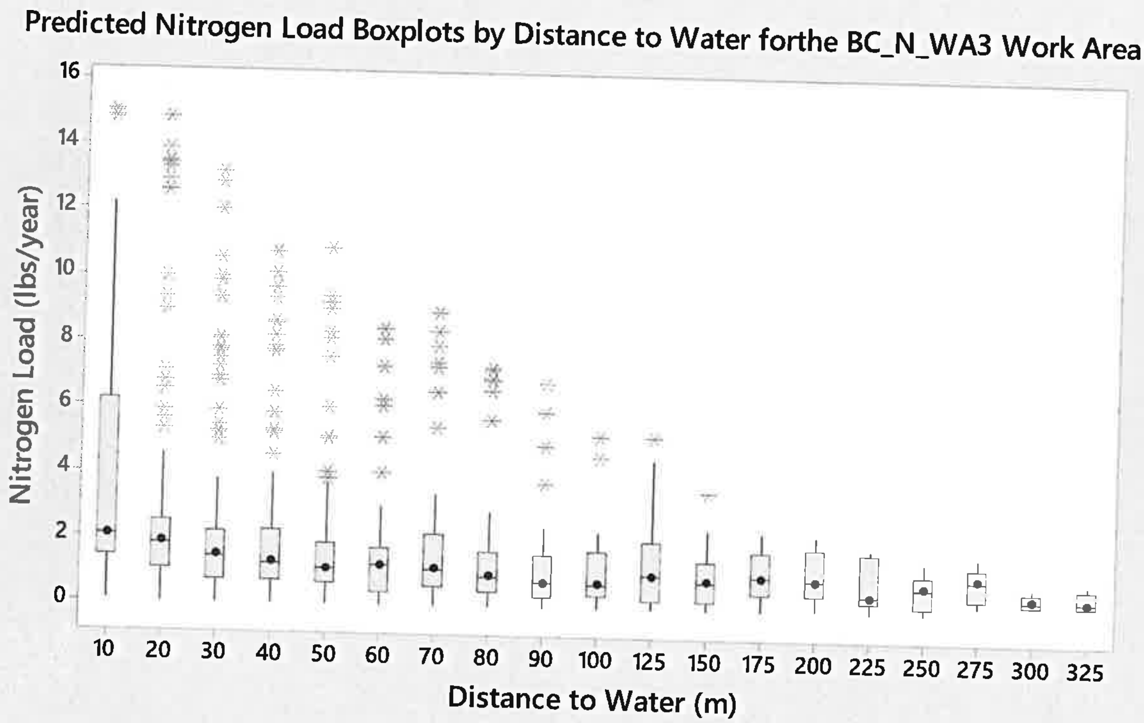


Figure 18. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for North WA3. Standard deviation was included as error bars.

Median nitrogen loading contributions present a more gradual reduction with distances, with medians above 2 lbs/year at 10-m, and gradually reducing to 1.4 at 30-m and final reaching below 1 lb/year at 80-m distance (Figure 19).



Results include rows where predicted nitrogen loads > 0.

Figure 19. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for North WA3.

Septic tanks located in the first 40 m from a waterway have the greatest impact in the loading, with highest relative contribution to the total loading of this areas of 8% of greater for each of the following distance classes: 10-20m, 20-30m, and 30-40m. Cumulatively, the total loading contribution from the septic tanks located within the first 40-m makes up 61% of the total work area's nitrogen loading (Figure 20). Expanding to include all the OTDS located within the first 60-m from the water (57% of all the OTDS), 74% of all loading into the waterways are captured. Relative loading contribution of septic tanks to the water decreases gradually with increased distanced, with the exception of around 100-125 m. This increase is mostly derived by the number of OTDS located within this distance, 129 or >7% of all modeled septic tanks.

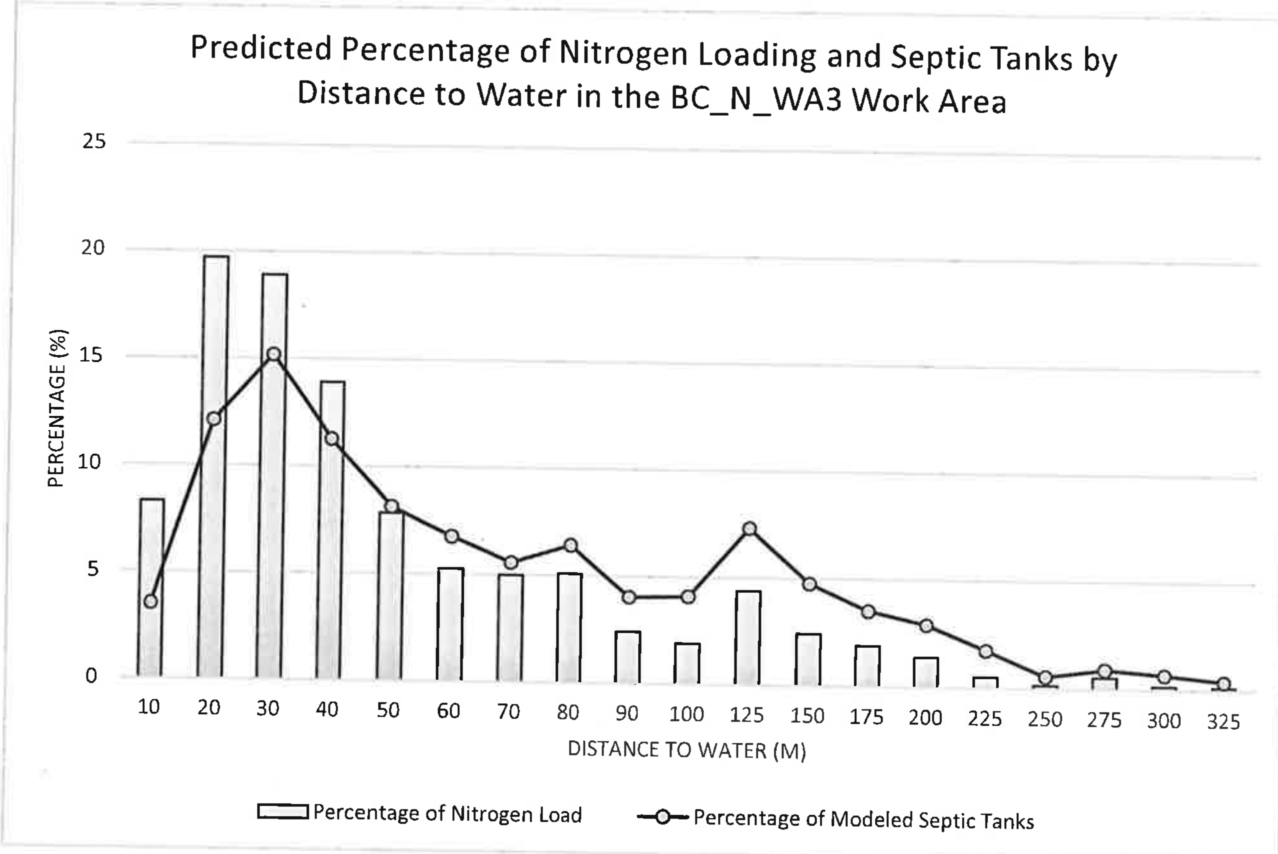


Figure 20. Percentage of total nitrogen loading and OSTDS by distance within North WA3.

Work Area North 4

The North Work Area 4 includes a large portion of eastern Merritt Island and the Barrier Island from Cape Canaveral to Cocoa Beach (Figure 1), with slightly over 60% of the soils represented by A or A/D soils, and another quarter as D soils (Figure 21). This work area has the largest percentage of D soils (poorly drained) from all examined work areas within the County.

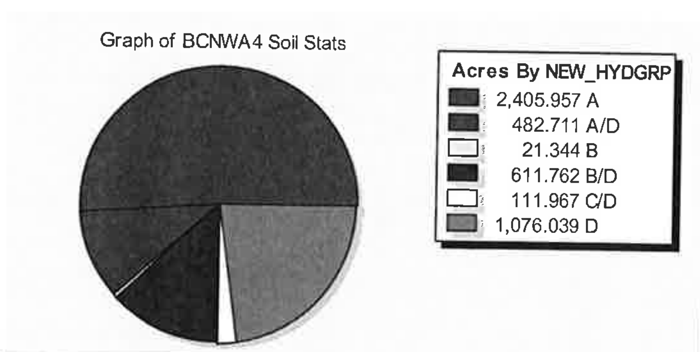


Figure 21. Distribution of the soil coverage by hydrologic group for North WA4.

In this North Work Area 4, all the septic tanks (1,091 total) were modeled for loading potential to nearby waterways, providing 100% representation of the OTDS loading on this smaller work area. Due to the location of the work area (Merritt Island and Barrier Island), with extensive exposure to canals and the Banana River Lagoon, over 62% of the septic tanks are located within 50-m of a waterbody/channel, and 83% within 100-m of water (Figure 22). No septic tanks were found at distances beyond 250-m from a waterbody in this area.

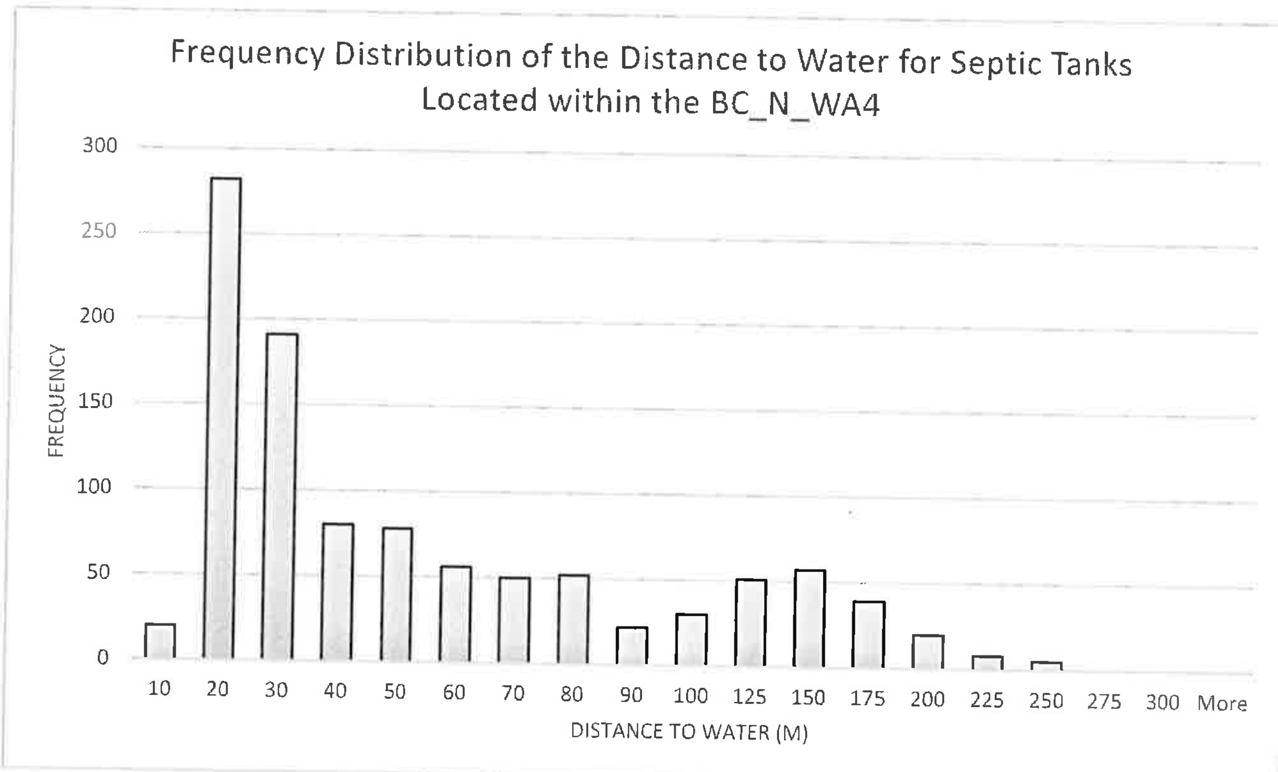


Figure 22. Frequency Distribution of septic tanks by distance to waterbodies within North WA4.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix D. Out of the 1041 septic tanks that generated plume paths, only a small fraction (185 or 18%) generated nitrate or ammonia plumes that did not reach a waterway.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are included in Figure 23Figure 18. The variability of individual septic tank loading contribution to nearby waterbodies is very high for the first few distance categories (10-50 m), unlike the previous northern work areas (Figure 23 and Figure 24). Highest per septic tank loading is for those tanks within 10-m of the waterbodies (mean of 4.2 lbs/year), rapidly dropping to less than half (1.5 lbs/year) by 60-m. Mean per septic tank values are further reduced to below 1 lb/yr at distances greater than 100-m. Mean septic tank loadings were detected for all distance classes in this work area, with exception of the 225-250-m distance class.

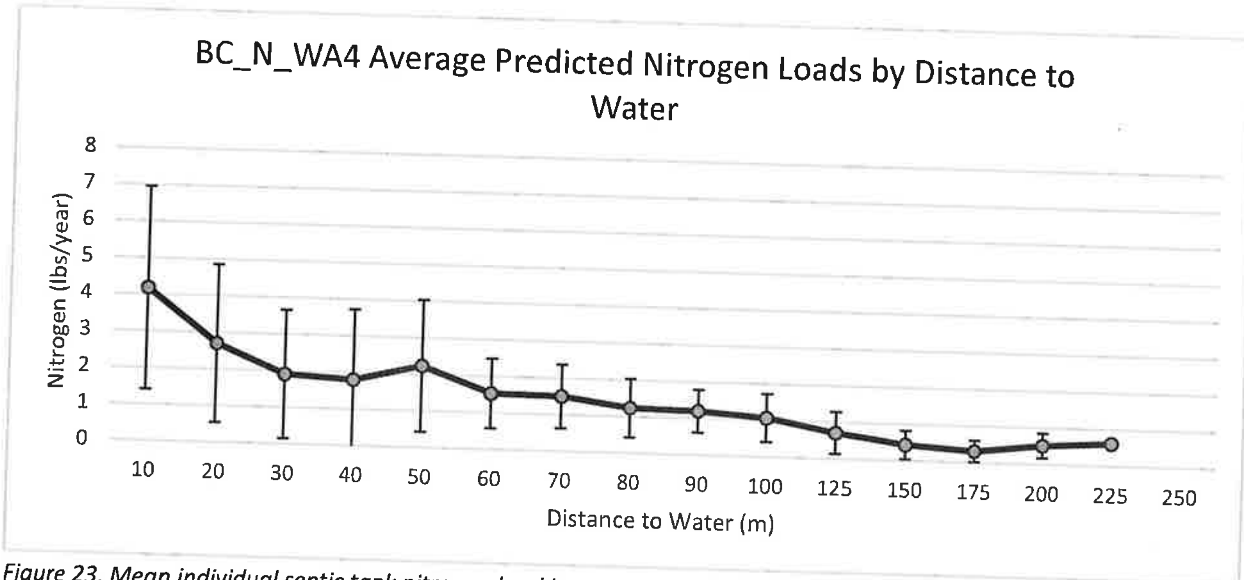


Figure 23. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for North WA4. Standard deviation was included as error bars.

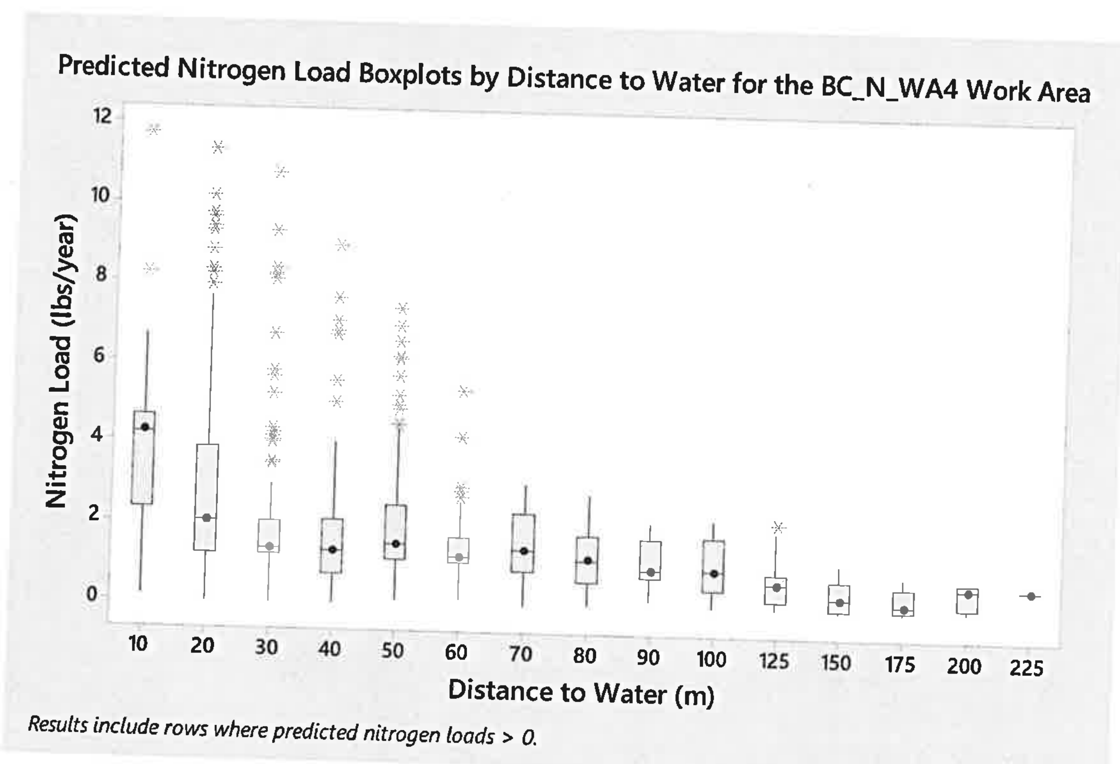


Figure 24. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for North WA4.

Septic tanks located between 10-30-m from a waterway have the greatest impact in the loading with both distance classes (10-20 and 20-30-m), contributing to >18% each to the total area loading. Cumulatively, the total loading contribution from the septic tanks located within the first 40-m makes up 65% of the total work area's nitrogen loading (Figure 25). Expanding to include all the OTDS located within the first 50-m from the water (63% of all the OTDS), allows 82% of all the area's loading into the waterways to be captured. The contribution of all the septic tanks located beyond 80-m corresponds to less than 6% of the total North Area 4 loading.

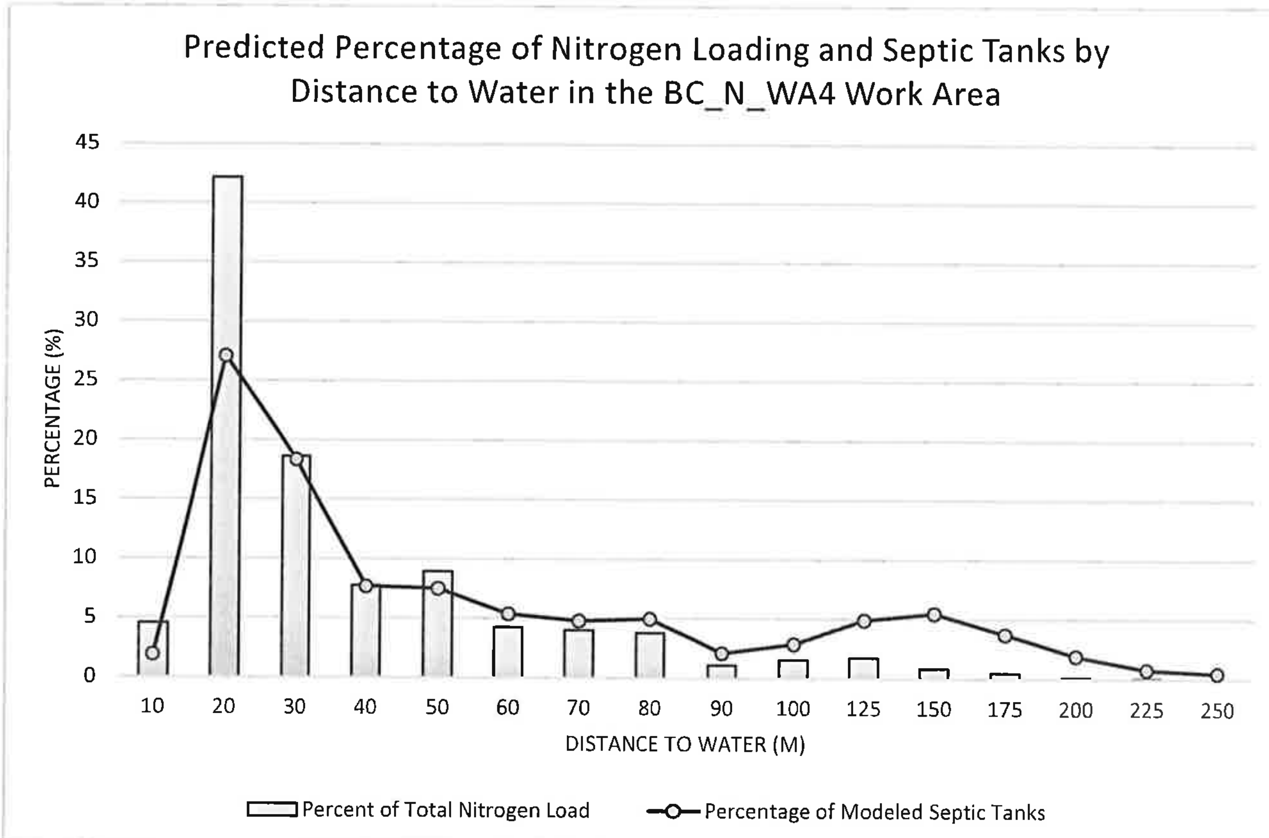


Figure 25. Percentage of total nitrogen loading and OSTDS by distance within North WA4.

Work Area North 5

The North Work Area 5 includes south Rockledge through Melbourne and a small portion of Merritt Island (Figure 1), with slightly over 50% of the soils represented by A or A/D soils, and most the remainder dominated by B/D (Figure 26). This work area has insignificant amounts of C/D and D soils (poorly drained).

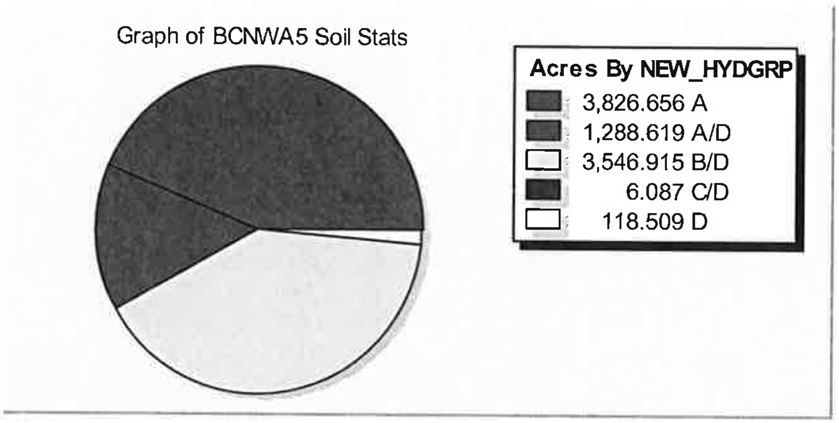


Figure 26. Distribution of the soil coverage by hydrologic group for North WA5.

For this North Work Area 5, all the septic tanks (1,791 total) were modeled for loading potential to nearby waterways, providing 100% representation of the OTDS loading on this smaller work area. About 57% of the septic tanks are currently located within 50-m of a waterbody/channel, and 84% within 100-m of water (Figure 27). No septic tanks were found at distances beyond 250-m from a waterbody in this area.

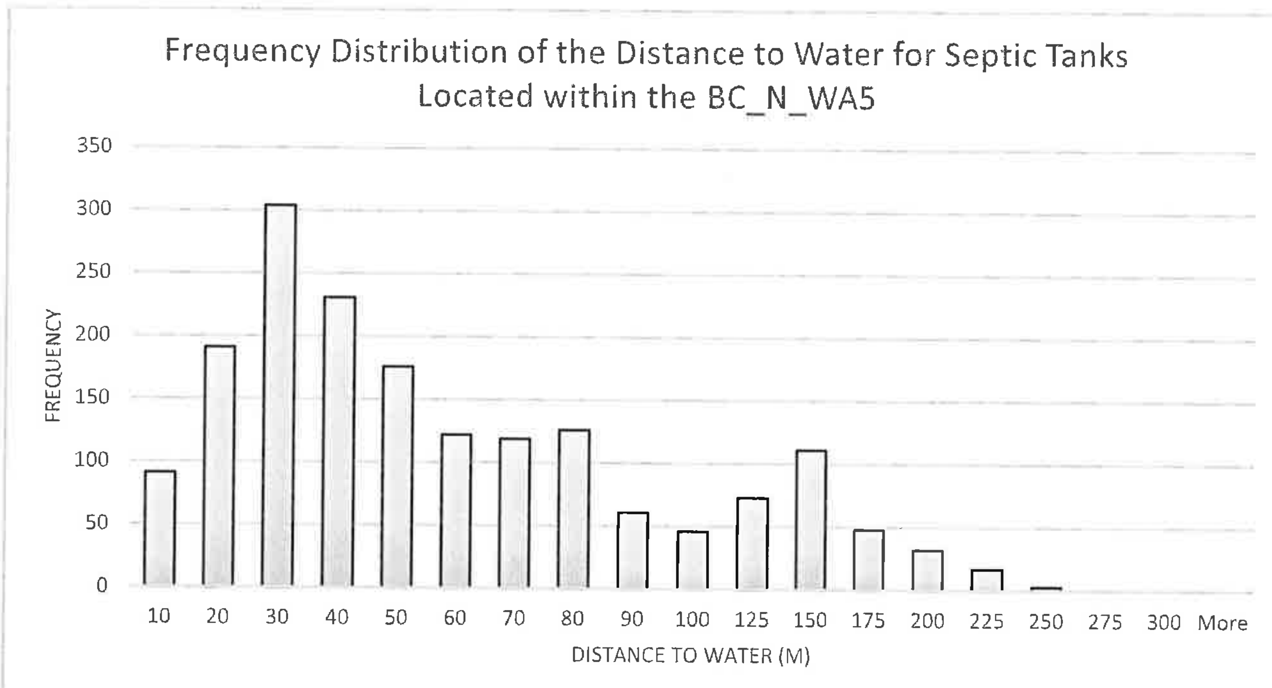


Figure 27. Frequency Distribution of septic tanks by distance to waterbodies within North WA6.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix E. Out of the 1751 septic tanks that generated plume paths, only a small fraction (229 or 13%) generated nitrate or ammonia plumes that did not reach a waterway.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are included in Figure 28Figure 18. The variability of individual septic tank loading contribution to nearby waterbodies is very high for the most distance categories up to 150-m, with greater number of outliers in the first seven distance categories (10-70-m, Figure 29). Highest per septic tank loading is for those tanks within 10-m of the waterbodies (mean of 4.6 lbs/year), more gradually sloping to 2.6 lbs/yr at 60-m than North Work Area 4. Mean per septic tank values are further reduced to below 2 lbs/yr at distances greater than 100-m. Mean septic tank loadings were detected for all distance classes in this work area with similar mean per septic tank loadings for distances classes between 100-250-m.

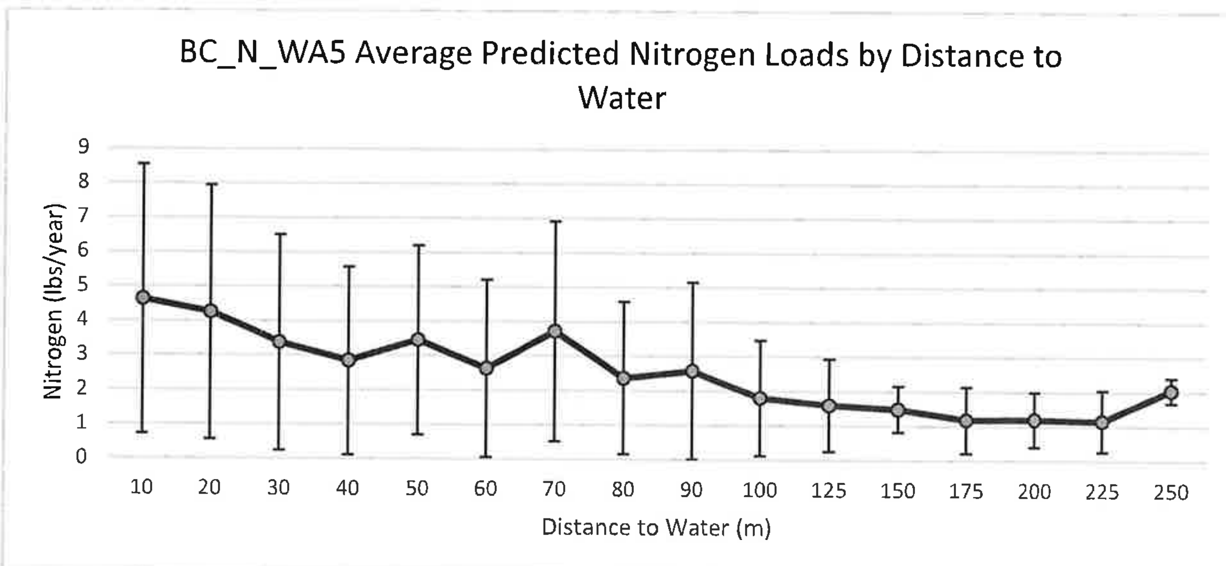


Figure 28. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for North WA5. Standard deviation was included as error bars.

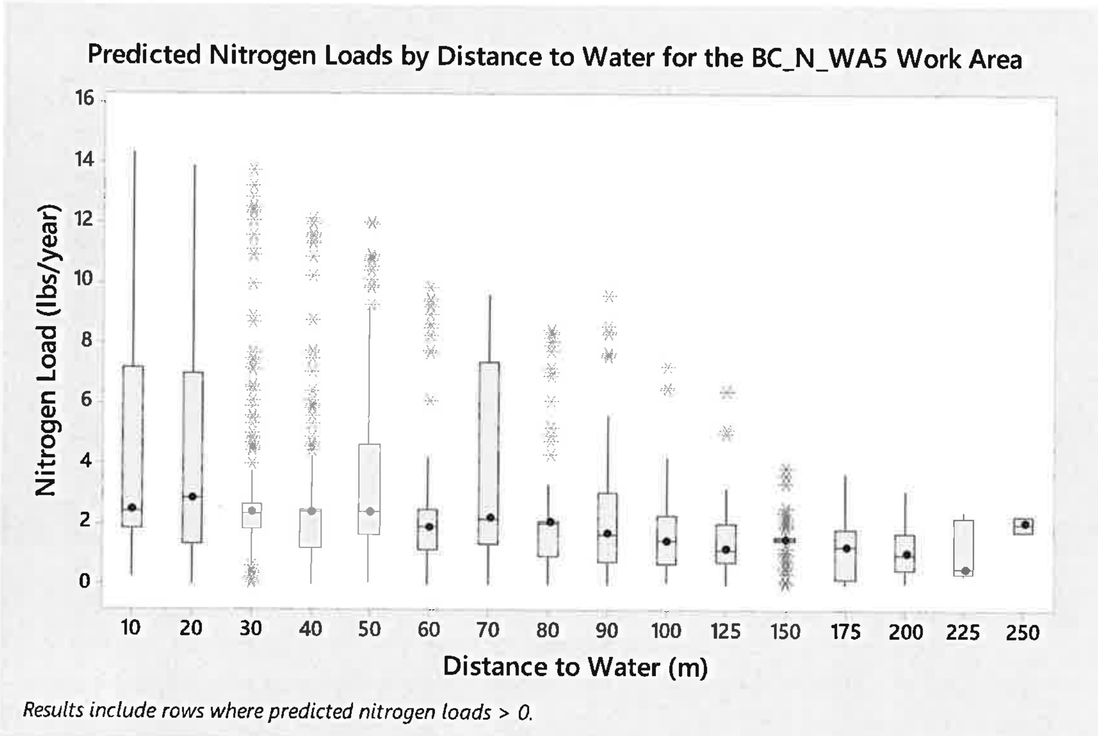


Figure 29. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for North WA5.

Septic tanks located between 0-70-m from a waterway have the greatest impact in the loading with each of the following distance classes contributing more than 8% of the total area loading: 10-20, 20-30-m, 30-40-m, 40-50m, and 60-70-m. Cumulatively, the total loading contribution from the septic tanks located within the first 70-m makes up 82% of the total work area's nitrogen loading (Figure 30). Expanding to include all the OTDS located within the first 100-m from the water (84% of all the OTDS), allows 92% of all the area's loading into the waterways to be captured. The contribution of all the septic tanks located beyond 100-m corresponds to less than 8% of the total North Area 5 loading.

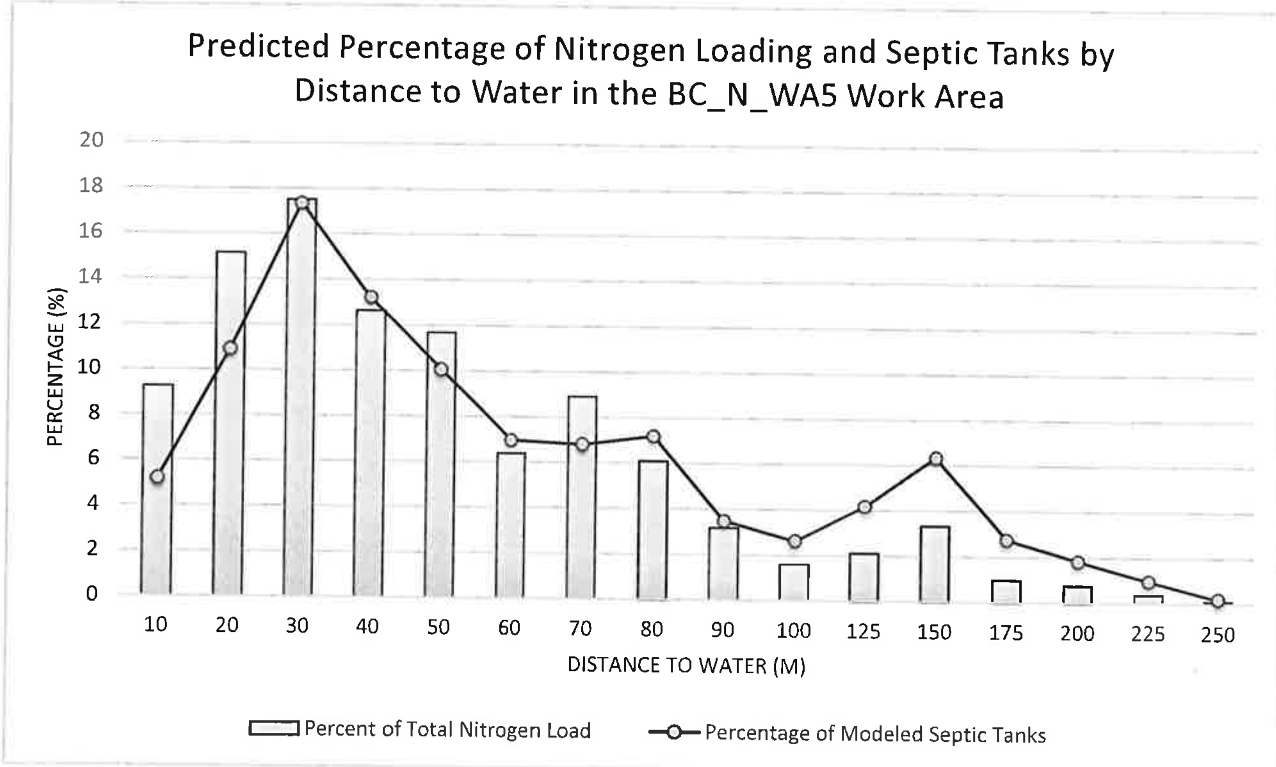


Figure 30. Percentage of total nitrogen loading and OSTDS by distance within North WA5.

Work Area North 6

The final northern area included in the preliminary analysis includes a portion of the Barrier island (Indian Harbour Beach, Satellite and portions of Patrick Air Force Base) and southern Merritt Island (Figure 1). Unlike in previously described work areas, the soils in this work area are dominated by A soils, with a very small percentage of remaining hydrologic groups (Figure 31).

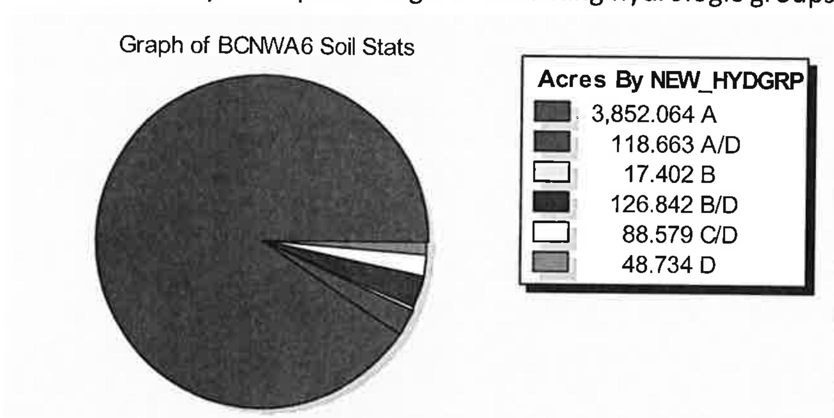


Figure 31. Distribution of the soil coverage by hydrologic group for North WA3.

A much smaller number of septic tanks is included in the modeling of this work area (456 of 100% of the OTDS were included), with 241 of these located within the immediate vicinity of a waterway/waterbody. Over 83% of all the septic tanks (365) in this work area are located within 100-m of any waterbody (Figure 32). Only 15 septic tanks were located >300-m distances from waterbodies within North Work Area 6.

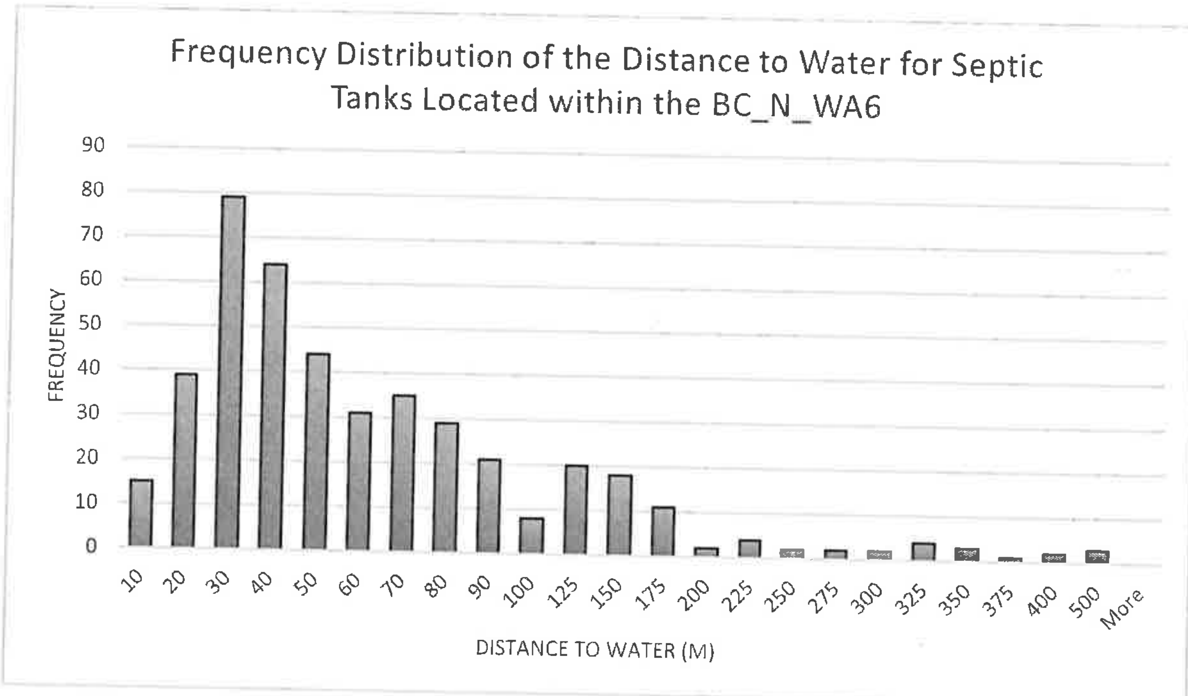


Figure 32. Frequency Distribution of septic tanks by distance to waterbodies within North WA6.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix F. Out of the 439 septic tanks that generated plume paths, only a small fraction (83 or 19%) generated nitrate or ammonia plumes that did not reach a waterway.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are included in Figure 33. As expected and previously reported for the other work areas, mean per septic tank contribution is highest for the shortest distances. However, in this work area, there is a lot of fluctuation in the 3-4 lbs N/year in the first 80-m, followed by a clear reduction in per septic tank contribution at greater than 80-m distances. Negligible per septic tank loading contribution was predicted at >175-m distances.

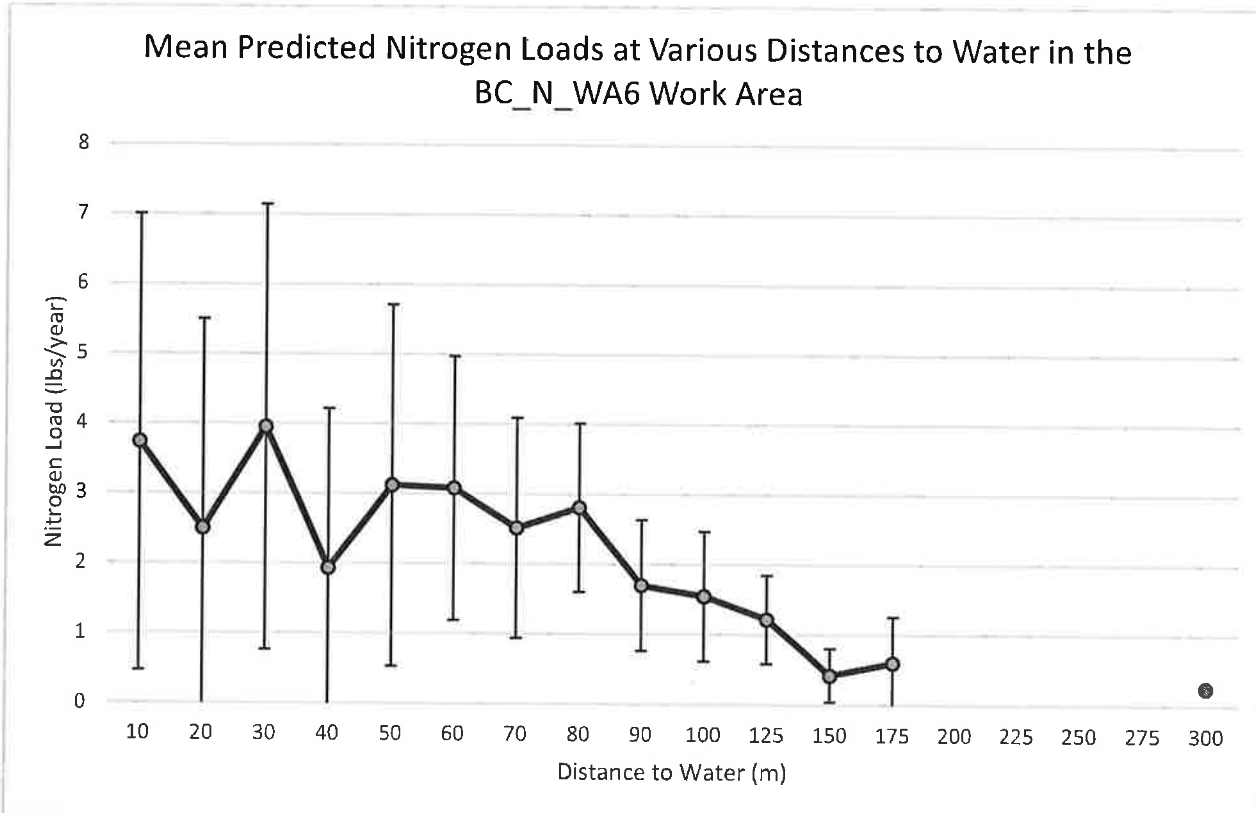


Figure 33. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for North WA6. Standard deviation was included as error bars.

Median nitrogen loading contribution values, per septic tank, are similar from the 10 to 80-m distance categories, with greatest variability at the 10-, 30-, and 50-m distance classes. Median loading values gradually drop after the 80-m class, with a more significant reduction for the >125-m distances. (Figure 34).

Septic tanks located between 10-80-m from a waterway have the greatest impact in the loading with each of the following distance classes contributing more than 6% of the total area loading: 10-20, 20-30-m, 30-40-m, 40-50m, 60-70-m, and 70-80-m. Cumulatively, the total loading contribution from the septic tanks located within the first 80-m makes up 94% of the total work area's nitrogen loading (Figure 35). Interestingly, the 20-30-m distance class provides the largest contribution (30% of the total loading) of any examined distance class. This is partially explained by a slightly higher per septic tank loading mean (Figure 33) and a large percentage of OTDS within this distance category (18% of all OTDS within the work area). The contribution of all the septic tanks located beyond 80-m corresponds to less than 7% of the total North Area 6 loading.

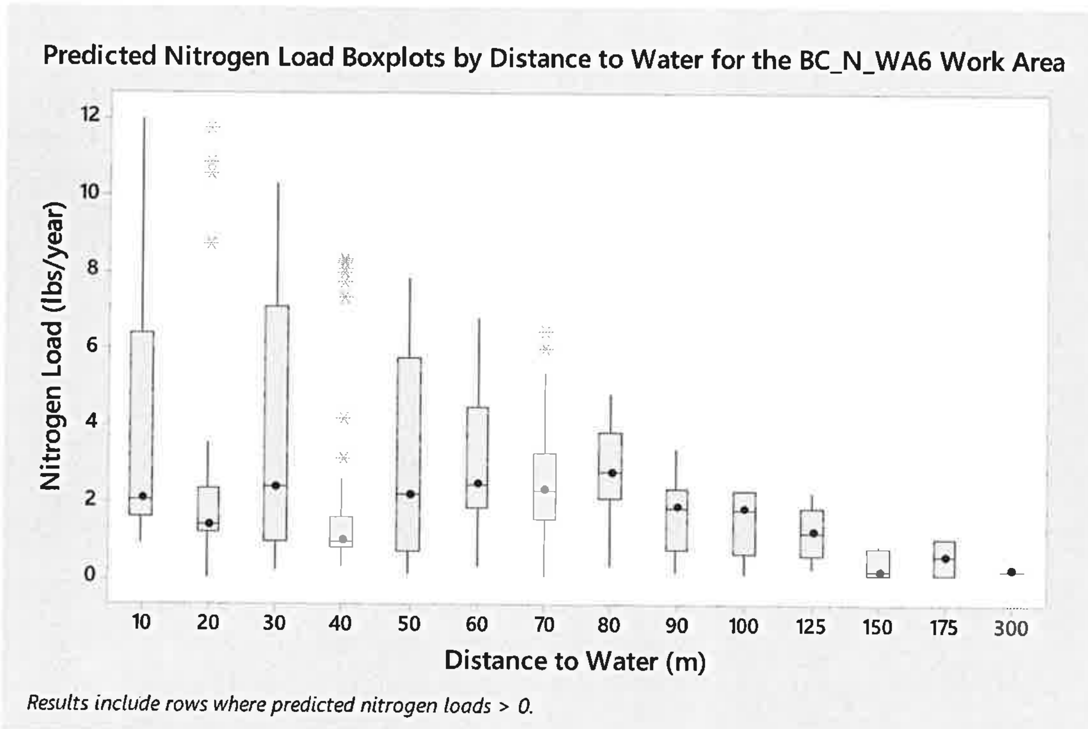


Figure 34. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for North WA6.

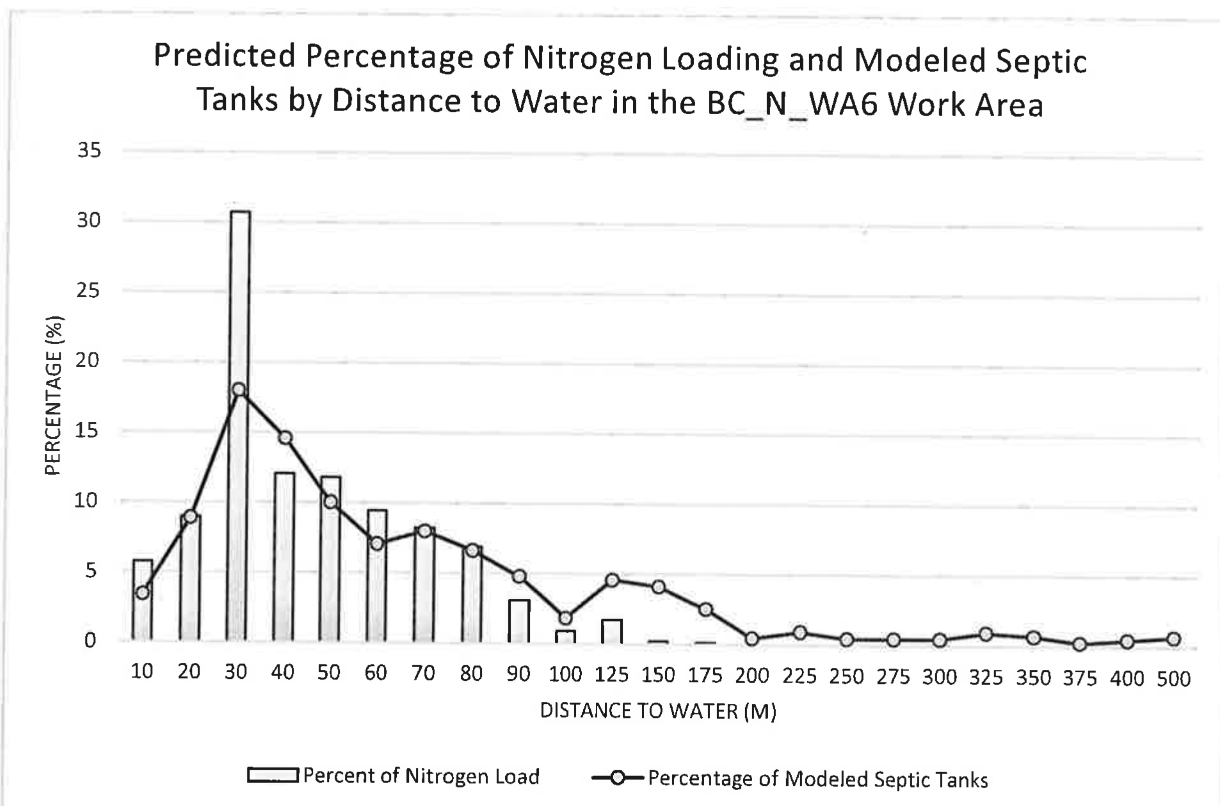


Figure 35. Percentage of total nitrogen loading and OSTDS by distance within North WA6.

Work Area South 1

The South Work Area 1 includes the southernmost mainland area of the County, representing the area north of Sebastian River, such as the Micco area (Figure 2). The soils in this work area are dominated by over 50% A/D soils, about 23% A soils, and the remainder mostly B/D soils. (Figure 36).

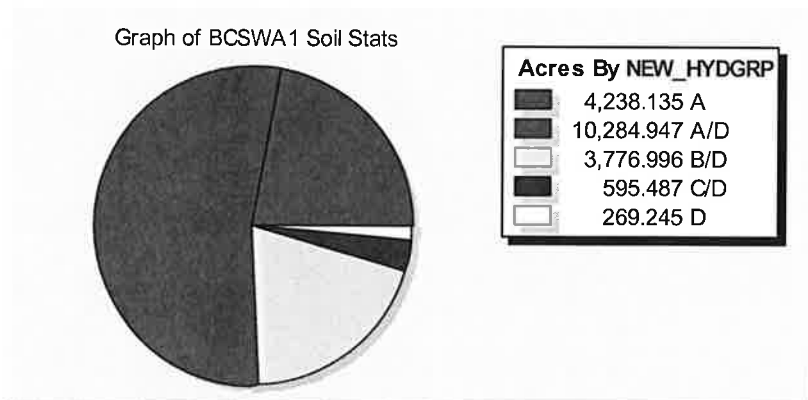


Figure 36. Distribution of the soil coverage by hydrologic group for South WA1

In South Work Area 1, all the septic tanks (982 total) were modeled for loading potential to nearby waterways, providing 100% representation of the OTDS loading of this less dense area. A large portion of the septic tanks in this area are located closer to the Indian River Lagoon or Sebastian River, where most of the development has historically taken place. Due to this, over 64% of the septic tanks are located within 50-m of a waterbody/channel, and 87% within 100-m of water (Figure 37). No septic tanks were found at distances beyond 250-m from a waterbody in this area.

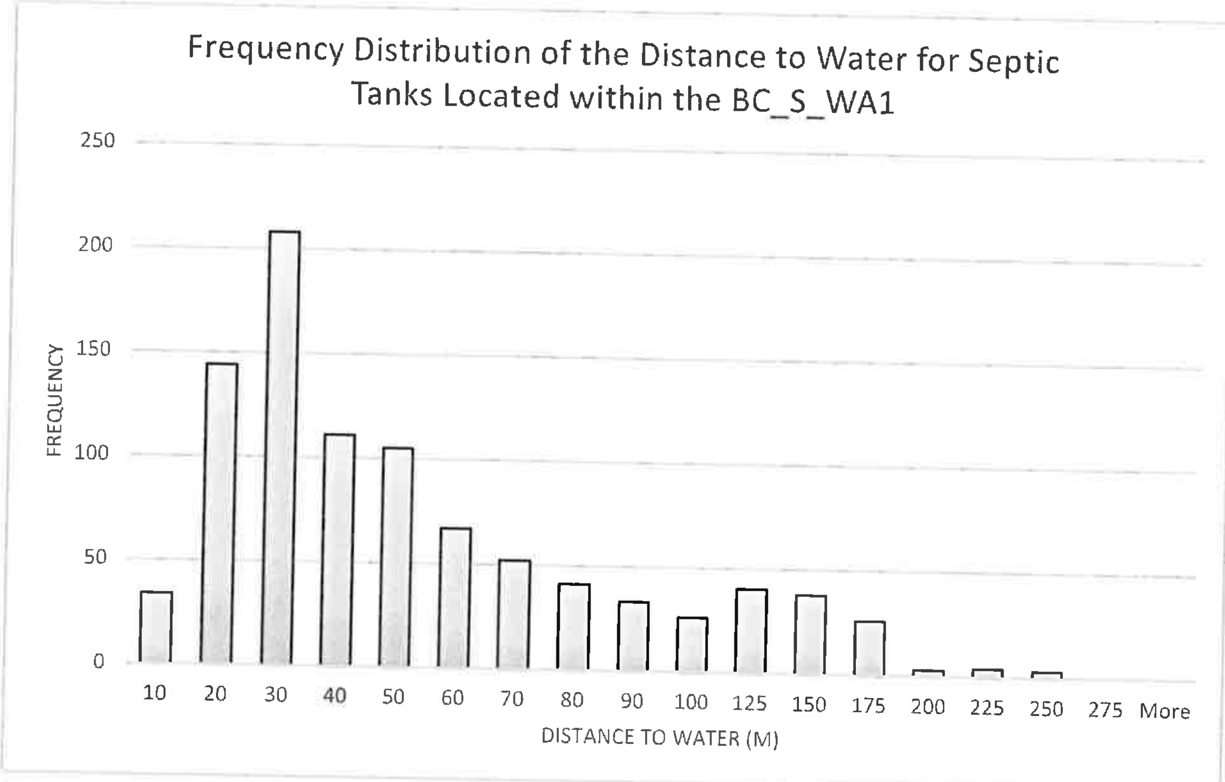


Figure 37. Frequency Distribution of septic tanks by distance to waterbodies within South WA1.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix G. Out of the 935 septic tanks that generated plume paths, only a small fraction (155 or 17%) generated nitrate or ammonia plumes that did not reach a waterway.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are included in Figure 38. Unlike previously described work areas, mean per septic tank contributions are similar for most distance classes (around 4 lbs/year), with exception of the most distant classes (> 175-m), where loads were around 2.0 lbs/year. No loading was produced for OSTDS tanks located at distances beyond 200-m. Median predicted per septic tank loading is extremely variable and not distinctly different for all distance classes (Figure 39Figure 40).

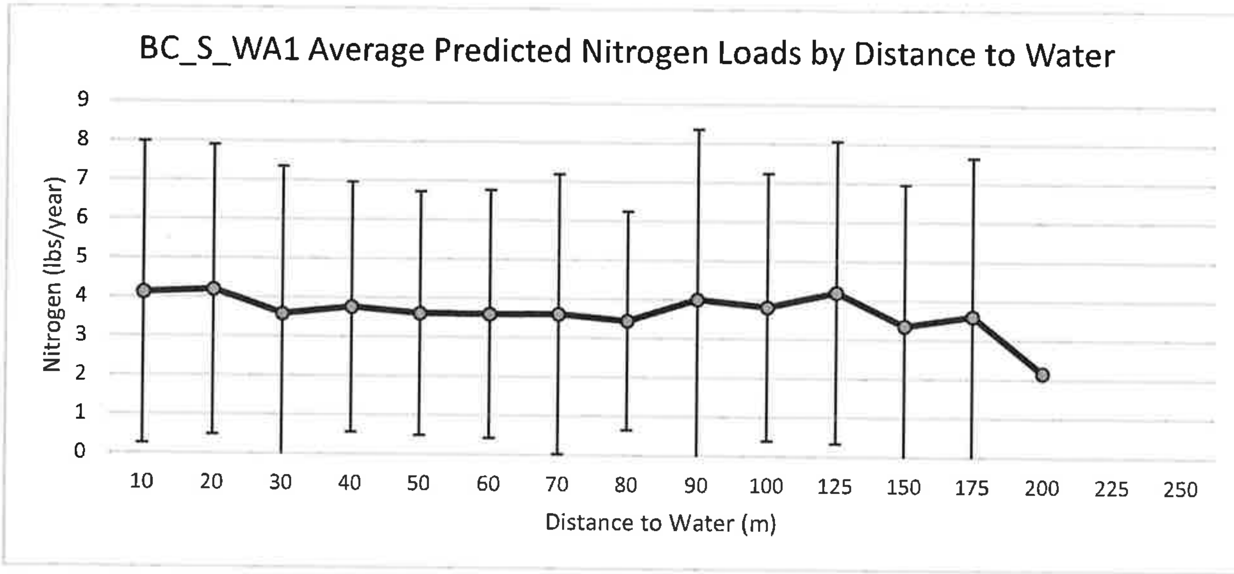


Figure 38. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for South WA1. Standard deviation was included as error bars.

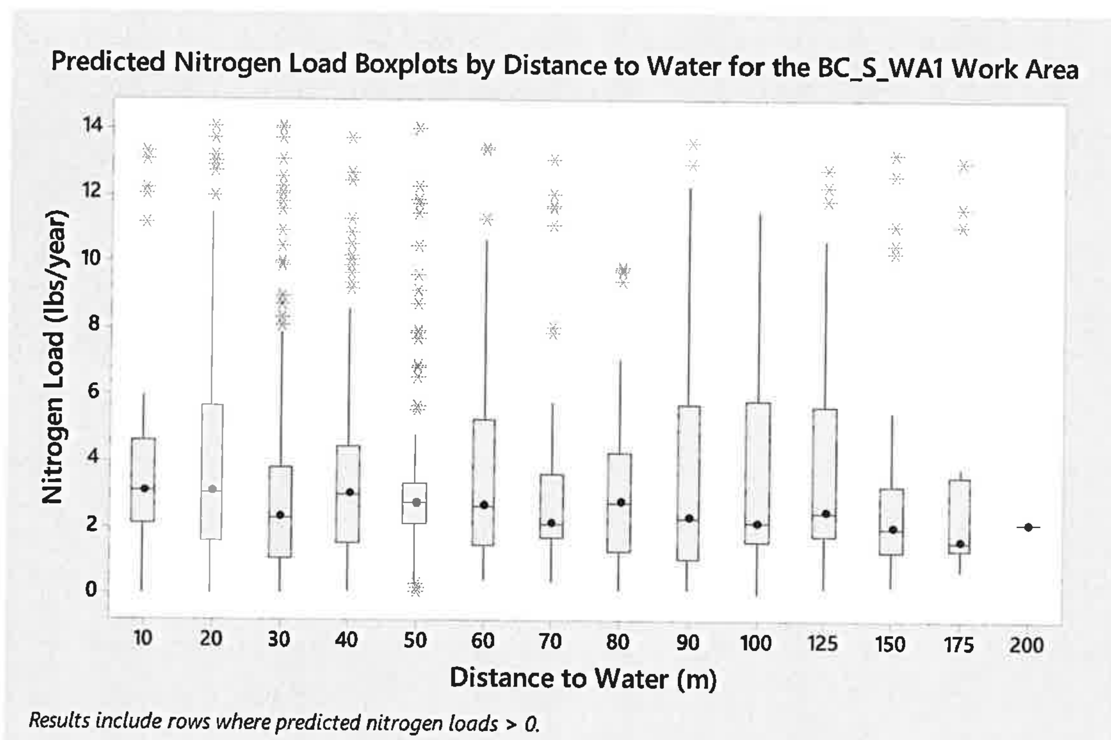


Figure 39. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for South WA1.

Septic tanks located between 10-60-m from a waterway have the greatest impact in the loading with each of the distance classes within this range contributing to greater than 7% of the total area loading. The septic tanks located within the 10-20, and 20-30-m distance classes provide a total contribution of 17 and 21%, respectively. Cumulatively, the total loading contribution from the septic tanks located within the first 60-m makes up 72% of the total work area's nitrogen loading (Figure 40). As observed in a few other work areas, such as North Work Area 6, the 20-30-m distance class provides the largest contribution of any examined distance class. In this case, this is driven by the large percentage of OTDS within this distance category (22% of all OTDS within the work area). The contribution of all the septic tanks located beyond 100-m corresponds to less than 12% of the total South Area 1 loading.

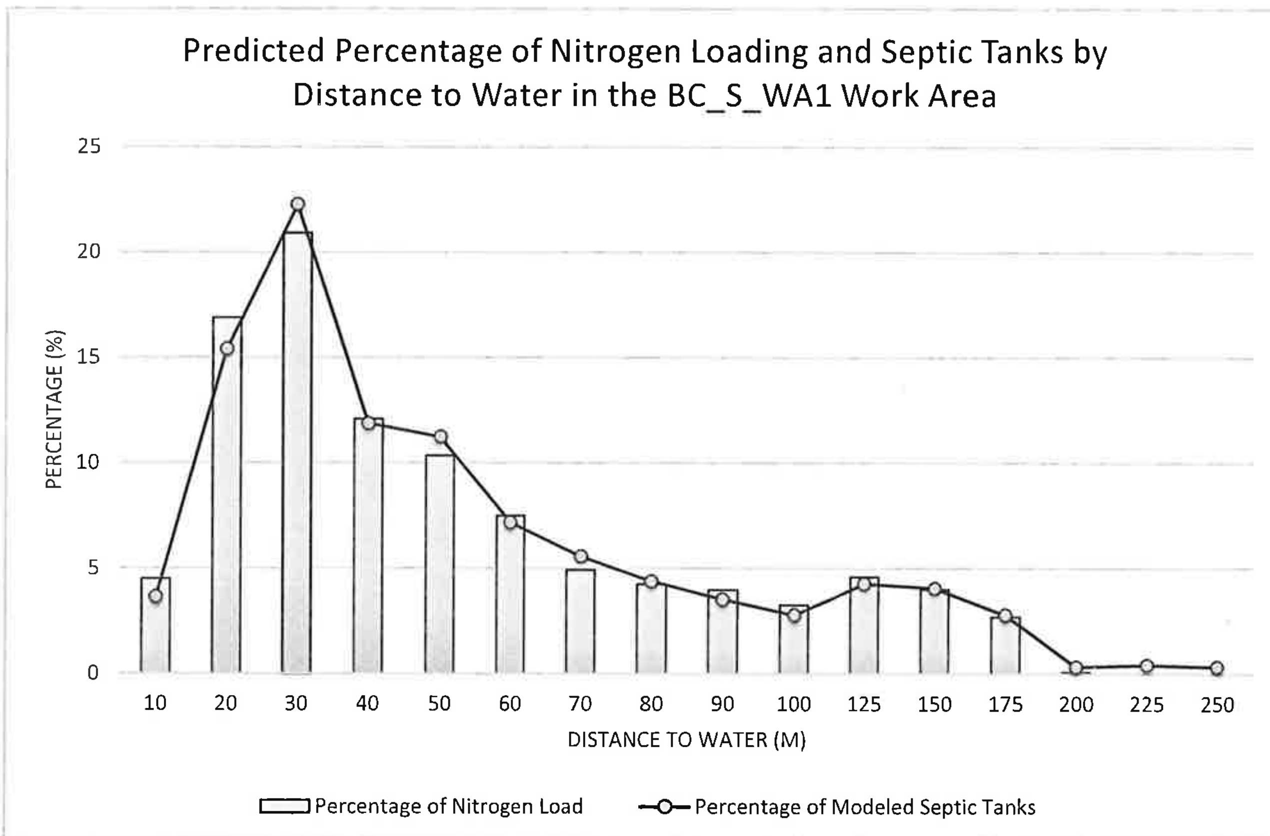


Figure 40. Percentage of total nitrogen loading and OSTDS by distance within South WA1.

Work Area South 2

The South Work Area 2 includes the southern Barrier island portion, from the Eau Gallie Causeway to Sebastian Inlet (Figure 2). The soils in this work area are in large part (~80%) dominated by A soils, with the remainder represented by poorly drained soils, C/D hydrologic group (Figure 41).

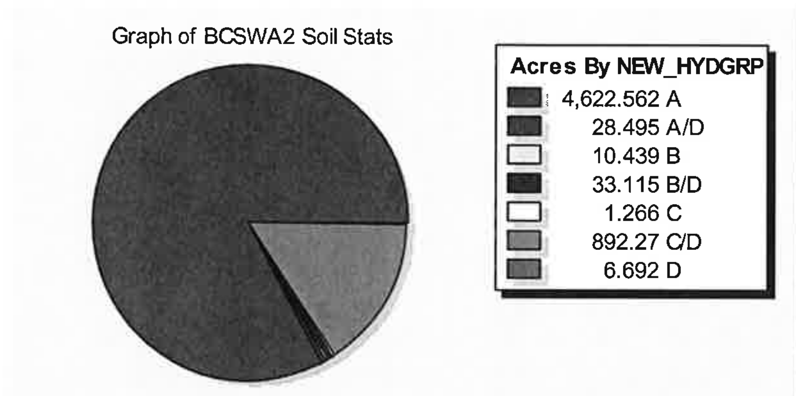


Figure 41. Distribution of the soil coverage by hydrologic group for South WA2

In the South Work Area 2, 1,800 septic tanks were modeled for loading potential to nearby waterways. This represents 71% of all the OSTDS in this work area (2,533 total), randomly selected using a random seed number generator in the GIS environment. Only 31% of the septic tanks in this area (532) are located within 50-m of any waterbody or channel and 50% located within 100-m distance from waterbodies (864 septic tanks). To include over 80% of all the septic tank locations within this work area, those located up to 200-m from a waterbody would have to be considered (Figure 42).

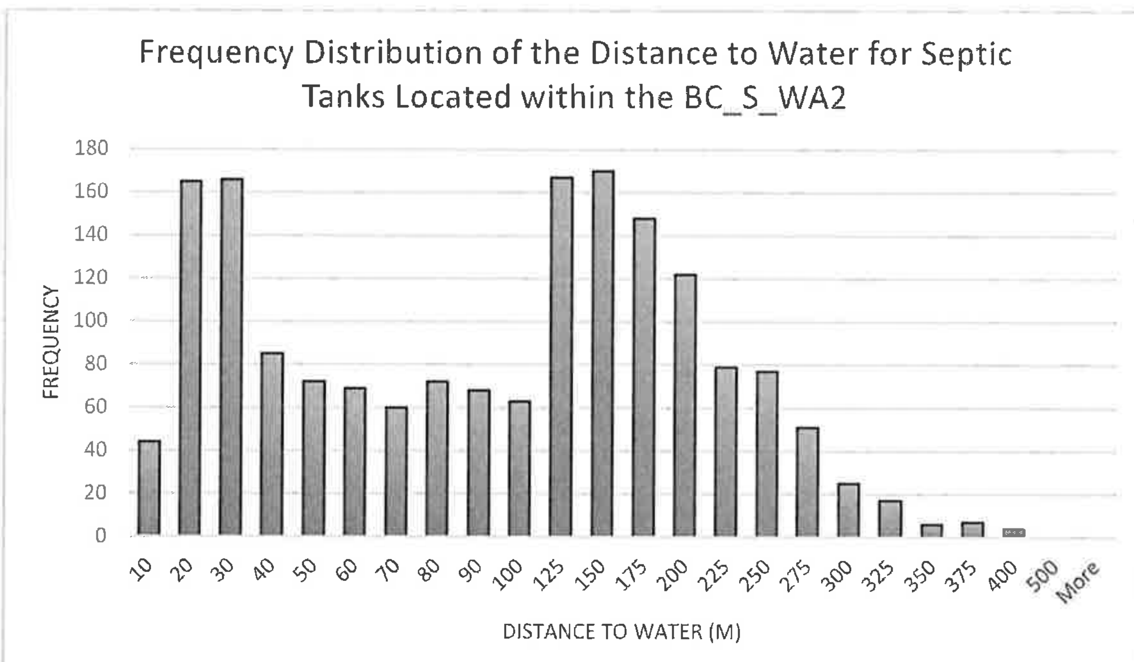


Figure 42. Frequency Distribution of septic tanks by distance to waterbodies within South WA2.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix H.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are included in Figure 43. As expected and previously reported for several other work areas, mean per septic tank contribution is highest for the shortest distances, and particularly higher (close to 6 lbs N/year) for the septic tanks located immediately adjacent to the water (within 10 m). Variability is also much higher for the 10-m distance interval than for any other distance class. Individual septic tank contributions vary between 2.5-3.8 lbs of N within the 20-70-m distance classes. After 70-m distance there is a clear reduction in per septic tank loading impact (below 1.9 lbs per yr), which is even further reduced to below 1 lb/yr at greater than 175-m distances.

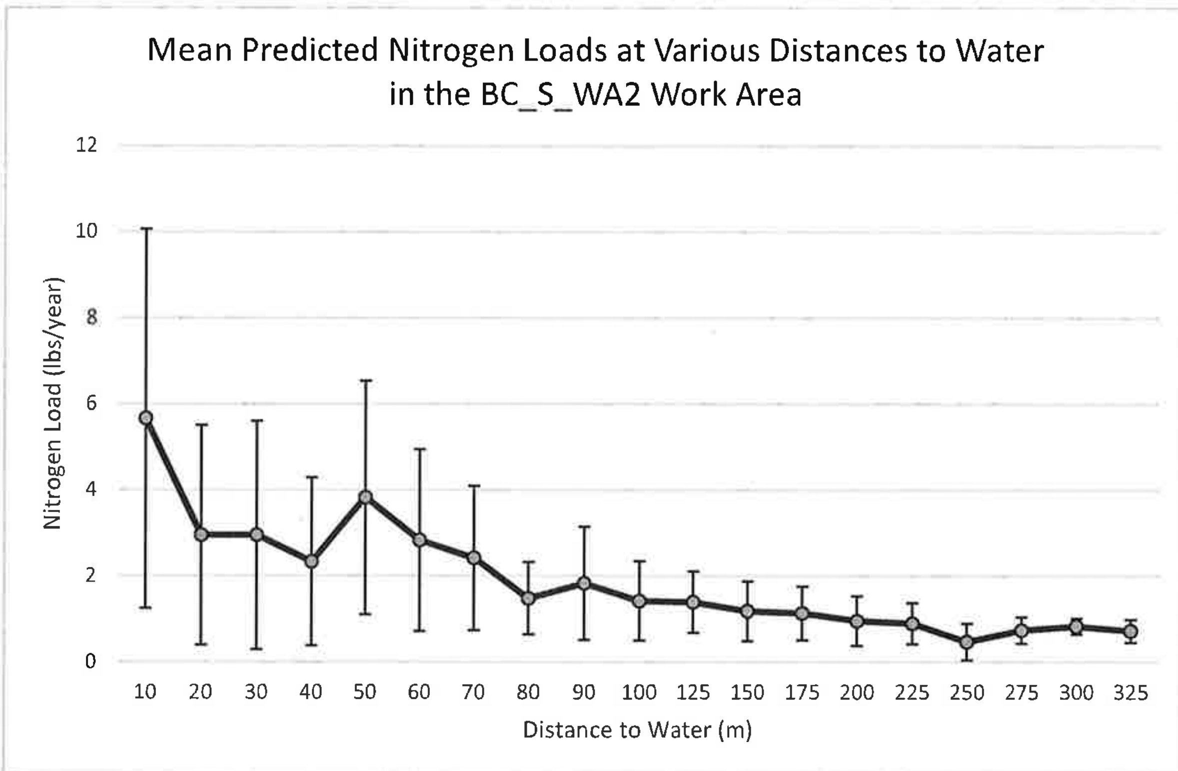


Figure 43. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for South WA2. Standard deviation was included as error bars.

Median values are lower, in general, than mean values for the close distances to water; however, the pattern is similar, which highest contribution in median nitrogen loading by the septic tanks located immediately adjacent of the water, followed by >2 lbs N/year contribution for those located within 70-m distance categories. At greater distances (≥ 250-m), median nutrient loading contributions gradually decreases to close to 1 lb per year (Figure 44).

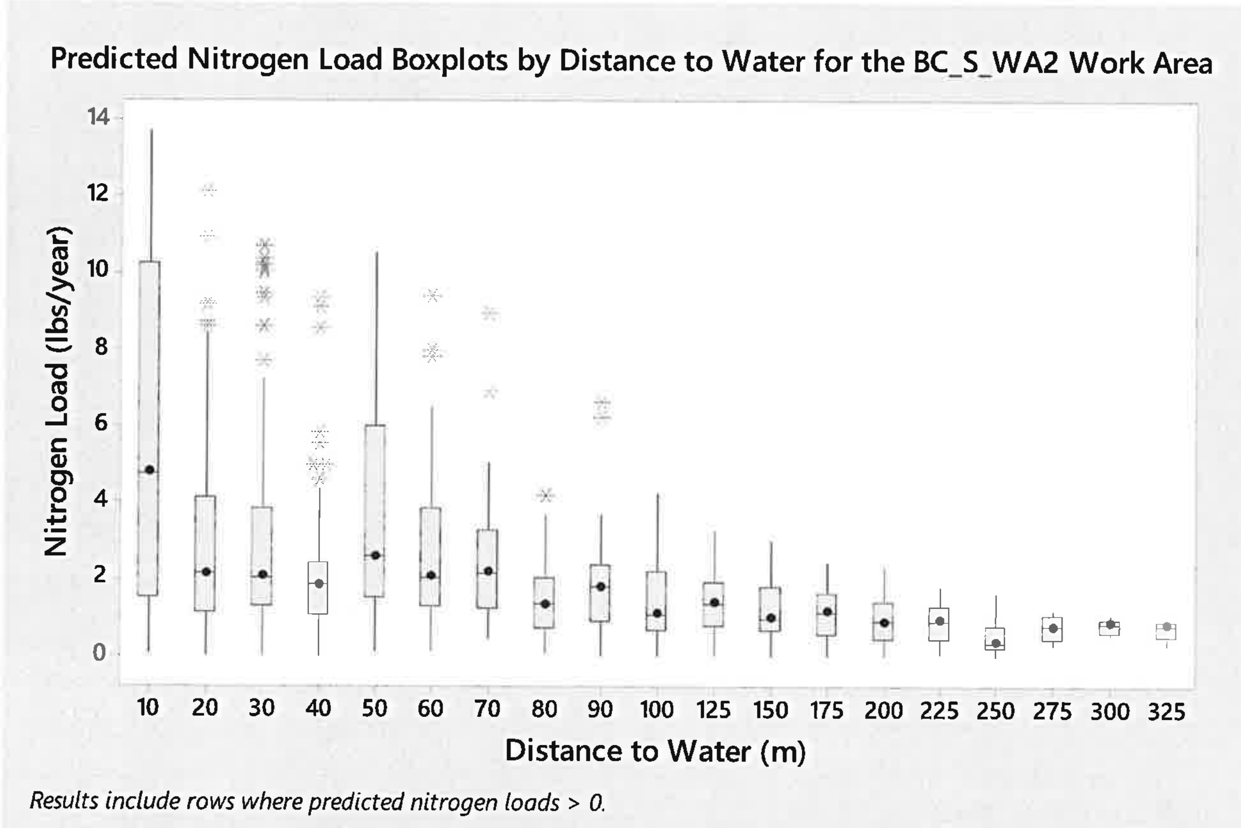


Figure 44. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for South WA2.

Septic tanks located within the first 50-m from a waterway have the greatest impact in the loading, with each of the distance classes within this range contributing to greater than 6% of the total area loading. The septic tanks located within the 10-20, and 20-30-m distance classes provide a total contribution of 16 and 17%, respectively. Cumulatively, the total loading contribution from the septic tanks located within the first 60-m makes up 64% of the total work area's nitrogen loading (Figure 45). Just as previously described for North Work Area 2, an increase in the relative percentage of loading contribution is also visible from the OTDS located within the 100-150 m distance intervals, totaling about 12.5% of the area's cumulative loads. This high relative contribution of the loading can be explained by the total number of septic tanks located at these distance intervals as well (337 tanks or 19% of all the modeled OTDS). The contribution of all the septic tanks located beyond 100-m corresponds to 25% of the total South Area 2 loading.

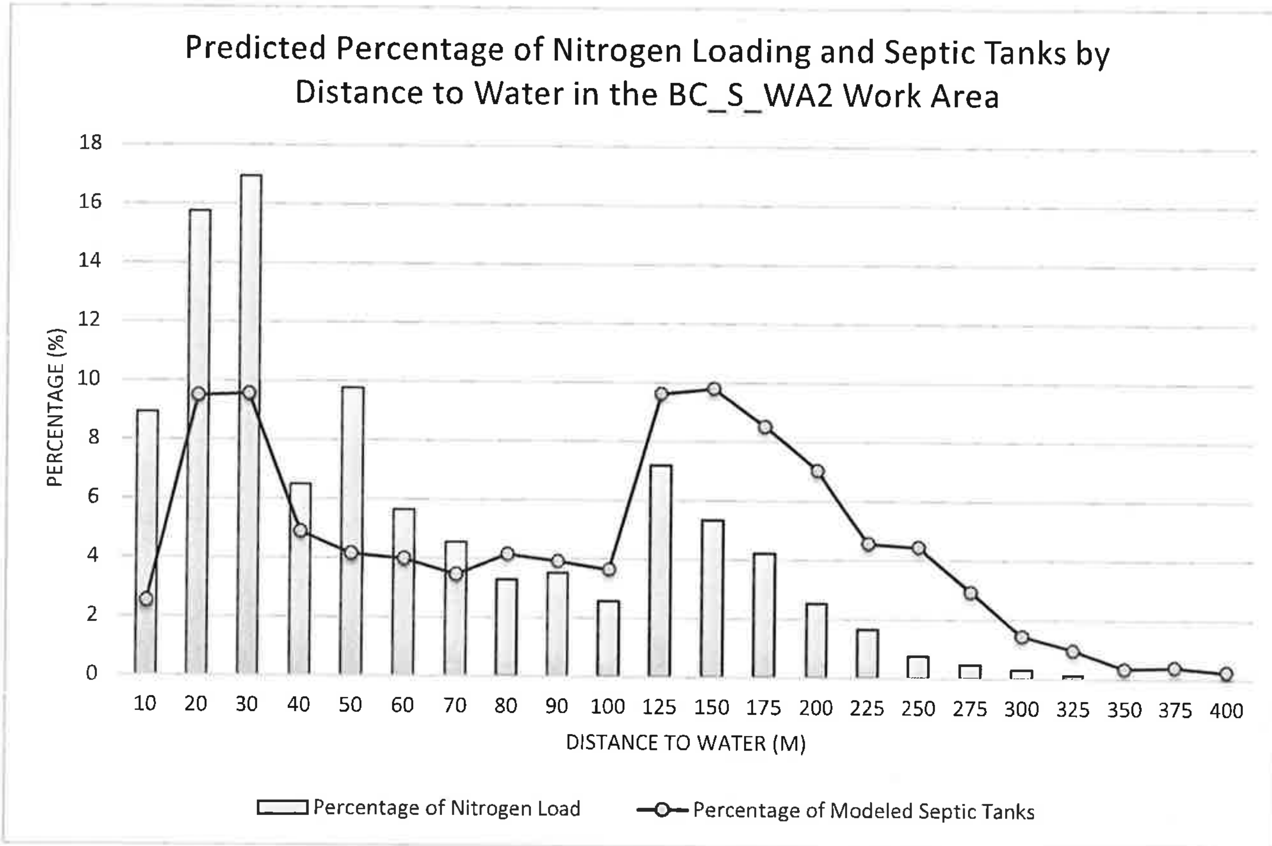


Figure 45. Percentage of total nitrogen loading and OSTDS by distance within South WA2.

Work Area South 3

The South Work Area 3 includes the mainland Melbourne area (Figure 2). The soils in this work area are almost equally distributed between three types, A, A/D, and B/D soils (Figure 46).

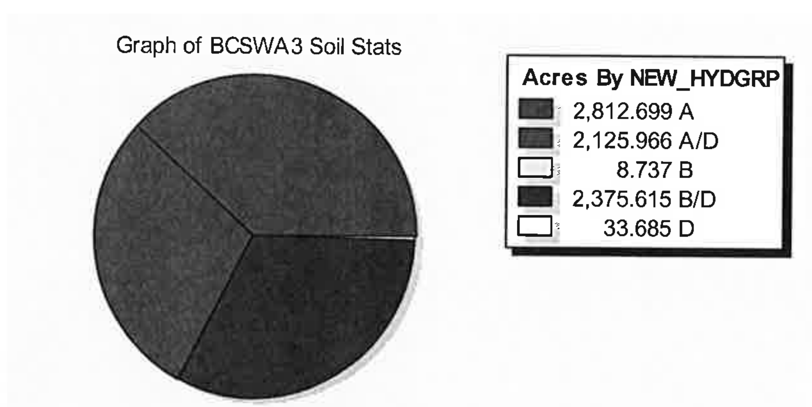


Figure 46. Distribution of the soil coverage by hydrologic group for South WA3.

In the South Work Area 3, 1935 septic tanks were modeled for loading potential to nearby waterways. This represents 47% of all the OSTDS in this work area (4,109 total), randomly selected using a random seed number generator in the GIS environment. From the modeled OSTDS, about 42% (815) are located within 50-m of any waterbody or channel and 66% located within 100-m distance from waterbodies (1273 septic tanks). To include over 80% of all the septic tank locations within this work area, those located up to 150-m from a waterbody would have to be considered (Figure 47).

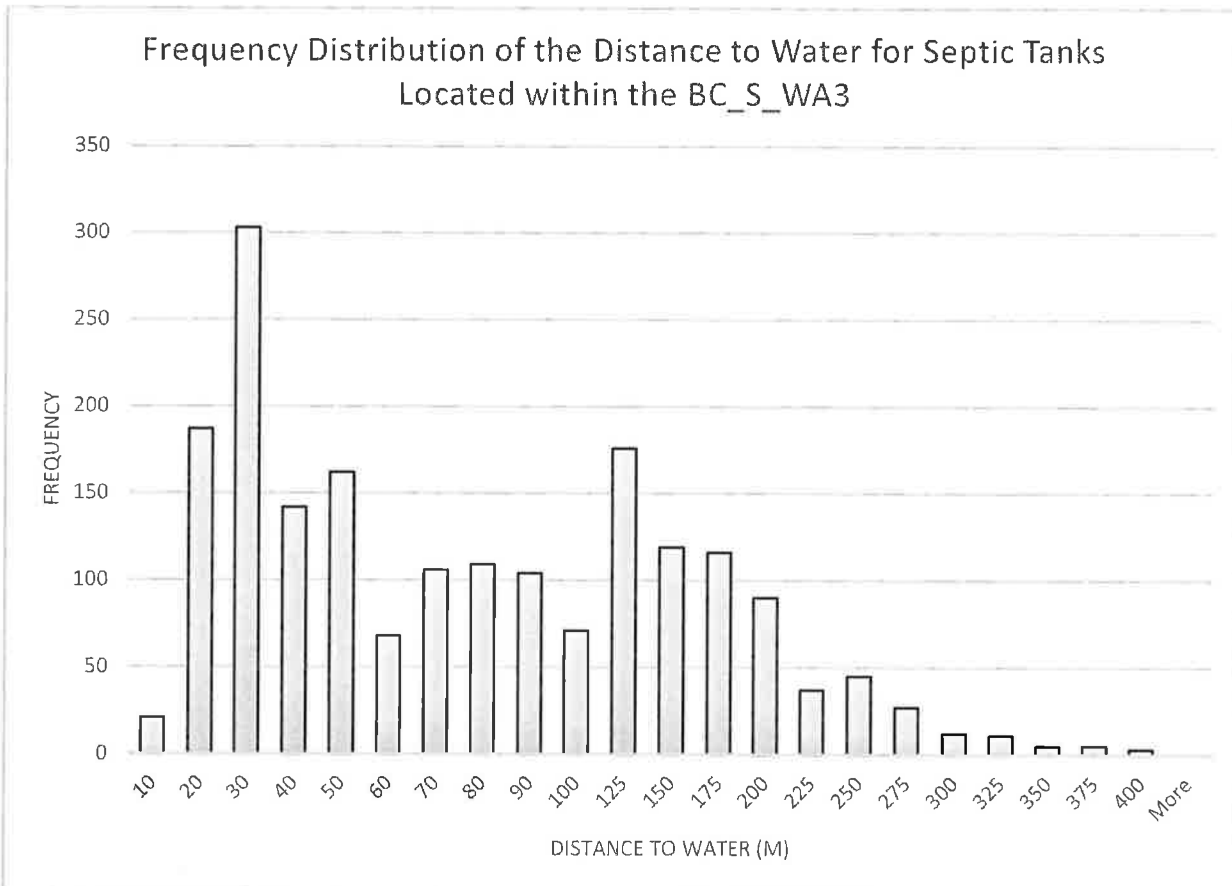


Figure 47. Frequency Distribution of septic tanks by distance to waterbodies within South WA3.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix I.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are included in Figure 48. As expected and previously reported for several other work areas, mean per septic tank contribution is highest for the shortest distances, and particularly higher (close to 5.5 lbs N/year) for the septic tanks located immediately adjacent to the water (within 10 m). Variability is also much higher for the 10-m distance interval than for any other distance class.

Individual septic tank contributions vary between 2-2.8 lbs of N within the 20-50-m distance classes. After 60-m distance there is a clear reduction in per septic tank loading impact (< 2 lbs per yr), which is even further reduced to < 1.5 lb/yr at greater than 150-m distances.

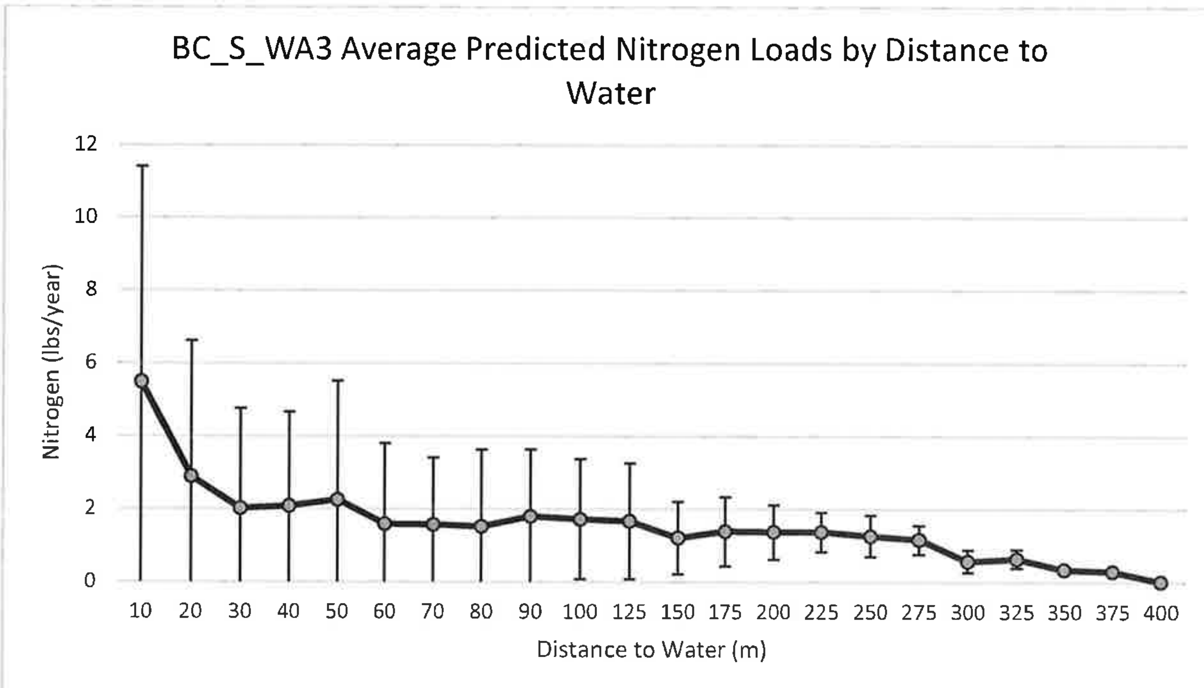


Figure 48. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for South WA3. Standard deviation was included as error bars.

Median values are lower, in general, than mean values for the close distances to water; however, the pattern is similar, which highest contribution in median nitrogen loading by the septic tanks located immediately adjacent of the water. The highest distribution of loading outputs per septic tank is noticeable for those within 10-m from the water, with a 75th percentile of the data distribution of 13.5 lbs N/year. Medians and distribution of per septic loadings are reduced for distances > 50-m and further reduced to well under 1 lb/year for distances > 275-m (Figure 49Figure 44).

Septic tanks located between 10-50-m from a waterway have the greatest impact in the loading with each of the distance classes within this range contributing to greater than 9% of the total work area loading. The septic tanks located within the 10-20 and 20-30-m distance classes provide a total contribution of 17% and 19%, respectively. Cumulatively, the total loading contribution from the OSTDS located within the first 50-m makes up 60% of the total area's nitrogen loading (Figure 50). The high loading contribution of these distance intervals can be explained by a combination of factors: a higher mean per septic tank loading, particularly for the 10-20-m interval, and relatively high number of OSTDS (10% of the total). The contribution of all the septic tanks located beyond 100-m corresponds to less than 19% of the total South Area 3 loading.

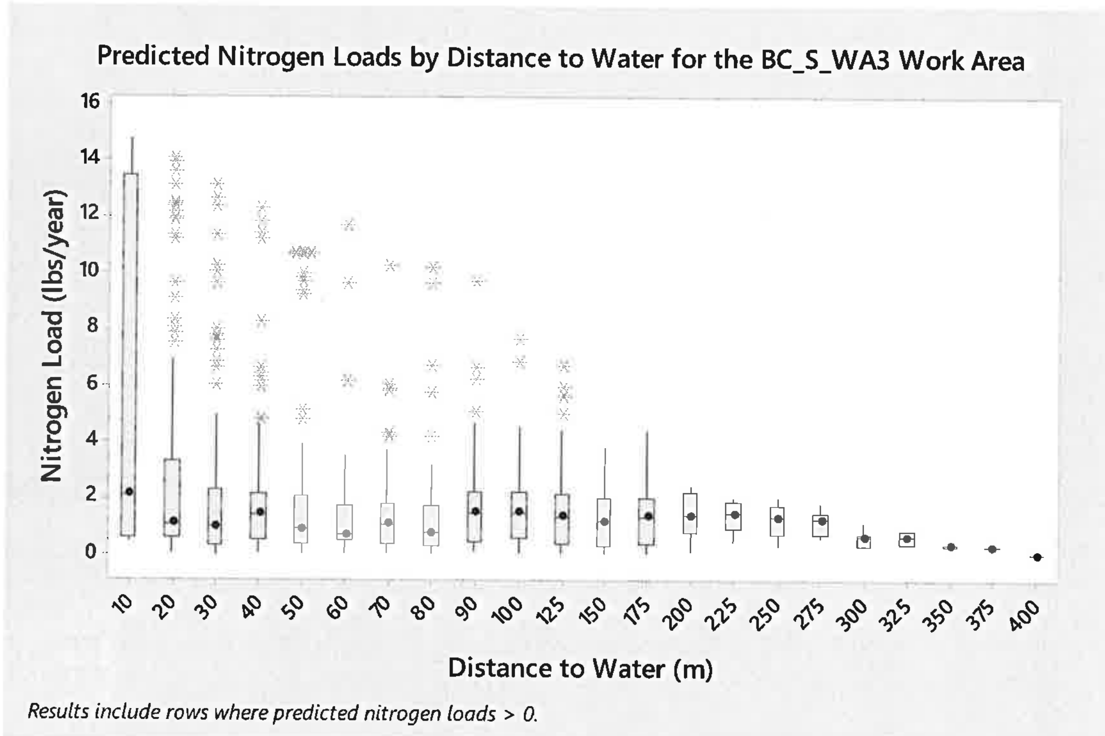


Figure 49. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for South WA3.

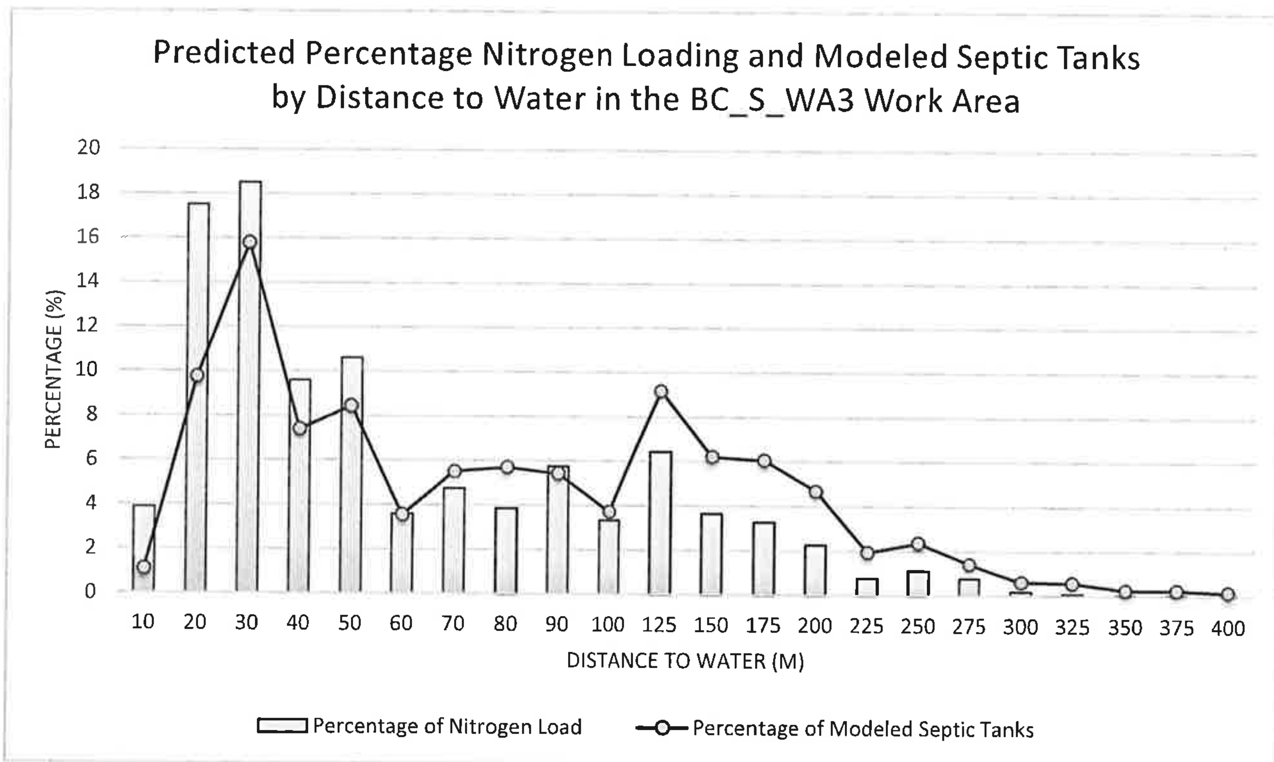


Figure 50. Percentage of total nitrogen loading and OSTDS by distance within South WA3.

Work Area South 4

The South Work Area 4 includes the southern portion of the Melbourne area, as well as portions of Melbourne Village and West Melbourne (Figure 2). The soils in this work area are about 50% A/D soils, around 30% B/D soils, and the remainder (20%) well drained or A soils (Figure 51).

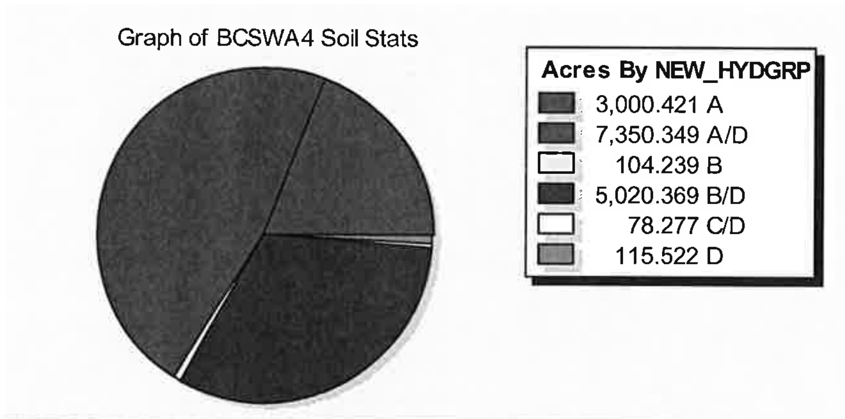


Figure 51. Distribution of the soil coverage by hydrologic group for South WA4.

In South Work Area 4, 1,800 the septic tanks were modeled for loading potential to nearby waterways, providing 42% representation of the OTDS loading of this area. A large portion of the septic tanks in this area are located closer to the Indian River Lagoon or Sebastian River, where most of the development has historically taken place. Due to this, over 64% of the septic tanks are located within 50-m of a waterbody/channel, and 87% within 100-m of water. No septic tanks were found at distances beyond 250-m from a waterbody in this area (Figure 55).

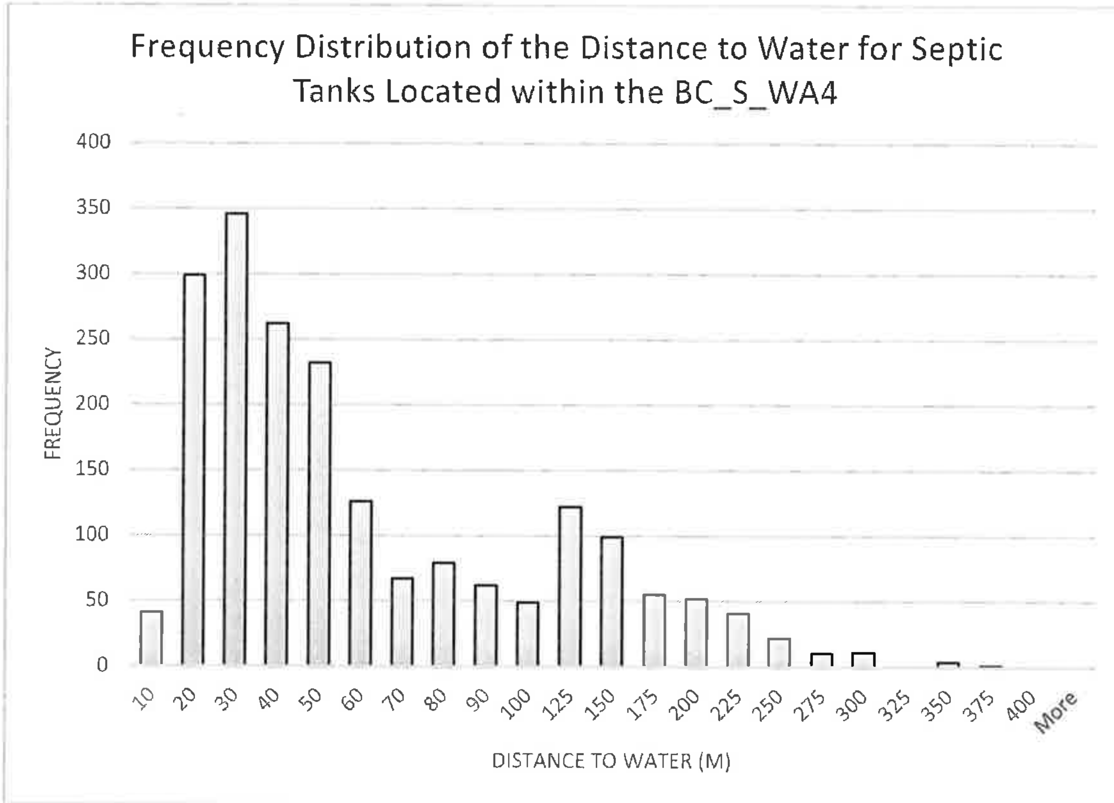


Figure 52. Frequency Distribution of septic tanks by distance to waterbodies within South WA4.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix J.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are included in Figure 53. As expected and previously reported for several other work areas, mean per septic tank contribution is highest for the 0-10-m distance (2.6 lbs N/year), with exception of the mean for the 200-225-m distance (3.2 lbs N/year), which is based on a very small sample size (10) and is accompanied by an extremely high variability. Median nitrogen loading contributions appear to have similar trends to the means, with highest values for the 0-10m distance class, and similar values for most other distances. The data distribution indicates the high variability throughout the distance categories, with greater number of maxima outliers in the 0-50-m distances (Figure 54)

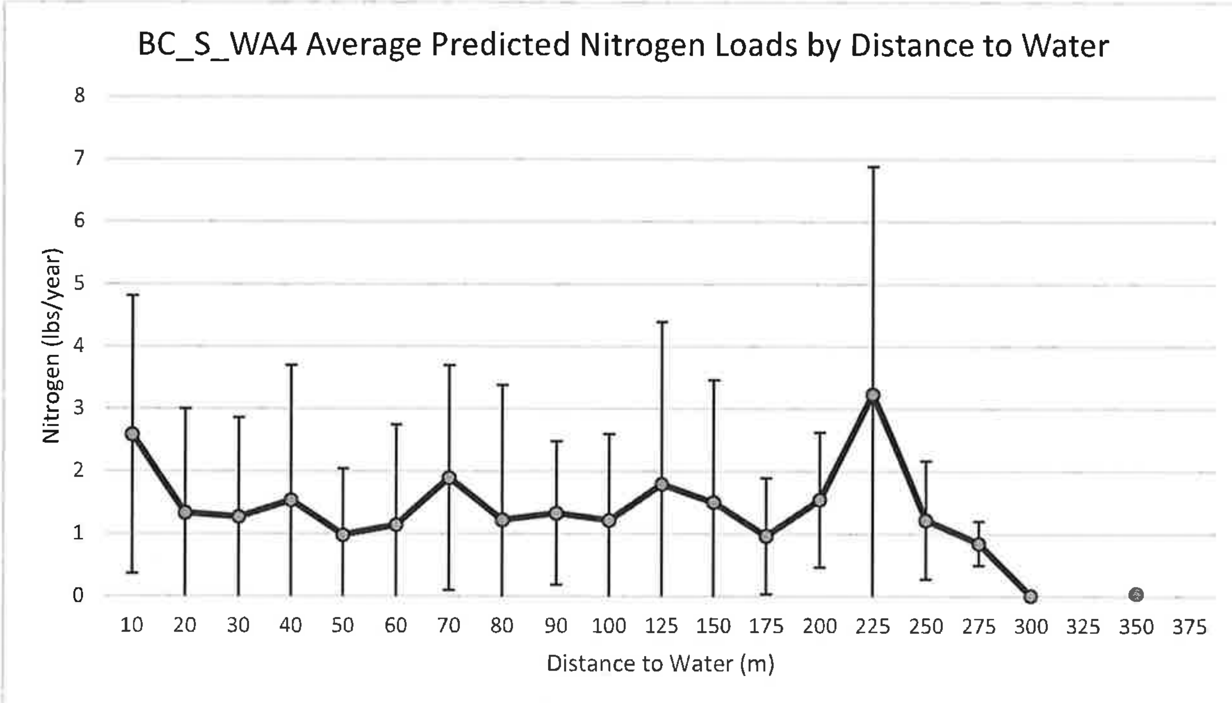


Figure 53. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for South WA4. Standard deviation was included as error bars.

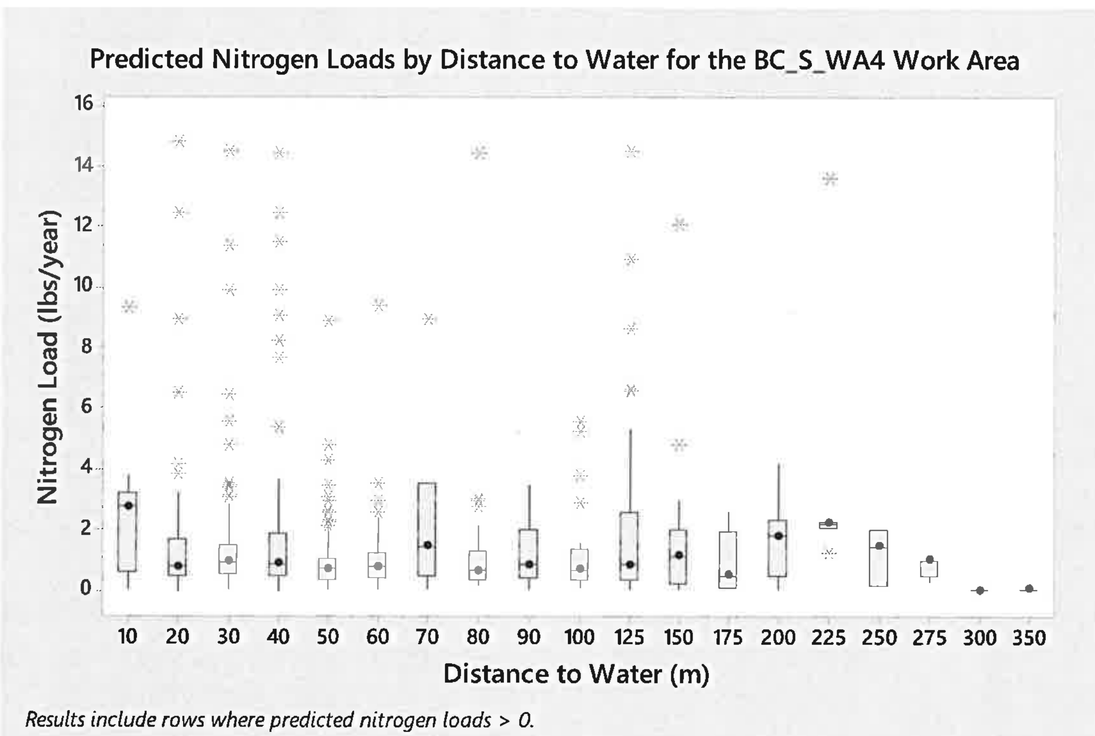


Figure 54. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for South WA4.

Septic tanks located in the first 50 m from a waterway have the greatest impact in the loading, with highest relative contribution to the total loading of this areas of 8% of greater for each of the following distance classes: 10-20m, 20-30m, 30-40m, and 40-50m. Cumulatively, OSTDS in the first 50-m from the water contribute to 63% of all the loading (Figure 55Figure 15). As previously described for a few of the work areas, there is an increase in the relative percentage of loading contribution from the OTDS located within the 100-150 m distance intervals, totaling about 12% of the total loading, mostly driven by the number of septic tanks located at these distance intervals (11% of all the OSTDS).

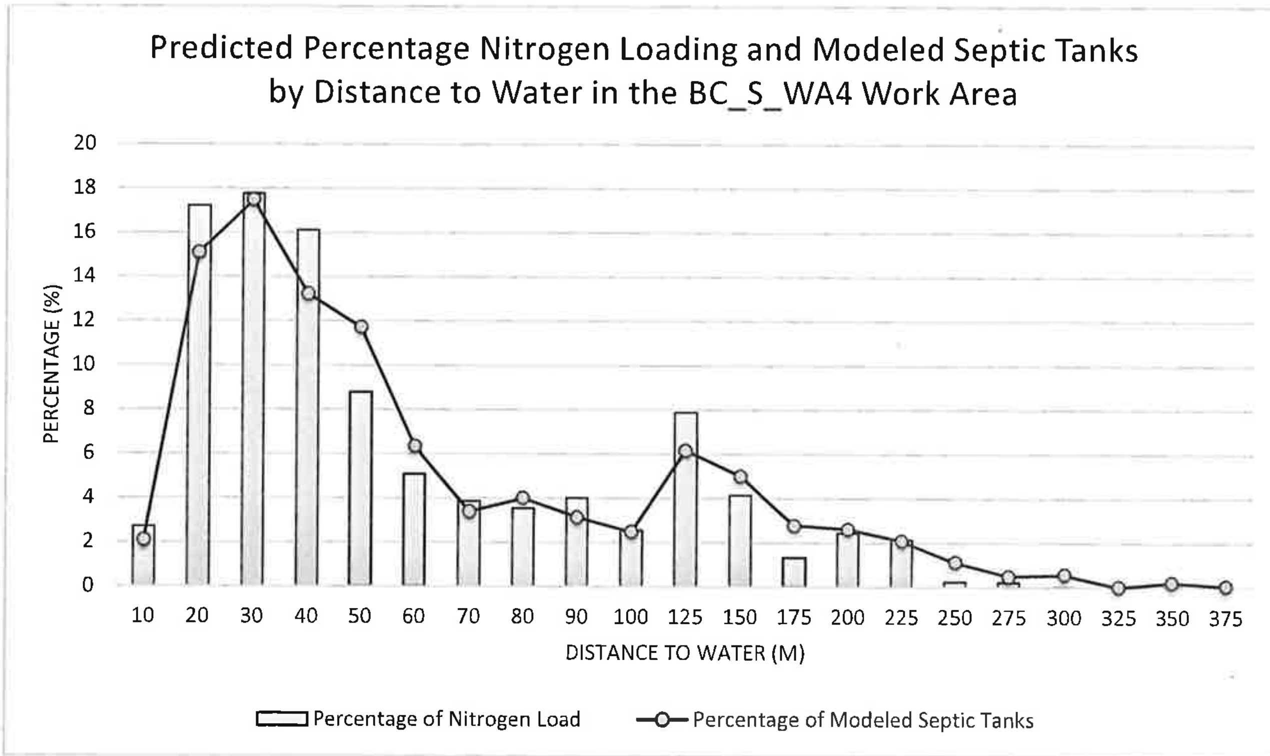


Figure 55. Percentage of total nitrogen loading and OSTDS by distance within South WA4.

Work Area South 5

South Work Area 5 covers a small portion of the Palm Bay area (Figure 2). The soils are dominated by either A/D or B/D hydrologic types (Figure 56).

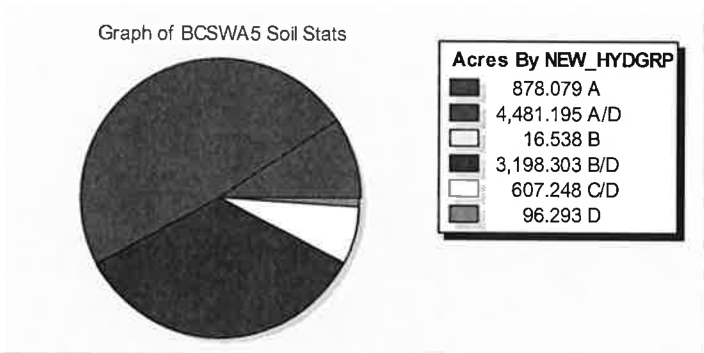


Figure 56. Distribution of the soil coverage by hydrologic group for South WA5.

In South Work Area 5, all the septic tanks (2,138 total) were modeled for loading potential to nearby waterways, providing 100% representation of the OTDS loading of this dense area. A large proportion of these (78%) are located within 50-m of a nearby waterway or waterbody, explained by the extensive channelization of this area. Over 92% of all the septic tanks in this work area are located within 100-m of any water (Figure 57).

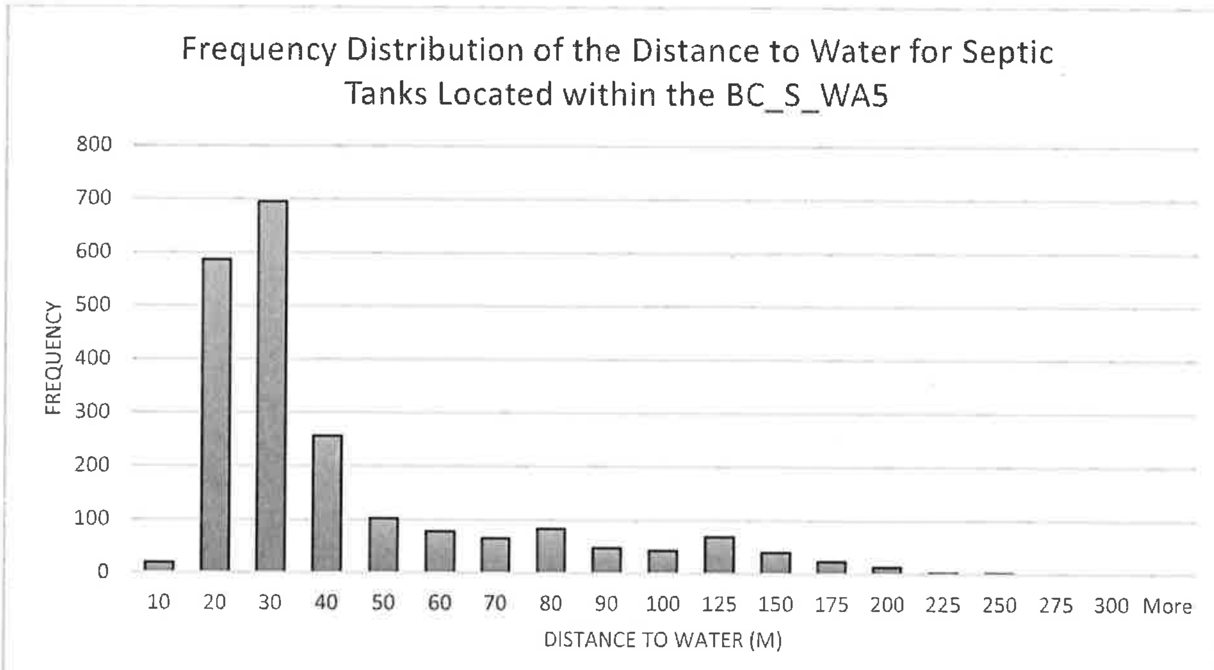


Figure 57. Frequency Distribution of septic tanks by distance to waterbodies within South WA5.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix K.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are included in Figure 58. As expected and previously reported for the other work areas, mean per septic tank contribution is highest for the shortest distances. However, unlike in other previously described work areas, the per septic tank contribution drastically drops between 30- and 60-m distances, with similar loading contributions at greater distances. As a matter of fact, mean loading contributions per septic tank were slightly higher for the 100-m and 175-m distance classes, than for the 60-m distance class.

Due to the high variability of predicted loadings per septic tank in this work area, median and interquartile distributions of the loads provide a better representation of the impact of distance on potential contributing loads to waterbodies (Figure 59). Median loading contributions are highest for septic tanks located within the first 50-m from a waterbody (>1 lb N/yr), fluctuating between 0.58-0.75 lbs N/yr between 60 and 100-m from waterbodies. Individual loading contributions are smallest (<0.5 lb TN/yr) at distances greater than 100-m.

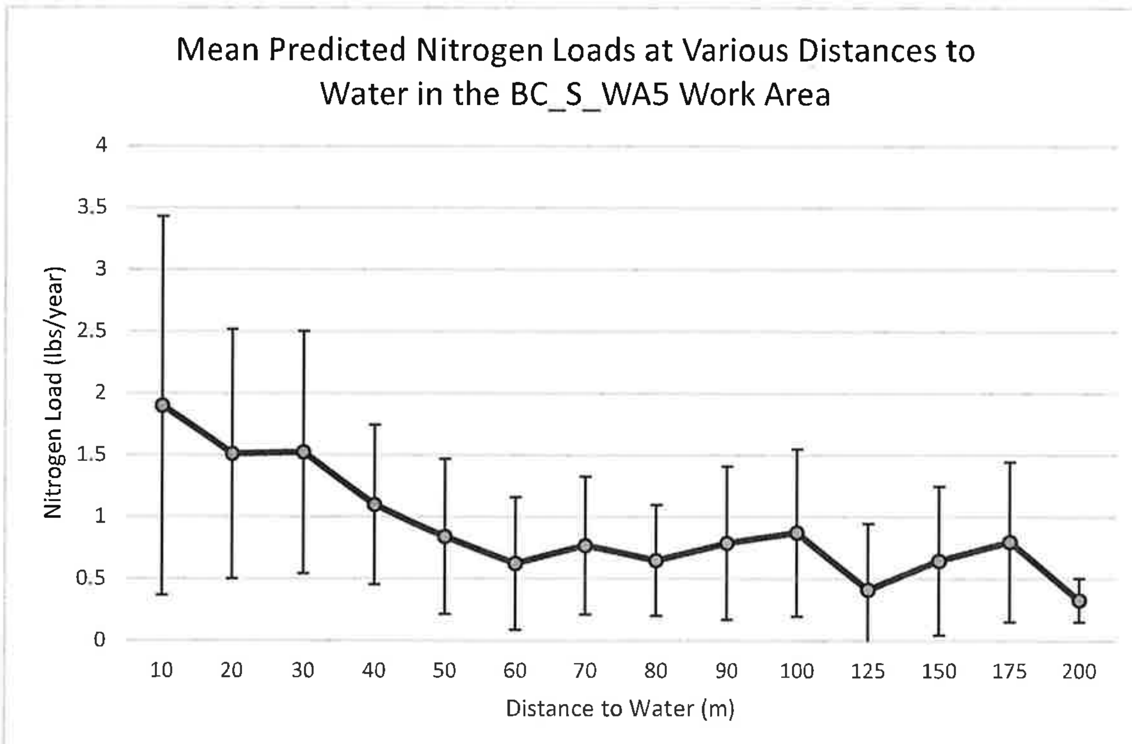


Figure 58. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for South WA5. Standard deviation was included as error bars.

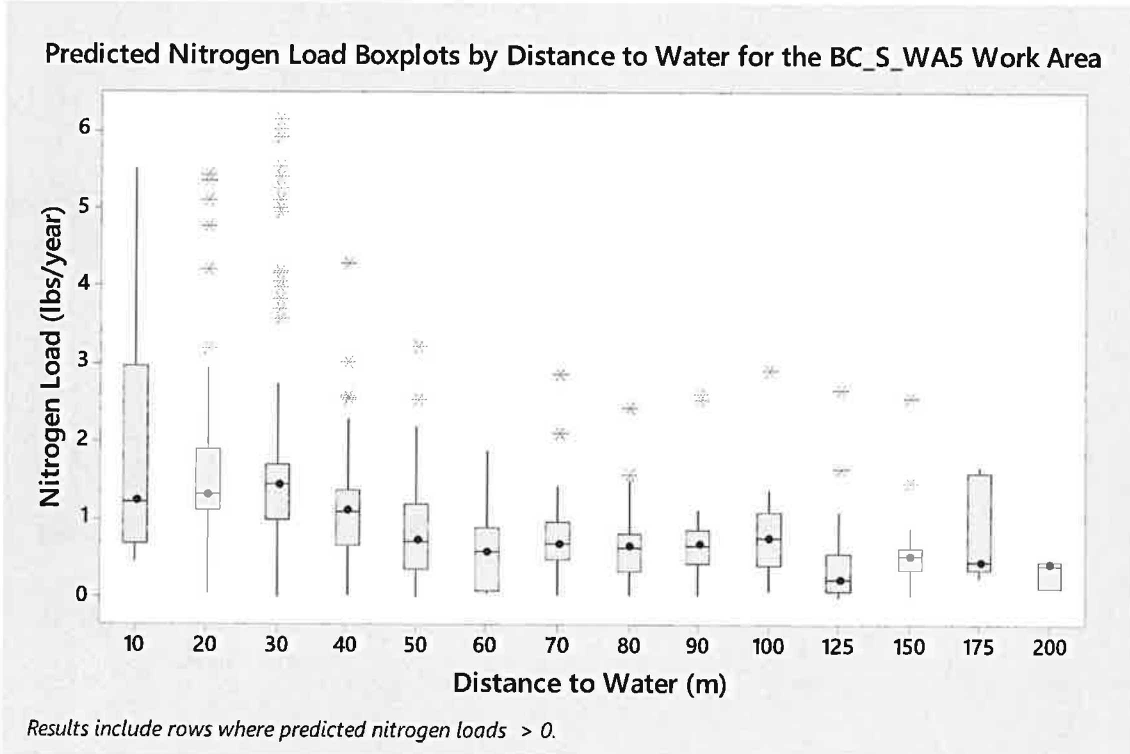


Figure 59. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for South WA5.

Septic tanks located between 10-40-m from a waterway have the greatest impact in the loading with each of the distance classes within this range contributing to greater than 14% of the total work area loading. The septic tanks located within the 10-20 and 20-30-m distance classes provide a total contribution of 24% and 39%, respectively. Cumulatively, the total loading contribution from the OSTDS located within the first 40-m makes up 81% of the total area's nitrogen loading (Figure 60Figure 50). The high loading contribution of these distance intervals can be explained by a combination of factors: a higher mean per septic tank loading and a large proportion of OSTDS (73%) located within the same distance classes. The contribution of all the septic tanks located beyond 60-m corresponds to less than 11% of the total South Area 5 loading.

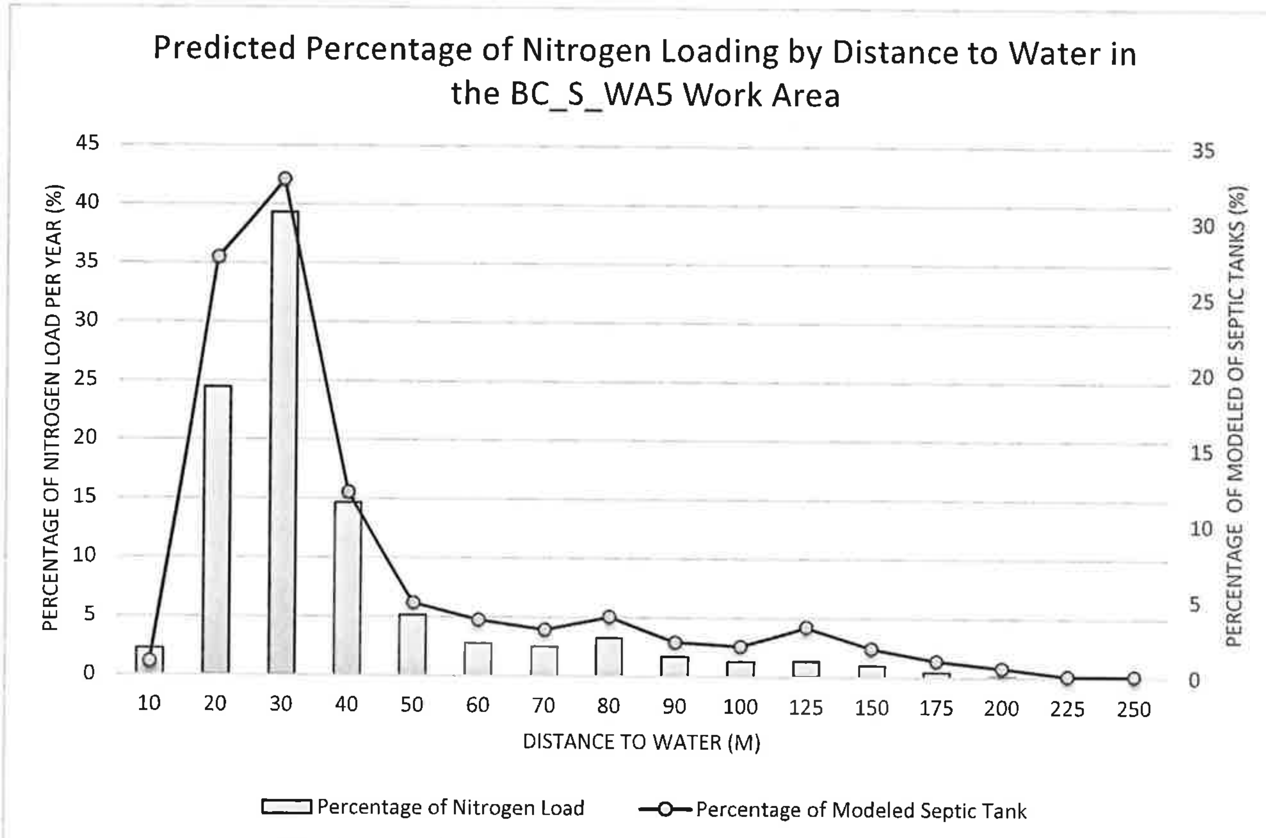


Figure 60. Percentage of total nitrogen loading and OSTDS by distance within South WA5.

Work Area South 6

South Work Area 6 covers portions of Palm Bay and Malabar (Figure 2). The soils are dominated by either A/D soils (60%), followed by A soils (20%), with the remainder represented by B/D hydrologic types and C/D (Figure 61Figure 56).

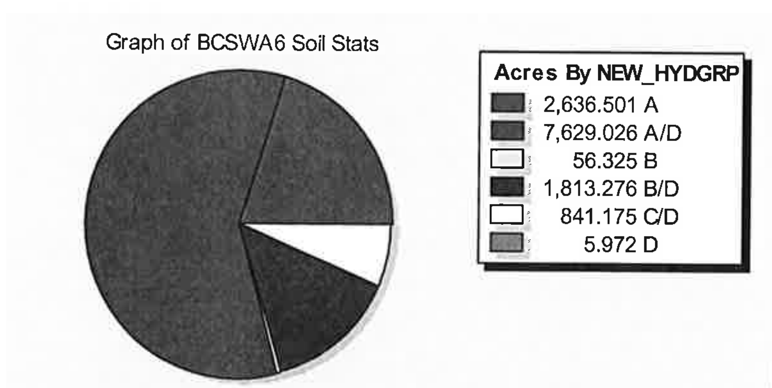


Figure 61. Distribution of the soil coverage by hydrologic group for South WA6.

In South Work Area 6, a total of 2,097 OSTDS were modeled for loading potential to nearby waterways, providing 21% representation of the OTDS loading of this extremely dense area. Due to the high channelization of this area, over 95% of all the modeled septic tanks (1984 septic tanks) are located within 30-m of a waterbody/channel (Figure 62). Unlike in previous work areas, there were less than 1% of the total modeled septic tanks located beyond 70-m distance from the water.

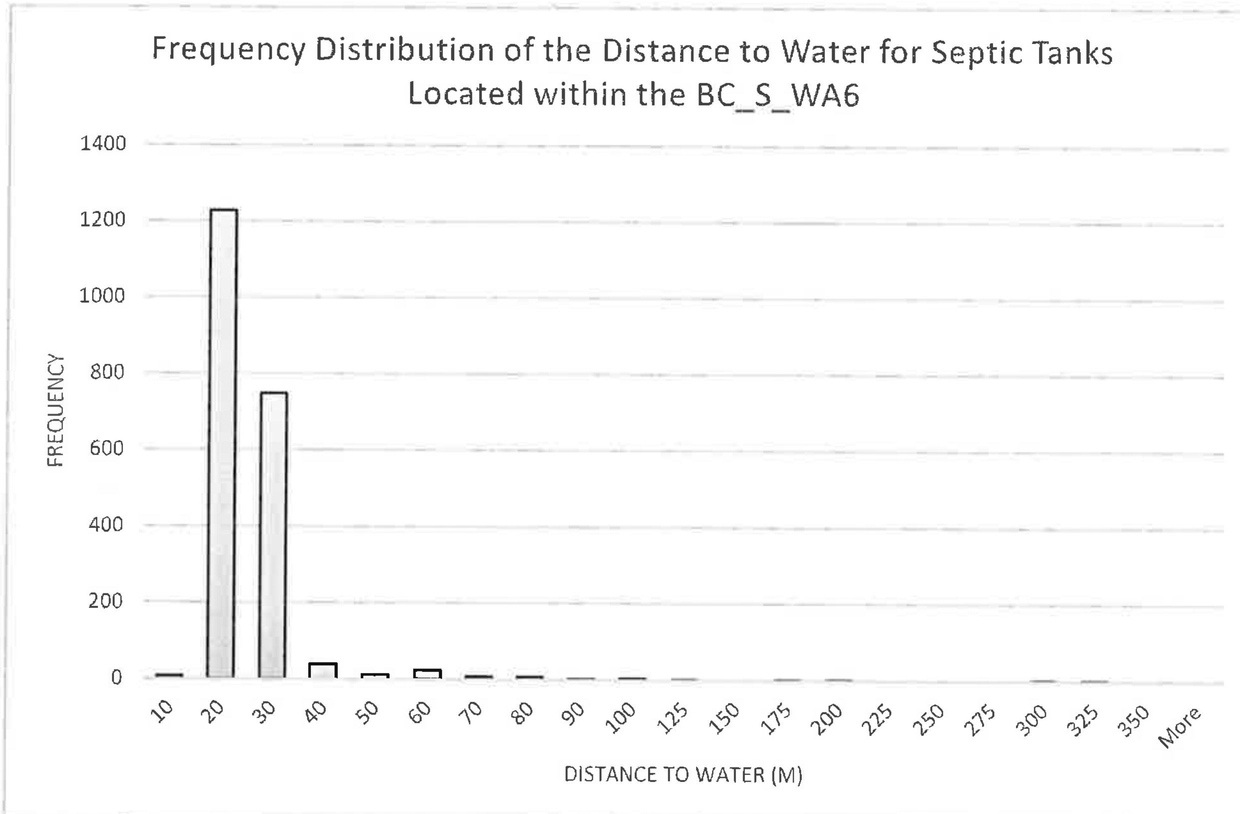


Figure 62. Frequency Distribution of septic tanks by distance to waterbodies within South WA6.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix L.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are highly variable, with highest values for the 10-m and also 80-m distance classes (Figure 63). Variability is highest for the 0-40-m distance classes, with a much smaller confidence in the mean values for distance classes with smaller sample size (<10 OSTDS in distance classes above 70-m).

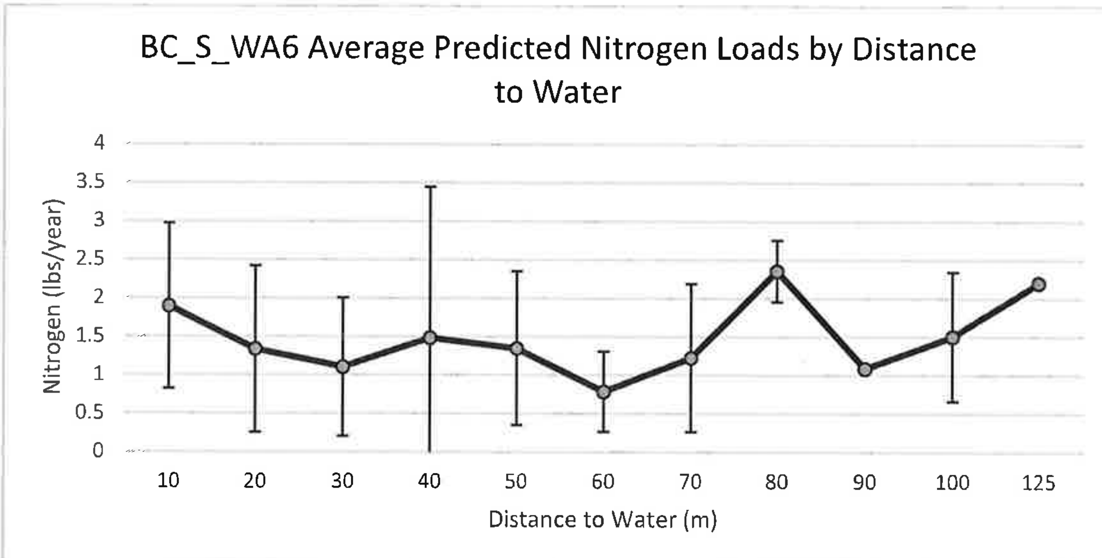


Figure 63. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for South WA6. Standard deviation was included as error bars. Only means of sample size >1 per distance category were included.

Septic tanks located between 10-30-m from a waterway have the greatest impact in the loading with each of these classes contributing to greater than 31% of the total work area loading. The septic tanks located within the 10-20 and 20-30-m distance classes provide a total contribution of 63% and 31%, respectively. Cumulatively, the total loading contribution from the OSTDS located within the first 30-m makes up 95% of the total area's nitrogen loading (Figure 64Figure 50). The high loading contribution of these short distance intervals can be explained by the high density of OSTDS located within 30-m from water.

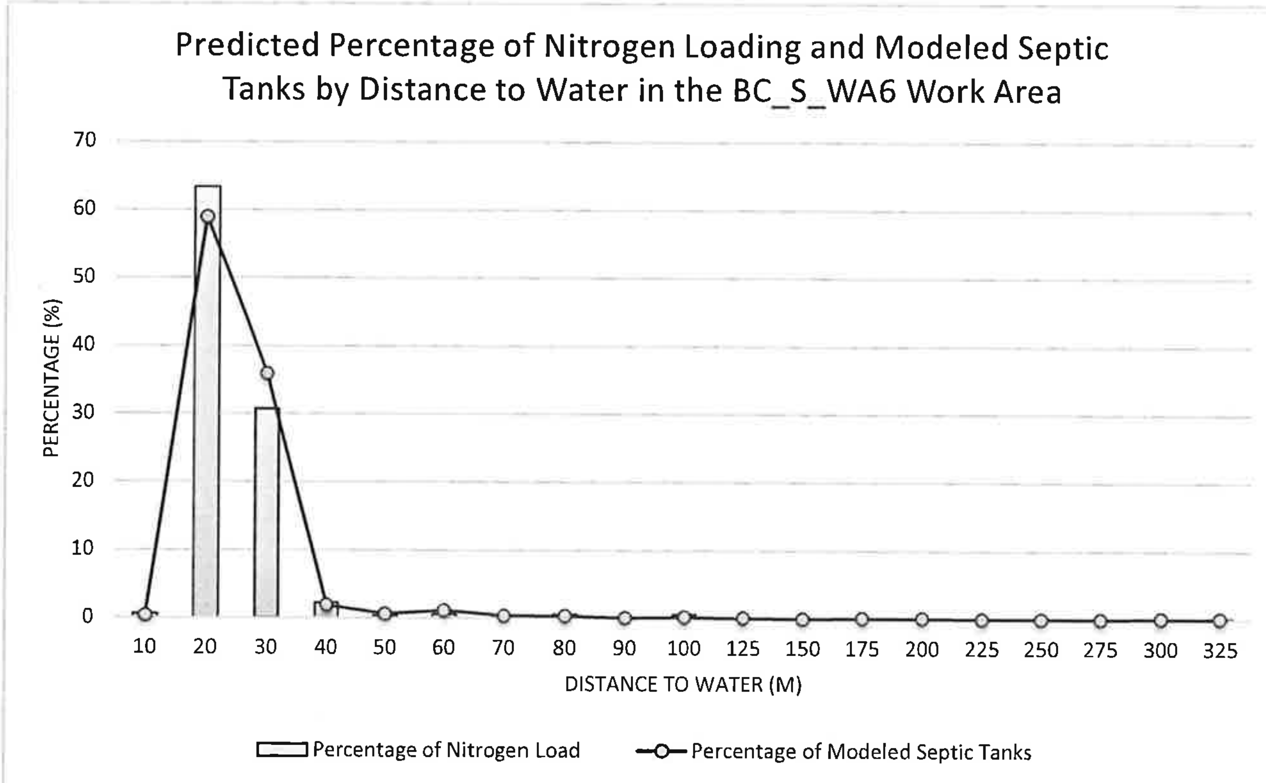


Figure 64. Percentage of total nitrogen loading and OSTDS by distance within South WA6.

Work Area South 7

South Work Area 7 covers portions of Malabar and southern Palm Bay (Figure 2). The soils are dominated by A/D soils (around 60%), followed by B/D soils (close to 25%), with a small percentage of A and C/D soils (Figure 65Figure 56).

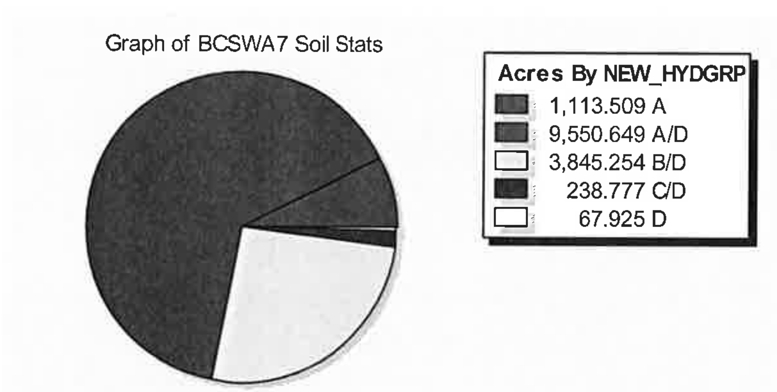


Figure 65. Distribution of the soil coverage by hydrologic group for South WA7.

In South Work Area 7 a total of 2,000 OSTDS were modeled for loading potential to nearby waterways, providing 28% representation of the OTDS loading of this extremely dense area. Due to the high channelization of this area, almost 90% of all the modeled septic tanks (1784 septic tanks) are located within 30-m of a waterbody/channel (Figure 66). Similarly to South Work Area 6, there were less than 2% of the total modeled septic tanks located beyond 70-m distance from the water.

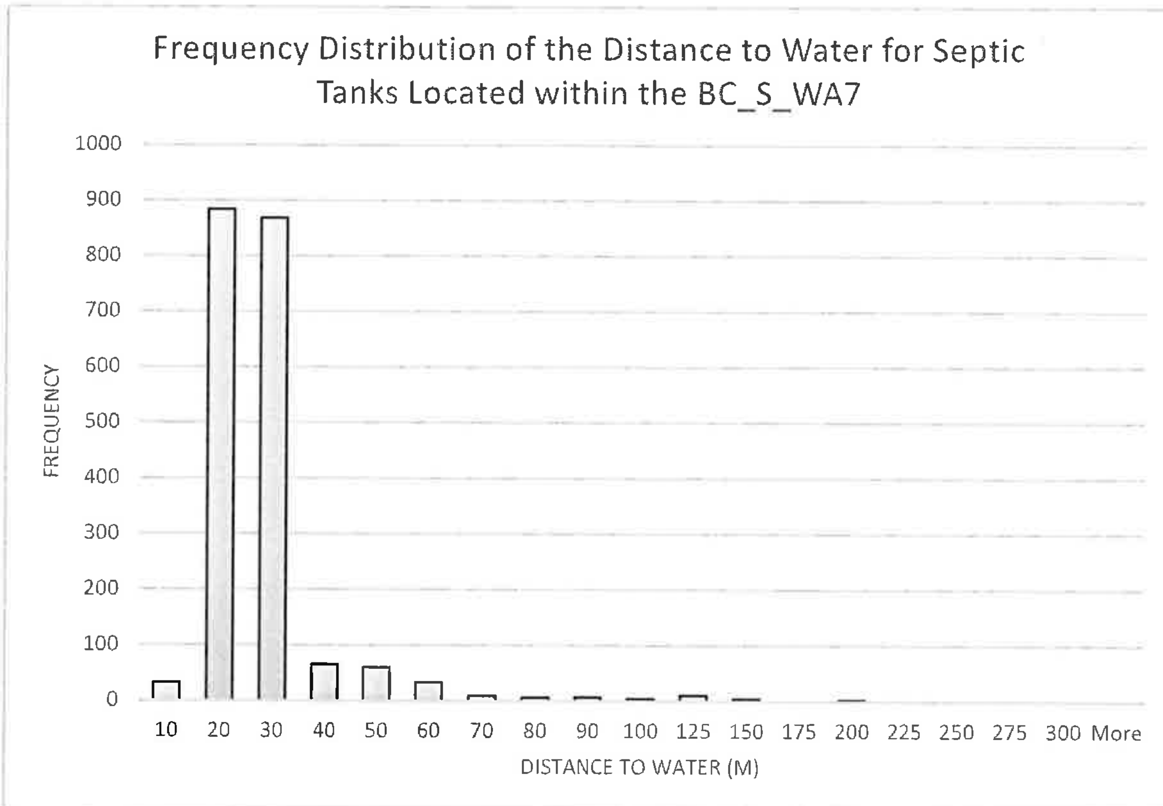


Figure 66. Frequency Distribution of septic tanks by distance to waterbodies within South WA7.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix M.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are highly variable, with highest values for the 10-m distance class (Figure 67). Variability is highest for the 0-20-m distance classes, with a much smaller confidence in the mean values for distance classes with smaller sample size (≤10 OSTDS in distance classes above 70-m). Median values show similar trends (Figure 68), with highest median values at the shortest distance intervals and broader interquartile distribution for a few distance classes (0-10, 60-70, and 125-150-m).

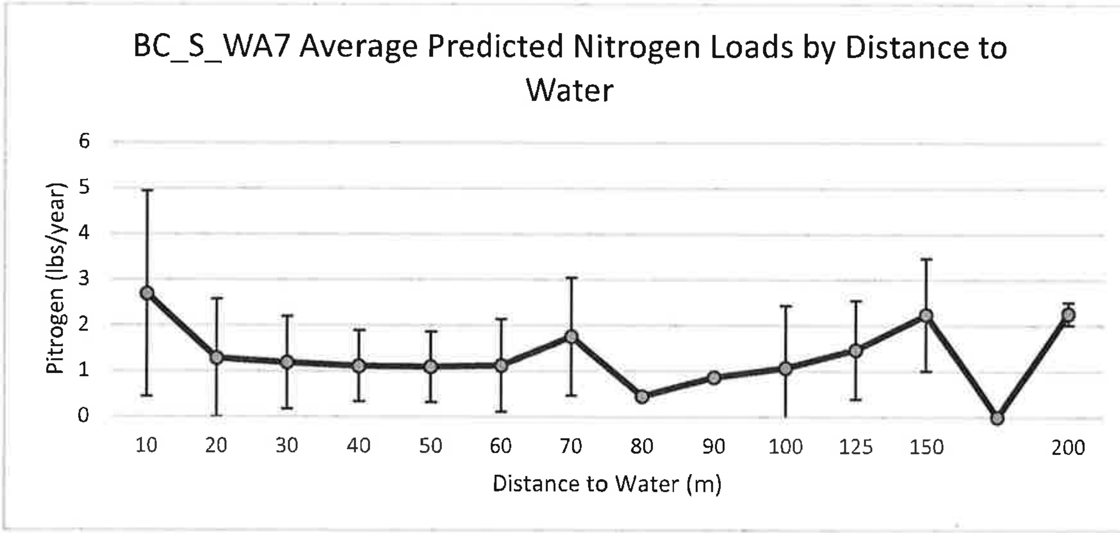


Figure 67. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for South WA7. Standard deviation was included as error bars.

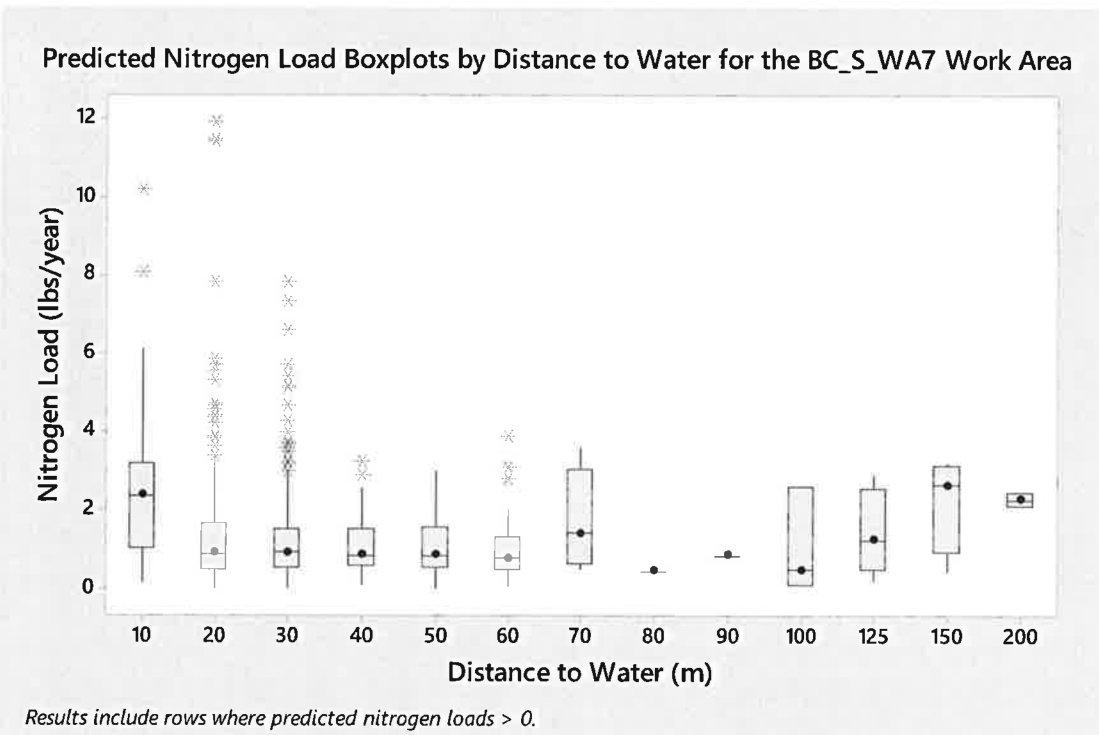


Figure 68. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for South WA7.

Septic tanks located between 10-30-m from a waterway have the greatest impact in the loading with each of these classes contributing to greater than 37% of the total work area loading, a pattern similar to the one described for Work Area South 6. The septic tanks located within the 10-20 and 20-30-m distance classes provide a total contribution of 47% and 37%, respectively. Cumulatively, the total loading contribution from the OSTDS located within the first 30-m makes up 90% of the total area's nitrogen loading (Figure 69Figure 64Figure 50). The high loading contribution of these short distance intervals can be explained by the high density of OSTDS located within 30-m from water.

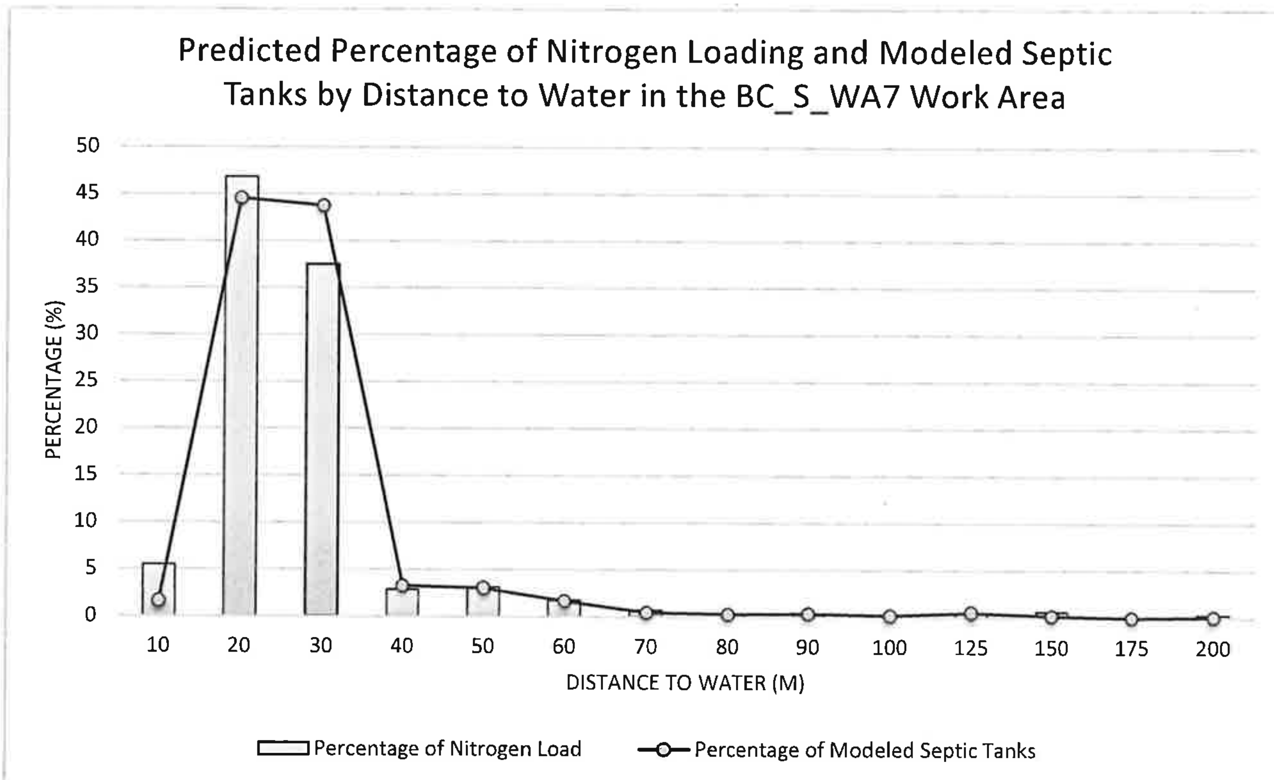


Figure 69. Percentage of total nitrogen loading and OSTDS by distance within South WA7.

Work Area South 8

South Work Area 8 covers portions of Malabar and Valkaria (Figure 2). The soils are dominated by A/D soils (around 60%), followed by B/D soils (close to 23%), with a smaller percentage of A soils (10%) and negligible C/D soils (Figure 70Figure 56).

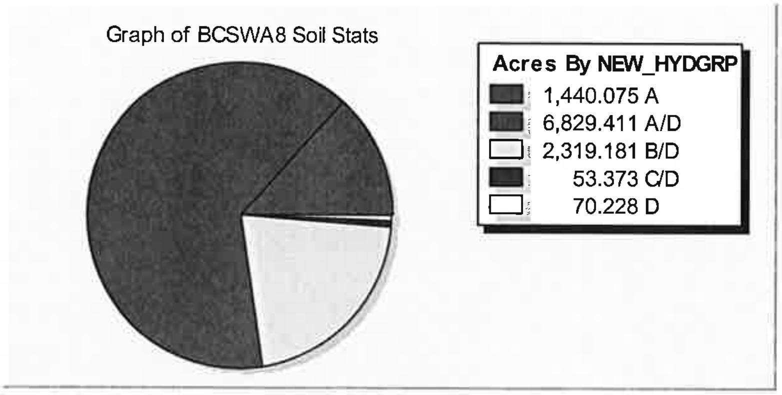


Figure 70. Distribution of the soil coverage by hydrologic group for South WA8.

In South Work Area 8 a total of 2,000 OSTDS were modeled for loading potential to nearby waterways, providing 37% representation of the OTDS loading of this dense area. The septic tank distribution of this work area is similar to the South Work Areas 6 and 7, with 88% of all the modeled septic tanks (1751 septic tanks) located within 30-m of a waterbody/channel (Figure 71). Fewer than 2% of the total modeled septic tanks located beyond 70-m distance from the water.

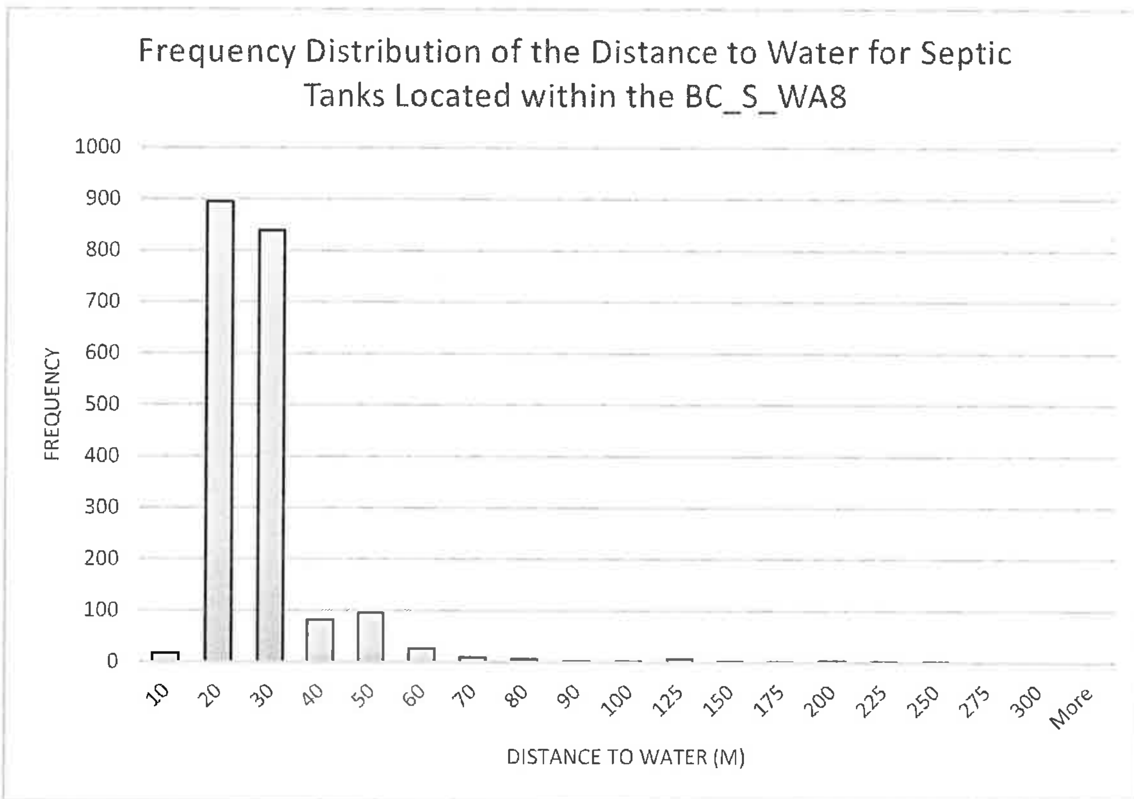


Figure 71. Frequency Distribution of septic tanks by distance to waterbodies within South WA8.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix N.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are highly variable, with highest values for the 10-m distance class (Figure 72Figure 67), and similar mean values for distance classes from 20-80-m. Variability is highest for the 0-10-m distance class, with a much smaller confidence in the mean values for distance classes with smaller sample size (≤10 OSTDS in distance classes above 70-m). Median values show similar trends (Figure 73), with highest median values at the shortest distance intervals and broader interquartile distribution for a few distance classes (0-10 and 60-70-m). This is a very similar pattern to the one described for South Area 7.

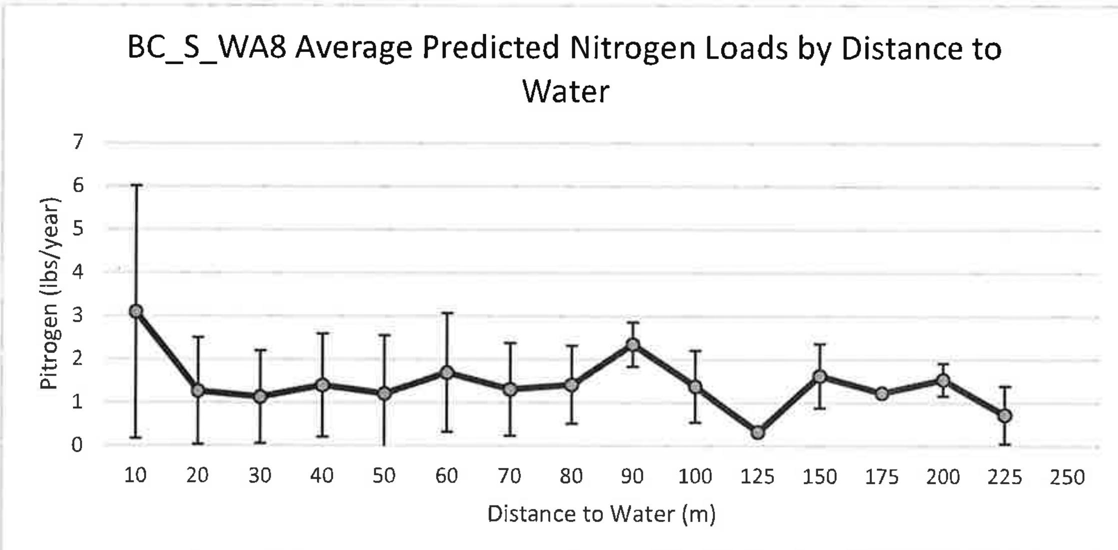


Figure 72. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for South WA8. Standard deviation was included as error bars.

Just as described for the South Work Areas 6 and 7, septic tanks located between 10-30-m from a waterway have the greatest impact in the total nitrogen loading. The septic tanks located within the 10-20 and 20-30-m distance classes provide a total contribution of 46% and 38%, respectively. Cumulatively, the total loading contribution from the OSTDS located within the first 30-m makes up 86% of the total area's nitrogen loading (Figure 74), slightly below the totals in South Work Areas 6 and 7. The high loading contribution of these short distance intervals can be explained by the high density of OSTDS (88% of the total) located within 30-m from water.

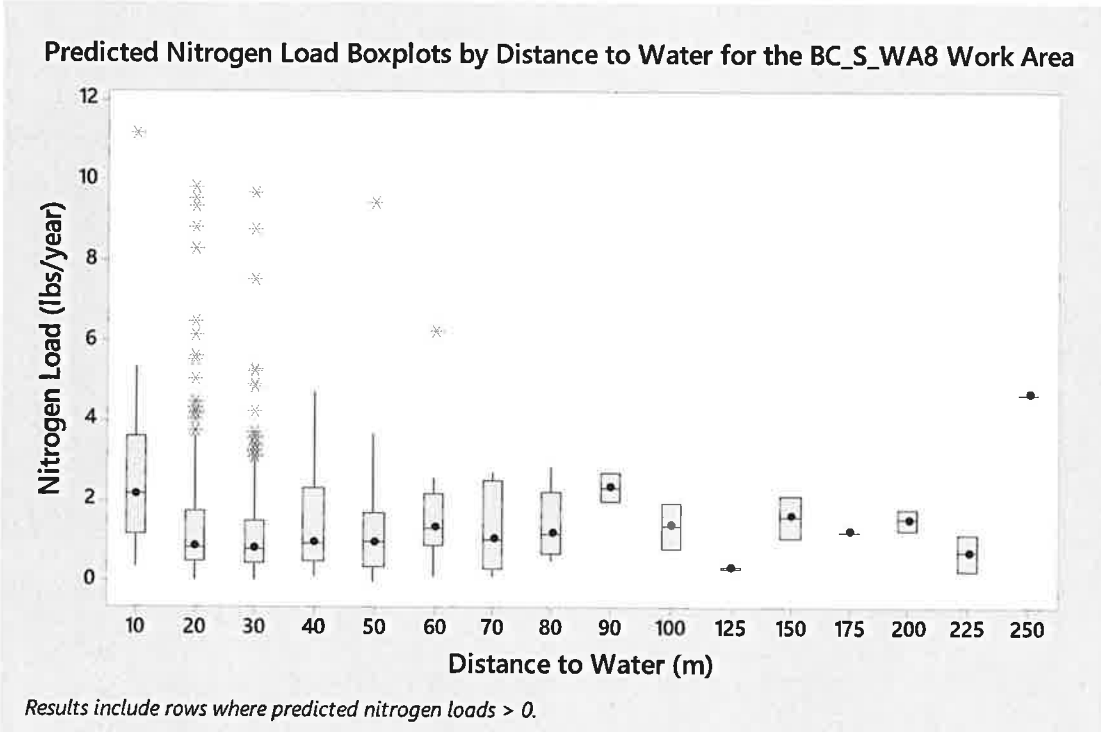


Figure 73. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for South WA8.

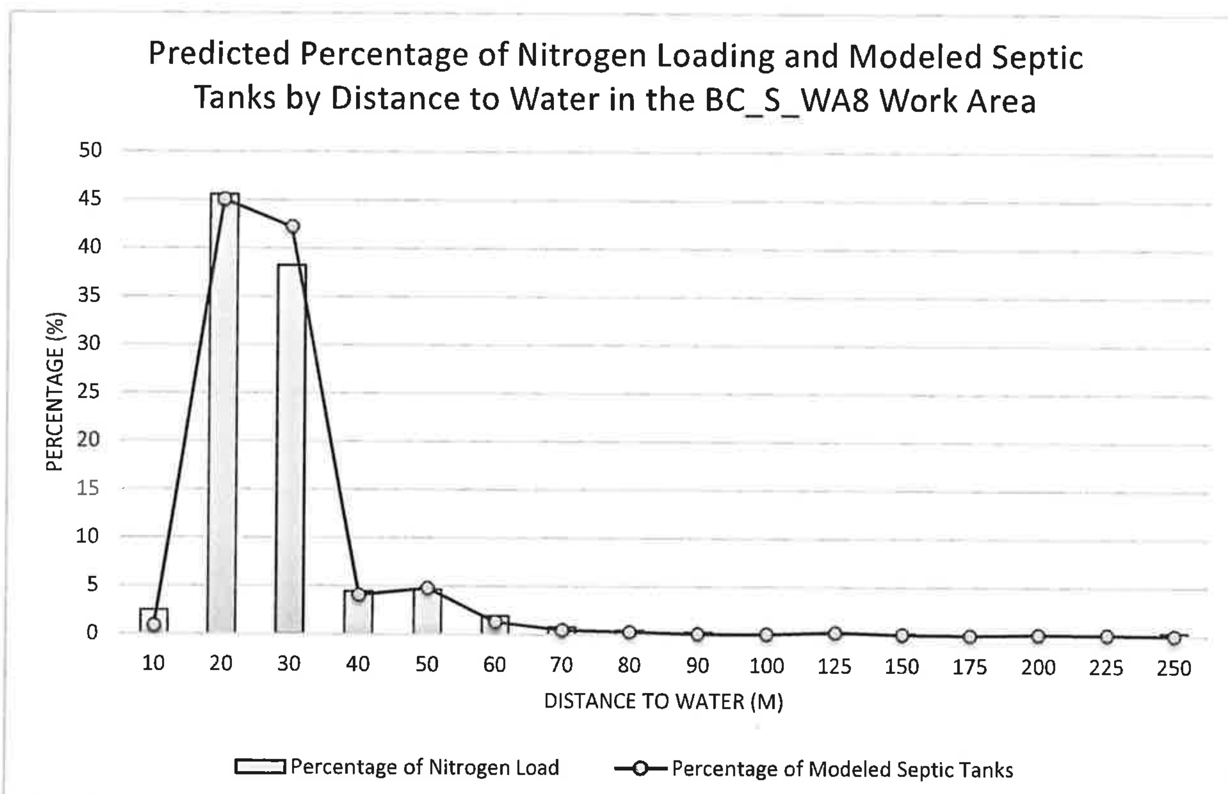


Figure 74. Percentage of total nitrogen loading and OSTDS by distance within South WA8.

Work Area South 9

South Work Area 9 is the second most southern area of the modeled areas within the County and covers large portions of Grant-Valkaria (Figure 2). The soils are dominated by A/D soils (around 75%), followed by much smaller proportions of C/D and B/D soils (close to 20% combined), with negligible A soils (Figure 75Figure 70Figure 56).

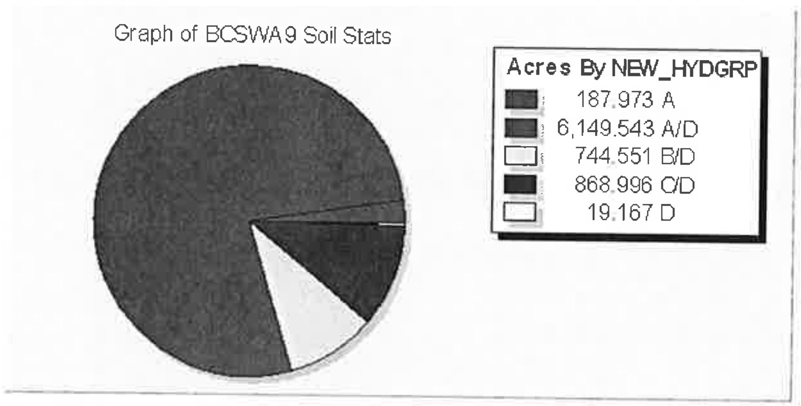


Figure 75. Distribution of the soil coverage by hydrologic group for South WA9.

For this work area all 2,341 OSTDS were modeled for loading potential to nearby waterways, providing 100% representation of the OTDS loading in this moderately dense area. The septic tank distribution of this work area is similar to the South Work Areas 6, 7, and 8, with 93% of all the modeled septic tanks (2090 septic tanks) located within 30-m of a waterbody/channel (Figure 76). Fewer than 1% of the total modeled septic tanks located beyond 70-m distance from the water.

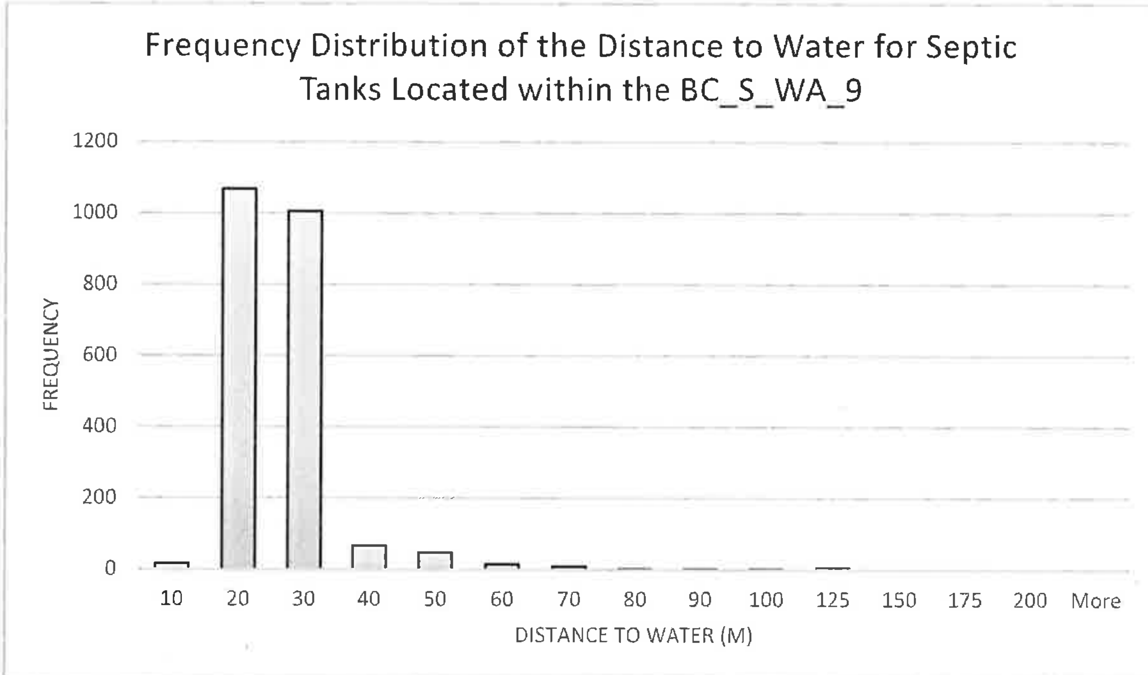


Figure 76. Frequency Distribution of septic tanks by distance to waterbodies within South WA9.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix O. Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are highly variable, with highest values for the 10-m distance class (2.2 lbs TN/yr), and lower mean values for all greater distances (Figure 77). Variability is high throughout all distance classes, with greater number of outliers for the 10-20, and 20-30-m distance classes (Figure 78).

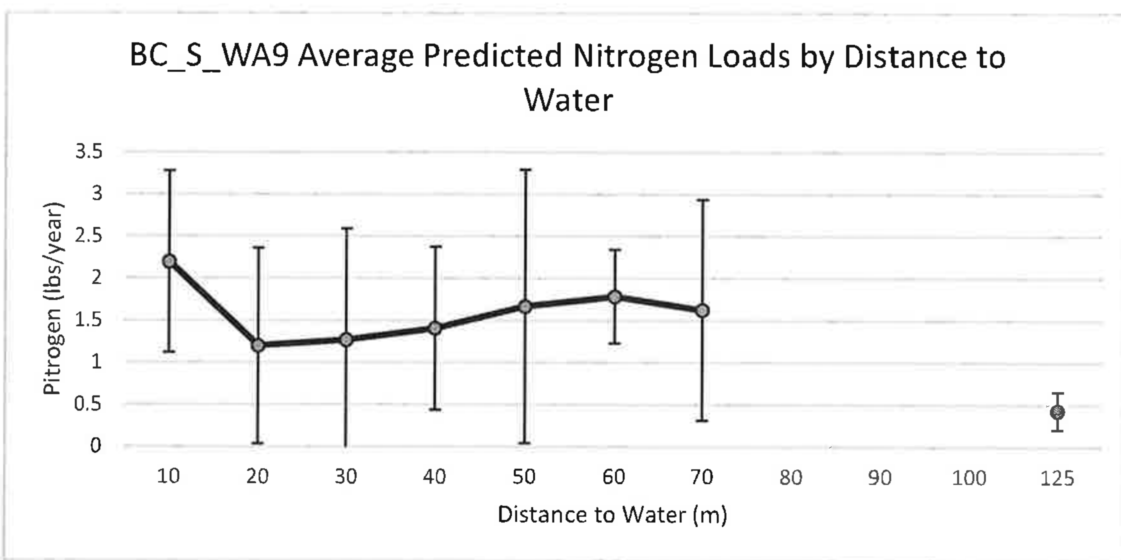


Figure 77. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for South WA9. Standard deviation was included as error bars.

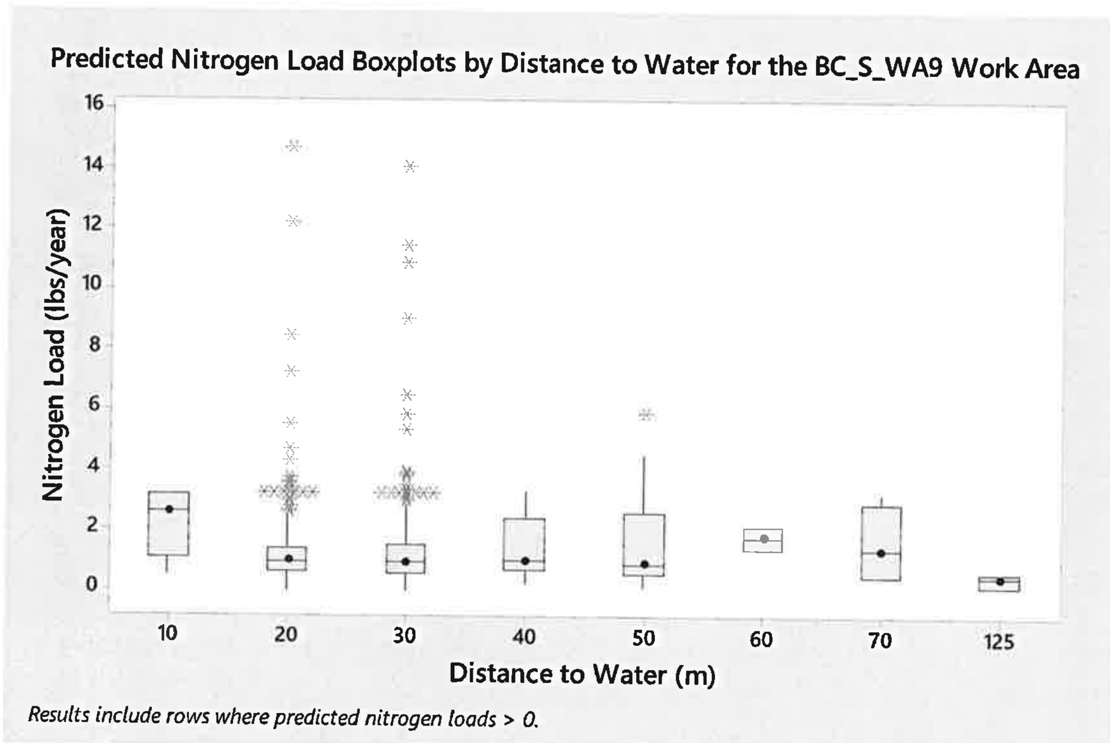


Figure 78. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for South WA9.

Septic tanks within the 10-30-m from a waterway have the greatest impact in the total nitrogen loading (Figure 79). Just as described for the South Work Areas 6, 7, and 8, the cumulative loading contribution from the OSTDS located within the first 30-m makes up 94% of the total area's nitrogen loading. The high loading contribution of these short distance intervals can be explained by the high density of OSTDS (93% of the total) located within 30-m from water.

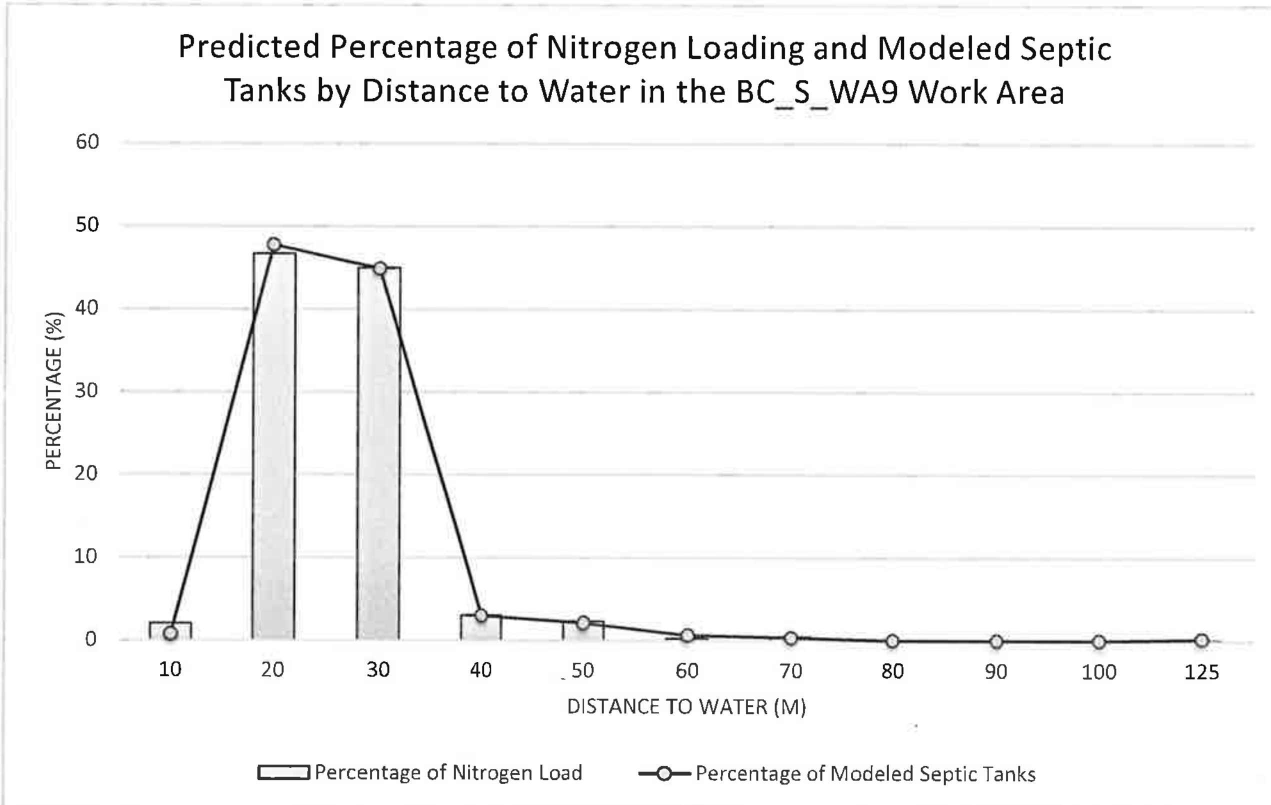


Figure 79. Percentage of total nitrogen loading and OSTDS by distance within South WA9.

Work Area South 10

South Work Area 10 is the southern-most modeled area within the County and covers the Micco area (Figure 2). The soils are dominated by A/D soils (around 80%), followed by much smaller proportions of C/D soils (close to 10%), with almost negligible B/D and A soils (Figure 80Figure 70Figure 56).

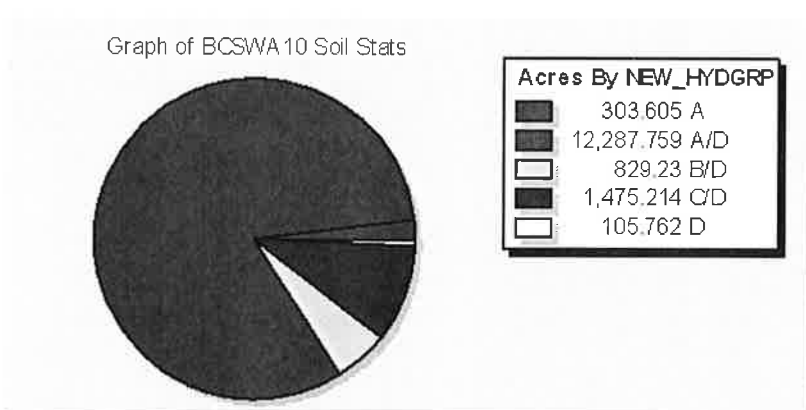


Figure 80. Distribution of the soil coverage by hydrologic group for South WA10.

In this South Work Area 10, 1,800 septic tanks were modeled for loading potential to nearby waterways. This represents 46% of all the OSTDS in this work area (3,941 total), randomly selected using a random seed number generator in the GIS environment. Due to the distribution of development in this area (closer to waterways), a large percentage of the modeled septic tanks (92% or 1605) are located within 50-m of a waterbody/channel (Figure 81Figure 62). Only about 7% of the total modeled septic tanks were located beyond 50-m distance from the water.

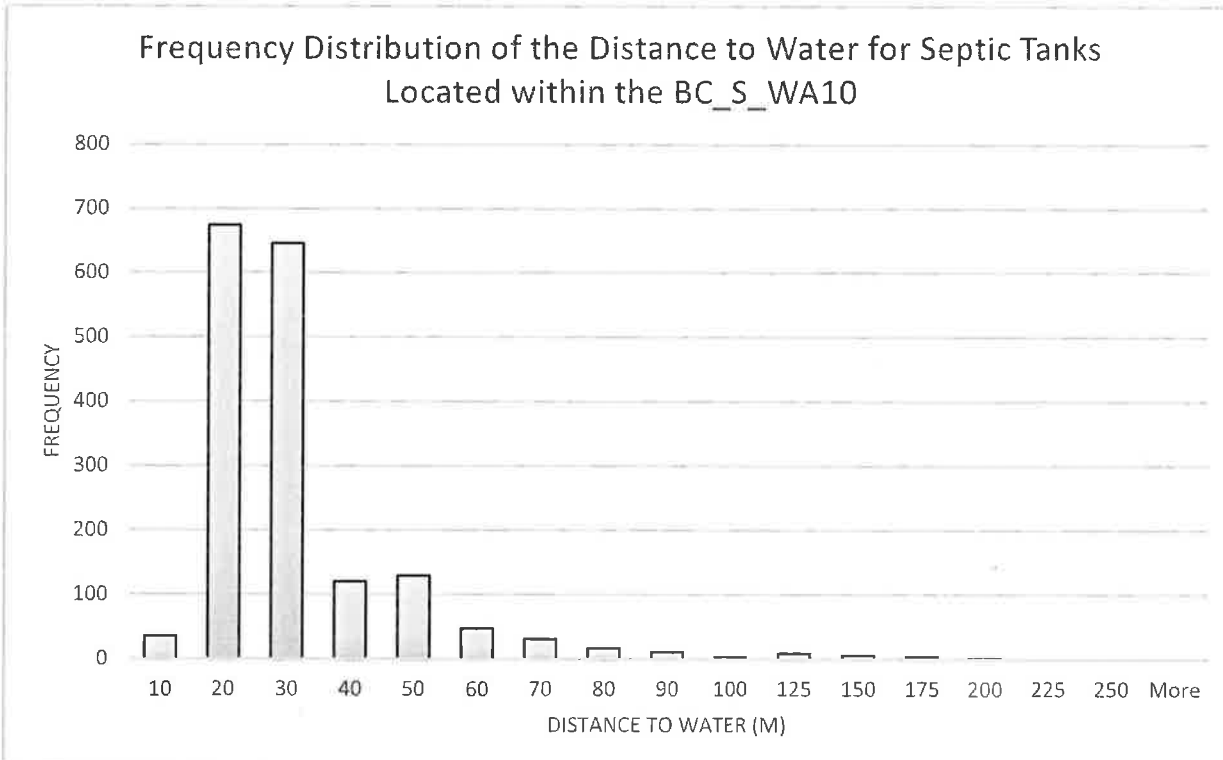


Figure 81. Frequency Distribution of septic tanks by distance to waterbodies within South WA10.

Histograms of the frequency of nitrogen load distributions by distance category are included for this work area in Appendix P.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in this work area are highly variable, with similar values throughout the distance classes (Figure 82). Unlike in previous work areas, variability seems highest for the higher distance classes (>100-m), where limited sample size yielded extremely large interquartile distribution of data (Figure 83).

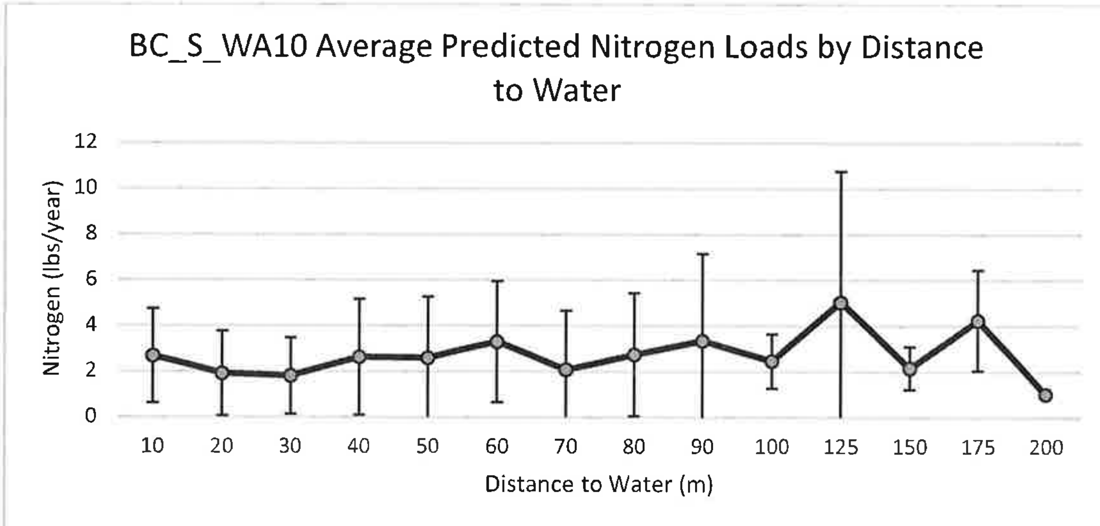


Figure 82. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for South WA10. Standard deviation was included as error bars.

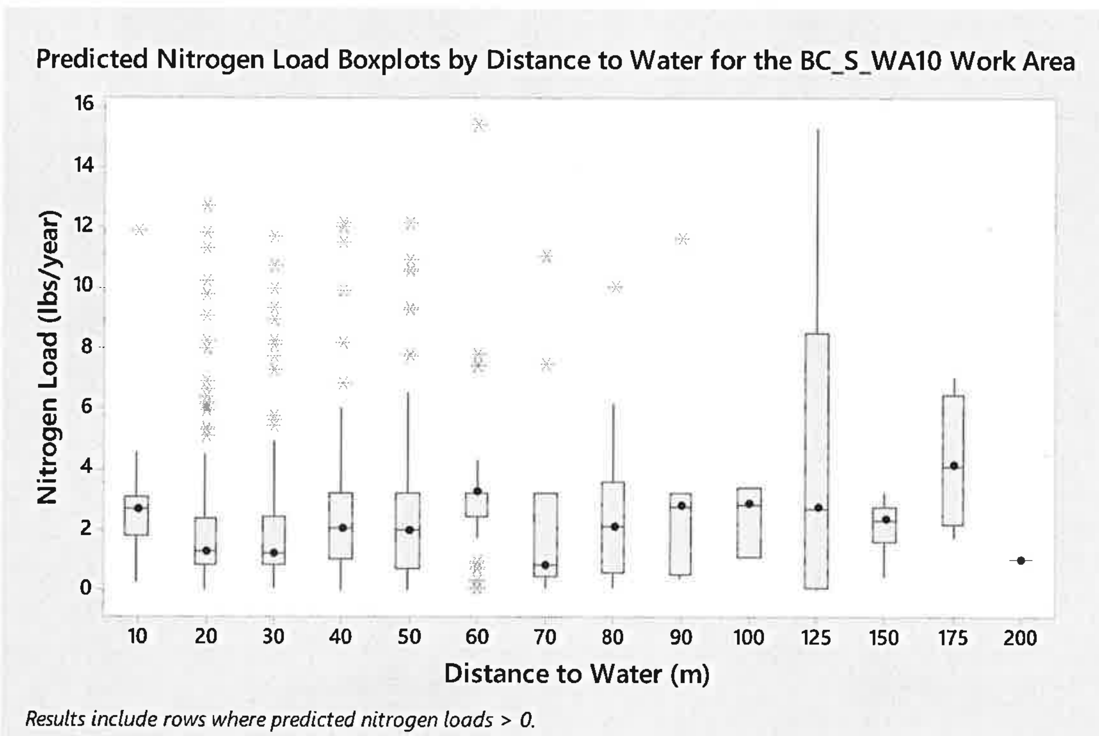


Figure 83. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for South WA10.

Just as described for the South Work Areas 6-9, septic tanks located between 10-30-m from a waterway have the greatest impact in the total nitrogen loading. The septic tanks located within the 10-20 and 20-30-m distance classes provide a total contribution of 30% and 28%, respectively. However, unlike in the previously mentioned work areas, the contribution of some of the further distances (up to 50-m) appear to have a greater impact in the total area nitrogen loading potential (Figure 84). Cumulatively, the total loading contribution from the OSTDS located within the first 30-m makes up 62% of the total area's nitrogen loading, in contrast to values between 88-95% for South Work Areas 6-9. Expanding the contribution of the OSTDS to 50-m, 85% of the total loading contribution is captured.

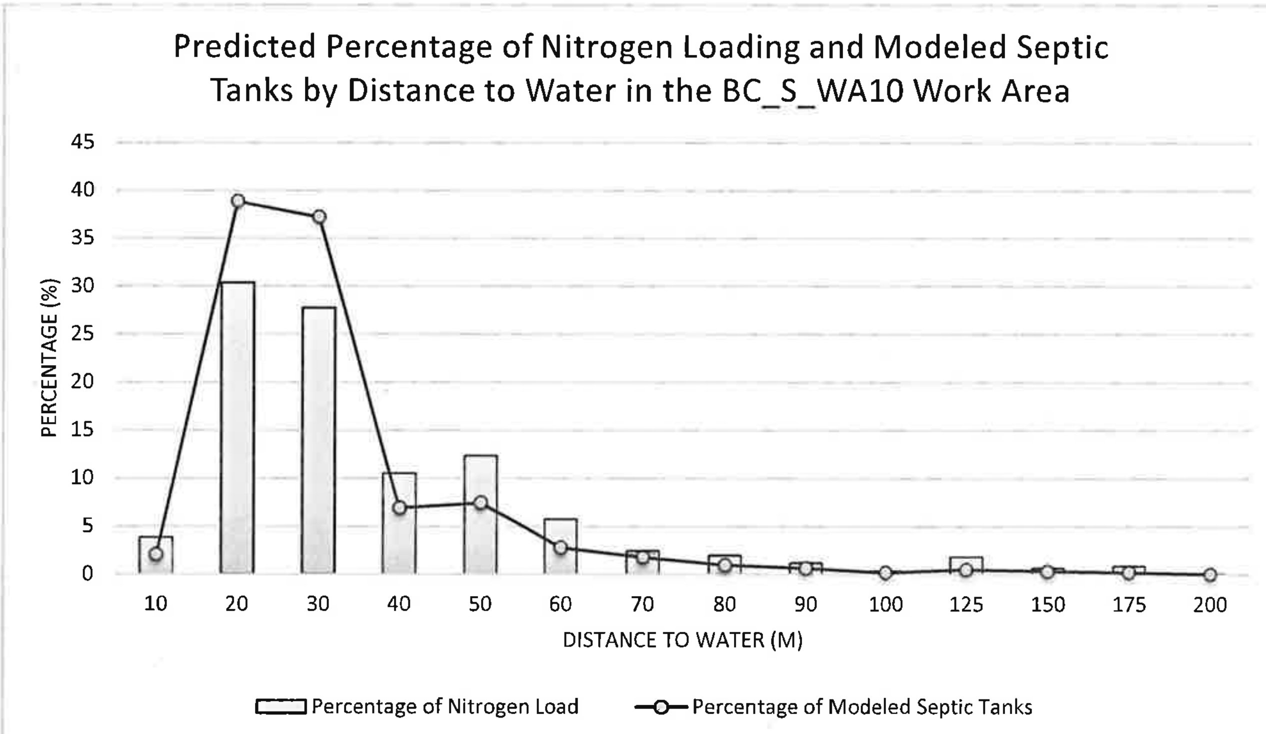


Figure 84. Percentage of total nitrogen loading and OSTDS by distance within South WA10.

Calibration and Importance of Soil Hydraulic Conductance

In late 2016, Florida Institute of Technology, Marine Resources Council and Applied Ecology, Inc. initiated a pilot study to develop a methodology for allocating groundwater sources of nutrients. A total of 11 shallow groundwater monitoring wells were installed in the Turkey Creek watershed, a tributary to the Indian River Lagoon (Figure 85). Three of these wells were located within a community with dense OSTDS, allowing these data to be used for site-specific calibration of the ArcNLET model.

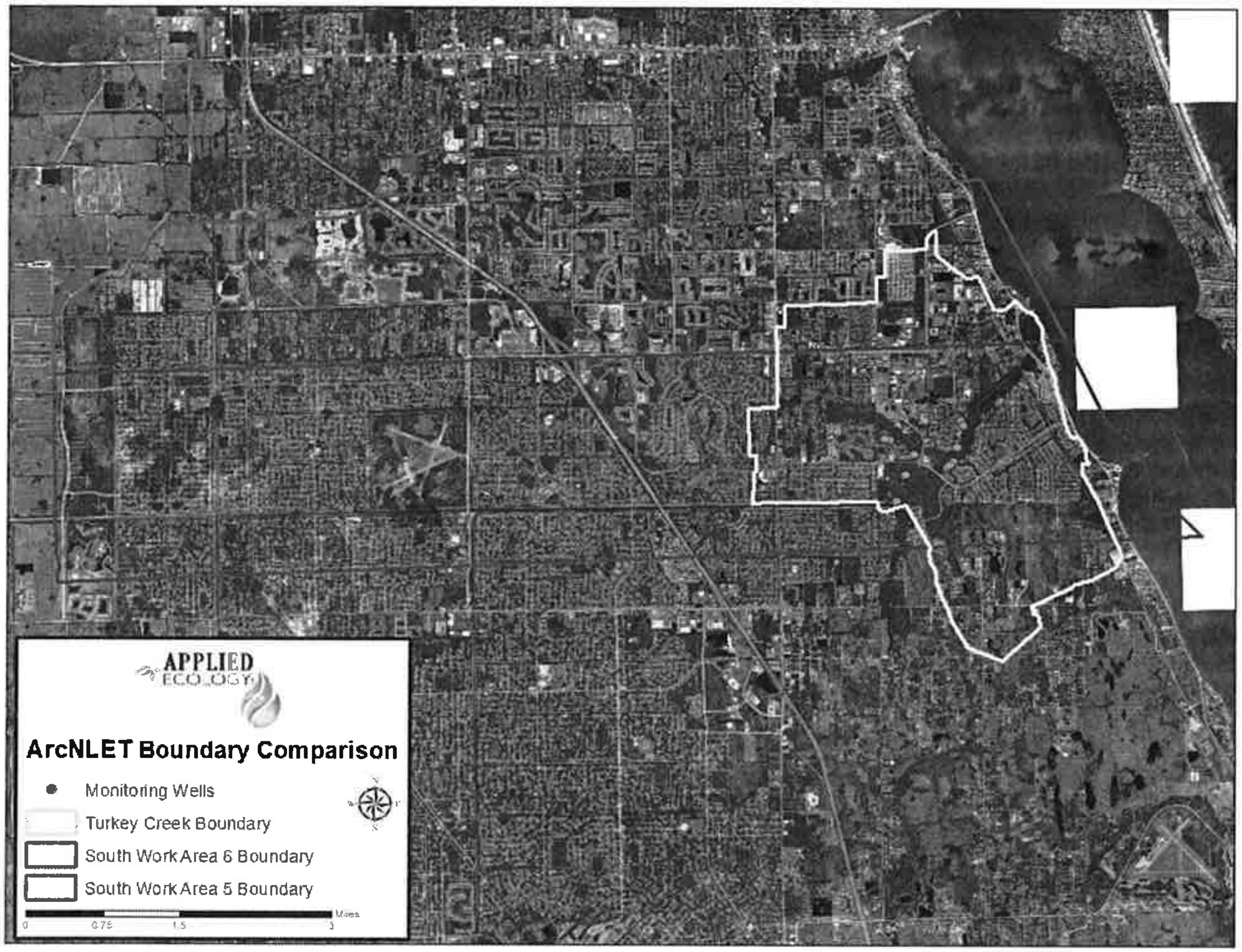


Figure 85. Calibration Model boundary, monitoring well locations, and studied work areas.

Water level, ammonia, and nitrate concentration datasets from the initial 10 sampling events were used to calibrate the Turkey Creek model area, which only contains 330 total OSTDS. Several model runs were performed to fine tune the results using in situ data for calibration of several key input parameters: hydraulic head, hydraulic conductivity, dispersivity (both longitudinal and horizontal transverse), and decay coefficient. Calibration is completed initially for hydraulic head and subsequently for the nutrient transport model (ammonia and nitrate concentrations). Best fit is tested for concentration data by comparing medians and interquartile ranges between measured and modeled data (Figure 86).

Comparison of per OSTDS loading between the calibrated Turkey Creek Basin and South Work Area 5, where the monitoring wells used for the calibration are located, clearly indicated that uncalibrated model runs were underpredicting the nutrient loading potential of OSTDS in this area (Table 1). A calibration factor of at least 5.8 (up to 18.3 for higher risk factor runs) should be added to the uncalibrated loads predicted by the ArcNLET model in this location. Calibration factors are likely to be closer to the higher number (18.3) in work areas where soil hydraulic conductance is average or above average, unlike the calibration areas, dominated by low-medium conductance values.

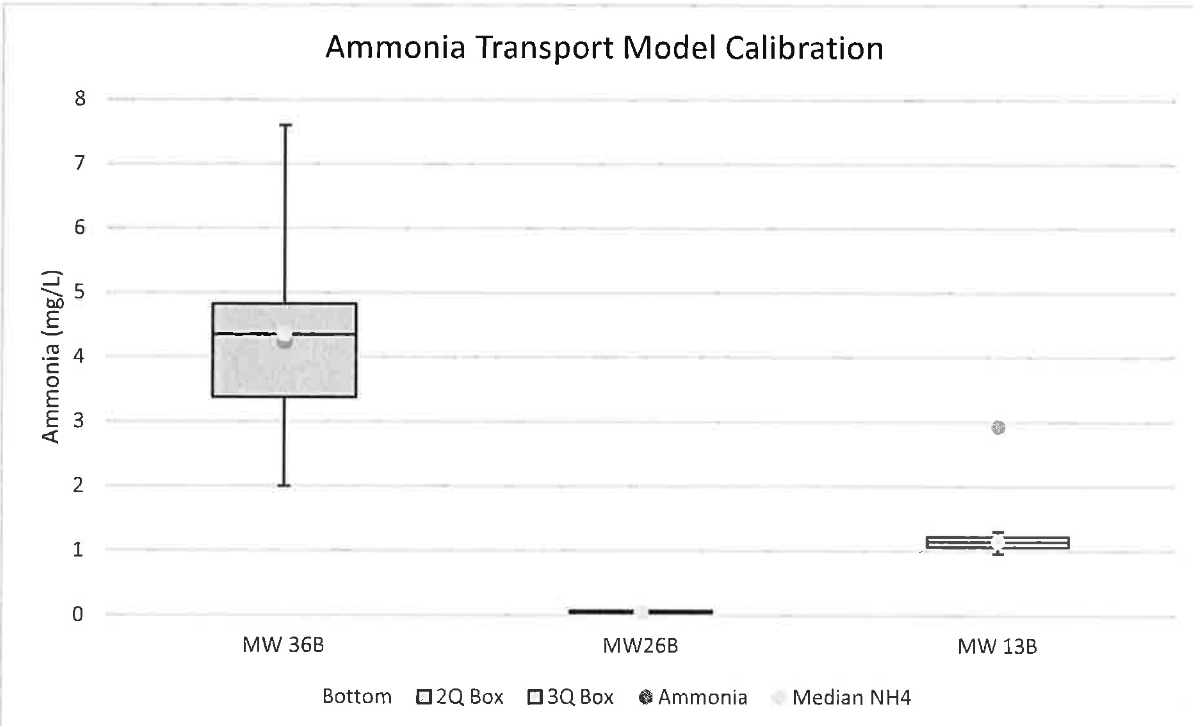


Figure 86. Modeled and predicted ammonia concentrations for plumes near monitoring wells using the best fit model for the Turkey Creek basin.

Table 1. Modeled total nitrogen load and per OSTDS load for calibrated Turkey Creek basin versus nearby Work Areas S5 and S6.

Location	Acres	Total OSTDS	Modeled OSTDS	Calibration Run Risk Factor	Predicted TN Loads (g/day)	Predicted TN Loads (lbs/year)	Per OSTDS Load (lbs/year/tank)
Turkey Creek Boundary	5,289.62	330	330 (100%)	1	1443	3607	3.65
Turkey Creek Boundary	5,289.62	330	330 (100%)	5	4486	1161	11.34
BC_S_WA_5	8,579.06	2138	2138 (100%)	N/A	1981	1594	0.75
BC_S_WA_6	13,550.85	9899	2097 (21%)	N/A	2945	2370	1.14

Soil Hydrologic Group and OSTDS Contribution to Loading

Most of the soils within the Indian River Lagoon watershed area are composed by either A or A/D soils, with a smaller percentage of soils composed by B/D soils. The overall composition of the soil types is included in Table 2. The distribution of the soil hydrologic types is spatially variable. Much of the Barrier Island and coastal mainland regions are composed of A soils, which are classified as high infiltration (Figure 87, Figure 88). South Merritt Island is composed of A soils, while the northern portion is composed of large portions of A/D and C/D soils. Southern mainland, particularly the western half is dominated by A/D soils with pockets of B/D and C/D soils. Northern mainland, when not coastal, is composed of almost equal parts A/D, B/D, and C/D soils.

Table 2. Area in acres and percentage of each soil hydrologic group within the Brevard County boundary.

Soil Hydro Group	Area (acres)	Percentage
A	74,634	16.22
A/D	129,479	28.14
B	1,034	0.22
B/D	57,824	12.57
C	217	0.05
C/D	24,055	5.23
D	27,903	6.06
W	144,975	31.51
Total	460,121	100.00

High infiltrations soils (type A) are often, but not always, correlated with high hydraulic conductivities, which lead to faster nutrient transport paths and measurable nitrogen plumes at a greater distance from OSTDS sources. To better understand the impact of soil hydrologic groups on the impact individual OSTDS by distance, loading data were summarized by soil type below.

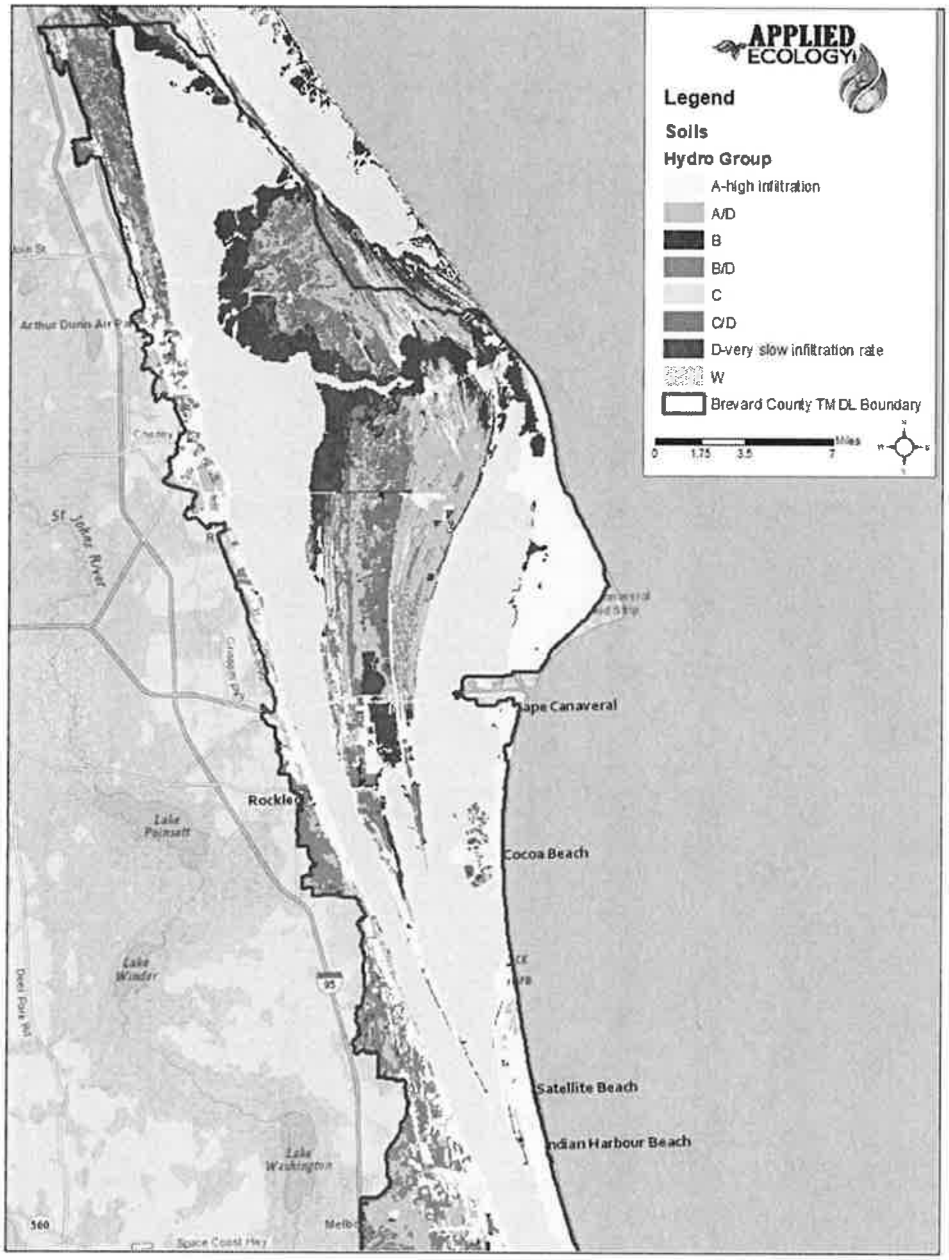


Figure 87. Soil distribution through the northern region of Brevard County.

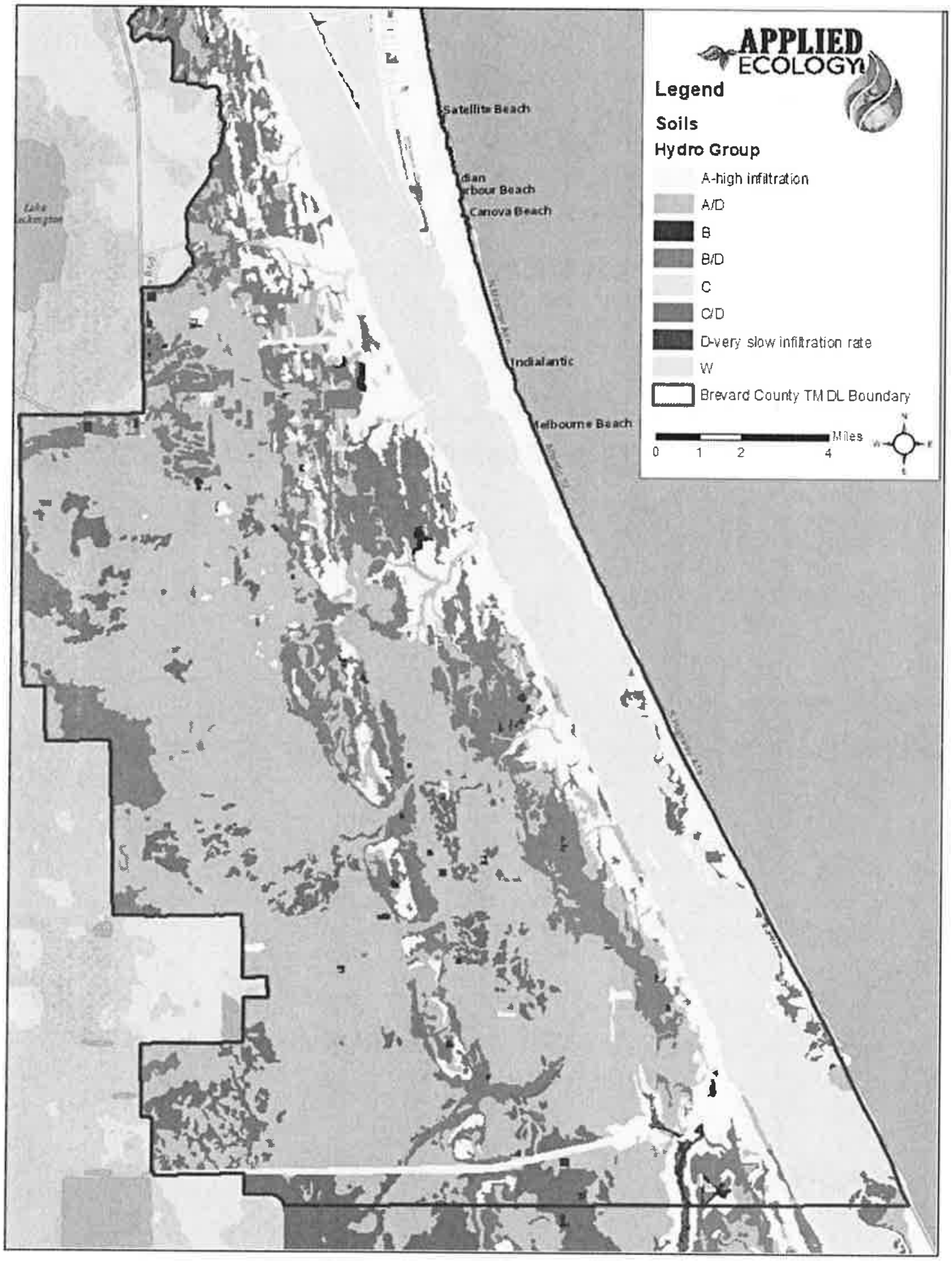


Figure 88. Soil distribution throughout the southern region of Brevard County.

Hydrologic Soil type A (well drained soils)

Type A soils are regionally distributed along the coastal areas of the Indian River Lagoon within the TMDL boundary (Figure 87, Figure 88). A large portion of A soil type is located within the Barrier

Island region and surrounding the major inlets such as Turkey Creek, Crane Creek, and the Eau Gallie River, all of which are highly urbanized. A total of 9,471 septic tanks were modeled throughout the 16 work areas, representing 59% of the OSTDS loading for the total area classified as soil type A. About 57% of the septic tanks are currently located within 50-m of a waterbody/channel, and 82% within 100-m of water. Aside from a single septic point located within the 400-m distance class, no septic tanks were found at distances beyond 350-m from a waterbody.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank within type A soils are included in Figure 89Figure 18. A calibration factor of 5.8 derived from a calibrated run of the ArcNLET model for the Turkey Creek basin was applied to the mean loading values. The variability of individual septic tank loading contribution to nearby waterbodies is very high for the most distance categories up to 250-m (Figure 89). Similar trends, although less drastic are also observed in the median uncalibrated values (Figure 90). The highest per septic tank loading is for those tanks within 10-m of the waterbodies (mean of 28.4 lbs/year). Loads decrease with a steep slope to 10.7 lbs/year at 80-m, then proceed to decrease with a very gentle slope with increased distance. Mean per septic tank values are only reduced to below 10 lbs/year at distances greater than 100-m and are still loading at significant at significant amounts (5 lbs/year) at 200-m from water. Loading becomes negligible at distances greater than 275-m.

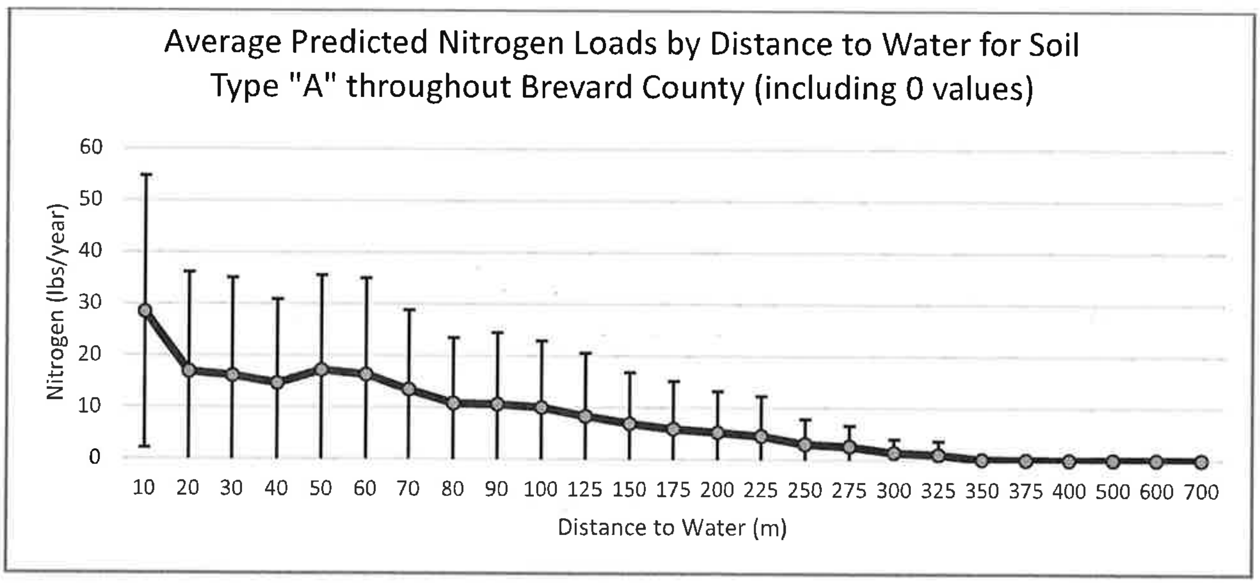


Figure 89. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for soil type "A" throughout Brevard County. A calibration factor of 5.8 derived from the ArcNLET Turkey Creek model run was applied to the uncalibrated outputs for septic tanks within soil type "A". Standard deviation was included as error bars.

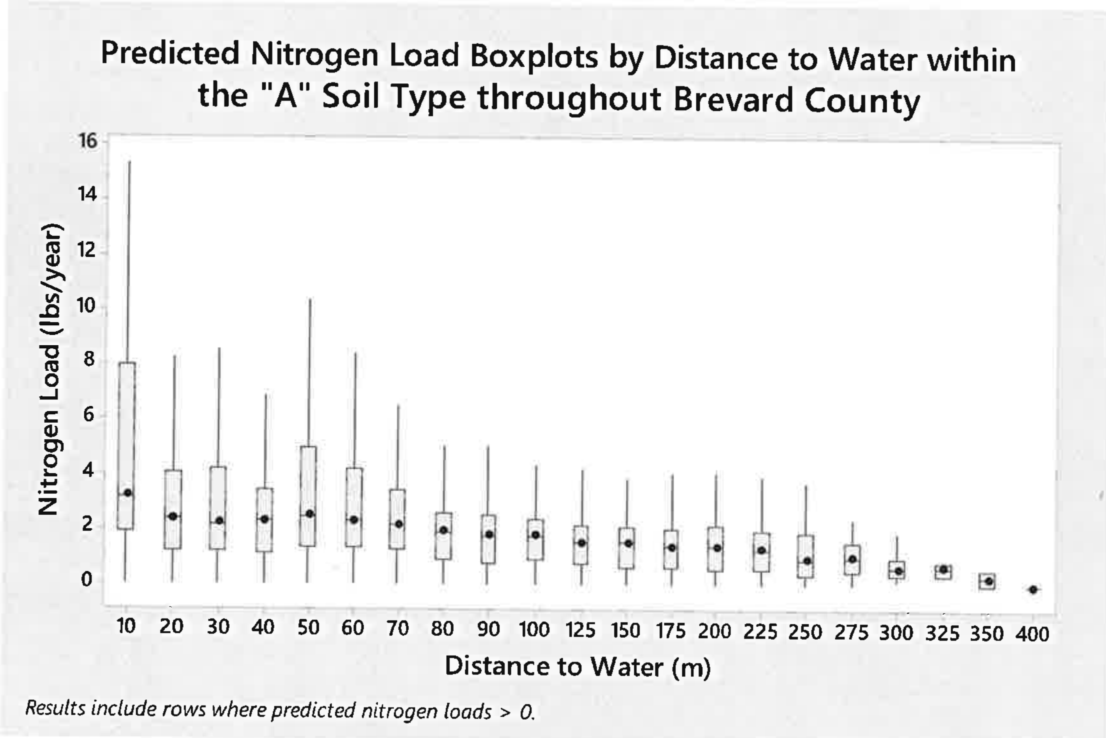


Figure 90. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for soil type "A".

The predicted percentages of nitrogen loads were expanded to include the 16,118 septic tanks located within A soils in order to provide a more representative view of the total nitrogen load at each distance interval. Septic tanks located between 0-70-m from a waterway have the greatest impact in the loading with each of the following distance classes contributing more than 10% of the total area loading: 10-20-m, 20-30-m, and 50-60-m. Cumulatively, the total loading contribution from the septic tanks located within the first 70-m makes up 69% of the total type A soil area's nitrogen loading (Figure 91). Expanding to include all the OSTDS located within the first 150-m from the water (76% of all the OSTDS), allows 92% of all the area's loading into the waterways to be captured. The contribution of all the septic tanks located beyond 150-m corresponds to less than 8% of the total loading for the type A soil area.

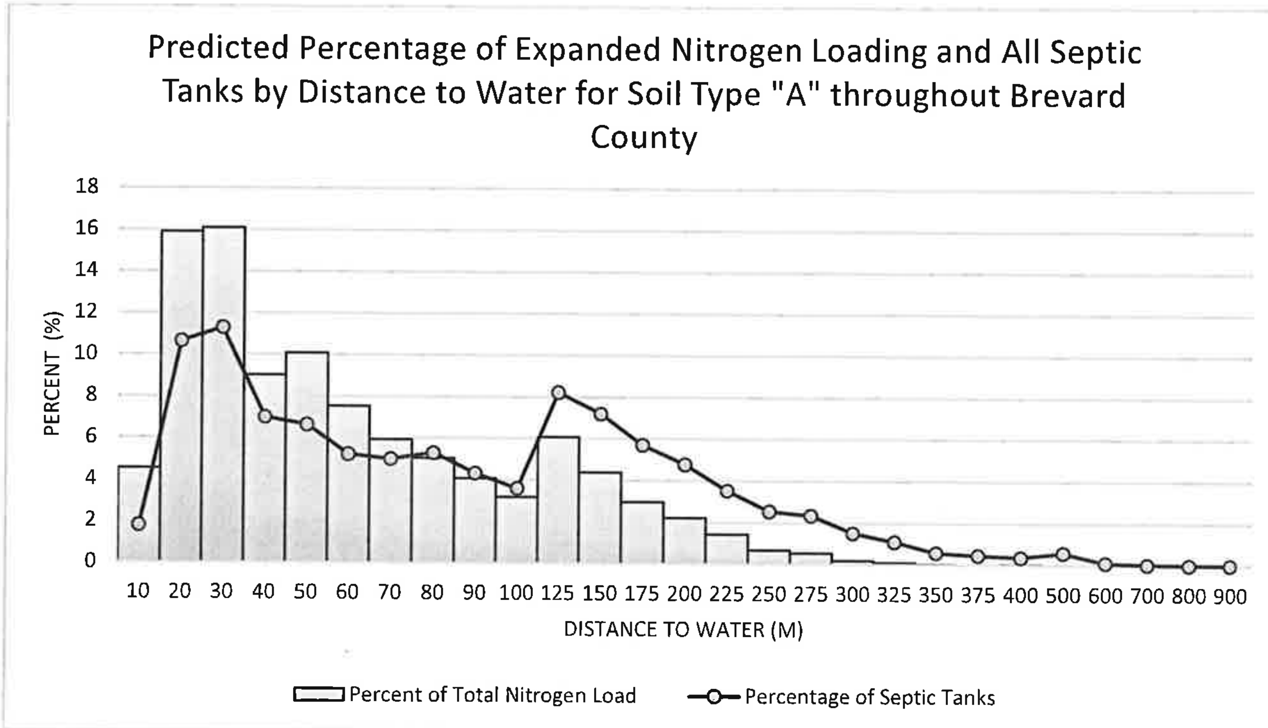


Figure 91. Percentage of total nitrogen loading and OSTDS by distance within the soil type "A" classification.

Hydrologic Soil type A/D

Type A/D is the largest contributing soil type within Brevard County, representing 28% of the total area (Table 2). Most of these soils are found in the southwestern region, which is primarily made up of residential and agricultural uses (Figure 88). Additionally, there is a large portion of the Kennedy Space Center which is comprised of A/D soils. A total of 11,204 septic tanks were modeled, which represents 40% of the OSTDS loading for the total area classified as soil type A/D. About 91% of the modeled septic tanks are currently located within 50-m of a waterbody/channel (10,189), and 98% within 100-m of water (10,934). No septic tanks were found at distances beyond 800-m from a waterbody.

Boxplots of predicted uncalibrated total nitrogen loads reaching waterways for an individual septic tank within type A/D soils, as well as their associated median, are included in Figure 92. Mean loads are included in Figure 93, which show very similar decreasing trends to the median predicted nitrogen load valuesFigure 18. The variability of individual septic tank loading contribution to nearby waterbodies is very high for the most distance categories up to 150-m (Figure 93). The highest per septic tank loading is for those tanks within 10-m of the waterbodies (mean of 14.9 lbs/year). Loads sharply decrease to 4.6 lbs/year from 10-m to 20-m and continue to follow a general decreasing trend, with a few minor fluctuations for the greater distance classes. Unlike the A soils where loading is significant for extensive distances from water, mean per septic tank values are only predicted to exceed 5 lbs/year between the 10-m to 40-m distance interval. Loads are reduced to below 3 lbs/year at distances greater than 90-m. Mean septic tank loadings were detected in all distance classes until 225-m, as well as 300-m and 350-m; septic tanks located at 250-m, 275-m, and 375-m to 700-m did not produce any loads.

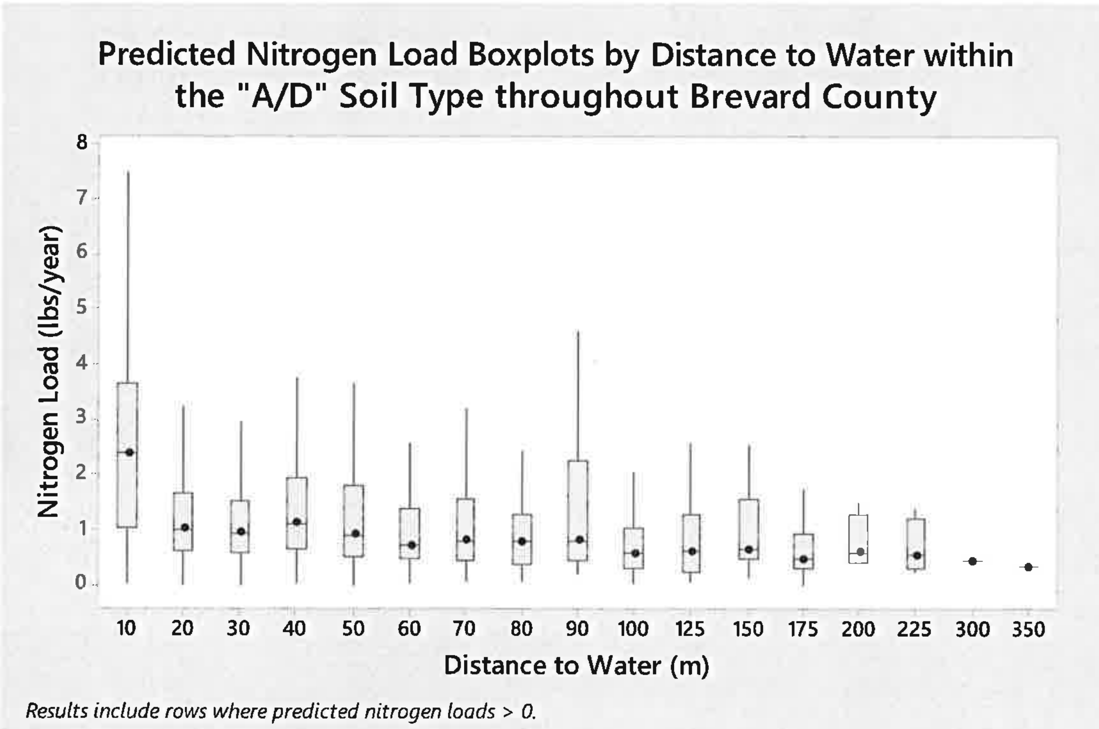


Figure 92. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for soil type "A/D".

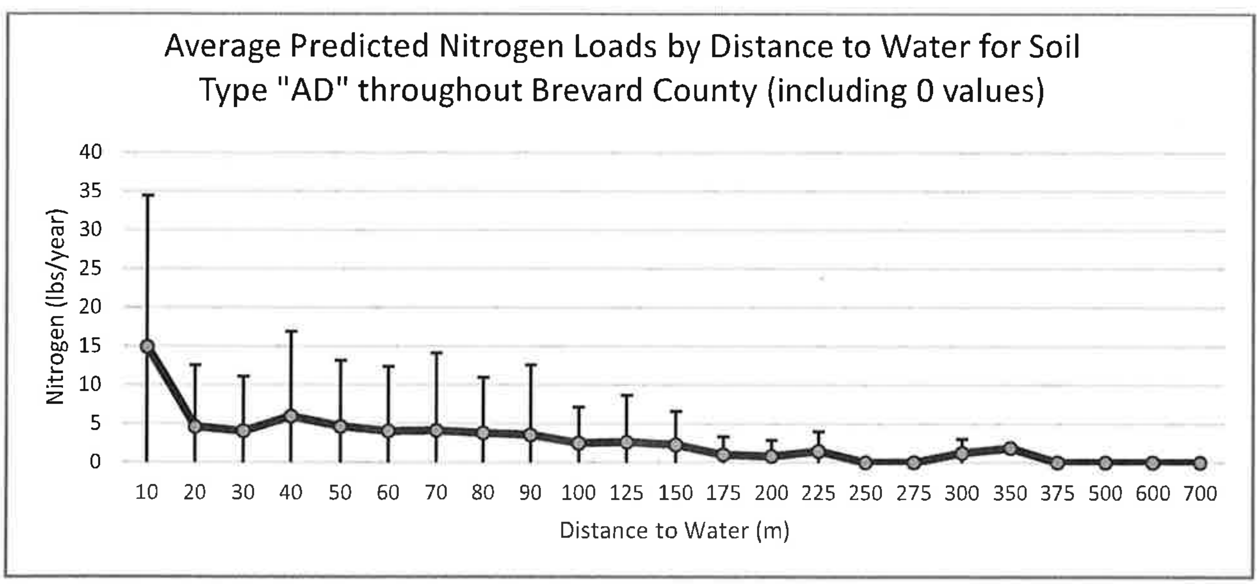


Figure 93. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for soil type "A/D" throughout Brevard County. A calibration factor of 5.8 derived from the ArcNLET Turkey Creek model run was applied to the uncalibrated outputs for septic tanks within soil type "A/D". Standard deviation was included as error bars.

The predicted percentages of nitrogen loads were expanded to include all 27,901 septic tanks located within A/D soils, providing a more representative view of the total nitrogen load at each distance interval. Septic tanks located between 10-40-m from a waterway have the greatest impact in the loading with each of the following distance classes contributing more than 8% of the total area loading: 10-20-m (46%), and 20-30-m (33%). Cumulatively, the total loading contribution from the septic tanks located within the first 40-m makes up 91% of the total type A/D soil area's nitrogen loading (Figure 94). Expanding to include all the OSTDS located within the first 50-m from the water (93% of all the OSTDS), allows 95% of all the area's loading into the waterways to be captured. The contribution of all the septic tanks located beyond 50-m corresponds to less than 5% of the total loading within the area for type A/D soil.

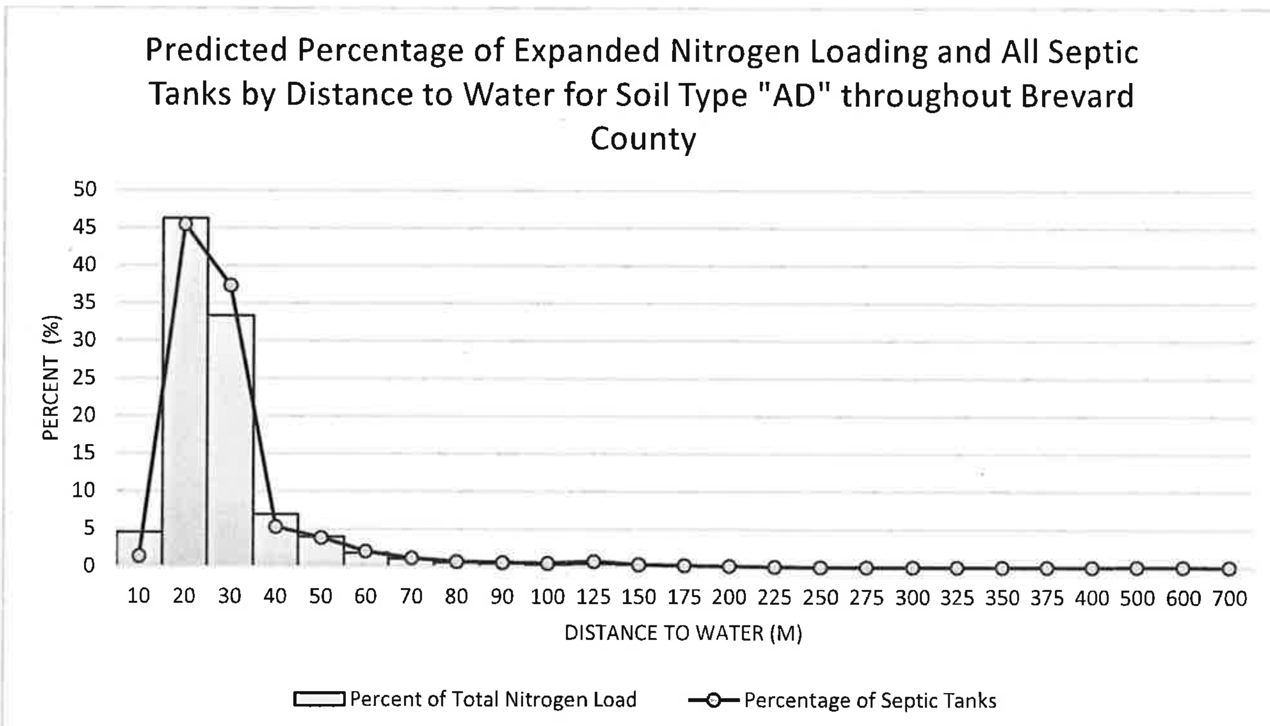


Figure 94. Percentage of total nitrogen loading and OSTDS by distance within the soil type "A/D" classification.

Hydrologic Soil type B

Type B soils are not distributed in any consistent pattern throughout the county and account for less than 1% of the total area (Figure 87, Figure 88). The sample size of 30 OSTDS modeled within this soil type made this inadequate for analysis and any true representation of the impact of B soils on the behavior of OSTDS with distance to water. Due to the inadequacy of data within B soils, summary data for this hydrologic group is not included in this report.

Hydrologic Soil type B/D (well drained soils)

Type B/D soils are distributed throughout the Brevard County TMDL boundary, mainly within the western side of the mainland and make up about 13% of the total area (Figure 87, Figure 88). A total of 4,939 septic tanks were modeled, representing 47% of the OSTDS loading for the total area classified as soil type B/D. About 58% of the septic tanks are currently located within 50-m of a waterbody/channel, and 79% within 100-m of water. No septic tanks were found beyond the 500-m distance class.

Boxplots with median uncalibrated values of the predicted total nitrogen loads reaching waterways for an individual septic tank within type B/D soils are included in Figure 95. Figure 18A calibration factor of 5.8 derived from a calibrated run of the ArcNLET model for the Turkey Creek basin was applied to the mean loading values (Figure 96). The variability of individual septic tank loading contribution to nearby waterbodies is very high for the most distance categories up to 200-m (Figure 96). The decreasing trend observed here is similar to that of the A/D soil type.

As expected and previously reported for the two of the previous soil types (A and A/D), mean per septic tank contribution is highest for the shortest distances, and particularly higher for the septic tanks located immediately adjacent to the water (within 10 m). The highest per septic tank loading is for those tanks within 10-m of the waterbodies (mean of 10.7 lbs/year). Variability is also much higher for the 10-m distance interval than for any other distance class. Individual septic tank contributions vary between 2.2-5.9 lbs of N within the 20-100-m distance classes, following a gradual decreasing trend with increased distance to a waterbody. After 100-m distance there is a clear reduction in per septic tank loading impact (below 1.8 lbs per year), which is even further reduced to below 1 lb/year at greater than 200-m distances. Mean septic tank loadings were detected for all distance classes until 375-m, however, there were six septic tanks which failed to produce any total nitrogen loads.

The high variability of the loadings within each distance class for this soil type is likely tied to the fact that soil hydraulic conductance values for B/D soils can range from low to high, resulting in a wide range in path lengths and plume sizes.

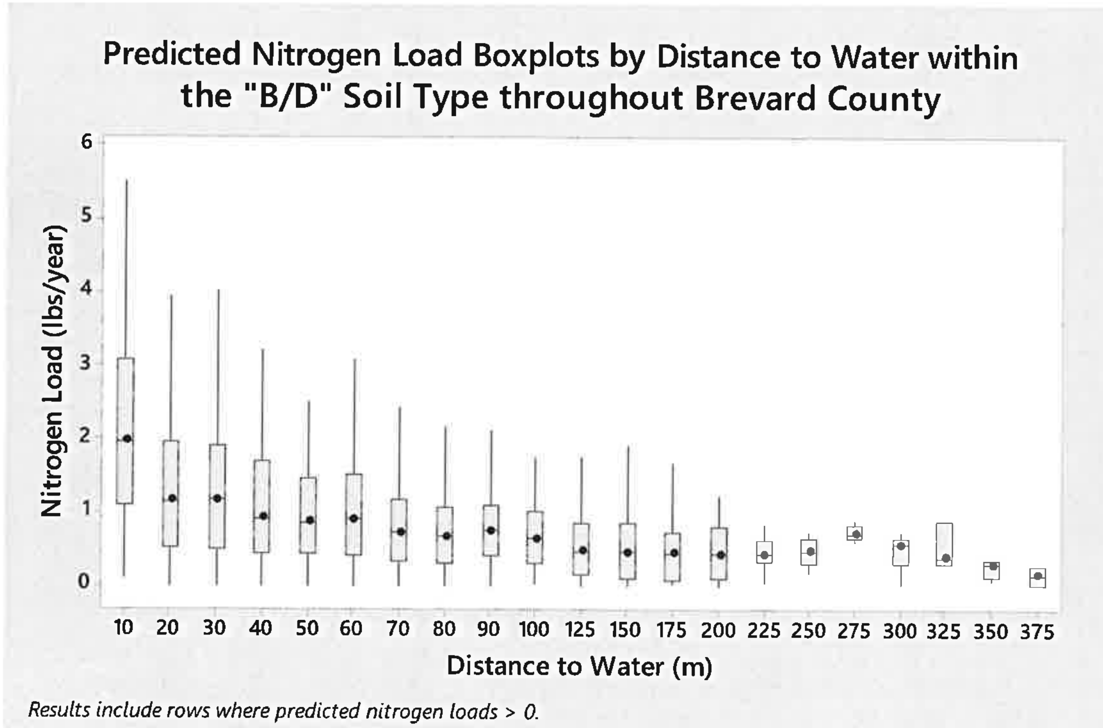


Figure 95. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for soil type "B/D".

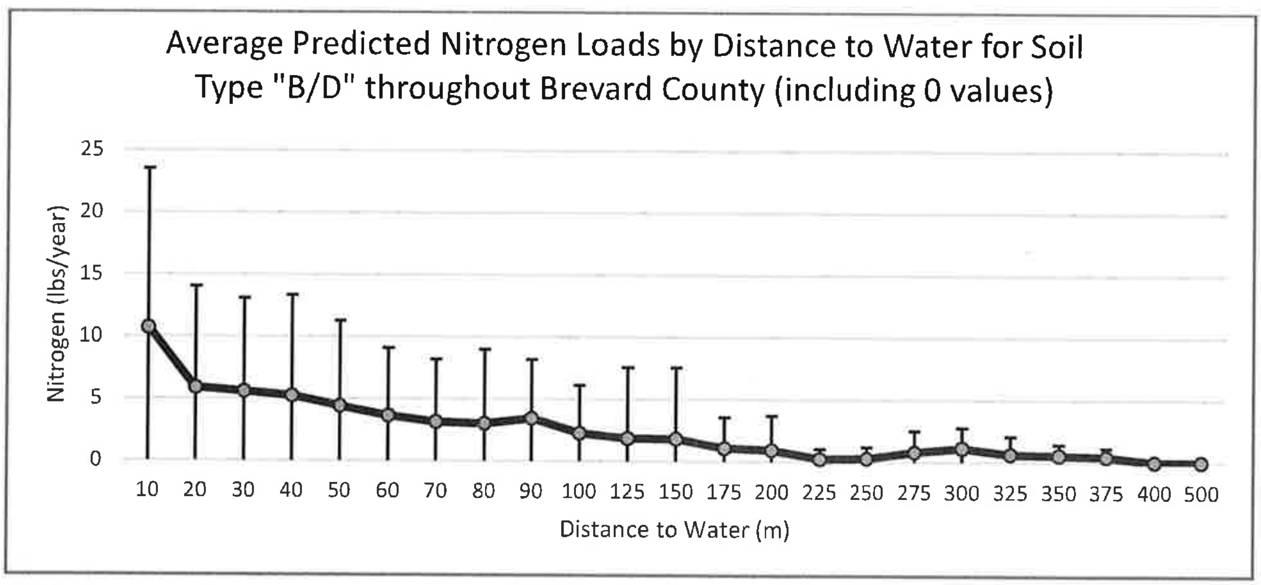


Figure 96. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for soil type "B/D" throughout Brevard County. A calibration factor of 5.8 derived from the ArcNLET Turkey Creek model run was applied to the uncalibrated outputs for septic tanks within soil type "B/D". Standard deviation was included as error bars.

The predicted percentages of nitrogen loads were expanded to include all 10,418 septic tanks located within B/D soils to provide a more representative view of the total nitrogen load at each distance interval. Septic tanks located between 10 to 50-m from a waterway have the greatest impact in the loading with each of the distance classes within this range contributing to greater than 5% of the total work area loading. The septic tanks located within the 10-20-m and 20-30-m distance classes provide a total contribution of 26% and 29%, respectively. Cumulatively, the total loading contribution from the OSTDS located within the first 50-m makes up 81% of the total area's nitrogen loading (Figure 97Figure 50). The high loading contribution of these distance intervals can be explained by the septic tanks within the same distance classes having higher mean nitrogen loads per septic tank. The remaining septic tanks beyond 50-m only represent 18.8% of the total load for the B/D soils.

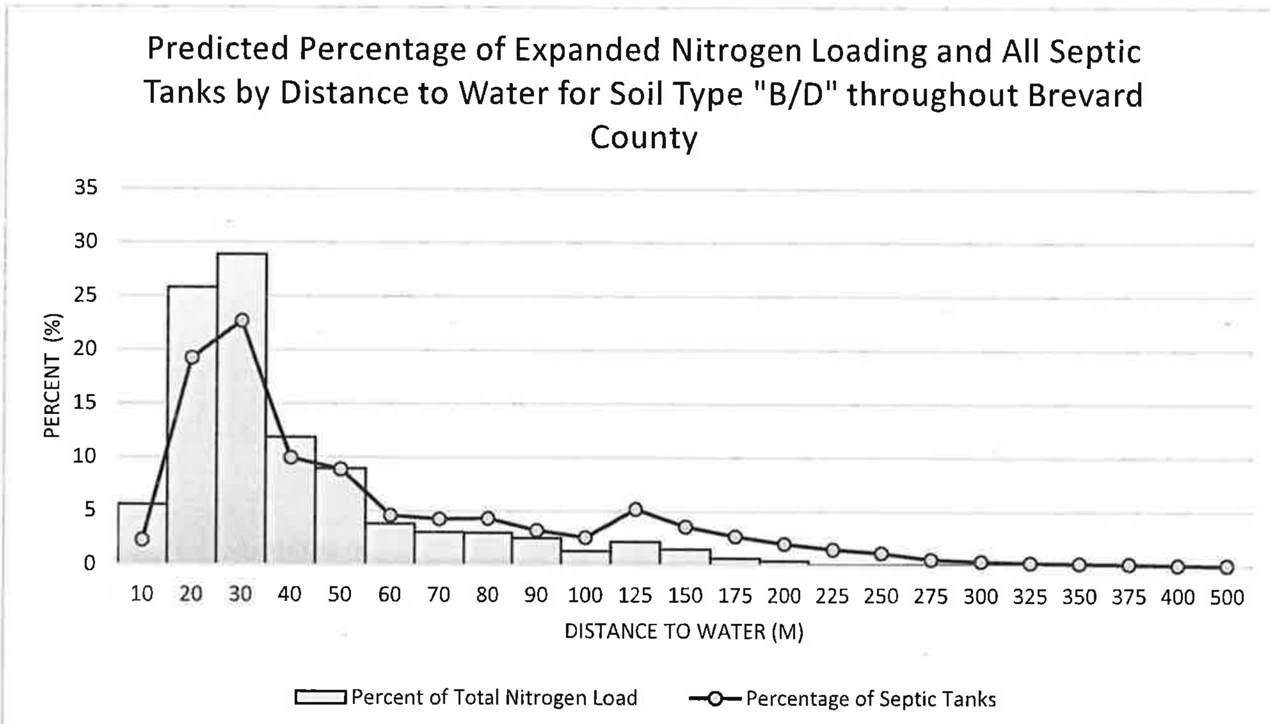


Figure 97. Percentage of total nitrogen loading and OSTDS by distance within the soil type "B/D" classification.

Hydrologic Soil type C/D

Type C/D soils are mainly found within the northern region of Merritt Island as well as smaller patches which are interspersed between the A/D soils in the southern half of the TMDL boundary, the majority of which are located within natural land use types (Figure 87, Figure 88). While a total of 1,522 septic tanks were modeled, representing 49% of the OSTDS loading for the C/D soil area, the C/D soil type only represents 5.23% of the total area within the Brevard County TMDL boundary. Almost 50% the septic tanks are currently located within 20-m of a waterbody/channel, and 93% within 50-m of water. No septic tanks were found beyond the 200-m distance class.

Boxplots with uncalibrated median values of the predicted total nitrogen loads reaching waterways for an individual septic tank within type C/D soils are included in Figure 98. Figure 18A calibration factor of 5.8 derived from a calibrated run of the ArcNLET model for the Turkey Creek basin was applied to the mean loading values (Figure 99). The variability of individual septic tank loading contribution to nearby waterbodies is very high for the most distance categories up to 70-m (Figure 99, Figure 98).

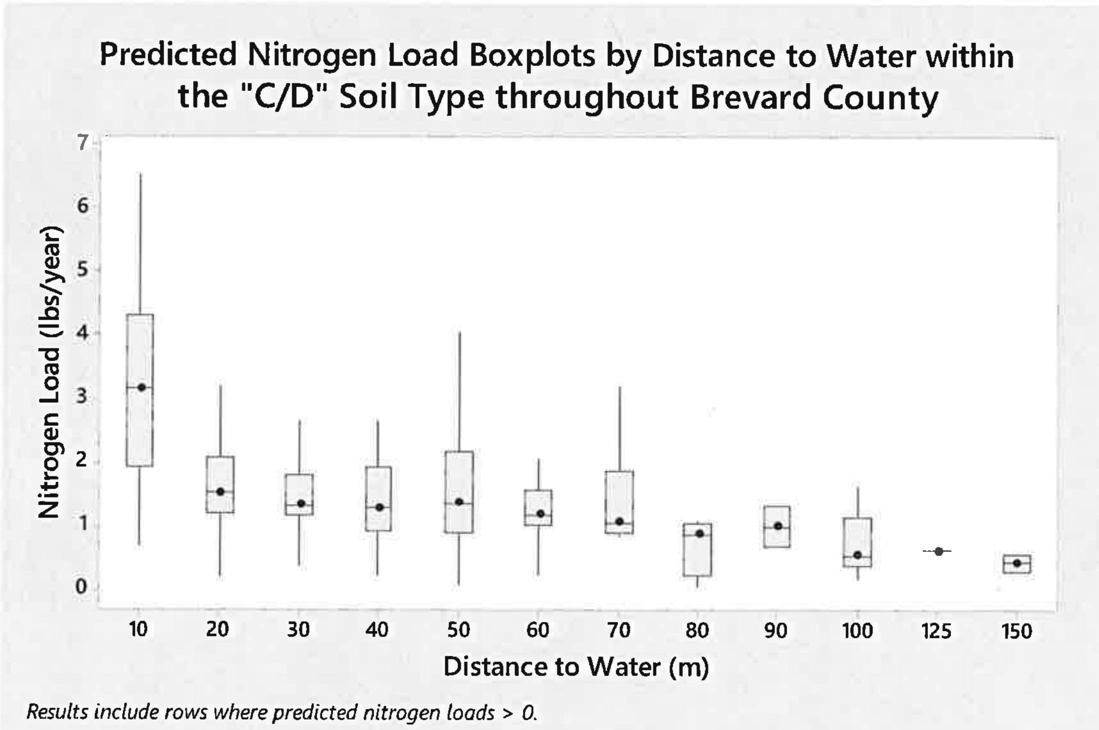


Figure 98. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for soil type "C/D".

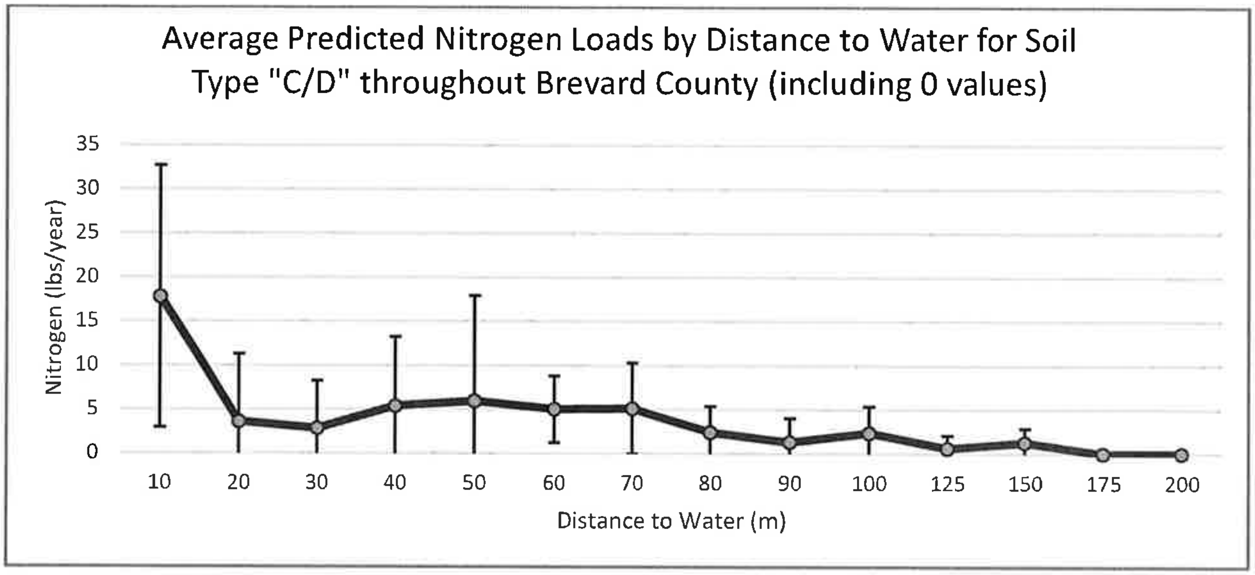


Figure 99. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for soil type "C/D" throughout Brevard County. A calibration factor of 5.8 derived from the ArcNLET Turkey Creek model run was applied to the uncalibrated outputs for septic tanks within soil type "C/D". Standard deviation was included as error bars.

As expected and reported for the previous soil types, mean per septic tank contribution is highest for the shortest distances, and particularly higher for the septic tanks located immediately adjacent to the water (within 10 m); however, there are differences in general trends as the mean loading values increase from 30-m to 50-m before return to the decreasing trend. The highest per septic tank loading is for those tanks within 10-m of the waterbodies (mean of 17.81 lbs/year), almost triple that of the second highest mean (5.94 lbs/year at 50-m). Variability at these two distance classes are much higher than for any other distance class. Aside from the 10-m distance class, individual septic tank contributions exceed 5 lbs/year from 30-m to 70-m and all other distance classes vary between 0.60 and 3.6 lbs of total nitrogen. Mean septic tank loadings were detected for all distance classes up to 150-m, after which, no OSTDS (only four located at these distances) contributed any nitrogen to the total loads.

The predicted percentages of nitrogen loads were expanded to include all 3,055 septic tanks located within C/D soils to provide a more representative view of the total nitrogen load at each distance interval. Septic tanks located between 0-30-m from a waterway have the greatest impact in the loading with each of the distance classes within this range contributing to greater than 7% of the total work area loading. The septic tanks located within the 10-20-m and 20-30-m distance classes provide a total contribution of 53% and 21%, respectively. This high relative contribution of the loading can be explained by the total number of septic tanks located at these distance intervals (2,580 tanks or 84% of all the total OTDS).Cumulatively, the total loading contribution from the OSTDS located within the first 30-m makes up 82% of the total area's nitrogen loading (Figure 100Figure 50). Expanding to include all the OSTDS located within the first 50-m from the water (93% of all the OSTDS), allows almost 94% of all the area's loading into the waterways to be captured. The contribution of all the septic tanks located beyond 50-m corresponds to less than 7% of the total loading within the area for type C/D soil.

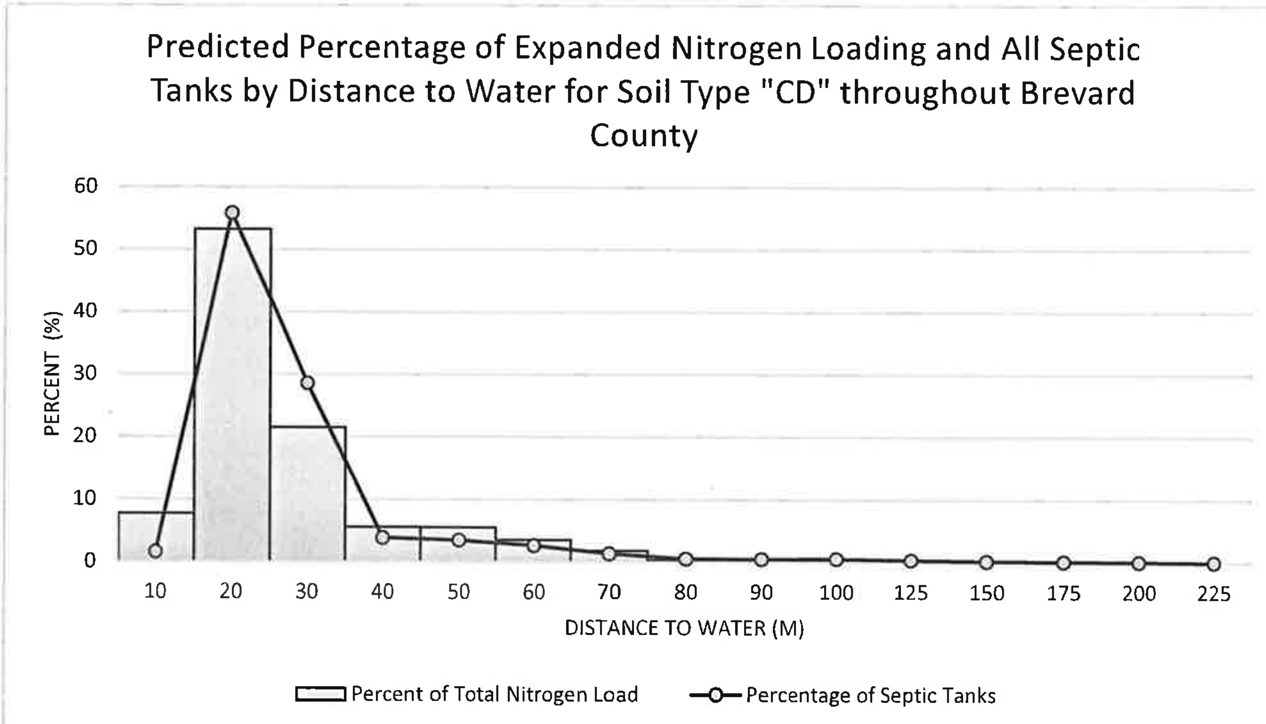


Figure 100. Percentage of total nitrogen loading and OSTDS by distance within the soil type "C/D" classification.

Hydrologic Soil type D (poorly drained soils)

The majority of type D soils are located within the northern half of the Brevard County TMDL boundary along the coastal regions of Merritt Island and are comprised of the natural land use types (Figure 87, Figure 88). Only 62 septic tanks were modeled, representing 65% of the OSTDS loading for the D soil area. The D soil type only represents a little over 6% of the total area within the Brevard County TMDL boundary. More than 85% the septic tanks are currently located within 50-m of a waterbody/channel. No septic tanks were found beyond the 90-m distance class. Due to the limited sample size, any conclusions derived from the patterns described below needs to be evaluated carefully and confirm with additional data in the future.

Boxplots with uncalibrated median nitrogen loading values for an individual septic tank within type D soils are included in Figure 101. Median values are lower, in general, than mean values when excluding the 0 loading septic tanks for the close distances to water, however, the pattern observed by both central tendency measures is similar. There is a gradual decreasing trend in mean loading until 50-m, after which there is an increase until the highest nitrogen load contribution by the septic tanks at the 60-m distance class, followed by another gradual decrease from the 60-80-m distance classes (Figure 101, Figure 102). Figure 18 The peak at 60-m is likely an outlier driven by a sample size of 1 OSTDS at this distance class, which happens to be located with an area with higher hydraulic conductance values and hydraulic head than most of the other modelled OSTDS within D soils.

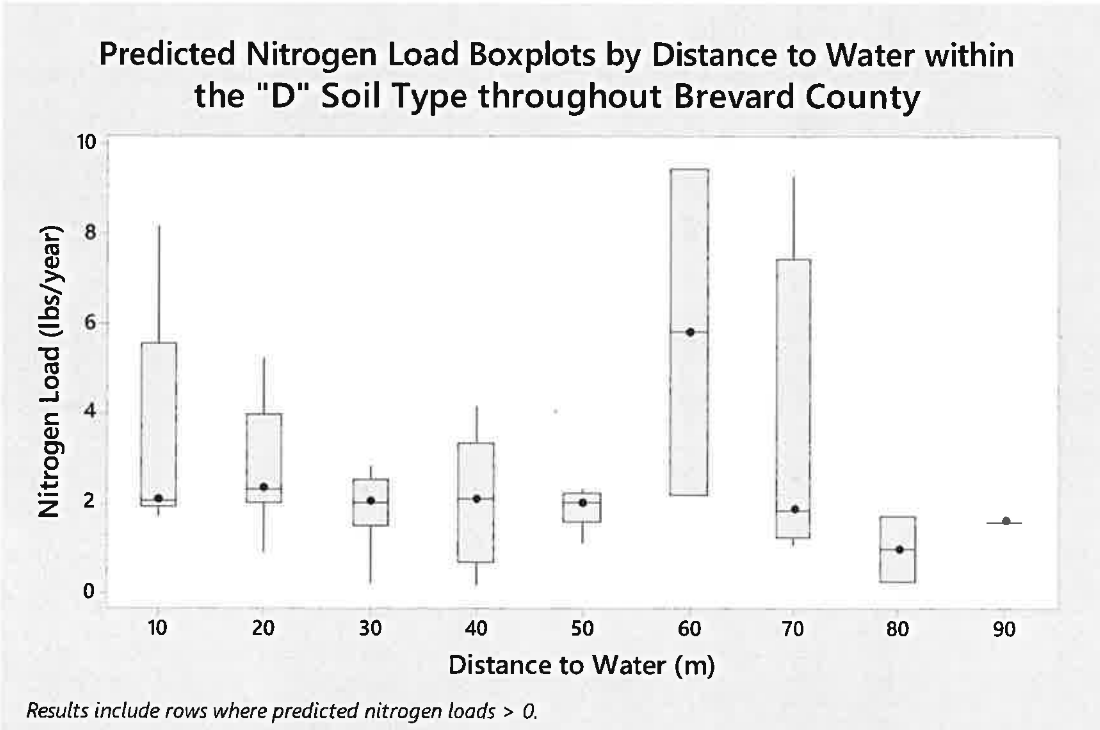


Figure 101. Boxplot representing the distribution of individual septic tank nitrogen loads into nearest waterbody by distance interval for soil type "D".

A calibration factor of 5.8 derived from a calibrated run of the ArcNLET model for the Turkey Creek basin was applied to the mean loading values (Figure 102). The highest per septic tank loading is for those tanks between 50-m and 60-m of the waterbodies (mean of 33.81 lbs/year), which also had the highest variability. Five of the nine distance classes have mean loading values greater than 11 lbs/year. Mean septic tank loadings were detected for all distance classes and there were no distance class with mean loads below 5 lbs/year. Interestingly, this resulted in D soil type having the highest overall mean individual septic tank load of any other soil type (15.10 lbs/year). It is important to note, however, that calibration factor from a very different area in terms of soil type and hydraulic head (southern mainland) is being applied to this area. Site specific calibration values might greatly improve the accuracy of the mean per OSTDS loading for additional areas within the County.

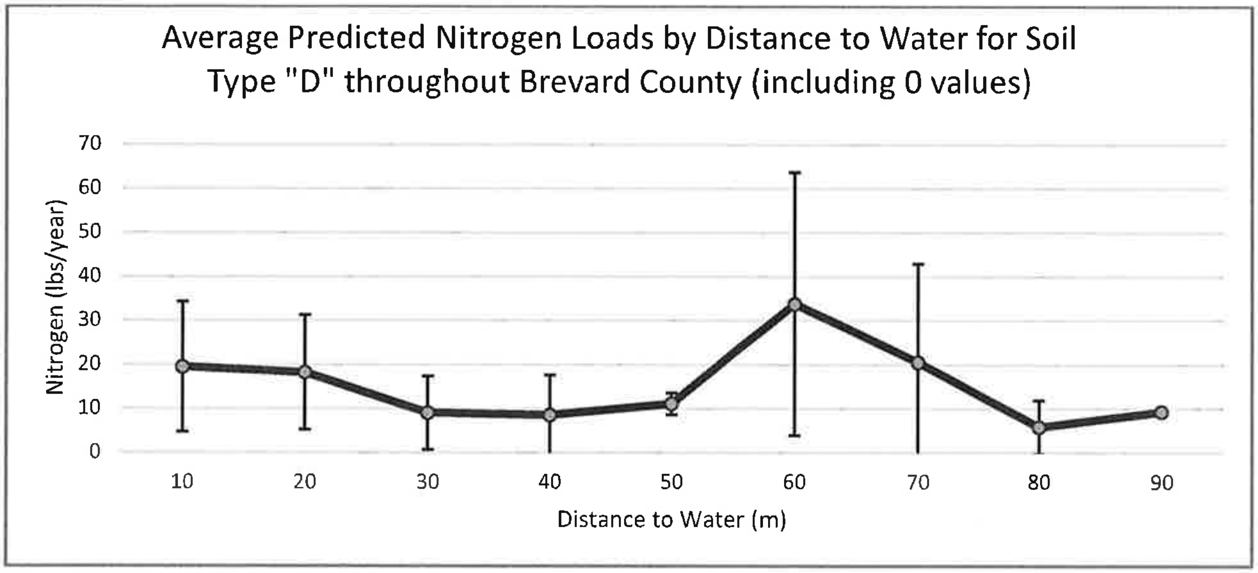


Figure 102. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for soil type "D" throughout Brevard County. A calibration factor of 5.8 derived from the ArcNLET Turkey Creek model run was applied to the uncalibrated outputs for septic tanks within soil type "D". Standard deviation was included as error bars.

The predicted percentages of nitrogen loads were expanded to the 96 septic tanks located within D soils to provide a more representative view of the total nitrogen load at each distance interval. Septic tanks located between 0-30-m from a waterway have the greatest impact in the loading with each of the distance classes within this range contributing to greater than 16% of the total work area loading. The septic tanks located within the 0-10m, 10-20-m, and 20-30-m distance classes provide a total contribution of 17%, 21%, and 29%, respectively. This high relative contribution of the loading can be explained by the total number of septic tanks located at these distance intervals (64 tanks or 67% of all the total OTDS).Cumulatively, the total loading contribution from the OSTDS located within the first 30-m makes up 69% of the total area's nitrogen loading (Figure 103Figure 50). Expanding to include all the OSTDS located within the first 50-m from the water (93% of all the OSTDS), allows almost 85% of all the area's loading into the waterways to be captured. The contribution of all the septic tanks located beyond 50-m corresponds to less than 15% of the total loading within the area for type D soil.

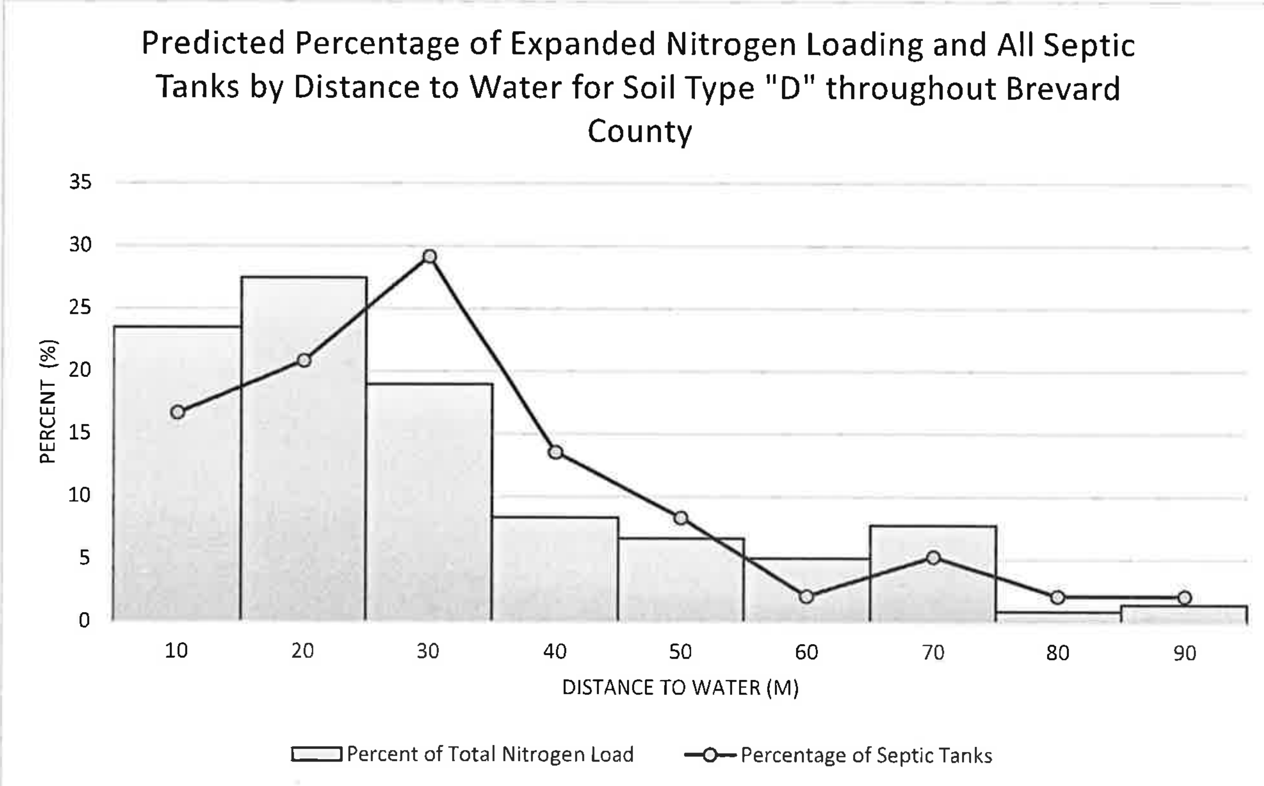


Figure 103. Percentage of total nitrogen loading and OSTDS by distance within the soil type "D" classification.

Floodplain Classification and OSTDS Contribution to Loading

Mean Elevation above mean sea level (MSL) is a good predictor of water table, with strong correlation coefficients (often above 0.8-0.9, Rios *et al.* 2011). Often, depth to groundwater is not available at a landscape scale and topography is used as a subdued replica of the water table (Rios *et al.*, 2011; Wang *et al.*, 2012). Chapter 64E-6 of the *Florida Administrative Code* for the Standards for Onsite Sewage Treatment and Disposal Systems has a criterion specifically designating a minimum water table elevation that is used for site evalutation when installing an OSTDS (State of Florida Department of Health, 2013). While elevation and, specifically, depth to water have a significant impact on the groundwater pollution potential of OSTDS, the lack of availability and ease of use of these two variables throughout the County, made these difficult to use in a county-wide ordinance. A simpler surrogate might be FEMA's classification of floodplain category throughout the County. Typically, areas located in lower elevations would also have shallow water tables, and would availability and practicability of applying these variables for a regional. Hydraulic head tends to be low when elevation above mean sea level is low, providing a proxy method of measuring mean groundwater levels. Communities with septic drainfields located where groundwater levels are high have the greatest polluting potential because there is insufficient time for denitrification processes to take place. Communities with drainfields well above the water table allow sufficient time for effluent attenuation, reducing the potential impact of OSTDS to local waterbodies.

Most of Brevard County's Indian River Lagoon watershed (66.7%) is classified by FEMA as X (minimal flood hazard areas outside of 500-year flood plain) or water (Table 3). Floodplain zones of high risk include zone A (or subtypes defined as AE, AH, and AO) and VE. In northern Brevard County, most high-risk areas are located in coastal mainland areas and in Merritt Island (Figure 104). In southern Brevard County, high-risk areas are located still in coastal areas, near tributaries, and in the western area close to the St. Johns river watershed (Figure 105).

Table 3. Floodplain categories, description and percentage distribution within Brevard County's Indian River Lagoon watershed.

Flood Zone	Area (acres)	%	Description
A	26,058	5.66	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas; no depths or base flood elevations are shown within these zones.
AE	126,136	27.41	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
AH	0	0.00	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
AO	237	0.05	River or stream flood hazard areas and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
Open Water	98,597	21.43	Area with ocean, lake, river or pond.
V/VE	954	0.21	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
X	208,147	45.24	Areas of minimal flood hazard, determined to be outside the 500-year flood plain.
Total	460,129	100.00	

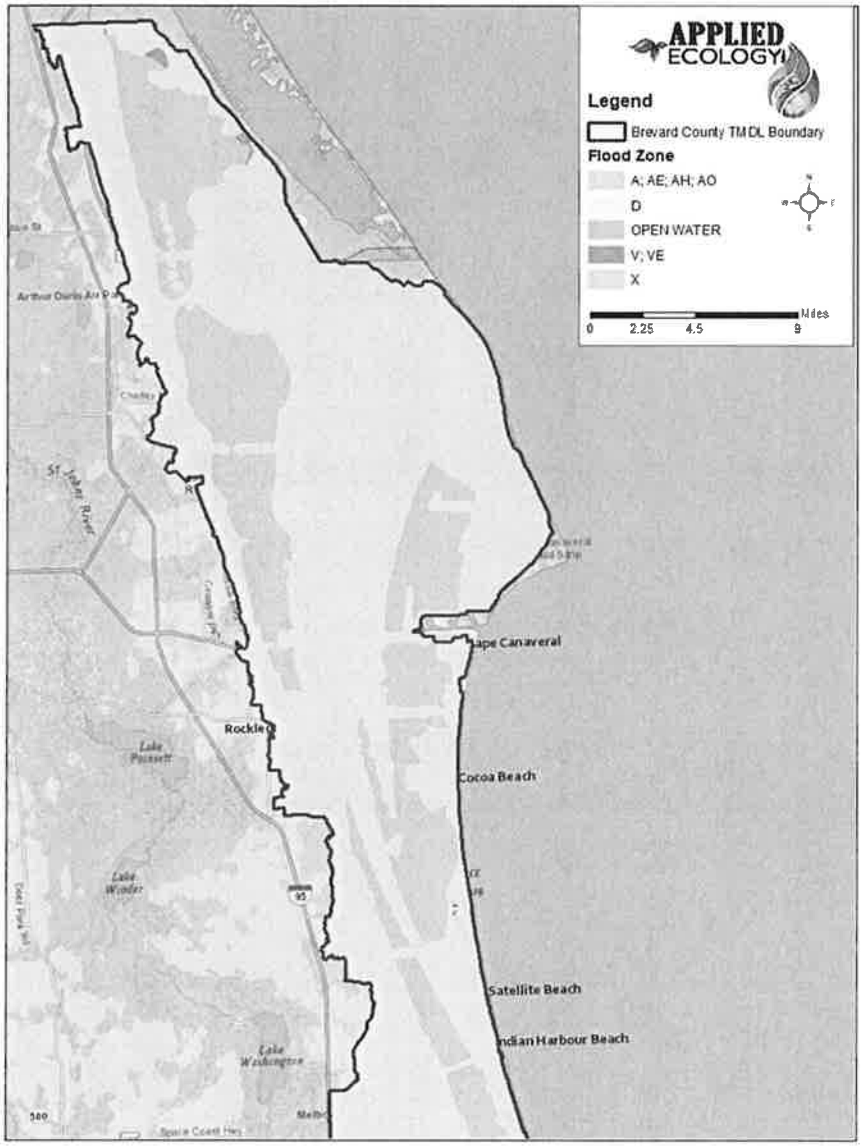


Figure 104. Floodplain zone distribution through the northern region of Brevard County.

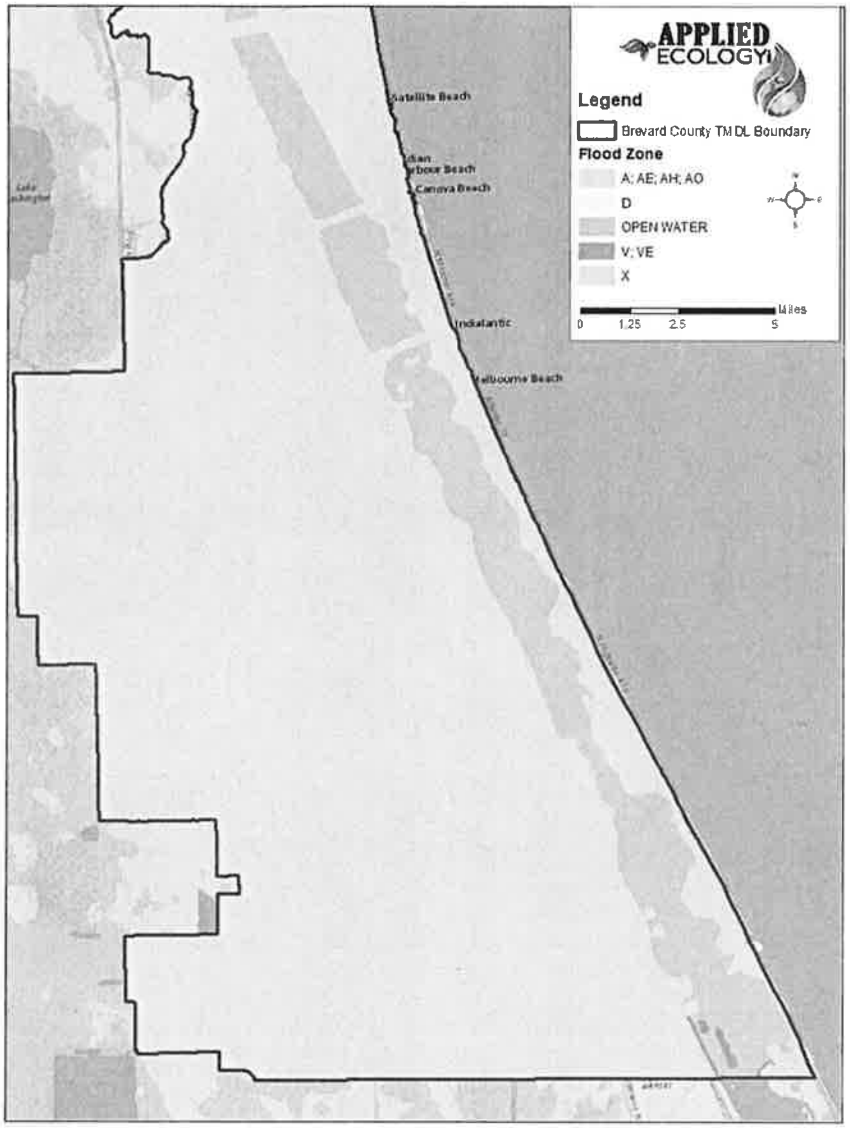


Figure 105. Floodplain zone distribution through the southern region of Brevard County.

To better understand the potential impact of floodplain classes on OSTDS loading potential, results were summarized by flood class below

Floodplain Zone A

The majority of floodplain zone A is distributed within the southern region of Brevard County's TMDL boundary, specifically in areas that are comprised of natural and agricultural land use types. A total of 415 septic tanks were modeled throughout the 16 work areas, this represents 48% of the OSTDS loading for the total area classified as floodplain zone A and less than 1% of all septic tanks within the Brevard County TMDL. About 79% of the septic tanks are currently located within 50-m of a waterbody/channel, and 92% within 100-m of water. Aside from a single OSTDS located within the 400-m distance class, no septic tanks were found at distances beyond 325-m from a waterbody.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in the A floodplain zone are provided in Figure 106. A calibration factor of 5.8 derived from a calibrated run of the ArcNLET model for the Turkey Creek basin was applied to the mean values.Figure 67 There is an overall decreasing trend throughout most of the distances, with a steeper slope from 10-90-m. At greater distances, means fluctuated as the approximated zero loading at 175-m or greater. Variability of individual septic tank loading contribution to nearby waterbodies is very high, particularly for the 40-90 m distance classes. Highest mean individual septic tank loading is predicted for the 10-m distance class (10.8 lbs. TN/year), while the mean of the 20-m to 60-m distance classes ranged between 4.67-7.97 lbs/year. These values are further reduced to < 5 lbs/year after the 80-m distance class. There was no contribution to the total loads for OSTDS outside of the 150- distance class within the floodplain zone A area.

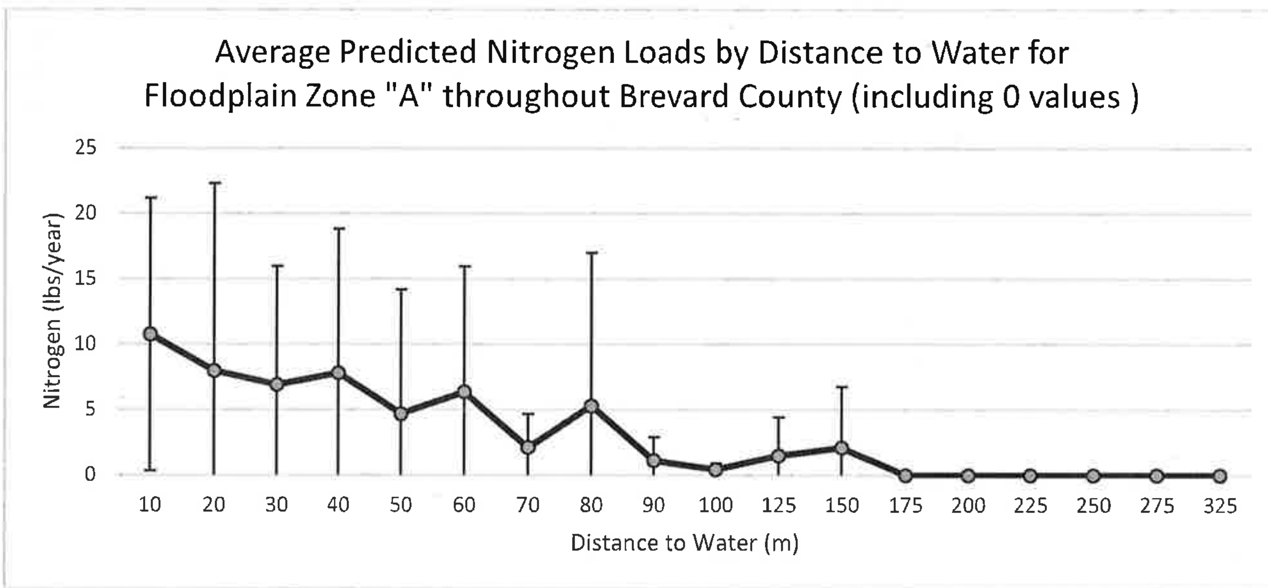


Figure 106. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for floodplain zone "A" throughout Brevard County. Standard deviation was included as error bars.

Septic tanks located between 0-60-m from a waterway have the greatest impact in the loading with each of the following distance intervals contributing more than 8% of the total area loading: 0-10-m (15%), 10-20-m (18%), 20-30-m (30%), 30-40-m (17%), and 40-50-m (9%). Cumulatively, the total loading contribution from the septic tanks located within the first 50-m makes up 89% of the total work area's nitrogen loading (Figure 107). The contribution of all the septic tanks located beyond 50-m corresponds to less than 11% of the total floodplain zone A area loading.

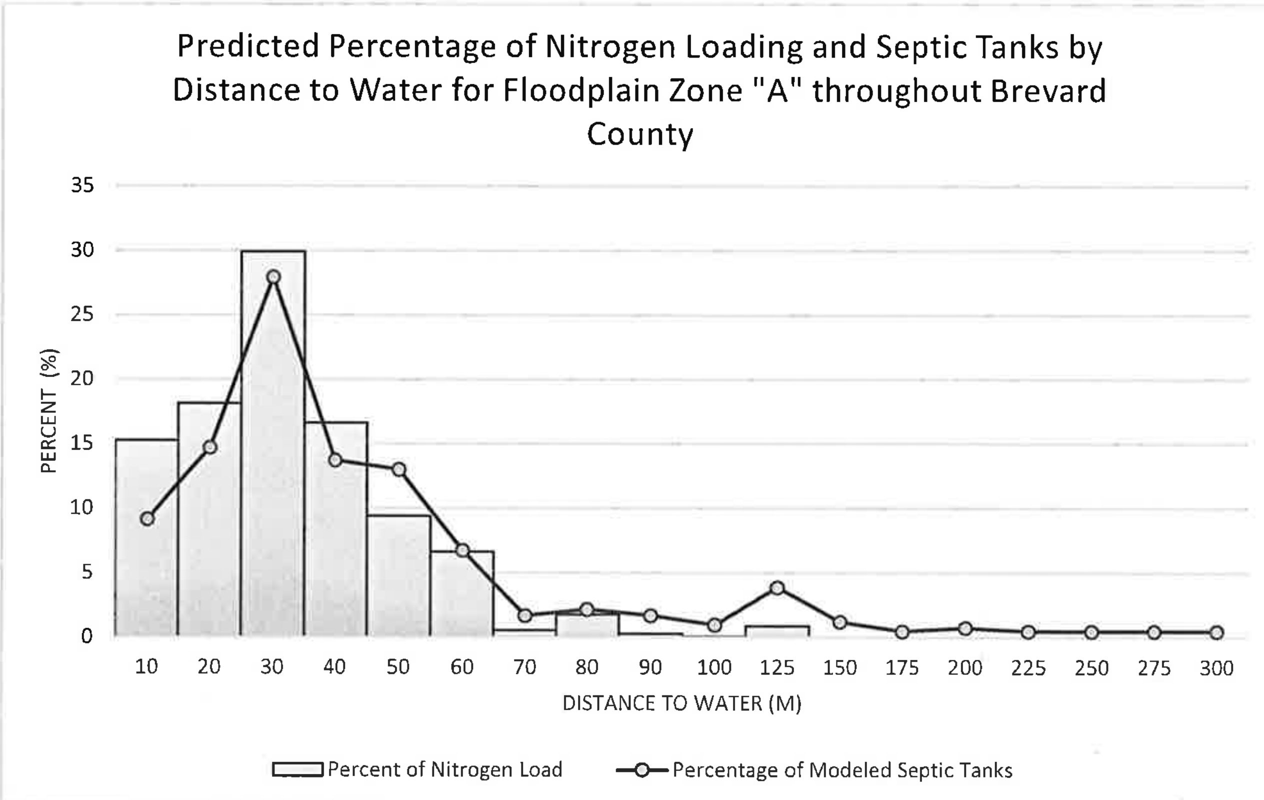


Figure 107. Percentage of total nitrogen loading and OSTDS by distance within the "A" floodplain zone.

Floodplain Zone AE

The majority of floodplain zone AE is distributed within the coastal areas along all of the Indian River Lagoon, Merritt Island, as well is the south-western region of the Brevard County boundary (Figure 104, Figure 105). This floodplain type has the second highest percentage of total area with 27.4% coverage throughout the County. A total of 661 septic tanks were modeled throughout the 16 work areas, representing 53% of the OSTDS loading for the total area classified as floodplain zone AE and a little over 1% of all OSTDS within Brevard County. Similar to floodplain A, approximately 80% of the septic tanks are currently located within 50-m of a waterbody/channel, and 94% were within 100-m. Aside from a single septic point located within the 275-m distance class, no septic tanks were found at distances beyond 225-m from a waterbody.

Mean predicted total nitrogen loads reaching waterways for an individual septic tank in the A floodplain zone are provided in Figure 108. A calibration factor of 5.8 derived from a calibrated run of the ArcNLET model for the Turkey Creek basin was applied to the mean values.Figure 67 There is an overall decreasing trend, with a steeper slope until 30-m, similar mean loadings between 30-50-m, and additional decrease at distances greater than 60-m. At distances between 80-175-m mean per OSTDS loading gently approaches zero and have limited total contribution. Variability of individual septic tank loading contribution to nearby waterbodies is very high until the 80-m. Highest mean individual septic tank loading is predicted for the 10-m distance class at 28.7 lbs. TN/year. Mean loadings per septic tank are reduced after the 50-m distance class and further reduced to < 5 lbs/year after the 80-m distance class. There was no contribution to the total loads for OSTDS outside of the 225-m distance class within the floodplain zone AE area.

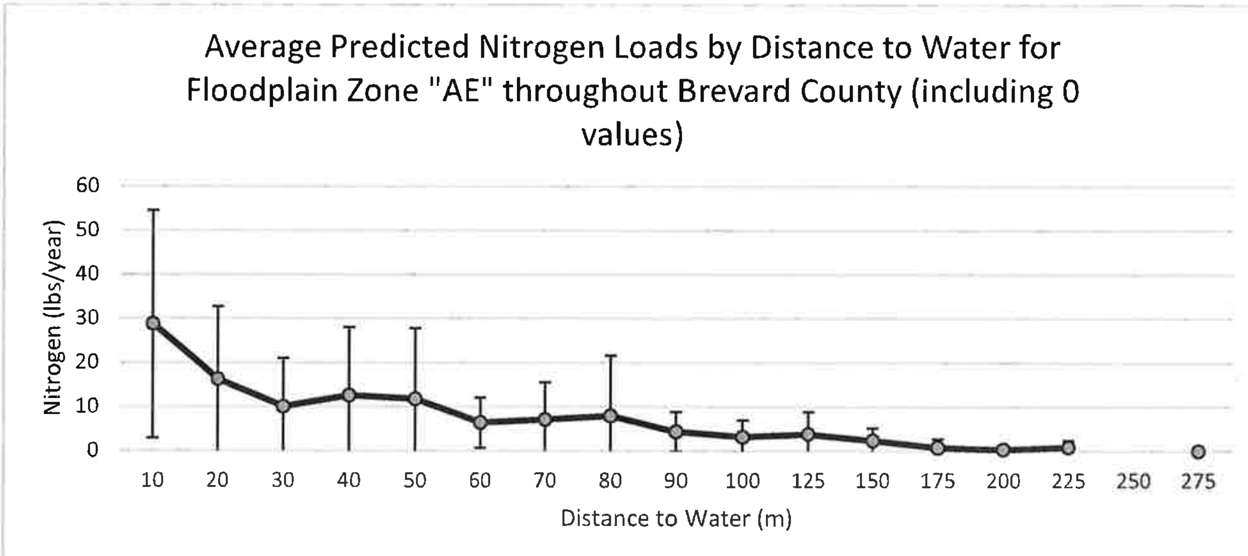


Figure 108. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for floodplain zone "AE" throughout Brevard County. Standard deviation was included as error bars.

Septic tanks located between 0-50-m from a waterway have the greatest impact in the loading with each of the following distance intervals contributing more than 8% of the total area loading: 0-10-m (24%), 10-20-m (35%), 20-30-m (18%), and 30-40-m (10%). Cumulatively, the total loading contribution from the septic tanks located within the first 50-m makes up 92% of the total work area's nitrogen loading (Figure 109). The high loading contribution of these short distance intervals can be explained by the high density of OSTDS located within 50-m from water. The contribution of all the septic tanks located beyond 50-m corresponds to less than 8% of the total floodplain zone AE area loading.

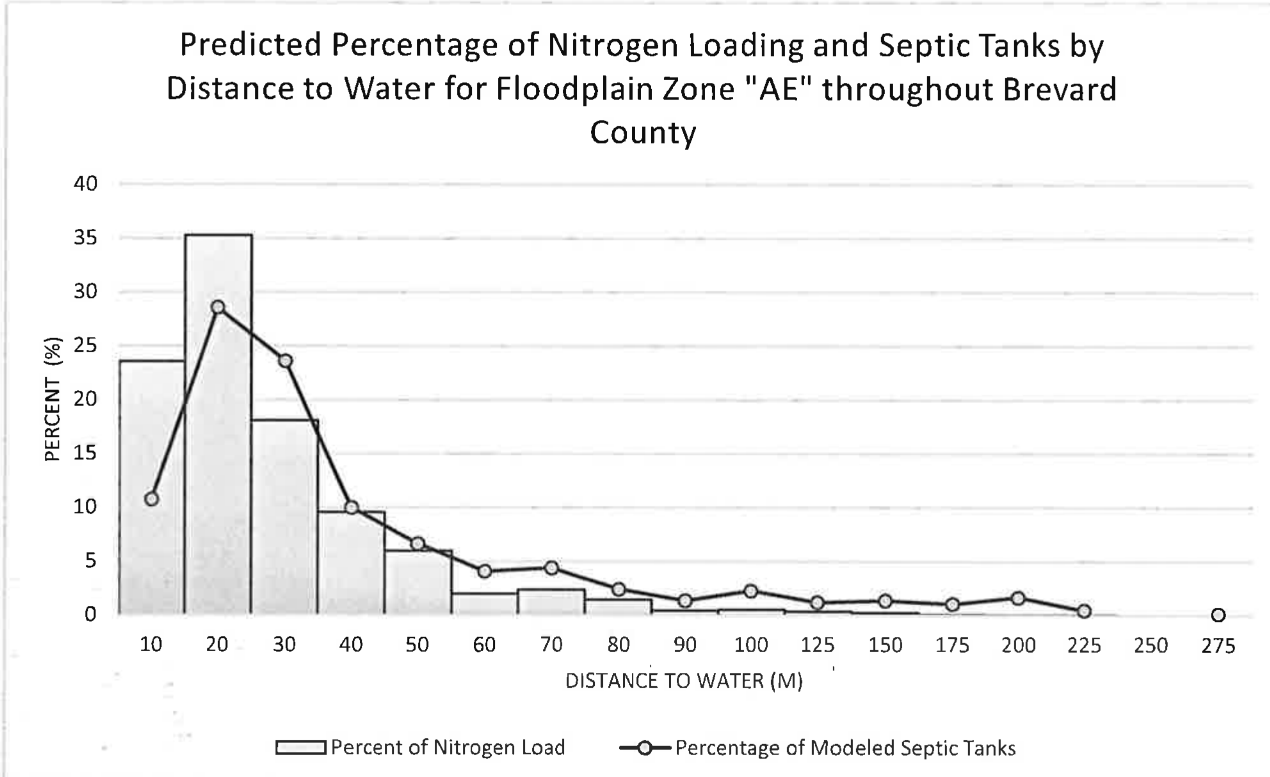


Figure 109. Percentage of total nitrogen loading and OSTDS by distance within the "AE" floodplain zone.

Floodplain Zone AO

The area corresponding to the AO floodplain zone is located in very thin areas along the very eastern edge of the TMDL boundary along the beach line. Only three septic tanks were located within the "AO" floodplain zone, all of which had no contributions to the overall total nitrogen loads.

Floodplain Zone X

Floodplain zone X encompasses 45% of the total floodplain area within the Brevard County TMDL area. A total of 26,149 septic tanks were modeled throughout the 16 work areas, this represents 47% of the OSTDS loading for the total area classified as floodplain zone X and over 45% of all septic tanks within the Brevard County TMDL. About 66% of the septic tanks are currently located within 50-m of a waterbody/channel, and 82% within 100-m of water. No septic tanks were found at distances beyond 700-m from a waterbody.

Mean predicted total nitrogen loads, including those producing 0 load values, reaching waterways for an individual septic tank in the X floodplain zone are provide in Figure 110. A calibration factor of 5.8 derived from a calibrated run of the ArcNLET model for the Turkey Creek basin was applied to the mean values.Figure 67 Beyond the steep decreasing slope in the first 20-m, mean per OSTDS impact is similar and well above 10 lbs/year, from 30-125-m distance intervals. Decreases in loading contribution decrease more rapidly at distances greater than 125-m, and approach zero only close to 300-m from water. Variability of individual septic tank loading impact is quite high, particularly for almost all distances to water. Highest per septic tank loading is predicted for those septic tanks within 10-m of the waterbodies (18.6 lbs/year), followed by those within 60-m distance category (9.8 lbs/year). Mean average septic tank loading decreases from 10-m to 20-m category, with some higher loading septic tanks located in the 30-60-m distance categories. Individual septic tank loading rapidly declines in this work area after the 90-m distance and was not detected for any septic tank located at distances > 500-m from any waterbody. The gentle gradually decreasing slope of mean loading for the X floodplain class is similar in some ways to the soil hydrologic group A mean curve. This is likely due to the fact that large portions of the areas classified as X floodplain type are constituted by A soils as well.

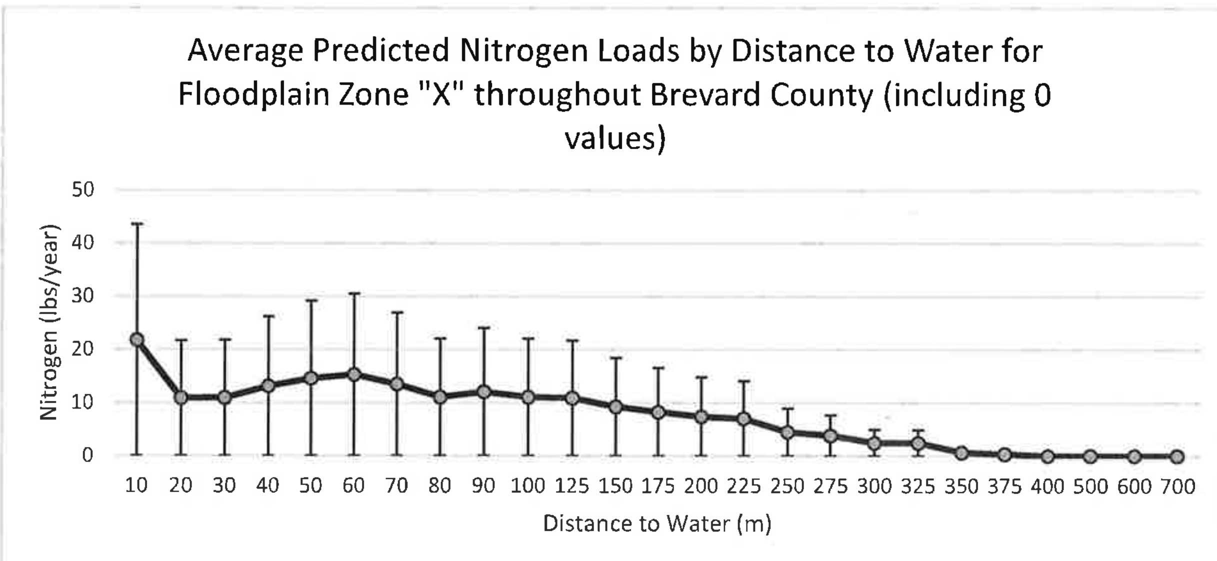


Figure 110. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for floodplain zone "X" throughout Brevard County. Standard deviation was included as error bars.

Septic tanks located between 20-50-m from a waterway have the greatest impact in the loading with each of the following distance intervals contributing more than 8% of the total area loading: 10-20-m (24%), 20-30-m (23%), 30-40-m (9%), and 40-50-m (9%). Cumulatively, the total loading contribution from the septic tanks located within the first 50-m makes up 69% of the total work area's nitrogen loading (Figure 111).In this case, this is driven by the large percentage of OSTDS within this distance category with 66% of all OSTDS within the first 50-m, 51% of that located between the 20-m and 30-m distance classes. The contribution of all the septic tanks located beyond 100-m corresponds to less than 12% of the total floodplain X area loading. Additionally, increased loading is also predicted for the 125-m distance class, which can be explained by the high number of OSTDS (1,192 or 4.1%).

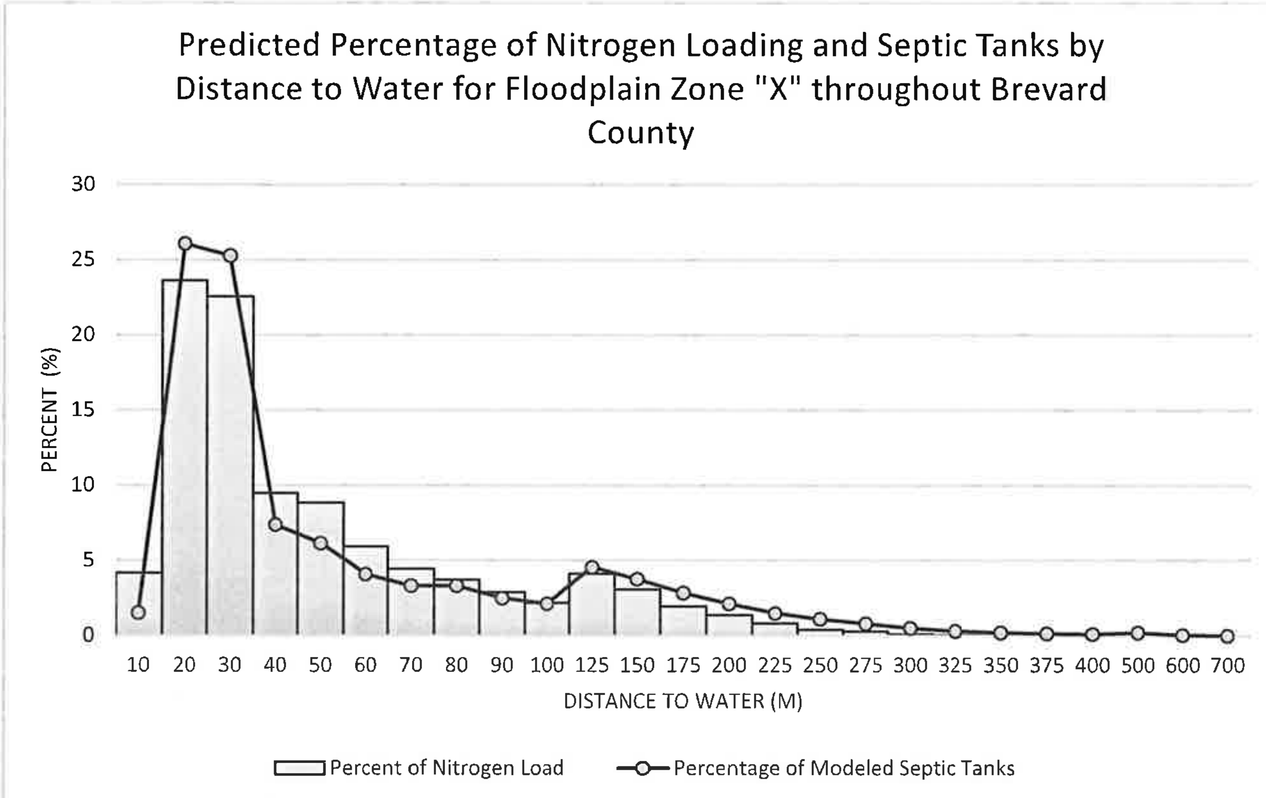


Figure 111. Percentage of total nitrogen loading and OSTDS by distance within the "X" floodplain zone.

Conclusion

The sixteen work areas analyzed for this report include mainland and barrier island communities throughout the County, where soil conditions, elevations, and flooding potential are very variable. Only areas with currently existing OSTDS area were included for modeling, future development could take place outside of the modeled boundaries. A total of 27,228 OSTDS were modeled from close to a total of 58,000 OSTDS within Brevard County. Beyond distance to water, there are many important drivers in potential septic tank loading, including soil type and associated hydraulic conductivity, porosity, and % organic contents, as well as hydraulic head and individual OSTDS condition. As a result, variability in the predicted loading potential by septic tank is extremely high, as portrayed by the large interquartile ranges of the datasets. Even with the high variability, median individual septic tank loading contributions were found to be statistically significant among distance classes (Kruskal-Wallis, $p<0.0001$ at $\alpha=0.05$).

Interestingly, patterns for the individual septic tank loading contributions are similar for most work areas. Loading potential drastically decreases with distance, even without taking any of the other variables, such as soil type, into account. The distances at which a significant reduction in per septic tank loading potential takes place do vary for the work areas, which can be likely explained by other types of variables, particularly hydraulic conductance and elevation. From the assessment of the County using individual work areas, the modeled individual potential septic tank loading contribution is highest for those located within the first 30- to 80-m range of any waterbody. For more conservative protection of the waterways, some areas, particularly those dominated by A soils and AE floodplain types would benefit from protection at greater distances, some up to 175-m from the water.

Cumulative loading potential by distance to the Lagoon is another metric that can be examined to inform any policy decision. Examining the cumulative loading curves includes both the individual impact of each septic tank by distance and the total number of septic tanks within each distance class. Total loadings by area vary significantly (Figure 112), but the general curve shapes are similar in nature.

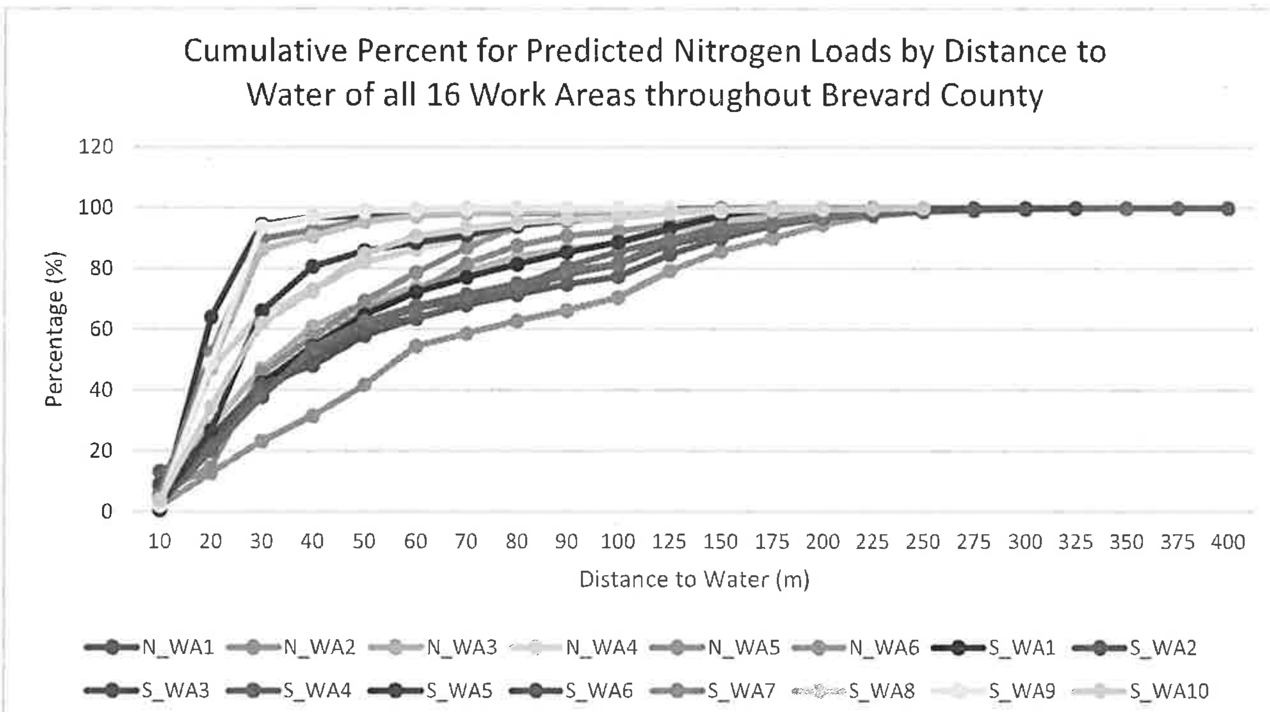


Figure 112. Cumulative percent impact curves for the 16 work areas. Total predicted cumulative loadings are dependent on number of septic tanks (which varies from 439 to 2,237 septic tanks), soil type and condition, elevation, distance to water, etc.).

Throughout the analysis process, it became apparent that certain parameters were significant drivers in the loading potential of individual OSTDS to across all work areas in addition to distance to water. These drivers include soil hydraulic conductance and soil hydrologic group. Regional differences in these factors resulted in additional analysis to take place for each of the following four regions of interest (Figure 113):

- Mainland Brevard County (excluding Melbourne Tillman Water Control District)

- Barrier Island
- Merritt Island
- Melbourne Tillman Water Control District

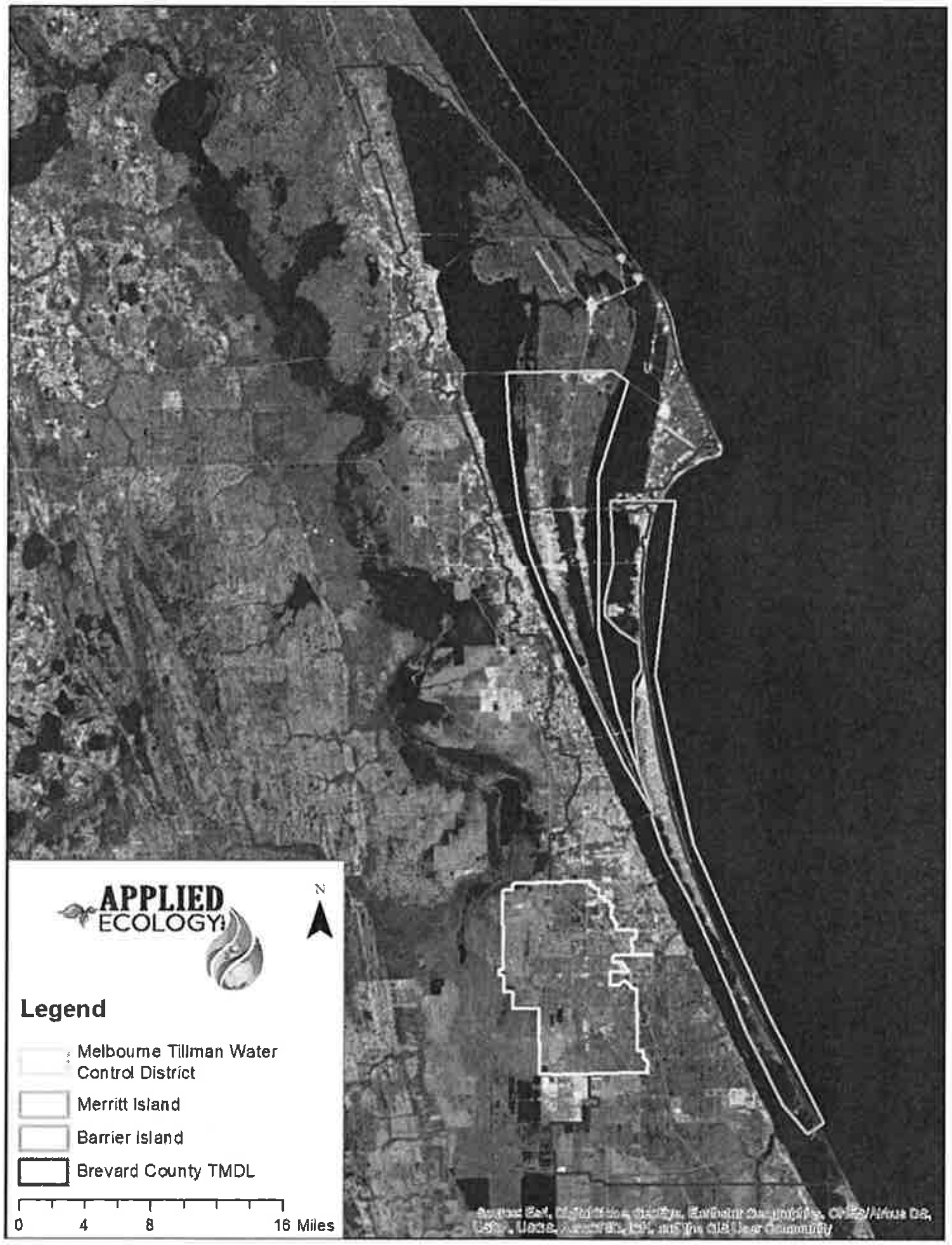


Figure 113. Regions of interest within the Brevard County TMDL.

Barrier Island Region

A total of 1,860 septic tanks were modeled throughout the Barrier Island region, which represents 70% of the total OSTDS loading for the region. Approximately 31% of the modeled existing septic tanks are located within 50-m of a waterbody/channel and only 50% within 100-m of water. None of the modeled septic tanks in this region were found at distances beyond 500-m from a waterbody.

A calibration factor of 5.8 derived from the more conservative calibrated of the ArcNLET model for the Turkey Creek basin (see Calibration section) was applied to the mean predicted total nitrogen loads reaching waterways for an individual septic tank (Figure 114). Median uncalibrated values for the OSTDS within the Barrier Island are provided in Figure 115, and although these values were slightly lower than the uncalibrated mean values, the general patterns are very similar. While there is a sharply decreasing slope in the first distance class, decreases beyond the 20-m distance classes show gentle slopes, with fluctuations in the 30-60-m distance class means. Highest mean individual septic tank loading is predicted for the 10-m distance class (31.2 lbs. TN/year). Mean predicted loads per septic tank are quite significant throughout great distances, decreasing to < 10 lbs/year beyond the 70-m distance class and further to < 5 lbs/year beyond the 125-m class. Only OSTDS at distances greater than 325-m had provided no contribution to the total loads within the Barrier Island Region.

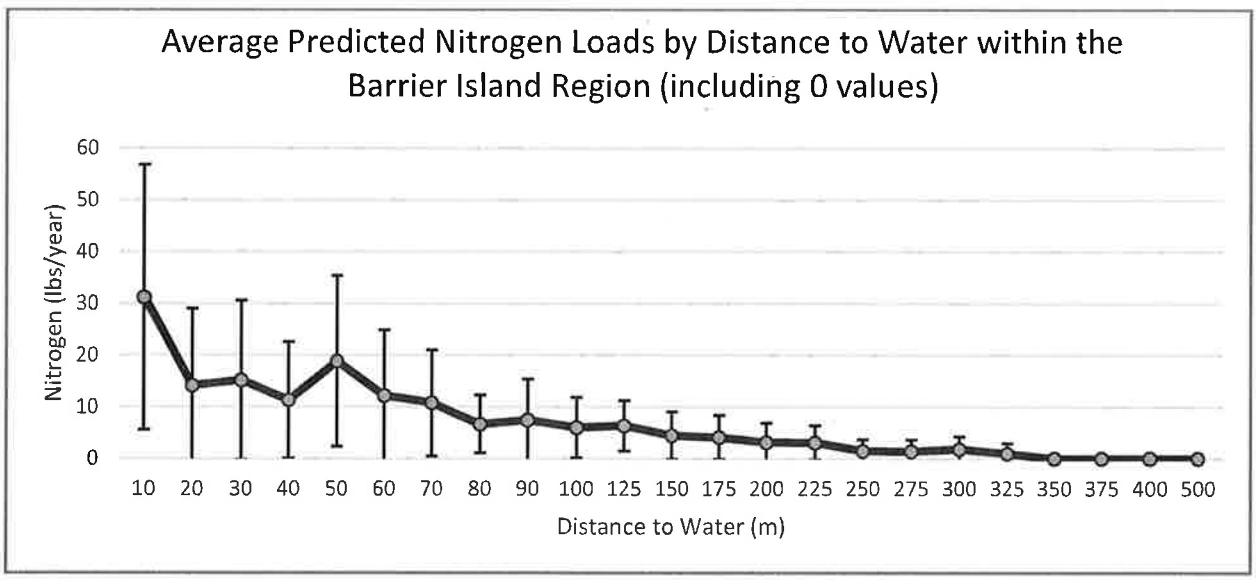


Figure 114. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for the Barrier Island Region of Brevard County. A calibration factor of 5.8 derived from the ArcNLET Turkey Creek model run was applied to the uncalibrated outputs for septic tanks within this region. Standard deviation was included as error bars.

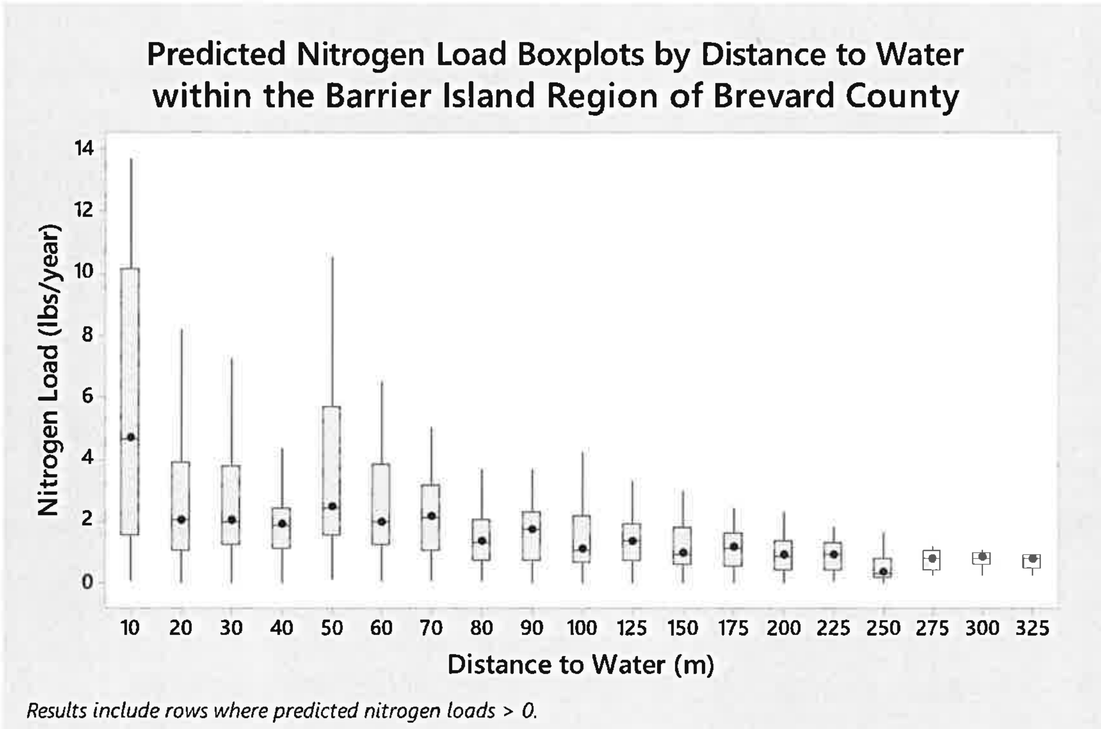


Figure 115. Boxplot representing the distribution of individual uncalibrated septic tank nitrogen loads into nearest waterbody by distance interval for the Barrier Island region.

The predicted percentages of nitrogen loads were expanded to all 2,661 septic tanks located within the Barrier Island region to provide a more representative view of the total nitrogen load at each distance interval. Septic tanks located between 0-30-m from a waterway have the greatest impact in the loading with each of the following distance classes within this range contributing to greater than 10% of the total work area loading: 0-10-m (10.5%), 10-20-m (17.1%), and 20-30-m (18%). This high relative contribution of the loading can be explained by the total number of septic tanks located at these distance intervals (2,580 tanks or 84% of all the total OTDS). Cumulatively, the total loading contribution from the OSTDS located within the first 30-m makes up 46% of the total area's nitrogen loading (Figure 116). Expanding to include all the OSTDS located within the first 60-m from the water (36% of all the OSTDS), only allows for 68% of all the area's loading into the waterways to be captured. The number of septic tanks past the 60-m is still relatively dense until the 100-m or 125-m distance classes. Additionally, mean predicted loading values for the all distance classes until 125-m distance from water provide significant loading at values greater than 6 lbs/year/septic tank.

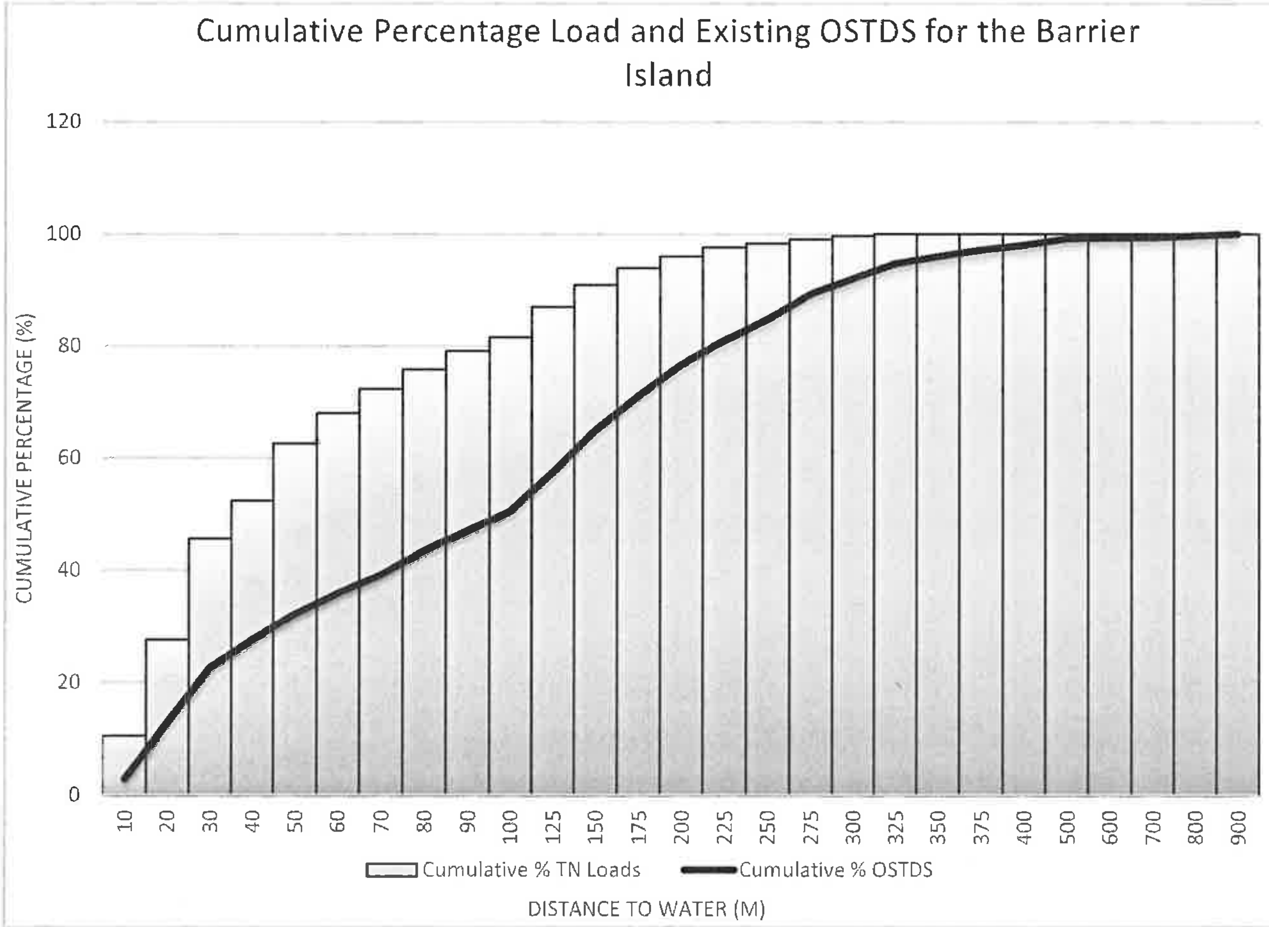


Figure 116. Cumulative percentage of total nitrogen loading and OSTDS by distance within the Barrier Island region.

The long distance traveled by many of the modeled OSTDS located beyond the 100-m distances is likely related to the soil composition of the Barrier Island: A or high infiltration soils (Figure 117) with low organic content, high porosity and high hydraulic conductance values (Figure 118). This allows for a quick rate of nutrient transport in the groundwater, reduces the time for denitrification processes to occur, and results in greater loads at relatively far distances from water.

With distances from water in the narrow Barrier Island being relatively short, most additional OSTDS would like an impact greater than 10 lbs/year N per year, with much higher potential loading in the area with extreme hydraulic conductance values. This likely scenario might imply greater caution in the management of OSTDS in the Barrier Island region.

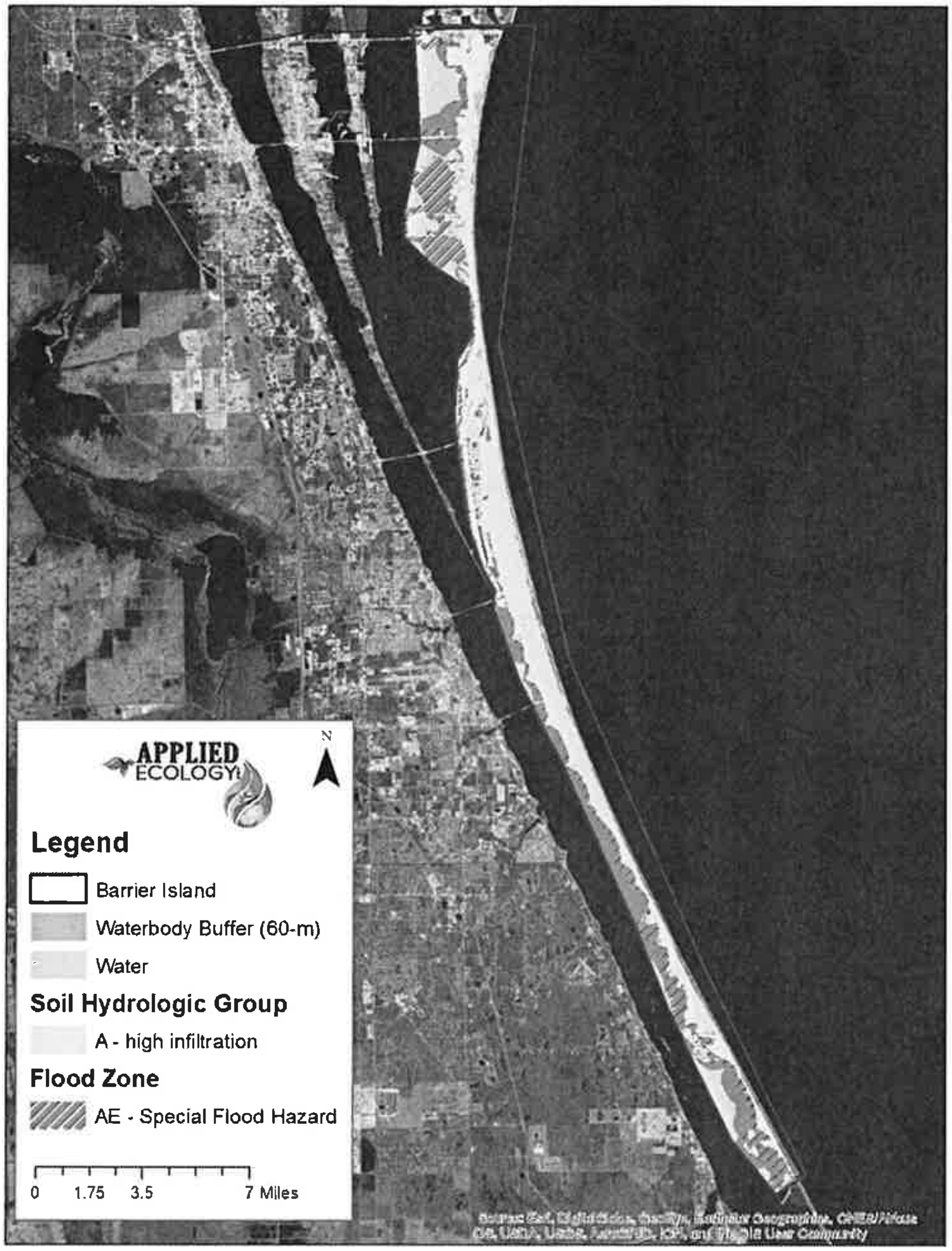


Figure 117. Distribution of soil hydrologic group A, floodplain zone AE, and water within the Brevard County TMDL Boundary for the Barrier Island.

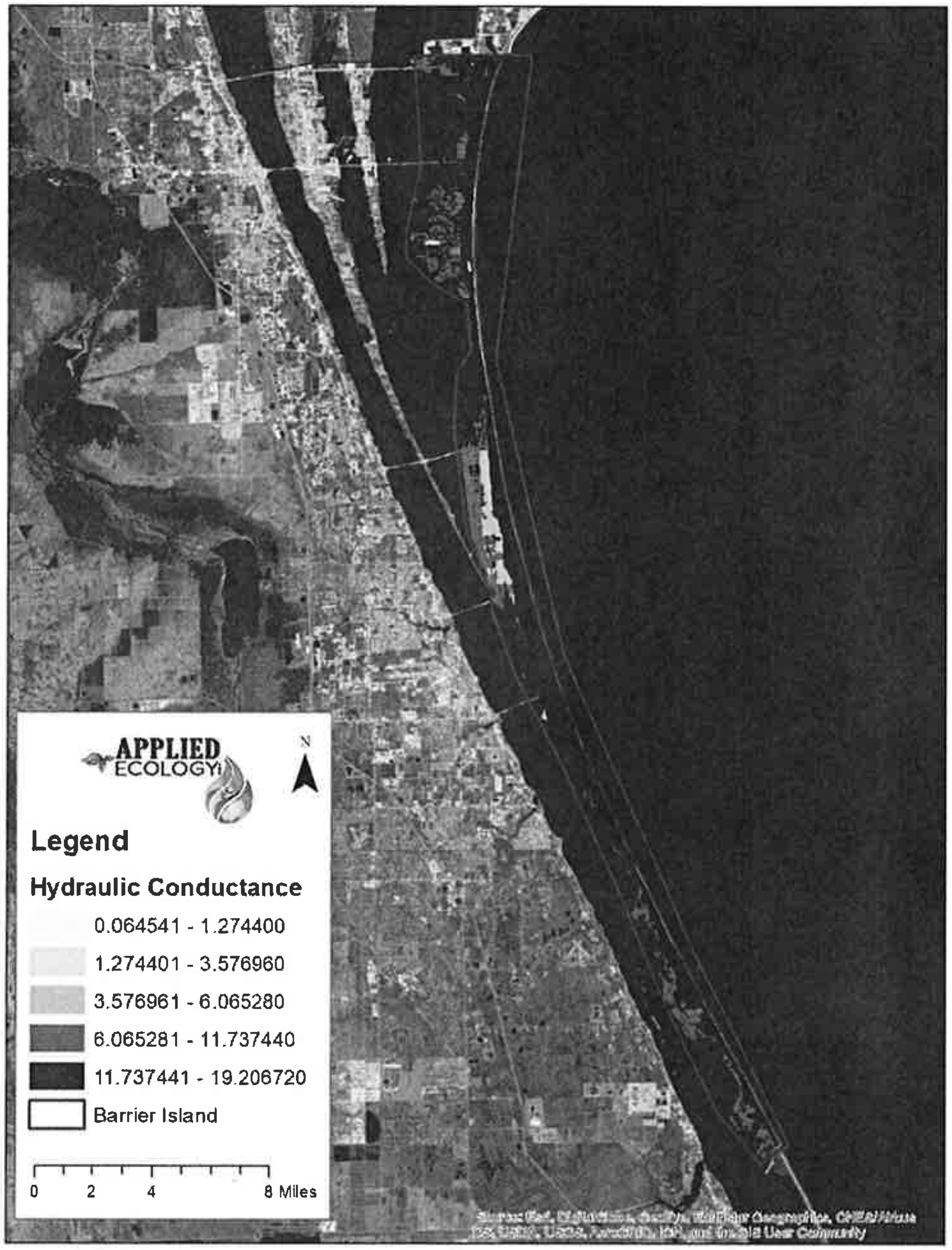


Figure 118. Distribution of soil hydraulic conductance within the Brevard County TMDL Boundary for the Barrier Island.

Merritt Island Region

The Merritt Island region covers the area from Nasa Parkway southward to the end of the island itself, just above the Eau Gallie Causeway (Figure 113). A total of 3,572 septic tanks were modeled throughout the region, this representing 54% of the OSTDS loading for the total area within the Brevard County TMDL. Approximately 54% of the septic tanks are currently located within 50-m of a waterbody/channel, and 80% within 100-m of water. None of the modeled septic tanks were found at distances beyond 325-m from a waterbody.

A calibration factor of 5.8 derived from a calibrated run of the ArcNLET model for the Turkey Creek basin was applied to the mean predicted total nitrogen loads (Figure 119). Median uncalibrated values for the OSTDS within Merritt Island are provided in Figure 120, and although these values were slightly lower than the uncalibrated mean values, the general patterns are very similar. Whereas there is a steeper slope in mean OSTDS loading from 0-40-m, very similar loading is predicted between 40-70-m from water. After 70-m, a very gently decreasing slope in mean load is visible until it approximates zero contribution near 250-m. Highest mean individual septic tank loading is predicted for the 10-m distance class (19.3 lbs. TN/year), rapidly decreasing to 10-15 lbs/year between 20-70-m. Per OSTDS loadings are still above 6 lbs/year all the way up to 90-m from water, which would span most of Merritt Island.

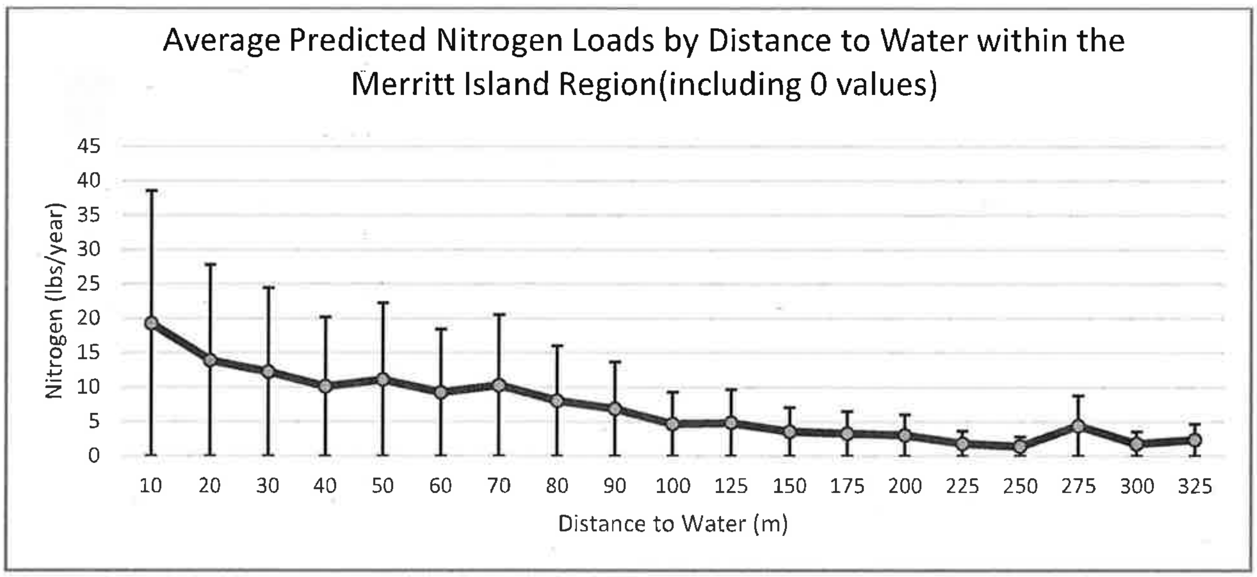


Figure 119. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for the Merritt Island Region of Brevard County. A calibration factor of 5.8 derived from the ArcNLET Turkey Creek model run was applied to the uncalibrated outputs for septic tanks within this region. Standard deviation was included as error bars.

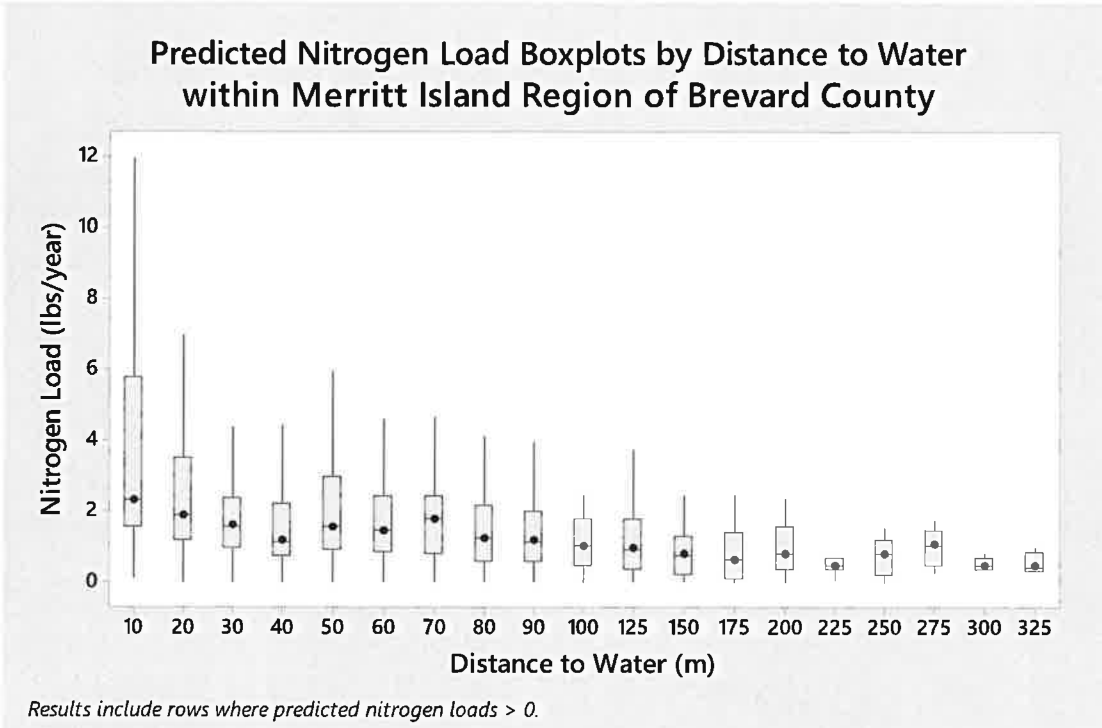


Figure 120. Boxplot representing the distribution of individual uncalibrated septic tank nitrogen loads into nearest waterbody by distance interval for the Merritt Island region.

The predicted percentages of nitrogen loads were expanded to all 6,637 septic tanks located within the Merritt Island region to provide a more representative view of the total nitrogen load at each distance interval. Septic tanks located between 0-70-m from a waterway have the greatest impact in relation to percentage of loading with each of the distance classes within this range contributing to greater than 5% of the total work area loading; the 20-m and 30-m represented 14.0% and 16.8%, respectively. This high relative contribution of the loading can be explained by the total number of septic tanks located at these distance intervals (4,288 tanks or 64% of all the total OTDS). A large percentage of the total load is also contributed by the OSTDS from the 125-m distance class (8.0%). Cumulatively, the total loading contribution from the OSTDS located within the first 50-m makes up 56% of the total area's nitrogen loading (Figure 121). Expanding to include all the OSTDS located within the first 100-m from the water (78% of all the OSTDS), allows for 75% of all the area's existing loading into the waterways to be captured. The number of septic tanks past the 100-m is still relatively dense until the 200-m or 225-m distance classes and contributions of those until at least 90-m are well above 6 lbs/year per OSTDS.

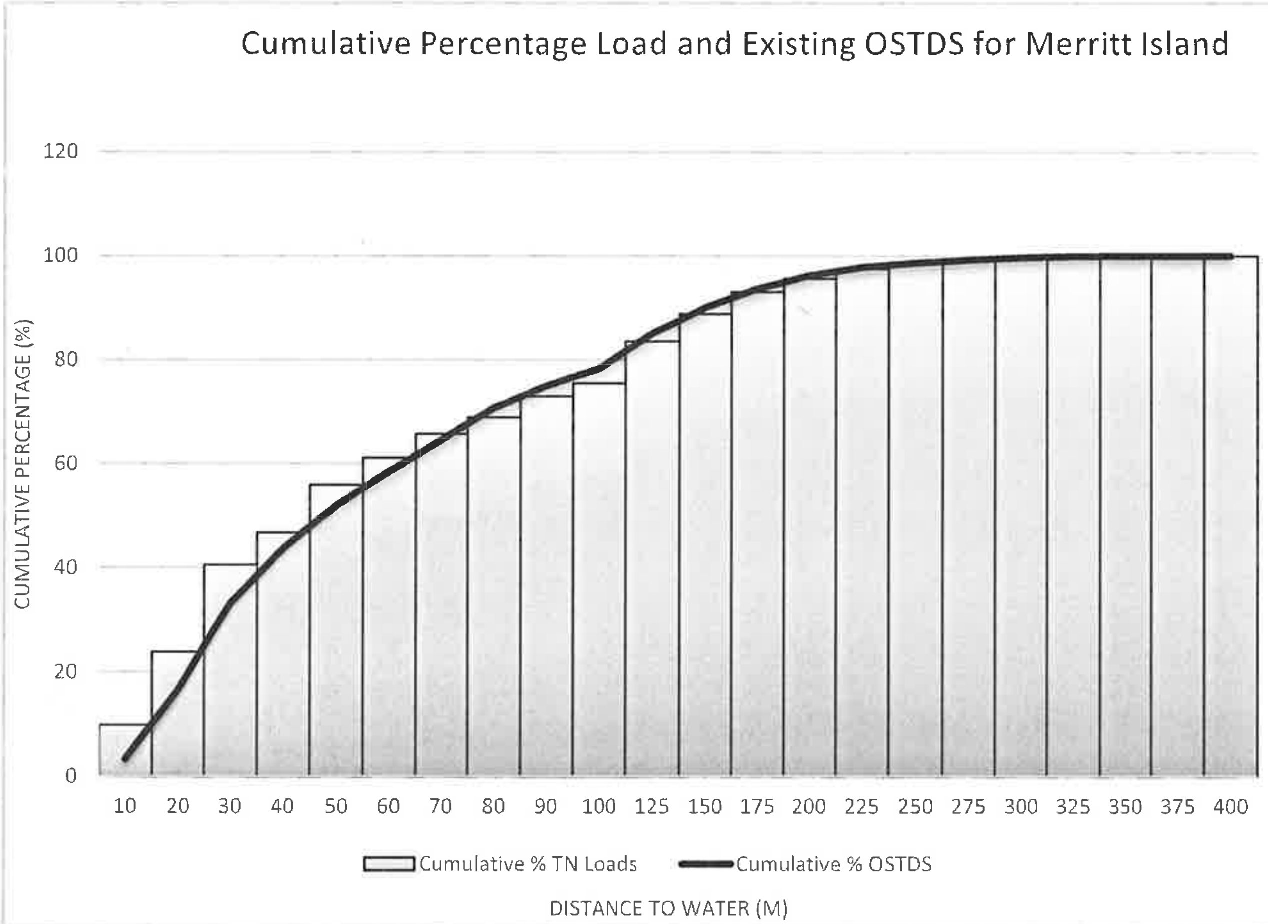


Figure 121. Cumulative percentage of total nitrogen loading and OSTDS by distance within the Merritt Island region.

Merritt Island presents some similar patterns to the Barrier Island, especially in the relic dune ridges areas, where soil hydraulic conductance values are very high (Figure 122). Areas that are not composed of A soils in this region are typically floodplain areas of high flooding potential (AE Category, Figure 123), not conducive for conventional OSTDS and a higher health due to the potential of exposure to untreated waste. Overlaying areas with high hydraulic conductance and A soils, AE high risk flood category, and a conservative 60-m buffer around water would cover most, if not all, of Merritt Island (Figure 123). Greater than average protection should be considered for the Merritt Island region.

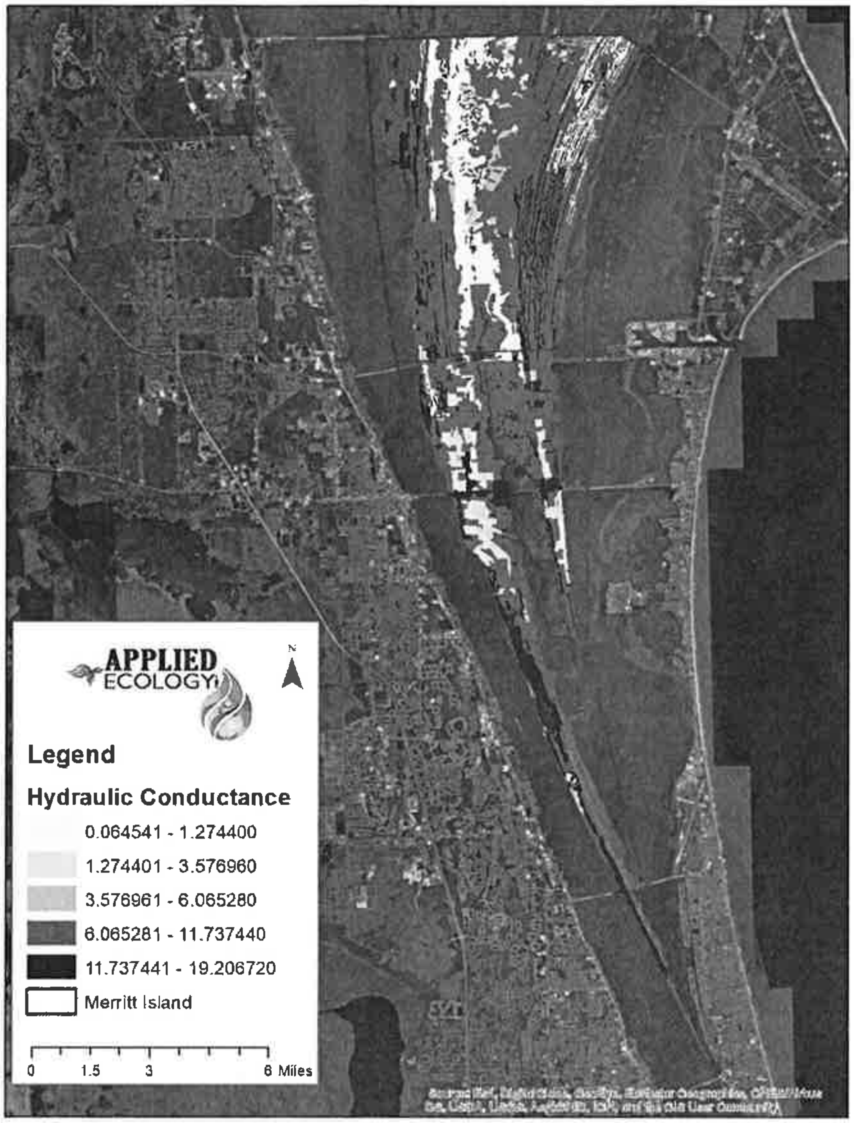


Figure 122. Distribution of soil hydraulic conductance within the Merritt Island region.

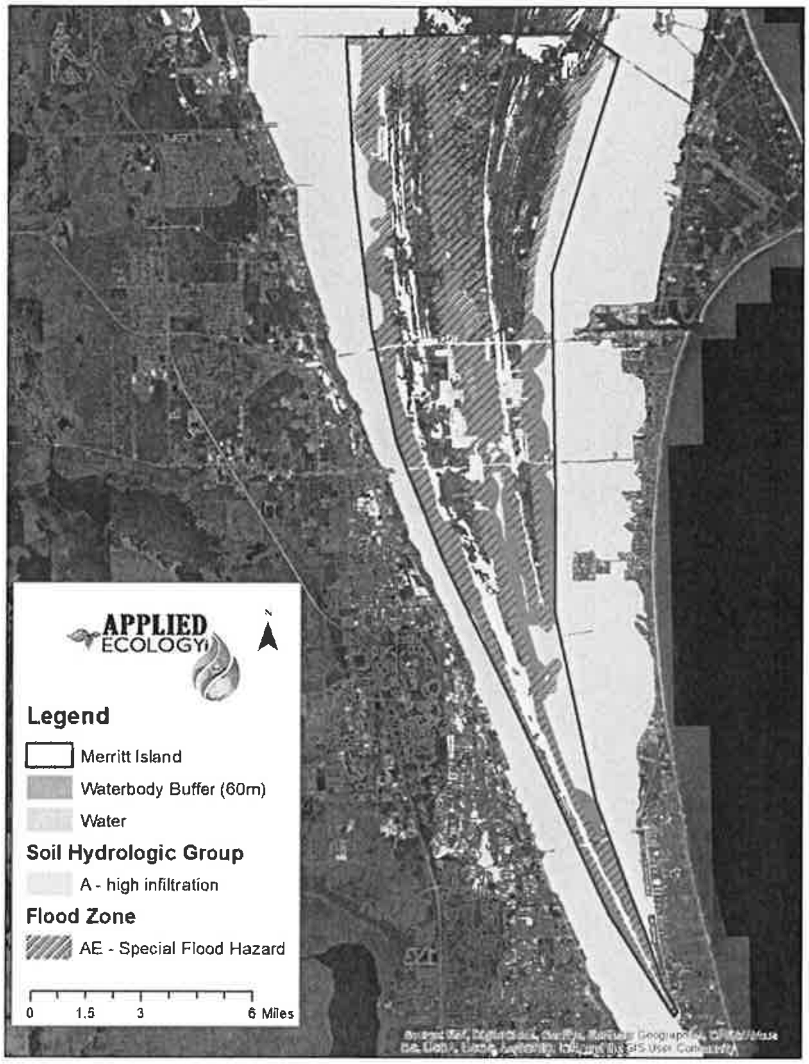


Figure 123. Distribution of the AE floodplain zone within the Merritt Island region.

Melbourne Tillman Water Control District Region

The Melbourne Tillman Water Control District (MTWCD) region covers the southwest area of the County and TMDL Boundary (Figure 113). A total of 10,388 septic tanks were modeled throughout the region, this representing 39% of the OSTDS loading for the total area within the Brevard County TMDL. Approximately 96% of the septic tanks are currently located within 50-m of a waterbody/channel, and 99% within 100-m of water, since this area is highly channelized throughout. None of the modeled septic tanks were found at distances beyond 250-m from a waterbody.

A calibration factor of 5.8 derived from a calibrated run of the ArcNLET model for the Turkey Creek basin was applied to the mean predicted total nitrogen loads reaching waterways for an individual septic tank (Figure 124). Differences in mean septic tank loadings in this area where driven by hydraulic conductance values. Means of OSTDS located at 30-m from water in an area with high hydraulic conductance might have two to three times the loading than one located at the same distance in low conductance area. To better aggregate the loading potential of the MTWCD region, mean OSTDS loads by distance were spatially weighed by the distribution of hydraulic conductivity for each distance class. In general, in contrast with the Barrier and Merritt Islands, the MTWCD watershed area is composed of 67% low values, 30% medium values, and only a negligible (<2%) of high values (Table 4).

Table 4. Distribution of soil hydraulic conductance classes for OSTDS within the

Hydro Conductance Class	Value Range	Acres	%
Low	0-5.9	33,094	66.96
Medium	6-15.9	14,950	30.25
High	16-20	852	1.72
Water	None	526	1.06
Total		49,422	

The resulting spatial weighted means per OSTDS by distance class are provided in Figure 124. There is a gradual decrease in mean loads until the 40-m distance class, after which there is a steeper decline in mean loading up to 80-m. The slope change after 40-m distance from water is clear: a decrease of a minimum of 20% of mean loading is visible for between each 10-m distance class between 40 and 80-m. Predicted mean values after the 90-m distance intervals are likely unreliable due to the extremely small sample size at these greater distances. Highest mean individual septic tank loading is predicted for the 10-m distance class (4.8 lbs. TN/year), likely underestimated due to lack of additional calibration data in the western portion of MTWCD. Mean predicted loads per septic tank are expected to reduce to < 2 lbs/year beyond the 60-m distance class. No contributions to the total loads were predicted beyond the 200-m distance classes within the MTWCD Region.

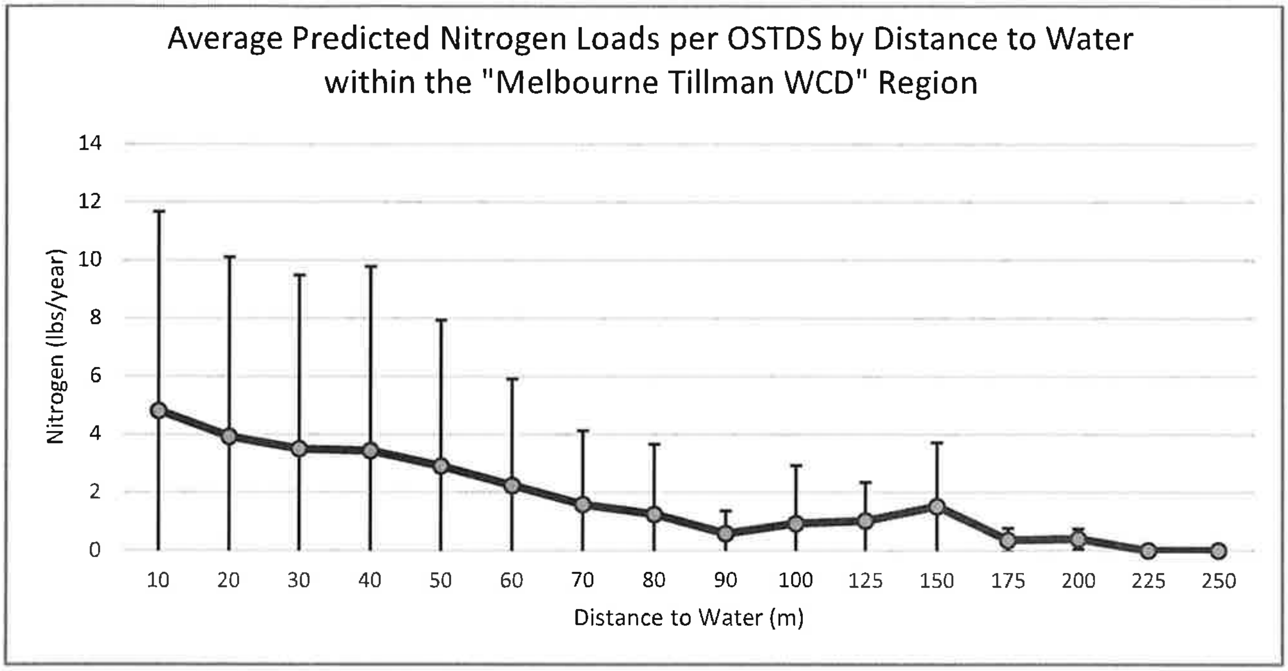


Figure 124. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for the MTWCD region of Brevard County. A calibration factor of 5.8 derived from the ArcNLET Turkey Creek model run was applied to the uncalibrated outputs for septic tanks within this region and spatially weighted using the distribution of soil hydraulic conductance. Standard deviation was included as error bars.

Septic tanks located between 0-40-m from a waterway have the greatest impact in the percentage of loading with two of the distance classes within this range contributing to greater than 40% of the total work area loading; the 20-m and 30-m represented 51.1% and 40.6%, respectively. This high relative contribution of the loading can be explained by the total number of septic tanks located at these distance intervals as this area is dense with ditching and swales (9,801 tanks or 94% of all the total OTDS). Cumulatively, the total loading contribution from the OSTDS located within the first 40-m makes up 97% of the total area's predicted nitrogen loading (Figure 125). Expanding to include all the OSTDS located within the first 60-m from the water (98% of all the OSTDS), allows for 99% of all the area's loading into the waterways to be captured.

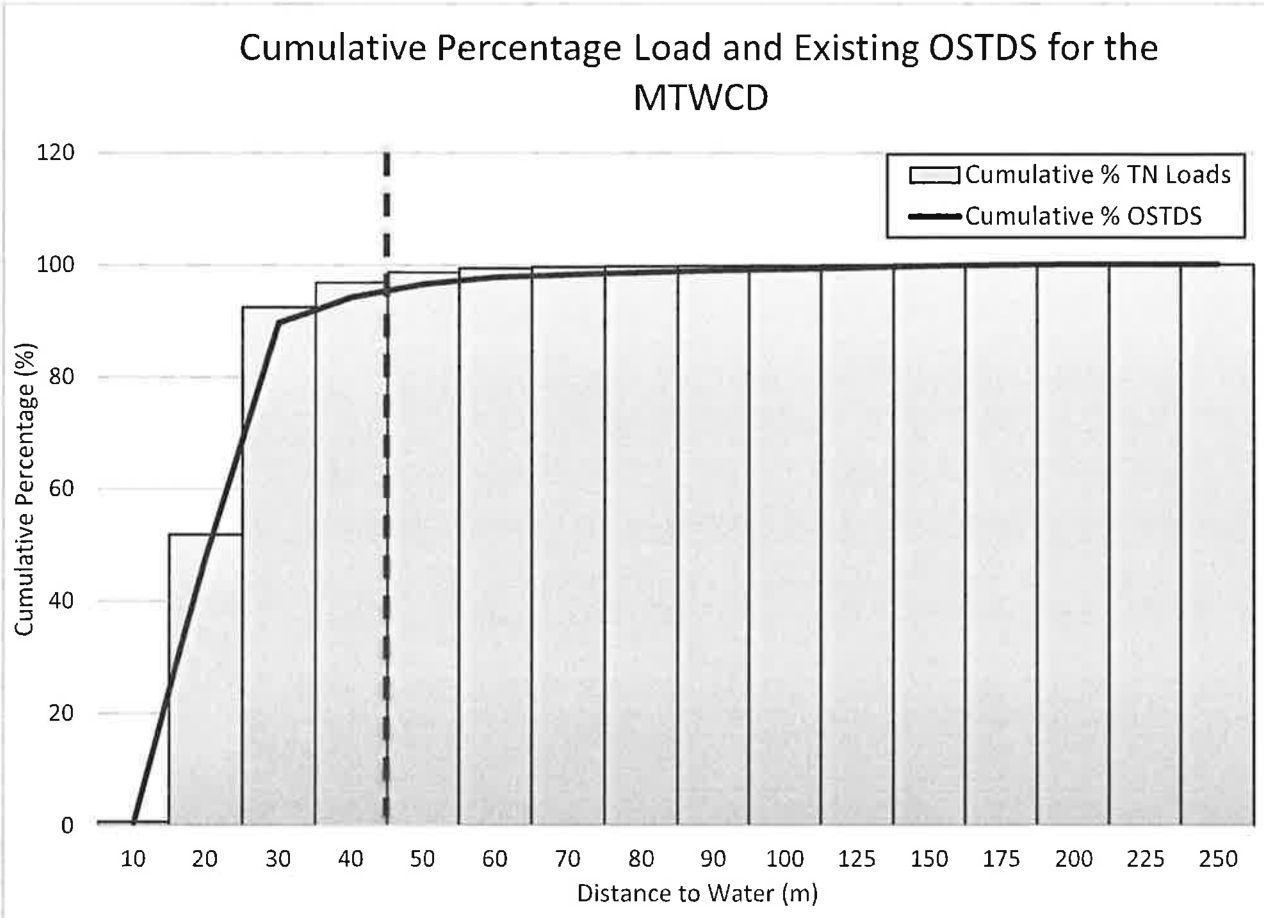


Figure 125. Cumulative percentage of total nitrogen loading and OSTDS by distance within the MTWCD region.

While many of the septic tanks are located in close proximity to neighboring waterbodies, the MTWCD is composed primarily of soils with low to moderate conductance values, contrasting the previously discussed regions (Table 4). These soils decrease the nitrogen transport time of nitrogen from the septic drainfields to adjacent waterbodies, providing higher than average contact time with denitrifying microbial communities. In addition, an increasing fraction of the MTWCD canal water is pumped away from the lagoon by the C-1 pump system and polished through a treatment marsh, reducing the pollutant impact from septic systems within MTWCD. Furthermore, management of water levels in the MTWCD canal system by the MS-1 control structure increases nutrient detention time in the MTWCD canals, further reducing the amount of OSTDS pollution that reaches the IRL System. Even though a large percentage of the current existing load is captured within the first 30-m from water, this number is greatly driven by the total number of existing OSTDS in close range to a swale or ditch. Potential new development can likely add OSTDS at greater distances from water, where the per septic tank mean is similar for distances between 20-40-m. Due to the steeper slope in mean OSTDS contribution after 40-m from the water and the reduced pollution potential of this managed watershed, we recommend a 40-m protection buffer from waterways in this region.

Brevard County Mainland Region (excluding MTWCD)

The Mainland region of Brevard County includes the remaining areas not previously described, including north Brevard county mainland, and some areas in south Brevard County that are excluded from the MTWCD (Figure 113). A total of 11,408 septic tanks were modeled throughout the region, which represents only 5% of the OSTDS loading for the total area within the Mainland County region. Approximately 51% of the septic tanks are currently located within 50-m of a waterbody/channel, and 73% within 100-m of water. None of the modeled septic tanks were found at distances beyond 500-m from a waterbody.

A calibration factor of 5.8 derived from a calibrated run of the ArcNLET model for the Turkey Creek basin was applied to the mean predicted total nitrogen loads (Figure 126). Additionally, the mean loads were spatially weighted by the distribution of hydraulic conductance within this region, as previously described in the MTWCD region. In general, the distribution of hydraulic conductance in the mainland area is quite different than one previously described for the MTWCD (Table 5). Almost 10% of the watershed is covered by high hydraulic conductance values, and the remaining values are about equally distributed between low and middle values. As an average the conductance values are higher in the mainland county region than the MTWCD, but lowed than both Merritt and Barrier Islands.

Table 5. Distribution of soil hydraulic conductance classes for OSTDS within the Mainland County region.

Hydro Conductance Class	Value Range	Acres	%
Low	0-5.9	55,133	41.17
Medium	6-15.9	63,296	47.26
High	16-20	13,355	9.97
Water	None	2,137	1.60
Total		133,922	

Spatially weighted mean values for the mainland region are included in Figure 126. There are sharp decreases in mean potential loading from the 10-m to 20-m distance class (of 41%) and 20-m to 30-m (16%), followed by similar loading mean values from 30-m to 60-m. Only after 60-m, a steeper decline in per OSTDS loading is observed of about 21% per distance class until 80-m, after which a gradual declining slope ensures until loads reach close to 0 at 300-m from water. Highest mean individual septic tank loading is predicted for the 10-m distance class (17.9 lbs. TN/year). Mean predicted loads per septic tank are reduced to 8-10 lbs/year for distance intervals between 20-60-m. Mean loads further reduce to < 6 lbs/year beyond the 125-m class. No contributions to the total loads were predicted beyond the 400-m distance classes within the Mainland Region.

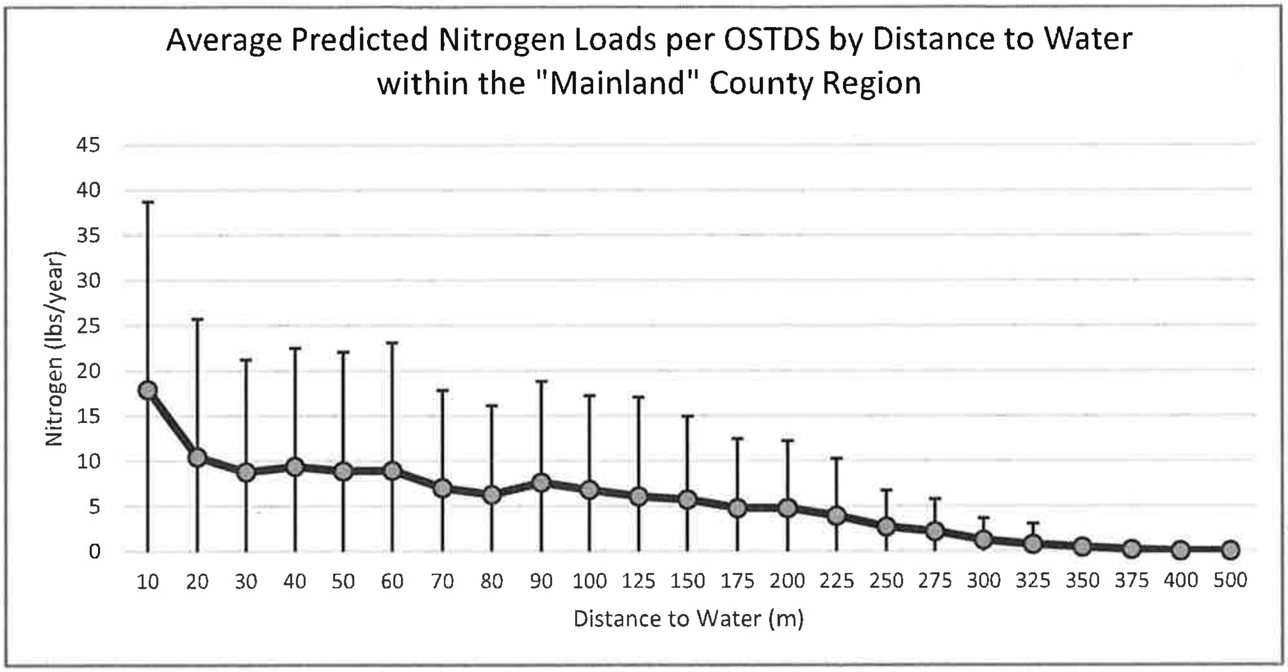


Figure 126. Mean individual septic tank nitrogen load into nearest waterbody by distance interval for the "Mainland County" region of Brevard County. A calibration factor of 5.8 derived from the ArcNLET Turkey Creek model run was applied to the uncalibrated outputs for septic tanks within this region. Standard deviation was included as error bars.

Septic tanks located between 0-60-m from a waterway have the greatest impact in the percentage of loading with all the distance classes within this range contributing to greater than 6% of the total work area loading; highest percentages were predicted within the 20-m and 30-m distance classes which represented 17.1% and 18.4%, respectively. This high relative contribution of the loading can be explained by the total number of septic tanks located at these distance intervals (6,369 tanks or 57% of all the total OTDS). Cumulatively, the total loading contribution from the OSTDS located within the first 60-m makes up 72% of the total area's predicted nitrogen loading (Figure 127). Expanding to include all the OSTDS located within the first 100-m from the water (73% of all the OSTDS), allows for 86% of all the area's loading into the waterways to be captured.

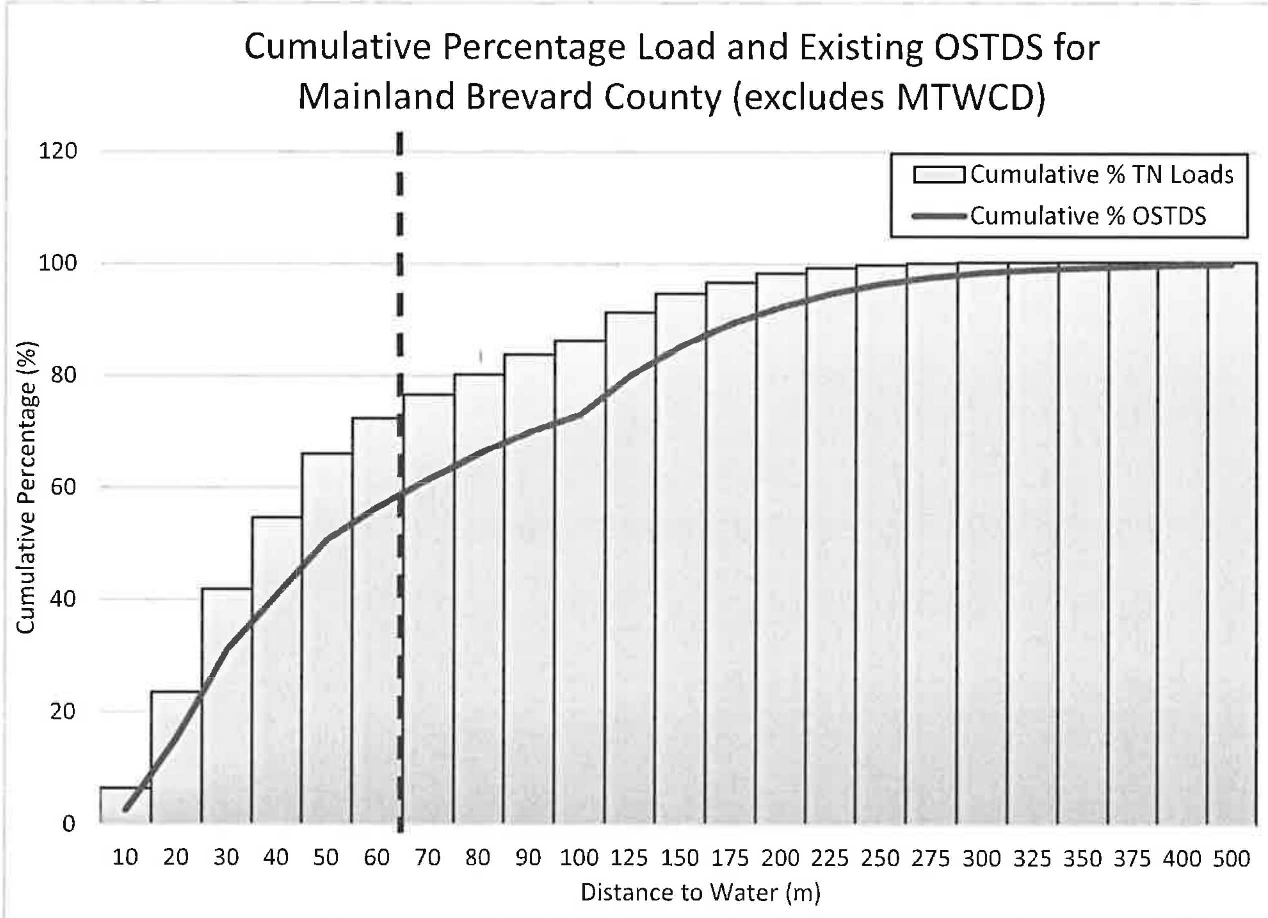


Figure 127. Cumulative percentage of total nitrogen loading and OSTDS by distance within the Mainland County region.

As the Mainland region spans across a large portion of the North and Central IRL watershed, it was expected that the existing OSTDS within this region would be spread across all soil hydraulic conductance categories and soil types, elevations, floodplains, and distances to water. A majority (88%) of the septic systems are classified between the low and medium categories (Table 5), indicating that a large percentage of effluent loading will migrate at a slower to average rate through drainfields before reaching a waterway. However, there are smaller pockets of high hydraulic conductance (10% of the total area) that will have faster nutrient transport, reduced time for denitrification processes, which likely leads to higher loading potential to the Lagoon. For these reasons, a conservative distance of 60-m is recommended to adequately reduce the potential OSTDS effluent loading from the Mainland Region into the Lagoon and connected waterways.

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