Attachment 1:

Mid-Currituck Bridge Cumulative Impact Report for Water Quality, May 2021

Mid-Currituck Bridge Cumulative Impact Report for Water Quality

Prepared for:

North Carolina Department of Transportation

North Carolina Turnpike Authority

May 2021

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List of Acronyms

ARHS	Albemarle Regional Health Services
ARHS-EHS	Albemarle Regional Health Services Environmental Health Services
BMP	Best Management Practices
CAMA	Coastal Area Management Act
CWA	Clean Water Act
DEIS	Draft Environmental Impact Statement
DEM	Digital Elevation Model
ECU	East Carolina University
EIS	Environmental Impact Statement
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
GIS	Geographic Information System
GPS	Global Positioning System
IPCC	International Panel on Climate Change
LID	Low Impact Development
M&N	Moffatt & Nichol
MS4	Municipal Separate Storm Sewer System
NC CREWS	North Carolina Coastal Region Evaluation of Wetland Significance
NCAC	North Carolina Administrative Code
NCCOG	North Carolina Council of Governments
NCCRC	North Carolina Coastal Resources Commission
NCDCM	North Carolina Division of Coastal Management
NCDEMLR	North Carolina Division of Energy, Mining, and Land Resources
NCDENR	North Carolina Department of Environment and Natural Resources
NCDEQ	North Carolina Department of Environmental Quality
NCDHHS-DPH-EPS-OSWPB	North Carolina Department of Health and Human Services, Division of Public Health, Environmental Health Section, On-Site Water Protection Branch
NCDIT	North Carolina Department of Information Technology
NCDOA	North Carolina Department of Administration
NCDOT	North Carolina Department of Transportation
NCDPS	North Carolina Department of Public Safety
NCDWQ	North Carolina Division of Water Quality
NCDWR	North Carolina Division of Water Resources

NCEMC	North Carolina Environmental Management Commission
NCNHP	North Carolina Natural Heritage Program
NCSU	North Carolina State University
NCTA	North Carolina Turnpike Authority
NCWRC	North Carolina Wildlife Resources Commission
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
ORC	Certified Wastewater Treatment Facility Operator
OHWM	Ordinary High-Water Mark
PDA(s)	Probable Development Area(s)
PUD(s)	Planned Unit Development(s)
RCP	Representative Concentration Pathway
ROD	Record of Decision
S&EC	Soil & Environmental Consultants, PA
SAV	Submerged Aquatic Vegetation
STI	Strategic Transportation Investments
STIP	State Transportation Improvement Program
TEAC	Turnpike Environmental Agency Coordination
TMDL	Total Maximum Daily Load
UDO	Unified Development Ordinance
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
WOTUS	Waters of the United States
WWTP	Wastewater Treatment Plant

Executive Summary

This cumulative impact report provides a comprehensive analysis of the potential water quality effects of planned and expected future development in the next 20 years in three specific, probable development areas (PDAs) associated with the Mid-Currituck Bridge, in Currituck County, North Carolina. These PDAs are:

1. The U.S. 158 Interchange PDA,
2. The Road Accessible Outer Banks PDA (located south of the end of the paved section of NC 12 to the Dare/Currituck County line), and
3. The Non-Road Accessible Outer Banks PDA (located north of the end of the paved section of NC 12 to the North Carolina / Virginia state line).

This assessment was conducted primarily to satisfy the Section 401 Water Quality Certification Rules of the North Carolina Division of Water Resources (NCDWR) (15A NCAC 2H .0506(b)(4) and (c)(4)). The analyses and conclusions contained in this report document current conditions and trends in the three PDAs and will be submitted to state and federal permitting agencies for their review during the Section 404/401 and Coastal Area Management Act (CAMA) major permit application processes in early to mid-2021.

This report builds upon a cumulative impact analysis completed in 2019 for the Reevaluation of the Final Environmental Impact Statement (FEIS) for the Mid-Currituck Bridge and serves as an expansion on that previous work in order to address specific, detailed issues raised by the permitting agencies, especially the NCDWR (U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), and North Carolina Turnpike Authority (NCTA), 2019).

The report provides a qualitative and quantitative analysis of potential water quality impacts in the PDAs which could occur in the next 20 years as a result of the construction of the proposed Mid-Currituck Bridge. This analysis involved intensive Geographic Information System (GIS), desktop, field and coordinated analyses of various issues surrounding the cumulative impacts of planned and expected development over a time frame of 20 years, focused on water quality impacts in Currituck Sound and the Atlantic Ocean. This analysis included a detailed selection of study areas; a scientific literature review; an in-depth GIS analysis; an assessment of existing non-discharge wastewater systems, septic tanks and drain fields; a review of current groundwater lowering measures; an analysis of the effects of sea level rise; assessment of flooding and stormwater management, a review of the occurrence of spills and wastewater emergencies; an evaluation of planning-related issues; and an assessment of potable water supplies.

In summary, this report determined, based on a GIS analysis, that there are six parcels in the U.S. 158 Interchange PDA that are planned and expected to be developed near the bridge interchange under the Build Alternative, consisting of approximately 68 acres of mostly commercial development, as documented in the Reevaluation of the FEIS. In the Non-Road Accessible Outer Banks PDA, there are approximately 1,742 parcels which could be developed as residential development. However, less than 10 percent of these parcels are expected to be developed in the next 20 years. In the Road Accessible Outer Banks PDA, this analysis identified approximately 535 parcels which could be developed as primarily residential units under the Build Alternative. In addition, in the Road

Accessible Outer Banks PDA, this report identified a potential for up to an additional 1,825 homes and/or hotel units, plus a possible 150,000 square feet of commercial development, in two large parcels which are subject to a long-standing settlement agreement between the landowner and Currituck County.

The pattern of planned and expected development in the Non-Road Accessible Outer Banks PDA is likely to begin with parcels along the ocean front (first row), followed by the second row, and then parcels along Currituck Sound and some existing finger canals. Development of the more interior parcels will likely occur later. This report has updated the analysis in the Revaluation of the FEIS for both the Road Accessible Outer Banks PDA and the Non-Road Accessible Outer Banks PDA using more recent GIS and land use data (see Chapter 8). This analysis now concludes that an additional 206 parcels (including the two large parcels subject to the settlement agreement) will be constructed in the Road Accessible Outer Banks PDA under the Build Alternative as compared to the No Build Alternative. This is consistent with the conclusions of the Reevaluation of the FEIS, considering that the two large parcels can be developed into many individual residential units. For the Non-Road Accessible Outer Banks PDA, the growth projections use comparable growth rates to the Reevaluation of the FEIS but have been aligned with current conditions in 2020. As a result, the 20-year growth projection for the Build Alternative is 151 new residential parcels, and 123 residential parcels for the No-Build Alternative. This also is consistent with the conclusions of the Reevaluation of the FEIS.

Overall, the findings of this indirect and cumulative impacts report indicate that construction of the Mid-Currituck Bridge project is expected to result in minimal indirect or cumulative impacts to downstream water quality. Estimated impacts attributable to the Mid-Currituck Bridge are not expected to be of sufficient magnitude to cause a violation of state water quality standards or a loss of existing or anticipated uses in Currituck Sound or the Atlantic Ocean. The amount of induced development that can be attributed to the bridge (i.e., the difference between the Build and No Build Alternatives) is modest. Existing wastewater treatment plants on the Outer Banks of Currituck County are meeting state water quality standards and functioning as permitted. The ongoing NCDWR permitting for these systems will provide ample opportunity to address any capacity or upgrade needs that may arise in the future. The projected proportional increase in on-site septic systems on the Outer Banks is small. Any new septic systems would have to meet current regulatory requirements which can be more stringent than those applied to previously installed systems, depending on when they were permitted. Impervious surface area, as a proportion of total watershed size, will increase slightly in some areas, particularly in the Road Accessible Outer Banks PDA. However, regional stormwater drainage infrastructure on the Outer Banks is expected to remain at current levels and should adequately handle any localized flooding-related issues. Currituck County will likely require on-site stormwater control measures for much, if not all, of the commercial development expected to occur on the mainland. In addition, on-site stormwater control measures will likely be required for development of the two settlement parcels in the Road Accessible Outer Banks PDA. These two parcels represent a large proportion of the total growth expected to occur in this PDA. Remaining infill development in the Road Accessible Outer Banks PDA will primarily drain toward existing roads and swales, which are already in place. The Mid-Currituck Bridge project is not expected to have any measurable impact on regional flooding, potable water supplies, or the implementation of groundwater lowering measures. Sea level rise over the next 20 years is not

projected to inundate any vacant parcels which might develop over that time period. Currituck County currently has an assertive regional planning effort, and progress is underway for a new regional plan, the Imagine Currituck Land Use Plan Update, to be completed soon. This planning will help to guide future development in all of the PDAs, including measures to protect water resources. For these reasons, the Mid-Currituck Bridge is expected to cause minimal indirect or cumulative impacts that would likely not cause a violation of state water quality standards in either Currituck Sound or the Atlantic Ocean. However, over the course of preparing these studies, NCDOT identified several opportunities for improved water quality management. These options could be implemented by NCDWR or the County if it is determined that they are warranted, or to address issues arising from past land use management practices which currently affect water quality in Currituck County.

1. Purpose, Goals, and Objectives for this Study

This chapter outlines the purpose, goals, and objectives of the Mid-Currituck Bridge Cumulative Impact Report for Water Quality. This report was prepared to examine potential cumulative impacts to water quality resulting from the Mid-Currituck Bridge Project for the North Carolina Turnpike Authority (NCTA), a division of the North Carolina Department of Transportation (NCDOT).

For reference, the Mid-Currituck Bridge Selected Alternative is shown in Figure 1.

1.1. Purpose

In 2019, the Reevaluation of the Final Environmental Impact Statement (FEIS) and Record of Decision (ROD) for the Mid-Currituck Bridge Project (Project) concluded that construction of the Project would add sufficient road capacity to allow for planned and expected development on the Outer Banks to occur between the NC 12/U.S. 158 intersection in Dare County to the North Carolina/Virginia State Line, a distance of approximately 32 miles (U.S. Department of Transportation (USDOT), Federal Highway Administration (FHWA), and NCTA, 2019). In contrast, with the No-Build Alternative, the road capacity of NC 12 would constrain development in this region, resulting in approximately 2,500 fewer homes and hotel rooms on this part of the Outer Banks. The Reevaluation of the FEIS and ROD also concluded that 68 acres of additional commercial development was likely to occur on the mainland of Currituck County near the proposed interchange with U.S. 158 due to the construction of the Project. The numbers of potential projected residential/lodging units and acres of commercial development were based on modeling transportation constraints on NC 12 and did not consider additional limitations resulting from available wastewater treatment capacity, soil suitability, presence of wetlands, or other factors.

Based on a review of scientific literature and existing monitoring data provided by the North Carolina Division of Water Resources (NCDWR), this report assumed that water quality issues resulting from traditional septic systems and reuse/reclaimed water systems are a valid concern related to reasonably foreseeable planned and anticipated growth of residential and commercial development on the Outer Banks. NCDWR believes that septic tanks and drain fields, along with conventional reuse/reclaimed water systems in the Outer Banks of Currituck County, are contributing to surface water contamination, especially when combined with groundwater lowering devices in place in this area This assumption was accepted as a founding principle during design of the study and the analysis for this report. No new water quality sampling was performed to validate this assertion. A scope of work was developed with active input from state and federal regulatory agencies (NCTA, 2020). This study also involved the active participation of Currituck County and Albemarle Regional Health Services staff.

One main purpose of this study was to assess wastewater treatment and stormwater runoff in the study area of Currituck County with respect to planned and expected development that is likely to occur as a result of construction of the proposed Project. Induced growth attributable to the Project is defined as residential and commercial development that is projected to occur following Project completion in the 20-year time frame of this analysis, as compared to that which would be expected without Project construction (the Build versus the No Build Alternatives). The difference between the projected Build and No Build Alternatives (Chapter 8) defines the induced growth which may be

attributed to the Mid-Currituck Bridge, and this difference established the basis for subsequent water quality analyses.

Critical issues to be addressed, according to NCDWR, are reflected in the April 9, 2020 Scope (NCTA, 2020) and include a Geographic Information System (GIS) analysis of the extent of planned and expected development (mainly residential) in three focused probable development areas (PDAs). Planned and expected development was assessed in terms of its probable effect on stormwater runoff and wastewater treatment (septic tank/drain fields and non-discharge systems). The efficiencies of different wastewater treatment systems (including advanced pre-treatment, nutrient removal, and other technologies) were examined as they relate to potential water quality impacts. Other issues evaluated include groundwater lowering measures, the effect of localized flooding, sea level rise, and sewage spills. This study also examined existing federal, state, and local environmental rules and developed practical recommendations to consider to these rules which could be implemented as needed by the appropriate government agency to address any cumulative impacts of the Project on water quality should those agencies determine that such actions are warranted.

This study also supplements the earlier cumulative impact analysis done in the 2019 Reevaluation of the FEIS and ROD to re-assess the number of potentially developable units in the PDAs from the GIS-based analysis of this report and any water quality related consequences of this growth.

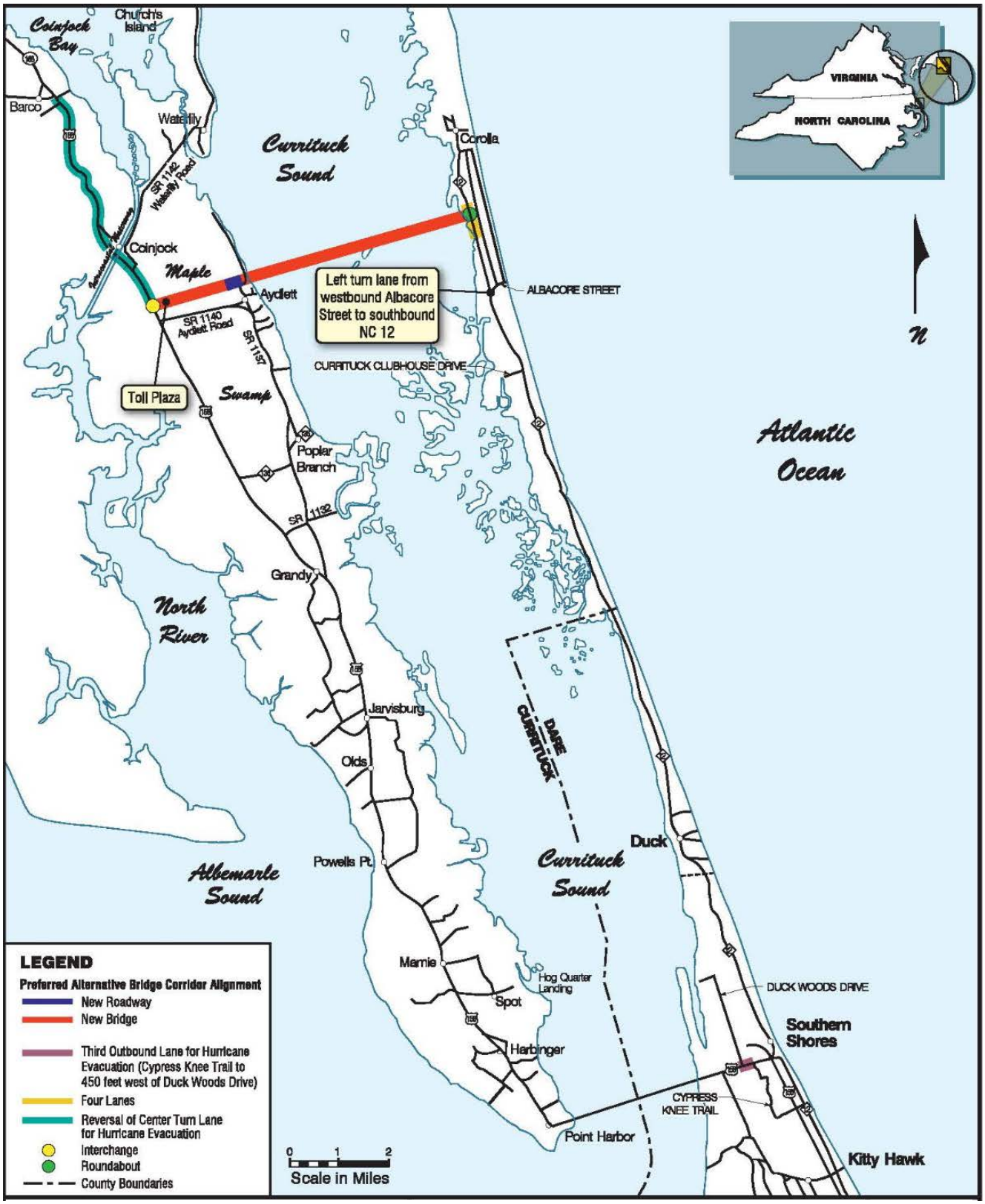

Figure 1: Selected Alternative for the Mid-Currituck Bridge Project (Source: www.ncdot.gov/projects/mid-currituck-bridge/Documents/selected-alternative.pdf)

1.2. Goals

This cumulative impact study intends to determine the geographic extent and magnitude of existing water quality issues in the three PDAs, and the potential for additional planned and expected development directly attributable to the Project to contribute to future water quality concerns. If future water quality issues are identified, then viable conceptual engineering and design solutions will be suggested which could help mitigate water quality impacts, along with considerations for feasible changes in regulatory requirements for the NCDWR, Currituck County, and the Albemarle Regional Health Services

1.3. Objectives

To accomplish the goals above, this study will:

1. Characterize the existing conditions of the PDAs,
2. Identify from the available literature the principal pollutants affecting the PDAs– i.e., nutrients (primarily nitrogen) and bacteria,
3. Conduct initial coordination with relevant agencies and local government, including the NCDWR, Currituck County, Albemarle Regional Health Services, the North Carolina Division of Coastal Management (NCDCM), and the U.S. Army Corps of Engineers (USACE),
4. Coordinate with on-site wastewater permitting agencies (state and local) regarding their current rules,
5. Conduct a literature review of both peer-reviewed and grey literature (non-peer reviewed publications) for information about the water quality effects of on-site wastewater treatment and stormwater management on the barrier islands in North Carolina, with a focus on Currituck and Dare Counties,
6. Perform GIS analyses to determine land suitability of developable areas based on the presence of resources including, but not limited to, soil type and presence of wetlands,
7. Map and quantify existing land use characteristics and developable parcels in the PDAs,
8. Assess the effect of future development directly attributable to the Project to the water quality of the PDAs, with regard to wastewater treatment, stormwater runoff, groundwater lowering, sea level rise, flooding, the occurrence of wastewater spills and emergencies, local planning, and potable water supplies, and
9. Assess practical and feasible management options for NCDWR, Currituck County, and the Albemarle Regional Health Services to consider to address water quality issues, should these agencies determine that such actions are warranted.

2. Cumulative Impact: Comparison of this Study to the NC Division of Water Resources 2004 Guidance

This chapter compares this cumulative impact report to the North Carolina Division of Water Quality (NCDWQ)—now the NCDWR—2004 guidance on cumulative impact analysis for the 401 Water Quality Certification Program. A copy of that Guidance is in Appendix 1.

2.1. NC Division of Water Resources Guidance

The NCDWR 401 Water Quality Certification rules (15A NCAC 2H .0506(b)(4) and (c)(4)) require an analysis of the cumulative impacts of all projects seeking 401 Water Quality Certifications. Those rules require that NCDWR determine that a project "does not result in cumulative impacts, based upon past or reasonably anticipated future impacts, that cause or will cause a violation of downstream water quality standards." These rules also require NCDWR staff to consider both numerical standards (such as the dissolved oxygen water quality standard of 5 mg/l) as well as narrative standards (for instance, to protect aquatic life propagation, survival, and maintenance of biological integrity) in any cumulative impact analysis.

NCDWQ adopted an Internal Policy document on April 10, 2004, which describes the process for staff and applicants to use to meet this rule provision. This policy has been in effect since 2004 and has been widely used on a variety of projects since that time. This policy states that the NCDWR cumulative impact provision is relatively narrow because it focuses on downstream water quality standards as mandated by the 401 rules. The policy also states that this analysis is usually tied to stormwater runoff that may increase with road construction and associated urban development.

During development of the Scope of Work for this current water quality cumulative impact reevaluation for the Mid-Currituck Bridge, NCDWR used this policy during their review and eventual approval of the final scope. The following analysis describes how this scope meets the requirements of NCDWQ's 2004 cumulative impact policy.

The NCDWR policy establishes three categories for NCDOT (and other public transportation) projects with varying levels of analysis required for a cumulative impact study:

1. Small scale widening projects, bridge replacement projects, and intersection improvement projects;
2. Projects such as widening with new locations; and
3. Projects such as roads on new location (such as the proposed Mid-Currituck Bridge).

The policy then describes three questions that need to be addressed during project evaluation. If the answer to all three questions is yes, then a quantitative (detailed) analysis of cumulative impact is needed. These questions are:

1. Is growth likely to be induced by the Project?
    a. In the case of the Mid-Currituck Bridge, the analysis outlined in the 2019 Reevaluation of the FEIS (as discussed in Chapter 4 of this report) concluded that planned and anticipated growth is likely to be greater with the Project than with the No-Build Alternative.

2. Are existing uses of the water likely to be impacted by induced growth?

    b. For North Carolina waters, like the Atlantic Ocean and Currituck Sound, the policy recommends a qualitative analysis, and if significant potential for cumulative impact is identified, then a quantitative analysis may be required. In this case, NCDWR has identified concerns about the cumulative effect of stormwater runoff and wastewater (on-site septic and reuse/reclaimed water) on downstream water quality through groundwater flow accelerated by groundwater withdrawal as potentially affecting the water quality of the Atlantic Ocean and Currituck Sound.

3. Are additional regulatory measures needed or are there existing regulatory programs which can address these impacts?

    c. In the case of the Mid-Currituck Bridge, NCDWR has expressed concerns that existing NCDWR, Currituck County, and Albemarle Regional Health Services regulatory programs may not adequately address the water quality implications of the additional growth.

Since all three questions above were answered in the affirmative by NCDWR staff, the policy indicated that a quantitative (detailed) analysis of cumulative impacts would be needed prior to issuance of a 401 Water Quality Certification.

2.2. Analytical Considerations

The following analytical considerations are defined below and are detailed in noted chapters of this report:

1. Impact or Service Area: The area chosen for detailed study was carefully considered based on examination of the cumulative impact results from the 2019 Reevaluation of the FEIS, resulting in the selection of three PDAs (Figure 3 in Chapter 5) (USDOT, FHWA, and NCTA, 2019). The first PDA is on the mainland near the proposed interchange at U.S. 158, the second is the area from the Dare/Currituck County line to the end of the paved section of NC 12 in Corolla, and the third is the unpaved area from the end of the paved section of NC 12 in Corolla to the North Carolina/Virginia state line. In addition, a potential fourth service or impact area near Duck, North Carolina, was evaluated and then subsequently excluded from this detailed analysis because this area includes only a small portion of the development difference noted in the three other evaluated impact areas. Most of Duck is already developed and future new development will be on vacant lots within existing subdivisions. Duck also uses another jurisdiction's sewer system and is otherwise not subject to the Currituck County regulatory program, further justifying its exclusion. These analyses and decisions are described more completely in Chapter 5 of this report.

2. Modeling Considerations: During scoping for this cumulative impact study, the agencies decided that a formal modeling effort would not be required if issues listed in the final Scope of Work were thoroughly addressed. The main issue of concern was the potential impact of wastewater (on-site septic and reuse/reclaimed water) on downstream water quality through groundwater flow accelerated by groundwater withdrawal. An in-depth analysis of this issue is included in Chapters 9 and 10 of this report.

3. Time Frame for Analysis: The NCDWQ 2004 policy defines "reasonably anticipated" (which is the phrase used in the 401 Water Quality Certification rules) as determined by NCDWR staff after consultation with local land use experts. The time frame for this study was based on the cumulative impact analysis in the 2019 Reevaluation of the FEIS and included extensive discussions with the Currituck County planning staff. The policy states that several time frames (10 and 20 years are listed) should be considered if possible. In the case of this study, the GIS analysis examined build out of developable lots in the three PDAs up to 20 years (to the year 2040). This timeframe also corresponds with the design year for the traffic forecast for the Project.
4. Non-point (i.e., stormwater) Measures to Consider: The NCDWQ 2004 policy points out that local land use control measures and other site-specific design features, such as use of Best Management Practices (BMP), should be focused on the likely (or known) cause of water quality impairment or concern. Stormwater management measures considered in this analysis are described in Chapter 14. In addition, management measures for non-discharge wastewater systems (Chapter 9), on-site wastewater (Chapter 10), groundwater lowering measures (Chapter 11), sea level rise (Chapter 12), flooding (Chapter 13), spills/emergencies (Chapter 15), planning (Chapter 16), and potable water (Chapter 17) were all examined in terms of existing programs and potential changes to address reasonably foreseeable cumulative impacts resulting from construction of the Project over the next 20 years.

Finally, the NCDWQ policy states (Section V of the policy) that if the cumulative impact analysis reveals that additional measures are needed to address the downstream impact of the Project, then NCDWQ (now NCDWR) will work with the local municipality to develop and implement local land use control measures. The policy also states that NCDWQ will examine its existing regulatory responsibilities to determine if NCDWQ can undertake the needed protection measures. This report provides proposed technical and practical regulatory considerations (Chapter 19) for the following topics: stormwater, wastewater (described separately for both NCDWR-permitted systems and septic tank/drain field systems), groundwater lowering, flooding, spills/emergencies, planning, potable water, and sea level rise. These solutions will be thoroughly reviewed and discussed with NCDWR and Currituck County staff. Finally, practical regulatory considerations have been provided which could be implemented to address each of the areas of concern raised by NCDWR and identified in this study. Currituck County, Albemarle Regional Health Services, and NCDWR staff have been contacted to begin considering addressing these measures, as described in Chapter 19, should NCDWR determine that such measures are warranted.

3. History of the Mid-Currituck Bridge Project

3.1. Purpose

This chapter provides an overview of the Project's history, from its early inception in the 1970s to the present day (2020). This background allows the reviewer to understand the general history of how planning, design, and permitting for this Project has evolved.

3.2. Project History: 1975 to 1998

Proposals for construction of a bridge over the Currituck Sound have been under investigation for more than 45 years. In 1975, Currituck County requested that the NCDOT Board of Transportation consider an east-west bridge crossing of Currituck Sound to the Currituck County Outer Banks. No additional action was taken at that time. The potential need for a crossing of Currituck Sound to supplement transportation movement along the Wright Memorial Bridge (located between mainland Currituck County and the barrier island beaches of Dare County over Albemarle Sound) was mentioned again in a 1989 NCDOT study, "Transportation Access over Currituck Sound: A Feasibility Study." A potential terminus for a Mid-Currituck Bridge on the Currituck County Outer Banks was identified in 1991. In 1995, a site was purchased and protected under the North Carolina Roadway Corridor Official Map Act.

The Federal Highway Administration (FHWA) published a Notice of Intent to prepare an Environmental Impact Statement (EIS) for a bridge on July 6, 1995 (Federal Register Vol. 60, No. 129, page 3255). Planning studies were subsequently undertaken by NCDOT on behalf of the FHWA, resulting in publication of a Draft Environmental Impact Statement (DEIS) in 1998. Over time, several changes to the Project occurred including expansion of the Project study area, modification of the purpose and need statement, and analysis of additional alternatives. Subsequent state legislation and highway planning strategies were developed or amended to incorporate the proposed Project, including the North Carolina Intrastate System and the North Carolina Strategic Highway Corridor System. These changes led to a decision to rescind the 1995 Notice of Intent and the 1998 DEIS.

3.3. Project History: 2000 to 2012

The Project was reactivated in 2000, primarily in response to comments received during public hearings conducted in 1998, which resulted in a decision by NCDOT and FHWA to include a wider range of alternatives and to reevaluate the Project's purpose and need. In 2003, NCDOT, FHWA, and state and federal agencies reached tentative agreement on a revised Statement of Purpose and Need for the proposed action to include three primary goals:

1. Improve traffic flow on NC 12 and U.S. 158,
2. Reduce travel times to the Currituck County Outer Banks, and
3. Improve hurricane clearance times (NCTA, 2008).

In 2002, the North Carolina General Assembly passed legislation that created the NCTA. In 2005, legislation was enacted that directed NCTA to "contract with a single private firm to design, obtain necessary permits for, and construct the toll bridge described in NC Gen. Stat. §136-89.183(a)(2): a bridge of more than two miles in length from the mainland to a peninsula bordering the State of

Virginia, in order to provide accelerated, efficient, and cost-effective completion of the Project" [H.B. 253 (2005); NC Gen. Stat. §136-89.183A(a)]. The Project was officially adopted by NCTA as a candidate toll project in 2006.

A series of agency meetings took place in 2006, 2007, 2008, and 2009 as part of the Turnpike Environmental Agency Coordination (TEAC) process, and written comments were received from the agencies and the public. These meetings resulted in preparation of an alternatives screening study (NCTA, 2009) outlining detailed factors for potential alternatives including: the ability to meet the Project's purpose and need; ability to improve system efficiency; economic feasibility; and potential impacts on communities and natural resources.

A new Notice of Intent for preparation of an EIS for the Mid-Currituck Bridge was issued on June 16, 2008 (Federal Register Vol. 73, No. 116, page 34065). NCDOT reached an understanding with the agencies regarding the Project's purpose and need and on the alternatives to be studied in the DEIS at a TEAC meeting on July 8, 2008. A DEIS was prepared and signed on March 10, 2010 and the FEIS on January 12, 2012.

3.4. Project History: 2013 to Present

In 2013, the North Carolina General Assembly, as part of the State Transportation Investment (STI) Law (Session Law 2013-183 and House Bill 817), withdrew the annual state appropriations ("gap funding") for the Mid-Currituck Bridge. Between 2013 and 2016, the Project subsequently went through the prioritization process required under STI. This process evaluates proposed transportation projects based on their merit through an analysis of existing and future conditions, the benefits of the Project, the Project's multi-modal characteristics, and how the Project fits with local priorities. The Mid-Currituck Bridge scored high during prioritization and was funded in the 2016 to 2025 State Transportation Improvement Program (STIP) for right-of-way acquisition and construction. The Project remains funded in the current 2020-2029 STIP.

Once funding for the Project was re-established, the 2012 FEIS was reevaluated to consider changes that may have occurred in the Project setting, travel demand, area plans, laws and regulations, and other information or circumstances since the 2012 FEIS was approved, in keeping with Title 23 CFR 771.129(b). The reevaluation found that the Project's purpose and need as outlined in the 2012 FEIS remained valid. The Project needs included: 1) the need to substantially improve traffic flow on the Project area's thoroughfares (U.S. 158 and NC 12); 2) the need to substantially reduce travel time for persons traveling between Currituck County mainland and the Currituck County Outer Banks; and 3) the need to substantially reduce hurricane evacuation times from the Outer Banks for residents and visitors who use U.S. 158 and NC 12 as an evacuation route. Therefore, a Supplemental EIS was determined not to be required. The Reevaluation of the FEIS was published in 2019. The ROD for the Project was signed on March 6, 2019, signifying completion of the environmental study process.

Design and permitting for the Project are currently underway. Agencies have requested a more detailed analysis of cumulative impacts relative to water quality as part of the permitting process, which is the focus of this supplemental cumulative impact study.

4. Indirect and Cumulative Effects Summary

4.1. Purpose

The purpose of this chapter is to summarize the indirect and cumulative effects analyses presented in the FEIS, Reevaluation of the FEIS, ROD, and supporting documents, which formed the basis upon which the more detailed, water quality-focused work described in this report was based. The ROD identifies the Selected Alternative for the Mid-Currituck Bridge.

Indirect effects are impacts caused by the Project but compared to direct impacts, are later in time or farther removed in distance but are still reasonably foreseeable. In the case of this Project, indirect effects include project-induced changes in the pattern of land use and the impacts those changes are likely to have on the community and natural environment.

Cumulative effects are impacts on the environment that result from the incremental impact of the proposed Project when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. In the case of the proposed Project, cumulative effects resulting from the Project, land use changes induced by the Project, and all other development activities expected through 2040, were considered.

4.2. Background

Indirect and cumulative effects of the Selected Alternative are presented in the 2012 FEIS in Section 3.6 and detailed in the 2011 *Indirect and Cumulative Effects Technical Report* prepared in support of the FEIS. This assessment was updated in Section 4.6 the 2019 *Reevaluation of Final Environmental Impact Statement Study Report*. As shown in Figure 3-11 of the FEIS, the Growth/Development Study Area on the Currituck County mainland was along U.S. 158 from approximately Barco to the Wright Memorial Bridge, and on the Outer Banks in Currituck and Dare counties from the Virginia state border to U.S. 64/U.S. 158 in Manteo (Figure 2). The Habitat/Water Quality Study Area covered the approximate boundaries of Currituck County, as well as Kitty Hawk, Duck, and Southern Shores in Dare County (Figure 2).

Assessment of indirect impact-causing activities indicated the potential for increased business/commercial development concentrated at the proposed U.S. 158/Mid-Currituck Bridge interchange on the Currituck County mainland. A Currituck County economic study indicates the potential for 34 businesses to locate near the interchange that would use approximately 68 acres of what is currently agricultural or undeveloped land (Lane & Jolley, 2008). In addition, on the Outer Banks, the Selected Alternative would provide adequate road capacity to permit planned and expected development by 2040 to occur. With the No-Build Alternative, planned and expected development would be constrained by traffic congestion on NC 12, reducing total residential planned and expected development (including hotel rooms) in 2040 by approximately 2,476 residential units, from approximately 13,100 total units to approximately 10,646 units (USDOT, FHWA, and NCTA, 2019). In 2014, there were 9,565 residential units already developed.

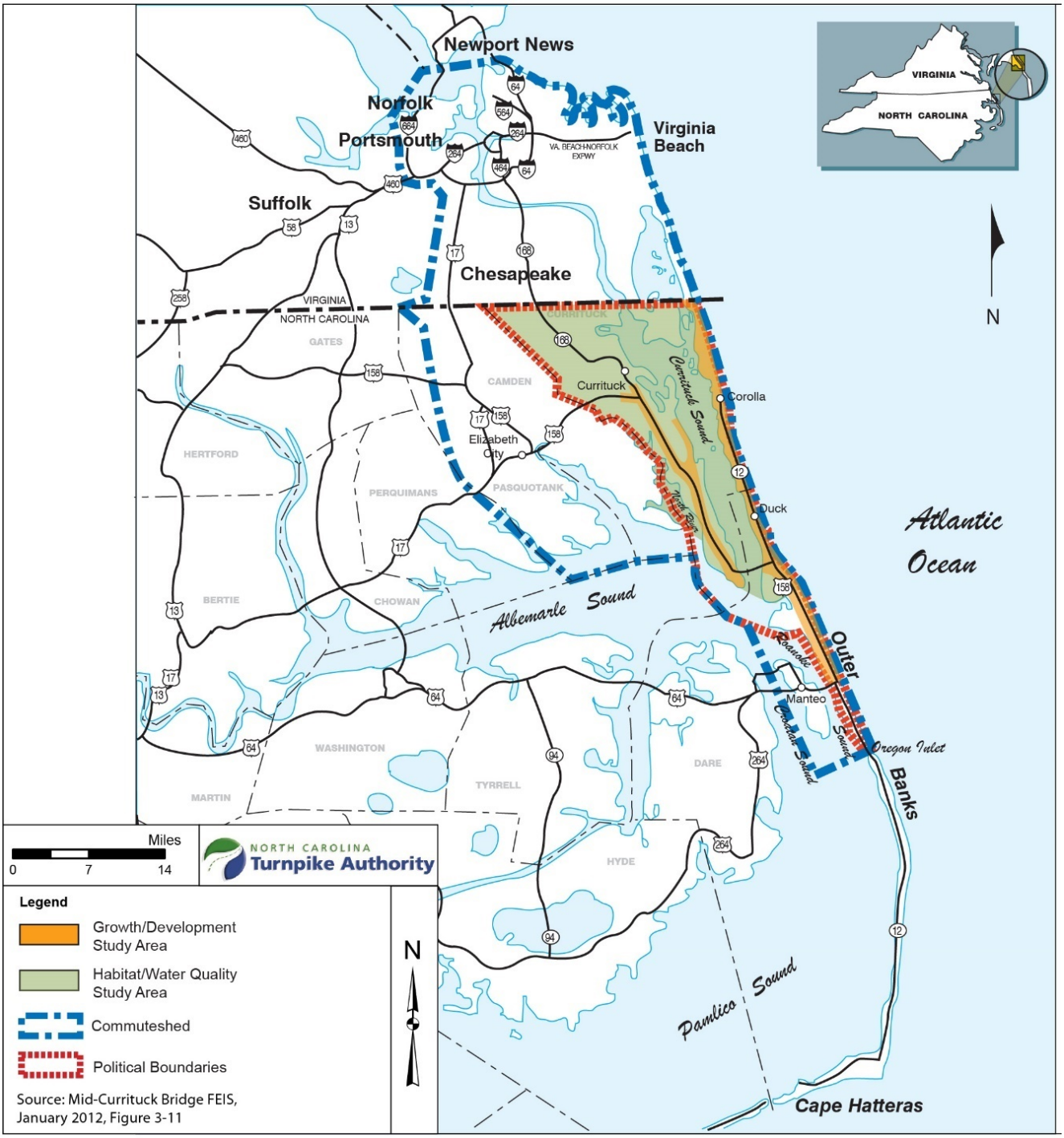

Figure 2: Growth/Development Study Area (Figure 3-11 from the FEIS) Indirect Effects

The analyses concluded that there was little potential for the Selected Alternative to increase demand for development beyond what is planned and expected. Nor would it change the type or density of development within the Road-Accessible Outer Banks PDA because the area is already substantially developed, land use plans and development regulations are in place, and the type of development planned and expected is similar within each government jurisdiction. However, it was determined that implementation of the Selected Alternative could influence the order in which developable parcels are developed. Similarly, the Selected Alternative is not anticipated to change the style of

development within the Non-Road Accessible Outer Banks PDA, despite the time travel benefits anticipated with the Selected Alternative, because of existing local development regulations, as well as numerous state and federal government policy constraints related to planned and expected development and the extension of NC 12.

The Selected Alternative would result in a negligible or slight increase in permanent residents on the Outer Banks because of the lack of employment centers within a reasonable commuting distance and because the dominant housing types are second homes and vacation properties that are not designed to serve permanent residents. The commuter shed is shown in Figure 2.

The Selected Alternative would have some potential to increase the number of day visitors to the Outer Banks, with this potential being higher for the Non-Road Accessible Outer Banks PDA because of the unique beach experience this area provides. The potential for increased day visitors would be reduced by the availability of other beach options in the region, the cost of combined tolls for visitors travelling from Virginia, and the limited number of beach access points, parking, and public facilities on the Currituck County Outer Banks compared to other available beach destinations.

The indirect effects assessment considered the effect of the above impact-causing activities anticipated with the Selected Alternative on the area's notable ecosystem and cultural/socioeconomic features, and their compatibility with local/regional goals, land use plans, and development regulations. The effect of impact-causing activities anticipated with the Selected Alternative would likely be minimal or low. Potential indirect effects to resources would include:

- Visual change near the proposed U.S. 158/Mid-Currituck Bridge interchange because of the anticipated concentration of new commercial development in addition to visual change associated with the Mid-Currituck Bridge.
- Impacts to water quality within Currituck Sound because of increased levels of impervious surface run-off and on-site septic facilities. The calculated 68 acres of new development on the Currituck County mainland is anticipated to result in 44 acres of increased impervious surface area.
- The biological conclusion associated with increased beach driving was "No Effect" on threatened and endangered species except as it relates to beach nesting of the loggerhead sea turtle where the biological conclusion was "May Affect, Not Likely to Adversely Affect." A biological conclusion is a determination of whether a project will have an effect on any federally endangered or threatened species or critical habitat.

The No-Build Alternative and its associated limit on the capacity of NC 12 would constrain planned and expected development based on CAMA land use plans, zoning, existing vacant lots, and settlement agreements specifying permitted land uses for unimproved parcels in Currituck County on the Outer Banks from Southern Shores to the Virginia line. The constraint on development would result in less potential for impact to water quality. The FEIS Reevaluation indicated in Section 4.6.3 that approximately 13,100 residential units are expected to be on the Outer Banks in 2040 between the US 158/NC 12 intersection in Southern Shores and the Virginia line. With the No-Build Alternative, the number of residential units were estimated to be approximately 10,600. The reduction of about 2,500 residential units would likely occur in Currituck County. The impervious surface of planned and expected development was not calculated in the FEIS or Reevaluation.

4.3. Cumulative Impacts

The 2011 cumulative effects assessment found that cumulative effects would be driven primarily by the continuation of current development trends in the Growth/Development Study Area and, as such, the Selected Alternative would not notably contribute to cumulative impacts on resources in the PDAs. Noteworthy cumulative resource effects in the PDAs could include:

- The FEIS cumulative effects assessment found that cumulative effects would be primarily associated with future population growth in Currituck County as a whole, irrespective of what detailed study alternative was implemented. Differences in expected development between the detailed study alternatives were found to be focused on the area of the bridge alternative's interchange with U.S. 158 and on the Currituck County Outer Banks. Potential additional commercial growth on the mainland at the U.S. 158 interchange would add approximately 44 acres of impervious surface. The additional roadways with the Preferred Alternative would add 64.4 acres of impervious surface. The constraint on development associated with the No-Build Alternative would reduce development on the Outer Banks by 2,500 residential units from what is planned and expected. All planned and expected development would occur with the bridge alternative. The induced development of approximately 34 businesses on the mainland would exert a minor additional water demand. Public water supply is adequate to serve planned and expected development on the Outer Banks.
- Submerged Aquatic Vegetation (SAV) within Currituck Sound would be affected by the general conversion of agricultural land to developed land and, in the case of the Selected Alternative, from shading by the proposed bridge. During land development, sediment loading and turbidity would increase, although once developed with a perennial ground cover, the conditions likely would be an improvement over tilled agricultural land.
- Non-coastal wetlands would be affected by the cumulative effect of logging and, in the case of the Selected Alternative, the direct impacts of land alteration and construction would occur through Maple Swamp.
- The Project could potentially contribute additional stress to waterbird habitats because of land use conversions and increased levels of ambient noise and light, although substantial impacts on waterbirds are not anticipated.

Cumulative socioeconomic effects could include the conversion of agricultural land and changes in neighborhoods, village communities, and scenic and natural area character. However, as high levels of growth are anticipated without the Project under the No Build Scenario, the Selected Alternative would have a very low contribution to anticipated changes.

Finally, potential impacts caused by planned and expected development could be altered through the local planning authority and the regulation of land use, density, and aesthetics. NCDOT would minimize impacts associated with the U.S. 158/Mid-Currituck Bridge interchange itself in the manner described in the FEIS from 2012 (Pages 3-124 through 3-125), which included selecting a Preferred Alternative that would avoid, minimize, and have the potential for mitigating environmental impacts; mitigating direct construction, maintenance, and operation impacts of the Preferred Alternative where feasible, practical, and reasonable; developing a project design that is sensitive to its context; and controlling access of induced and other development to public thoroughfares so that access is

provided in a manner that would not reduce the efficiency of public thoroughfares. Minimization of other indirect and cumulative effects would be the responsibility of Currituck County under their land use planning and development regulatory authority.

The current study discussed in this report expands upon the assessments done in the 2011 Indirect and Cumulative Effects Technical Report and its update in the FEIS Reevaluation with a more detailed analysis focused on the locations where development changes are expected with the bridge alternative. The findings of the FEIS and FEIS Reevaluation are revised and updated with additional information. The findings of the current study supersede those of previous reports with respect to water quality issues.

5. Selection of Study Areas (Probable Development Areas)

5.1. Purpose

The purpose of this chapter is to describe the process for selecting the study areas for this cumulative impact study.

5.2. Final PDAs

The three final PDAs that were selected to be assessed are shown on Figure 3. Section 4.6.3, "Indirect and Cumulative Effects," of the Reevaluation of the FEIS Study Report (WSP USA, 2018a), concluded that based on the Selected Alternative, the capacity of NC 12 would not constrain development north of the intersection of NC 12 and U.S. 158. With the No-Build Alternative, a predicted 2,476 (of 3,557) planned and expected residential units (hotel rooms, apartments, and houses) on 830 acres would not be built by 2040 because of traffic congestion on NC 12 (WSP USA, 2018a). The Reevaluation of the FEIS also concluded (Section 4.6, page 4-51), based on a Currituck County economic development study, that the Selected Alternative would generate 68 acres of commercial development on the mainland in the U.S. 158 interchange area.

The predicted 2,476-residential unit difference in planned and expected development by 2040 between the Build and No-Build Alternatives was identified during the Reevaluation of the FEIS's traffic study (WSP USA, 2018b). That study considered whether the capacity of NC 12 was adequate to accommodate the forecasted 2040 summer weekend travel demand generated by planned and expected development. The traffic study found that the existing NC 12 roadway could not accommodate 2040 travel demand with the No-Build Alternative. Thus, NC 12's capacity could act as a constraint on planned and expected development. With the Selected Alternative, some summer weekend traffic would be diverted from NC 12 to the bridge, and the existing NC 12 roadway could accommodate the remaining demand, allowing all planned and expected development to be realized.

The traffic study distributed the predicted 2,476-unit difference between the Build and No-Build as follows:

- Duck, Dare County: 90 units
- Road-accessible PDA of Currituck County: 2,291 units
- Non-Road Accessible PDA of Currituck County: 95 units (WSP USA, 2018a).

This report has updated the analysis in the Revaluation of the FEIS for both the Road Accessible Outer Banks PDA and the Non-Road Accessible Outer Banks PDA using more recent GIS and land use data (see Chapter 8). This analysis now concludes that an additional 206 parcels (including the two large parcels subject to the settlement agreement) will be constructed in the Road Accessible Outer Banks PDA, and an additional 28 new residential parcels will be built in the Non-Road Accessible Outer Banks PDA in the next 20 years, comparing the Build to No-Build Alternatives. It should be noted that the two parcels subject to a settlement agreement in the Road Accessible Outer Banks PDA could be developed in the future with many individual residential units, consistent with the predictions of the Reevaluation of the FEIS Study Report.

The inclusion of the Town of Duck as a PDA was also considered. Based on a meeting with the Town of Duck on July 17, 2020, and on GIS analyses, it was found that currently only 60

developable parcels remain out of 2,709 parcels within Duck's municipal limits. This represents approximately 2.2% of developable land within the Duck municipal limits, primarily within existing subdivisions.

In addition, most future construction is expected to be re-development according to the July 2020 draft Coastal Area Management Act (CAMA) land use plan, which notes that "the number of bedrooms per home is not rising" and "average home size is steady (or slightly falling)" (Town of Duck, 2020). Only a small portion of the potential development difference with the construction of the Project is predicted to occur in the Town of Duck, and most of the development in Duck would be in existing subdivisions, with no anticipated rise in housing density. For these reasons, Duck was not included as a fourth PDA.

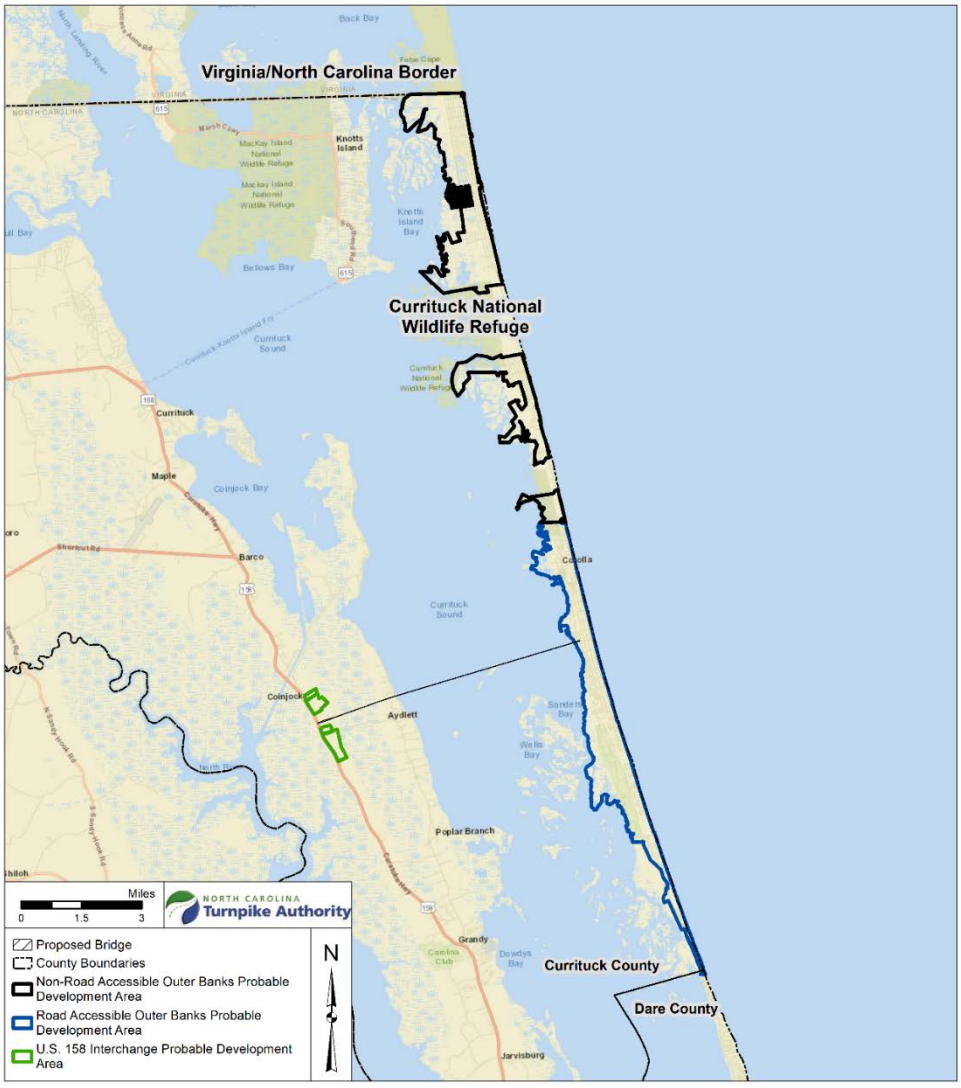

Figure 3: Locations of the Three Probable Development Areas

6. Literature Review

6.1. Purpose

The purpose of this chapter is to summarize the scientific and grey literature (non-peer reviewed publications) available to describe potential water quality impacts from the proposed Project.

There has long been a concern about the contribution of septic tanks/drain fields, reuse/reclaimed water, and urban stormwater runoff on surface water contamination on and adjacent to the Outer Banks of North Carolina. One of the earliest studies in North Carolina was done in 1980 when Nierstedt, *et al.*, reported on the surface water quality-related concerns caused by septic tanks and related on-site wastewater systems. Since then, several publications in and around North Carolina have examined the issue as summarized below.

The overall conclusion from this literature review is that unless properly designed, installed, and maintained, there is a high likelihood of contamination of surface waters in some locations, especially from conventionally designed systems installed in the sandy soils of the Outer Banks with high water tables. In addition, urban stormwater runoff can also contaminate nearby surface waters, unless it too is properly managed. However, the literature and a related analysis done for this study indicates that more highly advanced septic tank/drain fields and reuse/reclaimed water systems with features such as advanced pre-treatment, nutrient removal, and other technologies will help to address most of these contamination issues. Finally, the science and engineering supporting the ability of urban stormwater management to control pollution is becoming increasingly more advanced. These more advanced designs for both wastewater and stormwater are discussed in Chapters 10 and 14, respectively.

6.2. Water Quality Issues in the Three PDAs

The Pasquotank River Basin Water Quality Plan (NCDWQ, 2007) provides a valuable overview of water quality issues in the study area and summarizes issues that are of concern with this cumulative impact study and literature review. The plan states that Subbasin 03-01-54 (generally the area east of Elizabeth City including the Currituck County Outer Banks) is experiencing rapid growth. This change in land use also changes the source of water quality stressors from primarily agriculture to increased impervious surface runoff and associated pollutants, ineffective sewage systems, and lawn fertilizer runoff. According to the NCDWR plan, “local government and agencies are encouraged to proactively plan, provide public education programs and implement conservation strategies to prevent water quality degradation.” The waters of Currituck Sound are classified by the North Carolina Environmental Management Commission (NCEMC) as “Class SC” (Aquatic Life, Secondary Recreation Salt Water) waters and are not open for commercial shellfishing. It should be noted that the coliform bacteria water quality standard for SC waters is less strict than for waters classified for commercial shellfishing.

The Mid-Currituck Bridge Reevaluation of the FEIS provides an up-to-date summary of water quality issues in the area. The Reevaluation of the FEIS states that “water quality of the Albemarle-Pamlico estuarine system is undergoing substantial degradation because of the area’s increasing population, changes in agricultural practices, and urbanization and industrialization of the region” and “Historic and present stressors to Currituck Sound include natural and anthropogenic fluctuations in nutrient loading, turbidity, and salinity” (NCTA, 2012; pages 3-34).

SAV is considered a Habitat of Special Concern by the North Carolina Wildlife Resources Commission (NCWRC) due to its high fisheries and wildlife value. The Reevaluation of the FEIS states that the "shallow waters (6 feet deep or less) of Currituck Sound provide habitat and potential habitat for extensive beds of SAV" (see pages 3-51). SAV has been studied in Currituck Sound for several decades and there has been a recorded increase in SAV from 2002 to 2012 (RK&K and CSA, 2020).

In the nearby Hatteras area, which is similar to the Currituck Sound, the Tar-Pamlico River Basin Plan (NCDWQ, 2010; see page 5.5) states that an overall decline in bacteriological water quality has occurred since "many of the septic systems are old and are installed in fill or coarse sand, allowing possible discharge to adjacent water via groundwater." This situation is similar to that reported by NCDWR for the Currituck Sound area.

According to these NCDWR reports, in general, the waters of Currituck Sound are presently in good condition but there are threats from development (stormwater runoff and sewage systems). In addition, SAV is of special concern in Currituck Sound.

6.3. Water Quality Issues Resulting from Septic Tanks/Drain Fields on Barrier Islands

There is little existing research related to the impacts of on-site wastewater treatment in the Outer Banks. However, researchers at East Carolina University (ECU) (Charlie Humphrey, Mike O'Driscoll, and Guy Iverson) and North Carolina State University (NCSU) (Jane Harrison and Jared Bowden) are currently working on a project to evaluate nutrient and bacteria treatment by different wastewater treatment systems (including septic systems) in coastal areas. They have three septic system sites in Nags Head (Dare County) which they have been monitoring for almost one year. They expect to have some preliminary results by early 2021, so data were not available for use in this study (Charles Humphrey, Associate Professor at ECU, personal communication, October 14, 2020). This research could provide useful information in formulating changes to current on-site septic system rules necessary to protect water quality in areas with sandy soils and high-water tables in coastal areas such as the Outer Banks PDAs.

As far back as 1975, the United States Environmental Protection Agency (USEPA) studied the impact of septic systems adjacent to shallow and linear navigation channels, otherwise known as finger canals, in North Carolina and Florida (USEPA, 1975). The USEPA introduced tracer dyes into septic tank systems 50 feet from finger canals in North Carolina and found that the dyes reached the canal waters in 4 to 60 hours. From this finding, USEPA concluded that this is not an adequate amount of time for pathogens to be removed or for "die off" nor for any significant nutrient removal to occur. In 1988, Cogger *et al.,* found that a separation of 60 centimeters (24 inches) from the septic drain field to the top of the seasonal high-water table provided for adequate microbial treatment and also resulted in complete nitrification, while a 30-centimeter (12 inches) separation was not adequate. Complete nitrification is necessary prior to reaching the water table so that denitrification can occur efficiently prior to groundwater beneath the septic system being transmitted to adjacent surface waters. Cogger *et al.,* reported that nitrate levels declined with distance and depth from the drain fields indicating that denitrification was occurring in these soils.

In 2011, Humphrey also reported that coastal areas with septic systems installed in sandy soils with a seasonal high-water table within 60 centimeters (24 inches) of receiving waters are most vulnerable

to *E. coli* bacterial groundwater contamination (Humphrey *et. al.*, 2011). Humphrey also noted that while increasing the vertical separation distance requirements could help protect coastal water resources by reducing densities of bacteria in shallow groundwater beneath septic systems, requiring such an increase in separation distance may result in the denial of permits that are currently approvable due to the presence of shallow water tables in many coastal settings. He further stated that alternative and advanced technology such as pretreatment may be options for sites with shallow water tables, but these systems are often more expensive initially, require more intensive maintenance and have higher long-term costs than conventional septic systems. Like Cogger *et al.*, in a 2010 paper, Humphrey also found that nitrification was more complete when a 60-centimeter (24-inch) separation to the water table was present (Humphrey *et. al.*, 2010).

O'Driscoll *et al.* (2014) concluded that, although nitrate inputs to septic systems caused elevated groundwater nitrate concentrations between the drain fields and the estuary, the majority of nitrate was attenuated via denitrification between the septic system and 48 meters (157 feet) to the estuary. Humphrey *et al.* (2014) reported that based on his research, on-site system setback regulations may have to be increased (>30 meters or 98 feet) in some areas to ensure that groundwater phosphate concentrations are reduced to background concentrations before discharging to surface waters (Humphrey *et. al.*, 2014).

The limited literature available seems to consistently report that a 60-centimeter (24-inch) separation beneath septic system drain fields and a seasonal high-water table, along with a 30-meter (98-foot) horizontal distance to surface waters, is necessary for on-site septic systems without pretreatment to minimize the chance for microbial and nutrient contamination of nearby surface waters.

As noted above, Nierstedt *et al*. (1980) reported on wastewater treatment options in Dare, Carteret, and Onslow Counties, which are all coastal counties in North Carolina, in terms of land application of wastewater, ocean outfalls, or outfalls to inland waters. In the Dare County area, land application to large sites such as golf courses was examined and recommended in some instances. In fact, some of these land application facilities have been installed since then and are still operating successfully. Ocean outfalls of treated wastewater were recommended as the main option to manage wastewater but to date, this has not been permitted by the State or the USEPA. The report notes septic tank failures are due to high water tables, poor soils, and poor maintenance of existing systems. This study did not address specific measures to improve the management of non-discharging systems.

Since then, several studies have been completed on the effect of septic tanks and their associated drain fields, as well as reuse/reclaimed water treatment systems, on the barrier islands in North Carolina. Cahoon *et al*. (2006) reported on shellfish bed closures due to elevated levels of fecal coliform bacteria in Brunswick County, North Carolina, near Calabash and Sunset Beach. They reported that stormwater runoff alone could not account for the fecal coliform contamination since there was no effect of rainfall on coliform concentrations. Instead, they attributed most of these shellfish closures to poorly performing septic systems, which was the most important source of fecal coliform contamination. They attributed this situation to high densities of septic tanks, steep slopes, and soils poorly suited for septic tanks, especially on the barrier island near Sunset Beach. They also implicated ditching and draining systems in densely developed areas. Finally, these researchers implicated urban stormwater runoff, unless there was effective stormwater management in terms of coliform bacteria pollution. It should be noted that Sunset Beach was developed starting in 1955, then

was incorporated in 1963, and now has 1,200 homes (Wikipedia, 2020). Therefore, it is unlikely that many of the septic tanks on the island are of advanced designs.

Mallin and McIver (2012) reported on the effect of urban runoff and septic leachate in the Cape Hatteras National Seashore. They found a significant correlation of concentrations of ammonium, phosphorus, and fecal coliform bacteria with seasonal community water use in the Nags Head area, indicating that increased septic tank usage led to increased pollutant concentrations in local waterbodies. They state that it is "imperative to utilize alternatives to standard septic systems to treat human waste" in coastal barrier island environments.

Similarly, Mallin (2013) reviewed the use of septic tanks in coastal environments (notably in North Carolina, Georgia, and Florida) and concluded that in these areas with high local water tables and soils with very rapid permeability, "standard septic tank systems are clearly inappropriate." He noted that septic tank densities of more than three tanks per acre with water tables less than one foot in depth were problematic in terms of contributing to increases in nitrogen, phosphorus, and bacteria in nearby waterbodies. Again, he suggested "alternative means of treatment such as mounds or small-scale treatment plants" to address water quality issues.

Reay (2004) studied the movement of inorganic nitrogen and phosphorus as well as coliform bacteria from three year-round residential sites with conventional septic tank/drain fields near coastal waters in Virginia. The drain fields were 20 meters (65.6 feet) from the tidal waters and located in sandy soils (86 to 90 percent sand) with relatively high-water tables (mid-tide at 0.5 to 2 meters or 1.64 to 6.56 feet). He found that inorganic phosphorus and coliform bacteria were quickly removed from the drain field and did not enter the intertidal waters. However, inorganic nitrogen was transported into the tidal environment at rates that were similar to row crops in the Chesapeake Bay Basin. Overall, he concluded that shallow water tables and porous sandy soils are especially problematic for nitrogen pollution to surface waters. He recommended developing improved siting criteria, alternative disposal systems that would remove more nitrogen, and vegetated buffers to address the nitrogen transport issue to coastal waters.

A recent analysis by the Chesapeake Bay Program (Tetra Tech, 2016) examined the models used to predict movement of total nitrogen from on-site wastewater treatment systems throughout the Chesapeake Bay as part of the effort to refine the nutrient model for the watershed. This report summarized that total nitrogen can be transported from on-site wastewater systems (mainly septic tanks and drain fields in this study) to downstream waters. Transport was higher through sandy soil than loamy or clayey soils. The final model predicted that nitrogen movement from on-site wastewater could be a significant source of nitrogen depending on factors such as soils, depth of the water table, and distance to the receiving water. The study also noted that nutrient removal by modern versus systems installed based on previous rules may be significantly different.

Finally, the Town of Nags Head has a free program for septic tank owners, the Todd D. Krafft Septic Health Initiative Program (Town of Nags Head, 2020), which provides free technical advice to septic tank owners to help maintain mainly older systems such as inspections and pumping and addressing questions from the public. This is an attempt to extend the functional life of older septic tanks to prevent water quality issues. Financial assistance is also available for repairs and replacement.

6.4. Water Quality Issues Resulting from Reuse/Reclaimed Water on Barrier Islands

There has been little published in the scientific literature or grey literature concerning the potential effect of reuse/reclaimed water on nearby surface water quality in the barrier island environment. A Master's thesis by Mahoney (2016) studied seven package plants on Bogue Banks of Carteret County, North Carolina and found that these facilities could contribute to nutrients being added to groundwater. Mahoney concluded that advanced nutrient treatment should be considered to reduce exports to ground and surface waters. These systems are designed not to have a surface discharge and have extensive surface and groundwater monitoring requirements, as described in Chapter 9. In general, if these systems are designed, installed, and monitored properly, surface water contamination should be minimal. The only possible exception might be soluble nitrogen (similar to soluble nitrogen from septic tanks discussed below). A more detailed analysis of these data in Chapter 9 confirms that more advanced reuse/reclaimed water systems can reduce the impact of nutrients on local groundwater and thereby nearby surface water.

6.5. Submerged Aquatic Vegetation and Septic Tanks

Li *et al*. (2007) reported on the effect of development on SAV in Chesapeake Bay sub-estuaries. SAV impacts have also been a concern in Currituck Sound although SAV survey data from 2003 to 2012 show an increase in SAV coverage (RK&K and CSA, 2020). In their study of Chesapeake Bay sub-estuaries, Li *et al*. (2007) found that SAV declines were highly correlated with land use. Using a statistical method to identify values that separated their data into two groups (change point analysis), they found that SAV abundance was strongly correlated with septic tank density, point source total nitrogen and total phosphorus, and the ratio of local watershed area to sub-estuary area. With respect to septic tank density, they reported that a density of greater than 39 tanks per square kilometer (0.16 tanks per acre) was a critical point in terms of SAV abundance.

6.6. Water Quality Issues Resulting from Stormwater Runoff-Related on Barrier Islands

Numerous beach closures are periodically reported for Outer Banks ocean beaches. For instance, a recent Google search (Google, 2020) found several reported swimming beach closures (October 3, 2015 – general beach closures; July 25, 2018 – Nags Head; May 7, 2019 – Colington beach closure; September 19, 2019 – Nags Head to Corolla closures; and September 16, 2019 – Outer Banks beach closures). Most of these are attributed to bacteria from urban runoff and are of concern to the State and local governments in addition to vacationers. Several local municipalities (for example, Nags Head) have active ongoing programs to identify and address these local sources of contamination from stormwater.

Several stormwater management studies have been initiated to evaluate flood risk and water quality impacts. Currituck County initiated a study in the Whalehead subdivision that identified local flooding locations and subsequently identified locations to pump stormwater to be managed properly rather than directly discharging the stormwater into Currituck Sound (M&N, 2010a). The study involved a detailed modeling of stormwater in the subdivision and an examination of various alternatives. Ultimately, the alternative to discharge stormwater to Sound side ponds (near Timbuck II and Corolla Light) was recommended to address the local flooding.

Also, a study of NCDOT stormwater outfalls, mainly in Dare County near Kill Devil Hills and Nags Head, was conducted to address both flooding and water quality (bacteria) issues from these outfalls

directly to the ocean. This work identified BMPs to address stormwater quality such as infiltration systems, bioretention devices, sand filters, and detention basins. Measures to manage the existing outfalls were also discussed (M&N *et al*. 2016a). Finally, the Town of Emerald Isle (M&N, 2019a) implemented a project to direct stormwater flow into existing freshwater wetlands for assimilation and treatment. The results of three years of biological and water quality monitoring documented that stormwater had no effect on these wetlands. Practical, effective stormwater and flooding management has been implemented in coastal communities, including the Outer Banks but require intensive study and design.

6.7 Finger Canals and Concerns for Water Quality

Finger canals are artificial channels typically constructed to provide waterfront access for residential development in coastal environments. Most finger canals in existence along the North Carolina coast are historical in nature and would not be allowed today; CAMA rules, as well as water quality-related regulations enforced by NCDWR, have mostly prevented new finger canal construction in coastal North Carolina for at least the last 25 years (personal communication, Doug Huggett, retired NCDCM manager of the Major Permits Section, February 16, 2021).

In the Non-Road Accessible Outer Banks PDA, finger canals are present in the Carova Beach area and appear to have been constructed prior to the 1960's to the 1970s, based on the construction dates of nearby homes (Chapter 8 of this report). Approximately 6.5 miles (total length) of finger canals are present in the Carova Beach area with approximately 582 parcels platted adjacent to the canals. Approximately 26% of those parcels contain existing residential development.

Water quality in the Currituck Sound finger canals is influenced by a number of factors. Muted lunar tidal variations (less than 0.1 meter [4 inches] in Currituck Sound (Moran, 2012) may contribute to a reduced amount of flushing and longer residence times in finger canals located along the shoreline, thereby affecting water quality in these waterbodies. Wind-driven tides are probably the main influence on flushing these canals, but these tides occur irregularly. Local stormwater probably has a minor effect due to the muted relief in the area. Adequate flushing in the Carova Beach finger canals is further exacerbated by the fact that the area only has two discharge locations into Currituck Sound, potentially extending the residence times or waters in these channels.

Finger canals have been long documented to have water quality issues, especially for nutrients and bacteria. For instance, water quality work completed in Florida in 1997 on a series of finger canals showed that 83% of the samples taken during the study had excessively high *Clostridium perfingens* or coliform bacteria levels (Barda and Partington, 1972, reprinted 1977). Also, an in-depth study of finger canals near Pine Knoll Shores, North Carolina in 2012 found high levels of nutrients, especially ammonia, in these finger canals mainly due to stormwater and groundwater sources (Institute for the Environment, 2012). However, this study found no evidence of eutrophication in the canals, probably as a result of adequate flushing and relatively short residence times of water in the canals. The USEPA also studied the impact of septic systems adjacent to shallow and linear navigation channels (essentially finger canals) in North Carolina and Florida (USEPA, 1975). In North Carolina, the USEPA introduced tracer dyes into septic tank systems 50 feet from finger canals and found that the dyes reached the canal waters in approximately 4 to 60 hours. From this finding, USEPA concluded that this is not an adequate amount of time for nutrients or pathogens to be removed.

Management of these water quality issues is a challenge, especially in finger canals such as those around Carova Beach that have minimal tidal flushing. Regulatory controls may be necessary to mitigate potential pollution concerns. For example, Florida will soon begin implementing a Total Maximum Daily Load (TMDL) for coliform bacteria for finger canals in the Los Olas Isles area of Broward County (Florida Department of Environmental Protection, 2012). Adjacent lands along these Florida canals appear to be completely developed (residential); fecal coliform is coming from stormwater runoff, boat sewage discharges, and perhaps leaky sewer lines (Florida Department of Environmental Protection, 2012). To be in compliance with TMDLs, development will be required to implement controls or management strategies to curtail or contain runoff. In the future, North Carolina may need to re-visit this issue as well in areas such as Carova Beach.

6.8 Summary

Traditionally designed septic tanks can contribute to surface water pollution (most notably nutrients and bacteria) especially when designed and installed in highly porous soils that are also in areas with high local water tables. There has been little research on the potential effect of reuse/reclaimed water systems on surface water quality, although this issue is further examined by the data analysis in Chapter 9. In addition, several of these publications explicitly discuss the ability of advanced treatment systems to address these issues. Also, urban stormwater runoff can contribute to surface water pollution, especially bacterial pollution. Chapter 19 explicitly addresses these issues and provides considerations for NCDWR (which permits reuse/reclaimed water systems) and Currituck County (which permits on-site wastewater treatment like septic tank/drain fields) to help implement advanced treatment technologies if required on the Outer Banks of Currituck County to address the impact of on-site treatment. Finally, a recent U.S. Supreme Court case determined that wastewater discharged from an injection well into groundwater could require a National Pollutant Discharge Elimination System (NPDES) discharge permit if the discharge is "functionally equivalent" to a direct discharge to navigable waters (*County of Maui, Hawaii v. Hawaii Wildlife Fund*, 2020). The Court explicitly left it up to other courts to define "functionally equivalent" but also explicitly mentioned that septic tanks and drain fields were probably not included in this category. Obviously, the NCDWR will have to factor this case into their decision-making regarding wastewater permitting as the interpretation of this court decision evolves over time. Based on available literature, urban stormwater runoff is known to result in pollutants entering surface waters and this issue is further addressed in Chapters 14 and 19.

7. Geographic Information System Analysis

7.1. Purpose

The purpose of this chapter is to present the GIS spatial analysis utilized to determine the development potential of three PDAs in Currituck County, North Carolina for the Mid-Currituck Bridge as defined in Chapter 5. The results of this analysis approximate how much planned and expected development could occur as a result of the construction of the Project (Figure 4) within these PDA areas, as compared to the No Build Alternative. Since this is a regional planning level study, this analysis does not necessarily indicate that the specific parcels identified will be developed as a result of the Selected Alternative in the 20-year time frame of this study, but rather captures the general pattern and potential extent of projected development. This analysis quantifies which land is still available for planned and expected development in the three PDAs based on data available at the time of this study (Figure 4).

7.2. Background

The three PDAs were determined as described in Chapter 5 of this report. The Non-Road Accessible Outer Banks PDA is located from the north end of the paved section of NC 12 to the North Carolina/Virginia border on the Outer Banks of Currituck County. The Road Accessible Outer Banks PDA is located from the Currituck/Dare County line to the south end of the Non-Road Accessible Outer Banks PDA also on the Outer Banks of Currituck County. The U.S. 158 Interchange PDA is located west of the other two PDAs on the mainland of Currituck County along U.S. 158. It should be noted that the substantial protected areas of the Currituck National Wildlife Refuge and the Currituck Banks Estuarine Reserve were excluded from the Non-Road Accessible Outer Banks PDA because future development would be prohibited in these areas. Therefore, area calculations of this PDA do not include these large, protected zones of natural habitat. Eight development criteria were assessed to determine the potential land suitability of the three PDAs. When deciding if a parcel has future development potential, the following factors were examined in this order based on development suitability or limitations in the GIS analysis:

1. Existing development on the property,
2. Size of the parcel,
3. Areas managed for conservation,
4. Open space designations,
5. Estuarine wetland presence,
6. Shoreline setback regulations,
7. Freshwater wetland coverage, and
8. Soil suitability for septic tanks.

A “developable parcel” in the context of this report is defined as a platted parcel from Currituck County that is not prohibitively constrained by any of the eight factors listed above. Each parcel was evaluated using the eight development criteria to determine developability based on current land use, existing environmental conditions, current development rules/regulations, and existing state of

development. Developable parcels were identified by a sequential process to approximate the number of parcels without existing development (based on the 2016 aerial) which could potentially support future development. Parcels deemed undevelopable were excluded from this study because developing such parcels would involve extensive efforts to comply with current development rules and regulations. This assessment does not necessarily imply that these parcels are entirely undevelopable, but rather they are not readily developable because of current parcel site constraints. Since this is a regional planning effort, this approximation is not intended to be a precise number or location of parcels that would develop in the 20-year time frame for this study.

The Non-Road Accessible Outer Banks PDA is approximately 4,873 acres in size, the Road Accessible Outer Banks PDA is approximately 4,102 acres in size, and the U.S. 158 Interchange PDA is 282 acres in size. Parcel data (updated as of June 2020) for Currituck County was downloaded from NC OneMap and clipped to the three PDA boundaries. The term “parcel,” also referred to as “lot”, reflects polygon boundaries that indicate land ownership (NC OneMap, 2020). When the PDAs were established, the Currituck National Wildlife Refuge and the Currituck Banks Estuarine Reserve were not included because development will not take place in these federally protected areas, resulting in a non-contiguous Non-Road Accessible Outer Banks PDA (Figure 4). The Non-Road Accessible Outer Banks PDA contains 3,378 developed and undeveloped parcels, the Road Accessible Outer Banks PDA contains 5,242 developed and undeveloped parcels, and the U.S. 158 Interchange PDA contains 15 developed and undeveloped parcels. Satellite aerial imagery, dated 2016, the most current imagery available for Currituck County, was downloaded from NC OneMap to aid in the parcel analysis (NC OneMap, 2016).

Figure 4: Locations of the Three Probable Development Areas and Protected Conservation Areas

7.3. Existing Development

Determining the presence of existing development was the first step in identifying parcels suitable for future planned and expected development. For this study, a developed parcel was considered as having one or more residential, commercial, or recreational structures. Therefore, if a parcel has existing commercial or residential development, it no longer has development potential for this analysis. The potential for re-development of existing developed areas is addressed in Chapter 16 of this report. Commercial or residential development includes neighborhoods, shopping malls, and other similar land uses. Existing development was determined by utilizing the parcel use description found within the parcel dataset (NC OneMap, 2020). The category "Residential Improved" indicates residential homes, and these were selected and marked as not developable. Other parcel use descriptions, such as "'Office BLDGS 1 to 2 stories" and "Restaurant/Cafeteria and/or Bar," were helpful in identifying already commercially developed areas.

7.4. Size of Parcel

After studying the existing development in the study areas, it was determined that approximately 5,000 square feet of suitable land space is necessary to properly develop a coastal parcel (Doug Huggett, formerly NC Division of Coastal Management program manager, personal communication, June 10, 2020). The decision to use a threshold of 5,000 square feet was made utilizing Currituck County and Dare County GIS maps to analyze existing platted parcel sizes in an effort to estimate the average minimum available size needed to develop a parcel, when factoring in adequate space for the main structure, parking, and space for septic systems. There are few platted parcels less than 5,000 square feet, with many of the remaining undeveloped tracts being equal to or greater than 5,000 square feet. Therefore, the assumption was made that if at least 5,000 square feet of developable space existed on a parcel, the parcel could be reasonably expected to be developed.

To eliminate parcels that did not fit the size requirement of 5,000 square feet, the calculate geometry feature was used in GIS to find the square footages of all the parcels. The NAD 1983 State Plane North Carolina FIPS 3200 (U.S. Feet) coordinate system was used. A select by attributes query was performed to select the parcels whose square footage was below 5,000. Approximately 734 parcels were selected, and these parcels were marked as not developable. Approximately 503 of the 734 parcels have already been developed, even though they failed to meet the criteria for this analysis, and therefore would also be ruled out for future development potential due to existing structures. Approximately 75 of the 734 parcels are reserved for open space or public utility use, which would also exclude them from development regardless of their size.

7.5. Areas Managed for Conservation

Data from the North Carolina Natural Heritage Program (NCNHP) were used to locate areas that are reserved for conservation (NCNHP, 2020). For example, part of the Currituck National Wildlife Refuge overlaps the PDAs, as does the Currituck Banks Estuarine Reserve, as well as land owned and managed by the NC Audubon Society. Land that was designated as "managed for conservation" was determined not to have future development potential.

7.6. Open Space

The phrase "Open Space" for parcel use designation in the NC One Map (2020) includes many different types of land resources. Some examples include, but are not limited to, vacant parcels owned by homeowner associations, vegetative buffer areas, beach access areas, and recreational facilities (NC OneMap, 2020). The various land use types under the Open Space category were examined and were determined not to be developable.

Parcel data attributes were queried to locate parcels with a designation of Open Space. The parcels labeled "Open Space" based on this analysis were confirmed by the Currituck County staff on July 17, 2020. Open Space parcels were defined as not developable.

7.7. Estuarine Wetlands

The presence of estuarine wetlands was examined using NC Coastal Region Evaluation of Wetland Significance (NC CREWS) data from the North Carolina Department of Environmental Quality (NCDEQ) (NCDEQ, 1999). A parcel containing estuarine wetland types, including salt/brackish marsh, maritime forest (NC CREWS identifies maritime forest as a wetland type and for the purpose of this analysis, it was grouped with estuarine wetland types), estuarine forest, or estuarine shrub scrub, that also did not have at least 5,000 square feet of upland was considered not developable. The NCDCM does not allow fill of estuarine wetlands for any non-water dependent purpose such as development (North Carolina Coastal Resource Commission (NCCRC), 2020a, 2020b). Rather, permits are allowed only for water dependent activities such as docks, piers, and marinas. Permits may also be obtained for development on parcels containing freshwater wetlands. The process for analyzing parcels containing freshwater wetlands is described in section 7.9 below.

In order to locate the parcels that contained NC CREWS estuarine wetlands, a select by location query was performed in GIS to select the parcels that intersected with the NC CREWS estuarine wetlands layer. The selected parcels were then analyzed to determine if they still meet the minimum size criterion necessary for development (5,000 square feet of upland). The parcels that did not meet this criterion were marked as not developable.

7.8. Oceanfront Shoreline Setbacks

According to regulations set in place by the CAMA (1973), development cannot take place on a shoreline parcel in front of the first line of stable vegetation (NCDEQ, 1973). The CAMA law has a variety of rules mandating the required distance behind the first line of stable vegetation for any proposed development. This study uses a setback of approximately 60 feet, derived from 15A NCAC 07H.0306(a)(5), which establishes minimum setback requirements for any project located within an Ocean Hazard Area of Environmental Concern (AEC). Minimum setbacks are based on both the floor area of a proposed structure, as well as the established long-term annual erosion rate for a particular oceanfront area. However, in most cases, 60 feet is the minimum distance that a structure must be set back from the vegetation line. Shoreline parcels were marked as developable if they had at least 5,000 square feet of suitable land that was situated more than 60 feet behind the first line of stable vegetation, as visible on the 2016 aerial imagery.

Beginning at the Currituck/Dare County line, each undeveloped ocean shoreline parcel was examined to determine if at least 5,000 square feet of developable land was available with a setback of at least 60 feet behind the visible, stable line of vegetation. The line measurement tool in GIS was utilized in

this analysis at a scale of 1:2,000. At least two GIS analysts made the determination separately to increase the accuracy of the analysis. Parcels that did not meet the criteria of at least 5,000 square feet of developable land situated 60 feet behind the first line of stable vegetation were determined to not have development potential and, therefore, were not included in further analysis.

7.9. Freshwater Wetlands

Freshwater wetlands, as defined by NC CREWS, were ground-truthed in the field to determine the accuracy of the NC CREWS data. Freshwater wetlands are subject to relevant state and federal regulatory processes, though some development can occur under various permitting scenarios. The following freshwater wetland types are found within NC CREWS data in the PDAs: bottomland hardwood or riverine swamp, cutover wetlands, depressional swamp forest, drained wetlands, freshwater marsh, hardwood flat, headwater swamps, human impacted wetlands, managed pinelands, and pine flats. The process by which freshwater wetlands were assessed is described in detail below.

In order to determine the accuracy of NC CREWS freshwater wetlands data within the PDAs, and then to incorporate that accuracy into this analysis, Waters of the United States (WOTUS) determinations were performed in the field beginning August 4 through August 7, 2020 using the USACE -Wilmington District standard USACE wetland delineation method and the appropriate Coastal Plain Regional Supplement (USACE, 2010). Prior to performing the freshwater wetland assessment, the number of potentially developable parcels in the three PDAs was 2,880. Since wetland delineations could not be conducted on each of the 2,880 parcels for this regional planning study, a sampling procedure, as described below, was developed to determine which sites to visit in the field.

The U.S. 158 Interchange PDA, on the mainland of Currituck County, contained six developable parcels. All six parcels were visited in the field and results were compared to the location of the freshwater wetlands identified on NC CREWS mapping.

The Non-Road Accessible Outer Banks PDA contained 2,221 potentially developable parcels, not considering possible freshwater wetland constraints. According to NC CREWS, 431 of these parcels contained freshwater wetlands, and 1,790 parcels did not. Due to limited access and the large number of parcels, transect sampling was utilized in this area to determine which parcels would be visited during field work (see Figure 5 for an example of the transects and selected parcels). The length of the ocean shoreline in this study area is approximately 49,000 feet. The ocean shoreline length was divided by the number of desired transects (15) to yield a sampling interval of approximately 3,200 feet. The decision to use 15 transects was made based on the number of parcels that could be visited within the amount of time allocated to this field effort. A random number between 1 and 3,200 was selected to determine the number of feet north of Corolla that the first transect would be placed. The first transect was placed approximately 2,700 feet north of Corolla, and the subsequent transects were placed approximately every 3,200 feet northward toward the Virginia/North Carolina state line. Transects 2 and 3 did not intersect developable parcels. To yield a sufficient sample size, the location of transect 2 was moved south about 1,200 feet and transect 3 was moved north about 400 feet. This ensured that these two transects intersected at least one developable parcel. In each of the other 13 transects, a systematic sample of three parcels was performed. Using this sampling process, a total of 78 parcels were selected for wetland verification. Access to transects in the Non-Road Accessible Outer Banks PDA was mostly from the beach. Localized vehicular and pedestrian reconnaissance

was performed to gain access to sites along each transect. Parcels were located along the transect using a Geo7x Trimble Global Positioning System (GPS) unit, and staff performed a site inspection at each parcel using the Wilmington District standard USACE wetland delineation method and appropriate Coastal Plain Regional Supplement (USACE, 2010).

The Road Accessible Outer Banks PDA contained 653 developable parcels before freshwater wetland and soil suitability constraints were considered. This region contains paved roads which allowed for easier access to these parcels. The parcels in this region were split into two sampling categories:

1. Parcels that contain freshwater wetlands according to NC CREWS data, and
2. Parcels that did not contain freshwater wetlands according to NC CREWS data (i.e., upland parcels).

Parcels in each category were numbered using an east to west pattern across the peninsula beginning at the southern-most point of the Road Accessible Outer Banks PDA and working towards the end of NC 12. As a result, 187 parcels were identified with freshwater wetlands and 466 parcels without freshwater wetlands.

A statistical design was implemented to conduct on-site wetland evaluations on 20 parcels with NC CREWS freshwater wetlands and 10 parcels without NC CREWS freshwater wetlands (see Figure 6 for an example of parcels selected for sampling). This allocation was based on the assumption that parcels mapped by NC CREWS as having wetlands are more likely to actually support wetlands since estimating the rate and numbers of parcels with wetlands was the main objective of this study. A sampling interval of 9 was used for parcels with wetlands. This sampling interval was chosen to yield the desired number of samples by dividing the number of parcels with NC CREWS wetlands (187) by the desired number of samples (20). A number between 1 and 9 was selected using a random number generator to determine the first parcel. The first parcel chosen was parcel number 3. Subsequent parcel numbers were taken at intervals of 9, to yield the desired sample size. This same procedure was used for the parcels identified without wetlands, with a sampling interval of 47 (466 parcels divided by 10) to yield a sample size of 10 parcels (see Figure 5 for an example).

After the field verification visit, a statistical analysis was performed to determine the accuracy of the NC CREWS freshwater wetlands data. The analysis determined that of the 38 sites reported to contain wetlands in NC CREWS, 15 parcels, or approximately 40% were found to actually support freshwater wetlands in the field. Of the 34 sites reported to be completely upland, 32 parcels, or approximately 94% of those were found to be accurate and contain only uplands. This information was used to calculate the number of developable parcels in the three study areas. It was estimated that 60% of the parcels mapped as containing freshwater wetlands are developable, and 94% of the parcels that are mapped as upland are developable. These accuracy rates were then used to adjust the number of parcels defined as developable using the other criteria.

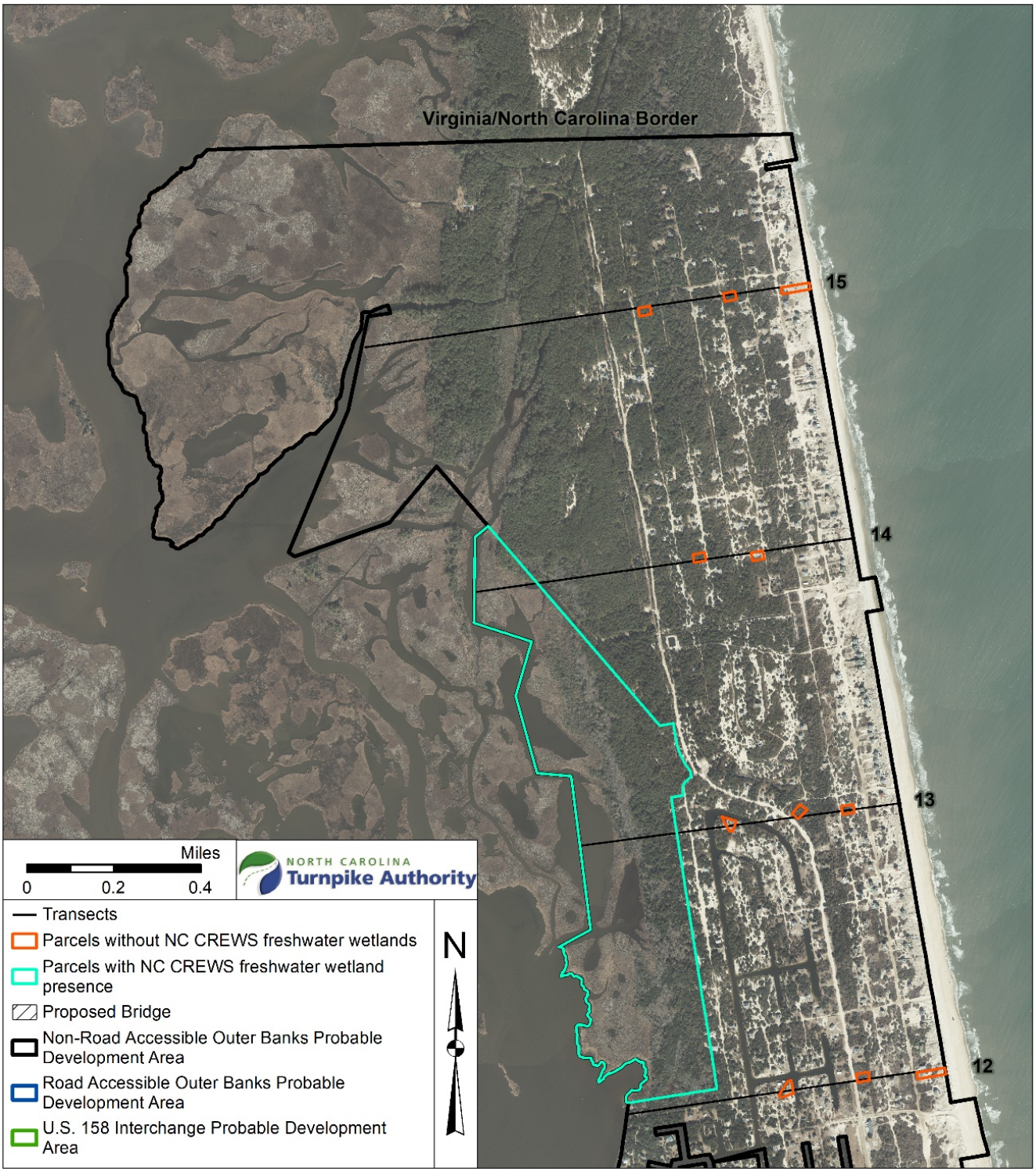

Figure 5: Representative Example of the Transects Drawn for Sampling in the Non-Road Accessible Outer Banks PDA

Figure 6: An Example of the Field Parcels in the Road Accessible Outer Banks PDA Chosen Using the Sampling Procedure Outlined in the Report

7.10. Soil Suitability

Given that approximately 83% of the undeveloped parcels identified in the PDAs, especially in the Non-Road Accessible Outer Banks PDA, would require individual septic tanks to be developed, the suitability of the parcels' soils for septic tank installation was evaluated. Parcels that would require on-site septic systems but did not contain suitable soil types were considered undevelopable.

Soil suitability criteria were developed in collaboration with soil scientists from the Project team using the U.S. Natural Resources Conservation Service Web Soil Survey (NRCS, 2019). A list of soil series that occur within each PDA was evaluated by soil scientists to define a preliminary suitability ranking for septic tank installation as follows: suitable, usually suitable, marginally suitable, and unsuitable based on set criteria outlined in the Soil Survey (see Chapter 10). Results are listed in Table 1. Soils were mapped based on their suitability ranking, and parcels that do not have at least 5,000 square feet of suitable, usually suitable, or marginally suitable soil were marked as not developable. Approximately 406 parcels in the Road Accessible Outer Banks PDA were not considered in this part of the evaluation since they fall within the service area boundaries of an existing non-discharging, wastewater facility (Figure 7) and, therefore, would not need a septic tank in order to be developed. The approximate service area boundaries of existing wastewater facilities were obtained from Currituck County (Eric Weatherly, P.E., County Engineer, July 15, 2020). The parcels that would require an on-site septic tank were provided by the Albemarle Regional Health Service (ARHS) to soil scientists on the Project team. Field work was performed to examine a sample of these parcels in the fall of 2020. The methodology and results of this field work is detailed in Chapter 10.

A list of the developable parcels that would require a septic tank in the Non-Road Accessible Outer Banks PDA was provided to Currituck County (approximately 2,400 parcels). Currituck County staff were then able to provide septic tank permitting data for 246 parcels on that list (Sandy Evans, Management Support Secretary, Albemarle Regional Health Services, personal communication, October 2, 2020). This information was used to adjust the number of developable lots which likely could not receive a traditional septic tank permit using the County's review and approval methodology (see Chapter 10 for a description of this process). As noted above, ARHS staff provided 246 septic tank permit reviews from 1990 to 2020 for this analysis. Of these 246 permits, 25 were not approved for septic tank installation, which yields a non-approval rate of 10.2%. This percentage was used to adjust the number of developable parcels that had been identified after the analyses discussed in Sections 7.3-7.9 of this report. Approximately 2,496 parcels were identified as developable prior to the assessment of soil suitability constraints. A total of 406 parcels in the Road Accessible Outer Banks PDA are within the service area of an existing wastewater facility, and so would not require on-site septic. Of the remaining 2,090 parcels, 89.8% would likely be approved for septic tank installation (10.2% would not). This calculation yields 1,877 parcels suitable for on-site septic systems, and 406 parcels serviced by an existing wastewater facility.

Table 1: Septic Tank Suitability Categories for the Soil Mapping Units Found in the Three PDAs

Soil Series	Suitability
Augusta fine sandy loam	Usually Suitable
Beaches Newhan Association	Suitable
Bojac loamy fine sand, 0-3% slopes	Suitable
Corolla-Duckston complex, 0-6% slopes	Marginally Suitable
Corolla fine sand, 0-6% slopes	Usually Suitable
Currituck mucky peat	Unsuitable
Dragston loamy fine sand	Usually Suitable
Duckston fine sand	Unsuitable
Dune land	Suitable
Dune land-Newhan complex, 2-40% slopes	Suitable
Munden loamy sand	Usually Suitable
Newhan-Corolla complex, 0-10% slopes	Usually Suitable
Newhan fine sand, 0-10% slopes	Suitable
Osier fine sand	Unsuitable
Ousley fine sand, 0-6% slopes	Usually Suitable
Portsmouth fine sandy loam	Suitable
State fine sandy loam, 0-2% slopes	Suitable
State fine sandy loam, 2-6% slopes	Suitable
Tomotely fine sandy loam	Unsuitable
Wasda muck	Unsuitable
Water	Unsuitable

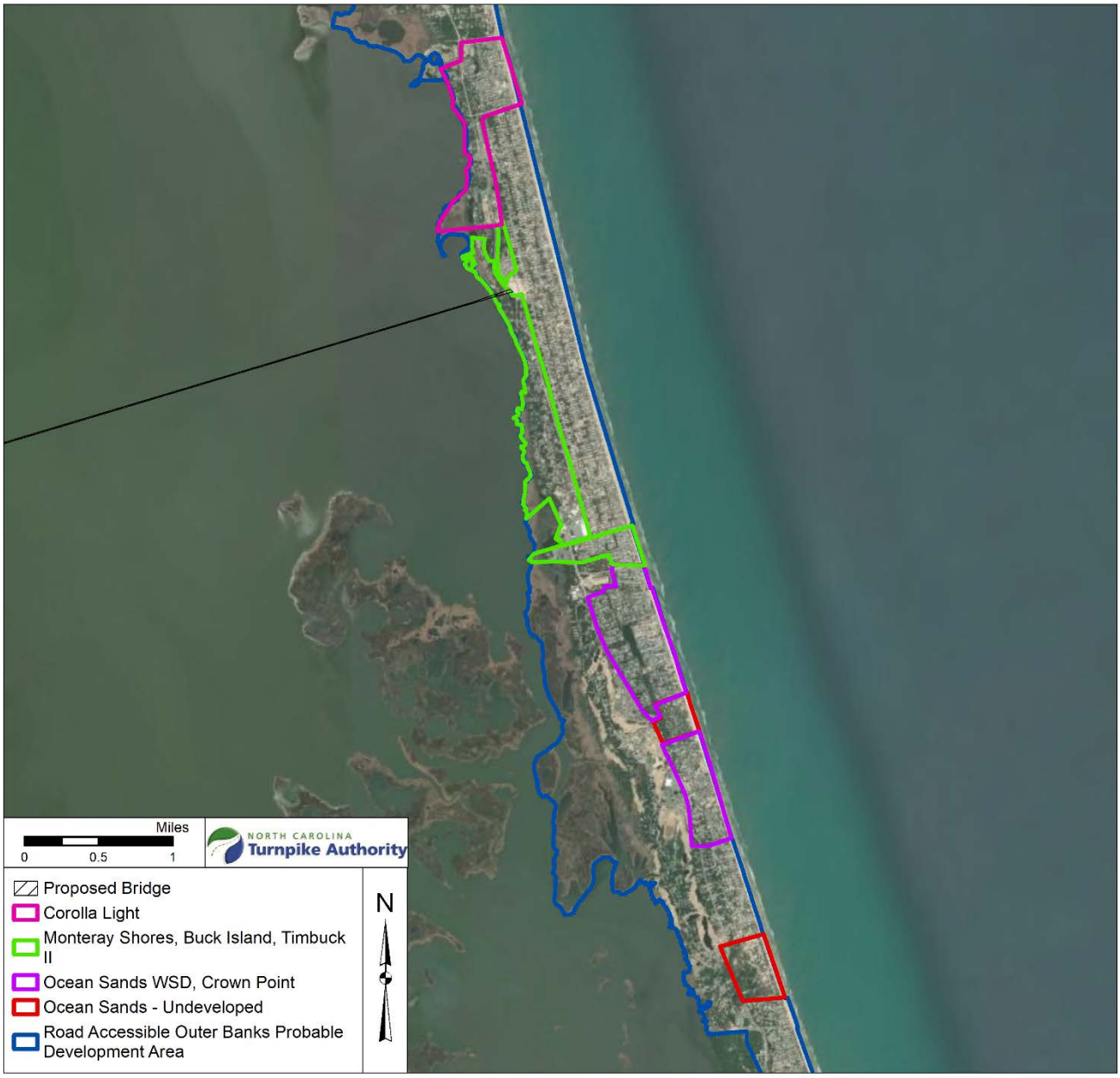

Figure 7: Wastewater Service Area Boundaries

7.11. Large Developable Parcels in the Road Accessible Outer Banks PDA

There are two relatively large, undeveloped parcels in the Road Accessible Outer Banks PDA (Parcel # 126A0000000000G and 126A0000000000T) which total approximately 117 acres (Figure 8). According to Currituck County, the development of these two parcels is the subject of a 1984 settlement agreement between the property owner and Currituck County (Laurie LoCicero, Currituck County Planner, personal communication, September 22, 2020). When the owner is ready to develop these parcels, the County will be allowed to add the wastewater flow from these parcels to the existing Ocean Sands wastewater treatment plant, per the settlement agreement. According to the

County, the agreement contains the following provisions for these parcels with respect to future development:

1. Parcel 126A0000000000G: approximately 275 residential units (multifamily or single family), 250 hotel rooms, and 50,000 square feet of commercial development.
2. Parcel 126A0000000000T: approximately 350 multifamily units, 1,000 hotel rooms, and 100,000 square feet of commercial development.

Development on these parcels to the maximum amounts allowed under the settlement agreement would be considered a challenge. According to the Currituck County Planner (Laurie LoCicero, Currituck County Planner, personal communication, September 22, 2020), it is unlikely that these development types would completely occur since any proposed projects would have to meet current stormwater management requirements, which are likely to utilize portions of the parcels. The wastewater treatment facility at Ocean Sands does appear to have the capacity to accommodate the expected wastewater for these developments. However, the County indicated that the level of treatment at the Ocean Sands facility may need to improve, which would be an issue for the non-discharge permit issued by the NCDWR for this facility. This issue is discussed in Chapters 9 and 19.

7.12. Summary

The GIS analysis outlined in this Chapter identified approximately 2,283 out of 8,365 parcels within the three PDAs as having a potential for planned and expected development based on eight development criteria. A map of these parcels can be found in Appendix 2. However, it is not expected that all of these parcels would develop in the 20-year time frame of this cumulative impact study. There are approximately 1,742 developable parcels in the Non-Road Accessible Outer Banks PDA, 535 developable parcels in the Road Accessible Outer Banks PDA, and six developable parcels in the U.S. 158 Interchange PDA. This cumulative impact assessment is a regional planning effort and, therefore, the number of parcels identified as developable in the three PDAs should be considered an approximation. In addition to the 2,283 existing parcels that have potential for planned and expected development, there are an additional 1,825 residential units that are planned but may not fully develop on the two large parcels near the Ocean Sands wastewater treatment plant in the Road Accessible Outer Banks PDA. The settlement agreement requires the County to accept wastewater from these parcels once they are developed (Laurie LoCicero, Currituck County Planner, personal communication, September 22, 2020) although the southernmost parcel appears to be outside the approximate service area for the Ocean Sands WWTP as it is currently identified (Figure 8).

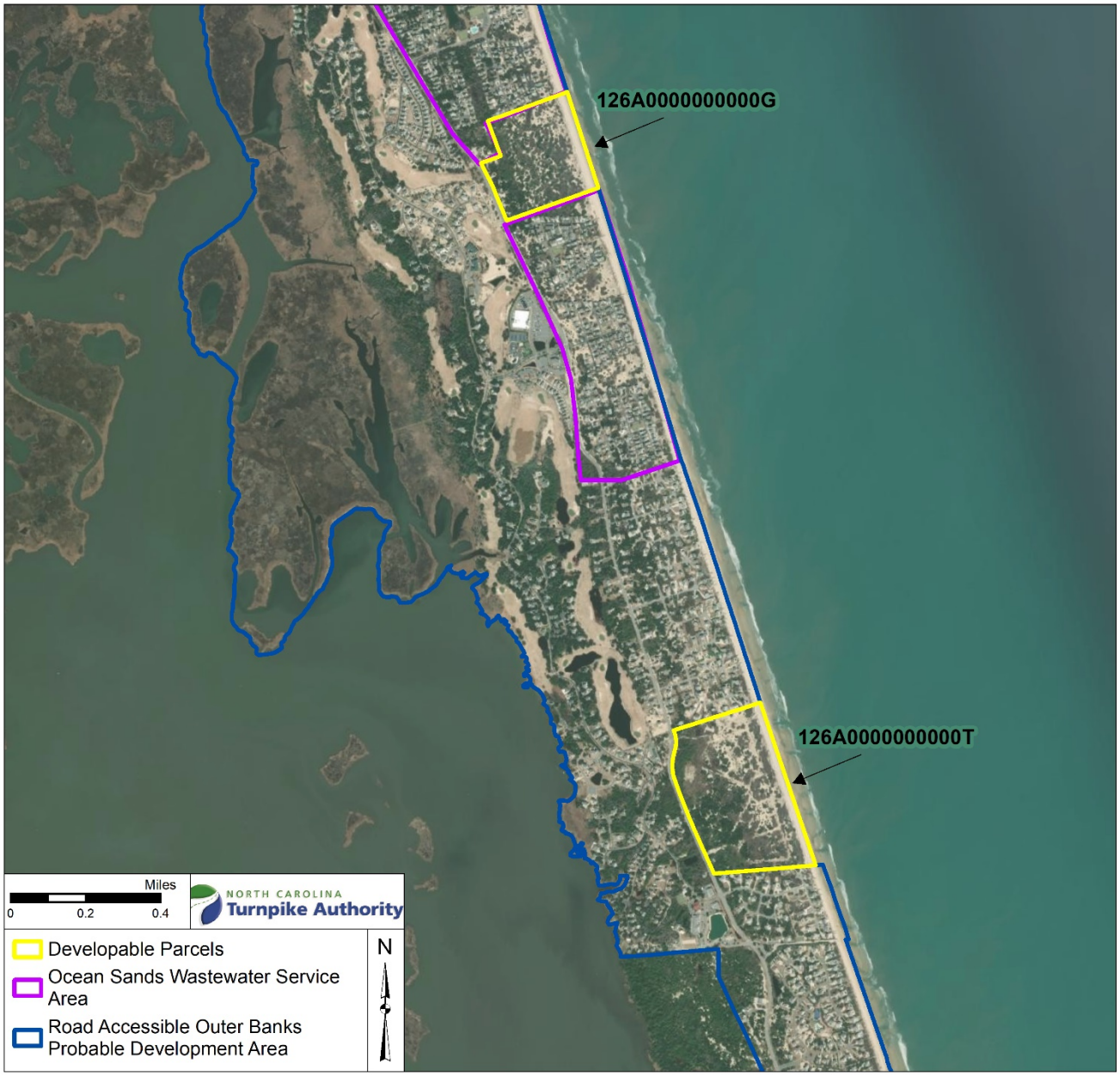

Figure 8: Two Large Developable Parcels that would Fall Within the Ocean Sands Service Area upon Development

8. Revised 2040 Growth Forecasts and Impervious Surface Estimates: No-Build Alternative and Build Alternative

8.1. Purpose

The purpose of this analysis is to compare the overall planned and expected development in the 20-year time frame for the indirect and cumulative impact analysis for the Mid-Currituck Bridge Project between the 2040 Build and the No-Build Alternatives as compared to the 2020 existing conditions. This comparison was conducted for the projected development outlined in the Final Environmental Impact Statement (FEIS) (USDOT, FHWA, and NCTA. 2012; USDOT, FHWA, and NCTA. 2019a and 2019b) for each of the three Probable Development Areas (PDAs) related to the project. The projected development for the Non-Road Accessible Outer Banks PDA was updated based on current development trends in the current study. This analysis also compares existing and projected impervious surface coverage for the No-Build and Build Alternatives for each PDA. The goal of this assessment is to provide a reference for comparing the scale of the potential water quality effects of the Mid-Currituck Bridge Project to the No-Build Alternative with respect to stormwater runoff.

8.2. Literature Review

A key general metric used to predict water quality is the percent of a particular watershed or drainage area covered by impervious surface. Several researchers have determined that stream degradation can occur when impervious coverage reaches 10% to 15% (Schuler, 2000), but other researchers reported impacts on fish communities at levels as low as 8% to 12% (Wang, *et al.* 2001). This impact is caused by increases in stormwater-derived pollutants and altered hydrographs that occur with increases in impervious surface coverage (Poff, *et al.* 2006; Scott, *et al.* 2002; Surasinghe and Baldwin, 2015; Wenger, *et al.* 2009). In addition to the general coverage of impervious surfaces across entire watersheds, increased levels of impervious surfaces can pose water quality problems on more localized drainages as well as within sensitive locations for water quality. For this reason, it is important to examine percent impervious coverage at various geographic scales. Thresholds of 8% and 12% impervious surface coverage were used in this analysis to compare potential development impacts between the Build and No-Build Alternatives as identified in Chapter 16 of this report.

8.3. Methodology

To better understand the planned and expected development likely to occur over the next 20 years, GIS was used to determine the proportion of expected parcel development and its associated percent impervious coverage for the No-Build and Build Alternatives compared to existing conditions. As noted above, percent impervious surface is a useful indicator for the potential water quality effects of development on stormwater (Wenger, et al. 2009; and Schuler, 2000). GIS was used to approximate the existing percent impervious surface for each PDA using the following procedure.

- GIS data were retrieved from the USA National Land Cover Database (NLCD) Impervious Surface Time Series data from ArcGIS Online (USA NLCD Impervious Surface Time Series (arcgis.com)) and the data were incorporated into the Working MXD file on ArcGIS Desktop.
- The Time Series (2001-2016) data show the percent imperviousness of USA land surfaces produced by the Multi-Resolution Land Characteristics Consortium for the NLCD in ranges in the following categories: <1%, 1-19%, 20-49%, 50-79%, 80-100% and No Data. The Time Series data was in raster form. The raster file was clipped to the boundary of each PDA. Then

the raster to polygon tool was used to transform the raster to a vector polygon shapefile. An area field was added to the attribute table for the new polygon shapefile and the calculate geometry tool was used to calculate the area in acres. Finally, the attribute table was copied to an Excel spreadsheet and summarized by acreage for each percentage point of imperviousness.

To update development trends in the Non-Road Accessible Outer Banks PDA, the reported build dates of existing structures were collected from Currituck County parcel data for the 767 currently developed parcels in this PDA (Table 2). These data showed that from 1971, an average of 15 homes were constructed per year in this PDA (average annual growth rate of 6.0%). However, that rate peaked between 2001 to 2010 at a rate of 26 homes per year and then decreased to 12 homes per year from 2011 to 2020 (an average annual growth rate of 1.7%). No homes have been recorded as constructed in 2019 or 2020, which shows that construction in this PDA has indeed slowed. These development trends were considered in updating the number of homes with the Build and No-Build Alternatives in this PDA as shown in Tables 4 and 5.

Table 2: Development Trends and Locations in the Non-Road Accessible Outer Banks PDA

Year Constructed	First Row Oceanfront	Second Row Oceanfront	Waterfront	Other	Total
1900-1910	0	0	1	0	**1**
1911-1920	0	1	0	0	**1**
1921-1930	0	0	0	0	**0**
1931-1940	0	0	1	0	**1**
1941-1950	0	0	2	0	**2**
1951-1960	0	0	4	4	**8**
1961-1970	0	0	6	19	**25**
1971-1980	4	3	16	45	**68**
1981-1990	16	13	44	85	**158**
1991-2000	36	20	19	57	**132**
2001-2010	62	46	44	103	**255**
2011-2020	23	13	22	58	**116**
Total	**141**	**96**	**159**	**371**	**767**

To determine the size and percent impervious surface coverage for a subset of parcels, the Currituck County parcel data were used, along with recent aerial photographs and the NLCD data as discussed above. A random sample of 20 developed, residential parcels in the Non-Road Accessible Outer Banks PDA was analyzed for parcel size and existing impervious surface, along with a separate random sample of 20 developed, residential parcels in the Road Accessible Outer Banks PDA. Based on this random sample, the residential parcels in the Non-Road Accessible Outer Banks PDA averaged approximately 1.13 acres in size and averaged approximately 9.4% impervious coverage. In the Road Accessible Outer Banks PDA, the residential parcels averaged approximately 0.42 acres in

size with approximately 43.6% impervious coverage. This higher percentage of impervious coverage in the Road Accessible Outer Banks PDA is expected for the area since the parcels are smaller and often have paved driveways as well as paved roads in front of each parcel. Half of the street width in front of each residential parcel was accounted for in this residential analysis.

Average parcel sizes and average percentage impervious coverage from the random samples were applied to the average size of the parcels and then multiplied by the difference in the number of residential parcels between the Build and No-Build Alternatives from Table 3 to yield predictions of future impervious surface area. There are approximately 533 additional developable parcels in the Road Accessible Outer Banks PDA that would likely be constructed on infill parcels over the next 20 years that are not included in the two large undeveloped parcels discussed below. More than 90% of the 533 parcels are zoned for residential uses and therefore are expected to be developed with residential units.

The two large, undeveloped parcels in the Road Accessible Outer Banks PDA were analyzed separately. They are subject to a settlement agreement between the property owner and Currituck County that specifies the potential types and amounts of land coverage as either multifamily, single family, commercial, or hotels. Estimates were made of the eventual percent impervious surface coverage for these two parcels based on the provisions of the settlement agreement. However, this is inherently an estimate since site-specific development plans for those parcels were not available at the time of this report and a precise impervious surface calculation cannot be determined without a detailed site plan. These estimates are considered to be higher than might actually occur since all future development was assumed to be multifamily homes, and multifamily homes generally have a higher impervious surface coverage than single family homes (see Table 3 below). The two parcels and the potential development from the settlement agreement are discussed in Chapter 7 of this report. As defined in the settlement agreement, the maximum allowable development on these parcels is:

1. For Parcel 126A0000000000G: approximately 275 residential units (multi-family or single family), 250 hotel rooms, and 50,000 square feet of commercial development can occur. This parcel is 42.70 acres in size.
2. For Parcel 126A0000000000T: approximately 350 multi-family units, 1,000 hotel rooms, and 100,000 square feet of commercial development can occur. This parcel is 73.82 acres in size.

The development of these parcels to the maximum amounts allowed would be difficult. According to the Currituck County Planner, it is unlikely development intensity and uses would reach allowable settlement levels since development would need to meet the current stormwater management requirements, which would require use of portions of the parcels, limiting the amount of land remaining for development (Laurie LoCicero, Currituck County Planner, personal communication, September 22, 2020).

In order to estimate the percent impervious surface coverage for the settlement parcels, the sizes and percent impervious surfaces were determined by GIS for the Outer Banks PDAs for specific land uses shown on Table 3. Half of the street width in front of each parcel was accounted for in the analysis in order to account for the projected local street network. The settlement agreement for parcel

126A0000000000G lists 275 allowable multi-family or single-family residential units. However, for this analysis, it was assumed that all 275 residential units would be developed as multi-family units. This assumption would yield a higher total impervious surface area estimate for this parcel because impervious surface coverage is substantially higher for multi-family than for single family development (Table 3). Finally, it was assumed that up to two hotels could be developed on each of the two large parcels.

Table 3: Average Parcel Size and Percent Impervious Used for Proportionality Metrics

Probable Development Area	Land Use Type	Sample Size (Number)	Average Parcel Size (Acres)	Average Percent Impervious Surface (%)
Non-Road Accessible Outer Banks	Single-Family[1]	20	1.13	9.4
Road Accessible Outer Banks	Single- Family	20	0.42	43.6
	Multi-Family	5	N/A[2]	84.1
	Commercial	4	N/A[3]	82.1
	Hotels	2	10.39	49.9

The settlement agreement lists commercial land uses in square feet, but hotel and multi-family land uses are listed as units which then needed to be converted to acres in order to estimate the projected percent impervious surface cover. Table 4 lists the equations that were used for each of the two large parcels to calculate acres of these land uses and then likely impervious surface cover.

[1] Single-family is from the sample of residential parcels in the PDA as described in the report.
[2] Calculated as parcel size minus (commercial area plus hotel area) as described below.
[3] Listed in the settlement agreement as 50,000 square feet for parcel G and 100,000 square feet for parcel T.

Table 4: Proportionality-related Equations used for the Two Large Parcels subject to the Settlement Agreement.

Type of Development	Calculation
Hotels:	Two hotels per parcel times the average hotel size (10.39 acres) = acres of hotels per parcel.
Multi-family acreage:	Parcel size for the two large parcels in the settlement agreement minus (commercial area + hotel area).
Acres of impervious surface of commercial development:	Commercial development area times the percent impervious surface for commercial (82.1%) based on commercial properties on the Currituck County Outer Banks.
Acres of impervious surface of hotels:	Hotel area per parcel times the percent impervious surface for hotels (49.9%) based on two hotels in Corolla and Duck.
Acres of impervious surface of multi-family development:	Multi-family area per parcel times the percent impervious surface for multifamily (84.1%.) based on multifamily parcels on the Currituck County Outer Banks.

The predicted acres of impervious surface were then added for the commercial development, hotels, and multi-family and converted to a percentage based on the sum of the areas of these three land uses on the two settlement parcels.

Based on this approach, the following equations were used for this analysis:

1. Parcel 126A0000000000G:
    a. Acres of impervious surface of commercial development = 50,000 square feet divided by 43,560 square feet per acre times 82.1% impervious surface = 0.94 acres.
    b. Acres of impervious surface of hotels: 2 hotels (assumed) times 10.39 acres per hotel times 49.9% impervious surface = 10.37 acres.
    c. Multi-family acreage = 42.70 acres (parcel size) minus acres of commercial development (1.15 acres [commercial development] minus 20.78 acres [hotels]) = 20.8 acres.
    d. Acres of impervious surface of multi-family development: 20.8 acres [multi-family acreage] times 84.1 percent impervious = 17.5 acres.

e. Total acres of impervious surface = 28.81 acres (67.5% of 42.70 acres).

2. Parcel 126A0000000000T:
    a. Acres of impervious surface of commercial development = 100,000 square feet divided by 43,560 square feet per acre times 82.1% impervious surface = 1.88 acres.
    b. Acres of impervious surface of hotels: 2 hotels (assumed) times 10.39 acres per hotel times the 49.9% impervious surface = 10.37 acres.
    c. Multi-family acreage = 73.82 acres (parcel size) minus acres of commercial development (2.30 acres [commercial development] plus 20.78 acres [hotels]) = 50.74 acres.
    d. Acres of impervious surface of multi-family development: 50.74 acres [multi-family acreage] times 84.1 percent impervious = 42.67 acres.
    e. Total acres of impervious surface = 54.92 acres (74.4% of 73.82 acres).

The percent impervious surface for the residential infill lots in the Road Accessible Outer Banks PDA was estimated by:

> Predicted number of developable infill lots (533, not including the two large settlement agreement parcels) times average size of infill lot (0.42 acres) times percent impervious for residential lots (43.6%) equals 97.6 acres of impervious surface on 206.22 acres.

This impervious surface estimate for the infill lots is also likely to be high because the 43.6% impervious coverage per lot multiplier includes a portion of the adjacent street. In most cases, remaining infill lots are within existing neighborhoods, where all streets have been built and are in place now. Therefore, additional future homes in these neighborhoods would not add to the street surface area.

Finally, the predicted acres of impervious surface for each of the two large parcels were added to the predicted impervious surface for the infill lots to yield the predicted new development-related impervious surface through 2040 for the Road Accessible Outer Banks PDA.

8.4. Probable Development Areas

The three PDAs have distinctive differences in the expected increase in impervious surface coverage as described below. Estimates of the additional predicted number of parcels were included from the estimates in the FEIS. Information concerning the two large parcels in the Road Accessible Outer Banks PDA that are subject to the settlement agreement as described in Chapter 7 of this report was also utilized in this analysis.[4]

8.4.1. U.S. 158 Interchange PDA

The FEIS predicts that, under the Build Alternative, approximately 68 acres of predominantly commercial development would occur on the six parcels that comprise this PDA. The GIS tool

[4] Some of the land development that was predicted under the No-Build Alternative in the prior ICE studies has already occurred and is now included in the Existing Conditions of the year 2020. Data used to establish the Existing Conditions of these earlier studies were from 2014, and from this baseline a future No-Build Alternative projected for the year 2040. Between 2014 and 2020, some of this predicted development has already occurred. For this reason, the predicted difference in the number of development units between the Build and No-Build Alternatives stated in the results of these earlier ICE studies are likely higher than what would be calculated at the present time.

estimates that the current level of impervious surface in these parcels is approximately 0.6%, which reflects the mostly agricultural and undeveloped, wooded areas existing in this PDA. The FEIS estimated that there would be approximately 44 acres of impervious surface coverage in this PDA following the 68 acres of induced commercial development associated with the interchange. The 44 acres of predicted impervious surface would be 65.0% of the 68-acre area expected to develop, or approximately 15.6 % of the entire 282-acre PDA. However, these 44 acres would comprise only about 0.6% of the total watershed of Maple Swamp, which is significantly larger than the U.S. 158 Interchange PDA. Chapter 14 discusses the existing stormwater rules as they would apply to this development and Chapter 19 of this report offers site-specific suggestions to Currituck County with respect to stormwater management to help ensure that this development would not adversely affect downstream water quality.

8.4.2. Non-Road Accessible Outer Banks PDA

As described in Chapter 7, this PDA is characterized by scattered homes and a large number of undeveloped parcels. The land use in this area is planned and expected to be strictly residential (Laurie LoCicero, Currituck County Planner, personal communication, September 22, 2020). Based on the GIS analysis, this PDA presently has approximately 2% impervious surface cover.

The previous traffic and indirect and cumulative effects studies for the FEIS Reevaluation (USDOT, FHWA, and NCTA. 2019a) predicted an increase of 123 homes in this PDA by 2040 under the Build Alternative, based on existing conditions in 2014. This represents 17% growth in 26 years, or an average annual growth rate of 0.6%. Prior studies established a likely potential growth range for 2040 based on low and high average annual growth rates from 0.6% to 2.6%. Growth in this PDA between 2014 and 2020 has added additional residences which represent 5% growth over these 6 years or a 0.8% annual growth rate. For this study, the average annual growth rate used for the Build Alternative from 2020 to 2040 is 0.9% or 151 homes. As indicated above, the average lot size in this area is 1.13 acres and the average percent impervious surface per lot is 9.4%. The 151 new parcels would cover an estimated 170.6 acres with 16.0 acres of impervious surface.

Since 767 homes already exist in this PDA in 2020, the 151 additional residences translate to a 19.7% increase in the number of homes over the 20-year study period. There are about 1,742 available developable parcels (Chapter 7 of this study) and 2,509 total developable parcels, so the additional 151 parcels of residential development would be about 8.7% of the available developable parcels and 6.0% of the total developable residential parcels. The phrase “available developable parcels” refers to those parcels left to be developed, and the phrase “total developable parcels” refers to those available to be developed as well as those that are already developed.

The No-Build Alternative has a slightly lower predicted average annual growth rate at 0.8% or 123 additional homes. This growth rate is consistent with previous studies for the Mid-Currituck Bridge project and reflects the influence of increasing traffic congestion along existing NC 12 on land development. This growth in residential units would cover an estimated 139.0 acres of land with approximately 13.1 acres of impervious surface. This amounts to a 16.0% increase in the number of homes over the 20-year study period. The growth would be about 7.1% of the available developable parcels and 4.9% of the total developable residential parcels.

Finally, in the next 20 years the majority of the residential parcels in this PDA will still be undeveloped under the No-Build and Build Alternatives (Table 5) so the overall percent impervious

surface would remain low at around 2%. As discussed in Chapter 16, it is not clear where it is most likely that these homes would be built, but first row from the ocean, second row from the ocean, and waterfront (finger canals and Currituck Sound) are considered the prime locations to develop first, while the interior lots are expected to develop later (Table 2).

Table 5: Summary of Residential Parcels for the Non-Road Accessible Outer Banks PDA

	Existing (2020)			No-Build (2040)		Build (2040)		Difference No-Build & Build Parcels
	Developed Residential Parcels	Total Developable Residential Parcels	Percent Developed	Developed Residential Parcels	Percent Developed	Developed Residential Parcels	Percent Developed	
Non-Road Accessible Outer Banks PDA	767	2,509	31%	890	35%	918	37%	28

8.4.3. Road Accessible Outer Banks PDA

Calculation of the proportional increase in development and/or impervious surface coverage in this PDA is more complicated since 1) the PDA has a mixture of commercial and residential land uses (which have very different proportions of impervious coverage) and 2) the two large undeveloped parcels that are subject to a settlement agreement in this PDA have a variety of allowable land uses. In addition, these two large parcels may not be able to be developed as envisioned since future on-site stormwater requirements will likely utilize some of the parcel area. Such potential stormwater considerations were not taken into account in the current calculations since the future stormwater requirements of the County are not clear at this time (Laurie LoCicero, Currituck County Planner, personal communication, September 22, 2020).

Based on the number of parcels (regardless of the type of development on the parcel), the No-Build Alternative shows a 7% increase compared to the existing level of development, while the Build Alternative shows an 11% increase from the existing level of development (Table 6). These numbers reflect the more developed nature of this PDA. Given the uncertain conditions of the settlement agreement and the higher diversity of land uses in this PDA (compared to the simpler, residential nature of the Non-Road Accessible Outer Banks PDA), calculations of the increase in commercial development versus residential development (single family versus multifamily for instance) would be inaccurate.

Based on the GIS analysis, the Road Accessible Outer Banks PDA currently has approximately 21% impervious surface coverage. The FEIS assumed that with the Build Alternative, full build-out would occur in the Road Accessible Outer Banks by 2040. Most of the new development under the Build Alternative would be within the two large parcels subject to the settlement agreement. Total development under the No-Build Alternative was estimated to be approximately 64 percent of the Build Alternative. The percent impervious cover for this development by 2040 was calculated in a stepwise manner as described above. Overall, this analysis yields an estimated total impervious surface of 26% for this PDA for the Build Alternative by 2040 as compared to a 23% impervious

surface for the No-Build Alternative. This slight increase over the existing 21% reflects the fact that the Road Accessible Outer Banks PDA is mostly already developed except for scattered residential lots and the two large settlement parcels.

Table 6: Summary of Residential, Hotel, and Commercial Development Parcels for the Road Accessible Outer Banks PDA

	Existing (2020)			No-Build (2040)		Build (2040)		
	Developed Parcels	Total Developable Parcels	Percent Developed	Developable Parcels	Percent Developed	Developable Parcels	Percent Developed	Difference No-Build & Build Parcels
Road Accessible Outer Banks PDA	4,181*	4,716**	89%	4,510*	96%	4,716**	100%	206

* These numbers include residential, one hotel, and commercial development.

** These numbers include the two large parcels under a settlement agreement which includes residential, hotel, and commercial development. The two large parcels are less likely to develop under the No-Build Alternative due to current traffic constraints on NC 12 and stormwater management requirements.

The existing acreage of development of impervious surface, as of 2020, for the Road Accessible Outer Banks PDA was calculated as 4,181 parcels multiplied by 0.42 acres (area of development) multiplied by 0.436 (percentage of impervious surface for infill parcels) and then adding 2.27 acres (Hampton Inn impervious surface acreage) plus 127.09 acres (existing commercial development impervious surface acreage) which totaled 894.98 acres (21.2% of the PDA). The No-Build acreage of development impervious surface was calculated in a similar way, except using 4,510 parcels multiplied by 0.42 acres (area of development) multiplied by 0.436 (percentage of impervious surface for infill parcels) and then adding 2.27 acres (Hampton Inn impervious surface acreage) plus 127.09 acres (existing commercial development impervious surface acreage) which totaled 955.23 acres (23.3% of the PDA). The Build acreage of development impervious surface acreage for the Road Accessible Outer Banks PDA was calculated as 4,714 parcels multiplied by 0.42 acres (area of development) multiplied by 0.436 (percentage of impervious surface for infill parcels) and then adding 28.81 (Parcel G impervious surface acreage) plus 54.92 (Parcel T impervious surface acreage) plus 2.27 acres (Hampton Inn impervious surface acreage) plus 127.09 acres (existing commercial development impervious surface acreage) which totaled 1,076.32 acres (26.2% of the PDA).

8.5. Summary

The results of this study, summarized below, are consistent with the general pattern from the FEIS (USDOT, FHWA, and NCTA 2019a and 2019b), which was based on an analysis from a transportation model based on development trends for units in 2014. The general pattern found in that report, which is similar to this GIS-based analysis, is that the Road Accessible Outer Banks PDA will fully develop under the Build Alternative (mainly infill residential lots and the two large settlement

parcels), while the Non-Road Accessible Outer Banks PDA will have a limited increase in residential development but will remain largely undeveloped within the 20-year timeframe of this analysis.

Tables 5 and 6 summarize the expected percent impervious surface and the percent of the developable parcels for the Existing, No-Build Alternative, and Build Alternative for the next 20 years for the Outer Banks PDAs. In general, in the next 20 years, the Non-Road Accessible Outer Banks PDA will remain mostly undeveloped with a low percent impervious surface (approximately 2% overall impervious surface coverage for both the Build and No Build Alternatives). The Road Accessible Outer Banks PDA will have an incremental increase in impervious surface from the existing condition of approximately 21.2% to 26.2% impervious surface as developable parcels get developed under the Build Alternative. This reflects the predominately residential nature, both current and projected, of this PDA. The No Build Alternative is projected to exhibit 23.3% impervious coverage in 2040. Thus, the Build Alternative is projected to increase the impervious surface in this PDA by 2.9% of the watershed area over that which would occur without the Project. Almost 70% of the estimated 2.9% difference in impervious coverage between the Build and No Build Alternatives can be attributed to the development of the two large parcels in the Road Accessible Outer Banks PDA that are subject to the settlement agreement. Future development of these parcels will likely require implementation of on-site stormwater management to comply with current County stormwater rules, which should help to reduce downstream water quality impacts.

Under the Build Alternative, the U.S. 158 Interchange PDA is predicted to have approximately 15.6% impervious surface in a localized concentration of development within an otherwise rural watershed that currently has much lower levels of impervious surface coverage. Expected commercial development in this PDA will account for approximately 0.6% impervious surface coverage of the entire Maple Swamp watershed. Chapter 19 of this report contains stormwater management options for Currituck County to consider regarding the development projected in the U.S. 158 Interchange PDA.

The recommendations in Chapter 19 of this report could be effective in protecting downstream water quality with 2040 development levels under either the Build Alternative or the No-Build Alternative. Localized concentrations of higher impervious surface area can lead to localized water quality problems, especially for development in particularly sensitive locations (such as development within 100 feet of open water, notably along the finger canals in the Non-Road Accessible Outer Banks PDA). However, the overall results of this assessment support the conclusions of Chapter 14: that on-site stormwater treatment is not needed for most of the Outer Banks PDAs in order to protect downstream water quality. There would be minimal overall increases in impervious surface as a result of the Mid-Currituck Bridge Project, as compared to that which would occur without the Project. Existing stormwater rules for Currituck County indicate that on-site stormwater management would likely be required for commercial development at the U.S. 158 Interchange PDA, and for residential/commercial development of the two large settlement parcels in the Road Accessible Outer Banks PDA. Remaining in-fill development within the two Outer Banks PDAs would be scattered, limited in number, and small in scale.

9. Non-Discharge (Reuse/Reclaimed Wastewater) Facilities

9.1. Purpose

The purpose of this chapter is to examine water quality-related data from the five existing non-discharge (reuse/reclaimed wastewater) facilities on the Outer Banks of Currituck County to determine if:

1. These facilities are likely sources of nutrients or bacteria to nearby waters, and
2. Whether the addition of nutrient removal capabilities would be warranted in future permit renewals by NCDWR to address additional nutrient and bacteria inputs to surface waters from population growth resulting from the planned and expected development directly attributable to the construction of the Project.

9.2. Existing Wastewater Facilities

Five non-discharge facilities currently exist on the Outer Banks of Currituck County, namely Corolla Light, Pine Island, Village at Ocean Hill, Monteray Shores, and Ocean Sands (Figure 9). However, one of these facilities (Corolla Light No 1 WWTP) is no longer discharging[5] but still provided useful, historic water quality monitoring data to address the study questions as outlined in Chapter 2. The five facilities had data from treated effluent, as well as from groundwater monitoring wells located at various distances from the disposal site. The purpose of groundwater monitoring wells is to ensure compliance with various North Carolina groundwater standards at the designated compliance boundary from the discharge location.

The frequency for data collection from these facilities (both effluent and monitoring well data) varied depending on the requirements of the NCDWR Non-Discharge Permit, but were mostly monthly and, in some cases, weekly. Data were gathered from the NCDWR for the past ten years for these five facilities. Nitrogen (normally in ammonia and nitrate forms; but in some cases, total nitrogen and Kjedahl nitrogen, which is organic nitrogen plus ammonia and ammonium nitrogen), fecal coliform bacteria, and chloride were the most frequent parameters collected. Phosphorus was rarely reported since NCDWR permits usually do not require phosphorus analysis.

Effluent and groundwater monitoring well data were tabulated for the five on-site treatment plants on the Currituck County Outer Banks from 2008 to 2020. Data used in this analysis include levels of ammonia-nitrogen, nitrate-nitrogen, fecal coliform bacteria, flow rate, and chloride, and these data were compared to North Carolina's water quality standards for groundwater (NCDWR, 2020a). Note that the groundwater standard is written in terms of total coliform rather than fecal coliform, a subset of total coliform that are more fecal-specific in origin. Our conclusion assumes that total and fecal values are practically equivalent. However, this has not been confirmed since data for both parameters are not available for comparison at these sites.

A total of 13,553 data points (samples taken) were included in the final analysis (Table 7). Most of the fecal coliform data for the monitoring wells were reported as less than the reported laboratory detection level, and many of the effluent data for fecal coliform were reported as less than detection.

[5] According to Robert Tankard, Washington Regional Assistant Regional Supervisor, NCDWR, personal communication, January 27, 2020. The wastewater from this facility is being treated at the Monteray Shores WWTP.

Finally, some of the ammonia and nitrate-nitrogen concentrations were also reported below the detection limits. The median values of the coliform bacteria, ammonia nitrogen, and nitrate-nitrogen were determined, rather than the average, to provide a more accurate representation of these data below detection limits. The median data are thus reported and analyzed below in Table 7.

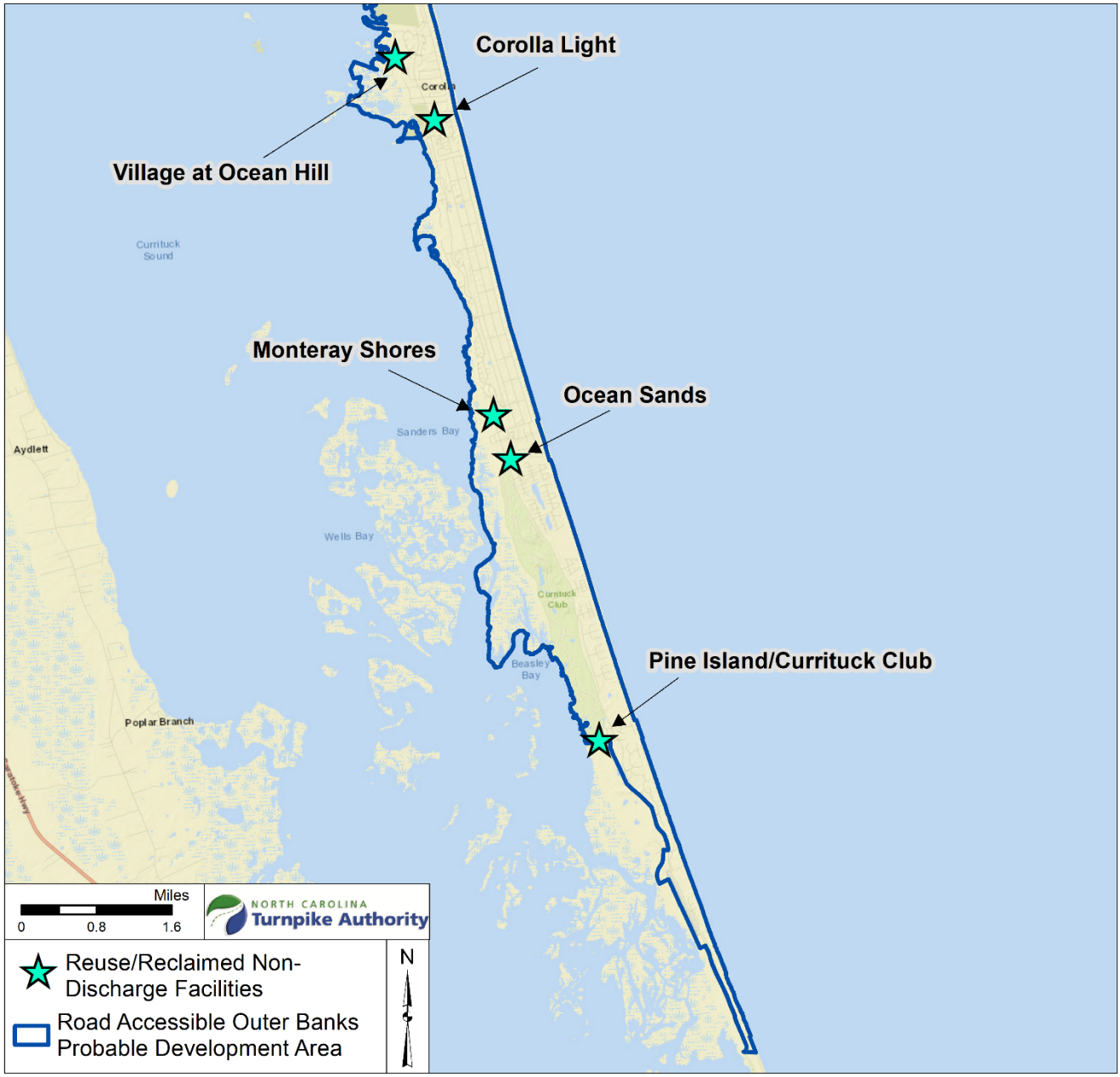

Figure 9: Location of Reuse/Reclaimed (Non-Discharge) Facilities in the Currituck County Outer Banks

Table 7: Total Number of Water Quality Samples from NCDWR for the Five Reuse/Reclaim Wastewater Facilities on the Currituck County Outer Banks from 2010-2020.

Dataset	Facility name	Ammonia-Nitrogen	Nitrate-Nitrogen	Fecal Coliform Bacteria[6]	Chloride	TOTAL
Effluent	Corolla Light	360	357	360	114	1,191
	Pine Island	387	541	540	543	2,011
	Village at Ocean Hill	354	354	354	84	1,146
	Monteray Shores	903	768	900	198	2,769
	Ocean Sands	783	699	780	114	2,376
Groundwater Monitoring Well	Corolla Light	252	252	244	252	1,000
	Pine Island	135	143	143	143	564
	Village at Ocean Hill	60	60	60	60	240
	Monteray Shores	61	61	61	61	244
	Ocean Sands	387	542	540	543	2012
TOTAL		3,682	3,777	3,982	2,112	13,553

As discussed in Chapter 6, nitrogen and phosphorus are nutrients which can contribute to eutrophication problems in water bodies such as Currituck Sound. In addition, the groundwater water quality standard for nitrate-nitrogen is 10 mg/l (NCDWR, 2020), which has been adopted as a measure to protect human health. Fecal coliform bacteria are an indication of water quality contamination caused by fecal waste; the groundwater quality standard for total coliform bacteria (NCDWR, 2020) is one colony per 100 ml. As described in Chapter 7, fecal coliform bacteria have been implicated in swimming beach closures in the Atlantic Ocean in Dare and Currituck Counties. Chloride was included in the analysis since it is a conservative pollutant that is generally not lost as the wastewater travels through the soil. Therefore, its presence is generally a reliable marker for the movement of treated effluent from the discharge point to the monitoring well. The groundwater standard for chloride is 250 mg/l (NCDWR, 2020). NCDWR does not have a surface or groundwater water quality standard for ammonia. However, there is an interim Maximum Allowable

[6] Note that the groundwater standard is written in terms of total coliform rather than fecal coliform, a subset of total coliform that are more fecal-specific in origin.

Concentration for ammonia at 1.5 mg/l which is reflected in the current discharge permits (Randy Sipe, Hydrogeologist, NC Division of Water Resources, Washington Regional Office, personal communication, January 6, 2021).

9.3. Wastewater Analysis and Results

9.3.1. On-site Wastewater Facilities Without Nutrient Removal

Effluent and groundwater monitoring well data provided by NCDWR for the five on-site treatment plants were analyzed separately for the parameters described above. Three of these facilities (Corolla Light, Pine Island, and Village at Ocean Hill) are not designed specifically for nutrient removal but do treat the removal of fecal coliform bacteria. Low levels of fecal coliform bacteria are expected in the effluent data from these three facilities since a primary focus of wastewater treatment from the facilities is to kill bacteria. Nitrogen levels should decrease from the effluent to monitoring wells at all on-site treatment facilities through natural removal and/or dilution in the groundwater. Chloride levels should show little change when comparing effluent to monitoring well data since it is a conservative pollutant not generally removed in the soil.

Tables 8 and 9 below compare the effluent and groundwater monitoring well data from the three facilities (Corolla Light, Pine Island, and Village at Ocean Hill) that are not specifically designed to remove nitrogen.

Table 8: Comparison of Effluent Dataset for Three Non-Discharge Facilities (from 2010 to 2020)

Sites	Overall Patterns	NCDWR Groundwater Standard Levels	Median Effluent Levels
Corolla Light	Nitrate-nitrogen levels higher in the summer months Fecal coliform levels higher in the warmer months Total nitrogen extremely high throughout 2016 to 2020 Chloride levels show little change in dataset	Nitrate-nitrogen = 10 mg/l Fecal coliform = 1 colony per 100 ml Chloride = 250 mg/l Ammonia – interim Maximum Allowable Concentration – 1.5 mg/l.	Ammonia = 0.20 mg/l Nitrate-nitrogen = 16.90 mg/l Fecal Coliform = 1.0 colonies per 100 ml Chloride = 142.00 mg/l
Pine Island	High levels of fecal coliform bacteria in 2016 Chloride levels show little variance Nitrogen levels vary but are low in comparison to Corolla Light and Village at Ocean Hill		Ammonia = 0.20 mg/l Nitrate-nitrogen = 2.17 mg/l Fecal Coliform = 1.0 colonies per 100 ml Chloride = 116.00 mg/l

Table 8 (Continued).

Sites	Overall Patterns	NCDWR Groundwater Standard Levels	Median Effluent Levels
Village at Ocean Hill	Nitrate-nitrogen levels were high throughout 2010 to 2020 Chloride levels show little to no change Fecal coliform levels vary (high to low) throughout dataset		Ammonia = 0.20 mg/l Nitrate-nitrogen = 28.00 mg/l Fecal Coliform = 1.0 colonies per 100 ml Chloride = 138.85 mg/l

Table 9: Comparison of Groundwater Monitoring Well Dataset for Three Non-Discharge Facilities from 2010 to 2020

Sites	Overall Patterns	NCDWR Groundwater Standard Levels	Median Levels
Corolla Light	Nitrate- nitrogen decreased while ammonia increased from effluent to monitoring well Chloride levels show little change in dataset Fecal coliform levels decreased from effluent to monitoring well	Nitrate-nitrogen = 10 mg/l Fecal coliform = 1 colony per 100 ml Chloride = 250 mg/l Ammonia – interim Maximum Allowable Concentration – 1.5 mg/l.	Ammonia = 1.00 mg/l Nitrate-nitrogen = less than 0.02 mg/l Fecal coliform = less than 1.00 colonies per 100 ml Chloride = 153.50 mg/l
Pine Island	Nitrate-nitrogen decreased while ammonia increased from effluent to monitoring well Chloride levels show little change in dataset Coliform levels decreased from effluent to monitoring well		Ammonia = 0.90 mg/l Nitrate-nitrogen = less than 0.10 mg/l Fecal coliform = less than 1.00 colonies per 100 ml Chloride = 120.00 mg/l
Village at Ocean Hill	Nitrate-nitrogen decreased while ammonia increased, from effluent to monitoring well Fecal coliform levels decreased Chloride levels decreased from effluent to monitoring well		Ammonia = 0.63 mg/l Nitrate-nitrogen = less than 0.10 mg/l Fecal coliform = less than 1.00 colonies per 100 ml Chloride = 73.56 mg/l

General trends in nutrient and bacterial movement from effluent discharges to groundwater monitoring wells were considered. Median values across each treatment facility dataset for 10 years were calculated and analyzed. It is assumed that these forms of nitrogen as well as coliform bacteria are being removed while being transported through the soil if there are lower concentrations in the groundwater monitoring wells as compared to effluent discharge concentrations. Also, the

assumption would be that subsequent transport through the soil towards receiving waters would further reduce contaminant concentrations, unless levels at the monitoring well are already at or below detection. This assumption does not account for seasonal variations or other physical factors that could affect future nutrient and bacterial levels, such as soil characteristics and the distance of wells from receiving waters.

The general trend observed in the three facilities that do not provide advanced nutrient treatment is a decrease in nitrate-nitrogen levels from effluent to the groundwater monitoring wells, ranging from 2 to 20 mg/l to less than detection limits for the median values. Median ammonia-nitrogen levels in the monitoring wells ranged from 0.6 to 1.0 mg/l and generally increased from the effluent to the monitoring wells but were still well within permit limits. Overall, these data indicate that some nitrogen (especially in the ammonia form) is moving from the application site toward Currituck Sound, although at very low concentrations. Therefore, the three facilities may be contributing small quantities of additional nitrogen to Currituck Sound, though all of the systems are currently meeting state water quality and effluent standards. All three systems are exhibiting nitrate-nitrogen concentrations much lower than the established 10 mg/l state water quality standard in their monitoring well data and are therefore in compliance with their permits.

Additionally, fecal coliform bacterial counts also generally show a reduction in concentration via soil transport at each of the three treatment facilities, while the chloride levels from the effluent to the monitoring wells indicated little change. Again, chloride is reported to confirm that flow is occurring from the effluent discharge to the monitoring wells. However, well data indicate that both fecal coliform and chloride concentrations are below North Carolina groundwater standards and are therefore in compliance with their permits.

9.3.2. On-site Wastewater Facilities with Nutrient Removal

Tables 10 through 13 present the comparison of effluent to monitoring well data for the remaining two wastewater treatment facilities, Monteray Shores (Tables 10 and 11) and Ocean Sands (Tables 12 and 13), which have had nutrient removal capabilities added after 2008 and 2019, respectively. These facilities were categorized into pre- versus post-nutrient removal based on the date that nutrient removal capabilities were added to these plants.

Table 10: Monteray Shores: Pre- (starting 2008) and Post-2008 Effluent Data

Time Frame	Overall Patterns	NCDWR Standard Levels	Median Levels
Pre-2008	Spike in nitrogen + ammonia levels November 2006 to July 2007 (with high levels of total nitrogen) Low levels of fecal coliform throughout dataset Levels of chloride show little change	Nitrate-nitrogen = 10 mg/l Fecal coliform = 1 colony per 100 ml Chloride = 250 mg/l Ammonia – interim Maximum Allowable Concentration – 1.5 mg/l.	Ammonia = 0.10 mg/l Nitrate-nitrogen = 2.85 mg/l Fecal coliform = 1.00 colonies per 100 ml Chloride = 158.00 mg/l

Table 10 (Continued)

Time Frame	Overall Patterns	NCDWR Standard Levels	Median Levels
Post-2008 (Nutrient removal in place)	Nitrate-nitrogen decreased post 2008 (Nutrient removal in place) while ammonia levels increased Fecal coliform bacteria remained low from effluent to monitoring well Chloride levels showed little change.		Ammonia = 0.30 mg/l Nitrate-nitrogen = 0.33 mg/l Fecal coliform = less than 1.00 colonies per 100 ml Chloride = 133.50 mg/l

Table 11: Monteray Shores: Post-2008 Monitoring Well Data

Time Frame	Overall Patterns	NCDWR Standard Levels	Median Levels
Post-2008	Ammonia and nitrate-nitrogen levels decreased dramatically from the effluent to monitoring well Fecal coliform levels remained low from effluent to monitoring well	Nitrate-nitrogen = 10 mg/l Fecal coliform = 1 colony per 100 ml Chloride = 250 mg/l Ammonia – interim Maximum Allowable Concentration – 1.5 mg/l.	Ammonia = 0.40 mg/l Nitrate-nitrogen = less than 0.02 mg/l Fecal coliform = less than 1.00 colonies per 100 mg/l Chloride = 142.00 mg/l

Table 12: Ocean Sands Pre- (2006-2018) and 2019 Effluent Data

Time Frame	Overall Patterns	NCDWR Standard Levels	Median Levels
2006-2018	Levels of fecal coliform bacteria sometimes high in effluent Chloride levels show little to no change	Nitrate-nitrogen = 10 mg/l Fecal coliform = 1 colony per 100 ml Chloride = 250 mg/l Ammonia – interim Maximum Allowable Concentration – 1.5 mg/l.	Ammonia = 0.20 mg/l Nitrate-nitrogen = 1.85 mg/l Fecal coliform = 2.53 colonies per 100 ml Chloride = 177.50 mg/l
2019 (Nutrient removal in place)	Nitrate-nitrogen and ammonia levels decreased Chloride levels remain generally constant Fecal coliform levels decrease post-2019		Ammonia = 0.00 mg/l Nitrate-nitrogen = 0.27 mg/l Fecal coliform = 2.00 colonies per 100 ml Chloride = 116 mg/l

Table 13: Ocean Sands 2006-2018 and 2019-2020 Groundwater Monitoring Well Data

Time Frame	Overall Patterns	NCDWR Standard Levels	Median Levels
2006-2018	Nitrate- nitrogen levels decreased from effluent to monitoring well Fecal coliform bacteria levels decreased from effluent to monitoring well Chloride levels remained consistent	Nitrate-nitrogen = 10 mg/l Fecal coliform = 1 colony per 100 ml Chloride = 250 mg/l Ammonia – interim Maximum Allowable Concentration – 1.5 mg/l.	Ammonia = 0.20 mg/l Nitrate-nitrogen = 4.12 mg/l Fecal coliform = 1.00 colonies per 100 ml Chloride = 116.00 mg/l
2019- 2020 (Nutrient removal in place)	Fecal coliform levels decrease from effluent to monitoring well Ammonia levels are similar while nitrate-nitrogen levels decreased from effluent to monitoring well after nutrient removal		Ammonia = 0.20 mg/l Nitrate-nitrogen = 0.97 mg/l Fecal coliform = less than 1.00 colonies per 100 ml Chloride = 116.5 mg/l

In general, the effluent and groundwater monitoring well data from these two plants, both before and after nutrient removal design was installed, show that nitrogen levels, both ammonia and nitrate, were higher in the effluent, as expected, and then decreased to median levels much lower than 10 mg/l standard (for nitrate-nitrogen) at the monitoring wells. Therefore, both of these facilities are successfully meeting the State groundwater standard for nitrate-nitrogen and ammonia at those locations and are therefore in compliance with their permits. Finally, comparison of pre- versus post-nutrient removal design additions to these plants showed a general reduction in nitrate-nitrogen and ammonia for both the effluent and groundwater monitoring wells, which supports the value of this design to reduce nitrogen transmission to Currituck Sound from these facilities.

Fecal coliform levels were generally low both in the groundwater monitoring wells and effluent after nutrient removal technology was added. Based on this analysis of fecal coliform bacteria from the monitoring wells as compared to the groundwater standard for total coliform bacteria, there appears to be no evidence of movement of fecal coliform bacteria to the monitoring wells from the effluent. Both facilities appear to be meeting the state water quality standards for fecal coliform and are therefore in compliance with their permits. Note that the groundwater standard is written in terms of total coliform rather than fecal coliform, a subset of total coliform that are more fecal-specific in origin. Our conclusion assumes that total and fecal values are practically equivalent. However, this has not been confirmed since data for both parameters are not available for comparison at these sites.

9.3.3. Seasonal/Annual Trends

As expected, higher discharge levels from the non-discharge facilities occur from May through September, which reflect the summer tourism season on the Outer Banks. Figure 10 is a representative example of discharge flow from the Ocean Sands facility. Although, a detailed analysis of the data was not conducted to detect seasonal variations in water quality parameters, trends varied between facilities, and there often appeared to be a seasonal pattern in the chemical constituents. Common themes suggest that nitrogen levels (of the various forms of nitrogen) were generally higher in the summer. Fecal coliform bacteria levels varied throughout each dataset, but high levels were

more common in the summer. Chloride levels seemed to show little or no change regardless of season. These trends are assumed to be the result of increased wastewater production by summer visitors as well as increased use of fertilizers and other chemicals during the growing season. Again, overall, the monitoring well data show that water quality standards are being met by these facilities.

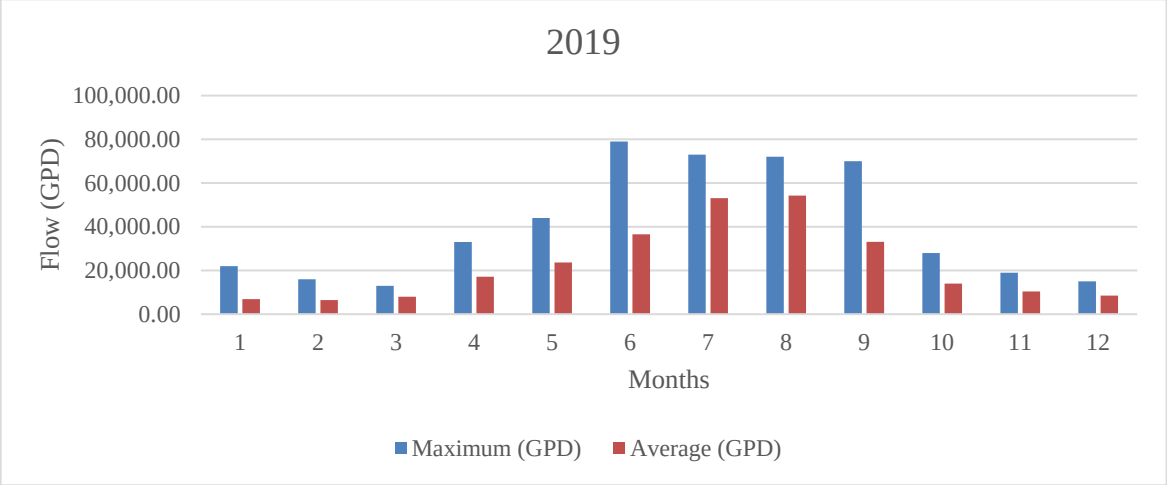

Figure 10: Ocean Sands Facility Discharge Levels (Gallons per Day, GPD) for 2019

9.4. Conclusions

Overall, the ten-year database provided by the five wastewater treatment facilities supports three important conclusions:

1. In general, these reclaimed/reused wastewater facilities meet North Carolina groundwater standards and are therefore in compliance with their permits. There is evidence to suggest that very small amounts of nitrogen (especially in the ammonia form) are moving from these facilities discharges to the monitoring wells, though all permit limits have been met. Very small amounts of ammonia-nitrogen may then be moving from the monitoring wells toward Currituck Sound, especially from those plants not designed to remove nitrogen removal, though it does not appear that the observed very low concentrations of localized ammonia-nitrogen would cause a violation of state water quality standards or a loss of existing or anticipated uses;
2. These data demonstrate the benefit of nutrient removal technology for non-discharge facilities. NCDWR may wish to consider whether the remaining plants should be required to install such technology at permit renewal or if any future plants that may be constructed in the study area should be required to incorporate that type of treatment; and
3. Levels of fecal coliform bacteria generally decreased from effluent to the groundwater monitoring wells and all facilities appear to be in compliance with state groundwater standards. Based on this analysis of fecal coliform bacteria from the monitoring wells as compared to the groundwater standard for total coliform bacteria, there appears to be no evidence of movement of fecal coliform bacteria to the monitoring wells from the effluent[7].

[7] Note that the groundwater standard is written in terms of total coliform rather than fecal coliform, a subset of total coliform that are more fecal-specific in origin. This conclusion assumes that total and fecal coliform values are practically equivalent. However, this has not been confirmed since data for both parameters are not available for direct comparison at these sites.

10. Septic Tanks/Drain Fields

10.1. Purpose

The purpose of this chapter is to review the requirements of the permitting process for on-site septic tank installation, as well as maintenance and repairs, for single family wastewater systems in Currituck County. This chapter also discusses the on-site treatment of wastewater and the enhanced pretreatment systems available to reduce nutrients and bacteria that could reach the Currituck Sound or the Atlantic Ocean from planned and expected development that may be occur as a result of construction of the Mid-Currituck Bridge. In addition, this chapter discusses the suitability of mapped soil series within the three PDAs for new on-site wastewater septic systems. Finally, this analysis includes considerations regarding the permitting process to improve septic system effectiveness, should the County or NCDWR determine that such actions are warranted. A detailed version of the considerations is provided in Chapter 19.

10.2. Background

Untreated wastewater effluent is known to contribute to degraded water quality as it can increase the levels of nutrients and bacteria in downstream waters or within the shallow aquifer. Wastewater effluent that is not discharged to surface waters is normally treated via a subsurface on-site septic system (this Chapter) or by a larger wastewater treatment system where disposal is via a surface spray application or groundwater infiltration systems (Chapter 9). Contaminants found in untreated wastewater effluent have been identified as general pollutants of concern for the Currituck Sound (See Chapter 6). As described further below, various State and local rules have been developed and implemented to manage and treat wastewater effluent to reduce its impact on downstream waters and the surficial aquifer.

10.3. Regulatory Overview of On-Site Wastewater Septic Systems

The NC Department of Health and Human Services, Division of Public Health, Environmental Health Section, On-Site Water Protection Branch (NCDHHS-DPH-EHS-OSWPB) has developed a set of rules and regulations which provides guidance on soil/site evaluations, design, and permitting for a wide variety of on-site wastewater septic systems. These rules and regulations are established in 15A North Carolina Administrative Code (NCAC) 18A .1900 (Laws and Rules for Sewage Treatment and Disposal Systems) (NCDENR, 2010). These regulations are utilized by the Currituck County Health Department (the Albemarle Regional Health Services Environmental Health (ARHS-EHS)) within their on-site wastewater program. Wastewater systems that are not permitted by the NCDHHS-DPH-EHS-OSWPB or the ARHS-EHS can be permitted by the NCDWR. NCDWR have their regulations and requirements set forth by either 15A NCAC 02T (NCDENR, 2020a) or by 15A NCAC 02U (NCDENR, 2020b). All of these rules and regulations are widely used across the state for siting and permitting on-site wastewater systems.

10.4. Currituck County Wastewater Permitting Process

10.4.1. On-Site Wastewater Septic Systems

To obtain a new on-site wastewater septic permit, the property owner or applicant must submit an application to ARHS-EHS. ARHS-EHS has a standard application form which requires a site plan to identify the target use of the recorded property. On the form they require information such as the property address, number of bedrooms for the new home and other information from the applicant. Once the application is completed, approved, and the fees paid, the ARHS-EHS will make a site visit to review the parcel and the plans shown on the provided site plan. The ARHS-EHS environmental health specialist or Registered Sanitarian will review the soils using the 15A NCAC 18A .1900 (Laws and Rules for Sewage Treatment and Disposal Systems) as guidance for evaluating the property. Then the site is either approved and an Improvement Permit is issued that describes the next step, or it is denied for an on-site wastewater system. If the Improvement Permit is issued, then the next step is called the Construction Authorization. That approval shows where the system and repair area are to be placed, the amount of area needed for the system and repair area, and the classification of the system. Depending on the results of the Licensed Soil Scientist evaluation, a Construction Authorization may be issued as well. With either review process, the property will be evaluated by a qualified individual (Registered Sanitarian or Licensed Soil Scientist) and a determination will be made if it is permittable for the intended use based on the soil and site plan. Depending on soil conditions or setbacks from surface waters, pretreatment may be required to accommodate new construction. Pretreatment can vary per the State's standards and are described in 15A NCAC 18A .1900 Laws and Rules for Sewage Treatment and Disposal Systems. Pretreatment can reduce nutrients and bacteria if designed accordingly. Pretreatment systems are discussed in more detail later in this chapter.

As permitted by the on-site rules, most residential septic systems can last for many years if properly maintained and utilized correctly. For instance, most septic systems can last for 20 years or more before any failures are typically observed. If an existing residential parcel has a septic system that is failing, then the property owner is required to notify the ARHS-EHS. ARHS-EHS will review the system and make a determination of the next step to correct the failure. The ARHS-EHS will issue a repair permit to the owner describing the steps for completing the repair. Once repairs are made, then the ARHS-EHS will inspect and signoff on the repairs made. Some older septic systems and parcels may require pretreatment to be added based upon available space, depth to the seasonal high-water table, or system flow. These requirements are noted in the 15A NCAC 18A .1900 Laws and Rules for Sewage Treatment and Disposal Systems. Either the Registered Sanitarian or a Licensed Soil Scientist will determine what is required to repair the failing system.

10.4.2. Surface Disposal Systems

If a property is to be developed and does not plan to have an on-site subsurface septic system, another option is to permit the new wastewater facility for a surface system such as a spray, drip irrigation, or an infiltration system. These systems are reviewed and permitted by the NCDWR regulations and requirements set forth by either 15A NCAC 02T or by 15A NCAC 02U rules. When these types of systems are considered for development, the applicant will have a team of licensed individuals such as a professional engineer, a soil scientist, and a surveyor to assist in the planning, siting, and evaluations needed for approval by NCDWR. When these types of systems are utilized, the local

health department is not involved in the review or permitting aspects. Per the rules and regulations, when one of these surface systems is proposed, one main aspect of the disposal process is pretreatment of the wastewater. The 15A NCAC 02T and 15A NCAC 02U rules specifically address the levels of treatment needed. With the team of licensed professionals, the applicant is provided guidance to ensure the new facility will operate as designed and maintenance is required for the performance of the system.

If a surface system is not performing properly per the issued permit, then the owner and operator must repair, replace, and upgrade as needed to be in compliance with the permit. If issues persist, then the NCDWR has the right to issue fines or revoke the permit for the facility. The operations, monitoring, and performance are described in the permitting conditions issued by NCDWR.

Within the three PDAs, there are five large systems permitted by the NCDWR all within the Road Accessible Outer Banks PDA (see Chapter 9 for details). They are as follows: Whalehead Club, Ocean Hill, Corolla Light, Monteray Shores (including, Buck Island and Timbuck II), and Ocean Sands. Within these communities in the Road Accessible Outer Banks PDA, there are undeveloped or vacant parcels (see Chapter 7). As these parcels are improved and if they are within the service areas of these facilities, they will tie into the NCDWR permitted systems, therefore they will not utilize on-site septic systems for wastewater disposal. There are no NCDWR permitted systems within the U.S. 158 Interchange PDA or the Non-Road Accessible Outer Banks PDA as of the development of this study.

10.5. Geographic PDAs

As outlined in Chapters 5 and 7 of this report, there are an estimated 2,283 undeveloped parcels, a portion of which may experience planned and expected development within the next 20 years as a result of the construction of the Project.

- The Non-Road Accessible Outer Banks PDA consists of residential development served by on-site septic tanks and drain fields permitted by the ARHS-EHS or possibly the NCDHHS-DPH-EHS-OSWPB (personal communication, Laurie LoCicero, Currituck County Planner, August 27, 2020).
- The Road Accessible Outer Banks PDA is mostly developed with some vacant parcels scattered throughout utilizing either on-site septic tanks or package plants with reuse/reclaimed water application of wastewater. Some of these non-discharge systems may utilize groundwater lowering measures (see Chapter 11 for details).
- The U.S. 158 Interchange PDA is expected to develop up to 68 acres of commercial land uses (see Chapters 4 and 5 for details) of additional commercial development associated with the construction of the Project.

These three PDAs present distinctly different challenges with respect to on-site wastewater management as described further below.

10.5.1. Non-Road Accessible Outer Banks PDA

This area is mostly undeveloped but was platted with parcels and unpaved roads starting in the 1960s (except for the Currituck National Wildlife Refuge, Currituck Banks Estuarine Reserve, and former refuge land now owned by Currituck County (see Chapter 7 for details)). There are a few scattered homes, especially in the southern portion of the PDA. Roads in this area are sand-based (rather than paved), and homes are accessed by these sand roads, or by driving on the beach. This area contains about 2,221 unsewered, recorded planned and expected developable parcels before wetlands presence and septic tank constraints are factored in. However, less than 10% of these vacant parcels are expected to be developed in the 20-year time frame for this study (Chapter 8). Based on discussions with Currituck County staff, the planned and expected development in this PDA will be residential development, as all commercial development is prohibited (personal communication, Laurie LoCicero, Currituck County Planner, August 27, 2020). Based on analysis of the wastewater rules, residential infill would require an on-site wastewater permit to be issued by the ARHS-EHS or the NCDHHS-DPH-EHS-OSWPB. As noted in Chapter 9, there are no large non-discharge facilities in this PDA and none are anticipated (personal communication, Eric Weatherly, Currituck County Engineer, August 27, 2020). Of the 2,221 unsewered, recorded parcels available for future development, 202 have been approved for an on-site septic system by the ARHS-EHS, and 22 parcels have been denied due to unsuitable soil and site conditions and therefore were unable to obtain a permit for an on-site septic system (personal communication and data provided by Sandy Evans, Albemarle Regional Health Services, October 2, 2020). After all development constraints have been considered, an estimated 1,742 developable parcels exist in this PDA (Chapter 7).

10.5.2. Road Accessible Outer Banks PDA

This area is mostly developed at this time, with remaining undeveloped parcels scattered among existing homes. Roads are paved, and a few commercial areas occur primarily along NC 12. This area contains about 653 unsewered recorded parcels (before wetlands presence or septic tank constraints are factored in) based on the GIS analysis described in Chapter 7. Out of the 653 unsewered parcels, 172 parcels would need on-site septic systems to be developed (assuming suitable soils were present), while the other 481 parcels could tie into the wastewater treatment plants that service those parcels in order to be developed. The Road Accessible Outer Banks PDA also contains two larger parcels (comprising approximately 117 acres total) which are the subject of a settlement agreement between the landowner and Currituck County. This settlement agreement requires that wastewater from the future development of these parcels be received by the Oceans Sands wastewater facility. Therefore, on-site septic will not be utilized on these two substantial parcels. In the past, on-site wastewater permit applications have been submitted for 22 of the undeveloped parcels, of which 19 were approved while three were denied. Based on the analysis in the FEIS (see Chapters 4 and 7 for details), most of the infill will be residential development, but there could be some limited commercial development as well (for instance, motels). Based on the analysis of these rules, it appears that some of this residential infill would require permits for on-site wastewater systems: however, about 481 developable parcels (before wetlands presence is factored in) are currently served by a community system permitted by the NCDWR (see Chapter 9 for details). Therefore about 73% of the developable parcels in this PDA probably could connect to existing non-discharge wastewater systems rather than use on-site septic tanks. Most of these parcels will tie into the permitted reuse/reclaimed water systems and each of these water systems has an operator in charge of

maintenance and general upkeep. These reuse/reclaimed systems use a combination of surface irrigation or infiltration to dispose of the treated wastewater. Some systems also utilize groundwater lowering measures in this area (refer to Chapter 11).

10.5.3. U.S. 158 Interchange PDA

It is expected that approximately 68 acres of the total 282 acres of this PDA have the potential for commercial development as a result of construction of the Project (see Chapter 4 for details). This would occur near the location of the proposed interchange with U.S. 158 (Caratoke Highway). Based on the analysis of the wastewater rules, this potential commercial development would require an on-site wastewater permit to be issued by the ARHS-EHS, NCDHHS-DPH-EHS-OSWPB, or NCDEQ-DWR, depending on the system utilized.

10.6. Criteria Used for Evaluation of Development Constraints

As discussed in detail in Chapter 7, this study included a GIS analysis to identify development patterns, available vacant parcels, wetlands, soils, distances from water, and other factors to estimate the number of existing developable parcels in the three PDAs, although, as noted, not all of these parcels are expected to develop in the 20-year time frame of this study. This analysis estimated the number of available undeveloped parcels within each PDA and then systematically excluded parcels with any known and identifiable constraints, including those affecting wastewater management. Listed below are the NRCS soil series mapped within each of the three PDAs and a general description of their potential suitability as related to on-site wastewater permitting.

10.6.1. Non-Road Accessible Outer Banks PDA and Road Accessible Outer Banks PDA

Within the Non-Road Accessible Outer Banks PDA and Road Accessible Outer Banks PDA, there are eleven different soil series identified in the Currituck County soil survey (USDA, 1982). These soil series are listed and described below. The soil series total approximately 8,237 acres within these PDAs. A GIS map of this area is included in Appendix 3 and Appendix 4.

For each of the mapped soil series, a correlation was established between the soil series and its general suitability for on-site wastewater as described below (USDA, 1982).

- Beaches-Newhan association – Always suitable; depth to water table is 6 feet, but sites must be stabilized with vegetation and meet appropriate setback to water requirements (100 feet from mean high tide line). Therefore, part of this soil unit closest to the water would not be useable even if the soils criteria are suitable or provisionally suitable.
- Corolla-Duckston complex, 0-6% slopes – Corolla portion is usually suitable; depth to water table is 1.5 to 3 feet, but Duckston portion is always unsuitable; depth to water table is 0 to 0.5 feet, so it is assumed that 50% of this mapped unit is useable.
- Corolla fine sand, 0-6% slopes – Usually suitable; depth to water table is 1.5 to 3 feet.
- Currituck mucky peat – Always unsuitable; depth to water table is 0 feet.
- Duckston fine sand – Always unsuitable; depth to water table is 0 to 0.5 feet.

- Dune land – Always suitable; depth to water table is 6 feet, but sites must be stabilized with vegetation and meet setback to water requirements. Sites may also need grading to overcome slope issues.
- Dune land-Newhan complex, 2-40% slopes – Always suitable; depth to water table is 6 feet, but sites must be stabilized with vegetation and grading may be needed to overcome slope issues.
- Newhan-Corolla complex, 0-10% slopes – Usually suitable; depth to water table is 1.5 to 6 feet.
- Newhan fine sand, 0-10% slopes – Always suitable; depth to water table is 6 feet.
- Osier fine sand – Always unsuitable; water table is less than one foot.
- Ousley find sand, 0-6% slopes – Usually suitable, depth to water table is 1.7 to 3.33 feet.

10.6.2. U.S. 158 Interchange PDA

Within this PDA, there are nine different soil series identified on the Currituck County Soil Survey (USDA, 1982). These soil series total approximately 282 acres within this PDA. A GIS map of this area is included in Appendix 3 and Appendix 4.

For each of the mapped soil series, a correlation was established between the soil series and its general suitability for on-site wastewater based on current on-site subsurface septic system rules and general knowledge of the on-site characteristics of the soils, as described below.

- Augusta fine sandy loam – Usually suitable; depth to water table is 1 to 2 feet.
- Bojac loamy sand, 0-3% slopes – Always suitable; depth to water table is 4 to 6 feet.
- Dragston loamy fine sand – Usually suitable; depth to water table is 1 to 2.5 feet.
- Munden loamy sand – Usually suitable; depth to water table is 1.5 to 2.5 feet.
- Portsmouth fine sandy loam – Always unsuitable; depth to water table is 0 to 1 foot.
- State fine sandy loam, 0-2% slopes – Always suitable; water table is 4 to 6 feet.
- State fine sandy loam, 2-6% slopes – Always suitable; water table is 4 to 6 feet.
- Tomotley fine sandy loam – always unsuitable; depth to water table is 0 to 1 foot.
- Wasda muck – Always unsuitable; depth to water table is 0 to 1 foot.

10.6.3. Soil Suitability for On-Site Wastewater Treatment

Using the above correlations, the soil series with similar suitability characteristics were combined into four mapping units of soil suitability. This assessment revealed those areas that may have permitting issues related to on-site wastewater disposal. Below is a list of each combined soil unit as described above within the three PDAs (Table 14). A GIS map of this area is included in Appendix 4.

Table 14: Summary of Soil Suitability Areas (Acres)

	Always Suitable (Acres)	Always Unsuitable (Acres)	Marginally Suitable (Acres)	Usually Suitable (Acres)	Totals (Acres)
Non-Road Accessible Outer Banks PDA	773	1,911	370	1,289	4,343
Road Accessible Outer Banks PDA	1,646	1,153	391	704	3,894
U.S. 158 Interchange PDA	127	93	0	62	282
Total Acreage	2,546	3,157	761	2,055	8,519

10.7. Septic System Constraints

Soil series is one criterion used to identify which undeveloped parcels in the PDAs may have potential for new development. It is solely based on the available area of potentially suitable soils. Once potentially useable areas are located through on-site vertical soil borings, the next consideration is the horizontal extent of those areas within a given parcel. The size and configuration of the useable soil area dictate the utility of that area. The required size of a subsurface disposal field is determined by 1) the design flow from the source, and 2) the long-term acceptance rate of the soil, which is based on the soil group classification - a function of the soil's texture, mineralogy, structure, porosity, and other factors. The configuration must be such that an efficient layout of disposal lines (on the contour) is possible. An additional consideration is the required setbacks for the system from various elements such as wells (50'), surface water (50' or more depending on regulations), property lines (10'), top of embankment (15') or building foundation (5').

The utility of a potential useable soil area for a subsurface system is most accurately determined by an on-ground layout of the proposed system. The total area needed for a system and repair will depend upon the system type, the layout of that system, and the total design flow (factors mentioned above). In the PDAs selected for this study, a typical area needed for a four-bedroom residence is approximately 3,000 to 5,000 square feet (though it could be more depending on site features). If the soils support a pretreatment system, then the area could be reduced by 40 to 50 percent depending on the type of pretreatment used. Within the U.S. 158 Interchange PDA, the commercial development characteristics will determine the design of the wastewater system needed. Without knowing the specific type of commercial uses to be developed, it is difficult to estimate the amount of area needed. For instance, if a hotel is planned for this area, then the new wastewater system will be designed based on the number of rooms, number of employees, and if it has in-house laundry or not.

As previously discussed in Chapter 7, there are 2,396 undeveloped parcels in the three PDAs which are not connected to a centralized wastewater treatment system. Most of these are in the Non-Road Accessible Outer Banks PDA and will need on-site septic systems for new, proposed development. As described in Chapter 7, approximately 482 of those undeveloped parcels are estimated to have

wetlands. Of these 482 parcels, most are identified as the Currituck mucky peat soil series, with some in the Duckston fine sand and Osier fine sand soil series as well. Presence of wetlands is considered an unsuitable characteristic for the permitting of wastewater disposal. Any undeveloped parcel will have to be reviewed by a qualified individual to determine if a septic permit can be issued in accordance with State rules.

In August and September of 2020, Soil & Environmental Consultants, PA (S&EC) performed a limited soil evaluation at 108 locations within portions of the three PDAs. The intent was to conduct rapid site evaluations for accessible sites within the PDAs and review the soil and site conditions as related to permitting of on-site wastewater systems. This was performed in order to estimate how accurate the NRCS soil survey mapping units are as related to on-site wastewater disposal rules. S&EC traversed selected areas within each PDA and observed landforms (slope, drainage patterns, past use) as well as soil conditions (depth, texture, structure, seasonal wetness, restrictive horizons) using soil auger borings. These limited numbers of soil borings and observations were compared to the mapped soil series relative to subsurface disposal of wastewater. The soil boring locations were flagged and located by S&EC staff using a handheld GPS unit. Soil boring locations completed by S&EC are shown on the soil series maps included in Appendix 3 of this report. As described on the maps, the soil borings were labeled as PS (provisionally suitable); PS Fill (provisionally suitable with imported fill); and UN (unsuitable for regular septic systems).

As described above, similar soil series were combined into general groups of suitability for installation of septic systems. The soil series were combined into four general categories listed as: Always Suitable; Always Unsuitable; Marginally Suitable; and Usually Suitable. By utilizing this approach to compare to the field-collected data, it is estimated that the “Always Suitable” soils were approximately 73% accurate, the “Always Unsuitable” soils were approximately 32% accurate, the “Marginally Suitable” soils were approximately 22% accurate, and the “Usually Suitable” soils were approximately 72% accurate. It is important to note that this is based on 108 soil borings completed within the much larger PDAs and are not intended to draw conclusions regarding individual undeveloped parcels and their suitability for an on-site septic system. The findings of this analysis reveal that the NRCS Soil Survey Maps are not accurate enough at the scale needed for detailed site planning for on-site septic systems. As previously mentioned, each parcel would need to be evaluated by a qualified individual that specializes in on-site wastewater systems and permitting to determine development potential on a parcel-by-parcel basis.

Similarly, a comparison was made between the two general categories of septic tank suitability and data for 246 parcels with septic tank data provided by the Albemarle Regional Health Service staff (personal communication and data provided by Sandy Evans, Albemarle Regional Health Services, October 2, 2020). These results are summarized in Table 15 below and reinforce the conclusion that the Currituck County soil data do not provide accurate information for the field intensive evaluations needed for permitting.

Table 15: Site Classification from Currituck County Septic Tank Data

Soil Suitability from NRCS SURGO Mapping	Suitable or Provisionally Suitable for Septic Tanks: data provided by the Albemarle Regional Health Services	Unsuitable for Septic Tanks: data provided by the Albemarle Regional Health Services	Total
Suitable	65	7	72
Usually Suitable	102	10	112
Marginally Suitable	49	7	56
Unsuitable	5	1	6
Total	221	25	246

10.8. Pretreatment Systems

The NCDHHS-DPH-EHS-OSWPB has developed rules and regulations concerning the use of pretreatment systems. The intent of a pretreatment system is to reduce the biological and nutrient levels in regular septic effluent. These rules were established in 15A NCAC 18A .1970(a). The type of treatment is usually designed to meet one of the effluent quality standards specified in Table 16 below prior to dispersal of the effluent to the soil and shall comply with the requirements of these rules.

Table 16: Effluent Quality Standards for Different Types of Advanced Pretreatment Systems

Parameter	NSF-40	TS-I	TS-II
Carbonaceous Biochemical Oxygen Demand (CBOD)	<25 (mg/l)*	<15 (mg/l)	<10 (mg/l)
Total Suspended Solids (TSS)	<30 (mg/l)	<15 (mg/l)	<10 (mg/l)
Total Ammonia Nitrogen (NH3)		<10 (mg/1), or at least 80% removal of NH3 if influent TKN exceeds 50 mg/l	<10 (mg/l)
Total Nitrogen (TN) (TN is Total Kjeldahl Nitrogen plus Nitrate+Nitrite Nitrogen)			<20 mg/l or >60% removal
Fecal Coliform		<10,000 (colonies/100 ml)	<1,000 (colonies/100 ml)

**mg/l is milligrams per liter*

Pretreatment can be used on parcels that have limiting suitable soil conditions such as available space, depth to the water table, type of effluent, or soil type. Pretreatment may also be employed when parcels have off-site buffers or setbacks that may impact siting of an on-site septic system. These types of buffers could be coastal marsh wetlands, open surface waters, or canals. Also, when pretreatment is utilized on a septic system, the performance of that system is required to be monitored annually by a certified wastewater treatment facility operator (ORC). The ORC will complete a

performance report of the pretreatment system and a copy of the report will be submitted annually to the local health department. Types of monitoring and monitoring frequency varies by the type of pretreatment and the type of septic system.

The use of surface systems as permitted by NCDWR can require the use of pretreatment depending on the type of permitted system. NCDWR regulations discussing the permit requirements are set forth by either 15A NCAC 02T or by 15A NCAC 02U rules. The intent of pretreatment is to treat the wastewater to an acceptable standard prior to disposal by spray, drip irrigation, or infiltration. A surface system also requires an ORC and reporting documents along with site testing are specified in the permit as issued by the NCDWR. The NCDWR permitted systems normally have groundwater monitoring as part of the compliance review process as well.

10.9. Conclusions

With our general understanding of the natural soils within the three PDAs, there are suitable soils in some areas that will support an on-site septic system and there are also unsuitable soils that would not support a septic system. The NRCS Currituck County Soil Survey can be used as a general guide in preliminary planning; however, it is not adequate for the permitting of on-site wastewater septic systems or for permitting central systems reviewed by the NCDWR. When the soil survey was developed, it was made at a very large scale and the soils were classified on the dominant soil characteristics needed to develop a series. There are inclusions listed in each soil series which may have different characteristics affecting on-site wastewater disposal suitability. In addition, soil series units less than two acres in size cannot be mapped when preparing a county soil survey due to scale.

Revised growth projections for the Non-Road Accessible Outer Banks PDA estimate that an additional 28 parcels will be developed in this area under the Build Alternative, as compared to the No Build Alternative (Chapter 8). Similarly, revised projections for the Road Accessible Outer Banks PDA indicate an expected 206 additional parcels will be developed under the Build Alternative, including the two large settlement parcels comprising 117 acres. All new development in the Non-Road Accessible Outer Banks PDA is expected to utilize on-site septic systems. The 28 additional parcels projected in the Non-Road Accessible Outer Banks PDA represents a 3.1 % increase in residential development and associated septic systems compared to the No Build Alternative.

Results from GIS analysis indicate that approximately 76% of all undeveloped parcels in the Road Accessible Outer Banks PDA would be served by a wastewater treatment plant, while the remaining 24% would require on-site septic systems. From this and the revised growth projections, it can be estimated that 49 of the projected 206 additional parcels developed under the Build Alternative will require on-site septic in this PDA. Wastewater from the two large settlement parcels in the Road Accessible Outer Banks PDA will be served by the Ocean Sands wastewater plant.

In the U.S. 158 Interchange PDA, an additional 66 acres of commercial development are expected. All of this development will utilize on-site septic systems. Substantial areas of agricultural lands currently exist in this PDA which could be utilized for the development of required on-site septic systems.

These projections indicate a relatively modest increase in the number of on-site septic systems, as compared to that which would occur without the Project. Currituck County maintains a septic permitting system which serves to exclude development from sites where on-site wastewater

treatment capacity would be a concern. Current rules for the location and design of on-site systems can be more stringent than those applied to older systems depending on when they were permitted. This permit system presently exhibits a denial rate of approximately 10%, indicating that unsuitable sites are being avoided. Chapter 19 of this report identifies some additional improvements to the permitting process that could be implemented, if NCDWR or Currituck County determines that such actions are warranted.

11. Groundwater Lowering Measures

11.1. Purpose

The purpose of this chapter is to describe the present known extent and purpose of various measures being undertaken to lower groundwater on the Outer Banks of Currituck County and their implications for cumulative impacts on downstream water quality. This information has been evaluated on a regional planning level to address cumulative impacts on water levels and water quality that may occur as a result of planned and expected development over the next 20 years with the Project. Data sources to evaluate measures being undertaken to lower groundwater were based on field observations, review of the NCDWR non-discharge data, review of local documents, and interviews with local, representative officials from the NCDWR, Currituck County, and Dare County.

Groundwater pumping and groundwater lowering are done in some instances in association with non-discharge wastewater facilities, stormwater management measures, and in some cases, in relation to the location and placement of septic tanks and associated drain fields. In general, groundwater lowering measures include, but are not limited to, wells which pump the surficial groundwater to lower the seasonal high-water table. These facilities often discharge either to land or to a nearby pond or wetland. The overall purpose of using groundwater lowering in Currituck County is to maintain the vertical separation between the wastewater or stormwater treatment measures and the seasonal high-water table in order to ensure that proper treatment occurs throughout the soil profile. This separation is outlined in requirements from NCDWR for stormwater and wastewater treatment (NC Department of Health and Human Services, 2020).

11.1.1. Present Practice of Groundwater Pumping U.S. 158 Interchange PDA

As far as can be determined from State or local officials, groundwater lowering measures are not being employed in the U.S. 158 Interchange PDA and would not likely be needed since that area naturally has a water table with sufficient separation for wastewater or stormwater treatment.

11.1.2. Currituck County, Outer Banks – Road Accessible Outer Banks PDA

11.1.2.1. Non-Discharge Facilities

Five non-discharge wastewater facilities are present on the Outer Banks of Currituck County, south of Corolla (Figure 1 and Chapter 9). Of the five facilities evaluated south of Corolla, at least three (Hampton Street Pond, Monteray Shores and Ocean Sands (both at Timbuck II)) have NCDWR-permitted groundwater lowering devices associated with each non-discharge facility. These facilities are designed to discharge into surface ponds and the discharge is subsequently designed to infiltrate this water to local groundwater rather than have a surface discharge to Currituck Sound.

Site visits to each of these three locations were conducted on September 2, 2020, to document whether surface connections to Currituck Sound existed from these facilities to the Sound. The site visits determined that surface water connections through at least ephemeral channels or continuous wetlands[8] were present for the three facilities: Hampton Street Pond, Monteray Shores (near the Timbuck II Shopping Village) and Ocean Sands (also near the Timbuck II Shopping Village). Currituck County (Eric Weatherly, P.E. Currituck County Engineer, personal communication, August

[8] Note that these wetlands are also contiguous to Currituck Sound.

27, 2020) has been in discussions with NCDWR about the surface connection from the Timbuck II facility and plans are being developed to address this connection.

Finally, Currituck County supplied very limited water quality monitoring data from the Hampton Street Pond to the NCDWQ. This pond receives groundwater from the Whalehead Subdivision flood management system. In addition, the County supplied water quality monitoring data for the pond at Timbuck II (Robert Tankard, NCDEQ Assistant Regional Supervisor, personal communication, January 27, 2020). For the lower (southern) end of the Hampton Street Pond (before it drains toward Currituck Sound), 10 grab samples (basically annual sampling) were collected from December 20, 2011 through January 8, 2019 by County staff. Those samples resulted in average concentrations of total phosphorus of 0.24 mg/l and total nitrogen of 1.31 mg/l for the Hampton Street Pond and average concentrations for total phosphorus of 0.36 and total nitrogen of 2.9 mg/l for the Timbuck II pond. No surface water quality standards currently exist for total phosphorus, while 10 mg/l is the surface water quality standard for total nitrogen for human health consumption. Therefore, the water quality standard for nitrogen appears to be met in the pond, though the water quality sampling is very sparse. These very limited data appear to show minimally elevated concentrations of total phosphorus and total nitrogen in the ponds associated with groundwater discharges. This issue will not be affected by the construction of the Mid-Currituck Bridge project since this discharge is already in place with NCDWR approval.

11.1.2.2. Septic Tank-Related Purposes

According to the Albemarle Regional Health Services (ARHS) (Kevin Carver, Environmental Health Supervisor, personal communication, August 10, 2020), the County does not require permits for groundwater lowering, especially in relation to septic tanks and drain fields. The possible occurrence of groundwater pumping by individual property owners could not be confirmed and may not be present in the three PDAs.

11.1.2.3. Stormwater-Related Purposes

According to Currituck County (Eric Weatherly, P.E., Currituck County Engineer, personal communication, August 27, 2020), permits are not issued by the County for groundwater lowering measures for stormwater purposes. Further, the County is not aware of stormwater-related groundwater pumping along the Outer Banks in Currituck County. However, the NC Division of Water Resources reports that a groundwater lowering system for flooding in the Whalehead subdivision is present and discharges to the Hampton Street Pond (Randy Sipe, Hydrogeologist, NC Division of Water Resources, Washington Regional Office, personal communication, January 6, 2021). In general, the practice of groundwater lowering typically does not need a permit (except for those instances when it is associated with another permit) so its extent is unknown, especially with respect to stormwater management.

11.1.2.4. Effect of Sea Level Rise

As global sea level gradually rises over the next several decades, it is generally assumed that the local seasonal high water table level will also rise since groundwater levels generally reflect the local surface water. However, the effect of sea level on groundwater level diminishes as the distance from the sea and site elevation increase (Fetter, 2001). As a result, there is not a one-to-one correlation between sea level rise and the associated groundwater rise (in other words, if sea level rises one foot,

then the groundwater rise will likely be less than one foot). The suggested approach to address this gradual increase with respect to groundwater lowering is outlined in Chapter 19 of this report.

11.1.2.5. Effect on Wetlands

In addition to the potential water quality-related effects from discharge to surface waters, groundwater lowering has the potential to affect the hydrology of nearby wetlands. The potential for groundwater lowering to actually impact these wetlands depends primarily on local geology and other localized factors (such as soil properties, wetland composition, and discharge water quality). Three recent and well documented North Carolina examples are described below. In one instance, groundwater lowering resulted in hydrologic changes to adjacent wetlands while in two instances, no effect on nearby wetlands was determined. This issue would only be relevant in the context of the cumulative impact of the project if additional groundwater lowering was conducted for planned and expected development over the next 20 years as a result of the project. In that rather unusual case, NCDWR should consider the following information in terms of potential wetland impact. In most if not all situations, this effect would not be a result of the Project.

Emerald Isle, NC: Groundwater drawdown in urban/residential areas can be used as a safe and effective flood control method, if employed properly. This procedure was applied in the Emerald Isle community in Carteret County in the early 2000's (M&N, 2019a). The community was investigating alternatives to prevent localized flooding during hurricanes and major storm events. Engineers recommended groundwater drawdown 24 to 48 hours prior to a major storm event with the effluent being pumped to an adjacent coastal wetland (mostly a depressional swamp forest) with eventual discharge into Bogue Sound though a relatively narrow tidal marsh. Working with biologists who investigated the vegetation and aquatic life composition of the proposed receptor wetland, it was determined that if the pumped groundwater was allowed to discharge from the wetland within a 48 to 72-hour time period, the structural composition of the wetland would not be compromised. Three years of biological monitoring was undertaken by an environmental consultant (Ecoscience, Ltd.) to Moffatt & Nichol and no negative impacts to the wetlands were documented.

PCS Phosphate, Aurora, NC: PCS Phosphate operates a phosphate ore surface mining operation near Aurora, NC. PCS Phosphate lowers the groundwater by at least 150 feet to access the phosphate ore. During the 401 Water Quality Certification process for a mine expansion (NCDWR Project Number 20030447), concern was raised about the potential for the mining operation to affect the hydrology of nearby freshwater wetlands in the context of the State's wetland standards (15A NCAC 2B.231 (c) (6)). PCS Phosphate then conducted an intensive groundwater monitoring effort which showed that their groundwater lowering measures were not affecting the hydrology of nearby wetlands mainly due to the presence of numerous effective clay lenses beneath the wetlands which maintained the wetland hydrology, regardless of the groundwater lowering measures (Leggette, Brashears, and Graham, 1990).

Martin-Marietta Quarry, Rocky Point, NC: Martin Marietta operates a crushed aggregate quarry near Rocky Point, NC which lowers groundwater approximately two to five feet above the floor pit elevation, allowing access to crush shallow limestone for construction aggregates. This project required several permits from the State regulatory agencies including a 401 Water Quality Certification (NCDWR Project Number 20031023) and a mining permit. Due to concerns raised by local residents, the NCDWR required Martin Marietta to develop a groundwater monitoring plan that

focused on the potential effect of groundwater lowering on the hydrology of nearby wetlands. Since the monitoring confirmed that some adjacent wetlands had their hydrology altered as a result of the groundwater pumping, NCDWR required that the quarry implement a management strategy to restore the hydrology of nearby freshwater wetlands starting in 2002 (Eisenhardt, J., 2002).

11.1.3. Currituck County, Outer Banks – Non-Road Accessible Outer Banks PDA

According to Eric Weatherly, P.E. (Currituck County Engineer, personal communication, August 27, 2020), the County is not aware of groundwater lowering measures being utilized in the Non-Road Accessible Outer Banks PDA. There are no non-discharge wastewater treatment plants in this PDA and groundwater pumping by individual property owners has not been confirmed. Therefore, there is no verifiable evidence that groundwater pumping occurs in this area.

11.2. Legal Precedents

The U.S. Supreme Court recently rendered a decision on a groundwater-related case which has potential implications for groundwater lowering measures and related water quality issues with respect to land application of wastewater on the Outer Banks (*County of Maui, Hawaii v. Hawaii Wildlife Trust*, 2020). This case involved a facility designed to discharge treated wastewater to a land application system and whether treated effluent should be regulated as a point source discharge since the discharge traveled approximately one-half mile underground to the Pacific Ocean. Historically, USEPA regulated discharges to surface water rather than groundwater. In this case, the Supreme Court was asked to rule if this land application should be regulated as a point source discharge. The Supreme Court decided that a discharge permit could be required if it is the "functional equivalent of a direct discharge". This wording is rather vague, but the Supreme Court discussed consideration of various factors such as time and distance of the pollutant travel and that the Court expected lower courts to provide "additional guidance through decisions in individual cases." The Supreme Court remanded the decision to the Ninth Circuit Court of Appeals to decide on this new "functional equivalency" test for this facility. Finally, the decision explicitly mentioned septic tanks as wastewater treatment devices that should not be covered by this decision so presumably potential septic tank discharges would not be covered by this decision. If this decision is extrapolated to situations here in North Carolina, it could, in theory, apply to the non-discharge facilities in Currituck County on the Outer Banks.

11.3. Implications for the Mid-Currituck Bridge Project

In general, other than groundwater lowering devices directly associated with a non-discharge permit, NCDWR permits are usually not required for groundwater lowering to facilitate the treatment of treated wastewater or stormwater (Robert Tankard, NCDEQ Assistant Regional Supervisor, personal communication, January 27, 2020). Therefore, additional groundwater lowering measures in Currituck County for septic tanks or stormwater treatment may be present but NCDWR and the County are not aware of them. The prospect of this activity occurring on small, individually owned parcels is probably low since individual property owners are unlikely to be aware of the groundwater level on their property or the need to maintain vertical separation in the soil profile, and they would not be monitored under any present permit requirements. Given the on-going expense of managing a pumping and discharging operation, it is unlikely that many landowners would commit to such an effort without a legitimate need. It is likely that groundwater pumping would only be an issue with respect to the cumulative impact of the Mid-Currituck Bridge if additional groundwater lowering is

proposed at the known locations for the planned and expected development that would occur in the 20-year time frame of this study.

11.4. Conclusions

In general, little comprehensive information is available on the extent of groundwater lowering on the Outer Banks PDAs since only those groundwater lowering facilities directly associated with a NCDWR permit are required to monitor water quality or quantity. Groundwater pumping at these facilities would only be relevant to the cumulative impact from the Project if new or expanded groundwater lowering measures are proposed as a result of planned and expected development that would occur over the next 20 years with construction of the bridge versus the constrained development levels associated with the No-Build Alternative. It is not clear that the at most modest increase in demand which could occur at these wastewater facilities as a result of the Build Alternative would necessitate any comparable increase in groundwater lowering activity, or whether current efforts are adequate to satisfy any new demand. In addition, the very limited monitoring data available do not indicate that current activities are causing a violation of downstream water quality standards. Any future groundwater pumping measures, if any, at wastewater treatment facilities would be required to satisfy the permit and monitoring criteria established by NCDWR.

12. Effects of Sea Level Rise in the Three PDAs

12.1. Purpose

The purpose of this chapter is to analyze projected sea level rise within the three PDAs in Currituck County within a 20-year time frame, with a baseline year of 2020 and extending to 2040. This is a comparative analysis of potential sea level rise within the three PDAs and the potential effect that an increase in sea level might have on future planned and expected development which could result from construction of the Project over the next 20 years.

12.2. Background

An increase in sea level due to climate change may pose a substantial risk to coastal communities and low-lying areas (NCDEQ, 2020a). Coastal communities would likely be first to experience the consequences of sea level rise due to generally flat terrain and regional high-water tables. For the purpose of this analysis, the local effects of sea level rise were examined within three PDAs in Currituck County. This sea level rise evaluation was based on a GIS analysis which investigated the possible impact of sea level rise using Digital Elevation Models (DEM) (see Chapter 7 for discussion of the GIS processes). DEM data were retrieved from the NC Emergency Management (2019). The DEM developed for this study focused on localized flooding events along the coastline, low-lying areas, and properties adjacent to Currituck Sound.

Several studies that address different sea level rise scenarios were evaluated. The North Carolina Sea Level Rise Assessment Report, prepared by the North Carolina Coastal Resources Commission (NCCRC) in 2015, estimated that by 2040, sea levels would increase between 6.7 to 7.5 inches. Data were derived from the "global mean sea level rise projections with respect to 1986-2005 at January 1 on the years indicated, with uncertainty ranges for the four Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathways (modified from Table AII.7.7, IPCC 2013a)." However, the North Carolina Climate Risk Assessment and Resilience Plan in 2020 provided different time frames (North Carolina Department of Agriculture and Consumer Services *et. al.*, 2020). For example, this plan explained that sea level along the northeastern coast of North Carolina has risen approximately twice as fast as compared to the southeastern North Carolina coast, averaging 1.8 inches per decade since 1978 at Duck, and 0.9 inches per decade since 1935 in Wilmington, NC. The North Carolina Climate Science Report indicated sea levels have risen approximately 7 to 8 inches since 1900 and predicted a global sea level rise increase by 1.3 to 3.6 feet by 2100 depending on greenhouse emissions (Kunkel *et. al*, 2020). Additionally, the North Carolina Climate Science Report stated that, based on the 2019 IPCC report, "Depending on the rate of greenhouse gas emissions, global average sea level is projected to increase by 1.3 to 2.4 feet (moderate emissions scenario) or 2.0 to 3.6 feet (higher emissions scenarios) from 1900 to 2100" (Kunkel *et. al.*, 2020). Kopp *et al*. (2015) examined past and future sea level rise along the North Carolina coast and determined that between 2000 and 2030, sea level at Duck is expected to rise between 4.7 to 13.0 inches.

12.3. Current Understanding of Sea Level Rise Rates

Sea level rise rates vary locally due to location (spatial variations) and the time frame for analysis (temporal variations). Two important aspects affect spatial variation of sea level rise rates along

North Carolina coastlines. The first is vertical movement of the Earth's surface, while the second is the effect of the movement of water in the oceans (NCCRC, 2015).

Five tide gauges are located along North Carolina's coastline; the closest location to the Project is the USACE Field Research Facility in Duck, NC. Data from this location for 1978 through 2013 were available at the time of the NCCRC report. Data continue to be collected and recorded at this location. Long-term sea level change trends at this Duck station revealed a rate of sea level change of 4.57 millimeters (0.1799 inches)/year plus or minus 0.84 millimeters (0.033 inches)/year for the 36 years that data were collected (NOAA, 2014).

These tide gauges provide data for past sea levels in NC. The NCCRC used the IPCC's low greenhouse gas emissions scenario Representative Concentration Pathway 2.6 (RCP 2.6) and the high greenhouse gas emissions scenario (RCP 8.5) to model sea level rise. These IPCC values were then combined with the rate of vertical land movement (subsidence) determined by the analysis of tide gauge records and data provided by NOAA to determine the range of sea level rise rates across the North Carolina coast (Zervas *et. al*, 2013). Vertical land movement trends for Duck revealed the highest amount of subsidence at minus 1.49 millimeters (0.058 inches)/year plus or minus 0.39 millimeters (0.015 inches)/year over the 36 years that data were collected (1978-2013) (NCCRC, 2015).

Using tidal gauge rates from the USACE Field Research Facility in Duck, sea level by 2045 was forecasted to increase approximately 5.4 inches (with a range between 4.4 and 6.4 inches) at Duck (NOAA, 2014). With incorporation of the IPCC scenario RCP 2.6 and vertical land movement, sea level rise was estimated to be approximately 7.1 inches (with a range between 4.8 and 9.4 inches) at Duck (IPCC, 2013b). With the incorporation of the IPCC scenario RCP 8.5 and vertical land movement, sea level rise was estimated to be approximately 8.1 inches (with a range between 5.5 and 10.6 inches) at Duck (IPCC, 2013b). The 95% confidence interval for both scenarios ranged from 2.3 inches to 2.5 inches. These values reflect both uncertainty in the predictions and spatial variations that affect the nature of sea level. These three estimates are presented in the Science Panel Report which are affirmed in the 2013 and 2014 reports (NCCRC, 2015).

The time frame for the NCCRC analysis is longer than the 20-year time frame of this cumulative impact study: therefore, the NCCRC projections are unlikely to be met in our 20-year time frame, which makes these results somewhat conservative.

Previously, M&N prepared two memoranda addressing sea level rise as it related to establishing the appropriate bridge deck elevation over Currituck Sound (M&N, 2019b and M&N, 2019c). These memoranda also discussed several of the projections, described above, made by the NCCRC Science Panel, the USACE and NOAA, and used these calculations to determine the potential amount of sea level rise by the end of the bridge's 75-year lifespan (assumed to be 2101).

12.4. Methodology

Sea level rise was modeled in GIS using elevation raster data obtained from the North Carolina Emergency Management Spatial Data Download website (NC Emergency Management, 2019). Utilizing a mean sea level rise of 5.4 inches, 7.1 inches, and 8.1 inches, respectively, from 2015 to 2045, impacts of sea level rise were assessed on surface area elevations throughout each PDA in Currituck County. By this analysis, the Project team identified which areas of the local community

could be flooded under the three mean sea level rise scenarios. Moffatt and Nichol evaluated current elevation data and analyzed a 5.4-inch (0.137 meters), 7.1-inch (0.18 meters), or 8.1-inch (0.206 meters) rise in sea level, respectively, for each PDA using ArcGIS.

12.5. Results

Each scenario revealed that no areas within the three PDAs in the Project study area would be considered undevelopable given the current sea level rise projections (i.e., no areas would be consistently flooded or inundated under these sea level rise scenarios) (see Figures 12 through 15). The Town of Duck also conducted a local sea level rise analysis in its Draft Comprehensive and CAMA Land Use Plan dated July 2020. However, their analysis procedure is not consistent with the analysis in the NCCRC report. Therefore, the official state agency report was used for this analysis of the effect of sea level rise on this Project.

12.6. Conclusions

Based on this analysis, little to no observable effects of sea level rise were predicted for the three PDAs in the 20-year time frame of this study, with respect to increased flooding or inundation from a rise in sea level. Because current land elevations of developable parcels are higher than the observed and predicted sea level rise scenarios within this study, no observable effects of sea level rise on consistent flooding or inundation were identified in the GIS analysis. However, a high degree of uncertainty should be understood when dealing with sea level rise modeling and projections and the frequency of coastal flooding, as these issues may affect sea level rise differently. Coastal flooding and storm surge related flooding are addressed in Chapter 13 of this report.

The effect of sea level rise on septic systems, non-discharge wastewater systems, and groundwater lowering measures is a separate issue of concern. As local sea level gradually rises over the next several decades, it is generally true that the local seasonal high-water table level will also rise, but not in a 1:1 correlation with sea level elevations. The effect of sea level on groundwater level diminishes as the distance from the sea and site elevation increases (Fetter, 2001; pages 327-337). Sea level rise over the next 20 years was estimated to be in the range of 5.4 to 8.1 inches, under various scenarios. The subsequent rise in groundwater levels would probably be less than these predictions. Therefore, it is possible that a few septic drain fields for a few parcels may be affected by a small rise in groundwater levels. Revised growth projections for the two Outer Banks PDAs indicate that 77 additional septic systems are expected as a result of the Build Alternative, as compared to the No Build Alternative (28 in the Non-Road Accessible Outer Banks PDA and 49 in the Road Accessible Outer Banks PDA). Given current County rules for the approval of septic systems, it is likely that only a small fraction (if any) of these 77 systems would be at risk over the next 20 years. The Albemarle Regional Health Service program may want to consider this issue going forward with respect to their permitting. In addition, it is possible that a small rise in groundwater levels may result in additional demand for groundwater lowering at permitted wastewater treatment plants, to maintain the current level of groundwater separation. Such activities would fall under the regulatory authority of NCDWR. Possible considerations to address this gradual increase in groundwater level with respect to non-discharge wastewater facilities is outlined in Chapter 19 of this report, should NCDWR determine that such activities are warranted.

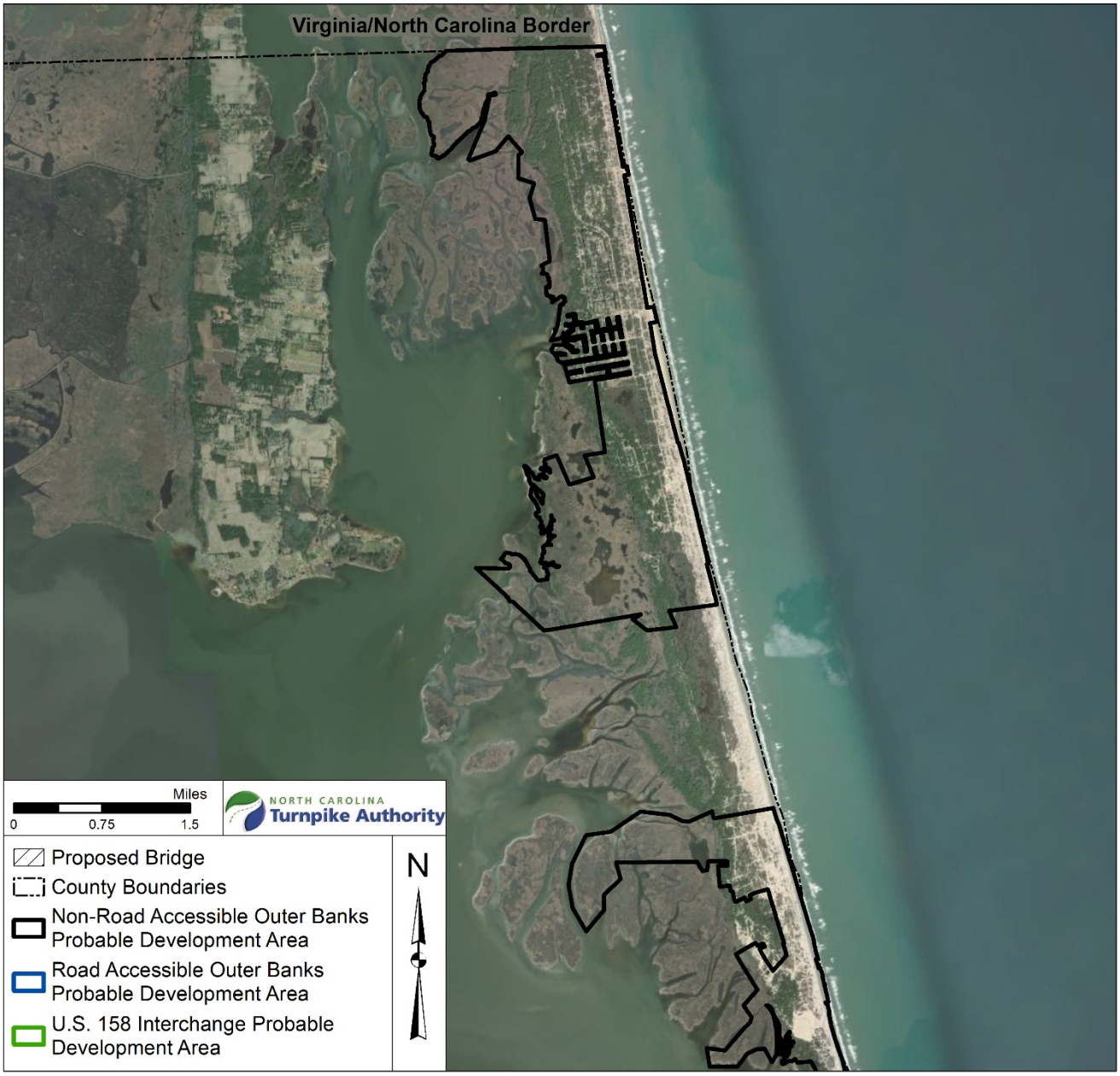

Figure 11: Sea Level Rise has no Observable Effect on the Non-Road Accessible Outer Banks PDA

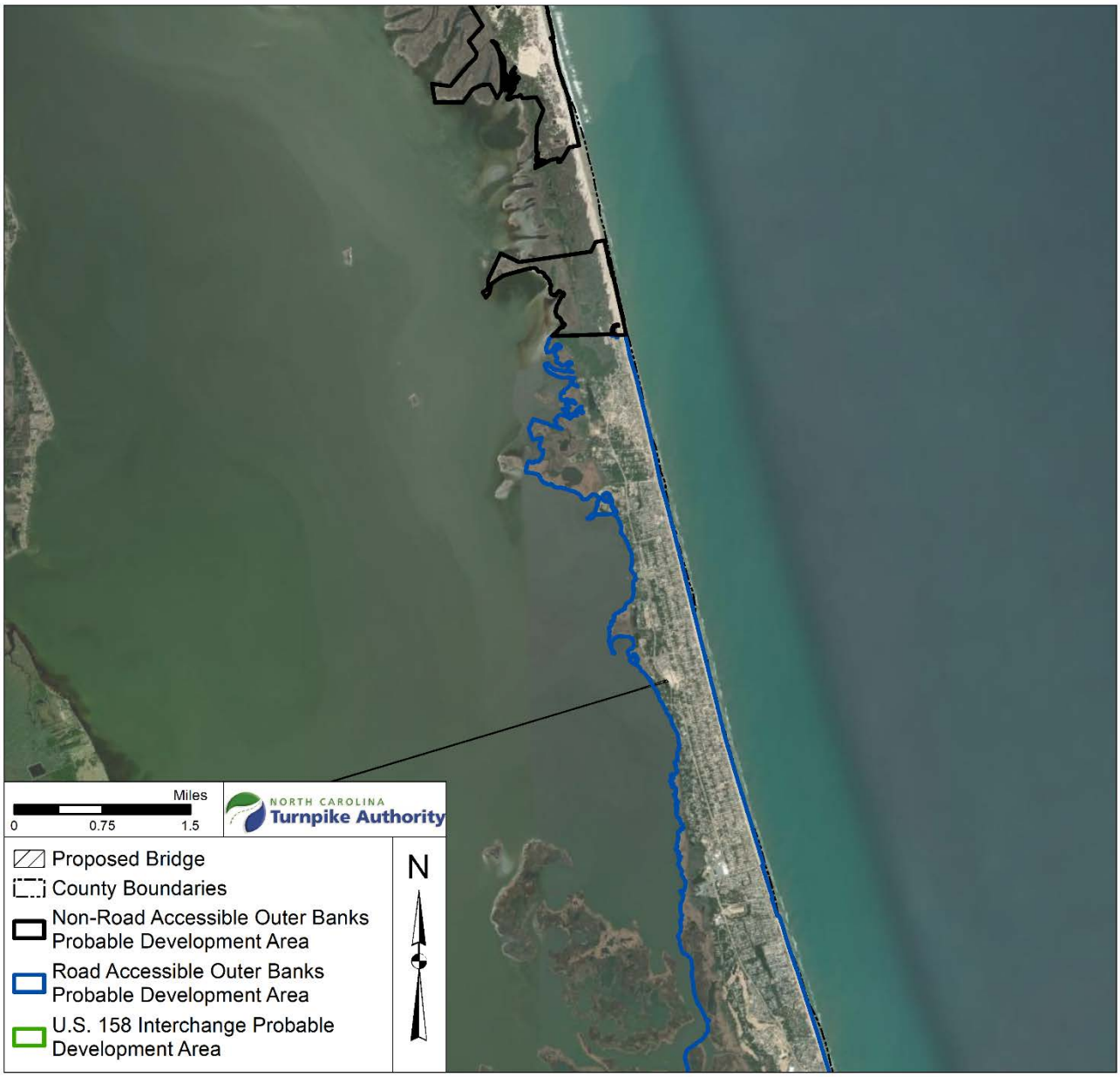

Figure 12: Sea Level Rise has no Observable Effect on the Road Accessible Outer Banks PDA (1 of2)

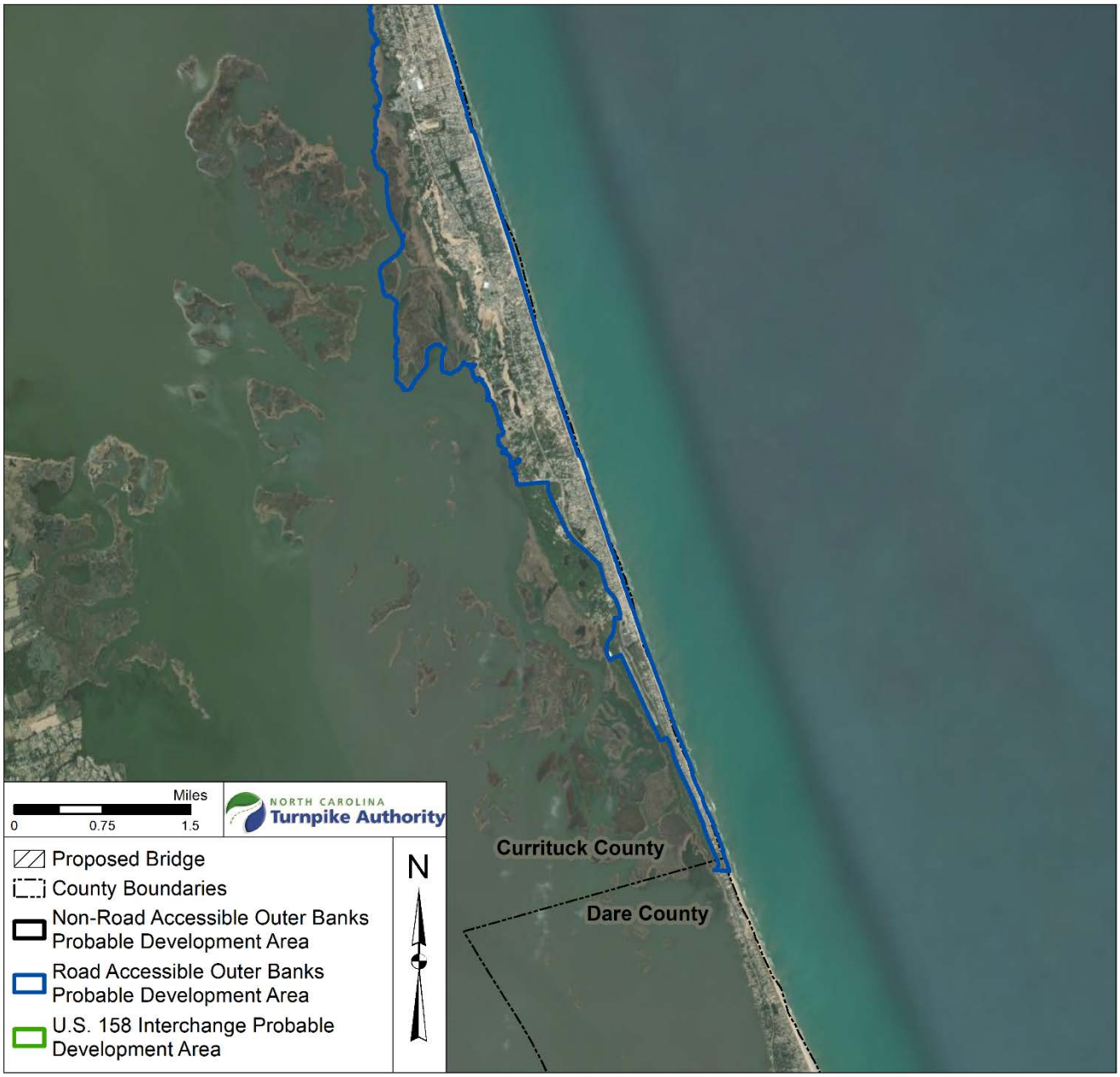

Figure 13: Sea Level Rise has no Observable Effect on the Road Accessible Outer Banks PDA (2 of 2)

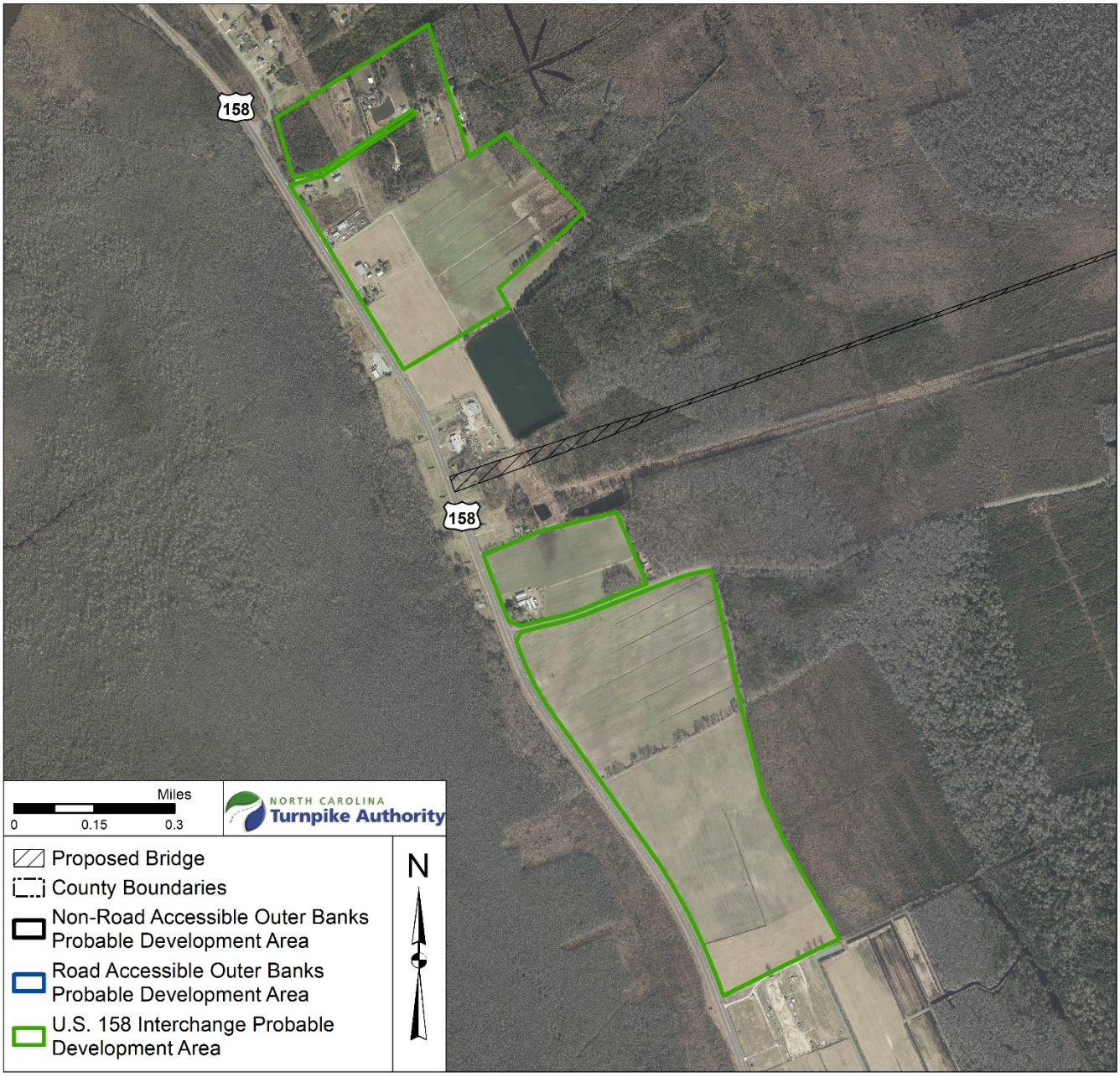

Figure 14: Sea Level Rise has no Observable Effect on the U.S. 158 Interchange PDA

13. Flooding

13.1. Purpose

The purpose of this chapter is to examine the frequency and extent of flooding in the three PDAs and how such flooding relates to existing State and local regulatory programs concerning floodwater management. Finally, this chapter examines how these programs would apply to planned and expected development resulting from construction of the Mid-Currituck Bridge Project. Chapter 19 of this report also examines potential regulatory options for NCDWR and/or Currituck County to consider while managing any development-related impacts of flooding that could be attributed to this Project.

13.2. Background

In Currituck County, water quality issues can result from and are related to localized flooding issues[9]. Localized flooding is typically associated with excess rain resulting from a tropical storm, Nor'easter, or hurricane event, or a series of consecutive heavy rainfalls (Eric Weatherly, P.E., Currituck County Engineer, personal communication, August 25, 2020). The local landform of the Outer Banks, which consists of low, flat islands or peninsulas spanning approximately one to three miles in width, creates locations where the rainwater and high groundwater can inundate large areas to flood depths of several feet (NCDWR and Currituck County, 2017). From a study conducted by GET Solutions, Inc. (2010), the groundwater table throughout the County was measured to occur at depths ranging from 1.5 to 4.7 feet below a variety of existing site grades. However, recent conversations with the Currituck County Soil/Stormwater Manager (Dylan Lloyd, personal communication, September 11, 2020) suggests that the groundwater table has fluctuated above normal ranges this current season (2020). Typically, floodwaters recede by infiltration and evaporation unless actively managed by surface pumping or drainage infrastructure such as roadside or community-wide ditches.

In Currituck County, flooding causes losses to property, restricts access for emergency vehicles and services, damages roadways, and results in human health concerns for those in the area. In severe conditions, it can take weeks for total recession of floodwaters. Standing water which persists for long periods of time can pose a health risk to humans with the potential for exposure to mold, bacteria, mosquito-borne diseases, and general nuisances.

Currituck County does not have a rigorous tracking system in place for known localized flooding locations but instead relies heavily on residential complaints and knowledge from their own experience to pinpoint flooded areas of concern (Eric Weatherly, P.E., Currituck County Engineer, personal communication, August 25, 2020). Some neighborhood drainage districts, with their own stormwater management plans, have been set up to maintain drainage improvements to the area as well. The County does rent portable pumps to handle localized flooding issues, and floodwaters are pumped directly into the Atlantic Ocean with standing permission from the State (i.e., NCDWR) (NCDWR and Currituck County, 2017). Floodwater removal by pumping on private properties is also done by some local residents on an ad-hoc basis (meaning only when necessary or needed), as well as by Homeowners' Associations in the area. Currently, an emergency pumping plan is in place that

[9] Note that stormwater is discussed in Chapter 14 of this report.

helps expedite this process (NCDWR and Currituck County, 2017). Typical pumping locations are noted in that plan.

The most significant flooding issues are in the unpaved portions of the areas north of Corolla in the Non-Road Accessible Outer Banks PDA, mainly due to lack of stormwater infrastructure (Eric Weatherly, P.E., Currituck County Engineer, personal communication, August 25, 2020). In the Road Accessible Outer Banks PDA, existing roadside stormwater swales are located along NC 12 and within neighborhoods. Additionally, localized ditches provide drainage throughout these neighborhoods and communities.

13.2.1. The U.S. 158 Interchange PDA

Currituck County staff are not aware of flooding issues in the U.S. 158 Interchange PDA. It is likely that the existing NCDOT stormwater infrastructure along U.S. 158 adequately handles floodwaters. Stormwater in this area drains to either Maple Swamp or Great Swamp, both of which provide substantial opportunity for stormwater retention and infiltration. Developable land in this PDA is not in a flood hazard area.

13.2.2. The Road Accessible Outer Banks PDA

For the paved area south of Corolla, a Currituck Outer Banks Emergency Pumping Plan was implemented and released on August 28, 2017 (NCDWR and Currituck County, 2017). This emergency pumping plan provides standing permission from the State (i.e., NCDWR) to address flooding issues by pumping surface floodwaters to the Atlantic Ocean. This pumping is reserved for extreme rainfall events and takes place in the paved areas south of Corolla. The plan specifies locations for temporary pumping stations. It also details how this emergency pumping should be accomplished, when the pumping should cease, how to initiate the pumping process, who is responsible for the pumping process, pump acquisition, pump size and equipment requirements, pumping protocol and labor requirements, and restoration of disturbed areas once the pump is removed (NCDWR and Currituck County, 2017). When pumping is approved, the discharge lines that span roadways are limited to help keep road corridors passable. If lines transect the roadways, this can create difficulties for emergency service vehicles and personnel, clean-up efforts, access for property owners, and timeliness of property assessment efforts.

Temporary pumping locations include:

- Six locations in the Carova Beach Subdivision,
- Two locations in the North Swan Beach Subdivision,
- Four locations in the Swan Beach Subdivision,
- One location in the Ocean Hill Subdivision,
- Three locations in the Whalehead Subdivision,
- Eight locations in the Ocean Sands Subdivision, and
- One location in the Spindrift Subdivision.

A total of 25 pumping locations as listed above have been identified in the Road Accessible Outer Banks PDA near Corolla, North Carolina.

Setting up a pump and discharge pipe requires a discharge pipe stabilizer, which acts to keep the pipe in the proper location, as well as an energy dissipater. The allowable discharge point is set back on the beach at a maximum of 60 feet from the ocean, which works to dissipate effluent energy (NCDWR and Currituck County, 2017). The energy dissipater consists of a wooden plywood pallet that is four-foot-by-eight-foot in size. Setup also requires warning signs to be posted on the beaches warning of storm water discharge that may increase the risk of waterborne illness for swimmers within 200 feet of the discharge pipe.

When pump operations are underway, a reporting form must be completed. The form includes the pump location, date placed, operator, start and stop time, number of hours, size of the pump, flow speed, flow volume, inches pumped (at suction), and tasks/comments. This form is submitted with the complete report package to NCDWR.

13.2.3. The Non-Road Accessible Outer Banks PDA

The area north of Corolla consists of sand roads with beach access reserved for four-wheel drive vehicles. Numerous unimproved roads are platted in this area and some are visible on maps. In extreme rain events, this area experiences erosion on the beach front and creation of ruts with deep water in the interior sand roads that can be unsafe for vehicles and pedestrians to pass through (personal experience of M&N staff during on-site field work in August of 2020) although flooding is generally temporary, minor, and localized.

Per the ARHS (ARHS staff, personal communication, August 10, 2020), stormwater management districts exist in this unpaved area. Typically, the districts are responsible for pumping floodwaters to the ocean as an emergency measure when flooding occurs in this area.

13.3. Storm Surge and FEMA Flood Insurance Mapping for Currituck County

Storm surge is a leading cause of flooding in Currituck County (Dewberry, 2018). Storm surges affecting Currituck County come from the Atlantic Ocean, as well as Currituck and Albemarle Sounds, depending on the approaching angle of storms in the area (Currituck County, 2020a). All significant storms, such as tropical storms, hurricanes, and post-tropical cyclones, can cause life-threatening storm surge in Currituck County (Currituck County, 2020a). Therefore, storm surge is included as a flood risk in the development of the flood maps which communicate flood risk (Currituck County, 2020a).

Flood maps for Currituck County are provided by the North Carolina Floodplain Mapping Program, which is part of the North Carolina Department of Public Safety (NCDPS) and works in conjunction with the Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) (Currituck County, 2018a). The current maps were prepared in 2018.

FEMA also provides flood hazard and risk data to participants in their NFIP and flood mapping is the basis of the NFIP regulations and flood insurance requirements (FEMA, 2020). The areas of storm surge inundation are reflected in these FEMA flood insurance maps. Figures 15 and 16 shows the FEMA mapping for the Road Accessible Outer Banks PDA with the locations of the wastewater treatment plants.

In 2018, Currituck County revised its Flood Ordinance section of the County's Unified Development Ordinance (UDO). This prompted the preparation of new flood insurance rate maps, which reduced

the number of properties located in special flood hazard areas in the County (Currituck County, 2018b). The Board of Commissioners examined this reduction of properties in special flood hazard areas and subsequently increased the required amount of freeboard from one foot to two feet. Freeboard is a term used by FEMA in their NFIP to represent a safety factor that is typically expressed in feet above the 1-percent-annual-chance of flood level (FEMA, 2020). Thus, this change in the ordinance provides greater protection for structures within the special flood hazard areas (Currituck County, 2018b).

According to the FEMA National Flood Hazard Layer (NFHL), wastewater treatment plant facilities and their components are located in the "Area of Minimal Flood Hazard (Zone X)" for the Road Accessible Outer Banks PDA. Zone X is defined as the 500-year area or 100-year flood areas with an average depth of less than one foot. Wastewater treatment plants do not exist and are not expected to be constructed within the foreseeable future in the Non-Road Accessible Outer Banks and U.S. 158 Interchange PDAs.

As indicated in Chapter 12, sea level is anticipated to rise by 5.4 to 8.1 inches by 2045. The current 100-year flood (storm surge) and 500-year flood elevations for the five wastewater plants, as shown on FEMA flood insurance mapping, are shown on Figures 15 and 16 for the Road Accessible Outer Banks PDA where the five wastewater plants are located. The Village at Ocean Hill wastewater treatment plant is located in the 100-year floodplain (1% Annual Chance of Flood Hazard Area), while the Pine Island/Currituck Club wastewater treatment plant is located in the 500-year floodplain (0.2% Annual Change of Flood Hazard Area). The Monteray Shores wastewater treatment plant is located in close proximity to the 500-year floodplain (0.2% Annual Change of Flood Hazard Area). The facilities at Corolla Light and Ocean Sands are not located in a flood hazard area. The Corolla Light facility has been decommissioned and is no longer in use to treat wastewater. Instead, the wastewater has been tied to the Monteray Shores facility and is treated there.

Therefore, based on these elevations, none of the five plants are at risk of being inundated by sea level rise within the 20-year time frame of this study. Three of the five plants are not at risk of being flooded or damaged by the current 100-year flood (storm surge) or the current storm surge plus sea level rise. For the remaining two, the wastewater treatment facility at the Village at Ocean Hill in Corolla is approximately 1.5 to 2.5 feet above sea level with no apparent protective berm. The Pine Island wastewater treatment facility in Corolla is situated approximately 4 to 5 feet above sea level and also does not appear to have a protective berm. As such, both are currently below the 100-year storm surge elevation and could flood or be damaged during a 100-year storm surge. The Pine Island facility is at a higher elevation and is at a less risk from lower storm surge levels than the Village at Ocean Hill facility. Recommended actions that could be used to address these elevation related issues are described in Chapter 19.

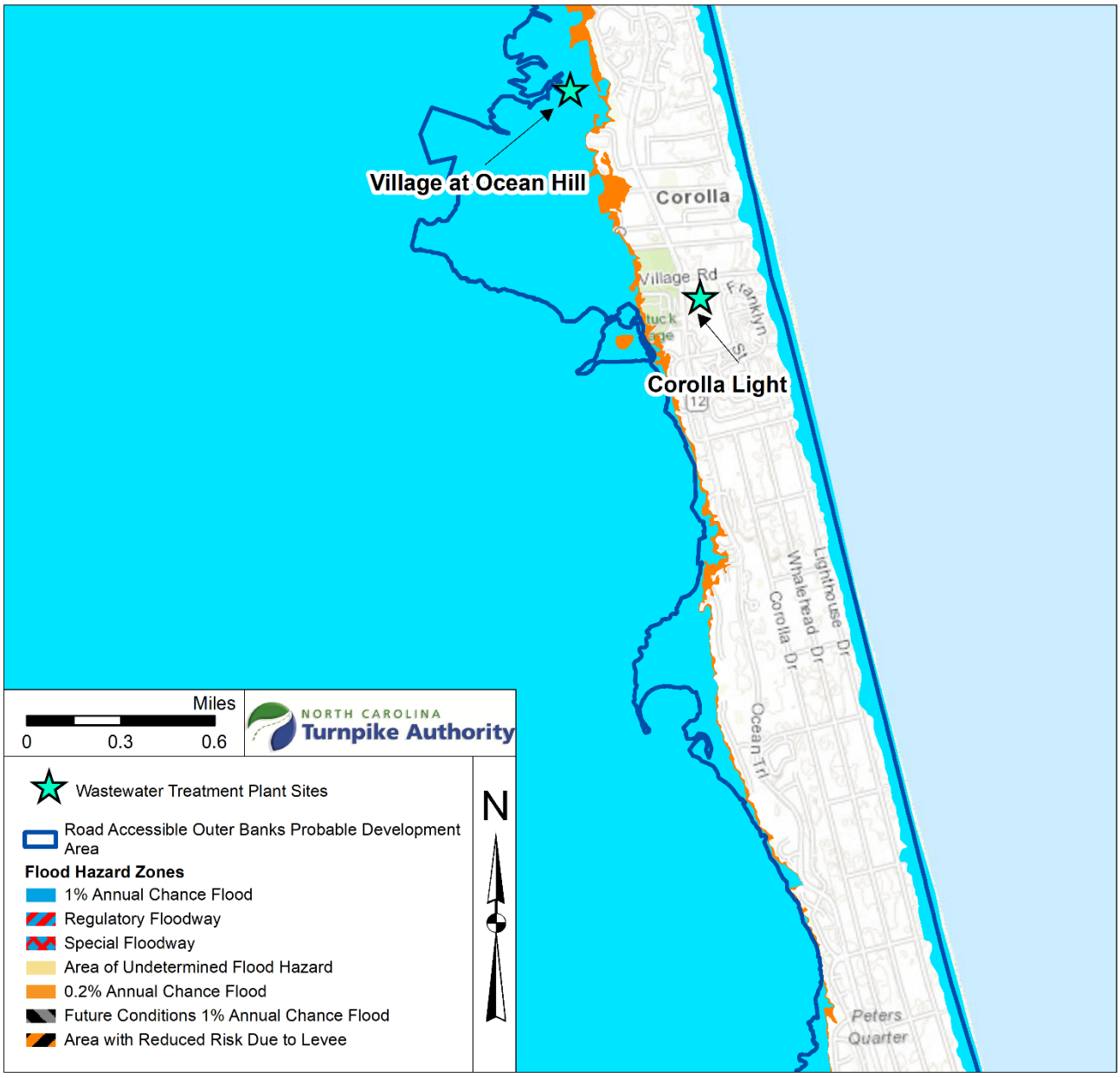

Figure 15: Map of the National Flood Hazard Layer and Two Wastewater Treatment Plants in the Road Accessible Outer Banks PDA

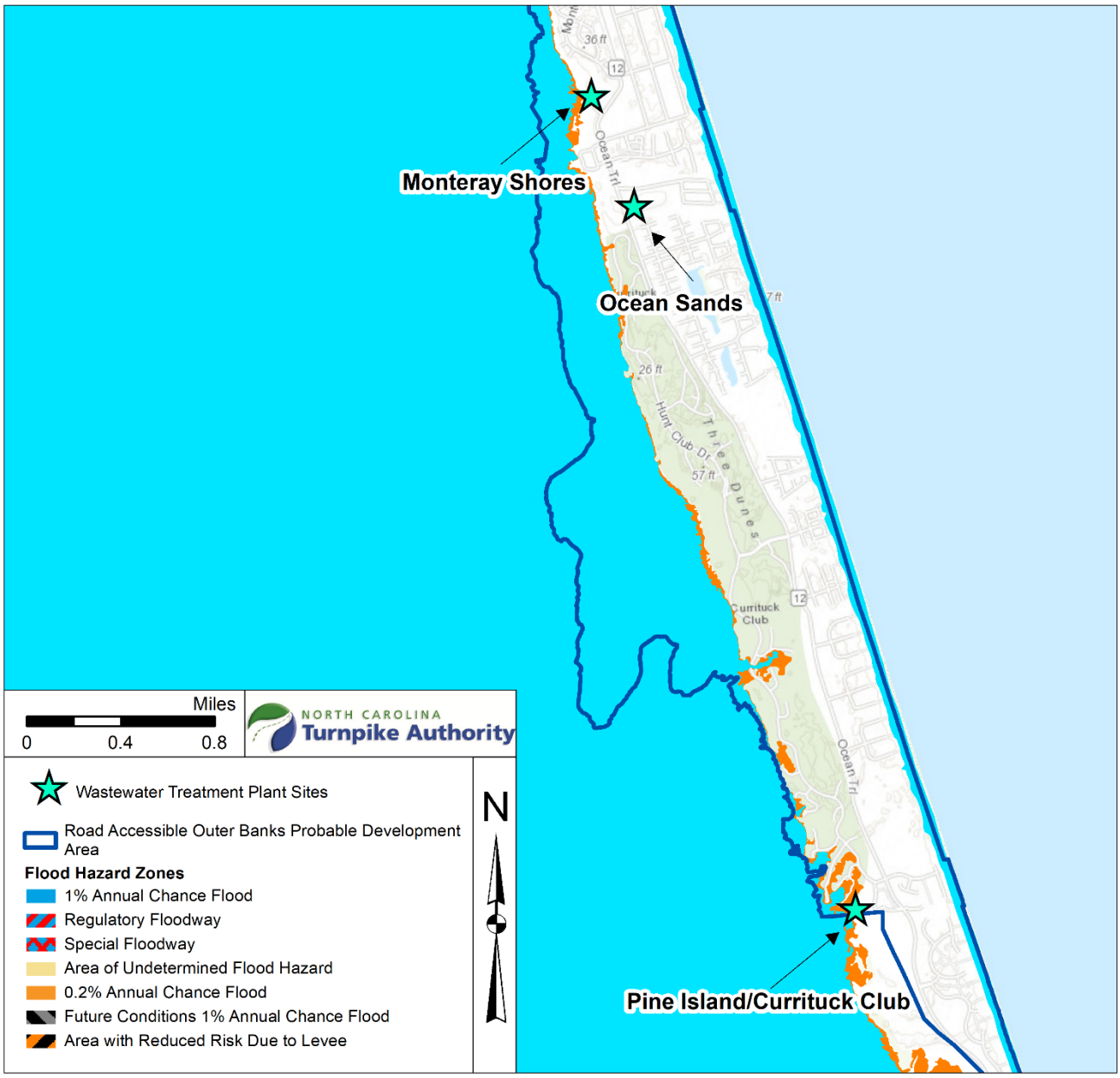

Figure 16: Map of the National Flood Hazard Layer and Three Wastewater Treatment Plants in the Road Accessible Outer Banks PDA

13.4. Previous Localized Planning Efforts

As outlined below, several studies have been conducted in both Currituck and Dare Counties to identify local flooding locations as well as appropriate locations to pump floodwaters where the pumping could be properly managed. Studies have also identified areas of flooding and water quality issues from outfall structures (M&N, 2016b). The work done in these studies identified BMPs to address these localized flooding, water quality, and stormwater management issues. These studies demonstrated that practical, effective stormwater and flooding management can be achieved on the

Outer Banks but will require intensive study and design beyond the scope of this cumulative impact study.

One such study was conducted by M&N (2016b) in coordination with the North Carolina Department of Environment and Natural Resources (NCDENR). The study examined NCDOT ocean outfalls in Dare County and resulted in development of a pilot stormwater project that aimed to identify better management strategies for these ocean outfalls and associated outlets. As the coast continues to experience development, there is evidence for increased pollutant loads from these outfalls that also enter the ocean. The pilot project studied ways to implement new and innovative technology including improved filtering mechanisms to enhance effluent water quality (from pollutants such as bacteria) from these outfalls that then discharge into the Atlantic Ocean. Challenges in the effort to improve these technologies include the relatively large drainage areas and high groundwater tables with low landscape relief. In order to advance these technologies, other well-known techniques like filtration and infiltration will likely be utilized for water quality improvements and developed on a site-by-site basis. Additional details can be found in M&N, 2016b.

Another study, also conducted by M&N (2010b), focused on a neighborhood scale, specifically the Whalehead Subdivision at the northern end of Corolla, that was experiencing flooding due to low topography, shallow water tables, and development beyond the capacity of the natural drainage system to handle runoff. This study aimed to evaluate the creation of bio-retention areas along with groundwater pumping (lowering) prior to impending storm events to allow the area to become more conducive to stormwater infiltration. It was determined that pumping stormwater to soundside ponds was the most effective option to reduce overland flood depth and volume[10] during a storm event. M&N also reviewed areas outside of these proposed infiltration systems and designed surface collection systems, known as “Hot Spots”, that would provide even more relief by pumping the localized floodwater to the infiltration basins. M&N worked with the County and Drainage Board to receive funding for implementation and operation of these systems. Projects were funded by a self-imposed tax for the drainage district by Currituck County for the Whalehead subdivision.

13.5. Conclusions and Recommendations

Flooding in the Outer Banks is not a novel issue but continues to be a concern as a result of the changing landscape of the area and sea level rise associated with climate change. Flooding along the Outer Banks typically occurs as the ponding of heavy rainfall events or storm surge associated with hurricanes and tropical storms. Future development will result in small amounts of additional impervious surface cover (Chapter 8) and may then add to the frequency and severity of localized flooding on the Outer Banks although the existing stormwater drainage infrastructure in the Road Accessible Outer Banks PDA should be adequate to handle the localized, additional stormwater in this area. Impervious surface added by new development would be marginally greater with the Build Alternative than the No-Build Alternative.

Increases in impervious surfaces or lack of drainage infrastructure may exacerbate flooding problems and contribute to increased runoff, but they are not causative factors of flooding. Whether the project will increase ponding or the need for additional pumping is unknown at this time. Pumping is often

[10] Note that groundwater lowering is addressed in Chapter 11 of this report.

done before storm events and the impacts, if any, on the Sound or Atlantic Ocean would need additional study to identify. These issues may require NCDWR review and consideration.

As noted above, developable land in the U.S. 158 Interchange PDA is not in a flood hazard area. The U.S. 158 Interchange PDA does not presently exhibit flooding issues and will not be likely to in the future. NCDWR currently monitors the floodwater pumping program administered by Currituck County along the Outer Banks. Floodwater pumping is performed at designated locations, and all pumped floodwaters are discharged to the Atlantic Ocean, so there are no impacts to Currituck Sound. Such occasional pumping of floodwater, monitored by NCDWR, is not likely to cause a violation of downstream water quality standards, with or without the Project. Similarly, the Project will not affect the current storm surge risk of the five non-discharge wastewater facilities in the Road Accessible Outer Banks PDA. Floodwater management options which could be implemented by Currituck County, as needed, to address on-going concerns are provided in Chapter 19. On the Outer Banks, innovative approaches and proactive management may be required in the future to deal with floodwaters and stormwater runoff on the Outer Banks with or without the Mid-Currituck Bridge (see Chapter 14 which discusses stormwater management).

14. Stormwater Management

14.1. Purpose

The purpose of this chapter is to examine existing state and local regulatory programs concerning stormwater management and how they would apply to planned and expected development that may occur with construction of the Mid-Currituck Bridge within the next 20 years. This Chapter will also assess any changes to impervious surface coverage in the three PDAs, which are expected to occur under the Build Alternative, as compared to the No-Build Alternative. Any direct impacts of stormwater from the bridge itself are addressed in the stormwater management plan for the Project. In addition, Chapter 19 of this report examines potential practical regulatory considerations for NCDWR and/or Currituck County to consider, if necessary, to manage any impacts of stormwater that are attributable to this Project.

14.2. Background

Stormwater runoff is well known to be an important contributor to degraded water quality (USEPA, 2020a and b). Stormwater is known to contribute nutrients and bacteria to downstream waters, which have been identified as general pollutants of concern for Currituck Sound and the Atlantic Ocean (Chapter 6 of this report). Stormwater runoff and its resulting water quality issues have been directly linked to impervious surfaces and the resulting increase in runoff (USEPA, 2020a and b). In the case of this Project, stormwater runoff from additional planned and expected development may have the potential to impact the water quality of Currituck Sound, its tributaries, and perhaps the Atlantic Ocean. As described below, various federal, State, and local rules have been developed and implemented to manage and treat stormwater runoff to reduce its impact on downstream waters.

14.3. Regulatory Overview of Stormwater Management

The federal Clean Water Act (CWA) was passed by the U.S. Congress in 1972 (33 U.S.C §§ 1251 et seq). The initial focus of the CWA was on wastewater treatment, and considerable regulatory attention and funding was directed at improving those discharges and reducing their impact on downstream waters, primarily through the NPDES permitting program (33 U.S. Code § 1342)

Less attention was initially paid to non-point sources of pollution, such as stormwater. However, in 1990, the USEPA started regulating stormwater discharges and encouraged the states to do likewise (USEPA, 2020c). Since then, a robust program of regulating stormwater runoff has been developed as state and local governments have worked to implement regulatory and non-regulatory programs focused on stormwater. In North Carolina, a complex and comprehensive stormwater management program has evolved which now covers about half of the state (NCDEQ, 2020b). The components of that program that are relevant to the Mid-Currituck Bridge Project are discussed below.

North Carolina has developed a detailed stormwater design manual (North Carolina Division of Energy, Mineral, and Land Resources (NCDEMLR, 2020c)) which provides engineering details on the latest, practical designs for a wide variety of stormwater control measures including wet detention ponds, bioretention, and stormwater wetlands. This manual is regularly updated to reflect the current state of science and engineering with respect to stormwater management. In addition, the manual is widely used across the state by local stormwater programs including Currituck County (Currituck

County, 2020b) and should be considered a critical, technical resource for all stormwater management programs in North Carolina.

14.4. Existing State Stormwater Programs in North Carolina

14.4.1. Division of Energy, Mining, and Land Resources – Coastal Stormwater Rules

The NCDEMLR administers rules which govern development in the 20 coastal counties of North Carolina (including Currituck County) as defined in 15A NCAC 2H .1019 (NC DEMLR 2020b). These rules apply to developments which drain to SA (commercial shellfishing) areas. Since Currituck Sound is classified as Class SC, these rules do not apply to development in the Project area's three PDAs. NCDEMLR also has a Universal Stormwater Rule (15A NCAC 2H.1020 (g)) which requires impervious surfaces to be at least 30 feet away from the shoreline for redevelopment, or 50 feet from the shore for new development (Annette Lucas, Environmental Engineer, NCDEMLR, personal communication, August 28, 2020). The 30-foot setback is similar to the NCDCM's development-focused setback (NCDCM, 2020).

14.4.2. Division of Energy, Mining, and Land Resources Programs – Other Stormwater Rules

The USEPA began Phase I of the NPDES Municipal Separate Storm Sewer System (MS4) stormwater programs in 1990 for large and medium sized municipalities (NCDEMLR, 2020a). That program was expanded in 1999 to include 122 smaller North Carolina municipalities as the Phase II program, which includes Elizabeth City but not Currituck County. This program has a list of six minimum requirements that all municipalities must include in their programs. These requirements are 1) Public Education & Outreach, 2) Public Involvement & Participation, 3) Illicit Discharge Detection & Elimination, 4) Construction Site Runoff Controls, 5) Post-Construction Site Runoff Controls, and 6) Pollution Prevention & Good Housekeeping for Municipal Operations. In addition, the state conducts audits of these programs to help ensure that they are effective.

Other parts of the state have NCDWR-based stormwater rules for specific waters such as riparian buffers in the Neuse and Tar-Pamlico basins, water supply protection rules, and rules for Outstanding Resource Waters and High-Quality Waters. None of these rules apply to the PDAs for this Project.

14.4.3. NCDWR 401 Water Quality Certification Conditions

401 Water Quality Certifications are issued by the NCDWR under Section 401 of the CWA and under the rules outlined in 15A NCAC. 2H. 0500. This Certification is required for projects that impact streams and wetlands and require a permit issued by the USACE under Section 404 of the CWA. This program can require on-site stormwater management for projects. However, if the development does not require a 404 Permit, then the 401 Water Quality Certification rules are not triggered, and on-site stormwater would not be required unless other state or local rules require stormwater management.

14.4.4. Existing Local Government Stormwater Rule

14.4.4.1. Other Parts of North Carolina

Other municipalities in North Carolina have adopted city-specific stormwater-related rules beyond the minimum required by the NPDES MS4 program. For instance, the City of Durham has added an additional 10 feet to the state-required 50-foot buffers, while the City of Hendersonville, Orange

County, the Town of Chapel Hill, and the City of Charlotte each have their own buffer rules. These rules tend to be adopted under the general zoning and subdivision authorities that these jurisdictions have under State law.

14.4.4.2. Currituck County

Currituck County stormwater plans are separated into two categories and two zones. The two categories of stormwater management plans are the Minor Stormwater Plan and Major Stormwater Plan. The two zones outlined in the Currituck Stormwater Management Plan (Currituck County, 2020b) are the Outer Banks Zone and the Mainland Zone.

A Minor Stormwater Plan (form SW-001) is used during development of "individual single-family lots or minor subdivisions in the Outer Banks zone, where lot coverage is above the maximum allowed…". (see discussion below). Currituck County's Unified Development Ordinance (UDO), especially Chapter 7.3 of the UDO, sets forth certain thresholds that help determine whether a Minor Stormwater Management Plan is needed. If new or existing single-family residential lots are above the thresholds outlined in Table 17, then a Minor Stormwater Management Plan is needed. Lot sizes must be at least 10,000 square feet, and above the allowable impervious coverage (such lots above 45% impervious surface may have an additional 15% impervious cover, up to the increased thresholds as noted in Table 17), before requiring a plan. Furthermore, a stormwater plan is required for new or existing lots, and new minor subdivisions that require fill above existing grade.

Table 17: Allowable Impervious Cover on Residential Lots (Currituck Co. UDO)

Lot Size	Allowable Impervious Cover	Allowable Cover with Stormwater Controls (Minor Stormwater Plan)
< 10,000 sq. ft.	45%	60%
10,000 – 19,000 sq. ft.	35%	50%
> 19,000 sq. ft.	30%	45%

A Major Stormwater Plan is required for major subdivisions and major site plans. The Stormwater Manual also requires a major plan for development or expansion on a nonresidential, multi-family, or mixed-use lot with 5,000 square feet or more of impervious coverage or resulting in 10% or more total impervious coverage (based on lot size). Lastly, a Major Plan is required for the development of major subdivisions.

Currituck County has laid out certain exemptions for activities that would not require a stormwater management plan. These exemptions are covered under Section 2.2.3 in the Currituck County Stormwater Management Plan and are also listed below, for reference.

- Improvements or additions made to existing single-family residential lots resulting in total impervious cover less than the thresholds set forth in Table 16,
- Improvements or additions made to lots with an approved stormwater permit, which do not exceed the allowable coverage,
- Any new single-family residential lot developed having total impervious cover less than the thresholds set forth in Table 17, and less than 10,000 square feet of impervious cover,

- Any new or existing lot that proposes fill below the maximum allowed,
- Any minor subdivision located within the mainland that proposes fill below the maximum allowed,
- The division of five or fewer additional lots with an average lot size greater than three acres located within a single-family residential subdivision platted prior to January 1, 2013, and
- Development or expansions of a non-residential, multi-family, or mixed-use lot by less than 5,000 square feet of impervious surface or resulting in less than 10% impervious coverage.

Currituck County recommends BMPs "to minimize the adverse effects of development on the surrounding environment". The Currituck County Stormwater Manual lists twelve different options for selection of appropriate BMPs, and lists a corresponding application for each, matching up specific BMPs with specific site conditions. For example, stormwater wetlands are recommended for large commercial or residential developments with adequate space and a reliable water source. In addition, these BMPs are also suitable for flat sites and sites with a high-water table. Another example is riparian stream buffers, which are recommended only for the mainland of Currituck County because these are "ideal for small areas adjacent to perennial or intermittent streams and developments where natural areas and trails are planned". More information can be found in Chapter 3.1 of the Currituck County Stormwater Manual (Currituck County, 2020). Fill is allowed with requirements and limits as summarized below:

1. When two or more adjoining properties exhibit consistently higher elevations, fill may be used on a lot being developed or redeveloped to achieve consistency with adjacent grades,
2. Fill may be used when the placement of fill is located at least 100 feet from all lot lines, and
3. A lot shall not be filled or graded higher than the average adjacent grade of the first 30 feet of adjoining property. Through approval of an alternative stormwater plan the following exceptions are allowed:
    a. When ARHS determines that fill is necessary for a septic system to function properly. The maximum fill area shall be limited to the septic system and drain field areas and shall not exceed 24 inches. An additional 12 inches of fill above the septic system and drain field may be allowed for the house pad to ensure adequate flow from the building to the septic system.
    b. On the mainland, fill may be required to raise the lot elevation to the regulatory flood protection elevation.
    c. When fill is required to raise the lot elevation to the regulatory flood protection elevation, not to exceed a maximum of three feet.
    d. When fill is essential to meet the required building pad elevation as shown on approved construction drawings or stormwater plans.

Low Impact Development (LID) is a program started by Currituck County to promote sustainable and environmentally friendly development. The program was created with six objectives in mind:

1. Conserve natural resources,
2. Minimize impact,
3. Optimize water infiltration,
4. Create multifunctional and multipurpose landscapes,
5. Focus on small scale development and create areas for local stormwater storage and treatment, and
6. Build capacity for maintenance.

According to Currituck County, "LID offers a potential range of techniques and BMPs, both structural and non-structural, to prevent adverse stormwater impacts from new development and to address some stormwater problems in existing communities through retrofit opportunities" (Currituck County, 2020b). For more information on the program, refer to Section 4.0 of the Currituck County Stormwater Manual. (Currituck County, 2020b).

14.4.5. Existing Stormwater Infrastructure in the PDAs

The County Engineer was interviewed about the present status of stormwater infrastructure in the three PDAs (Eric Weatherly, P.E., Currituck County Engineer, personal communication, August 27, 2020) as well as any plans for improvements in these areas.

Existing stormwater infrastructure in the U.S. 158 Interchange PDA is limited to roadside ditches along U.S. 158 which then drain either to the west toward Great Swamp (and eventually to North River) or drain to the east toward Maple Swamp (and eventually to Currituck Sound). The County stormwater rules would apply for any commercial development that exceeds the impervious surface requirements in the rules. Maintenance of any on-site stormwater facility would be the responsibility of the landowner.

Existing stormwater infrastructure in the Road Accessible Outer Banks PDA is limited to roadside swales along the paved roads. Planned and expected residential development in this area generally has little to no site-specific stormwater management measures other than draining to the nearby paved road. Commercial development in this area is similarly designed to drain to the nearby paved road. The County has no specific plans for stormwater infrastructure improvements in this area. Any new residential or commercial development would need to comply with the existing County rules. It is unlikely that planned and expected residential development would have to provide on-site stormwater management based on the existing rules. There has been some discussion in the Ocean Hill subdivision about a more formal stormwater management approach, but no decision or action has been made or taken. It is unlikely that the planned and expected development in this PDA over the next 20 years would have any significant effect on stormwater management in this PDA. In fill development in existing neighborhoods will utilize the roadside drainage systems that are in place now. In addition, as described earlier, the two large parcels that are subject to a settlement agreement with the County will probably be required by the County to have on-site stormwater management.

Existing stormwater infrastructure in the Non-Road Accessible Outer Banks PDA is essentially non-existent since the mainly unpaved roads in this area do not generally have specific drainage design. Residential development in this area generally has little to no site-specific stormwater management measures other than draining into the sandy substrate. The County has no specific plans for stormwater infrastructure improvements in this area. Any new planned and expected residential or commercial development would need to comply with the existing County rules. It is unlikely that new residential development would have to provide on-site stormwater management based on the existing rules.

14.4.6. Implications of Existing State and Local Stormwater Permitting Programs for Planned and Expected Development Attributable to the Mid-Currituck Bridge

As outlined in Chapter 7 of this report, there are an estimated 2,283 developable lots in the Project area's three PDAs, plus the potential for an additional 1,825 homes and hotel units in the two large undeveloped parcels that are subject to the settlement agreement discussed in Chapter 7. However as noted earlier, not all of these parcels will be developed in the 20-year time frame of this report. In the U.S. 158 Interchange PDA, it is expected that 68 acres of mostly commercial development will occur on the existing six lots. In the Outer Banks PDAs, the resulting growth will be mainly residential in nature, with about 535 developable lots available in the Road Accessible Outer Banks PDA and about 1,742 developable lots available in the Non-Road Accessible PDA. It is expected that that most of the Non-Road Accessible Outer Banks PDA will remain undeveloped with or without the Mid-Currituck Bridge. Less than 10% of the available parcels in this PDA are projected to be developed in the 20-year time frame of this study (Chapter 8). New development that does take place in this PDA is expected to occur primarily along the Atlantic Ocean beach-front and the first rows back from the beach, as well as on Currituck Sound, particularly in the area of the finger canals leading from the sound to some parcels. In addition, as discussed in Chapter 7, the two large, undeveloped parcels in the Road Accessible Outer Banks PDA that are subject to the settlement agreement could have up to 1,825 additional homes and hotel rooms. According to the Currituck County Planner (Laurie LoCicero, Currituck County Planner, personal communication, September 22, 2020), it is unlikely that full development of the land uses planned for these two parcels will occur since they would now have to meet current stormwater management requirements, which are likely to utilize portions of the parcels.

14.4.6.1. Projected impervious surface increases comparing the present condition, to the No Build and Build Alternatives

Chapter 8 presents a detailed analysis comparing the Build to No-Build Alternative. As part of that analysis, the existing level of impervious surface was determined, as well as how that might change with the No-Build and Build Alternatives. This analysis is summarized below, as detailed in Chapter 8.

Tables 4 and 5 from Chapter 8 summarize the expected percent impervious surface and the percent of total parcels developed for the Existing, No-Build Alternative, and Build Alternative over the next 20 years for the Outer Banks PDAs. In general, in the next 20 years, the Non-Road Accessible Outer Banks PDA will remain mostly undeveloped with a low percent impervious surface (approximately 2% overall impervious surface coverage for both the Build and No Build Alternatives). The Road Accessible Outer Banks PDA is projected to have an incremental increase in impervious surface from

the existing condition of approximately 21.2% to 26.2% impervious surface, as developable parcels get developed under the Build Alternative. This reflects the predominately residential nature, both current and projected, of this PDA. The No Build Alternative is projected to exhibit 23.3% impervious coverage in 2040. Thus, the Build Alternative is projected to increase the impervious surface in this PDA by 2.9% of the watershed area over that which would occur without the Project. Almost 70% of the estimated 2.9% difference in impervious coverage between the Build and No Build Alternatives can be attributed to the development of the two large parcels in the Road Accessible Outer Banks PDA that are subject to the settlement agreement. Future development of these parcels will likely require implementation of on-site stormwater management to comply with current County stormwater rules, which should reduce downstream water quality impacts.

Under the Build Alternative, the U.S. 158 Interchange PDA is predicted to have approximately 15.6% impervious surface in a localized concentration of development within an otherwise rural watershed that currently has much lower levels of impervious surface coverage. Expected commercial development in this PDA is projected to account for approximately 0.6% impervious surface coverage of the entire Maple Swamp watershed.

14.4.6.2. U.S. 158 Interchange PDA

This area contains six relatively large, mostly undeveloped parcels near the location of the proposed intersection of the Project with U.S. 158 (Caratoke Highway). In the Reevaluation of the FEIS analysis, this area was projected to gain about 68 acres of mostly commercial development related to the construction of the Mid-Currituck Bridge. These 68 acres of new commercial development may result in an additional 44 acres of impervious surface, depending on the final site plans of the proposed projects. The area east of U.S. 158 drains to Maple Swamp, while the area west of U.S. 158 drains to Great Swamp. The area east of and adjacent to U.S. 158 is mostly upland and could probably be developed without needing a 404 Permit from USACE or a 401 Water Quality Certification from NCDWR. Therefore, any on-site stormwater would be required as part of the Coastal Stormwater rules or local Currituck County rules. Based on analysis of these rules, it appears that some of the possible commercial development would likely require on-site stormwater management, based on the requirements for a Major Stormwater Plan. It is important to note that any stormwater from this area would eventually drain to very extensive wetlands in Maple Swamp or Great Swamp before entering surface waters (Currituck Sound or North River, respectively). It is to be expected that these large extensive wetlands would provide additional stormwater treatment before runoff entered surface waters.

14.4.6.3. Road Accessible Outer Banks PDA

Based on the GIS analysis described in Chapter 7 of this report, the Road Accessible Outer Banks PDA contains about 535 developable lots, mostly scattered among existing homes. Roads here are paved and there are a few commercial areas, primarily along NC 12. Of the developable lots, a total of about 23 are near water, defined as being within 100 feet of Currituck Sound or its tributaries. Revised growth projections indicate an additional 206 parcels will be developed in this PDA under the Build Alternative, as compared to the No Build Alternative (Chapter 8). From the analysis in the FEIS, most of the infill will be planned and expected residential development, but there also could be limited commercial development, such as motels. Current stormwater rules for Currituck County suggest that most, if not all, of this residential infill would not require on-site stormwater

management, since most planned and expected residential development would be less than the impervious surface requirements shown on Table 16 (i.e., 30-45% per lot). In addition, as discussed in Chapter 7, the two large undeveloped parcels that are subject to the settlement agreement could have up to 1,825 additional homes and hotel rooms, as well as up to 150,000 square feet of commercial development. Development of these two parcels at this scale will probably require a Major Stormwater Plan and on-site stormwater treatment.

14.4.6.4. Non-Road Accessible Outer Banks PDA

This area contains about 1,742 developable lots based on the GIS analysis described in Chapter 7 of this report. This area is mostly undeveloped but appears to have been almost fully platted with lots and roads, except for the Currituck National Wildlife Refuge, the Currituck Banks Estuarine Reserve, and land owned by Currituck County obtained in a land swap with the wildlife refuge. There are a few scattered homes, especially in the southern part of the study area. Roads in this area are sand based, rather than paved, and homes are accessed by these sand roads, or by driving on the beach. Of the developable lots, a total of 409 are near water, defined as being within 100 feet of the Atlantic Ocean, Currituck Sound, its tributaries or along finger canals in the center of this area. It is expected that most of the Non-Road Accessible Outer Banks PDA will remain undeveloped in the next 20 years with or without a Mid-Currituck Bridge. Revised growth projections indicate that an additional 123 units are expected under the No Build Alternative, and 151 new units under the Build Alternative (Chapter 8). From the analysis in the FEIS, most of the infill will be planned and expected residential development (Laurie LoCicero, County Planner, personal communication, August 27, 2020). Current stormwater rules for Currituck County suggest that most, if not all, of this residential infill would not require on-site stormwater management, since it would be less than the impervious surface requirements shown on Table 17. Constraints on development in this area are discussed in Chapter 16 (Planning).

14.4.6.5. Effect of Sea Level Rise on Stormwater Management

Sea level rise is discussed in Chapter 12 of this report. As global sea level gradually rises over the next several decades, it is generally true that the local seasonal high-water table level will also rise since groundwater levels generally reflect the local sea level. However, the effect of sea level on groundwater level diminishes as the distance from the sea and site elevation increases (Fetter, 2001; pages 327-337). Therefore, there is not a one-to-one correlation between sea level rise and the associated groundwater rise. However, exact predictions of any effect of sea level rise on stormwater is beyond the scope of this regional planning effort. Options to address this gradual increase with respect to stormwater management or localized flooding is outlined in Chapter 19 of this report.

14.4.6.6. Effect of Flooding on Stormwater Quality

Flooding-related issues for the Project are addressed in Chapter 13 of this report.

14.4.6.7. Effect of Distance from Open Water on Stormwater Quality

The scientific literature was examined to help assess the relationship between stormwater quality and the distance between development activities and open waters. The scientific literature for nitrogen removal based on buffer width shows that 100-foot-wide buffers remove over 90% of the total nitrogen, while wider buffers have little additional benefit in terms of total nitrogen removal (Zhang, *et al*., 2010). Therefore, this study suggests that development beyond 100 feet of open water would

have little effect on water quality, while development closer than 100 feet to open water could have a larger effect on water quality of Currituck Sound or its tributaries.

14.5. Conclusions

Overall, the Build Alternative is not expected to substantially increase stormwater runoff in the three PDAs. The analysis detailed in Chapter 8 indicates that projected impervious surface coverage will increase only slightly between the Build and No Build Alternatives. The U.S. 158 Interchange PDA exhibits the most dramatic projected increase on a percentage basis, but this is largely the result of the small size of this PDA (e.g., 282 acres) and its confined boundaries at the proposed Mid-Currituck Bridge Interchange. When viewed more on a watershed scale, the estimated 44 acres of new impervious surface in this PDA under the Build Scenario represents only 0.6% of the total watershed area of Maple Swamp. In addition, Currituck County will likely require on-site stormwater management for much, if not all, of the commercial development that is expected to occur. Thus, the overall effect to the Maple Swamp watershed and the water quality of its discharge would be minor.

In the Non-Road Accessible Outer Banks PDA, there are only 28 additional residential units expected for the Build Alternative as compared to the No Build. These 28 homes, in a total PDA area of 4,873 acres, represent only a tiny fraction of additional impervious coverage, particularly considering that there are no associated paved roads, drainage swales, or commercial infrastructure. Table 5 in Chapter 8 shows only a 0.1 percentage point increase in impervious coverage in the Non-Road Accessible Outer Banks PDA under the Build Alternative. In the Road Accessible Outer Banks PDA, impervious surface coverage is expected to increase from 23.3% under the No Build Alternative to 26.2% under the Build Alternative, an increase of 2.9 percentage points. However, it should be noted that approximately 70% of this increase is the result of projected development of the two large parcels in this PDA that are subject to the settlement agreement. Because of their size and the density of expected development, these two parcels will likely require a Major Stormwater Plan from Currituck County, with the associated on-site stormwater control measures. The remaining infill lots in the Road Accessible Outer Banks PDA will likely not require any stormwater control measures. However, the vast majority of these parcels exist as scattered lots within established neighborhoods. Lots in such neighborhoods tend to drain toward roadside swales which are almost entirely in place now. Therefore, future development of vacant infill lots will not appreciably contribute to new stormwater drainage infrastructure.

15. Spills/Emergencies

15.1. Purpose

The purpose of this chapter is to summarize the potential for spills and emergencies associated with wastewater treatment systems to increase as a result of planned and expected development which could be attributed to the Mid-Currituck Bridge Project over the next 20 years.

15.2. Results

The potential for wastewater spills and emergencies relates to the following:

- Extreme weather events, including heavy rainfall, high tides, and storm events (storm surges),
- Aging wastewater treatment plants or poor maintenance of these plants, and
- The extent of development using centralized wastewater treatment.

North Carolina state law requires operators of wastewater collection and treatment systems to notify the NCDWR of spills of over 1,000 gallons into surface waters and to send a press release to local media within 24 hours. For spills greater than 15,000 gallons, operators are required to place a notice in the newspapers of counties impacted by the spill within 10 days (NCGS 143-215.1C).

NCDWR records through September 15, 2020, indicated that between July 8, 2003, and July 27, 2018, eight sanitary sewer leaks occurred in the Road Accessible Outer Banks PDA. Volumes of wastewater released were 200, 400, 1,000 (with two incidents at this magnitude), 1,500, 2,000, 14,000, and 40,000 gallons. The two largest spills occurred in 2003 and 2006.

From NCDWR records, Table 18 identifies four wastewater treatment plant spills which occurred along the Road Accessible Outer Banks PDA, of which at least two were weather related.

The volumes discharged were neither estimated nor included in the NCDWR records for the three on-site spills at the Ocean Sands plant. However, it is important to note that recorded wastewater spills to date associated with weather events have been confined to the treatment plant site and did not reach surface water.

In an August 2020 interview, the County Engineer (Eric Weatherly, P.E., personal communication, August 27, 2020) indicated that during Hurricane Matthew, a spill of less than 1,000 gallons (thus, not reported to the NCDWR for their records) occurred at the Ocean Sands Wastewater Treatment Plant. Hurricane Matthew made landfall in North Carolina on October 8, 2016, as a Category 1 storm.

None of the spills noted above were directly attributed to age of the treatment system. However, the Ocean Sands Wastewater Treatment Plant, where the majority of the wastewater spills occurred, was built in 1976. The plant was upgraded in 2019. The new plant's capacity is approximately 600,000 gallons per day; an increase from the old plant's 500,000 gallons per day.

Construction of the Selected Alternative could possibly result in planned and expected development on the Outer Banks and commercial development on the mainland (U.S. 158 Interchange PDA). The development constraints analysis prepared for the Reevaluation of the FEIS traffic forecasts found that 2,955 residential units are planned and expected in the Road Accessible Outer Banks PDA

Table 18: Wastewater Spills in the Road Accessible Outer Banks PDA from NCDWR Records from 2006 to 2018

Date	Treatment Plant	Cause	Outcome	Did Wastewater leave Treatment Plant Site?	Did Wastewater Reach Water?
8/31/06	Ocean Sands	Excessive flow into the plant	Sand filters had to be bypassed	No	No
9/21/16	Corolla Light	Surge tank leak	6,100 gallons discharged	Yes (Location not specified in NCDWR records.)	No
9/22/16	Ocean Sands	12-14 inches of rain overwhelmed the plant with high inflow	Wastewater discharge into the canal surrounding the plant	No	No
7/27/18	Ocean Sands	High rainfall over several days causing leaks at pipe penetrations for two older tanks	Wastewater discharge into the canal surrounding the plant and a leak out of the berm surrounding an infiltration bed	No	No

compared with an estimated 664 with the No-Build Alternative (WSP, 2018b). In the Non-Road Accessible Outer Banks PDA, the traffic analysis estimated 123 additional residential units with the Selected Alternative and 28 with the No-Build Alternative. These forecasts have been updated for this report in Chapter 8, though the magnitude of the overall trends is similar. In general, these two analyses found similar amounts of potential planned and expected development that could occur as a result of the Mid-Currituck Bridge. According to the Currituck County Planner (Laurie LoCicero, Currituck County Planner, personal communication, September 22, 2020) it is unlikely that the planned and expected development on the two large parcels in the Road Accessible Outer Banks PDA would completely occur since they would have to meet current stormwater management requirements, which are likely to utilize portions of the parcels.

Additional planned and expected development in the Road Accessible Outer Banks PDA would be served by individual septic systems or sewers and treatment plants depending on the subdivision (Chapters 9 and 10), following the existing pattern of development. Wastewater treatment plants and sanitary sewers do not serve the U.S. 158 Interchange and Non-Road Accessible Outer Banks PDAs (Chapters 9 and 10). These areas are currently served exclusively by individual septic systems (Chapter 10). Use of septic systems is expected to continue in the Non-Road Accessible Outer Banks PDA as well. It is likely that the commercial development in the Mainland (U.S. 158 Interchange) PDA area would be served by on-site septic systems, rather than a treatment plant. Refer to Chapter

19 for a discussion of options to minimize the potential for spills associated with current and future development, should NCDWR determine that such actions are warranted.

15.3. Conclusions

The Mid-Currituck Bridge is not expected to affect the risk of wastewater spills and emergencies associated with wastewater treatment plants in the Road Accessible Outer Banks PDA. The number and location of wastewater plants is not expected to differ under the Build Alternative. The modest increase in demand which may be experienced under the Build Alternative is unlikely to affect operation of the treatment plants. The U.S. 158 Interchange PDA and the Non-Road Accessible Outer Banks PDA do not presently contain wastewater treatment plants, and they are not expected to occur under either the Build or No Build Alternatives.

16. Planning

16.1. Purpose

The purpose of this chapter is to examine programs concerned with planning and development in Currituck County and how these programs would apply to development that may result over the next 20 years from construction of the Mid-Currituck Bridge, for each of the three PDAs addressed in this report. This chapter also addresses the likely pattern of development in the Outer Banks of Currituck County based on development patterns on similar barrier islands.

16.2. Background

Hard infrastructure—water, sewer, electric, roads, broadband—and soft infrastructure—healthcare, schools, law enforcement—are the building blocks of communities. The availability of both types of infrastructure is linked to economic prosperity (Puentes, 2015).

The aim of community planning is "to maximize the health, safety, and economic well-being of all people living in communities" (American Planning Association, 2020a). The planning process involves thoughtful consideration of appropriate patterns of land use, mobility, economic development, historic preservation, recreation, housing availability, and a variety of other topics. Given the importance of infrastructure on community and economic well-being and value, the process of preparing, funding, pricing, and regulating infrastructure is a vital aspect of the planning profession and its varied outputs (American Planning Association, 2020b).

Development and/or extension of infrastructure requires planners to consider the downstream impacts to a community that may result from implementation of infrastructure. These impacts can be both positive—community and economic expansion, growth of the tax base—and negative—degradation of the environment, loss of habitat, additional public expenditure needed in support of expanding soft infrastructure demand.

NOAA manages the federal coastal zone programs, delegated to state programs such as the NCDCM, and also provides advice for coastal communities to manage their growth wisely while protecting the sensitive resources. NOAA's *Smart Growth* initiative provides valuable information for Currituck County (and other NC coastal counties) to use in planning for growth (NOAA, 2009). This initiative contains ten principles for local communities to consider as outlined below:

1. Mixed land uses to include water-dependent uses;
2. Taking advantage of compact community design that enhances, preserves, and provides access to waterfront resources;
3. Providing a range of housing opportunities and choices to meet the needs of both seasonal and permanent residents;
4. Creating walkable communities with physical and visual access to waterfronts;
5. Fostering distinctive, attractive communities with a strong sense of place that capitalizes on the natural and waterfront heritage;
6. Preserving open space, farmland, natural beauty, and critical environmental areas that characterize and support coastal and waterfront communities;
7. Strengthening and directing development towards existing communities and encouraging waterfront revitalization;

8. Providing a variety of land and water transportation options;
9. Making development decisions predictable, fair, and cost effective through consistent policies and coordinated permitting processes; and
10. Encouraging community and stakeholder collaboration in development decisions, ensuring that public interest in and rights of access to the waterfront and coastal waters are upheld.

As detailed in this report, construction of the Mid-Currituck Bridge may result in indirect and cumulative impacts to the County and region. From a community planning perspective, development of the Mid-Currituck Bridge is anticipated to result in planned and expected development, with associated population growth, and resulting consumption of available land approved for development in the Road Accessible and Non-Road Accessible Outer Banks PDAs as well as the U.S. 158 Interchange PDA. Adopted plans and growth management controls at both the state and local levels will guide these changes in land use. Potential development scenarios and development patterns will be discussed in detail in subsequent sections of this chapter.

Lane and Jolley (2008) conducted an economic analysis of the development implications for the Mid-Currituck Bridge. This report estimated that the Mid-Currituck Bridge would induce 68 acres of commercial development in the area of the bridge's interchange with U.S. 158. This development would generate a total of 468 new jobs, with $9.6 million in new labor income in addition to the direct construction-related effect of the bridge.

16.3. Review of Plans and Planning in Currituck County

16.3.1. Planning in Currituck County: Overview

Currituck County's Planning & Community Development Department is the primary governmental entity responsible for plan making and zoning in all three PDAs. This Department consists of four divisions, including the Planning & Zoning Division. The Planning & Zoning Division assists in establishing County development objectives, prepares plans which incorporate those objectives, and coordinates development activities affecting County growth. The Planning and Zoning Division is responsible for administering and enforcing the UDO and updating the Land Use Plan (Currituck County, 2020h).

The general pattern of zoning in the three PDAs is shown on Figure 17. Basically, the Non-Road Accessible Outer Banks PDA is zoned Single Family Residential, Outer Banks Remote while most of the Road Accessible Outer Banks PDA is zoned Single Family Residential, Outer Banks with some relatively small locations of commercial zoning (Currituck County, 2020g). The U.S. 158 Interchange PDA is zoned either Agriculture or General Business. If the U.S. 158 Interchange PDA develops as expected with 68 acres of commercial development, rezoning will likely be required which will afford the County the opportunity to add site specific conditions such as on-site stormwater management as recommended in Chapter 19 of this report.

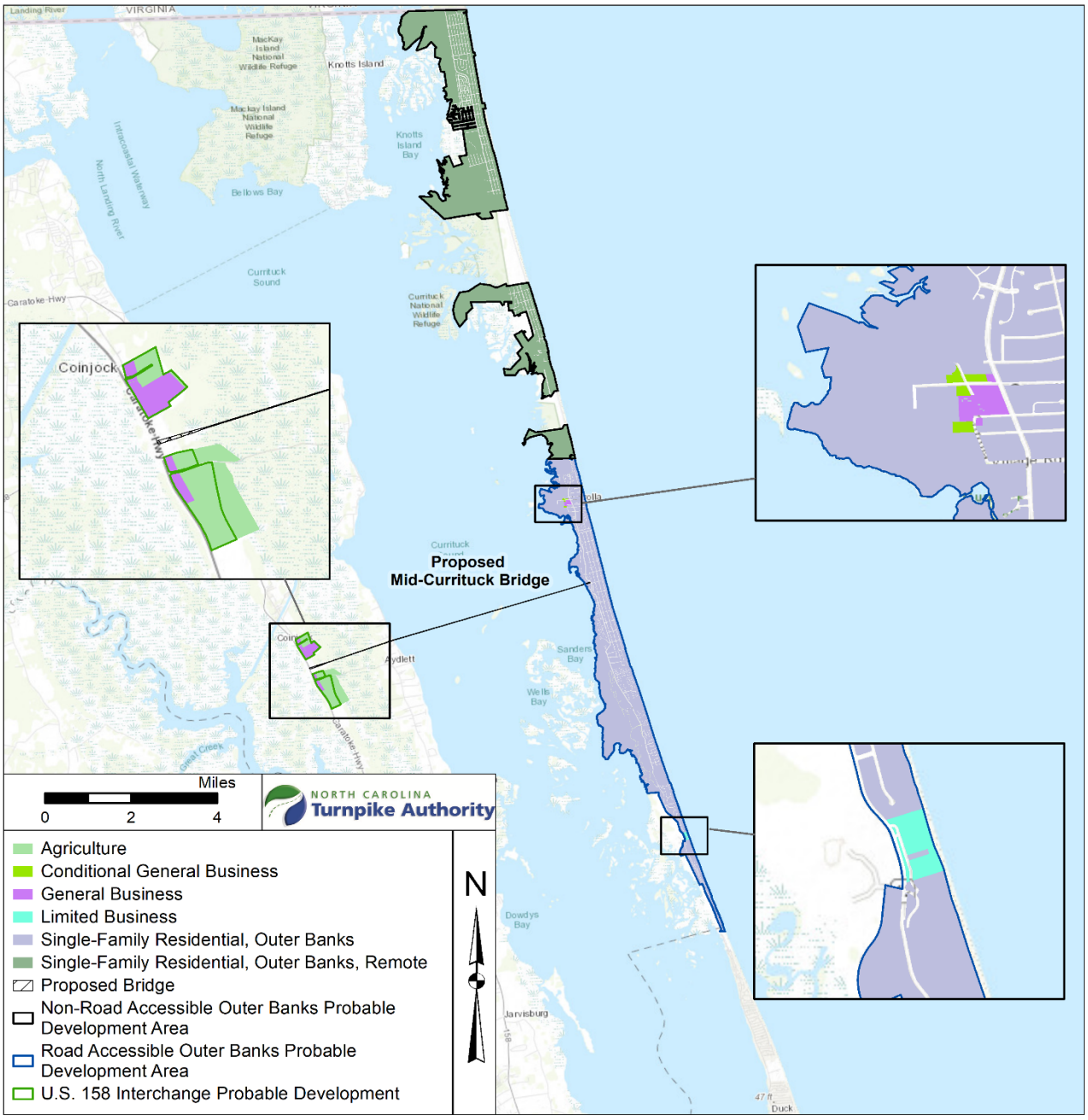

Figure 17: Currituck County Zoning Designations in the Three PDAs

Currituck County is a member of the Albemarle Commission, one of sixteen regional North Carolina Councils of Governments (NCCOG) that provide many services to members. Services include providing current information on state and federal programs of concern to local governments, transportation planning, economic and workforce development, community planning, GIS mapping, and convening of regional leaders for problem solving (Association of Regional Councils of Governments, 2020).

16.3.2. Relevant Plans and Planning: Currituck County

Currituck County has adopted plans and regulations that work to guide development throughout the County. Currituck County is in the process of updating its current Land Use Plan. Existing plans, as well as the draft Imagine Currituck Land Use Plan Update, are reviewed in the following section.

16.3.2.1. 2006 Land Use Plan (Amended, 2007, 2008, 2009)

CAMA requires each of North Carolina's twenty coastal counties to have a local land use plan in accordance with guidelines established by the CRC (NCDEQ, 2020c). Land use plans include local policies that address environmental and productive resources protection, economic development, reduction of storm hazards, and other topics. Plans are used at a local level to provide guidance for both individual projects as well as to address a broad range of policy issues, such as the development of a UDO and public investment programs. Prepared plans must be certified by the CRC. These plans are also used by the NCDCM in the issuance of CAMA permit decisions that require federal consistency determinations (NCDEQ, 2020c).

16.3.2.2. Imagine Currituck Land Use Plan Update

In 2016, Currituck County began to prepare a new land use plan and assessment of the community's existing land uses and the County's projected land use characteristics in 2040 (Currituck County, 2020h). This plan, entitled "Imagine Currituck 2020 Vision Plan," is in draft form and currently undergoing review and public comment (Currituck County, 2019 and 2020f).

The Imagine Currituck Plan provides "a framework for land use and development decision-making" that serves as a comprehensive update to the County's adopted 2006 Land Use Plan (Currituck County Department of Planning and Community Development, 2019). Once adopted, the Imagine Currituck Plan will be submitted for certification by the CRC.

The Imagine Currituck Plan presents broad County-wide goals for land use, economic development, infrastructure and County services, transportation, environment, and parks and recreation. It also emphasizes specific goals for all areas of relevance to this study. A detailed comparison of land use densities and development allowable under the current and Imagine Currituck Plan is offered in Section 15.4.

16.3.2.3. Unified Development Ordinance

Currituck County has an adopted UDO intended to "to protect the public health, safety, and general welfare of the citizens and landowners of Currituck County, and to implement the policies and objectives of county-adopted plans addressing the county's growth and development." (Currituck County, 2020). The specific intent of the UDO is to:

- Foster convenient, compatible, and efficient relationships among land uses;
- Establish new compact, mixed-use community centers in appropriate locations, as identified in adopted plans;
- Better manage or lessen congestion in the streets;
- Ensure the provision of adequate open space between uses for light, air, and fire safety;
- Improve development quality and the quality of life for county residents and visitors;
- Prevent the overcrowding of land and avoid undue concentrations of population;

- Preserve the character and quality of residential communities while providing increased housing choices indicated in adopted plans, as appropriate;
- Promote desirable living conditions and the sustained stability of communities;
- Protect the county's rural character and agricultural heritage;
- Facilitate the adequate provision of transportation, utilities, parks, recreation, emergency services, and other public facilities;
- Maintain and enhance the character of various districts within the county through an emphasis on design quality;
- Maintain and protect high quality aesthetic standards for development;
- Conserve the value of buildings and land;
- Conserve the natural resources, cultural resources, and environmental quality of the county and its environs, particularly in the Outer Banks;
- Protect development and residents from flooding and other natural hazards; and
- Incorporate and foster sustainable development practices.

The UDO is generally applicable to all development on land within Currituck County unless specifically made exempt by the ordinance. The UDO covers general administration, zoning, use and development standards, environmental protection, and other topics.

As described previously, the majority of the two Outer Banks PDAs is zoned Single Family Residential Outer Banks and Single Family Residential Outer Banks Remote. For the Single Family Residential Outer Banks district, the following purpose is stated in the UDO:

> The Single-Family Residential-Outer Banks district is established to accommodate low- to medium-density residential neighborhoods and supporting uses on the portion of the outer banks south of Currituck Milepost 13. The district is intended to accommodate residential and supporting uses in a manner that preserves sensitive natural resources, protects wildlife habitat, reduces traffic congestion, and seeks to minimize damage from flooding and catastrophic weather events. A variety of residential use types are allowed in the district, including single-family detached homes, and detached accessory dwelling units (with a use permit). The district also accommodates minor utilities, as well as various neighborhood-supporting institutional uses such as parks, open space, shoreline access, religious institutions, and schools. All development in the district is subject to stormwater management, dune and maritime forest protection, and special exterior lighting limitations. Major utilities and marinas require approval of a use permit, while commercial, office, and industrial uses are prohibited.

For the Single Family Residential Outer Banks Remote district, the following purpose is stated in the UDO:

> The Single-Family Residential-Outer Banks Remote district is established to accommodate very low-density residential development on the portion of the outer banks north of Currituck Milepost 13. The district is intended to accommodate limited amounts of development in a manner that preserves sensitive natural resources, protects wildlife habitat, recognizes the inherent limitations on development due to the lack of infrastructure, and seeks to minimize damage from flooding and catastrophic

> weather events. The district accommodates single-family detached homes on lots platted prior to April 2, 1989, even in cases where the lot does not meet the minimum lot area requirement for the district. All development in the district is subject to stormwater management, dune and maritime forest protection, and special exterior lighting limitations. Public safety and utility uses are allowed, while commercial, office, and industrial uses are prohibited.

Throughout the Road Accessible Outer Banks PDA, there are multiple Outer Banks Planned Developments intended to encourage the use of innovate and creative approaches to provide a mix of different residential areas in close proximity to one another. The eastern end of the planned bridge falls within a planned development zone. In discussions with Currituck County planners, it is possible this area's zoning would change to a mixed category suitable for the interchange (Laurie B. LoCicero, Currituck County Planner, personal communication, November 6, 2020). This area is currently zoned as Single Family Residential, Outer Banks.

The U.S. 158 Interchange PDA is zoned either Agriculture or General Business. For Agriculture, the UDO calls for the following.

> The Agriculture district is established to accommodate agriculture and agriculturally related uses (including residential development) at very low densities in rural portions of the county. The district is intended to preserve and protect active agricultural uses, farmlands, and other open lands for current or future agricultural use. The district accommodates small-scale residential uses and allows farmers to capture a portion of the land's development potential through special provisions for conservation subdivisions that allow a portion of a tract or site to be developed with single-family homes while the balance of the site is left as open lands available for continued agricultural use. The district accommodates a wide range of agricultural and agricultural-related uses like "agri-business" and "agri-entertainment" but prohibits uses that are not directly related to or that do not provide direct support for agricultural activities.

For General Business, the UDO calls for the following:

> The General Business district is established to accommodate a wide variety of residential and nonresidential uses on lots bounding major roadways outside of community and village center areas. The district is intended to accommodate small to medium-sized commercial, office, personal service, and institutional uses that provide goods and services to county residents and visitors in ways that protect the county's scenic corridors as well as maintain the traffic carrying capacity of major roadways. The district also accommodates low density single-family detached dwellings, accessory dwelling units, and manufactured homes on individual lots (on the mainland). New commercial development is subject to commercial design standards to ensure development quality and consistency with surrounding development patterns. New commercial development of 5,000 square feet or more proposed on lots located outside of areas designated as Full Service areas in the Land Use Plan is required to obtain use permit approval. New development on lots along major arterials (like Caratoke Highway) outside designated Full Service areas are subject to increased minimum front setbacks and increased landscaping requirements to help protect the

scenic character of these areas. New industrial, multi-family, and institutional residential uses are prohibited in the General Business district.

As noted, it is likely the introduction of the bridge and interchange will spur a zoning change in this area. In discussions with the Currituck County planner, it is likely some or all of the Agriculture districts will be modified to General Business or Limited Business (Laurie B. LoCicero, Currituck County Planner, personal communication, November 6, 2020).

16.4. Anticipated Growth with the Mid-Currituck Bridge

16.4.1. Parcel Numbers, Sizes, and Platting in the PDAs

In general, the Non-Road Accessible Outer Banks PDA was platted in the 1960s (personal communication, Laurie LoCicero, Currituck County Planner, September 22, 2020). With respect to the planned residential development of this PDA, parcels in this PDA will be grandfathered in as long as their development can meet any relevant federal or state wetland regulations as well as current septic tank regulations (see Chapter 10 for a discussion of the septic review and approval process). Both Outer Banks PDAs are almost entirely platted; however, there are two large parcels in the Road Accessible Outer Banks PDA (discussed in Chapter 7 and below) that are subject to a settlement agreement between the landowner and Currituck County and will be further subdivided as described below. Table 19 summarizes the total parcel numbers, developable parcel numbers, and sizes in the three PDAs. This information is derived from Currituck County parcel data from NC OneMap (NC OneMap, 2020). The procedure for determining developable parcels is described in Chapter 7. The Currituck County Planning Office indicates that the Imagine Currituck 2020 Vision Plan will be adopted prior to June 2021 (Laurie LoCicero, County Planner, personal communication, November 6, 2020).

Table 19: Number of Parcels and Average Parcel Size across each PDA

	Non-Road Accessible Outer Banks PDA		Road Accessible Outer Banks PDA		U.S. 158 Interchange PDA	
	Number of Parcels	Average Size of Parcels (Acres)	Number of Parcels	Average Size of Parcels (Acres)	Number of Parcels	Average Size of Parcels (Acres)
All Parcels (8,635)	3,378	1.3	5,242	0.7	15	26.3
All Developable Parcels (2,283)	1,742	1.0	535	0.7	6	46.9

16.4.2. Expected Development Pattern

Based on development patterns on other barrier islands, the pattern of planned and expected development in the two Outer Banks PDAs is likely to be primarily the ocean front (first row) parcels first, followed by the second row, and then the parcels along Currituck Sound and the finger canals present in the Non-Road Accessible Outer Banks PDA. Development of the more interior parcels will likely follow. Table 20 depicts those parcels by PDA based on the GIS analysis presented in Chapter 7.

Table 20: Development Patterns for Developable Parcels by PDA for the Mid-Currituck Bridge

	U.S. 158 Interchange PDA	Road Accessible Outer Banks PDA	Non-Road Accessible Outer Banks PDA
First Row Oceanfront Parcels	0	20	190
Second Row Oceanfront Parcels	0	22	174
Water Access Parcels	0	23	409
Other Parcels	6	470	969
Totals	6	535	1,742

Note: Water access parcels are those within 100 feet of open water including Currituck Sound, tributaries, and finger canals; other parcels refer to those not under first row oceanfront, second row oceanfront, or water access parcels designations.

In the Road Accessible Outer Banks, the waterfront parcels are almost all currently developed except on the two large parcels yet to be subdivided which are discussed in Chapter 7 of this report. The FEIS and FEIS reevaluation assumed that full build-out would occur in the Road Accessible Outer Banks PDA with the Selected Alternative. Table 20 shows that there are about 535 subdivided and developable parcels in the Road Accessible Outer Banks PDA that could be developed.

The two large, undeveloped parcels in the Road Accessible Outer Banks PDA (Parcel # 126A0000000000G and 126A0000000000T), which together are approximately 117 acres in size, are subject to a settlement agreement from 1987 and could be developed at any time. When the owner is ready to develop, the County will be required to add the wastewater flow from these parcels to the existing Ocean Sands wastewater treatment plant, per the settlement agreement. According to the County Planner, the agreement contains the following provisions with respect to future development (Laurie LoCicero, Currituck County Planner, personal communication, September 22, 2020).

1. Parcel 126A0000000000G: approximately 275 residential units (multifamily or single family, 250 hotel rooms, and 50,000 square feet of commercial development.

2. Parcel 126A0000000000T: approximately 350 multifamily units, 1000 hotel rooms, and 100,000 square feet of commercial development.

Ms. LoCicero further explained that it is unlikely development intensity and uses would reach allowable settlement levels since proposed projects would have to meet current stormwater management requirements, and any implemented stormwater control measures are likely to utilize portions of the parcels. The wastewater treatment facility at Ocean Sands has sufficient capacity to

manage the wastewater needs for these developments, but Ms. LoCicero stated that the level of treatment may need to improve, which could be an issue for the non-discharge permit issued by the NCDWR. Wastewater treatment plants are discussed in Chapter 9, with potential management considerations discussed in Chapter 19. Development of these two parcels has been an ongoing topic in Currituck County since 1984. Thus, the precise number of units (homes and hotel rooms) that will develop on these large parcels cannot be predicted at this time, but the levels of development in the settlement agreement noted above provide some perspective for the likely scale of that development.

If construction of the bridge affects the real estate market, the timing of development in the Road Accessible Outer Banks PDA could also be affected. It is expected that the past rate of gradual infill, especially near the Dare/Currituck County line and northward, will continue over the time frame of 20 years for this study.

In the Non-Road Accessible Outer Banks PDA, the Reevaluation of the FEIS assumed that, based on building permit trends, construction of the bridge would lead to development of a net increase of 95 residential units in the Non-Road Accessible Outer Banks PDA from 2014 to 2040. The FEIS concluded that "For the Non-Road Accessible Outer Banks there would be no reasonably foreseeable change in the location, rate, or type of development with the implementation of the detailed study alternatives [including the Selected Alternative], in comparison to the No-Build Alternative." This analysis was conducted using the best available data at that time (see Section 4.2.4 of the November 2011 *Indirect and Cumulative Effects Technical Report* whose findings were affirmed in Section 4.6 the March 2019 *Reevaluation of the FEIS*). The factors assumed in those analyses remain valid today, though the growth forecasts have been revised for this report to reflect current trends (Chapter 8).

Recently, several new variables have arisen that could affect development in the Non-Road Accessible Outer Banks PDA. These variables include the continued evolution of the sharing economy as it relates to vacation rentals, expansion of affordable satellite-based communications and internet services, and other mega economic trends that may or may not affect development patterns (MSN Money, 2020 and Newsbreak.com, 2020). However, when adding these new trends to the previously considered factors, it is still expected that most of the Non-Road Accessible Outer Banks PDA will remain undeveloped in the 20-year time frame of this report with or without a Mid-Currituck Bridge.

For the U.S. 158 Interchange PDA, the conclusion in the FEIS and the Reevaluation of the FEIS that the bridge would induce 68 acres of commercial development is unchanged and assumed in this assessment of cumulative water quality impacts.

16.4.3. Site Redevelopment

Residential and commercial business redevelopment are commonly observed in coastal communities. The replacement of smaller homes with larger ones occurs most commonly in locations where vacant land is scarce, housing stock is older, and/or the vacation rental market is strong. Redevelopment also tends to occur when portions of housing stock are damaged or destroyed due to hurricanes and other storms. With 75% or more of post-storm coastal community road and utility reconstruction costs covered by the federal government via the Stafford Act, the rebuilding, update, and often enlargement of residential dwellings is made more feasible as the recovery of the community is nearly assured (Barringer, 2012).

Commercial redevelopment tends to follow population and visitation trends. With more consumption, the renewal of older single structures and strip retail areas becomes more viable. Since the size of parcels tends to be small and land assembly difficult, the quality and quantity of commercial development in beachfront communities can vary widely.

For sites within the PDAs, the cycle of extensive redevelopment due to market forces is probably far in the future. As documented in Chapter 7, the availability of vacant land for single family dwellings is significant, and as such, available lots are likely to meet market demand for years to come. Larger, mixed-use development parcels, such as the two large parcels in the Road Accessible Outer Banks PDA discussed below and in Chapter 7, also can be brought to market to address near- to mid-term demand. However, extensive storm-damage to coastal areas would likely trigger a more rapid upgrade and upsizing of housing stock.

As the Urban Land Institute reports, market-based incentives should be put into place by communities to drive the type of development—and redevelopment—they desire. The least expensive market-based incentive to implement is regulatory. This includes "organizing the development review process so that good design and siting, as well as good practices for environmental protection, are the path of least resistance to quick project approval. This strategy is called making the right thing easy to do" (Michael Pawlukiewica, 2007).

16.4.4. Planned Unit Development Provisions

There are seven Planned Unit Developments (PUDs) created in settlement agreements in the Road Accessible Outer Banks PDA described in the Currituck County Land Use Plan (Currituck County, 2020h). According to the Land Use Plan, a major concern of the landowners of this PDA has been management of potential commercial development within these neighborhoods.

16.4.5. Analysis of No-Build Alternative: Comparison of PDAs

The No-Build Alternative is described in detail in the FEIS (USDOT, FHWA, and NCTA, 2019). The Reevaluation of the FEIS included a traffic analysis that concluded that capacity constraints on NC 12 would reduce future Outer Banks development levels from US 158 to the North Carolina/Virginia line by approximately 2,500 units (homes and hotel rooms), including a reduction of approximately 2,300 units in the Road Accessible Outer Banks PDA (from 2,955 to 664) and approximately 100 units in the Non-Road Accessible Outer Banks PDA (123 to 28). These forecasts have been revised for this report to reflect current trends (Chapter 8), though the scale of the revised estimates is comparable. In general, the pattern of development has been spreading northward from the Dare/Currituck County line with basic residential infill of vacant lots in already developed neighborhoods in the Road Accessible Outer Banks PDA. The Non-Road Accessible PDA has had more development at its southern end with more scattered residential development throughout remaining portions of this PDA (personal communication, Laurie LoCicero, Currituck County Planner, September 22, 2020). Without the Mid-Currituck Bridge, this pattern is expected to continue with the traffic constraint identified in the FEIS as an eventual controlling or limiting factor.

For the reasons noted in Section 16.4.2, it is expected that that most of the Non-Road Accessible Outer Banks PDA will remain undeveloped in the next 20 years with or without the Mid-Currituck Bridge.

In the Road Accessible Outer Banks PDA, infill development will continue to occur on the existing subdivision's estimated 535 developable parcels. The constraint on development by the capacity of NC 12 will likely primarily affect the development of the two large parcels described earlier.

This report has updated the analysis in the Reevaluation of the FEIS for both the Road Accessible Outer Banks PDA and the Non-Road Accessible Outer Banks PDA using more recent GIS and land use data (see Chapter 8). This analysis now concludes that 206 additional parcels (including the two large parcels subject to the settlement agreement) will be constructed in the Road Accessible Outer Banks PDA under the Build Alternative as compared to the No Build Alternative. This is consistent with the conclusions of the Reevaluation of the FEIS, considering that the two large parcels can be developed with many individual housing units. For the Non-Road Accessible Outer Banks PDA, the new growth projections use comparable growth rates to the Reevaluation of the FEIS, but they have been aligned with the current conditions observed in 2020. As a result, the 20-year growth projection for the Build Alternative is 151 new residential parcels and 123 residential parcels for the No-Build Alternative. This also is consistent with the conclusions of the Reevaluation of the FEIS.

With the No-Build Alternative, the commercial development induced by the bridge in the U.S. 158 Interchange PDA would not occur.

16.5. Analysis of Selected Alternative: Comparison of PDAs

The Selected (Build) Alternative is described in detail in the FEIS (USDOT, FHWA, and NCTA, 2019). The Project traffic forecast was updated in the FEIS based upon the revised design year (2040), which saw a reduction in traffic as opposed to the original design year of 2035. This lower traffic forecast will allow more travel benefits with fewer improvements. The Build Alternative includes a toll plaza at the U.S. 158 interchange and includes enhanced safety features that will provide greater flexibility for local traffic, as well as visitors to the area. The constraint on Outer Banks' planned and expected development associated with the No-Build Alternative would not occur with the Build Alternative.

The Build Alternative includes purchasing of parcels on the Outer Banks portion of Currituck County as part of the right-of-way acquisition process. This includes the purchase of a portion of a subdivision east of NC 12 to accommodate the bridge terminus on the Outer Banks portion of Currituck County. The Build Alternative offers the greatest summer travel benefits due to less severe congestion and shorter duration of travel. The Build Alternative is consistent with CAMA land use plans for the area. Multiple towns have included support for construction of the bridge in their land use plan updates. The two relatively large, undeveloped parcels in the Road Accessible Outer Banks PDA (Parcel # 126A0000000000G and 126A0000000000T) will likely be developed under the Build Alternative since all permit requirements have been met, but perhaps not within the 20-year time frame of this study. Stormwater management will still need to be addressed, which may require a reduction in the Project's density to provide space for on-site stormwater treatment.

The Build Alternative is not likely to impact existing businesses, or associated access, in an adverse or disproportionate way in any of the PDAs. The Build Alternative is not likely to promote an increase in year-round, permanent residents primarily due to the relatively high cost of real estate on the Outer Banks PDAs (U.S. Department of Transportation, FHWA, and NCTA, 2019). The Build Alternative is also unlikely to promote an increase in year-round, permanent residents due to toll costs and the commute distance to major employment centers.

16.6. Conclusions

Planning issues with respect to the three PDAs have been and continue to be proactively addressed by Currituck County. Currituck County currently has an assertive regional planning effort, and progress is underway to finalize and formally adopt its new land use plan - the Imagine Currituck Land Use Plan Update. This planning will help to guide future development in all of the PDAs, including measures to protect water resources. With respect to the Build versus the No-Build Alternative, the above analysis describes the planning and development related effects of both options. There will be challenges for the County to address in each of the three PDAs primarily related to wastewater treatment and stormwater runoff with either the Build Alternative or the No-Build Alternative, but the amount of development will be somewhat less with the No-Build Alternative. Different considerations to address these challenges are outlined in Chapter 19 of this report.

17. Potable Water

17.1. Purpose

The purpose of this chapter is to describe the present situation with regard to potable (drinkable) water in the three PDAs and to discuss how potable water supplies could be impacted by potential planned and expected development with the Mid-Currituck Bridge over the 20-year time frame of this study.

17.2. Background

This chapter was developed based on conversations with the Currituck County Engineer (Eric Weatherly, P.E. County Engineer, personal communication, August 27, 2020) and staff at the ARHS (Joe Hobbs, Environmental Health Specialist, ARHS, personal communication, September 29, 2020) as well as review of documents from the Currituck County website (Currituck County, 2020d and 2020e).

Potable water for the U.S. 158 Interchange PDA and the Road Accessible Outer Banks PDA is provided by Currituck County and will continue to be provided by the County after the Mid-Currituck Bridge is constructed. The mainland and Outer Banks water systems use different aquifers and treatment methods (Currituck County, 2020d and 2020e). The U.S. 158 Interchange PDA has been served by the County since 1999 and uses water collected from shallow and deep wells near Maple (Currituck County, 2020d). Water consistently meets USEPA drinking water standards according to the Currituck County website (2020d).

The Outer Banks system blends water from the shallow aquifer with water from the deeper Yorktown aquifer and then treats the water with reverse osmosis to remove excess natural salt (Eric Weatherly, P.E., personal communication, August 27, 2020). The Southern Outer Banks Water System, which includes the Ocean Sands Water System, became operational in 2005 with over 3,000 customers in 11 communities (Currituck County, 2020e). This water also consistently met all USEPA drinking water standards according to the Currituck County website (2020e).

Potable water for the Non-Road Accessible Outer Banks PDA is provided by individual wells dug for each residential lot. These wells tap into the shallow, freshwater aquifer in this part of the island. From data for homes constructed in this PDA and provided by the ARHS (Sandy Evans, Management Support Secretary, personal communication, October 5, 2020), these wells average about 24 feet deep. If the well is shallower than 20 feet, they would require a state issued variance since they are less than the standard 20 foot well depth (Joe Hobbs, ARHS, personal communication, September 29, 2020). The County is unaware of water quality issues with these individual wells in this PDA. (Eric Weatherly, P.E. County Engineer, personal communication, August 27, 2020).

17.3. Conclusion

The water treatment facilities are considered modern and receive regular maintenance and upgrades (Eric Weatherly, P.E. County Engineer, personal communication, August 27, 2020). The County presently has no plans to provide potable water to the Non-Road Accessible Outer Banks PDA. Any planned and expected development that may occur as a result of the construction of the Mid-Currituck Bridge over the next 20 years is expected to utilize current potable water supply systems or individual wells and will not result in any additional cumulative or secondary impacts to these systems or wells. The existing system has adequate capacity to serve the planned and expected development in all three PDAs. For these reasons, the Project is not expected to have any impacts to available potable water supplies.

18. Summary: Potential Cumulative Impact of the Mid-Currituck Bridge on Water Quality of Currituck Sound and the Atlantic Ocean

18.1. Purpose

The purpose of this chapter is to summarize the potential cumulative impacts for planned and expected development that may result over the next 20 years from the Mid-Currituck Bridge in the three PDAs as required by the NCDWR 401 Water Quality Certification rules and the 2004 NCDWQ policy guidance. The analysis was conducted based on the existing regulatory and planning environment for this Project. Proposed regulatory and non-regulatory modifications for the NCDWR and County to consider to address potential water quality-related issues are discussed in Chapter 18.

18.2. Regulatory Context

The North Carolina Environmental Management Commission (NCEMC) first approved the 401 Water Quality Certification rules 15A NCAC 2H .0500 in 1996 and has subsequently updated the rules (NCDWR, 2020d). Rules outlined in 15A NCAC 2H .0500 that are relevant to this report, state that a certification should be issued unless it "would result in secondary or cumulative impacts that cause or contribute to, or will cause or contribute to, a violation of water quality standards" (15A NCAC 2H .0506(b)(3)). In 2004, NCDWR developed a guidance document to provide staff and the public information on how to address this requirement in the rules (NCDWQ, 2004).

These rules and related guidance focus on projects and associated impacts that could potentially violate water quality standards in NC. Water quality standards can be numeric or narrative. For example, the numeric water quality standard for chlorophyll *a* of 40 mg/l is to protect surface waters from eutrophication. An example of a narrative standard is the antidegradation water quality standard which states (in part) that the NCDWR "shall not allow degradation of the quality of waters with quality higher than the standards below the water quality necessary to maintain existing and anticipated uses of those waters" (15A NCAC 2B .0201(c)) (NCDWR, 2020e). As discussed in Chapter 6 of this report, the most important potential water quality effects from the construction of the Project are identified as nutrients in Currituck Sound and bacteria in the Atlantic Ocean.

This cumulative impact assessment has examined various water quality issues related to the potential cumulative impact of the Project over the next 20 years on the water quality of the Currituck Sound and the Atlantic Ocean. These issues were addressed in the literature review (Chapter 6), GIS analysis (Chapter 7), revised 2040 growth forecasts and impervious surface estimates: No-Build Alternative and Build Alternative (Chapter 8), non-discharge (reuse/reclaimed wastewater) facilities (Chapter 9), septic tanks and drain fields (Chapter 10), groundwater lowering devices (Chapter 11), sea level rise (Chapter 12), flooding (Chapter 13), stormwater management (Chapter 14), spills/emergencies (Chapter 15), planning (Chapter 16), and potable water (Chapter 17). Based on these environmental analyses the most likely effects on water quality would be nutrients and/or coliform bacteria from stormwater runoff, reuse/reclaimed wastewater facilities, and septic tanks/drain fields. These effects are summarized below in the context of the existing federal, State, and local regulatory and non-regulatory backgrounds. As noted above, suggested modifications for NCDWR and Currituck County to consider for these regulatory and non-regulatory frameworks are addressed in Chapter 19.

18.3. Summary Comparison of the No-Build and Build Alternatives

The location, rate, and type of development in the Road Accessible Outer Banks PDA for the Build Alternative and No-Build Alternative would be what is planned and expected, although the Build Alternative may induce additional growth. There will likely be infill of the remaining undeveloped lots for the Road Accessible Outer Banks PDA under both the No-Build Alternative and Build Alternative.

It is still expected that most of the Non-Road Accessible Outer Banks PDA will remain undeveloped with or without a Mid-Currituck Bridge within the 20-year time frame of this report. New development that does take place is expected to occur primarily along the Atlantic Ocean beach-front and the first rows back from the beach, as well as on Currituck Sound, particularly in the area of the finger canals leading from the sound to some parcels. This report has updated the analysis in the Revaluation of the FEIS for both the Road Accessible Outer Banks PDA and the Non-Road Accessible Outer Banks PDA using more recent GIS and land use data (see Chapter 8). This analysis now concludes that an additional 206 parcels (including the two large parcels subject to the settlement agreement) will be constructed in the Road Accessible Outer Banks PDA under the Build Alternative as compared to the No Build Alternative. This is consistent with the conclusions of the Reevaluation of the FEIS, considering that the two large parcels can be developed with many individual housing units. For the Non-Road Accessible Outer Banks PDA, the new growth projections use comparable growth rates to the Reevaluation of the FEIS, but they have been aligned with current conditions in 2020. As a result, the 20-year growth projection for the Build Alternative is 151 new residential parcels and 123 residential parcels for the No-Build Alternative. This also is consistent with the conclusions of the Reevaluation of the FEIS.

With the No Build Alternative, the 68 acres of new commercial development induced by the bridge in the U.S. 158 Interchange PDA would not occur.

Regardless of what future development patterns and rates may be, the recommendations described in Chapter 19 of this report could be implemented to address potential water quality-related effects of development in the three PDAs, including those related to stormwater or on-site wastewater treatment, should NCDWR determine that such actions are warranted. Recommended measures could address the potential “past or reasonably anticipated future impact” of project development on water quality as required by 401 Water Quality Certification regulations (NCDWR, 2020d), if there is an indication that downstream water quality standards will be violated.

18.4. Comparison of the PDAs for Potable Water, Wastewater, and Stormwater

Potable water, wastewater, and stormwater management varies in the three PDAs based on past development patterns, soils, and existing infrastructure. Regardless of whether the bridge is built or not, potable water, wastewater, and stormwater treatment will remain an issue. A summation for each PDA is reiterated below.

The U.S. 158 Interchange PDA is served by the County potable water system (see Chapter 17) and generally has suitable soils for on-site wastewater treatment if designed properly (see Chapter 10). The County and local landowners have the ability to manage stormwater on-site before it discharges into Maple Swamp or Great Swamp through a variety of measures including wet detention ponds, constructed swales, and other measures (see Chapter 14 for details).

The Road Accessible Outer Banks PDA is also served by the County potable water system (see Chapter 17). Most of this PDA is served by the five non-discharge wastewater systems (discussed in Chapter 9) and these facilities have capacity to add additional wastewater flow and they appear to be in compliance with their non-discharge permits. Of the 535 developable lots in this PDA, about 129 of them are readily developable (as described in Chapter 7) and are outside the present service areas of the wastewater plants. Therefore, these 129 parcels will likely need on-site wastewater treatment. Finally, stormwater in this PDA is mostly handled by local subdivision and roadside drainage systems as discussed in Chapter 14. The two parcels subject to the Settlement Agreement in the Road Accessible Outer Banks PDA will be required to have on-site stormwater management as discussed in Chapter 14.

The Non-Road Accessible Outer Banks PDA contains individual wells to provide potable water (see Chapter 17). This PDA has on-site wastewater treatment as opposed to the regionalized systems present in most of the Road Accessible Outer Banks PDA. Stormwater is handled on a parcel-by-parcel basis as well in this PDA. Since these parcels were platted in the 1960s, their development will be grandfathered by Currituck County as long as they can meet any requirements of wetland permitting and have septic tank approval (personal communication, Laurie LoCicero, Currituck County Planner, September 22, 2020).

18.5. Potential Indirect and Cumulative Effects on the Water Quality of Currituck Sound and the Atlantic Ocean

18.5.1. Stormwater

Untreated stormwater is well known to be a source of contaminants such as nutrients or coliform bacteria discharging to downstream waters (Chapters 6 and 14). Existing State and local stormwater regulations that are in effect in the three PDAs could require on-site stormwater measures for planned and expected development at the U.S. 158 Interchange PDA and at selected locations in both Outer Banks PDAs. However, most of the planned and expected residential development in the Non-Road Accessible Outer Banks PDA, as well as infill development of vacant lots in the Road Accessible Outer Banks PDA, would likely not require on-site stormwater management based on existing State and local rules (see Chapter 14 for details).

In general, stormwater from planned and expected development will potentially affect water quality when the planned and expected development occurs within 100 feet of surface water (see Chapter 14 for this discussion). Approximately 432 developable parcels are within 100 feet of surface water, mostly in the Non-Road Accessible PDA, particularly along the finger canals, as shown in Figures 5 and 12. Without additional on-site stormwater treatment measures for these parcels, any planned and expected development of these parcels in the next 20 years that are a result of the Project could potentially contribute to degraded water quality within these tributaries to Currituck Sound. However, revised growth projections for the Non-Road Accessible Outer Banks PDA (Chapter 8) indicate that only 28 additional residential units are expected throughout this area under the Build Alternative as compared to the No Build Alternative. The precise location of projected future development cannot be accurately determined, but it is reasonable to assume that these 28 additional units will be distributed throughout the PDA. Therefore, the number of additional units to be expected in these sensitive areas should be small, relative to the total watershed. On the Atlantic Ocean side of the Outer Banks PDAs, most houses would be setback more than 100 feet from surface waters based on

existing CAMA rules. Therefore, any planned or expected development is less likely to result in degraded water quality in the Atlantic Ocean.

18.5.2. Reuse/Reclaimed Wastewater

As discussed in Chapter 9, analysis of effluent and groundwater well monitoring data provided by NCDWR demonstrate that ammonia -nitrogen is moving from treatment plant discharge locations to the monitoring wells. A small amount may be moving toward Currituck Sound, though all systems are successfully meeting state groundwater quality standards and are in full compliance with their permit limits. A further reduction of nitrogen is expected to occur in the soil prior to reaching Currituck Sound, as concentrations typically diminish as distance from the discharge source increases. Analysis of the effluent and groundwater monitoring well data from wastewater treatment plants, which have been upgraded to include advanced nutrient removal, generally have lower levels of nitrogen in the effluent and monitoring wells compared to those which have yet to be upgraded (Chapter 9).

Wastewater treatment facilities do not appear to be important sources of fecal coliform bacteria since fecal coliform bacteria levels in effluents and in the monitoring wells are low and successfully meeting state standards and are in compliance with their permit limits (see Chapter 9 for details). These facilities are focused on removal/treatment of coliform bacteria and provide wastewater treatment for the majority of residential/commercial units in the Road Accessible Outer Banks PDA.

In terms of indirect and cumulative impacts in the Road Accessible Outer Banks PDA, the two large parcels that are the subject to the settlement agreement discussed in Chapter 7 are intended to use the Ocean Sands wastewater treatment plant which does have advanced nutrient removal capabilities (Chapter 9). Most of the remaining developable parcels in the Road Accessible Outer Banks PDA could utilize the existing non-discharge wastewater facilities since they have sufficient capacity as described in Chapter 10. NCDWR should consider whether to require advanced nutrient removal capabilities for all of these facilities.

As discussed in the summary of the non-discharge facilities (Chapter 9), the analysis of the monitoring well data provided by NCDWR from the effluent and associated monitoring wells for the five non-discharge facilities that serve the Road Accessible Outer Banks PDA indicated lower levels of coliform bacteria and are therefore in compliance with their permits. Therefore, these facilities are unlikely to be a significant source of coliform bacteria loading into the Atlantic Ocean or Currituck Sound.

18.5.3. Septic Tanks/Drain Fields

As discussed in Chapters 6 and 10, septic tanks and drain fields can contribute nitrate-nitrogen and coliform bacteria to adjacent waters depending on soil parameters in the area and the distance between the end of the drain fields and receiving surface waters. If septic tanks and drain fields are not maintained properly, this could result in additional pollutants migrating through the soil toward surface waters. This issue is especially important for septic tanks and drain fields that are within 100 feet of surface waters compared to those that are some distance removed.

As summarized in Chapter 10, planned and expected development in the next 20 years for those parcels which develop closest to surface waters that rely on septic tanks and drain fields for wastewater treatment (mainly in the Non-Road Accessible Outer Banks PDA) could contribute to

nitrate-nitrogen loading to Currituck Sound. As discussed in Chapter 19 below, an additional local requirement for advanced pre-treatment would address this concern for those parcels closest to surface waters.

As discussed in Chapters 6 and 10, septic tanks and drain fields can be sources of coliform bacteria to surface waters depending on the ability of the intervening soils to reduce those bacteria levels. The CAMA set back rules (Chapter 16) that are in effect for the lots closest to the Atlantic Ocean require a setback at least 60 feet from the first line of stable natural vegetation. The setback distance depends on the size of the building, as described in Chapters 10 and 16. Therefore, septic/tanks and drain fields are unlikely to be significant sources of bacteria to the Atlantic Ocean.

18.5.4. Other Potential Influences

Based on the analyses done earlier in this report, groundwater lowering devices (Chapter 11), sea level rise (Chapter 12), flooding (Chapter 13), spills/emergencies (Chapter 15), and potable water (Chapter 17) are not likely to be significant sources of nitrogen or coliform bacteria loading to Currituck Sound or the Atlantic Ocean from the planned and expected development in the three PDAs in the next 20 years, including the development of the two large parcels that are subject to a settlement agreement as discussed in Chapter 7.

18.5.5. Overall Conclusions

Based on the analyses presented in Chapters 6 through 16, the planned and expected development with the construction of the Mid-Currituck Bridge Project within the next 20 years are expected to have only a minimal and localized impact on downstream water quality, mainly in man-made tributaries of Currituck Sound. Indirect and cumulative impacts on the overall water quality in the Atlantic Ocean and Currituck Sound are not expected to cause violations of state standards or a loss of existing and anticipated uses. Though some sensitive areas near water are present in localized parts of Currituck Sound such as the finger canal area, the extent of expected development which can be attributed to the Project is small and may at most cause minimal and localized impacts on water quality. Existing local and State water quality-related regulations (such as CAMA setback limits) and utilization of existing water treatment facilities will likely control certain sources of pollution (especially coliform bacteria). However, to address any potential concerns, NCDWR and Currituck County could review and consider implementation of practical regulatory and non-regulatory changes as outlined in Chapter 20, should these agencies determine that such action is warranted.

19. Regulatory and Non-Regulatory Considerations

19.1. Purpose

The purpose of this chapter is to outline practical regulatory and non-regulatory considerations for the issues relevant to the NCDWR cumulative impact guidance, discussed elsewhere in this report (Chapter 2; NCDWQ, 2004). The overall purpose of this listing is to provide possible measures for either NCDWR, Currituck County, or the ARHS to consider to address any potential water quality cumulative impacts associated with development of the Mid-Currituck Bridge over the next 20 years. In general, the Project is not expected to result in indirect or cumulative effects to downstream water quality that would cause a violation of state standards or a loss of existing or anticipated uses in Currituck Sound or the Atlantic Ocean, though there may be minimal and localized effects on water quality in some man-made tributaries to Currituck Sound. However, these management options could be implemented if it is determined by NCDWR that they are warranted, or to address issues from previous land use management practices which currently affect water quality in Currituck County.

The issues raised (presented in the order in which they were described in the report) include:

1. Wastewater:
    a. NCDWR-permitted systems (non-discharge [reuse/reclaimed water] systems);
    b. Currituck County-permitted systems (on-site wastewater);
2. Groundwater lowering measures;
3. Sea level rise;
4. Flooding attenuation;
5. Stormwater management;
6. Spills and emergencies;
7. Planning; and
8. Potable water protection.

19.2. Wastewater

19.2.1. Non-Discharge (Reuse/Reclaimed Water) Systems

Results from the analysis in Chapter 9 support two important conclusions:

1. Local reclaimed/reused wastewater facilities generally meet the State's groundwater standards and are in compliance with their permits. Also, there is evidence to suggest that low concentrations of ammonia-nitrogen are moving from the discharges of these facilities to the monitoring wells especially from those plants without nitrogen removal in their design;
2. Available monitoring data demonstrate the benefit of nutrient removal technology for non-discharge facilities; NCDWR will need to determine if the remaining plants will be required to install such technology at permit renewal or if any future plants in the area should be required to incorporate that type of technology.

19.2.2. On-Site Wastewater (Septic Tanks and Drain Fields)

Based on an analysis of existing state and county on-site wastewater rules and a preliminary analysis of soil and site conditions in the undeveloped areas within the PDAs, the following options are provided for consideration to Currituck County and/or the NCDWR to address potential on-site wastewater issues that might be attributed to development that may result from the construction of the Mid-Currituck Bridge.

1. U.S. 158 Interchange PDA – Existing rules and regulations are likely adequate to protect downstream water quality.
2. Currituck County Outer Banks – Both the Non-Road Accessible and Road Accessible PDA
    a. Interior Infill Parcels – For residential parcels with on-site groundwater wells to be used for consumption, the ARHS should consider revising its planning ordinances and/or begin the process of obtaining State approval of County on-site wastewater regulations that would require a separation of at least 24 inches (60 centimeters) beneath the trench of the septic system to the seasonal high- water table for all undeveloped parcels with Group I soils (sand, loamy sand) or require the well setback to be 100 feet from the septic system area. For well sites less than 100 feet from the septic system or where the separation distance to the seasonal high-water table is less than 24 inches but greater than 12 inches, the ARHS should consider requiring the use of pretreatment to be added to the septic system.
    b. Infill Parcels Near Open Surface Waters (Currituck Sound or the Existing Finger Canals in the Non-Road Accessible Outer Banks PDA) – Development on the undeveloped parcels adjacent to the Currituck Sound or the finger canals in the Non-Road Accessible Outer Banks PDA have higher potential to contribute pollutants to the Currituck Sound and its associated open water tributaries. Based on the GIS analysis described in Chapter 7 of this report, there are about 430 of these parcels in the Outer Banks PDAs. It is suggested that the ARHS consider revisions of its planning ordinances or begin the process of obtaining state approval of county on-site wastewater regulations that would require pretreatment of septic tank effluent for all undeveloped parcels within 100 feet of a finger canal to protect the immediately adjacent surface waters. For other undeveloped parcels within 100 feet of the CAMA OHWM (or the USACE OHWM), or any other open water directly connected to the Currituck Sound, the ARHS should consider revising its planning ordinances and/or begin the process of obtaining state approval of county on-site wastewater regulations that would require pretreatment of septic tank effluent OR a separation of 24 inches (60 centimeters) beneath the trench a septic system to the seasonal high water table for all undeveloped parcels.

19.2.3. Groundwater Lowering Measures

As described in Chapter 11 (Groundwater Lowering), the NCDWR has permitted groundwater lowering devices for several locations on the Outer Banks of Currituck County as associated with non-discharge permits issued for specific projects. However, neither the County nor NCDWR appear to have regulatory programs that require permitting solely for groundwater lowering devices, except

in the context of an otherwise permitted facility (such as a non-discharge facility). Therefore, it is unclear whether this practice is widespread on the Outer Banks of Currituck County and whether any additional groundwater lowering would affect downstream water quality from planned and expected development over the next 20 years. A recent Supreme Court case may provide the opportunity for the NCDWR and the NC Attorney General's Office to determine whether a regulatory process is warranted to address this regulatory void (*County of Maui, Hawaii v. Hawaii Wildlife Fund*, 2020). Such a review should first focus on measures (such as non-discharge facilities, individual homeowner septic tanks, or perhaps NCDOT roads) that require an environmental permit. Associated permitting should also include water quality monitoring for pollutants of interest (such as total nitrogen or fecal coliform bacteria) with discharge limits as appropriate to address any downstream water quality issues.

Based on the analysis of the very limited water quality monitoring data from the Hampton Street Pond described in Chapter 11, an additional, more rigorous sampling regimen may be preferable for any expanded discharges from this facility.

If discharges of groundwater for projects that are permitted by the NCDWR plan to expand and increase their discharges, then NCDWR should consider requiring a multi-year, comprehensive (i.e., academic-level) study to examine the water quality effects of these discharges into Currituck Sound. The three examples described in Chapter 11 appear to be relevant case studies to use for this purpose. Existing water quality data (similar to the limited data from Currituck County that is discussed in Chapter 10) should be collected as part of this analysis. Local universities, such as Elizabeth City State University or East Carolina University, could provide a detailed study plan to address this concern in the future.

Finally, surface water connections that do not have a permit to discharge groundwater to stormwater ponds (such as those identified in the field and described in Chapter 11 of this report) should be addressed by NCDWR to specifically bring these dischargers into compliance with water quality standards. However, the surface water connections which presently exist would therefore not be associated with the Mid-Currituck Bridge.

In response to a comment received from NCDWR, the following approach could be considered by the NCDWR to resolve surface water connections between the discharge ponds and Currituck Sound, though resolution of this issue is not related to the indirect and cumulative impact of the Project because this situation currently exists. These breaches or connections could be reduced or eliminated by installing fill below the ponds associated with the Hampton Street and Monteray Shores discharges to construct an intact berm around the ponds which would theoretically hold the receiving water and allow it to infiltrate and/or evaporate within the ponded area. This would require a careful and thorough wetland delineation around the lower ends of the ponds (the ends closest to Currituck Sound) as well as wetland impact approvals issued by the USACE and NCDWR. A groundwater flow modeling study accompanied by a water balance budget may be useful to indicate whether these berms would successfully address the matter. In addition, it would probably be useful to install level spreaders across existing channels that have developed in these wetlands to ensure that diffuse flow is maintained through the wetlands to the Sound. For the Ocean Sands facility, the discharge is reportedly through a pipe under NC 12 towards the parking lots at the Timbuck II Shopping Village into what is likely a wetland according to a LiDAR and NCCREWS analysis. In this instance, again, a careful and through wetland delineation would likely be recommended to identify existing

ephemeral channel flow or other channel flows. Installation of level spreaders across existing channels that have formed in the wetland would be helpful to ensure diffuse flow to Currituck Sound. Finally, installation of these level spreaders would likely require Section 404/401 permitting with the USACE and the NCDWR. CAMA Permits issued by the NCDCM may be needed as well if channels in the salt/brackish marsh need to be addressed.

19.2.4. Sea Level Rise

Sea level rise has occurred in the study area and is predicted to continue in the future, although the impact of sea level rise in the 20-year time frame for this study is negligible. Sea level rise would most likely affect developable parcels nearest open water and their associated on-site wastewater treatment facilities, some of the existing non-discharge wastewater treatment (reuse/reclaimed water) facilities, and stormwater management strategies as outlined in this report.

Sea level rise will present challenges for federal, state, and local governments with respect to these issues. Given the uncertainties inherent in the accuracy of predicting and planning for sea level rise, state and local governments could implement an adaptive management approach to regularly evaluate their rules and procedures and adjust them as needed.

19.2.5. Flooding

As described in Chapter 13, flooding results in challenges as a minor, temporary, and localized event especially in the Non-Road Accessible Outer Banks PDA after excessive rainfall due to a lack of stormwater infrastructure, while extensive flooding appears to be presently uncommon in the Road Accessible Outer Banks PDA because of the widespread system of roadside drainage. Also, the County has developed a specific flooding management plan with the NCDWR to allow floodwaters to be pumped to the ocean under managed conditions. The following recommendations are made for Currituck County to consider to manage flooding that might occur in relation to the Mid-Currituck Bridge Project over the next 20 years:

1. Develop a systematic way to encourage citizens to report local flooding problems and develop a GIS-based system to collect and analyze this information. This will allow the County to have a better understanding of the location and frequency of flooding events on the Outer Banks.
2. Modify the existing NCDWR-approved flood management approval to address the Non-Road Accessible Outer Banks PDA so this mechanism is in place as development occurs.
3. Encourage detailed, local stormwater management plans like that done for the Whalehead subdivision to proactively address flooding issues.
4. Work closely with NCDWR to determine the appropriate conditions under which pumping of stormwater to local ponds (which usually drain to Currituck Sound) could be allowed along with appropriate water quality monitoring.
5. As discussed in Chapter 13, it appears that the wastewater treatment facility for the Village at Ocean Hill is at 1.5 to 2.5 feet above sea level and the facility does not appear to have a protective berm. It is recommended that NCDWR at the next permit renewal cycle consider requiring the Village at Ocean Hill facility to begin the process of delineating wetlands on the site and obtaining necessary permits to construct a protective berm to protect against storm

surge and sea level rise. These permits might include a 404 Permit from the USACE, the associated 401 Water Quality Certification from NCDWR, and FEMA approval, if needed. This protective berm could be constructed during the next permit period for this wastewater facility. The wastewater facility at Pine Island is generally at a sufficient elevation to currently offer protection from sea level rise but not necessarily storm surge. Therefore, NCDWR should consider a requirement that the facility be at an elevation above the storm surge, plus additional elevation to take into account sea level rise then forecast for the life of the new facility.

19.2.6. Stormwater Management

As described in Chapter 14, the State of North Carolina and Currituck County have existing stormwater management programs that must be considered with respect to the cumulative impact of the Mid-Currituck Bridge. The following is a list of recommendations for the State and Currituck County to consider, if necessary, to address any effects of stormwater more comprehensively:

1. NCDWR – As described in Chapter 14, the state has established baseline rules for stormwater management for the PDAs of the Mid-Currituck Bridge. In addition, the state has an updated stormwater manual which provides current engineering designs for various stormwater BMPs (NCDEQ, 2020d). Since the cumulative impact of the bridge on water quality is limited to Currituck County, which has a well-developed stormwater and planning process, any improvements which might be needed to stormwater treatment in areas affected by the bridge would be most efficiently administered by Currituck County.
2. Currituck County – The following modifications to the Currituck County stormwater regulations are suggested to be considered to address potential stormwater effects from cumulative impact from the Mid-Currituck Bridge:
    a. Modifications to the existing stormwater review process as outlined in the County UDO could be considered, especially Chapter 7.3 of the UDO. Based on the existing Minor Stormwater Plan rules shown in Table 16 in Chapter 14, only site development with high impervious surfaces will require on-site treatment which would likely exclude most individual homes that are likely to develop in the next 20 years. The County could consider expanding on-site stormwater treatment by lowering these thresholds and/or having an on-site stormwater management provision for parcels closest to surface water as described below.
        i. U.S. 158 Interchange PDA
            1. As described in Chapter 14, this area is projected to be developed into about 68 acres of commercial uses associated with the bridge interchange. Depending on the site plans, it is likely that these developments would require on-site stormwater management based on the existing Currituck County stormwater rules. However, it is suggested that Currituck County consider modifications to their existing stormwater rules or planning ordinances to require on-site stormwater for all commercial development in this PDA.

ii. Currituck County, Outer Banks

1. Interior infill parcels – These parcels tend to be at a considerable distance from either the Atlantic Ocean or Currituck Sound. Given the lack of existing stormwater infrastructure, other than the roadside drainage in the Road Accessible Outer Banks PDA, stormwater generated from any new development on these interior infill parcels will likely be readily adsorbed by the very porous sandy soils and not directly discharged to surface waters. Therefore, the existing stormwater rules administered by the County should be sufficient to handle any impact of development of these parcels on surface waters. However, if the County installs more robust stormwater infrastructure in the next 20 years, then this may trigger the need for the County to focus on stormwater from any parcels developed after the construction of this new infrastructure. More robust stormwater infrastructure should be designed and developed in close coordination with the NCDWR – Washington Regional Office.

2. Infill parcels along water from Currituck Sound or the existing finger canals in the Non-Road Accessible Outer Banks PDA – In contrast, planned and expected development in the next 20 years on the undeveloped parcels adjacent to Currituck Sound, its tributaries, or the finger canals in the Non-Road Accessible Outer Banks PDA have some potential to deliver stormwater-carried pollutants to Currituck Sound. Based on the GIS analysis from Chapter 7 of this report, there are about 432 parcels in the Outer Banks PDAs within 100 feet of these water bodies. However, revised growth projections indicate that only 28 additional parcels will be developed in the Non-Road Accessible Outer Banks PDA under the Build Alternative, as compared to the No Build Alternative. These 28 parcels will be distributed throughout the PDA, including areas further away from the water. Therefore, the actual number of parcels developed within 100 feet of water may be small.

   If it is determined to be warranted, the County could consider amending its stormwater and planning ordinances to require on-site stormwater management for all undeveloped parcels within 100 feet of the NCDCM CAMA OHWM (or USACE OHWM), to protect the immediately adjacent surface water. The existing low-impact development (LID) recommendations could readily be expanded to require appropriate on-site stormwater treatment on these parcels due to increased impervious surfaces. This distance is not a recommendation for riparian buffer rules *per se*, but rather an observation that lots within 100 feet of open water have the largest potential effect on water quality and on-site stormwater management requirements might be considered to address this potential impact on water quality.

If the County develops a more robust stormwater management plan for these parcels near water, it is suggested that careful consideration be given to final drainage locations with close coordination with NCDWR. Finally, given the inherent water quality problems with finger canals, especially in areas like Currituck Sound with little tidal flushing, it is recommended that the Currituck County consider amending their planning ordinance to prevent any future finger canals on the Outer Banks of Currituck County.

19.2.7. Spills and Emergencies

Chapter 15 includes a discussion of potential wastewater spills and emergencies within the Currituck County Road Accessible Outer Banks PDA. As noted, spills have occurred in the past but were contained and did not discharge into adjacent water resources.

In addition to measures in the County's UDO, new and expanded wastewater systems are subject to NPDES permitting through NCDWR, which requires measures for peak flow management for high rain weather events. The existing regulatory requirements from Currituck County and NCDWR for wastewater systems are expected to minimize the potential for inadequate maintenance or plant age to result in or contribute to a spill from planned and expected development over the next 20 years.

19.2.8. Planning

The following recommendations are made for Currituck County to consider to expand the scope and relevance of their planning process.

- Implement relevant recommendations of the Imagine Currituck Land Use Plan Update to the Road Accessible Outer Banks PDA and the Non-Road Accessible Outer Banks PDA. Four years in the making, the Imagine Currituck planning effort provides a well-researched, collaborative planning initiative that advances forward thinking approaches to the County overall as well as both Outer Banks PDAs. It addresses growth issues and opportunities presently being experienced throughout the County and anticipated over the next two decades.
- Implement Small Area Plan Development for the Outer Banks PDAs. A small area plan defines the character of an area and provides a more detailed level of planning direction to address the unique requirements and conditions of a subset of a larger planning area. Small area plans also help to define very specific, often small capital improvements. They are often utilized to plan zones that are anticipated to undergo rapid change or development. For example, the Corolla Village Small Area Plan, completed in 2011, provides guidance to balance growth in a way that preserves the physical and natural environments that make Corolla Village distinct from other coastal communities (Currituck County Planning and Zoning Department, 2011).

While not a small area plan at present, the Draft Imagine Currituck Land Use Plan identifies the eastern end of the future Mid-Currituck Bridge landing as a "significant opportunity for the County to capitalize on improved access to the Outer Banks" and recommends detailed master-planning for this area (Currituck County Department of Planning and Community Development, 2019). Uses identified for this small area include a new destination-quality mixed-use area that could include a

regional conference center with hotel; retail and restaurant space; and public amenities such as access to the sound and a community center for Corolla.

It is recommended that prior to construction of the Mid-Currituck Bridge, small area plans be prepared for the U.S. 158 Interchange PDA and the eastern Bridge landing near Corolla. Both areas will be important gateways from the mainland to the Outer Banks, and given their economic and social importance, should be carefully planned. Planning should ensure integration with existing economic and mobility initiatives and reflect the character and quality of development desired by the community.

The Draft Imagine Currituck Land Use Plan recommends—and this report further validates—the need for development of a small area plan for the Non-Road Accessible Outer Banks PDA. As noted in the Draft Plan, "development pressure in the Off-Road Area is increasing despite very limited infrastructure… and a stable and sustainable future depends on striking the appropriate balance between conservation and maintaining a high quality of life for residents and visitors" (Currituck County Department of Planning and Community Development, 2019). Construction of Mid Currituck Bridge will affect the timing of development and therefore, its highly appropriate to advance a small area planning effort in this zone.

- The two large, undeveloped parcels in the Road Accessible Outer Banks PDA (Parcel # 126A0000000000G and 126A0000000000T) comprising approximately 117 acres have established settlement agreements that—in the context of the Road Accessible Outer Banks PDA—allow significant development densities to these parcels (personal communication, Laurie LoCicero, County Planner, October 22, 2020) as outlined below.
    - Parcel 126A0000000000G: approximately 275 residential units (multifamily or single family, 250 hotel rooms, and 50,000 square feet of commercial development.
    - Parcel 126A0000000000T: approximately 350 multifamily units, 1,000 hotel rooms, and 100,000 square feet of commercial development.

    As documented in Chapters 7 and 11, there are a number of practical constraints in place that make achievement of these densities challenging (e.g., meeting current stormwater management requirements). Implementation of the Mid-Currituck Bridge Project, however, will increase the likelihood that these challenges could be resolved and the feasibility of these projects increased (personal communication, Laurie LoCicero, County Planner, September 22, 2020). If and when development of these parcels advances, Currituck County should encourage a planning process and ultimate built form in line with the principles for smart growth and sustainable design (American Planning Associaion, 2020).

19.2.9. Potable Water

As described in Chapter 17 (Potable Water), the Currituck County Water System presently operates a successful, high-quality water supply system throughout the County. However, in the Non-Road Accessible Outer Banks PDA, parcels are on separate, individual wells. At present, the County has no plans to supply public water to this area.

20. Conclusions and Considerations

20.1. Purpose

The purpose of this chapter is to provide an overview of conclusions and considerations made previously in this report. This report examined the cumulative impacts of planned and expected growth in the next 20 years in the three PDAs as a result of the Mid-Currituck Bridge in terms of its potential effect on water quality. This analysis was done primarily in the context of the 401 Water Quality Certification rules (15A NCAC 2H .0500) administered by the NCDWR.

20.2. Cumulative Impact Assessment and the NCDWR 401 Water Quality Certification Rules

The NCDWR 401 Water Quality Certification rules (15A NCAC 2H .0506(b)(4) and (c)(4)) require an analysis of the cumulative impacts of projects seeking a 401 Water Quality Certification. Those rules require that NCDWR determine that a project "does not result in cumulative impacts, based upon past or reasonably anticipated future impacts, that cause or will cause a violation of downstream water quality standards."

The NCDWQ adopted an internal policy document on April 10, 2004 which describes the process for staff and applicants to meet the rule provision stated above (NCDWQ, 2004 and in Appendix 1). This policy has been in effect and widely used on a variety of projects since 2004. The policy states that the cumulative impact provision is relatively narrow because it focuses on downstream water quality standards as mandated by the NCDWR 401 rules. This report was prepared using this guidance and its associated rule as a framework. A 20-year time frame for assessment was adopted, as suggested in the NCDWQ guidance, which was also used as a time frame for the design year for traffic forecast for the Project.

This study builds upon a cumulative impact analysis done earlier for the Reevaluation of the FEIS for the Mid-Currituck Bridge (USDOT, FHWA, and NCTA, 2019) and serves as an expansion on that previous work to address specific, detailed issues raised by the permitting agencies mainly the NCDWR and outlined in the Scope of Work dated April 9, 2020 (NCTA, 2020).

20.3. Water Quality Issues in the Currituck Sound and Atlantic Ocean

According to various NCDWR reports (summarized in Chapter 6), waters of Currituck Sound are presently in fairly good condition. However, expanded development over time has increased the levels of coliform bacteria at some locations in the Atlantic Ocean and increased the concentration of nutrients, notably nitrogen, on the Currituck Sound side. The most likely sources of nitrogen and coliform bacteria are septic tank/drain fields, non-discharge facilities (reuse/reclaimed wastewater), and stormwater runoff, as well as associated groundwater lowering activities.

20.4. Overview of Planned and Expected Development in the Three PDAs

The area chosen for detailed study was carefully considered based on evaluation of the indirect and cumulative impact results from the 2019 Reevaluation of the FEIS (USDOT, FHWA, and NCTA, 2019). As a result, three distinct PDAs were selected which exhibit very different future growth scenarios. The first Probable Development Area is on the mainland near the proposed interchange (known as the U.S. 158 Interchange PDA), the second is the area from the Dare/Currituck County

line to the end of the paved section of NC 12 in Corolla (known as the Road Accessible Outer Banks PDA), and the third is the area from the end of the paved section of NC 12 in Corolla to the North Carolina/Virginia state line (known as the Non-Road Accessible Outer Banks PDA).

The Non-Road Accessible Outer Banks PDA is approximately 4,875 acres in size; the Road Accessible Outer Banks PDA is approximately 4,100 acres in size; and the U.S. 158 Interchange PDA is approximately 282 acres in size. A detailed GIS analysis was performed to approximate the number of privately owned, undeveloped parcels in each PDA that would likely be available for future development activity (see Chapters 7 and 8). This analysis assessed the future development potential of individual parcels using eight factors, including the presence of freshwater and estuarine wetlands and soil suitability for septic tanks, which at a regional planning scale could restrict or prevent development of these parcels.

This report estimates that six parcels within the U.S. 158 Interchange PDA are planned and expected to be developed into approximately 68 acres of primarily commercial development. In the Non-Road Accessible Outer Banks PDA, approximately 1,742 parcels are available to be developed as future residential, per input from the Currituck County Planner and as predicted from the GIS analysis. However, it is not projected that all of these parcels would develop in the next 20 years (Chapter 8). In the Road Accessible Outer Banks PDA, this analysis identified approximately 535 parcels which could be developed. In addition, in the Road Accessible Outer Banks PDA, this report identified a potential for an additional 1,825 homes and hotel units, plus 150,000 square feet of commercial development, in two relatively large parcels comprising approximately 117 acres. Maximum allowable development of these parcels is defined in a settlement agreement between the landowner and Currituck County. It is unlikely that the development types stated in the agreement would completely occur since any proposed development would have to meet current stormwater management requirements, which are likely to utilize portions of the parcels (Laurie LoCicero. County Planer, personal communication, September 22, 2020, and October 1, 2020). The wastewater treatment facility at Ocean Sands appears to have sufficient capacity to accommodate the wastewater needs for future development on these parcels. While the precise number of units (homes and hotel rooms) that will develop on these large parcels is not predictable at this time without site plans, the levels of development identified in the settlement agreement noted above provide some perspective for the probable scale of that development. As described in Chapter 16, the pattern of planned and expected development over the next 20 years in the Non-Road Accessible Outer Banks PDA is likely to be the ocean front (first row) parcels first, followed by the second row, and then the parcels along Currituck Sound and the finger canals present along a part of the Sound. Development of the more interior parcels of this PDA will likely be slower. It is expected that that most of the Non-Road Accessible Outer Banks PDA will remain undeveloped within the 20-year time frame of this study with or without a Mid-Currituck Bridge (Chapter 8).

20.5. Overview of the Potential Indirect and Cumulative Impact of the Mid-Currituck Bridge on Water Quality

20.5.1. Non-Discharge Wastewater Systems

Chapter 9 contains an in-depth discussion of the water quality-related implications of the five existing non-discharge systems in the Road Accessible Outer Banks PDA. Water quality monitoring data from the treated effluent and associated groundwater monitoring wells were examined in terms of their potential for nitrogen or coliform bacteria pollution into Currituck Sound or the Atlantic Ocean. Two of the facilities have been recently upgraded to include advanced nutrient removal technology. Monitoring data from these two plants demonstrated the benefit of this advanced treatment in reducing nitrogen levels in the effluent and monitoring wells. In general, coliform bacteria levels in the effluent and monitoring wells were low and the monitoring well data appeared to meet state groundwater standards and are therefore in compliance with their permits. This conclusion reflects the standard treatment to remove coliform bacteria from these plants. In contrast, especially in the plants with only standard treatment, some nitrogen (especially in the ammonia form) appears to be migrating through the groundwater from the effluent to the monitoring wells and then in very low levels toward Currituck Sound, though all of the facilities were in compliance with state groundwater standards and are in compliance with their permits. In plants with advanced nutrient removal, nitrogen levels in effluent and monitoring wells were lower. Further reductions in nitrogen concentrations are expected as groundwater percolates through the soil profile toward Currituck Sound or the Atlantic Ocean.

Overall, these data support three important conclusions. First, these reclaimed/reused wastewater facilities meet the North Carolina groundwater standards and are in compliance with their permits. Evidence suggests that some very low levels of ammonia-nitrogen may be moving from these facilities toward Currituck Sound although additional reduction would be expected in the soil. This low level of ammonia-nitrogen appears to be slightly higher from those plants without nitrogen removal in their design. Second, the data demonstrates the benefit of nutrient removal technology for non-discharge facilities. NCDWR would need to determine if the remaining plants should be required to install such technology at permit renewal or if additional, future plants that may be constructed in the study area would be required to incorporate that type of treatment in their design. Third, levels of fecal coliform bacteria generally decreased from effluent to the monitoring wells to low levels; thus, indicating that these facilities are probably not important sources of fecal coliform bacteria to surface waters such as the Atlantic Ocean and Currituck Sound. All of these facilities appear to have sufficient available capacity to meet expected increases in demand. Because these systems are meeting state groundwater quality standards and functioning as intended, they are not likely to cause a violation in water quality standards to downstream waters.

20.5.2. Septic Tanks and Drain Fields

Chapter 10 contains an in-depth discussion of the on-site sewage permitting process administered by the ARHS-EHS program, as well as the implications for this permitting for individual parcels in the PDAs. Permitting for on-site sewage is especially important in the Non-Road Accessible Outer Banks PDA where this type of wastewater treatment is exclusive. Chapter 10 contains an in-depth analysis of soil suitability for septic tanks in these PDAs as well as the results of field work and analysis of permitting data provided by the ARHS-EHS program. This chapter also provides an analysis of

pretreatment technology which has been used to enhance the nutrient removal efficiencies of traditional septic tank and drain field systems.

The limited literature available seems to consistently report that a 60-centimeter (24 inches) separation beneath septic system drain fields and a seasonal high-water table along with a 30-meter (98 feet) horizontal distance to surface waters is necessary for on-site septic systems without pretreatment to minimize the chance for microbial and nutrient contamination of nearby surface waters.

Results from GIS analysis indicate that approximately 77 additional septic systems are projected to be installed in the two Outer Banks PDAs (49 in the Road Accessible PDA and 28 in the Non-Road Accessible PDA) under the Build Alternative as compared to the No Build Alternative. These additional systems would represent an increase of approximately 4.5% in the Road Accessible Outer Banks PDA and 3.1% in the Non-Road Accessible Outer Banks PDA over the number of on-site septic systems that would occur under the No Build Alternative. In addition, all future septic systems would have to meet current regulatory requirements which can be more stringent than those applied to previously installed systems, depending on when they were permitted.

This chapter concludes that enhanced treatment should be considered for those parcels within 100 feet of open water to reduce the potential for these systems to degrade water quality. The chapter then describes several specific, practical enhancements which could be applied to existing regulatory programs to address these parcels as they develop in the next 20 years, should the NCDWR determine that such actions are warranted to protect downstream water quality.

20.5.3. Groundwater Lowering Measures

Chapter 11 addresses the known extent and water quality effect of groundwater lowering measures in the Road Accessible Outer Banks PDA. No known groundwater lowering measures exist in the other two PDAs.

Groundwater pumping and groundwater lowering is currently done in the Outer Banks of Currituck County in association with some non-discharge wastewater facilities and stormwater management measures. In some cases, groundwater pumping and groundwater lowering may be occurring in relation to the location and placement of septic tanks and associated drain fields, but this cannot be confirmed and local officials are not aware of any current activities. In general, these groundwater lowering measures are facilities such as wells which pump the surficial groundwater to lower the seasonal high-water table. These facilities then either discharge to land or a nearby stormwater pond or wetland. The overall purpose of utilizing groundwater lowering in Currituck County is to maintain the vertical separation from the wastewater or stormwater treatment discharges relative to the seasonal high-water table to ensure that proper treatment occurs throughout the soil profile. This separation is outlined in requirements from NCDWR for stormwater and wastewater treatment. During this analysis, three sites were visited in the field (Hampton Street Pond, Monteray Shores and Ocean Sands (both at Timbuck II)), which have NCDWR-permitted groundwater lowering devices associated with each non-discharge facility. It was field-confirmed that these three facilities have surface connections to Currituck Sound through wooded and/or marshy wetlands.

In general, there is not substantial comprehensive information available on the extent of groundwater lowering on the Outer Banks PDAs since only three groundwater lowering facilities that currently

operate under an NCDWR permit are required to monitor water quality or quantity. These facilities would chiefly be relevant to the cumulative impact from the Mid-Currituck Bridge if new or expanded groundwater lowering measures are proposed in association with future development in the next 20 years. This is possible for non-discharge wastewater systems in the Road Accessible Outer Banks PDA. However, the magnitude of the potential effect is difficult to quantify. Revised growth projections (Chapter 8) indicate that there will be an additional 206 parcels developed in this PDA under the Build Alternative as compared to the No Build Alternative, including the two large settlement parcels. Of these 206 parcels, an estimated 49 parcels would be in areas of on-site septic, with the remainder in the service areas of one of the five existing wastewater plants. It is difficult to estimate how much, if any, additional groundwater pumping would be associated with this limited growth, and how much future demand for treatment could be addressed by the wastewater systems as they currently function. In the Non-Road Accessible Outer Banks PDA, this concern may be relevant in the future if local groundwater lowering measures are installed for septic tanks associated with undeveloped parcels in this area. However, groundwater pumping by individual property owners does not require permits issued by state or local agencies (expect in association with another permit), and its occurrence in the Outer Banks PDAs cannot be confirmed. Local officials are not aware of any such activity at this time.

Finally, groundwater drawdown has been used elsewhere in coastal communities to reduce flooding or to allow certain activities to continue (such as mining) with minimal impacts, if carefully employed and monitored. However, adverse impacts to adjacent or receiving ecosystems can occur from over pumping or if local conditions (such as local geology, soil properties, wetland conditions, or water quality of discharge waters) are not fully understood. It is recommended that if NCDWR permits new or expanded groundwater lowering activities, extensive monitoring should be required to determine the effect of these groundwater lowering measures on nearby wetlands that could be affected by potential drawdown effects. Monitoring should also be utilized to ensure that the hydrology of these wetlands remains unaffected and that these groundwater lowering measures are in compliance with current Wetland Standards as stated in 15A NCAC 2B.231 (c) (6): “Hydrological conditions necessary to support the biological and physical characteristics naturally present in wetlands shall be protected…”

20.5.4. Sea Level Rise

Chapter 12 addresses sea level rise as it may affect the cumulative impact of planned and expected development from the Mid-Currituck Bridge. A literature review and GIS analysis were conducted to determine the effect of sea level rise over the next 20 years on the PDAs. The sea level rise model was run in GIS for the 5.4-inch, 7.1-inch, and 8.1-inch projections for the 2015-2045 scenarios based on the information from the NCCRC report. From this modeling analysis, the Project team determined that under each scenario, no areas would be affected by sea level rise (i.e., no areas would be flooded or inundated under these sea level rise scenarios) in the PDAs within the next 20 years.

20.5.5. Flooding

Chapter 13 addresses the extent and impact of flooding for the three PDAs as well as existing state and local regulatory programs that address flooding. In Currituck County, localized flooding is associated with excessive rain events resulting from a tropical storm (i.e., a Nor’easter or hurricane event) or a series of consecutive heavy rainfall events (Eric Weatherly, P.E., Currituck County

Engineer, personal communication, August 25, 2020). Flooding in the Outer Banks is not a novel issue but continues to be a concern as a result of relative landform change in the area and sea level rise associated with climate change. Changes in development patterns could result in additional impervious surface cover and could contribute to the frequency and severity of localized flooding on the Outer Banks although flooding in the Non-Road Accessible Outer Banks PDA is minor and localized and the existing stormwater infrastructure in the Road Accessible Outer Banks PDA generally handles the stormwater adequately.

20.5.6. Stormwater Management

Chapter 14 addresses stormwater management for the three PDAs. This chapter examined existing state and local regulatory programs concerning stormwater management and how each would apply to planned and expected development that may occur as a result of the construction of the Mid-Currituck Bridge.

20.5.6.1. U.S. 158 Interchange PDA

This area contains six relatively large, mostly undeveloped, parcels near the location of the proposed intersection with U.S. 158 (Caratoke Highway). Based on an analysis of existing local and state stormwater rules, it appears that some of the possible commercial development would likely require on-site stormwater management based on the requirements for a Major Stormwater Plan (see Chapter 14 for details). It is important to note that stormwater from this area would eventually drain to unnamed wetlands that drain to Great Swamp or Maple Swamp before entering surface waters (North River or Currituck Sound, respectively). It is likely that these large extensive wetlands would provide additional stormwater treatment before entering surface waters.

20.5.6.2. Road Accessible Outer Banks PDA

This area is already mostly developed with vacant developable parcels being scattered among existing residences. In general, roads in this location are paved, with a few commercial parcels located along NC 12. Of the developable parcels, addressed in Chapter 7, a total of 23 parcels are located in proximity to water, defined as being within 100 feet of Currituck Sound or its tributaries. As stated in the FEIS, most of the infill will be planned and expected residential development. Based on our current analysis of existing stormwater rules for Currituck County, it appears that most, if not all, of this residential infill would not require on-site stormwater management. The major exception to this conclusion involves two large, undeveloped parcels (totaling 117 acres in size) which are subject to a settlement agreement as described in Chapter 7. This settlement agreement requires on-site stormwater treatment as this area develops.

20.5.6.3. Non-Road Accessible Outer Banks PDA

The Non-Road Accessible Outer Banks PDA contains approximately 1,742 developable parcels based on the GIS analysis described in Chapter 7 of this report. Currently, this area is mostly undeveloped, but it has been extensively platted with parcels and roads, except for lands comprising the Currituck National Wildlife Refuge, the Currituck Banks Estuarine Reserve, and the Audubon Society preserve. Scattered homes, mainly situated in the southern portion of the PDA, are located in this area. Roads in this area are sand based, rather than paved, and homes are accessible by the unpaved roads. Of the remaining developable parcels, a total of 409 are near water, defined as being within 100 feet of Currituck Sound, its tributaries, or along finger canals in the center of this area.

Based on analysis of the existing stormwater rules, it appears that most residential infill would not require on-site stormwater management.

20.5.7. Spills/Emergencies

Chapter 15 addresses the frequency and magnitude of spills and emergencies associated with wastewater treatment systems in the Road Accessible Outer Banks PDA. From an analysis of spills reported to NCDWR, and confirmed by the County Engineer, spills of wastewater rarely occur from permitted wastewater treatment systems and are addressed promptly. There is no evidence to expect that the frequency or severity of such spills would increase with the Mid-Currituck Bridge, or that downstream water quality standards would be violated as a result.

20.5.8. Planning

Chapter 16 discusses planning implications for the three PDAs to address possible indirect or cumulative effects on water quality. As described in Chapter 7, approximately 2,283 undeveloped parcels are estimated to be available for development within the three PDAs subject to this report. However, it is very unlikely that they will all be developed within the 20-year time frame of this study. This is especially true for the Non-Road Accessible Outer Banks PDA, which is only expected to exhibit about 36% development by 2040 (Chapter 8). In addition to these parcels, an additional 1,825 residential units could be created upon development of the two large parcels near the Ocean Sands wastewater treatment plant in the Road Accessible Outer Banks PDA, as described in Chapter 7. It is unlikely that the future development of these parcels would completely occur as originally planned since they would be required to meet current stormwater management requirements, which are likely to utilize portions of the parcels.

As is evidenced by the Draft Imagine Currituck Land Use Plan Update, the quality of planning underway in Currituck County continues to improve. The issues and topics undertaken by this planning effort are relevant and in line with comparable, forward thinking coastal communities. If adopted, the Currituck Land Use Plan Update will increase the prospect of better-quality development at “densities appropriate for their location” (Currituck County, 2020). Furthermore, the Draft Imagine Currituck Plan Update encourages planning at a village and neighborhood level. To this end, the Plan encourages implementation of the recommendations of existing small area plans, advancing new ones, and many other recommendations intended to protect natural resources, increase resilience, coordinate growth, expand economic prosperity, enhance mobility, and preserve and celebrate the unique identity of the County and region. Since Mid-Currituck Bridge implementation will alter the pattern and timing of the planned and expected development within all three PDAs, having the Imagine Currituck Land Use Plan adopted by the County and certified by the Coastal Resources Commission will go far in ushering in development aligned with the community’s current vision of itself and up to date planning principles.

For the three primary PDAs subject to this study, the following planning-related conclusions are offered for the County to consider:

20.5.8.1. U.S. 158 (Mainland) Proximate to the Western Landing of the Planned Bridge

This area contains mostly undeveloped lots near the location of the proposed intersection with U.S. 158 (Caratoke Highway). In the FEIS Reevaluation, this area was projected to support 68 acres of commercial development from traffic flow associated with the Mid-Currituck Bridge. The 2006 Adopted Land Use designates these parcels as Limited Service Areas (Low Density Development). The Draft Imagine Currituck County Land Use Plan updates this zone as a G-3 Mixed-Use Center and Corridor which allows from up to 2 dwelling units per acre or as established in Civic Master Plan. The goal of the G-3 classification is to encourage attractive mixed-use developments by incentivizing multi-story buildings that comply with design standards. Densities are established in existing and future Civic Master Plans (Currituck County Department of Planning and Community Development, 2019).

Given the commercial and mixed-use viability of this area if the Mid-Currituck Bridge advances, property owners would likely advance planning for this area as a Civic Master Plan. Civic Master Plans are defined as a tool for "making detailed land use, transportation, and place-making recommendations for a small geographic area" (Currituck County Department of Planning and Community Development, 2019). These plans are highly visual to help illustrate the desired future build-out. Finally, a mixed-use center as opposed to strictly commercial development could prove to be an alternative development outcome at this location.

20.5.8.2. Road Accessible Outer Banks PDA

As described in Chapter 7, this PDA is mostly developed residential with local commercial activities. There are about 535 developable parcels in this PDA and all but 129 are within the service areas of existing non-discharge wastewater facilities described in Chapter 8. In addition to these scattered parcels, there are two large parcels in this PDA that are subject to a settlement agreement.

20.5.8.3. Non-Road Accessible Outer Banks PDA

As described in Chapter 7, this PDA contains about 1,742 developable parcels, most of which were platted in the 1960s. Currituck County expects this area to develop as strictly residential (personal communication, Laurie LoCicero, County Planner, September 22, 2020). As described in Chapter 16 (especially in Section 15.4.7), it is very unlikely that all of these parcels will be developed in the 20-year time frame of this study.

20.5.8.4. Summary of Planning issues

Currituck County has a robust planning process already in place. Suggestions are made in Chapter 16 for Currituck County to consider adopting small area plans in specified locations to address any water quality related issues more thoroughly, such as stormwater management if the NCDWR concludes that additional stormwater management is needed to protect downstream water quality.

20.6. Potable Water

Potable water is supplied by Currituck County for the U.S. 158 Interchange PDA and the Road Accessible Outer Banks PDA. These systems meet state and federal requirements for safe drinking water standards. The Non-Road Accessible Outer Banks PDA is served by individual wells on each parcel. The Road Accessible Outer Banks PDA and the US 158 Interchange PDA is served by public

water provided by the County. Construction of the Mid-Currituck Bridge is not expected to have any impact on the availability or quality of potable water supplies in the three PDAs.

20.7. Regulatory and Non-Regulatory Considerations

The overall purpose of the following section is to provide possible scenarios for the NCDWR, Currituck County, and/or the Albemarle Regional Health Services to consider, if needed, to address any water-quality related issues raised during this cumulative impact analysis which would be expected to cause a violation of downstream water quality standards. Refer to Chapter 19 of this report for the details of these considerations. In general, the Project is not expected to result in indirect or cumulative impacts to downstream water quality of sufficient magnitude to cause a regional violation of state standards or a loss of existing or anticipated uses in Currituck Sound or the Atlantic Ocean. However, these options could be implemented if it is determined by NCDWR that they are warranted, or to address issues that result from past regulatory and non-regulatory measures which currently affect water quality in Currituck County.

20.7.1. Non-Discharge Systems

It is recommended that NCDWR determine if all wastewater treatment plants should be required to install nutrient removal technology in their design at permit renewal.

20.7.2. Septic Tanks and Drain Fields

For the U.S. 158 Interchange PDA, the existing state regulations administered by Currituck County should be adequate to protect surface waters, as long as such systems are properly sited and maintained. Currituck County may wish to consider modifying existing septic tank regulations to require pre-treatment for septic tanks and drain fields installed on parcels within 100 feet of open surface water.

20.7.3. Groundwater Lowering Measures

For groundwater lowering systems permitted under state authority, the NCDWR should consider a more rigorous water sampling regimen to ensure that waters of Currituck Sound are adequately protected from resulting discharge.

20.7.4. Sea Level Rise

State and local government agencies should implement an adaptive and comprehensive management approach to regularly evaluate their rules and procedures and then adjust them as needed to account for sea level rise.

20.7.5. Flooding

Currituck County may wish to consider the following items:

- Develop a systematic way to encourage residents and visitors to report local flooding problems and develop a GIS-based system to collect and analyze this information.
- Modify the existing NCDWR-approved flood management approval process to address the Non-Road Accessible Outer Banks PDA, so that this mechanism is in place as development occurs.

- Encourage detailed, local stormwater management plans, like that done for the Whalehead subdivision, to proactively address flooding issues.
- Work closely with the NCDWR to determine the appropriate conditions under which pumping of stormwater to local ponds (which usually drain to Currituck Sound) will be allowed along with appropriate water quality monitoring.

NCDWR should consider requiring a protective berm to address potential flooding issues at the Village at Ocean Hill facility during its next non-discharge permit renewal cycle.

20.7.6. Stormwater Management

Currituck County should consider modifying its existing stormwater regulations to:

- Require on-site stormwater management for development in the U.S. 158 Interchange PDA;
- Require on-site stormwater management for infill parcels within 100 feet of open water as they develop in the remaining two PDAs; and
- Prohibit additional construction of finger canals on the Currituck County Outer Banks.

20.7.7. Spills/Emergencies

Continue to administer the existing NCDWR permitting program to address future spills and emergencies.

20.7.8. Planning

Currituck County could consider the following items:

- Implement the "Imagine Currituck Land Use Plan Update": The Imagine Currituck planning effort provides a well-researched, collaborative planning initiative that advances forward thinking approaches to the County overall as well as both Outer Banks PDAs. It addresses growth issues and opportunities presently being experienced throughout Currituck County and anticipated over the next two decades.
- Prepare Small Area Development Plans for specific locations in the PDAs, i.e.:
    - Outer Banks PDAs
    - Mid-Currituck Bridge Landing Area on the Outer Banks
    - U.S. 158 Interchange PDA.
- Prepare a Small Area Plan for the Non-Road Accessible Outer Banks PDA
- Implement a Smart Growth Planning Effort for the two large parcels in the Road Accessible Outer Banks PDA that are subject to the settlement agreement.

20.7.9. Potable Water

Potable water supplies in all three PDAs are currently adequate and will not be affected by the proposed Project.

20.8. Overall Conclusions

The findings of this indirect and cumulative impacts report indicate that construction of the Mid-Currituck Bridge project is not expected to result in indirect or cumulative impacts to downstream water quality that would cause a violation of state standards or a loss of existing or anticipated uses in either Currituck Sound or the Atlantic Ocean over the 20-year timeframe of this study. The amount of induced development that can be attributed to the bridge (i.e., the difference between the Build and No Build Alternatives) is modest.

Existing wastewater treatment plants on the Outer Banks of Currituck County are meeting state water quality standards, are in compliance with their permits, and are functioning as permitted. The ongoing NCDWR permitting for these systems will provide ample opportunity to address any capacity or upgrade needs that may arise in the future. The projected proportional increase in on-site septic systems on the Outer Banks is small. Any new septic systems added in the future will need to meet current County requirements, which can be more stringent than those applied to older systems. Impervious surface area, as a proportion of total watershed size, will increase slightly in some areas, particularly in the Road Accessible Outer Banks PDA. Regional stormwater drainage infrastructure on the Outer Banks is expected to remain at current levels. Currituck County will likely require on-site stormwater control measures for much, if not all, of the commercial development expected to occur on the mainland. In addition, on-site stormwater control measures will likely be required for development of the two large parcels subject to the settlement agreement in the Road Accessible Outer Banks PDA. These two parcels represent a large proportion of the total growth expected to occur in this PDA. Remaining infill development in the Road Accessible Outer Banks PDA will primarily drain toward existing roads and swales, which are already in place now. The project is not expected to have any measurable impact on regional flooding, potable water supplies, or the implementation of groundwater lowering measures. Sea level rise over the next 20 years is not projected to inundate any vacant parcels which might develop over that time period. Currituck County currently has an assertive regional planning effort, and progress is underway for a new regional plan, the Imagine Currituck Land Use Plan Update, to be completed soon. This planning will help to guide future development in all of the PDAs, including measures to protect water resources. In general, existing regulatory processes should address any water quality related impacts for the US 158 Interchange PDA as well as the Road Accessible Outer Banks PDA. For the Non-Road Accessible Outer Banks PDA, at most minimal and localized impacts to water quality may occur in the finger canal area although the projected amount of development there is small.

For these reasons, the Mid-Currituck Bridge is expected to cause at most only minimal and localized indirect or cumulative impacts that would likely not cause a violation of state water quality standards in either Currituck Sound or the Atlantic Ocean but could have at most a minimal and localized effect on some man-made tributaries to Currituck Sound. However, over the course of preparing these studies, NCDOT identified several opportunities for improved water quality management. These options could be implemented by NCDWR or the County if it is determined that they are warranted, or to address issues from previous land use management practices which currently affect water quality in Currituck County.

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Appendix 1:
NCDWQ 2004 Cumulative Impact Guidance

Michael F. Easley, Governor
William G. Ross Jr., Secretary
North Carolina Department of Environment and Natural Resources

Alan W. Klimek, P. E. Director
Division of Water Quality
Coleen H. Sullins, Deputy Director
Division of Water Quality

April 10, 2004

MEMO

TO: Coleen Sullins

FROM: John Dorney

RE: Final version of DWQ Cumulative Impact Policy

Please see the attached final version (Version 2.1, dated April 10, 2004) of the Cumulative Impact Policy for the 401 and Isolated Wetland Permitting Programs. The policy was put out to public notice on October 3, 2002. We received comments from DOT, Charlotte-Mecklenburg Stormwater Services, the NC Wildlife Resources Commission, the Home Builders Association, and the US Environmental Protection Agency. I believe that this policy addresses the questions raised by these comments. The policy has also benefited from our work over the past year and one-half with DOT and various local governments.

Please advise as to the next step in getting final approval for this policy. I can be reached at 733-9646. Thankx

Cc: John Hennessy, Transportation Permitting
Dennis Ramsey

Cumulative impacts and the 401 Water Quality Certification and Isolated Wetland Permit Programs

Division of Water Quality Internal Policy
NC Division of Water Quality

April 10, 2004
Version 2.1

Background

Existing rules for the 401 Water Quality Certification Program (15A NCAC 2H .0506(b)(4) and (c)(4)) as well as those for the Isolated Wetland Permit Program (15A NCAC 2H .1300) require that DWQ determine that a project "does not result in cumulative impacts, based upon past or reasonably anticipated future impacts, that cause or will cause a violation of downstream water quality standards." This internal policy is meant to give direction to DWQ Central and Regional Office staff as well as the regulated public on how to implement this rule. Cumulative impact is defined as those "environmental impacts resulting from incremental effects of an activity when added to other past, present, and reasonably foreseeable future activities regardless of what entities undertake such other actions" (taken from 15A NCAC 1A which implement the State Environmental Policy Act) for the Department of Environment and Natural Resources.

It is important to note that the 401 Certification rules require an examination of cumulative impacts in terms of their impact on downstream water quality standards and their associated designated uses. This is a relatively narrow provision that requires DWQ staff to focus on downstream standards (narrative and numeric) rather than (for instance) the effect of the development on wildlife habitat. Therefore, only if that impact will cause a violation of downstream water quality standards is the project of concern in the context of cumulative impact for DWQ's wetland permitting programs. However, water quality standards form the basis of all water quality regulation and permitting programs. This rule (although narrow in its scope since it focuses on downstream water quality) provides an essential tool for DWQ to use to manage cumulative impact. Water quality impairment is usually tied to stormwater runoff that can increase with road construction and urban development. This policy is intended to address this regulatory requirement.

Policy

I. DOT (and other public transportation) projects

The major types of DOT projects and their need for different levels of cumulative analysis are outlined below. The three types of cumulative impact analysis with respect to this policy are 1) Generic description, 2) Qualitative analysis, and 3) Quantitative analysis.

A. **Generic description of water quality impacts:** Small-scale widening projects, bridge replacements projects and intersection improvement projects – These projects which include categorical exclusions (23 C.F.R. § 771.117) and minimum criteria (19A NCAC 2F .0102) normally have a low potential for cumulative impact since little (if any) new impervious surface is added and the projects are usually in already developed locales. DWQ believes that a generic description can be developed which addresses the cumulative impacts of the majority of these projects in the context of the 401 Certification and isolated wetland rules. However, if DWQ staff determines that any of these projects may have growth-stimulating effects and downstream impacts, then either a qualitative cumulative impact analysis (see B below) or (more rarely) a quantitative analysis (see C

below) should be required of the applicant. These projects which will require a more complex analysis often coincide with projects identified by the Pre-screening process of the Department of Transportation.

B. **Qualitative Analysis of water quality impacts:** Projects such as widening with new locations: Most of these projects have a low potential for cumulative impacts since these locations tend to be near existing roads and already developed areas. Therefore, a narrative cumulative impact analysis prepared using the methodology outlined in the DOT/DENR NEPA/SEPA document (Guidance for Assessing Indirect and Cumulative Impacts of Transportation Projects in North Carolina. Volumes I and II. 2001, State of North Carolina Department of Transportation and Environmental and Natural Resources prepared by The Louis Berger Group, Inc., Cary, N.C. or their updates) should suffice for the 401 Certification and Isolated Wetland permitting programs.[1] If DWQ technical staff determines that any of these projects will have growth-stimulating effects and downstream impacts, then a quantitative analysis should be required of the applicant (see below).

C. **Quantitative (i.e., Detailed) Analysis of water quality impacts:** Projects such as roads on new location: Many of these projects may have growth-stimulating effects (i.e., urban growth beyond that expected without the project) since new growth has the potential to occur on otherwise undeveloped property adjacent to the new road alignment. Therefore, these projects may result in cumulative impacts to water quality. The overall process as outlined below will be used to deal with new location projects or for any other project that will have growth-stimulating effects, including projects that would otherwise be categorized as "Generic Description" or "Qualitative Analysis" projects.

1. Sequential questions to address for quantitative analyses:

a. Is growth likely to be induced by the project? This may be indicated by projected land use changes or by the purpose and need of the project (i.e., if the project is specifically planned to stimulate growth). For instance, projects on new location near urban areas often have the greatest potential for cumulative impacts since they provide improved access to previously inaccessible sites. A narrative cumulative impact analysis prepared using the methodology outlined in the DOT/DENR NEPA/SEPA Cumulative Impacts Guidance document mentioned earlier should generally suffice to answer this question. If the answer to this question is "no", then no further analysis is needed and the narrative (qualitative) analysis should be sufficient.

b. **Are existing uses of the water (as reflected in the classification of the waters) likely to be impacted by the growth?** The following descriptions (categories 1, 2 and 3) should help clarify the answer to this question.

1. *Water Supply, HQW and ORW classifications* –DWQ has several existing regulatory programs that address cumulative impacts for these waters. Specifically, the Water Supply Protection Program as well as the watershed-specific management plans for ORW and HQW watersheds provides considerable protection from cumulative impact on downstream water quality. In addition, DWQ often relies on other state permitting programs such as the High Quality Waters Best Management Practices developed by the Division of Land Resources for protection of water quality. DOT reports for projects impacting these waters should describe and analyze these existing programs for a particular project. In most cases, a narrative analysis based on the DOT/DENR NEPA/SEPA report with clear reference to these existing DWQ permitting program as well as a description of the general effectiveness of these programs in protecting water quality should be sufficient. However, if DWQ staff determines that a project appears to have growth-stimulating effects and downstream impacts

[1] These documents will need to be revised to explicitly refer to water quality-related issues for the 401 Certification and Isolated Wetland Permitting Programs. In the interim, DWQ believes that the procedures outlined in these documents will normally suffice for cumulative impact analysis for these projects.

that are not addressed by existing regulatory programs, then a quantitative analysis may be required.

2. *Class C, B, SC and SB classifications* – The potential for cumulative analysis from these projects should be discussed utilizing the qualitative analysis described above for these stream classifications. If significant potential for cumulative impact is identified (for instance due to the presence of endangered aquatic species), then a quantitative analysis may be required.
3. *Impaired Waters (303 (d) listed Waters), SA (Commercial Shellfishing), and Trout classification* – These watersheds warrant special attention with respect to cumulative impact analysis since existing regulatory programs often have not adequately addressed pollution sources for these waters. With respect to the impaired waters, the reported parameter of concern and source (for instance, point versus non-point) of the contaminant should be examined to determine if the new location road and any induced development are likely to further impact these waters. For instance, if the impaired water is listed as impacted by dioxin from point sources, it is very unlikely that a new road and its associated development would exacerbate the situation. In this case, a qualitative analysis of cumulative impacts will usually suffice. However, for Trout and SA waters as well as impaired waters which are impaired by pollutants likely increased by development (such as bacteria, nutrients or sedimentation), then a detailed, quantitative analysis should be conducted by DOT to determine 1) if cumulative impacts are likely and then (if impacts are predicted to occur) as well as 2) what non-point source control measures will be needed and how they are to be implemented. This analysis will often require watershed-level modeling using export coefficients, estimated levels of treatment for BMP's and comparison to numerical water quality standards or numeric water quality goals. With respect to implementation, discussion with and commitment from local governments may be needed to address these cumulative impacts.

c. Are additional regulatory measures needed? (i.e., are there existing regulatory programs which can address these impacts?). For instance, the Phase II NPDES Stormwater Permit Program addresses stormwater runoff from development as do riparian buffer rules in place in several watersheds across the state. Finally in some cases, local governments already have land use control programs in place that adequately address stormwater runoff. In many cases, these programs should reduce or eliminate the need for additional regulatory measures. Modeling may be needed to determine the effect of these existing programs.

If the answers to all three questions of these questions are yes, then a quantitative analysis of cumulative impact would be needed for the 401 Water Quality Certification. The following information describes this process in more detail

2. Analytical considerations for quantitative analyses:

a. Impact or service area – The area chosen for detailed study should be selected by DWQ after consultation with local planning experts and the applicant. The area should be limited to the downstream location most likely affected by the growth induced as a result of the project. Boundaries such as major rivers, major physiographic constraints and already developed areas should be used as appropriate. For instance in some instances, a seven-mile distance from the road on new location has been used to put boundaries on the study area.

b. Modeling considerations – The selection of models and their study plan must be approved by DWQ before their use. The model must be in the public domain and include

water quality parameters of concern for the water body. An examination of the effectiveness of various land use control scenarios would also be helpful in evaluating the cumulative impact of a project on downstream water quality.

c. Time frame for analysis – DWQ's approval of a time frame for analysis must hinge on what is "reasonably anticipated" as noted in the 401 Certification and Isolated Wetland rules. Local land use experts should be consulted for their expertise in the local area. The analysis should (if possible) consider several time frames including a) known proposed projects, b) 10 years, and c) 20 years. The final determination of the appropriate time frame should be done by DWQ staff based on the "reasonably anticipated" criteria.

d. Non-point source (i.e., stormwater) measures to consider – Management of the cumulative impacts of development on downstream water quality necessarily involves stormwater management since stormwater is often the major source of these pollutants. The local land use control measures to consider must be focused on the likely (or known) cause of water quality impairment or concern. For instance in watersheds with eutrophication issues, measures to manage inputs of nitrogen and phosphorus should be considered. In watersheds where sediment is the concern, the measures that address sediment from a) construction, b) developed landscapes, and c) streambank erosion must all be evaluated.

Measures which often need to be considered include a) enhanced sedimentation and erosion control BMPs and inspections, b) riparian buffers, and c) on-site stormwater management, Where appropriate, these measures should utilize the various DWQ design manuals or be patterned after other DWQ rules in order to ensure that the specific BMPs are adequately designed, implemented and maintained to protect downstream water quality.

II. Other publicly-funded development projects

Other publicly funded development projects may or may not result in cumulative impacts. For instance, the development of a regional, public park or a new library is unlikely to result in cumulative impacts. For these projects, a generic description similar to that described in step I A above should suffice. However, other projects will likely result in cumulative impacts and therefore, then either a qualitative cumulative impact analysis (see I B above) or (more rarely) a quantitative analysis (see I C above) should be required of the applicant. Examples of projects in this later category would be projects targeted to encourage development such as the Global TransPark.. DWQ staff should use their professional judgment to determine if a publicly funded project is likely to result in cumulative impacts and would then need a quantitative analysis of this impact.

III. Private development projects

Privately funded development projects are normally not subject to SEPA or NEPA and therefore, only rarely require formal environmental documentation. However, if these projects require 401 Water Quality Certification or an Isolated Wetland Permit, then the cumulative impact provisions of the Water Quality Certification and Isolated Wetland Permit rules are applicable.

Many private development projects are unlikely to cause cumulative impacts, including projects such as urban in-fill, most residential subdivisions, and small commercial developments as well as agricultural and silvicultural operations that may need permitting from DWQ. However, some private projects may cause significant cumulative impacts on water quality. In these cases if a 401 Water Quality Certification or Isolated Wetland Permit is required, then either a qualitative or quantitative analysis of cumulative impact would be needed.

Some private development projects can clearly result in cumulative impact. Recent examples of this effect include the Streets at South Point Mall in Durham and the Landfall development in

Wilmington. Often these developments are 1) relatively large, 2) involve commercial development, and 3) occur in otherwise relatively undeveloped landscapes with an impact on regional growth patterns. When these or similar characteristics are present with a private development project, then DWQ staff should use the guidance outlined in Section I.C. above to determine if a quantitative analysis of cumulative impacts is needed or whether a qualitative analysis will be sufficient.

IV. Decision making and Elevation Process

DWQ staff will use the three tiered system outlined above to decide what level of cumulative impact analysis is appropriate for a given project. This action will normally occur during a pre-application meeting or in the initial review of a project to help ensure that these analyses do not cause an undue delay in a project.

A. Elevation Process for DOT projects – If, after review of the information provided by DOT and the methodology used to produce it, DWQ technical staff disagrees with the analysis of growth-stimulating effects and downstream impacts contained in the narrative or qualitative analysis, then DOT and DWQ will implement (upon DOT's request) an elevation process to resolve the issue. A review panel will be established comprised of the Water Quality Section Chief, the Wetlands/401 Unit Supervisor and the DOT project coordinator from DWQ as well as the PDEA Branch Managers a representative from the Project Development Branch, a representative from the Office of Human Environment from DOT and consultants who prepared the report. This review panel will convene and review the available materials to determine whether the proper methodology and analysis were used or whether the correct conclusion was made regarding the growth-stimulating effects of the project. DWQ expects to work via consensus with these parties. However, the ultimate decision as to what type of analysis is needed must remain with DWQ.

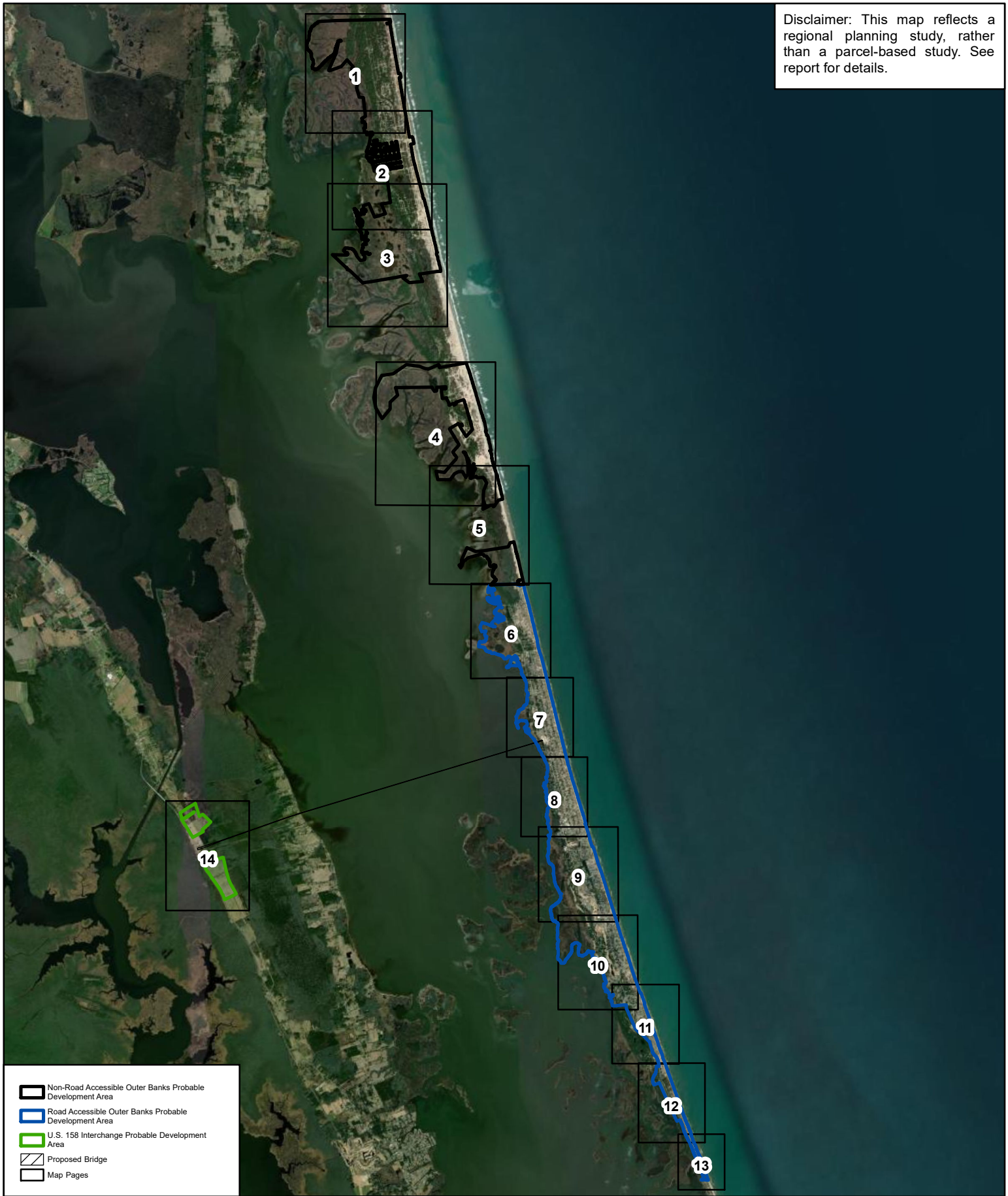
B. Other applicants - If other private or public applicants do not concur with a decision made by DWQ staff with respect to the level of cumulative impact analysis, the applicant may request a meeting with the Wetlands/401 Unit Supervisor (or the appropriate Branch Chief if the initial decision was made by the Unit Supervisor) and other relevant DWQ staff as well as the applicant and all relevant consultants. DWQ expects to work via consensus with these parties. However, the ultimate decision as to what type of analysis is needed must remain with DWQ.

V. Implementation of Measures to Address Cumulative Impact

If the above analyses (especially the quantitative analysis) reveal that additional measures are needed within a specific geographic area in order to address downstream water quality impacts of the project and associated growth, the DWQ will work with the local municipalities to develop and implement local land use control measures which will address the water quality impacts. Based on DWQ's experience with the water supply watershed protection rules, NPDES Stormwater Permitting and riparian buffer protection rules, DWQ believes that these decisions are most efficiently made at the local level. DWQ staff will work actively with all interested local entities to help ensure the timely implementation of any needed ordinances. In the unlikely event that a local government is unable or unwilling to implement the needed protections, DWQ will examine its existing regulatory responsibilities (including, but not limited to, the 401 Certification Program and NPDES Stormwater Permitting Program) to determine what measures DWQ can undertake to provide the needed protection for downstream water quality.

Finally, DWQ believes that once the appropriate land use control measures are in place for a specific area, then these actions should adequately address cumulative impact concerns for that geographic area for future projects. Therefore, other development projects should be able to rely on the previous analysis and land use management actions rather than each project conducting their own, separate analyses as long as the basic conditions under which the land use management measures were designed and implemented have not changed.

Appendix 2:
Developable Parcels in the Three PDAs



NORTH CAROLINA Turnpike Authority

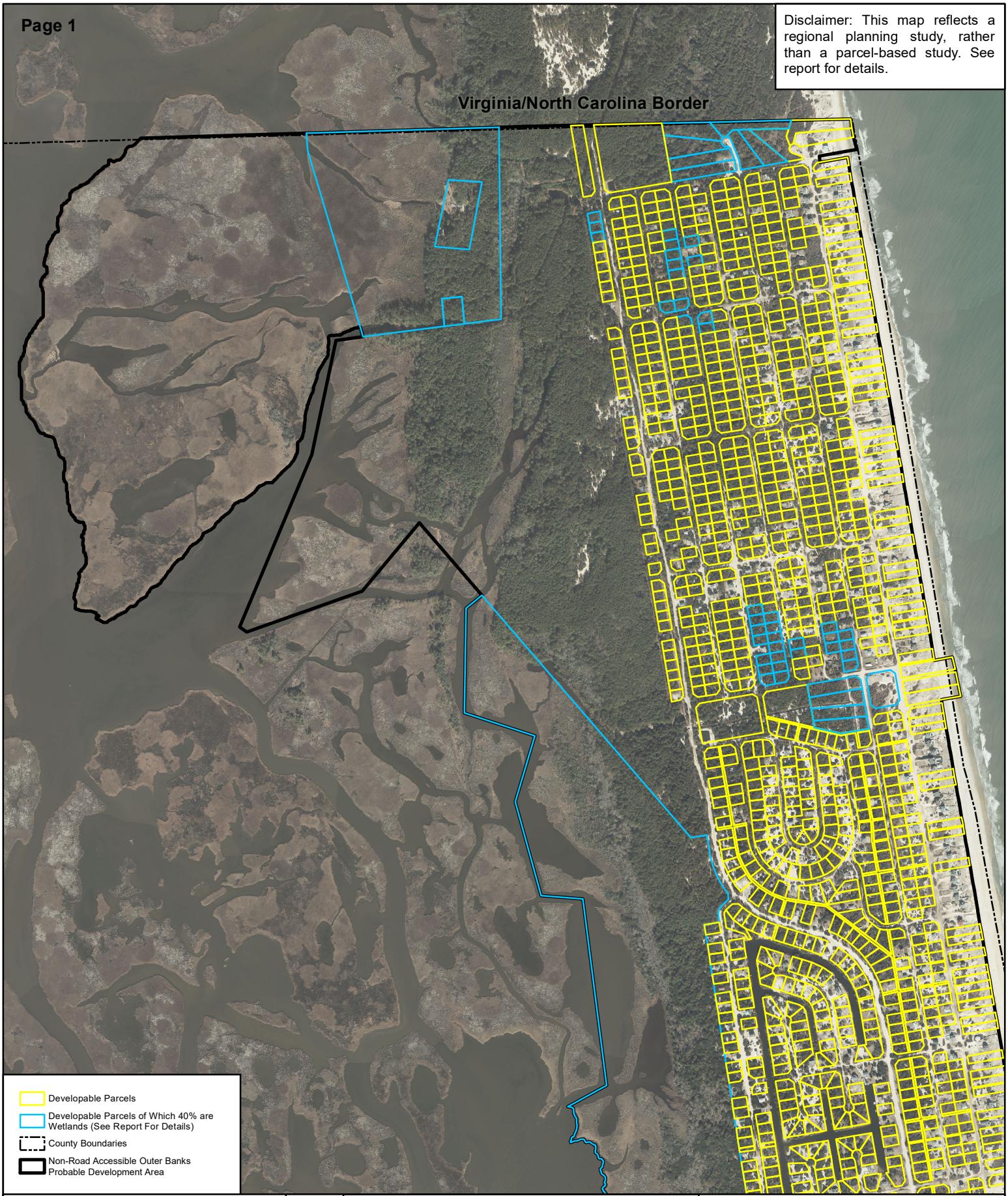
N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 2 4

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.2 0.4

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.

NORTH CAROLINA Turnpike Authority

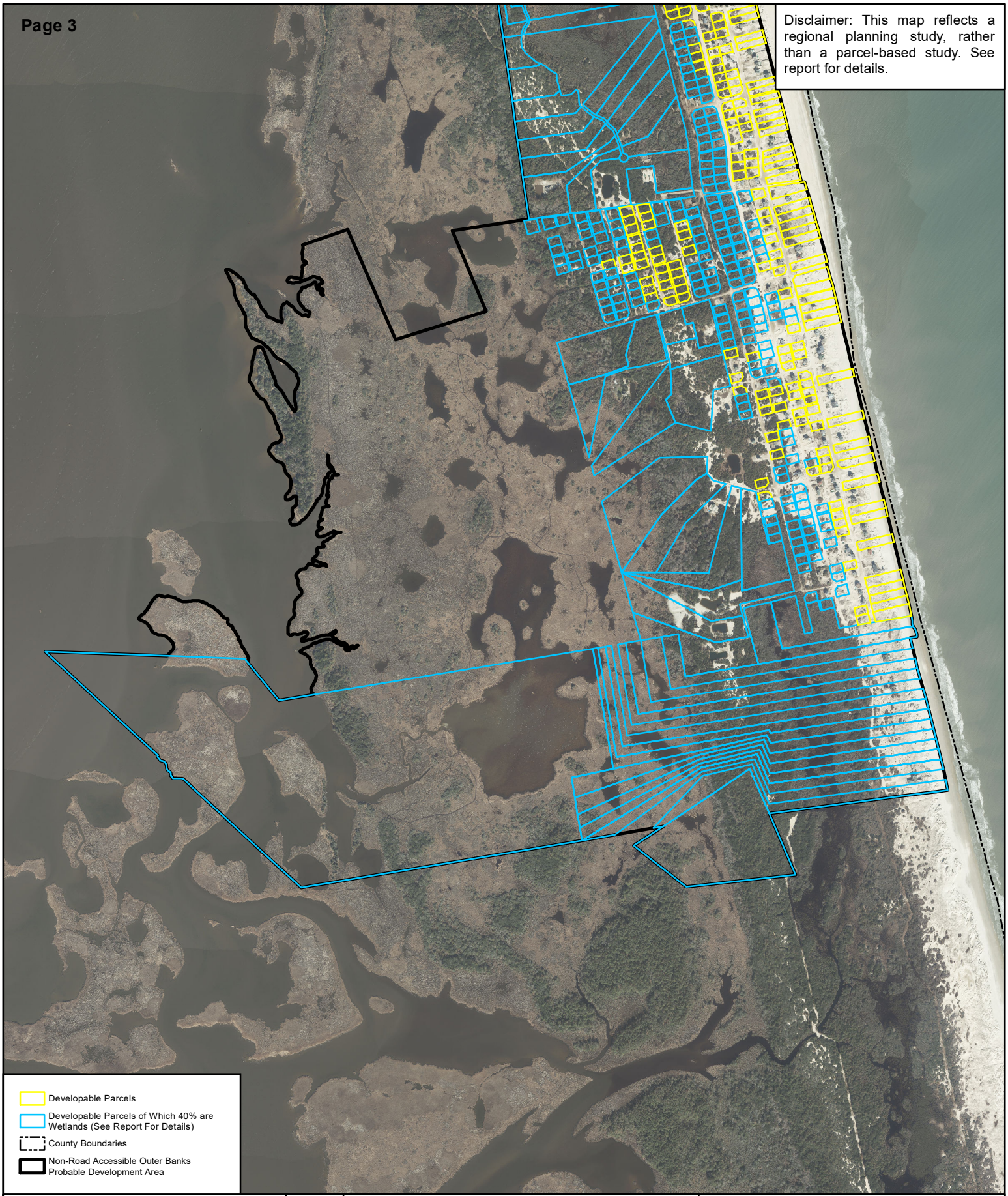
N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.2 0.4

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



- Developable Parcels
- Developable Parcels of Which 40% are Wetlands (See Report For Details)
- County Boundaries
- Non-Road Accessible Outer Banks Probable Development Area

NORTH CAROLINA Turnpike Authority

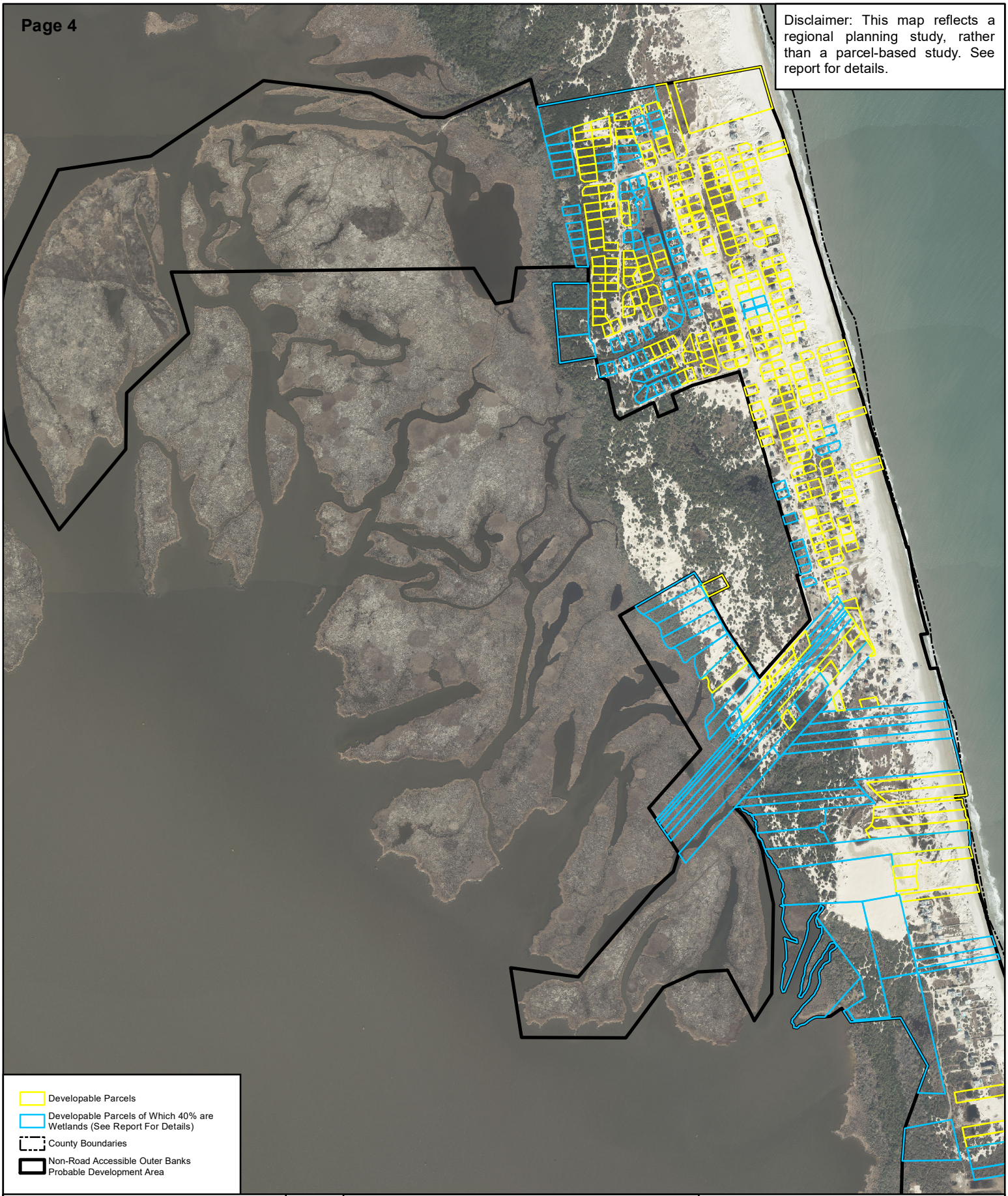
N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.25 0.5

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

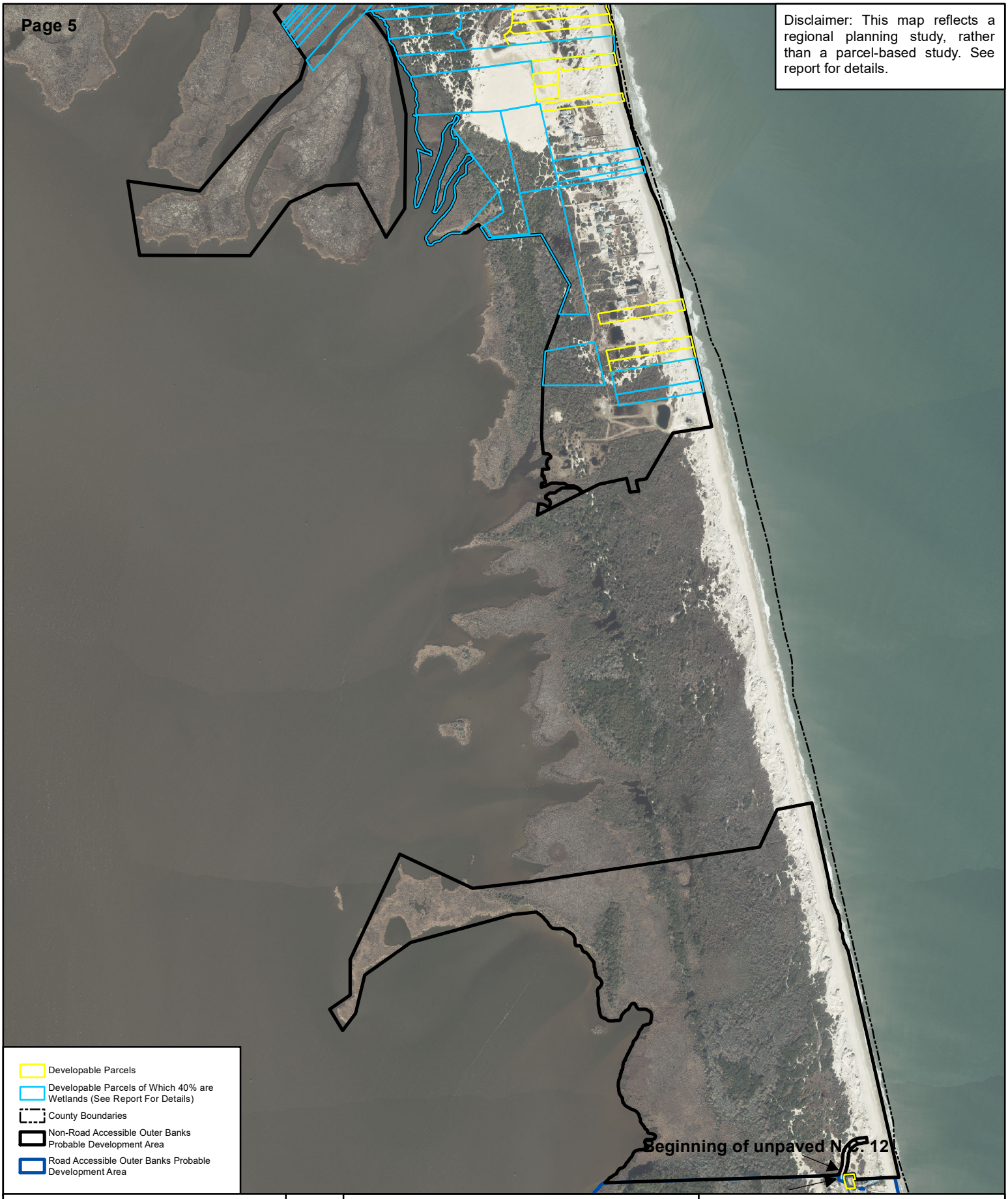
N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.25 0.5

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



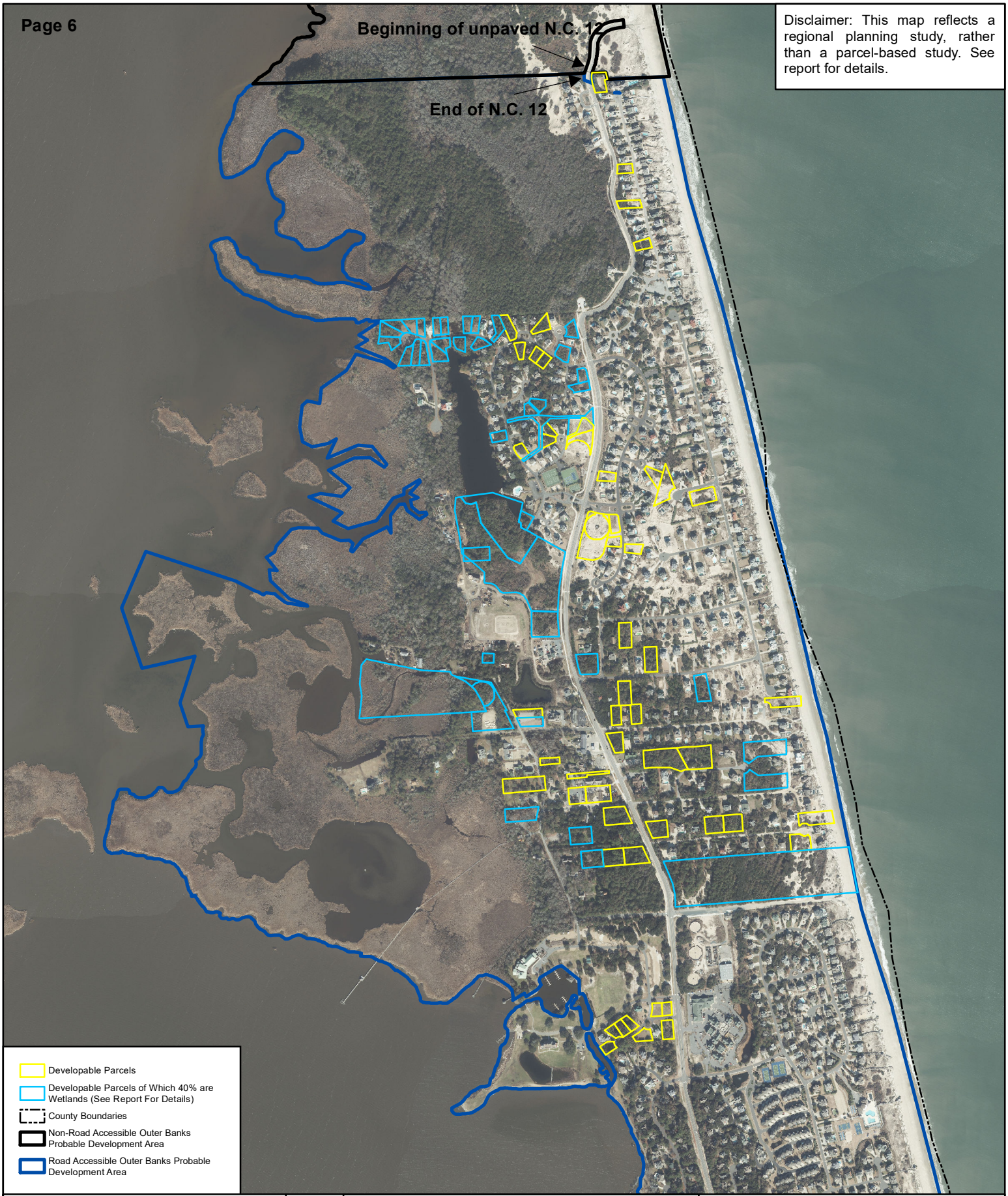
Developable Parcels
Developable Parcels of Which 40% are Wetlands (See Report For Details)
County Boundaries
Non-Road Accessible Outer Banks Probable Development Area
Road Accessible Outer Banks Probable Development Area

NORTH CAROLINA Turnpike Authority

N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles
0 0.25 0.5



Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.

Developable Parcels
Developable Parcels of Which 40% are Wetlands (See Report For Details)
County Boundaries
Non-Road Accessible Outer Banks Probable Development Area
Road Accessible Outer Banks Probable Development Area

NORTH CAROLINA Turnpike Authority

N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles
0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.

NORTH CAROLINA Turnpike Authority

N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.

Developable Parcels
Developable Parcels of Which 40% are Wetlands (See Report For Details)
County Boundaries
Road Accessible Outer Banks Probable Development Area

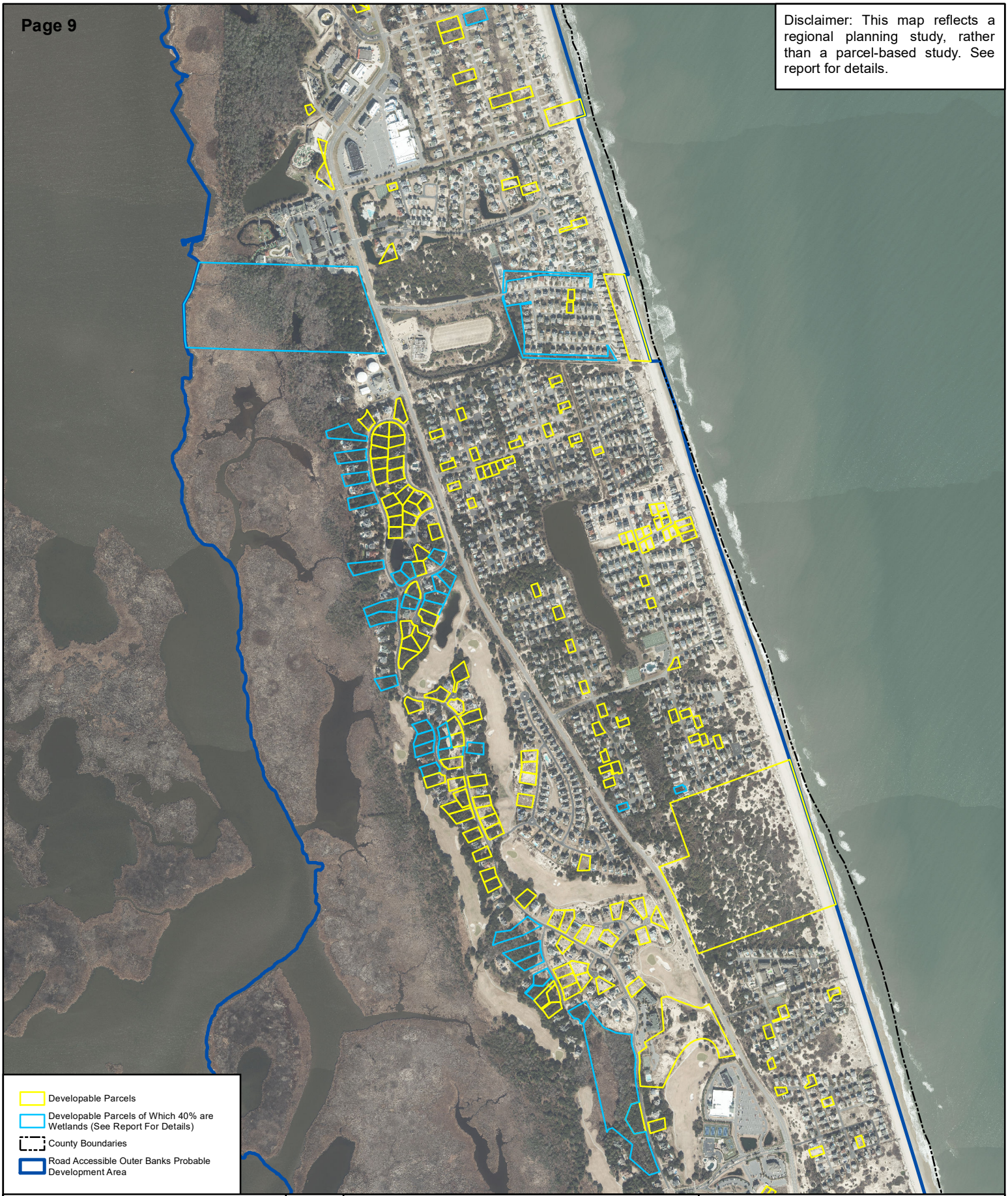
NORTH CAROLINA Turnpike Authority

N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles
0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.2 0.4

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.

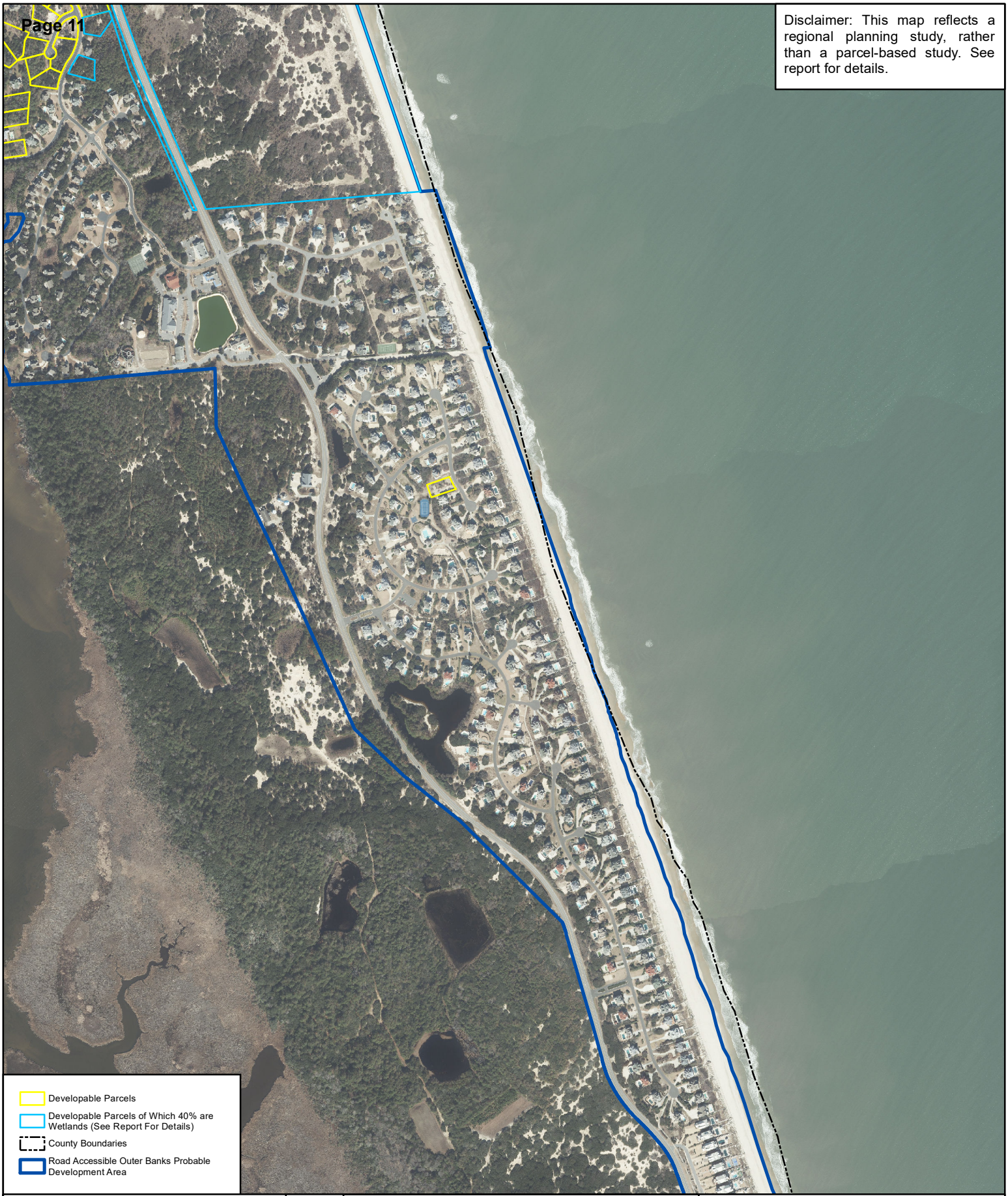
NORTH CAROLINA Turnpike Authority

N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles
0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.

NORTH CAROLINA Turnpike Authority

N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.

NORTH CAROLINA Turnpike Authority

N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles
0 0.1 0.2

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.

NORTH CAROLINA Turnpike Authority

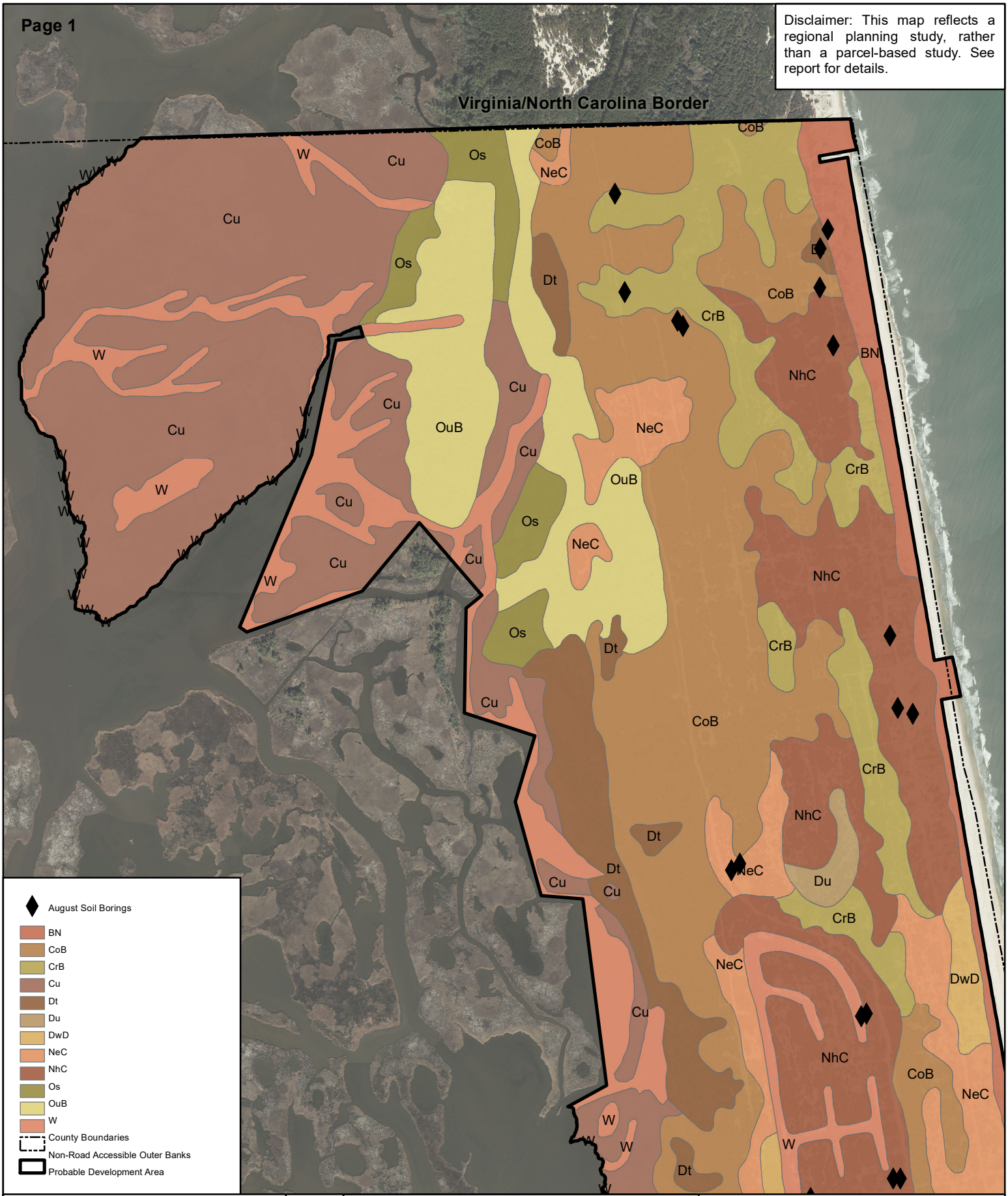
N

POTENTIAL DEVELOPABLE PARCELS MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles
0 0.15 0.3

Appendix 3:
Soil Series Map for the Three PDAs with Field-Based Soil Samples

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

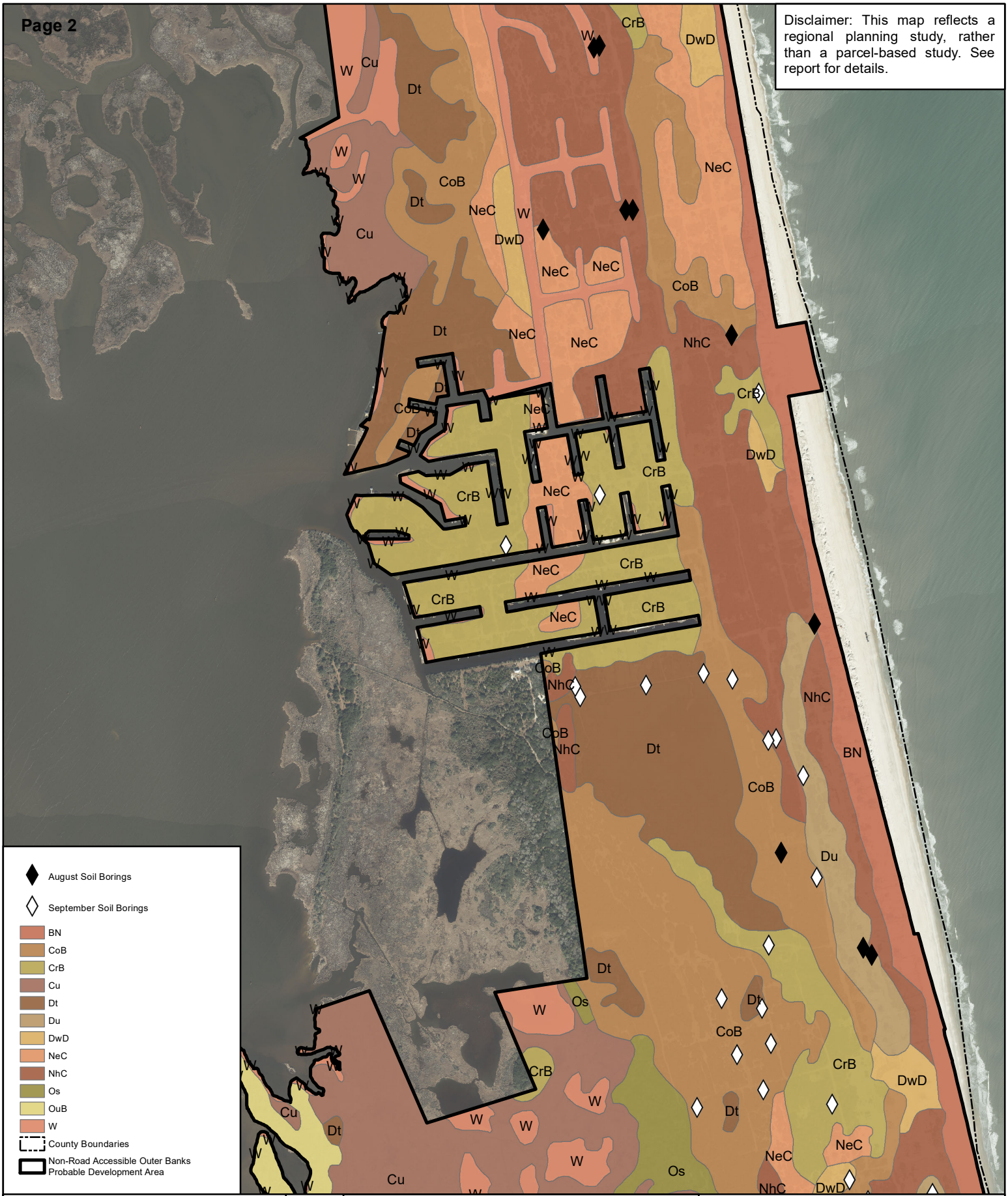
N

SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.2 0.4

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

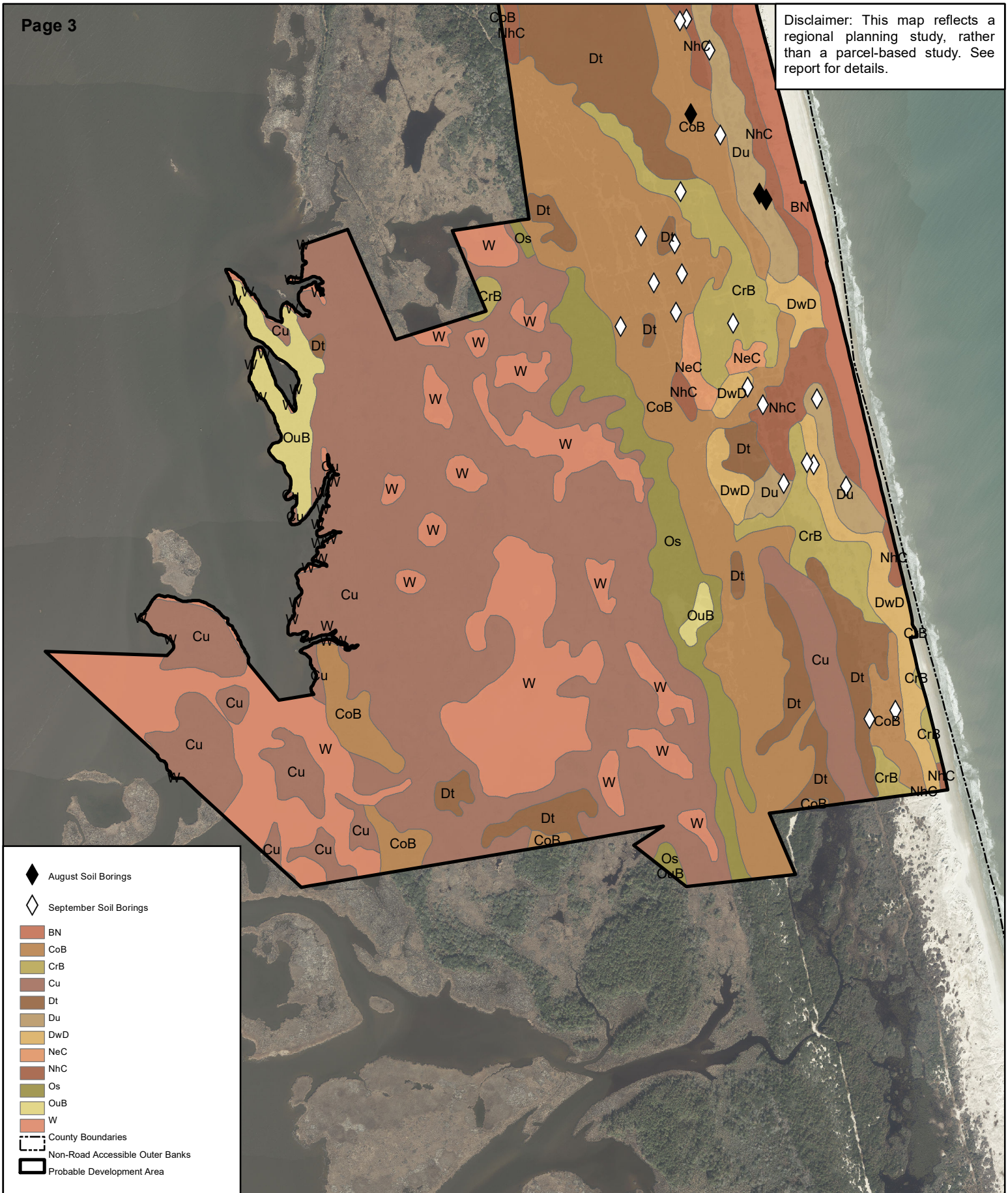
N

SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.2 0.4

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



- August Soil Borings
- September Soil Borings
- BN
- CoB
- CrB
- Cu
- Dt
- Du
- DwD
- NeC
- NhC
- Os
- OuB
- W
- County Boundaries
- Non-Road Accessible Outer Banks
- Probable Development Area

NORTH CAROLINA Turnpike Authority

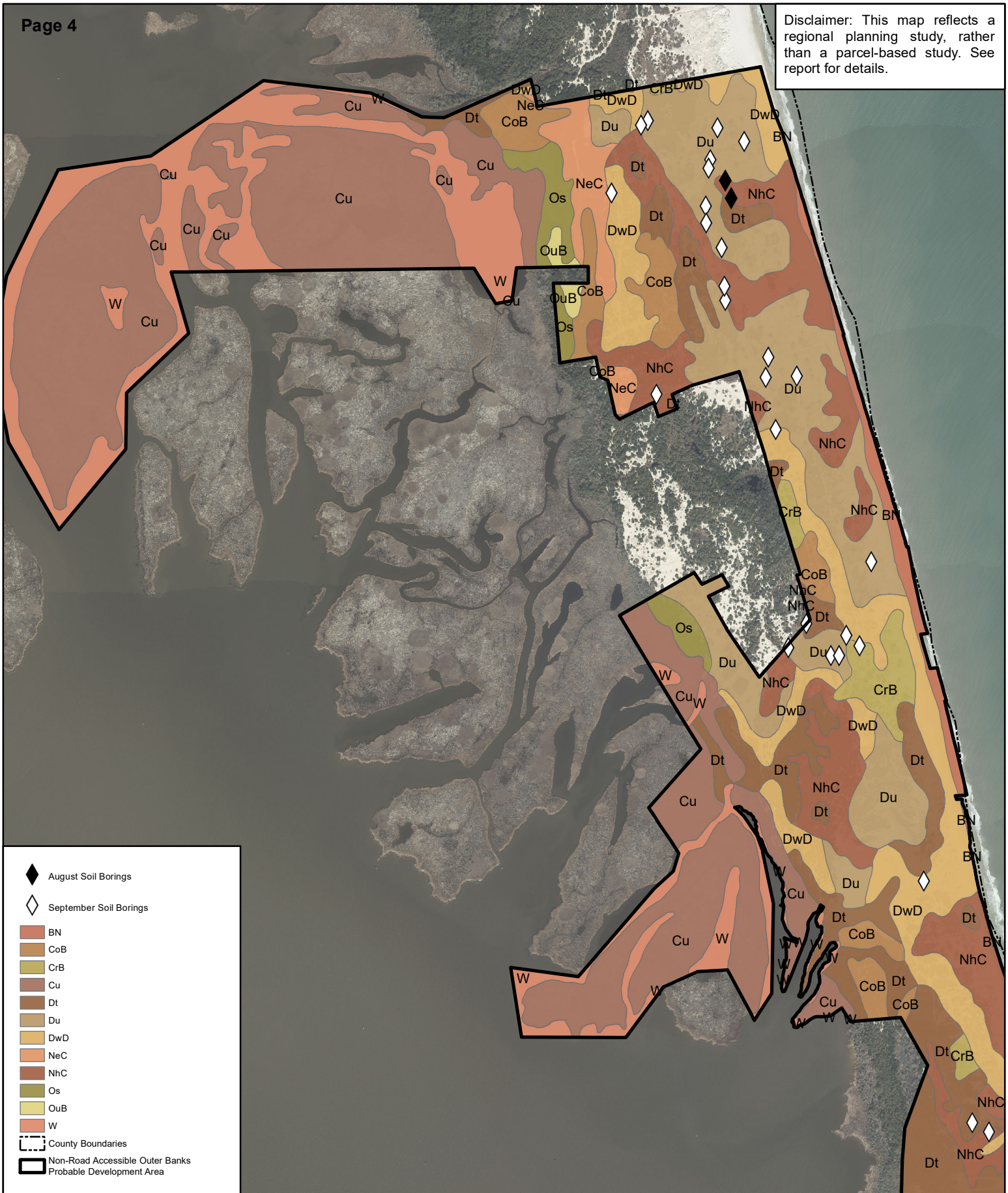
N

SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.25 0.5

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

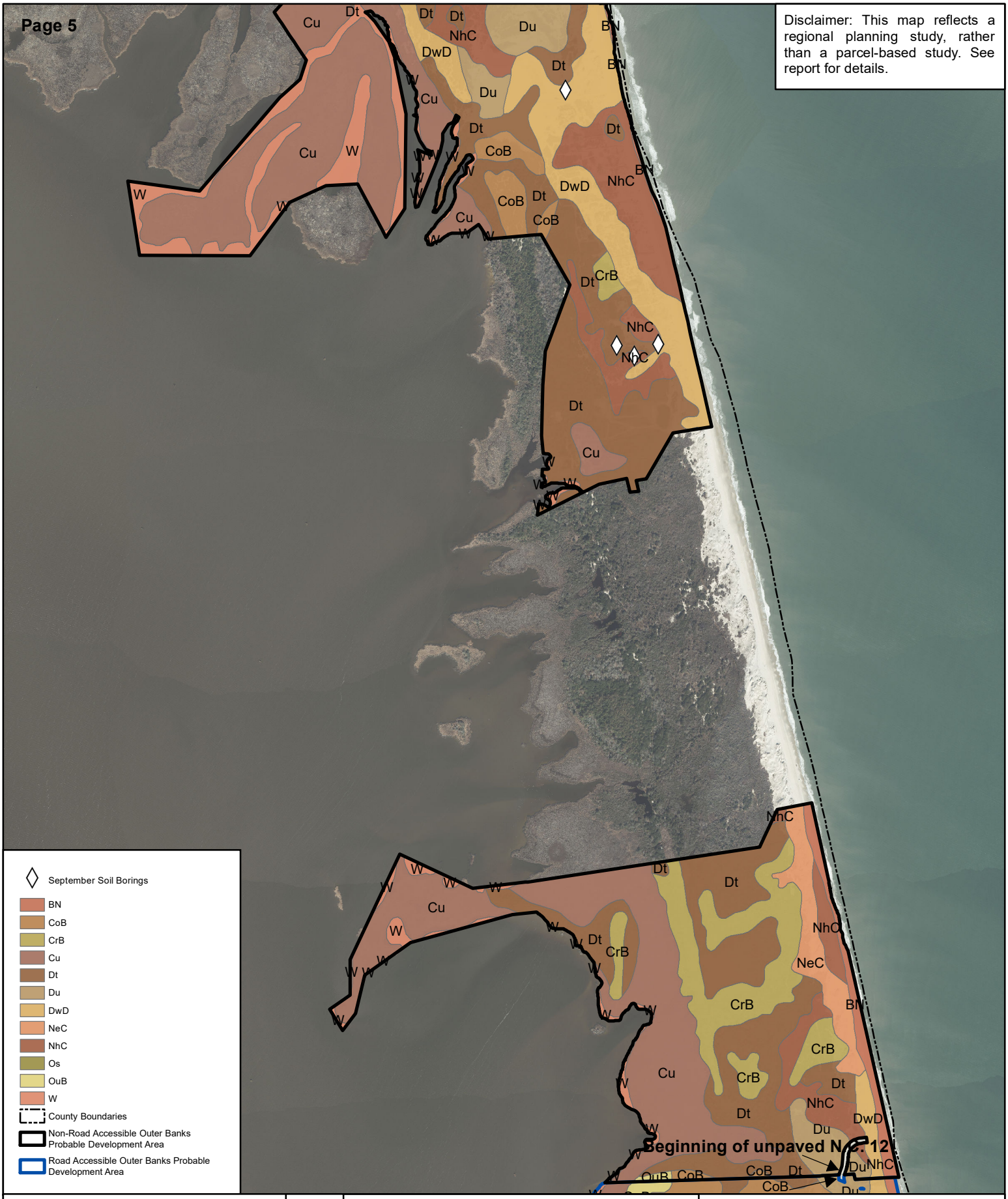
N

SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.25 0.5

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



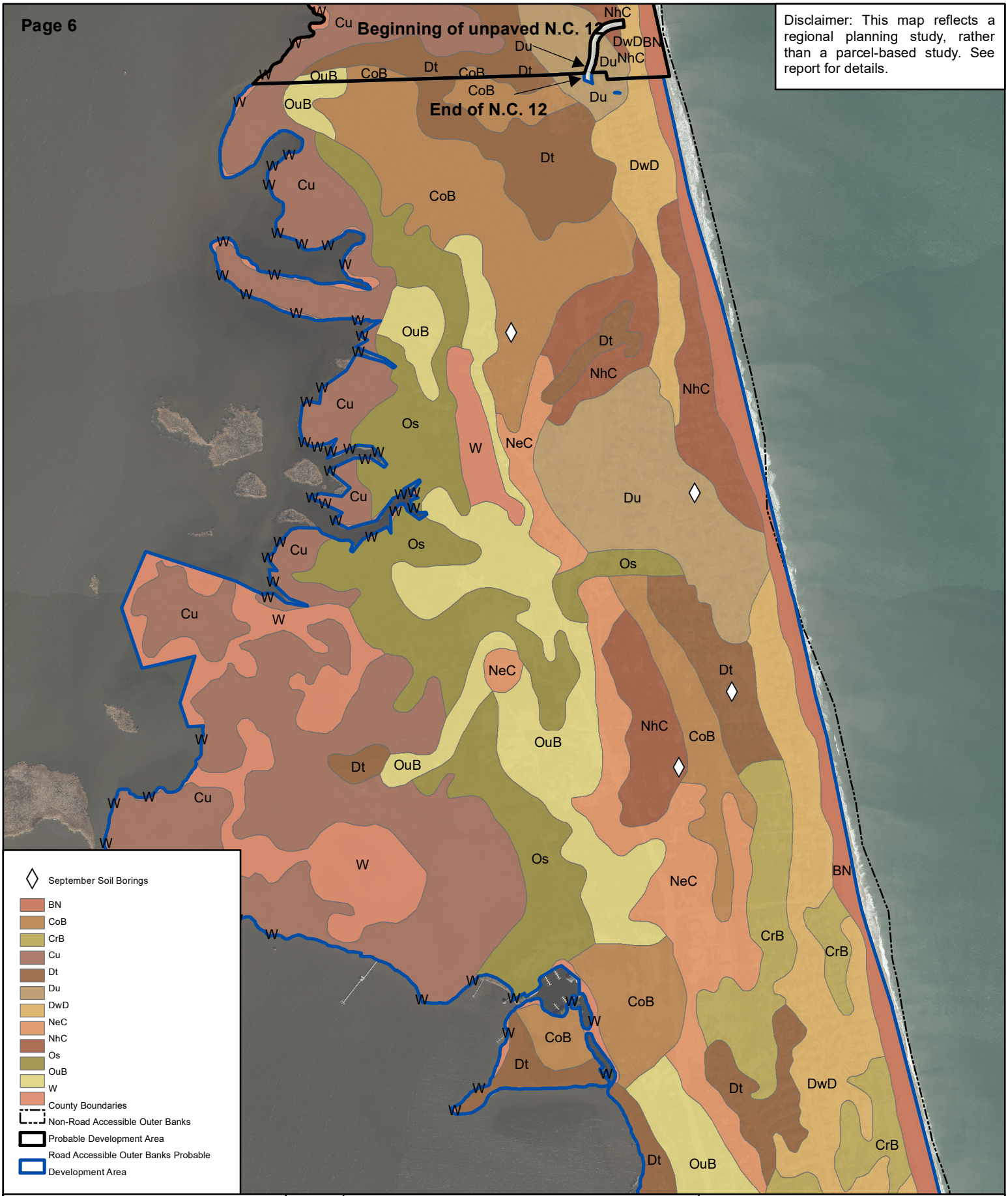
NORTH CAROLINA Turnpike Authority

N

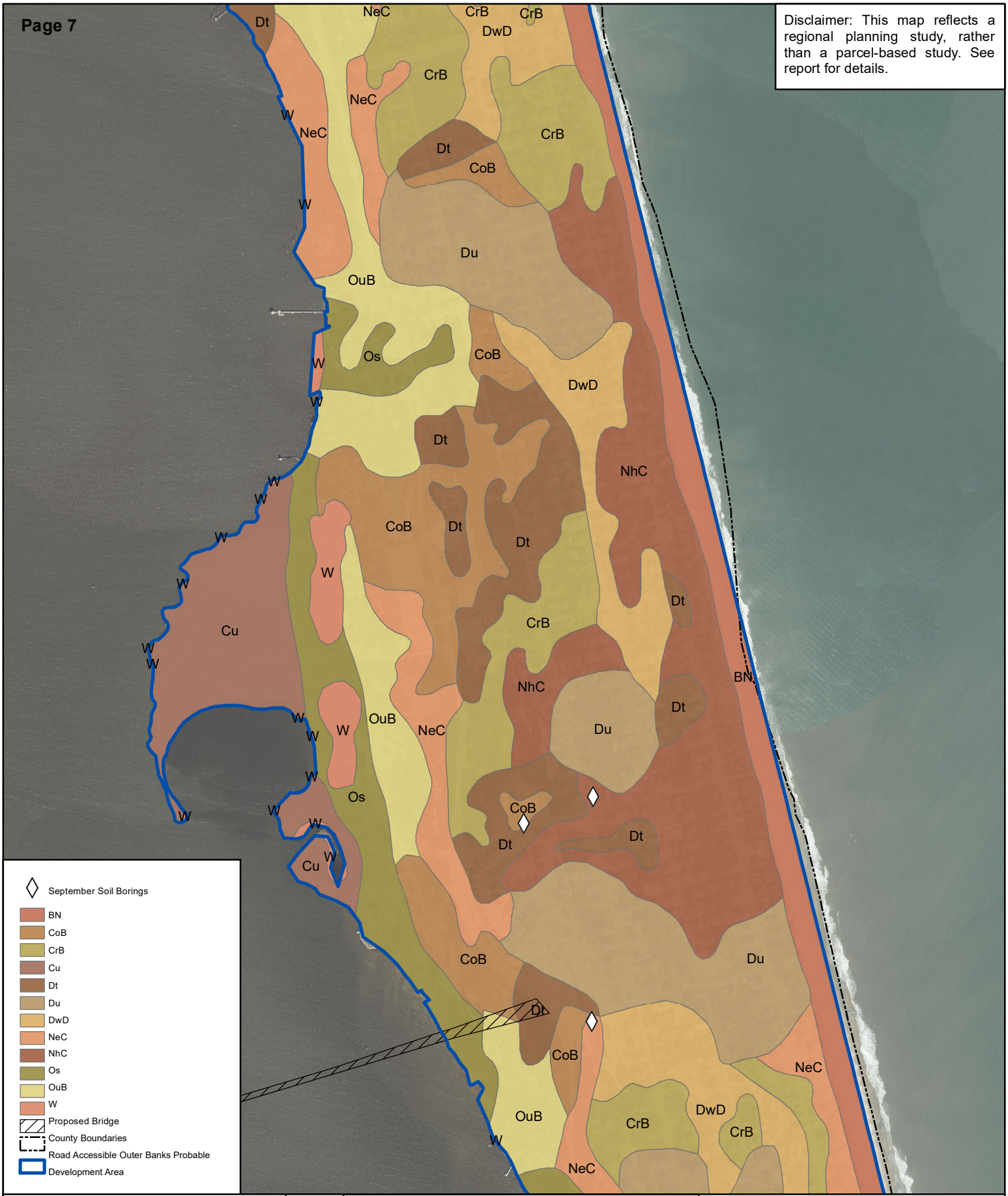
SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.25 0.5


Page 6
Beginning of unpaved N.C. 12
End of N.C. 12
Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.
September Soil Borings
BN
CoB
CrB
Cu
Dt
Du
DwD
NeC
NhC
Os
OuB
W
County Boundaries
Non-Road Accessible Outer Banks
Probable Development Area
Road Accessible Outer Banks Probable Development Area
N
SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC
Miles
0
0.15
0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

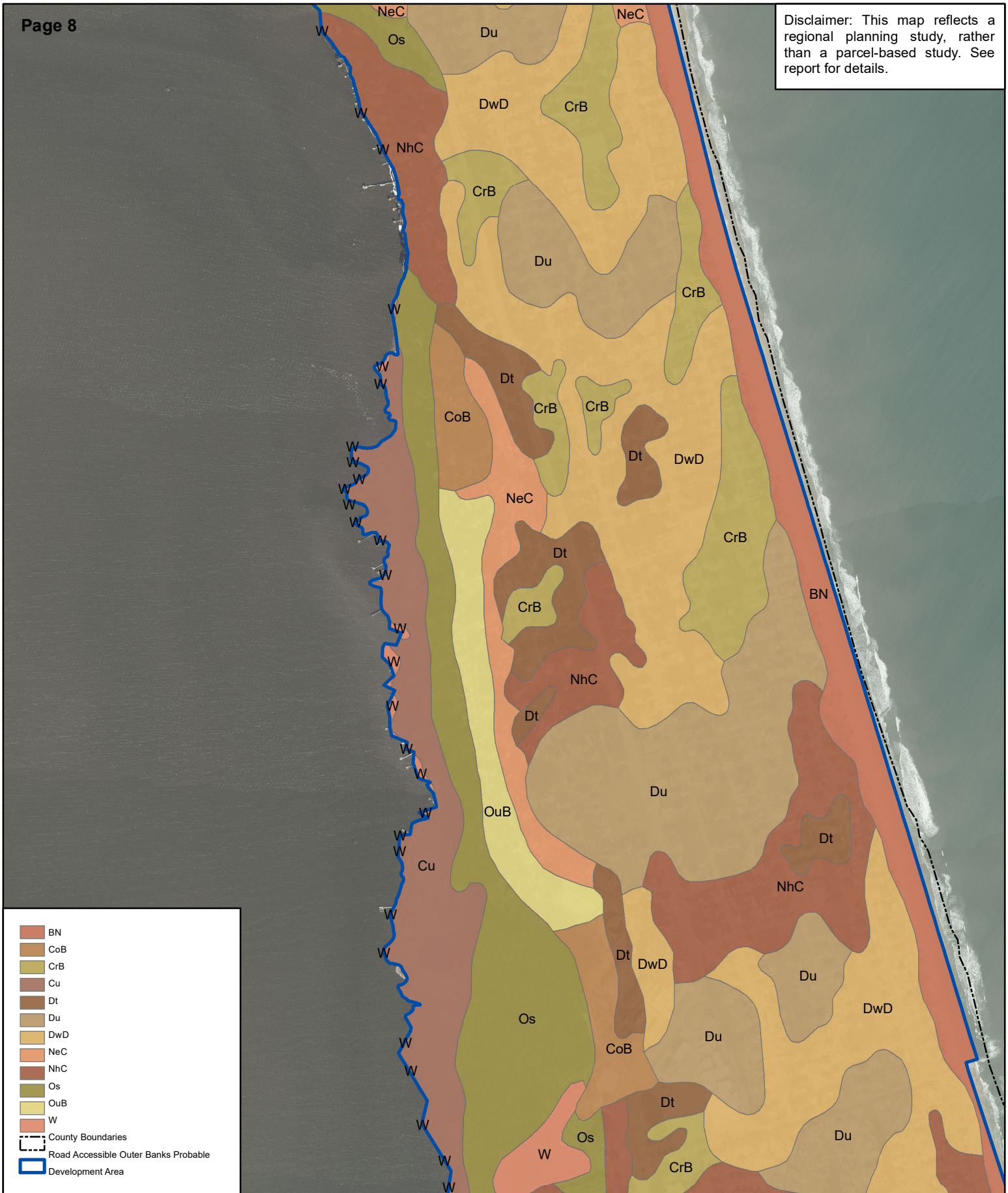
N

SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

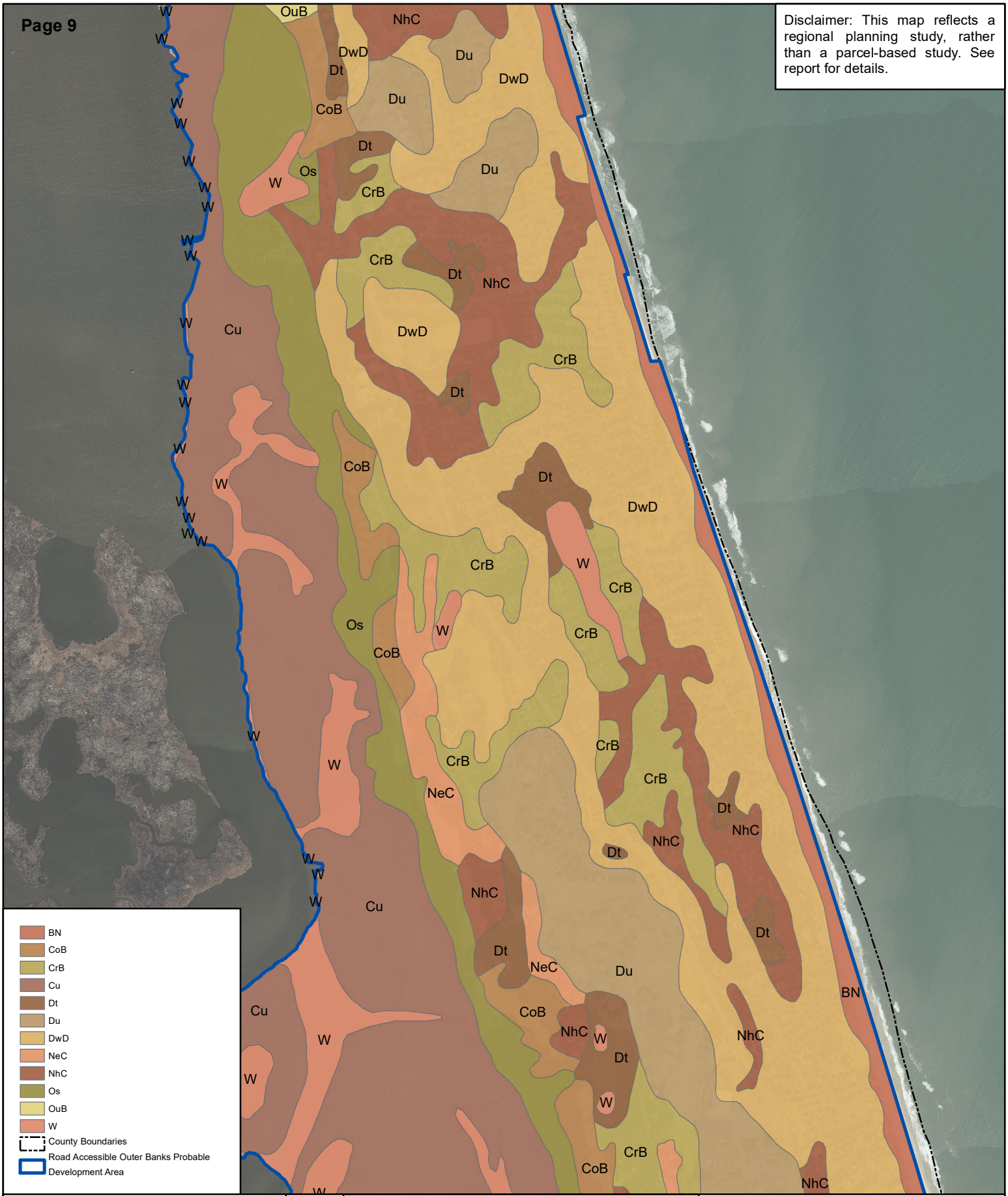
N

SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

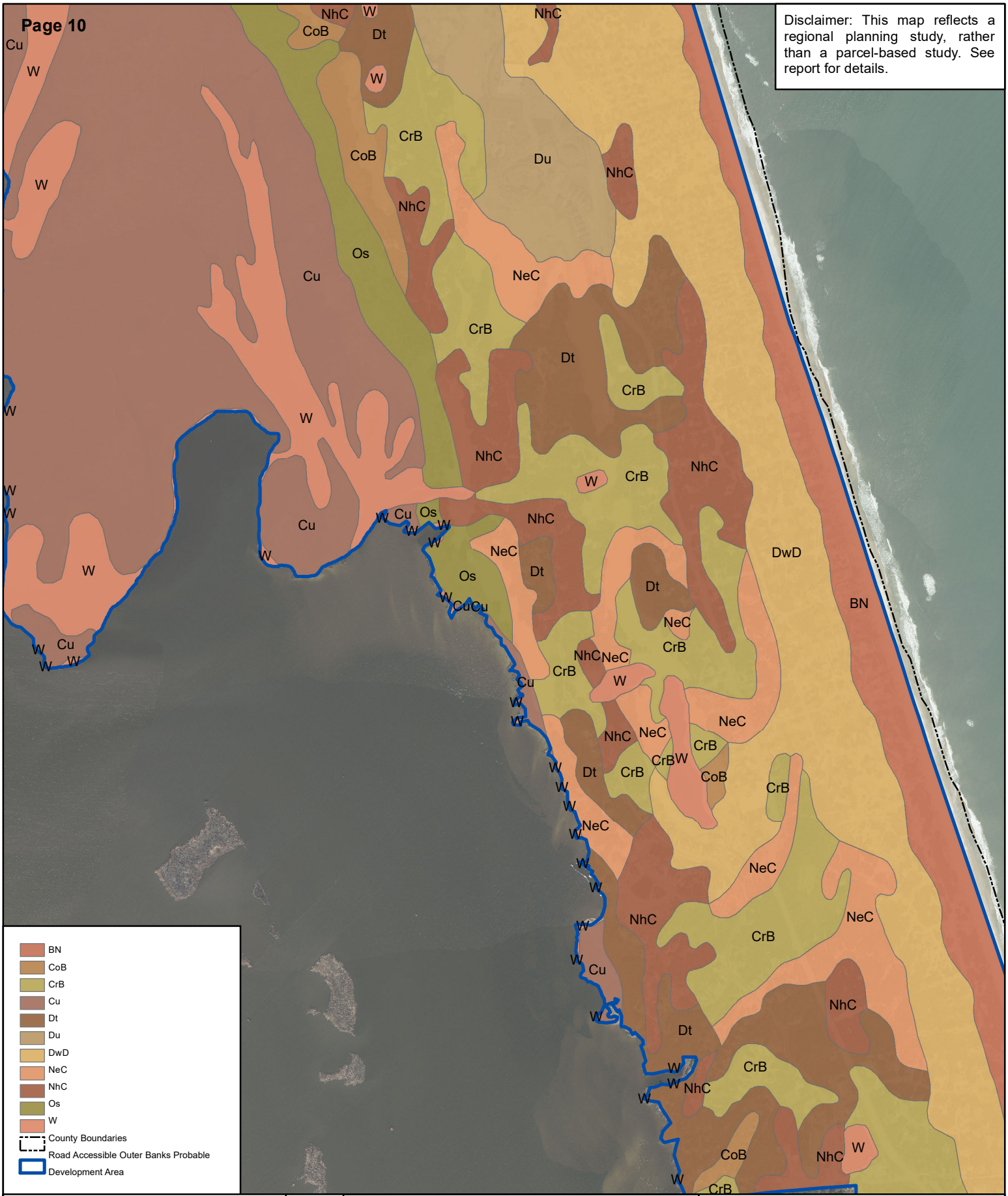
N

SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.2 0.4

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



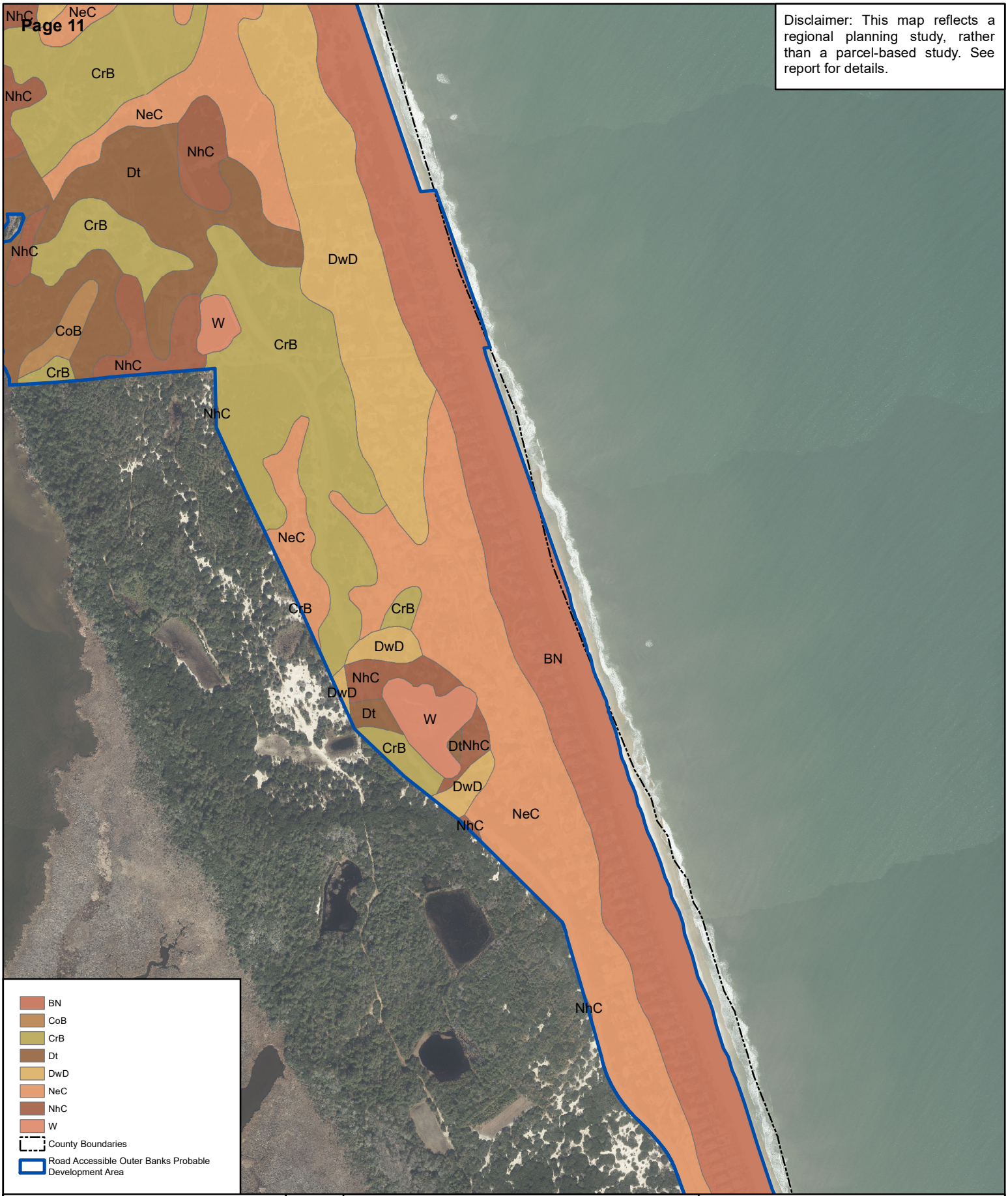
NORTH CAROLINA Turnpike Authority

N

SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3



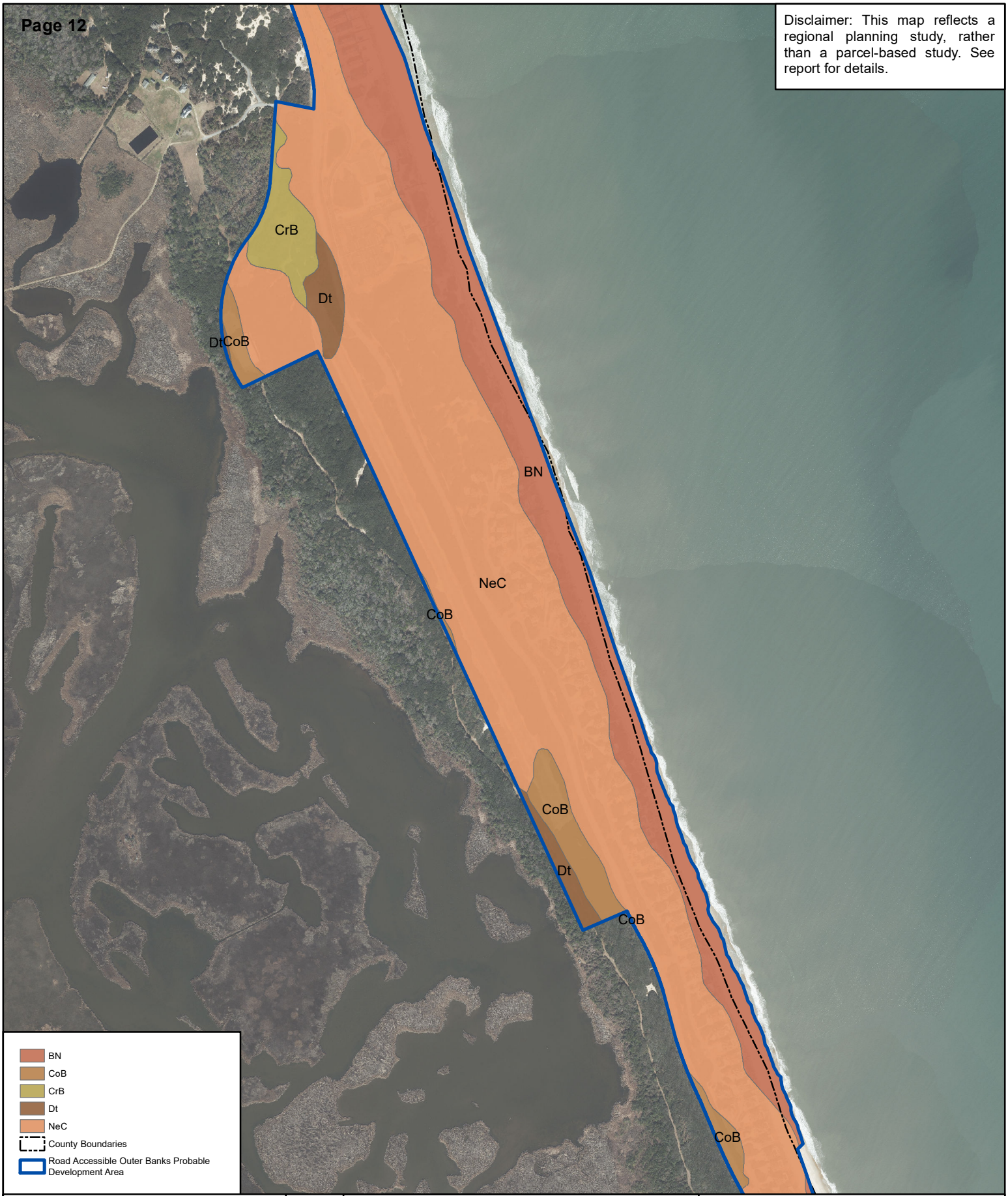
NORTH CAROLINA Turnpike Authority

N

SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles
0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

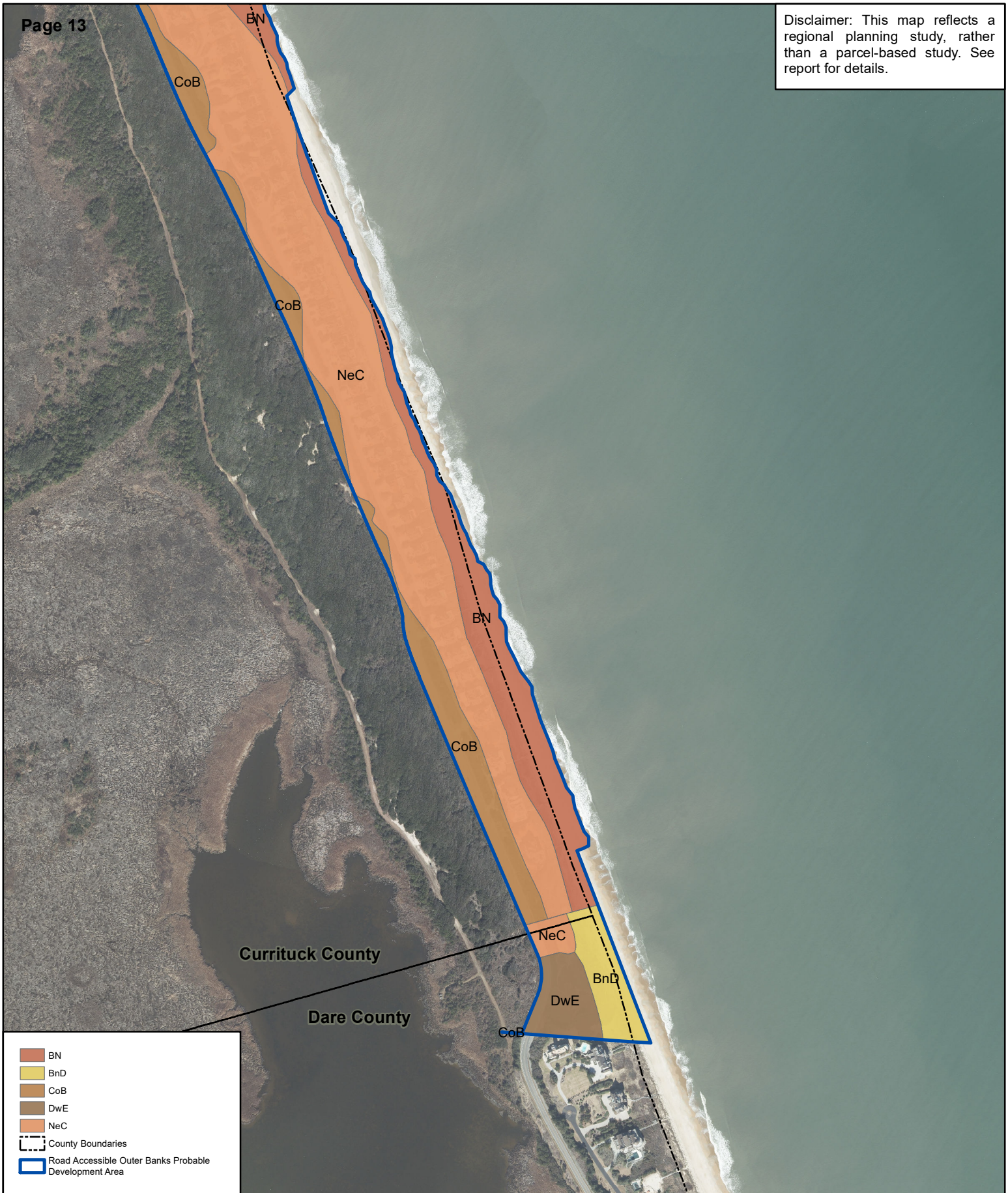
N

SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



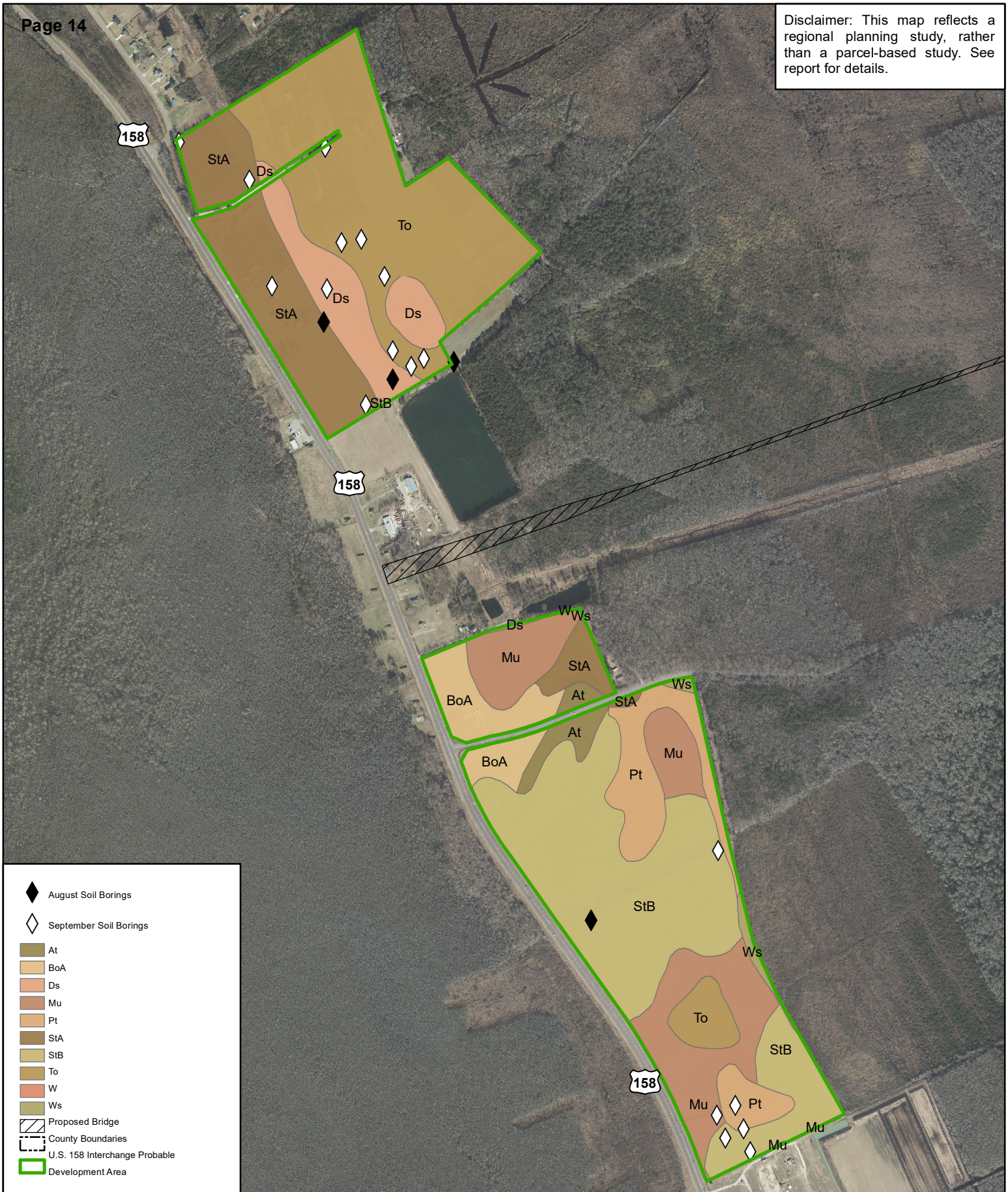
NORTH CAROLINA Turnpike Authority

N

SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles
0 0.1 0.2

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

N

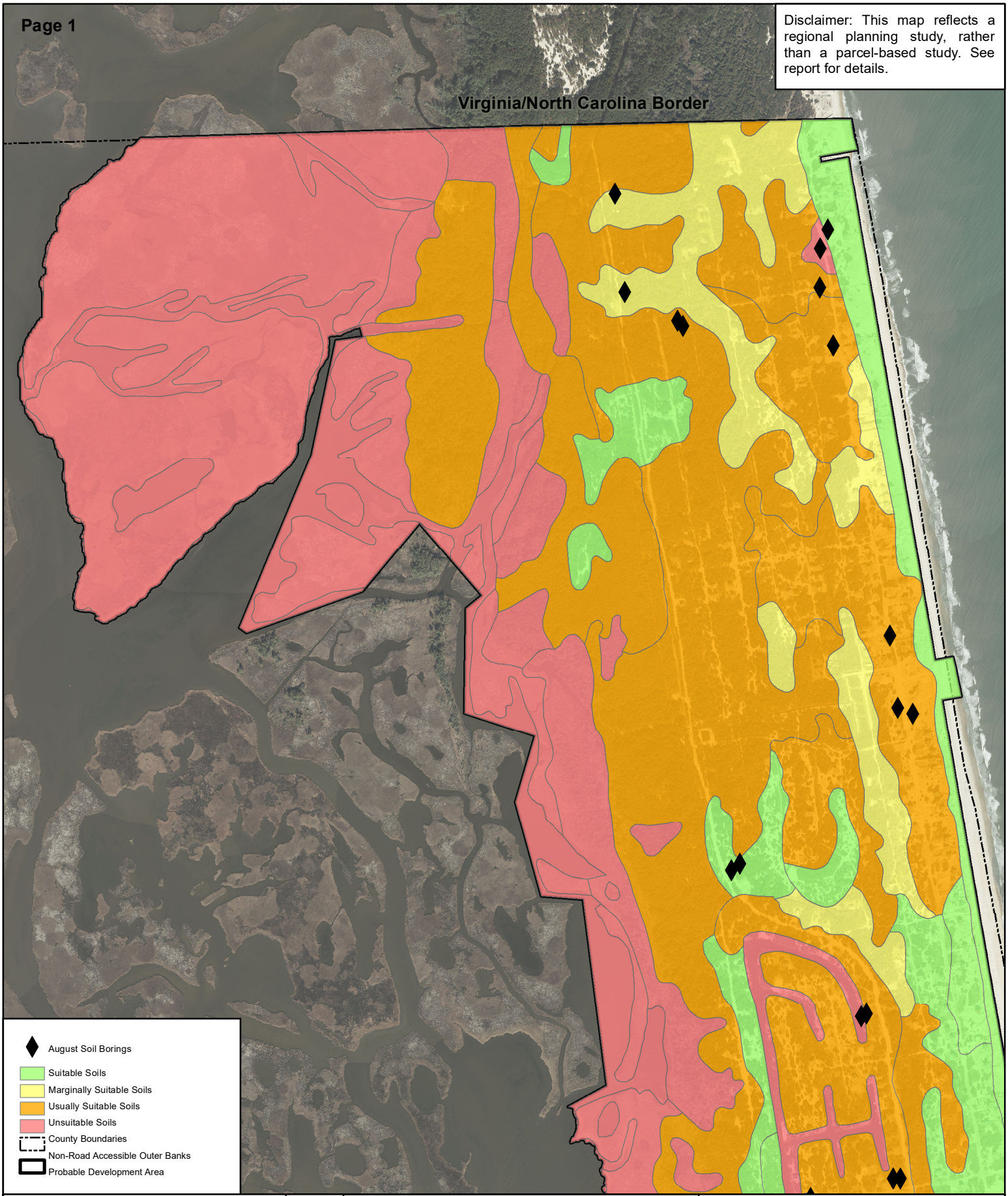
SOIL SERIES MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3

Appendix 4:
Soil Suitability Map for the Three PDAs with Field-Based Soil Samples

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

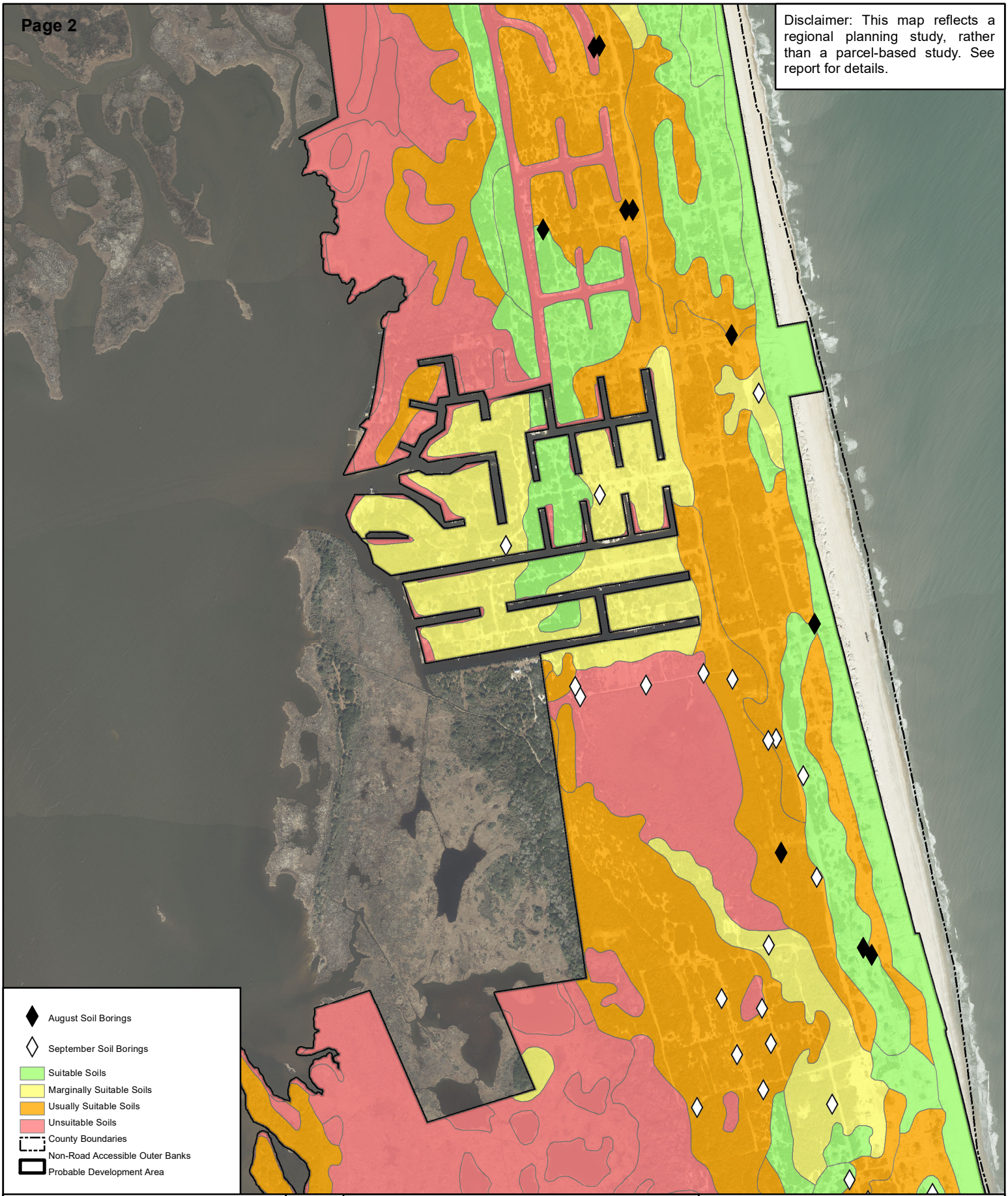
N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.2 0.4

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

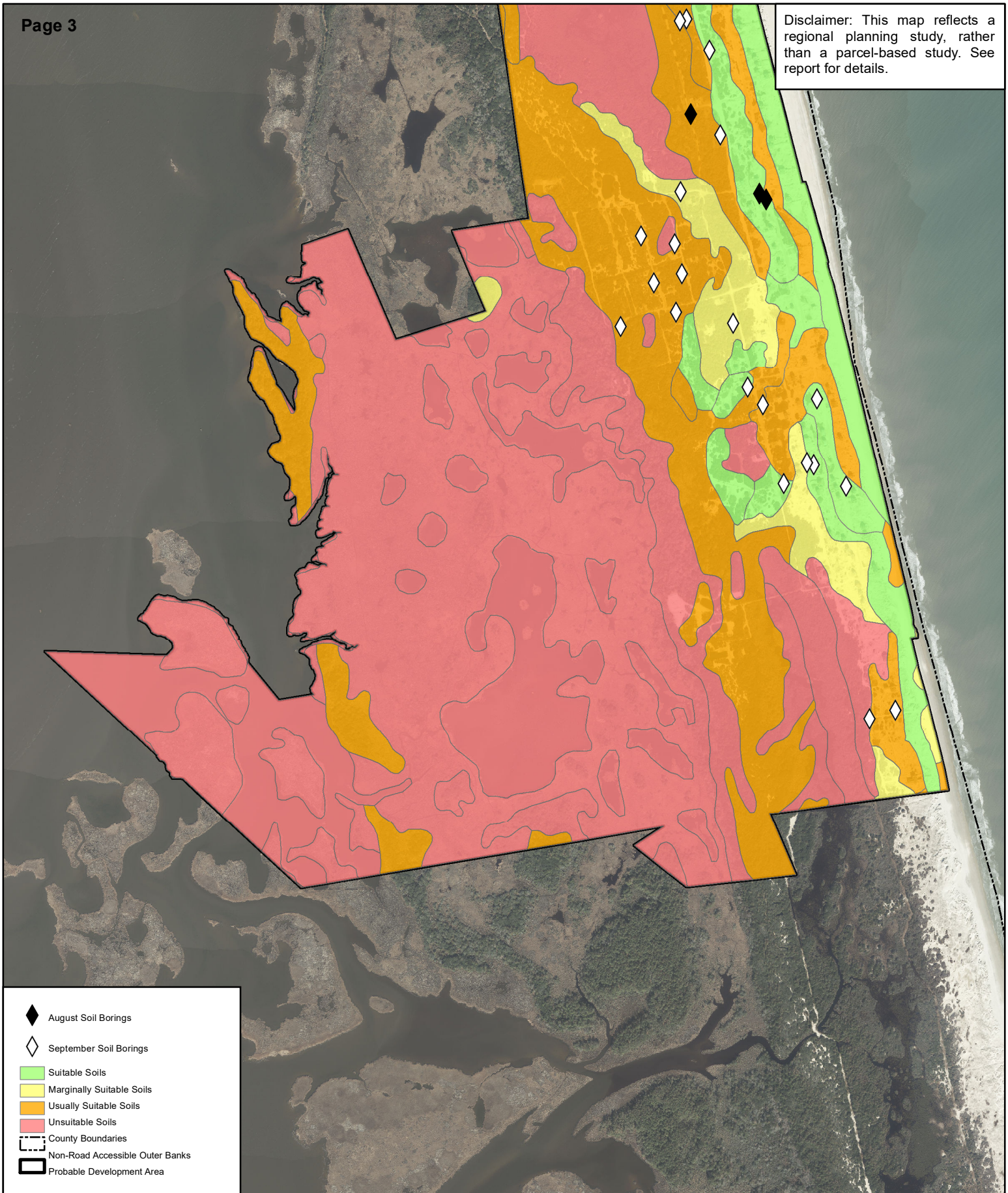
N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.2 0.4

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

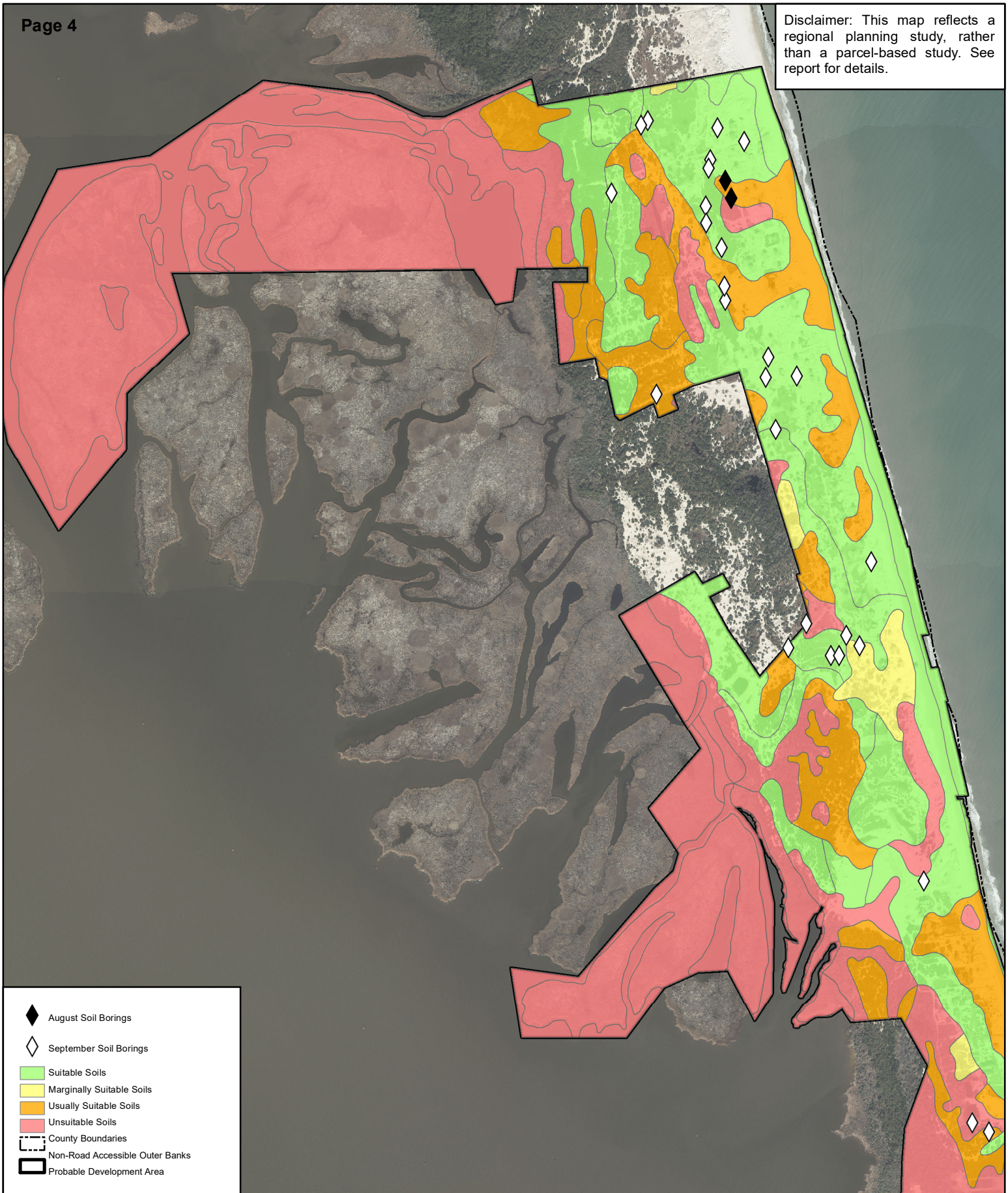
N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.25 0.5

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

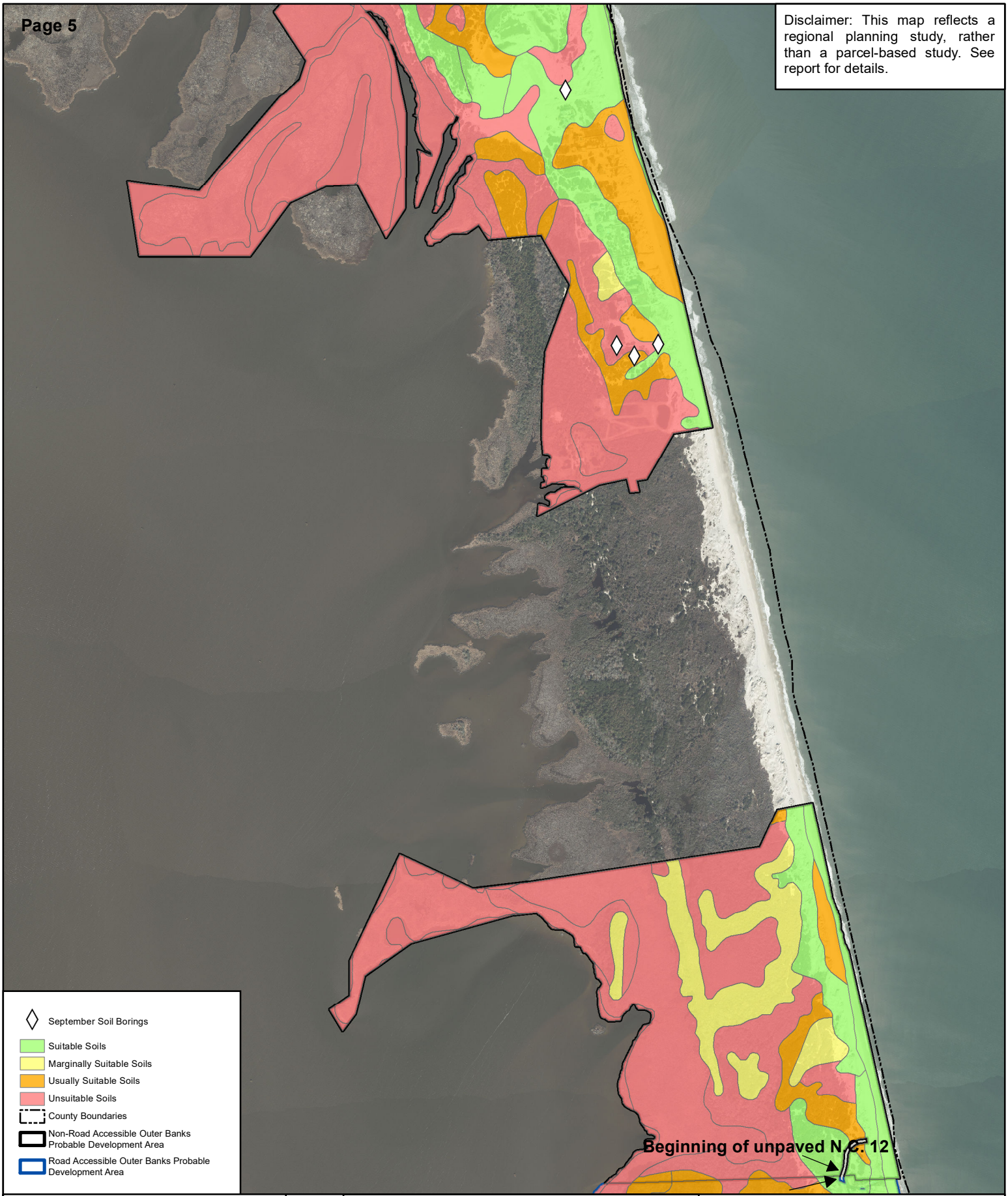
N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.25 0.5

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



- September Soil Borings
- Suitable Soils
- Marginally Suitable Soils
- Usually Suitable Soils
- Unsuitable Soils
- County Boundaries
- Non-Road Accessible Outer Banks Probable Development Area
- Road Accessible Outer Banks Probable Development Area

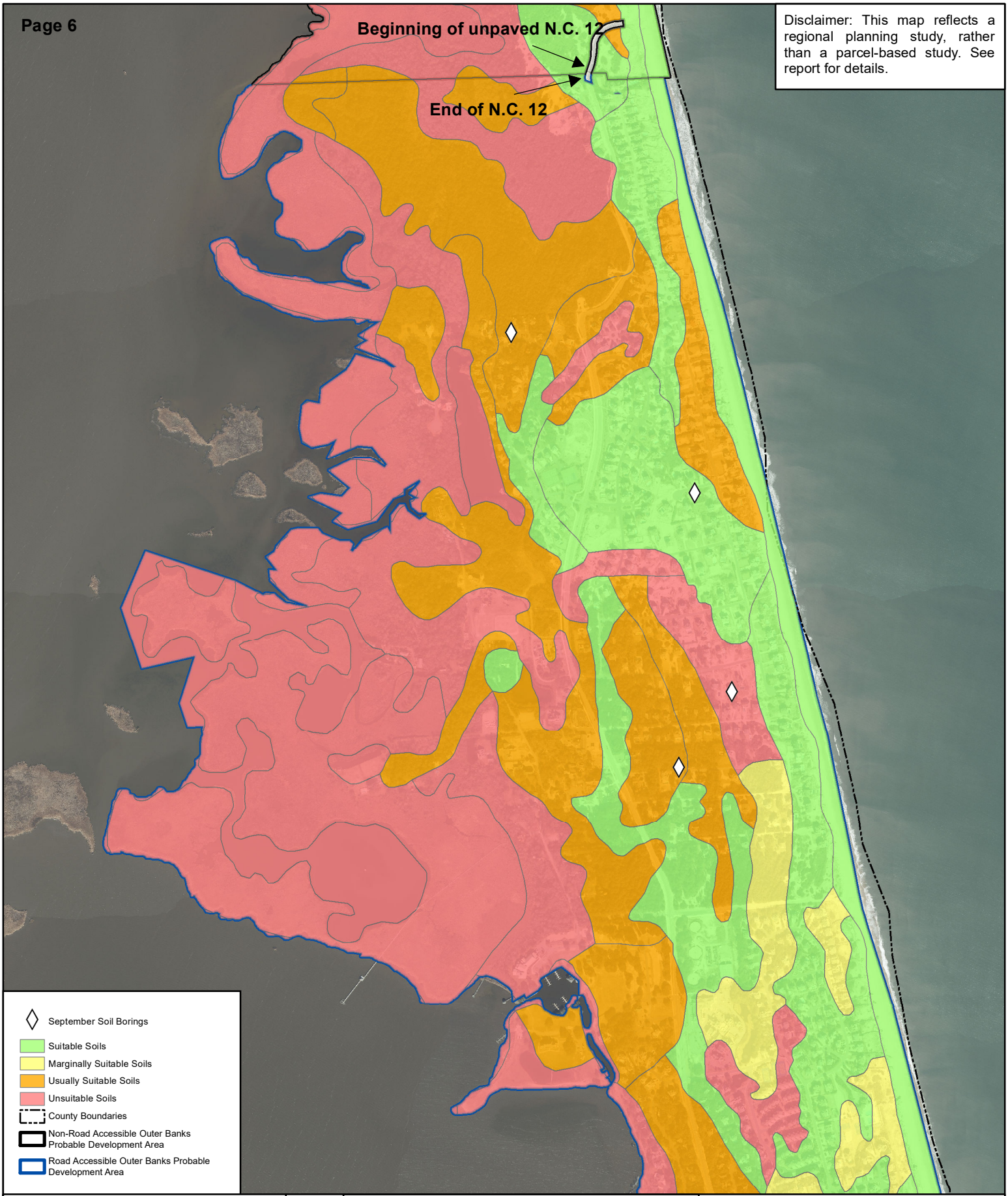
NORTH CAROLINA Turnpike Authority

N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.25 0.5



NORTH CAROLINA Turnpike Authority

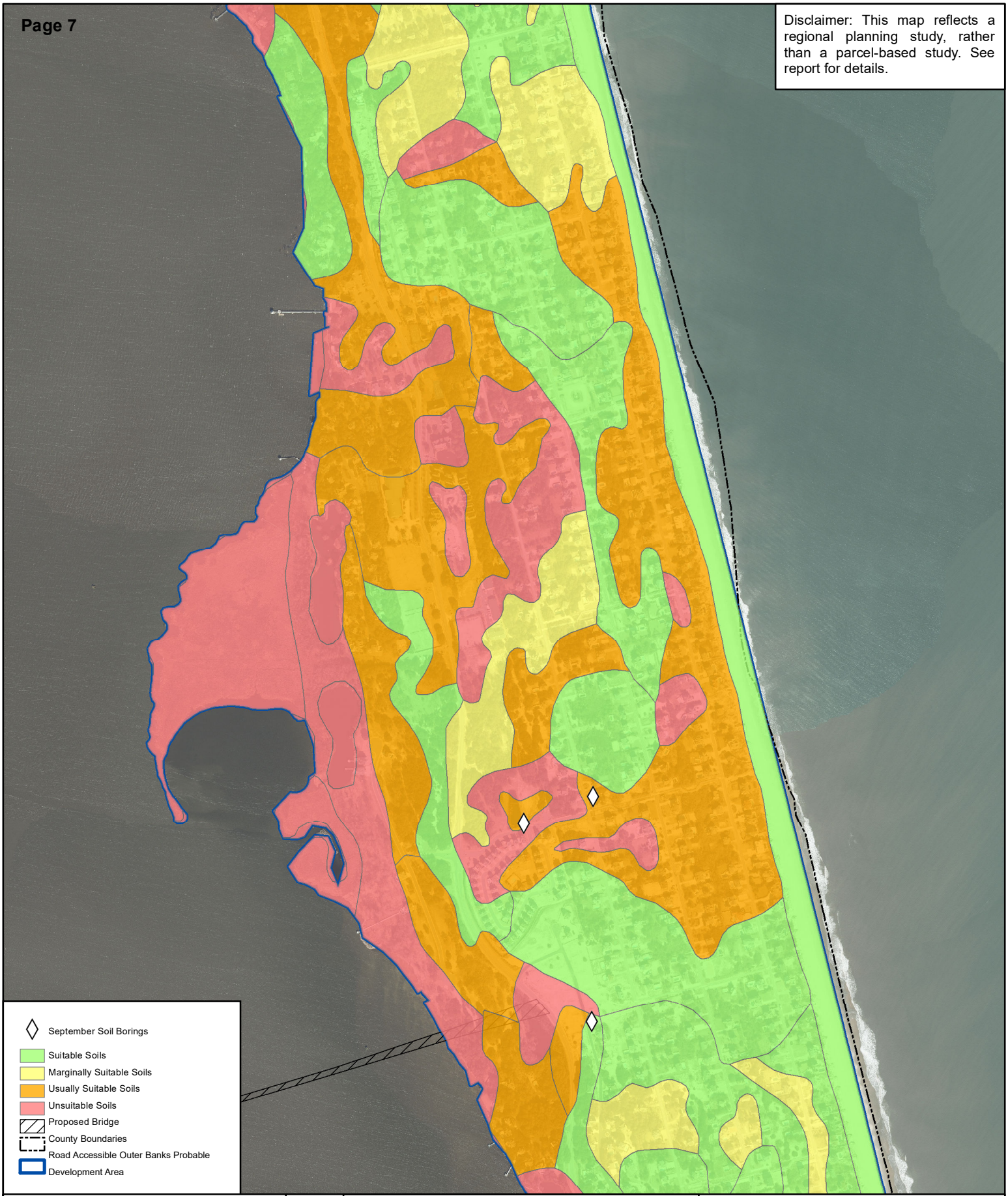
N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3

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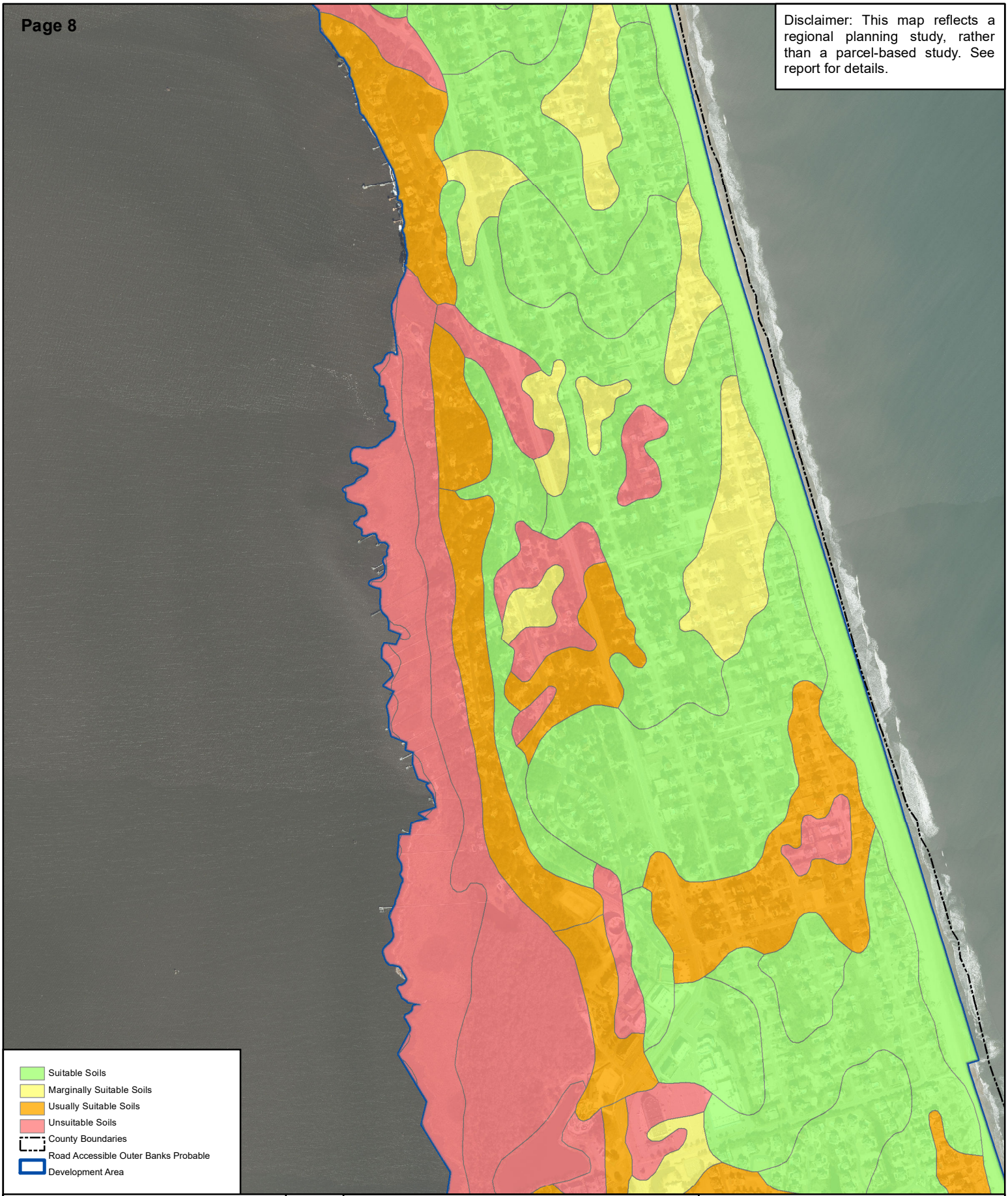

NORTH CAROLINA Turnpike Authority

N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3

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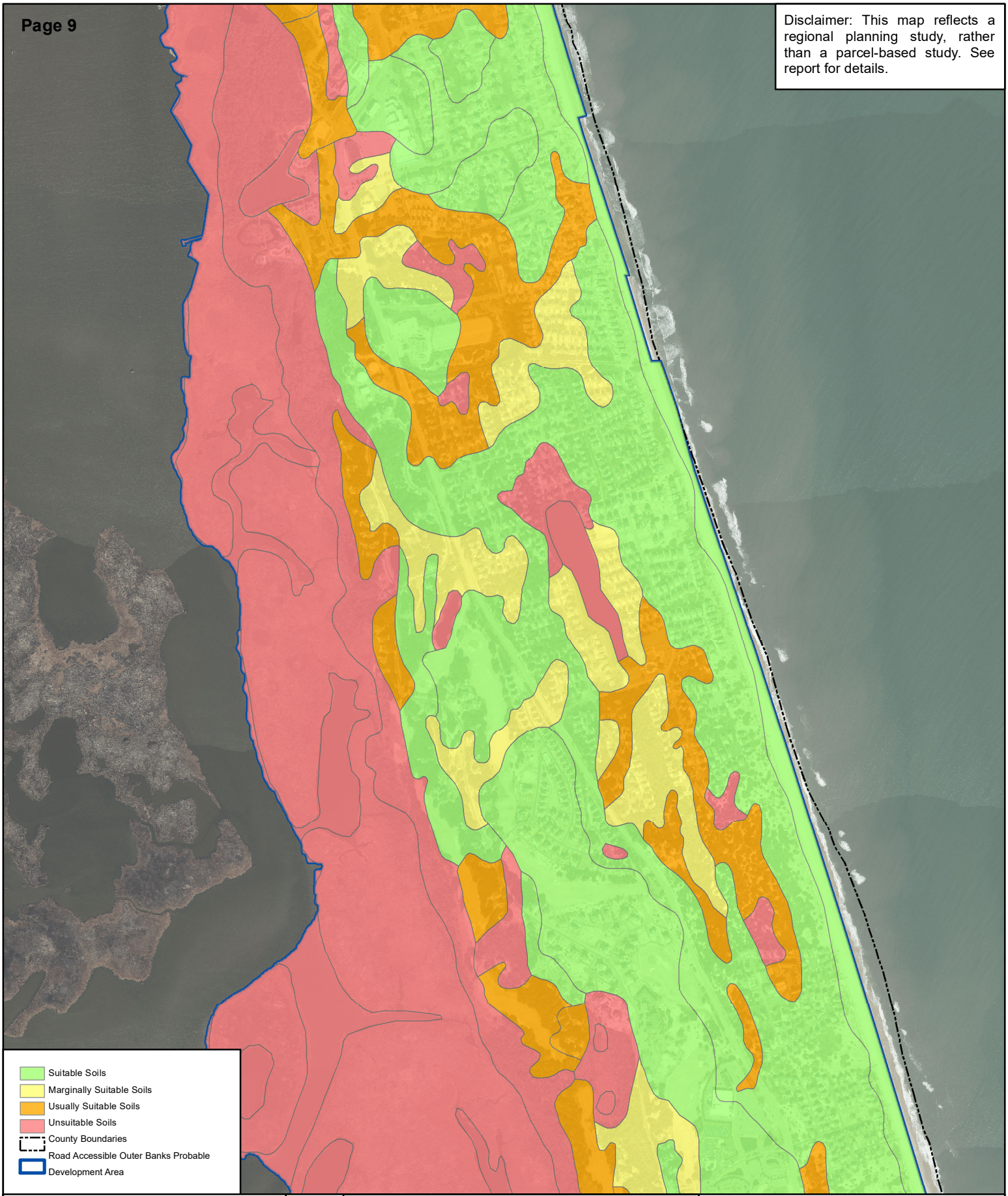


NORTH CAROLINA Turnpike Authority

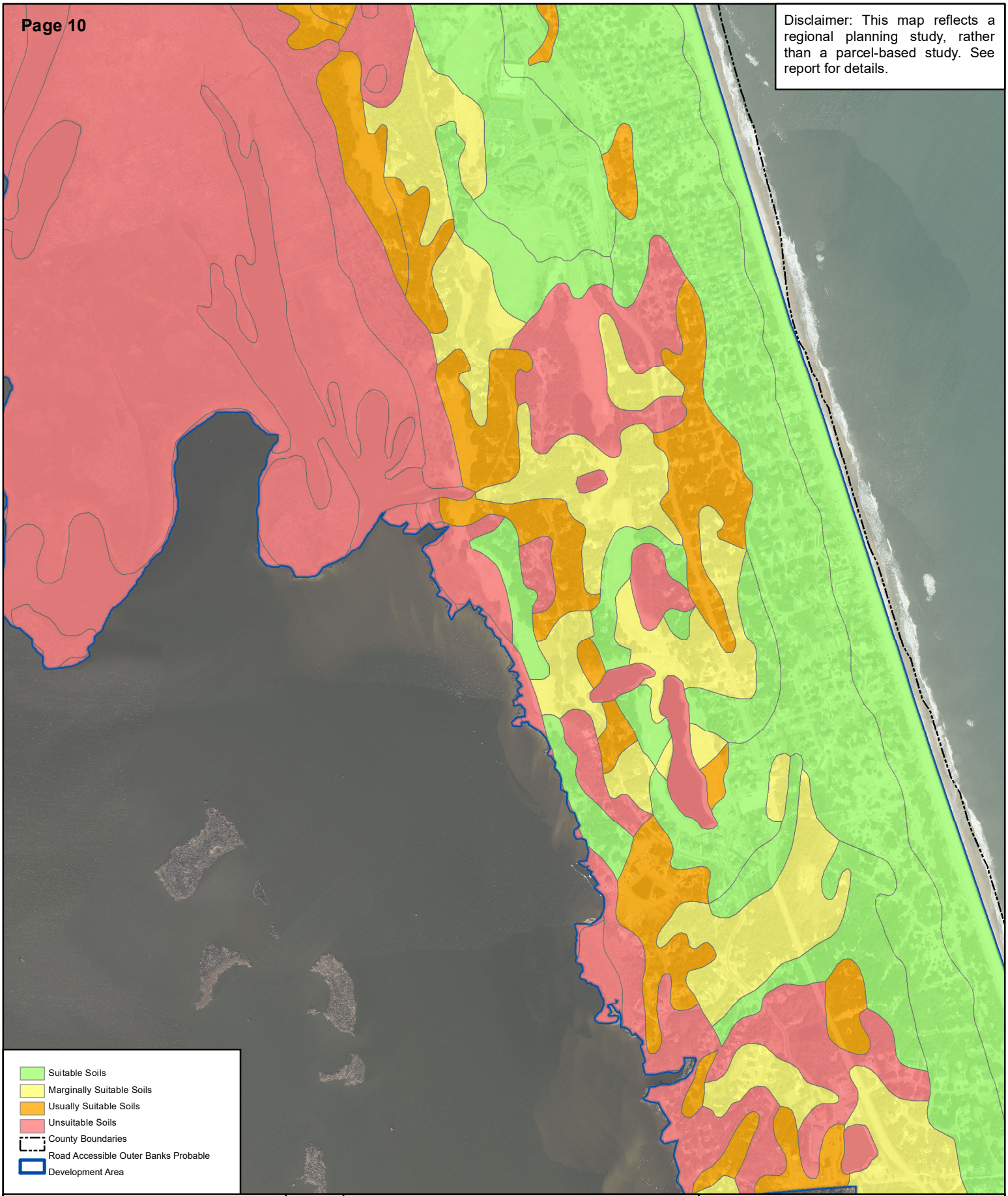
N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.2 0.4

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

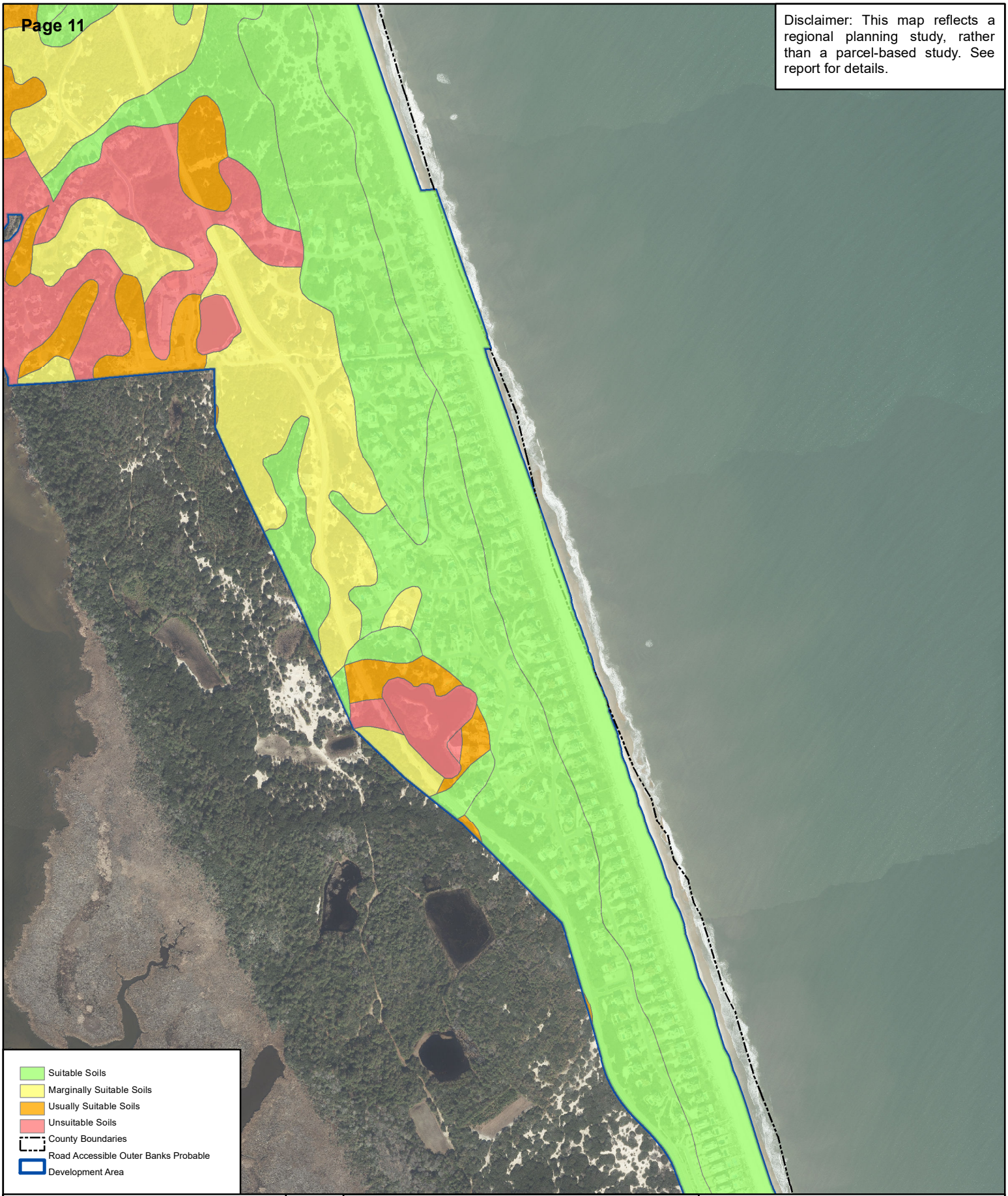
N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



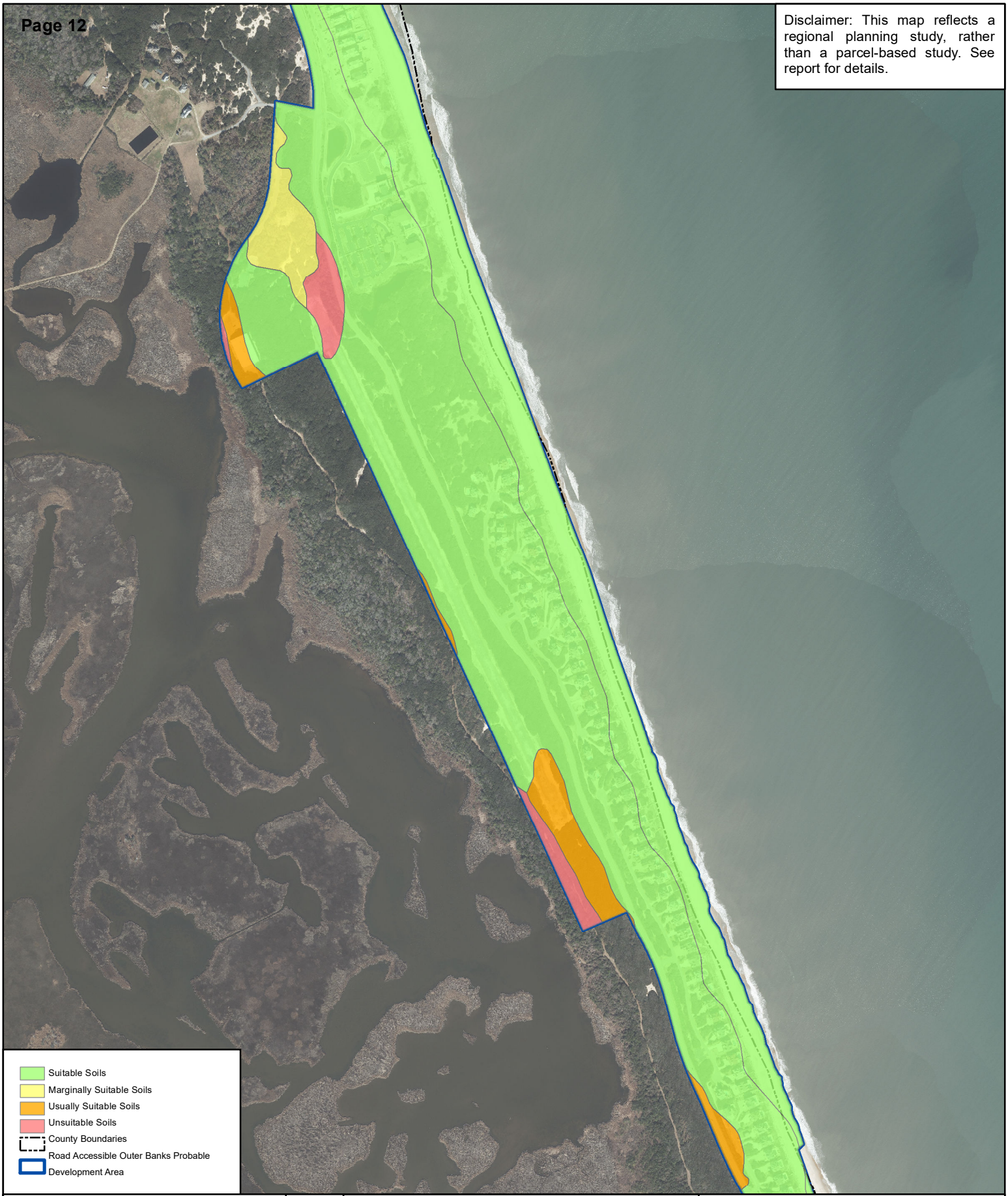
NORTH CAROLINA Turnpike Authority

N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles
0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



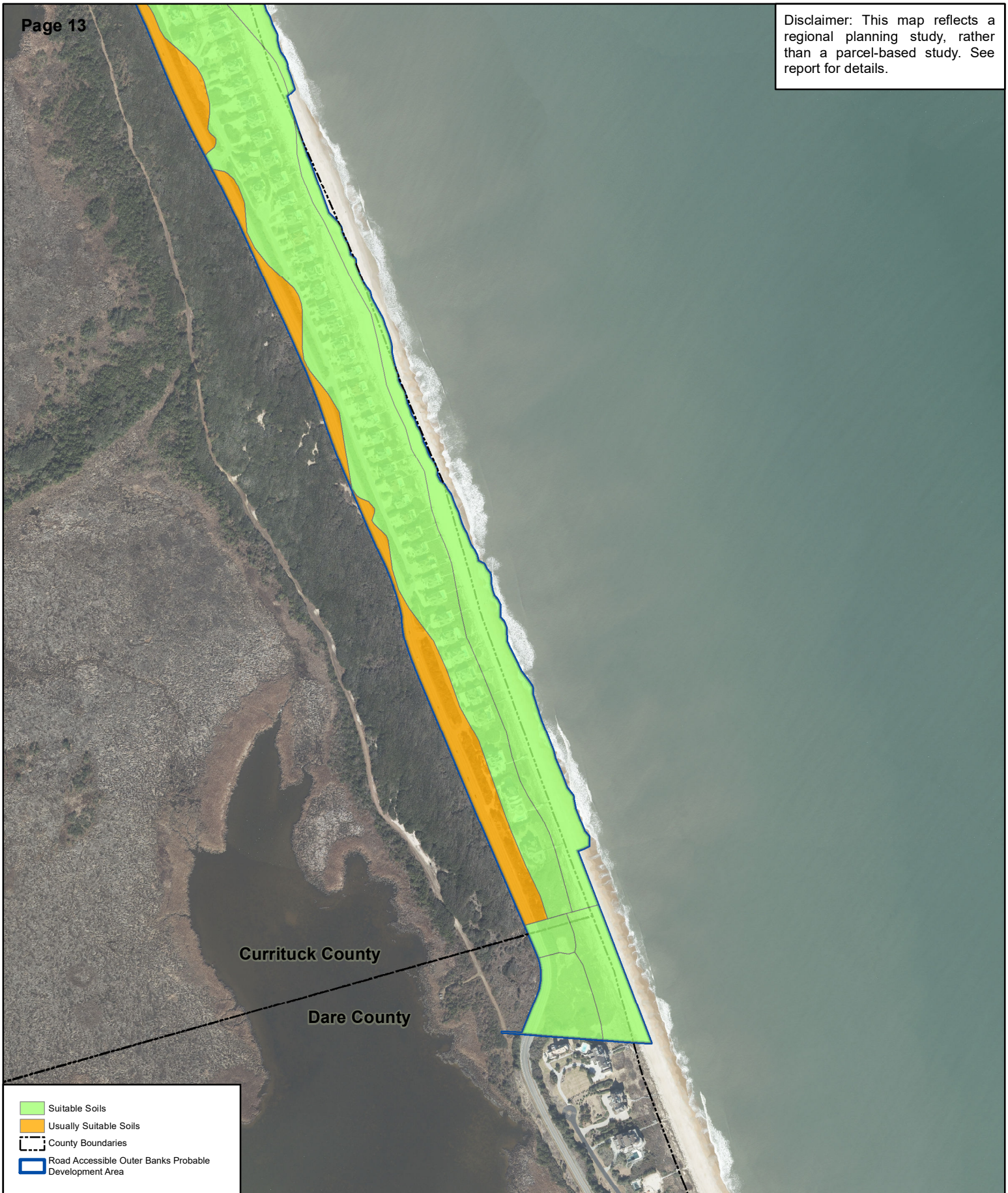
NORTH CAROLINA Turnpike Authority

N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles
0 0.15 0.3

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



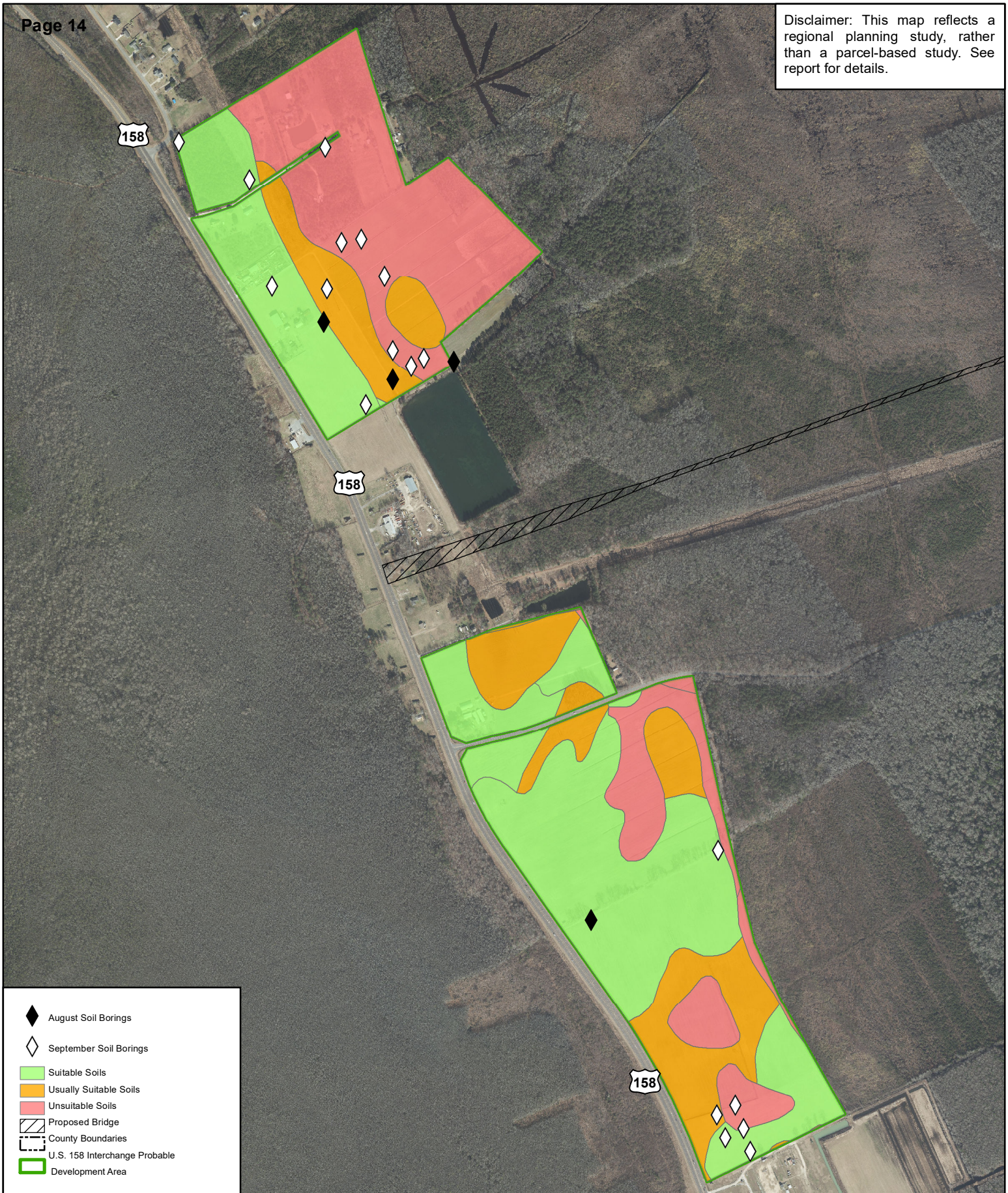
NORTH CAROLINA Turnpike Authority

N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles
0 0.1 0.2

Disclaimer: This map reflects a regional planning study, rather than a parcel-based study. See report for details.



NORTH CAROLINA Turnpike Authority

N

SOIL SUITABILITY MAP
MID-CURRITUCK BRIDGE
CURRITUCK COUNTY, NC

Miles

0 0.15 0.3