The following maps show average amounts (parts per million - ppm) of key nutrients: Total Kjeldhal Nitrogen (**TKN**), Nitrate (**NO3**), Ammonium (**NH4**), Organic Nitrogen (**ON**), Total Phosphorus (**TP**), and Dissolved Oxygen (**DO**). The data is from **2018 to June, 2021** and different symbol sizes represent ranked data -- the larger the symbol, the bigger the data value. Data for all sample sites may be viewed and analyzed using ArcGIS Online: https://arcg.is/11GfuC0

Total Kjeldahl Nitrogen or TKN is the sum of nitrogen (N) bound in organic substances, nitrogen in ammonia (NH_3-N) and in ammonium (NH_4^+-N) in the chemical analysis of soil, water, or waste water (e.g. sewage treatment plant effluent). It is an important measure for water quality in the Albemarle region because it estimates both organic and inorganic sources of N. Monitoring sites on the Little River, Symonds Creek, Newbegun Creek, Knobbs Creek and Charles Creek have relatively high TKN (Figure 1).

Nitrates (NO3) are important because they are highly soluble. Although nitrates can enter the aquatic environment by way of natural processes, including the breakdown of plant materials and the decomposition and waste products of dead animals, more typically, it is human influence that causes problems. This includes runoff of fertilizers from lawns and farm fields, the seeping of sewage wastes from septic fields and animal husbandry operations, urban storm water runoff, and even nitric acids from automobile-exhaust induced acid precipitation. NO3 levels above 3 ppm are indicative of pollution (often from fertilizers or septic wastes) running off the land and into aquatic habitats (DDNREC, 2003). In the Little River watershed, the monitoring sites at Sandy Road and Foreman Bundy Road have the highest average NO3, but are below 3 ppm (Figure 2). **Ammonium (NH4)** is relatively high across the area, but in particular the upper part of the Little River watershed (Figure 3). **Organic N** is relatively high across the region, which may indicate problems with soil erosion from agricultural lands, and leaching of nutrients from cypress/gum forests that have been clearcut and left with insufficient buffers along creeks (Figure 4). Organic N is increasing in waters across the state and determining the reasons is a major research question.

Levels of **phosphates** in excess of 0.07 ppm in NE NC usually indicate organic pollution and may lead to explosive algae growth (APNEP Nutrients Workgroup DRAFT Meeting Notes September 21, 2016). All monitoring sites have **phosphorus** (P) greater than 0.07 ppm (Figure 5). Halls Creek, Upper Symonds Creek, Newbegun Creek , and Knobbs Creek have the highest P. Although phosphates can enter the aquatic environment by way of natural processes, including the breakdown of plant materials, and the decomposition and waste products of dead animals, levels above 0.07 ppm usually indicate human-influenced pollution sources. This includes runoff into waterways from wastes produced by poultry, dairy and other animal farming operations that are not properly managed, concentrations of droppings from nuisance animals (e.g. Canada geese) and even household pets, and seeping of sewage wastes from improperly-sited or poorly-maintained home septic systems. Inadequate sewage treatment plants, including storm sewer systems that overload a treatment plant's capacity during flood events, may cause untreated sewage wastes to be released directly into streams (DDNREC, 2003).

Although phosphorus is relatively high at most sample sites across the region, recent research indicates that nitrogen may be the limiting nutrient at many locations (Hall and Paerl, 2020). In other words, additions of N to the system generate a greater response in algal blooms.

Phosphorus (soluble and particulate) inputs, can come from natural sources such as weathering of soils and rocks. This can be exacerbated by soil exposure and erosion in disturbed areas, such as clear cuts of cypress/gum swamp forests. There is an important chemical distinction between P and N, in that there are no gaseous forms of the former, but there are for the latter (N2, NH3, NO, NO2). This is important with regard to legacy loads and fates of the two elements: P tends to accumulate in receiving waters (i.e. Albemarle and Pamlico Sounds), whereas N can "escape" via denitrification and other transformation processes that lead to gaseous forms. This is a main reason why N tends to be limiting in the receiving waters as there is plenty of P cycling between the sediments and water column with little net loss, while N can escape. Thus the system is always "hungry" for more N inputs to sustain and enhance primary production and algal blooms (Paerl et. al., 2016).

Dissolved Oxygen (DO) concentrations range from 0 to as high as 20. In general, the higher the DO the greater the variety of plant and animal life the water can support. A low amount of DO in the water is a sign that the habitat can be stressed. Water must contain around 5.0 ppm DO to sustain aquatic life. Most monitoring sites in the Little River and Pasquotank River tributaries have DO close to or above 5.0 ppm (Figure 6). Two sites, Foreman Bundy Road and Knobbs Creek have DO below 3.0 ppm.

References

Delaware Dept. of Natural Resources & Environmental Control, 2003. *Background Information for Interpreting Water Quality Monitoring Results.* Adopt-a-Wetland Program.

Hall, N. and H. Paerl, 2020. *Quantitative Evaluation of Changing Nutrient Sources to the Albema.rle Sound System*. Report prepared for the Albemarle Commission under Clean Water Management Trust Fund Planning Grant 2017-801. 34 p.

Paerl, H., J. T. Scott, M. J. McCarthy, S.E. Newell, W.S. Gardner, K.E. Havens, D. K. Hoffman, S.W. Wilhelm, and W. A. Wurtsbaugh. 2016. *It Takes Two to Tango: When and Where Dual Nutrient (N & P) Reductions Are Needed to Protect Lakes and Downstream Ecosystems*. Environ. Sci. Technol. 50, 10805−10813.

Figure 1. TKN

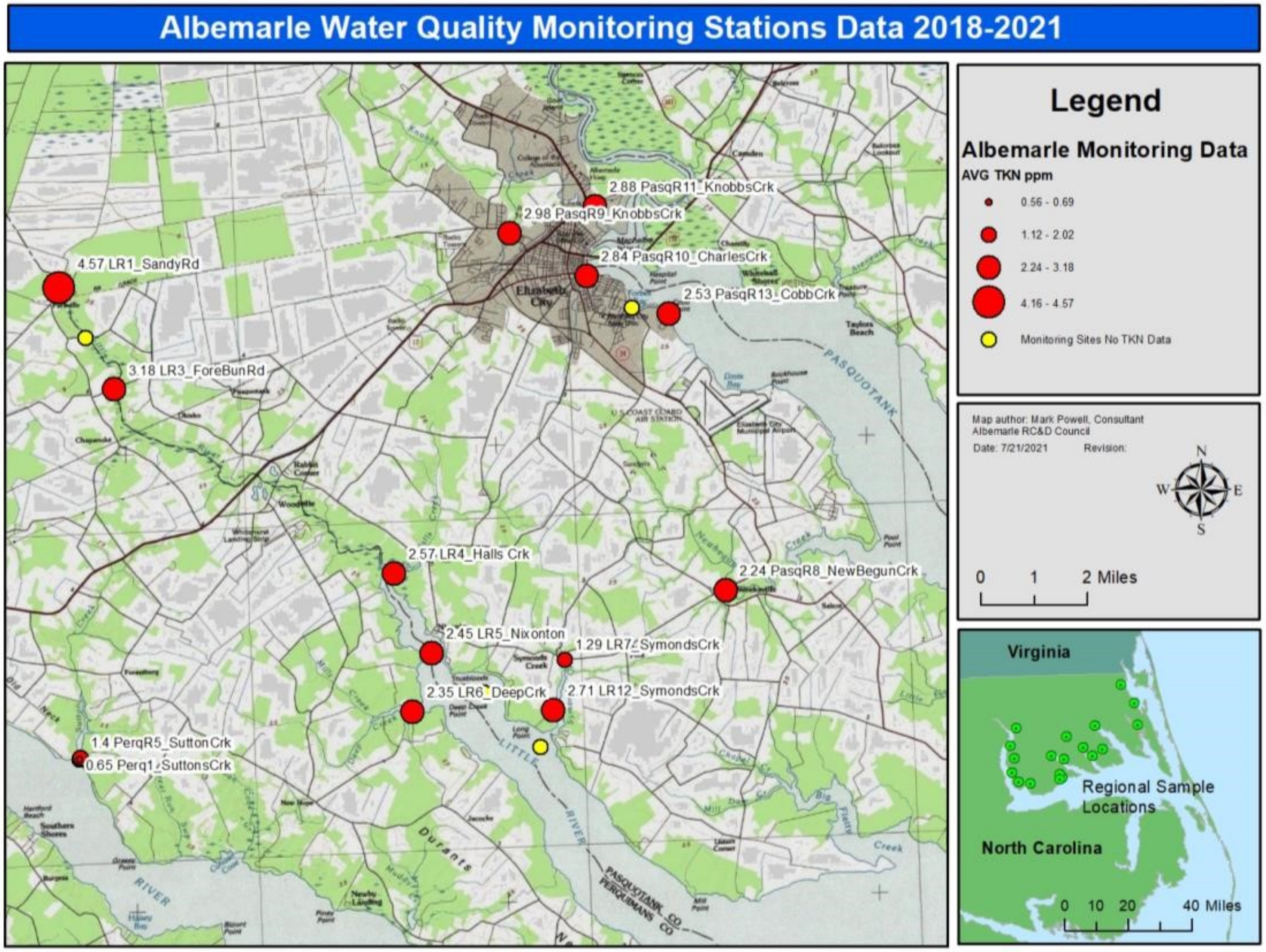
Albemarle Water Quality Monitoring Stations Data 2018-2021
4.57 LR1_SandyRd
3.18 LR3_ForeBunRd
2.88 PasqR11_KnobbsCrk
2.98 PasqR9_KnobbsCrk
2.84 PasqR10_CharlesCrk
2.53 PasqR13_CobbCrk
2.57 LR4_Halls Crk
2.24 PasqR8_NewBegunCrk
2.45 LR5_Nixonton
1.29 LR7_SymondsCrk
2.35 LR6_DeepCrk
2.71 LR12_SymondsCrk
1.4 PerqR5_SuttonCrk
0.65 Perq1_SuttonsCrk
Legend
Albemarle Monitoring Data
AVG TKN ppm
0.56 - 0.69
1.12 - 2.02
2.24 - 3.18
4.16 - 4.57
Monitoring Sites No TKN Data
Map author: Mark Powell, Consultant
Albemarle RC&D Council
Date: 7/21/2021
Revision:
N
S
E
W
0 1 2 Miles
Virginia
Regional Sample Locations
North Carolina
0 10 20 40 Miles

Figure 2. NO3

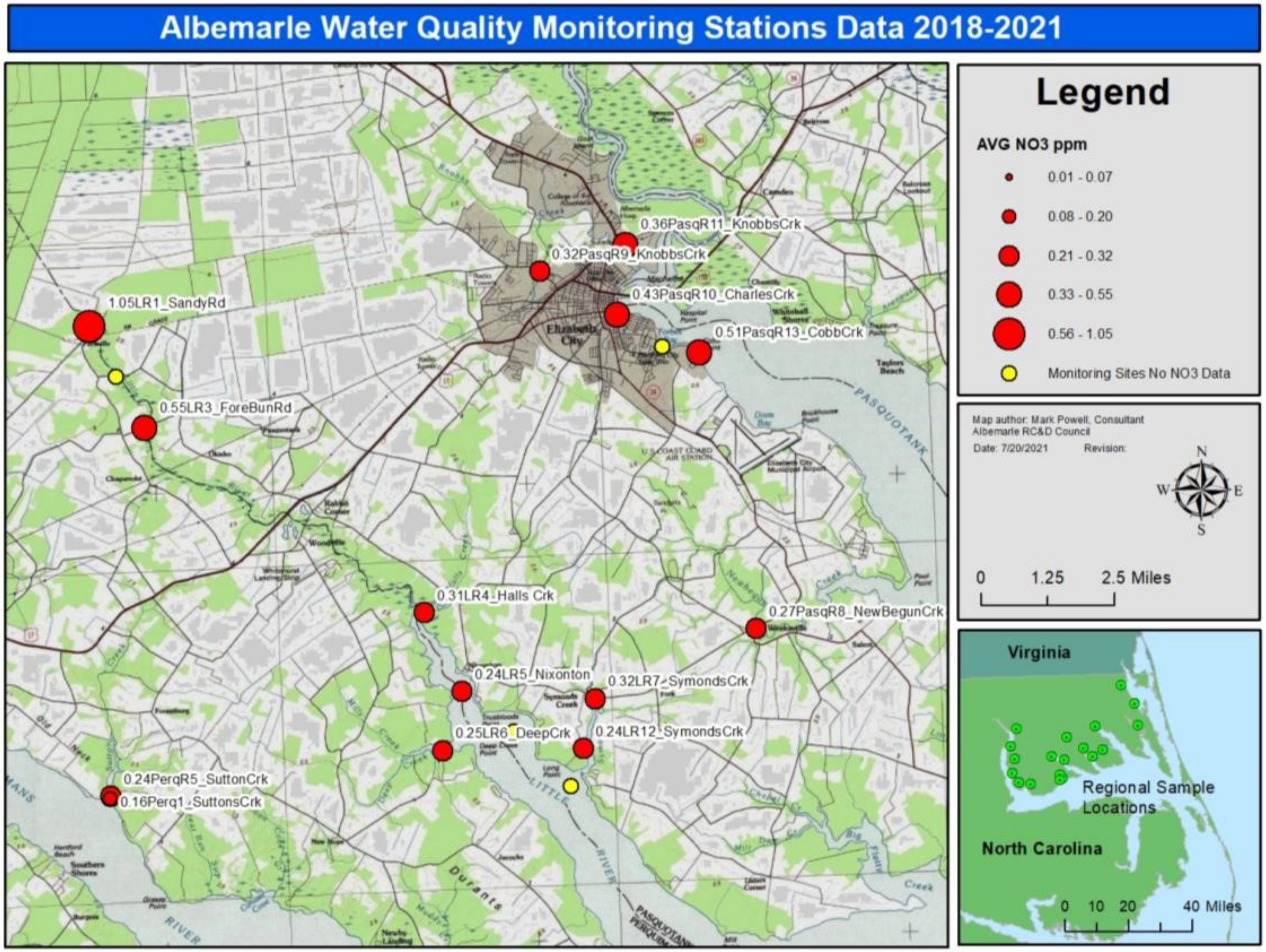
Albemarle Water Quality Monitoring Stations Data 2018-2021
Legend
AVG NO3 ppm
0.01 - 0.07
0.08 - 0.20
0.21 - 0.32
0.33 - 0.55
0.56 - 1.05
Monitoring Sites No NO3 Data
Map author: Mark Powell, Consultant
Albemarle RC&D Council
Date: 7/20/2021
Revision:
N
W
E
S
0 1.25 2.5 Miles
Virginia
North Carolina
Regional Sample Locations
0 10 20 40 Miles
0.36PasqR11_KnobbsCrk
0.32PasqR9_KnobbsCrk
0.43PasqR10_CharlesCrk
0.51PasqR13_CobbCrk
1.05LR1_SandyRd
0.55LR3_ForeBunRd
0.31LR4_Halls Crk
0.27PasqR8_NewBegunCrk
0.24LR5_Nixonton
0.32LR7_SymondsCrk
0.25LR6_DeepCrk
0.24LR12_SymondsCrk
0.24PerqR5_SuttonCrk
0.16Perq1_SuttonsCrk
PASQUOTANK
LITTLE RIVER
Durants

Figure 3. NH4

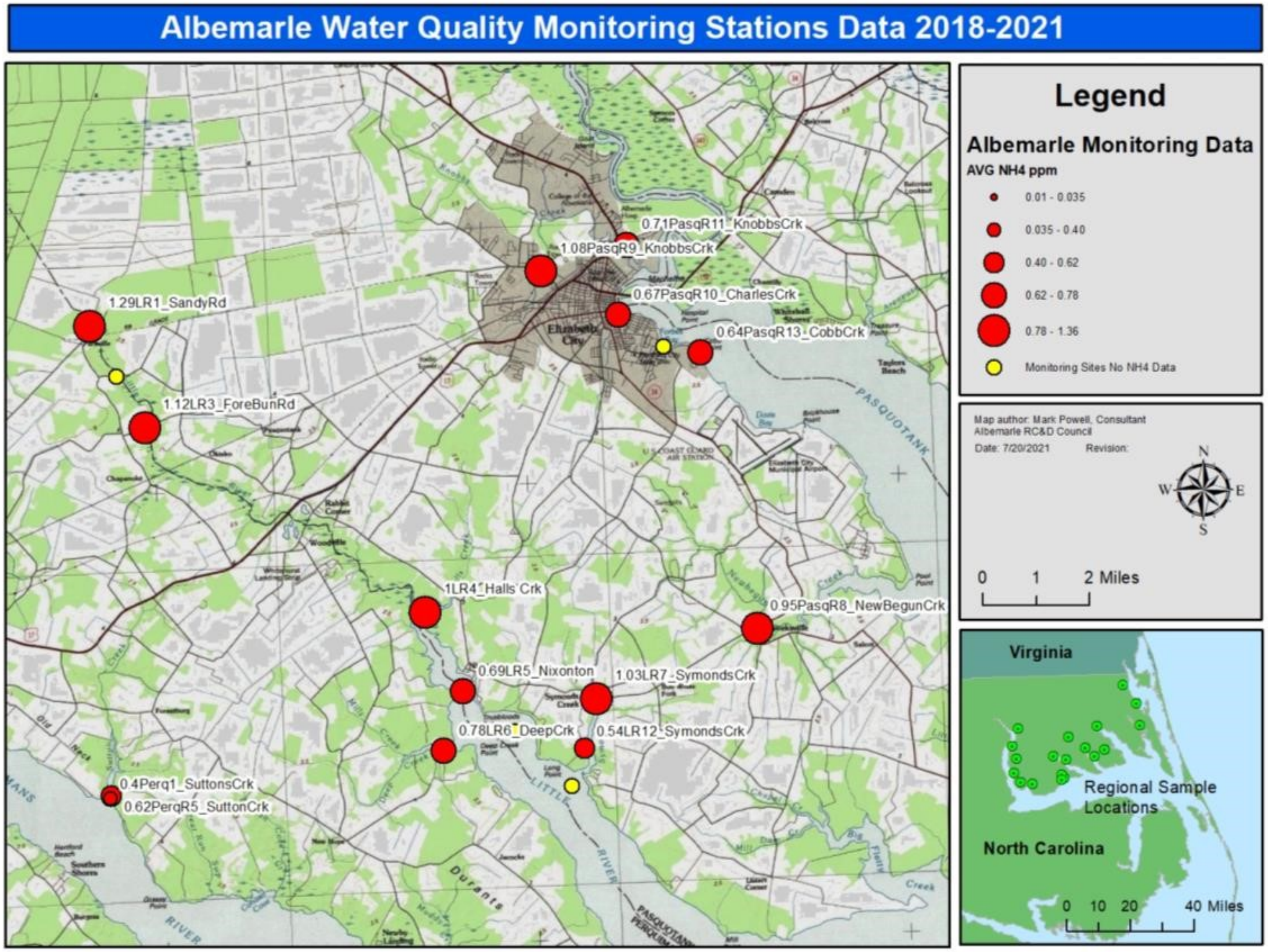
Albemarle Water Quality Monitoring Stations Data 2018-2021
Legend
Albemarle Monitoring Data
AVG NH4 ppm
0.01 - 0.035
0.035 - 0.40
0.40 - 0.62
0.62 - 0.78
0.78 - 1.36
Monitoring Sites No NH4 Data
Map author: Mark Powell, Consultant
Albemarle RC&D Council
Date: 7/20/2021
Revision:
N
S
W
E
0
1
2 Miles
Virginia
Regional Sample Locations
North Carolina
0
10
20
40 Miles
0.71PasqR11_KnobbsCrk
1.08PasqR9_KnobbsCrk
0.67PasqR10_CharlesCrk
0.64PasqR13_CobbCrk
1.29LR1_SandyRd
1.12LR3_ForeBunRd
1LR4_Halls Crk
0.95PasqR8_NewBegunCrk
0.69LR5_Nixonton
1.03LR7_SymondsCrk
0.78LR6_DeepCrk
0.54LR12_SymondsCrk
0.4Perq1_SuttonsCrk
0.62PerqR5_SuttonCrk
PASQUOTANK
LITTLE RIVER

Figure 4. Organic N

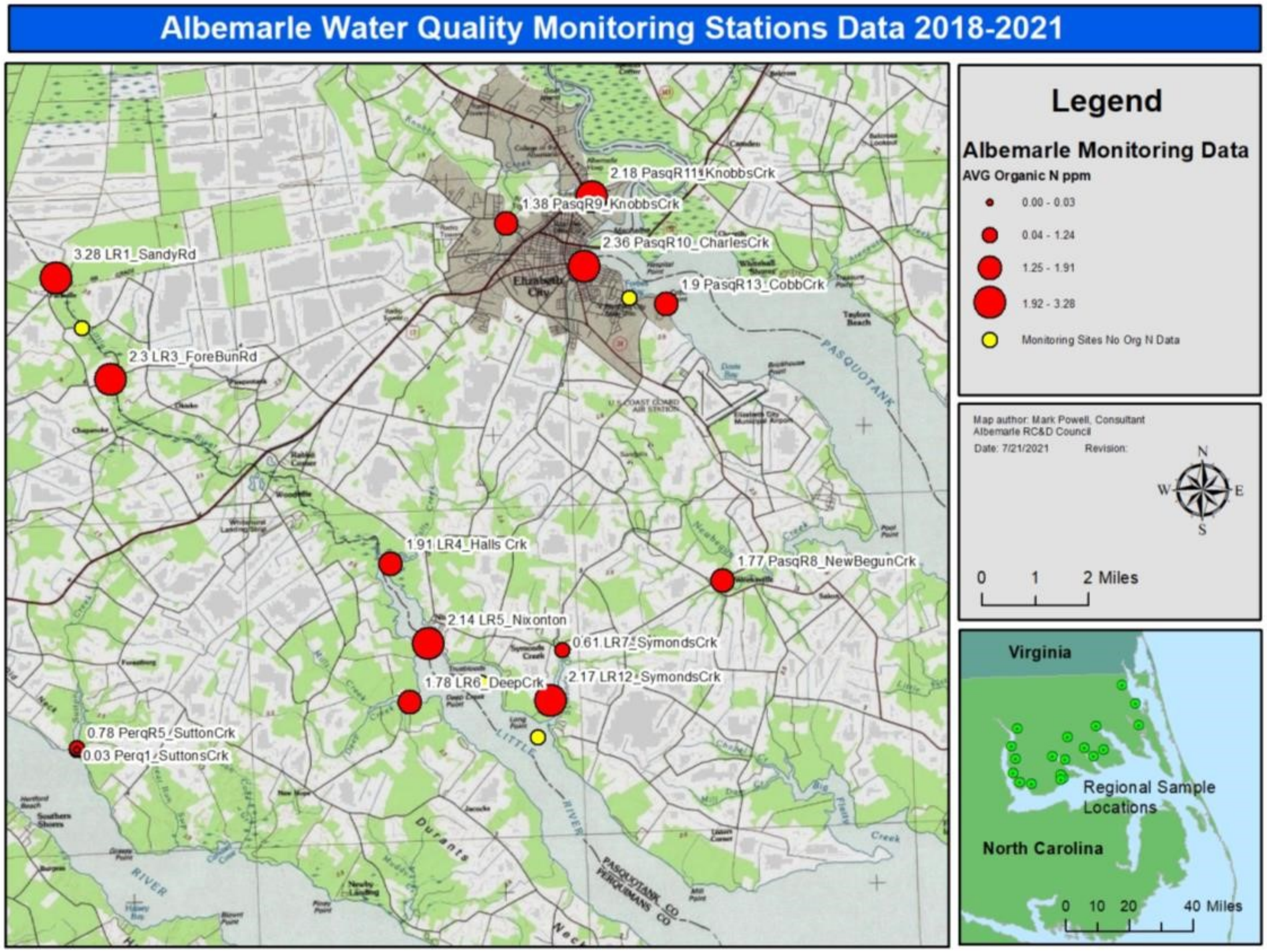

Figure 5. Total P

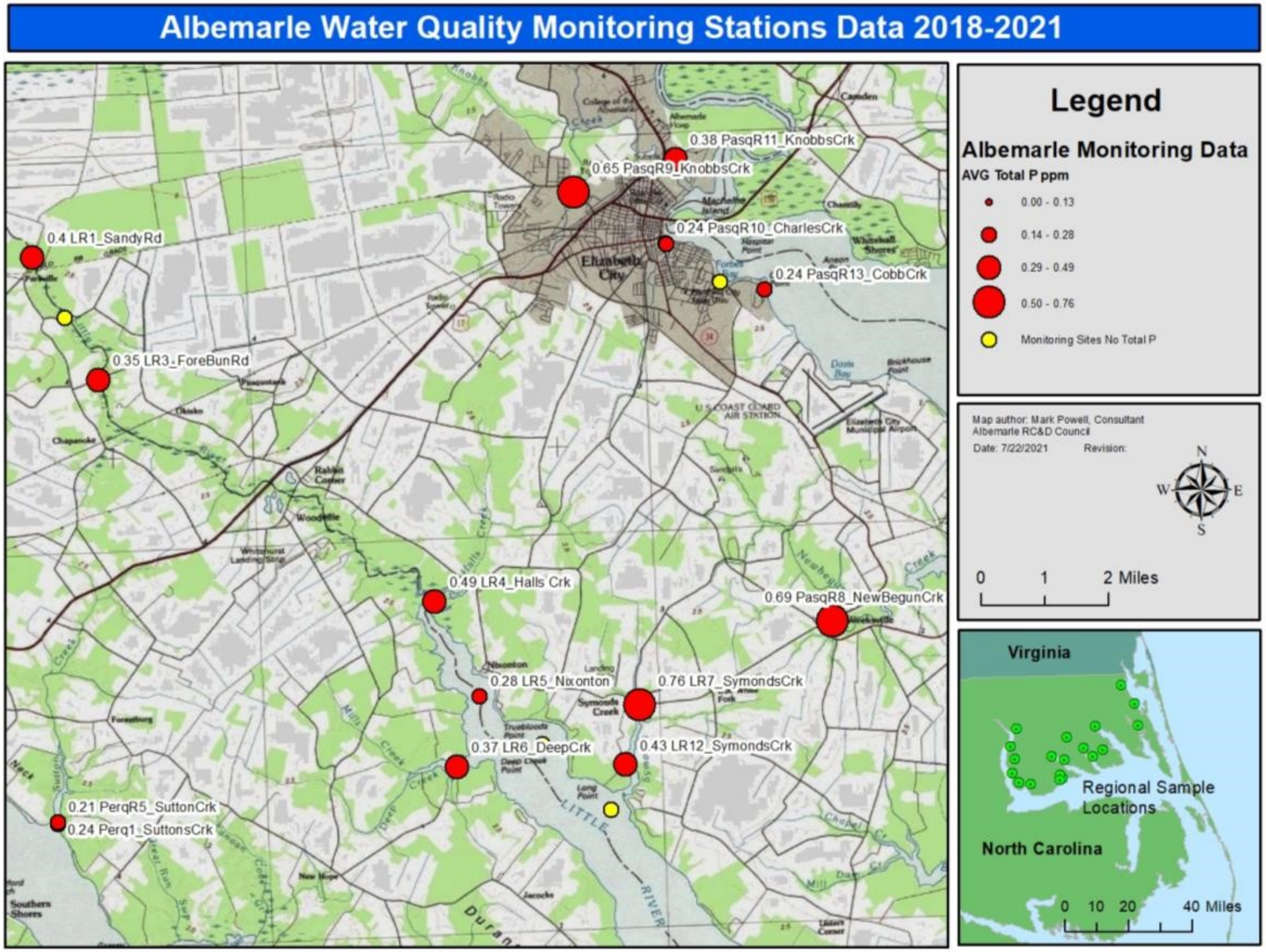

Figure 6. Dissolved Oxygen