INTEGRATED
FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

COASTAL STORM DAMAGE REDUCTION

BOGUE BANKS, CARTERET COUNTY

NORTH CAROLINA

APPENDIX I

Parking and Access

US Army Corps of Engineers
Wilmington District

1.0 INTRODUCTION

The Army Corps of Engineers has several requirements that must be met in order to fully cost share in a coastal storm damage reduction project (see ER 1105-2-100 and ER 1165-2-130). These requirements include that the beaches must be available for public use and provide adequate parking and access. As described in ER 1165-2-130 (Federal Participation in Shore Protection, paragraph 6.h.), "Parking should be sufficient to accommodate the lesser of the peak hour demand or the beach capacity", and "public use is construed to be effectively limited to within one-quarter mile from available points of public access to any particular shore. In the event public access points are not within one-half mile of each other, either an item of local cooperation specifying such a requirement and public use throughout the project life must be included in the project recommendations or the cost sharing must be based on private use." The Corps' Wilmington District, additionally, has developed more specific public access and parking requirements for participation in coastal storm damage reduction projects within the District's boundaries of North Carolina and Virginia. The Wilmington District requirement requires that a minimum of 10 public parking spaces be located within one-quarter mile of a public access point. The criteria for 10 spaces was based on using an average lot size along the shoreline area and determining how many parking spaces could be provided in that lot size (e.g. a 50' x 95' lot size can provide 10 spaces).

This Appendix contains an analysis of the current parking and access situation at Bogue Banks and how it relates to the distribution and peak demand requirements. The local sponsor will need to address any parking and access deficiencies prior to the signing of the PPA, otherwise project cost sharing could be adjusted. If the required number of parking spaces cannot be obtained, in some cases a public transportation system adequate for the needs of projected beach users may suffice instead (see ER 1165-2-130, section 6h(2)). Recognizing that circumstances can change between the time that this initial analysis was done and the PPA is signed, the parking and access needs as presented in this Appendix may be revisited at some point prior to the PPA signing.

2.0 Data

The spatial analysis of available public access and parking within the project areas was conducted using the following data:

Existing spatial data assembled for this analysis:

- Public Beach Access 2004 – Source: State of North Carolina CAMA Office
- Carteret County Tax Parcels 2010 – Source Carteret County Tax Office

New spatial data layers created for this analysis:

- Beach Access ½ Mile Radius – ½ Mile Radius buffers were created from the Public Beach Access Points. These circles represent the maximum distance allowed between Public Beach Access Points.
- Access Distance Greater than ½ Mile – Line segments were created between each Public Access Point. Data layer contains a definition query limiting display to only those

segments that exceed ½ Mile, or the maximum distance allowed between Public Access facilities per USACE Policy.

- Town Properties – Properties owned by the towns were derived from the Carteret County Tax Parcel Data to illustrate where potential Public Beach Access may be obtained if needed.

3.0 BEACH ACCESS

3.1 Methodology

Public Access Points were compared to the Project Area. Those Public Access Points adjacent to the given Project Area were selected for further analysis. Circular buffers with ½ Mile radii were generated from the selected Public Access Points. These circular features were given the layer name "Beach Access ½ Mile Radius" and are depicted as hollow blue circles in Maps 1-9 (all maps are contained at the end of this Appendix). These features, originating at each Public Access Point, must intersect with a Public Access Point on both east and west sides to meet the required maximum distance between public access points per USACE Policy. Instances where Public Access fails to meet this requirement are found on Access Maps (Attachment 1) 1,2,5,6,7 and 8 within Emerald Isle, Indian Beach, Salter Path, Pine Knoll Shores, and Atlantic Beach.

Further analysis was conducted to determine the distance between those Public Beach Access Points that were more than ½ Mile apart. The line feature "Access Distance Greater than ½ Mile" was generated using the Public Beach Access Points. The lengths of these line segments were calculated and a definition query used to select those segments with a length exceeding ½ Mile. These selected lines were then labeled with their calculated lengths to illustrate the magnitude of public access deficiencies within the project areas.

3.2 Results

There are 98 existing access points distributed throughout the study area.

Maps 1 and 2 define four instances within Emerald Isle that fail to meet the USACE public access density requirement. The distance between Public Access points located Wyndtree and Randy's Way has been calculated as 1.16 Miles (see Map 1). To meet access density requirements, two additional Public Access Points are required between these two points. The distance between Public Access points located at Heavenly and Seagull has been calculated as 1.22 Miles (see Map 2). At least two additional Public Access Points are required between these two points to meet access density requirements.

Map 5 illustrates two instances of public beach access deficiency. The distance between the Indian Beach Regional Access and the Salter Path Regional Access has been calculated to be 0.58 Miles. Technically, to meet access density requirements, an additional Public Access is required between these two points. However, since this distance is within 500 Feet of the maximum allowable distance, USACE may consider a waiver for this segment of the project. The distance between Salter Path Regional Access and the Sea Plantation West Access has been calculated to be 0.59 Miles. Technically, to meet access density requirements, an additional

Public Access is required between these two points. However, since this distance is within 500 Feet of the maximum allowable distance, USACE may consider a waiver for this segment of the project.

There are three instances of Public Beach Access deficiency in Pine Knoll Shores on Map 6. The distance between the Trinity Center Regional Access and the Ramada Inn Regional Access has been calculated to be 1.14 miles. Two additional Public Beach Access points are required between these two points. The distance between the Ramada Inn Regional Access and the Iron Steamer Regional Access has been calculated to be 0.95 miles. One additional Public Beach Access is required between these two points.

Another three Public Beach Access deficiencies in Pine Knoll Shores can be found on Map 7. The distance between Iron Steamer Regional Access and memorial Park Regional Access has been calculated to be 1.33 Miles. Two additional Public Beach Access Points are required between these two points. The distance between Memorial Park Regional Access and the Amerisuites Regional Access has been calculated to be 1.02 Miles. One additional Public Beach Access is required between these two points to meet the minimum access requirement.

Map 8 shows the last three Public Beach Access deficiencies of the project in Atlantic Beach. The distance between the Sheraton East Regional Access and the Coral Bay Regional Access has been calculated to be 0.65 Miles. One additional Public Beach Access is required between these two points. The distance between the Coral Bay Regional Access and the Durham Street Regional Access has been calculated to be 1.34 Miles. Two additional Public Beach Access points are required between these two points.

In summary, at least 13 additional beach access points are needed throughout the project area to meet the USACE requirement for adequate distribution.

4.0 PARKING DISTRIBUTION

4.1 Methodology

Public Access Points and Parking Data were compared to the Project Areas. Those Public Access Points adjacent to the given Project Area were selected for further analysis. Circular buffers with ¼ Mile radii were generated from the selected Public Access Points. These circular features were given the layer name “Parking Radius ¼ Mile” and are depicted as hollow blue circles in Maps 1-9. These features, originating at each Public Access Point, must contain a minimum of 10 public parking spaces within ¼ Mile per USACE Policy. Instances where Public Access Parking fails to meet this requirement are found on Parking Maps (Attachment 2) 1, 2, 3, 4, 8, and 9.

4.2 Results

There are an estimated 1,832 existing parking spots distributed throughout the study area (including Fort Macon). Beach Access Points were symbolized with a Green Filled Circle where the number of parking spaces met or exceeded the minimum of 10 spaces. Beach Access Points

were symbolized with a Red Filled Circle where the number of parking spaces was less than the required 10 spaces. Each Beach Access was labeled with the number of known Parking Spaces.

The Beach Access Points Channel Drive, Inlet and Coast Guard Road, and Wyndtree are all within ¼ mile of each other. Each Access point in this group has 10 Parking Spaces within ¼ mile. None of the other Beach Access Points on Map 1 meet the minimum requirement for parking.

The Beach Access Points Western Regional Access and Janell are located within ¼ mile of each other and both have 10 or more parking spaces available within ¼ mile. No other Beach Access Points on Map 2 meet the minimum requirement for parking.

Only Beach Access Point Dog Leg meets the minimum requirement for parking on Map 3. Dog Leg is located within ¼ mile of Western Regional Access 2 and has access to 10 or more parking spaces.

On Map 4, Beach Access Points at Western Regional Access 2, 25th, 5th, 3rd, and 2nd all have 10 Parking Spaces within ¼ mile. None of the other Beach Access Points on Map 4 meet the minimum requirement for parking.

All Beach Access Points on Map 5 meet minimum parking requirements. Beach Access 1st, Baptist Church Gazebo, Ocean Club, Indian Beach Regional Access, Sea Plantation West, and Trinity Center Regional Access all meet the minimum parking requirements with access to 10 or parking spaces within ¼ mile.

Map 5 illustrates Beach Access Points at Salter Path Regional Access and Trinity Center Regional Access both meet or exceed the minimum parking requirement. No other Beach Access Points on Map 5 meet the minimum requirement for parking.

The Ramada Inn Regional Access and Iron Steamer Regional Access located on Map 6 both meet or exceed the minimum parking requirement.

The memorial Park Regional Access and the Amerisuites Regional Access on Map 7 meet the minimum requirement for parking, along with the Iron Steamer Regional Access also visible on Map 7. However, the Sheraton West Regional Access does not meet minimum parking requirements.

On Map 8, Durham Street Regional Access, Charlotte Avenue Regional Access, Raleigh Avenue Regional Access, Bath House Regional Access, The Circle Regional Access and Beaufort Avenue Regional Access all meet the minimum parking requirements by having 10 available parking spaces within ¼ mile.

New Bern Street Regional Access and Club Colony Drive Regional Access both meet required minimum of 10 Parking Spaces within ¼ mile. None of the other Beach Access Points on Map 9 meet the minimum requirement for parking.

4.0 PEAK PARKING

A study/survey was conducted by the University of North Carolina at Wilmington (UNCW) in 2003 was used as the basis for estimating potential peak hour parking demand in the area (this study can be made available upon request) at the time a project is constructed (currently estimated to be 2019 for the Bogue Banks Project). Peak hour demand is defined here as the average number of non-overnight visitors at the beaches at 1 p.m. on July 4, 5, 12, 13 and Aug 2, 3, 9, 10, 30, and 31. Sufficient parking capacity is defined here as having enough parking spaces to accommodate peak hour demand on 60% of peak days. This means that on average, there would be enough public parking to accommodate all beach visitors year round, with the exception of at peak hour (1 p.m.) on four of the busiest (peak) days of the year.

The increase in peak demand is based on increases to the width of the beach. Because beach width will vary over the life of the project, an average annual change in beach width between the with and without project condition was calculated. This difference in beach width was measured for each of the individual towns in the project area (Emerald Isle, Indian Beach, Salter Path, Pine Knoll Shores, and Atlantic Beach) and used as the basis for determining project recreation benefits (see Appendix B – Economics) and the peak hour parking demand in each of these towns with a project in place in 2019. The methodology for determining the number of required spaces is included as Attachment 3 to this Appendix. The number of parking spaces required to meet the peak hour parking demand requirement, as well as the current number of parking spaces in each of the towns is shown in Table 1 below.

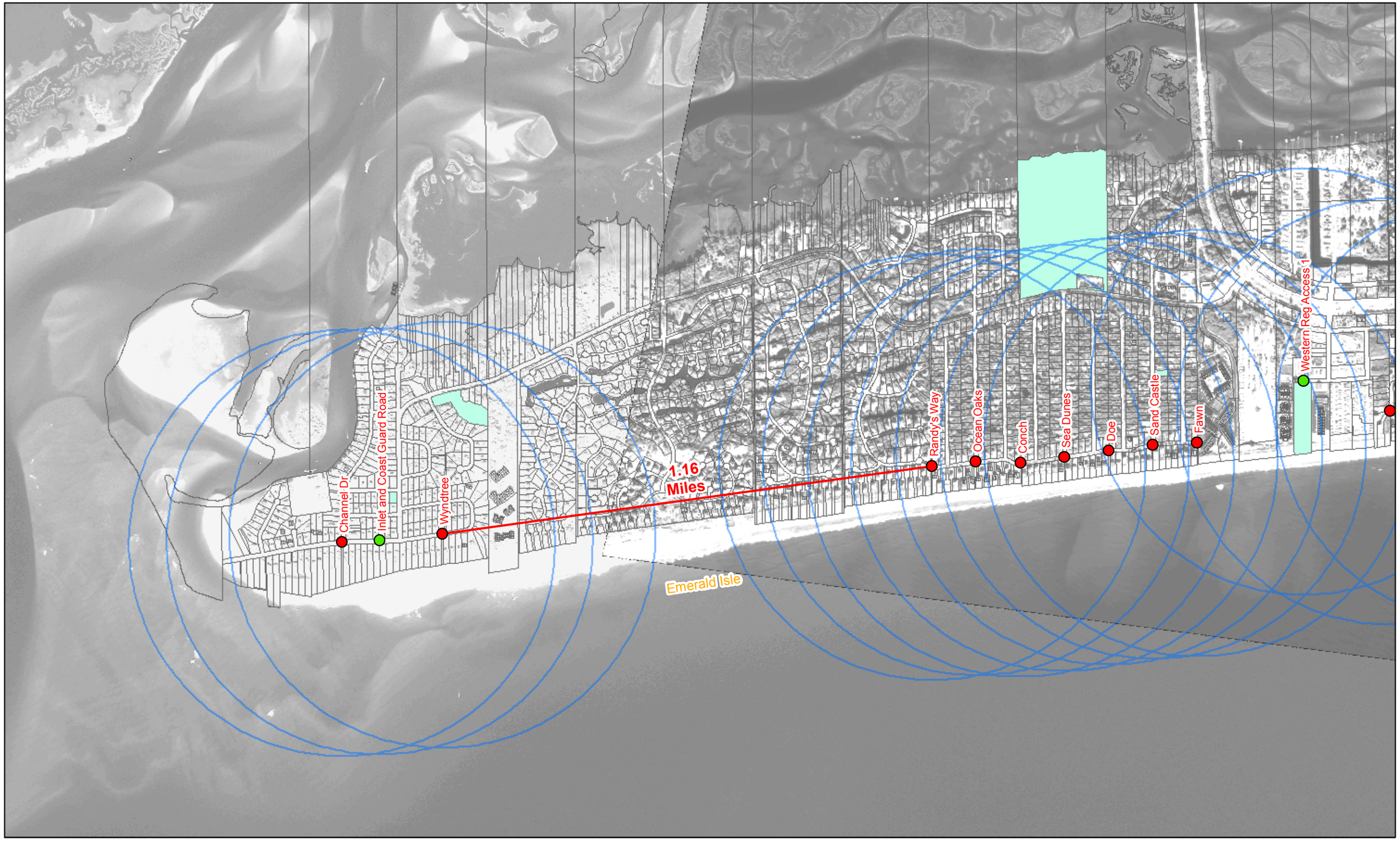
Town	Total Parking Spaces Needed	Current Parking Spaces
Emerald Isle	662	525
Salter Path/Indian Beach	96	141
Pine Knoll Shores	210	155
Atlantic Beach	2,303	1,011*
Total	**3,271**	**1,832**

*Includes parking spots available at Fort Macon State Park

Table 1. Number of parking spaces needed to meet peak parking requirement, and estimated number of current parking spaces.

ATTACHMENT 1

PUBLIC ACCESS MAPS



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Wilmington District

Bogue Banks
Beach Access/Parking Assessment

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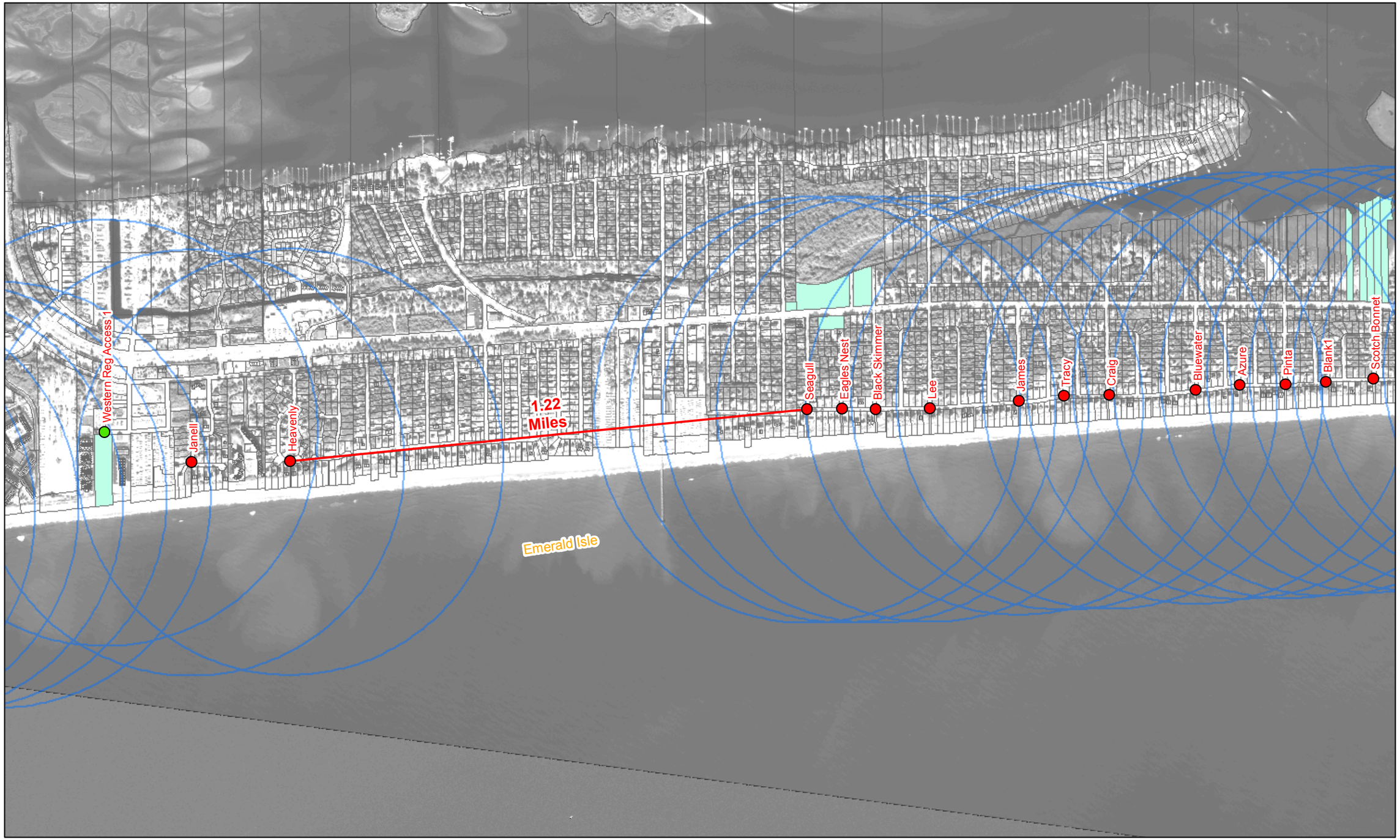
1 inch = 1,149 feet

1,000 500 0 1,000 Feet

Legend

Beach Access/Parking Spaces

- Less Than 10 Parking Spaces
- 10 or More Parking Spaces
- Access Distance > 1/2 Mile
- Beach Access 1/2 Mile Radius
- Town Properties
- Carteret Tax Parcels 2010



U.S. Army Corps of Engineers Wilmington District	Bogue Banks Beach Access/Parking Assessment

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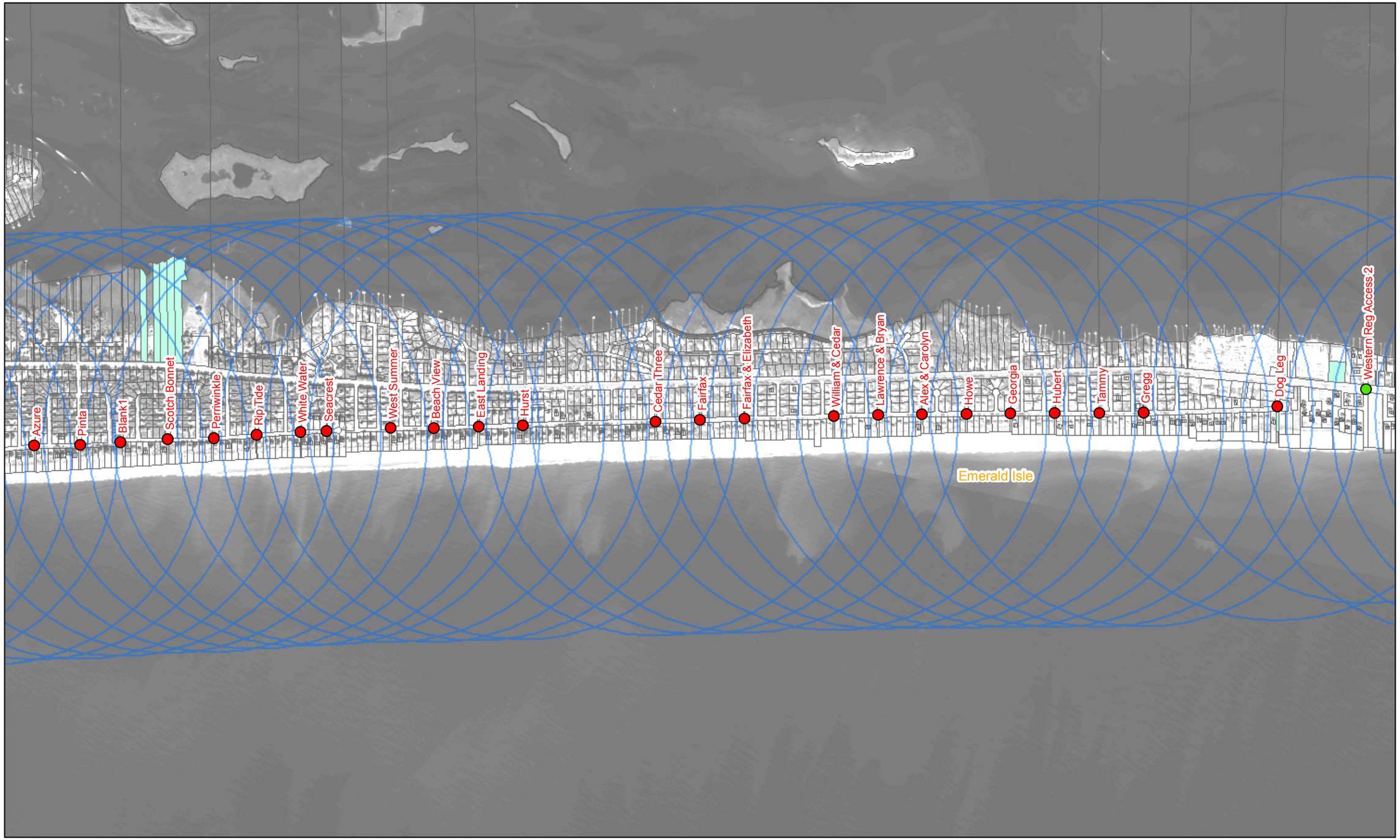

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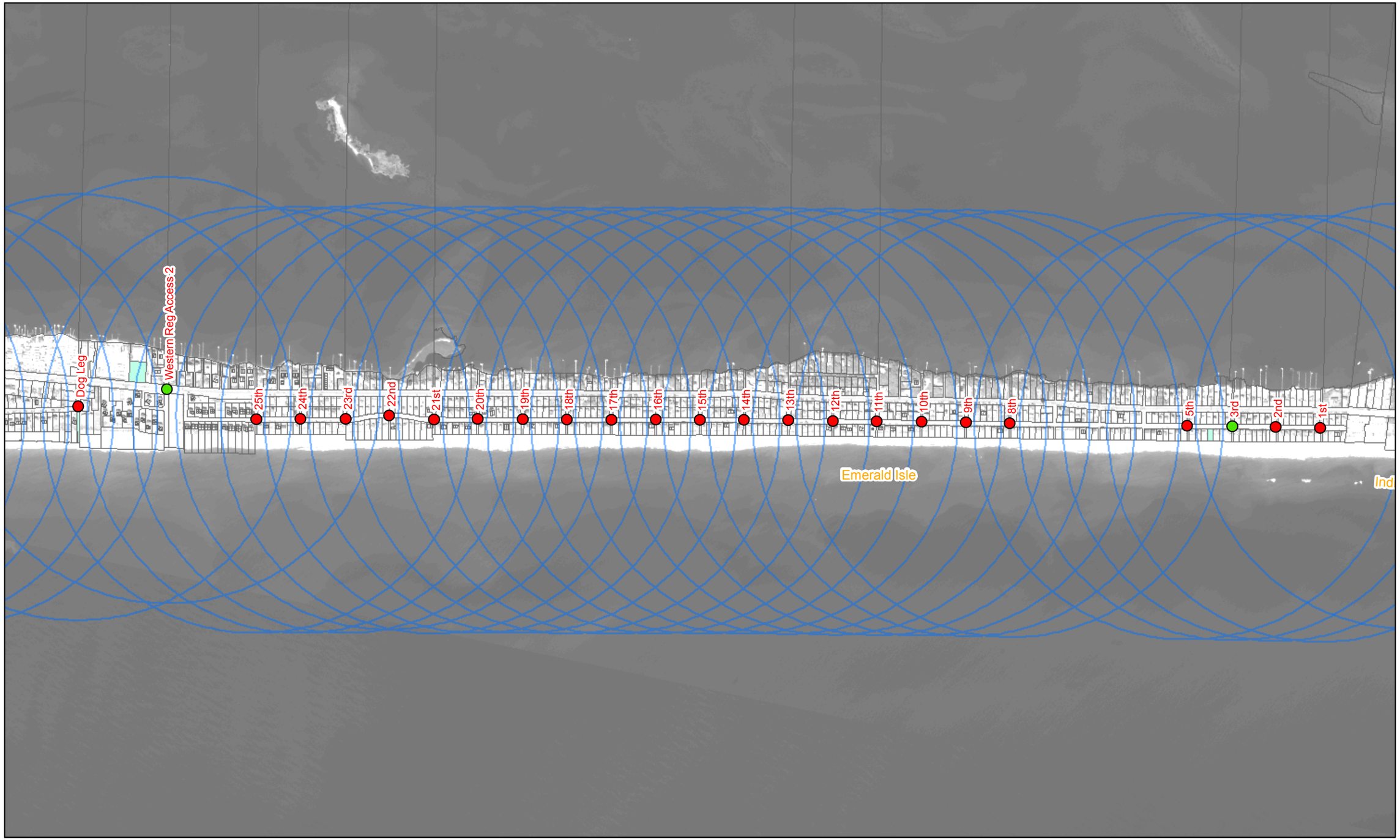

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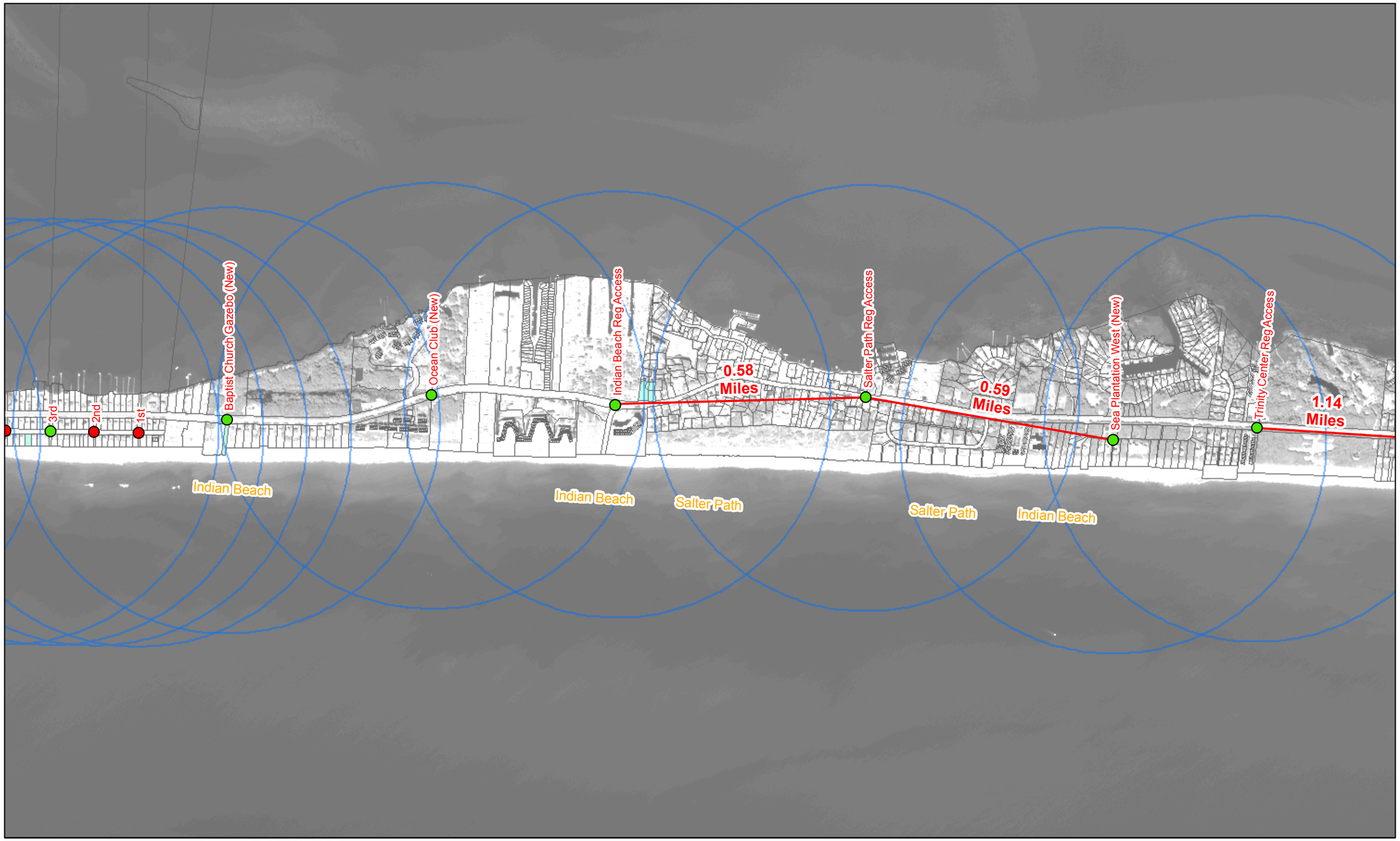

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N

Sheet 5 of 9

Trinity Center Reg Access

1.14 Miles

Ramada Inn Reg Access

0.95 Miles

Iron Steamer Reg Access

1.33 Miles

Pine Knoll Shores

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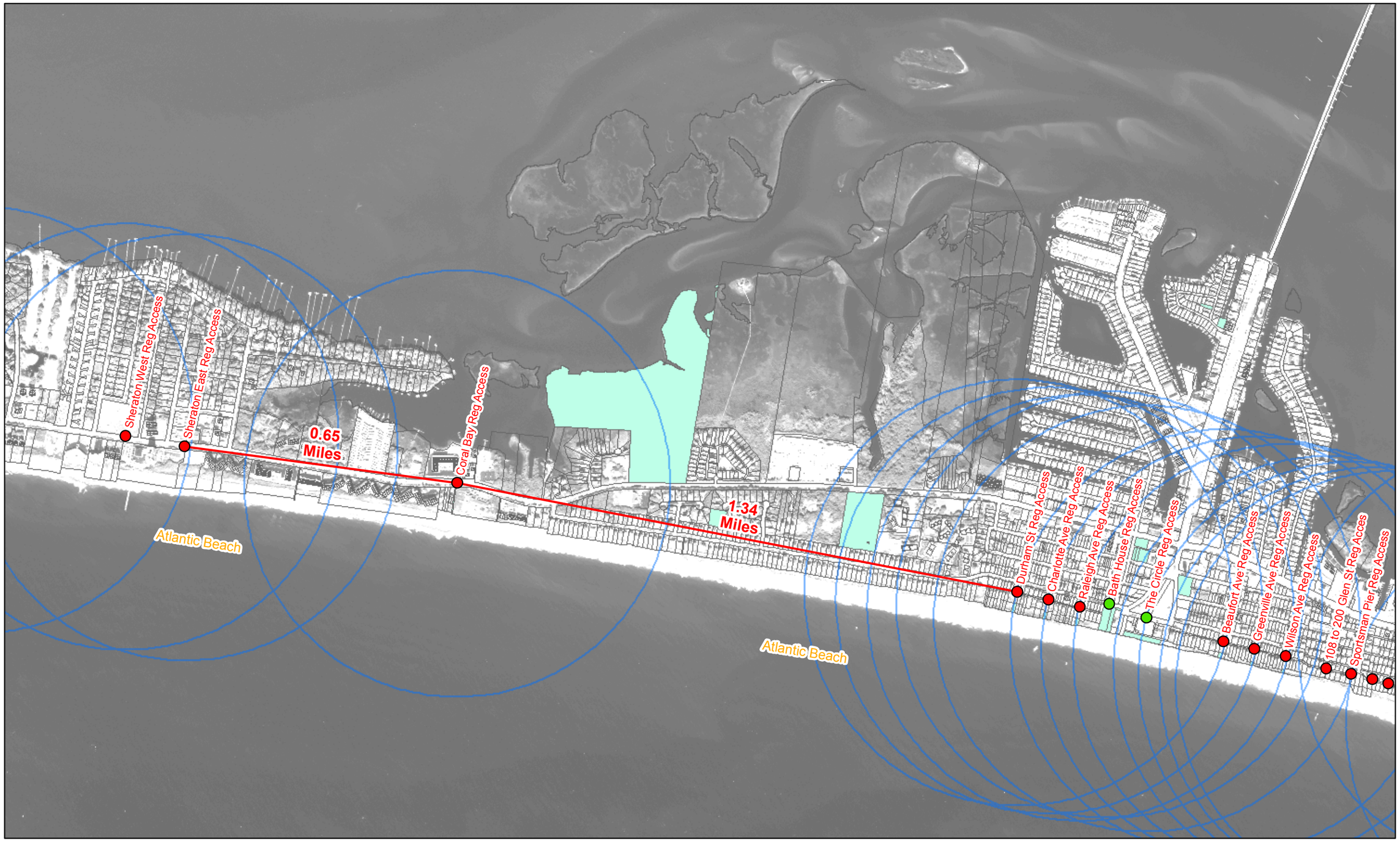

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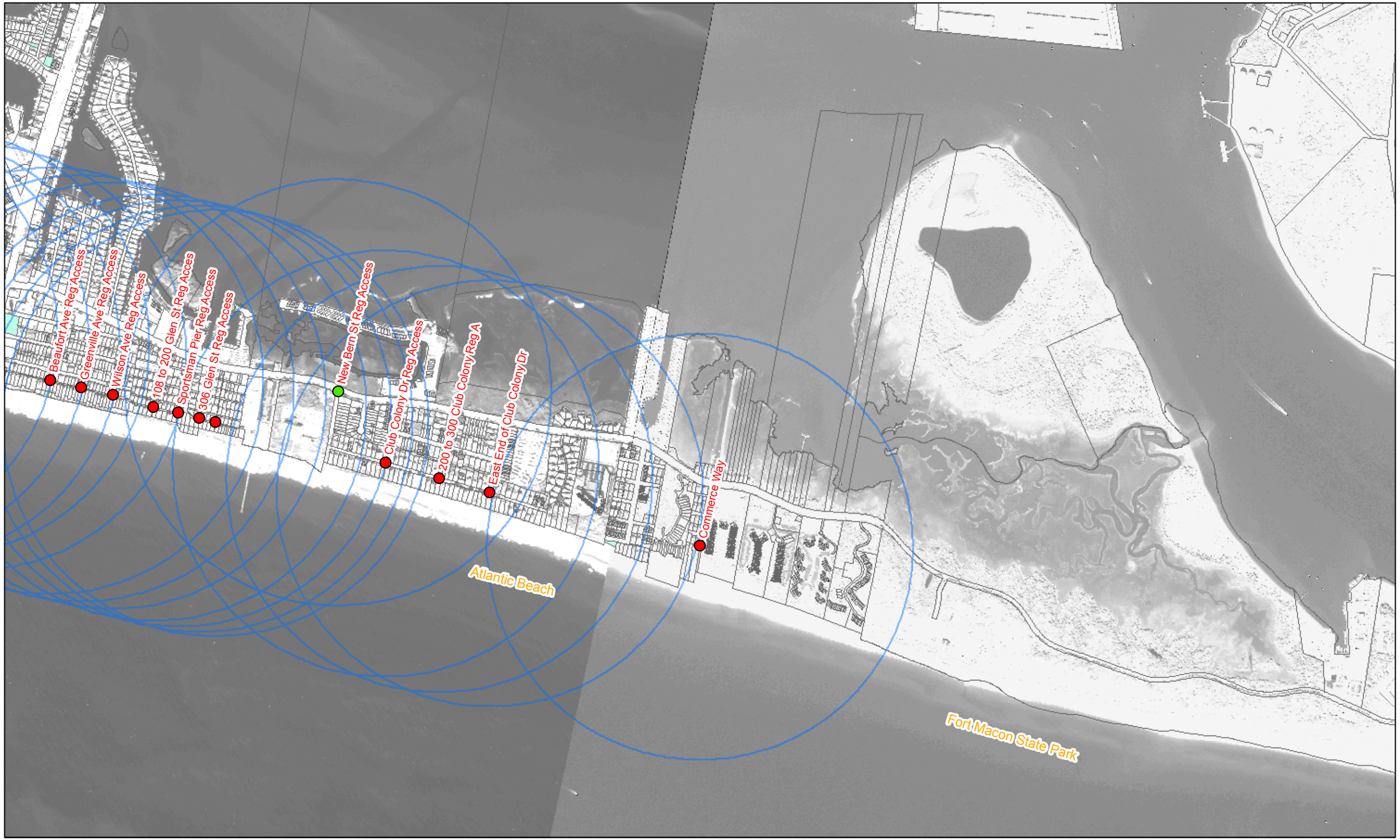

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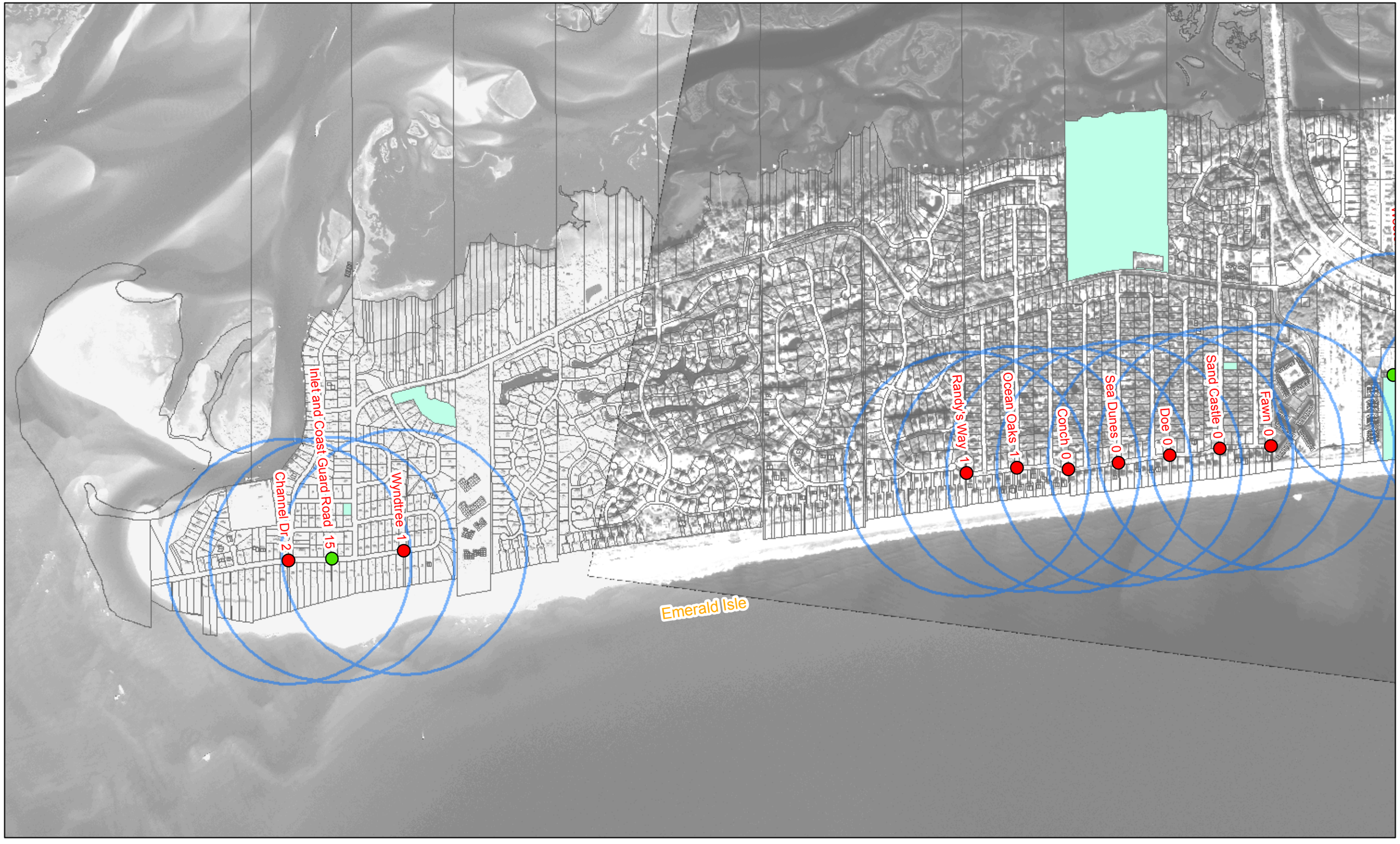
ATTACHMENT 2

PARKING DISTRIBUTION MAPS



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- Parking Radius 1/4 Mile
- Town Properties
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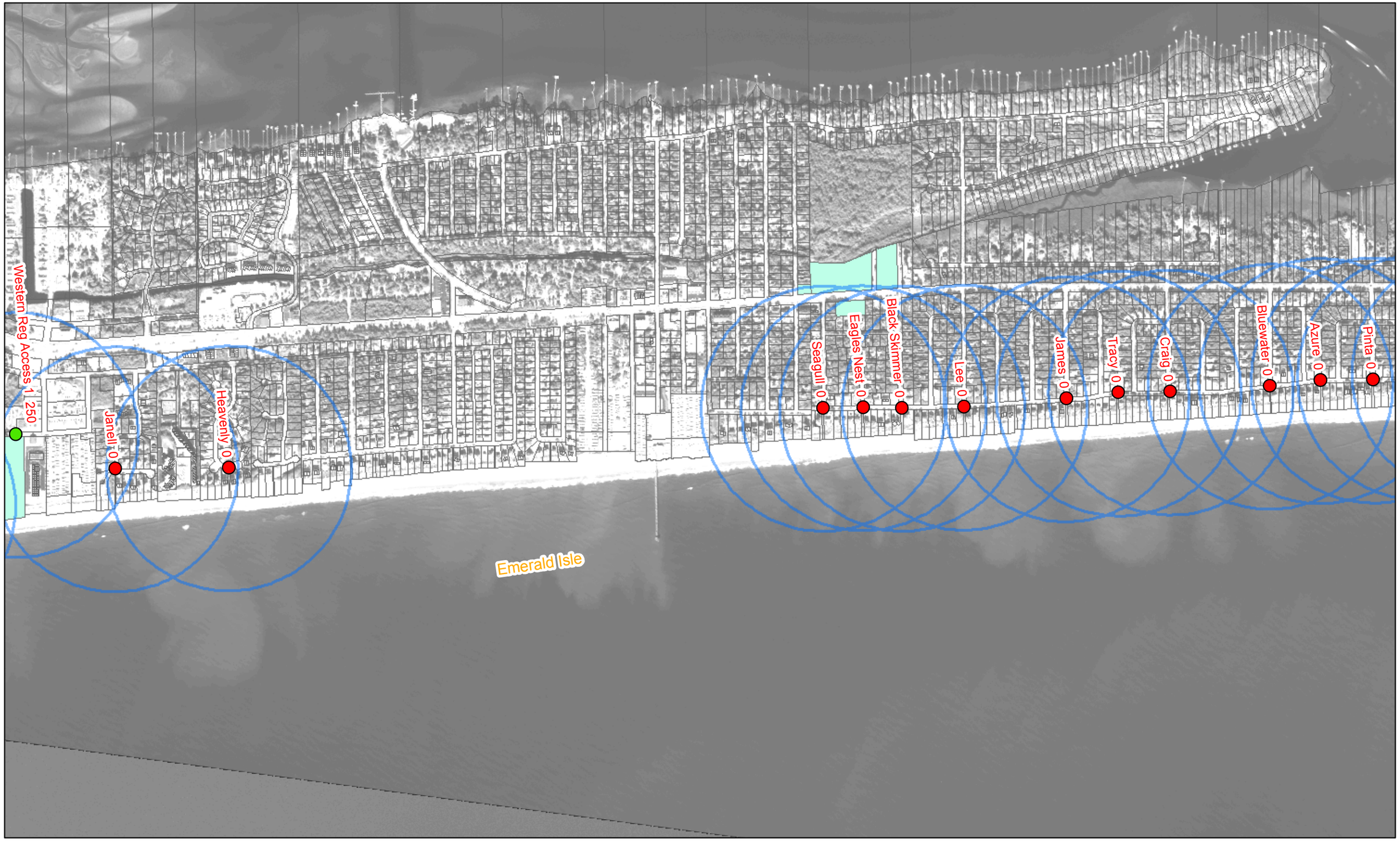

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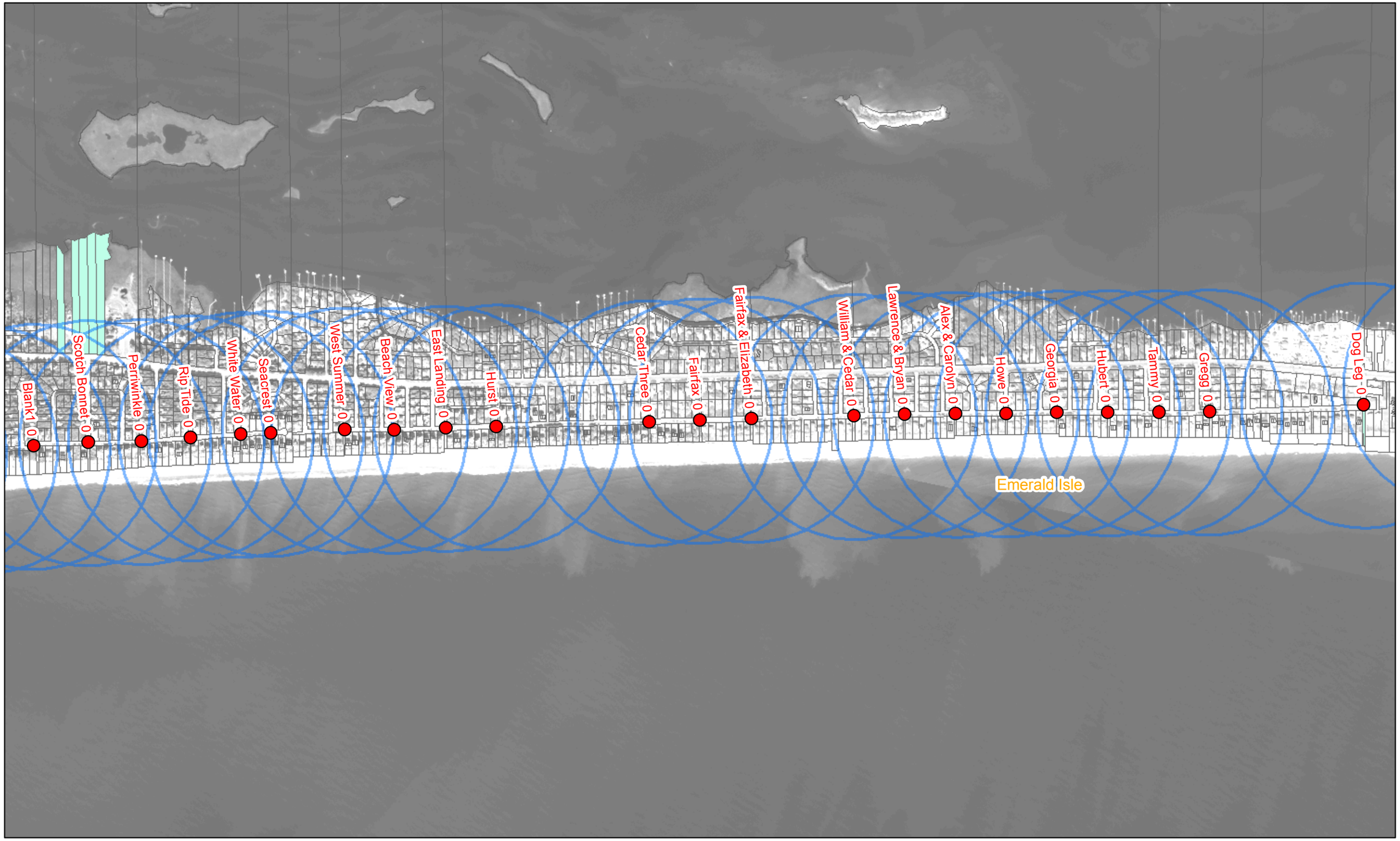

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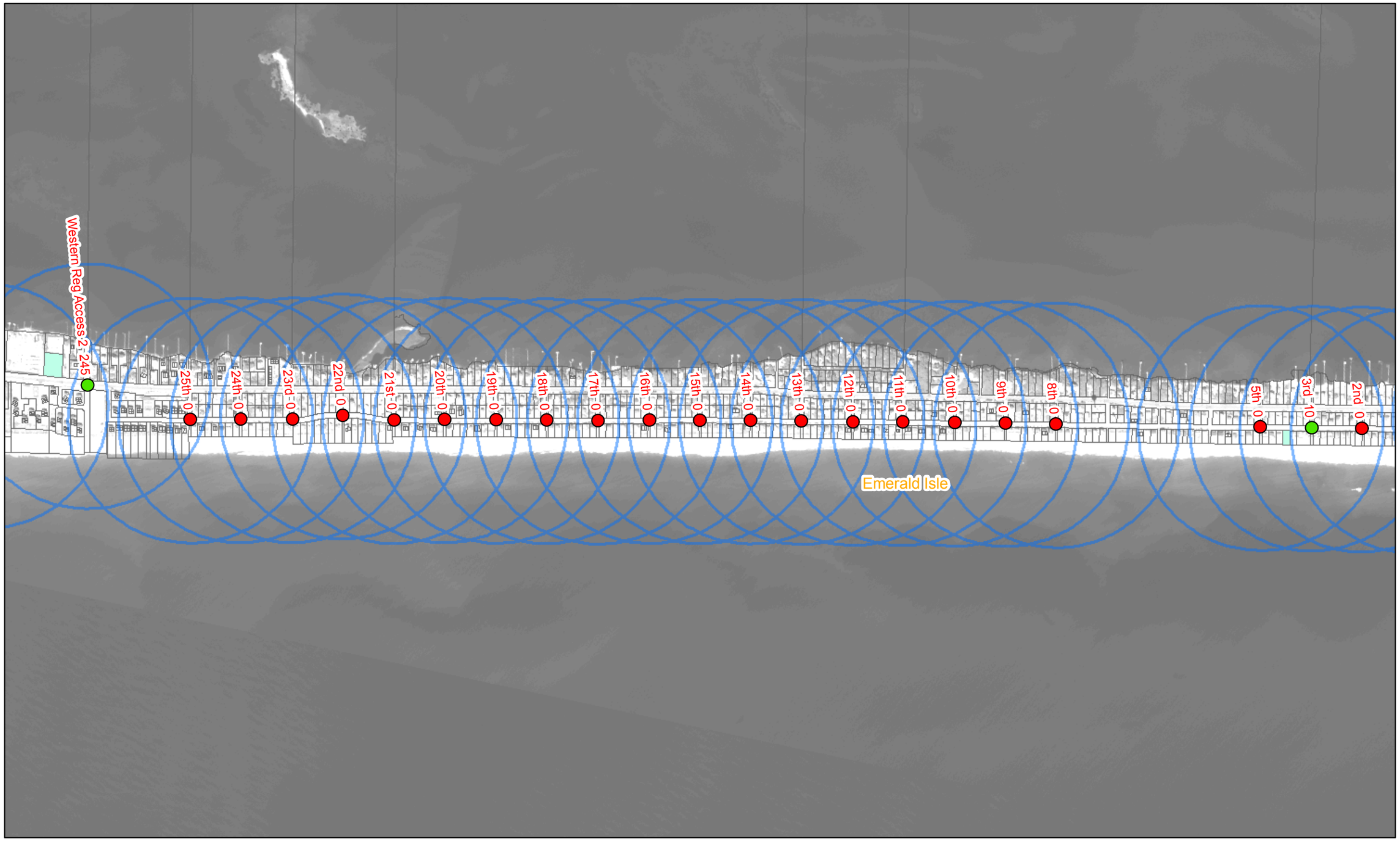

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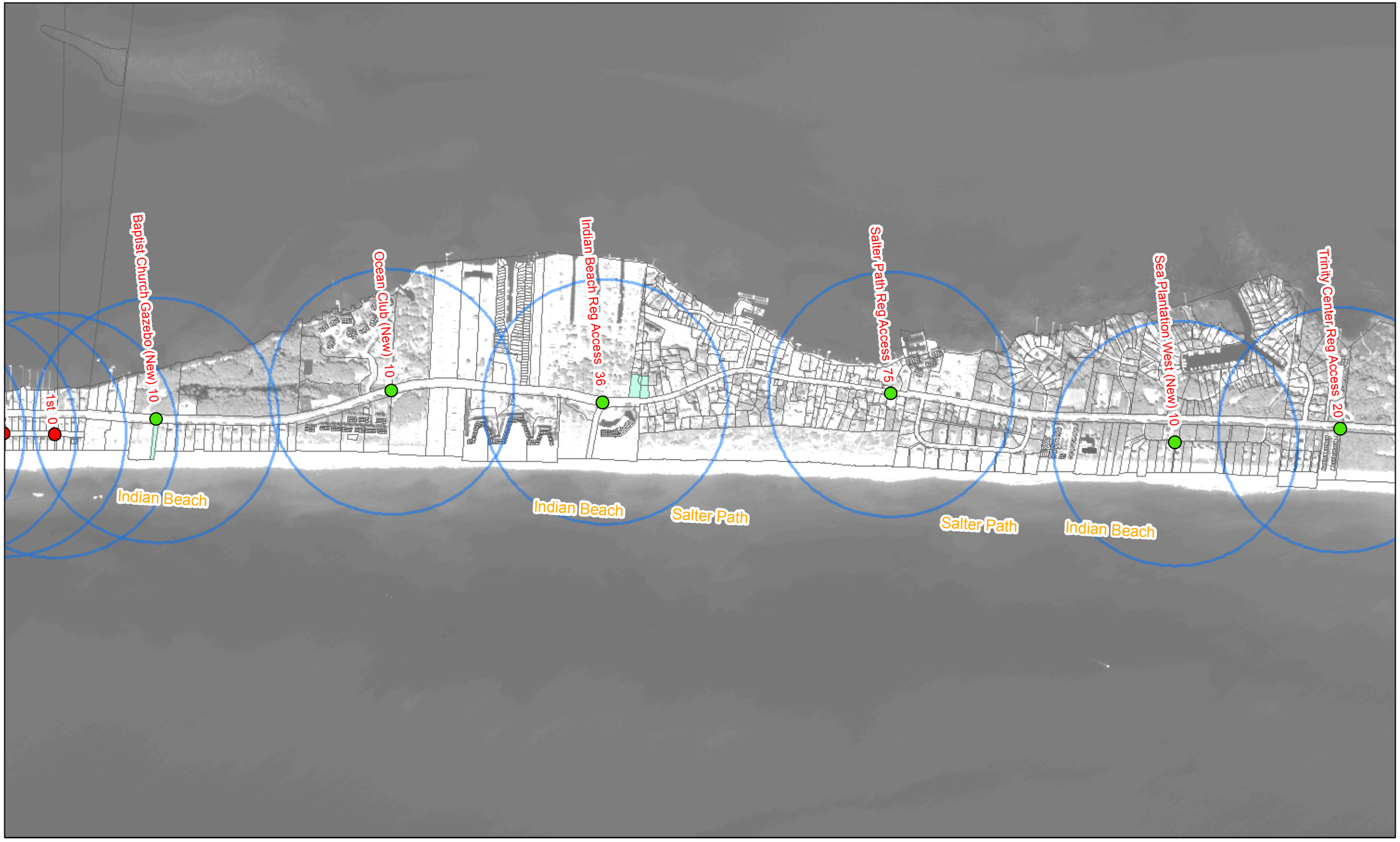

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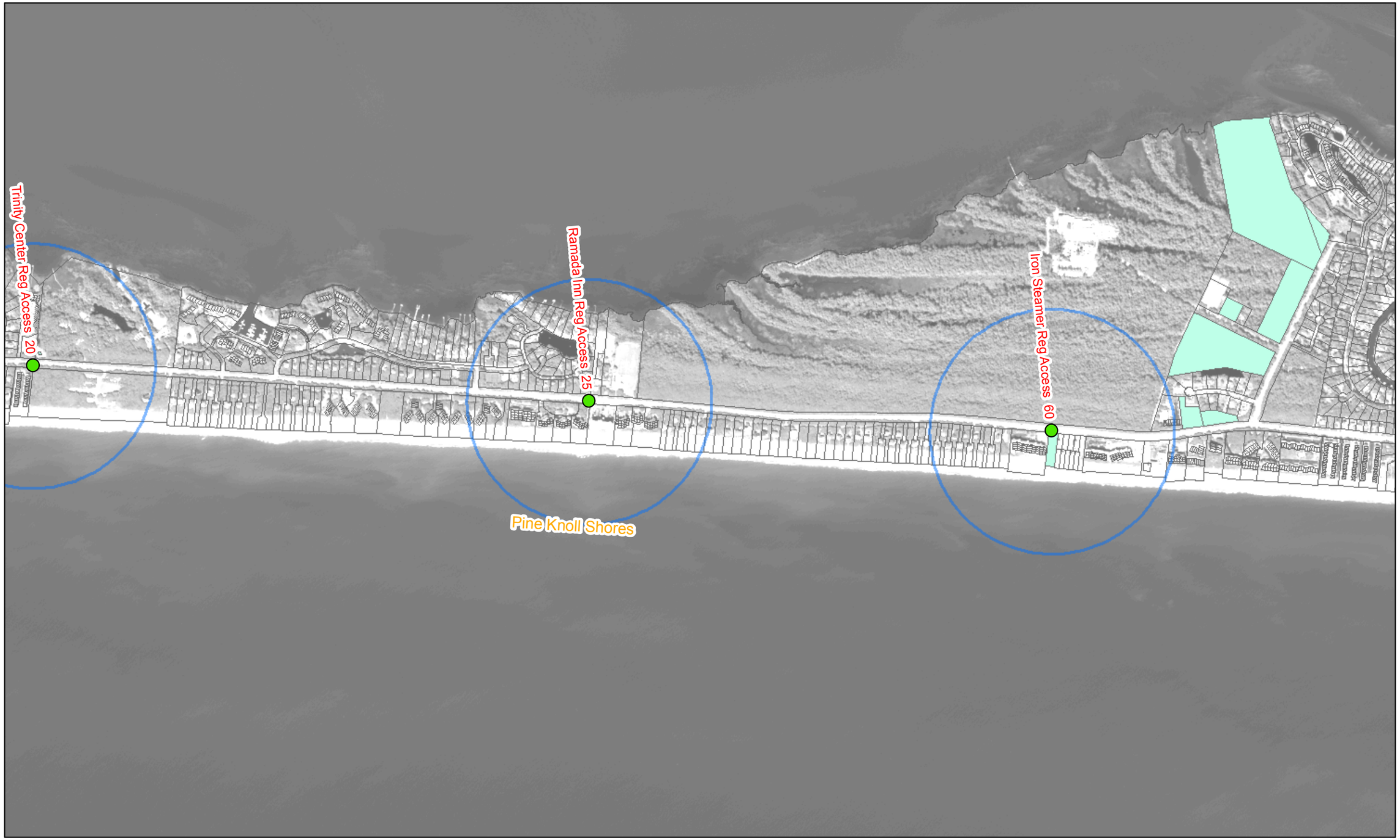

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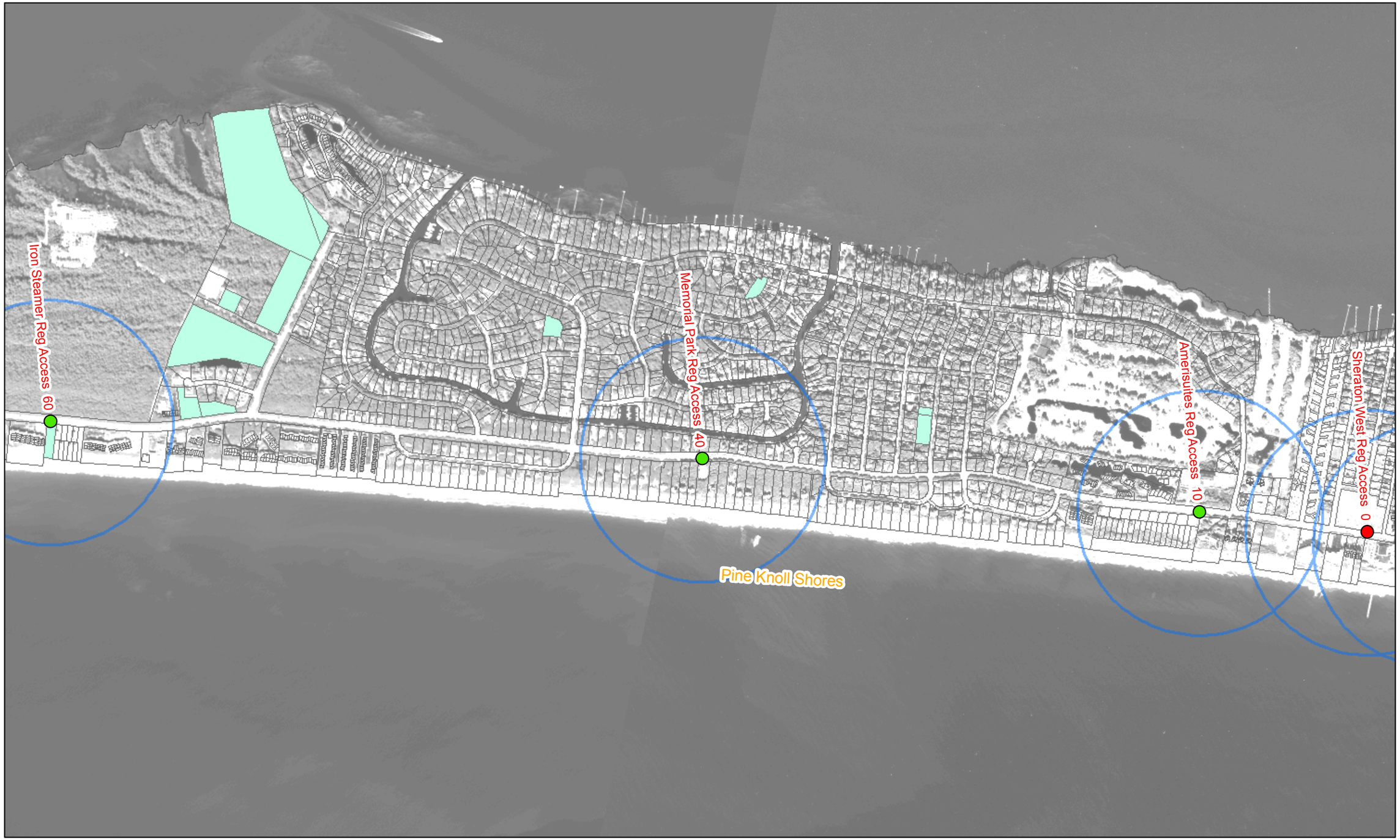

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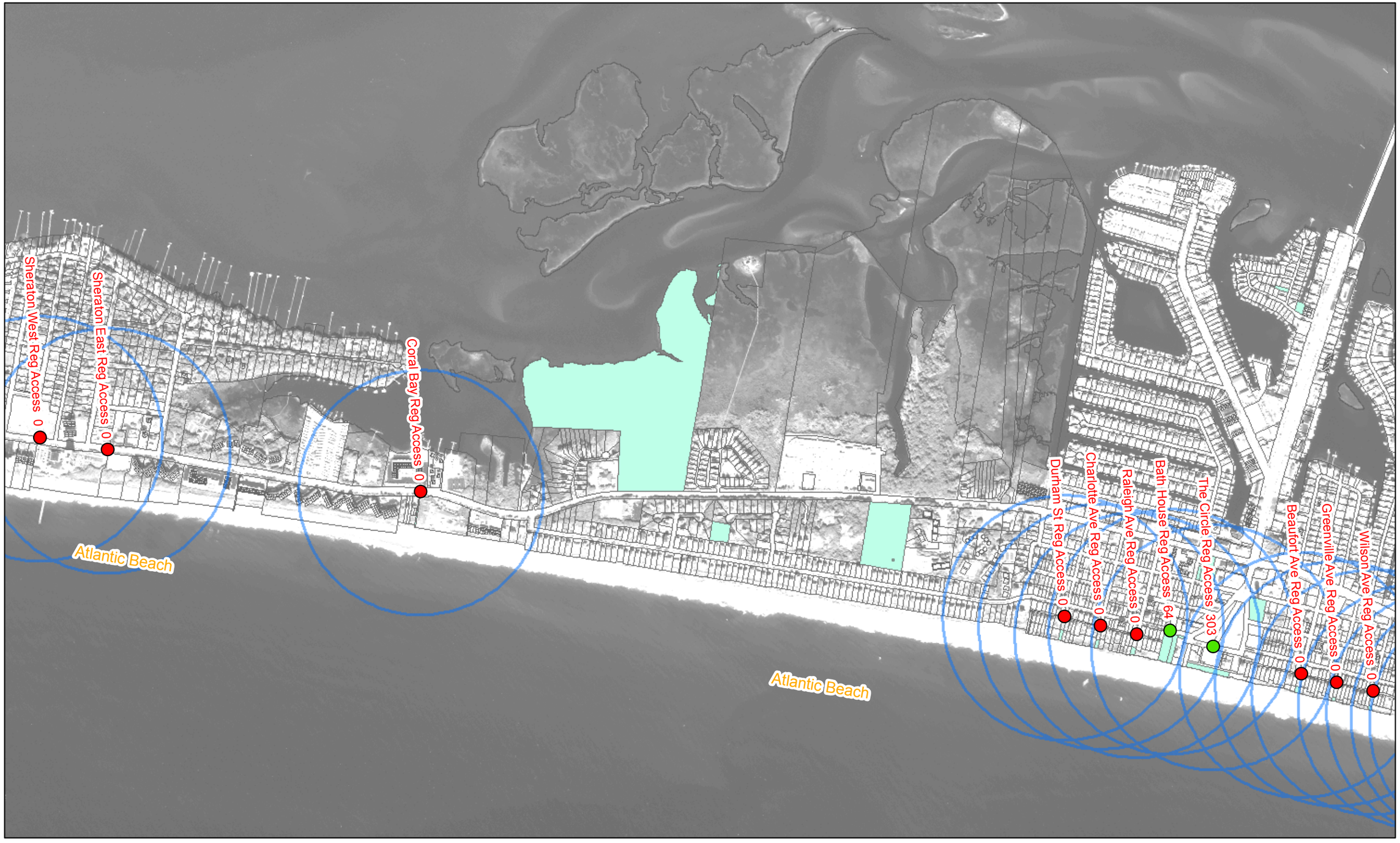

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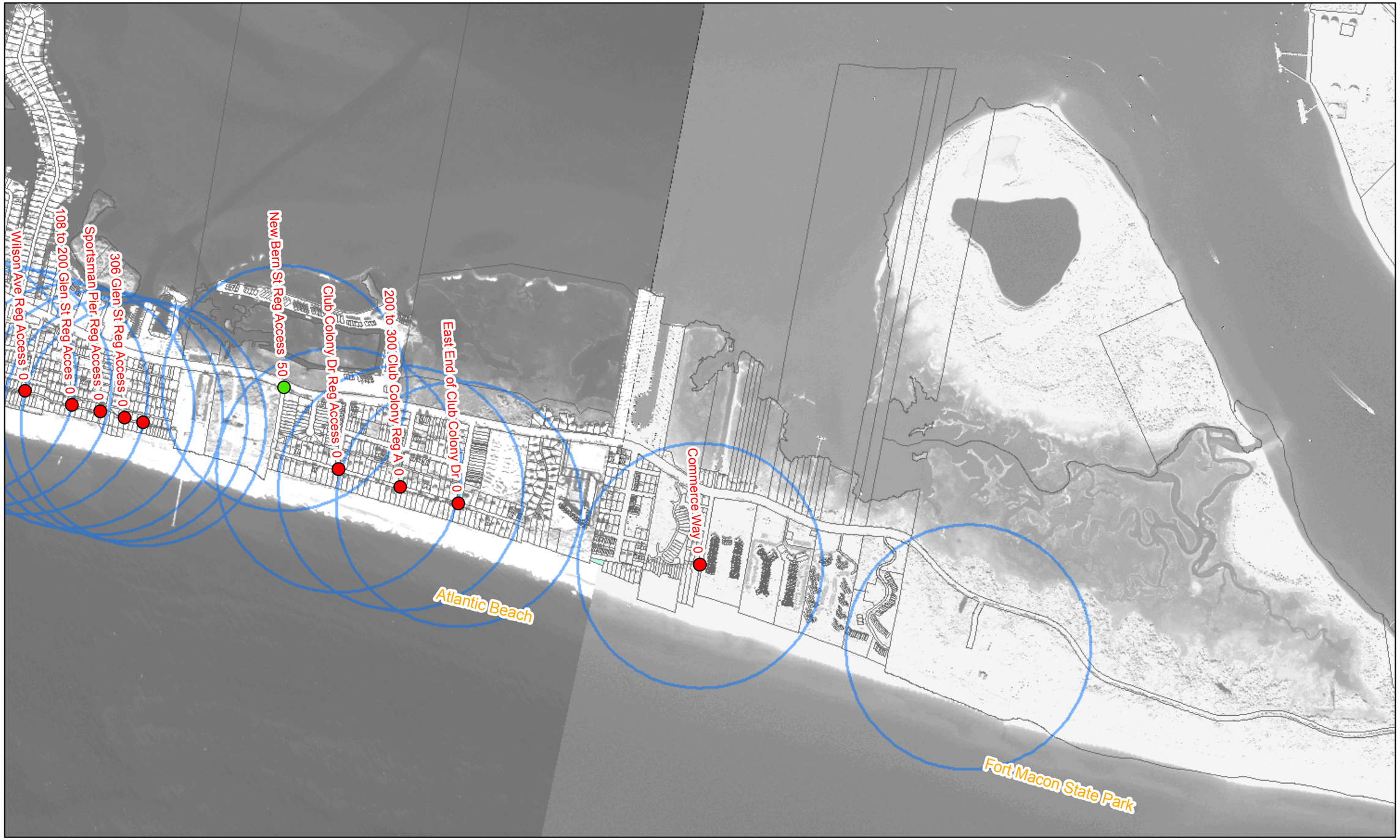

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ATTACHMENT 3

PEAK PARKING ANALYSIS – DETAILED METHODOLOGY

Introduction

This attachment provides an overview of the data and methodology that was used to determine the peak parking space requirements. The data on which the analysis is based comes the from telephone and onsite surveys conducted by the University of North Carolina at Wilmington in 2003 (the full report can be made available upon request). This data was used to establish parking requirements for Bogue Banks at the estimated start of project construction.

Methodology

The telephone survey asked respondents about trips taken in a 120-mile radius of the North Carolina coast during a typical peak summer season. The data was used to construct an index of the number of recreational day trip (TRIPINDX) to a beach. $TRIPINDX_i$ is the estimated number of recreational day trips taken to beach i per year by 1,067 households in the telephone survey sample. PC Miler, a Poisson/negative-binomial cluster regression model, was used to generate TRIPINDX. Other data collected for this study include stay time, STAYTIME, which is the average length of time in hours that a visitor remained at the beach. The duration of stay is assumed to affect parking demand. If the duration of stay is usually long, more parking spaces should be provided.

The on-site survey collected parking space data for ten beaches on peak (weekend) days in July and August 2003. For this analysis the variable SPACES, which gives the existing number of parking spaces at each beach, is used as a censoring variable by the Tobit regression procedure. Each beach has a separate censoring limit, as specified by the $SPACES_i$ variable. Two holidays were included in the survey effort: the Fourth of July weekend and the Labor Day Weekend. To test for the effect of holiday on parking demand, a dummy variable, $HOLIDAY_d$, was generated equal to 1 if the day is July 4 or 5, or August 30 or 31, days corresponding to the Fourth of July and Labor Day holidays.

To account for fixed effects in the model, beach-specific dummy variables, DB00, DB09, that shift the intercept were generated for nine beaches. The dummy for beach 10 is omitted to avoid a dummy variable trap. Observe that beach 08 is omitted from the whole analysis. Dummy variables capturing time of day effects were constructed as follows: if t = 9am-11am, DMORN = 1, DMORN = 0 otherwise; if t = 3pm-5pm, DAFTN = 1, DAFTN = 0 otherwise. Note that potential dummy variable DMID = 1 when t = 12noon-2pm is omitted to avoid the dummy variable trap. Under this specification, with all dummy variables set to zero, the regression predicts uncensored FILLEDSP (dependent variable) at midday on a non-holiday weekend day on beach 10 (Atlantic Beach). Setting one of the various dummy variables to the value “1” adjusts the regression predictions for an alternative time of day or an alternative beach destination. Table A1 summarizes key statistics for the survey data sample.

Variable	Description	Mean	Std.Dev.	Minimum	Maximum
FILLEDSP	Filled Parking Spaces	2.5666	2.2871	0	9.09
STAYTIME	Stay Time at beach	4.339445	1.318575	0.1875	9.5
HOLIDAY	Holiday {Fourth of July and Labor Day}	0.532934	0.49929	0	1
TRIPINDX	Trip index	428.956	255.16	146	924
DMORN	Day time dummy variable	0.377246	0.48506	0	1
DAFTN	Afternoon time dummy variable	0.211078	0.408379	0	1
DB00	Caswell Beach	0.0329	0.178598	0	1
DB01	Oak Island Beach	0.0449	0.207262	0	1
DB02	Holden Beach	0.0404	0.197088	0	1
DB03	North Topsail Beach	0.0449	0.207262	0	1
DB04	Surf City Beach	0.0404	0.197088	0	1
DB05	Topsail Beach	0.0404	0.197088	0	1
DB06	Pine Knoll Shores Beach	0.0389	0.193554	0	1
DB08	Indian Beach	0.0404	0.197088	0	1
DB09	Emerald Isle Beach	0.0434	0.203938	0	1

Notes: Only aggregate statistics are reported in table. The descriptive statistics for the 10 individual beaches are not presented to economize on space.

Table A1. Summary statistics of survey data.

It is likely that some visitors may not use the beach because parking capacity is limited. Suppose that out of 500 potential beach visitors, 200 are unable to use the beach because they cannot find parking space. One strategy of dealing with this difficulty is to ignore or drop these observations from the sample. However, by eliminating this subset from the sample not only do we lose degrees of freedom and therefore precision, we also risk biased estimates of the effects of independent variables. That is, important factors correlated with the dependent variable may characterize this group of visitors that has been dropped. In situations such as these, a better strategy that allows use of the entire sample is to assume that the dependent variable FILLEDSP (number of parking spaces filled at a give beach) has a censored distribution; that is, the dependent variable cannot be observed above or below some threshold value, and therefore is reported as this threshold value.

The underlying model of censored regression assumes that the true value of the dependent variable is unobservable. The basic form of the censored regression model is given by the latent variable formulation:

$$Y_i^* = X'_i\beta + \varepsilon_i \qquad (1)$$

Where y_i^* *is the latent variable,* X'_i *is a vector of exogenous variables and* ε_i *is a normal error term with zero mean and standard deviation* σ *.*

Define the censored random variable Y_i *as*

$$y_i = o \;\; if \;\; y_i^* \leq 0$$
$$y_i = y^*{}_i \;\; if \;\; y_i^* \succ 0$$

The dependent variable of the censored regression model is observed when $y_i^* \succ 0$. With the survey we can obtain the observable response (y_i) which represents the unobservable outcome of a particular range.

When the range of dependent variable is limited, censored regression methodology are used to analyze the data. Given the censored nature of the dependent variable, performing OLS on equation (1) will result in inconsistent coefficient estimates. To account for censored dependent variable and to obtain consistent estimates of the parameters, we estimate a censored regression within a maximum likelihood Tobit model.

The Tobit regression model (with upper and lower tail censoring) is specified as:

$$\begin{aligned} Ln(FILLEDSP_{idt}) &= \beta_o + \beta_1 DMORN + \beta_2 DAFTN + \beta_3 DB00 + ...\beta_{11} DB09 \\ &+ \beta_{12} STAYTIME_{id} + \beta_{13} HOLIDAY_d + \beta_{14} TRIPINDX_i + e_{idt} \end{aligned} \qquad (2)$$

If $\text{Ln}(FILLEDSP_{idt}) \leq 0$, then $\text{Ln}(FILLEDSP_{idt}) = 0$,
If $\text{Ln}(FILLEDSP_{idt}) \geq \text{In}(SPACES_i)$, then In $((FILLEDSP_{idt}) = (SPACES_i)$,

where:

FILLEDSP, STAYTIME, SPACES, HOLIDAY, DMORN, DAFTN, DB00…DB9, and TRIPINDX are variables defined above, e_{idt} is a heteroskedastic error term. The error term is specified as $e_{idt} \sim N(0, \sigma^2.\exp(\alpha.TRIPIND_i))$, where σ (the standard deviation of the uncensored dependent variable in the absence of heteroskedasticity), α and $\beta_0 - \beta_{14}$ are the parameters to be estimated.

Parameters of the distribution of the latent dependent variable are estimated by maximum likelihood in LIMDEP (2002). The Tobit regression model estimates the probability distribution of FILLEDSP, including the number of FILLEDSP that would occur if the number of parking spaces were not constrained. The resulting probability distribution can be used to estimate parking requirements beyond current parking space capacity.

Results:

Projected Annual Visitation

As state population increases, the number of visitors to Bogue Banks is expected to increase, assuming that the number of trips per household remains constant. Table A1 shows baseline annual visitation to each of the towns in future years, as well as with various changes in beach width.

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
NC State Gov't projections of households in telephone survey area	1,800,076	1,826,960	1,854,353	1,881,535	1,929,183	1,957,774	1,987,225	2,016,205	2,042,055	2,068,172	2,094,974
EMERALD ISLE											
Baseline Trips to this beach	986,726	1,001,463	1,016,478	1,031,378	1,057,497	1,073,169	1,089,314	1,105,199	1,119,369	1,133,685	1,148,377
Trips w. -50 width	875,400	888,474	901,796	915,015	938,186	952,091	966,413	980,506	993,078	1,005,779	1,018,813
Trips w. +50 width	1,112,210	1,128,820	1,145,745	1,162,540	1,191,980	1,209,646	1,227,843	1,245,749	1,261,721	1,277,858	1,294,417
Trips w. +100 width	1,253,651	1,272,374	1,291,452	1,310,382	1,343,566	1,363,478	1,383,990	1,404,172	1,422,176	1,440,365	1,459,030
Trips w. +150 width	1,413,080	1,434,184	1,455,687	1,477,026	1,514,430	1,536,874	1,559,994	1,582,743	1,603,036	1,623,538	1,644,578
INDIAN BEACH & SALTER PATH											
Baseline Trips to this beach	158,483	160,850	163,262	165,655	169,850	172,367	174,960	177,512	179,788	182,087	184,447
Trips w. -50 width	140,603	142,703	144,842	146,965	150,687	152,920	155,221	157,484	159,504	161,543	163,637
Trips w. +50 width	178,638	181,306	184,024	186,722	191,450	194,288	197,210	200,086	202,652	205,244	207,903
Trips w. +100 width	201,356	204,363	207,427	210,468	215,797	218,996	222,290	225,532	228,423	231,345	234,343
Trips w. +150 width	226,962	230,352	233,806	237,233	243,241	246,846	250,559	254,213	257,472	260,765	264,144
PINE KNOLL SHORES											
Baseline Trips to this beach	193,522	196,412	199,357	202,279	207,401	210,475	213,641	216,757	219,536	222,344	225,225
Trips w. -50 width	171,688	174,252	176,865	179,457	184,002	186,729	189,538	192,302	194,767	197,258	199,814
Trips w. +50 width	218,132	221,390	224,709	228,003	233,777	237,242	240,811	244,322	247,455	250,620	253,867
Trips w. +100 width	245,872	249,544	253,286	256,999	263,507	267,412	271,435	275,393	278,924	282,491	286,152
Trips w. +150 width	277,140	281,279	285,496	289,681	297,017	301,419	305,954	310,415	314,395	318,416	322,543
ATLANTIC BEACH											
Baseline Trips to this beach	871,446	884,461	897,722	910,881	933,949	947,790	962,048	976,077	988,592	1,001,236	1,014,211
Trips w. -50 width	773,126	784,673	796,438	808,113	828,577	840,857	853,506	865,953	877,055	888,273	899,784
Trips w. +50 width	982,269	996,939	1,011,887	1,026,720	1,052,720	1,068,322	1,084,393	1,100,207	1,114,313	1,128,564	1,143,189
Trips w. +100 width	1,107,186	1,123,722	1,140,570	1,157,289	1,186,596	1,204,182	1,222,297	1,240,122	1,256,021	1,272,085	1,288,571
Trips w. +150 width	1,247,988	1,266,627	1,285,618	1,304,463	1,337,497	1,357,319	1,377,738	1,397,830	1,415,752	1,433,858	1,452,440

Table A1. Projected annual visitation at Bogue Banks communities.

Total visits include both day and overnight visitors. For instance, about 52% of the visitation at Atlantic Beach is from day visitors, as compared to about 35% of the visitation at Emerald Isle. This leads to greater peak parking needs at Atlantic Beach, despite there being more overall visitation at Emerald Isle.

Projected Parking Needs

Estimates of the beach parking demand model using the two-limit Tobit regression estimation procedure is shown in Table A2.

Explanatory Variables	Coefficient	Std. Error.	t-ratio	P-value	Mean
Constant	4.557***	0.506	9.00	0	1
DMORN	-0.666	0.488	-1.36	0.1727	0.3772
DAFTN	-0.307	0.490	-0.63	0.5311	0.2111
DB00	-0.518	0.567	-0.92	0.3601	0.0329
DB01	0.699	0.512	1.37	0.1723	0.0449
DB02	-0.379	0.527	-0.719	0.4722	0.0404
DB03	0.166	0.595	0.279	0.7803	0.0449

DB04	-0.706	0.564	-1.252	0.2105	0.0404
DB05	-0.101	0.543	-0.186	0.8521	0.0404
DB06	-0.262	0.5577	-0.47	0.6383	0.0389
DB07	-0.946*	0.5378	-1.76	0.0785	0.0404
DB09	-1.271**	0.5544	-2.293	0.0218	0.0434
STAYTIME	0.008	0.0206	0.362	0.7175	4.339
HOLIDAY	0.364***	0.0536	6.78	0	0.5329
TRIPINDX	0.003***	0.00018	12.6	0	428.656
Sigma	0.451***	0.0161	28.023	0	----
Alpha	0.0007***	0.000067	10.992	0	----
Log-likelihood	-623.66				

Notes: ***,**, and * refer to significance at the 1%, 5%, and 10% levels, respectively. The chi-square and overall likelihood ratio statistics are 29.1 and 546.7, respectively. Number of observations =699. Dependent variable: FILLEDSP. D13 is the omitted time of day dummy variable.

Table A2. Tobit regression results - Dependent Variable: FILLEDSP

As expected the coefficient on the beach specific index of recreation demand, TRIPINDX, is positive and strongly significant. The large t statistic, 12.6, allows us to reject the null hypothesis of no trip demand at the 1% level of significance. This provides evidence that beach trip demand impacts the number of parking spaces. The heteroskedasticity parameter α is positive and strongly significant, indicating that larger values of TRIPINDX increase the variance of ln(FILLEDSP). There is evidence to indicate that HOLIDAY has a positive and significant effect on filled spaces. We also find evidence that STAYTIME has a positive but insignificant effect on filled spaces. Fixed effects dummy variables DB00…DB09 vary in sign, reflecting differences in the estimated value of filled parking spaces, ln(FILLEDSP), at midday across beaches. However, after controlling for other variables in the regression, only DB07 and DB09 are statistically significant at the 10% and 5% level, respectively. There is no evidence to indicate that this data suggests that time of day variables, DMORN and DAFTN, significantly impact beach-parking demand. In all, the explanatory power of the regression is reasonably good given the individual cross section data. The likelihood ratio test indicates that the overall regression is significant at $p<0.01$.

As mentioned earlier, an important component of this analysis was to determine parking spaces that would be required to accommodate all peak (weekend holiday) day beach visitors. With the estimated Tobit coefficients, it is possible to calculate the number of spaces that would be required to accommodate all peak (weekend holiday) day beach visitors 60% of the time, 95% of the time, etc. For each beach, ln(FILLEDSP) follows a normal distribution, with a beach-specific mean value given by the Tobit regression equation (with variables replaced by their mean values), and a beach-specific standard deviation given by $(\sigma^2 \cdot \exp[\alpha \cdot TRIPINDX_i])^{0.5}$. The unconditional mean of ln($FILLEDSP_i$), denoted $\bar{\mu}$, is given by: $\bar{\mu} = \beta_0 + \beta_1$ DMORN + β_2 DAFTN + β_3 DB00 + . . . + β_{11} DB09 + β_{12} $STAYTIME_{id}$ + β_{13} $HOLIDAY_d$ + β_{14} $TRIPINDX_i$,

where mean values are inserted for independent variables. The standard deviation of ln($FILLEDSP_i$), denoted SD, is given by: $SD = \sigma^2 \cdot \exp[\alpha \cdot TRIPINDX_i])^{0.5}$. The unconditional

90 percentile, for example, of $FILLEDSP_i$ is then given by: 90 percentile $FILLEDSP_i$ = EXP(NORMINV(0.90, $\bar{\mu}$, SD)), where NORMINV is the inverse normal cumulative distribution function.

For each beach, the frequency of FILLEDSP can be graphed against FILLEDSP to determine the number of spaces that would be necessary to accommodate all peak (weekend holiday) day beach visitors 60% of the time, 95% of the time, etc. Furthermore, changes in beach conditions may shift the frequency distribution of FILLEDSP. An increase in beach width attracts additional beach visitation, which shifts the frequency distribution to the right. As the distribution shifts to the right, the current number of parking spaces accommodates all visitors less frequently.

Tables A3-A6 shows the number of parking spaces needed to meet peak demand at each of the Bogue Banks communities 60%, 70%, 80%, 90% and 95% of the time at future years with the various beach width increases associated with the tentatively selected plan.

The average change in beach width at each of the communities, as compared to the without project condition, is as follows:

Emerald Isle: +6 ft
Salter Path and Indian Beach: +26 ft
Pine Knoll Shores: +21 ft
Atlantic Beach: +54 ft

The project year of project construction is 2019. Having sufficient parking to meet peak demand 60% of the time at the start of project construction is considered sufficient for satisfying the USACE requirement for accommodating peak demand.

	USACE									
Telephone Survey				EMERALD ISLE	Parking Space Requirements, with +6 ft beach width					
	Region									
	Population									
	Index		Mean	Std. Dev.	Mean	60%tile	70%tile	80%tile	90%tile	95%tile
Year	(2004 Base)	TRIPINDX	ln(FILLEDSP)	ln(FILLEDSP)	FILLEDSP	0.6	0.7	0.8	0.9	0.95
2013	1.142909226	1072	6.11E+00	0.674463107	448	532	638	791	1064	1359
2014	1.158993672	1087	6.14E+00	0.678298367	464	551	662	821	1106	1415
2015	1.175403086	1103	6.17E+00	0.682233588	480	571	687	853	1151	1475
2016	1.191880291	1118	6.21E+00	0.686208039	497	592	713	886	1198	1538
2017	1.208539311	1134	6.24E+00	0.690249885	515	614	740	921	1248	1604
2018	1.225643369	1150	6.28E+00	0.694424477	534	637	769	959	1301	1674
2019	1.243302456	1166	6.32E+00	0.698761028	555	662	800	999	1358	1751
2020	1.260632105	1182	6.36E+00	0.703043004	575	688	832	1040	1417	1829
2021	1.275861877	1197	6.39E+00	0.706827781	594	711	861	1077	1470	1901
2022	1.291205705	1211	6.42E+00	0.710661507	614	735	891	1117	1527	1976
2023	1.306920061	1226	6.45E+00	0.714609364	635	761	923	1158	1586	2057

Table A3. Peak parking demand requirements for +6 ft beach width at Emerald Isle.

	USACE									
Telephone Survey			INDIAN BEACH & SALTEirements, with +26 ft beach width							
	Region									
	Population									
	Index		Mean	Std. Dev.	Mean	60%tile	70%tile	80%tile	90%tile	95%tile
Year	(2004 Base)	TRIPINDX	ln(FILLEDSP)	ln(FILLEDSP)	FILLEDSP	0.6	0.7	0.8	0.9	0.95
2013	1.142909226	181	4.41E+00	0.482447833	82	93	106	123	153	182
2014	1.158993672	183	4.42E+00	0.482908849	83	93	107	124	154	183
2015	1.175403086	186	4.42E+00	0.483379634	83	94	107	125	155	184
2016	1.191880291	188	4.43E+00	0.483852826	84	95	108	126	156	185
2017	1.208539311	191	4.43E+00	0.48433171	84	95	109	127	157	187
2018	1.225643369	194	4.44E+00	0.484823881	85	96	109	127	158	188
2019	1.243302456	196	4.45E+00	0.485332547	85	96	110	128	159	189
2020	1.260632105	199	4.45E+00	0.485832242	86	97	111	129	160	191
2021	1.275861877	202	4.46E+00	0.486271813	86	98	111	130	161	192
2022	1.291205705	204	4.46E+00	0.486715078	87	98	112	131	162	193
2023	1.306920061	206	4.47E+00	0.487169466	87	99	113	131	163	194

Table A4. Peak parking demand requirements for +26 ft beach width at Indian Beach and Salter Path.

	USACE									
Telephone Survey			PINE KNOLL SHORES Parking Space Requirements, with +21 ft beach width							
	Region									
	Population									
	Index		Mean	Std. Dev.	Mean	60%tile	70%tile	80%tile	90%tile	95%tile
Year	(2004 Base)	TRIPINDX	ln(FILLEDSP)	ln(FILLEDSP)	FILLEDSP	0.6	0.7	0.8	0.9	0.95
2013	1.142909226	218	5.18E+00	0.489335203	178	201	230	268	333	398
2014	1.158993672	221	5.19E+00	0.489900521	179	203	232	270	335	401
2015	1.175403086	225	5.19E+00	0.490477933	180	204	233	273	338	404
2016	1.191880291	228	5.20E+00	0.491058415	182	206	235	275	341	407
2017	1.208539311	231	5.21E+00	0.491646001	183	207	237	277	344	411
2018	1.225643369	234	5.22E+00	0.492250016	184	209	239	279	346	414
2019	1.243302456	237	5.22E+00	0.492874409	186	210	240	281	349	418
2020	1.260632105	241	5.23E+00	0.493487925	187	212	242	283	352	421
2021	1.275861877	244	5.24E+00	0.494027729	188	213	244	285	355	424
2022	1.291205705	247	5.24E+00	0.494572173	190	215	246	287	357	428
2023	1.306920061	250	5.25E+00	0.495130387	191	216	247	290	360	431

Table A5. Peak parking demand requirements for +21 ft beach width at Pine Knoll Shores.

	USACE									
Telephone Survey			ATLANTIC BEACH Parking Space Requirements, with +54 ft beach width							
	Region									
	Population									
	Index		Mean	Std. Dev.	Mean	60%tile	70%tile	80%tile	90%tile	95%tile
Year	(2004 Base)	TRIPINDX	ln(FILLEDSP)	ln(FILLEDSP)	FILLEDSP	0.6	0.7	0.8	0.9	0.95
2013	1.142909226	1062	7.35E+00	0.671860737	1563	1854	2224	2752	3698	4721
2014	1.158993672	1077	7.39E+00	0.675644439	1617	1919	2305	2856	3844	4914
2015	1.175403086	1092	7.42E+00	0.679526545	1674	1988	2391	2966	3999	5119
2016	1.191880291	1107	7.46E+00	0.683447134	1733	2060	2480	3080	4161	5333
2017	1.208539311	1123	7.49E+00	0.68743398	1795	2136	2574	3201	4331	5560
2018	1.225643369	1139	7.53E+00	0.691551531	1860	2217	2674	3329	4513	5802
2019	1.243302456	1155	7.57E+00	0.695828576	1931	2303	2781	3468	4710	6064
2020	1.260632105	1171	7.60E+00	0.700051546	2002	2391	2890	3609	4911	6333
2021	1.275861877	1185	7.63E+00	0.703783963	2067	2471	2990	3738	5095	6579
2022	1.291205705	1200	7.67E+00	0.707564455	2135	2554	3094	3873	5287	6837
2023	1.306920061	1214	7.70E+00	0.71145729	2207	2643	3205	4016	5492	7112

Table A6. Peak parking demand requirements for +54 ft beach width at Atlantic Beach.

To summarize, the number of spaces needed to meet peak demand with the project in place is as follows:

Emerald Isle: 662 spaces
Salter Path and Indian Beach: 96 spaces
Pine Knoll Shores: 210 spaces
Atlantic Beach: 2,303 spaces
Total: 3,271 spaces