ANNUAL REPORT FOR 2023

Bodie Island Lighthouse Pond Mitigation Site
Dare County

COE Action ID: SAW-1993-03077
CAMA #: 106-12
401 Certification #: 20120629

Prepared By:
Environmental Analysis Unit
North Carolina Department of Transportation
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SUMMARY

The Bodie Island Lighthouse Pond Mitigation Site (Site) is located in Dare County, North Carolina**.** Wetland mitigation consists of rehabilitating former *Spartina*-dominated marsh habitat through exotic plant control measures for *Phragmites australis* in accordance with the approved *Final Wetland Mitigation Plan NC 12 Replacement of Herbert C. Bonner Bridge (Bridge No. 11) over Oregon Inlet* (dated January 30, 2013, hereafter referred to as Mitigation Plan). Herbicide hand treatment began in May 2018 in areas adjacent to the Bodie Island Lighthouse Boardwalk. Aerial herbicide applications (via Unmanned Aerial Systems (UAS)) began on October 2018 following final mitigation approval by the National Park Service (NPS). Approximately 2.5 acres of wetland mitigation will be debited from the Site for unavoidable wetland impacts associated with the Replacement of the NC 12 Herbert C. Bonner Bridge (Bridge No. 11) over Oregon Inlet.

Based on 2011 aerial photography, the North Carolina Department of Transportation (NCDOT) proposed wetland mitigation that encompassed approximately 50 acres of wetland restoration through the rehabilitation of marsh habitat. *Phragmites* mapping and modeling efforts conducted in May 2019 estimated approximately 53.4 acres of *Phragmites*-affected marsh were located within the Site. Additional mapping and modeling has been conducted over the past two years. Results from the 2023 modeling efforts indicate that there are a total of 9.9 acres of live *Phragmites* present within the Site. However, ground reconnaissance confirmed that *Phragmites* was also present in areas mapped as Non-*Phragmites* in the 2023 modeling report. Areas that appeared to contain *Phragmites* were sprayed using the UAS between September 6 and 8 of 2023. This area totaled approximately 61.4 acres. Treated acreage was larger than the modeled acreage of *Phragmites* because the scattered nature of the distribution on-site made it difficult to isolate and the model underpredicted *Phragmites* occurrence. Hand spraying was also conducted in areas surrounding the boardwalk and lighthouse, and along the wood line surrounding the marsh. In total, approximately 3.17 acres were treated by hand spraying. Burning was not conducted in 2023; however, approximately 4 acres of Phragmites was hand trimmed between April 24 and May 2 to facilitate hand spraying along the woodline.

Restoration success criteria include: 1) a decrease in total aerial coverage of dense *Phragmites* stands from the current densities after first-year treatment; 2) a decreasing trend in aerial coverage of mapped *Phragmites* each treatment year; and 3) total aerial coverage of dense *Phragmites* stands of 10 acres or less with stems less than three feet tall at the end of the final monitoring year. Hydrologic monitoring is not required for this project. Based on the 2020 Monitoring Report, the total aerial coverage of dense *Phragmites* stands decreased within treated areas after first-year treatment. In addition, aerial coverage of *Phragmites* decreased by approximately 43.5 acres from 2019 to 2023, based on aerial mapping and modeling. Modeling results also showed that the distribution is patchy, with *Phragmites* occurring at low densities throughout the survey area. Twenty, one square meter vegetation monitoring plots were surveyed to ground truth the model results. There was a moderate positive relationship between observed and predicted fractional cover of *Phragmites*, with a correlation value of 0.55.

NCDOT proposes to continue hand and aerial herbicide applications to *Phragmites* affected marsh areas in 2024 and perform vegetation monitoring via aerial photography, in-situ vegetation plots, and *Phragmites* modeling. NCDOT will also visually monitor the Site to ensure that new *Phragmites* is not intruding into unmapped areas. NCDOT is coordinating with NPS to schedule a prescribed burn in the coming years. Manual trimming of dead Phragmites stems may be conducted along the woodline to facilitate hand spraying in 2024 if prescribed burning is delayed.

1.0 INTRODUCTION

1.1 Project Description

The Site is located adjacent to the Bodie Island Lighthouse six miles south of Nags Head, NC and three miles north of Oregon Inlet (Figure 1). The Site consists of approximately 60 acres of wetland restoration through the rehabilitation of marsh habitat. Proposed debits to the Site include 2.5 acres of wetland mitigation for wetland impacts associated with construction of the Replacement of the NC 12 Herbert C. Bonner Bridge (Bridge No. 11) over Oregon Inlet. Wetland mitigation measures include reducing and controlling percent aerial coverage of the exotic plant *Phragmites australis* using approved herbicides and prescribed burning, while allowing natural reestablishment of native marsh plant species.

1.2 Purpose

In order for the Site to be considered successful it must meet success criteria established in the *Final Wetland Mitigation Plan, NC 12 Replacement of the NC 12 Herbert C. Bonner Bridge (Bridge No. 11) over Oregon Inlet* dated January 30, 2013 (hereafter referred to as Mitigation Plan). This report details mitigation activities at the Site in 2022, as recommended through the adaptive management guidelines approved in the Mitigation Plan. Hydrologic monitoring is not required for the Site.

1.3 Project History

May 2018	Begin Hand Herbicide Application in Selected Areas
October 2018	NPS Issues Special Use Permit for UAS Application
October 2018	Begin Herbicide Application Season 2018
November 2018	End Herbicide Application Season 2018
June 2019	Begin Herbicide Application Season 2019
November 2019	End Herbicide Application Season 2019
January 2020	USDOI Grounds all UAS Flights over all DOI Property
October 2020	Hand Herbicide Application in Selected Areas
Oct-Nov 2021	UAS Herbicide Application over 59.37 Acres
August 2022	DOT Collected Aerial Imagery for Modeling Purposes
September 2022	UAS Herbicide Application over 58.94 acres
September 2022	Hand Herbicide Application over 1.12 acres
April-May 2023	Manual Trimming of ~4 acres along Woodline
June 2023	DOT Collected Aerial Imagery for Modeling Purposes
June-July 2023	Hand Herbicide Application over 3.17 acres
September 2023	UAS Herbicide Application over 61.4 acres

1.4 Debit Ledger

A total of 2.5 wetland acres of the Site will be debited for unavoidable wetland impacts associated with the NC 12 Replacement of the Herbert C. Bonner Bridge (Bridge No. 11) over Oregon Inlet. Remaining site assets must have regulatory agency approval prior to use as mitigation on other projects.

2.0 VEGETATION

2.1 Success Criteria

NCDOT shall monitor wetland mitigation by photographs and determinations of aerial percent vegetation cover of *Phragmites* stands. Vegetation success criteria are:

- Total aerial coverage of dense *Phragmites* stand will decrease from mapped acreage after the first-year treatment.
- The trend of decreased aerial coverage of mapped *Phragmites* will continue each treatment year.
- Total aerial coverage of dense *Phragmites* stands will be 10 acres or less with stems less than three feet tall at the end of the final monitoring year.

The Site will be monitored until success criteria are met with a brief annual progress report being submitted to the United States Army Corps of Engineers (USACOE), North Carolina Division of Water Resources (NCDWR), and North Carolina Division of Coastal Management (NCDCM). Upon meeting success criteria, NCDOT will schedule an agency field meeting to determine if the restored areas have achieved mitigation requirements.

2.2 Vegetation Treatment

Prior to conducting herbicide applications, DOT completed rare plant and bird surveys within the Site on June 26, 2023. Surveys consisted of pedestrian transects combined with a sit and scope component (i.e. stationary observation with binoculars). Several patches of *Eleocharis halophila* were observed within the Site as depicted on Figure 2. The spray boundary was adjusted to account for a 100-foot buffer around known populations of *Eleocharis halophila*. No bird nests were identified during the survey; however, bird activity was high within the marsh and nesting behavior (i.e. aggressive behavior by a pair of eastern willets) was observed between VP2 and VP3. Due to high bird activity within the marsh, DOT scheduled aerial herbicide applications to occur in September, outside of the avian nesting period.

Approved *Phragmites* control treatments for the Site include Glyphosate and Imazapyr herbicide application, and prescribed burning. A total of 61.4 acres of the Project Area (Figure 2) was treated with UAS aerial herbicide applications in September 2023. An additional 3.17 acres were treated in June and July 2023 by hand spraying around the boardwalk and wood line surrounding the marsh. Treatments included a mixture of both Glyphosate (Roundup Custom®) and Imazapyr (Habitat®) herbicides. Aerial herbicide treatment consisted of Habitat®/Roundup Custom®/Methylated Seed Oil (MSO) (64oz/64oz/1%) per acre. Hand spraying treatment consisted of Roundup Custom® (0.925 gal per acre) and a dye/foaming agent. The treatment area consisted of *Phragmites* affected marsh surrounding the Bodie Island Lighthouse Pond as depicted in Figure 2. Prescribed burning was not conducted in 2023; however, DOT is currently coordinating with NPS to schedule a prescribed burn in the coming years. In addition, DOT manually trimmed approximately 4 acres of living and dead *Phragmites* stems along the woodline to facilitate hand spraying in 2023 and will likely

continue hand trimming in the absence of burning to thin out the dead stems of *Phragmites*.

2.3 Vegetation Modeling

Vegetation modeling was conducted by DOT between June and August 2023. Visual spectrum imagery (RGB) and multispectral imagery (MSI) were collected by NCDOT on June 13, 2023, with a Sony DSC-RX1 RII and a MicaSense RedEdge-MX, respectively, both onboard a WingtraOne GEN II. All imagery was post-processed in Pix4Dmapper v4.8.4 by Geo Owl. Results indicate that there are a total of approximately 9.9 acres of live Phragmites present at the Site, representing a reduction of approximately 43.5 acres of Phragmites affected marsh between 2019 and 2023.

Model assessment was performed using 20 ground verification plots where fractional cover of live *Phragmites* was recorded *in-situ*. Observed *in-situ* fractional cover of Phragmites was compared to model predictions to calculate Pearson correlation coefficient (Correlation), coefficient of determination (R^2), Root Mean Squared Error (RMSE), and Mean Absolute Error (MAE) between the observations and model predictions (Table 1).

Table 1. Summary Statistics of Field Observations versus SVM Model Predictions.

Indicator	Correlation	R^2	RMSE	MAE
Fractional Coverage of *Phragmites*	0.55	0.31	16.8	10.2

A correlation value of 0.55 represents a moderate positive relationship between observed versus predicted fractional cover of *Phragmites*. An R^2 value of 0.31 indicates that the model can account for 31% of the variability between the observed fractional cover values from each plot. The RMSE indicates an average 16.8% difference, while MAE indicates an average absolute difference of 10.2% between observed and predicted fractional cover of *Phragmites.* It is important to note that the verification plots where fractional vegetation cover was measured comprised 0.004 acres of the 159 acres predicted by the model (0.0025% of area predicted was used for verification). Additional *in-situ* data would improve confidence in future model assessments.

The moderate positive correlation between observed versus predicted fractional cover shows the model is predicting *Phragmites* effectively, but there is room for improvement. Through individual plot analysis, it is apparent that areas with high mixing of dead *Phragmites*, live *Phragmites*, and other vegetation types have the highest rates of misclassification. This is especially prevalent in mixed areas that appear to have low densities of live *Phragmites* from imagery, but significantly higher densities of *Phragmites* when observed *in-situ*.

Two factors contribute to these model limitations –sensor resolution limitations/the “mixed pixel problem” and the presence of dead Phragmites. Even when using high resolution sensors such as were used in this project, the sensors still have limitations in comparison to the human eye. The human eye on the ground can distinguish between individual strands of *Phragmites* amidst other vegetation types (or stands of dead *Phragmites*), while the sensor will often mix spectral signatures from surrounding vegetation, causing individual or low-density Phragmites to be indistinguishable in the imagery and model.

Figure 3 depicts vegetation changes within the Site from 2019 to 2023. Continued vegetation modeling of treated areas are anticipated for the 2024 season.

2.4 Vegetation Monitoring Results

Eleven vegetation monitoring plots were collected via UAS in 2023 for purposes of quantifying percent coverage of *Phragmites* across the Site. Figure 2 depicts the location of each monitoring plot and photographs of each plot are presented in Appendix A. Vegetation monitoring results for 2023 showed approximately 27 percent average aerial coverage of Phragmites across the Site, down from 35 percent in 2022. Individual monitoring plot results are presented in Table 2.

Table 2. 2022 Visual Vegetation Monitoring Plots

Vegetation Plot ID	**% *Phragmites* Coverage***
1	0
2	0
3	75
4	30
5	40
6	25
7	40
8	0
9	20
10	25
11	40
Average	**27**

**Phragmites* coverage based on living stems only

2.5 Conclusions

Phragmites coverage at the Site decreased by approximately 43.5 acres between 2019 and 2023. Areas that appeared to contain *Phragmities* were sprayed using the UAS between September 6 to 8 of 2023. This area totaled approximately 61.4 acres. The area sprayed is larger than the area currently covered by Phragmites because the patchy, low-density distribution made it difficult to isolate Phragmites affected marsh from native marsh vegetation.

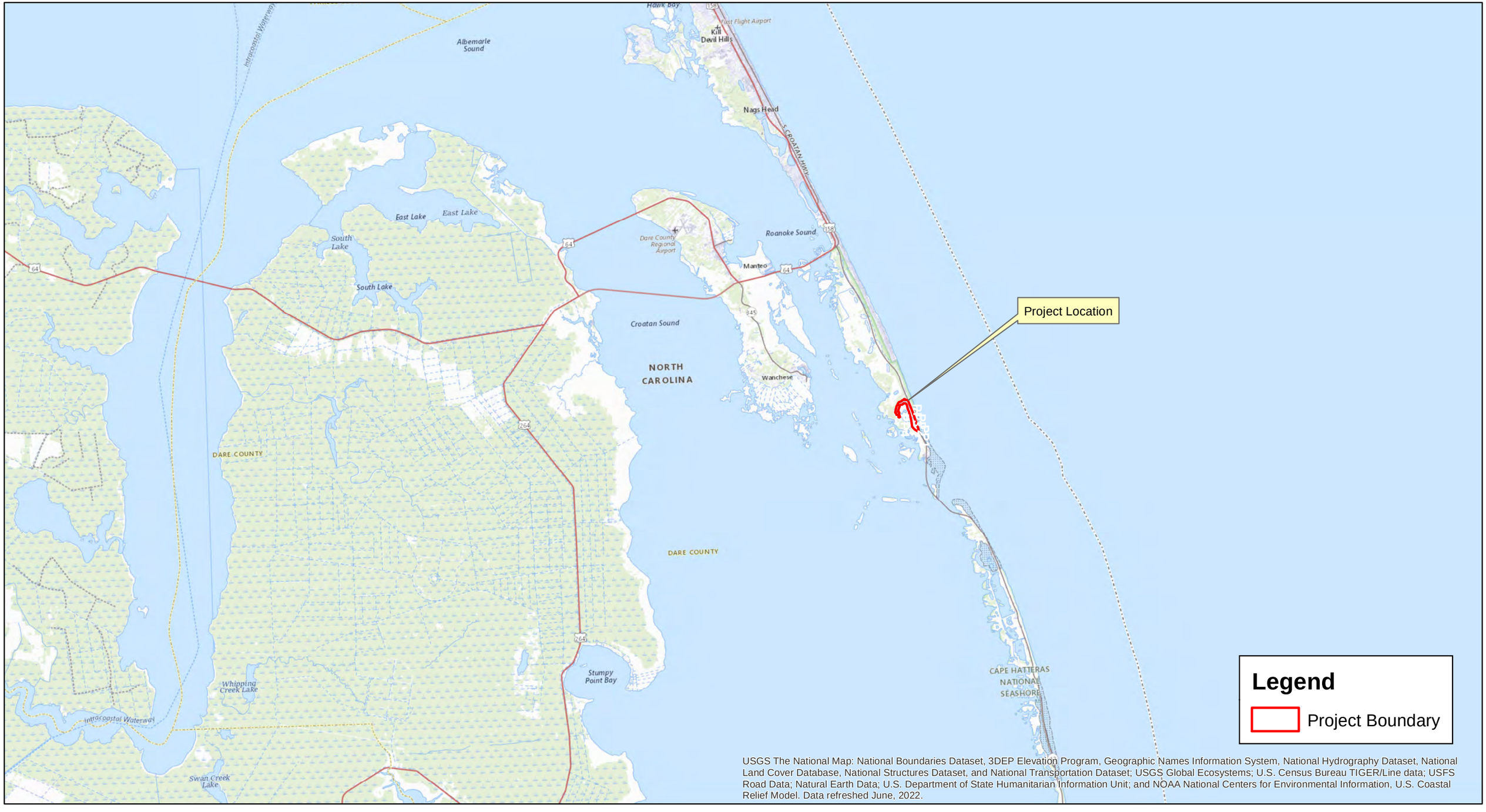
Hand spraying was conducted in areas surrounding the boardwalk and around the wood line adjacent to the marsh. In total, approximately 3.17 acres were treated by hand spraying. Burning was not conducted in 2023 but approximately 4 acres of living and dead *Phragmites* were manually trimmed along the woodline to facilitate hand spraying. Results of 2019-2022 herbicide applications were assessed between June and August 2023 via aerial imagery and *Phragmites* modeling. Modeling results showed a total of approximately 9.9 acres of

Phragmites, occurring mostly at low densities, throughout the Site. Vegetation monitoring plots showed approximately 27 percent average aerial coverage of Phragmites across the Site. At this time, *Phragmites* regrowth will continue to be evaluated and any adjustments to herbicide application rates will be made in accordance with the pesticide label.

As in previous years, continued successes at the Site will include: 1) Precise application of herbicide to *Phragmites* dominated areas with no unintended adverse impacts to the park vegetation or wildlife, and 2) Minimal disturbances to Bodie Island Lighthouse Park operations and visitors. Evaluation of the approved herbicides and herbicide delivery methods used at the Site have demonstrated that herbicide applications continue to remain viable and effective methods for delivering pesticide application in environmentally sensitive areas.

3.0 RECOMMENDATIONS

In 2024, NCDOT anticipates continued herbicide applications to *Phragmites* affected marsh areas located within the Site. Total acres to be treated in 2024 are contingent on NPS approvals, site weather conditions, 2024 vegetation monitoring, and *Phragmites* modeling results. In Spring 2024, NCDOT plans continued aerial mapping of the existing *Phragmites* boundary to determine the extent of the 2024 spray area. Aerial herbicide applications are anticipated to occur in September 2024, outside of the avian nesting season. The National Park Service (NPS) notified NCDOT that they obtained an updated Fire Management Plan in November 2023 and that NPS will be initiating processes to develop a burn plan for the Bodie Island area in the coming months. If burning is not conducted in winter/early spring of 2024, NCDOT plans to hand clear approximately four acres of *Phragmites* affected areas along the woodline in April of 2024 to eliminate dead standing stems of phragmites and enable hand spraying in May/June 2024.



This Exhibit is for planning purposes only and shown herein does not meet NC 47-30 Requirements and therefore is not for design, construction, or recording or transfer of ittle. The Exhibit was compiled from available information obtained from the sources listed below.

Sources: NCOneMap - 2020 Aerial Imagery

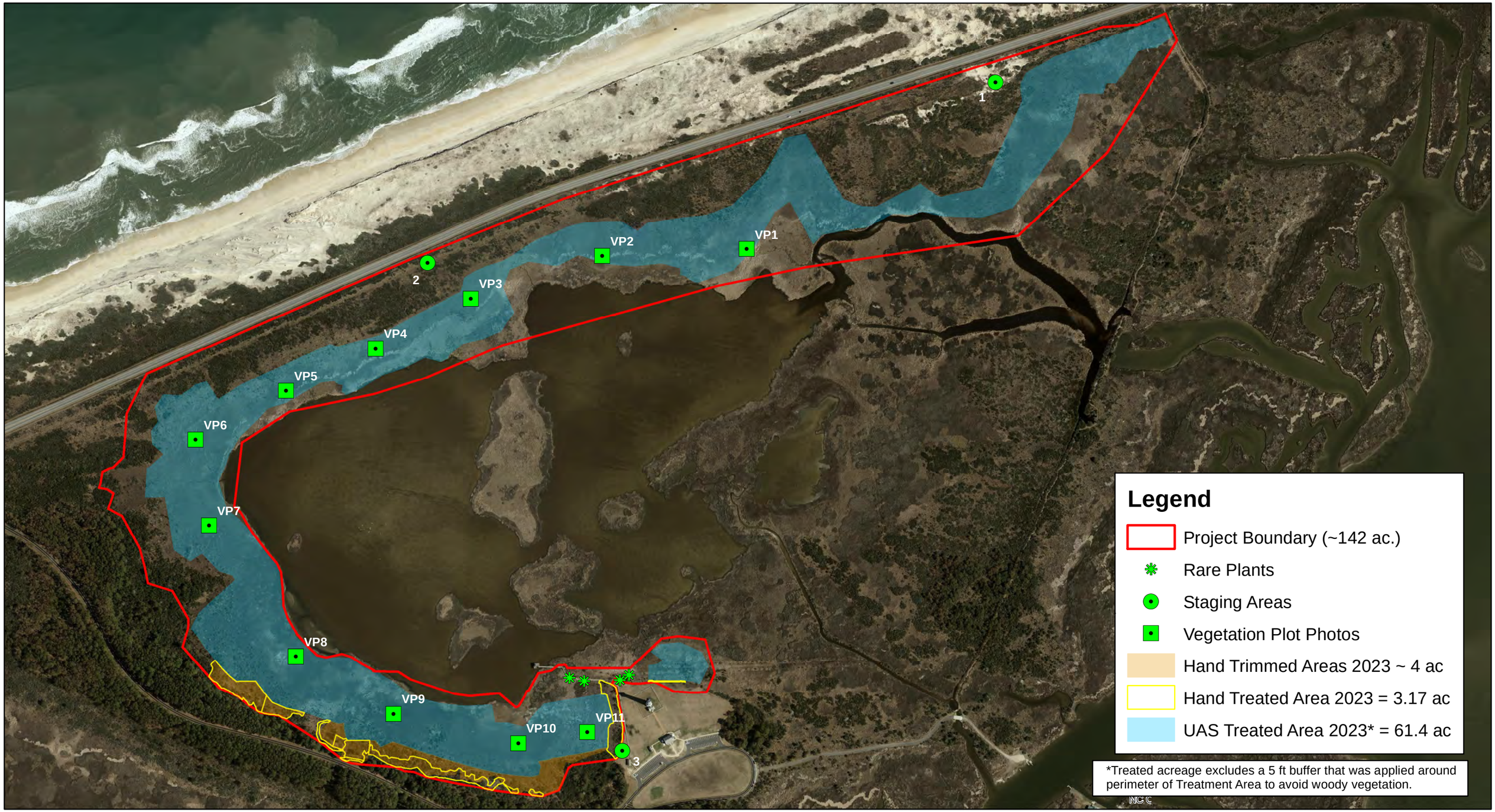
NOT TO SCALE

GRAPHIC SCALE

0 12,500 25,000 50,000 Feet

FIGURE 1
Bodie Island Lighthouse Pond Mitigation Site
Vicinity Map

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION



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Sources: NCOneMap - 2020 Aerial Imagery

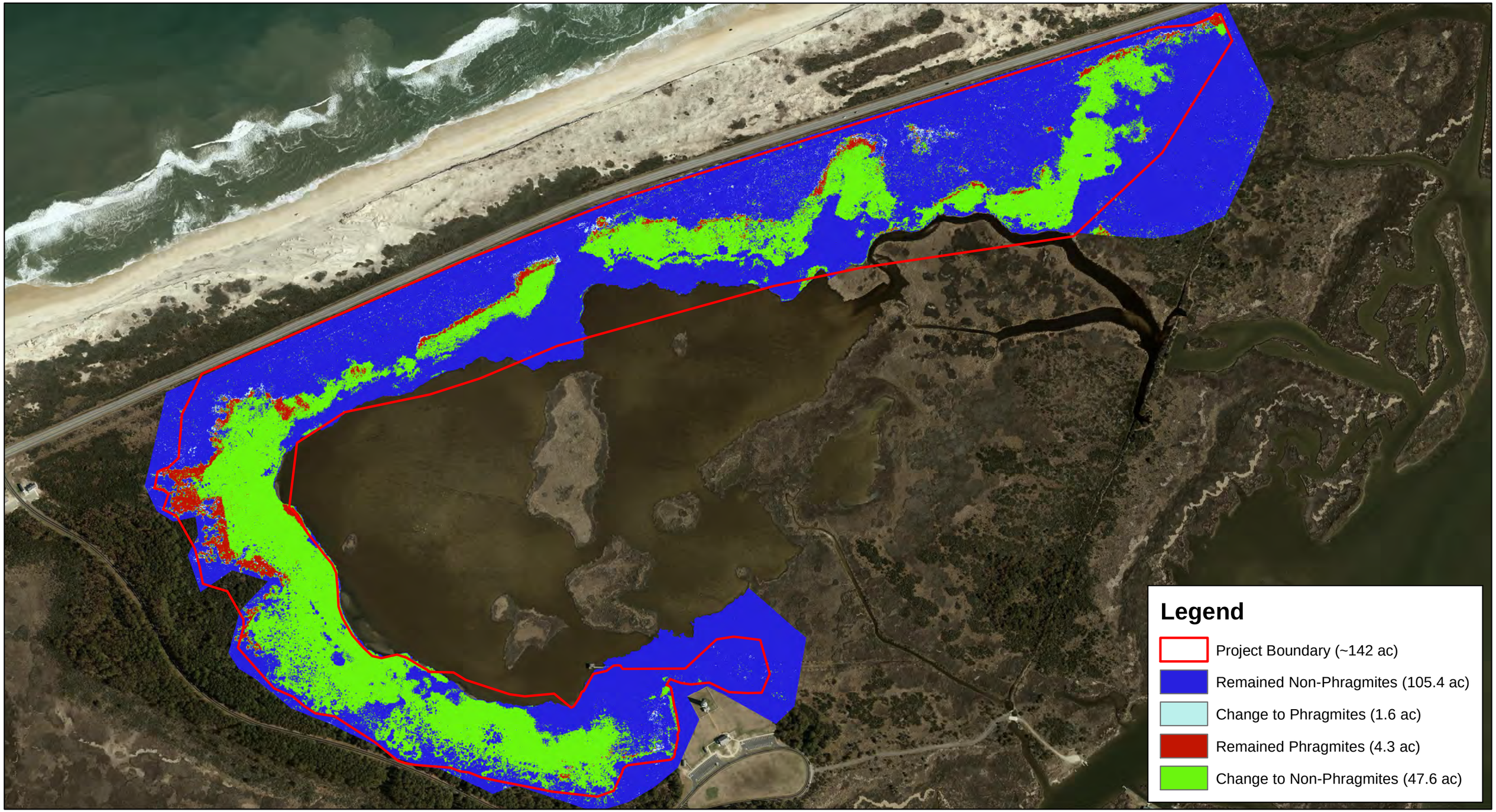
NOT TO SCALE

GRAPHIC SCALE

0 375 750 1,500 Feet

FIGURE 2
Bodie Island Lighthouse Pond Mitigation Site
Herbicide Treatment Areas 2023

STATE OF NORTH CAROLINA · DEPARTMENT OF TRANSPORTATION



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NOT TO SCALE

GRAPHIC SCALE

0 375 750 1,500 Feet

FIGURE 3
Bodie Island Lighthouse Pond Mitigation Site
Change Detection Results: 2019 to 2023

STATE OF NORTH CAROLINA · DEPARTMENT OF TRANSPORTATION

APPENDIX A

SITE PHOTO POINTS 2023

Bodie Island Lighthouse Pond Mitigation Site

September 2023

Hand trimmed area adjacent to woodline.

Eleocharis halophila adjacent to boardwalk.

VP1 ~ 0% Coverage of *Phragmites*

VP2 ~ 0% Coverage of *Phragmites*

VP3 ~ 75% coverage of *Phragmites*

VP4 ~ 30% coverage of *Phragmites*

VP5 ~ 40% coverage of *Phragmites*

VP6 ~ 25% coverage of *Phragmites*

VP7 ~ 40% coverage of *Phragmites*

VP8 ~ 0% coverage of *Phragmites*

VP9 ~ 20% coverage of *Phragmites*

VP10 ~ 25% coverage of *Phragmites*

VP11 ~ 40% coverage of *Phragmites*

APPENDIX B

PESTICIDE RECORD FORMS 2023

Herbicide Application Record

Client, Project Name:	NC DOT (Wes Cartner), Bodie Island Spray						
Site Address:	Bodie Island Lighthouse (8210 Bodie Island Lighthouse Road, Nags Head NC 27959)						
Category:	Phragmities Spray					Other: 9-6 to 9-8-2023	

PRODUCT APPLIED and SITE CONDITIONS

Date	Occurrence Site Name	Species controlled	Mix Code	Quantity of Mix Applied	End Use Concentrate	Air Temp	Wind Speed	Wind Direct	Start Time	End Time	Equip. Code	MoA Code	Acres Treated & Comments
9/6/2023	DRG Plot 8 / DOT Plot 9	Phragmites australis	1	56.75 Gallons	17%	90°F	<5 MPH	W, N, NE	8:00 AM	5:48 PM	A	i, iv	18.9 acres total
9/6/2023	DRG Plot 8 / DOT Plot 9	Phragmites australis	2	56.75 Gallons	17%	90°F	<5 MPH	W, N, NE	8:00 AM	5:48 PM	A	i, iv	18.9 acres total
9/7/2023	DRG Plots 5 - 7	Phragmites australis	1	69.20 Gallons	17%	85°F	5-8 MPH	SW	8:44 AM	1:38 PM	A	i, iv	22.4 acres total
9/7/2023	DRG Plots 5 - 7	Phragmites australis	2	69.20 Gallons	17%	85°F	5-8 MPH	SW	8:44 AM	1:38 PM	A	i, iv	22.4 acres total
9/8/2023	DRG Plots 1 - 4	Phragmites australis	1	64.00 Gallons	17%	85°F	7-10 MPH	SW, S	8:02 AM	12:35 PM	A	i, iv	20.1 acres total
9/8/2023	DRG Plots 1 - 4	Phragmites australis	2	64.00 Gallons	17%	85°F	7-10 MPH	SW, S	8:02 AM	12:35 PM	A	i, iv	20.1 acres total

STAFF

Employee Name	Pesticide License #	Hours	Comments	Employee Name	Pesticide License #	Hours	Comments
William Dortch (DRG)	027-951 and 028-775	3 days					
Ben Furr (DRG)	027-954	3 days					
Wes Cartner (NCDOT)	034-703	3 days					

MATERIAL and EQUIPMENT

Herbicide/Adjuvant Information

Mix Code	EPA Reg. No.	Brand Name	Manufacturer	Mix Description
1	524-343	Roundup Custom	Bayer	17% Solution Roundup Custom (64 oz)
2	241-426-67690	Habitat	Sepro	17% Solution Habitat (64 oz)
3	n/a	Sunwet	Brewer	4 oz
4	n/a	n/a	n/a	Water to make 3 gallon solution (278 oz)

Equipment Information

Equip. Code	Equipment Description	MoA Code	Mode of Application (MoA)
A	UAS Sprayer	i	Foliar
B	Backpack Sprayer	ii	Basal Bark
C	Wicking Device	iii	Hack-and-Squirt
D	Injector	iv	Aerial

ADDITIONAL DATA REQUESTED BY CLIENT

Bodie Island Lighthouse Pesticide Record Keeping Form 2023 (Backpack Spray)									
Name	**NC Pesticide Applicator License**	**Application Date**	**Brand or Product Name**	**EPA Registration Number**	**Size of Area Treated (ac)**	**Application Rate (gal/ac)**	**Total Amount Applied (gal)**	**Location**	**Crop**
Thomas Barrett	026-19493	6/5/2023	Roundup Custom	524-343	0.76	1.09	0.83	Bodie Island Lighthouse Marsh	*Phragmites australis*
Thomas Barrett	026-19493	6/6/2023	Roundup Custom	524-343	0.72	1.15	0.83	Bodie Island Lighthouse Marsh	*Phragmites australis*
				Total	**1.48**		**1.66**		
					Average [A]	**1.12**			

Additional Notes

Roundup Custom refers to the original concentrate solution purchased from the supplier.

Dye/Foaming Agent - JARFACTANT 225 DK (Chemical Name: Alkyl Polyglycoside, CAS# 68515-73-1) used for 2023 spray solutions.

Foliar Treatment - 1.6 oz dye/foaming agent per gallon of 2.23% A.I. Roundup Custom spray solution.

[A] - Average Rate for Entire Area Treated with Backpack Sprayer

I certify that the information shown above is true and correct to the best of my knowledge.

7/13/2023

Bodie Island Lighthouse Pesticide Record Keeping Form 2023 (Backpack Spray)									
Name	**NC Pesticide Applicator License**	**Application Date**	**Brand or Product Name**	**EPA Registration Number**	**Size of Area Treated (ac)**	**Application Rate (gal/ac)**	**Total Amount Applied (gal)**	**Location**	**Crop**
Thomas Barrett	026-19493	7/18/2023	Roundup Custom	524-343	0.75	0.23	0.17	Bodie Island Lighthouse Marsh	*Phragmites australis*
Thomas Barrett	026-19493	7/19/2023	Roundup Custom	524-343	0.82	0.80	0.66	Bodie Island Lighthouse Marsh	*Phragmites australis*
Thomas Barrett	026-19493	7/20/2023	Roundup Custom	524-343	0.12	3.42	0.41	Bodie Island Lighthouse Marsh	*Phragmites australis*
				Total	**1.69**		**1.24**		
					Average [A]	**0.73**			

Additional Notes

Roundup Custom refers to the original concentrate solution purchased from the supplier.

Dye/Foaming Agent - JARFACTANT 225 DK (Chemical Name: Alkyl Polyglycoside, CAS# 68515-73-1) used for 2023 spray solutions.

Foliar Treatment - 1.6 oz dye/foaming agent per gallon of 2.23% A.I. Roundup Custom spray solution.

[A] - Average Rate for Entire Area Treated with Backpack Sprayer

I certify that the information shown above is true and correct to the best of my knowledge.

10/30/2023