APPENDIX B HEALTH AND SAFETY

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B HEALTH AND SAFETY

This appendix addresses the approach defined by regulatory requirements to evaluating the health and safety impacts associated with the two alternatives identified for the Environmental Impact Statement (EIS): the Proposed Action and the No Action Alternative.

B.1 Affected Environment

B.1.1 Definition and Description

The health and safety analysis for this addresses any hazards and their impacts to individuals associated with activities related to the construction or operation of the launch site that fall outside of the Title 14 Code of Federal Regulations (CFR) Part 400 series regulations. Those individuals may be launch site workers or members of the public. Worker safety (i.e., occupational safety) is concerned with the potential impacts to launch site workers associated their normal workplace responsibilities. For a site such as a launch site, this could include the handling of hazardous materials or the performance of hazardous tasks. Occupational health and safety can be impacted by normal operation or by accidents. Public health and safety impacts more typically result from accidents, as the public is not located onsite and, therefore, not exposed to operational hazards associated with normal operations.

B.1.2 Regulatory Setting

Federal

The Occupational Health and Safety Administration (OSHA) was created to ensure safe and healthful working conditions by setting and enforcing standards. The General Duty Clause of the Occupational Safety and Health Act of 1970 requires employers to keep their workplace free of serious recognized hazards. OSHA regulations at 29 CFR Part 1910 contain occupational safety and health national consensus or established Federal standards for general industry, which are intended to require employers to provide a workplace free from serious recognized hazards. (Title 29 CFR Part 1926 contains equivalent regulations for the construction industry.) To increase worker awareness of the hazards associated with their activities, 29 CFR §1910.1200 requires an employer to develop a hazard communication program to communicate information concerning hazards and appropriate protective measures to employees, including development of training programs.

The U.S. Department of Transportation (DOT) Hazardous Materials Transportation Act of 1975 and the Hazardous Material Transportation Uniform Safety Act of 1990 provide provisions for the DOT regulation of safe transport of hazardous materials for truck transportation codified in 49 CFR Parts 171–180. Parts 174 through 177 provide requirements specific to the mode of hazardous material transport. Delivery to the site is expected to be by truck (addressed in 49 CFR Part 177); delivery by vessel (Part 176) is possible. These requirements would be applicable to the transport of hazardous material to the launch site.

State

Georgia is not a "state plan" state. It does not have a federally approved OSHA program; rather, all private employers must meet the requirements of the Federal Occupational Safety and Health Act.

The Georgia Emergency Management and Homeland Security Agency coordinates preparedness, response, and recovery efforts to disasters under the Emergency Management Act of 1981. This agency works with local, State, and Federal governments and the private sector to prevent and respond to natural and man-made emergencies. At the local level, Camden County maintains an emergency management capability with responsibilities that include developing and implementing emergency plans, mitigation, and response activities.

B.1.3 Existing Conditions

The proposed launch site would be constructed in Camden County, Georgia, in the extreme southeastern part of the state, approximately 11.5 miles due east of the town of Woodbine. The proposed launch site would be constructed within an existing 11,800-acre industrial site, consisting of property currently owned by the Union Carbide Corporation and Bayer CropScience. The industrial site is currently not in use and consists of a mix of uplands and marshland. The area surrounding the proposed site is generally rural.

The proposed launch site has several areas within it that have been identified as potentially contaminated sites containing hazardous wastes, including munitions and explosives of concern (MECs). Historically, it has been the site for the production of silicone coatings and sealants and the pesticide TEMIK® (aldicarb). The industrial site has been used in support of Department of Defense activities for the manufacture of orthochlorobenzalmalononitriel (CS) (also known as "tear gas"), including the production of CS-containing munitions, trip flares, illumination cartridges, and M84A1 fuzes. After these manufacturing activities ended, the site was again used for the production of pesticides. Several of the Proposed Action projects overlap contamination sites. The Vertical Launch Facility overlaps two historical contamination sites, the Munitions Response Area (MRA)-2, also known as Solid Waste Management Unit (SWMU) 9, and the Empty Drums Area. The proposed Mission Preparation Area overlaps two historical contamination sites, Loop Road Site and SWMU 6. The Proposed Action also includes improvements to several existing roads. These roads traverse the following historical contamination sites: MRA-1 (SWMU 8), MRA-2 (SWMU 9), Loop Road Site, and SWMU 6. In addition to these sites, 10 additional potentially contaminated sites have been identified. While some may contain munitions-related contaminants, no MECs are located in these areas. They are located in the northwest quadrant of the launch site or located near Union Carbide Road. EIS Section 3.7, *Hazardous Materials, Solid Waste, and Pollution Prevention*, provides a description of hazardous materials and hazardous and solid wastes that may exist on the site and a detailed discussion of each of these areas.

B.2 Environmental Consequences

B.2.1 Proposed Action

B.2.1.1 Construction

The County would build the spaceport facilities and the site infrastructure necessary to support these facilities over an approximately 15-month construction period. During construction, contractors and their workers would be required to meet the Federal OSHA occupational safety standards 29 CFR Parts 1910 and 1926.

Several historical areas of contamination are located within Proposed Action areas. These contamination (MEC) sites are primarily associated with historical uses of munitions. Construction in areas such as MRA-1 and MRA-2 could potentially expose workers to MECs.

Direct (handling) or indirect contact with MECs has the potential to result in injury or death. Unlike chemical exposure, for which there may be an exposure limit where no adverse effects will occur, there is no accepted method for establishing the incremental probability for injury or death from an encounter with MECs. If the potential for an encounter with MECs exists, the potential that the encounter will result in death or injury also exists.

To minimize the potential for impacts, prior to any work on MEC sites (e.g., MRA-1 and MRA-2), comprehensive surveys would be conducted by a qualified unexploded ordnance disposal contractor. These surveys usually include establishing transects throughout the entire work area and then performing surface and subsurface scans (visual and electronic) along these transects. To ensure maximum coverage, subsurface scans would employ both magnetometers and electromagnetic metal detectors (magnetometers detect only ferrous metals while electromagnetic metal detectors detect both ferrous and nonferrous metals).

Prior to construction, workers would also be educated on the potential for MECs in these areas, including how to recognize MECs and what procedures to apply in case MECs are encountered. These procedures would include leaving MECs where found, stopping all work around the MECs, and contacting the appropriate response personnel. Any detected MECs (either during the surveys or during construction activities) would be investigated and disposed of by an approved unexploded ordnance disposal contractor. If any explosive MEC is encountered, it would be detonated in place after coordination with local agencies, such as the police and fire departments, and the Georgia Environmental Protection Division.

B.2.1.2 Operation

Operational activities would include all launch related activities (beginning with the delivery of the launch vehicle and payload to the launch site) and activities between launches. During these operational activities, workers would be exposed to hazards associated with the storage and handling of hazardous materials (propellants and other hazardous chemicals) and those associated with the testing and operation of the launch vehicle. Launch site workers (both Spaceport Camden workers and launch provider workers) would be required to meet the Federal OSHA occupational safety standards, 29 CFR Part 1910. Any hazardous materials would be handled in accordance with Federal, State, and local laws and regulations. Spaceport Camden would also have its own staff and local first responders trained on emergency response to materials held at the launch site.

The potential for impacts during operations from MEC sites would be minimized with the identification and removal of any identified MEC during construction. Additionally, it is anticipated that, short of the complete removal of all MEC from the launch site, the current MEC Institutional Control Plan would be maintained. Therefore, operational workers would also be educated on how to recognize MECs and what procedures to apply in case MECs are encountered.

After construction, signage would be posted along all noncleared MEC areas to inform employees and visitors of potential MEC hazards. Additionally, when nonemployees visit the site, they would be escorted and instructed not to leave the prescribed travel routes. As long as these travel routes are adhered to, the probability of an employee or a visitor being exposed to MECs would be extremely low.

B.2.2 No Action Alternative

Under the No Action Alternative, FAA would not issue a Launch Site Operator License to the County. No activities related to constructing or operating a commercial spaceport would occur at the site. The County would not exercise its option to purchase the property and the property would continue to be owned by the private landowner. The property is currently unused, under private ownership, and is not accessible to the public. It is assumed that the property would continue to be unused.

Under the No Action Alternative, no activity is projected for the site. There would be no workforce of any kind associated with spaceport activities, including no launch site or launch service provider workers. There would be no occupational health or safety impacts other than those currently at the site associated with Union Carbide Corporation or Bayer CropScience ongoing or future activities. The site is inaccessible to the general public. With no spaceport activity on site, there would be no public health and safety impacts associated with spaceport development or operation.

APPENDIX C NOISE STUDY

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Federal Aviation Administration

Memorandum

Digitally signed by DONALD S SCATA
Date: 2020.05.08 11:26:16 -04'00'

Date: May 08, 2020

From: Don Scata, Manager, Noise Div., Office of Environment & Energy (AEE)

To: Dan Murray, Office of Commercial Space Transportation (AST)

Subject: Noise Modeling Methodology to Revised EIS of Spaceport Camden Launch Site for Operator License in Camden County, Georgia.

The Office of Environment and Energy (AEE) has reviewed the proposed non-standard noise modeling methodology for the revision of the Environmental Impact Study (EIS) of Spaceport Camden Launch Site for Operator License in Camden County, Georgia.

As the FAA does not currently have an approved propulsion noise model for launch vehicles, in accordance with FAA Order 1050.1F, all non-standard noise analysis in support of the noise impact analysis for the National Environmental Policy Act (NEPA) that must be approved by AEE. This letter serves as AEE's response to the method proposed in AST memorandum "Noise Methodology Approval Request for Spaceport Camden Launch Site Operator License" on May 7, 2020.

The noise levels generated from the commercial space launch vehicles will be predicted using the Launch Noise Model (LNM) based on Eldred's Distributed Source Method 1 (DSM-1) reported in NASA SP-8072 and inclusive of methods that address propagation, variable ground impedance and required metrics. In addition, the PCBoom sonic boom noise analysis will also be used to account for the added small launch vehicles impacts in flight.

The proposed methodology appears to be adequate for modeling propulsion noise and sonic boom for the additional smaller launch vehicles included for the Camden site. Therefore, AEE concurs with the methodology proposed for this project. Please understand that this approval is limited to this particular revision of EIS and added vehicle. Any additional projects using this or other launch noise methodologies or variations of launch vehicle will require separate approval.

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Camden Spaceport Noise Study ITAR Small Launcher

June, 2020

ICF

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1. Introduction

The Camden County Board of Commissioners (the County) is proposing to develop and operate a commercial space launch site called Spaceport Camden. The proposed Spaceport Camden site would be located in Camden County, Georgia on the Atlantic seaboard. To operate a commercial space launch site, the County must obtain a commercial launch site operator license from the Federal Aviation Administration Office of Commercial Space Transportation. The issuance of a launch site operator license is considered a Federal action subject to environmental review under the National Environmental Policy Act (NEPA) of 1969 as amended (42 United States Code [U.S.C.] §4321, et seq.). The noise impact of the proposed future action is evaluated based on the FAA Order 1050.1F, Environmental Impacts: Policies and Procedures.

The County's Proposed Action is to construct and operate a commercial space launch site. The Spaceport Camden launch site would include a vertical launch facility, a mission preparation area, and operational support facilities. The County plans to offer the site for up to 12 vertical launches of small, orbital and suborbital vertical launch vehicles.

This noise study describes the environmental noise effects associated with the proposed small, vertical launch vehicles. This study analyzes the noise effects of the vehicle launches, and sonic booms generated by the vehicles at velocities more than Mach 1. Sonic booms are expected to not impinge land because of the nearly vertical orientation of the launch vehicle as it passes the sound barrier at Mach 1.

Section 2 discusses noise metrics and criteria, Section 3 describes the general methodology of launch noise and sonic boom analysis, Section 4 provides the inputs to the modeling, Section 5 presents the results of the analysis, and Section 6 is a summary of the report.

Representative Launch Vehicle

The small, vertical launch vehicle used as a representative vehicle for this noise analysis is RocketLab's Electron Expendable Launch Vehicle. The Electron launch vehicle is a two-stage liquid-fueled orbital rocket. Both stages use Rutherford rocket engines and Liquid Oxygen (LOX)/Kerosene propellant. The engines are fed by battery-powered electromechanical pumps and have electromechanical Thrust Vector Control. The first stage uses nine Rutherford engines while the second stage uses one, vacuum-optimized version of the engine. The second stage uses a cold-gas Reaction Control System for additional attitude control. The vehicle has an optional third "kick" stage to place numerous payloads into different, circularized orbits. Stage separation uses pneumatically-actuated guided springs. The vehicle is primarily constructed from carbon fiber composites with integral propellant tanks, pressurized with Helium. Figure 1 is a diagram of the Electron vehicle.

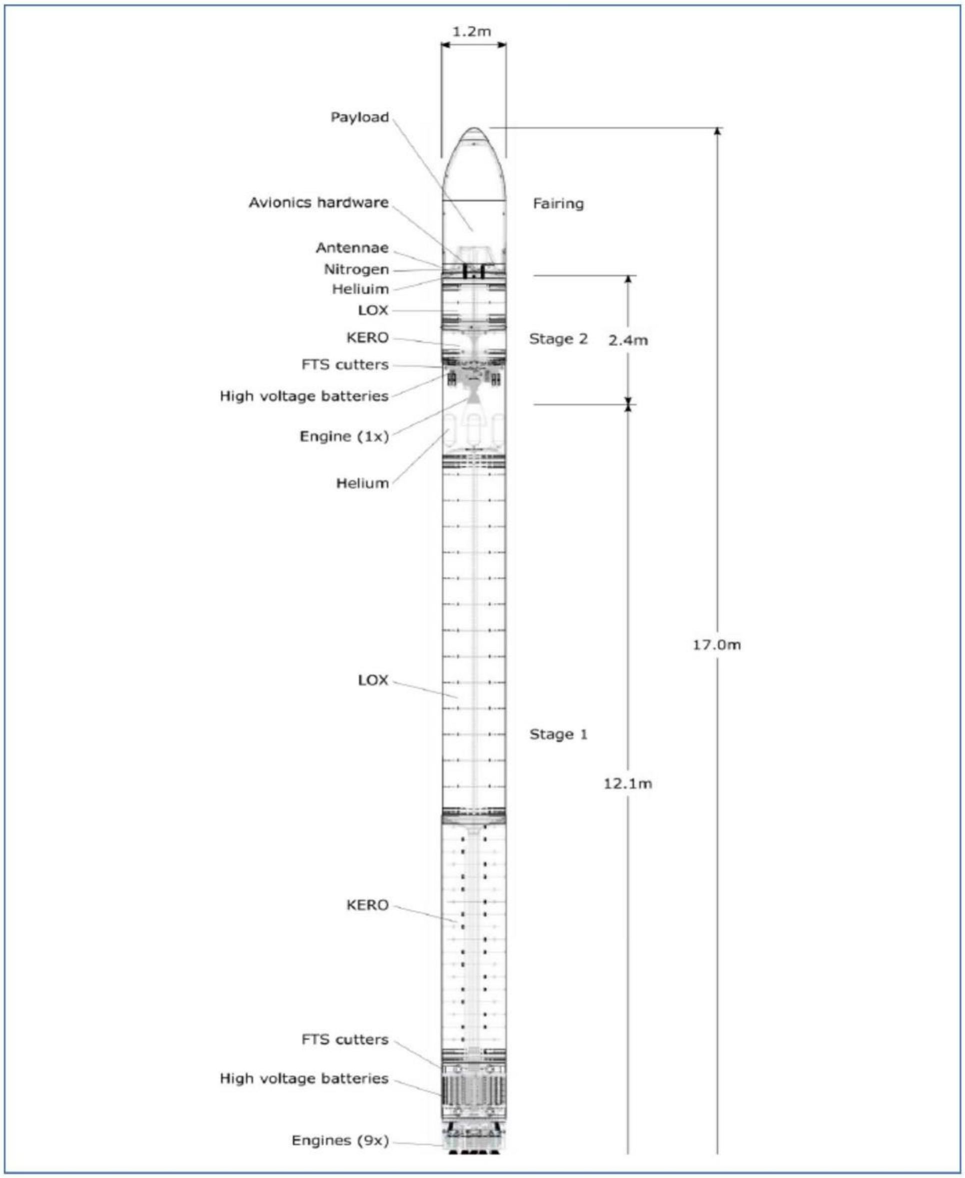

Figure 1. Electron Launch Vehicle

Affected Environment

The lands in the vicinity of the proposed Spaceport Camden include a combination of uplands and marshlands. Historical land use of the property has included two plantations and a ship-building enterprise in the 1800s and between 1927 and 1942 was redeveloped and used as a hunting preserve. In the early 1940s it was used as a tree farm and source of fiber for a local paper mill. During the 1960s, the Thiokol Corporation (later Morton Thiokol) produced and tested solid rocket motors for NASA.

Properties southwest of the site are owned by Mead Timber Company and Cabin Bluff, a private hunting, fishing, golf, and recreation retreat established in 1928 on the Cumberland River. The Stratford Land Company owns silvicultural and natural vegetation land immediately west of the site. Land use to the north remains undeveloped marsh lands. The closest residence is located approximately 2.5 miles west of the western boundary of the site and additional low-density residential properties are located further to the southeast along Union Carbide Road near Fancy Bluff Creek.

Other land uses and recreational areas nearby to the proposed Spaceport Camden include the communities of Woodbine, Kingsland, and St. Mary's, Naval Submarine Base Kings Bay, Crooked River State Park, the Intracoastal Waterway, Cumberland Island National Seashore, and Little Cumberland Island. Little Cumberland Island is located at the north tip of Cumberland Island. It is a 2,400-acre tract that is separated from the Great Cumberland Island by Christmas and Brockington Creeks. Although part of Cumberland Island National Seashore, Little Cumberland Island is privately owned and not open to visitors without an invitation. Figure 2 is an area map of the proposed launch facility.

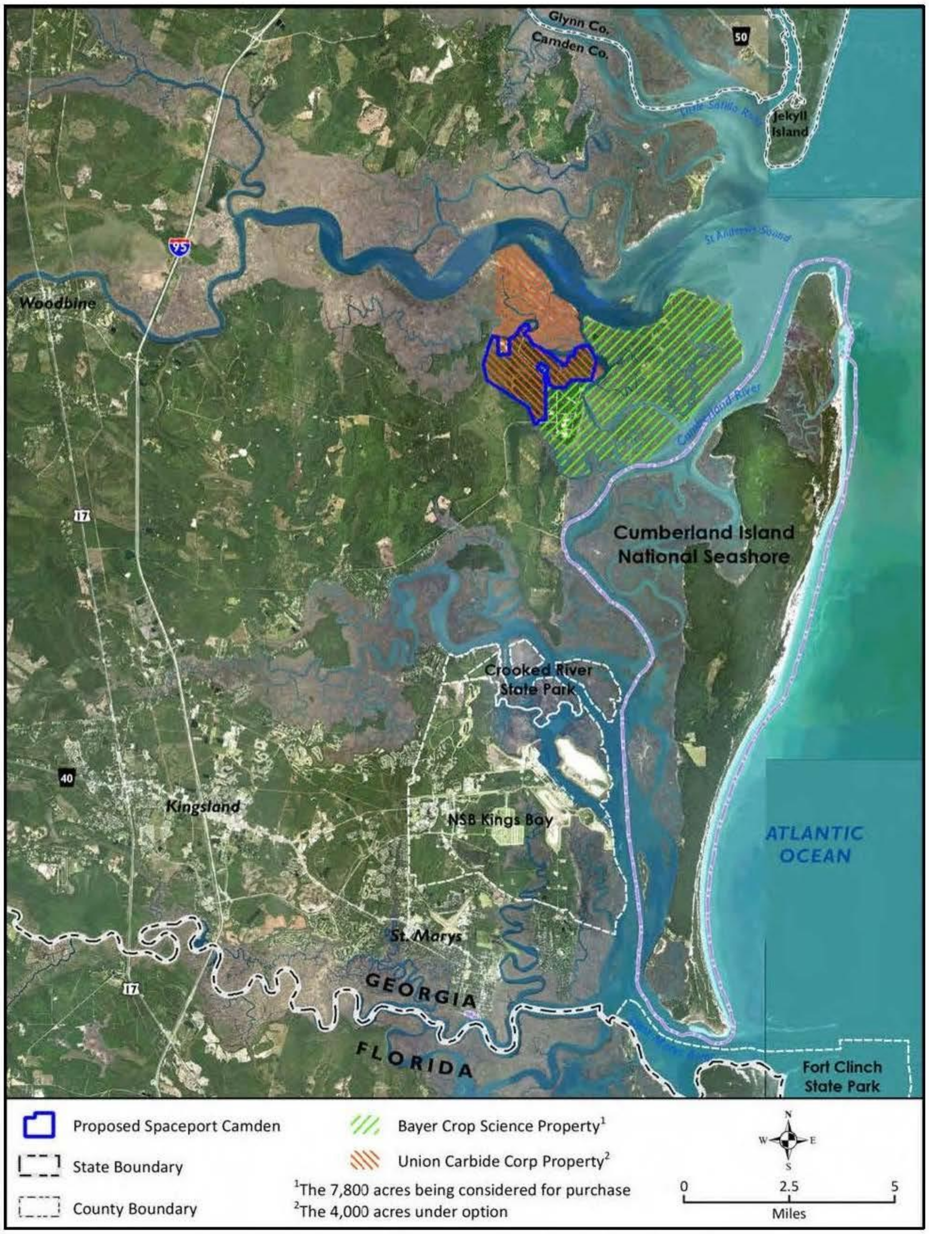

Figure 2. Camden Spaceport Area Map

2. Noise Metrics and Criteria

2.1 Noise Metrics

Noise is defined as unwanted sound that interferes with human activities or wildlife behavior. Noise sources can be steady-state (constant) or transient. An example of a constant noise is the noise of a fan. A sonic boom is an example of a very short transient noise event. Human perception of noise depends on several factors including overall noise level, number of noise events, the extent of audibility above the background ambient noise level, and frequency content. Frequency content refers to pitch. Rocket noise generally has low frequency content which can be described as a low pitch rumble.

Sound is measured in terms of the decibel (dB), which is the ratio between the sound pressure of the sound source and 20 micropascals (μPa), which is nominally the threshold of human hearing. Various weighting schemes have been developed to collapse a frequency spectrum into a single dB value. The A-weighted decibel (dBA) corresponds to human hearing accounting for the higher sensitivity in the mid-range frequencies. Another sound level weighting is the C-weighted scale (dBC) which emphasizes low frequency sounds, such as sonic booms.

Launch noise is a transient noise event initially at a high sound pressure level which then recedes into the background noise level as the rocket climbs in altitude. The Sound Exposure Level (SEL) is a noise metric applicable to launch noise. The SEL normalizes the acoustic energy of a launch event as if it occurred in one second. The SEL allows an "apples to apples" comparison between two different noise events which may have different durations and magnitudes.

Other noise metrics used in launch noise analysis include OASPL (Overall Sound Pressure Level) which can also be used to express an un-weighted linear value (dB). L_{max} refers to the maximum level that occurs during a noise time history sequence.

Sonic booms are typically measured in pounds per square foot (psf) for comparison with building structural damage criteria.

2.2 Noise Criteria

2.2.1 Human Annoyance

Past and present research by the Federal Interagency Committee on Noise (FICON) verified that the DNL metric provides an excellent correlation between transportation vehicle noise and community annoyance to that noise level. The Day Night Average Sound Level (DNL) is a 24-hour average of noise levels with a 10 dB penalty for noise occurring at night. This adjustment is made to account for people's greater sensitivity to noise during nighttime hours (between 10 p.m. and 7 a.m.). DNL can be calculated on the basis of SEL and the number of daytime and nighttime noise events. However, little research has been conducted to determine how well DNL correlates with loud and infrequent noise events such as with launch facilities.

Per FAA Order 1050.1F, a significant noise impact would occur if analysis shows that the Proposed Action would cause noise sensitive areas to experience an increase in noise of DNL 1.5 dB or more at or above DNL 65 dB noise exposure when compared to the No Action Alternative for the same timeframe.

2.2.2 Hearing Conservation

In terms of hearing conservation, the Occupational Safety and Health Administration (OSHA) set a limit of 115 dBA[1] for short exposure periods (less than 15 minutes).

2.2.3 Structural Damage

Rocket Noise

Structural damage due to rocket engine noise is extremely rare. The reasons for this include the fact that airborne sound pressure levels must be extremely high to induce vibration levels high enough to cause damage. Glass windows and particularly fragile windows would be the most likely candidate for structural damage if it did occur. The following table (Table 5.3[2]) shows that window damage may occur at sound pressure levels of 150 dB (linear) or higher. Such high sound pressure levels would only be possible for residential locations in very close proximity to large rockets.

Air Overpressure Threshold Scale[1,7]		
dB (lin)	Categorisation	Source
180[6]	Onset of structural damage	BS 6472, BS 5228
171[5]	General window breakage	USBM [34]
170	Most windows crack	BS 6472, BS 5228
160	Cracking of pre-stressed or poorly mounted windows	BS 6472, BS 5228
151[4]	Some window breakage	USBM [41]
150	Pre-stressed or poorly mounted windows may crack	BS 6472, BS 5228
140[3]	Reasonable threshold to prevent glass and plaster damage	USBM [34]
134[2]	USBM 'Safe' maximum	USBM [34]
120	Secondary vibration effects including rattling windows and objects	BS 6472, BS 5228, USBM [34]
<120	No material effect	-

TABLE 5.3: AIR OVERPRESSURE THRESHOLDS FOR DAMAGE EFFECTS ON BUILDING STRUCTURE

Notes:
[1] – Compendium of advised thresholds from BSi and USBM sources.
[2] – USBM [34]. Level based on measurements with high pass filtering at 0.1 Hz. Precautionary advice for design of blasting, pre-supposes groundborne vibration components. Not recognised by BSi. Included for information.
[3] – USBM [34] – 'Despite the widely varied source characteristics, assumptions of damage probabilities and experimental design, and also the differing interpretations among the studies, there is a consensus that damage becomes improbable below approximately 140 dB'.
[4] - Perkins and Jackson (as cited in USBM [42]) – damage thresholds for 'poorly mounted glass under stress'
[5] – USBM [34] – 'Damage to properly mounted glass is reported to have occurred at overpressures of 170 dB to 172 dB, while none was observed at 167 dB to 168 dB'. Mean value of 171 adopted.
[6] – BS 6472 -2. 'Structural damage would not be expected at air overpressure levels below 180 dB(lin)'.
[7] – Shaded entries originate from primary sources of information and are recommended for application to the main study.

Modern frequency-based structural damage criteria, such as promulgated in the DIN 4150 standard[3] and shown in Figure 3, are useful to assess potential structural effects on commercial, residential, and sensitive structures. Recent studies by Garg et al[4] have developed empirically based methods to predict the airborne sound induced vibration effects on various building elements such as floors and walls. These methods can be used to calculate induced-vibration levels in buildings based on rocket noise spectra, for comparison with the DIN 4150 standard. Such frequency-based methods are useful for the specific requirements of launch vehicle noise where the low-frequency content may not be completely accounted for by using single value linear values (i.e., dB).

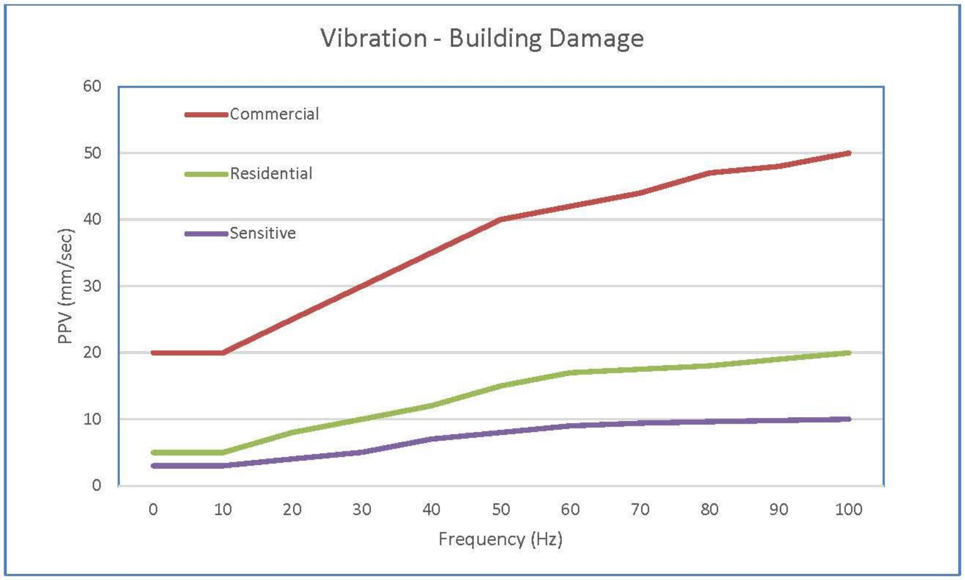

Figure 3. DIN 4150 Building Vibration Standard

Sonic Booms

A sonic boom can cause building damage, in terms of glass breakage and other effects, if the magnitude is great enough. However, in most cases, the potential for sonic booms to damage structures is extremely small. At 1 psf, the probability of a window breaking ranges from one in a billion[5] to one in a million[6]. At 10 psf, the probability of breakage is between one in a hundred and one in a thousand.[7] In general, the threshold for building damage due to sonic booms is 2 psf[7], below which damage is unlikely.

Table 1[7] shows possible types of building damage at increasing sonic boom psf values.

Table 1. Possible Building Damage Due to Sonic Booms of Increasing Magnitude

Sonic Boom Peak Overpressure (pounds per square inch)	Item Affected	Type of Damage
0.5 – 2	Cracks in Plaster	Fine; extension of existing; more in ceilings; over door frames; between some plaster boards.
	Cracks in Glass	Rarely shattered; either partial or extension of existing.
	Damage to Roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to Outside Walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass (e.g., large goblets).
	Other	Dust falls in chimneys.
2 – 4	Glass, plaster, roof, ceilings	Failures show that would have been difficult to forecast; nominally in good condition.
4 – 10	Glass	Regular failures within a population of well-installed glass; industrial as well as domestic; green houses; ships; oil rigs.
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High-probability rate of failure in nominally good slate, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can bodily move.
	Walls (outside)	Old, free-standing walls in fairly good condition can collapse.
	Walls (inside)	"Party" walls known to move at 10 pounds per square inch.
Greater than 10	Glass	Some good glass will fail regularly to sonic booms from the same direction; glass with existing faults could shatter and fly; large window frames move.
	Plaster	Most plaster affected.
	Ceilings	Plaster boards displaced by nail popping.
	Roofs	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gable-end and wall-plate cracks; chimneys damaged if not in good condition.
	Walls	Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall (e.g., large pictures; especially if fixed to party walls).

3. Launch Noise Modeling

The launch noise effects of the ITAR small rocket launcher were analyzed using FAA's Launch Noise Model (LNM). The following sections discuss the modeling algorithms used in LNM.

3.1 Distributed Source Method

LNM is based on Eldred's Distributed Source Method 1 (DSM-1) reported in NASA SP-8072[8]. The noise level at a specific listener location depends on the vehicle specific sound power level and the distance between the listener and rocket. Sound power level is a measure of the overall acoustic energy of the launch vehicle. The DSM-1 method determines the launch vehicle's total sound power level based on its total thrust and exhaust velocity.

For launch vehicles with multiple engines, the DSM-1 method computes an effective exit diameter and total thrust for the vehicle. The modeled noise source comprises a range of frequencies, each of which contains a portion of the total sound power. "Distributed Source Method" refers to the fact that noise generated along the rocket plume can be modeled as separate frequency-dependent sources distributed along the rocket plume. The Eldred model was originally developed to evaluate near-field or mid-field structural concerns on launch facilities. However, in the far field where the rocket plume would be relatively small compared to the distances of concern, the distributed sources can be modeled as a single compact noise source. Noise contours generated by LNM for NEPA analyses are in this far field category.

3.2 Atmospheric Absorption

The atmosphere absorbs sound and this mechanism is a function of several variables including humidity, temperature, and air pressure. High frequencies are attenuated more than low frequencies. Consequently, low frequency sound of rockets can propagate through the atmosphere for greater distances than high frequency sounds. The total attenuation provided by atmospheric absorption can be considerable over long distances.

LNM employs the equations detailed in ISO 9613[9] and ANSI S1.26[10] to calculate atmospheric absorption as a function of 1/3 octave band frequency.

3.3 Ground Interference

A sound source such as a rocket on its trajectory has two ray paths to an observer location, a direct path and a reflected path from the ground, both combining at the observer location (as shown in Figure 4). If the ground is soft, the total combined noise level can be reduced somewhat, whereas if the surface is hard (for example, water), the total combined noise level can be increased somewhat. These acoustical interactions are complex, including interference at specific frequencies due to a phase shift of the reflected acoustic ray.

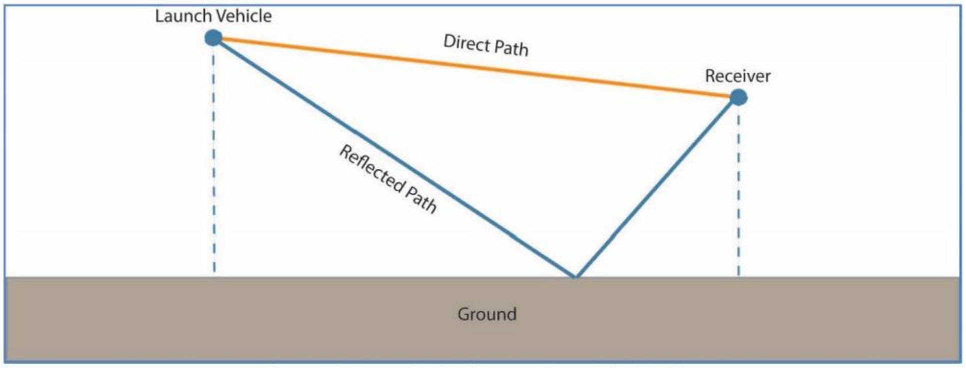

Figure 4. Ground Interference Acoustical Paths

The ground interference equations in references 11 to 26 are incorporated into LNM. Ground surfaces and water bodies with associated flow resistivity values can be input into LNM according to a user-specified grid system.

3.4 Acoustic Efficiency

The acoustic efficiency of a rocket engine refers to how much mechanical energy is converted to sound. Smaller rockets typically have lower acoustic efficiency than larger rockets. Figure 5 shows the relationship between acoustic efficiency[27] and the launch vehicle mechanical power (in watts). LNM calculates the acoustic efficiency based on this relationship.

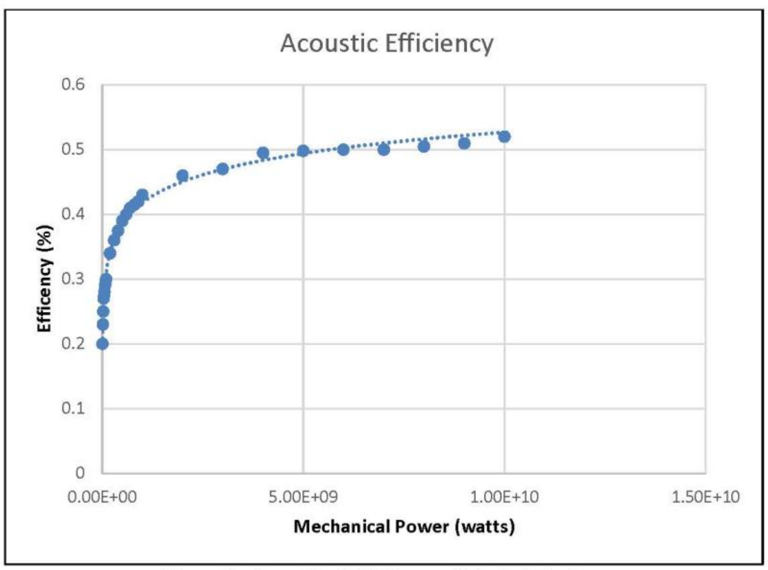

Figure 5. Acoustical Efficiency of Rocket Engines

3.5 Directivity

Rocket engine/plume generated noise is highly directive. The frequency content of the rocket noise is dependent upon the angle of orientation between the rocket plume and listener location. In 2009, NASA's Project Constellation[28] updated the rocket engine directivity data originally included in Eldred's methodology. Figure 6 shows the results of this data collection effort which greatly improved the accuracy and range of angles between the source and listener location. LNM calculates directivity based on these improved directivity data.

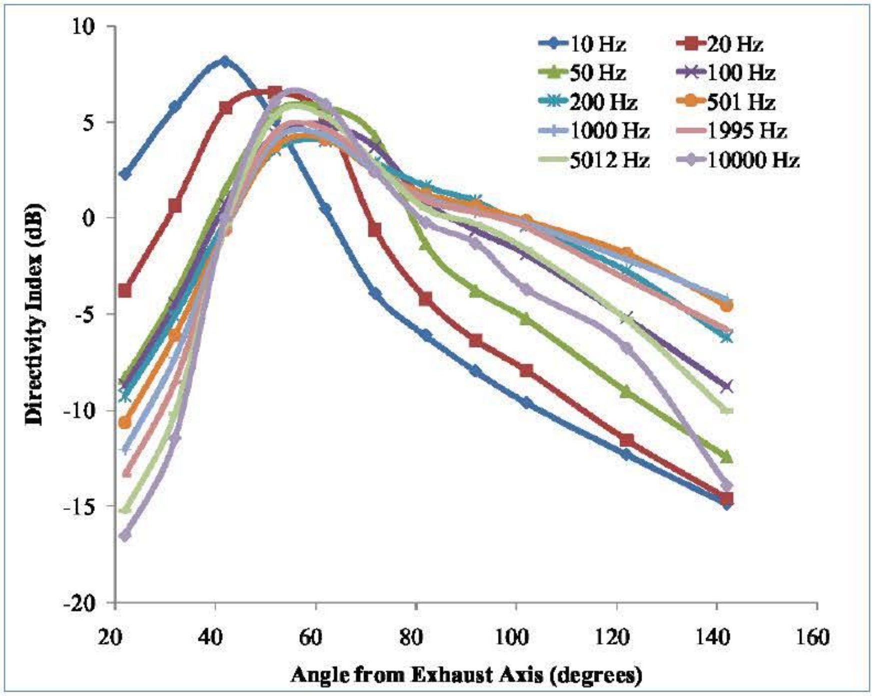

Figure 6. NASA Project Constellation Updated Directivity Data

3.6 Doppler Shift

Doppler shift refers to the effect of a moving sound source either coming toward or moving away from an observer. The frequency of the sound will increase when the sound source approaches the observer and will decrease when moving away from the observer. A common example is the sound of a siren changing in frequency or pitch as the vehicle passes by an observer.

As a launch vehicle ascends away from an observer, the doppler shift would result in a downward shift of the launch noise frequencies. As a result, the A-weighted noise level would also decrease since A-weighting de-emphasizes low frequencies. LNM includes algorithms to calculate the doppler shift.

3.7 LNM Model Validation

FAA's Launch Noise Model (LNM) has been validated for several launch noise projects. Figure 7 shows an example of a comparison between LNM calculated time histories versus actual measured time histories for the NASA Wallops Antares project. This validation included the actual vehicle trajectory, measurement location, and various vehicle parameters needed for the modeling. The data shows very close agreement between modeled and measured results.

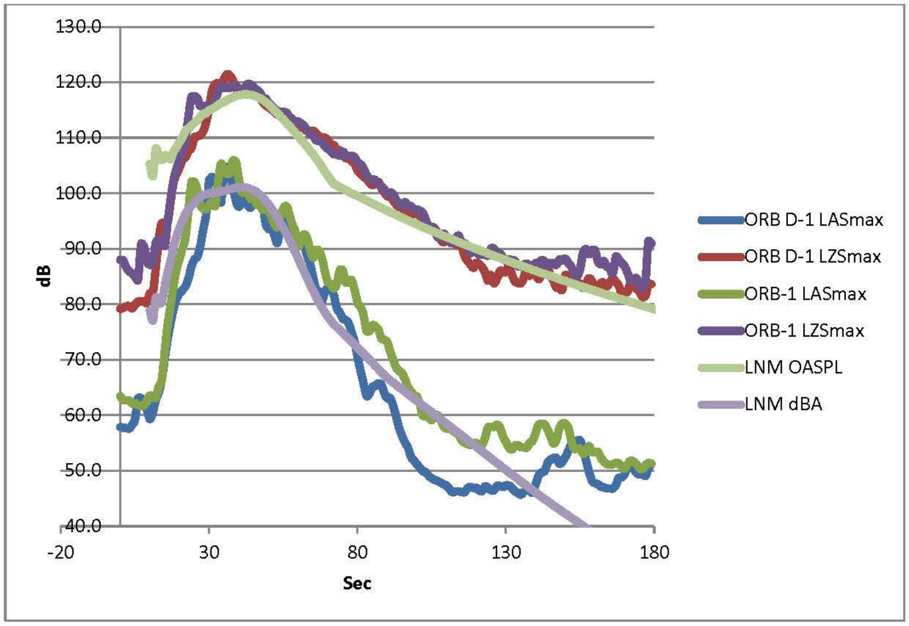

Figure 7. LNM Modeled vs. Measured Launch Noise Time History for NASA Antares

4. ITAR Small Launcher Noise Modeling Input

Table 2 shows ITAR Small Launcher parameters incorporated in the noise modeling.

Table 2. Launch Noise Modeling Parameters

Thrust (Newtons)	81,000
Exhaust exit velocity (m/sec)	2,600
Number of nozzles	3
Diameter of nozzle (m)	0.4064
Annual daytime launches	0.0301
Annual nighttime launches	0.0027

5. Results

The following sections present the study results and findings in terms of the ITAR Small Launcher noise levels for comparison with FAA significance criteria (FAA Order 1050.1F).

5.1.1 65 dBA Lmax Contours

For the purposes of establishing the potential area for speech interference, LNM was used to generate 65 dBA Lmax noise contours. The 65 dBA threshold is generally used as a speech interference threshold although in this case the total time of noise levels at 65 dBA would be relatively small. Based on the input data shown in Table 2 and trajectory data provided by the Applicant (lat/long, altitude, and velocity per second), Figure 8 shows the results of this analysis. The areas immediately adjacent to the launch area are a myriad of water channels and land. Consequently, the noise contours vary due to the ground interference calculations—caused by the reflective nature of the water and correspondingly high flow resistivity values. In general, the noise contours expand at water bodies due to the reflective nature of water. Figure 8 also shows that the area exposed to 115 dBA (for hearing conservation) is entirely within the Spaceport boundary.

Figure 8. 65 dBA Lmax Noise Contours associated with ITAR Launches

5.1.2 SEL Contours

Figure 9 shows Sound Exposure Level (SEL, dBA) contours and the trajectory for the ITAR generated by LNM. The DNL calculations are based on the SEL data. The SEL values at the Settlement is 91 dBA and 89 dBA at the closest residence.

Figure 9. Sound Exposure Level Contours (SEL, dBA) for ITAR Launch

5.1.3 DNL Contours

Because of the low number of annual launches (11 during the day and 1 at night) and the low thrust value, the DNL for this proposed action will be very low and substantially lower than FAA's 65 DNL significance threshold. To demonstrate this, the smallest SEL contour of 115 dBA shown in Figure 9 corresponds to 53 DNL.

Figure 10 shows the actual 65 DNL launch noise contour, which would be difficult to see in Figure 8 and is essentially contained within the Spaceport and not touching residences and thus there are no significant noise impacts per FAA Order 1050.1F. The reflective nature of the nearby waterways slightly increased the size of the contours in those areas. The outer contour line is at 65 DNL and 1 dB increments within those contours.

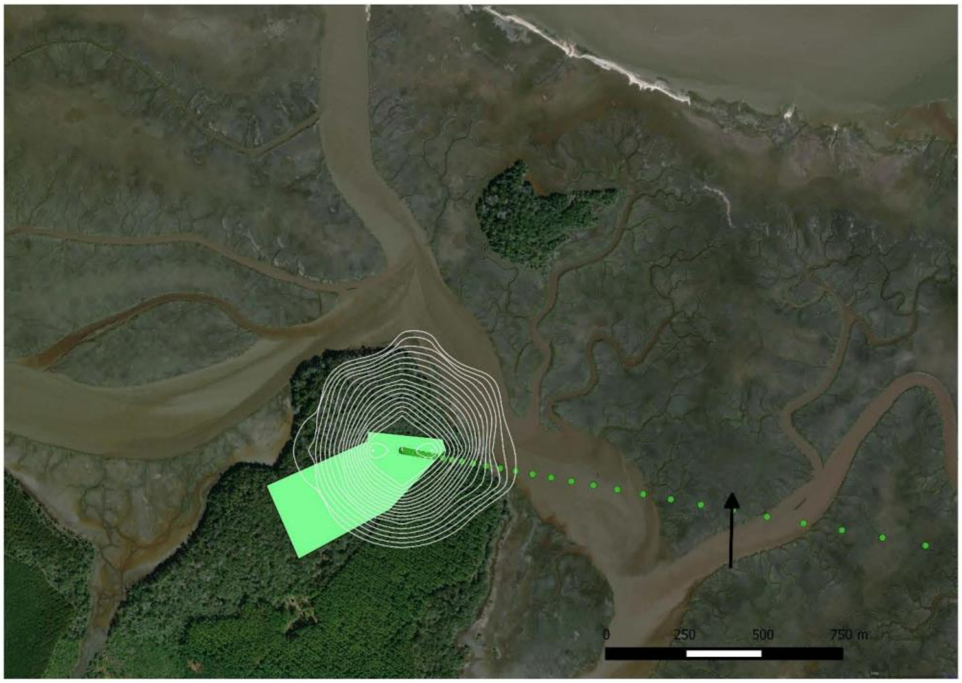

Figure 10. 65 dB Day Night Average Sound Level (DNL, dBA) for ITAR Launch

Figure 11 shows the static engine firing 65 DNL contours assuming 12 daytime tests per year lasting for 7 seconds each with a firing heading of 75 degrees and exit angle of 0 degrees. The static engine firing 65 DNL contour lies completely within the Spaceport property and therefore there would be no significant noise impacts. Because static engine firing 65 DNL values are substantially lower than the 65 DNL launch noise contours, logarithmic addition of the two does not visibly increase the contours shown in Figure 10.

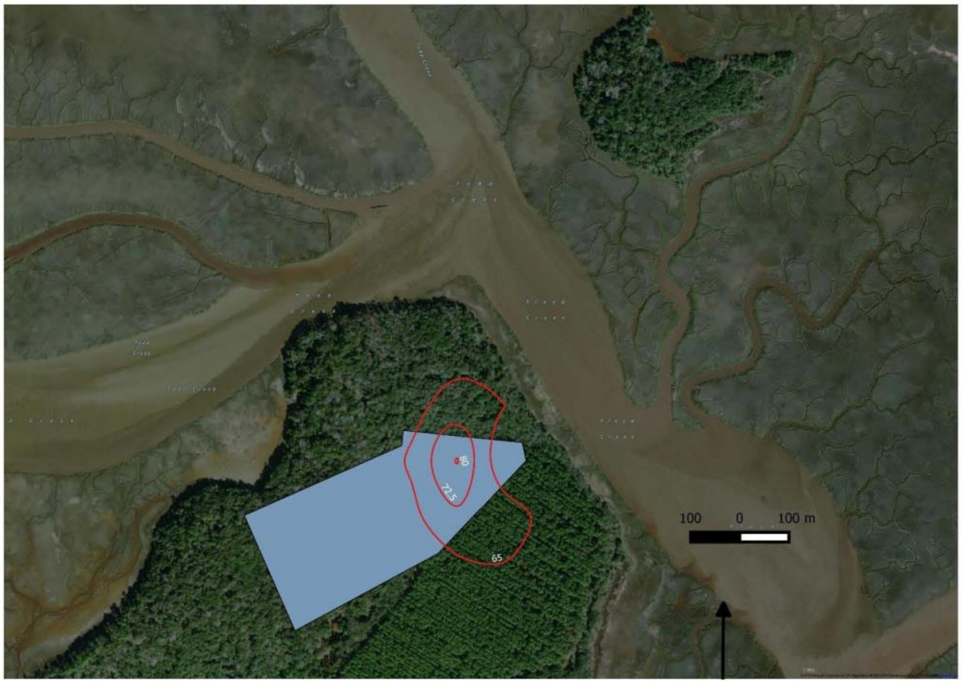

Figure 11. 65 dB Day Night Average Sound Level (DNL, dBA) for Static Engine Firing

Figure 12 shows the 65 dBA L_{max} contours for static engine firing.

Figure 12. 65 dBA Lmax Static Engine Firing Contours

5.1.4 Launch Noise Levels – At the Settlement and Closest Residence

Two specific points of interest were analyzed for noise in more detail.

1. The Settlement (30.923750°N, 81.434717°W), which is located on Cumberland Island (4.6 miles from the mission preparation area) and has been identified as the closest location on the island with standing structures of historic value, and
2. The closest residence (30.919417°N, 81.567733°W), which is located southwest of Spaceport Camden in Camden County (2.6 miles from the mission preparation area).

Figure 13 shows launch noise time history at the Settlement in terms of OASPL and dBA. This data shows that launch noise would exceed speech interference criteria at 66 dBA for 51 seconds per launch. Static engine firing would result in 44 dBA for 7 seconds per test.

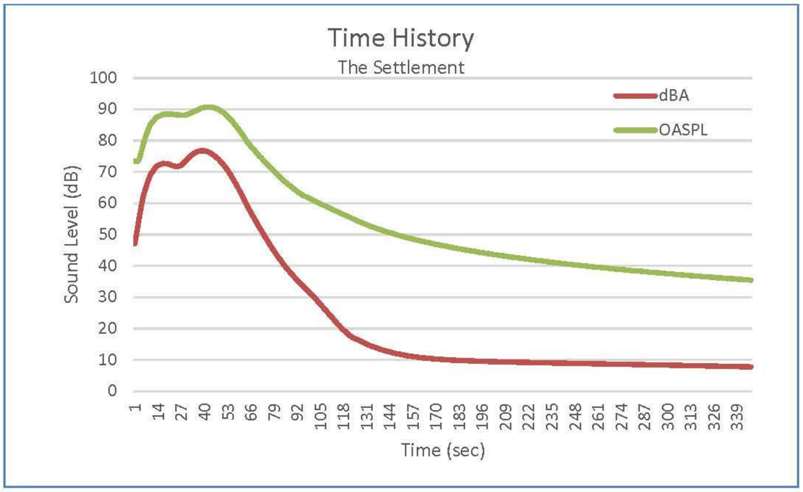

Figure 13. Time history launch noise levels at the Settlement

Using 1/3 Octave Frequency Band sound pressure levels which occur at the peak noise level shown in Figure 10, Figure 14 shows the Settlement structural vibration levels induced by launch noise compared with the DIN 4150 standard. These levels are far below the "sensitive" building category, and therefore no building damage is expected.

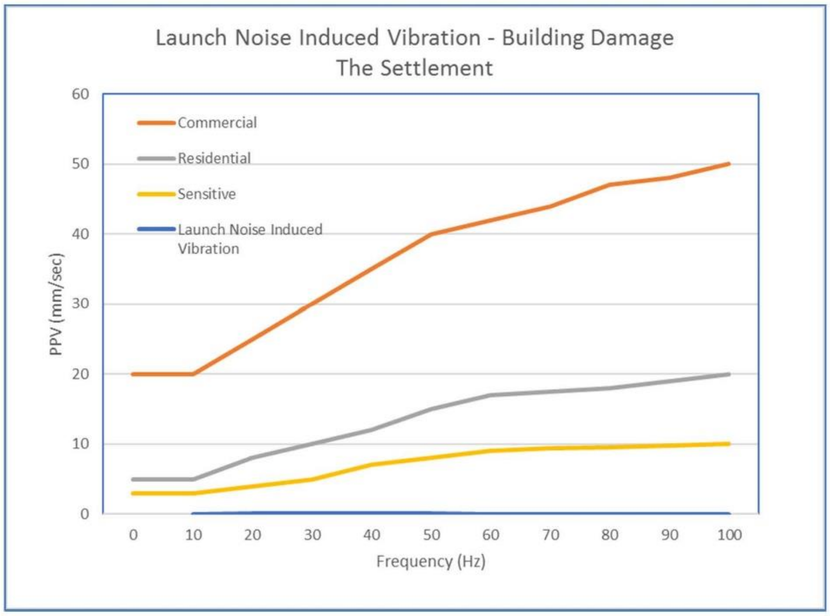

Figure 14. Building Damage at the Settlement

Figure 15 shows launch noise time history at the nearest residence. This data shows that launch noise would exceed speech interference criteria at 66 dBA for 36 seconds per launch. Static engine firing would result in 38 dBA at the nearest residence for 7 seconds per test.

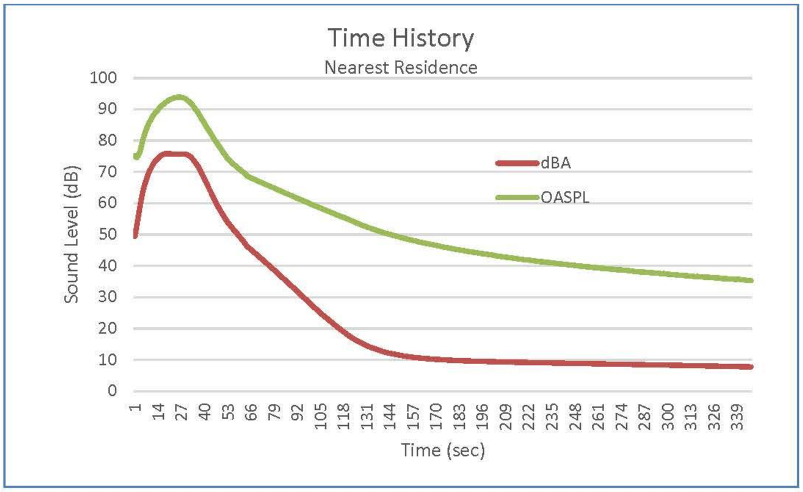

Figure 15. Time history launch noise levels at the nearest residence

Figure 16 shows sound pressure level induced vibration level at several culturally/historically significant sites in the project area. The only site which matches the most sensitive structure type is the Floyd cemetery. All other locations result in vibration levels of less than 1 mm PPV. It is important to note that robust structures such as monuments would have vibration criteria substantially higher than the commercial PPV criteria since the methodology is based on conventional building structure elements such as floors and walls.

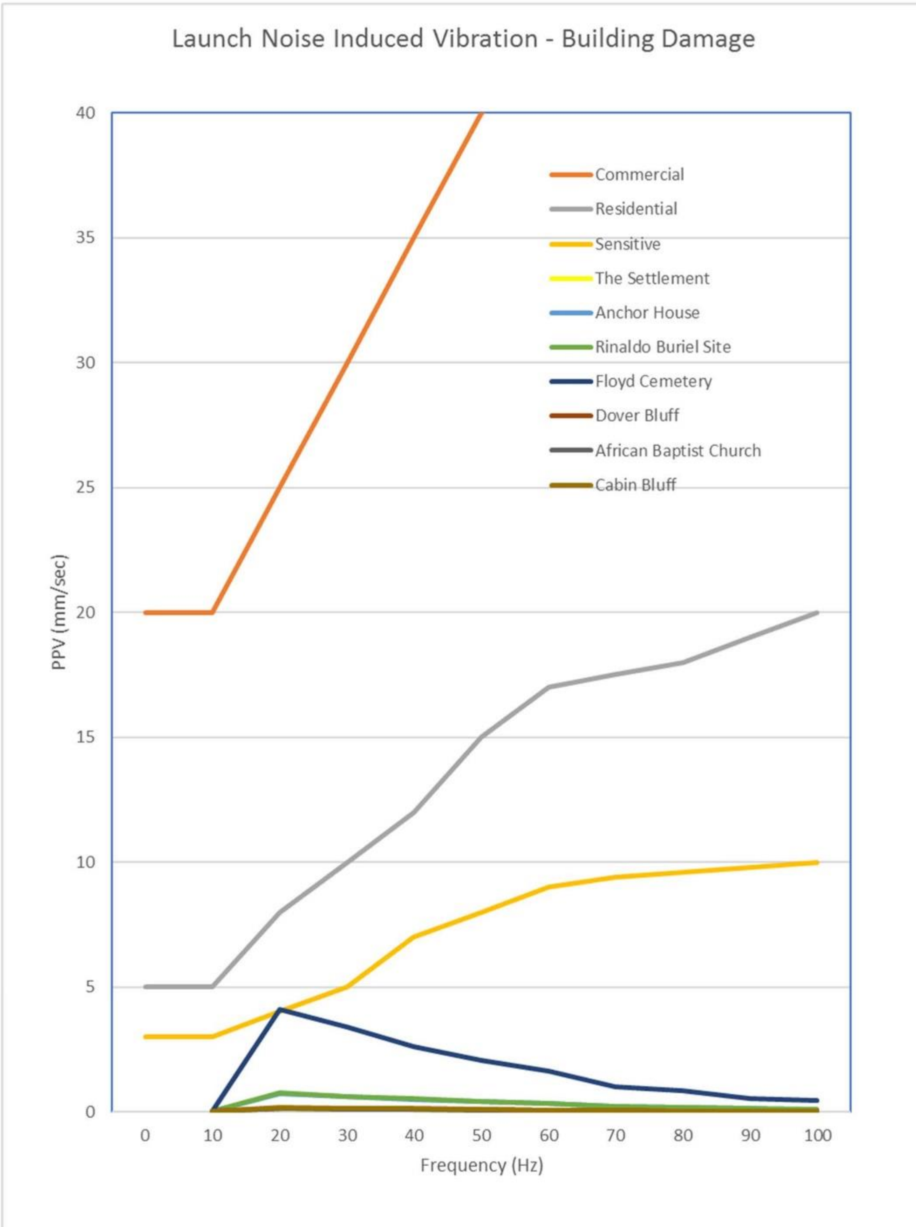

Figure 16. "Building" Damage at Culturally/Historically Significant Locations

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5.1.5 Sonic Boom Analysis

A sonic boom, similar to the sound of a thunderclap, is the sound associated with the shock waves created by a vehicle traveling through the air faster than the speed of sound. The location of a sonic boom footprint is dependent on the actual trajectory and atmospheric conditions at the time of flight as well as various other parameters including the size of the vehicle and orientation relative to the earth's surface. The sonic boom contours for the ITAR are shown in Figure 17. The maximum overpressure of the sonic boom footprint is 0.20 psf on the Atlantic Ocean. The small psf value is due to a number of factors including the relatively small size of the launch vehicle and high altitude at which the sonic boom would be generated.

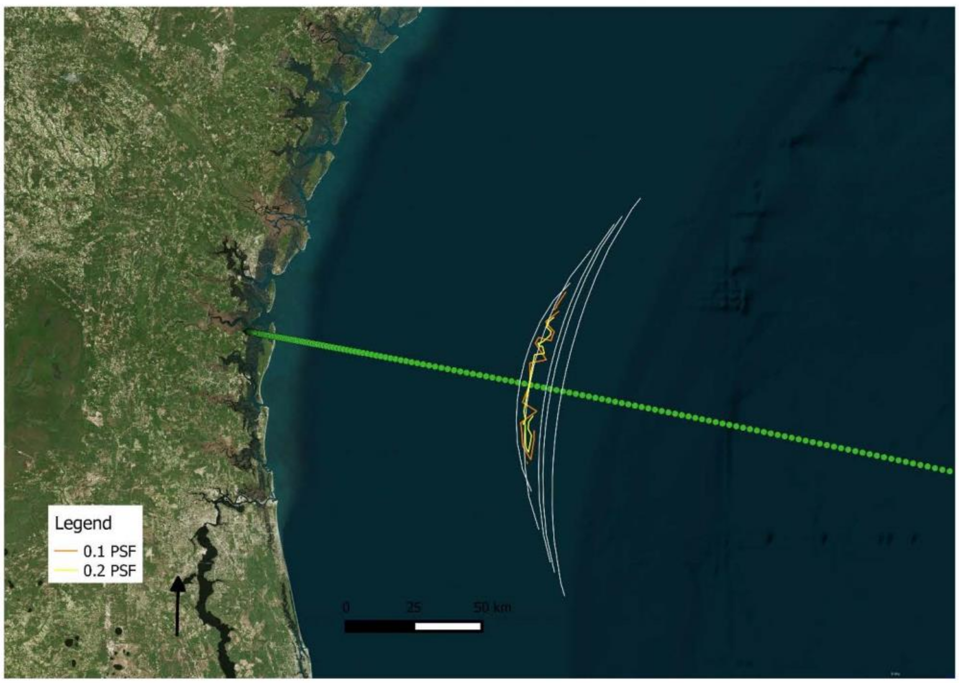

Figure 17. Sonic boom peak overpressure contours for the ITAR small launcher from Spaceport Camden

6. Summary

Camden County is proposing to develop and operate a commercial space launch site called Spaceport Camden. This report documents the noise study associated with Spaceport Camden's proposed 12 vertical launches and 12 static fire engine tests per year of an ITAR small launcher vehicle.

The noise impact of the proposed future actions is evaluated based on the FAA Order 1050.1F, Environmental Impacts: Policies and Procedures. A significant noise impact is one in which the action would increase noise by DNL 1.5 dBA or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dBA noise exposure level, or that will be exposed at or above this level due to the increase, when compared to the No Action Alternative for the same timeframe. The DNL at or in excess of 65 dBA would be within the Spaceport boundary which is uninhabited.

To assess the impact of rocket noise with respect to hearing conservation, OSHA's upper limit of 115 dBA is also contained within the Spaceport boundary.

To assess the impact of rocket noise with respect to structural damage due to airborne sound-induced structural vibration, 1/3 octave frequency band rocket noise spectra were used to empirically predict structural vibration in terms of peak particle velocity. The Settlement historic structures are predicted to have structural vibration levels far below the levels for "sensitive" structures according to DIN 4150. Likewise, launch noise levels at the nearest residence with similar rocket noise levels would result in structural vibration levels even further below the residential criteria of DIN 4150 and therefore no building damage is expected.

The maximum predicted sonic boom level is 0.2 psf which would be downrange over the Atlantic Ocean. This is a very low magnitude sonic boom and would be perceived as a distant thunderclap. No sonic booms are expected on land.

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APPENDIX D BIOLOGICAL RESOURCES

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Acronyms and Abbreviations

Acronym	Definition
CV	coefficient of variation
DPS	distinct population segment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
MMPA	Marine Mammal Protection Act
NM^2	square nautical miles
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
RCW	red-cockaded woodpecker
ROI	region of influence
U.S.	United States
USFWS	U.S. Fish and Wildlife Service

D BIOLOGICAL RESOURCES

This appendix provides additional information on biological resources identified in the Environmental Impact Statement (EIS), Chapter 3, *Affected Environment*.

D.1 Terrestrial Animals

Eastern Indigo Snake

The federally threatened eastern indigo snake (*Drymarchon corais couperi*) is a wide-ranging snake primarily found in sandhills habitat, but during warmer months, it may also be found on stream bottoms and in swamps and flatwoods. The average home range of the indigo snake varies by season, with an individual using up to 100 hectares for foraging during late summer and fall and a range as limited as 10 hectares during the winter (NatureServe, 2020). Indigo snakes frequently utilize gopher tortoise burrows as refugia from cold temperatures in winter, for egg laying, and for protection during shedding when they are more vulnerable to predation. Mating occurs from November through March, and eggs are laid in late spring and hatch approximately 3 months later. Indigo snakes feed on small mammals, snakes, frogs, birds, and other small vertebrates.

The current range from the indigo snake includes southern Georgia and Florida, with rare occurrences in Alabama, Mississippi, and South Carolina. Habitat destruction and fragmentation are the primary threats to this species.

Gopher Tortoise

The gopher tortoise (*Gopherus polyphemus*) is a Federal candidate species in the eastern portion of its range (east of the Mobile and Tombigbee Rivers). The 12-month finding on a petition to list it as threatened within its eastern range stated that the listing of the gopher tortoise is warranted. However, listing is currently precluded by higher-priority actions, and a proposed rule to list the gopher tortoise will be developed as priorities allow.

The gopher tortoise is found primarily in longleaf pine and oak sandhills but may also be found in pine flatwoods, dry hammock, scrub, coastal grasslands, and in disturbed habitats, such as roadsides and powerline rights-of-way. Gopher tortoises excavate tunnel-like burrows for shelter from climatic extremes and refuge from predators; these burrows can vary from 9 to 23 feet deep and 3 to 52 feet long but typically are closer to 15 feet long and 6.5 feet deep (USFWS, 2019). The primary features of good tortoise habitat are well-drained sandy soils, open canopy with plenty of sunlight, and abundant food plants (forbs and grasses). Prescribed fire is often employed to maintain these conditions. During warmer months when tortoises are active, they typically will dig and use multiple burrows. Breeding season is April to November, with nest construction from mid-May to mid-June. Eggs are typically laid at the opening to the burrow.

The current range of the gopher tortoise extends from Louisiana to southern South Carolina, primarily in the Coastal Plain. Populations are threatened by habitat destruction, degradation, and fragmentation, incompatible herbicide use, and predation.

Gopher Frog

The gopher frog (*Lithobates capito*) is a State-listed rare species that is restricted to the Coastal Plain of the southeastern U.S. In Georgia, it is known to range from the Upper to Middle and Lower Coastal Plains. Protected populations occur on Fort Benning Military Reservation, Fort Stewart Military Reservation, Okefenokee National Wildlife Refuge, Sandhills Wildlife Management Area, and Alligator Creek Wildlife Management Area. The gopher frog does not have any Federal listing status.

In Georgia, gopher frog habitat primarily consists of wiregrass sandhills, dry pine flatwoods, longleaf pine, and saw palmetto communities. Breeding habitat occurs in isolated depressional and ephemeral (seasonally dry) wetlands, such as cypress ponds, limesink ponds, and Carolina bays. The longleaf pine uplands and open-canopied, grassy wetlands preferred by gopher frogs are fire-maintained communities. Gopher frogs are known to seek refuge in other animal burrows, including those of the gopher tortoise, old field mouse, and crayfish.

Gopher frogs typically migrate to breeding wetlands and ponds in the fall, winter, and early spring in association with heavy rains. Adult males remain in the breeding ponds longer than females. Females attach large egg masses (up to 2,000 or more eggs) to emergent vegetation near the water's surface. Hatching occurs approximately 1 week after being laid, and metamorphosis follows an 87- to 215-day developmental period.

Threats to gopher frogs include habitat fragmentation, fire suppression, or any impacts to breeding pond integrity or hydrology (Stevenson et al., 2018).

Red-Cockaded Woodpecker

The red-cockaded woodpecker (RCW) (*Picoides borealis*) is federally listed as endangered. This small woodpecker requires large expanses of mature, open pine forest, particularly longleaf, slash, or loblolly pine. These habitats are typically maintained by fire. Nest and roost cavities are excavated only in old living pines, and the process may take several years to complete. Trees selected for cavities are usually infected with red heart fungus, which softens the heartwood, making excavation easier.

RCWs exist in family groups that typically consist of an adult breeding pair and up to four helpers that are usually male offspring from previous years. The group roosts in a cluster of cavity trees, and may include 1 to 20 or more trees on 3 to 60 acres. The cluster average is about 10 acres. The typical territory for a group ranges from about 125 to 200 acres (USFWS, 2020). In mid-April, the female lays eggs in the tree cavity of the breeding male, and eggs incubate for 10 to 11 days. Both the parents and helpers participate in incubating eggs and brooding and feeding nestlings, which fledge from the nest cavity 24 to 27 days after hatching (USFWS, 2020). RCWs feed primarily on insects but may also forage on fruits and seeds.

The current range of the RCW includes Alabama, Arkansas, Florida, Georgia, Louisiana, North Carolina, Mississippi, Oklahoma, South Carolina, Virginia, and Texas. Habitat degradation, destruction, and fragmentation are the major threats to RCWs, including conversion to nonforested land uses and fire suppression.

Wood Stork

Wood storks (*Mycteria americana*) are federally threatened birds that nest in large colonies, primarily in cypress or mangrove swamps, where they often nest in the upper branches of large trees. In Georgia, the nesting period occurs from March to late May, with fledging in July and August (USFWS, 2018). Preferred foraging habitats for wood storks include narrow tidal creeks, freshwater marshes, and flooded tidal pools, especially depressions where fish become concentrated when water levels fall. Wood stork colonies occur approximately 5 miles north of the Spaceport Camden site at Black Hammock, 10 miles northeast of the site at Jekyll Island, and 15 miles to the south near St. Marys (see Exhibit 3.2-2, Known Occurrences of Special Status Animal Species Within the Construction ROI, in the EIS).

Nesting of the threatened southeastern wood stork population is limited to Georgia, Florida, and South Carolina, with storks moving northward after breeding as far as North Carolina, Alabama, and eastern

Mississippi. Primary threats to the wood stork include loss of feeding habitat, human manipulation of water levels at nesting sites, predation, and lack of nest tree regeneration. To minimize adverse impacts to wood storks, the U.S. Fish and Wildlife Service (USFWS) has identified management zones for activities in close proximity to rookeries, foraging areas, and roosting sites (USFWS, 1990; USFWS, 1997).

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is protected by the Bald and Golden Eagle Protection Act. Eagles are territorial and exhibit a strong affinity for a nest site once a nest has been established. It is common for a breeding pair to rebuild damaged or lost nests in the same tree or in an adjacent tree. Individual pairs return to the same territory year after year, and territories are often inherited by subsequent generations. The nesting period in the southeast United States extends from October 1 to May 15, with most nests being completed by the end of November. The quality and amount of forage resources, mainly fish and carrion, heavily influence fledgling survival.

Piping Plover

The piping plover (*Charadrius melodus*) is federally listed as threatened in the Atlantic coast region. The south Atlantic coast is utilized as winter breeding grounds for the Atlantic coast population as well as other U.S. populations (USFWS, 2016). Piping plovers forage along intertidal mudflats and beaches and the shorelines of streams, ephemeral ponds, lagoons, and salt marshes. They feed by probing the ground for insects, molluscs, worms, and small crustaceans. Small sand dunes, debris, and sparse vegetation on beach and shoreline habitat provide shelter from wind and extreme temperatures (USFWS, 2016). Wintering birds (July through late October) utilize a variety of habitats, including beaches, mudflats, sandflats, and spoil islands. Critical habitat for the piping plover includes portions of Cumberland Island and Jekyll Island (Exhibit 3.2-4, Terrestrial and Marine Species Critical Habitat, in the EIS).

Red Knot

The red knot (*Calidris rufa*) is federally listed as threatened. The red knot breeds in central and eastern Russia, Alaska, Canada, and Greenland. Wintering areas occur along the southeast Atlantic Coast, including Georgia. During migration and in the winter, red knots eat bivalves, small snails, and crustaceans. In Georgia, small clams including coquina (*Donax* spp.) and dwarf surf (*Mulinia lateralis*) are an important part of their fall and winter diet; horseshoe crab eggs are consumed heavily during spring staging along the Georgia coast.

Eastern Black Rail

The eastern black rail (*Laterallus jamaicensis jamaicensis*) is federally listed as threatened. The eastern black rail is and one of four subspecies of black rail and is broadly distributed, living in salt and freshwater marshes in portions of the United States, Central America, and South America. Partially migratory, the eastern subspecies winters in the southern part of its breeding range. Black rails are considered very rare in Georgia, with a limited number of recorded occurrences in the past century (Watts, 2016). While there are no known occurrences within the project area, the eastern black rail may occur throughout associated marshy areas.

D.2 Marine Mammals

Marine mammals are species that rely on ocean environments for all or a significant portion of their life cycles. All marine mammals are protected by the Marine Mammal Protection Act (MMPA). Marine mammals that occur in the Proposed Action area include whales, dolphins, porpoises (under the National Oceanic and Atmospheric Administration [NOAA] jurisdiction) and manatees (under the USFWS jurisdiction). Five species of marine mammals may occur in waters of or close to Spaceport Camden: North

Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), Atlantic spotted dolphin (*Stenella frontalis*), bottlenose dolphin (*Tursiops truncatus*), and West Indian manatee (*Trichechus manatus*). All marine mammals are protected under the MMPA, and two of these species (North Atlantic right whale and West Indian manatee) are also protected under the Endangered Species Act (ESA).

North Atlantic Right Whale

The North Atlantic right whale is federally listed as an endangered species under the ESA (35 *Federal Register* 18319); this listing was revised in 2008 (73 *Federal Register* 12024). A 5-year review completed in August 2008 recommended maintaining the endangered classification of this species (NMFS, 2012). The North Atlantic right whale is designated as depleted under the MMPA. They primarily occur in Atlantic coastal waters or close to the continental shelf. North Atlantic right whales migrate seasonally, generally feeding in the spring and summer in waters off New England and further north into Canadian waters. Each fall, they travel more than 1,000 miles from feeding grounds to calving grounds within shallow coastal waters of South Carolina, Georgia, and northeastern Florida. These waters in the southeastern U.S. are the only known calving area for this species, where females regularly give birth during the winter (NOAA Fisheries, 2020a).

North Atlantic right whales are baleen whales that typically feed on dense patches of zooplankton (primarily *Calanus* and *Pseudocalanus*), including copepods, euphausiids, and cyprids. Unlike many other baleen whales, right whales feed by opening their mouths and swimming through large patches of zooplankton. Their baleen filters out tiny prey but allows water to flow through (NOAA Fisheries, 2020a). Right whales feed at or just below the surface (Kenney et al., 2001) or within a few meters of the seafloor on near-bottom aggregations of zooplankton (Baumgartner, 2009; Baumgartner et al., 2009; Warren, 2009).

NOAA Fisheries has established a series of seasonal management areas along the U.S. east coast at certain times of the year to reduce the threat of ships collisions with the endangered North Atlantic right whales (NOAA Fisheries, 2020a). Within these management areas, all vessels 65 feet or longer must travel at 10 knots or less. Regulations to reduce the likelihood of serious injuries and deaths from ship collisions were enacted in 2008 (73 *Federal Register* 60173) and amended in 2013 (78 *Federal Register* 73726). The Southeast U.S. Seasonal Management Area restricts ship speed in the calving and nursery grounds from November 15 through April 15. The offshore waters of Spaceport Camden are included in the Southeast U.S. Seasonal Management Area.

Critical habitat for North Atlantic right whales was originally designated in 1994 (59 *Federal Register* 28793) and included portions of Cape Cod Bay and Stellwagen Bank (off the coast of Massachusetts), the Great South Channel (also off the coast of Massachusetts), and waters adjacent to the coasts of Georgia and the east coast of Florida. These areas were identified as providing critical feeding, nursery, and calving habitat. On January 27, 2016, the National Marine Fisheries Service (NMFS) issued a final rule (81 *Federal Register* 4837) to replace the critical habitat for North Atlantic right whales with two new, expanded areas. These expanded areas contain the physical and biological features essential to the conservation of the North Atlantic right whale, providing requirements for successful foraging, calving, and calf survival (NMFS, 2015). Critical habitat for the protection of essential foraging features is located in the Gulf of Maine and Georges Bank region (Unit 1) and covers a total area of approximately 21,334 square nautical miles (NM^2). Critical habitat for the protection of calving essential features is located off the southeast U. S. coast between North Carolina and Florida (Unit 2) and covers 8,429 NM^2 (Exhibit D-1).

Humpback Whale

NOAA Fisheries revised the ESA listing for humpback whales in September 2016 (81 *Federal Register* 62259) to divide the globally listed endangered species into 14 distinct population segments (DPSs), remove the current species-level listing, and in its place list four DPSs as endangered and one DPS as threatened. The nine remaining DPSs were identified as not warranted for listing. Individuals that occur off Spaceport Camden are considered part of the Gulf of Maine stock (NMFS, 2019). The Gulf of Maine stock is part of the West Indies DPS, which was identified as not warranting listing (81 *Federal Register* 62259) in the 2016 revision to the ESA listing of humpback whales. Since this DPS is not listed under the ESA, there is no critical habitat. The humpback whale remains designated as depleted under the MMPA.

Atlantic Spotted Dolphin

Atlantic spotted dolphins in U.S. waters have been divided into three stocks for management purposes: the Northern Gulf of Mexico Stock, the Puerto Rico and U.S. Virgin Islands Stock, and the Western North Atlantic Stock (NOAA Fisheries, 2020c). Individuals that occur off Spaceport Camden belong to the Western North Atlantic Stock.

Atlantic spotted dolphins are distributed in tropical and warm temperate waters of the western North Atlantic, ranging from southern New England, south through the Gulf of Mexico and the Caribbean to Brazil (Leatherwood et al., 1976; Perrin, 2008). Atlantic spotted dolphin sightings have been concentrated in the slope waters north of Cape Hatteras, but in the shelf waters south of Cape Hatteras, sightings extend into the deeper slope and offshore waters of the mid-Atlantic. This species is common in continental shelf waters south of Cape Hatteras and in continental shelf edge and continental slope waters north of Cape Hatteras (NOAA, 2014). Higher numbers of Atlantic spotted dolphins have been reported over the continental shelf west of Florida from November to May than during the rest of the year, suggesting that this species may migrate seasonally (Griffin, 2003). This species occurs in deeper waters of the continental shelf, typically at least 4.9 to 12.4 miles offshore (Perrin & Hohn, 1994; Davis, 1998; Perrin, 2002).

The best abundance estimate available for Atlantic spotted dolphins in the western North Atlantic is 44,715 (coefficient of variation [CV] = 0.43). This estimate is from summer 2011 surveys covering waters from central Florida to the lower Bay of Fundy (NOAA, 2014).

The diet of the Atlantic spotted dolphin varies depending on its location (Jefferson, 2008; Perrin & Hohn, 1994). Atlantic spotted dolphins feed on small cephalopods, fishes, and benthic invertebrates (Perrin & Hohn, 1994). In the Gulf of Mexico, Atlantic spotted dolphins were observed feeding cooperatively on clupeid fishes and are known to feed in association with shrimp trawlers (Fertl & Leatherwood, 1997; Fertl & Würsig, 1995; MacLoud et al., 2004). In the Bahamas, this species has been observed chasing and catching flying fish (MacLoud et al., 2004).

Bottlenose Dolphin

Bottlenose dolphins in the vicinity of Spaceport Camden may be individuals belonging to any of the following stocks: Western North Atlantic Offshore Stock, Jacksonville Estuarine System Stock, Western North Atlantic Northern Florida Coastal Stock, and Western North Atlantic Southern Migratory Coastal Stock.

Bottlenose dolphins occur in tropical and temperate waters of the Atlantic Ocean and can be found in inshore, nearshore, and offshore waters along the U.S. east coast and Gulf of Mexico. They generally do not range north or south of 45° latitude (Jefferson, 2008; Wells & Scott, 2008). Bottlenose dolphins can be found in most habitats, from shallow, murky, estuarine waters to deep, clear offshore waters in oceanic regions (Jefferson, 2008; NOAA Fisheries, 2020d). Bottlenose dolphins are commonly observed in groups of 2 to 15 individuals, but offshore herds with several hundred individuals have been reported (Shane, 1986; Kerr et al., 2005; NOAA Fisheries, 2020d). Based on habitat preferences and incidental sightings in the vicinity of Spaceport Camden (Foley, Paxton, et al., 2019; Foley, Waples, et al., 2019), bottlenose dolphins are expected to occur regularly within the region of influence (ROI).

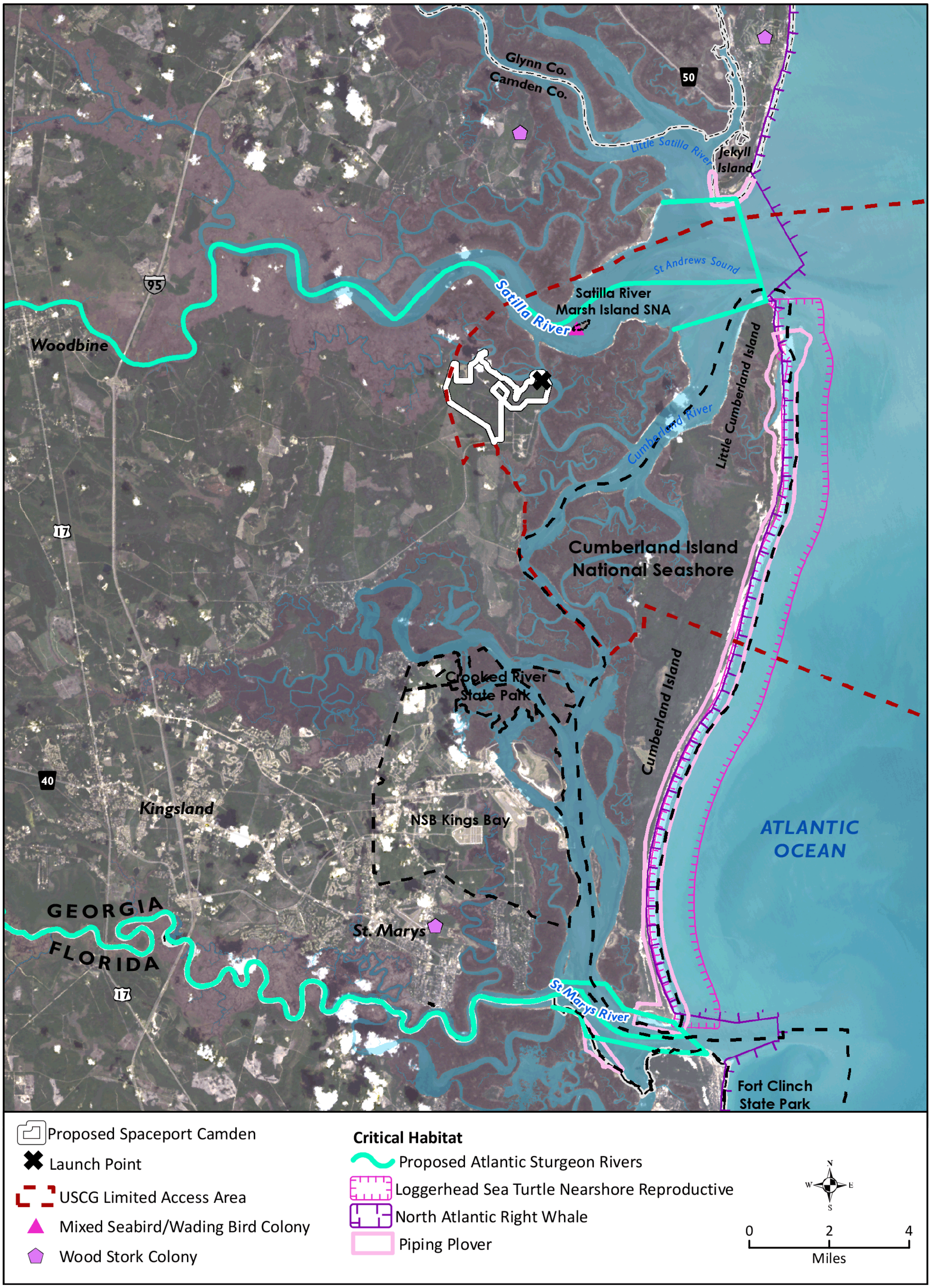

Exhibit D-1. Critical Habitat

The best available estimate for the Western North Atlantic Offshore Stock of common bottlenose dolphins is 77,532 (CV = 0.40) (NOAA, 2016). The best available estimate for the Western North Atlantic Northern Florida Coastal Stock of common bottlenose dolphins is 1,219 (CV = 0.67). For the Western North Atlantic Southern Migratory Coastal Stock, the best available estimate is 9,173 (CV = 0.46). These estimates are from aerial surveys conducted during the summers of 2010 and 2011, covering waters from Florida to New Jersey. The total number of common bottlenose dolphins residing within the Jacksonville Estuarine System Stock is unknown, because previous estimates are greater than 8 years old and deemed unreliable (NOAA, 2016). A mark-recapture analyses based on photo identification data collected from 1994 to 1997 estimated the population size for the Jacksonville Estuarine System Stock to be 412 residents (CV = 0.06) (Gubbins, 2003).

Bottlenose dolphins can thrive in many environments and feed on a variety of prey, such as fish, squid, and crustaceans (e.g., crabs and shrimp). They use different techniques to pursue and capture prey, searching for food individually or cooperatively. For example, they can work to bring fish together into groups (herding). They then take turns charging through the schools to feed. They may also trap schools of fish against sand bars and seawalls for an easy dinner. They also use passive listening and/or high-frequency echolocation to locate prey (NOAA Fisheries, 2020d).

West Indian Manatee

The West Indian manatee is federally listed as an endangered species under the ESA (32 *Federal Register* 4001) and classified as depleted under the MMPA. On January 8, 2016, the USFWS announced its 12-month finding on a petition to downlist the West Indian manatee and proposed a rule to reclassify this species from endangered to threatened (81 *Federal Register* 1000). This is due to substantial improvements in the species' overall status since the original listing as endangered under the ESA in 1967. The West Indian manatee is divided into two distinct subspecies, the Florida manatee (*Trichechus manatus latirostris*) and the Antillean manatee (*Trichechus manatus manatus*) (Lefebvre et al., 2001).

The West Indian manatee occurs in warm coastal and riverine waters of the western North Atlantic Ocean and is found in the southeastern U.S., Central America, northern South America, and in the islands of the Caribbean (Lefebvre et al., 2001). West Indian manatees are a subtropical species with little tolerance for cold, and they are generally restricted to the inland and coastal waters of peninsular Florida during the winter, when they shelter in or near warm-water springs, industrial effluents, and other warm-water sites (Hartman, 1979; Lefebvre et al., 2001; Stith, 2006). In the warmer months, manatees leave these sites and can disperse great distances. Individuals have been sighted as far north as Massachusetts, as far west as Texas, and in all states in between (Fertl et al., 2005; Rathbun, 1988; Schwartz, 1995; USFWS, 2008). However, warm weather sightings are most common in Florida and coastal Georgia. West Indian manatees have an 11-month gestation period and no defined breeding season; calves are born year-round (O'Shea, 1995). Manatee sightings have been recorded near the Spaceport Camden area since 2011, with 89 percent of the sightings occurring between the months of May and November (Department of the Navy, 2015). West Indian manatees are expected to occur frequently within the ROI.

The best available information suggests a minimum population size for the Florida Stock of the West Indian manatee of 4,834 (79 *Federal Register* 3856-3859). This estimate is based on the 2011 Florida Fish and Wildlife Conservation Commission winter count of manatees at warm-water sites throughout peninsular Florida.

West Indian manatees are herbivorous and are known to consume more than 60 species of plants. They typically feed on bottom vegetation, plants in the water column, and shoreline vegetation, such as hyacinths and marine sea grasses (Reynolds, 2009). In some areas, they are known to feed on algae and parts of mangrove trees (Mignucci-Giannoni, 1998; Jefferson, 2008).

Critical habitat for the West Indian manatee was designated in 1976 (41 *Federal Register* 41914) and reorganized in 1977. It encompasses multiple inland rivers and coastal waterways throughout Florida; however, the designation does not define any primary constituent elements. The St. Johns River and Federal navigation channel to the northwest of the ROI are included in this designation (Exhibit D-1). A petition to revise manatee critical habitat was submitted in 2009, and a 12-month finding on that petition by the USFWS stated that revisions should be made, including definition of primary constituent elements (75 *Federal Register* 1574-1581); however, sufficient funding to make these revisions is not currently available.

D.3 Marine Sea Turtles

There are five species of sea turtles that may occur in proximity to Spaceport Camden: the green sea turtle (*Chelonia mydas*), the hawksbill sea turtle (*Eretmochelys imbricata*), the Kemp's ridley sea turtle (*Lepidochelys kempii*), the loggerhead sea turtle (*Caretta caretta*), and the leatherback sea turtle (*Dermochelys coriacea*). The USFWS and NOAA Fisheries share Federal jurisdiction for sea turtles, with the USFWS having lead responsibility on nesting beaches and NOAA Fisheries in the marine environment. The descriptions below focus on marine habitat usage by sea turtles. All sea turtle species that occur in the area are listed under the ESA as either threatened or endangered. The occurrence of the olive ridley sea turtle (*Lepidochelys olivacea*) in the project area is extralimital (outside the species' normal range). Currently, there are no olive ridley nesting beaches in the eastern United States, and there are no known feeding, breeding, or migration areas within the vicinity of Spaceport Camden.

<u>Green Sea Turtle</u>

Breeding populations of the green sea turtle in Florida and the Pacific coast of Mexico were federally listed as endangered species under the ESA in 1978 (43 *Federal Register* 32800); throughout the rest of its range, this species was listed as threatened. In April 2016, the range-wide and breeding population listing of the green turtle was removed and replaced with eight threatened and three endangered DPSs (81 *Federal Register* 20057). Individuals that occur off Spaceport Camden belong to the North Atlantic DPS, which is listed as threatened under the ESA.

Green sea turtles live all over the world, nest in over 80 countries, and live in the coastal areas of more than 140 countries. In the U.S., nesting green sea turtles are primarily found in the Hawaiian Islands, U.S. Pacific Island territories (Guam, the Commonwealth of the Northern Mariana Islands, and American Samoa), Puerto Rico, the Virgin Islands, and the East Coast of Florida (NOAA Fisheries, 2020e). Between 2011 and 2012, female nesting abundance in Georgia was estimated to be five individuals (NOAA, 2015).

After emerging from the nest, green turtle hatchlings swim to offshore areas where they float passively in major current systems. Post-hatchling green turtles forage and develop in the open ocean associated with floating mats of algae of the genus *Sargassum*. At the juvenile stage (estimated at 5 to 6 years) they leave the open-ocean habitat and retreat to protected lagoons and open coastal areas that are rich in seagrass or marine algae (Bresette, 2006), where they will spend most of their lives (Bjorndal & Bolten, Growth rates of immature green turtles, Chelonia mydas, on feeding grounds in the southern Bahamas, 1988). In the southeastern U.S., green sea turtles nest from June through September, and incubation ranges from 45 to 75 days, depending on incubation temperatures (Department of the Navy, 2015). Green sea turtles have been reported in the Spaceport Camden ROI and turning basin (U.S. Army Corps of Engineers, 2016).

The green sea turtle is the only species of sea turtle that, as an adult, primarily consumes plants and other types of vegetation (Mortimer, 1995). They have a finely serrated jaw that assists with tearing vegetation, and the esophagus is lined with papillae (spiny projections) that trap food before swallowing. While primarily herbivorous, a green sea turtle's diet changes substantially throughout its life. Very young green sea turtles are omnivorous (Bjorndal, 1997). Post-hatchling green sea turtles off the coast of southeastern Florida were found to feed near the surface on seagrasses or at shallow depths on comb jellies and unidentified gelatinous eggs (Salmon, 2004). Pelagic juveniles smaller than 8 to 10 inches (20.3 to 25.4 centimeters) in length eat worms, young crustaceans, aquatic insects, grasses, and algae (Bjorndal, 1997). After settling in coastal juvenile developmental habitat, when they are 8 to 10 inches (20.3 to 25.4 centimeters) in length, they eat mostly mangrove leaves, seagrass, and algae (Balazs, 1994; Nagaoka, 2012).

The loss of eggs to land-based predators such as mammals, snakes, crabs, and ants occurs on some nesting beaches. As with other sea turtles, hatchlings may be preyed on by birds and fish. Sharks are the primary nonhuman predators of juvenile and adult green sea turtles at sea (NMFS and USFWS, 1991).

Critical habitat was designated for the green sea turtle in 1998 (63 *Federal Register* 46693) but does not occur within the ROI. NOAA Fisheries had indicated that it is in the process of identifying other potential critical habitat, which will be proposed in a future rulemaking (NOAA Fisheries, 2020e).

Hawksbill Sea Turtle

The hawksbill sea turtle was federally listed as an endangered species under the ESA in 1970 (35 *Federal Register* 8491). In June 2013, NMFS and the USFWS released a 5-year review, which concluded that the hawksbill sea turtle remains in danger of extinction throughout all or a significant portion of its range and should not be delisted or reclassified (NMFS and USFWS, 2013a).

The hawksbill is the most tropical of the world's sea turtles, rarely occurring above 35° north or below 30° south (The State of the World's Sea Turtles Team, 2008; Witzell, 1983). Hawksbill turtles use different habitats during different stages of their life cycle but are most commonly associated with healthy coral reefs (NOAA Fisheries, 2020f). Hatchlings are believed to occupy open-ocean waters, associating themselves with surface algal mats in the Atlantic Ocean (Witzell, 1983; Parker, 1995; Witherington & Hirama, 2006). Juveniles leave the open-ocean habitat after 3 to 4 years and settle in coastal foraging areas, typically coral reefs but occasionally seagrass beds, algal beds, mangrove bays, and creeks (Mortimer & Donnelly, Hawksbill Turtle (Eretmochelys imbricata), 2008). Juveniles and adults share the same foraging areas, including tropical nearshore waters associated with coral reefs, hard bottoms, or estuaries with mangroves (Musick & Limpus, 1997).

In the continental United States, hawksbill turtles have been recorded in all Gulf states and along the Atlantic coast as far north as Massachusetts (NOAA Fisheries, 2020f). However, sightings north of Florida are rare, and Texas is the only other state where hawksbills are sighted with any regularity (Keinath et al., 1991; Lee, 1981; Parker, 1995; Plotkin P. T., 1995). Within the continental U.S., nesting is restricted to the southeast coast of Florida and the Florida Keys, but nesting is rare in these areas (NOAA Fisheries, 2020f). Considering that Camden County is located north of the typical nesting range for the hawksbill turtle, and the region lacks suitable juvenile and adult habitat, the likelihood that this species will occur within the study area is low. Critical habitat was designated for the hawksbill sea turtle in 1998 (63 *Federal Register* 46693) but does not occur in or near the ROI.

The 2013 5-year review (NMFS and USFWS, 2013a) determined that the population trends and distribution of the hawksbill sea turtle was largely unchanged from those identified in the previous (2007) 5-year review. The hawksbill turtle was once abundant in tropical and subtropical regions throughout the globe. Over the last century, this species has declined in most areas and stands at only a fraction of its historical abundance. Although greatly depleted from historical levels, in general, nesting populations in the Atlantic are doing better than those in the Indian and Pacific Oceans (NMFS and USFWS, 2013a).

Post-hatchling hawksbill turtles feed on floating *Sargassum* in the open ocean (Plotkin & Amos, 1988). During the juvenile stage, hawksbills are considered omnivorous, feeding on sponges, sea squirts, algae, molluscs, crustaceans, jellyfish, and other aquatic invertebrates (Bjorndal, 1997). Older juveniles and adult hawksbills are more specialized, feeding primarily on sponges, which compose as much as 95 percent of their diet in some locations (Witzell, 1983; Meylan, 1988). The hawksbill turtle fills a unique ecological niche in marine and coastal ecosystems; feeding on sponges helps to control populations of sponges that may otherwise compete for space with reef-building corals (Hill, 1998; Leon & Bjorndal, 2002).

As with other sea turtles, hatchlings may be preyed upon by terrestrial predators after emerging from the nest and by birds and fish at sea. Sharks are the primary nonhuman predators of juvenile and adult hawksbills at sea (Witzell, 1983).

Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle was federally listed as an endangered species under the ESA in 1970 (35 *Federal Register* 18319). In August 2015, NMFS and the USFWS released a 5-year review that evaluated the best available information and recommended that the Kemp's ridley remain classified as endangered (NMFS and USFWS, 2015).

Distribution of the Kemp's ridley sea turtle is limited to the Gulf of Mexico and the western North Atlantic Ocean from Florida to the Grand Banks (NMFS and USFWS, 2015; NOAA Fisheries, 2020g). There are also sporadic reports of this species occurring near the Azores, in the waters off Morocco, and in the Mediterranean Sea. Adult female Kemp's ridley sea turtles take part in mass synchronized nesting emergences known as "arribadas" on only a few nesting beaches; a strategy unique to *Lepidochelys* spp. Kemp's ridley turtles may also be solitary nesters, but this is less common and generally occurs outside of the main nesting areas in Mexico (NMFS and USFWS, 2015). In the U.S., nesting occurs primarily in Texas, and occasional nesting occurs in Florida, Alabama, Georgia, South Carolina, and North Carolina (NMFS and USFWS, 2015).

Like other sea turtles, newly emerged hatchlings may forage and develop in floating *Sargassum* habitats of the North Atlantic Ocean. At around 2 years of age, juveniles migrate to habitats along the U.S. Atlantic continental shelf from Florida to New England (Morreale, 1998; Peña, 2006). Habitats frequently used by adult and juvenile Kemp's ridley sea turtles are muddy or sandy bottoms of warm-temperate to subtropical sounds, bays, estuaries, tidal passes, shipping channels, and beachfront waters, where their preferred food, the blue crab, is abundant (Lutcavage & Musick, 1985; Seney, 2005). Kemp's ridley turtles have been recorded in nearby Kings Bay (U.S. Army Corps of Engineers, 2016) and, therefore, may be present in the vicinity of Spaceport Camden. The occurrence of this species in the study area is expected to be seasonal, rare, and correlate with the availability of preferred species of prey.

Since the mid-1980s, the number of nests observed at the main nesting beach of Kemp's ridley sea turtles, Rancho Nuevo, and nearby beaches increased 14 to 16 percent per year and is expected to continue to grow 12 to 16 percent per year, provided that nest protection and other management measures continue (Heppell, 2005). Preliminary data through May 30, 2015, show a total of 11,955 for the three main nesting sites: Rancho Nuevo, Tepehuajes, and Playa Dos (NMFS and USFWS, 2015).

Kemp's ridley sea turtles feed primarily on crabs but are also known to prey on molluscs, shrimp, fish, jellyfish, and plant material (Frick, 1999; Marquez-M., 1994). Blue crabs (*Callinectes sapidus*) and spider crabs (*Libinia emarginata*) are important prey species for the Kemp's ridley (Keinath, 1987; Lutcavage & Musick, 1985; Seney, 2005).

In February 2010, NOAA Fisheries and the USFWS were jointly petitioned (WildEarth Guardians, 2010) to designate critical habitat for Kemp's ridley sea turtles for nesting beaches along the Texas coast and marine habitats in the Gulf of Mexico and Atlantic Ocean. No further action on this petition has been documented (NOAA Fisheries, 2020g).

Loggerhead Sea Turtle

The loggerhead sea turtle was federally listed as a threatened species throughout its range under the ESA in 1978 (43 *Federal Register* 32800). In September 2011, the range-wide population listing of the loggerhead turtle was removed and replaced with four threatened and five endangered DPSs (76 *Federal Register* 58868). The study area is located within the Northwest Atlantic DPS, which is listed as threatened.

Loggerhead sea turtles occur in temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. In the Atlantic, loggerhead turtles range from Newfoundland to as far south as Argentina. They are the most abundant species of sea turtle found in U.S. coastal waters of the Atlantic Ocean. Adult loggerheads make extensive migrations between foraging areas and nesting beaches. Major nesting concentrations in the U.S. are found from North Carolina through southwest Florida. Loggerheads nest on ocean beaches, generally preferring high-energy, relatively narrow, steeply sloped, coarse-grained beaches (NOAA Fisheries, 2020h). At emergence, hatchlings swim to offshore currents and remain in the open ocean, often associating with floating mats of algae of the genus *Sargassum* (Carr, 1986; Carr, 1987; Witherington & Hirama, 2006). Loggerheads spend the first 7 to 15 years (an average 12 years) of their lives in open ocean and then migrate from oceanic to nearshore coastal areas (Bolten, 2003; Mansfield, 2006; NOAA Fisheries, 2020h). Nearshore, coastal areas also provide crucial foraging, internesting, and migratory habitat for adult loggerheads in the western North Atlantic Ocean (NMFS, 2013).

The nesting season for loggerhead sea turtles in the Northwest Atlantic extends from late April through early September, with the largest nesting aggregations in the U.S. occurring along peninsular Florida (NMFS, 2013). Smaller nesting aggregations also occur along the U.S. East Coast from Georgia through North Carolina and in the Northern Gulf of Mexico. The total estimated loggerhead sea turtle nesting in the U.S. is approximately 68,000 to 90,000 nests per year (NOAA Fisheries, 2020h). Loggerheads have nested on Cumberland Island National Seashore since record keeping began in 1998 (Department of the Navy, 2015; SEATURTLE.ORG, 2020).

Juvenile and subadult loggerhead turtles are omnivorous, foraging on crabs, molluscs, jellyfish, and vegetation captured at or near the surface (Dodd, 1988). Adult loggerhead sea turtles are generalized carnivores that forage on nearshore bottom-dwelling invertebrates (molluscs, crustaceans, and anemones) and sometimes fish (Dodd, 1988).

Globally, common predators of eggs and hatchlings on nesting beaches are ghost crabs (*Ocypode* spp.), raccoons (*Procyon lotor*), feral pigs (*Sus scrofa*), foxes (*Vulpes* spp.), coyotes (*Canis latrans*), armadillos (Chlamyphoridae and Dasypodidae), and fire ants (*Solenopsis* spp.) (Dodd, 1988). In the water, hatchlings are susceptible to predation by birds and fish. Sharks are the primary predator of juvenile and adult loggerhead sea turtles (Fergusson, 2000; Simpfendorfer, 2001).

On July 10, 2014, NMFS issued a final rule (79 *Federal Register* 39856) designating specific areas of critical habitat that included 38 occupied marine areas within the range of the Northwest Atlantic Ocean DPS (Exhibit 3.2-4, Terrestrial and Marine Species Critical Habitat, in the EIS). These areas contain one or a combination of habitat types: nearshore reproductive habitat, winter area, breeding areas, constricted migratory corridors, and/or *Sargassum* habitat. On the same date, the USFWS issued a separate rule (79 *Federal Register* 39756) designating approximately 685 miles of loggerhead sea turtle nesting beaches as critical habitat in the states of North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. These beaches account for 45 percent of an estimated 1,531 miles of coastal beach shoreline and approximately 84 percent of the documented nesting (numbers of nests) within these six states. Cumberland Island National Seashore is one of the most important loggerhead sea turtle nesting areas in Georgia, accounting for 25 to 30 percent of the statewide nesting total. Since 2014, Cumberland Island has produced over 1,800 nests (National Park Service, 2019).Given the presence of both nesting and foraging habitat, loggerhead sea turtles are expected to occur regularly in the study area.

Leatherback Sea Turtle

Under the ESA in 1970 (35 *Federal Register* 8491), the leatherback sea turtle was federally listed as an endangered species throughout its range. In November 2013, NMFS and the USFWS released a 5-year review that evaluated the best available information and recommended that the leatherback turtle remain classified as endangered (NMFS and USFWS, 2013b). NMFS and the USFWS also reported that information exists that indicates an analysis and review of the species should be conducted in the future to determine the application of the DPS policy to the leatherback turtle (NMFS and USFWS, 2013b).

Leatherback turtles have a wide global distribution and can be found in the Atlantic, Pacific, and Indian Oceans (NOAA Fisheries, 2020i). Upwelling areas serve as nursery grounds for post-hatchling and early juvenile leatherback sea turtles because these areas provide a high biomass of prey (Musick & Limpus, 1997). Late juvenile and adult leatherback sea turtles are known to range from mid-ocean to the continental shelf and nearshore waters (Grant, 1993; Schroeder, 1987; Shoop, 1992). Juvenile and adult foraging habitats include both coastal and offshore feeding areas (Frazier, 2001).

Nesting typically occurs between March and July in the southeastern U.S., with incubation requiring between 55 and 75 days, depending on incubation temperatures (Department of the Navy, 2015). Leatherback populations in the Caribbean, Atlantic, and Gulf of Mexico are generally increasing. The Atlantic coast of Florida is one of the main nesting areas in the continental U.S. for which nesting data reveal a general upward trend (NOAA Fisheries, 2020i).

Leatherback sea turtles have pointed, tooth-like cusps and sharp-edged jaws that are adapted for a diet of soft-bodied open-ocean prey such as jellyfish, which is their main food source (Bjorndal, 1997; James & Herman, 2001; Salmon, 2004). Leatherback sea turtles feed throughout the water column (Davenport, 1988; Eckert, 1989; Eisenberg, 1983; Grant, 1993; James et al., 2005; Salmon, 2004).

Globally, predators of leatherback sea turtle eggs include feral pigs, dogs, raccoons, ghost crabs, and fire ants. As with other sea turtle species, leatherback hatchlings are preyed on by birds and large fish such as tarpon (*Megalops atlanticus*) and snapper (Lutjanidae). Sharks and killer whales are predators of adult leatherbacks (NMFS and USFWS, 2013b).

Critical habitat was designated for the leatherback sea turtle in the waters adjacent to Sandy Point Beach, St. Croix, and U.S. Virgin Islands in 1979 (44 *Federal Register* 17710). In January 2012, NMFS revised the critical habitat designation to include waters along the U.S. west coast (77 *Federal Register* 4170). There is no critical habitat designated for the leatherback turtle along the east coast of the continental U.S. The occurrence of this species in the study area is expected to be seasonal, rare, and correlate with the availability of preferred species of prey. Leatherback turtles may also occur in the in the study area while migrating between nesting habitat south and more-productive foraging habitat in the North Atlantic.

D.4 Marine Fish

Table D-1 lists the most abundant fish species and their life stages occurring within the ROI.

Fish occurrence is influenced by physical factors (for example, bottom topography, water temperature, salinity, and depth), as well as biotic factors such as food availability. Fish that occur in the vicinity of Spaceport Camden may be generally categorized as those associated with estuaries (transition zone between fresh and salt water), bottom structure, unstructured seafloor, or the pelagic (open water) environment. A report of the biological resources of the lower St. Johns River (Brody, 1994) identified 170 fish species, many of which are presumably estuarine species. Many additional species inhabit nearshore and offshore areas of the South Atlantic Ocean.

Estuarine fish inhabit areas of varying salinity in the lower portion of the St. Johns River and nearshore areas of the Atlantic Ocean. Some species, such as bay anchovy (*Anchoa mitchilli*) and Atlantic silverside (*Menidia menidia*), typically occur year-round in the estuarine environment but may occur very near the marine shoreline. Other species may move between estuarine and more offshore marine environments.

Striped mullet (*Mugil cephalus*), black drum (*Pogonias cromis*), and sturgeon species are examples of fish that occur in both estuarine and offshore waters, depending on life stage and/or season. Structure-dependent species (typically adults) are associated with areas of topographic relief (e.g., ledges, hard bottom habitat), biotic structures (e.g., reefs, shellfish beds), or artificial structures (e.g., artificial reefs, shipwrecks). Common structure-oriented fish include numerous species of groupers, snappers, drums, amberjack, and triggerfish. Over 300 species of reef fish occur over the continental shelf in the region of Jacksonville (Department of the Navy, 2008). Bottom fish that do not rely significantly on structures are often associated with soft substrates and include species such as flatfish (e.g., flounders) and stingrays. Pelagic species typically occur away from shore (although some species enter estuarine waters at times) and may occupy any level of the water column. Typical pelagic species include mackerels, cobia (*Rachycentron canadum*), and sharks.

Atlantic Sturgeon

The Atlantic sturgeon (*Acipenser oxyrinchus*) is federally listed as endangered and is divided into four DPSs. The South Atlantic DPS population corresponds with the location of the action area. Atlantic sturgeon is a long-lived, estuarine-dependent, anadromous fish, meaning adults spawn in freshwater in the spring/summer and migrate into estuarine and marine waters in the fall/winter. Atlantic sturgeon are similar in appearance to shortnose sturgeon (*Acipenser brevirostrum*) but can be distinguished by their larger size, smaller mouth, different snout shape, and scutes. Atlantic sturgeon are benthic feeders and typically forage on benthic invertebrates, including crustaceans, worms, mollusks.

Spawning adults migrate upriver in spring, typically beginning February/March. Following spawning, males may remain in the river or lower estuary until the fall; females typically exit the rivers within 4 to 6 weeks. Juveniles move downstream and inhabit brackish waters for a few months; when they reach a size of about 30 to 36 inches (76 to 92 centimeters), they move into nearshore coastal waters. Tagging data indicate that these immature Atlantic sturgeon travel widely once they emigrate from their natal (birth) rivers. Subadults and adults live in coastal waters and estuaries when not spawning, generally in shallow (10- to 50-meter depth) nearshore areas dominated by gravel and sand substrates. Sturgeon eggs are highly adhesive and are deposited on bottom substrate, usually on hard surfaces (e.g., cobble). It is likely that cold, clean water is important for proper larval development. Once larvae begin migrating downstream, they use benthic structure (especially gravel matrices) as refuges. Juveniles usually reside in estuarine waters for months to years.

Historical threats include overharvest, which led to widespread declines in Atlantic sturgeon abundance and commercial fishing from the 1950s through the 1990s. The most significant threats include bycatch of sturgeon in some commercial fisheries; dams that block access to spawning areas; habitat degradation through poor water quality, dredging of spawning areas, water withdrawals from rivers, saltwater intrusion from groundwater pumping, and chemical contamination from sediments; and injury or mortality from vessel strikes (e.g., Delaware and James Rivers) (NOAA Fisheries, 2020j).

Critical habitat has been proposed for the South Atlantic Sturgeon DPS, specifically in the Satilla River (78 *Federal Register* 36078, June 3, 2016), which is north of Spaceport Camden.

Table D-1. Managed Fishery Species Potentially Present in the Action Area

Common Name	Scientific Name	Habitat Associations	Nursery/ Spawning Habitats	Sensitive Life Stage Use of Action Area	Primary Prey	Life Stage in Project Area
Atlantic menhaden	*Brevoortia tyrannus*	Pelagic – water column; migratory	Nursery: estuary Spawn: offshore (mainly north of Carolinas)	Transient	Plankton	P/J/S/A
Bluefish	*Pomatomus saltatrix*	Pelagic – water column; migratory	Nursery: estuary, inshore Spawn: offshore	Nursery (spring–summer) Transient	Opportunistic feeders on fish (e.g., menhaden and herring), squid, lobster	J/S/A
Red drum	*Sciaenops ocellatus*	Tidal creeks, aquatic vegetation, mangrove areas, oyster reefs, unconsolidated sediment, beaches; migratory	Nursery: estuary, inshore Spawn: inshore-offshore	Nursery (summer–fall) Spawn (late summer-fall) Transient	Opportunistic feeders on fish, invertebrates, small crabs, and shrimp	P/J/S/A
Spot	*Leiostomus xanthurus*	Tidal creeks, unconsolidated sediment; migratory	Nursery: estuary Spawn: offshore	Nursery (spring–fall, may overwinter) Transient	Benthic invertebrates such as worms and crustaceans	P/J/S/A
Spotted seatrout	*Cynoscion nebulosus*	Tidal marsh creeks, oyster beds, shallow grass beds, open water; generally nonmigratory	Nursery: estuary Spawn: estuary, inshore	Spawn (spring–summer) Transient	Shrimp and small fish	J/S/A
Weakfish	*Cynoscion regalis*	Sand and sand/seagrass areas; migratory	Nursery: estuary Spawn: estuary, inshore	Spawn (spring–summer) Transient	Shrimp and small schooling fish such as herring and anchovy	J/S/A
Highly Migratory Species—Atlantic Sharks						
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	Pelagic – water column; migratory	Nursery: estuary, inshore	Nursery (spring–fall) Transient	Opportunistic feeders on fish (e.g., menhaden, eels, silversides, wrasses, jacks), shrimp, crabs, and mollusks	J/S/A
Bonnethead shark	*Sphyrna tiburo*	Pelagic – water column; migratory	Nursery: estuary, inshore	Nursery (warm months) Transient	Opportunistic feeders on crustaceans (e.g., shrimp), mollusks, and fish	J/S/A

Table D-1. Managed Fishery Species Potentially Present in the Action Area

Common Name	Scientific Name	Habitat Associations	Nursery/ Spawning Habitats	Sensitive Life Stage Use of Action Area	Primary Prey	Life Stage in Project Area
Coastal Migratory Pelagics						
Cobia	*Rachycentron canadum*	Pelagic – water column, manmade structures, over reefs, mangroves; migratory	Nursery: inshore Spawn: offshore	Transient	Opportunistic feeders on small fish, crabs, shrimp, and squid	P/J/S/A
Spanish mackerel	*Scomberomorous maculatus*	Pelagic – water column, over rock or seagrass; migratory	Nursery: inshore Spawn: offshore	Nursery (spring–fall) Transient	Pelagic schooling fish such as anchovies	P/J/S/A
Shad and River Herring						
Blueback herring	*Alosa aestivalis*	Eggs – demersal on substrate; juveniles – submerged vegetation; adults – water column; migratory	Nursery: river estuary Spawn: river	Transient	Plankton	J/S/A
Hickory shad	*Alosa mediocris*	Pelagic – water column; migratory	Nursery: estuary, inshore Spawn: river	Nursery (spring–summer) Transient	Opportunistic feeders on small fish, squid, small crabs, and pelagic crustaceans	P/J/S/A
South Atlantic Snapper—Grouper Complex						
Atlantic spadefish	*Chaetodipterus faber*	Manmade structures, oyster reefs, mangroves, unconsolidated sediment; migratory	Nursery: estuary, inshore Spawn: inshore, offshore	Nursery (spring–summer, may overwinter) Transient	Benthic invertebrates including crustaceans, mollusks, annelids, sponges, and cnidarians; plankton	P/J/S
Bank sea bass	*Centropristis ocyurus*	Hard bottom; unconsolidated sediment	Nursery: inshore Spawn: offshore	Transient	Benthic invertebrates (e.g., crustaceans), squid, and small fish	P/J/S
Black sea bass	*Centropristis striata*	Manmade structures, oyster reefs, submerged vegetation, unconsolidated sediment; migratory	Nursery: estuary, inshore Spawn: offshore	Nursery (spring–summer) Transient	Benthic invertebrates (crustaceans, mollusks, and worms) and fish	P/J/S

Table D-1. Managed Fishery Species Potentially Present in the Action Area

Common Name	Scientific Name	Habitat Associations	Nursery/ Spawning Habitats	Sensitive Life Stage Use of Action Area	Primary Prey	Life Stage in Project Area
Crevalle jack	*Caranx hippos*	Pelagic – water column, juveniles may occur on seagrass beds; migratory	Nursery: estuary, inshore Spawn: offshore	Nursery (spring–summer) Transient	Opportunistic feeders on fish, shrimp, and invertebrates	P/J/S/A
Gray snapper	*Lutjanus griseus*	Rocky areas, seagrass beds, mangrove areas, reefs, unconsolidated sediment; offshore movement with age	Nursery: estuary, lower reaches of rivers Spawn: offshore	Transient	Opportunistic feeders on small fish, shrimps, crabs, gastropods, and cephalopods	J/S/A
Lane snapper	*Lutjanus synagris*	Mangrove and vegetated flats, reefs, unconsolidated sediment; offshore movement with age	Nursery: mangrove and sea grass beds, bays Spawn: offshore	Transient	Opportunistic feeders on small fish, shrimps, crabs, gastropods, and cephalopods	J/S
Rock sea bass	*Centropristis philadelphica*	Hard bottom, rocks, jetties, unconsolidated sediment; offshore movement with age	Nursery: inshore Spawning: offshore	Nursery (summer–fall) Transient	Opportunistic feeders on small fish, crustaceans, and shellfish	P/J/S
Sheepshead	*Archosargus probatocephalus*	Structure, unconsolidated sediment; limited seasonal movements	Nursery: estuary, inshore Spawn: offshore	Nursery (spring–summer) Transient	Benthic invertebrates, including crabs, crustaceans, and mollusks	P/J/S
Shrimp						
Brown shrimp	*Farfantepenaeus aztecus*	Marsh grass-water interface, mud-sandy substrate; migratory	Nursery: estuary Spawn: offshore	Nursery (spring–summer; may overwinter)	Invertebrates, decaying plant matter, organic debris	P/J/S/A
White shrimp	*Litopenaeus setiferus*	Marsh grass-water interface, mud-sandy substrate; migratory	Nursery: estuary Spawn: offshore	Nursery (spring–summer; may overwinter)	Invertebrates, decaying plant matter, organic debris	P/J/S/A

Notes: A = adult; J = juvenile; P = post-larva; S = sub-adult

Shortnose Sturgeon

The shortnose sturgeon (*Acipenser brevirostrum*) is federally listed as endangered. Critical habitat has not been designated for this species. The shortnose sturgeon is the smallest of the three sturgeon species that occur in eastern North America. Similar to Atlantic sturgeon, shortnose sturgeon are anadromous fish living mainly in the slower-moving riverine waters or nearshore marine waters and migrating periodically into faster-moving freshwater areas to spawn. Spawning typically occurs in the coastal rivers along the east coast of North America from the St. John River in Canada to the St. Johns River in Florida. Shortnose sturgeon do not appear to make long-distance offshore migrations. They are benthic feeders, eating crustaceans, mollusks, and insects. The most significant threats to shortnose sturgeon include habitat alterations from dams, dredging, water withdrawals, saltwater intrusion from groundwater pumping, and chemical contamination of sediments. Other threats include bycatch primarily from gillnet fisheries but also from pound nets, hoop nets, catfish pots, shrimp trawls, and recreational hooks and lines (NOAA Fisheries, 2020k).

Historically, the shortnose sturgeon had wide occurrence along the eastern seaboard that included rivers in Georgia such as the St. Marys River (NMFS, 1998). Breeding populations are specific to a particular river, and today the southern portion of their range includes the Altamaha, Ogeechee, and Savannah Rivers in Georgia. Their southern range is characterized by distinct populations in two Georgia rivers (the Ogeechee and Altamaha Rivers) and one in Florida. The National Marine Fisheries Shortnose Sturgeon Recovery Plan indicates that collection efforts for sturgeon in the St. Marys and Satilla Rivers in 1994 and 1995 were not successful (NMFS, 1998). Therefore, probability of occurrence within the Spaceport Camden Action Area is low.

D.5 Marine Invertebrates

Animals that live on the seafloor are called benthos. Most of these animals lack a backbone and are called invertebrates. Typical benthic invertebrates include sea anemones, sponges, corals, sea stars, sea urchins, worms, bivalves, crabs, and many more. Invertebrates also occur in the water column.

Macroinvertebrates (those large enough to be seen easily with the unaided eye, such as jellyfish) are relatively infrequent in the water column compared to bottom habitats. However, zooplankton may be abundant. Zooplankton includes organisms that drift passively or swim weakly in the water column, such as protozoans, copepods, and the eggs and larvae of many marine species.

Foraminifera, Radiolarians, Ciliates (Kingdom Protozoa)

Foraminifera, radiolarians, and ciliates are miniscule singled-celled organisms, sometimes forming colonies of cells, belonging to kingdom Protozoa. They are found in the water column and seafloor, and most are microscopic. Foraminifera form shells out of calcium carbonate, organic compounds, or sand or other particles cemented together (University of California Berkeley, 2010a). Radiolarians are microscopic zooplankton that form shells made of silica. Ciliates are protozoans with small hair-like extensions that are used for feeding and movement. In general, the distribution of foraminifera, radiolarians, and ciliates is patchy, occurring in regions with favorable growth conditions.

Sponges (Phylum Porifera)

Sponges are bottom-dwelling, multicellular animals that may be best described as an aggregation of cells that perform different functions. Sponges are largely sessile and are common in the Atlantic Ocean at all depths. Sponges are typically found on intermediate to hard bottoms, artificial structures, and biotic reefs. Water flow through the sponge provides food, oxygen, and removes wastes. This filtering process is an important coupler of pelagic and benthic processes (Perea-Bla´zquez et al., 2012). Many sponges form calcium carbonate or silica spicules or bodies embedded in cells to provide structural support. Sponges provide homes for a variety of animals including shrimp, crabs, barnacles, worms, brittle stars, sea cucumbers, and other sponges (Colin & Arneson, 1995).

Corals, Hydroids, Jellyfish (Phylum Cnidaria)

Cnidarians include corals, sea anemones, sea pens, sea pansies, hydroids, hydromedusae, jellyfish, and sea wasps. Individuals are characterized by a simple digestive cavity with an exterior mouth surrounded by tentacles. Microscopic stinging capsules known as nematocysts are present (especially in the tentacles) and are a defining characteristic of the phylum. The majority of species are carnivores that eat zooplankton, small invertebrates, and fishes. However, many species suspension feed on plankton and dissolved organic matter or contain symbiotic dinoflagellate algae (zooxanthellae) from which they may derive nutrients (Lough & van Oppen, 2009). Cnidarians have many diverse body shapes but may generally be categorized as one of two basic forms: polyp and medusa. The polyp form is tubular and sessile and includes examples such as corals and anemones. The medusa form is bell- or umbrella-shaped (e.g., jellyfish), with tentacles typically around the rim. The medusa form generally is pelagic. Many species alternate between these two forms during their life cycle.

A wide variety of cnidarian species occur in nearshore waters of the Atlantic Ocean at all depths and in most habitats. Sessile species typically occur on hard surfaces such as hard bottom habitat or artificial reefs. Some cnidarians form biotic habitats that harbor other animals and influence ecological processes, the primary examples being shallow-water and deep-water corals.

Flatworms (Phylum Platyhelminthes)

Flatworms are the simplest form of marine worm. The largest group of flatworms are parasites commonly found in fishes, seabirds, and marine mammals (University of California Berkeley, 2010b). The remaining groups are nonparasitic carnivores, living without a host. Flatworms are found in various habitats.

Ribbon Worms (Phylum Nemertea)

Ribbon worms, with their distinct gut and mouth parts, are more complex than flatworms. A unique feature of ribbon worms is the extendable proboscis (an elongated, tubular mouth part), which can be ejected to capture prey, to aid in movement, or for defense. Most ribbon worms are active, bottom-dwelling predators of other small invertebrates such as annelid worms and crustaceans (Castro & Huber, 2000). Some are scavengers or symbiotic (parasites or commensals). Some ribbon worms are pelagic, with approximately 100 pelagic species identified from all the oceans (Roe & Norenburg, 1999). Pelagic species generally drift or slowly swim by undulating the body. Ribbon worms occur in most marine environments, although usually in low abundances.

Round Worms (Phylum Nematoda)

Round worms are small and cylindrical and abundant in sediment habitats such as soft to intermediate shores and soft to intermediate bottoms and can also be found in host organisms as parasites (Castro & Huber, 2000). Round worms are some of the most widespread marine invertebrates. This group has a variety of food preferences, including algae, small invertebrates, annelid worms, and organic material from sediment.

Segmented Worms (Phylum Annelida)

Segmented worms include approximately 12,000 marine species worldwide in the phylum Annelida, although most marine forms are in the class Polychaeta (World Register of Marine Species Editorial Board, 2015). Polychaetes are the most complex group of marine worms, with a well-developed respiratory and gastrointestinal system (Castro & Huber, 2000). Different species may be highly mobile or burrow in the bottom. Polychaete worms exhibit a variety of lifestyles and feeding strategies and may be predators, scavengers, deposit-feeders, filter-feeders, or suspension feeders (Jumars et al., 2014). The variety of feeding strategies and close connection to the bottom make annelids an integral part of the marine food web. Burrowing and agitating the sediment increase the oxygen content of bottom sediments and make important buried nutrients available to other organisms. This allows bacteria and other organisms, which are also an important part of the food web, to flourish on the bottom. Benthic polychaetes also vary in their mobility, including sessile attached or tube-dwelling worms, sediment burrowing worms, and mobile surface or subsurface worms. Some polychaetes are commensal or parasitic. Many polychaetes have planktonic larvae.

The reef-building tube worm (*Phragmatopoma caudata*, synonymous with *P. lapidosa*) constructs shallow-water worm reefs in some areas (Florida Oceanographic Society, 2017). Large pseudocolonies of worms (formed from large numbers of individual larvae that settle in close proximity and undergo fusion to form complex habitats) develop relatively smooth mounds up to 2 meters high (Zale & Merrifield, 1989). The species is particularly common along Florida's east coast, at depths to 2 meters.

Bryozoans (Phylum Bryozoa)

Bryozoans are small box-like, colony-forming animals that make up the "lace corals." Colonies can be encrusting, branching, or free-living. Bryozoans may form habitat similar in complexity to sponges (Buhl-Mortensen et al., 2010). Bryozoans attach to a variety of surfaces, including intermediate and hard bottom, artificial structures, and algae, and feed on particles suspended in the water (University of California Berkeley, 2010c). Habitat-forming species are most common on temperate continental shelves with relatively strong currents (Wood et al., 2012).

Squid, Bivalves, Sea Snails, Chitons (Phylum Mollusca)

Molluscs occur throughout the Atlantic Ocean at all depths. Sea snails and slugs (gastropods), clams, and mussels (bivalves), chitons (polyplacophorans), and octopus and squid (cephalopods) are examples of common molluscs. Snails and slugs occur in a variety of soft, intermediate, hard, and biogenic habitats. Chitons are typically found on hard bottom and artificial structures from the intertidal to littoral zone but may also be found in deeper water and on substrates such as aquatic plants. Many molluscs possess a muscular organ called a foot, which is used for mobility. Many molluscs also secrete an external shell, although some molluscs have an internal shell or no shell at all. Sea snails and slugs eat fleshy algae and a variety of invertebrates, including hydroids, sponges, sea urchins, worms, other snails, and small crustaceans, as well as detritus (Castro & Huber, 2000). Clams, mussels, and other bivalves feed are filter feeders, ingesting suspended food particles (e.g., phytoplankton, detritus). Chitons, sea snails, and slugs use rasping tongues, known as radula, to scrape food (e.g., algae) off rocks or other hard surfaces. Squid and octopus are active swimmers at all depths and use a beak to prey on a variety of organisms including fish, shrimp, and other invertebrates. Octopuses mostly prey on fish, shrimp, eels, and crabs.

Shrimp, Crab, Lobster, Barnacles, Copepods (Phylum Arthropoda)

Shrimp, crabs, lobsters, barnacles, and copepods are animals with an exoskeleton, which is a skeleton on the outside of the body and are classified as crustaceans in the phylum Arthropoda. There are over 57,000 marine arthropod species, with most of these belonging to the subphylum Crustacea (World Register of Marine Species Editorial Board, 2015). These organisms occur throughout the Atlantic Ocean at all depths. Crustaceans may be carnivores, omnivores, predators, or scavengers, preying on molluscs (primarily gastropods), other crustaceans, echinoderms, small fishes, algae, and seagrass. Barnacles and copepods are filter feeders, extracting algae and small organisms from the water. As a group, arthropods occur in a wide variety of habitats. Shrimp, crabs, lobsters, and copepods may be associated with soft to hard substrates, artificial structures, and biogenic habitats. Barnacles inhabit hard and artificial substrates.

Sea Stars, Sea Urchins, Sea Cucumbers (Phylum Echinodermata)

Organisms in this phylum include species such as sea stars, sea urchins, and sea cucumbers. Asteroids (e.g., sea stars), echinoids (e.g., sea urchins), holothuroids (e.g., sea cucumbers), ophuiroids (e.g., brittle stars and basket stars), and crinoids (e.g., feather stars and sea lilies) are symmetrical around the center axis of the body (Mah & Blake, 2012). Echinoderms occur at all depth ranges and are almost exclusively benthic, potentially found on all substrates and structures. Many echinoderms are either scavengers or predators on sessile organisms such as algae, stony corals, sponges, clams, and oysters, although some also predate on other species of sea stars. Some species, however, filter food particles from sand, mud, or water.

Habitats present at the alternate mooring sites include the water column and unconsolidated substrate (primarily sand). Therefore, invertebrates that may occur in the area would consist of zooplankton, pelagic macroinvertebrates such as jellyfish and squid, and benthic species living on or within the sand. No structures, such as coral reefs, hard bottom, or artificial reefs, are known to occur in the area. The biological condition of benthic habitats off the southeastern U.S. coast has been rated good overall, based on the number and abundance of species (U.S. Environmental Protection Agency, 2012). A diverse benthic invertebrate assemblage was reported for nearshore environments of the South Atlantic Bight (the area between Cape Hatteras, North Carolina, and West Palm Beach, Florida). Over 300 invertebrate species were identified in sediment samples collected in this region, with polychaete worms and various crustaceans (particularly amphipods) accounting for about 75 percent of the species.

D.6 References

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APPENDIX E AIR QUALITY

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
%	Percent
<	less than
$\mu g/m^3$	micrograms per cubic meter
AP	Air Pollutant Emission Factors
AQCR	Air Quality Control Region
CAA	Clean Air Act
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2e	carbon dioxide equivalent
gal	gallon
GHG	greenhouse gas
HDDV	heavy-duty diesel vehicle
HP	horsepower
HSMST	High Speed Maneuvering Surface Target
Kg	kilogram
kW	kilowatt
LDGT	light-duty gas truck
LDGV	light-duty gas vehicle
mi	miles
MMBtu	one million British Thermal Units
MOVES	Motor Vehicle Emission Simulator
O_3	ozone
Pb	lead
PM_{10}	particulate matter equal to or less than 10 microns
$PM_{2.5}$	particulate matter equal to or less than 2.5 microns
ppb	parts per billion
ppm	parts per million
PSD	Prevention of Significant Deterioration
ROI	region of influence
RP-1	rocket propellant-1
SIP	State Implementation Plan
SO_2	sulfur dioxide
SO_x	sulfur oxides
U.S.	United States
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
yd^3	cubic yards
yr	year

E AIR QUALITY

This appendix presents an overview of the Clean Air Act (CAA) and the Georgia Department of Natural Resources Environmental Protection Division requirements, as well as calculations, including the assumptions used for the air quality analyses presented in the Environmental Impact Statement.

E.1 Air Quality Program Overview

In order to protect public health and welfare, the United States (U.S.) Environmental Protection Agency (USEPA) has developed numerical concentration-based standards, or National Ambient Air Quality Standards (NAAQS), for six "criteria" pollutants (based on health-related criteria) under the provisions of the CAA Amendments of 1970. There are two kinds of NAAQS—primary and secondary standards. Primary standards prescribe the maximum permissible concentration in the ambient air to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards prescribe the maximum concentration or level of air quality required to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings (40 Code of Federal Regulations [CFR] Part 50).

The CAA gives states the authority to establish air quality rules and regulations. These rules and regulations must be equivalent to, or more stringent than, the Federal program. The Air Protection Branch of the Georgia Department of Natural Resources Environmental Protection Division is the State agency that regulates air quality emissions sources in Georgia under the authority of the Federal CAA and amendments, Federal regulations, and State laws.

Georgia has adopted the Federal NAAQS as shown in Table E-1. Based on measured ambient air pollutant concentrations, USEPA designates areas of the United States as having air quality better than the NAAQS (attainment), worse than the NAAQS (nonattainment), and unclassifiable. The areas that cannot be classified (on the basis of available information) as meeting or not meeting the NAAQS for a particular pollutant are "unclassifiable" and are treated as attainment areas until proven otherwise. Attainment areas can be further classified as "maintenance" areas, which are areas previously classified as nonattainment areas, but where air pollutant concentrations have been successfully reduced to below the standard. Maintenance areas are subject to special maintenance plans and must operate under some of the nonattainment area plans to ensure compliance with the NAAQS. Camden County is in attainment for all criteria pollutants.

A general conformity analysis is required to be conducted for areas designated as nonattainment or maintenance of the NAAQS if the action's direct and indirect emissions have a potential to emit one or more of the six criteria pollutants at or above concentration standards shown in Table E-1 or the *de minimis* emission rate thresholds in Table E-2 or Table E-3.

Each state is required to develop a State Implementation Plan (SIP) that sets forth how CAA provisions will be imposed within the state. The SIP is the primary means for the implementation, maintenance, and enforcement of the measures needed to attain and maintain the NAAQS within each state and includes control measures, emissions limitations, and other provisions required to attain and maintain the ambient air quality standards. The purpose of the SIP is twofold. First, it must provide a control strategy that will result in the attainment and maintenance of the NAAQS. Second, it must demonstrate that progress is being made in attaining the standards in each nonattainment area.

Table E-1. Summary of National Ambient Air Quality Standards

Criteria Pollutant	Averaging Time	Federal Primary NAAQS	Federal Secondary NAAQS
CO	8-hour	9 ppm	No standard
	1-hour	35 ppm	No standard
Pb	Rolling 3-month average	0.15 μg/m^3[a]	0.15 μg/m^3
NO_2	Annual	53 ppb[b]	53 ppb
	1-hour	100 ppb	No standard[c]
PM_{10}	24-hour	150 μg/m^3	150 μg/m^3
$PM_{2.5}$	Annual	12 μg/m^3	15 μg/m^3
	24-hour	35 μg/m^3	35 μg/m^3
O_3	8-hour	0.070 ppm[c]	0.070 ppm
SO_2	Annual	No standard	No standard
	24-hour[1]	No standard	No standard
	3-hour	No standard	0.50 ppm[c]
	1-hour	75 ppb[d]	No standard

Notes: μg/m^3 = micrograms per cubic meter; CFR = Code of Federal Regulations; CO = carbon monoxide; NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; ppb = parts per billion; ppm = parts per million; SO_2 = sulfur dioxide; USEPA = U.S. Environmental Protection Agency.

[a] In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 μg/m^3 as a calendar quarter average) also remain in effect.

[b] The level of the annual NO_2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

[c] Final rule was signed October 1, 2015 and became effective December 28, 2015. The previous (2008) O_3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

[d] The previous SO_2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards and (2) any area for which an implementation plan providing for attainment of the current (2010) standards has not been submitted and approved and which is designated nonattainment under the previous SO_2 standards or is not meeting the requirements of a State Implementation Plan (SIP) call under the previous SO_2 standards (40 CFR §50.4(3)). A SIP call is a USEPA action requiring a state to resubmit all or part of its SIP to demonstrate attainment of the required NAAQS.

Source: (USEPA, 2016)

Table E-2. Emission Rates for Criteria Pollutants in Nonattainment Areas[1]

Pollutant	Emission Rate[2] (tons/year)
Ozone (VOCs or NO_x)	
Serious NAAs	50
Severe NAAs	25
Extreme NAAs	10
Other ozone NAAs outside an ozone transport region	100
Marginal and moderate NAAs inside an ozone transport region	
VOCs	50
NO_x	100
CO: all NAAs	100
SO_2 or NO_2: all NAAs	100
PM_{10}	
Moderate NAAs	100
Serious NAAs	70
$PM_{2.5}$ (direct emissions, SO_2, NO_x, VOCs, and ammonia)	
Moderate NAAs	100
Serious NAAs	70
SO_2	100
NO_x (unless determined not to be a significant precursor)	100
VOCs or ammonia (if determined to be significant precursors)	100
Pb: all NAAs	25

Notes: CFR = Code of Federal Regulations; CO = carbon monoxide; NAA = nonattainment area; NO_2 = nitrogen dioxide; NO_x = nitrogen oxides; Pb = lead; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; SO_2 = sulfur dioxide; VOC = volatile organic compound.
[1] *De minimis* threshold levels for conformity applicability analysis
[2] 40 CFR §93.153(b)(1) – For the purposes of paragraph (b) of this section, the following rates apply in NAAs.
Source: (USEPA, 2020a)

Table E-3. Emission Rates for Criteria Pollutants in Attainment (Maintenance) Areas[1]

Pollutant	Emission Rate[2] (tons/year)
Ozone (NO_x, SO_2, or NO_2): all maintenance areas	100
Ozone (VOCs)	
Maintenance areas inside an ozone transport region	50
Maintenance areas outside an ozone transport region	100
CO: all maintenance areas	100
PM_{10}: all maintenance areas	100
$PM_{2.5}$	
Direct emissions	100
SO_2	100
NO_x (unless determined not to be a significant precursor)	100
VOCs or ammonia (if determined to be significant precursors)	100
Pb: all maintenance areas	25

Notes: CFR = Code of Federal Regulations; CO = carbon monoxide; NO_2 = nitrogen dioxide; NO_x = nitrogen oxides; Pb = lead; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; SO_2 = sulfur dioxide; VOC = volatile organic compound.
[1] *De minimis* threshold levels for conformity applicability analysis
[2] 40 CFR §93.153(b)(2) – For the purposes of paragraph (b) of this section, the following rates apply in maintenance areas.
Source: (USEPA, 2020a)

In attainment areas, major new or modified stationary sources of air emissions on and in the area are subject to Prevention of Significant Deterioration (PSD) review to ensure that these sources are constructed without causing significant adverse deterioration of the clean air in the area. A major new source is defined as one that has the potential to emit any pollutant regulated under the CAA in amounts equal to or exceeding specific major source thresholds, that is, 100 or 250 tons per year based on the source's industrial category. A major modification is a physical change or change in the method of operation at an existing major source that causes a significant "net emissions increase" at that source of any regulated pollutant. Table E-4 lists the PSD significant emissions rate thresholds for selected criteria pollutants (USEPA, 1990).

Table E-4. Criteria Pollutant Significant Emissions Rate Increases Under PSD Regulations

Pollutant	Significant Emissions Rate (tons/year)
PM_{10}	15
$PM_{2.5}$	10
Total suspended particulates	25
SO_2	40
NO_x	40
Ozone (VOCs)	40
CO	100

Notes: CFR = Code of Federal Regulations; CO = carbon monoxide; NO_x = nitrogen oxides; VOC = volatile organic compound; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; PSD = Prevention of Significant Deterioration; SO_2 = sulfur dioxide; VOC = volatile organic compound.
Source: 40 CFR Part 51

The goals of the PSD program are to (1) ensure economic growth while preserving existing air quality; (2) protect public health and welfare from adverse effects that might occur even at pollutant levels better than the NAAQS; and (3) preserve, protect, and enhance the air quality in areas of special natural recreational, scenic, or historic value, such as national parks and wilderness areas. Sources subject to PSD review are required by the CAA to obtain a permit before commencing construction. The permit process requires an extensive review of all other major sources within a 50-mile radius and all Class I areas within a 62-mile radius of the facility. Emissions from any new or modified source must be controlled using best available control technology. The air quality, in combination with other PSD sources in the area, must not exceed the maximum allowable incremental increase identified in Table E-5. National parks and wilderness areas are designated as Class I areas, where any appreciable deterioration in air quality is considered significant. Class II areas are those where moderate, well-controlled industrial growth could be permitted. Class III areas allow for greater industrial development.

The Ambient Monitoring Program measures levels of air pollutants throughout the state. The data are used to determine compliance with air standards established for five compounds and to evaluate the need for special controls for various other pollutants.

The air quality monitoring network is used to identify areas where the ambient air quality standards are being violated and plans are needed to reduce pollutant concentration levels to be in attainment with the standards. Also included are areas where the ambient standards are being met, but plans are necessary to ensure maintenance of acceptable levels of air quality in the face of anticipated population or industrial growth.

Table E-5. Federal Allowable Pollutant Concentration Increases Under PSD Regulations

Pollutant	Averaging Time	Maximum Allowable Concentration (μg/m^3)		
		Class I	Class II	Class III
PM_{10}	Annual	4	17	34
	24-hour	8	30	60
SO_2	Annual	2	20	40
	24-hour	5	91	182
	3-hour	25	512	700
NO_2	Annual	2.5	25	50

Notes: μg/m^3 = micrograms per cubic meter; CFR = Code of Federal Regulations; NO_2 = nitrogen dioxide; PM_{10} = particulate matter equal to or less than 10 microns; PSD = Prevention of Significant Deterioration; SO_2 = sulfur dioxide.
Source: 40 CFR Part 51

The result of this attainment/maintenance analysis is the development of local and statewide strategies for controlling emissions of criteria air pollutants from stationary and mobile sources. The first step in this process is the annual compilation of the ambient air monitoring results, and the second step is the analysis of the monitoring data for general air quality, exceedances of air quality standards, and pollutant trends.

E.2 Regulatory Comparisons

The CAA §176(c)(4), the General Conformity rule, requires Federal agencies to demonstrate that their proposed activities would conform to the applicable SIP for attainment of the NAAQS. General conformity applies only to nonattainment and maintenance areas. If the emissions from a Federal action proposed in a nonattainment area exceed annual *de minimis* thresholds identified in the rule, a formal conformity determination is required of that action. The thresholds are more restrictive as the severity of the nonattainment status of the region increases. Since the project region is designated as attainment for all criteria pollutants (USEPA, 2020b), the criteria pollutants are compared with the region of influence (ROI) emissions (Camden County and the Jacksonville, Florida-Brunswick, Georgia Interstate Air Quality Control Region [AQCR]). Camden County and all counties within the AQCR are all in attainment.

For the analysis, in order to evaluate air emissions and their impact on the overall ROI, the emissions associated with the project activities were compared with the total emissions on a pollutant-by-pollutant basis for the ROI's 2017 National Emissions Inventory (NEI) data, which was last updated June 16, 2020 (USEPA, 2020c). Potential impacts to air quality are evaluated with respect to the extent, context, and intensity of the impact in relation to relevant regulations, guidelines, and scientific documentation. The Council on Environmental Quality defines significance in terms of context and intensity in 40 CFR §1508.27. This requires that the significance of the action must be analyzed in respect to the setting of the Proposed Action and based relative to the severity of the impact. The Council on Environmental Quality's National Environmental Policy Act regulations (40 CFR §1508.27(b)) provide 10 key factors to consider in determining an impact's intensity. To provide a more conservative analysis, the county was selected as the ROI instead of the USEPA-designated AQCR, which is a much larger area.

E.3 National Emissions Inventory

The NEI is operated under the USEPA's Emission Factor and Inventory Group, which prepares the national database of air emissions information with input from numerous state and local air agencies, tribes, and industries. The database contains information on stationary and mobile sources that emit criteria air pollutants and hazardous air pollutants. The database includes estimates of annual emissions, by source, of air pollutants in each area of the country on a yearly basis. The NEI includes emission estimates for all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands. Emission estimates for individual point or major sources (facilities), as well as county-level estimates for area, mobile, and other sources, are currently available for years 2014 and 2017 for criteria pollutants and hazardous air pollutants. The 2017 NEI data was last updated June 16, 2020, so those data were used in all analyses.

Criteria air pollutants are those for which USEPA has set health-based standards. The six criteria pollutants included in the NEI database are as follows:

- Carbon monoxide
- Nitrogen oxides
- Sulfur dioxide
- Particulate matter (with a diameter less than or equal to 10 microns)
- Particulate matter (with a diameter less than or equal to 2.5 microns)
- Volatile Organic Compounds

Volatile organic compounds are ozone precursors emitted from motor vehicle fuel distribution and chemical manufacturing, as well as other solvent uses. VOCs react with nitrogen oxides in the atmosphere to form ozone. The NEI database defines three classes of criteria air pollutant sources:

- **Point sources –** Point sources are stationary sources of emissions, such as an electric power plant, that can be identified by name and location. A "major" source emits a threshold amount (or more) of at least one criteria pollutant and must be inventoried and reported. Many states also inventory and report stationary sources that emit amounts below the thresholds for each pollutant.
- **Area sources.** Area sources are small point sources, such as a home or office building, or a diffuse stationary source, such as wildfires or agricultural tilling. These sources do not individually produce sufficient emissions to qualify as point sources. Dry cleaners are one example; for instance, a single dry cleaner within an inventory area typically will not qualify as a point source, but collectively the emissions from all of the dry cleaning facilities in the inventory area may be significant and, therefore, must be included in the inventory.
- **Mobile sources.** Mobile sources are any kind of vehicle or equipment with a gasoline or diesel engine (such as an airplane or ship).

The following are the main sources of criteria pollutant emissions data for the NEI:

- For electric generating units—USEPA's Emission Tracking System/Continuous Emissions Monitoring Data and Department of Energy fuel use data

- For other large stationary sources—state data and older inventories where state data were not submitted
- For on-road and nonroad mobile sources—the Federal Highway Administration's estimate of vehicle miles traveled and emission factors from USEPA's Motor Vehicle Emission Simulator (MOVES) 2014a Model
- For electric power plants - USEPA's Clean Air Market program
- For stationary area sources—state data, USEPA-developed estimates for some sources, and older inventories where state or USEPA data were not submitted
- For point source data - state and local environmental agencies

E.4 Project Calculations

E.4.1 Construction Emissions

This construction emissions section presents the results exported directly from the air quality analysis modeling software, Air Conformity Applicability Model Version 5.0.16b, retaining its organizational headings and table formatting. Emission factors for on-road and nonroad vehicles in the software program were derived from the USEPA's MOVES 2014b.

1. General Information

- Action Location
State: Georgia
County(s): Camden
Air Quality Control Region: Jacksonville-Brunswick Interstate AQCR
Regulatory Area(s): NOT IN A REGULATORY AREA

- Action Title: Spaceport Camden Environmental Impact Statement

- Project Number/s (if applicable):

- Projected Action Start Date: 1 / 2021

- Action Purpose and Need:
The purpose and need for the action is as described in Section 1.3 of the EIS.

- Action Description:
The action description is as described in Section 2.1 of the EIS.

- Point of Contact
Name: Brad Boykin
Title: CTR
Organization: Leidos
Email: boykinb@leidos.com

Phone Number: 9795753552

- Activity List:

Activity Type		Activity Title
2.	Construction / Demolition	Launch Control Center
3.	Construction / Demolition	Alt Control Ctr and Visitor Ctr
4.	Construction / Demolition	Mission Preparation Area
5.	Construction / Demolition	Vertical Launch Facility
6.	Construction / Demolition	Infrastructure/Roads

Emission factors and air emission estimating methods come from the United States Air Force's Air Emissions Guide for Air Force Stationary Sources, Air Emissions Guide for Air Force Mobile Sources, and Air Emissions Guide for Air Force Transitory Sources.

2. Construction / Demolition

2.1 General Information & Timeline Assumptions

- Activity Location
County: Camden
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Control Center

- Activity Description:
See Tables 2.1-2, 2.1-3, and 2.1-4

- Activity Start Date
Start Month: 1
Start Month: 2021

- Activity End Date
Indefinite: False
End Month: 12
End Month: 2021

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.954524
SO_x	0.012473
NO_x	4.965352
CO	5.329484
PM 10	13.185148

Pollutant	Total Emissions (TONs)
PM 2.5	0.220713
Pb	0.000000
NH_3	0.003123
CO_2e	1213.1

2.1 Site Grading Phase

2.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 12
Number of Days: 0

2.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 105000
Amount of Material to be Hauled On-Site (yd^3): 105
Amount of Material to be Hauled Off-Site (yd^3): 105

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	6
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	6
Tractors/Loaders/Backhoes Composite	1	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

2.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Graders Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**Pb**	**NH_3**	**CO_2e**
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

2.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

2.2 Trenching/Excavating Phase

2.2.1 Trenching / Excavating Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 6
Number of Days: 0

2.2.2 Trenching / Excavating Phase Assumptions

- General Trenching/Excavating Information

Area of Site to be Trenched/Excavated (ft^2): 7200
Amount of Material to be Hauled On-Site (yd^3): 7.2
Amount of Material to be Hauled Off-Site (yd^3): 7.2

- Trenching Default Settings

Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	2	8
Other General Industrial Equipment Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

2.2.3 Trenching / Excavating Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Graders Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Tractors/Loaders/Backhoes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

2.2.4 Trenching / Excavating Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)

2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

2.3 Building Construction Phase

2.3.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 12
Number of Days: 0

2.3.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 10900
Height of Building (ft): 45
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust

Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips

Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

2.3.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Cranes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0845	0.0013	0.6033	0.3865	0.0228	0.0228	0.0076	128.82
Forklifts Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0293	0.0006	0.1458	0.2148	0.0056	0.0056	0.0026	54.462
Tractors/Loaders/Backhoes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

2.3.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase
CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)

0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
VMT_{VT} = BA * BH * (0.38 / 1000) * HT

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

2.4 Architectural Coatings Phase

2.4.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date
Start Month: 7
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 6
Number of Days: 0

2.4.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential
Total Square Footage (ft^2): 10900
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

2.4.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

2.4.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase

$VMT_{WT} = (1 * WT * PA) / 800$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase

$VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0$

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

2.5 Paving Phase
2.5.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 12
Number of Days: 0

2.5.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 3100

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cement and Mortar Mixers Composite	4	6
Pavers Composite	1	7
Rollers Composite	1	7
Tractors/Loaders/Backhoes Composite	1	7

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

2.5.3 Paving Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Graders Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

2.5.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
VOC_P = (2.62 * PA) / 43560

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)
PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)^2 / acre)

3. Construction / Demolition

3.1 General Information & Timeline Assumptions

- Activity Location
County: Camden
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Alt Control Ctr and Visitor Ctr

- Activity Description:
See Tables 2.1-2, 2.1-3, and 2.1-4

- Activity Start Date
Start Month: 1
Start Month: 2021

- Activity End Date
Indefinite: False
End Month: 12
End Month: 2021

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	1.031302
SO_x	0.013221
NO_x	5.432367
CO	5.779535
PM 10	13.215088

Pollutant	Total Emissions (TONs)
PM 2.5	0.250644
Pb	0.000000
NH_3	0.003298
CO_2e	1287.9

3.1 Site Grading Phase

3.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 12
Number of Days: 0

3.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 105000
Amount of Material to be Hauled On-Site (yd^3): 105
Amount of Material to be Hauled Off-Site (yd^3): 105

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	6
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	6
Tractors/Loaders/Backhoes Composite	1	7

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

3.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Graders Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

3.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)

20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds

EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

3.2 Trenching/Excavating Phase

3.2.1 Trenching / Excavating Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 6
Number of Days: 0

3.2.2 Trenching / Excavating Phase Assumptions

- General Trenching/Excavating Information
Area of Site to be Trenched/Excavated (ft^2): 7200
Amount of Material to be Hauled On-Site (yd^3): 7.2
Amount of Material to be Hauled Off-Site (yd^3): 7.2

- Trenching Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	2	8
Other General Industrial Equipmen Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

3.2.3 Trenching / Excavating Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Graders Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**Pb**	**NH_3**	**CO_2e**
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

3.2.4 Trenching / Excavating Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

3.3 Building Construction Phase

3.3.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 12
Number of Days: 0

3.3.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 10900
Height of Building (ft): 45
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

3.3.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Cranes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0845	0.0013	0.6033	0.3865	0.0228	0.0228	0.0076	128.82
Forklifts Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0293	0.0006	0.1458	0.2148	0.0056	0.0056	0.0026	54.462
Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**Pb**	**NH_3**	**CO_2e**
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

3.3.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
VMT_{VT} = BA * BH * (0.38 / 1000) * HT

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

3.4 Architectural Coatings Phase

3.4.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date
Start Month: 7

Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 6
Number of Days: 0

3.4.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential
Total Square Footage (ft^2): 10900
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

3.4.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

3.4.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase
$VMT_{WT} = (1 * WT * PA) / 800$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

3.5 Paving Phase

3.5.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 12
Number of Days: 0

3.5.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 23700

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cement and Mortar Mixers Composite	4	6
Pavers Composite	1	7
Paving Equipment Composite	1	8
Rollers Composite	1	7
Tractors/Loaders/Backhoes Composite	1	7

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

3.5.3 Paving Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Graders Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Tractors/Loaders/Backhoes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

3.5.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment

WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase

VOC_P = (2.62 * PA) / 43560

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)

PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)^2 / acre)

4. Construction / Demolition

4.1 General Information & Timeline Assumptions

- Activity Location
County: Camden
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Mission Preparation Area

- Activity Description:
See Tables 2.1-2, 2.1-3, and 2.1-4

- Activity Start Date
Start Month: 1
Start Month: 2021

- Activity End Date
Indefinite: False
End Month: 12
End Month: 2021

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	1.609968
SO_x	0.023937
NO_x	9.841890
CO	9.608477
PM 10	59.572017

Pollutant	Total Emissions (TONs)
PM 2.5	0.429975
Pb	0.000000
NH_3	0.006510
CO_2e	2352.1

4.1 Site Grading Phase

4.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 10
Number of Days: 0

4.1.2 Site Grading Phase Assumptions

- General Site Grading Information

Area of Site to be Graded (ft^2): 563000
Amount of Material to be Hauled On-Site (yd^3): 563
Amount of Material to be Hauled Off-Site (yd^3): 563

- Site Grading Default Settings

Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	1	8
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Scrapers Composite	2	8
Tractors/Loaders/Backhoes Composite	3	8

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

4.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Excavators Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0687	0.0013	0.3576	0.5112	0.0158	0.0158	0.0062	119.73
Graders Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93

Other Construction Equipment Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Scrapers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.1814	0.0026	1.2262	0.7745	0.0491	0.0491	0.0163	262.89
Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**Pb**	**NH_3**	**CO_2e**
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

4.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

4.2 Trenching/Excavating Phase

4.2.1 Trenching / Excavating Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 10
Number of Days: 0

4.2.2 Trenching / Excavating Phase Assumptions

- General Trenching/Excavating Information
Area of Site to be Trenched/Excavated (ft^2): 31500
Amount of Material to be Hauled On-Site (yd^3): 31.5
Amount of Material to be Hauled Off-Site (yd^3): 31.5

- Trenching Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	2	8
Other General Industrial Equipmen Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

4.2.3 Trenching / Excavating Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Excavators Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0687	0.0013	0.3576	0.5112	0.0158	0.0158	0.0062	119.73
Graders Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61

Rubber Tired Dozers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Scrapers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.1814	0.0026	1.2262	0.7745	0.0491	0.0491	0.0163	262.89
Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**Pb**	**NH_3**	**CO_2e**
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

4.2.4 Trenching / Excavating Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)

HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

4.3 Building Construction Phase

4.3.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 10
Number of Days: 0

4.3.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial

Area of Building (ft^2): 242500
Height of Building (ft): 20
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	7
Forklifts Composite	2	7
Generator Sets Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8
Welders Composite	3	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

4.3.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Cranes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0845	0.0013	0.6033	0.3865	0.0228	0.0228	0.0076	128.82
Forklifts Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0293	0.0006	0.1458	0.2148	0.0056	0.0056	0.0026	54.462

Generator Sets Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0362	0.0006	0.2977	0.2707	0.0130	0.0130	0.0032	61.074
Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890
Welders Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0280	0.0003	0.1634	0.1787	0.0088	0.0088	0.0025	25.665

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**Pb**	**NH_3**	**CO_2e**
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

4.3.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)

VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase

VMT_{VT} = BA * BH * (0.38 / 1000) * HT

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

4.4 Architectural Coatings Phase

4.4.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date

Start Month: 7
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 6
Number of Days: 0

4.4.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential
Total Square Footage (ft^2): 2600
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

4.4.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

4.4.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase
$VMT_{WT} = (1 * WT * PA) / 800$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

4.5 Paving Phase

4.5.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 10
Number of Days: 0

4.5.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 29500

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cement and Mortar Mixers Composite	4	6
Pavers Composite	1	7
Paving Equipment Composite	1	8
Rollers Composite	1	7
Tractors/Loaders/Backhoes Composite	1	7

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

4.5.3 Paving Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Excavators Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0687	0.0013	0.3576	0.5112	0.0158	0.0158	0.0062	119.73
Graders Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Scrapers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.1814	0.0026	1.2262	0.7745	0.0491	0.0491	0.0163	262.89
Tractors/Loaders/Backhoes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

4.5.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase

$VOC_P = (2.62 * PA) / 43560$

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)
PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)^2 / acre)

5. Construction / Demolition

5.1 General Information & Timeline Assumptions

- Activity Location
County: Camden
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Vertical Launch Facility

- Activity Description:
See Tables 2.1-2, 2.1-3, and 2.1-4.

- Activity Start Date
Start Month: 1
Start Month: 2021

- Activity End Date
Indefinite: False
End Month: 3
End Month: 2022

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	6.170378
SO_x	0.041317
NO_x	17.142972
CO	15.352981
PM 10	205.170431

Pollutant	Total Emissions (TONs)
PM 2.5	0.734591
Pb	0.000000
NH_3	0.015348
CO_2e	4127.4

5.1 Site Grading Phase

5.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 15
Number of Days: 0

5.1.2 Site Grading Phase Assumptions

- General Site Grading Information

Area of Site to be Graded (ft^2): 1270000
Amount of Material to be Hauled On-Site (yd^3): 1270
Amount of Material to be Hauled Off-Site (yd^3): 1270

- Site Grading Default Settings

Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	1	8
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Scrapers Composite	3	8
Tractors/Loaders/Backhoes Composite	3	8

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

5.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Excavators Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0687	0.0013	0.3576	0.5112	0.0158	0.0158	0.0062	119.73
Graders Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93

Other Construction Equipment Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Scrapers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.1814	0.0026	1.2262	0.7745	0.0491	0.0491	0.0163	262.89
Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**Pb**	**NH_3**	**CO_2e**
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

5.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

5.2 Trenching/Excavating Phase

5.2.1 Trenching / Excavating Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 15
Number of Days: 0

5.2.2 Trenching / Excavating Phase Assumptions

- General Trenching/Excavating Information
Area of Site to be Trenched/Excavated (ft^2): 100000
Amount of Material to be Hauled On-Site (yd^3): 100
Amount of Material to be Hauled Off-Site (yd^3): 100

- Trenching Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	2	8
Other General Industrial Equipment Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

5.2.3 Trenching / Excavating Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Excavators Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0687	0.0013	0.3576	0.5112	0.0158	0.0158	0.0062	119.73
Graders Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53

Scrapers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.1814	0.0026	1.2262	0.7745	0.0491	0.0491	0.0163	262.89
Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**Pb**	**NH_3**	**CO_2e**
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

5.2.4 Trenching / Excavating Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

5.3 Building Construction Phase

5.3.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 15
Number of Days: 0

5.3.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 302300
Height of Building (ft): 65
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	7
Forklifts Composite	2	7
Generator Sets Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8
Welders Composite	3	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

5.3.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Cranes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0845	0.0013	0.6033	0.3865	0.0228	0.0228	0.0076	128.82
Forklifts Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0293	0.0006	0.1458	0.2148	0.0056	0.0056	0.0026	54.462
Generator Sets Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0362	0.0006	0.2977	0.2707	0.0130	0.0130	0.0032	61.074

Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890
Welders Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0280	0.0003	0.1634	0.1787	0.0088	0.0088	0.0025	25.665

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**Pb**	**NH_3**	**CO_2e**
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

5.3.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
VMT_{VT} = BA * BH * (0.38 / 1000) * HT

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

5.4 Architectural Coatings Phase

5.4.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 6
Number of Days: 0

5.4.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential
Total Square Footage (ft^2): 302000
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

5.4.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

5.4.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase
$VMT_{WT} = (1 * WT * PA) / 800$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)

2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

5.5 Paving Phase

5.5.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 12
Number of Days: 0

5.5.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 296200

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Pavers Composite	1	8
Paving Equipment Composite	2	6
Rollers Composite	2	6

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

5.5.3 Paving Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Excavators Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0687	0.0013	0.3576	0.5112	0.0158	0.0158	0.0062	119.73
Graders Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Scrapers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.1814	0.0026	1.2262	0.7745	0.0491	0.0491	0.0163	262.89
Tractors/Loaders/Backhoes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

5.5.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)

EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
VOC_P = (2.62 * PA) / 43560

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)
PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)^2 / acre)

6. Construction / Demolition

6.1 General Information & Timeline Assumptions

- Activity Location
County: Camden
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Infrastructure/Roads

- Activity Description:
See Tables 2.1-2, 2.1-3, and 2.1-4.

- Activity Start Date
Start Month: 1
Start Month: 2021

- Activity End Date
Indefinite: False
End Month: 12
End Month: 2021

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.896915
SO_x	0.012106
NO_x	5.539686
CO	4.795922
PM 10	64.595889

Pollutant	Total Emissions (TONs)
PM 2.5	0.252231
Pb	0.000000
NH_3	0.001795
CO_2e	1205.8

6.1 Site Grading Phase

6.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 7
Number of Days: 0

6.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 924000
Amount of Material to be Hauled On-Site (yd^3): 924

Amount of Material to be Hauled Off-Site (yd^3): 924

- Site Grading Default Settings

Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	1	8
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Scrapers Composite	3	8
Tractors/Loaders/Backhoes Composite	3	8

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

6.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Excavators Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0687	0.0013	0.3576	0.5112	0.0158	0.0158	0.0062	119.73
Graders Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53

Scrapers Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.1814	0.0026	1.2262	0.7745	0.0491	0.0491	0.0163	262.89
Tractors/Loaders/Backhoes Composite								
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**CH_4**	**CO_2e**
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

6.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

6.2 Paving Phase

6.2.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2021

- Phase Duration
Number of Month: 7
Number of Days: 0

6.2.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 924000

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Pavers Composite	1	8
Paving Equipment Composite	2	8
Rollers Composite	2	6

- Vehicle Exhaust

Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

6.2.3 Paving Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Excavators Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0687	0.0013	0.3576	0.5112	0.0158	0.0158	0.0062	119.73
Graders Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0860	0.0014	0.5212	0.5747	0.0247	0.0247	0.0077	132.93
Other Construction Equipment Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0533	0.0012	0.3119	0.3497	0.0121	0.0121	0.0048	122.61
Rubber Tired Dozers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.2015	0.0024	1.4660	0.7661	0.0581	0.0581	0.0181	239.53
Scrapers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.1814	0.0026	1.2262	0.7745	0.0491	0.0491	0.0163	262.89
Tractors/Loaders/Backhoes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0407	0.0007	0.2505	0.3606	0.0112	0.0112	0.0036	66.890

- Vehicle Exhaust & Worker Trips Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.273	000.002	000.207	003.148	000.007	000.006		000.023	00320.956
LDGT	000.345	000.003	000.366	004.453	000.009	000.008		000.024	00414.257
HDGV	000.716	000.005	000.988	014.742	000.020	000.017		000.044	00766.469
LDDV	000.103	000.003	000.133	002.604	000.004	000.004		000.008	00312.295
LDDT	000.240	000.004	000.378	004.437	000.007	000.006		000.008	00443.620
HDDV	000.494	000.013	004.839	001.748	000.167	000.153		000.028	01500.756
MC	002.588	000.003	000.723	013.090	000.027	000.024		000.054	00395.915

6.2.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)

1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
VOC_P = (2.62 * PA) / 43560

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)
PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)2 / acre)

E.4.2 Operational Emissions

E.4.2.1 Vessel Emissions

It was assumed that small vessels with dual outboard motors (assumed dual 250-horsepower gas outboards) would be used during launch operations to provide support and security when clearing the safety area. Operational hours assumed that small vessels would average 15 knots.

Table E-6. Vessel Emission Factors

Vessel Type	Engines	HP	VOCs	SO_x	NO_x	CO	PM_{10}	$PM_{2.5}$	CO_2
HSMST[1]	2	250	0.02	0.00	0.01	0.23	0.00	0.00	646.08

Notes: CO = carbon monoxide; CO_2 = carbon dioxide; HP = horsepower; HSMST = High Speed Maneuvering Surface Target; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; SO_x = sulfur oxides; VOC = volatile organic compound.
[1] Source: (USEPA, 2010)

Emissions were calculated using the formula below, and calculated emissions are shown in Table E-7 and Table E-8.

Emissions = HP×HR/YR×EF×ENG×CF

Where:
Emissions = Surface craft emissions (tons per year)
HP = Horsepower (reflective of a particular load factor/engine power setting)
HR/YR = Hours per year
EF = Emission factor for specific engine type (pounds per hour)
ENG = Number of engines
CF = Conversion Factor for pounds to tons

Table E-7. Proposed Action Vessel Emissions

Vessel Type	Engines	HP	Hours	Load Factor	VOCs	SO_x	NO_x	CO	PM_{10}	$PM_{2.5}$	CO_2
Small vessel	2	250	200	1	1.12	0.00	0.30	11.25	0.01	0.01	32,304

Notes: CO = carbon monoxide; CO_2 = carbon dioxide; HP = horsepower; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; SO_x = sulfur oxides; VOC = volatile organic compound.

E.4.2.2 Launch and Static Test Operations

While emission factors were not available specific to the Rocket Lab Electron, for extremely conservative estimates, it was assumed that launches would include a maximum of 12 Falcon 9-type vehicles. The Falcon 9 is a much larger rocket and requires more fuel for propulsion than the smaller Electron. However, they are both propelled by the same fuels (rocket propellant-1 and liquid oxygen), so the use of Falcon 9 emission factors represents a highly conservative approach, as the actual fuel required and emissions would likely be much lower. Because the vehicles would leave the 3,000-foot above ground level relatively quickly, it was assumed that 20 percent of fuel burn would occur for launches. Similarly, static engine fire tests are assumed to be 5 percent of the total.

Table E-8. Launch and Static Test Emissions

Launch Type	Launches	RP-1 gal/launch	RP-1 MMBtu/gal	CO (tons/launch)	CO (tons)	20% Emissions	5% Emissions
Falcon 9	12	38000	0.135	857.15	10,285.8	2,057.16	514.29

Notes: % = percent; CO = carbon monoxide; gal = gallon; MMBtu = one million British Thermal Units; RP-1 = rocket propellant-1.
1. Launches are assumed to be 20 percent of total emissions, as the vehicle would exit the 3000-foot mixing layer within seconds. Static engine fire tests are assumed to be 5 percent of total emissions.

Table E-9. Launch and Static Test Greenhouse Gas Emissions

Launch Type	Launches	RP-1 (gal/ launch)	RP-1 (MMBtu/ gal)	CO_2[1] (kg/MMBtu/ gal)	CH_4[2] (kg/MMBtu/ gal)	N_2O[2] (kg/MMBtu/ gal)	CO_2 (kg)	CH_4 (kg)	N_2O (kg)	CO_2e (MT/yr)
Falcon 9	12	38000	0.135	75.2	0.003	0.0006	4,629,312	184.68	36.936	4,646.967

Notes: CFR = Code of Federal Regulations; CH_4 = methane; CO_2 = carbon dioxide; CO_2e = carbon dioxide equivalent; gal = gallon; GHG = greenhouse gas; kg = kilogram; MMBtu = one million British Thermal Units; MT = metric ton; N_2O = nitrous oxide; RP-1 = rocket propellant-1; yr = year.
[1] Emission factor from Table C-1 to Subpart C of 40 CFR Part 98, Mandatory GHG Reporting Rule
[2] Emission factor from Table C-2 to Subpart C of 40 CFR Part 98, Mandatory GHG Reporting Rule

E.4.2 Generator Operations

It was assumed that up to ten 300-kilowatt diesel generators would be operated 0.5 hours per week for testing and maintenance. Additionally, it was assumed that generators would operate during five 24-hour periods of outages annually. It was also assumed that an additional twelve 48-hour operational periods would occur for launches.

Table E-10. Generator Emission Factors

Pollutant	Emission Factors Diesel Fuel (<447 kW or <600 HP)[1]
CO	5.50E-03
NO_x	0.024
PM_{10}	0.0007
$PM_{2.5}$	0.0007
SO_2	8.09E-03
VOCs	7.05E-04
CO_2	1.16

Notes: < = less than; AP = Air Pollutant Emission Factors; CO = carbon monoxide; CO_2 = carbon dioxide; HP = horsepower; kW = kilowatt; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; SO_2 = sulfur dioxide; USEPA = U.S. Environmental Protection Agency; VOC = volatile organic compound.
[1] Emission factors are from USEPA, Compilation of Air Pollutant Emission Factors - Volume I (AP-42), Section 3.4, 5th Edition; factors are based upon power output.

Table E-11. Generator Annual Emissions

Operational Activity	Proposed Action						
	Emissions						
	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOCs	CO_2e
Generator Operations	3.99	17.43	0.51	0.51	5.87	0.51	842

Notes: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; SO_2 = sulfur dioxide; VOC = volatile organic compound.

E.4.2.3 Staff Commutes

It was assumed that 77 full-time employees would commute to work an average of 250 days per year. It was further assumed that an additional 233 staff personnel would commute to the site for launches an average of 144 days per year. A 50/50 mix of light-duty gas vehicles (cars) and light-duty gas trucks (pickup trucks) was assumed for all personnel.

Table E-12. Commuter Vehicle Emission Factors

	VOCs	SO_x	NO_x	CO	PM_{10}	$PM_{2.5}$	NH_3	CO_2
LDGV	0.265	0.002	0.2	3.208	0.006	0.005	0.023	325.859
LDGT	0.34	0.003	0.357	4.561	0.008	0.007	0.024	421.18

Notes: CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; LDGV = light-duty gas vehicle; LDGT = light-duty gas truck; NH_3 = ammonia; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; SO_x = sulfur oxides; VOC = volatile organic compound.
Source: USEPA MOVES (Motor Vehicle Emission Simulator) 2014b

Table E-13. Commuter Vehicle Annual Emissions

		No. of Vehicles	No. of Days	Round Trip (mi)	Emissions (tons/yr)						
					CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOCs	CO_2e
Regular Staff	LDGV	38.5	250	50	1.70	0.11	0.00	0.00	0.00	0.14	172.86
	LDGT	38.5	250	50	2.42	0.19	0.00	0.00	0.00	0.18	223.43
Launch Event Staff	LDGV	116.5	144	50	2.97	0.18	0.01	0.00	0.00	0.25	301.29
	LDGT	116.5	144	50	4.22	0.33	0.01	0.01	0.00	0.31	389.43
TOTAL					11.30	0.81	0.02	0.02	0.01	0.88	1087.02

Notes: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; LDGV = light-duty gas vehicle; LDGT = light-duty gas truck; mi = miles; No. = number; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; SO_2 = sulfur dioxide; VOC = volatile organic compound; yr = year.

E.4.2.4 Deliveries

It was assumed that deliveries of fuels and other necessary components would occur over the course of the year, totaling an average of 600 annual deliveries.

Table E-14. Delivery Vehicle Emission Factors

	VOCs	SO_x	NO_x	CO	PM_{10}	$PM_{2.5}$	NH_3	CO_2
HDDV	0.44	0.013	4.473	1.638	0.165	0.152	0.028	1512.371

Notes: CO = carbon monoxide; CO_2 = carbon dioxide; HDDV = heavy-duty diesel vehicle; NH_3 = ammonia; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; SO_x = sulfur oxides; VOC = volatile organic compound.
Source: USEPA MOVES (Motor Vehicle Emission Simulator) 2014b

Table E-15. Delivery Vehicle Annual Emissions

	No. of Vehicles	No. of days	Round Trip (mi)	Emissions (tons/yr)						
				CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOCs	CO_2e
Shipping Trucks	1	600	200	0.22	0.59	0.02	0.02	0.00	0.06	200.05

Notes: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; mi = miles; No. = number; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter equal to or less than 2.5 microns; PM_{10} = particulate matter equal to or less than 10 microns; SO_2 = sulfur dioxide; VOC = volatile organic compound; yr = year.

E.5 References

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APPENDIX F CULTURAL RESOURCES

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F CULTURAL RESOURCES

F.1 Historic Context

The material in this appendix is summarized from comprehensive cultural resources studies conducted for the Federal Aviation Administration (Cultural Resources Analysts, Inc., 2017a; Cultural Resources Analysts, Inc., 2017b), which contain complete citations and reference lists.

F.1.1 Prehistory

This section briefly describes the state of knowledge regarding pre-contact occupation of the general project area and the specific archeological area of potential effects (APE). It describes the prehistoric chronology of the region and includes a discussion of broad patterns of human occupation in the project region, as evidenced by known cultural resources, including archeological sites. This information supports conclusions regarding the sensitivity of the APEs for the presence of previously unrecorded archeological resources that could be encountered in the course of construction or operation of the spaceport.

Pre-Paleoindian (Before 13,500 B.P.)

The timing and actual entry point of the first humans into North America are still topics for debate. Over the last decade, increasing data have indicated human occupation in North American circa 16,000 to 15,000 B.P.

Several sites in the southeastern United States have been suggested as pre-Clovis candidates. Among these are the Cactus Hill site in southeast Virginia, the Topper site in South Carolina, and the Debra L. Friedkin site in Texas.

Paleoindian Period (11,500–10,000 B.P.)

The earliest known human occupation of Georgia occurred during the Paleoindian period, which coincided with the end of the Wisconsin Glaciation and beginning of the Holocene epoch. Most archeologists divide the Paleoindian period into three subperiods based on changes in projectile point morphology through time. The Early Paleoindian period (11,500 to 10,800 B.P.) is identified by the presence of Clovis points, which are large lanceolate-shaped points with parallel sides and a ground haft with a fluted, slightly concave base. During the Middle Paleoindian period (10,800 to 10,500 B.P.), fluted points decrease in size and unfluted lanceolate points with broad blades and constructed haft elements appear. The Late Paleoindian period (10,500 to 10,000 B.P.) tool kit corresponded with the onset of Holocene environments. The extinction of the megafauna and the establishment of an ecology similar to that of the modern period necessitated new resource procurement strategies. Late Paleoindian points include Dalton, Hardaway, Quad, San Patrice, and Beaver Lake.

The majority of Paleoindian artifacts recovered in Georgia are found in archeologically mixed contexts or as isolated finds. Fieldwork in the vicinity of the project site has produced little information concerning this time period, and no Clovis or Dalton points have been found in Camden County. Almost all of the Early Paleoindian sites identified to date were located on the floodplains, with fewer sites on the upland edge. A shift in the choice of habitation sites appears to have occurred during the Middle and Late Paleoindian periods, with sites distributed in floodplains, the upland edge, and the uplands.

Archaic Period (10,000–3000 B.P.)

Early Archaic Period (10,000–8000 B.P.)

The transition to the Early Archaic period is marked by the absence of fluted projectile points/knives and the appearance of side-notched hafted bifaces, including Big Sandy, Taylor, and Bolen, along with corner-notched types, such as Palmer and Kirk. The hafted Edgefield scraper is also considered to be diagnostic of this period. In some schemes, the Early Archaic may be divided into four phases. Those phases, from earliest to latest, include Taylor (9900–9500 B.P.), Palmer/Kirk (9500–8300 B.P.), Bifurcate (8900–8000 B.P.), and Kirk Stemmed (8000–7500 B.P.). This scheme may apply to the entire Georgia Coastal Plain.

Research conducted in the Coastal Plain has provided little information about the Early Archaic period. Sites are generally small, consisting of small lithic scatters. Early Archaic groups in this area were likely organized like those noted near the Fall Line in the Lake Oconee basin, where people were living in small seasonal base camps and utilizing smaller camps near extractive resources.

Middle Archaic Period (8000–6000 B.P.)

The Middle Archaic period is marked by a warming climate and an increase in population. The appearance of bannerstones (atlatl weights) signals the innovation of a new projectile technology, while the production of grooved axes signals another technological development. The transition to the Middle Archaic is marked by the appearance of stemmed bifaces, such as the Kirk Stemmed/Serrated, Stanly Stemmed, Morrow Mountain Stemmed, Benton, Guilford, and Brier Creek. The Stanly Stemmed is seldom seen on Coastal Plain sites, and the Benton, Guilford, and Brier Creek are types more typically found in the Piedmont. Sites representing the Middle Archaic are extremely rare on the Coastal Plain.

A Middle Archaic chronology for the Savannah River Valley probably also applies to the study area. Their proposed phases include Stanly (7800–7500 B.P.), Morrow Mountain (7500–6000 B.P.), and Guilford/Brier Creek/MALA (6000–5000 B.P.). Middle Archaic sites appear to be far more common in the Piedmont to the north of the Fall Line than in the Coastal Plain in general, but the highest concentration of known Middle Archaic sites in the Coast Plain is within the Fall Line Hills and the Vidalia Uplands subprovinces. By the latter part of the Middle Archaic, shell middens appear on the St. Johns River in northeastern Florida, along with tapered-stem Newnan bifaces.

Late Archaic Period (6000–3000 B.P.)

The Late Archaic is marked by an increase in the use of riverine environments, an increase in the exploitation of shellfish, more use of ground stone implements, the introduction of soapstone vessels, and emergent ceramic technology. The increased use of soapstone and pottery containers likely indicate a more sedentary population and more extensive trade networks to facilitate the movement of raw materials and ideas. The earliest known house structures in Georgia, found on sites in the Augusta area, date to the Late Archaic. Diagnostic projectile points include the Savannah River, Elora, Kiokee Creek, Ledbetter, and Paris Island. Other artifacts indicative of the Late Archaic include perforated steatite slabs, steatite bowls, winged bannerstones, and grooved axes.

The late Archaic may be divided into four phases. Those phases include, from oldest to youngest, Paris Island (4450–4150 B.P.), Mill Branch 42 (4150–3800 B.P.), Lover's Lane (3800–3300 B.P.), and Dickens (3300–2850 B.P.).

Some of the earliest ceramic technology in the southeast is found near the Georgia coast. The first ceramic vessels were introduced circa 4500 B.P., although it would be about 1,000 more years before its use would become widespread. Fiber-tempered pottery is dominated by plain vessels with a fine, consistent paste, more common on the Georgia coast, in contrast to sand-tempered pottery that does not appear in coastal Georgia. Pottery of this period found on the upper Satilla River is semi-fiber tempered with a very sandy paste, and in both plain and simple-stamped styles in the area between the Satilla and Ocmulgee Rivers. The soapstone sources used to make bowls are located north of the Fall Line, so it is expected that soapstone bowls would occur in lower frequency as distance increases south of the Fall Line. It appears that the manufacture of soapstone bowls began after the introduction of pottery in Georgia.

Woodland Period (3000–1000 B.P.)

The Woodland period is marked by changes in settlement and subsistence patterns, technology, and social organization. In the southeastern United States, the Woodland period may be divided into three subperiods: Early (3000–2200 B.P.), Middle (2200–1600 B.P.), and Late (1600–1100 B.P.). The use of stemmed bifaces continued into the Early Woodland and was followed by a transition to a variety of large triangular bifaces, which are reduced in size over time. Use of the bow and arrow became widespread by the Late Woodland period, and extensive trade networks were established as well. The construction of mounds increased and larger villages were settled as horticulture increased in importance. There is evidence, however, that the Woodland period on the Georgia coast was expressed differently than in the interior. With abundant supplies of food from riverine and estuarial sources, small bands continued seasonal rounds from centralized base camps.

Pottery types increase in number and become more varied in both temper and decorative techniques, and recent researchers have begun to discuss the Woodland period in terms of the ceramic traditions that were the hallmark of distinct cultures throughout the period, as changes in lithic technology are less useful in defining cultural differences, especially on the coast.

Mississippian Period (1100–500 B.P.)

The Mississippian period, which is recognized throughout the core southeastern United States, is characterized by major changes in the social structure, subsistence patterns, and settlement patterns of Native Americans. Large permanent settlements arose, led by chiefs and primarily supported by the cultivation of corn. Political and military power emerged in these large centers and appears to have been highly centralized, with each center supported by numerous outlying hamlets and farmsteads. Practices such as the construction of wall-trench houses and changes in pottery technology and style serve as the material correlates for the shared ideology associated with the Mississippian world. Based on firsthand observation by early Spanish explorers in the southeast, Mississippian chiefs maintained armies of professional soldiers who were adept at guerilla warfare.

Across the interior of the southeast, the Mississippian period marked a fundamental change in the settlement patterns that persisted for thousands of years prior. The people of this period were no longer dispersed across the landscape pursuing a hunter-gatherer subsistence system. They were concentrated instead into villages, mainly in floodplain settings with a subsistence base centered on the cultivation of corn, beans, squash, and other cultigens. This change was less drastic, however, for the people that occupied the coast of Georgia. The coastal region lacked the broad, fertile river valleys that were favored by those further inland, so there was much less reliance on maize production and other cultigens, and the population remained more dispersed. The inhabitants of the coast were reliant on the resources provided by the marshes and waters, along with foods gathered and hunted in the uplands, just as they had prior to the Mississippian period. Maize, beans, and squash were eventually cultivated but at a much smaller scale. They did provide a store of foods for periods during the year when wild plant foods were not available.

As with the chronology of the Woodland, the Mississippian period is described based on the prevailing ceramic types as markers of the cultures that occupied the Georgia coast. While the northern and central coastal areas were dominated by Savannah and then Irene types, the southern coastal sequence has been defined as St. Johns II (1250–850 B.P.), followed by St. Marys II (900–550 B.P.), then San Pedro (550–375 B.P.). This sequence has been applied to the area referred to as the St. Marys Region, which extends from the Satilla River in Georgia southward to the St. Johns River in Florida. It was defined to "reflect the transition between cultures of the central and north Georgia coast and the St. Johns culture of northeast Florida."

F.1.2 History

The post-contact history of the general project area dates from the time when written records were kept. It includes ethnohistory of American Indian tribes inhabiting the region and discusses the current status of any tribes with claims to the area. The historical context also describes the non-Native American settlement of the region. Topics of discussion include settlement patterns and historical land use and also include historic themes pertinent to known cultural resources in the project vicinity, including the historic period lighthouse and structures built with tabby construction methods.

Mission Period (A.D. 1526–1683)

The first documented contact between the indigenous people of coastal Georgia and the Spanish occurred in 1521 during a slave raid. Another expedition aimed at locating a favorable location for colonization arrived in 1525, taking on native people to train as interpreters. Based on their linguistic differences, the Spanish identified two groups, the Guale and the Timucua. The Guale were located to the north of the Altamaha River, while the Timucua occupied southeastern Georgia and northeastern Florida from the Altamaha River south to the vicinity of modern-day Ocala, Florida, and from the Aucilla River east to the Atlantic. Based on archeological evidence, it appears that the Guale were the descendants of the Irene prehistoric culture, while the Timucua were descended from the St. Johns culture. The Timucua were organized into a series of loose chiefdoms, with one chief presiding over a small number of separate villages. Four groups of Timucua were identified at contact, including the Tacatacuru on Cumberland Island, the Yufera to the south, the Cascange-Icafui to the north, and the Yui to the west.

In 1526, a party of Spanish colonists led by Lucas Vázquez De Ayllón settled at the colony of San Miguel de Gualdape, presumed to be near Sapelo Sound. This first attempt at Spanish colonization ended just 6 weeks later after disease and starvation claimed many of the colonists, including Ayllón. However, the establishment by the French of Fort Caroline, presumably near the mouth of the St. Johns River in 1564 near present-day Jacksonville, led the Spanish to continue to focus on the southeastern coast of North America. A French settlement in close proximity to the sea lanes used by treasure fleets transporting booty from Mexico to Spain posed a threat. Spain's King Phillip II charged Mendes de Avilles to "dislodge" the French, which led to the establishment of St. Augustine in 1565 and the conquering of Fort Caroline later that year.

Both Fort Caroline (which became San Mateo after changing to Spanish hands) and St. Augustine were established before the Spanish designated Santa Elena as the capital of La Florida in 1566, on what is now Parris Island, South Carolina (on the site of the former Charles Fort established in 1562 by French Admiral Jean Ribault). Santa Elena was the capital of La Florida from 1566 to 1587, after which the capital was moved southward to St. Augustine. A series of forts with small garrisons were constructed along the coast, including a small fort on Cumberland Island, which the Spaniards called San Pedro. The forts, intended to both control the Indians and protect them from English slave raids and attacks on indigenous populations near missions, were widely dispersed, poorly supplied, and difficult to defend against consistent attacks by the French and their Indian allies, so they were abandoned.

Efforts to Christianize the indigenous population began with Jesuits in the 1560s, but permanent missions were not established until the arrival of the Franciscans in the 1580s. The Franciscans constructed a mission, San Pedro de Mocama, on the southern end of San Pedro Island in 1587.

As was the case across the southeast, European diseases took a heavy toll on the Timucua. Those living around San Pedro were especially hard hit, and by 1670, the Timucua mission at San Pedro had been abandoned. It was replaced that year by the mission of San Phelipe, a Guale mission, which also included a number of Yamassee refuges from the north. The scattered mainland missions moved to the barrier islands in an attempt to avoid inland raids by Indians armed by the English from their colony at Charles Town, but the coastal missions fared no better. Raids by French privateers in the 1680s led to the abandonment of the Georgia missions and their consolidation around St. Augustine by 1683.

Camden County (A.D. 1733–Present)

Located on the coast, Camden County is the southernmost county in the state of Georgia. It was created in 1777 by the Georgia constitution as the state's eighth original county. The county features tidal rivers and creeks with plentiful marshlands along the coastal region. Cumberland Island, the largest of the barrier sea islands, is located just off Camden County's coast. The interior portions of the county are flat and sandy. Prior to the county's establishment and European occupation, the land was inhabited by the Mocama Native Americans, followed by the Creek Native Americans. The first European to land in present-day Camden County was Captain Jean Ribault of France, who was in search of a suitable place for a Huguenot settlement. Ribault named the rivers he first saw the Seine and Somme; today these are the Satilla and St. Marys Rivers.

In 1565, Spain sent a large force to take the region from the French and subsequently constructed missions in the county but eventually abandoned those, leaving the lands open for English occupation. In 1742, General James Oglethorpe led the English to victory over the Spanish. General Oglethorpe left his mark upon Georgia's landscape as he designed the town of Savannah, constructed a hunting lodge on Cumberland Island named Dungeness (a predecessor to the mansions of the same name built by Greene and Carnegie), founded two forts on Cumberland Island, Fort St. Andrews on the north end and Fort Williams on the south end, and was responsible for naming Amelia Island.

In 1763, Spain ceded Florida to Britain via the Treaty of Paris (also called the Treaty of 1763), which altered Georgia's borders. The state boundaries were extended from the present-day boundary of Glynn County to the St. Marys River, the southern boundary for Camden County. Four parishes were established in 1765: St. Davids, St. Patricks, St. Marys, and St. Thomas.

Camden County was created by combining the colonial parishes of St. Thomas and St. Mary with lands ceded by the Creek Tribe of Native Americans. In 1854, a portion of Camden County was taken to create

Charlton County. The first county seat of Camden County was selected in 1787 and was located at St. Patrick, a town on the south side of the Great Satilla River. In 1792, the county seat was moved to St. Marys. In 1800, it was moved back to the vicinity of St. Patrick to Jefferson, later called Jeffersonton. A courthouse and jail was constructed in 1802. During the antebellum period, large plantations located along the river produced rice, cotton, corn, and other products, but following the Civil War, Jeffersonton was abandoned. In 1872, the county seat was moved back to St. Marys, where it remained until 1923 when it was relocated to Woodbine.

Although slavery was outlawed in Georgia by General Oglethorpe, it was legalized in 1751 by Georgia's government. In Camden County, enslaved African Americans harvested rice, cotton, and timber, the most profitable crops in the county. By 1860, the slave population made up 76 percent of the 5,420 people living in Camden County.

Two full divisions of men from Camden County fought during the Civil War. The outcome of the war was devastating for plantation owners, many of whom left the area, leaving the land and their names to the formerly enslaved. Land values dropped dramatically, and newly freed slaves were able to purchase large tracts of land. By the turn of the 20th century, approximately half of the land in the county was owned by African Americans.

The arrival of the railroad in 1894 opened up new economic opportunities for Camden County. Bayard Cutting, a New York industrialist, built a 138-mile connector from Savannah to Jacksonville, Florida, creating the Florida Central and Peninsular Railroad (now Seaboard Coast Lines). In 1924, a spur line was completed from Kingsland to St. Marys.

Construction began on the first modern highway in Camden County, the old Dixie Highway, in 1912. The road, which stretched from Quebec to Miami, entered Camden County near Glenco, passed through Woodbine and Kingsland, and extended to the ferry on the St. Marys River before entering Florida. In 1927, the Atlantic Coastal Highway (U.S. 17) was completed through Camden County with a bridge across the St. Marys River. The highway became the main thoroughfare for travelers to Camden County. In the 1960s, construction on I-95 began; it bisects the county from north to south and generally follows the Seaboard rail line.

The current project area is located on land that was once part of the Floyd family's extensive plantation. A veteran of the Revolutionary War, Charles Floyd moved with his wife, Mary, and son, John, from Virginia to his land at Floyd's Neck in Camden County in 1800. In 1804, John Floyd constructed two plantation houses. His home was named Fairfield and was located in the northeastern corner of the current project area. The home that he constructed for his father, Charles, was named Bellevue and was located to the west of Fairfield. While no known description of Fairfield has been located, Bellevue was said to have been a two-story structure that was anchor-shaped in plan to reflect Charles' ship building past. The main floor walls were constructed of tabby, while the second floor was frame construction. The tabby walls of Bellevue are still standing. After Charles's death in 1820, John moved his family to Bellevue, leaving Fairfield to his son, Charles Rinaldo (C.R.) Floyd. C.R. Floyd became a noted military man during the Seminole Wars after pursuing a group of Indians through the Okefenokee Swamp. He died in 1848 and was buried behind the Fairfield plantation house. A large marble monument was erected over his grave sometime later; it was enclosed by a block wall in the 20th century and is still standing. The Floyd Family Cemetery is located east of Fairfield Plantation and is the final resting place of several members of the Floyd family. Following the Civil War, the property was divided among the family and eventually sold to corporate interests. The portion where the project area is located is currently owned by Dow Chemical/Union Carbide and Bayer CropScience.

In the 1840s, or possibly earlier, C.R. Floyd founded and ran the Camden Hunt Club, which was one of the first such hunt clubs in the nation. The Camden Hunt Club was located on Floyd's land, but the club likely hunted on adjacent plantation land, including the land associated with the present-day Cabin Bluff area, about 2 miles south of the project area. During the first part of the 20th century, several logging operations bought the land on Floyd's Neck and operated railroad logging facilities while maintaining the hunting preserve. Today, the facility still functions as a recreational hunting resort, and the land is also a managed forest, or tree farm. The small community of Dover Bluff, approximately 3 miles north of the project area and within the APE, also began as a hunting club sometime in the early 1920s, although some of the original community buildings may have been built prior to then. Subsequent development of homes continued into the modern era, with surviving homes dating from as early as 1890 into the 1970s.

A small boost to Camden County's economy occurred in the 1960s when the Thiokol Chemical Company located to the area. In 1964, Thiokol opened a plant on the former Floyd Plantation, including the current project area for a rocket test facility and chemical processing plant. The plant consisted of a complex of 36 buildings located on approximately 7,400 acres. The facility tested and built solid-fuel rockets for the National Aeronautics and Space Administration (NASA) as part of the Saturn I missile program, and the first 3-million-pound-thrust solid propellant rocket motor was manufactured and tested at the site. When NASA changed plans to use liquid fuel instead, Thiokol began manufacturing other products at the plant. In 1966, Thiokol began production of silicone coatings and sealants for General Electric and TEMIK® (aldicarb) for Union Carbide. In 1967, Thiokol began to manufacture orthochlorobenzalmalononitrile (CS) (also known as "tear gas") for Edgewood Arsenal. This work developed into Thiokol's production of several "deterrent containing" munitions including 40-millimeter (40mm) CS rounds and the XM-15-CS canister cluster. Later, production included M49 trip flares, 81mm mortar illumination cartridges, and M84A1 fuzes. In 1969, an Army contract was received to manufacture trip flares for the Vietnam War. Following a devastating explosion in 1971 that killed 29 people and injured 50, Thiokol stopped production of trip flares but continued making munitions until 1977. In 1977, the Camden operation was sold to the Union Carbide Corporation, and agricultural chemical production continued. In 1986, Rhone Poulenc (eventually Bayer CropScience) acquired the manufacturing capabilities, and Union Carbide retained the landfill and the solid waste management units. In 2001, Union Carbide merged with Dow, and Dow continues to operate and maintain the landfill. The facility in Camden County is no longer operational, and most of the associated buildings have been demolished. Photos 1 and 2 show the view of the site from the water in 2009 and 2016, respectively.

Photo 1. Proposed site viewed west to east from the water circa 2009.

Photo credit: *Tribune & Georgian* (4 September 2009); provided by Bryan-Lang Historical Archives

Photo 2. Proposed site viewed east to west from the water circa 2016.

Photo credit: Camden County (April 2017)

The Kings Bay Naval Submarine Base, south of the project area, has had the greatest impact on the growth of the county. The naval base was originally constructed as the Kings Bay Army Terminal in 1955. By 2003, Kings Bay employed almost 9,000 people.

Cumberland Island

Sometimes referred to as Great Cumberland Island to distinguish Little Cumberland Island to the north, Cumberland Island is the largest of the barrier islands off Georgia's coast. Since the occupation of the Spanish in the 17th century, the island's population has seldom exceeded 500 people. When the Spanish arrived on Cumberland Island in the 1550s, the island was already inhabited by the Tacatacura tribe of the Timucua Native Americans; they spoke the Mocamo dialect of Timucuan. The Tacatacuru occupied the island sporadically, most likely during the winter months, making seasonal visits to the island for provisions such as fish, shellfish, turtles, and deer. Europeans became interested in Native American medicinal techniques, most notably their use of sassafras. During the late 16th century and into the 17th century, Cumberland Island became a center for sassafras trade, which brought high prices in Europe.

The Spanish established several missions during their occupation, linking the dispersed coastal Spanish garrisons. The Spanish abandoned the missions between 1690 and 1702, when the English, with the help of some Native American allies, moved in from the north and began attacking them. Spain and England spent the first half of the 18th century fighting for control of the land located between the Savannah and St. Marys Rivers. Once General James Oglethorpe established the settlement in Savannah in 1733, Cumberland Island became a strategic coastal defense point. General Oglethorpe arrived on Cumberland Island in 1736, establishing Fort St. Andrews on the north end of the island and a second fort on the southern end of the island in 1740. In 1742, Fort St. Andrews was burned during an attack by the Spanish and never rebuilt. The southern fort, Fort Prince William, remained and functioned as an important outpost until the late 1750s. In addition to the two forts, the English were responsible for naming the island after the Duke of Cumberland, constructing a garrison town of Barrimacke at the northern end of the island, and building a hunting lodge for General Oglethorpe at the southern end. It may have been General Oglethorpe who was responsible for the first horses on Cumberland Island, bringing them in 1739.

Once the 1763 Treaty of Paris was passed, Cumberland Island was awarded by the British Crown to the Georgia Colony. Permanent settlements began on Cumberland Island in 1765, and advertisements for Cumberland Island land showcased its agricultural and timber qualities. By the American Revolution, the island featured sizeable homesteads and extensive cultivation, with indigo and rice dominating; cotton corn, horses, and cattle were also raised, and live oak and cypress were harvested from existing tree stands.

In 1783, General Nathanael Greene purchased land on Cumberland Island. In 1803, Greene's widow and her second husband, Phineas Miller, built a four-story, tabby mansion called Dungeness on the southern end of Cumberland Island. The Greene-Miller plantation was one of the first places that sea island cotton was cultivated, and the Greene-Millers successfully produced cotton raised and processed by the 210 slaves on the plantation. In addition to Dungeness, plantations owned by Greene-Miller descendants include Oakland, Rayfield, and Littlefield; other plantations included Spring Garden, Plum Orchard, High Point, Longwood, and Fairmount. The labor force of the Cumberland Island plantations consisted of a large, enslaved African American population. During the antebellum period, the white population of Cumberland Island likely never reached beyond 60 people; however, the African American population increased from approximately 200 in 1835 to 455 in 1850.

During the Civil War (1861–1865), almost all of the white landholders abandoned the island, with the exception of Robert Stafford at Rayfield Plantation and Rachel Church at High Point. The outcome of the Civil War drastically changed the way of life on the island. At the end of the Civil War, military authorities placed Cumberland Island within the Sherman Reservation, a 30-mile-wide land reserve running the length of the Georgia-South Carolina coast. It was established in 1865–1866 as a reservation for freedmen to receive land of their own. As a result, a small freedmen's settlement grew up at Half Moon Bluff at the north end of Cumberland Island. Their Gullah-speaking descendants lie buried in a small cemetery at north end, and a Baptist church, built by descendants, still stands. The population declined to fewer than 100 people between 1865 and 1880, most of whom were Gullah-speaking African Americans.

At the start of the war, Phineas Miller Nightingale, owner of Dungeness, had fled his plantation. Upon his return in 1865 or 1866, he found the main house burned, and he sold it to repay debts. After his death, his nephews inherited his remaining land and eventually sold it to Thomas Carnegie, the younger brother of Pittsburg steel baron Andrew Carnegie. The Carnegies constructed a large, eclectic house on the site of the original Dungeness mansion, completed in 1885. They acquired more land and built gardens and additional structures, including specialty buildings and areas devoted to specific activities, including pool houses, squash courts, beach houses, a golf course, and horse stables. The Carnegies came to own approximately 90 percent of Cumberland Island.

While the Carnegies owned most of the island, the northernmost portion remained in others' hands. Hotels, first constructed in the 1870s, were popular during the latter part of the 19th century and into the 20th century. Travel to the island was made possible due to an increase in steamboat traffic along the Inland Waterway, as well as more accessible rail lines on the mainland to carry passengers to the coast. Around the turn-of-the 20th century, the hotel complex was purchased by a private company and used for a private hunting club and resort. The Candler family, heirs to the Coca Cola fortune, eventually purchased the property, and it became a private family estate.

Upon the death of Lucy Carnegie in 1916, 16,000 acres of Cumberland Island passed to her children with the covenant that the land could not be sold while any of them were alive. The buildings on the island fell into a deteriorated state. A good portion of Dungeness was lost to an arsonist's fire in 1959. The Lucy Carnegie Trust ended in 1962, at which point the property was divided and sold. Ten years later, Congress established the Cumberland Island National Seashore. Since 1972, the National Park Service has acquired a majority of the island and its structures, with the exception of reserve life estates and some individually owned properties.

Following the Civil War, former slaves on Cumberland Island settled on the northern end of the island. In the 1890s, a 5-acre tract known as Martin's Half Moon Bluff was divided into 42 lots, each measuring 50 by 100 feet, with three access roads off the main road. This tract was sold to Gullah-speaking African Americans already living in the area (Cultural Resources Analysts, Inc., 2017b). They constructed a log church/school in 1893 and residences, none of which are extant. Their Gullah-speaking descendants lie buried in a small cemetery on the north end of the island, and a Baptist church, built by descendants, still stands in the High Point-Half Moon Bluff Historic District. The existing buildings associated with the settlement at Half Moon Bluff date to the 1930s and 1940s. The resort at High Point was established in the mid-1880s and was accessed via steamboat at Cumberland Wharf. Guests then traveled by a horse-drawn tramway along High Point Road to the resort. Many residents from the African American settlement found employment at the High Point resort.

Cumberland Island National Seashore was created by Congress in 1972 (Public Law 92-536, codified at 16 United States Code §459i et seq.) "to provide for public outdoor recreation use and enjoyment of certain significant shoreline lands and waters of the United States and to preserve related scenic, scientific, and historical values." High Point-Half Moon Bluff was listed on the National Register of Historic Places (NRHP) in 1978. The United States Congress designated the Cumberland Island Wilderness Area in 1982.

The majority of the historic structures on Cumberland Island today date to the late 1880s and are associated with the Carnegie occupation south of the APE for audible and visual effects. A few resources pre-date this period, such as the tabby house associated with the Greene-Miller occupation, a handful of cemeteries, the slave chimneys associated with the Stafford plantation, and archeological sites.

The historic resources on Cumberland Island are contained within five historic districts, two archeological districts, and two individual sites:

- High Point-Half Moon Bluff Historic District, located at the island's north end, within the APE for audible and visual effects (#78000265, listed on the NRHP 12/22/1978)
- Dungeness Historic District, located on the island's south end, outside the APE for audible and visual effects (#84000920, listed on the NRHP 02/13/1984)
- Greyfield Historic District, located on the south within privately held property, outside the APE for audible and visual effects (#03000675, listed on the NRHP 07/24/2003)
- Stafford Plantation Historic District, located mid-island, outside the APE for audible and visual effects (#84000265, listed on the NRHP 11/23/1984)
- Plum Orchard Historic District, located mid-island, outside the APE for audible and visual effects (#84000258, listed on the NRHP 11/23/1984)
- Table Point Archeological District, located mid-island, outside the APE for audible and visual effects (#84000260, listed on the NRHP 11/23/1984)

- Rayfield Archeological District, located mid-island, outside the APE for audible and visual effects (#84000924, listed on the NRHP 02/13/1984)
- Duck House, outside the APE for audible and visual effects (#84000938, listed on the NRHP02/13/1984)
- Main Road, within the APE for audible and visual effects (#84000941, listed on the NRHP 02/13/1984)

The NRHP-listed High Point-Half Moon Bluff Historic District contains two complexes of buildings: an African American settlement at Half Moon Bluff and a former resort at High Point. The African American settlement at Half Moon Bluff is located in the current project's APE, as is a portion of the NRHP-listed Main Road. The remainder of these historic districts and properties are outside the APE for audible and visual effects.

The Gullah Geechee

The Gullah Geechee people are the descendants of Central and West Africans who came from different ethnic and social groups. They were enslaved together on the isolated sea and barrier islands that span what is now designated as the Gullah Geechee Cultural Heritage Corridor—a stretch of the U.S. coastline that extends from Pender County, North Carolina, to St. Johns County, Florida, and for 30 miles inland. The result was an intense interaction among Africans from different language groups in settings where enslaved Africans and their descendants formed the majority. Over time, they developed the creole Gullah Geechee language as a means of communicating with each other, and they were able to preserve many African practices in their language, arts, crafts, and cuisine (Gullah Geecheee Cultural Heritage Corridor Commission, 2020).

F.2 References

Cultural Resources Analysts, Inc. (2017a). *Phase 1 Archaeological Survey of the Proposed Spaceport Camden, Camden County, Georgia.* Leidos for FAA.

Cultural Resources Analysts, Inc. (2017b). *Historic Resources Survey for the Proposed Camden Spaceport Project in Camden County, Georgia.* Leidos, for Federal Aviation Administration.

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APPENDIX G SOILS AND GEOLOGY

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G SOILS AND GEOLOGY

G.1 Affected Environment

G.1.1 Definition and Description

This section describes the physiographic, geologic, morphologic, and hypsologic features and processes that have and continue to mold the proposed Spaceport Camden landscape configuration and ecological functions, particularly soils. The region of influence (ROI) is defined as the proposed Spaceport Camden and areas in proximity to the proposed Spaceport Camden (see Exhibit 2.1-2, Proposed Spaceport Camden Site Plan, in the Environmental Impact Statement [EIS]). A basic premise of any environmental assessment process is to understand the quantity and quality of natural resources that could be affected by the proposed project. The purpose of this section is to identify landscape features, formulate feature baseline metrics (acres, number, etc.) to assess conditions, and establish a context for comparative and cumulative analysis. The goal is to convey an understanding of the proposed Spaceport Camden and proximity area earth resources and the potential interactions that may accompany proposed disturbances to natural landscape settings.

G.1.2 Regulatory Setting

For this assessment, regulations relating to potential impacts to earth resources are primarily associated with the effects of soil detachment (erosion) and deposition of materials (sedimentation) on aquatic resource water quality and habitats. The State of Georgia has jurisdiction for surface water quality standards for all waters of the state, in accordance with provisions of the Clean Water Act. For more information on Federal and State water quality regulations, refer to EIS Section 3.14, *Water Resources*. Prime farmlands are protected under the Farmland Protection Policy Act and are discussed in EIS Section 3.6, *Farmlands*.

G.1.3 Existing Conditions

This subsection describes the ROI physiography, surficial geology, surface morphometry, hypsology, soils, paleontological resources, and earthquakes.

G.1.3.1 Physiography

Physiography compartmentalizes landscapes into areas in which all parts are similar in geologic structure and climate, have a unified geomorphic history, and whose landforms differ significantly from adjacent areas. The ROI is located within the Tidewater Major Land Resource Area (MLRA) (153B) of the Atlantic and Gulf Coast Lowland Forest and Crop (T) Land Resource Region. The region includes Atlantic coastal plains, drowned estuaries, tidal marshes, islands, and beaches and Gulf of Mexico river deltas, coastal lowlands, and coastal plains. Generally, it is characterized by level to gently sloping topography and shallow relief. The proposed Spaceport Camden site covers approximately 1,413.2 acres.

The Tidewater MLRA extends along the Atlantic coast from north Florida to Delaware. The majority of the area is within the Sea Island Section of the Atlantic Plain Coastal Province. The nearly level coastal plains are dissected by shallow valleys associated with meandering streams and rivers that discharge into coastal estuaries. The topography is comparatively smooth and level with gently undulating land;

typically, there are no prominent hills or valleys. The Tidewater MLRA is primarily the product of alluvial, fluvial, and marine deposition and erosion (U.S. Department of Agriculture [USDA], 2006).

G.1.3.2 Surficial Geology

Surficial geology defines surface and near-surface consolidated or unconsolidated earth materials, including aggregate materials, and significant landscapes. Frequent advances and retreats of sea level associated with glacial activity during Quaternary Period Pleistocene and Holocene Epochs[1] formed terrace steps that decreased in elevation toward the ocean. Shoreline retreats created sediment deposit complexes that generally parallel the present coast. Area subsurface deposits include cretaceous marine, shale, sandstone, and limestone (USDA, 2006). Local inclusions of kaolin (clay mineral composed of layered silicate minerals) occur in updip areas. The underlying sediment wedge is thickest at the coast and thins in a northwestern direction (Herrick, 1965). Legacy Pleistocene barrier island-salt marsh environments, formed during advancing sea levels, were similar to the current coastal environments (USDA, 1980).

The ROI geomorphology is generally characterized by marine terraces and elongated ridges separated by flatlands that formed from barrier island and back barrier complex formation processes associated with sea-level fluctuations. The proposed Spaceport Camden is within the Pleistocene Age Princess Anne Barrier Island Complex, and the tidal flats adjacent to the proposed Spaceport Camden are within the Holocene Age Silver Bluff Back Barrier Complex (CH2MHill, 2015a; Kellam, 1986).

In addition to unconsolidated coastal marine deposits, there were also periodic inundations and meanders of the area by the Satilla and Cumberland Rivers (north and south of the proposed project area, respectively) that formed deposits along coastal riverbed terraces, floodplains, and deltas (Veatch & Stephenson, 1911). Younger river-laid deposits were composed of clay, silt, sand, and gravel (USDA, 2006). Shoreline advances generally ranged from 20 to 30 miles inland of the current coastline (Veatch & Stephenson, 1911).

A late 19th century report describes steep bluffs along the Satilla River near Brunt Fort (approximately 22 miles east of the proposed Spaceport Camden) from 20 to 30 feet high comprising sands, stratified clays, and occasional clayey-limestone (McCallie, 1896). However, in proximity to the proposed Spaceport Camden, the river is a broad, relatively flat gradient channel with relatively indistinct streambanks that has formed an extensive delta plain[2] of tidal wetlands (see EIS Section 3.14, *Water Resources*).

G.1.3.3 Surface Morphometry

Surface morphometry describes land surface landform and geomorphic component features and geometry such as position, aspect, gradient, complexity, profile, patterns, and shape. Predominate flatplain[3] landforms[4] and geomorphic components[5] that characterize the ROI include tidal marshes, flats,

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[1] The Pleistocene Epoch followed the Pliocene Epoch and preceded the Holocene Epoch from approximately 10,000 to 12,000 to 1.6 million years ago. The Holocene Epoch followed the Pleistocene Epoch from the present to about 10,000 to 12,000 years ago. Each epoch includes corresponding temporal-stratigraphic earth materials.

[2] The level or nearly level surface composing the landward part of a large delta characterized by repeated channel bifurcation and divergence, multiple distributary channels, and interdistributary flood basins.

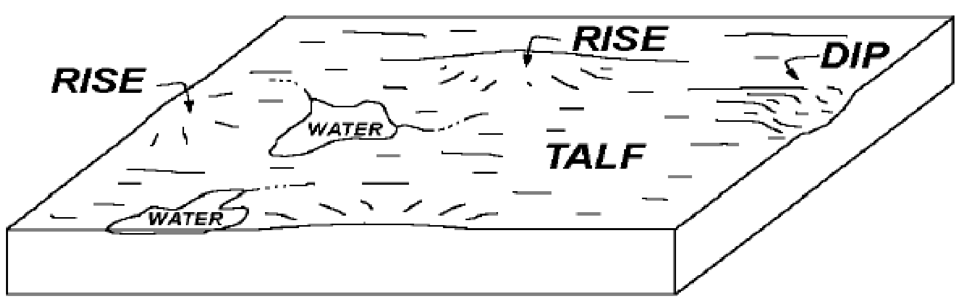
[3] A low, generally broad plain formed by a recently prograded (growth of land further out into the sea) or emerged seafloor with oceanic shore margins and strata that is horizontal or gently slopes toward the water.

[4] Recognizable surface forms that have a characteristic shape and internal composition and were produced by natural processes.

depressions, and drainageways and talfs, dips, and rises, respectively (Table G-1). Over geologic time, these flatplain landforms tend toward dynamic equilibrium, which can be altered by human disturbance activities.

Table G-1. Proposed Spaceport Camden Flatplain Landforms and Geomorphic Components

Feature	Description
Landforms	
Tidal marsh	An extensive, nearly level wetland formed from unconsolidated sediments (e.g., clays, silts, and/or sands and organic materials) bordering a coast (e.g., lagoon, bay, or estuary) that is regularly inundated by high tides.
Flat	An area characterized by a relatively smooth, level (or nearly so), continuous surface that lacks significant slope, elevations, or depressions.
Depression	A shallow and typically closed surface depression that tends to be an area of focused groundwater recharge but not a permanent water body. It is slightly lower and wetter than the adjacent talf and favors the accumulation of fine sediments and organic materials.
Drainageway	A relatively small, roughly linear or arcuate depression that moves concentrated water. Generally, these low-gradient features lack a defined channel (e.g., head slope, swale) or have a small, defined channel (e.g., low-order headwater streams).
Geomorphic Components	
Talf	A relatively flat (e.g., 0 to 1 percent slopes) and broad area dominated by closed depressions and a nonintegrated or poorly integrated drainage system. Stormwater tends to pond, and surface and groundwater lateral transport is slow, which favors the accumulation of soil organic matter and the retention of fine-textured soils. Better-drained soils are frequently adjacent to drainageways and rises.
Dip	A component of plains consisting of a shallow and typically closed depression that tends to be an area of focused groundwater recharge but not a permanent water body and that lies slightly lower and is wetter than the adjacent talf and favors the accumulation of fine sediments and organic materials.
Rise	A slightly elevated but low, broad area with gentle slope gradients (e.g., 1 to 3 percent slopes) and broad, low summits. Typically, this area exists as a microfeature but can be fairly extensive. Generally, rise soils are better drained than those on the surrounding talf.



Source: (USDA, 2012)

Site observations in 2011 documented several depressions and seasonally flooded sites throughout the flatplains area (CH2MHill, 2015a).

[5] A distinct area or geomorphic setting that has unique and prevailing kinetic energy dynamics and sediment transport conditions that result in their characteristic form and patterns of sedimentation and soil development.

G.1.3.4 Hypsology

Hypsology is the study of the relative altitude of places. Generally, changes in topographic relief equate to changes in surface hydrology, geohydrology, and/or soils that affect the biological composition and function of ecosystems. Subtle changes in surface elevations over relatively flat to gently sloping land areas can produce dramatic changes in hydrology (surface and subsurface), soil development, and vegetative communities. Distinguishable differences between landscapes with wet conditions and areas with relatively dry conditions may only reflect changes of a foot or less in elevation. The movement of water across low-gradient landform geomorphic components generally defines the ecology of the ROI landscape. Surface runoff tends to collect and reside at lower elevation dips and depressions and move slowly within natural drainageways or constructed drainage systems.

Elevations and slopes in the proposed Spaceport Camden area generally range from 5 to 29 feet above mean sea level (CH2MHill, 2015a; Kellam, 1986) and 0 to 2 percent, respectively. Although area hypsometry is generally characterized as relatively flat, there are landform intersects that can create rather abrupt elevation changes. These pronounced increases in surface elevation primarily occur along higher ground flatplain intersects with tidal streams, such as Todd Creek and Floyd Basin to the north and Floyd Creek to the east. Based on a review of photographs and imagery of Todds Creek along the northwestern proposed Spaceport Camden boundary, it is estimated that there are approximately 920 linear feet of streambank along Todd Creek with bare ground conditions indicating active soil erosion. These landform convergence areas may create slope profiles susceptible to natural and accelerated soil erosion.

G.1.3.5 Soils

The ROI soils are a direct result of geologic alluvial, fluvial, and marine deposition and erosion processes. These parent materials[6] generally defined the physical and chemical properties of the eight soils that occur within and in proximity to the proposed Spaceport Camden, including the following:

Bohicket-Capers soil association[7]	Brookman soil series[8]	Cainhoy soil series
Mandarin soil series	Pelham soil series	Pottsburg soil series
Rutlege soil series	Sapelo soil series	

These soils are described in Table G-2 and shown in Exhibit G-1. Soils data were primarily derived from the Natural Resources Conservation Service (NRCS) Official Soil Descriptions and Web Soil Survey websites.

Over most of the southeastern part of Camden County, the primary material exposed is unconsolidated sand (Veatch & Stephenson, 1911). Proposed Spaceport Camden area soils generally fall into two categories: (1) very poorly drained, clayey soils in marshes along tidal streams and (2) dominantly poorly drained sandy soils on higher ground flatplains (see Section G.1.3.3, *Surface Morphometry*). Approximately 62 percent of the proposed Spaceport Camden site soils developed in sandy marine, alluvial, and/or fluvial sediments.

[6] Parent materials are the unconsolidated and chemically weathered mineral or organic matter from which a soil's solum is developed by pedogenic processes.

[7] A soil association is made up of two or more geographically associated soils or miscellaneous areas. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar.

[8] A soil series is a group of soils formed from a particular type of parent material and having soil horizons that are similar in all profile characteristics (e.g., color, texture, structure, reaction, consistence, and mineralogical and chemical composition) and arrangement.

Table G-2. Soil Series Features and Characteristics

Texture (percent)[1]			Landform (Component)	Water Table (feet)		Hydric Status/Criteria[2]
Sand	Silt	Clay		Upper Limit	Lower Limit	
Bohicket series: These are very poorly drained, very slowly permeable, and continuously saturated tidal flats soils that are flooded twice daily by seawater. The soils were formed in silty and clayey marine sediments. Slopes are less than 2 percent.						
—	—	30 to 60	Tidal marsh (—)	0.0	>6.0	Yes[3]/2
Brookman series: This series consists of clay loam, very deep, very poorly drained, slowly permeable soils that were primarily formed in thick silty and clayey marine sediments. They are saturated in late winter and early in the spring and occasionally in the summer and fall. Slopes are typically less than 2 percent, and surface runoff is slow.						
39	43	5 to 30	Depression (—)	0.0 to 1.0	>6.0	Yes/2,4
Cainhoy series: This is a fine sand, very deep, excessively drained, rapidly permeable soil that formed in sandy marine sediments. Runoff is slow, with slopes that range from 0 to 10 percent, and elevations generally range from 10 to 120 feet.						
90	1	2 to 15	Flat (rise)	—	—	No[3]/—
Capers series: These are very deep, very poorly drained, very slowly permeable soils occurring within tidal flats and along the lower margins of larger streams that flow into tidal flats. They are flooded with brackish water at least twice monthly and in some places twice daily. Runoff is very slow, and slopes are generally less than 2 percent.						
8	50	35 to 50	Tidal marsh (—)	0.0	>6.0	Yes/2,3
Mandarin series: This is a fine sand, somewhat poorly drained, moderately permeable soil that formed in sandy alluvial and marine sediments. Slopes range from 0 to 3 percent, and elevations generally range from 0 to 250 feet.						
90 to 99	0 to 10	0 to 10	Flat (talf)	1.5 to 2.5	>6.0	No/—
Pelham series: These are loamy sand, very deep, poorly drained, moderately permeable, sandy soils that formed in unconsolidated alluvial and marine sediments. Runoff is slow, slopes range from 0 to 5 percent, and elevations generally range from 20 to 450 feet. Some areas may be ponded or subject to brief flooding.						
84	9	5 to 10	Flat (talf, dip), depression, drainageway	0.0 to 1.0	>6.0	Yes/2
Pottsburg series: This is a sandy, somewhat poorly drained, moderately permeable soil that developed in sandy marine sediments. Runoff is negligible to very low, and some areas are subject to flooding. Slopes are 0 to 2 percent, and elevations generally range from 0 to 300 feet.						
96	2	1 to 4	Flat (talf, rise)	2.0 to 3.5	>6	No/—
Rutlege series: This series consists of fine sand, very poorly drained, rapidly permeable soils that developed in sandy marine and fluvial sediments. Runoff is negligible and ponding is common, slopes are normally 0 to 2 percent, and elevations range from 0 to 300 feet.						
92	2	2 to 10	Flat (talf, dip), depression	0.0 to 0.5	>6.0	Yes/2
Sapelo series: This series consists of fine sand, very deep, somewhat poorly and poorly drained, moderately permeable soils that developed in sandy marine sediments. Runoff is negligible to low, slopes are normally 0 to 2 percent, and elevations range from 14 to 450 feet.						
96	1	2 to 5	Flat (talf, dip)	0.5 to 1.5	>6	No/—

Notes: > = greater than

[1]Soil texture values are based on the A horizon depth for a typical soil pedon, which are 0 to 8 inches (Bohicket, Capers, Mandarin), 0 to 10 inches (Pottsburg), 0 to 15 inches (Brookman and Rutlege), 0 to 17 (Sapelo), 0 to 25 inches (Pelham), and 0 to 50 inches (Cainhoy).

[2]**Hydric soil**: A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (*Federal Register*, 1994). The hydric criteria code is as follows:

1. All Histels except for Folistels, and Histosols except for Folists.
2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, Pachic subgroups, or Cumulic subgroups that:
   A. are somewhat poorly drained and have a water table at the surface (0.0 feet) during the growing season, or
   B. are poorly drained or very poorly drained and have either a water table at:
      1.) the surface (0.0 feet) during the growing season if textures are coarse sand, sand, or fine sand in all layers within a depth of 20 inches, or
      2.) a depth of 0.5 foot or less during the growing season if permeability is equal to or greater than 6.0 inches/hour in all layers within a depth of 20 inches, or
      3.) a depth of 1.0 foot or less during the growing season if permeability is less than 6.0 inches/hour in any layer within a depth of 20 inches.
3. Soils that are frequently ponded for long or very long duration during the growing season.
4. Soils that are frequently flooded for long or very long duration during the growing season.

[3]*Yes* means all map unit components are rated as hydric. *No* means none of the components of a given map unit meet hydric soil criteria.

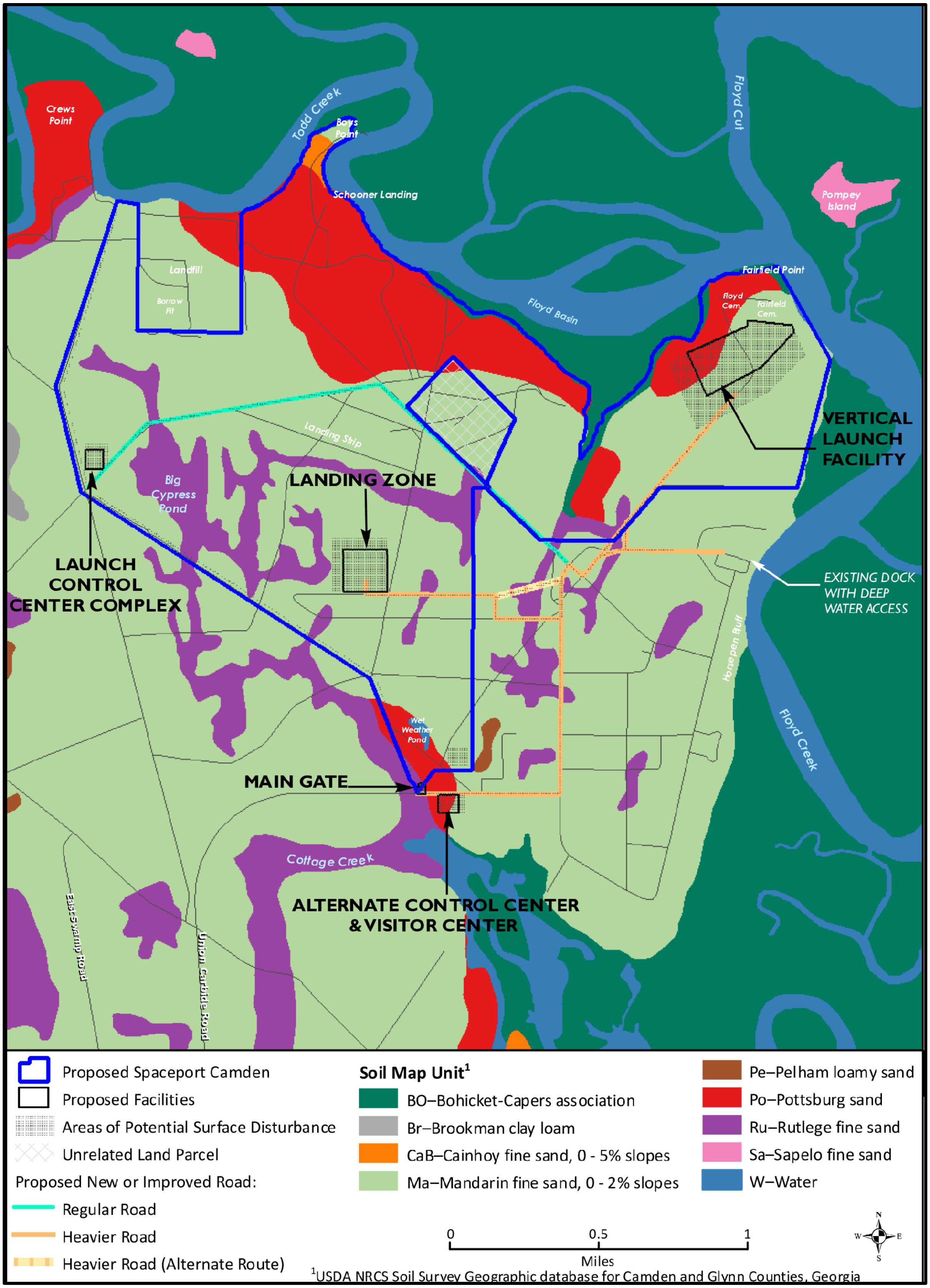


Exhibit G-1. Proposed Spaceport Camden Soil Map

Soil Hydrologic Features

Notable soil hydrologic features include poor to very poor drainage, moderate to rapid permeability, hydric soils, and water tables[9] that are seasonally at or within 2 feet of the surface. For the proposed Spaceport Camden project area, Mandarin, Pelham, Pottsburg, and Rutlege series water table upper limits typically occur during the months of December through April, January through April, November through April, and December through May, respectively. Wet soils exhibit characteristic morphologies that result from repeated periods of saturation, inundation, or both for more than a few days. For the Cainhoy soil series, the water table upper limit is greater than 6 feet year-round. Flooding is very frequent (the chance of flooding is more than 50 percent in all months of any year) for the Bohicket-Capers association and frequent (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year) for the Pelham series.

Pine Plantation Soils

Approximately 900 acres of the proposed Spaceport Camden and adjacent areas have been converted to loblolly and slash pine plantations. Native communities replaced by the pine plantation included oak hammocks, mixed hardwoods, and pine flatwoods (CH2MHill, 2015a). The plantation areas are interspersed with emergent and scrub-shrub wetlands that were too wet to plant.

Plantation site preparations result in intensive surface disturbances to remove competing vegetation and create rows of raised beds for planting pine seedlings. Typically, mechanical site preparation includes timber harvesting; shearing, raking, V-blading, roller drum chopping, and burning; and bedding. Bulldozers and other specialized heavy machinery are used to prepare pine planting sites. Bedding plows are used to create 4- to 6-foot-wide planting beds (Exhibit G-2). Difference in elevations between the crest of the planting bed and bottom of the plow furrow on each side of the bed can range from 1 to 3 feet. A frequent consequence of pine plantation site preparation is the disturbance of natural drainage patterns and soil physical damage from compaction and/or rutting and soil profile mixing (Grace et al., 2006; Kelting, 1999; Miwa et al., 2004).

Exhibit G-2. Pine Seedling Planting Beds and Bedding Plow
(North Carolina Division of Forest Resources)

Pine plantation soils in the area include the Bohicket-Capers soil association and the Mandarin, Pottsburg, and Rutlege soil series. Recent observations of local plantation sites determined that the Mandarin soils had been disturbed to a depth of 2 feet, and organic surface layers of Rutlege soils were generally absent and mineral soil layers were exposed (CH2MHill, 2015a). Considering the seasonally high water tables and wet nature of sandy soils at the proposed Spaceport Camden site (see Table G-2), it is likely that site preparation activities resulted in localized soil damage (see Section G.2.1.1, *Construction*). Pine plantation soil damage measurements or soil monitoring data were not available.

[9] *Water table* refers to a saturated zone in the soil. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

Soil Erosion

Soil erosion is a three-phase process of detachment, transport, and deposition of surface materials by water overland flow that is difficult to control and easily accelerated by humans. Accelerated erosion caused by humans occurs at rates much greater than under natural erosion conditions. Large quantities of eroded soil sediment delivered to streams can adversely affect channel morphology, degrade aquatic species habitats, and impair water quality by increasing stream water column turbidity, altering water chemistry parameters, and introducing chemical contaminants and other pollutants (see EIS Section 3.14, *Water Resources*).

The primary types of natural soil erosion associated with the proposed Spaceport Camden site include streambank and tidal flats erosion. Typically, streambank instabilities occur as a result of channel entrenchment and scouring of bendway cutbanks. Bank retreat is primarily a result of mass failure of unstable (overheightened and oversteepened) banks. Streambed and bank toe scour increases the bank height and slope angel, decreasing its stability. Noncohesive bank materials such as sandy soils tend to fail from bank slides and sloughing. Site-specific failure mechanisms depend on the topography (height and steepness) and stratigraphy of the bank and the properties of the bank soils.

Generally, the low river delta gradients and water flow and dense vegetative cover minimize the potential for the occurrence of unstable streambanks and their erosion. However, as previously discussed, there are locations at the proposed Spaceport Camden site with abrupt elevation changes between the tidal marshes and higher ground flats that can create streambank conditions susceptible to erosion (see Section G.1.3.4, *Hypsology*). A recent study (CH2MHill, 2015a) identified active erosion on streambanks along Todd Creek that parallels the northern boundary of the proposed Spaceport Camden. It stated that the sites near the landfill are monitored, and a streambank stabilization plan would be implemented if bank erosion rates exceed benchmark tolerances (CH2MHill, 2015b). The plan was revised and is under review for final approval by the Georgia Environmental Protection Division.

Typically, tidal flats soil erosion is related to the loss of vegetative cover caused by saltwater intrusion or aggradation, degradation, and migration of intertidal stream and tributary channels. If waters become more saline, vegetation may die, which would allow underlying organic matter, held in place by plant roots, to be washed way. River deltas and estuaries are generally aggrading from riverine and marine sediment deposits. The vegetated mudflats that typically form between tidal creeks and channels tend to capture silty and clayey sediments, whereas the fluvial channels predominantly transport and deposit sandy sediments. As with other natural soil erosion processes, human intervention can accelerate the development of adverse conditions that exceed natural thresholds.

G.1.3.6 Paleontological Resources

Paleontological resources (fossils) are the remains or other indicators (trace fossils) of prehistoric plants and animals. Regional coastal Pleistocene, Holocene, and Miocene[10] marine fossils include pelecypod and gastropod molluscan shells, vertebrate remains (e.g., shark and crocodile teeth and vertebrae), and ostracods. In coastal downdip areas, Pleistocene deposits of invertebrate and vertebrate fossils are often found in abundance; Georgia Pleistocene deposits are generally nonfossiliferous except along the coast. Extinct mammal fossil remains have included giant beaver, ground sloth, armadillo, elephant, mastodon, bear, cougar, lynx, saber-tooth tiger, deer, buffalo, and horse. Regional coastal county "bone beds" have been identified near tide levels. Large bones of Pleistocene mammals have been found at

[10] A Tertiary Period epoch (approximately 5.2 to 23 million years ago) that followed the Oligocene and preceded the Pliocene Epoch; also includes the corresponding temporal-stratigraphic earth materials.

Whiteoak (approximately 14 miles northwest of the proposed Spaceport Camden site) in Camden County. Fossils are commonly found at surface outcrops and during soil excavations or well construction (Herrick & Vorhis, 1963; Herrick, 1965). No significant paleontological resources are known to occur within the proposed Spaceport Camden site.

G.1.3.7 Earthquakes

The earthquake of 1886 at Charleston, South Carolina (155 miles northeast of the proposed Spaceport Camden site) had an estimated Richter scale magnitude of 6.8 and is the most damaging earthquake known to have occurred in the southeastern United States and one of the largest historical shocks in eastern North America. The magnitude of an earthquake (measure of the energy released during the event) is often measured on the Richter scale, which runs from 0.0 upwards. The Richter scale is logarithmic; a quake of magnitude 5 is 10 times more destructive than a quake of magnitude 4. Earthquakes greater than magnitude 6 can be regarded as significant, with a high likelihood of damage and loss of life.

Earthquake-produced ground motion is expressed in units of percent *g* (force of acceleration relative to that of Earth's gravity). The latest probabilistic peak ground acceleration (PGA) data from the U.S. Geological Survey (USGS) were used to indicate seismic hazard. The PGA values cited are based on a 2 percent probability of exceedance in 50 years. This corresponds to an annual occurrence probability of about 1 in 2,500 (USGS, 2014). Most of the PGA is related to the proximity of the proposed Spaceport Camden site to the Charleston seismic zone and not from locally generated earthquakes. USGS data show that there is less than a 0.3 percent chance of a major earthquake within 31 miles of Camden County (http://www.homefacts.com/earthquakes/Georgia/Camden-County.html). No evidence of liquefaction or paleoliquefaction has been identified for the proposed Spaceport Camden site.

G.2 Environmental Consequences

This section describes potential impacts on earth resources as a result of the Proposed Action and No Action Alternative. Impacts on the existing environmental features and conditions (see Section G.1, *Affected Environment*) have been assessed for both the construction and operational phases of the Proposed Action and No Action Alternative.

The environmental consequences analysis was based on an evaluation of the impacts of the proposed project effectors on soil and landform receptors. The proposed project effectors include ground-disturbance activities relating to the construction of proposed Spaceport Camden facilities and infrastructure and rocket launch support activities. Effector activity scenarios described in EIS Chapter 2, *Proposed Action and Alternatives*, are used to define the project actions and expenditures.

The analysis focused on the defined and, as required, estimated interactions between effector actions and receptor vulnerabilities that result in ground disturbance. The determination of earth resource impacts was based on an analysis of the potential for the proposed project activities to damage soil by altering its physical properties or increasing the potential for soil erosion.

The earth resource receptor issues that are the focus of this analysis include (1) soil disturbance, (2) soil erosion, and (3) landform disturbance. Soil disturbance is generally defined as an abrupt change in the physical, chemical, or biological properties of a soil and may be categorized as displacement, exposure of mineral soil, physical damage, mass wasting, nutrient depletion, microclimate changes, and/or hydrologic changes. Soil physical damage includes disturbances to the structural and/or biological properties of soil or geologic features that compromise their natural condition and function. Examples include compaction,[11] rutting,[12] and soil erosion. Potential impacts of effector soil pollution and contamination on soil chemistry and biology are evaluated in EIS Section 4.7, *Hazardous Materials, Solid Waste, and Pollution Prevention*.

Soil compaction is identified by physical depressions of the soil without soil displacement. In contrast, soil rutting is the churning of a wet soil above its liquid limit to the point that it is broken into its ultimate soil particles and flows outward and upward (soil berming) from applied downward pressure. Compaction may occur in surface as well as subsurface layers of the soil, whereas rutting generally represents the depth and extent of a disturbed soil surface layer or upper seal of a soil column. As soils become saturated, the potential for compaction generally decreases and potential for rutting increases. Under comparable conditions, silt and clay soils generally compact more severely than sandy soils. Structurally damaged soils also increase surface runoff and reduce water-soil infiltration rates, which can increase soil erosion potentials.

The NRCS estimates which soils are highly erodible or potentially highly erodible due to sheet and rill erosion primarily based on the Revised Universal Soil Loss Equation. A highly erodible soil has a maximum potential for erosion that equals or exceeds eight times the tolerable erosion rate.[13] The soils on the proposed Spaceport Camden site have a low soil erodibility rating (little or no natural erosion is likely to occur). The rating is primarily based on horizontal to gentle slope gradients, flatplain surface morphometry, and slow surface runoff. However, erodibility is only one component of the soil erosion process. The disturbance or loss of vegetative cover, localized soil compaction, increases in slope gradients, and stormwater runoff channelization and unprotected discharge at constructed outlets can increase soil erosion potentials.

Landform disturbances would include effector-induced physical alterations in surface gradients, patterns, or shape geometries and/or alterations in surface or geohydrology drainage patterns. Soil disturbance focuses on physical impacts to specific soils, whereas landform disturbance is concerned with mechanical alterations to the overall form and function of landforms (see Section G.1.3.3, *Surface Morphometry*). During construction, site land surfaces are reconfigured to meet design specifications by adding fill materials and/or using heavy equipment to reshape the land. Whether by soil filling or grading, there is the potential for loss of landform integrity[14] during construction preparation, emplacement, and stabilization.

Earth resource receptors must be exposed to an effector for an impact to occur. For this analysis, project-related earth resource environmental impacts are described by their likelihood, intensity, duration, and significance. These impact attributes provide a physical, spatial, temporal, and relational basis for describing the nature and importance of an impact on earth resources. Impact evaluation criteria are presented in Table G-3.

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[11] *Soil compaction* is the increase in soil density resulting from moving soil particles in response to an applied external force. It significantly increases bulk density, water-filled porosity, heat conductivity and diffusion, and available water and decreases aeration porosity, water infiltration rates, and hydraulic conductivity.

[12] *Soil rutting* is the deformation of the surface that destroys soil structure. It primarily occurs as a result of the operation of heavy vehicles on wet soils. Rutting effects on soils are most severe when the soil is saturated or nearly saturated.

[13] Erosion rates that are lower than the rate of soil development. Soils are assigned a tolerance value primarily based on the thickness of the soil above bedrock or unaltered parent material.

[14] The integrity of landform components helps maintain resistance to damage from threats such as development and land use conversion. Generally, integrity relates to the intactness of the landform structure and provision of applicable ecosystem services (ESs). These services are the benefits of ecosystem features and functions directly consumed, used, or enjoyed to yield human well-being. The structural and functional capabilities of landscapes to provide ESs can differ dramatically and are frequently altered by anthropogenic land uses.

Table G-3. Earth Resources Impact Analysis Evaluation Criteria

Attribute	Description
Likelihood (probability)	
Probable	There is a level certainty that the anticipated impact would occur.
Possible	It is likely that the anticipated impact would occur, however, there are no data to support a level of certainty that the impact would or would not occur.
Unlikely	There is a level of certainty that the anticipated impact is improbable and would not occur.
Unavoidable	Adverse effects would occur regardless of the proposed mitigations or other actions intended to eliminate adverse effects.
Intensity (how much)	
Major	Substantial impact on or change in earth resources receptors that is easily defined, noticeable, and/or calculable but may not be measurable or exceeds a threshold level that may threaten the integrity of one or more resource components.
Moderate	Noticeable change in one or more earth resource receptors occurs, but resource integrity remains intact.
Minor	The impact on earth resource receptors is at the lowest levels of detection (barely measurable and with no perceptible consequences) or would result in only a minor change.
Negligible	Impact is at the lowest level of measurement or is so low as to be immeasurable and has no perceptible consequences.
Duration (how long)	
Long term	The impact would likely persist for a period greater than the medium-term impact and would likely extend beyond the life of the project.
Medium term	The impact would only occur for specific, relatively brief periods during the project life, interrupted by periods of no impacts.
Short term	The impact would extend for short periods much less than the overall project life (for example, during launch operations).
Significance	
Significant	Impacts would be adverse, regional or localized, probable or unavoidable, of major intensity, of any duration, and impact effect is partially reversible or irreversible with mitigation.
Nonsignificant with mitigation	Appropriate mitigation measures are identified to reverse impact affects to a level below significant criteria.
Nonsignificant	Impacts would occur resulting in a beneficial or neutral changes to the existing environment and do not meet the significant criteria.

Earth resource impacts analysis considered but not carried forward include (1) soil subsidence (2) paleontological resources, and (3) seismic effects. Subsidence of organic soils was excluded from the analysis because the only ROI organic soil of concern is the Bohicket and Capers soil association, which would not be impacted by the proposed effector construction or operation activities. The greatest potential for exposures of fossil-bearing limestone and marl layers beneath the superficial Pleistocene sands and clay to occur is in the margins of Satilla River tributary streams such as Todd Creek (see Section G.1.3.6, *Paleontological Resources*). The fossils that could be encountered during proposed Spaceport Camden construction-related excavations would likely include relatively common marine shells and vertebrate remains that would likely have minimal research or scientific collection value. The type and scale of the proposed construction and operation activities would not expose or disrupt geologic formations or induce seismic activity; therefore, further analysis of potential consequences to geologic features was excluded.

G.2.1 Proposed Action

To establish a spatial context for analysis, the proposed project facility and infrastructure features were compartmentalized into the proposed Spaceport Camden site and the proximity area. Spatially, the proximity area is the extents of the proposed facility and infrastructure footprints and is not presented in the context of an encompassing polygon area like the approximately 1,413.2-acre proposed Spaceport Camden site.

G.2.1.1 Construction

The construction process is generally divided into three phases: (1) surface preparation, (2) structure emplacement, and (3) stabilization of remaining disturbed areas not covered by the constructed feature. Surface preparations typically include altering the surface by grubbing, clearing, and grading (cuts and fills); topsoil may or may not be removed. Soil excavations may be required to create the appropriate construction feature subgrade and base components.

Disturbance of earth resources includes excavating soil, soil mixing, and soil compaction and rutting and covering with building foundations, parking lots, roadways, and fill materials. Imported crushed stone, aggregates, sand, clay, or gravel are often used as fill during facility and road construction. The physical properties of soil may be dramatically altered during construction. Even when topsoils are stockpiled and replaced, the soil profile will be altered. Depending on pyogenic conditions, recreating a soil profile may take decades or hundreds of years. The subsequent land use changes are essentially permanent. Changes in natural drainageway landforms may also accompany construction activities. Channel alterations may be a direct result of construction activities or an indirect result of natural systems responding to changes in hydrologic features or conditions (see EIS Section 4.14, *Water Resources*). Typically, the primary pollutant generated by the construction process is sediment.

<u>**Construction Footprints**</u>

The proposed Spaceport Camden construction activities include facility buildings and parking lots, rocket launch and mission preparation pads, a main gate facility, and infrastructure roads and rights-of-way. The proposed project construction footprint soil metrics are presented in Table G-4.

Table G-4. Proposed Spaceport Camden Construction Footprints

<table>
<tr><th>Construction Feature</th><th>Mandarin Series</th><th>Pottsburg Series</th><th>Rutlege Series</th><th>Total (acres)</th></tr>
<tr><td colspan="5">Proposed Spaceport Camden[1]</td></tr>
<tr><td>Vertical Launch Facility</td><td>49.6</td><td>11.4</td><td rowspan="3">0</td><td>61.0</td></tr>
<tr><td>LCC Complex</td><td>3.9</td><td rowspan="4">0</td><td>3.9</td></tr>
<tr><td>Mission Preparation Area</td><td>21.4</td><td>21.4</td></tr>
<tr><td>Main Gate</td><td>0</td><td>0.1</td><td>0.1</td></tr>
<tr><td>ACC and Visitor Center</td><td>2.5</td><td>0</td><td>2.5</td></tr>
<tr><td>Infrastructure</td><td>25.7</td><td>0.7</td><td>2.2</td><td>28.6</td></tr>
<tr><td>Subtotal</td><td>103.1</td><td>12.1</td><td>2.3</td><td>117.5</td></tr>
<tr><td colspan="5">Proximity Area (Outside the Proposed Spaceport Camden)</td></tr>
<tr><td>ACC and Visitor Center</td><td>1.5</td><td>1.7</td><td>0</td><td>3.2</td></tr>
<tr><td>Main Gate</td><td>0</td><td>0.1</td><td>0.4</td><td>0.5</td></tr>
<tr><td>Infrastructure</td><td>30.5</td><td>1.5</td><td>4.0</td><td>36.0</td></tr>
</table>

Table G-4. Proposed Spaceport Camden Construction Footprints

Construction Feature	Mandarin Series	Pottsburg Series	Rutlege Series	Total (acres)
Subtotal	**32.0**	**3.3**	**4.4**	**39.7**
Total	**135.1**	**15.4**	**6.7**	**157.2**

Notes: LCC = Launch Control Center; ACC = Alternate Control Center.
[1] The proposed Spaceport Camden is delineated by the blue line boundary in Exhibit G-1. Proposed Spaceport Camden Soil Map. The proximity area facility and infrastructure construction footprints are located to the immediate south and east of the proposed Spaceport Camden site.

The proposed Spaceport Camden site and proximity area total construction footprint areas are approximately 117.5 acres and 39.7 acres, respectively. Proposed facility and infrastructure construction footprints would impact approximately 8 percent (117.5 acres) of the approximately 1,413.2 acres that compose the proposed Spaceport Camden site.

Exposure to potential geologic hazards and potential for soil erosion and soil limitations were considered when evaluating impacts to earth resources. Generally, impacts can be avoided or minimized if proper construction techniques, erosion-control measures, and structural engineering designs are incorporated into project development.

With the implementation of permit requirements and associated best management practices (BMPs) (see EIS Chapter 6, *Mitigation*, for examples), the Federal Aviation Administration (FAA) has identified no significant adverse impacts under the Proposed Action. Because ground-disturbing activities would exceed 1 acre, a National Pollutant Discharge Elimination System (NPDES) permit would be required. Under the permit, Camden County would be required to implement BMPs as part of the Erosion, Sedimentation, and Pollution Control Plan requirements. These BMPs would serve to mitigate any potential impacts to soils. The base would also have to obtain a Camden County Land Disturbing Permit per the Georgia Erosion and Sedimentation Control Act. With application of BMPs as required and adherence to permit stipulations, potential impacts to soil resources and groundwater recharge areas would not be anticipated.

Much of the activity associated with the Proposed Action would occur on Mandarin and Pottsburg series soils. With flood control and proper drainage measures, there are no major limitations that would preclude this soil type from development. The disturbance footprint would negligibly impact the utility of this soil type, since it is not currently used for, nor are there future plans to utilize the parcel for, any other purposes.

Ground disturbance owing to tree removal, addition of fill, grading, construction, and pavement construction activities could result in soil erosion within the project area. The use of permit-required BMPs would reduce any potential impacts from erosion during these activities. With the implementation of these actions, groundwater resources in the area are likely to be unaffected as well.

Overall, it is probable that impacts associated with soil disturbance and erosion would occur. However, impacts would be of moderate intensity and localized to construction footprints during the short term (i.e., during construction and until soils are stabilized). These impacts would likely be nonsignificant provided that permit-related BMPs and mitigations are implemented.

Mitigation

Soil structural damage can result in impacts to soil and water environments for many years. The natural recovery or amelioration of damaged soils to pre-compaction conditions is extremely slow, if it occurs at all. Recovery of sandy soils is very slow, and compacted subsurface layers take much longer to recover.

Any mitigations associated with construction activities would be covered under the NPDES and Camden County Land Disturbing permits.

G.2.1.2 Operation

An assessment of proposed Spaceport Camden operational launch and support activities and performance scenarios (see EIS Chapter 2, *Proposed Action and Alternatives*) did not identify activities that would result in impacts to earth resources. The extent of proposed Spaceport Camden operation activity footprints (constructed facility and infrastructure platforms) would be conducted on permanently disturbed sites and would not result in impacts to adjacent natural areas.

Vibrations from rocket launch events were evaluated as a potential source of impacts to unstable streambanks. However, since streambanks potentially sensitive to noise vibrations are over 8,000 feet west of the proposed launch facility, no launch operation impacts are anticipated. Should streambank erosion issues arise, a stabilization plan is in place to prevent further damage (see Section G.1.3.5, *Soils: Soil Erosion*).

In addition, all proposed operational activities would be conducted on constructed building and pad platforms or roadways, which minimize the potential for offsite earth resource impacts. Therefore, analysis of the impacts of proposed operational activities on earth resources is not carried forward.

G.2.2 No Action Alternative

Under the No Action Alternative, FAA would not issue a Launch Site Operator License for operation of Spaceport Camden, and no spaceport facilities would be constructed. The property use would not change, and the proposed construction and operations would not take place. There are no anticipated impacts to earth resources, since there would be no change in the current state.

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APPENDIX H WETLANDS DELINEATION

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H WETLANDS DELINEATION

Spaceport Camden

Final
Wetlands Delineation Report

Camden County, Georgia

November 2017

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ACRONYMS AND ABBREVIATIONS

ArcGIS	geographical information system mapping program
CFR	*Code of Federal Regulations*
CWA	Clean Water Act
GPS	global positioning system
LIDAR	light detection and ranging
NASA	National Aeronautics and Space Administration
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
PEM	palustrine emergent
PFO	palustrine forested
PSS	palustrine scrub-shrub
PUB	palustrine unconsolidated bottom
SFWMD	South Florida Water Management District
USGS	U.S. Geological Survey
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WRAP	Wetland Rapid Assessment Procedure

1.0 PURPOSE AND BACKGROUND

This report provides the results of the wetland and surface water delineation performed by Leidos, Inc., staff (Brian Tutterow/Sarah Bresnan Rauch) on August 15 through 19, 2016, and a site visit with the USACE on June 22, 2017, at the proposed Spaceport Camden site, Camden County, Georgia (Figure 1).

The site is located in an unincorporated area of Woodbine, Georgia, in Camden County, approximately 11.5 miles east of the town of Woodbine, at the mouth of the Satilla and Cumberland Rivers and just west of Cumberland Island. The site has been in industrial use since the early 1940s and initially was used as a tree farm to supply a local paper mill. During the 1960s, the Thiokol Chemical Company operated a solid rocket motor facility at the site. When the National Aeronautics and Space Administration (NASA) decided to concentrate on liquid-fueled rockets, the site was converted to manufacture military hardware, including mortar ammunition and trip flares. From the mid-1970s to 2012, the property was occupied by a pesticide manufacturing facility operated by various owners.

The purpose of the Camden County Board of Commissioners' (i.e., the County's) proposal to construct and operate Spaceport Camden is to enable the County to offer a commercial space launch site to a growing number of medium and small, orbital and suborbital, vertical launch vehicle operators to conduct commercial launches on the east coast of the United States. A commercial space launch site could more effectively respond to the scheduling needs of commercial launch providers than Federal facilities, which involve national security priorities and logistical complexities.

Under the proposed project, the County would construct and operate Spaceport Camden under a Launch Site Operator License on approximately 4,000 acres of upland at the approximately 11,800-acre industrial site shown on Figure 1. The 11,800-acre site is currently owned by Bayer Crop Science and Union Carbide Corporation (Figure 1). Spaceport Camden would include a Vertical Launch Facility, a Landing Zone, a Launch Control Center Complex, and an Alternate Control Center and Visitor Center. These facilities would be constructed on approximately 100 non-contiguous acres (as shown on Figure 2). In addition to improving existing roads, at least one new road may be constructed. The remainder of the 4,000-acre site, some of which is wetland, would be used as a safety buffer. No additional development has been proposed for the buffer area. The area requested for verification of wetland boundaries is 184.1 acres in size and is shown as the field survey area on Figures 3, 3A, 3B, and 3C.

An existing dock with deep-water access (on the portion of the property not currently under option to Camden County) may be utilized during construction and operation of the proposed Spaceport Camden site. No construction or other changes are proposed for the dock.

Figure 1. Project Location

2.0 REGULATORY FRAMEWORK

2.1 FEDERAL AND STATE ACTS AND REGULATIONS

The U.S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (USEPA) jointly define wetlands as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (USACE 1987).

Section 404 of the Clean Water Act (CWA) establishes a program to regulate discharges of dredged or fill material in waters of the United States to ensure protection of the biological and chemical quality of the water. Waters of the United States that are subject to jurisdictional review are defined by 33 *Code of Federal Regulations (CFR)* 328 as follows:

- Waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide including the territorial seas;
- All interstate waters including interstate wetlands;
- All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds;
- All impoundments and tributaries of waters defined as waters of the United States; and
- Wetlands adjacent to waters defined as waters of the United States.

As defined previously, jurisdictional waters subject to Section 404 include streams, rivers, and creeks that are navigable waters or tributaries to navigable waters. Certain wetlands are also considered jurisdictional waters of the United States and would also be subject to regulation under Section 404. For a water or wetland to be considered a water of the United States, a jurisdictional determination and/or wetland delineation must be completed and approved by the USACE. If jurisdictional waters or wetlands are found, Section 404 requires a Federal facility to obtain a Section 404 permit from the USACE before dredged or fill material may be discharged into jurisdictional waters of the United States, unless the activity is exempt from Section 404.

The State of Georgia has no state-specific wetland regulations for non-tidal wetlands. Georgia does regulate tidal wetlands under the Georgia's Coastal Marshland Protection Act. No tidal wetlands were identified in the survey areas.

2.2 WETLAND FUNCTIONAL ASSESSMENT

The Wetland Rapid Assessment Procedure (WRAP) is a rating index developed to assist in the regulatory evaluation of wetland sites that have been created, enhanced, preserved, or restored. This standardized rating index can be used in combination with professional judgment to provide an accurate and consistent evaluation of wetland sites (SFWMD 1997).

A WRAP conducted during the wetland delineation documents the functional condition of the wetlands (see Appendix A, Attachment A-1). The WRAP assessed five variables to determine the functional condition of the wetland. These variables are: wildlife utilization; wetland overstory/shrub canopy; wetland vegetative ground cover; adjacent upland support/wetland buffer; field indicators of wetland hydrology; and water quality input and treatment systems evaluation. These variables are assigned a score from 0 to 3, and then the variables are summed and divided by the maximum potential score for each variable to result in an index score. The index score is shown in the "WRAP Score" section of each data sheet as a number from 0 to 1. A higher WRAP index number represents higher functionality, whereas a lower number represents poor functionality.

3.0 METHODS

Prior to the site visit, the following resources were reviewed:

- Natural Resources Conservation Service (NRCS) soils maps,
- National Wetland Inventory (NWI) maps,
- Camden County elevation models derived from light detection and ranging (LIDAR),
- U.S. Geological Survey (USGS) topographic maps, and
- 2011 Woodbine "Wetland Mitigation Bank–Wetland Delineation" (USACE 2011).

NRCS soil maps were reviewed to identify areas of hydric soils that might support wetlands, and LIDAR and topographic maps were reviewed for evidence of low-lying areas that might support the formation of wetlands.

In November 2010, a wetland delineation was conducted within a portion of the proposed Spaceport Camden site. The delineation was prepared as part of a feasibility study for a wetland mitigation bank. Appendix C, Attachment C-2, contains a figure showing the study area for the mitigation bank and the results of the wetland study.

Areas of the project proposed for construction were selected to avoid known wetland areas (previously delineated wetlands and NWI) and, therefore, few of these areas have wetlands mapped by the NWI. The NWI does map several of the areas that are not proposed for construction as wetlands. These wetlands include emergent and forested/shrub wetlands.

A site visit was conducted from August 15 through August 19, 2016, to identify and delineate waters and surface features in the field survey areas identified on Figure 3. Boundaries and locations of previously delineated wetlands and surface water features were verified in the field, and new wetland features were delineated during the field visit. Any new surface water features observed were mapped using aerial photography and global positioning system (GPS) field points. Only wetlands, streams, and ditches within field survey areas were delineated and mapped.

Wetlands were identified and delineated in accordance with the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0)* (USACE 2010). Observation points were used to characterize wetlands and to determine the location of the wetland boundary lines. For wetland and surface water features, delineation of the line occurred by walking the line and taking single GPS points and then connecting the points using a geographical information system mapping program (ArcGIS). Each point was taken within visual sight distance of the previous points. Wetland Determination Data Forms were created for observation points used to characterize wetland and upland areas (see Appendix A, Attachment A-2), and photographs were taken at each site (Appendix B). Ditches were mapped using a combination of aerial photography and GPS field mapping.

The primary soil mapped at the proposed Spaceport Camden site is classified as Mandarin fine sand, with 0 to 2 percent slopes (Appendix C, Attachment C-1). This soil has a hydric rating of 6 (i.e., 6 percent of the soil map unit meets the criteria for hydric soil). Other significant soils by acreage include Pottsburg sand (hydric rating 5) and Rutlege fine sand (hydric rating 100). Other soils with hydric components that occur less frequently at the proposed Spaceport Camden site include Bohicket-Capers association and Pelham loamy sand. Cainhoy fine sand, a non-hydric soil, is also present in low percentages (USDA 2016).

3.1 U.S. ARMY CORPS OF ENGINEERS SITE VISIT

A site visit occurred with the USACE, Savannah District, on June 22, 2017, to verify the results of the wetland delineation. After consultation with USACE, the wetland delineation boundaries were revised for Wetlands 6, 10, and 11. A new wetland, Wetland 21, was added alongside an ephemeral stream, and Wetland 5 was re-evaluated and determined to not meet the criteria for a wetland.

4.0 RESULTS

As part of the wetland delineation at the proposed Spaceport Camden site, 184.1 acres were surveyed. This survey resulted in the observation of 3.61 acres of wetlands and 1,043 linear feet of ephemeral streams within the field survey area. Approximately 0.78 acres of wetlands and 0.166 acres of ephemeral streams were observed within the area of project impact (Table 1 and 2). According to the Cowardin Classification System (USFWS 1979), these wetlands are comprised of Palustrine System habitat types including palustrine forested (PFO), palustrine emergent (PEM), palustrine scrub-shrub (PSS), and palustrine unconsolidated bottom (PUB). Table 1 lists the identified wetland areas by habitat type, observation point, wetland type (by Cowardin classification), potential impacted acres, and location (latitude/longitude). The observation point number references the point that was used to characterize that wetland. The habitat type refers to the characteristic vegetation type encountered within the wetland survey area. Table 2 lists stream impacts. A list of habitat types and associated species follows.

- Pine plantation (open canopy) – *Pinus taeda* and/or *P. palustris*
- Pine plantation (closed canopy) – *P. taeda* and/or *P. palustris*
- Cypress/Redbay – *Taxodium ascendens* and *Persea borbonia*
- Unvegetated – no vegetation observed within wetland area
- Grass-sedge meadow – dominated by *Carex* spp. and *Juncus* spp.
- Tupelo – *Nyssa sylvatica*
- Buttonbush scrub/Cattail marsh – *Cephalanthus occidentalis* and *Typha* sp.
- Cypress/Grass-sedge – *T. ascendens* and *Carex* spp. and *Juncus* spp.
- Oak/Sedge – *Quercus nigra, Q. virginiana,* and/or *Q. laurifolia*

Several ditches were field verified and mapped as roadside ditches (Figures 3, 3A, 3B, and 3C). Three ephemeral streams were observed in the survey area. No other surface water features were identified within the survey area.

The following figures and appendices document the results of the field survey.

- Figure 1. Project Location
- Figure 2. Proposed Facilities and Survey Areas
- Figures 3, 3A, 3B, and 3C. Mapped Wetlands, Water Features, and Observation Points
- Figure 4. Photo Points
- Appendix A. Wetland Delineation Data Forms
- Appendix B. Site Photographs
- Appendix C. Natural Resources Conservation Service Soil Survey and Previously Delineated Wetlands Maps
- Appendix D. Global Positioning System Delineation Form
- Appendix E. U.S. Army Corps of Engineers Verification Letter

Figure 2. Proposed Spaceport Camden

Table 1. Aquatic Resources within the Field Survey Area at the Proposed Spaceport Camden

Wetland	Acres in the Field Survey Area	Habitat Type	Wetland Type[a]	Estimated Impacted Wetlands (Proposed Project)[b]	Latitude	Longitude
3A	0.184	Cypress/Redbay	PFO	0.043 (Regular Road)	30.94321000	-81.54158000
3B	0.1410	Cypress/Redbay	PFO	0.041 (Regular Road)	30.94363000	-81.53896000
3C	0.4770	Cypress/Redbay	PFO	0.081 (Regular Road)	30.94312000	-81.54120000
3D	0.1720	Cypress/Redbay	PFO	0	30.94342000	-81.53904000
3E	0.3660	Cypress/Redbay	PFO	0.134 (Regular Road)	30.93678000	-81.53945000
6	0.0020	Grassland	PUB	0.002 (Vertical Launch Facility)	30.94697800	-81.50976100
7	0.1960	Unvegetated	PEM	0.073 (Heavier Road)	30.94037400	-81.51296800
9	0.1210	Grass-Sedge Meadow	PEM	0.015 (Heavier Road)	30.94253300	-81.51037800
10	0.6440	Tupelo	PFO	0.267 (Heavier Road [Alternate Route])	30.93529300	-81.51991800
11	0.0820	Grass-Sedge Meadow	PSS/PEM	0.012 (Heavier Road)	30.93688500	-81.51536800
12A	0.0480	Oak/Sedge	PFO	0	30.93181000	-81.51838000
12B	0.0790	Buttonbush Scrub/Cattail Marsh	PFO	0	30.93033000	-81.51839000
14	0.1890	Oak/Sedge	PEM	0.021 (Regular Road)	30.94325800	-81.53758000
15	0.0570	Scrub/Emergent	PEM	0.002 (Regular Road)	30.94369900	-81.53644800
16	0.2760	Grass-Sedge Meadow	PFO/PSS/PEM	0.026 (Regular Road)	30.94452900	-81.53815500
17	0.2100	Grass-Sedge Meadow	PFO/PSS/PEM	0.061 (Regular Road)	30.93489900	-81.53610900
18	0.0920	Cypress/Grass-Sedge	PFO/PSS	0	30.93557000	-81.52572600
19A	0.0780	Cypress/Grass-Sedge	PSS/PFO	0	30.94062000	-81.52322500
19B	0.1610	Cypress/Redbay	PSS/PFO	0	30.93496000	-81.52385000
20	0.0150	Oak/Sedge	PFO	0	30.93700000	-81.51400000
21	0.0170	Cypress/Redbay	PEM	0.004 (Regular Road)	30.93797000	-81.51504000
TOTALS	**3.61**			**0.78**		

[a] PEM = Palustrine Emergent, PFO = Palustrine Forested, PSS = Palustrine Scrub Shrub, PUB = Palustrine Unconsolidated Bottom.
[b] All wetland areas were determined by Leidos, Inc., to be jurisdictional, and any impacts will require Section 404 permits.

Table 2. Potential Ditch and Stream Impacts by Project Area

Ephemeral Stream	Acres in the Field Survey Area	Disturbance	Potentially Impacted Area	
			Linear Feet	Acres
1	0.152	Landing Zone	660	0.1524
2A	0.009	Heavier Road	107	0.0069
2B	0.003	Heavier Road	53.962	0
3A	0.007	Heavier Road	109.492	0.0002
3B	0.015	Heavier Road (Alternate Route)	112.571	0.0062
		TOTALS	**1043.025**	**0.166**

Figure 3. Mapped Wetlands, Water Features, and Observation Points

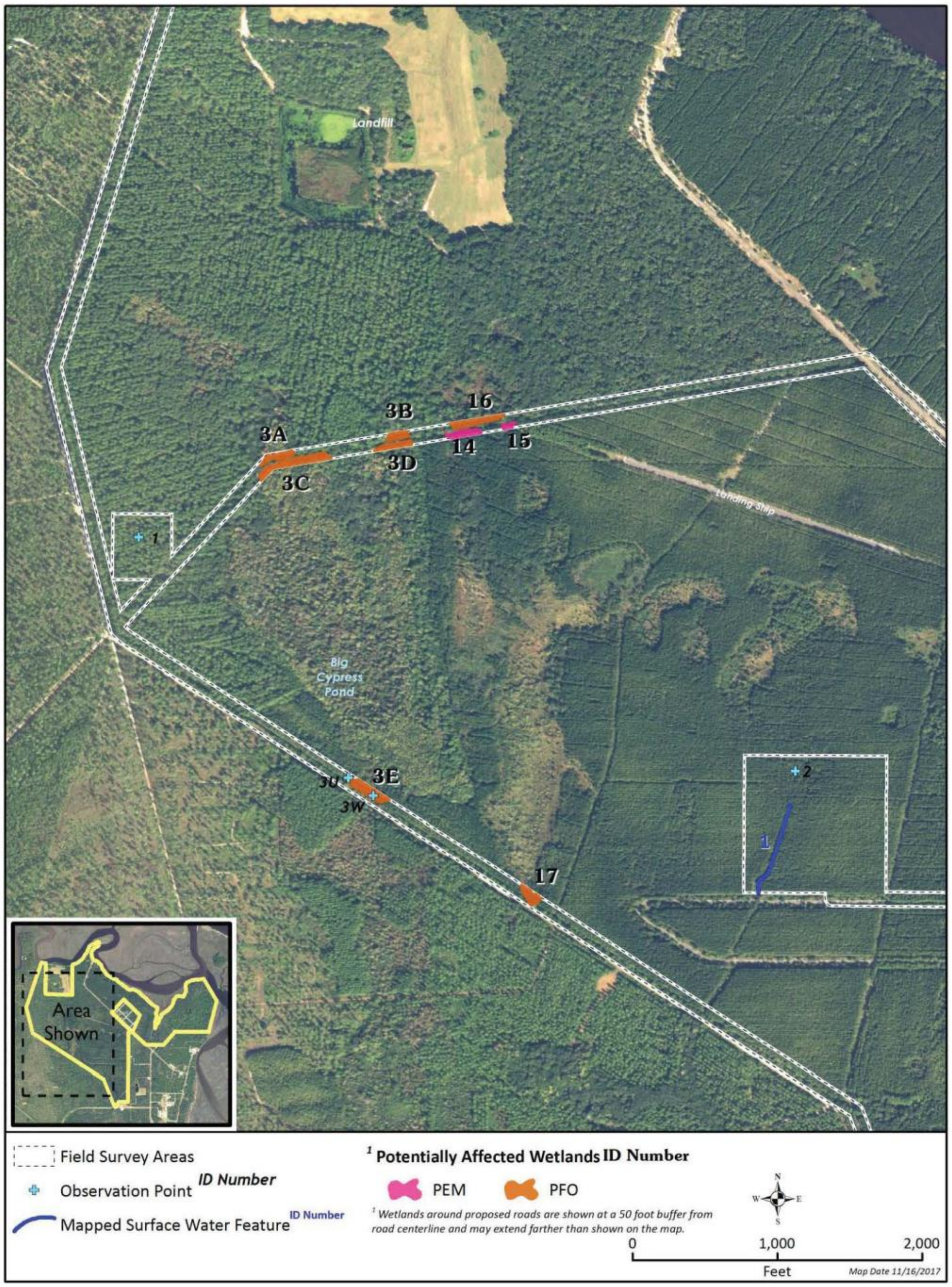

Figure 3A. Mapped Wetlands, Water Features, and Observation Points

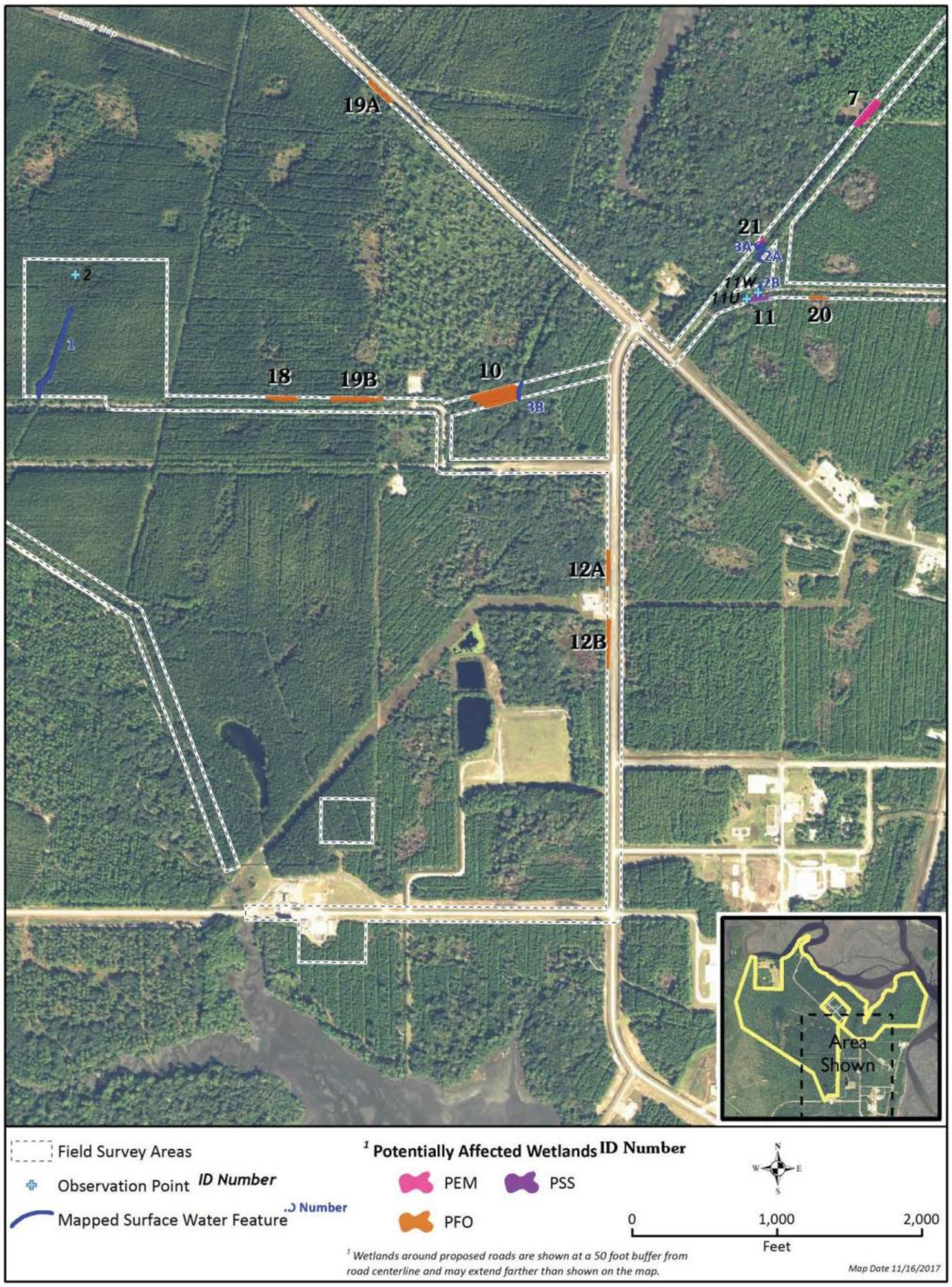

Figure 3B. Mapped Wetlands, Water Features, and Observation Points

Figure 3C. Mapped Wetlands, Water Features, and Observation Points

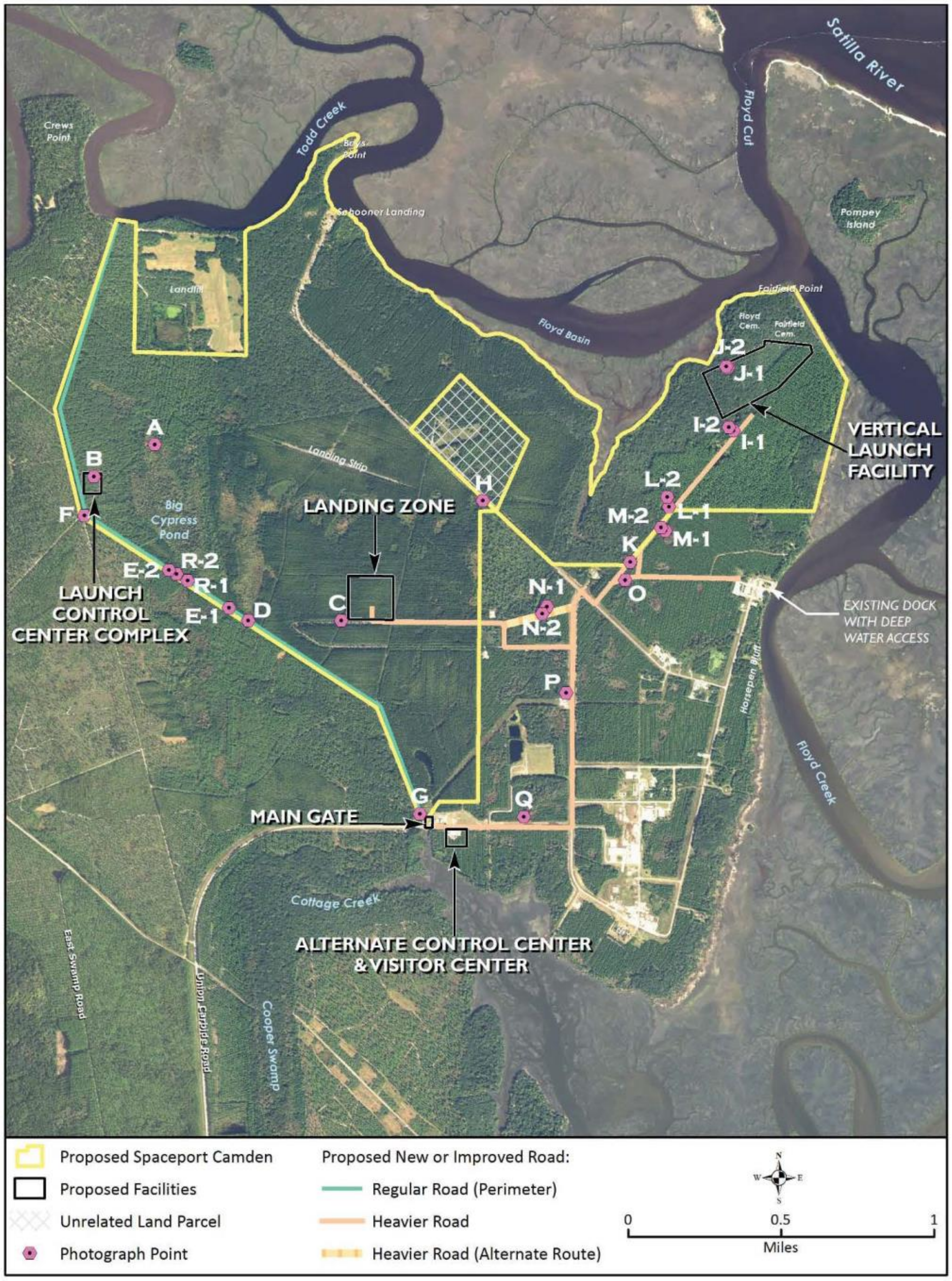

Figure 4. Photo Points

5.0 POTENTIAL IMPACTS

As part of the wetland delineation at the proposed Spaceport Camden site, 184.1 acres were surveyed. Approximately 0.78 acres of wetlands may be impacted as a result of the proposed project. Approximately 886 linear feet of ephemeral streams could be impacted as a result of the proposed project.

A conservative estimate of wetland impacts was made based on the preliminary facility design. To provide the conservative estimate, the survey areas for facilities and any proposed alternatives were used as the extent of potential impacts. Road impacts were assessed based on a 24-foot right-of-way for the perimeter road, a 36-foot right-of-way for internal site regular roads, and a 40-foot right-of-way for internal heavier roads. The footprint for actual impacts is anticipated to be smaller as roads may be shifted to avoid wetlands, alternatives such as the heavy roads may not be used, and the overall wetland impacts are estimated to be less than the 0.78 acres of wetlands described previously. The actual total extent of wetland and ephemeral stream impact will be determined during final permitting and design. A wetland permit will be required from the USACE prior to any work in the wetland or stream areas.

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6.0 REFERENCES

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APPENDIX A

WETLAND DELINEATION DATA FORMS

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Attachment A-1

Wetland Rapid Assessment Procedure (WRAP) Forms

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Wetland 3

Wetland Rapid Assessment Procedure

Check one: ☐ Existing Conditions ☑ Proposed Conditions

(WRAP)

Application Number	Project Name	Date	Evaluator	Wetland Type
	Spaceport Camden	8-16-16	Brian Tutterow	PFO

Land Use: open space

FLUCCS Code: 621 Description: Cypress

Wetland Acreage: 58.25

Wildlife Utilization (WU): 2.5

Wetland Canopy (O/S): 2

Wetland Ground Cover (GC): 2

Field Hydrology (HYD): 2

WQ Input & Treatment (WQ)*: 1.5

* The value of WQ is obtained by adding the TOTAL scores of Land use Category and Pretreatment category then dividing by 2

Habitat Support / Buffer

Buffer type	(Score)	X (% of area)	=Sub Totals
Wet	3	80	2.4
Upl	3	15	0.45
Upl	1	5	0.05
		TOTAL	2.9

Land use Category (LU)

Land use Category	(Score)	X (% of area)	=Sub Totals
undevel	3	100	3
		(LU) TOTAL	3

Pretreatment Category (PT)

Pretreatment Category	(Score)	X (% of area)	=Sub Totals
None	0	0	0
		(PT) TOTAL	0

WRAP Score: 0.72

Field Notes:

Wildlife Utilization (WU)

Site is in relatively undeveloped portion of the site. Some disturbance for access roads and pine plantations. Evidence of deer and wild pigs was observed.

Wetland Canopy (O/S)

Open cypress swamp

Wetland Ground Cover (GC)

Graminoid dominated community, no invasives observed, some disturbance related to unimproved roads.

Habitat Support / Buffer

Site is located in undeveloped area with wetlands and historic pine plantations functioning as buffer. Adjacent land owners to the west have created roads which reduce the buffer areas.

Field Hydrology (HYD)

Despite disturbance related to access roads and pine plantation the hydrology is relatively undisturbed.

WQ Input & Treatment (WQ)

This is a small watershed area. Most of the surface water runoff flow directly into the wetland with no treatment.

Wetlands 7,9
Wetlands 14,15

Wetland Rapid Assessment Procedure (WRAP)

Check one: ☐ Existing Conditions ☑ Proposed Conditions

Application Number	Project Name	Date	Evaluator	Wetland Type
	Spaceport Camden	8-17-16	Brian Tutterow	PEM

Land Use	FLUCCS Code	Description	Wetland Acreage
open space	640	freshwater non-forest	3.64

Wildlife Utilization (WU)	Wetland Canopy (O/S)	Wetland Ground Cover (GC)
2	2	2

Field Hydrology (HYD): 2

WQ Input & Treatment (WQ)*: 1.5

* The value of WQ is obtained by adding the TOTAL scores of Land use Category and Pretreatment category then dividing by 2

Habitat Support / Buffer

Buffer type	(Score)	X (% of area)	=Sub Totals
Upl	2.5	90	2.25
Upl	0	10	0

TOTAL: 2.25

Land use Category (LU)

Land use Category	(Score)	X (% of area)	=Sub Totals
undevel	3	100	3

(LU) TOTAL: 3

Pretreatment Category (PT)

Pretreatment Category	(Score)	X (% of area)	=Sub Totals
None	0	0	0

(PT) TOTAL: 0

WRAP Score: 0.65

Field Notes:

Wildlife Utilization (WU)

Sites are in relatively undeveloped portions of the site. Some disturbance for access roads and pine plantations. Evidence of wild pigs was observed.

Wetland Canopy (O/S)

Emergent wetland vegetation.

Wetland Ground Cover (GC)

No invasives observed, some disturbance related to roads.

Habitat Support / Buffer

Sites are located in historic pine plantation and coastal oak scrub bordered by access roads.

Field Hydrology (HYD)

Despite disturbance related to access roads and pine plantation the hydrology is relatively undisturbed.

WQ Input & Treatment (WQ)

This is a small watershed area. Most of the surface water runoff flow directly into the wetland with no treatment.

Wetland 6

Wetland Rapid Assessment Procedure (WRAP)

Check one: ☐ Existing Conditions ☐ Proposed Conditions

Application Number	Project Name	Date	Evaluator	Wetland Type
	Spaceport Camden	8-17-16	Brian Tutterow	PUB

Land Use: open space

FLUCCS Code: 616 Description: Pond

Wetland Acreage: 0.05

Wildlife Utilization (WU): 1

Wetland Canopy (O/S): 0

Wetland Ground Cover (GC): 0

Field Hydrology (HYD): 2

WQ Input & Treatment (WQ)*: 3.0

* The value of WQ is obtained by adding the TOTAL scores of Land use Category and Pretreatment category then dividing by 2

Habitat Support / Buffer

Buffer type	(Score)	X (% of area)	=Sub Totals
UPL	2.5	100	2.5

TOTAL: 2.5

Land use Category (LU)

Land use Category	(Score)	X (% of area)	=Sub Totals
natural	3	100	3.0

(LU) TOTAL: 3.0

Pretreatment Category (PT)

Pretreatment Category	(Score)	X (% of area)	=Sub Totals
Natural	3	100	3

(PT) TOTAL: 3

WRAP Score: 0.48

Field Notes:

Wildlife Utilization (WU)

Site is located in oak forest area. Small depressional wetland with some evidence of use by pigs.

Wetland Canopy (O/S)

None, wetland was devoid of vegetation

Wetland Ground Cover (GC)

None.

Habitat Support / Buffer

Site is located in oak forest, relatively undisturbed.

Field Hydrology (HYD)

Hydrology appears to be solely based on precipitation.

WQ Input & Treatment (WQ)

Surface water runoff flows directly into the wetland with only natural treatment.

Wetland 10 and 12

Wetland Rapid Assessment Procedure (WRAP)

Check one: ☐ Existing Conditions ☐ Proposed Conditions

Application Number	Project Name	Date	Evaluator	Wetland Type
	Spaceport Camden	8-18-16	Brian Tutterow	PFO

Land Use: open space

FLUCCS Code: 621 Description: Cypress

Wetland Acreage: 13.57

Wildlife Utilization (WU): 2.5

Wetland Canopy (O/S): 2

Wetland Ground Cover (GC): 2

Field Hydrology (HYD): 2

WQ Input & Treatment (WQ)*: 1.5

* The value of WQ is obtained by adding the TOTAL scores of Land use Category and Pretreatment category then dividing by 2

Habitat Support / Buffer

Buffer type	(Score)	X (% of area)	=Sub Totals
Upl	2	70	1.4
Upl	0	30	0
		TOTAL	1.4

Land use Category (LU)

Land use Category	(Score)	X (% of area)	=Sub Totals
undevel	3	100	3
		(LU) TOTAL	3

Pretreatment Category (PT)

Pretreatment Category	(Score)	X (% of area)	=Sub Totals
None	0	0	0
		(PT) TOTAL	0

WRAP Score: 0.63

Field Notes:

Wildlife Utilization (WU)

Site is in relatively undeveloped portion of the site. Some disturbance for access roads and pine plantations. Evidence of deer, wild pigs, and alligators were observed.

Wetland Canopy (O/S)

Oak swamp

Wetland Ground Cover (GC)

No invasives observed, some disturbance related to roads.

Habitat Support / Buffer

Site is located in undeveloped area with wetlands and historic pine plantations functioning as buffer. Several roads are located adjacent to the wetland boundaries.

Field Hydrology (HYD)

Despite disturbance related to access roads and pine plantation the hydrology is relatively undisturbed.

WQ Input & Treatment (WQ)

This is a small watershed area. Most of the surface water runoff flow directly into the wetland with no treatment.

Wetland 11

Wetland Rapid Assessment Procedure
(WRAP)

☑ Check one
☐ Existing Conditions ☐ Proposed Conditions

Application Number	Project Name	Date	Evaluator	Wetland Type
	Spaceport Camden	8-17-16	Brian Tutterow	PFO/PSS/PEM

Land Use: open space

FLUCCS Code: 610 Description: hardwoods

Wetland Acreage: 5.97

Wildlife Utilization (WU): 2.5

Wetland Canopy (O/S): 2

Wetland Ground Cover (GC): 2

Field Hydrology (HYD): 2

WQ Input & Treatment (WQ)*: 1.5

* The value of WQ is obtained by adding the TOTAL scores of Land use Category and Pretreatment category then dividing by 2

Habitat Support / Buffer

Buffer type	(Score)	X (% of area)	=Sub Totals
Upl	2	100	2
		TOTAL	2

Land use Category (LU)

Land use Category	(Score)	X (% of area)	=Sub Totals
undevel	3	90	2.7
devel	1	10	0.1
		(LU) TOTAL	2.8

Pretreatment Category (PT)

Pretreatment Category	(Score)	X (% of area)	=Sub Totals
None	0	0	0
		(PT) TOTAL	0

WRAP Score: 0.67

Field Notes:

Wildlife Utilization (WU)

Site is in slightly more developed portion of the site near an electrical substation and surrounding on three sides by roads.

Wetland Canopy (O/S)

Oak swamp mixed with emergent and scrub wetlands.

Wetland Ground Cover (GC)

No invasives observed, some disturbance related to roads and fill for the electrical substation.

Habitat Support / Buffer

Site is located in more developed area with historic pine plantations and roads surrounding the sites.

Field Hydrology (HYD)

Despite disturbance related to access roads and pine plantation the hydrology is relatively undisturbed.

WQ Input & Treatment (WQ)

This is a small watershed area. Most of the surface water runoff flow directly into the wetland with no treatment.

Wetland 16, 17

Wetland Rapid Assessment Procedure
(WRAP)

Check one: ☐ Existing Conditions ☐ Proposed Conditions

Application Number	Project Name	Date	Evaluator	Wetland Type
	Spaceport Camden	8-17-16	Brian Tutterow	PFO/PSS/PEM

Land Use: open space

FLUCCS Code: 621 Description: Cypress

Wetland Acreage: 32.91

Wildlife Utilization (WU): 2.5

Wetland Canopy (O/S): 2

Wetland Ground Cover (GC): 2

Habitat Support / Buffer

Buffer type	(Score)	X (% of area)	=Sub Totals
Wet	3	80	2.4
Upl	3	20	0.6

TOTAL: 3

Field Hydrology (HYD): 2

WQ Input & Treatment (WQ)*: 1.5

* The value of WQ is obtained by adding the TOTAL scores of Land use Category and Pretreatment category then dividing by 2

Land use Category (LU)

Land use Category	(Score)	X (% of area)	=Sub Totals
undevel	3	100	3

(LU) TOTAL: 3

Pretreatment Category (PT)

Pretreatment Category	(Score)	X (% of area)	=Sub Totals
None	0	0	0

(PT) TOTAL: 0

WRAP Score: 0.72

Field Notes:

Wildlife Utilization (WU)

Sites are in relatively undeveloped portion of the site. Some disturbance for access roads and pine plantations. Evidence of deer and wild pigs was observed.

Wetland Canopy (O/S)

Cypress swamp mixed with emergent and scrub wetlands

Wetland Ground Cover (GC)

Graminoid dominated community, no invasives observed, some disturbance related to unimproved roads.

Habitat Support / Buffer

Sites are located in undeveloped area with wetlands and historic pine plantations functioning as buffer. Adjacent roads reduce the buffer areas.

Field Hydrology (HYD)

Despite disturbance related to access roads and pine plantation the hydrology is relatively undisturbed.

WQ Input & Treatment (WQ)

This is a small watershed area. Most of the surface water runoff flow directly into the wetland with no treatment.

Wetland 18,19

Wetland Rapid Assessment Procedure

Check one: ☐ Existing Conditions ☐ Proposed Conditions

(WRAP)

Application Number	Project Name	Date	Evaluator	Wetland Type
	Spaceport Camden	8-17-16	Brian Tutterow	PFO/PSS

Land Use: open space

FLUCCS Code: 621 Description: Cypress

Wetland Acreage: 15.57

Wildlife Utilization (WU): 2.5

Wetland Canopy (O/S): 2

Wetland Ground Cover (GC): 2

Habitat Support / Buffer

Buffer type	(Score)	X (% of area)	=Sub Totals
UPL	3	80	2.4
Upl	1	20	0.2

TOTAL: 2.6

Field Hydrology (HYD): 2

WQ Input & Treatment (WQ)*: 1.5

* The value of WQ is obtained by adding the TOTAL scores of Land use Category and Pretreatment category then dividing by 2

Land use Category (LU)

Land use Category	(Score)	X (% of area)	=Sub Totals
undevel	3	100	3

(LU) TOTAL: 3

Pretreatment Category (PT)

Pretreatment Category	(Score)	X (% of area)	=Sub Totals
None	0	0	0

(PT) TOTAL: 0

WRAP Score: 0.7

Field Notes:

Wildlife Utilization (WU)

Wetlands are in relatively undeveloped portion of the site. Some disturbance for access roads and pine plantations. Evidence of deer and wild pigs was observed.

Wetland Canopy (O/S)

Cypress swamp mixed with scrub wetlands

Wetland Ground Cover (GC)

Graminoid dominated community, no invasives observed, some disturbance related to unimproved roads.

Habitat Support / Buffer

Sites are located in undeveloped area with wetlands and historic pine plantations functioning as buffer. A major north/south access road borders wetland 19 to the east and wetland 18 to south

Field Hydrology (HYD)

Despite disturbance related to access roads and pine plantation the hydrology is relatively undisturbed.

WQ Input & Treatment (WQ)

This is a small watershed area. Most of the surface water runoff flow directly into the wetland with no treatment.

Wetland 20

Wetland Rapid Assessment Procedure

(WRAP)

Check one: ☐ Existing Conditions ☐ Proposed Conditions

Application Number	Project Name	Date	Evaluator	Wetland Type
	Spaceport Camden	8-17-16	Brian Tutterow	PFO/PSS/PEM

Land Use	FLUCCS Code	Description	Wetland Acreage
open space	613	Gum pond	0.34

Wildlife Utilization (WU)	Wetland Canopy (O/S)	Wetland Ground Cover (GC)
2	2	2

Field Hydrology (HYD): 2

WQ Input & Treatment (WQ)*: 1.5

* The value of WQ is obtained by adding the TOTAL scores of Land use Category and Pretreatment category then dividing by 2

Habitat Support / Buffer

Buffer type	(Score)	X (% of area)	=Sub Totals
Upl	2	90	1.8
		TOTAL	1.8

Land use Category (LU)

Land use Category	(Score)	X (% of area)	=Sub Totals
undevel	3	100	3
		(LU) TOTAL	3

Pretreatment Category (PT)

Pretreatment Category	(Score)	X (% of area)	=Sub Totals
None	0	0	0
		(PT) TOTAL	0

WRAP Score: 0.63

Field Notes:

Wildlife Utilization (WU)

Site is in relatively undeveloped portion of the site. Some disturbance for an access road and pine plantations. Evidence of wild pigs was observed.

Wetland Canopy (O/S)

Tupelo swamp mixed with emergent vegetation.

Wetland Ground Cover (GC)

No invasives observed, some disturbance related to roads.

Habitat Support / Buffer

Site is located in historic pine plantation and bordered by an access road.

Field Hydrology (HYD)

Despite disturbance related to access roads and pine plantation the hydrology is relatively undisturbed.

WQ Input & Treatment (WQ)

This is a small watershed area. Most of the surface water runoff flow directly into the wetland with no treatment.

Wetland 21

Wetland Rapid Assessment Procedure (WRAP)

☐ Existing Conditions ☑ Check one ☐ Proposed Conditions

Application Number	Project Name	Date	Evaluator	Wetland Type
	Spaceport Camden	6-22-17	Brian Tutterow	PEM

Land Use: open space

FLUCCS Code: 640 Description: freshwater non-forest

Wetland Acreage: 0.017

Wildlife Utilization (WU)	Wetland Canopy (O/S)	Wetland Ground Cover (GC)
2	1	1

Field Hydrology (HYD): 2

WQ Input & Treatment (WQ)*: 1

* The value of WQ is obtained by adding the TOTAL scores of Land use Category and Pretreatment category then dividing by 2

Habitat Support / Buffer

Buffer type	(Score)	X (% of area)	=Sub Totals
Upl	2.5	90	2.25
Upl	0	10	0

TOTAL 2.25

Land use Category (LU)

Land use Category	(Score)	X (% of area)	=Sub Totals
low highw	2	100	2

(LU) TOTAL 2

Pretreatment Category (PT)

Pretreatment Category	(Score)	X (% of area)	=Sub Totals
None	0	0	0

(PT) TOTAL 0

WRAP Score: 0.47

Field Notes:

Wildlife Utilization (WU)

Site is a small emergent wetland located adjacent to a gravel road Evidence of pigs and some use by amphibians was observed.

Wetland Canopy (O/S)

Vegetation is sparse.

Wetland Ground Cover (GC)

No invasives observed, some disturbance related to roads.

Habitat Support / Buffer

Site is located in historic pine plantation and coastal oak scrub bordered by an access road.

Field Hydrology (HYD)

Despite disturbance related to access roads and pine plantation the hydrology has stabilized and is relatively undisturbed.

WQ Input & Treatment (WQ)

This is a small watershed area. Most of the surface water runoff flow directly into the wetland with no treatment.

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Attachment A-2

Wetland Determination Data Forms

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WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Spaceport Camden City/County: Camden County Sampling Date: 8/15/16
Applicant/Owner: Union Carbide State: GA Sampling Point: 1
Investigator(s): Tutterow, Rauch Section, Township, Range: ______
Landform (hillslope, terrace, etc.): flat Local relief (concave, convex, none): none Slope (%): 0-3%
Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 30.94167 Long: -81.54464 Datum: NAD 83
Soil Map Unit Name: Ru - Rutledge fine sand NWI classification: none - upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ___ No X (If no, explain in Remarks.)
Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___
Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No X	Is the Sampled Area within a Wetland?	Yes ___ No X
Hydric Soil Present?	Yes ___ No X		
Wetland Hydrology Present?	Yes ___ No X		

Remarks:
Climate - Moderate drought (USDA Drought Monitor 2016).

Plot is located in the location of the proposed Launch Control Command Complex. Area is within a historic pine plantation with thick underbrush.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ___ No X	Depth (inches): ___	
Water Table Present?	Yes ___ No X	Depth (inches): ___	
Saturation Present? (includes capillary fringe)	Yes ___ No X	Depth (inches): ___	**Wetland Hydrology Present? Yes ___ No X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
No hydrology indicators observed.

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VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: 1

Tree Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Pinus taeda	20	Y	FAC
2. Pinus palustris	3	N	FACU
3. Acer rubrum	2	N	FAC
4.			
5.			
6.			
7.			
8.			
	25 = Total Cover		
50% of total cover: 12.5	20% of total cover: 5		

Sapling/Shrub Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Serenoa repens	30	Y	FACU
2. Morella cerifera	10	N	FAC
3. Ilex opaca	15	Y	FACU
4. Lyonia ligustrina	5	N	FACW
5. Lyonia ferruginea	5	N	FACU
6.			
7.			
8.			
	65 = Total Cover		
50% of total cover: 32.5	20% of total cover: 13		

Herb Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Serenoa repens	8	Y	FACU
2. Morella cerifera	1	N	FAC
3. Lyonia ferruginea	2	N	FACU
4. Lyonia ligustrina	2	N	FACW
5. Ilex opaca	2	N	FACU
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	15 = Total Cover		
50% of total cover: 7.5	20% of total cover: 3		

Woody Vine Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	______ = Total Cover		
50% of total cover: ______	20% of total cover: ______		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 25% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

__ 1 - Rapid Test for Hydrophytic Vegetation
__ 2 - Dominance Test is >50%
__ 3 - Prevalence Index is ≤3.0[1]
__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** ______ **No** X

Remarks: (If observed, list morphological adaptations below).

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SOIL

Sampling Point: 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-6	10 YR 4/1	100					sand	
6-24	10 YR 6/1	100					sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ______ **No** X

Remarks:
No soil indicators observed.

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WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Spaceport Camden City/County: Camden County Sampling Date: 8/16/16

Applicant/Owner: Union Carbide State: GA Sampling Point: 2

Investigator(s): Tutterow, Rauch Section, Township, Range: ______

Landform (hillslope, terrace, etc.): flat Local relief (concave, convex, none): none Slope (%): 0-3%

Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 30.93728 Long: -81.53015 Datum: NAD 83

Soil Map Unit Name: Ma - Mandarin fine sand NWI classification: none - upland

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No X (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ______	Is the Sampled Area within a Wetland? Yes ______ No X
Hydric Soil Present?	Yes X	No ______	
Wetland Hydrology Present?	Yes ______	No X	

Remarks:

Climate - Moderate drought (USDA Drought Monitor 2016).
Normal circumstances include historic pine plantation, altered topography (furrowed rows), and vegetation.
Plot was taken at location of the proposed Landing Zone. This area is characteristic of the pine plantations of the central region of the proposed spaceport. In addition to walking transects through this survey area, the the drainage ditch located near the west side of the proposed landing zone was walked. The ditch was dry during the survey but included several sedge and rush species as well as hooded pitcher plants.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☑ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ______	No X	Depth (inches): ______
Water Table Present?	Yes ______	No X	Depth (inches): ______
Saturation Present? (includes capillary fringe)	Yes ______	No X	Depth (inches): ______

Wetland Hydrology Present? Yes ______ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

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VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: 2

Tree Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Pinus taeda	60	Y	FAC
2. Pinus palustris	10	N	FACU
3. Acer rubrum	2	N	FAC
4.			
5.			
6.			
7.			
8.			
	72 = Total Cover		
50% of total cover: 36	20% of total cover: 14.4		

Sapling/Shrub Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Serenoa repens	15	N	FACU
2. Ilex glabra	60	Y	FACW
3.			
4.			
5.			
6.			
7.			
8.			
	85 = Total Cover		
50% of total cover: 42.5	20% of total cover: 17		

Herb Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Panicum hemitomon	1	Y	OBL
2. Panicum dichotomiflorum	1	Y	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	2 = Total Cover		
50% of total cover: 1	20% of total cover: 0.4		

Woody Vine Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (If observed, list morphological adaptations below).

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SOIL

Sampling Point: 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-24	10 YR 2/1	100					sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☑ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ______

Remarks:

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WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Spaceport Camden City/County: Camden County Sampling Date: 8/16/16
Applicant/Owner: Union Carbonide State: GA Sampling Point: 3U
Investigator(s): Tutterow, Rauch Section, Township, Range: ______
Landform (hillslope, terrace, etc.): flats Local relief (concave, convex, none): none Slope (%): 0-3%
Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 30.93709 Long: -81.54008 Datum: NAD 83
Soil Map Unit Name: W - Water NWI classification: none - upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No X (If no, explain in Remarks.)
Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______
Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ______	**Is the Sampled Area within a Wetland?** **Yes** ______ **No** X
Hydric Soil Present?	Yes ______	No X	
Wetland Hydrology Present?	Yes ______	No X	

Remarks:
Climate - Moderate drought (USDA Drought Monitor 2016).
Upland plot taken at the edge of the wetland and surrounding pine plantation.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)
- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)
- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☑ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ______	No X	Depth (inches): ______
Water Table Present?	Yes ______	No X	Depth (inches): ______
Saturation Present? (includes capillary fringe)	Yes ______	No X	Depth (inches): ______

Wetland Hydrology Present? Yes ______ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

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VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: 3U

Tree Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Pinus taeda	40	Y	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	40 = Total Cover		
50% of total cover: 20	20% of total cover: 8		

Sapling/Shrub Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Serenoa repens	20	Y	FACU
2. Magnolia virginiana	30	Y	FACW
3. Lyonia lucida	60	Y	FACW
4.			
5.			
6.			
7.			
8.			
	110 = Total Cover		
50% of total cover: 55	20% of total cover: 11		

Herb Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Serenoa repens	2	N	FACU
2. Lyonia lucida	10	Y	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	12 = Total Cover		
50% of total cover: 6	20% of total cover: 2.4		

Woody Vine Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	____ = Total Cover		
50% of total cover: ____	20% of total cover: ____		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 80% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

__ 1 - Rapid Test for Hydrophytic Vegetation
__ 2 - Dominance Test is >50%
__ 3 - Prevalence Index is ≤3.0[1]
__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ____

Remarks: (If observed, list morphological adaptations below).

Thick pine leaf litter in herb layer.

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SOIL

Sampling Point: 3U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-14	10 YR 5/1	100					sand	
14-18	10 YR 6/1	100					sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ______ No X

Remarks:

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WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Spaceport Camden City/County: Camden County Sampling Date: 8/16/16
Applicant/Owner: Union Carbonide State: GA Sampling Point: 3W
Investigator(s): Tutterow, Rauch Section, Township, Range: ______
Landform (hillslope, terrace, etc.): flats Local relief (concave, convex, none): none Slope (%): 0-3%
Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 30.93678 Long: -81.53945 Datum: NAD 83
Soil Map Unit Name: W - Water NWI classification: none - upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No X (If no, explain in Remarks.)
Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______
Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ______	**Is the Sampled Area within a Wetland?** **Yes** X **No** ______
Hydric Soil Present?	Yes X No ______	
Wetland Hydrology Present?	Yes X No ______	

Remarks:
Climate - Moderate drought (USDA Drought Monitor 2016).
Survey area 3 is part of a large wetland that is located adjacent to the western boundary road and other proposed interior roads. Wetland boundaries in the vicinity of this observation point were expanded slightly from previously delineated boundaries.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☑ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☑ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ______
Water Table Present? Yes ______ No X Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ______ No X Depth (inches): ______

Wetland Hydrology Present? Yes X **No** ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

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VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: 3W

Tree Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Pinus taeda	40	Y	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	40 = Total Cover		
50% of total cover: 20	20% of total cover: 8		
Sapling/Shrub Stratum (Plot size: 30 ft)			
1. Serenoa repens	15	N	FACU
2. Taxodium distichum	2	N	OBL
3. Lyonia lucida	60	Y	FACW
4. Magnolia virginiana	20	Y	FACW
5.			
6.			
7.			
8.			
	97 = Total Cover		
50% of total cover: 48.5	20% of total cover: 19.4		
Herb Stratum (Plot size: 30 ft)			
1. Carex glaucescens	15	Y	OBL
2. Juncus effusus	15	Y	FACW
3. Rhexia mariana	2	N	FACW
4. Xyris fimbriata	1	N	OBL
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	33 = Total Cover		
50% of total cover: 16.5	20% of total cover: 6.6		
Woody Vine Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

__ 1 - Rapid Test for Hydrophytic Vegetation
__ 2 - Dominance Test is >50%
__ 3 - Prevalence Index is ≤3.0[1]
__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ____

Remarks: (If observed, list morphological adaptations below).

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SOIL

Sampling Point: 3W

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-12	2.5 YR 2.5/1	70					sand	stripped matrix
	10 YR 5/1	30						
12-14	10 YR 5/1	100					sand	strong sulfur odor

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☑ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☑ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes X No ______

Remarks:

Soil moist but not saturated.

US Army Corps of Engineers — Atlantic and Gulf Coastal Plain Region – Version 2.0

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Spaceport Camden City/County: Camden County Sampling Date: 7/22/17
Applicant/Owner: Union Carbide State: GA Sampling Point: 5U
Investigator(s): Tutterow Section, Township, Range: ______
Landform (hillslope, terrace, etc.): depression Local relief (concave, convex, none): concave Slope (%): 0-3%
Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 30.94415 Long: -81.50970 Datum: NAD 83
Soil Map Unit Name: Ma - Mandarin fine sand NWI classification: PEM1C
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)
Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______
Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ______	Is the Sampled Area within a Wetland? Yes ______ No X
Hydric Soil Present?	Yes ______	No X	
Wetland Hydrology Present?	Yes ______	No X	

Remarks:
Area 5 is a depressional area located adjacent to an existing site access road.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ______	No X	Depth (inches): ______
Water Table Present?	Yes ______	No X	Depth (inches): ______
Saturation Present? (includes capillary fringe)	Yes ______	No X	Depth (inches): ______

Wetland Hydrology Present? Yes ______ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
In addition to the soil profile taken at this observation point, several soil borings were taken throughout the site. No oxidized rhizopheres or other hydrology indicators were observed.

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VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: 5U

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
50% of total cover:		20% of total cover:	
Sapling/Shrub Stratum (Plot size: 30 ft)			
1. Acer rubrum	5	Y	FAC
2. Quercus virginiana	2	Y	FACU
3.			
4.			
5.			
6.			
7.			
8.			
	7 = Total Cover		
50% of total cover: 3.5		20% of total cover: 1.4	
Herb Stratum (Plot size: 30 ft)			
1. Eupatorium capillifollium	10	N	FACU
2. Juncus effusus	80	Y	FACW
3. Rhexia mariana	2	N	FACW
4. Andropogon virginicus	2	N	FAC
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	94 = Total Cover		
50% of total cover: 47		20% of total cover: 18.8	
Woody Vine Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
50% of total cover:		20% of total cover:	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (If observed, list morphological adaptations below).

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SOIL

Sampling Point: 5U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-4	10YR 2/2	100					silt loam	
4-7	10YR 3/1	100					sand	
7-20	10YR 6/1	100					sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ______ No x

Remarks:
No hydric soil indicators were observed. The soils did not meet criteria for S7 or S9.

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WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Spaceport Camden City/County: Camden County Sampling Date: 8/17/16
Applicant/Owner: Union Carbide State: GA Sampling Point: 6U
Investigator(s): Tutterow, Rauch Section, Township, Range: ______
Landform (hillslope, terrace, etc.): flat Local relief (concave, convex, none): none Slope (%): 0-3%
Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 30.94702 Long: -81.50986 Datum: NAD 83
Soil Map Unit Name: Po - Pottsburg sand NWI classification: none - upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ____ No X (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ____	Is the Sampled Area within a Wetland? Yes ____ No X
Hydric Soil Present?	Yes X	No ____	
Wetland Hydrology Present?	Yes ____	No X	

Remarks:
Climate - Moderate drought (USDA Drought Monitor 2016).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☑ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ____	No X	Depth (inches): ____
Water Table Present?	Yes ____	No X	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes ____	No X	Depth (inches): ____

Wetland Hydrology Present? Yes ____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

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VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: 6U

Tree Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Sabal palmetto	20	Y	FAC
2. Quercus virginiana	60	Y	FACU
3.			
4.			
5.			
6.			
7.			
8.			
	80 = Total Cover		
50% of total cover: 40	20% of total cover: 16		
Sapling/Shrub Stratum (Plot size: 30 ft)			
1. Ilex cassine	10	Y	FACW
2. Ilex coriacea	5	Y	FACW
3.			
4.			
5.			
6.			
7.			
8.			
	15 = Total Cover		
50% of total cover: 7.5	20% of total cover: 3		
Herb Stratum (Plot size: 30 ft)			
1. Bulbostylis barbata	60	Y	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	60 = Total Cover		
50% of total cover: 30	20% of total cover: 12		
Woody Vine Stratum (Plot size: 30 ft)			
1. Campsis radicans	2	Y	FAC
2.			
3.			
4.			
5.			
	2 = Total Cover		
50% of total cover: 1	20% of total cover: 0.4		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 83% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species ______	x 1 = ______
FACW species ______	x 2 = ______
FAC species ______	x 3 = ______
FACU species ______	x 4 = ______
UPL species ______	x 5 = ______
Column Totals: ______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No ____

Remarks: (If observed, list morphological adaptations below).

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SOIL

Sampling Point: 6U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-14	10 YR 2/1	100					sand	
14-20	10 YR 4/1	100					sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☑ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☑ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes X No ______

Remarks:

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WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Spaceport Camden City/County: Camden County Sampling Date: 8/17/16
Applicant/Owner: Union Carbide State: GA Sampling Point: 6W
Investigator(s): Tutterow, Rauch Section, Township, Range: ____
Landform (hillslope, terrace, etc.): flat Local relief (concave, convex, none): none Slope (%): 0-3%
Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 30.94698 Long: -81.50976 Datum: NAD 83
Soil Map Unit Name: Po - Pottsburg sand NWI classification: none - upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ____ No X (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ____	**Is the Sampled Area within a Wetland?** **Yes** X **No** ____
Hydric Soil Present?	Yes X No ____	
Wetland Hydrology Present?	Yes X No ____	

Remarks:
Climate - Moderate drought (USDA Drought Monitor 2016).
Plot was located in the center of a ~65 ft x 40 ft deep depression. Approximately 3-5 ft deep. The plot is located within the boundaries of the proposed Vertical Launch Facility.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- [ ] Surface Water (A1)
- [ ] High Water Table (A2)
- [ ] Saturation (A3)
- [ ] Water Marks (B1)
- [ ] Sediment Deposits (B2)
- [ ] Drift Deposits (B3)
- [ ] Algal Mat or Crust (B4)
- [ ] Iron Deposits (B5)
- [ ] Inundation Visible on Aerial Imagery (B7)
- [ ] Water-Stained Leaves (B9)
- [ ] Aquatic Fauna (B13)
- [ ] Marl Deposits (B15) **(LRR U)**
- [x] Hydrogen Sulfide Odor (C1)
- [ ] Oxidized Rhizospheres along Living Roots (C3)
- [ ] Presence of Reduced Iron (C4)
- [ ] Recent Iron Reduction in Tilled Soils (C6)
- [ ] Thin Muck Surface (C7)
- [ ] Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- [ ] Surface Soil Cracks (B6)
- [x] Sparsely Vegetated Concave Surface (B8)
- [ ] Drainage Patterns (B10)
- [ ] Moss Trim Lines (B16)
- [ ] Dry-Season Water Table (C2)
- [ ] Crayfish Burrows (C8)
- [ ] Saturation Visible on Aerial Imagery (C9)
- [ ] Geomorphic Position (D2)
- [ ] Shallow Aquitard (D3)
- [ ] FAC-Neutral Test (D5)
- [ ] Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present? Yes ____ No X Depth (inches): ____
Water Table Present? Yes ____ No X Depth (inches): ____
Saturation Present? (includes capillary fringe) Yes ____ No X Depth (inches): ____

Wetland Hydrology Present? Yes X **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

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VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: 6W

Tree Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Serenoa repens	1	Y	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Sapling/Shrub Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. none			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Herb Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. none			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Woody Vine Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Campsis radicans	2	Y	FAC
2.			
3.			
4.			
5.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (If observed, list morphological adaptations below).

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SOIL

Sampling Point: 6W

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-7	10 YR 2/2	100					silty sand	
7-14	10 YR 2/1	100					sand	decomposed leaves in soil layer
8-22	10 YR 2/1	100					sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☑ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes X No ____

Remarks:

Soil moist but not saturated.

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WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Camden Spaceport City/County: Camden County Sampling Date: 8/19/16

Applicant/Owner: Bayer Crop Science State: GA Sampling Point: 11U

Investigator(s): Tutterow, Rauch Section, Township, Range: ______

Landform (hillslope, terrace, etc.): flats Local relief (concave, convex, none): none Slope (%): 0-3%

Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 30.93689 Long: -81.51537 Datum: NAD 83

Soil Map Unit Name: Ma - Mandarin fine sand NWI classification: none - upland

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No X (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ______
Hydric Soil Present?	Yes ______	No X
Wetland Hydrology Present?	Yes ______	No X

Is the Sampled Area within a Wetland? Yes ______ No X

Remarks:

Climate - Moderate drought (USDA Drought Monitor 2016).
Plot located near the edge of a wetland within an area with an abrupt terrain change. The plot point is located approximately 2 ft above the wetland terrain.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ______	No X	Depth (inches): ______
Water Table Present?	Yes ______	No X	Depth (inches): ______
Saturation Present? (includes capillary fringe)	Yes ______	No X	Depth (inches): ______

Wetland Hydrology Present? Yes ______ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No hydrology indicators observed.

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VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: 11U

Tree Stratum (Plot size: 30 ft)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Quercus nigra	70	Y	FAC
2. Sabal palmetto	20	Y	FAC
3.			
4.			
5.			
6.			
7.			
8.			
	90 = Total Cover		

50% of total cover: 45 20% of total cover: 18

Sapling/Shrub Stratum (Plot size: 30 ft)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Sabal palmetto	40	Y	FAC
2. Morella cerifera	2	N	FAC
3. Quercus nigra	20	Y	FAC
4. Serenoa repens	20	Y	FACU
5.			
6.			
7.			
8.			
	82 = Total Cover		

50% of total cover: 41 20% of total cover: 16.4

Herb Stratum (Plot size: 30 ft)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Panicum hemitomon	1	Y	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	1 = Total Cover		

50% of total cover: 0.5 20% of total cover: 0.2

Woody Vine Stratum (Plot size: ______)

	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	____ = Total Cover		

50% of total cover: ____ 20% of total cover: ____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ____

Remarks: (If observed, list morphological adaptations below).

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SOIL

Sampling Point: 11U

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 4/1	100					sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ______ No X

Remarks:
Dry soil. No indicators observed.

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WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Camden Spaceport City/County: Camden County Sampling Date: 8/19/16
Applicant/Owner: Bayer Crop Science State: GA Sampling Point: 11W
Investigator(s): Tutterow, Rauch Section, Township, Range: ____
Landform (hillslope, terrace, etc.): flat Local relief (concave, convex, none): concave Slope (%): 0-3%
Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 30.93701 Long: -81.51512 Datum: NAD 83
Soil Map Unit Name: Ma - Mandarin fine sand NWI classification: none - upland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ____ No X (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ____	Is the Sampled Area within a Wetland? Yes X No ____
Hydric Soil Present?	Yes X	No ____	
Wetland Hydrology Present?	Yes X	No ____	

Remarks:
Climate - Moderate drought (USDA Drought Monitor 2016).
Plot located near edge of an existing road. A culvert extends to the north of the site into the drainage. A larger unmapped wetland is located to the south, approximately 100 feet from the existing road.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☑ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☑ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☑ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☑ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ____	No X	Depth (inches): ____
Water Table Present?	Yes ____	No X	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes ____	No X	Depth (inches): ____

Wetland Hydrology Present? Yes X No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

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VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: 11W

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	0 = Total Cover		
50% of total cover: 0	20% of total cover: 0		
Sapling/Shrub Stratum (Plot size: 30 ft)			
1. Salix caroliniana	10	Y	OBL
2. Cephalanthus occidentalis	30	Y	OBL
3. Quercus nigra	5	N	FAC
4.			
5.			
6.			
7.			
8.			
	45 = Total Cover		
50% of total cover: 22.5	20% of total cover: 9		
Herb Stratum (Plot size: 30 ft)			
1. Typha latifolia	30	Y	OBL
2. Saururus cernuus	10	N	OBL
3. Panicum hemitomon	20	Y	OBL
4. Echinochloa crus-galli	30	Y	FACW
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	90 = Total Cover		
50% of total cover: 45	20% of total cover: 18		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
	____ = Total Cover		
50% of total cover: ____	20% of total cover: ____		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

X 1 - Rapid Test for Hydrophytic Vegetation
__ 2 - Dominance Test is >50%
__ 3 - Prevalence Index is ≤3.0[1]
__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ____

Remarks: (If observed, list morphological adaptations below).

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SOIL

Sampling Point: 11W

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-10	10 YR 2/1	100					silt	
10-12	10 YR 6/1	100					sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☑ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☑ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☑ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ________

Depth (inches): ________

Hydric Soil Present? Yes X No ____

Remarks:

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APPENDIX B

SITE PHOTOGRAPS

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Photo Point A, Wetland 3

Photo B-1. View facing north into a portion of Wetland 3 located north of an existing access road.

Photo B-2. View facing east along raised road.

Photo Point B

Photo B-3. View of Area 1 facing north.

Photo B-4. Characteristic soil profile from Area 1.

Photo Point C, Drainage

Photo B-5. View of ephmeral stream 1 in Area 2.

Photo Point D, Wetland 17

Photo B-6. View facing north.

Photo B-7. View facing southwest toward property boundary.

Photo Point E-1

Photo B-8. View northwest along the west perimeter boundary road.

Photo B-9. View facing southeast along the west perimeter boundary road.

Photo Point R, Wetland 3

Photo B-10. View facing northeast into Wetland 3.

Photo B-11. View facing southwest toward property boundary.

Photo Point R-1, Wetland 3

Photo B-12. View facing northwest along west boundary road.

Photo B-13. View facing southeast along western boundary road. The neighboring property road is visible to the right.

Photo Point R-2, Wetland 3 Upland Point

Photo B-14. View facing north at upland point.

Photo B-15. View facing south.

Photo Point E-2 and F

Photo B-16. Western boundary road (Photo Point E-2).

Photo B-17. Access road intersecting the western boundary road (Photo Point F).

Photo Point G, Area 4

Photo B-18. View facing southeast at the power line cut along Shellbine Creek.

Photo B-19. View facing south-southeast along Shellbine Creek. Box culvert under the main site access road is visible in the background. Shellbine Creek is outside the field survey area.

Photo Point H

Photo B-20. View facing south at culvert and Wetland 19.

Photo B-21. View of asphalt roadway near Wetland 19.

Photo Points I-1 and I-2, Area 5

Photo B-22. View of Area 5 facing north. Area extends past the tree line visible to the left.

Photo B-23. View area north of Area 5.

Photo Point J-1 and J-2, Wetland 6

Photo B-24. View of Wetland 6 (Photo Point J-1).

Photo B-25. View of upland observation point near Wetland 6 (Photo Point J-2).

Photo Point K

Photo B-26. View of ephemeral stream 3 north of access road.

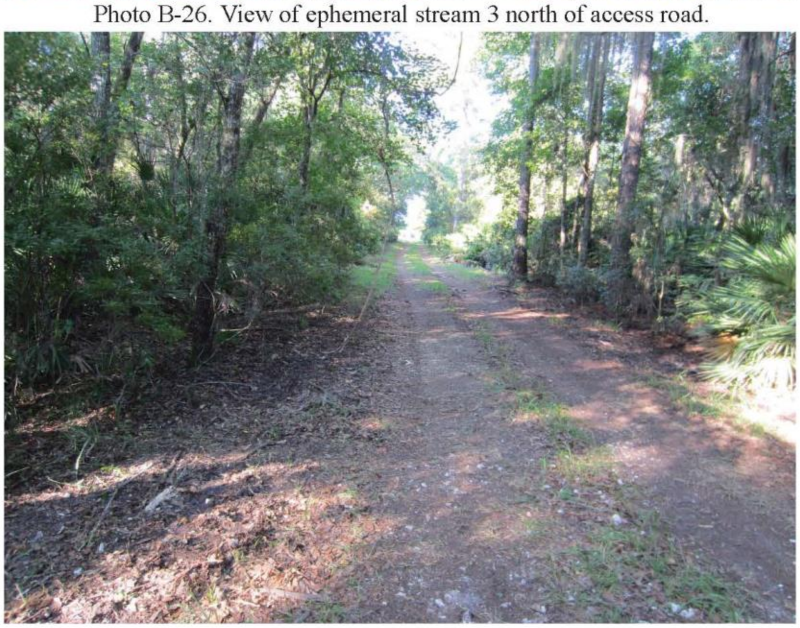

Photo B-27. View of access road facing northeast.

Photo Points L-1 and L-2, Wetland 7

Photo B-28. View of Wetland 7, facing north (Photo Point L-1).

Photo B-29. View of upland observation point near Wetland 7, facing north (Photo Point L-2).

Photo Points M-1 and M-2, Wetland 8

Photo B-30. View of Wetland 8, facing south (Photo Point M-1).

Photo B-31. View of upland observation point near Wetland 8 (Photo Point M-2).

Photo Point N-1, Wetland 10

Photo B-32. Wetland 10.

Photo B-33. Soil profile.

Photo Point N-2

Photo B-34. Upland observation point.

Photo B-35. Soil profile.

Photo Point O, Wetland 11

Photo B-36. Wetland 11, view facing south.

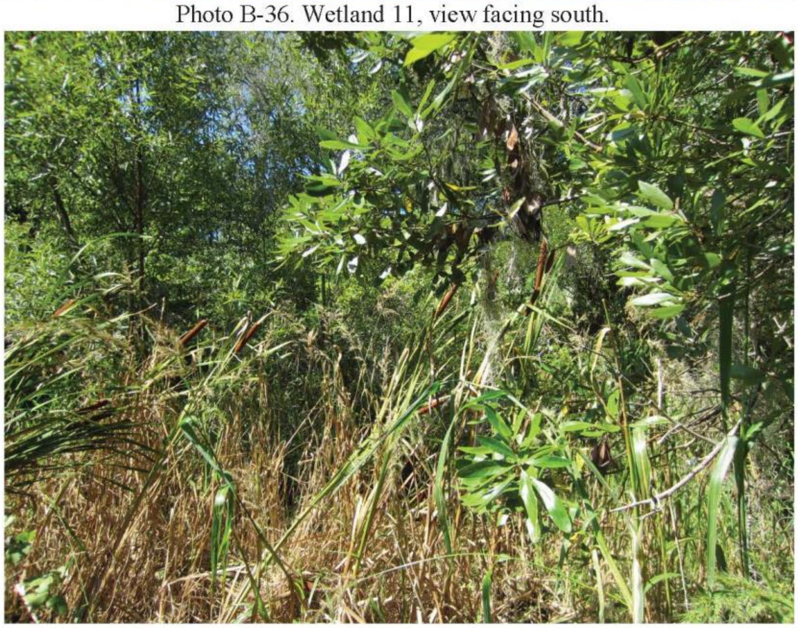

Photo B-37. Wetland 11.

Photo Point P, Wetland 12

Photo B-38. View facing north, Wetland 12.

Photo B-39. View facing west.

Photo Point Q, Wetland 13

Photo B-40. View facing north.

Photo B-41. View facing north.

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APPENDIX C

NATURAL RESOURCES CONSERVATION SERVICE SOIL SURVEY MAPS AND PREVIOUSOLY DELINEATED WETLANDS MAPS

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Attachment C-1

National Resources Conservation Soil Survey Maps

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Map Unit Description

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Report—Map Unit Description

Camden and Glynn Counties, Georgia

BO—Bohicket-Capers association

Map Unit Setting

National map unit symbol: 46h8
Elevation: 0 to 10 feet
Mean annual precipitation: 44 to 52 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 230 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition

Bohicket and similar soils: 80 percent

Capers and similar soils: 20 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bohicket

Setting

Landform: Tidal marshes

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Marine deposits

Typical profile

H1 - 0 to 8 inches: stratified silty clay loam

H2 - 8 to 65 inches: silty clay

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Very poorly drained

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)

Depth to water table: About 0 inches

Frequency of flooding: Very frequent

Frequency of ponding: Frequent

Gypsum, maximum in profile: 1 percent

Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)

Sodium adsorption ratio, maximum in profile: 55.0

Available water storage in profile: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8w

Hydrologic Soil Group: D

Description of Capers

Setting

Landform: Tidal marshes

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Marine deposits

Typical profile

H1 - 0 to 8 inches: silty clay

H2 - 8 to 60 inches: clay

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Very poorly drained

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Very frequent
Frequency of ponding: Frequent
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8w
Hydrologic Soil Group: D

CaB—Cainhoy fine sand, 0 to 5 percent slopes

Map Unit Setting
National map unit symbol: 46hd
Elevation: 10 to 120 feet
Mean annual precipitation: 44 to 52 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 230 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition
Cainhoy and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cainhoy

Setting
Landform: Rises
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Marine deposits

Typical profile
H1 - 0 to 50 inches: fine sand
H2 - 50 to 99 inches: fine sand

Properties and qualities
Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.2 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s

Hydrologic Soil Group: A

Ma—Mandarin fine sand, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2sxql
Elevation: 0 to 250 feet
Mean annual precipitation: 39 to 62 inches
Mean annual air temperature: 53 to 81 degrees F
Frost-free period: 209 to 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Mandarin and similar soils: 92 percent
Minor components: 6 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mandarin

Setting

Landform: Rises
Landform position (three-dimensional): Talf, rise
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Sandy marine deposits

Typical profile

A - 0 to 7 inches: fine sand
E - 7 to 13 inches: fine sand
Bh - 13 to 18 inches: fine sand
E' - 18 to 62 inches: fine sand
B'h - 62 to 80 inches: fine sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.28 to 19.98 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A

Other vegetative classification: Sandy soils on rises and knolls of mesic uplands (G153AA131FL)

Minor Components

Leon

Percent of map unit: 5 percent
Landform: Flatwoods
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G153AA141FL)

Rutlege

Percent of map unit: 1 percent
Landform: Depressions, drainageways
Down-slope shape: Concave, linear
Across-slope shape: Concave
Other vegetative classification: Sandy soils on stream terraces, flood plains, or in depressions (G153AA145FL)

Pe—Pelham loamy sand

Map Unit Setting

National map unit symbol: 46hn
Elevation: 20 to 450 feet
Mean annual precipitation: 44 to 52 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 230 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition

Pelham and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pelham

Setting

Landform: Flats, depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Parent material: Marine deposits

Typical profile

H1 - 0 to 25 inches: loamy sand
H2 - 25 to 40 inches: sandy clay loam
H3 - 40 to 75 inches: sandy clay loam

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D

Po—Pottsburg sand

Map Unit Setting

National map unit symbol: 46hp
Elevation: 0 to 300 feet
Mean annual precipitation: 44 to 52 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 230 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition

Pottsburg and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pottsburg

Setting

Landform: Flats
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Marine deposits

Typical profile

H1 - 0 to 10 inches: sand
H2 - 10 to 63 inches: sand
H3 - 63 to 80 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None

Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A

Minor Components

Rutlege

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Down-slope shape: Linear, concave
Across-slope shape: Concave

Ru—Rutlege fine sand

Map Unit Setting

National map unit symbol: 46hr
Elevation: 0 to 300 feet
Mean annual precipitation: 44 to 52 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 230 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition

Rutlege and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rutlege

Setting

Landform: Drainageways, depressions
Down-slope shape: Linear, concave
Across-slope shape: Concave
Parent material: Marine deposits

Typical profile

H1 - 0 to 15 inches: sand
H2 - 15 to 70 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.9 inches)

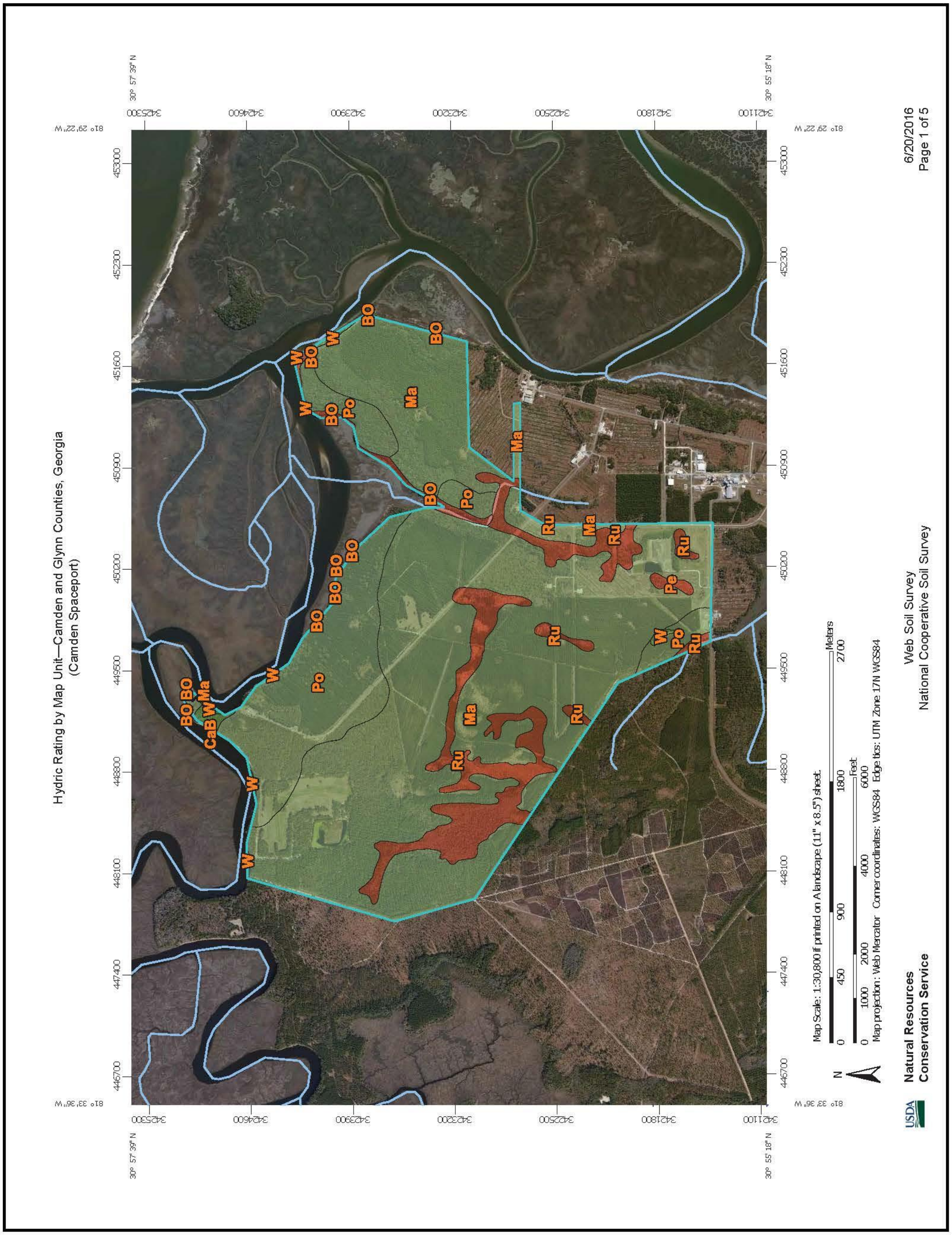
Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D

W—Water

Map Unit Composition
Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Data Source Information

Soil Survey Area: Camden and Glynn Counties, Georgia
Survey Area Data: Version 7, Sep 17, 2014


Hydric Rating by Map Unit—Camden and Glynn Counties, Georgia
(Camden Spaceport)
6/20/2016
Page 1 of 5
Map Scale: 1:30,800 if printed on A landscape (11" x 8.5") sheet.
Meters
Feet
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84
USDA
Natural Resources
Conservation Service
Web Soil Survey
National Cooperative Soil Survey

Hydric Rating by Map Unit—Camden and Glynn Counties, Georgia
(Camden Spaceport)

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Lines
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Points
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Camden and Glynn Counties, Georgia
Survey Area Data: Version 7, Sep 17, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 13, 2011—Mar 15, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

USDA **Natural Resources Conservation Service** | Web Soil Survey National Cooperative Soil Survey | 6/20/2016 Page 2 of 5

Hydric Rating by Map Unit

Hydric Rating by Map Unit— Summary by Map Unit — Camden and Glynn Counties, Georgia (GA616)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
BO	Bohicket-Capers association	100	17.0	0.9%
CaB	Cainhoy fine sand, 0 to 5 percent slopes	0	5.4	0.3%
Ma	Mandarin fine sand, 0 to 2 percent slopes	6	1,247.9	69.2%
Pe	Pelham loamy sand	100	5.2	0.3%
Po	Pottsburg sand	5	323.8	18.0%
Ru	Rutlege fine sand	100	196.9	10.9%
W	Water	0	7.4	0.4%
Totals for Area of Interest			**1,803.6**	**100.0%**

Description

This rating indicates the percentage of map units that meets the criteria for hydric soils. Map units are composed of one or more map unit components or soil types, each of which is rated as hydric soil or not hydric. Map units that are made up dominantly of hydric soils may have small areas of minor nonhydric components in the higher positions on the landform, and map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform. Each map unit is rated based on its respective components and the percentage of each component within the map unit.

The thematic map is color coded based on the composition of hydric components. The five color classes are separated as 100 percent hydric components, 66 to 99 percent hydric components, 33 to 65 percent hydric components, 1 to 32 percent hydric components, and less than one percent hydric components.

In Web Soil Survey, the Summary by Map Unit table that is displayed below the map pane contains a column named 'Rating'. In this column the percentage of each map unit that is classified as hydric is displayed.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

References:

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

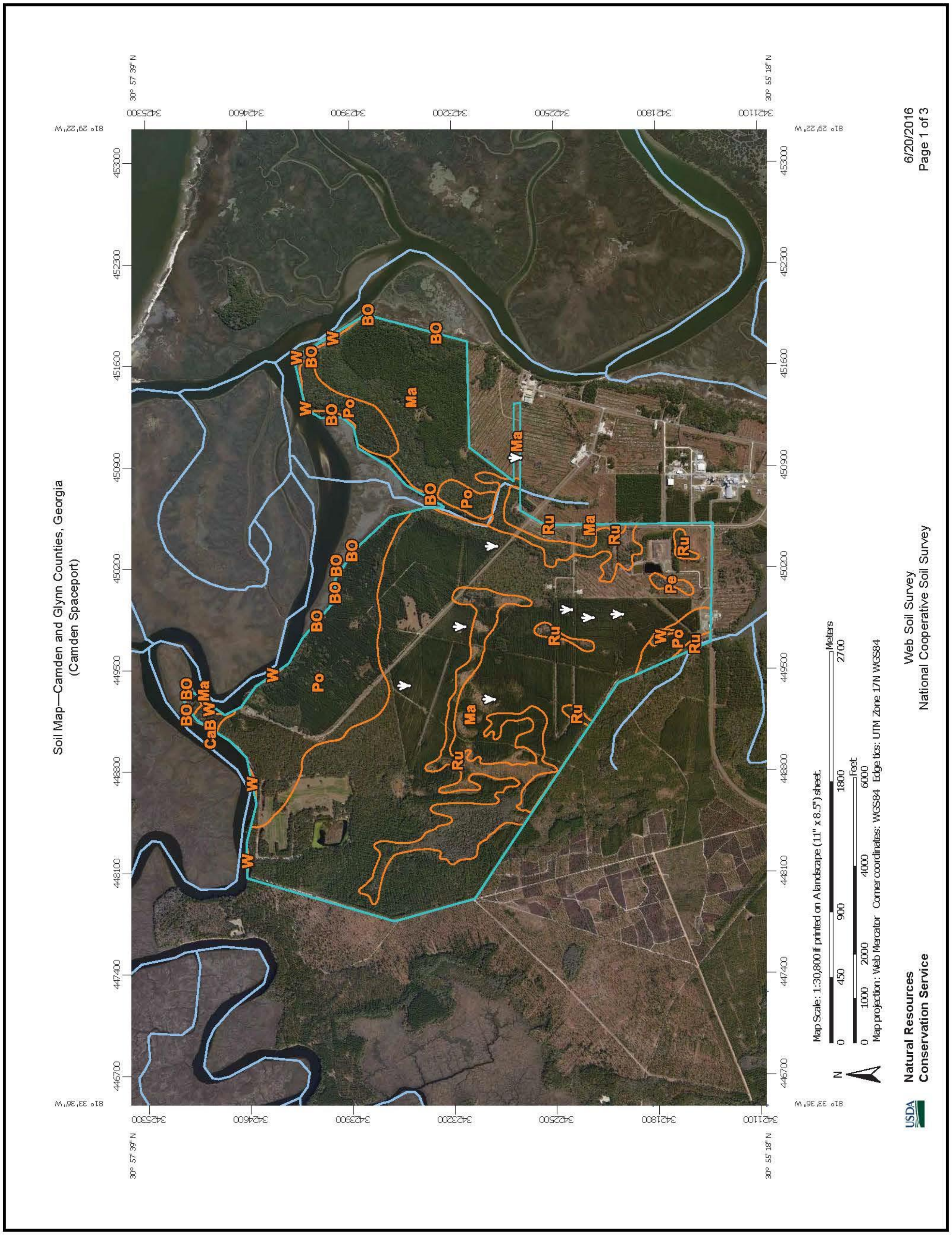
Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

Rating Options

Aggregation Method: Percent Present

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower


Soil Map—Camden and Glynn Counties, Georgia
(Camden Spaceport)
Ma
BO
W
Po
Ru
Pe
CaB
Map Scale: 1:30,800 if printed on A landscape (11" x 8.5") sheet.
Meters
0 450 900 1800 2700
Feet
0 1000 2000 4000 6000
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84
N
USDA
Natural Resources
Conservation Service
Web Soil Survey
National Cooperative Soil Survey
6/20/2016
Page 1 of 3

Soil Map—Camden and Glynn Counties, Georgia
(Camden Spaceport)

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Camden and Glynn Counties, Georgia
Survey Area Data: Version 7, Sep 17, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 13, 2011—Mar 15, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

USDA **Natural Resources Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

6/20/2016
Page 2 of 3

Map Unit Legend

Camden and Glynn Counties, Georgia (GA616)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
BO	Bohicket-Capers association	17.0	0.9%
CaB	Cainhoy fine sand, 0 to 5 percent slopes	5.4	0.3%
Ma	Mandarin fine sand, 0 to 2 percent slopes	1,247.9	69.2%
Pe	Pelham loamy sand	5.2	0.3%
Po	Pottsburg sand	323.8	18.0%
Ru	Rutlege fine sand	196.9	10.9%
W	Water	7.4	0.4%
Totals for Area of Interest		**1,803.6**	**100.0%**

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Attachment C-2

Previously Delineated Wetlands Map

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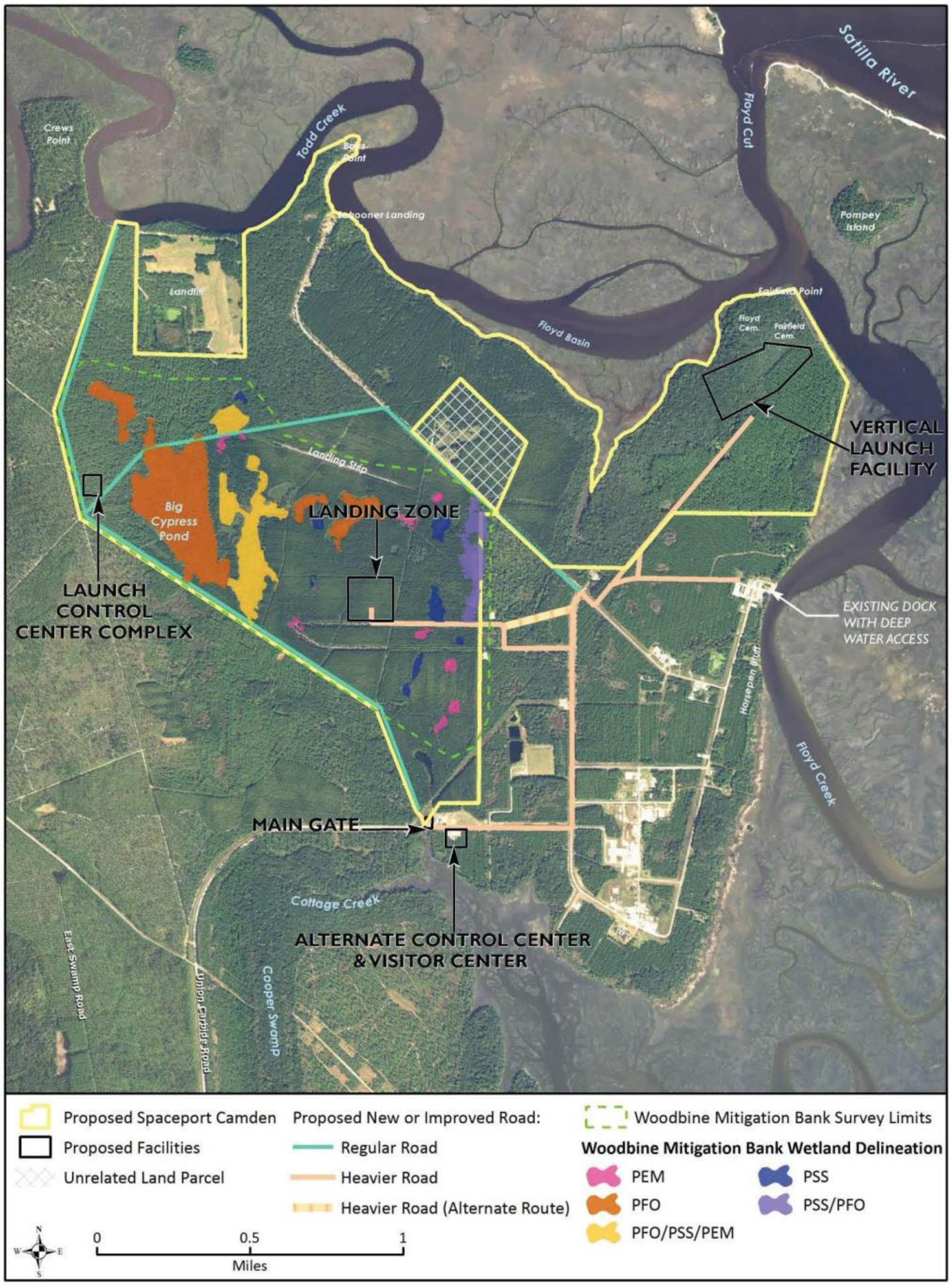

Figure C-1. Previously Delineated Wetlands Map

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APPENDIX D

GLOBAL POSITIONING SYSTEM DELINEATION FORM

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US Army Corps of Engineers
Savannah District, Regulatory Division
Global Positioning Systems (GPS) Datasheet
Delineation of Wetlands, Streams and Other Waters
Within the State of Georgia

USACE File Number__________ Date of Delineation 8/15-8/19 2016

Name of Delineator Present Brian Tutterow

Make and Model of GPS Device Used (must be capable of sub-meter accuracy)
Trimble Geo7X

Geographic Coordinate System Used NAD 83 20111 State Plain Georgia East FIPS 1001 Ft US

Name of Continually Operated Reference Station Used for Post-processing
CORS, TIFTON (GATF), GEORGIA (ITRF00 (1997)-Derived from IGS08 (NEW))

Date Post-processing Performed 8/29/2016

Percent Dilution of Position (PDOP) (6 or less is required) <6 in all cases

Name and Coordinates of Known Property Corner and/or Monument
Control Point 3 851891.436 346449.894; Control Point 5 853592.363 347117.012

GPS Reading of Known Property Corner and/or Monument
Control Point 3 851889.167 346450.98; Control Point 5 853589.589 347117.634

Frequency of Waypoints Taken During Survey Visual site distance

Note: GPS data must be provided, if requested. If GPS data and/or a GPS delineation is determined unacceptable by the Savannah District, a survey sealed by a surveyor licensed in Georgia will be required.

GPS Datasheet 19 Mar 2008

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APPENDIX E

U.S. ARMY CORPS OF ENGINEERS VERIFICATION LETTER

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, SAVANNAH DISTRICT
100 W. OGLETHORPE AVENUE
SAVANNAH, GEORGIA 31401-3604

NOVEMBER 0 3 2017

Regulatory Branch
SAS-2015-00823

Mr. Steve Howard
Camden County Administrator
Post Office Box 99
Woodbine, Georgia 31569

Dear Mr. Howard:

I refer to a letter received July 31, 2017, and supplemental information dated July 31, 2017, and September 7, 2017, submitted on your behalf by Mr. Brian Tutterow of Leidos, Inc., requesting a delineation of aquatic resources for a 184.1 acre project site (146.3 acres owned by Union Carbide Corporation and 37.8 acres owned by Bayer CropScience LP). This project site is located at the eastern termination of Union Carbide Road, 11.5 miles east of the town of Woodbine, in Camden County, Georgia (Latitude 30.9042, Longitude -81.5268). This project has been assigned number SAS-2015-00823 and it is important that you refer to this number in all communication concerning this matter.

The enclosed exhibits entitled, "Figure 1., Figure 1A., Figure 1B., Figure 1C., Aquatic Resources at the Proposed Spaceport Camden, and Table 1. Aquatic Resources within the Field Survey Area at the Proposed Spaceport Camden", dated September 7, 2017, identifies the delineation limits of all aquatic resources within the review area. The wetlands were delineated in accordance with criteria contained in the 1987 "Corps of Engineers Wetland Delineation Manual," as amended by the most recent regional supplements to the manual. This delineation will remain valid for a period of 5-years unless new information warrants revision prior to that date.

Please be advised, aquatic resources that are under the jurisdiction of Section 404 of the Clean Water Act (33 United States Code (U.S.C.) § 1344) and/or Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. § 403) may require a permit for the placement of dredged or fill material or mechanized land clearing of those aquatic resources may require prior Department of the Army authorization pursuant to Section 404.

If you intend to sell property that is part of a project that requires Department of the Army Authorization, it may be subject to the Interstate Land Sales Full Disclosure Act. The Property Report required by Housing and Urban Development Regulation must state whether, or not a permit for the development has been applied for, issued or denied by the U.S. Army Corps of Engineers (Part 320.3(h) of Title 33 of the Code of Federal Regulations).

This communication does not convey any property rights, either in real estate or material, or any exclusive privileges. It does not authorize any injury to property, invasion of rights, or any infringement of federal, state or local laws, or regulations. It does not obviate your requirement to obtain state or local assent required by law for the development of this property. If the information you have submitted, and on which the U.S. Army Corps of Engineers has based its determination is later found to be in error, this decision may be revoked.

A copy of this letter is being provided to the following parties: Mr. Timothy A. King, Union Carbide Corporation (C/O Dow Chemical), Post Office Box 150, Building 2304, Plaquemine, Louisiana 70765; Mr. David Pittman, Bayer Crop Science, 5954 Union Carbide Road, Woodbine, Georgia 31569; and, Mr. Brian Tutterow, Leidos, Inc., 13397 Lakefront Drive, Suite 100, Earth City, Missouri 63045.

Thank you in advance for completing our on-line Customer Survey Form located at http://corpsmapu.usace.army.mil/cm_apex/f?p=regulatory_survey. We value your comments and appreciate your taking the time to complete a survey each time you have interaction with our office.

If you have any questions, please call me at 912-652-5086.

Sincerely,

Shaun Blocker
Project Manager, Coastal Section

Enclosures

Figure 1. Aquatic Resources at the Proposed Spaceport Camden

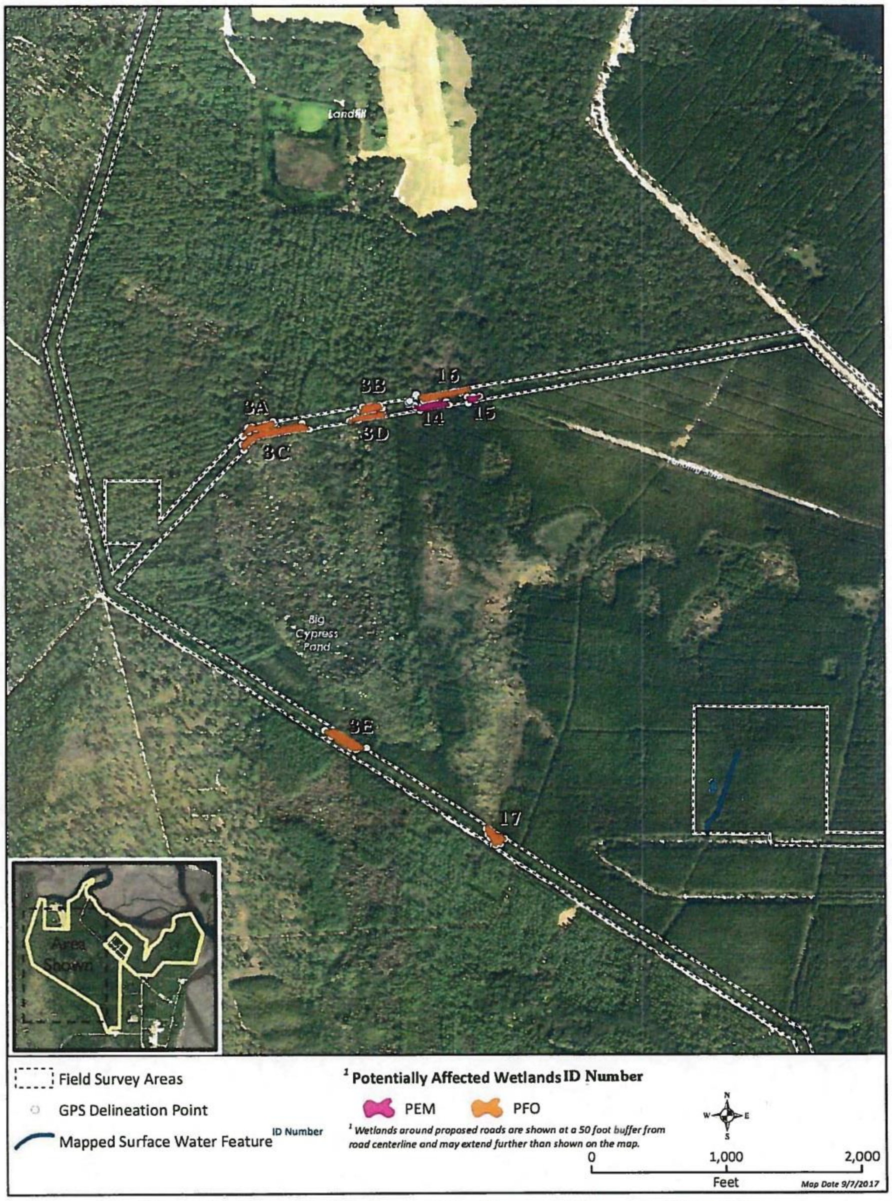

Figure 1A. Aquatic Resources at the Proposed Spaceport Camden

Figure 1B. Aquatic Resources at the Proposed Spaceport Camden

Figure 1C. Aquatic Resources at the Proposed Spaceport Camden

Table 1. Aquatic Resources within the Field Survey Area at the Proposed Spaceport Camden

Wetland	Acres	Latitude	Longitude
3A	0.184	30.94321000	-81.54158000
3B	0.1410	30.94363000	-81.53896000
3C	0.4770	30.94312000	-81.54120000
3D	0.1720	30.94342000	-81.53904000
3E	0.3660	30.93678000	-81.53945000
6	0.0020	30.94697800	-81.50976100
7	0.1960	30.94037400	-81.51296800
9	0.1210	30.94253300	-81.51037800
10	0.6440	30.93529300	-81.51991800
11	0.0820	30.93688500	-81.51536800
12A	0.0480	30.93181000	-81.51838000
12B	0.0790	30.93033000	-81.51839000
14	0.1890	30.94325800	-81.53758000
15	0.0570	30.94369900	-81.53644800
16	0.2760	30.94452900	-81.53815500
17	0.2100	30.93489900	-81.53610900
18	0.0920	30.93557000	-81.52572600
19A	0.0780	30.94062000	-81.52322500
19B	0.1610	30.93496000	-81.52385000
20	0.0150	30.93700000	-81.51400000
21	0.0170	30.93797000	-81.51504000

Stream	Acres	Linear Feet	Latitude	Longitude
1	0.152	660.051	30.93579933	-81.53063736
2A	0.009	122.672	30.93781000	-81.51501000
2B	0.003	53.962	30.93705000	-81.51510000
3A	0.007	109.492	30.93779369	-81.51509391
3B	0.015	112.571	30.93511116	-81.52041196

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APPENDIX I TRANSPORTATION

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I TRANSPORTATION

This appendix addresses the potential direct, indirect, and cumulative environmental impacts of construction and operation of the proposed launch site on the capacity and traffic flow of surface transportation systems serving and in proximity to the proposed project site that would result from the Federal Aviation Administration's (FAA's) Proposed Action to issue a Launch Site Operator License to Camden County Board of Commissioners (the County) for Spaceport Camden. The region of influence for transportation would include roads that could be used to transport building materials, hazardous and nonhazardous materials, asphalt and concrete, and construction equipment to the proposed project site and remove construction waste materials from the site. It also includes roads used by contractors traveling to and from the site during construction and by personnel and contractors traveling to and from the proposed spaceport site once it is in operation.

I.1 Affected Environment

I.1.1 Definition and Description

The Federal Highway Administration classifies roadways as principal arterial, minor arterial, collector, or local. Principal arterial roadways (i.e., interstates, freeways, and expressways) serve a large percentage of travel between cities and other activity centers, especially when minimizing travel time and distance is important. Principal arterials are typically roadways with high traffic volumes and are frequently the route of choice for intercity buses and trucks. Minor arterials provide service for trips of moderate length, serve geographic areas that are smaller than principal arterial roadways, and provide intracommunity continuity. Collector roadways (i.e., major collectors and minor collectors) funnel traffic from local roads to principal or minor arterial roadways and generally serve intracounty travel. Local roads provide direct access to abutting land and are not intended for use in long distance travel (Federal Highway Administration, 2013).

The Proposed Action involves truck and worker commuter trips to or from the proposed project site, coming from and going to destinations within the local area and wider region. These trips represent additional traffic volumes over baseline levels that could affect the quality of traffic flow (expressed as a level of service [LOS] rating for each road), based on road, traffic, and control conditions. The level of service rating is a qualitative measure used to relate the quality of traffic service using letter designations A (best) through F (worst) as summarized in Table I-1.

Table I-1. Level of Service Definitions

LOS	Operating Conditions
A	Highest quality of service; free traffic flow, low volumes and densities; little or no restriction on maneuverability or speed
B	Stable traffic flow; speed becoming slightly restricted; low restriction on maneuverability
C	Stable traffic flow but less freedom to select speed, change lanes, or pass; density increasing
D	Approaching unstable flow; speeds tolerable but subject to sudden and considerable variation; less maneuverability and driver comfort
E	Unstable traffic flow with rapidly fluctuating speeds and flow rates; short headways, low maneuverability, and lower driver comfort
F	Forced traffic flow; speed and flow may drop to zero with high densities

Notes: LOS = level of service.
Source: (Transportation Resources Board, 2010).

I.1.2 Regulatory Setting

The Georgia Department of Transportation (GDOT) regulates speed and other vehicle safety parameters using the GDOT Design Policy Manual. The manual is the primary resource for design guidelines and standards adopted by GDOT for the design of roadways and related infrastructure. The guidelines and standards presented in the manual are based on policies and principles defined by GDOT, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and various national research organizations (Georgia Department of Transportation, 2017a). Additionally, the United States (U.S.) Department of Transportation (DOT) regulates the transport of hazardous materials in 49 Code of Federal Regulations (CFR) Parts 171–179.

I.1.3 Existing Conditions

The proposed spaceport is located in an unincorporated area of Camden County, approximately 11.5 miles east of the town of Woodbine and approximately 19 miles northeast of the city of Kingsland. Interstate 95 (I-95) traverses north-south approximately 9 miles to the west of the proposed spaceport, and U.S. Route 17 (Ocean Highway) parallels I-95 for 1 to 2 miles to the west for much of Camden County. I-95 traverses north-south, providing local access to the town of Woodbine and the city of Kingsland and regional access to Brunswick to the north and Jacksonville, Florida, to the south (see Exhibit I-1).

Access to Spaceport Camden would be provided by way of Harrietts Bluff Road, which transitions into Union Carbide Road approximately 5.5 miles southwest of the gated entry to the project site. Harrietts Bluff Road is classified as an urban minor arterial road located entirely in Camden County that intersects two urban arterial roads in the area (I-95 [major] and Ocean Highway [minor]). Most traffic to and from the Spaceport Camden site would access Harrietts Bluff Road and Union Carbide Road through one of these two arterial roads. Regional access to the site would be provided by way of Exit 7 (Harrietts Bluff Road/Woodbine) of I-95. Harrietts Bluff Road originates at Ocean Highway and travels approximately 10 miles east until it transitions into Union Carbide Road (classified as a rural collector road) before terminating at the proposed Spaceport Camden project site, which contains a series of unnamed, sporadically maintained roads that were utilized during previous site activities.

As Harrietts Bluff Road, a two-lane road with a speed limit of 35 miles per hour, travels east from Ocean Highway and I-95, it provides access to multiple residential developments and local businesses. As it transitions into Union Carbide Road, population density and the presence of commercial properties diminishes considerably, and the road progresses through undeveloped woodland area up to the site access gate. Table I-2 and Table I-3 list the average annual daily traffic (AADT) counts for roadways providing regional and local access to the Spaceport Camden site. Exhibit I-2 illustrates the roadway network in proximity to Spaceport Camden and the locations of GDOT AADT monitoring locations listed in Table I-2. Based on GDOT traffic counts for 2018, 240 vehicles (19 of which were trucks) accessed Union Carbide Road just north of Marys Drive. Since Marys Drive provides access to the last residential area before the proposed spaceport site, it can be assumed that this count represents all traffic to and from the site.

By contrast, in 2018, 3,450 vehicles (207 of which were trucks) accessed Harrietts Bluff Road just south of Pine Drive, which provides access to residential and commercial areas before reaching the transition point of Harrietts Bluff Road and Union Carbide Road (i.e., the access road to the proposed spaceport site/current Union Carbide/Bayer CropScience property).

Exhibit I-1. Spaceport Camden Regional Transportation Network

Table I-2. Average Daily Traffic for Roadways in the Vicinity of Spaceport Camden

#	Description	Functional Classification	Annual Average Daily Traffic					
			2018	2017	2016	2015	2014	2013
1	I-95 just south of Exit 7 - Harrietts Bluff Road	Urban - interstate	60,400	61,600	58,800	54,900	54,900	No data
2	I-95 Exit 7 - Harrietts Bluff Road (northbound)	Urban - interstate	2,440	2,640	2,980	2,870	2,730	2,520
3	Harrietts Bluff Road east of U.S. 17	Urban - minor arterial[1]	1,400	1,370	1,350	1,310	1,270	940
4	Harrietts Bluff Road just south of Pine Drive	Urban - minor arterial	3,450	3,410	3,360	3,250	3,010	3,010
5	Union Carbide Road just east of Marys Drive	Rural - major collector[2]	240	240	230	220	210	210

Notes: I- = Interstate Highway (I-95, I-75, etc.); U.S. = United States.
[1] Functional classification for a street or highway serving urban areas and provides the highest level of service at the greatest speed for the longest uninterrupted distance, with some degree of access control (Georgia Department of Transportation, 2017a).
[2] A street or highway that generally serves travel of primarily intracounty rather than statewide importance and constitutes those routes on which (regardless of traffic volume) predominant travel distances are shorter than on arterial routes. On average such roads, more moderate speeds may be typical (Georgia Department of Transportation, 2017a).
Source: (Georgia Department of Transportation, 2017b; Georgia Department of Transportation, 2019)

Table I-3. Average Daily Truck Traffic for Access Roadways to Spaceport Camden

Location	Functional Classification	Annual Average Daily Truck Traffic		
		2018	2017	2016
Harrietts Bluff Road just south of Pine Drive	Urban - minor arterial	207	205	202
Union Carbide Road just east of Marys Drive	Rural - major collector	19	19	18

Source: (Georgia Department of Transportation, 2017b)

A 3.7-mile stretch of Harrietts Bluff Road and Union Carbide Road, from White Oak Place to just north of the Deep Creek crossing, was milled and resurfaced in 2010 (Georgia Department of Transportation, 2015). Based on AADT counts and road characteristics, the entirety of Harrietts Bluff Road and Union Carbide Road would be categorized as LOS A or B, as indicated in Table I-1. Considering the type, condition, and function of the roadways, coupled with the AADT counts listed in Table I-2 and Table I-3, traffic along this corridor is currently well below the capacity of Harrietts Bluff Road.

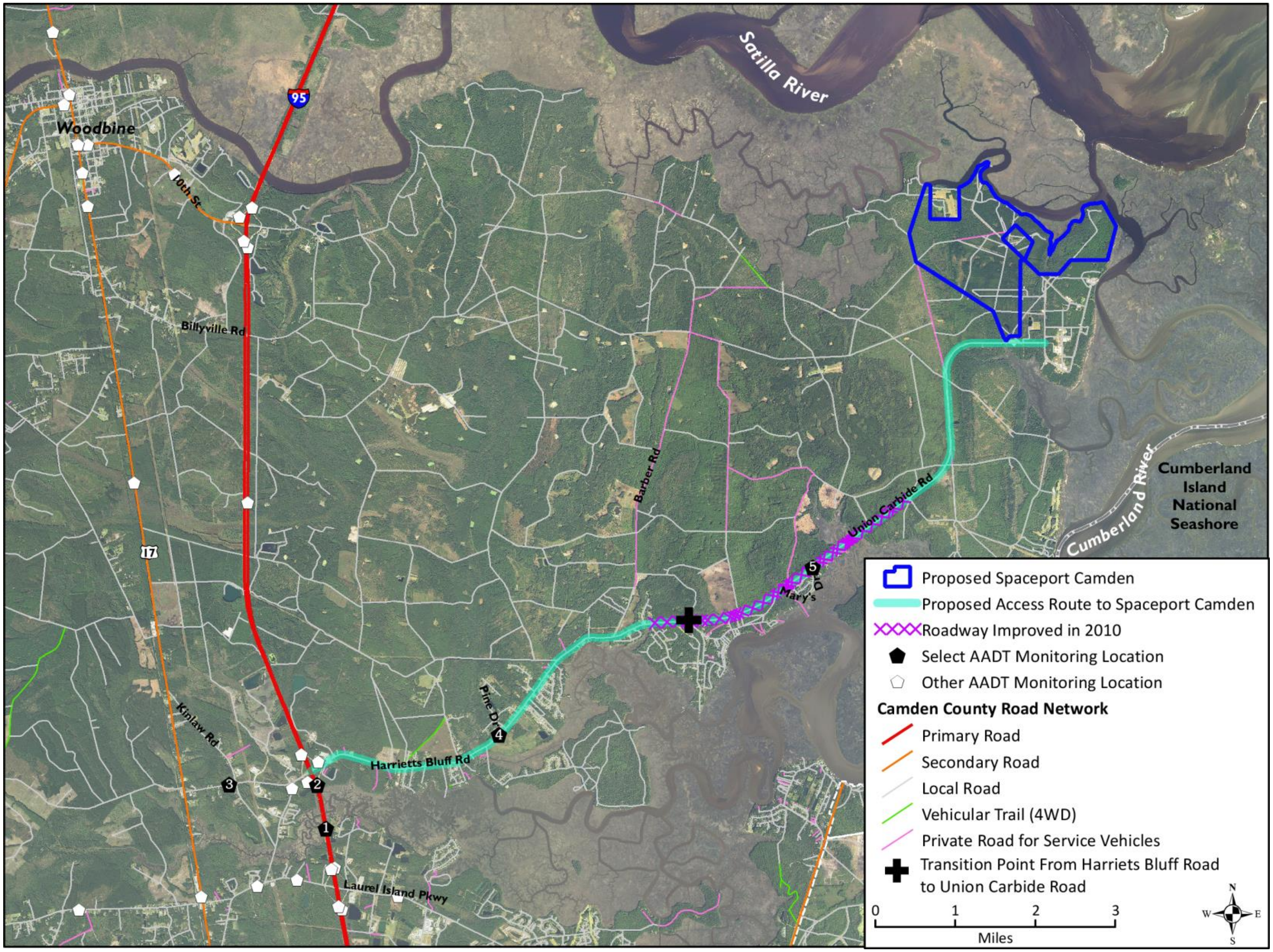

Exhibit I-2. Spaceport Camden Local Transportation Network and AADT Monitoring Locations

Because are no bridges or roadways connecting Cumberland Island to the mainland, public access is provided by ferry service operated by the National Park Service. Ferries depart downtown St. Marys twice daily from a dock at the Cumberland Island National Seashore Visitor Center and navigate the St Marys River to the Cumberland Sound before making stops at two docks located on the southern part of the Island (Ice House Museum and Sea Camp Ranger Station) (see Exhibit I-1). To accommodate increased ridership during the spring and summer (March through September), an additional ferry makes a return trip in the afternoon from the island to St. Marys. During winter (December through February), the ferry does not operate on Tuesday or Wednesday. Guests of a privately owned, 16-room hotel on Cumberland Island (The Greyfield Inn) access the island by way of a ferry, the Lucy R. Ferguson, which runs from Fernandina Beach, Florida, to a dock approximately 1 mile north of the Sea Camp Ranger Station dock, but as this ferry is open only to guests of the inn, it is not considered a public access route.

Portions of coastal Georgia are included in the Intracoastal Waterway, specifically the Atlantic Intracoastal Waterway, a network of rivers, bays, inlets, and canals that provide navigable routes for commercial boats and recreational water crafts, protected from the open sea. Types of craft using the waterway and waters near Spaceport Camden would typically consist of military craft transiting to and from Kings Bay Naval Submarine Base (NSB) and commercial shipping vessels and recreational craft (e.g., motorboats and sailboats. Navigable water routes and waterways in proximity to Spaceport Camden include St. Andrew Sound, the Satilla River, Cumberland River, Floyd Creek, and Todd Creek.

I.2 Environmental Consequences

I.2.1 Proposed Action

Implementing the Proposed Action has the potential to impact the local ground traffic and transportation during construction and operation of Spaceport Camden. Based upon the relatively high AADT values for the area of I-95 closest to the regional access point to the site (61,600 in 2017 and 60,400 in 2018), no significant impacts are expected to major roadways utilized by vehicles associated with the Proposed Action. Because all or most of Harrietts Bluff Road/Union Carbide Road would be used to transport materials and personnel, which have considerably lower AADT counts than the major roads that would be utilized by vehicles associated with the construction and operation of Spaceport Camden, this analysis only considers traffic impacts along 15 miles of Harrietts Bluff Road/Union Carbide Road. The County does not anticipate improvements or expansions required for Harrietts Bluff Road/Union Carbide Road outside the spaceport site, but portions of Union Carbide Road within the boundary of the proposed spaceport site would require improvement. Proposed improvements to the internal roadway network on the site are discussed in the Environmental Impact Statement (EIS), Section 2.1.1.6, *Infrastructure*. No significant impacts to the local roads connecting to Harrietts Bluff Road/Union Carbide Road are anticipated as a result of the Proposed Action.

Construction

Under the Proposed Action, the County would construct and operate Spaceport Camden, as identified in EIS Section 2.1, *Proposed Action*. Construction of the facilities and infrastructure would occur concurrently and last approximately 15 months, the length of time needed for construction of the Vertical Launch Facility. During the construction period, additional vehicle traffic associated with the Proposed Action would include transportation of construction equipment, delivery of construction materials, removal of construction-related debris, and additional traffic associated with construction workers. Construction activities would occur during daylight hours 6 days a week. Because the proposed project site is relatively isolated at the terminus of Union Carbide Road, all material delivery and construction worker traffic is assumed to use Harrietts Bluff Road and Union Carbide Road to access the site. Based on the construction material requirements, delivery of these materials to the site would require an average of 15 trucks per day in each direction (Table I-4).

Table I-4. Construction Truck Trip Requirements – Proposed Action

Construction Material	Total Volume Required (cubic yards)	Delivery Truck Capacity (cubic yards)	Total Number of Trucks
Construction materials	60,600	10	6,060
Backfill[1]	N/A	N/A	N/A
		Total number of trucks (over 15 months)	**6,060**
		Average number of trucks per day in each direction [2]	**15**

Notes: N/A = not applicable.
[1] It was assumed that all material excavated onsite (estimated at 126,000 cubic yards) would remain onsite to be used as backfill, with any excess suitable material stockpiled onsite. Therefore, no transport of backfill to or from an offsite location would be required during construction of Spaceport Camden facilities.
[2] Construction activities would occur during daylight hours 6 days a week.

While the average number of trucks per day is estimated to be 15 in each direction, it is expected that over the duration of construction activities, some days would require more truck trips and some days would require fewer truck trips. For example, as discussed in EIS Section 3.7.3, *Hazardous Materials, Solid Waste, and Pollution Prevention, Existing Conditions*, the construction of Spaceport Camden would generate a total of 435 tons of debris that would be disposed of at the Camden County Construction and Demolition Industrial Waste Landfill. In addition, it is anticipated that construction of the launcher track and integration building at the Launch Pad Complex would require large pours of concrete and, therefore, could require more than 15 truck trips per day in each direction. However, the increases are expected to be temporary and would not significantly impact the traffic flow of Harrietts Bluff Road and Union Carbide Road. All other facilities would not require large pours of concrete and could be constructed using the average number of daily truck trips presented in Table I-4.

It is anticipated that about 40 to 50 construction workers would be required for the construction of the facilities, and about 20 additional construction workers would be required for the construction of new infrastructure (water, sewer, drainage, and roads). For purposes of analysis, it was assumed that all 70 workers would access the site each day. As shown in Table I-5, traffic along Harrietts Bluff Road/Union Carbide Road would increase from 240 vehicles per day in each direction to 325 vehicles per day in each direction during the Spaceport Camden construction period.

Table I-5. Harrietts Bluff Road/Union Carbide Road Maximum Construction Traffic

Traffic Source	Vehicles per Day in Each Direction
Existing AADT	240
Construction truck traffic	15
Construction worker traffic	70
Total construction traffic during large concrete pours	**325**

Notes: AADT = average annual daily traffic.

Due to Harrietts Bluff Road/Union Carbide Road being the only access point to the proposed project site, it is possible that the increased vehicle traffic from construction activities could cause traffic delays during daily rush hour. To avoid these delays, construction truck access would be scheduled throughout other parts of the day. Although truck access would be scheduled for off-peak times, there would still be potential traffic delays along the local roads that connect to Harrietts Bluff Road. However, these delays are expected to be minimal, and there would not be permanent or significant traffic delays. Therefore, the level of service rating for Harrietts Bluff Road is not expected to change as a result of Spaceport Camden construction activities.

As stated in the introduction to this appendix, hazardous materials (i.e., gasoline, diesel, compressed gas, paints, and epoxies) would be transported to the proposed project site during construction activities. Transport of these materials would comply with DOT regulations in 49 CFR Parts 171–179 (i.e., using DOT-approved trucks, containers, and packaging and properly marking the contents for shipment over public roadways). While shipment of hazardous materials is routinely done across the country, there is the potential for a traffic accident. The DOT estimates that the likelihood of an accident involving transport of hazardous materials is 0.32 accidents per million vehicle miles (U.S. Department of Transportation, 2001). However, to be conservative, the nonhazardous material transport accident rate of 0.73 per million vehicle miles traveled was used to calculate potential accidents resulting from construction activities. Assuming that each vehicle travels the entire length of Harrietts Bluff Road and Union Carbide Road (approximately 30 miles round trip), there would be no additional accidents expected (calculated value of 0.13) over the duration of Spaceport Camden construction activities. Therefore, the transport of hazardous and nonhazardous materials during construction is not anticipated to significantly impact traffic and transportation in the vicinity of the proposed project area.

Operation

Operations at Spaceport Camden would consist of up to 12 launch operations per year, with onsite activities supporting a launch beginning up to 4 weeks before launch day. The level of ground traffic and transportation would fluctuate between normal operational levels and launch operation levels. As stated in EIS Section 2.1.2, *Representative Launch Vehicle and Operational Activities*, there would be approximately 77 full-time employees (27 Spaceport Camden employees and 50 launch operator employees) working onsite during normal operations. However, during launch operations, the number of staff would increase to a maximum of 100 Spaceport Camden employees and a maximum of 200 launch operator employees beginning about 2 weeks before the launch (see Table I-6). Because construction of housing facilities is not included in the Proposed Action, it is assumed that these workers would commute from offsite locations. If no carpooling of employees takes place and only privately owned vehicles are used, traffic along Harrietts Bluff Road/Union Carbide Road would increase from 240 vehicles per day in each direction to 350 vehicles per day in each direction during normal Spaceport Camden operations and 554 total vehicles per day during launch operation windows.

Table I-6. Additional Traffic on Harrietts Bluff Road/Union Carbide Road Resulting from Spaceport Camden Operation – Proposed Action

Traffic Source	Vehicles per Day in Each Direction	
	Normal Operations	Launch Operations
Existing AADT	240	240
Spaceport Camden employees	77	100
Launch operator employees	27	200
Truck traffic (deliveries and rocket components)	8	14
Total	**350**	**554**

Notes: AADT = average annual daily traffic.

Public access in the vicinity of the Spaceport Camden would be restricted during launches, wet dress rehearsals, and static fire engine tests. Closures could last up to 3.5 hours; however, access controls could be in place for up to 12 hours on an atypical launch day.

Launch operations would also include the delivery of rocket vehicle components and propellants and other necessary fluids. A total of approximately six to eight vehicles or trucks per month would make deliveries of fluids on an as-needed basis. Ground transportation support for vehicle deliveries would consist of a truck to deliver a crane and four or five delivery trucks for delivery of rocket stages and any miscellaneous items. Average annual daily truck trips in 2015 on Union Carbide Road south of the entry gate was measured by GDOT at 18 and 206 on Harrietts Bluff Road just south of Pine Drive.

Please see Section 2.1.2.5, *Pre-Launch Activities* for additional information on the Spaceport Camden Security Plan and pre-launch coordination and notification efforts.

Public notification would be transmitted via multiple channels, including dynamic messaging signs, social media announcements, and county-maintained websites. The County would coordinate with Glynn County, Georgia Department of Natural Resources and law enforcement agencies, the U.S. Coast Guard (USCG), U.S. Navy at NSB Kings Bay, Marine Corps Air Station Beaufort, and the appropriate regional Air Route Traffic Control Center, Jacksonville Tower, and local commercial/general aviation airports. Notices to mariners and notices to airmen would also be disseminated. In addition, the County and the launch operator would notify the City of Brunswick, the National Park Service, Crooked River State Park, and other appropriate agencies of the launch operation.

Pre-launch interagency coordination among local jurisdictions; the military; and local, regional, and state agencies would help identify and address any potential compatibility issues with NSB Kings Bay (see EIS Section 2.1.2.5, *Pre-launch Activities*). Therefore, operation of Spaceport Camden would not be anticipated to significantly inhibit NSB Kings Bay daily operations and missions.

Roadway Closures

The land-based portion of the USCG Limited Access Area (LAA) would likely include areas around the access points to the launch site at the end of Harrietts Bluff Road (also referred to as Union Carbide Road). If needed, additional land security checkpoints could be implemented on Cumberland Island near Brickhill Bluff or Plum Orchard and on the Atlantic beach to ensure appropriate population monitoring. “Authorized persons” as described in EIS Section 1.4.2, *Other Licenses, Permits, and Approvals*, would have the same rights of access as they currently experience on areas of Little Cumberland Island and Cumberland Island located within the USCG LAA.

The only road closure that could potentially affect the local roadway network is the closure of Union Carbide Road just south of Spaceport Camden site. This stretch of roadway had an AADT of 240 in 2018 and provides access only to and from the Spaceport Camden site and a network of unnamed logging roads. The Camden County Sheriff’s Office would be responsible for, and would coordinate, land closure checkpoints. During closures, only authorized vehicles and personnel would be permitted through these checkpoints and into the closure areas, including approved government and Camden County officials, launch operators, emergency personnel, and other individuals with appropriate credentials. Because this section of roadway is primarily used for access to and from the current Union Carbide/Bayer CropScience properties, impacts to residents on Harrietts Bluff Road and other arterial roads connected to it would not be expected during closures.

Waterway Closures

The USCG LAA would be expected to include the waterways surrounding the launch site and some of the waterways surrounding Cumberland Island and Little Cumberland Island extending along the trajectory and out to sea. Water-based portions of the USCG LAA would be enforced by the USCG and their designated authorities. On a case-by-case basis and subject to operation-specific considerations, the captain of the port and/or their designated authority would allow vessel travel through the USCG LAA.

Waterway LAAs would affect portions of St. Andrews Sound, the Satilla River, and the Cumberland River; access to, and activities on, these waterways could be limited for up to 12 hours on a launch day, with up to 3.5 hours representing the nominal time for a normal launch. As shown in Exhibit 2.1-10 of the EIS, for the trajectory considered, waterway checkpoints could be located along the Satilla River/St. Andrews Sound area, the Atlantic Ocean, and the Cumberland River. Under USCG delegation of authority, Camden County Sheriff Department vessels would be used to secure the river, streams, and ocean checkpoints.

Access to the Intracoastal Waterway could be temporarily limited north of Crooked River State Park and east to the St. Andrews Sound, as would a section of the Cumberland River from the middle potion of Cumberland Island north to the St. Andrews Sound. Primary users of these sections of waterways would include recreational boaters accessing Crooked River State Park and Cumberland Island National Seashore. Portions of the Atlantic Ocean east of Cumberland Island would be within the USCG LAA on launch days. Because launch trajectories and LAAs would occur well to the north (approximately 10 miles) of dock locations, Cumberland Island Ferry operations would not be impacted by pre-launch and launch activities.

Maritime traffic could be present through the USCG LAA. Potential delays and cancellations resulting from limited access to certain areas during launches could have adverse impacts on maritime transportation. Potential limited access for "unauthorized" personnel (see EIS Section 1.4.2, *Other Licenses, Permits, and Approvals*) would occur in the USCG LAA for up to 3.5 hours each launch, for up to 12 times per year, for a total of 42 hours. However, adverse impacts to maritime transportation from access limitations would be minimized through advance notice and issuance of notices to mariners.

I.2.2 No Action Alternative

Under the No Action Alternative, FAA would not issue a Launch Site Operator License to the County. The County would not exercise its option to purchase the property, and the property would continue to be owned by the private landowner in accordance with its current industrial zoning. No activities related to constructing or operating a commercial spaceport would occur at the launch site. No launch-related access limitations to roads or waterways would occur. As a result, any changes to the local and regional transportation network, traffic volumes, and associated LOS as described in Section I.1.3, *Existing Conditions*, would be the result of ongoing and future transportation planning projects.

I.3 References

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APPENDIX J AIRSPACE

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List of Exhibits

ACRONYMS AND ABBREVIATIONS

Acronym	Definition
AGL	above ground level
ARTCC	Air Route Traffic Control Center
ATC	air traffic control
CFR	Code of Federal Regulations
FAA	Federal Aviation Administration
IFR	Instrument Flight Rules
J	Jet Route
LOA	Letter of Agreement
MOA	Military Operations Area
MSL	mean sea level
NOTAM	Notice to Airmen
SUA	Special Use Airspace
T	Tango Route
UHF	ultra-high frequency
U.S.	United States
V	Victor Route
VFR	Visual Flight Rules
VHF	very high frequency
VOR	VHF navigational facility-Omnidirectional Course
VORTAC	collocated VOR and Tactical Air Navigation facilities
W-	Warning Area

J AIRSPACE

J.1 Definition and Description

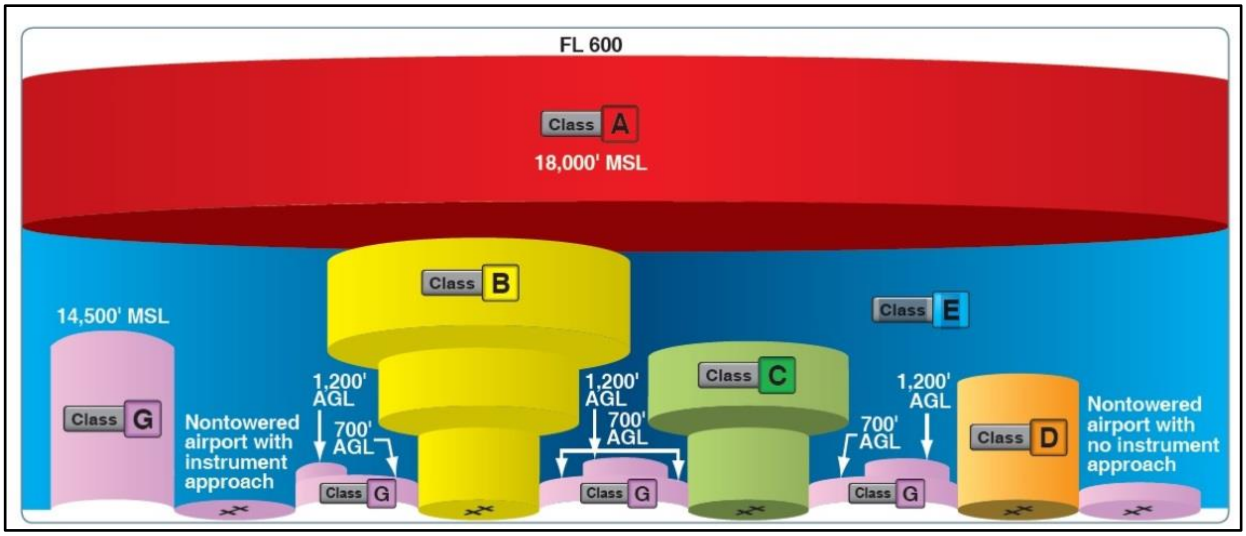
The airspace resource area encompasses how airspace is designated, used, and administered to best accommodate the needs of commercial, military, and general aviation. The Federal Aviation Administration (FAA) considers multiple and sometimes competing demands for airspace in relation to airport operations, Federal airways, jet routes, military flight training activities, and other special needs to determine how the National Airspace System can be best structured to address all user requirements. FAA has designated four types of airspace above the United States—controlled airspace, Special Use Airspace (SUA), other airspace, and uncontrolled airspace (FAA, 2016):

- Controlled airspace is categorized into Classes A, B, C, D, and E (see Exhibit J-1). Each class is associated with its own minimum pilot qualifications, rules of flight, and required types of equipment. Class A airspace extends from 18,000 feet above mean sea level (MSL) to 60,000 above MSL throughout the United States and above waters within 12 miles of the coast. Class B, C, and D airspace is designated in specific altitude bands at specified horizontal distances from airports. Class E airspace is designated in areas where air traffic control (ATC) services are provided during Instrument Flight Rules (IFR) operations, but where the level of control is less than in the other controlled airspace categories. During IFR operations, guidance is provided to aircrews based on radar and other instruments, allowing safe flying operations in low-visibility conditions.

- SUA is designated volumes of airspace within which specific activities must be confined or where limitations are imposed on aircraft not participating in those activities. SUA types include Prohibited Areas, Restricted Areas, Warning Areas, and Military Operations Areas (MOAs). As described in FAA Order 7400.10B, each SUA type is associated with a specific set of rules regarding access by nonparticipating aircraft. Access to Prohibited Areas and Restricted Areas by nonparticipating aircraft is not permitted while the airspace is active. MOAs are established to separate certain non-hazardous military activities from IFR traffic and to identify for Visual Flight Rules (VFR) traffic where these activities are conducted. VFR operations are permitted only when visibility is good, as they rely on aircrews seeing and avoiding hazards, such as other aircraft. Warning Areas, which are only designated over international waters, contain activities that may be hazardous to nonparticipating aircraft. Each SUA has specific times of use that may be established permanently or through the United States (U.S.) Notice to Airmen (NOTAM) system.

- Other airspace consists of advisory areas, areas that have specific flight limitations or designated prohibitions, areas designated for parachute jump operations, military training routes, and aerial refueling tracks. This category also includes Air Traffic Control Assigned Airspace and airspace designated for altitude reservations.

- Uncontrolled airspace is designated Class G airspace and has no specific prohibitions associated with its use.



Source: (FAA, 2016)

Exhibit J-1. Cross Section of Controlled and Uncontrolled Airspace Classes

J.2 Regulatory Setting

FAA regulates all aspects of civil aviation in "navigable airspace" including, but not limited to, the management of air traffic during the launch and reentry of commercial space vehicles. Navigable airspace is airspace above the minimum altitudes of flight prescribed by regulations under U.S. Code Title 49, Subtitle VII, Part A, and includes airspace needed to ensure safety in takeoff and landing of aircraft (49 U.S. Code §40102). This navigable airspace is a limited natural resource that Congress has charged FAA to administer in the public interest, as necessary, to ensure the safety of aircraft and its efficient use (FAA Order 7400.2M). The system of airspace, navigation facilities, and airports, along with their associated equipment, personnel services, rules, regulations, and policies, are collectively known as the National Airspace System. Airspace classes and designations, as discussed in Section J.1, *Definition and Description*, are defined at 14 Code of Federal Regulations (CFR) Part 71.

Regulations published at 14 CFR Part 400 require the launch operator to establish agreements with ATC facilities with jurisdiction over the airspace to be used. The Letter of Agreement (LOA) must describe the terms and conditions required for safe launch or reentry operations, including procedures for notification and the issuance of NOTAMs (FAA Order 7400.2M). As per 14 CFR §91.143, aircraft may not operate in space flight operations aircraft hazard areas except when authorized by ATC. The dimensions of the area and the time window for the flight restrictions must be published via NOTAM (Advisory Circular 91-63D, *Temporary Flight Restrictions (TFR) and Flight Limitations*).

J.3 Region of Influence

The region of influence for airspace includes the airspace temporarily closed to traffic during launch operations. The dimensions of this area would be determined based on the trajectory of the vehicle itself, any planned debris such as stages, and potential falling debris in the event of an operational failure. Because air traffic is routed by the Air Route Traffic Control Center (ARTCC) to avoid temporarily closed airspace, aircraft routings could deviate from normal throughout the region.

J.4 Existing Conditions

Exhibit J-2 shows the airspace associated with the Proposed Action area. Class E airspace has been designated beginning at 700 feet above ground level (AGL) above portions of Spaceport Camden and continues at this floor altitude to the north. This designation of Class E airspace at 700 AGL (rather than the standard floor altitude of 1,200 feet AGL, which extends across most of the United States) facilitates instrument approaches to nearby McKinnon St. Simons Island Airport and Jekyll Island Airport. The McKinnon St. Simons Island Airport (also known as St. Simons Island Airport at McKinnon Field) is a county-owned, public-use airport, located 5 miles east of the central business district of Brunswick, Georgia. Located on St. Simons Island, it is approximately 18 miles northeast of the proposed spaceport site. Jekyll Island Airport is a small, general aviation airport located on Jekyll Island, Georgia. It is approximately 11 miles northeast of the proposed spaceport site. Due to its small runway size and the nearby Brunswick Golden Isles Airport, no commercial airlines fly there, but scenic tours of the island fly from there. Brunswick Golden Isles Airport, previously known as Glynco Jetport, is a county-owned, public-use airport located 5 nautical miles north of the central business district of Brunswick, Georgia and approximately 23 miles north of the proposed spaceport site. It is mostly used for general aviation, but is also served by one commercial airline.

FAA Advisory Circular 91-36D, *Visual Flight Rules (VFR) Flight Near Noise-Sensitive Areas*, requests that all aircraft maintain a minimum altitude of 2,000 feet above the surface of lands and waters administered by the National Park Service. This guidance applies to Cumberland Island and is reflected in navigational charts (FAA, 2016). The Brunswick VHF (very high frequency) navigational facility-Omnidirectional Course and UHF (ultra-high frequency) navigational facility-Omnidirectional Course and Distance information navigational facility (VORTAC) is located immediately west of Jekyll Island, approximately 8 miles north of the proposed spaceport site. The VORTAC is a facility that emits signals intended to be used by aircrews for aerial navigation, and acts as a waypoint for aircraft en route. Several Victor (V) Routes, including V179, V3-37, V441, V3, V37, and V362, as well as the Tango Route (T) T204, intersect at this waypoint. These routes extend to 18,000 feet above MSL. V1 and V437 are located off shore from Spaceport Camden. Jet Routes (J) J51-55, J121-174, and J79-103 traverse the area directly above or immediately to the east of Spaceport Camden, facilitating air traffic at altitudes between 18,000 feet above MSL and 45,000 feet above MSL.

Coastal 4 MOA is located approximately 8 miles north of Spaceport Camden. This SUA, which extends from 14,000 feet above MSL up to but not including 18,000 feet MSL, is controlled by Jacksonville ARTCC, and its using agency is Marine Corps Air Station Beaufort. Coastal 4 MOA is used intermittently between 7:00 a.m. and 10:00 p.m. on Monday through Friday and intermittently by NOTAM during the same hours on Saturday and Sunday (FAA Order 7400.10B). Coastal 4 MOA is part of the Townsend Bombing Range SUA that is comprised of eight MOAs and R3007 A/B/C/D/E; the most common set of SUA used aboard Townsend Bombing Range is Coastal 1 East and 1 West, along with Coastal MOA 2 and 4. The combination of those particular four MOAs is considered the “Standard Set” at Townsend Bombing Range.

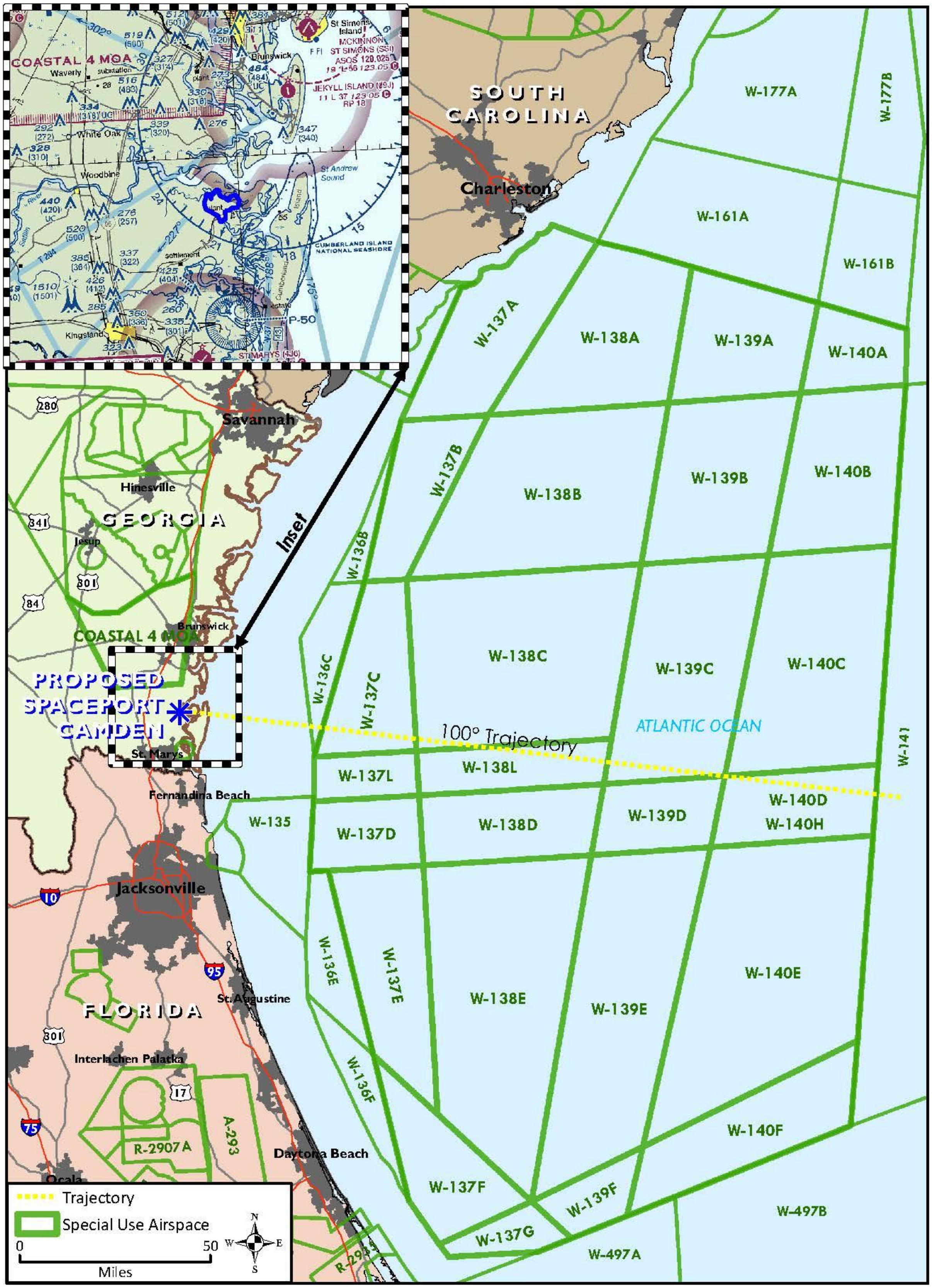


Exhibit J-2. Airspace Associated with the Proposed Action Area

Several Warning Areas (W-) are located off shore in the Atlantic Ocean (Exhibit J-2) and extend from the surface to unlimited altitudes. These SUAs are controlled by Jacksonville ARTCC, and their using agency is the U.S. Navy's Fleet Area Control and Surveillance Facility.

Prohibited airspace unit P-50 is located approximately 5 miles south of Spaceport Camden and incorporates altitudes from the surface to 3,000 feet above MSL. The using agency is FAA, and the airspace is designated for continuous use.

J.5 Proposed Action

Construction

The proposed construction activities would involve use of tall equipment (e.g., crane, impact pile driver) that could obstruct the navigable airspace. Prior to construction, the launch site operator would be required to consult 14 CFR 77 and FAA Advisory Circular 70/7460-IL to determine whether or not an obstruction evaluation is required. It is possible, although unlikely, that the use of cranes and the construction of the water tower and lighting towers may require an obstruction analysis.

Operation

Under the Proposed Action, FAA would issue a Launch Site Operator License to the Camden County Board of Commissioners (the County). The license would allow the County to offer the commercial space launch site, Spaceport Camden, to commercial launch operators to conduct launches of liquid-fueled, small, orbital, vertical-launch vehicles. Airspace use would be coordinated by FAA and the appropriate SUA using agencies (to include Marine Corps Air Station Beaufort and the U.S. Navy). The launch operator must obtain LOAs from the Jacksonville ARTCC and local airspace using agencies, to include Marine Corps Air Station Beaufort and the U.S. Navy, before any launches could commence. Under the Proposed Action, FAA would not alter the dimensions (shape and altitude) of any existing airspace. However, temporary closures of existing airspace units may be necessary to ensure the safety of the proposed operations. The LOAs would include the airspace closure notification requirements, which would be accomplished through the NOTAM system. The specific airspace units that would be affected that are associated with the 100-degree trajectory are shown in Exhibit J-2; air traffic (both military and general aviation from local airports) within the airspace may need to be rerouted to avoid temporarily closed airspace units, similar to airspace management procedures used in preparation for launches from existing space facilities (e.g., Cape Canaveral, Wallops Island).

Because there would be few launches each year and the duration of any potential closures would be very short, temporary closures of existing airspace would not impact the performance and capability of the National Airspace System.

J.6 No Action Alternative

Under the No Action Alternative, FAA would not issue a Launch Site Operator License to the County. Under this alternative, the proposed construction would not occur and no additional flight activities would occur in the airspace above Spaceport Camden. As there would be no potential for additional obstructions and airspace use would not change, there would be no impacts to airspace management.

J.7 References

FAA. (2016). *Pilot's Handbook of Aeronautical Knowledge.*