REQUEST FOR REGULATION AND LETTER OF AUTHORIZATION FOR THE INCIDENTAL TAKNG OF MARINE MAMMALS RESULTING FROM PILE DRIVING ACTIVITIES AT NAVAL SUBMARINE BASE KINGS BAY, KINGS BAY, GEORGIA

Submitted to:

Office of Protected Resources,
National Marine Fisheries Service,
National Oceanographic and Atmospheric Administration

Prepared for:

Naval Submarine Base Kings Bay

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ACRONYMS AND ABBREVIATIONS

AT/FP	Anti-terrorism/Force Protection
B	logarithmic loss
BMP	best management practice
C	linear (scattering and absorption) loss
CFR	Code of Federal Regulations
CGC	Coast Guard Cutters
CV	coefficient of variation
dB	decibel
dBA	decibel (A-weighted)
DOD	Department of Defense
ESA	Endangered Species Act
FAC	Facility
ft.	feet
FR	Federal Register
FY	Fiscal Year
h	height
HDPE	high-density polyethylene
Hz	Hertz
IDP	Installation Development Plan
in.	inch
km	kilometer
kHz	kiloHertz
μPa	microPascal
m	meter
MHW	mean high water
MLLW	mean lower low water
MMPA	Marine Mammal Protection Act
MSDD	Marine Species Density Database
MSF	Magnetic Silencing Facility
NAVFAC	Naval Facilities Engineering Command
NAVFAC SE	Naval Facilities Engineering Command, Southeast
n.d.	no date
NMFS	National Marine Fisheries Service
OSV	Off-shore Supply Vessel
POC	point of contact
PTS	permanent threshold shift
R_1	range from source in meters
R_2	range from driven pile to original measurement location
rms	root-mean-square
SOD	Ship Overboard Drainage
SPL	sound pressure level
SSBN	ballistic missile submarine
SSGN	guided missile submarine
SSP	steel sheet pile
SUBASE	(Naval) Submarine Base

SV	Screening Vessels
TL	transmission loss
TPS	Transit Protection System
UMC	Unspecified Minor Construction
U.S.	United States
USFWS	United States Fish and Wildlife Service
W	width
WRA	Waterfront Restricted Area

1 INTRODUCTION AND DESCRIPTION OF ACTIVITIES

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

1.1 INTRODUCTION AND PROPOSED ACTION

Naval Submarine Base (SUBASE) Kings Bay is the United States (U.S.) Department of the Navy's (Navy's) east coast home port for ballistic missile nuclear submarines supporting the Trident II (D-5) missile. SUBASE Kings Bay manages, maintains, and operates Trident ballistic missile (SSBN) and guided missile (SSGN) submarines, Trident II D-5 and Tomahawk Land Attack Missiles and systems, and infrastructure and quality of life facilities and programs.

A study of SUBASE Kings Bay water-based support facilities found that conditions varied widely from good to seriously deteriorated (NAVFAC 2010). Continuous monitoring of these conditions by SUBASE Kings Bay logistical support staff has confirmed the advanced deterioration and critical nature of some issues that pose operational and safety risks. Additionally, other areas of initial deterioration were identified which require remedy in order to maintain the useful life of existing structures. Damage observed (Figure 1-1) includes deteriorated concrete piles, pile caps, and deck components (cracked, spalled, delaminated, exposed/corroded internal reinforcing steel structures); marine pest (wood borer) damage on wooden piles; broken or unmaintained moorings fittings; and corrosion on steel piles and pile caps.

In some cases, it is more cost effective to demolish older structures that are deteriorated and not well configured to fit existing and upcoming assets with new structures that are specifically designed to meet new mission requirements.

Figure 1-1. Example damage observed at SUBASE Kings Bay waterfront facilities

The purpose of the Proposed Action is to maintain the structural integrity of the in-water pile-supported structures across the installation's waterfront. This action would be accomplished by repairing damaged and aged piles and installing new piles, and ensuring compliance with the current revisions to Department of Defense (DOD) and Navy security directives. The Proposed Action is needed because the in-water pile-supported structures and associated infrastructure are deteriorating and do not provide adequate and stable mooring facilities for ships and submarines, and do not comply with current DOD and Navy security directives.

1.2 DESCRIPTION OF ACTIVITIES

The requested effective date of the Letter of Authorization is 12 July 2017.

To ensure the Navy can continue its mission of supporting the Fleet Ballistic Missile System and Trident Submarine Program, the Navy proposes to repair (including direct repairs and repairs by component replacement) in-water structures at SUBASE Kings Bay, construct a new Transit Protection System (TPS) Operational Support Facility, and extend the existing Layberth Pier in Site VI. These repairs, upgrades, and new construction would 1) address critical damage and mission and safety requirements, 2) limit further deterioration and increase the useful life of the structures, and/or 3) upgrade infrastructure to meet requirements of new submarine technology.

The Proposed Action (henceforth, "Project") is comprised of six distinct projects. Of those six projects, Projects 1, 3, 4, and 6 are comprised of multiple smaller projects. A summary of the six proposed projects is provided in Table 1-1, and Table 1-2 details pile removal and installation requirements associated with each.Table 1-3 provides summary information on the number and types of piles to be installed and removed per fiscal year. Figure 1-2 illustrates the general locations of the proposed projects. Detailed individual project information is provided immediately following Figure 1-2.

For all Proposed Action projects involving replacement of piles, the replacement piles would be brought to SUBASE Kings Bay via barge and staged on the delivering barge. If necessary, the piles would be placed onshore adjacent to the construction site on previously disturbed areas for temporary staging. Pile-driving equipment would be barged-mounted and placed immediately adjacent to the piles being removed or installed.

A vibratory hammer would be used for all pile removal work. If the use of vibratory hammer is not feasible for pile installation (i.e., with steel piles), a Delmag Pile Hammer D62-22 or equivalent impact hammer would be used. Estimates of the numbers of pile driven per day are given in the text descriptions for each project. These estimates are based on previous construction projects at given locations within SUBASE Kings Bay. The per-pile drive time for each pile type and method will vary based on the project location and the environmental conditions (including substrate) where each pile is driven. In general, it should take no more than one hour to drive each pile.

The most effective and efficient method of pile installation available will be implemented for each project. The method fitting these criteria may vary based on specific project requirements and local conditions. In some areas of Kings Bay a limestone layer can be found relatively close to the substrate / water interface. This type of layer requires impact driving because vibratory installation will not drive the piles to a sufficient depth. Impact driving, while generally producing higher source levels also minimizes the net amount of active driving time, reducing the amount of time during which marine mammals may be exposed to noise.

Table 1-1. Summary of Proposed Waterfront Repairs and Security-Related Upgrades

Project ID	Project Description	Facility Number (FAC #)	Project Summary
Project 1: Port Operations Waterfront Facilities Repair			
1A	Tug Pier	5926	Repair concrete structural piles, pile caps, utility cover grates, headwall, mooring support and hardware, and deck undersides; replace wooden fender piles with concrete piles; and modify the fender system on the south side of access pier.
1B	General Access Pier Crab Island	5888	Install new guide piles, and repair brow and handrails.
Project 2: Unspecified Minor Construction Layberth Fender Pile Modification			
2	Unspecified Minor Construction (UMC) Layberth Fender Pile Modification P661 Project	5976	Install additional fender piles to shorten the distance between existing piles and provide the required support for hydro-pneumatic fenders.
Project 3: Waterfront Repair and Replacement Maintenance Program			
3A	Explosive Handling Wharf #2 Pier W/Capstans (7)	5109	Repair high-density polyethylene (HDPE) fender pile wraps, sacrificial anodes attached to the steel fender piles, steel safety ladders and treated timber bracing; repair or replace various pile caps, piles, and mooring foundations; and clean and repaint mooring fittings and two steel guide pipe piles on the diver's float.
3B	(Dry Dock) Interface Wharf	5995	Replace timber fender bearing strips and wales, repair concrete deck, bullrail, edge beams, and mooring foundations; and repair, paint and recoat cathodic protection on the steel H-pile fender system and sheet pile.
3C	Refit Wharf #1	5909	Replace various pile caps, piles, and the outboard edge beam; and repair, clean, and paint several mooring fittings.
3D	Refit Wharf #2	5910	Replace or repair various pile caps, piles, outboard edge beams, and mooring foundations; and reattach underdeck lighting conduit and clean and repaint various mooring fittings.
3E	Refit Wharf #3	5916	Replace or repair various pile caps, piles, the outboard edge beams, and mooring foundations; and clean and repaint various mooring fittings.
3F	Warping Wharf W/Capstan (4)	5877	Repair HDPE fender pile wraps; replace or repair various pile caps, piles, and mooring foundations; and clean and repaint mooring fittings.
3G	Tug Pier	5926	Replace timber fender piles with guide piles and small boat access floats; paint mooring fittings; and repair concrete pile caps, concrete piles, concrete underdeck, and storm drain.

Table 1-1. Summary of Proposed Waterfront Repairs and Security-Related Upgrades (*continued*)

Project 4: Transit Protection System Pier and Off-Shore Supply Vessel Berthing Modification Project			
4A	New TPS Pier	P617	Construct a new pier with full hotel service capability including power; potable water; fire protection; sewage connections; Ship Overboard Drainage (SOD) collection; fuel; and telephone, cable, and Local Area Network (LAN) services.
4B	Small Craft Berth Site VI	5936	Once the new TPS pier is constructed, floating berthing slips would be constructed and provided with full hotel service capability. The berthing pier would consist of a pile supported reinforced concrete structure with floating sections. This project includes the installation of two 5,000-gallon above ground storage tanks and provides two associated truck off-loading connections and fuel dispensing units.
Project 5: Trident Refit Facility Waterfront Facilities Repair, Magnetic Silencing Facility with Crane			
5	Magnetic Silent Facility with Cranes (RM14-1710 Trident Refit Facility Waterfront Facilities Repair)	5980	Replace timber fender piles, restraining chains, aluminum utility tray, and concrete pile utility guide bracket; and repair wooden hand rails and the cracked concrete deck underside.
Project 6: Demolition of the Transit Protection System Pier and Layberth North Trestle			
6A	Demolition of TPS Pier	5934	Remove the tip of the existing TPS Pier.
6B	Demolition of Layberth North Trestle	5977	Demolish the North Layberth Trestle.

Table 1-2. Summary of Proposed Pile Removal and Installation Requirements

ID	FAC #	Project Description	Project Start (FY)	Water Depth at Pile Driving Location (feet)	Pile Size (in)	Pile Material	Pile Type	Total # of Piles		Installation Method	Removal Method	Estimated # of Strikes per Pile (Impact Driving only)	Total Maximum Number of In-Water Work Days
								Installed	Removed				
1A	5926	Tug Pier	2017	24	18	Concrete	Square	148	0	Impact	N/A	60	30
					24	Concrete	Square	18	0	Impact	N/A	70	4
					16	Timber	Round	0	159	N/A	Vibratory	N/A	31
1B	5888	General Access Pier Crab Island	2017	15	16	Composite	Round	2	0	Vibratory	N/A	N/A	1
					16	Timber	Round	0	2	N/A	Vibratory	N/A	1
2	5976	UMC Layberth Fender Pile Modification P661 Project	2017	46	14	Steel	H	55	0	Impact	N/A	80	7
3A	5109	Explosive Handling Wharf #2 Pier W/Capstans	2017	46	24	Steel	Round	2	2	Impact	Vibratory	70	2
			2022	46	24	Concrete	Square	3	3	Impact	Vibratory	75	2
				46	24	Steel	Round	10	10	Impact	Vibratory	70	7
3B	5995	(Dry Dock) Interface Wharf	2021	46	14	Steel	H	99	99	Impact	Vibratory	60	15

Table 1-2. Summary of Proposed Pile Removal and Installation Requirements (*continued*)

ID	FAC #	Project Description	Project Start (FY)	Water Depth (feet)	Pile Size (in)	Pile Material	Pile Type	Total # of Piles		Installation Method	Removal Method	Strikes per Pile (Impact Driving only)	Max. In-Water Work Days
								Installed	Removed				
3C	5909	Refit Wharf #1	2018	46	24	Steel	Round	6	0	Impact	N/A	70	1
					30	Steel	Round	0	6	N/A	Vibratory	N/A	1
3D	5910	Refit Wharf #2	2017	46	24	Steel	Round	6	0	Impact	NA	70	1
					30	Steel	Round	0	6	N/A	Vibratory	N/A	1
3E	5916	Refit Wharf #3	2018	46	24	Steel	Round	6	0	Impact	N/A	70	1
					30	Steel	Round	0	6	N/A	Vibratory	N/A	1
3F	5877	Warping Wharf W/Capstan (4)	2021	46	30	Steel	Round	8	8	Impact	Vibratory	70	4
3G	5926	Tug Pier	2022	30	14	Steel	H	77	77	Impact	Vibratory	60	16
4A	P617	New Facility	2020	35	24	Concrete	Square	165	0	Impact	N/A	200	55
					18	Concrete	Square	50	0	Impact	N/A	80	17
					24	Concrete	Square	0	121	N/A	Vibratory	N/A	8
4B	P617	Small Craft Berth Site VI	2020	35	24	Steel	Round	30	30	Impact	Vibratory	100	8
5	5980	Magnetic Silent Facility (RM14-1710 TRIREFFAC Waterfront Facilities Repair)	2017	46	18	Composite	Round	18	0	Vibratory	N/A	N/A	3
					16	Timber	Round	0	18	N/A	Vibratory	N/A	3
6A	5934	TPS Pier Demolition	2022	46	24	Concrete	Square	0	649	N/A	Vibratory	N/A	41
6B	5977	North Trestle Demolition	2022	46	24	Concrete	Square	0	121	N/A	Vibratory	N/A	6

Table 1-3. Total Piles Installed by Type and Fiscal Year

Pile Material	Pile Shape	Pile Size (in)	FY2017		FY2018		FY2020		FY2021		FY2022		TOTAL	
			Install	Remove	Install	Remove	Install	Remove	Install	Remove	Install	Remove	Install	Remove
Composite	Round	16	2	0	0	0	0	0	0	0	0	0	2	0
Composite	Round	18	18	0	0	0	0	0	0	0	0	0	18	0
Concrete	Square	18	148	0	0	0	50	0	0	0	0	0	198	0
Concrete	Square	24	18	0	0	0	165	121	0	0	3	773	186	894
Steel	H	14	55	0	0	0	0	0	99	99	77	77	231	176
Steel	Round	24	8	2	12	0	24	30	0	0	10	10	54	42
Steel	Round	30	0	6	0	12	0	0	8	8	0	0	8	26
Timber	Round	16	0	179	0	0	0	0	0	0	0	0	0	179
Total piles per fiscal year			**249**	**187**	**12**	**12**	**239**	**151**	**107**	**107**	**90**	**860**	**697**	**1317**
			436		**24**		**390**		**214**		**950**		**2014**	

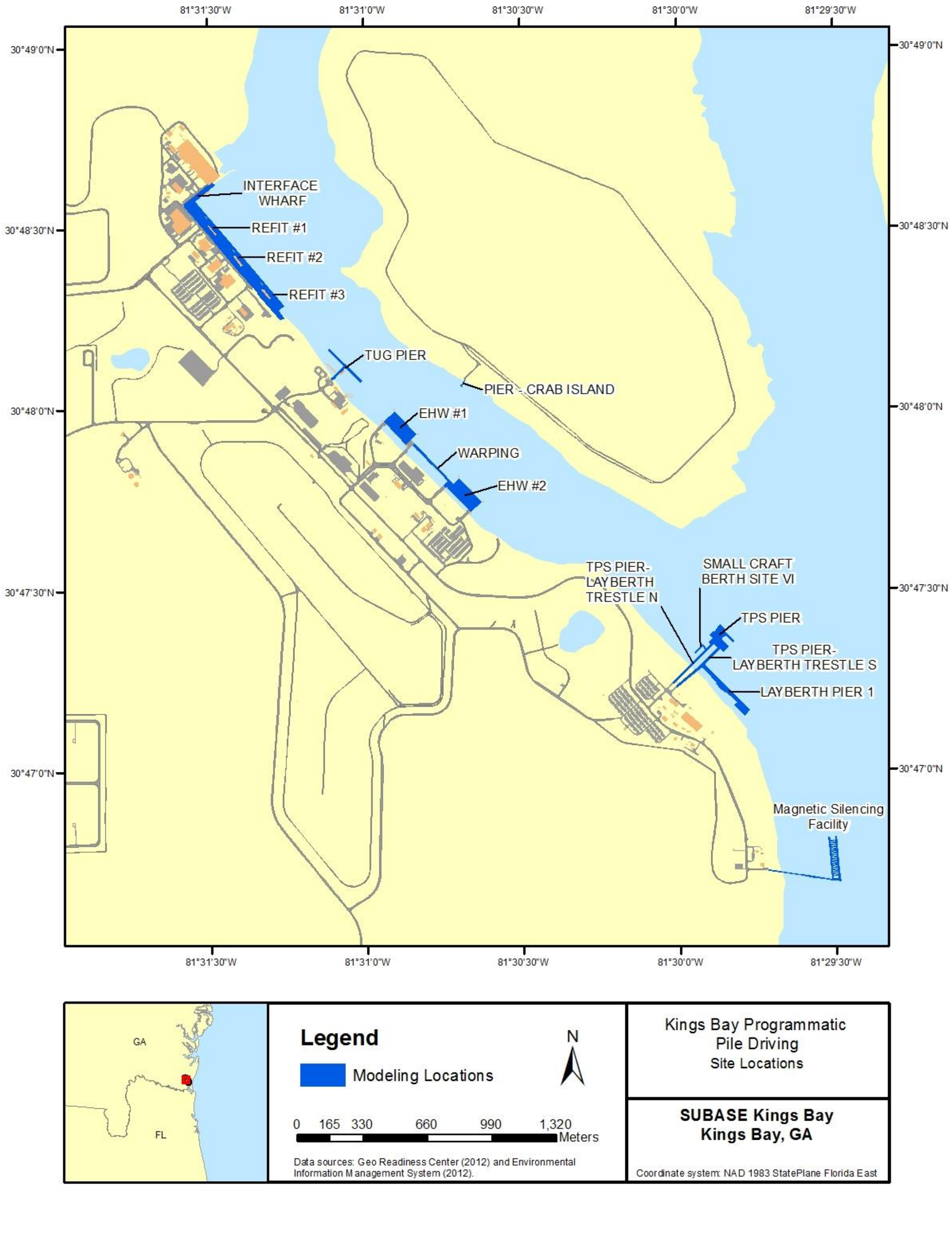

Figure 1-2. Locations of the Proposed Projects

1.2.1 Project 1: Port Operations Waterfront Facilities Repair

In order to maintain the waterfront infrastructure and security required to carry out homeport and refit services to SSBN and SSGN submarines, repairs to the Port Operations Waterfront Facilities are required. Under the Project, structural concrete and steel repairs and corrosion protection is needed on the following waterfront facilities:

- Tug Pier Facility [FAC] #5926 (Project 1A)
- General Access Pier Crab Island FAC #5888 (Project 1B)

1.2.1.1 1A: Tug Pier

The existing Tug Pier is currently operating in a generally dilapidated and unsafe condition. Although several timber piles appear to have recently been replaced, extensive marine borer damage has caused significant loss of pile integrity near the low tide level on 53 older timber fender piles along the inboard (center) side of the pier head and the pier approach. Deterioration and cracking, such as spalling, delamination, and corrosion of internal reinforcing steel are occurring on six concrete piles, 23 concrete pile caps, and 20 square feet of concrete deck underside. Forty-four mooring fittings show areas of coating loss and surface corrosion.

Under the Project, the Tug Pier concrete structural piles, pile caps, headwall, and deck undersides would be repaired. Concrete would be removed to expose the corroded steel reinforcing bars in areas where the concrete has already cracked and spalled, the steel would be repaired or replaced, and the overlying concrete restored. Wooden fender piles would be replaced with concrete piles. The steel reinforcing bars and utility cover grates would be replaced as needed. The fender system on the south side of the access pier would be modified with floats on guide piles to allow mooring of smaller vessels. The concrete base support structures on mooring hardware would be repaired and the mooring hardware would be repainted. All broken and cracked wooden fenders piles and wooden fender piles with wooden guide piles would be replaced with concrete piles

Repairing the Tug Pier would require the installation of 148 new 18-inch square concrete piles, the installation of 18, 24-inch square concrete piles, and the removal of 159 existing 16-inch wood fender piles. The piles would be removed with a vibratory hammer. The concrete piles would be driven by a Delmag Pile Hammer D62-22 or equivalent impact hammer. It is anticipated that five to 16 piles would be removed or installed per day or up to 65 days of in-water work. In-water work is scheduled to begin in Fiscal Year (FY) 17.

1.2.1.2 1B: General Access Pier Crab Island

The Access Pier at Crab Island was impacted by tropical storms in 2012 and the wooden guide piles are damaged. New fiberglass re-enforced plastic composite guide piles with HDPE jackets would be installed at the Access Pier, and the gangplank and handrails would be repaired. Repairing the Access Pier at Crab Island would require the installation of two, 16-inch round composite piles and the vibratory removal of two wooden guide piles. Extraction and installation would both be performed using a vibratory hammer. It is anticipated that an average of two piles would be installed or removed per day for approximately two days of in-water work. In-water work is scheduled to begin in FY17.

1.2.2 Project 2: Unspecified Minor Construction Layberth Fender Pile Modification P661

The Layberth Pier serves the critical functions of weapons loading and unloading, resupply, and maintenance activities for allied vessels visiting SUBASE Kings Bay. The Pier is currently designated as a site for loading Tomahawk missiles in the event weapons loading operations are underway in one of the Explosive Handling Wharves. The loss of the use of this pier would significantly impact SUBASE Kings Bay's ability to berth SSBNs, SSGNs, and foreign vessels. The existing Layberth fenders are currently installed on 5-foot centers (i.e. center of pile to center of pile), and the gaps between the fender piles are too wide to adequately support the necessary fender system.

The Unspecified Minor Construction (UMC) Layberth Fender Pile Modification P661 would provide berthing for the Submarine Group 10 SSGN homeported at SUBASE Kings Bay, berthing for visiting vessels, and overflow berthing for Tridents homeported at SUBASE Kings Bay. By reducing the distance between existing piles by installing additional piles, the pier would provide necessary structural support required for the installation and operation of an upgraded Yokahama pneumatic fender, which is necessary to safely moor submarines.

Upgrading the Layberth pier would require the installation of 55 new 14-inch steel H-piles. No existing piles would need to be removed. The steel piles would be driven by a Delmag Pile Hammer D62-22 or equivalent impact hammer. It is anticipated that an average of eight piles would be installed per day for approximately seven days of in-water work. In-water work is scheduled to begin in FY17.

1.2.3 Project 3: Waterfront Repair and Replacement Maintenance Program

The Waterfront Pile Repair and Replacement Maintenance Program consist of repairing and/or replacing structurally unsound piles along the WRA. This project includes multiple individual projects as follows:

- Explosives Handling Wharf #2, Pier with Capstans (7), FAC #5109 (Project 3A)
- (Dry Dock) Interface Wharf, FAC #5995 (Project 3B)
- Refit Wharf #1, FAC #5909 (Project 3C)
- Refit Wharf #2, FAC #5910 (Project 3D)
- Refit Wharf #3, FAC #5916 (Project 3E)
- Warping Wharf with Capstan (4), FAC #5877 (Project 3F)
- Tug Pier, FAC #5926 (Project 3G)

1.2.3.1 3A: Explosives Handling Wharf #2 Pier with Capstans (7)

The Explosive Handling Wharves at SUBASE Kings Bay serve as covered deep water facilities for the loading and off-loading of munitions and other heavy objects onto submarines. Without this facility in operational condition, the secondary loading location would be the only place for such actions to take place. In the event of a mechanical failure or any other event causing the secondary location to be disabled, munitions or heavy supplies could not be loaded or unloaded from the submarines.

Explosives Handling Wharf #2 displays significant deterioration of a non-rated cleat mooring fitting on the diver's float, various HDPE fender pile wraps, sacrificial anodes attached to the steel fender piles, steel safety ladders and treated timber bracing; damaged reinforced concrete on various pile caps, piles, and mooring foundations. Likewise, mooring fittings and two steel guide pipe piles on the diver's float require cleaning and repainting.

Upgrading Explosives Handling Wharf #2 would require the installation of two new 24-inches round steel piles and the removal of two guide piles. The piles would be removed with a vibratory hammer. The steel piles would be driven by a Delmag Pile Hammer D62-22 or equivalent impact hammer. It is anticipated two piles would be installed or removed per day for approximately two days of in-water work.

Additional future repair projects at this location may include the installation of three, 24-inch square concrete and ten, 24-inch round steel piles and the removal of three dolphin piles and ten fender piles. The piles would be removed and installed as described in the above paragraph. For the second phase, it is anticipated that three to eight piles would be removed or installed per day or up to nine days of in-water work. The in-water work is scheduled to begin in FY22.

1.2.3.2 3B: (Dry Dock) Interface Wharf

The Interface Wharf serves as a loading and unloading for the submarine fleet as well as a service and storage wharf for non-dry-dock repairs and maintenance. Without this facility in operational condition, other refit wharves or the dry dock would have to be used to complete such tasks.

The existing Interface Wharf is increasingly deteriorating. Marine borer damage and subsequent peeling and rot are documented on 96 timber fender piles at and below mean high water (MHW). Fifteen linear feet of timber wale at the curb elevation has impact and rot damage. Spalled concrete occurs at one location on the bullrail corner, on one mooring foundation, on one location on the deck at the handrail attachment, and on two linear feet of the beam seat on the east side of the dry dock gate. All steel fender piles show areas of surface corrosion within and immediately above the tidal zone. (Visual examination and ultrasonic thickness testing indicates the steel piles have up to 0.25-inch of rust scale; the actual loss of steel is less than 0.125-inch loss of actual steel thickness.)

Under the Project, the timber fender bearing strips and wales would be replaced, and the concrete deck, bullrail, edge beams, and mooring foundations would be repaired. Additionally, the steel H Pile fender system would be repaired and painted. Cathodic protection would be recoated on the steel H Pile fender system and sheet pile.

Repairing the Interface Wharf would require the installation of 99 new 14-inch steel H-piles and removal of 99 existing 14-inch steel H-piles. The piles would be removed with a vibratory hammer. The steel piles would be driven by a Delmag Pile Hammer D62-22 or equivalent impact hammer. It is anticipated that an average of 14 piles would be removed or installed per day for approximately 15 days of in-water work. The in-water work is scheduled to begin in FY21.

1.2.3.3 3C: Refit Wharf 1

Refit Wharfs 1, 2, and 3 provide storage and maintenance services to Trident Submarines and others as requested, including incremental overhaul, modernization, and repair support. All three Refit Wharfs are in disrepair and present a safety risk to the personnel and heavy equipment utilizing the pier; in certain areas, it is recommended that vehicles, mobile cranes, storage and any other heavy loads be prohibited from within the areas supported by deteriorated pile cap locations to limit the possibility of further damage or structural failures. Without the wharves in operational condition, submarines would need to be docked at other locations for repairs, reducing the operational efficiency of Kings Bay maintenance mission, extending the length of vessel docking times, and creating congestion with other vessels already in port.

Refit Wharf 1 displays damaged steel beams supporting the outboard access walkway; damaged reinforced concrete on various pile caps, piles, and the outboard edge beam. Likewise, several mooring fittings require repair, cleaning, and painting.

Repairing Refit Wharf 1 would require the installation of six, 24-inch round steel guide piles and the removal of six existing 30-inch fender piles. The piles would be removed with a vibratory hammer. The steel piles would be driven by a Delmag Pile Hammer D62-22 or equivalent impact hammer. It is anticipated that an average of six piles would be removed or installed per day for approximately two days of in-water work. The in-water work is scheduled to begin in FY18.

1.2.3.4 3D: Refit Wharf 2

Refit Wharf 2 displays broken steel beams supporting the outboard access walkway and damaged reinforced concrete on various pile caps, piles, outboard edge beams, and mooring foundations. Additionally, some of the underdeck lighting conduit is detached and various mooring fittings require cleaning and repainting.

Repairing Refit Wharf 2 would require the installation of six, 24-inch round steel guide piles and the removal of six existing 30-inch fender piles. The piles would be removed with a vibratory hammer. The steel piles would be driven by a Delmag Pile Hammer D62-22 or equivalent impact hammer. It is anticipated that an average of six piles would be removed or installed per day for approximately two days of in-water work. The in-water work is scheduled to begin in FY17.

1.2.3.5 3E: Refit Wharf 3

Refit Wharf 3 displays broken steel beams supporting the outboard access walkway and damaged reinforced concrete on various pile caps, piles, the outboard edge beams, and mooring foundations. Likewise, the mooring fittings require cleaning and painting.

Repairing Refit Wharf 3 would require the installation of six, 24-inch round steel guide piles and the removal of six, 30-inch fender piles. The piles would be removed with a vibratory hammer. The steel piles would be driven by a Delmag Pile Hammer D62-22 or equivalent impact hammer. It is anticipated that an average of six piles would be removed or installed per day for approximately two days of in-water work. The in-water work is scheduled to begin in FY18.

1.2.3.6 3F: Warping Wharf with Capstan (4)

The Warping Wharf serves as a non-covered extension of the inboard leg of the Explosives Handling Wharfs used for aligning submarines prior to berthing in the covered facilities. This facility provides for quick transfer from one Explosives Handling Wharf to the other, as well as protection for the submarines as there is a continuous barrier beside the submarine and attached capstans during docking. The Warping Wharf also functions as a berthing facility for Fleet Ballistic Cargo Ships.

Deterioration at the Warping Wharf includes various degraded HDPE fender pile wraps and damaged reinforced concrete on various pile caps, piles, and mooring foundations. Likewise, the mooring fittings require cleaning and painting.

Repairing the Warping Wharf would require the installation of eight, 30-inch round steel piles and the removal of eight existing fender piles. The piles would be removed with a vibratory hammer. The steel piles would be driven by a Delmag Pile Hammer D62-22 or equivalent impact hammer. It is anticipated that an average of five piles would be removed or installed per day for approximately four days of in-water work. The in-water start work is scheduled to begin in FY21.

1.2.3.7 3G: Tug Pier

Although this location is also discussed in Project 1A, additional future repair projects at this location may include the installation of 77 new 14-inch steel H-piles and removal of 77 existing steel fender piles. The piles would be removed with a vibratory hammer. The steel piles would be driven by a Delmag Pile Hammer D62-22 or equivalent impact hammer. It is anticipated that an average of 10 piles would be removed or installed per day for approximately 16 days of in-water work. The in-water work is scheduled to begin in FY22.

1.2.4 Project 4: Transit Protection System Off-Shore Supply Vessel Berthing Modification Project

This project includes the construction of a new pier associated with TPS functions, and the modification of the existing berthing pier on the north trestle at Site VI to comply with current DOD and Navy security directives.

- New Facility, P617 (Project 4A)
- Small Craft Berth Site VI, P617, FAC #5936 (Project 4B)

1.2.4.1 4A: New Facility P617

The new TPS pier would be provided with full hotel service capability including power, potable water, fire protection, wastewater, Ship Overboard Drainage (SOD) collection, fuel, and telecommunications (i.e., telephone, cable, and Local Area Network [LAN] services). The construction of the new pier would require the installation of 165 new 24-inch square concrete piles and 50 new 18-inch square concrete piles. Approximately 121 piles would be removed with a vibratory hammer. The steel piles would be driven by a Delmag Pile Hammer D62-22 or equivalent impact hammer. It is anticipated 16 to 22 piles would be removed and three to 12 piles would be installed per day for approximately 80 days of in-water work. The in-water work is scheduled to begin in FY20.

1.2.4.2 4B: Small Craft Berth Site VI P617

The existing berthing pier on the north trestle at Site VI would be relocated to align with the new pier associated with the proposed TPS Operational Facility and modified to accommodate two OSVs, two 87-foot Coast Guard Cutters (CGC), six 33-foot long Screening Vessels (SVs), and six 72-foot long SVs in accordance with current DOD and Navy security directives. The berthing pier would consist of a pile-supported, reinforced concrete structure including floating sections to berth the smaller craft. Two, 5,000 gallon horizontal, protected above-ground storage tanks and two associated truck off-loading connections (one for each tank) and fuel dispensing units for refueling the U.S. Coast Guard escort vessels would be installed.

As with the new trestle described in Project 4A, the floating berthing slips would be provided with full hotel services. Drainage water from the piers would be collected, run through oil-water separators, and then disposed through existing sewage connections. The modification of the small craft berthing site associated with the TPS Pier would require the installation of 30 new 24-inch round steel piles and the removal of 30 existing piles. The piles would be removed with a vibratory hammer. The steel piles would be driven by a Delmag Pile Hammer D62-22 or equivalent impact hammer. It is anticipated that an average of eight piles would be installed or removed per day for approximately eight days of in-water work. The in-water work is scheduled to begin in FY20.

1.2.5 Project 5: RM14-1710 TRIREFFAC Waterfront Facilities Repair, Magnetic Silencing Facility with Cranes

The Magnetic Silencing Facility (MSF) serves as a degaussing (process of decreasing or eliminating a remnant magnetic field) station for Trident Submarines. During normal oceanic operations ships and submarines naturally build up a magnetic signature, which can be visible and exploitable by enemy craft as well as damaging to sensitive equipment aboard the ship. The earth's magnetic fields between the North and South Poles are being crossed routinely at sea, and while either traversing these natural fields or lying dormant for extended periods of time during scheduled maintenance, a vessel's magnetic signature changes. To minimize the level of permanent magnetism, the MSF treatment slip is the first structure vessels encounter on their way into or out of SUBASE Kings Bay facilities.

The MSF at Kings Bay is in a deteriorated condition. Deterioration includes a broken 5-linear foot aluminum utility tray, one fender system restraining chain, and one utility guide bracket. Marine borer damage is occurring on one timber fender pile at and below MLW. The concrete underdeck has a 6-linear foot crack (0.125-inch wide).

The Project would replace the MSF and MSF trestle timber fender piles, restraining chains, aluminum utility tray, and concrete pile utility guide bracket. Wooden hand rails and the cracked concrete deck underside would be repaired. Repairing the MSF and MSF trestle would require the vibratory removal of 18 existing timber piles, and the installation of 18 new 18-inch round composite piles. The fiberglass re-enforced plastic composite piles would be driven by a vibratory hammer. It is anticipated that an average of six piles would be installed per day for approximately three days of in-water work. The in-water work is scheduled to begin in FY17.

1.2.6 Project 6: Demolition Project using Restoration Modernization Funds: TPS Pier and North Trestle

As part of this project, the existing TPS Pier and the North Trestle would be demolished. The North Trestle and TPS Pier were designed to meet the short-term need to moor a floating dry dock and med-moor (moor using a bow anchor and stern lines to attach to the dock) a submarine tender for Poseidon Class submarines. Demolition work described below includes removal of pier decks, pile caps, and piles. This work will be accomplished using barge mounted cranes. There is no dredging associated with the proposed action, and no other in-water work will occur during demolition.

- Demolition of the TPS Pier, FAC #5934 (Project 6A)
- Demolition of the North Trestle, FAC #5977 (Project 6B)

1.2.6.1 6A: Demolition of the TPS Pier

Demolition of the TPS pier would require the vibratory removal of 649 existing 24-inch square concrete piles. It is anticipated that an average of 16 piles would be removed per day for approximately 41 days of in-water work. The in-water work is scheduled to begin in FY22.

1.2.6.2 6B: Demolition of the North Trestle

The trestle was intended as an interim fix during the transition to the newer Ohio Class submarines as the Poseidon Class submarines were decommissioned. The facility is obsolete, in poor condition, and cannot meet any current or future mission needs cost effectively. Demolition of the Layberth North trestle would require the removal of 121 existing 24-inch square concrete piles. The piles would be removed with a vibratory hammer. It is anticipated that an average of 20 piles would be removed per day for approximately six days of in-water work.

2 DURATION AND LOCATION OF ACTIVITIES

The dates and duration of such activity and the specific geographical region where it will occur.

SUBASE Kings Bay is located in the southeastern corner of Georgia, eight miles north of the Georgia-Florida border, approximately four miles inland (straight line distance) from the Atlantic Ocean, and approximately two miles north of St. Mary's, Georgia, along the western shore of Cumberland Sound (Figure 2-1). The approximate 16,000-acre installation provides berthing and support services to naval submarines and other assets. The entirety of SUBASE Kings Bay, including the land areas and adjacent water areas along Kings Bay and Cumberland Sound between Marianna Creek to the north and Mill Creek to the south, is restricted from general public access.

SUBASE Kings Bay is an estuarine environment, receiving salt water input from ocean waters through tidal exchange, and fresh waters input from rivers, tributaries, and stormwater outfalls. Water temperature ranges from 54°F in winter to a high of 85 °F in summer (NOAA 2015). The large tidal range and strong currents result in tidally mixed waters that are refreshed on a daily basis.

The Kings Bay submarine channel is regularly maintenance-dredged and has fairly uniform depths of -45 feet mean lower low water. The submarine channel is depositional with fine-grained sediment, accumulation of organic matter, and reduced DO (Pinckard and Morris 2005, 2006). Benthic invertebrate communities within the channel are characterized as moderately to highly degraded due to the presence of low DO or methane bubbles indicative of anoxic conditions and presence of only opportunistic early succession organisms (e.g., species capable of quickly colonizing disturbed sites).

Channel maintenance results in a relatively narrow intertidal zone along most of the shoreline. The north end of Kings Bay is not dredged beyond the turning basin and abruptly transitions to shallow subtidal and intertidal habitat, with fine sands predominant in the channel and finer-grained silts and clays in marsh creeks. Shallow subtidal and intertidal habitat areas also occur along the northwestern and southwestern shoreline of Crab Island, and along the southern shoreline of the base between the south end of the developed waterfront area and the Magnetic Silencing Facility. These areas have a predominance of fine sands in more exposed locations (i.e., close to open channel) and silts and clays in more protected locations.

The Project would begin in fiscal year (FY) 2017, with construction continuing through FY 2022. Projects would occur at specific facilities on the installation, shown in Figure 1-2. Construction could occur year-round. While impact and vibratory driving / extraction may occur interchangeably thoughout a given day of construction, no simultaneous (i.e., two drivers operating at the same time) would take place.

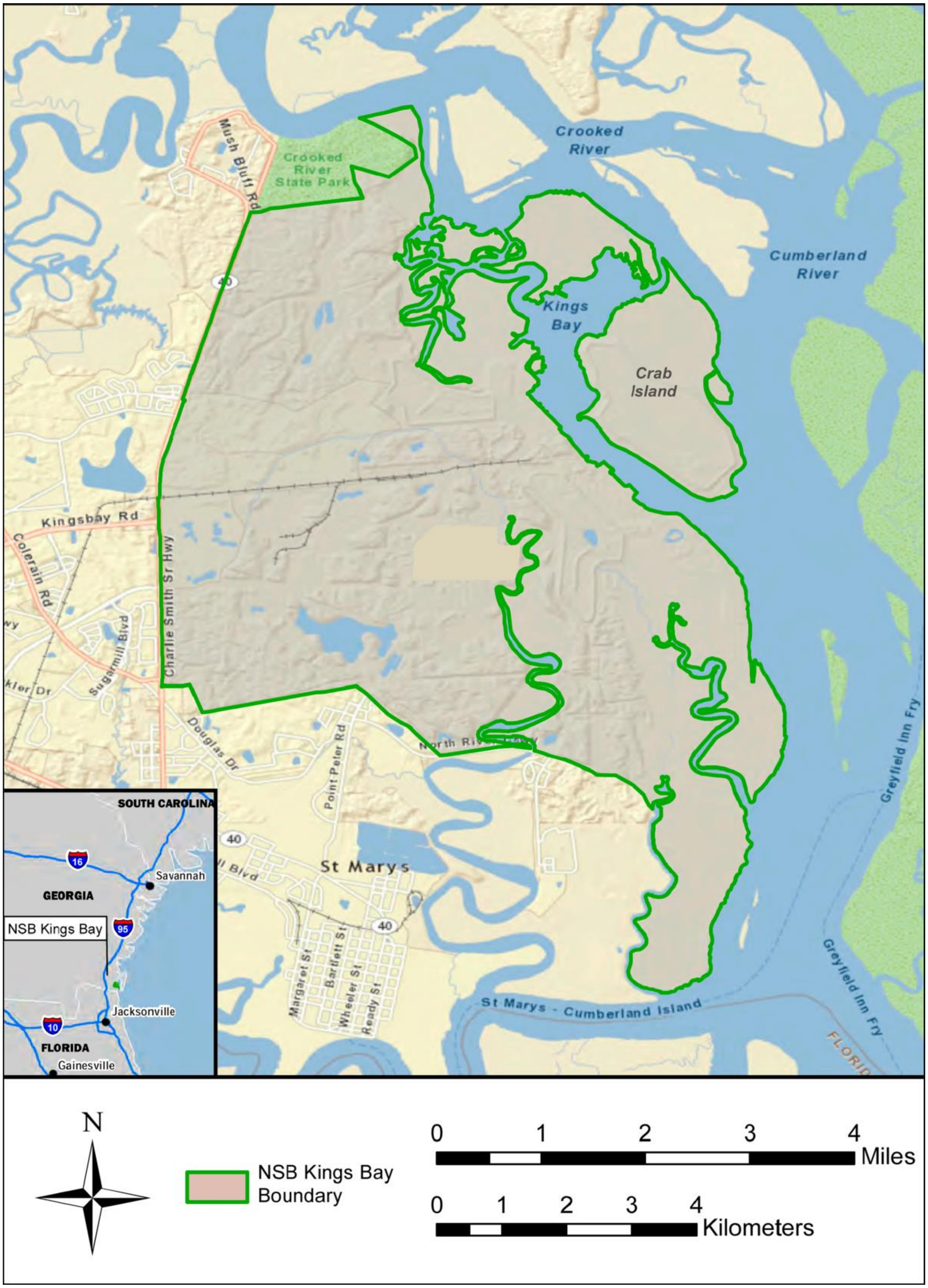

Figure 2-1. SUBASE Kings Bay Location Map

3 MARINE MAMMAL SPECIES AND NUMBERS

The species and numbers of marine mammals likely to be found within the activity area

The Navy has reviewed marine mammal species occurring in the western Atlantic along the east coast of southern Georgia and northern Florida, and has determined that only bottlenose dolphins (*Tursiops truncatus*) and West Indian manatees (*Trichechus manatus*) may occur in the vicinity of the Project (Table 3-1). The West Indian manatee, while protected under the MMPA, is not regulated by NMFS and therefore is not considered further in this application. The responsible regulator for manatees is the U.S. Fish and Wildlife Service (USFWS). USFWS has promulgated guidance for protecting manatees occurring in the vicinity of near shore construction. The Navy and its contractors shall comply with the conditions intended to protect manatees from in-water work as outlined in Appendix A.

Bottlenose dolphin density was calculated based on surveys of the Kings Bay region during 2006 – 2007 (U.S. Department of the Navy 2009).

Table 3-1. Species Potentially Occurring in the Project Area

Species and Estimated Density	Stock	Occurrence[1] and Abundance Best (CV) / MIN	STATUS	
			MMPA[2]	ESA
bottlenose dolphin 1.12 / km^2	Southern Georgia Estuarine System	Likely – year round 194 (0.05)/185[2]	Strategic Stock	n/a
	Western North Atlantic South Carolina-Georgia Coastal Stock	Likely – year round 4,377 (0.43) / 3,097[2]	Strategic Stock (depleted)	n/a
	Western North Atlantic Offshore	Extralimital 77,532 (0.40) / 56,053[2]	n/a	n/a
	Western North Atlantic Northern Florida Coastal	Rare – year round 1,219 (0.67) / 730[2]	Strategic Stock	n/a
	Jacksonville Estuarine System	Extralimital- year round, numbers may be slightly lower in winter unknown / unknown[2]	Strategic Stock	n/a
	Western North Atlantic Southern Migratory Coastal	Seasonal - January to March 9,173 (0.46) / 6,326[2]	Strategic Stock	n/a

Sources: U. S. Department of the Navy 2009; [1]Extralimital: there may be a small number of sighting or stranding records, but the activity area is outside the species' range of normal occurrence; Rare: there may be a few confirmed sightings, or the distribution of the species is near enough to the area of concern that the species could occur there; the species may occur but only infrequently or in small numbers; Likely: confirmed and regular sightings of the species occur year-round; [2]Waring et al. 2014

4 AFFECTED SPECIES STATUS AND DISTRIBUTION

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities.

Bottlenose Dolphin

Bottlenose dolphins occurring in the waters of SUBASE Kings Bay may be individuals belonging to any of the following stocks: the Southern Georgia Estuarine System Stock; the Western North Atlantic South Carolina-Georgia Coastal Stock; the Western North Atlantic Southern Migratory Coastal Stock; the Western North Atlantic Northern Florida Coastal stock; and extralimitally, the Western North Atlantic Offshore Stock and the Jacksonville Estuarine System stock.

Along the Atlantic coast of the U.S., where the majority of detailed work on bottlenose dolphins has been conducted, male and female bottlenose dolphins reach physical maturity at 13 years, with females reaching sexual maturity as early as seven years (Mead and Potter 1990). Bottlenose dolphins are flexible in their timing of reproduction. Seasons of birth for bottlenose dolphin populations are likely responses to seasonal patterns of availability of local resources (Urian et al. 1996). Thayer et al. (2003) found bottlenose dolphins in North Carolina to exhibit a strong calving peak in spring, particularly May and June, and a diffuse peak from late spring to early fall. There is a gestation period of one year (Caldwell and Caldwell 1972). Calves are weaned as early as one and a half years of age (Reynolds et al. 2000), and typically remain with their mothers for a period of three to eight years (Wells et al. 1987), although longer periods are documented (Reynolds et al. 2000). There are no specific breeding locations for this species.

Dive durations as long as 15 min are recorded for trained individuals (Ridgway et al. 1969). Typical dives, however, are shallower and have a much shorter duration. Mean dive durations of Atlantic bottlenose dolphins typically range from 20 to 40 seconds at shallow depths (Mate et al. 1995).

Bottlenose dolphins typically occur in groups of 2 – 15 individuals, but significantly larger groups have also been reported (Shane et al. 1986; Kerr et al. 2005). Coastal bottlenose dolphins typically exhibit smaller group sizes than larger forms, as water depth appears to be a significant influence on group size (Shane et al. 1986). Shallow, confined water areas typically support smaller group sizes, some degree of regional site fidelity, and limited movement patterns (Shane et al. 1986; Wells et al. 1987).

An Unusal Mortality Event (UME) was declared for bottlenose dolphins along the Atlantic Coast between New York and Florida starting in July 2013, and is considered ongoing. Preliminary testing has indicated that the elevated numbers of stranded dolphins is likely due to cetacean morbillivirus, a disease which may affect the lungs and brain of infected individuals (National Marine Fisheries Service 2015). Strandings have been reported through 12 July 2015; as of that time, 103 bottlenose dolphins had stranded in the state of Georgia since 1 July 2013. While no individuals have been found stranded at SUBASE Kings Bay, 31 dolphins have been found along the ocean shore of Cumberland Island, five of these with confirmed morbillivirus infections (National Marine Fisheries Service 2015).

There are two genetically and morphologically distinct common bottlenose dolphin morphotypes described as the coastal and offshore forms (Waring et al. 2014). Offshore bottlenose dolphins are considered extralimital in the action area because they are primarily found along the outer continental shelf and slope; however, they have appeared in the stranding records (Waring et al. 2014).

Prior to 2009, coastal bottlenose dolphins were managed as one stock, the Western North Atlantic Coastal Stock (Waring et al. 2014). In 2009, this stock was split into multiple stocks based on genetic and photo identification studies. Additionally, genetic and photo-identification studies showing a distinct difference between animals inhabiting coastal waters near the shore, and those inhabiting bays, sounds, and estuaries prompted several estuarine stocks to be named (Waring et al. 2014). The stocks considered likely within the action area are the Southern Georgia Estuarine System Stock, and the Western North Atlantic South Carolina-Georgia Coastal Stock. The stock most likely to be present within the action area is the Southern Georgia Estuarine System Stock, because the stock boundaries encompass the action area, and the animals within this stock are thought to exhibit high site fidelity based on their contaminant loads (Waring et al. 2014). The Western North Atlantic South Carolina-Georgia stock is primarily found in the coastal waters outside the action area, but could enter the neighboring bays and estuaries including the action area. The Western North Atlantic Northern Florida Coastal Stock is considered rare because the Northern boundary of the stock is the Georgia/Flordida line, however these animals could potentially enter the action area. The Jacksonville Estuarine System (JES) stock is considered extralimital because while Jacksonville is close enough for animals to be able to reasonably travel to Kings Bay, photo-ID studies have shown that 96% of the animals within the northernmost area of the JES stock boundary have only been seen within the Jacksonville estuary system and exhibit yearround site fidelity (Waring et al. 2014), so it is unlikely that these animals would enter the Kings Bay estuarine system. The Western North Atlantic Southern Migratory Coastal stock has a seasonal presence in the coastal waters of Georgia during winter (Waring et al. 2014) and could potentially enter the action area.

Surveys performed at SUBASE Kings Bay have shown that bottlenose dolphins in the vicinity of the action area occur in groups (range of 1 – 11 animals), pairs, and individually (U.S.

5 TAKE AUTHORIZATIONS REQUESTED

The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury, and/or death), and the method of incidental taking.

Under the 1994 Amendments to the MMPA, harassment is statutorily defined as, any act of pursuit, torment, or annoyance which:

- **Level A Harassment** has the potential to injure a marine mammal or marine mammal stock in the wild; or,
- **Level B Harassment** has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild (National Marine Fisheries Service 2013).

The marine mammal density data used for this analysis was determined from surveys conducted at SUBASE Kings Bay between 2006 and 2007 (U.S. Department of the Navy 2009). While a number of stocks have been identified as occurring or possibly occurring in this area (see Chapters 3 and 4), it is not currently possible to determine which stock an affected individual belongs to or to estimate take numbers based on stocks. The Navy therefore uses a single year-round average site-specific density for all bottlenose dolphin stocks occurring at SUBASE Kings Bay.

The full methods and data used for density calculations are given in U.S. Department of the Navy 2009. A brief summary is given here. Transect lines were run in the waters around SUBASE Kings Bay during summer and fall 2006 and during winter and spring 2007. The survey area included estuarine waters extending from the mouth of the St. Marys River north through the Cumberland Sound to approximately 8 nautical miles inland along the Satilla River. The Crooked River and the Brickhill River, which flow into Cumberland Sound, were also part of the study area, though line transects were not possible in these locations, and census counts were substituted here. The geographic limits ranged from 30°40’ N to 31°00’ N and inland limits to 81°40’ W. Nearshore Atlantic waters were not included in the surveys.

Observations were made with 7x50 power binoculars and with the naked eye, scanning from 0º to 90º relative to the vessel’s line of travel, and reported sightings, radial distance, angle, and number of individuals to the data recorder. For census count areas, the vessel was driven along the center line of the river and distance and angle to sightings were noted. Distance 5.0® was used to analyze the collected data, including area surveyed (in km^2), and calculate a seasonal density. Seasonal densities were combined to calculate the average annual density of 1.12 dolphins per km^2.

The density of bottlenose dolphins, which are the only cetacean found in the Project Area, was estimated to be 1.12 / km^2 (U.S. Navy 2009) based on prior survey results. The estimated number of exposures that could result for the five year period of construction for the Project from 2017 -

2022 is summarized in Table 5-. Takes are divided by year of the Project and by individual projects within years. Total numbers of takes are summarized in Table 5-2.

The density of each species was multiplied by the size of the relevant zone of influence to determine the estimated number of exposures per day. This number was rounded to the nearest whole number and multiplied by the estimated number of pile-driving days to calculate takes for the entire Project. The Navy is requesting authorization for a total of 0 Level A and 845 Level B (behavioral) incidental takes of bottlenose dolphins due to acoustic impacts from pile driving, over the course of the Project (Table 5-3). Exposures may be to any age / reproductive class of the species. No incidental takes are requested for any other marine mammal species.

Methods for developing the incidental take estimate are detailed in Chapter 6.

Table 5-1. Estimated Marine Mammal Exposures from Vibratory Pile Driving by Fiscal Year

Project			Species	Density (per km^2)	Calculated Exposures		Totals
Map ID	FAC#	Name			Level A	Level B	
Beginning in FY 2017[1]							
1A	5926	Tug Pier	bottlenose dolphin	1.12	0	124	124
1B	5888	General Access Pier Crab Island			0	6	6
2	5976	UMC Layberth Fender Pile Modification			N/A	N/A	N/A
3A	5109	EHW #2			0	4	4
3D	5910	Refit Wharf #2			0	4	4
5	5980	Magnetic Silencing Facility			0	36	36
Beginning in FY 2017 Calculated Vibratory Exposure Totals					0	174	174
Beginning in FY 2018[1]							
3C	5909	Refit Wharf #1	bottlenose dolphin	1.12	0	4	4
3E	5916	Refit Wharf #3			0	4	4
Beginning in FY 2018 Calculated Vibratory Exposure Totals					0	8	8

Table 5-1. Estimated Marine Mammal Exposures from Vibratory Pile Driving by Fiscal Year (*continued*)

Project			Species	Density (per km^2)	Calculated Exposures		Totals
Map ID	FAC #	Name			Level A	Level B	
Beginning in FY 2017[1]							
4A	P617	New Facility	bottlenose dolphin	1.12	0	64	64
4B	P617	Small Craft Berth Site VI			0	32	32
Beginning in FY 2020 Calculated Vibratory Exposure Totals					0	96	96
Beginning in FY 2021[1]							
3B	5995	(Dry Dock) Interface Wharf	bottlenose dolphin	1.12	0	21	21
3F	5877	Warping Wharf W/Capstan (4)			0	8	8
Beginning in FY 2021 Calculated Vibratory Exposure Totals					0	29	29
Beginning in FY 2022[1]							
3A	5109	EHW #2	bottlenose dolphin	1.12	0	4	4
					0	12	12
3G	5926	Tug Pier			0	32	32
6A	5934	TPS Pier Demolition			0	410	410
6B	5977	North Trestle Demolition			0	60	60
Beginning in FY 2022 Calculated Vibratory Exposure Totals					0	518	518
5-YEAR VIBRATORY CALCULATED EXPOSURE TOTALS					**0**	**825**	**825**

Sources: U.S. Department of the Navy 2009

[1] Work that begins in one fiscal year may continue into the following fiscal year; however, since exact project start dates are not available at this time, the takes resulting from each project are assumed to occur duing the fiscal year in which a given project starts.

Table 5-2. Estimated Marine Mammal Exposures from Impact Pile Driving by Fiscal Year

PROJECT			SPECIES	DENSITY (per km^2)	CALCULATED EXPOSURES		TOTALS
ID	FAC#	Project Name			Level A	Level B	
Beginning in FY 2017[1]							
1A	5926	Tug Pier	bottlenose dolphin	1.12	0	0	0
					0	0	0
1B	5888	General Access Pier Crab Island			N/A	N/A	N/A
2	5976	UMC Layberth Fender Pile Modification			0	0	0
3A	5109	EHW #2			0	1	1
3D	5910	Refit Wharf #2			0	1	1
5	5980	Magnetic Silencing Facility			N/A	N/A	N/A
Beginning in FY 2017 Calculated Impact Exposure Totals					0	2	2
Beginning in FY 2018[1]							
3C	5909	Refit Wharf #1	bottlenose dolphin	1.12	0	1	1
3E	5916	Refit Wharf #3			0	1	1
Beginning in FY 2018 Calculated Impact Exposure Totals					0	2	2
Beginning in FY 2019[1] – No Scheduled Work							
Beginning in FY 2020[1]							
4A	P617	New Facility	bottlenose dolphin	1.12	0	0	0
4B	P617	Small Craft Berth Site VI			0	8	8
Beginning in FY 2020 Calculated Impact Exposure Totals					0	8	8

Sources: U.S. Department of the Navy 2009

[1] Work that begins in one fiscal year may continue into the following fiscal year; however, since exact project start dates are not available at this time, the takes resulting from each project are assumed to occur duing the fiscal year in which a given project starts.

Table 5-2. Estimated Marine Mammal Exposures from Impact Pile Driving by Fiscal Year (*continued*)

PROJECT			SPECIES	DENSITY (per km^2)	CALCULATED EXPOSURES		TOTALS
ID	FAC#	Project Name			Level A	Level B	
Beginning in FY 2021[1]							
3B	5995	(Dry Dock) Interface Wharf	bottlenose dolphin	1.12	0	0	0
3F	5877	Warping Wharf W/Capstan (4)			0	4	4
Beginning in FY 2021 Calculated Impact Exposure Totals					0	4	4
Beginning in FY 2022[1]							
3A	5109	EHW #2	bottlenose dolphin	1.12	0	0	0
					0	4	4
3G	5926	Tug Pier			0	0	0
6A	5934	TPS Pier Demolition			N/A	N/A	N/A
6B	5977	North Trestle Demolition			N/A	N/A	N/A
Beginning in FY 2022 Calculated Impact Exposure Totals					0	4	4
5-YEAR IMPACT CALCULATED EXPOSURE TOTALS					**0**	**20**	**20**

Sources: U.S. Department of the Navy 2009

[1] Work that begins in one fiscal year may continue into the following fiscal year; however, since exact project start dates are not available at this time, the takes resulting from each project are assumed to occur duing the fiscal year in which a given project starts.

Table 5-3. Estimated Marine Mammal Exposures by Fiscal Year and Pile Driving Method

Fiscal Year	Species (density)	Vibratory		Impact		Exposure totals
		Level A	Level B	Level A	Level B	
FY 2017	Bottlenose dolphin ($1.12 / km^2$)	0	174	0	2	176
FY 2018		0	8	0	2	10
FY 2019		0	0	0	0	0
FY 2020		0	96	0	8	104
FY 2021		0	29	0	4	33
FY 2022		0	518	0	4	522
Estimated total exposures by method		0	825	0	20	
Total Level A exposures						0
Total Level B exposures						845
Total exposures (entire Project)						845

6 NUMBERS AND SPECIES TAKEN

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in Section 5, and the number of times such takings by each type of taking are likely to occur.

The methods for estimating the number and types of exposure are described in the sections below, followed by the method for quantifying exposures of marine mammals to sources of energy exceeding those threshold values. Exposure of each was determined by:

- The potential of each species to be impacted by the acoustic sources as determined by the acoustic criterion for marine mammals.
- The potential presence of each species and their estimated density in the zone of influence for the Project.
- The area of impact for each pile driving sound source (estimated by taking into account the source levels, propagation loss and thresholds at which each acoustic criterion are met).

Potential exposures were calculated by multiplying the density of each marine mammal species potentially present by the total impacted area for each threshold value by the potential number of days of pile driving.

An introduction to the fundamentals of acoustics and use of the decibel unit can be found in Appendix B.

Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic source and the potential effects that sound may have on the animal's physiology and behavior. Although it is known that sound is important for marine mammal communication, navigation, and foraging (National Research Council 2003, 2005), there are many unknowns in assessing impacts such as the potential interaction of different effects and the biological significance of responses by marine mammals to sound exposures (Nowacek et al. 2007; Southall et al. 2007). Furthermore, many factors other than the received level of sound may affect an animal's reaction, such as the animal's physical condition, prior experience with the sound, and proximity to the source of the sound (Nowacek et al. 2007).

Acoustically-mediated behaviors, including social interactions, foraging, and navigation, may be particularly vulnerable to disturbance during pile-driving activities, and it is important to understand the source characteristics of marine mammal vocalizations in order to address potential masking (see Appendix B) and disturbance. The following sections address hearing and sound production of all marine mammals that may be present in the Project Area during pile driving.

6.1 HEARING AND VOCALIZATION FOR BOTTLENOSE DOLPHINS

Bottlenose dolphins can typically hear within a broad frequency range of 200 Hz to 160 kHz (Au 1993; Turl 1993), though with exposure during testing some dolphins might receive information as low as 50 Hz (Turl 1993). Electrophysiological experiments suggest the bottlenose dolphin brain has a dual analysis system: one specialized for ultrasonic clicks and another for lower-frequency sounds, such as whistles (Ridgway 2000). Scientists have reported a range of highest sensitivity between 25 and 70 kHz, with peaks in sensitivity at 25 and 50 kHz (Nachtigall et al. 2000). Recent research on the same individuals indicates auditory thresholds obtained by electrophysiological methods correlate well with those obtained in behavior studies, except at the some lower (10 kHz) and higher (80 and 100 kHz) frequencies (Finneran and Houser 2006).

Sounds emitted by bottlenose dolphins have been classified into two broad categories: pulsed sounds (including clicks and burst-pulses) and narrow-band continuous wave sounds (whistles), which usually are frequency modulated. Clicks and whistles have dominant frequency ranges of 110 to 130 kHz and source levels of 218 to 228 dB re 1 μPa-m (Au 1993) and 3.4 to 14.5 kHz and 125 to 173 dB re 1 μPa-m, respectively (Ketten 1998). Whistles are primarily associated with communication and can serve to identify specific individuals (i.e., signature whistles) (Caldwell and Caldwell 1965; Janik et al. 2006). Up to 52% of whistles produced by bottlenose dolphin groups with mother-calf pairs have been classified as signature whistles (Cook et al. 2004).

Sound production is also influenced by group type (single or multiple individuals), habitat, and behavior (Nowacek 2005). Bray calls (low-frequency vocalizations; majority of energy below four kHz), for example, are used when capturing fishes, specifically sea trout (*Salmo trutta*) and Atlantic salmon (*Salmo salar*), in some regions (i.e., Moray Firth, Scotland) (Janik 2000). Additionally, whistle production has been observed to increase while feeding (Acevedo-Gutiérrez and Stienessen 2004; Cook et al. 2004). Both whistles and clicks have been demonstrated to vary geographically in terms of overall vocal activity, group size, and specific context (e.g., feeding, milling, traveling, and socializing) (Jones and Sayigh 2002; Zaretsky et al. 2005; Baron 2006). For example, preliminary research indicates characteristics of whistles from populations in the northern Gulf of Mexico significantly differ (i.e., in frequency and duration) from those in the western north Atlantic (Zaretsky et al. 2005; Baron 2006).

6.2 SOUND EXPOSURE CRITERIA AND THRESHOLDS

Under the MMPA, NMFS has defined levels of harassment for marine mammals. Level A harassment is defined as "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment is defined as "Any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding or sheltering."

Since 1997, NMFS has used generic sound exposure thresholds to determine when an activity in the ocean that produces sound might result in impacts to a marine mammal such that a take by harassment might occur (70 FR 1871). Current NMFS practice regarding exposure of marine mammals to pile driving sounds is that cetaceans exposed to impulsive sounds ≥180 re 1 μPa rms are considered to have been taken by Level A (i.e., injurious) harassment. Level A injury thresholds have not been established for non-impulsive sounds such as vibratory pile driving, but the Navy has applied the threshold values for impulsive sounds to vibratory sound in this analysis.

Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to underwater sounds below the injury threshold, but ≥ 160 dB re 1 μPa rms for impulsive sounds (e.g., impact pile driving) and 120 dB re 1 μPa rms for non-impulsive noise (e.g., vibratory pile driving).

6.2.1 Limitations of Existing Noise Criteria

To date, there is no research or data supporting a response by odontocetes to non-impulsive sounds from vibratory pile driving as low as the 120 dB re 1 μPa rms threshold. The application of the 120 dB re 1μPa rms threshold can be problematic because this threshold level can be either at or below the ambient noise level of certain locations. For example, noise levels at some industrialized ports in Puget Sound, WA, have been measured at between 120 and 130 dB re 1μPa (Washington State Department of Transportation 2012). Assuming a 120 dB disturbance threshold in such environments implies any animals in the area will be disturbed with or without additional pile driving noise. This has led to analyses that may be overly conservative, and as a result of these issues, the threshold level is subject to ongoing discussion (74 FR 41684). NMFS is developing new science-based thresholds to improve and replace the current generic exposure level thresholds, but the criteria have not been finalized (Southall et al. 2007). The 120 dB re 1 μPa rms threshold level for non-impulsive noise originated from research conducted by Malme et al. (1984, 1988) for California gray whale response to non-impulsive industrial sounds such as drilling operations. Note: The 120 dB re 1 μPa rms *non-impulsive* sound threshold should not be confused with the 120 dB re 1 μPa rms *impulsive* sound criterion established for migrating bowhead whales in the Arctic as a result of research in the Beaufort Sea (Richardson et al. 1995; Miller et al. 1999).

6.2.2 New Critieria in Development

NMFS is currently developing new acoustic criteria to evaluate the effects of sound on marine mammals. On 27 December 2013, draft criteria for thresholds at which temporary threshold shift (TTS) and permanent threshold shift (PTS) effects occur were published for public comment (78 FR 78822). Revised draft criteria were published for public comment on 31 July 2015 (80 FR 45642). At the time of this application, these new criteria have not yet been finalized. If the finalized criteria take effect during the period of this Project, the Project proponent may re-consult to determine accurate take estimates.

The criteria in development do not currently include changes to the behavioral criteria; as such, the existing thresholds of 160 dB re 1μPa rms (impact) and 120 dB re 1μPa rms (vibratory) will remain.

6.3 AMBIENT NOISE

The baseline noise level along the waterfront is referred to as the “ambient noise level”. Ambient noise is comprised of sounds produced by a number of natural and anthropogenic sources. Natural noise sources can include wind, waves, precipitation, and biological sources such as shrimp, fish, and cetaceans. These sources produce sound in a wide variety of frequency ranges (Urick 1983; Richardson et al. 1995) and can vary over both long (days to years) and short (seconds to hours) time scales. In shallow waters, precipitation may contribute up to 35 dB to the existing sound level, and increases in wind speed of five to 10 knots can cause a 5 dB increase in ambient ocean noise between 20 Hz and 100 kHz (Urick 1983). High noise levels may also occur in near shore areas during heavy surf, which may increase low frequency (200 Hz – 2 kHz) underwater noise levels by 20 dB or more within 200 yards of the surf zone (Wilson et al. 1985).

At SUBASE Kings Bay, vessel passages may cause breaking waves on shore, contributing to the ambient acoustic environment.

Anthropogenic noise sources also contribute to ambient noise levels, particularly in ports and other high use areas in coastal regions. Normal port activities include vessel traffic (from large ships, support vessels, and security boats), loading and maintenance operations, and other activities (sonar and echo-sounders from commercial and recreational vessels, construction, etc.) which all generate underwater sound (Urick 1983). Additionally, noise produced by mechanized equipment on wharves or adjacent shorelines may propagate underwater and contribute to underwater ambient noise levels.

The underwater acoustic environment at SUBASE Kings Bay is dominated by noise from day-to-day port and vessel activities. The base is sheltered from most wave noise, but is a high-use area for naval ships, tugs, submarines, and security vessels. When underway, these sources can create noise between 20 Hz and 16 kHz (Lesage et al. 1999), with broadband noise levels up to 180 dB re 1 µPa rms (Table 6-1). Normal port operations, including transits, docking, and maintenance by multiple vessels would continue. Measurements of ambient noise levels at SUBASE Kings Bay were taken in February 2015, finding that ambient sound levels averaged around 135 dB re 1 µPa rms, with peake levels ranging from 145 to 155 dB peak (Acentech 2015). The high levels of anthropogenic activity in the area are the likely cause of ambient noise levels significantly above “quiet” habitats in which marine mammal reactions to 120 dB sounds were observed (Malme et al. 1984, 1988).

The existing sources of anthropogenic noise at SUBASE Kings Bay are generally non-impulsive (see Appendix B), intermittent sources such as vessel engines; this category also includes noise from vibratory pile driving. Impact pile driving noise differs from these sources in that it is impulsive, with a fast rise time and multiple short-duration (50 – 100 millisecond; Illingworth & Rodkin 2001) events. Because of the relatively short term use of impact pile driving during the Project (days – weeks per project), the Navy expects no long-term change in the average ambient noise environment with respect to impulsive sounds as a result of impact pile driving.

Table 6-1. Representative Levels of Noise from Anthropogenic Sources

Noise Source	Frequency Range (Hz)	Underwater Noise Level (dB re 1 µPa)
Small vessels[1]	250–6,000	151 dB rms at 1 m
Large vessels[2]	20 – 1,500	170 – 180 dB rms at 1 m
Tug docking barge[3]	200–1,000	149 dB rms at 100 m

m = meter ; Sources: [1]Lesage et al. 1999; [2]Richardson et al. 1995; [3]Blackwell and Greene 2002

Airborne ambient noise in industrial areas such as the SUBASE Kings Bay waterfront is comprised of sounds from trucks, cranes, compressors, generators, pumps, ship engines, and other equipment. While there are no current measurements of airborne ambient noise, expected noise levels range from a daytime minimum of 55 dBA to a maximum of 99 dBA, assuming that multiple sources will be operating simultaneously (Washington State Department of Transportation 2007).

6.4 UNDERWATER NOISE FROM PILE DRIVING

Noise levels produced by pile driving are greatly influenced by factors including pile type, driving method, and the physical environment in which the activity takes place. A number of studies have examined sound pressure levels recorded from underwater pile driving projects in California and Washington, and a few studies have recently been conducted on the U.S. East Coast at a number of naval installations. Data are generally concentrated on steel pipe piles of a range of diameters, but other pile types have also been measured. These data were used to determine source level values for modeling the pile driving activities associated with the Project.

While some pile types are well-represented in the existing data, other types have been measured only infrequently. There were therefore a few different methods for determining the proxy source levels for modeling for the Project. The full methodology and source data are given in Appendix C. Data from the East Coast were prioritized due to the differences in bathymetry and sediment between west coast sites in Washington and California, and the location at Kings Bay. For pile types for which East Coast data were not available, averages of west coast data were used to approximate source levels.

For composite piles (used in projects 1B and 5), no measured data are available. The source level estimates for this type of pile were based on data from timber piles driven on the east coast of the U.S.

Tables 6-2 and 6-3 summarize the proxy source levels and rationale used to model sound propagation for each pile type, as well as the projects associated with that pile type.

Table 6-2. Vibratory Installation and Extraction Underwater Sound Pressure Levels* Expected Based on Similar In-Situ Monitored Construction Activities

Pile Type	Projects	Model Proxy	Proxy Source Level[1] [dB rms]
18” Concrete	1A	24" steel pipe	166
24” Concrete	3A, 4A, 6A, 6B	24" steel pipe	166
16 – 18” Composite	1B, 5	12 – 16” timber piles	161
16” Timber piles	1A, 1B	12 – 16” timber piles	161
14” Steel H	2, 3B, 3G	14” Steel H	163
24” Steel pipe	3A, 3C, 3D, 3E, 4B	24" steel pipe	166
30” Steel pipe	3C, 3D, 3E, 3F	30” Steel Pipe	166

*Note that Peak and SEL metrics are not measured for vibratory driving.
[1]See Appendix C for full reference list and source data.

Table 6-3. Impact Installation Underwater Sound Pressure Levels Expected Based on Similar In-Situ Monitored Construction Activities

Pile Type	Projects	Model Proxy	Proxy Source Level[1]		
			dB rms	dB Peak	dB SEL
18” Concrete	1A, 4A	18" concrete	170	184	159
24” Concrete	1A, 3A, 4A	24" concrete	174	184	165
14” Steel H	2, 3B, 3G	18" steel pipe	178	196	168
24” Steel pipe	3A, 3C, 3D, 3E, 4B	24" steel pipe	190	208	181
30” Steel pipe	3F	30" steel pipe	193	209	188

[1]See Appendix C for full reference list and source data.

6.4.1 Underwater Sound Propagation

Pile driving can generate underwater noise that may result in disturbance to marine mammals within the Project Area. Modeling sound propagation is useful in evaluating noise levels to determine which marine mammals may be exposed at a given distance from the pile driving activity. The decrease in acoustic intensity as a sound wave propagates outward from a source is known as transmission loss (TL).

The formula for transmission loss is:

$$TL = B * log_{10}\left(\frac{R_1}{R_2}\right) + C * R_1$$, where

B = logarithmic (predominantly spreading) loss

C = linear (scattering and absorption) loss

R_1 = range from source in meters

R_2 = range from driven pile to original measurement location (generally 10 m)

The amount of linear loss (C) is proportional to the frequency of a sound. Due to the low frequencies of sound generated by impact and vibratory pile driving, this factor was assumed to be zero for all calculations in this assessment and transmission loss was calculated using only logarithmic spreading. Therefore, using practical spreading (B=15), the revised formula for transmission loss is $TL = 15 \log_{10} (R_1/10)$.

6.4.2 Calculated Zones of Influence

The practical spreading loss model discussed above was used to calculate the propagation of pile driving sound in and around the individual project locations within the Project Area. No sound mitigation methods (bubble curtains, cofferdams, etc.) are proposed and therefore no attenuation was included in the acoustic model. All projects are assumed to happen independently, with only one pile driving rig operating at any given time. No simultaneous driving of multiple piles was modeled.

The calculations presented in Tables 6-4 and 6-5 assume a field free of obstruction, which is unrealistic because the waters of SUBASE Kings Bay do not represent open water conditions (free field) and sounds will attenuate as they encounter land or other solid obstacles. As a result, the distances calculated may not actually be attained at the Project Area. The actual distances to the behavioral disturbance thresholds for impact and vibratory pile driving are likely to be shorter than those calculated due to the irregular contour of the waterfront and the maximum fetch (farthest distance sound waves travel without obstruction [i.e. line of sight]) at the Project Area. Tables 6-4 and 6-5 depict the actual areas encompassed by the marine mammal thresholds during the project.

Marine mammal densities were multiplied by the size of the applicable zone of influence to estimate number of incidental takes per day. This number was rounded to the nearest whole number and multiplied by the estimated number of pile-driving days (Table 2-2) to calculate takes for the entire Project (see Chapter 5).

Table 6-4. Calculated Distances to / Areas Encompassed by the Underwater Marine Mammal Noise Thresholds for Vibratory Pile Driving

PROJECT			Pile Type and Size	Source Level (dB re 1µPa rms @ 10 m)	Level A (180 dB re 1µPa rms)		Level B (120 dB re 1µPa rms)	
ID	FAC#	Project Name			Distance (m)	Area (km^2)[1],[2]	Distance (m)	Area (km^2)
Beginning in FY 2017								
1A	5926	Tug Pier	16" Timber	161	< 1	0	5,412	3.685649
1B	5888	General Access Pier Crab Island	16" Composite	161	< 1	0	5,412	3.124661
			16" Timber	161	< 1	0	5,412	3.124661
3A	5109	EHW #2	24" Steel pipe	166	1.2	0	11,659	3.64538
3D	5910	Refit Wharf #2	24" and 30" Steel pipes	166	1.2	0	11,659	3.167033
5	5980	Magnetic Silencing Facility	18" Composite	161	< 1	0	5,412	10.745466
			16" Timber	161	< 1	0	5,412	10.745466
Beginning in FY 2018								
3C	5909	Refit Wharf #1	24" and 30" Steel pipes	166	1.2	0	11,659	3.315251
3E	5916	Refit Wharf #3	24" and 30" Steel pipes	166	1.2	0	11,659	3.723009
Beginning in FY 2019 – No Scheduled Work Starts								
Beginning in FY 2020								
4A	P617	New Facility	24" Concrete	166	1.2	0	11,659	7.512735
4B	P617	Small Craft Berth Site VI	24" Steel pipe	166	1.2	0	11,659	63862192
Beginning in FY 2021								
3B	5995	(Dry Dock) Interface Wharf	14" Steel H	163	< 1	0	7,356	2.396074
3F	5877	Warping Wharf W/Capstan (4)	30" Steel pipe	166	1.2	0	11,659	3.485042

[1] Areas less than 0.0001 km^2 are rounded down to 0 km^2.

[2] Areas given indicate exact area depicted in figures presented later in this chapter, adjusted for interactions with shorelines and line-of-sight transmission pathways.

Table 6-5. Calculated Distances to / Areas Encompassed by the Underwater Marine Mammal Noise Thresholds for Vibratory Pile Driving (*continued*)

PROJECT			Pile Type and Size	Source Level (dB re 1µPa rms @ 10 m)	Level A (180 dB re 1µPa rms)		Level B (120 dB re 1µPa rms)	
ID	FAC#	Project Name			Distance (m)	Area (km^2)[1, 2]	Distance (m)	Area (km^2)
Beginning in FY 2022								
3A	5109	EHW #2	24" Concrete	166	1.2	0	11,659	3.62879
			24" Steel pipe	166	1.2	0	11,659	3.62879
3G	5926	Tug Pier	14" Steel H	163	< 1	0	7,356	3.995195

dB = decibel; rms = root-mean-square; µPa = micro Pascal; NA = Not Applicable
Practical spreading loss (15 log, or 4.5 dB per doubling of distance) used for calculations.
Sound pressure levels used for calculations are given in Tables 6-2 and 6-3.

[1] Areas less than 0.0001 km^2 are rounded down to 0 km^2.

[2] Areas given indicate exact area depicted in figures presented later in this chapter, adjusted for interactions with shorelines and line-of-sight transmission pathways.

Table 6-5. Calculated Distances to / Areas Encompassed by the Underwater Marine Mammal Noise Thresholds for Impact Pile Driving

PROJECT			Pile Type and Size	Source Level (dB re 1µPa rms @ 10 m)	Level A (180 dB re 1µPa rms)		Level B (160 dB re 1µPa rms)	
ID	FAC#	Project Name			Distance (m)	Area (km^2) [1], [2]	Distance (m)	Area (km^2)
Beginning in FY 2017								
1A	5926	Tug Pier	18" Concrete	170	2.2	0	46.4	0.006744
			24" Concrete	174	4.0	0	85.8	0.023042
2	5976	UMC Layberth Fender Pile Modification	14" Steel H	178	7.4	0.000171	159	0.063433
3A	5109	EHW #2	24" Steel pipe	190	46.4	0.006744	1,000	0.879388
3D	5910	Refit Wharf #2	24" Steel pipe	190	46.4	0.003402	1,000	0.900136
Beginning in FY 2018								
3C	5909	Refit Wharf #1	24" Steel pipe	190	46.4	0. 003411	1,000	0.753328
3E	5916	Refit Wharf #3	24" Steel pipe	190	46.4	0.003411	1,000	0.884824
Beginning in FY 2019 – No Scheduled Work Starts								
Beginning in FY 2020								
4A	P617	New Facility	18" Concrete	170	2.2	0	46.4	0.023042
			24" Concrete	174	4.0	0	85.8	0.006729
4B	P617	Small Craft Berth Site VI	24" Steel pipe	190	46.4	0.006744	1,000	1.630796
Beginning in FY 2021								
3B	5995	(Dry Dock) Interface Wharf	14" Steel H	178	7.4	0	159	0.03779
3F	5877	Warping Wharf W/Capstan (4)	30" Steel pipe	193	73.6	0.016343	1,585	1.345953
Beginning in FY 2022								
3A	5109	EHW #2	24" Concrete	174	4.0	0	85.8	0.023042
			24" Steel pipe	190	46.4	0.006744	1,000	0.879388
3G	5926	Tug Pier	14" Steel H	178	7.4	0.000171	159	0.066822

dB = decibel; rms = root-mean-square; µPa = micro Pascal; NA = Not Applicable
Practical spreading loss (15 log, or 4.5 dB per doubling of distance) used for calculations.
Sound pressure levels used for calculations are given in Tables 6-2 and 6-3.

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[1] Areas less than 0.0001 km^2 are rounded down to 0 km^2.

[2] Areas given indicate exact area depicted in figures presented later in this chapter, adjusted for interactions with shorelines and line-of-sight transmission pathways.

6.4.2.1 Projects Beginning in FY 2017

Six projects would be completed during 2017. Maps of ZOIs for each project and summary of estimated exposures are briefly described below. A total of 0 Level A and 176 Level B sound exposures were estimated for this year of the Project.

6.4.2.1.1 Project 1A: Tug Pier Repair

Project 1A was modeled based on an estimated 31 days of vibratory pile extraction of 16” timber piles, generating the ZOI shown in Figure 6-1. This resulted in an estimate of 0 Level A and 124 Level B sound exposures to bottlenose dolphins.

Impact installation of 18” and 24” concrete piles during the Tug Pier repair project was estimated to take 34 days of pile driving, leading to the ZOI displayed in Figure 6-2. No sound exposures rising to the level of harassment were estimated during this phase of Project 1A.

A total of 0 Level A and 124 Level B exposures are expected during this project.

6.4.2.1.2 Project 1B: Crab Island Access Pier Repairs

The Crab Island Access Pier repair project requires 2 days of vibratory pile extraction of 16” timber piles and installation of 16” composite piles (ZOI shown in Figure 6-3), resulting in 0 Level A and 6 Level B exposures.

A total of 0 Level A and 6 Level B exposures are expected during this project.

6.4.2.1.3 Project 2: Unspecified Minor Construction Layberth Fender Pile Modification P661

Upgrading the Layberth pier would require seven days of impact pile driving of 55 steel H piles, resulting in 0 Level A and 0 Level B exposures (Figure 6-5). It is anticipated that an average of eight piles would be installed per day for approximately seven days of in-water work.

A total of 0 Level A and 0 Level B exposures are expected during this project.

6.4.2.1.4 Project 3A: Explosives Handling Wharf #2 Pier with Capstans (7)

Repairs to EHW-2 at SUBASE Kings Bay during 2017 will require one day of vibratory extraction of 24” steel pipe piles (Figure 6-5), resulting in 0 Level A and 4 Level B exposures. Installation of replacement 24” steel pipe piles will require 1 day of impact driving (Figure 6-6), with an estimated 0 Level A and 1 Level B exposures.

A total of 0 Level A and 5 Level B exposures are expected during this project.

6.4.2.1.5 Project 3D: Refit Wharf 2

Project 3D requires one day of vibratory extraction of 30” steel pipe piles (Figure 6-7), resulting in 0 Level A and 4 Level B exposures. Installation of replacement 24” steel pipe piles will require 1 day of impact driving (Figure 6-8), with an estimated 0 Level A and 1 Level B exposures.

A total of 0 Level A and 5 Level B exposures are expected during this project.

6.4.2.1.6 Project 5: RM14-1710 TRIREFFAC Waterfront Facilities Repair, Magnetic Silencing Facility with Cranes

The repairs to the Magnetic Silencing Facility required three days of vibratory extraction of 16” timber piles and three days of vibratory installation of 18” composite piles (Figure 6-9). The relatively exposed location of this facility resulted in a large ZOI, leading to 0 Level A and 36 Level B estimated sound exposures from this project.

A total of 0 Level A and 36 Level B exposures are expected during this project.

Figure 6-1. Project 1A – Tug Pier Repair Vibratory Driving ZOIs

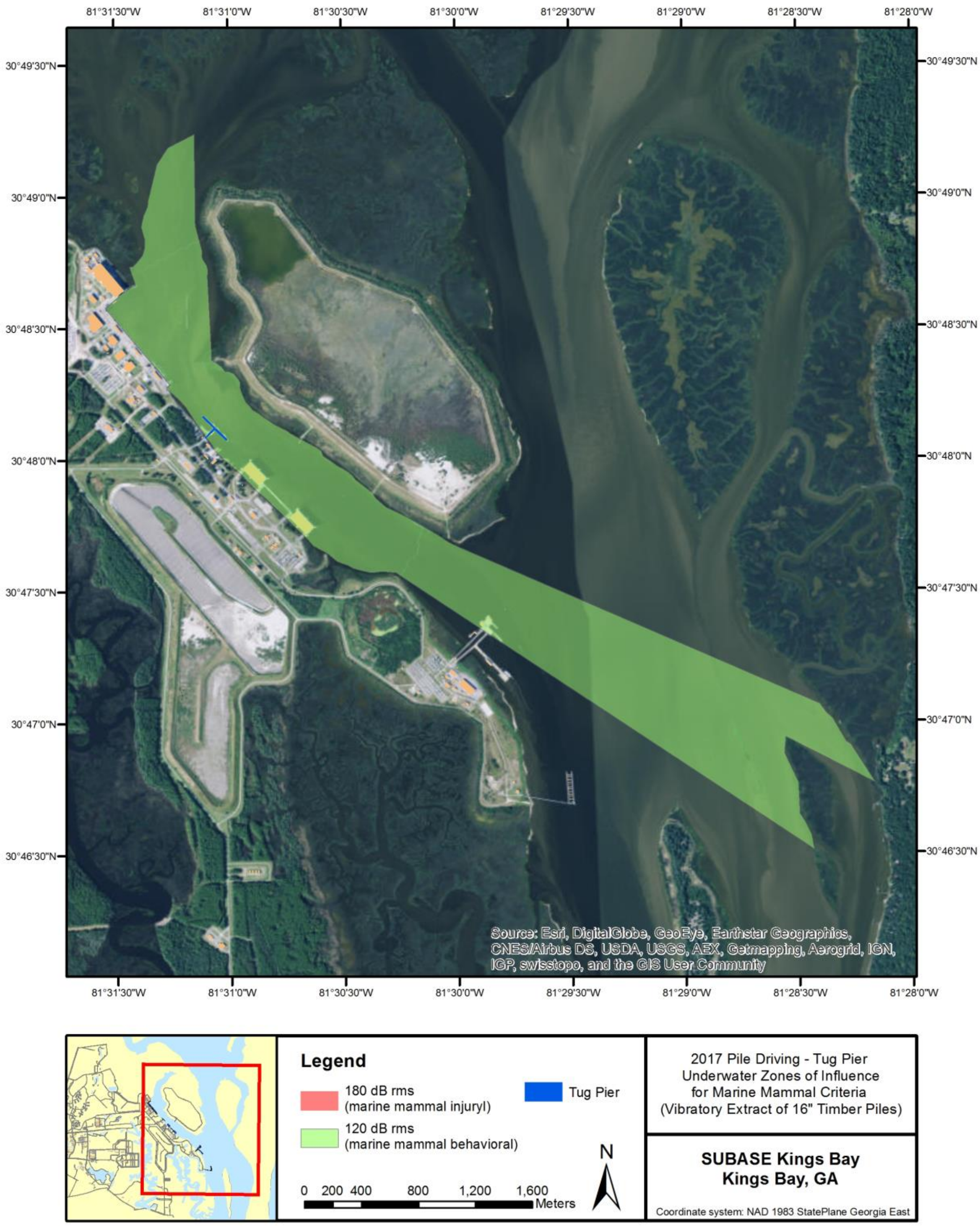


Figure 6-2. Project 1A – Tug Pier Repair Impact Driving ZOIs

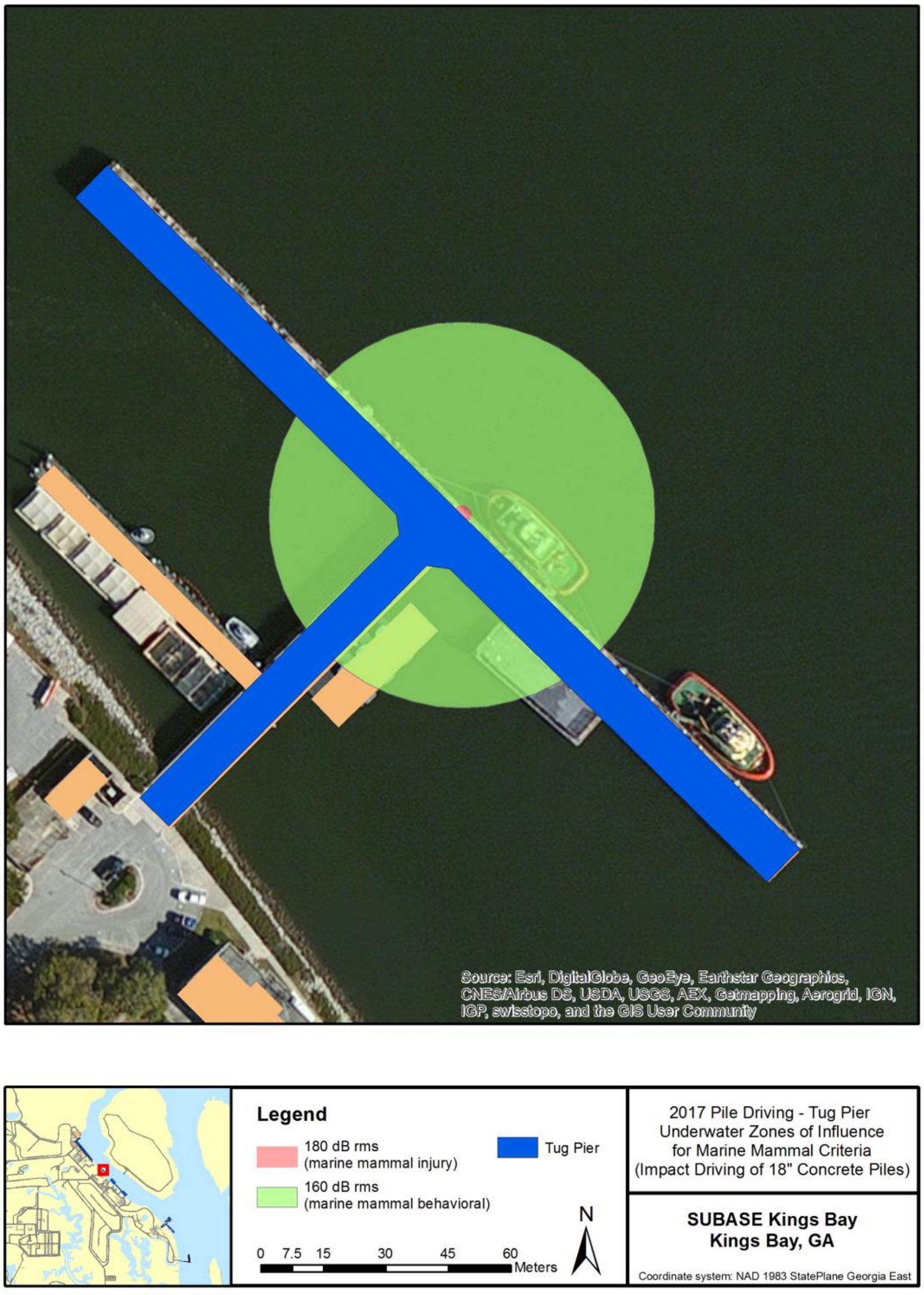


Figure 6-3. Project 1B – Crab Island Access Pier RepairsVibratory Driving ZOIs

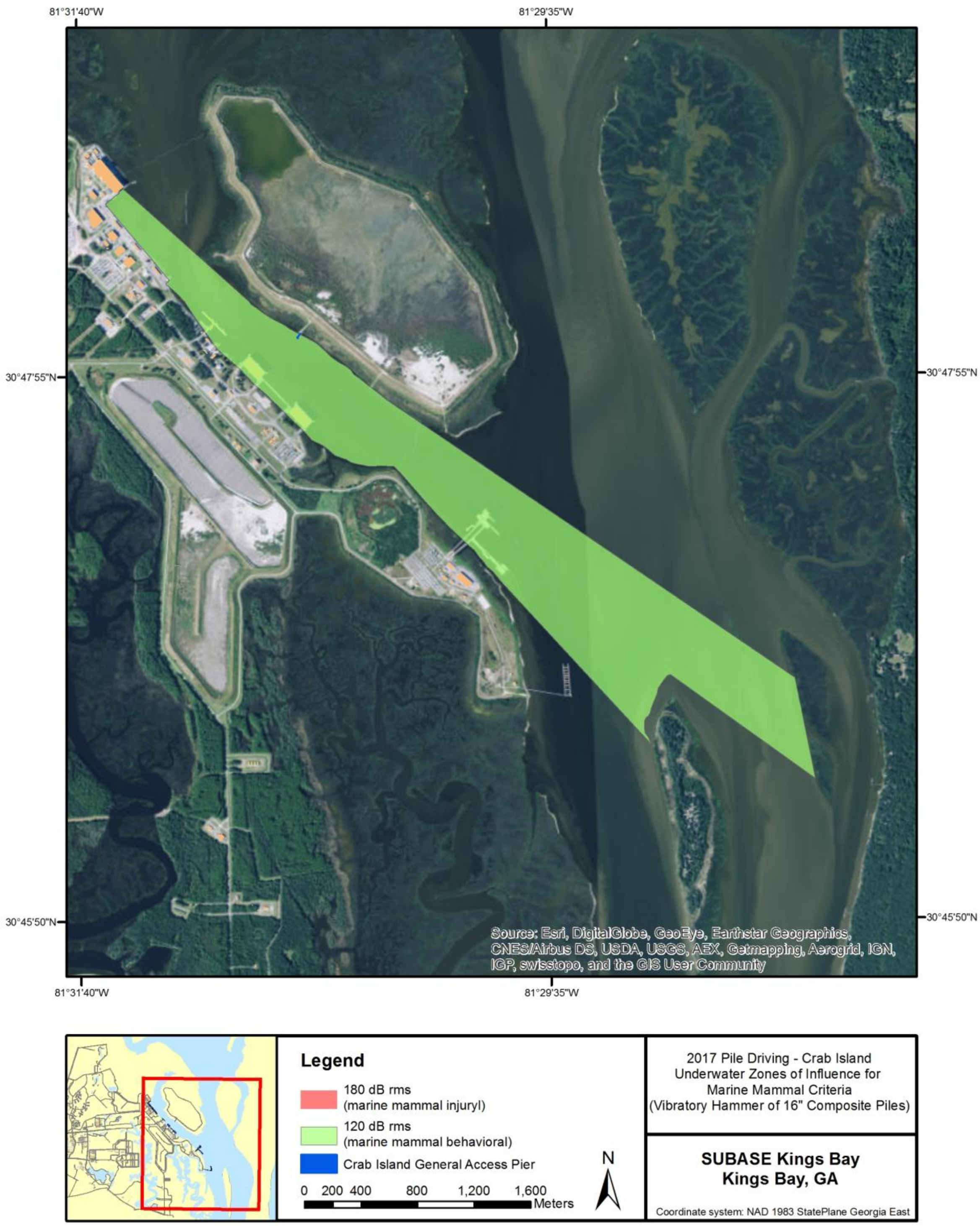


Figure 6-4. Project 2 – UMC Layberth Fender Pile Modification Impact Driving ZOIs

Figure 6-5. Project 3A – EHW-2 Repairs Vibratory Driving ZOIs

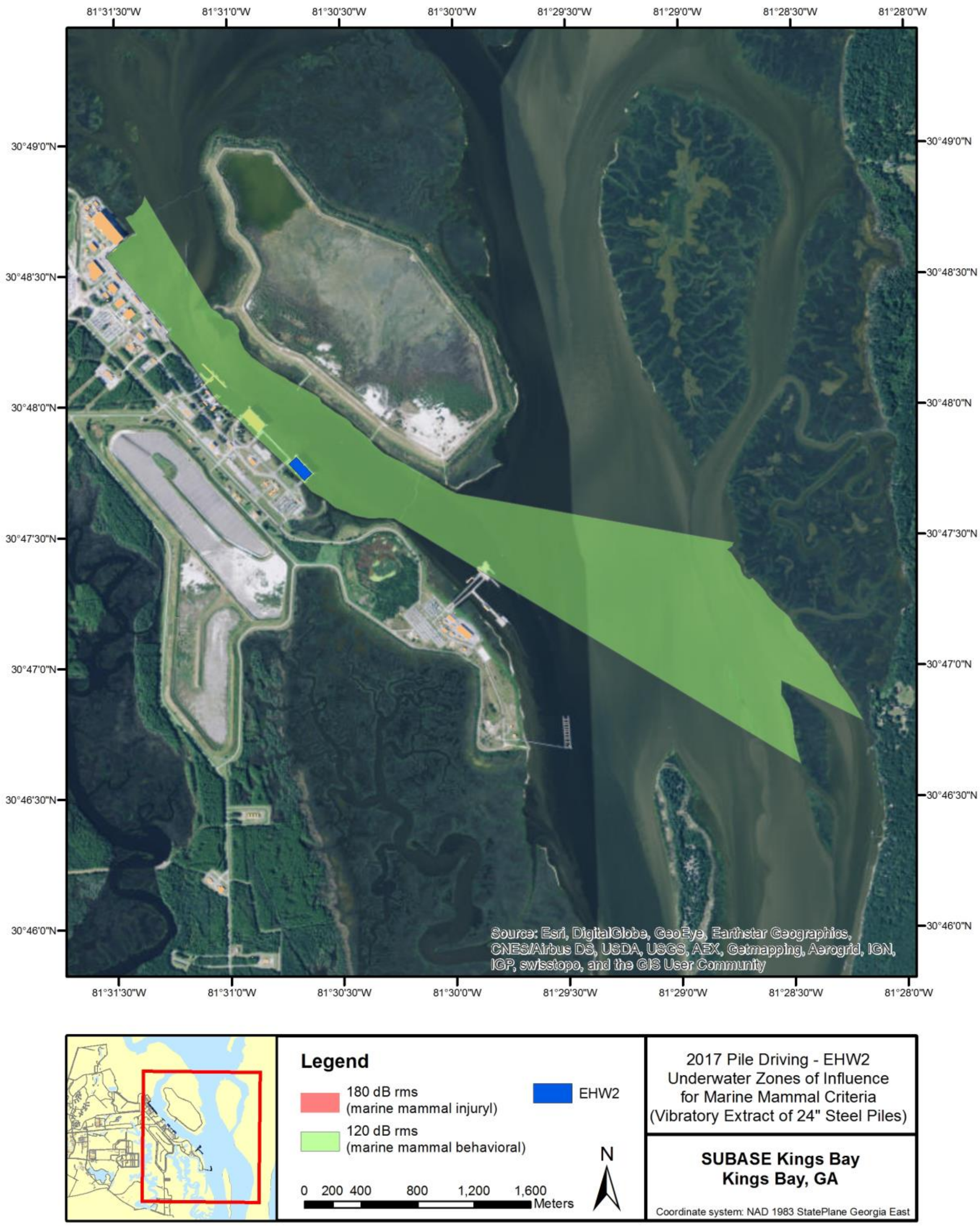


Figure 6-6. Project 3A – EHW-2 Repairs Impact Driving ZOIs

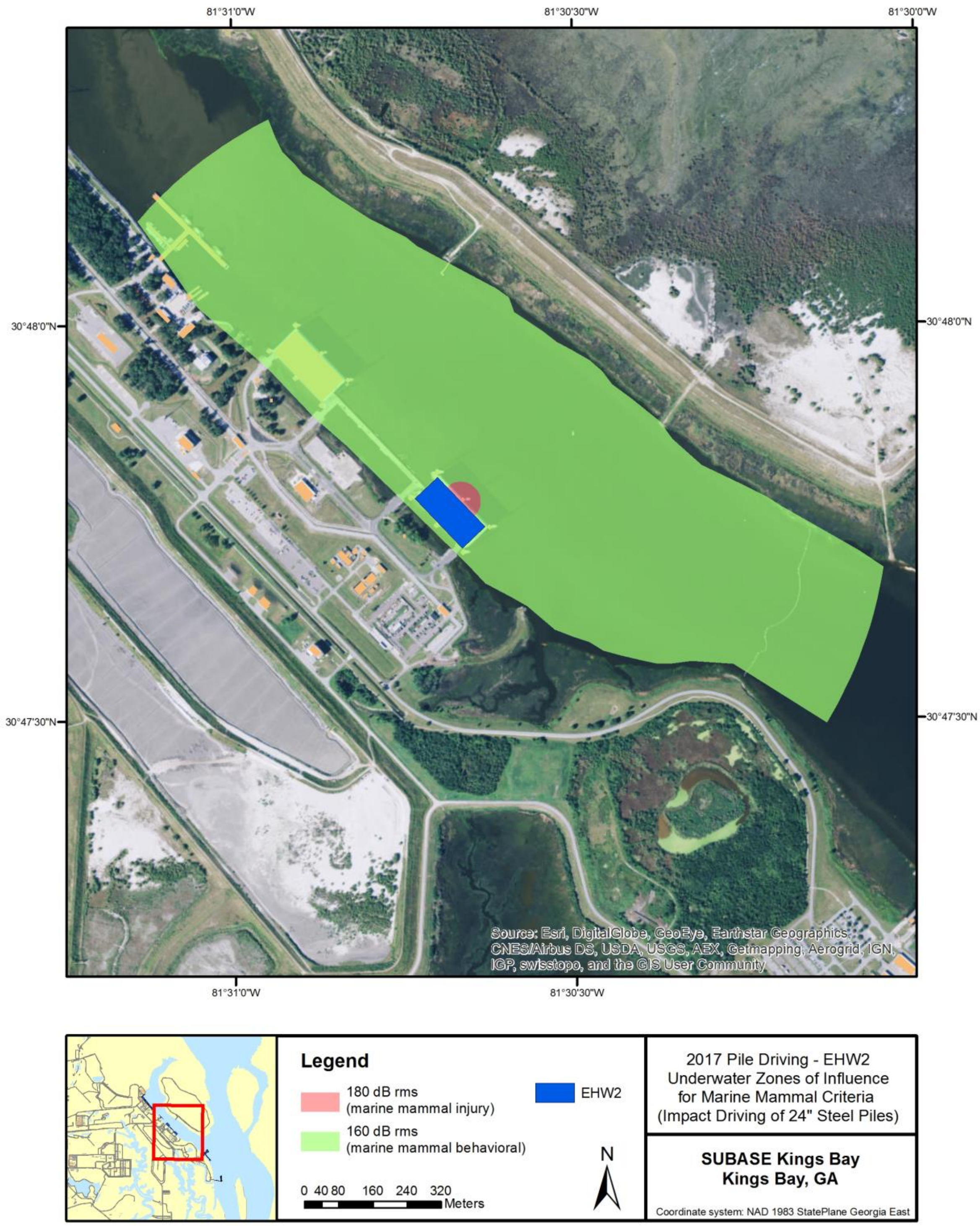


Figure 6-7. Project 3D – Refit Wharf 2 Vibratory Driving ZOIs

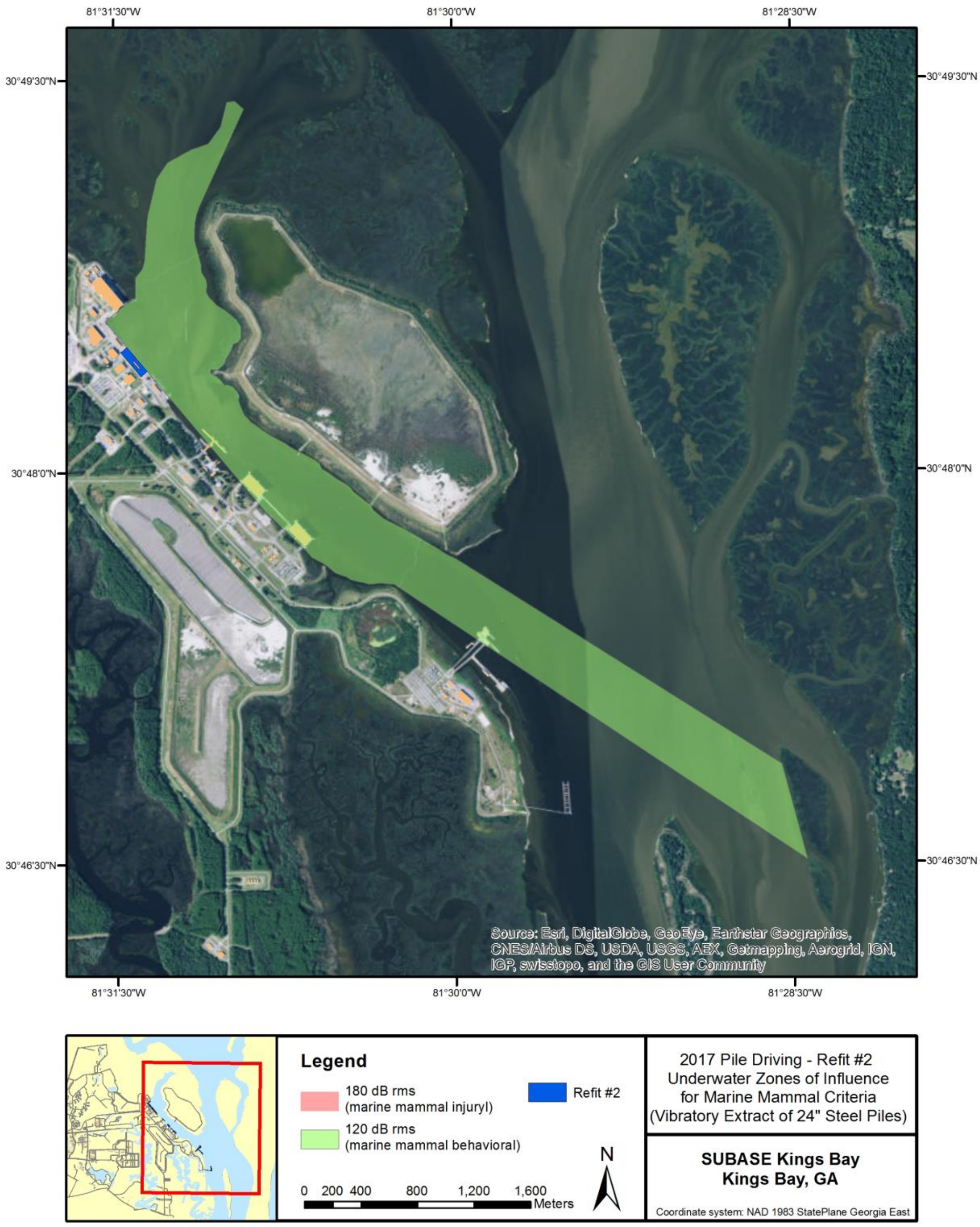


Figure 6-8. Project 3D – Refit Wharf 2 Impact Driving ZOIs

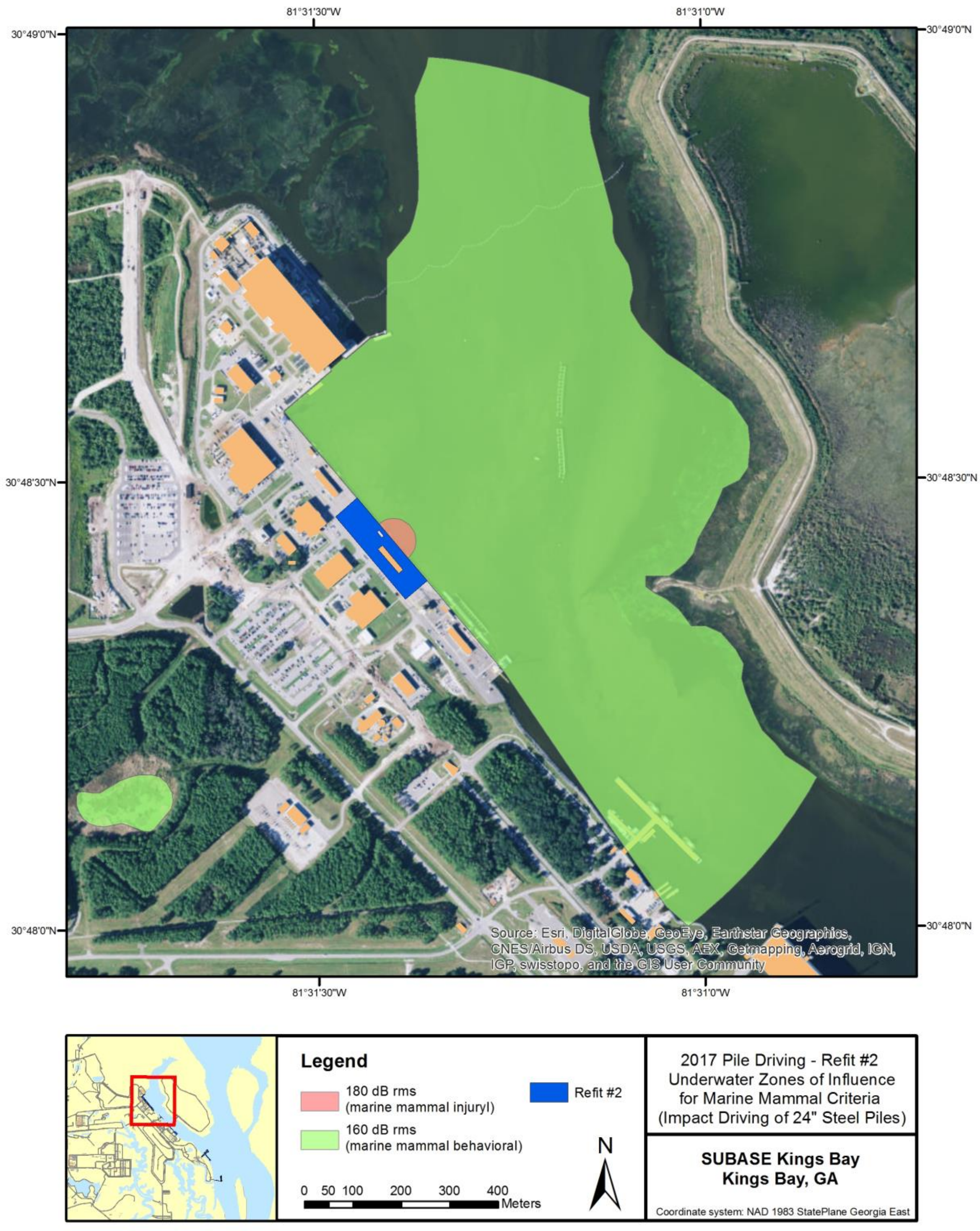
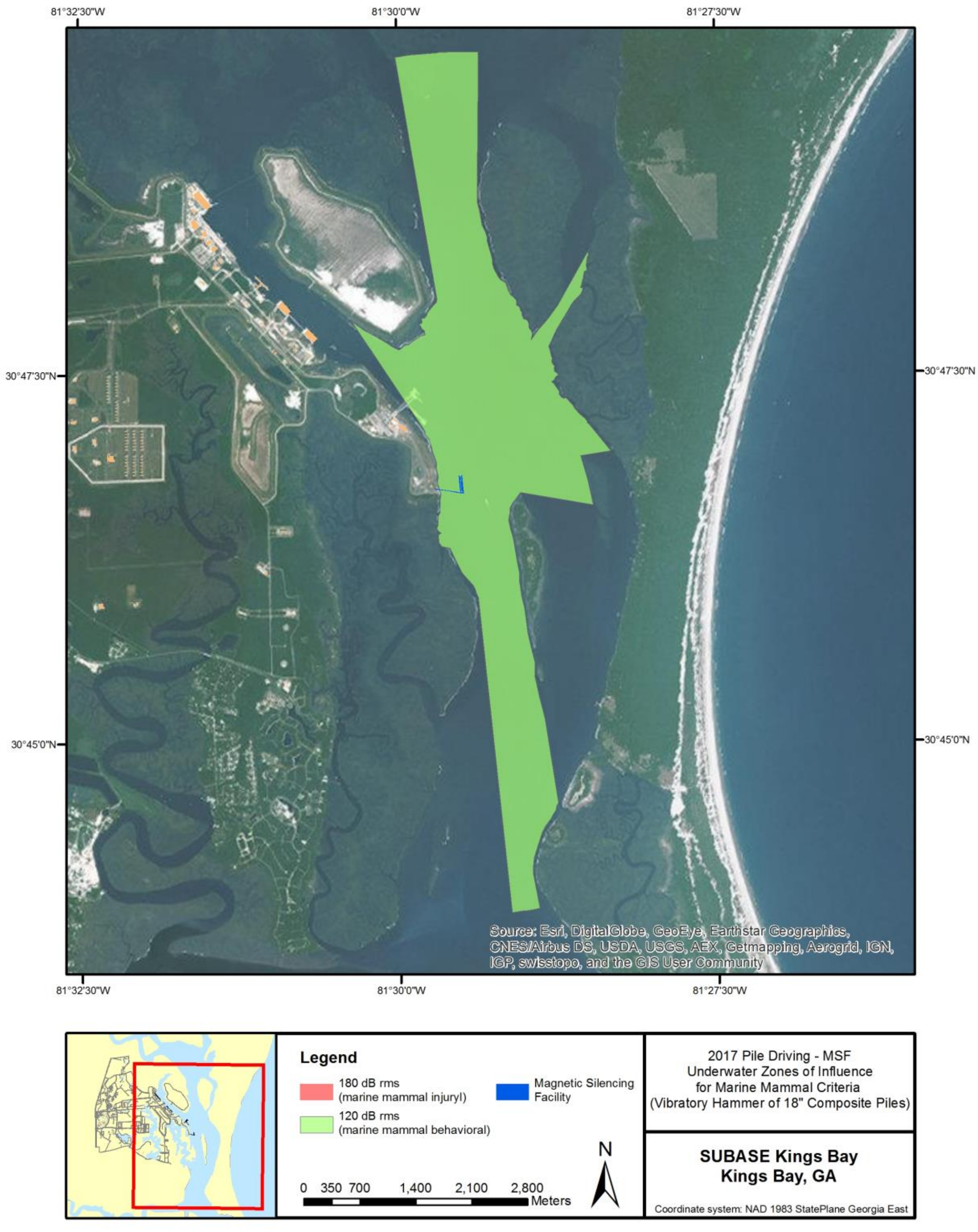


Figure 6-9. Project 5 – MSF Repairs Vibratory Driving ZOIs



6.4.2.2 Projects beginning in FY 2018

Two projects would be completed during 2018. Maps of ZOIs for each project and summary of estimated exposures are briefly described below. A total of 0 Level A and 10 Level B sound exposures were estimated for this year of the Project.

6.4.2.2.1 Project 3C: Refit Wharf 1

Project 3C requires one day of vibratory extraction of 30” steel pipe piles (Figure 6-10), resulting in 0 Level A and 4 Level B exposures. Installation of replacement 24” steel pipe piles will require 1 day of impact driving (Figure 6-11); no sound exposures rising to the level of harassment are expected for this portion of the project.

A total of 0 Level A and 4 Level B exposures are expected during this project.

6.4.2.2.2 Project 3E: Refit Wharf 3

Project 3E requires one day of vibratory extraction of 30” steel pipe piles (Figure 6-12), resulting in 0 Level A and 4 Level B exposures. Installation of replacement 24” steel pipe piles will require 1 day of impact driving (Figure 6-13), with an estimated 0 Level A and 1 Level B exposures.

A total of 0 Level A and 6 Level B exposures are expected during this project.

Figure 6-10. Project 3C – Refit Wharf 1 Vibratory Driving ZOIs

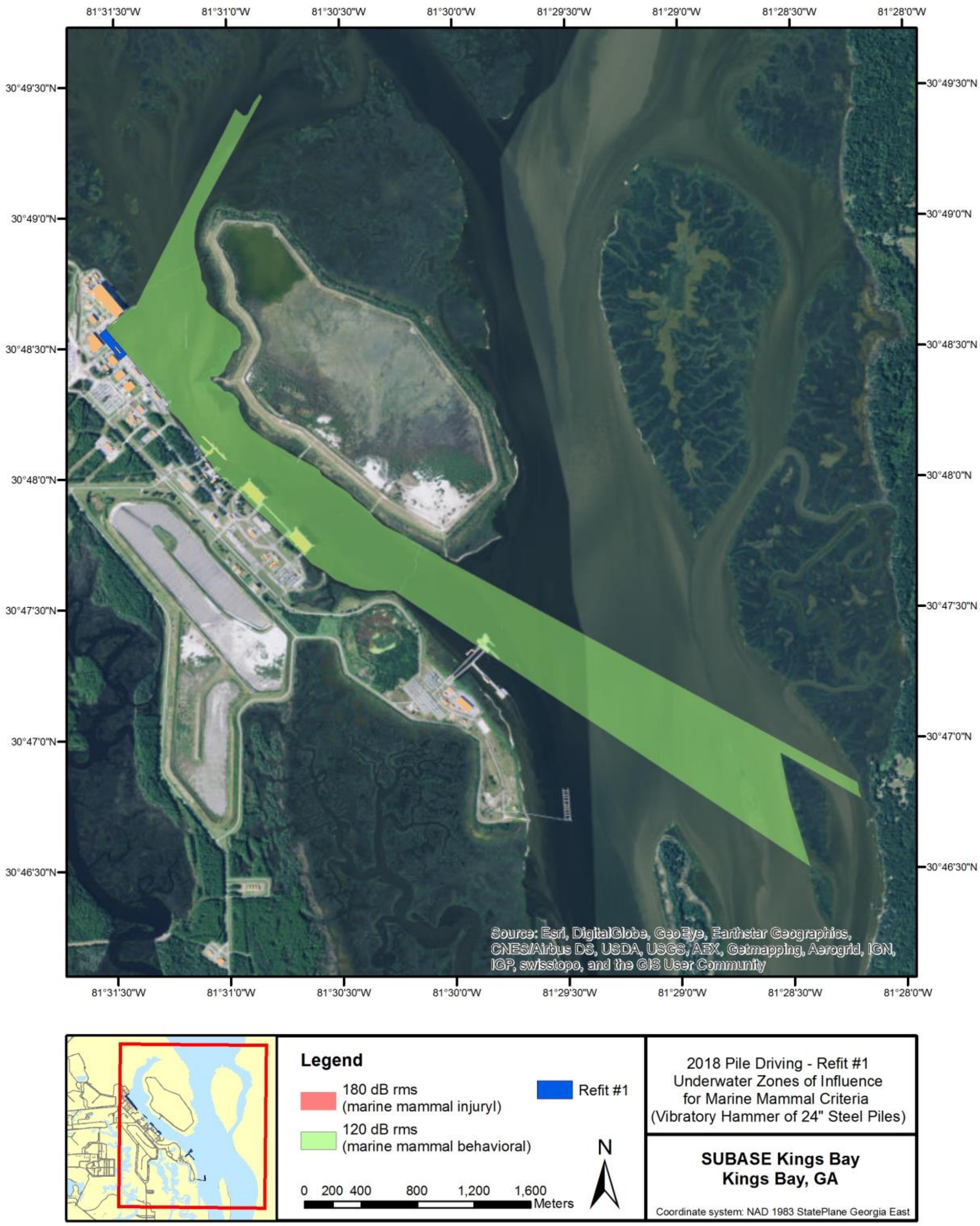


Figure 6-11. Project 3C – Refit Wharf 1 Impact Driving ZOIs

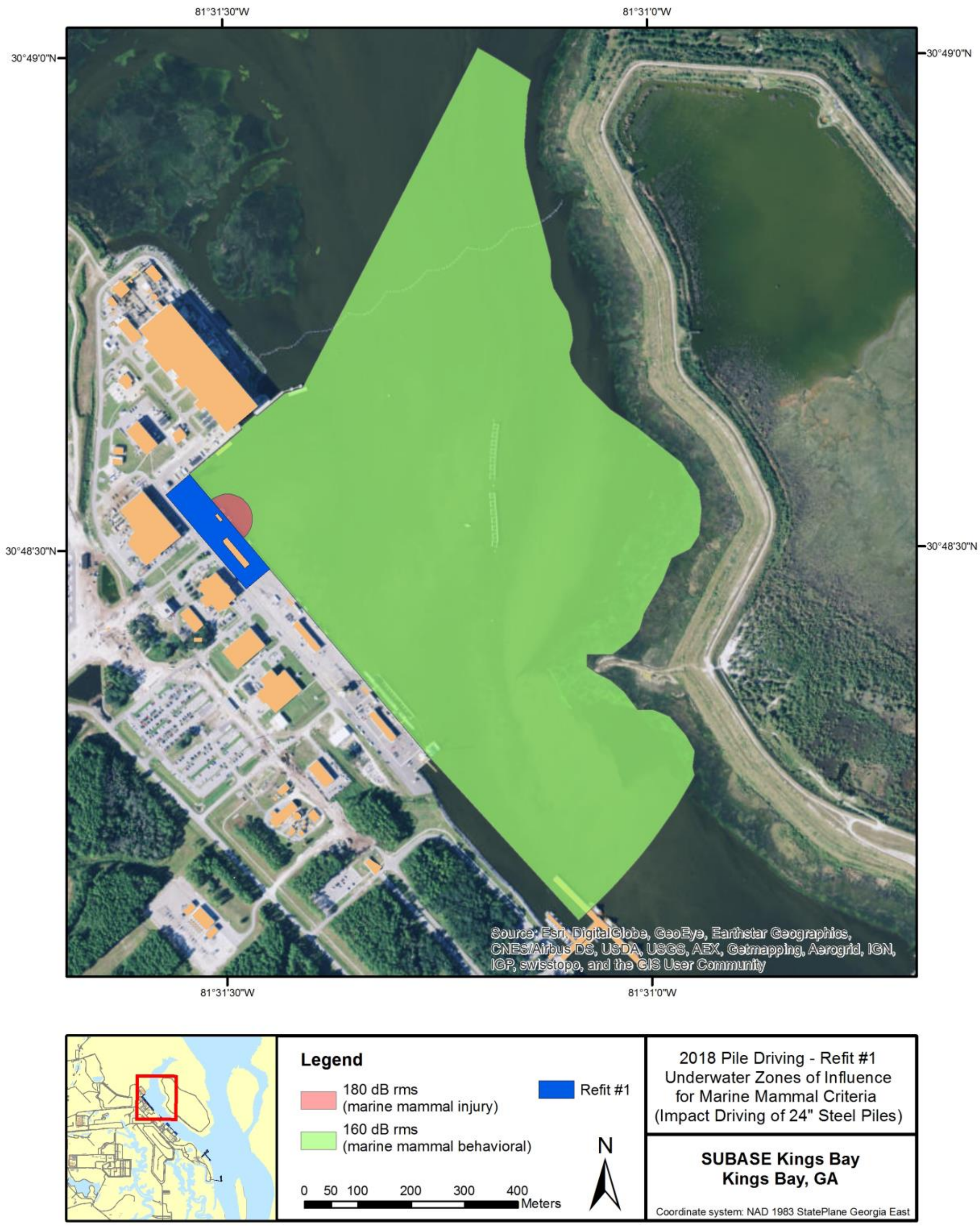


Figure 6-12. Project 3E – Refit Wharf 3 Vibratory Driving ZOIs

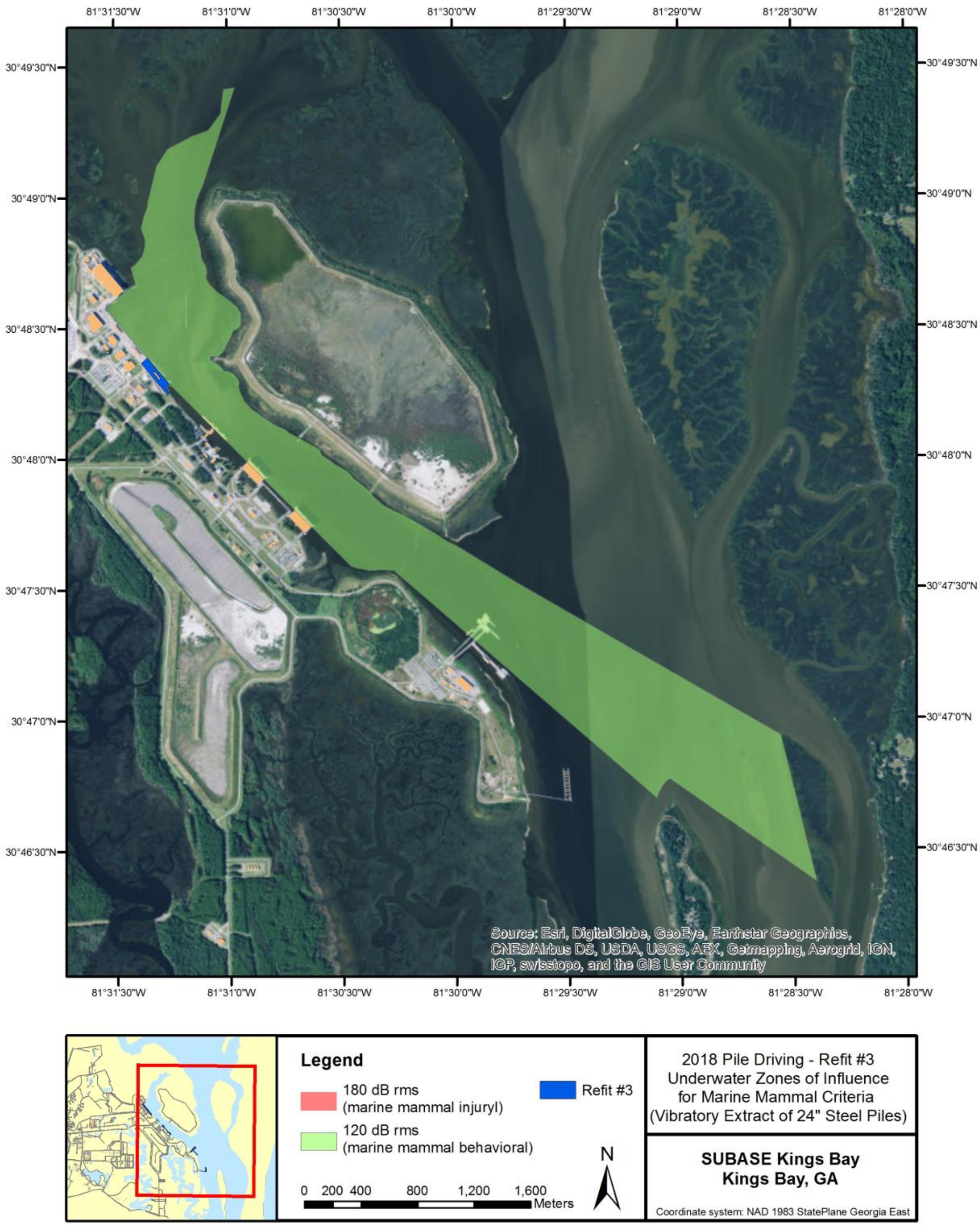
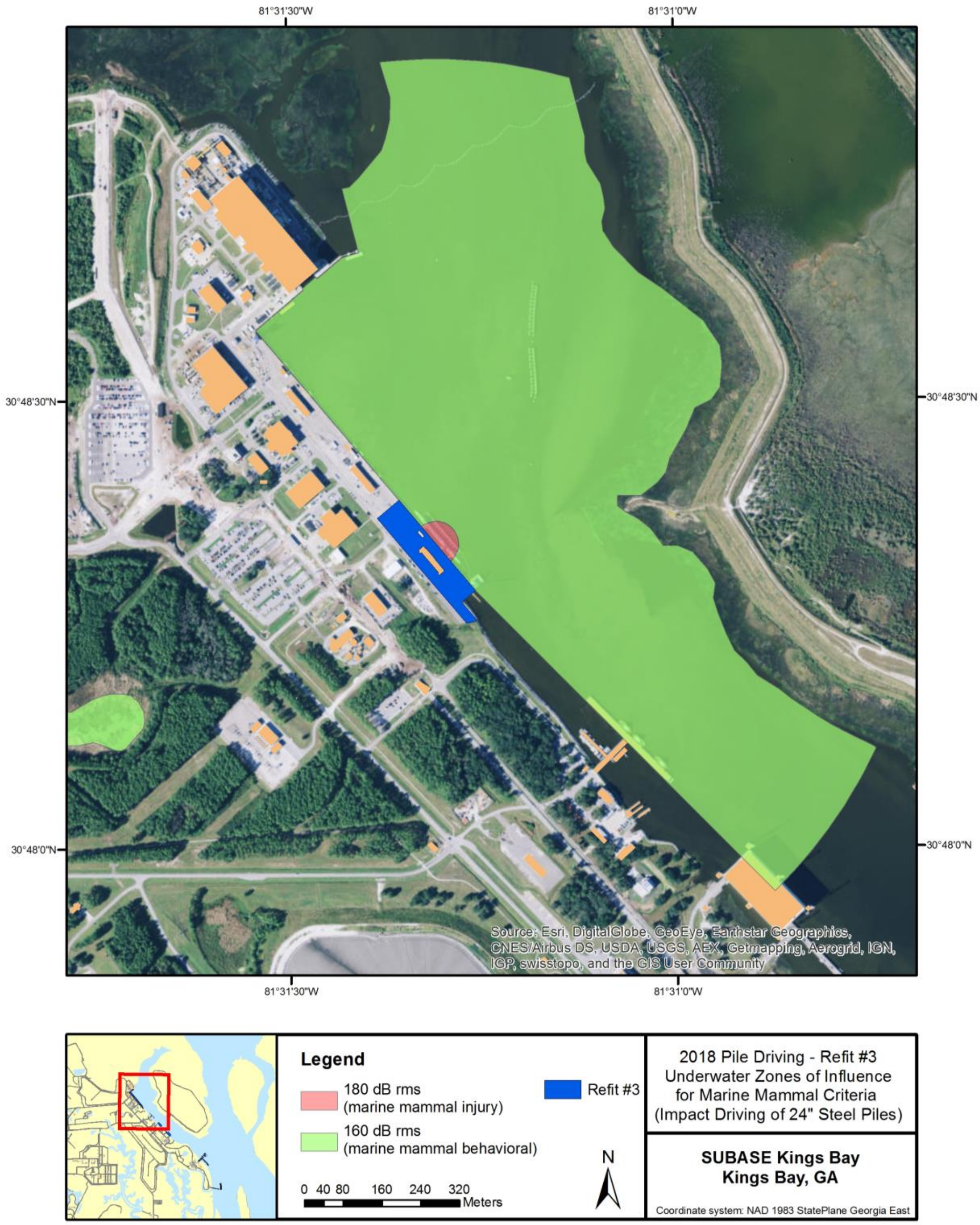


Figure 6-13. Project 3E – Refit Wharf 3 Impact Driving ZOIs



6.4.2.3 Projects beginning in FY 2019

No projects are expected to begin during FY 2019. While projects beginning in previous fiscal years may continue into this year, those potential exposures are accounted for in the fiscal years in which the projects begin.

6.4.2.4 Projects beginning in FY 2020

Two projects would be completed during 2020. Maps of ZOIs for each project and summary of estimated exposures are briefly described below. A total of 0 Level A and 104 Level B sound exposures were estimated for this year of the Project.

6.4.2.4.1 Project 4A: New Facility

The new facility project would require installation of 165 new 24-inch square concrete piles and 50 new 18-inch square concrete piles. Approximately 121 piles would be removed with a vibratory hammer. It is anticipated 16 to 22 piles would be removed and three to 12 piles would be installed per day for approximately 80 days of in-water work. Figures 6-14 and 6-15 illustrate the zones of influence for this project; modeling estimated 0 Level A and 64 Level B exposures.

A total of 0 Level A and 64 Level B exposures are expected during this project.

6.4.2.4.2 Project 4B: Small Craft Berth Site VI P617

Pile driving at the Site VI Small Craft Berth Site requires four days of vibratory extraction of 24" steel pipe piles (Figure 6-16), resulting in an estimated 0 Level A exposures and 32 Level B exposures. Impact installation of replacement 24" steel pipe piles will require 4 days of driving (Figure 6-17), resulting in 0 Level A and 8 Level B exposures.

A total of 0 Level A and 40 Level B exposures are expected during this project.

Figure 6-14. Project 4A – New Facility Vibratory Driving ZOIs

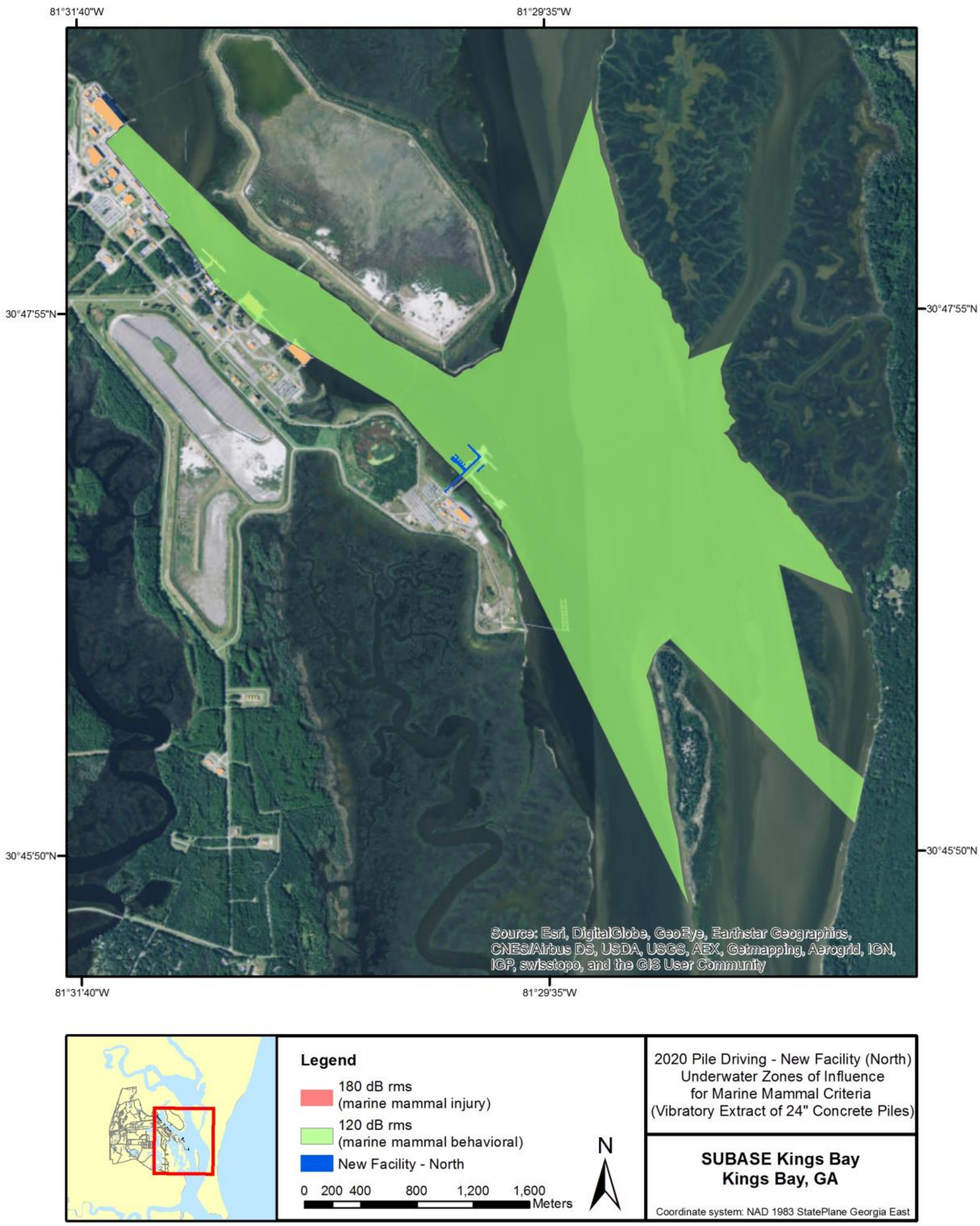


Figure 6-15. Project 4A – New Facility Impact Driving ZOIs

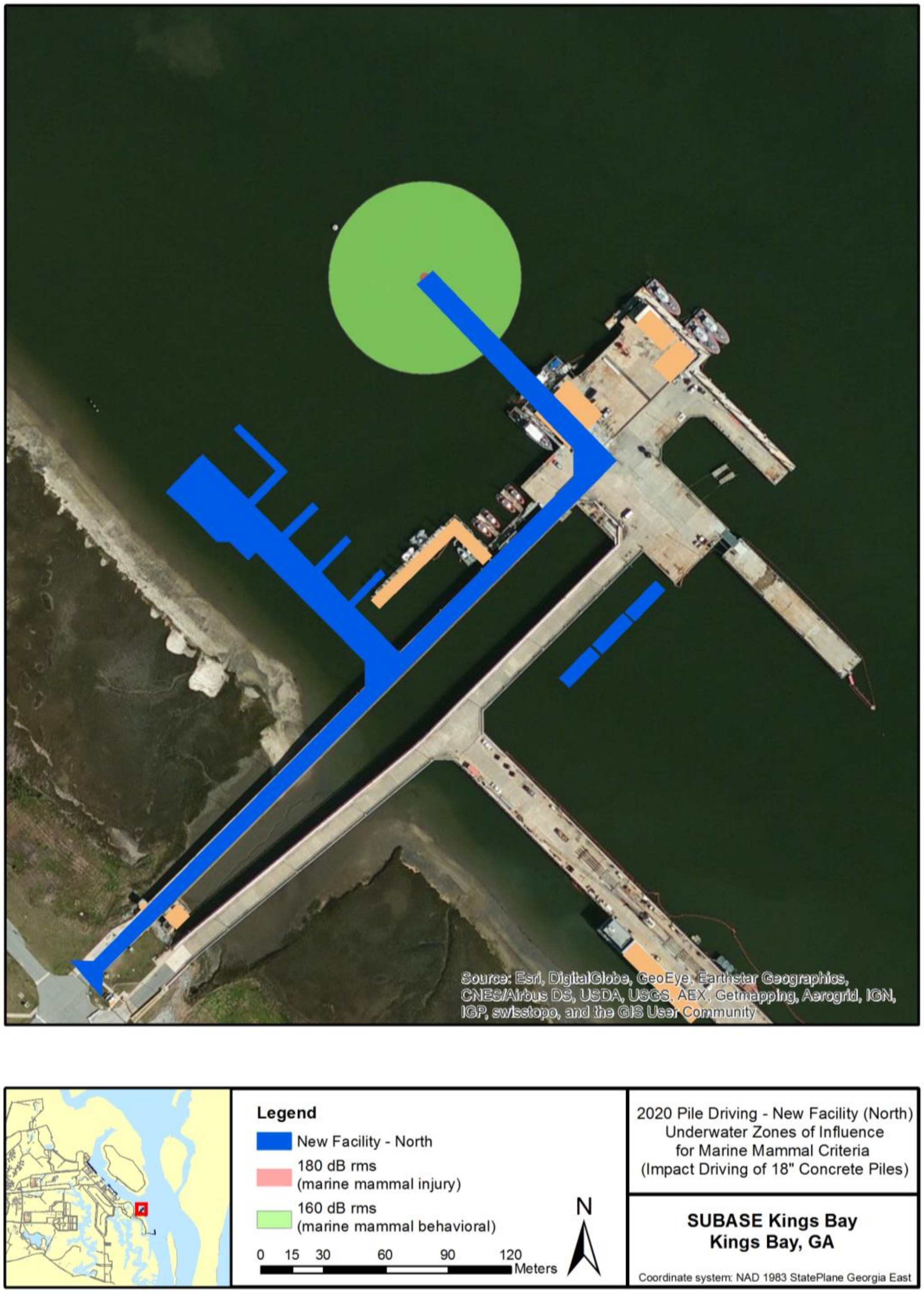


Figure 6-16. Project 4B – Small Craft Berth Site VI Vibratory Driving ZOIs

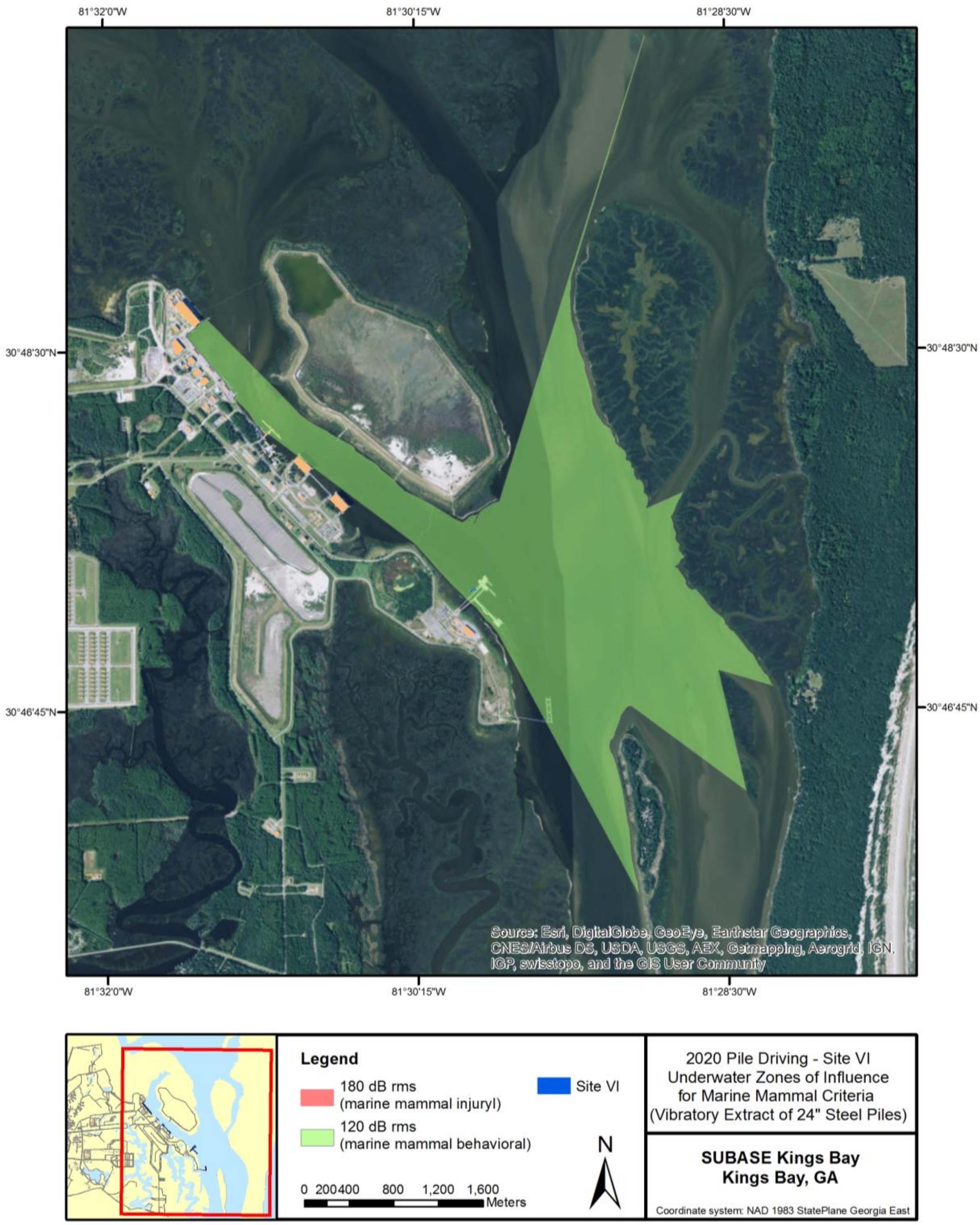
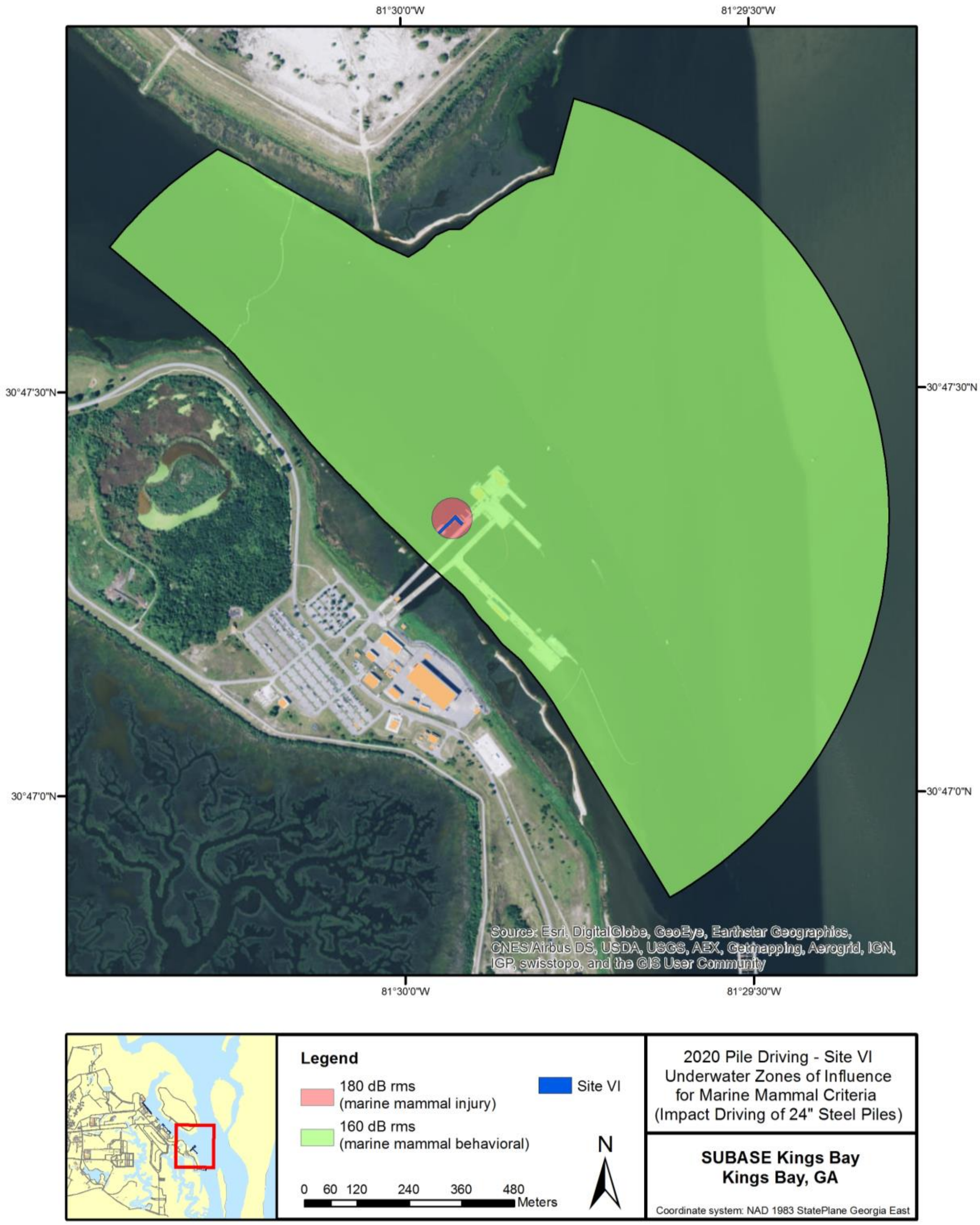


Figure 6-17. Project 4B – Small Craft Berth Site VI Impact Driving ZOIs



6.4.2.5 Projects beginning in FY 2021

Four projects would be completed during 2021. Maps of ZOIs for each project and summary of estimated exposures are briefly described below. A total of 0 Level A and 33 Level B sound exposures were estimated for this year of the Project.

6.4.2.5.1 Project 3B: (Dry Dock) Interface Wharf

Project 3B requires seven days of vibratory extraction of 14” steel H piles (Figure 6-18), resulting in an estimated 0 Level A exposures and 21 Level B exposures. Impact installation of replacement 14” steel H piles will require eight days of driving (Figure 6-19), resulting in 0 Level A and 0 Level B exposures.

A total of 0 Level A and 21 Level B exposures are expected during this project.

6.4.2.5.2 Project 3F: Warping Wharf with Capstan (4)

Project 3B requires two days of vibratory extraction of 30” steel pipe piles (Figure 6-20), resulting in an estimated 0 Level A exposures and 8 Level B exposures. Impact installation of replacement 30” steel pipe piles will require two days of driving (Figure 6-21), resulting in 0 Level A and 4 Level B exposures.

A total of 0 Level A and 12 Level B exposures are expected during this project.

Figure 6-18. Project 3B – (Dry Dock) Interface Wharf Vibratory Driving ZOIs

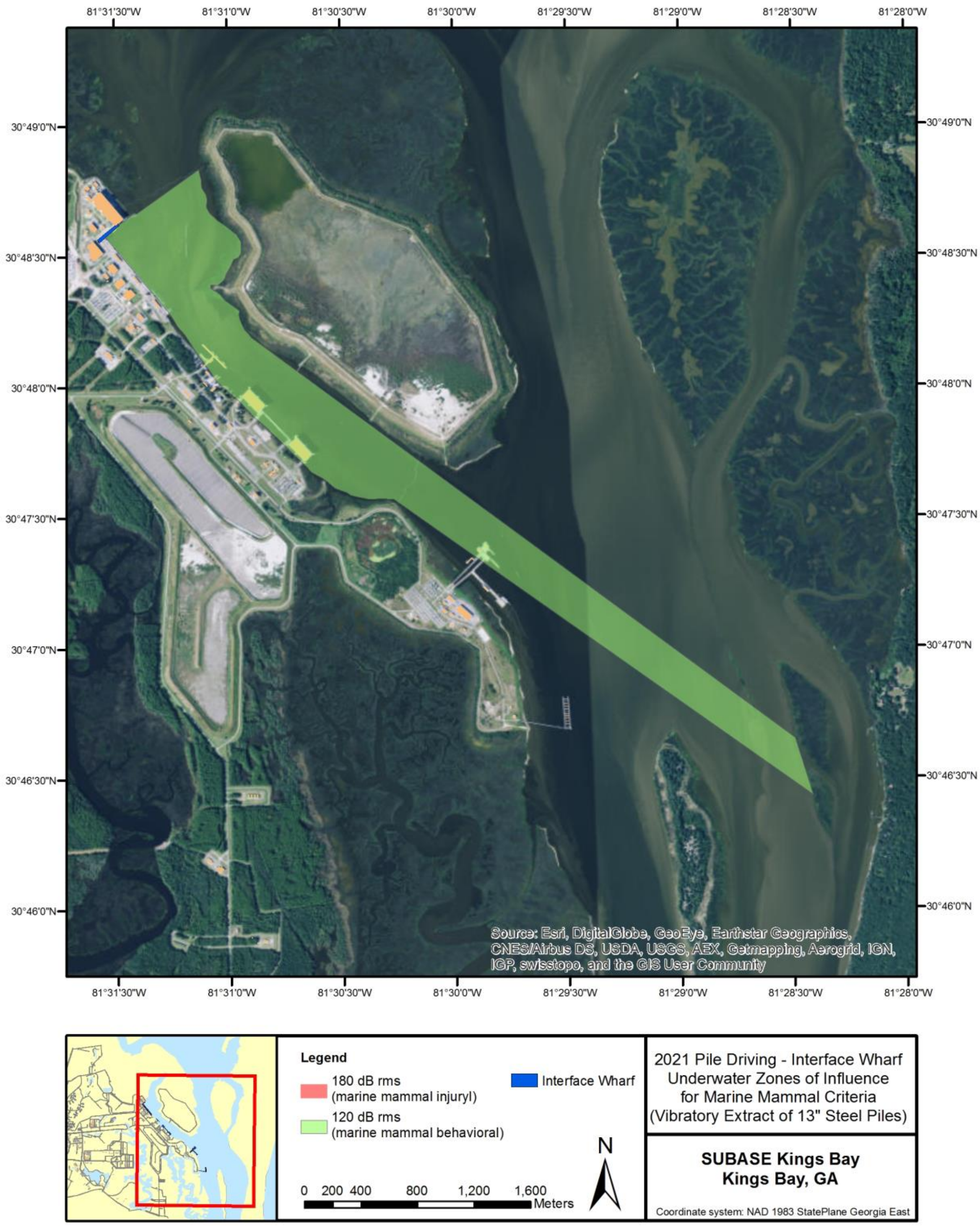


Figure 6-19. Project 3B – (Dry Dock) Interface Wharf Impact Driving ZOIs

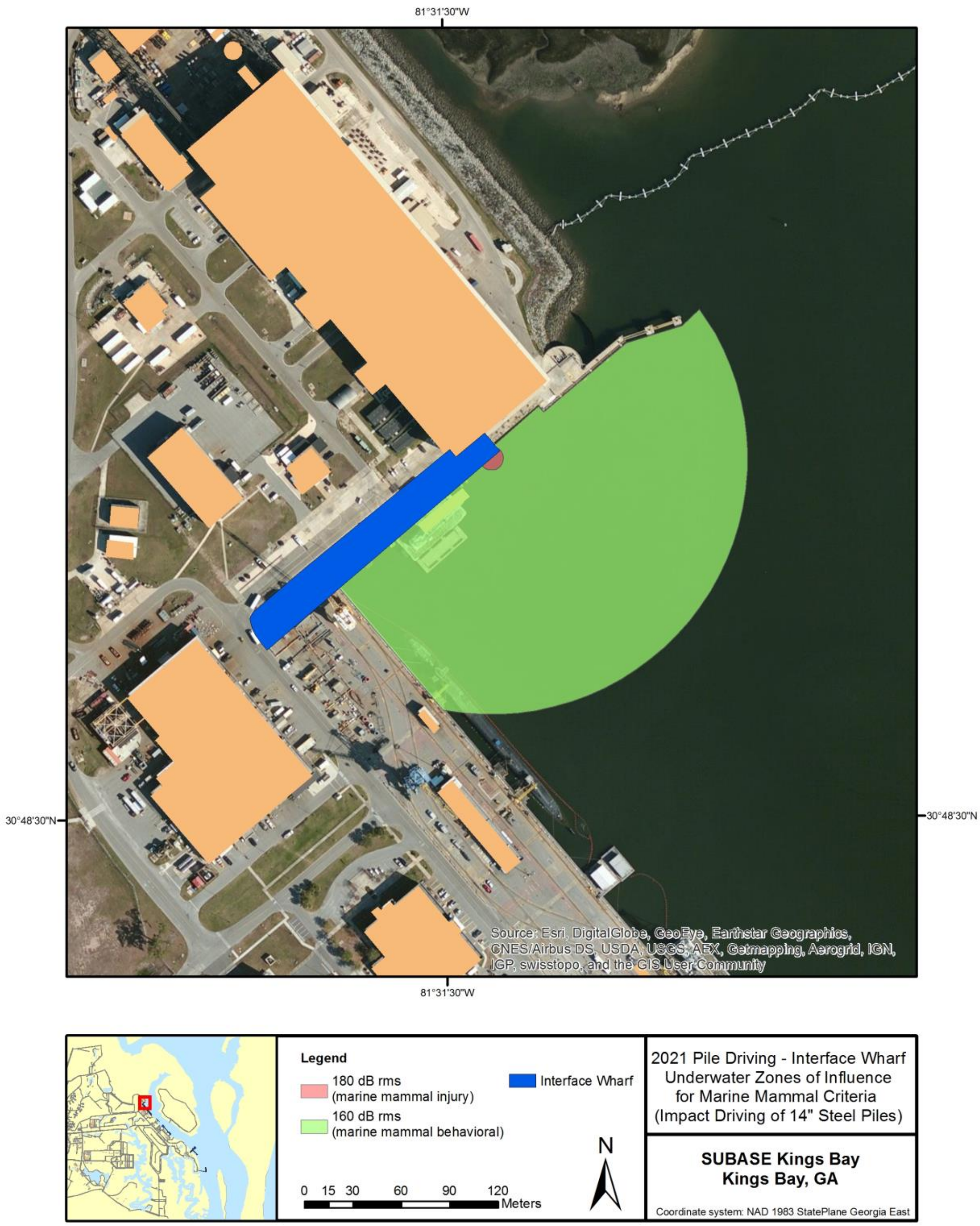


Figure 6-20. Project 3F – Warping Wharf Vibratory Driving ZOIs

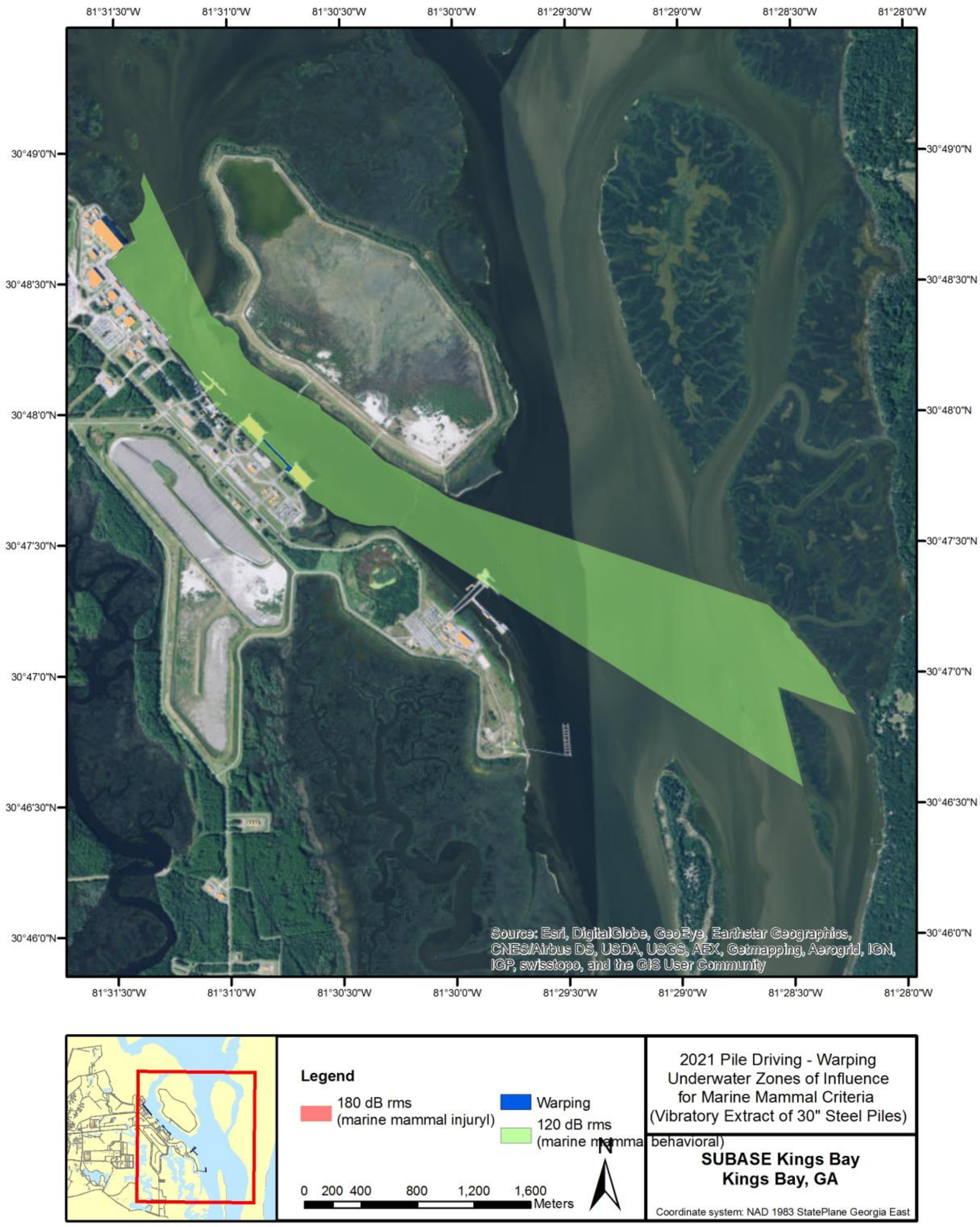
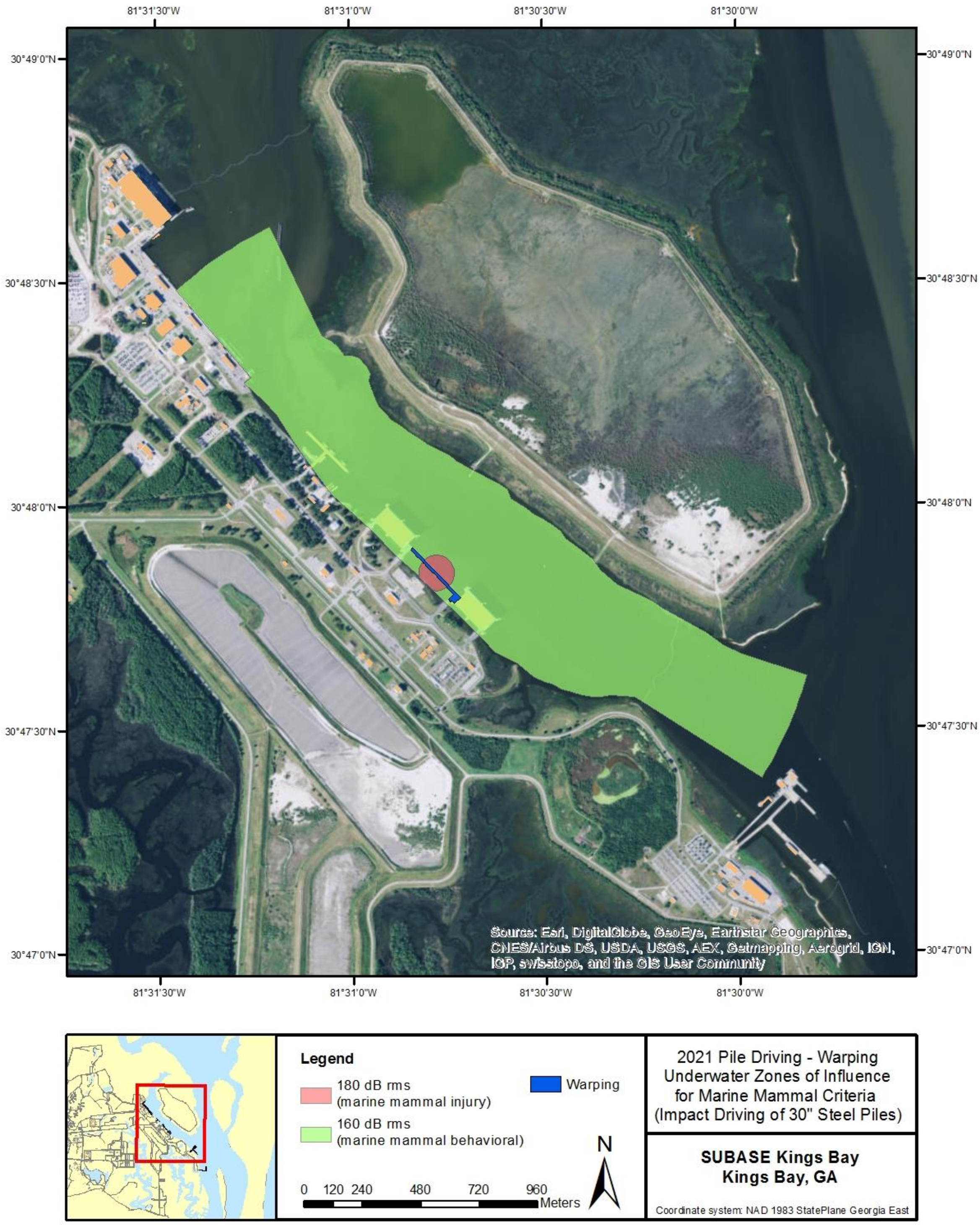


Figure 6-21. Project 3F – Warping Wharf Impact Driving ZOIs



6.4.2.6 Projects beginning in FY 2022

Three projects would be completed during 2022. Maps of ZOIs for each project and summary of estimated exposures are briefly described below. A total of 0 Level A and 522 Level B sound exposures were estimated for this year of the Project.

6.4.2.6.1 Project 3A: Explosives Handling Wharf #2 Pier with Capstans (7)

Repairs to EHW-2 at SUBASE Kings Bay during 2022 will require one day of vibratory extraction of 24” concrete piles, and three days of vibratory extraction of 24” steel pipe piles. These ZOIs are shown in Figure 6-24. Vibratory extraction is expect to result in 0 Level A and 16 Level B exposures. Installation of replacement 24” concrete and steel pipe piles will require one and four days of impact driving, respectively (Figure 6-25), with an estimated 0 Level A and 4 Level B exposures.

A total of 0 Level A and 20 Level B exposures are expected during this project.

6.4.2.6.2 Project 3G: Tug Pier

Repairs to the Tug Pier (Project 3G) at SUBASE Kings Bay will require eight days of vibratory extraction of 14” steel H piles (Figure 6-26), resulting in 0 Level A and 32 Level B exposures. Installation of replacement 14” steel H piles will require eight days of impact driving (Figure 6-27), with an estimated 0 Level A and 0 Level B exposures.

A total of 0 Level A and 32 Level B exposures are expected during this project.

6.4.2.6.3 Project 6A: Demolition of TPS Pier

Demolition at the TPS Pier will require 41 days of vibratory extraction of 24” concrete piles (Figure 6-28), resulting in 0 Level A and 410 Level B exposures.

A total of 0 Level A and 410 Level B exposures are expected during this project.

6.4.2.6.4 Project 6B: Demolition of Layberth North Trestle

Demolition at the Layberth North Trestle will require 6 days of vibratory extraction of 24” concrete piles (Figure 6-28), resulting in 0 Level A and 60 Level B exposures.

A total of 0 Level A and 60 Level B exposures are expected during this project.

Figure 6-22. Project 3A – EHW-2 Vibratory Driving ZOIs

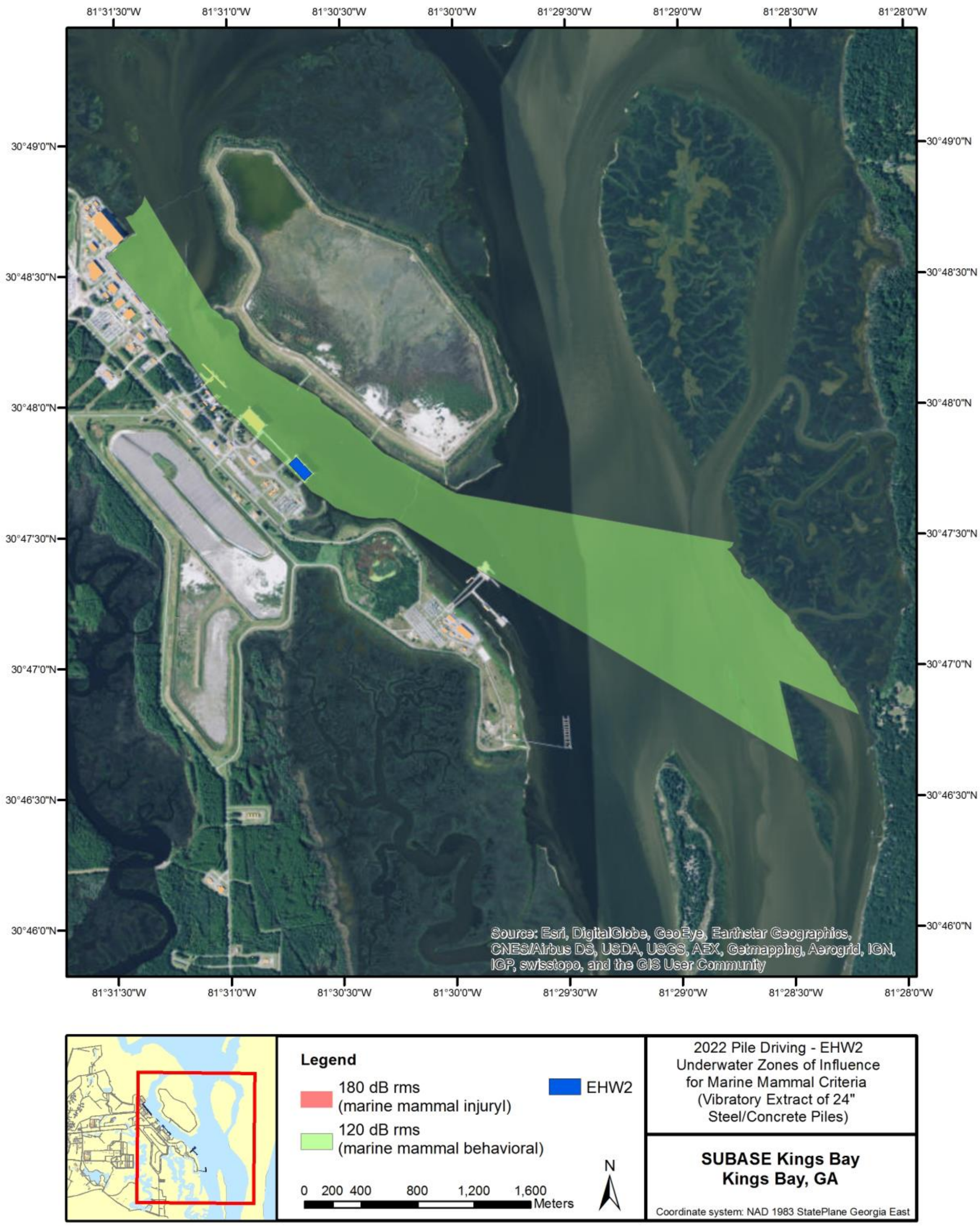


Figure 6-23. Project 3A – EHW-2 Impact Driving ZOIs

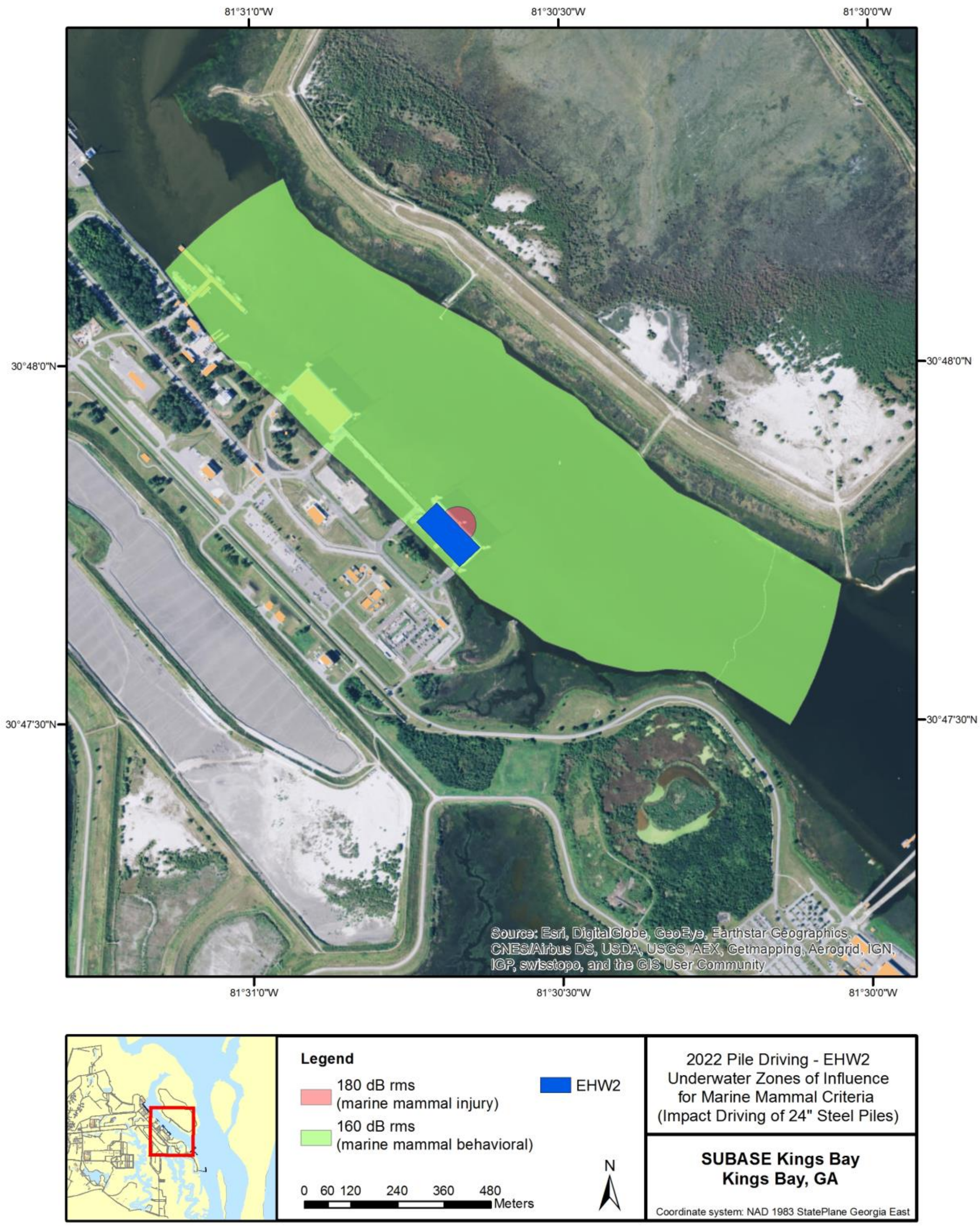


Figure 6-24. Project 3G – Tug Pier Repairs Vibratory Driving ZOIs

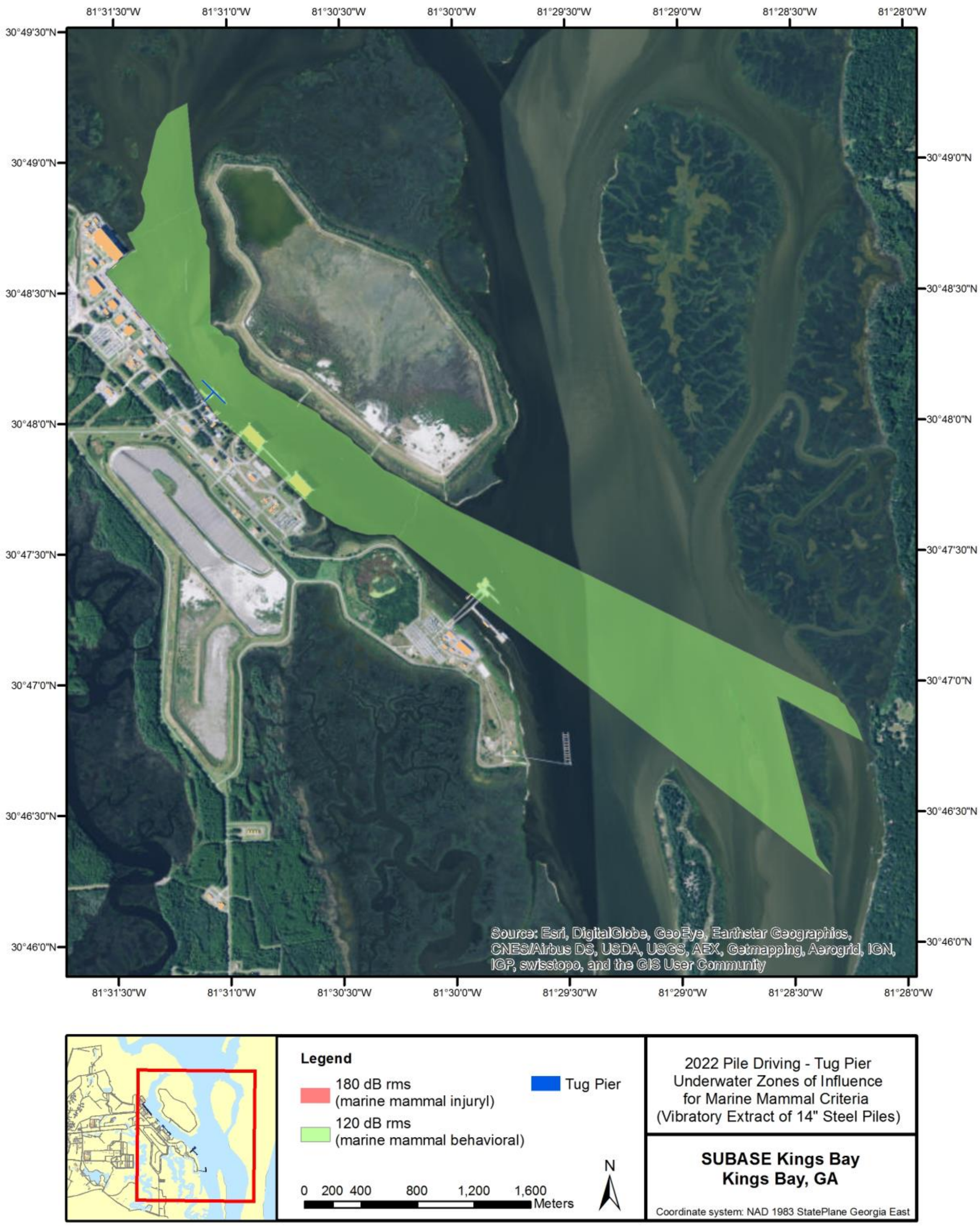


Figure 6-25. Project 3G – Tug Pier Repairs Impact Driving ZOIs

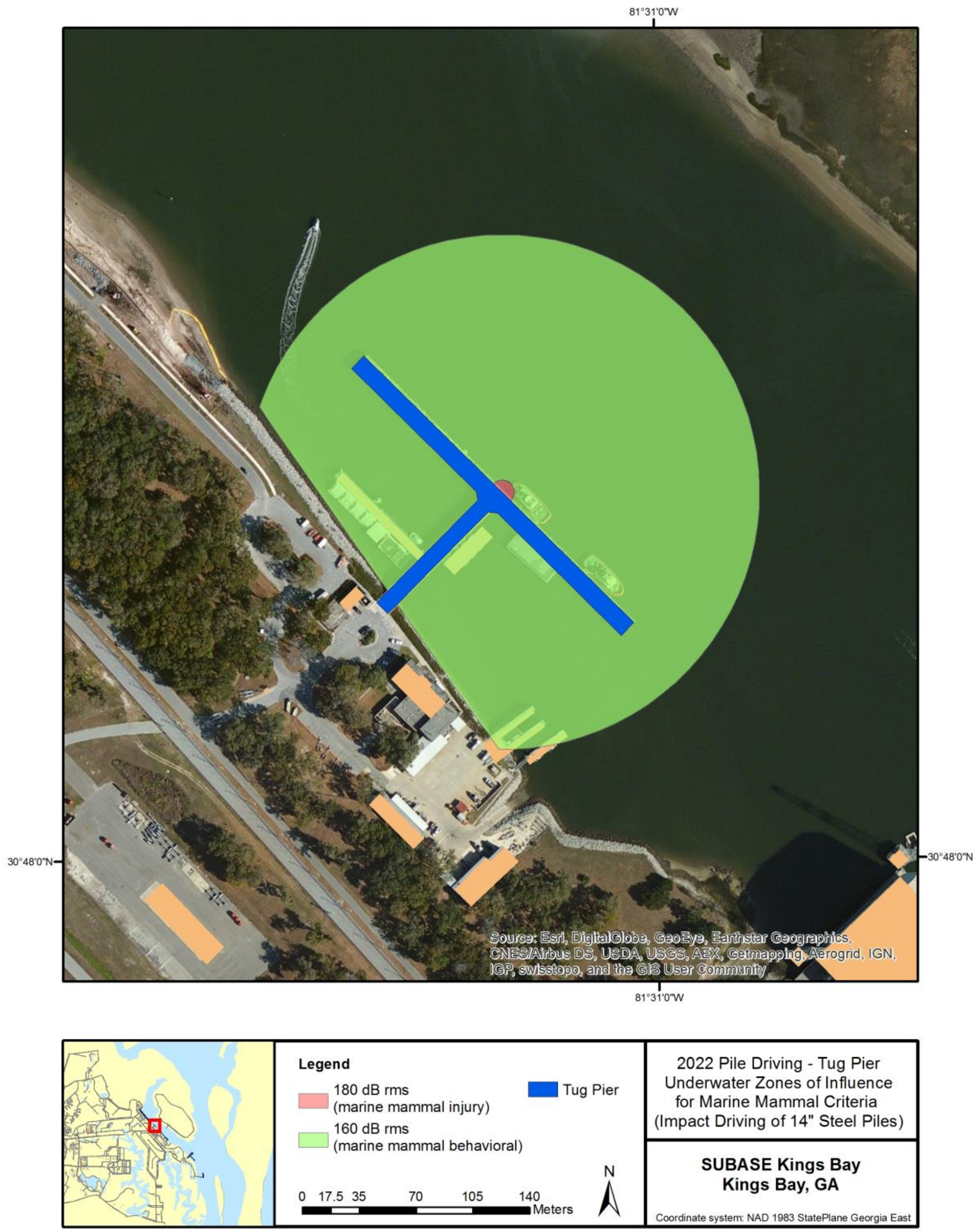
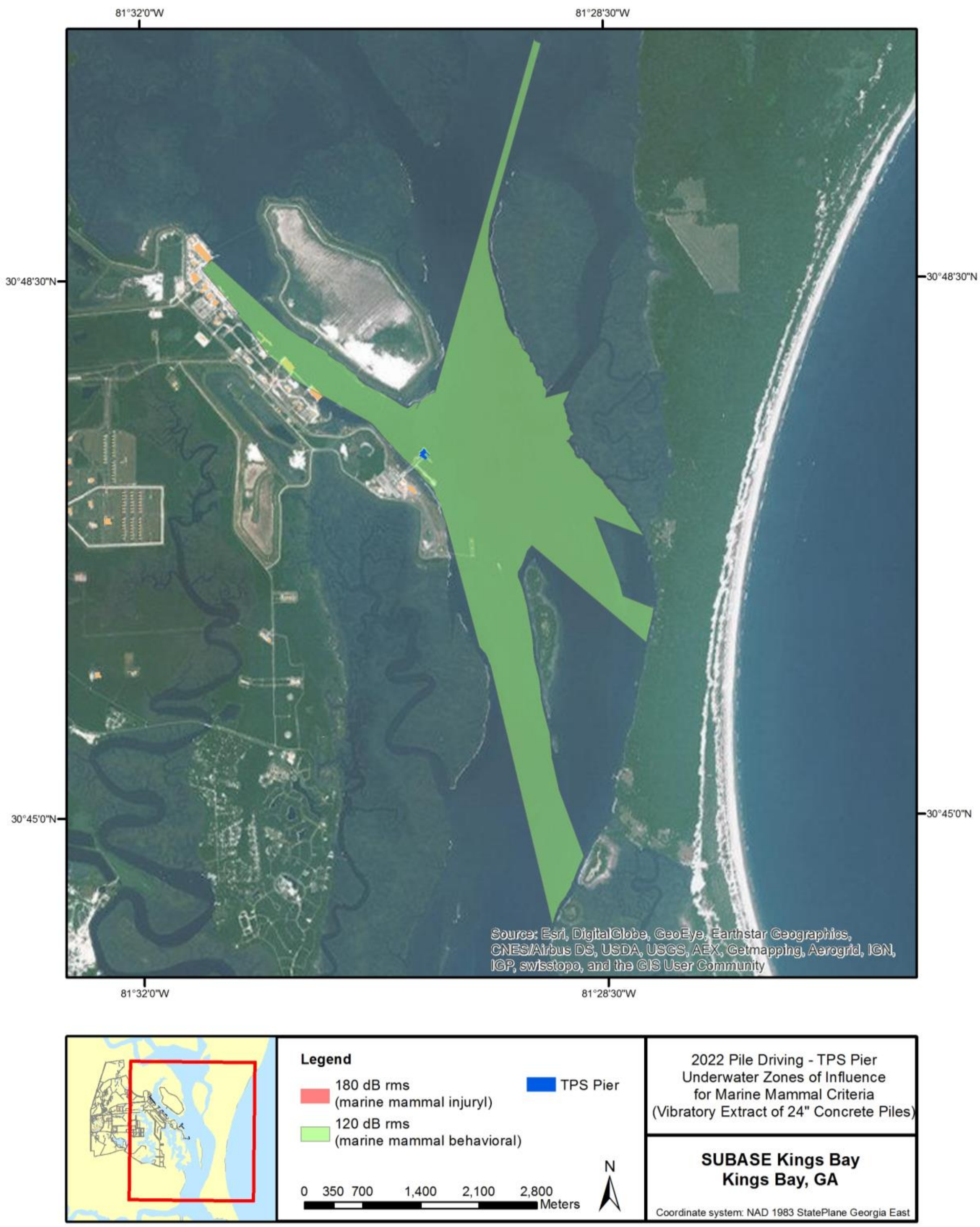


Figure 6-26. Projects 6A and 6B – Demolition of TPS Pier and North Trestle Vibratory Driving ZOIs



7 IMPACTS ON MARINE MAMMAL SPECIES OR STOCKS

The anticipated impact of the activity upon the species or stock of marine mammals

The effects of pile driving noise on marine mammals depend on several factors, including:

- Type, depth, intensity, and duration of the pile driving sound,
- species,
- size of the animal and its proximity to the source,
- depth of the water column,
- substrate of the habitat, and
- sound propagation properties of the environment.

Impacts to marine mammals from pile driving activities are expected to result primarily from acoustic pathways. As such, the degree of effect is intrinsically related to the received level and duration of the sound exposure, which are in turn influenced by the distance between the animal and the source. The farther away from the source, the less intense the exposure will be. The substrate and depth of the habitat affect the sound propagation properties of the environment. Shallow environments are typically more structurally complex, which leads to rapid sound attenuation. In addition, substrates that are soft (i.e., sand) absorb and attenuate the sound more readily than hard substrates (rock) which may reflect the acoustic wave. Soft porous substrates will also likely require less time to drive the pile, and possibly less forceful equipment, which would ultimately decrease the intensity of the acoustic source to other locations

Behavioral impacts may occur, but the type and severity of these effects are difficult to define due to individual differences in response and limited studies addressing the behavioral effects of sounds on marine mammals. The behavioral responses most likely to occur during the proposed Project are habituation and temporary relocation (Ridgway et al. 1997; Finneran et al. 2003; Wartzok et al. 2003). The time required to drive each pile would be short, so anticipated behavioral disturbances are expected to be discreet and brief. Injurious impacts to marine mammal species are not expected, but would be the result of physiological responses to both the type and strength of the acoustic signature (Viada et al. 2008).

7.1 PHYSIOLOGICAL RESPONSES

No Level A exposures are expected during the Project due to the mitigation measures outlined in Chapter 11 and the conservative modeling assumptions discussed in Chapter 5. In general, physiological responses of marine mammals to impulsive sound stimulation range from non-injurious vibration or compression of tissue to injurious tissue trauma, although BMPs and mitigation measures would minimize or eliminate such occurrences during this Project.

7.2 BEHAVIORAL RESPONSES

The intent of the Project is to complete repairs and modernizations of port facilities at SUBASE Kings Bay. These projects will require vibratory extraction of exisiting pilings, as well as impact installation of replacement and new piles. The geology of the SUBASE Kings Bay area includes a relatively shallow limestone layer that prevents the use of vibratory installation of piles. However, the time required to extract and install piles via vibratory and impact methods is expected to be short (< 60 min per pile). Therefore, potential behavioral disturbances are anticipated to be intermittent and brief.

Studies of marine mammal responses to pile driving (both impact and vibratory methods) are limited. Marine mammal monitoring at the Port of Anchorage marine terminal redevelopment project in Anchorage, Alaska, found no response by marine mammals swimming within the threshold distances to noise impacts from construction activities including pile driving (both impact hammer and vibratory driving) (Integrated Concepts & Research Corporation 2009). Small numbers of cetaceans (beluga whales, harbor porpoise) and pinnipeds (harbor seals, Steller sea lions) were observed. This study also noted that the background noise levels at this port are typically relatively high (~125 dB rms). This background noise is due to both strong tidal currents and marine traffic from shipping vessels at the Port of Anchorage. Such high background noise levels could help habituate marine mammals to non-impulsive sounds from vibratory pile driving in their environment.

Responses to impact pile driving are expected to be more acute than response to vibratory driving. Controlled experiments with captive marine mammals showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway et al. 1997; Finneran et al. 2003). Observed responses of wild marine mammals to loud impulsive sound sources (typically seismic guns or acoustic harassment devices) have been varied, but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds 2002; also see reviews in Gordon et al. 2003; Wartzok et al. 2003; and Nowacek et al. 2007).

Regardless of the source of the sound, behavioral responses to sound are highly variable. The magnitude of each potential behavioral change ultimately determines the severity of the response. A number of factors may influence an animal's response to noise, including its previous experience, its auditory sensitivity, its biological and social status (including age and sex), and its behavioral state and activity at the time of exposure.

A comprehensive review of acoustic and behavioral responses to noise exposure by Nowacek et al. (2007) concluded one of the most common responses is displacement. To assess the significance of displacements, it is necessary to know the areas to which the animals relocate, the quality of that habitat, and the duration of the displacement in the event they return to the pre-disturbance area. Short-term displacement may not be of great concern unless the disturbance happens repeatedly. Similarly, long-term displacement may not be of concern if adequate replacement habitat is available.

Marine mammals exposed to pile driving sound over the course of the Project would likely avoid affected areas if they experience noise-related discomfort. As described in the section above, individual responses to pile driving noise are expected to be variable. Some individuals may occupy the Project Area during pile driving without apparent discomfort while others may be displaced with undetermined long-term effects. Avoidance of the affected area during pile driving operations would reduce or eliminate the likelihood of injury impacts, but may also reduce access to foraging areas on SUBASE Kings Bay. Given the duration of the project there is a potential for displacement of marine mammals from the affected area due to these behavioral disturbances during the in-water work period. However, the time required to drive each pile by impact and/or vibratory methods would be short (< 60 min per pile), and the number of days of pile driving for each project within the action is limited. Potential behavioral disturbances are therefore expected to be discreet and brief. Further, since pile driving will only occur during daylight hours, marine mammals transiting the activity area or foraging or resting in the Project Area at night will not be affected.

At SUBASE Kings Bay, the background sound levels exceed 120 dB re 1µPa, with average levels as high as 135 dB rms. Marine mammals that regularly inhabit the installation's waters may therefore become habituated to non-impulsive sound over 120 dB rms, and would in fact not be able to distinguish noise from pile driving at or below background sound levels. The modeling for this project was thus very conservative, as ZOIs were modeled out to the 120 dB rms criterion.

Habituation is a response that occurs when an animal's reaction to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok et al. 2003). Animals are most likely to habituate to sounds that are predictable and unvarying. The opposite process is sensitization—when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. Behavioral state or differences in individual tolerance levels may affect the type of response as well. For example, animals that are resting may show greater behavioral change in response to disturbing noise levels than animals that are highly motivated to remain in an area for feeding (Richardson et al. 1995; National Research Council 2003; Wartzok et al. 2003). Indicators of disturbance may include sudden changes in the animal's behavior or avoidance of the affected area. A marine mammal may show signs that it is startled by the noise and/or it may swim away from the sound source and avoid the area. Increased surfacing time and temporary cessation of foraging in the Project Area could indicate disturbance or discomfort in marine mammals.

Given the relatively low density of marine mammals found in the SUBASE Kings Bay waters, it is unlikely that the area is used extensively for foraging by a discrete population of animals. Effects of pile driving activities may be experienced by individual marine mammals, but are highly unlikely to cause population-level impacts or affect the continued survival of the stock.

7.3 CONCLUSIONS REGARDING IMPACTS TO SPECIES OR STOCKS

Individual marine mammals may be exposed to high sound pressure levels during pile removal and installation, which may result in Level B behavioral harassment. Any marine mammals exposed (harassed) may change their normal behavior patterns (i.e., swimming speed, foraging habits, etc.) or be temporarily displaced from the construction area. Any exposures will likely have only a minor effect on individuals and no effect on their populations. The sound generated from vibratory pile driving is non-impulsive, which is not known to cause injury to marine mammals, and mitigation measures and BMPs are expected to prevent adverse physiological impacts to marine mammals from impact pile driving. Nevertheless, some exposure is unavoidable. The expected level of unavoidable exposure (defined as acoustic harassment) is presented in Chapter 6. This level of effect is not anticipated to have any adverse impact to bottlenose dolphins' population recruitment, or survival.

8 IMPACTS ON SUBSISTENCE USE

The anticipated impact of the activity on the availability of the species or stock of marine mammals for subsistence uses.

Potential marine mammal impacts resulting from the Project will be limited to populations for which there is no known historic or current subsistence use. Therefore, no impacts on the availability of species or stocks for subsistence use are considered.

9 IMPACTS ON MARINE MAMMAL HABITAT AND THE LIKELIHOOD OF RESTORATION

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

Activities associated with the Project are expected to result in removal of a small amount of low-quality habitat, and disturb sediments, and benthic and forage fish communities, on a temporary, highly localized scale. The relatively high amount of vessel traffic in the confined space of the SUBASE Kings Bay area and the transition to the federal navigation channel, has resulted in a determination the Kings Bay project area encompasses relatively low quality habitat for most marine species.

Pile installation and deployment of anchors and / or spuds from barges may result in temporary, small scale disturbance of benthic communities and marine vegetation in the immediate vicinity of the project. Benthic organisms may be disturbed, buried or crushed by anchors and / or spuds and removal of piles; this may result in a temporary degradation or loss of isolated foraging habitat for marine mammals. However, sediments and marine vegetation are expected to return to their prior conditions and cover within a short time of the conclusion of the in-water work.

The new surfaces associated with the piles and exposed concrete will likely result in establishment of fouling communities on the new and existing structures, and may attract fish and benthic organisms resulting in very small scale shifts in prey distribution.

Overall, small-scale, temporary changes to habitat and community assemblages in the immediate project area are expected to occur, but natural sedimentation and succession / recruitment will likely return the project footprint to pre-construction conditions within a short amount of time after in-water work is completed.

10 IMPACTS ON MARINE MAMMALS FROM LOSS OR MODIFICATION OF HABITAT

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The Project is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual or populations of marine mammals because of the relatively small footprint and existing disturbed conditions. Further, all impacts will be temporary, with pile driving activity for each project within the Project being completed within days to weeks of the project start. Information provided in Chapter 9 (Impacts on Marine Mammal Habitat and the Likelihood of Restoration) indicates there may be temporary impacts, but those impacts would be limited to the immediate area. Impacts will cease upon the completion of activities associated with the Project.

11 MEANS OF EFFECTING THE LEAST PRACTICABLE ADVERSE IMPACTS – STANDARD OPERATING PROCEDURES AND MITIGATION MEASURES

The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of affecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

This section summarizes best management practices and mitigation measures that will be implemented during in-water construction activities. Best Management Practices (BMPs) are essential to maintaining safety and mission success, and in many cases have the added benefit of reducing potential environmental impacts. Mitigation measures are designed to help reduce or avoid potential impacts on marine resources. When applicable, mitigation measures developed for construction activities are consistent with those developed as part of the Atlantic Fleet Training and Testing EIS/OEIS and section 7 consultation for the West Indian manatee (*Trichechus manatus*). BMPs and minimization measures are included in the construction contract plans and specifications and must be agreed upon by the contractor prior to any construction activities. Upon signing the contract, it becomes a legal agreement between the contractor and the Navy. Failure to follow the prescribed BMPs and minimization measures is a contract violation.

A separate *Marine Mammal Monitoring Plan for Waterfront Pile Repair, Replacement, and Facilities Maintenance at Naval Submarine Base Kings Bay, Georgia* has been prepared, and contains specific details for each project.

General Construction Best Management Practices

1. All work shall adhere to performance requirements of the Clean Water Act, Section 404 permit and Section 401 Water Quality Certification. No in-water work shall begin until after issuance of regulatory authorizations.
2. The construction contractor is responsible for preparation of an Environmental Protection Plan. The plan shall be submitted and implemented prior to the commencement of any construction activities and is a binding component of the overall contract. The plan shall identify construction elements and recognize spill sources at the site. The plan shall outline BMPs, responsive actions in the event of a spill or release, and notification and reporting procedures. The plan shall also outline contractor management elements such as personnel responsibilities, project site security, site inspections, and training.
3. No petroleum products, lime, chemicals, or other toxic or harmful materials shall be allowed to enter surface waters.
4. Washwater resulting from washdown of equipment or work areas shall be contained for proper disposal, and shall not be discharged unless authorized.

5. Equipment that enters surface waters shall be maintained to prevent any visible sheen from petroleum products.
6. No oil, fuels, or chemicals shall be discharged to surface waters, or onto land where there is a potential for re-entry into surface waters shall occur. Fuel hoses, oil drums, oil or fuel transfer valves, fittings, etc. shall be checked regularly for leaks, and be maintained and stored properly to prevent spills.
7. No cleaning solvents or chemicals used for tools or equipment cleaning shall be discharged to ground or surface waters.
8. Construction materials shall not be stored where high tides, wave action, or upland runoff could cause materials to enter surface waters.
9. Barge operations shall be restricted to tidal elevations adequate to prevent grounding of a barge.
10. All in-water construction activities shall occur during daylight hours (one hour post sunrise to one hour prior to sunset[1]). Construction activities on land could occur between 6:00 AM and 10:00 PM during any time of the year.

Pile Removal and Installation Best Management Practices

1. A containment boom surrounding the work area shall be used during creosote-treated pile removal to contain and collect any floating debris and sheen. The boom may be lined with oil-absorbing material to absorb released creosote.
2. Oil-absorbent materials shall be used in the event of a spill if any oil product is observed in the water.
3. All creosote-treated material and associated sediments shall be disposed of in a landfill that meets Georgia environmental standards.
4. Removed piles and associated sediments (if any) shall be contained on a barge. If a barge is not utilized, piles and sediments may be stored in a containment area near the construction site.
5. Soft starts are performed at the beginning of impact pile driving. During a soft start, an initial set of strikes from the impact hammer at reduced energy are performed before it is able to be operated at full power and speed. The energy reduction of an individual hammer cannot be quantified because they vary by individual drivers. Also, the number of strikes will vary at reduced energy because raising the hammer at less than full power and then releasing it results in the hammer "bouncing" as it strikes the pile resulting in multiple "strikes." Initiating impact pile driving at a lower power may allow marine mammals an opportunity to move away from the immediate vicinity of the activity,

[1] Sunrise and sunset are to be determined based on the National Oceanic and Atmospheric Administration data which can be found at http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html.

thereby reducing the likelihood of exposure to sound levels that could cause further behavioral disturbance or injury.

6. Pilings that break or are already broken below the waterline may be removed by wrapping the piles with a cable or chain and pulling them directly from the sediment with a crane. If this is not possible, they shall be removed with a clamshell bucket. To minimize disturbance to bottom sediments and splintering of piling, the contractor shall use the minimum size bucket required to pull out piling based on pile depth and substrate. The clam shell bucket shall be emptied of piling and debris on a contained barge before it is lowered into the water. If the bucket contains only sediment, the bucket shall remain closed and be lowered to the mud line and opened to redeposit the sediment. In some cases (depending on access, location, etc.), piles may be cut below the mud line and the resulting hole backfilled with clean sediment.
7. Any floating debris generated during installation shall be retrieved. Any debris in a containment boom shall be removed by the end of the work day or when the boom is removed, whichever occurs first. Retrieved debris shall be disposed of at an upland disposal site.
8. Whenever activities that generate sawdust, drill tailings, or wood chips from treated timbers are conducted, tarps or other containment material shall be used to prevent debris from entering the water.
9. If excavation around piles to be replaced is necessary, hand tools or a siphon dredge shall be used to excavate around piles to be replaced.

Additional Minimization Measures for Marine Mammals

The following minimization measures shall be implemented during pile driving to avoid marine mammal exposure to Level A injurious noise levels generated from impact pile driving and to reduce to the lowest extent practicable exposure to Level B noise levels.

Coordination

Barge operators, construction observers, and compliance monitors will complete applicable portions of the Navy's *Marine Species Awareness Training*, and a general environmental awareness briefing conducted by Navy marine resources specialists. Specific characteristics and sample photos of the marine mammal species that would most likely be observed in the project area, as well as techniques to estimate distance and document behavior, would be included in the briefing. This training is tailored to the audience and designed to improve the effectiveness of visual observations for protected species and provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures.

Standard Conditions

Marine mammal construction observers and compliance monitors shall also read and ensure adherence to the following conditions (Appendix A):

- *NFMS Southeast Region Marine Mammal and Sea Turtle Viewing Guidelines*
- *Sea Turtle and Smalltooth Sawfish Construction Conditions*
- *Special Provisions for Manatees*

Compliance Monitoring and Shutdown Procedures

The *Marine Mammal Monitoring Plan for Waterfront Pile Repair, Replacement, and Facilities Maintenance at Naval Submarine Base Kings Bay, Georgia* include all details for shutdown and monitoring.

Observers and Procedures

Construction crews and barge operators will complete applicable portions of the Navy's *Marine Species Awareness Training*, and a general environmental awareness briefing prior to the start of repair and maintenance activities. This training is designed to improve the effectiveness of visual observations for protected species and provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures.

Marine species observers (“observers”) designated by the contractor will be placed at the best vantage point(s) practicable to monitor for protected species and implement shutdown/delay procedures when applicable by calling for the shutdown to equipment operators. The observers shall have no other construction related tasks while conducting monitoring.

Methods

Construction observer(s) will monitor the entire shutdown zone before, during, and after pile driving and removal. The shutdown zone for impact pile driving was calculated based on acoustic modeling at a notional pile location. The zone to be viewed varies at each location; shutdown zones are listed in Table 11-1. In no case will the shutdown zone be less than 15 m (50 ft), which is the standoff distance required in the Manatee Protection Measures given in Appendix A. This measure allows for a physical buffer zone between protected marine mammals and construction equipment. The construction observer(s) will have full visibility of the shutdown zone regardless of the type of driving taking place, and will be able to immediately report a marine mammal observation and initiate shutdown procedures.

Table 11-1. Vibratory and Impact Shutdown Zones For All Projects

Project	FAC #	Fiscal Year	Vibratory Shutdown Zone [m]	Impact Shutdown Zone [m]
1A	5926	2017	15	15
1B	5888	2017	15	N/A
2	5976	2017	N/A	15
3A	5109	2017/2022	15	50
3B	5955	2021	15	15
3C	5909	2018	15	50
3D	5910	2017	15	50
3E	5916	2018	15	50
3F	5877	2021	15	75
3G	5926	2022	15	15
4A	P617	2020	15	15
4B	P617	2020	15	50
5	5980	2017	15	N/A
6A	5934	2022	15	N/A
6B	5977	2022	15	N/A

Construction observers and compliance monitors designated by the contractor will be placed at a vantage point (e.g., from a small boat, construction barges, on shore, elevated perch [e.g. scissor lift], or any other suitable location) to observe all waters encompassed by the calculated zone.

The shutdown zone shall be viewed for 15 minutes prior to in water construction activities. If a marine mammal is observed in the shutdown zone, in-water activities shall be delayed until the animal(s) leaves the shutdown zone. Activity shall resume only after the construction observer has determined, through re-sighting or by waiting approximately 15 minutes that the animal(s) has moved outside the shutdown zone. The construction observer(s) shall notify the foreman/point of contact (POC) when construction activities can commence. Observation of the shutdown zone will continue for 30 minutes following the completion of pile driving.

Data Collection

The following information shall be recorded on sighting forms used by construction observers and compliance monitors:

- Date and time that pile driving or removal begins or ends
- Construction activities occurring during each observation period
- Weather parameters identified in the acoustic monitoring (e.g., wind, temperature, percent cloud cover, and visibility)
- Tide and sea state

If a marine mammal approaches or enters the shutdown zone, the following information will be recorded once shutdown procedures have been implemented:

- Any shutdown procedures implemented
- Species, numbers, and if possible sex and age class of the species (to estimate number of potential incidental takes)
- Behavior patterns observed, including bearing and direction of travel
- Location of the construction observer / compliance monitor, and distance from the animal(s) to the observer

Data collection forms shall be furnished to the NAVFAC Southeast POC within a mutually agreeable timeframe.

Interagency Notification

If the contractors encounter a marine mammal that is injured, sick, or dead, the installation natural resources manager shall be notified immediately. The Navy will in turn notify the appropriate regulatory agencies.

The Navy will provide the regulatory agencies with information as requested, such as the species or description of the animal(s), the condition of the animal (including carcass condition if the animal is dead), location, the date and time of first discovery, observed behaviors (if alive), and photo or video (if available).

In preservation of biological materials from a dead animal, the construction observer / compliance monitor has the first responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Construction observers / compliance monitors shall not handle dead animals.

Reporting

Monitoring reports will be provided to NMFS in accordance with permit requirements and timelines.

12 MINIMIZATION OF ADVERSE IMPACTS ON SUBSISTENCE USE

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;

(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;

(iii) A description of what measures the applicant has taken an/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

As detailed in Chapter 8, no impacts on the availability of species or stocks for subsistence use are considered. Therefore, no minimization efforts are applicable.

13 MONITORING AND REPORTING EFFORTS

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding.

The Navy is committed to demonstrating environmental stewardship while executing its National Defense Mission and complying with the suite of Federal environmental laws and regulations. As a complement to the Navy's commitment to avoiding and reducing impacts of the Proposed Action through mitigation (Chapter 11, Means of Effecting the Least Practicable Adverse Impacts), the Navy will implement monitoring efforts under the existing Integrated Comprehensive Monitoring Program. Taken together, mitigation and monitoring comprise the Navy's integrated approach for reducing environmental impacts from the Proposed Action. The Navy's overall monitoring approach will seek to leverage and build on existing research efforts whenever possible.

13.1 INTEGRATED COMPREHENSIVE MONITORING PROGRAM TOP-LEVEL GOALS

The Integrated Comprehensive Monitoring Program is intended to coordinate monitoring efforts across all regions where the Navy trains and tests and to allocate the most appropriate level and type of effort for each range complex (U. S. Department of the Navy 2010). Originally, the Navy monitoring program was composed of a collection of "range-specific" monitoring plans, each developed individually as part of Marine Mammal Protection Act and Endangered Species Act compliance processes as environmental documentation was completed. These individual plans established specific monitoring requirements for each range complex and were collectively intended to address the Integrated Comprehensive Monitoring Program top-level goals.

A 2010 Navy-sponsored monitoring meeting in Arlington, Virginia, initiated a process to critically evaluate the Navy monitoring plans and begin development of revisions and updates to both the region-specific plans as well as the Integrated Comprehensive Monitoring Program. Discussions at that meeting as well as the following Navy and NMFS annual adaptive management meeting established a way ahead for continued refinement of the Navy's monitoring program. This process included establishing a Scientific Advisory Group of leading marine mammal scientists with the initial task of developing recommendations that would serve as the basis for a Strategic Planning Process for Navy monitoring. The Strategic Plan is intended to be a primary component of the Integrated Comprehensive Monitoring Program and provide a "vision" for Navy monitoring across geographic regions - serving as guidance for determining how to most efficiently and effectively invest the marine species monitoring resources to address Integrated Comprehensive Monitoring Program top-level goals and satisfy MMPA Letter of Authorization regulatory requirements.

The objective of the Strategic Planning Process is to continue the evolution of Navy marine species monitoring towards a single integrated program, incorporating Scientific Advisory Group recommendations, and establishing a more transparent framework for soliciting, evaluation, and implementing monitoring work across the range complexes and testing ranges. The Strategic Planning Process must consider a range of factors in addition to the scientific recommendations including logistic, operational, and funding considerations and will be revised regularly as part of the annual adaptive management process.

Details on the Navy's marine species monitoring program including the ICMP and Strategic Planning Process can be found on the program's web portal –

www.navymarinespeciesmonitoring.us.

14 RESEARCH EFFORTS

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

At this time the Navy does not anticipate any specific research conducted in conjunction with the Project.

The Navy strives to be a world leader in marine species research and has provided more than $100 million over the past five years to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to increase the understanding of marine species physiology and behavior with several projects ongoing in Washington.

The Navy sponsors 70 percent of all U.S. research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. Major topics of Navy-supported research include the following:

- Gaining a better understanding of marine species distribution and important habitat areas
- Developing methods to detect and monitor marine species before and during training
- Understanding the effects of sound on marine mammals
- Developing tools to model and estimate potential effects of sound

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and outside research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods into Navy activities. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential monitoring tool. Overall, the Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include monitoring programs, data sharing with NMFS from research and development efforts, and future research as previously described.

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Appendix A

Construction Conditions for Protected Marine Species

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, FL 33701

SEA TURTLE AND SMALLTOOTH SAWFISH CONSTRUCTION CONDITIONS

The permittee shall comply with the following protected species construction conditions:

a. The permittee shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles and smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of these species.

b. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles or smalltooth sawfish, which are protected under the Endangered Species Act of 1973.

c. Siltation barriers shall be made of material in which a sea turtle or smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

d. All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

e. If a sea turtle or smalltooth sawfish is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle or smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.

f. Any collision with and/or injury to a sea turtle or smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

g. Any special construction conditions, required of your specific project, outside these general conditions, if applicable, will be addressed in the primary consultation.

Revised: March 23, 2006
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Southeast Region Marine Mammal & Sea Turtle Viewing Guidelines

Limit your viewing time.

- Prolonged exposure to one or more vessels increases the likelihood that marine mammals will be disturbed.
- Viewing periods of greater than 1/2 hour should be undertaken only if you are absolutely sure that you are not causing disturbance or any changes in behavior.
- Since individual animals' reactions will vary, carefully observe all animals and leave the vicinity if you see signs of disturbance.
- Your vessel may not be the only vessel in the day that approaches the same animal(s); please be aware of cumulative impacts.

Travel in a predictable manner.

- Marine mammals appear to be less disturbed by vessels that are traveling in a predictable manner.
- The departure from a viewing area has as much potential to disturb animals as the approach.
- If a marine mammal or sea turtle approaches, put your engine in neutral and allow the animal to pass.
- Never pursue of follow marine wildlife.
- Never attempt to herd, chase, or separate groups of marine mammals or females from their young.
- Avoid excessive speed or sudden changes in speed or direction in the vicinity of animals.

If you need to move around marine wildlife, do so from behind (i.e., never approach head-on).

- Vessels that wish to position themselves so that the animals would pass them, should do so in a manner that stays fully clear of the animal's path.

Be aware that marine mammals may surface in unpredictable locations.

- Breaching and flipper slapping whales may endanger people and/or vessels.

Be on the look-out for seals.

- As their populations expand, seals are being found in southeastern states with increasing regularity, especially in North Carolina.
- Viewing or approaching seals hauled out on land should be done without the animal's awareness of your presence.
- Avoid detection by sight, smell, or sound (e.g., by staying hidden behind natural cover and approaching viewing areas quietly by avoiding conversation and noisy movements).
- Pups are often left alone when the mother is feeding. *They are not abandoned and should be left alone.*

Marine mammals are more likely to be disturbed when more than one boat is near them.

- Avoid approaching the animals when another vessel is near.
- Always leave marine mammals an "escape route."
- When several vessels are in an area, communication between operators will help ensure that you do not cause disturbance.

Marine mammals have sensitive hearing and many species communicate by vocalizing underwater.

- Underwater sound produced by a vessel's engines and propellers can disturb these animals.

Cautiously move away from the animals if you observe any of the following behaviors:

- Rapid changes in direction or swimming speed.
- Erratic swimming patterns.
- Escape tactics such as prolonged diving, underwater exhalation, underwater course changes, or rapid swimming at the surface.
- Tail slapping or lateral tail swishing at the surface.
- Female attempting to shield a calf with her body or by her movements.

Even if approached by a marine mammal or sea turtle:

- Do not touch or swim with the animals.

Never feed or attempt to feed marine mammals or sea turtles.

- It can alter their natural behavior, make them dependent on handouts, and can be harmful to their health.
- Marine mammals, like all wild animals, may bite and inflict injuries to people who try to feed them.

Note: NMFS regulations at 50 CFR § 216.3 strictly prohibit feeding or attempting to feed a marine mammal in the wild.

Close approaches by humans to marine mammals may cause them to lose their natural wariness and become aggressive towards people. They are also vulnerable to injury or death from entanglement in fishing gear or boat strikes. NMFS strongly encourages people to follow the guidelines presented here while spending time on or near the water.

Please review these guidelines and make the "Code of Conduct" personal practice. Bring binoculars along on a viewing excursion to assure a good view from the recommended viewing distances. Together we can assure marine mammal viewing will be as rewarding as it is today for many generations to come.

Special Provisions for Manatee

The following conditions are intended as a minimum to protect this species and its habitat during any activities that are in close proximity to the known locations of this species on this project.

1. The permittee agrees that all personnel associated with the project will be advised that there are civil and criminal penalties for harming, harassing or killing manatees, which are protected under the Endangered Species Act of 1973 and the Marine Mammal Protection Act of 1972. The permittee and contractor will be held responsible for any manatee harmed, harassed, or killed as a result of construction activities.

2. All on-site project personnel are responsible for observing water-related activities for the presence of manatees. All construction and activities in open water will cease upon sighting of manatees within 100 feet of the project area. Construction activities will not resume until the manatees have left the project area for at least thirty minutes.

3. A trained spotter provided by the Contractor, shall be onsite for sightings of manatees during the construction of the project. Personnel designated by the Contractor shall receive training by the Georgia Department of Natural Resources, Coastal Resources Division, Brunswick, Georgia. The contact person for the Georgia Department of Natural Resources is Clay George at 912-262-3336.

4. Siltation barriers will be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exit from essential habitat.

5. All vessels associated with the project will operate at "no wake/idle" speeds at all times while in the construction area. All vessels will follow routes of deep water whenever possible.

6. Propellers on all boats 21 feet or less in length shall be equipped with propeller guard systems, approved by the Project Manager, designed to prevent harm to manatees.

7. Extreme care will be taken in lowering equipment or materials, including, but not limited to piles, sheet piles, casings for drilled shaft construction, spuds, pile templates, anchors, etc., below the water surface and into the stream bed; taking any precaution not to harm any manatee(s) that may have entered the construction area undetected. All such equipment or materials will be lowered at the lowest possible speed.

8. Prior to initiation of construction, the permittee shall install at least two (2) temporary manatee awareness construction signs in locations clearly visible from the navigation channel (Attachment A). The signs shall be displayed and maintained throughout construction and shall be removed by the permittee upon completion of construction. Placement of all signs shall be as approved by the Georgia Department of Natural

Resources, Coastal Resources Division, Brunswick, Georgia. The contact person for the Georgia Department of Natural Resources is Clay George at 912-262-3336.

9. All temporary construction materials will be removed upon completion of the work, and salt marsh areas will be restored. No construction debris or trash will be discarded in the water.

10. Any dead manatee(s) found in the project area must be secured to a stable object to prevent the carcass from being moved by the current. The Contractor shall immediately notify the Government Project Manager who in turn will notify the Environmental Office at 912 573-4678. The Environmental Office will notify:

a. the U. S. Fish and Wildlife Service, Coastal Sub-Office at 912-832-8739 and,
b. the GDNR, Nongame Conservation Section at 912-262-3336.

11. The Contractor shall immediately report to the Government Project Manager any incident (e.g. collisions, injuries and mortalities) which occurs that causes harm or could be detrimental to the continued existence of the manatee along the project corridor. The Government Project Manager will in turn notify the Environmental Office at 912 573-4678. The Environmental Office will notify:

a. the U. S. Fish and Wildlife Service, Coastal Sub-Office at 912-832-8739 and,
b. the GDNR, Nongame Conservation Section at 912-262-3336 or,
800-2-SAVE-ME.

12. In the event of injury or mortality of a manatee, all aquatic activity in the project area must cease pending section 7 consultation under the Endangered Species Act with the U. S. Fish and Wildlife Service and the lead Federal agency.

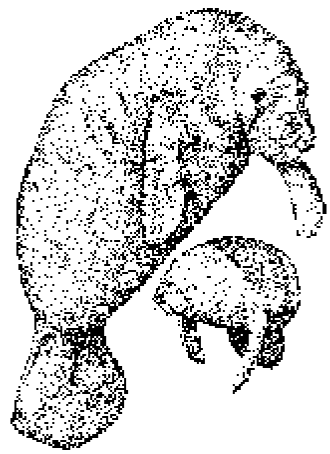
13. The Contractor shall keep a log detailing sightings, collisions, or injury to manatees, which have occurred during the contract period. Following project completion, the log and a report summarizing the any incidents and / or sightings of manatees will be submitted to the Government Project Manager and Environmental Office.

14. The Environmental office will submit above mentioned log to:

a. the U. S. Fish and Wildlife Service, 4980 Wildlife Drive, NE, Townsend, Georgia 31331 and,
b. the GDNR, Nongame Conservation Section, One Conservation Way, Brunswick, Georgia 31520

Attachment A

**MARINE FACILITY
MANATEE SIGNS
PLACEMENT PROCEDURES**



The West Indian manatee (*Trichechus manatus*) is an endangered species throughout its range. Manatees are protected at the Federal level by the Endangered Species Act of 1973 and the Marine Mammal Protection Act of 1972, as amended. Protection measures such as these signs are necessary to increase boater awareness. The increased level of Georgia coastal development and associated marinas and boat traffic will increase the probability of negative impacts to the seasonal manatee population. Manatees inhabit Georgia waters from March through November. The main threat to manatee populations is human related boat/barge collisions. Raising boater awareness and educating the public is necessary for manatee conservation in Georgia waters and has been proven effective.

The informational/educational display sign, "Manatee Habitat", is intended to increase boater awareness of manatees that are present in Georgia waters. This sign informs boaters of the potential threat boats pose to the animals and how to help decrease negative impacts caused by those vessels. Although the placement of these signs is mandatory and required by permit, they are informative and non-regulatory in nature.

<u>Procedure for Approval of Sign Installation</u>:

1. The applicant should forward a project site plan, including the proposed location for the permanent signs to: Manatee Sign Approval, Nongame Conservation Section, Department of Natural Resources, One Conservation Way, Brunswick, Georgia 31520. The applicant should also include a chart indicating the location of the facility in relation to waterways, location within a

given county (specify county name), Contact person with phone number, and the Permit and/or Lease number associated with the project

2. The Nongame Conservation Section of the Georgia Department of Natural Resources (GDNR) will review the proposed sign placement site plan and will respond to the applicant within 30 days. If the proposed location is unacceptable, guidance on an alternate site will be provided. The contact person should notify the Nongame Conservation Section when sign placement has been completed (912-264-7218). A photograph(s) of the posted manatee signage at your facility must be submitted with the required permit compliance form to the Marsh and Shore Regulatory Program of the Coastal Resources Division/Georgia Department of Natural Resources.

3. If during a site visit, approved signs, and their locations are found not to be in compliance with the instructions given in this document, relocation or addition of signs will be required. Annual site visits will be conducted to document sign placement and condition. All signs locations will be recorded in the GDNR manatee database.

Approved Sign Suppliers:
The signs are available through the companies listed below and may also be available from other local suppliers throughout the state. Permit/lease holders, marinas, and boat docking/launching facilities should contact sign companies directly to obtain pricing information and arrange for shipping and billing.

Approved Suppliers of Manatee Signs:

Grafix, Inc.
455 Montgomery Street
Post Office Box 1028
Savannah, Georgia 31402
Voice: 912-691-1117
Fax: 912-232-3845

Image Sign Company
785 King George Blvd., Bldg. 3
Savannah, Georgia 31419
Voice: 912-961-1444
Fax: 912-961-1499

Doug Bean Signs, Inc.
160 Dean Forest Rd
Savannah, Georgia 31408
Voice: 912-964-1900
Fax: 912-964-2900

Fendig Signs
411 Arnold Rd
Saint Simons Island, Georgia 31522

Good & Associates
Saint Simons Island, Georgia
(912) 638-7664

Temporary Construction Signs

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Appendix B

Fundamentals of Acoustics

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B.1 Fundamentals of Acoustics

Bioacoustics, or the study of how sound affects living organisms, is a complex and interdisciplinary field that includes the physics of sound production and propagation, the source characteristics of sounds, and the perceptual capabilities of receivers. This appendix is intended to introduce the reader to the basics of sound measurements and sound propagation, as well as the hearing and vocal production abilities of species that may occur in the project area. The potential for noise from pile driving to cause auditory masking for marine mammals within the project area is also considered.

Sound is an oscillation in pressure, particle displacement, or particle velocity, as well as the auditory sensation evoked by these oscillations, although not all sound waves evoke an auditory sensation (i.e., they are outside of an animal's hearing range) (ANSI S1.1-2013). Sound may be described in terms of both physical and subjective attributes. Physical attributes may be directly measured. Subjective (or sensory) attributes cannot be directly measured and require a listener to make a judgment about the sound. Physical attributes of a sound at a particular point are obtained by measuring pressure changes as sound waves pass. The following material provides a short description of some of the basic parameters of sound.

Sound can be characterized by several factors, including frequency, intensity, and pressure (Richardson et al. 1995). Sound frequency (measured in Hertz [Hz]) and intensity (amount of energy in a signal [Watts per meter^2]) are physical properties of the sound which are related to the subjective qualities of pitch and loudness (Kinsler et al. 1999). Sound intensity and sound pressure (measured in Pascals [Pa]) are also related; of the two, sound pressure is easier to measure directly, and is therefore more commonly used to evaluate the amount of disturbance to the medium caused by a sound ("amplitude").

Because of the wide range of pressures and intensities encountered during measurements of sound, a logarithmic scale known as the decibel is used to evaluate these properties; in acoustics, "level" indicates a sound measurement in decibels. The decibel [dB] scale expresses the logarithmic strength of a signal (pressure or intensity) relative to a reference value of the same units. This document reports sound levels with respect to sound pressure only. Each increase of 20 dB reflects a ten-fold increase in signal pressure, i.e., an increase of 20 dB means ten times the pressure, 40 dB means one hundred times the pressure, 60 dB means one thousand times the pressure, and so on.

The sound levels in this document are given as sound pressure levels [SPL]. For measurements of underwater sound, the standard reference pressure is 1 microPascal [μPa, or 10^{-6} Pascals], and is expressed as "dB re 1μPa". For airborne sounds, the reference value is 20 μPa, expressed as "dB re 20 μPa". Sound levels measured in air and water are not directly comparable, and it is important to note which reference value is associated with a given sound level.

Airborne sounds are commonly referenced to human hearing using a method which weights sound frequencies according to measures of human perception, de-emphasizing very low and very high frequencies which are not perceived well by humans. This is called A-weighting, and the decibel level measured is called the A-weighted sound level [dBA]. A similar method has been proposed for evaluating underwater sound levels with respect to marine mammal hearing. While preliminary weighting functions for marine mammal hearing have been developed (Southall et al. 2007), they are not yet applied to sound exposure from pile driving activities. Therefore, underwater sound levels given in this document are not weighted and evaluate all frequencies equally.

Table B-1 summarizes common acoustic terminology. Two of the most common descriptors are the instantaneous peak SPL and the root-mean-square [rms] SPL. The peak SPL is the instantaneous maximum or minimum over- or underpressure observed during each sound event and is presented in dB re 1 μPa peak. The rms level is the square root of the energy divided by a defined time period, given as dB re 1 μPa rms.

Table B-1. Definitions of Acoustical Terms

Term	Definition
Decibel [dB]	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure or intensity of the sound measured to the appropriate standard reference value. This document uses only sound pressure measurements to calculate decibel levels. The reference pressure for water is 1 microPascal (µPa) and for air is 20 µPa (approximate threshold of human audibility).
Sound Pressure Level [SPL]	Sound pressure is the force per unit area, usually expressed in microPascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. Sound pressure level is the quantity that is directly measured by a sound level meter, and is expressed in decibels referenced to the appropriate air or water standard.
Frequency, Hz	Frequency is expressed in terms of oscillations, or cycles, per second. Cycles per second are commonly referred to as Hertz (Hz). Typical human hearing ranges from 20 Hz to 20,000 Hz; hearing ranges in non-humans are widely variable and species specific.
Peak Sound Pressure (unweighted), dB re 1µPa peak	The maximum absolute value of the instantaneous sound pressure expressed as dB re 1µPa peak.
Root-Mean-Square [rms], dB re 1µPa	The rms level is the square root of the pressure divided by a defined time period, expressed in decibels. For impulsive sounds, the rms has been defined as the average of the squared pressures over the time that comprise that portion of waveform containing 90 percent of the sound energy for one impact pile driving impulse. For non-impulsive sounds, rms energy represents the average of the squared pressures over the measurement period and is not limited by the 90 percent energy criterion. Expressed as dB re 1µPa.
Sound Exposure Level [SEL], dB re 1µPa^2 sec	Sound exposure level is a measure of energy. Specifically, it is the dB level of the time integral of the squared-instantaneous sound pressure, normalized to a 1-second period. It can be an extremely useful metric for assessing cumulative exposure because it enables sounds of differing duration to be compared in terms of total energy.
Waveforms, µPa over time	A graphical plot illustrating the time history of positive and negative sound pressure of individual pile strikes shown as a plot of µPa over time (i.e., seconds).
Frequency Spectra, dB over frequency range	A graphical plot illustrating the frequency content over a given frequency range. Bandwidth is generally defined as linear (narrowband) or logarithmic (broadband) and is stated in frequency (Hz).
A-Weighted Sound Level, dBA	A frequency-weighted measure used for airborne sounds only. A-weighting de-emphasizes the low and high frequency components of a given sound in a manner similar to the frequency response of the human ear and correlates well with subjective human reactions to noise. A-weighted levels are referenced to 20 µPa unless otherwise noted.
Ambient Noise Level	The background noise level, which is a composite of sounds from all sources near and far. The normal or existing level of environmental noise at a given location, given in dB referenced to the appropriate pressure standard.

Adapted and derived from URS Corporation (2007)

B.2 Sound vs. Noise

Sound may be purposely created to convey information, communicate, or obtain information about the environment. Examples of such sounds are sonar pings, marine mammal vocalizations/echolocations, tones used in hearing experiments, and small sonobuoy explosions used for submarine detection.

Noise is undesired sound (ANSI S1.1-1994). Whether a sound is noise depends on the receiver (i.e., the animal or system that detects the sound). For example, small explosives and sonar used to locate an enemy submarine produce *sound* that is useful to sailors engaged in anti-submarine warfare, but is may be aversive *noise* to marine species. Sounds produced by naval aircraft and vessel propulsion are considered noise because they represent possible energy inefficiency and increased detectability, which are undesirable.

Noise also refers to all sound sources that may interfere with detection of a desired sound and the combination of all of the sounds at a particular location (ambient noise).

B.3 Description of Noise Sources

Ambient noise in the project area is a composite of sounds from natural sources, normal port activities, and temporary projects such as maintenance dredging or pile driving.

In-water construction activities associated with this project include vibratory and impact pile driving. The sounds produced by these activities fall into two sound types: impulsive (impact driving) and non-impulsive (vibratory driving). Distinguishing between these two general sound types is important because of each sound type may cause different types of physical effects, particularly with regard to hearing (Ward 1997).

Impulsive sounds (e.g., explosions, seismic airgun pulses, and impact pile driving) are referred to as pulsed sounds in Southall et al. (2007), and are brief, broadband, atonal transient sounds which can occur as isolated events or be repeated in some succession (Southall et al. 2007). Impulsive sounds are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures (Southall et al. 2007). Impulsive sounds generally have a greater capacity to induce physical injury compared with sounds that lack these features (Southall et al. 2007).

Non-impulsive sounds ("non-pulsed" in Southall et al. 2007) can be tonal, broadband, or both. They lack the rapid rise time and can have longer durations than impulsive sounds. Non-impulsive sounds can be either intermittent or continuous sounds. Examples of non-impulsive sounds include vessels, aircraft, and machinery operations such as drilling, dredging, and vibratory pile driving (Southall et al. 2007).

In environments with non-porous boundaries (i.e. rock seafloor, rigid sides, etc.), reverberation may extend the duration of both impulsive and non-impulsive sounds.

References

American National Standards Institute (ANSI). American National Standard on Acoustical Terminology. Rev. 2013.

Kinsler, L.E., A.R. Frey, A.B. Coppens, and J.V. Sanders. 1999. *Fundamentals of Acoustics* (4th ed.). New York, NY: Wiley.

Richardson, W.J., C.R. Greene, C.I. Malme, and D.H. Thomson. 1995. *Marine Mammals and Noise*: Academic Press.

Southall, B. L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr. et al. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals,* 33(4), 411-521.

URS Corporation. 2007. *Port of Anchorage Marine Terminal Development Project Underwater Noise Survey Test Pile Driving Program, Anchorage, Alaska*. Report prepared for Integrated Concepts & Research Corporation, Anchorage, Alaska.

Ward, W. D. 1997. Effects of high-intensity sound. In M. J. Crocker (Ed.), *Encyclopedia of Acoustics* (pp. 1497-1507). New York, NY: Wiley.

Appendix C

Extended Methods – Proxy Source Levels for Acoustic Modeling

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C.1 Acoustic Modeling

Acoustic modeling was conducted to estimate the zones of influence in which acoustic energy produced during pile driving has the potential to affect marine mammal physiology and behavior. This modeling was conducted using the current thresholds that NMFS uses to evaluate marine mammal harassment (Table C-1).

Table C-1. Current Thresholds for Physiological and Behavioral Impacts to Marine Mammals from Sounds Produced by Pile Driving

Species	Sound type	Level A (Injury) [dB re 1μPa rms]	Level B (Behavioral Harassment) [dB re 1μPa rms]
Cetaceans	Impulsive	180	160
	Non - impulsive	180	120

The ambient noise environment in the waters of SUBASE Kings Bay was measured during an ongoing project in early 2015 (Acentech 2015). Average background noise levels were around 135 dB rms, which is significantly higher than the NMFS' threshold for behavioral harassment from non-impulsive noise (120 dB rms). Our modeling estimates are therefore very conservative and are likely overestimates of ZOI size and marine mammal exposures during pile driving.

C.2 Proxy Source Levels

Noise levels produced by pile driving are greatly influenced by factors including pile type, driving method, and the physical environment in which the activity takes place. A number of studies have examined sound pressure levels recorded from underwater pile driving projects in California and Washington, and a few studies have recently been conducted on the U.S. East Coast at a number of naval installations. Proxy source levels were determined using existing data from piles driven in previous projects. Published data was gathered from reports published by the California Department of Transportation (CALTRANS), the Washington State Department of Transportation (WSDOT), and the U.S. Navy. A regional source level proxy document was compiled by NAVFAC Northwest for Puget Sound projects (U.S. Navy 2014); some of these analyses were also applied to the Kings Bay projects due to a lack of additional data.

While some pile types are well-represented in the existing data, other types have been measured only infrequently. There were therefore a few different methods for determining the proxy source levels for modeling for the Action. For all projects, data points that were not reported at 10 m distance from the incident pile were normalized using the practical spreading equation, and estimated source levels at 10 m were used in the calculations of proxy source levels. For this analysis, data from individual piles was used (when available). When individual pile data was not available for a project, the project average was used. This approach removes the necessity for weighting project averages by the number of piles, while still including the environmental context from each included project.

Data from the East Coast were prioritized due to the differences in bathymetry and sediment between west coast sites in Washington and California, and the location at Kings Bay. For pile types for which East Coast data were not available, data collected on the west coast were averaged to approximate source levels. During the averaging process, reported data points were converted from dB values into pressure measurements, averaged, and re-converted to decibels.

C.2.1 Impact Driving

Impact driving is the primary method intended for use during the Action, due to a shallow limestone layer underneath the surface sediments at SUBASE Kings Bay. The depth of this layer varies due to prior dredging of the facility basins during construction of the existing piers and wharves. Pile types that will be installed with impact driving include 18 and 24 in. concrete piles, as well as 14 in. steel H piles and 24 and 30 in. steel pipe piles.

Sound level metrics for impact driving include RMS, Peak, and SEL metrics. Definitions of these terms and formulae for calculating them can be found in CALTRANS (2009) guidance.

C.2.1.1 Concrete Piles

Concrete piles to be driven via impact during the Action include 18 in. and 24 in. diameter piles. There are no measured data on concrete piles smaller than 24 in. from the East Coast of the U.S. Therefore, for 18 in. concrete piles, proxy source levels were determined from the CALTRANS (2012) compendium. Data were available from the west coast for 18 in. concrete piles (N=1), and these data were used as a proxy for driving of 18 in. concrete piles during the action (CALTRANS 2012).

Driving of 24 in. concrete piles has been measured in Norfolk, VA, by the U.S Navy. These data were averaged to determine a proxy value for this pile type. Source data for impact driving of concrete piles is given in Table C-2.

Table C-2. Proxy Source Level Data for Impact Driving of Concrete Piles

Pile to be driven	Proxy Pile type	Source Level								
		RMS			Peak			SEL		
		dB	Pa	Average [dB re 1 µPa rms]	dB	Pa	Average[dB re 1 µPa Peak]	dB	Pa	Average[dB re 1 µPa SEL]
16” and 18” Concrete	16" and 18" Concrete*[1,2]	171	2.51189E+11	170	183	1.58E+12	184	na	na	159
		159	39810717055		172	2.93E+11		155	2.15E+10	
		169	1.84785E+11		189	3.98E+12		159	3.98E+10	
24” Concrete	24" Concrete[3]	169	1.84785E+11	174	183	1.58E+12	184	166	1.17E+11	165
		162	63095734448		176	5.41E+11		153	1.58E+10	
	24" Concrete[4,¥]	173	3.58296E+11		183	1.66E+12		163	7.72E+10	
		175	4.64159E+11		185	2.15E+12		165	1E+11	
		177	5.95286E+11		186	2.37E+12		167	1.28E+11	
		176	5.56991E+11		185	2.22E+12		166	1.2E+11	
		176	5.17539E+11		186	2.4E+12		166	1.12E+11	

*Values are weighted project averages as analyzed in US Navy 2014; original data from CALTRANS 2012; 1 – US Navy 2014; 2- CALTRANS 2012; 3 – US Navy 2013; 4- US Navy 2015

¥ – values measured at > 10m from incident pile were normalized to 10m before calculating averages.

C.2.1.2 Steel Piles

Three types of steel piles will be installed with an impact hammer during the Action. Impact driving of steel pipe piles (24 in. and 30 in.) has both been measured in a number of locations, though not on the U.S. East Coast. For steel H piles (14 in.), measurements of impact driving are available only from west coast projects, as given in CALTRANS 2012. Calculations and source data are presented in Table C-3.

Table C-3. Proxy Source Level Data for Impact Driving of Steel Piles

Pile to be driven	Proxy Pile Type	Source Level								
		RMS			Peak			SEL		
		dB	Pa	Average	dB	Pa	Average	dB	Pa	Average
14" Steel H	14" Steel H[1]	175	4.64159E+11	178	190	4.64E+12	196	na	na	168
		178	7.35642E+11		200	2.15E+13		163	7.36E+10	
		176	5.4117E+11		193	7.36E+12		165	1E+11	
		178	7.35642E+11		194	8.58E+12		163	7.36E+10	
		178	7.35642E+11		194	8.58E+12		177	6.31E+11	
		180	1E+12		195	1E+13		170	2.15E+11	
24" Steel Pipe*	24" Steel Pipe[2]	184	1.84785E+12	190	211	1.17E+14	206	183	1.58E+12	179
		170	2.15443E+11		211	1.17E+14		181	1.17E+12	
		180	1E+12		209	8.58E+13		181	1.17E+12	
		186	2.51189E+12		207	6.31E+13		178	7.36E+11	
		184	1.84785E+12		209	8.58E+13		181	1.17E+12	
		186	2.51189E+12		207	6.31E+13		175	4.64E+11	
		194	8.57696E+12		208	7.36E+13		178	7.36E+11	
		195	1E+13		205	4.64E+13		176	5.41E+11	
		193	7.35642E+12		208	7.36E+13		179	8.58E+11	
		196	1.16591E+13		204	3.98E+13		174	3.98E+11	
	24" Steel Pipe[3]	192	6.30957E+12		209	8.58E+13		185	2.15E+12	
		189	3.98107E+12		208	7.36E+13		181	1.17E+12	
		188	3.41455E+12		204	3.98E+13		180	1E+12	
		183	1.58489E+12		199	1.85E+13		180	1E+12	
		166	1.16591E+11		183	1.58E+12		176	5.41E+11	
		178	7.35642E+11		194	8.58E+12		171	2.51E+11	
		185	2.15443E+12		202	2.93E+13		178	7.36E+11	
		182	1.35936E+12		197	1.36E+13		174	3.98E+11	
		183	1.58489E+12		200	2.15E+13		174	3.98E+11	
	24" Steel Pipe[1]	194	8.57696E+12		207	6.31E+13		178	7.36E+11	
		189	3.98107E+12		203	3.41E+13		178	7.36E+11	
		188	3.41455E+12		205	4.64E+13		173	3.41E+11	

<table>
<tr><th rowspan="3">Pile to be driven</th><th rowspan="3">Proxy Pile Type</th><th colspan="9">Source Level</th></tr>
<tr><th colspan="3">RMS</th><th colspan="3">Peak</th><th colspan="3">SEL</th></tr>
<tr><th>dB</th><th>Pa</th><th>Average</th><th>dB</th><th>Pa</th><th>Average</th><th>dB</th><th>Pa</th><th>Average</th></tr>
<tr><td rowspan="9">30" Steel Pipe*</td><td rowspan="3">30" Steel Pipe[4]</td><td>192</td><td>6.00387E+12</td><td rowspan="9">193</td><td>212</td><td>1.29E+14</td><td rowspan="9">209</td><td>182</td><td>1.29E+12</td><td rowspan="9">188</td></tr>
<tr><td>192</td><td>5.95286E+12</td><td>213</td><td>1.5E+14</td><td>182</td><td>1.28E+12</td></tr>
<tr><td>192</td><td>5.97161E+12</td><td>211</td><td>1.1E+14</td><td>184</td><td>1.75E+12</td></tr>
<tr><td>30" Steel Pipe[2]</td><td>195</td><td>1E+13</td><td>209</td><td>8.58E+13</td><td>186</td><td>2.51E+12</td></tr>
<tr><td rowspan="2">30" Steel Pipe[1]</td><td>190</td><td>4.64159E+12</td><td>210</td><td>1E+14</td><td>177</td><td>6.31E+11</td></tr>
<tr><td>190</td><td>4.64159E+12</td><td>205</td><td>4.64E+13</td><td>na</td><td>na</td></tr>
<tr><td rowspan="3">30" Steel Pipe[5]</td><td>192</td><td>6.30957E+12</td><td>204</td><td>3.98E+13</td><td>189</td><td>3.98E+12</td></tr>
<tr><td>193</td><td>7.35642E+12</td><td>204</td><td>3.98E+13</td><td>191</td><td>5.41E+12</td></tr>
<tr><td>196</td><td>1.17703E+13</td><td>207</td><td>6.37E+13</td><td>196</td><td>1.18E+13</td></tr>
<tr><td colspan="11">[1]CALTRANS (2012); [2]WSDOT(2005a); [3]WSDOT(2005b); [4]WSDOT(2010b); [5]WSDOT(2005c)

* Inconsistencies in source levels given between US Navy (2014) and this analysis are due to the use of data given in the executive summary table of WSDOT 2005a and 2005b, rather than the text of the report by US Navy 2014. This analysis uses data from the reports' text due to an ambiguous metric ("RMS (peak) dB") in the executive summary table.</td></tr>
</table>

C.2.2 Vibratory Driving

Vibratory driving is to be used at SUBASE Kings Bay during the Action as a method of extracting piles that are intended for demolition or replacement, and to install composite piles. Piles to be extracted with vibratory methods will only be vibrated out if an initial effort to remove them with a crane fails. Vibratory extraction may be used on 18 in. and 24 in. concrete piles, 14 in. steel H piles, and 24 in. and 30 in steel pipe piles.

C.2.2.1 Concrete Piles

During the Action, both 18 in. and 24 in. concrete piles may be extracted with a vibratory pile driver. There are no current data for vibratory driving of concrete piles, either for installation or extraction. Therefore, vibratory driving of steel pipe piles was used as an estimate of source levels. To avoid pseudoreplication, when multiple measured points were available for a single pile (due to multiple sensors in the water), the mid-water column sensor measurement was used. Source data were gathered from 24" steel pipe piles, as this is the smallest steel pipe pile for which vibratory driving data are available (Table C-4).

C.2.2.2 Steel Piles

Three types of steel piles will be installed or extracted with vibratory methods during the Action. Measured source level data was available for all three pile types (14 in. steel H piles, and 24 in. and 30 in. steel pipe piles). These data are presented in Table C-4.

Table C-4. Proxy Source Level Data for Vibratory Extraction of Steel Piles

Pile to be driven	Proxy Pile Type	Source Level RMS dB	Source Level RMS Pa	Source Level RMS Average [dB re 1µPa rms]
14" Steel H Piles	14" Steel H Pile[1]	162	6.03E+10	163
		166	1.12E+11	
		158	3.51E+10	
		163	7.17E+10	
		163	6.96E+10	
24" Steel Pipe Piles and 18” and 24” Concrete Piles	24" Steel Pipe Pile[2]	157	2.93E+10	166
	24" Steel Pipe Pile[3]	157	2.93E+10	
	24" Steel Pipe Pile[4]	160	4.64E+10	
		160	4.64E+10	
	24" Steel Pipe Pile[5]	156	2.51E+10	
		157	2.72E+10	
		158	3.17E+10	
		155	2.15E+10	
		154	1.9E+10	
		168	1.63E+11	
		163	7.36E+10	
		160	4.64E+10	
		156	2.54E+10	
		171	2.4E+11	
		166	1.12E+11	
		167	1.3E+11	
		168	1.52E+11	
		174	4.27E+11	
		170	2.31E+11	
		175	4.78E+11	
		175	4.64E+11	
		159	3.98E+10	
		160	4.64E+10	
		164	8.58E+10	
		162	6.5E+10	
		168	1.58E+11	
		169	1.74E+11	
		171	2.51E+11	
		148	7.36E+09	
		149	8.58E+09	
		147	6.77E+09	

Pile to be driven	Proxy Pile Type	Source Level RMS		
		dB	Pa	Average [dB re 1μPa rms]
30" Steel Pipe Piles	30" Steel Pipe Pile[6]	164	8.58E+10	166
		173	3.25E+11	
		162	6E+10	
	30" Steel Pipe Pile[7]	170	2.03E+11	
		163	7.43E+10	
		161	5.11E+10	
		163	7.43E+10	
	30" Steel Pipe Pile[8]	165	1E+11	
		165	1E+11	
[1]U.S. Navy (2013b); [2]WSDOT (2010a); [3] U.S. Navy (2012); [4]CALTRANS (2012); [5]U.S. Navy (2013a); [6]WSDOT (2010c); [7]WSDOT (2010d); [8]WSDOT (2011c)				

C.2.2.3 Composite and Timber Piles

For composite piles (used in projects 1B and 5), no measured data on vibratory installation or extraction are available. The source level estimates for this type of pile were based on data from timber piles driven on the east coast of the U.S. (Table C-5). These data were also used to estimate source levels for the extraction of 16” timber piles during projects 1A, 1B, and 5.

Table C-5. Proxy Source Level Data for Vibratory Installation of Composite Piles

Pile to be driven	Proxy Pile Type	Source Level RMS		
		dB	Pa	Average [dB re 1μPa rms]
16 – 18 in. Composite Piles and 16” Timber Piles	12 - 16" Timber Piles[1]	142	3.13E+09	161
		142	3.01E+09	
		141	2.69E+09	
		151	1.12E+10	
		164	8.09E+10	
		162	6.31E+10	
		164	8.83E+10	
		165	1.17E+11	
		164	9E+10	
[1]U.S. Navy (2015)				

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