CP16-454-000

Rio Grande LNG Project

Incidental Harassment Authorization Application for First Year of In-Water Construction of the LNG Terminal

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Abbreviations and Acronyms

μPa	microPascal
$\mu Pa^2 s$	microPascal squared per second
BND	Brownsville Navigational District
BSC	Brownsville Ship Channel
BSC Waterway	the portion of the BSC outside the federally maintained portion of the BSC (where Project construction activities would occur)
CFR	Code of Federal Regulations
CV	coefficient of variation
dB	decibel
DOE	U.S. Department of Energy
ESA	Endangered Species Act
FTA	Free Trade Agreement
Hz	hertz
IHA	Incidental Harassment Authorization
kHz	kilohertz
km	kilometer
km^2	square kilometer
LNG	liquefied natural gas
L_{pk}	peak sound pressure level
m/s	Meters per second
m^3	cubic meter
mi	statute miles
MLLW	mean lower low water
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MOF	material offloading facility
NGA	Natural Gas Act
NOAA Fisheries	National Oceanic and Atmospheric Administration Fisheries Service
NWR	National Wildlife Refuge

OSP	optimum sustainable population
PATON	Private Aid to Navigation
Pipeline System	The pipelines and all associated facilities owned by Rio Bravo Pipeline Company, LLC
Project	Terminal and Pipeline System
PSO	Protected Species Observer
RB Pipeline	Rio Bravo Pipeline Company, LLC
re	relative to
RG Developers	Rio Grande LNG, LLC and Rio Bravo Pipeline Company, LLC
RGLNG	Rio Grande LNG, LLC
RMS	root mean square
SEL	sound exposure level
SEL_{cum}	cumulative sound exposure level
SPCC Plan	Spill Prevention, Control, and Countermeasures Plan
SPL	sound pressure level
Terminal	RGLNG's natural gas liquefaction facility and liquefied natural gas export terminal
UME	Unusual Mortality Event
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
yd^3	cubic yard
ZOI	zone of influence

1 Description of Specified Activity

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 of the Proposed Activity

Rio Grande LNG, LLC (RGLNG) proposes to construct a natural gas liquefaction facility and liquefied natural gas (LNG) export terminal (Terminal) in Cameron County, Texas, along the north embankment of the Brownsville Ship Channel (BSC). In concert with the Terminal, Rio Bravo Pipeline Company, LLC (RB Pipeline) proposes to construct an associated pipeline system (Pipeline System) within the state of Texas to provide gas feedstock to the Terminal. RGLNG and RB Pipeline are hereinafter referred to collectively as the "RG Developers," and the Terminal and Pipeline System are hereinafter referred to collectively as the "Project."

On May 5, 2016, the RG Developers filed an application for authorization pursuant to Sections 3(a) and 7(c) of the Natural Gas Act (NGA) with regard to a proposed natural gas liquefaction plant/export terminal and natural gas pipeline facility, respectively. The Federal Energy Regulatory Commission has assigned the RG LNG Project to Docket Number CP16-454-000 and the associated RB Pipeline Project to Docket Number CP16-455-000.

The in-water portion of the Terminal would occur in waters that support marine mammal species. The Marine Mammal Protection Act (MMPA) of 1972 prohibits the taking of marine mammals, which is defined as to "harass, hunt, capture, kill, or attempt to harass, hunt capture or kill," except under certain situations. Section 101(a)(5)(D) allows the issuance of an Incidental Harassment Authorization (IHA) provided that an activity results in small numbers of takes and negligible impacts on marine mammals, and does not adversely affect subsistence use of these animals. The in-water pile-driving activities associated with the Terminal (e.g., pile installation and removal) may result in incidental taking of marine mammals protected under the MMPA by Level B behavioral harassment. RGLNG is submitting an IHA application requesting take numbers for three marine mammal species that may occur in the vicinity of the Terminal site throughout the first year of construction.

1.2 Project Purpose and Need

The RG Developers' stated purpose of the Rio Grande LNG Project is to develop, own, operate, and maintain a natural gas pipeline system to access natural gas from the Agua Dulce Hub and an LNG export facility in south Texas to export 24.5 million metric tons (27 million U.S. tons) per annum of natural gas that provides an additional source of firm, long-term, and competitively priced LNG to the global market. The Project purpose also includes providing LNG for truck transport and for fueling operations. Any exports would be consistent with authorizations from the U.S. Department of Energy (DOE). The DOE granted an authorization to RGLNG for export to countries having a free trade agreement (FTA) with the United States that includes national treatment for trade in natural gas (FTA nations) on August 17, 2016. An application for export to non-FTA nations is pending the DOE's review of RGLNG's application, which was filed on December 23, 2015.

1.3 Construction Methods and Descriptions

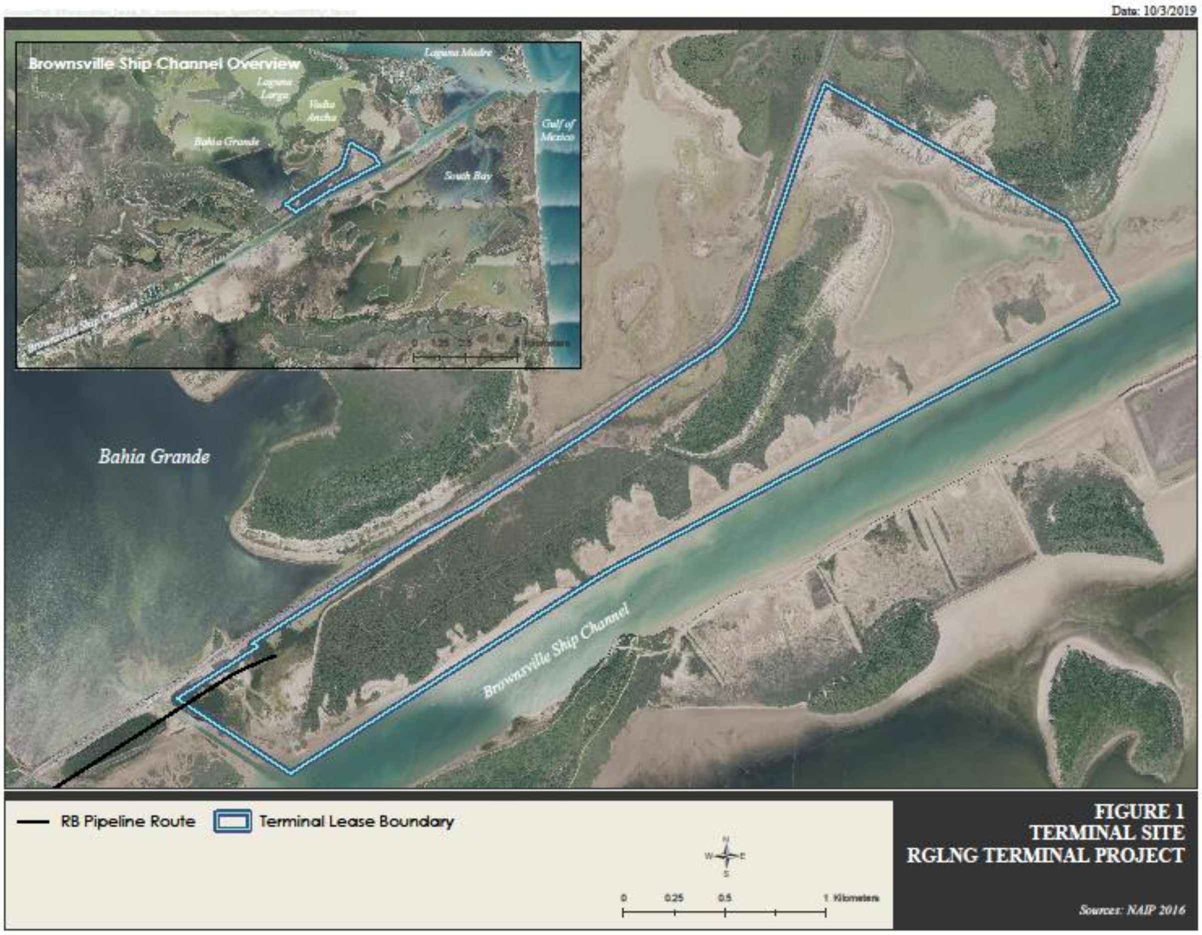
The Project would be located in south Texas. All construction activities associated with the Terminal would occur outside the federally maintained portion of the BSC, which is referred to as the "BSC waterway" throughout this document. The larger BSC will be referred to when indicating the more general region—for example, when discussing habitat or marine mammal distribution patterns. A description of the facilities is provided below.

Terminal

The Terminal would be located on approximately 3.04 square kilometers (km^2) (750.4 acres) of a 3.98-km^2 (984.2-acre) parcel of land along the northern shore of the BSC in Cameron County, Texas, approximately 16 kilometers (km) (9.8 statute miles [mi]) east of Brownsville and about 3.5 km (2.2 mi) west of Port Isabel (see Figure 1). The Terminal, which is currently expected to begin operations in late 2023, would have a minimum 20-year life span (which could be extended to a 50-year life span). The Terminal would include the following major facilities:

- six liquefaction trains;
- four full-containment LNG storage tanks;
- docking facilities for two LNG vessels, turning basin, and material offloading facility (MOF);
- LNG truck loading facilities with four loading bays; and
- Pipeline System's Compressor Station 3, a metering site, and the interconnection to the Pipeline System.

Figure 1: Terminal Site



Pipeline System

The Terminal would receive natural gas via the proposed Pipeline System, which would connect the Terminal to the existing infrastructure near the natural gas Agua Dulce hub interconnection in Nueces County. The Pipeline System would include two new approximately 218.1-km (135-mi)-long, 42-inch-diameter, parallel, feed natural gas pipelines sharing a right-of-way. The pipelines would originate in Kleberg County and transit through Kenedy, Willacy, and Cameron Counties before terminating at Compressor Station 3 within the boundaries of the Terminal.

As construction and operation of the Pipeline System is not anticipated to have any potential impacts on marine mammals, this application will focus on potential impacts associated with construction of marine facilities at the Terminal.

Marine Facilities and Structures to Be Constructed

LNG Loading and Vessel Berthing Area

Two LNG vessel loading berths would be constructed along the south-central boundary of the Terminal to accommodate simultaneous loading of two LNG vessels (see Figure 2). The berths would be recessed into the Terminal property so that loading LNG vessels, separated by 76 meters (250 feet), would not encroach on the navigable channel boundaries of the BSC. Construction of the loading berths would require dredging to a depth of up to -14 meters (43 feet plus 2 feet allowable overdepth) mean lower low water (MLLW) (-13-meters [43 feet] plus -0.6 meters [2 feet] of allowable overdepth).

Each berth would consist of a loading platform with an LNG spill containment system, LNG piping, and safety and electrical systems, which would be connected to the shore via a trestle wide enough to support a personnel walkway, a 4.5-meter (15-foot)-wide roadway, and space for auxiliary systems and LNG piping. The loading platform would be designed such that equipment is at least 0.3 meters (1 foot) above the predicted 500-year storm surge.

RGLNG anticipates that the Terminal would receive one LNG vessel per LNG train per week, with capacities between 125,000 and 185,000 cubic meters (m^3) (163,494 and 241,971 cubic yards [$yd^{3]}$). At full build-out, this would equate to six LNG vessels calling at the Terminal per week (about 312 vessels per year, or as authorized by the U.S. Coast Guard [USCG]). During loading operations, LNG would be transferred from the storage tanks to the loading platforms using a 36-inch-diameter loading header line and 24-inch-diameter loading lines. Four marine loading arms, each 20 inches in diameter, would transfer product to and from the LNG vessels.

Figure 2: Terminal Rendering

FIGURE 2
TERMINAL RENDERING
RGLNG TERMINAL PROJECT

Turning Basin

A 457.2-meter (1,500-foot)-diameter turning basin would be constructed to the east of the LNG vessel loading berths to accommodate turning maneuvers of the LNG vessels calling on the Terminal. LNG vessels would be escorted into the BSC and turning basin via tug boats, rotated in the turning basin, and then placed adjacent to a loading berth with the bow facing downstream (i.e., eastward). The turning basin would be partially recessed into the Terminal site, but the area of the turning basin would encroach on the navigable channel of the BSC such that channel transit would be temporarily precluded until the LNG vessels were moored at the berth. As with the loading berths, the turning basin would be dredged to a depth of up to -13.1 meters (-43 feet plus 2 feet allowable overdepth). The navigable channel is maintained at -12.8 meters (-42 feet) MLLW and would be deepened to -15.8 meters (-52 feet) plus 0.6 meters (2 feet) allowable overdepth and an additional 0.6 meters (2 feet) for advanced maintenance dredging. An in-water Private Aid to Navigation (PATON) consisting of steel pipe piles would be installed just outside of the footprint of the turning basin.

Material Offloading Facility and Tug Berth

RGLNG would construct an MOF along the western extent of the Terminal site, adjacent to the BSC. The MOF would primarily be used during construction for marine delivery of bulk materials and larger or prefabricated equipment as an alternative to road transportation; however, it would be maintained for the life of the Terminal for periodic delivery of bulk materials. The MOF, which would require a dredged depth of up to -7.6-meters (-25 feet) MLLW plus 0.6 meters (2 feet) advanced maintenance allowance), would be constructed of a steel sheet pile bulkhead on land. Fencing would be placed around the MOF to control access and separate it from the adjacent wetlands on the west side of the Terminal site; access would be through the western LNG Terminal entrance. The MOF would be capable of berthing two barges simultaneously. RGLNG anticipates that 880 barges would deliver materials to the MOF during the first 5 years of construction, although deliveries would continue as needed for the remainder of construction and into operations. Bulk materials delivered to the MOF would include the crushed sand or stone necessary for concrete fabrication. Equipment requiring transport via deeper-draft vessels would be delivered to the Port of Brownsville for road transport to the Terminal site.

In-water Noise-Generating Construction Procedures

Construction of the Terminal facilities and structures includes the following in-water noise-generating activities, which are described in the following sections:

- in-water pile-driving activities (installation and removal),
- vessel operations, and
- dredging.

1.3.1 In-Water Pile-Driving Activities

In-water pile-driving activities associated with the Terminal are anticipated to produce noise levels that could result in incidental harassment of marine mammals. Only in-water pile-driving activities are presented in Table 1. The contents of this table provide the basis for the rest of the discussion and analysis presented in this application. All pile installation for the construction of two LNG berth jetties and the MOF would occur on land and therefore is not included in this application.

Table 1: In-Water Pile-Driving Activities Associated with Construction of the Terminal

Terminal Component	Pile Type	Pile Size	Number of Piles	Driving Location[1]	Method	Estimated Duration in Days
PATON (Private Aid to Navigation) at the LNG Berth	Steel tube piles	48-inch-diameter	2	BSC Waterway (in water)	Vibratory hammer (24 min) and impact (72 min, 400 strikes/min) hammer	2 days
Removal of Existing U.S. Coast Guard Navigation Aid	Timber piles	12-inch-diameter	5	BSC Waterway (in water)	Vibratory hammer (480 min)	5 days
Pile Installation at the Tug Berth	Steel tube piles	42-inch-diameter	10	Within the MOF dredge pocket (in water)	Vibratory (24 min) hammer and impact (72 min, 400 strikes/min) hammer	5 days (2 piles/day)

[1]Construction of the Terminal would occur outside the federally maintained BSC.
Key:
BSC = Brownsville Ship Channel
min = minutes
MOF = material offloading facility

Rock Armoring at the MOF and Installation of Piles at the Turning Basin

East of the MOF, channel embankments and the top slope of the shoreline (to a depth of -0.6 meters [-2 feet] MLLW) would be graded to a 1:3 slope, stabilized with bedding stone overlain by geotextile fabric, and then covered with riprap (i.e., rock armoring) (see Section 1.3.2 for further discussion of dredging activities). In the marine berths and turning basin, where vessel activity could erode the underwater channel slopes, the shoreline would be dredged to a 1:3 slope and stabilized with riprap to a depth of -13.1 meters (-43 feet) MLLW. The rock armoring would extend to the top of the slope at elevation +1.8 meters (+6 feet) North American Vertical Datum of 1988 and would tie in to the MOF bulkhead. RGLNG would maintain the integrity of the shoreline protection throughout the operational life of the Terminal.

Within the western side of the Terminal site, ten 42-inch-diameter steel tube piles would be installed using a vibratory and impact hammer in the MOF dredge pocket area. During installation, a double bubble curtain would be deployed during both vibratory and impact piling to reduce noise generated by the hammers (see Section 6.2 for additional details on noise reduction through use of double bubble curtains). The bubble curtains for the Terminal would be specifically designed to account for the pile parameters as described in this application. The curtains would be designed with effectiveness in mind—e.g., curtains would not start mid-water-column and would instead begin near the benthos surrounding the piles rather than just offer partial coverage. The curtains would be designed and operated by experienced bubble curtain designers and operators with a proven record of successful deployment. The steel tube piles would be installed at a rate of two per day over a 5-day period.

Construction of the PATON at the LNG Berth

Construction of a PATON at the LNG berth would involve installation of two 48-inch-diameter steel tube piles using a vibratory and impact hammer accompanied by a double bubble curtain. The PATON would be constructed at a rate of one per day over a 2-day period.

Removal of the United States Coast Guard Navigation Aid

RGLNG proposes to relocate one of the USCG fixed navigation aids in the BSC waterway. Pile driving would include in-water removal of five 12-inch-diameter timber piles at the existing navigation aid location using a vibratory hammer. The new navigation aid would be installed on land near the shoreline. A rough grade working platform would be built up to a minimum elevation of +2 feet to keep all installation pile driving on land. A double bubble curtain would be deployed during all vibratory hammer operations to reduce noise generated by the hammer (see Section 6.2 for additional details on noise reduction through use of double bubble curtains). The navigation aid would be removed over a 5-day period, with one pile removed per day.

<u>Vessel Operations</u>

Various types of vessels would operate in the vicinity of the Terminal and transit between the Terminal and other areas along the BSC. Barges and support vessels would deliver construction materials and equipment to the MOF and Port of Brownsville during Terminal construction. RGLNG estimates that about 880 marine deliveries would take place during the first 5 years of construction. No deliveries are currently anticipated during the remainder of the construction period, though sporadic deliveries could occur as needed. Based on the location of the Terminal within a shipping channel that is also utilized by fishing and recreational vessels (e.g., dolphin watch boats), RGLNG expects that the background ambient noise is dominated by other vessel noise and that noise impacts from Terminal-related vessels would be comparable to, if not less than, those generated by existing vessel traffic (for further details, see Section 2.3.2). Therefore, RGLNG does not expect that the vessels associated with the Terminal would constitute a major noise source of concern relative to the noise from existing vessel traffic in the vicinity of the Terminal site.

1.3.2 Dredging

Construction associated with the in-water activities described above would include dredging at three locations: the vessel berthing areas, turning basin, and MOF. This dredging is not anticipated to produce noise levels that could result in incidental harassment of marine mammals but is included to inform potential impacts on habitat, and subsequent effects of those impacts (see Sections 9 and 10).

<u>Dredging of the Vessel Berthing Areas, Turning Basin, and MOF</u>

RGLNG would dredge the berthing areas and turning basin to a depth of -13.1 meters (-43 feet) MLLW, with a -0.6-meter (-2 foot) allowable over-dredge. The sides of the berthing areas and turning basin would be contoured at a 1:3 slope. The MOF would be excavated and dredged to a depth of -7.6 meters (-25 feet) MLLW plus 0.6 meters (2 feet) advanced maintenance allowance), to allow barges and shallow-draft vessels to directly offload bulk materials at the Terminal site. RGLNG would install rock armoring to provide scour protection from propeller wash on the slope parallel to the shoreline.

About 476,317.7 m^3 (623,000 yd^3) of material would be excavated along the shoreline and outside the federally maintained BSC by land-based equipment for the construction of the berthing areas, turning basin, and MOF. This material would be directly placed at the Terminal site for fill. An additional 29,817.6 m^3 (39,000 yd^3) of material would be dredged from the MOF using a mechanical dredge from the shoreline.

About 4.6 million m^3 (6.1 million yd^3) of material would be dredged from the berths and turning basin using water-based equipment. Material would be dredged using a hydraulic dredge and temporary pipeline and placed at a U.S. Army Corps of Engineers (USACE)-approved dredged-material-placement area.

RGLNG's Dredged Material Management Plan is being developed, and the final determination of dredging methods and dredged material placement locations would be finalized in consultation with the Brownsville Navigational District (BND) and federal and state agencies. RGLNG is also considering potential beneficial uses of the dredged material.

RGLNG does not expect sound associated with dredging to be an issue because the noise produced by the dredge would not reach levels that would incidentally harass marine mammals.

2 Dates, Duration, and Specified Geographic Region

The date(s) and duration of such activity and the specified geographical region where it will occur.

2.1 Dates of Construction

The start of in-water construction is anticipated to be June 2020 but will be based on receipt of all certifications, authorizations, and necessary permits. The Terminal has been proposed to be constructed in six stages and would be developed over the course of approximately 7 years, with the first LNG train becoming operational in Year 4 of construction and the final LNG train becoming operational by Year 7. Each stage of construction would be associated with one of the six LNG trains; Stage 1 would include site preparation and security fencing of the entire work area, construction of LNG Train 1, and construction of all infrastructure required for the operation of LNG Train 1. Each subsequent stage of construction would begin approximately 6 to 9 months after construction of the previous train and would include all additional infrastructure required for that train. Construction activities would occur primarily during the day, between 7:00 a.m. and 7:00 p.m., Monday through Friday, and site preparation and construction activities, including pile driving, would be limited to daytime hours. However, dredging may occur up to 24 hours per day, 7 days per week.

As previously noted, similar to the Terminal, the Pipeline System would be constructed in stages that correspond to the Terminal stages. Activities covered by the analysis in this application include pile-driving activities associated with construction of the MOF and fixed navigation aid structures occurring during the first year of the Project. However, the entire Project timeline has been included for context.

2.2 Duration of Activities

Construction of the Terminal would involve in-water pile driving and removal of timber piles. In-water pile-driving activities, anticipated types and total number of piles, and duration of pile driving are listed in Table 2.

Table 2 Total Number of Anticipated In-Water Installed Piles

Area	Pile Type	Pile Size	Method	Total Piles	Duration (days)	Average Time per Pile (minutes)	Piles per Day	Average Strikes per Pile[1]
PATON at the LNG Berth	Steel tube pipe	48-inch-diameter	Vibratory and impact hammer	2	2	96 (24 minutes for vibratory and 72 min for impact)	1	400 (applies to impact hammer only)
Removal of existing USCG navigation aid	Timber pile	12-inch-diameter	Vibratory hammer	5	5	480	1	N/A
Pile Installation at the Tug Berth	Steel tube pipe	42-inch-diameter	Vibratory and impact hammer	10	5	96 (24 minutes for vibratory and 72 minutes for impact)	2	400 (applies to impact hammer only)

[1]Vibratory pile driving does not involve striking the pile and thus average strikes per pile are not provided for this type of pile driving

Key:
LNG = liquefied natural gas
N/A = not applicable
PATON = Private Aid to Navigation
USCG = U.S. Coast Guard

The in-water pile-driving activities related to construction would occur in discrete phases, and the analysis covered in this application covers the 12 days during which pile installation or removal would occur over 12 months. In-water pile-driving activities at the Terminal would include the installation of two 48-inch-diameter steel tube piles for the PATON at the LNG berth, occurring over a 2-day period with 96 minutes of pile-driving activity per day, installation of ten 42-inch-diameter steel tube piles at the MOF over a 5-day period with 96 minutes of pile-driving activity per day, and removal of five 12-inch-diameter timber piles over a period of 5 days, with up to 8 hours of pile-driving activity per day. Installation of both types of piles would be executed using a vibratory and impact hammer. It is anticipated to take up to 24 minutes for vibratory and 72 minutes for impact pile driving per pile. For removal of the existing USCG navigation aid structure consisting of five 12-inch-diameter timber piles, it is anticipated to take up to 480 minutes of vibratory pile removal per pile. Activities covered by the analysis in this application include a total of 12 days of in-water pile-driving activity. Pile-driving activities would occur up to 8 hours in a given day, and up to 5 days in a given week.

2.2.1 Specified Geographical Region

The Terminal site is on the north shore of the BSC within the BSC waterway. The BSC is a man-made marine navigation channel that connects to the Gulf of Mexico and forms the western terminus of the Gulf Intracoastal Waterway system. The BSC is a deep-draft navigation channel connecting the deepwater Port of Brownsville to the Gulf of Mexico via the Brazos Santiago Pass and is an established shipping corridor. The Port of Brownsville is managed by the BND, and the BSC is maintained by regular dredging (USACE 2014). The BSC, along with its Entrance Channel and Jetty Channel, forms the Brazos Island Harbor. The current depth of the Brazos Island Harbor is -12.8 meters (-42 feet) relative to the MLLW. Vessels entering the BSC from the Gulf of Mexico transit the Entrance Channel and Jetty Channel, which collectively extend about 3.7 km (2.4 mi) into the Gulf of Mexico. Vessels then enter the BSC, which extends about 27.4 km (17 mi) inland to the Port of Brownsville turning basin (USACE 2014).

The western boundary of the Terminal site is the Bahia Grande Channel, which was constructed in 2005 to connect the BSC and the Bahia Grande to restore tidal exchange to the Bahia Grande (USFWS 2015). The Bahia Grande, a 26.3-km^2 (6,500-acre) shallow bay located north of State Highway 48 and the LNG Terminal site, is one of three basins, along with the Laguna Larga and Little Laguna Madre, that form the Bahia Grande system. In the 1930s, the construction of State Highway 48 and placement of dredged material from construction of the BSC isolated the Bahia Grande from the Lower Laguna Madre and altered the hydrology of the system (USACE 2014). The Bahia Grande system was primarily dry after its isolation due to high rates of evaporation and the loss of tidal exchange with the Lower Laguna Madre (Ocean Trust 2009). In 2000, the U.S. Fish and Wildlife Service acquired the Bahia Grande Unit of the Laguna Atascosa National Wildlife Refuge (NWR), which is made up of 87.8 km^2 (21,700 acres) of water, wetlands, and land between the cities of Laguna Vista and Brownsville (USFWS 2015). As part of a comprehensive restoration plan, channels were constructed between the basins in the Bahia Grande system, and future plans include widening the Bahia Grande Channel from approximately 10.4 meters (34 feet) to 76.3 meters (250 feet) to increase tidal exchange via the BSC (Ocean Trust 2009; USFWS 2010).

The Bahia Grande and Lower Laguna Madre are hypersaline (saltier than typical sea water) due to the shallow water, limited freshwater inflow, and limited surface water exchange with the Gulf of Mexico (USACE 2014). The Laguna Madre is a long, narrow lagoon between the Texas mainland and South Padre Island, extending from Corpus Christi Bay into Mexico. The Lower Laguna Madre is connected to the north side of the BSC, and its entrance would be passed by vessels transiting to the Terminal site.

Currents in the BSC are primarily wind-driven. The USACE estimates that current velocities average 0.3 meters per second (m/s) (0.6 knots) at the Gulf of Mexico and are about 0.05 m/s (0.1 knots) near the Terminal site (USACE 2012). RGLNG conducted hydrodynamic modeling and estimated the maximum current velocity within the proposed marine facilities would be 0.15 m/s (0.3 knots). Current velocities in the main channel of the BSC near the Terminal would be similar.

2.2.2 Vessel Traffic and Ambient Underwater Soundscape

Ambient noise is sound that already exists in the environment prior to the introduction of another noise-producing activity. Ambient noise can come from both natural and man-made sources. Natural sources of ambient noise include biological sources (i.e., various marine species), wind, waves, rain, and naturally occurring seismic activity (i.e., earthquakes) (Richardson et al. 1995). Human-generated sources can include vessel noise (e.g., commercial shipping/container vessels), seismic air guns, and marine construction. Various factors contribute to the ambient noise within the BSC. One of the major contributors to ambient noise is the commercial shipping traffic near the Terminal site. In 2017, 1,317 vessels called on the Port of Brownsville, and vessel traffic is increasing overall (Port of Brownsville 2018). The channel also experiences frequent use by fishing vessels, with the Port of Brownsville fishing harbor housing up to 500 boats (Port of Brownsville 2019). Water-based tourism in the channel is also popular and is supported by recreational vessels such as whale watching tour boats. Based on the location of the Terminal site within a shipping channel, RGLNG expects that ambient noise would include large vessels (i.e., container ships) that produce source levels of 180 to 190 decibel (dB) relative to (re) 1 micropascal (µPa) root mean square (RMS) at frequencies between 0.2 and 0.5 kilohertz (kHz) (Thomsen et al. 2009; Jasny et al. 2005). Noise from smaller vessels varies in terms of frequencies and source levels produced, with larger vessels typically producing greater source levels. Large outboard motors can produce noise up to 175 dB re 1 µPa-m (measured at 1 meter) (Richardson et al. 1995). RGLNG expects that noise associated with the Terminal vessels would be comparable to that generated by existing vessel traffic within the BSC.

3 Species and Numbers of Marine Mammals

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

3.1 Species Descriptions and Abundances

Three species (four separate stocks) of marine mammals are found along the southern coast of Texas: the Atlantic spotted dolphin (*Stenella frontalis*), the common bottlenose dolphin (*Tursiops truncatus truncatus*), and the rough-toothed dolphin (*Steno bredanensis*) (Table 3) (Waring et al. 2016; Hayes et al. 2019). While none of these species are protected under the Endangered Species Act (ESA), they are all protected under the MMPA. Further information regarding detailed population status, distribution, and numbers of each species are discussed in Section 4. Given the Terminal location, and after initial consideration, species that occur in deeper and/or more offshore waters, such as sperm whales (*Physeter macrocephalus*), Risso's dolphins (*Grampus griseus*), and pantropical spotted dolphins (*Stenella attenuata*), were deemed unlikely to occur in the portions of the Terminal site that overlap the BSC. These species will not be further discussed in this application.

Atlantic-spotted and rough-toothed dolphins, though unlikely to occur in the Project area, are included in this application to ensure coverage if these species are observed. Both species have higher predicted abundance in deeper waters but do have predicted occurrence in nearshore waters (Roberts et al. 2016). The predicted densities of these species differ from species such as Risso's dolphin and sperm whales, which have sharp bathymetric delineations between regions of high predicted density in deeper waters and regions of no predicted density in near-shore waters (Roberts et al. 2016). In contrast, the predicted densities of Atlantic spotted and rough-toothed dolphins exhibit a gradual decline as waters become shallower, with some predicted occurrence in nearshore waters. The two stocks of bottlenose dolphins found in this estuarine area are the Laguna Madre Estuarine stock and the Gulf of Mexico Western Coastal stock.

Table 3: Marine Mammal Species Potentially in the Region of the BSC

Common Name	Scientific Name	Endangered Species Act Status	Marine Mammal Protection Act Status	Best Population Estimate	Presence in Terminal Site
Cetaceans					
Dolphins					
Atlantic Spotted Dolphin (Northern Gulf of Mexico Stock)[1]	*Stenella frontalis*	None	Not strategic	37,611 (coefficient of variation [CV]=0.28)[1]	Possible
Common Bottlenose Dolphin (Gulf of Mexico Western Coastal Stock)	*Tursiops truncatus*	None	Not strategic	20,161 (CV=0.17)[2]	Common
Common Bottlenose Dolphin (Laguna Madre Estuarine Stock)	*Tursiops truncatus*	None	Strategic	80 (CV=1.57)[3]	Common
Rough-toothed dolphin (Northern Gulf of Mexico Stock)	*Steno bredanensis*	None	Not strategic	624 (CV=0.99)[4]	Possible

[1]This abundance estimate is reported in latest stock assessment report for Atlantic spotted dolphin Northern Gulf of Mexico Stock (Hayes et al. 2017). This estimate is considered outdated (more than 8 years old) by the National Oceanic and Atmospheric Administration (NOAA) and is based on surveys from 2000–2004 (Fulling et al. 2003; Mullin 2007). Data combined from 1992–2009 resulted in an estimate of 47,488 (CV = 0.13) (Roberts et al. 2016).

[2]This abundance estimate is reported in the latest stock assessment report for common bottlenose dolphin Gulf of Mexico Western Coastal Stock (Hayes et al. 2017) based on surveys from 2011–2012 (no report citation provided). This estimate will be considered outdated (more than 8 years old) in 2020.

[3]This abundance estimate is reported in the latest stock assessment report for common bottlenose dolphin Gulf of Mexico Bay, Sound, and Estuary stocks (Hayes et al. 2019). This estimated is considered outdated (more than 8 years old) by NOAA and is based on surveys from 1992–1993 (Blaylock and Hoggard 1994). Recent photo-identification surveys by Piwetz and Whitehead (2019) in Lower Laguna Madre identified 109 individuals, raising the minimum number of bottlenose dolphins to 109. Neither Blaylock and Hoggard (1994) nor Piwetz and Whitehead (2019) distinguished between estuarine and coastal bottlenose dolphins, though mixing of estuarine and coastal stocks has been documented in other bays (e.g., Balmer et al. 2008).

[4]This abundance estimate is reported in the latest stock assessment report for rough-toothed dolphins in the Northern Gulf of Mexico stock (Hayes et al. 2018). This estimate is considered outdated (more than 8 years old) and is based on surveys from 2009 (Garrison 2016). It does not include continental shelf waters and does not correct for unobserved animals. Data combined from 1992–2009 resulted in an estimate of 4,853 (CV=0.19) (Roberts et al. 2016).

4 Affected Species Status and Distribution

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

As described in Section 3, three species of marine mammals (four separate stocks) occur along the southern coast of Texas: Atlantic spotted dolphins, common bottlenose dolphins (Laguna Madre and Gulf of Mexico Western Coastal stocks), and rough-toothed dolphins. Each species may be present in the area throughout the year.

4.1 Atlantic Spotted Dolphin

The Atlantic spotted dolphin belongs to the Delphinidae family of toothed whales. There are three stocks of Atlantic spotted dolphins, but only the Northern Gulf of Mexico stock occurs in Texas waters (Waring et al. 2016).

Atlantic spotted dolphins rely on echolocation for foraging and navigation, much like many other cetaceans. Their hearing capabilities are critical to their survival. These, like all dolphins, are considered mid-frequency cetaceans. Mid-frequency cetaceans have an estimated functional hearing range of 150 hertz (Hz) to 160 kHz (NOAA Fisheries 2018a). The following subsections provide additional information about the status, distribution, and population numbers of this species as it relates to the region of the BSC.

4.1.1 Population Status

The northern Gulf of Mexico stock of Atlantic spotted dolphins is not considered strategic under the MMPA. The status of these dolphins relative to the optimum sustainable population (OSP) is unknown. Atlantic spotted dolphins are not listed as threatened or endangered under the ESA (Waring et al. 2016).

4.1.2 Distribution

In the Gulf of Mexico, Atlantic spotted dolphins occur primarily from continental shelf waters (20–200 meters [66–656 feet] deep) to slope waters up to 500 meters (1,640 feet) deep (Waring et al. 2016). This distribution was gathered from Southeast Fisheries Science Center spring and fall vessel surveys conducted from 1996 to 2001 and from summer 2003 and spring 2004 surveys. Additionally, Atlantic spotted dolphins were seen in all seasons during aerial surveys of the northern Gulf of Mexico from 1992 to 1998. It has been suggested that this species may move inshore seasonally during spring, but data supporting this hypothesis are limited (Waring et al. 2016). While this species is more likely to occur along the outer continental shelf, it is possible that individuals or small groups could be present in the vicinity of the Terminal site.

4.1.3 Numbers

The total number of Atlantic spotted dolphins in the Northern Gulf of Mexico stock is based on abundance estimates, which have been generated from survey efforts beginning in 1991 (Waring et al. 2016). The most recent population estimate for this stock is 37,611 individuals (coefficient of variation [CV] = 0.28), which is based on fall surveys conducted in 2000 and 2001 between the 20-meter (66-foot) to 200-meter (656-foot) isobaths (Fulling et al. 2003; Mullin 2007). Data combined from 1992–2009 resulted in an estimate of 47,488 (CV = 0.13) (Roberts et al. 2016).

4.2 Common Bottlenose Dolphin

Common bottlenose dolphins are toothed whales that belong to the Delphinidae family. The Gulf of Mexico hosts many stocks of common bottlenose dolphins, including an Oceanic stock, a Continental Shelf stock, three Coastal stocks, and 31 Northern Gulf of Mexico Bay, Sound, and Estuary stocks (including the estuarine Laguna Madre stock) (Waring et al. 2016; Hayes et al. 2019). Distinguishing between individuals of each stock is difficult as members of these stocks have nearly identical physical characteristics and often have overlapping range boundaries. Coastal and estuarine stocks overlap in their ranges, with estuarine dolphins observed in coastal waters and coastal dolphins observed in estuarine waters (e.g., Bassos-Hull et al. 2013; Laska et al. 2011; Maze and Würsig 1999). For example, two bottlenose dolphins tagged in St. Joseph Bay travelled more than 40 km from the bay (Balmer et al. 2008). The two stocks that are likely to be present In the Project area are the Laguna Madre Estuarine and Gulf of Mexico Western Coastal stocks.

Common bottlenose dolphins rely on echolocation for foraging and navigation, much like many other cetaceans. Their hearing capabilities are critical to their survival. These, like all dolphins, are considered mid-frequency cetaceans. Mid-frequency cetaceans have an estimated functional hearing range of 150 Hz to 160 kHz (NOAA Fisheries 2018a). The following subsections provide additional information about the status, distribution, and population numbers of this species as it relates to the region of the BSC.

4.2.1 Western Gulf of Mexico Coastal Stock

The coastal waters of the Gulf of Mexico contain three separately managed stocks of common bottlenose dolphins (Waring et al. 2016). The Gulf of Mexico Western Coastal stock represents one of these three stocks and occurs in the vicinity of the Terminal site (Waring et al. 2016).

4.2.1.1 Population Status

The Gulf of Mexico Western Coastal stock of common bottlenose dolphins is not considered strategic under the MMPA, and the status of the stock relative to OSP in the Gulf of Mexico is unknown. Additionally, the common bottlenose dolphin is not listed as threatened or endangered under the ESA (Waring et al. 2016).

In May of 2012, the National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) declared an Unusual Mortality Event (UME) for common bottlenose dolphins occurring in Texas state waters. The UME lasted from November of 2011 to March of 2012 and consisted of 126 dolphin mortalities. The majority of these dolphins stranded in five Texas counties: Aransas, Brazoria, Calhoun, Kleburg, and Galveston, none of which contain the Terminal site. The cause of the common bottlenose strandings is undetermined, and NOAA Fisheries still lists the UME status as active (NOAA Fisheries 2018b). In 2019, NOAA Fisheries issued a UME for bottlenose dolphins occurring in the Northern Gulf of Mexico along Louisiana, Mississippi, Alabama, and the panhandle of Florida. As of June 27, 2019, 285 dolphins have stranded (NOAA Fisheries 2019). Again, the region of the UME does not overlap with the Terminal site. Both UMEs did not identify the bottlenose dolphin stock affected.

4.2.1.2 Distribution

NOAA Fisheries defines the range of the Western Coastal stock of common bottlenose dolphins as beginning at the shore and extending out to the 20-meter (66-foot) isobath from the Texas/Mexico border to the Mississippi River Delta (Waring et al. 2016). The Western Coastal stock overlaps boundaries with other common bottlenose dolphin stocks—namely, the estuarine stocks. The Gulf of Mexico Western Coastal stock may occur in the vicinity of the Terminal site and may enter the estuarine area of the BSC. Individual bottlenose dolphins have been observed during photo-identification surveys both inside and outside of the Brazos Santiago Pass, which is an inlet between the coastal waters of the Gulf of Mexico and the estuarine waters of the Laguna Madre adjacent to the BSC (Ronje and Whitehead 2016; Piewitz and Whitehead 2019). As noted in Section 4.2, studies of other bays have clearly indicated that bottlenose dolphins that are not part of local resident populations transiently use bays (Hull et al. 2013; Laska et al. 2011; Maze and Würsig 1999; Balmer et al. 2008).

4.2.1.3 Numbers

The population estimate of the Gulf of Mexico Western Coastal stock of common bottlenose dolphins is 20,161 individuals (CV = 0.17) (Waring et al. 2016). This estimate was determined using an inverse-variance weighted average of seasonal abundance estimates derived from aerial surveys conducted during spring 2011, summer 2011, fall 2011, and winter 2012 (Waring et al. 2016).

4.2.2 Northern Gulf of Mexico Bay, Sound and Estuary Stocks: Laguna Madre Estuarine Stock

Bay, sound, and estuarine populations of common bottlenose dolphins are currently split into 31 distinct blocks within the northern Gulf of Mexico and adjacent areas. NOAA Fisheries is in the process of writing individual stock assessment reports for 31 common bottlenose dolphin estuarine stocks in the northern Gulf of Mexico, including the Laguna Madre Estuarine stock.

4.2.2.1 Population Status

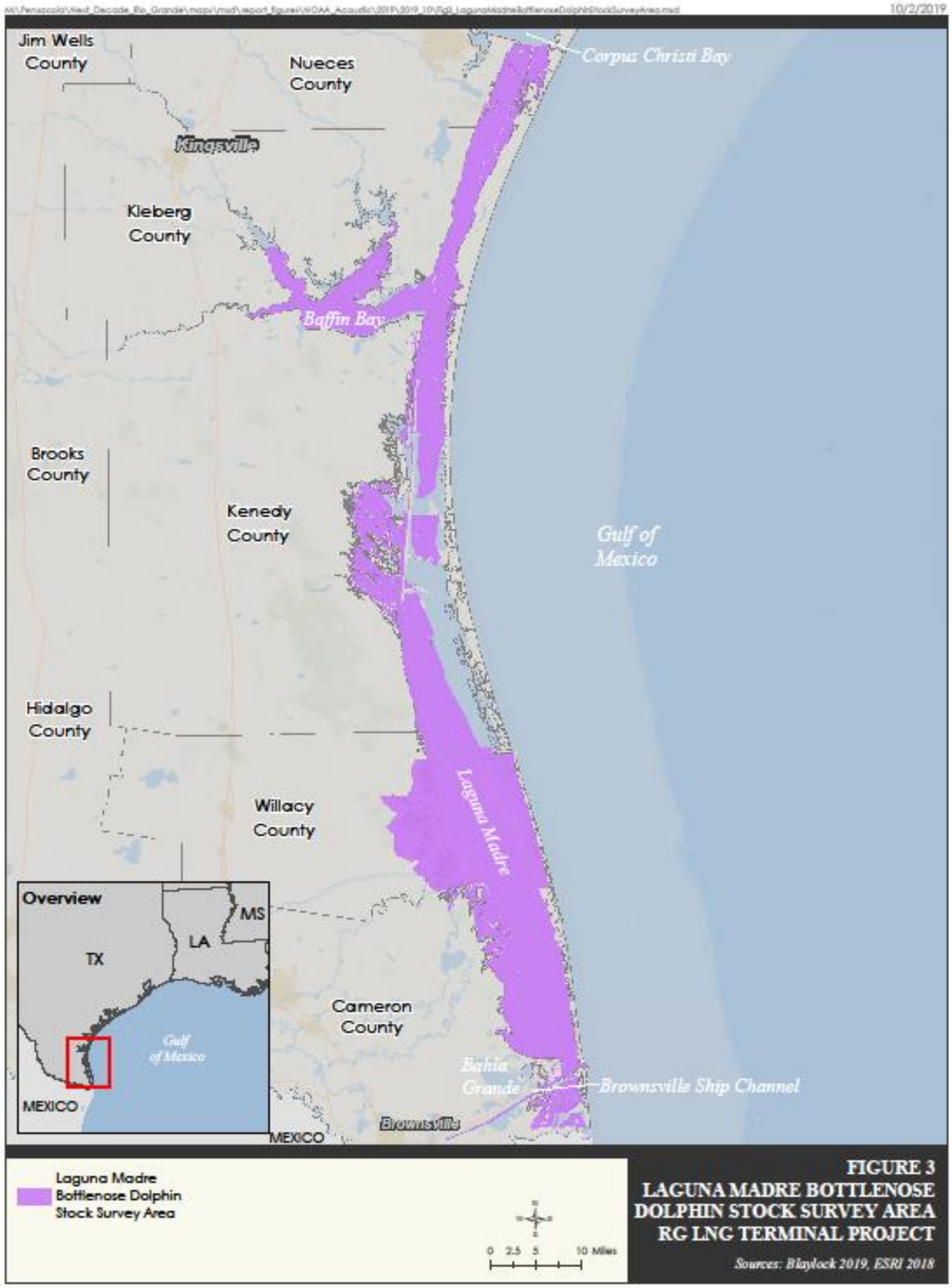
The population status of the Laguna Madre Estuarine stock of common bottlenose dolphins relative to OSP is unknown because the stock size is currently unknown (Hayes et al. 2019); however, NOAA Fisheries does consider this stock to be strategic under the MMPA. Common bottlenose dolphins are not listed as threatened or endangered under the ESA (Hayes et al. 2019).

As described in Section 4.2.1.1, mass strandings of Texas common bottlenose dolphins occurred from November 2011 to March 2012. These strandings led NOAA Fisheries to declare a UME in May 2012. The UME is still active today (NOAA Fisheries 2018b). The UME did not identify the bottlenose dolphin stock affected.

4.2.2.2 Distribution

The Laguna Madre stock of common bottlenose dolphins is likely a year-round resident stock of lower Texas estuarine waters. The boundary associated with this stock (Rosel et al. 2011), which is also the survey area for abundance estimates from 1992/1993 (Blaylock and Hoggard 1994) and 1984/1985 (Scott et al. 1989), is the Laguna Madre estuary, which spans from Port Isabel to Corpus Christi Bay, including Baffin Bay (Figure 3). Piwetz and Whitehead (2019) conducted photo-identification surveys in Lower Laguna Madre in 2018–2019. They consistently observed bottlenose dolphins along the length of the BSC. Researchers also conducted a four-day opportunistic survey within the BSC in July of 2016 (Ronje and Whitehead 2016). Although the primary goal of the effort was to locate, track, and disentangle a reported bottlenose dolphin severely entangled in recreational fishing gear, opportunistic photographs and data were collected for sightings of other dolphin groups. During the four-day effort, approximately 287 km (178 mi) were surveyed and common bottlenose dolphins were sighted within the BSC as far into the channel as the shrimp docks and often travelling behind the boats of shrimp trawlers. Dolphins were observed foraging throughout the day at the mouth of the Brazos Santiago Pass and inside the BSC slowly traveling in the direction of tidal movement or behind shrimp trawlers. While older research yielded rarer sightings of common bottlenose dolphins in the area (Scott et al. 1989; Blaylock and Hoggard 1994; Phillips and Rosel 2014), newer research efforts suggest that these dolphins are residents of the estuarine waters of the Terminal site and commonly occur in the channel (Piwiez and Whitehead 2019).

Figure 3: Laguna Madre Bottlenose Dolphin Stock Survey Area



4.2.2.3 Numbers

Population abundance for the Laguna Madre estuarine stock of common bottlenose dolphins has not been assessed since 1992/1993. The stock assessment report provides an abundance estimate of 80 dolphins (CV = 1.57) (Blaylock and Hoggard 1994). Recent photo-identification surveys of the lower Laguna Madre and BSC have identified 109 individuals (Piwetz and Whitehead 2019). Of these, 42 percent were sighted on more than one survey day, and 6 percent were observed during both seasons of the survey (winter and summer), suggesting some degree of residency. Hence, 109 can be considered a minimum population size. The survey area represents less than 25 percent of the area of the boundary of the Laguna Madre Estuarine stock of bottlenose dolphins, which suggests that the population size is likely much larger.

4.3 Rough-Toothed Dolphin

Rough-toothed dolphins belong to the Delphinidae family of toothed whales. There are three stocks of rough-toothed dolphins in U.S. waters, but only one occurs off the coast of Texas: the northern Gulf of Mexico stock (Hayes et al. 2017).

Rough-toothed dolphins rely on echolocation for foraging and navigation, much like many other cetaceans. Their hearing capabilities are critical to their survival. These, like all dolphins, are considered mid-frequency cetaceans. Mid-frequency cetaceans have an estimated functional hearing range of 150 Hz to 160 kHz (NOAA Fisheries 2018a). The following subsections provide additional information about the status, distribution, and population numbers of this species as it relates to the region of the BSC.

4.3.1 Population Status

The northern Gulf of Mexico stock of rough-toothed dolphins is not considered strategic under the MMPA. The status of these dolphins relative to the OSP is unknown. Additionally, rough-toothed dolphins are not listed as threatened or endangered under the ESA (Hayes et al. 2017).

4.3.2 Distribution

Rough-toothed dolphins typically occur in oceanic and offshore waters, though they are also present, to a lesser extent, in continental shelf waters in the northern Gulf of Mexico. In 2000 and 2001, the Southeast Fisheries Science Center conducted ship-based line transect surveys and recorded two sightings of rough-toothed dolphins approximately 40 km (25 mi) offshore of Corpus Christi, Texas, in approximately 35 meters (115 feet) of water (SEFSC 2000, 2001). The group size of the two encounters ranged from 8 to 20 animals. During aerial surveys of the northern Gulf of Mexico from 1992 to 1998, rough-toothed dolphins were observed during all seasons of the calendar year (Hayes et al. 2017). While the presence of rough-toothed dolphins in the nearshore waters of the Terminal site is unlikely, they do have the potential to occur within the Terminal site.

4.3.3 Numbers

The current population size of the northern Gulf of Mexico stock of rough-toothed dolphins is estimated in the stock assessment report to be 624 individuals (CV=0.99) (Hayes et al. 2017). This estimate is based on a summer line-transect shipboard survey conducted in 2009 that covered waters from the 200-meter (656-foot) isobath out to the outer boundary of the U.S. Exclusive Economic Zone (Garrison 2016). This may be an underestimate because it does not include continental shelf waters and is not corrected for missed animals during surveys (Hayes et al. 2018). Data combined from 1992–2009 resulted in an estimate of 4,853 individuals (CV=0.19) (Roberts et al. 2016).

5 Type of Incidental Taking Authorization 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.

The MMPA defines "harassment" as "any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A injury harassment]; or (ii) 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 [Level B behavioral harassment]" (50 Code of Federal Regulations [CFR], Part 216, Subpart A, Section 216.3 - Definitions).

Level A harassment may result in injury, and Level B harassment results in behavioral disturbance without the potential for injury. After analysis of potential Levels A and B exposures, this IHA application is requesting estimated takes resulting only from Level B behavioral harassment for the Atlantic spotted dolphin, common bottlenose dolphin, and rough-toothed dolphin. Clearance and a shut-down zone would be implemented to avoid Level A take. As per the proposed mitigation and monitoring protocols discussed in Section 11, visual monitoring would begin 30 minutes prior to the start of construction to clear the Level A exclusion zone of any marine mammals that may be present. If an animal is sighted within the Level A exclusion zone during pre-construction, operations would be delayed until the animal is sighted outside the zone or disappears from view for 15 minutes.

5.1 Take Authorization Request

RGLNG is requesting issuance of an IHA pursuant to Section 101(a)(5) of the MMPA for the incidental Level B take (disturbance due to Level B behavioral harassment) of small numbers of three marine mammal species by impact and vibratory pile-driving activities, as described in this application. These activities are associated with construction of the Terminal in the BSC and nearshore coastal regions of southern Texas.

5.2 Method of Incidental Taking

The activities outlined in Section 1 have the potential to take marine mammals by behavioral harassment during impact and vibratory pile-driving activities. More specifically, the requested authorization is for the incidental harassment of four stocks of marine mammals that might either be within the Level B ensonified areas at start-up or enter the Level B ensonified areas during the described construction activities. Level B isopleths (straight-line distances to the thresholds) were estimated using proxies for sound source levels and a practical spreading loss model. Level A isopleths were estimated using the NOAA Fisheries (2018a) acoustic guidance; however, as the implementation of the planned mitigation measures described in Section 11 would avoid Level A take of marine mammals, no Level A takes are being requested.

6 Take Estimates for Marine Mammals

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.

6.1 Introduction

The NOAA Fisheries application for an IHA requires applicants to analyze the number of marine mammals with the potential to be exposed to incidental harassment (Level A or Level B) associated with the Terminal. The in-water pile-driving activities that would occur at the Terminal site (outlined in Sections 1 and 2) have the potential to take marine mammals only by behavioral harassment (Level B). Other activities, such as dredging, are not expected to result in take since the BSC is an active waterway that already experiences ongoing and regular maintenance dredging activities. The additional construction dredging activities associated with the Terminal are expected to be similar to the existing maintenance dredging and are not expected to cause a significant underwater noise impact in the BSC (FERC 2018). Airborne noise associated with pile-driving activities would not result in take of marine mammals because no pinnipeds reside in the vicinity of the Terminal site.

In-water pile driving would temporarily increase the sound levels within the BSC at the Terminal site and may result in Level B behavioral harassment of small numbers of Atlantic spotted dolphins, common bottlenose dolphins (including members of both coastal and estuarine stocks), and rough-toothed dolphins. The following sections provide a characterization of the underwater sound analyzed for this application, the sound exposure criteria thresholds and calculated isopleths, and methods and calculations used to determine take by Level B behavioral harassment. Level A injury harassment of cetaceans would be avoided through the implementation of mitigation measures (described in Sections 11 and 13). However, propagation modeling to the Level A criteria thresholds is included for reference.

6.2 Description of Noise Sources

The construction of the Terminal would include installation of two 48-inch-diameter steel tube piles and ten 42-inch-diameter steel tube piles using vibratory and impact hammers. Construction would also include removal of ten 12-inch-diameter timber piles with a vibratory hammer. See Table 1 and Sections 1 and 2 for full descriptions of installation and removal methods and durations. To estimate the sound levels for pile installation and removal activities, RGLNG identified source levels for each pile type and size using comparable literature values. Proxy values for pile driving are often sources from the "Compendium of Pile Driving Sound Data" (Appendix I in Caltrans 2015) which contains measured sound source levels for a variety of pile types and sizes from the Pacific Northwest including Alaska. However, the compendium does not contain comparable values for vibratory pile driving 42 to 48 inch piles; it does contain measured values for impact pile driving 48 inch steel piles and the resulting SPLrms measurements were 185 dB re 1 µPa @ 10 m and 195 dB re 1 µPa @ 10 m in the Russian River, California, and 190 dB re 1 µPa @ 10 m at Bangor Washington. Austin et al. (2016) measured sound source levels for both impact and vibratory pile driving 48-inch piles in Anchorage Port, Anchorage, Alaska. The measurements were made with no sound dampening (i.e. unattenuated) and with two methods of sound dampening. For comparison with the Compendium values, the unattenuated sound source levels for impact pile driving 48" steel piles from Austin et al. (2016) was 198.6 dB re 1 µPa @ 10 m, therefore comparable and slightly higher than those reported in the compendium. Because Austin et al. (2016) measured both impact and vibratory pile driving, RGLNG considers it appropriate to use the values from Austin et al. (2016) for both hammer types. While we discuss the sound attenuation achieved by Austin et al. (2016), RGLNG uses the unattenuated sound source levels provided by Austin et al. (2016) in the analysis with a 7 dB reduction to account for the use of double bubble curtains as proposed in the mitigation. The environmental conditions and equipment used for the pile driving are comparable to the current project (details provided below). A key difference would be water temperature, while sound will travel faster in warmer water, RGLNG does not propose to use the propagation measured by Austin et al. (2016), only the measured, unattenuated sound source levels. Furthermore, water temperatures for the proxies in the Compendium would also be considerably lower than the project site. Therefore, for the 42-inch and 48-inch piles, RGLNG used unattenuated sound source levels from Austin et al. (2016) for 48-inch piles for vibratory and impact hammer driving with no attenuation. Austin et al. (2016) describes measurements for two different impact hammers. The one most similar to the equipment proposed for the Project was an APE D180-42 diesel hammer, which strikes 34–53 blows per minute with an energy range of 272 to 446,513 feet per pound. The impact hammer RGLNG is proposing is a model D100-52 with maximum energy of 248,063 feet per pound (or equivalent equipment). Water depths for the pile driving in Austin et al. (2016) ranged from 8 to 28 meters, which is comparable to the dredge depths of 7.6 and 14 meters in the proposed Project area. For the 12-inch timber pile removal with a vibratory hammer, Laughlin (2011) was used for proxy values, where an ICE 415 vibratory hammer with approximately 12,500 inches per pound momentum was used to remove 12-inch timber piles. Laughlin (2011) did not provide water depths; however, the work was done at a near-shore ferry terminal location so the water depths should be comparable to the proposed Project.

While the pile sizes and water depths chosen as proxies do not exactly match those for the Terminal, they are similar enough to the proposed pile driving parameters that the source levels shown in Table 4 are representative for each pile type and associated pile-driving method. Note that use of a double bubble curtain would result in noise reductions from the source levels for both vibratory and impact installation and removal of piles listed in Table 4. Typical noise reduction from a double bubble curtain ranges from 5 to 15 dB (Caltrans 2015; Hannay 2008; Matthews and Zykov 2012). Based on the environment and pile-driving activity similarities, for the current Project, proxy unattenuated sound source levels were obtained from Austin et al. (2016) and a conservative 7 dB reduction was applied to account for the use of double bubble curtains (see Section 6.3.2). This value is consistent with NOAA Fisheries-approved applications for IHAs for in-water construction projects that modeled an 8- to 10-dB noise reduction from bubble curtains and assumed an average reduction of 12 dB (CTJV 2018; WSDOT 2018). Austin et al. (2016) achieved mean noise reductions of 8.7 dB for vibratory hammering and 8.9 dB impact hammering using an encapsulated bubble curtain compared to unattenuated hammering. The amount of noise reduction depends on several environmental factors—particularly, the flow rate of currents. As the currents in the BSC are relatively slow (see Section 2.3.1), higher noise reduction levels should be achievable. The double bubble curtains for the Terminal would be specifically designed for the Terminal to account for the pile parameters as described in this application. The curtains would be designed with effectiveness in mind—e.g., curtains would not start mid-water-column and instead would begin near the benthos and surround the piles rather than offer partial coverage. The curtains would be designed and operated by experienced bubble curtain designers and operators with a proven record of successful deployment. Hence, RGLNG concludes that the noise reduction achieved by Austin et al. (2016) would be achievable in this system, however RGLNG proposes the use of the median source levels measured in that sound source verification study when no noise reduction technology was in use, and apply a 7 dB reduction. The sound source levels reported in Table 4 are the median source levels measured during unattenuated pile driving in Austin et al. (2016) with a 7 dB reduction applied.

Table 4: Source Levels

Pile Type[1]	Hammer Type	Proxy[1]	Source Levels		
			SEL (re 1 µPa)	RMS (re 1 µPa)	Peak (re 1 µPa)
42-inch-diameter steel tube piles	Vibratory	48-inch steel pipe pile 7 dB bubble curtain attenuation	ND	161.2 @ 10 meters	178.3 @ 10 meters
42-inch-diameter steel tube piles	Impact	48-inch steel pipe pile 7 dB bubble curtain attenuation	179.7 @ 10 meters	191.6 @ 10 meters	205.5 @ 10 meters
48-inch-diameter steel tube piles	Vibratory	48-inch steel pipe pile 7 dB bubble curtain attenuation	ND	161.2 @ 10 meters	178.3 @ 10 meters
48-inch-diameter steel tubes	Impact	48-inch steel pipe pile 7 dB bubble curtain attenuation	179.7 @ 10 meters	191.6 @ 10 meters	205.5 @ 10 meters
12-inch-diameter timber piles	Vibratory	12-inch steel pipe pile 7 dB bubble curtain attenuation	ND	145 @ 16 meters	ND

[1]Proxies were obtained from Austin et al. (2016) for 42-inch and 48-inch piles and from Laughlin (2011) for 12-inch timber piles[1]. A 7 dB reduction in sound source levels is assumed rather than the higher dB reduction values determined for larger steel piles in Austin et al. (2016). Only source levels considered the best proxies for the proposed pile driving and bubble curtain mitigation are shown above, as these were the levels used in calculating harassment thresholds.
Key:
µPa = micropascal
dB = decibels
ND = no data
re = relative to
RMS = root mean square
SEL = sound exposure level

6.3 Distance to Sound Thresholds

6.3.1 Sound Exposure Criteria and Thresholds

NOAA Fisheries recognizes two levels of incidental harassment, or "take." Each level has different thresholds and models to determine potential take. Level A injury harassment has the potential to injure a marine mammal or marine mammal stock in the wild. Level B behavioral 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 does not have the potential to injure a marine mammal or marine mammal stock in the wild.

Level A Criteria: NOAA Fisheries issued new acoustic guidance in 2016 (updated in 2018) for determining potential impacts on marine mammals and established new injury thresholds for Level A injury harassment (NOAA Fisheries 2016, 2018a). The technical guidance for determining potential impacts on marine mammals differentiates between marine mammal functional hearing groups. In addition to differentiating among functional hearing groups, the guidance uses metrics that address the impacts of noise on hearing sensitivity. The guidance criteria use dual metric acoustic thresholds for impulsive sounds, peak sound pressure (L_{pk}) re 1 µPa and cumulative sound exposure level (SEL_{cum}) re 1 µPa^{2}s. For a non-impulsive source, such as vibratory pile driving, the guidance criteria specify a single SEL_{cum} re 1 μPa²s for each hearing group. Importantly, the SEL_{cum} thresholds account for duration of the activity and associated accumulation of noise over time. The designated thresholds for mid-frequency cetaceans are 185 dB SEL_{cum} or 219 dB L_{pk} for impulsive sound sources, and 198 dB SEL_{cum} for non-impulsive (i.e., continuous) sound sources. For the analyses herein, RGLNG applied thresholds for the mid-frequency cetacean group, which includes dolphins, toothed whales, beaked whales, and bottlenose whales, to determine isopleths as all dolphin species analyzed belong to the mid-frequency hearing group.

Level B Criteria: To determine potential behavioral impacts on marine mammals from underwater acoustic sources, NOAA Fisheries has established a harassment threshold of 160 dB re 1 μPa RMS for impulsive sounds and 120 dB re 1 μPa RMS for non-impulsive sounds.

6.3.2 Underwater Sound Propagation Modelling

RGLNG applied the proxy sound source levels (Table 4; see Section 6.2 for description) to the practical spreading loss model for simple geometric propagation to obtain sound propagation for each pile type and hammer type.

Practical Spreading Loss Model:

TL = 15 log (R1/R0)

where:

TL = Source Level – Noise Threshold Level

R1 = Range distance the noise criterion extends away from the source (in meters)

R0 = Reference range (i.e., at 1 meter, at 10 meters, etc.,)

6.3.3 Underwater Noise from Pile Driving

Level A Analysis: RGLNG used the Companion User Spreadsheet provided by NOAA Fisheries to develop noise propagation modelling for assessment of potential impacts on marine mammals. The Companion User Spreadsheet, issued in 2016 and updated in 2018 in conjunction with NOAA Fisheries' *Technical Guidance for Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearing* and its subsequent revision, is a tool that allows project proponents to estimate distances to injury thresholds for various pile-driving activities (NOAA Fisheries 2018a).

The Companion User Spreadsheet provides a variety of different models for specific in-water construction situations. RGLNG used the "Stationary Source: Non-Impulsive, Continuous" model to calculate underwater noise thresholds for vibratory pile-driving activities and the "Impact Pile Driving Stationary Source: Impulsive, Intermittent" model for impact pile-driving activities. For vibratory hammer pile driving, the suggested default weighting factor adjustment of 2.5 was used to calculate isopleths. For impact hammer pile driving, the suggested default weighting factor adjustment of 2 was used to calculate isopleths. Source levels used in the calculations are listed in Table 4. Calculations were also run for source levels with noise reductions of 7 dB to capture noise attenuation resulting from the use of double bubble curtains during impact pile driving. All calculated isopleths are presented in Table 5.

For calculations using the new NOAA Fisheries injury thresholds, all calculations proceeded even if the source level was less than the threshold, as the User Spreadsheets account for accumulation of noise over time so the threshold may be crossed if an activity persists long enough for the accumulated noise to surpass the threshold.

Level B Analysis: Using proxies for sound source levels based on literature values (Austin et al. 2016; Laughlin 2011), the Practical Spreading Loss model was used to calculate distances to the mid-frequency cetacean behavioral thresholds for all pile-driving types. Note that for calculations made with the Practical Spreading Loss model, if the source level was less than the threshold, no calculation was performed since this model treats noise as instantaneous. As the Practical Spreading Loss model does not account for hearing group, RGLNG applied the M-weighting function as described in Section 6.3.2.1 to achieve SPLrms weighted for mid-frequency cetaceans. RGLNG reports isopleths for both the weighted and unweighted source levels. The practical spreading loss model generally overestimates distances to thresholds compared to models that account for environmental metrics (e.g., Farcas et al. 2016) and the results are therefore likely to be conservative. All calculated isopleths are presented in Table 5.

Table 5: Isopleths for Level A and B Harassment Exposure

Pile Type	Hammer Type	Proxy[1]	Level B Radius (meters)	Level A Radius (meters)
42-inch-diameter steel tube piles	Vibratory	48-inch steel pipe pile 7 dB bubble curtain attenuation	5,580	0.5
42-inch-diameter steel tube piles	Impact	48-inch steel pipe pile 7 dB bubble curtain attenuation	1,278	24.7
48-inch-diameter steel tube piles	Vibratory	48-inch steel pipe pile 7 dB bubble curtain attenuation	5,580	0.3
48-inch-diameter steel tube piles	Impact	48-inch steel pipe pile 7 dB bubble curtain attenuation	1,278	15.6
12-inch-diameter timber piles[2]	Vibratory	48-inch steel pipe pile 7 dB bubble curtain attenuation	743	0.3

Note that as construction would take place in the BSC, the actual noise propagation would be restricted by the presence of land. Therefore, the area of possible exposure to noise, referred to as the zone of influence (ZOI) or ensonifed area, would be reduced compared to an open-water construction scenario. To determine the ZOI for each pile-driving activity and level of potential impact, the isopleths from Table 5 were mapped using geospatial analysis to determine the area (km^2) of possible exposure (Table 6), which is presented and used in Section 6.5 to calculate the potential take for each species (see Figures 4 through 6; Table 7).

Table 6: Zones of Influence for Level A and B Harassment Exposure

Pile Type	Hammer Type	Level B Behavioral Zone of Influence (km^2)	Level A Zone of Influence (km^2)
42-inch-diameter steel tube pile	Vibratory	4.85	<0.01
42-inch-diameter steel tube	Impact	1.06	<0.01
48-inch-diameter steel tube pile	Vibratory	4.58	<0.01
48-inch-diameter steel tube	Impact	1.18	<0.01
12-inch-diameter timber piles	Vibratory	0.68	<0.01

Key:
km^2 = square kilometers

Figure 4: Removal of 12-inch Timber Piles for the Existing USCG Navigation Aid

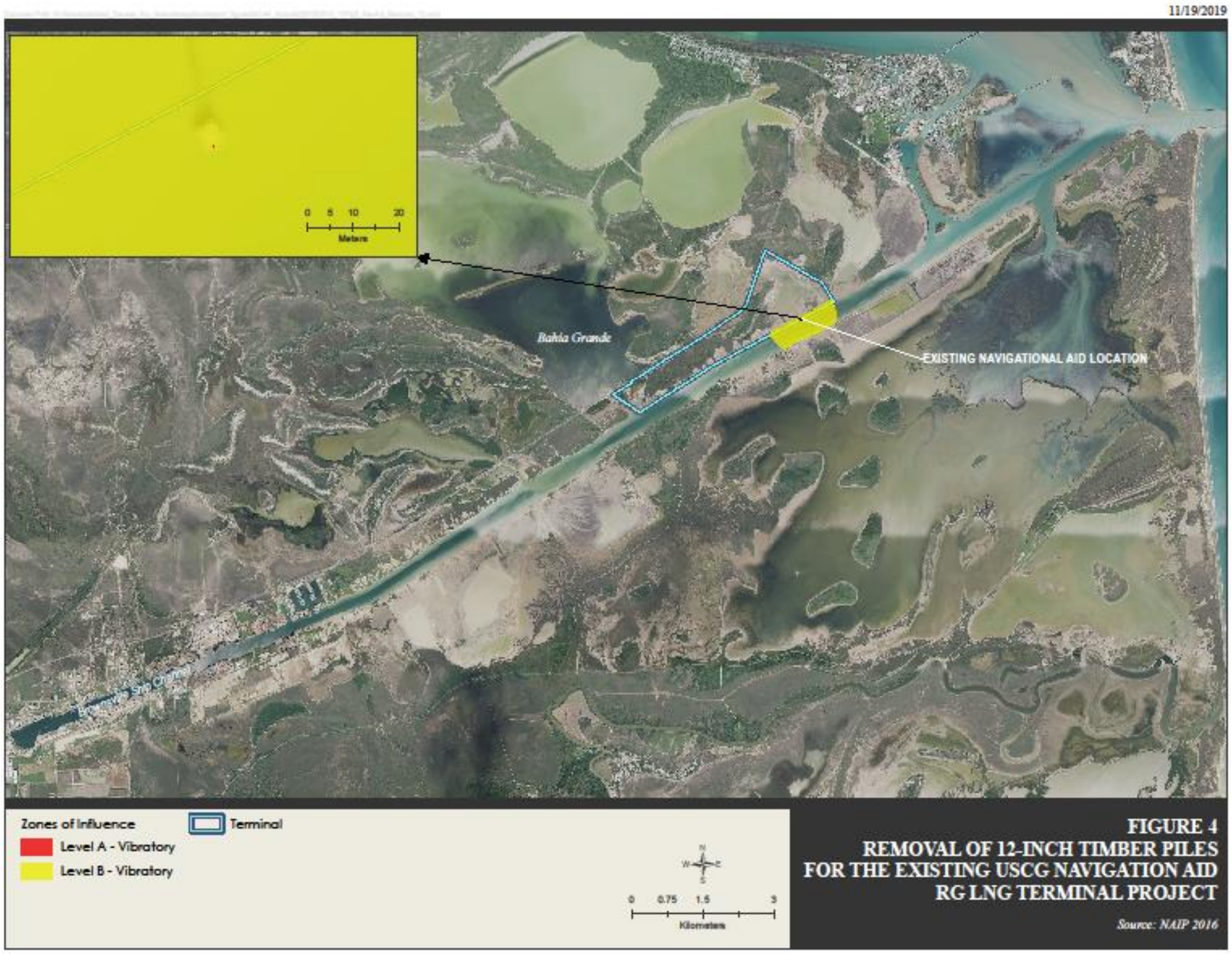


Figure 5: Installation of 42-inch Steel Tube Piles

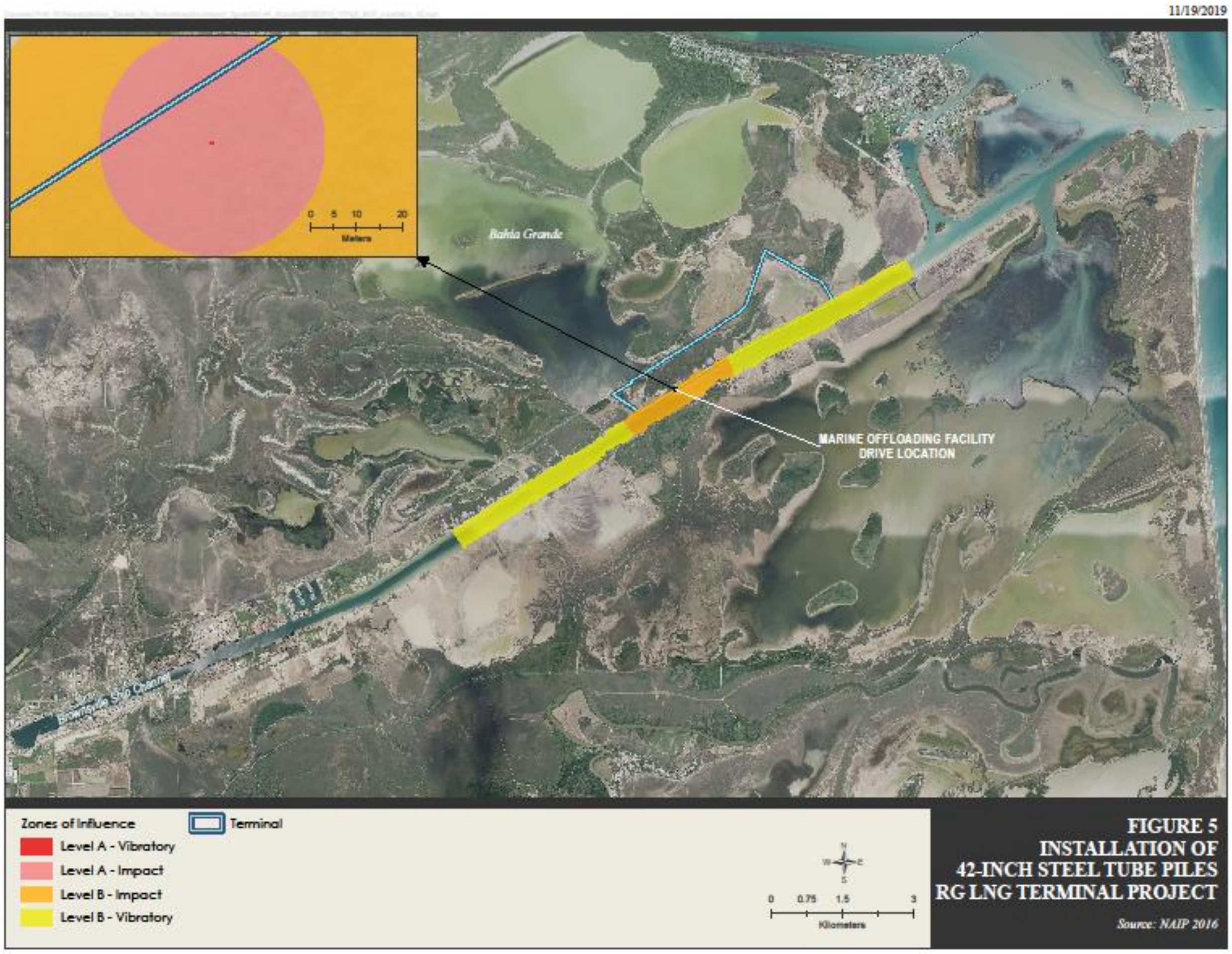
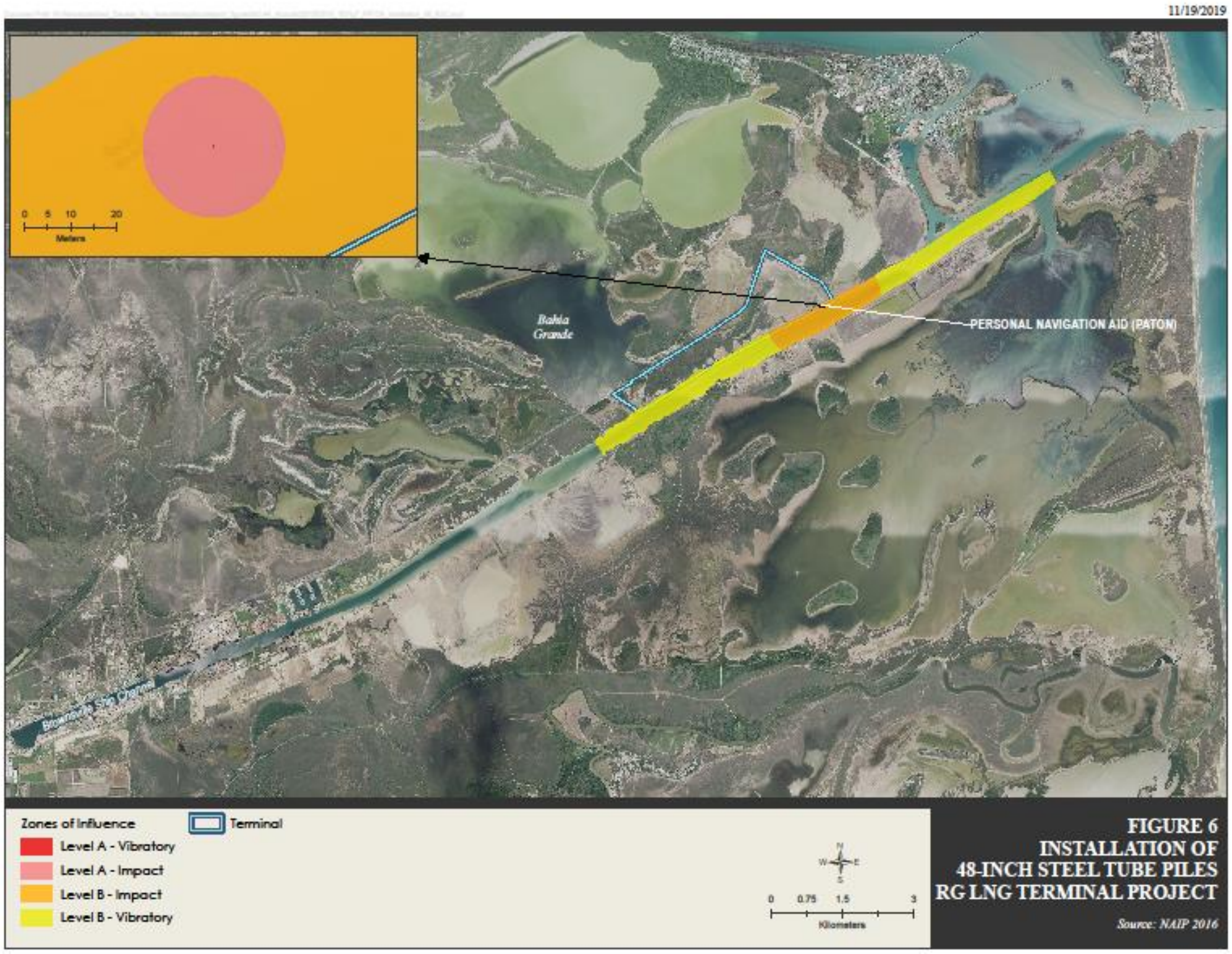


Figure 6: Installation of 48-inch Steel Pipe Piles



6.3.4 Airborne Sound from Pile Driving

No pinniped species are known to occur in the Gulf of Mexico; therefore, the effects of airborne sound associated with the construction of the Terminal were not analyzed and will not be discussed further herein.

6.4 Species Density

It is unlikely that rough-toothed dolphins or Atlantic spotted dolphins will occur in the Project area, and none were observed during opportunistic and planned surveys in 2016–2019 (Ronje and Whitehead 2016; Piwetz and Whitehead 2019); however, because there is a small risk that these animals may be exposed to Project-related sound were they to enter the BSC, RGLNG is requesting one mean group size of these species based on the most recent analysis of group size (Maze-Foley and Mullin 2006). These mean group sizes are 14 rough-toothed dolphins and 26 Atlantic spotted dolphins. The maximum group sizes of these species observed in Maze-Foley and Mullin (2006) were 28 and 68, respectively; note that estuarine areas were not included in the surveys upon which these group sizes are based. Because RGLNG is requesting a mean group size of each of these species, no density values were estimated. For bottlenose dolphins, density in the Laguna Madre area was estimated using the minimum abundance of identified individuals by Piwetz and Whitehead (2019), which was 109 dolphins. The area of the region defined as "Laguna Madre" is the area known as Block B-51 in Rosel et al. (2011), Blaylock and Hoggard (1994), and Scott et al. (1989) (see Figure 3).

RGLNG used habitat data layers from Finkbeiner et al. (2009) to estimate the area of the Laguna Madre and Baffin Bay, removing the layers that were not dolphin habitat (e.g., land, emergent marsh, and mangroves). This resulted in a 1,938 km^2 area. Separately, RGLNG estimated the area of the BSC at 27 km^2, for a total area of 1,965 km^2 for the Laguna Madre Estuarine stock area (i.e., Block B-51). An abundance of 109 dolphins for this stock would equate to a density of 0.055 dolphins/ km^2 (109/1,965=0.055). The mean group size of bottlenose dolphins observed by Piwetz and Whitehead (2019) was 4.5, with sizes ranging from 1 to 14.

Although not directly studied in Laguna Madre, studies in other Gulf of Mexico estuaries suggest that mixing of coastal and estuarine bottlenose dolphins occurs and some individuals may not show a clear preference for estuarine or coastal waters (e.g., Laska et al. 2011). Based on studies indicating that estuarine residents and coastal bottlenose dolphins both occur in estuaries (e.g., Maze and Würsig 1999), the coastal and estuarine stocks of bottlenose dolphins would both be expected to occur in Block B-51, so it would be expected that some proportion of bottlenose dolphins in the estuary at any given time would be from the coastal stock. There is no estimate of the number of coastal stock individuals that may be in the Laguna Madre area at any given time. Thus, as with rough-toothed dolphins and Atlantic spotted dolphins, RGLNG has not defined a density of coastal stock animals but are requesting a mean group size of 21 (Maze-Foley and Mullin 2006) of the Western Coastal bottlenose dolphin stock to address potential harassment of this stock.

6.5 Description of Take Calculation

Take calculations presented in this IHA application relied on the best available data on marine mammal populations and distributions within or near the region of the BSC. Level A injury and Level B behavioral harassment take were estimated, representing a conservative number of potential marine mammal exposures to sound above NOAA Fisheries' designated thresholds during in-water activities to construct the Terminal. RGLNG estimated exposures for the pile-driving scenarios are detailed in Section 1.3.1. All impact and vibratory pile installation and removal activities would be conducted while implementing a double bubble curtain, resulting in an estimated 7 -dB reduction in sound level emissions, based on Austin et al. (2016) and a 7-dB reduction for vibratory hammers used to remove timber piles.

The calculations for marine mammal Level A and Level B takes are estimated by the following formulas:

Level A take estimate = (n * ZOI) * X days of total activity

Level B take estimate = (n * ZOI) * X days of total activity

where:

n	=	density estimate used for the particular species
ZOI	=	zone of influence representing the noise threshold impact area
X	=	number of days of pile-driving activity, estimated based on the total number of piles and the average number of piles that the contractor can install in one day.

Level A injury and Level B behavioral harassment exposures were first calculated for each day of in-water pile-driving activity across all vibratory and impact hammering in a given day. All Level A and Level B calculated take estimates were then multiplied by the total number of days of the activity to result in total calculated take numbers for the duration of the construction of the Terminal. If the calculated take was less than 0.5 of an individual animal, then 0 take was estimated, but if the calculated take was equal to or greater than 0.5, that value was increased to the next whole number (Table 7). There were insufficient data to evaluate individuals exposed versus total exposures.

Based on initial exposure estimation calculations, <<0.001 (rounded to 0) Level A injury harassment exposures were calculated for all species.

6.5.1 Common Bottlenose Dolphin Laguna Madre Estuarine Stock

Table 7: Level B Harassment Exposure Estimates for Laguna Madre Stock

Pile Type	Hammer Type	Days of Pile Driving	Estimated Exposures Per Day (ZOI X density)	Estimated Total Exposures
42-inch-diameter steel tube piles	Vibratory	5 days	0.27	01.35
42-inch-diameter steel tube piles	Impact	5 days	0.06	0.30
48-inch-ddiamete steel tube piles	Vibratory	2 days	0.25	00.5
48-inch-diameter steel tube piles	Impact	2 days	0.07	0.14
12-inch-diameter timber piles	Vibratory	5 days	0.04	0.2
Total Exposures				**2.49**

Key:
ZOI = zone of influence
Density = 0.055 dolphins/ km^2

6.6 Requested Take

Although total exposures of Laguna Madre Estuarine stock bottlenose dolphins are estimated to be 2.49, this estimate does not account for group size nor for the fact that abundance, based on minimum number of individually identified dolphins, is underestimated for this stock (Piwetz and Whitehead 2019). Observations in the BSC suggest relatively frequent use by bottlenose dolphins, which could include dolphins from both the estuarine and coastal stocks (Ronje and Whitehead 2016; Piwetz and Whitehead 2019). This is a challenge because requesting a larger number of takes to accommodate a more realistic population size of these animals makes it difficult to compare the requested take to an appropriate abundance for "small numbers" considerations; however, requesting one mean group size may underestimate exposures because the estimates of population size, upon which the density is based, are inaccurate.

The pile driving would take place for 1.6 hours for each of 2 days, 3.2 hours for each of 5 days, and 8 hours for each of 5 days. That is a total of 59.2 hours of pile driving over 12 days. It is difficult to predict how many groups of estuarine dolphins would pass through the channel during that activity. Piwetz and Whithead (2019) reported six sightings during summer and one sighting during winter of bottlenose dolphins within the area that includes the predicted Level B ZOI for 48-inch piles (largest Level B ZOI), but the level of effort in that specific location cannot be extrapolated from the survey line information and surveys are mobile rather than stationary (like pile driving). One-third of the number of individually identified dolphins in the area is 36 (109/3). Mean group size is 4.5 (Piwetz and Whitehead 2019), so 36 dolphins would be approximately eight groups of dolphins. Although it is likely that less than 36 dolphins would be in the Level B harassment zone during piling activities, RGLNG is requesting 36 Laguna Madre Estuarine stock takes to ensure the most conservative possible situation has been addressed within the confines of ensuring a small number of takes. This request for 36 dolphins conservatively assumes that all dolphins that would occur in the Level B zones over the 12 days of activity would be different individuals with respect to consideration of small numbers. Further, in order to ensure no more than a small number (maximum of 36) Laguna Madre Estuarine stock bottlenose dolphins are taken, RGLNG will assume all bottlenose dolphins observed during operations are from that stock (not the Western Coastal stock which occurs in this geography) and additional shutdown mitigation will be implemented in the event that a threshold of 27 observed Level B exposures of bottlenose dolphins occur (see Section 11 for additional mitigation to prevent Level B take).

Requested takes are presented below in Table 8. The incorporation of mitigation measures, in particular, the clearance and shut-down procedures (described in detail in Section 11.1) will prevent animals from being exposed to noise levels above Level A injury harassment from pile-driving activities. There is the potential for behavior disturbance of small numbers of the three species. Takes may occur from either in-water impact or vibratory pile-driving operations.

Table 8: Total Number of Requested Level B Takes by Species

Species	Total Estimated Level B Exposures	Total Requested Level B Takes
Atlantic Spotted Dolphin	26	26
Common Bottlenose Dolphin Laguna Madre Estuarine Stock	2.49	36
Common Bottlenose Dolphin Western Coastal Stock	21	21
Rough-toothed Dolphin	14	14

7 Anticipated Impact of the Activity

The anticipated impact of the activity to the species or stock of marine mammal.

7.1 Potential Effects of Pile Driving on Marine Mammals

RGLNG is proposing to install and remove piles using impact and vibratory devices. The sound generated by in-water vibratory and impact pile-driving activities during construction of the Terminal would exceed the NOAA Fisheries in-water acoustic thresholds for Level A injury and Level B behavioral harassment for marine mammals. However, mitigation measures would avoid Level A injury take of marine mammals (see Section 11).

RGLNG is requesting authorization for Level B behavioral harassment for small numbers of three marine mammal species: Atlantic spotted dolphin, common bottlenose dolphin, and rough-toothed dolphin. For the purpose of calculating the percentage of each species' stock potentially affected by construction of the Terminal, we have assumed all exposures are of different individuals and provide comparison to the stock sizes reported in the stock assessment reports and more current or comprehensive abundances if available. The number of takes in relation to the overall stock size of each of the three species are presented in Table 9.

Table 9: Requested Number of Takes and Percentage of Marine Mammal Stock Potentially Affected by Level B Behavioral Harassment during In-Water Installation of Piles

Species	Stock	Stock Assessment Report Abundance	Other Available Abundance	Level B Takes Requested	Percentage of Stock Potentially Affected by Level B Take[1]
Atlantic Spotted Dolphin	Northern Gulf of Mexico Stock	37,611	47,488 [2]	26	0.07%/0.05%
Common Bottlenose Dolphin	Laguna Madre Estuarine Stock	80	109[3]	36	45.00%/33.03%
Common Bottlenose Dolphin	Western Coastal Stock	20,161	N/A	21	0.10%/N/A
Rough-toothed Dolphin	Northern Gulf of Mexico Stock	624	4,853 [2]	14	2.24%/0.29%

[1]Percentage of exposures relative to the reported abundance in the Stock Assessment Report/Percentage of exposures relative to the other (more current or comprehensive) abundance provided in the table. This percentage assumes all exposures are of different individuals.
[2]Roberts et al. (2016)

[3]Piwetz and Whitehead (2019) number of individually identified dolphins in lower Laguna Madre and BSC.
Key: N/A = not applicable

7.1.1 Underwater Noise Effects

Impacts on marine mammals are expected to result primarily from underwater sound propagation during pile-driving activities associated with construction of the Terminal. The effects of pile driving are highly dependent on a number of factors, including the physical characteristics of each affected species (e.g., size, type, hearing thresholds); intensity and duration of the pile-driving sound; the bottom substrate composition; the water depth; existing ambient sound levels; and the distance of the animal from the sound source. The degree of effect is related to the received level and duration of the sound exposure, which is influenced by the distance of the animal from the sound source. Sound propagation in shallow water environments is generally more complex than in deep water. The shallower the water depth, the more repeated sound reflections off the surface and the bottom can occur, causing sound to travel further distances. In addition to water depth, soft bottom substrate composition (e.g., mud) would likely absorb the sound more readily than hard substrates (e.g., rock), which can cause more repeated sound reflections. The softer the bottom, the less time required for a single pile to be driven into the substrate, which would decrease the intensity of the sound source.

For all cetaceans, sound serves three main functions: (1) provide information about their environment, (2) facilitate communication, and (3) enable the detection of prey (David 2006). When the level of noise in the environment increases (e.g., impulsive sound sources), marine mammals are likely to experience behavioral and physiological changes. Behavioral changes or reactions can include changes in call rates and frequencies, sudden changes in traveling speed, changes in breathing and diving patterns, and avoidance of important habitat or migration areas, while physiological changes can include physical discomfort, temporary and/or permanent hearing loss, injury of internal organs, and death of the animal (Southall et al. 2007; Richardson et al. 1995; Nowacek et al. 2007).

Physiological Responses

Increased sound levels can lead to physiological damage in the hearing systems of marine mammals through the temporary or permanent alteration of the sensory hair cells. The hearing system includes organs most susceptible to high-intensity, impulsive (i.e., impact), and continuous (i.e., vibratory) sounds. Damage of these hair cells can affect the neurosensory system, which causes dizziness and vertigo in humans; however, little is known of the effects in marine mammals (Southall et al. 2007). Sound-related trauma can be lethal, resulting in death, or sub-lethal, resulting in hearing loss. Hearing loss can occur after a single, very loud event that damages the hair cells of the inner ear. The degree of damage in marine mammals exposed to pile-driving activities is poorly understood. No physiological responses are expected from in-water pile-driving activities associated with construction of the Terminal due to preventative mitigation.

Behavioral Responses

Behavioral responses of marine mammals to sound are not fully understood, are highly variable, and are context specific. Several factors can influence an animal's response to a specific sound source, including its existing habitat condition, its auditory sensitivity, its biological structure (e.g., age, sex, existing hearing loss), and its behavior at the time of exposure. Animals can become habituated to certain sound stimuli with repeated exposure. An animal's behavioral response depends critically on the exposure history of the animal to the sound source. For example, the majority of coastal marine mammals are habituated to noise above background, naturally occurring levels because they already inhabit a noisy environment with fishing vessels, trawling, dredging, and cargo shipping lanes (Southall et al. 2007). As noted in Section 2.3.2, the BSC experiences frequent vessel traffic, and thus the dolphins in the area are likely accustomed to some noise. Noise associated with the construction of the Terminal could temporarily alter behaviors such as foraging or calving.

While no marine mammal foraging areas are known to be in or near the BSC due to limited available data, during opportunistic surveys conducted by Ronje and Whitehead (2016), dolphins were observed foraging throughout the day at the mouth of the Brazos Santiago Pass. Dolphins have also been observed following shrimp boats into the BSC (Ronje and Whitehead 2016) (additional discussion of potential impacts to foraging habit can be found in Section 9.1). Mixing of resident and non-resident bottlenose dolphins has been observed for other stocks, especially in passes and at the mouths of estuaries, and is therefore likely to occur in the Laguna Madre as well (Hayes et al. 2019). No information on calving behavior is available for the BSC, and since there are known differences in reproductive seasonality from site to site for other better-studied estuarine stocks in the Gulf of Mexico, it is difficult to predict the potential patterns for this specific region (Hayes et al. 2019). Controlled experiments with captive and wild marine mammals show that avoidance behavior of loud sound sources is the primary reaction (Hastie et al. 2017; Bailey et al. 2010; Southall et al. 2007). Responses to continuous noise (e.g., vibratory pile driving) have not been documented as well as responses to pulsed sounds (e.g., impact pile driving). Behavioral responses in small numbers of marine mammals are expected from in-water pile-driving activities associated with construction of the Terminal.

7.1.2 Airborne Noise Effects

No pinniped species are known to inhabit the vicinity of the Terminal site; therefore, airborne noise associated with construction of the Terminal was not examined as it is not anticipated to affect marine mammals present in the vicinity of the Terminal.

7.1.3 Conclusions Regarding Impacts on Species or Stocks

RGLNG does not anticipate any physiological responses in marine mammals during construction of the Terminal. RGLNG has proposed the use of a double bubble curtain during impact and vibratory pile driving, which would reduce the peak SPL and cumulative SELs. This would greatly reduce the potential for injury of a marine mammal exposed to pile-driving noise associated with in-water construction activities at the Terminal. Lastly, RGLNG is proposing a shutdown zone to ensure that no marine mammals are injured (see Section 11.1). With both types of in-water pile driving, it is likely that the onset of pile driving could result in temporary, short-term changes in an animal's typical behavior (behavioral response) and/or avoidance of the Terminal area, resulting from Level B behavioral harassment. Any takes associated with Level B would be expected to have only a minor effect on the individual and no effect on the population. Therefore, based on the best available information and the information provided in this authorization request (including density, status, and distribution), Terminal-related in-water pile-driving activities are expected to have a negligible impact on the marine mammal species and stocks that could occur in the vicinity of the Terminal during the in-water construction period.

8 Anticipated Impacts on Subsistence Uses

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

This section is not applicable. The construction of the Terminal would take place in the Gulf of Mexico—specifically, the BSC. There are no traditional subsistence hunting areas in the Terminal region.

9 Anticipated Impacts on Habitat

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

9.1 Pile-Driving and Dredging Effects on Potential Prey (Fish)

As described in Section 7, in-water pile-driving and dredging activities within the BSC waterway due to construction of the Terminal could result in short-term increases in underwater noise levels. Underwater sounds could have physiological and behavioral impacts on fish, which are a primary dietary component of the cetaceans discussed in this application. Additionally, dredging activities could cause temporary increases in turbidity and loss of bottom habitat, which could impact fish, in addition to the potential for direct injury or mortality to bottom-dwelling species within the limits of disturbance.

Pile-Driving Effects

Noise impacts on fish can cause physical damage, stress, and changes in typical behavior (ICF Jones and Stokes and Illingworth and Rodkin, Inc. 2009; Popper et. al 2014). Fish with swim bladders are particularly vulnerable to the changes in pressure that occur quickly during pile-driving activities, which can result in the inability to control buoyancy (ICF Jones and Stokes and Illingworth and Rodkin, Inc. 2009) and/or the temporary loss of hearing (Popper and Hastings 2009; Popper et al. 2005; Popper et al. 2014). General stress responses such as a startle reaction or site avoidance during pile-driving activities are also likely, with fish moving laterally away from the sounds or moving into deeper water (Wysocki et al. 2006).

Direct injury or mortality of fish due to sound could also occur if SPL or SEL_{cum} criteria are exceeded. NOAA Fisheries' Greater Atlantic Regional Fisheries Office issued interim acoustic guidance in 2017 for determining the potential effects on ESA-listed fish, including sturgeon and salmon, and sea turtle species exposed to elevated levels of underwater sound produced during pile-driving activities. A cooperative effort between several federal and state transportation and resource agencies along the west coast of the United States resulted in the establishment of interim criteria for the onset of physical injury to fish exposed to the underwater sounds generated by impact pile driving (NOAA Fisheries GARFO 2017). The onset of physical injury is determined using the dual criteria of the SPL and SEL_{cum}, with injury expected to occur if either of these criteria is exceeded. A potential onset of physical injury is determined if either the peak SPL exceeds 206 dB re 1 μPa or the SEL, accumulated over all pile strikes generally occurring within a single day, exceeds 187 dB re 1 μPa^2s for fishes 2 grams or larger and 183 dB re 1 μPa^2s for smaller fishes. Adverse behavioral effects occur at a threshold of 150 dB re 1 μPa (NOAA Fisheries GARFO 2017).

To determine reasonable source levels for pile-driving activities associated with the Terminal, studies of pile-driving operations with similar properties were evaluated. Refer to Section 6.2 for additional description of noise sources. Note that use of a double bubble curtain would result in noise reductions from the source levels for impact and vibratory piling (see Section 6.2). Typical noise reduction from a double bubble curtain ranges from 5 to 15 dB (Caltrans 2015; Hannay 2008; Matthews and Zykov 2012). The amount of noise reduction depends on several environmental factors, particularly the flow rate of currents. As the currents in the BSC are relatively slow (see Section 2.3.1), good reduction should be achievable. Sound source levels for impact and vibratory hammers of the 48-inch piles were 8.7 dB and 8.9 dB, respectively (Austin et al. 2016); to be conservative we use a 7 dB reduction in sound source levels to account for the use of double bubble curtains. There was no proxy available for sound reduction by bubble curtains for the vibratory hammer for 12-inch timber piles, so 6-dB sound reduction was assumed. This range is consistent with NOAA Fisheries-approved applications for IHAs for in-water construction projects that modeled an 8- to 10-dB noise reduction from bubble curtains and assumed an average reduction of 12 dB (CTJV 2018; WSDOT 2018). As the proxy underwater noise estimates indicate, in-water pile-driving activities would exceed the limit for adverse behavioral impacts and have the potential to exceed limits for the onset physical injury per the above-mentioned criteria.

As described in Section 2.2, in-water pile driving would be required for the installation of two 48-inch-diameter steel pipe piles for the PATON at the LNG berth, occurring over a 2-day period, ten 42-inch-diameter steel piles at the tug berth within the MOF dredge pocket over a 5 day period, and vibratory hammer removal of five 12-inch-diameter timber piles from an existing USCG navigation aid structure over a 5-day period. Given this temporal nature of the pile driving, permanent deterrence of fish from the area for foraging would not occur. In addition, noise impacts would be localized to the immediate vicinity of the marine berths, and ample similar habitat is found throughout the BSC, so it is anticipated that displaced fish species would find suitable nearby habitat.

Based on the short duration of pile-driving activities, the abundance of available fish habitat adjacent to the Terminal site, and implementation of mitigation and minimization measures, impacts on fish (and thereby cetacean foraging) from in-water pile-driving noise would be short term and minor.

Dredging Effects

Seafloor-disturbing activities such as dredging (described in Section 1.3.2) would suspend sediments in the water column for a period of time, depending on the size of the sediment particles. Coarser sediments are expected to fall out and resettle quickly (within hours), while finer sediments are likely to remain suspended for longer periods of time (days). Sediments suspended within the water column can cause an increase in turbidity and temporary siltation or sedimentation. These effects could result in a reduction in predation efficiency for local fish species, as extended periods of elevated turbidities have been shown to reduce feeding rates by up to 20 percent and to reduce the efficiency of the foraging process for visual predators (Gardner 1981).

Juvenile and adult fish are likely to temporarily relocate during periods of increased turbidity where forage efficiency would improve. Fish eggs and larvae may be impacted more than juveniles and adults due to the potential decrease in dissolved oxygen that corresponds to an increase in turbidity, as they are more sensitive to water quality stresses and unable to emigrate from the affected area. However, the effects from elevated turbidities are associated with long-term exposure, which would not occur as part of construction of the Terminal. The Environmental Assessment for the Brazos Island Harbor Channel Improvement Project determined that short-term elevated turbidity concentrations occurring from pile-driving, drilling, and dredging activities are not likely to cause chronic adverse effects (USACE 2014). Additionally, as an active navigation channel, the BSC is subject to maintenance dredging on a regular basis, and the aquatic communities within the BSC are regularly subjected to periodic disturbance and associated increases in turbidity. An RGLNG Dredged Material Management Plan is being developed, and the determination of dredging methods and dredged material placement locations would be finalized in consultation with the BND and federal and state agencies. Regardless of the dredging methodology employed (mechanical or hydraulic), all work would be conducted in accordance with Texas state water quality standards, and any necessary mitigation measures would be employed on an as-needed basis in the event that water quality standards cannot be achieved without them. RGLNG will continue to coordinate with federal and state agencies to develop mitigation measures for excavation and dredging activities.

In addition to water quality and/or sedimentation impacts, dredging activities could impact cetacean prey from the temporary removal of the seafloor habitat within the limits of the dredge area. Impacts of these activities would differ among species, depending on life history, habitat use, and distribution. Some bottom-dwelling species, such as mollusks, crustaceans, and demersal shrimp (if present), may be affected because they could be entrained during dredging activities. Larger, more mobile, demersal species (e.g., blue crab) would be temporarily displaced. These impacts could extend to higher trophic groups, from fish to cetaceans. However, habitat use would reestablish within days following dredging operations (USACE 2014). Relocation of prey could limit foraging in the localized area of dredging activities; however, prey would still be accessible in nearby unaffected areas. The dredging activities could also suspend floating debris or prey that could attract marine mammals to the area (Clement 2017). In addition, the area of impact would be small compared to the total available habitat present within the BSC. Therefore, although dredging activities would have an effect on species occupying the substrate, impacts on fish and the habitat supporting them, as well as cetaceans that predate them, would be short term and minor and not expected to have population-level impacts.

Finally, within the limits of the dredge area, bottom-dwelling fish species and their prey could experience direct injury or mortality due to crushing, localized disruption, removal, turnover, and/or deposition of sediment in the immediate vicinity of the dredging. These impacts could extend to higher trophic groups, from benthic communities to fish to cetaceans. As most benthic infauna live on or within the upper 6 inches of the sediment surface, it is expected that removal of sediment and burial from settling of sediments resulting from increased turbidity would result in some loss of these organisms. These patterns are currently occurring within the BSC as a result of ongoing maintenance dredging activities. However, benthic communities typically recover to pre-disturbance conditions within six months to two years after a physical disturbance (Germano et al. 1994; Murray and Saffert 1999; Rhoads et al. 1978). While recovery time would vary depending on the site-specific environmental conditions, disturbance-related impacts on bottom dwelling species (and thereby higher trophic level effects) would be short term and minor, with species recolonizing the impacted area (USACE 2014).

9.2 Pile-Driving and Dredging Effects on Potential Foraging Habitat

Marine mammal foraging habitat could be impacted as a result of ground-disturbing activities during in-water pile-driving activities. In-water ground-disturbing activities are expected to impact water quality through the temporary increase in turbidity, associated noise, and increased potential for resuspension of contaminated sediments. However, in 2013, the USACE sampled sediments of the BSC as part of the Brazos Island Harbor Channel Improvement Project and concluded that there were no contaminants of concern within the BSC (USACE 2014); therefore, the potential release of contaminated sediments would not be a concern for impacts on marine mammal foraging habitat. RGLNG has conducted sediment sampling of the portion of the BSC that would support the MOF and the berthing area during the first and second quarters of 2019.

As pile-driving and drilling activities disturb the seafloor, resuspended disturbed sediments would result in turbid conditions in the immediate area of the Terminal site. Coarser sediments would fall out and resettle quickly (within hours), while finer sediments could remain suspended for longer periods of time (days). Effects could include reduced dissolved oxygen concentrations and a corresponding reduction in primary production, as well as a reduction in predation efficiency for visual predators (Gardner 1981). However, based on the tidal fluctuation within the BSC and the channel's linear nature, localized turbidity plumes are expected to be dispersed quickly. Additionally, these effects are expected to be localized and not significantly different from impacts resulting from current and ongoing maintenance dredging activities conducted within the BSC. During periods of increased turbidity, marine mammals are likely to temporarily relocate to similar surrounding waters and return once turbidity reverts to pre-existing conditions.

The increased in-water noise from pile-driving activities may cause marine mammals to avoid potential available foraging habitat within the BSC in favor of quieter surrounding waters. However, no distinct marine mammal foraging habitat has been identified within the BSC. Disturbance from underwater noise associated with the Terminal would therefore be limited, as marine mammals can avoid noise disturbance by temporarily relocating to surrounding habitats for forage.

Based on the discrete duration and localized nature of the in-water pile-driving activities, permanent displacement from the area is not expected to occur. Given the low density of marine mammal populations in the BSC, the small area of impact, the abundance of suitable habitat adjacent to the Terminal site, and implementation of proposed mitigation measures, any habitat impacts that do occur would have no effect on populations and impacts would be short term and minor.

9.3 Summary of Impacts on Marine Mammal Habitat

No direct loss of habitat available to marine mammals (or their primary diet, fish) is expected to occur as a result of any activities associated with the construction of the Terminal. No known marine mammal foraging areas are located in the vicinity of the Terminal site; however, during opportunistic surveys conducted by Ronje and Whitehead (2016), dolphins were observed foraging throughout the day at the mouth of the Brazos Santiago Pass. All marine mammals using the BSC for foraging habitat would have the ability to temporarily relocate to ample surrounding waters for forage. Any potential adverse impacts are expected to be temporary and localized, with the habitat reverting to pre-existing conditions after completion of construction activities.

10 Anticipated Effects of Habitat Impacts on Marine Mammals

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

Existing benthic communities would be disturbed by construction of the Terminal due to ground-disturbing activities such as dredging, pile installation and removal, and vessel anchoring. However, benthic disturbances would not result in a significant permanent loss or modification of habitat for marine mammals or their prey. The greatest potential impact on marine mammal habitat resulting from construction of the Terminal would be the temporary loss of habitat and decrease in availability of prey due to elevated noise levels and increased turbidity associated with pile-driving activities. These temporary impacts are discussed in detail in Section 9.

11 Mitigation Measures to Protect Marine Mammals and Their Habitat

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

The in-water construction phase of the Terminal is anticipated to result in take by Level B behavioral harassment of small numbers of Atlantic spotted dolphins, common bottlenose dolphins, and rough-toothed dolphins. RGLNG is proposing mitigation measures to avoid and minimize impacts on marine mammals protected under the MMPA. In addition to the mitigation measures described below, RGLNG will comply with all federal and state requirements of the Clean Water Act.

11.1 Proposed Mitigation for Pile-driving Activities

Based on the initial analysis of potential impacts on marine mammals discussed in Section 6, RGLNG plans to employ mitigation to reduce exposure of marine mammals to pile-driving noise (i.e., vibratory and impact pile driving) and avoid Level A injury harassment. Anticipated mitigation measures include the following:

a. A NOAA Fisheries-approved observer (i.e., Protected Species Observer [PSO] or Marine Mammal Observer [MMO]) would visually monitor 20 meters around the pile-driving site within the in-water area of the ZOI from a vantage point that allows visibility of the complete Level A ZOI, beginning 30 minutes prior to the start of pile driving ("pre-construction") to clear the 20-meter zone (Level A zone is <20 meters for all pile-driving activities) of any marine mammals that may be present ("pre-clearance"). If animals are sighted within the 20-meter zone during pre-construction, pile driving would be delayed until the animals are sighted outside the zone or disappear from view for 15 minutes. Observations would be conducted using high-quality binoculars throughout the entire pile-driving activity, and all observations would be documented based on an approved monitoring and reporting plan (described in Section 13). To adequately perform observations, two PSOs would be needed to ensure no PSO works more than 4 hours in succession. The longest pile driving efforts are 8 hours in a day, with no pile driving at night, so two PSOs are sufficient to cover the required observations.

b. Visual monitoring of a 20-meter (32.8-foot) zone would be conducted during all phases of vibratory and impact pile-driving activities, and a shutdown would be implemented during impact pile driving if a dolphin is sighted approaching near the 20-meter exclusion zone. Pile driving would remain shut down until the animal is re-sighted outside the 20-meter zone traveling away from the pile-driving activity, is observed at least 50 meters from the pile-driving activity, or disappears from view for 15 minutes.

c. Standard monitoring and documentation procedures would be conducted for the observable portion of the Level B behavioral harassment zone. This includes documenting species, numbers, locations, and behavior of the dolphins (see Section 13).

d. A "soft start" would be implemented at the start of impact pile driving and at any time following cessation of impact pile driving for a period of 30 minutes or longer. The soft start technique provides an initial set of strikes at reduced energy, followed by a 30-second waiting period, then two subsequent reduced energy strike sets.

e. In-water pile-driving operations may commence only if the 20-meter exclusion zone is fully visible to observers for the time needed for clearance. Therefore, pile-driving operations would be limited to daylight hours and weather conditions suitable for monitoring. All in-water pile-driving activities would begin no earlier than 30 minutes after sufficient light is available for monitoring and the 30-minute pre-clearance monitoring is completed. All in-water pile-driving activities would finish no later than 30 minutes before sunset each day.

f. A 30-minute "post-construction" survey would be conducted at the completion of each day.

g. A double bubble curtain would be employed during in-water impact and vibratory pile driving to achieve an increase in noise attenuation. These bubble curtains would be specifically designed for the Terminal to account for the pile parameters as described in this application. The curtains would be designed with effectiveness in mind—e.g., curtains would not start mid-water-column and would instead begin near the benthos and surround the piles rather than offer partial coverage. The curtains would be designed and operated by experienced bubble curtain designers and operators with a proven record of successful deployment.

h. Construction would adhere to all laws and regulations pertaining to discharges and prevention and control of spills.

i. In the unlikely case that PSOs observe a total of 27 bottlenose dolphins (which would be approximately 6 groups based on mean group size) over any portion of pile driving activities within Level B ZOIs during pile driving operations, RGLNG would implement additional mitigation. This mitigation would consist of using at least four additional PSOs (two for observations on either side of the ZOI in the channel) to observe the Level B zone border area during remaining activities. If dolphins are observed approaching the Level B zone, pile driving operations will be shutdown until dolphins are observed leaving the zone or disappear from view for 30 minutes. An individual PSO can observe the border area of one side of the ZOI at any given time because the channel is approximately 300-meters across, allowing visibility across the full channel with the equipment for PSOs described above. RGLNG will implement this mitigation if 27 dolphins have been observed (rather than 36) to allow for the unlikely potential that PSOs at the ZOI borders along the channel may miss dolphins. Six groups of dolphins (on average) would result in 27 exposures, so two additional mean group sizes of bottlenose dolphins could be missed by PSOs and taken within the activity area within the limits of the requested takes. This is an extra measure to ensure that take stays within the take request of 36 exposures.

11.2 Transiting Vessels

Vessel traffic in the vicinity of the Terminal site would increase during the pile-driving activities of Terminal construction. All vessels used during construction of the proposed Terminal would comply with all federal and state regulations in an effort to minimize pollution in the oceans, both accidental and resulting from routine operations. The BSC was specifically created to provide deepwater access for maritime commerce and is maintained by regular dredging. Use of the waterways by LNG vessels, barges, and support vessels during construction of the Terminal would be consistent with the planned purpose. Vessels associated with the Terminal are not expected to cause harassment of marine mammals; however, vessel operators and the crew will use the following protocols at all times and locations:

- Maintain a vigilant watch for marine mammals and slow down or stop the vessel as is safe to avoid striking the animal(s). Vessels will maintain course and avoid abrupt changes in direction.
- All transiting vessels will comply with speed regulations, reducing to 10 knots or less if a marine mammal(s) is present.
- All vessels will avoid approaching marine mammals and will maintain a safe distance.

11.3 Construction Activities

To prevent contamination of waters within the Terminal site during construction, RGLNG would develop and implement the Terminal's specific spill prevention and response procedures in accordance with the requirements of 40 CFR 112. RGLNG would implement their Spill Prevention, Control, and Countermeasures Plan (SPCC Plan) during construction of the Terminal. These plans would outline potential sources of releases at the sites, measures to prevent a release to the environment, and initial responses in the event of a spill. All vessels associated with the Terminal are expected to comply with USCG requirements for the prevention and control of oil and fuel spills (International Convention for the Prevention of Pollution from Ships [MARPOL], Annex V, Pub. L. 100–220 [101 Stat. 1458]). All activities associated with construction of the Terminal would be designed to avoid or minimize, to the extent practicable, any impacts on marine mammals and their habitat. Mitigation measures would include the following:

- There shall be no discharge of ballast and bilge waters, sanitary waste, trash and debris, oil, fuel, chemicals, or other contaminants into the surface water or onshore. All contaminants would be disposed of properly, adhering to all federal and state regulations.
- Fuel hoses, oil drums, transfer valves, fittings, etc., shall be routinely checked for leaks and stored properly to prevent accidental spills.
- All chemicals and solvents used for cleaning and maintenance of tools or equipment shall be properly handled and stored to prevent discharge to ground or surface waters.
- No petroleum products or other toxic deleterious material shall be allowed to enter surface waters.
- Applicable spill response equipment outlined in the SPCC Plan shall be available and maintained at the job site.
- All activities associated with Terminal construction will comply with water quality restrictions imposed by the Texas Commission of Environmental Quality and the U.S. Environmental Protection Agency.

12 Mitigation Measures to Protect Subsistence Uses

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, you must submit either a plan of cooperation (POC) 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.

This section is not applicable. The construction of the Terminal would take place in the Gulf of Mexico off the coast of Texas, specifically in the BSC, and no activities would take place in or near a traditional Arctic subsistence hunting area. No subsistence uses of marine mammals would be impacted by this action.

13 Monitoring and Reporting

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.

13.1 Monitoring Plan

RGLNG has developed a marine mammal monitoring plan (described in Section 11.1) that would be implemented to reduce impacts on marine mammals to the lowest extent practicable. The plan would be reviewed by NOAA Fisheries for final approval well in advance of the start of construction, and a finalized monitoring plan would include the following measures:

- A minimum of two PSOs would primarily be located on boats, barges, docks, and/or land at the best vantage point(s) to properly observe the entire shutdown and behavioral zones(s) during both vibratory and impact in-water pile-driving activities.
- PSOs would monitor 360 degrees around the stationed location.
- PSOs would use marine binoculars with a reticle rangefinder and/or the naked eye to continuously search for marine mammals during all in-water pile installation activities.
- Handheld range finders would be used to measure distances from the PSO to the sighting, if possible. Handheld range finders would also be used to measure and verify the distance of the Level A shutdown zone(s) from the sound source.
- All data would be recorded using waterproof notebooks or entered into a digital database.
- Environmental conditions (i.e., weather conditions, wind speed/direction, wave height, cloud cover, visibility, and glare) would be documented throughout the day.
- The date and time of each in-water pile-driving activity beginning and end would be documented.
- In-water pile-driving activities would be curtailed under adverse weather conditions that prevent the PSO from observing the entire Level A and B zone(s) (i.e., heavy fog or poor visibility).
- All marine mammal sightings would be fully documented to include the following when possible:

i. Distance and bearing to animal(s) relative to the PSO position;
ii. Distance of animals(s) from the sound source (i.e., impact hammer location);
iii. Number of individuals present;
iv. If possible, sex and age class;
v. Current phase of construction activity (i.e., impact, vibratory [pre-clearance, active-, post- construction]); and
vi. Behavior of animal(s) (i.e., foraging, resting, social, traveling), making note of any possible reaction related to the in-water pile-driving activity.

13.2 Reporting Plan

RGLNG would provide NOAA Fisheries a draft monitoring report within 90 days of the conclusion of monitoring. A final report would be prepared and submitted to NOAA Fisheries within 30 days following receipt of comments on the draft report. If no comments are received from NOAA Fisheries, the report submitted would be considered the final report.

In general, reporting would include the following details:

- Summary of completed pile-driving activities and mitigation measures implemented to minimize impacts on marine mammals, including:
  i. Duration of activity;
  ii. Location(s) of activity;
  iii. Number of days of activities; and
  iv. Times and durations of all shutdown events due to the presence of marine mammals.
- Summary of water (e.g., Beaufort sea state, tidal state) and weather conditions (e.g., percent cloud cover, visibility).
- Summary of PSO monitoring and marine mammal sightings, including:
  i. Date, time, and location of sighting;
  ii. Locations of observation station(s);
  iii. Total number of animals sighted;
  iv. Species;
  v. Descriptions of observed behavior (both in the presence and absence of activities);
  vi. Weather conditions during each sighting; and
  vii. Assessment of implementation and effectiveness of prescribed mitigation and monitoring measures.

If an injured, stranded, or deceased marine mammal is observed for which the cause of injury or death is unclear, and death is relatively recent (i.e., the animal is in less than a moderate state of decomposition), the NOAA Fisheries Southeast Marine Mammal Stranding Hotline (877-942-5343) and the Texas Marine Mammal Stranding Network (1-800-962-6625) would be contacted immediately. If an injured or dead marine mammal is discovered for which the cause of death is clear and unrelated to the construction of the Terminal, or if death is not recent (i.e., the animal is in a moderate to advanced state of decomposition), the observation would be reported within 24 hours.

14 Suggested Means of Coordination

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

Any and all marine mammal data gathered during the in-water construction of the Terminal along the BSC will be provided to NOAA Fisheries and any other interested federal agencies, environmental groups, or educational institutions upon request. This practice is especially important for this Terminal because of the lack of recent marine mammal research in the area. This knowledge would help to reduce incidental taking of marine mammals and to evaluate project-related impacts to inform future construction projects with similar environmental conditions.

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