INITIAL ENVIRONMENTAL EVALUATION

PALMER PIER REPLACEMENT
PALMER STATION, ANTARCTICA

ANTARCTIC SUPPORT CONTRACT, U.S. ANTARCTIC PROGRAM
PROJECT NO.: 160704

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
ACA	Antarctic Conservation Act
ASC	Antarctic Support Contract
ASMA	Antarctic Specially Managed Area
ASPA	Antarctic Specially Protected Area
ATS	Antarctic Treaty Secretariat
BioLab	Biology Laboratory
BMP	Best Management Practice
CCAMLR	Convention on the Conservation of Antarctic Marine Living Resources
cy	cubic yards
DTH	down the hole
EIA	Environmental Impact Assessment
ESA	Endangered Species Act
ft	foot/feet
gal	gallon
GWR	Garage, Warehouse, and Recreation Building
IBA	Important Bird Area
IEE	Initial Environmental Evaluation
IHA	Incidental Harassment Authorization
IWC	International Whaling Commission
km	kilometer
LMG	*Lawrence M. Gould*
L	liter
LTER	Long Term Ecological Research
m	meter
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships
mi	mile
MLD	mixing level depth
MMPA	Marine Mammal Protection Act
MSD	marine sanitation device
MSL	mean sea level
NBP	*Nathaniel B. Palmer*
NMFS	National Marine Fisheries Service
nmi	nautical mile
NSF	National Science Foundation
NOAA	National Oceanic and Atmospheric Administration
PPE	personal protective equipment
PSO	protected species observer
PTS	permanent threshold shift
R&M	R&M Consultants, Inc.
TTS	temporary threshold shift

UCDW	upper circumpolar deep-water
USAP	United States Antarctic Program
WAP	western Antarctic Peninsula

1.0 BACKGROUND

1.1 PROJECT INTRODUCTION

Palmer Station (64˚46.45'S, 64˚03.25'W) is located on Anvers Island, Antarctica and is one of three scientific research stations in Antarctica operated by the United States that are occupied year-round (**Appendix A, Figures A-01 through A-03**). It was originally constructed in 1968 and is operated by the National Science Foundation (NSF) for the United States Antarctic Program (USAP). There are multiple structures, a helipad, fuel tanks, and other support facilities distributed on the approximately 15-acre site (**Appendix A, Figure A-04 and Photos 1 through 4**).

All cargo deliveries and personnel transfer operations are conducted by marine vessel due to the lack of an air strip or commercial air service to Palmer Station. Two NSF research vessels, the *Nathaniel B. Palmer (NBP)* and the *Lawrence M. Gould (LMG)*, access Palmer Station. The nearest major port facility is Punta Arenas, Chile, which is approximately 1770 km (1100 mi) north of Palmer Station (**Appendix A, Figure A-01**). As further described below, the existing pier is at the end of its useful life and replacement of the structure is proposed.

1.1.1 PURPOSE AND NEED

The purpose of the project is to provide a safe and reliable pier for the unloading of personnel and critical supplies from marine vessels at Palmer Station, which is necessary for NSF to effectively carry out its scientific mission.

The existing pier is constructed of sheet piles arranged to form interconnected cells. Sheet piles are long structural sections of steel with interlocking edges that are driven into the ground to create a continuous wall (**Appendix A, Photo 5**). This circular sheet pile structure (cellular bulkhead) is backfilled with gravel, cobbles, and boulders (**Appendix A, Photo 6)**. The 8.2-m (27-ft) diameter pier was constructed in 1967 and is at the end of its useful life (typically 50 years). Corrosion has resulted in the deterioration of the existing structure. There is severe sheet pile section loss in places, and it has been patched numerous times over the years. The pier is now in critical need of replacement.

Of the two research vessels currently utilized at Palmer Station, only the *LMG* has regular use of the pier. Larger vessels such as the *NBP* can only moor during high tide and typically only do so in emergency situations. Replacement of the existing pier would allow for regular use by the *NBP* and potentially other research vessels for 50 to 75 years (estimated life span for new structure; dependent on maintenance).

1.2 REGULATORY COMPLIANCE

USAP activities are conducted in accordance with applicable international and domestic agreements and laws including, but not limited to, the Antarctic Treaty of 1959 (Antarctic Treaty), the Protocol on Environmental Protection to the Antarctic Treaty (Protocol; Antarctic Treaty Secretariat [ATS] 1991), and the Antarctic Conservation Act, as amended by the Antarctic Science, Tourism, and Conservation Act of 1996, 16 United States Code § 2401 *et seq*. (ACA). The ACA implements the provisions of the Antarctic Treaty and the Protocol. The ACA conserves and protects the native mammals, birds, and plants of Antarctica and the ecosystems of which they are a part.

Article 8 and Annex 1 of the Protocol introduce and describe the Environmental Impact Assessment (EIA) process, providing categories of environmental impacts according to their significance. Potential impacts associated with the proposed activity are anticipated to incur a no more than minor or transitory impact to the environment; therefore, documentation of existing conditions and anticipated impacts is being evaluated herein under an Initial Environmental Evaluation (IEE) in accordance with the requirements as set forth in the ACA regulations and the Protocol.

2.0 DESCRIPTION OF PROPOSED ACTIVITY

2.1 OVERVIEW

This project would replace the existing pier with a new pile-supported concrete deck pier, a modern energy absorbing fender system, as well as on-pier power and lighting (**Appendix A, Figure A-05**). Upland civil earthwork would consist of site improvements adjacent to the pier to facilitate movement of equipment and cargo from the pier to upland facilities. The existing wastewater line and outfall would be relocated to accommodate the new pier. The deck for the pier would be supported by steel pipe piles, which would be drilled into the shallow bedrock. These piles would be filled with gravel and topped with a pile cap. A retaining wall would be installed along the shoreline at the location where the pier comes into contact with (i.e. abuts) the shoreline (pier abutment) and would extend to the northwest and along the northeastern edge of the pier (**Appendix A, Figure A-05**). The steel pile supported fender system along the eastern pier edge will also be installed for small boat moorage. At this time, piles for a wave attenuator are planned for installation; however, the wave attenuator itself would be installed at a future date. The wave attenuator would be constructed of foam-filled pipes secured in place by the piles and would act as a protective shield against incoming waves by reflecting or dissipating wave energy.

2.2 PROPOSED ACTIVITY

2.2.1 MOBILIZATION TO PALMER STATION

All equipment and supplies would be transported to Palmer Station via barge or the *LMG*. The majority of equipment and materials would be mobilized from Seattle, Washington, where the construction barge would be located. Construction equipment would likely include two cranes, excavator, dozer, skidsteer, several forklifts, welder, impact hammer, vibratory hammer, down the hole (DTH) hammer, and other smaller specialized tools (**Appendix A, Photos 7 through 12 and 15**). A separate cargo supply vessel will meet the construction barge at Palmer Station and remain onsite for approximately three days to offload additional construction material, primarily fill material. Components to assemble a modular work platform would also be included on the construction barge as well as a small skiff to transport crew between the barge and the station and a work boat. Initial mobilization of equipment and materials from the U.S. is scheduled for September 2021 but would rely on verification from Palmer Station that the site is free of ice. The distance from Seattle to Palmer Station is approximately 8717 nmi and the trip would take an estimated 57 days. The barge would be accompanied by a tugboat (crew of five) and the journey would be made in four legs. The tugboat would take on water, fuel, and supplies at each port of call *en route*. Upon arrival at Palmer Station, the tugboat would be tied by to the barge or anchored in the vicinity of Hero Inlet for the duration of the project. No independent trips are anticipated. The 26-member construction crew would travel aboard the *LMG* from Punta Arenas, Chile to Palmer Station in late October 2021. The *LMG* will make three more visits to Palmer Station between November 1, 2021 and April 15, 2022 transporting construction personnel from Punta Arenas to the Station.

2.2.2 PIER REPLACEMENT

The following is a description of the activities anticipated to occur during construction of the replacement pier in the order in which they are expected to occur. Pile installation/removal activities to support construction of the new pier are anticipated to be the most prominent and time-consuming construction activity.

2.2.2.1 TEMPORARY CRANE ASSEMBLY PAD

Upon arrival at the site, the construction contractor (Contractor) would moor the construction barge against the existing pier using soft lines to the existing moorage points. Once moored, the Contractor would deploy anchors and spuds (type of anchor) to further secure the barge. Select equipment would be unloaded from the barge to the existing pier and relocated upland for construction of the temporary crane assembly pad.

The pier replacement work would largely be performed by two cranes, one based on the barge and one based on land. The existing sheet pile pier cannot be relied upon to transfer heavy, pier-building equipment off the barge utilizing ramps. Based on the weights of the land-based crane components and the safe working radius (reach) of the barge-based crane, a temporary crane assembly pad is required in order to facilitate the land-based crane offload and assembly. The Contractor's Crane Assembly Pad Construction Plan is included in **Appendix C** for reference.

The temporary crane assembly pad would be mostly constructed of coarse aggregate material including crushed stone and gravel imported in bulk bags via a separate gravel barge. Bulk bags are also known as super sacks or flexible intermediate bulk containers and are made of woven polypropylene material (i.e. plastic) for strength and durability. It is estimated that 1376 cubic meters (m^3; 1800 cy) of material is needed to construct the pad. The aggregate material would, at a minimum, meet cleanliness requirements under the Protocol and ACA.

The bagged aggregate would be transferred directly from the cargo supply vessel to the existing pier and moved to a staging area. The bulk bags would then be opened as needed to create a pile of aggregate material. Once a sufficient pile is developed, the Contractor would begin pushing material into the water with a dozer to the southern end of the pad. Material would continue to be placed until the southern end of the crane pad is developed and an elevation of zero (i.e. water level at 1.03 m [3.38 ft] MSL) or higher is reached. It is estimated that approximately 70% of the material would be deposited below the waterline (1260 cy or 963 m^3). At this point, unopened bags of aggregate would be placed on the pad. Once the appropriate elevation has been reached, aggregate placement (loose and bagged) would cease and crane mats would be laid out to match the existing pier elevation. It is important to note there is no plan to place the bulk bags in the water, only loose aggregate material.

Once the land-based crane has been offloaded from the barge and assembled, it would be moved into position to assist with deconstruction of the existing pier. The temporary crane pad would be located largely within the footprint of the new pier. Much of the loose aggregate material placed for the crane pad would be left in place on the seaward side of the new pier abutment where riprap armor (rock used to protect shoreline structures) is prescribed as well as along the edge of the boat ramp where the aggregate would aid in wave protection (see **Appendix A, Figure A-05** for riprap placement locations). No riprap will be imported for this project. Rock will be sourced from the imported aggregate material as well as the demolition of the existing pier and other upland areas as described in the following sections. The portion of the temporary crane pad fill material, bagged and above the waterline, would be salvaged for reuse as pile fill or used elsewhere on-site during construction. Loose fill would be removed from below the waterline to the extent practicable but would be limited by the reach and capabilities of the equipment. It is estimated that approximately 50% of the total crane pad fill aggregate material would be recovered.

2.2.2.2 DEMOLITION OF THE EXISTING PIER

The existing pier, consisting of steel sheet piles backfilled with gravel, cobbles, and boulders, would be demolished and materials reused as much as practicable to construct the new pier facility. An excavator, skidsteer, and dozer would be used to remove and repurpose fill material from the existing bulkhead pier. Salvaged gravel fill material may be used in uplands for site grading/contouring or as pile fill (see **Appendix**

A, Figure A-05 for locations where grading will occur). Depending on the size, boulders removed from the existing pier may be placed along the bottom of the new retaining wall and/or the existing boat ramp to protect against wave scour (erosion at the base of the structure). Should larger rock formations/bedrock be encountered, they would be broken using a rock breaker attachment on the excavator. The existing sheet piles would be extracted with a vibratory hammer or cut off at the mud line. Material that cannot be reused would be stockpiled in an upland location and later loaded onto the barge for offsite disposal outside the Antarctic Treaty area. The foam-filled marine fenders located at the end of the existing pier would be removed.

2.2.2.3 PILE INSTALLATION

Pile installation for the new pier would begin once the existing pier facility is removed. Temporary template piles would be installed first to develop a support structure to ensure proper placement of the permanent piles. The template piles serve as a grid and would not be installed in the same locations as the permanent piles. The permanent piles would support the pier, pier abutment, retaining wall, three of the six fenders, and future wave attenuator (**Appendix A, Figure A-05**). Only the three fenders on the eastern side of the pier are supported by dedicated piles. The three fenders on the face of the pier would be supported by structural pier piles. The primary technique for installing temporary and permanent piles would be DTH drilling. The DTH drill/hammer acts on a shoe at the bottom of the pile and uses a pulsing/rotating mechanism to break up rock below the pile while simultaneously installing the pile through the rock formation. Rotating bit wings extend below the pile and remove the broken rock fragments as the pile advances. The pulsing sounds produced by the DTH method reduces sound propagation because the noise is primarily contained within the steel pile and below ground. Because the shoreline and upland areas are comprised of rocky or exposed bedrock, the piles would be socketed in place. This involves drilling into the rock to create a socket deeper and larger than the pile diameter. Once the pile is set, the remaining void space is filled with a high-performance cement-based sealing grout (refer to **Appendix C** for specifications). The piles would likely be hammered (impact-driven) for short periods of time to seat (set) the piles in the sockets. Once permanent piles are installed, the temporary template piles would be removed with a vibratory hammer or cut off at the mudline. **Table 2-1** details the number and size of the piles needed for each structure as well as the socket depth and diameter. **Figure A-05 (Appendix A)** identifies pile locations. **Section 2.2.2.5** provides more detail on these pier structures.

TABLE 2-1: PILE SUMMARY

Structure	Diameter of Pile[a]	Socket Depth (feet)	Number of Piles
Pier Abutment	32- or 36-in steel piles	30	4
Pier	36-in steel piles	20	Up to 18[b]
Retaining Wall	Steel H-piles inserted in pre-drilled 24-in diameter hole	10	Up to 9[b]
Wave Attenuator	24-in steel piles	20	2
Fenders[c]	24-in steel piles	20	3
Template Piles	24-in steel piles	10	16[d]

a Dimensions provided in United States customary units to match design; metric units not provided.
b Includes two additional piles as a contingency for design flexibility.
c Only the three fenders on the eastern side of the pier are supported by dedicated piles. The three fenders on the face of the pier would be supported by structural pier piles (**Appendix A, Figure A-05**)
d Includes additional piles for contingency during construction.

2.2.2.4 ROCK CHIPPING

Rock chipping may be required to level the sea bottom at pile locations to ensure accurate pile location and alignment. Rock chipping would first be attempted using the DTH hammer and appropriate bit(s) to flatten the surface for pile installation. This method could be used at every pile location, but this is not expected to occur. If the DTH hammer is not able to flatten the surface at the pile location, the excavator with rock breaking attachment (as previously discussed) would be used. If rock chipping is necessary, it would occur on the same days as DTH drilling.

2.2.2.5 PIER STRUCTURES

Construction of the pier abutment and retaining wall would require bedrock excavation using the excavator/rock breaker. Trench excavation would begin about 0.9 m (3 ft) seaward of the retaining wall alignment and extend to 1.5 m (5 ft) landward for approximately 16.8 m (55 ft). The retaining wall would be constructed along the shoreline at the new pier location, landward of the pier abutment (**Appendix A, Figure A-05**). The retaining wall would be constructed using a series of stacked horizontal pre-cast concrete planks between the retaining wall piles. Upland fill would be placed on the landward side of the retaining wall, as required, to close any gaps below the planks. Where the retaining wall extends beyond the pier abutment, riprap armor stone would be placed on the seaward side of the retaining wall at a 50% slope to aid in wave protection. The pier abutment would consist of steel pipe piles with armor stone placed between the piles at a 50% slope.

Concrete caps would be installed on top of the piles and welded in place. Precast concrete deck panels would be set and grouted in place on top of the caps, followed by railing installation. The grout is the same high-performance cement-based sealing grout to be used for pile installation (refer to **Appendix C** for specifications). A total of three prefabricated fenders would be installed on the pier from the pier deck (**Appendix A, Figure A-05**).

2.2.2.6 INSTALLATION OF ANODES

Sacrificial anodes are included in the design in order to protect the major submerged steel components from corrosion. A sacrificial anode is made of a different metal alloy than the structure it is protecting and preferentially corrodes to protect the structure from corrosion. These aluminum alloy anodes would be installed below the waterline by divers. Installation would involve welding using hand-held equipment.

2.2.3 SEWER LINE RELOCATION

The existing sewer outfall is within the footprint of the proposed pier (**Appendix A, Photo 14**). A new outfall would therefore be constructed and most of the existing pile-supported sewer line would be relocated. Because the existing sewer line outfall is in the same area as the crane assembly pad and ultimately the new pier, the first priority would be to create a temporary bypass for the existing sewer line until the new permanent alignment is constructed (**Appendix A, Figure A-05**). The alignment for temporary sewer bypass would be determined in the field with the intent to purposely be routed overland to outfall near where the new, permanent outfall would be construction and to avoid rock outcrops (no rock removal is planned for the temporary bypass). The temporary bypass would be constructed of flexible 6-in tubing/piping, starting at the treatment plant, and will have a pump with a cistern, powered by station power. The system would be maintained in operation at all times while the new line is being constructed. Approximately 70.1 m (230 linear ft) of new sewer line would be installed as part of the sewer line relocation and would discharge to the water, above the waterline, via a new outfall west of the new pier. Portions of the new sewer line would require that a trench be excavated through the bedrock to provide clearance for the pile-supported line and maintain gravity flow through the system (see sewer line bedrock trenching in **Appendix A, Figure A-05 and Photo 13**). This trench excavation may be done with an excavator using a breaker attachment or drilling holes and using a high expansion grout agent such as Dexpan® to create a non-explosive, controlled expansion to fracture the rock. After fracturing, the demolished rock and debris, including grout, would be collected. The Safety Data Sheet for Dexpan® is included in **Appendix C**. Although excavation (trenching) is required in certain areas of the alignment, the sewer line will be placed aboveground on pipe supports and not buried. Mechanical means would be used as much as possible for rock breaking and excavation. The method of drilling holes and using expanding grout would occur if the equipment cannot successfully break/remove the rock. The existing sewer lines near the dock would be demolished once the relocation is complete and operational.

2.2.4 POWER AND LIGHTING

The project would provide a new power pedestal with modifications to the existing power feeder from the Biological Lab (BioLab) as well as power for the fuel system heat trace and pier lighting (**Appendix A, Figure A-05**). The power and lighting system would include a power center, power stations for refrigerated containers, and an outlet for welding/hand tool use. Exterior pier lighting would consist of light poles, floodlights, small area lights, catwalk lights, navigation/marker lights and low-level pedestals. No communications or surveillance is included.

2.2.5 SITE GRADING, UPLAND WORK, AND EXCESS MATERIAL

Portions of the upland areas would be graded to improve access and use of the pier facility (identified as resurfaced area in **Appendix A, Figure A-05**). A filled and graded upland site would be required to provide vehicle access to the pier and a boat parking area of approximately, 12.1-m by 12.1-m (40-ft by 40-ft). The boat parking area would replace the existing boat parking grid (**Appendix A, Figure A-05**). This upland site is adjacent to the pier and bounded on the east by the boat launch ramp, on the northeast by several existing buildings, and on the northwest by the relocated sewer line. A vertical adjustment of the upper portion of the concrete boat launch ramp would be required (identified as boat ramp modification in Appendix A, Figure A-05) and two bedrock outcrops would be removed, as needed, for site grading. Construction methods previously discussed for bedrock excavation would be used. In general, strategic placement of the excess fill is anticipated and rocks greater than 0.5 m (18 in) in diameter would be salvaged and placed for toe and shore protection for the boat launch ramp and retaining wall. Any remaining fill could be used in the graded area north of the pier (identified as resurfaced area in Appendix A, Figure A-05) or used to fill in holes and even out surfaces along existing roads and pads within the Station. Any unused fill would be loaded onto the barge and removed at the end of the project.

2.2.6 DEMOBILIZATION

Upon completion of the project, the contractor would remove all unused material and equipment brought to the Station. Most material will be stored on barge for the duration of the project except when in use. Demobilization would begin with the final inspection followed by transfer of all remaining equipment, material, and waste onto barge and securing all cargo. Upon final acceptance of project, the construction barge and tugboat will disembark. Demobilization is expected to take between 10 and 14 days.

2.3 PROJECT DURATION

The construction window is limited due to sea ice. As such, a majority of the construction is anticipated to occur between 1 November 2021 and April 2022. Project completion would occur once final as-built drawings have been approved and is scheduled for 28 August 2022.

TABLE 2-2: PROJECT DURATION

Activity	Begin [a]	End [a]
Mobilization [b]	07/14/2021	11/09/2021
Site Development	11/02/2022	11/14/2021
Install temporary sewer bypass	11/02/2021	11/02/2021
Crane pad construction	11/10/2021	11/11/2021
Transfer crane to shore and assemble	11/12/2021	11/14/2021
Demolition	11/15/2021	12/03/2021
Construction	12/04/2021	04/30/2022
Bedrock excavation (as needed)	--	--
Retaining wall/abutment	12/12/2021	01/06/2022
Pier pile installation	01/07/2021	03/06/2022
Fender systems	03/07/2022	03/08/2022
Install wave attenuator piles	02/21/2022	02/24/2022
Miscellaneous pier work	02/25/2022	03/07/2022
Upland site grading	02/14/2022	02/17/2022
Sanitary sewer line and outfall	02/14/2022	02/20/2022
Cathodic protection [c]	03/01/2022	04/30/2022
Contractor Demobilization	Approximately 10 -14 days from date construction is completed	
Final inspection and project acceptance		
Load and prepare barge for departure		
Depart Palmer Station		
Final closeout (Onsite work complete)	05/17/2022	06/27/2022
Project completion	08/28/2022	

a Time frames are based on 95% construction schedule and may be modified based on field conditions and/or logistics.
b Mobilization includes multiple site preparation activities.
c Leidos/ASC to install anodes, not construction contractor.

3.0 ALTERNATIVES TO THE PROPOSED ACTIVITY

3.1 NO ACTION ALTERNATIVE

The alternative to take no action must also be evaluated during development of the IEE. Under the No Action alternative, the existing pier would remain in place and no improvements would be made. The anticipated impacts associated with construction of the new pier would not be incurred. The station users would continue to use the pier until it is determined structurally unsound, inoperative, and/or unsafe for further use. If access becomes limited or prohibited as a result of pier failure, difficulties in reaching or leaving the station in the event of an emergency could occur and the station users would be unable to access research facilities. Degradation of water quality could also occur as the pier deteriorates and unstable material erodes away. Reduced access to Palmer Station would have a negative impact on scientific research efforts, which conflicts with the purpose and mission of the facility and the USAP.

3.2 ALTERNATIVES CONSIDERED BUT NOT ANALYZED

A total of three discrete alternatives, including the proposed activity, were developed up to a 15% design stage. Each alternative was designed to meet comparable size, design loads, vessels/moorage, and other minimum design criteria. In order to identify a preferred alternative, each option was compared with respect to

- function/performance,
- environmental factors,
- relative construction cost, and
- maintenance considerations.

The two alternatives eliminated from further consideration are summarized in the following sections. The third alternative, identified as the preferred option, is now considered the proposed activity.

3.2.1 SHEET PILE BULKHEAD

This alternative would replace the existing pier with a similar sheet pile bulkhead structure; however, the new design would connect the sheet piles with king piles, which are steel beams instead of pipes, and use anchors tied into the shore for added stability and structural integrity. The structure would then be backfilled with imported material. A mooring dolphin (a mooring point that extends above water level and is not connected to shore) and fender system was included in the design to protect the pier from ship and ice impact.

Although this option provided somewhat higher load capacity (not required), resistance to wave/ice uplift, and ice impact protection, factors associated with constructability, environmental impacts, and maintenance (**Table 3-1**) resulted in the elimination of this alternative.

TABLE 3-1: SHEET PILE BULKHEAD – PROS AND CONS

Pros	Cons
Slightly higher load capacity	Large volume of costly imported fill required
Resists wave/ice uplift	Higher potential for delays leading to increased wildlife impacts
Stable/resists ice impact	Most tidelands fill impact (0.33 acres)
	High number of sheet piles
	Wave amplification
	Medium-high cost

3.2.2 COMBINATION BULKHEAD AND PILE-SUPPORTED DOCK

This alternative considered using a combination approach, which included a bulkhead at the shore end with a pile-supported concrete deck extending from the face of the bulkhead. The intent of this alternative was to capture the benefits of both options. A bulkhead structure constructed at the shore end could provide protection from wave activity and shore ice. By combining this option with a pile-supported structure, the volume of fill material would also be reduced. Despite some identified benefits to this alternative, cost, potential impacts to marine mammals, the amount of fill placed in the marine environment (tideland fill), and potential design challenges (**Table 3-2**) resulted in the elimination of this alternative.

TABLE 3-2: COMBINATION BULKHEAD AND PILE-SUPPORTED DOCK – PROS AND CONS

Pros	Cons
Bulkhead portion is stable/resists ice impact	Challenging bulkhead/pile-supported dock interface
Various construction types may allow phasing	Costly imported fill required
	Higher potential for delays leading to increased wildlife impacts
	Highest number of piles
	Tideland fill impact (0.26 acres)
	Highest cost

4.0 EXISTING ENVIRONMENTAL CONDITIONS

4.1 GEOGRAPHIC SETTING/ENVIRONMENTAL SETTING

Palmer Station (64°46.45'S, 64°03.25'W), one of three continuously occupied scientific research stations operated by the NSF for the USAP, is located on the southwestern coast of Anvers Island. Anvers Island is the largest and most southerly island in the Palmer Archipelago and is separated from the northwestern edge of the Antarctic Peninsula by Gerlache Strait (**Appendix A, Figure A-02**). The research station is situated on a rocky, ice-free bluff at Gamage Point that is bound by Hero Inlet to the south, Arthur Harbor to the north and west, and the Marr Ice Piedmont to the east (**Appendix A, Figure A-03**).

Palmer Station is located within the Antarctic Specially Managed Area (ASMA) No. 7, Southwest Anvers Island and Palmer Basin (ATS. 2019a). This ASMA includes several Restricted Zones, two Antarctic Specially Protected Areas (ASPAs), and four Antarctic Important Bird Areas (IBAs). While Palmer Station is not located within any of the Restricted Zones, ASPAs, or IBAs, it is located across Hero Inlet from the Bonaparte Point Restricted Zone. While most Restricted Zones include a 50-m (164-ft) marine buffer, Bonaparte Point does not include one due to the need to maintain boat access to Hero Inlet (ATS 2019a). The Area is situated within Environment B – Antarctic Peninsula mid-northern latitudes geologic and Environment E – Antarctic Peninsula, Alexander and other islands, based on the Environmental Domains Analysis for Antarctica (Resolution 3 (2008). Areas of ice-free ground classified as Region 3 – Northwest Antarctic Peninsula under the Antarctic Conservation Biogeographic Regions classification (Resolution 3 (2017)) lie within the Area (ATS. 2019a).

4.2 PALMER STATION FACILITY DESCRIPTION

Palmer Station, which features laboratory space and a sea water aquarium, supports a wide array of scientific research in diverse fields including, but not limited to, climate systems, marine biology, astrophysics, and glaciology and is one of 28 locations designated as a Long Term Ecological Research (LTER) site by NSF (NSF 2020a; NSF LTER 2020). Over the past five decades, several structures have been constructed at the station such as the BioLab, which houses the dining facilities, offices, laboratory space, the aquarium, and dorms and the Garage, Warehouse, and Recreation (GWR) Building, which houses the garage, station power plant, warehouse space, store, clinic, dorms, and lounge. Additional structures located at Palmer Station include, but are not limited to, the Carpentry/Trade Shop, Earth Station with satellite link, Terra Lab, Clean Air Facility, Boat House, and fuel tanks (NSF 2016). The station supports approximately 40 personnel during the austral summer months and roughly 20 personnel during the winter (NSF 2016, NSF 2020a).

Although the primary mission of Palmer Station is to foster scientific research, Palmer Station personnel and researchers welcome a limited number of tourists every year, as part of USAP's educational outreach efforts, primarily during the austral summer. In recent years, the average number of cruise ships has been limited to approximately 8-10 per season (NSF 2018). In addition to cruise ships, a number of yachts also visit the area. While NSF does not limit the number of yachts that visit each season, unscheduled visits to Palmer Station are only allowed on a case by case basis and if the visit will not interfere or inhibit the work of staff and researchers. Based on tourism data from 2003-2016, an average of 6500 tourists visit Southwest Anvers Island and Palmer Basin annually, though only roughly one-third opt for an on-shore visit (ATS 2019a).

4.3 CLIMATIC CONDITIONS

The southwestern coast of Anvers Island, where Palmer Station is located, has a cold, Antarctic maritime climate. Compared to the rest of Antarctica, the climate in the area is relatively mild with an annual mean temperature of -3°C (26.6°F). Monthly average temperatures range from -10°C (14°F) during the austral winter months of July and August to 2°C (36°F) during the austral summer months of January and February (NSF 2020a). Since the mid-twentieth century, the area has experienced rapid warming with an observed atmospheric temperature increase of approximately 3°C (5.4°F; Meredith and King 2005).

Precipitation events are common at Palmer Station, which annually receives an average of 4 m (13 ft) of snow and 76 cm (30 in) of rain. Persistent light to moderate winds with speeds of approximately 10-11 knots are common (ATS 2019a), though storm systems frequently bring high winds that can reach 70 knots or more (NSF 2020b).

Sea ice extent and duration in the region exhibits a high level of inter-annual variability. In general, however, sea ice coverage and duration has been rapidly decreasing. Sea ice records from Palmer Station indicate that the seasonal duration of sea ice has decreased by an average of 92 days, or approximately three months, for the time period from 1979-2012 (Ducklow et al. 2013).

4.4 MARINE WATER QUALITY

The Palmer LTER site, which includes the southern portion of Anvers Island and Palmer Station, divides the marine environment into three separate regions based on depth: coastal, shelf, and slope (Palmer LTER 2020a). The marine environment surrounding Palmer Station is classified as coastal (Palmer LTER 2020b), which has water depths of 0-300 m (0-984 ft; Palmer LTER 2020a). The shelf region, which is located adjacent to the coastal region and has an interconnected ecosystem, has depths ranging from 300-1000 m (984-3281 ft; Palmer LTER 2020a).

Geography, sea ice seasonality and extent, and glacial meltwater heavily influence the coastal marine environment of Arthur Harbor and Hero Inlet. The Antarctic Peninsula, which has a north-south orientation, is directly exposed to westerly atmospheric and oceanic circulation patterns. The Antarctic Circumpolar Current is adjacent to the continental shelf along the western Antarctic Peninsula (WAP) and conveys warmer, nutrient-rich upper circumpolar deep-water (UCDW) to the area (Ducklow et al. 2013; ATS 2019a). In the austral summer, glacial meltwater dictates the mixing level depth (MLD) and creates a distinguishable divide between the coastal and continental shelf regions with the coastal marine environment extending out nearly 40 km (25 mi) from the coast. The MLD during the austral summer is approximately 5-10 m (16-33 ft) deep for the coastal marine environment while the mid-shelf/slope region has a MLD of approximately 25-50 m (82-164 ft) or deeper (Ducklow et al. 2013). Wind-driven mixing is known to occur in the protected waters of Arthur Harbor (Schram et al. 2015), which when combined with buoyancy loss due to sea ice production, increases the depth of the MLD during the winter months (Ducklow et al. 2013). Glacial meltwater has been shown to increase the turbidity of nearshore waters while also adding macronutrients such as phosphate, nitrate, and silicate to the marine water environment (Dierssen et al. 2002). Diatom communities frequently occur at the edge of the ice and are known to have high rates of sedimentation (Ducklow et al. 2007).

The pH in Arthur Harbor has been shown to exhibit little variability throughout the austral fall and winter. In the austral spring and summer, an abrupt increase in pH occurs as sea ice retreats and phytoplankton activity increases. Research conducted in Arthur Harbor from May 2012 to May 2013 recorded a baseline pH of 8.09, which increased to 8.62 in mid-November roughly corresponding to the peak of phytoplankton activity. These increases were accompanied by a decrease in the levels of dissolved inorganic carbon. In addition to phytoplankton, benthic macroalgae (seaweed) may also contribute to pH increases in Arthur Harbor (Schram et al. 2015).

Summer surface water temperatures have increased by more than 1°C (1.8°F) since the mid-twentieth century, which has been accompanied by an increase in salinity. Increased surface water temperatures and salinity would likely result in decreasing sea ice production trends in future years. Seasonal salinity is greatest during the austral winter (Meredith and King 2005).

Despite the remote location of the Antarctic Peninsula, pollution does impact the region. One recent study estimated a mean concentration of 1794 plastic items per square km (0.4 square mi) in the marine environment surrounding the Antarctic Peninsula (Lacerda et al. 2019). The predominant types of plastic found in the region were polyurethane and polyamide, though small quantities of polyethylene and polypropylene were also identified. The same study also found paint fragments in the marine environment in quantities that were approximately 30 times greater than that of plastics (Lacerda et al. 2019). While rare, oil spills have occurred in the region. In 1989, the ship *Bahia Paraiso* sank in Arthur Harbor, roughly 2 km (1.2 mi) from Palmer Station, spilling approximately 600,000 L (158,503 gal) of arctic diesel fuel (Kennicutt et al. 1992; Harris et al. 2015). This spill impacted the nearshore marine environment for several years following the accident (Harris et al. 2015).

4.5 TOPOGRAPHY, GEOLOGY, AND SOILS

Anvers Island is bisected by a southwest-northeast trending fault line that divides the island into two distinct tectonic blocks (Birkenmajer 1999). The western section of the island, including Palmer Station, is on the Anvers-Melchior Tectonic Block. It consists of three distinct geologic groups:

- Volcanic rocks found in coastal areas near Palmer Station and Cape Monaco that may belong to the Lower Cretaceous Antarctic Peninsula Volcanic Group and consist of tuffs, agglomerates, and rocks formed from basaltic and andesitic lavas
- Intrusive igneous rock formations from the Paleocene to early Miocene that consist of granite, diorite, and tonalite
- Horneblende- and pyroxene-bearing dykes (Birkenmajer 1999)

The Marr Ice Piedmont, the glacier located directly east of Palmer Station, is a defining feature of southwestern Anvers Island and is approximately 64 km (40 mi) long and in places, nearly 32 km (20 mi) wide (Montaigne 2009) (**Appendix A, Figure A-03**). The glacier, which has retreated roughly 300 m (984 ft) since 1975, occupies the low-lying coastal areas and rises from the coastline to an elevation of approximately 1000 m (3281 ft). As the glacier retreats, portions of Anvers Island have been revealed as separate islands. In 2014, the collapse of an ice bridge near Palmer Station revealed an island that was originally believed to be a spit of land connected to Anvers Island (Rejcek 2014). While the Marr Ice Piedmont dominates the southwestern coastline of Anvers Island, rocky outcrops, ice-free promontories, and small islands are interspersed amongst the ice cliffs. Gamage Point, as well as Bonaparte Point, which is located directly across Hero Inlet from Gamage Point, are both ice-free promontories located in the area (ATS 2019a). These ice-free areas provide a wide range of habitats for vegetation growth (Smith and Corner 1973).

In general, soils in Antarctica are comprised of a surface layer (gravel, stones, or boulders) and an active layer. The seasonally thawed active layer, which lies above permafrost, consists of unconsolidated material and ranges in depth from a few centimeters up to 1 m (3 ft) depending on location. Coastal Antarctic soils, unlike inland Antarctic soils, tend to be nutrient rich due to the presence of bird and plant communities (Lambrechts et al. 2019; Teixeira et al. 2013). Guano, feathers, eggshells, and bird remains create ornithogenic soils that contain organic matter rich in nitrogen, phosphorus, and carbon (Teixeira et al. 2013).

The underwater terrain immediately adjacent to Palmer Station is dominated by glacially-carved bays, fjords, and channels (Ducklow et al. 2012). In 2005, the ocean floor surrounding Palmer Station was mapped, revealing previously unknown pinnacles that rise to a depth of 6 m (20 ft) below the water surface (Woods Hole Oceanographic Institution [WHOI] 2005). A few kilometers beyond the WAP coast, the seafloor abruptly deepens, reaching depths of 200-300 m (656-984 ft) below the water surface (Ducklow et al. 2013). The coastal region eventually transitions into the continental shelf, which is approximately 200 km (124 mi) wide and has an average depth of 430 m (1411 ft; Ducklow et al. 2012). The seafloor in the WAP region ranges from sand or mud bottoms devoid of algae to rocky bottoms covered in algal growth (Barrera-Oro 2002). Topography and bathymetry information is provided in **Appendix A, Figure A-06**.

4.6 BIOLOGICAL RESOURCES

4.6.1 MARINE MAMMALS

Twelve cetacean and five pinniped species can be found in the vicinity of the project (**Table 4-1**). Five of the cetacean species are listed as endangered under the Endangered Species Act (ESA): blue, fin, sei, sperm, and southern right whales. None of the pinnipeds are ESA-listed. Abundances shown in **Table 4-1** are based on a thorough review of the best available information. Data on marine mammal abundance or density in the Antarctic are difficult to obtain given the remote location therefore, some abundance and density estimates have been extrapolated across broad regions. Distribution, life history, and nearshore and offshore densities of each species are discussed in detail in the Marine Mammal Assessment (**Appendix B**). **Tables 4-2 and 4-3** summarize specific sightings of marine mammals in the project vicinity (**Appendix A, Figures A-03 and A-04**). Figure A-07 (Appendix A) shows previously identified Elephant seal colony and haul out locations in the project vicinity. Observations were conducted by staff posted at Palmer Station between 2019 and 2020. Observations taken three times a day for six minutes each. These sightings are discussed in applicable species-specific subsections in the Marine Mammal Assessment included in **Appendix B**.

TABLE 4-1: ABUNDANCE AND STATUS OF MARINE MAMMAL SPECIES POTENTIALLY PRESENT IN THE PROJECT AREA

Common Name	Species	Estimated Abundance		ESA Status[a]	MMPA Status[b]	Frequency of Occurrence in Project Area
		Number	Data Sources			
Cetaceans						
Antarctic Minke Whale	*Balaenoptera bonaerensis*	7395[c]	Reilly et al. (2004)	NL	NS	Common Nearshore and Offshore
		360,000-730,000[d]	International Whaling Commission (IWC; 2019)			
Arnoux's Beaked Whale	*Berardius arnuxii*	599,300[e]	Kasamatsu and Joyce (1995)	NL	NS	Rare
Blue Whale	*Balaenoptera musculus*	2300[f]	IWC (2019)	E	D	Rare Offshore
Fin Whale	*Balaenoptera physalus*	38,200[g]	Wursig et al. (2018)	E	D	Nearshore and Offshore
		1725[h]	National Oceanic and Atmospheric Administration (NOAA; 2015)			
		1492[c]	Reilly et al. (2004)			

Common Name	Species	Estimated Abundance		ESA Status[a]	MMPA Status[b]	Frequency of Occurrence in Project Area
		Number	Data Sources			
Hourglass Dolphin	*Lagenorhynchus cruciger*	144,300[d]	Kasamatsu and Joyce (1995)	NL	NS	Rare
Humpback Whale	*Megaptera novaeangliae*	6500[g]	Bettridge et al. (2015)	NL	NS	Common Nearshore
		42,000[h]	NOAA (2015)			
		34,000-52,000[d]	IWC (2019)			
Killer Whale	*Orcinus orca*	50,000[i]	Wursig et al. (2018)	NL	NS	Common
		25,000[j]	Jefferson et al. (2008)			
Long-finned Pilot Whale	*Globicephala melas edwardii*	200,000[k]	NOAA (2018)	NL	NS	Rare Offshore
Southern Bottlenose Whale	*Hyperoodon planifrons*	500,000[j]	Jefferson et al. (2008)	NL	NS	Rare Offshore
Sei Whale	*Balaenoptera borealis*	626[h]	NOAA (2015)	E	D	Uncommon Offshore/ Extralimital
Southern Right Whale	*Eubalaena australis*	43[c]	Reilly et al. (2004)	E	D	Rare
		25,000-30,000[l]	Wursig et al. (2018)			
		12,000[d]	IWC (2019)			
Sperm Whale	*Physeter macrocephalus*	12,069[h]	NOAA (2015)	E	D	Uncommon Offshore/Extralimital
Pinnipeds						
Antarctic Fur Seal	*Arctocephalus gazella*	21,190[m]	Wursig et al. (2018)	NL	NS	Common
		2,700,000[n]	Wursig et al. (2018)			
Crabeater Seal	*Lobodon carcinophaga*	3,187,000[o]	Southwell et al. (2012)	NL	NS	Common
		5-10 million[p]	Wursig et al. (2018)			
Southern Elephant Seal	*Mirounga leonina*	413,671[q]	Erickson and Hanson (1990); Hindell et al. (2016)	NL	NS	Common
		749,385[l]	Hindell et al. (2016)			
Leopard Seal	*Hydruga leptonyx*	13,200[o]	Southwell et al. (2012)	NL	NS	Common
		220,000[j]	Jefferson et al. (2008)			
Weddell Seal	*Leptonychotes weddellii*	302,000[o]	Southwell et al. (2012)	NL	NS	Common
		+1,000,000[l]	Wursig et al. (2018)			

a NL = not listed; E = Endangered; T = Threatened
b NS = not strategic; S = strategic; D = Depleted
c Scotia Sea and northern Antarctic Peninsula
d Abundance in all of the Southern Hemisphere
e Abundance of all beaked whales south of the Antarctic Convergence, mostly consisting of Southern bottlenose whales
f Abundance in partial area of Antarctic feeding grounds
g South of 30.7°S
h South of 60°S
i Minimum global abundance estimate for killer whales
j Abundance south of the Antarctic convergence
k Abundance in all Antarctic waters
l Total global abundance
m Abundance in South Shetland Islands only
n Abundance in South Georgia area
o Antarctic Pack Ice Seals program survey 1998/1999; aerial surveys along the Antarctic Peninsula
p Circumpolar abundance
q South Georgia Stock of Elephant Seals only

TABLE 4-2: MARINE MAMMAL OBSERVATIONS IN HERO INLET OR HAULED OUT AT GAMAGE OR BONAPARTE POINTS NEAR PALMER STATION FOR SPECIFIC MONTHS 2019-2020

Species	Summer Observations 2019[a]			Winter Observations 2019[b]			Summer Observations 2019-2020[c]		
	#	% Swimming	% Hauled Out	#	% Swimming	% Hauled Out	#	% Swimming	% Hauled Out
Humpback Whale	0	100%	N/A	2	100%	N/A	0	N/A	N/A
Antarctic Fur Seal	73	16%	84%	70	21%	79%	241	4%	96%
Crabeater Seal	20	5%	95%	24	4%	92%	9	44%	56%
Southern Elephant Seal	1	0%	100%	0	N/A	N/A	278	1%	99%
Leopard Seal	3	33%	67%	2	100%	0%	3	100%	0%
Weddell Seal	8	0%	100%	6	0%	100%	39	0%	100%
Unidentified Seal Species	0	N/A	N/A	1	100%	0%	0	N/A	N/A

a Observations conducted from 21 January 2019 through 28 March 2019.
b Observations conducted from 30 March 2019 through 10 October 2019.
c Observations conducted from 12 October 2019 through 31 March 2020.

TABLE 4-3: MARINE MAMMAL OBSERVATIONS IN ARTHUR HARBOR FOR SPECIFIC MONTHS 2019-2020

Species	Summer Observations 2019[a]	Winter Observations 2019[b]	Summer Observations 2019[c]
Antarctic Minke Whale	0	1	1
Humpback Whale	20	18	0
Antarctic Fur Seal	11	3	1
Crabeater Seal	51	66	7
Southern Elephant Seal	0	3	3
Leopard Seal	15	12	0
Weddell Seal	0	0	0
Unidentified Seal Species	0	0	3

a Observations conducted from 21 January 2019 through.28 March 2019
b Observations conducted from 30 March 2019 through 10 October 2019.
c Observations conducted from 12 October 2019 through 31 March 2020.

4.6.2 MARINE SPECIES

Sea ice and glacial meltwater profoundly influence the ecological and biogeochemical processes of the marine environment with the inter-annual variations of sea ice influencing the life cycle of most marine organisms (Palmer LTER 2020a). As sea ice retreats during the austral summer, phytoplankton blooms are common in the coastal regions near Palmer Station (Ducklow et al. 2013). The primary production of phytoplankton blooms are dependent on an infusion of warm, nutrient-rich UCDW and timing of sea ice retreat (Steinberg et al. 2012). Phytoplankton growth in the region, which has average primary production rates similar to those found in subtropical locations, starts as early as October and continues throughout the austral summer into the autumn. In addition, nano- and picoplankton such as cryptomonads play a role in the WAP marine environment (Ducklow et al. 2007; Ducklow et al. 2012).

Copepods, euphausiids, and salps are the primary zooplankton found in waters off the coast of the WAP. Mixing of neritic (shallow water, near shore) and pelagic (deep water, open ocean) zooplankton occurs in the region, though the distribution of each type varies depending on location in relation to the coast and open ocean. Neritic species found in the region include *Thysanöessa macrura* and *Limacina helicina* (Ducklow et al. 2007). While *Euphausia superba* is the predominant krill species in the Antarctic marine ecosystem and along the continental shelf region of the WAP, including the inner shelf near Palmer Station, the coastal region of the WAP is the preferred habitat for the krill species *Euphausia crystallorophias* (Ducklow et al. 2013).

Fish communities in the west Antarctic Peninsula continental shelf region are a combination of both neritic and mesopelagic (intermediate-depth, open ocean) fauna due to the oceanic circulation patterns, which brings an infusion of warmer UCDW to the area (Donnelly and Torres 2008; Ducklow et al. 2007; Steinberg et al. 2012). The distribution of neritic and mesopelagic fauna in the continental shelf and coastal region is dependent on the subsurface temperature and salinity with neritic fish species preferring the colder, less-saline waters of the WAP coastal region (Steinberg et al. 2012). Studies in the WAP coastal and continental shelf region have found several species of fish from the following families: Bathydraconidae, Channichthyidae, Harpagiferidae, Nototheniidae, Rajidae, Trichiuridae, and Zoarcidae (Barrera-Oro 2002; Dearborn et al. 1972). Greater numbers of fish are found in the benthic zones with rocky bottoms and algal growth, which provides abundant food and shelter from predators such as penguins (Barrera-Oro 2002). The benthic zone is the ecological region at the bottom of a body of water, including the sediment surface and sub-surface layers (seabed).

The rocky shores of the region provide a rich marine habitat where a diverse flora of benthic macroalgae (seaweed) are able to flourish and includes all three types of macroalgae: brown, red, and green algae (Wiencke and Amsler 2012; Dombrov 2019). Brown macroalgae, such as *Desmarestia anceps* and *Desmarestia menziesii*, are the dominant species in the shallow waters of the western Antarctic Peninsula (Ducklow et al. 2013), though other macroalgae species, such as the red macroalgae species *Gigartina skottsbergii* and *Plocamium cartilagineum* (Huang et al. 2007; Amsler et al. 2015), also occur.

The Antarctic Peninsula region hosts diverse communities of mollusks, including approximately 85 species of shelled gastropods and 45 species of bivalves of which 6 shelled gastropod species and 1 bivalve species are considered endemic (Linse et al. 2006). In the subtidal zones surrounding Palmer Station, gastropods are commonly associated with brown and red macroalgae species such as *Desmarestia anceps* and *Gigartina skottsbergii*. Gastropod species identified in these subtidal zones include, but are not limited to, *Skenella umbilicata*, *Margarella Antarctica*, *Cyclostrema meridionale*, *Eatoniella caliginosa*, *Laevilacunaria Antarctica*, and *Omalogyra antarctica* (Amsler et al. 2015).

Benthic communities of echinoderms are known to exist in shallow, hard bottom, nearshore waters of the WAP. Several species have been identified in the region and include, but are not limited to *Odontaster validus*, *Granaster nutrix*, *Lysasterias perrieri*, *Adelasterias papillosa*, *Psolicrux coatsi*, *Psolus carolineae*, and *Sterechinus neumdyeri* (White et al. 2012). In Arthur Harbor, communities of other echinoderms such as *Labidiaster annulatus*, which eat other invertebrates such as mollusks, and *Ophionotus victoriae*, which live on mud and mixed bottom surfaces, have also been observed. Sponges, coelenterates, ectoprocts, and ascidians have been found in waters near Arthur Harbor (Dearborn et al. 1972). Near Palmer Station, communities of gammaridean amphipods such as *Metaleptamphopus pectinatus* are associated with macroalgal species (Huang et al. 2007).

4.6.3 BIRDS

The southwest Anvers Island and Palmer Basin region is one of the most biologically diverse in Antarctica (ATS 2019a). Eleven species of birds breed in the Palmer Basin region (ATS 2019a), though only eight species are known to breed within a 1.5 km radius of Palmer Station, which is the approximate audible range that noise from the station can be detected (W. Fraser personal communication). Breeding colonies of birds are present on ice-free areas along the coast of Anvers Island, as well as on many of the offshore islands within the area. Palmer Basin is also an important foraging area for birds, including species that do not breed in Arthur Harbor, Hero Inlet, or offshore islands near Palmer Station. **Table 4-4** presents the bird species known to breed, feed, and frequent the Palmer Station region and their abundance. Bird species and abundances shown in **Table 4-4** are based on observations from staff posted at Palmer Station from 2019-2020, the ASMA No. 7 Management Plan (ATS 2019a), and a thorough review of the best available information. Since data on bird species abundance in the Antarctic are primarily based on bird census data at specific locations that count either breeding pairs or active nests, breeding pair data has been limited to locations in the Antarctic Peninsula region to the extent practicable.

TABLE 4-4: ABUNDANCE OF BIRD SPECIES POTENTIALLY PRESENT IN THE PROJECT AREA

Common Name	Species	Estimated Abundance		
		Estimated Global Population	Breeding Pairs	Data Sources
Species known to breed within 1.5 km of Palmer Station				
Adélie Penguin	*Pygoscelis adeliae*	10,000,000	—	BirdLife International (BirdLife; 2021a)
		—	3,790,000[a]	Lynch and LaRue (2014)
		—	390[b]	Lynch et al. (2010)
Kelp Gull	*Larus dominicanus*	3,300,000-4,300,000	N/A	BirdLife (2021b)
		—	437[c]	González-Zevallos et al. (2013)
Wilson's Storm Petrel	*Oceanites oceanicus*	8,000,000-20,000,000	—	BirdLife (2021c)
Southern Giant Petrel	*Macronectes giganteus*	95,600-108,000	—	BirdLife (2021d)
		—	161[c]	González-Zevallos et al. (2013)
South Polar Skua	*Catharacta maccormicki*	6000-15,000	—	BirdLife (2021e)
		—	335[c]	González-Zevallos et al. (2013)
Brown Skua	*Catharacta antarctica*	26,000-28,000	—	BirdLife (2021f)
Antarctic Tern	*Sterna vittata*	—	44,500[d]	Tree and Klages (2004)
		—	248[c]	González-Zevallos et al. (2013)
Snowy Sheathbill	*Chionis albus*	—	27[c]	González-Zevallos et al. (2013)
Species known to feed in the Arthur Harbor/Hero Inlet region (not known to breed within 1.5 km of Palmer Station)				
Chinstrap Penguin	*Pygoscelis antarcticus*	8,000,000	—	BirdLife (2021g)
		—	4486[c]	González-Zevallos et al. (2013)
Gentoo Penguin	*Pygoscelis papua*	774,000	—	BirdLife (2021h)
		—	6270[c]	González-Zevallos et al. (2013)

Common Name	Species	Estimated Abundance		
		Estimated Global Population	Breeding Pairs	Data Sources
Gentoo Penguin	*Pygoscelis papua*	—	2719[b]	Lynch et al. (2010)
		—	585[e]	Dunn et al. (2019)
Imperial Shag	*Leucocarbo atriceps*	Unknown[f]	—	BirdLife (2021i)
Arctic Tern	*Sterna paradisaea*	3,000,000	—	Bird Conservancy of the Rockies (Bird Conservancy; 2021)
Species known to frequent the Arthur Harbor/Hero Inlet region (not known to breed within 1.5 km of Palmer Station)				
Antarctic Petrel	*Thalassoica antarctica*	10,000,000-20,000,000	—	Franeker et al. (1999)
		—	A few nests to more than 200,000 per colony	Australian Antarctic Program (AAP; 2017)
Cape Petrel	*Daption capense*	2,000,000+	—	BirdLife (2021j)
Snow Petrel	*Pagodroma nivea*	4,000,000+	—	BirdLife (2021k)
Southern Fulmar	*Fulmarus glacialoides*	4,000,000	—	BirdLife (2021l)

a Abundance in Antarctica. Approximately 21% of the population breeds on the Antarctic Peninsula.
b Nest numbers from Petermann Island, 2007/2008 census numbers.
c Northern part of Danco Coast, 2010/2011 survey numbers
d Total global population of breeding pairs
e Nest numbers from Goudier Island, Port Lockroy, 2012/2013 census numbers
f According to BirdLife International, the population has not been quantified due to a recent taxonomic split.

Bird colonies with breeding populations within 1.5 km of Palmer Station are primarily located on Bonaparte Point/Kristie Cove and off-shore islands including Litchfield Island, Humble Island, Elephant Rocks, Torgersen Island, and Shortcut Island/Shortcut Point (ATS 2019a). Litchfield Island has been designated as Antarctic IBA No. 086 due to the presence of a South Polar skua population with 50 breeding pairs on the island (ATS 2019a). **Table 4-5** lists known bird colonies within 1.5 km of Palmer Station and their breeding status by location. Figure A-07 (Appendix A) shows bird nesting areas near Palmer Station. Breeding seasons vary by species, though the breeding, nesting, and rearing season for most bird species in the Palmer Station area is during the austral spring, summer, and/or autumn from approximately the beginning of October through the end of May (W. Fraser personal communication). The breeding seasons for specific bird species are shown in **Table 4-6**.

TABLE 4-5: KNOWN BIRD COLONIES ON ISLANDS AND REGIONS APPROXIMATELY 1.5 KM FROM PALMER STATION

Island/Region[a]	Location from Palmer Station	Protection	Bird Species	Breeding Population
Bonaparte Point/Kristie Cove	100 m south	Restricted Zone within ASMA No. 7	Southern Giant petrel	Yes
			Kelp gull	Yes
			South Polar skua	Yes
			Wilson's Storm petrel	Yes
Torgensen Island	1 km west	Within ASMA No. 7/SW half of island is a Restricted Zone	Adélie penguin	Yes
			South Polar skua	Yes
			Brown skua	Yes
			Wilson's storm petrel	Yes
			Chinstrap penguin	No
			Gentoo penguin	No
Elephant Rocks	1 km west	Restricted Zone within ASMA No. 7	Southern Giant petrel	Yes
			Imperial shag	No[b]
			Kelp gull	Yes
Shortcut Island/Shortcut Point	1 km southeast	Restricted Zone within ASMA No. 7	Southern Giant petrel	Yes
			Kelp gull	Yes
			South Polar skua	Yes
			Antarctic tern	Yes
Litchfield Island	1.3 km west	ASPA No. 113 within ASMA No. 7[c]	Southern Giant petrel	Yes
			Kelp gull	Yes
			South Polar skua	Yes
			Wilson's Storm petrel	Yes
			Southern Giant petrel	Yes
			Antarctic tern	Yes
			Hybrid skua	Yes
			Brown skua	Historical[c]
			Imperial shag	No
			Chinstrap penguin	No
			Gentoo penguin	No
			Snow petrel	No
			Cape petrel	No
			Antarctic petrel	No
			Southern fulmar	No

a All information referenced from the Management Plan for ASMA No. 7 except where noted.
b Historically, Imperial shags were known to breed on Elephant Rocks (Harris et al. 2015). While they no longer breed on Elephant Rocks, they are known to still roost there (ATS 2019a).
c Bird information for Litchfield Island from Harris et al. (2015). Brown skua commonly bred on Litchfield Island until an outbreak of fowl cholera in 1979.

TABLE 4-6: BREEDING BIRD SPECIES TYPICALLY FOUND WITHIN 1.5 KM PALMER STATION AND THEIR BREEDING SEASONS

Bird Species[a]	IUCN Red List Status[b]	Breeding Season	Breeding Season Source
Adélie Penguin	Least Concern	October-February	Ellenbroek (2017)
Kelp gull	Least Concern	September-March	Miskelley (2013)
Wilson's Storm Petrel	Least Concern	November-April	Southey (2013)
Southern Giant Petrel	Least Concern	October-May	Szabo (2013)
South Polar Skua	Least Concern	November-January	Hemmings (2013a)
Brown Skua	Least Concern	September-February	Hemmings (2013b)
Antarctic Tern	Least Concern	September-April	Sagar (2013)
Snowy Sheathbill	Least Concern	December-March	Montgomery (1998)

a While Blue-eyed/Imperial shags, Chinstrap penguins, and Gentoo penguins are known to breed in the Palmer Basin, they are not known to breed within a 1.5 km radius of Palmer Station.
b International Union for Conservation of Nature (IUCN; BirdLife 2018)

While multiple bird species are known to feed in the Arthur Harbor/Hero Inlet region, most feed aerially (on land or near the water surface). Only the Adélie, Gentoo, and Chinstrap penguins are known to dive deeper for their food (W. Fraser personal communication). **Table 4-7** lists the number of penguins, by species, that were observed swimming or hauled out during the 2019 and 2019-2020 summer seasons. These observations were taken three times a day for six minutes each by staff posted at Palmer Station.

TABLE 4-7: PENGUIN OBSERVATIONS IN ARTHUR HARBOR/HERO INLET OR HAULED OUT AT GAMAGE OR BONAPARTE POINTS NEAR PALMER STATION DURING THE SUMMER

Species	Summer Observations 2019[a]			Summer Observations 2019-2020[b]		
	#	No. Swimming	No. Hauled Out	#	No. Swimming	No. Hauled Out
Gentoo penguin	23	3	20	71	16	55
Adélie penguin	12	7	5	17	8	9
Chinstrap penguin	0	0	0	2	0	2
Penguins (species not identified)	22	22	0	40	31	9

a Observations conducted from 21 January 2019 through 28 March 2019.
b Observations conducted from 12 October 2019 through 31 March 2020.

4.6.4 TERRESTRIAL FLORA AND FAUNA

Due to the maritime climate, the WAP region has temperature conditions and moisture availability that permits a large variety of vegetation to flourish compared to the rest of the continent. These include bryophytes (mosses and liverworts), lichens, and the only two vascular plant species native to Antarctica (*Deschampsia antarctica* and *Colobanthus quitensis*). The distribution of vegetation in the region is dependent on surface conditions with bryophytes largely occupying moist ground surfaces and lichens and some mosses preferring drier ground surfaces. *Deschampsia antarctica* (Antarctic hairgrass) and *Colobanthus quitensis* (Antarctic liverwort) grow primarily on sheltered, north-facing slopes near sea level. Due to recent warming trends, populations of these vascular plant species are proliferating with the distribution expanding into recently exposed surface areas (ATS 2019a).

Communities of fruticose and crustose lichen, as well as moss sub-formation, have been observed in the Arthur Harbor region, primarily in areas with a rocky or stony ground surface. Crustose lichens form crusts against their substrate. Fruticose lichens can be pendant or hair-like, are generally upright, and shrubby or cupped. Cushion-forming mosses, including species of *Dicranoweisia* and *Andreaea,* were predominantly observed in sheltered north-facing areas while fruticose lichen communities such as *Himantormia* and *Unsnea* were found in drier, more exposed habitats (Smith and Corner 1973). Other lichens that have also been observed in dry, rocky areas in the region include species of the fruticose lichen *Pseudephebe* and the foliose lichen *Umbilicaria* (ATS 2019a). Foliose lichens have two easily distinguishable sides and can be flat, leafy, or convoluted and full of bumps and ridges. Rocky areas near the shoreline that are influenced by nitrogen inputs from penguin and petrel colonies often host brightly colored crustose and foliose lichen sub-formation communities including species such as *Amandinea*, *Buellia*, *Caloplaca*, *Haematomma*, *Lecanora*, *Lecidea*, and *Xanthoria* (ATS 2019a). Other crustose lichen species that have been observed in the region include *Haematomma erythromma*, *Mastodia tesselata*, *Rinodina petermanii*, Xanthoria *elegans*, and species of *Verrucaria* (Smith and Corner 1973).

The immediate vicinity surrounding Palmer Station is developed and primarily consists of gravel that is devoid of vegetation. The distal end of Gamage Point, which is frequented by line handlers when securing ships, has known colonies of the moss species *Sanionia uncinata* and the vascular plant species *Deschampsia antarctica* (N. van Gestel personal communication). Other areas of Gamage Point, including the area directly behind Palmer Station and the cliffs on the northern shore, are also known to be vegetated with *Deschampsia antarctica*, *Colobanthus quitensis*, and a variety of moss species (N. van Gestel personal communication). As the Marr Ice Piedmont has retreated away from Palmer Station, newly exposed terrestrial landscapes have been colonized by a variety of vegetation (ATS 2019a).

Vegetated areas on Anvers Island and the other small islands near Palmer Station provide ideal habitat for a variety of invertebrates including, but not limited to, springtails and mites. One mite common to the Antarctic Peninsula, *Alaskozetes antarcticus*, is found on the sides of dry rocks. Other mite species can be found in areas of fructose lichens, mosses, Antarctic Hairgrass, and even bird nests. Moss beds and the underside of rocks are favored habitat for the most common springtail in the area, *Cryptopygus antarcticus*. Springtails have also been found in bird nests (ATS 2019a).

The southernmost, free living true insect, the wingless midge *Belgica antarctica*, can be found in a range of terrestrial habitats in the ASMA No. 7 such as moss, algae, and nutrient-rich areas near elephant seal wallows and penguin colonies. The seabird tick, *Ixodes uriae*, is found in the area as well, primarily beneath well-drained rocks near seabird nests and Adélie penguin colonies (ATS 2019a).

5.0 IDENTIFICATION AND PREDICATION OF IMPACTS AND MITIGATION MEASURES OF THE PROPOSED ACTIVITY

5.1 INTRODUCTION

The following section identifies the potential impacts predicted to result from the activities associated with the proposed project. Mitigation measures such as best management practices (BMPs), which would be incorporated during construction are also discussed. Direct and indirect impacts are discussed in **Section 5.3** and cumulative impacts are discussed in **Section 5.4**.

5.2 DATA SOURCES AND METHODOLOGY

The primary guidance for this impact assessment came from the Guidelines for EIA in Antarctica as stated in **Section 1.2** (ATS 2016). Research scientists with specific knowledge of the local flora and fauna were consulted to identify potentially impacted species, impact potential, and mitigation strategies. Subject matter specialists were contracted to provide an assessment of underwater acoustic levels resulting from the proposed project as well as to assess the impact to marine mammals to assist in determining impacts. Other publicly available research articles and sources of information about Palmer Station and the vicinity were sought, when needed, to provide more understanding and background and are cited herein.

A direct impact is a change in an environmental resource or value resulting from an action or activity via a direct cause and effect relationship. Impacts may result from physical changes or releases to the environment. Other impacts such as personnel safety or impacts to the function of Palmer Station are considered here.

5.3 IMPACTS

5.3.1 PHYSICAL DISTURBANCES

5.3.1.1 TOPOGRAPHY AND HYDROGRAPHY

Land surface changes to topography include the potential removal of two bedrock outcroppings west of the existing boat parking grid to facilitate site grading (**Section 2.2.5**). Construction of the retaining wall and pier abutment (**Section 2.2.2.5**), and sewer line (**Section 2.2.3**) would require excavating trenches through bedrock. If bedrock outcroppings within the pier footprint are higher than expected, underwater rock chipping may be required to provide workable surfaces for pile installation.

The temporary crane pad (**Section 2.2.2.1**) would require an estimated 1376 m^3 (1800 cy) of imported aggregate fill material to construct. It is anticipated that 50% of this imported material can be recovered once the crane is in position and the assembly pad is no longer necessary. The non-recovered material would remain on the sea floor. The larger rock would provide scour protection along the retaining wall and pier abutment and it is likely that the smaller particles would succumb to tidal scour over time.

The existing pier would be demolished, and excavated material would be reused on-site where possible or removed upon project completion (**Section 2.2.2.2**). Large rocks would be used within the riprap areas designated along the retaining wall, pier abutment, and boat ramp. The existing pier demolition includes extracting the sheet piles, if possible, utilizing a vibratory hammer. If sheet piles cannot be removed, they will be cut off at the sea floor so that the pile is flush with the surrounding sea floor.

Construction of the new pier requires the use of template piles. Once the permanent piles are installed, the template piles would also be removed, if possible, with a vibratory hammer. If this method proves unsuccessful, they too would be cut off at the sea floor. A single 60.96 cm (24 in) diameter template pile, cut off at the sea floor, would result in a surface area of 0.09 m^2 (1.02 ft^2) of steel pipe at the sea floor.

Areas of excavation, fill, and pile installation would result in changes to the existing topography and hydrography near Palmer Station. These impacts are considered minor in terms of their magnitude given the limited footprint. The duration of these impacts is considered long-term given that these changes would persist after construction is complete and until such time as they may be changed in the future. Mitigation measures include limiting excavation areas, to the fullest extent possible, as part of the design for this project, and utilizing coarse fill material meant to withstand easy transport thereby limiting the expansion of the fill area.

Indirect impacts associated with changes in topography and hydrography listed here include disturbances to vegetation or benthic communities within and adjacent to the areas of fill and excavation. Impacts are most likely to be seen below the water surface as the areas of disturbance on land are previously disturbed and not vegetated. Indirect impacts may also arise from the change in substrate material with the introduction of any steel piles that may be cut off at the sea floor. The impact to benthic communities is discussed in **Section 5.3.3.2**. Water quality impacts associated with excavation and placement of fill below the water surface are discussed in the following Marine Water Quality Section.

5.3.1.2 MARINE WATER QUALITY

Impacts to water quality can occur from work occurring below the water surface as well as from runoff or spills from construction above the water surface. In-water fill may increase turbidity as sediments enter the water column and travel beyond the limits of fill placement. Instances of fill below the water surface for this project include the temporary crane pad (**Section 2.2.2.1**), pile installation (**Section 2.2.2.3**), and the retaining wall and riprap (**Section 2.2.2.5**). Mitigation measures include the use of coarse fill material meant to withstand easy transport through the water column. BMPs such as sandbags, absorbent socks, and tarps will be used to secure dirt stockpiles to prevent stormwater and/or snowmelt runoff as well as wind from transporting sediment into adjacent marine waters.

Driving piles into the marine bottom would stir up sediments that would lead to higher turbidity levels. This increase would be temporary, and the suspended sediments should settle back to the marine floor within a few minutes to several hours (**Marine Mammal Assessment, Appendix B**). Drilling fluids and rock cuttings generated during drilling would be redirected back into the water. Drilling fluid would be comprised of potable water only. Rock cuttings would be comprised of native rock and may create a temporary increase in turbidity.

The presence of construction equipment at Palmer Station would result in an increased risk of oil or lubricant spills. The sewer line relocation has the potential to cause a release and other products such as grout will be utilized that could impair water quality. **Section 5.3.2.6** discusses accidental releases in more detail including mitigation measures to be used.

Indirect impacts from marine water quality impacts include impacts to the benthic community and the marine and terrestrial species that feed on them. Impacts to marine species are discussed in **Sections 5.3.3.1 and 5.3.3.2**.

General water quality impacts such as increases in turbidity associated with construction are considered less than minor or transitory. Potential water quality impacts resulting from spills may be more significant but also less likely to occur with BMPs in place.

5.3.2 RELEASES TO THE ENVIRONMENT

5.3.2.1 AIR EMISSIONS

The barge, cranes, excavator, and other construction equipment running combustion engines would result in an increase in air emissions at Palmer Station for the duration of construction. These emissions are not expected to result in an overall reduction in the ambient air quality of the area. Most of the equipment will be diesel-powered. To the extent practicable, diesel-powered equipment would meet Tier 3 or Tier 4 exhaust emission standards for nonroad engines as defined by United States Code of Federal Regulations Title 40, parts 89 and 1039. These standards reduce the emissions of particulate matter, nitrogen oxides, carbon monoxide, and nonmethane hydrocarbons in diesel exhaust. The equipment used is expected to be in proper working order prior to arrival at Palmer Station and would be maintained so as to prevent unnecessary air emissions.

Construction activities may generate fugitive dust emissions. These activities include grout mixing and placement, grading, rock chipping, and cutting or chipping concrete panels or caps. Mitigation measures to help reduce or eliminate air emissions include wet cutting techniques for cutting concrete and prohibition of open burning. Water may be sprayed on surfaces to eliminate fugitive dust if needed. Indirect impacts could include deposition of dust on nearby land and water surfaces, but this would likely be kept to a minimum with the mitigation measures described.

Air emissions associated with this project are expected to result in less than minor or transitory impacts to air quality.

5.3.2.2 WASTEWATER

Palmer Station maintains an on-site wastewater treatment system, meeting Antarctic Treaty requirements, that consists of only maceration of solids before the waste stream is discharged into Hero Inlet. This system would be utilized by construction staff while working at Palmer Station. The temporary bypass of the sewer line as well as the new sewer line installation have the potential to result in minor releases of macerated sewage waste to the environment during construction. All sewer line work would occur between the maceration only treatment system and the outfall. Any land surface release would be considered a spill and would be reported. Production of wastewater on the barge and tugboat would be kept to a minimum as all construction personnel would primarily utilize services at Palmer Station while the barge is docked. The tugboat and construction barge would be equipped with a United States Coast Guard-approved marine sanitation device (MSD) system capable of treating wastewater generated onboard the vessel. Untreated wastewater from construction vessels including the cargo supply ship and the *LMG* would comply with the ACA and would not be released within 22.2 km (12 nmi) of land. The number of construction personnel on-site would not exceed the number of staff typically located at the station. There should be no increase in wastewater output over normal conditions and therefore no negative impacts resulting from the project. There are a number of items prohibited or regulated at the station to avoid impacts to wastewater and environmental receptors (e.g., avian products [raw or cooked]). The net output from the system after construction would be the same. The system capacity would not be altered, only the location of the outfall to accommodate the new pier (see **Section 2.2.3** for more info on the sewer line relocation). Indirect impacts to wastewater impacts include impacts to the marine water quality should a spill occur. The Contractor would have spill response kits on hand which would be employed should a spill occur. This should prevent any such spills from entering the marine environment. Any spill would be reported allowing for further investigation of potential transport.

Mitigation measures include utilization of the temporary bypass until construction of the new line is completed as well as the use of spill response kits should an accidental spill occur. No hazardous materials/fluids would be disposed of into the wastewater system.

The project is not expected to result in any impact due to the release of wastewater to the environment beyond what occurs during normal station operations. Any impact that may occur is considered less than minor and transitory.

5.3.2.3 NOISE/ACOUSTIC RELEASES

There are numerous noise-generating activities associated with this project:

- Pile installation
- Below-water excavation to prepare surface for pile installation
- Demolition of the existing pier
- Bedrock excavation for the retaining wall, sewer line, and pier abutment
- General construction and heavy equipment

The primary source of underwater noise would be pile driving. An acoustic assessment was prepared for the project, which identified and analyzed the in-water noise impacts from three different possible methods of pile driving: vibratory hammer, impact hammer, and DTH drilling. Vibratory hammers produce vertical vibrations that are transferred through the pile to the ground which reduces friction and allows the pile to be driven into the ground. Impact hammers work like a traditional hammer and drop a heavy weight from a height onto the top of the pile, forcing it into the ground. DTH drilling, as described in **Section 2.2.2.3**, uses an attachment at the end of a drill to break up rock into small flakes, allowing the pile to be driven into the ground. All three methods (vibratory hammer, impact hammer, and DTH drilling) were considered in the noise assessment as construction techniques that could be used depending on site conditions. Rock chipping may be utilized to prepare the sea bottom at pile locations to ensure accurate pile location and alignment. Rock chipping may also be utilized for bedrock excavation associated with construction of the retaining wall, sewer line, and pier abutment. Rock chipping was not considered separately from DTH drilling in the acoustic assessment performed for this project because the area of ensonification for DTH drilling is larger than for rock chipping and both activities would occur on the same day. Vibratory driving may be used to remove the template piles and sheet piles associated with the existing pier but not to install new piles.

The acoustic assessment performed for this project evaluated underwater noise only in order to assess impacts to marine mammals. Specific impacts to marine mammals resulting from noise generating activities are discussed in **Section 5.3.3.1**. In addition to the underwater noise impacts on marine species, the above ground noise generation has the potential to impact birds and other fauna found near Palmer Station as well as Palmer Station staff and construction personnel. Impacts to birds are addressed specifically in **Section 5.3.3.3**.

Construction personnel are expected to wear personal protective equipment (PPE) to mitigate against occupational noise exposure. During construction, non-Antarctic Support Contract (ASC) scientific staff are not expected to be present at Palmer Station but would conduct research aboard the research vessels. Noise impacts to researchers are possible within 1.5 km (0.93 mi) of the construction area (W. Fraser, personal communication). It is recommended that PPE be available for all staff to reduce noise exposure, particularly for staff performing work outside during noise generating activities.

Noise generated by the project is likely to result in impacts, which would be no more than minor or transitory given that they would end with the cessation of noise generating activities.

Construction would be limited to one construction season (November through June) and workdays would be limited to 12-hour shifts, 7 days a week. The reduced timeframe and work hours will reduce the length and duration of the noise impacts.

5.3.2.4 NON-NATIVE SPECIES

The introduction of personnel, equipment, construction materials, and imported fill carries the risk of introducing non-native species to Antarctica. Non-native species include insects and microorganisms, as well as vectors such as seeds and soil. Non-native species introduction prevention procedures apply to work at Palmer Station, including work done through ASC and subcontractors. The project would adopt the guidelines set out by ATS (2019b) which identified pathways of non-native species introduction such as:

- cargo (including aggregate materials),
- construction equipment,
- personal clothing and gear,
- procured items,
- food, and
- mail.

Indirect impacts associated with the introduction of non-native species include impacts to terrestrial and marine species native to Palmer Station including the adjacent Gamage Point and Hero Inlet. Research suggests that climate change increases the risk of establishment of non-native species, making the prevention of their introduction even more important (Newman et al. 2014).

Mitigation measures to be implemented to prevent the introduction of non-native species would include cleaning and inspecting all cargo, construction equipment, gear, clothing, and personal equipment for the presence of non-native species and organic matter before shipping and loading on the shipping vessels. Ballast water would be discharged only outside the Antarctic Treaty area, at reception facilities, or as otherwise permitted under Annex I of the International Convention for Prevention of Pollution from Ships (MARPOL 73/78) and Resolution 3 (ATS 2006). Aggregate rock (fill) imported for this project is required to be cleaned and sterilized prior to shipment to Antarctica.

The potential impact to local microbiological habitats from the introduction of non-native species can be significant given that the impact can be long-term and spread beyond the local environment. Incorporating the prescribed guidance measures into standard operating procedures for construction should reduce this to a minor risk.

5.3.2.5 SOLID WASTE

The ACA requires training and education of personnel to comply with waste management requirements and procedures. Construction personnel would attend a solid waste orientation and follow provisions of the ACA and direction by Palmer Station staff. No polychlorinated biphenyls, non-sterile soil, polystyrene beads, chips (packaging materials), or pesticides would be imported or used. Any waste, including hazardous waste, generated during construction would be stored in containers and removed from the site by barge. Demolished materials would be considered for future use at Palmer Station. Any remaining material that cannot be reused locally would be returned with the barge. With these measures in place, no solid waste impacts are anticipated.

5.3.2.6 ACCIDENTAL RELEASES

Construction vehicles and equipment would adhere to the guidance detailed in ASMA No. 7 Management Plan including taking steps to prevent the accidental release of fuel or chemicals and ensure that spill kits are available and secondary containment units are used. Safety measures to be utilized include proper storage of all chemical and petroleum products and regular inspections of equipment, hoses, and fuel storage containers. Waste Regulations (45 Code of Federal Regulations § 671) would be followed including regular inspections of storage containers.

The Contractor anticipates two major fueling events over the course of construction. Each event is expected to transfer approximately 37,854 L (100,000 gal) of diesel fuel. The transfer would occur by running a hose between the support vessel and the deck of the barge. Refueling is anticipated to occur over two days at a rate of 1211 L (320 gal) per minute. During this time, no work would be conducted from the barge in order to observe necessary safety protocols and ensure fueling operations are conducted properly. Secondary containment would be utilized for all fuel storage and fueling activities and spill response material would be located and available for immediate deployment. Spill response material would include absorbent pads, socks, protective gear, and a rope mop skimmer. ASC trained staff will be on-site to provide fuel spill response including installing a 152.4 m (500 ft) boom as a precautionary measure prior to fuel transfer.

The sewer line installation may require using a high expansion grout agent such as Dexpan® to create a non-explosive, controlled expansion to fracture the rock (see **Section 2.2.3** for more discussion on the use of Dexpan®). The Safety Data Sheet for Dexpan®, included in **Appendix C**, indicates toxicity levels in aquatic environments occur at levels far higher than what would be expected to occur from the quantities and use specified for this project. After fracturing, the demolished rock and debris, including grout, would be collected. An absorbent sock would be employed around the demolition area to promote absorption of any stray material and aid in collection efforts. If Dexpan® or similar product is used, the surplus material and its container would be segregated for special disposal considerations. Any hazardous wastes would be disposed of outside the Antarctic Treaty area in accordance with pertinent regulations and permits.

Indirect impacts from accidental releases include impacts to water quality as well as impacts to marine species and birds. These impacts could be long term in duration depending on the material released.

This project has the potential to release hazardous material into the environment, particularly diesel fuel. The impact from such spills would be a major impact, but this impact can be effectively minimized by following established BMPs such as ensuring spill containment and response materials are in place.

5.3.3 DISTURBANCES TO BIOLOGICAL RESOURCES

5.3.3.1 MARINE MAMMALS

As described in **Section 4.6.1**, 12 cetacean and five pinniped species can be found in the vicinity of the project. Five of the cetacean species are listed as endangered under the ESA: blue, fin, sei, sperm, and southern right whales. None of the pinnipeds are ESA-listed. Sources of direct impacts to marine mammals include auditory injury or disturbance due to underwater noise from DTH drilling, vibratory and impact pile installation and removal, and possibly rock chipping, as well as physical disturbance to marine mammals from project vessels and human presence in the vicinity of the pier. Unavoidable impacts to marine mammals during construction are anticipated; therefore, an Incidental Harassment Authorization (IHA) for the incidental taking of marine mammals pursuant to Section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA) is required. Under the MMPA, "take" means to harass, hunt, capture, or kill any marine mammal or attempt such actions. For the purposes of the IEE, the estimated exposures to increased underwater noise due to construction provide the basis for assessing the extent, duration, intensity, and significance of effects according to the EIA guidelines (ATS 2016).

The potential sources of physical disturbance to marine mammals during Palmer Pier construction activities are associated with the physical presence of humans on the pier, construction vessels present within Hero Inlet, and noise introduced into the air from drilling and pile driving activities. Vessels or humans would not be permitted to intentionally approach marine mammals on sea or land during the project. Mortality and serious injury of marine mammals due to vessel strikes is not expected in Hero Inlet due to the slow speed of the single working tug and the required use of Protected Species Observers (PSOs) as a required mitigation measure. Project activities can be shut down by the PSO if the activity presents any immediate threat or harm to a marine mammal.

Direct impacts on marine mammals due to the Palmer Pier construction project may result from underwater noise from DTH and pile driving. The extent of potential auditory impacts to marine mammals during in-water construction activities were evaluated based on the area that may be ensonified (filled with sound) by underwater noise and the potential for marine mammals to occur in this area using published studies and recent observation data in Hero Inlet near Palmer Station. The estimated area that would be ensonified above behavioral thresholds by source is calculated based on the distance from the Palmer Pier to the edge of the NMFS thresholds for each species for Level A and Level B threshold (**Appendix B)**. Shutdown zones will be implemented during pile or sheetpile installation and removal activities. If marine mammals are observed within the shutdown zone, DTH drilling, or pile-driving or removal activities would be delayed until they move out of the area. If a marine mammal is seen by the PSOs above water and then dives below, the contractor would wait 15 minutes. If no marine mammals are seen in that time, work would resume based on the assumption the animal has moved away from the shutdown area. While this will not prevent MMPA "takes" from occurring, it will prevent any serious injury to a marine mammal from a close approach.

The duration of potential effects is, in part, based on the project schedule for in-water construction. The project Contractor assumes that installation of approximately one to two piles would occur over a 12-hour workday. To be precautionary, this assessment assumes that two pile installation activities would occur simultaneously using DTH drilling. The corresponding noise assessment assumes one 36-in pile would be installed to a 20-ft socket depth while a second 36-in pile would be installed to a 30-ft socket depth. Brief impact pile driving of about 10 strikes may be used to seat the piles.

Seals have been observed hauled out at Gamage Point (near Palmer Pier) but ATS (2019a) shows the closes haul out location at Bonaparte Point (approximately 135-150 m [442-492 ft] from Palmer Pier). In-air noise generated during construction activities at the pier should attenuate in air to <100dB, or less than levels that exceed National Marine Fisheries Service (NMFS) established Level B thresholds, before reaching the opposite side of Hero Inlet where seals may be on shore. A 2016 Final Rule for construction of a Navy Pier (81 FR 52614) estimated the greatest possible distances to airborne noise during installation of a 24" steel pile (using a source level of 111 dB re 20 microPascals) as 168.3 m to the 90 dB threshold for harbor seals and 53.2 m for all other seals. A 2019 Final Rule published for construction of the Liberty Development in Alaska estimated airborne noise during impact pile driving as 93 dB re 20 microPascals at 160 m from the source (84 FR 70274). It is unlikely that animals hauled out across Hero Inlet will be exposed to levels above the NMFS Level B threshold for disturbance. Therefore, construction noise is not expected to disturb hauled out animals across Hero Inlet or similar distances away. Any animals hauled out closer to Palmer Station would be subject to the 50-m shutdown zone and therefore pile driving activities would not commence until the animal moved out of the area. Further, disturbance of hauled out seals or animals in the Hero Inlet waters due to the physical presence of vessels and equipment does not automatically imply that harassment has occurred. If disturbed, seals may leave the haulout area briefly, but would be expected to return. There is recognition that minor and brief changes in behavior such as this do not generally have biologically significant consequences for marine mammals (NRC 2005). Given the limited vessel traffic, slow vessel speed or stationary nature of the support vessels, and that other construction activities would be on land at the pier, only negligible impacts would be expected due to disturbance from human or vessel activities.

Temporary behavioral changes or avoidance of the affected area is the most common response of marine mammals to increased noise levels. Marine mammal exposures to underwater noise generated during construction activities would possibly result in the potential for Level A and Level B takes as determined by established criteria (NMFS 2018). However, the relatively short duration of these exposures is not expected to result in anything more than biologically insignificant to minor, transitory effects to any of the marine mammal species that may be taken during this project. Avoidance responses may be initially strong if the marine mammals move away from the source or weak if animal movement is only slightly deflected away from the source. This type of behavioral response might further protect animals from elevated sound exposures.

The biological significance of potential behavioral disturbances is difficult to predict, especially if the detected disturbances seem minor. However, it is likely that impacts or responses to elevated sound sources would be short-term, localized, and would have no biological significance to reproduction and survival rates or population trends. While increased underwater sound levels from project activities have the potential to result in Level A (i.e., permanent threshold shift) harassment to certain species, the potential for this effect is minimized through mitigation. No serious injury or mortality of marine mammals is expected from project activities. A more detailed assessment of the impacts to marine mammals can be found in the Marine Mammal Assessment developed to support the IHA Application (**Appendix B**).

Indirect impacts associated with impacts to marine mammals include decreased predation on other marine species. This impact is likely minor and transitory, particularly in relation to other direct impacts on marine organisms addressed in **Section 5.3.3.2.**

These mitigation measures are recommended to minimize and avoid adverse impacts to marine mammals and are based on the best guidance available:

- Implementation of a soft-start procedure (see below) to reduce the total number of animals potentially exposed to increased noise levels from pile installation
- Implementation of a 12-hour workday followed by a 12-hour period without increased noise from the project allowing for acoustic "recovery" throughout each 24-hour period
- The use of PSOs for monitoring ensonified areas and a shutdown procedure that would reduce the total amount of time and exposure that a marine mammal is potentially exposed to noise levels that exceed the Level A thresholds established by NMFS

Soft-start protocols will be finalized during consultation with the National Oceanic and Atmospheric Administration (NOAA)/NMFS during ESA consultation and in conjunction with the IHA permitting process under the MMPA. Soft-start (or ramp-up) procedures are typically defined as a brief interval of pile driving at reduced energy followed by a waiting period where pile driving stops. This is repeated several times before the equipment can be used at full energy.

See **Appendix B** for further details on these mitigation measures including monitoring protocols and reporting requirements.

5.3.3.2 MARINE SPECIES

In addition to marine mammals, other marine species including fish, invertebrates, microorganisms and plant life account for the underwater ecosystem around Palmer Station. The benthic community along the seafloor may be displaced or covered as a result of sediments stirred up during pile driving activities or during the placement of fill below the water surface for the temporary crane pad and additional riprap placement as wave protection against the boat ramp, retaining wall, and pier abutment. Portions of the fill material from the temporary crane pad may also disperse over time as a result of wave action. A study on the variability of phytoplankton biomass along the West Antarctic Peninsula found that sediments in the water column reduce irradiance and resulted in lower abundance of phytoplankton (Kim et al. 2018). Suspended sediments are likely to dissipate within a single tidal cycle (**Marine Mammal Assessment, Appendix B**). Kim et al. (2018) found significant seasonal variation in phytoplankton abundance from year to year, corresponding to other disturbance variables including the amount of suspended sediments in the water column. This would suggest phytoplankton numbers may be only seasonally affected by increased sediment loads associated with this project. Ice scour and high wind and wave events are common disturbance events for benthic communities and much research has looked at the colonization and succession of these communities (Barnes and Conlan 2007). Many Antarctic benthic organisms are found in widely distributed sites around the Antarctic continent (Clarke 1996). The Southern Ocean contains a high level of species abundance (Barnes and Conlan 2007, Barnes and Brockington 2003) although the authors note that the ability to make generalizations on larval abundance suffers from a lack of existing data. It is difficult therefore, to determine the rate at which the benthic community within and adjacent to the project will recover but the capacity for recovery is assumed and the footprint of impact is relatively small. Therefore, the impacts are expected to be minor and potentially long-term.

Removal of the existing pier would also result in the displacement of microalgae, macroinvertebrates, and other benthic organisms that have colonized the surface of the pier and the pier abutment. A review by Barnes and Conlan (2007) describes two patterns of nearshore colonization on hard substrata: slow and continuous (i.e., 2% cover after 21 months) versus interannual mass events (major build-up of organisms after nearly a decade). Barnes and Brockington (2003) state that while the High Antarctic sees very low rates of colonization, maritime Antarctic Islands are characterized by continuous colonization and summer ice scour structures communities. Barnes and Conlan (2007) noted a lack of experiments detailing recolonization hypothesizing that ice scour makes such studies difficult. The monitoring plan proposed for this project (see **Section 5.6**) includes documentation of the recolonization of the benthic environment on the newly built pier and fill areas. This data may help advance understanding of the recolonization rates and processes for benthic organisms along the WAP.

The sewer outfall is another area where marine organisms congregate. In a review of disturbance and recovery of Antarctic benthic communities, Barnes and Conlan (2007) reported that the benthic footprint resulting from sewage outfalls from coastal research stations was found to extend up to 2 km from the source. The proposed outfall is approximately 28.3 m (93 ft) from the existing outfall and both outfalls terminate above the water. The movement of this outfall may result in a short-term impact until organisms adjust to the new location, but it is not anticipated that any long-term shifts in the types or quantity of organisms would occur as a result of the sewer outfall relocation; therefore, any impact is expected to be minor.

Fish species in the project vicinity would be impacted in a manner similar to that discussed for marine mammals. It is expected that species found in the vicinity of the pier are tolerant to noise levels associated with a seasonally active marine station. Noise impacts would be temporary and would be limited to the duration of construction. Popper et al. (2019) concluded that fish exposed to pile driving sounds may show alarm responses including an increase in swim speed as well as changes to ventilation and heart rate. These transient startle responses are not expected to result in adverse impacts as fish often rapidly return to normal behavior. The specific noise levels to which fish react and a further treatment of the impacts from this project are described in the Marine Mammal Assessment (**Appendix B**). Fish are likely to respond to pile-driving activities by temporarily avoiding the area and therefore impacts are expected to be less than minor.

Not much information is available on the effects of underwater noise on krill and zooplankton (Erbe et al. 2019). A study reported by McCauley et al. (2017) showed a two- to three-fold decrease in zooplankton abundance in response to air gun sounds as far as 1.2 km away. Pinkerton et al. (2020) reports a three-fold seasonal change in zooplankton abundance with increases occurring through the summer. This suggests that while a three-fold reduction in zooplankton abundance may result from this project, this is not larger than typical seasonal variations in zooplankton abundance and therefore may only result in a minor or transitory impact.

Indirect impacts associated with impacts to marine species include impacts to birds and marine mammals that feed on these organisms. The Marine Mammal Assessment (**Appendix B**) provides a further treatment of indirect impacts to marine mammals from impacts to prey species and found the impacts to be less than minor. Mitigation measures include the use of coarse fill material meant to withstand easy transport through the water column.

5.3.3.3 BIRDS

Impacts to birds are most likely to stem from noise generated during construction. A long-term scientist at Palmer Station provided information on the bird species likely to be affected by construction of this project. The audible range over which normal noise levels coming from Palmer Station can be detected by humans and the bird species found in the area is 1.5 km (0.93 mi; W. Fraser, personal communication). **Table 5-1** includes the birds most likely to be found within 1.5 km (0.93 mi) of Palmer Station. The table also identifies the breeding status of each species during the construction time frame, the species population status, feeding model and location, and how sensitive to disturbance the species is.

TABLE 5-1. BIRD SPECIES TYPICALLY FOUND WITHIN 1.5 KM OF PALMER STATION

Bird Species Within 1.5 km of Palmer Station (Nov 1-May 15)[a]	Breeding	Non-Breeding	Population Status	Feeding Model/Feeding Locally	Sensitivity to Disturbance
Kelp Gull	X		Stable	Aerial/Yes	High
Wilson's Storm Petrel	X		Unknown	Aerial/Yes	High
Southern Giant Petrel	X		Stable	Aerial/Yes	High
South Polar Skua	X		Decreasing	Aerial/Yes	High
Brown Skua	X		Decreasing	Aerial/Yes	High
Antarctic Tern	X		Stable	Aerial/Yes	High
Arctic Tern		X	Unknown	Aerial/Yes	High
Adelie Penguin	X		Decreasing	Diving/Yes	Moderate
Chinstrap Penguin		X	Increasing	Diving/Yes	Moderate
Gentoo Penguin		X	Increasing	Diving/Yes	Moderate
Snowy Sheathbill	X		Stable	Aerial/Yes	Low
Blue-eyed Shag		X	Decreasing	Aerial/Yes	Low

a Source: (W. Fraser personal communication)

Many factors influence the potential for impacts to bird species. These species typically breed some distance from the station but feed more locally. Those species that utilize diving in their search for food (feeding model) would be affected by both the above and below water noise generation. The sensitivity to disturbance metric reflects observations from four decades of research showing how these species have responded to human activities (W. Fraser, personal communication). Noise from construction activities can impact the behavior and physiology of birds by masking the signals used for communication, mating, and hunting (Bottalico et al. 2015). Ultimately an increase in noise or the presence of noise may lead to a decrease in bird density as birds leave the area where their signals are masked (Bottalico et al. 2015). As noise levels increase or distance to noise decreases, increased impacts to bird include temporary hearing loss (temporary threshold shift, TTS) and permanent hearing loss (permanent threshold shift, PTS).

Very little is known about underwater hearing in marine birds, with research only reported for three species: long-tailed ducks (Clangula hyemalis), great cormorants (Phalacrocorax carbo) and more recently, gentoo penguins (*Pygoscelis papua*) (Sorensen et al. 2020). Based on research reported in Sorensen et al. (2020), gentoo penguins responded to underwater noise bursts at received SPLs between 100 and 120 dB re 1 μPa RMS. A "graded reaction to the noise bursts" was exhibited by the penguins, ranging from no reactions at 100 dB to strong reactions to 120 dB re 1 μPa. A "strong reaction" was defined as a "startle response" or greater than 90% change of swim direction and change of speed. Due to limited information on marine bird hearing, it is not possible to estimate the potential distance at which behavioral disturbance could occur during DTH drilling or pile installation/removal. However, it is reasonable to assume some level of behavioral disturbance will occur during in-water construction due to underwater noise.

Airborne noise may also result in behavioral disturbance. Dooling and Popper (2016) report that above 60 dBA, masking may occur. No data is available for TTS in birds caused by multiple impulse noise such as that produced by pile driving but studies show that PTS can occur at 125 dBA (Dooling and Popper 2016). As stated in **Section 5.3.3.1**, pile driving noise should attenuate to below this level before reaching across Hero Inlet. Results from Alaska show levels reducing to 93dB at 160m from the source (84 FR 70274). It is expected that bird species will avoid areas closer to the construction noise while pile-driving and other noise producing activities occur in order to avoid acute impacts such as hearing loss.

The ACA defines "take" as "to kill, injure, capture, handle, or molest a native mammal or bird" "or to attempt to engage in such conduct." Disturbance of concentrations of native birds or mammals is classified under the ACA as "harmful interference." Because behavioral disturbance of bird species that may be found in the area could occur due to temporary in-air or underwater noise during construction, the project will apply for an ACA permit due to harmful interference. No taking of birds is expected as a result of this project.

Noise impacts, while far reaching, are expected to be no more than minor disturbance to a selected few species. Temporary impacts to bird behavior or avoidance of the project area are anticipated to be the most common response to increased noise levels. However, the relatively short duration of these noise levels is expected to result in no more than minor or transitory impacts. Avoidance responses would vary by species; however, this type of behavioral response might further protect birds from elevated noise. Although some birds dive to feed, penguins are more likely to be affected by noise than other bird species. Adélie penguins, while not a global species of concern as shown in **Table 4-6**, are considered to be in decline locally. Therefore the soft-start procedures described in **Section 5.3.3.1** as well as the 50-m shutdown zone for pile driving and 10-m shutdown zone for heavy equipment movement in water will be applied to penguins in addition to marine mammals.

Indirect impacts from impacts to birds include a potential decrease in predation of marine organisms such as fish and zooplankton within the vicinity of Palmer Station. This impact is likely minor and transitory, particularly in relation to other direct impacts on marine organisms addressed in **Section 5.3.3.2.**

Potential mitigation measures include limiting the loudest activities to the evening hours when species such as penguins are typically not feeding (W. Fraser, personal communication). This is dependent upon the Contractor's schedule and ability to accommodate. The work schedule does include 12-hour workdays and 12-hour noise "recovery" periods as described in **Section 5.3.3.1.**

5.3.3.4 TERRESTRIAL FLORA AND FAUNA

Construction personnel would receive training regarding the requirements of the ASPAs and Restricted Zones within ASMA No. 7. Personnel would not enter Restricted Zones or ASPAs. Personnel would not approach any animals (birds or mammals) or collect or trample vegetation (including moss and lichen). Personnel would not collect and export material such as animal or plant parts, bones, feathers, rocks, etc. Personnel access would be limited to the barge, tugboat, construction areas, and facilities associated with Palmer Station.

Impacts to vegetation such as lichens and moss should be minimal as construction is limited largely to the previously disturbed areas of Palmer Station. There is an area near the tie-up location for the *LMG* on Gamage Point where the moss *Sanionia uncinata* and the vascular plant *Deschampsia antarctica* are found (N. van Gestel, personal communication). This area is outside of the construction zone for this project. The construction barge would initially anchor utilizing the existing moorings at Gamage Point but would set up anchors to the seaward side of the barge. Once completed, this project would eliminate the need for the *LMG* to be tied-off at this location, potentially preventing future degradation of this vegetation.

Indirect impacts from impacts to terrestrial flora and fauna include potential introduction of non-native species and impacts to other species such as birds that feed on local vegetation. Impacts resulting from the introduction of non-native species are discussed in **Section 5.3.2.4**. Impacts to birds from loss of vegetation is not directly discussed in **Section 5.3.3.3** given the low likelihood that terrestrial vegetation will be impacted by this project. Mitigation measures include restricting personnel access to areas outside the construction area, providing training to construction personnel as stated above, and providing staff member escorts to construction personnel in vegetated areas should access be needed.

5.3.4 OTHER

5.3.4.1 STATION FUNCTION AND ACCESS

A total of 24 construction personnel would utilize the existing facilities at Palmer Station for office space, crew quarters, laundry, meals, phone, and internet for the duration of the project. The Palmer Station Master Plan (NSF 2016) states that the population of the station is not expected to exceed 46 people during the austral summer. This would allow a staff of 22 people to continue working at the station through construction. No researchers would be residing at Palmer Station during construction, although some research is expected to be carried out onboard research vessels. The construction barge would be docked at the station during the entirety of construction and would restrict station access during that time period. No tour visits to Palmer Station would be allowed during the period of construction. This impact is considered less than minor or transitory given that the impact will end when construction is completed.

Indirect impacts associated with impacts to station function and access include impacts to scientific research which is discussed in **Section 5.3.4.3**. No mitigation measures are proposed.

5.3.4.2 VISUAL DISTURBANCES

Wilderness and aesthetic values associated with Antarctica have been previously characterized as areas without permanent improvements or visible evidence of human activity (NSF 2015). Visible changes resulting from this project include removal of the existing pier, construction of a new pier, surface grading, and sewer line relocation. See **Section 2.2** for a description of these activities as well as **Figure A-05** (**Appendix A**). However, this project is limited to the existing Palmer Station footprint and would not expand the area of disturbance or development except for the larger size of the new pier relative to the current one. For this reason, this impact is considered less than minor or transitory.

During construction there would be two large cranes as well as other construction equipment, which would temporarily impact the visual characteristics of Palmer Station. This equipment would be located only within the project area shown on **Figure A-04** (**Appendix A**) and would be located at the station only for the duration of the project.

No indirect impacts are anticipated as a result of impacts to the visual characteristics of Palmer Station. Mitigation measures include limiting the extents of excavation to the fullest extent possible during design.

5.3.4.3 IMPACTS TO SCIENTIFIC RESEARCH AND OTHER USES OR VALUES

The primary function of Palmer Station is to support Antarctic scientific research. Full utilization of the station by scientists and staff would be reduced during construction due to accessibility, the presence of construction staff, and the limits on available accommodations. Many projects with field components would be supported using the *NBP* or *LMG,* which would function as floating research platforms, allowing a very limited amount of scientific research to continue while not impacting construction activities. The impacts described in **Sections 5.1 through 5.4** may impact scientific research projects.

Current investigations for the Palmer LTER are focused on the following

- physical forcing (solar, atmospheric, oceanic, and sea ice) with emphasis on ecological consequences of annual and inter-annual variation;
- ecology and population biology of marine bacteria and archaea, phytoplankton, zooplankton, seabirds, and whales;
- biogeochemical cycling of carbon and nitrogen;
- ecosystem responses to climate mitigation; and
- physical/chemical/biological modeling linking ecosystem processes to environmental forcing (NSF 2015).

Much of this research occurs within the broader study area of the Palmer LTER regional grid and Palmer Basin grid. Most of the impacts noted in **Sections 5.1-5.4** are limited to the construction area but the noise impacts to marine mammals extend as far as 18 km (11.2 mi; Marine Mammal Assessment, **Appendix B**). One of the primary values of ASMA No. 7 is its importance for long-term studies of natural variability in Antarctic ecosystems and the impact of world-wide human activities on Antarctica and on the physiology, populations, and behavior of its plants and animals (ATS 2019a). Impacts to these long-term ecosystem research include changes in species numbers and behaviors as a result of this project. Data collected during this time period and potentially after would likely need to account for human-induced impacts. Studies cited throughout Section 5.3 highlighted the lack of information regarding human-induced impacts to Antarctic species. This project would provide a valuable opportunity to collect this information in order to better inform future impact analysis.

Other scientific research projects currently underway at Palmer Station that will be impacted include data and samples for seismology and air sampling projects. Thirteen research projects (including LTER) will experience a deferral of work as a result of pier construction activities (J. Johnson personal communication). Remote weather systems, tide gauge, and waterwall datasets at Palmer Station will be interrupted by pier construction (J. Johnson personal communication).

5.4 CUMULATIVE IMPACTS

The cumulative impacts analysis must consider not only the impacts and effects from the proposed activity, but also from the effects and impacts of past, present, and future actions in the region. In order to fully evaluate the cumulative effects, three factors were considered:

- Temporal and/or spatial overlap with other activities that might result in impacts
- Likely pathways or processes of accumulation for assessed impacts
- Effects that may result from proposed activity that may contribute to cumulative impacts

Past projects include the development of Palmer Station, which began in the 1960s with the construction of the pier, the BioLab, and the GWR. Additional structures and facilities were constructed in the following decades with the boat ramp, which was built in 2013, being the most recent significant construction project (NSF 2016). These past development projects at Palmer Station have had long-term, direct impacts to the environment such as loss of vegetation and habitat. When considered with the current project, minor, cumulative impacts associated with the loss of terrestrial and aquatic habitats may occur, but none are anticipated to exceed the threshold of significance.

Three current projects and activities in the vicinity of Palmer Station were identified and determined to not contribute to the cumulative impacts. **Table 5-2** identifies each project or activity and provides an explanation of the cumulative impacts determination.

TABLE 5-2: CURRENT PROJECTS AND ACTIVITIES NEAR PALMER STATION[a]

Project/Activity	Cumulative Impacts Determination
Commercial Fishing	Palmer Station is located within the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) Management Area 48.1, which had a total krill catch of 155,907 tonnes (171,858 tons) in 2019 (Meyer et al. 2020). Based on a large-scale krill biomass survey conducted in 2019, which estimated a krill biomass of 60 million tonnes (66.1 million tons), commercial fishing has a minimal impact on krill populations and is unlikely to have a direct impact on cumulative impacts to marine species (Meyer et al. 2020). Any other impacts, such as noise or air emissions, are anticipated to be short-term and transitory.
Palmer LTER	Impacts from the current Palmer LTER are largely short-term and localized. The Palmer LTER is unlikely to contribute to the cumulative impacts, though the pier construction would have a direct impact on research (**Section 5.1.4.1**).
Tourism	Cruise ships and yachts currently operate in the Palmer Basin, though visits to Palmer Station are limited by NSF (**Section 4.2**). Ships may contribute to short-term, transitory impacts in Arthur Harbor and the Palmer Basin, but are not anticipated to directly contribute to cumulative impacts at Palmer Station.

a Includes Arthur Harbor, Hero Inlet, and the Palmer Basin.

In 2016, NSF published the Palmer Station Master Plan, which provides an overview of potential future development aimed at maintaining a facility capable of supporting scientific research for the foreseeable future. Potential development projects included in the master plan are listed in **Table 5-2** and may be amended or altered based on available funding or the needs of USAP (NSF 2016). Specific projects in the master plan were divided into a total of nine development phases, which would help preserve the functionality of Palmer Station during redevelopment. Select structures and utilities slated for demolition would be preserved until their replacement structures have been constructed while other structures may remain onsite and be repurposed. Construction of a new pier, which is a Phase 1 activity and the subject of this IEE, would help improve the safety and efficiency of future station construction projects (NSF 2016), making future development more feasible.

TABLE 5-3: POTENTIAL FUTURE DEVELOPMENT AT PALMER STATION

Development Phase [a]	Action	Facility
Phase 1	Build	Palmer Pier
	Relocate	Storage containers
Phase 2	Build	New fuel tanks
		Fuel distribution network
Phase 3	Demolish	Fuel tanks and associated Pump House
Phase 4	Build	Hazardous waste processing
		Hazardous waste storage
		Power plant/garage
		Water treatment
		Wastewater treatment
		Water tank
		Seawater intake
		Utility distribution network between new buildings and GWR
Phase 5	Demolish	First floor GWR
	Build	New lodging building
	Extend	Utilities to lodging
Phase 6	Relocate	Aquariums GWR first floor
		Provide temporary utilities
Phase 7	Demolish	Aquarium
		Carpentry shop
Phase 8	Build	Central services/labs
		Boathouse
		Permanent utilities
Phase 9	Renovate	GWR
	Demolish	BioLab and associated shipping containers
		Existing Boathouse

a Source: The Palmer Station Master Plan (NSF 2016).

The proposed activity was considered with the projects listed in the master plan to determine the potential for cumulative impacts. Unless specifically stated in the analysis below, past and current projects when considered together with the proposed project are not anticipated to contribute to cumulative impacts in the following categories:

- **Topography/Hydrography**: Multiple phases of the future development listed in the master plan would result in topographic changes due to activities such as grading. Cumulative impacts to the topography are expected to be minimal since any topographic changes would likely be limited to the current boundaries of Palmer Station and involve areas of prior disturbance. Phase 4, which includes construction of a new seawater intake, may result in hydrography changes. The excavation area for a new seawater intake is likely to be small and cumulative impacts to hydrography are expected to be minimal.

- **Marine Water Quality**: Future development projects are primarily surface projects, which have the potential to impact water quality through surface runoff or spills. Impacts to marine water quality during pier construction are likely to be short-term, though a spill could potentially result in impacts that are longer lasting. If BMPs are utilized to minimize the risk of spills or runoff during pier construction and future projects, cumulative impacts are unlikely. The installation of a seawater intake in Phase 4 would likely impact water quality during construction but would likely be short-term and not contribute to cumulative impacts. Construction of a wastewater treatment facility, which is listed as a potential Phase 4 project, would likely be designed to separate solids from the waste stream and deactivate organics, which would be an improvement over the current maceration-only wastewater treatment system and likely result in an improvement in the water quality of the surrounding marine environment (NSF 2016).
- **Air Emissions**: Most future development in the master plan would result in air emissions due to either fugitive dust emissions from construction activities or from emissions from non-road vehicles such as graders or excavators. Air emissions from future construction projects would be short-term in nature and limited to the duration of individual projects. Cumulative air emission impacts are not anticipated.
- **Wastewater**: Any wastewater impacts associated with pier construction and installation of a new wastewater outfall are anticipated to be short-term in nature. Any wastewater impacts are likely to resolve prior to future development and cumulative wastewater impacts are not anticipated.
- **Noise/Acoustic Releases**: Noise releases for pier construction and future development projects are likely to be limited to the duration of the project. No cumulative noise impacts are anticipated.
- **Non-Native Species**: The introduction of construction personnel or equipment carries the risk of introducing non-native species to the area. If a non-native species were introduced to the site, it could have long-term consequences that would be compounded if additional non-native species were introduced during future development. As discussed in **Section 5.1.2.4**, measures would be taken to minimize the risk of introducing non-native species during pier construction. With proper adherence to mitigation measures during pier construction and future development, the probability of introducing non-native species to the region is relatively low and cumulative impacts are unlikely to occur.
- **Solid Waste**: Solid waste produced during the construction of the new pier would be properly stored in containers and returned to the barge. Materials recovered during demolition would be either loaded on to the barge for eventual disposal or reused. Future development would also produce solid waste, especially during demolition activities, which would have to be disposed of properly. Negative cumulative impacts are not anticipated to occur for solid waste that is removed from the site and shipped for proper disposal elsewhere.
- **Accidental Releases**: Phase 2 includes building new fuel tanks and a fuel distribution network and Phase 3 includes demolishing the old fuel tanks and associated pump house. Impacts from these activities would revolve around the potential for spills and releases associated with fuel storage and delivery. If any substance were to be released to the environment, the effects could be long-lasting. Cumulative impacts are possible if there were accidental releases of substances into the environment from the pier construction project or future development projects, but the risk can be effectively managed through the use of BMPs.
- **Marine Mammals**: Impacts to marine mammals would primarily result from noise-generating activities which are expected to be short-term and mostly limited to the duration of the project. Current/ongoing projects including commercial fishing, research activities, and tourism may also have the potential to impact marine mammals either directly or indirectly should prey availability or habitat be affected. The majority of potential development projects listed in the master plan are surface projects that are unlikely to have a direct impact on marine mammals. Although unavoidable take of marine mammals is anticipated (as authorized by the IHA), the takes requested for this project would result in no more than a negligible impact to any of the marine mammal species that may be taken. Cumulative impacts are possible depending on the timing, duration, and extent of the activities listed in **Table 5-2** if any unanticipated long-term impacts are incurred by the project.

- **Marine Species**: The majority of potential development projects listed in the master plan are surface projects that are unlikely to have a direct impact on marine species. Phase 4 includes construction of a new seawater intake, which would likely result in site-specific impacts to marine species, including possible displacement of benthic communities. The seawater intake is unlikely to be located near the wastewater outfall that is being constructed as part of the proposed activity and cumulative impacts are not anticipated.
- **Birds**: During pier construction, as well as future development phases, impacts to bird species would mostly result from noise generation, which is expected to be short-term and mostly limited to the duration of the project. While noise impacts to bird species may resolve prior to the next development phase, some bird species may be susceptible to long-term impacts stemming from back-to-back construction seasons. Cumulative impacts are possible depending on the timing and/or duration of future development phases.
- **Flora**: Construction of the new pier is anticipated to result in minimal, short-term impacts to flora, with impacted populations expected to recover. Potential future development at Palmer Station is likely to result in flora impacts, including construction of new structures that may cause long-term impacts. It is expected that flora populations impacted during pier construction would recover following completion of the project. If disturbances continued to happen on a seasonal basis, the opportunity for recovery for each species may be compromised.
- **Station Function and Access**: As is the case with the current project, future development of Palmer Station is likely to result in short-term reductions in station function and access during construction. Any reductions in station function and access would be limited to the duration of the development/project phase and no cumulative impact is anticipated. Upon completion, construction of the pier and additional future development is likely to have a positive, cumulative impact as Palmer Station is redeveloped to meet the current and future needs of USAP.
- **Visual Disturbances**: Pier construction is anticipated to result in minor, long-term changes to the visual characteristics in the area due to a larger pier size and removal of bedrock outcrops. Proposed future development phases would contribute additional impacts to the visual characteristics at Palmer Station when select structures are demolished, relocated, or consolidated and new ones are constructed, resulting in over positive, long-term, cumulative impacts due to an improvement in the visual environment.

5.5 IMPACT SUMMARY

The findings of this IEE indicate that the activities associated with the proposed activity to reconstruct the pier at Palmer Station would result in no more than minor or transitory environmental impacts. See **Table 5-4** for a summary of the impacts described in **Sections 5.3 and 5.4**.

Notable potential impacts are

- introduction of non-native species,
- disturbance to marine mammals and birds from underwater noise,
- disturbance to bird species from construction noise,
- loss of marine benthic habitat, and
- pollution from accidental releases (including fuel and/or sewage).

The introduction of non-native species and marine pollution from oil spills, while potentially significant in nature, can be almost eliminated as a possibility if the Contractor follows BMPs and the guidelines identified in **Sections 5.1.2.4** and **5.1.2.6**. Noise impacts, while far reaching, are not expected to result in permanent impacts. The impacts to the benthic community around the existing pier and associated structures such as the boat ramp and sewer outfall, while potentially more than minor or transitory, are expected to be short-term since it is anticipated that the new structures would be colonized. Therefore, this impact is considered no more than minor or transitory.

TABLE 5-4: IMPACT SUMMARY TABLE

Activity	Action	Environmental Aspect	Environmental Impact	Impact Type	Duration[a]	Extent[b]	Intensity[c]	Probability[d]	Reversibility/Resilience[e]	Significance[f]	Mitigation
Temporary crane assembly pad construction	Fill below water surface	Marine water quality	Increased turbidity from deposition of fill	Direct Indirect	Long-term	Local	Low	Likely	System likely to recover	1	Coarse material would be used to reduce erosion potential.
		Marine species	Fill material placed over existing benthic communities	Direct Indirect	Long-term	Local	High	Likely	System could recover	2	Coarse material would be used to reduce erosion potential
		Hydrography	Changes to underwater surface elevations and substrate	Direct Indirect	Long-term	Site-specific	Low	Possible	System could recover	2	50% of fill material would be reclaimed for use elsewhere, if possible, or removed from site.
Demolition of existing bulkhead pier	Mechanical excavation	Noise; Marine mammals; Birds	Above and below water noise generation that could impact nearby marine mammals, birds, and personnel at Palmer Station	Direct; Indirect	Short-term	Local	Medium	Likely	System likely to recover	2	Measures such as soft-start procedures, PSOs, and shutdown zones would be used.
	Vibratory hammer			Direct; Indirect	Short-term	Local	High	Likely	System likely to recover	2	
	Rock chipping			Direct; Indirect	Short-term	Local	Low	Possible	System likely to recover	2	
	Stockpiled material	Solid waste	Potential for environmental release while stockpiled	Direct; Indirect	Short-term	Site-specific	Low	Unlikely	Full recovery possible	1	Proper BMPs would be utilized to secure stockpiles until reuse on-site or shipment off-site.
	Sheet pile removal	Noise; Marine mammals; Birds	Noise generation	Direct; Indirect	Short-term	Local	Medium	Likely	System likely to recover	2	Measures such as soft-start procedures, PSOs, and shutdown zones would be used.
		Hydrography; Marine species	Change to seafloor composition	Direct; Indirect	Long-term	Site-specific	Low	Likely	System could recover	1	Full removal using vibratory hammer will be attempted first.
	General	Marine species	Loss of benthic community formed on existing pier and associated appurtenances	Direct: Indirect	Long-term	Site-specific	Medium	Likely	System could recover	2	New pier would provide new substrate for colonization.
Upland earthwork	Demolition and grading	Topography; Visual disturbance	Removal of surface bedrock	Direct	Long-term	Site-specific	High	Likely	No recovery likely	1	Limits of excavation would be minimized to the fullest extent practicable.
		Noise; Birds	Noise generation	Direct	Short-term	Local	Medium	Likely	System likely to recover	2	Noise-generating activities may be timed to minimize impacts including 12-hour workdays.
		Marine water quality	Runoff from stockpiles may enter water	Direct	Short-term	Local	Low	Possible	System likely to recover	1	BMPs would be utilized to prevent runoff from stockpiles.
Template piles	Driving	Marine water quality	Increased turbidity	Direct	Short-term	Local	Low	Likely	System likely to recover	1	No mitigation suggested at this time.

Activity	Action	Environmental Aspect	Environmental Impact	Impact Type	Duration[a]	Extent[b]	Intensity[c]	Probability[d]	Reversibility/Resilience[e]	Significance[f]	Mitigation
		Noise; Marine mammals; Birds	Noise generation	Direct	Short-term	Local	High	Likely	System likely to recover	2	Measures such as soft-start procedures, PSOs, and shutdown zones would be used.
Template piles	Removal	Marine species; Hydrography	Change to seafloor composition	Direct Indirect	Long-term	Site-specific	Low	Possible	System could recover	1	Full removal using vibratory hammer will be attempted first.
Permanent piles	Rock chipping	Noise; Marine mammals; Birds	Noise generation	Direct	Short-term	Local	Medium	Likely	System likely to recover	2	Measures such as soft-start procedures, PSOs, and shutdown zones would be used.
	Driving	Noise; Marine mammals; Birds	Noise generation	Direct	Short-term	Local	High	Likely	System likely to recover	2	Measures such as soft-start procedures, PSOs, and shutdown zones would be used.
		Marine water quality	Release of process wastewater	Direct	Short-term	Local	Medium	Likely	System likely to recover	1	Only potable water would be used.
	General	Marine water quality; Marine species	Increased turbidity during installation	Direct	Short-term	Local	Low	Likely	System likely to recover	1	Process water and drill fluids would be discharged to water. No hazardous materials would be discharged.
Anodes	Installation	Marine mammals; Birds; Noise	Underwater noise generation	Direct	Short-term	Local	Medium	Possible	System likely to recover	1	Measures such as soft-start procedures, PSOs, and shutdown zones would be used.
Retaining wall and pier abutment	Bedrock excavation	Noise; Birds	Noise generation	Direct	Short-term	Local	Medium	Likely	System likely to recover	2	Noise-generating activities may be timed to minimize impacts including 12-hour workdays.
		Topography; Visual disturbance	Change in topography and visual characteristics	Direct	Long-term	Site-specific	Low	Likely	No recovery likely	1	Limits of excavation would be minimized to the fullest extent practicable.
	Riprap armor	Hydrography; Marine species	Change in seafloor composition	Direct	Long-term	Site-specific	Medium	Likely	System could recover	2	Coarse material would be used to reduce erosion potential
Concrete Panels and Pile caps	Cutting and chipping	Air emissions	Fugitive dust emissions	Direct	Short-term	local	Low	Possible	Full recovery possible	1	Wet cutting techniques would be used.
Pier	General	Visual disturbance	Change in visual characteristic	Direct	Long-term	Site-specific	Low	Likely	System not likely to recover	1	The new pier would alter and minimally expand the developed footprint of the station.
	Grout mixing and rock cutting	Air emissions	Fugitive dust emissions	Direct	Short-term	Local	Low	Possible	Full recovery possible	1	Wet cutting techniques would be used.
	Grouting of concrete panels	Accidental releases	Potential to release grout into the environment	Direct	Short-term[g]	Local	Low	Possible	System likely to recover	1	BMPs would be utilized to prevent accidental releases and only pre-approved materials would be used.

Activity	Action	Environmental Aspect	Environmental Impact	Impact Type	Duration[a]	Extent[b]	Intensity[c]	Probability[d]	Reversibility/Resilience[e]	Significance[f]	Mitigation
Sewer line	Mechanical excavation	Noise; Birds	Noise generation	Direct	Short-term	Local	Medium	Likely	System likely to recover	2	Noise-generating activities may be timed to minimize impacts including 12-hour workdays.
		Topography; Visual disturbance	Removal of surface bedrock	Direct	Long-term	Site-specific	Low	Likely	No recovery likely	2	Limits of excavation would be minimized to the fullest extent practicable.
Sewer line	High expansion grout	Accidental releases	Potential release of grout into environment	Direct Indirect	Short-term[g]	Local	Low	Possible	System likely to recover	1	BMPs would be utilized to prevent accidental releases and only pre-approved materials would be used.
		Noise; Birds	Noise generation	Direct	Short-term	Local	Low	Possible	System likely to recover	2	Noise-generating activities may be timed to minimize impacts; 12-hour workdays.
	Temporary bypass and new line installation	Accidental release	Potential release of wastewater	Direct Indirect	Short-term	Local	Low	Unlikely	System likely to recover	1	Proper installation techniques and monitoring would limit opportunities and extent of potential spills.
Construction personnel	General	Non-native species	Introduction of non-native species	Direct Indirect	Short-term[g]	Local	Low	Unlikely	System could recover	2	Personnel would receive training and would be required to clean and inspect gear/belongings prior to travel to Antarctica.
		Wastewater	Barge and tug wastewater	Direct Indirect	Short-term	Local	Low	Unlikely	System likely to recover	1	Wastewater would not be discharged within 12 nmi of land.
		Terrestrial flora and fauna; Birds	Interference with native species	Direct	Short-term	Local	Low	Unlikely	Full recovery possible	1	Personnel would receive training to prevent harassment or interference with native species, access to restricted zones would be prohibited, and staff escort would be used when access to vegetated areas is needed.
Construction equipment	General	Station function; Scientific research	Reduction in station function and limited scientific personnel on-site	Direct; Indirect	Short-term	Site-specific	Low	Likely	Full recovery possible	1	Research to be performed from research vessels.

Activity	Action	Environmental Aspect	Environmental Impact	Impact Type	Duration[a]	Extent[b]	Intensity[c]	Probability[d]	Reversibility/Resilience[e]	Significance[f]	Mitigation
	Routine maintenance & refueling	Accidental releases	Potential release of oils and lubricants	Direct Indirect	Short-term[g]	Local	Low	Unlikely	System could recover	1	BMPs for proper maintenance including spill response supplies and secondary containment. No work would be conducted from barge during major fueling events.
	Normal operations	Air emissions	Emissions from construction equipment	Direct	Short-term	Local	Low	Likely	System likely to recover	1	BMPs for proper maintenance of construction equipment to reduce emissions.
		Visual disturbance	Construction equipment on-site	Direct	Short-term	Site-specific	Low	Certain	Full recovery possible	1	Unavoidable temporary impact.
		Solid waste	Increased production of waste from construction	Direct	Short-term	Site-specific	Low	Unlikely	Full recovery possible	1	All waste would be transported off-site by barge at the end of construction.
Construction equipment	Normal operations	Accidental releases	Potential release of oils and lubricants	Direct Indirect	Short-term[g]	local	Low	Unlikely	System could recover	2	Banned substances would not be transported to Palmer station. BMPs would be utilized during construction to prevent releases of allowed substances.
		Non-native species	Introduction of non-native species	Direct Indirect	Short-term[h]	Regional	Low	Unlikely	System could recover	2	Contractor would verify that no non-native soils, plants, or animals are included in any shipped equipment and materials.
		Noise	Noise impacts to humans and birds	Direct	Short-term	Site-specific	Medium	Possible	System could recover	1	PPE to be worn by personnel at Station; 12-hour workdays.

a Short-term = Length of construction to 1 year; Long-term = Greater than 1 year
b Site-specific = Project area; Local = Larger than project area but less than 10 km; Regional = Greater than 10 km
c Low, Medium, or High
d Certain, Likely, Possible, Unlikely, or Uncertain
e No recovery likely, System could recover, System likely to recover, Full recovery possible
f 1 = Less than a minor or transitory impact; 2 = No more than a minor or transitory impact; 3 = More than a minor or transitory impact
g Although the potential for accidental releases associated with construction would exist only for a short period of time, the overall effect of any releases could be felt much longer
h Although the potential for introducing non-native species would exist only for a short period of time, the overall effect of any introduction could be felt much longer

5.6 ENVIRONMENTAL MONITORING PLAN

Environmental monitoring is critical in ensuring that anticipated impacts resulting from the proposed activity are in alignment with the findings of the IEE. The Protocol requires appropriate monitoring of key environmental indicators. As a result, USAP has developed a monitoring program for this project that follows guidance in the *Antarctic Environmental Monitoring Handbook: Standard techniques for monitoring in Antarctica* (COMNAP and SCAR 2000) and the *Practical Guidelines for Developing and Designing Environmental Monitoring Programmes in Antarctica* (COMNAP 2005).

This section details recommended monitoring and management practices for potential impacts identified in **Section 5.5**. The Palmer Station Manager (the designated responsible environmental position) would designate one (or multiple) Station staff to document general site conditions, the presence of certain species, and other information as outlined below. The staff would be familiar with this monitoring plan, the proposed activity and project area, as well as any identified sensitive or protected areas. Efforts to maintain consistency in observation locations and daily routines is expected.

- **Introduction of Non-Native Species**: The introduction of non-native species into Antarctica poses a major threat to local ecosystems and native species. Guidelines and resources have been developed to prevent introduction as well as handling, removal, and management of non-native species (if identified; ATS 2019b). The Contractor would have primary responsibility for ensuring that all procured materials, including fill/gravel, are free of non-native species. All cargo, construction equipment, gear, clothing, and personal equipment would be checked for the presence of non-native species and organic matter (e.g., soil) before shipping and before loading on to shipping vessels as well as before mobilizing to Palmer Station (**Section 5.3.2.4**). Any observation or indication of the presence of non-native species would be reported to the Station Manager and ASC Environmental immediately.
- **Disturbance to Marine Mammals from Construction Noise**: Temporary disturbances to marine mammals from underwater noise associated with construction (pile installation) is anticipated. Due to this unavoidable impact, an IHA application has been submitted to NOAA/NMFS for incidental take. The IHA would have specific monitoring protocols for PSOs during in-water noise generating activities. The PSOs are responsible for monitoring the appropriate observation and shutdown zones, documenting takes (marine mammal presence within the observation zones) and coordinating construction shutdowns with the site superintendent should a marine mammal enter the shutdown zone. These specific monitoring and mitigation requirements are summarized in **Section 5.3.3.1** and detailed in **Appendix B**. In addition to IHA-required monitoring, documentation, and reporting, the designated Palmer Station staff would also be required to independently look for marine mammals in the general project vicinity. Sighting details (species, location, number, sex, behavior, etc.) would be recorded similar to previous observation data. The intent of this monitoring effort is to ensure that marine mammal observations are being conducted throughout project construction regardless of whether pile installation and other in-water noise generating activities are occurring. Marine mammal observations would continue for one year beyond construction completion to identify potential changes in species occurrence. Results of these continued observations would be evaluated after one year to determine whether they should be continued and for what duration.
- **Disturbance to Bird Species from Construction Noise:** Temporary impacts to bird behavior or avoidance of the project area may occur in response to increased noise levels during construction (including increased activity during mobilization/demobilization). Based on previous bird observations, it is recommended that designated Palmer Station staff observe bird species for six minutes, three times per day as part of wildlife monitoring. Sighting details (species, location, number, behavior, reactions, etc.) would be recorded. Bird species observations would be documented from a consistent location based on daily conditions. Information on the types of species known to occur in the project area are included in **Section 4.6.3** It is necessary that this monitoring effort be continued

after construction is complete to help identify potential patterns and/or effects to bird presence and activity in the general project vicinity as a result of the project or other environmental conditions. Feedback would be solicited from the scientific community regarding the extent of monitoring for bird presence and activity. Any evidence of disturbance or injury would be reported to the Palmer Station Manager immediately. In addition to observations by Station staff, the PSO is also required to monitor the area for penguins as well as marine mammals and initiate shut down procedures should a penguin be observed within the shutdown zone.

- **Loss of Marine Benthic Habitat:** Areas of excavation, fill, and pile installation may result in temporary and/or permanent loss of marine benthic habitat. Long-term effects may be expected locally but are not anticipated given the general abundance of adjacent, quality habitat. The relocation of the sewer outfall may also create a change in the location of desirable benthic habitat. It is not practicable to conduct regular underwater assessments during construction. A pre-construction underwater assessment of the benthic environment within the project area would be conducted prior to construction. A follow-up assessment would be conducted after construction is complete. An evaluation of the changes to the underwater environment and available benthic habitat would determine if continued monitoring is needed.
- **Pollution from Spills**: Although this assessment has identified fuel and sewage as the most likely sources of pollution, spills could involve any designated pollutant (fuel, oil, glycol, lab chemicals, or sewage). Immediate and effective responses to spills is critical in avoiding and/or minimizing impacts to the environment. USAP has developed spill reporting and response procedures and the Contractor has a project-specific spill response plan in place. Visual and olfactory indicators of a spill may include sheen, odor, improperly disposed of containers (fuel, oil, etc.), soil staining or discoloration, and misplaced debris. Any indication of a release would be reported immediately to the Palmer Station Manager to identify the source and appropriate cleanup response.
- **Vegetation**: Although the immediate vicinity surrounding Palmer Station is heavily disturbed and primarily consists of gravel that is devoid of vegetation, some species of moss and lichen occur on the distal end of Gamage Point. The Station staff would scan the project area (including Gamage Point, if accessible) for vegetation and note the location, type, and condition (if found). Monitoring the condition of the vegetation and any potential impacts would be a responsibility of the designated Palmer Station staff. Reference photos of the vegetation would be taken monthly, beginning prior to construction. The Palmer Station Manager and ASC Environmental would be notified immediately if damage to existing vegetation occurs.

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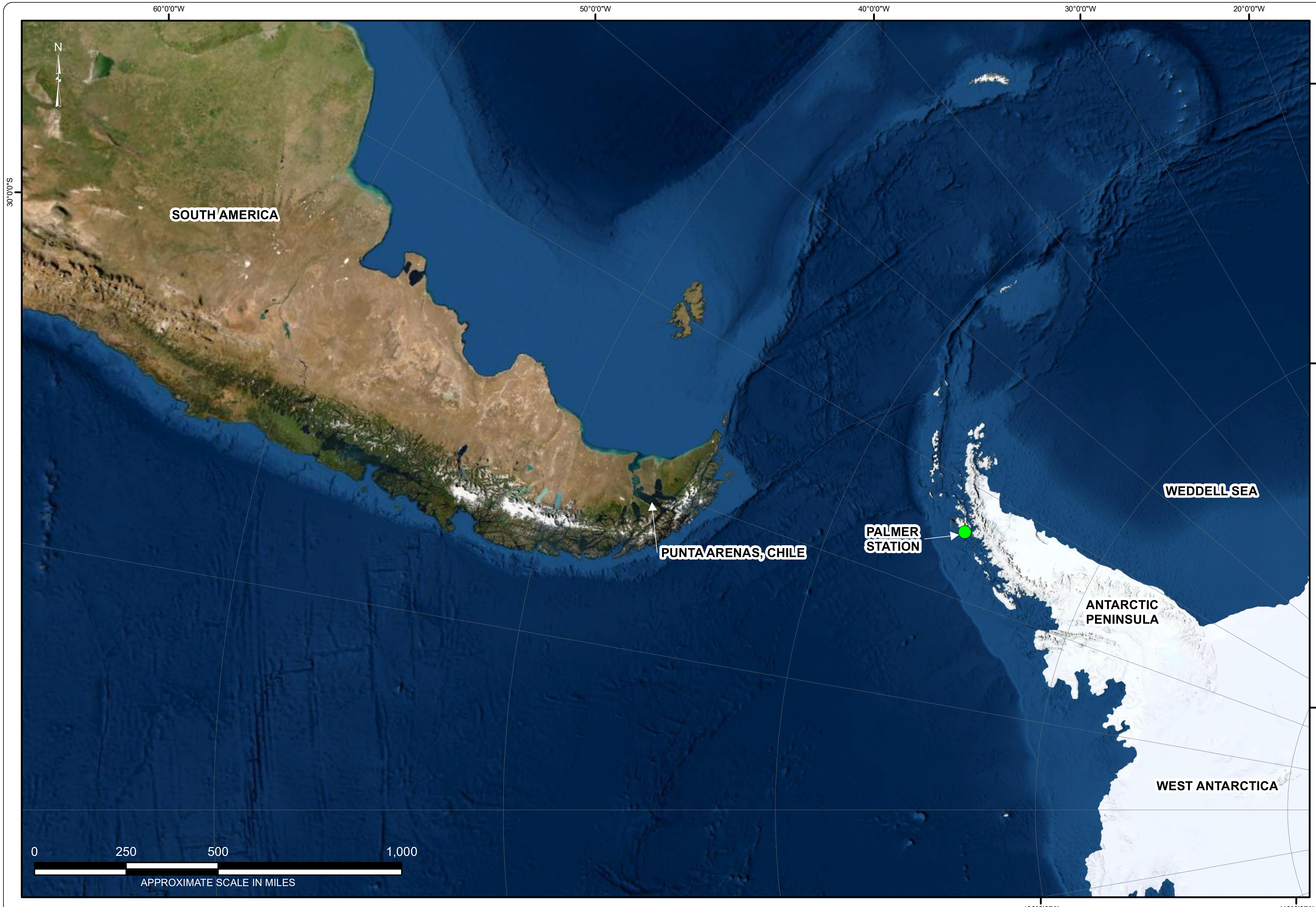
APPENDIX A

FIGURES AND PLAN SHEETS

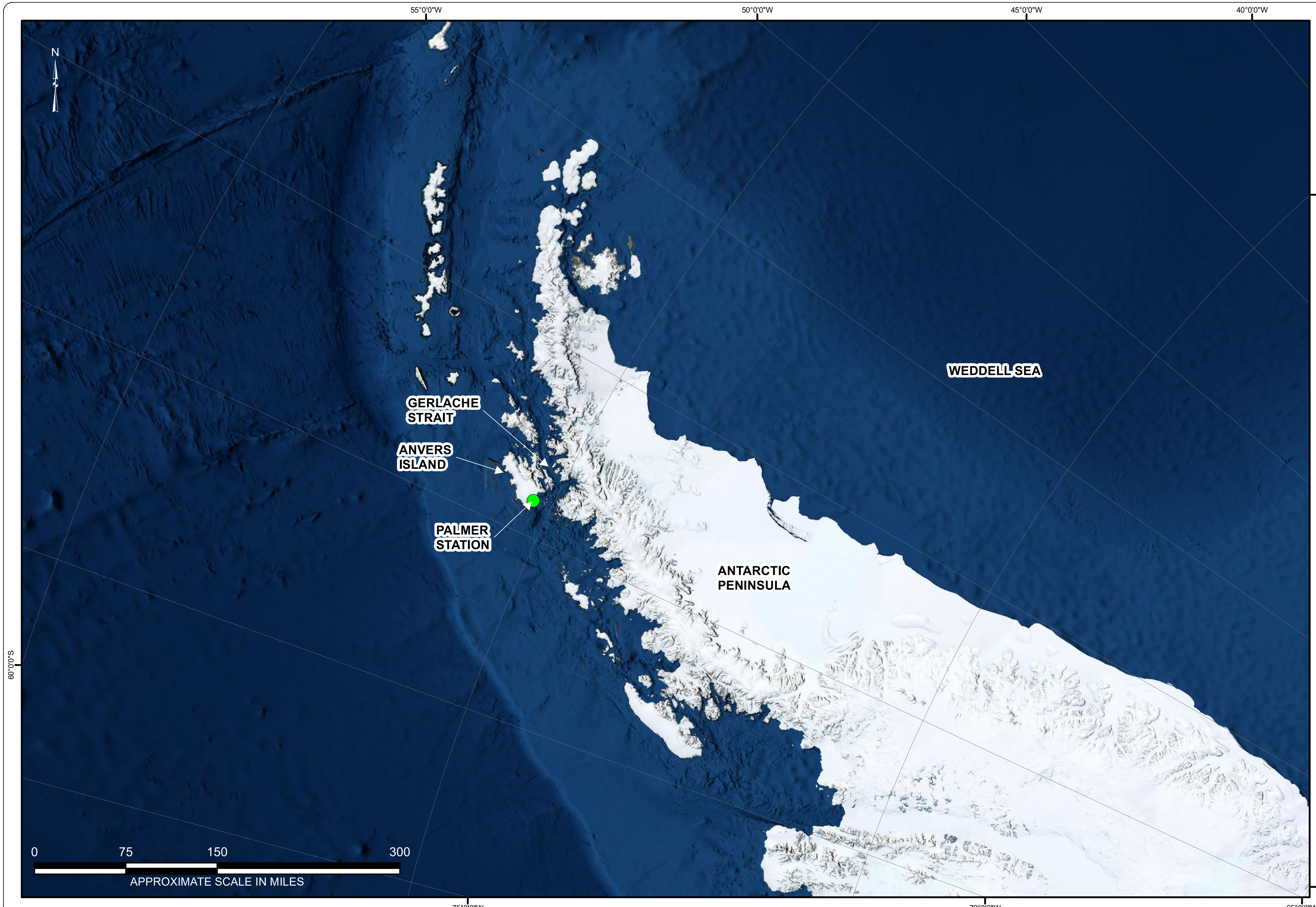


PROJ.NO: 2699.02
DATE: JAN 2021
REF: IEE
FIGURE: A-01

PALMER STATION PIER REPLACEMENT PROJECT
ANTARCTIC SUPPORT CONTRACT

PROJECT VICINITY MAP

R&M CONSULTANTS, INC.



PROJ.NO: 2699.02
DATE: JAN 2021
REF: IEE
FIGURE: A-02

PALMER STATION PIER REPLACEMENT PROJECT
ANTARCTIC SUPPORT CONTRACT

PROJECT REGION MAP

R&M CONSULTANTS, INC.

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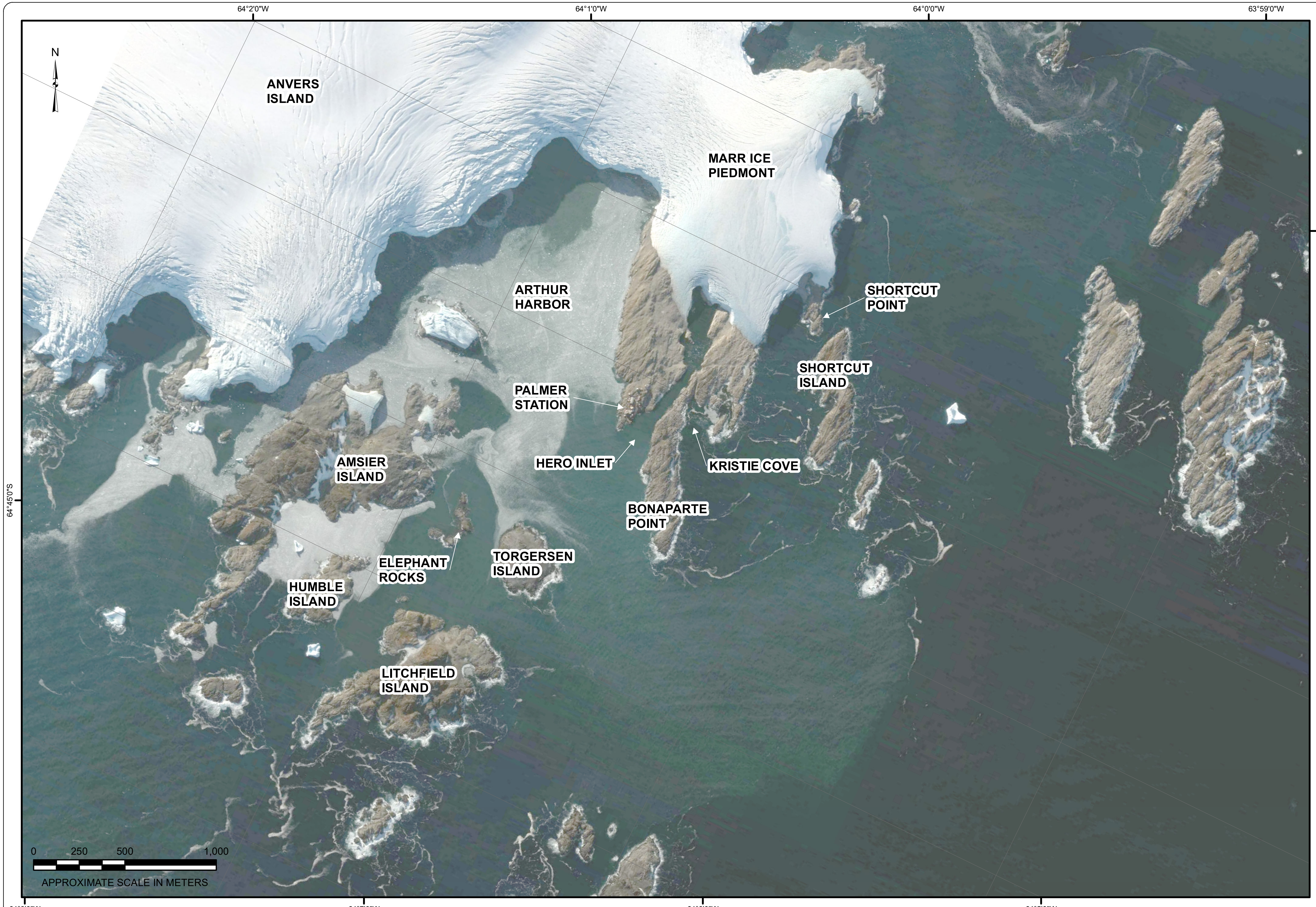

PROJ.NO: 2699.02
DATE: JAN 2021
REF: IEE
FIGURE: A-03

PALMER STATION PIER REPLACEMENT PROJECT
ANTARCTIC SUPPORT CONTRACT

PROJECT AREA MAP

R&M CONSULTANTS, INC.

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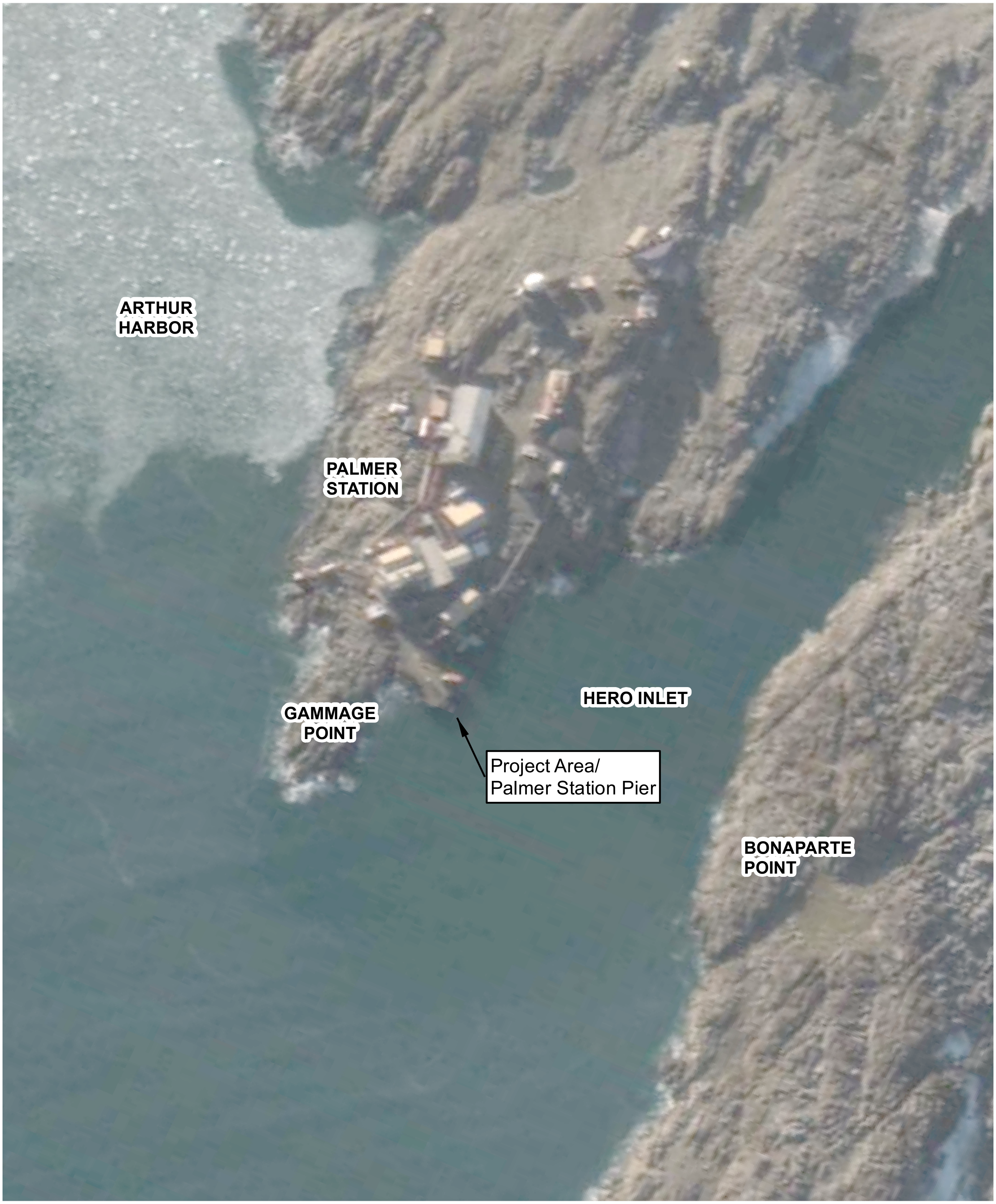


ALL LOCATIONS ARE APPROXIMATE

0 30 60 120

APPROXIMATE SCALE IN METERS

NOTES:
Google Earth Pro, Historical Image, April 2017

N

Date Saved: 1/5/2021 1:21:59 PM by EBetts Z:_GIS\Projects\2699.02 LEIDOS Antarctica PAL Pier Final Design\Map Documents\IEE\Project Area.mxd

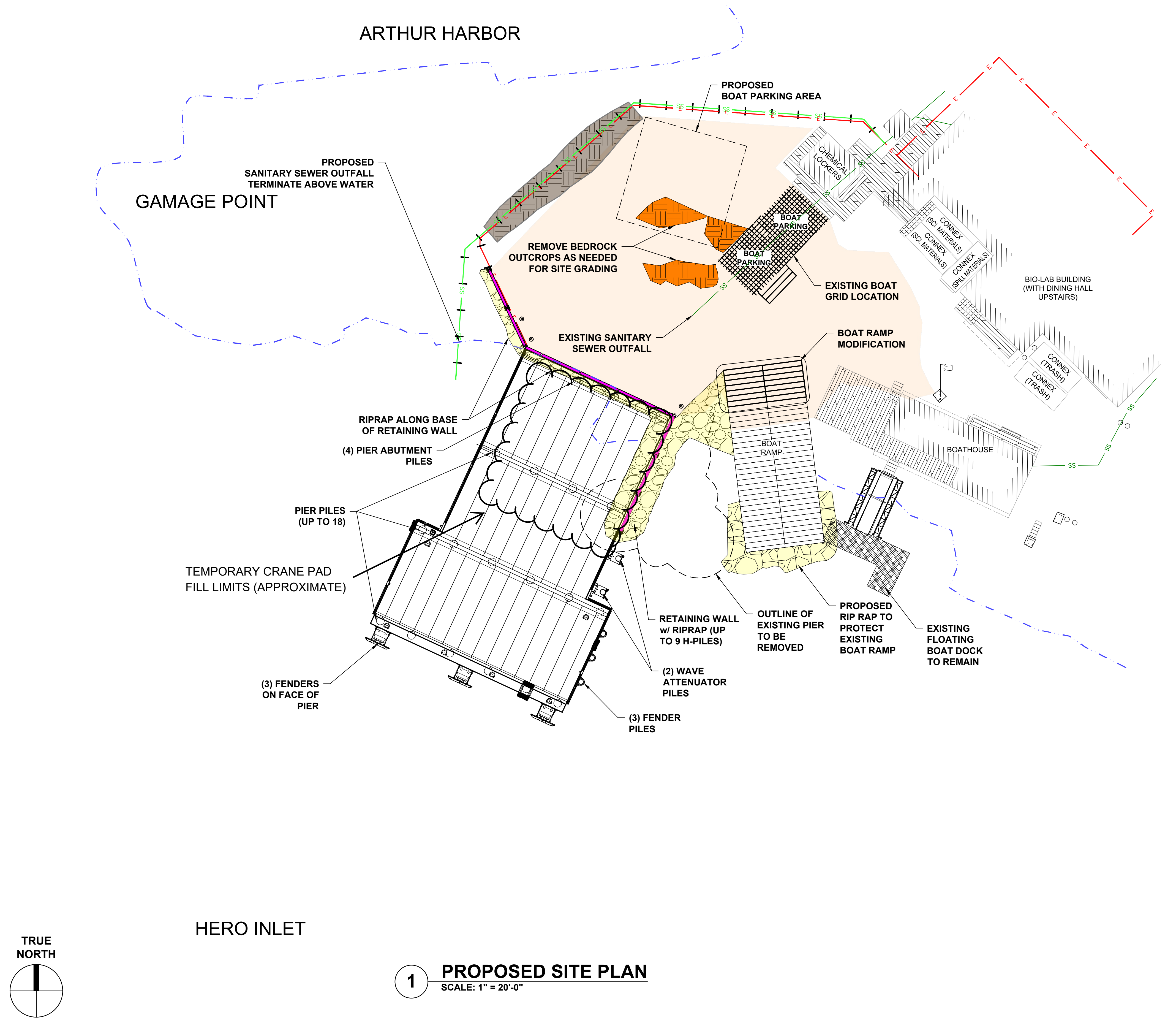
R&M CONSULTANTS, INC.

PALMER STATION PIER REPLACEMENT PROJECT
ANTARCTIC SUPPORT CONTRACT

PROJECT SITE MAP

PROJ.NO:	2699.02
DATE:	JAN 2021
REF:	IEE
FIGURE:	A-04

Plotted: 3/19/2021 10:34 AM by Aldrey Antonio \\rm.rmnet\z\project\2699.02 LEIDOS Antarctica PAL Pier Final Design\Earth\ACAD\ES-101 - AA [Enviro Figure].dwg



1 PROPOSED SITE PLAN

SCALE: 1" = 20'-0"

LEGEND:

DESCRIPTION	PROPOSED	EXISTING
ELECTRICAL LINE	E	
SEWER LINE	SS	SS
SHORELINE		
RESURFACED AREA (INCLUDES FILL AND GRADING)		
BEDROCK OUTCROPS		
SEWER LINE BEDROCK TRENCHING		
RIP RAP PROTECTION		
RETAINING WALL		

0 20 40 FEET

INCHES 1 2
CENTIMETERS 1 2 3 4 5 6

NATIONAL SCIENCE FOUNDATION
OFFICE OF POLAR PROGRAMS WASHINGTON, D.C. NSF CONTRACT OPP. 000373

REVISION LOG

REV.	DATE	DESCRIPTION	DFTG.	APPD.
1	01-22-2021	ISSUED FOR CONSTRUCTION	JC/JMR	JD

PALMER STATION
PALMER PIER REPLACEMENT
CIVIL

ASC ANTARCTIC SUPPORT CONTRACT
7400 South Tucson Way
Centennial, Colorado
80112-3938 USA
303-790-8606
800-688-8606

PROJECT NUMBER: 160704
FILE NAME: ES-101 - AA [ENVIRO FIGURE]
DESIGNED BY: JD/MDA
DRAWN BY: JC/MKA/JMR
DATE CREATED: 01/22/2021
SHEET TITLE: PROPOSED SITE PLAN
SHEET NUMBER: A-05

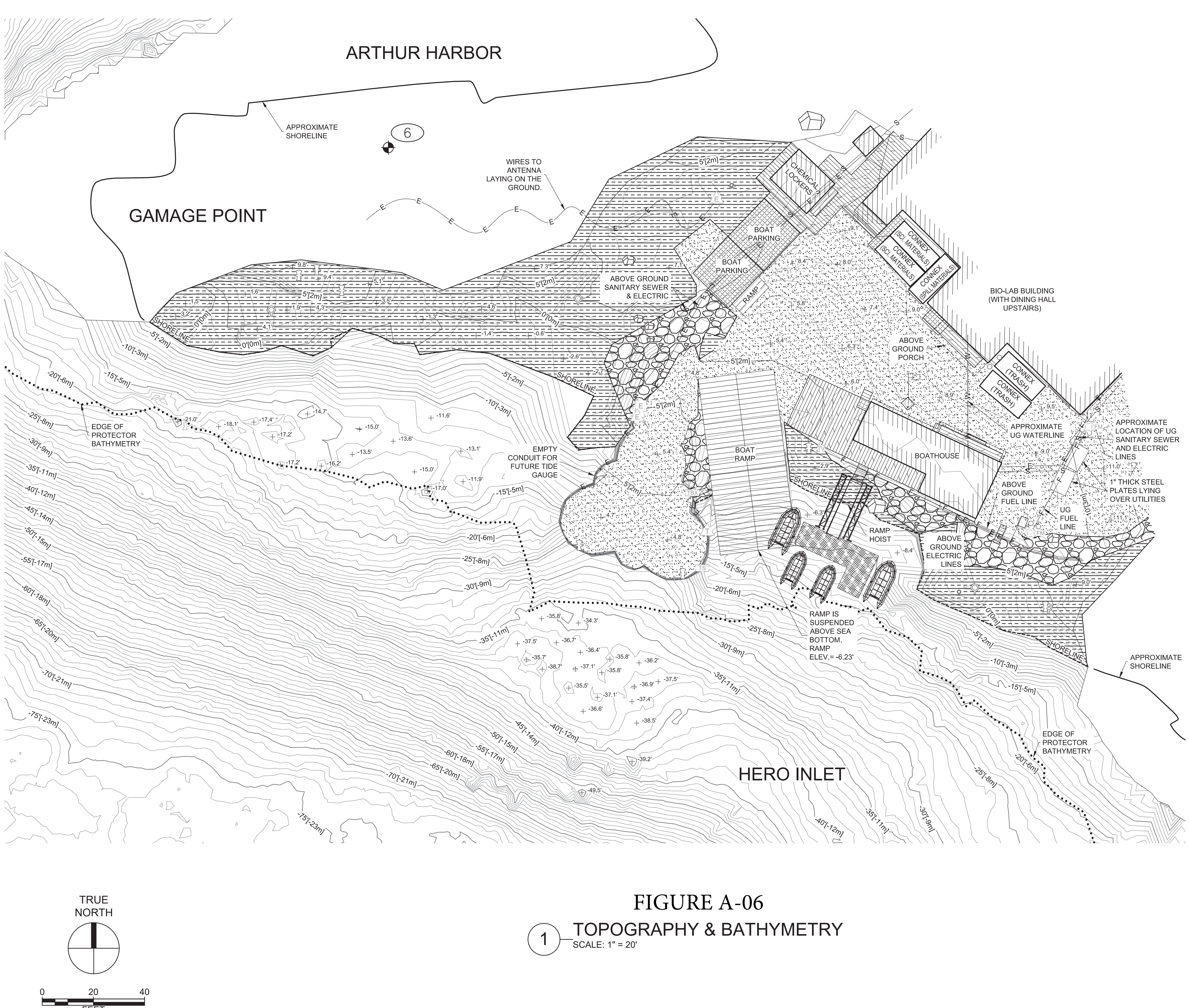


FIGURE A-06

1 TOPOGRAPHY & BATHYMETRY
SCALE: 1" = 20'

GENERAL NOTES:

1. THIS SURVEY WAS PERFORMED BY R&M CONSULTANTS, INC. MARCH 29TH - APRIL 3RD, 2017. THE INTENT OF THIS SURVEY IS TO PROVIDE DATA FOR THE DESIGN OF A NEW PIER FOR DOCKING SUPPLY SHIPS COMING TO PALMER STATION.
2. UPLANDS DATA WAS COLLECTED USING A LEICA 1105+ TOTAL-STATION. SONAR DATA WAS COLLECTED USING A SONARMITE/HYDROLITE-TM CONTROLLED BY TRIMBLE RTK GPS AND MOUNTED ON A ZODIAC INFLATABLE RAFT.
3. DEEP-WATER BATHYMETRY WAS PROVIDED BY THE HMS PROTECTOR SURVEY PERFORMED APRIL 2, 2012. A GAP EXISTED BETWEEN THE SHORELINE AND THE PROTECTOR SURVEY. THE SONAR DATA FOR THIS GAP IS PROVIDED BY R&M. NO PROTECTOR CONTROL POSITIONS WERE PROVIDED. R&M PERFORMED CROSS-SECTIONS THROUGH THE PROTECTOR SURVEY AND ESTABLISHED A VERTICAL SHIFT OF -6.03'. THIS SHIFT WAS APPLIED TO THE PROTECTOR BATHYMETRY. ONCE THIS SHIFT WAS PERFORMED, R&M DATA AND PROTECTOR DATA WERE IN AGREEMENT. THE PROTECTOR SURVEY WAS ACCEPTED AND ONLY R&M SONAR WORK ALONG THE PERIMETER OF THE PROTECTOR SURVEY WERE ADDED.
4. ALL DISTANCES AND ELEVATIONS REPORTED HERE ARE INTERNATIONAL FEET.
5. NO UNDERGROUND UTILITIES WERE LOCATED THIS SURVEY. PALMER STATION PERSONNEL VISITED WITH R&M AND DISCUSSED THE LOCATIONS OF THE UNDERGROUND UTILITIES. THE UNDERGROUND UTILITIES SHOWN HERE ARE DRAWN PER THOSE DISCUSSIONS. DO NOT DIG WITHOUT QUALIFIED PERSONNEL LOCATING UNDERGROUND UTILITIES.
6. REFERENCE PROJECT SURVEY CONTROL PLAN FOR DETAILED DATUM AND CONTROL INFORMATION.

LEGEND

- ELECTRIC BOX
- ELECTRIC SWITCH
- TIDE GAUGE
- TIDE GAUGE CONTROL BOX
- TIDE STAFF
- CAMERA
- FUEL MANHOLE
- HAWSER BOLLARD
- HAWSER RING, 8" DIAM.
- HAWSER RING, 3" OR 4" DIAM.
- UTILITY BOLLARD
- BOULDER, ROUGHLY TO SCALE
- 6 SURVEY CONTROL POINT
- BUILDING HATCH
- GRAVEL HATCH
- BEDROCK HATCH
- RIP RAP HATCH
- CONCRETE HATCH
- WOOD DECKING HATCH
- STEEL GRATE HATCH
- PLASTIC DOCK HATCH

PRELIMINARY DRAWING
FOR REVIEW ONLY - NOT FOR CONSTRUCTION

INCHES 1 2
CENTIMETERS 1 2 3 4 5 6

NATIONAL SCIENCE FOUNDATION
OFFICE OF POLAR PROGRAMS
WASHINGTON, D.C. NSF
CONTRACT OPP. 0000373

REVISION LOG

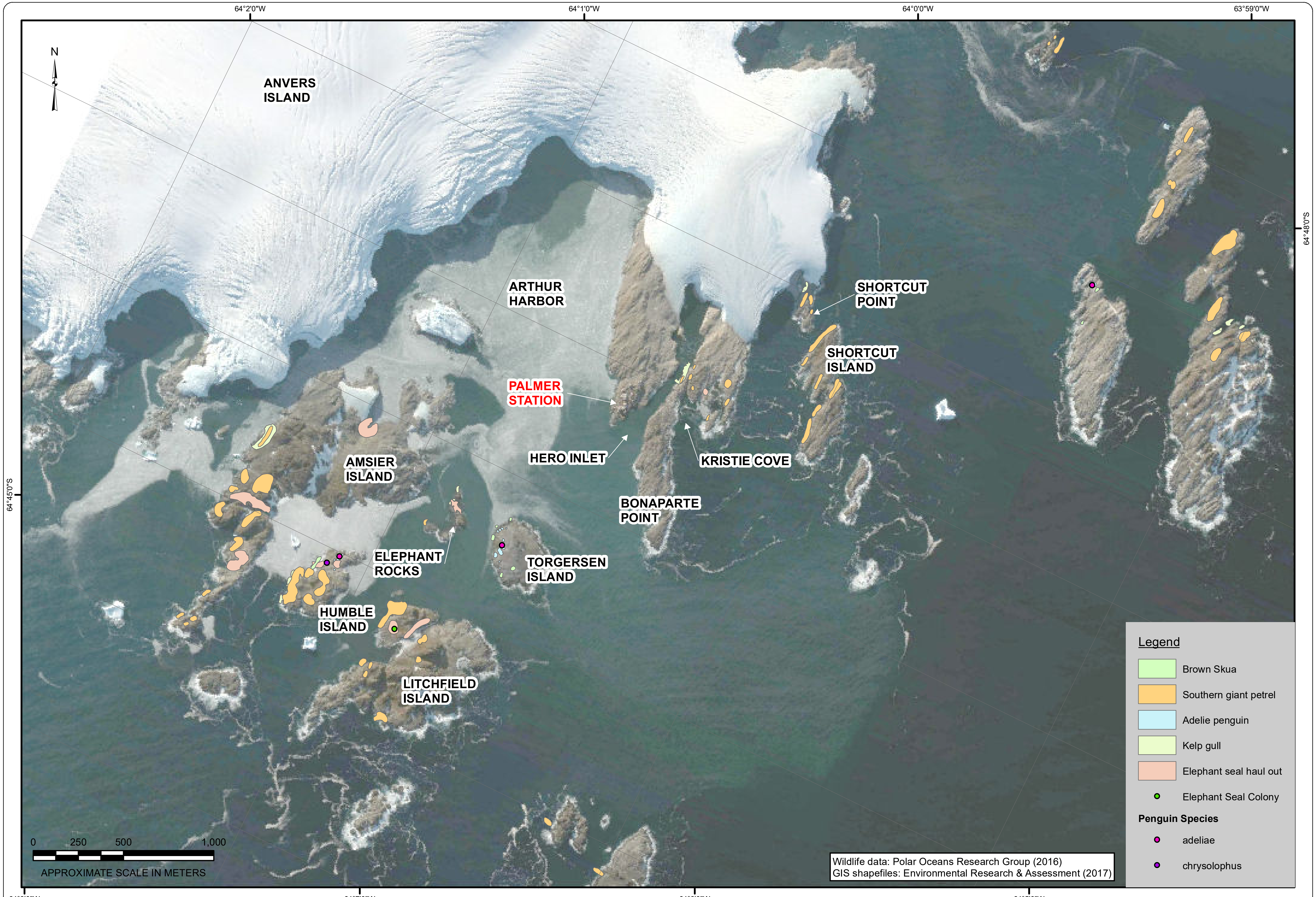
REV.	DATE	DESCRIPTION	DFTG.	APPD.
D	09-11-2020	95% SUBMITTAL	JVC	RHB
C	06-15-2017	FINAL 35% PIER DESIGN	RHB	KN

STATE OF ALASKA 49TH — Randal H. Brinker LS 8652 Registered Professional Land Surveyor

PALMER STATION
PALMER PIER REPLACEMENT
018 PIER
SURVEY/MAPPING

ASC ANTARCTIC SUPPORT CONTRACT
7400 South Tucson Way
Centennial, Colorado
80112-3938 USA
303-790-8606
800-688-8606

PROJECT NUMBER: 160704
FILE NAME: V-102
DESIGNED BY: RHB
DRAWN BY: RHB
DATE CREATED: 06/15/2017
SHEET TITLE: TOPOGRAPHIC & BATHYMETRIC SURVEY
FIGURE NUMBER: A-06



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PROJ.NO: 2699.02
DATE: JUL 2021
REF: IEE
FIGURE: A-07

PALMER STATION PIER REPLACEMENT PROJECT
ANTARCTIC SUPPORT CONTRACT

PROJECT AREA MAP WITH NEARBY BIRD AND MAMMAL AREAS

R&M CONSULTANTS, INC.

Photo 1

Description: Palmer Station

Photo 2

Description: Palmer Station and pier

Photo 3

Description: Palmer Station uplands and boat launch ramp.

Photo 4

Description: Launch ramp with existing pier to the left.

Photo 5

Description: Sheet piles are long structural sections of steel with interlocking edges that are driven into the ground to create a continuous wall.

Photo 6

Description: Waterfront installation of sheetpiles

Photo 7

Description: D4 Dozer

Photo 8

Description: The Hitachi 470 excavator

Photo 9

Description: Bobcat Skidsteer (compact track loader)

Photo 10

Description: Impact hammer (typical)

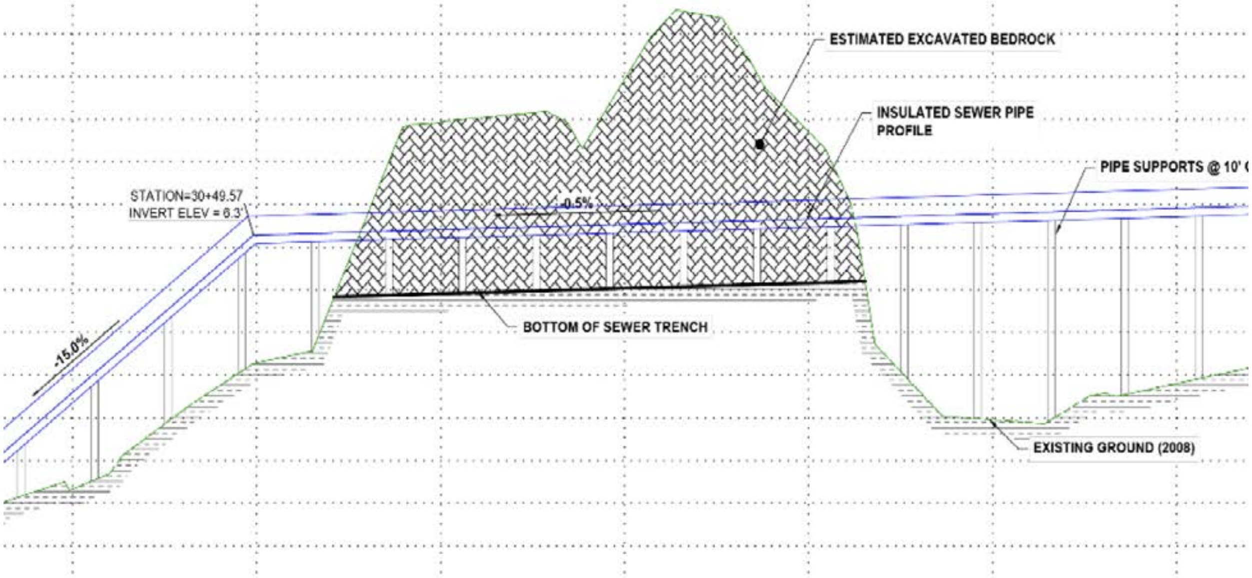
Photo 11

Description: Vibratory hammer

Photo 12

Description: DTH hammer

Photo 13



Description: Sanitary sewer line cross section (proposed)

Photo 14

Description: Existing sanitary sewer outfall

Photo 15

Description: DTH hammer attachments.

APPENDIX B

MARINE MAMMAL ASSESSMENT

Marine Mammal Assessment
Developed for Incidental Harassment Authorization Application and
Initial Environmental Evaluation
Palmer Pier Replacement Project
Prepared by ECO49
August 2021

1 MARINE MAMMALS – EXISTING CONDITIONS

Twelve cetacean and five pinniped species can be found in the Action Area for this Project (Table 1). The Action Area is larger than the project's construction footprint and includes the area in which underwater noise from the project may affect marine mammals. Five of the cetacean species are listed as endangered under the Endangered Species Act (ESA): blue, fin, sei, sperm, and southern right whales. None of the pinnipeds are ESA-listed. Abundances shown in Table 1 are based on a thorough review of the best available information. Data on marine mammal abundance or density in the Antarctic are difficult to obtain given the remote location therefore, some abundance and density estimates have been extrapolated across broad regions. For example, the upper range of the abundance estimate for Antarctic minke whales is for the entire Southern Ocean. In addition, some data are based on deep-basin surveys whereas Hero Inlet would be considered nearshore and shallower. Data sources for abundance estimates are provided in Table 1. Footnotes indicate the area considered for the abundance estimate (i.e., Southern Hemisphere, Antarctic Peninsula, Scotia Sea, etc.). Distribution, life history, and nearshore and offshore densities of each species are discussed in the following subsections. Information provided on potentially affected marine mammal species including abundance and distribution is summarized from Wursig et al. (2018), unless otherwise noted. Tables 2 and 3 summarize observations conducted by staff posted at Palmer Station between 2019 and 2020. Observations taken three times a day for six minutes each. These observations are discussed in applicable species-specific subsections.

Table 1. Abundance and Status of Marine Mammal Species Potentially Present in The Project Area

Common Name	Species	Estimated Abundance: Number	Estimated Abundance: Data Sources	ESA Status[a]	MMPA Status[b]	Frequency of Occurrence in Project Area
Cetaceans						
Antarctic Minke Whale	*Balaenoptera bonaerensis*	7,395[c]	Reilly et al. (2004)	NL	NS	Common Nearshore and Offshore
		360,000-730,000[d]	IWC (2019)			
Arnoux's Beaked Whale	*Berardius arnuxii*	599,300[e]	Kasamatsu and Joyce (1995)	NL	NS	Rare
Blue Whale	*Balaenoptera musculus*	2,300[f]	IWC (2019)	E	D	Rare Offshore
Fin Whale	*Balaenoptera physalus*	38,200[g]	Wursig et al. (2018)	E	D	Nearshore and Offshore
		1,725[h]	NOAA (2015)			
		1,492[c]	Reilly et al. (2004)			
Hourglass Dolphin	*Lagenorhynchus cruciger*	144,300[d]	Kasamatsu and Joyce (1995)	NL	NS	Rare
Humpback Whale	*Megaptera novaeangliae*	6,500[g]	Bettridge et al. (2015)	NL	NS	Common Nearshore
		42,000[h]	NOAA (2015)			
		34,000-52,000[d]	IWC (2019)			
Killer Whale	*Orcinus orca*	50,000[i]	Wursig et al. (2018)	NL	NS	Common
		25,000[j]	Jefferson et al. (2008)			
Long-finned Pilot Whale	*Globicephala melas edwardii*	200,000[k]	NOAA (2018)	NL	NS	Rare Offshore
Southern Bottlenose Whale	*Hyperoodon planifrons*	500,000[j]	Jefferson et al. (2008)	NL	NS	Rare Offshore
Sei Whale	*Balaenoptera borealis*	626[h]	NOAA (2015)	E	D	Uncommon Offshore/ Extralimital
Southern Right Whale	*Eubalaena australis*	43[c]	Reilly et al. (2004)	E	D	Rare
		25-30,000[l]	Wursig et al. (2018)			
		12,000[d]	IWC (2019)			

Common Name	Species	Estimated Abundance		ESA Status[a]	MMPA Status[b]	Frequency of Occurrence in Project Area
		Number	Data Sources			
Sperm Whale	*Physeter macrocephalus*	12,069[h]	NOAA (2015)	E	D	Uncommon Offshore/Extralimital
Pinnipeds						
Antarctic Fur Seal	*Arctocephalus gazella*	21,190[m]	Wursig et al. (2018)	NL	NS	Common
		2,700,000[n]	Wursig et al. (2018)			
Crabeater Seal	*Lobodon carcinophaga*	3,187,000[o]	Southwell et al. (2012)	NL	NS	Common
		5-10 million[p]	Wursig et al. (2018)			
Southern Elephant Seal	*Mirounga leonina*	413,671[q]	Erickson and Hanson (1990); Hindell et al. (2016)	NL	NS	Common
		749,385[l]	Hindell et al. (2016)			
Leopard Seal	*Hydruga leptonyx*	13,200[o]	Southwell et al. (2012)	NL	NS	Common
		220,000[j]	Jefferson et al. (2008)			
Weddell Seal	*Leptonychotes weddellii*	302,000[o]	Southwell et al. (2012)	NL	NS	Common
		+1,000,000[l]	Wursig et al. (2018)			

[a]NL – not listed, E – Endangered, T – Threatened
[b]NS – not strategic, S – strategic, D – Depleted
[c]Scotia Sea and northern Antarctic Peninsula
[d]Abundance in all of the Southern Hemisphere
[e]Abundance of all beaked whales south of the Antarctic Convergence, mostly consisting of Southern bottlenose whales.
[f]Abundance in partial area of Antarctic feeding grounds
[g]South of 30.7°S.
[h]South of 60°S
[i]Minimum global abundance estimate for killer whales
[j]Abundance south of the Antarctic convergence
[k]Abundance in all Antarctic waters
[l]Total global abundance
[m]Abundance in South Shetland Islands only
[n]Abundance in South Georgia area
[o]APIS survey 1998/1999; aerial surveys along the Antarctic Peninsula
[p]Circumpolar abundance
[q]South Georgia Stock of Elephant Seals only

Table 2. NSF Marine Mammal Observations in Hero Inlet or Hauled Out at Gamage or Bonaparte Points Near Palmer Station January 2019 – March 2020 in Hero Inlet[a]

Species	January 21 – March 28, 2019 Observations[b]			March 30 – October 10, 2019 Observations[c]			October 12, 2019 – March 31, 2020 Observations[b, d]		
	Number	% Swimming	% Hauled Out	Number	% Swimming	% Hauled Out	Number	% Swimming	% Hauled Out
Humpback Whale	0	100%	N/A	0	N/A	N/A	2[e]	100%	N/A
Antarctic Fur Seal	73	16%	84%	241	4%	96%	70	21%	79%
Crabeater Seal	20	5%	95%	9	44%	56%	24	4%	92%
Southern Elephant	1	0%	100%	278	1%	99%	0	N/A	N/A
Leopard Seal	3	33%	67%	3	100%	0%	2	100%	0%
Weddell Seal	8	0%	100%	39	0%	100%	6	0%	100%
Unidentified Seal	0	N/A	N/A	0	N/A	N/A	1	100%	0%

[a]Includes animals observed in Hero Inlet waters and hauled out at Gamage Point or Bonaparte Point.
[b]Defined by observers as Antarctic "summer".
[c]Defined by observers as "winter".
[d]Observations during this period occurred over six months, nearly twice as long as the previous summer season. This may explain higher seal numbers.
[e]Observed outside of Hero Inlet between Bonaparte Point and Janus Island.

Table 3. NSF Marine Mammal Observations in Arthur Harbor Located on the Opposite Side of the Peninsula from Palmer Station[1] for Specific Months 2019 – 2020

Species	January 21 – March 28, 2019 Observations[b]	March 30 – October 10, 2019 Observations[c]	October 12, 2019 – March 31, 2020 Observations[b]
Antarctic Minke Whale	0	1	1
Humpback Whale	20	18	0
Antarctic Fur Seal	11	3	1
Crabeater Seal	51	66	7
Southern Elephant Seal	0	3	3
Leopard Seal	15	12	0
Weddell Seal	0	0	0
Unidentified Seal Species	0	0	3

[a]Includes animals observed in Arthur Harbor located on the northwest side of the peninsula on which Palmer Station is located. The peninsula provides a land buffer between Palmer Pier and where these animals were observed.
[b]Defined by observers as Antarctic "summer".
[c]Defined by observers as "winter".

Antarctic Minke Whale

Antarctic minke whales (*Balaenoptera bonaerensis)* are similar in shape and coloration to the more global species of minke whale (*B. acutorostrata).* The two species differ in relative size and shape of several cranial features, and Antarctic Minke whales lack the distinct white flipper mark of the more common minke whale.

The seasonal distribution and migration patterns of nearly all populations of minke whales are poorly understood (Risch et al. 2019). Antarctic minke whales are abundant from 60ºS to the ice edge during the austral summer then retreat in the austral winter to breeding grounds in mid-latitudes. This species is highly associated with sea ice and is generally less abundant in ice-free waters.

Reilly et al. (2004) estimated the abundance of Antarctic minke whales in the area of the Antarctic Peninsula to be 7,395 individuals. IWC (2019) estimated the total abundance of Antarctic minke whales in the Southern Hemisphere to be 360,000-730,000. Using sighting data from Santora et al. (2009) a density of 0.00182 minke whales/km^2 was determined within a survey area that included locations at the northern tip of the Antarctic Peninsula (near Elephant and Joinville islands, and in the Bransfield Strait) and the Scotia Sea. Ainley et al. (2007) counted 104 Antarctic minke whales in 5,590.4 km^2 during a survey in the Amundsen and Bellingshausen seas. Open ocean density assumes that only 20% of the actual total is observed and reported. Ainley et al. (2007) observed 104 minke whales, but offshore density (0.0930) was calculated using 520 total whales.

The population is considered to be stable and the species is not listed under the ESA or designated as depleted under the MMPA. Over the period January 21, 2019 through March 31, 2020, one minke whale was observed during bird observation studies at Palmer Station. The whale was observed feeding about 300 m offshore in Arthur Harbor.

Antarctic minke whales feed mainly on euphausiids; their feeding rates around sea-ice in Antarctic waters are among the highest documented (Friedlaender et al. 2014). They can be easily approached while feeding. In general, minke whales are commonly observed alone or in small groups of two or three individuals. Aggregations of up to 400 may form on occasion in high latitudes. During the feeding season, mature females are found closer to the ice than immature females, and immature males are more solitary than mature males.

Antarctic minke whales attain sexual maturity at 8 years for males and 7 to 8 years for females. At maturity Antarctic minke whales are estimated to average 9.0 m for females and to 8.5 m for males. Mating behavior has not been observed, but they are assumed to breed in winter in warm waters of low latitudes. Pregnancy rates are at or near 90% and births peak in July and August. Calves are 2.4 to 2.7m in length at birth, about 10 months after conception. Lactation lasts 5–6 months.

Minke whales in the Southern Ocean were not hunted in the early days of modern commercial whaling because of their small size but as other species such as blue, fin, and sei whales became depleted, hunters turned their attention to Antarctic minke whales in the early 1970s. After 1979, minke whales were only allowed by the IWC to be taken in factory-ship operations. Annual catches by Japan and the USSR in the Antarctic ranged up to about 8,000 individuals (Horwood, 1990; as cited in Wursig *et al.* 2018). Japan has continued to take Antarctic minke whales annually under a research permit issued under the terms of the International Convention for the Regulation of Whaling. In 2015/2016 the annual allowed catch was 333 whales.

Potential threats to minke whales in the Antarctic region include the reduction in sea ice potentially causing dietary shifts, offshore energy development, and increased vessel traffic and pollution. Acoustic disturbance from increased vessel noise, seismic surveys, and naval undersea warfare training exercises may also impact this species on a local or regional level. Any changes to sea ice due to climate change would likely affect Antarctic minke whales since their distribution and ecology are directly tied to sea ice (Herr et al. 2016). Currently, Antarctic minke whales and humpback whales are thought to partition prey resources in this region by feeding in different habitats (sea ice versus open water) but when the two species do overlap in time and space, they partition prey vertically (Friedlaender et al. 2008; as cited in Wursig et al. 2018). With continued sea ice decline, the potential for overlap, and thus competition for prey, increases.

Minke whales are in the low-frequency functional hearing group with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Vocalizations range from 60 Hz to 20 kHz (DON 2008).

Arnoux's Beaked Whale

Arnoux's beaked whales (*Berardius arnuxii)* are one of the largest members of the family *Ziphiidae*. The entire body is dark brown with the ventral side paler with irregular white patches; tooth marks of conspecifics are numerous on the back, particularly on adult males. The body is slender with a small head, low falcate dorsal fin and small flippers that fit into depressions on the body. The melon is small and its front surface is almost vertical with a slender projecting rostrum. Mean body length is 8.5 to 9.75 m. *B. arnuxii* is the least sexually dimorphic species in the Ziphiidae. Little is known of the diet of Arnoux's beaked whales but one individual's stomach was found to be mostly filled with squid beaks (Wursig et al. 2018).

Arnoux's beaked whales inhabit vast areas of the Southern Hemisphere, between 24°S and Antarctica. They are a deep diving species and can be found in areas of heavy ice cover. Population abundance data is not available specifically for Arnoux's beaked whales, but Kasamatsu and Joyce (1995) determined the population of all beaked whales south of the Antarctic Convergence to be 599,300. An offshore density of 0.0000038 whales per km^2 was calculated from sightings recorded by Gohl (2010) in the Amundsen Sea. Arnoux's beaked whales have been observed in the Project area (A. Friedlaender, email message, June 29, 2020). The species is not listed under the ESA or designated as depleted under the MMPA.

Specific information on Arnoux's beaked whales' reproduction is not available, but general information on the genus is available. The gestation time of *Berardius* is estimated to be 17 months long; newborns are approximately 4.6 m long at birth (Kasuya, 2009; as cited in Wursig et al. 2018). Females become sexually mature between ages 10 and 15 years when reach 9.8 to 10.7 m long; females may live as long as 54 years. Males become sexually mature when they are between 6 and 11 years old and their body lengths have reached 9.1 to 9.8 m. Males have been known to live for 84 years. Ovulation occurs once every 2 years throughout a female's life. The apparent high fecundity and shorter longevity of females combined with greater male longevity have invited speculations on their social structure including a possible male contribution in rearing calves.

Arnoux's beaked whales have not been historically hunted. Current threats are likely to be similar to Southern bottlenose whales. Because they are heavily ice-associated Arnoux's beaked whales may be directly affected by loss of sea ice due to climate change.

There is no information on acoustics for this species. They are likely in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Vocalizations ranges are similar at 300 Hz to 135 kHz (DON 2008).

Blue Whale

Blue whales (subspecies *Balaenoptera musculus intermedia*, found in Antarctic waters) have a tapered elongated shape, a broad, relatively flat, U-shaped head, with a prominent ridge from the splash-guard to the tip of the rostrum, and massive mandibles. They have 1m long black baleen plates on each side of the upper jaw. Southern Hemisphere blue whales are on average larger than those in the Northern Hemisphere. The largest recorded blue whales were caught in the Southern Ocean and measured 31.7–32.6m (104–107ft) long. When surfacing, the blue whale raises its shoulder and blowhole region out of the water. The splash guard or fleshy ridge just forward of the blowhole is large in this species. Blue whales can live for 80-90 years, or even longer.

Blue whales are a cosmopolitan species with North Atlantic, North Pacific and Southern hemisphere populations. They were historically most abundant in the Southern Ocean but are very rare today. Due to food availability they are found predominately offshore. IWC (2019) provides an abundance estimate of 2,300 blue whales in a part of their Antarctic feeding grounds. There are no estimates of blue whale density in the immediate area of the Antarctic Peninsula, but NMFS (2020) calculated a density of 0.00005 whales per km^2 in the Amundsen Sea. The species is listed as endangered under the ESA and designated as depleted under the MMPA.

Blue whales feed almost exclusively on euphausiids in areas of cold-water upwelling. If krill is close to the surface, they will lunge vertically by projecting their large lower jaws up through the water surface to capture the prey. Surface feeding has often been observed during the day, but it is more usual for blue whales to dive to at least 100 m, where layers of euphausiids are concentrated during daylight hours. They rise to feed near the surface in the evening, following as their prey ascends in the water column.

Little is known of mating behavior in blue whales. However, female–male pairings have been noted summer into fall, some lasting for as long as 5 weeks. Blue whales reach sexual maturity at 8–10 years of age. Length at sexual maturation in females is 23–24 m in the Southern Hemisphere, while males reach sexual maturity at 22 m. Mating occurs from late fall and throughout the winter and females give birth every 2–3 years in winter after a 10–12-month gestation period. The calves can weigh 2–3 tons and measure 6–7 m at birth; they are weaned when they reach about approximately 16 m in length at about 6–8 months. No specific breeding grounds have been discovered for blue whales in any ocean.

Documentation of natural blue whale mortality is rare. The principal predator is the killer whale*, Orcinus orca*, but there is little evidence of attacks on blue whales in the North Atlantic or Southern Hemisphere. In the Southern Hemisphere, blue whales were severely depleted by whaling; during the first half of the 20th century 325,000–360,000 were killed in Antarctic waters. Unrestrained hunting for blue whales lasted until 1966 and brought the species to the brink of extinction. Though still endangered species today, there is evidence of population increases in the Antarctic (Branch 2004; as cited Wursig et al. 2018). Current threats in the northern hemisphere include interaction with fishing gear and collisions with ships. Persistent contaminants accumulated over time such as PCBs may have an impact on reproduction and have limited the recovery of certain blue whale populations (Wursig et al. 2018). Increasing anthropogenic noise from shipping and oil exploration may also be impacting their recovery in parts of their global range.

Blue whales regularly vocalize throughout the year with peaks occurring from midsummer into winter. The majority of their vocalizations are infrasonic sounds in the range of 17–20 Hz and are lower than humans can detect. Their sounds, at 188 decibels (re: 1 µPa at 1m) are one of the loudest and lowest made by any animal. The calls can be heard easily for hundreds, even thousands, of kilometers under optimal oceanographic conditions, and may cover whole ocean basins. They, along with other mysticetes, are in the low-frequency functional hearing group, with an estimated auditory range of 7 Hz to 22 kHz (Southall et al. 2007).

Fin Whale

Fin whales (*Balaenoptera physalus*) are closely related to blue whales. Northern and southern populations remain separated leading to genetic isolation of the populations. In the Southern Hemisphere, the average body length of female adults is about 26 m and 25 m for males. Fin whales are slender with the maximum individual girth between 40% and 50% of the total length. From 350–400 baleen plates are found in each row and their maximum length is up to 80 cm. the body mass of an adult fin whale ranges from 40-50 metric tons and varies seasonally according to nutritive condition. The skin of adults near the flanks in the rear trunk is often covered by small round scars and stripes caused by the attachment of lampreys and other parasites or epizoites.

The fin whale is found in most large water masses of the world, from tropical to polar regions. However, in the most extreme latitudes individuals may be absent near the ice edge; there have been no sightings in the Weddell or Bellinghausen seas. Therefore, fin whales may be considered rare to extralimital in the vicinity of Palmer Station and the Action Area. Overall, fin whale densities in the southern hemisphere tends to be higher outside the continental slope than inside it. Wursig et al. (2018) cited an abundance estimate of 38,200 individuals south of 30.7ºS, including the Antarctic, while NOAA (2015) estimated an abundance of 1,725 fin whales south of 60ºS, and Reilly et al. (2004) estimated the abundance around the northern Antarctic Peninsula and Scotia Sea to be 1,492 whales. Assuming a strip width of 1 km, Santora et al. (2009) recorded 0.08391 fin whales per linear km^2 within a survey area that included locations at the northern tip of the Antarctic Peninsula (near Elephant and Joinville islands and in the Bransfield Strait) and the Scotia Sea. NMFS (2020) estimated a density of 0.0072 fin whales in the Amundsen Sea. The species is listed as endangered under the ESA and designated as depleted under the MMPA.

Fin whales feed on an assortment of prey items, depending on their availability (Kawamura 1980; as cited in Wursig et al. 2018); their diet varies with season and locality. Southern Hemisphere fin whales have a diet of almost exclusively krill, and other planktonic crustaceans. Similar to other *Balaenopterid* whales, they feed intensively during the summer months, consuming up to 1 ton of euphausiids per day.

In the Southern Hemisphere, fin whales seasonally migrate north to south; they feed in the summer at high latitudes and breed and fast in the winter at low latitudes. Pregnant females are usually the first to initiate the seasonal migration and are quickly followed by adult males and resting females. Lactating females and juvenile individuals of both sexes are the last to migrate. In the Southern Hemisphere, individuals attain sexual maturity at about 19 m long in males and 20 m 18.5 m in females; corresponding to an age of about 6–7 years in males and 7–8 years in females. In the Southern Hemisphere, the mating period is from May–July. The gestation period lasts about 11 months, when a calf about 6–7 m long and weighing 1–1.5 metric tons is born. Weaning occurs when the calf is about 6–7 months old and is followed by a 6-month resting period for the female, at the end of which mating again takes place.

Because they are large and swim fast, fin whales do not have significant predators, with the exception of the killer whale (*Orcinus orca*). In certain regions where this odontocete is abundant, signs of past attacks of killer whales can be seen on the flippers, flukes, and flanks of fin whales. The fin whale was highly desired by whalers, who targeted the species starting in the early 1870s and continuing until the moratorium on commercial whaling in 1985. Since 2005, 0–10 individuals per year have been taken in the Southern Ocean under the Japanese Special Permit Research Program.

Threats to fin whales worldwide include collisions with vessels, where boat traffic is very intense; incidental catches and entanglement in fishing gear, and behavioral impacts from anthropogenic noise generated during seismic surveys, and increased ship traffic. Because fin whales are so widely distributed and are low in the food chain, neither pollution nor a reduction of food supply by overfishing is likely to have a significant impact. Levels of contaminants in fin whales have been found to be low or extremely low as compared to other marine mammals (O'Shea and Brownell 1994, Law 1996; as cited in Wursig et al. 2018).

Fin whale vocalizations consist of low-frequency moans and grunts and higher frequency pulses, apparently with a social function (Watkins *et al.* 2000; as referenced in Wursig et al. 2018). They are in the low-frequency functional hearing group, with an estimated auditory range of 7 Hz to 22 kHz (Southall et al. 2007). They also vocalize at low frequencies of 15-30 Hz (DON 2008).

Hourglass Dolphin

Hourglass dolphins (*Lagenorhynchus cruciger*) are colored with dark black patterns alternating with pure white areas. They are recognized by a white hourglass shaped lateral patch. These dolphins are stocky and have a large, recurved dorsal fin that can vary from erect to hooked. In large males, the tail stock is often keeled. Total length of adults ranges from 142 cm to 187 cm. Females measured 142 to183 cm, while males were 163 to 187 cm long. Hourglass dolphins are rapid swimmers and are capable of speeds exceeding 22 km/hr. They commonly bow-ride ships and large whales, especially in rough weather. While swimming at high speed, hourglass dolphins sometimes swim rapidly just below the surface, and have been observed to spin.

Hourglass dolphins are pelagic and circumpolar in the Southern Ocean; they are found in Antarctic and sub-Antarctic waters. Most sightings of live hourglass reflect observer effort and are centered on the Antarctic convergence with most sightings from the Drake Passage. Abundance for dolphins observed in January in the Southern Hemisphere, was based on sighting surveys from 1976–77 to 1987–88 and estimated at 144,300 (Kasamatsu et al. 1988 and Kasamatsu and Joyce 1995; as referenced in Wursig et al. 2018). Using relative abundance provided by Santora et al. (2009) a density of 0.0015 hourglass dolphins per km^2 was calculated for the northern tip of the Antarctic Peninsula. Although oceanic, hourglass dolphins are often observed near islands and banks, in areas with turbulent waters; they have been observed in the Project area (A. Friedlaender, email message, June 29, 2020). Hourglass dolphins tend to be found in groups of 10 or less and when in the open ocean they tend to ride vessel bow and stern wakes. They are often observed with fin whales.

Hourglass dolphins often feed in large aggregations of seabirds such as great shearwaters and black-browed albatrosses, and in plankton slicks (White et al. 1999; as cited in Wursig et al. 2018). Their prey items include mall fish (about 2.4 g and a length of 55 mm), small squid, fish otoliths, squid beaks and crustaceans. They are believed to feed in surface waters.

Migratory movements of this species are not well known. It is thought that hourglass dolphins from the Antarctic convergence zone and the continental shelf break may move into sub-Antarctic waters or near-shore in winter. Thus, the range of the species thus probably shifts north and south with the seasons (Carwardine 1995; as cited in Wursig et al. 2018).

No confirmed predators of hourglass dolphins are known, although given that they overlap, killer whales are possible predators. Hourglass dolphins seem to be attracted to ships. They often approach from considerable distances, changing course to do so, and remain with the ship for up to 30 min (Goodall 1997; as cited in Wursig et al. 2018). Several hourglass dolphins have been taken for scientific study, but no other directed catches are known. At least one stranded animal was probably the result of a ship strike or net capture held against the side of a ship, as there were cuts along the anterior dorsal surface and the skin and blubber had been rubbed off near the dorsal fin, flippers, and flukes (Wursig et al. 2018). An incidental drift net catch has been reported in the southern Pacific Ocean.

Like other delphinids, they are social and have a repertoire of vocalizations such as clicks, whistles, and squeals (or burst-pulse sounds). These sounds are used for echolocation and communication. Hourglass dolphins are in the high-frequency hearing group with a generalized hearing range of 275 Hz to 160 kHz (NMFS 2018).

Humpback Whale

Humpback whales (*Megaptera novaeangliae*) are well-known baleen whales that are easily recognized by their remarkably long flippers, which are approximately one-third of the length of the body. Maximum adult lengths are in the 16 to 17 m range, with most from 14 to15 m (Clapham and Mead, 1999; as referenced in Wursig et al. 2018). Adult female humpback whales are typically 1 to 1.5 m longer than males, and calves are 4 to 5 m at birth, and approximately 8 to10 m long at the end of their first year when they reach independence (Clapham and Mead 1999; as cited in Wursig et al. 2018). Other than length, they are not sexually dimorphic. The humpback has between 270 and 400 baleen plates on each side of the mouth, ranging from black to white or partly white. They can live for up to 50 years.

Humpback whales are distributed throughout the world. They are highly migratory, spending spring through fall on feeding grounds in mid- or high-latitude waters, and wintering on calving grounds in the tropics, where they do not eat (Dawbin 1966; as referenced in Wursig et al. 2018). Seven populations of humpback whales are found in the Southern hemisphere and feed throughout the waters off Antarctica. In the Southern Hemisphere, humpbacks feed in circumpolar waters and migrate to breeding grounds in tropical waters to the north. Seven breeding populations are recognized by the International Whaling Commission (IWC) in the Southern Hemisphere, and these are linked to six feeding areas in the Antarctic. Bettridge et al. (2015) identify the southeast Pacific breeding stock breeding stock as feeding in waters to the west of the Antarctic Peninsula where Palmer station is located. These animals breed in the Pacific-Central America waters. According to Bettridge et al. (2015), the abundance of the Southeastern Pacific DPS is 6,500 (2005-2006 estimate most recent). NOAA (2015) estimated the population of humpback whales south of 60ºS to be 42,000 and IWC (2019) estimated that there are in 34,000 to 52,000 in the Southern hemisphere. Assuming a strip width of 1 km, Santora et al. (2009) recorded 0.03605 humpback whales within a survey area that included locations at the northern tip of the Antarctic Peninsula (near Elephant and Joinville islands and in the Bransfield Strait) and the Scotia Sea (NMFS 2020). Gohl (2010) estimated a density of 0.0001 whales per km^2 in the Amundsen Sea strongly suggesting a more nearshore distrubution around the Antarctic Peninsula. The species is listed as endangered under the ESA and designated as depleted under the MMPA.

From January 21, 2019 through March 31, 2020, marine mammal sightings have been recorded during bird observation studies at Palmer Station. On January 23, 2019, three humpback whales (2 adults and a juvenile) were observed feeding off Torgersen Island. One adult and one juvenile were observed feeding in Arthur Harbor on January 26, 2019. Several groups of up to four individuals (likely adults and juveniles) were observed feeding in Arthur Harbor in early February 2019. No humpbacks were observed after February 12. At the end of May 2019, two humpbacks were again observed near Bonaparte Point, with no other sightings until the end of December 2019 when one humpback was observed feeding in Arthur Harbor. From late December 2019 thru January to early February 2020, individual whales or groups of two adults and possibly a juvenile were observed feeding in Arthur Harbor on 10 separate occasions. A large group of 5 whales (4 adults and a juvenile) was observed in Arthur Harbor on March 3, 2020. This was the last sighting recorded.

Humpback whales are considered generalists, feeding on euphausiids and various species of small schooling fish. They appear to be unique among large whales in their use of bubbles to corral or trap these schooling fish. Whales blow nets, clouds, or curtains of bubbles around or below schools of fish, then lunge with mouths open into the center of the bubble structure. As with other balaenopterids, the humpback's ventral pleats expand when feeding, greatly increasing capacity. It is not known exactly how humpbacks find their prey. They do not appear to possess echolocation, but may have an active sense of smell, which could be used to detect prey at the water surface.

Breeding in humpback whales is strongly seasonal. In winter, male humpback whales sing long, complex songs, the primary function of which is presumably to attract females. Males aggressively compete for access to females; tail slashing, ramming, or head butting among males can last for hours. Males tend to remain in breeding areas longer than females and attempt repeatedly mate, while newly pregnant females quickly return to higher latitudes where they will feed for many months in order to prepare for the considerable energetic cost of lactation. Females gestate for about 11.5 months, and most calves are born in mid-winter. At about 6 months of age, calves are believed to begin feeding independently, but nursing likely continues until they become independent at about 1 year old. Sexual maturity varies among populations but is generally from about 5 years to 10 years.

Whalers targeted humpback whales for several centuries. In the last century, more than 215,000 humpbacks were killed in the Southern Hemisphere (Rocha et al. 2014; as cited in Wursig et al. 2018). It is possible than more than 95% of the animals in some populations were killed during intense periods of exploitation. Despite this, most studied populations appear to be making a recovery. Small aboriginal hunts for humpbacks still occur in a couple of locations, but worldwide many more whales die from entanglement in fishing gear or collisions with ships. However, none of these impacts appears to be significant at the population level, and the outlook for this once-overexploited species appears good in most areas. Humpback whales do not have significant predators, but rake-mark scars from teeth indicate that they are commonly attacked by killer whales. However, it seems likely that fatal attacks are largely confined to young calves (Pitman et al. 2014; as referenced in Wursig et al. 2018).

Humpback whales produce three classes of vocalizations: (1) "songs" in the late fall, winter, and spring by solitary males; (2) sounds made within groups on the wintering (calving) grounds; and (3) social sounds made on the feeding grounds (Richardson et al. 1995). Humpback whale songs lie between 0.2 and 3.0 kHz, with frequency peaks at 4.7 kHz. Feeding calls, unlike song and social sounds, are highly stereotyped series of narrow-band trumpeting calls. They are 20 Hz to 2 kHz, less than 1 second in duration, and have source levels of 175 to 192 dB re 1 μPa-m. Humpback whales are in the low-frequency functional hearing group, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Their vocal repertoire ranges from 20 Hz to greater than 10 kHz (DON 2008).

Killer Whale

The killer whale (*Orcinus orca*) is the ocean's apex predator, and is found in all the world's oceans and most seas. It is the largest member of the family *Delphinidae* and has very distinctive black-and-white coloration. Killer whales can attain maximum body lengths of 9.0 m in males and 7.9 m in females. Maximum measured weights are 6600 kg for a 7.65-m male and 4700 kg for a 6.58-m female (Yamada *et al.* 2007; as referenced in Wursig et al. 2018). In addition to being larger than females, mature males develop disproportionately larger appendages. Antarctic killer whales make periodic rapid long-distance migrations to subtropical waters, possibly for skin maintenance (Durban and Pitman 2011; as referenced in Wursig et al. 2018).

Killer whales are social animals that are usually observed traveling in groups containing a few to 20 or more individuals. Reports of larger groups usually involve temporary aggregations of smaller, more stable social units. The basic social unit is the matriline, which is a highly stable group typically composed of an old female, her sons and daughters, and the offspring of her daughters. Because females may live for 80 to 90 years, matrilines may contain as many as five generations of matrilineally related individuals. The pod is the next level of organization that is a group of related matrilines that shared a common maternal ancestor. The next level of social structure is the clan, followed by a resident society.

Currently only one species of killer whale is recognized (*O. orca*) but it is likely that some genetically distinct forms found in different regions of the world represent distinct species (Wursig et al. 2018). In the Antarctic, five distinct forms of killer whale have been identified: Types A, B1, B2, C, and D. They differ in coloration, morphology, and in some cases diet (Pitman and Ensor 2003). Types B1 and B2 are the most common form observed around the Antarctic Peninsula and Anvers Island (Durban et al. 2016).

Because of its wide distribution and scarcity in many regions, the killer whale is a difficult species to census. A minimum global abundance estimate of 50,000 killer whales has been estimated (Wursig et al. 2018); with over half occurring in Antarctic waters (Jefferson et al. 2008). Santora et al. (2009) recorded a density of of 0.00151 killer whales/km^2 (based on an assumed strip width of 1 km) within a survey area that included locations at the northern tip of the Antarctic Peninsula (near Elephant and Joinville islands and in the Bransfield Strait) and the Scotia Sea. Ainley et al. (2007) estimated a density of 0.0313 killer whales/km^2 in the Amundsen and Bellingshausen seas. They have been observed in the Project area (A. Friedlaender, email message, June 29, 2020). Killer whales in the Antarctic area are not listed under the ESA or designated as depleted under the MMPA.

Killer whales prey on a wide range of vertebrates and invertebrates; they have no natural predators other than humans. It is the only cetacean with Types that routinely prey upon marine mammals, with attacks or kills documented for 50 different species. Mammalian taxa that are prey of killer whales include other cetaceans—both mysticetes and odontocetes—pinnipeds, sirenians, and on rare occasions ungulates. A variety of fish species are also important food of killer whales. In the Antarctic, killer whales in open water prey on Antarctic minke whales, seals, and fish.

Births may occur in any month but most are in October-March. Females give birth when they are 11 and 16 years of age, with a 5-year interval between births until about 40 years of age. Males attain sexual maturity at about 15 years of age. Gestation is 15-18 months, and at birth killer whales are 2–2.5 m long and weigh about 200 kg. Calves are nursed for at least a year but may start taking solid food from the mother while still nursing. Typical age at weaning in the wild is not known, but it likely occurs between 1 and 2 years of age. Neonate mortality may be high, with an estimated 43% dying within the first 6 months.

Historically, killer whales in several regions have been the target of directed fisheries, culling, and persecution. An average of 43 whales per year were taken by Japanese whalers from their coastal waters during 1946–81, mostly for human consumption. Norwegian whalers took an average of 56 whales per year during 1938–81 in a government-subsidized hunt aimed at reducing killer whale numbers to reduce competition for other fisheries. Current threats include conflicts with fisheries resulting in injury or mortality through entanglement in gear or directed shooting. Killer whales have been known to target longline fisheries in the Southern Ocean. Other potential threats include direct effects of oil spills and other forms of toxic pollution, reduced prey availability and disturbance caused by vessel traffic.

As with most delphinids, killer whales are highly vocal. They produce a wide variety of clicks, whistles, and pulsed calls for echolocation and social signaling. As summarized in DON (2008), the peak-to-peak source levels of echolocation signals range between 195 and 224 dB re 1 µPa-m. The source level of social vocalizations ranges between 137 to 157 dB re 1 µPa-m. The killer whale has the lowest frequency of maximum sensitivity and one of the lowest high frequency hearing limits known among toothed whales. The upper limit of hearing is 100 kHz for this species.

Long-Finned Pilot Whale

Long-finned pilot whales (*Globicephala melas edwardii*) grow up to 6 m in length, have round, bulbous heads, broad-based dorsal fins, and are generally black in color. They appear black or dark gray; the body is robust with a thick tailstock. The melon is exaggerated and bulbous and they have on beak or a barely discernable one. Long-finned pilot whales are sexual dimorphic with adult males reaching an average length of 6 m. Males are longer and heavier than females, develop a more pronounced melon, and have a much larger dorsal fin. Females can live more than 60 years; males reach 35 to 45 years.

Long-finned pilot whales inhabit the cold temperate waters of both the North Atlantic and the Southern Ocean. Pilot whales are found in both nearshore and pelagic environments. NOAA (2018) estimated long-finned pilot whale abundance in Antarctic waters to be 200,000 individuals. There are no specific estimates of abundance of the long-finned pilot whale in the vicinity of the Project. Based on a strip width of 1 km, Santora et al. (2009) estimated a density of 0.00757 long-finned pilot whales/km^2 within a survey area that included locations at the northern tip of the Antarctic Peninsula (near Elephant and

Joinville islands and in the Bransfield Strait) and the Scotia Sea. The species is not listed under the ESA or designated as depleted under the MMPA.

Pilot whales are generally nomadic but are highly social and are usually observed in schools averaging 20–90 individuals. They also have been observed in mixed species aggregations A variety of group behaviors has been documented including traveling, foraging in loose formations, and collective surfacing. Their diet consists mostly of squid and other cephalopods, with smaller amounts of fish. Pilot whales use a ram-and-suction method for consuming their prey. Pilot whales are known to dive deep for prey; the maximum dive depth measured is about 1,000 m.

These whales are polygynous; huge aggregations of pilot whales have been reported and males may move between family groups to mate during these temporary aggregations. Sexual maturity in long-finned pilot whales occurs at 8 years for females and about 12 years for males. The birth interval in pilot whales is one of the longest of all the cetaceans ranging from 4 to 6 years. Lactation lasts for at least 3 years, or often longer.

Pilot whales are subject to several types of human interactions, including direct exploitation, bycatch in fisheries, exposure to chemical contaminants, and anthropogenic noise. They are particularly susceptible to entanglement in driftnets and are one of the most frequently reported cetaceans in mass strandings. Pilot whales strand singly as well as in groups; often single animals are diseased.

The calls of long-finned pilot whales are of a lower frequency and a narrower frequency range than those of the short-finned pilot whale. The mean frequency for long-finned pilot whales is 4,480 Hz. They are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007).

Sei Whale

The sei whale (*Balaenoptera borealis*) is the third largest whale (behind blue and fin) reaching a maximum length of about 20 m (with 15 m typical) and weighing 20 tons; the dorsal fin is larger than that of the blue and fin. Sei whales are dark gray on the dorsal side; the ventral surfaces of their flukes and flippers are also dark gray. There is no whitening of the lower right jaw as in fin whales and the baleen is dark gray, often with a yellowish-blue hue; but white baleen can be seen in some individuals. There are about 350 plates on each side of the jaw, and they are up to 80 cm long.

Sei whales inhabit all ocean basins; they are oceanic and not commonly found in shelf seas. Sei whales migrate seasonally, spending the summer months feeding in the subpolar higher latitudes and returning to the lower latitudes to calve in winter. In the Southern Hemisphere, they are rarely found as far south as blue, fin, and minke whales, with summer concentrations mainly between the subtropical and Antarctic convergences (between 40ºS and 50ºS).

Different populations of sei whales have not been identified by genetic studies (Kanda et al. 2006; as cited in Wursig et al. 2018). However, on the basis of migration patterns and biological characteristics, populations have been identified for management purposes. In the Southern Hemisphere, six populations are assumed. In the Southern Hemisphere, the original population was about 100,000, and in 1980 was thought to be 24,000, by now there may be more than 70,000 (Wursig et al. 2018). NOAA Fisheries has used an estimated population of 626 animals south of 60°S, and an offshore density of 0.00025 (NMFS 2020). Sei whales are formally listed as endangered under the ESA and depleted under the MMPA.

Sei whales feed on copepods, euphausiids, shoals of fish, and squid if they are encountered. They feed primarily at dawn, and less frequently during the day (Wursig et al. 2018). Male and female sei whales become sexually mature at about 10 years of age in both sexes (Masaki 1976, as cited in Wursig et al. 2018). Conceptions peak in June for Southern Hemisphere whales. Gestation is almost a year and newborn calves are about 4.5 m. Most calves are weaned in 7 months, after they have migrated to colder waters with their mothers.

Due to its speed and location offshore, the sei whale was not exploited until the end of the 1800s. In the Southern Hemisphere, these whales were caught from Brazil, Chile, Peru, South Africa, and South Georgia. The largest catches were made by the Antarctic pelagic fleets, after the numbers of blue and fin whales had been reduced. Between 1960 and 1970 over 110,000 sei whales were killed. Whaling for sei whales ceased in the Southern Hemisphere in 1979.

Sei whales are in the low-frequency hearing group, along with other baleen whales, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). There are few recordings of sei whale vocalizations in the North Pacific, where the sweep frequency ranged from 1.5 to 3.5 kHz (DON 2008).

Southern Bottlenose Whale

Southern bottlenose whales (*Hyperoodon planifrons*) are large deep-diving beaked whales that can be identified by their bulbous forehead and pronounced bottle-shaped beak. They are medium-sized whales, ranging from 6 to 10 m in length. Their coloration ranges from chocolate brown to yellow with lighter areas on the flanks and belly.

Southern bottlenose whales occur widely throughout the Southern Hemisphere mainly south of 30°S, and are most common between 58 and 62°S. An abundance of 500,000 of these whales has been estimated for waters south of the Antarctic Convergence (Jefferson et al. 2008). Santora et al. (2009) estimated density of 0.00061 southern bottlenose whales within a survey area that included locations at the northern tip of the Anatarctic Peninsula (near Elephant and Joinville islands and in the Bransfield Strait) and the Scotia Sea. The species is not listed under the ESA or designated as depleted under the MMPA.

Bottlenose whales seem to prefer deeper waters and, like other beaked whales, they make regular deep dives to forage. Stomach content analyses of six southern bottlenose whales show that this species feeds primarily on squid (MacLeod et al. 2003). Bottlenose whales are typically observed in small groups of up to ten individuals, though groups of up to 20 animals of mixed age/sex classes have been reported. Social behaviors have not been studied in southern bottlenose whales. Little is known about southern bottlenose whale reproduction. Calving is thought to take place off South Africa in spring and early summer.

As described for Arnoux's beaked whale there is no information on acoustics for this species. However, beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. There is no information on the hearing abilities of southern bottlenose whales. They are likely in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Vocalizations ranges are similar at 300 Hz to 135 kHz (DON 2008).

Southern Right Whale

Southern right whales (*Eubalaena australis*) are extremely robust body with a thick blubber layer; their girth often exceed 60% of total body length. The head is relatively large, comprising about one quarter to one third of the body length and the upper jaw is arched. The body is mostly black, sometimes with irregular white ventral patches. The most conspicuous external characteristic of right whales are irregular patches of keratinized tissue on the head referred to as callosities. These callosities are inhabited by dense populations of specialized amphipod crustaceans. Callosities patterns are unique to individuals and are therefore extremely useful as natural "tags," which allow repeated identification of individuals by photographs. Adults are typically 13-16 m long.

Southern right whales are found between 20ºS and 60ºS. The total abundance of southern right whales was estimated in 1997 at over 7500 animals, with the three well-studied stocks increasing at 7%–8% annually. Given that there were no estimates available for some stocks, and that a population increasing at 7% doubles every 10 years, total abundance could currently exceed 25–30,000 animals (Wursig et al. 2018). Reilly et al. (2004) estimated the population in the vicinity of the Antarctic Peninsula to be about 43 whales, and the IWC (2019) estimated southern right whale density in the southern hemisphere to be 12,000 animals. Williams et al. (2006) estimated the density of southern right whales in near the tip of the Antarctic Peninsula and in the Scotia Sea to be 0.0004 animals /km^2. The species is listed as endangered under the ESA and designated as depleted under the MMPA.

Right whales are "skimmers" (Baumgartner et al. 2007; as cited in Wursig et al. 2018). They feed offshore, pelagic regions in areas of high productivity by swimming forward with the mouth agape. Feeding can occur at or just below the surface, where it can be observed easily, or at depth. At times, right whales apparently feed very close to the bottom, because they are observed to surface at the end of an extended dive with mud on their heads. Typical feeding dives last for 10–20 min. It is likely that krill comprise a high proportion of the diet in southern right whales.

Right whales have a three-year reproductive cycle. Breeding or mating occurs during the winter. It often involves aggregations of whales centered around a single female and may involve large numbers of males; groups of more than 20 animals have been observed. Because of the three-year female reproductive cycle, breeding can take place geographically distant from calving grounds which are located in shallow coastal waters and bays. Calving also occurs during winter.

Right whale vocalizations are primarily low-frequency moans, groans, belches, and pulses (Cummings 1985 and Parks and Clark 2007; each as cited in Wursig et al. 2018). Most acoustic energy produced is below 500 Hz, with some sounds up to 1500–2000 Hz. There is no information specifically for southern right whales, but morphometric analyses of North Atlantic right whale inner ears estimate a hearing range of approximately 0.01 to 22 kHz based on established marine mammal models. The estimated functional hearing range for right whales may be 15 Hz to 18 kHz, putting right whales in the low-frequency functional hearing group (Southall et al. 2007).

Sperm Whale

Sperm whales (*Physeter macrocephalus*) are unusually large sexually dimorphic with adult lengths of about 11 m for females and 16 m for males. The head is large (comprising about one-third of the body length) and squarish. The lower jaw is narrow and under slung. The blowhole is located at the front of the head and is offset to the left. Sperm whales are brownish gray to black in color with white areas around the mouth and often on the belly. Sperm whales dive to about 600 m below the surface where they hunt primarily for squid. Aggregations of of 50 or more sperm whales have been observed within a few kilometers, presumably the result of concentrations of food.

Sperm whales are widely distributed, but distribution of the sexes is different. Female sperm whales almost always inhabit water deeper than 1,000 m and at latitudes less than 40°, corresponding roughly to sea surface temperatures greater than 15°C. Large males from high latitudes can be found in almost any ice-free deep water. Therefore, any sperm whales encountered in Antarctic waters would be male. They are more likely to be sighted in productive waters, such as those along the edges of continental shelves

An abundance of 12,069 has been estimated for sperm whales south of 60ºS (NOAA 2015). Based on data reported by Santora et al. (2009) the density of sperm whales in the vicinity of the Antarctic Peninsula is 0.0006 whales/km^2 and is estimated to be 0.01699 per km^2 for the Amundsen and South Bellingshausen seas. The species is listed as endangered under the ESA and depleted under the MMPA.

Sperm whales have low birth rates, slow growth and high survival rates. They give birth about once every 5 years. Females reach physical maturity when growth ceases, at about 30 years old and 10.6-m long. Males, which are slightly larger than females during the first 10 years of life, continue to grow at a substantial rate until well into their 30s, finally reaching physical maturity at about 16-m long when roughly 50 years old.

Sperm whales were heavily exploited by whalers, but the species has survived better than most other large whales. Current threats include entrapment in fishing gear, choking on and ingesting plastic, and collision with ships.

As summarized in Wursig et al. (2018) sperm whales typically produce short-duration repetitive broadband clicks used for communication and echolocation. These clicks range in frequency from 0.1 to 30 kHz, with dominant frequencies between the 2 to 4 kHz and 10 to 16 kHz ranges. Source levels from adult sperm whales' highly directional (possible echolocation), short (100 µs) clicks have been estimated up to 236 dB re 1 µPa-m rms. Creaks (rapid sets of clicks) are heard most frequently when sperm whales are engaged in foraging behavior in the deepest portion of their dives with intervals between clicks and source levels being altered during these behaviors. In summary, sperm whales are in the mid-frequency functional hearing group, with an estimated auditory range of 150 Hz to 160 kHz (Southall et al. 2007).

Antarctic Fur Seal

Antarctic fur seals (*Arctocephalus gazella*) are midsize otariids with thick bodies and relatively long necks. When born they are about 67.4 cm long and weigh about 5.9 kg (males) and 5.4 kg (females). As adult bulls weigh about 133 kg and are about 180 cm long. They are almost 1.5 times longer and 4 times heavier than cows, who are about 129 cm long and weigh an average of 34 kg. A defining feature of this species is their long facial vibrissae that can grow up to 48 cm long in bulls and are longer than in any other pinniped.

Antarctic fur seals exhibit a circumpolar distribution. They are found from the Antarctic continent to the Falkland Islands. Land-based breeding strongly influences the distribution of females and their foraging ecology. Lactating females are restricted to foraging in the waters immediately surrounding the breeding beaches, whereas males can disperse after mating. Female distribution expands after breeding as they leave rookeries.

An available population estimate for Antarctic fur seals in the South Shetland Islands (near the northern Antarctic Peninsula) is about 22,000 individuals (Wursig et al. 2018). However, total population estimates are as high as 2,800,000 (Wursig et al. 2018). Santora et al. (2009)estimated a density of 0.0999 Antarctic fur seals /km^2 within a survey area that included locations at the northern tip of the Anatarctic Peninsula (near Elephant and Joinville islands and in the Bransfield Strait) and the Scotia Sea. The species is not listed under the ESA or designated as depleted under the MMPA.

Over three seasons from 2019 through 2020 (i.e., two Antarctic summers and one winter), marine mammal sightings were recorded during daily bird observation studies at Palmer Station (Tables 2 and 3). A total of 73 fur seals were observed either hauled out or swimming in Hero Inlet during the Antarctic summer months between January and March 2019. Over a longer summer period between October 2019 and March 2020, there were 241 seals observed in Hero Inlet, with the majority of seals hauled out (see Table 2). During the winter months between March and October 2019, 70 seals were observed in Hero Inlet. Fewer fur seals were observed over the same 2019 – 2020 months in Arthur Harbor.

Antarctic krill (*Euphausia superba*) dominates the diet of Antarctic fur seals in the vicinity of the Action Area. Penguins are occasionally taken by Antarctic fur seal bulls. Killer whales are likely the main predator of the species, but Leopard seals are thought to limit the population growth at Elephant Island in the South Shetland Islands. Large bulls of other species also prey on pups where species coexist.

Each sex exhibits completely different life histories leading to the extreme sexual dimorphism observed in this species. Average female age at maturation is 4 years (range 2–7), and by ages 6–7 most females have attained full adult size. Females live about 20 years, with an observed maximum of 24. Reproductive rates increase rapidly from age 2, peak at age 8, and remain high, on average 0.75 (0.68–0.77). Females breed annually, with a gestation period of 8 and 9 months. Males reach sexual maturity at ages 3–4, but most breed at an age of 8–9 when they reach maximum body size and establish breeding territories. Average survival rate for males after age 8 is below 50%. Trauma and starvation are the most common causes of early pup mortality.

Antarctic fur seal populations went through intense commercial exploitation. In the South Shetlands, the species was almost extirpated in just three seasons, starting in 1819, but the population has rebounded. Current threats include direct interactions with fisheries, and mortality from entanglement in anthropogenic debris (mostly from the fishing industry).

Like other pinnipeds, these fur seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008).

<u>Crabeater Seal</u>

Adult crabeater seals (*Lobodon carcinophaga*) range in length from about 205–240 cm, with some older males as long as 264 cm and females up to 277 cm (Laws *et al.* 2003a; as cited in Wursig et al. 2018). Body mass when they start to molt in summer is about 200 kg for males to about 215 kg for females. Pups weigh about 35 kg at birth but reach more than 100 kg by the time they are weaned. Crabeater seals are medium brown to silver over most of the body, with darker coloration and spotting on the flippers and flank. Many individuals show scarring, likely caused by Leopard seal attacks. They have finely divided lobed teeth with multiple cusps that interlock to filter crustaceans. Crabeater seals are highly mobile on ice. When they are disturbed they will often raise their heads and arch their backs, and are able to quickly move over ice and snow. Though crabeater seals can live up to 40 years, their lifespan is usually 20–25 years.

Crabeater seals have a circumpolar Antarctic distribution; they spend the entire year in pack ice. They move over large distances with the annual advance and retreat of pack ice. Although they can be found anywhere within the pack ice zone, they are typically found at the edge of the continental shelf, as well as in the marginal ice zone (Burns *et al.* 2004 and Southwell *et al.* 2005; as referenced in Wursig et al. 2018). Circumpolar abundance estimates range from 5–10 million. During a survey condicted by the Antarctic Pack-Ice Seals (APIS) program, aerial surveys were conducted in the area around the Antarctic Peninsula. Those surveys estimated an anundance of 3,187,00 crabeater seals offshore of the peninsula (Southwell et al. 2012). Erickson and Hanson (1990) reported an overall estimated density of 1.76 seals per km^2 (6.05/nm^2) in the Antarctic. The species is not listed under the ESA or designated as depleted under the MMPA.

Crabeater seals sometimes congregate in large groups of up to several hundred, which might be associated with general patterns of seasonal movement or foraging. As with other Antarctic seals, crabeater seals have a daily haulout pattern in summer that generally involves hauling out on ice floes during the middle of the day (Bengtson and Cameron, 2004; as referenced in Wursig et al. 2018), though usually less than 80% are hauled out on the ice at the same time. Haulout patterns also vary markedly among seasons, with as little as 40% of seals hauling out at the peak of daily haulout in winter.

Over three seasons (i.e., two Antarctic summers and one winter) from January 21, 2019 through March 31, 2020, marine mammal sightings were recorded during bird observation studies at Palmer Station (Tables 2 and 3). Crabeater seals were commonly observed individually or in small groups lying on the ice in Arthur Harbor and Hero Inlet in late January and February of 2019; the frequency of sightings decreased by March. Groups of up to four individuals were observed in or near the Action Area in early April of 2019, some were actually lying on the floating dock. Groups of crabeater seals were observed swimming in Hero Inlet near Gamage Point in April and early May of 2019. No crabeater seals were recorded in June, but in early July of 2019 groups of two seals and individuals were observed on the ice at Arthur Harbor and Hero Inlet, and on the shore at Bonaparte Point. No crabeater seals were observed from mid-July to mid-October of 2019. Observations of crabeater seals increased in Arthur Harbor frequency into November of 2019, with sightings continuing into December. However, from January of 2020 through March of 2020, crabeater seals were only observed on nine occasions; this was less frequently compared to sightings recorded from January to March of 2019.

Antarctic krill is the primary prey item for crabeater seals, constituting over 95% of their diet. They also eat small quantities of fish and squid (Øritsland, 1977; as referenced in Wursig et al. 2018). Crabeater seals do not appear to seasonally switch prey. During daily nocturnal foraging periods in summer, crabeater seals will nearly continuously dive for up to 16 h at a time. In one study, a single crabeater seal continued diving for 44 h without interruption. Most dives are less than 100 m deep and less than 5 min long, but they have been recorded as diving to depths of over 600 m (Bengtson and Stewart 1992, Nordøy *et al.* 1995, Burns *et al.* 2004, and Wall et al. 2007; all as referenced in Wursig et al. 2018).

Crabeater seals form ‘family groups’ of a female, her pup, and an attending male during the breeding season; peak pupping is mid to late October with some pups born into December (Southwell *et al.* 2003, and Southwell 2004; both as referenced in Wursig et al. 2018). Newborn pups are relatively large, and they grow quickly in girth while remaining with their mothers on sea-ice floes for about 3 weeks. Once a male has mated with a female, he leaves her in search of other potential partners (i.e., serial monogamy).

Mortality of crabeater seals pups can be as much as 80% during their first year (Boveng and Bengtson, 1997; as referenced in Wursig et al. 2018). Most of the survivors exhibit large raking scars on their bodies from leopard seal attacks that occur during the seals’ first year of life; suggesting that leopard seals have a negative impact on crabeater seal populations. Fresh wounds are rarely seen on crabeater seals that are older than 1 year (Siniff and Bengtson, 1977; as cited in Wursig et al. 2018).

Crabeater seals were harvested commercially in 1964/1965 by Norway and in 1986/1987 by the Soviet Union. In both cases, the sealing ventures were determined to be economically unsuccessful. The Convention for the Conservation of Antarctic Seals (effective as of 1978) provides international oversight for the conservation and management of crabeater seals, as well as Southern elephant, leopard, Weddell, Ross, and Southern fur seals. A crabeater seal mass mortality event was documented along the Antarctic Peninsula in 1955, killing about 97% of the population (Laws and Taylor 1957 as referenced in Wursig et al. 2018). The event occurred near a research base where sledge dogs were routinely used for travel and the clinical symptoms suggested a distemper virus. Due to this concern, dogs were prohibited in Antarctica beginning in 1994 under Annex II to the Environmental Protocol (Conservation of Antarctic Fauna and Flora).

Crabeater seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008).

Southern Elephant Seal

Southern elephant seals (*Mirounga leonina*) are the largest of all pinnipeds. The species is sexually dimorphic; male southern elephant seals have been weighed at 3700 kg, whereas females only weigh between 400 and 800 kg. Males have a large inflatable proboscis and a pronounced chest shield; these attributes are associated with fighting with other males on land to acquire females. Females lack the proboscis and chest shield. Both males and females are gray to brown in color. Southern elephant seals have an extensive range, with breeding sites on islands scattered around the subantarctic and the Antarctic Peninsula. They spend as much as 80% of their annual cycle at sea, migrating long distances to favorable foraging locations. During the 8-month long winter migration seals of both sexes can make trips of up to 8000–10,000 km. Elephant seals spend as much as 90% of the time submerged, the majority of it hunting for food, but other behaviors, such as traveling from place to place, and apparently even resting, take place at depths of more than 200 m.

Southern elephant seals can be divided into three distinct stocks: Maguire Island, Iles Kerguelen, and South Georgia, the latter of which is relevant to the Action Area. Hindell et al. (2016) estimated the size of the South Georgia stock to be 413,671 seals; this is about 55% of the total population estimate of 749,385. Between the 1950s and 1990s the southern elephant seal experienced a population decline of about 50% throughout most of the breeding range in the Southern Ocean. Modeling suggests that the declines are due to relatively small changes in fecundity and survival (McMahon et al. 2005; as cited in Wursig et al. 2018), but the underlying causes are presently unclear, but may be related to environmental changes causing change in food availability. Santora et al. (2009) estimated a density of 0.0003 elephant seals/km^2 within a survey area that included locations at the northern tip of the Antarctic Peninsula (near Elephant and Joinville islands and in the Bransfield Strait) and the Scotia Sea. The species is not listed under the ESA or designated as depleted under the MMPA.

Over three seasons (two Antarctic summers and one winter) from January 21, 2019 through March 31, 2020, marine mammal sightings were recorded during bird observation studies at Palmer Station (Tables 2 and 3). One elephant seal was observed lying on shore near Palmer Station in early March of 2019. No other seals were observed again until October of 2019 when on six days over the period October 8 to 19, 2019 a single seal was observed lying on the ice in Arthur Harbor. Additional sightings were noted in November and December 2019 in Hero Inlet. Sightings increased from January 6 to February 10, 2020, when elephant seals were observed at Bonaparte Point as individuals or in groups as large as 7 nearly every day and sometimes several times a day. No elephant seals were observed after February 10, 2020. This is noticeably different than 2019, when no elephant seals were observed in January or February.

Southern elephant seals are highly polygynous, with large, dominant alpha males presiding over large “harems” of females. Competition between males for the alpha position culminates in dramatic fights. Successful males have almost exclusive access to harems consisting of up to 100 females and so the reproductive benefits of success are very high. Adult breeding males haulout onto deserted beaches in August; large numbers of pregnant females arrive soon after and a single pup is born about 2-5 days later. The females stay with their pup throughout lactation and do not feed, relying on a thick blubber layer for sustenance and milk production. At birth pups weigh between 30 and 40 kg and by the time they wean at 23–25 days, southern elephant seal pups weigh approximately 120–130. Several days before weaning their pups, s). Once the pup is weaned, females come into estrus and mate with the dominant male(s) before departing to sea. The pups are left behind and spend the next 4–6 weeks teaching themselves to swim and hunt, relying on blubber reserves built up while nursing. After leaving their natal beaches, the pups spend the next 6 months at sea; as many as 30% of them perish after weaning and at sea.

There is some separation of feeding areas between the sexes, with males tending to feed more in continental shelf waters, while females either use ice-free waters broadly associated with the Antarctic Polar Front, or the marginal ice zone, moving northward as the ice expands. Elephant seals prey on deepwater and bottom dwelling organisms, including fish, squid, crab, and octopus. They are extraordinary divers with some dive depths exceeding 1,500 m and lasting up to 120 minutes.

Elephant seals have a long history of direct exploitation by humans as they were hunted extensively during the 1800s for their blubber, which yielded an unusually high-quality oil; the population was severely reduced at all major breeding locations. The exploitation of southern elephant seals continued until 1964 at South Georgia. At present, elephant seals are relatively free of adverse interactions with humans. Southern elephant seals are only rarely captured in the nets of Southern Ocean fishing fleets. There are some grounds for concern that some large-scale fisheries may be competing with the seals for preferred prey species. Climate change may affect elephant seals; there is evidence of correlations between population–dynamics parameters and incidences of the El Niño-Southern Oscillation, which may provide insights into the potential impacts of climate change on elephant seals (McMahon and Burton, 2005; as cited in Wursig et al. 2018).

Like other pinnipeds, elephant seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008).

Leopard Seal

The leopard seal (*Hydrurga leptonyx*) is the largest Antarctic pack ice seal. They are sexually dimorphic; females can grow up to 3.8 m long and weigh 500 kg, while males are generally 3.3 m long and weigh 300 kg (Rogers 2009; as cited in Wursig et al. 2018). Leopard seals have an elongated, streamlined body with long, flipper-like forelimbs, and large, reptilian-shaped heads with a very large mouth. They are gray with irregular, darker spots. Leopard seals do not dive much, they tend to carry out short (~2 min), shallow (30 m or less) dives (Krause *et al.* 2015; as cited in Wursig et al. 2018).

Leopard seals are solitary pinnipeds and are widely dispersed at low densities on the circumpolar Antarctic pack ice (Rogers *et al.* 2013; as cited in Wursig et al. 2018). Most of the leopard seal population remains within the pack ice, but when the sea ice extent is minimal, leopard seals are restricted to coastal habitats (Meade *et al.* 2015; as cited in Wursig et al. 2018). There have been no systematic, large-scale population census studies of this species, but the leopard seal population is estimated to be between 222,000 and 440,000 (Southwell *et al.* 2008; as cited in Wursig et al. 2018), and Jefferson et al. (2008) Jefferson et al. (2008) estimated the abundance of these seals south of the Antarctic convergence to be 220,000. The APIS program estimated 13,200 leopard seals in the area around the Antarctic Peninsula. Santora et al. (2009) estimated a density of 0.0003 leopard seals/km^2 within a survey area that included locations at the northern tip of the Anatarctic Peninsula (near Elephant and Joinville islands and in the Bransfield Strait) and the Scotia Sea. The species is not listed under the ESA or designated as depleted under the MMPA.

Over three seasons (two Antarctic summers and one winter) from January 21, 2019 through March 31, 2020, marine mammal sightings were recorded during bird observation studies at Palmer Station (Tables 2 and 3). Single leopard seals were occasionally observed lying on the ice in Arthur Harbor or swimming in Hero Inlet starting in late January until April of 2019. One additional sighting was recorded in July. No leopard seals were observed again until November 19, 2019, when three were observed on the ice in Arthur Harbor. Occasional sightings continued from November 2019 through March of 2020. One March 31, a leopard seal was observed feeding on a crabeater seal in Hero Inlet.

Because they do not rely on pack ice to breed leopard seals can escape winter food shortages by dispersing northward. These seals prey on penguins, other marine mammals, and zooplankton; this combination of apex predator and planktivore is unique for marine mammals. Due to the size of their mouth, leopard seals can take large-bodied prey including crabeater, Weddell, southern elephant seals and fur seals.

Male leopard seals reach sexually maturity by 4.5 years, and females by 4 years of age. Mating occurs in the water but has been observed only for captive seals. Births occur from October to mid-November on of Antarctic pack ice floes. Females wean pups on the pack ice. Males do not remain with the females; and only mother-pup pairs are observed on the ice surface. Lactation lasts for approximately 4 weeks.

Because of their dispersed distribution, leopard seals have never been commercially exploited. Interactions between seals and scientists or tourists in Antarctica have been benign for the most part, although there has been one reported human fatality. Because these seals are ice-dependent for breeding, predicted decreases in Antarctic sea ice due to climate change are likely to negatively affect the leopard seal.

Acoustics play an important role in the mating system of leopard seals and they become highly vocal prior to and during breeding. Male seals produce vocalizations in distinctive patterns; each male has a unique song. The underwater vocalizations of the leopard seal are loud and can be up to 177 dB re 1 μPa at 1 m (Rogers 2014; as cited in Wursig et al. 2018). Vocalizations range from <4 to 120 kHz (DON 2008). Leopard seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007).

Weddell Seal

Weddell seals (*Leptonychotes weddellii*) are members of the phocid family. They are large, weighing up to 600 kg with typical weights between 300 and 500 kg. They do not exhibit sexual dimorphism, but females are slightly larger than males. Weddell seals are thickset often reaching 3 m long and 1 m wide; their fore flippers are short relative to body length. Their coloration ranges from dark gray dorsally to light gray/silver ventrally, and this often changes to shades of brown before their annual molt.

Weddell seals aggregate on the ice to molt and also sporadically dive during this period. After molting, in fall-winter these seals disperse to sea; some individuals remain within the vicinity of their colonies, whereas other individuals disperse several hundreds of kilometers away and may not return to their colonies for several weeks.

The Weddell seal's range includes coastal areas around the Antarctic continent and they are found in areas of both fast and pack ice. Weddell seals rarely venture into open, ice-free waters. Animals inhabiting the islands of the mostly ice-free northern Antarctic Peninsula are primarily coastal in their distribution. Weddell seals are the second most abundant species of Antarctic phocid, after the crabeater seal. The best available abundance estimate suggests that there are well over 1,000,000 individuals in the Antarctic (Wursig et al. 2018). Specific to this Project, the APIS program estimated about 302,000 Weddell seals in the area of the Antarctic Peninsula (Southwell et al. 2012).

Over three seasons (two Antarctic summers and one winter) from January 21, 2019 through March 31, 2020, marine mammal sightings were recorded during bird observation studies at Palmer Station (Tables 2 and 3). On several occasions individual Weddell seals were observed on shore at Bonaparte Point from the end of February of 2019 through April of 2019. Weddell seals were observed swimming in Hero Inlet in early April 2019 on several occasions. No Weddell seals were sighted again until mid-September of 2019, when an individual was again observed on the ice in Hero Inlet. After September 16, 2019, no Weddell seals were observed in the vicinity of Palmer Station until January 6, 2020; at that time a seal was observed in the vicinity of the outfall. As with 2019 observations, Weddell seal sightings at Bonaparte Pointe increased in mid- to late February of 2020, and continued every day or every few days through March 27, 2020.

Weddell seals consume epipelagic (0–200 m), mesopelagic (200–1000 m) and benthic prey. They can dive to depths over 600 m to each the deeper prey items. Thir diet consists maily of fish but they also eat cepalapods, decapods and Antarctic krill. Their feeding/haulout pattern is diurnal; they haulout during the day and forage at night, in response to the vertical migration of their prey (Andrews-Goff et al. 2010; as cited in Wursig et al. 2018).

During the breeding season adult females paired with pups form loose aggregations of up to 100 individuals or more along cracks in the fast ice, with some distance between pairs. Mothers fast during the first phase of the lactation. Pups are weaned at about 6 weeks; females resume foraging a few weeks before their pups are weaned. Weddell seal pups, accompanied by their mothers, begin to swim about 2 weeks after birth. Generally adult males remain in the water throughout the breeding season; they maintain underwater territories and control females' access to breathing holes and cracks. Fights among males are common.

When breeding in fast-ice areas Weddell seals are naturally protected from predation. However, when they move to the pack ice and open waters to forage after molt, they are vulnerable to killer whales. Antarctic killer whales of the ecotype B (found in the vicinity of the Project) specialize in hunting seals on the pack ice. Juvenile Weddell seals can also fall prey to leopard seals.

Weddell seals were hunted as a food source for both men and dogs during the early periods of Antarctic exploration and limited harvests continued until the 1990s. Local populations were affected but have recovered since harvests ended. Because they are ice dependent Weddell seal populations may decline with increasing temperatures if as Antarctic sea ice is reduced. However, the fact that some populations breed on land (e.g., at South Georgia), indicates that the species can colonize different environments, although the extent of such plasticity is uncertain. Thus, the cumulative effects of global climate change on Weddell seals are unknown. Other impacts on these seals include increased seasonal tourism, causing increased vessel noise, disturbance from vessels passage, and close approach by people. A small number of animals could be injured from collision large vessels as they pass through ice fields. Currently, there are no reports of Weddell seals significantly interacting with fisheries, but fisheries in Antarctic waters, particularly those targeting the Antarctic toothfish, could have an impact on Weddell seal nutrition.

The species emits a wide variety of calls, some of which are complex, and last as long as 70 s (Green and Burton 1988; as cited in Wursig et al. 2018). Males guard their territories using loud vocalizations (up to 193 dB re 1 μPa), which can transmit across an area of hundreds of km^2 (Thomas and Kuechle, 1982; as cited in Wursig et al. 2018). Weddell seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from <4 to 120 kHz (DON 2008).

2 MARINE MAMMALS – IMPACTS

As described above, twelve cetacean and five pinniped species can be found in the vicinity of the Project. Five of the cetacean species are listed as endangered under the ESA (blue, fin, sei, sperm, and southern right whales). None of the pinnipeds are ESA-listed. Sources of direct impacts to marine mammals include auditory injury or disturbance due to underwater noise from DTH drilling, vibratory and impact pile installation and removal, and physical disturbance to marine mammals from project vessels and human presence in the vicinity of the pier. Concurrent with the IEE, NSF seeks an Incidental Harassment Authorization (IHA) for the incidental taking of marine mammals pursuant to Section 101(a)(5)(A) of the MPA. Under the MMPA, "take" means to harass, hunt, capture, or kill any marine mammal or attempt such actions. For the purposes of the IEE assessment, the estimated exposures to increased underwater noise due to construction provide the basis for assessing the extent, duration, intensity and significance of effects according to the EIA guidelines (Resolution 1 2016 Annex).

While increased underwater sound levels from project activities have the potential to result in Level A (i.e., permanent threshold shift [PTS]) harassment to certain species, the potential for this effect is minimized through mitigation. No serious injury or mortality of marine mammals is expected from project activities. The following subsections describe the nature, extent, duration and intensity of the potential auditory and physical disturbance impacts on marine mammals. Mitigation and monitoring measures described would be implemented to minimize the potential for injury or harassment to the maximum extent practicable.

2.1 Direct Impacts to Marine Mammals

Auditory Impacts

Permanent or temporary hearing threshold shifts (PTS or TTS) could occur when marine mammals are in close proximity to the sound source and are exposed to very loud sounds of a short duration or to quieter sounds over a prolonged time period. Whether the threshold shift is temporary or permanent depends on the intensity of the sound and length of time exposure. Typically, TTS occurs due to impacts to middle-ear muscular activity, increased blood flow, and general auditory fatigue (Southall et al. 2007). At the TTS level, the animals do not experience a permanent change in hearing sensitivity and exhibit no signs of physical injury.

Hearing impairment and non-auditory physical effects (e.g., stress) might occur in marine mammals exposed to strong, pulsed underwater sounds. However, only limited data are available from studies using captive marine mammals, and there is no evidence that these effects occur even for marine mammals in close proximity to sound sources (Southall et al. 2007).

Acoustic thresholds that may result in auditory injury defined by a permanent threshold shift (PTS) or Level A injury in marine mammals are provided in NMFS (2018). A dual metric approach considering both cumulative sound exposure and peak sound levels was used to determine the PTS thresholds for impulsive sounds. For non-impulsive sounds, unless the impulsive peak level threshold was exceeded, only the cumulative sound exposure level was used. As defined in the Technical Acoustic Guidance (NMFS 2018), different thresholds and auditory weighting functions are provided for different marine mammal hearing groups. In addition, NMFS released informal guidance in June 2020 regarding DTH drilling source levels for drilling 42-in piles based on limited data reviewed in Reyff and Heyvaert 2019, Reyff 2019, and Denes et al. 2019; all as cited in NMFS 2020 unpublished. For DTH drilling, new NMFS guidance recommends that for 18- to 24-in diameter piles, an SEL of 154 dB should be used. For 25- to 42 in. diameter piles, the assigned level is 164 dB. The Level A harassment assessment is to be considered as impulsive.

The 2018 NMFS guidance uses marine mammal hearing groups defined by Southall et al. (2007) with some modifications based on recent studies. These groups and their generalized hearing ranges are shown in Table 4. Of the seventeen marine mammal species (twelve cetaceans and five pinnipeds) that may occur in the Action Area, six are classified as low frequency cetaceans (LF), five are mid-frequency cetaceans (MF), and hourglass dolphins are classified as high-frequency cetaceans (HF) (NMFS 2018). Crabeater, southern elephant, leopard and Weddell seals are members of the phocid group, while Antarctic fur seals are otariid pinnipeds. NMFS (2018) considered acoustic thresholds by hearing group to acknowledge that not all marine mammals have identical hearing ability or identical susceptibility to noise or noise-induced PTS. NMFS (2018) also used the hearing groups to establish marine mammal auditory weighting functions (Table 5). These functions are considered in the determination of Level A threshold criteria.

Marine mammals exposed to underwater sounds of 160 dB RMS or greater are considered to experience behavioral harassment (Level B) due to impulsive sources such as impact pile driving while the Level B threshold for non-impulsive sources such as vibratory pile driving is 120 dB RMS or greater (see Table 6). NMFS recent guidance on DTH drilling advises analysts to use a source level of 166 dB for Level B harassment (Denes et al. 2019; as cited in NMFS 2020 unpublished[1]). The PTS thresholds corresponding to each marine mammal hearing group are shown in Table 6. Table 6 also shows Level B disturbance thresholds for vibratory and impact pile driving. Table 7 shows the potential of each of the project components to cause auditory effects in marine mammals.

Table 4. Generalized Hearing Ranges for Marine Mammal Hearing Groups in Water

Hearing Group	Hearing Range
Low-frequency cetaceans[1] (LF)	7 Hz to 35kHz
Mid-frequency cetaceans[2] (MF)	150 Hz to 160 kHz
High-frequency cetaceans[3] (HF)	275 Hz to 160 kHz
Phocids[4] (P)	50 Hz to 86 kHz
Otariids[5] and other non-phocid marine carnivores (O)	60 Hz to 39kHz

Source: NMFS 2018.
[1] For example, humpback and minke whales.
[2]For example, killer whales.
[3]For example, hourglass Dolphins.
[4]Crabeater, Southern Elephant, Leopard and Weddell Seals.
[5]Antarctic Fur Seals

[1] *NMFS Guidance for Assessment of DTH Pile Installation*, July 2020

Table 5. Summary of Weighting and Exposure Function Parameters

Hearing Group	*a*	*b*	f_1 (kHz)	f_2 (kHz)	*K* (dB)
Low-frequency cetaceans (LF)	1.0	2	0.20	19	0.13
Mid-frequency cetaceans (MF)	1.6	2	8.8	110	1.20
High-frequency cetaceans (HF)	1.8	2	12	140	1.36
Phocids in water (PW)	1.0	2	1.9	30	0.75
Otariids in water (OW)	2.0	2	0.94	25	0.64

Source: NMFS 2018.

Table 6. Underwater Acoustic Thresholds for Marine Mammals

Hearing Group	Non-Impulsive Sources (Vibratory Pile Driving)		Impulsive Sources (Impact Pile Driving)		
	Level A (dB SELcum)	Level B (dB RMS)	Level A Dual Criteria (dB Peak SPL)	Level A Dual Criteria (dB SELcum)	Level B (dB RMS)
Low-frequency cetaceans[1] (LF)	199	120	219	183	160
Mid-frequency cetaceans[2] (MF)	198		230	185	
High-frequency cetaceans[3] (HF)	173		202	155	
Phocid pinnipeds in water[4] (PW)	201		218	185	
Otariid pinnipeds in water[5] (OW)	219		232	203	

Note: All decibel (dB) levels are referenced to one microPascal (1µPa). Cumulative levels should be appropriately weighted for the hearing group for assessment to the threshold

[1]For example, humpback and minke whales.

[2]For example, killer whales.

[3]For example, hourglass dolphins.

[4]Crabeater, Southern elephant, leopard and Weddell seals.

[5]Antarctic fur seals.

Table 7. Project Components: Potential to Cause Marine Mammal Effects

Project Component	Equipment	Potential for Marine Mammal Effects (Yes/No)
Pile/Sheetpile Removal	Excavator and loader operated above water	No
	Crane operated above water	No
	Vibratory hammer	Yes
	Underwater cutting tool[1]	No
Pile Installation	Crane operated above water	No
	DTH drill	Yes
	Impact hammer	Yes
	Vibratory hammer	Yes
Anode Protection	Pneumatic hydrogrinder[2]	Yes
Optional rock chipping	*Hoe ram (chipping)*	*Yes[3]*

[1]For example, a diamond wire saw or hydraulically powered Guillotine saw for cutting pipe as needed. Operationally, both saws have similar underwater acoustic properties. Based on a study conducted by the U.S. Navy in 2016, the diamond wire

sawing is relatively quiet (below 85 decibels [dB]) and does not require ear protection for divers using the tool.
[2]These tools scrape off surfaces for rust, paint, etc. Use of these tools would be limited and would occur once pile installation is complete. Underwater source levels are estimated at 148 dB at 10 m.[3]Rock chipping may not be necessary. However, if it does occur it would most likely occur on the same days as DTH driving. As described in Reyff and Donavan (2020), the ensonified area from rock chipping is smaller than for DTH driving and a shutdown zone of 50 m would protect any hauled out pinnipeds during this or any construction activities. .

Physical Disturbance

The potential sources of physical disturbance to marine mammals during Palmer Pier construction activities are associated with the physical presence of humans on the pier, vessels such as the tug working within Hero Inlet, and noise introduced into the air from drilling and pile driving activities. Vessels or humans would not be permitted to intentionally approach marine mammals on sea or land during the project. Mortality and serious injury of marine mammals due to vessel strikes is not expected in Hero Inlet due to the slow speed of the working tug. As described in Section 1, seals have been observed hauled out at Gamage Point (near Palmer Pier) and Bonaparte Point (approximately 135 – 150 m from Palmer Pier). Noise in air generated during construction activities at the pier would attenuate more quickly than in water and is not expected to disturb hauled out animals. Disturbance of hauled out seals or animals in the Hero Inlet waters due to the physical presence of vessels and equipment does not automatically imply that harassment has occurred. The proposed project only anticipates using one tug during construction which further minimizes potential physical disturbance to seals that may be in the area. If disturbed, seals may leave the haulout briefly but would be expected to return. There is recognition that minor and brief changes in behavior such as this do not generally have biologically significant consequences for marine mammals (NRC 2005). Given the limited vessel traffic and slow vessel speed or stationary nature of the working tug and that other construction activities would be on land at the pier, only negligible impacts would be expected due to disturbance due to human or vessel activities.

Extent and Duration of Direct Impacts to Marine Mammals

Direct impacts on marine mammals due to the Palmer Pier construction project may result from underwater noise from DTH and pile driving. As described above, physical disturbance from vessels and other human activity is expected to be negligible.

The extent of potential auditory impacts to marine mammals during in-water construction activities were evaluated based on the area that may be ensonified by underwater noise (Table 8) and the potential for marine mammals to occur in the Action Area using recent observation data in Hero Inlet near Palmer Station (Table 2). Data are limited regarding source levels for DTH drilling. However, in June 2020 NMFS released guidance stating that source levels (Reyff and Heyvaert 2019, Reyff 2019, and Denes et al. 2019; all as cited in NMFS 2020 unpublished) the following sources for drilling 42-in piles should be used:

- SELs: 164 dB
- 1-sec SEL: 174 dB
- SPLpeak: 194 dB

To be conservative, this assessment considers source levels for installing 42-in piles are based on NMFS June 2020 guidance (unpublished). Noise levels during installation of the 24- and 36-in piles are expected to be slightly less than the assumed source levels. Table 8 provides the noise source levels at 10 m for two pile driving scenarios during installation of 24-in and 36-in piles. For additional information on modeling DTH drilling sources for this project, please refer to Reyff and Donavan (2020).

Table 8. Noise Source Levels at 10 Meters for 24-in. and 36-in. Pile Installation

Measured Sound Levels[1]				
Activity	**Peak**	**RMS**	**SEL[2]**	**TL[3]**
24-Inch Piles@ 20-Foot Socket Depth				
DTH Driving	190	170	154	15
Vibratory Driving[4]	170	165	165	15
Impact Driving	195	181	168	15
36-Inch Piles @ 30-Foot Socket Depth[5]				
DTH Driving	190	175	164	15
Vibratory Driving	180	170	170	15
Impact Driving	210	193	183	15
H Piles inserted in 24-in. Sockets @ 20-foot Socket Depth				
DTH Driving	190	170	154	15
Vibratory Driving	170	165	165	15
Impact Driving	195	180	170	15

[1]See Reyff and Donavan (2020) for references.
[2]SEL is per pulse for impact driving and DTH drilling. SEL for vibratory installation is per second.
[3] Based on average TL for 24-in and 42-in. piles levels.
[4] 24-in. HP Piles have slightly lower Peak and RMS levels. Please see Reyff and Donavan (2020).
[5] While it is possible the socket depth would be only 20 feet, this assessment assumes the greater depth to be precautionary.

Using a transmission loss coefficient of 15 (Reyff and Donavan 2020), the estimated area that would be ensonified above behavioral thresholds by source is calculated based on the distance from the Palmer Station Pier to the edge of the NMFS thresholds for each species for Level A and Level B (Table 9). Table 9 also shows the estimated number of days for each construction method and pile type (including contingency days for weather, equipment malfunctions or other unexpected circumstances).

The duration of potential effects is, in part, based on the proposed project schedule for in-water construction. The project contractor assumes that installation of approximately one to two piles would occur over a 12-hour workday. To be precautionary, this assessment assumes two installation activities would occur simultaneously using DTH drilling. For example, two 36-in piles or one 36-in pile and one 24-in pile would be installed at the same time. The corresponding noise assessment assumes one 36-in pile would be installed to 20-ft socket depth while a second 36-in pile would be installed to a 30-ft socket depth. Brief impact pile driving of about 10 strikes may be used to seat the piles.

Figures 1 through 6 show potential ensonified areas to NMFS thresholds for construction scenarios used to evaluate potential effects. The Level B distance to the 120 dB and 160 dB behavioral harassment zones does not change depending on the amount of activity per day since they are computed from the RMS source level. As noted in Table 9, it may be possible to install the 24-in piles on the same day as 36-in piles. If this occurs, overall construction days may be reduced for pile installation, thereby reducing the duration that marine mammals would be exposed to increased noise levels. However, to be precautionary the longest estimated duration for in-water construction and the maximum extent of underwater noise were used to analyze potential effects on marine mammals. As shown in Table 9, the maximum Level A distance would be 1,864 m (1.4 km^2) for phocids in water (PW), 3,484 m (3.38 km^2) for LF cetaceans, and 4,149 m (4.4 km^2) for HF cetaceans (although HF cetaceans are considered rare in the Action Area). Simultaneous installation of two 36-in piles at 30-ft and 20-ft socket depths is referred to as Scenario 1A and would result in the greatest potential area ensonified to NMFS thresholds. In-water DTH drilling or pile driving would result in approximately 54.99 km^2 (18,478 m distance) to Level B thresholds as shown in Table 9.

Table 9. Pile Sizes, Estimated Days for Simultaneous Pile Installation and Distances/Areas Ensonified During Construction[1]

Construction Scenario[2]	Pile Type	Total Piles	Contingency Days	Total Days Including contingency	Level A Max Distance Cetaceans[3] (m)	Level A Max Area Cetaceans[3] (km^2)	Level A Max Distance Pinnipeds[3] (m)	Level A Max Area Pinnipeds[3] (km^2)	Level B Distance All Species (m)	Level B Area All Species (km^2)
1A	36-in piles (one @30-ft socket depth and one @20-ft socket depth)	16	2	47	3,484 (LF) 4,149 (HF) 124 (MF)	3.38 (LF) 4.4 (HF) 0.03 (MF)	1,864 (PW) 136 (OW)	1.4 (PW) 0.03 (OW)	18,478	54.99
	32-in piles (Bent 1)	8	2							
See footnote 4	36-in piles (@20-ft socket depth)	See footnote 4			3,002 (LF) 3,576 (HF) 107 (MF)	2.75 (LF) 3.51 (HF) 0.02 (MF)	1,607 (PW) 117 (OW)	1.12 (PW) 0.03 (OW)	18,478	54.99
	24-in @ 20-ft socket depth and 36-in @ 30-ft socket depth simultaneously				2,885 (LF) 3,436 (HF) 103 (MF)	2.61 (LF) 3.31 (HF) 0.02 (MF)	1,544 (PW) 133 (OW)	1.06 (PW) 0.03 (OW)	18,478	54.99
2	24-in RHIB fender	3	2	16	647 (LF) 770 (HF) 23 (MF)	0.30 (LF) 0.40 (HF)	346 (PW) 25 (OW)	0.11 (PW) 0.0017 (OW)	18,478	54.99
	24-in Template	16	2							
	24-in Retaining Wall	2								
	24-in HP Pile	7								
3	24-in Pile Removal	16	2	4	51 (LF) 75 (HF) 5 (MF)	0.006 (LF) 0.012 (HF) ~ 0 (MF)	31 (PW)	0.002 (PW)	10,000	20.78
	Sheetpile Removal[5]	20	2	4	23 (LF) 35 (HF) 2 (MF)	0.001(LF) 0.003 (HF) ~ 0 (MF)	14 (PW)	0.0006 (PW)	4,642	5.27
	Anode Installation	n/a	2	18	n/a[6]	n/a	n/a	n/a	251	0.07
Optional	*Rock Chipping*	*unk*		*unk*	447 (LF)		215 (PW)		3,162	
TOTAL		**88**	**9**	**89**						

[1]Assumes simultaneous installation (i.e., two pile installations occurring at the same time).

[2] Scenario 1A presents the greatest extent of potential underwater noise and therefore is used to estimate potential marine mammal exposures. If rock chipping occurs, it has been accounted for by calculating takes based on the area enosonified during DTH. If required, it is not possible to estimate the number of days it may occur (per K. Mansfield Pers. Comm. June 25, 2020). Therefore, this application assumes it may occur during the days when DTH may be used and therefore takes are calculated based on DTH zones. DTH driving would be the dominant noise source during those days.
[3]Level A Max Distances are shown for cetaceans and pinnipeds by hearing group based on the NMFS User Spreadsheet and new DTH guidance. For all scenarios, the distances/areas for MF cetaceans are much smaller than for HF or LF and are therefore, not considered for determining mitigation and monitoring measures. These zones are based on the assumption that listed activities happen simultaneously. For example, two 36-in piles would be installed at a time as shown for Construction Scenario 1. Zones shown for Construction Scenario 2 assume two 24-in piles would be installed at a time.
[4]The most likely approach to installing 36-in piles is to drill two 36-in piles simultaneously to 20-ft depth. However, to be precautionary in accounting for the potential to impact marine mammals, this application assumes the socket depth will be 30 feet and hence, a larger ensonified area shown in the first row. It is possible that two 36-in piles (one at 20-ft socket depth and a second at 30-ft socket depth) may be driven simultaneously. As another option, 24-in piles may be driven on the same day as 36-in piles. If either of these options occur, overall days may be reduced for pile installation. These distances are less than if two 36-in piles are driven simultaneously.
[5]Total sheetpile is unknown but this assessment assumes 20 pairs.
[6]Anode installation would involve the use of a hydrogrinder or needle scaler. These tools would not result in reaching Lvel A thresholds.
Optional: indicates activities that are only contingencies. For example, rock chipping would occur during other sound-producing activities with greater threshold distances and therefore, are accounted for in the estimate of days required.

Intensity of Direct Impacts to Marine Mammals

As described above, for the purposes of the IEE assessment, the estimated marine mammal exposures to increased underwater noise due to construction provide the basis for assessing the extent, duration, intensity and significance of effects according to the EIA guidelines (Resolution 1 2016 Annex). Therefore, in the following discussion the term exposures or “take” is used to help describe a change that may be imposed on individual marine mammals. Estimated exposures or takes are also used to help describe the number of animals that may be affected by in-water construction.

Exposure to underwater noise that exceeds NMFS threshold levels (i.e., “takes”) for Level A (serious injury or mortality) and Level B (disturbance) could occur during construction due to a single take of an individual marine mammal or multiple takes of the same individuals. Despite the potential to adversely impact individual marine mammals, adverse effects on annual rates of recruitment or survival of the affected marine mammal species or stocks are not anticipated. Table 11 provides the total Level A and B takes as a percentage of each species abundance (from Table 1). If abundance is provided as a range, an average abundance was used to estimate the percentage of the population that could be affected by underwater noise that exceed NMFS thresholds.

PTS is a way to measure intensity of a potential effect such that if PTS occurs, it may be considered a long-term, permanent change to mammal hearing and therefore, significantly adverse. During construction at Palmer Pier, PTS would only be expected to occur if an animal is exposed to a noise source that exceeds the Level A exposure threshold for a full 24-hour duration. To minimize the potential for PTS, construction would occur over a 12-hour workday. Therefore, an individual animal would only be exposed to underwater noise for a maximum of 12 hours followed by a 12-hour period without the active noise source. After sound exposure ceases or between successive sound exposures, marine mammal hearing may recover although predicting the level of recovery (i.e., partial or complete recovery) is complicated. In addition, shutdown zones are proposed for LF cetaceans and pinnipeds to prevent exposure to levels of noise that may result in PTS (see Section 3.1). While some Level A exposure may occur, PTS is unlikely given the duration of exposure that exceed thresholds.

Most marine mammals in the immediate project area are pinnipeds that can haul out on land or swim with their heads above water, thereby minimizing exposure. As shown in Table 2, most seals observed in Hero Inlet during the period 2018 – 2020 were hauled out (i.e., not swimming under water) which would minimize potential impacts from project noise because of faster attenuation of sound in the air. Therefore, animals hauled out across the Inlet are not likely to experience Level A noise levels at all. In addition, the peninsula on which Palmer Station is situated would buffer underwater noise from entering Arthur Harbor. In 2018 – 2020, most humpback whales and one minke whale were observed in Arthur Harbor, not Hero Inlet (See Table 2). In addition, Hero Inlet is relatively narrow (135 – 150 m) and would likely inhibit large whales from entering. Taking this into account, animals would have to stay under water in or near Hero Inlet for an extended period during construction to be affected. This makes the potential for PTS even less likely. For these reasons, the intensity of potential effects on marine mammals would be minor.

As demonstrated by data in Tables 2 and 3, and considering how shallow and narrow Hero Inlet is, large cetaceans are not expected to be present within the identified Level A distances, particularly for long periods when strong anthropogenic sounds are present. Shutdown zones described in Section 3.1 would also minimize exposure to Level A thresholds. For pinnipeds, a 50-m shutdown zone would be established during all in-water construction to prevent any direct, physical interaction between Project activities and a marine mammal. During DTH driving of two 36-in piles, if a PSO observes a LF cetacean about to enter or within the estimated Level A zone (3,484 m), DTH activities will be shut down until the animal has not been observed within the zone for 30 minutes. During DTH driving of two 24-in piles, the Level A shutdown zone is 647 m for LF cetaceans. If these species are observed entering or within this Level A zone during 24-in pile installation, activities will be shut down until the animal has not been observed within the zone for 30 minutes.

Since DTH drilling, pile driving and other sound sources do not operate continuously over a 24-hour period (rather they would operate for a maximum of 12 hours a day), the shorter work schedule acts as a form of mitigation and minimizes the potential for prolonged exposure to sound sources that exceed the Level A thresholds established in NMFS (2018). Therefore, while exposure to Level A sound thresholds could occur if a cetacean (or pinniped) moves through the area, it is highly unlikely that PTS would occur given the duration of exposure and shutdown zones to be implemented. Animals are not expected to permanently abandon any area as a result of this Project, and any behaviors that are interrupted during the activity are expected to resume once the activity ceases. The exposure of pinnipeds to sounds produced by this Project is not expected to affect annual rates of recruitment or survival of the five species that may occur in the area. Mitigation and monitoring measures are described in Section 3.0.

For all marine mammals, exposure to underwater noise is estimated by considering the density of marine mammals per km^2. Each species has an estimated density (either nearshore or offshore, whichever is higher) based on the best available information. In addition, Level B takes for cetaceans including Arnoux's beaked whale, blue whale, hourglass dolphin, killer whale, sei whale, Southern right whale and sperm whale were adjusted based on group size such that a higher level of Level B take is estimated as compared to only using densities. Finally, where appropriate, takes are adjusted based on observation data as summarized in Table 2.

To calculate exposures, and potential for direct impacts, the highest density[2] is multiplied by the ensonified area (km^2) and the number of days the noise source could occur. Table 10 presents total estimated exposures for Level A and Level B by species taking into consideration local observation data, average group size and mitigation measures. These exposures comprise the extent of impacts of underwater noise on marine mammals due to construction at Palmer Pier.

DTH drilling or pile driving could result in temporary, short-term changes in typical animal behavior or avoidance of the affected area (Richardson et al. 1995). The biological significance of behavioral disturbances is difficult to predict, especially if the detected disturbances appear to be minor. Behavioral modification would only be considered biologically significant if the growth, survival, or reproduction are affected. Long-term, permanent impacts from Level A exposures are unlikely to occur. Any pinnipeds potentially exposed to Level A impact thresholds and potential injury would have to be in close proximity to the pier while transiting to or from foraging in areas. Therefore, the exposure would occur over a very short duration. As described above, if seals or LF cetaceans are observed during pile installation or

[2] For Antarctic minke whale, killer whale, long-finned pilot whale, southern bottlenose whale and sperm whale, takes are based on the highest density estimate available.

removal activities, activities would be shut down. Therefore, potential effects would be no more than minor, transitory impacts on marine mammals that may occur in the Action Area during construction.

Table 10. Total Level A and Level B Take[1,2]

Species	Total Level A Take	Total Level B Take
Antarctic Minke Whale (LF)	15	312
Arnoux's Beaked Whale (MF)[4]	0	12
Blue Whale (LF)[4]	0	2
Fin Whale (LF)	14	282
Hourglass Dolphin (HF)[4]	0	25
Humpback Whale (LF)	6	121
Killer Whale (MF)	0	112
Long-finned Pilot Whale (MF)	0	28
Southern Bottlenose Whale (MF)	0	24
Sei Whale (LF)[4]	0	6
Southern Right Whale (LF)[4]	0	20
Sperm Whale (MF)	0	17
Antarctic Fur Seal (OW)[3]	80	357
Crabeater Seal (PW)	120	6,129
Southern Elephant Seal (PW)	0	1
Leopard Seal (PW)[3]	5	5
Weddell Seal (PW)[3]	10	188

[1] For the purposes of the IEE assessment, the estimated marine mammal takes associated with exposure to increased underwater noise during in-water construction provide the basis for assessing the extent, duration, intensity and significance of effects according to the EIA guidelines (Resolution 1 2016 Annex). Estimated takes consider the mitigation and monitoring measures described in Section 3.

[2]Takes requested are shown in whole numbers, with anything below one counted as zero following NMFS guidance.

[3] Level A increased from calculated exposures based on observations presented in Table 2.

[4] Level B increased to account for group size. This is likely an overestimate.

Table 11. Total Level A and B Exposures[1] as a Percentage of Species Abundance

Species	Annual Level A and B Take[2]	Take as Percent of Abundance
Antarctic Minke Whale (LF)	327	0.0654%
Arnoux's Beaked Whale (MF)	12	0.0020%
Blue Whale (LF)	2	0.0870%
Fin Whale (LF)[3]	295	0.7749%
Hourglass Dolphin (HF)	25	0.0173%
Humpback Whale (LF)	127	0.2540%
Killer Whale (MF)	112	0.1400%
Long-finned Pilot Whale (MF)	28	0.0140%
Southern Bottlenose Whale (MF)	24	0.0048%
Sei Whale (LF)	6	0.9585%
Southern Right Whale (LF)	20	0.0667%
Sperm Whale (MF)	17	0.1417%
Antarctic Fur Seal (OW)	437	0.0162%
Crabeater Seal (PW)	6,249	0.0893%
Southern Elephant Seal (PW)	1	0.0001%
Leopard Seal (PW)	10	0.0045%
Weddell Seal (PW)	198	0.0198%

[1] For the purposes of the IEE assessment, the estimated marine mammal exposures to increased underwater noise during in-water construction provide the basis for assessing the extent, duration, intensity and significance of effects according to the EIA guidelines (Resolution 1 2016 Annex).
[2]Exposure estimates for these species have been adjusted based on NSF observation data in Table 2 and group sizes where appropriate.

Drilling and pile driving activities associated with the proposed Project have the potential to temporarily disturb or displace marine mammals due to increased underwater noise associated with pile removal and installation. Specifically, underwater sound generated from DTH drilling and pile driving during construction activities may result in increased noise levels that exceed the Level A or Level B harassment thresholds (behavioral disturbance) for all species authorized for take. Potential takes could occur if individuals of these species are present in the ensonified zones when drilling or pile driving is underway. Therefore, the proposed Project would have the potential to result in Level A and Level B takes by harassment of pinnipeds and cetaceans.

The potential impacts from behavioral disturbance or harassment (Level B) would be temporary. As noise exposure would not exceed 12 hours during any 24-hour period (a 12-hour workday followed by a 12-hour period without noise related to the Project), recovery from Level B sound exposure is expected to occur within each 24-hour period. Similarly, while Level A exposures to marine mammals (primarily pinnipeds) may occur, mitigation measures would be implemented to prevent PTS from occurring to any marine mammal. Considering the brief duration of increased noise levels and the proposed monitoring and mitigation measures, auditory impairment or other non-auditory physical effects as a result of activities at the Project site are considered highly unlikely.

While Level A exposures have been calculated for this project, the occurrence of PTS, serious injury, or death is not considered as this would be extremely unlikely for all authorized species. The estimation of Level A exposures is considered precautionary and helps to determine the appropriate level of mitigation and monitoring, which would further ensure that Level A takes are avoided and the possibility of PTS is further reduced. Any pinnipeds exposed to Level A take thresholds and potential injury would have to be in close proximity to the pier while transiting from one location to another within Hero Inlet. Therefore, the exposure would occur over a very short duration or the Project activity would be stopped until it was considered safe to resume the activity.

Potential effects on individual marine mammals due to underwater noise that may reach levels considered to be Level A or Level B harassment under the MMPA would be considered insignificant to minor. Most individuals would simply move through, or away from, the sound source or be temporarily displaced from the areas of DTH and pile driving. This reaction has been observed primarily only in association with impact pile driving. In response to vibratory driving, pinnipeds (which may become somewhat habituated to human activity) have been observed to orient towards and sometimes even move towards the sound. Repeated exposures of individuals to levels of sound that may cause Level B harassment are unlikely to result in hearing impairment or to significantly disrupt foraging behavior. Thus, even repeated Level B harassment of some small subset of the overall stock is unlikely to result in any significant realized decrease in fitness of individuals and would not result in any adverse impact to the stock.

Reversibility of Direct Impacts to Marine Mammals

As described above under "duration", direct impacts due to construction activities at Palmer Pier would be expected to be temporary disturbance or displacement that would not cause a decrease in fitness of any given individual. Therefore, effects would be reversible once the construction activity has ended. Irreversible impacts such as mortality from ship strikes or PTS from noise exposure are not expected.

2.2 Indirect Impacts to Marine Mammals

Construction Effects on Potential Prey and Foraging Habitat of Marine Mammals

Antarctic mysticetes feed primarily on krill, but may also forage for small fish, zooplankton, and possibly squid (Erbe et al. 2019). The odontocetes eat fish and squid, with certain killer whale ecotypes also hunting penguins and other marine mammals (both cetaceans and pinnipeds). Antarctic pinnipeds forage on krill, fish, zooplankton, and squid, with leopard seals also taking other seals and seabirds. Construction activities would produce continuous (i.e., vibratory pile driving) sounds and pulsed (i.e., impact-driving) sounds. Fish react to sounds that are especially strong or intermittent and low frequency. Short duration, sharp sounds can cause overt or subtle changes in fish behavior and local distribution. At present, NMFS uses 150 dB re 1 μPa7 as the SPL that may result in onset of behavioral effects (Caltrans 2015). Popper et al. (2019) summarized relevant data from 2005 to mid-2018 on the effects of sounds on fishes. The authors conclude that fish exposed to pile driving sounds may show alarm responses, including an increase in swimming speed and changes in ventilation and heart rate. These transient startle responses are unlikely to result in adverse impacts because the fish often rapidly return to normal behavior. However, stronger more sustained behavioral responses to longer duration sounds may place an energetic load on the fish by generate oxygen debt as ventilation rates increase. In addition, anthropogenic noise may interfere with the fishes' ability to detect, locate, and identify predator threats. Generally, the most likely impact to fish from pile-driving activities in the Project area would be temporary behavioral avoidance of the area and expected to be negligible.

There is not much information available on the effects of underwater noise on krill and zooplankton species, particularly noise from ship traffic and construction (Erbe et al. 2019). McCauley et al. (2017) presented evidence that suggests that seismic surveys can cause significant mortality to zooplankton populations. McCauley et al. (2017) conducted a 2-day study to examine the potential effects of sound exposure of a 150 in3 airgun on zooplankton off the coast of Tasmania; they concluded that exposure to airgun sound decreased zooplankton abundance compared to control samples and caused a two- to three-fold increase in adult and larval zooplankton mortality. They observed impacts on the zooplankton as far as 1.2 km from the exposure location – a much greater impact range than previously thought; however, there was no consistent decline in the proportion of dead zooplankton as distance increased and received levels decreased. The conclusions by McCauley et al. (2017) were based on a relatively small number of zooplankton samples, and more replication is required to increase confidence in the study findings. However, such seismic airguns that use these intense low-frequency impulses (4-8 Hz) and also release high pressure air into the water to produce the impulse signal, are not used for this project. Erbe et al. (2019) suggests that additional research on the impacts of anthropogenic noise on marine mammal prey and prey responses to noise are needed as part of research in Antarctica.

Water and Sediment Quality

In water DTH drilling, impact pile driving and pile removal activities using vibratory methods would cause short-term effects on water quality due to increased turbidity. The physical resuspension of sediments could produce localized turbidity plumes that could last from a few minutes to several hours.

While contaminated sediments are not expected at the Project site, any contaminants associated with the re-suspended sediments would be tightly bound to the sediment matrix. Cetaceans are not expected to come close enough to Project site to encounter temporary turbidity plumes from construction activities. Any pinnipeds in the immediate vicinity would avoid the short-term, localized areas of turbidity. There is little potential for them to be directly exposed to increased turbidity during construction operations, but these short term increases in water turbidity levels could temporarily affect the distribution and availability of their prey species. Overall, any impacts on marine mammals from increased turbidity levels would be short term and negligible.

Increased turbidity from construction activities has the potential to adversely affect forage fish and in the Project area. However, suspended sediments and particulates are expected to dissipate quickly within a single tidal cycle, and any effects on forage fish or krill from increased turbidity are expected to be short term and minor or negligible.

2.3 Impact Summary

Temporary changes in an animal's typical behavior or avoidance of the affected area are the most common responses of marine mammals to increased noise levels. Marine mammal exposures to underwater noise generated during construction activities would possibly result in the potential for Level A and Level B takes as determined by established criteria (NMFS 2018). However, the relatively short duration of these exposures is not expected to result in anything more than biologically insignificant to minor, transitory effects to any of the marine mammal species that may be taken during this Project.

Avoidance responses may be initially strong if the marine mammals move away from the source or weak if animal movement is only slightly deflected away from the source. This type of behavioral response might further protect animals from elevated sound exposures.

The biological significance of potential behavioral disturbances is difficult to predict, especially if the detected disturbances seem to be minor. However, it is likely that impacts or responses to elevated sound sources in this Project would be short-term, localized and would have no biological significance to reproduction and survival rates or population trends. This determination is based on: (1) the overall effectiveness of proposed mitigation measures at minimizing the effects of DTH drilling and pile driving and associated construction activities; (2) the low probability of serious injury or mortality to species from underwater noise or the physical presence of vessels and humans do in large part to the shortened duration of noise-producing activities during any 24-hour period; and (3) the anticipated incidents of Level B harassment likely consisting of nothing more than minor biologically insignificant, short-term modifications in behavior. There is no indication that the activities at Palmer Station would have greater than a temporary impact on marine mammal behavioral in the Project area. Serious injury or mortality is not anticipated from the proposed activities. There is no indication that the activities would have any impacts on reproductive or survival rates of any of the species and would therefore not result in population-level impacts.

3 MARINE MAMMALS – MITIGATION

3.1 Mitigation Measures

NSF has based the proposed mitigation measures on the best guidance available to avoid and minimize (to the greatest extent possible) impacts on the environment, species protected under the MMPA, and ESA species and their designated critical habitats.

Mitigation measures to reduce total exposures (i.e., takes) to underwater noise (e.g., shutdown and a reduced 12-hour workday) would be employed during in-water construction work at the pier. General mitigation measures used for all construction practices are listed first, followed by specific mitigation measures for pile installation activities.

General Construction Activities

NSF would perform construction in accordance with the best guidance available (e.g., BMPs and mitigation measures) to avoid and minimize (to the greatest extent possible) impacts on the environment, ESA species, designated critical habitats, and species protected under the MMPA. Mitigation measures include:

- The pier would be maintained in a manner that does not introduce any pollutants or debris into the harbor or cause a migration barrier for fish;
- Fuels, lubricants, and other hazardous substances would not be stored below the ordinary high-water mark;
- Properly sized equipment would be used to drive piles;
- Oil booms would be readily available for containment should any releases occur;
- The contractor would check for leaks regularly on any equipment, hoses, and fuel storage that occur at the project site;
- All chemicals and petroleum products would be properly stored to prevent spills; and
- No petroleum products, cement, chemicals, or other deleterious materials would be allowed to enter surface waters.

Standard Mitigation Measures

For any in-water work that involves heavy machinery other than pile driving (e.g., excavator in water), if a marine mammal comes within 10 m, operations shall cease. A work barge will be mobilized to the site by vessel and once the barge is in place, will provide a stationary platform for installing piles. When transiting to site, marine mammal watches must be conducted by those navigating the vessel or crew. When in the Project Area, if a whale is sighted in the path of a support vessel or within 92 m (300 feet) from the vessel, reduce speed and shift the engine to neutral. Do not engage the engines until the animals are clear of the area. If a whale is sighted farther than 92 m (300 feet) from the vessel, maintain a distance of 92 m (300 feet) or greater between the whale and the vessel and reduce speed to 10 knots or less . Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group. A group is defined as being three or more whales observed within a 500 m area and displaying behaviors of directed or coordinated activity (e.g., group feeding). It should be reemphasized that whale occurrence in the proposed Project Area is limited based on how narrow Hero Inlet is. Therefore, the need to steer around whales in the area should be minimal.

Pile Removal and Installation Activities

The primary source of underwater sound during construction would be from the removal and installation of piles to support the pier. Piles would be removed by cutting piles off at the mudline or using a vibratory hammer. NSF would drive piles using DTH driving prior to using an impact hammer. A vibratory hammer would be used to remove existing piles and sheet piles. If rock chipping is necessary, takes have been calculated assuming DTH occurs. Therefore, takes associated with rock chipping are accounted for in takes estimated for DTH. The minimum hammer energy needed to safely install the piles would be used.

During installation of the piles, the primary technique for installing the piles would be the DTH driving technique. The maximum distances that sound would Project from the Project were calculated using NMFS guidance that DTH be considered a continuous sound source for Level B harassment and an impulsive sound source for Level A impacts. Chapter 2 describes the ensonified exposure areas for cetaceans and pinnipeds that may occur in the Project area.

The following subsections describe proposed mitigation measures of soft start, pre-activity monitoring of the immediate area within the Level A zone, a 50-m shutdown zone for seals and 3,500-m and 650-m shutdown zones for LF cetaceans based on the estimated ensonified area during pile or sheetpile removal/driving or DTH driving activities. These measures would reduce impacts on marine mammals to the extent practicable during in-water construction. In addition to the mitigation measures listed here, NSF also proposes specific monitoring measures including the use of PSOs as described in detail in below.

Soft Start

When impact pile driving is used, NSF would implement a “soft-start” procedure using reduced energy (i.e., no more than half of the operational power) to allow animals to leave the area prior to full sound exposure. Specifically, NSF would use the soft-start technique at the beginning of impact pile driving each day, or if pile driving has ceased for more than 30 minutes. The requirements for soft start include a brief interval of pile driving at reduce energy, followed by a 1-minute waiting period, repeated two subsequent times.

Time Restriction

In-water construction would occur over a 12-hour workday followed by a 12-hour period without noise due to Project activities. This intermittent exposure would allow for a period of potential ‘recovery’ within each 24 hour period to minimize the potential for PTS. The reduced workday minimizes the potential for PTS.

Level A Shutdown Zones

Shutdown zones are regularly used as an effective mitigation measure to minimize exposure of marine mammals to thresholds that may cause harm. Shutdown zones can be variable and are Project-specific, ranging from 10 m[3] to several hundred meters depending on noise modeling, human safety and local conditions. A total of two Protected Species Observers (PSOs) would monitor Level A shutdown zones from two elevated locations at the Project site as shown below. The proposed monitoring locations are:

- A primary location on the roof platform of the Garage Warehouse Recreation (GWR) building located high on the bluff above Palmer Pier. The GWR building sits 9.8 m above sea level and the platform on the roof is another 9-10.5 m above that, giving a total elevation of approximately 20 m above sea level for observations. With reticle binoculars the distance potentially visible by a 1.8-m tall PSO from this point would be about 4,360 m.
- An office within the BioLab building or its observation deck overlooking the pier. Figure 11-2 shows the view from the office location. The BioLab building observation deck near Palmer Pier with an elevation of about 3.5 m above sea level. Assuming the height of an observer is about 1.8 m and they are using 5 mil reticle binoculars, this would allow visualization out to about 1,060 m.

During all DTH drilling, pile driving or removal activities, a 50-m shutdown zone would be implemented. If pinnipeds are found within the 50-m shutdown zone, DTH driving would be delayed until they move out of the area. If a seal is seen by the PSOs above water and then dives below, the contractor would wait 15 minutes. If no pinnipeds are seen by the PSOs in that time, work can resume based on the assumption the animal has moved away from the shutdown area.

A 50-m shutdown would avoid exposure of Southern elephant seals (otariids) to Level A thresholds that could be reached if they remained underwater for one hour (i.e., distance to Level A for a 1-hour duration is estimated at 30 m). While the estimated distance for Antarctic fur seals for a 1-hour duration is larger (413 m), the distance across Hero Inlet is approximately 135 m. Based on observation data, fur seals are known to swim up Hero Inlet to haul out (Table 2). The Project location is not conducive to placing observers in vessels or on remote lands away from Palmer Station where the edges of Level A thresholds are estimated. To allow construction to continue safely and efficiently so as not to extend the overall construction schedule (and therefore increase level of marine mammal exposure to underwater noise), a 50-m shutdown zone can safely be observed, would prevent injury to seals while still allowing seals to move up the inlet where they may haul out on land.

During DTH driving of two 36-in piles, if a PSO observes a LF cetacean about to enter or within the estimated Level A zone (3,500 m), DTH activities will be shut down until the animal has not been observed within the zone for 30 minutes. During DTH driving of two 24-in piles, the Level A shutdown zone is 650 m for LF cetaceans. If these species are observed entering or within this Level A zone during 24-in pile installation, activities will be shut down until the animal has not been observed within the zone for 30 minutes.

Protected Species Observers

PSOs would conduct marine mammal monitoring during all pile removal or driving activities. In addition to notifying work crews to shut down operations if necessary to prevent non-acoustic injury to marine mammals from potentially hazardous in-water construction activities at the pier, PSOs would record observations and behavioral responses of any marine mammals observed during drilling operations. Two

[3] For example, during impact driving of 36-in piles for a pier in New London, Connecticut, NMFS issued a Letter of Authorization in 2018 to the U.S. Navy to implement a 10-m shutdown zone for Level A thresholds that exceeded 900m (83 FR 36773).

PSOs would be on duty during construction and two alternate PSOs would be on site and rotate through the observer positions in 4-hour shifts as described below. The lead PSO would have previous experience and be trained in marine mammal identification and behaviors. The other three PSOs need not be formally trained through a PSO program but must have received specific training (in person or through online PSO training programs compliant with NMFS standards), be familiar with the marine mammal species that may occur and understand the applicable sections of this Monitoring Program. PSOs would have no other Project-related tasks while monitoring.

NSF would implement the following monitoring procedures during pile removal and installation:

- PSOs would be on duty in shifts of 4 hours duration, with sufficient breaks and a maximum of 12 hours watch time per day per PSO; the exact shift schedule would be established prior to Project initiation.
- PSOs would scan the waters using reticle binoculars and would use a hand-held GPS or range-finder device to verify the distance to each sighting.
- If the shutdown zones are not visible due to poor environmental conditions, (e.g., excessive wind or fog, high Beaufort state), pile installation would cease.
- DTH drilling or pile driving activities would only be conducted during daylight hours when it is possible to visually monitor marine mammals.
- A PSO would be placed in two elevated vantage points as described above. Local conditions present safety concerns due to the potential for severe weather and the remote location. For this reason, it is not safe nor feasible to place observers on vessels or on land at the edges of the Level A zones.
- The waters would be monitored 30 minutes prior to commencing DTH drilling or pile driving at the beginning of each day, and prior to commencing drilling or pile driving after any stoppage of 30 minutes or greater. If marine mammals enter or are observed within the designated shutdown zones during or 15 minutes prior to drilling or driving, the PSOs would notify the on-site construction manager to not begin until the animal has moved outside the designated radius or has not been observed for 15 minutes.
- All animals entering the Level A zone would be considered Level A takes.
- The waters would continue to be scanned for at least 30 minutes after DTH drilling or pile driving has completed each day, and after each stoppage of 30 minutes or greater.
- If DTH drilling or pile driving is stopped, pile installation would not commence or would be suspended temporarily if any marine mammals are observed anywhere within the shutdown zones.
- In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by the IHA, such as serious injury or mortality (e.g., ship-strike), the PSO would immediately cease the specified activities and report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS as soon as possible.

PSO OBSERVATION LOCATIONS

Monitoring Protocol

PSOs have a dedicated role to observe and record data on marine mammals and would follow these general protocols during monitoring:

- Observe from the safest, highest vantage point at the three locations identified (Biolab, GWR Building or support tug);
- Conduct a systematic visual sweep of the area as far as visibility permits, focusing on a 2-km radius from the pier into Hero Inlet;
- Alternate between binoculars and the naked eye; and

- Limit monitoring to 4 hours per shifts with sufficient breaks and no more than 12 hours per day to minimize fatigue.
- PSOs would observe and collect data on marine mammals in and around the Project area for 15 minutes before, during, and for 30 minutes after all pile removal and pile installation work.

Communication Procedures

Briefings would occur between construction supervisors and crews and the PSO team prior to the start of all pile driving activities, and when new personnel join the work, in order to explain responsibilities, communication procedures, marine mammal monitoring protocol, and operational procedures.

If marine mammals are detected within the shutdown zones, shutdown procedures would be implemented. To assure prompt implementation of these procedures, multiple channels of communication between the PSOs and the construction supervisor would be established. During the shutdown, PSOs would continue to maintain watch to determine when the animal(s) are outside the shutdown zones. Sheet pile and pipe driving can be resumed if the observers have visually confirmed that the animal(s) moved outside the safety zone, or in the case of otariid pinnipeds were not observed within the shutdown zone for more 15 minutes. Direct communication with the construction supervisor would be maintained throughout these procedure

Data Collection

NSF would require that observers use approved data forms developed for this Project. Among other pieces of information, the observers would record detailed information about any implementation of shutdowns, including the distance of animals to the pile and description of specific actions that ensued and resulting behavior of the animal, if any. In addition, the observers would attempt to distinguish between the number of individual animals taken and the number of incidents of take. At a minimum, the following information would be collected on the observer forms:

1. Date and time that monitored activity begins or ends;
2. Construction activities occurring during each observation period;
3. Weather parameters (e.g., percent cover, visibility);
4. Water conditions (e.g., sea state, tide state);
5. Species, numbers, and, if possible, sex and age class of marine mammals;
6. Description of any marine mammal behavior patterns, including bearing and direction of travel and distance from DTH drilling or pile driving activity;
7. Distance from drilling or pile driving activities to marine mammals and distance from the marine mammals to the observation point;
8. Description of implementation of mitigation measures (e.g., shutdown or delay);
9. Locations of all marine mammal observations; and
10. Other human activity in the area.

3.2 Mitigation Summary

NSF has developed the proposed mitigation measures to ensure the least practicable impact on potentially affected marine mammal species and stocks and their habitat. The potential measures include consideration of: (1) the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals; (2) the proven efficacy of the specific measure to minimize adverse impacts as planned based on monitoring plans from previous, similar IHA applications incorporating DTH drilling and impact and vibratory pile driving; and (3) the practicability of the measure for implementation.

Based on these factors NSF believes the mitigation measures being considered accomplish the required objectives:

- Implementation of a soft-start procedure to reduce the total number of animals potentially exposed to increased noise levels from DTH drilling and impact pile driving;
- Implementation of a 12-hour workday followed by a 12-hour period without increased noise from the Project allowing for acoustic "recovery" throughout each 24-hour period;
- The use of PSOs and a shutdown procedure that would reduce the total amount of time and exposure that a marine mammal is potentially exposed to noise levels that exceed the Level A thresholds established by NMFS.

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APPENDIX C

CONTRACTOR-PROVIDED PLANS

- SAFETY DATA SHEET FOR DEXPAN®
- SAFETY DATA SHEET FOR SURE-GRIP HIGH PERFORMANCE GROUT
- CRANE ASSEMBLY PAD CONSTRUCTION PLAN

APPENDIX C
CONTRACTOR-PROVIDED PLANS

- SAFETY DATA SHEET FOR DEXPAN®
- SAFETY DATA SHEET FOR SURE-GRIP HIGH PERFORMANCE GROUT
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SAFETY DATA SHEET

DEXPAN (Non-Explosive Demolition Agent)

Section 1. Identification

GHS product identifier : DEXPAN (Non-Explosive Demolition Agent)

Product code : Not available.

Other means of identification : Expanding Cement.

Product type : Powder.

Relevant identified uses of the substance or mixture and uses advised against

Identified uses : For controlled demolition, reinforced concrete cutting, rock breaking, quarrying, stone dimension, mining, excavating...

Manufacturer :
Archer Company USA, Inc.
2031 Appaloosa Dr.
Sunland Park, NM 88063
Tel: 575-528-5454
Fax: 575-528-5458
Toll Free: 866-272-4378

Distributor/Canada :

Emergency telephone number (with hours of operation) : +1-575-528-5454 (24/7)

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture :
SKIN CORROSION/IRRITATION - Category 2
SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 1
SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Respiratory tract irritation) - Category 3

GHS label elements

Hazard pictograms :

Signal word : Danger

Section 2. Hazards identification

Hazard statements : H318 - Causes serious eye damage.
H315 - Causes skin irritation.
H335 - May cause respiratory irritation.

Precautionary statements

Prevention : P280 - Wear protective gloves. Wear eye or face protection.
P271 - Use only outdoors or in a well-ventilated area.
P261 - Avoid breathing dust.
P264 - Wash hands thoroughly after handling.

Response : P304 + P340 + P312 - IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER or physician if you feel unwell.
P302 + P352 + P362+P364 - IF ON SKIN: Wash with plenty of soap and water. Take off contaminated clothing and wash it before reuse.
P332 + P313 - If skin irritation occurs: Get medical attention.
P305 + P351 + P338 + P310 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or physician.

Storage : P405 - Store locked up.

Disposal : P501 - Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : Not applicable.

Section 3. Composition/information on ingredients

Substance/mixture : Mixture

Other means of identification : Expanding Cement.

Ingredient name	%	CAS number
Calcium dihydroxide	≥75 - ≤90	1305-62-0

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Get medical attention immediately. Call a poison center or physician. Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 20 minutes. Chemical burns must be treated promptly by a physician.

Inhalation : Get medical attention immediately. Call a poison center or physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Section 4. First aid measures

Skin contact : Get medical attention immediately. Call a poison center or physician. Flush contaminated skin with plenty of water. Wash contaminated clothing thoroughly with water before removing it, or wear gloves. Continue to rinse for at least 20 minutes. Chemical burns must be treated promptly by a physician. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Get medical attention immediately. Call a poison center or physician. Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Chemical burns must be treated promptly by a physician. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Causes serious eye damage.

Inhalation : May cause respiratory irritation.

Skin contact : Causes skin irritation.

Ingestion : No known significant effects or critical hazards.

Over-exposure signs/symptoms

Eye contact : Adverse symptoms may include the following:
pain
watering
redness

Inhalation : Adverse symptoms may include the following:
respiratory tract irritation
coughing

Skin contact : Adverse symptoms may include the following:
pain or irritation
redness
blistering may occur

Ingestion : Adverse symptoms may include the following:
stomach pains

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media	: Use an extinguishing agent suitable for the surrounding fire.
Unsuitable extinguishing media	: None known.
Specific hazards arising from the chemical	: No specific fire or explosion hazard.
Hazardous thermal decomposition products	: Decomposition products may include the following materials: metal oxide/oxides
Special protective actions for fire-fighters	: Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.
Special protective equipment for fire-fighters	: Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel	: No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Do not breathe dust. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.
For emergency responders	: If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".
Environmental precautions	: Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Spill	: Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labeled waste container. Avoid creating dusty conditions and prevent wind dispersal. Dispose of via a licensed waste disposal contractor. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures	: Put on appropriate personal protective equipment (see Section 8). Do not get in eyes or on skin or clothing. Do not breathe dust. Do not ingest. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.

Section 7. Handling and storage

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination. See Section 10 for incompatible materials before handling or use.

Section 8. Exposure controls/personal protection

Control parameters

United States

Occupational exposure limits

Ingredient name	Exposure limits
Calcium dihydroxide	**ACGIH TLV (United States, 3/2017).** TWA: 5 mg/m³ 8 hours. **NIOSH REL (United States, 10/2016).** TWA: 5 mg/m³ 10 hours. **OSHA PEL (United States, 6/2016).** TWA: 5 mg/m³ 8 hours. Form: Respirable fraction TWA: 15 mg/m³ 8 hours. Form: Total dust

Canada

Occupational exposure limits

Ingredient name	Exposure limits
Calcium dihydroxide	**CA Alberta Provincial (Canada, 4/2009).** 8 hrs OEL: 5 mg/m³ 8 hours. **CA British Columbia Provincial (Canada, 7/2016).** TWA: 5 mg/m³ 8 hours. **CA Ontario Provincial (Canada, 7/2015).** TWA: 5 mg/m³ 8 hours. **CA Quebec Provincial (Canada, 1/2014).** TWAEV: 5 mg/m³ 8 hours. **CA Saskatchewan Provincial (Canada, 7/2013).** STEL: 10 mg/m³ 15 minutes. TWA: 5 mg/m³ 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Environmental exposure controls : In some cases, dust collection, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Section 8. Exposure controls/personal protection

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles and/ or face shield. If inhalation hazards exist, a full-face respirator may be required instead.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Based on the hazard and potential for exposure, select a respirator that meets the appropriate standard or certification. Respirators must be used according to a respiratory protection program to ensure proper fitting, training, and other important aspects of use.

Section 9. Physical and chemical properties

Appearance

Physical state	: Solid. [Powder.]
Color	: Gray.
Odor	: Odorless.
Odor threshold	: Not available.
pH	: Not available.
Melting point	: 1000°C (1832°F)
Boiling point	: Not available.
Flash point	: Not available.
Evaporation rate	: Not available.
Flammability (solid, gas)	: Not available.
Lower and upper explosive (flammable) limits	: Not available.
Vapor pressure	: Not available.
Vapor density	: Not available.
Relative density	: 3.2
Solubility	: Very slightly soluble in the following materials: cold water.
Partition coefficient: n-octanol/water	: Not available.
Auto-ignition temperature	: Not available.
Decomposition temperature	: Not available.
Viscosity	: Not available.
Flow time (ISO 2431)	: Not available.

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : No specific data.

Incompatible materials : Reactive or incompatible with the following materials: moisture.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
Calcium dihydroxide	LD50 Oral	Rat	7340 mg/kg	-

Irritation/Corrosion

Product/ingredient name	Result	Species	Score	Exposure	Observation
Calcium dihydroxide	Eyes - Severe irritant	Rabbit	-	10 mg	-

Sensitization

There is no data available.

Mutagenicity

There is no data available.

Carcinogenicity

There is no data available.

Reproductive toxicity

There is no data available.

Teratogenicity

There is no data available.

Specific target organ toxicity (single exposure)

Name	Category	Target organs
Calcium dihydroxide	Category 3	Respiratory tract irritation

Specific target organ toxicity (repeated exposure)

There is no data available.

Aspiration hazard

There is no data available.

Information on the likely routes of exposure : Dermal contact. Eye contact. Inhalation. Ingestion.

Potential acute health effects

Section 11. Toxicological information

Eye contact : Causes serious eye damage.

Inhalation : May cause respiratory irritation.

Skin contact : Causes skin irritation.

Ingestion : No known significant effects or critical hazards.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : Adverse symptoms may include the following:
pain
watering
redness

Inhalation : Adverse symptoms may include the following:
respiratory tract irritation
coughing

Skin contact : Adverse symptoms may include the following:
pain or irritation
redness
blistering may occur

Ingestion : Adverse symptoms may include the following:
stomach pains

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : No known significant effects or critical hazards.

Potential delayed effects : No known significant effects or critical hazards.

Long term exposure

Potential immediate effects : No known significant effects or critical hazards.

Potential delayed effects : No known significant effects or critical hazards.

Potential chronic health effects

General : Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

There is no data available.

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
Calcium dihydroxide	Acute LC50 33884.4 µg/L Fresh water	Fish - Clarias gariepinus - Fingerling	96 hours

Persistence and degradability

There is no data available.

Bioaccumulative potential

There is no data available.

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling empty containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 14. Transport information

	DOT Classification	TDG Classification	IMDG	IATA
UN number	Not regulated.	Not regulated.	Not regulated.	Not regulated.
UN proper shipping name	-	-	-	-
Transport hazard class(es)	-	-	-	-
Packing group	-	-	-	-
Environmental hazards	No.	No.	No.	No.

AERG : Not applicable.

Section 14. Transport information

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): All components are listed or exempted.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : SKIN CORROSION/IRRITATION - Category 2
SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 1
SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Respiratory tract irritation) - Category 3

Composition/information on ingredients

Name	Classification
Calcium dihydroxide	SKIN CORROSION/IRRITATION - Category 2 SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 1 SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Respiratory tract irritation) - Category 3

SARA 313

There is no data available.

State regulations

Massachusetts : The following components are listed: Calcium dihydroxide; Silica, vitreous; Diiron trioxide; Aluminium oxide

New York : None of the components are listed.

New Jersey : The following components are listed: Calcium dihydroxide; Silica, vitreous; Diiron trioxide; Aluminium oxide

Pennsylvania : The following components are listed: Calcium dihydroxide; Diiron trioxide; Aluminium oxide

California Prop. 65

No products were found.

Section 15. Regulatory information

Canada

Canadian lists

Canadian NPRI : None of the components are listed.

CEPA Toxic substances : None of the components are listed.

Canada inventory (DSL NDSL) : All components are listed or exempted.

Section 16. Other information

Procedure used to derive the classification

Classification	Justification
SKIN CORROSION/IRRITATION - Category 2 SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 1 SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Respiratory tract irritation) - Category 3	Calculation method Calculation method Calculation method

History

Date of issue mm/dd/yyyy : 01/15/2018

Date of previous issue : 04/15/2015

Version : 6

Prepared by : KMK Regulatory Services Inc.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Safety Data Sheet
acc. to OSHA HCS

Printing date 09/29/2016 Reviewed on 09/29/2016

1 Identification

· ***Product identifier***

· ***Trade name:*** ***Sure-Grip® High Performance Grout***

· ***Article number:*** *83-67440*

· ***Application of the substance / the mixture***

· ***Details of the supplier of the safety data sheet***

· ***Manufacturer/Supplier:***

Dayton® Superior
4226 Kansas Avenue *Tel.: (866) 329-8724*
Kansas City, KS 66106

Emergency Telephone Number: Use only in the event of an emergency involving a spill, leak, fire, exposure, or accident involving chemicals. Within the U.S., Canada, or the U.S. Virgin Islands, call ChemTrec at (800) 424-9300, 24 hours a day. Or, outside these areas, call international number, +1 703 741-5970. Collect calls are accepted.

· ***Information department:*** *Environmental, Health, and Safety department.*

2 Hazard(s) identification

· ***Classification of the substance or mixture***

Skin Corr. 1C	*H314*	*Causes severe skin burns and eye damage.*
Eye Dam. 1	*H318*	*Causes serious eye damage.*
Skin Sens. 1	*H317*	*May cause an allergic skin reaction.*
Carc. 1A	*H350*	*May cause cancer.*
STOT SE 3	*H335*	*May cause respiratory irritation.*

· ***Label elements***

· ***GHS label elements*** *The product is classified and labeled according to the Globally Harmonized System (GHS).*

· ***Hazard pictograms***

GHS05 GHS07 GHS08

· ***Signal word*** *Danger*

· ***Hazard-determining components of labeling:***

Cement, portland, chemicals
Quartz (SiO2)

· ***Hazard statements***

Causes severe skin burns and eye damage.
May cause an allergic skin reaction.
May cause cancer.
May cause respiratory irritation.

· ***Precautionary statements***

Do not breathe dusts or mists.
If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Immediately call a POISON CENTER/doctor.
Store locked up.
Dispose of contents/container in accordance with local/regional/national/international regulations.

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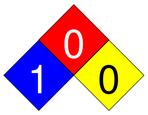
Trade name: Sure-Grip® High Performance Grout

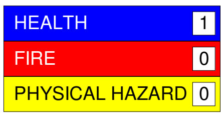
(Contd. of page 1)

· **Classification system:**
· **NFPA ratings (scale 0 - 4)**



Health = 1
Fire = 0
Reactivity = 0

· **HMIS-ratings (scale 0 - 4)**



Health = 1
Fire = 0
Reactivity = 0

· **Other hazards**
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.
· **vPvB:** Not applicable.

3 Composition/information on ingredients

· **Chemical characterization: Mixtures**
· **Description:** Mixture of the substances listed below with nonhazardous additions.

· **Dangerous components:**		
14808-60-7	Quartz (SiO2)	50-75%
65997-15-1	Cement, portland, chemicals	25-50%
13397-24-5	Gypsum (Calcium sulfate)	≤ 2.5%

· **Additional information:** For the wording of the listed hazard phrases refer to section 16.

4 First-aid measures

· **Description of first aid measures**
· **General information:**
Immediately remove any clothing soiled by the product.
In the event of persistent symptoms recieve medical treatment.
· **After inhalation:**
Supply fresh air and to be sure call for a doctor.
In case of unconsciousness place patient stably in side position for transportation.
Immediately move exposed person to fresh air. If breathing difficulty persists or develops get prompt medical attention.
· **After skin contact:**
Immediately wash with water and soap and rinse thoroughly.
Immediately rinse with water.
If skin irritation continues, consult a doctor.
· **After eye contact:** Rinse opened eye for several minutes under running water. Then consult a doctor.
· **After swallowing:**
Drink copious amounts of water and provide fresh air. Immediately call a doctor.
Seek medical treatment.
· **Information for doctor:**
· **Most important symptoms and effects, both acute and delayed** No further relevant information available.
· **Indication of any immediate medical attention and special treatment needed** No further relevant information available.

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Trade name: Sure-Grip® High Performance Grout

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5 Fire-fighting measures

· ***Extinguishing media***
· ***Suitable extinguishing agents:***
CO_2, extinguishing powder or water spray. Fight larger fires with water spray or alcohol resistant foam.
· ***Special hazards arising from the substance or mixture*** *No further relevant information available.*
· ***Advice for firefighters***
· ***Protective equipment:***
Because fire may produce thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full face piece operated in pressure-demand or positive-pressure mode.

6 Accidental release measures

· ***Personal precautions, protective equipment and emergency procedures***
Wear protective equipment. Keep unprotected persons away.
· ***Environmental precautions:***
Do not allow product to reach sewage system or any water course.
Inform respective authorities in case of seepage into water course or sewage system.
No special measures required.
· ***Methods and material for containment and cleaning up:***
Use neutralizing agent.
Dispose contaminated material as waste according to item 13.
Ensure adequate ventilation.
· ***Reference to other sections***
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.

7 Handling and storage

· ***Handling:***
· ***Precautions for safe handling***
Wear appropriate personal protective clothing to prevent eye and skin contact. Avoid breathing vapors or mists of this product. Use with adequate ventilation. Do not take internally.
· ***Information about protection against explosions and fires:*** *Keep respiratory protective device available.*

· ***Conditions for safe storage, including any incompatibilities***
· ***Storage:*** *cool and dry*
· ***Requirements to be met by storerooms and receptacles:*** *No special requirements.*
· ***Information about storage in one common storage facility:*** *Store away from foodstuffs.*
· ***Further information about storage conditions:*** *Keep receptacle tightly sealed.*
· ***Specific end use(s)*** *No further relevant information available.*

8 Exposure controls/personal protection

· ***Additional information about design of technical systems:*** *No further data; see item 7.*

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Trade name: Sure-Grip® High Performance Grout

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· **Control parameters**

· **Components with limit values that require monitoring at the workplace:**	
14808-60-7 Quartz (SiO2)	
PEL	see Quartz listing
REL	Long-term value: 0.05* mg/m³ *respirable dust; See Pocket Guide App. A
TLV	Long-term value: 0.025* mg/m³ *as respirable fraction
65997-15-1 Cement, portland, chemicals	
PEL	Long-term value: 50 mppcf or 15* 5** mg/m³ *total dust **respirable fraction
REL	Long-term value: 10* 5** mg/m³ *total dust **respirable fraction
TLV	Long-term value: 1* mg/m³ E; *as respirable fraction
13397-24-5 Gypsum (Calcium sulfate)	
REL	Long-term value: 10* 5** mg/m³ *Total dust; **Respirable fraction
TLV	Long-term value: 10* mg/m³ *as inhalable fraction

· **Additional information:** The lists that were valid during the creation were used as basis.

· **Exposure controls**
· **Personal protective equipment:**
· **General protective and hygienic measures:**
Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Store protective clothing separately.
Avoid contact with the eyes and skin.
· **Breathing equipment:** Suitable respiratory protective device recommended.
· **Protection of hands:**

Protective gloves

The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
· **Eye protection:** Wear appropriate eye protection to prevent eye contact.

9 Physical and chemical properties

· **Information on basic physical and chemical properties**
· **General Information**
· **Appearance:**

Form:	Solid
Color:	According to product specification
· **Odor:**	Characteristic
· **Odor threshold:**	Not determined.

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Trade name: Sure-Grip® High Performance Grout

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· **pH-value:**	*Not applicable.*
· **Change in condition** **Melting point/Melting range:** **Boiling point/Boiling range:**	 *Undetermined.* *>999 °C (>1830 °F)*
· **Flash point:**	*Not applicable.*
· **Flammability (solid, gaseous):**	*Not determined.*
· **Ignition temperature:**	
Decomposition temperature:	*Not determined.*
· **Auto igniting:**	*Product is not selfigniting.*
· **Danger of explosion:**	*Product does not present an explosion hazard.*
· **Explosion limits:** **Lower:** **Upper:**	 *Not determined.* *Not determined.*
· **Vapor pressure:**	*Not applicable.*
· **Density at 20 °C (68 °F):** · **Relative density** · **Vapor density** · **Evaporation rate**	*2.85531 g/cm³ (23.828 lbs/gal)* *Not determined.* *Not applicable.* *Not applicable.*
· **Solubility in / Miscibility with** **Water:**	 *Soluble.*
· **Partition coefficient (n-octanol/water):**	*Not determined.*
· **Viscosity:** **Dynamic:** **Kinematic:**	 *Not applicable.* *Not applicable.*
· **Solvent content:** **Organic solvents:**	 *0.0 %*
Solids content: · **Other information**	*100.0 %* *No further relevant information available.*
· **Volatile Organic Compounds:**	*Not determined*

10 Stability and reactivity

· **Reactivity** *No decomposition if stored and applied as directed.*
· **Chemical stability** *No decomposition if stored and applied as directed*
· **Thermal decomposition / conditions to be avoided:** *No decomposition if used according to specifications.*
· **Possibility of hazardous reactions** *No dangerous reactions known.*
· **Conditions to avoid** *Keep away from heat and sources of ignition.*
· **Incompatible materials:** *No further relevant information available.*
· **Hazardous decomposition products:** *No dangerous decomposition products known.*

US

(Contd. on page 6)

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acc. to OSHA HCS

Printing date 09/29/2016 Reviewed on 09/29/2016

Trade name: Sure-Grip® High Performance Grout

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11 Toxicological information

· **Information on toxicological effects**
· **Acute toxicity:**
· **Primary irritant effect:**
· **on the skin:** May cause skin irritation.
· **on the eye:**
Strong caustic effect.
Irritating effect.
· **Sensitization:** Sensitization possible through skin contact.
· **Additional toxicological information:**
The product shows the following dangers according to internally approved calculation methods for preparations:
Corrosive
Irritant
Swallowing will lead to a strong caustic effect on mouth and throat and to the danger of perforation of esophagus and stomach.
Carcinogenic.

· **Carcinogenic categories**

· **IARC (International Agency for Research on Cancer)**		
14808-60-7	Quartz (SiO2)	1
50-00-0	formaldehyde	1

· **NTP (National Toxicology Program)**		
14808-60-7	Quartz (SiO2)	K
50-00-0	formaldehyde	K

· **OSHA-Ca (Occupational Safety & Health Administration)**	
50-00-0	formaldehyde

12 Ecological information

· **Toxicity**
· **Aquatic toxicity:** No further relevant information available.
· **Persistence and degradability** No further relevant information available.
· **Behavior in environmental systems:**
· **Bioaccumulative potential** No further relevant information available.
· **Mobility in soil** No further relevant information available.
· **Additional ecological information:**
· **General notes:**
Water hazard class 1 (Self-assessment): slightly hazardous for water
Must not reach bodies of water or drainage ditch undiluted or unneutralized.
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.
· **vPvB:** Not applicable.
· **Other adverse effects** No further relevant information available.

US

(Contd. on page 7)

(Contd. of page 6)

13 Disposal considerations

· **Waste treatment methods**
· **Recommendation:**
Must not be disposed of as normal garbage. Do not allow product to reach sewage system.
It is the generator's responsibility to determine if the waste meets applicable definitions of hazardous waste. State and local regulations may differ from federal disposal regulations. Dispose of waste material according to local, state, federal, and provincial environmental regulations.

· **Uncleaned packagings:**
· **Recommendation:** *Disposal must be made according to Federal, State, and Local regulations.*
· **Recommended cleansing agent:** *Water, if necessary with cleansing agents.*

14 Transport information

· **UN-Number** · **DOT, ADR, ADN, IMDG, IATA**	*Not Regulated*
· **UN proper shipping name** · **DOT, ADR, ADN, IMDG, IATA**	*Not Regulated*
· **Transport hazard class(es)** · **DOT, ADR, ADN, IMDG, IATA** · **Class**	*Not Regulated*
· **Packing group** · **DOT, ADR, IMDG, IATA**	*Not Regulated*
· **Environmental hazards:** · **Marine pollutant:**	*No*
· **Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code**	*Not applicable.*
· **Transport/Additional information:**	
· **ADR**	
· **U.S. Domestic Ground Shipments:**	*Same as listed for Standard Shipments above.*
· **U.S. Domestic Ground Non-Bulk (119 gal or less per container) Shipments:**	*Same as listed for Standard Shipments above.*
· **Emergency Response Guide (ERG) Number:**	*Not determine*
· **UN "Model Regulation":**	*Not Regulated*

15 Regulatory information

· **Safety, health and environmental regulations/legislation specific for the substance or mixture**
· **Sara**

· **Section 355 (extremely hazardous substances):**	
50-00-0	formaldehyde

· **Section 313 (Specific toxic chemical listings):**
This product may contain 1 or more toxic chemicals subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 and 40 CFR part 372. If so, the chemicals are listed below.

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Trade name: Sure-Grip® High Performance Grout

(Contd. of page 7)

50-00-0	formaldehyde	≤0.01%

· TSCA (Toxic Substances Control Act):	
14808-60-7	Quartz (SiO2)
65997-15-1	Cement, portland, chemicals
9084-06-4	Naphthalenesulfonic acid, polymer with formaldehyde, sodium salt
7757-82-6	sodium sulphate
10043-35-3	boric acid
1344-95-2	Silicic acid, calcium salt
1310-73-2	sodium hydroxide
21645-51-2	aluminium hydroxide
50-00-0	formaldehyde
497-19-8	sodium carbonate
7732-18-5	water, distilled, conductivity or of similar purity

· Proposition 65

· Chemicals known to the State of California (Prop. 65) to cause cancer:	
14808-60-7	Quartz (SiO2)
50-00-0	formaldehyde

· Chemicals known to cause reproductive toxicity for females:
None of the ingredients is listed.

· Chemicals known to cause reproductive toxicity for males:
None of the ingredients is listed.

· Chemicals known to cause developmental toxicity:
None of the ingredients is listed.

· Cancerogenity categories

· EPA (Environmental Protection Agency)		
10043-35-3	boric acid	I (oral)
50-00-0	formaldehyde	B1

· TLV (Threshold Limit Value established by ACGIH)		
14808-60-7	Quartz (SiO2)	A2
10043-35-3	boric acid	A4
1344-95-2	Silicic acid, calcium salt	A4
50-00-0	formaldehyde	A2

· MAK (German Maximum Workplace Concentration)		
14808-60-7	Quartz (SiO2)	1
50-00-0	formaldehyde	4

· NIOSH-Ca (National Institute for Occupational Safety and Health)	
14808-60-7	Quartz (SiO2)
50-00-0	formaldehyde

· **GHS label elements** The product is classified and labeled according to the Globally Harmonized System (GHS).

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Safety Data Sheet
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· ***Hazard pictograms***

GHS05 GHS07 GHS08

· ***Signal word*** *Danger*

· ***Hazard-determining components of labeling:***
Cement, portland, chemicals
Quartz (SiO2)

· ***Hazard statements***
Causes severe skin burns and eye damage.
May cause an allergic skin reaction.
May cause cancer.
May cause respiratory irritation.

· ***Precautionary statements***
Do not breathe dusts or mists.
If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Immediately call a POISON CENTER/doctor.
Store locked up.
Dispose of contents/container in accordance with local/regional/national/international regulations.

· ***National regulations:***

· ***Information about limitation of use:***
Workers are not allowed to be exposed to the hazardous carcinogenic materials contained in this preparation. Exceptions can be made by the authorities in certain cases.

· ***Water hazard class:*** *Water hazard class 1 (Self-assessment): slightly hazardous for water.*
· ***Chemical safety assessment:*** *A Chemical Safety Assessment has not been carried out.*

16 Other information

The provided information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.
This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· ***Department issuing SDS:*** *Environmental, Health & Safety Department*
· ***Contact:*** *Environmental, Health & Safety Manager*
· ***Date of preparation / last revision*** *09/29/2016 / 58*
· ***Abbreviations and acronyms:***
ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
IMDG: International Maritime Code for Dangerous Goods
DOT: US Department of Transportation
IATA: International Air Transport Association
ACGIH: American Conference of Governmental Industrial Hygienists
EINECS: European Inventory of Existing Commercial Chemical Substances
ELINCS: European List of Notified Chemical Substances
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
PBT: Persistent, Bioaccumulative and Toxic
vPvB: very Persistent and very Bioaccumulative
NIOSH: National Institute for Occupational Safety

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OSHA: Occupational Safety & Health
TLV: Threshold Limit Value
PEL: Permissible Exposure Limit
REL: Recommended Exposure Limit
Skin Corr. 1C: Skin corrosion/irritation, Hazard Category 1C
Eye Dam. 1: Serious eye damage/eye irritation, Hazard Category 1
Skin Sens. 1: Sensitisation - Skin, Hazard Category 1
Carc. 1A: Carcinogenicity, Hazard Category 1A
STOT SE 3: Specific target organ toxicity - Single exposure, Hazard Category 3

PALMER PIER REPLACEMENT (PALPIER)

CRANE ASSEMBLY PAD CONSTRUCTION PLAN

95% Design Phase

Effective Date:
October 23, 2020

United States Antarctic Program (USAP)
Support Contract #NSFDACS1219442

Pacific Pile & Marine

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Introduction

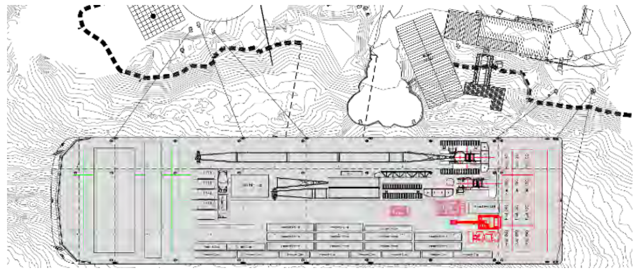
The work will largely be performed by two (2) Manitowoc 2250 cranes; one based on the barge and one based on the land. The existing sheet pile pier was built in 1967 and multiple consultant studies, workshops, and reports have deemed it beyond its safe working life. As such, it cannot be relied upon to walk equipment off the barge utilizing ramps. Based on the weights of the crane components and the safe working radius (reach) of the crane, a temporary crane assembly pad is required in order to facilitate the crane offload and assembly.

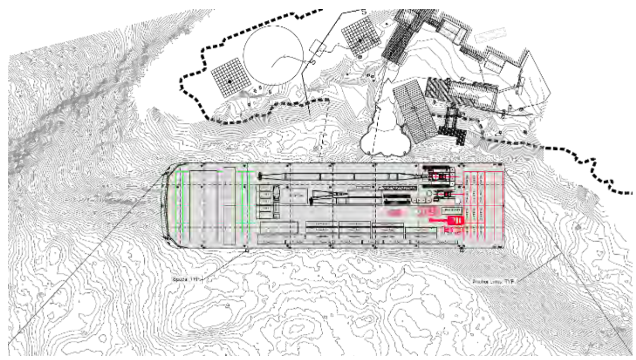
Mobilization

Upon arrival to the Project Site, PPM will moor the barge against the existing pier using soft lines to the existing moorage points.

Once secured in place, PPM will deploy two (2) 30,000 lb Stevshark anchors and two (2) external spud pockets using 100-ft long 30-in spuds with Oslo points off the seaward side of the barge. The Stevshark is a Stevpris anchor with modifications for very hard soil conditions. The anchor is fitted with a serrated shank, and is reinforced, particularly at the fluke points.

Spuds will be set with a D36 impact hammer or similar. Stevshark anchors will be controlled by two (2) 850 winches using 1,000 LF each of 1 1/2-in (1.5”) wire.



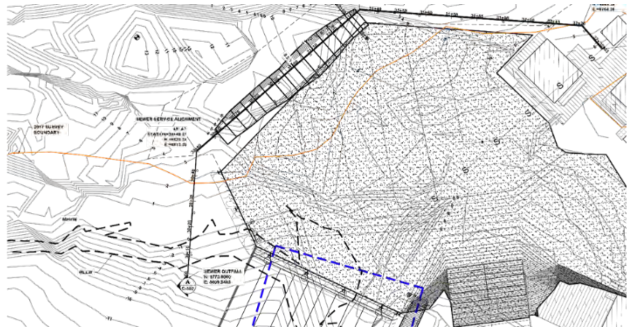


Once on-site, PPM’s surveyor will stake out the proposed assembly pad location using the coordinates provided at the start of the project. Select civil works equipment will be transloaded from the barge to the existing pier and relocated upland for construction of the temporary crane assembly pad including a 10,000 lb forklift. The forklift will also be used to assist in assembly of the crane.

Temporary Sewer Bypass

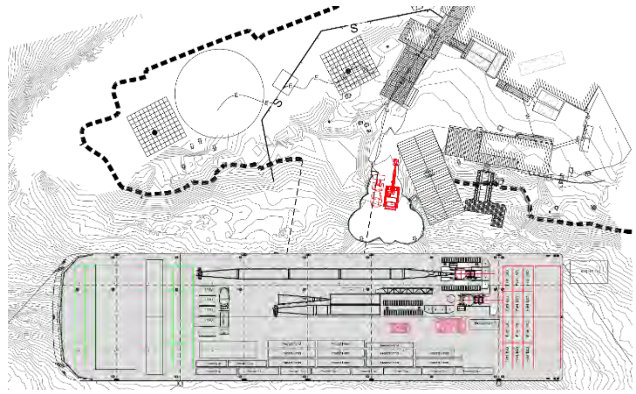
The existing sewer line is in conflict with the crane assembly pad.

One of the first items of work will be to create a temporary bypass for the existing sewer in order to relocate it until PPM is ready to install in the intended permanent location. Once the sewer is relocated the next item of work will be to construct the temporary crane assembly pad.

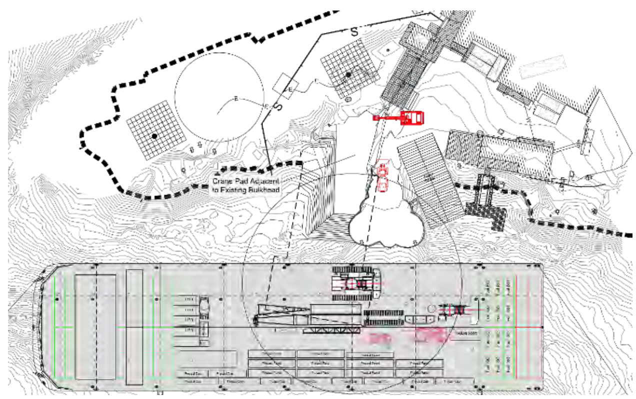


Leidos's aggregate supply vessel will arrive alongside the PPM's 400x100 Martin Ray barge at which point offload will begin using the barge-based Manitowoc 2250.

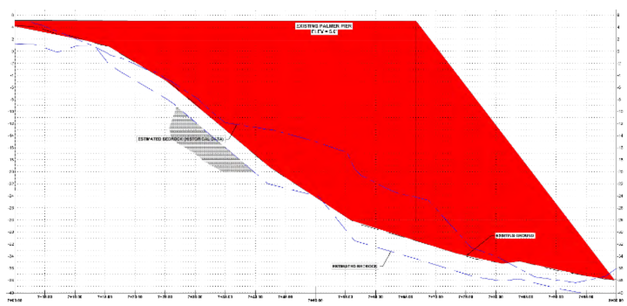
3-inch minus aggregate material will be imported in 40x40x48-in supersacks for construction of the temporary crane assembly pad. It is estimated that 1,000 CY of material is needed to construct the pad.



The prebagged supersacks of aggregate will be transferred directly to the existing sheet dock and moved to a staging area by the 10,000 lb telehandler forklift. After completion of the offload, placement of pad will commence.



The next activity will be to lift, open and develop a pile of aggregate. Once a sufficient pile is developed, the D4 dozer will begin pushing materials from the northern most point of the surveyed area toward the water. This process will continue until the southern end of the pad is developed.



PPM estimates that 50-percent of the material used to construct the crane assembly pad can be salvaged and repurposed for the project. It is PPM's understanding the desired intent is to maximize that recovery effort. In support of that, PPM has considered constructing the pad using loose fill to an elevation 0 or higher and placing the remaining super sacks unopened for future recovery. It is important to note there is no plan to place the super sack bags in the water. If this methodology is not allowed, it may increase the time needed for material placement and the recovery effort and result in a reduced amount that can be recovered.

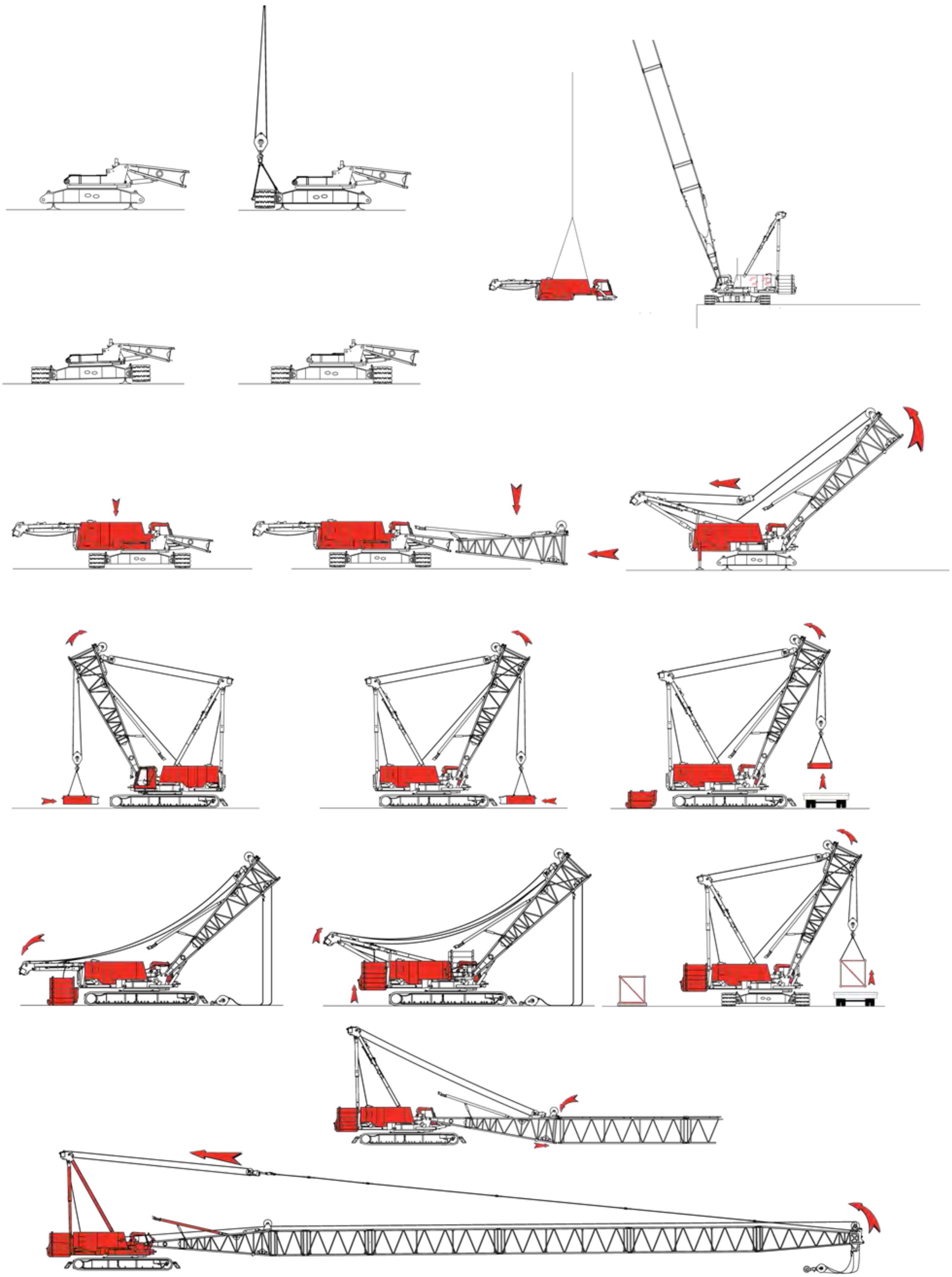
At elevation +4.00, as determined by survey, aggregate placement will cease and 12-in x 20-ft crane mats will be laid out to match the existing dock elevation.

It is understood that PPM has NOT been on-site and planning relies upon and is based on coordinates and drawings provide during the design phase. PPM's planned approach was developed with the intent to minimize the amount of aggregate required to construct the pad. This approach requires PPM to use both the temporary pad and the existing cell to land and assemble the Manitowoc 2250. The crane mats will help to distribute an even load on both the newly placed aggregates and the existing pier. They will also protect the placed aggregate from disturbance. The crane mats will create a barrier preventing direct contact from the equipment or personnel reducing wear and any risk of damage or ripping of the super sacks if allowed to be placed, in addition to aiding in the stability and low footprint of the ground pressure. In short, the timber matting will spread the ground pressure and protect the surface beneath it, which is true of walking the crane onto the newly constructed pier as well.

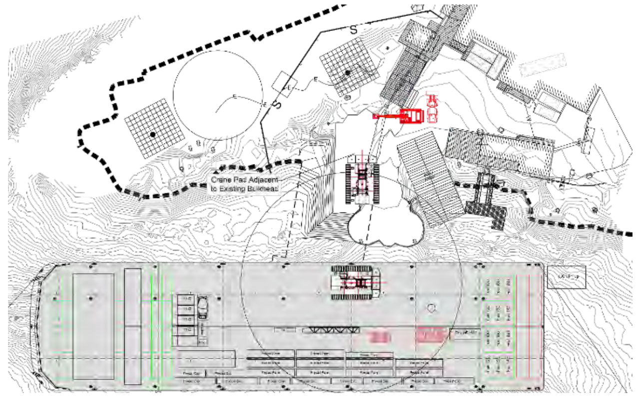
Based on weights and distances required to transfer to shore, the land-based Manitowoc will be shipped to Palmer Station disassembled and offloaded in pieces, per the manufacturer's recommendation. The GC will position the Martin Ray barge adjacent to the existing bulkhead pier to allow safe offload of the land-based Manitowoc 2250 crane to the crane assembly pad using the barge-based Manitowoc 2250 crane in sequenced sections for assembly. The sequence for assembly on-site and associated weights of each section is as follows:

1. Carbody	64,350 lb
2. Crawlers (tracks) (2 ea)	53,820 lb
3. Upperworks	85,020 lb
4. No. 44 Bottom boom (1 ea)	12,475 lb
5. Upper center counterweight	37,000 lb
6. Counterweight tray	39,115 lb
7. Side counterweight (6 ea)	15,500 lb
8. Side counterweight (4 ea)	20,000 lb
9. Carbody center counterweight (2 ea)	30,000 lb
10. Carbody side counterweight (4 ea)	15,000 lb
11. No. 44 Upper boom butt (1 ea)	11,450 lb
12. No. 44 40' boom insert (5 ea)	6,500 lb

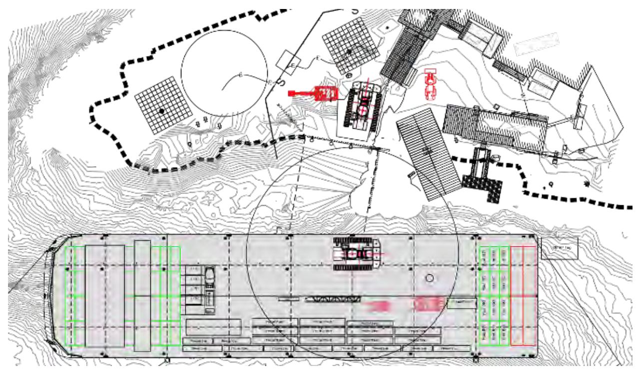
An assembly sequence is provided on the next page for reference.



Once the crane is assembled, it will be walked behind the location of the retaining wall to be in position to assist with deconstruction of the existing pier. A portion of the temporary pad will be salvaged for re-use, as indicated above, to be used as pile fill and/or for the uplands area.



PPM will coordinate with Leidos work site access point(s) and material laydown and storage area(s), assumed to primarily be located near the existing boat grid and beyond the limits of the new proposed sewer alignment.



The construction area will be marked off using temporary barricades. Access points and the proper signage shall be provided by Leidos and put in place to alert the Palmer Station community to the ongoing construction zone and the requirements for entering the construction area. The Safety Plan will describe access points and methods of delineation in more detail, as required.