Coastal Virginia Offshore Wind

Balance of Plant

Engineering, Procurement, Transportation and Installation Services

Pile Driving Monitoring, Mitigation, and Management Plan

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Dominion Energy Coastal Virginia Offshore Wind Commercial Project

APPENDIX C - Pile Driving Monitoring, Mitigation and Management Plan (PDMP)

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ACRONYMS AND ABBREVIATIONS

ASFV	Abbreviated Sound Field Verification
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
CMMP	Construction Mitigation & Monitoring Plan
COP	Coastal Virginia Offshore Wind Project Construction and Operations Plan
CR	Dominion Energy Client Representative
CTV	Crew transfer vessel
CVOW-C	The Dominion Coastal Virginia Offshore Wind Commercial Project
CZ	Clearance Zone
dB	decibel
DBBC	Double big bubble curtain
DEME	DEME Offshore US LLC., part of the DEME Group
DMA	Dynamic Management Area
Dominion Energy	Virginia Electric and Power Company, doing business as Dominion Energy Virginia
DVO	Dedicated Visual Observer
ECC	Dominion Energy Environmental Compliance Coordinator
ECM	Environmental Compliance Monitor
ESA	Endangered Species Act
FOU	A Monopile foundation
FR	Federal Register
ft	feet
GARFO	NMFS Greater Atlantic Regional Fisheries Office
HFC	High Frequency Cetaceans
HSD	Hydro Sound Damper
Hz	hertz
HZ	Harassment Zone
IR	infrared
ITA	Incidental Take Authorization
IV	Installation vessel
km	kilometer
km/h	kilometer per hour
kHz	kilohertz
Lease Area	Lease No. OCS-A 0483
LFC	low frequency Cetacean
LOA	Letter of Authorization
LPSO	Lead Protected Species Observer
m	meter
MCC	Monitoring and Coordination Center
MCPG	Motion Compensated Pile Gripper
MF	mid-frequency
MFC	Mid-Frequency Cetaceans

MLLW	Mean Lower Low Water level
MMPA	Marine Mammal Protection Act
MP	monopile
MVZ	Minimum Visibility Zone
nm	nautical mile
NARW	North Atlantic right whale
NAS	Noise Abatement or Attenuation System
NMFS	NOAA National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NVD	Night Vision Device
OCS	Outer Continental Shelf
OPR	NMFS Office of Protected Resources
OSS	Offshore Substations
PAM	Passive Acoustic Monitoring
PDMP	Pile Driving Monitoring, Mitigation and Management Plan
PDV	Pile driving vessel
PP	Pin Pile
PPT	Pin Pile Template
Project	Dominion Coastal Virginia Offshore Wind Commercial Project
PSO	Protected Species Observer
PTS	permanent threshold shift
QHSE	Quality Health Safety and Environment
RPS	RPS Group
RWSAS	Right Whale Sightings Advisory System
SELcum	Cumulative Sound Exposure Level
SFV	Sound Field Verification
SMA	Seasonal Management Area
SZ	Shutdown Zone
TSFV	Thorough Sound Field Verification
USCG	United States Coast Guard
VSA	Vessel Strike Avoidance
WDA	Wind Development Area
WM	Works Manager
WTG	Wind Turbine Generator

GLOSSARY OF TERMS

Term	Definition
Adaptive Monitoring & Mitigation Plan	A stepwise approach to additional measures in the event that the initial field measurements of the SFV indicate that the distances to isopleths of concern are larger than those modeled.
Alternative Monitoring Plan	A protected species monitoring plan that must be submitted to BOEM and NMFS, which details monitoring methodology that will be used during night-time and low-visibility conditions
Double Big Bubble Curtain Plan (DBBC)	A technical summary of a NAS detailing a pneumatic barrier system that intentionally disturbs the water column to dampen the propagation of sound waves traveling from the sound source equipment by attenuating the noise. See DBBC plan in CMMP – Appendix G.
Clearance Zone (CZ)	The area that must be visually or acoustically clear of protected species prior to starting any sound source that could result in Level A or Level B exposures. This applies to construction sources using approved pre-determined distances.
Dedicated Visual Observer (DVO)	An individual (i.e., PSO or trained crew member) aboard a vessel whose sole responsibilities are to conduct vigilant watch for all marine mammals and slow down, stop their vessel, or alter course (as appropriate) to avoid striking any marine mammal. They will have completed prior training on protected species detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements.
Environmental Subcontractors	All the subcontractors of main contractor DEME that contribute to marine mammal and protected species monitoring, and to underwater noise mitigation. These subcontractors supply services such as PSO, PAM, TSFV, ASFV and DBBC deployment.
Harassment Zone (HZ)	Area in which it is determined that marine mammals will be impacted by the sound produced by the sources when active. These zones are specific to each species and hearing group of marine mammals. Any marine mammal within the zone, while the source is active, will be considered a Level A or Level B ‘take’ pending the exposure decibels and distance.
Level A Harassment Zone	The area within which Level A harassment, defined as the potential to injure a marine mammal, may occur. This includes but is not limited to the area ensonified by a sound source, within

Term	Definition
	which a permanent threshold shift in hearing or other types of non-serious injury can occur.
Level B Harassment Zone	The area within which Level B harassment, defined as the potential to disturb (but not injure) a marine mammal, may occur. This includes but is not limited to the area, ensonified by a sound source, within which a behavioral disturbance or temporary threshold shift in hearing can occur.
LOA	Letter of Authorization effective from February 5, 2024 through February 4, 2029, issued by the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) detailing the conditions to taking Marine Mammals Incidental to the Coastal Virginia Offshore Wind Commercial Project Offshore of Virginia.
Minimum Visibility Zone (MVZ)	In addition to the clearance and shutdown zones that would be monitored both visually and acoustically, NMFS is proposing to establish a minimum visibility zone of 2000 m to ensure both visual and acoustic methods are used in tandem to detect marine mammals resulting in maximum detection capability.
Mitigation Zone (MZ)	An area within which mitigation measures must be applied if a protected species is detected. Mitigation zones (MZ) include CZs, SZs, and HZs. The size of the MZ varies between species. This term (MZ) has replaced the previously used terminology, Exclusion zone (EZ).
Near Real-Time	In relation to Passive Acoustic Monitoring (PAM) buoy detections, refers to the time delay between detection of an acoustic event and the receipt of the processed data by the PAM Operator. This delay is caused by automatic processing of the electronic communication, but implies that there are no significant delays for mitigation purposes.
PAM Clearance Zone	The area that must be cleared by acoustic monitoring for marine mammals prior to starting any sound source that could result in Level A or Level B exposures.
PAM Monitoring Zone	The area around any sound source that could result in Level A or Level B exposures which is acoustically monitored for the presence of marine mammals.

Term	Definition
PAM plan	Refers to the Passive Acoustic Monitoring (PAM) plan, Appendix D in CMMP The technical approach to performing near real-time PAM during pile driving activities for the Coastal Virginia Offshore Wind Commercial (CVOW-C) Project.
Pile Driving Monitoring, Mitigation and Management Plan (PDMP)	The technical approach to monitor, mitigate and manage potential impacts to marine mammals and protected species during pile driving operations of the construction activities for the CVOW-C Project in accordance with applicable regulatory documents and permits.
Pile driving or piling	The continuous sequence inclusive of vibratory and impact piling to install a WTG monopile or OSS pin pile foundation into the seabed as per following consecutive phases: 1. Vibratory piling 2. Transition from vibratory hammer to impact hammer 3. Impact piling soft-start 4. Impact piling
Pile instability	Occurs when the pile is unstable and unable to stay standing if the piling vessel were to "let go." During these periods of instability, the Works Manager may determine a shutdown is not feasible because the shutdown combined with impending weather conditions may require the piling vessel to "let go," which then poses an imminent risk of injury or loss of life.
Pile refusal	Occurs when the pile driving sensors indicate the pile is approaching refusal, and a shutdown would lead to a stuck pile which then poses an imminent risk of injury or loss of life.
Protected Species	May refer to multiple taxa, including ESA-listed marine mammals, marine mammals, sea turtles, and Atlantic Sturgeon.
Project	Dominion Coastal Virginia Offshore Wind Commercial Project
PSO plan	Refers to the Foundation Installation specific Protected Species Observer plan, Appendix F in CMMP The technical approach to performing in-situ visual Protected Species Observations (PSO) during pile driving activities for the Coastal Virginia Offshore Wind Commercial (CVOW-C) Project.

Term	Definition
Separation Distances	The distances from a vessel within which observation of a protected species would require mitigation. The distances and the required mitigations vary between species.
SFV plan	Refers to the Sound Field Verification Plan, Appendix E in CMMP The technical approach to performing in-situ Sound Field verifications during pile driving activities for representative piles for the Coastal Virginia Offshore Wind Commercial (CVOW-C) Project.
Shutdown Zone (SZ)	The area in which equipment shutdown or other active mitigation measures must be applied, once a source is active, if a protected species is sighted inside the corresponding zone.
Vessel Strike Avoidance (VSA) Monitoring Zone	The area around a vessel that is monitored by PSOs or Visual Observers while the vessel is underway.
VSAP	Refers to the Vessel Strike Avoidance Plan, Appendix A in CMMP
Works Manager (WM)	The main point of communication for pile driving operations on board the piling vessel. The Works Manager (WM) will communicate directly with LPSO for planned piling operations, clearance, soft-start, shutdown/delays, and post piling. In addition, the WM will assess the stability of a pile in the event that a shutdown is called. In close consultation with the piling vessel Captain, they may determine a shutdown is not feasible because the shutdown combined with impending weather conditions may require the piling vessel to “let go,” which poses an imminent risk of injury or loss of life.

1 PURPOSE OF THIS DOCUMENT

As pile driving operations represent a potential to cause acoustic harassment to marine species, Dominion Energy has decided to combine all activities related to monitoring, mitigation and management during foundation pile driving construction activities (i.e., monopiles and OSS pin piles) in one document for ease of review and process understanding.

This Pile Driving Monitoring, Mitigation and Management Plan (PDMP) gives an overview of all the mitigation and monitoring measures in place, and management thereof, during foundation pile driving construction. This PDMP is annexed and forms an integral part of the overarching Construction Mitigation and Monitoring Plan (CMMP).

2 INTRODUCTION

2.1 The Project

Virginia Electric and Power Company, operating as Dominion Energy Virginia (Dominion Energy), is proposing to construct, own, and operate the Coastal Virginia Offshore Wind (CVOW) Commercial Project (Project) in the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS) Offshore Virginia (Lease No. OCS-A 0483, the Lease Area; Figure 1) and in coastal waters where an Offshore Export Cable Route Corridor will be established.

DEME Offshore US LLC, part of the DEME Group (DEME) has been contracted to install wind turbine generators and the offshore substations (OSS) using pile driving equipment, which is subject to monitoring and mitigation conditions outlined in the Project permits. Within the pile driving Scope of Work, Dominion Energy intends to use impact and vibratory pile driving to install Wind Turbine Generator (WTG) Monopile Foundations and Offshore Substation Jacket Foundations (jacket foundations with pin piles).

Both the National Oceanic and Atmospheric Administration (NOAA) and the Bureau of Ocean Energy Management (BOEM) have advised that construction activities (including monopile and pin-pile installation activities) have the potential to cause acoustic harassment to marine species, in particular marine mammals.

Dominion Energy has committed to the following comprehensive set of mitigation and monitoring measures during pile driving operations for the Project; Dominion Energy also commits to engaging in ongoing consultations with NOAA National Marine Fisheries Service (NMFS) regarding mitigation protocols. The measures detailed in this document are designed to ensure that marine protected species are not adversely affected by the Project activities.

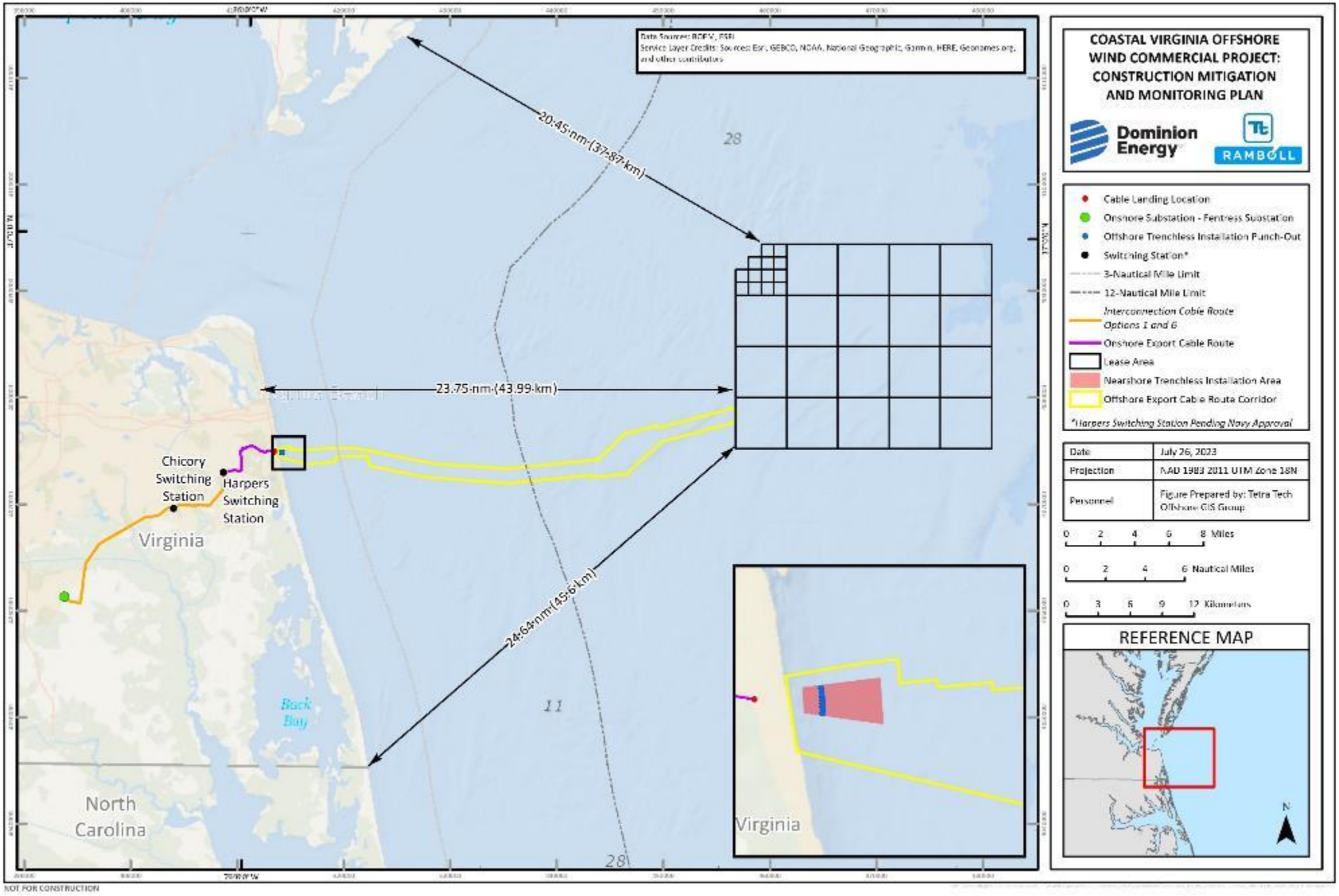

Figure 1. Project Area

2.2 Applicable Regulatory Documents and Permits

The pile driving shall be conducted in accordance with the measures stipulated in the CVOW-C ROD, BOEM COP T&C, MMPA final rule LOA, NMFS BiOP, and any other relevant regulatory permitting document. For a full overview of applicable regulatory documents and permits, reference is made to the CMMP, of which this PDMP is an Appendix of.

2.3 Marine Protected Species in the Project Area

Reference is made to the dedicated CMMP section on Marine Protected Species in the Project area as this list is applicable to the overall CVOW Project and not only the Foundations installation scope.

3 GENERAL PROCEDURES

3.1 Vessel strike avoidance plan

Vessel crew members responsible for navigation duties will receive site-specific training on protected species sighting/reporting and vessel strike avoidance measures as detailed in the Vessel Strike Avoidance Plan (VSAP).

Reference is made to the to the CMMP Appendix A – VSAP..

3.2 Environmental Training

All Project personnel will receive environmental training. The purpose will be to establish responsibilities of each party, define the chains of command, discuss communication procedures, provide an overview of monitoring purposes, and review operational procedures.

3.2.1 All crew onboard the installation vessel

Reference is made to the CMMP Appendix B – Environmental Training therein.

3.2.2 Specific for PSO

Reference is made to the CMMP Appendix F – Foundation installation Protected Species Observer Plan therein.

3.2.3 Specific for PAM Operators

Reference is made to the CMMP Appendix D –Passive Acoustic Monitoring Plan therein.

4 PILE DRIVING ACTIVITIES

4.1 Pile driving preparations

4.1.1 Monopile preparations

The CVOW pre-monopile driving preparations consists of upending the monopile from its horizontal feeder into a vertical position through the Motion Compensated pile gripper (MCPG) until stabbing of the pile onto the seabed surface as depicted in Figure 2. No pile driving takes place at this stage yet. For upending, the quad vibratory hammer (see Figure 4, Left) is used as lifting tool.

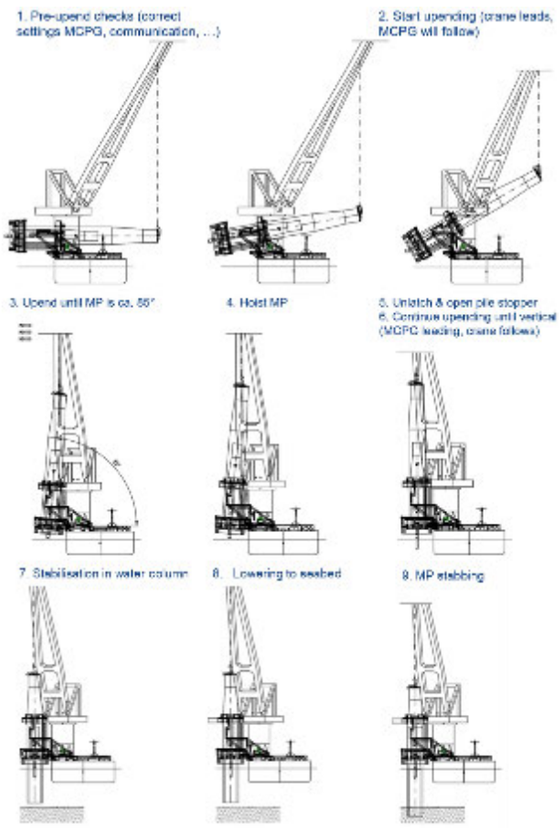

Figure 2. Pre-piling preparation (upending & stabbing) conceptual process diagram

4.1.2 Pin Pile preparations

The CVOW pre-pin pile driving preparations consists of deploying the pin pile template (PPT) on the seabed at OSS location. Picking-up and upending the pin pile (PP) from a feeder barge and stabbing it through the designated sleeve of the PPT (see Figure 3). This preparatory step is identical for each of the four PP per OSS. No pile driving takes place at this stage yet. For upending, the single vibratory hammer (see Figure 4, Right) is used as lifting tool. At the end of driving all four OSS specific PP to final penetration depth, the PPT is recovered for use at the next OSS location.

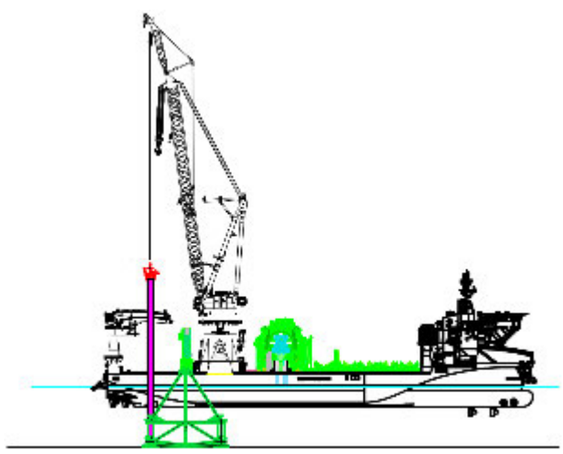

Figure 3. Stabbing of first pin-pile (purple) through designated sleeve of seabed placed pin-pile template (dark green)

4.2 Pile Driving Process

The CVOW pile driving process consists of the continuous sequence inclusive of vibratory and impact piling to install a monopile or OSS pin pile foundation into the seabed as per following 4 consecutive phases: (1) vibratory piling, (2) vibratory to impact hammer switch, (3) impact piling soft-start, and (4) impact piling. Two different hammer types, a vibratory (see Figure 4) and hydraulic impact hammer (see Figure 6), are used for phase 1 and 4, respectively. Both hammer types will be used consecutively to drive each MP and PP, considering different versions for different pile designs.

At maximum for a standard to drive single MP a day, it is expected that vibratory hammering may be needed for approximately 60 minutes per MP before impact piling can begin. Duration can vary depending on the soil conditions. The transition time between vibratory and impact activities may take about 1.2 hours on average all going well. Duration can vary depending on weather conditions. Impact pile driving for each MP foundation is expected to take no more than 3.5 hours to achieve the target penetration depth (Tetra Tech 2022). Duration can vary depending on the soil conditions.

For sake of clarity, in this document the monitoring and mitigation measures are applicable for both MP and OSS pin piles, unless stated otherwise.

4.2.1 Vibratory Piling

For upending, lifting, and driving the piles through the pile run risk zone, a vibratory hammer (as shown in Figure 4, or equivalent) will be used to install the MP and OSS pin pile up to a safe depth. Depending on the location of the WTG, different vibratory target depths apply (See Attachment C-1).

Vibratory hammers install piles into the seabed by applying a rapidly alternating force to the pile. This is generally accomplished by rotating eccentric weights about shafts. Each rotating eccentric produces a force acting in a single plane and directed toward the centerline of the shaft. The weights are set off-center of the axis of rotation by the eccentric arm. If only one eccentric is used, in one revolution a force will be exerted in all directions, giving the system significant lateral whip. To avoid this problem, the eccentrics are paired so the lateral forces cancel each other, leaving only axial force for the pile.

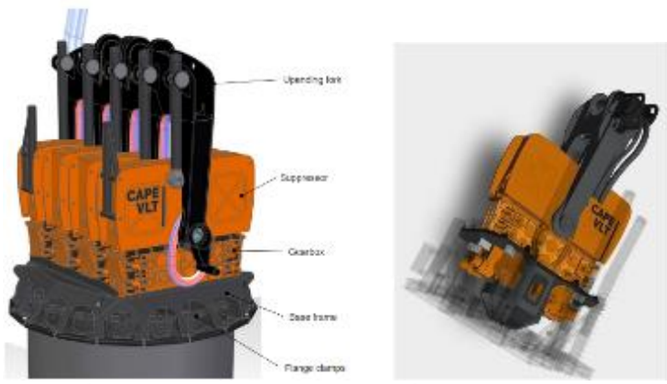

Figure 4. **The planned Cape Holland supplied Vibratory lifting technology hammers (type CAPE VLT-640). Left, the Monopile 'Quad' version and Right the Pin piles 'Single' version to accommodate for different pile design.**

4.2.2 Vibratory to Impact hammer switch

Once the intended vibratory target depth (i.e., depth at which there is no more risk of having a pile run) is reached, the vibratory hammer will be retrieved from the top of the pile and safely stored on deck. The hydraulic impact hammer will consequently be deployed and positioned on top of the pile ready to start impact driving.

Figure 5. **Aerial picture showing the placement of the hydro hammer on a MP at safe depth in the gripper of the installation vessel Orion on the Vineyard Wind 1 Project.**

4.2.3 Impact piling soft-start

Prior to impact driving a soft-start is required and at any time following a cessation of impact pile driving of 30 minutes or longer. For detailed soft-start procedure, reference is made to Section 5.3 (Soft-Start procedure for impact piling).

4.2.4 Impact Piling

After the vibratory driving process and completion of the soft-start procedure, the hydro hammer (i.e., a hydraulic impact hammer, as shown in Figure 6, or equivalent) will be used for driving the piles for the remainder of the driving length until final penetration target depth. The maximum energy during Monopile driving will be 4000 kJ and during Pin Pile driving 3000kJ.

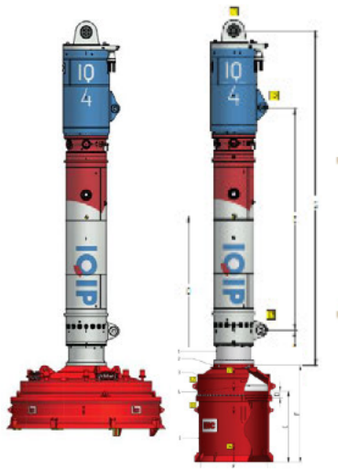

Figure 6. **The planned IQ4 hydraulic impact hammer supplied by IQIP with a Monopile anvil (Left) and a Pin Pile anvil (Right) to accommodate for different pile design.**

4.3 Pile driving operational risks

This section details potential operational risks that can be encountered during pile driving which could have severe negative consequences, both for the safety of personnel aboard the installation vessel and significant risk of damage to piles and equipment.

Any significant stoppage of foundation pile driving progress may allow displaced sediments along the piling surface areas to consolidate and bind which presents a significant engineering risk. Restarting the driving of a stopped piling may not be feasible and has the potential to create a situation where a piling is permanently bound in an unsafe and partially driven position. As such, the full pile driving sequence (inclusive of vibratory piling, hammer transition and impact piling) is to be completed as one continuous operation. This is required to ensure that the installation is safe and not compromising health & safety of

humans and the environment and/or to avoid pile instability, refusal, or integrity concerns on the Project. As required, the alternative monitoring plan (AMP) will be utilized during the pile driving process (after clearance) in case of reduced visibility. Reference is made to section 7.1.

Operational risk assessment for pile driving operations has been included in attachment C-2.

4.4 Pile driving restrictions

4.4.1 Seasonal restrictions

Pile driving operations are subject to the following seasonal moratorium:

- **November 1 through April 30** – Foundation pile driving (i.e., vibratory and impact) is not allowed during this time period

4.4.2 Daily restrictions

- Pile driving must not commence until **one (1) hour after civil sunrise** to minimize the effects of sun glare on visibility.
- Pile driving must not commence **within 1.5 hours of civil sunset** to minimize the potential for pile driving to continue after civil sunset when visibility will be impaired and may only continue into darkness if stopping operations represents a risk to human health, safety, and/or pile stability and the AMP has been approved by NMFS. No new pile driving may begin when pile driving continues into darkness.
- No nighttime pile driving will take place under the current LOA, other than if pile driving continues after dark. This would only occur when installation of the same pile begins during daylight (before 1.5 hours prior to civil sunset). The full pile driving sequence (inclusive of vibratory piling, hammer transition and impact piling) is to be completed as one continuous operation. This is required to ensure that the installation is safe and not compromising health of humans and/or to avoid pile instability, refusal, or integrity concerns on the Project. As required, the AMP, if approved, will be utilized during completion of the pile driving in reduced visibility conditions, see section 1.1.
- No more than two monopiles may be driven per day for WTG Monopile Foundations for a maximum number of days per campaign.
- No more than two full pin piles may be driven per day for OSS Jacket Foundation Installation. It is foreseen to drive each PP until penetration depth over a period of 2 installation days, meaning a stable intermediate target depth is required at the end of the first day. From operational aspect, this might consist of 2 to 4 PP being driven partially to intermediate pile penetration depth on day 1 (i.e. vibratory hammering until vibratory target depth and minor impact hammering until stable intermediate target depth). Following by PP impact driving to final penetration depth on that second installation day.
- Monopiles must be no larger than 9.5-m in diameter, representing the larger end of the tapered 9.5/7.5-m monopile design. Pin piles must be no larger than 2.8-m in diameter. During all monopile and pin pile installation, the minimum amount of hammer energy necessary to effectively and safely install and maintain the integrity of the piles must be used. Hammer energies must not exceed 4,000 kJ for monopile installations and 3,000 kJ for pin pile installation.

4.5 Installation sequence

4.5.1 Monopile installation sequence

Hereunder an indicative overview of the MP installation sequence is provided, for illustration purpose only shown in groups “1” to “5”, whereby piles in section “1” will be installed first on the Project, then section “2” until section “5”. MPs are planned to be installed in the piling seasons of 2024 and 2025. As a contingency, MPs could be installed in the piling season of 2026. A detailed sequence per MP will be available. The presented sequence may change during further optimization and operational adjustments, for instance following changing supply chain, vessel planning, weather forecast, etc.

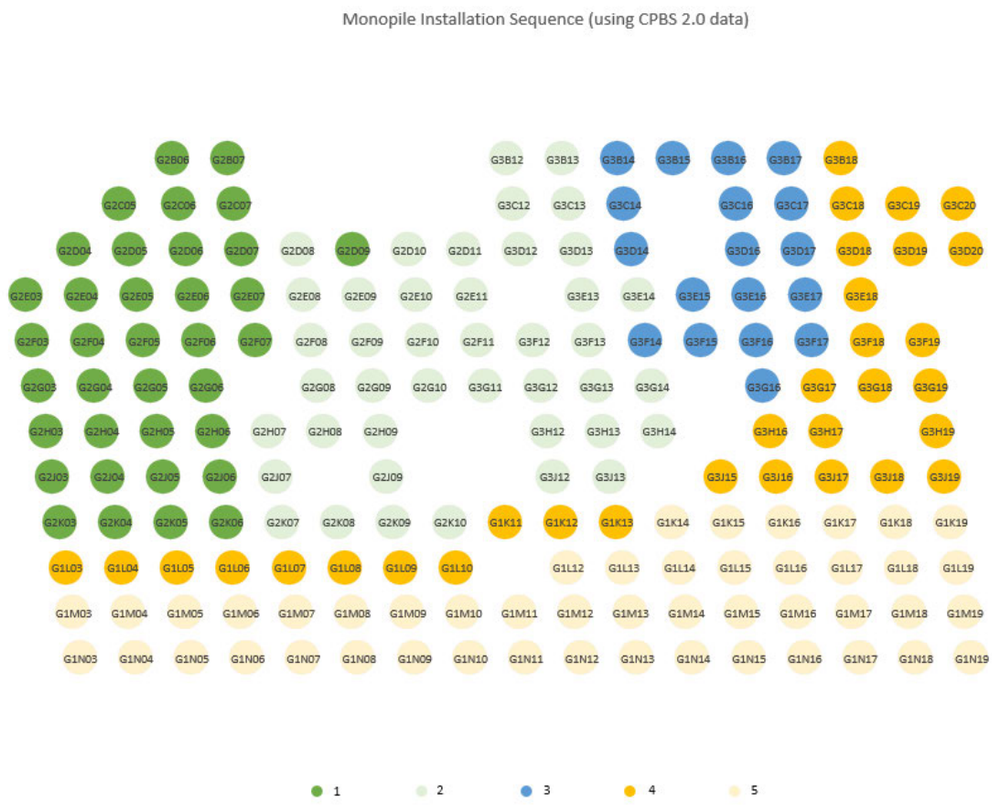

Figure 7. Lease area overview depicting the currently foreseen MP installation sequence

[Note: This is the current best estimation, hence, indicative, and subject to change]

4.5.2 OSS installation sequence

Three offshore substations will be installed on the Project. Each substation consists of a topside installed onto a jacket foundation. Each jacket foundation is connection with grout onto 4 pin piles which are driven into the seabed prior to jacket installation. Thus, a total of 12 pin piles needs to be installed on the Project. Current plan is to install all pin piles during the piling season of 2024 with following sequence:

1. Installation of 4 pin piles of OSS#2
2. Installation of 4 pin piles of OSS#3
3. Installation of 4 pin piles of OSS#1

The 4 PP of each OSS will be installed by means of a PPT. As per current plan all 4 PP will be installed first to stable intermediate pile penetration depth, mainly with the vibrohammer, after which all piles will be driven to final pile penetration depth with the impact hammer.

4.1 Depth distributions

Monopile activities were analyzed at two sites to represent the potential range of underwater acoustic impacts associated with each scenario for foundations within the Lease Area. Since actual foundation locations had not been finalized at the time of the request, one location was selected to represent the shallowest water depth (Universal Transverse Mercator [UTM] Coordinates: 459,846 m, 4,075,324 m) within the Lease Area while the other location was selected to represent the deepest water depth (UTM Coordinates: 480,666 m, 4,089,018 m) within the Lease Area: 21 m (69 ft) and 37 m (121 ft), respectively. It is expected that by modeling these two locations, the range of anticipated sound fields resulting from pile driving activities will be represented.

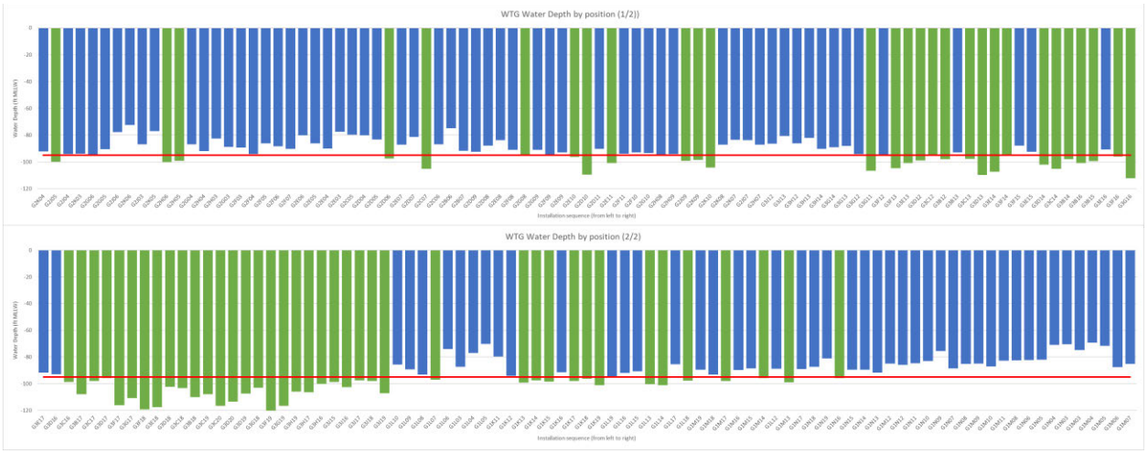

Figure 8 **Current foreseen sequence of MP installation per depth representation. Blue are assumed shallow, and Green are assumed deep piles based on the two modelled sites. Red line is threshold value separating both scenarios, i.e. 95ft MLLW water depth.**

With regards to the Thorough Sound Field Verifications (TSFV) on the first 3 monopiles, Figure 8 shows the 2nd monopile (G2J05) as being representative of a deep location, and the first and third piles (G2K04 and G2J04 respectively), as being representative of shallow locations.

For more details regarding Sound Field Verification representative pile selection and TSFV-ASFV strategy, reference is made to the CMMP – Appendix E – Sound Field Verification plan.

For the jacket pin pile installation, a representative location (UTM Coordinates OSS: 474,075 m, 4,085,595 m) was selected. It is expected that by modeling these three locations, the range of anticipated sound fields resulting from pile-driving and vibratory hammer activities will be represented.

4.2 Validation of acoustic modeling scenarios

This section outlines the categorization of each MP to the MMPA ITA submitted underwater acoustic model simulation scenarios. Using MP specific hydraulic impact driving energies and foreseen pile strikes in combination with estimated vibratory driving speed, a more detailed forecast is made categorizing each MP in one of the two modelled scenarios, i.e. a standard to drive (scenario 1) and a hard to drive (scenario 2) scenario for 1 MP per day.

The total energy categorization concept for monopiles allows for pile driving categorization of all installation sites. These data are used in combination with the foreseen installation sequencing, to identify required sound field verification campaigns, including the first three monopile installation sites. For more information on the latter, reference is made to the Sound Field Verification plan in Appendix E of the CMMP.

[As disclaimer, the authors of this PDMP plan would like to re-iterate all data are preliminary, approximated, and dependent on the local site conditions that will be encountered during operational installation, hence, subject to change]

4.2.1 Dominion's Energy basic acoustic and exposure model

Dominion Energy's basic modeling approach was to characterize the sounds produced by the source, determine how the sounds propagate within the surrounding water column, and then estimate species-specific exposure probability by considering the range- and depth-dependent sound fields in relation to animal movement in simulated representative construction scenarios.

Three types of pile driving conditions were modelled in order to take variation of pile design, soil parameters and corresponding driving conditions across the Project site into account: a standard pile driving location (Scenario 1), a hard-to-drive location (Scenario 2), and joint one-standard and one-hard-to-drive locations (Scenario 3) (Table 1). The other scenarios are not for monopile foundations and do not require selection for SFV campaigns and thus are discarded from this exercise. Acoustic propagation modeling was conducted as described in the CVOW-C LOA application (Acoustic Appendix) and can be found in BOEM FEIS (Vol. II, Appendix J – Noise model assumptions) and CVOW-C COP (Appendix Z – Underwater Acoustic Assessment).

As evaluated in Scenario 3, up to 2 monopiles may be installed per day, but since this scenario is the sum of scenario 1 and 2, this categorization exercise will only focus on the two first scenarios 1 and 2.

Table 1. Modelled assumptions

Scenario	Max impact hammer Energy	Estimated vibratory durations (min)	Estimated average total impact hammer blows (#)	Estimated average Cumulative Energy (MJ) see 4.6.2
Standard to drive location (Scenario 1)	4.000kJ	~60 min	3,240	7.715MJ
Hard to drive location (scenario 2)	4.000kJ	~30min	3,720	9.341MJ

4.2.2 Cumulative impact energy categorization concept for Monopiles

The cumulative monopile impact energy ($E_{\mathbf{total}}$) is defined as the sum of the energy per node ($E_{\mathbf{@node}}$), i.e., a fictious depth repartition of the impact driven monopile segment. It is defined as the total number of blows at a specific node multiplied by the hammer energy used at that node. The total number of blows at the node is defined by the blowcount per meter at the node ($4 \cdot BC_{\mathbf{node}}$) multiplied by the node distance.

The energy at each node is therefore defined as

$$E_{\mathbf{@node}} = 4 \cdot BC_{\mathbf{node}} \cdot D \cdot E_{\mathbf{H@node}}$$

The cumulative energy for a given location corresponds to the sum of all node energies:

$$E_{\mathbf{total}} = \sum_{i=0}^{N_{\mathbf{nodes}}} E_{\mathbf{@node},i} = \sum_{i=0}^{N_{\mathbf{nodes}}} 4 \cdot BC_{\mathbf{node},i} \cdot D \cdot E_{\mathbf{H@node},i}$$

Input for the cumulative energy is derived from the best estimate drivability analysis:

- Evenly spaced depth nodes (e.g., every 0.5 m) – node distance: D
- Blowcount per 0.25 m at each depth node ($BC_{\mathbf{node}}$)
- Hammer energy at each depth node ($E_{\mathbf{H@node}}$)

Following estimated cumulative energy categorization was applied for impact piling (units in Megajoules, MJ).

1. < 8.528MJ = Standard to drive locations
2. > 8.528MJ = Hard to drive locations

[Note: The threshold value for cumulative energy categories is currently approximated, hence, subject to change. Voluntary embedment of the pile under its own weight has not been accounted for in above calculations]

4.2.3 Modelled assumptions per Monopiles

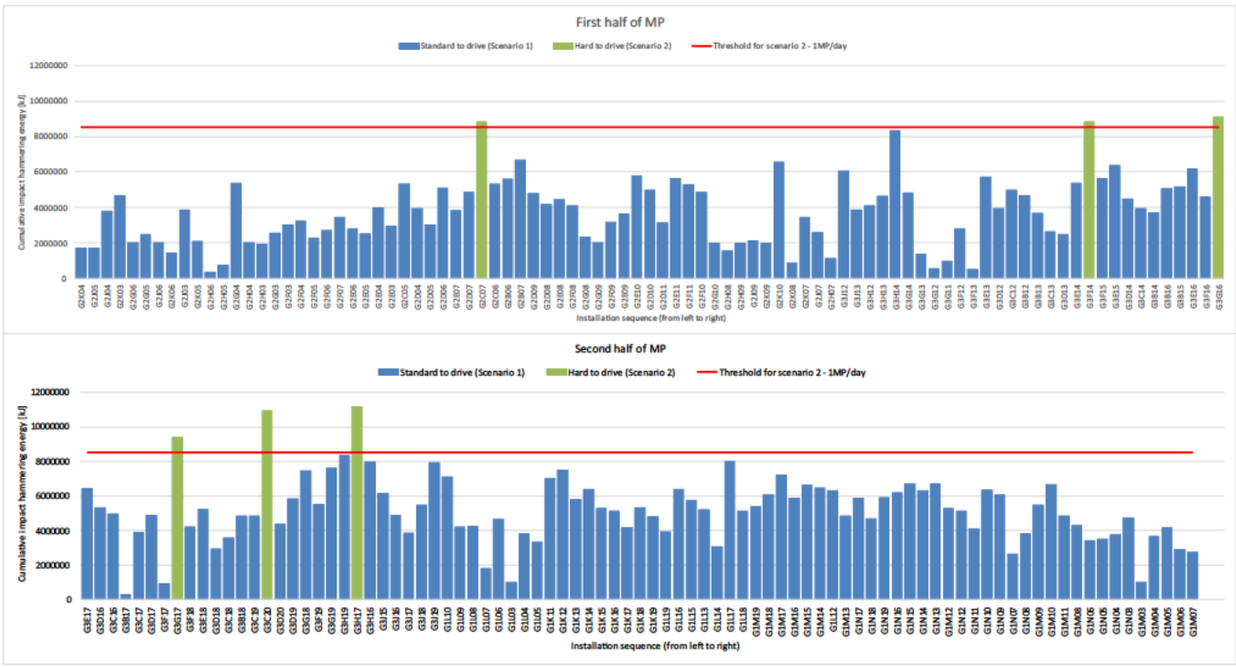

Figure 8. **Current foreseen sequence of MP installation. Blue are assumed Standard to drive piles and Green are assumed Hard to drive piles. Red line is threshold value separating both scenarios.**

All first three monopile foundations (G2K04, G2J05, and G2J04) are standard to drive but are expected to use the maximum hammer energy (4000 kJ) and represent both shallow and deep water. If the measured ranges to thresholds are found to be longer than the modeled ranges assuming 10 dB of attenuation, thorough SFV will continue on additional piles while adjustments are made (such as optimizing NAS performance). From these thorough SFV measurements, sound production (received levels at 750 m as a function of hammer energy) and sound propagation in shallow and deep water will be established.

For more details regarding Sound Field Verification representative pile selection and TSFV-ASFV strategy, reference is made to the CMMP – Appendix E – Sound Field Verification plan.

The cumulative energy results yield the following results in comparison to the used model assumptions.

Table 2. **Cumulative Energy Results**

Scenario	Amount of piles in each category
Standard to drive location (Scenario 1)	170
Hard to drive location (Scenario 2)	6
Total	**176**

5 MITIGATION METHODS FOR CONSTRUCTION SOUND SOURCES

5.1 Vibratory Piling

The use of vibratory pile driving itself is considered a noise mitigation strategy. The main energy associated with vibratory pile driving is radiated at lower frequencies compared to impact piling, and sound waves below a lower cut-off frequency do not propagate in shallow waters. As a result, high peak levels can be avoided, and continuous sound levels can be kept low. Noise emissions from vibratory pile driving are on the order of 10 to 20 dB (Leq,30s) below mitigated impact pile driving at identical monopiles (Koschinski and Lüdemann 2020). Reference is made to the CVOW-C LOA application (Acoustic Appendix) and CVOW-C COP Appendix Z - Underwater Acoustic Assessment.

5.2 Noise Abatement Systems

Dominion Energy must deploy dual noise abatement systems (NAS) that are capable of achieving, at a minimum, 10 decibel (dB) of sound attenuation, during all vibratory and impact pile driving of monopiles and pin piles. Dominion Energy achieved this level of reduction with a double big bubble curtain system during the Pilot Project. Therefore, a Double Big Bubble Curtain (DBBC) will be used during pile-driving activities to avoid or minimize impacts on marine mammals, sea turtles, fishes, and mobile invertebrates. Dominion Energy may consider alternative technologies that are anticipated to achieve at least a similar level of attenuation.

5.2.1 Double Big Bubble Curtain

Reference is made to the DBBC plan in Appendix G of the CMMP for the system specifications, the system deployment and logistics, and specific communication and reporting.

5.3 Soft-Start procedure for impact piling

The soft-start technique involves initially driving a pile (e.g., 20min) using a low hammer energy (e.g., 20% of max energy). As the pile is driven further into the soil, the hammer energy is increased as necessary to achieve soil penetration. This technique gives fish and marine mammals an opportunity to move out of the area before full-powered impact pile-driving begins.

Soft-start is required, and will be documented each time it is implemented:

- at the beginning of each day's impact pile driving sequence for monopile and pin pile installation

AND

- following cessation of impact pile driving of 30 minutes or longer

As indicated before, the CVOW-C pile driving process consists of 4 consecutive phases: (1) vibratory piling, (2) vibratory to hydraulic impact hammer switch, (3) impact piling soft-start, and (4) impact piling.

During vibratory pile driving (phase 1), the pile will be "vibrated" into the sediment, which will not generate an impulsive sound source. As stated in section 5.1, this non-impulsive process produces a continuous sound with peak pressures lower than those generated by impact pile driving. In addition, from a technical feasibility point of view of the vibratory hammer and hook load specifications are not designed for soft-start and to undergo fluctuating energy peaks (see section 4.2.1 for more info on the working process). Henceforth, it is not foreseen to include a soft-start mitigation procedure at the start of phase 1. During hammer switch operations (phase 2), no impact induced noise generation takes place.

During phase 3, at the beginning of each day's impact pile driving monopile and pin pile installation, an impact piling soft-start procedure will take to initiate phase 4.

5.3.1 Utilized impact pile driving soft-start protocol

Dominion Energy will utilize a soft-start protocol for all monopile and jacket foundation impact pile driving by performing no more than 6 strikes per 1 minute using hammer energies not to exceed 20 percent. In total, the soft-start procedure for each foundation pile will be no less than 20 minutes. No soft-start for vibratory pile driving is necessary.

5.4 Delays to Pile Driving Activities

Prior to the start of pile driving, the CZs will be monitored for 60 minutes for all protected species.

At any time of year, a visual detection of a NARW at any distance by a PSO on the pile driving vessel or dedicated vessel triggers a delay in pile driving.

A confirmed PAM detection of a NARW within the PAM MZ must be immediately relayed to the LPSO to increase situational awareness and for consideration as pile driving is planned.

Pile driving must be delayed upon a confirmed PAM detection of a NARW, if the detection is confirmed to have been located within the relevant PAM CZ. At all times of the year, any unidentified whale sighted by a PSO within any distance of the pile must be treated as if it were a NARW.

If a marine mammal is observed entering or within the relevant CZ prior to the initiation of impact pile driving activities, pile driving must be delayed and will not begin until either:

- the marine mammal(s) has voluntarily left the specific clearance zones and have been visually or acoustically confirmed beyond that CZ

  OR

- when specific time periods have elapsed with no further sightings or acoustic detections have occurred
  - **15 minutes** for small odontocetes
  - **30 minutes** for all other marine mammal species
  - **60 minutes** for sea turtles

Both the clearance search period and the mandatory delay for animals observed within the CZ must be completed before pile driving initiation. The communications flow chart that outlines these procedures are found in Section 9 of this document.

5.5 Shutdown of Pile Driving Activities

The shutdown zones around the pile driving activities will be maintained, as previously described, by PSOs for the presence of marine mammals and full visibility before, during, and after pile driving activity. It is expected that while conducting impact pile driving, any marine mammals in the area will move away from the sound source. If a marine mammal is observed (visually or acoustically) entering or within the respective zones after pile driving has commenced, a shutdown of pile driving will occur when practicable as determined by the Works Manager on duty, who must evaluate the following to determine whether shutdown is safe and practicable:

- Use of site-specific soil data and real time hammer log information to judge whether a stoppage would risk causing piling refusal at restart of piling.
- Confirmation that pile penetration is deep enough to secure pile stability in the interim situation, considering weather statistics for the relevant season and the current weather forecast; and
- Determination by the Works Manager on duty will be made for each pile as the installation progresses and not for the site as a whole.

If a shutdown is called, the Works Manager in close collaboration with the vessels' captain can determine shutdown is not practicable due to an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk of injury or loss of life for individuals. Reduced hammer energy (power down) can be implemented when the Works Manager determines it is practicable.

Subsequent restart/increased power of the equipment can be initiated if the animal has been observed exiting its respective zone within 30 minutes of the shutdown, or after additional time has elapsed with no further sighting of the animal that triggered the shutdown (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).

If pile driving shuts down for reasons other than mitigation (e.g., mechanical difficulty) for brief periods (i.e., less than 30 minutes), it may be activated again without soft-start, if PSOs have maintained constant observation and no detections of any marine mammal have occurred within the respective zones.

5.5.1 Restart guidance for following pile driving shutdown for all protected marine species

Following a shutdown, pile driving may not commence, until either:

- the animal has been observed exiting its respective SZ within 30 minutes of the shutdown

  OR

- after an additional time period has elapsed with no further sightings
  - **15 minutes** for small odontocetes
  - **30 minutes** for all other marine mammal species
  - **30 minutes** for sea turtles

5.5.2 Additional Requirements & Reporting

If an individual from a marine mammal species for which authorization has not been granted, or a species for which authorization has been granted but the authorized take number has been met, is observed entering or within the CZ, pile driving activities must shutdown immediately (when technically feasible as described above). Activities must not resume until the animal has been confirmed to have left the relevant CZ or the observation time period has elapsed with no further sightings.

If an ESA-listed species is observed within the identified shutdown zone during active pile driving, CVOW-C must file a report with NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) and BSEE (via TIMSWeb and notification email to protectedspecies@bsee.gov). This report must be filed within 48 hours of the incident and include the following: duration of pile driving prior to the detection of the animal(s), location of PSOs and any factors that impaired visibility or detection ability, time of first and last detection of the animal(s), distance of animal(s) at first detection, closest point of approach of animal(s) to pile, behavioral observations of the animal(s), time the PSO called for shutdown, hammer log (number of strikes, hammer energy), time the pile driving began and stopped, and any measures implemented (e.g., reduced hammer energy) prior to shutdown. If shutdown was determined not to be feasible, the report must include an explanation for that determination and the measures that were implemented (e.g., reduced hammer energy).

If a shutdown is requested but not implemented, hammer energy must be reduced to the lowest level practicable and the reason(s) for not shutting down pile driving operations must be documented and reported to BOEM and NMFS within 24 hours of the decision, with a detailed explanation of the imminent risk presented, what measures were implemented (e.g., reduced hammer energy), and the animals potentially impacted. Additional reporting must be made to NMFS Office of Protected Resources within the applicable monitoring reports (e.g., weekly, monthly).

6 MONITORING FOR CONSTRUCTION

6.1 Zone Definitions

6.1.1 Monitoring zone around installation vessel

Both noise attenuation technology and soft-start techniques will be employed during foundation installation impact pile driving to mitigate impacts to protected species. During vibratory pile driving activities, a monitoring zone of 500 m in all directions will be maintained for ESA-listed fish species. If any ESA-listed species is sighted, data on the sighting will be recorded and reported as per the Lease conditions.

6.1.2 Clearance and Shutdown Zones

Clearance and Shutdown zones are established and continuously monitored during vibratory and impact pile driving to minimize impacts to marine mammals and sea turtles (Table 3 & Table 4, respectively). Dominion Energy has estimated the Minimum Visibility Zone (MVZ) distance to be 2,000 m, which is consistent and conservative with previous experience during the CVOW Pilot Project and in line with other proposed minimum visibility zones for offshore wind construction.

Table 3. Clearance and Shutdown Zones for Vibratory Pile Driving of Foundations

Species	Clearance Zone (m)		Shutdown Zone (m)	
	One Per Day	Two per Day	One Per Day	Two per Day
North Atlantic right whale – PAM	at any distance	at any distance	at any distance	at any distance
North Atlantic right whale – visual detection	at any distance, minimum 2,000	at any distance, minimum 2,000	at any distance, minimum 2,000	at any distance, minimum 2,000
Minimum visibility distance	2,000	2,000	2,000	2,000
All other Mysticetes and sperm whales	1,000	1,000	1,000	1,000
Harbor porpoise	500	500	500	500
Dolphins and pilot whales	250	250	250	250
Seals	250	250	250	250
Sea Turtles	1,000	1,000	100	100

Notes:
Clearance and shutdown zones account for practicality concerns, including the functional effective distances for visual monitoring as based on experiences from the CVOW Pilot Project.
In general, if the modeled PTS distance was less than 100 m, the clearance zone was set at 250 m; whereas if the modeled zone was greater than 100 m but less than 500 m, it was set at 500 m.
Zones provided are inclusive of 10dB of sound attenuation.
Assumes deepwater conditions.
Assumes the maximum daily build-out of two piles installed per day.

Table 4. Clearance and Shutdown Zones for Impact Pile Driving

Species	Clearance Zone (m)		Shutdown Zone (m)	
	One per Day	Two per Day	One per Day	Two per Day
North Atlantic right whale – PAM	at any distance	at any distance	at any distance	at any distance
North Atlantic right whale – visual detection	at any distance, minimum 2,000	at any distance, minimum 2,000	at any distance, minimum 2,000	at any distance, minimum 2,000
Minimum visibility distance	2,000	2,000	2,000	2,000
All other Mysticetes and sperm whales	5,100	6,500	1,750	1,750
Harbor porpoise	750	750	750	750
Dolphins and pilot whales	500	500	500	500
Seals	500	500	500	500
Sea Turtles	1,000	1,000	500	500

Species	Clearance Zone (m)		Shutdown Zone (m)	
	One per Day	Two per Day	One per Day	Two per Day

Notes:
Clearance and shutdown zones account for practicality concerns, including the functional effective distances for visual monitoring as based on experiences from the CVOW Pilot Project. Note for high frequency cetaceans, the peak PTS distance was used given the small size of harbor porpoises and the likely visible identification range. In general, if the modeled PTS distance was less than 100 m, the clearance zone was set at 250 m; whereas if the modeled zone was greater than 100 m but less than 500 m, it was set at 500 m.
Zones provided are inclusive of 10dB of sound attenuation.
Assumes deepwater conditions.
Assumes the maximum daily build-out of two piles installed per day.

6.2 Visual Observations

Reference is made to the CMMP – Appendix F – Foundation Installation Protected Species Observer Plan.

6.2.1 PSO Protocols for Construction

Reference is made to the CMMP – Appendix F – Foundation Installation Protected Species Observer Plan.

6.2.2 PSO Roles & Responsibilities

Reference is made to the CMMP – Appendix F – Foundation Installation Protected Species Observer Plan.

6.3 Acoustic monitoring

Reference is made to the CMMP – Appendix D – Passive Acoustic Monitoring Plan.

6.3.1 PAM Protocols for Construction

Reference is made to the CMMP – Appendix D – Passive Acoustic Monitoring Plan.

6.3.2 PAM Roles & Responsibilities

Reference is made to the CMMP – Appendix D – Passive Acoustic Monitoring Plan.

6.4 Mitigation Monitoring Details

Radial distances around the pile driving activities where mitigation actions will be requested by PSOs and PAM Operators and implemented if safe to do so have been defined for this Project in section 6.1.2.

Different mitigation zones have been determined for impact pile driving activities and for vibratory piling.

Unidentified whales that cannot be confirmed to NOT be NARWs will be treated as a NARW for clearance purposes.
CZs are the species/species group specific radial distances around a pile that must be visually and acoustically monitored prior to initiating pile driving activities. Acoustic detections of a marine mammal within detection range of PAM location in closest proximity to acoustic source noise or expected to be within the zones will result in a delay to initiation of pile driving initiation as described in Section 5.4.

If a marine mammal is acoustically detected entering or within the respective SZ after pile driving has commenced, a shutdown of pile driving must be implemented when technically feasible. Shutdown Procedures are described in Section 5.5

7 ADAPTIVE MANAGEMENT

Additional innovative technologies may be implemented as available market options continue to evolve, following approval by the relevant federal agencies. Dominion Energy would consider incorporating innovative technologies; however, nothing proposed in terms of the construction scenarios (e.g., piles per day, etc.) or mitigation (e.g., clearance and shutdown zones) would change. Should new information become relevant, NMFS, in agreement and discussion with Dominion Energy, may perform adaptive management and request changes per the LOA.

7.1 Sound Field Verification

Reference is made to the SFV plan in Annex D. The plan includes measurement procedures and results reporting that meet ISO standard 18406:2017 (Underwater acoustics – Measurement of radiated underwater sound from percussive pile driving).

For CVOW-C justification for representative SFV campaigns reference is made to the section 4.1 and subsections therein.

7.2 Alternative Monitoring Plan (AMP)

The AMP applies during daytime periods of low visibility that begin after pile driving has commenced (e.g., darkness, rain, fog etc.), as determined by the LPSO, who will assess the weather conditions, using their experience in monitoring, and then decide if the respective CZs and SZs are fully visible. This plan includes deploying alternative monitoring technologies (night vision, thermal, infrared, fixed cameras) to the PSOs actively monitoring on visual watches and use of PAM with the goal of ensuring the ability to maintain all SZs for all ESA-listed species in the event of unexpected, reduced visibility conditions.

As this execution and determination is led by the LPSO, reference is made to the CMMP Appendix F – Protected Species Observation plan, for more details on the AMP.

7.3 Enhanced Monitoring & Mitigation plan

If any of the SFV measurements indicate that the distance to any isopleth of concern is greater than those modeled assuming 10 dB attenuation (see Appendix H of the FEIS), Dominion Energy will communicate this information and discuss with all relevant regulatory authorities (i.e., BOEM, NMFS, BSEE) to determine the next steps. Following this, if deemed appropriate, a stepwise approach for modifying operations and/or modifying or adding sound attenuation measures that can reasonably be expected to avoid exceeding those thresholds prior to the next pile being driven will be implemented as follows.

Additional Mitigative stepwise measures following an underestimation of the Sound Field:

1. **Attenuate confounding factors** to the sound field measurements, i.e., reposition vessels in field to aim for the highest possible distance between dynamic positioning thrusters to SFV hydrophones, under the conditions it is safe and does not jeopardize pile driving operations.
2. **Evaluate the performance of the installed NAS** and, if needed and possible, increase its efficiency, i.e., execute additional maintenance, increase DBBC bubble flow rate, add compressors, redrill holes, etc.
3. **Reduce hammer energy**, under the condition it is safe, it does not increase pile refusal risk and it is within the hammer supplier tolerances.
4. **Extend clearance and shutdown zones**, i.e., increase the visual and acoustic clearance zones, and shutdown zones to meet the actual isopleth (Level A and level B) and if needed, increase the PSO and PAM detection range with as goal of ensuring the ability to maintain all clearance and shutdown zones for all ESA-listed species.
5. **Engage the alternative monitoring plan** outside reduced visibility conditions. Make use of the equipment (mainly FLIR) ensuring the ability to maintain all clearance and shutdown zones for all ESA-listed species.
6. **Increase visual detection capacity**, after initial set of piles for which a SFV campaign was planned (3 first SFV piles or set of additional SFV piles) by an additional dedicated PSO vessel with 3 active duty PSO on board ensuring the ability to maintain all clearance and shutdown zones for all ESA-listed species.
7. **Deployment of additional NAS** after initial set of piles for which a SFV campaign was planned (3 first SFV piles or set of additional SFV piles). Depending on market availability and lead times for additional technology

7.4 Innovative technologies

With the current market evolution in technology development and future shortage in availability of monitoring capacity, i.e., PSO’s, PAM equipment, dedicated PSO vessels, and noise abatement systems,

Dominion Energy would like to keep the possibility to implement innovative technologies for observation monitoring and noise mitigation.

Our intention is to evaluate novel, innovative technologies that would supplement the existing methods utilizing Protected Species Observers and Passive Acoustic Monitoring systems. Such technologies would only be used after being proven safe to use and not to cause additional harassment. This could potentially allow Dominion Energy to reduce the duration of pile driving within a piling season, shifting higher piling frequency in the periods of lower protected species densities.

8 COMMUNICATION PROTOCOLS

8.1 Communication pertaining all protected species

Any reportable events pertaining to protected species during operations will be transferred by the LPSO to the appropriate parties. Reportable events are explained in more detail in the following sections of this plan. Throughout this section, where a report, notification, or submittal is required per a Project permit, Dominion Energy's Contractor or their delegates will report to the issuing authority. All marine mammal related reports will be submitted to both NMFS OPR and GARFO.

For a more detailed overview of all the communication protocols initiated by the LPSO, reference is made to the CMMP Appendix F – Protected Species Observation plan.

Below Figure 10 represents a quick guide cheat sheet that will be present on the bridges of all the vessels in the field as part of the permit documentation.

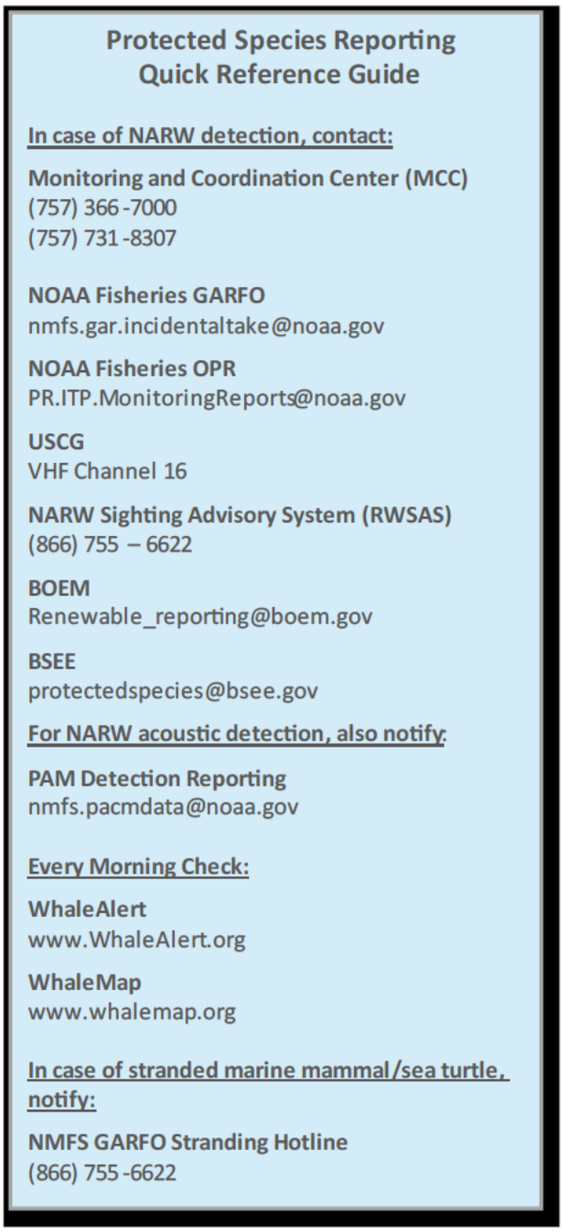

Figure 10 Protected species reporting quick guide

Below sections summarize the dedicated NARW and Shutdown protocols relevant for piling operations.

8.1.1 NARW detection communication protocol

For any NARW detection, either acoustic or visual, notifications will follow the procedure outlined in the CMMP Appendix F– Protected Species Observation plan. For all other protected species, at the first detection of a protected species (e.g., detection of a live, dead, or injured protected species), the observer

immediately notifies the Lead PSO or ECM. Throughout the detection incident, the observer will continuously monitor and record ongoing behavior and location of the detected animal(s). The Lead PSO notifies the Works Manager if mitigation measures, such as a shutdown, are requested. The Works Manager assesses the viability of the mitigative action request and notifies MCC who then notifies the Dominion Energy Environmental Compliance Coordinator (ECC). The Lead PSO will compile a report of the detection incident (per Section 8) and submit it to the Works Manager to then be submitted to the Dominion Energy Environmental Compliance Coordinator. Notification of regulatory agencies will follow the procedures outlined in Section 8 Reporting.

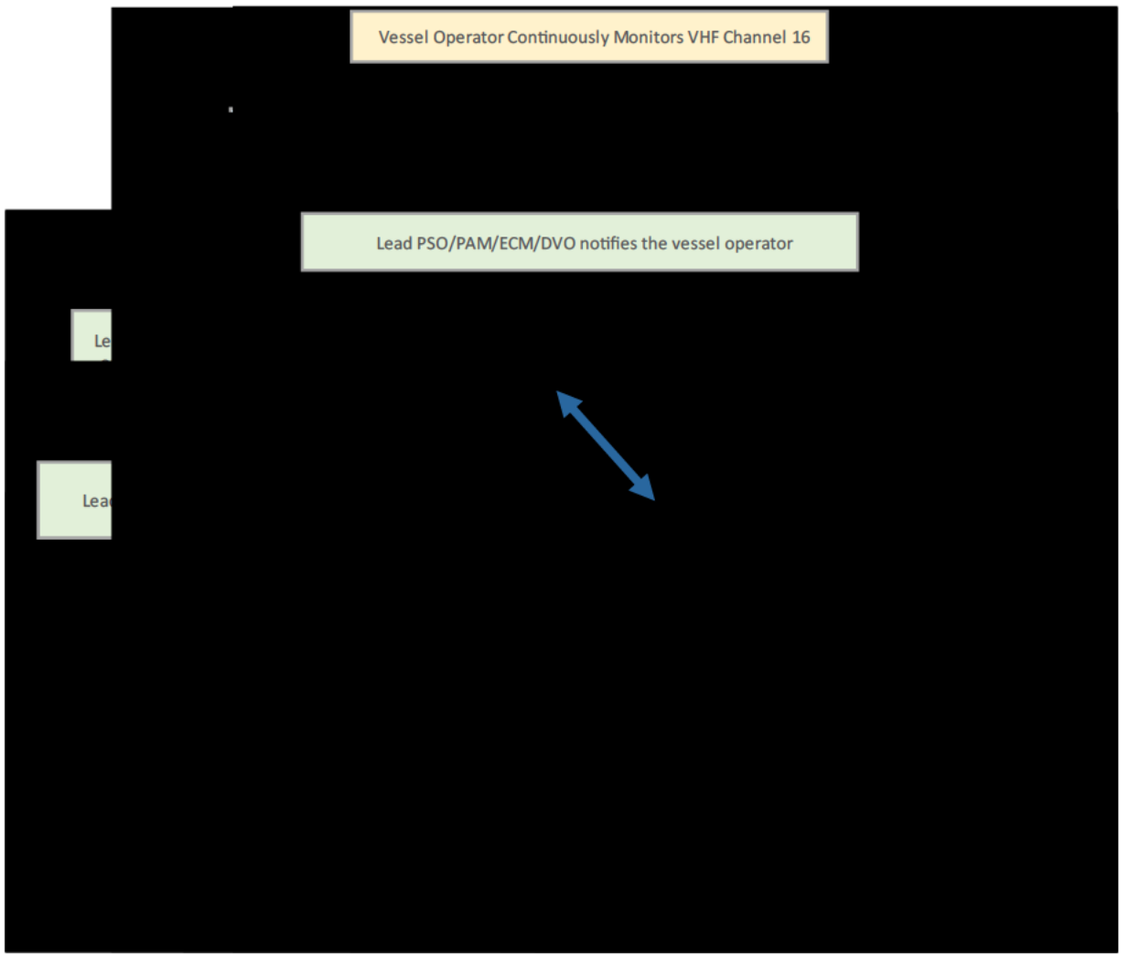

Figure 11 NARW Detection Communication Flowchart

8.1.2 Shutdown communication protocol

At the first detection of a protected species inside the respective shutdown zone, the PSO or PAM Operator immediately notifies the Lead PSO aboard the activity vessel that a shutdown of operations must be requested, and the Works Manager is notified. The Works Manager will confirm the shutdown with the Lead PSO who will notify the PSO and PAM operator. This step is identified by the red box in the flowchart below.

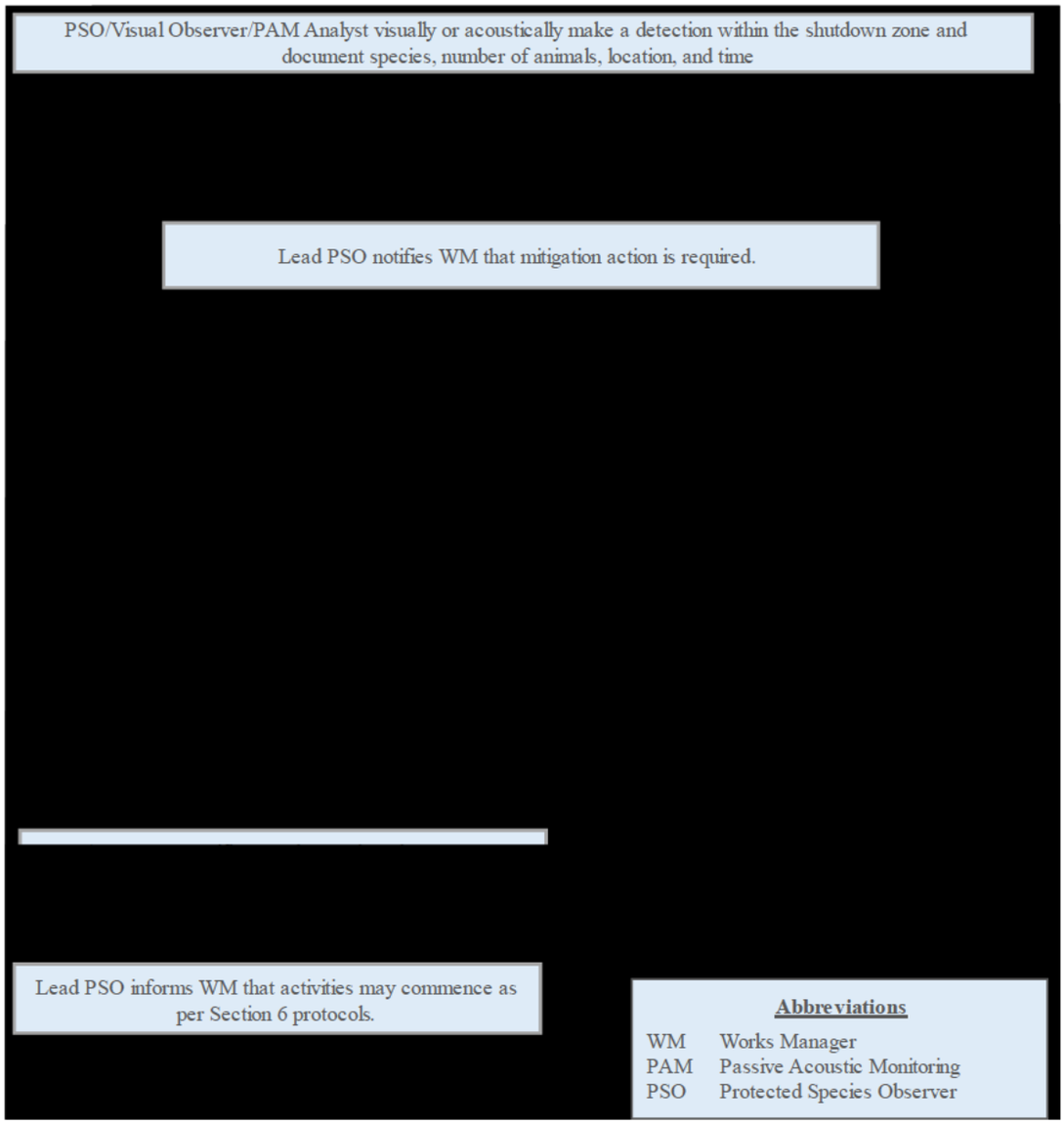

Figure 12 Shutdown Request Communication Flowchart

During the detection, the PSO/PAM will continue to monitor and record ongoing behavior of the detected animal(s). When the animal exists within the zone, the time that the protected species is last detected inside the respective shutdown zone is documented. Monitoring continues for 15 to 30 minutes following the last detection as appropriate based on species. The PSO/PAM Operator informs the Lead PSO that a soft-start is cleared to commence after another 30 minutes have elapsed without re-detection (for all large whales, non-delphinid odontocetes, and sea turtles) or 15 minutes have elapsed without re-detection (for all other marine mammals) (§ 217.294 Mitigation Requirements (c)(4)). The PSO and PAM monitoring will continue throughout the pile driving activities and for 30 minutes following cessation of pile driving activities.

8.2 Communication pertaining piling Installation

Any communication from the Contractor project team towards his environmental subcontractors will be transferred by the Works Manager (WM)

Any communication from the Contractor and his environmental subcontractors to the outside (MCC, USCG, …) will be transferred by the Captain/Master of the Installation Vessel Orion or by the Captains/Masters of the auxiliary vessels.

8.2.1 Soft-start communication protocol

The Works Manager on duty informs the Lead PSO aboard the activity vessel what time the activity is planned to commence so the PSO and PAM teams can coordinate their clearance periods accordingly (see

Section 5.3 for guidelines). After the clearance period has passed, the Lead PSO receives confirmation from the PSO and PAM teams that the clearance and shutdown zones have been appropriately monitored, no delay is required, and soft-start may begin.

If a detection occurred within the identified clearance zones, the activity may commence after another 60 minutes have elapsed without re-detection (for large whales, non-delphinid odontocetes, and sea turtles) or 15 minutes have elapsed without re-detection (for all other marine mammals) (§ 217.294 Mitigation Requirements (c)(6)). This step is illustrated in the red box below for reference.

Once the Works Manager has clearance to begin soft-start, they will notify the Lead PSO (who will then notify the PSO and PAM teams) that soft-start has commenced. After the soft-start is complete, the Works Manager will inform the Lead PSO (who will in turn notify the PSO and PAM teams) that full power has commenced. PSO and PAM monitoring will continue for the duration of the activity and 30 minutes following cessation of activity. If at any time WhatsApp is not available, (i.e., due to an internet outage) alternate means of communication will be available via satellite phone or radio (reference above sections).

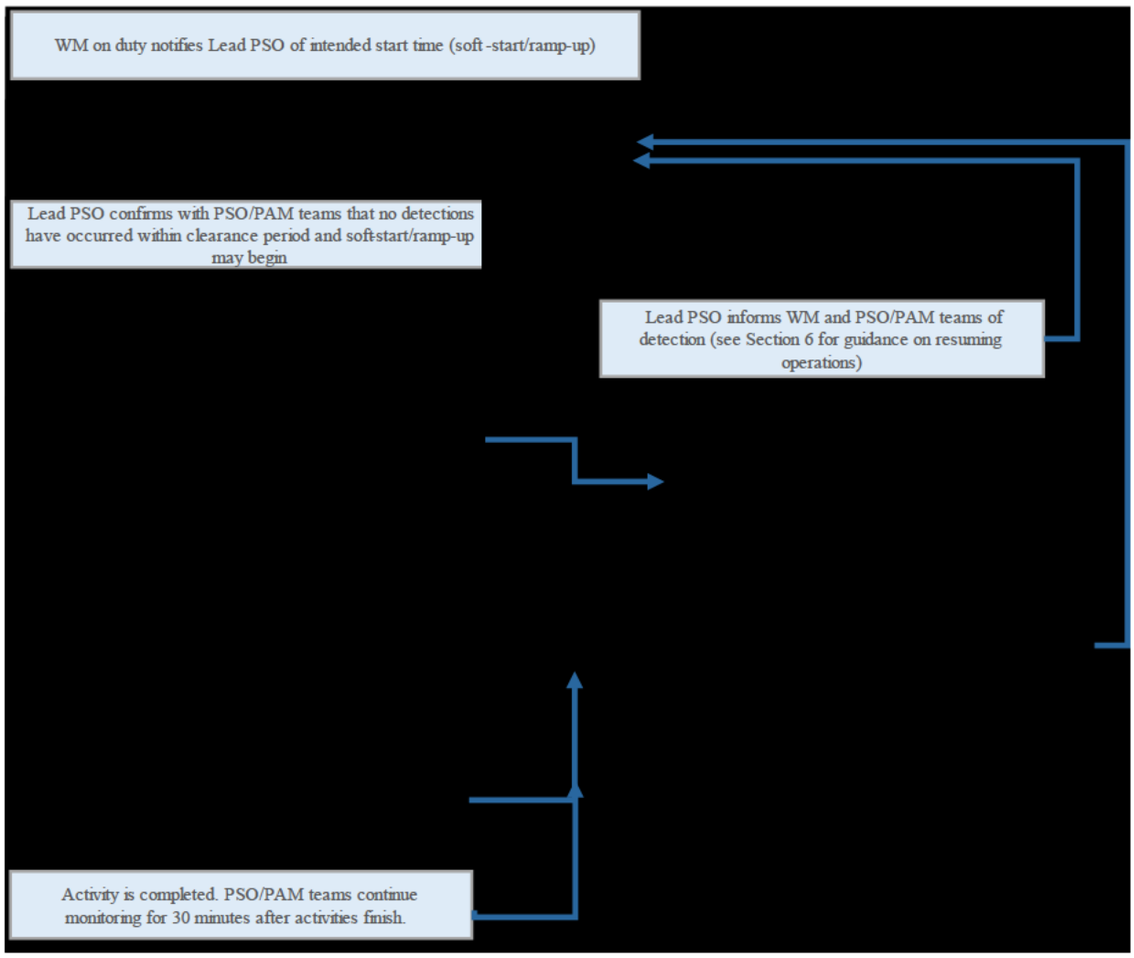

Figure 13 Soft-Start Communications Protocol Flowchart

8.2.2 Project Briefings

Mandatory briefings will be conducted between the supervisors and crews, the PSOs, ECMs, DVOs, and Dominion Energy personnel prior to the start of all pile driving activities in order to clarify and reiterate all roles, responsibilities, communication procedures, marine mammal monitoring protocols (including daily reminders to be aware of protected species), safety, reporting, and other operational procedures. This briefing will be repeated as needed in the event that new personnel join the Project (§ 217.294 Mitigation Requirements (a)(2)).

Prior to all pile driving activities, there will be meetings to discuss the Project scope, expectations, coordination, and communication, including a pre-pile driving kickoff covering the technical and safety aspects of operations.

A robust three-way communication strategy will be universally implemented across all Projects and HSE platforms. This approach ensures that information is shared, comprehended, and acknowledged, fostering

transparent coordination and real time updates throughout the Project's operations. The individual broadcasting the communication should select the most efficient method whenever possible considering safety precautions associated with that means of communication. Methods of communication can include in-person conveyance, radio, satellite phone, or WhatsApp, an end-to-end encrypted multiplatform instant messaging app. WhatsApp messages display notifications when a message is transmitted and a different notification when a message is read. As the three-way communication strategy necessitates, all parties shall respond to acknowledge receipt of communications to document that the message was conveyed and understood by the supervisors and pertinent crews, the PSOs, ECMs, DVOs, and Dominion Energy personnel. If a time-sensitive message is not acknowledged as received by all relevant parties, the party initiating the communication must move on to a different communication method (e.g., radio or satellite phone).

Although all PSOs, ECMs, and DVOs deployed have the authority to request protected species mitigation as described in this document, the ultimate decision regarding implementation of mitigation measures lies with the construction Director of Operations in consideration of vessel and human safety concerns. The chain of command will be discussed during a preliminary briefing on an individual vessel basis. As vessel staffing or shifts change, the chain of command will be disseminated to ensure all crew are aware of proper procedures.

8.2.3 Monitoring & Coordination Centre (MCC)

A daily 15:00 (local time) Monitoring & Coordination Center (MCC) briefing will occur with all Project vessel captains and any other pertinent crew and personnel to discuss the status of any DMAs and Slow Zones. Project vessels and their crew will be instructed to monitor the NOAA website for updates on DMAs, Slow Zones, and any NARW sightings in the Project area.

PSOs will check the NOAA website and Whale Alert prior to the start of every monitoring shift for the presence of DMAs, Slow Zones, or NARW sightings in the Project Area.

If a NARW is observed at any time by PSOs or Project personnel, Dominion Energy must ensure the sighting is as soon as possible, and no longer than 24 hours after the sighting, reported to NMFS, the U.S. Coast Guard (Channel 16), and the Right Whale Sightings Advisory System (RWSAS).

Any time a vessel enters the 500 m zone of the installation vessel (IV), a notification should be given via radio. See below for guidance on Project communication protocols.

8.2.4 General Foundation Installation Communication Protocols

Table 8. Foundation Installation Communication Protocols

Notification	When	Who	How
Installation Vessel (IV) captain/master decides heading of the vessel for pile installation. Survey Team to Provide Positioning Sketch & Double Big Bubble Curtain (DBBC) Way Points	2 days prior to piling *Any deviations or alterations in plan to be communicated asap.*	IV to: • DBBC vessel	E-mail by survey team or IV engineers
Regular updates provided to all vessels on next pile.	ETA at next pile	IV to: • DBBC vessel • Lead PSO	WhatsApp notifications E-mail sent by Captain or Works Manager
Update Plans for Next Pile Installation Batch	End of piling at last location of a trip	IV to: • DBBC vessel • Lead PSO	E-mail sent by Works Managers or WhatsApp
3-hr Pre-Piling Notice	3-hr prior to start of piling	IV to: • DBBC vessel • Lead PSO	WhatsApp or VHF or radio
1-hr Pre-Piling Notice	1-h prior to start of piling	IV to: • DBBC vessel • Lead PSO	WhatsApp or VHF or radio
30 min Pre-Piling Notice	30 min prior to start of piling	IV to: • DBBC vessel • Lead PSO	WhatsApp or VHF or radio
DBBC full pressure verification notice	When DBBC reaches full pressure	DBBC vessel to IV	WhatsApp or VHF
PSO Notice of Clearance to Start Piling (minimum visibility acceptable and 60 minutes of visual and PAM monitoring completed)	When possible, according to clearance protocols	LEAD PSO to Works Manager	WhatsApp or radio
Constant communication between vessels during all piling operations	Start / Stop piling / Piling interrupted / Other relevant info	IV Lead PSO DBBC vessel and reverse.	WhatsApp or VHF
Constant communication between PSO and Works Managers during MP piling	Soft-start/ Start piling / Stop piling / Piling interrupted / shutdown	Lead PSO to Works Manager and reverse	WhatsApp or radio

Notification	When	Who	How
Communication between PSOs and PAM operators According to CMMP (Construction Mitigation and Monitoring Plan)	When possible, during pre-piling and piling	Lead PSO to Lead PAM Operator and reverse	WhatsApp or Satellite phone (back-up)
Sound Field Verification and PAM vessel operations Update planning and buoy deployment	When possible	Lead PAM to respective bridges of both PSO vessels and reverse	WhatsApp or email
Communication between SFV and DBBC Operators via Works Manager	When possible, during operations	SFV to Works Manager to DBBC and reverse	TBD

9 REPORTING

Reference is made to the CMMP reporting section and the dedicated reporting sections in the separate CMMP appendices. Regarding foundation pile driving operations, Dominion Energy will provide the following reports, as necessary, during Project activities:

- Daily report (incl. PSO/PAM detections)
- Weekly report (incl. ASFV results)

Any opportunistic detections by the crew will be brought to the PSOs if present. The on board PSOs will include the detection in their daily PAM/PSO detection report. For vessels without PSO, the basic list of data items to document utilizing the Visual Observer Log at the time of the detection:

- Time (HH:MM), date (YYYY-MM-DD) and location (latitude/longitude);
- The vessel's activity, heading (degrees) and speed (kts);
- Sea state, water depth (m) and visibility;
- Protected species identification to the best of the observer's ability (e.g., A W, whale, dolphin, seal, sea turtle);
- Initial distance protected species was observed from the vessel (m) and closest point of approach (m); and
- Any avoidance measures taken in response to the protected species sighting.

Attachment C-1

Installation site pile driving sequence

MP INSTALLATION SEQUENCE - MP 19 (SKS update 22-Nov-2023) CVOW1-TIP-DMN-LST-LG-00003				
Install Sequence	**Location ID**	**Easting [m]**	**Northing [m]**	**Depth [m]**
1	G2K04	459337,14	4080459,17	-92,19
2	G2J05	460554,14	4082171,17	-99,79
3	G2J04	459168,14	4082171,17	-94,15
4	G2J03	457782,14	4082171,17	-86,85
5	G2G06	461601,14	4085595,17	-94,23
6	G2G05	460215,14	4085595,17	-90,44
7	G2J06	461940,14	4082171,17	-77,63
8	G2K06	462109,14	4080459,17	-72,31
9	G2K03	457951,14	4080459,17	-93,75
10	G2K05	460723,14	4080459,17	-76,94
11	G2H06	461770,14	4083883,17	-99,98
12	G2H05	460384,14	4083883,17	-99,16
13	G2G04	458829,14	4085595,17	-86,95
14	G2H04	458998,14	4083883,17	-91,95
15	G2H03	457612,14	4083883,17	-82,59
16	G2G03	457443,14	4085595,17	-88,87
17	G2F03	457273,14	4087306,17	-89,26
18	G2F04	458659,14	4087306,17	-94,11
19	G2F05	460045,14	4087306,17	-86,07
20	G2F06	461431,14	4087306,17	-88,23
21	G2F07	462817,14	4087306,17	-90,32
22	G2E06	461262,14	4089018,17	-80,13
23	G2E05	459876,14	4089018,17	-86,18
24	G2E04	458490,14	4089018,17	-89,89
25	G2E03	457104,14	4089018,17	-77,57
26	G2C05	459439	4092460,3	-79,62
27	G2D04	458320,14	4090730,17	-80,08
28	G2D05	459706,14	4090730,17	-83,36
29	G2D06	461092,14	4090730,17	-97,46
30	G2E07	462648,14	4089018,17	-87,18
31	G2D07	462478,14	4090730,17	-81,37
32	G2C07	462308,59	4092442,17	-105,23
33	G2C06	460923,14	4092442,17	-86,95
34	G2B06	460753,14	4094153,17	-74,90
35	G2B07	462139,14	4094153,17	-91,78
36	G2D09	465250,14	4090730,17	-92,30
37	G2D08	463864,14	4090730,17	-87,93
38	G2E08	464034,14	4089018,17	-83,63
39	G2F08	464203,14	4087306,17	-90,98
40	G2G08	464373,14	4085595,17	-95,02
41	G2G09	465759,14	4085595,17	-90,94
42	G2F09	465589,14	4087306,17	-94,65
43	G2E09	465420,14	4089018,17	-92,96
44	G2E10	466806,14	4089018,17	-96,17

Install Sequence	Location ID	Easting [m]	Northing [m]	Depth [m]
45	G2D10	466636,14	4090730,17	-109,49
46	G2D11	468022,14	4090730,17	-90,16
47	G2E11	468192,14	4089018,17	-100,91
48	G2F11	468361,14	4087306,17	-93,80
49	G2F10	466975,14	4087306,17	-92,78
50	G2G10	467145,14	4085595,17	-93,31
51	G2H08	464542,14	4083883,17	-94,52
52	G2H09	465928,14	4083883,17	-94,12
53	G2J09	466098,14	4082171,17	-99,23
54	G2K09	466267,14	4080459,17	-98,31
55	G2K10	467653,14	4080459,17	-104,15
56	G2K08	464881,14	4080459,17	-87,07
57	G2K07	463495,14	4080459,17	-83,56
58	G2J07	463326,14	4082171,17	-83,76
59	G2H07	463156,14	4083883,17	-87,17
60	G3J12	470256,14	4082171,17	-86,44
61	G3J13	471642,14	4082171,17	-80,56
62	G3H12	470086,14	4083883,17	-86,19
63	G3H13	471472,14	4083883,17	-81,97
64	G3H14	472858,14	4083883,17	-90,20
65	G3G14	472689,14	4085595,17	-89,04
66	G3G13	471303,14	4085595,17	-88,06
67	G3G12	469917,14	4085595,17	-93,98
68	G3G11	468531,14	4085595,17	-106,56
69	G3F12	469747,14	4087306,17	-94,55
70	G3F13	471133,14	4087306,17	-104,55
71	G3E13	470964,14	4089018,17	-100,73
72	G3D12	469408,14	4090730,17	-98,94
73	G3C12	469239,14	4092442,17	-95,06
74	G3B12	469069,14	4094153,17	-97,90
75	G3B13	470455,14	4094153,17	-92,77
76	G3C13	470625,14	4092442,17	-97,74
77	G3D13	470794,14	4090730,17	-109,75
78	G3E14	472350,14	4089018,17	-107,21
79	G3F14	472519,14	4087306,17	-95,35
80	G3F15	473905,14	4087306,17	-87,78
81	G3E15	473736,14	4089018,17	-92,30
82	G3D14	472180,14	4090730,17	-101,99
83	G3C14	472011,14	4092442,17	-105,09
84	G3B14	471841,14	4094153,17	-97,87
85	G3B16	474613,14	4094153,17	-100,90
86	G3B15	473227,14	4094153,17	-99,34
87	G3E16	475122,14	4089018,17	-90,71
88	G3F16	475291,14	4087306,17	-96,07

Install Sequence	Location ID	Easting [m]	Northing [m]	Depth [m]
89	G3G16	475461,14	4085595,17	-112,12
90	G3E17	476508,14	4089018,17	-91,76
91	G3D16	474952,14	4090730,17	-92,95
92	G3C16	474783,14	4092442,17	-98,80
93	G3B17	475999,14	4094153,17	-107,96
94	G3C17	476169,14	4092442,17	-97,95
95	G3D17	476338,14	4090730,17	-95,83
96	G3F17	476677,14	4087306,17	-116,12
97	G3G17	476847,14	4085595,17	-110,78
98	G3F18	478063,14	4087306,17	-119,16
99	G3E18	477894,14	4089018,17	-117,58
100	G3D18	477724,14	4090730,17	-102,44
101	G3C18	477555,14	4092442,17	-103,23
102	G3B18	477385,14	4094153,17	-110,04
103	G3C19	478941,14	4092442,17	-107,83
104	G3C20	480327,14	4092442,17	-116,54
105	G3D20	480496,14	4090730,17	-113,51
106	G3D19	479110,14	4090730,17	-107,50
107	G3G18	478233,14	4085595,17	-103,00
108	G3F19	479449,14	4087306,17	-120,45
109	G3G19	479619,14	4085595,17	-116,60
110	G3H19	479788,14	4083883,17	-105,95
111	G3H17	477016,14	4083883,17	-106,35
112	G3H16	475630,14	4083883,17	-100,16
113	G3J15	474414,14	4082171,17	-98,64
114	G3J16	475800,14	4082171,17	-102,70
115	G3J17	477186,14	4082171,17	-97,45
116	G3J18	478572,14	4082171,17	-98,06
117	G3J19	479958,14	4082171,17	-107,29
118	G1L10	467823,14	4078748,17	-85,82
119	G1L09	466437,14	4078748,17	-89,31
120	G1L08	465051,14	4078748,17	-93,16
121	G1L07	463665,14	4078748,17	-97,10
122	G1L06	462279,14	4078748,17	-74,13
123	G1L03	458121,14	4078748,17	-87,42
124	G1L04	459507,14	4078748,17	-76,99
125	G1L05	460893,14	4078748,17	-70,29
126	G1K11	469039,14	4080459,17	-79,67
127	G1K12	470425,14	4080459,17	-94,08
128	G1K13	471811,14	4080459,17	-99,15
129	G1K14	473197,14	4080459,17	-97,58
130	G1K15	474583,14	4080459,17	-98,52
131	G1K16	475969,14	4080459,17	-91,42
132	G1K17	477355,14	4080459,17	-98,14

Install Sequence	Location ID	Easting [m]	Northing [m]	Depth [m]
133	G1K18	478741,14	4080459,17	-96,26
134	G1K19	480127,14	4080459,17	-101,18
135	G1L19	480297,14	4078748,17	-94,53
136	G1L16	476139,14	4078748,17	-91,86
137	G1L15	474753,14	4078748,17	-90,74
138	G1L13	471981,14	4078748,17	-100,46
139	G1L14	473367,14	4078748,17	-101,08
140	G1L17	477525,14	4078748,17	-85,39
141	G1L18	478911,14	4078748,17	-97,83
142	G1M19	480466,14	4077036,17	-89,46
143	G1M18	479080,14	4077036,17	-93,28
144	G1M17	477694,14	4077036,17	-97,91
145	G1M16	476308,14	4077036,17	-89,75
146	G1M15	474922,14	4077036,17	-88,64
147	G1M14	473536,14	4077036,17	-95,91
148	G1L12	470595,14	4078748,17	-88,84
149	G1M04	459676,14	4077036,17	-69,26
150	G1N17	477864,14	4075324,17	-89,05
151	G1N18	479250,14	4075324,17	-87,46
152	G1N19	480636,14	4075324,17	-81,01
153	G1N16	476478,14	4075324,17	-95,93
154	G1N15	475092,14	4075324,17	-89,50
155	G1N14	473706,14	4075324,17	-89,60
156	G1N13	472320,14	4075324,17	-91,65
157	G1M12	470764,14	4077036,17	-84,99
158	G1N12	470934,14	4075324,17	-85,88
159	G1N11	469548,14	4075324,17	-84,71
160	G1N10	468162,14	4075324,17	-83,03
161	G1N09	466776,14	4075324,17	-75,54
162	G1N07	464004,14	4075324,17	-88,64
163	G1N08	465390,14	4075324,17	-85,26
164	G1M09	466606,14	4077036,17	-85,07
165	G1M10	467992,14	4077036,17	-87,23
166	G1M11	469378,14	4077036,17	-82,88
167	G1M08	465220,14	4077036,17	-82,44
168	G1N06	462618,14	4075324,17	-82,22
169	G1N05	461232,14	4075324,17	-81,97
170	G1N04	459846,14	4075324,17	-70,91
171	G1N03	458460,14	4075324,17	-70,58
172	G1M03	458290,14	4077036,17	-74,74
173	G1M13	472150,14	4077036,17	-99,01
174	G1M05	461062,14	4077036,17	-71,59
175	G1M06	462448,14	4077036,17	-87,66
176	G1M07	463834,14	4077036,17	-85,19

Attachment C-2

Risk Assessment – Pile driving operations

Risk Assessment - Pile Driving Operations

Nr	(Sub)Activity	Hazard / Aspect	Event: Consequence / Impact	P,A,Q,E,R	Severity (ref. DEME-QHSE-601-065)	Probability (ref. DEME-QHSE-601-065)	Risk (ref. DEME-QHSE-601-065)	Measures cfr. ISO 45001 1. Elimination 2. Substitution 3. Engineering controls 4. Administrative controls (Procedures, signage, warnings, training, inspecting equipment) 5. Personal protective equipment 6. Damage Control	Severity (ref. DEME-QHSE-601-065)	Probability (ref. DEME-QHSE-601-065)	Risk (ref. DEME-QHSE-601-065)	Actions
1	**General**											
1.1	**Standard mitigating measures for all activities**	Reference is made to section 5						4. Personnel competent for the task assigned 4. Toolbox talk to be held prior operation 4. Perform "Take 5" (LMRA). 4. Stop Work Authority. 4. PtW in place 4. To use 3-way communication 5. Standard PPE to be worn as minimum; additional PPE to be used as per the task risks				
1.2	**Communication**	**Communication issues**	Damage to MP, upending line, vessel	A	3	3	9	4. Clear communication between lifting supervisor, crane operator, tool operator and crew 4. Use of certified crane operators and lifting supervisors 4. Conduct a toolbox talk on the lifting plan, lifting arrangements, responsibilities and communication prior to start lift. During TBT applicable channels will be listed for all personnel involved 2. Sufficient spare radios will be available on board in case of need 4. Hand signals to be used in case radio communication fails	3	1	3	
			Injury to personnel	P	5	3	15	4. Clear communication between lifting supervisor, crane operator, tool operator and crew 4. Use of certified crane operators and lifting supervisors 4. Conduct a toolbox talk on the lifting plan, lifting arrangements, responsibilities and communication prior start lift. During TBT applicable channels will be listed for all personnel involved 2. Sufficient spare radios will be available on board in case of need 4. Hand signals to be used in case radio communication fails	5	1	5	
2	**Vibrodriving of MP**											
2.1	**Pile Driving with vibro hammer**	**Noise and vibration**	Excessive exposure to noise and vibrations: temporary and permanent hearing damage (to humans)	P	4	4	16	4. Experienced hammer operators 4. Experienced vessel crew 4. Project HSE management plan 5. Hearing protection for riggers available during piling activities	4	1	4	
			Excessive exposure to noise and vibrations: temporary and permanent hearing damage (to marine mammals)	E	4	3	12	4. Clearance zone established before the start of operations.4. Experienced hammer operators4. Experienced vessel crew3. Noise mitigation and monitoring on DBBC vessel as per DBBC management plan.4. Constant communication from DBBC vessel with Installation Vessel.4. in case of visual of marine mammal, to cease piling operations if there is no risk for safety of personnel and safety of operations,1. Monitoring as per PSO and PAM management plan4. Project HSE management plan	4	1	4	
		Pile Driving has to be stopped due to unforeseen circumstances	Soil set-up: > Pile refusal	A Q	3	3	9	2. Early switch the hydro hammer if driving protocol allows for this,	3	1	3	
		Pile refusal	Excessive forces on MP: damage to assets	A	3	3	9	3. Pile driveability analysis and driving protocol created ref. 6 3. Survey for sub seabed objects carried out by Employer prior to start of Project 4. Monitoring pile penetration during piling 4. Experienced hammer operator and works manager 4. Constant communication between hammer operator and works manager	3	1	3	
			Pile refusal before reaching the vibro target depth range	A Q	5	2	10	2. Early switch the hydro hammer if driving protocol allows for this.	5	1	5	
			Damage to equipment, crane Loss of quality (inability to install pile within required tolerances)	A Q	4	2	8	3. Reference to CPT and soil profile data prior to hammering at each location 3. Pile driveability assessment and driving protocol created based on soil data from site investigation prior start of Project 3. Hook load limit applied,	4	1	4	

Risk Assessment - Pile Driving Operations

Nr	(Sub)Activity	Hazard / Aspect	Event: Consequence / Impact	P,A,Q,E,R	Severity (ref. DEME-QHSE-SPL-065)	Probability (ref. DEME-QHSE-SPL-065)	Risk (ref. DEME-QHSE-SPL-065)	Measures cfr. ISO 45001 1. Elimination 2. Substitution 3. Engineering controls 4. Administrative controls (Procedures, signage, warnings, training, inspecting equipment) 5. Personal protective equipment 6. Damage Control	Severity (ref. DEME-QHSE-SPL-065)	Probability (ref. DEME-QHSE-SPL-065)	Risk (ref. DEME-QHSE-SPL-065)	Actions
								4. Conduct a toolbox talk with the involved personnel 4. Controlled lowering and phased weight reduction in hoist during vibro driving 4. Repeated, continual radio communication with positive feedback between crane operator, lift supervisor and control room during all the above steps.				
		Pile refusal due to extended break , soil settlement	Instability of pile, risk to damage to vessel	A P	5	3	15	3. Pile driveability assessment and driving protocol created based on soil data from site investigation prior start of Project 3. To follow plan for alternative monitoring 2. Early switch the hydro hammer if driving protocol allows for this.	5	1	5	
		Proximity of gripper arms, front access platforms and hammer; Gripper arms, front access platforms not positioned correctly	Collision between hammer and piling frame: multiple fatalities, severe damage to assets, production delay,	P A Q	5	3	15	4. The gripper arms will be opened entirely before the hammer may pass. 4. Continuous radio communication between hammer operator and gripper operator/WM 4. Competent operator 4. Conduct a toolbox talk with the involved personnel	5	2	10	
		Frequency exceeded	Fatigue damage on MP	A	3	3	9	3. Hammer operator to check maximum allowable frequency 4. Pile driveability analysis and drivng protocol created	4	1	4	
		Personnel to access MCPG walkways	People hit by moving elements:> injuries	P	4	3	12	3. Sounder when MCPG goes in motion-compensation mode3. Light beacon as long as motion goes on4. Only people required for operations allowed on the walkways4. Access split in two parts: access from deck to X-skid, access from x-skid to y-skid. Personnel never enters walkway moving in two direction4. Orion MCPG Induction	4	1	4	
2.2	**Pile Driving Monitoring**	**Survey equipment not working**	Monopile installation out-of-tolerance: > Risk for overdriving > Inclination out of tolerance > Position out of tolerance	A Q	4	3	12	3. MST Survey & Testing 3. Communication between survey team and hammer operator to identify when target depth is reached and hammering should be stopped 3. Multiple survey tools available for same purpose to have redundancy 4. In case piling out of tolerance, MCPG to correct inclination of MP	4	1	4	
2.3	**Load control in lifting points for hose handling**	**Improper control of load in tuggers and pedestal crane resulting in overload of tuggers during hose handling**	Overloaded tuggers, delay in operations as other lifting points need to be adjusted to reduce load in overloaded tugger	Q	2	3	6	4. Second dedicated crane operator keeps tuggers at their required level while monitoring tugger load 4. Display screen in crane operator cabing showing tugger loads 4. Lifting supervisor and dedicated banksman must maintain a clear view for continuous monitoring of the tuggers 4. Effective communication bewteen all parties involved	2	1	2	
2.4	**Hammer swap**	**Pile instability**	Monopile installation out-of-tolerance: > Inclination out of tolerance > Position out of tolerance Damage to MP gripper Risk to personnel onboard of installation vessel	P,A,Q	5	3	15	3. Pile driveability analysis and driving protocol created to be shared with LS and Crane operator 3. Piling procedure taking into account soil layers (flowchart in SSR Hydrohammer 4. Monitoring pile penetration during piling 4. To respect hammer switch period. 4. Alternative monitoring to complete pile with hydro piling in the event of reduced visbility	5	1	5	
3	**Pile Driving with hydro hammer**											
3.1	**Pile Driving with hydro hammer**	**Noise and vibration**	Excessive exposure to noise and vibrations: temporary and permanent hearing damage (to humans)	P	4	4	16	4. Experienced hammer operators 4. Experienced vessel crew 4. Apply soft start procedure 4. Project HSE management plan 5. Hearing protection for riggers obligated during piling activities 4. Hearing protection zones on deck will be indicated 4. During first piling operation, noise measurements will be performed to identify risk	4	2	8	

Risk Assessment - Pile Driving Operations

Nr	(Sub)Activity	Hazard / Aspect	Event: Consequence / Impact	P,A,Q,E,R	Severity (ref. DEME-QHSE-SPL-065)	Probability (ref. DEME-QHSE-SPL-065)	Risk (ref. DEME-QHSE-SPL-065)	Measures cfr. ISO 45001 1. Elimination 2. Substitution 3. Engineering controls 4. Administrative controls (Procedures, signage, warnings, training, inspecting equipment) 5. Personal protective equipment 6. Damage Control	Severity (ref. DEME-QHSE-SPL-065)	Probability (ref. DEME-QHSE-SPL-065)	Risk (ref. DEME-QHSE-SPL-065)	Actions
								zones. 4. All unauthorized personal to clear the exclusion zone				
			Excessive exposure to noise and vibrations: temporary and permanent hearing damage (to marine mammals)	E	4	3	12	3. Noise mitigation and monitoring on DBBC vessel as per DBBC plan 4. Experienced hammer operators 4. Experienced vessel crew 4. Apply soft start procedure 4. Constant communication from DBBC vessel with Installation Vessel. 4. Monitoring as per PSO and PAM plan 4. Project HSE management plan	4	1	4	
		Pile Driving has to be stopped due to unforeseen circumstances	Soil set-up:> Pile refusal	AQ	3	3	9	3. Piling procedure taking into account soil layers (flowchart in SSR Hydrohammer3. Regular inspection of tools prior use4. Experienced hammer operators and awareness of special site conditions (toolbox and location specific piling book)4. Increase blowcount after pile driving had to be stopped. Increase blowcount until pile refusal criteria are met6. In case of pile refusal, FND Abandonment plan	3	1	3	
		Pile refusal	Excessive forces on MP: damage to assets	A	3	3	9	3. Pile driveability analysis and driving protocol created to be shared with LS and Crane operator 3. Survey for sub seabed objects carried out by Employer prior to start of Project 4. Experienced hammer operator and works manager 4. Monitoring pile penetration during piling	3	1	3	
			MP not deep enough in soil	A Q P	5	2	10	2. Attempt with vibro hammer 3. FND Abandonment plan (ref. 14)	5	1	5	
			Damage to equipment, crane Loss of quality (Installation of pile out of tolerance)	A	4	2	8	3. Reference to CPT and soil profile data prior to hammering at each location 3. Pile driveability assessment and driving protocol created based on soil data from site investigation prior start of Project 4. Conduct a toolbox talk with the involved personnel 4. Controlled lowering and phased weight reduction in hoist during lowering of hammer on stabbed MP 4. Required slack on hammer rigging verified prior to soft start hammer blows 4. Slack in hammer rigging is monitored by crane driver and lift supervisor 4. Soft start procedure involving repeated low energy single blows until soil resistance is high enough to execute groups of low energy blows. Continuous low energy piling only starts when there is consistent soil resistance. 4. Controlled ramp up in piling energy relative to increase in soil resistance. 4. Repeated, continual radio communication with positive feedback between crane operator, lift supervisor and control room during all of the above steps. 4. Pile driving procedure	4	1	4	
		Proximity of gripper arms, front access platforms and hammer; Gripper arms, front access platforms not positioned correctly	Collision between hammer and piling frame: multiple fatalities, severe damage to assets, production delay,	P	5	3	15	4. Competent operator 4. The gripper arms will be opened entirely before the hammer may pass. 4. Continuous radio communication between hammer operator and piling frame operator 4. Conduct a toolbox talk with the involved personnel	5	1	5	
		Pile drive energy exceeded	Fatigue damage on MP	A	3	3	9	3. Hammer operator to check maximum allowable pile drive energy 4. Pile driveability analysis	4	1	4	
		Piling on DP	DP-system malfunctioning: > MP Installation out of tolerance	A Q	3	3	9	3. DP system is class approved and redundant 4. Simulator trainings	3	2	6	
		Personnel to access MCPG walkways	People hit by moving elements:> injuries	P	4	3	12	3. Sounder when MCPG goes in motion-compensation mode3. Light beacon as long as motion goes on4. Only people required for operations allowed on the walkways4. Access	4	1	4	

Risk Assessment - Pile Driving Operations

Nr	(Sub)Activity	Hazard / Aspect	Event: Consequence / Impact	P,A,Q,E,R	Severity (ref. DEME-QHSE-60-065)	Probability (ref. DEME-QHSE-60-065)	Risk (ref. DEME-QHSE-60-065)	Measures cfr. ISO 45001 1. Elimination 2. Substitution 3. Engineering controls 4. Administrative controls (Procedures, signage, warnings, training, inspecting equipment) 5. Personal protective equipment 6. Damage Control	Severity (ref. DEME-QHSE-60-065)	Probability (ref. DEME-QHSE-60-065)	Risk (ref. DEME-QHSE-60-065)	Actions
								split in two parts: access from deck to X-skid, access from x-skid to y-skid. Personnel never enters walkway moving in two direction 4. Orion MCPG induction				
3.2	**Pile Driving Monitoring**	**Survey equipment not working**	Monopile installation out-of-tolerance: > Risk for overdriving > Inclination out of tolerance > Position out of tolerance	A Q	4	3	12	3. MST Survey & Testing (ref. 9) 3. Communication between survey team and hammer operator to identify when target depth is reached and hammering should be stopped 3. Multiple survey tools available for same purpose to have redundancy (ref. 9) 4. In case piling out of tolerance, MCPG to correct inclination of MP	4	1	4	
3.3	**Load control in lifting points for hose handling**	**Improper control of load in tuggers and pedestal crane resulting in overload of tuggers during hose handling**	Overloaded tuggers, delay in operations as other lifting points need to be adjusted to reduce load in overloaded tugger	Q	2	3	6	4. Second dedicated crane operator keeps tuggers at their required level while monitoring tugger load 4. Display screen in crane operator cabing showing tugger loads 4. Lifting supervisor and dedicated banksman must maintain a clear view for continuous monitoring of the tuggers 4. Effective communication between all parties involved	2	1	2	