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Sound Source Verification Plan

Gustavus Ferry Terminal Improvements

Gustavus, Alaska

Prepared for

Alaska DOT&PF Southcoast Region

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Sound Source Verification Plan

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1.0 PROJECT SUMMARY

The Alaska Department of Transportation and Public Facilities (DOT&PF) is proposing to make improvements to the Gustavus Ferry Terminal, located on Icy Passage, Gustavus, in Southeast Alaska (Figure 1). These improvements include in-water pile driving, which is known to generate high levels of underwater noise. The marine environment surrounding the ferry terminal supports several marine mammal species that are protected under the Marine Mammal Protection Act of 1972 (MMPA) and are known to be sensitive to underwater noise. To allow pile driving work to proceed while meeting the requirements of the MMPA, the National Marine Fisheries Services (NMFS) issued DOT&PF an Incidental Harassment Authorization (IHA) (NMFS 2018). The IHA prescribes avoidance and minimization measures that DOT&PF and its contractors must use to limit injury and disturbance of marine mammals, allows a limited amount of "take," and specifies other compulsory terms and conditions for the proposed in-water pile driving. One of the requirements defined in the IHA is to conduct acoustic monitoring during pile driving to verify whether the assumptions used to model noise are accurate and to augment the database of pile driving source levels frequently used for planning future projects. This document represents the acoustic monitoring, or sound source verification (SSV) plan that the contractor will be responsible for implementing during construction. Marine mammal monitoring during construction, which is also a requirement of the IHA, is described separately (Hart Crowser 2016).

The following is a summary of the planned pile driving activities:

- Remove the existing steel bridge float and restraint structure and replace them with two pile-supported bridge lift towers capable of elevating the relocated steel transfer bridge above the water when not in use;
- Construct two new four-pile (30-inch) lift towers;
- Construct new steel six-pile (30-inch) bridge abutment;
- Expand dock by approximately 3,560 square feet, requiring 15 new 24-inch steel piles;
- Relocate the steel transfer bridge and vehicle apron;
- Relocate timber log float (four 16-inch steel piles);
- Install refurbished 18-foot by 200-foot steel mooring float, three four-pile float restraints (six 30-inch and six 24-inch steel piles), and 7-foot by 80-foot aluminum harbor access gangway;
- Provide access gangways and landing platforms for lift towers, and access catwalk to existing breasting dolphins;

- Remove 10-foot by 28-foot timber float, 10-foot by 50-foot timber log float, and timber sectional floats; and
- Remove 14 steel piles.

Pile driving is limited to a work window from March 1 to May 31, and September 1 to November 30 to avoid the peak seasonal use of the area by marine mammals.

2.0 SPECTRAL CONSIDERATIONS

Marine mammals hear underwater noise differently depending on species type (Southall et al. 2007, NMFS 2018). Using the best available information, NMFS suggests grouping species according to hearing range frequencies shown in Table 1.

Table 1. Marine Mammal Hearing Groups and Ranges

Hearing Group	Example	Generalized Hearing Range
Low-frequency (LF) cetaceans	Baleen whales	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans	Dolphins, toothed whales, beaked whales, bottlenose whales	150 Hz to 160 kHz
High-frequency (HF) cetaceans	True porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*	275 Hz to 160 kHz
Phocid pinnipeds (PW)	True seals	50 Hz to 86 kHz
Otariid pinnipeds (OW)	Sea lions and fur seals	60 Hz to 39 kHz

Notes:

a. Auditory weighting functions described by NMFS (2018).

Acoustic monitoring equipment must be capable of recording frequencies that relate to hearing capabilities by the anticipated species of marine mammals. This project has the potential to encounter at least one species in each category; therefore, this range would be between 7 hertz (Hz) and 160 kilohertz (kHz). However, Reinhall and Dahl (2011) demonstrated that virtually all of the acoustic energy generated by pile driving is propagated at frequencies less than 20 kHz. Therefore, for practical purposes, equipment need not be capable of recording noise at frequencies greater than 20 kHz because the amount of sound energy within the higher spectra is insignificant.

Similarly, analysis of the acoustic data should consider broadband sound energy between 7 Hz and 20 kHz, and sound energy within the frequency bands specific to each marine mammal hearing group based on auditory weighting functions described by NMFS (2018). For example, Dall's porpoise, a high-frequency cetacean, will not hear sound energy in the frequencies below 275 Hz because these frequencies are outside the range of its functional hearing. The metrics used to characterize sound energy are described further in the Data Processing and Reporting Requirements sections below.

3.0 SOUND MONITORING

An acoustic monitoring study to verify source levels of underwater noise generated by pile driving activities at the Gustavus Ferry Terminal is a required component of the contracted work. This study plan was developed based on guidance from NMFS (2012, 2018) and must be performed by a qualified acoustical firm with prior experience conducting SSV tests in Alaska.

The goals of the study are to:

- Measure underwater sound pressure levels (SPLs) from representative impact and vibratory pile driving activities at the site to determine source levels.
- Provide evidence to either confirm or revise the predicted distances to noise threshold values corresponding with Level A and Level B harassment of marine mammals that were established in the IHA based on attenuation modeling.

3.1 Locations

Underwater sound will be measured at two fixed distances from the active pile driving operations (Figure 2):

- One hydrophone will be deployed at 10 meters from the pile location to measure near source levels. If multiple piles will be driven over the recording period, the recorder may need to be repositioned to maintain the 10-meter distance between the source and receiver for each pile.
- The second hydrophone will be deployed approximately 20H from the pile, where H is the water depth at the pile. The location of the monitoring station should be selected such that the pathway between the source and receiver does not contain highly variable bathymetry and is outside of established shipping or ferry lanes.

At each location, the hydrophone will be positioned at a depth between 70 percent and 85 percent of the total water depth (H).

In addition, spot measurements will be made using a boat-based hydrophone system at two to three locations for a minimum duration of 2 to 5 minutes at each location. Distance to the source will be calculated based on the vessel's coordinates as measured with GPS. During spot measurements, the vessel's engines and sonar will be temporarily shut down to reduce extraneous sources of noise.

3.2 Sample Size

At least three representative pile driving events will be recorded and processed for each of the following scenarios:

- Vibratory driving of 30-inch steel pile;
- Vibratory driving of 24-inch steel pile;

- Impact driving of 30-inch steel pile; and
- Impact driving of 24-inch steel pile.

A pile driving event is considered the complete installation of one pile, except that vibratory and impact driving must be characterized separately. Therefore, if a pile is initially driven with a vibratory hammer then proofed with an impact hammer, the total installation would constitute two events. If attenuation devices are to be used (e.g., bubble curtains, pile caps), measurements will be taken both while attenuation devices are applied, and while they are not applied to determine how well the device is working.

If feasible, additional events will be measured to help characterize the variability caused by differences in bathymetry, substrate type, distance from shore, water depth, and hammer power setting. These variables will be reported with the results.

3.3 Timing and Duration

The acoustic recorders will be deployed for a sufficient length of time necessary to capture at least three of each of the events described above, and will record noise continuously. Spot measurements with a mobile, boat-based system will be made during this same period to capture the same pile driving events.

4.0 EQUIPMENT SPECIFICATIONS

The make and model of the underwater sound measuring equipment will be determined by the contractor, but must meet the following specifications:

- Frequency – The recording systems must be capable of recording broadband sound between 7 Hz and 20 kHz. It is preferable if frequencies up to 160 kHz can be recorded to capture the full bandwidth as determined by species' hearing sensitivities, (i.e., Table 1).
- Pressure – Receiving sensitivities should be sufficient to measure very high acoustic pressures. For close-range measurements, peak pressures may reach as high as 105 Pascals, which is equivalent to 220 decibels relative to 1 micropascal (dB re: 1 µPa). Documentation of hydrophone sensitivities will be provided in the final report.
- Data storage – Autonomous acoustic recorders must have onboard data storage capacity that is sufficient for capturing acoustic data over the entire study period.
- Calibration – All acoustic recorders will be calibrated with a pistonphone before they are deployed and after they are retrieved.
- Spot measurements – The boat-based system will be capable of real-time monitoring and data recording. Depth of the hydrophone during measurements will be recorded.

5.0 DATA PROCESSING

At the end of the study period, recorders will be retrieved, and the data downloaded and permanently stored. The continuously recorded data will be parsed into discrete sampling events, using a cross-check of the construction log to identify the activity (impact or vibratory), pile size, and other conditions. Source levels for vibratory and impact pile driving will be characterized as described below.

For vibratory pile driving, the average SPL will be calculated in decibels relative to 1 micropascal (dB re 1 µPa) normalized to a range of 10 meters. The root mean squared (RMS) SPL will be calculated by dividing each sampling event into 10-second periods, within which the RMS levels will be averaged. Subsequently, all of the 10-second periods will be averaged to calculate a single overall dB RMS value for the entire event that captures the variation in sound levels over the pile-driving event. Non-weighted sound exposure level (SEL) will be calculated in decibels relative to 1 micropascal squared normalized to an exposure of one second (dB re 1 $\mu Pa^2 \cdot s$). In addition, frequency-weighted SEL will be calculated for each hearing group (NMFS 2018). This metric is described in the Reporting Requirements section below.

For impact pile driving, the metrics will include broadband peak levels (Peak), as well as $RMS_{90\%}$ levels, which will be characterized by integrating sound for each waveform across 90 percent of the acoustic energy in each wave (using the 5 to 95 percentiles to establish the 90 percent criterion) and averaging across all waves in the pile-driving event. Non-weighted and frequency-weighted single-strike SEL will also be calculated for impact pile driving results.

6.0 REPORTING REQUIREMENTS

The data summary report will document the methods and equipment used to monitor underwater noise. The report will also include a summary of relevant observations relating to weather, tide, and sea state during monitoring, as well as information from the construction log to describe specific conditions of pile driving; i.e., hammer type, power settings, piling diameter and length, water depth, substrate conditions, etc. This information will be used to ensure appropriate comparisons to results from other studies and in future planning.

The recorded sound pressure levels will be reported in the following metrics:

- Peak (db re 1 µPa at 10 m) – Broadband/Flat-weighted. Median, minimum, maximum, standard deviation. Only report for impact pile driving activities.
- $RMS_{90\%}$ (db re 1 µPa at 10 m) – Auditory-weighted (i.e., separate values for each of the five hearing groups). Median, minimum, maximum, standard deviation, plus the time integral used for calculating 90 percent SPL. Report for both impact and vibratory.
- Single Strike SEL (dB re 1 $\mu Pa^2 \cdot s$ at 10 m) – Auditory-weighted. Median, minimum, maximum, standard deviation.
- Cumulative SEL – Auditory-weighted. This metric is calculated based on the single strike SEL and the number of strikes anticipated over a 24-hour accumulation period. Because the number of strikes is not

limited by the IHA, this value would represent an estimate for comparative purposes. A typical pile driving scenario, with a combination of vibratory and impact proofing over the course of one day will be proposed for this estimate.

The same metrics will be calculated at each measurement distance (i.e., 10 m, 20H, and spot measurement locations) and a regression analysis will be used to calculate the observed transmission loss, and to validate the Practical Spreading Loss model. If necessary, the Level A and Level B injury/harassment thresholds and the monitoring zones will be redefined based on new values for source levels and transmission loss.

A final report will be prepared that summarizes the results within one week after monitoring and analysis is completed.

7.0 REFERENCES

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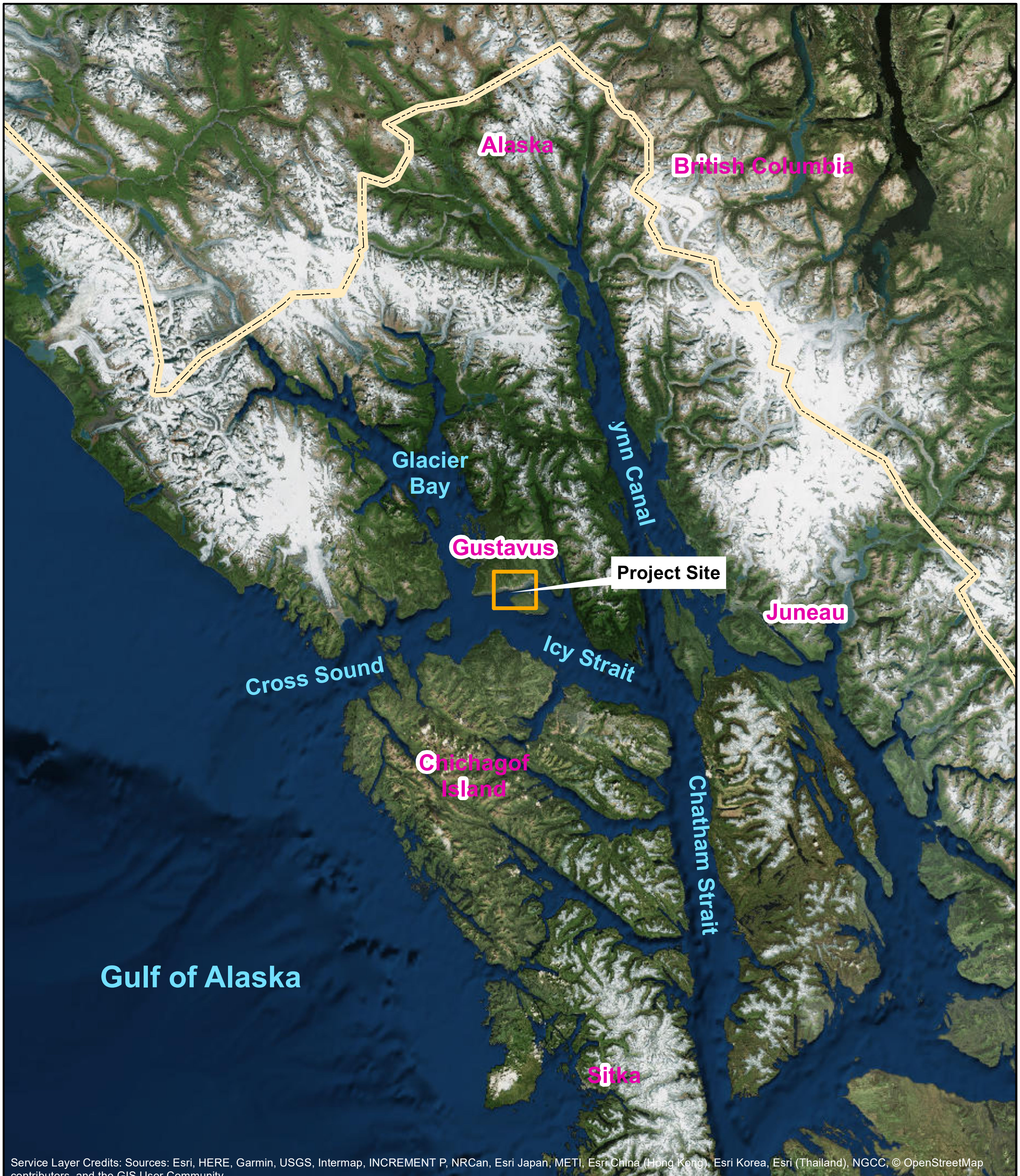

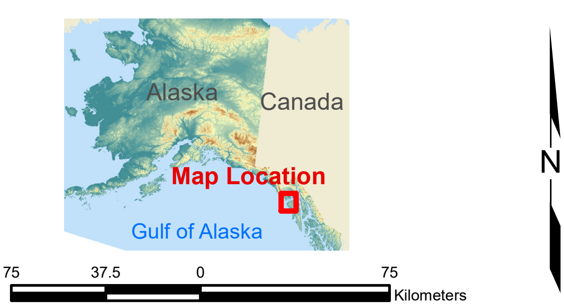

Gustavus Ferry Terminal, SSV Plan
Gustavus, Alaska

Vicinity Map

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Figure

1

0.3 0.15 0 0.3 Kilometers

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Gustavus Ferry Terminal, SSV Plan
Gustavus, Alaska

Project Area

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Figure **2**