



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
16 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0016

Janet T. Mills
GOVERNOR

Bruce A. Van Note
COMMISSIONER

September 15, 2020
Subject: Mattawamkeag Bridge
Replacement
State WIN: 023234.01
Location: Mattawamkeag
Amendment No. 2

Dear Sir/Ms.:

Please make the following changes to the Bid Documents:

In the Bid Book:

CHANGE on page 14, NOTICE TO CONTRACTORS, the bid opening date from September 16, 2020, to read "**September 23, 2020**". Make this change in pen and ink.

REMOVE pages 64 – 85, SPECIAL PROVISION – SECTION 105 – General Scope of Work – (Environmental Requirements), 22 pages, dated 8/19/2020, and **REPLACE** with the attached, revised SPECIAL PROVISION – SECTION 105 – General Scope of Work – (Environmental Requirements), 22 pages, dated 9/14/2020.

The following question has been received:

Question: Please advise under what line item pier excavation falls.

Response: Pier excavation is paid for under Item 206.082, Structural Earth Excavation, Major Structures, Plan Quantity.

Consider these changes and information prior to submitting your bid on **September 23, 2020**.

Sincerely,

Kevin Hanlon for

George M. A. Macdougall P.E.
Contracts & Specifications Engineer

SPECIAL PROVISION
SECTION 105
 General Scope of Work
 (Environmental Requirements)

In-Water work consists of any activity conducted below the normal highwater mark of a river, stream, brook, lake, pond or “Coastal Wetland” areas that are subject to tidal action during the highest tide level for the year which an activity is proposed as identified in the tide tables published by the National Ocean Service. <http://www.oceanservice.noaa.gov/> For the full definition of “Coastal Wetlands”, please refer to 38 MRSA 480-B(2)

I. In-Water Work is allowed for the following activities as follows:

Activity	In-Water Work Window
Fill placement for temporary bridge	July 15 to October 31
Installation of work trestle	July 15 to October 31
Pier demolition	July 15 to October 31
Pile driving	July 15 to October 31
Cofferdam construction	July 15 to October 31
Work within cofferdam	anytime
Cofferdam removal	July 15 to October 31
Temporary fill removal	July 15 to October 31
Temporary structure removal	July 15 to October 31

II. In-Water work window applies to the following water bodies at the following station #'s:

1. Mattawamkeag River at proposed bridge replacement

III. In consultation with the environmental agencies, the Department may grant an instream work extension based on the results of an Atlantic salmon redd survey conducted during the month of November and the nature of the instream work proposed by the Contractor.

IV. Additional Requirements for In-water Pile Driving

1. Piles driven by impact hammer may not exceed the following pile sizes:
 - i. Pipe pile: 30 inch
 - ii. Steel H-pile: 14-inch
2. Installation of piles with an impact hammer shall be limited to no more than 3 piles per day.
3. The contractor shall use a vibratory hammer for pile installation as much as practicable.
4. Pile driving shall occur during the day.
5. Any use of an impact hammer during pile driving shall require the use of passive attenuation measures (changing hammer type, reducing driving duration, reducing force settings) and active measures (cushions and bubble curtains).
6. **The contractor shall employ a bubble curtain for all in-water impact pile driving. The bubble curtain shall meet the design specifications and performance requirements in the attached Bubble Curtain Specification. The contractor shall complete a performance test of the bubble curtain prior to any impact pile driving. The performance test shall confirm the calculated pressures and flow rates at each manifold ring.**

7. **Hydroacoustic monitoring for impact pile driving shall be completed as follows for at least one pile:**
 - i. **Largest pile driven in-water (in at least two feet of water)**
 - ii. **A minimum of three hydrophones must be used, located approximately 33, 66, and 100 feet from the in-water sound producing activity.**
8. The Contractor shall retain the services of a qualified person or firm to prepare and implement a hydroacoustic monitoring plan following the attached “Underwater Noise Monitoring Plan” template. The Contractor shall provide MaineDOT a completed draft hydroacoustic monitoring plan at least 45 days prior to implementation for review. **No in-stream noise-generating activities may commence until MaineDOT has approved the monitoring protocol.**
9. The Contractor shall provide Hydroacoustic monitoring data to the Department. A preliminary data report shall be submitted within 5 business days of pile driving activity. A final summary report of all of the data must be submitted within 2 months of completion of in-water construction.
10. The contractor shall be responsible for implementing noise monitoring and noise attenuation as described above. Payment shall be made as a lump sum under Pay Item 501.237.

V. Special Conditions:

1. Special Conditions of Army Corps of Engineers (ACOE) Individual permit apply (see permit and conditions in SP 105).
2. Special Conditions of Formal Endangered Species Act (Section 7) Consultation with U.S. Fish and Wildlife Service apply (summarized in this Special Provision 105 and ACOE permit).
3. The MaineDOT will conduct Atlantic salmon red surveys during the spawning season prior to start of construction and each year during construction.
4. The Contractor shall hold a pre-construction meeting with appropriate MaineDOT Environmental Office staff, other MaineDOT staff, and the Contractor(s) to review all procedures and requirements for avoiding and minimizing effects to Atlantic salmon (ATS). The following individuals/agencies shall be invited: ACOE (Jay Clement, jay.l.clement@usace.army.mil); FHWA (Eva Birk, eva.birk@dot.gov); and U.S. Fish and Wildlife Service (Patrick Dockens, patrick_dockens@fws.gov).
5. The contractor shall contact Eric Ham of MaineDOT Environmental Office (207-215-7356, eric.ham@maine.gov) at least two weeks prior to installation of cofferdams to coordinate fish evacuation. Fish evacuation includes electrofishing. Electrofishing activities are prohibited when water temperatures is greater than or equal to 22 degrees Celsius (71.6 degrees Fahrenheit).
6. If adult Atlantic salmon are observed during active construction, all activities shall cease and the MaineDOT shall immediately contact the Service’s Maine Field Office at 207-902-1586 (Patrick Dockens) within 48 hours of occurrence.
7. The MaineDOT will implement their BMPs in accordance with the MaineDOT: Best Management Practices for Erosion and Sedimentation Control. This BMP manual outlines means and methods to prevent sedimentation into streams from construction activities or storm events. These BMP measures include many filtering and sedimentation control techniques designed to dissipate water discharge energy (flow), filtering out sediments, and allowing particulate matter to settle out from suspension to the greatest extent practicable.
8. When cofferdams are placed within the water column, they shall be installed in a manner so as to avoid trapping fish. A pre-installation “sweep” of the area will be conducted to ensure there are no fish in the enclosed area. If cofferdams trap water during installation and project personnel

- determine that they need to be dewatered, then MaineDOT (or approved consultants) will capture and carefully remove as many fish species as possible from within the dam prior to dewatering. The MaineDOT will inspect the cofferdams after installation for adult Atlantic salmon.
9. All Atlantic salmon mortalities from electrofishing or any other project related activities shall be reported to the Service's Maine Field Office at 207-902-1586 (Patrick Dockens) within 48 hours of occurrence. Any Atlantic salmon death(s) shall be immediately preserved (refrigerate or freeze) for delivery to the Service's office in East Orland, Maine. If the Service is not available, contact the National Marine Fisheries Service in Orono Maine at 207-867-3755 (Dan Tierney) at arrange for delivery.
 10. Fish passage through the project area shall be available at all times. Cofferdams or netting shall never close off the stream, and flow will continue between the devices on either side of the stream.
 11. For any required pumping operations, the contractor shall use a screen on each pump intake sufficiently large enough so that the approach velocity does not exceed 6.10 m sec⁻¹ (0.20 ft sec⁻¹). Square or round screen face openings are not to exceed 2.38 mm (3/32 in) on a diagonal. Criteria for slotted face openings must not exceed 1.75 mm (approximately 1/16 in) in the narrow direction. These screen criteria follow NMFS guidance (2008). Intake hoses shall be regularly monitored while pumping to minimize adverse effects to Atlantic salmon.
 12. During construction, any disturbed soils shall be temporary stabilized with BMPs, such as straw mulch, plastic sheeting, erosions control mix, or other appropriate BMPs.
 13. All areas of temporary waterways or wetland fill shall be restored to their original contour and character upon completion of the project.
 14. The contractor shall minimize vegetation clearing adjacent to the river to the maximum extent practicable. Areas of disturbed soil adjacent to the waterways shall be stabilized and re-vegetated with a seed mix appropriate for riparian areas in Maine.
 15. Hoe ram removal of the existing abutment shall occur behind dewatered cofferdams.
 16. The Contractor shall contact Eric Ham of MaineDOT Environmental Office (207-215-7356) at least two weeks prior to in-water activities to coordinate turbidity monitoring during cofferdam installation and pile driving.
 17. Construction impacts shall be confined to the minimum area necessary to complete the project.
 18. Construction of temporary approaches and abutments shall be contained within turbidity curtains. Temporary fill shall consist of non-erodible material. Fill for temporary approaches shall limited to no more than 25 percent of the width of the river.
 19. Temporary fill shall extend no more than 25 feet from the shoreline from each side of the river. The allowable fill represents less than 25 percent of the width of the river, which is approximately 335 feet at the location of the temporary bridge. .
 20. Demolition of concrete piers of existing bridge shall occur within containment such as turbidity curtains.
 21. Movement effects and other effects created from cofferdam use will be minimized by limiting cofferdam placement to the time necessary to complete instream activities, assuring that the cofferdam will be placed in the stream as shown in submitted drawings, and by maintaining a flow channel throughout the instream construction period. Cofferdams shall be removed from the stream within 2 days of completion of instream construction, allowing for minor delays due to high stream flows following heavy precipitation.

22. To minimize the spread of noxious weeds into the riparian zone, all off-road equipment and vehicles (operating off of existing open and maintained roads) shall be cleaned prior to entering the construction site to remove all soil, seeds, vegetation, or other debris that could contain seeds or reproductive portions of plants. All equipment shall be inspected prior to off-loading to ensure that they are clean.
23. All concrete shall be poured in the dry, or within confined waters not being dewatered to surface waters. Prior to release to a natural resource, any impounded water that has been in contact with concrete placed during construction shall have a pH between 6.0 and 8.5, shall be within one pH unit of the background pH level of the resource and shall have a turbidity level no greater than the receiving resource. This requirement is applicable to concrete that is placed or spilled (including leakage from forms) as well as indirect contact via tools or equipment.
24. As a component of the SEWPCP required for each project, MaineDOT or their contractor will develop and implement a Spill Prevention Control and Countermeasure Plan (SPCCP) designed to avoid any stream impacts from hazardous chemicals, such as diesel fuel, oil, lubricants, and other hazardous materials. All refueling or equipment maintenance will take place away from the stream and in a careful manner that prohibits chemical or other hazardous materials from entering the stream. These measures include the following:
 - a. All vehicle and equipment refueling activities shall occur more than 100 feet from any water course.
 - b. All vehicles carrying fuel shall have specific equipment and materials needed to contain or clean up any incidental spills at the Project site. Equipment and materials would include spill kits appropriately sized for specific quantities of fuel, shovels, absorbent pads, straw bales, containment structures and liners, and/or booms.
 - c. During use, all pumps and generators shall have appropriate spill containment structures and/or absorbent pads in place.
 - d. All equipment used for in-stream work shall be cleaned of external oil, grease, dirt, and mud. Any leaks or accumulations of these materials would be corrected before entering areas that drain directly to streams or wetlands.

V. Approvals:

1. Temporary Soil Erosion and Water Pollution Control Plan
2. Permitted Resource Impacts (square feet), see ACOE permit for locations:

Stream (RUS):

Permanent: 3,230

Temporary: 4,425

Wetland (PEM):

Permanent: 710

Temporary 2,060

VI. All activities are prohibited (including placement and removal of cofferdams unless otherwise permitted by Regulatory Agencies) below the normal highwater mark if outside the prescribed in-water work window, except for the following:

1. Work within a cofferdam constructed according to MaineDOT's Standard Specifications and in adherence with the contractors approved "Soil Erosion and Water Pollution Control Plan".

VII. No work is allowed that completely blocks a river, stream, or brook without providing downstream flow.

NOTE: Regulatory Review and Approval is required to modify the existing In-Water work window. Requests for work window extensions must be submitted to the MaineDOT Environmental Office. Approval of requests for work window extensions is not guaranteed and may result in delays in construction schedule that are the sole responsibility of the contractor.

UNDERWATER NOISE MONITORING PLAN

*****TEMPLATE*****

Replace underlined blue italic text with project information.

Blue italic text is guidance.

Plain, black text is template language.

All blue italic text should be replaced or omitted for final production.

Prepared by:

Name and full contact information

Signature Block

Date

INTRODUCTION *(This section will be project specific)*

The full agency name proposes to detailed project description. See vicinity map (Figure 1).

Figure 1. Vicinity map of name project.

PROJECT AREA *(This section will be project specific)*

Describe the location of the project, including all water bodies that are affected. Identify the USGS hydrologic unit, both the name and code, where the project is located. Include detailed maps and figures, when available, relative to environmental features that influence monitoring (e.g., geology, bathymetry, etc.).

PERMIT/ESA CONDITIONS *(This section will be project specific and is applicable only when the ESA consultation is complete or Federal/State/local permits have been issued. Each agency should modify this section to reflect the various types of permit/ESA conditions that they see.)*

Summarize the Federal/State/local permit conditions and the ESA requirements that relate to the underwater noise. Permit conditions include monitoring requirements, timing restrictions, etc. The ESA requirements are found in the Incidental Take Statement and Terms and Conditions sections of the biological opinion. These requirements vary between biological opinions, but can include monitoring requirements, timing restrictions, limits on cumulative sound exposure level (cSEL) at a given distance, description of the area where the thresholds must not be exceeded, the allowable number of piles driven per day, the allowable number of pile strikes per day, or a limit on the single strike SEL.

PILE INSTALLATION LOCATION *(This section will be project specific)*

Figure 2 indicates the location of the provide location of the structure(s) in need of pile driving. There will be a total of XX piles driven as part of the name structure(s).

Figure 2. Location of name structure(s) where pile driving activity will take place. *This information must be in enough detail to allow the reader to assess the monitoring locations.*

PILE INSTALLATION

Impact Pile Driving for Fish Consultations

Provide pile installation information. For example:

Hydroacoustic monitoring will be conducted for X piles struck with an impact hammer. Piles chosen to be monitored are driven in water depths that are representative of mid-channel or typical water depths at the project location where piles will be driven.

The number of piles to be monitored will depend on a variety of factors – some projects may require that all piles be monitored, while others may require a representative sample of piles be monitored. If a sample of piles is to be monitored, provide the considerations taken and the rationale used in choosing a representative number of piles, such as, bathymetry, total number of piles to be driven, substrate type, depth of water, distance from shore, river, or stream bank, and any other considerations, as appropriate. When monitoring a subset, a minimum of 5 piles should be monitored. Additional monitoring to produce a representative sample may be warranted when projects are

driving a large number of piles, driving multiple piles of varying diameters in differing substrates, driving different types of piles, or driving piles in widely differing depths.

Hydroacoustic monitoring of *type of pile* with impact driving will include:

- Monitoring *X piles, out of a total of Y piles driven for the project.*
- Testing sound attenuation system effectiveness.

Figure 3 indicates the location of the piles to be monitored and the approximate hydrophone locations for each pile being monitored. All hydrophones will be placed at least 1 m (3.3 feet) below the surface. *If only one hydrophone at one distance is to be used it is acceptable for the hydrophone to be placed 10 meters from the pile at midwater depth. If hydrophones will be placed at more than one distance from the pile and used to calculate transmission loss over distance, water depth should be at least 4m (13 ft) and it is suggested that the additional hydrophone nearest the pile be placed at least 3H from the pile where H is the water depth at the pile and at 0.7 to 0.85H depth from the surface. In waters less than 4m (13 ft) deep, a single hydrophone at midwater depth is sufficient¹.* Hydrophones will be located *X* meters from each pile with a clear acoustic line-of-sight between the pile and the hydrophone. *Additional distances measured concurrently are desirable, if possible, to estimate the site specific range to the threshold boundary. Include any additional distances or depths where hydrophones will be located. If airborne noise monitoring is required, the primary measurement microphone shall be placed 50 feet (e.g. 15 meters) from the pile at least 6 feet above the ground or water, and shall have an unobstructed view of the length of the pile.*

¹ Some projects may need or require more than one hydrophone to collect real time measurements at multiple locations or multiple distances. In these situations multiple hydrophones can be placed at midwater depths.

Figure 3. Location of the piles that will be monitored on the name structure(s).

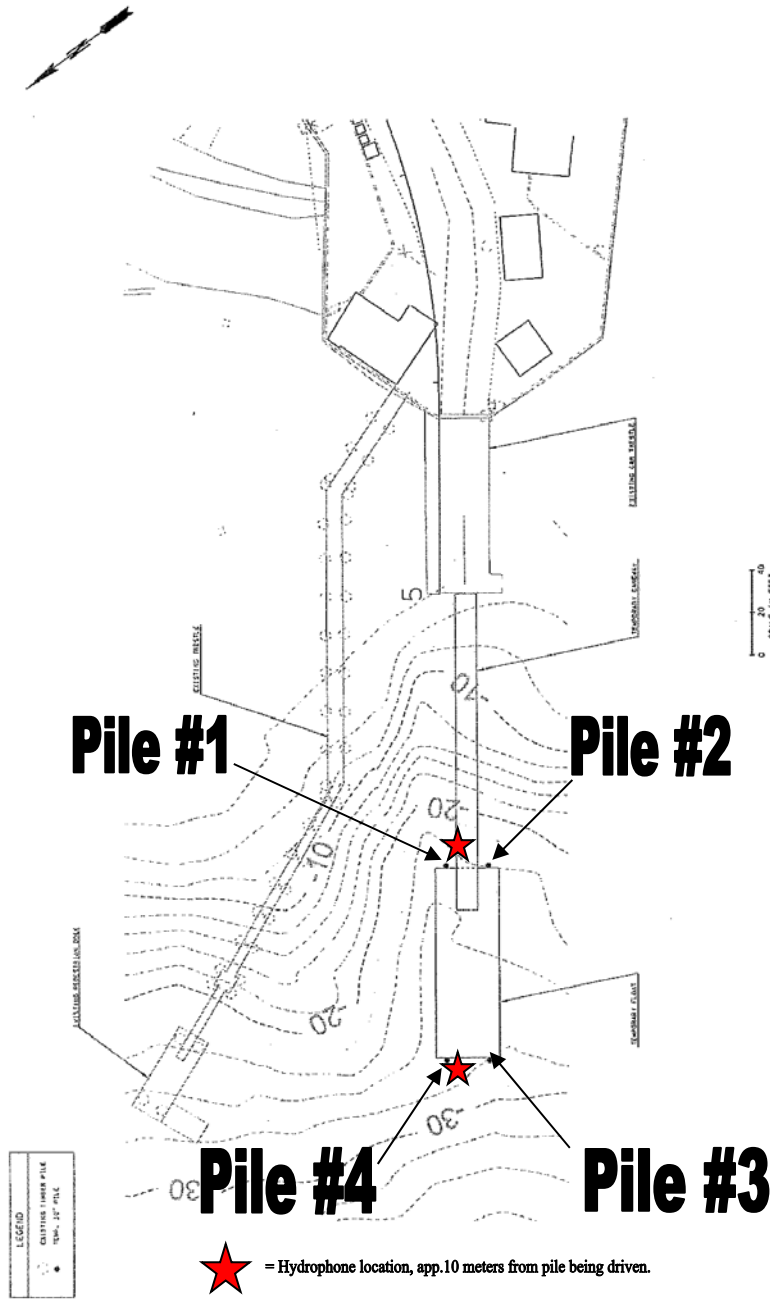


Table 1 lists the name structure(s) to be installed, the water depth, and the number and size of piles that will be installed.

Table 1
Depth, Number Piles to be Monitored

Structure	Water Depth	Structural Components Installed
<u>Name structure</u>	<u>X feet to X feet</u>	<u>X - XX-inch diameter type of pile</u>

CONTRACTOR REQUIREMENTS

The contractor will submit a detailed description of their qualifications, which must include a minimum of a bachelor's degree in a related field² and 3 years' experience in noise monitoring and analysis, and monitoring plan based on this template for approval by [INSERT AGENCY NAME]. A list of the contractors' proposed sound level monitoring equipment shall be included along with specifications and a description of the purpose. The measurement range in terms of amplitude (in dB referenced to one micropascal (re: 1 uPa)), sensitivity and frequency shall be stated. A minimum frequency range of 20 Hz to 20 kHz and a minimum sampling rate of 48,000 Hz will be used when monitoring. Sampling rates higher than 48 kHz are preferred. Table 2 describes the minimum requirements of the equipment to be used. In addition to the equipment selection, quality control/quality assurance procedures should be described (e.g., how will system responses be verified and how will data be managed).

Table 2.

Equipment for underwater sound monitoring (hydrophone, signal amplifier, and calibrator). All have current National Institute of Standards and Technology (NIST) traceable calibration. *This table is intended as a guideline and exact specifications can be adjusted to meet the needs of the individual project or contractors' equipment.*

Item	Specifications	Minimum Quantity	Usage
<u>Hydrophone</u>	<u>Receiving Sensitivity-</u> <u>-211dB re 1V/μPa</u>	<u>1</u>	<u>Capture underwater sound pressures near the source and convert to voltages that can be recorded/analyzed by other equipment.</u>
<u>Hydrophone</u>	<u>Receiving Sensitivity –</u> <u>-200dB re 1/μPa</u>	<u>1</u>	<u>Capture underwater sound pressures for background levels and convert to voltages that can be recorded/analyzed by other equipment.</u>
<u>Signal Conditioning Amplifier</u>	<u>Amplifier Gain-</u> <u>0.1 mV/pC to 10 V/pC</u> <u>Transducer Sensitivity Range-</u> <u>10-12 to 103 C/MU</u>	<u>1</u>	<u>Adjust signals from hydrophone to levels compatible with recording equipment.</u>
<u>Calibrator (pistonphone-type)</u>	<u>Accuracy-</u> <u>IEC 942 (1988) Class 1</u>	<u>1</u>	<u>Calibration check of hydrophone in the field.</u>

² This can include Institute of Noise Control Engineering of the USA (INCE/USA) certification or related fields such as acoustics, physics, oceanography, geology or other physical sciences that have required coursework in physics.

<u>Digital Signal Analyzer</u>	<u>Sampling Rate- 48kHz or greater</u>	<u>1</u>	<u>Analyzes and transfers digital data to laptop hard drive.</u>
	<u>Range- 30 – 120 dBA</u>		
<u>Microphone (free field type)</u>	<u>Sensitivity- -29 dB ± 3 dB (0 dB = 1 V/Pa)</u>	<u>1</u>	<u>Monitoring airborne sounds from pile driving activities (if not raining).</u>
	<u>Wind Screen</u>		
<u>If water velocity ~> 1m/s, Flow shield</u>	<u>Open cell foam cover or functional equivalent</u>	<u>1/hydrophone</u>	<u>Eliminate flow noise contamination.</u>
<u>Laptop computer</u>			
<u>or Digital Audio Recorder</u>	<u>Compatible with digital signal analyzer</u>	<u>1</u>	<u>Record digital data on hard drive or digital tape.</u>
<u>Real Time and Post-analysis software</u>	<u>=</u>	<u>1</u>	<u>Monitor real-time signal and post-analysis of sound signals.</u>

To facilitate further analysis of data full bandwidth, time-series underwater signal shall be recorded as a text file (.txt) or wave file (.wav) or similar format. Recorded data shall not use data compression algorithms or technologies (e.g. MP3, compressed .wav, etc.).

METHODOLOGY

Impact Pile Driving for Fish Consultations (and listed US FWS, diving sea bird, if relevant)

Underwater background sound level measurements are optional, however, if desired then the NMFS (2012a) guidance should be followed.

*If one hydrophone at one distance is to be used it is acceptable for the hydrophone to be placed 10 meters from the pile and at midwater depth. If hydrophones will be placed at more than one distance from the pile it is suggested that the hydrophone nearest the pile be placed at least 3H from the pile where H is the water depth at the pile and 0.7 to 0.85H depth from the surface. The hydrophone(s) will be placed at X meters depth at a distance of X meters from each pile being monitored, in waters of X meters depth. *If water velocity is 1 meter/second or greater, 1-3 meters off the bottom may be recommended for near field hydrophones and greater than 5 meters from the surface may be recommended for any far field hydrophones.* A weighted tape measure will be used to determine the depth of the water. The hydrophone(s) will be attached to a nylon cord, a steel chain, or other proven anti-strum features if the current is swift enough to cause strumming of the line. The nylon cord or chain will be attached to an anchor that will keep the line the appropriate distance from each pile. The nylon cord or chain will be attached to a float or tied to a static line at the surface. The distances will be measured by a tape measure, where possible, or a range-finder. The acoustic path (line of sight) between the pile and the hydrophone(s) should be unobstructed in all cases.*

When collecting sound measurements in an area with currents (i.e., in rivers or tidally influenced areas), appropriate measures will be taken, when necessary, to ensure that the flow-induced noise at the hydrophone will not interfere with the recording and analysis of the relevant sounds (NMFS, 2012a). As a general rule, current speeds of 1.5 meters/second or greater are expected to generate significant flow-induced noise, which may interfere

with the detection and analysis of low-level sounds such as the sounds from a distant pile driver or background sounds. If such measures are necessary, include a description of those measures. For example:

If it becomes necessary to reduce the flow-induced noise at the hydrophone, a flow shield will be described and installed around the hydrophone to provide a barrier between the irregular, turbulent flow and the hydrophone. If no flow shield is used in these situations, the current velocity will be measured and a correlation between the levels of the relevant sounds (background or pile driving) and current speed will be made to determine whether the data is valid and can be included in the analysis.

The hydrophone calibration(s) will be checked at the beginning of each day of monitoring activity. *The method of calibration and calibration equipment used will be described.* NIST traceable calibration forms shall be provided for all relevant monitoring equipment. Prior to the initiation of pile driving, the hydrophone will be placed at the appropriate distance and depth as described above.

The onsite inspector/contractor will inform the acoustics specialist when pile driving is about to start to ensure that the monitoring equipment is operational. Underwater sound levels will be continuously monitored during the entire duration of each pile being driven with a minimum one-third octave band frequency resolution. The wideband instantaneous absolute peak pressure and Sound Exposure Level (SEL) values of each strike, and daily cumulative SEL should be monitored in real time during construction to ensure that the project does not exceed its authorized take level. Peak and rms pressures will be reported in dB (re: 1 μ Pa). SEL will be reported in dB (re: 1 μ Pa²·sec). Wideband time series recording is strongly recommended during all impact pile driving.

Prior to, and during, the pile driving activity, environmental data will be gathered, such as water depth and tidal level, wave height, and other factors that could contribute to influencing the underwater sound levels (e.g. aircraft, boats, etc.). Start and stop time of each pile driving event and the time at which the bubble curtain or functional equivalent³ is turned on and off will be logged.

The contractor or agency will provide the following information, in writing, to the contractor conducting the hydroacoustic monitoring for inclusion in the final monitoring report: a description of the substrate composition, approximate depth of significant substrate layers, hammer model and size, pile cap or cushion type, hammer energy settings and any changes to those settings during the piles being monitored, depth pile driven, blows per foot for the piles monitored, and total number of strikes to drive each pile that is monitored.

Sound Attenuation Monitoring

All monitored piles may be tested with the sound attenuation system on and off (or presence and absence) to test its effectiveness⁴. To account for varying resistance as the pile is driven; the sound attenuation device will be turned off for *(describe schedule for turning on and off)* periods during the beginning, the middle third, and near the end of the drive. After turning off the attenuation system, pile driving should not resume for at least 2 minutes to allow time for air bubbles to completely disperse. *For piles that require less than 5 minutes to drive, pile driving should occur for only two periods with the bubbles off, one near the beginning and once near the end of the drive.*

³ A functional equivalent must function as well as or better than the attenuation device that was proposed during consultation or required by the ESA consultation or applicable permits. It must achieve the same or better sound level reductions that were used in the calculations during ESA consultation or the permitting process.

⁴ Note: There may be circumstances where the U.S. Fish and Wildlife Service determines that unattenuated pile driving (striking the pile with the bubble curtain turned off) would pose a significant risk of injury to species. In those situations, the Service may request that unattenuated pile driving does not occur and that hydroacoustic monitoring be conducted to determine the extent at which certain thresholds are met instead. This will need to be determined on a case by case basis for projects that may affect listed species.

SIGNAL PROCESSING

Impact Pile Driving for Fish Consultations (and any US FWS listed, diving sea bird)

Post-analysis of the underwater pile driving sounds will include:

- Number of pile strikes per pile and per day.
- For each recorded strike (or each strike from a subset), determine the following:
 - The peak pressure, defined as the maximum absolute value of the instantaneous pressure (overpressure or underpressure).
 - The root mean squared sound pressure across 90% of the strikes energy (RMS_{90%}).
 - Sound exposure level, measured across 90% of the accumulated sound energy (SEL_{90%}). Calculation methodology is provided in Appendix A.
- Maximum, mean, and range of the peak pressure, with, and if applicable, without attenuation.
- Maximum, mean, range, and Cumulative Distribution Function (CDF) of the RMS_{90%}, both with and if applicable, without attenuation where the CDF is used to report the percentage of RMS_{90%} values above the thresholds.
- Maximum, mean, and range of the SEL_{90%}, both with and if applicable, without attenuation.
- Cumulative SEL (cSEL) across all of the pile strikes. If SEL was calculated for all strikes, cSEL is estimated as indicated in Appendix A. If SEL was calculated for a subset of strikes, cSEL is estimated as follows: $cSEL = SEL_{mean} + 10 \cdot \log(\text{total \# strikes})$.
- Where surrogate piles are monitored to represent a larger project, an estimate of the cSEL during a typical day of construction driving must be reported by summing the SEL over the expected number of pile strikes in a typical day for the larger project: $cSEL = SEL_{mean} + 10 \cdot \log(\text{\#strikes})$. The SEL_{mean} used in this calculation must correspond with the actual sound attenuation measures that will be used during construction of the larger project.
- A frequency spectrum both with and, *if applicable*, without attenuation, between a minimum of 20 and 20 kHz for up to eight successive strikes with similar sound levels.

If airborne noise monitoring is required, both A-weighted and unweighted measurements will be acquired. Broadband back-to-back RMS L_{max} (peak) and L_{eq} (average) 5-minute measurements will be made over the duration of pile driving. L_{max} measurements should be taken with a portable analyzer set for “fast” response (125 msec). For at least one full pile sequence of each pile size and substrate type, frequency spectrum measurements (L_{max} and L_{eq}) using a minimum resolution of one-third octave bands shall be taken to show the spectral content of the impact pile. If measuring background sound levels in the absence of construction is not possible, then report the L_{95} statistic.

ANALYSIS

Impact Pile Driving for Fish Consultations

Analysis of the data from the San Francisco-Oakland Bay Bridge Pile Installation Demonstration project (PIDP) indicated that 90 percent of the acoustic energy for most pile driving impulses occurred over a 50 to 100 millisecond period with most of the energy concentrated in the first 30 to 50 milliseconds (Illingworth and Rodkin, 2001). The RMS values computed for this project will be computed over the duration between where 5% and 95% of the energy of the pulse occurs. The SEL energy plot will assist in interpretation of the single strike waveform. The single strike SEL associated with the highest absolute peak strike along with the total number of strikes per pile and per day will be used to calculate the cumulative SEL for each pile and each 24-hour period.

In addition a waveform analysis of the individual absolute peak pile strikes will be performed to determine any changes to the waveform with the [*name type of noise attenuation device*](#). A comparison of the frequency content

with and without noise attenuation will be conducted. Units of underwater sound pressure levels will be dB (re:1 μPa) and units of SEL will be re:1 $\mu\text{Pa}^2\cdot\text{sec}$.

REPORTING

If sound attenuation devices are used during the monitoring, include the following text and analysis:

An analysis of the change in the waveform and sound levels with and without the *name type of noise attenuation device for impact driving* operating will be conducted.

Preliminary results for the daily monitoring activities, if required, will be submitted/reported to the primary point of contact⁵ at each of the Services within *X hours* after monitoring concludes for the day. In addition a final draft report including data collected and summarized from all monitoring locations will be submitted to the Services within 90 days of the completion of hydroacoustic monitoring. The results will be summarized in graphical form and include summary statistics and time histories of impact sound values for each pile. A final report will be prepared and submitted to the Services within 30 days following receipt of comments on the draft report from the Services. The report shall include:

1. Size and type of piles.
2. A detailed description of the *name type of noise attenuation device*, including design specifications (*if applicable*).
3. The impact hammer energy rating used to drive the piles, make and model of the hammer.
4. A description of the sound monitoring equipment.
5. The distance between hydrophone(s) *or microphone(s)* and pile.
6. The depth of the hydrophone(s) and depth of water at hydrophone locations.
7. The distance from the pile to the water's edge.
8. The depth of water in which the pile was driven.
9. The depth into the substrate that the pile was driven.
10. The physical characteristics of the bottom substrate into which the piles were driven.
11. The total number of strikes to drive each pile and for all piles driven during a 24-hour period.
12. The underwater wideband background sound pressure level reported as the 50% CDF (*if applicable*).
13. The results of the hydroacoustic monitoring, as described under Signal Processing. An example table is provided in Appendix C for reporting the results of the monitoring.
14. The distance at which peak, cSEL, and rms values exceed the respective threshold values.
15. A description of any observable fish, marine mammal, or bird behavior in the immediate area will and, if possible, correlation to underwater sound levels occurring at that time.
16. *If airborne noise monitoring is required, broadband A-weighted and unweighted maximum, minimum, and average L_{max} and L_{eq} levels shall be tabulated for every pile. For each pile size and substrate type frequency spectra (one-third octave minimum frequency resolution) charts will be included to show the frequency content of L_{max} and L_{eq} signatures. The frequency content of airborne noise background levels shall also be shown. Background sound levels or L_{95} surrogate for background sound shall be reported.*

⁵ The primary point of contact is the biologist that conducted the Section 7 consultation for the Service(s). In the event that the consulting biologist is not available, communication regarding monitoring results and reports should be addressed to the manager of the consultation branch or division with a reference to the consultation title.

REFERENCES

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- NMFS, 2012b. Guidance Document: Data Collection Methods to Characterize Impact and Vibratory Pile Driving Source Levels Relevant to Marine Mammals. Memorandum: NMFS Northwest Fisheries Science Center – Conservation Biology Division and Northwest Regional Office – Protected Resources Division, January 31, 2012.
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- Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals* 33(4): 411-521.

APPENDIX A

Calculation of Cumulative SEL

An estimation of individual SEL values can be calculated for each pile strike by calculating the following integral, where T is T₉₀, the period containing 90% of the cumulative energy of the pulse (eq. 1).

$$SEL = 10 \log \left(\int_0^T \frac{p^2(t)}{p_0^2} dt \right) \text{ dB} \quad (\text{eq. 1})$$

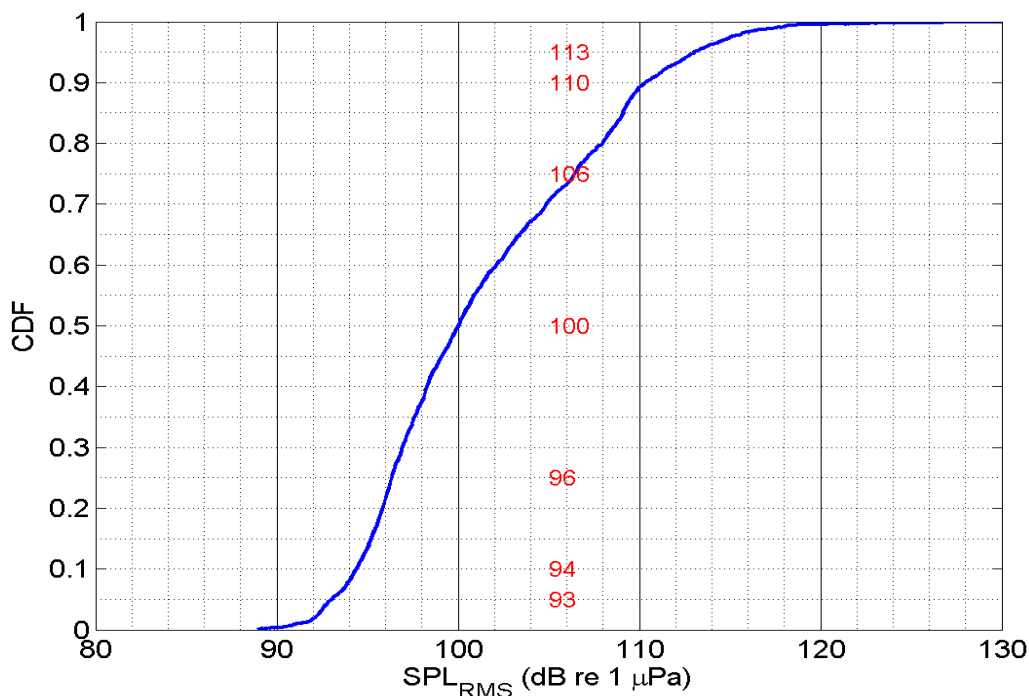
Calculating a cumulative SEL from individual SEL values cannot be accomplished simply by adding each SEL decibel level arithmetically. Because these values are logarithms they must first be converted to antilogs and then accumulated. Note, first, that if the single strike SEL is very close to a constant value (within 1 dB), then cumulative SEL = single strike SEL + 10 times log base 10 of the number of strikes N, i.e, 10Log₁₀(N). However if the single strike SEL varies over the sequence of strikes, then a linear sum of the energies for all the different strikes needs to be computed. This is done as follows: divide each SEL decibel level by 10 and then take the antilog. This will convert the decibels to linear units (or uPa²•s). Next compute the sum of the linear units and convert this sum back into dB by taking 10Log₁₀ of the value. This will be the cumulative SEL for all of the pile strikes.

APPENDIX B

Calculation of a Cumulative Distribution Function and Plot for Background Sound Level Analysis

Data from three full 24-hour underwater measurement cycles (minimum) are used to calculate a 30-second Root Mean Square (RMS) value for each 30-second period for the entire dataset. The RMS should be calculated for both the full frequency range recorded as well as a separate dataset which has been passed through a high pass filter thus eliminating those frequencies below 1000 Hz. These datasets are then grouped into 24-hour periods. To determine if the data is approximately log-normal in distribution, each 24-hour period is plotted as a Probability Density Function (PDF). Each 24-hour period can be plotted on the same PDF plot. The plots should be approximately log normal in distribution and thus can be used in the further analysis. Each day of data should have an approximately Gaussian sigmoid shape, the differences between them and the ideal might be hard to spot, but the sigmoid from day to day will show noticeable variation. Data which does not approximate a log normal distribution should be excluded from further analysis.

The Cumulative Distribution Function (CDF) plot is obtained by plotting the normalized cumulative sum vs. the bin location. You can also get the PDF from plotting the normalized bin count vs. the bin location. The normalized bin count is obtained by dividing the count column by (number of data points multiplied by the space between 2 consecutive bins). This provides the integral of the PDF equal to 1. For instructions on creating a histogram in Microsoft Excel, see: <http://www.vertex42.com/ExcelArticles/mc/Histogram.html>



Appendix I—Bubble Curtain Specification

These specifications are verbatim from National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS), Western Washington Fish and Wildlife Office Impact Pile Driving Sound Attenuation Specification

Unconfined Bubble Curtain Specifications:

1. General - An unconfined bubble curtain is composed of an air compressor(s), supply lines to deliver the air, distribution manifolds or headers, perforated aeration pipe, and a frame. The frame facilitates transport and placement of the system, keeps the aeration pipes stable, and provides ballast to counteract the buoyancy of the aeration pipes in operation.
2. The aeration pipe system shall consist of multiple layers of perforated pipe rings, stacked vertically in accordance with the following:

Water Depth (m)	No. of Layers
0 to less than 5	2
5 to less than 10	4
10 to less than 15	7
15 to less than 20	10
20 to less than 25	13

3. The pipes in all layers shall be arranged in a geometric pattern which shall allow for the pile being driven to be completely enclosed by bubbles for the full depth of the water column and with a radial dimension such that the rings are no more than 0.5 meters from the outside surface of the pile.
4. The lowest layer of perforated aeration pipe shall be designed to ensure contact with the substrate without burial and shall accommodate sloped conditions.
5. Air holes shall be 1.6 mm (1/16-inch) in diameter and shall be spaced approximately 20 mm (3/4 inch) apart. Air holes with this size and spacing shall be placed in four adjacent rows along the pipe to provide uniform bubble flux.
6. The system shall provide a bubble flux of 3.0 cubic meters per minute per linear meter of pipe in each layer (32.91 cubic feet per minute per linear foot of pipe in each layer). The total volume of air per layer is the product of the bubble flux and the circumference of the ring:

$$V_t = 3.0 \text{ m}^3/\text{min}/\text{m} * \text{Circum of the aeration ring in m}$$

or

$$V_t = 32.91 \text{ ft}^3/\text{min}/\text{ft} * \text{Circum of the aeration ring in ft}$$

7. Meters shall be provided as follows:

- a. Pressure meters shall be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.
- b. Flow meters shall be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feed line from the compressor is continuous from the compressor to the aeration pipe inlet the flow meter at the compressor can be eliminated.
- c. Flow meters shall be installed according to the manufactures recommendation based on either laminar flow or non-laminar flow.

Confined Bubble Curtain Specifications:

1. General - A confined bubble curtain is composed of an air compressor(s), supply lines to deliver the air, distribution manifolds or headers, perforated aeration pipe(s), and a means of confining the bubbles.
 - a. The confinement (e.g. fabric, plastic or metal sleeve, or equivalent) shall extend from the substrate to a sufficient elevation above the maximum water level expected during pile installation such that when the air delivery system is adjusted properly, the bubble curtain does not act as a water pump (i.e., little or no water should be pumped out of the top of the confinement system).
 - b. The confinement shall contain resilient pile guides that prevent the pile and the confinement from coming into contact with each other and do not transmit vibrations to the confinement sleeve and into the water column (e.g. rubber spacers, air filled cushions).
2. In water less than 15 meters deep, the system shall have a single aeration ring at the substrate level. In waters greater than 15 meters deep, the system shall have at least two rings, one at the substrate level and the other at mid-depth.
3. The lowest layer of perforated aeration pipe shall be designed to ensure contact with the substrate without sinking into the substrate and shall accommodate for sloped conditions.
4. Air holes shall be 1.6 mm (1/16-inch) in diameter and shall be spaced approximately 20 mm (3/4 inch) apart. Air holes with this size and spacing shall be placed in four adjacent rows along the pipe to provide uniform bubble flux.
8. The system shall provide a bubble flux of 3.0 cubic meters per minute per linear meter of pipe in each layer (32.91 cubic feet per minute per linear foot of pipe in each layer). The total volume of air per layer is the product of the bubble flux and the circumference of the ring:

$$V_t = 3.0 \text{ m}^3/\text{min}/\text{m} * \text{Circ of the aeration ring in m}$$

or

$$V_t = 32.91 \text{ ft}^3/\text{min}/\text{ft} * \text{Circ of the aeration ring in ft}$$

5. Meters shall be provided as follows:
 - a. Pressure meters shall be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.
 - b. Flow meters shall be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feed line from the compressor is continuous from the compressor to the aeration pipe inlet the flow meter at the compressor can be eliminated.
 - c. Flow meters shall be installed according to the manufactures recommendation based on either laminar flow or non-laminar flow.