RFI 160
Pebble Project EIS

Request for Information

Title/Subject:	**Seismic Design Considerations, Caisson Dock**
Requestor:	AECOM
Date Transmitted:	12/30/2019
Recipient:	Pebble Limited Partnership (PLP)
Response Requested by:	1/09/2020
Rationale:	A PLP letter dated 8/12/19, *Proposal for additional avoidance and minimization of impacts at the Amakdedori port,* describes the conceptual design of the applicant's preferred caisson dock alternative at the port site. The letter describes the presence of shallow bedrock and the increased ability of the caisson dock to withstand ice impacts and reduce erosion, but does not address seismic design other than tsunami elevation considerations. In a recent update to the seismic hazard analysis for the project by Knight Piesold (2019), deterministic ground motion estimates for the port site increased significantly (peak ground acceleration [PGA] up to 1.04g at Amakdedori) since the earlier version of this report (Knight Piesold 2013), and structural design information for the port site was removed. The PLP (2019) letter also indicates that caisson construction would be managed by existing drydock facilities in Alaska. It is our understanding that the only such facility is located in Ketchikan and is used for ferry maintenance. Given the high seismic zone and unprecedented use of caisson design in Alaska, this RFI requests additional information regarding PLP plans for current and future investigation and analysis at the port site to support seismic design and mitigation. The information will be used to evaluate geohazards impacts and inform mitigation sections in the EIS.
Describe the Information Requested and Level of Detail:	1) Describe current and future plans for subsurface geotechnical and geophysical investigation and analysis, including planned depth and spacing of geotechnical drilling, and additional seismic hazard analysis. 2) Provide the report of geophysical data collected in summer 2019 (described in the PLP [2019] letter) that indicates the presence of shallow bedrock beneath the proposed causeway and dock. 3) What would be the maximum earthquake and ground shaking used in dock design? 4) How does PLP plan to evaluate and analyze static and seismic stability of the caisson dock structure, including soil bearing capacity and settlement, evaluation of liquefaction potential and lateral spreading, flow sliding, slope stability, and evaluation of other loads? 5) What industry standards and guidelines would be used in this evaluation? 6) What regulatory oversight or independent design reviews are expected during port design? 7) Describe examples of the successful use of caisson design in high seismic zone areas. 8) If necessary based on the results of future stability analysis, would PLP consider foundation improvements for the caissons, such as stone columns, compaction grouting, or other soil stabilization methods? 9) Describe the capacity of the existing drydock facilities in Alaska to handle the construction of the caissons. 10) In the event of a major earthquake that disrupts operations at the port, how does PLP plan to get emergency supplies and equipment to the port terminal and mine site? **References** Knight Piesold. 2013. Report on Seismicity Assessment and Seismic Design

	Parameters. Prepared for PLP, VA101-176/44-1, Rev B, August 14. Knight Piesold. 2019. Peble Project, Report on Seismicity Assessment and Seismic Design Parameters. Prepared for PLP, VA101-176/60-1, Rev 1, September 26. PLP. 2019. Letter to USACE, re: Proposal for additional avoidance and minimization of impacts at the Amakdedori port. August 12.

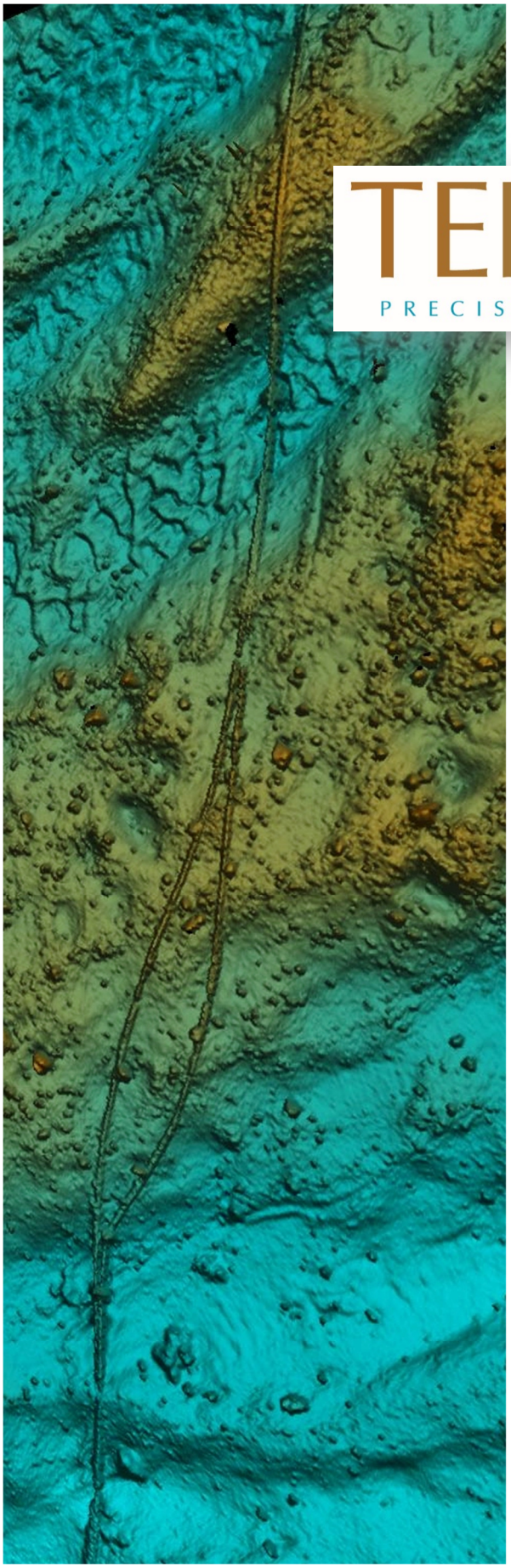
Recipient Response Form

Date Received from USACE:	Click here to enter text.
Response from Recipient (Describe Information Requested to the Level of Detail Requested; Provide Attachments as Needed):	1) Additional geotechnical programs will cover the extents of the caisson construction and provide sufficient data to design the caissons and transition structures. This will likely include completing boreholes, rock cores, SPT's / CPT's, and geophysical surveys of the site area. It is anticipated there will be at least one CPT or SPT per caisson location along with representative boreholes along the length of the structure. 2) See attached geophysical survey report. 3) The marine structural design will be developed in general conformance with ASCE 7, ASCE 61 and AASHTO. The design of the structure will consider the Operational Basis Earthquake (OBE) (1:475) and Maximum Design Earthquake (MDE) (1:2475). Performance based design criteria will be developed during the next stage of design. Other reference standards such as BS6349 may be used to supplement as required. 4) Appropriate design methodology will be established once the geotechnical program has been completed and soil characteristics have been determined. Liquefaction assessment will be completed at the early stages of the design to determine what modeling methodologies are required for the lateral spreading of the soil in a seismic event. If more detailed slope stability analysis is required, FLAC software may be utilized to estimate the soil movements and overall performance of the structure. Conventional geotechnical design methodologies will be used to determine the ground bearing capacities, lateral slope sliding resistance and estimated settlements applicable to design the caisson and bridge supporting structures. 5) Refer to response 3. 6) The design of the caisson structures will follow industry practice design and checking standards. This will include the design and checking supervised by Professional Engineers registered in the state of Alaska. Additionally, independent structural / quality review process will be undertaken internally on the design to review conformance with the applicable codes and standards. 7) Caissons are routinely used throughout the northern pacific coast of California, Washington, and British Columbia. In British Columbia Canada there are several terminals that use caissons as their main supporting structure for the ship loading equipment. These caissons are utilized at Delta Port Terminal in Delta BC and are currently planned for the Roberts Bank Terminal 2 project as well. These caissons are designed to take into account the loading from seismic accelerations and supporting ground conditions.

	8) Soil stabilization will be reviewed and evaluated once geotechnical information is available. Ground improvement will be considered during the design development process. 9) Support infrastructure and vendors are available in Alaska for caisson construction. There are probably not suitable/available dry dock facilities in Alaska that can construct the caisson structures of the size required. Construction of the caissons will likely utilize a mobile floating dry dock, initial on-shore construction for the base with in water slip forming to extend the caissons, or other construction methods at local facilities in Alaska. 10) Land them on the beach with a barge or landing craft as is widely used throughout Alaska for every day operations, including the current use at Williamsport in Iliamna Bay.
List Number and Type of Response Attachments:	Amakdedori Marine Site Detailed Geotechnical Report 062419.pdf
Date Returned to USACE:	Click here to enter text.

AECOM Intake Form

Date Response was Received:	1/06/2020
Received by:	AECOM
Describe any Follow-up Related to this RFI:	Click here to enter text.



TERRASOND®
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Amakdedori Marine Site
Detailed Geophysical Survey

Survey Report

June 24, 2019

Submitted to:

ALASKA PENINSULA
CORPORATION

Submitted by:

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES:

1. INTRODUCTION AND SCOPE OF WORK

TerraSond was contracted to perform a geophysical survey of the Amakdedori Marine site. This work was requested by Ausenco and performed for the Pebble limited Partnership. The survey was comprised of multibeam bathymetric data, seismic reflection data (via both sub-bottom profiler and boomer/single channel streamer systems). The survey area was located at Pebble Port (Amakdedori) on the west side of Cook Inlet, Alaska (Figure 1.1).

This survey was performed in conjunction with the pipeline route geophysical survey utilizing vessels and equipment already mobilized for this this simultaneous field effort.

Due to coverage and timeline, acquisition was split between two vessels. The nearshore vessel, *M/V Latent Sea*, collected the multibeam and sub-bottom profiler data with the *M/V Q105*, collected intermediate penetration seismic reflection. See Tables 3-1 through 3-2 for equipment summary for each vessel.

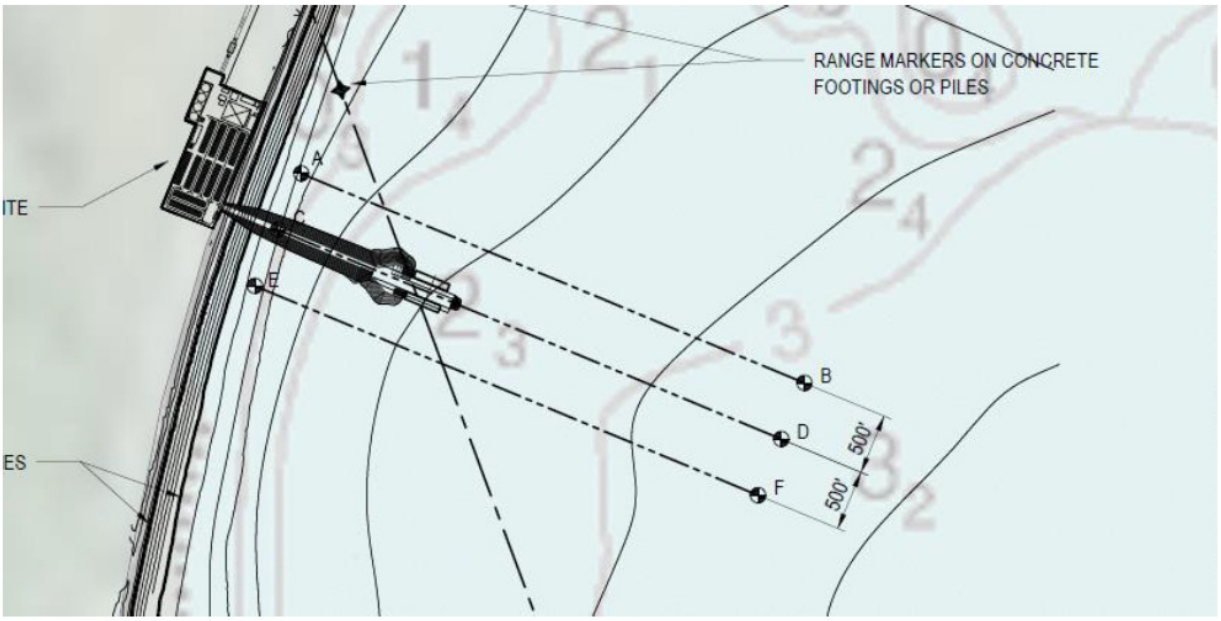

Figure 1.1 Overview of Planned Seismic Reflection Survey lines at Amakdedori

2. SURVEY OPERATIONS

Each vessel operated in blocks along the pipeline route to ease data management. The *M/V Latent Sea*, collected in blocks APSW and PPSW, *R/V Q105* in Blocks 1, 2, and 3. Blocks PPSW and Blocks 3 overlapped with the Amakdedori Marine Site Detailed Geophysical Survey Area.

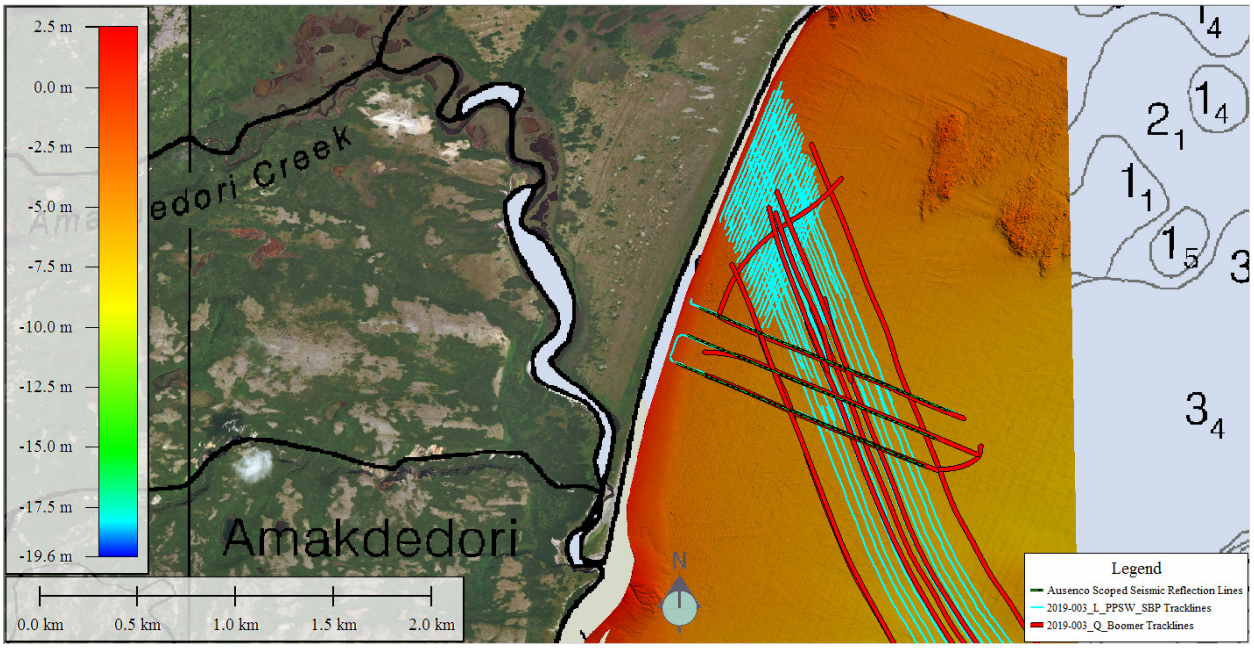

Figure 2.1 Overview of Acquired Seismic Reflection Survey Lines at Amakdedori (for Ausenco and IntecSea SOWs)

2.1 **M/V Latent Sea**

Figure 2.2 M/V Latent Sea *during survey operations at the Pebble Port Site at Amakdedori, AK*

Mobilization of survey equipment onto the *M/V Latent Sea* was conducted between March 20, 2019 and March 24, 2019 at TerraSond's shop in Palmer, AK. The *M/V Latent Sea* was trailered to Homer, AK by the survey crew and launched in the Homer Harbor on March 25, 2019. Sea trials and calibrations where undertaken in the Homer Harbor, at the Homer Deep water dock, and in Halibut Cove on March 26, 2019 and March 27, 2019. The *M/V Latent Sea's* support vessel, the *M/V Spirit*, was mobilized for towing, data processing, and crew accommodations at the Homer Harbor during sea trials. The M/V Latent Sea Mobilization and Calibration Report is included in this report as Appendix A.

The *M/V Latent Sea* was towed from the Homer Harbor to Anchor Point, AK by the *Spirit* on March 28, 2019 and began survey operations the same day. Data acquisition was split into two phases; multibeam only acquisition and simultaneous side scan, sub-bottom profiler, and magnetometer acquisition. Survey operations were limited to day light hours due to visibility requirements of the onboard protected species observer.

The *Latent Sea* was towed from Anchor Point to the Pebble Port site at Amakdedori, AK by the *Spirit* on the afternoon and evening of March 31, 2019. Survey operations at the Pebble Port site began on April 1, 2019. In addition to the pipeline corridor, the *Latent Sea* surveyed three sub-bottom profiler (reflection) lines and three multibeam echosounder lines at the proposed port site. Survey operations proceeded from April 1st, 2019 to April 3, 2019. On the evening of April 3, 2019, the *Latent Sea* was towed from the Pebble Port site to Iniskin Bay, AK by the *Spirit* to shelter from the forecasted weather. The *Spirt* and *Latent Sea* stayed in Iniskin Bay until the evening of April 7, 2019 at which time the *Spirit* towed the *Latent Sea* back to the Pebble Port site. Survey operations resumed on April 8, 2019 and where completed the same day. The *Latent Sea* was then towed from the Pebble Port to Homer Harbor by the *Spirit* the evening of April 8, 2019 and

the morning of April 9, 2019. The *Spirit* was then demobilized on April 9, 2019 and the *Latent Sea* was towed back to Palmer, AK the same day.

2.2 **R/V Q105**

Figure 2.3 R/V Q105 *acquiring Boomer at Amakdedori*

Starting on April 28th the survey crews mobilized the *Qualifier 105* (*Q105*) with multibeam and sub-bottom to perform a reroute survey of the pipeline route. At this time the boomer was also mobilized. Sea trials were performed on April 30th and the mobilization was deemed complete. A *Q105* mobilization and calibration report is included with this report in Appendix A. The boomer survey commenced on May 2nd. Boomer data was acquired along the shallow water portion of the pipeline route at Amakdedori and the Pebble Port Seismic Reflection survey lines on May 2nd and 3rd during the afternoon high tides. A high tide of +2.7 meters on the afternoon of May 3rd allowed the Q105 to obtain coverage very near to shore (see Figure 2.1 above).

3. EQUIPMENT

Table 3.1 Latent Sea Survey Equipment

Sensor	Manufacturer	Model
Inertial Motion Unit (IMU)	Applanix	IMU 45
IMU Topside	Applanix	POS MV V5-1
IMU Antennas	Trimble	AT6175-540TS
Auxiliary Antenna	Hemisphere	V113
Multibeam Sonar (MBES)	Teledyne Reson	7125
MBES Topside	Teledyne Reson	7125
Side Scan Sonar (SSS)	EdgeTech	4125
SSS Topside	EdgeTech	4125-P
Sub-bottom Profiler (SBP)	EdgeTech	SB216
SBP Topside	EdgeTech	3100-P
Magnetometer (MAG)	Geometrics	G882 AR/2
MAG Topside	Geometrics	NA
Sound Velocity - Surface Probe	AML Oceanographic	Micro-X
	AML Oceanographic	SV-Xchange
Sound Velocity - Profiler	AML Oceanographic	Minos-X
	AML Oceanographic	SV-Xchange
	AML Oceanographic	dB-Xchange

Table 3.2 Qualifier 105 Survey Equipment During Boomer Survey

Sensor	Manufacturer	Model
DGPS and Heading	Hemisphere	V113
Power Supply	Applied Acoustics	AAE CSP-P HV
Junction Box	Applied Acoustics	AAE CSP
Sound Source	Applied Acoustics	AAE AA301
Tow Vehicle	Applied Acoustics	AAE CAT200
Hydrophone	Applied Acoustics	AAE AH360/8

4. DATA ASSESSMENT

4.1 Data Coverage

The *Latent Sea* surveyed 100% of the three port reflections lines as well as numerous additional lines along the pipeline corridor that crosses the pebble port seismic reflection lines. The *Q105* surveyed more than 90% of each seismic reflection line with boomer obtaining coverage as close as possible to shore will maintaining a safe operating depth for the vessel. Again, the *Q105* acquired numerous additional boomer lines along the pipeline corridor that crosses the pebble port reflection lines (Figure 4.1).

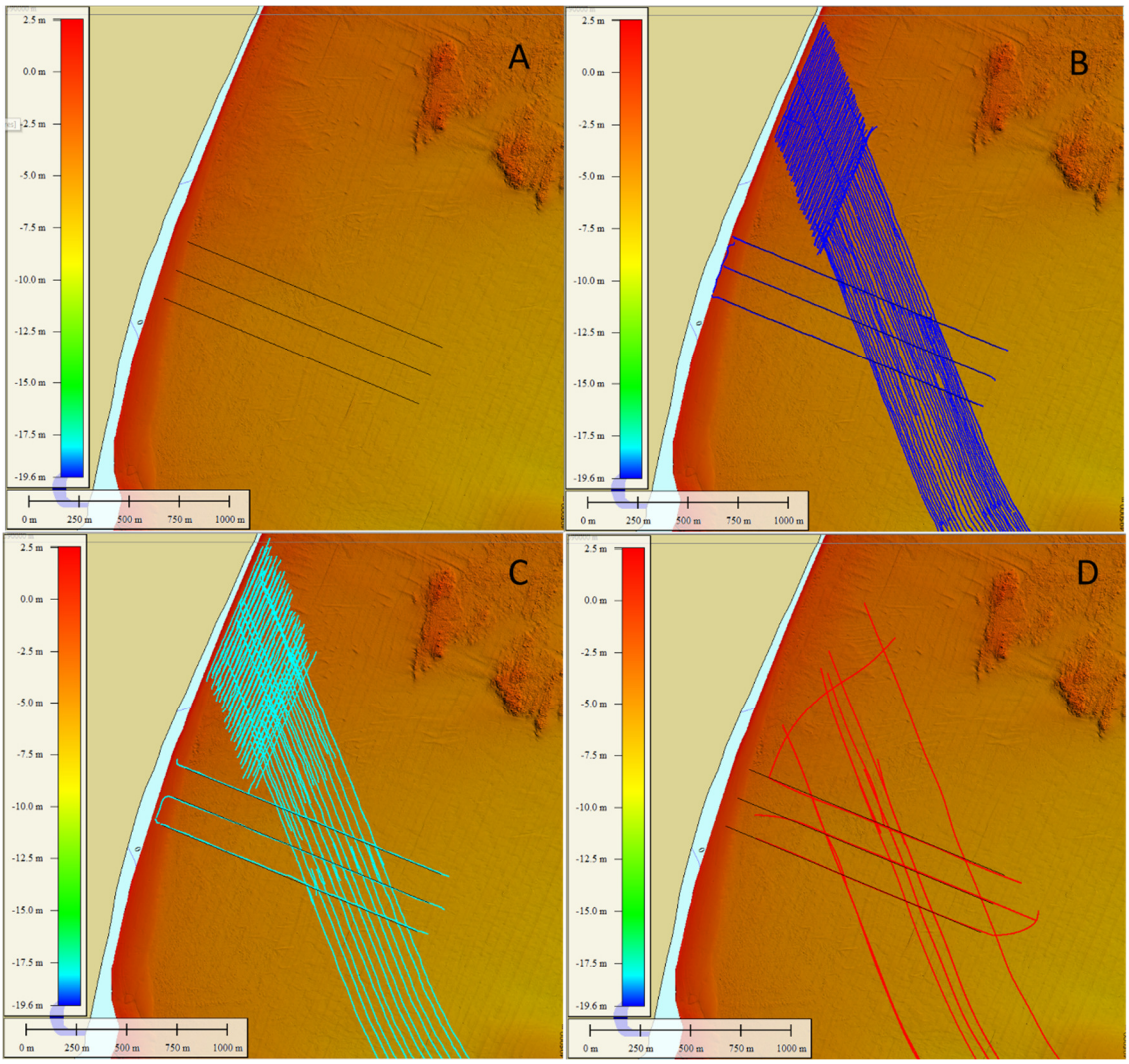

Figure 4.1 Amakdedori Marine Site Detailed Geophysical Survey Coverage. A. Planned Lines, B. Latent Sea MBES Track lines, C. Latent Sea SBP Track lines, D. Q105 Boomer Track lines.

4.2 **Data Quality**

Multibeam data from the *Latent Sea's* survey operations revealed sparse boulders throughout the entire Pebble Port survey area. Boulders >1 m high where honored in the multibeam surfaces. Due to the large number of boulders observed, features (e.g. sparse boulder and abundant boulder shapefiles) where created to represent boulder areas instead of individual boulder contacts. However, boulders that where significantly larger than the average boulder size were still tagged as individual contacts.

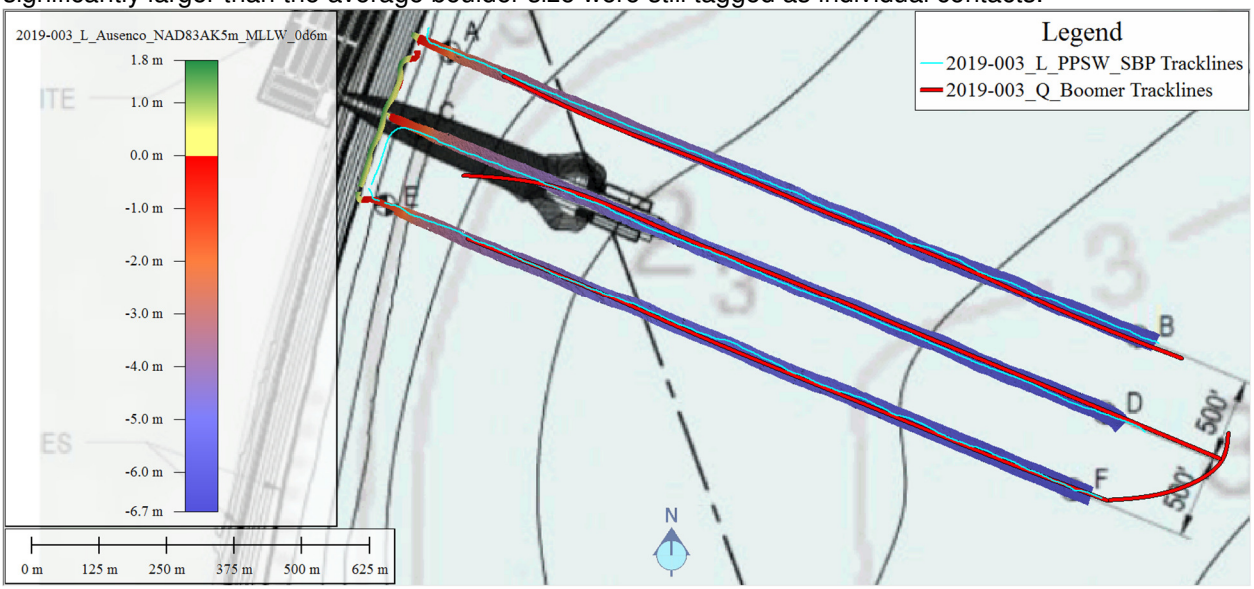

Figure 4.2 Amakdedori Marine Site Data Overview

Sub-bottom profiler data was of high quality as demonstrated during sea trials and documented in the mobilization and calibration report. Some areas of the pipeline route survey showed reflectors as deep as 20m below the seafloor and provided high resolution records, while in other areas sediment penetration was minimal due to sediment type. In other areas it was not possible to assess sub-bottom penetration due to the homogenous nature of the sediment. At the Pebble Port site, a subsurface reflector is evident at about 1.5m below grade just offshore of the shelf break, but little other subsurface structure was revealed by the higher frequency SBP data (Figure 4.2). The navigational quality of the sub-bottom data was excellent as verified through alignment checks with bathymetric features.

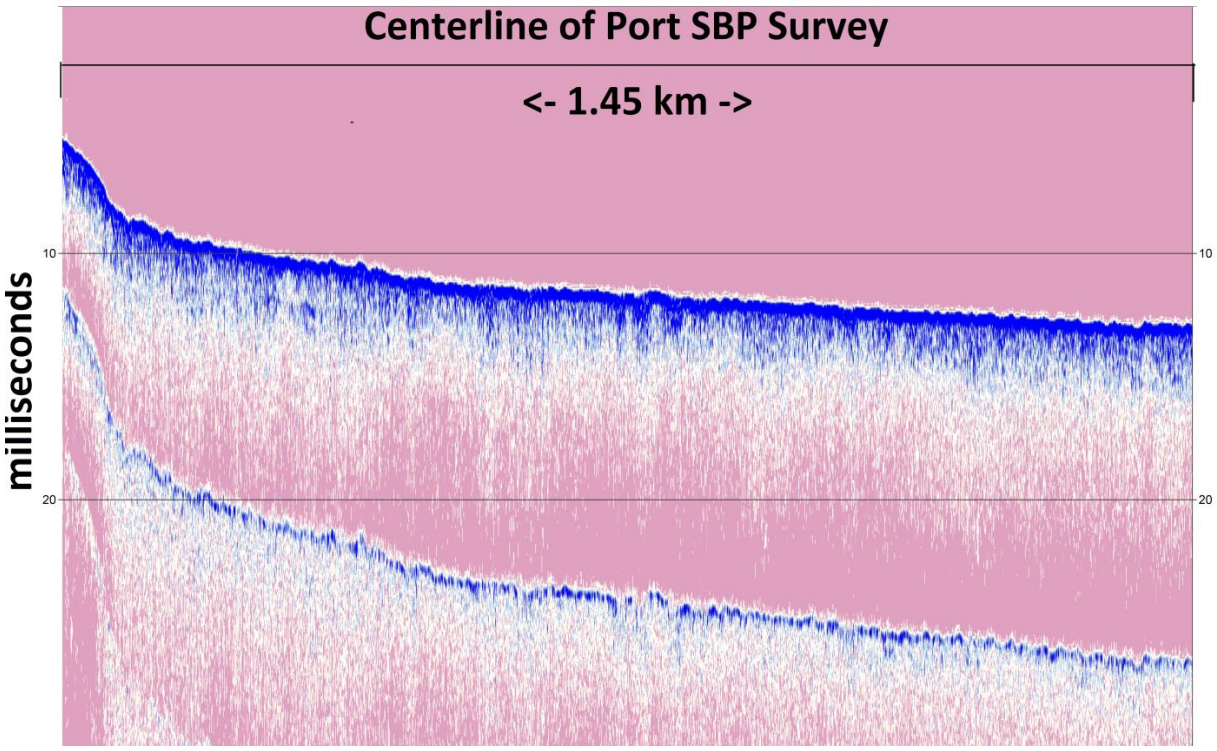

Figure 4.3 Amakdedori Marine Site SBP Reflection Data Along Centerline (line C-D in Fig. 1.1)

The boomer data was of high quality as demonstrated during sea trials and documented in the mobilization and calibration report. Seafloor penetration with the boomer greater than 30 meters was observed however some areas produced little to no subsurface records, presumably due to the nature of the seafloor composition. Boomer data along the shallow Pebble Port survey lines provided better penetration, albeit with lesser vertical resolution, than the SBP data did at the site (Figure 4.3). Layback calculations in the data acquisition software and a fixed towing distance resulted in good navigational quality of the boomer data. Navigation quality was routinely verified through alignment checks with bathymetric features.

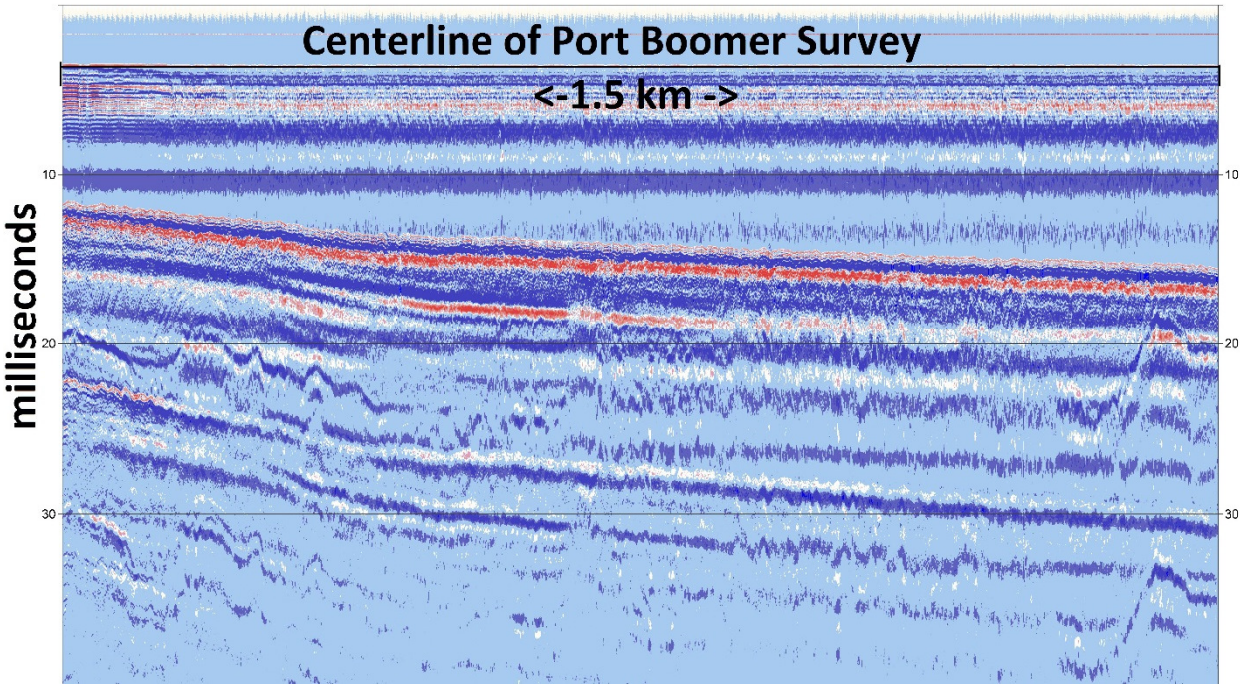

Figure 4.4 Amakdedori Marine Site Boomer Reflection Data Along Centerline (line C-D in Fig. 1.1).

5. DELIVERABLES

The following data sets have been included electronically with this report:

- Track lines
  - Latent Sea PPSW Survey Area MBE and SBP track lines
  - Q105 Block 3 and Pebble Port Boomer Track lines
- Geophysical Data
  - MBE
    - 2019 PPSW 0.6m Gridded Bathymetry Shifted to MLLW
    - 2017 Amakdedori 1.0 Gridded Bathymetry Shifted to MLLW
  - Boomer
    - Block 3 and Pebble Port Datum Aligned SEGY Files
  - SBP
    - PPSW and Pebble Port Survey Area Datum Aligned SEGY Files

6. APPENDICES

The following appendices have been submitted digitally with this report;

Appendix A. *Latent Sea* and *Q105* Mobilization and Calibration Reports