Oregon International Port of Coos Bay

US Army Corps of Engineers®
Portland District

Oregon International Port of Coos Bay

Proposed Section 204(f)/408 Channel Modification Project

Appendix 2

Geophysical Assessment and Reports

May 2024

Table of Contents

Attachments

ATTACHMENT A: Coos Bay Channel Modification 60% Design Digital Terrain Model: Metadata Final Report

ATTACHMENT B: Coos Bay Channel Modification, Geophysical Interpretation Summary

ATTACHMENT C: Coos Bay Channel Modification, Utilities Investigation Report

ATTACHMENT D: Coos Bay Channel Modification, William T. Rossell Wreck Investigation: Hydrographic Survey Draft Report

ATTACHMENT E: Coos Bay Channel Modification, 2016 Pile Dike Surveys, Coos Bay, Hydrographic Survey Report

ATTACHMENT F: Coos Bay Channel Modification, Geophysical Survey Report

ATTACHMENT G: Coos Bay Channel Modification, Coos Bay 3D Bedrock Model

1. PROJECT SUMMARY

The Oregon International Port of Coos Bay (OIPCB or Port) is home to the largest deep-draft coastal harbor between San Francisco and the Puget Sound, based on the tonnage of cargo transported through the Port. Access to the Port's facilities is provided by the Coos Bay Federal Navigation Channel (FNC), a federal channel which was first dredged in the early 1900s. The channel was last improved in 1998, when the channel was deepened by 2 feet (ft) from 35 ft to 37 ft. Since 1998, vessels calling at the Port have substantially increased in size, and extensive improvements have occurred to marine terminals and landside facilities at Coos Bay.

The OIPCB seeks approval to modify portions of the Coos Bay, Oregon Federal Navigation Project, under the authority granted by Section 204(f) of the Water Resources Development Act (WRDA) of 1986, as amended by Section 1014 (b) of the Water Resources Reform and Development Act (WRRDA) of 2014 and Section 1127 of Water Infrastructure Improvements for the Nation (WIIN) Act of 2016 (also referred to as WRDA 2016, hereinafter referred to as WIIN Act of 2016). Section 204 delegates authority to the Assistant Secretary of the Army for Civil Works (ASA(CW)) to approve requests by non-federal entities to design and construct non-federal improvements to Federal navigation projects, and to assume federal responsibility for maintenance of those improvements after non-federal construction is completed. The proposed action also requires permission to modify the existing Coos Bay Federal Navigation Project under Section 14 of the Rivers and Harbors Appropriation Act of 1899, 33 USC 408 (Section 408).

This appendix documents the geophysical work completed for the project in support of the 90% design.

2. APPENDIX SUMMARY

This appendix includes seven attachments, each in support of the geophysical work and baseline assessment for the project. The reports are of three types:

- survey efforts and documentation used to inform modeling of the estuary and associated resources,
- survey and data interpretation to inform geophysical interpretation, and
- survey and research efforts around specific infrastructure (e.g., utilities, pile dikes).

Each report is included as a separate attachment and is described in brief below.

2.1 Attachment A: Coos Bay Channel Modification 60% Design Digital Terrain Model: Metadata Final Report, March 2017.

This report summarizes the horizontal and vertical datum used for the project, outlines model limitations, gridding techniques and a review of the digital terrain model datasets. Finally, the report compares the bathymetric data to current USACE surveys. The comparison was developed to provide the Portland District with data to address questions about the value of the 2008 survey compared to more recent USACE surveys.

2.2 Attachment B: Coos Bay Channel Modification, Geophysical Interpretation Summary, March 2019.

Over many decades, various investigations have been conducted in the Coos Bay region to ascertain the depth of local bedrock. Most of these investigations have focused on the Coos Bay entrance and the area along the navigation channel up as far as the railroad bridge at river mile (RM) 9+00. The methods used to locate shallow rock have included: Physical probes (e.g., jet probes), direct sampling (i.e., borings), interpretation of high resolution multibeam bathymetric data, and analysis of data from a variety of acoustic sub-bottom profiling systems (i.e., geophysical data). This document is intended to summarize how these various methods and data sources were combined to produce the latest rock elevation surface (Version 5.0 [v. 5.0]), which is included, as contours, in the 90% design drawings.

This report was developed to replace previously reviewed reports in effort to improve reader understanding of the efforts conducted to develop comprehensive geophysical interpretation for the proposed project.

- Attachment C: Coos Bay Channel Modification, Geophysical Investigation Report: Seismic Reflection and Geologic Interpretation, May 2016.
- Attachment G: Coos Bay Channel Modification, Single Channel Seismic Investigation, Hydrographic Survey Report, June 2017.

2.3 Attachment C: Coos Bay Channel Modification, Utilities Investigation Report, July 2018.

The purpose of this report is to document and describe findings from research and mapping of utilities that may impact the Coos Bay Channel Modification Project. The report includes results of the following three tasks: utility research and coordination with owners/operators, utility location, and land survey. Results of the work are incorporated on project design sheets for the 60% design.

2.4 Attachment D: Coos Bay Channel Modification, William T. Rossell Wreck Investigation: Hydrographic Survey Draft Report, December 2016.

This report describes a hydrographic survey of the wreckage of the USACE dredge William T. Rossell in the channel entrance near Charleston Oregon conducted in December of 2016. The survey consisted of high resolution multibeam bathymetric coverage, subbottom profiling and video inspection. The primary goal of the survey was to assess the general condition of the wreckage and establish the level to which it had buried into the sand. This report describes the control used for the survey, data acquisition methodology, and data processing procedures.

2.5 Attachment E: 2016 Pile Dike Surveys, Coos Bay, Hydrographic Survey Report, December 2016.

Attachment E describes hydrographic surveys of the five sets of wooden pile dikes in the shipping channel in Coos Bay between river miles 6.4 and 7.3. The surveys were conducted for the project in December of 2016 and consisted of high resolution multibeam bathymetric coverage obtained during a high tide and laser scanning of the exposed pile dike and surrounding shoreline collected during low tide to provide a complete data set of each pile dike. In addition, a multitude of high-resolution digital photographs were taken to provide detail of the structural condition of the dikes. The primary goal of the survey was to develop accurate elevation data over each of the five pile dikes and the immediate surrounding seafloor/shoreline in order to evaluate the physical condition of the structures and map the extent of armor rock at the base of each pile dike. The report describes the control used for the surveys, data acquisition methodology, and data processing procedures. A detailed summary is provided for each of the five pile dikes highlighting the general condition of each pile dike as well as noting particular features, defects, and areas of interest observed during data acquisition and/or discovered during data processing.

2.6 Attachment F: Coos Bay Geophysical Survey, Coos Bay, Oregon, 3D Integrated Digital Geological Model (IDGM), August 2023.

Attachment F describes the bathymetric and geophysical survey of Coos Bay between river miles -1 and 8.3 using electrical resistivity to ascertain the depth and character of bedrock in and near the channel. The survey was conducted in the spring of 2023. The primary goal of the survey was to correlate resistivity values found in the bedrock to measured rock hardness values measured in nearby boreholes. Resistivity values were incorporated into a three-dimensional model of the local geology for visualization and analysis.

2.7 Attachment G: Coos Bay 3D Bedrock Model, May 2024.

Attachment G describes the process used to create a three-dimensional model of the bedrock surface in the area of the 2023 Proposed Alteration from RM -1 to RM 8.2 in Coos Bay. The report provides documentation of input data, assumptions and context in which the geological model was built, as well as to provide guidance on general limitations and disclaimers applicable to the model and its use. The primary use of the model was to inform volume estimations for rock and sediment to be removed during construction.

ATTACHMENT A: Coos Bay Channel Modification 60% Design Digital Terrain Model: Metadata Final Report

Coos Bay Channel Modification
90% Design Digital Terrain Model

METADATA FINAL REPORT
AUGUST 2019

Prepared for:

OREGON INTERNATIONAL PORT OF COOS BAY
Coos Bay, OR
(208) 388-5472

Prepared by:

DAVID EVANS AND ASSOCIATES, INC.
2801 SE Columbia Way, Suite 130
Vancouver, WA 98661
(360) 314-3200

Coos Bay Channel Modification
90% Design Digital Terrain Model

METADATA FINAL REPORT
AUGUST 2019

Prepared by:

____
Jason M. Dorfman, MS
David Evans and Associates, Inc.
Hydrographer

Reviewed by:

____
Jon L. Dasler, PE, PLS, CH
David Evans and Associates, Inc.
Director of Marine Services

TABLE OF CONTENTS

List of Figures

List of Tables

1.0 BACKGROUND

This report is meant to serve as the background metadata and description of sources for the 1-meter gridded digital terrain model (DTM) created by David Evans and Associates, Inc. Marine Services in the vicinity of the Coos Bay Federal Channel which was used for the 90% design efforts. The 90% design DTM is a composite of multiple existing data sets collected between 2007 and 2016. The DTM was modeled and generated in Trimble TerraModel v10.61. The data sets used were from the highest resolution data sets available at the time, using various data acquisition methods of multibeam and single-beam sonar, aerial photogrammetry and LIDAR technology. The spatial limits of the composite DTM were constrained to the project footprint, roughly river mile (RM) 0 to RM 8 and centered on the navigation channel with coverage to each side of a few hundred feet, enough to cover the planned widening and side slope design footprint. As designs were modified or concerns raised, the extent of the coverage was modified with best available data into a composite DTM, while holding the extent of the original data acquired for the project. The objective of the composite DTM was to produce a high detail and spatially dense dataset from which 90% design cross section and other plans could be produced. It was not intended to cover the entire estuary which, given its large area, would have produced too large a data set, at the 1-meter density, to be handled easily and was outside of the design footprint.

Commented [CS1]: A-2-4

Each data set was collected on different horizontal and vertical datums, as well as different units. The data sets were converted to the North American Datum of 1983 High Precision Geodetic Network (NAD83), projected to State Plane Coordinate System Oregon South Zone, horizontal datum with units in international feet. Elevation data was converted to Mean Lower Low Water (MLLW) on National Tidal Datum Epoch (NTDE) 1983-2001 for the reference vertical datum. When a conversion was required, Corpscon v6.0.1, which uses the National Geodetic Survey conversion utility (NADCON), or ESRI ARCMAP v10.31 was used for the horizontal conversions and National Oceanic and Atmospheric Administration (NOAA) vertical datum conversion model VDatum v3.4 or v3.6 was used for the vertical conversions.

The composite data set is delivered in an American Standard Code for Information Interchange (ASCII) file named "**60% Design Bathymetric Model Data Points_V4.0.txt**". Data is formatted into a comma delimited file with values listed as Easting, Northing, and Elevation. Also provided is an AutoCAD drawing file of the model edge limits named "**60% Design Bathymetric Model Edge_V4.0.dxf**" and the bounding polygons of individual data sets, outlined under 2.0 below, as an Data Exchange Format (DXF) file named "**60% Design Bathymetric Model Data Date Limits_V4.0.dwg**". Filenames reflect support of the 60% design, but this model is also in support of the subsequently developed 90% design.

1.1 Horizontal Datum

The combined dataset is projected to the North American Datum 1983 (High Precision Geodetic Network), Oregon South Zone– State Plane Coordinate System, with units in International Feet.

1.2 Vertical Datum

The vertical datum is Mean Lower Low Water using the National Tidal Datum Epoch 1983-2001.

1.3 Model Limitations

This model is intended to serve as a high resolution surface to capture rock outcrops, rock cuts and channel excavation limits for preliminary project evaluation. The disparate data is from a range of sources acquired by different methods ranging over a seven year period resulting in artifacts at the junction between data sets (see graphic below). The increasing age of this data is further impacted by sediment migration and periodic dredging of the channel, therefore the terrain model contains elevation data that are out of date and do not accurately represent current conditions of unconsolidated sediment in some areas. In general, the elevation discrepancies between various surveys is 2 to 3 feet. Over areas of stable bottom, such as exposed rock, the surveys generally agree to less than 1-foot of difference. A comparison was made between the resultant surface model and more recent (2015 and 2016) U.S. Army Corps of Engineers (USACE) single beam surveys to assess the magnitude of sediment change and is discussed in section 3.0 of this report. Figure 1 depicts a portion of the v4.0 DTM at the Coos Bay channel entrance showing linear features associated with elevation differences between surveys due to ephemeral changes in sediment due to erosion, deposition or dredging over time. Note that linear features disappear over stable bottom, as identified within the yellow circles.

Commented [CS2]: A-2-5

Commented [CS3]: A-2-5 Graphic added in response to comment

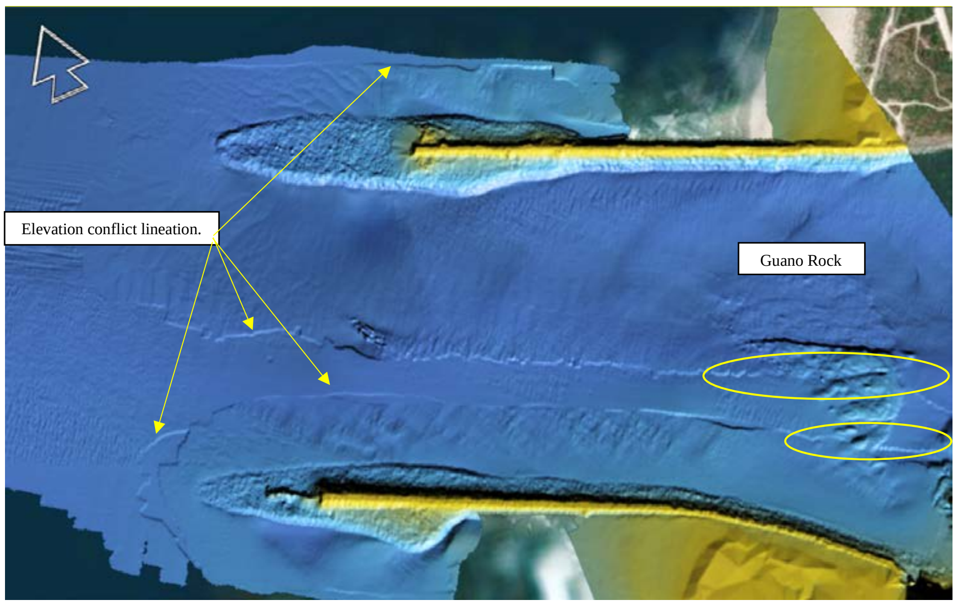


Figure 1: Section of the v4.0 DTM at the Coos Bay channel entrance.

1.4 Model Gridding Techniques

Horizontal data densities and survey methodologies varied between individual surveys, requiring modeling efforts to control the DTM to provide the best representation of the geo-morphology. Bathymetric data sets (i.e., data from an individual survey) provide observable differences in elevation due to ephemeral conditions or activities such as dredging and sedimentation migration and can be detected in the final DTM as shown above.

Commented [CS4]: A-2-6

The data sets were merged and clipped, by using two criteria. The first was to hold the complete coverage of the navigation channel collected with multibeam by DEA in 2008, which represented the largest continuous extent of high-resolution bathymetric data. Remaining data sets from an array of sources were clipped to the 2008 boundary and remaining datasets were selected based on most recent in time and type of coverage. The final composite DTM contained 8,720,927 "original survey" data points. The composite DTM was used to generate a final 1-meter grid in TerraModel. The 1-meter grid of the final 90% design DTM v4.0 contains 10,025,768 data points and was exported as a single American Standard Code for Information Interchange (ASCII) point.

Commented [CS5]: A-2-8 edited for clarity

Commented [CS6]: A-2-7

2.0 DIGITAL TERRAIN MODEL DATASETS

Bounding areas for each source used in the combined 1meter resolution gridded data set are outlined in Figure 2. In areas of overlap, with the exception of DEA 2008 multibeam data of the channel which was held as the primary data source, more recent survey data took priority over older data and held higher density data sets took priority over lower density data sets (i.e. high density multibeam surveys had priority over low density single beam surveys). DEA 2008 multibeam data held priority over all other sources, as it represented the largest and densest, single detailed survey. Source descriptions of datasets defining methods, datums, and accuracy are provided below. The source descriptions are listed in the order applied, meaning sources listed at the beginning held priority over data sets listed later.

Commented [CS7]: A-2-9

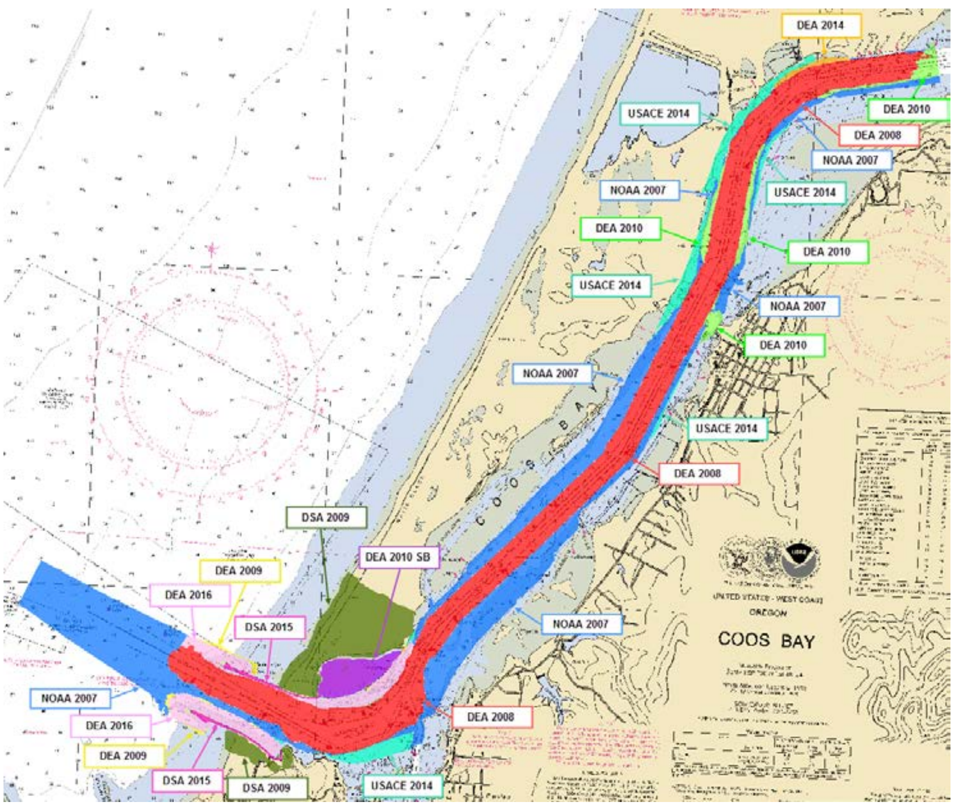


Figure 2: Data sources used for the 1 meter digital terrain grid

DEA 2008
Project: Port of Coos Bay Federal Channel Multibeam Survey
Project Number: POCB05_2
Survey by: David Evans and Associates, Inc.
Method of Acquisition: Multibeam Bathymetric Sonar
Date Collected: April 22-25, 2008
Horizontal Datum: NAD83 (1998) Oregon South Zone
Horizontal Positioning: RTK GPS (5cm accuracy at 95% confidence level)
Vertical Datum: MLLW National Tidal Datum Epoch 1983-2001, based on four USACE Portland District controlling tide gauges referenced to NGVD1929\47. Collected using NGVD-88 using Geoid 2003 then converted to MLLW 1983-2001.
Vertical Positioning: RTK GPS (5cm accuracy at 95% confidence level)
Units: International Feet
Grid Resolution: 1 meter
Equipment: Reson 8101 multibeam bathymetric sonar

DEA 2016
Project: Coos Bay Jetties
Project Number: DSAX00000070
Survey by: David Evans and Associates, Inc.
Method of Acquisition: Multibeam Bathymetric Sonar
Date Collected: May 11-12, 2016
Horizontal Datum: NAD83 (2011) Oregon South Zone
Horizontal Positioning: RTK (5cm accuracy at 95% confidence level)
Vertical Datum: MLLW National Tidal Datum Epoch 1983-2001. Collected using NGVD-88 using Geoid 12b then converted to MLLW 1983-2001 using VDatum v3.6.
Vertical Positioning: RTK (5cm accuracy at 95% confidence level)
Units: International Feet
Grid Resolution: 3 feet
Equipment: Reson 7101 multibeam bathymetric sonar

DSA 2015
Project: Coos Bay Jetties
Project Number: DSAX00000070
Survey by: David Smith and Associates, Inc.
Method of Acquisition: Aerial Photogrammetry
Date Collected: November 22, 2015
Horizontal Datum: NAD83 (2011) Oregon South Zone
Horizontal Positioning: RTK (5cm accuracy at 95% confidence level)
Vertical Datum: MLLW National Tidal Datum Epoch 1983-2001. Collected using NGVD-88 using Geoid 12b then converted to MLLW 1983-2001 using VDatum v3.6.
Vertical Positioning: RTK (5cm accuracy at 95% confidence level)
Units: International Feet
Grid Resolution: 1 meter
Equipment: Vexcel UltraCam Falcon digital mapping camera

DEA 2014

Project: Jordan Cove
Project Number: JCEP00000010
Survey by: David Evans and Associates, Inc.
Method of Acquisition: Multibeam Bathymetric Sonar
Date Collected: January 30-31, 2014
Horizontal Datum: NAD83 (91) Oregon South Zone
Horizontal Positioning: RTK (5cm accuracy at 95% confidence level)
Vertical Datum: MLLW National Tidal Datum Epoch 1983-2001. Collected using NGVD-88 using Geoid 2009 then converted to MLLW 1983-2001 using VDatum v3.4.
Vertical Positioning: RTK (5cm accuracy at 95% confidence level)
Units: International Feet
Grid Resolution: 0.5 meters
Equipment: Reson 7101 multibeam bathymetric sonar

USACE 2014
ID: 2014_NWP
Survey By: U.S. Army Corps of Engineers (USACE), JALBTCX (Joint Airborne Lidar Bathymetry Technical Center of eXpertise)
Method of Acquisition: Bathymetric Light Detection and Ranging (LiDAR)
Date Collected: October 2-5, 2014
Horizontal Datum: NAD83 (HARN) Oregon South Zone
Horizontal Positioning: PPK (Compiled to meet 1m at 95% confidence level)
Vertical Datum: MLLW National Tidal Datum Epoch 1983-2001. Collected using NGVD-88 using Geoid 2009 then converted to MLLW 1983-2001 using VDatum v3.4.
Vertical Positioning: PPK (CZMIL topographic data – tested 9.5cm at 95% confidence level, CZMIL bathymetric shallow FOV data – tested 12.5cm at 95% confidence level, CZMIL bathymetric deep FOV data – tested 20cm at 95% confidence level)
Units: International Feet
Grid Resolution: 1 meter
Equipment: These data were collected by the Coastal Zone Mapping and Imaging Lidar (CZMIL) system. CZMIL integrates a Lidar sensor with simultaneous topographic and bathymetric capabilities, a digital camera and a hyperspectral imager on a single remote sensing platform for use in coastal mapping and charting activities.

DEA 2010
Project: Port of Coos Bay supplemental multibeam survey
Project Number: POCB05_3
Surveyed by David Evans and Associates, Inc.
Method of Acquisition: Multibeam Bathymetric Sonar
Date Collected: March 18-19 & 27, 2010
Horizontal Datum: NAD83 (CORS96, Epoch2002) Oregon South Zone
Horizontal Positioning: RTK GPS (5cm accuracy at 95% confidence level)
Vertical Datum: MLLW National Tidal Datum Epoch. 1983-2001, based on four USACE Portland District controlling tide gauges referenced to NGVD1929\47. Collected using NGVD-88 using Geoid 2003 then converted to MLLW 1983-2001.
Vertical Positioning: RTK GPS (5cm accuracy at 95% confidence level)
Units: International Feet
Grid Resolution: 1 meter
Equipment: Reson 8101 multibeam bathymetric sonar

DEA 2010 SB
Project: USACE Jetty Surveys
Project Number: DSAX00057 USACE Portland District Contract No. W9127N-09-D-0009, Task Order No. 0001
Method of Acquisition: Single Beam Bathymetric Sonar
Date Collected: March 20, 2010
Horizontal Datum: NAD83 (CORS96, Epoch2002) Oregon South Zone
Horizontal Positioning: RTK GPS (5cm accuracy at 95% confidence level)
Vertical Datum: MLLW National Tidal Datum Epoch 1983-2001, based on four USACE Portland District controlling tide gauges referenced to NGVD1929\47. Collected using NGVD-88 using Geoid 2003 then converted to MLLW 1983-2001.
Vertical Positioning: RTK GPS (5cm accuracy at 95% confidence level)
Units: International Feet
Grid Resolution: Approximate line spacing = 100 feet: sorted approximately 10 feet along vessel track
Equipment: Odom CV-100 single beam echosounder

DEA 2009
Project: USACE Jetty Surveys
Project Number: DSAX00000057 USACE Portland District Contract No. W9127N-09-D-0009, Task Order No. 0001
Survey by: David Evans and Associates, Inc.
Method of Acquisition: Multibeam Bathymetric Sonar
Date Collected: September 9-10, 2009
Horizontal Datum: NAD83 (CORS96, Epoch2002) Oregon South Zone
Horizontal Positioning: RTK GPS (5cm accuracy at 95% confidence level)
Vertical Datum: MLLW. Collected on NAVD88 (GEOID 03) then converted to MLLW 1983-2001 USACE Portland District Profile during 2010 project.
Vertical Positioning: RTK GPS (5cm accuracy at 95% confidence level)
Units: International Feet
Grid Resolution: 1 meter
Equipment: Reson 8101 multibeam bathymetric sonar

DSA 2009
Project: USACE Jetty Surveys
Project Number: USACE Portland District Contract No. W9127N-09-D-0009, Task Order No. 0001
Survey by: David C. Smith and Associates, Inc.
Method of Acquisition: Photogrammetry derived upland topography (no overlap with bathymetric data)
Date Collected: September 9, 2009
Horizontal Datum: NAD83 (CORS96, Epoch2002) Oregon South Zone
Horizontal Positioning: unknown (0.5 foot horizontal positional accuracy reported)
Vertical Datum: MLLW National Tidal Datum Epoch 1983-2001, based on four CENWP controlling tide gauges referenced to NGVD1929\47. Collected using NGVD-88 using Geoid 2003 then converted to MLLW 1983-2001.
Vertical Positioning: unknown (0.25 foot vertical positional accuracy reported)
Grid Resolution: Random
Equipment: Zeiss TOP 15 camera

NOAA 2007

ID: Survey Registration H11744 and H11745
Survey by: NOAA Office of Coast Survey, Hydrographic Surveys Division
Method of Acquisition: Multibeam Bathymetric Sonar
Date Collected: 8/10/2007 to 11/14/2007
Horizontal Datum: NAD83 (CORS96, Epoch2002) Oregon South Zone, converted from NAD83 UTM Zone
10 North using CORPSCON.
Horizontal positioning: DGPS (2 meter accuracy at 95% confidence)
Vertical Datum: MLLW National Tidal Datum Epoch 1983-2001
Vertical Positioning: NOAA discrete zoned tides (0.5 meter accuracy at 95% confidence)
Units: International Feet
Grid Resolution: 1 meter
Equipment: Simrad EM3000 multibeam bathymetric sonar

3.0 BATHYMETRIC DATA COMPARISON TO CURRENT USACE SURVEYS

Initial reviews by the USACE on the composite DTM resulted in questions regarding why the inclusion of USACE survey data were not included in the DTM (see comment 6444767). To address this concern, DEA evaluated the most recent U.S. Army Corps of Engineers (USACE) partial coverage single beam channel line surveys at Coos Bay from a Fall 2015 condition survey and a Winter 2016 post dredge survey (2015 data was used where dredging did not occur and no 2016 post dredge data was available with 2016 data used where available) to assess the amount of change that has occurred since 2008. The data from single beam surveys in the channel were decimated to approximately one data point every 30-feet along track. The individual data points were compared to the composite 60% design DTM. The point elevations were differenced against the DTM reference surface using CARIS software with the USACE depths being subtracted from the DTM surface depth at that location. The resultant depth differences are positive if USACE depths are shallower than the composite DTM and negative if the more recent coverage is deeper. The differences were exported as an ASCII point file, with the Z value being the difference at the USACE sounding point, and loaded in to ARCGIS for a spatial analysis.

Commented [CS8]: A-2-10. Comparison was done in response to comment 6444767 from prior USACE review

Commented [CS9]: A-2-11, A-2-12. Edits and expanded explanation in response to comments supporting the use of specific surveys and the interpretation of these data

Table 1 shows the distribution of differences between the DTM and the 2015/2016 USACE single beam surveys with negative values representing deeper depths in the USACE survey and positive values representing shallower depths. Approximately 42 percent of the data fell within +/- 0.5 feet, the accuracy standard for USACE single beam surveys. There is also a deep bias in the distribution with 46 percent of the data being deeper than 0.5 feet in the USACE surveys and only 12 percent being shallower than 0.5 feet. This is most likely due to dredging activity and the USACE 2016 survey being conducted shortly after completion of a dredging project.

Table 1. Distribution of Differences

Difference Range	Number of Points	Percent
-5.1 to -13.59	215	2.2%
-2.1 to -5.0	1353	13.9%
-1.1 to -2.0	1522	15.7%
-0.6 to -1.0	1385	14.2%
-0.26 to -0.5	1558	16.0%
0.25 to -0.25	2029	20.9%
0.25 to 0.5	499	5.1%
0.6 to 1.0	491	5.1%
1.0 to 2.0	347	3.6%
2.0 to 5.0	294	3.0%
5.0 to 10.0	29	0.3%
Totals	9722	100.0%

Figures 3 through 5 are difference plots depicting USACE survey soundings thinned to every 30-feet and color coded by difference from the composite DTM. Grey points represent no change at plus or minus 0.50 feet. The difference plot images are for reference only and a more through detailed evaluation of the difference was conducted in ArcGIS.

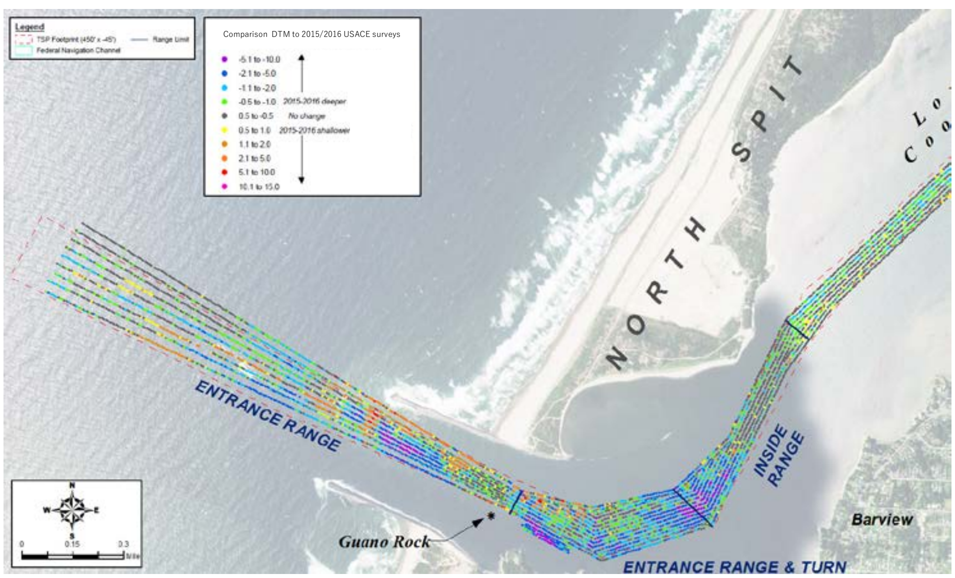


Figure 3: Entrance Range, Turn and Inside Range difference plot

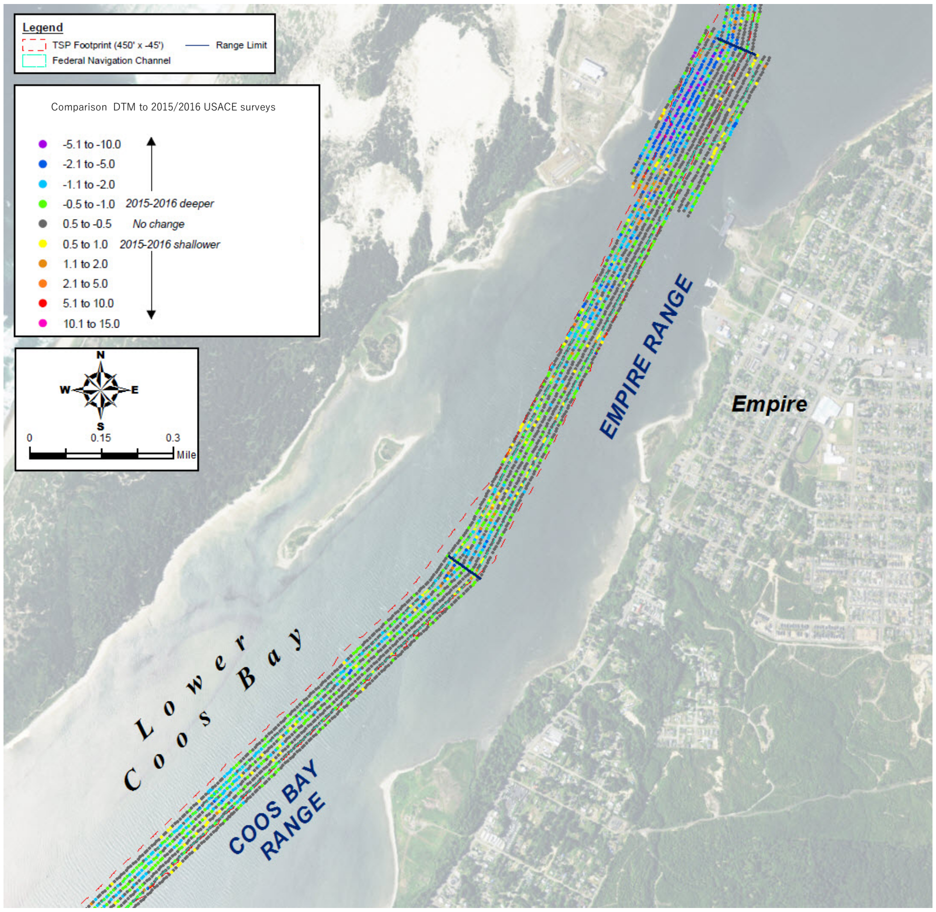


Figure 4: Coos Bay Range and Empire Range difference plot

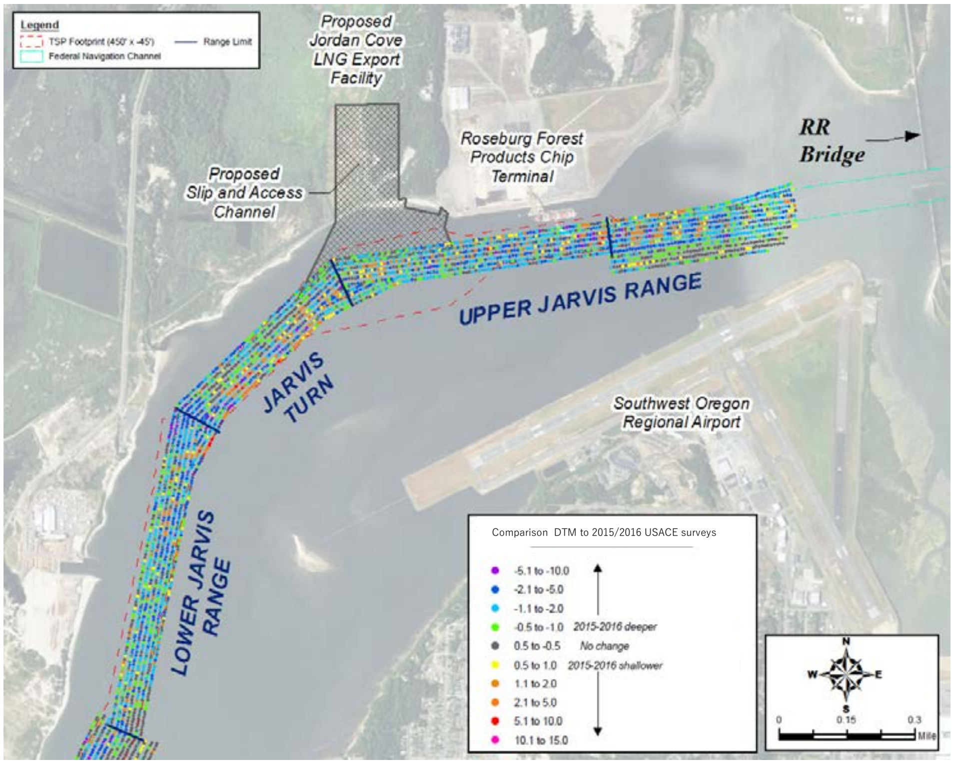


Figure 5: Lower Jarvis Range, Jarvis Turn and Upper Jarvis Range difference plot

ATTACHMENT B: Coos Bay Channel Modification, Geophysical Interpretation Summary

Coos Bay Channel Modification Geophysical Interpretation Summary

HYDROGRAPHIC SURVEY DRAFT REPORT

AUGUST 2019

Prepared for:

OREGON INTERNATIONAL PORT OF COOS BAY
Coos Bay, OR
(208) 388-5472

Prepared by:

DAVID EVANS AND ASSOCIATES, INC.
2801 SE Columbia Way, Suite 130
Vancouver, WA 98661
(360) 314-3200

Coos Bay Channel Modification Geophysical Interpretation Summary

HYDROGRAPHIC SURVEY DRAFT REPORT

AUGUST 2019

Commented [CS1]: A-2-1 Page numbers are found at the bottom right of pages of this document and the metadata report as well as other elements (attachments, appendices) of the overall geophysical report – "Sub-Appendix 2). Sequential page numbers of the overall package are not viable.

Prepared by:

Nicholas Lesnikowski, LG, CH
David Evans and Associates, Inc.
Senior Associate

Reviewed by:

Jonathan Dasler, PE, PLS, CH
David Evans and Associates, Inc.
Director of Marine Services

TABLE OF CONTENTS

Page

List of Figures

List of Tables

Acronyms and Abbreviations

AML	Applied Microsystems Ltd.
ASCII	American Standard Code for Information Interchange
DEA	David Evans and Associates, Inc.
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRI	Geotechnical Resources, Inc
HIPS	Hydrographic Information Processing System
kHz	Kilohertz
MLLW	Mean Lower Low Water
NAD83 (2011)	North American Datum of 1983, National Adjustment 2011, Epoch 2010.00
NORTEC	Northern Technical Services
NSPS	National Society of Professional Surveyors
POCB	Port of Coos Bay
PLS	Professional Land Surveyor
POS/MV	Position and Orientation System for Marine Vessels
ROV	Remotely Operated Vehicle
RTK	Real-time Kinematic
SBP	Sub Bottom Profile/Profiler
SPCS	State Plane Coordinate System
S/V	Survey Vessel
THSOA	The Hydrographic Society of America
USACE	United States Army Corps of Engineers

1.0 INTRODUCTION

Over many decades, various investigations have been conducted in the Coos Bay region to ascertain the depth of local bedrock which is a required consideration in the design and planning of channel modifications. Knowing the presence and depth to bedrock informs the selection of equipment and methods of removal, slope stability, disposal suitability, cost calculations, and analysis of environmental effects. Most of these investigations have focused on the Coos Bay entrance and the area along the navigation channel up as far as the railroad bridge at river mile (RM) 9+00. David Evans and Associates, Inc. (DEA) has been involved with these surveys for over 13 years. The methods used to locate shallow rock have included: Physical probes (e.g., jet probes), direct sampling (i.e., borings), interpretation of high resolution multibeam bathymetric data, and analysis of data from a variety of acoustic sub-bottom profiling systems (i.e., geophysical data). This document is intended to summarize how these various methods and data sources were interpreted and combined to produce the latest rock elevation surface (Version 5.0 [v. 5.0]), which is included, as contours, in the 90% design drawings.

Commented [CS2]: A-2-13

Commented [CS3]: A-2-2. Revision to this document do post-date the 60% design submittal, but the reference date of March and now August reflects the month of revision in response to prior comments on this product.

2.0 OVERVIEW OF DATA SOURCES

2.1 Probes

Jet probing is a very effective and direct tool for establishing the presence or absence of rock with a reasonable degree of accuracy and confidence. The probe is a heavy steel tube with a central channel that conveys high pressure water to the end of the tube. The probe is marked on its exterior with depth marks. The probe is lifted vertically into position with a crane and placed into the water down to the mudline. Once the probe is on the bottom, the water is turned on at pressures between 60 pounds per square inch (psi) and 120 psi (although some systems go up to 175 psi , USACE 1995), and the probe is allowed to descend into the material being "jetted" out of the way. When the probe will no longer descend, it is deemed to be "at refusal" and the depth is photo-recorded and the value logged. If the length of the probe descends to its maximum length and never encounters resistance, then the maximum depth is logged as "no-refusal." The depth values of "no refusal" varied by probe lengths and configuration but, in general, the maximum depth of the probes for the 1974, 1992 and 2017 investigations, were approximately -55, -50 and -90 feet, respectively. In most instances, refusal is associated with encountering rock. Contact with the rock interface is usually very noticeable; however, the probe can sometimes hit refusal but may be stopped by something other than bedrock, such as boulders or dense sands that exert enough resistance to stop the probe's progress. Because the procedure is relatively simple, a jet probe can be accomplished within a matter of a few minutes once the platform is in position.

Commented [CS4]: A-2-15 – refusal lengths by year were added in response

Commented [CS5]: A-2-16 – "very deep" removed from this statement

The jet probe information that was utilized for the v. 5.0 rock elevation map included:

- 324 probes from the U.S. Army Corps of Engineers (USACE) 1974 explorations
- 151 probes from 1994 explorations
- 56 probes from 2017 Geotechnical Resources, Inc. (GRI) explorations

2.2 Borings

Borings are obtained by physically drilling into the subsurface with a rotary corer. These corers are typically truck-mounted drill rigs that are loaded onto barges for work in the marine environment. The process of boring is more complicated and time intensive than jet probing, but it results in obtaining a physical sample of material. Boring data that was utilized for rock interpretation included:

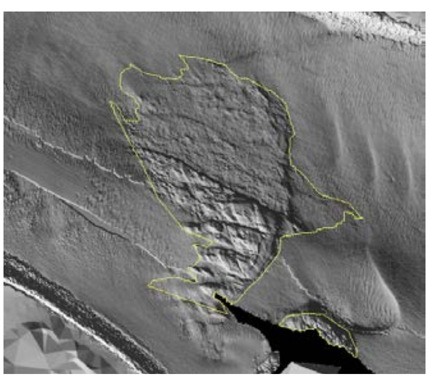
- 14 borings from the USACE 1974 explorations
- 10 borings from the 1994 explorations
- 3 borings from 2002 pipeline installation near Empire
- 39 borings from 2010, 2016 GRI explorations
- 1 land boring from 1997 at the Jordan Cove LNG (JCLNG) site by GRI

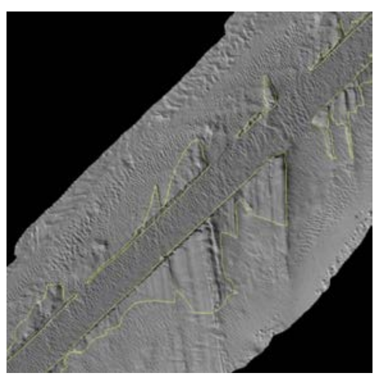
2.3 Multibeam Bathymetric Data

DEA has performed several high-resolution multibeam bathymetric surveys of the Coos Bay area in support of the channel deepening project (see Digital Terrain Model Metadata report, 2017). These datasets produce extremely dense bathymetric soundings (3-foot grids) over the entire survey area. When this bathymetric data was rendered as a three-dimensional (3D) surface with artificial lighting, referred to as "hillshade" images, bottom features (sand waves, rock bedding, ship wrecks, etc.) stood out very well (see Figure 1). These images were used to delineate areas where it appeared bedrock was exposed at the surface and the bathymetric data points within those areas were extracted and used in the rock mapping process. The method of determining the rock areas is an interpretation based on familiarity with the local geology (texture, local strike and dip, knowledge of local rock exposures, etc.) and familiarity with analyzing multibeam hillshade imagery. The outlines were constructed in a conservative manner by visually inspecting and outlining areas believed to have a very high confidence of containing exposed or shallow

Commented [CS6]: A-2-17 – "hillshade" replaced hill-shade and hill shade globally

Commented [CS7]: A-2-18 - text revised and "bottom topography" removed to be consistent





rock as depicted in the multibeam bathymetric surface. Near- or at-surface bedrock in areas at Guano Rock show greater surface variability and are generally rougher than the nearby smoother surfaces interpreted to be thicker sand. Jet probe data in the area confirm this interpretation. Similarly, areas near RM 3 show aligned ridges interpreted to be west-southwesterly dipping beds of sedimentary bedrock. The alignment of these linear bedrock features differs from the alignment of sand waves in the channel, thereby making them more readily identifiable. These areas were delineated and added to the rock surface point database to improve and expand the regional rock surface.

Commented [CS8]: A-2-19 - Additional explanation of how and why the multibeam bathymetry sorced rock data information was dervied was added to the text in response to this comment

2.4 Geophysical Data

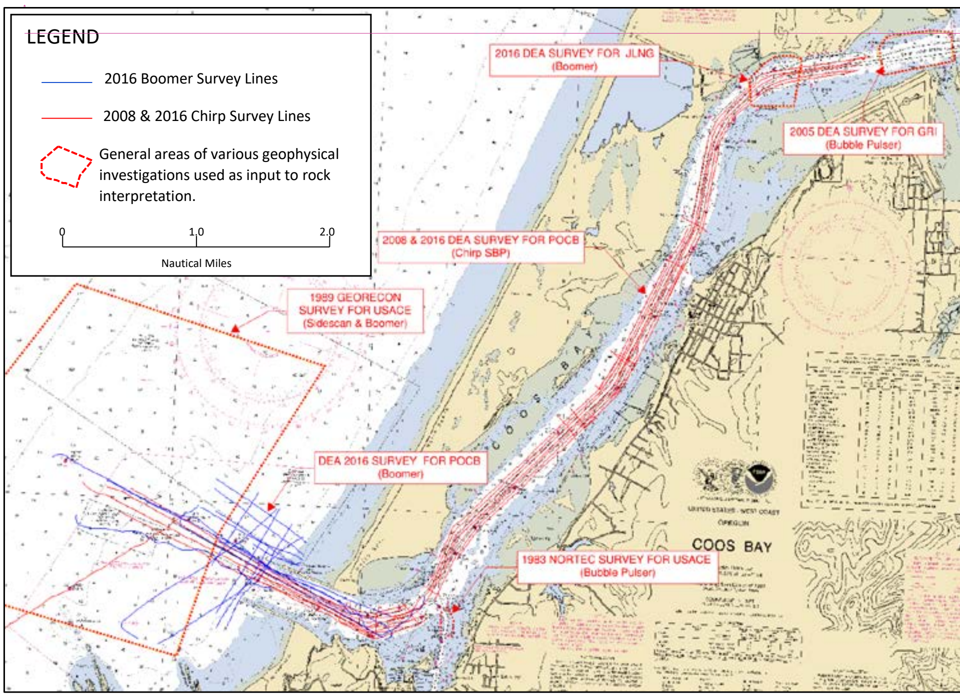
In addition to the aforementioned probe, core and bathymetric points, data from six geophysical surveys conducted in various isolated locations around the Coos Bay project area (Table 1 and Figure 2) were used to inform the interpretation of the top of rock model v. 5.0. These surveys were conducted by Nortec Survey, GeoRecon International, Limited (GeoRecon) and DEA for the United States Army Corps of Engineers Portland District (USACE), Geotechnical Resources, Inc. (GRI), Port of Coos Bay (POCB), and Jordan Cove LNG (JCLNG).

Figure 1: Multibeam hillshade image showing exposed bedrock (yellow outline) at Guano Rock (left) and RM 3 to RM 3.6 (right).

Survey	DATE	General Location	Instruments
Nortec Survey for USACE	1983	Charleston Entrance	Single Channel Reflection
GeoRecon Survey for USACE	1989	Offshore	Single Channel Reflection
DEA Survey for GRI	2005	RM 7.5	Single Channel Reflection
DEA Survey for POCB	2008	RM 0 to RM 8	Chirp SBP
DEA Survey for POCB	2016	Offshore to RM 8	Chirp SBP
DEA Survey for POCB	2016	Offshore to RM 2	Single Channel Reflection
DEA for JCLNG	2017	Jarvis Turn	Single Channel Reflection

All the surveys utilized some type of acoustic sub-bottom profiling, typically either single channel seismic reflection (i.e., Boomer and Bubble Pulser) or EdgeTech's proprietary FM (Frequency Modulated) CHIRP technology. Single channel seismic reflection consists of an acoustic source and a separate, towed "streamer," with the point of reflection being midway between them. These systems operate from approximately 100 hertz (Hz) to 2 kilohertz (kHz) and can achieve penetration in sands of up to 100 to 200 feet. CHIRP systems incorporate the transmit and receive arrays into a single tow-body that has the point of reflection directly below the unit. These systems produce a swept FM CHIRP which is a broadband output signal which typically achieves penetration depths up to 50 to 150 feet depending on the chirp spectrum utilized. Through advanced processing and match filtering, the reflected signal has qualities associated with both the high and low frequency components (good resolution with the high frequencies and good penetration with the low). The system that DEA used in both the 2008 and 2016 surveys was an EdgeTech 512i CHIRP which is capable of frequency ranges from 500 Hz to 12 kHz; however, the primary pulse used during these surveys was 500 Hz to 7.2 kHz. The subsurface penetration achieved in these surveys ranged from more than 150 feet using the single channel seismic reflection systems to only approximately 10 to 30 feet using the CHIRP system. The CHIRP system achieved better resolution in shallow depths, where there was thin layer of sand over rock, but it lacked the power to penetrate areas where the rock was covered by thick sands.

Commented [CS9]: A-2-20 – no revision, but the following explanation is provided in response to the reviewer's comment: The explanation of the technologies is to give a general understanding of how the systems vary as part of rthe summary of the various data sources used in the rock interpretation. Because the data interpretation, being discussed in this appendix, was based on numerous sources, individual survey reports are not included to avoid confusion with earier interpretations or conclusions.



Commented [CS10]: A-2-21 – remaking the map is not viable. A scale and legend has been added to provide the viewer with additional information and context

3.0 ROCK INTERPRETATION BY RIVER MILE

3.1 Offshore to RM 0

The geophysical data from the Geo Recon International, Limited (GeoRecon) survey conducted for the USACE in 1989 and the single channel seismic data collected by DEA in December 2016 agree well in areas of overlap. In general, the GeoRecon survey depicts exposed rock in the southern section of the survey area, which trends deeper towards the northwest, where it was mapped to depths greater than 200 feet MLLW (Krieger, 1989).

A feature, that correlates well with the extension of Mussel Reef at Yokam Point (see Figures 3 and 4) in the area directly offshore from the channel entrance, is depicted in both the GeoRecon 1989 survey and the DEA December 2016 survey (see Figure 5). The reef extension correlates well with undulations of the interpreted horizon in the seismic record and helps confirm that the reflector being tracked is likely the highly resistive sandstone of the Upper Coaledo Formation (Ehlen, 1967) that forms Mussel Reef.

In general, along the channel alignment in an offshore direction from RM 0, rock elevations are lower than -90 feet MLLW and should pose no issue to channel deepening.

Commented [CS11]: A-2-22 Statement added reflecting commenters request.

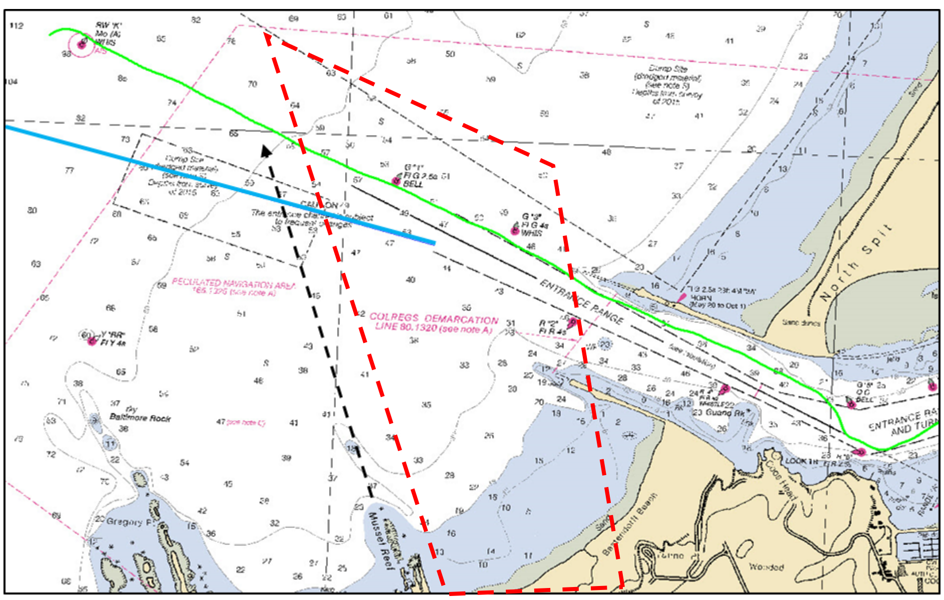


Figure 3: 2016 seismic line BP1W (green) and location of GeoRecon profile 3 (blue). The projection of Mussel Reef (dashed black arrow) correlates very well with both surveys. The red dashed outline represents the estimated projection of north striking, steeply eastward dipping Bastendorff shale (green box in Figure 4 below.)

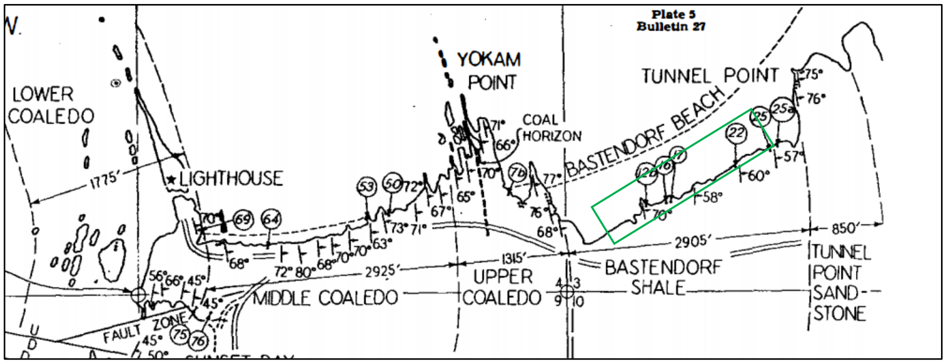


Figure 4: Sketch showing rock units south of the Coos Bay entrance channel along Lighthouse and Bastendorf beaches (Allen and Baldwin 1944.)

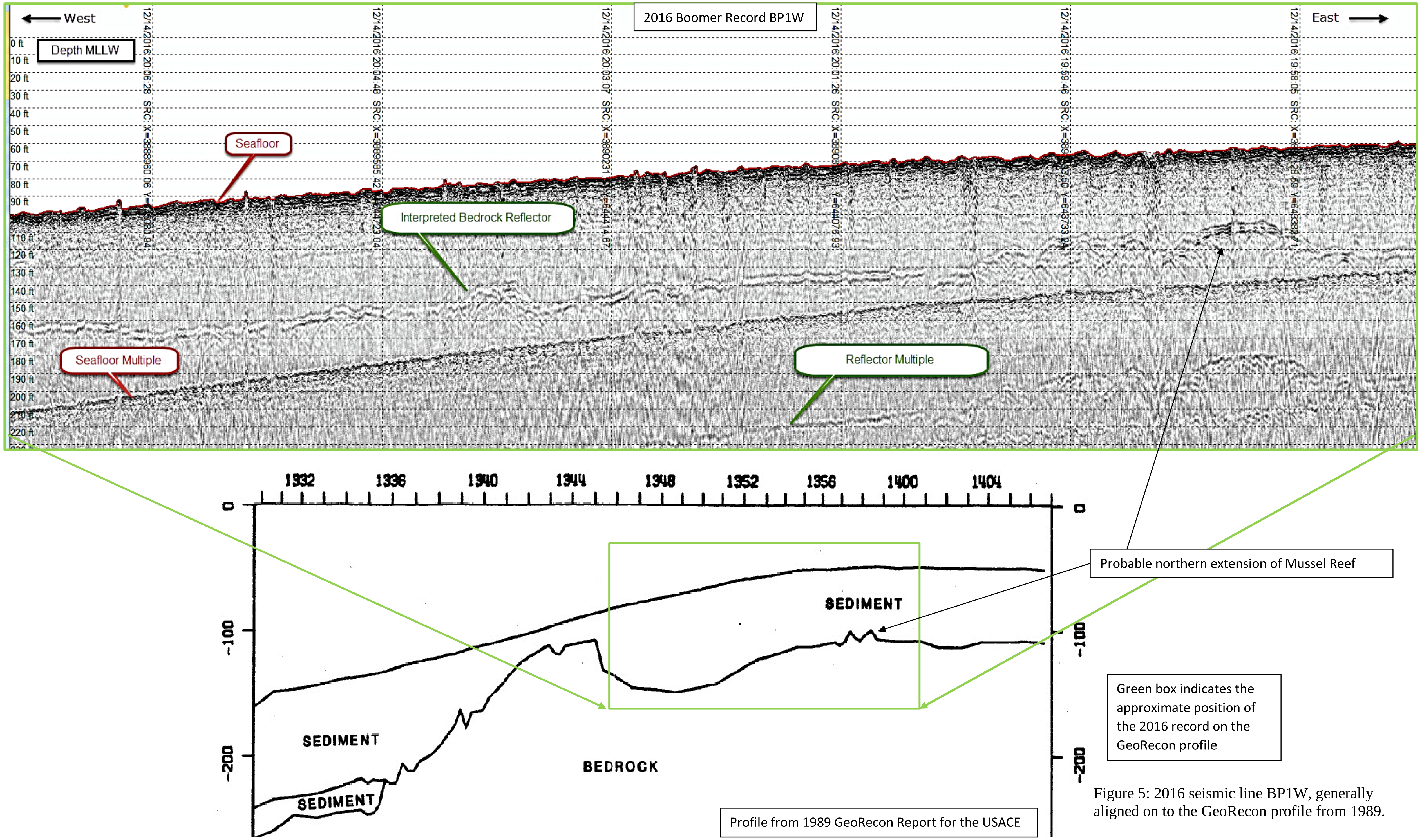


Figure 5: 2016 seismic line BP1W, generally aligned on to the GeoRecon profile from 1989.

3.2 RM 0 to RM 1

Interpreted rock contours between the jetties, as shown in Figure 6, generally run at elevations from -80 feet MLLW and rise in elevation toward the east. Due to the relatively thick sands in this area, the single channel seismic systems yielded the best sub-bottom penetration. The boomer lines from the December 2016 survey show a reflector at a depth of approximately -100 feet (MLLW) at RM 0 that climbs steadily upward toward the east, eventually breaking through at Guano Rock just before RM 1 as seen in Figure 7. Jet probes in the middle and south channel in this area confirmed that rock is between -80 and -70 feet MLLW near RM 0+18 to RM 0+30. However, jet probes on the north side of the channel, just south of the North Jetty (between RM 0+27 and RM 0+47), never went to refusal at full probe length (approximately 89 feet). This deep zone is believed to carry around the north side of Guano Rock to the east and may be associated with local faulting in the area. Just east of the exposed portion of Guano Rock, a drastic change appears to occur in the interpretation of the rock surface. It appears that rock elevations drop suddenly from the east margin of Guano Rock at RM 0+50 to RM 1+00, where the interpreted geophysical reflector drops to an elevation of -117 feet MLLW, and several jet probes encountered no refusal at -88 feet MLLW. This dramatic change also correlates closely with what would be the northward projection of the Charleston Fault (Mandin, et. al, 1995) as seen in Figures 8 and 9. Also helping validate the interpretation of the drastic drop in rock elevation east of Guano Rock is the location of the original river channel prior to the jetty construction and channel modifications that occurred in the 1920's. The location of the original river channel is depicted in an overlay of the 1861 sounding plot to an aerial image in Figure 10. The east side of Guano Rock may have originally controlled the path of the river, forcing the channel more to the northwest, creating a thalweg on the outside of the turn which may help explain the sudden deepening of the bedrock surface in this area.

Commented [CS12]: A-2-23 – No revision. This discussion refers to the original river channel prior to jetty construction in the 1920's and is not referring to the paleochannel

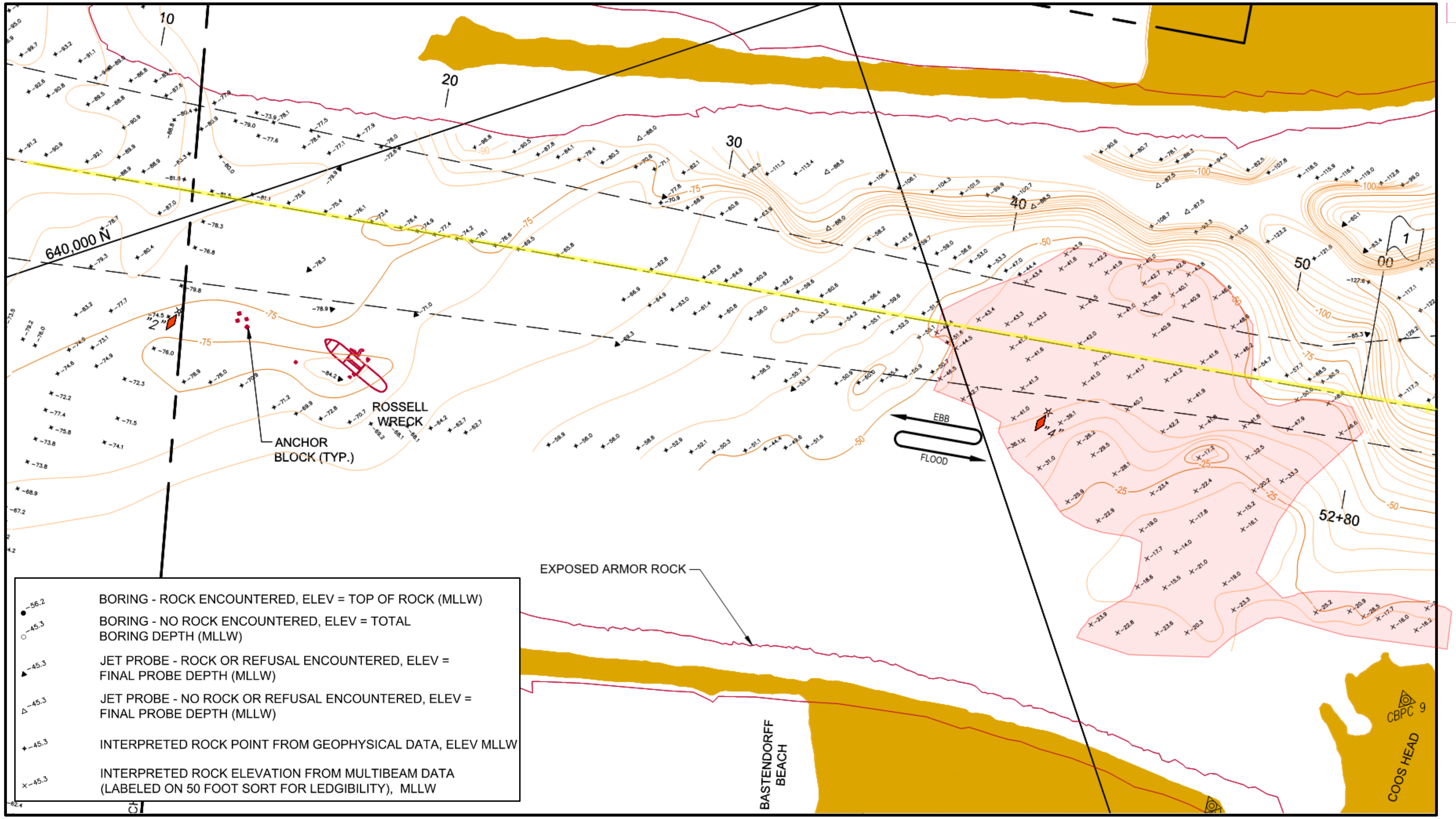


Figure 6: Rock contours and data points between RM 0 and RM 1 (The red shaded area is exposed rock, as interpreted from multibeam bathymetry data). Solid triangles are probes that hit refusal [i.e., assumed rock]. Open triangles represent probes that did not encounter refusal. Yellow highlight is boomer line BP-Chan1 shown in Figure 7. All depths are relative to MLLW vertical datum. (For detailed view, see original plates in 60% design package.)

Commented [CS13]: A-2-24, A-2-25 The pink outlines were created within the word document to highlight the general areas of rock. The latest 60% design drawing do not have outlines around rock areas because it would make the figures busy and potentially unreadable. A-2-25 - Some of the elements are explained in the caption below the figure. A legend (key) has been added to this and other figures to help the reader determine the type or source of data

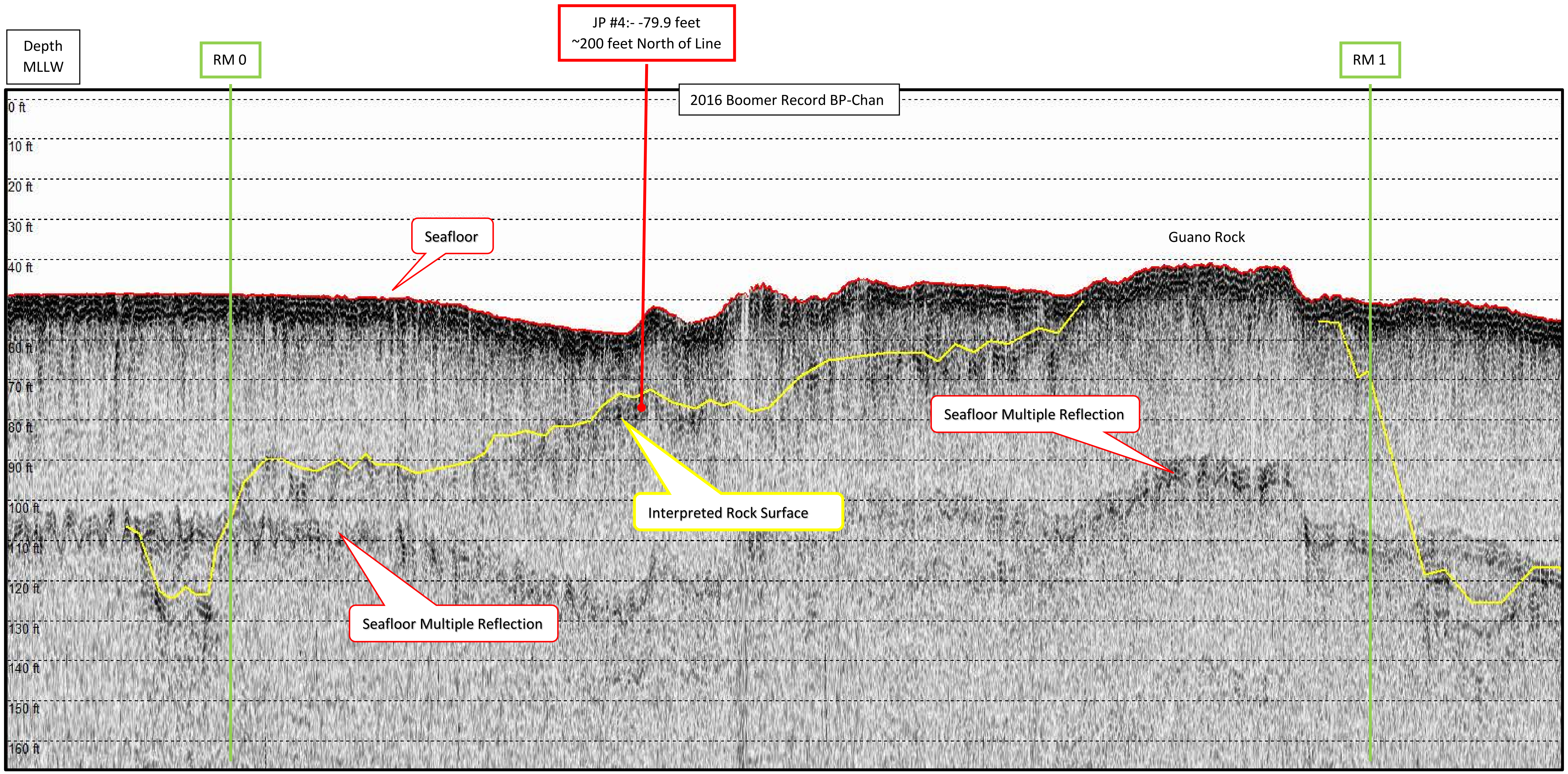


Figure 7: Seismic profile (boomer) BP-Chan, looking north along center line of entrance channel between RM 0 and RM 1

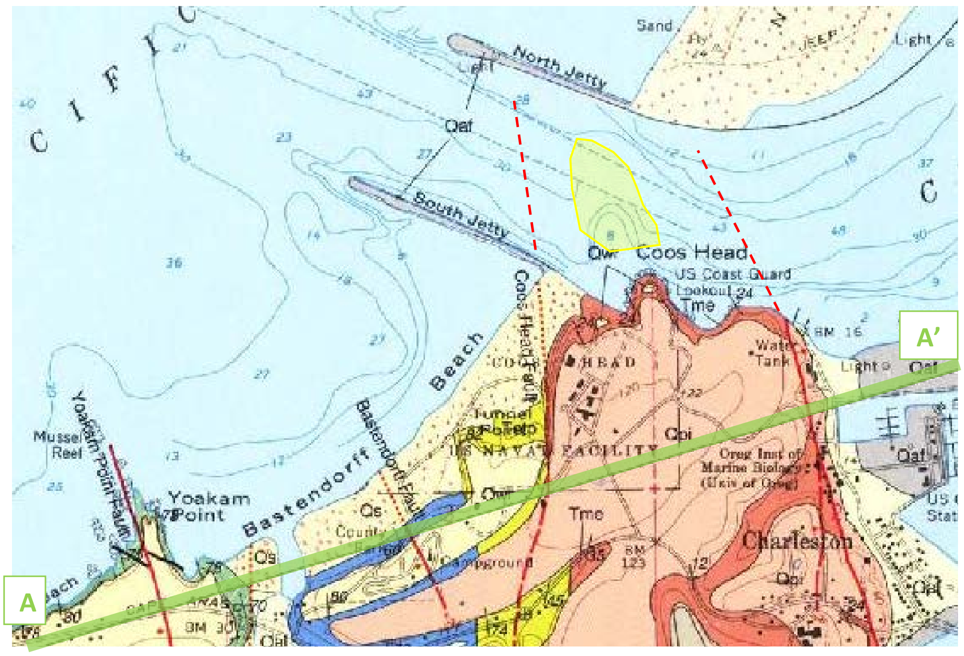


Figure 8: Portion of the Oregon Department of Geology and Mineral Industries (DOGAMI) geologic map of the Charleston Quadrangle. Red dashed lines show approximate extension of the Coos Head Fault (left) and the Charleston Fault (right). Yellow highlight in the channel is the general location of Guano Rock. Green line from A to A’ represents a section of the DOGAMI geologic profile, which is shown below in Figure 9. Note the up-thrust zone between the Coos Head Fault and the Charleston Fault.

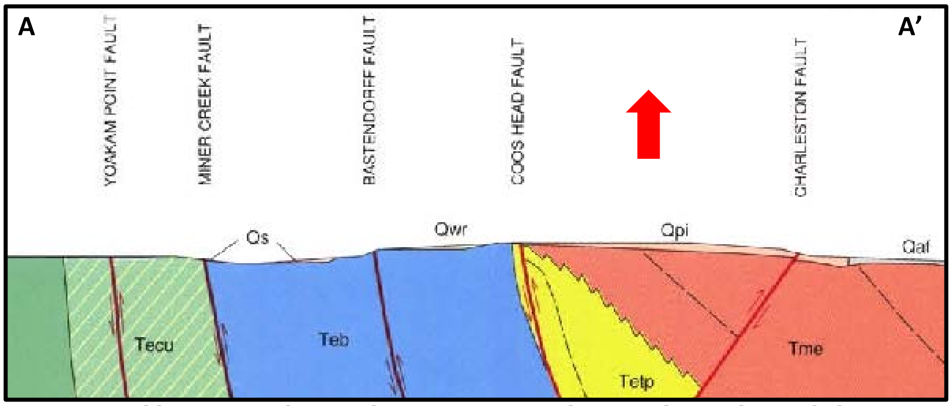


Figure 9: An oblique image showing the 1861 navigational survey plot overlain with the current multibeam bathymetric hillshade image. Yellow highlight shows general area of “no refusal” jet probes from 2017. North is indicated by arrow in upper left.

Figure 10: Overlay of the original U.S. Coast Survey (now NOAA) sounding chart of the Coos Bay Entrance channel from 1861 to a modern aerial photograph. Note the northwesterly orientation of the original river channel, possible diverted by the up-thrust area around Guano Rock (approximately yellow highlight.)

3.3 RM 1 to RM 2

This area east of Guano Rock includes a significant turn in the channel toward the north. Most of the geophysical elevations are off the boomer records, which had better sub-bottom penetration than the Chirp systems. The sub-bottom reflector in this zone is not strong and continuous, but rather comes in and out on the seismic record. This could be because the thickness of the sands over the deeper rock is attenuating the signal, and the previously discussed natural channel and local faulting are producing a geometrically complex rock surface. In general, probes and geophysical data indicate a rock elevation of -100 feet MLLW or deeper in the channel east of Guano Rock to RM 1+10, where it appears that the rock climbs and may outcrop in a small knob, as interpreted from the multibeam hillshade image, at an elevation of -51.6 feet MLLW. A second deeper knob occurs near RM 1+25, where a jet probe encountered refusal at -64.7 feet MLLW (and there were a few confirming picks from the geophysical data). Although the data is sparse for the area between RM 1+25 and RM 1+48, indications are that the rock is located at -80 feet MLLW, or deeper before it starts to become shallower in the upriver direction to approximately -50 feet MLLW at RM 2+00. See Figure 11.

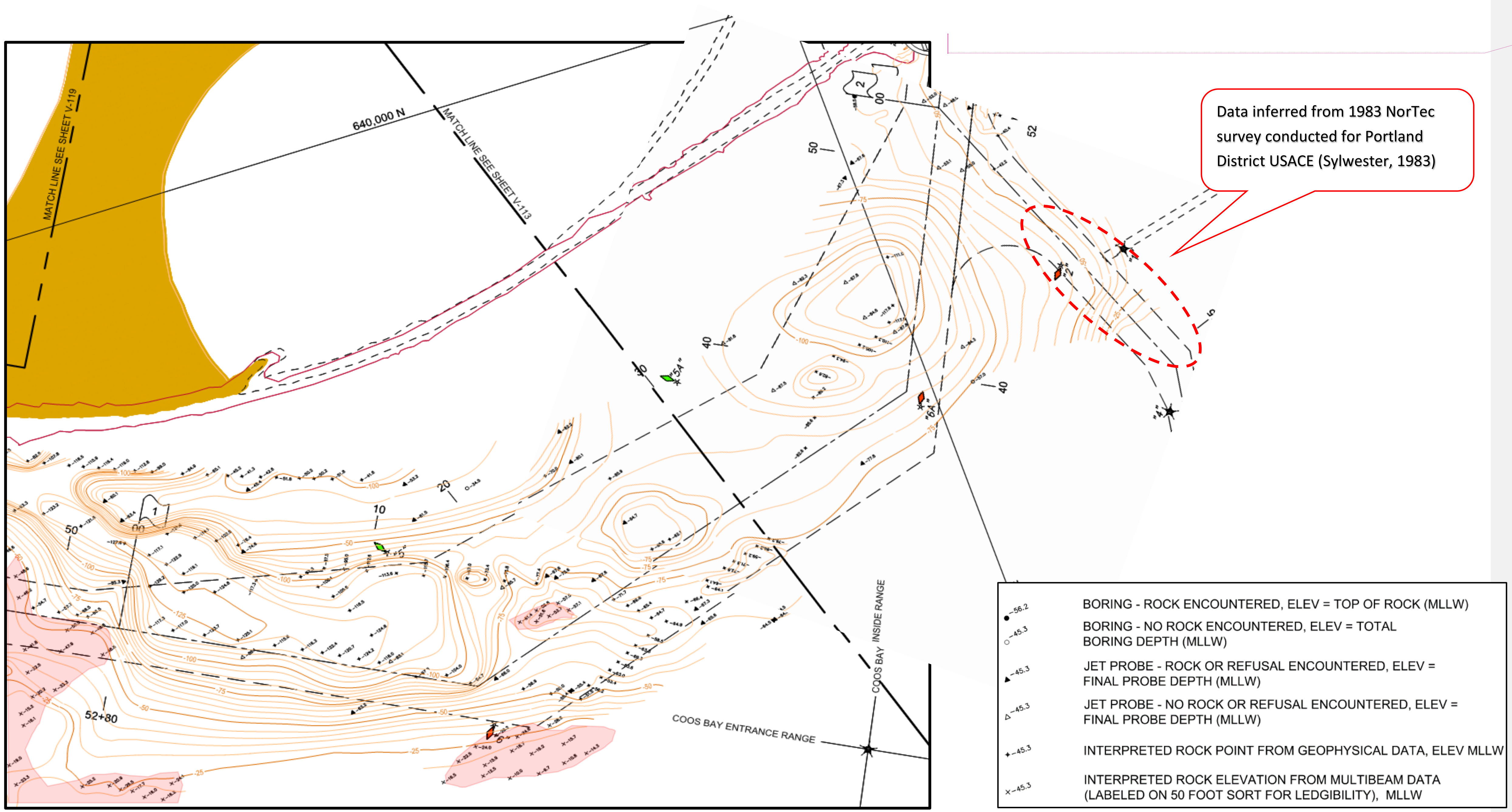


Figure 11: Rock contours and data points between RM 1 and RM 2. Red shaded areas are exposed rock interpreted from multibeam bathymetry data. Solid triangles are probes that hit refusal (i.e., assumed rock). Open triangles represent probes that did not encounter refusal. All depths are relative to MLLW. (For detailed view, see original plates in 60% design package.)

Commented [CS14]: A-2-26, A-2-27 – Image corrected in response to these comments

3.4 RM2 to RM3

In advance of the last channel deepening in 1996, the USACE conducted extensive jet probe and geophysical exploration in the channel of the river in this area (USACE 1974, 1995). Subsequently, DEA conducted CHIRP sub-bottom profiling surveys in 2008 and 2016 to collect data in the channel and along lines 125 feet and 250 feet beyond the east and west channel limits. The CHIRP system worked well in this area, where the sands are relatively thin. In this area, the multibeam data clearly displayed indications of exposed bedding and rock outcrops. The rock elevation within the channel is generally -39 feet to -40 feet MLLW. Outside of the channel on the east side from RM2+00 to RM2+30, the rock is at elevations between -22 feet and -24 feet. The east side channel cut, from RM2+00 to RM2+40, is very steep and cut into rock. Beyond RM2+40 to 3+00, the channel cut is less distinct. On the west side of this area, the rock elevations appear slightly deeper, averaging -25 feet to -30 feet MLLW, and the channel cut is less distinct due to the reduced differential with the channel elevation. See Figure 12.

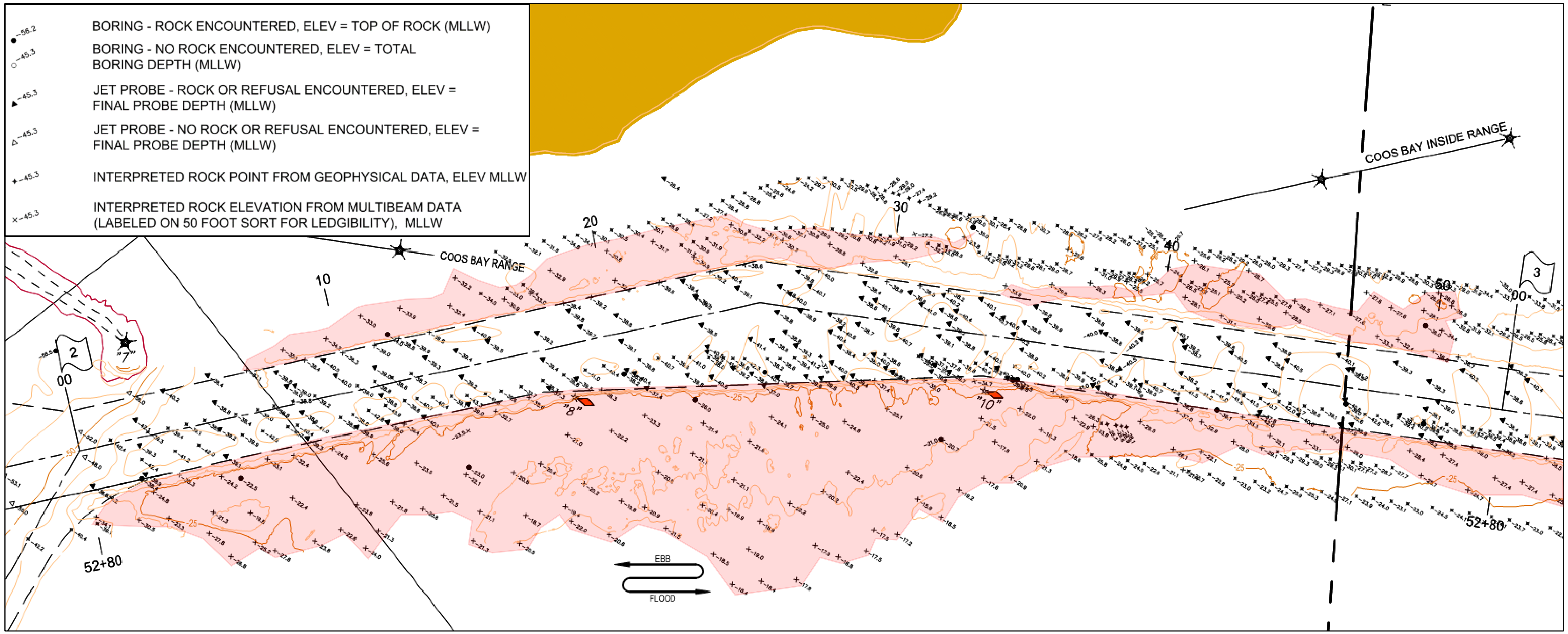


Figure 12: Rock contours and geophysical data points between RM 2 and RM 3. Red shaded area is exposed rock, as interpreted from multibeam bathymetry data. Solid triangles are probes that hit refusal (i.e., assumed rock). Open triangles represent probes that did not encounter refusal. All depths are relative to MLLW. (For detailed view, see original plates in 60% design package.)

3.5 RM3 to RM4

This area shown in Figure 13 has also been extensively investigated over the years by the USACE (USACE 1974, 1995). In addition, DEA conducted CHIRP sub-bottom profiling surveys in 2008 and 2016 to collect data in the channel and along lines 125 feet and 250 feet beyond the east and west channel limits. The CHIRP system worked well in this area, where the sands were relatively thin. In this area, the multibeam data clearly displayed indications of exposed bedding and rock outcrops. The rock elevation within in the channel is generally -38 feet to -40 feet MLLW. Outside of the channel on the east side from RM3+00 to RM3+10, the rock is between -20 feet and -22 feet MLLW. The east side channel cut, from RM3+00 to RM3+11, is very steep and is cut into a rock that bisects the channel in a northerly orientation along the known strike of the local bedding. Careful examination of the multibeam hillshade image (see Figure 14) reveals a subtle change in the exposed rock bedding between RM2 to RM3 and RM3 to RM4. The rock bedding at the former location show regular and close bedding over a relatively consistent elevation, whereas the latter shows zones of higher relief with sand-filled lows in between. These zones are probably related to changes within sequences of the dipping rock units. The most significant low associated with these features is located at RM3+49, where the rock elevation drops to -61 feet MLLW along the center line of the navigation channel. This low can be seen on the left edge of the CHIRP profile (Figure 15), which also depicts the pattern of rock relief that is likely associated with variations in resistance to weathering. This location is also very near the contact between the Empire Formation (to the south) and the Bastendorff formation (to the north) as shown in Figure 2.2 of the 2017 Geotechnical Report for the project.

Commented [CS15]: A-2-28 – Reference corrected – changed from RM 4+49 to 3+49

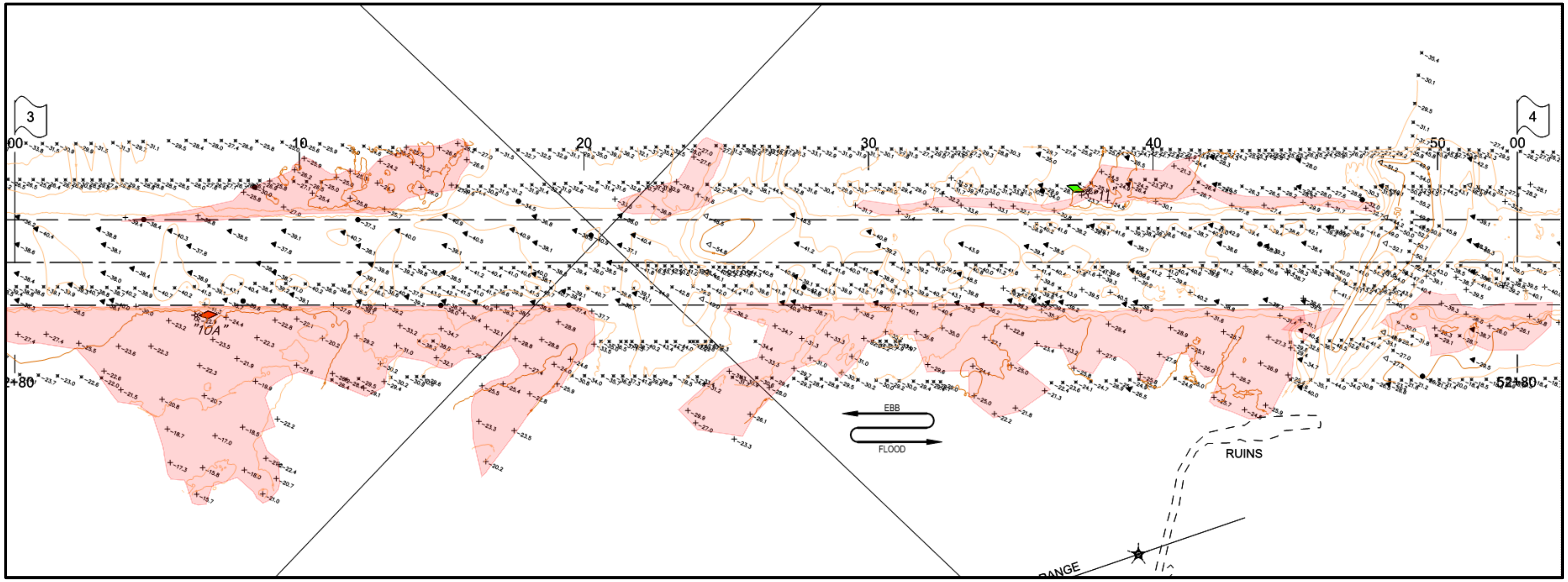


Figure 13: Rock contours and data points between RM 3 and RM 4. Red shaded area is exposed rock, as interpreted from multibeam bathymetry data. Solid triangles are probes that hit refusal (i.e., assumed rock). Open triangles represent probes that did not encounter refusal. All depths are relative to MLLW. (For detailed view, see original plates in 60% design package.)

● -56.2	BORING - ROCK ENCOUNTERED, ELEV = TOP OF ROCK (MLLW)
○ -45.3	BORING - NO ROCK ENCOUNTERED, ELEV = TOTAL BORING DEPTH (MLLW)
▲ -45.3	JET PROBE - ROCK OR REFUSAL ENCOUNTERED, ELEV = FINAL PROBE DEPTH (MLLW)
△ -45.3	JET PROBE - NO ROCK OR REFUSAL ENCOUNTERED, ELEV = FINAL PROBE DEPTH (MLLW)
+ -45.3	INTERPRETED ROCK POINT FROM GEOPHYSICAL DATA, ELEV MLLW
× -45.3	INTERPRETED ROCK ELEVATION FROM MULTIBEAM DATA (LABELED ON 50 FOOT SORT FOR LEDGIBILITY), MLLW

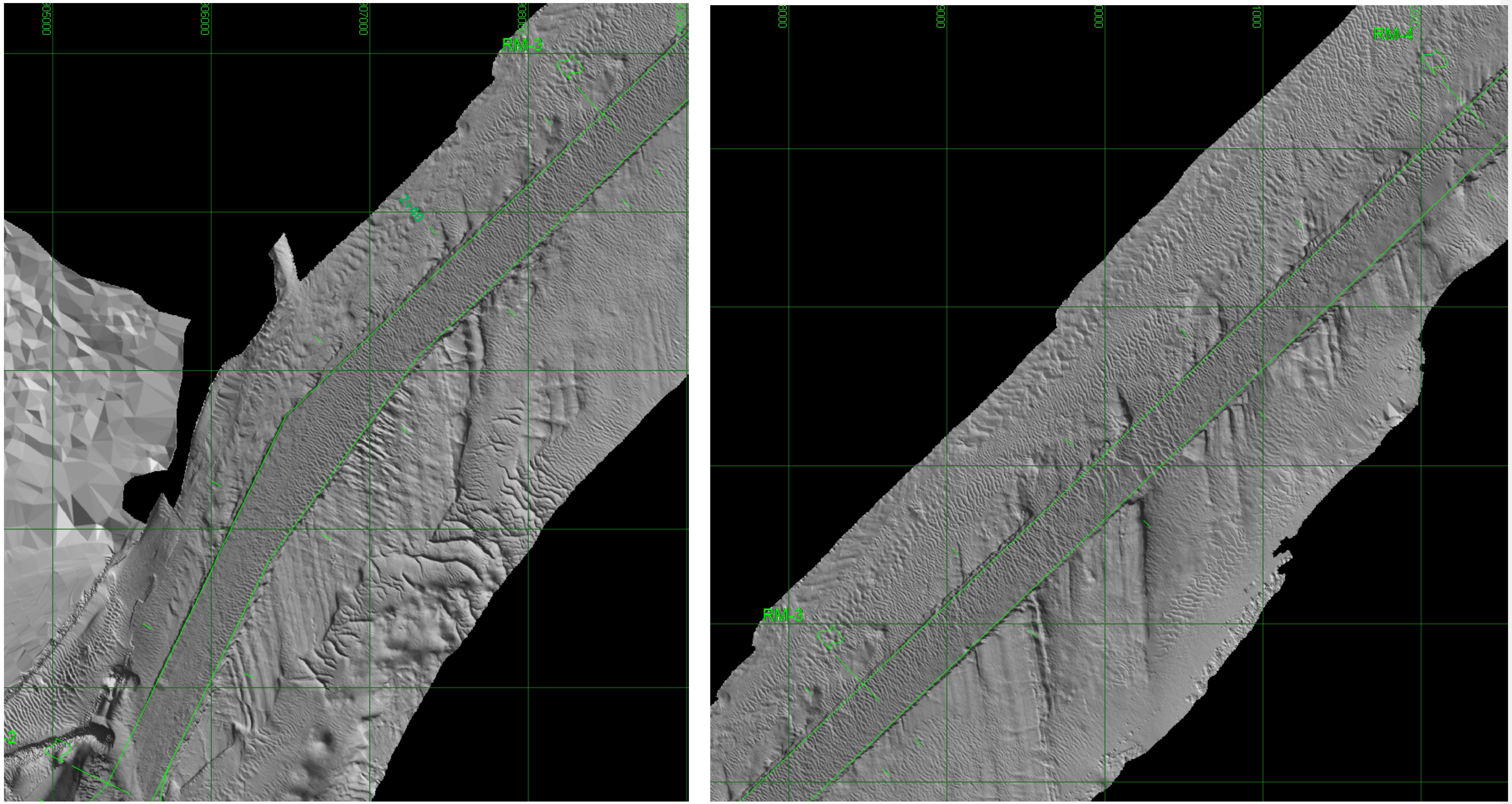


Figure 14: Multibeam hillshade images of RM 2 to RM 3 (left) and RM 3 to RM 4 (right), showing the subtle change in exposed rock characteristics (The image on the left shows relatively even rock surface to RM 2+40. The image on the right shows 800-foot to 900-foot sequences and more irregular rock elevations.)

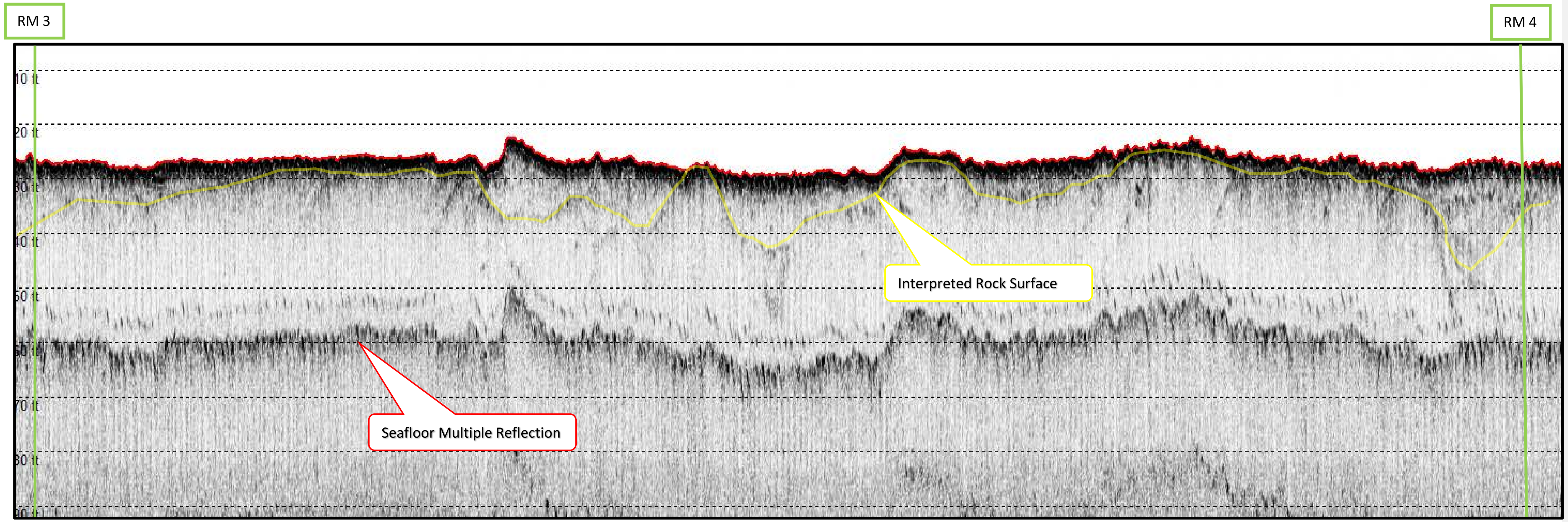


Figure 15: 2008 CHIRP line CB_RNG_250W (250 feet west of channel edge) between RM 3 and RM 4, showing undulating rock surface (yellow highlight) (High spots probably reflect more resistant units and correlate to the exposed rock pattern previously discussed in Figure 14. Elevations are relative to MLLW.)

3.6 RM 4 to RM 5

In general, from RM 4+00 to RM 4+19, rock elevations within the channel are between -39 feet and -41 feet MLLW, and there are shallower (i.e., untouched during channel deepening) elevations of approximately -25 feet MLLW found immediately to the east and west, outside of the channel limits. From RM 4+20 and onward, clear expressions of rock in the multibeam hillshade images are very limited, indicating a general deepening of rock toward the north. At RM 4+30, there is a narrow, north-south trending deep "channel" (approximately -50 feet), similar to those described previously. From RM 4+33 to RM 5+00, rock depths within the channel start to deepen, averaging -42 feet to -44 feet and occasionally having deeper pockets (deeper than -50 feet). See Figure 16.

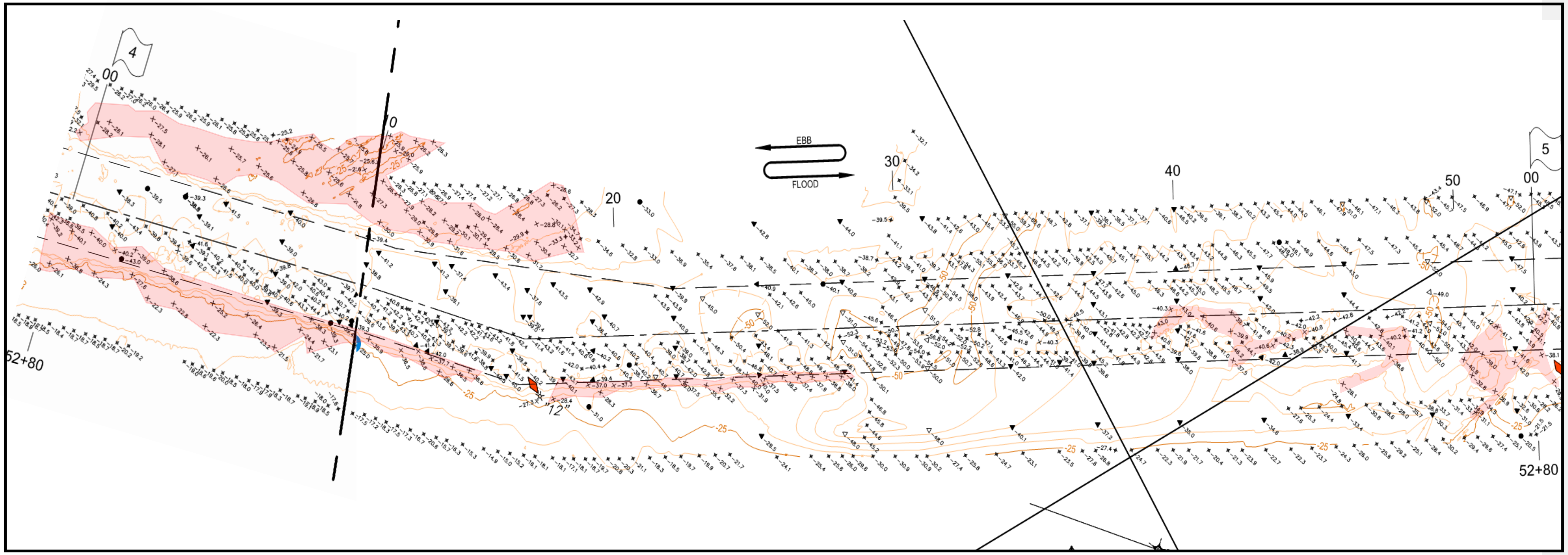


Figure 16: Rock contours and data points between RM 4 and RM 5. Red shaded area is exposed rock, as interpreted from multibeam bathymetry data. Solid triangles are probes that hit refusal (i.e., assumed rock). Open triangles represent probes that did not encounter refusal. All depths are relative to MLLW. (For detailed view, see original plates in 60% design package.)

● -56.2	BORING - ROCK ENCOUNTERED, ELEV = TOP OF ROCK (MLLW)
○ -45.3	BORING - NO ROCK ENCOUNTERED, ELEV = TOTAL BORING DEPTH (MLLW)
▲ -45.3	JET PROBE - ROCK OR REFUSAL ENCOUNTERED, ELEV = FINAL PROBE DEPTH (MLLW)
△ -45.3	JET PROBE - NO ROCK OR REFUSAL ENCOUNTERED, ELEV = FINAL PROBE DEPTH (MLLW)
+ -45.3	INTERPRETED ROCK POINT FROM GEOPHYSICAL DATA, ELEV MLLW
× -45.3	INTERPRETED ROCK ELEVATION FROM MULTIBEAM DATA (LABELED ON 50 FOOT SORT FOR LEDGIBILITY), MLLW

3.7 RM 5 to RM 6

Rock elevations in the channel average approximately -39 feet to -41 feet from RM 5+-00 to 5+20, at which point another “channel” feature is encountered, and rock surface is mapped down to -60.5 feet MLLW. A slight conflict appears to occur at this same location on the east side, where a boring (B3, 2010) encountered no rock to an elevation of -61.5 feet but surrounding geophysical and muiltibeam data and probes place the rock surface higher, at an approximate elevation of -40 feet to -30 feet. Figure 17 shows the closest geophysical line and shows the conflicting boring projected. It is possible that the boring location was not accurately positioned, and the actual sample intersected the channel feature 90 feet toward the south. On the west side, near RM 5+31, numerous jet probe data points are depicted that were in support of driving operations that occurred during construction of the T-dock. This cluster of probes shows the variability that can exist in rock elevations over short distances (-24 feet to -54 feet in less than 100 feet of horizontal distance). Rock depths within the turning basin (RM 5+30 to RM 5+45) are approximately -45 feet on the channel centerline, -38 feet on the east edge, and -48 feet on the west edge. Boring, probes, and geophysical points all continue to indicate a slight deepening of the rock towards the north; however, shallow rock is known to the be present approximately 1,400 feet east of RM 5+40 in the form of Utter Rock. RM 5+40 is also close to the contact between the Bastendorff and Coaledo formations, as depicted in Figure 2.2 of the 2017 Geotechnical Report. See Figure 18.

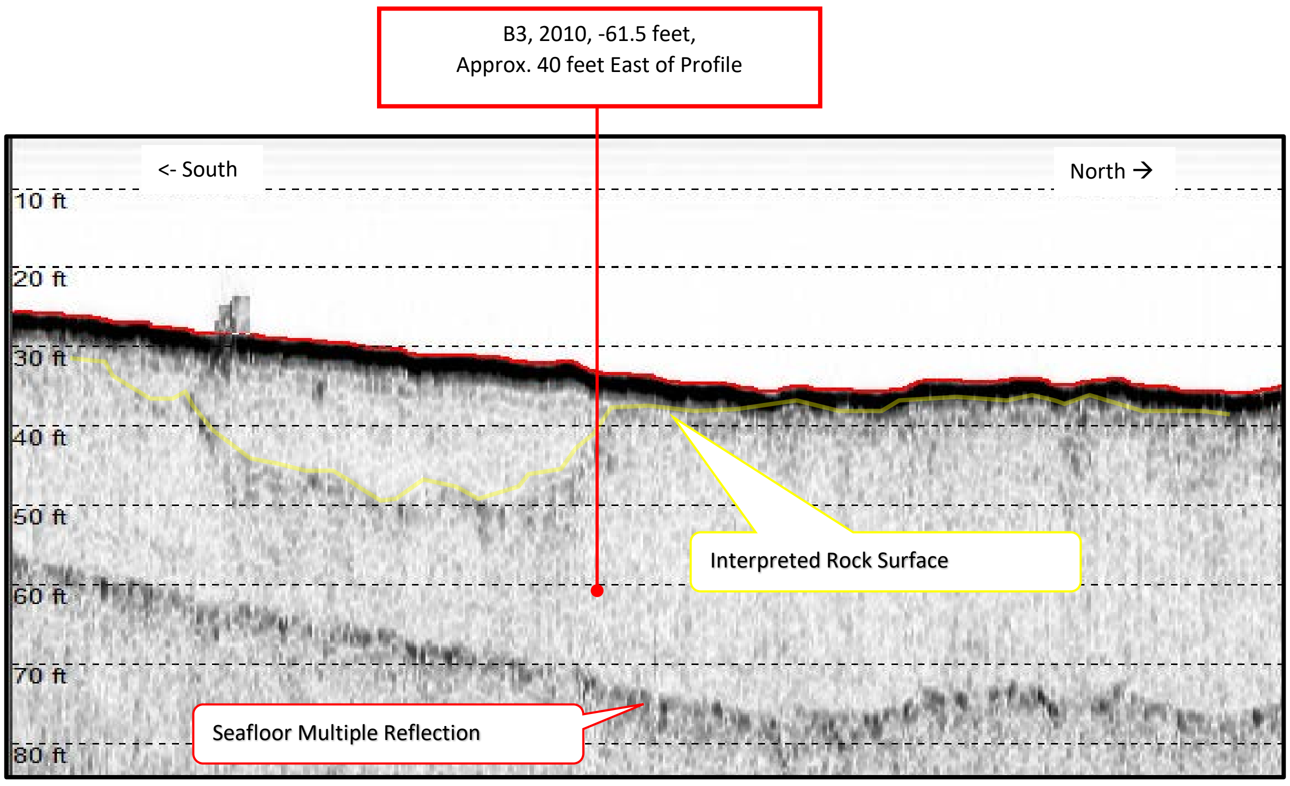


Figure 17: 2010 Boring B3, no rock to -61.5 feet, projected approximately 40 feet west on to 2008 CHIRP line 002_1318 (Note deeper rock section south of the projected boring. Elevation scale on vertical axis is relative to MLLW.)

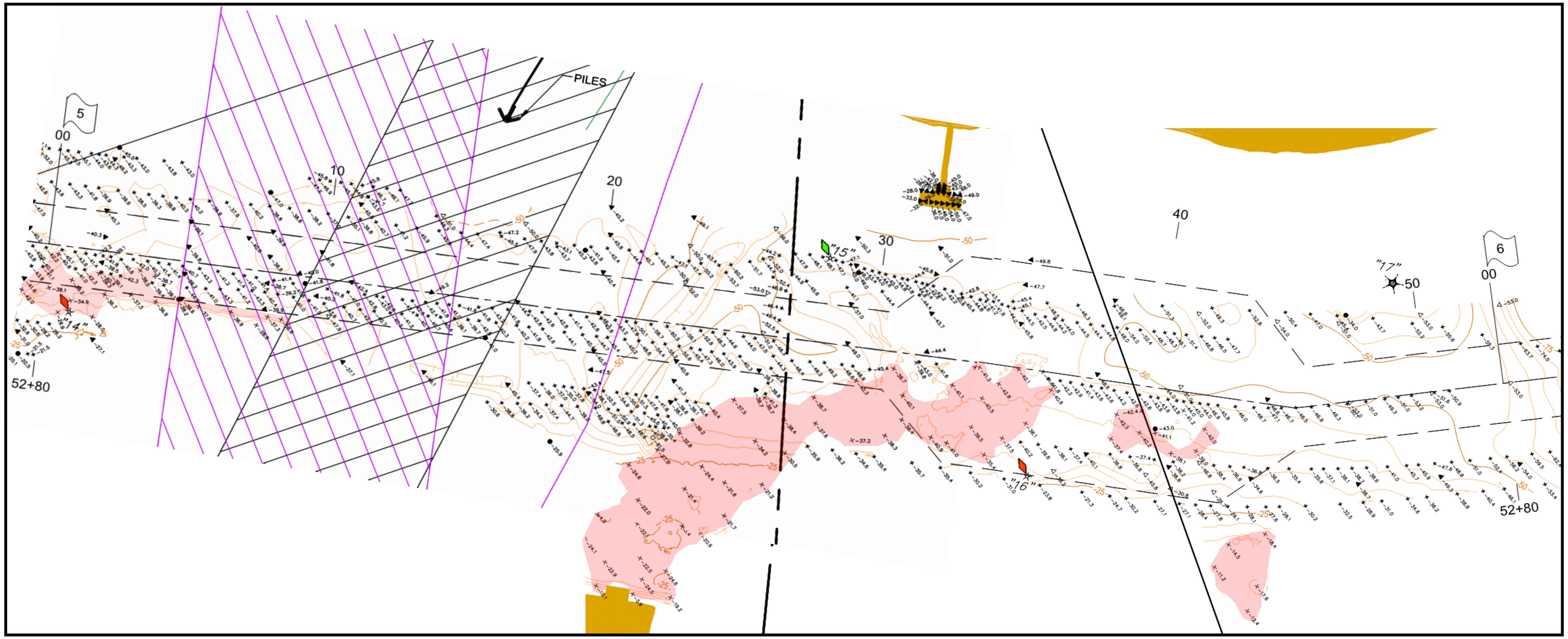


Figure 18: Rock contours and data points between RM 5 and RM 6. Red shaded area is exposed rock, as interpreted from multibeam bathymetry data. Solid triangles are probes that hit refusal (i.e., assumed rock). Open triangles represent probes that did not encounter refusal. All depths are relative to MLLW. (For detailed view, see original plates in 60% design package.)

● -56.2	BORING - ROCK ENCOUNTERED, ELEV = TOP OF ROCK (MLLW)
○ -45.3	BORING - NO ROCK ENCOUNTERED, ELEV = TOTAL BORING DEPTH (MLLW)
▲ -45.3	JET PROBE - ROCK OR REFUSAL ENCOUNTERED, ELEV = FINAL PROBE DEPTH (MLLW)
△ -45.3	JET PROBE - NO ROCK OR REFUSAL ENCOUNTERED, ELEV = FINAL PROBE DEPTH (MLLW)
+ -45.3	INTERPRETED ROCK POINT FROM GEOPHYSICAL DATA, ELEV MLLW
× -45.3	INTERPRETED ROCK ELEVATION FROM MULTIBEAM DATA (LABELED ON 50 FOOT SORT FOR LEDGIBILITY), MLLW

3.8 RM 6 to RM 7

Probes and geophysical points near RM 6+00 indicate rock elevations lower than -55 feet MLLW as seen in Figure 19. Several CHIRP sub-bottom lines were run along this section of the channel, but yielded no reliable sub-bottom reflector, probably due to the thickness of the sand over rock. One boomer line was run in 2016 to tie the JCLNG seismic survey to borings and known rock near RM 6. This line indicates deep rock toward the north that increases in elevation toward the south. This interpretation is supported by probes in the vicinity that indicate rock elevations between RM 6+05 to RM 7+00 that are lower than -80 feet MLLW.

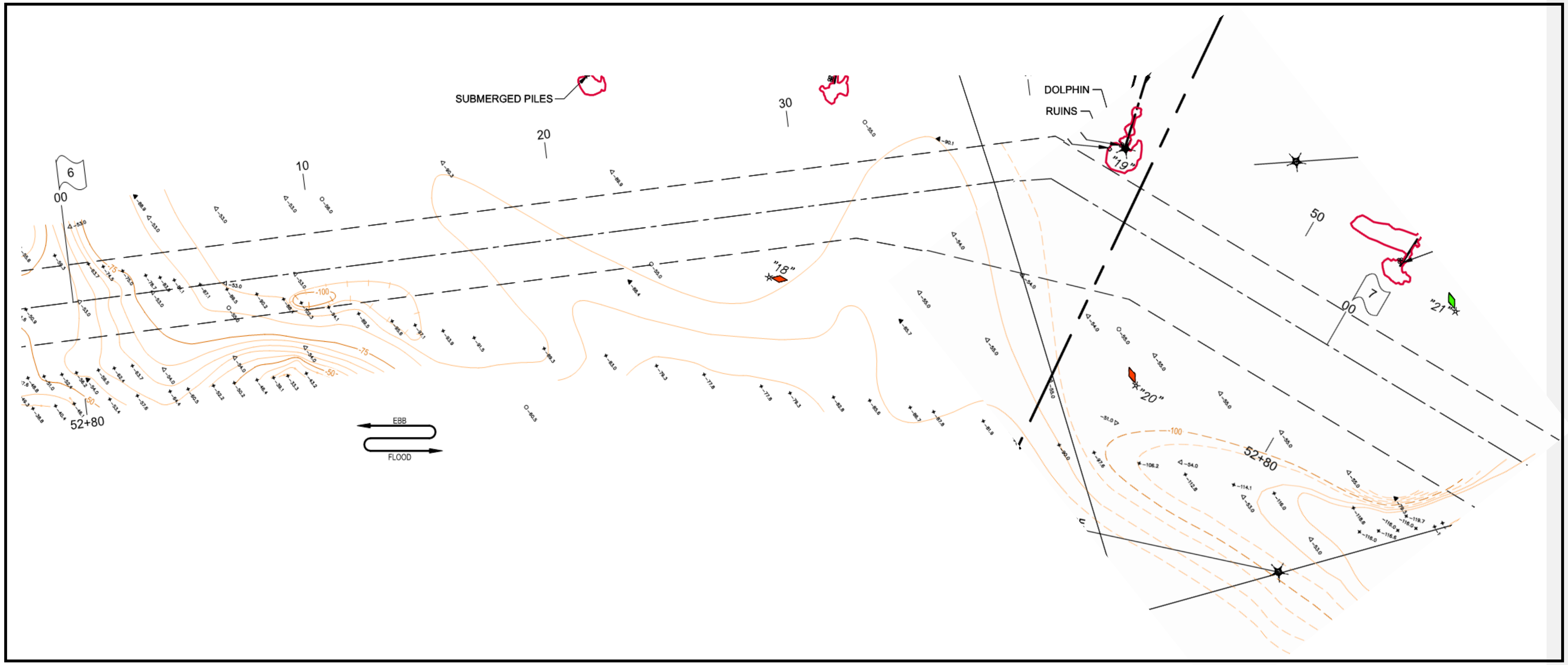


Figure 19: Rock contours and data points between RM 6 and RM 7. Solid triangles are probes that hit refusal (i.e., assumed rock). Open triangles represent probes that did not encounter refusal. All depths are relative to MLLW. (For detailed view, see original plates in 60% design package.)

● -56.2	BORING - ROCK ENCOUNTERED, ELEV = TOP OF ROCK (MLLW)
○ -45.3	BORING - NO ROCK ENCOUNTERED, ELEV = TOTAL BORING DEPTH (MLLW)
▲ -45.3	JET PROBE - ROCK OR REFUSAL ENCOUNTERED, ELEV = FINAL PROBE DEPTH (MLLW)
△ -45.3	JET PROBE - NO ROCK OR REFUSAL ENCOUNTERED, ELEV = FINAL PROBE DEPTH (MLLW)
+ -45.3	INTERPRETED ROCK POINT FROM GEOPHYSICAL DATA, ELEV MLLW
× -45.3	INTERPRETED ROCK ELEVATION FROM MULTIBEAM DATA (LABELED ON 50 FOOT SORT FOR LEDGIBILITY), MLLW

3.9 RM7 to RM8

Figure 20 shows an interpretation of relatively deep rock in the Jarvis Turn area. An extensive geophysical survey was conducted near RM7+10 to RM7+35 in 2017 to confirm rock elevations near the proposed Jordan Cove LNG facility. Borings along the shore directly north of RM7+24 had drilled to elevations as low as -112 feet without encountering rock. The geophysical survey, which was composed of boomer lines on a 250-foot primary line spacing, produced an interpretation showing two deep basins with elevations as low as -150 feet MLLW. The location of theses basins at a major turn in the river could indicate that they were produced from river current scour. Between RM7+35 and RM8+00, only data from probes was available. This data indicates rock elevations lower than -53 feet MLLW toward the south side of the navigation channel.

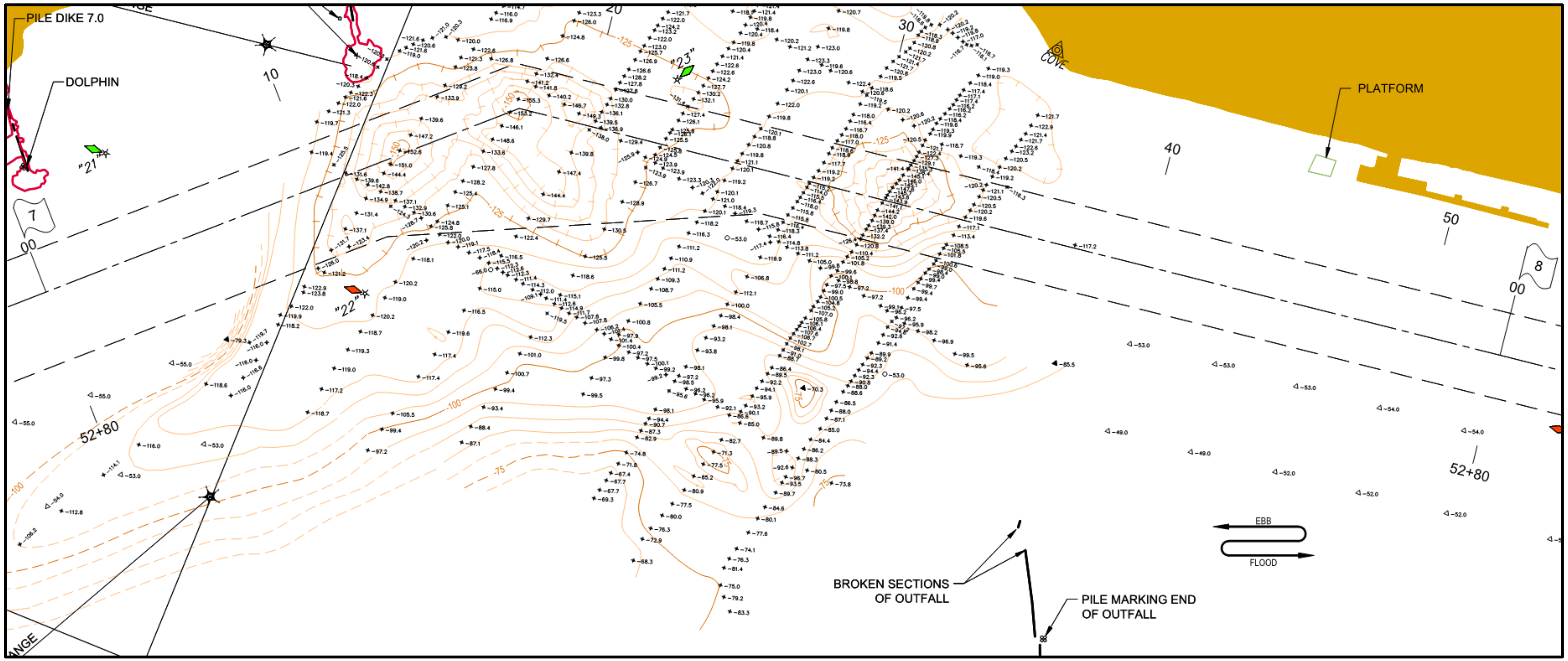


Figure 20: Rock contours and data points between RM 7 and RM 8. Solid triangles are probes that hit refusal (i.e., assumed rock). Open triangles represent probes that did not encounter refusal. All depths are relative to MLLW. (For detailed view, see original plates in 60% design package.)

● -56.2	BORING - ROCK ENCOUNTERED, ELEV = TOP OF ROCK (MLLW)
○ -45.3	BORING - NO ROCK ENCOUNTERED, ELEV = TOTAL BORING DEPTH (MLLW)
▲ -45.3	JET PROBE - ROCK OR REFUSAL ENCOUNTERED, ELEV = FINAL PROBE DEPTH (MLLW)
△ -45.3	JET PROBE - NO ROCK OR REFUSAL ENCOUNTERED, ELEV = FINAL PROBE DEPTH (MLLW)
+ -45.3	INTERPRETED ROCK POINT FROM GEOPHYSICAL DATA, ELEV MLLW
× -45.3	INTERPRETED ROCK ELEVATION FROM MULTIBEAM DATA (LABELED ON 50 FOOT SORT FOR LEDGIBILITY), MLLW

4.0 SUMMARY

The production of the Coos Bay rock elevation model v. 5.0 involved the assimilation and interpretation of a wide variety of data points gathered over an extensive time frame. In general, the rock model can serve as a guide to the current understanding of the distribution and depth of bedrock along the proposed project corridor. Some areas have denser, and therefore more reliable, interpretations than others. It is recommended that additional geophysical surveys, using both CHIRP and single channel seismic systems, be conducted to augment and improve the latest interpretation.

References

Allen, J. and Baldwin, E. 1944. Geology and Coal Resources of the Coos Bay Quadrangle, State of Oregon Department of Geology and Mineral Industries, Bulletin No. 27.

Ehlen, J. 1967. Geology of the state parks near Cape Arago, Coos County, Oregon. The ORE BIN, vol. 29, No. 4, pages 61-82.

Krieger, W. M. 1989. Results of a side scan sonar and sub-bottom profiling study Coos Bay, Oregon. Prepared by Geo Recon International, LTD. for the Portland District, U.S. Army Corps of Engineers.

Mandin, I. P., McInelly, G. W., and Kelsey, H. M. 1995. Geologic map of the Charleston quadrangle, Coos County, Oregon: State of Oregon Geologic Map Series GMS-49, scale 1:24,000.

Sylwester, R. E. 1983. Charleston channel seismic reflection sub-bottom investigation. Prepared by Northern Technical Services for the Portland District, U.S. Army Corps of Engineers.

U.S. Army Corps of Engineers (USACE). 1974. Coos Bay and Harbor, Oregon Geologic Investigations, Appendix A.

U.S. Army Corps of Engineers (USACE). 1995. Lower Coos River, Oregon Coos Bay Channel Deepening 1994 Subsurface Explorations.

ATTACHMENT C: Coos Bay Channel Modification, Utilities Investigation Report

Coos Bay Channel Modification
UTILITIES INVESTIGATION REPORT

JULY 2018

Prepared for:

OREGON INTERNATIONAL PORT OF COOS BAY
Coos Bay, OR
(208) 388-5472

Prepared by:

DAVID EVANS AND ASSOCIATES, INC.
2801 SE Columbia Way, Suite 130
Vancouver, WA 98661
(360) 314-3200

Coos Bay Channel Modification

UTILITIES INVESTIGATION REPORT

JULY 2018

Prepared by:

Michael R. Nichols, PLS (WA)
David Evans and Associates, Inc.
Project Surveyor

Reviewed by:

Gregory P. Baird, PLS, CH
NSPS/THSOA Certified Hydrographer #201
Project Surveyor/Lead Hydrographer

TABLE OF CONTENTS

Page

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

APS	Applied Professional Services, Inc.
ATON	Aids to Navigation
CAD	Computer Aided Drafting
CBNBWB	Coos Bay – North Bend Water Board
CH	Certified Hydrographer
DSL	Department of State Lands
DEA	David Evans and Associates, Inc. (Marine Services Division)
DPW	Department of Public Works
FAA	Federal Aviation Administration
HDPE	High Density Polyethylene
LLC	Limited Liability Company
MALSR	Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights
MLLW	Mean Lower Low Water
NAD83 (2011)	North American Datum of 1983, National Adjustment 2011
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
NSCPO	Naval Seafloor Cable Protection Office
NSPS	National Society of Professional Surveyors
NWN	Northwest Natural (Gas)
ORS	Oregon Revised Statute
PDF	Portable Document Format
PE	Professional Engineer
PLS	Professional Land Surveyor
QL	Quality Level
RTK GNSS	Real Time Kinematic-Global Navigation Satellite System
SPCS	State Plane Coordinate System
SUE	Subsurface Utility Engineering
THSOA	The Hydrographic Society of America
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
3D	Three-dimensional

1.0 BACKGROUND

The purpose of this report is to document and describe findings from research, field investigation, and mapping of upland utilities located that may impact the Coos Bay Channel Modification Project. The utility location processes described in this report allow for locating upland utilities. Utility design and as-built drawings were used to extrapolate from the land located positions across the channel. Other areas were mapped from hydrographic surveys performed by David Evans and Associates, Inc., Marine Services Division (DEA).

To initiate this effort, DEA contracted Applied Professional Services, Inc. (APS) to perform the initial utility research, to coordinate with utility owners and/or operators, and to provide the physical locations of upland underground utilities. The effort was broken into the following three tasks:

Task 1 – Utility Research and Coordination with Owners/Operators:

APS and DEA worked with the Utility Notification Center for Oregon, along with local and federal utility owners and operators, to identify utilities within the upland limits shown on Figure 1. U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration (NOAA) charts include on-shore and off-shore cables and utilities corridors. None are recorded in the area between the jetties and to the limits of the proposed construction, and thus none are shown on the 60% design drawings or included in this report. This effort to identify utilities includes the acquisition of utility and as-built maps, as well as visits with the utility owners/operators at their facilities to ascertain the safest and most effective methods for locating the utility. Utilities identified through this process are subject to observable physical features and utility owner/operator records. When observable features and records provided sufficient information, subsurface investigation practices were employed.

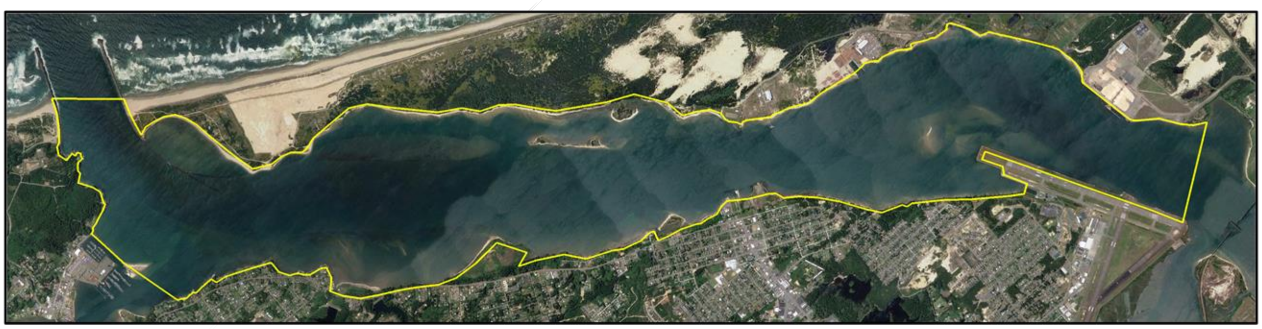


Figure 1: Coos Bay underground utility locate limits

Task 2 – Utility Location

APS, using information obtained in Task 1, visited the physical locations of upland utilities and, with the use of varied technologies, marked on the ground with paint, flags, and/or wooden stakes the approximate locations of buried utilities within the limits shown in Figure 1.

Task 3 – Land Survey

A DEA land surveyor collected horizontal and vertical positions on utility location markings identified as impactful to the Coos Bay Channel Modification Project. Where APS marked utilities with an approximate burial depth, the approximate vertical positions of the buried utilities were derived. The survey data have been assembled into a drawing that maps and relates them to the Coos Bay Channel Modification Project. These mapped upland utility locations provide an approximate alignment in the event a Submerged Utility Location operation is needed.

2.0 DATUMS AND PROJECT CONTROL

Conducting a survey on an established coordinate system, referenced by monuments, enables the survey to be reproduced at a later date with repeatable results. For this survey, hydrographic field operations were conducted using the North American Datum of 1983, National Adjustment 2011, Epoch 2010.00 (NAD83 (2011)) horizontal datum projected to the State Plane Coordinate System (SPCS) Oregon South Zone with units in International Feet. The vertical datum used during data acquisition was Mean Lower Low Water (MLLW) using the NOAA VDatum separation model.

3.0 RESEARCH – UTILITY OWNER/OPERATOR

APS initiated a call to the Utility Notification Center for Oregon to establish a utility locate ticket that encompassed the area outlined in Figure 1. The locate ticket generated notifications to all utility owners that subscribe to the Utility Notification Center, a requirement under Oregon Revised Statute (ORS) 757.557(1). Subscribers responded to the ticket to assist APS in locating their respective utilities. Because this administrative process does not guarantee that all utility owners will mark their utilities, APS contacted each owner directly and requested information on its system. APS used information gathered from these owners and performed a field investigation using various technologies, including electronic pipe and cable locators, metal fish tapes with transmitters, and rod and sonde devices. Northwest Natural Gas (NWN) physically located its system on both sides of the bay. APS verified the field location and applied approximate burial depths using its instruments.

DEA coordinated directly with the U.S. Naval Seafloor Protection Office, the U.S. Coast Guard (USCG), and USACE to identify the existence of their respective buried utilities within the area outlined in Figure 1.

This utility location process is subject to each utility owner's records, physical features that can be observed, and land-based tone tracking over a limited distance from an access point such as a utility vault. Though these methods are generally accepted to provide a reasonable assurance that existing utilities are identified, DEA makes no guarantee that ***all*** utilities are located.

Table 1 identifies utility owners and/or operators that APS and/or DEA contacted during this effort:

Table 1: Owner/Operator Contacts

Initial Contact Date	Contacted By	Owner/ Operator	Points of Contact	Utility
11/22/16	DEA	USCG	Mr. Thomas Booth Thirteenth Coast Guard District (DPW) Projects and Planning Thomas.E.Booth@uscg.mil Phone: 206.220.7276	Solar-powered Aids to Navigation (ATON) – no active power cables known
11/29/16	DEA	U.S. Navy	Naval Sea Floor Cable Protection Office Catherine Creese, Director Naval Facilities Engineering Command 1322 Patterson Ave. SE, Suite 1000 Washington, DC 20374 catherine.creese@navy.mil Phone: 202.433.5325 Mobile: 202.330.7944 United States Department of the Navy Jim Pyles, Realty Specialist 1101 Tautog Circle Silverdale, WA 98315 james.pyles@navy.mil Phone: 360.396.0259	No utilities identified
12/1/16	APS	NW Natural Gas	Elden Cooper elden.cooper@nwnatural.com Phone: 541.267.5655 Mobile: 541.294.7269 John Radosevich District Engineering Supervisor john.radosevich@nwnatural.com Phone: 541.954.1336	Coos Bay Crossing: 12” high pressure High Density Polyethylene (HDPE), directionally drilled, mainline gas pipeline
12/1/16	APS	Coos Bay – North Bend Water Board	Coos Bay – North Bend Water Board Matt Whitty, Engineering Manager matt_whitty@cbnbh2o.com Phone: 541.267.3128, extension 232 Fax: 541.269.5370 HMI Technical Solutions, LLC, a Henkels & McCoy Group Company Tom Readinger, Vice President treadinger@hmiservices.com Phone: 215.283.7600 SHN Consulting Engineers & Geologists, Inc. Steve Donovan, PE sdonovan@shn-engr.com Phone: 541.266.9890	Coos Bay Crossing: 24” HDPE, steel encased, directionally drilled water line

Initial Contact Date	Contacted By	Owner/ Operator	Points of Contact	Utility
12/2/16	APS	City of Coos Bay Public Works Department	Jessica Spann, Engineering Service Coordinator jspann@coosbay.org Phone: 541.269.1181 extension 2221 Mobil: 541.808.8195	Coos Bay Crossing: 10" HDPE directionally drilled sewer pipeline (never used for sewer and is currently housing the ORCA Communications, Inc. fiber optic line) Outfalls: - Empire: 24" Sewer Outfall (pipe material unconfirmed) - North Spit: 24" Sewer Outfall (pipe material unconfirmed)
12/9/16	APS	ORCA Communica-tions, Inc.	Chris Howe Mobile: 541.515.2343	Coos Bay Crossing: - Fiber optic (see City of Coos Bay Public Works, above)
12/9/16	APS	City of North Bend Public Works Department	Derek Windham, EIT, PLS, Engineering Coordinator emap@northbendcity.org Phone: 541.756.8505	Outfall - Airport: (pipe size and material unconfirmed)
12/13/16	APS	Federal Aviation Administration	Jim Bell, FAA SCC JimBell@faa.gov Phone: 541.607.4621 Mobile: 541.736.6264	Medium Intensity Approach Lighting System With Runway Alignment Indicator Lights (MALSR) at Runway 04
2/08/17	DEA	USACE	Daniel R. Proudfit U.S. Army Corps of Engineers CENWP-OD-NH 333 SW 1st Ave. Portland, OR 97204 Daniel.R.Proudfit@usace.army.mil Phone: 503.808.4349	No utilities identified

4.0 SUBSURFACE UTILITY ENGINEERING (SUE)

SUE is a process that combines civil engineering, surveying, and geophysics with the use of varying technologies for locating utilities. The SUE process has become a routine requirement on highway projects in many states, because it identifies degrees of risk associated with the quality of resolved utility locations. SUE Quality Levels (QLs) range from QL-D (the lowest level) to QL-A (the highest level). The highest level of accuracy and comprehensiveness is generally not needed at every point along the path of a utility; rather, the highest level of accuracy is needed only where conflicts with design features are most likely to occur. Hence, lesser levels of information may be appropriate at points where fewer conflicts or no conflicts are expected.

The following are QLs as defined by the U.S. Department of Transportation:

- *Quality Level D. QL-D is the most basic level of information for utility locations. It comes solely from existing utility records or verbal recollections, both typically unreliable sources. It may provide an overall "feel" for the congestion of utilities, but is often highly limited in terms of comprehensiveness and accuracy. QL-D is useful primarily for project planning and route selection activities.*
- *Quality Level C. QL-C is probably the most commonly used level of information. It involves surveying visible utility facilities (e.g., manholes, valve boxes, etc.) and correlating this information with existing utility records (QL-D information). When using this information, it is not unusual to find that many underground utilities have been either omitted or erroneously plotted. Its usefulness, therefore, is primarily on rural projects where utilities are not prevalent, or are not too expensive to repair or relocate.*
- *Quality Level B. QL-B involves the application of appropriate surface geophysical methods to determine the existence and horizontal position of virtually all utilities within the project limits. This activity is called "designating." The information obtained in this manner is surveyed to project control. It addresses problems caused by inaccurate utility records, abandoned or unrecorded facilities, and lost references. The proper selection and application of surface geophysical techniques for achieving QL-B data is critical. Information provided by QL-B can enable the accomplishment of preliminary engineering goals. Decisions regarding location of storm drainage systems, footers, foundations and other design features can be made to successfully avoid conflicts with existing utilities. Slight adjustments in design can produce substantial cost savings by eliminating utility relocations.*
- *Quality Level A. QL-A, also known as "locating," is the highest level of accuracy presently available and involves the full use of the subsurface utility engineering services. It provides information for the precise plan and profile mapping of underground utilities through the nondestructive exposure of underground utilities, and also provides the type, size, condition, material and other characteristics of underground features.*

With respect to the SUE standards, utility owners and operators provided utility records and parole evidence (QL-D) to APS and DEA. This information, together with physically locating the approximate positions of utilities on the ground between the existing structures with the use of sensor and detection systems, results in QL-B information for the upland buried utilities.

At the time of this report, the submerged utilities would be classified as QL-D, because the information is *solely from existing utility records or verbal recollections, both of which are typically unreliable sources*. Before disturbing the bed of Coos Bay, the contractor should verify utility locations when possible conflicts exist.

5.0 UTILITY INSTALLATION RECORDS AND AS-BUILTS

5.1 United States Coast Guard (USCG)

DEA contacted the USCG on November 22, 2016. Thomas Booth responded to the request for information on USCG-owned utilities within the area outlined in Figure 1 as follows:

> *After reviewing the files for the aids to navigation in the area you delineated, I cannot find anything that references any submerged power cables that were not removed.*
>
> *This is not a guarantee that there might not be an abandoned cable down there, or one that was too heavily mudded/sanded in to be removed. I can guarantee that there are currently no active cables on the aids to navigation structures there, and all the lights operate with a solar power system.*
>
> *Mr. Thomas Booth*

5.2 Naval Seafloor Cable Protection Office (NSCPO)

DEA contacted the NSCPO on November 29, 2016. Catherine Creese responded to the request for information on Navy utilities within the area outlined on Figure 1 as follows:

> *Thanks again for making contact with me about this project. We have reviewed your project plans and no Navy owned property would be affected by it.*
>
> *If you have additional questions you can contact Mr. Jim Pyles (copied).*
>
> *Good luck with the project.*
>
> *Best regards,*
> *Catherine*

5.3 NW Natural Gas (NWN)

APS contacted NWN on December 1, 2016. Elden Cooper of NWN identified a 12-inch high pressure High Density Polyethylene (HDPE) mainline pipe crossing Coos Bay. NWN located its own facility on both sides of Coos Bay using an inductive, direct connection method. NWN did not include burial depths. APS, using the same inductive method, provided approximate burial depths at locate marks near the edge of the east and west beaches.

On December 18, 2016, a DEA land surveyor collected horizontal positions along the buried utility locate marks left by APS and NWN using a Real Time Kinematic-Global Navigation Satellite System (RTK-GNSS) rover with a Trimble brand TSC-2 data collector, receiving corrections from the RTK-GNSS base station. The surveyor noted the burial depths marked by APS, and these are shown below converted to MLLW (see Figure 2). In this vicinity, North American Vertical Datum of 1988 (NAVD88) elevations are 0.7 foot lower. DEA compiled AutoCAD Civil3D map products for the design team of the approximate alignment of the crossings, along with location information from APS positioned by the surveyor.

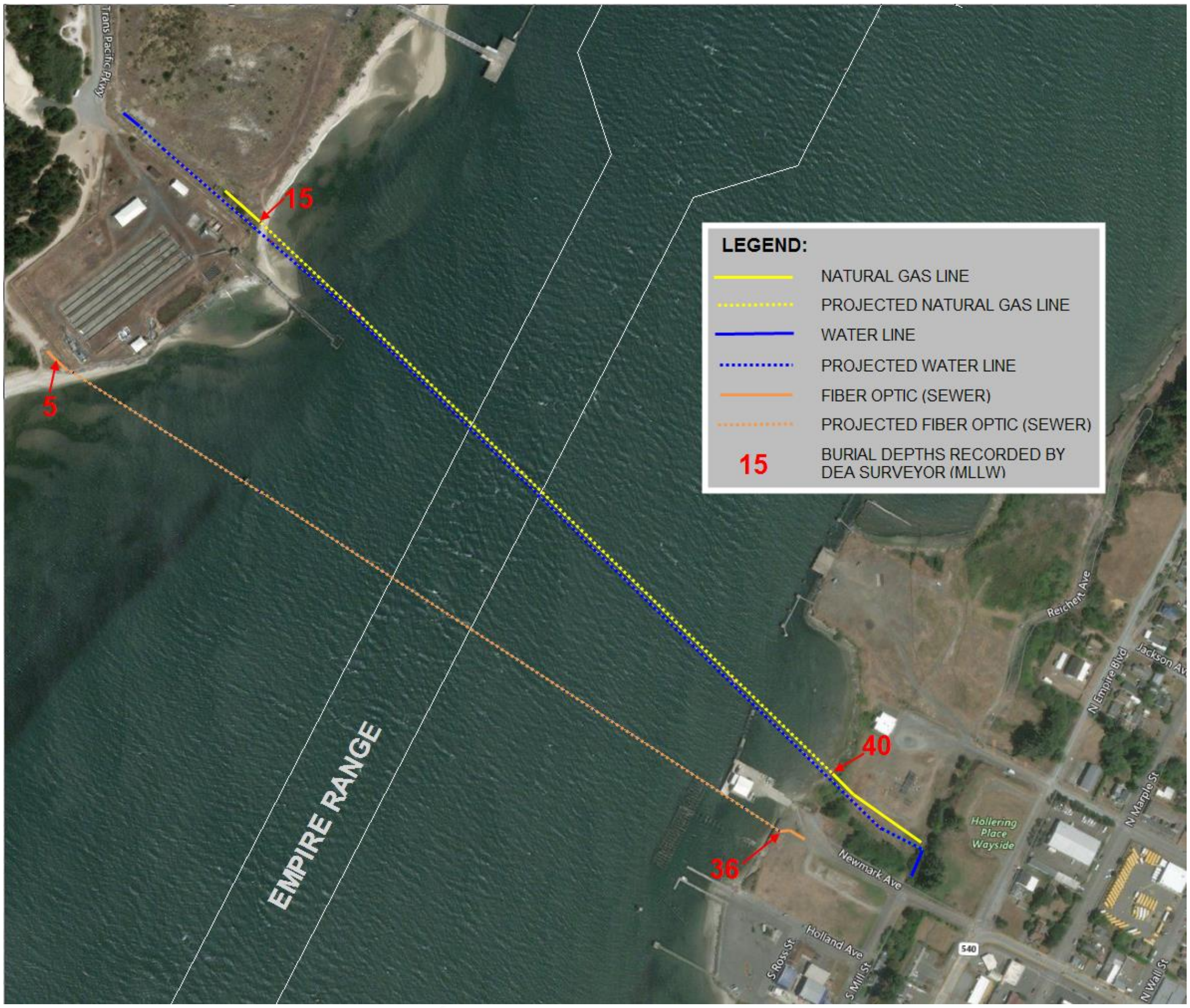


Figure 2: Aerial imagery illustrating utility crossings

DEA contacted NWN on January 24, 2017, to inquire about obtaining additional as-built information. John Radosevich, the NWN District Engineering Supervisor, explained that the 12-inch HDPE, steel-encased, high pressure gas line was directionally drilled by the same contractor that drilled the Coos Bay – North Bend Water Board (CBNBWB) water line, as well as the City of Coos Bay Public Works Department sewer line. Mr. Radosevich provided Portable Document Format (PDF) copies of NWN's as-built plan and profile maps (see Appendix B) and of the USACE permit "to install utility lines under Coos Bay from Empire to the North Spit." This permit is a joint permit for both CBNBWB and NWN, though each has an individual easement for its respective utility.

According to NWN, the gas line does not include a tracer system for locating the utility. NWN energizes the steel pipe casing to accomplish location efforts. For a submerged gas-line location effort, NWN insists on being on-site to provide direction on energizing this facility. NWN also expressed that, in its experience, burial depths observed on its facilities beyond 10 feet from the receiver have been unreliable.

A section of the as-built map profile view, shown on Figure 3, depicts an approximate burial depth of **-62 feet MLLW (-63 feet NAVD88)**. Figure 4 is a section from a cross-section map NWN also provided as part of the as-built drawing that identifies four geotechnical borings from which it appears that the approximate depth of the siltstone layer was determined. The ground profile was based on bathymetric data provided to NWN by USACE and topographic data from the 7.5' series U.S. Geological Survey (USGS) Empire Quadrangle. Figure 5 depicts the plan view of the pipe and bore locations.

The plan and profile map is based on the plan and profile "as-built" map that Henkels and McCoy, Inc., provided to the CBNBWB, with the exception that the profile depicts the gas line. Shown on the plan portion of both the CBNBWB and the NWN maps are two lines parallel within the 40-foot easement. This evidence is in agreement with the joint permit for NWN and CBNBWB and their respective easements. The as-built drawings are included in Appendix A. The USACE Portland District Operations Division Regulatory Branch permit number 200300706 for the NWN crossing is included in Appendix D.

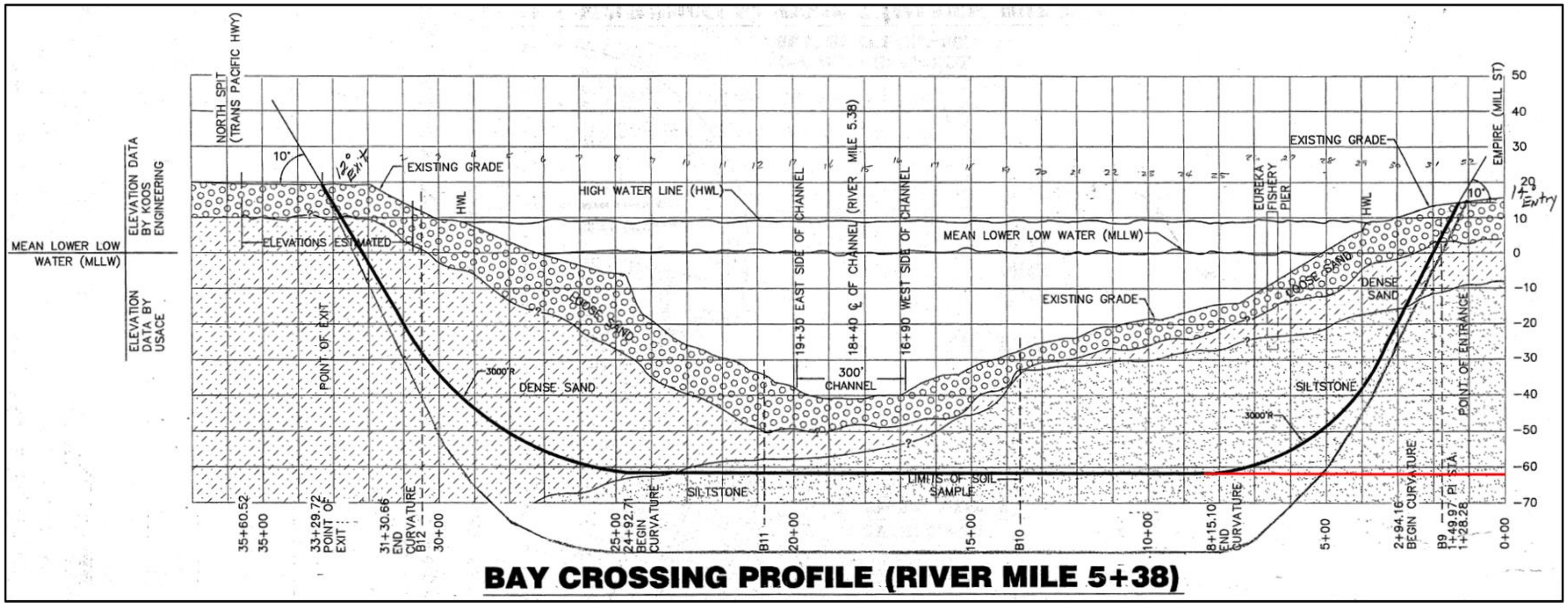


Figure 3: Gas-line profile from final design plans

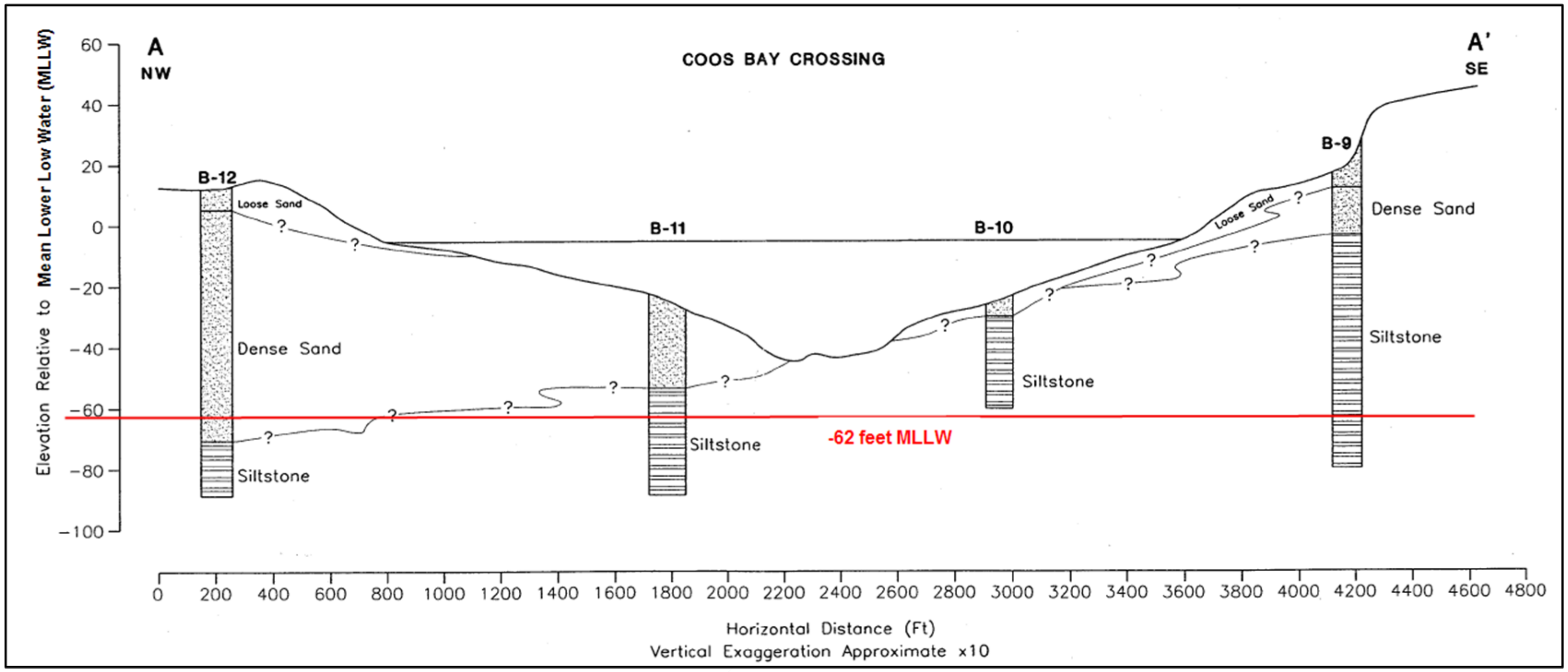


Figure 4: Cross-section of Coos Bay – vertical bore positions

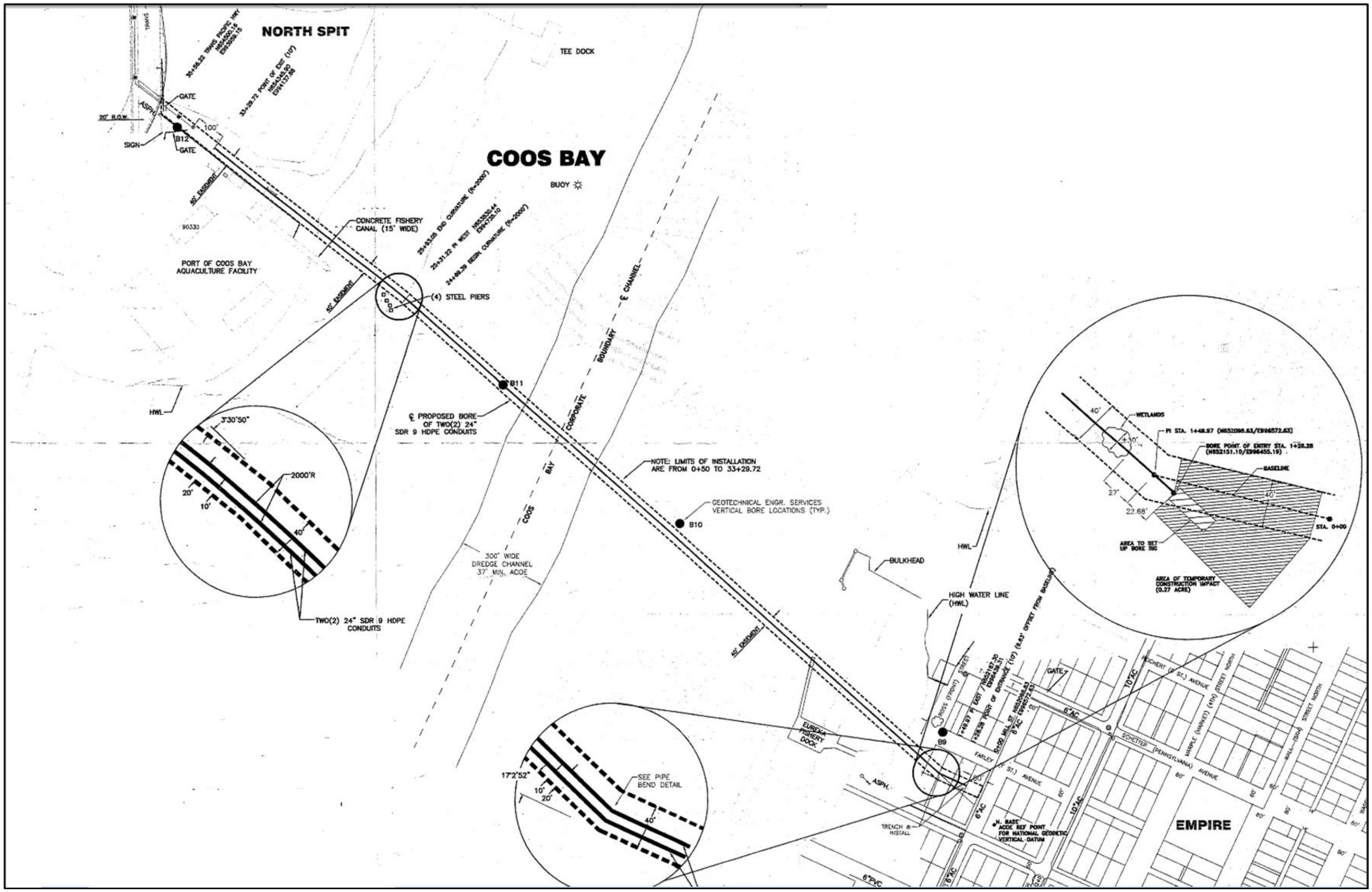


Figure 5: Plan view of Coos Bay - gas-line and vertical borings

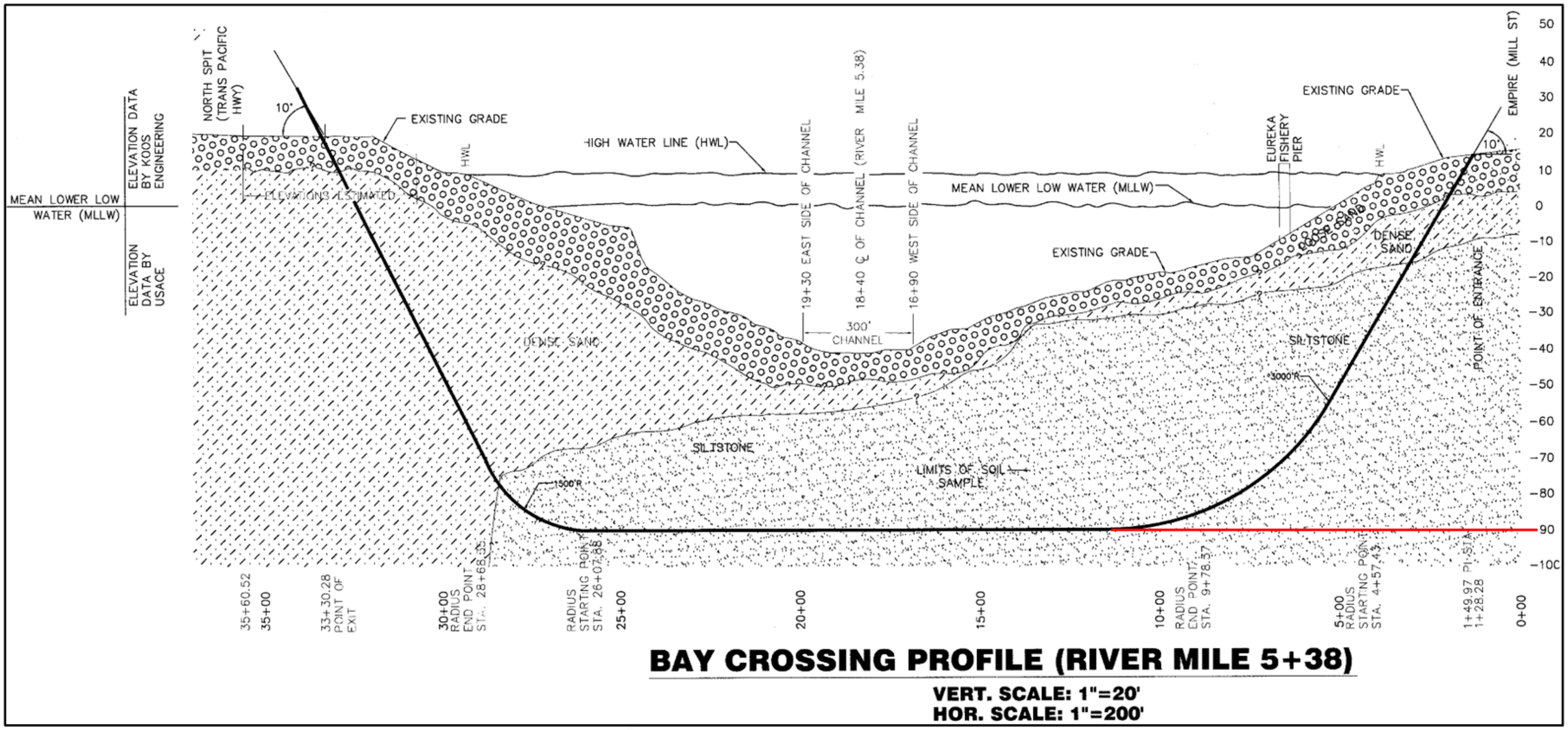


Figure 6: Water-line profile from as-built plans

5.4 Coos Bay – North Bend Water Board (CBNBWB)

APS contacted CBNBWB on December 1, 2016. Matt Whitty, Engineering Manager at CBNBWB, identified a 24-inch HDPE directionally drilled water line crossing Coos Bay. The water line was installed without an inductive tracer system, and APS was unable to locate it in the field. CBNBWB provided APS with its as-built plan sheet produced by Henkels & McCoy, Inc., (see Appendix B). A clip of the profile view, shown on Figure 6, depicts an approximate burial depth of **-90 feet MLLW (-91 feet NAVD88)**.

On December 18, 2016, a DEA land surveyor collected horizontal positions of a water vault containing a 24-inch steel pipe (Figure 7 – left) on the east side of Coos Bay and a water-line manhole and bore exit pipe (Figure 7 – right) on the west side of Coos Bay. The approximate horizontal location of this water-line crossing, based from the field ties and as-built information, is shown above on Figure 5.

Figure 7: Water-line vault (left); water-line bore exit (right)

DEA contacted Matt Whitty on December 20, 2016, to inquire about obtaining additional as-built information for this facility. Mr. Whitty provided the PDF copy of the Oregon Department of State Lands (DSL) easement described in Section 5.5.3. Further evidence of the easement being a joint one with NWN is the as-built plan (a clip of which shown in Figure 8), which shows the same easement as NWN and highlights two HDPE “conduits” within the 40-foot easement. The located positions of the water line and gas line on the upland portions imply that the gas line was intended to be along the centerline of the easement, while the water line is drawn 10 feet southerly of and parallel with the easement centerline.

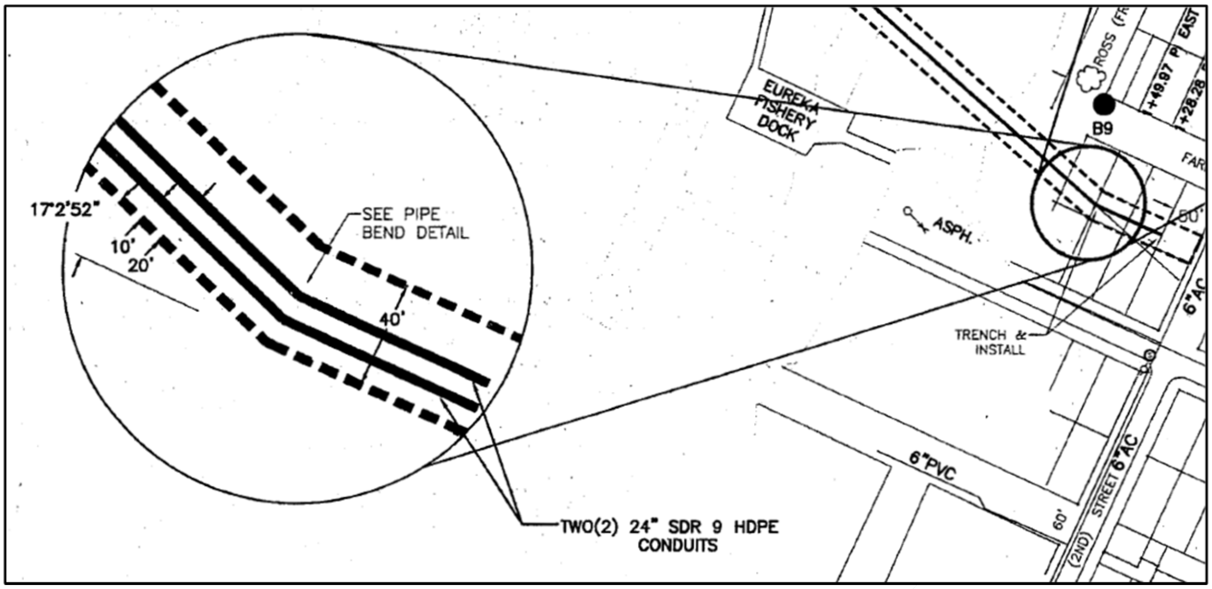


Figure 8: Water line and gas line from as-built plans

DEA contacted Henkels & McCoy, Inc. on January 3, 2017, to obtain Computer Aided Drafting (CAD) drawings of the as-builts. Tom Readinger, Vice President of Henkels & McCoy, Inc., provided an AutoCAD drawing of the as-built plan.

5.5 City of Coos Bay Public Works Department (Empire Outfall and North Spit Outfall)

APS contacted the City of Coos Bay Public Works Department on December 2, 2016. They confirmed that there was no active sewer line crossing Coos Bay, but that the Public Works Department owns a 10-inch HDPE sewer line that was installed by directional drilling across Coos Bay and is leased to ORCA Communications, Inc. The Public Works Department also owns a 24-inch sewer outfall designated as the Empire Outfall and a 24-inch sewer outfall designated as the North Spit Outfall. The City of Coos Bay Public Works Department reported that there were no other systems, active or abandoned, within the limits shown on Figure 1.

5.5.1 Empire Outfall

On December 18, 2016, a DEA land surveyor collected horizontal positions along the 24-inch sewer outfall locate marks established by APS. The submerged portion of this outfall was mapped during a DEA bathymetric survey that took place from December 11 to December 16, 2016. The horizontal position of the outfall in Figure 8 shows the end location of outfall pipe, with protective piling marking the offshore extent. The bathymetric data shown in Figures 9 and 10 illustrate further details of the pipe. DEA compiled AutoCAD Civil3D map products of the outfall alignment and pile locations for the design team.

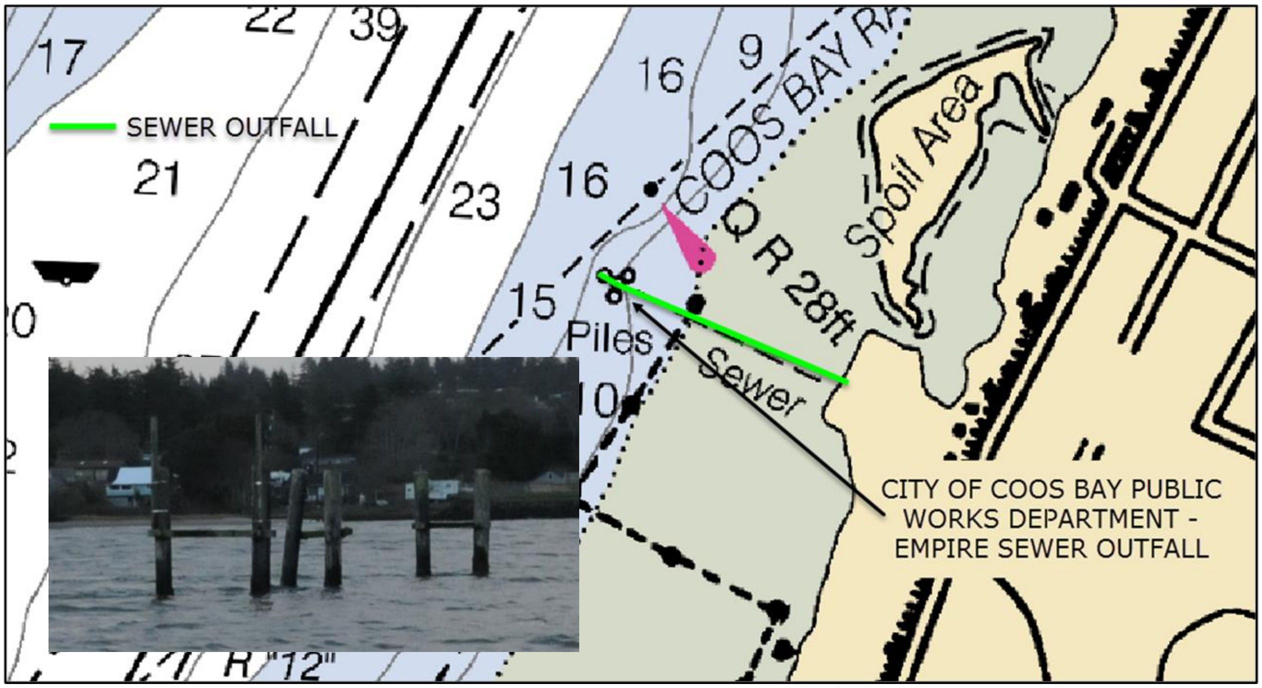


Figure 9: NOAA Chart 18587 with City of Coos Bay sewer outfall – Empire

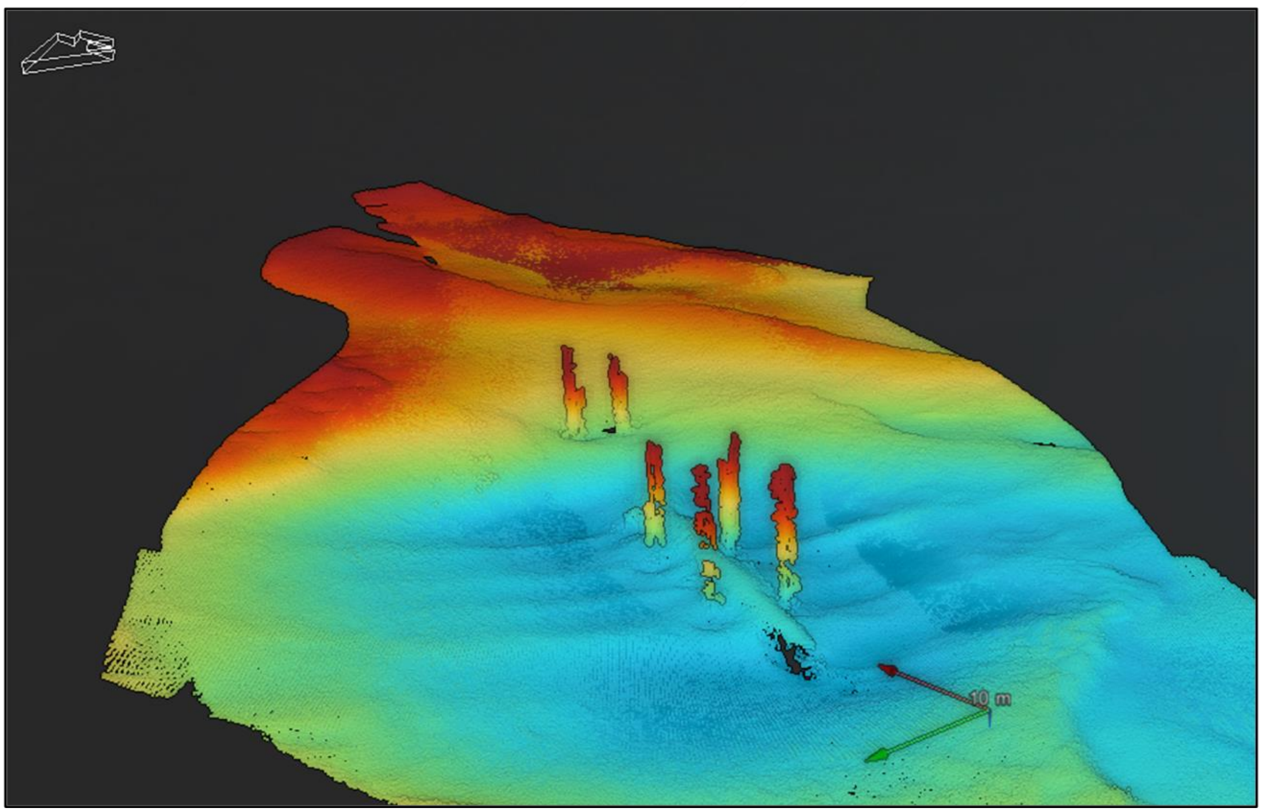


Figure 10: Three-dimensional (3D) hillshade detail of the City of Coos Bay sewer outfall – Empire (from northwest)

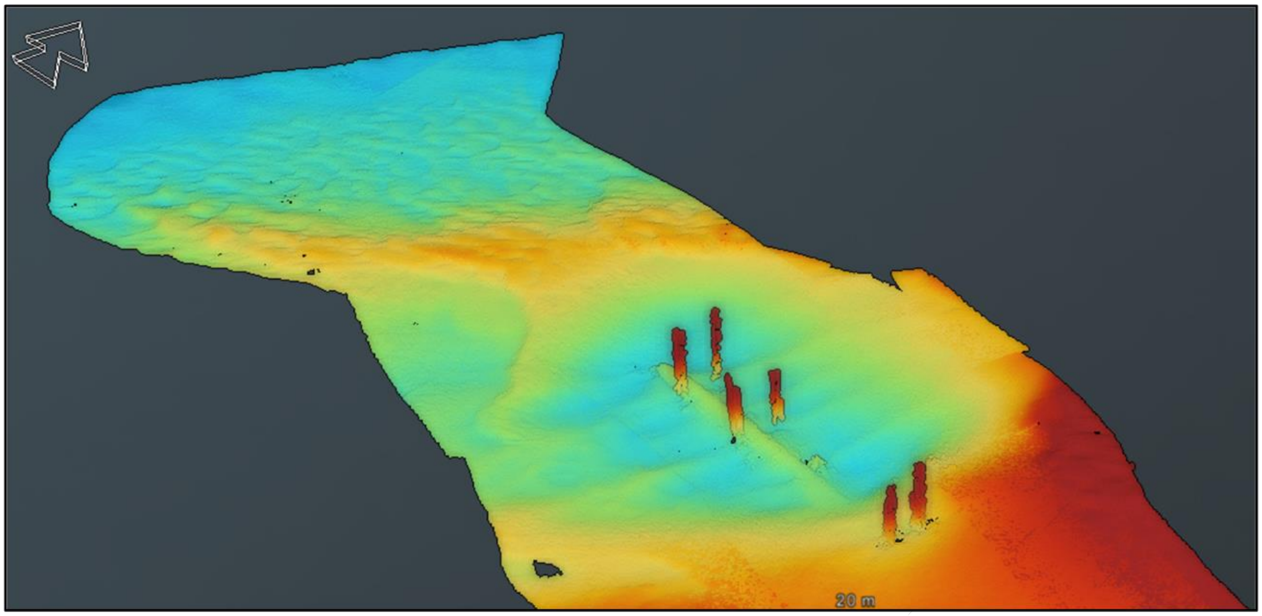


Figure 11: 3D hillshade detail of the City of Coos Bay sewer outfall – Empire (from southeast)

5.5.2 North Spit Outfall

On December 18, 2016, a DEA land surveyor collected horizontal positions along one of the 24-inch sewer outfall pipes located by APS. APS could not locate the second pipe. The submerged portion of this outfall system was mapped during a DEA bathymetric survey in December 2016. The horizontal position of the outfall in Figure 12 shows the end locations of the two outfall pipes among piling. The bathymetric data shown in Figures 13 and 14 illustrate further details of those segments lying on the bed surface and disconnected from the outfall block. No evidence of the outfall to the northeast (circled in red on Figure 12) was found in the bathymetric coverage. DEA compiled AutoCAD Civil3D map products of the outfall alignment and pile locations for the design team.

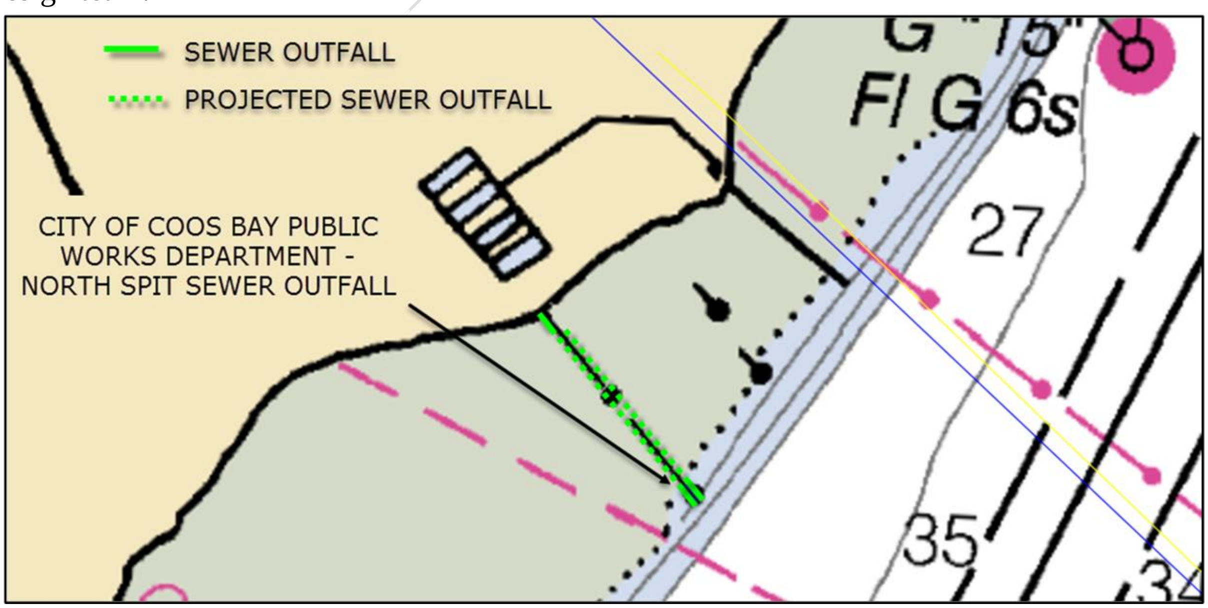


Figure 12: NOAA Chart 18587 with City of Coos Bay sewer outfall - North Spit

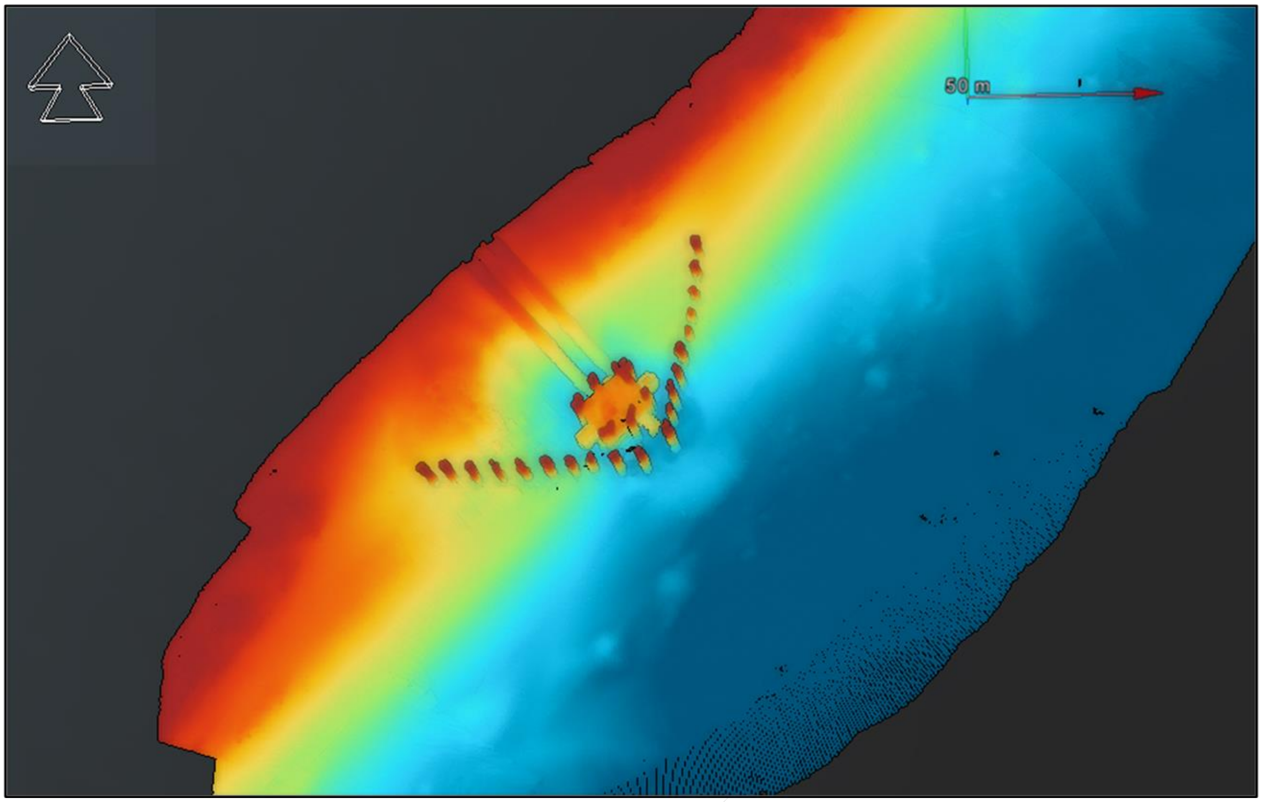


Figure 13: 3D hillshade of City of Coos Bay sewer outfall – North Spit (from south)

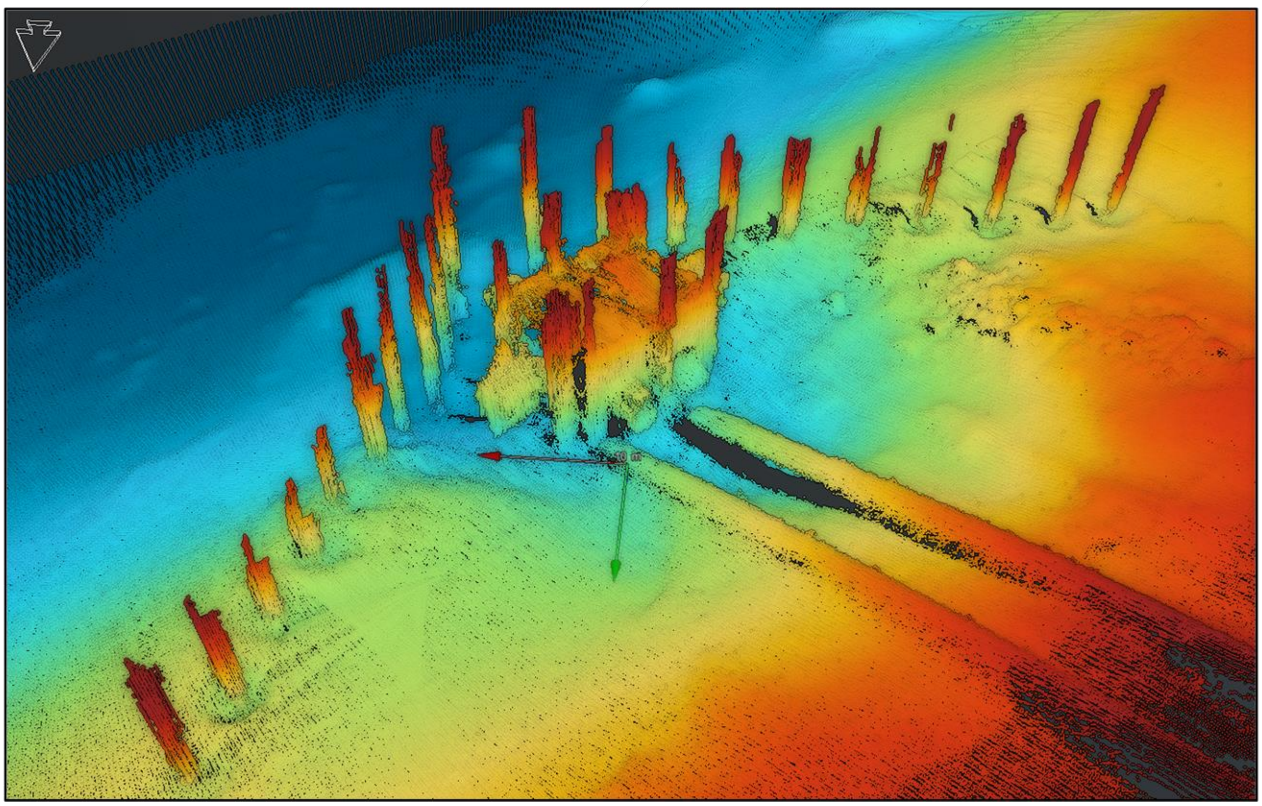


Figure 14: 3D hillshade detail of City of Coos Bay sewer outfall – North Spit (from north)

5.5.3 Coos Bay Crossing

DEA contacted the City of Coos Bay Public Works Department on December 22, 2016, to inquire about obtaining additional information on the 10-inch HDPE sewer line containing ORCA Communications, Inc. fiber optic inner-ducts. Specifically requested were as-built CAD drawings of the 10-inch HDPE sewer-line, the Oregon DSL easement, and the USACE permit. Jessica Spann, City of Coos Bay Sewer Department Engineering Service Coordinator, provided a PDF copy of the “Bay Crossing HDD Sewer Line Project” contract plans (see Appendix C), AutoCAD drawings of the contract plans, and the Oregon DSL easement. As of the date of this report, the City of Coos Bay is still searching its records for the USACE permit. Clips from the contract plan profile shown in Figure 15 depict the burial depth at approximately **-71.67 feet NAVD88 (-71.02 feet MLLW)**.

Additional utility locate information on this facility is included below in Section 5.6.

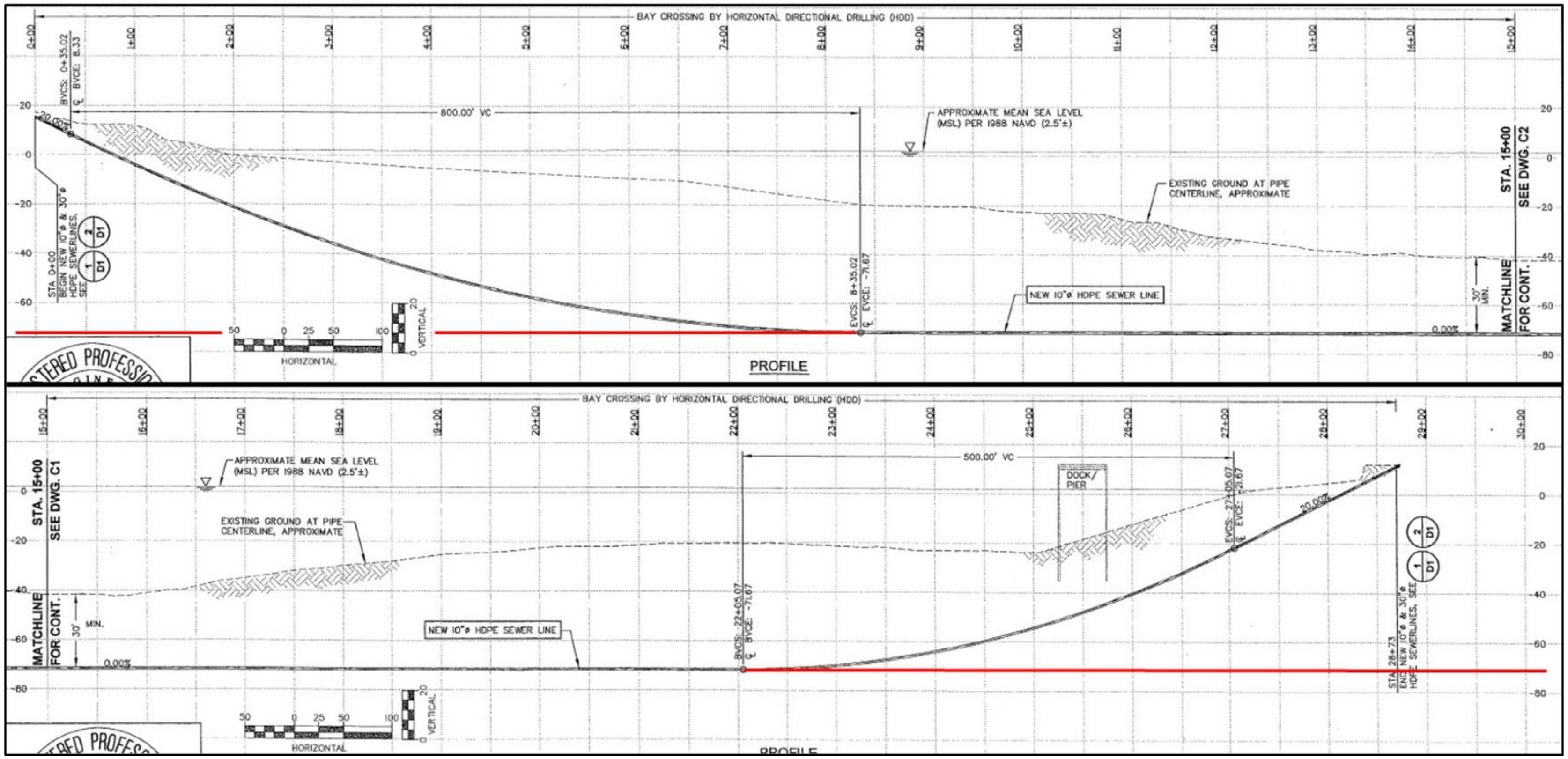


Figure 15: Sewer-line crossing profiles from contract plans

5.6 ORCA Communications, Inc. (Tribal One Broadband Technologies, LLC)

APS contacted ORCA Communications, Inc. on December 9, 2016. Chris Howe of ORCA Communications met APS on-site and reported that ORCA Communications has fiber optic inner-ducts crossing Coos Bay inside the 10-inch HDPE sewer line constructed by the City of Coos Bay Public Works Department. Chris showed APS the locations of the 10-inch HDPE sewer-line hand holes on the west and east sides of Coos Bay, and confirmed that the fiber optic inner-ducts do not include an inductive tracer system.

On the west side of Coos Bay, APS inserted a metal fishtape into the hand hole and fed it through the HDPE pipe as far as possible. The fishtape was then energized, and the utility was traced on the surface using an 810 Metrotech sensor. Approximate burial depths were observed and marked on the ground for the land surveying operation.

On the east side of Coos Bay, APS inserted a flexible fiberglass line with a transmitter attached into the hand hole and fed it through as far as possible. The transmitter was located by APS at bends in the line using a Radio Detection brand RD4000 pipe and cable locator unit. Approximate burial depths were observed and marked on the ground for the land surveying operation.

On December 18, 2016, a DEA land surveyor collected horizontal positions along the buried utility locate marks left by APS. The surveyor noted the burial depths marked by APS, which are shown converted to MLLW in Figure 6. DEA compiled AutoCAD Civil3D map products for the design team of the approximate alignment of the 10-inch HDPE crossing, along with location information from APS positioned by the surveyor.

5.7 City of North Bend Public Works Department (Airport Outfall)

APS contacted the City of North Bend Public Works Department on December 9, 2016. Derek Windham of the engineering department provided PDF copies of mapping of the plant’s utility inventory, including the waste water treatment plant outfall entering the bay from under the Southwest Oregon Regional Airport – North Bend.

This outfall was mapped during the DEA bathymetric survey in December 2016. The horizontal position of the outfall shown in Figure 16 illustrates three segments of disconnected sewer outfall pipe. The bathymetric data shown in Figures 17 and 18 illustrate further detail of those disconnected segments lying on the bed surface. It should be noted that the horizontal position of the charted light was found to have been removed at the original extent of the outfall, and a new pile and light positioned approximately 450 feet farther southeast along the sewer line, near the first disconnect in the line. DEA compiled AutoCAD Civil3D map products of the outfall alignment and pile location for the design team.

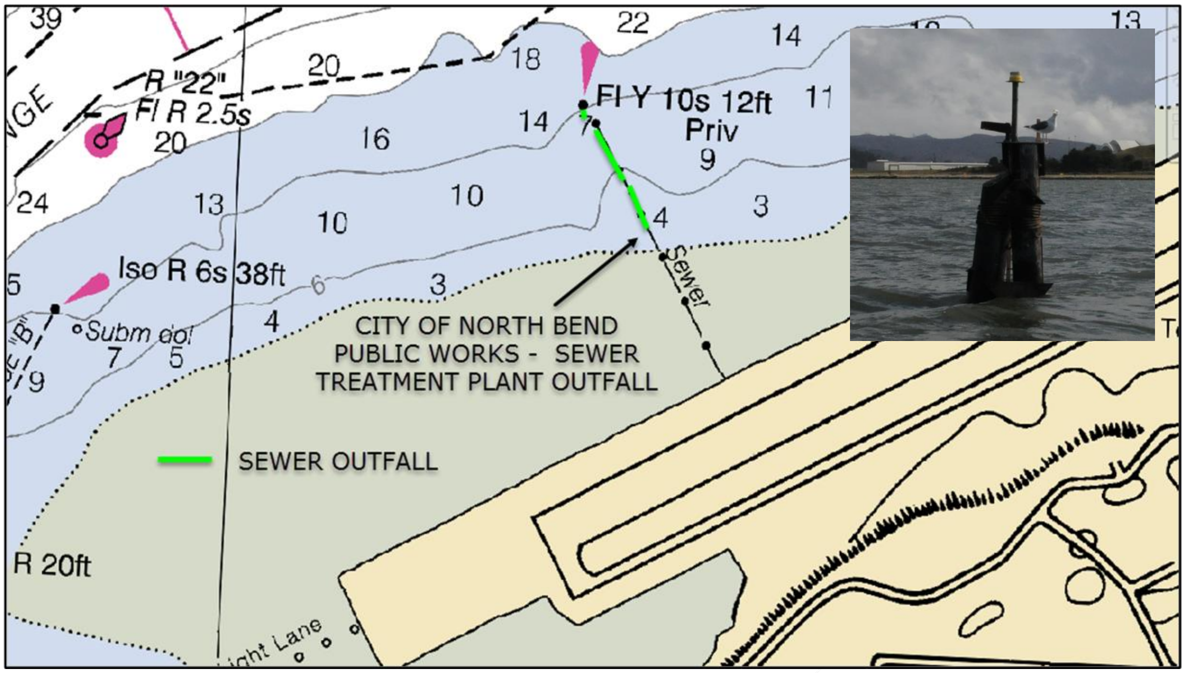


Figure 16: NOAA Chart 18587 with 3 segments of the City of North Bend sewer outfall – Airport

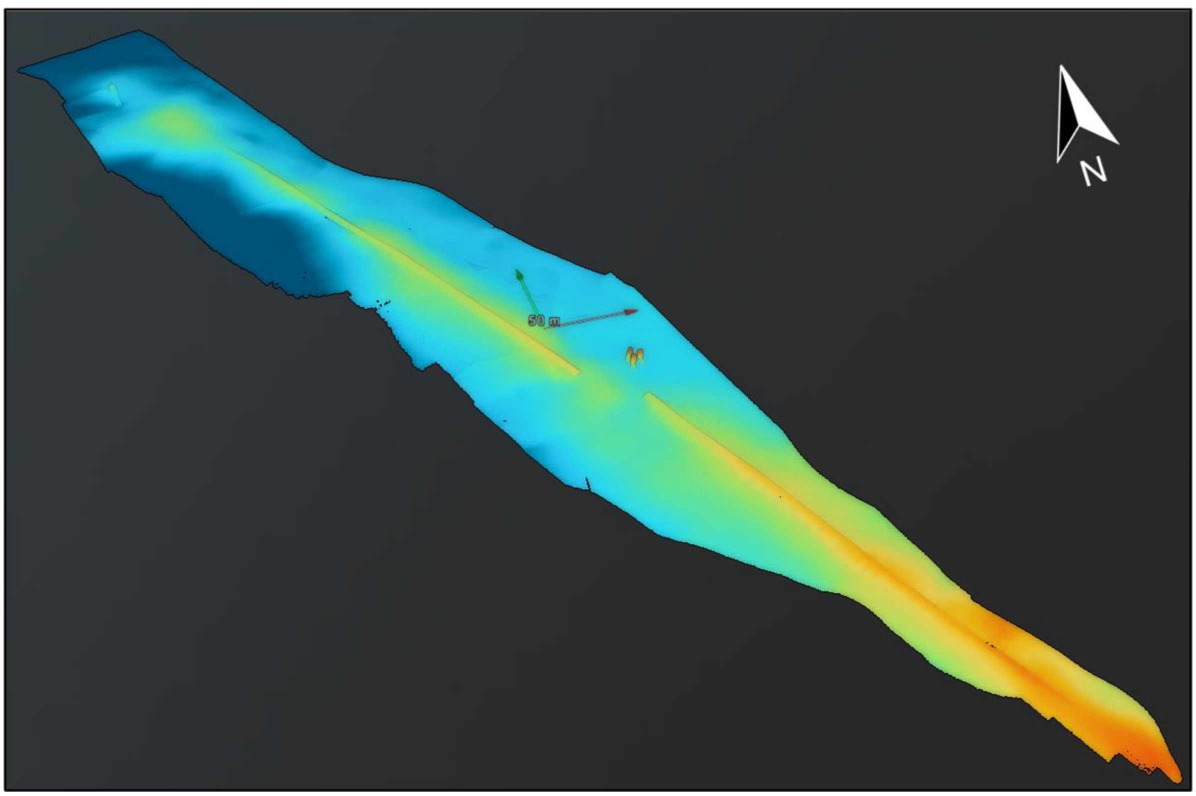


Figure 17: 3D hillshade of City of North Bend sewer outfall – Airport (from south)

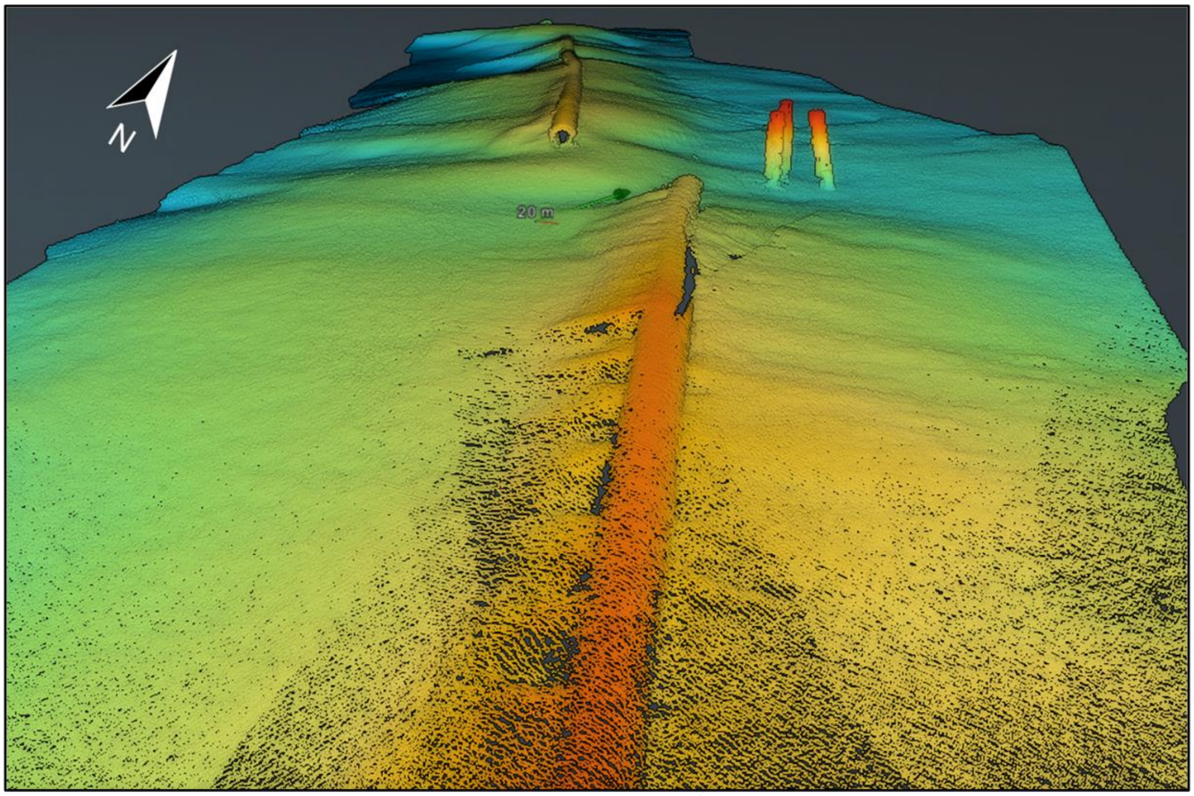


Figure 18: 3D hillshade detail of City of North Bend sewer outfall – Airport (from southeast)

5.8 Federal Aviation Administration (FAA)

APS contacted the FAA on December 13, 2016. Jim Bell of the FAA told APS that there were no utilities crossing Coos Bay. Mr. Bell sent a PDF copy of the Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) – Runway 04 Plan and Profile, together with a PDF copy of the North Bend Municipal Airport Facility Layout Plan. The MALSR Runway 04 Plan and Profile show that the MALSR system is connected by a walkway that includes the infrastructure used to operate the system. There is a "Middle Marker" southwesterly of this system that is reported as decommissioned.

5.9 United States Army Corps of Engineers (USACE)

DEA reviewed current USACE and NOAA charts for utilities impacting the Coos Bay Channel Modification Project, and none were found. On February 8, 2017, DEA contacted the USACE. Dan Proudfit of the USACE Portland District verified that no utilities exist within the project according to USACE's records.

6.0 COMPILATION OF UTILITIES INTO DRAWING FILES

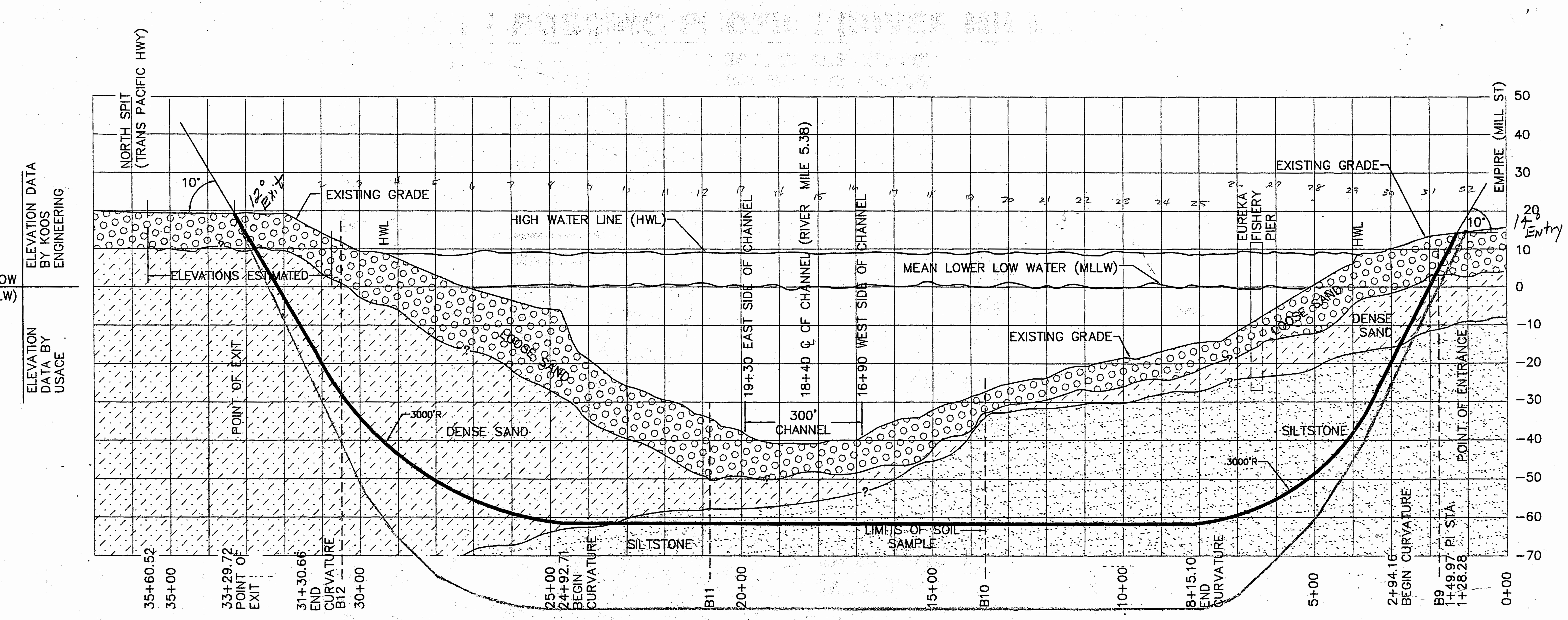
DEA compiled AutoCAD Civil3D map products of the utilities for the design team. The products include: alignment and locations provided by APS as surveyed; best-fit projected alignments across the channel as a three-dimensional (3D) polyline, which includes elevations as shown on the as-built or design drawings for best estimate of elevation of the crossings relative to proposed channel modifications; and alignment of outfall pipelines and piling detected and mapped with a multibeam sonar during survey efforts.

7.0 DELIVERABLES

Deliverables for the Coos Bay Utilities Investigation include the following:

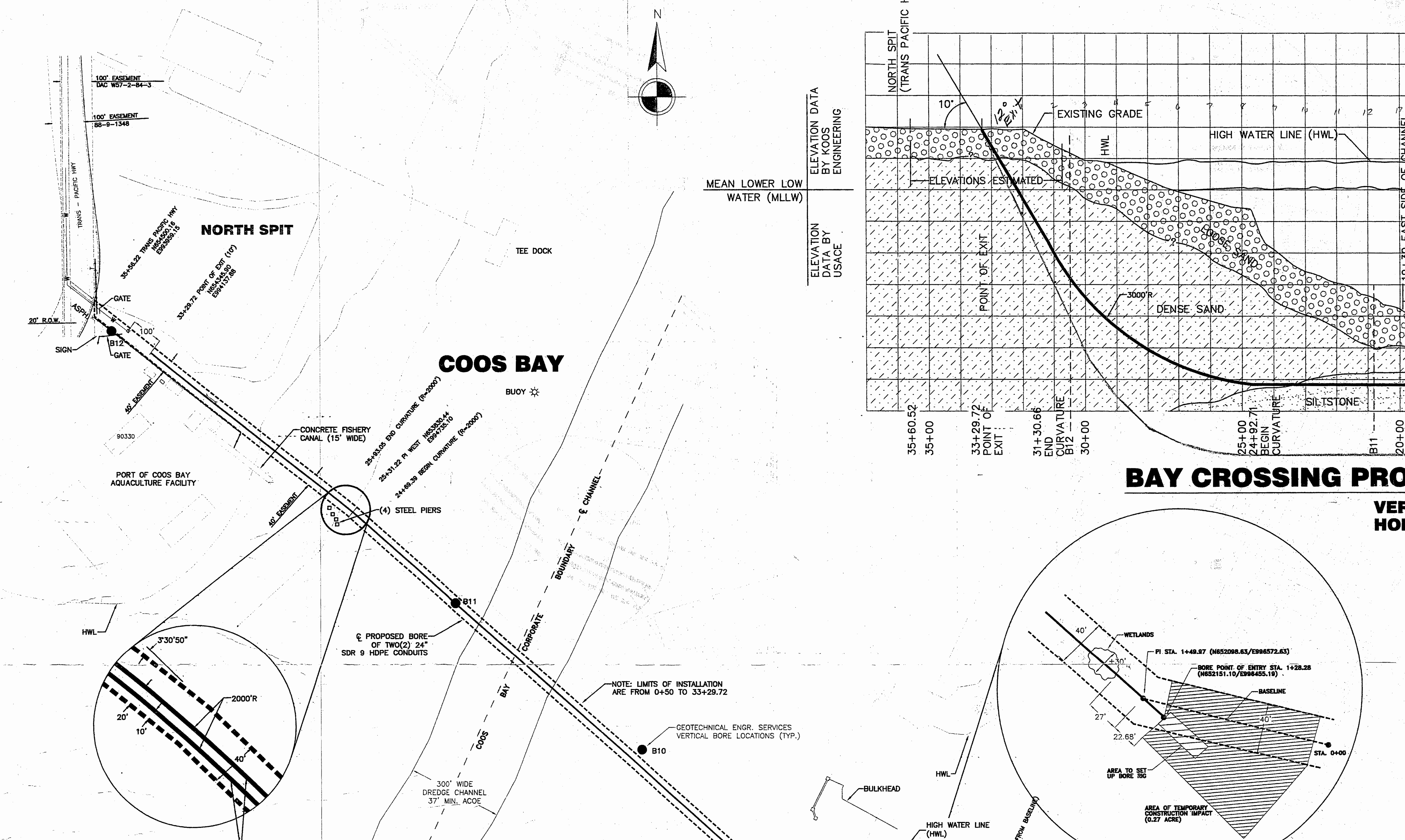
1. XYZ comma-delimited ASCII data in XYZ format gridded at 1-foot for each outfall using the following naming convention:
   Outfall_N_1ft_ENZup_V1.txt
   Where N is the outfall name and Z values are MLLW elevations.
2. XYZ comma-delimited ASCII data in XYZ format for outfall least depths (highest point on submerged features) using the following naming convention:
   Coos Bay Out Fall-N high point spots_ENZc.txt
   Where N is the outfall name and Z values are MLLW elevations.
3. Color hillshade georeferenced images of 1-foot gridded surface delivered as TIFF images with associated TFW (Tif File World) files using the following naming convention:
   Outfall_N_1ft_Hillshade_V1.*
   Where N is the outfall name and * is the file extension of .tif, and .tfw.
4. AutoCAD drawings including contours, high point elevations, and baring and submerged feature locations in files using the following naming convention:
   Outfall_N_V10.dwg
   Where N is the outfall name.
5. Utility Investigation Report documenting findings from the investigation and generated mapping products, stamped by an Oregon Professional Land Surveyor (PLS) and National Society of Professional Surveyors/The Hydrographic Society of America (NSPS/THSOA) Certified Hydrographer.

APPENDIX A
NW Natural Gas Crossing
Final Design Plan and Profile



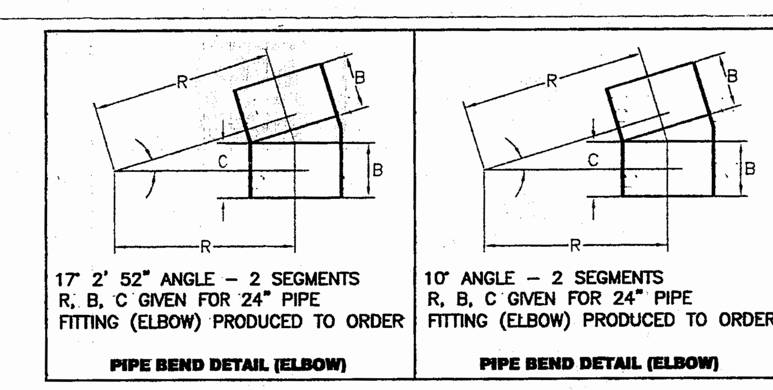
BAY CROSSING PROFILE (RIVER MILE 5+38)

VERT. SCALE: 1"=20'
HOR. SCALE: 1"=200'



PLAN VIEW

SCALE: 1"=200'



CONSTRUCTION NOTES:

1. HDPE pipe rated SDR-9, OD 24" has been specified for the project. This pipe will meet or exceed requirements for strength, resistance to collapse.
2. The fusion of individual pipes will occur at the placement site. The creation of longer segment lengths will be done in advance of the pull so that the time required for heating/cooling the joints during the pullback operation is minimized.
3. Pipes should be inspected in advance of use to insure that there is no ovality (non-circularity), necking (reduced cross-section), or gouging in them. Scratches or gouges greater than 10% of the wall thickness are cause for rejection since they increase the stress concentration and may introduce failure points.
4. Similarly, the pipe extending from the ground after the pullback should be checked for evidence of physical deformity.
5. The pipe should be filled with potable water during the pullback to reduce the effect of floating in the borehole and increasing the frictional forces.
6. The pipe must extend about 3% - 4% beyond its final length after pullback, and be given time (typically equal to the duration of the pull) to recover from the axial strain. (Ref: PPI Handbook Chapter 11 - Polyethylene Pipe for Horizontal Directional Drilling).
7. The pipe should be anchored to the bore rig after pullback so that all contraction occurs from the feed end.
8. The entry/exit angles of 10° must be addressed. Fused pipe sections should be not exceed the manufacturer's minimum recommended bend radius (50 *D) during entry/exit. Otherwise kinking may result.
9. All splicing of elbows to the pipe will be done in the field.
10. Once equilibrium is attained and no movement occurs, the ends can be fused to 10° elbows to bring the pipes to a level position and allow for transition in a vertical direction.
11. Splicing of the 17°2'52" elbow at the entry point will allow for transition in horizontal direction.
12. The elbows will be fabricated by FNW Industrial Plastics of Washougal, WA or a similar vendor.
13. The specifications for fusion joining of the pipes describe six general steps. Details of the steps are available from manufacturer literature, and from ASTM D2657-03 Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings, and Section 192 series, Code of Federal Regulations (CFR). The six steps involved in making a butt fusion joint are:
    a. Securely fasten the components to be joined
    b. Face the pipe ends
    c. Align the pipe profile
    d. Melt the pipe interfaces
    e. Join the two profiles together
    f. Hold under pressure until cooling has occurred

Note - Fusion joining of HDPE is a function of Temperature, Time, and Pressure. In turn, Time and Pressure are themselves a function of wall thickness, diameter, recommended interfacial pressure (IFP), and typical effective piston area (TEPA) of the equipment used. See ASTM D2657-03 Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings, and refer to manufacturer specifications for details.

1. The weld beads caused by the fusion will remain in place. The Plastics Pipe Institute (PPI) has determined that these are not consequential to the flow of fluids in the pipes.
2. The minimum trench width at pipe grade should be equal to the pipe outer diameter (O.D.) plus 12 inches.
3. The amount of earth cover over the bore path as it traverses the channel is at least 20', which should be sufficient to insure that the potential for hydro fracture is minimal.
4. Since all core bore holes along the route were plugged with bentonite at the completion, there should be no chance of encountering a man made fault from that operation.

FINAL DESIGN

H&M HENKELS & McCOY, INC.
ENGINEERS AND CONTRACTORS

REGISTERED PROFESSIONAL ENGINEER 74777PE OREGON MAY 11, 2004 THOMAS E. GALLAGHER

REV	DATE	DESCRIPTION	REQ	DONE
2				
1	7/15/04	TYPO	SAF	

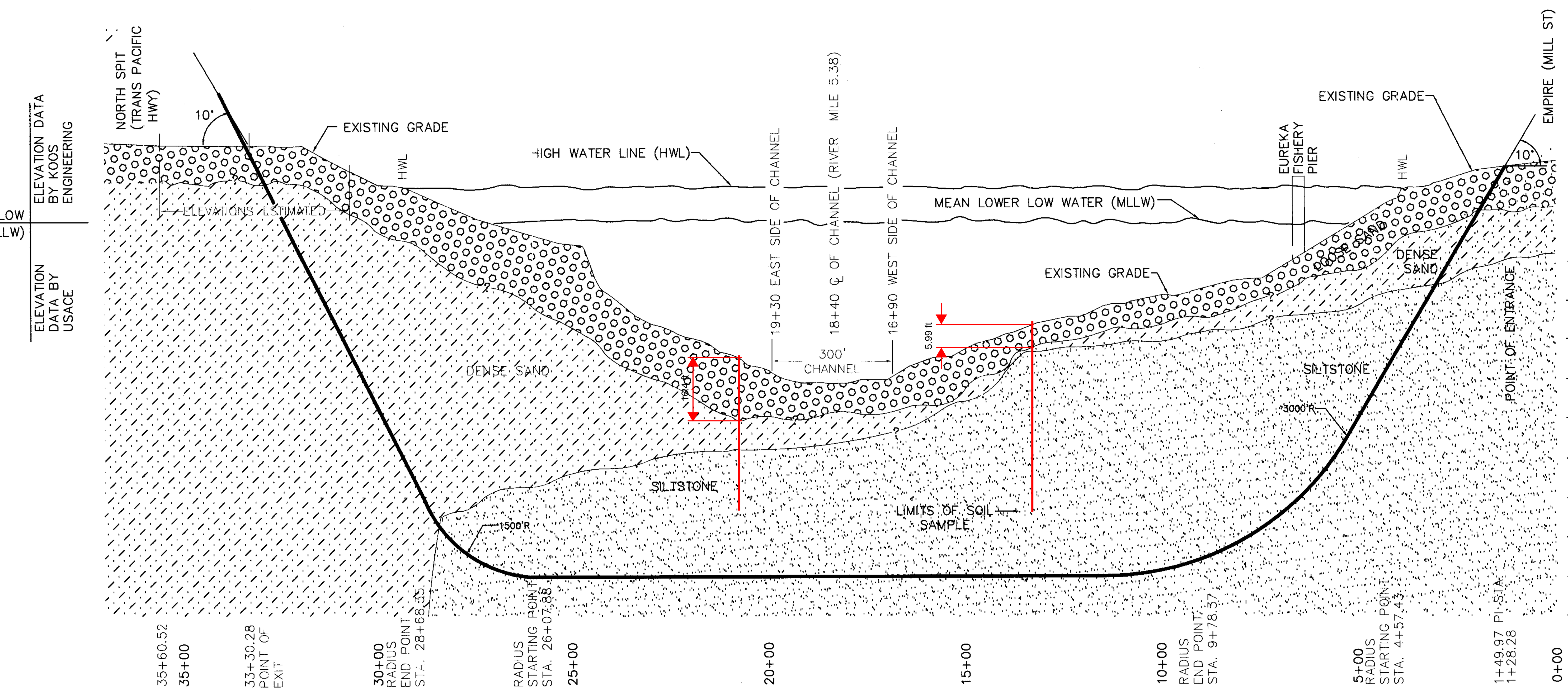
COOS BAY - NORTH BEND WATER BOARD

EAST BAY CROSSING

SCALE: AS SHOWN
DRAWN:
DATE: 7/15/04

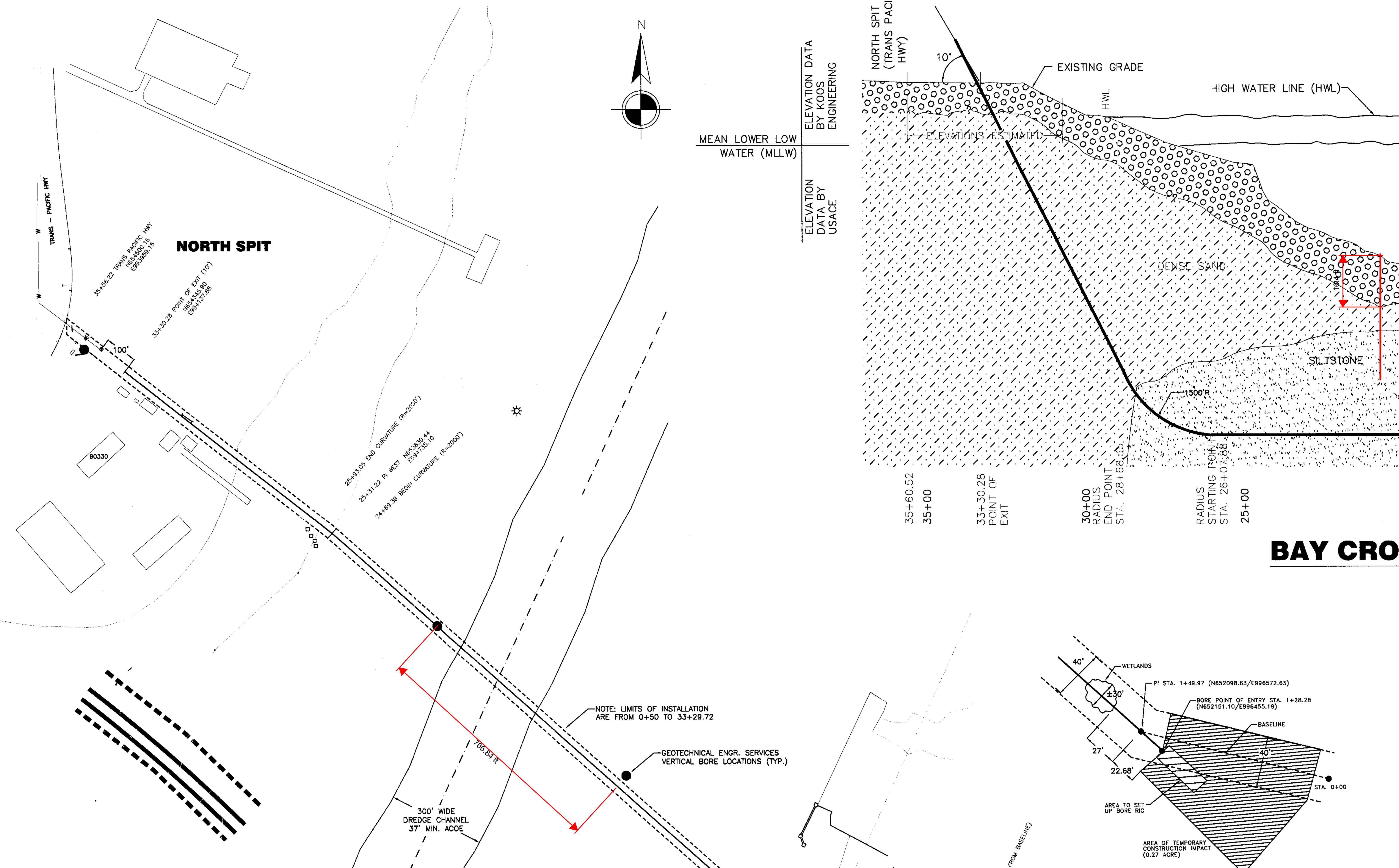
SHEET NO. 1

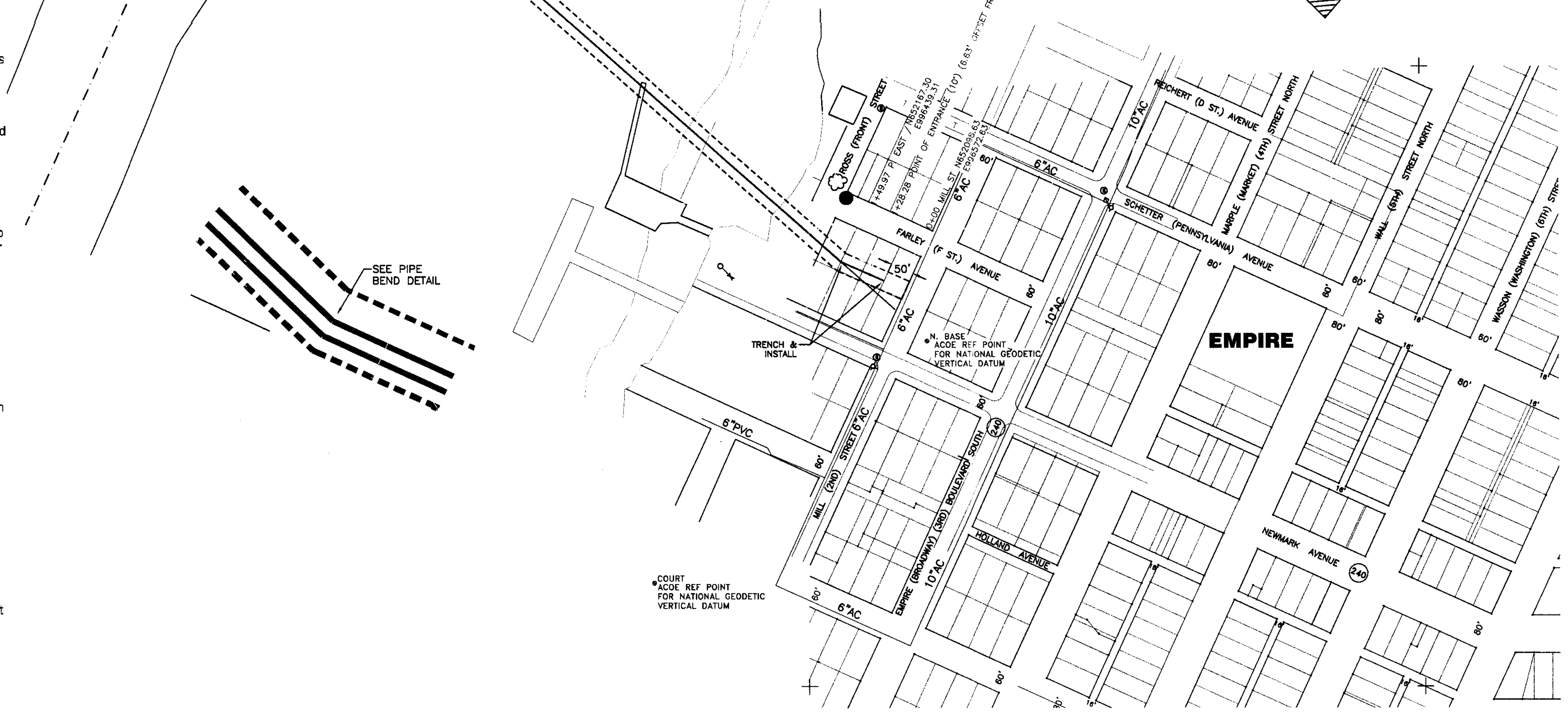
APPENDIX B
Coos Bay – North Bend Water Board
East Bay Crossing
As-Built Plan and Profile



BAY CROSSING PROFILE (RIVER MILE 5+38)

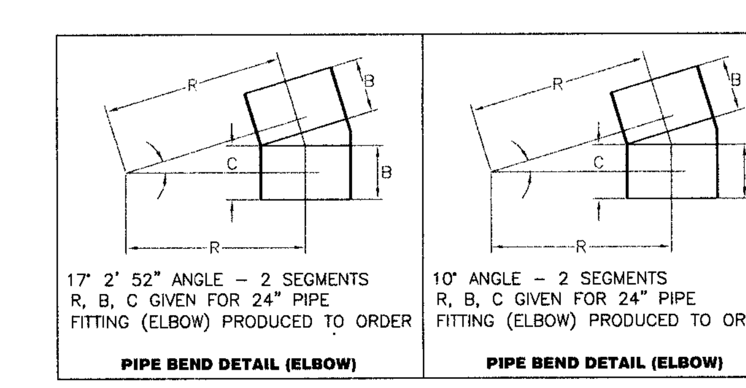
VERT. SCALE: 1"=20'
HOR. SCALE: 1"=200'





PLAN VIEW

SCALE: 1"=200'



CONSTRUCTION NOTES:

1. HDPE pipe rated SDR-9, OD 24" has been specified for the project. This pipe will meet or exceed requirements for strength, resistance to collapse.
2. The fusion of individual pipes will occur at the placement site. The creation of longer segment lengths will be done in advance of the pull so that the time required for heating/cooling the joints during the pullback operation is minimized.
3. Pipes should be inspected in advance of use to insure that there is no ovality (non-circularity), necking (reduced cross-section), or gouging in them. Scratches or gouges greater than 10% of the wall thickness are cause for rejection since they increase the stress concentration and may introduce failure points.
4. Similarly, the pipe extending from the ground after the pullback should be checked for evidence of physical deformity.
5. The pipe should be filled with potable water during the pullback to reduce the effect of floating in the borehole and increasing the frictional forces.
6. The pipe must extend about 3% - 4% beyond its final length after pullback, and be given time (typically equal to the duration of the pull) to recover from the axial strain. (Ref: PPI Handbook Chapter 11 - Polyethylene Pipe for Horizontal Directional Drilling).
7. The pipe should be anchored to the bore rig after pullback so that all contraction occurs from the feed end.
8. The entry/exit angles of 10° must be addressed. Fused pipe sections should be not exceed the manufacturer's minimum recommended bend radius (60 *D) during entry/exit. Otherwise kinking may result.
9. All splicing of elbows to the pipe will be done in the field.
10. Once equilibrium is attained and no movement occurs, the ends can be fused to 10° elbows to bring the pipes to a level position and allow for transition in a vertical direction.
11. Splicing of the 17°2'52" elbow at the entry point will allow for transition in horizontal direction.
12. The elbows will be fabricated by FNW Industrial Plastics of Washougal, WA or a similar vendor.
13. The specifications for fusion joining of the pipes describe six general steps. Details of the steps are available from manufacturer literature, and from ASTM D2657-03 Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings, and Section 192 series, Code of Federal Regulations (CFR). The six steps involved in making a butt fusion joint are:
    a. Securely fasten the components to be joined
    b. Face the pipe ends
    c. Align the pipe profile
    d. Melt the pipe interfaces
    e. Join the two profiles together
    f. Hold under pressure until cooling has occurred

    Note - Fusion joining of HDPE is a function of Temperature, Time, and Pressure. In turn, Time and Pressure are themselves a function of wall thickness, diameter, recommended interfacial pressure (IFP), and typical effective piston area (TEPA) of the equipment used. See ASTM D2657-03 Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings, and refer to manufacturer specifications for details. **Additionally, refer to ASTM E1003 - Standard Test Method for Hydrostatic Leak Testing.**
14. The weld beads caused by the fusion will remain in place. The Plastics Pipe Institute (PPI) has determined that these are not consequential to the flow of fluids in the pipes.
15. The minimum trench width at pipe grade should be equal to the pipe outer diameter (O.D.) plus 12 inches.
16. The amount of earth cover over the bore path as it traverses the channel is at least 20', which should be sufficient to insure that the potential for hydro fracture is minimal.
17. Since all core bore holes along the route were plugged with bentonite at the completion, there should be no chance of encountering a man made fault from that operation.

AS-BUILT

HENKELS & McCOY, Inc.
ENGINEERS AND CONTRACTORS

REV	DATE	DESCRIPTION	REQ	DONE
2	12/27/04	CHANGE PER ENG. MARK-UP		
1	7/15/04	TYPO	SAF	

REGISTERED PROFESSIONAL ENGINEER 74777PE OREGON MAY 11, 2004 THOMAS E. GALLAGHER
exp 6/30/05

COOS BAY - NORTH BEND WATER BOARD

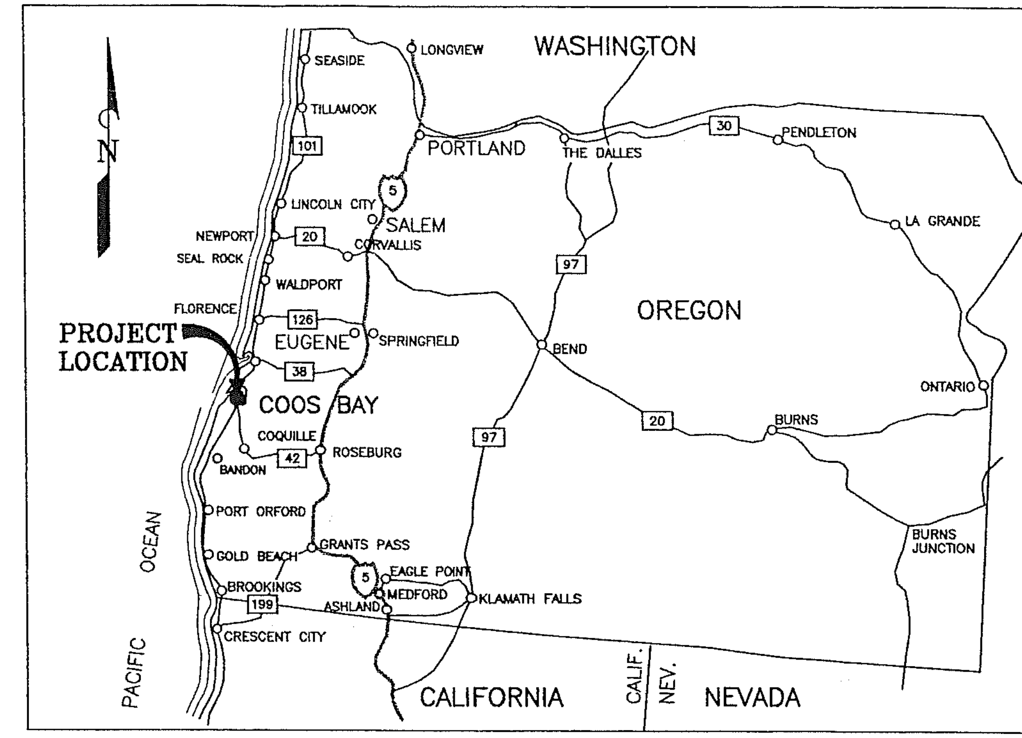
EAST BAY CROSSING

SCALE: AS SHOWN
DRAWN:
DATE: 7/15/04

SHEET NO. 1

APPENDIX C
City of Coos Bay Public Works
Bay Crossing
HDD Sewer Line
Project Plans

BAY CROSSING
HDD SEWER LINE PROJECT



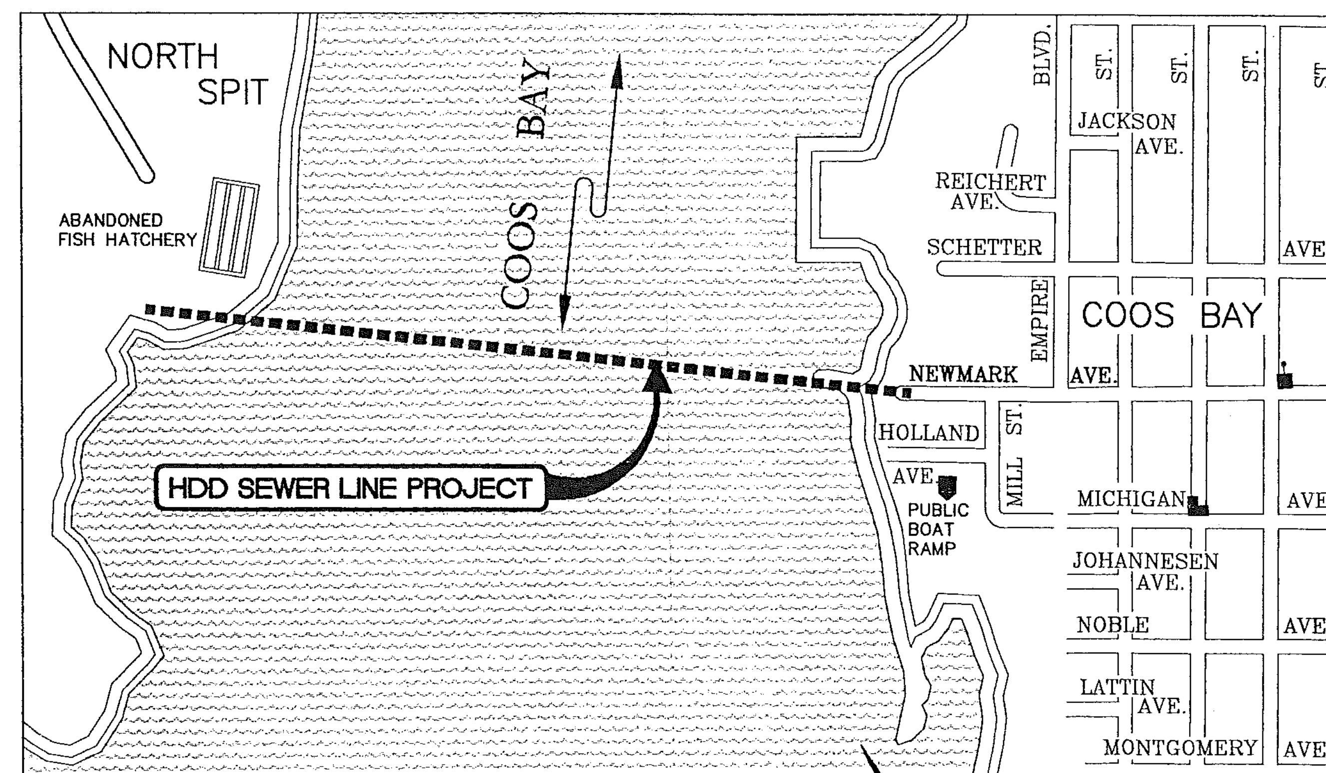
LOCATION MAP

0 20 40 60
SCALE IN MILES

CITY OF COOS BAY
COOS COUNTY, OREGON

PROJECT NO. 109.08

SEPTEMBER, 2004



CITY OF COOS BAY
VICINITY MAP
SCALE: 1" = 800 FEET

ENGINEER:

**THE DYER PARTNERSHIP
ENGINEERS AND PLANNERS, INC.
COOS BAY, OR**

REGISTERED PROFESSIONAL ENGINEER
13,551
OREGON
MAY 21, 1987
MICHAEL W. ERICKSON
EXPIRES 12/31/05

\\Dyer\projects\01Active\109.08\dwg\GENERAL.dwg 11/12/2004 4:15:33 PM PST

INDEX TO DRAWINGS

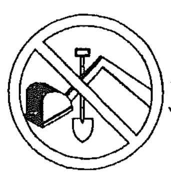
DWG NO.	SHEET NO.	DESCRIPTION
GENERAL		
GI	I	INDEX TO DRAWINGS, REFERENCE SYMBOLS, GENERAL NOTES, ABBREVIATIONS & LEGEND
CONSTRUCTION		
CI	2	PLAN & PROFILE STA 0+00 TO STA 15+00
C2	3	PLAN & PROFILE STA 15+00 TO STA 28+73
DETAILS		
DI	4	STANDARD DETAILS CUTOFF WALLS & END CONFIGURATIONS

REFERENCE SYMBOLS

A / C5 — SECTION DESIGNATION — DRAWN ON DWG NO. C5

2 / D3 — DETAIL DESIGNATION — DRAWN ON DWG NO. D3

UNDERGROUND SERVICE ALERT
ONE-CALL NUMBER



1-800-332-2344
CALL TWO BUSINESS DAYS BEFORE YOU DIG

GENERAL NOTES

1. VERTICAL DATUM BASED ON 1988 NAVD DATUM. HORIZONTAL CONTROL BASED ON NAD 83-91 DATUM.

2. THE CONTRACTOR IS SPECIFICALLY CAUTIONED THAT THE LOCATION AND/OR ELEVATION OF EXISTING UTILITIES, AS SHOWN ON THESE PLANS, IS BASED ON FIELD LOCATES AND RECORDS OF THE VARIOUS UTILITY COMPANIES AND, WHERE POSSIBLE MEASUREMENTS IN THE FIELD. THE INFORMATION IS NOT TO BE RELIED UPON AS BEING EXACT OR COMPLETE. THE CONTRACTOR MUST CONTACT "ONE-CALL" AT 1-800-332-2344 FOR UTILITY LOCATES AT LEAST 48 HOURS BEFORE ANY EXCAVATION. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL VERIFY PERTINENT LOCATIONS AND ELEVATIONS ESPECIALLY AT CONNECTIONS AND AT POTENTIAL UTILITY CONFLICTS.

3. THE OVERHEAD ELECTRIC LOCAL DISTRIBUTION SYSTEMS AND INDIVIDUAL SERVICE LINES ARE NOT SPECIFICALLY INDICATED ON THE DRAWINGS BUT DO EXIST ALONG THE PIPELINE ROUTES. THE CONTRACTOR SHALL EXERCISE CAUTION WHILE WORKING NEAR, OR UNDER, ALL ELECTRIC LINES.

ABBREVIATIONS

A	AIR
AB	ANCHOR BOLT
AC	ASPHALTIC CONCRETE
ADPTR	ADAPTER
AGG	AGGREGATE
AL	ALUMINUM
APPROX	APPROXIMATE
ARV	AIR RELEASE VALVE
AUX	AUXILIARY
BKFL	BACKFILL
BVCE	BEGIN VERTICAL CURVE ELEVATION
BVCS	BEGIN VERTICAL CURVE STATION
BLDG	BUILDING
BM	BENCH MARK
C	CONDUIT
CARV	COMBINATION AIR RELEASE VALVE
CB	CATCH BASIN
CI	CAST IRON
CMP	CORRUGATED METAL PIPE
CNTRL	CONTROL
CO	CLEAN OUT
CONC	CONCRETE
CONN	CONNECTION
CONST	CONSTRUCTION
CONT	CONTINUOUS
CORP	CORPORATION
CPLG	COUPLING
CTR	CENTER
CUL	CULVERT
D	DRAIN
DET	DETAIL
DIA	DIAMETER
DIM	DIMENSION
DIP	DUCTILE IRON PIPE
DWG	DRAWING
EA	EACH
EFF	EFFLUENT
EL/ELEV	ELEVATION
ELB	ELBOW
ELEC	ELECTRICAL
EOP	EDGE OF PAVEMENT
EVCE	END VERTICAL CURVE ELEVATION
EVCS	END VERTICAL CURVE STATION
EW	EACH WAY
EXIST'G	EXISTING
EXT	EXTERIOR
FCA	FLANGE COUPLING ADAPTER
FD	FLOOR DRAIN
FE	FLOW ELEMENT
FF/FIN FLR	FINISH FLOOR
FG	FINISH GRADE
FH	FIRE HYDRANT
FLG	FLANGED
FM	FORCE MAIN
FO	FIBER OPTIC
FOC	FACE OF CURB
FT	FEET
FTG	FOOTING
GALV	GALVANIZED
GIP	GALVANIZED IRON PIPE
GND	GROUND (ELEC)
GPD,H,M	GALLONS PER DAY, HOUR, MINUTE
GV	GATE VALVE
HB	HOSE BIB
HDD	HORIZONTAL DIRECTIONAL DRILLING
HDPE	HIGH DENSITY POLYETHELENE
HORIZ	HORIZONTAL
HP	HORSE POWER
HPT	HIGH POINT
HT	HEIGHT
IE	INVERT ELEVATION
INT	INTERIOR
INV	INVERT
JB	JUNCTION BOX
LAT	LATERAL
L	LENGTH
LF	LINEAR FEET
LPT	LOWPOINT
LT	LEFT
MATL	MATERIAL
MAX	MAXIMUM
MECH	MECHANICAL
MFR	MANUFACTURER
MH	MANHOLE
MIN	MINIMUM
MJ	MECHANICAL JOINT
MSTR	MASTER
NTS	NOT TO SCALE
NIC	NOT IN CONTRACT
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF	OVERFLOW
P	PHASE (ELEC)/PUMP
PE	PLAIN END
PERF	PERFORATED
PI	POWER INPUT
PL	PLATE
PV	PLUG VALVE
PM	PRESSURE MAIN
P/P	POWER POLE/UTILITY POLE
PRESS.	PRESSURE
P/S	PUMPING STATION
PS	PIPE SUPPORT
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PTDF	PRESSURE TREATED DOUG. FIR
PVC	POLYVINYL CHLORIDE
PVMT	PAVEMENT
R	RADIUS
RDCR	REDUCER
REINF	REINFORCING
REQ'D	REQUIRED
ROW	RIGHT OF WAY
RT	RIGHT
SCH	SCHEDULE
SD	STORM DRAIN
SEC	SECTION
SPEC	SPECIFICATIONS
SQ	SQUARE
SS	SANITARY SEWER
SST	STAINLESS STEEL
STA	STATION
STD	STANDARD
STL	STEEL
SUBM	SUBMERSION
SOG	SLAB-ON-GRADE
SVC	SERVICE
TBC	TOP BACK CURB
TCPLG	TRANSITION COUPLING
TOB	TOP OF BANK
TOE	TOE OF BANK
THD	THREADED
TRANS	TRANSITION
TYP	TYPICAL
VAR	VARIES
VC	VERTICAL CURVE
VLV	VALVE
W	WATER LINE
W/	WITH
W/O	WITHOUT
YD	YARD
(W)	WEST
(E)	EAST
(N)	NORTH
(S)	SOUTH
ø	DIAMETER

LEGEND

EXISTING

BUILDING/STRUCTURE

DOCK/PIER STRUCTURE

PAVED ROADWAY

DIRT/GRAVEL ROADWAY

FENCE

STORM DRAIN (24")

SANITARY SEWER (8")

SANITARY SEWER MANHOLE

POWER POLE/UTILITY POLE

LIGHT POLE

DECIDUOUS TREE

MAJOR CONTOUR (-10)

MINOR CONTOUR (2' INTERVAL)

NEW

NEW 10"ø HDPE SEWER LINE

ALTERNATE 30"ø HDPE SEWER LINE

REVISED	DESCRIPTION	SUBMIT.	APPR'D.	DATE

REVISIONS

DESIGNED: MWE
DRAWN: JGW
CHECKED: MWE
APPROVED:

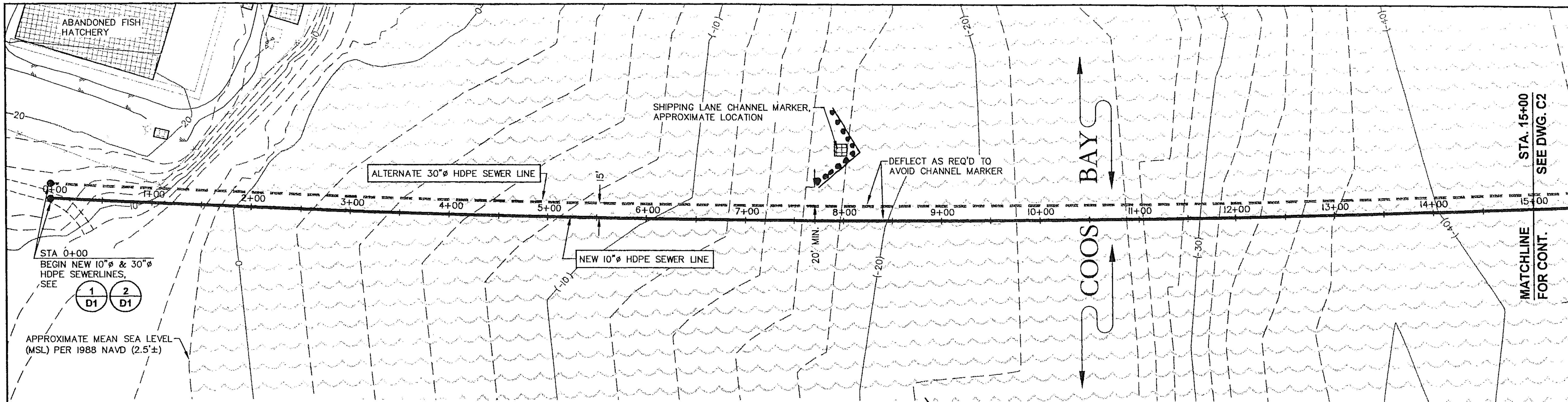
THE DYER PARTNERSHIP
ENGINEERS & PLANNERS, INC.
1330 TEAKWOOD AVENUE
COOS BAY, OREGON 97420
TELEPHONE: (541) 269-0732
www.dyerpart.com

LINE IS 1 INCH AT FULL SCALE

BAY CROSSING - HDD SEWER LINE PROJECT
CITY OF COOS BAY

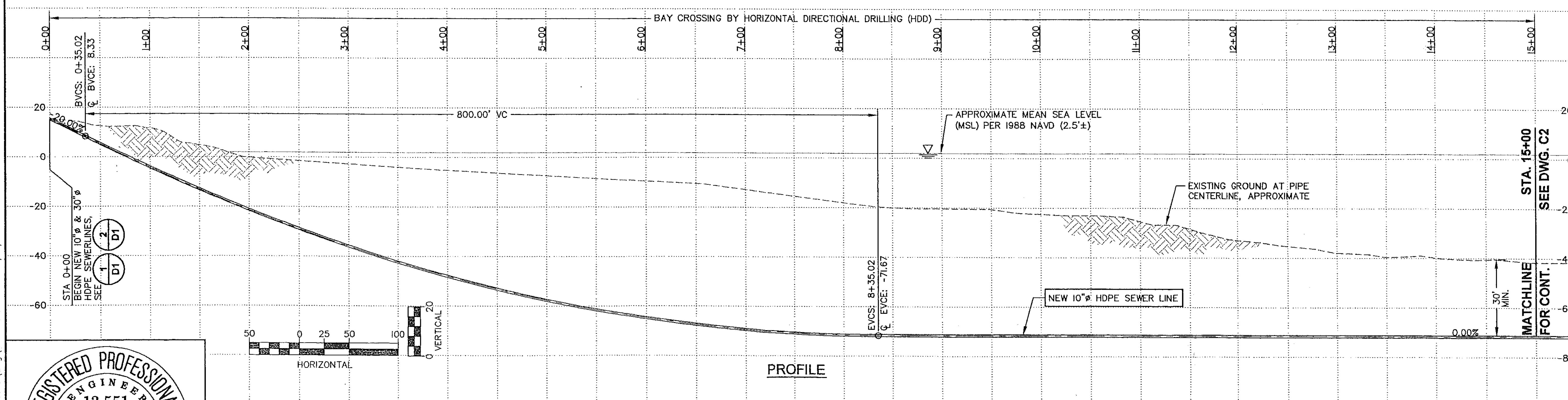
INDEX TO DRAWINGS, REFERENCE SYMBOLS, GENERAL NOTES, ABBREVIATIONS & LEGEND

PROJECT NO. 109.08
DRAWING NO. G1
DATE SEPT., 2004
SHEET NO. 1 OF 4



PLAN VIEW - STA 0+00 TO STA 15+00 (1/C1)

PLAN SCALE 50 0 25 50 100



PROFILE

REGISTERED PROFESSIONAL ENGINEER 13,551 OREGON MAY 21, 1987 MICHAEL W. ERICKSON EXPIRES 12/31/05

REVISED	DESCRIPTION	SUBMIT.	APPR'D.	DATE

DESIGNED: MWE/JGW
DRAWN: JGW
CHECKED: MWE
APPROVED:

THE DYER PARTNERSHIP ENGINEERS & PLANNERS, INC.
1330 TEAKWOOD AVENUE
COOS BAY, OREGON 97420
TELEPHONE: (541) 269-0732
www.dyerpart.com

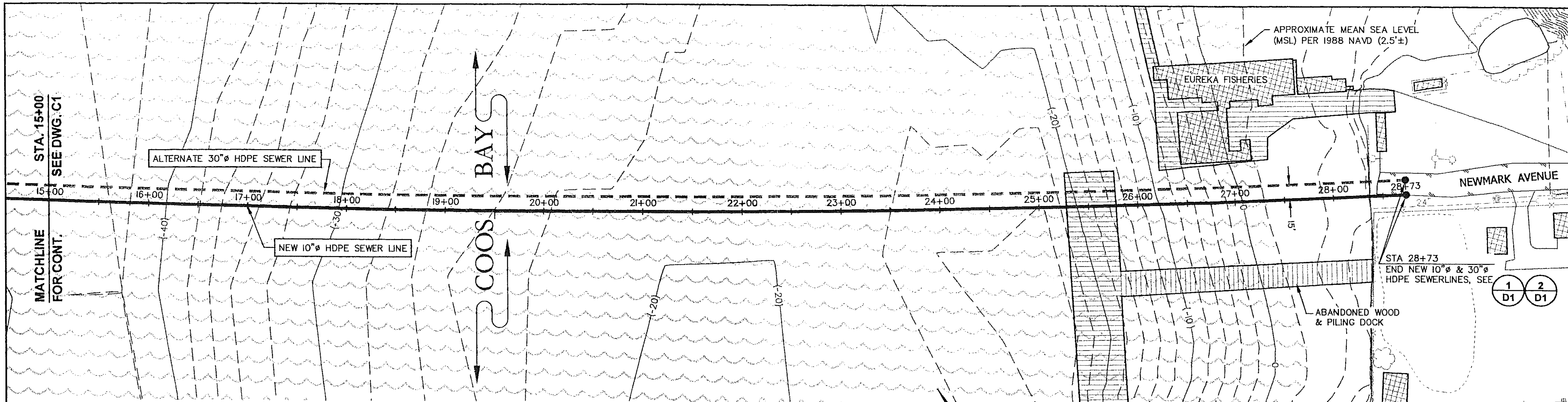
LINE IS 1 INCH AT FULL SCALE
IF NOT 1-INCH - SCALE ACCORDINGLY

BAY CROSSING - HDD SEWER LINE PROJECT
CITY OF COOS BAY

PLAN & PROFILE
STA 0+00 TO STA 15+00

PROJECT NO. 109.08
DRAWING NO. C1
DATE SEPT., 2004
SHEET NO. 2 OF 4

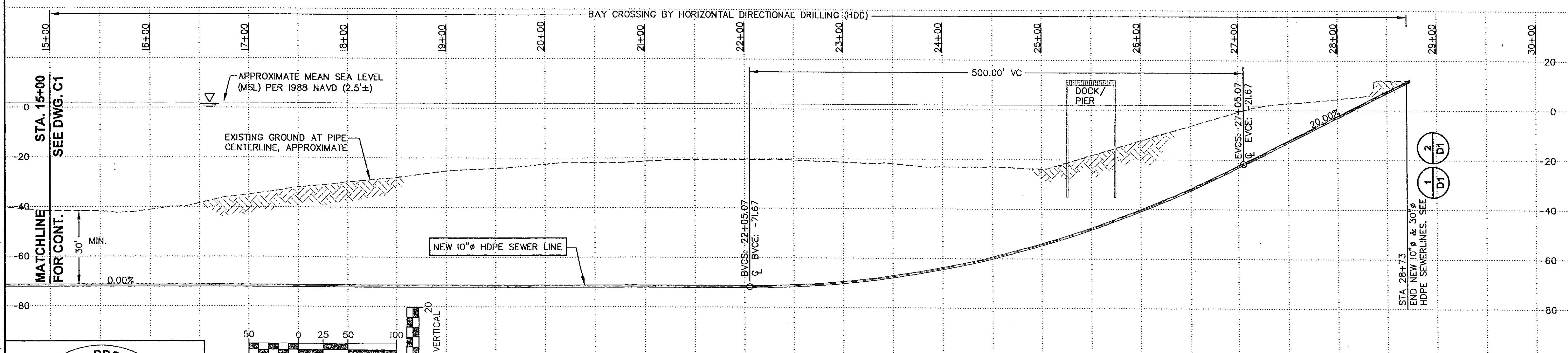
\Dyer\projects\01Active\109.08\dwg\COOSBAY-M.DWG 11/12/2004 3:54:33 PM PST



PLAN VIEW - STA 15+00 TO STA 28+73 (1/C2)

PLAN SCALE

50 0 25 50 100



PROFILE

REGISTERED PROFESSIONAL ENGINEER 13,551 OREGON MAY 21, 1987 MICHAEL W. ERICKSON EXPIRES 12/31/05

REVISED	DESCRIPTION	SUBMIT.	APPR'D.	DATE

DESIGNED: MWE/JGW
DRAWN: JGW
CHECKED: MWE
APPROVED:

THE DYER PARTNERSHIP ENGINEERS & PLANNERS, INC.
1330 TEAKWOOD AVENUE
COOS BAY, OREGON 97420
TELEPHONE: (541) 269-0732
www.dyerpart.com

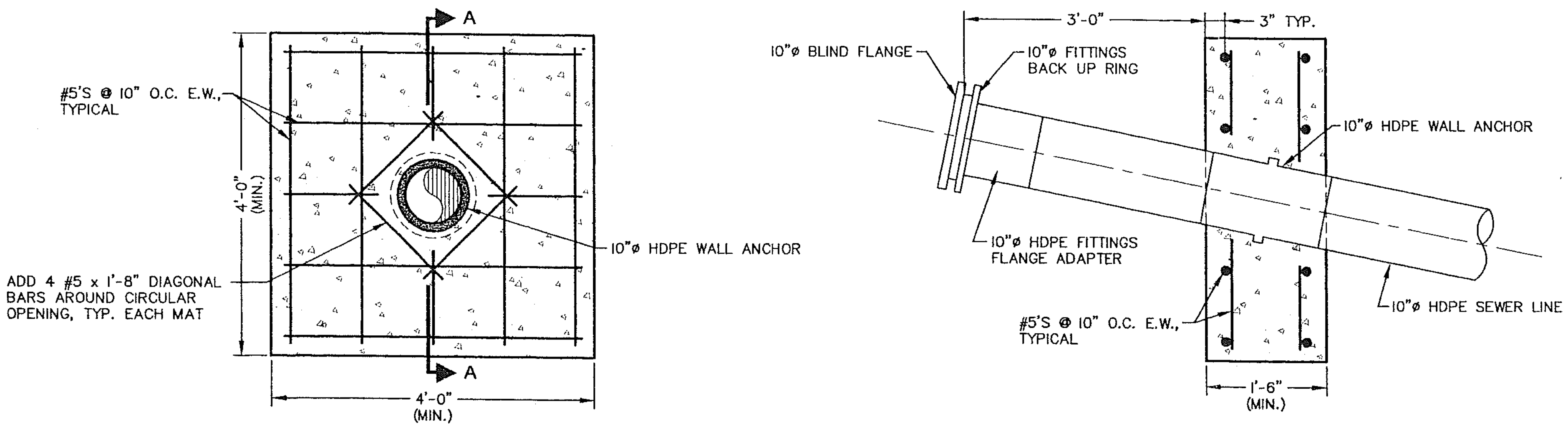
LINE IS 1 INCH AT FULL SCALE
IF NOT 1-INCH - SCALE ACCORDINGLY

BAY CROSSING - HDD SEWER LINE PROJECT
CITY OF COOS BAY

PLAN & PROFILE
STA 15+00 TO STA 28+73

PROJECT NO. 109.08
DRAWING NO. C2
DATE SEPT., 2004
SHEET NO. 3 OF 4

\Dyer\projects\01Active\109.08\dwg\COOSBAY-M.DWG 11/12/2004 3:54:33 PM PST

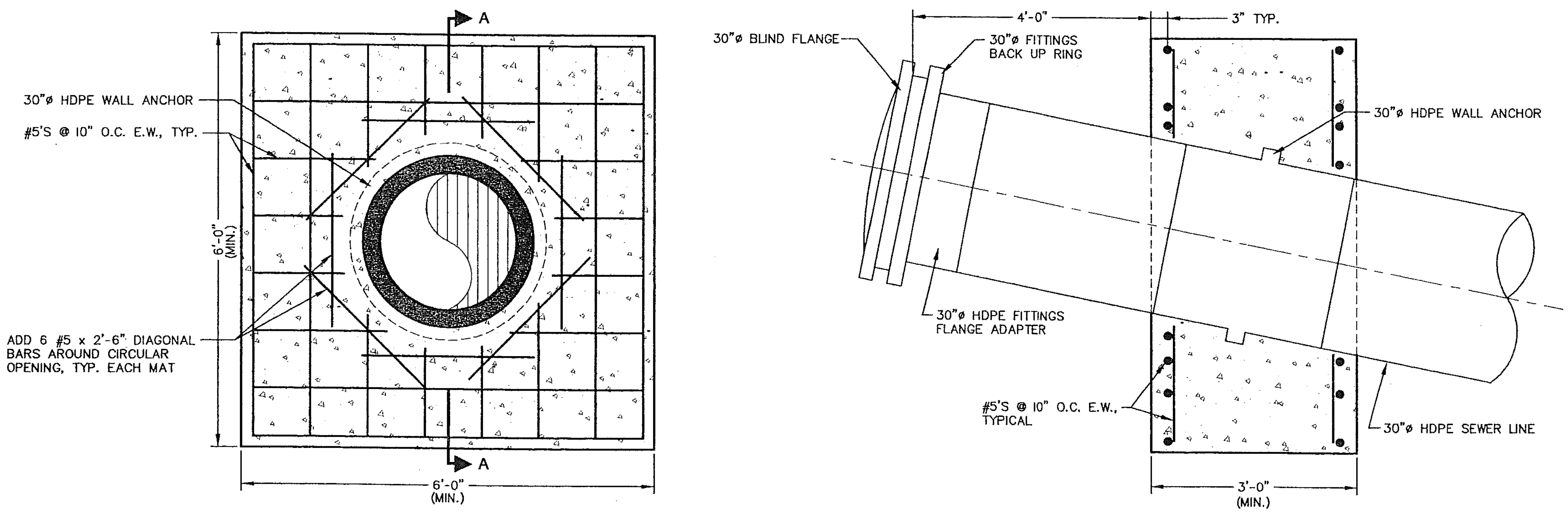


ELEVATION

SECTION A-A

NOTES:
1. CONCRETE CUTOFF WALL SHALL BE FORMED AND PLACED UPON UNDISTURBED GROUND.

CONCRETE CUTOFF WALL & END CONFIGURATION - 10"Ø SEWER LINE (1/D1)
SCALE: 1/2" = 1'



ELEVATION

SECTION A-A

NOTES:
1. CONCRETE CUTOFF WALL SHALL BE FORMED AND PLACED UPON UNDISTURBED GROUND.

CONCRETE CUTOFF WALL & END CONFIGURATION - 30"Ø SEWER LINE (2/D1)
SCALE: 1/2" = 1'

REGISTERED PROFESSIONAL ENGINEER 13,551
OREGON
MAY 21, 1987
MICHAEL W. ERICKSON
EXPIRES 12/31/05

REVISIONS

REVISED	DESCRIPTION	SUBMIT.	APPR'D.	DATE

DESIGNED: MWE/JGW
DRAWN: JGW
CHECKED: MWE
APPROVED:

THE DYER PARTNERSHIP
ENGINEERS & PLANNERS, INC.
1330 TEAKWOOD AVENUE
COOS BAY, OREGON 97420
TELEPHONE: (541) 269-0732
www.dyerpart.com

LINE IS 1 INCH AT FULL SCALE
IF NOT 1-INCH - SCALE ACCORDINGLY

BAY CROSSING - HDD SEWER LINE PROJECT
CITY OF COOS BAY

STANDARD DETAILS
CUTOFF WALLS & END CONFIGURATIONS

PROJECT NO. 109.08
DRAWING NO. D1
DATE SEPT., 2004
SHEET NO. 4 OF 4

\\Dyer\projects\01Active\109.08\dwg\DETAILS.dwg 11/12/2004 4:09:33 PM PST

APPENDIX D
NW Natural
Coos Bay Crossing
Corps Permit

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, PORTLAND DISTRICT
EUGENE FIELD OFFICE
1600 EXECUTIVE PARKWAY, SUITE 210
EUGENE, OREGON 97401-2156

REPLY TO
ATTENTION OF:

July 2, 2004

Operations Division
Regulatory Branch
Corps No. 200300706

Mr. Michael Hayward
Northwest Natural
220 NW Second Avenue
Portland, Oregon 97209-3991

Mr. Hayward:

The U.S. Army Corps of Engineers (Corps) has received Northwest Natural's request to modify a permit authorization to install utility lines under Coos Bay from Empire to the North Spit. You are proposing to directional bore approximately 20 feet below the bottom elevation. The project is in the city of Coos Bay, Coos County County, Oregon. The site is in Section 34, Township 26 South, Range 13 West.

Based on geologic surveys and your analysis of substrate conditions, Northwest Natural believes the modification will not measurably increase the potential for hydro-fracture (frac-out) through the substrate and release drilling fluid into the water. The permit verification dated June 18, 2004, has been amended to include the above description.

In addition the Corps hereby amends special condition "d" of the verification letter as follows:

d. All in-water work for this project shall be conducted during the standard in-water work period of October 1 through February 15. The in-water work period for the 2004 season has been extended to include the dates from June 15 through September 30. Exceptions to this time period require specific approval by the Corps.

All other terms and conditions of the original verification remain in full force and effect. This letter must be attached to the original verification letter. If you have any questions about this re-verification, please write or call Mr. Dominic Yballe at the letterhead address, telephone (541) 465-6894, or email at dominic.p.yballe@nwp01.usace.army.mil.

Sincerely,

Michele E. [signature]
for Lawrence C. Evans
Chief, Regulatory Branch

CO-G	
CO-GP	
MEH 9/2/04	
PM	DY 7/2/04
TECH	
TYPIST	

7/2/04

Copies Furnished:

Oregon Department of State Lands (Lobdell)
Oregon Department of Environmental Quality (Melville)
Oregon Department of Land Conservation and Development (Blanton)
NOAA Fisheries (Wheeler)

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, PORTLAND DISTRICT
EUGENE FIELD OFFICE
1600 EXECUTIVE PARKWAY, SUITE 210
EUGENE, OREGON 97401-2156

REPLY TO
ATTENTION OF:

June 18, 2004

Operations Division
Regulatory Branch
Corps No. 200300706

Mr. Michael Hayward
Northwest Natural
220 NW Second Avenue
Portland, Oregon 97209-3991

Dear Mr. Hayward:

The U.S. Army Corps of Engineers (Corps) has received Northwest Natural's permit application requesting Department of the Army authorization to install a utility line across Pony Creek, Coalbank Slough, and Coos Bay. The project involves directional drilling to install a natural gas pipeline at two sites under Pony Creek: 1) site under Coalbank Slough; and 2) one crossing under Coos Bay. At Coos Bay, the pipeline will be drilled concurrently with the installation of a sewer line (Corps #200400058) and water main (Corps #200400339). The project details are enclosed with this letter (Enclosure 1). The project sites at the following location descriptions:

Coos Bay:

Start: Latitude 43° 23' 60" North; Longitude 124° 17' 17" West
End: Latitude 43° 23' 37" North; Longitude 124° 16' 34" West

Pony Creek:

Start: Latitude 43° 24' 24" North; Longitude 124° 13' 52" West
End: Latitude 43° 23' 21" North; Longitude 124° 14' 34" West

Coalbank Slough:

Latitude 43° 21' 22" North; Longitude 124° 12' 30" West

At Coos Bay, the drilling would extend a minimum of 35 feet below the bottom elevation of the bay and traverse approximately 4,800 feet from Empire to the North Spit sand dunes near an aquaculture facility. The project would impact 0.28-acre of vegetated drainage for drill placement and staging. Oak matting will be used to distribute the weight of heavy machinery and minimize compaction of the surrounding soil. Impacts include removal of shrubs and approximately 55 trees size three inches diameter or less. Native woody vegetation would be planted after construction at a 2:1 replacement to removal ratio. Bare soil will be seeded with appropriate native herbaceous species.

At Pony Creek and Coalbank Slough, the pipeline construction would traverse approximately 200 feet across tidally influenced tributaries. Drilling depths would occur a minimum of 20 feet below the bottom elevations of the water bodies.

This letter verifies that your project is authorized under the terms and limitations of Nationwide Permit No. 12 (Utility Line Activities). Your activities must be conducted in accordance with the conditions found in Regional Conditions (Enclosure 2), General Conditions (Enclosure 3), and the following project specific conditions:

a. You shall notify the Regulatory Branch with the start of work date when the activities authorized in waters of the U.S. begin. Notification shall be sent by e-mail to CENWP.Notify@usace.army.mil or mailed to the following address:

U.S. Army Corps of Engineers
CENWP-OP-GC
Permit Compliance, Coos County
P.O. Box 2946
Portland, Oregon 97208-2946

The subject line of the message shall contain the name of the county in which the project is located followed by the Corps of Engineers permit number.

b. To protect against inadvertent impacts to cultural resources permittee shall ensure all soil disturbing activities on the North Spit are confined to the dredge disposal site. All activities, which will or could result in a soil disturbance shall be monitored by a qualified archeologist. (Refer to Portland District Regional Condition "5" (Enclosure 2) in the event a resource is uncovered.)

c. To minimize the potential for any adverse impacts during construction or from hydrofracturing substrate (frac-outs), the permittee shall fully implement the submitted Best Management Procedures (Enclosure 4).

d. All in-water work for this project shall be conducted during the standard in-water work period of October 1 through February 15. The in-water work period for the 2004 season has been extended to include the dates from September 30 through June 15. Exceptions to this time period require specific approval by the Corps.

e. Construction debris, chemical compounds, and other contaminants shall be prevented from entering any active water channel. All vehicles and equipment shall be clean and free of leaks prior to operation near wetlands and waterways. Containment measures shall be available onsite for immediate implementation in the event of a spill.

f. The worksite shall be isolated from the active channel to minimize impacts to water quality. Sediment laden water shall be taken to an appropriate upland location for disposal or pretreated prior to discharge back into a waterway.

g. The permittee shall replace impacted woody vegetation at a 2:1 replacement to removal ratio. Plantings shall consist of native, non-invasive species randomly placed with a minimum of ten-foot clearance from center of plant. Bare soil shall be seeded with appropriate native herbaceous species. The plantings shall be completed by the end of the first appropriate growing season following drilling completion. The expected period for restoration planting is Fall 2004.

h. The permittee shall fully implement the mitigation plan entitled "Coos Bay-North Bend Water Board / Northwest Natural: Bay Pipeline Crossing Mitigation Plan" (Plan), dated May 2004 (Enclosure 5). The goal of the plan is to reduce and minimize impacts and restore the Coos Bay worksite to pre-construction conditions.

i. The permittee shall submit an "as-built" report within 60 days upon completion of the Plan. The contents of the report shall include photographs representing the entire restoration site and a summary of the restoration efforts.

j. The permittee shall submit annual monitoring reports by December 1 for a three-year period upon completion of the Plan. The contents of the reports are described on page 6 and 7 of the Plan.

k. All reports shall be mailed to the following address:

U.S. Army Corps of Engineers
CENWP-OP-GC (Compliance – Coos County)
P.O. Box 2946
Portland, Oregon 97208-2946

The Oregon Department of Environmental Quality (DEQ) and the Oregon Department of Land Conservation Development (DLCD) have provided their Certification Conditions (Enclosure 6) and Concurrence Conditions (Enclosure 7). You must also comply with these conditions.

We also direct your attention to the Regional Conditions (Enclosure 2) that requires the transfer of this permit if the property is sold, and General Condition No. 14 (Enclosure 3) that requires you to submit a signed certificate when the work is completed. A "Compliance Certification" is provided (Enclosure 8).

Failure to comply with any of the listed conditions could result in the Corps initiating an enforcement action. This authorization does not obviate the need to obtain other permits where required. Permits, such as those required from the Oregon Department of State Lands (ODSL) under Oregon's Removal /Fill Law, must also be obtained before work begins.

This verification is valid for a period of two years from the date of this letter unless the nationwide permit expires, is modified, reissued, or revoked prior to that date. All nationwide permits are scheduled to be modified, reissued, or revoked in March 2007. If you commence or are under contract to commence this activity before the date the nationwide permit expires, is modified, or revoked, you will have 12 months from the date of the modification or revocation to complete the activity under the present terms and conditions of the current nationwide permit.

If you have any questions regarding this nationwide permit verification, please contact Mr. Dominic Yballe at the letterhead address, by telephone at (541) 465-6894, or email dominic.p.yballe@nwp01.usace.army.mil.

Sincerely,

Lawrence C. Evans
Chief, Regulatory Branch

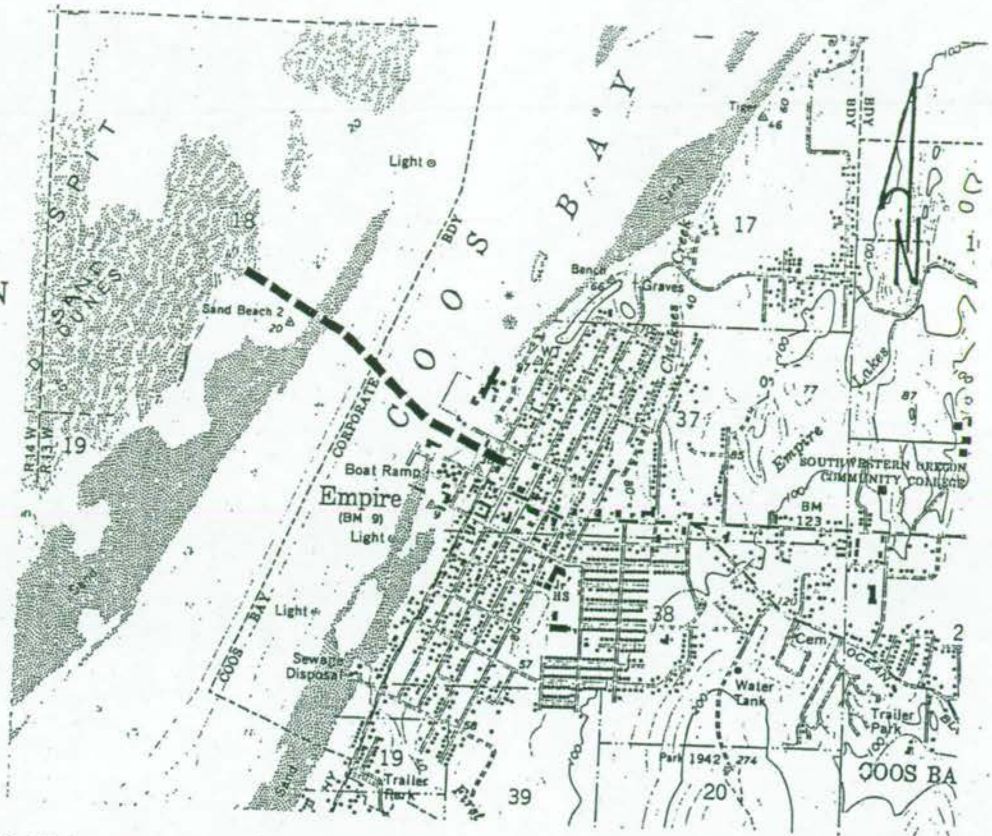
CO-G
CO-GP 6/18/04
PM
TECH
TYPIST
6/18/04

Enclosures

Copy Furnished:

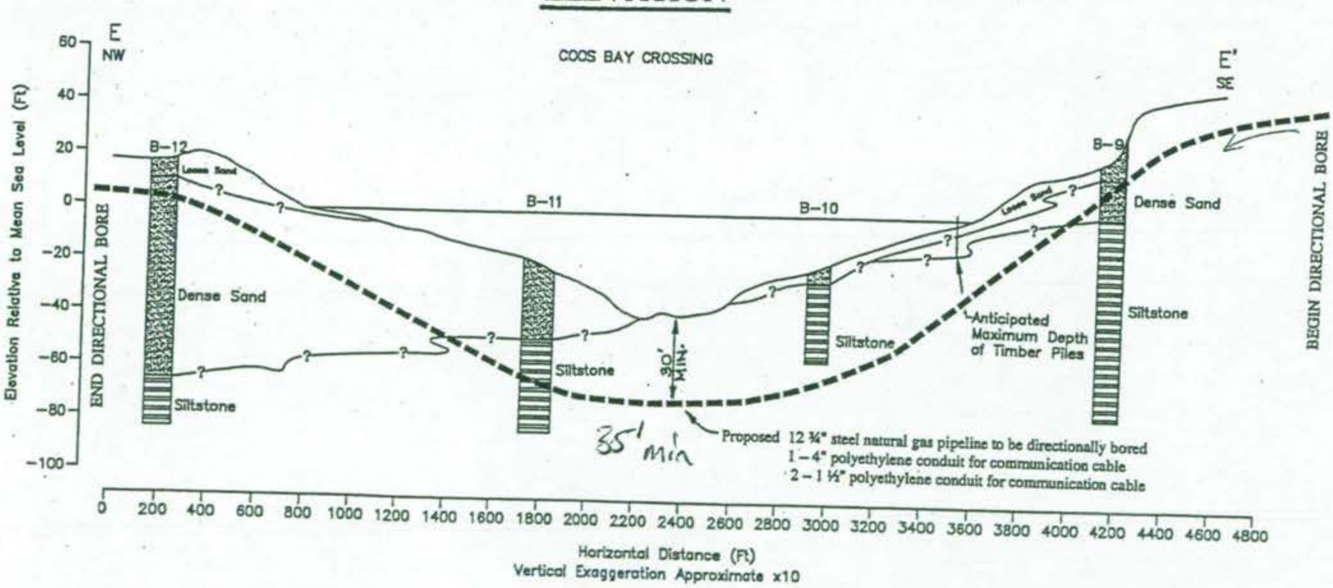
Oregon Department of State Lands (Lobdell)
Oregon Department of Environmental Quality (Melville)
Oregon Department of Land Conservation and Development (Blanton)
NOAA Fisheries (Wheeler)

PROJECT LOCATION
MAP REFERENCE:
USGS MAP
EMPIRE OREGON



Begin 43-23-60; 124-17-17
End 43-23-37; 124-16-34

ELEVATION



NORTHWEST NATURAL GAS CO. JOINT PERMIT APPLICATION
US ARMY CORPS OF ENGINEERS & ORE. DIVIDION OF STATE LANDS
PROPOSED COOS BAY CROSSING, COOS COUNTY, OREGON
SE ¼ SEC. 18 & NE ¼ SEC. 19, T 25 S, R 13 W, WM. - DATE 9/12/03

1 OF 2

Enclosure (1)

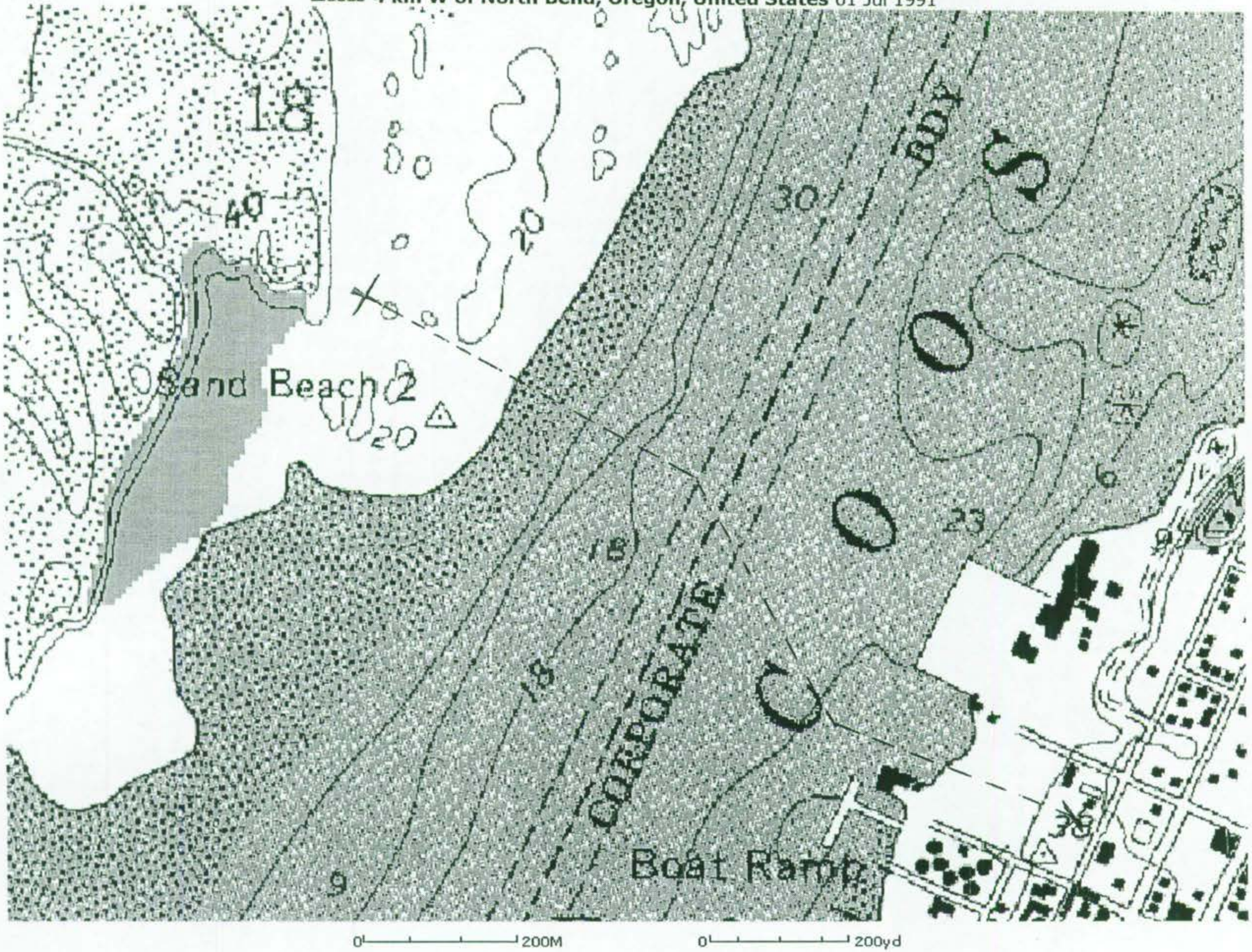
COE #200300706

Page 2 of 6

Enclosure (1)

Send To Printer   Back To TerraServer   Change to 11x17 Print Size   Show Grid Lines   Change to Portrait

USGS 4 km W of North Bend, Oregon, United States 01 Jul 1991



COE #200300706

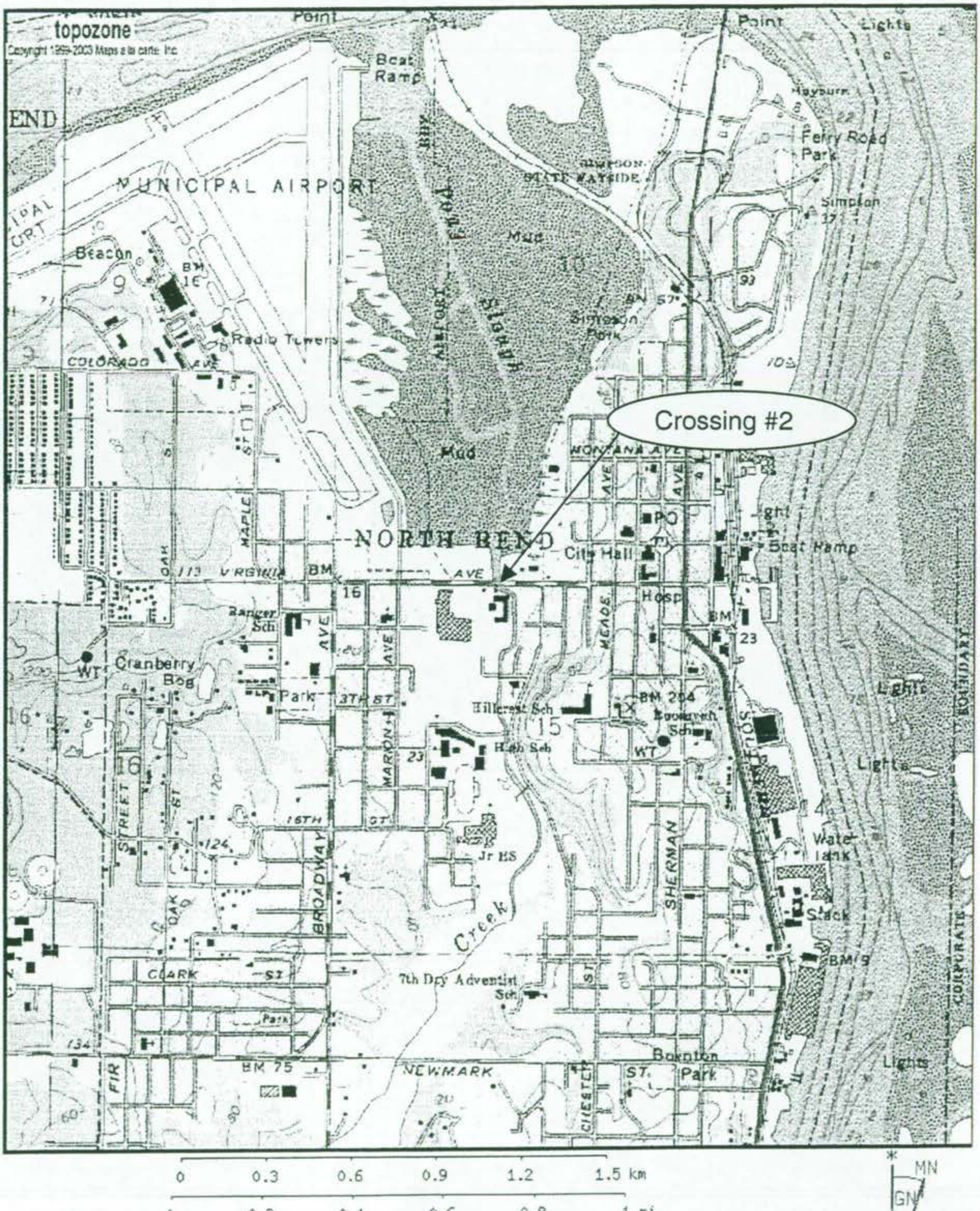
Page 3 of 6

Enclosure (1)

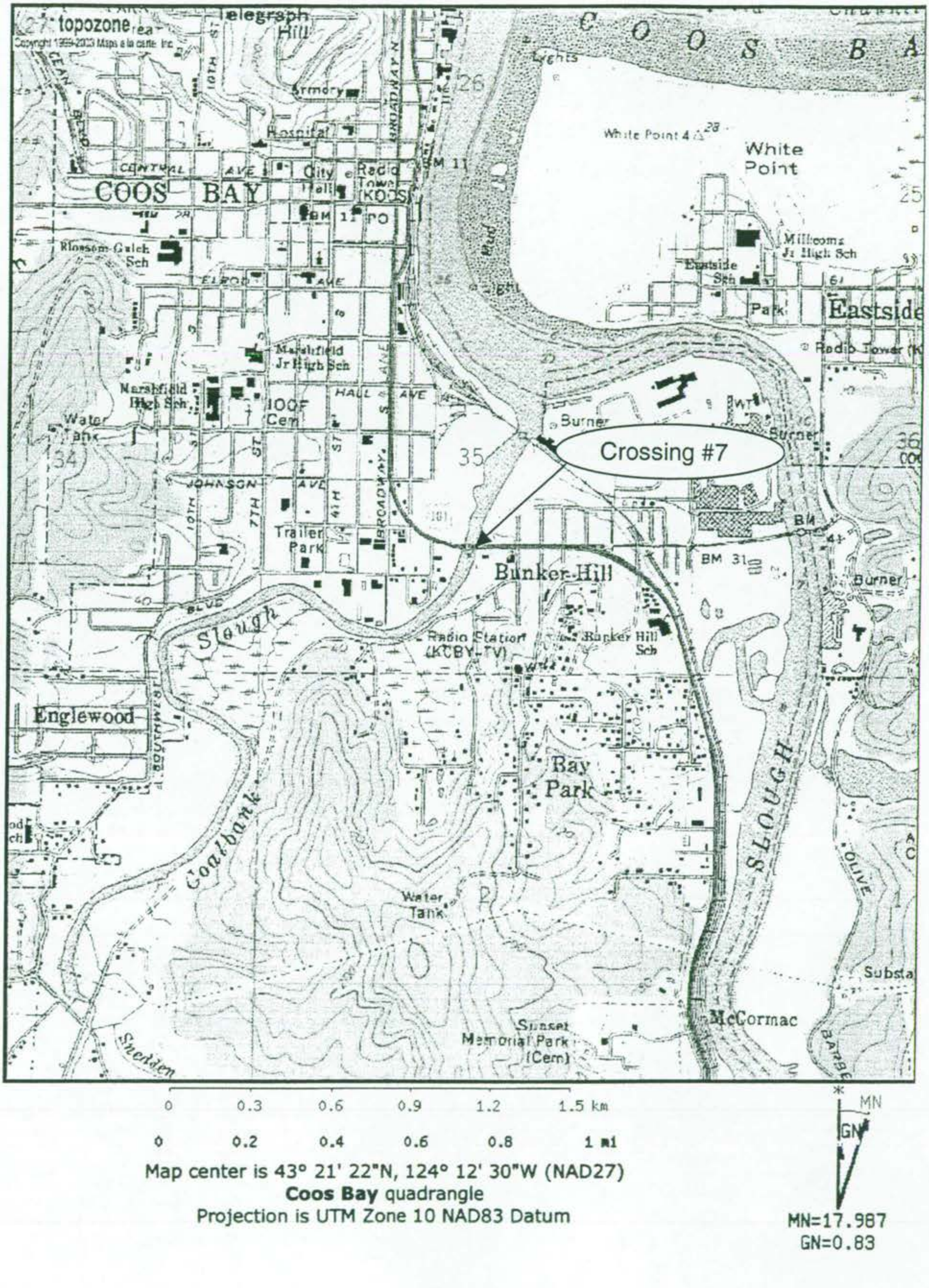
Send To Printer Back To TerraServer Change to 11x17 Print Size Show Grid Lines Change to Portrait

USGS **4 km W of North Bend, Oregon, United States** 27 May 1994

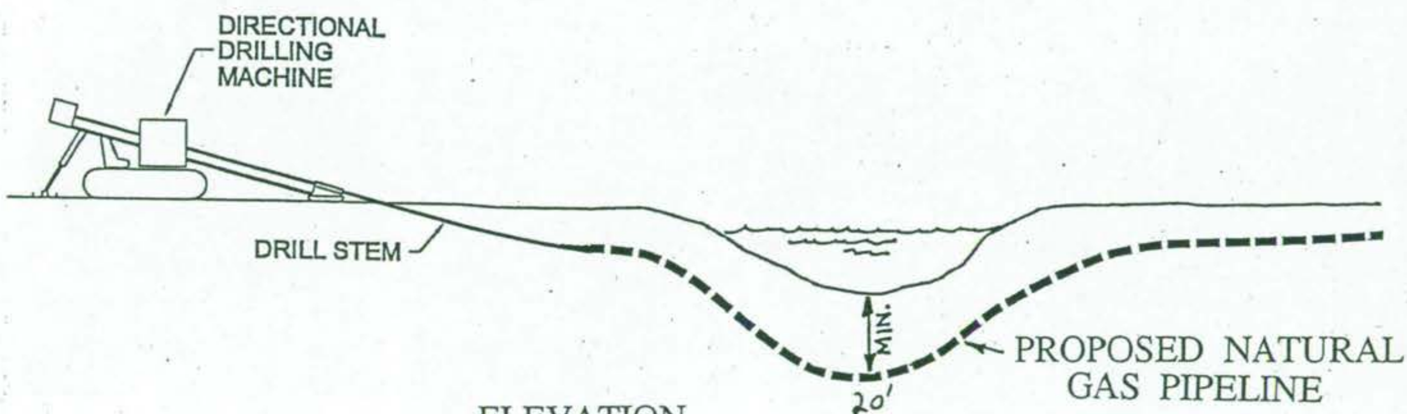
0 200M 0 200yd



Map center is 43° 24' 24"N, 124° 13' 52"W (NAD27)
North Bend quadrangle
Projection is UTM Zone 10 NAD83 Datum



Map center is 43° 21' 22"N, 124° 12' 30"W (NAD27)
Coos Bay quadrangle
Projection is UTM Zone 10 NAD83 Datum



ELEVATION

NORTHWEST NATURAL GAS CO. JOINT PERMIT APPLICATION
US ARMY CORPS OF ENGINEERS &
OREGON DIVISION OF STATE LANDS
STANDARD PROPOSED HORIZONTAL DIRECTIONAL BORE
FOR RIVER CROSSINGS

Portland District Regional Conditions

1. **In-water Work Windows:** All in-water work, including temporary fills or structures, shall occur between **October 1** and **February 15** (timeframes are specific to the waterbody). Exceptions to these time periods require specific approval from the Corps.

2. **Upland Disposal:** All excess material will be taken to a suitable upland location for disposal. The material shall be placed in a location and manner that prevents its discharge into waterways or wetlands.

3. **Heavy Equipment:** Heavy equipment shall be operated from the bank and not placed in the stream unless specifically authorized by the District Engineer. Heavy equipment must be placed on mats or similar precautions must be taken to minimize damage to wetland resources.

4. **Fish Screening:** Fish screening will comply with standards approved by the National Marine Fisheries Service (NOAA) or the Oregon Department of Fish & Wildlife (ODFW), as appropriate.

5. **Cultural Resources and Human Burials**: Permittees must immediately notify the District Engineer if at any time during the course of the work authorized, human burials, cultural resources, or historic properties, as identified by the National Historic Preservation Act, may be affected. Failure to stop work in the area of exposure until such time the Corps has complied with the provisions of 33 CFR 325, Appendix C, the National Historic Preservation Act and other pertinent regulations could result in violation of state and federal laws. Violators are subject to civil and criminal penalties.

6. **Fish Passage:** Permittee shall ensure activities authorized by Nationwide Permit will not restrict passage of aquatic life. Activities such as the installation of culverts, diversion structures, or other modifications to channel morphology must be designed to be consistent with fish passage standards developed by the Oregon Department of Fish & Wildlife and the National Marine Fisheries Service. The standards can be found in the document entitled "ODFW Standards and Criteria for Stream Road Crossings." The streambed shall be returned to preconstruction contours after construction unless the purpose of the activity is to eliminate a fish barrier.

7. **Riparian Vegetation Protection and Restoration:** When working in waters of the United States or riparian areas, the construction boundary shall be minimized to the maximum extent practicable. Permittee shall mark and clearly define the construction boundary before beginning work. Native riparian vegetation will be successfully established along tributaries where the vegetation was removed by construction. The plantings shall start at the ordinary high water mark and extend 10 feet back from the top of the bank. The plantings must be completed by the end of the first planting season following the disturbance.

8. **Erosion Controls:** All practicable erosion control devices shall be installed and maintained in good working order throughout construction to prevent the unauthorized discharge of material into a wetland or tributary. The devices shall be installed to maximize their effectiveness, e.g., sediment fences shall generally be buried or similarly secured. These controls shall be maintained until permanent erosion controls are in place.

   Practicable erosion control measures include, but are not limited to the following:
   a. Fill is placed in a manner that avoids disturbance to the maximum practicable extent (e.g. placing fill with a machine rather than end-dumping from a truck);
   b. Prevent all construction materials and debris from entering waterway;
   c. Use filter bags, sediment fences, sediment traps or catch basins, silt curtains, leave strips or berms, Jersey barriers, sand bags, or other measures sufficient to prevent movement of soil;
   d. Use impervious materials to cover stockpiles when unattended or during rain event;
   e. Erosion control measures shall be inspected and maintained daily to ensure their continued effectiveness;
   f. No heavy machinery in a wetland or other waterway;
   g. Use a gravel staging area and construction access;
   h. Fence off planted areas to protect from disturbance and/or erosion; and
   i. Flag or fence off wetlands adjacent to the construction area.

9. **Maps and Drawings**: In addition to the items required in Nationwide Permit General Condition No. 13, all preconstruction notifications shall contain maps showing the project location as well as plan-view and cross-sectional drawings showing the proposed work. The map(s) shall be of a scale and detail to clearly identify the projection location(s). Drawings shall be sufficient in number and detail to accurately portray the project.

10. **Bank Protection:** Riprap shall be clean, durable, angular rock. The use of other materials such as broken concrete, asphalt, tires, wire, steel posts, or similar materials is not authorized. The project design shall minimize the placement of rock and maximize the use of vegetation and organic material such as rootwads to the extent practicable. Riparian plantings shall be included in all project designs unless the permittee can demonstrate they are not practicable. The permittee must notify the District Engineer in accordance with Nationwide Permittee General Condition No. 13 for any activity that includes bank stabilization.

11. **Inspection of the Project Site:** The permittee must allow representatives of the Corps to inspect the authorized activity to confirm compliance with nationwide terms and conditions. Personnel from the Oregon Department of Environmental Quality (ODEQ) and Department of Land Conservation and Development (DLCD) are considered to be authorized "representatives" for the purpose of Section 401 Water Quality or Coastal Zone Management inspections. For projects on tribal land, the Environmental Protection Agency (EPA) is considered an authorized representative. A request for access to the site will normally be made sufficiently in advance to allow a property owner or representative to be on site with the agency representative making the inspection.

12. **Sale of Property/Transfer of Permit:** If you sell the property associated with this permit, you must transfer the permit to the new owner(s) and obtain their signature(s). A copy of this permit with the new owner(s) signature shall be sent to this office to validate the transfer of this permit authorization.

Nationwide Permit General Conditions

(From the January 15, 2002, Federal Register, Vol. 67, No. 10
and February 13, 2002, Federal Register, Vol. 67, No. 30)

1. Aids to Navigation
2. Structures in Artificial Canals
3. Maintenance
4. Fish and Wildlife Harvesting, Enhancement, and Attraction Devices and Activities
5. Scientific Measurement Devices
6. Survey Activities
7. Outfall Structures and Maintenance
8. Oil and Gas Structures
9. Structures in Fleeting and Anchorage Areas
10. Mooring Buoys
11. Temporary Recreational Structures
12. Utility Line Activities
13. Bank Stabilization
14. Linear Transportation Projects
15. U.S. Coast Guard Approved Bridges
16. Return Water from Upland Contained Disposal Areas
17. Hydropower Projects
18. Minor Discharges
19. Minor Dredging
20. Oil Spill Cleanup
21. Surface Coal Mining Activities
22. Removal of Vessels
23. Approved Categorical Exclusions
24. State Administered Section 404 Programs
25. Structural Discharges
26. (Reserved)
27. Stream and Wetland Restoration Activities
28. Modifications of Existing Marinas
29. Single-Family Housing
30. Moist Soil Management for Wildlife
31. Maintenance of Existing Flood Control Facilities
32. Completed Enforcement Actions
33. Temporary Construction, Access, and Dewatering
34. Cranberry Production Activities
35. Maintenance Dredging of Existing Basins
36. Boat Ramps
37. Emergency Watershed Protection and Rehabilitation
38. Cleanup of Hazardous and Toxic Waste
39. Residential, Commercial and Institutional Developments
40. Agricultural Activities
41. Reshaping Existing Drainage Ditches
42. Recreational Facilities
43. Stormwater Management Facilities
44. Mining Activities

C. Nationwide Permit General Conditions

The following General Conditions must be followed in order for any authorization by an NWP to be valid:

1. *Navigation.* No activity may cause more than a minimal adverse effect on navigation.

2. *Proper Maintenance*. Any structure or fill authorized shall be properly maintained, including maintenance to ensure public safety.

3. *Soil Erosion and Sediment Controls*. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow.

4. *Aquatic Life Movements*. No activity may substantially disrupt the necessary life-cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. Culverts place in streams must be installed to maintain low flow conditions.

5. *Equipment.* Heavy equipment working in wetlands must be placed on mats, or other measures must be taken to minimize soil disturbance.

6. *Regional and Case-by-Case Conditions*. The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state or tribe in its Section 401 Water Quality Certification and Coastal Zone Management Act consistency determination.

7. *Wild and Scenic Rivers*. No activity may occur in a component of the National Wild and Scenic River System; or in a river officially designated by Congress as a "study river" for possible inclusion in the system, while the river is in an official study status; unless the appropriate Federal agency, with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely affect the Wild and Scenic River designation, or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency in the area (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service.)

8. *Tribal Rights.* No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

9. *Water Quality.*

   (a) In certain states and tribal lands an individual 401 Water Quality Certification must be obtained or waived {See 33 CFR 330.4(c)}.

(b) For NWP's 12, 14, 17, 18, 32, 39, 40, 42, 43, and 44, where the state or tribal 401 certification (either generically or individually) does not require or approve water quality management measures, the permittee must provide water quality management measures that will ensure that the authorized work does not result in more than minimal degradation of water quality (or the Corps determines that compliance with state or local standards, where applicable, will ensure no more than minimal adverse effect on water quality). An important component of water quality management includes stormwater management that minimizes degradation of the downstream aquatic system, including water quality (refer to General Condition 21 for stormwater management requirements). Another important component of water quality management is the establishment and maintenance of vegetated buffers next to open waters, including streams (refer to General Condition 19 for vegetated buffer requirements for the NWP's).

This condition is only applicable to projects that have the potential to affect water quality. While appropriate measures must be taken, in most cases it is not necessary to conduct detailed studies to identify such measures or to require monitoring.

10. *Coastal Zone Management*. In certain sates, an individual state coastal zone management consistency concurrence must be obtained or waived (see Section 330.4(d)).

11. *Endangered Species.*

(a) No activity is authorized under any NWP which is likely to jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will destroy or adversely modify the critical habitat of such species. Non-federal permittees shall notify the District Engineer if any listed species or designated critical habitat might be affected or is in the vicinity of the project, or is located in the designated critical habitat and shall not begin work on the activity until notified by the District Engineer that the requirements of the ESA have been satisfied and that the activity is authorized. For activities that may affect Federally-listed endangered or threatened species or designated critical habitat, the notification must include the name(s) of the endangered or threatened species that may be affected by the proposed work or that utilize the designated critical habitat that may be affected by the proposed work. As a result of formal or informal consultation with the FWS or NMFS the District Engineer may add species-specific regional endangered species conditions to the NWP's.

(b) Authorization of an activity by a NWP does not authorize the "take" of a threatened or endangered species as defined under the ESA. In the absence of separate authorization (e.g., an ESA Section 10 Permit, a Biological Opinion with "incidental take" provisions, etc.) from the USFWS or the NMFS, both lethal and non-lethal "takes" of protected species are in violation of the ESA. Information on the location of threatened an endangered species and their critical habitat can be obtained directly from the offices of the USFWS and NMFS or their world wide web pages at http://www.fws.gov/r9endspp/endspp.html and http://www.nfms.gov/prot_res/eashome.html respectfully.

12. *Historic Properties.* No activity which may affect historic properties listed, or eligible for listing, in the National Register of Historic Places is authorized, until the District Engineer has complied with the provisions of 33 CFR part 325, Appendix C. The prospective permittee must notify the District Engineer if the authorized activity may affect any historic properties listed, determined to be eligible, or which the prospective permittee has reason to be believe may be eligible for listing on the National Register of Historic Places, and shall not begin the activity until notified by the District Engineer that the requirements of the National Historic Preservation Act have been satisfied and that the activity is authorized. Information on the location and existence of historic resources can be obtained from the State Historic Preservation Office and the National Register of Historic Places (see 33 CFR 330.4(g)). For activities that may affect historic properties listed in, or eligible for listing in, the National Register of Historic Places, the notification must state which historic property may be affected by the proposed work or include a vicinity map indicating the location of the historic property.

13. *Notification*.

(a) *Timing;* where required by the terms of the NWP, the prospective permittee must notify the District Engineer with a preconstruction notification (PCN) as early as possible. The District Engineer must determine if the notification is complete within 30 days of the date of receipt and can request additional information necessary to make the PCN complete only once. However, if the prospective permittee does not provide all of the requested information, then the District Engineer will notify the prospective permittee that the notification is still incomplete and the PCN review process will not commence until all of the requested information has been received by the District Engineer. The prospective permittee shall not begin the activity:

(1) Until notified in writing by the District Engineer that the activity may proceed under the NWP with any special conditions imposed by the District or Division Engineer; or

(2) If notified in writing by the District or Division Engineer that an Individual Permit is required; or

(3) Unless 45 days have passed from the District Engineer's receipt of the complete notification and the prospective permittee has not received written notice from the District or Division Engineer. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

(b) *Contents of Notification:* The notification must be in writing and include the following information:

(1) Name, address and telephone numbers of the prospective permittee;

(2) Location of the proposed project;

(3) Brief description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause; any other NWP(s), Regional General Permit(s), or Individual Permit(s) used or intended to be used to authorize any part of the proposed project or any related activity. Sketches should be provided when necessary to show that the activity complies with the terms of the NWP (Sketches usually clarify the project and when provided result in a quicker decision.);

(4) For NWPs 7, 12, 14, 18, 21, 34, 38, 39, 40, 41, 42, and 43, the PCN must also include a delineation of affected special aquatic sites, including wetlands, vegetated shallows (e.g., submerged aquatic vegetation, seagrass beds), and riffle and pool complexes (see paragraph 13(f));

(5) For NWP 7 (Outfall Structures and Maintenance), the PCN must include information regarding the original design capacities and configurations of those areas of the facility where maintenance dredging or excavation is proposed;

(6) For NWP 14 (Linear Transportation Projects), the PCN must include a compensatory mitigation proposal to offset permanent losses of waters of the US and a statement describing how temporary losses of waters of the US will be minimized to the maximum extent practicable;

(7) For NWP 21 (Surface Coal Mining Activities), the PCN must include an Office of Surface Mining (OSM) or state-approved mitigation plan, if applicable. To be authorized by this NWP, the District Engineer must determine that the activity complies with the terms and conditions of the NWP and that the adverse environmental effects are minimal both individually and cumulatively and must notify the project sponsor of this determination in writing;

(8) For NWP 27 (Stream and Wetland Restoration Activities), the PCN must include documentation of the prior condition of the site that will be reverted by the permittee;

(9) For NWP 29 (Single-Family Housing), the PCN must also include:

(i) Any past use of this NWP by the Individual Permittee and/or the permittee's spouse;

(ii) A statement that the single-family housing activity is for a personal residence of the permittee;

(iii) A description of the entire parcel, including its size, and a delineation of wetlands. For the purpose of this NWP, parcels of land measuring ¼ -acre or less will not require a formal on-site delineation. However, the applicant shall provide an indication of where the wetlands are and the amount of wetlands that exists on the property. For parcels greater than ¼-acre in size, formal wetland delineation must be prepared in accordance with the current method required by the Corps. (See paragraph 13 (f));

(iv) A written description of all land (including, if available, legal descriptions) owned by the prospective permittee and/or the prospective permittee's spouse, within a one mile radius of the parcel, in any form of ownership (including any land owned as a partner, corporation, joint tenant, co-tenant, or as a tenant-by-the-entirety) and any land on which a purchase and sale agreement or other contract for sale or purchase has been executed;

(10) For NWP 31 (Maintenance of Existing Flood Control Facilities), the prospective permittee must either notify the District Engineer with a PCN prior to each maintenance activity or submit a five year (or less) maintenance plan. In addition, the PCN must include all of the following:

(i) Sufficient baseline information identifying the approved channel depths and configurations and existing facilities. Minor deviations are authorized, provided the approved flood control protection or drainage is not increased;

(ii) A delineation of any affected special aquatic sites, including wetlands; and,

(iii) Location of the dredged material disposal site;

(11) For NWP 33 (Temporary Construction, Access, and Dewatering), the PCN must also include a restoration plan of reasonable measures to avoid and minimize adverse effects to aquatic resources;

(12) For NWPs 39, 43 and 44, the PCN must also include a written statement to the District Engineer explaining how avoidance and minimization for losses of waters of the US were achieved on the project site;

(13) For NWP and NWP 42, the PCN must include a compensatory mitigation proposal to offset losses of waters of the US or justification explaining why compensatory mitigation should not be required. For discharges that cause the loss of greater than 300 linear feet of an intermittent stream bed, to be authorized, the District Engineer must determine that the activity complies with the other terms and conditions of the NWP, determine adverse environmental effects are minimal both individually and cumulatively, and waive the limitation on stream impacts in writing before the permittee may proceed;

(14) For NWP 40 (Agricultural Activities), the PCN must include a compensatory mitigation proposal to offset losses of waters of the US. This NWP does not authorize the relocation of greater than 300 linear-feet of existing serviceable drainage ditches constructed in non-tidal streams unless, for drainage ditches constructed in intermittent non-tidal streams, the District Engineer waives this criterion in writing, and the District Engineer has determined that the project complies with all terms and conditions of this NWP, and that any adverse impacts of the project on the aquatic environment are minimal, both individually and cumulatively;

(15) For NWP (Stormwater Management Facilities), the PCN must include, for the construction of new stormwater management facilities, a maintenance plan (in accordance with state and local requirements, if applicable) and a compensatory mitigation proposal to offset losses of waters of the US. For discharges that cause the loss of greater than 300 linear feet of an intermittent stream bed, to be authorized, the District Engineer must determine that the activity complies with the other terms and conditions of the NWP, determine adverse environmental effects are minimal both individually and cumulatively, and waive the limitation on stream impacts in writing before the permittee may proceed;

(16) For NWP 44 (Mining Activities), the PCN must include a description of all waters of the US adversely affected by the project, a description of measures taken to minimize adverse effects to waters of the US, a description of measures taken to comply with the criteria of the NWP, and a reclamation plan (for all aggregate mining activities in isolated waters and non-tidal wetlands adjacent to headwaters and any hard rock/mineral mining activities);

(17) For activities that may adversely affect Federally-listed endangered or threatened species, the PCN must include the name(s) of those endangered or threatened species that may be affected by the proposed work or utilize the designated critical habitat that may be affected by the proposed work; and

(18) For activities that may affect historic properties listed in, or eligible for listing in, the National Register of Historic Places, the PCN must state which historic property may be affected by the proposed work or include vicinity map indicating the location of the historic property.

(c) *Form of Notification*: The standard Individual Permit application form (Form ENG 4345) may be used as the notification but must clearly indicate that it is a PCN and must include all of the information required in (b) (1)-(18) of General Condition 13. A letter containing the requisite information may also be used.

(d) *District Engineer's Decision*: In reviewing the PCN for the proposed activity, the District Engineer will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. The prospective permittee may submit a proposed mitigation plan with the PCN to expedite the process. The District Engineer will consider any proposed compensatory mitigation the applicant has included in the proposal in determining whether the net adverse environmental effects to the aquatic environment of the proposed work are minimal. If the District Engineer determines that the activity complies with the terms and conditions of the NWP and that the adverse effects on the aquatic environment are minimal, after considering mitigation, the District Engineer will notify the permittee and include any conditions the District Engineer deems necessary. The District Engineer must approve any compensatory mitigation proposal before the permittee commences work. If the prospective permittee is required to submit a compensatory mitigation proposal with the PCN, the proposal may be either conceptual or detailed. If the prospective permittee elects to submit a compensatory mitigation plan with the PCN, the District Engineer will expeditiously review the proposed compensatory mitigation plan. The District Engineer must review the plan with 45 days of receiving a complete PCN and determine whether the conceptual or specific proposed mitigation would ensure no more than minimal adverse effects on the aquatic environment. If the net adverse effects of the project on the aquatic environment (after consideration of the compensatory mitigation proposal) are determined by the District Engineer to be minimal, the District Engineer will provide a timely written response to the applicant. The response will state that the project can proceed under the terms and conditions of the NWP.

If the District Engineer determines that the adverse effects of the proposed work are more than minimal, then the District Engineer will notify the applicant either: (1) That the project does not qualify for authorization under the NWP and instruct the applicant on the procedures to seek authorization under an Individual Permit; (2) that the project is authorized under the NWP subject to the applicant's submission of a mitigation proposal that would reduce the adverse effects on the aquatic environment to the minimal level; or (3) that the project is authorized under the NWP with specific modifications or conditions. Where the District Engineer determines that mitigation is required to ensure no more than minimal adverse effects occur to the aquatic environment, the activity will be authorized within the 45-day PCN period. The authorization will include the necessary conceptual or specific mitigation or a requirement that the applicant submit a mitigation proposal that would reduce the adverse effects on the aquatic environment to the minimal level. When conceptual mitigation is included, or a mitigation plan is required under item (2) above, no work in waters of the US will occur until the District Engineer has approved a specific mitigation plan.

(e) *Agency Coordination*: The District Engineer will consider any comments from Federal and state agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the project's adverse environmental effects to a minimal level.

For activities requiring notification to the District Engineer that result in the loss of greater than ½-acre of waters of the US, the District Engineer will provide immediately (e.g., via facsimile transmission, overnight mail, or other expeditious manner) a copy to the appropriate Federal or state offices (USFWS, state natural resource or water quality agency, EPA, State Historic Preservation Officer (SHPO), and, if appropriate, the NMFS). With the exception of NWP 37, these agencies will then have 10 calendar days from the date the material is transmitted to telephone or fax the District Engineer notice that they intend to provide substantive, site-specific comments. If so contacted by an agency, the District Engineer will wait an additional 15 calendar days before making a decision on the notification. The District Engineer will fully consider agency comments received with the specified time frame, but will provide no response to the resource agency, except as provided below. The District Engineer will indicate in the administrative record associated with each notification that the resource agencies' concerns were considered. As required by section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act, the District Engineer will provide a response to NMFS within 30 days of receipt of any Essential Fish Habitat conservation recommendations. Applicants are encouraged to provide the Corps multiple copies of notifications to expedite agency notification.

(f) Wetland *Delineations:* Wetland delineations must be prepared in accordance with the current method required by the Corps (For NWP 29 see paragraph (b)(9)(iii) for parcels less than (1/4-acre in size). The permittee may ask the Corps to delineate the special aquatic site. There may be some delay if the Corps does the delineation. Furthermore, the 45-day period will not start until the wetland delineation has been completed and submitted to the Corps, where appropriate.

14. *Compliance Certification*. Every permittee who has received NWP verification from the Corps will submit a signed certification regarding the completed work and any required mitigation. The certification will be forwarded by the Corps with the authorization letter and will include:

(a) A statement that the authorized work was done in accordance with the Corps authorization, including any general or specific conditions;

(b) A statement that any required mitigation was completed in accordance with the permit conditions; and

(c) The signature of the permittee certifying the completion of the work and mitigation.

15. *Use of Multiple Nationwide Permits*. The use of more than one NWP for a single and complete project is prohibited, except when the acreage loss of waters of the US authorized by the NWPS does not exceed the acreage limit of the NWP with the highest specified acreage limit (e.g. if a road crossing over tidal waters is constructed under NWP 14, with associated bank stabilization authorized by NWP 13, the maximum acreage loss of waters of the US for the total project cannot exceed 1/3-acre).

16. *Water Supply Intakes*. No activity, including structures and work in navigable waters of the US or discharges of dredged or fill material, may occur in the proximity of a public water supply intake except where the activity is for repair of the public water supply intake structures or adjacent bank stabilization.

17. *Shellfish Beds.* No activity, including structures and work in navigable waters of the US or discharges of dredged or fill material, may occur in areas of concentrated shellfish populations, unless the activity is directly related to a shellfish harvesting activity authorized by NWP 4.

18. *Suitable Material*. No activity, including structures and work in navigable waters of the US or discharges of dredged or fill material, may consist of unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.) and material used for construction or discharged must be free from toxic pollutants in toxic amounts (see section 307 of the CWA).

19. *Mitigation*. The District Engineer will consider the factors discussed below when determining the acceptability of appropriate and practicable mitigation necessary to offset adverse effects on the aquatic environment that are more than minimal.

(a) The project must be designed and constructed to avoid and minimize adverse effects to waters of the US to the maximum extent practicable at the project site (i.e. on site).

(b) Mitigation in all its forms (avoiding, minimizing, rectifying, reducing or compensating) will be required to the extent necessary to ensure that the adverse effects to the aquatic environment are minimal.

(c) Compensatory mitigation at a minimum on-for-one ratio will be required for all wetland impacts requiring a PCN, unless the District Engineer determines in writing that some other form of mitigation would be more environmentally appropriate and provides a project-specific waiver of this requirement. Consistent with National policy, the District Engineer will establish a preference for restoration of wetlands as compensatory mitigation, with preservation used only in exceptional circumstances.

(d) Compensatory mitigation (i.e., replacement or substitution of aquatic resources for those impacted) will not be used to increase the acreage losses allowed by the acreage limits of some of the NWPs. For example, ¼-acre of wetlands cannot be created to change a ¾-acre loss of wetlands to a ½-acre loss associated with NWP 39 verification. However, ½-acre of created wetlands can be used to reduce the impacts of a ½-acre loss of wetlands to the minimum impact level in order to meet the minimal impact requirement associated with NWPS.

(e) To be practicable, the mitigation must be available and capable of being done considering costs, existing technology, and logistics in light of the overall project purposes. Examples of mitigation that may be appropriate and practicable include, but are not limited to: reducing the size of the project; establishing and maintaining wetland or upland vegetated buffers to protect open waters such as streams; and replacing losses of aquatic resource functions and values by creating, restoring, enhancing, or preserving similar functions and values, preferably in the same watershed.

(f) Compensatory mitigation plans for projects in or near streams or other open waters will normally include a requirement for the establishment, maintenance, and legal protection (e.g., easements, deed restrictions) of vegetated buffers to open waters. In many cases, vegetated buffers will be the only compensatory mitigation required. Vegetated buffers should consist of native species. The width of the vegetated buffers required will address documented water quality or aquatic habitat loss concerns. Normally, the vegetated buffer will be 25 to 50 feet wide on each side of the stream, but the District Engineers may require slightly wider vegetated buffers to address documented water quality or habitat loss concerns. When both wetlands and open waters exist on the project site, the Corps will determine the appropriate compensatory mitigation (e.g., stream buffers or wetlands compensation) based on what is best for the aquatic environment on a watershed basis. In cases where vegetated buffers are determined to be the most appropriate form of compensatory mitigation, the District Engineer may waive or reduce the requirement to provide wetland compensatory mitigation for wetland impacts.

(g) Compensatory mitigation proposals submitted with the "notification" may be either conceptual or detailed. If conceptual plans are approved under the verification, then the Corps will condition the verification to require detailed plans be submitted and approved by the Corps prior to construction of the authorized activity in waters of the US.

(h) Permittees may propose the use of mitigation banks, in-lieu fee arrangements or separate activity-specific compensatory mitigation. In all cases that require compensatory mitigation, the mitigation provisions will specify the party responsible for accomplishing and/or complying with the mitigation plan.

20. *Spawning Areas*. Activities, including structures and work in navigable waters of the US or discharges of dredged or fill material, in spawning areas during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., excavate fill, or smother downstream by substantial turbidity) of an important spawning area are not authorized.

21. *Management of Water Flows*. To the maximum extent practicable, the activity must be designed to maintain preconstruction downstream flow conditions (e.g., location, capacity, and flow rates). Furthermore, the activity must not permanently restrict or impede the passage of normal or expected high flows (unless the primary purpose of the fill is to impound waters) and the structure or discharge of dredged or fill material must withstand expected high flows. The activity must, to the maximum extent practicable, provide for retaining excess flows from the site, provide for maintaining surface flow rates from the site similar to preconstruction conditions, and provide for not increasing water flows from the project site, relocating water, or redirecting water flow beyond preconstruction conditions. Stream channelizing will be reduced to the minimal amount necessary, and the activity must, to the maximum extent practicable, reduce adverse effects such as flooding or erosion downstream and upstream of the project site, unless the activity is part of a larger system designed to manage water flows. In most cases, it will not be a requirement to conduct detailed studies and monitoring of water flow.

This condition is only applicable to projects that have the potential to affect waterflows. While appropriate measures must be taken, it is not necessary to conduct detailed studies to identify such measures or require monitoring to ensure their effectiveness. Normally, the Corps will defer to state and local authorities regarding management of water flow.

22. *Adverse Effects From Impoundments*. If the activity creates an impoundment of water, adverse effects to the aquatic system due to the acceleration of the passage of water, and/or the restricting its flow shall be minimized to the maximum extent practicable. This includes structures and work in navigable waters of the US, or discharges of dredged or fill material.

23. *Waterfowl Breeding Areas*. Activities, including structures and work in navigable waters of the US or discharges of dredged or fill material, into breeding areas for migratory waterfowl must be avoided to the maximum extent practicable.

24. *Removal of Temporary Fills*. Any temporary fills must be removed in their entirety and the affected areas returned to their preexisting elevation.

25. *Designated Critical Resource Waters*. Critical resource waters include, NOAA-designated marine sanctuaries, National Wild and Scenic Rivers, critical habitat for Federally listed threatened and endangered species, coral reefs, state natural heritage sites, and outstanding national resource waters or other waters officially designated by a state as having particular environmental or ecological significance and identified by the District Engineer after notice and opportunity for public comment. The District Engineer may also designate additional critical resource waters after notice and opportunity for comment.

(a) Except as noted below, discharges of dredged or fill material into waters of the US are not authorized by NWPS 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, and 44 for any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters. Discharges of dredged or fill materials into waters of the US may be authorized by the above NWPs in National Wild and Scenic Rivers if the activity complies with General Condition 7. Further, such discharges may be authorized in designated critical habitat for Federally listed threatened or endangered species if the activity complies with General Condition 11 and USFWS or the NMFS has concurred in a determination of compliance with this condition.

(b) For NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, and 38, notification is required in accordance with General Condition 13, for any activity proposed in the designated critical resource waters including wetlands adjacent to those waters. The District Engineer may authorize activities under these NWPs only after it is determined that the impacts to the critical resource waters will be no more than minimal.

26. *Fills Within 100-Year Floodplain*. For purposes of this General Condition, 100-year floodplains will be identified through the existing Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps or FEMA-approved local floodplain maps.

(a) *Discharges in Floodplain; Below Headwaters.* Discharges of dredged or fill material into waters of the US within the mapped 100-year floodplain, below headquarters (i.e. five cfs), resulting in permanent above-grade fills, are not authorized by NWPs 39, 40, 42, 43, and 44.

(b) *Discharges in Floodway; Above Headwaters*. Discharges of dredged or fill material into waters of the US within the FEMA or locally mapped floodway, resulting in permanent above-grade fills, are not authorized by NWPs 39, 40, 42, and 44.

(c) The permittee must comply with any applicable FEMA-approved state or local floodplain management requirements.

27. *Construction Period*. For activities that have not been verified by the Corps and the project was commenced or under contract to commence by the expiration date of the NWP (or modification or revocation date), the work must be completed within 12-months after such date (including any modification that affects the project).

For activities that have been verified and the project was commenced or under contract to commence within the verification period, the work must be completed by the date determined by the Corps.

For projects that have been verified by the Corps, an extension of a Corps approved completion date maybe requested. This request must be submitted at least one month before the previously approved completion date.

APPENDIX A

COAL BANK SLOUGH

SURFACE CONDITIONS

The Coal Bank Slough crossing is located near the mouth of the slough and the confluence with Isthmus Slough in Coos Bay, Oregon, as shown in Figure 1. Specifically, we understand that the planned crossing will be located near the south side of the Highway 101 bridge, approximately beneath the location of the old bridge. On the east end of the crossing, west-facing slopes descend moderately towards the slough. The slope is dissected with paved and gravel covered roads. Timber piles are scattered along the east bank. The slopes on both sides have been oversteepened by fill placed for the bridge abutments. The west side of the crossing consists of grass covered slopes that descend gently to the east towards the slough.

SUBSURFACE EXPLORATION AND LABORATORY TESTING

We explored subsurface conditions at the site by drilling one boring at each end of the crossing at the approximate locations shown in Figure A-1. Our interpretation of the subsurface profile along the bore alignment is presented in Cross Section A-A', Figure A-2.

The boring logs are presented in Figures A-3 and A-4. The materials observed were classified in the field in accordance with ASTM Standard Practice D 2488, which is described in Figure A-5. Figure A-6 provides a description of the boring log form. Soil classifications and sampling intervals are shown on the boring logs. Inclined lines at the material contacts shown on the log indicate uncertainty as to the exact contact elevation, rather than the inclination of the contact itself.

Laboratory testing included moisture and density determination, soil particle size gradation, Atterberg limits determination, and unconfined compression tests. Test results are presented in Figures A-7 through A-10.

SUBSURFACE CONDITIONS

Subsurface conditions at the site generally consist of about 18 feet of sand and silt fill overlying soft elastic silt to a depth of 70 feet, where medium stiff clay was encountered to a depth of 80 feet. Underlying the clay, soft siltstone was encountered to a depth of at least 81 feet, the maximum depth explored. The following paragraphs provide a more detailed description of the soil units that were encountered.

Mixed Fill

We encountered fill composed of elastic silt with sand and occasional wood fragments to a depth of about 18 feet in boring B-4 at the east side of the slough. The fill is medium stiff, based on standard penetration test (SPT) results. We encountered loose silty sand fill on the west side of the slough to a depth of about 20 feet in boring B-3.

Elastic Silt

Underlying the fill, we encountered dark gray elastic silt from a depth of about 20 feet to a depth of approximately 70 feet. The silt contains occasional fine sand, shell fragments, and wood fragments. The silt is soft to medium stiff based on unconfined compression test results and SPT results.

Silty Clay

Underlying the silt, we encountered gray silty clay from a depth of 70 to 80 feet. The clay is medium stiff, based on SPT results.

Siltstone

Underlying the clay, we encountered dark gray soft siltstone to a depth of about 80.7 feet. However, this unit is too deep to affect the planned crossing.

CONCLUSIONS AND RECOMMENDATIONS

The following conditions will likely affect design and construction of the planned Coal Bank Slough directional bore.

1. The work areas at the planned bore entry and exit points are relatively small, and may impede or slow staging and mud processing operations. Special material handling procedures and erosion control methods will likely be required to export drill spoils.
2. Horizontal borings will encounter mostly soft silt and fill at the entrance and exit locations. The soft silt along the alignment can be drilled using conventional directional boring equipment and techniques.
3. Due to the low strength of the silt, it may be susceptible to hydrofracturing at standard drilling fluid pressures along the entire alignment that may result in soil collapse and mudloss. The directional bore contractor should plan for contingencies should borehole stability problems be encountered during drilling. Such measures may include reduced drilling fluid pressures, casing, and drilling fluid admixtures.
4. The path of the directional bore may be difficult to maintain in the soft silt and loose sand. The directional bore contractor should plan for any contingencies associated with difficulties in keeping the cutting bit and drill string on path.
5. The Directional Crossing Contractors Association recommends a minimum depth of cover of 20 feet for river crossings. Assuming standard drilling pressures, and a skilled drilling operator, it is our opinion that with at least 20 feet of cover, the risk of hydrofracturing resulting in mud loss to the slough is low.
6. There is the potential to encounter buried wood debris, timber piles, or other obstructions along the bore alignment, especially on the east side.

APPENDIX B

PONY CREEK AT VIRGINIA AVENUE

SURFACE CONDITIONS

The Pony Creek (Virginia Avenue) crossing is located at the mouth of Pony Creek at its confluence with Coos Bay in North Bend, Oregon. Specifically, the crossing is planned within the city right-of-way at the north side of Virginia Avenue. The east side of the crossing is occupied by a vacant restaurant building and an asphalt parking lot. The west side of the crossing is an undeveloped right-of-way vegetated with grass. Site topography is flat.

SUBSURFACE EXPLORATION AND LABORATORY TESTING

We explored subsurface conditions at the site by drilling one boring at each end of the crossing at the approximate locations shown in Figure B-1. Our interpretation of the subsurface profile along the bore alignment is presented in Cross Section B-B', Figure B-2.

The boring logs are presented in Figures B-3 and B-4. The materials observed were classified in the field in accordance with ASTM Standard Practice D 2488, which is described in Figure B-5. Figure B-6 provides a description of the boring log form. Soil classifications and sampling intervals are shown on the boring logs. Inclined lines at the material contacts shown on the log indicate uncertainty as to the exact contact elevation, rather than the inclination of the contact itself.

Laboratory testing included moisture and density determination, one soil particle size gradation, and one unconfined compression test. Test results are presented in Figures B-7 and B-8.

SUBSURFACE CONDITIONS

Subsurface conditions at the site generally consist of about 20 feet of sand and silt fill overlying soft elastic silt to a depth of 31.5 feet, the maximum depth explored. The following paragraphs provide a more detailed description of the soil units that were encountered.

Sand and Silt Fill

We encountered silty fine sand and poorly graded sand fill with occasional fine gravel and wood debris to a depth of about 20 feet. A layer of soft silt was encountered from 10 to 12 feet below ground surface. The sand is very loose on the east side of the crossing and medium dense on the west side of the crossing based on standard penetration test (SPT) results.

Elastic Silt

Underlying the fill, we encountered elastic silt to a depth of about 31.5 feet. The silt is soft, based on unconfined compression test results and SPT results.

CONCLUSIONS

The following conditions will likely affect design and construction of the planned Pony Creek directional bore at Virginia Avenue.

1. The work areas at the planned bore entry and exit points are relatively small, and may impede or slow staging and mud processing operations. Special material handling procedures and erosion control methods will likely be required to export drill spoils.
2. Drilling will likely be completed in loose sand and soft silt along the alignment. This loose sand and soft silt can be drilled using conventional directional boring equipment and techniques.
3. Due to the low strength of the silt and sand, it may be susceptible to hydrofracturing at standard drilling fluid pressures along the entire alignment that may result in soil collapse and mudloss. The directional bore contractor should plan for contingencies should borehole stability problems be encountered during drilling. Such measures may include reduced drilling fluid pressures, mud admixtures, or casing.
4. The path of the directional bore may be difficult to maintain in the soft silt and loose sand. The directional bore contractor should plan for any contingencies associated with difficulties in keeping the cutting bit and drill string on path.
5. The Directional Crossing Contractors Association recommends a minimum depth of cover of 20 feet for river crossings. Assuming standard drilling fluid pressures, it is our opinion that the risk of hydrofracturing beneath the stream channel with at least 20 feet of cover is low.
6. There is moderate potential for soil collapse around the drill string within the loose sand. The directional bore contractor should plan for contingencies should borehole stability problems be encountered during drilling.

APPENDIX E

COOS BAY

SURFACE CONDITIONS

The east end of the Coos Bay crossing is located within a mixed residential/commercial neighborhood in Empire, Oregon. Slopes descend gently to the west towards Coos Bay. Timber piles are located along the east shore of Coos Bay.

The west end of the crossing is located at the north spit sand dunes near an aquaculture facility. We anticipate that the exit/entry point of the bore will be within the developed portion of the dunes that has been graded flat and appears generally stable. The west bank of the bay is protected by rock riprap and concrete debris. West of the developed aquaculture, the dunes are well vegetated with conifer trees and shrubs. There are localized dunes outside of the project area on the spit that are not vegetated and are prone to migration.

SUBSURFACE EXPLORATION AND LABORATORY TESTING

We explored subsurface conditions at the site by drilling one boring at each end of the crossing and drilling two over-water borings within Coos Bay along the planned alignment at the approximate locations shown in Figure E-1. Our interpretation of the subsurface profile along the bore alignment is presented in Cross Section E-E', Figure E-2.

The boring logs are presented in Figures E-3 through E-6. The materials observed were classified in the field in general accordance with ASTM Standard Practice D 2488 and the Unified Rock Classification System (URCS), which are described in Figures E-7 and E-8, respectively. Figure E-9 provides a description of the boring log form. Soil classifications and sampling intervals are shown on the boring logs. Inclined lines at the material contacts shown on the log indicate uncertainty as to the exact contact elevation, rather than the inclination of the contact itself.

Laboratory testing included moisture and density determination, two fines content determinations, and two unconfined compression tests. Unconfined compression test results are presented in Figures E-10 and E-11.

SUBSURFACE CONDITIONS

Subsurface conditions along the planned crossing alignment generally consists of 25 to 80 feet of medium dense to very dense sand at the east and west ends of the crossing, respectively. Underlying the sand, very soft siltstone with interbeds of soft sandstone was encountered to a depth of 100 feet, the maximum depth explored.

Sand

We encountered sand with silt to varying depths in all four explorations. The sand is medium dense to dense based on standard penetration test (SPT) results.

Siltstone

Underlying the sand, we encountered gray siltstone occasionally interbedded with sandstone. As shown in Figure E-4, the siltstone unit appears to dip consistently to the west, being encountered at a depth of about 25 feet and 82 feet, from east to west, respectively. The siltstone was penetrated relatively easily at a rate of about 10 feet per hour using mud-rotary drilling equipment with a tri-cone drill bit. The siltstone and sandstone is friable according to the URCS and based on unconfined compression test results.

CONCLUSIONS

The following conditions will likely affect design and construction of the planned ~~Coal Bank Slough~~ Coos Bay directional bore.

1. The sand and soft siltstone and sandstone along the alignment can be drilled using conventional directional boring equipment and techniques.
2. Due to the low strength of the loose surficial sand, it may be susceptible to hydrofracturing at standard drilling fluid pressures in the vicinity of the entry point and exit points, where overburden pressures are relatively low.
3. The Directional Crossing Contractors Association recommends a minimum depth of cover of 20 feet for river crossings. Assuming standard drilling pressures, it is our opinion that with at least 20 feet of cover, the risk of hydrofracturing resulting in mud loss to the bay is low. 35 ft. min. depth
4. More than 20 feet of cover may be required to maintain the pipeline sufficiently below potential future dredging depth. The surface profile along the planned crossing uses bathymetry data provided by the U.S. Army Corps of Engineers. We recommend that a site-specific survey be conducted along the planned crossing alignment to determine the maximum depth of water within the bay.
5. There is moderate potential for soil collapse around the drill string within the loose sand, particularly on the west side of the bore. The directional bore contractor should plan for contingencies should borehole stability problems be encountered during drilling.
6. There is potential to encounter buried timber piles or other obstructions along the bore alignment, especially on the east side. Based on discussions with local pile driving contractors and our experience, the timber piles in the area are driven into dense sand typically no more than 25 feet below ground surface and typically do not penetrate the siltstone. We have plotted the anticipated maximum depth at which timber piles would have been driven based on the subsurface conditions and plotted them on the cross section E-E' in Figure E-2. We recommend that the bore alignment be designed to pass well below the anticipated maximum depth of piles.

Frac-out Mitigation Procedures

To minimize the potential of natural resource damages, the following procedures must be followed during a horizontal directional drill.

- A spotter must be stationed to observe any crossing, stream or wetland, that is being bored and notify the drill operator immediately of any presence of drilling mud.
- The drill operator must constantly monitor gauge pressures and immediately cease operations upon a sudden drop in mud pump pressure.

In the event of a release of drilling mud (bentonite) as a result of boring operations during pipeline construction, the boring operation will be stopped until the following procedures are completed.

- A siltation fence will be immediately placed around the vent in a manner that will provide full encirclement.
- The siltation fence will be installed in a manner that ensures the bottom edges of the fence material provide a tight seal.
    - The bottom edges can be sealed using native materials such as mud, sands, or streambed rocks.
    - In the absence of native materials, or where moving native materials would produce excessive turbidity, clean sand bags may be used to seal the fence bottom.

- Drilling mud will then be allowed to vent into the siltation fence containment enclosure throughout the drilling process.

- To ensure the integrity of the siltation fence enclosure, drilling mud will be pumped from the containment area.
    - Drilling mud removal equipment choice depends on accessibility to the containment area, a vacuum truck or pump will be utilized.

- The containment enclosure will remain in place throughout the entire drilling operation including pilot hole, back reaming, and pipe pulling.
- Upon completion of the pipe pulling, the containment enclosure will remain in place to ensure the vent has sealed. The enclosure could remain in place for a couple of hours, a couple of days, or up to a week. **The enclosure is to remain in place until all venting of drilling mud is complete**.
- When venting of mud is complete, the enclosure will be removed in a manner that provides the least amount of disturbance to the surrounding natural resource. The natural resource area must be fully restored.

Figures

1.0 INTRODUCTION

On behalf of the North Bend Water Board and NW Natural, this wetland mitigation plan is prepared for the US Army Corps of Engineers (Corps). This project would temporarily impact wetland functions and values due to the disturbance of soil and removal of vegetation during the construction and installation of buried water and natural gas pipelines.

The project would temporarily impact approximately 0.012 acre of a drainage channel and 0.27 acre of associated riparian area. In accordance with Section 404 of the Clean Water Act, the Coos Bay - North Bend Water Board and NW Natural would offset the temporary loss of wetland function and values by restoring functions and values to the impacted areas upon completion of the project.

Originally the bore pad was designed to remain outside of the drainage ditch and the riparian area, but due to easement constraints, the area is now needed. The easement offered by the property owner required an approximate 20 degree bend from the bore pad to the easement acquired across the bay. To facilitate the installation of all 3 pipelines, a straighter approach is required, hence the request for the temporary impact to the drainage and the riparian zone which is adjacent to, but outside of the permanent easement.

2.0 PROJECT DESCRIPTION

The North Bend Water Board plans to install 2 – 24 inch polyethylene water lines along with a 12 inch natural gas line across Coos Bay. The pipelines would provide both water and natural gas service from the city of Coos Bay to the North Spit area.

This crossing is a joint effort by the Coos Bay - North Bend Water Board and NW Natural to minimize impacts, costs, materials, and easements to better service the local communities of Coos Bay and North Bend. All three pipelines will be horizontally directionally drilled under the bay from the same bore pad, combined purchasing of pipe for greater savings, utilizing the same drilling contractor, and all within a common easement.

2.1 PROJECT LOCATION

The proposed bay crossing is located in the NW Corner of Section 20, Township 25S, Range 13W adjacent to a boat dock north of Newmark Avenue and between Mill Street and Ross Street. The bore pad location is at the westerly edge of a graveled parking lot for local businesses.

2.2 RESPONSIBLE PARTIES

Applicant:	Coos Bay-North Bend Water Board 2305 Ocean Boulevard Coos Bay, Oregon 97420-0108 <u>Contact</u>: Rob K. Schab 541.269.5370	NW Natural 220 NW Second Avenue Portland, Oregon 97209 Michael J. Hayward 503.226.4211 x 4327

2.3 TEMPORARY IMPACTS AND COMPENSATION

Construction of the pipelines would temporarily impact a drainage channel and 0.27 acre of associated riparian area. The total wetland impact area would be approximately 0.012 acres. Construction would not impact any other identified waterways/other waters. These impacts were either considered unavoidable due to engineering and/or geographic limitations or other reasons as described in Section 1.0. No grading will take place at the bore pad location.

To offset the impacts during construction, the Coos Bay-North Bend Water Board and NW Natural are proposing to restore areas disturbed during the pipeline construction activities by re-vegetating disturbed areas with salvaged plant material, new plant material and/or applying native seed. Except for repairs and maintenance, there are no anticipated impacts to wetlands and waterways/other waters during operation of the pipeline. To the extent that repairs and maintenance result in disturbance, the Coos Bay-North Bend Water Board and NW Natural will adhere to the mitigation goals in Section 4.1 and otherwise follow the proposed mitigation for soils, hydrology, vegetation, and waterways outlined in Section 5.0.

2.4 INITIAL STEPS TAKEN TO AVOID AND MINIMIZE IMPACTS TO WETLANDS

NW Natural conducted a rigorous selection study to identify a corridor within which a specific route could be chosen for the pipeline alignment. To prepare for review and certification by federal, state, and local agencies, NW Natural established the following criteria for the corridor selection process:

- Incorporate all relevant rules and regulations.
- Address key regulatory, public acceptance, engineering, and cost factors.
- Use a rigorous, understandable, fair process for evaluating alternatives.

During the selection study, the Coos Bay-North Bend Water Board approached NW Natural about a joint project to perform a bay crossing with 2 additional pipelines. The joint project was designed to minimize impacts and maximize utility service.

4.0 MITIGATION APPROACH

The first priority of mitigation is avoidance of wetlands and other waters. The second priority is to minimize impacts to unavoidable wetlands and other waters by routing the pipeline to areas of lower quality.

Because of the desire to minimize impacts to the drainage, no permanent impacts are proposed within the pipeline route. Short-term losses attributed to the temporary disturbance of vegetation during the pipeline installation could be mitigated.

The Coos Bay-North Bend Water Board and NW Natural would mitigate for these temporary disturbances onsite and in-kind, which is the preferred method. Except for repairs and maintenance, there are no anticipated impacts to wetlands and waterways during operation of the pipelines. To the extent that any repairs and maintenance result in disturbance, protocol would be to adhere to the mitigation goals in Section 4.1 and otherwise follow the proposed mitigation for vegetation, outlined in Section 5.0.

4.1 MITIGATION GOALS

Mitigation goals were established to minimize the duration of the loss of drainage and other water functions and to ensure restoration of wetland and other waters functions. Included below are descriptions of the general mitigation measures proposed to avoid, minimize, or replace short-term construction losses to the drainage functions:

- Avoid wetlands and other waters/waterways where practicable
- Avoid important wetland and other waters/waterway habitat for endangered species.
- Minimize the width of the construction corridor in riparian areas, and waterways.
- Avoid construction in and waterways during critical life stages of endangered species or during seasons when such species are known to occur.
- Remove all rock and matting and restore the site immediately after completion of construction.
- Restore vegetation structure in impacted areas by replanting vegetation salvaged during the pipeline's installation. For areas with vegetation, a native seed mix may be applied to the site to encourage establishment of native vegetation.
- Restore drainage channels to pre-construction condition, if damaged.

4.2 PERFORMANCE STANDARDS

To gauge the success of the restoration after construction is complete, performance standards have been established. These standards would be monitored and assessed during the regularly scheduled site-monitoring visits. If the standards are not met by the second year, contingency measures would be initiated as described in Section 7.0.

Year 1: Soil, and in-water features shall be restored to pre-construction conditions. Restore vegetation structure to pre-construction structure by replanting vegetation after the directional drilling activities and applying an approved native vegetation seed mix where appropriate.

Year 2: Soil, and in-water features shall resemble pre-construction conditions with no visible signs of significant soil erosion caused by the pipeline construction. The vegetation community shall provide similar coverage and compositions compared to pre-construction conditions with an 80% survival rate..

5.0 PROPOSED MITIGATION

This section describes the proposed mitigation, which focuses on minimizing impacts and restoring temporary unavoidable construction impacts to vegetation within the drainage and associated riparian zone. Except for repairs and maintenance, there are no anticipated impacts to wetlands and waterways during operation of the pipelines. Except for repairs and maintenance, there are no anticipated impacts to wetlands and waterways during operation of the pipelines. To the extent that any repairs and maintenance result in disturbance, protocol would be to adhere to the mitigation goals in Section 4.1 and otherwise follow the proposed mitigation for vegetation, outlined in Section 5.0.

5.3 VEGETATION

Vegetation would be mowed and covered with rock during construction activities. Red Alder would be promptly replanted at random intervals upon the removal of rock at a 2:1 offset ratio. After installation of the vegetation, disturbed areas may be seeded with a mix of sterile erosion control grass, and/or an approved native seed mix. Disturbed riparian areas would be replanted with a mixture of native grasses and trees to provide soil stabilization and shade. To ensure survivability, monthly site visits during the drier months, June through October, will be performed to monitor vitality and to irrigate if necessary.

6.0 MONITORING

Coos Bay-North Bend Water Board will conduct monitoring that will determine whether the mitigation proposed for the project is successful at offsetting the temporary impacts that are anticipated to occur during the construction. Coos Bay-North Bend Water Board shall provide annual monitoring reports that:

- Include supporting data needed to document the status of the project.
- Monitor the impacted areas during the first and second years following mitigation.

Regularly scheduled monitoring would take place each year to gather data for the monitoring reports. The annual reports would be submitted to the Corps. The initial site-monitoring visit would establish permanent vegetation sampling transects that would provide a representation of the restored area. At a minimum, monitoring visits would include:

- Vegetation sampling that provides information on tree survival.
- Planted vegetation would be classified by condition (e.g., vigor, survival, stress, and death)
- Maintenance concerns.
- Fixed photo points.

7.0 MAINTENANCE AND CONTINGENCY PLAN

After the completion of the pipeline installation, the Coos Bay-North Bend Water Board would maintain the mitigation area such that the impacted drainage and riparian zone function equal to or surpass pre-construction functions for a period of two years. Sites would be monitored during the first and second year from the time the plantings have been replanted. Problems identified during the monitoring period would be addressed as soon as practicable.

If, by the second year, performance standards are not met, necessary measures such as installing erosion control devices, applying seed and native plantings, may be instituted so that standards are met by the third year.

7.1 WEED CONTROL

Hand-weeding, mowing, cutting, or herbicide applications may be necessary to retard the growth of undesirable species during the first years of monitoring. Treated areas would be seeded and/or planted with native vegetation when appropriate.

7.2 REPLANTING

Salvaged vegetation that was damaged during the construction would be replaced with a similar native species. An approved native seed mix and/or sterile seed mix may be applied to the disturbed areas to help stabilize soils.

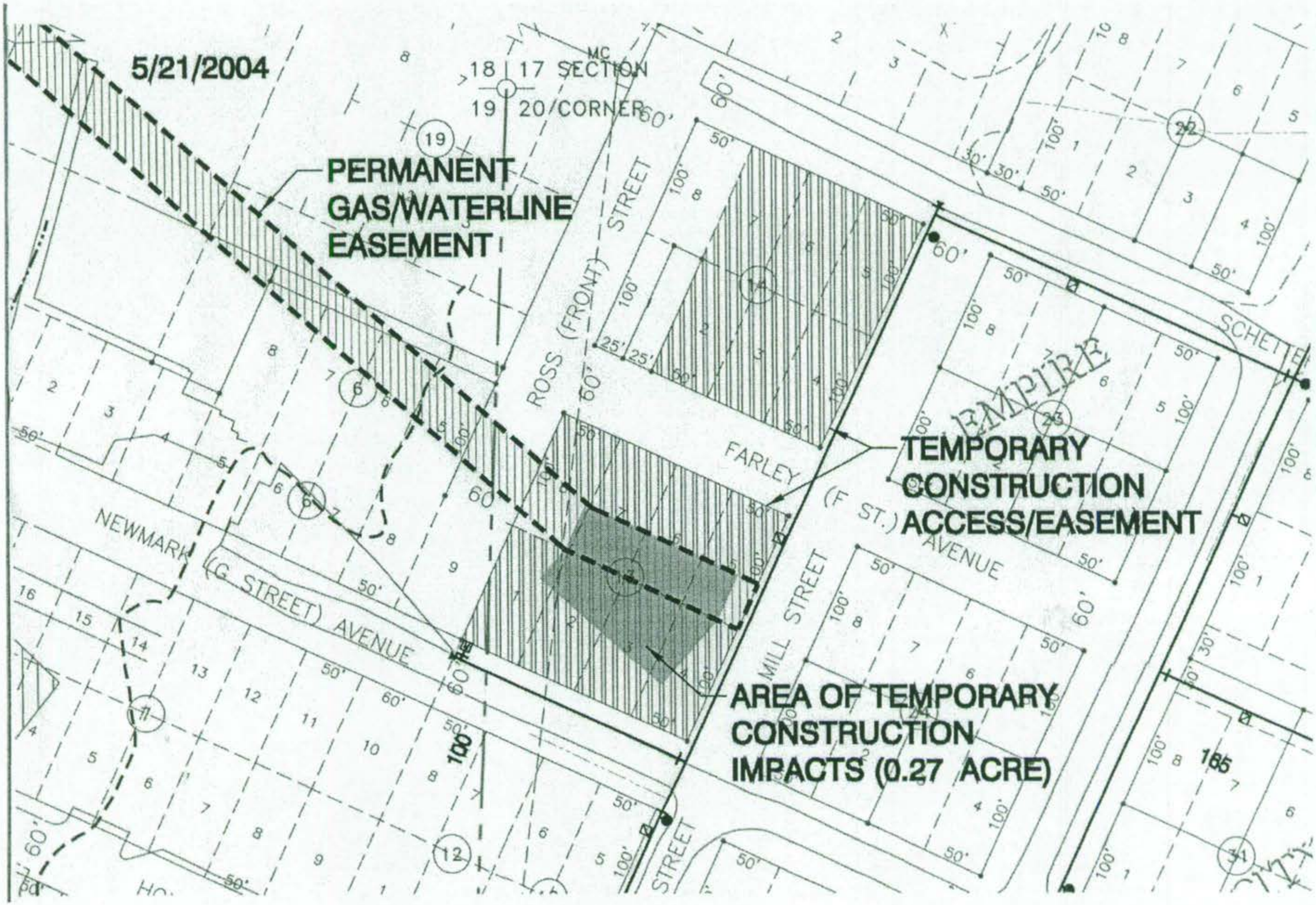
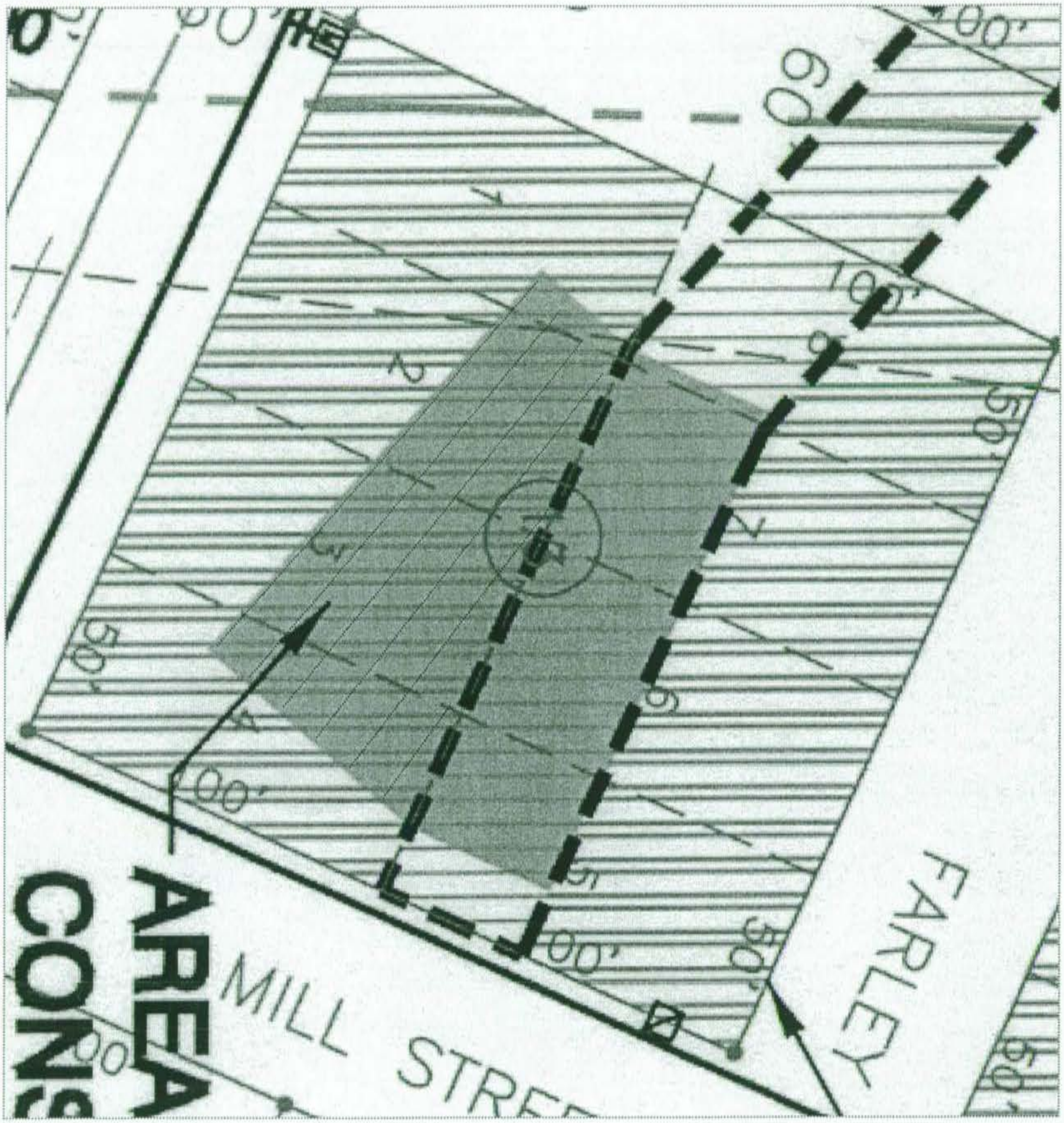

5/21/2004
18 | 17 SECTION
19 | 20 CORNER
PERMANENT GAS/WATERLINE EASEMENT
TEMPORARY CONSTRUCTION ACCESS/EASEMENT
AREA OF TEMPORARY CONSTRUCTION IMPACTS (0.27 ACRE)
ROSS (FRONT) STREET
FARLEY (F ST.) AVENUE
NEWMARK (G STREET) AVENUE
MILL STREET
EMPIRE

Figure 1

Figure 2



Oregon Department of Environmental Quality
Conditions for Compliance with Section 401 of the Clean Water Act

1. **Turbidity/Erosion Controls:** The permittee shall ensure the authorized work does not cause the turbidity of affected waters to exceed 10 percent over natural background turbidity 100 feet downstream from the activity causing the turbidity. For projects proposed in areas with no discernible gradient break (gradient of two percent or less), monitoring must be done at four-hour intervals, and the turbidity standard may be exceeded for a maximum of one monitoring interval per 24-hour work period provided all practicable control measures have been implemented. This turbidity standard exceedance interval applies only to coastal lowlands and floodplains, valley bottoms, and other low-lying and/or relatively flat land. For projects in all other areas, the turbidity standard may be exceeded for a maximum of two hours (limited duration) provided all practicable erosion control measures have been implemented.

   Turbidity must be monitored during active in-water work periods. Monitoring points must be at an undisturbed site (representative background), 100 feet upstream from the turbidity causing activity i.e., fill or discharge point, 100 feet downstream from the fill point, and at the point of fill. A turbidimeter is recommended, however, visual gauging is acceptable. Turbidity that is visible over background is considered to exceed the standard.

   Practicable erosion control measures must be implemented. Such measures must include, but are not limited to the following:
   a. Place fill in the water using methods that avoid disturbance to the maximum practicable extent, e.g., placing fill with a machine rather than end dumping from a truck;
   b. Prevent all construction materials and debris from entering waterway;
   c. Use filter bags, sediment fences, sediment traps or catch basins, silt curtains, leave trips or berms, Jersey barriers, sand bags, or other measures sufficient to prevent movement of soil;
   d. Use impervious materials to cover stockpiles when unattended or during rain event;
   e. Erosion control measures shall be inspected and maintained daily to ensure their continued effectiveness;
   f. No heavy machinery in a wetland or other waterway;
   g. Use a gravel staging area and construction access;
   h. Fence off planted areas to protect from disturbance and/or erosion; and
   i. Flag or fence off wetlands adjacent to the construction area.

   Turbidity must be measured (or visually assessed) and recorded at the designated monitoring interval prescribed above during periods of active construction. The designated person attending the monitoring equipment shall be responsible for notifying the project foreman of any exceedance of the turbidity standard. If a 10 percent exceedance of the background level occurs at 100 feet below the project site, modify the activity causing the problem and continue to monitor at the proper interval. If exceedances occur with two consecutive measurements, the activity causing the turbidity must be stopped until the problem is resolved.

2. **In-Water Work Periods:** All in-water work, including temporary fills or structures, may be undertaken only during the time periods recommended by the Oregon Department of Fish & Wildlife (ODFW) for in-water work specified in the most current version of *Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources.*[1] An exception is allowed only with specific approval from the U.S. Army Corps of Engineers (Corps) after consultation with ODFW or National Marine Fisheries Service (NOAA Fisheries). On tribal lands, the Corps will coordinate exceptions with the Environmental Protection Agency (EPA).

3. **Riparian Vegetation Protection and Restoration:** Riparian, wetland, and shoreline vegetation in the project area must be protected from disturbance to the maximum extent possible and be restored and enhanced when unavoidably disturbed due to activities associated with the authorized work. All damaged or destroyed vegetation must be replaced with native plant materials. The standard for success is 75 percent area coverage after the fifth growing season for native plant species that replace the habitat type lost or damaged. Planted areas must be temporarily fenced or otherwise protected from damage until the vegetation is established. Project sites must be revegetated to the extent possible up to the bankfull stage or line of non-aquatic vegetation, whichever is greater. When any wetland areas are adversely affected, revegetation must extend to the upland limits of the wetland area.

4. **Stormwater:** Stormwater from any authorized activity, conveyed, or discharged to a water of the state, must be treated by a facility specifically designed to remove stormwater contaminants before entering steams, wetlands, or other waters of the state including, mitigation wetlands, so as to minimize pollutants entering those water bodies.

5. **Bank Stabilization:** The linear threshold for bank stabilization projects under any nationwide permit is 250 feet. All projects exceeding the threshold require individual water quality certification.
   a. Bioengineering is required. Native plantings such as willow saplings must be incorporated into stream bank stabilization structures in order to provide bank erosion protection, variable habitat for wildlife, and shade[2].
   b. The project must not include retaining walls, bulkheads, gabions, or similar vertical structures.

---

1 See current version at http://www.dfw.state.or.us/ODFWhtml/InfoCntrHbt/0600_inwtrguide.pdf.

2 See the Oregon Department of State Land's *Riparian Restoration: Bioengineering* at http://www.oregonstatelands.us/bioengineering.htm.

Oregon Department of Land Conservation and Development (DLCD) Conditions for Compliance with the Coastal Zone Management Act

1. **Aquaculture:** For projects involving commercial aquaculture cultivation, authorization for projects in Oregon's coastal zone under this Nationwide Permit is valid only if the applicant has obtained authorization when required from the Oregon Department of Agriculture for use of state submerged and submersible lands for aquaculture purposes.

2. **Bank Stabilization:**
   a. Land use management practices and other non-structural methods of bank stabilization shall be preferred. The project design shall avoid or minimize the placement of rock or other hard materials and shall maximize the use of vegetation and organic materials such as rootwads and willow cuttings.
   b. Projects shall be designed to meet the following conditions:
      (1) No material is placed in excess of the minimum needed for erosion protection of the existing bankline. Placement of fill, including riprap or other bank stabilization materials, to reclaim lands to pre-flooding or erosion contours or the preexisting ordinary high water mark is not authorized.
      (2) The bank stabilization activity occurs along no more than 250 feet of streambank. Bank stabilization projects utilizing only rootwads, willow cuttings, or other vegetative materials with no riprap materials are not subject to this length threshold.
      (3) No material is placed in any special aquatic site, including wetlands.
      (4) Materials and placement will be designed to the extent possible to withstand expected normal and high stream flows and shall not result in changes to stream gradients.
      (5) The project does not include retaining walls, bulkheads, gabions, or similar vertical structures.
      (6) Bank stabilization materials shall not include materials such as broken concrete, asphalt, tires, wire, steel posts, or similar materials. Any riprap material shall be clean, durable, angular rock that is predominately course or heavy-duty material.
      (7) Riparian plantings shall be included in the project design unless the permittee can demonstrate that they are not practicable.

3. **Fish Passage:** The permittee shall ensure that activities authorized by a nationwide permit will not restrict the passage of aquatic life. Activities requiring the placement of culverts, diversion structures, or changes to channel morphology must be designed to be consistent with fish passage standards developed by the Oregon Department of Fish and Wildlife (ODFW) and National Marine Fisheries Service (NMFS), entitled ODFW Standards and Criteria for Stream Road Crossings[1].

[1] See ODFW website at http://www.dfw.state.or.us/odfwhtml/infocntrfish/Management/stream_road.htm.

4. **Fish Screening:** Where applicable, fish screening will meet the current standards developed by the Oregon Department of Fish and Wildlife and National Marine Fisheries Service.

5. **Floodways:** No fill or development shall occur within a designated floodway.

6. **Heavy Equipment Use:** Heavy equipment shall be operated from the bank and not placed in the stream unless specifically authorized. In-stream work may be authorized by the U.S. Army Corps of Engineers (Corps) if necessary in the interest of safety or due to site conditions that prohibit work from the bank. Heavy equipment in wetlands must be placed on mats or other measures must be taken to minimize damage to wetland resources.

7. **In-water Work Periods:** All in-water work, including temporary fills or structures, shall occur within the Oregon Department of Fish and Wildlife's recommended period for in-water work (as specified in the most current version of Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources[2]). Exceptions to the recommended time periods require specific approval from the Corps. The Corps will generally coordinate exceptions to the Guidelines with the Oregon Department of Fish and Wildlife and/or National Marine Fisheries Service. On tribal lands, the Corps will coordinate exceptions with the Environmental Protection Agency (EPA).

8. **Inspection of Project Sites:** The permittee shall allow a representative of the Oregon Coastal Management Program to inspect the authorized activity and site to confirm compliance with coastal zone management conditions. A request for access to the site will normally be made sufficiently in advance to allow a property owner or representative to be on site with the agency representative making the inspection.

9. **Limited, Coastal Wetlands:** Permanent loss (i.e., from placement of fill, water diversion, mechanized land clearing, or other methods) of salt marsh or other estuarine wetlands, bogs or fens, mature forested wetlands, or Goal 5[3] or 17[4] protected wetlands is not authorized. Contact the applicable local government planning department to determine if protected Goal 5 or 17 wetlands are present in the project area. For other listed wetland types see also Portland District Guidance regarding "Special Areas of Concern."

10. **Local Comprehensive Plans:** Authorization for projects in Oregon's coastal zone under any nationwide permit is valid only if the proposed project is consistent with or not subject to the applicable local comprehensive plan and implementing land use regulations. Permits or other authorizations must be obtained when required from the applicable local government before work is initiated under any nationwide permit.

---

[2] See ODFW website at ftp://ftp.dfw.state.or.us/pub/timing/tim97_01.doc.

[3] Goal 5: National Resources, Scenic and Historic Areas, and Open Spaces. (Oregon Statewide Planning Goals & Guidelines) see http://www.lcd.state.or.us/goalpdfs/goal5.pdf.

[4] Goal 17: Coastal Shorelands. (Oregon Statewide Goals & Guidelines) see http://www.lcd.state.or.us/goalpdfs/goal17.pdf.

11. **Restoration/Mitigation Sites:** The permittee shall ensure that activities authorized by a nationwide permit will not negatively impact and/or revert wetlands or waterways to upland via fill, removal, drainage, or other methods in either previous habitat restoration or compensatory mitigation sites.

12. **Riparian Vegetation Protection and Restoration:** Riparian vegetation in the project area shall be protected from disturbance to the maximum extent practicable during work. Any disturbed areas shall be restored with native vegetation and temporarily fenced or otherwise protected from damage until the vegetation is established.

13. **State Lands/Removal-Fill Law:** Authorization for projects in Oregon's coastal zone under any nationwide permit is valid only if the proposed project is consistent with or not subject to the state statutes for state lands and Removal-Fill in waters of the state. Permits or other authorizations must be obtained when required from the Oregon Department of State Lands (ODSL) before work is initiated under any nationwide permit.

14. **Streambed Protection:** Permanent loss of wetted streambed in fish-bearing waters is not authorized. Other impacts to streambeds should be avoided or minimized to ensure the project will not result in more than minimal environmental impact to coastal zone resources.

15. **Stream Channelization or Relocation:** Neither stream channelization nor stream relocation is authorized.

16. **Upland Disposal:** All excess materials will be taken to a suitable upland location for disposal. The material shall be placed in a location and manner that prevents their discharge into waterways or wetlands. (Exception for discharges authorized under Nationwide Permit No. 16 Return Water from Upland Contained Disposal Areas.)

Water Quality: DLCD considers compliance with the Department of Environmental Quality (DEQ)-imposed water quality conditions to be necessary to ensure compliance with the water quality components of the Oregon Coastal Management Program.

Compliance Certification

Project County:	**Coos**
Permit Number:	**200300706**
Date of Issuance:	**June 18, 2004**
Name of Permittee:	**Northwest Natural**

I hereby certify that the work authorized by the above referenced permit, has been completed in accordance with the terms and conditions of the said permit, and that required mitigation was completed in accordance with the permit conditions, except as described below.

____
Signature of Permittee

Enclosure (8)

ATTACHMENT D: Coos Bay Channel Modification, William T. Rossell Wreck Investigation: Hydrographic Survey Draft Report

Coos Bay Channel Modification
William T Rossell Wreck Investigation

HYDROGRAPHIC SURVEY REPORT

DECEMBER 2016

Prepared for:

OREGON INTERNATIONAL PORT OF COOS BAY
Coos Bay, OR
(208) 388-5472

Prepared by:

DAVID EVANS AND ASSOCIATES, INC.
2801 SE Columbia Way, Suite 130
Vancouver, WA 98661
(360) 314-3200

TABLE OF CONTENTS

Page

List of Figures

List of Appendices

Acronyms and Abbreviations

AML	Applied Microsystems Ltd.
ASCII	American Standard Code for Information Interchange
DEA	David Evans and Associates, Inc.
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
kHz	Kilohertz
MLLW	Mean Lower Low Water
NAD83 (2011)	North American Datum of 1983, National Adjustment 2011, Epoch 2010.00
NSPS	National Society of Professional Surveyors
PLS	Professional Land Surveyor
POS/MV	Position and Orientation System for Marine Vessels
ROV	Remotely Operated Vehicle
RTK	Real-time Kinematic
SPCS	State Plane Coordinate System
S/V	Survey Vessel
THSOA	The Hydrographic Society of America
USACE	United States Army Corps of Engineers

1.0 INTRODUCTION

In December of 2016, David Evans and Associates, Inc. (DEA), conducted a hydrographic survey of the wreckage of the USACE dredge *William T. Rossell* in the channel entrance near Charleston Oregon. The survey consisted of high resolution multibeam bathymetric coverage, subbottom profiling and video inspection. The primary goal of the survey was to assess the general condition of the wreckage and establish the level to which it had buried into the sand.

This report describes the control used for the survey, data acquisition methodology, and data processing procedures. In addition to this report, deliverable files were provided to the design team which include: American Standard Code for Information Interchange (ASCII) XYZ point cloud data, ASCII XYZ gridded data, gridded hill-shade images, AutoCAD mapping products, digital video clips and digital photos.

2.0 DATUMS AND PROJECT CONTROL

Conducting a survey on an established coordinate system, referenced by monuments, enables the survey to be reproduced at a later date with repeatable results. For this survey, hydrographic field operations were conducted using the North American Datum of 1983, National Adjustment 2011, Epoch 2010.00 (NAD83(2011)) horizontal datum projected to the State Plane Coordinate System (SPCS) Oregon South Zone with units in International Feet. The vertical datum used during data acquisition was Mean Lower Low Water (MLLW) using the NOAA VDatum separation model.

3.0 HYDROGRAPHIC SURVEY METHODOLOGY

3.1 Survey Vessel and Instrumentation

The vessel used for this survey was the *William R. Broughton*. DEA's 24-foot custom built survey vessel with twin outboard 115 horsepower engines (Figure 1). The vessel is equipped with an integrated navigation and data acquisition system, custom mounts for the Reson SeaBat T50-P multibeam sonar head, and is ideal for structural and bathymetric mapping and working in both rough and shallow waters. Additional survey vessel equipment onboard consisted of an Applanix POS/MV Version 5 (Position and Orientation System for Marine Vessels) combined inertial and RTK GNSS, an Applied Microsystems Ltd. (AML) Smart SVP&T sound speed sensor, and two data acquisition computers running Reson PDS2000 software for multibeam data acquisition. Geophysical systems included a Falmouth Scientific HMS620 single channel seismic system which was onboard as part of a more extensive geophysical survey but was run over the wreckage to ascertain the depth of bedrock which may impact salvage or dredging design parameters. Video inspection systems included a SeaBotix LBV 150 remotely operated vehicle (ROV).

Figure 1. Survey Vessel *William R. Broughton*

3.2 Hydrographic Data Acquisition

The S/V *Broughton* was equipped with a Reson SeaBat T50-P multibeam bathymetric sonar operating at a frequency of 400 kilohertz (kHz) and an integrated AML MicroX with a sound velocity exchange sound speed sensor. The sonar head was tilted 15 degrees to port, and data were acquired during a high tide window to allow for maximum coverage on vertical structures and maximum data overlap with the laser scanning data collected during low tide. To account for sound speed variability of the water column, an AML Oceanographic AML SmartX sound speed profiler was utilized to take sound speed profiles while underway.

The Applanix POS/MV Version 5 motion reference sensor was utilized to measure and record vessel heading (yaw), heave (vertical movement from seas), pitch and roll. By utilizing vessel speed over ground and heading data provided by GNSS, the POS/MV can isolate horizontal accelerations from vessel turns and provide highly accurate motion data. The POS/MV position and motion data were used to derive sonar/laser beam orientation and position individual soundings. Height data were logged for vertical positioning.

3.3 Hydrographic Data Processing

Processing of multibeam sonar and laser scanning data were conducted utilizing Caris Hydrographic Information Processing System (HIPS) multibeam analysis and processing software version 9.1.6. Patch test data were analyzed and alignment corrections were calculated and applied during processing. GPS tides were computed and applied, and final sounding elevations were reduced to MLLW. Sound speed profiles were used to correct multibeam slant range measurements and compensate for any ray path bending.

Data were reviewed through the Caris HIPS subset editing program to search for any errant flyers remaining in the dataset, or to re-accept data previously flagged as rejected in the swath editor that may be valid.

4.0 VESSEL INFORMATION

The *William T Rossell* (Figure 2) was a steel hopper-style dredge, built in 1924 by the Sun Shipbuilding Co. of Chester, PA and operated by the U.S. Army Corps of Engineers (USACE). The ship was approximately 268 feet in length, 46 feet in beam with a molded depth of 22.5 feet. She displaced 3015 long tons light and 5250 long tons when fully loaded. Note: 1 long ton = 2240 lbs. The ship was powered by two 1000-horsepower McIntosh & Seymour diesel engines (Figure 3) each driving an 800 horsepower Westinghouse electric motor. Another set of the same diesel electric configuration was used to drive the dredging pump.

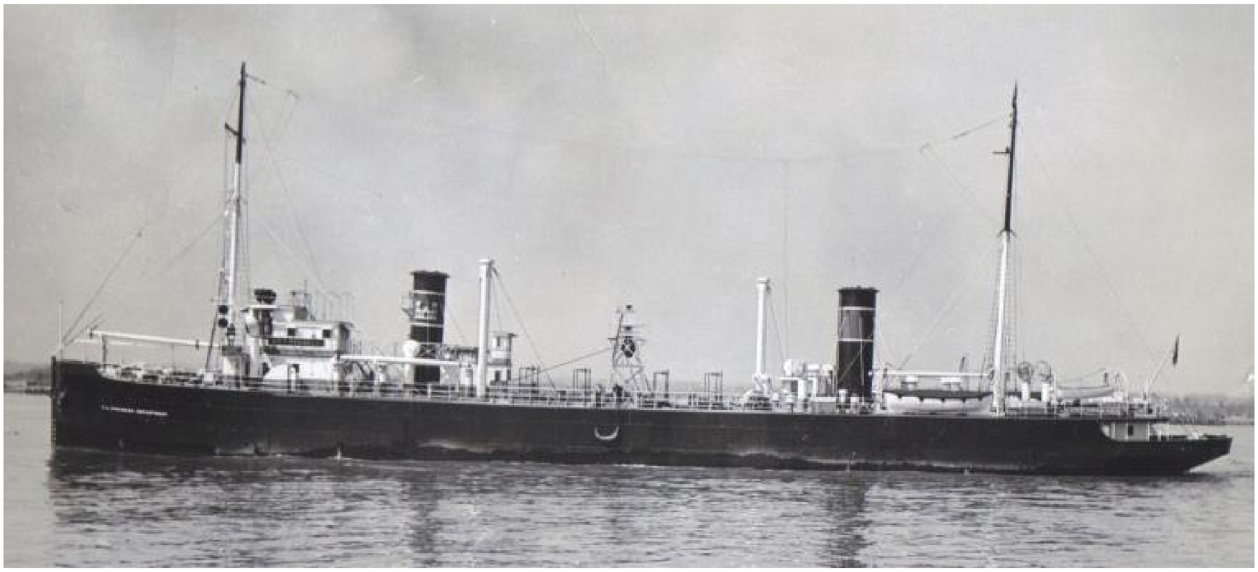


Figure 2: The USACE hopper dredge *William T Rossell*.

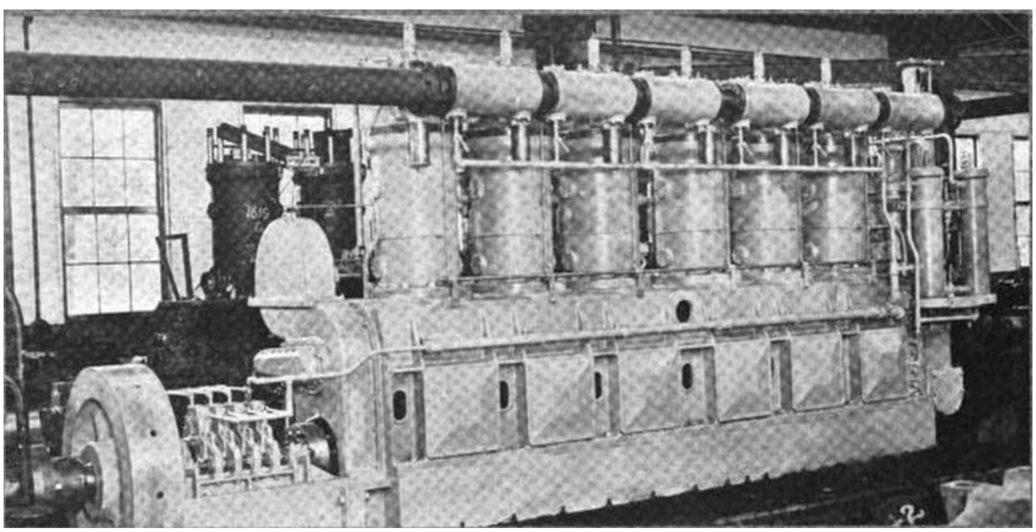


Figure 3: A 500 HP M&S diesel engine of similar style to the 1000 HP engines on the *Rossell*.

On September 10, 1957, while inbound in the southern half of the Coos Bay entrance channel, the *Rossell* was struck by the outbound freighter *Thorshall* who had suffered a steering problem. The *Rossell* was struck at frame 50 on her port side by the bow of the *Thorshall* which penetrated to a depth of 6 feet at the boat deck level. The damage was a symmetrical gash approximately 8 feet wide at the boat deck. The opening decreased in both width and depth lower on the vessel and did not extend past the 4.5-foot waterline. (Figure 4)

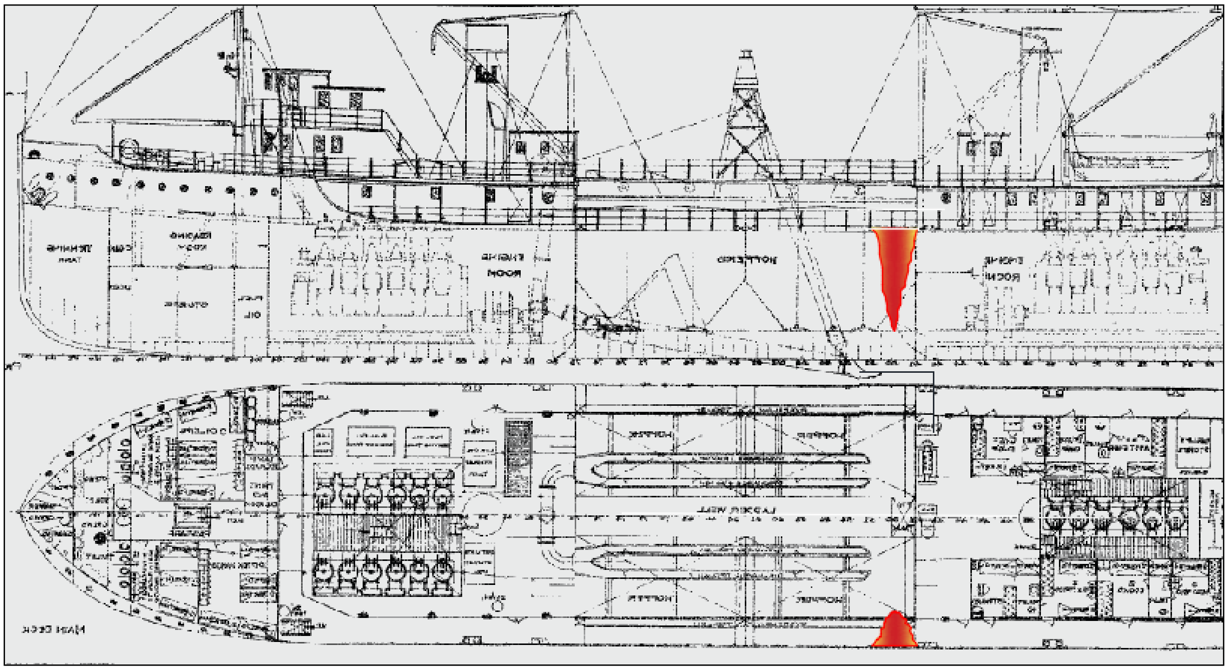


Figure 4: Damage to port side of *Rossell* from collision with *Thorshall* shown in red.

5.0 WRECKAGE POSITION AND DEPTH

Over 11,400,000 precision soundings were collected in a 500-foot by 900-foot area directly over and immediately surrounding the wreck of the *Rossell*. All sounding were carefully edited and adjusted to the MLLW vertical datum as previously discussed in this report. The wreckage lies approximately 150 feet south of the entrance channel with an orientation of 328° T, approximately NW- SE (Figure 5).

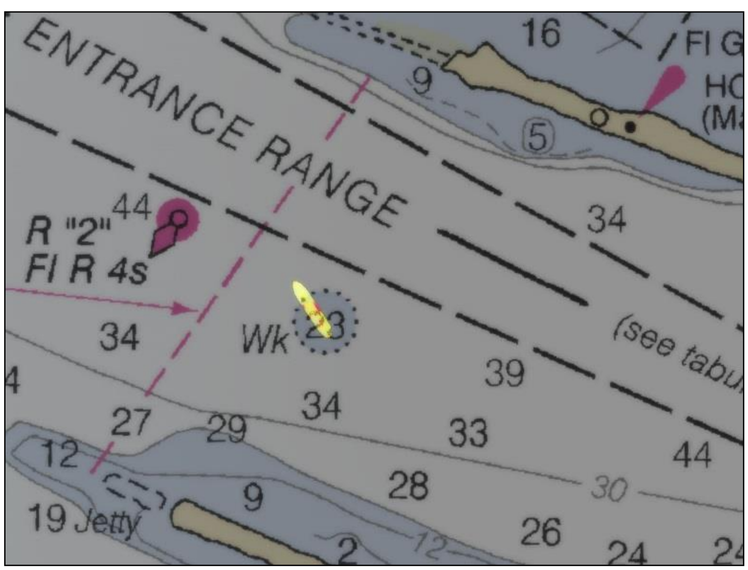


Figure 5: Point cloud of *Rossell* wreckage (yellow) overlaying NOAA chart 18587 (North up).

Although the current nautical chart for Coos Bay (NOAA chart 18587) shows a minimum depth over the wreck of 23 feet MLLW, this survey found the minimum depth to be 30.2 feet MLLW. The full point cloud coverage of the wreckage survey is displayed in Figure 6. Additional views of the wreckage are shown in Figures 7, 8 and 9.

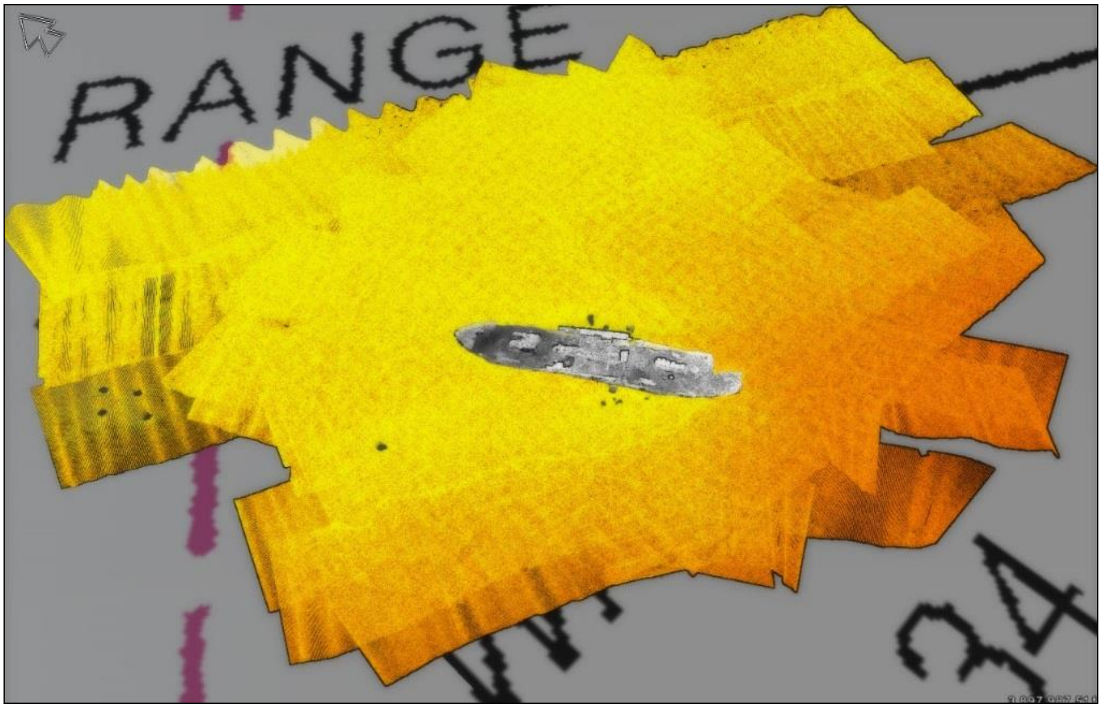


Figure 6: Detail survey coverage in area of *Rossell* wreckage overlaying NOAA chart 18587 (North indicated by arrow).

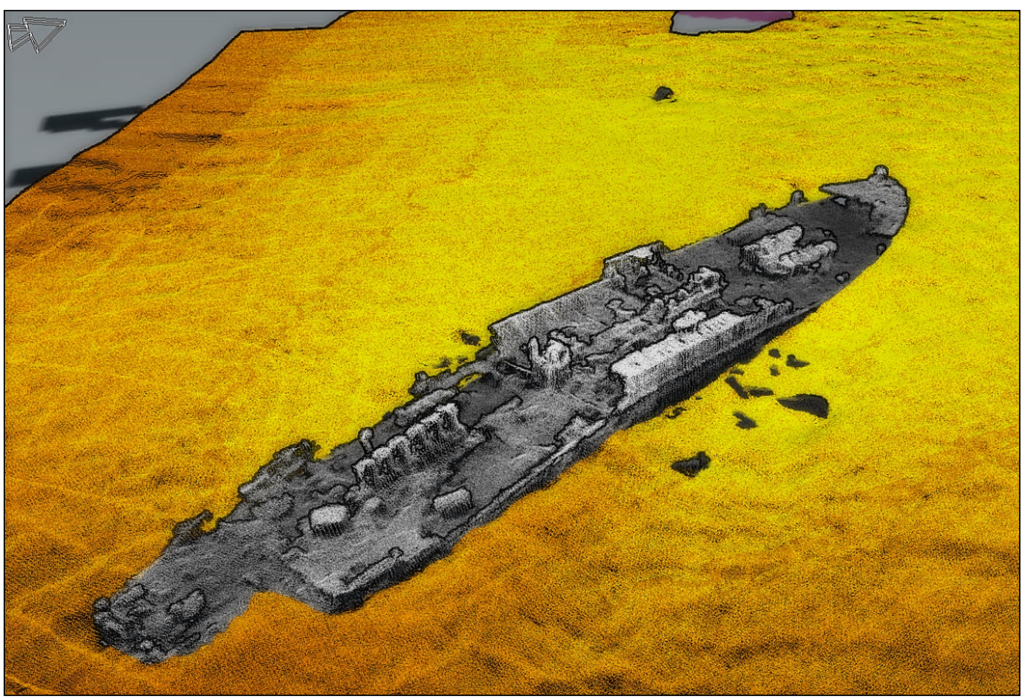


Figure 7: View of starboard quarter of *Rossell* wreckage. (North indicated by arrow)

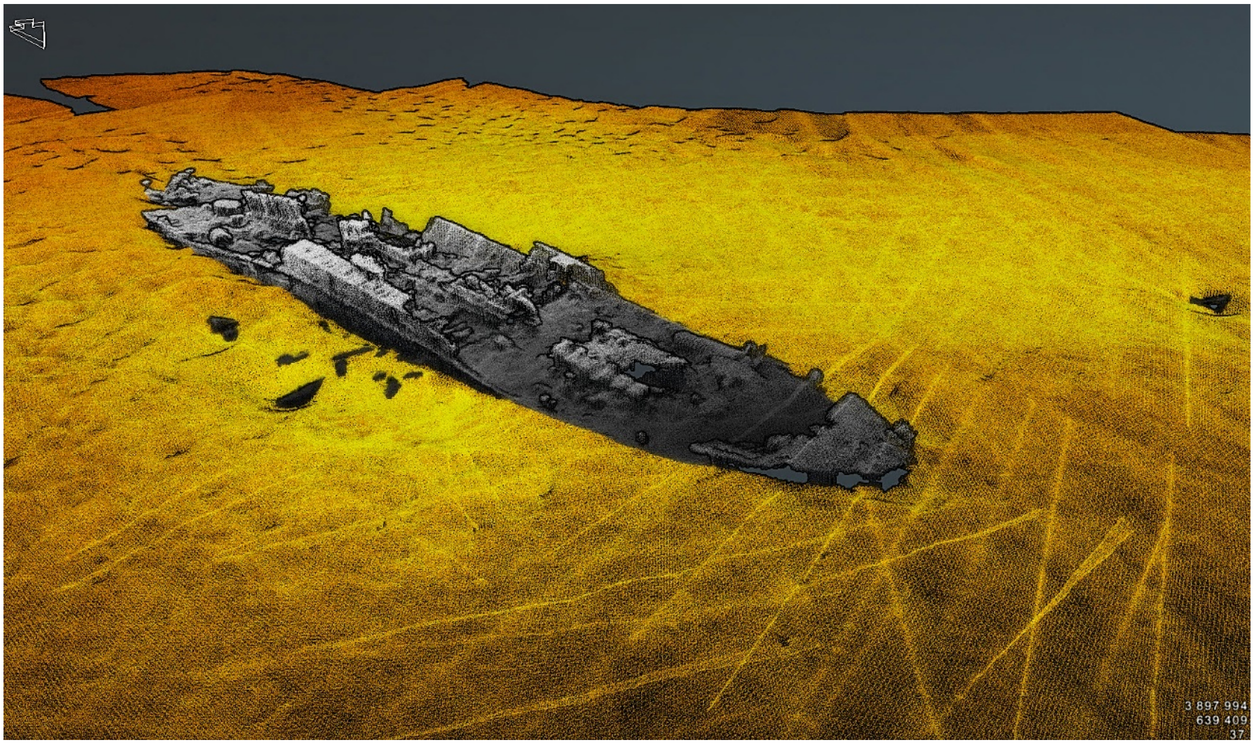


Figure 8: View of starboard bow of *Rossell* wreckage. (North indicated by arrow)

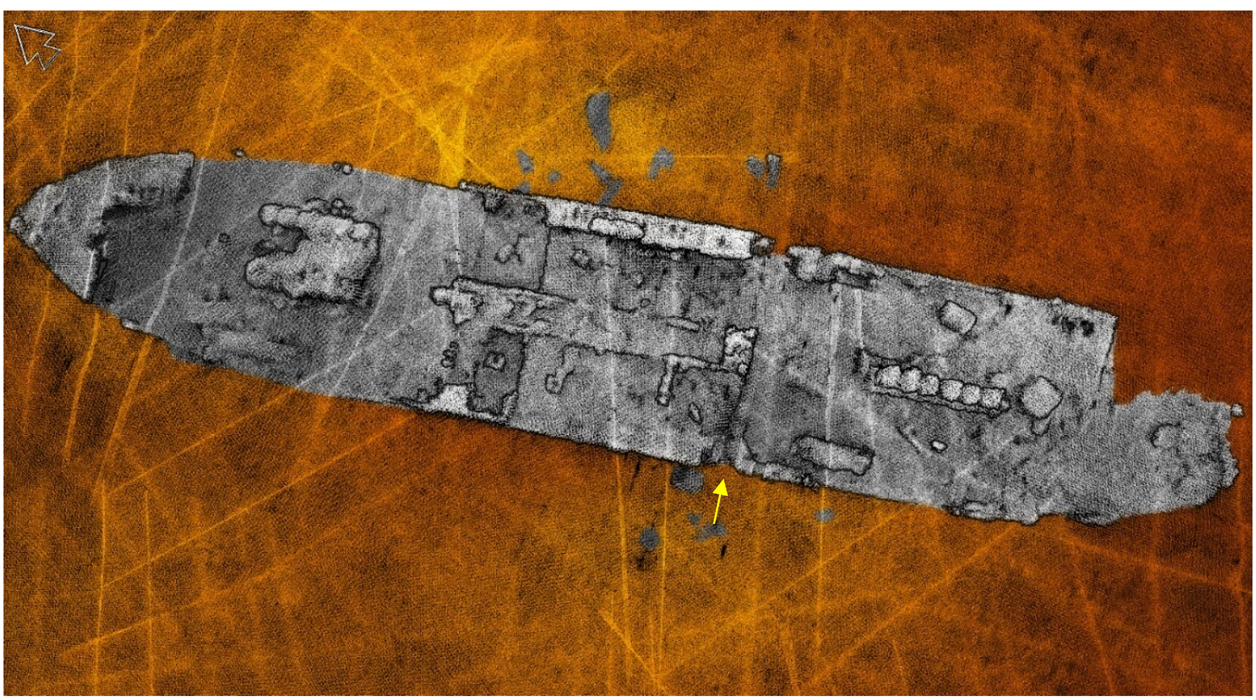


Figure 9: Map view of *Rossell* wreckage, impact zone on port side indicated by yellow arrow.

6.0 ESTIMATION OF WRECK BURIAL DEPTH

The detailed point cloud from the multibeam survey clearly shows major features of the *Rossell* including some deck plating and the main engines. Using these know features as reference points and matching to scaled drawings of the ships plans, it is possible to make reasonable estimations of the depth to which the ship has sunk into sandy bottom. Matching the point cloud to the plans yields an estimated deepest depth for the wreck to be approximately 70 feet MLLW at the bow. Figure 10 shows a profile view of the bow section of *Rossell* plan, aligned with narrow slice through central portion of wreckage point cloud (colored). Top of engine cylinders, pipe flange and decking used as reference points. Best fit of plan indicates a possible break in the hull forward of engine.

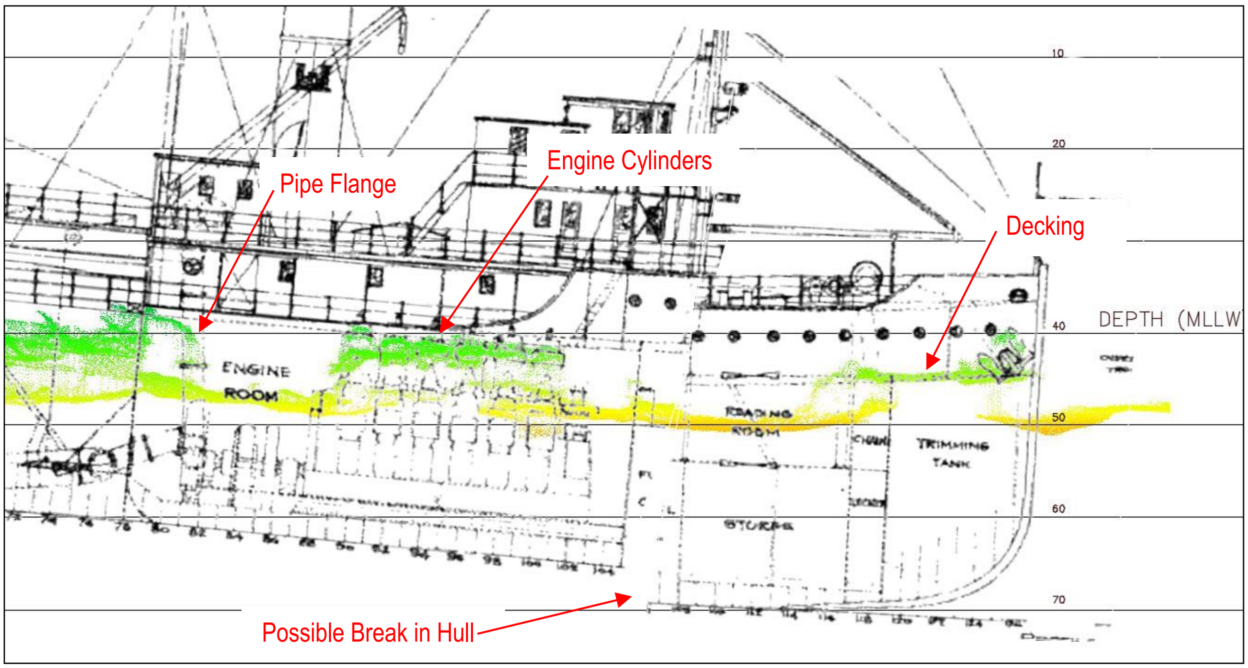


Figure 10: Profile view of bow section of *Rossell* plan

Figure 11 shows a profile view of the aft section of *Rossell* plan aligned with narrow slice through central portion of wreckage point cloud (colored). Top of engine cylinders, pipe flange and decking used as reference points. Best fit of plan indicates a break in the hull aft of hoppers.

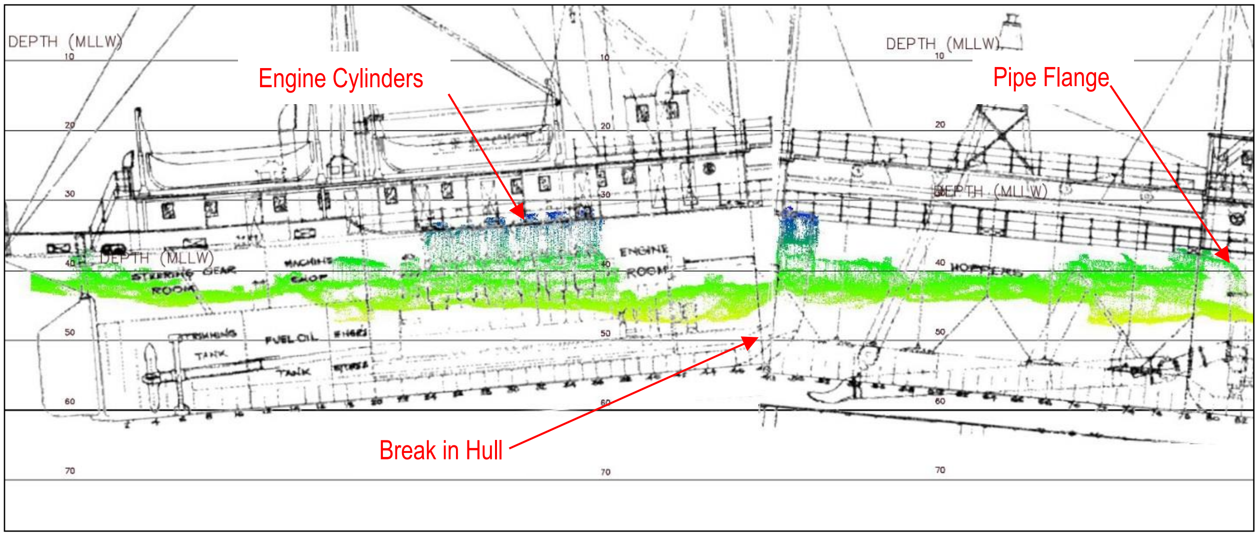


Figure 11: Profile view of aft section of *Rossell* plan

Figure 12 shows a cross sectional view at frame 84 of *Rossell* plan aligned with narrow slice across forward portion of wreckage point cloud (colored). Suction pipe flange and decking used as reference points.

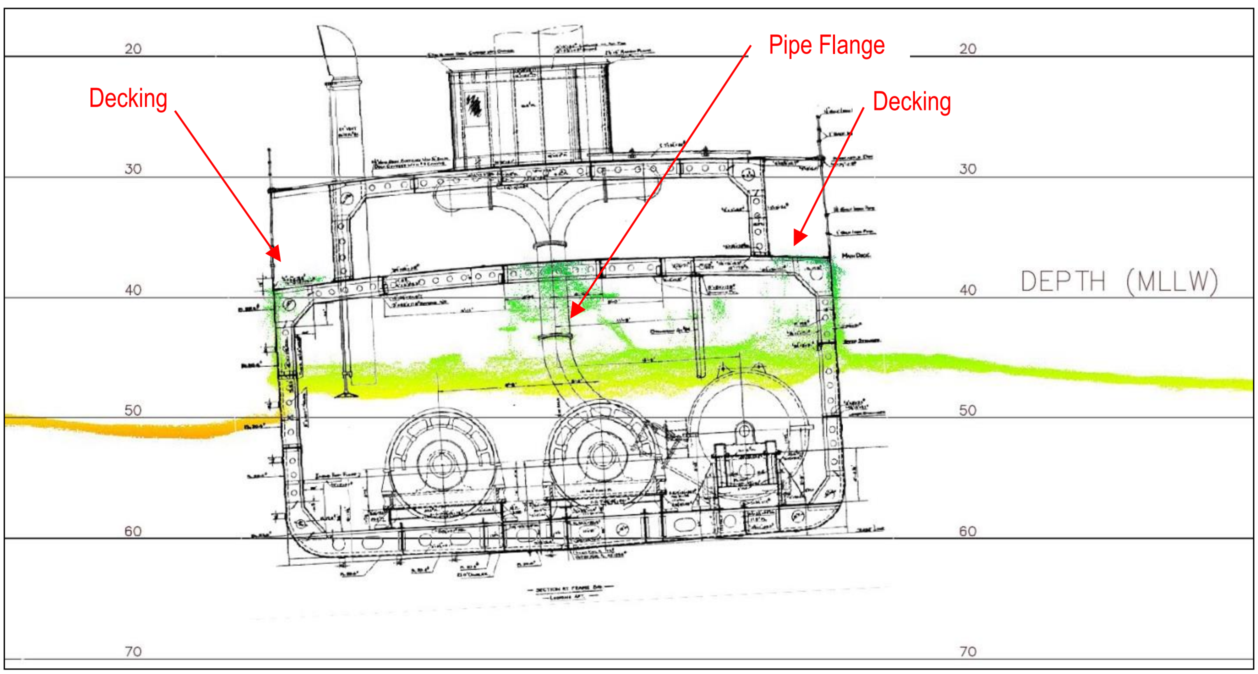


Figure 12: Cross sectional view at frame 84 of *Rossell* plan

Geophysical investigations in the area of the *Rossell* indicate bedrock is at an elevation of approximately 70 feet. This may indicate that the forward section of the wreck is supported by bedrock which may have produced stresses leading to the forward break in the hull.

7.0 VISUAL INSPECTION OF WRECK

An additional objective of the *Rossell* wreck investigation was to obtain video images of the wreck, if weather conditions allowed. The idea was indications of the condition of the metal and give so insight into what might be encountered if removal operations were conducted. On December 15, 2016, the survey crew took advantage of a short weather window and slack tide to send a remotely operated vehicle (ROV) down to the wreck. The ROV was equipped with camera and lights and thrusters which allow it to be maneuvered remotely by the pilot on the survey vessel. Even with the favorable tide and weather the conditions on the site were challenging. The vessel deployed its bow anchor in order to limit movement. The ROV umbilical was weighted down in order to force it to hang relatively straight down so it a general position could be estimated and the chance of snagging the umbilical on wreckage would be minimized. The operations window lasted for approximately 1.5 hours before the ebb current prevented any further dives. Three dive attempts were made on the center section of the wreck toward the starboard side (Figure 13) but the only useful video came from dives 2 and 3.

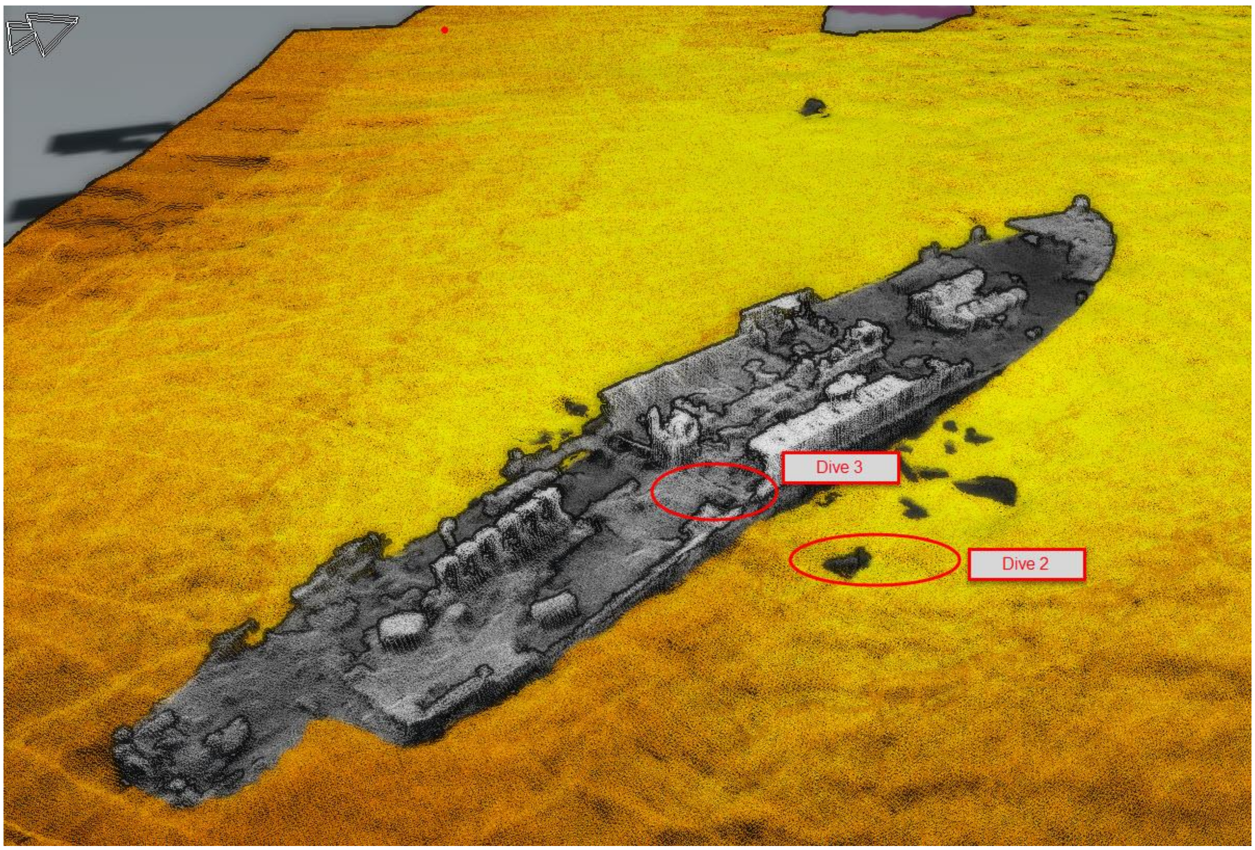


Figure 13: General locations of ROV drops on *Rossell* wreckage during slack water on 12/15/16

In general, the ROV inspection found metal objects to appear fairly competent. Dive 2 confirmed an object off the starboard side was debris but did not get close enough to confirm any details of the object (Figure 14).

Figure 14: Debris on seafloor outboard of *Rossell* on starboard side.

The tall structure in the center of the ship may be remnants of a tall fresh water tank that extended from the keel to the boat deck near frames 48 to 52 (Figure 15).

Figure 15: Tall structure in center section of *Rossell* wreck

The ROV came up against a large cylindrical object which may be a tank of some kind. Figure 16 is a photo of the tank showing rivets and apparently competent metal features. A tall structure in the center section of the *Rossell* wreck in the distance is seen on the left side of the image. One of multiple fish seen in the area is also shown in the photo.

Figure 16: Tank feature near Rossell wreck

The video showed that the lower areas of the deck are extremely cluttered with debris, cables, etc. (Figure 17). The videos also show several species of fish and other marine life on the wreck.

Figure 17: Typical debris piles imaged within the center section of the *Rossell* wreckage.

8.0 DELIVERABLES

Deliverables for the *William T Rossell* Hydrographic Survey include the following:

1. XYZ comma-delimited ASCII data in XYZ format gridded at 1-foot titled: **Rossell_1ft_ENZup_V1.txt**
2. XYZ comma-delimited ASCII data in XYZ format for least depths (highest point on submerged features) on the Rossell titled: **Rossell_Least_Depths_ENZup.txt**
3. Full resolution XYZ comma-delimited ASCII data in XYZ format for viewing in EIVA NaviViewer , or similar, software
4. Color hillshade georeferenced image of 1-foot gridded surface titled: **Rossell_1ft_Hillshade_V1.***
   Where * is the file extension of .tif, .tfw, .tif.ovr, and .tif.aux.xml.
5. AutoCAD drawings including contours and submerged feature locations titled: **Rossell Model_V1.0.dwg**
6. Video files and single scree captures from ROV dive video imagery.
7. *Rossell* Survey Report documenting survey methodology and general structural evaluation, stamped by an Oregon Professional Land Surveyor (PLS) and National Society of Professional Surveyors/ The Hydrographic Society of America (NSPS/THSOA) Certified Hydrographer

APPENDIX A
Large Scale Report Images

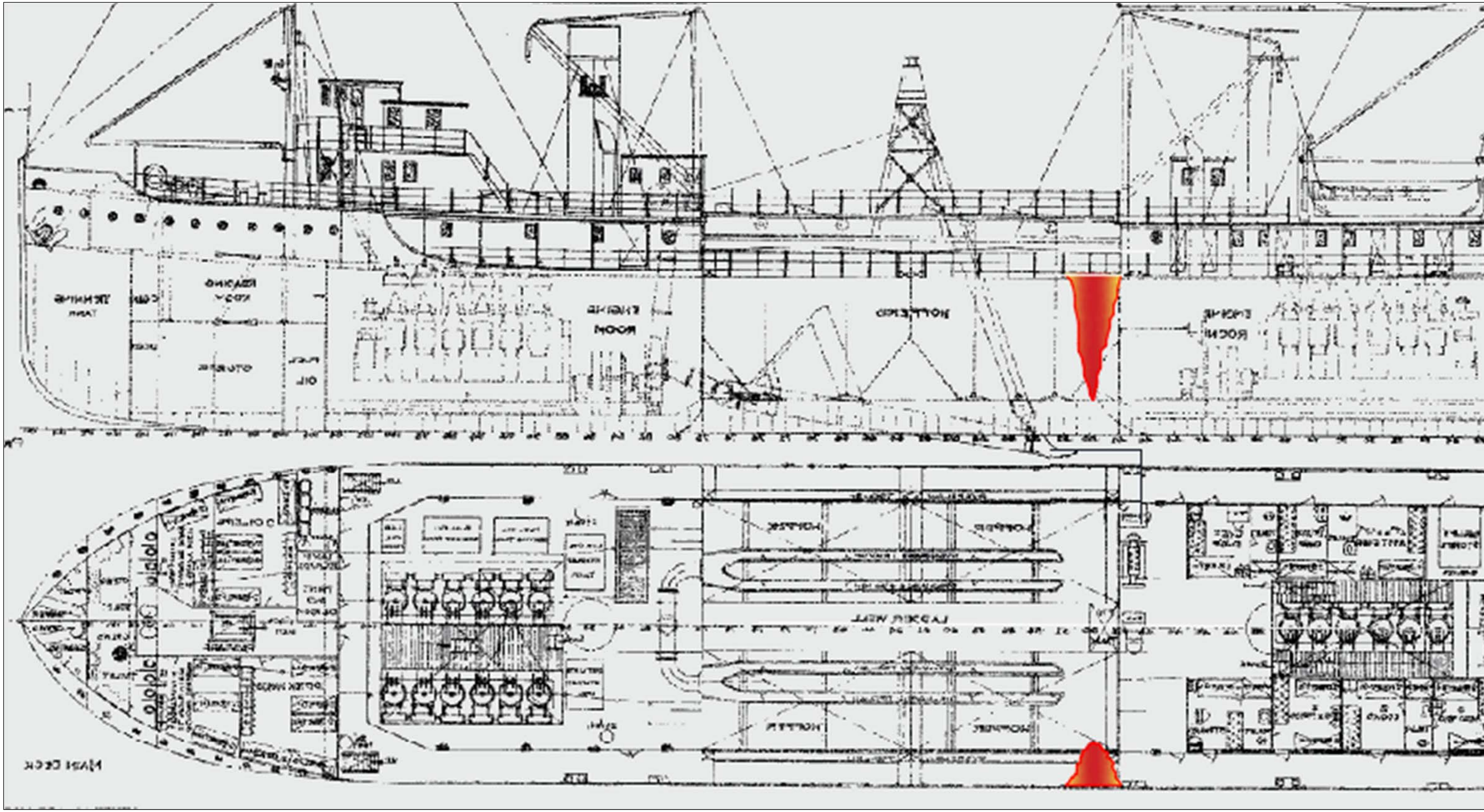


Figure 4: Damage to port side of *Rossell* from collision with *Thorshall* shown in red.

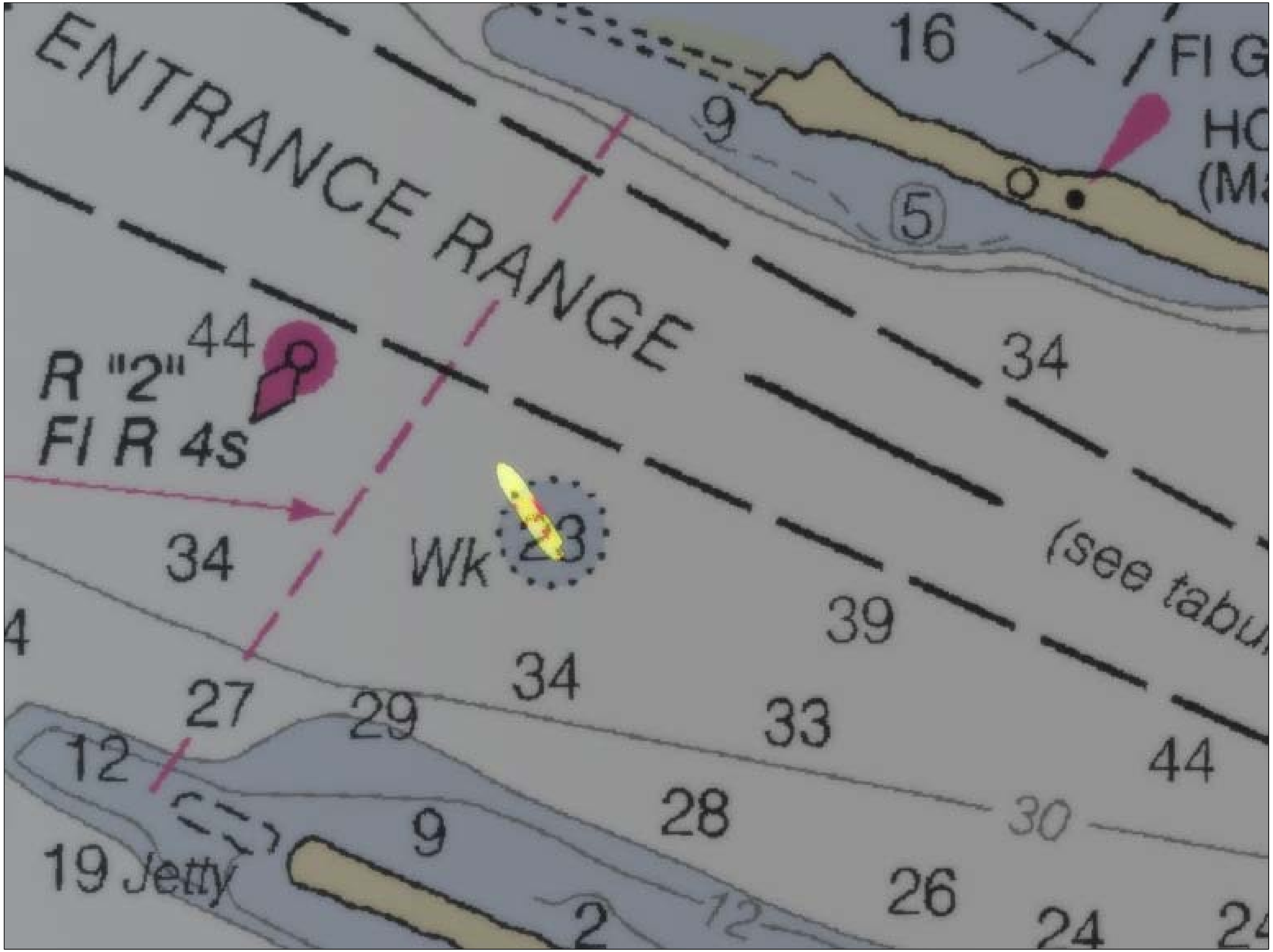


Figure 5: Point cloud of *Rossell* wreckage (yellow) overlaying NOAA chart 18587 (North up).

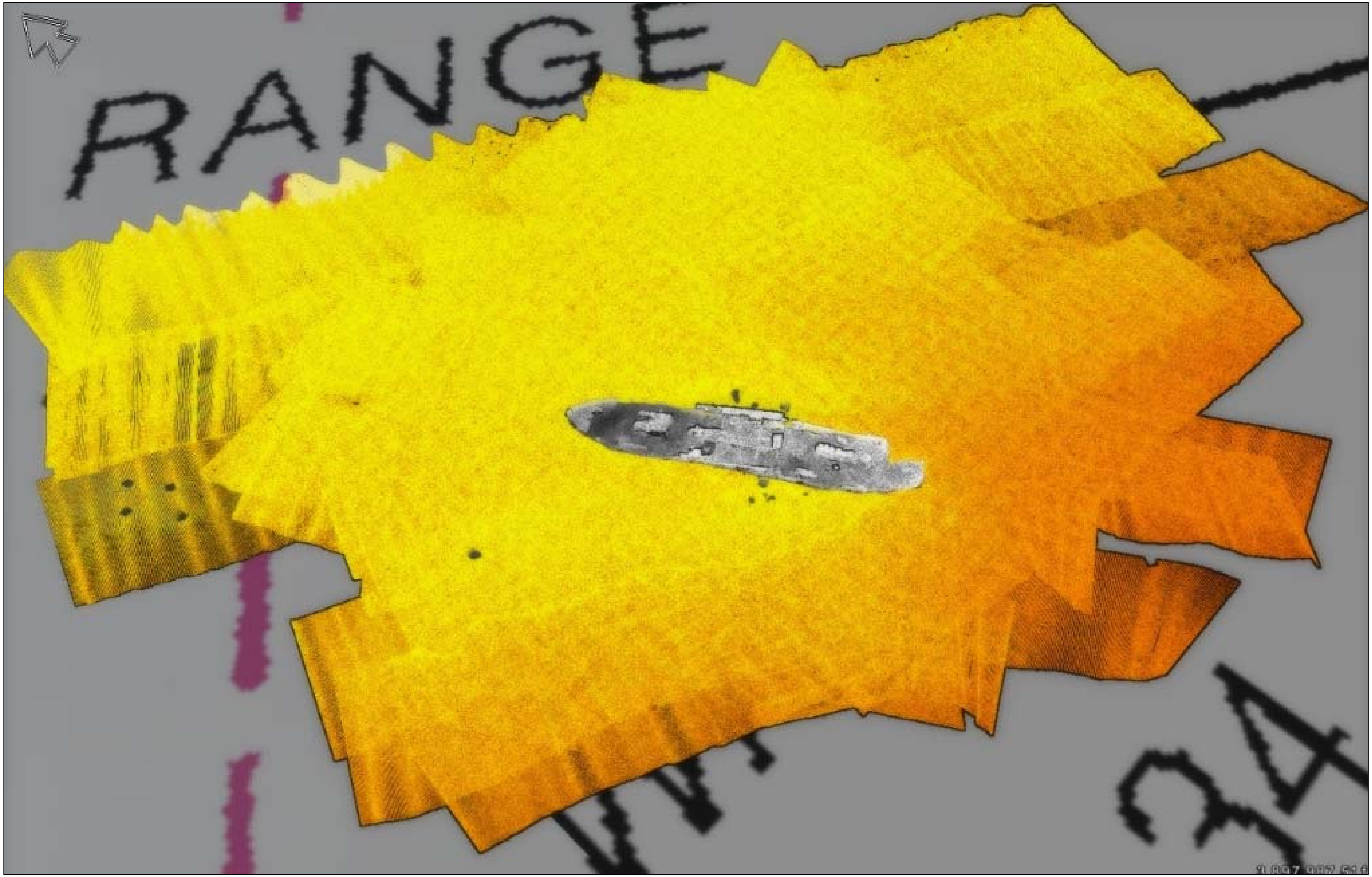


Figure 6: Detail survey coverage in area of *Rossell* wreckage overlaying NOAA chart 18587 (North indicated by arrow).

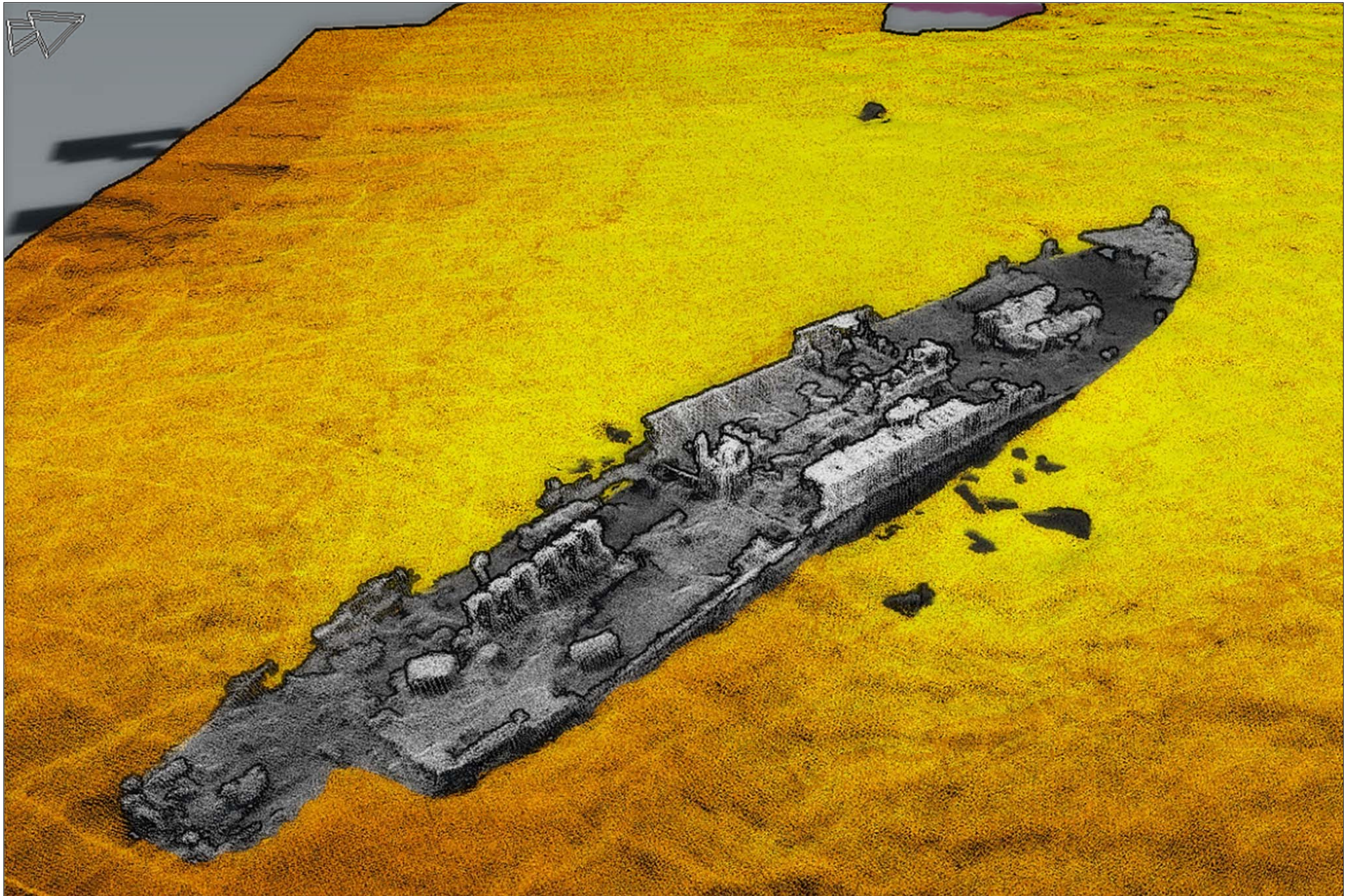


Figure 7: View of starboard quarter of *Rossell* wreckage. (North indicated by arrow)

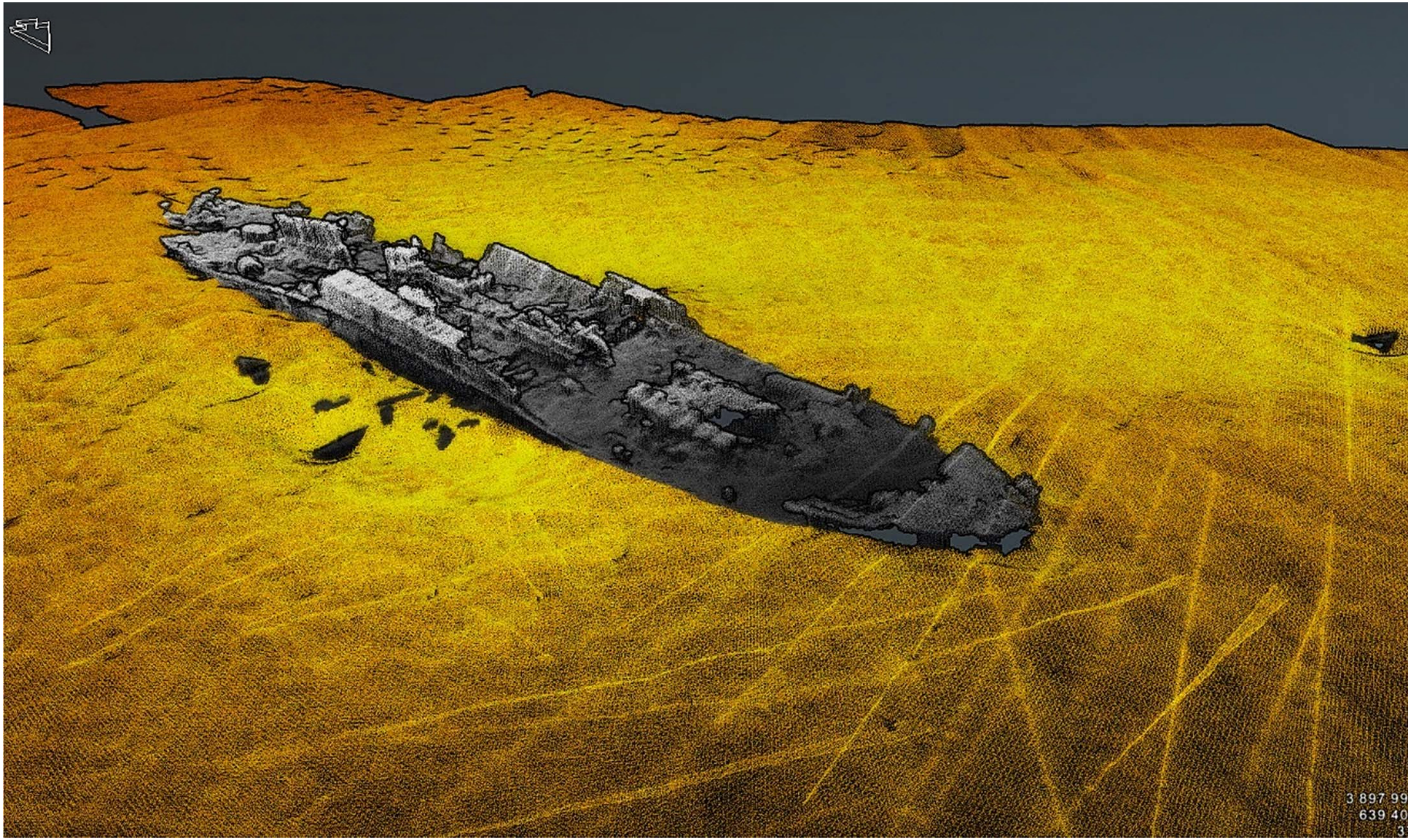


Figure 8: View of starboard bow of *Rossell* wreckage. (North indicated by arrow)

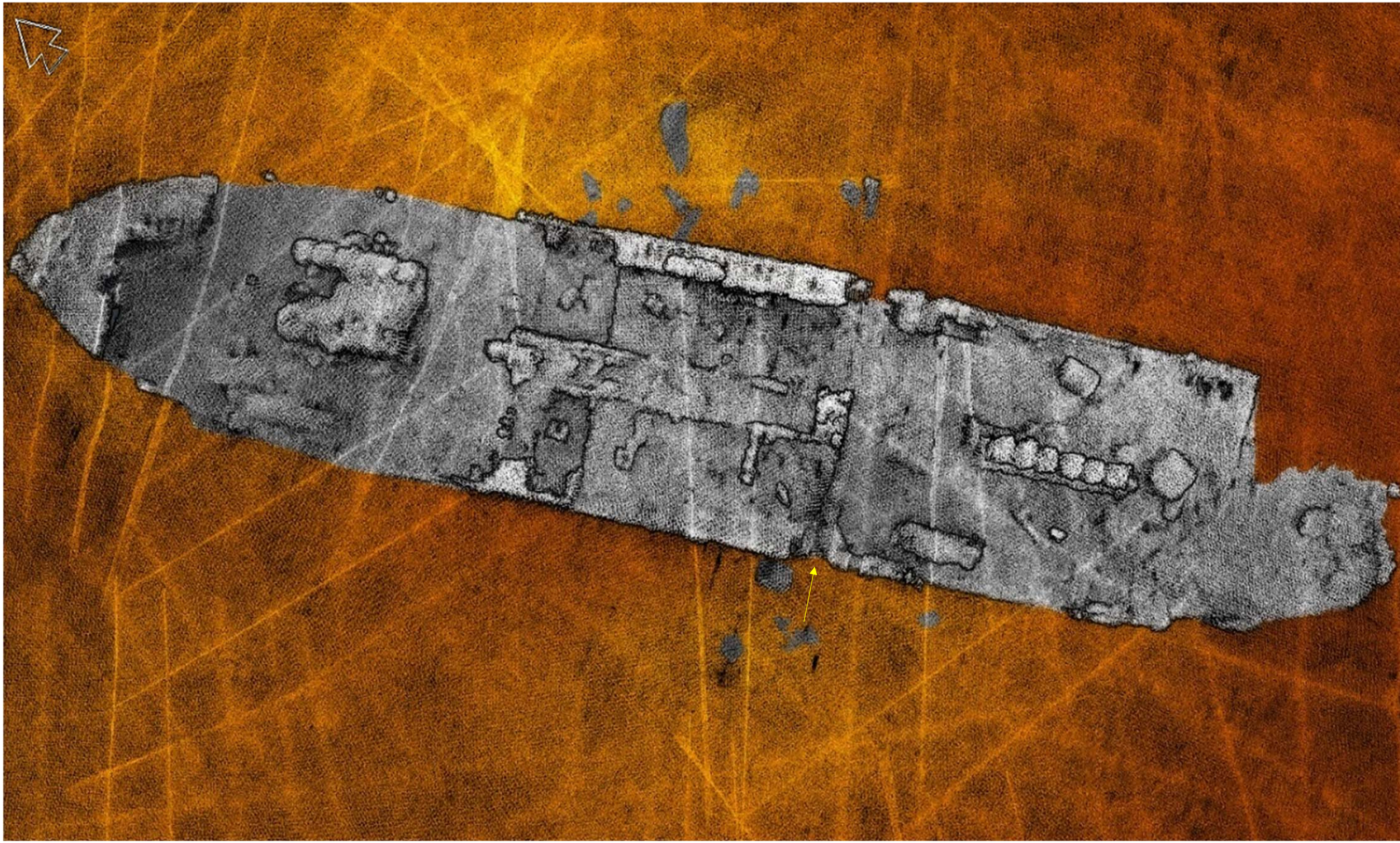


Figure 9: Map view of *Rossell* wreckage, impact zone on port side indicated by yellow arrow.

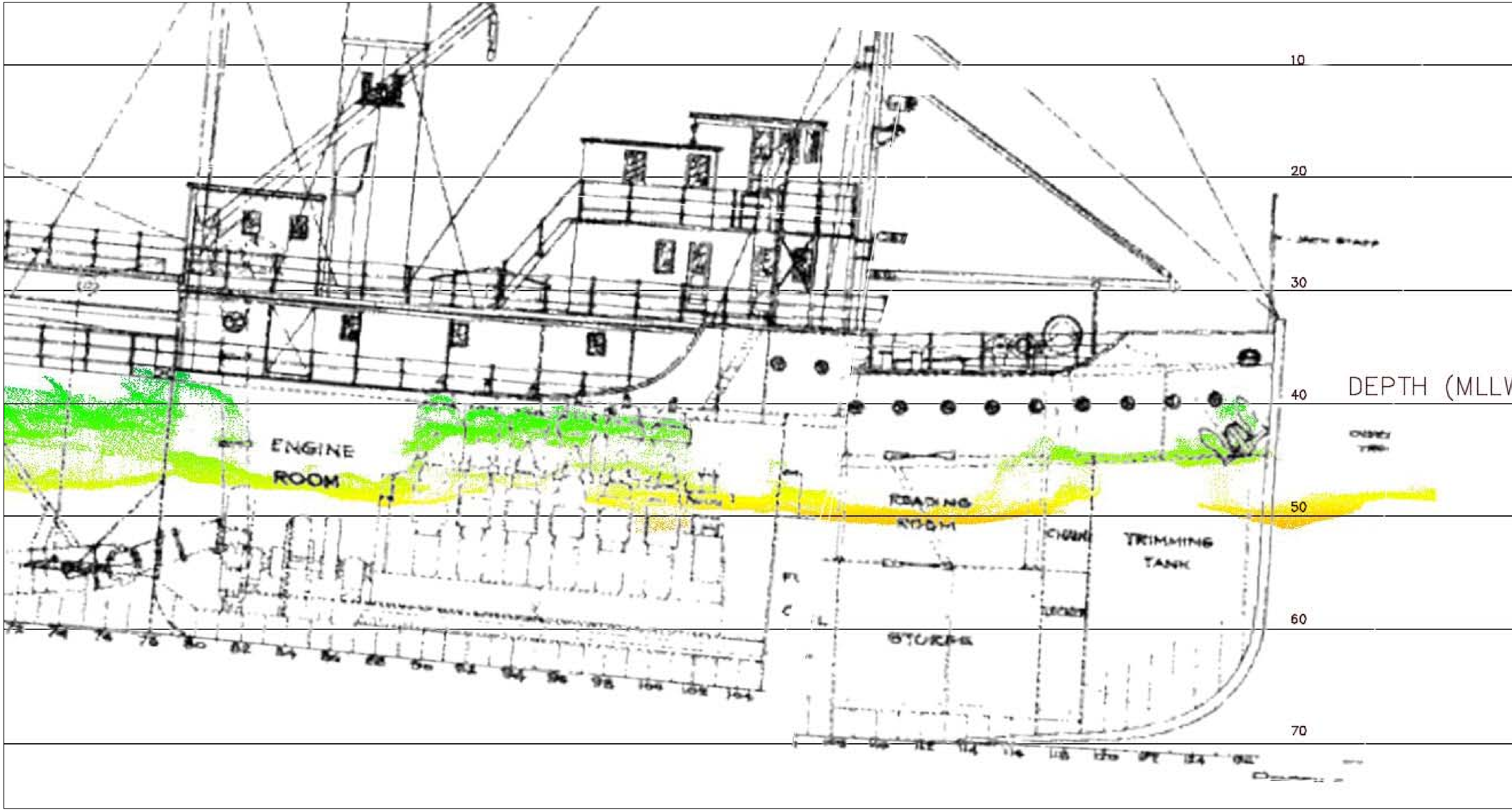


Figure 10: Profile view of bow section of *Rossell* plan with multibeam point cloud overlay (colored)

Figure 11: Profile view of aft section of *Rossell* plan with multibeam point cloud overlay (colored)

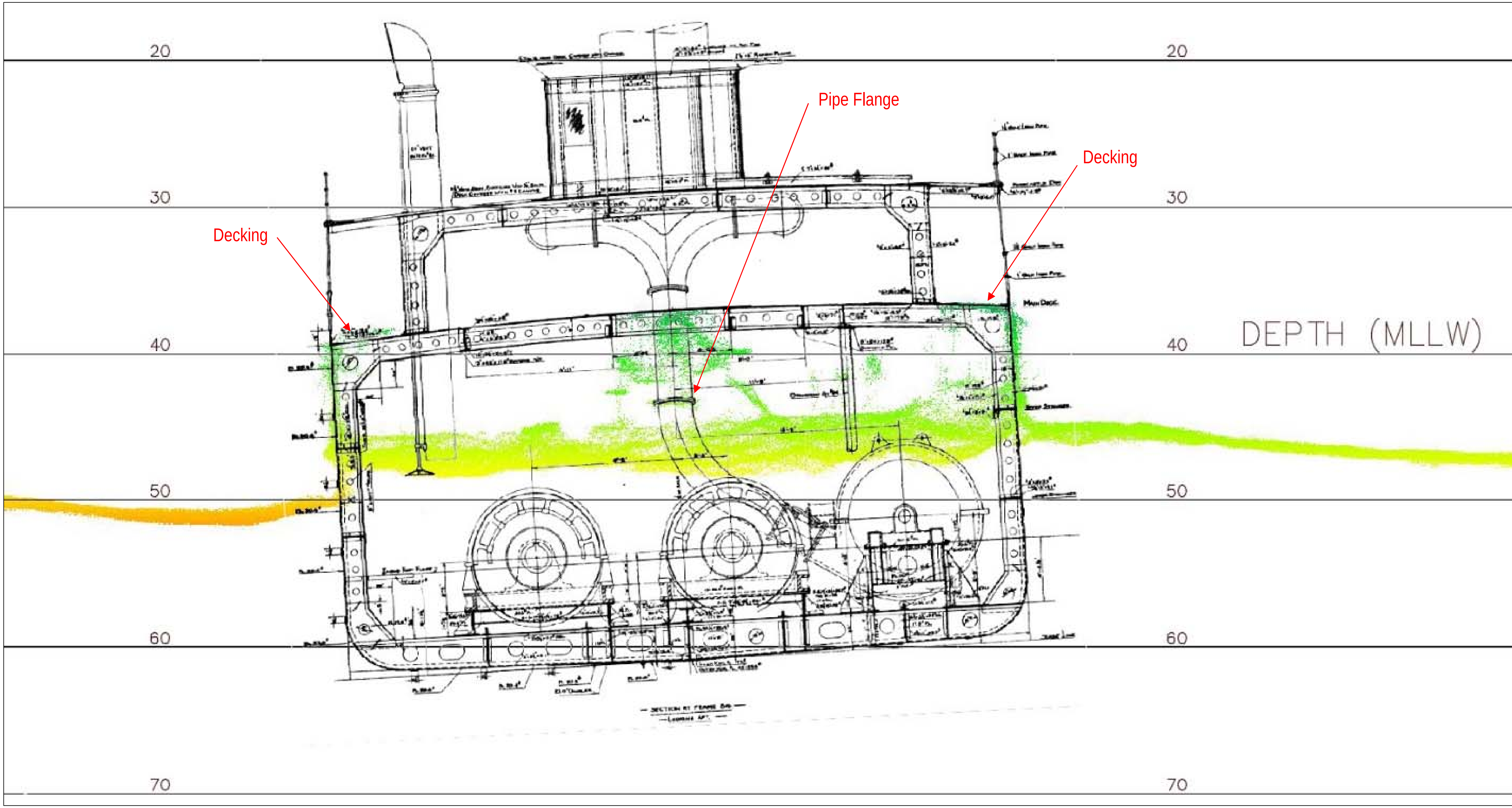
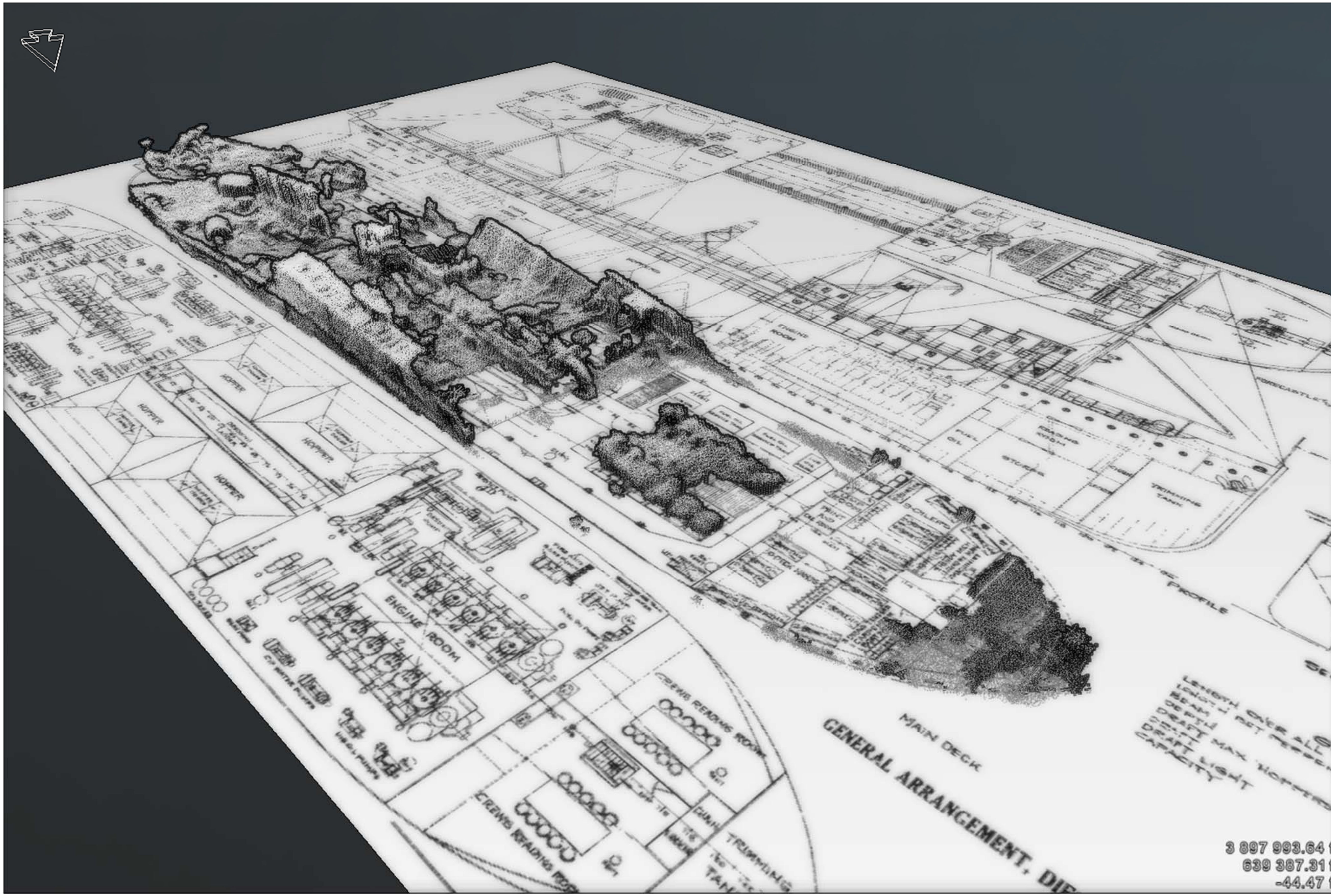


Figure 12: Cross sectional view at frame 84 of *Rossell* plan with multibeam point cloud (colored)



Additional Figure: Orthographic view showing point cloud data aligned with scaled ships plans.

ATTACHMENT E: Coos Bay Channel Modification, 2016 Pile Dike Surveys, Coos Bay, Hydrographic Survey Report

2016 Pile Dike Surveys, Coos Bay

HYDROGRAPHIC SURVEY REPORT

DECEMBER 2016

Prepared for:

OREGON INTERNATIONAL PORT OF COOS BAY
Coos Bay, OR
(208) 388-5472

Prepared by:

DAVID EVANS AND ASSOCIATES, INC.
2801 SE Columbia Way, Suite 130
Vancouver, WA 98661
(360) 314-3200

TABLE OF CONTENTS

Page

List of Figures

Acronyms and Abbreviations

AML	Applied Microsystems Ltd.
ASCII	American Standard Code for Information Interchange
DEA	David Evans and Associates, Inc.
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
kHz	Kilohertz
MLLW	Mean Lower Low Water
NAD83 (2011)	North American Datum of 1983, National Adjustment 2011, Epoch 2010.00
NSPS	National Society of Professional Surveyors
PLS	Professional Land Surveyor
POS/MV	Position and Orientation System for Marine Vessels
RTK	Real-time Kinematic
SPCS	State Plane Coordinate System
S/V	Survey Vessel
THSOA	The Hydrographic Society of America
USACE	United States Army Corps of Engineers

1.0 INTRODUCTION

In December of 2016, David Evans and Associates, Inc. (DEA), conducted hydrographic surveys of the five sets of wooden pile dikes in the shipping channel in Coos Bay between river miles 6.4 and 7.3. The survey consisted of high resolution multibeam bathymetric coverage obtained during a high tide and laser scanning of the exposed pile dike and surrounding shoreline collected during low tide to provide a complete data set of each pile dike. In addition, a multitude of high-resolution digital photographs were taken to provide detail of the structural condition of the dikes. The primary goal of the survey was to develop accurate elevation data over each of the five pile dikes and the immediate surrounding seafloor/shoreline in order to evaluate the physical condition of the structures and map the extent of armor rock at the base of each pile dike.

This report describes the control used for the surveys, data acquisition methodology, and data processing procedures. A detailed summary is provided for each of the five pile dikes highlighting the general condition of each pile dike as well as noting particular features, defects, and areas of interest observed during data acquisition and/or discovered during data processing. Pile dikes are referenced by River Mile (6.4, 6.6, 6.8, 7.0, and 7.3), which is consistent with the U.S. Army Corps of Engineers (USACE) Portland District naming convention. In addition to this report, deliverable files were provided to the design team which include: American Standard Code for Information Interchange (ASCII) XYZ point cloud data, ASCII XYZ gridded data, gridded hill-shade images, AutoCAD mapping products, and digital photos.

2.0 DATUMS AND PROJECT CONTROL

Conducting a survey on an established coordinate system, referenced by monuments, enables the survey to be reproduced at a later date with repeatable results. For this survey, hydrographic field operations were conducted using the North American Datum of 1983, National Adjustment 2011, Epoch 2010.00 (NAD83(2011)) horizontal datum projected to the State Plane Coordinate System (SPCS) Oregon South Zone with units in International Feet. The vertical datum used during data acquisition was Mean Lower Low Water (MLLW) using the NOAA VDatum separation model.

3.0 HYDROGRAPHIC SURVEY METHODOLOGY

3.1 Survey Vessel and Instrumentation

The vessel used for this survey was the *William R. Broughton*. DEA's 24-foot custom built survey vessel with twin outboard 115 horsepower engines (Figure 1). The vessel is equipped with an integrated navigation and data acquisition system, custom mounts for the Reson SeaBat T50-P multibeam sonar head and Riegl LMS-Z390i laser scanning system, and is ideal for structural and bathymetric mapping and working in both rough and shallow waters. Additional survey vessel equipment onboard consisted of an Applanix POS/MV Version 5 (Position and Orientation System for Marine Vessels) combined inertial and RTK GNSS, an Applied Microsystems Ltd. (AML) Smart SVP&T sound speed sensor, and two data acquisition computers running Reson PDS2000 software (for multibeam data acquisition) and HYPACK/HYSWEEP version 2011 (for laser data acquisition).

Figure 1. Survey Vessel *William R. Broughton*

3.2 Hydrographic Data Acquisition

The S/V *Broughton* was equipped with a Reson SeaBat T50-P multibeam bathymetric sonar operating at a frequency of 400 kilohertz (kHz) and an integrated AML MicroX with a sound velocity exchange sound speed sensor. The sonar head was tilted 15 degrees to port, and data were acquired during a high tide window to allow for maximum coverage on vertical structures and maximum data overlap with the laser scanning data collected during low tide. To account for sound speed variability of the water column, an AML Oceanographic AML SmartX sound speed profiler was utilized to take sound speed profiles while underway.

The Riegl LMS-Z390i terrestrial laser scanning system was mounted on top of the vessel. The LMS-Z390i is a highly accurate and fast 3D scanner with a vertical scanning range of 80 degrees and a 360 degree rotating optical head. The system was configured to have a maximum number of 800 shots per scan with a vertical angle increment of 0.1 degrees, and could be controlled to scan off the port or starboard side of the vessel depending on vessel heading.

The Applanix POS/MV Version 5 motion reference sensor was utilized to measure and record vessel heading (yaw), heave (vertical movement from seas), pitch and roll. By utilizing vessel speed over ground and heading data provided by GNSS, the POS/MV can isolate horizontal accelerations from vessel turns and provide highly accurate motion data. The POS/MV position and motion data were used to derive sonar/laser beam orientation and position individual soundings. Height data were logged for vertical positioning.

4.0 HYDROGRAPHIC DATA PROCESSING

Processing of multibeam sonar and laser scanning data were conducted utilizing Caris Hydrographic Information Processing System (HIPS) multibeam analysis and processing software version 9.1.6. Patch test data were analyzed and alignment corrections were calculated and applied during processing. GPS tides were computed and applied, and final sounding elevations were reduced to MLLW. Sound speed profiles were used to correct multibeam slant range measurements and compensate for any ray path bending.

Data were reviewed through the Caris HIPS subset editing program to search for any errant flyers remaining in the dataset, or to re-accept data previously flagged as rejected in the swath editor that may be valid. Vegetation along the shoreline was flagged as rejected, and baring piles were flagged as suppressed just above the mudline in order to provide a bare earth model for final gridded products and XYZ point cloud data, and contouring, though some of these data are shown for context in the images below (see sections 5.1 – 5.5). Submerged objects, and large pieces of submerged or exposed debris were not rejected as they could provide useful information on the condition of the pile dikes and the surrounding area. It should be noted, however, that these features, along with suppressed data on the baring piles will not be accurately represented in gridded deliverables, and should only be evaluated in the full resolution point cloud datasets. The extent of armor rock was delineated using the 1-foot gridded bathymetric hill shade images generated in Caris, with the aid of EIVA NaviModel software to view the full resolution data.

Contours from the 1-foot gridded data, line-work, and additional final mapping products were generated in AutoCAD.

5.0 EVALUATION OF PILE DIKE PHYSICAL CONDITION

There are five pile dikes in the survey area, ranging from one at RM 6.4 to a fifth at RM 7.3. The pile dikes are wooden structures built with vertical wooden piles, horizontal spreaders, and outer dolphins. Armor rock was mapped where detected by sonar. Following is a summary of observations during field data collection and data processing relating to the general structural condition of the pile dikes, the surrounding seabed, and other significant features.

5.1 Pile Dike 6.4

Pile Dike 6.4 is the southern-most pile dike in the survey area and the first of the five pile dikes in the Jarvis Turn if approaching inbound from the Coos Bay entrance channel. The structure is approximately 332 feet long and consists of vertical wooden piles connected by a horizontal spreader. An outer dolphin (piles lashed together into a single structure) is present at the seaward tip of the pile dike on the south side. The structure extends to the beach and appears to end at the base of a vegetated bank. Figure 2 shows the point cloud dataset of the pile dike and surrounding area from four points of view.

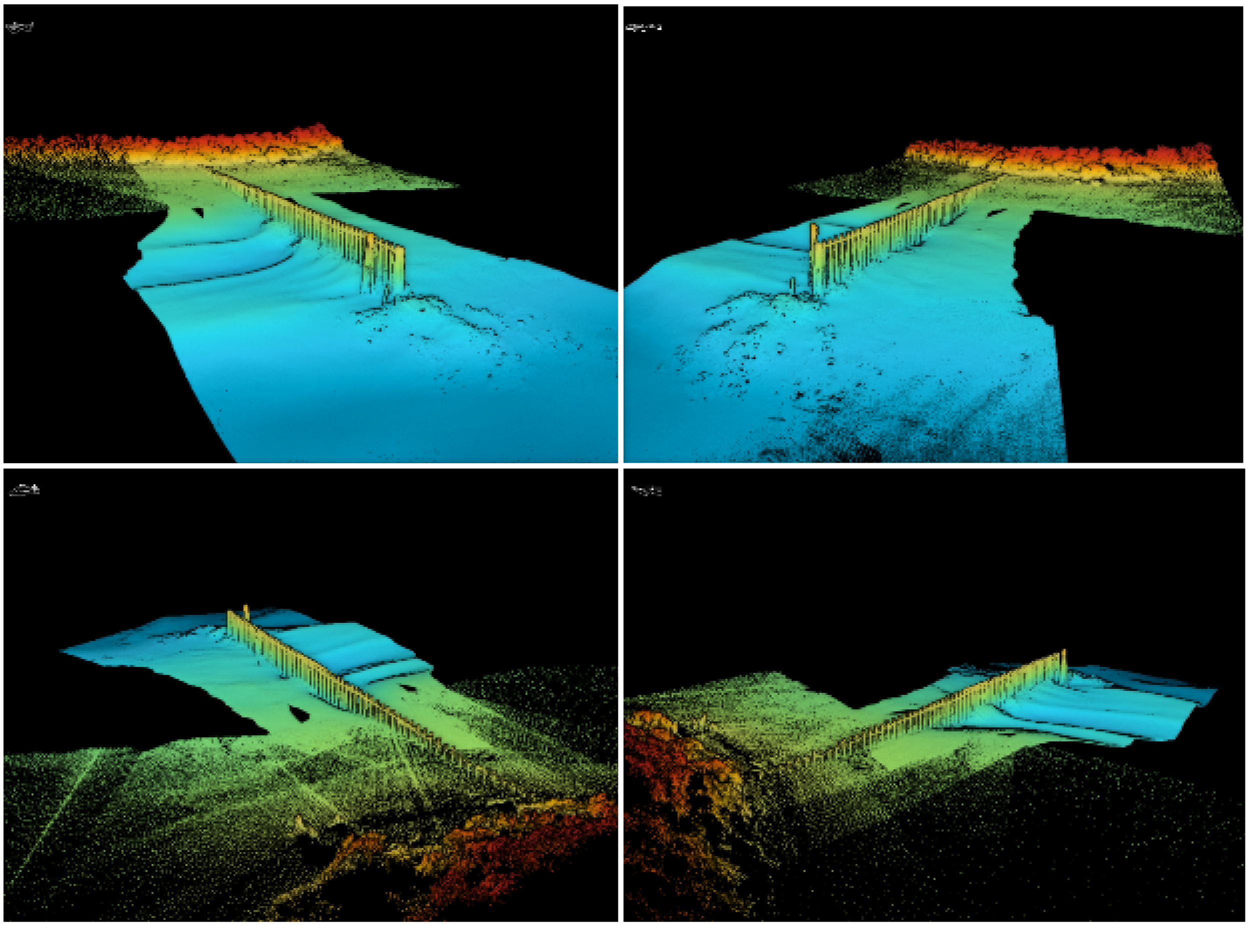


Figure 2. Pile Dike 6.4 at four points of view: Northwest (top left), Southwest (top right), Southeast (bottom left), Southwest (bottom right).

Figures 3-6 include photographs with matching features from the point cloud depicting physical features, wood debris, and submerged pile. The most notable features of Pile Dike 6.4 include logs that are either: resting on top of the spreader, stuck between the vertical piles, or resting at the base of the dike. There is also a single broken submerged pile near the outer tip of the pile dike that rises approximately 10 feet above the seafloor. Additional images of the wood debris and submerged pile are shown in Figure 7.

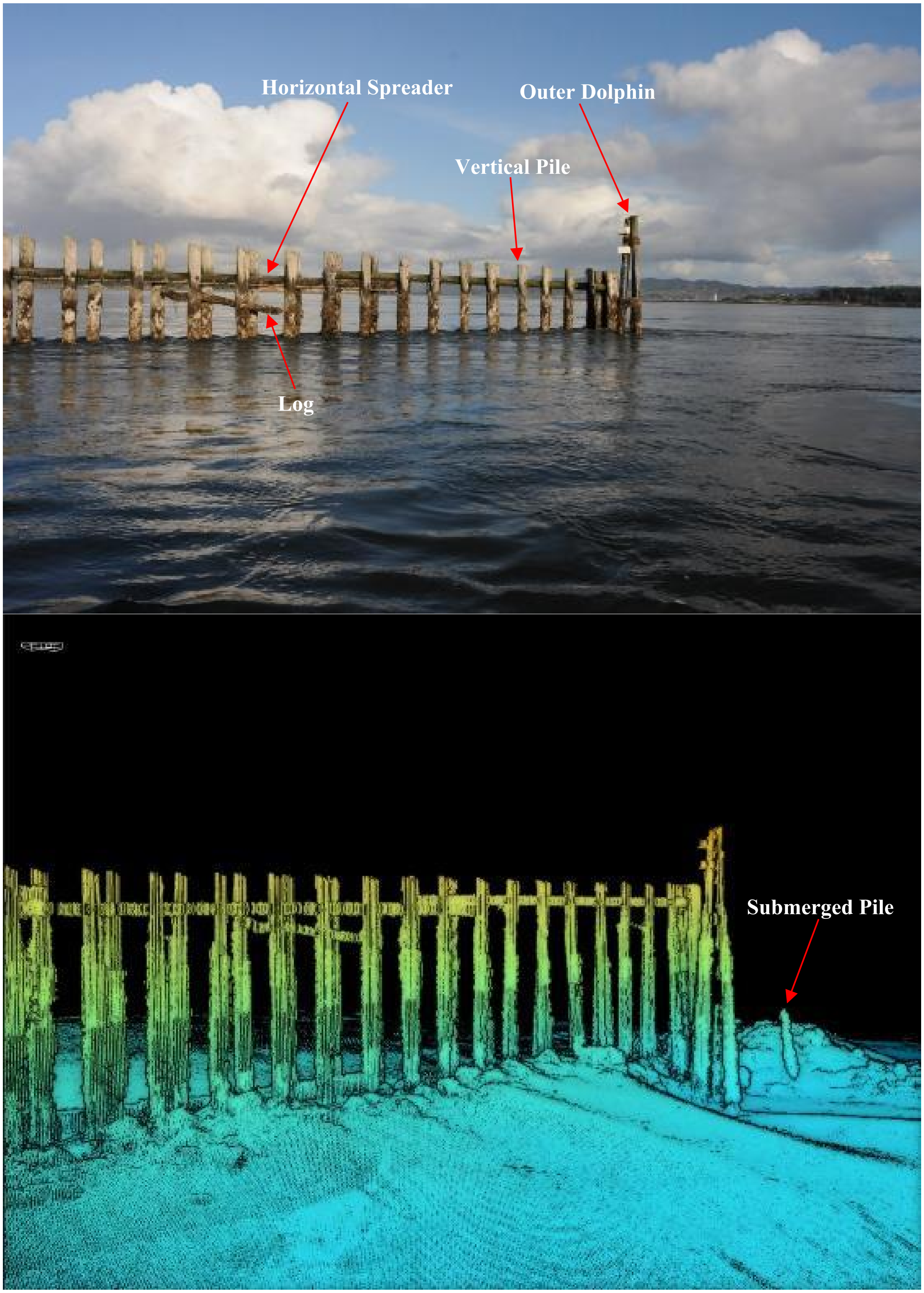


Figure 3. Pile Dike 6.4 viewed from downstream looking riverward.

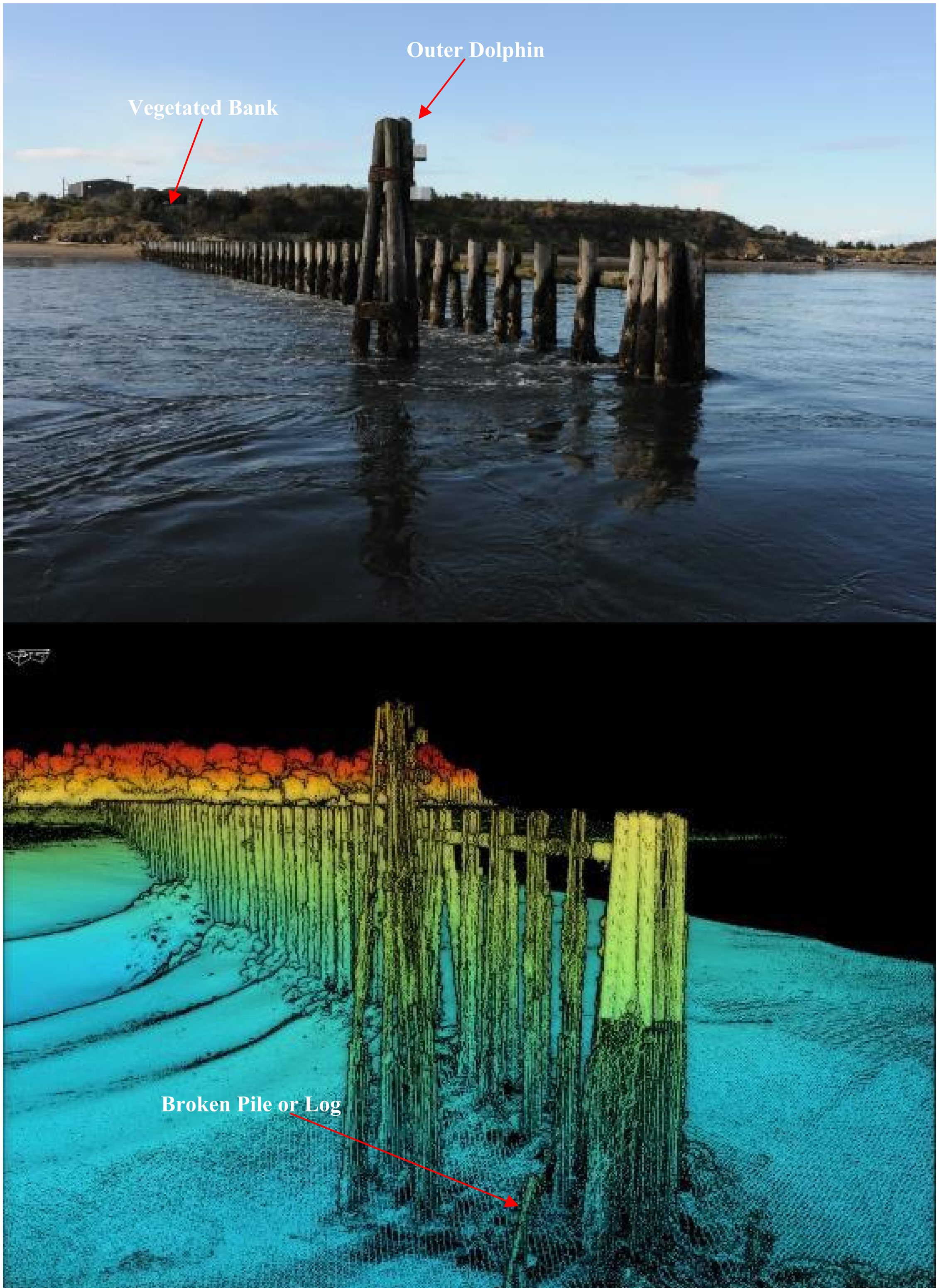


Figure 4. Pile Dike 6.4 viewed from downstream looking shoreward.

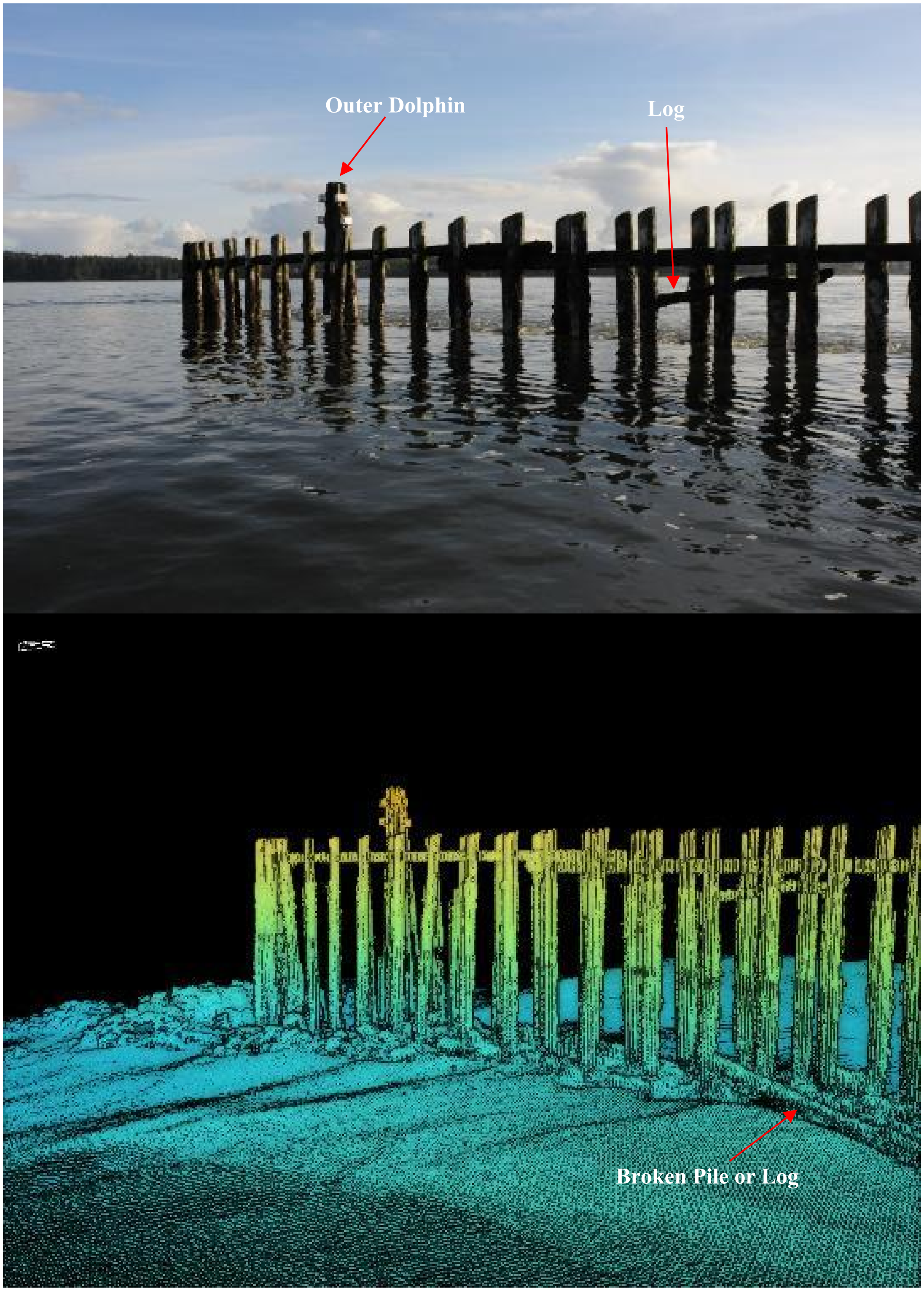


Figure 5. Pile Dike 6.4 viewed from upstream looking riverward.

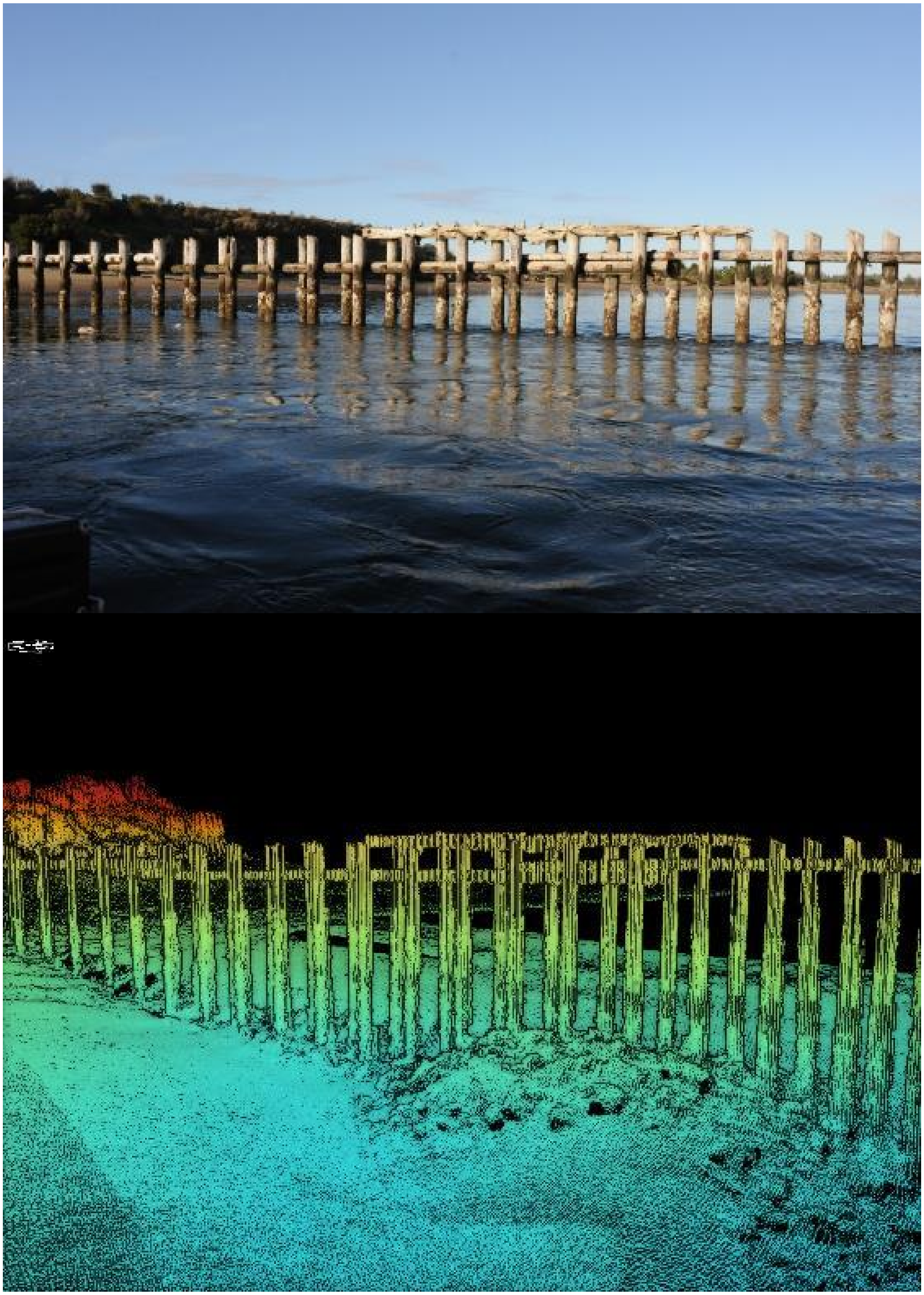


Figure 6. Pile Dike 6.4 viewed from downstream looking shoreward.

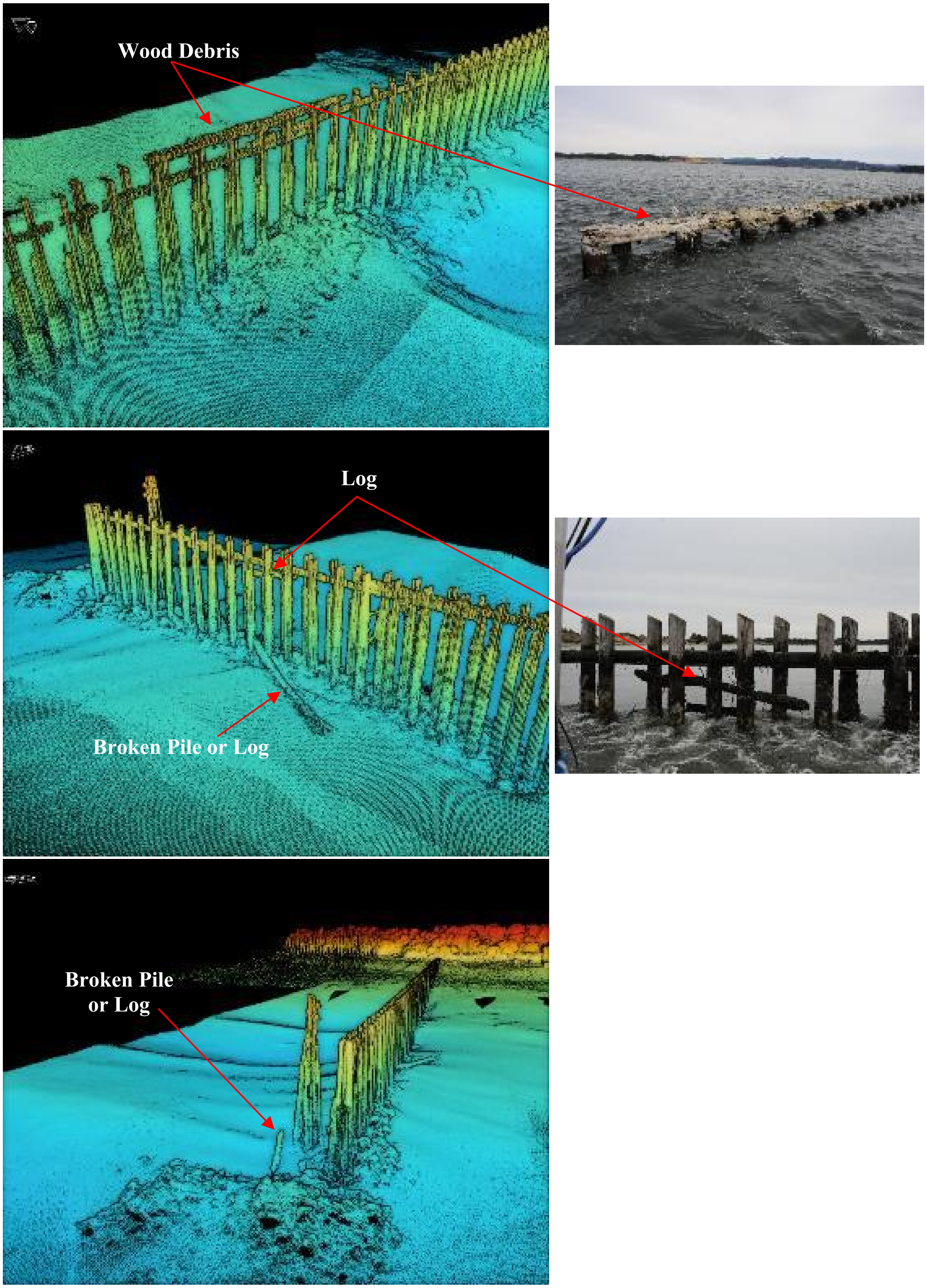


Figure 7. Pile Dike 6.4 with corresponding photographs and point cloud images.

Figure 8 provides photos of the pile dike's general physical condition.

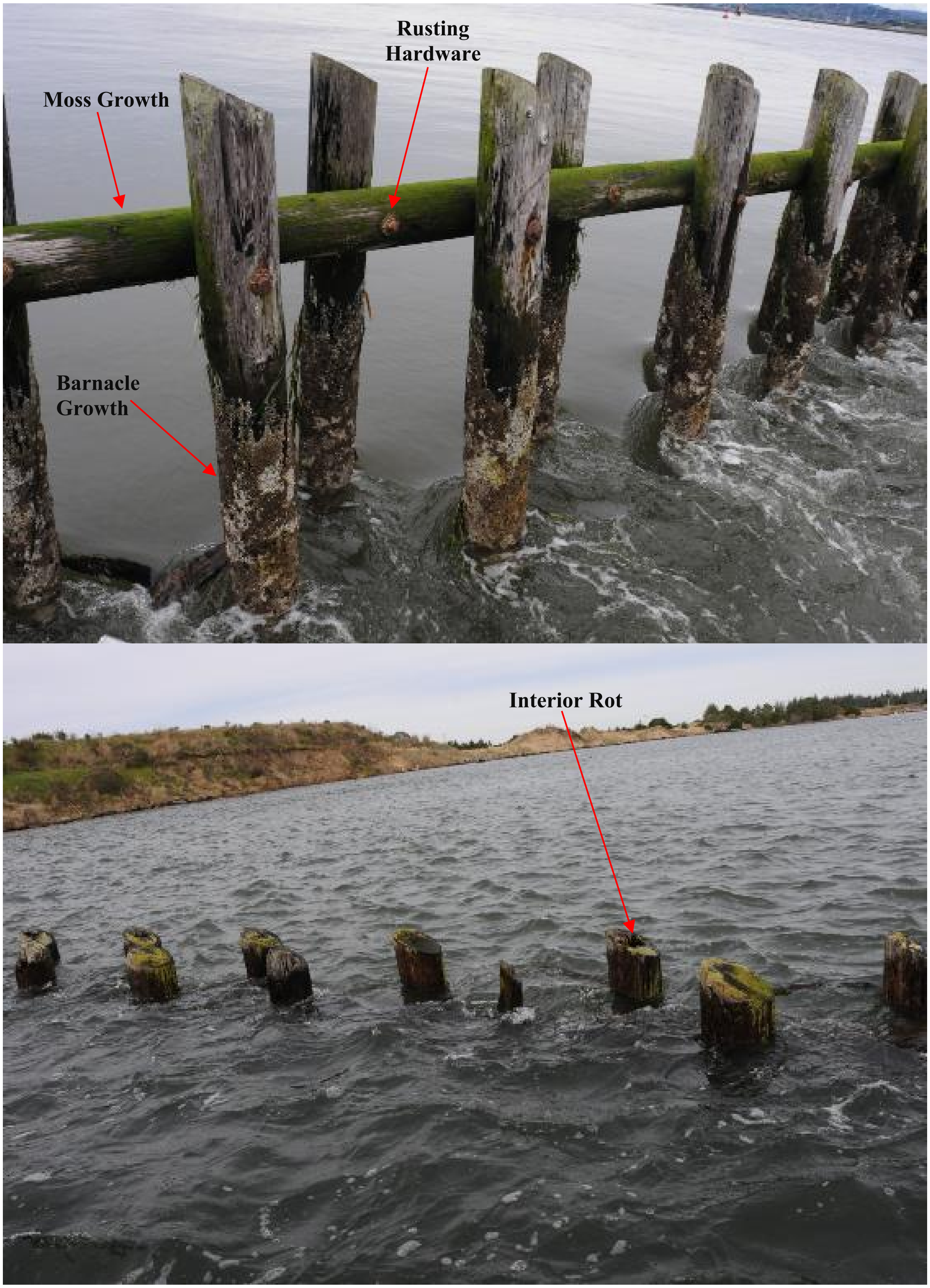


Figure 8. Pile Dike 6.4 Photographs depicting the condition of the piles and hardware.

Figure 9 shows the extent of armor rock surrounding the base of the pile dike, delineated from the gridded hillshade image.

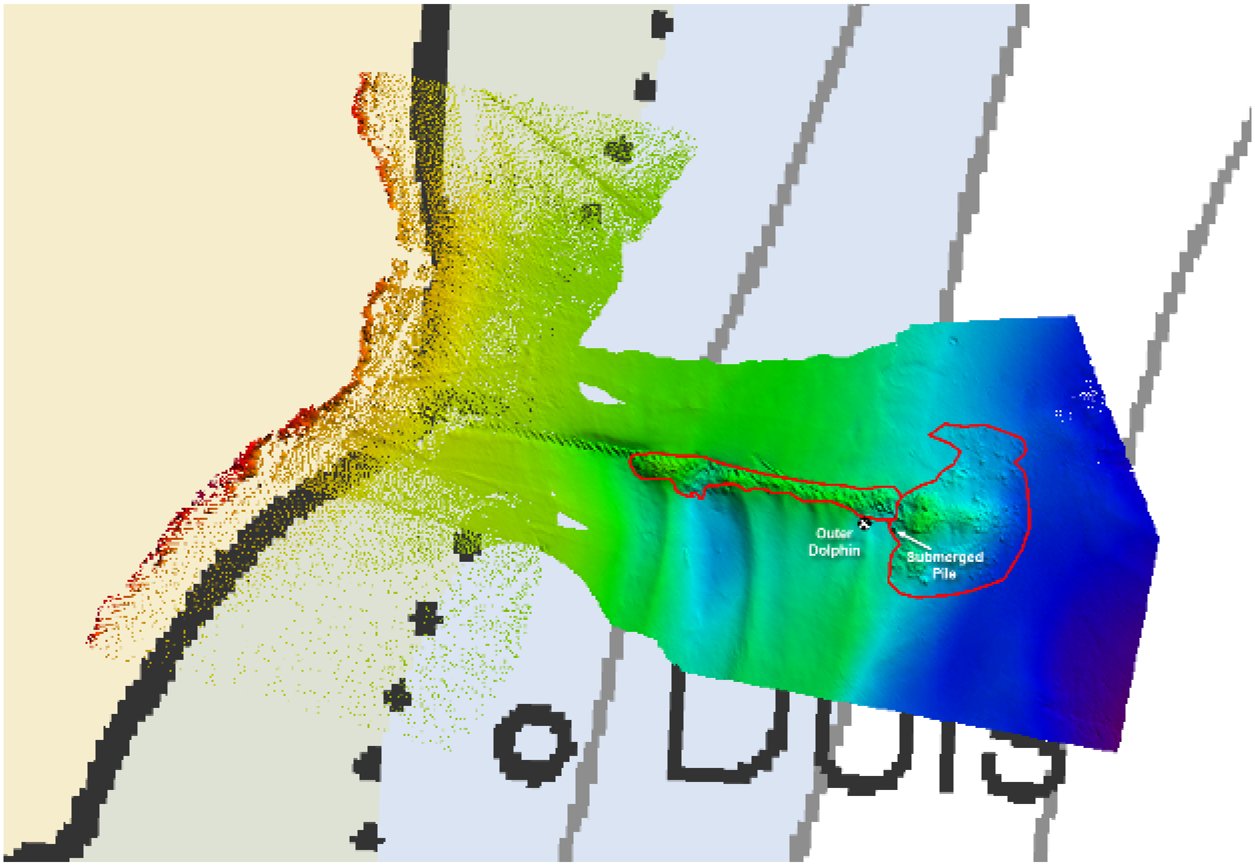


Figure 9. Pile Dike 6.4 Hillshade map depicting the extent of exposed armor rock (outlined in red) and the location of the baring outer dolphin and submerged pile.

5.2 Pile Dike 6.6

Pile Dike 6.6 is approximately 300 feet long and consists of vertical wooden piles connected by a horizontal spreader. An outer dolphin is present at the riverward tip of the pile dike on the south side and an additional dolphin stickup is present approximately 200 feet landward of the tip, positioned on the centerline of the structure. The pile dike extends to the beach and appears to end at the base of a vegetated bank near some wood debris. Figure 10 shows the point cloud of the pile dike and surrounding area from four points of view. Some of the vertical steel piles and light posts associated with the boat ramp to the north are visible in the following images, however these are not associated with the pile dike structure.

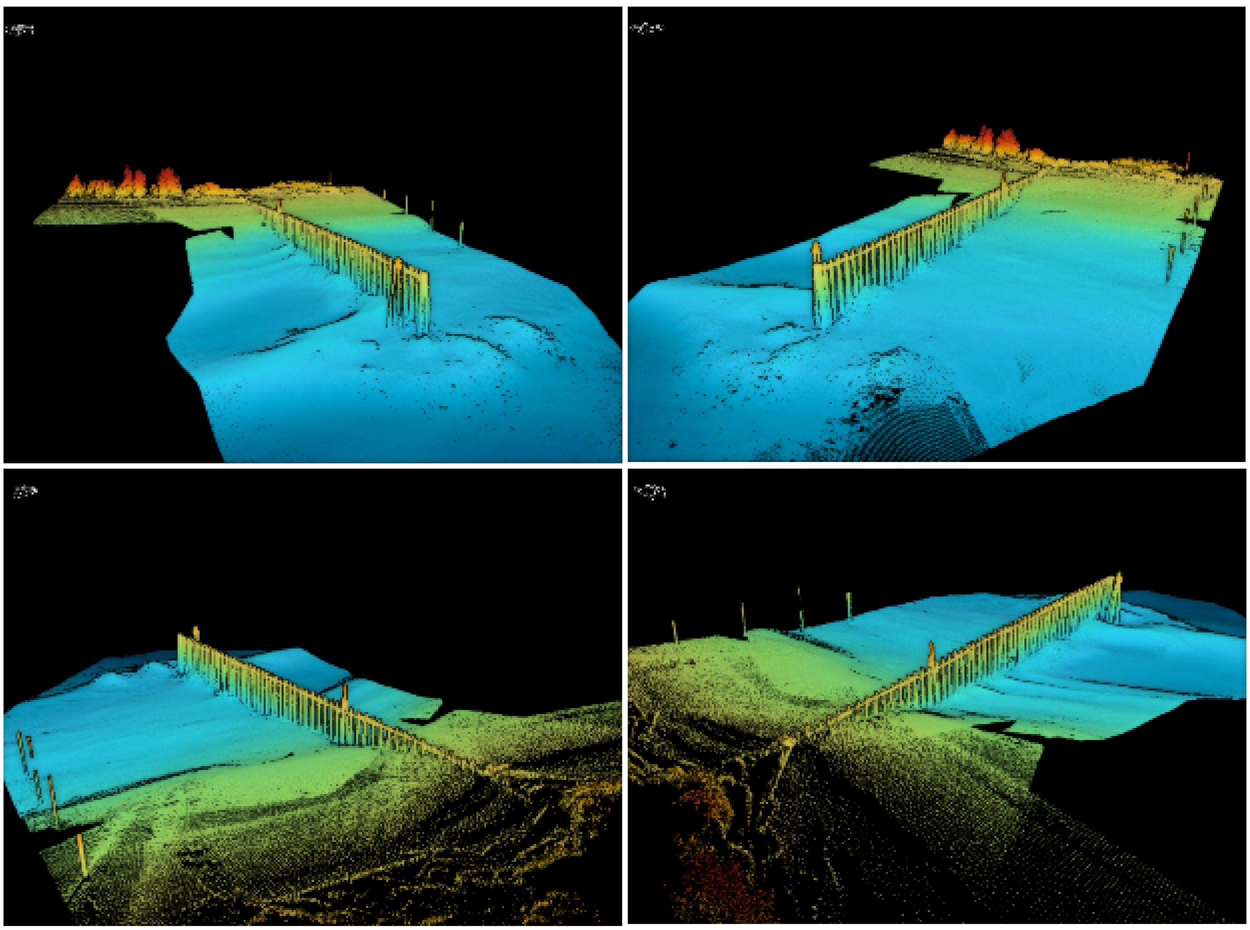


Figure 10. Pile Dike 6.6 point cloud viewed from: Northwest (top left), Southwest (top right), Southeast (bottom left), Southwest (bottom right).

Figures 11-13 include photographs with matching features from the point cloud.

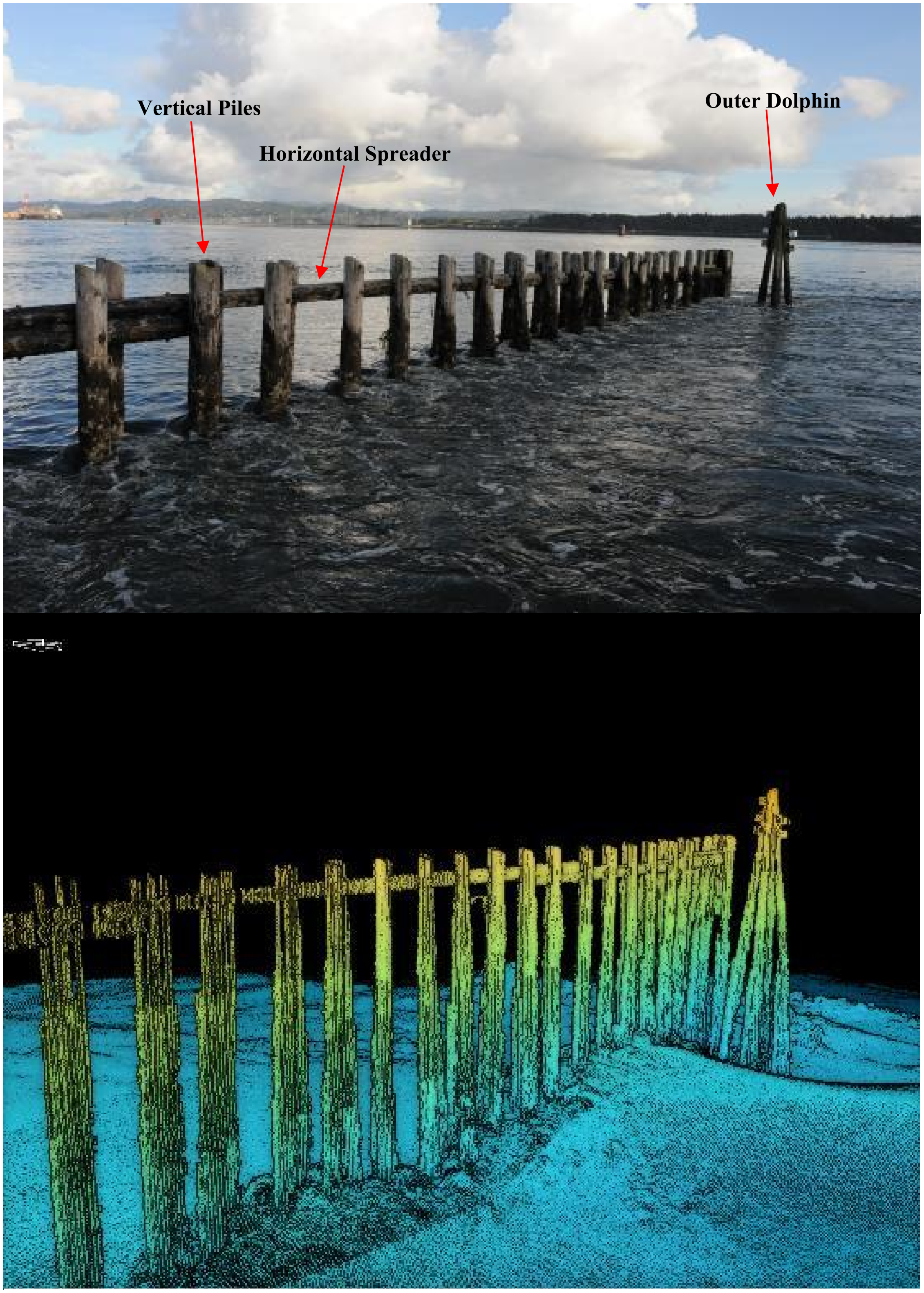


Figure 11. Pile Dike 6.6 viewed from downstream looking riverward.

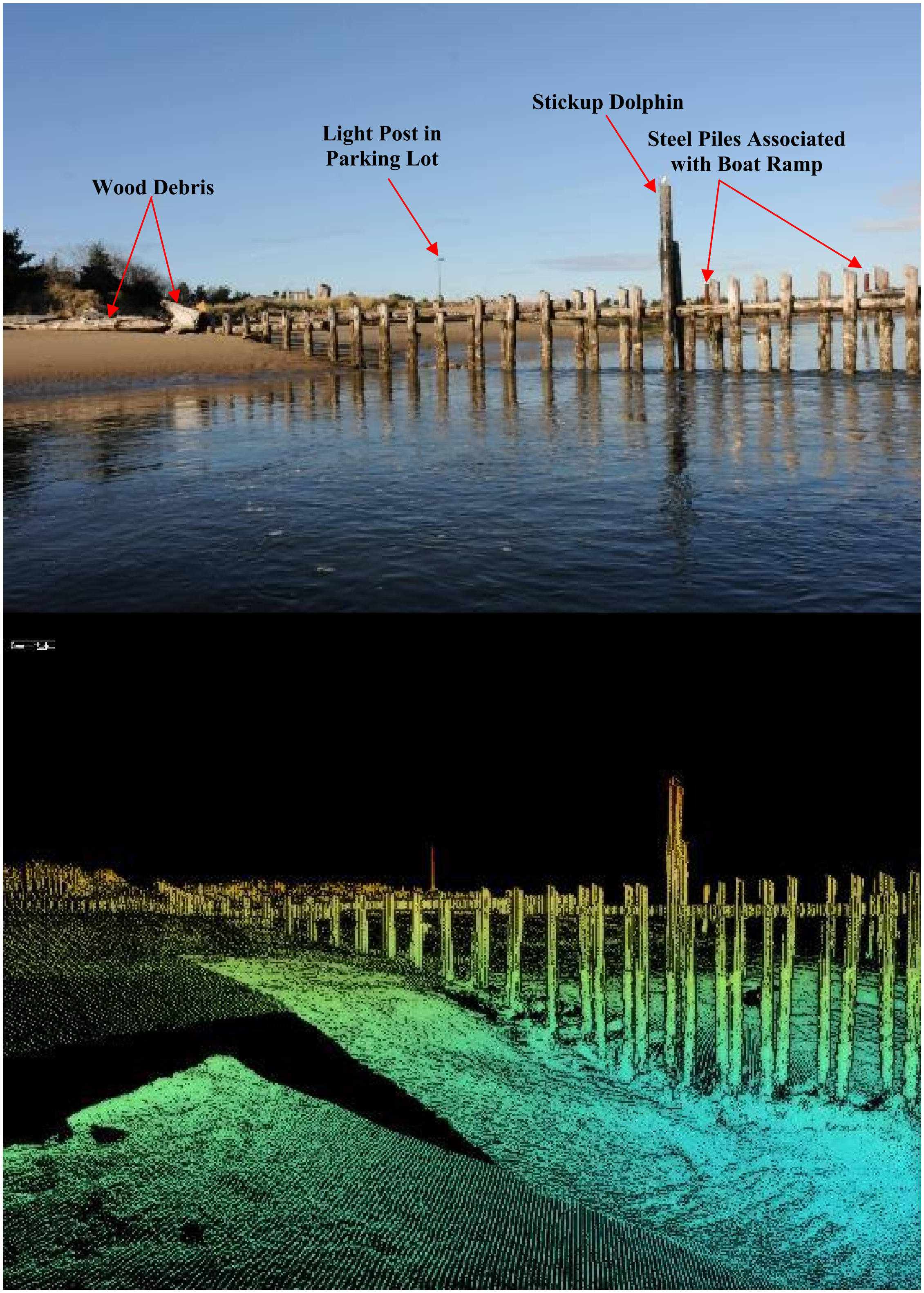


Figure 12. Pile Dike 6.6 viewed from downstream looking shoreward.

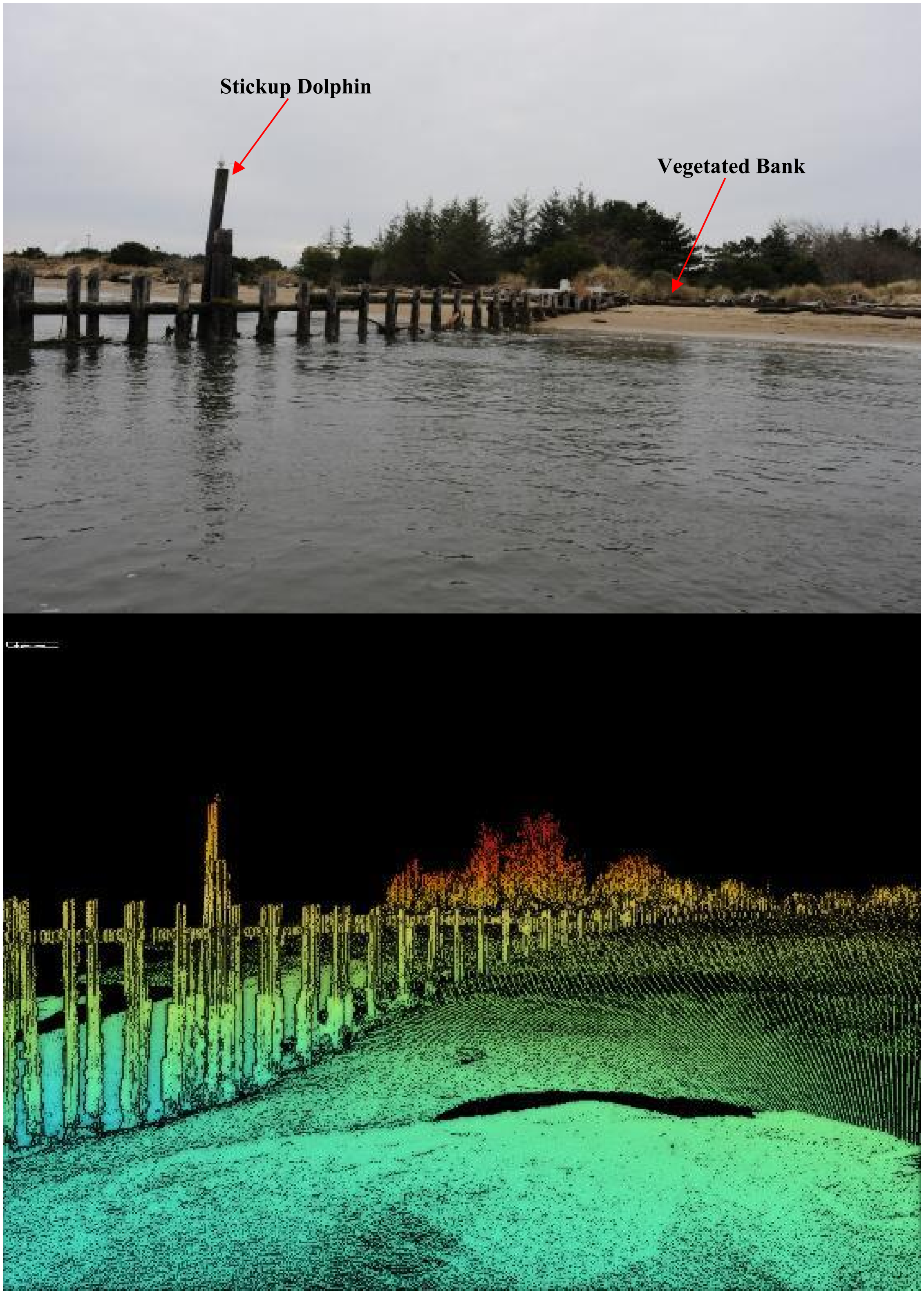


Figure 13. Pile Dike 6.6 viewed from upstream looking shoreward.

Though small pieces of wood debris and vegetation were caught between the piles from incoming and outgoing tides, there was one particularly larger piece of submerged wood debris sticking out from the base of the piles on the south side of the structure (Figure 14).

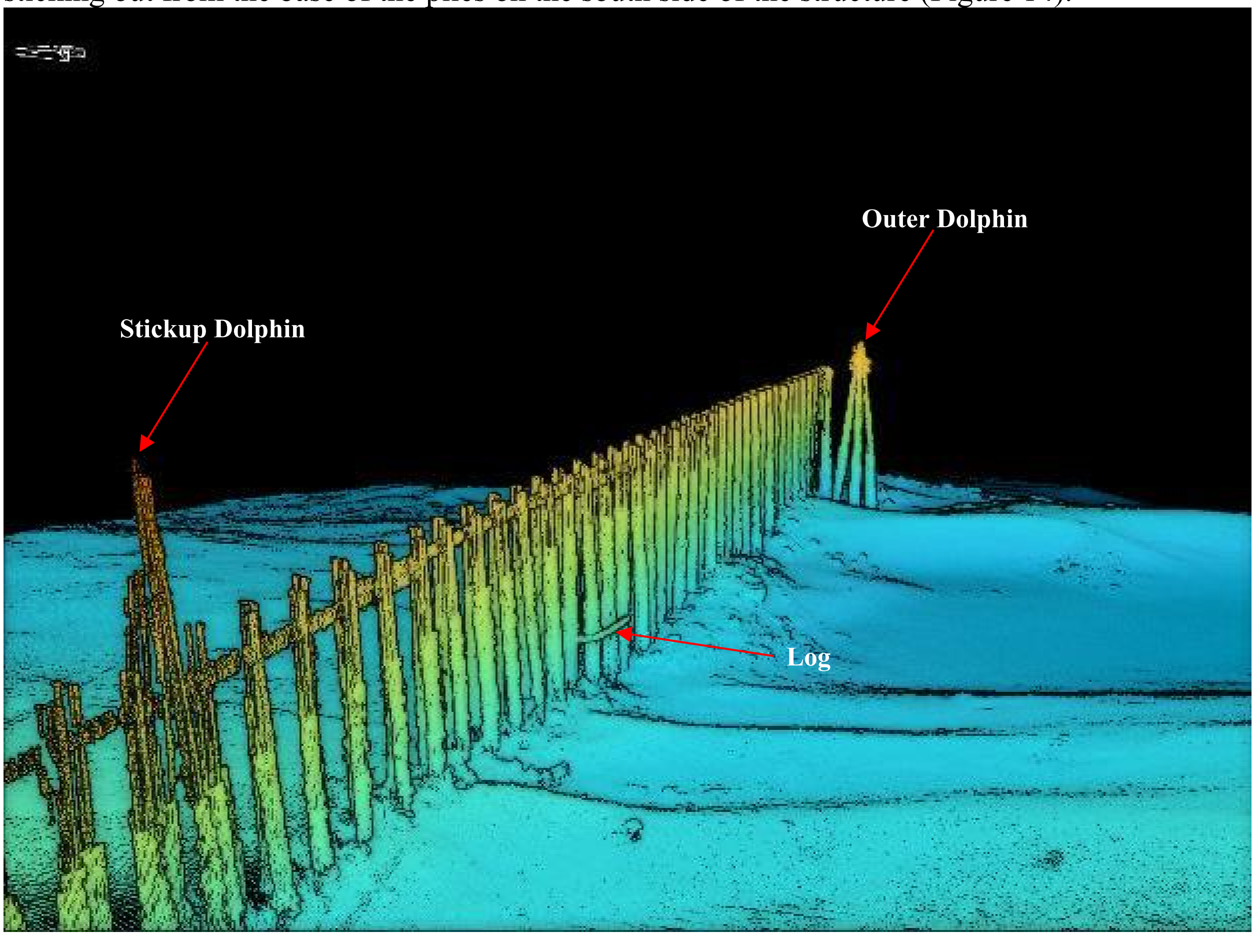


Figure 14. Pile Dike 6.6 point cloud viewed from downstream looking riverward.

Figure 13. Pile Dike 6.6 with corresponding photograph and point cloud depicting structural features and surrounding shoreline.

Figure 15 provides photos of the pile dike's general physical condition, which are representative of the structure as a whole.

Figure 15. Pile Dike 6.6 photographs depicting the condition of the piles and hardware.

Figure 16 shows a bathymetric hillshade coverage map of Pile Dike 6.6 depicting the extent of exposed armor rock, and location of the baring outer dolphin and boat ramp piles.

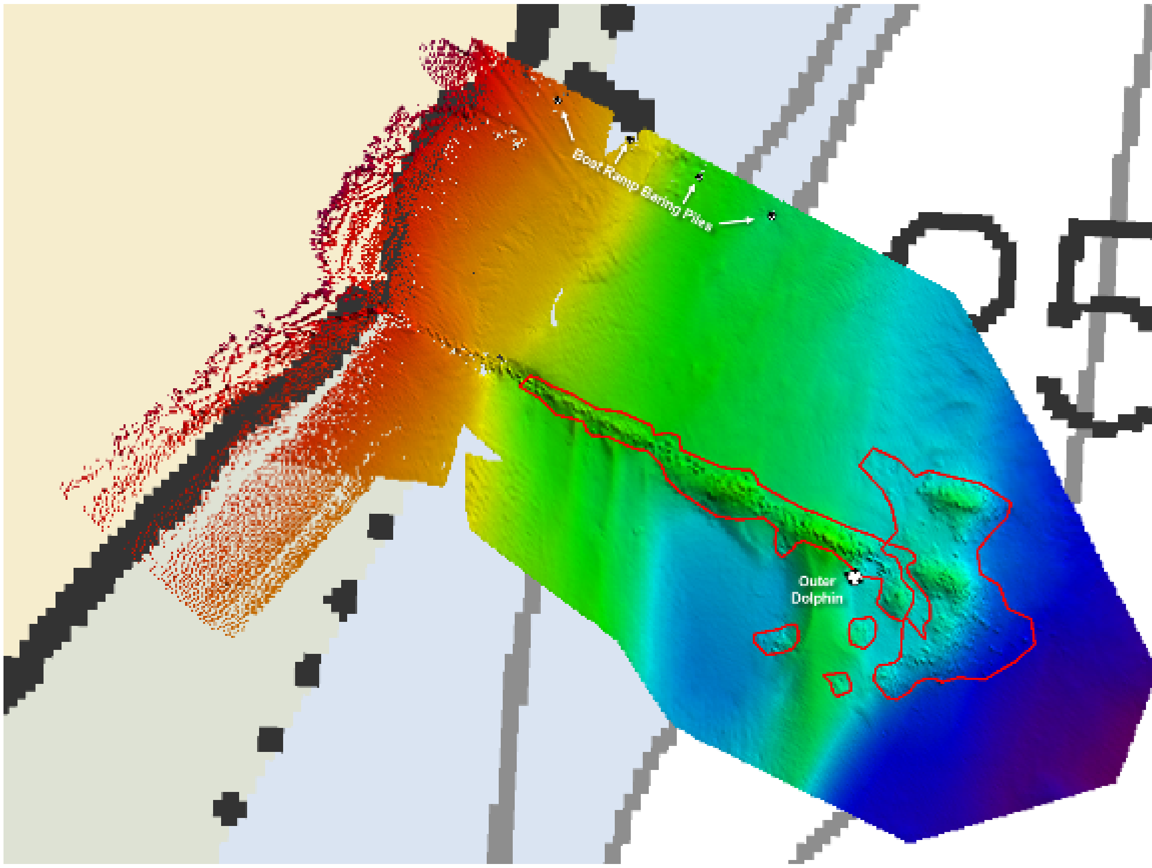


Figure 16. Pile Dike 6.6 plan view hillshade map depicting the extent of exposed armor rock (outlined in red), outer dolphin and boat ramp piles.

5.3 Pile Dike 6.8

Pile Dike 6.8 is approximately 318 feet long and consists of vertical wooden piles connected by a horizontal spreader. An outer dolphin is present at the riverward tip of the pile dike on the south side as well as a lighted aid to navigation (Green 19) atop a steel dolphin. The pile dike extends shoreward up a gently sloping beach, and appears to end about 265 feet short of the vegetated bank. Figure 17 shows the point cloud of the pile dike and surrounding area from four points of view.

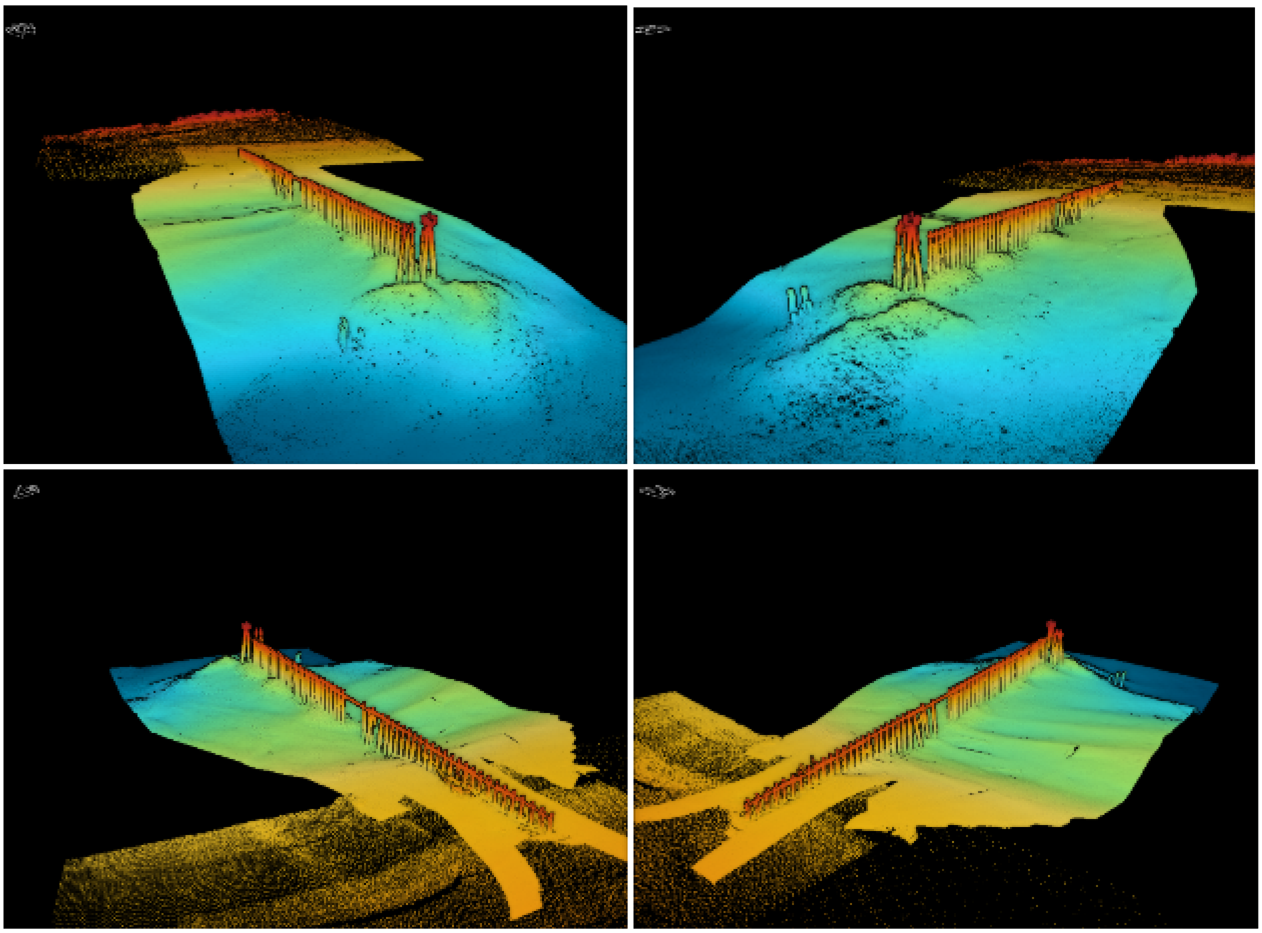


Figure 17. Pile Dike 6.8 point cloud viewed from: Northwest (top left), Southwest (top right), Southeast (bottom left), Southwest (bottom right).

Figures 18-21 include photographs with corresponding features in the point cloud. The most notable feature of Pile Dike 6.8 is a 41-foot section of missing piling. The horizontal spreader remains and there are angled piles from the spreader along this gap. These are either driven as brace piling or have been broken at the mudline and are hanging from the spreader and just touching the riverbed. A few of the missing pile that have been broken off of this section can be seen resting on the riverbed on the upstream and downstream sides of the pile dike.

Figure 18 shows submerged broken piles located approximately 60 feet south of the outer tip of the structure and approximately 15.7 feet above the bottom which are likely ruins from a navigation aid or dolphin.

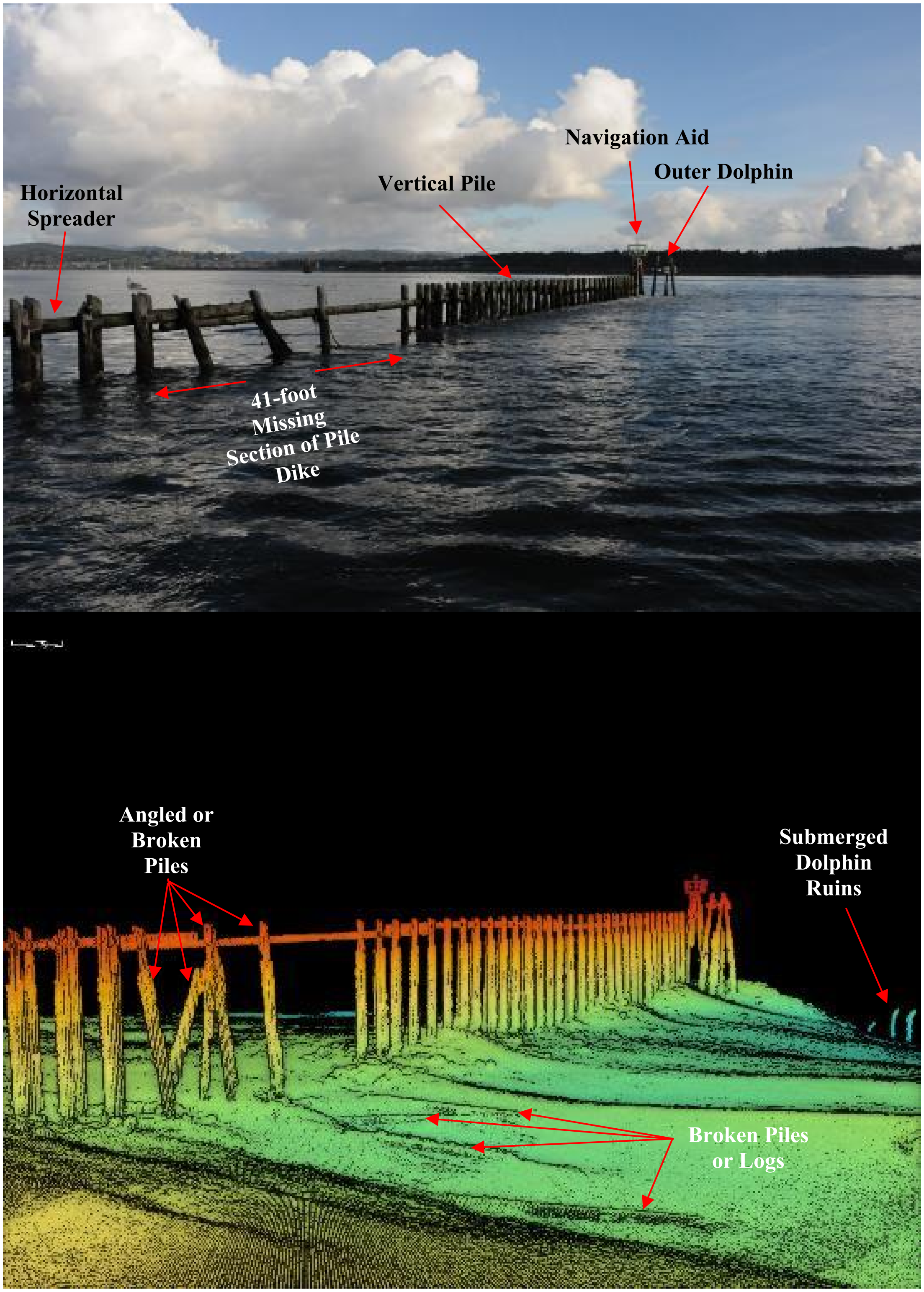


Figure 18. Pile Dike 6.8 viewed from downstream looking riverward.

Figure 19 shows submerged broken piles located approximately 60 feet south of the outer tip of the structure and approximately 15.7 feet above the bottom which are likely ruins from a navigation aid or dolphin. A large piece of wood debris is wedged between the vertical pile at the outer end of the pile dike.

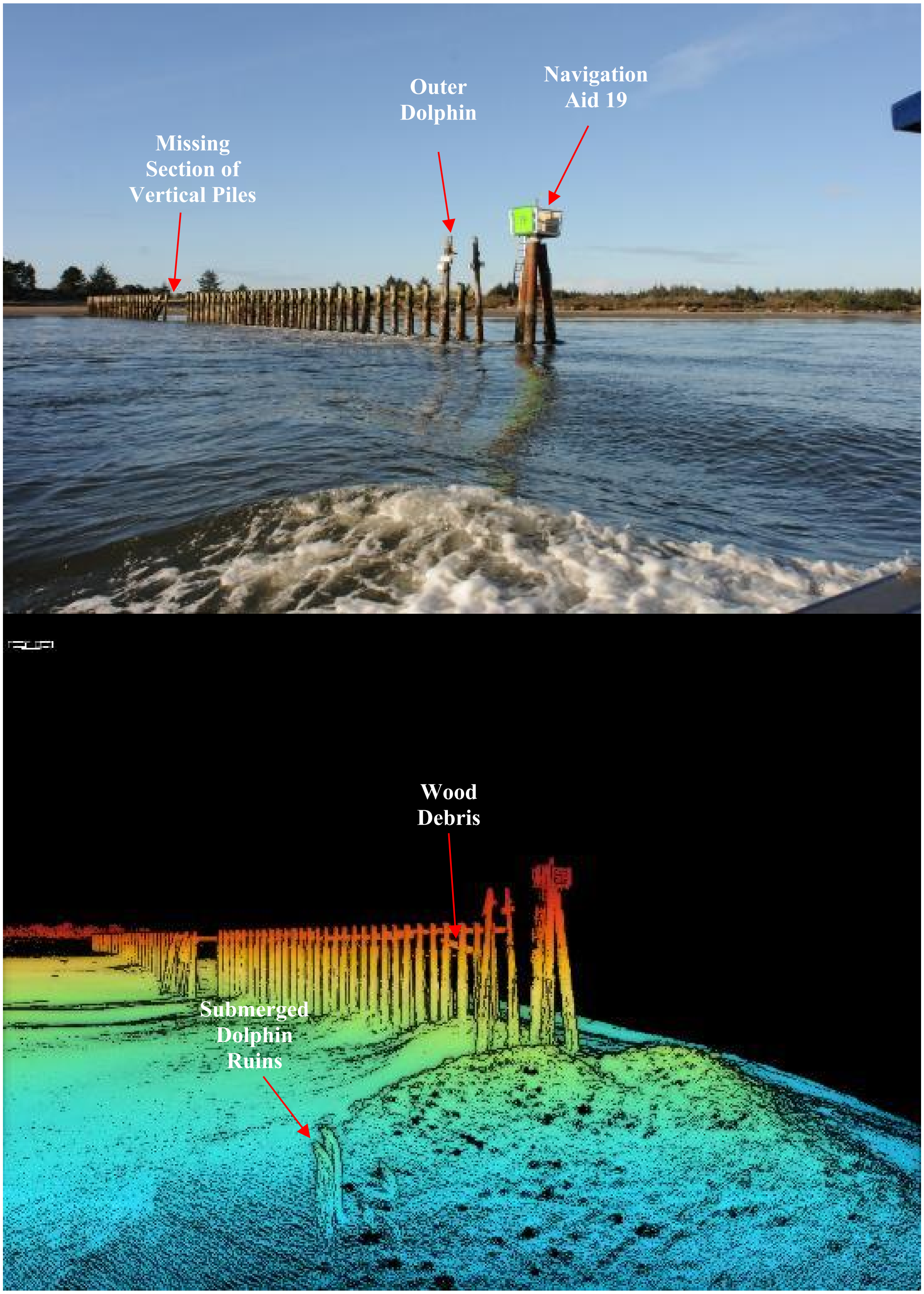


Figure 19. Pile Dike 6.8 viewed from downstream looking shoreward.

Figure 20 shows a broken pile on the outer dolphin. A large piece of wood debris is wedged between the vertical pile at the outer end of the pile dike.

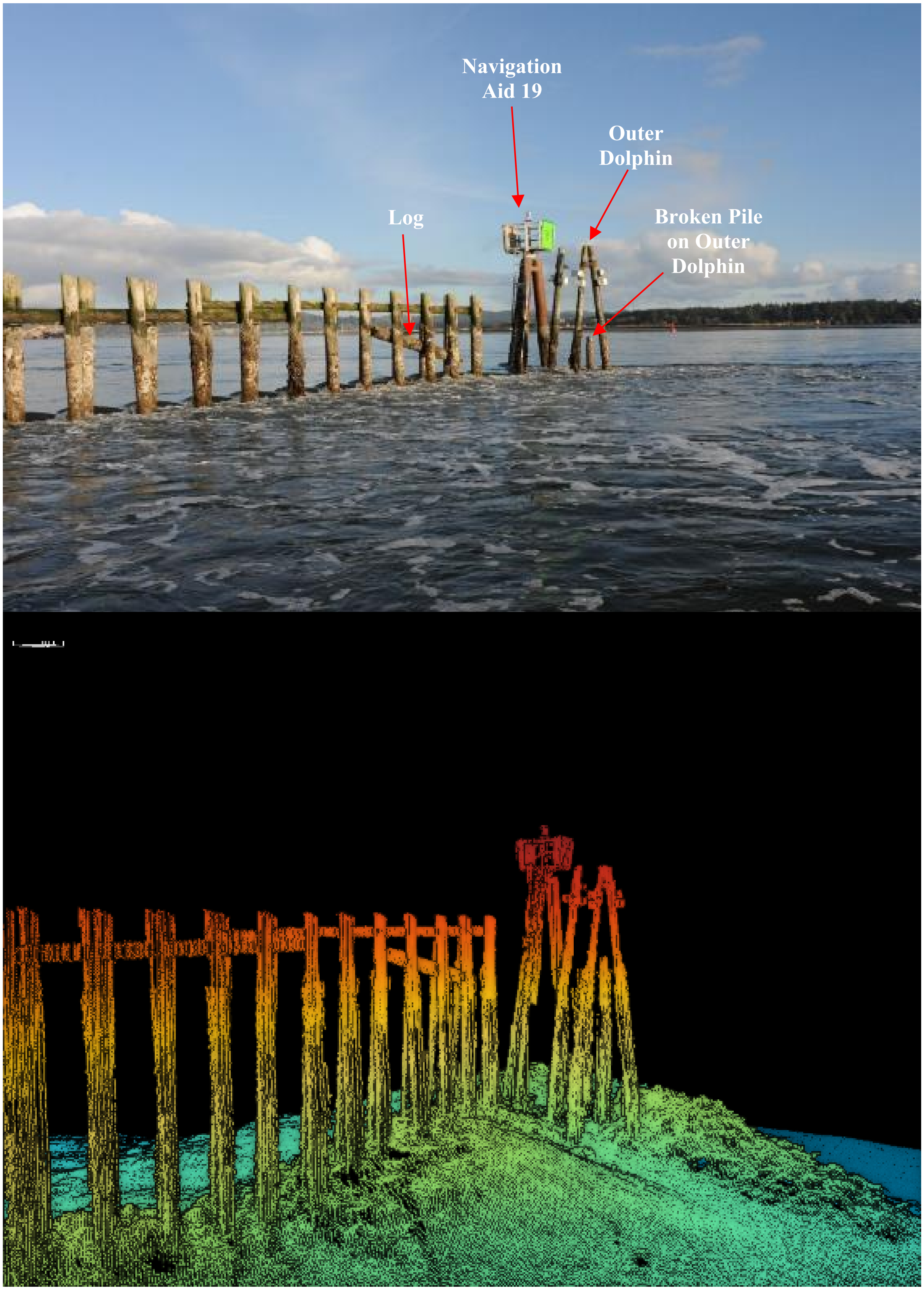


Figure 20. Pile Dike 6.8 viewed from downstream looking riverward.

Figure 21 shows corresponding photograph and point cloud depicting structural features, tree debris and surrounding shoreline. A large piece of debris can be seen resting against the north side of the pile dike closer to shore.

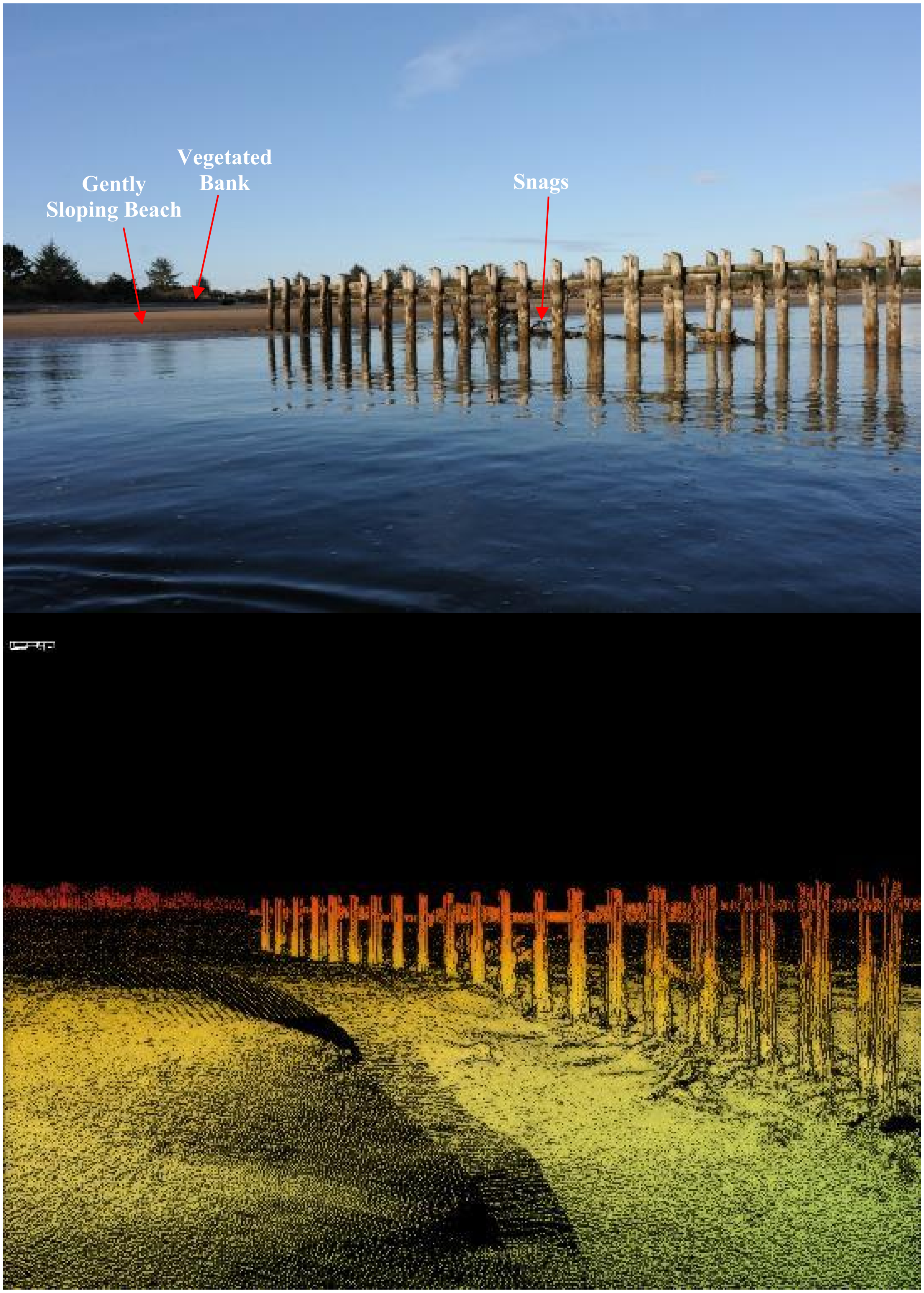


Figure 21. Pile Dike 6.8 viewed from downstream looking shoreward.

Figure 22 includes additional images of the missing section of piling.

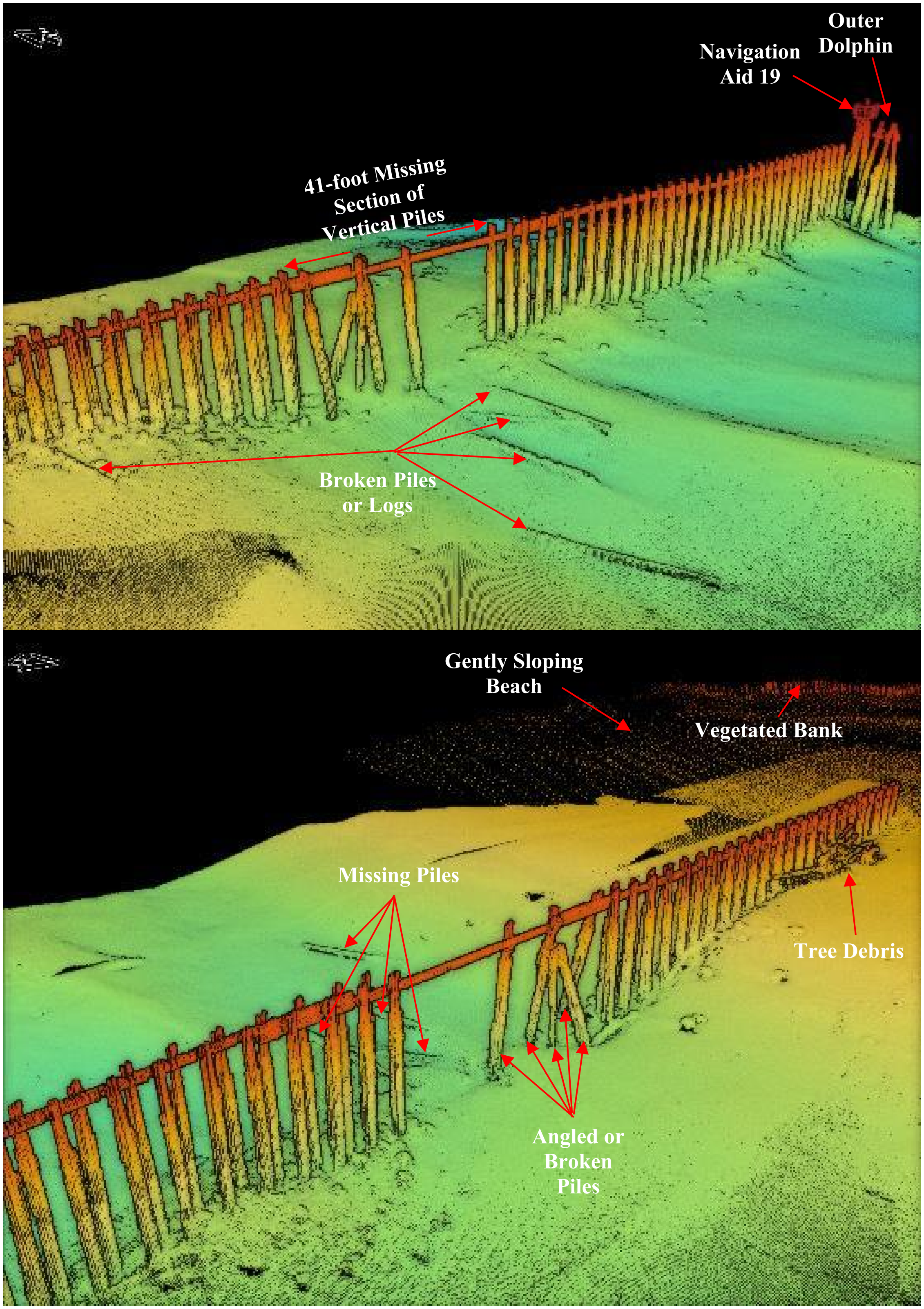


Figure 22. Pile Dike 6.8 point cloud viewed from downstream looking riverward (top) and from upstream looking shoreward (bottom).

Figure 23 provides photos of the pile dike's general physical condition, which are representative of the structure as a whole.

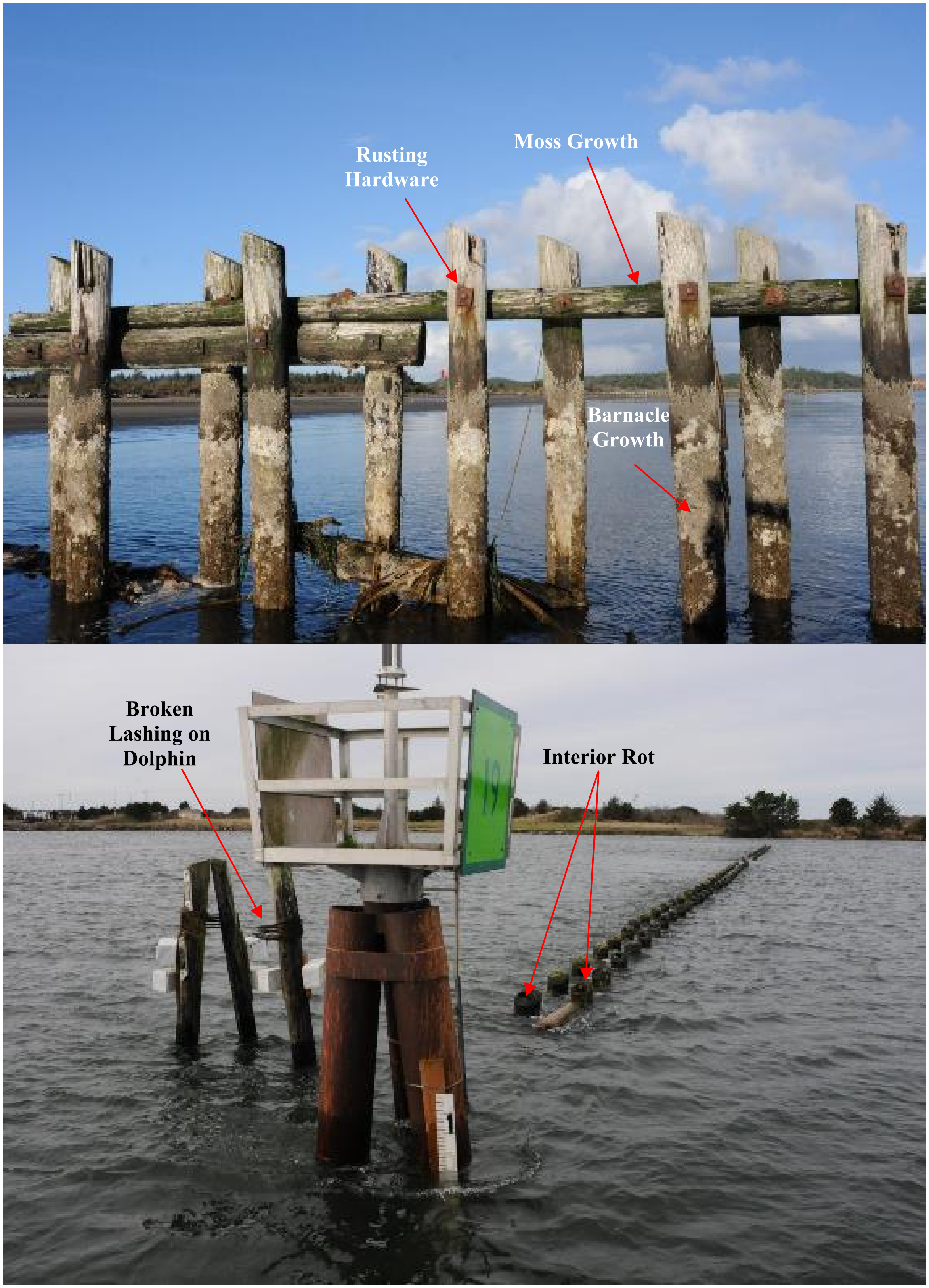


Figure 23. Pile Dike 6.8 photographs depicting the condition of the piles and hardware.

Figure 24 shows the extent of armor rock surrounding the base of the pile dike.

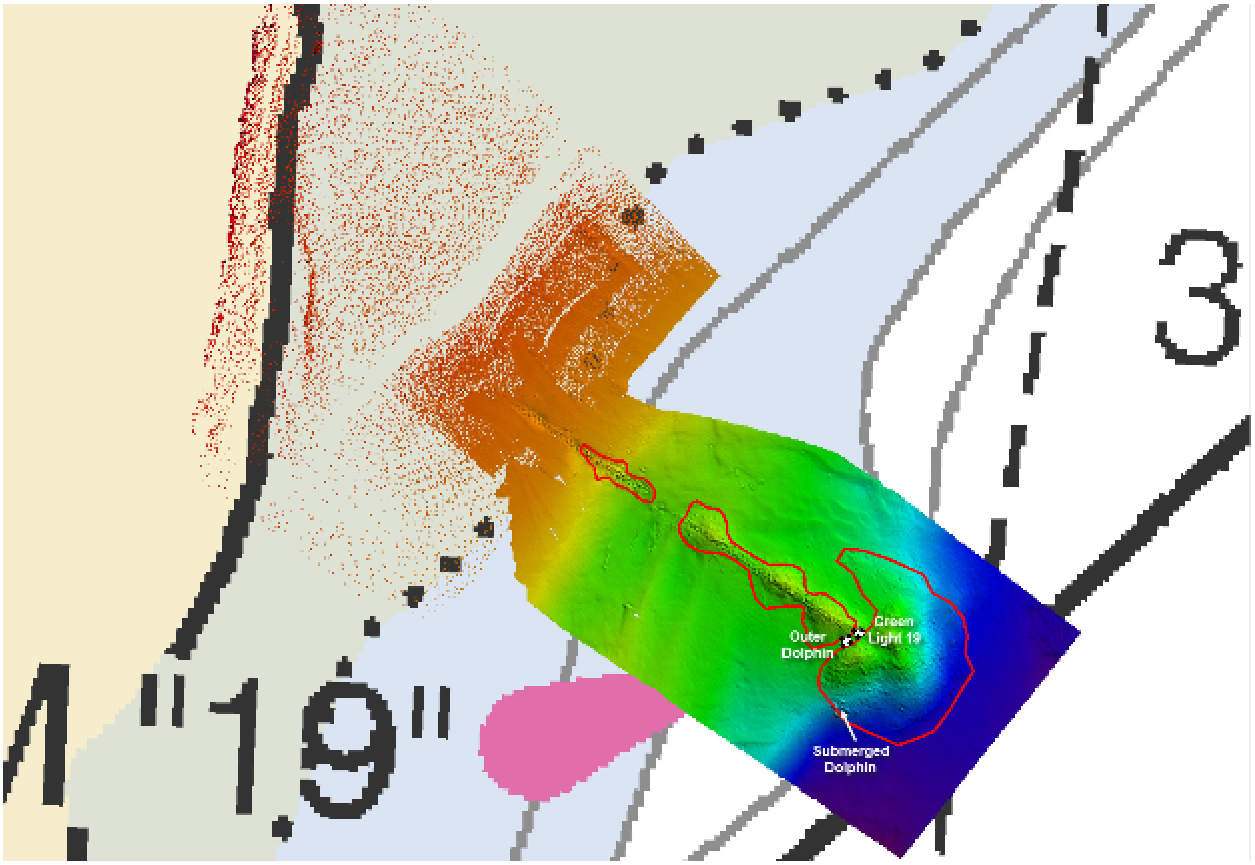


Figure 24. Pile Dike 6.8 plan view bathymetric hillshade depicting the extent of exposed armor rock (outlined in red) and the location of the baring outer dolphin, green light 19 and submerged dolphin.

5.4 Pile Dike 7.0

Pile Dike 7.0 is approximately 315 feet long and consists of vertical wooden piles connected by a horizontal spreader. An outer dolphin is present at the riverward tip of the pile dike on the south side. The pile dike extends shoreward up a gently sloping beach, and appears to end about 40 feet short of the vegetated bank. Figure 25 shows the pile dike and surrounding area from four points of view.

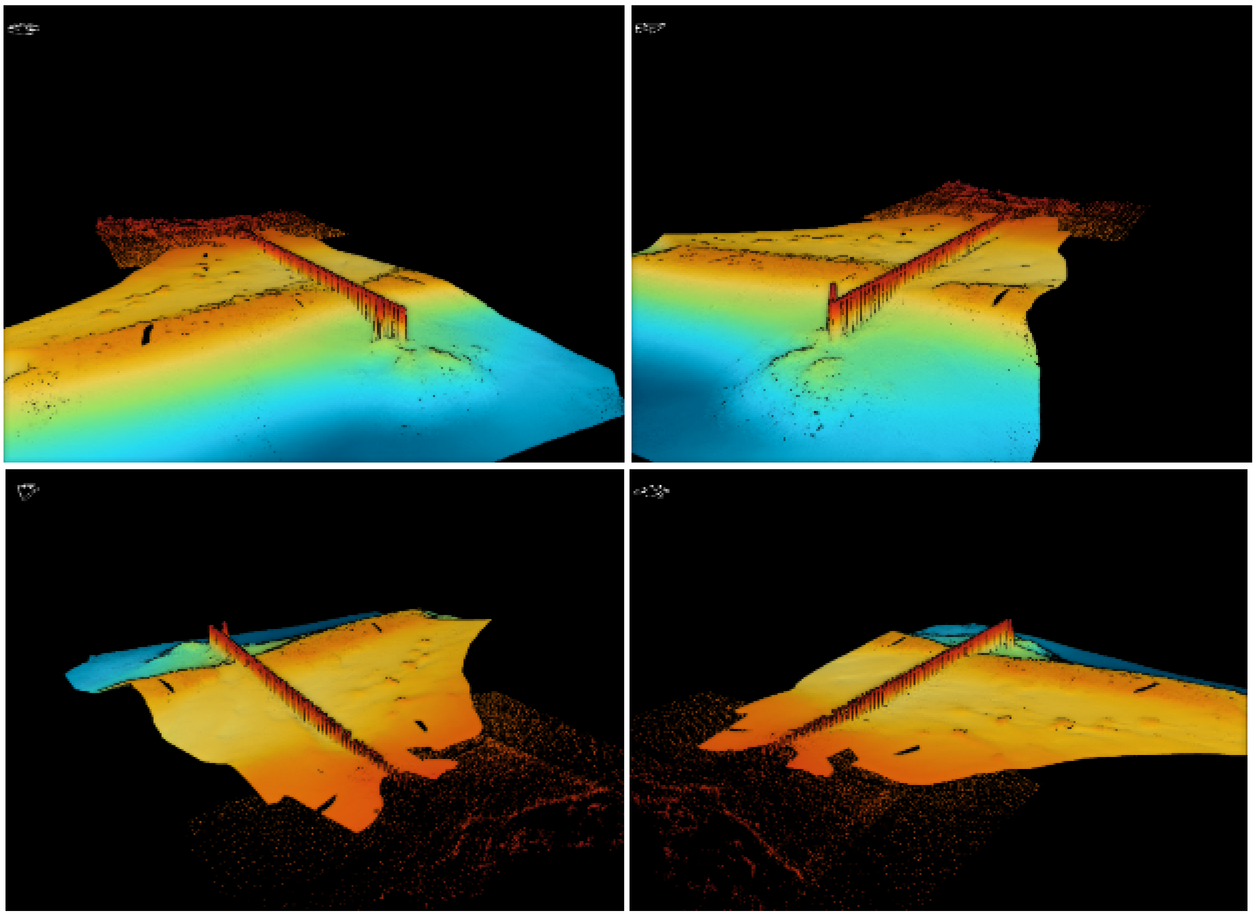


Figure 25. Pile Dike 7.0 point cloud viewed from: North (top left), West (top right), South (bottom left), East (bottom right).

Figures 26-29 include photographs with corresponding features in the point of Pile Dike 7.0 depicting structural features and submerged wood debris.

Figure 26 shows large pieces of wood debris wedged in between the piles towards the outer tip.

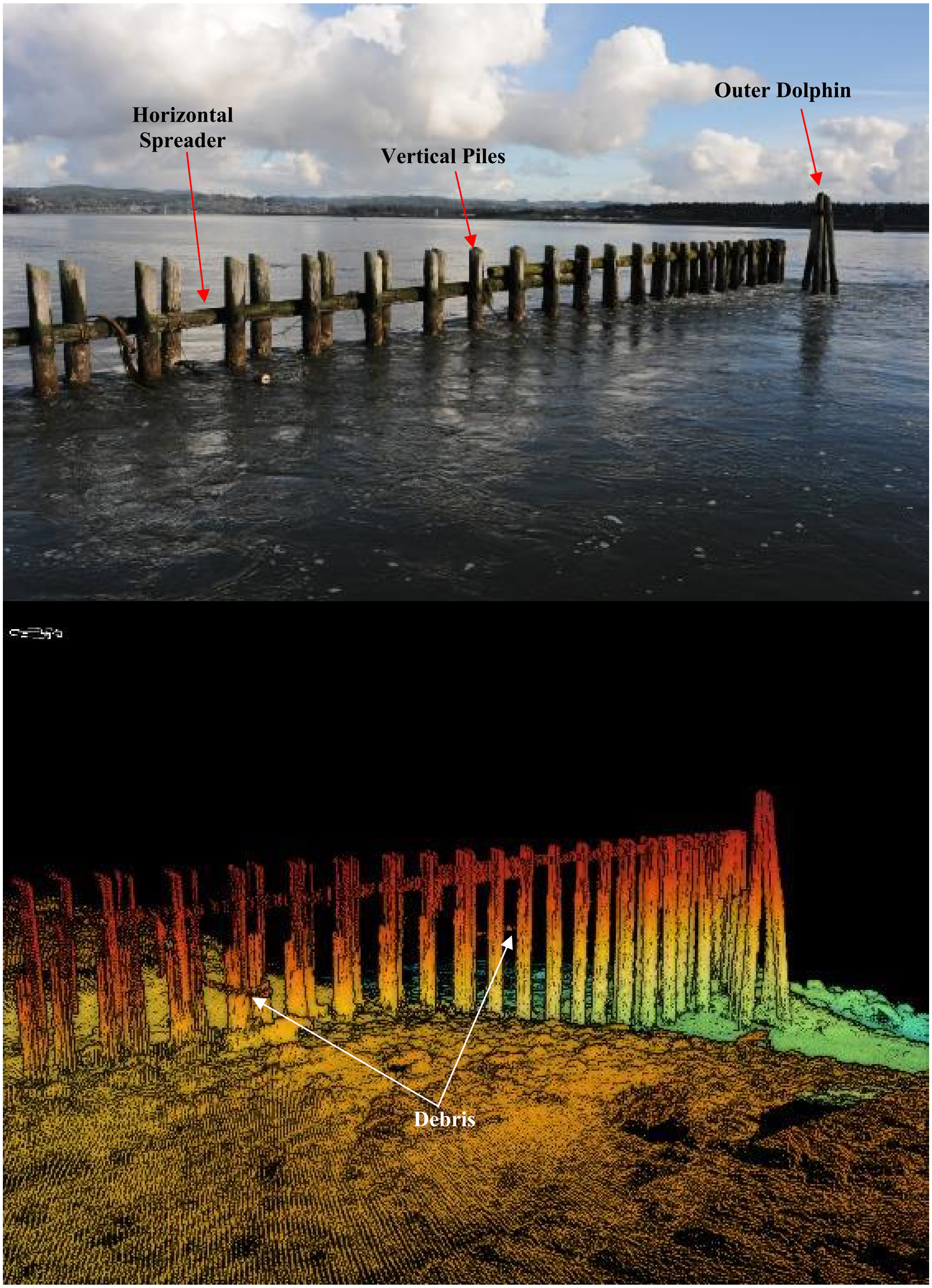


Figure 26. Pile Dike 7.0 viewed from downstream looking riverward.

Figure 27 shows large pieces of wood debris wedged in between the piles towards the outer tip.

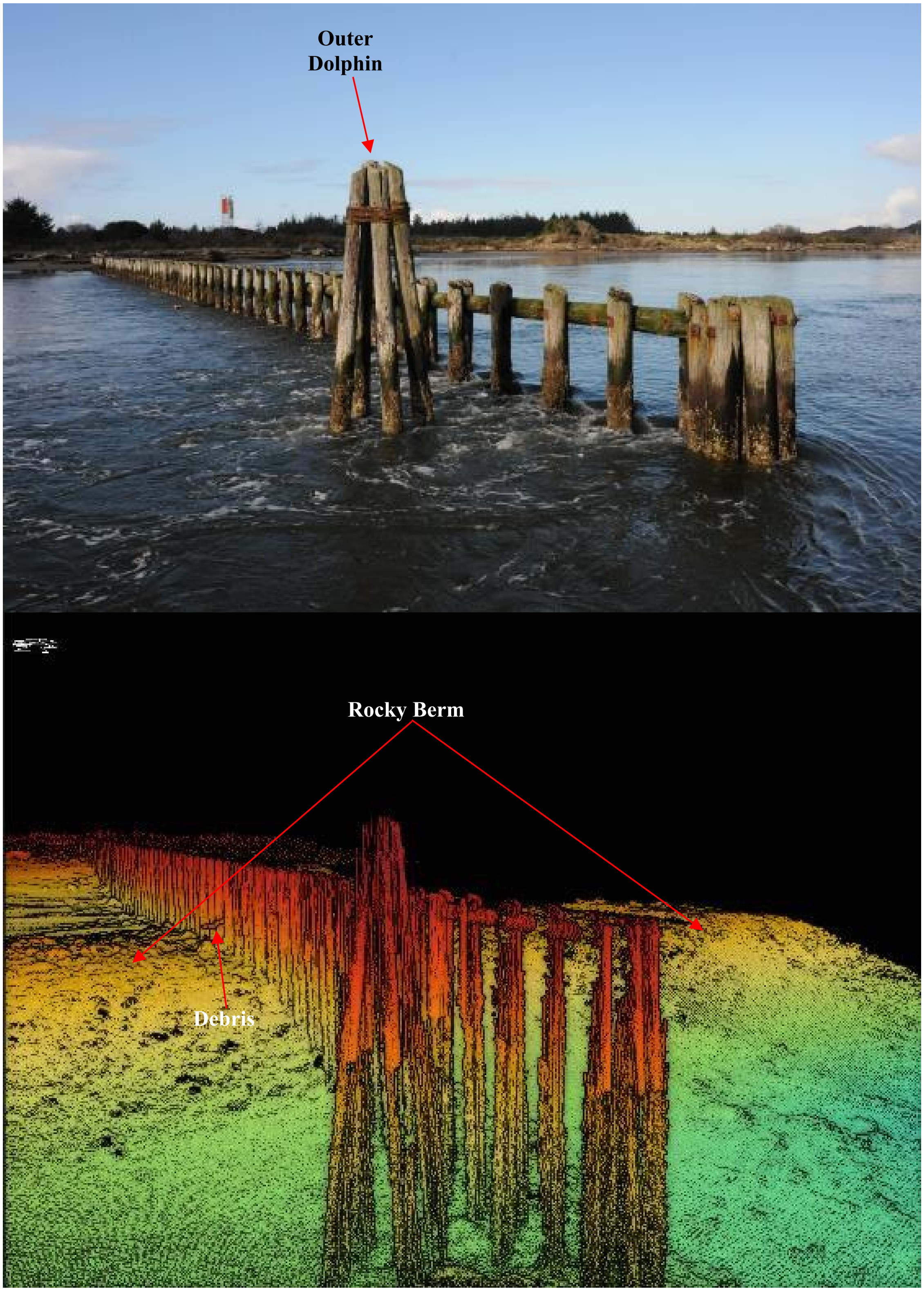


Figure 27. Pile Dike 7.0 viewed from downstream looking shoreward.

Figure 28 shows large pieces of wood debris wedged on top of the structure closer to shore. Due to shallow conditions and rocky obstructions nearshore, the vessel was unable to acquire dense enough laser scanning coverage to clearly view the piles and debris closest to shore. Some of these rocky obstructions (possibly scattered armor rock) are visible on the southeast side of the pile dike in Figure 28.

Figure 28. Pile Dike 7.0 viewed from downstream looking shoreward.

Similar to the other structures, there are large pieces of wood debris wedged in between the piles on top of the structure closer to shore (Figures 28 and 29).

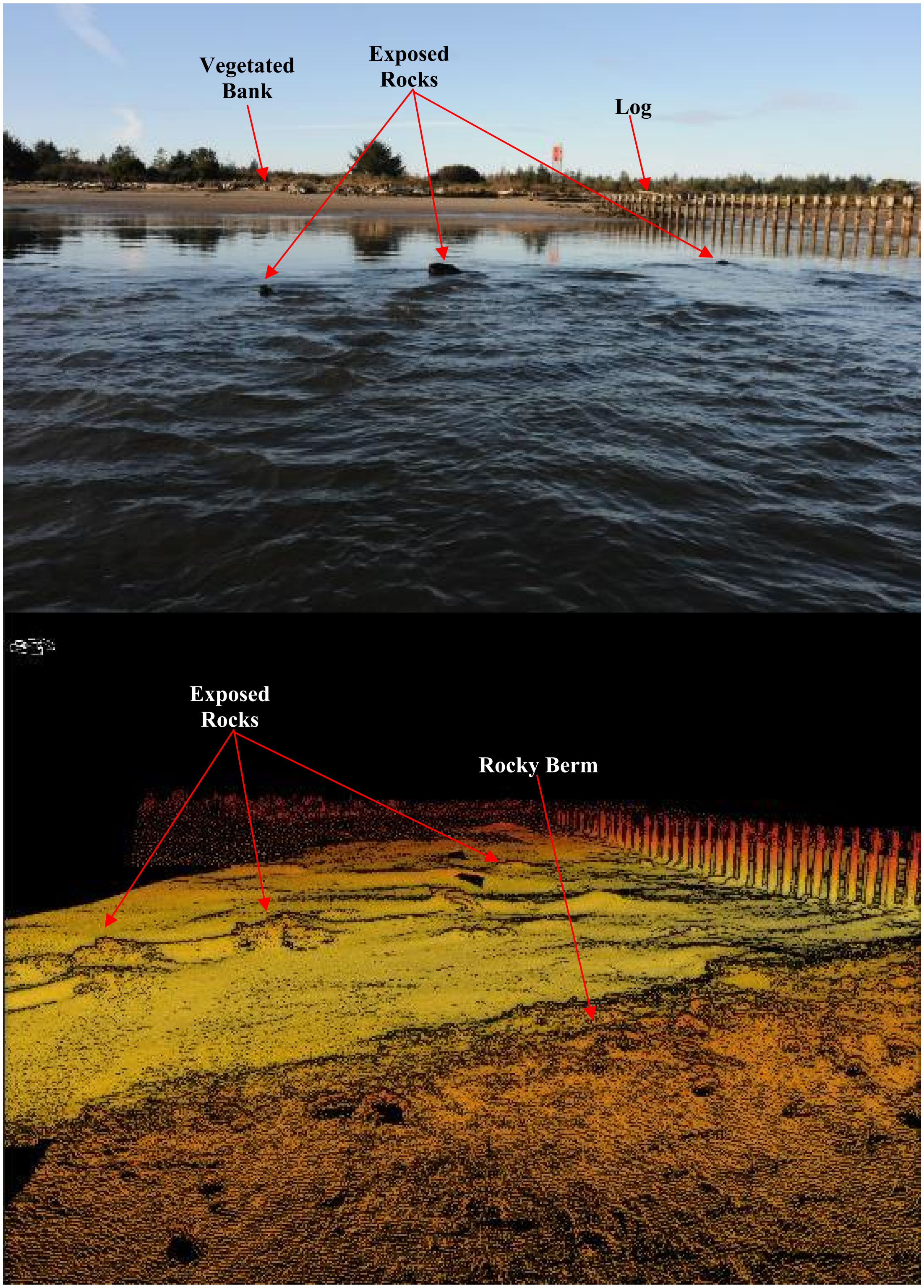


Figure 29. Pile Dike 7.0 photograph and point cloud viewed from downstream looking shoreward.

Figure 30 includes photos of the pile dike's general physical condition, which are representative of the structure as a whole.

Figure 30. Pile Dike 7.0 photographs of the pile condition and hardware.

Figure 31 shows the extent of armor rock surrounding the base of the pile dike. There is also a large amount of exposed rocky material on the berm that runs perpendicular to the structure as well as the small outcrops on the south side closer to shore.

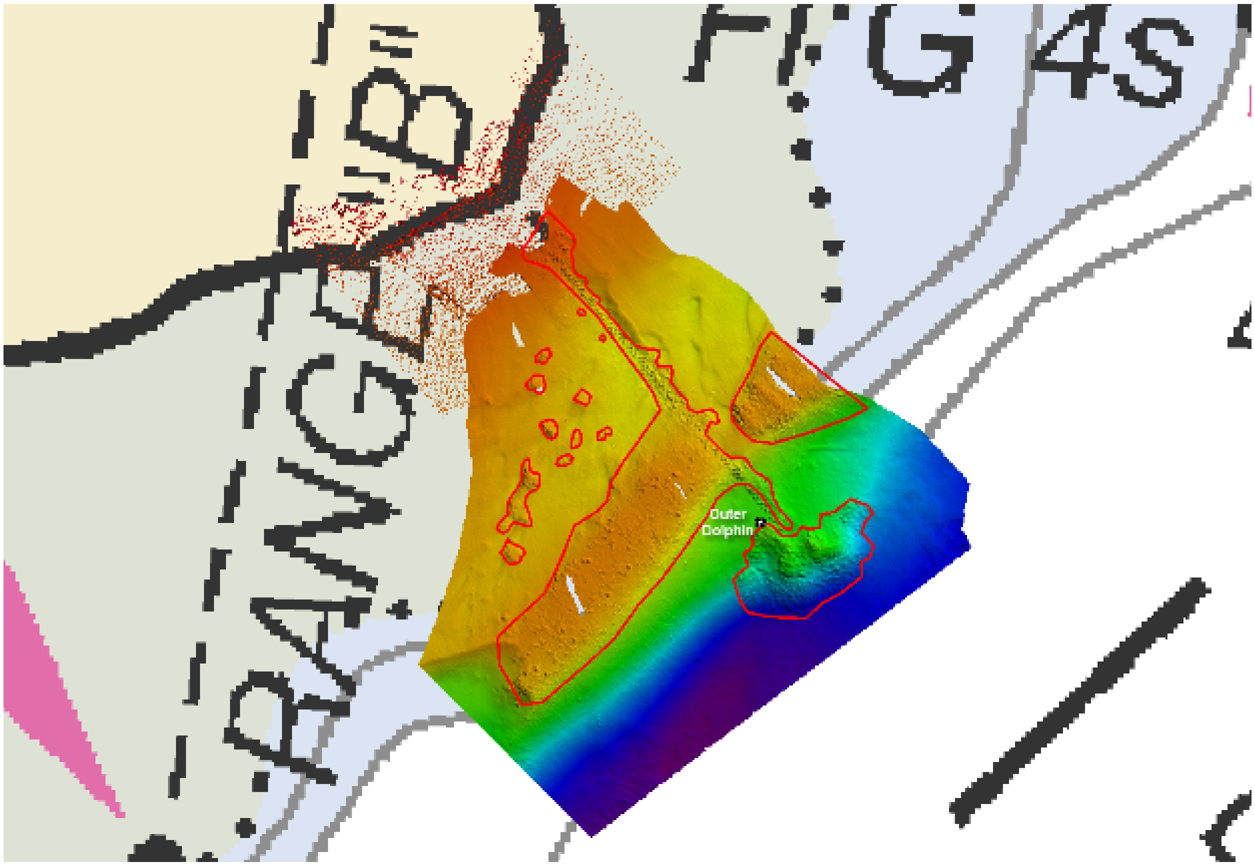


Figure 31. Pile Dike 7.0 plan view bathymetric hillshade depicting the extent of exposed armor rock (outlined in red) and the location of the baring outer dolphin.

5.5 Pile Dike 7.3

Pile Dike 7.3 is the furthest upriver of the five pile dikes and is approximately 234 feet long consisting of vertical wooden piles connected by a horizontal spreader. The pile dike extends shoreward and appears to end at the foot of a vegetated bank. Figure 32 shows the pile dike and surrounding area from four points of view.

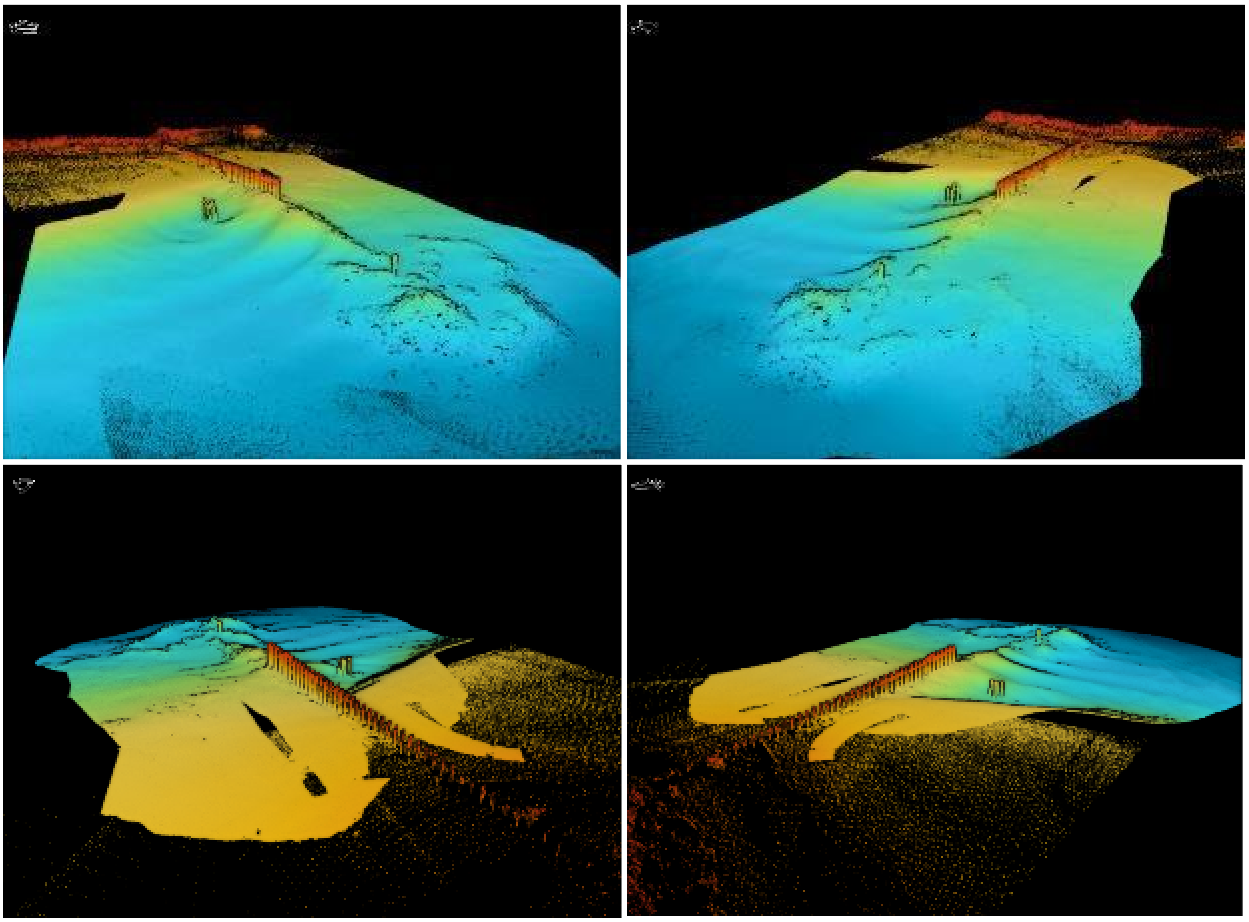


Figure 32. Pile Dike 7.3 point cloud viewed from: North (top left), West (top right), South (bottom left), East (bottom right).

Figures 33-35 include photographs with corresponding features in the point cloud. Unlike the other structures, there is no outer dolphin present, however the submerged remnants of a dolphin are located approximately 45 feet southwest of the dike, near the outer tip. Pile Dike 7.3 is significantly shorter in length than the other pile dikes. Armor rock at the base of the structure continues to extend past the end of the pile dike leading to a single submerged pile located in line with the structure, approximately 124 feet beyond the outer tip, suggesting that the structure may have originally extended riverward beyond its current extent. Another notable feature was a large piece of wood debris resting on top of piles near the outer tip.

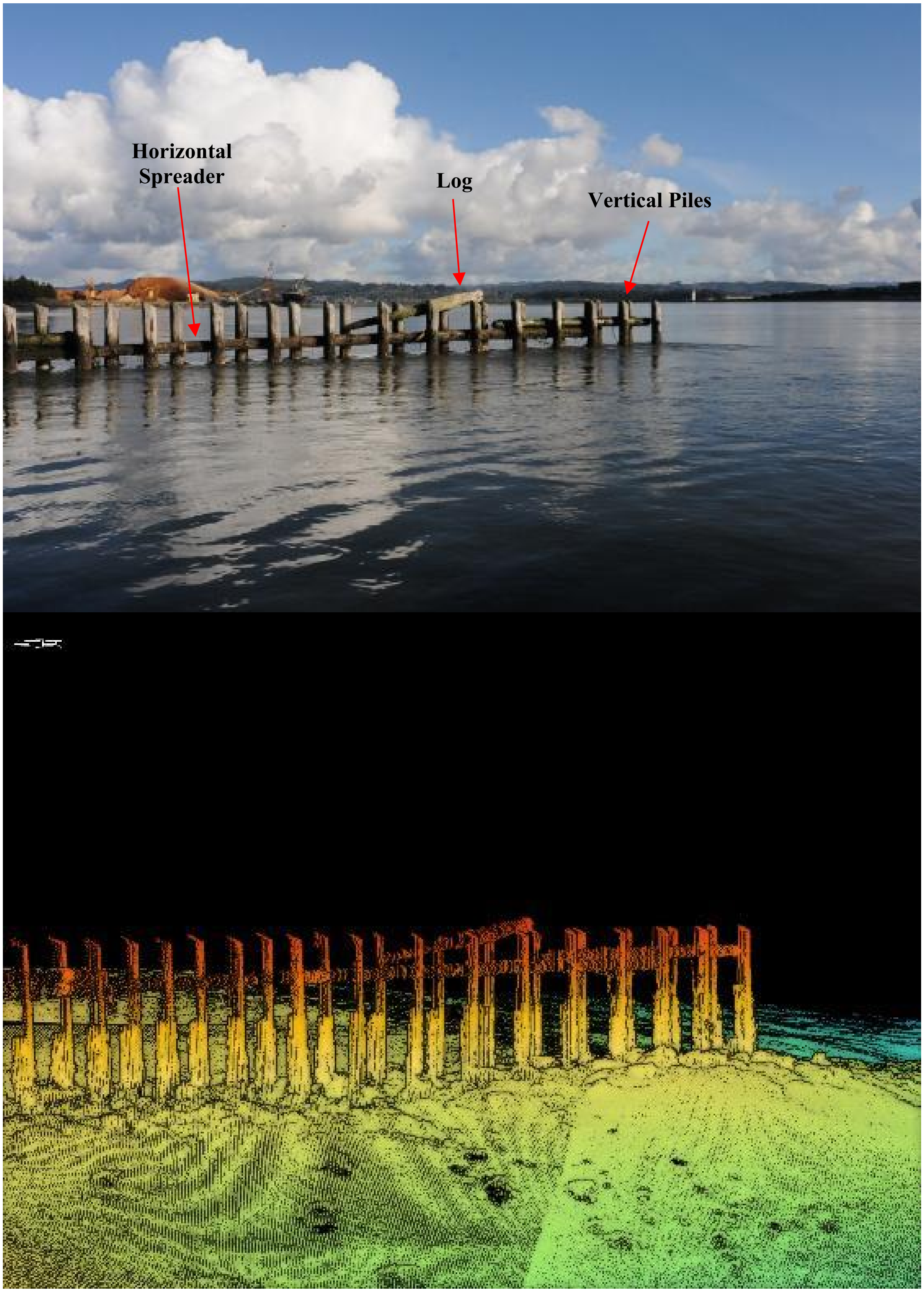


Figure 33. Pile Dike 7.3 viewed from downstream looking riverward.

Figure 34. Pile Dike 7.3 viewed from downstream looking shoreward.

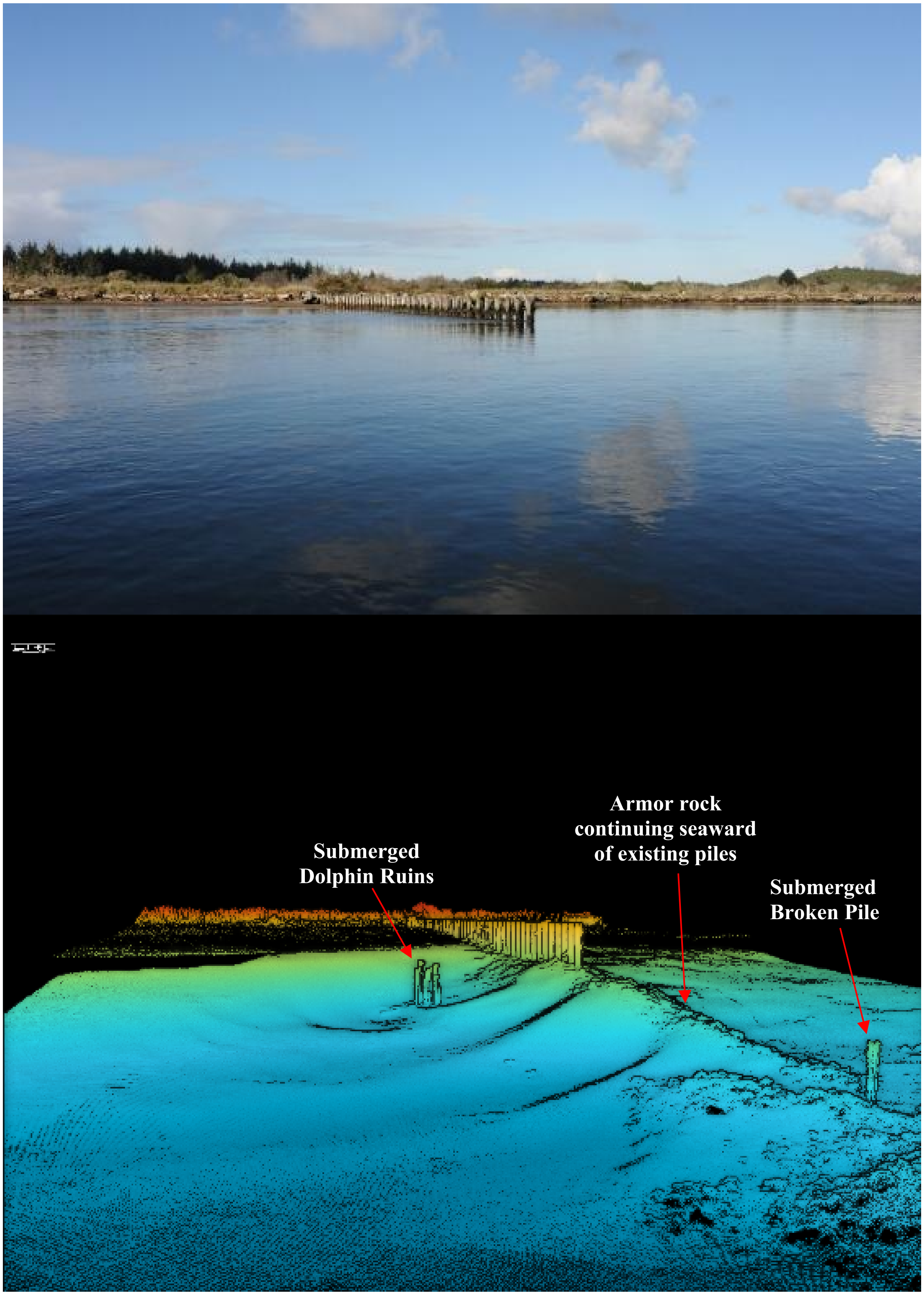


Figure 35. Pile Dike 7.3 viewed from downstream looking shoreward.

Figure 36 includes photographs of the pile dike's general physical condition. While floating wood debris trapped against the piles during tidal swings was a common feature of all the pile dikes, Pile Dike 7.3 seemed to trap an unusually large amount of debris during the ebb tide as it was furthest up river.

Figure 36. Pile Dike 7.3 photographs depicting the physical condition of the piles, hardware and floating debris during an ebb tide.

Figure 37 shows the extent of armor rock surrounding the base of the pile dike.

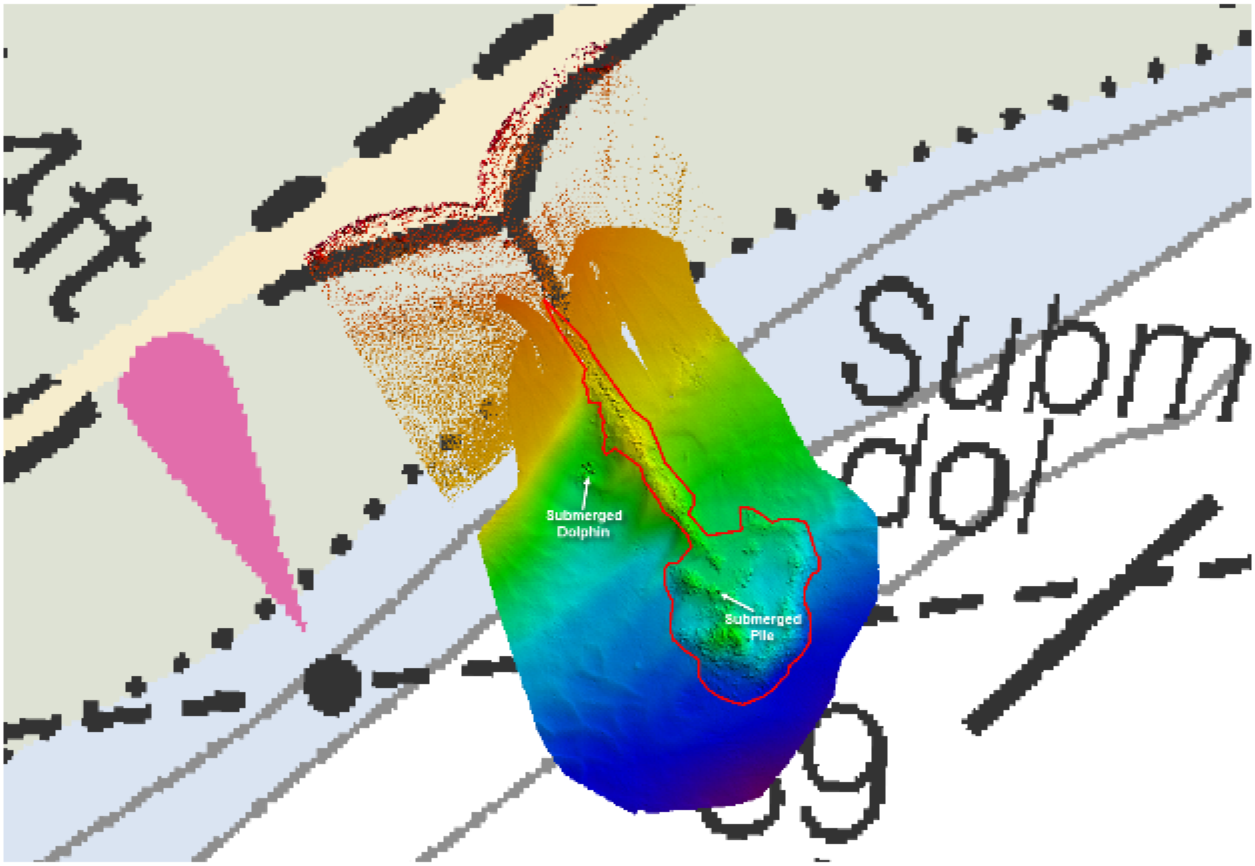


Figure 37. Pile Dike 7.3 plan view bathymetric hillshade depicting the extent of exposed armor rock (outlined in red) and the location of the submerged dolphin and submerged pile.

6.0 DATA EXPORT

Using the combined multibeam and laser scanning datasets, comma-delimited ASCII XYZ data gridded at a 1-foot resolution were exported out of Caris in XYZ format (Z – positive up for elevations) for each of the five pile dikes, along with corresponding 1-foot gridded hillshade bathymetric georeferenced images. Comma-delimited ASCII XYZ data (Z – positive up for elevations) was also exported for the shoalest point on any submerged piles. Full resolution comma-delimited ASCII XYZ (Z – positive down for depths) was exported from Caris for each pile dike for point cloud viewing in EIVA NaviModel software.

Final mapping products including contours from the 1-foot gridded data, pile dike alignments, rock delineation and point locations for baring and submerged features were exported from AutoCAD in .dwg format and provided to the design team.

7.0 DELIVERABLES

Deliverables for the Coos Bay Pile Dikes Hydrographic Survey include the following:

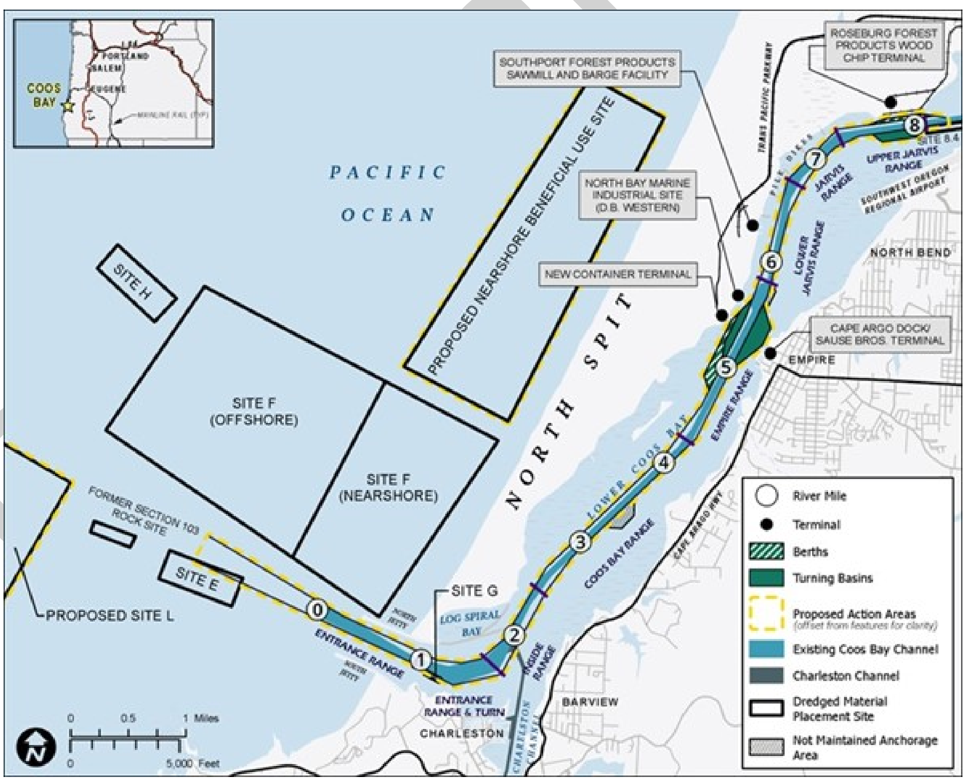
1. XYZ comma-delimited ASCII data in XYZ format gridded at 1-foot for each Pile Dike using the following naming convention: **DikeM.D_1ft_ENZup_V1.txt**
   Where M.D is the river mile and decimal mile and Z values are Mean Lower Low Water elevations (positive up).
2. Full resolution XYZ comma-delimited ASCII data in XYZ format for viewing in EIVA NaviModel software using the following naming convention:
   DikeM.D_FullRes_ENZdown_V1.txt
   Where M.D is the river mile and decimal mile and Z values are Mean Lower Low Water depths (positive down which allows correct viewing in NaviModel software).
3. XYZ comma-delimited ASCII data in XYZ format for submerged piles least depths (highest point on submerged features) using the following naming convention:
   DikeM.D_SubPilesLD_ENZup_V1.txt
   Where M.D is the river mile and decimal mile and Z values are Mean Lower Low Water elevations (positive up).
4. Color hillshade georeferenced images of 1-foot gridded surface delivered as TIFF images with associated TFW world files and ARCGIS associated files using the following naming convention:
   DikeM.D_1ft_Hillshade_V1.*
   Where M.D is the river mile and decimal mile and * is the file extension of .tif, .tfw, .tif.ovr, and .tif.aux.xml.
5. High Resolution Digital photographs in a Pile_Dike_Photos folder with subfolders by pile dike and subfolders by date with 20161212 containing photos at low tide and 20161213 containing photos at high tide.
6. AutoCAD drawings including contours, pile dike alignments, rock delineation and baring and submerged feature locations in file **“Pile Dikes Model_V1.0.DWG”**
7. Survey Report documenting survey methodology, data processing, and general structural evaluation, stamped by an Oregon Professional Land Surveyor (PLS) and National Society of Professional Surveyors/ The Hydrographic Society of America (NSPS/THSOA) Certified Hydrographer.

ATTACHMENT F: Coos Bay Geophysical Survey, Coos Bay, Oregon, 3D Integrated Digital Geological Model (IDGM)

Coos Bay Geophysical Survey Report

Prepared for:

David Miller & Associates, Inc.
Midcontinent Regional Office
523 Cary Woods Circle
Cary, IL 60013
Attn: Christopher S. McGarry
Email: cmcgarry@dma-us.com
Phone: (779) 220-0166



August 2023

Coos Bay Geophysical Survey
Coos Bay, Oregon
3D Integrated Digital Geological Model (IDGM)

Report: R 22-227 Coos Bay, Oregon, Geophysical Survey
May-July 2023
Coos Bay IDGM

Surveyor: Arc Surveying & Mapping, Inc.
5202 San Juan Avenue
Jacksonville, FL 32223
Office: (904) 384 8377
Mobile: (904) 616 7039
Email: jsawyer@arcsurveyors.com

Prepared by: Arc Surveying & Mapping, Inc. & Demco, NV

Contents

Figures

1. *Overview*

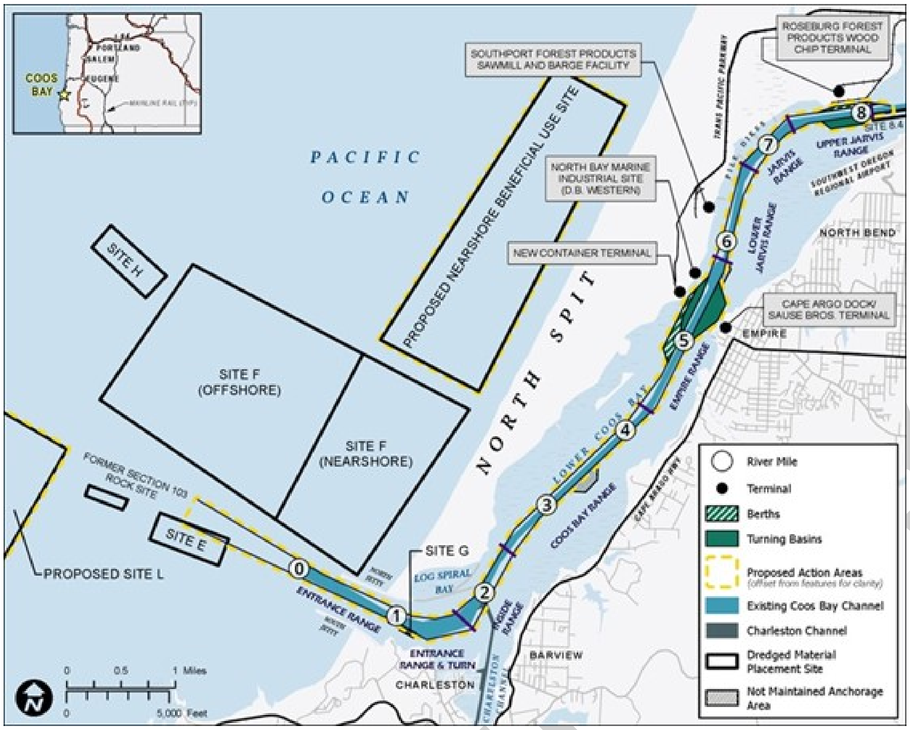


Figure 1: Overview of Coos Bay Site, provided by Client

Arc Surveying & Mapping, Inc. (Arc) was contracted by David Miller & Associates, Inc. (DMA) to perform a bathymetric and geophysical survey at Coos Bay, Oregon. The purpose of the survey was to assist the Port of Coos Bay in identifying the location and extent of various subsurface strictures such as sand, rock, clay, etc. and correlating the geophysical information with other existing geological information for potential deepening and widening of the existing navigation channel.

The Coos Bay site is approximately nine (9) miles in length. A profile line spacing of fifty feet (50) was selected for the survey site, including the proposed channel and extending 50 feet beyond top of the proposed channel slope.

2. *Survey Methods*

Control: Surveys identified in this report are referenced to Mean Lower Low Water (MLLW) and horizontally to North American Datum of 1983 (NAD83). See Section 2.4 (d) for survey notes and hardware setup.

Positioning: Arc contracted a local surveying company, AKS Engineering & Forestry, to provide a vessel and captain assisting Arc to conduct the surveys. AKS provided a 26' aluminum workboat with cabin, suitable for the challenging conditions of the area in the spring season. The vessel came equipped with a Trimble R10 RTK GPS for vertical and horizontal positioning. RTK corrections were supplied by the Oregon Real Time GNSS Network.

***Bathymetry**:* Arc performed a dual-frequency survey of the extensive Coos Bay inlet during March through July 2023. The Teledyne Odom single-beam sounder collected soundings at frequencies of 28 kHz and 200 kHz.

Aquares Geophysics: A geophysical survey of the project area was accomplished utilizing an Aquares Resistivity system developed by Demco, NV. Sediment layering and subsurface structures were located to an approximate depth of 35 ft below existing bottom by towing a 200 ft long, 1” diameter multichannel cable across the existing bottom at fifty (50) ft interval profile line spacing. The survey began as close to the shoreline as shallow water depths and structures permitted, covering the entire survey location.

2.1. Principles of Electrical Resistivity Surveying

An electrical current is injected into the subsurface by means of two current electrodes. The voltage gradient associated with the electrical field of this current is measured between two voltage electrodes placed in between the current electrodes (see fig. 1). Based on the measured values of current and voltage the average resistivity of the subsurface is calculated for a subsurface volume down to a certain penetration depth. The penetration depth depends on the distance between the current electrodes. Larger electrode distances are associated with increasing penetration depths.

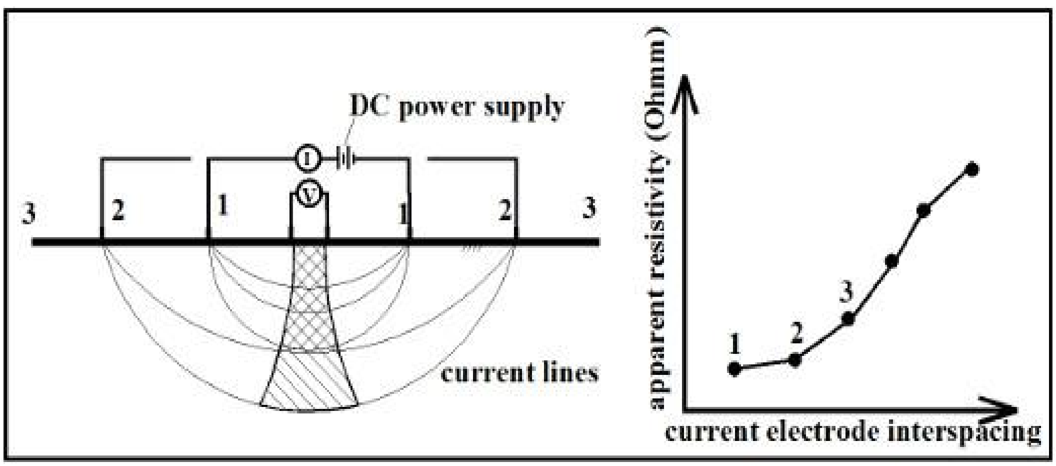


Figure 2: Principles of Vertical Electrical Sounding

If the measurements are repeated with progressively increasing current electrode distances, information is obtained from progressively deeper geological structures (fig. 1). As such, a field curve is obtained showing the resistivity as a function of the (horizontal) distance between the current electrodes. After computer modeling, the field curve is transformed into a real geophysical subsurface section showing the resistivity as a function of depth.

The resistivity of a geological structure depends on its porosity, water saturation and the pore water conductivity. Sand can be expected to show higher resistivity values as compared to silt. Soft clay generally shows low resistivity values while stiff clay is marked by relatively higher resistivity values. Cemented sediments show higher resistivity values as compared to soft sediments. Thus, every geological structure has its own specific resistivity value.

2.2. Fluvial and marine applications

For water-based applications the electrodes are placed on a multichannel cable trailing behind the survey vessel (fig. 2). The electrode geometry is chosen such that good quality data may be obtained even for shallower targets.

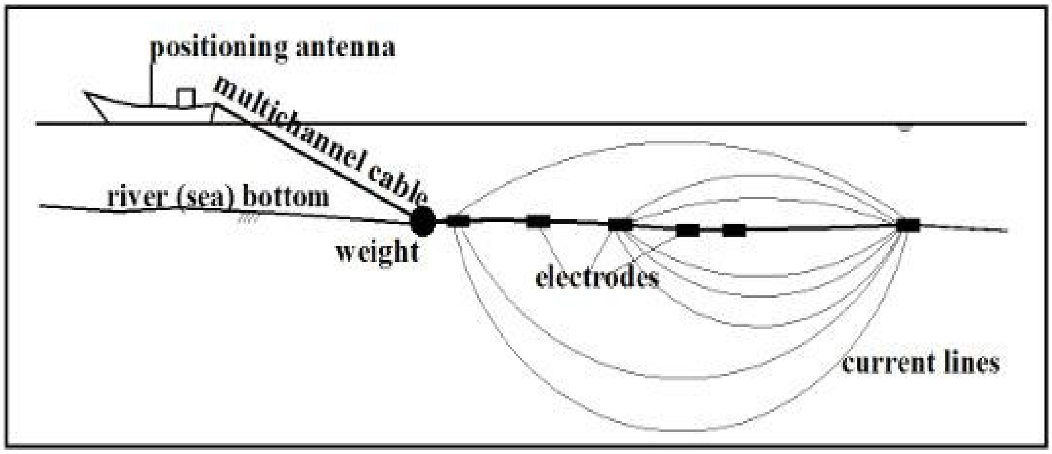


Figure 3: Marine/Fluvial Applications

While the survey vessel is transiting predetermined profile lines, measurements are acquired and stored automatically without any intervention from the operator. An entire electrical sounding may be obtained once per second. At a boat speed of two m/s this corresponds to a horizontal resolution of one sounding every two meters. The time of measurement is stored with each resistivity measurement. This provides the opportunity to synchronize the resistivity data with the positioning data and tidal information. During the field survey qualitative results are monitored, allowing the operator to adjust and optimize the survey parameters.

2.3. Data processing and interpretation

The resistivity field data are edited and filtered to increase the signal/noise ratio. The conductivity of the water column is calculated and removed from the measured resistivity values. The bathymetric and positioning data are edited and merged with the resistivity data. Geometrical corrections are applied to correct for the fact that the sailed line (and the cable as well) may show more or less significant curvatures. Measurements made with a strongly curved cable are rejected. In case of a bottom towed cable other corrections are made to account for the water depth. A correct water correction requires homogeneous vertical water column resistivities or a detailed knowledge of vertical resistivity layering in the water column.

An important phase in the processing sequence is the resistivity data inversion. In this step the apparent resistivity data is transformed into a vertical section of the subsurface showing depths and thicknesses of each geological structure.

The resistivity information is interpolated into a regular grid either on a cross-section or in two dimensions. Each interpolated grid point represents a complete geological profile of the subsurface showing the resistivity as a function of depth. The results are visualized in color on cross sections showing the different geological structures in function of depth and geographical position. The results can be interpreted using information from a limited number of well-chosen borehole locations targeting each of the structures identified.

The processing procedure described above is an interactive process. In order to extract maximum information from the raw survey data, the processing sequence must be repeated several times in order to find the optimum processing parameters.

2.4 Survey Procedure and Quality Control

Hydrographic surveys for this project were performed under the direct supervision of an NSPS/THSOA Certified Hydrographer to ACOE standards as described in USACE Policies, Guidelines and Requirements for Hydrographic Surveying and Mapping Digital Projects, EM1110-2-1033 Hydrographic Survey Manual.

a) Prior to the start of the Coos Bay geophysical survey, Arc identified local horizontal and vertical control (see survey notes).

b) During the Aquares geophysical survey, single beam depth soundings were collected simultaneously, to horizontally and vertically geo-referenced the subsurface data to the seafloor.

c) Survey Notes:

1. Refer to Arc Survey No. 22-227
2. The dual-frequency soundings were collected March 14, 2023- March 20, 2023. The direct current resistivity measurements were collected during May through July 2023.
3. Raw depth soundings were corrected for tidal changes to create elevations in MLLW datum during post processing. Elevations depicted in this report are referenced to MLLW unless otherwise noted.
4. Plane coordinates are based on the Universal Transverse Mercator Projection (UTM) for the East Zone of Florida and referenced to The North American Datum of 1983 (NAD83) US Survey Foot.
5. Survey equipment was set to Pacific Standard Time (PST).
6. Survey positioning was supplied by a Trimble R10 RTK (Real Time Kinematic) GPS. RTK corrections were supplied by the Oregon Real-Time GNSS Network, using mount point P365.
7. Daily network and GPS equipment checks were performed referencing points OA 0651 and DH 7197. Monument with PID OA 0651 and designation “943 2780 TIDAL 9” is located in state plane OR S, at coordinates: N 634,724.06, E 3,903,491.19, with Elevation = 15.91 feet NAVD88. Monument with PID DH 7197 with designation “943 2780 B TIDAL RESET” is located in state plane OR S, at coordinates N 634,470.02 iFt, E 3,904,371.26 iFt and Elevation = 14.7 feet, NAVD88.

8. Sonar measurements were made utilizing a Teledyne Odom CV 100 (single beam sonar), operating at 28 kHz and 200 kHz.
9. Geophysical data were acquired utilizing an Aquares subsurface resistivity system developed by Demco, NV.
10. The information depicted on maps and models represents the results of surveys performed on the indicated dates and can only be considered as indicating general conditions at the time of survey.

3. Geophysical Aquares Data Acquisition

A bottom towed cable was used with a maximum penetration depth of about 40 feet. The survey operations have had difficulties caused by strong tidal currents tending to lift the resistivity cables from the seabed. By slowing down the boat velocity and deleting low resistivity measurements related to the resistivity cable floating above the seabed, very satisfactory results were obtained as expected when using a resistivity cable in contact with the geology.

A lot of cable repairs were carried out – almost every other day – because of wear and tear caused by the resistivity cable being towed on top of rock along most of the channel.

Before the geophysical survey older multibeam survey were made available by the client out while the geophysical survey was carried out combined with a single beam echosounder.

Borings, geotechnical information as well as side scan sonar and reflection seismic information were provided by the client to be included in the Integrated Digital Geological Model. The seismic information is presented in the IDGM as vertical seismic sections as well as a compilation of all interpreted seismic information, borings and probes results in to a "Rock Free surface".

4. Geophysical Survey Results

4.1 ArcGeoTwin IDGM

The IDGM (Integrated Digital Geological Model) is available and accessible on the Arc Surveying & Mapping server in Jacksonville, Florida using the ArcGeoTwin platform. Four (4) models are used to cover the entire survey area: (1) In the entrance area up to RM1, (2) From the entrance area RM1 to RM3 miles upstream (3) from RM3 to RM5.6 including the proposed container terminal at RM5 and (4) from RM5.6 to RM9 including the proposed turning basin at RM7.5.

4.2 Bathymetry

The bathymetry of the survey area in figure 4 is based on the most recent multibeam image draped over the single beam results. The multibeam information is limited to the channel while the single beam information covers more than only the channel.

The red line shows the projected channel design.

Between RM0.7 and RM0.9 a relatively shallow area is seen in the bathymetry corresponding to the location of Guano Rock.

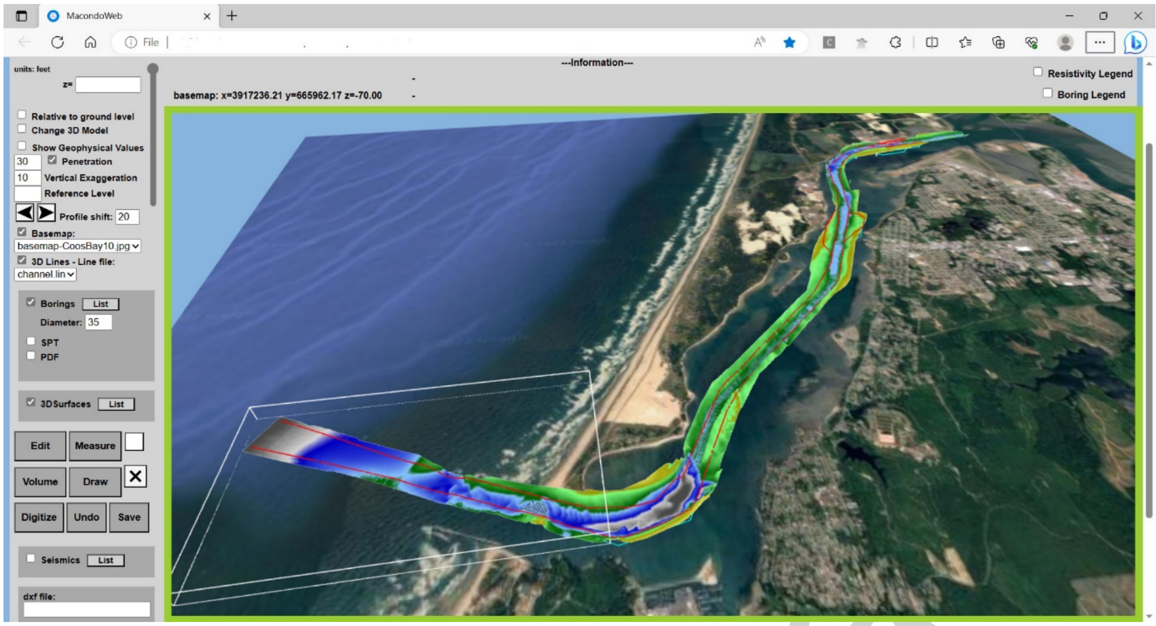


Figure 4: ArcGeoTwin – Singlebeam-Multibeam combined bathymetry (MLLW)

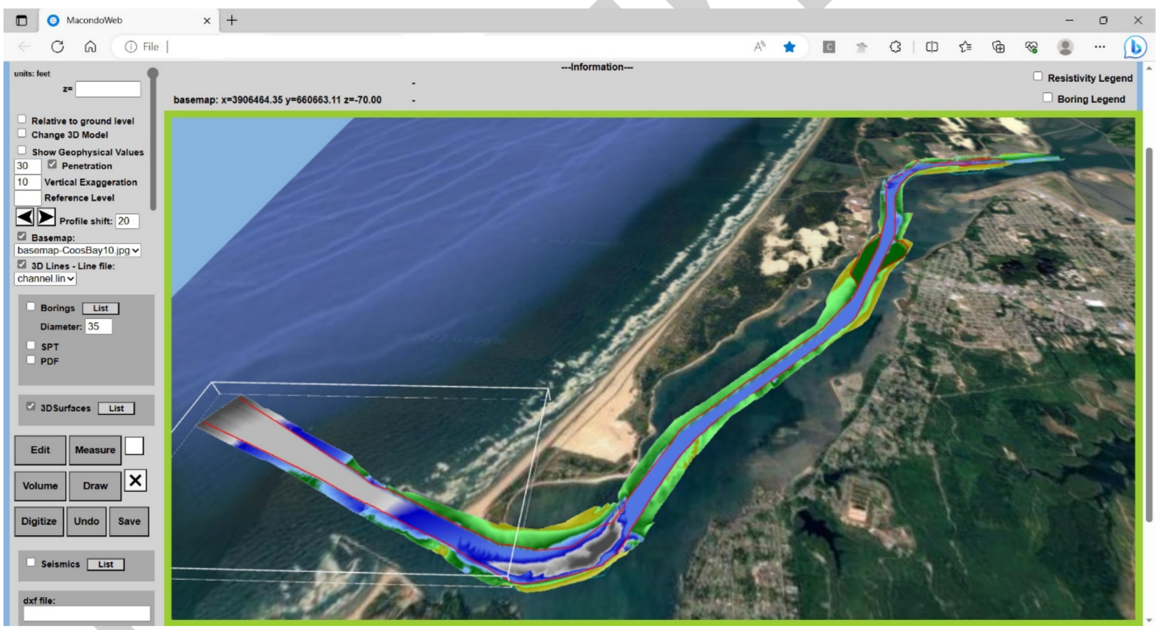


Figure 5: ArcGeoTwin – Channel design

Figure 5 shows the channel design with the entrance channel to be dredged to -57 ft, a transition zone from -57 to -45 ft and the rest of the channel at -45 ft. The turning basin near RM5 is to be dredged to -45 ft while the turning basin at RM7.5 is to be dredged to -37 ft.

Comparing the design depth to the bathymetric map it is clear that the Guano Rock area needs at least eight feet of deepening while the entire channel upstream of 1 miles 5100 ft needs deepening and – some parts of it – widening as well.

4.2. Side scan sonar - Borings

Figure 6 presents side scan sonar results in the shallows bordering the channel as well as a large number of probe results (gray) and borings. The boring lithologies are color coded following the corresponding color legend accessible on the ArcGeoTwin platform. Most of the borings describe relatively soft siltstones and sandstones. The side scan sonar results shows many obstacles in the shallow limiting the access – in some areas – for the bottom towed resistivity cable.

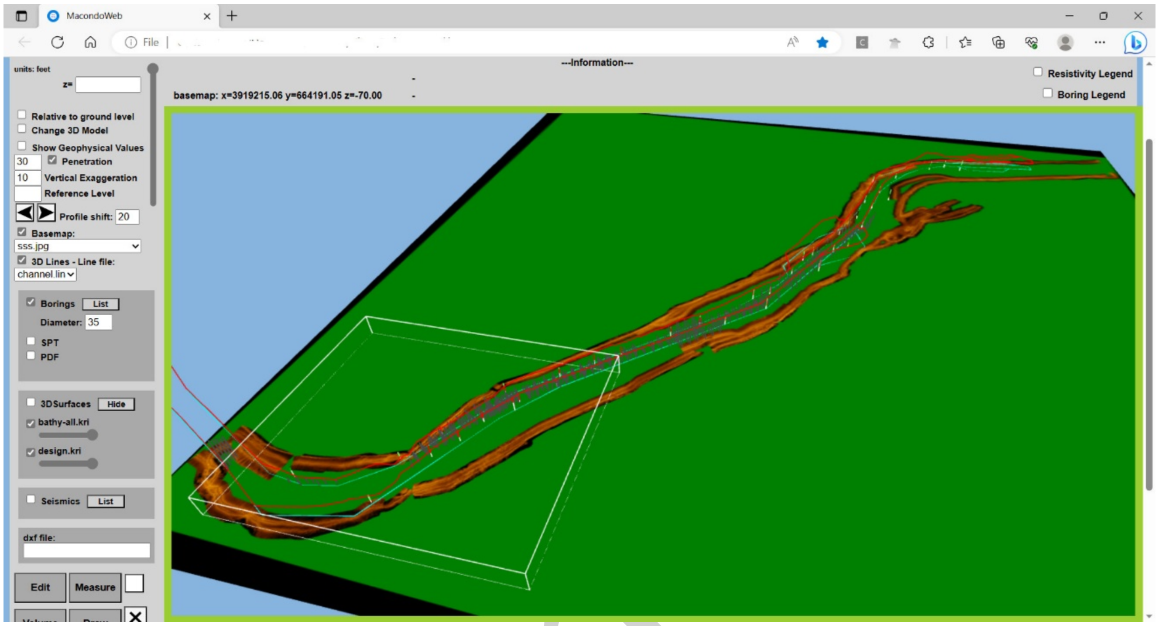


Figure 6: ArcGeoTwin – Side scan sonar results

4.3. Aquares results in the entrance area (up to RM1)

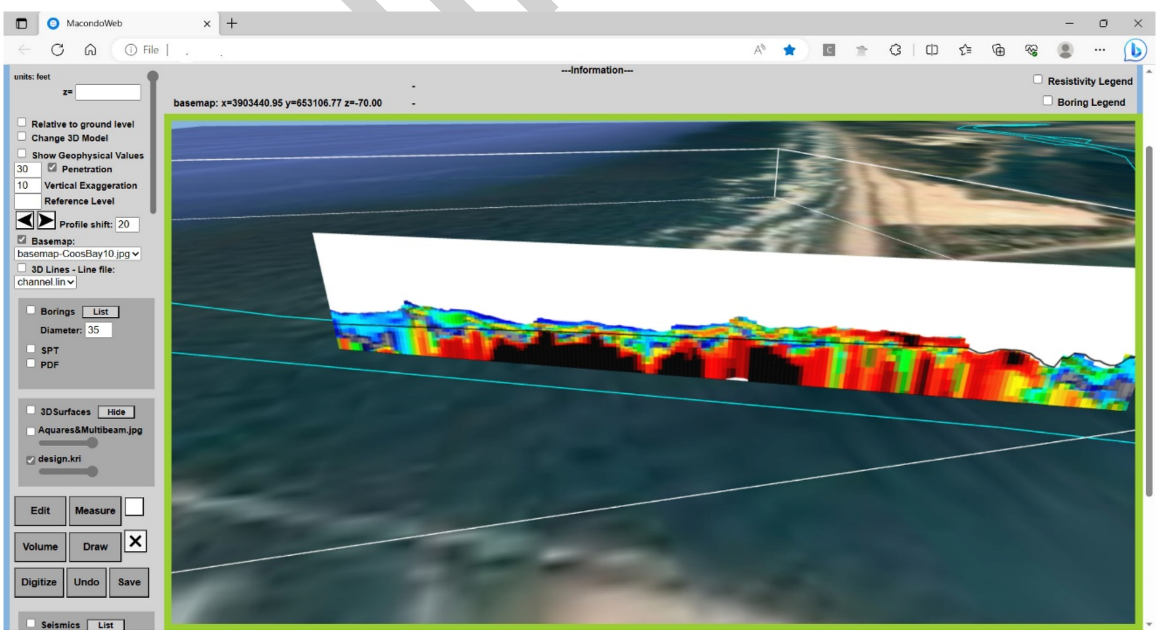


Figure 7a: Vertical longitudinal geophysical section at Guano Rock
High resistivity material above grade

Figure 7a shows a vertical longitudinal section across Guano Rock. The black line shows the design depth rising from -57 ft to -45 ft. Blue colors mark the lowest resistivity values, green colors intermediate resistivity values and red colors correlate with high resistivity values. Guano rock is identified by the high resistivity structures above grade on this section. Low resistivity structures at shallow depths could possibly be explained by previous dredging activities. Note: Post survey borings provided by client during March 2024 were incorporated into the ArcGeoTwin 3D model. The same low resistivity structures appear to correlate with jointed and fractured rock in more recent borings B-13-23, B-14-23B and B-15-23.

Figure 7b shows a cross section across Guano Rock with high resistivity material above grade and lower resistivity structures at slightly deeper levels possibly representing fracturing due to previous dredging activities. High resistivity shallow rock is located on the southern side of the channel.

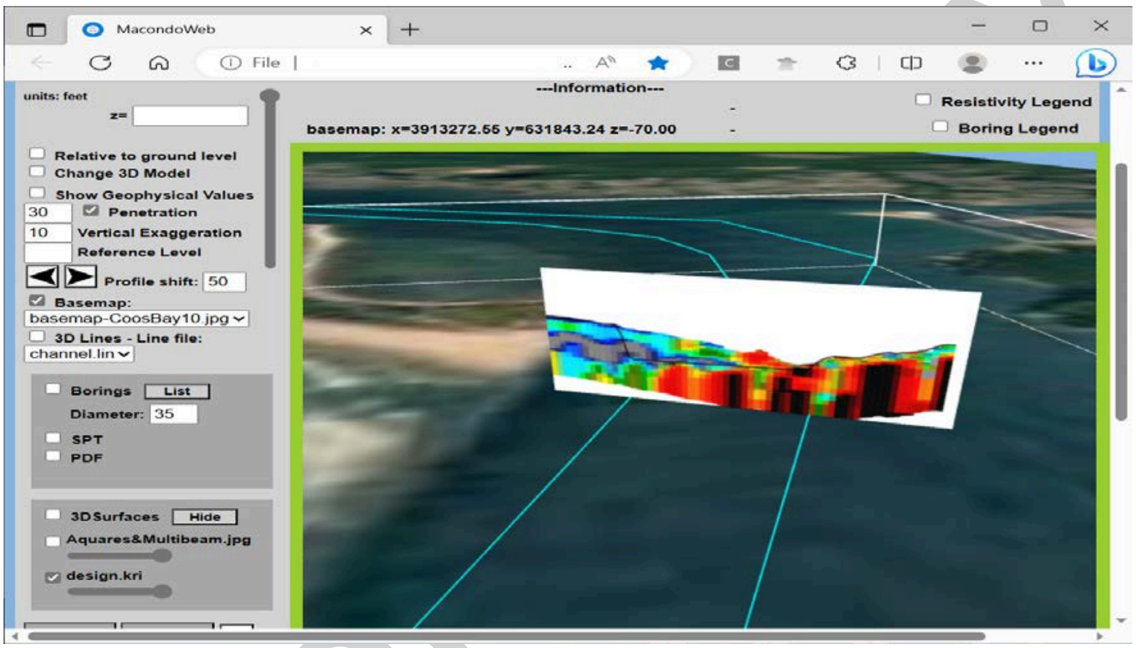


Figure 7b: Vertical geophysical cross section through Guano Rock High resistivity material above grade

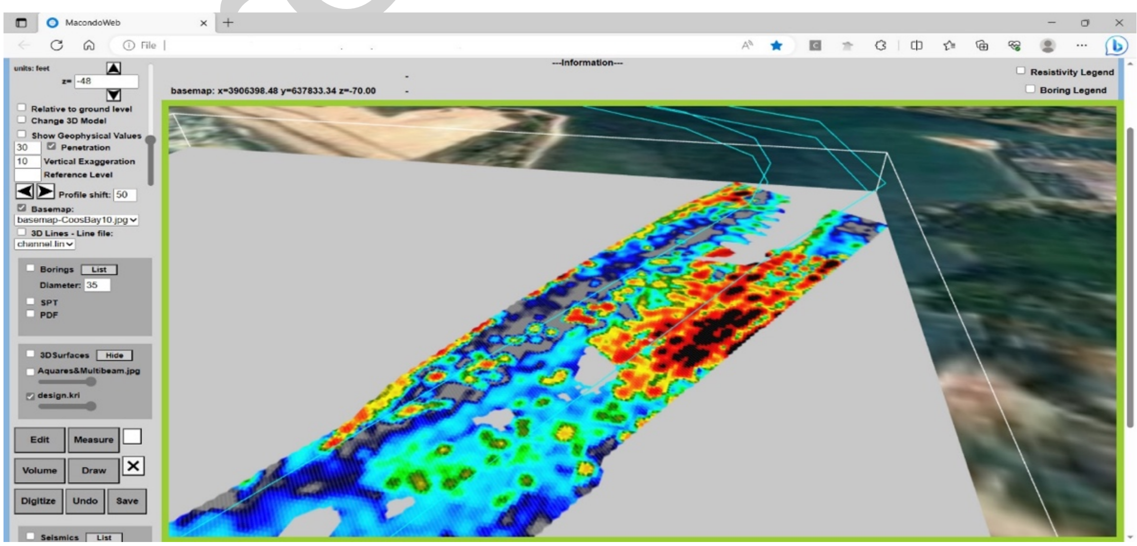


Figure 7c: Horizontal geophysical sections at -48 ft showing high resistivity structures at Guano Rock

Figure 7d shows one of the available seismic profiles georeferenced in the Guano Rock IDGM. Probing results showing the depth to refusal (at the time of probing) are presented in dark gray.

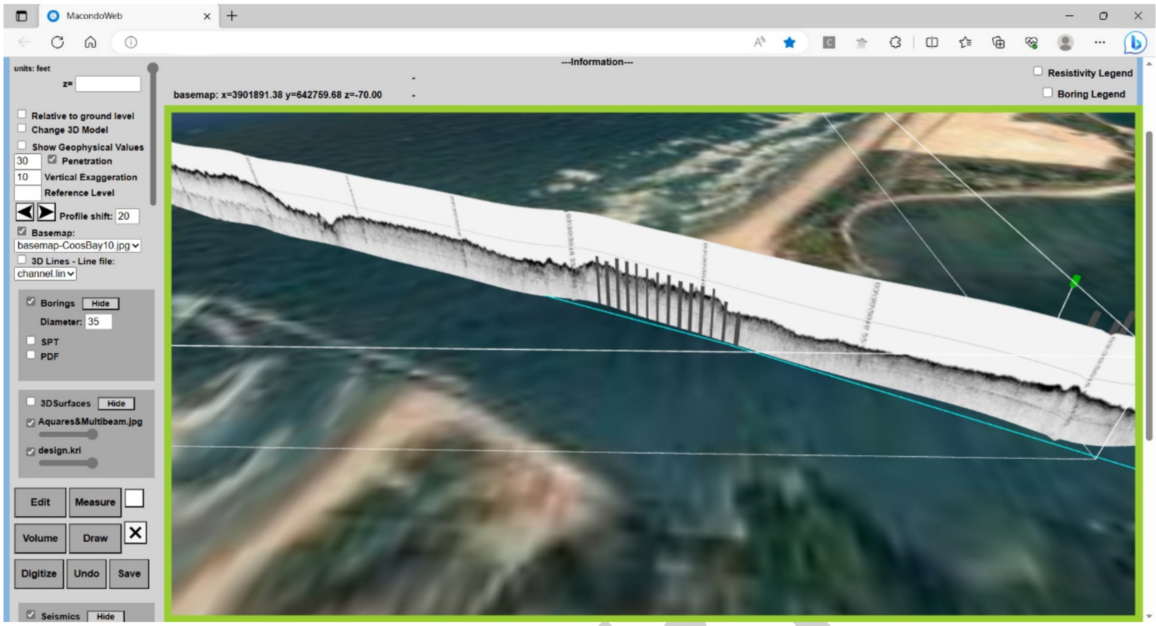


Figure 7d: Seismic reflection profile and probes at Guano Rock

4.4. RM1 to RM3

Figure 8a shows a cross section near boring B40. This section shows high resistivity structures in the current channel and south east of the current channel in the channel widening area. In the latter area a low resistivity zone is seen below the high resistivity surface structure. This low resistivity zone correlates with fractured rock descriptions in boring B40. Low resistivity structures such as these could possibly correlate with fracturing caused by dredging activities (drilling and blasting), though in this case NNW-SSE trending structures shown in the bathymetry corresponding with the general stratigraphic orientation appear to suggest other explanations related to sub-horizontal thrust faulting as known to exist in this area.

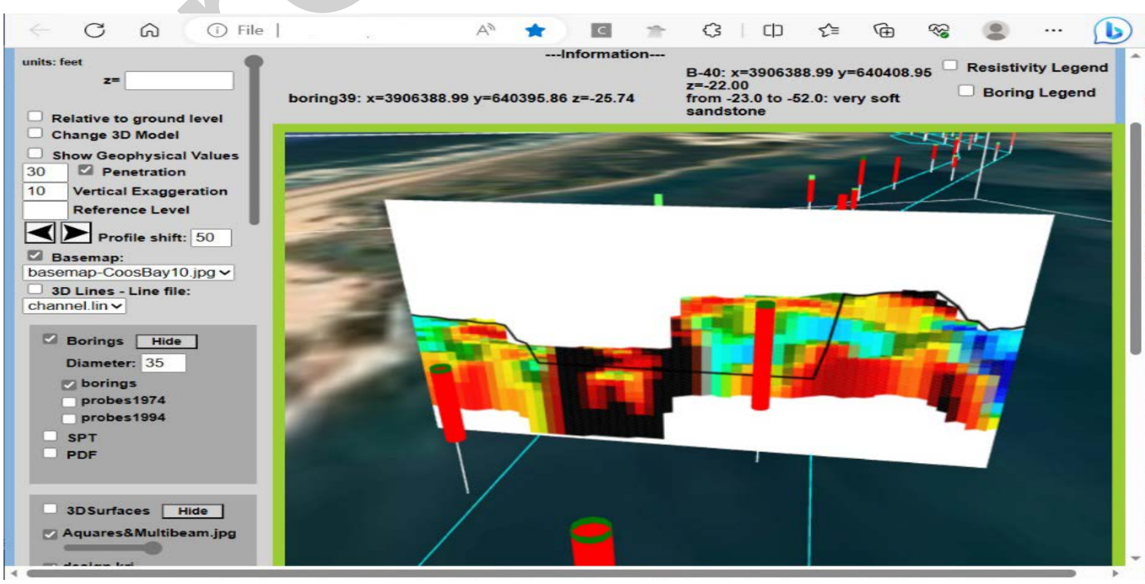


Figure 8a: Vertical cross section at boring B40

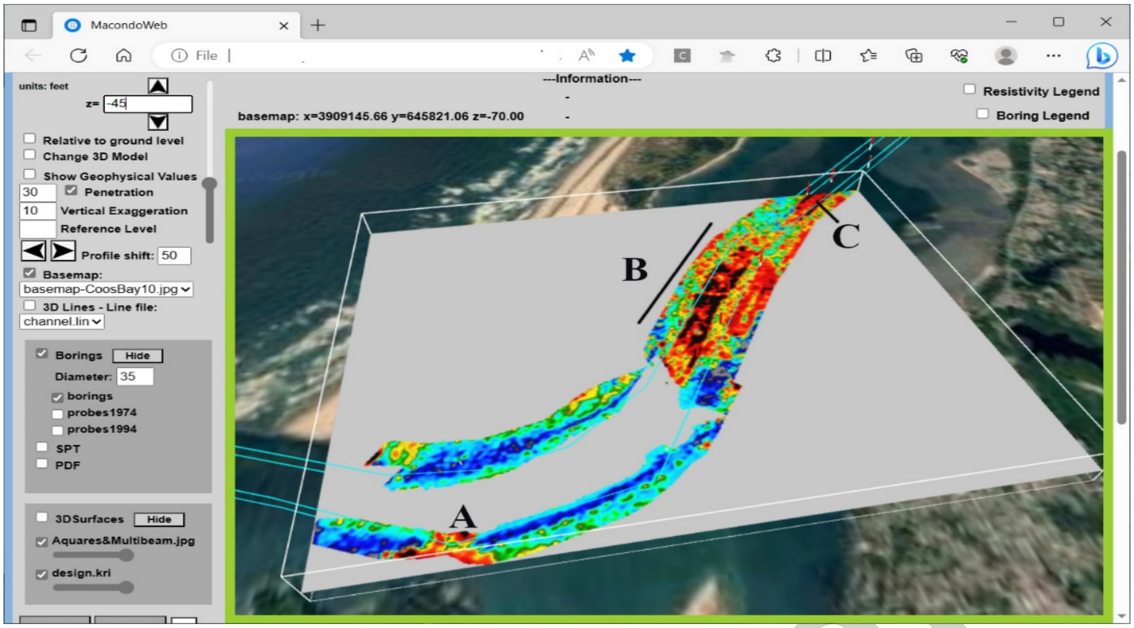


Figure 8b: Horizontal geophysical sections at -45 ft dredge level

Figure 8b shows a horizontal section at -45 feet with 3 high resistivity spots A, B and C. The higher resistivity structures of Area B appears to be delimited west and east by the same NNW-SSE alignments.

4.5. RM3 to RM5.6

Figure 9a shows a horizontal section at -45 feet of the third model between RM and RM5.6.

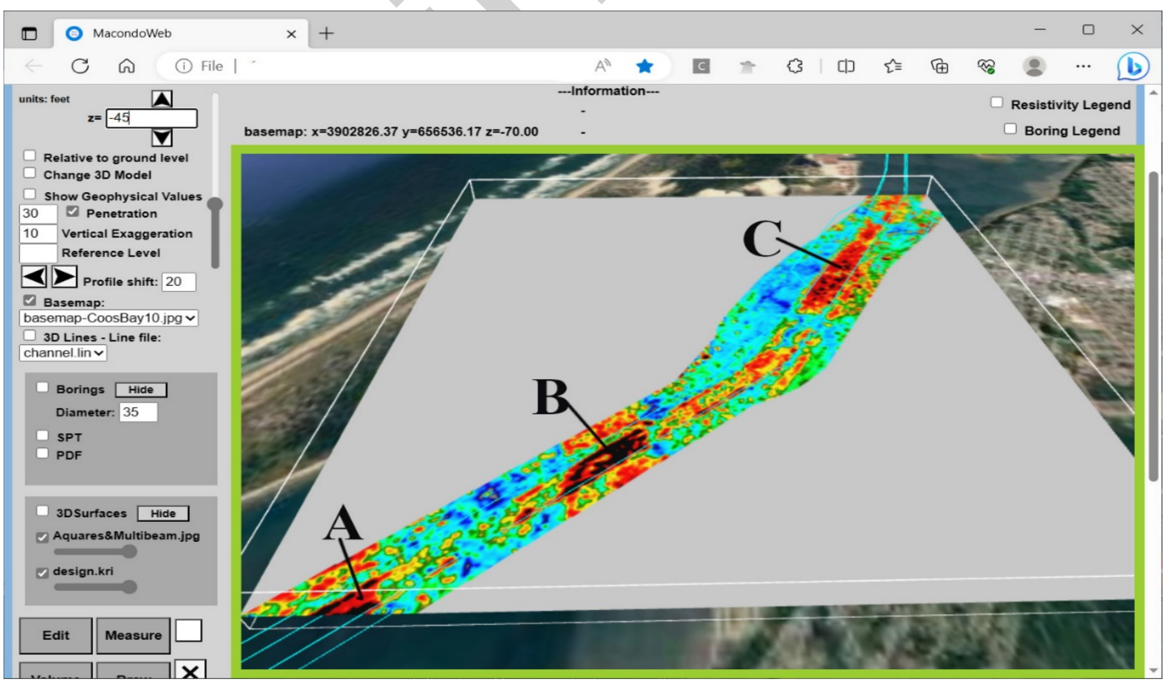


Figure 9a: Horizontal geophysical section at -45 ft dredge level

Again, three high resistivity areas are seen at locations A, B and C. Area A corresponds with the extension of area C in the former model (figure 8b). The high resistivity structure in the current channel between B and C is relatively thin as shown in figure 9b (below) and could possibly correlate with loose rock fragments from former dredging activities. No further information is available to confirm the true nature of these structures. The more recent post survey borings B-6-23, B-8-23 and B-9-23 in the southeastern reaches of the widener (C) correlate the relatively low resistivity values with very soft siltstone containing shell fragments.

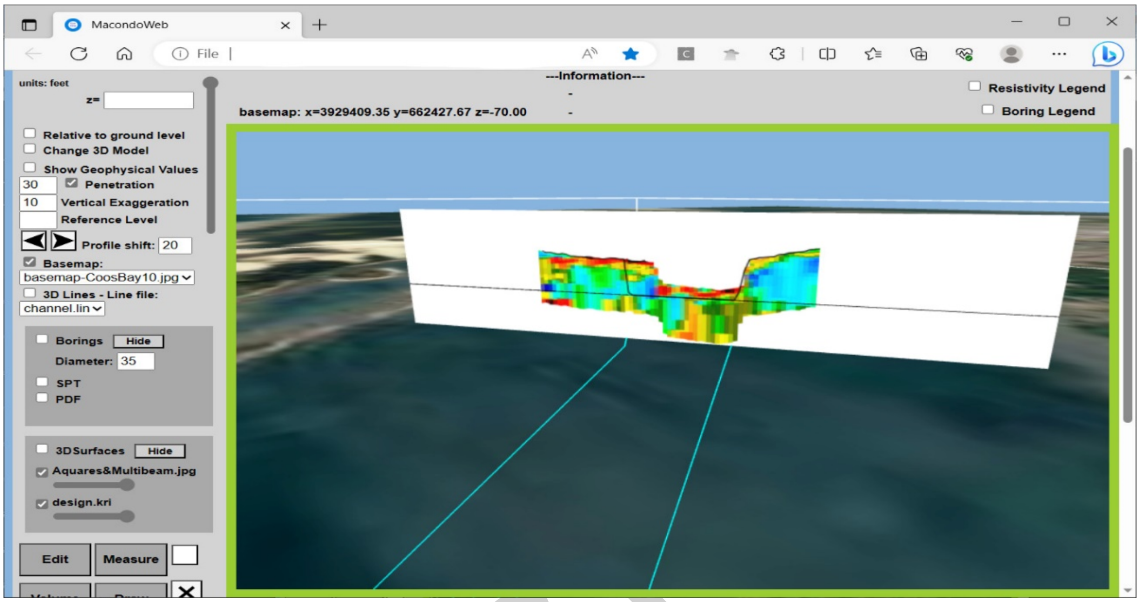


Figure 9b: Vertical resistivity section between B and C

4.6. RM5.6 to RM9

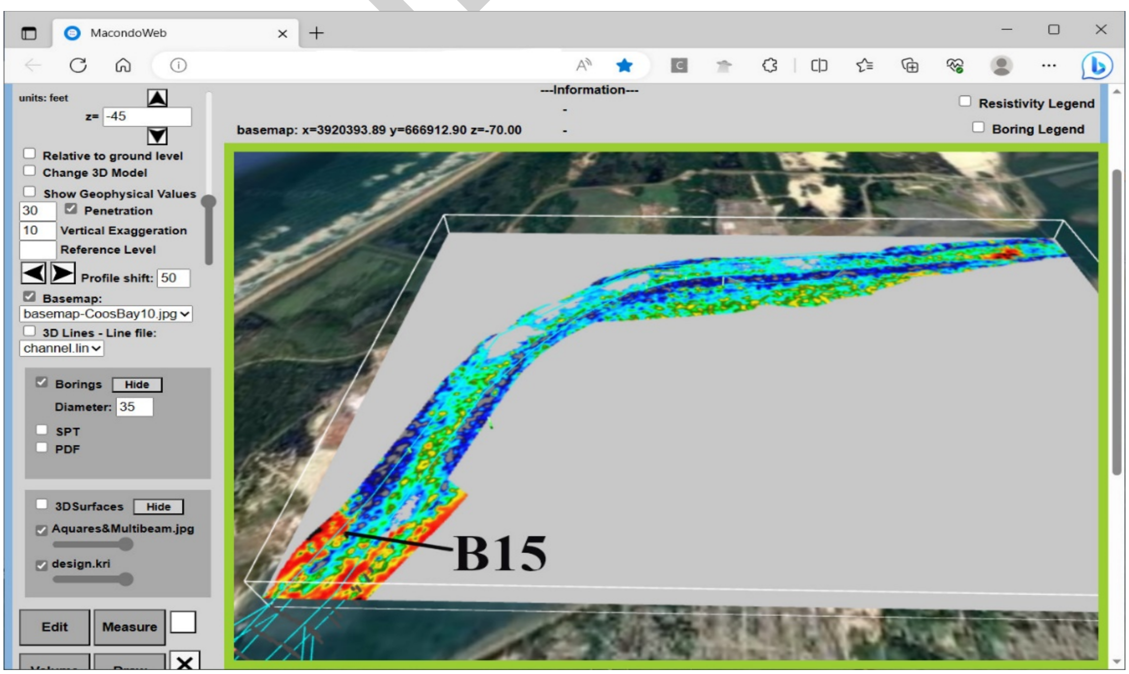


Figure 10: Horizontal geophysical section at -45 ft dredge level

Figure 10 shows a horizontal section of model 4 including the turning basin at RM7.5. It shows the high resistivity extension of area C (of model 3) in the southern reaches. Boring B15 suggests this area to correlate with hard sandstone at grade and below grade while boring B-4-23 suggests a correlation with very soft siltstone instead. The shallower resistivity structures correlate much better with boring B-4-23 than with boring B15. In the lower resistivity structures areas upstream of B15 the other borings show rock at considerable depth and no rock above grade.

Another high resistivity area at the upstream end of this model is situated outside the dredging area.

5. Conclusions

The Aquares results suggest the subsurface of the survey area to consist mostly of rock while in the entrance area some of this rock is covered by sediments (except for Guano Rock). Further upstream and particularly beyond the RM5.7 mark the areas outside the channel appear to consist of sediments.

Low resistivity zones in Guano rock and other rock areas upstream appear to correlate with fracturing possibly related to previous dredging activities, to sub horizontal thrust faulting or any other unknown cause. No further information is available to clarify the true nature of these geophysical structures.

The Integrated Digital Geological Model, integrating boring information, geotechnical information, single beam and multibeam bathymetry, design template, side scan sonar, seismic information and Aquares information is accessible through the ArcGeoTwin platform. It clearly shows the location, extent and thickness of above described geophysical structures.

***Note*:** Arc Surveying & Mapping, Inc. and its subconsultants provide this report and attachments with the understanding that hydrographic, subsurface, and side-scan surveys have been performed professionally to high standards and with careful consideration regarding accuracy, jobsite conditions and safety. Standard practice precautions have been taken to assure the enclosed data meets the directions and requirements of David Miller & Associates, Inc. Project design, geotechnical core borings and seismic refraction data included in this survey report have been provided by David Miller & Associates, Inc.

End Report

For more information please contact:

John F. Sawyer, Vice-president
Project Administrator
Arc Surveying & Mapping Inc.
Office: (904) 384-8377
Mobile: (904) 616-7039
Email: jsawyer@arcsurveyors.com

Peteralv Brabers, Ph.D., Director

Geological Engineering
Demco, NV
Wintershoven, Belgium
Email: p.brabers@demco-surveys.com

John K. Maffett, PLS, Vice-president
Project Surveyor
Arc Surveying & Mapping, Inc.
Office: (904) 384-8377
Email: jmaffett@arcsurveyors.com

ATTACHMENT G: Coos Bay Channel Modification, Coos Bay 3D Bedrock Model

Coos Bay 3D Bedrock Model

May 24, 2024

To	Mr. Christopher S. McGarry, David Miller and Associate Inc. (DMA)	**Contact No.**	+ 1 779-220-0166
Copy to	Mr. Sébastien Monarque, GHD	**Email**	cmcgarry@dma-us.com
From	Mr. David Beauseigle, GHD	**Project No.**	12594003 (1)
Project Name	Coos Bay Channel Modification Project		
Subject	3D Bedrock Model, Oregon USA		

1. Introduction

GHD Consultant Ltd. (GHD) was mandated by David Miller and Associates, Inc. (DMA) to construct a 3D bedrock model as part of the Coos Bay Channel Modification Project, for the purpose of calculating bedrock excavation volumes and assessing the technical requirements for dredging the channel.

The DMA team provided all data used to develop the 3D model, including bathymetry and LiDAR data, a 3D dredge prism, historical data (jet probe surveys, borehole surveys, rock depth, bathymetry, geological map, geophysical data including an interpreted seismic survey and resistivity survey), as well as an existing bedrock surface model. The DMA team provided insight during model production and confirmed assumptions to address data gaps.

The intent of the model is to produce bedrock level isocontours intended for volume estimations and risk determination. As 3D digital bedrock surface modelling is inherently interpolative, it is important that the conditions and modelling assumptions used in the Coos Bay Channel 3D Bedrock Model are understood and applied to any further application of the data or results.

This report is intended to support the digital deliverables, provide documentation of input data, assumptions and context in which the geological model was built, as well as to provide guidance on general limitations and disclaimers applicable to the model and its use. Other digital deliverables included with this report are listed in Section 6 and were sent to the client by email. The final version of the model was sent on March 12th, 2024.

2. Scope and Limitations

2.1 Scope of Work

The scope of work, using Leapfrog Works, from Seequent (Version 3.1 and updated to 2023.2.1) included the following activities:

- Review of available data and assessment of suitability for use;
- Create a 3D bedrock model based on the provided data;
- Review and update the model after client and project team presentations and workshops;
- Provide a Digital 3D bedrock surface model exported from the Coos Bay Channel 3D Bedrock Model in dwg format and 10 ft. x 10 ft. points elevation grid;
- Prepare a technical memorandum providing an overview of the model, data sources, assumptions made, outputs, and use of limitations and disclaimers.

2.2 Limitations

- GHD did not verify the accuracy of the data provided. It is assumed that data collected or previously interpreted was accurate and represented field conditions.
- The model does not necessarily incorporate every piece of historical information provided, as certain data conflicted with other data. Discarded data is discussed in Section 5.
- Where primary source data was sparse within the model domain, assumptions were made following a discussion with and review by the client and are listed in Section 3 of this report.
- Geological data was incorporated into the 3D model in various formats. Source data varied in spatial extent and precision. Interpolation was used to model areas between source data points and extrapolation was used to model areas within the model domain, but outside the extent of source data. The model is most accurate at locations near source data locations.

3. Site Context

3.1 Site Location

Coos Bay is located in Coos County, Oregon, on the southern Oregon coast, about 200 miles (mi) south of the mouth of the Columbia River (MCR) and 445 mi north of San Francisco Bay. It is the navigational approach to Charleston, Empire, North Bend, Glasgow, Coos Bay, and Eastside. The bay is formed by the junction of Isthmus Slough, Coos River, South Slough, Kentuck Slough, Haynes Slough, and Winchester Creek, and is located at the foot of the Coast Range. Deep-draft navigation is limited to the lower 15 mi of the Coos Bay estuary. The Channel Modification Project is then expected to stretch from offshore in the Pacific Ocean starting near River Mile (RM) -1 and finishing north of the city of North Bend at RM 8.2. New turning basins are also planned along the new channel near RM 5 and RM 8.

3.2 Site History

The Federal navigation channel (FNC) at Coos Bay has been dredged and excavated multiple times in support of previous channel modification projects, several geotechnical investigations, geophysical investigations, surveys, boreholes, and jet probes have been acquired. In 2016, using data available at the time, David Evans and Associates, Inc. (DEA) produced a “Rock Free” surface model depicting the lowest known elevation to not penetrate bedrock in and near the channel.

Old channel footprints and evidence of previous dredging activities are today still visible in recent high resolution bathymetry surveys. These activities have notably reshaped the bedrock surface over time.

Many of the areas previously dredged to the rock surface have since been covered by varying thicknesses of sediment. Today, many areas previously dredged in rock can be identified by observing the steeply dipping to near vertical walls of the Federal navigation channel in bathymetric surveys. These surveys provide an approximate and incomplete geometry of the bedrock within these areas.

3.3 Regional Geology

The Coos Bay Channel Modification Project geological interpretation is based on public[1,2] geological surveys and crosses three main sedimentary rock formations, Upper Empire, Bastendorff, and Coaledo, from the Tertiary geological period:

– **Empire Formation**: thickly bedded sandstone with minor, thin interbedded siltstone;
– **Bastendorff Formation**: thinly bedded shale and siltstone;
– **Coaledo Formation, upper member**: sandstone interbedded with siltstone, local conglomerate, and coal beds.

These formations are covered by diverse unconsolidated Quaternary deposits of alluvial, aeolian, estuarine, or anthropogenic origin.

The project site is located within the north-south oriented South Slough Synclines. Various faults are present in the region, notably the mapped Barview Fault, Charleston Fault, and Coos Head Fault. These are mostly normal faults that likely extend into the channel footprint, but direct evidence is lacking. Named, well known rock outcrops, specifically Guano Rock (RM 0.7) and Utter Rock (RM 5.8), are also present near the channel. High resolution bathymetric surveys show in some areas, especially between RM 2 and RM 5 of the channel, that the visible bedrock surface is irregular to the northeast and southwest presenting a frequent undulating/striated pattern.

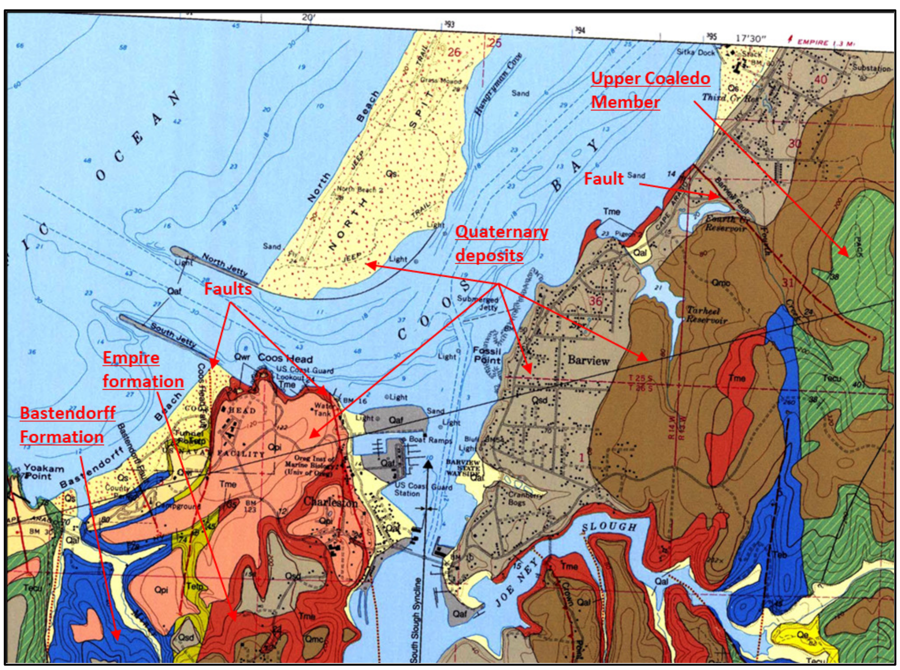


Figure 3.1 Section of the Regional Geological Map (Madin and others, 1995) (annotated by GHD)

[1] Beaulieu J. and Hughes P.W., 1975, Environmental Geology of Western Coos and Douglas Counties, Oregon, State of Oregon Departement of Geology and Mineral Industries.

[2] Madin and others, 1995, Geological Map of the Charleston Quadrangle, Coos County, Oregon, State of Oregon Departement of Geology and Mineral Industries.

4. Input Data

This section presents a list of all input data used to build the geological model and surfaces.

The model was developed in the Oregon State Plane South horizontal coordinate system using the NAD83(2011) datum in international feet. The vertical datum used was the local mean lower low water (MLLW). GHD did not convert any georeferencing data as all data provided was already in these systems. The model includes 57 boreholes, 328 jet probes and 92 surveyed bedrock depths. Portions of seismic geophysical lines used in the DEA 2016 "Rock Free" surface model were used in key areas.

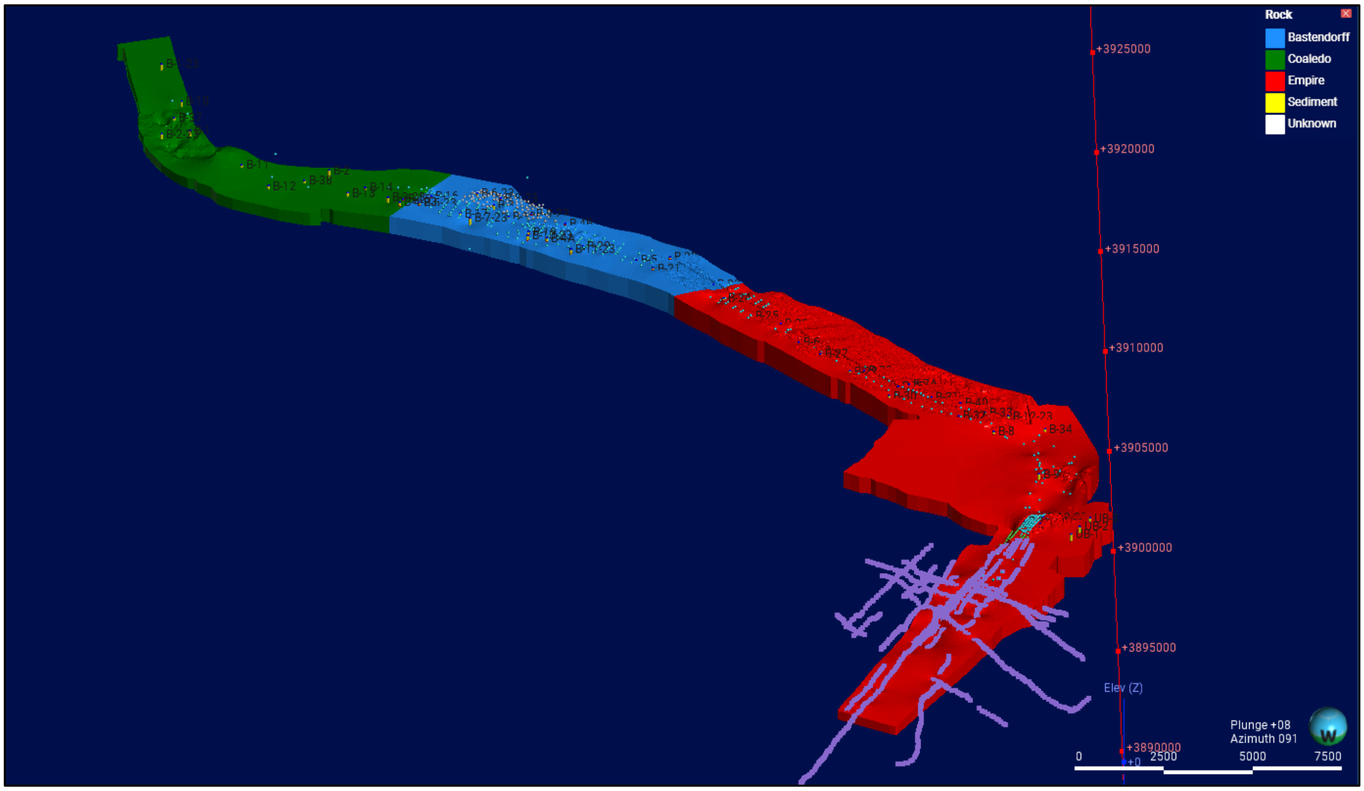


Figure 4.1 Included boreholes, jet probes and geophysical data (Vertical exaggeration x5)

Table 4.1 lists the data that was retained in the final model version, whereas Table 4.2 lists other data provided by DMA, but excluded from the final model version. All decisions to reject data for use in the model were made in consultation with the client.

Table 4.1 Input Data

Description	Data File Authors	File Names	Format	Data Date
Bathymetry, 1 m resolution	DEA	– 60% Design Bathymetric Model Data Date Limits_V4.0	.dwg	March 27th, 2017
Proposed channel polygons and river mile locations	DMA team	– ProposedChannel – ProposedTurningBasin1 – ProposedTurningBasin2 – RiverMiles	.shp	Received January 23rd, 2024
3D dredge prism	DMA team	– 231031_Channel_POD_CS	.xml	October 10th, 2023
Geological map	DOGAMI	– GMS-094	.jpg	1995
Coos Bay Channel deepening, as-built data	USACE	– CB_02-CB2 points series – CB_03-CB3 points series – CB-04_CB4 points series	.xyz	1997
Existing channel footprint	USACE	– Existing Channel	.shp	Received January 23rd, 2024
Ongoing 2023 geotechnical investigation data	GRI	– Coos Bay Sediment Boring Rock Elevations (GRI 5128-1-5-24) – Table 1B – Summary of Laboratory Results + RQD – GRI #5128 – Coos Bay Channel – Draft 2023 Boring Logs	.xls .xls .pdf	January 2024
2023 geophysical resistivity data	Arc Surveying & Mapping, inc.	– coosbay-3dmodels (Coos1.pts to Coos4.pts) Resistivity_Entrance_STP_v3	.pts .shp	October 17th, 2023
2016 geotechnical investigation data	GRI	– Oregon International Port of Coos Bay Section 204(f)/408 Report: Geotechnical Data Report	.pdf.	June 28th, 2017
Historical borehole and jet probe compilation (1974, 1994, 2002, 2011)	DEA	– DMAA0001.gdb	.gdb	August 23rd, 2016
Empire Dock Access Channel: 1952 Bedrock Depth	USACE	– CB-1-392_Apr1952	.png	February 29th, 2024
2016 bedrock surface model	DEA	– 20170525_V4.11_RockFree-DTM	.dwg .txt (ACII points) .xml	May 25th, 2017
2016 seismic geophysics data	DEA	– POCB16_Geophysical – CoosBay_Geophysical	.gbd .gdb	March 2016

Table 4.2 Other Data Provided but not Retained for the Model

Description	Data File Authors	File Names	Format	Data Date
Bathymetry, 20-foot resolution	DEA	– POCB_Hybridbathysurface_20ft	.shp	July 27th, 2017
Coos Bay bathymetry 2016	DMA team from USACE data	– CoosBayBathymetry2016	.gdb	2016
Bathymetry, 1 m and 0.5 m	NOAA	– H11744_1m_MLLW_9of11 (to 11of11) – H11744_50 cm_MLLW_1of11 (to 11of11) – H11745_1m_MLLW_1of8 (to 8of8)	.bag	January 24th, 2018
LiDAR bare earth	DOGAMI	– LQD-2009-43124D3-Empire – LDQ-2009-SouthCoast-Bundle16	Folders with multiple files	2008-2009
LiDAR bare earth, 1m grid	USACE	– 2014_NWP_CoosBay_OR_32_BareEarth_1mGrid (to OR_37) – 2014_NWP_CoosBay_OR_43124c2b_BareEarth_1mGrid (also c2c, c3a, c3b, c3c, c3d, d2a, d2b, d2c, d2d)	Folders with multiple files	1997
LiDAR, 1 m grid	DEA	– NBL_60pct_1-MeterGrid_2007-2014_CoosBay_NAD83(HPGN)_OR-S_INT-FT_MLLW(83-91)_DTMwLIDAR_20160511Final_ENZ	.xyz	May 12th, 2017
Coos Bay, Oregon, Boring at Empire Dock 1945-1946	USACE	– CB-1-365	.png	February 29th, 2024
Sidescan imagery	DEA	– 2010_Coos_Bay_Sidescan_Imagery	Folder with multiple files	Received January 23rd, 2024
Various survey instrument logs from DEA.	DEA	– 20170620	Folder with multiple files	January 2024
2016 seismic geophysics data	DEA	– CoosBay_Seismic_Images – CADExports	Folder with multiple files	2016-2017

5. Modelling Assumptions

The disparate spatial distribution of data used to build the model required assumptions and manual adjustments of the supporting data at some locations within the model domain to better represent the bedrock surface.

Assumptions and manual adjustments were actively discussed in project team presentations and workshops and agreed upon during bedrock surface model development.

Specific assumptions made for the draft models can be found in section 6.1.

5.1 Geological Units

The model was divided into four units:

1. The surficial unit grouped all unconsolidated sediment deposits, regardless of sediment type.
2. Bedrock was divided into three units representing the geologic formations encountered and described in GRI boreholes. Borehole data provided only encountered one bedrock unit (i.e., each borehole did not contain any record of the physical contact between geologic units). Accordingly, all contacts between the three units are interpreted and manually inserted into the model. This interpretation of geologic contacts is for visual purposes only and have not been delivered with the final model bedrock surface.

5.2 Outcrops

Bedrock outcrops are readily identifiable within the provided bathymetric data. Using the bathymetry, outcrop borders were identified and manually drawn within the model domain. These areas of exposed bedrock were used as the top of bedrock in these areas.

Points and lines were also added manually over the outcrops to ensure that the interpolated bedrock surface properly represents the elevation of the outcrops.

Note that the eastern portion of the existing channel between RM 2 and RM 4 was modelled entirely as bedrock at the bathymetric surface. The bathymetry in this area depicts bedrock at the or very near the bathymetric surface. Furthermore, no additional data depicting the thickness of sediment was available in the area. This method was also applied to the east and west sides of the existing channel around near RM 4 and RM 4.5.

In contrast, this assumption was not made for the west side of the existing channel between RM 2 and RM 4 because boreholes depicting the thickness of sediment above the bedrock surface were available in this area.

Examples of these assumptions and manually developed bedrock surface datasets are presented in the subsequent figures. Within the figures, unconsolidated sediments are represented by the yellow unit. The Empire, Bastendorff, and Coaledo Formations are represented respectively by the red, blue, and green units. Green and blue lines and points shown on the figures represent the manual adjustments made within the software to generate the previously described assumption.

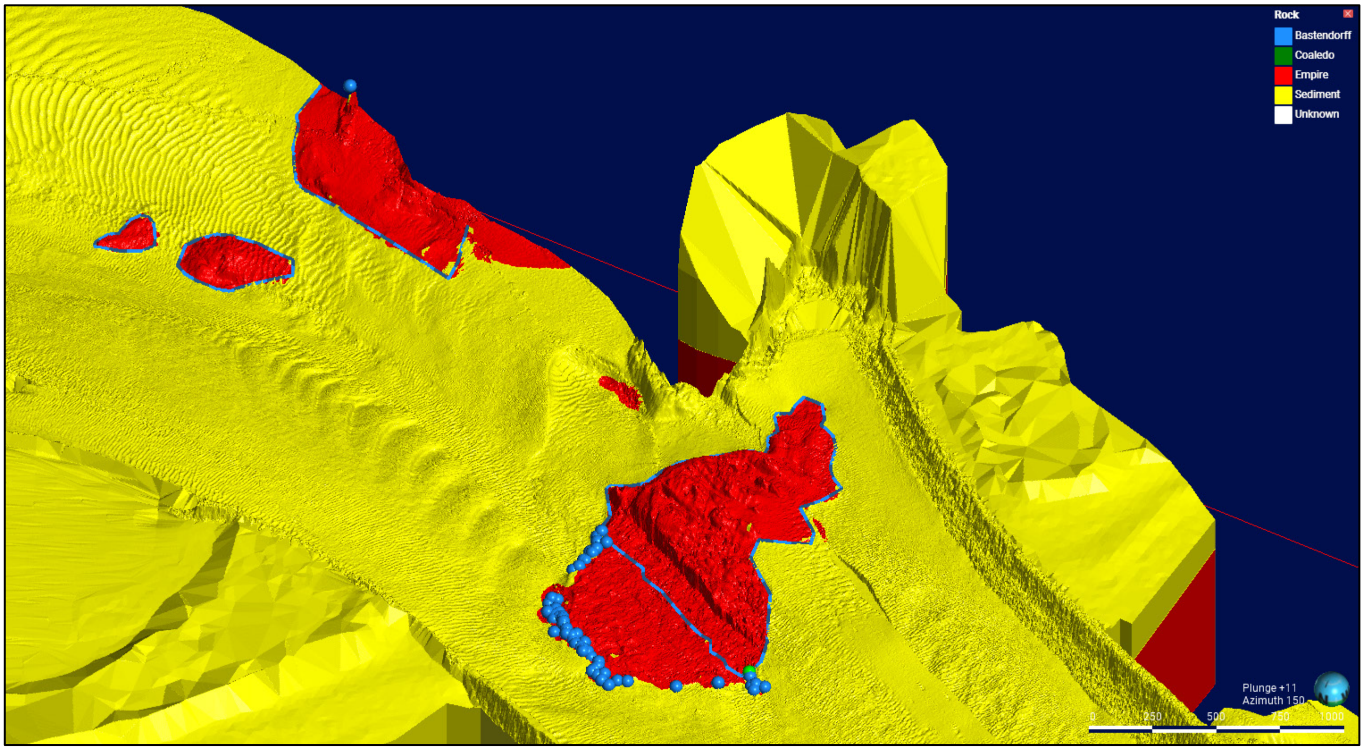


Figure 5.1 Manual outcrops drawing: Guano Rock (to the right) and outcrops between RM 1 and RM 2 (Vertical exaggeration x5)

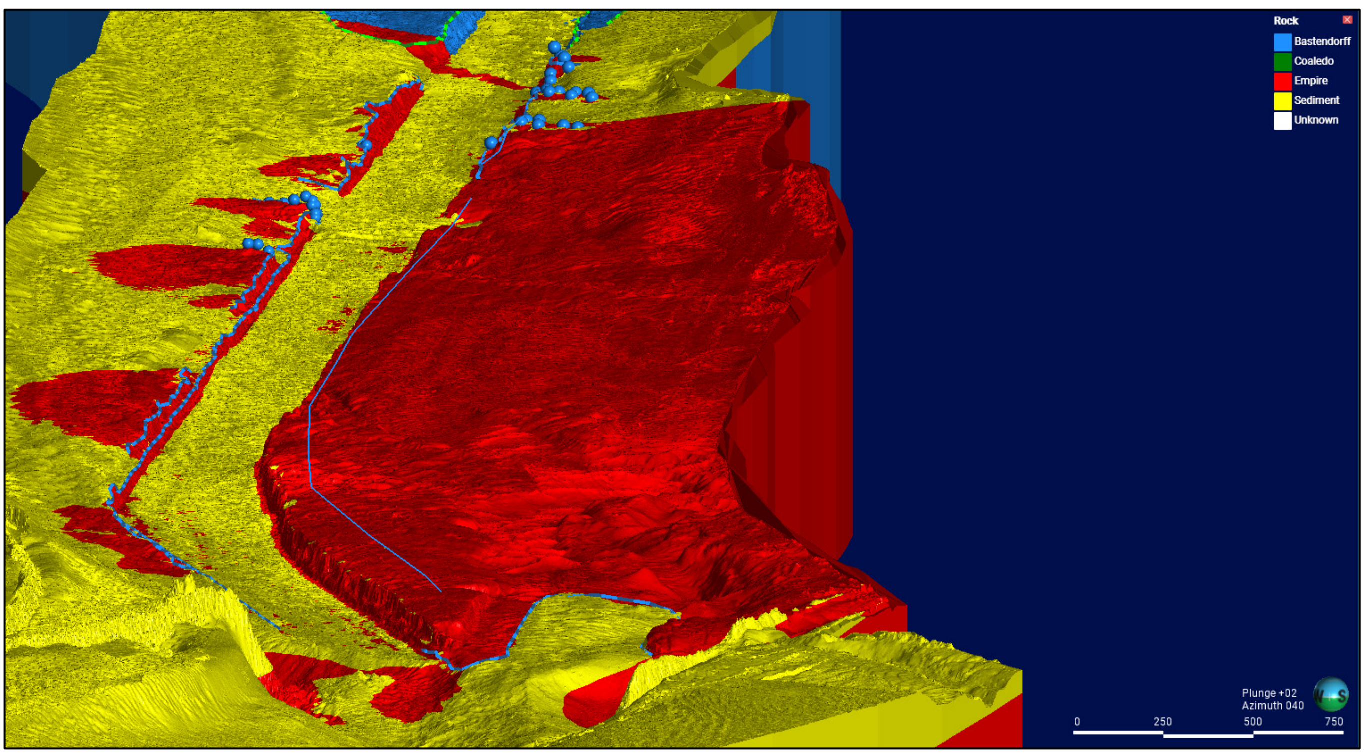


Figure 5.2 Manual outcrops drawing: Between RM 2 and RM 4. (Vertical exaggeration x5)

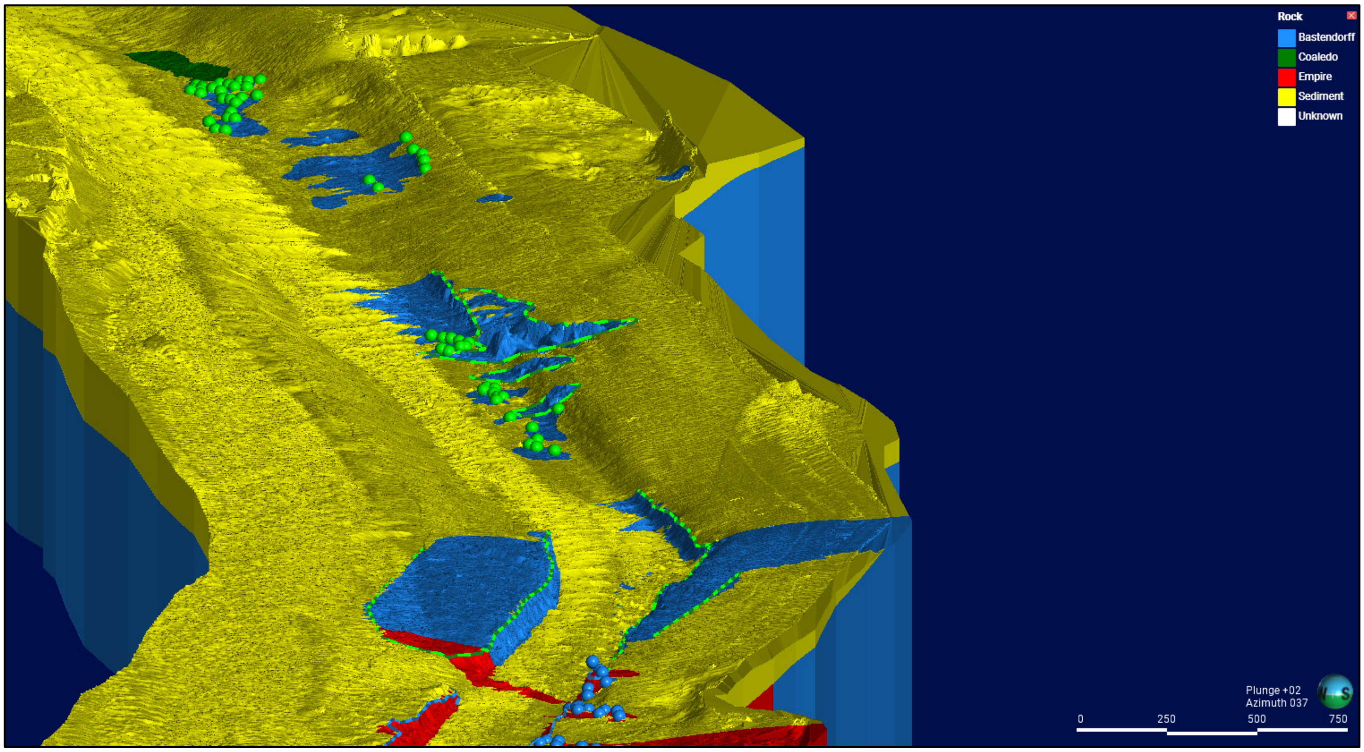


Figure 5.3 Manual outcrops drawing: Between RM 4 and RM 6. (Vertical exaggeration x5)

5.3 Historical Data

Some historical jet probe and borehole information was found to be obsolete or incorrect during the modelling process. The assumptions and data discarding applied to historical data are discussed in the following sections.

5.3.1 1974 and 1994 Jet Probes

Several sections of the existing navigation channel are completed in bedrock. The channel was last deepened in 1997. As such, the bathymetry of channel in those reaches that are completed in bedrock reflect the bedrock surface at the time of deepening. Accordingly, bedrock elevations from 1974 jet probes were found to exceed bathymetric elevations in existing between RM 2 and RM 4.4.

In areas where the channel is not finished in bedrock, bedrock elevations from 1974 boreholes were at or below bathymetric levels. This was also true for jet probes from 1994 since the bedrock surface had been mechanically lowered since these jet probes were acquired.

After discussion with the project team, the 1974 and 1994 jet probes within the existing channel footprint between RM 2 and RM 4.4 were considered obsolete and discarded.

Jet probes outside the existing channel footprint, on the outcrop edges of the existing channel, such as jet probes downstream of RM 2 and upstream of RM 4.4, were retained for use.

The modelling process revealed that bedrock elevation from the 1974 jet probe JP-160 was lower in elevation compared to outcrop levels visible in the bathymetry in close proximity. The reason for this anomaly was uncertain. This jet probe was not included in the model and the outcrop border was used as the reference bedrock elevation at this location.

5.3.2 Empire Dock Access Channel: 1952 Bedrock Depth

A US Army Corps of Engineers map for maintenance dredging depicting rock depth data near the dock on the left descending bank at Empire from 1952 was provided.

Data points within the existing channel footprint were discarded, much like the previously discussed jet probes. Data points mentioning that no rock was reached were also discarded. These tops of rock elevation values were an important resource in a region lacking detailed data to refine the top of rock surface in the proposed turning basin.

5.3.3 1974 "Miles" Boreholes

A series of 1974 boreholes with names beginning with the relevant river mile and stations were provided. These boreholes were found to have systematically lower bedrock levels than other data collected in the vicinity. When used in the modelling software, the aberrant rock surface data points created bedrock surface elevations inconsistent with nearby source data.

The cause of this systematic lower bedrock level is uncertain and possibly due to an improper datum. These boreholes were discarded from the model.

5.3.4 1997 Bathymetry

Bathymetry of the existing channel footprint, measured in 1997 immediately after the most recent dredging between RM 2 and approximately RM 4.4, was used as the bedrock surface in this area where the channel cut through bedrock since it is representative of the current bedrock depth.

5.3.5 2016 Seismic Geophysics Data

The modelling process revealed that bedrock levels from 2016 seismic geophysics data were questionable in several locations, most notably in the entrance of the channel. In some areas, top of the bedrock elevation data would mirror sand wave shapes from the bathymetry while in other locations it would exceed expected bedrock level where bedrock was known to be considerably deeper. To clarify the origins of the issue, the originator of the data, DEA, was contacted to discuss the quality of the data obtained in 2016. DEA acknowledged that the seismic survey conducted was better suited in areas where the bedrock surface was shallow rather than areas where the bedrock surface is at considerable depth.

Due to uncertain and variable data concerning 2016 geophysical lines this data was removed entirely from the model. In contrast, portion of the Rock Free Model produced by DEA in 2019, and notably excluding the 2016 seismic data in the entrance channel, was used in the entrance channel and around RM 7 where bedrock is at considerable depth.

5.4 2023 Resistivity Geophysics Data

A resistivity geophysical survey conducted in 2023 by Arc Surveying & Mapping, Inc. was incorporated in the 3D model to determine the utility of the survey to refine the elevation of the bedrock surface. The resistivity measurements were compared with physical data such as boreholes and jet probes; however, correlation between the resistivity measurements and the physical data failed to reveal a clear bedrock/sediment contact. The resistivity geophysics data was not used to create the bedrock surface due to the imprecision of the contact. Nonetheless, the resistivity data showed interesting signal correlation where bedrock was very shallow under the sediment in the physical data and ultimately acted as a comparison tool for the model validation.

6. Digital Deliverables (DD)

6.1 Draft Deliverables

DMA was provided with four draft bedrock surface elevation models, based on different assumptions regarding the bedrock surface of the Coos Bay Channel 3D Bedrock Model, enabling on the review and analysis of interpretations showing higher or lower quantities of bedrock within the project's dredge prism.

Multiple files were sent to the client for each version, adjusting bathymetry resolution, refining outcrop drawings, and including additional data and input based on discussions and comments.

Version Nº. 1: contrary to the assumption discussed in section 5.3.1, jet probes between RM 2 and RM 4.4 were retained, resulting in a draft with the highest amounts of bedrock in this area. Assumption 5.3.4 was not applied to this version.

Version Nº. 2: contrary to version Nº. 1, 1974 jet probes between RM 2 and RM 4.4, within the existing channel footprint and that encountered bedrock at an elevation of over -39 feet, were filtered and discarded, resulting in less bedrock than in version Nº. 1 in that area. Assumption 5.3.4 was not applied to this version.

Version Nº. 3: instead of applying assumption 5.3.4, contacts were drawn manually at the bottom edges of the existing channel footprint between RM 2 and RM 4.4, resulting in the lowest amount of bedrock in this area among the four versions.

Version Nº. 4: all assumptions mentioned in section 5 were applied, resulting in less bedrock than version Nº. 2 within the existing channel footprint RM 2 and RM 4.4.

6.2 Final Deliverable

The bedrock surface and associated assumptions from Version Nº. 4 best fit the project purposes.

After all final reviews were carried out and final adjustments were made to the bedrock surfaces file from the Coos Bay Channel 3D Bedrock Model, the following files were provided by email on March 12th, 2024:

A points elevation grid with 10 ft. x 10 ft. resolution of the bedrock surface in ACII format:

– 12594003_Coos Bay_ 3D Bedrock surface_20240312.asc

A Meshed 3D surface model of the bedrock surface in AutoCAD format:

– 12594003_Coos_Bay_3D_Bedrock_Surface_20240312.dwg

<table>
<tr><th>Project name</th><td colspan="7">Coos Bay Channel Modification Project</td></tr>
<tr><th>Document title</th><td colspan="7">Coos Bay 3D Bedrock Model | Coos Bay 3D Bedrock Model</td></tr>
<tr><th>Project number</th><td colspan="7">12594003 (1)</td></tr>
<tr><th>File name</th><td colspan="7">12594003-RPT-1-REV1-Coos Bay bedrock 3D Geological Model.docx</td></tr>
<tr><th rowspan="2">Status Code</th><th rowspan="2">Revision</th><th rowspan="2">Author</th><th colspan="2">Reviewer</th><th colspan="3">Approved for issue</th></tr>
<tr><th>Name</th><th>Signature</th><th>Name</th><th>Signature</th><th>Date</th></tr>
<tr><td>S4</td><td>1</td><td>Sebastien Monarque</td><td>David Beauseigle</td><td></td><td>David Beauseigle</td><td></td><td>May 24, 2024</td></tr>
</table>

GHD
320 Goddard Way, Suite 200
Irvine, California 92618, USA
T + 1 949 648 5200 | **E** David.beauseigle@ghd.com | **GHD.com**