PROJECT

DESKTOP STUDY

Volume 1: Text

Prepared for the NEPTUNE Consortium

Submitted by
Fugro Seafloor Surveys, Inc,

2727 Alaskan Way · Pier 69
Seattle, Washington 98121 USA

Telephone: (206) 441-9305
Facsimile: (206) 441-9308

* * *

13 February 2002

EXECUTIVE SUMMARY

This Desktop Study examines the natural and human factors that would affect cable safety, route survey, installation, and maintenance of the proposed Project NEPTUNE submarine cable system. The NEPTUNE system will be comprised of a fiber optic cable ring along the margins of the Juan de Fuca plate with two additional segments running ashore to Victoria (Vancouver Island, B.C.) and Nedonna Beach (Oregon), two cables crossing the Juan de Fuca plate, and four extensions. The extensions will proceed northwest to the Explorer Plate, to the south onto the Gorda Plate, and in a westerly direction to weather stations PAPA and UNCLE.

Prior to preparation of this Desktop Study, the Project NEPTUNE team had collected considerable information, including the design of preliminary cable routes. More data were collected in the course of this study and site visits were carried out to several potential landing sites. All data were reviewed during a meeting held on 04 December 2001 and, as a result, new routes were designed and several node locations were adjusted. Since the review meeting, of particular importance is the fact that new information was collected on fisheries and permitting.

A summary of the significant results of the Study would include:

- Extensive bottom contact fishing is expected to occur along those portions of the route that cross the continental margin offshore of the Oregon landing site, and off the western coast of Vancouver Island. To provide maximum protection from damage, we recommend that the cables be safely buried down to 1,800 meters water depth in these areas.

- Where cable burial is recommended, offshore approaches should have adequate sediment thickness to facilitate burial by plowing. However, burial difficulties are expected in areas very close to the shore, in particular across the Swiftsure and La Perouse Banks and across the continental slope off the Victoria landing, and offshore Oregon down to 1,200 meters water depth where hard bottom has been identified during previous surveys. In these areas, route development is expected to be necessary.

- Segments of the route that run along the base of the continental slope were designed to stay off steep areas. To the extent possible the deep water portions of the route were also designed to stay in sediment covered areas to protect against possible cable suspensions and chaffing faults.

- To circumvent potential permitting problems offshore Vancouver Island, a route has been selected that avoids the Olympic Coast National Marine Sanctuary.

- The changing situation at the Nedonna landing site will have to be monitored. The courts will soon make a decision on who the new owner of the existing station and landing site will be. The problems caused by recent beach erosion at Nedonna also need to be followed

as decisions made by the State of Oregon Parks Department will affect how new cables can be landed at this site, and if existing available conduits will be removed.

- Branching units for node modules were placed along the route in areas of particular scientific interest. In other areas, the branching units were spaced to maintain sections of less than 100 kilometers in length between network modules.

- Several crossings of the NEPTUNE cable with existing systems have been taken into account for the design of the proposed route. Contacts should be made in the future with the owners of these systems, in particular with the owners of those that are still at a planning stage at this time so route adjustments can be made if necessary.

- There is a possibility that there are uncharted military cables in the area of interest to the NEPTUNE project. This information is not publicly available, but the route has been submitted to the US Navy to ensure that they are no conflicts with any military activities. FSSI has received clearance to use the NEPTUNE route that is being proposed.

- There are few restricted areas and obstructions along or in the vicinity of the NEPTUNE route. These have been avoided where possible, however, the route still passes through military exercise areas, intense shipping traffic zones, and close to several explosive or other dumping grounds.

A summary of cable types and quantities for all segments of the NEPTUNE cable is provided below:

Segment	LW	LWP	SAL,b	SA,b	DA,b	Total
Main Ring	0.0	1,921.9	0.0	0.0	0.0	1,921.9
Victoria	0.0	19.8	99.6	203.7	0.7	323.7
Nedonna	0.0	69.1	60.1	57.5	1.7	188.4
Plate Mid	269.3	7.2	0.0	0.0	0.0	276.6
Plate North	189.7	10.9	0.0	0.0	0.0	200.6
Explorer	0.0	103.0	0.0	0.0	0.0	103.0
Gorda	0.0	221.8	0.0	0.0	0.0	221.8
Papa	918.1	326.3	0.0	0.0	0.0	1,244.4
Uncle	1,210.8	64.0	0.0	0.0	0.0	1,274.8
Survey Totals	2,587.9	2,744.1	159.6	261.2	2.4	5,755.1

LW	Light Weight
LWP	Light Weight Protected
SAL,b	Single Armor Light, buried
SA,b	Single Armor, buried
DA,b	Double Armor, buried

Table of Contents

VOLUME 1

1. INTRODUCTION 1
1.1 General 1
1.2 Summary of Landing Site Information 3
1.3 Risks 3
1.4 Recommendations 4
2. ROUTE DESCRIPTION 5
2.1 Route Information 6
2.2 Burial Feasibility 8
2.2.1 Victoria Segment 8
2.2.2 Nedonna Segment 9
2.3 Proposed NEPTUNE Route 9
2.3.1 Main Ring Segment 9
2.3.2 Victoria Segment 12
2.3.3 Nedonna Segment 14
2.3.4 Plate Mid Segment 15
2.3.5 Plate North Segment 15
2.3.6 Explorer Segment 16
2.3.7 Gorda Segment 16
2.3.8 PAPA Extension 16
2.3.9 UNCLE Extension 17
2.4 Cartography 18
3. BATHYMETRY AND GEOLOGY 20
3.1 Geologic and Physiographic Overview 20
3.1.1 The Juan de Fuca Microplate System 21
3.1.2 Pacific Northwest Continental Margin 28
3.1.3 The Juan de Fuca Strait 31
3.2 Sediment Types 32
3.2.1 Deposits of the Northwest Pacific Continental margin 33
3.2.2 Deep-Sea deposits 34
3.3 Sediment Transport 36
3.4 Potential Geohazards 39
3.4.1 Seismicity and Surface Faulting 39
3.4.1.1 Ridge Seismicity 40
3.4.1.2 Transform Boundary Seismicity 41
3.4.1.3 Cascadia Subduction Zone 41
3.4.1.4 Seismic Hazards 44
3.4.2 Turbidity Currents 45
3.4.3 Tsunamis 46
3.4.4 Volcanic Activity 49
4. ENVIRONMENTAL CONDITIONS 52
4.1 Climate and Weather 52
4.1.1 Overview 53
4.1.2 Monthly Weather Conditions 55
4.2 Oceanography 60
4.2.1 Waves 60
4.2.2 Currents 60
4.2.2.1 Surface Currents 61

4.2.2.2 Bottom Currents 62
4.2.2.3 Tidal Currents 63
4.2.3 Tides 64
4.2.4 Water Temperatures 64
5. FISHERIES 66
5.1 United States 66
5.1.1 Groundfish Bottom Trawling 67
5.1.2 Shrimp Bottom Trawling 69
5.1.3 Dungeness Crab Potting 70
5.1.4 Halibut and Sablefish Longline and Pot Fishing 71
5.1.5 Scallop Dredging 73
5.1.6 Other Commercial Bottom Contact Fisheries 74
5.1.7 Recreational Fisheries 75
5.2 Canada 75
5.2.1 Groundfish Bottom Trawling 76
5.2.2 Groundfish Mid-water Hake Trawling 77
5.2.3 Shrimp Trawling 78
5.2.4 Halibut and Rockfish Longline Fishing 78
5.2.5 Sablefish Longline Fishing 78
5.2.6 Salmon Gillnet and Seine Fishing 79
6. PERMITTING 80
6.1 Oregon 80
6.1.1 Maritime Delimitations 80
6.1.2 Land Ownership 80
6.1.3 Route Permitting Requirements 81
6.1.4 Maritime Operational Permits 83
6.1.5 Outstanding Inquiries 84
6.2 Canada 84
6.2.1 Offshore Permits 84
6.2.2 Inland Permits 88
6.3 Cable Crossing Agreements 90
7. HAZARDS and OBSTRUCTIONS 91
7.1 Existing and Planned Cables and Pipelines 91
7.1.1 Fault History 94
7.1.2 Fishbite Risk 96
7.2 Restricted Areas and Obstructions 97
7.3 Offshore Mineral Resource Activities 102
7.3.1 Mineral Resources 102
7.3.2 Petroleum Resources 103
7.4 Outstanding Inquiries 103
8. OTHER CONCERNS 104
8.1 Oregon 104
8.1.1 Shipping and Anchoring 104
8.1.2 Leisure Activities 104
8.1.3 Outstanding Inquiries 104
8.2 Canada 104
8.2.1 Shipping and Anchoring 104
8.2.2 Leisure Activities 106
8.2.3 Outstanding Inquiries 106
9. LANDING SITES 107
9.1 Oregon 107
9.1.1 Preferred Landing Site – Nedonna Beach 108

9.1.2 Alternate Landing Site – Rockaway 110
9.1.3 Alternate Landing Site – Pacific City 110
9.1.4 Alternate Site – Warrenton 111
9.1.5 Permits 112
9.1.5.1 Maritime Delimitations 112
9.1.5.2 Land Ownership 112
9.1.5.3 Route Permitting Requirements 113
9.1.5.4 Maritime Operational Permits 115
9.1.6 Existing and Planned Cable/Pipeline Installations 115
9.1.7 Restricted Areas and Obstructions 117
9.1.8 Port, Shipping, and Fishing Activities 117
9.1.9 Other Activities 118
9.1.10 Environmental Issues 118
9.1.10.1 Protected Environmental Areas 118
9.1.10.2 Climate and Oceanography 119
9.1.11 Contacts 120
9.1.12 Outstanding Inquiries 121
9.2 British Columbia, Vancouver Island (B.C., Canada) 122
9.2.1 Preferred Landing Site – Fleming Bay 123
9.2.2 Alternate Landing Site – Bamfield Marine Station 125
9.2.3 Other Sites Visited 130
9.2.3.1 Parry Bay - Taylor Road 130
9.2.3.2 Pedder Bay - Pearson College 131
9.2.3.3 Port Alberni - Polly Point 132
9.2.4 Permits 134
9.2.4.1 Offshore Permits 135
9.2.4.2 Inland Permits 138
9.2.5 Existing and Planned Cable/Pipeline Installations 140
9.2.6 Restricted Areas and Obstructions 142
9.2.7 Port, Shipping, and Fishing Activities 144
9.2.8 Other Activities 145
9.2.9 Environmental Issues 146
9.2.9.1 Protected Environmental Areas 146
9.2.9.2 Climate and Oceanography 147
9.2.10 Contacts 148
9.2.11 Outstanding Inquiries 151

10. RISK ASSESSMENT 153

10.1 Burial areas 154
10.2 Non-Burial areas 155

11. CABLE ENGINEERING 157

11.1 Guidelines and specifications 157
11.1.1 Cable Types and Slack Specifications 157
11.1.2 Cable Burial Specifications 158
11.1.3 Cable Routing Specifications 159
11.2 Engineering Recommendations along the NEPTUNE Cable Route 161
11.2.1 Main Ring Segment 161
11.2.2 Victoria Segment 161
11.2.3 Nedonna Segment 163
11.2.4 Plate Mid Segment 163
11.2.5 Plate North Segment 164
11.2.6 Explorer Segment 164
11.2.7 Gorda Segment 164
11.2.8 PAPA Segment 165
11.2.9 UNCLE Segment 165

12. SURVEY RECOMMENDATIONS 167

12.1 Marine Route Survey 167
12.2 Cable Installation 168
12.3 Estimated Overall Schedule 168

13. CONTACTS 170

14. REFERENCES 176

Appendix A Tidal Information
- Tillamook Bay, Barview
- Victoria, Vancouver Island
- Bamfield, Barclay Sound

Appendix B Fisheries Reports
- Natural Resource Consultants, Inc.
- Archipelago Marine Research Ltd.

Appendix C Permitting
- Navigable Waters Protection Act (NWPA) Application Guide
- Navigable Waters Protection Division Application Form

Appendix D Olympic Coast National Marine Sanctuary Regulations

VOLUME 2

Identity	Description	Scale
Chart 001	Overview	1:2,500,000
Chart 002	Overview Juan de Fuca Plate	1:1,500,000
Chart 003	USGS GLORIA data, Juan de Fuca Overview	1:1,300,000
Chart 004	Vancouver Island and Washington	1:500,000
Chart 005	Pacific Ocean	1:500,000
Chart 006	Pacific Ocean	1:500,000
Chart 007	Pacific Ocean	1:500,000
Chart 008	California and Oregon	1:500,000
Chart 009	Oregon and Washington	1:500,000
Chart 010	Pacific Ocean	1:500,000
Chart 011	Pacific Ocean	1:500,000
Chart 012	Pacific Ocean	1:500,000
Chart 013	Pacific Ocean	1:500,000
CHS 3419	Esquimalt Harbour	1:5,000
CHS 3440	Race Rocks to D'Arcy Island	1:40,000
CHS 3606	Juan de Fuca Strait	1:110,000
NOAA 18003	Cape Blanco to Cape Flattery	1:736,560
NOAA 18520	Yaquina Head to Columbia River	1:185,238
NOAA 18556	Nehalem River	1:20,000

List of Figures, Photographs, and Tables

Section 1 – Introduction

Figure 1.1 Physiographic overview of the Project NEPTUNE system

Table 1.2.1 Summary Landing Site Information for Clatsop County, Oregon
Table 1.2.2 Summary Landing Site Information for Vancouver Island, Canada

Section 2 – Route Description

Figure 2.1.1 Sketch showing the make-up of a node
Figure 2.1.2 Location of original nodes and revised positions

Table 2.1.1 Project NEPTUNE Route Information Summary
Table 2.1.2 NEPTUNE Node Information Summary with Reasons for Change to Original Positions
Table 2.1.3 Summary Cable Distances Between Nodes
Table 2.4.1 FSSI charts produced for the Project NEPTUNE Desktop Study
Table 2.4.2 Nautical charts used to compile the Desktop Study

Section 3 – Bathymetry and Geology

Figure 3.1.1 Active volcanoes, plate tectonics, and the Ring of Fire
Figure 3.1.2 General plate tectonic map of the NE Pacific Ocean
Figure 3.1.3 Northeast Pacific tectonic environment
Figure 3.1.4 High-temperature vent field of the Endeavor Ridge
Figure 3.1.5 Bathymetric map of the Coaxial Ridge
Figure 3.1.6 Bathymetric map of the Axial Volcano
Figure 3.1.7 Bathymetric map of the Axial Caldera
Figure 3.1.8 Bathymetric map of the Cleft segment
Figure 3.1.9 SeaBeam bathymetric map of the southern Juan de Fuca Ridge
Figure 3.1.10 Geologic features at a convergent plate boundary
Figure 3.1.11 Block diagram showing major depositional processes in oceanic forearc environments
Figure 3.1.12 Physiography of the Juan de Fuca Plate
Figure 3.1.13 Shaded relief structure contour map of the late Miocene unconformity on the central Cascadia Margin
Figure 3.1.14 Hydrate Ridge off the Oregon Coast
Figure 3.3.1 Physiography of the Cascadia Basin region
Figure 3.4.1 T-Phase events along the Juan de Fuca Ridge from 1991 to 1995
Figure 3.4.2 Nominal distribution of seismicity in the Pacific Northwest
Figure 3.4.3 Earthquake distribution in the Cascadia Subduction Zone
Figure 3.4.4 Seismic hazard map for the northeast Pacific Ocean
Figure 3.4.5 Turbidite channel systems of the Cascadia Subduction Zone
Figure 3.4.6 Estimates of tsunami inundation limits off the Oregon Coast (Nedonna Beach)
Figure 3.4.7 Estimates of tsunami inundation limits off the Oregon Coast (Rockaway Beach)
Figure 3.4.8 Estimates of tsunami inundation limits off the Oregon Coast (Pacific City)
Figure 3.4.9 Volcanic hazards in Washington and Oregon
Figure 3.4.10 Sketch of volcano hazards associated with a Cascade-type volcano

Table 3.3.1 Relationship between current strength and grain size moved into suspension
Table 3.4.1 Damaging Tsunamis in the Eastern North Pacific (1900-1998)
Table 3.4.2 Volcanic Activity in the Eastern North Pacific (1900-1998)

Section 4 – Environmental Conditions

Figure 4.1.1 January surface winds, waves, and currents along the proposed route
Figure 4.1.2 February surface winds, waves, and currents along the proposed route
Figure 4.1.3 March surface winds, waves, and currents along the proposed route
Figure 4.1.4 April surface winds, waves, and currents along the proposed route
Figure 4.1.5 May surface winds, waves, and currents along the proposed route
Figure 4.1.6 June surface winds, waves, and currents along the proposed route
Figure 4.1.7 July surface winds, waves, and currents along the proposed route
Figure 4.1.8 August surface winds, waves, and currents along the proposed route
Figure 4.1.9 September surface winds, waves, and currents along the proposed route
Figure 4.1.10 October surface winds, waves, and currents along the proposed route
Figure 4.1.11 November surface winds, waves, and currents along the proposed route
Figure 4.1.12 December surface winds, waves, and currents along the proposed route
Figure 4.2.1 Surface Currents in the North Pacific Ocean
Figure 4.2.2 Current meter data from selected moorings along the Neptune route.
Figure 4.2.3 Seasonal sea surface temperature near the Nedonna Beach and Victoria landing sites

Section 6 – Permitting

Table 6.1.1 Contact Information for possible Oregon Permitting Agencies
Table 6.2.2 Inland Permitting in British Columbia, Vancouver Island

Section 7 – Hazards and Obstructions

Figure 7.2.1 Olympic Coast National Marine Sanctuary (OCNMS) Limit

Table 7.1.1 Cables Crossed by the proposed Project NEPTUNE route
Table 7.1.2 Detailed Information on the Cables crossed by the proposed route
Table 7.1.3 Known Cable Faults in the vicinity of the NEPTUNE route
Table 7.2.1 Restricted Areas along the proposed NEPTUNE cable route
Table 7.2.2 Obstructions along the proposed NEPTUNE cable route

Section 9.1 – Nedonna Beach, Oregon

Figure 9.1.1 Extract of Oregon road map showing the landing sites visited for Project NEPTUNE
Figure 9.1.2 Sketch of the Nedonna Beach landing site
Figure 9.1.3 Sketch of the Nedonna Beach landing site with existing manholes
Figure 9.1.4 Beach profile at the Nedonna Beach landing site
Figure 9.1.5 Extract of NOAA Chart 18556 showing the location of the landing sites
Figure 9.1.6 Sketch of the Pacific City landing site
Figure 9.1.7 Relative locations of the planned Warrenton Cable Stations and possible BMHs

Oregon Photo 1 Aerial photograph of the Nedonna Beach area
Oregon Photo 2 Sign at the entrance to Nedonna Beach
Oregon Photo 3 Beach manholes on Lake Street in Nedonna Beach
Oregon Photo 4 View to the west across the right-of-way at Nedonna Beach
Oregon Photo 5 View to the north from the dune crest at the Nedonna Beach landing site
Oregon Photo 6 View to the south from the dune crest at the Nedonna Beach landing site
Oregon Photo 7 Panoramic view of the coast at Nedonna Beach
Oregon Photo 8 View of the north end of the WCI Cable Station at Nedonna Beach
Oregon Photo 9 Beach manhole at 3rd Avenue South in Rockaway
Oregon Photo 10 View to the north from the beach at Rockaway

Oregon Photo 11 View to the south from the beach at Rockaway.
Oregon Photo 12 View to the east from the beach at Rockaway
Oregon Photo 13 View toward the Pacific City landing site
Oregon Photo 14 View to the east across the beach manhole at Pacific City
Oregon Photo 15 View along the backhaul route toward the Pacific City cable station
Oregon Photo 16 View of the entrance driveway to the Pacific City cable station
Oregon Photo 17 View of the front of the Pacific City cable station
Oregon Photo 18 View to the northwest from the dune at the Pacific City landing
Oregon Photo 19 View to the south at the Pacific City landing site
Oregon Photo 20 View across the dune at Pacific City toward Pacific Avenue
Oregon Photo 21 Part of the offshore fishing fleet in Warrenton, Oregon

Table 9.1.1 Monthly Climatic Data for Astoria, Oregon

Section 9.2 – Canada

Figure 9.2.1 Extract of NOAA Chart 18465 showing the locations of the sites visited near Victoria, B.C.
Figure 9.2.2 Extract of chart CHS 3415 showing the portion of the Fleming Bay preferred landing site
Figure 9.2.3 Street map of the Victoria, B.C. area
Figure 9.2.4 Beach plan of the preferred landing site at Fleming Bay
Figure 9.2.5 Road map of the SW coast of Vancouver Island showing the route access to Bamfield
Figure 9.2.6 Extract of chart CHS 3671 showing the location of Bamfield Inlet
Figure 9.2.7 Extract of chart CHS 3646 showing details of Bamfield Inlet
Figure 9.2.8 Bamfield Marine Station Facilities Map
Figure 9.2.9 Sketch of the Bamfield Marine Station facilities at the alternate landing site
Figure 9.2.10 Victoria Harbor Traffic Scheme
Figure 9.2.11 The Location of Race Rocks Marine Protected Area

Table 9.2.1 Cable Route Length Estimates
Table 9.2.2 Inland Permitting in British Columbia, Vancouver Island
Table 9.2.3 Monthly Climatic Data for Victoria Tillicum, B.C.
Table 9.2.4 Monthly Climatic Data for Bamfield East, B.C.

Canada Photo 1 View to the north above Kinver Street at the Fleming Bay landing site
Canada Photo 2 View to the south from Kinver Street of the Fleming Bay preferred landing site
Canada Photo 3 View to the north (inland) from the beach landing site at Fleming Bay
Canada Photo 4 Panoramic view from east to southwest at the Fleming Bay Preferred landing site
Canada Photo 5 Inland panorama viewed from WNW to ENE taken from the jetty
Canada Photo 6 Panorama view from southwest to west taken from the jetty protecting Fleming Bay
Canada Photo 7 View to the east from the beach showing an unknown power cable
Canada Photo 8 View to the west of Fleming Bay showing an unknown power cable route
Canada Photo 9 The main building of the Bamfield Marine Station (BMS)
Canada Photo 10 View to the north along Bamfield Inlet towards Trevor Channel
Canada Photo 11 Viewed to the east, an aerial photo of the Bamfield Marine Station
Canada Photo 12 Panoramic view, from SW to NNW, taken from the main building at BMS
Canada Photo 13 Details of the old telegraph cable landing next to the BMH sewer outfall
Canada Photo 14 The old telegraph cable storage house at BMS shore
Canada Photo 15 Panoramic view, from WSW to NNW, at the alternate landing site in BMS
Canada Photo 16 Panoramic view inland, from east to south, showing the road access to the BMH
Canada Photo 17 Panoramic view inland, from north to east, at the main pier
Canada Photo 18 View to the SE from Taylor Road showing the proposed BMH location at Parry Bay
Canada Photo 19 View to the NW along Taylor Road from the proposed BMH at Parry Bay
Canada Photo 20 View to the west along Pedder Bay from the proposed BMH at Pearson College
Canada Photo 21 View to the north along the access ramp at the proposed BMH at Pearson College

Section 10 – Hazard Assessment

Figure 10.1.1 Bathymetry along the Victoria segment of the proposed NEPTUNE cable route
Figure 10.1.2 Risk Assessment Diagram showing potential conflict areas along the Victoria segment
Figure 10.1.3 Bathymetry along the Nedonna segment of the proposed NEPTUNE cable route
Figure 10.1.4 Risk Assessment Diagram showing potential conflict areas along the Nedonna segment
Figure 10.2.1 Bathymetry along the NEPTUNE route showing deep water areas of possible route development and risk

Section 11 – Cable Engineering

Table 11.1.1 Route Position List for the Main Ring Segment
Table 11.1.2 Route Position List for the Victoria Segment
Table 11.1.3 Route Position List for the Nedonna Segment
Table 11.1.4 Route Position List for the Plate Mid Segment
Table 11.1.5 Route Position List for the Plate North Segment
Table 11.1.6 Route Position List for the Explorer Segment
Table 11.1.7 Route Position List for the Gorda Segment
Table 11.1.8 Route Position List for the PAPA Segment
Table 11.1.9 Route Position List for the UNCLE Segment

Table 11.2.1 Straight Line Diagram for the Main Ring Segment
Table 11.2.2 Straight Line Diagram for the Victoria Segment
Table 11.2.3 Straight Line Diagram for the Nedonna Segment
Table 11.2.4 Straight Line Diagram for the Plate Mid Segment
Table 11.2.5 Straight Line Diagram for the Plate North Segment
Table 11.2.6 Straight Line Diagram for the Explorer Segment
Table 11.2.7 Straight Line Diagram for the Gorda Segment
Table 11.2.8 Straight Line Diagram for the PAPA Segment
Table 11.2.9 Straight Line Diagram for the UNCLE Segment

Section 12 – Survey Recommendations

Figure 12.1.1 Example of an alignment sheet

1. INTRODUCTION

1.1 General

On 9 October 2001 the Institute for Pacific Ocean Sciences and Technology (IPOST) informed Fugro Seafloor Surveys, Inc. (FSSI) of their intent to enter into a contract for a Desktop Study for Project NEPTUNE. Project NEPTUNE is an initiative to create the world's first large-scale, long-term deepwater observatory. The project is being orchestrated by IPOST, the University of Washington (UW), the Monterey Bay Aquarium Research Laboratory (MBARI), the Woods Hole Oceanographic Institution (WHOI) and the Jet Propulsion Laboratory (JPL) at the California Institute of Technology.

FSSI immediately commenced work on the project, which involved full route design and charting. Project NEPTUNE will be comprised of a fiber optic cable ring along the margins of the Juan de Fuca plate with two additional cables crossing the plate and four extensions. Nodes located at specific sites of scientific interest and at a spacing not to exceed 100 kilometers will be located on these cable segments. The entire system will be tied into cable landings at Victoria, British Columbia and Nedonna Beach, Oregon.

A "kick-off" meeting was held at the FSSI office in Seattle on 23 October 2001 between members of the NEPTUNE consortium and FSSI staff to discuss details of the Desktop Study. At this meeting Alan Chave of the Woods Hole Oceanographic Institution (WHOI) presented a general introduction to Project NEPTUNE and Gene Massion of the Monterey Bay Aquarium Research Institute (MBARI) presented Project MARS, a "proof of concept" predecessor for NEPTUNE. These presentations were followed by detailed discussions of plans for the desktop study. As a general principle the backbone route for NEPTUNE was designed for safety of the system while at the same time placing nodes as close as is reasonable to specific targets of scientific interest.

Figure 1.1 is an overview of the proposed Project NEPTUNE configuration overlain on a background of ETOPO2 bathymetry. The ETOPO2 data are described later in this section.

The following study provides pertinent information on seabed depths and conditions along the nine cable route segments of the NEPTUNE system, weather conditions, permitting considerations at and off the landing sites, information on existing cables, and fisheries

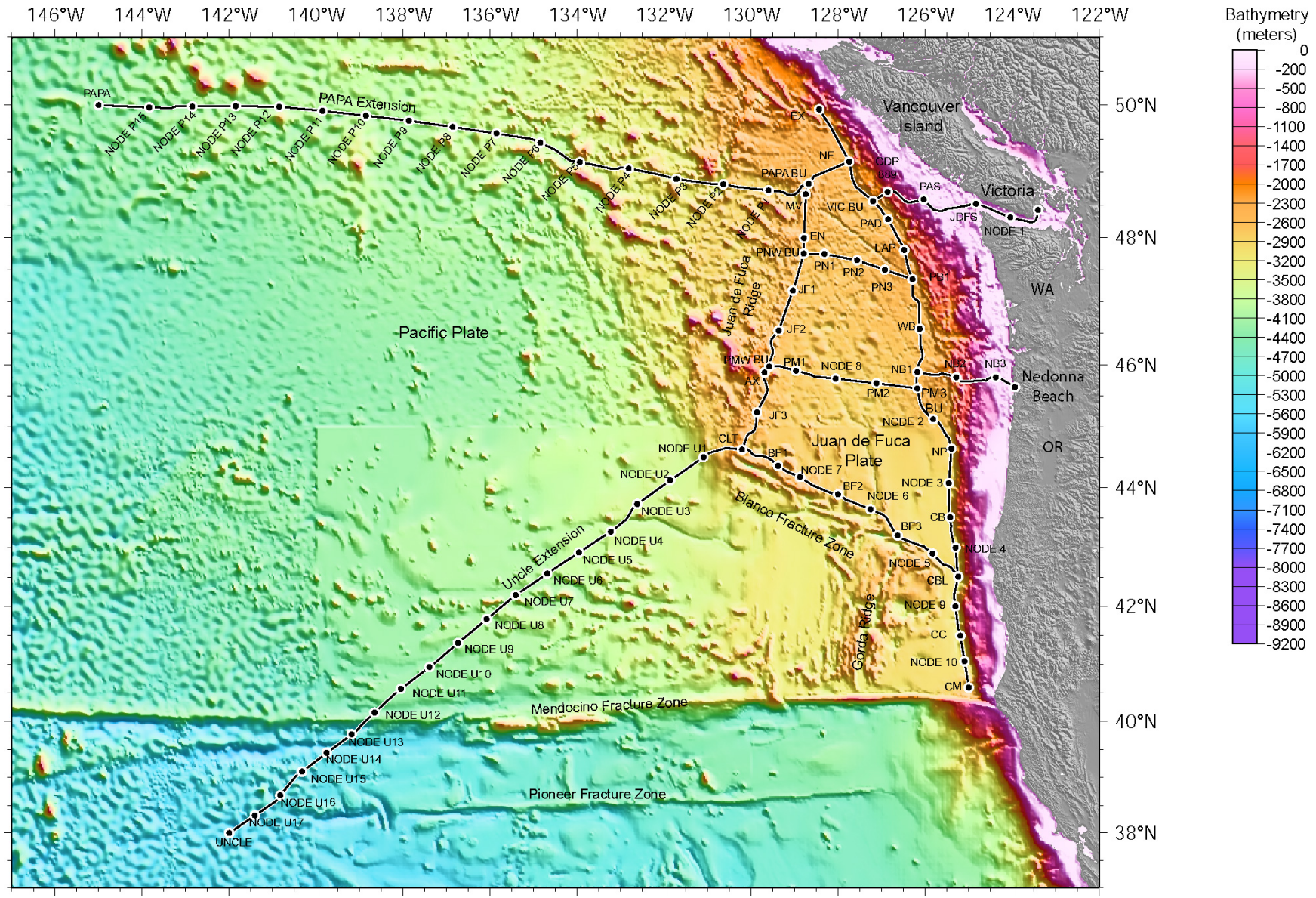

Figure 1.1 Bathymetry of the Pacific Ocean from ETOPO2 data, showing the various segments of the proposed Project NEPTUNE route (including PAPA and UNCLE extensions)

considerations. Cable engineering information is based on bathymetric charts and other data currently available at FSSI as well as data provided by our customers and is considered to be as complete as possible at this time. The proposed routes are obviously subject to modification when additional information is collected by detailed surveys of the routes.

Compilation and evaluation of regional bathymetric data was a critical aspect of the overall route design. To do this, we generated charts by placing GEBCO bathymetry contours, and where available other higher resolution bathymetry data, on a color background formed of ETOPO2 and multibeam bathymetry, so that both absolute bathymetry and finer-scale relief are delineated for design of the cable route. The data used were:

- The **GEBCO** (General Bathymetric Chart of the Oceans) 5th edition digital database was compiled from actual shipboard depth measurements integrating all sounding profiles available through the end of 1993. Through 1993, the GEBCO database assimilated over 8 million soundings, covering over 2 million nautical miles of ship tracks collected during 900 cruise legs. The data set was last revised in 1997.

- **ETOPO2** predicted 2-minute bathymetry derived from satellite altimetry data by D. T. Sandwell and W. H. F. Smith (from Sandwell and Smith, Journal of Geophysical Research, Volume 102, #B5, Pages 10,039 to 10,054, May 10, 1997). Although not actual bathymetry data, the Smith and Sandwell gravity is at a very dense (2 minute) grid and is more indicative of seafloor roughness than the GEBCO data.

- High-resolution multibeam bathymetric data synthesized for the RIDGE Project by the Lamont-Doherty Earth Observatory at Columbia University. This data covering the immediate vicinity of the Juan de Fuca and Gorda Ridges and along the Blanco Fracture Zone can be found under Northeast Pacific Ridges at: http://ocean-ridge.ldeo.columbia.edu/general/html/home.html

Some of the information provided in this report has been derived from public sources or sources available to FSSI that are not considered to be confidential. The public information may have been used, or may in the future be used, in other reports prepared by FSSI. Any information specifically collected for use in this report, such as landing site descriptions, will be considered as proprietary by FSSI and will not be made public without the specific permission of the customer.

Although a remarkable amount of information has been acquired and digested in the short available time and a great effort was made to verify information provided in this study, there is no way FSSI can guarantee that such a comprehensive study can be completely

conclusive or encompassing. This information should be used for the intended purpose, i.e. for initial planning and as a guide to assist in collecting verifiable survey data, which can be used as a basis for complete pre-installation cable engineering.

1.2 Summary of Landing Site Information

Tables 1.2.1 and 1.2.2 provide matrices of the pertinent information gathered about the Canadian and Oregon landings during the site visits. More detailed information on these sites is provided in Section 9 of this report. Since the site visit to Oregon was completed, FSSI has been informed that a new cable landing site is being planned for the area south of Astoria, Oregon. Information on this site, provided by the company planning the cable station and landing sites is provided in Section 9.

FSSI has also been informed that a recent winter storm, occurring after the site visit on 7 November, has caused severe beach erosion and damaged the infrastructure that is in place at the Nedonna Beach landing site. This includes damage or exposure of existing conduits and ground plates that were located under the beach. FSSI understands that the Oregon Parks and Recreation Department is requiring there be a permanent repair of this damage before other permits are granted for cables to land at the Nedonna Beach landing. We also understand the state is considering requiring any new cables be installed in slant drilled conduits that would be located several meters under the existing dunes and beach as they crossed the coastal area.

1.3 Risks

The greatest potential risks to any cable system are from human related activities, specifically from bottom contact fisheries and large ships' anchors. There is also a smaller danger that dumping or dredging operations could harm a cable. Natural events, such as slumps, slides and turbidity currents on steep, sediment covered slopes, and volcanic and tectonic events near the boundaries of tectonic plates are also a risk to cables.

Since about 1984, cables have been protected from bottom contact fisheries and anchors by burying them under the seafloor where possible and adding extra armor where burial is not possible. These strategies, though not 100 percent effective, have proved to be very successful. Since these human related risks are associated with shallow water areas,

FSSI recommends the NEPTUNE cable be buried wherever possible down to 1,800 meters water depth. Since it is impossible to predict the occurrence of natural events, and various segments of NEPTUNE will have to cross areas of potential danger that may occur at plate boundaries and along the continental slope, we have designed the route to minimize this danger as much as possible. This has been done by traversing as perpendicular as possible to steep slopes and avoiding, where possible, areas with potential for volcanic activity.

1.4 Recommendations

In order to find the safest possible environment for the NEPTUNE cables, a comprehensive cable route survey should be conducted along the routes suggested in this study. This survey should use a modern swath-mapping system. In depths where the cable is to be buried, to 1,800 meters depth, the mapping system should be capable of producing accurate 1 or 2 meter contours. Along with the high-resolution bathymetry survey, the route in the burial area should use high-quality side-scan sonar and subbottom profiling equipment to characterize the upper few meters of seafloor. A burial assessment survey capable of making near continuous measurements along the burial route is also strongly recommended.

In order to facilitate cable installation all survey data should be presented in an “industry standard” format.

Table 1.2.1
Summary Landing Site Information for Clatsop County, Oregon

Site Name	Nedonna Beach	Rockaway Beach	Pacific City
Landing Site Information	**Preferred Site**	**Alternative Site**	**Alternative Site**
Beach Manhole Location (BMH)	45°38.585'N - 123°56.423'W	45°36.582'N - 123°56.717'W	42°12.130'N - 123°57.964'W
Beach Manhole Status	Existing	Existing	Existing
Planned Terminal Site	WCI Nedonna Beach Terminal	WCI Nedonna Beach Terminal	PT Cable Pacific City Terminal
Beach Conditions			
Access to beach	Existing right-of-way	Existing right-of-way	Existing right-of-way
Surf conditions	<1 meter during visit, large and dangerous in winter	<1 meter during visit, large and dangerous in winter	<1 meter during visit, large and dangerous in winter
Currents	Unknown, probably strong during high surf conditions	Unknown, probably strong during high surf conditions	Unknown, probably strong during high surf conditions
Obstacles	Possible sunken logs	Possible sunken logs	Possible sunken logs
Inaccessible areas	None known	None known	None known
Other	N/A	N/A	N/A
Sediments			
At the Landing Position (LP)	Sand	Sand	Sand
Landing Pt to High water	Sand	Sand	Sand
HWL to LWL	Sand	Sand	Sand
LP to 5 m contour	Sand	Likely sand	Likely sand
LP to 10 m contour	Sand and/or gravel	Likely sand	Likely sand
Backing dunes/cliffs	Sand	Sand	Sand
Sediment movements	Unknown	Unknown	Unknown
Existing Services			
Other BMH	Existing	Existing	Existing
Other in-service cables	NorthStar and Southern Cross	TGN Pacific	NPC
Planned cable	TGN Pacific	None	None
Other retired cables	None	None	None
Existing cable station	Yes	Yes	Yes
Power	Sufficient	Sufficient	Available
Sewage	Unknown	Unknown	Unknown
Electricity substation	Yes	Yes	Yes
Water treatment plant	Unknown	Unknown	Unknown
Land ownership			
Of the LP	State of Oregon	State of Oregon	State of Oregon
Of the BMH	Tillamook County	Tillamook County	Tillamook County
Of the beach	State of Oregon	State of Oregon	State of Oregon
Restricted areas	None known	None known	Haystack Rock
Permitting Issues	Federal, State and Local Government permits required	Federal, State and Local Government permits required	Federal, State and Local Government permits required
Marine Route Issues			
Distance BMH to 20 meters contour	~600 meters	~500 meters	~1,900 meters
Distance BMH to 50 meters contour	~1,100 meters	~1,00 meters	~5,500 meters
Survey Permit and Installation Permit	Not required for US registered vessel	Not required for US registered vessel	Not required for US registered vessel
Fishing			
Vessel type	Bottom trawl for groundfish and shrimp	Bottom trawl for groundfish and shrimp	Bottom trawl for groundfish and shrimp
Fixed gears	None	None	None
Fish havens	None	None	None
Fish farms	N/A	N/A	N/A
Hydrocarbon activity			
Rigs/platforms	None	None	None
Field development	None expected	None expected	None expected
Dredging			
Mineral locations	None	None	None
Sand mining	None	None	None
Development Plans	None	None	None
Shipping			
Anchorage zones	None in immediate vicinity	None in immediate vicinity	None in immediate vicinity
Frequency/vessel size	N/A	N/A	N/A
Shipping routes	Several kilometers distant off Columbia River	Several kilometers distant off Colombia River	None in immediate vicinity
Shipping channels	None	None	None
Ports	None in immediate vicinity	None in immediate vicinity	None in immediate vicinity
Ferry	None	None	None
Development plans	None	None	None
Dump sites	~10 kilometers to south	~5 kilometers to south	None nearby
Onshore waste	None known	None known	None known
Positive Aspects	Existing landing site with existing conduits Existing cable station with space and power available Permits previously granted Back haul available to Portland	Existing landing site with existing conduits Existing cable station with space and power available Permits previously granted Back haul available to Portland	Existing landing site Existing cable station with space and power available Permits previously granted Back haul available to Portland
Negative Aspects	Proximity to existing cables	Proximity to existing cables	Proximity to existing cables

Table 1.2.2
Summary Landing Site Information for Vancouver Island, Canada

Site Name	**Fleming Bay**	**Bamfield Marine Station**
Landing Site Information	**Preferred Landing Site**	**Alternate Landing Site**
Beach Manhole Location (BMH)	48°25.262'N - 123°24.680'W	48°50.101'N - 125°08.196'W
Beach Manhole Status	Existing LEDCOR cable BMH	Proposed
Planned Terminal Coordinates	Unknown	Unknown at the time of the visit
<u>Beach Conditions</u> Beach access Surf conditions Currents Obstacles Inaccessible areas Other	 Existing right-of-way with existing cable conduits (number unknown) <1 meter during visit, usually protected in Fleming Bay Little observed during the site visit Near grass beds, possible logs and rocks None known Riprap protecting the shore line	 Existing Road access from the Marine station to the shore (no conduits) <1 meter during visit, possibly larger in winter No strong current in the area Possible rocks, existing cables None known Riprap protecting the shore line
<u>Sediments</u> At the Landing Position (LP) Landing to High Water Mark (HWM) HWL to LWL (Low water mark) LP to 5 meters contour LP to 10 meters contour Backing dunes/cliffs Sediment movements	 Gravelly sand and rocks Gravelly sand and rocks Gravelly sand, possible rocks Likely gravelly sand and rocks Likely gravelly sand and rocks N/A, beach is protected by a riprap of large rocks Unknown	 No sediment (mainly rocks) No sediment (mainly rocks) No sediment (mainly rocks) Likely mud, sand and rocks Likely mud, sand and rocks None Unknown
<u>Existing Services</u> Other BMH Other in-service cables Planned cable Other retired or scientific cables Existing cable terminal station Power cables Sewage Electricity substation Water treatment plant	 1 manhole for the Ledcor cable Ledcor None at this time 3 other cables displayed on nautical charts (not identified), 1 cable observed None Nearby 1 sewage outfall next to the BMH, and two storm drains Unknown Unknown	 None None None 3 retired telegraph cables (one observed) None At the station Several sewage outfall / pumping station Power available Unknown
<u>Land ownership</u> Of the LP Of the BMH Of the beach Restricted areas Permitting Issues	 Esquimalt Municipality, and/or Local Government Esquimalt Municipality Esquimalt Municipality, and/or Local Government None known Canadian Coast Guard, Federal Department of Fisheries and Ocean Canada, Department of Defence, Department of Natural Resources, Municipality and Private Parties and possibly others.	 Bamfield Marince Science Center (BMS) BMS BMS None known Canadian Coast Guard, Federal Department of Fisheries and Ocean Canada, Department of Defence, Local First Nations Tribes, Department of Natural Resources, Municipality, and possibly others.
<u>Marine Route Issues</u> Distance BMH to 20 meters contour Distance BMH to 50 meters contour Survey Permit and Installation Permit	 ~ 700 meters ~ 1,100 meters Canadian Coast Guard, Federal Department of Fisheries and Ocean Canada, Department of Defence, Local First Nations Tribes, Department of Natural Resources, Municipality and Private Parties.	 ~100 meters ~750 meters Canadian Coast Guard, Federal Department of Fisheries and Ocean Canada, Department of Defence, Local First Nations Tribes, Department of Natural Resources, Municipality, and possibly others.
<u>Fishing</u> Vessel type Fixed gears Fish havens Fish farms	 Essentially bottom trawl for shrimp None None N/A	 Bottom trawl for shrimp, salmon fishing Unknown Unknown Unknown
<u>Hydrocarbon activity</u> Rigs/platforms Field development	 None None expected	 None None expected
<u>Dredging</u> Mineral locations Sand mining Development plans	 None None None expected	 None None None expected
<u>Shipping</u> Anchorage zones Frequency and size of vessels Shipping routes Shipping channels Ports Ferry and Floatplanes Development plans	 Designated anchorage areas to the west of Victoria Numerous traffic to Victoria Harbor and Esquimalt Military Base Offshore Victoria Offshore Victoria Victoria and Esquimalt Numerous Unknown	 No anchorage in Trevor Channel and offshore the BMS Frequent ship transit to Port Alberni Well offshore None Port Alberni Some traffic, essentially to Port Alberni None known
<u>Dump sites</u> <u>Onshore waste</u>	2 dump sites offshore Victoria Unknown	None None
<u>Positive Aspects</u>	Existing landing site Permits for landing previously obtained for the LEDCOR cable Existing back haul	Landing located within the BMS property Existing facilities and space available at the BMS
<u>Negative Aspects</u>	Proximity of LEDCOR cable Rocky environment, no feasible ploughing in Fleming Bay	Accurate position of existing Telegraph cables is unknown (will need to be identified during the survey). Backhaul route to Victoria may be very expensive.

2. ROUTE DESCRIPTION

The most notable points in this section include:

- *The proposed route has been deviated from the original route provided by the NEPTUNE Group in areas where the cable was considered at risk. This applies in particular to sections of the Main Ring segment.*
- *A series of 10 intermediate nodes have been added along the NEPTUNE route; 24 nodes have been added to the PAPA and UNCLE routes.*
- *It is recommended the cable be buried to a water depth of 1,800 meters offshore the proposed NEPTUNE landing site and that the cable be buried to 1.0 to 1.5 meters below the seafloor, if possible,*
- *Offshore Victoria (B.C.) and Nedonna Beach, burial difficulties are expected across the continental shelf and slope, and route development work will likely be necessary during survey operations.*
- *In non-burial area, the NEPTUNE cable was designed to run in areas where the sediment thickness is thought to be sufficient.*
- *Where it may encounter steep slope gradients, the route was designed to run as perpendicular as possible to slopes, and to avoid possible area of volcanism or tectonic activity.*
- *The route avoids all natural or man-made obstructions and all restricted areas, where possible. In particular, the Victoria segment of the route avoids the Olympic Coast National Marine Sanctuary offshore Washington.*
- *Most segments of the NEPTUNE system cross existing or planned cables.*

The proposed route for the NEPTUNE cable is displayed on a series of ten charts at a scale of 1:500,000, and three overview charts of various scales (see details in Section 2.4). These charts show regional bathymetric data as a color background with selected contours, and side-scan sonar imagery data collected within the US Exclusive Economic Zone (EEZ).

The 1:500,000 charts also indicate the original positions of sites provided to FSSI that were considered to be priority sites for science. Some of these have been moved during this study. These sites and an indication of why they were moved are listed below.

Cleft	Moved off ridge crest into a more benign environment
Axial	Moved off ridge crest into a more benign environment
Endeavour	Moved off ridge crest into a more benign environment