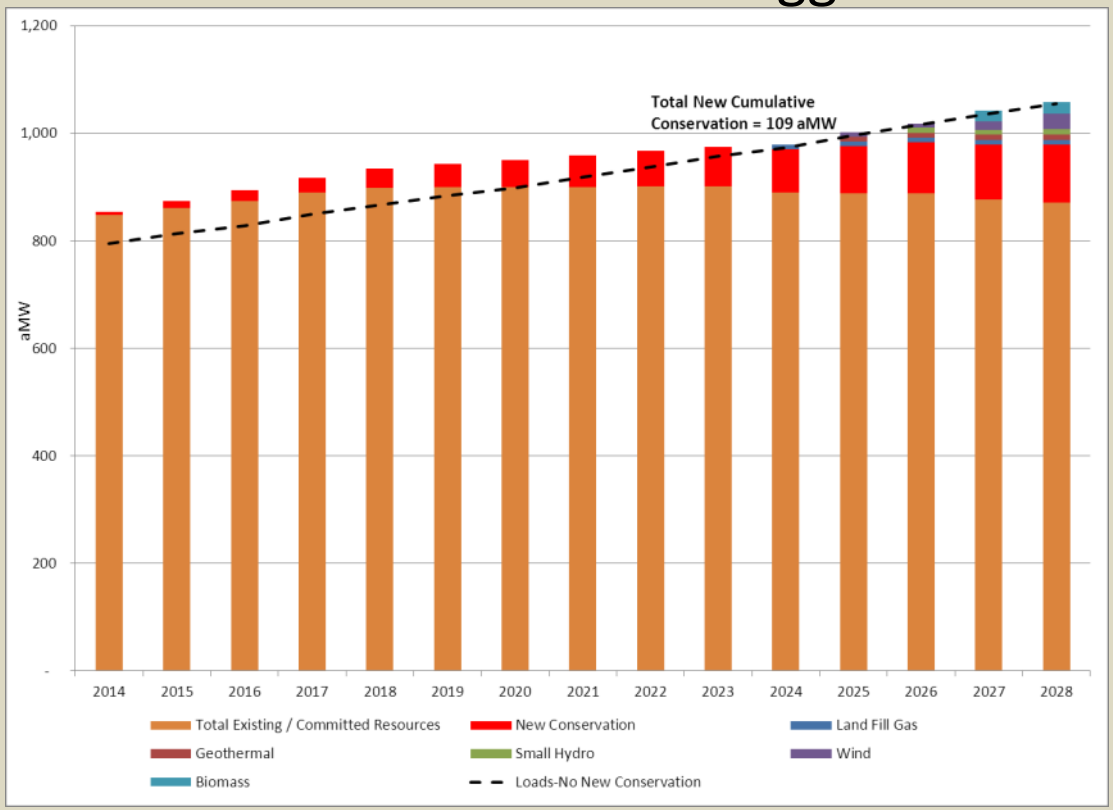
ADMIRALTY INLET PILOT TIDAL ENERGY PROJECT

SNOHOMISH PUBLIC UTILITY DISTRICT #1 – SOUND WATERS 2014

Snohomish Power Needs

- Integrated Resource Plan (IRP) – Updated October 2013
  - covers the 15-year period from 2014 - 2028
  - expected 259 aMW load growth
  - target goal of 109 aMW of new cost-effective energy efficiency
- Need for renewable resources for load that exceeds aggressive conservation effort
  - 85% supply from BPA (BPA's largest customer)
  - 9% from Market Purch
  - 6% from PUD Hydro



Tidal Energy

Why Tidal Energy?

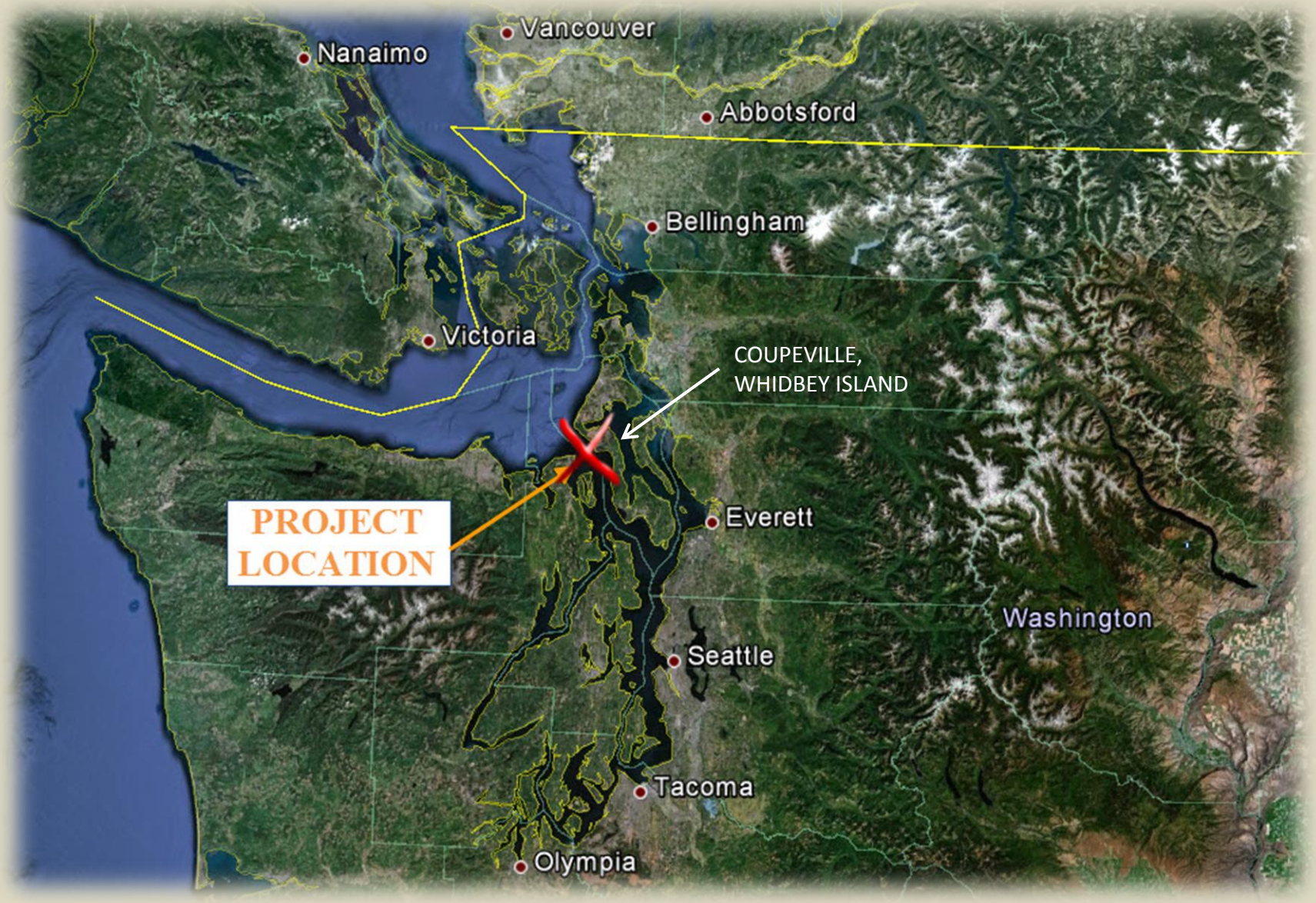
- Clean, non-greenhouse-emitting, renewable resource
- Available locally
- Meets PUD policy focus (no greenhouse gas emissions)
- I-937 “Eligible” renewable resource

Tidal Pilot Project

- **10-Year Pilot license issued by the Federal Energy Regulatory Commission (FERC)**
  - Install, operate and remove within 10-year license
  - Goal to collect 3-5 years of operational and environmental data
- **Monitoring and Data Collection**

  Objective is to generate relevant data to better evaluate the technical, economic, and environmental feasibility of tidal energy generation

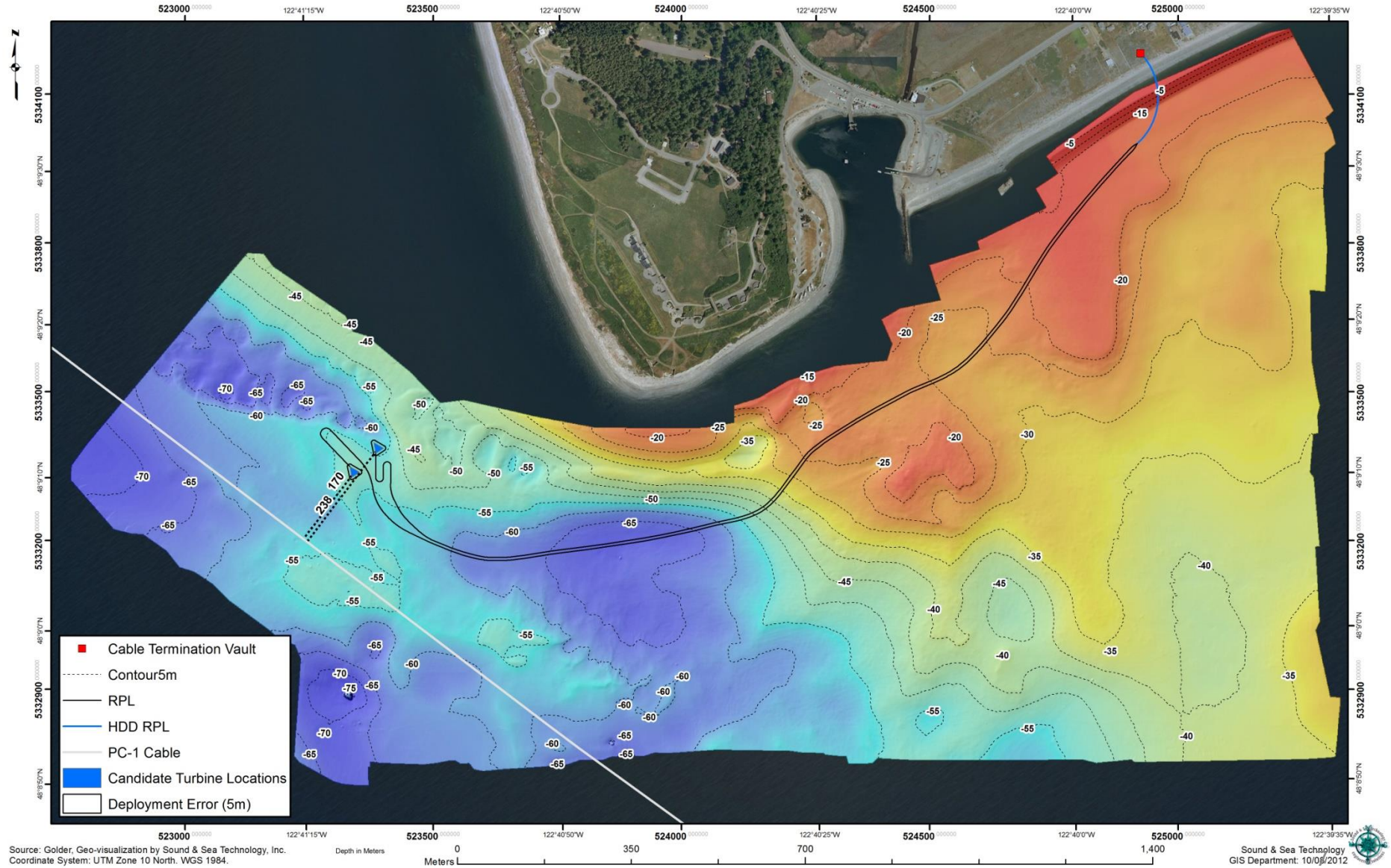
Regional Map



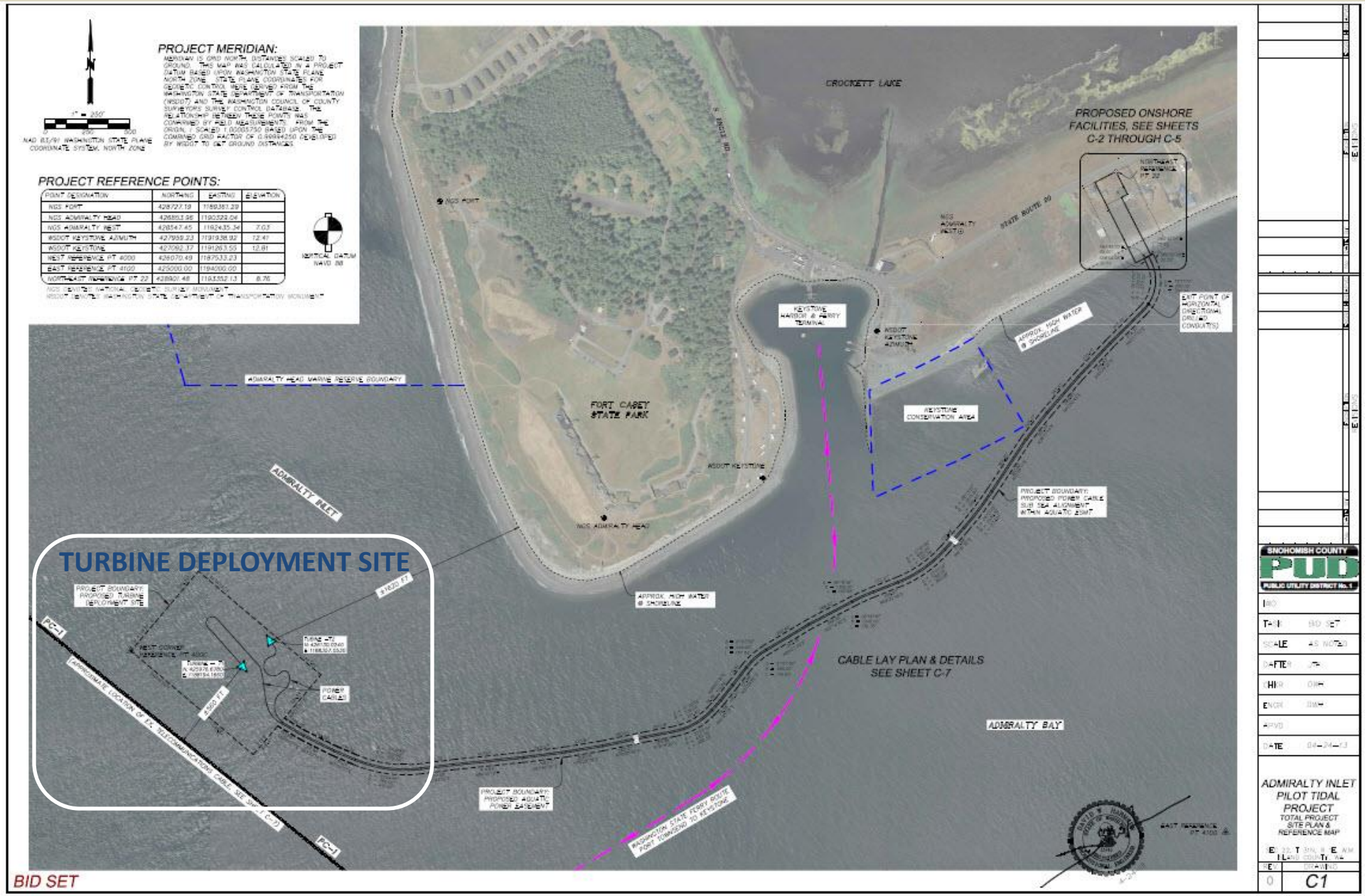
Area Map


WHIDBEY ISLAND
Coupeville
Island
Camano Island
Camano Island
PROJECT
LOCATION
Port Townsend
Greenbank

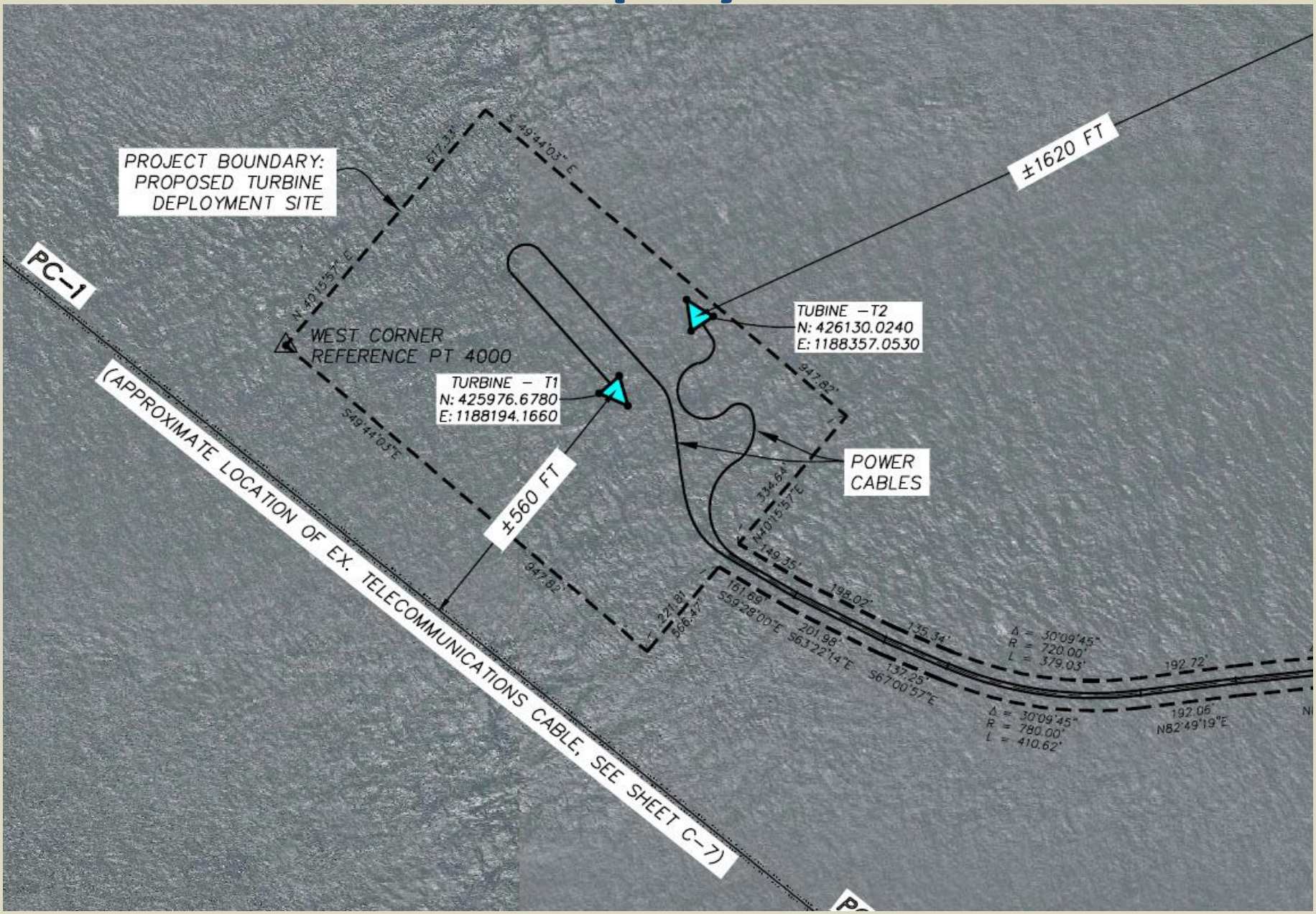
Vicinity Map



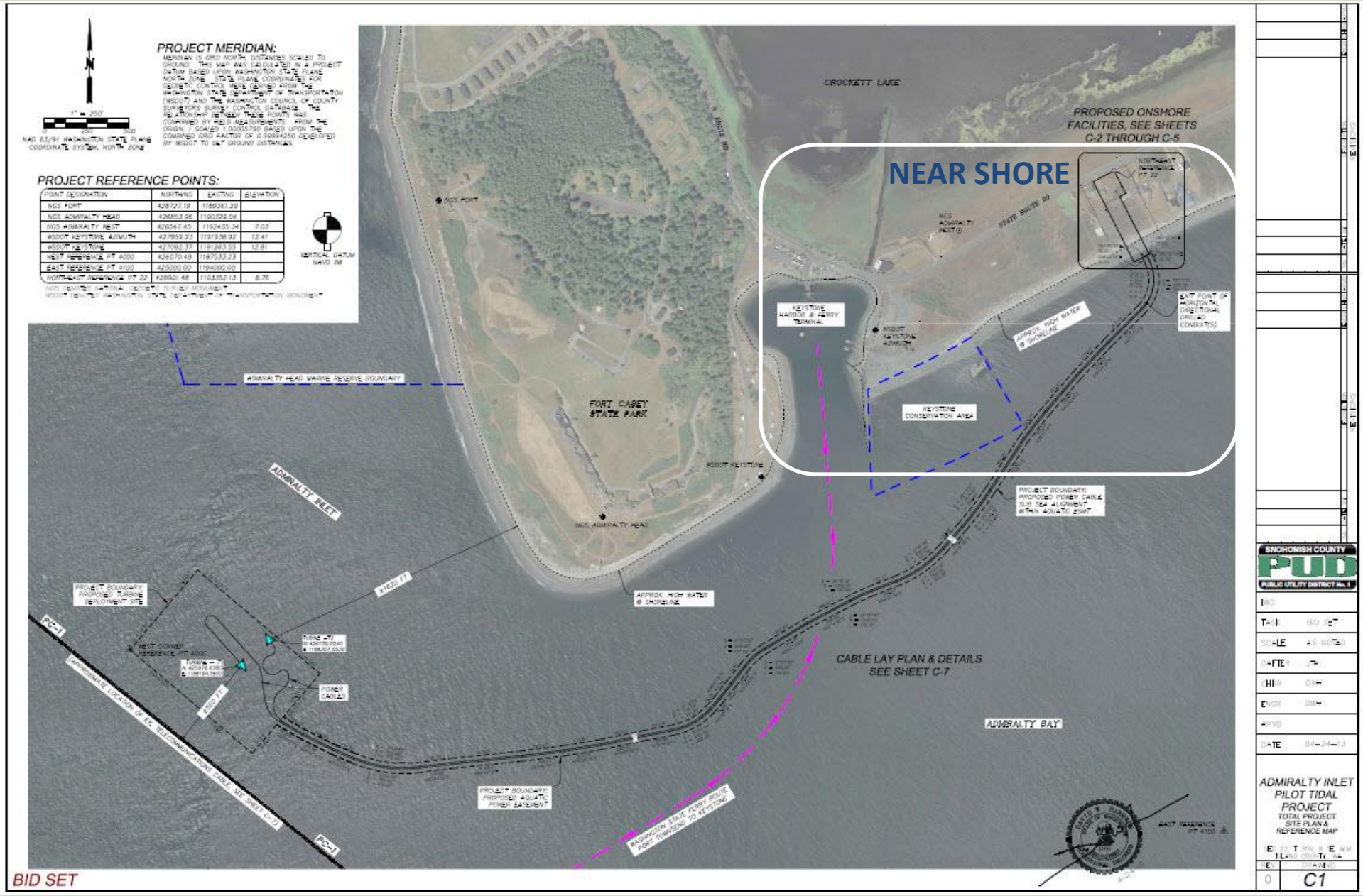
Vicinity Map



Turbine Deployment Site



Vicinity Map



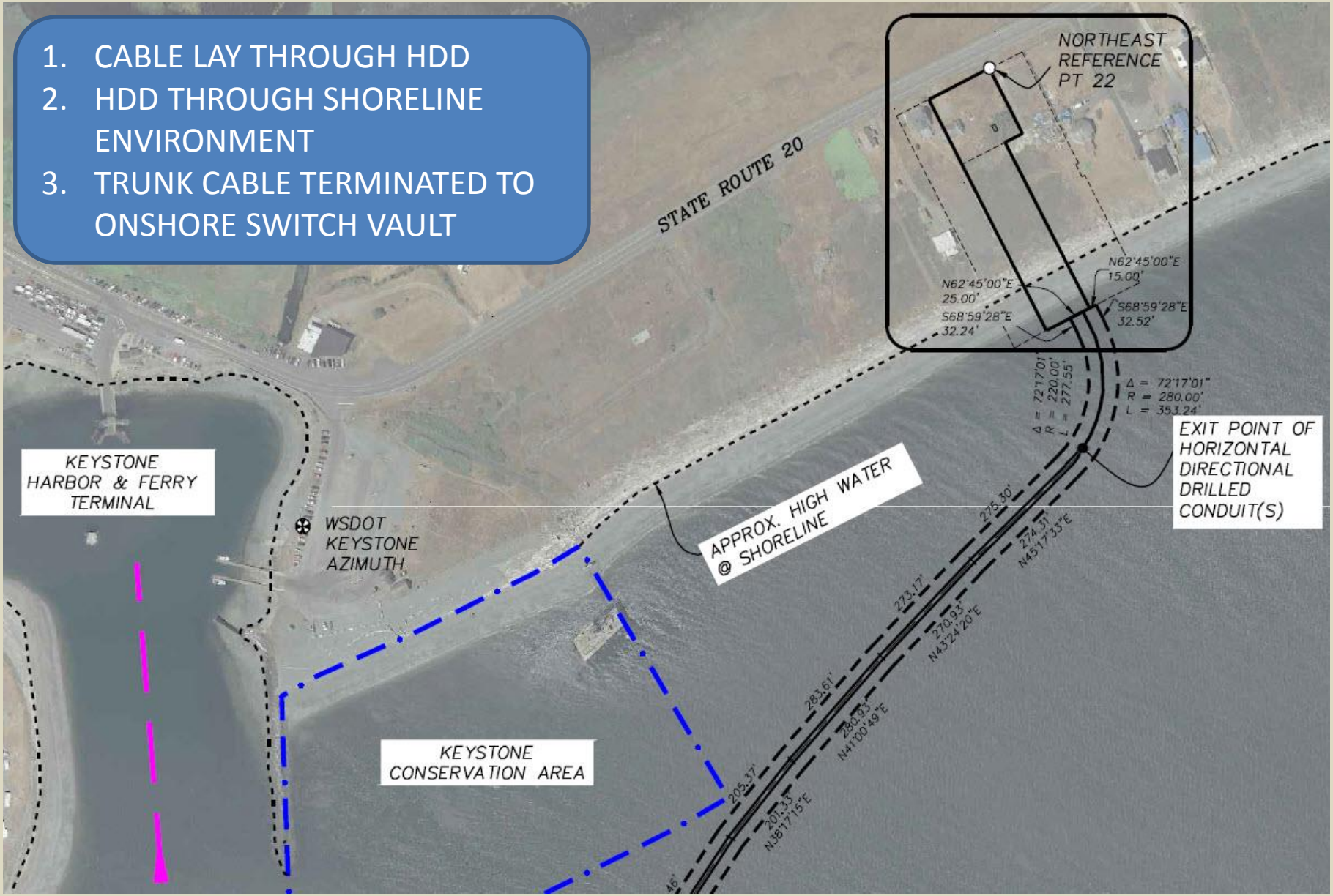
PROJECT REFERENCE POINTS:			
POINT DESIGNATION	NORTHING	EASTING	ELEVATION
NGS PORT	428727.19	1189351.29	
NGS ADMIRALTY HEAD	426851.96	1190323.04	
NGS ADMIRALTY WEST	426547.45	1192435.34	7.03
WSDOT KEYSTONE AZIMUTH	427959.23	1191938.92	12.41
WSDOT KEYSTONE	427092.37	1191263.55	12.81
WEST REFERENCE PT 4000	426070.49	1187533.23	
EAST REFERENCE PT 4100	425900.00	1194000.00	
NORTHEAST REFERENCE PT 22	428801.48	1193,552.13	8.76

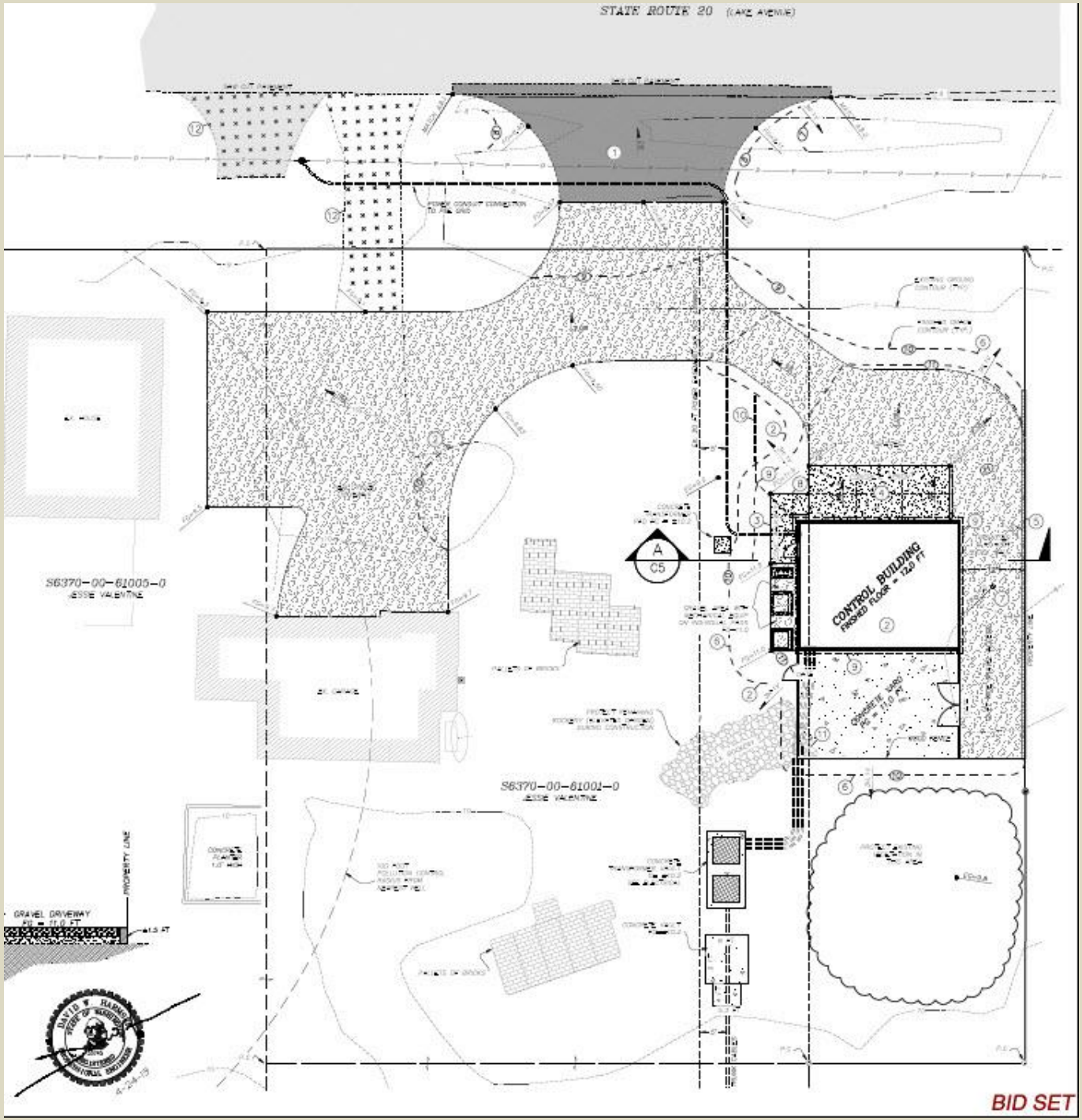
SCALE	AS NOTED
DATE	04-24-13
DRAWING	C1

ADMIRALTY INLET PILOT TIDAL PROJECT
TOTAL PROJECT SITE PLAN & REFERENCE MAP

Near Shore

1. CABLE LAY THROUGH HDD
2. HDD THROUGH SHORELINE ENVIRONMENT
3. TRUNK CABLE TERMINATED TO ONSHORE SWITCH VAULT



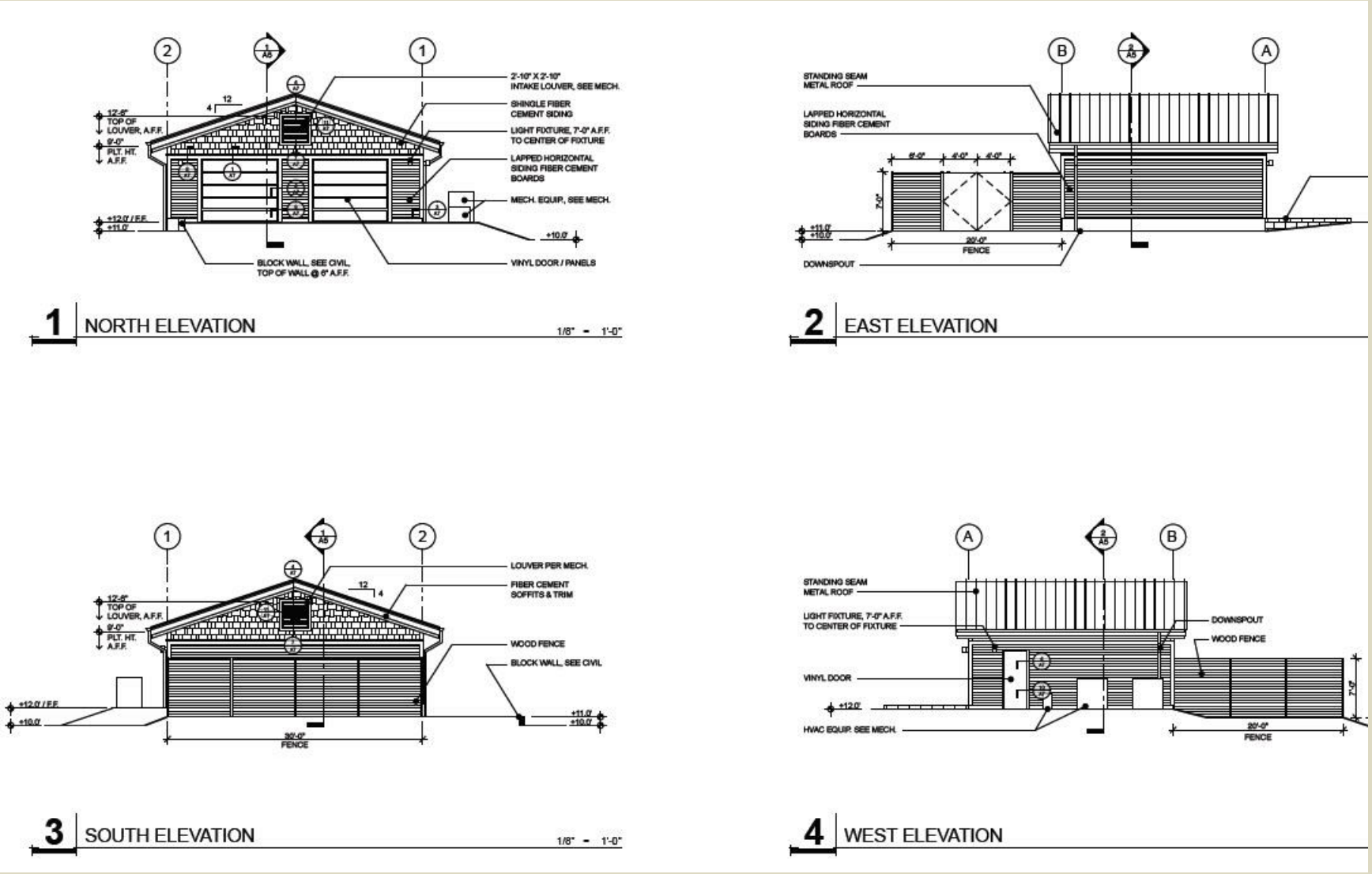


On-Shore Details

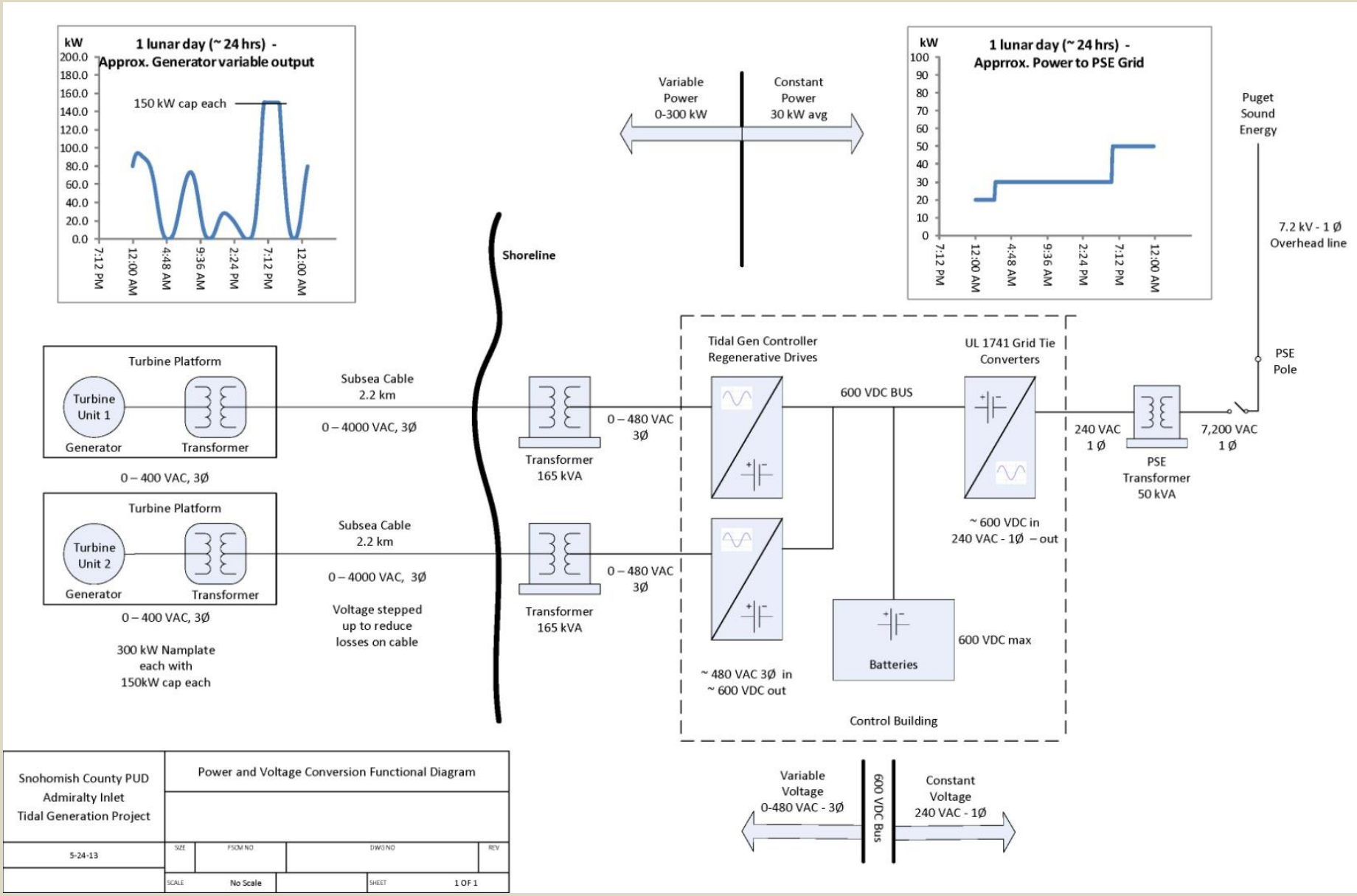
OVERVIEW

1. SWITCH VAULT
2. TRANSFORMERS
3. POWER CONTROL & CONDITIONING BLDG. (PCCB)
4. BATTERY STORAGE SYSTEM
5. GRID CONNECTION EQUIPMENT
6. CONCRETE FENCED YARD
7. GRAVEL SURFACING
8. REVISED ACCESS APRON
9. REMOVAL OF EXISTING ACCESS
10. FLOODPROOFING PER FEMA

Power Conditioning and Control Building



Functional One-Line



Snohomish County PUD Admiralty Inlet Tidal Generation Project	Power and Voltage Conversion Functional Diagram			
5-24-13	SIZE	FSCM NO	DWG NO	REV
	SCALE No Scale		SHEET 1 OF 1	

Project Permits

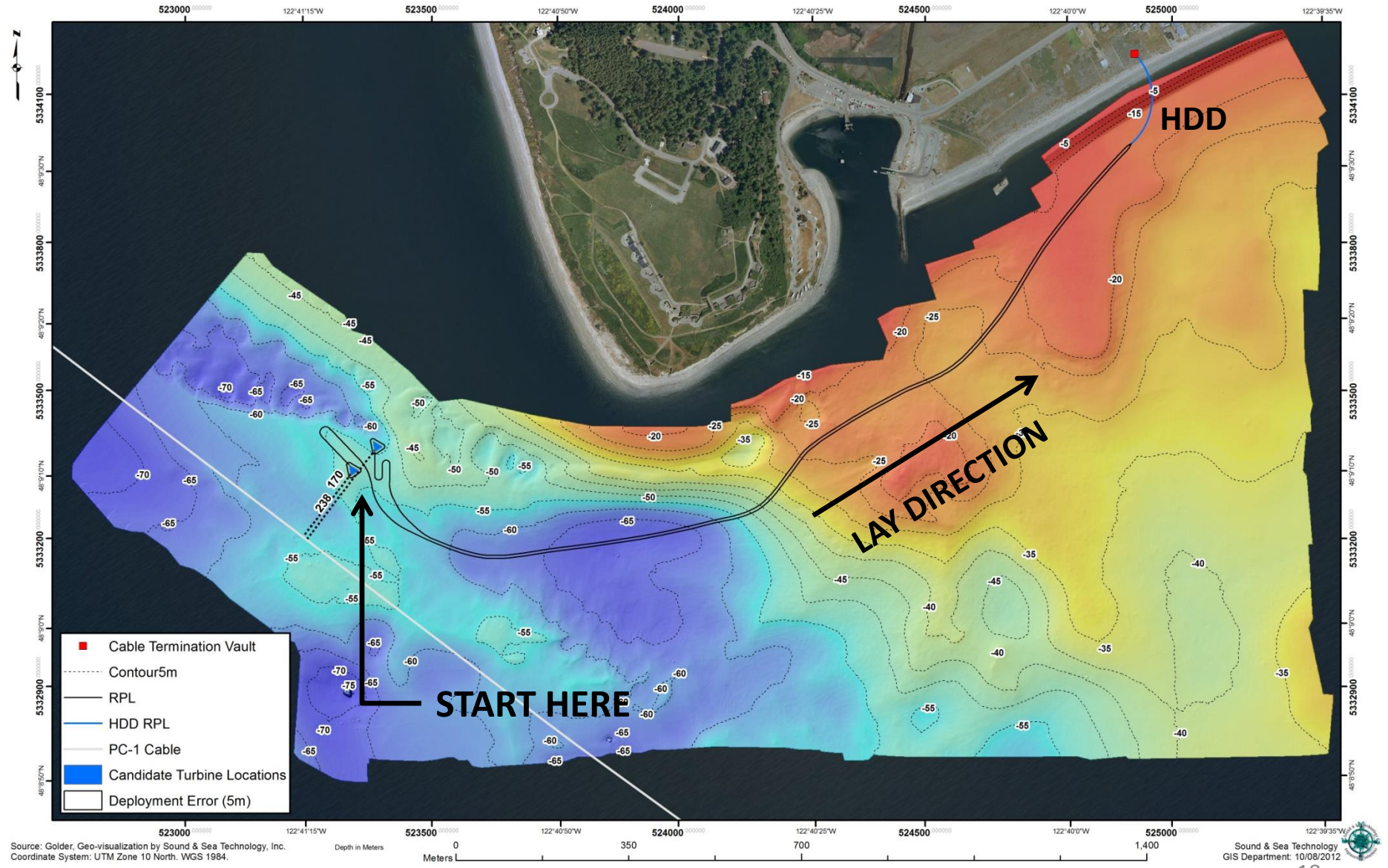
1. FEDERAL ENERGY REGULATORY COMMISSION (FERC)
2. HYDRAULIC PROJECTS APPROVAL (HPA) - WDFW
3. ISLAND COUNTY CONDITIONAL USE PERMIT (CUP)
4. ISLAND COUNTY BUILDING PERMIT
5. WASHINGTON ECOLOGY (401) – WATER QUALITY CERTIFICATE
6. NOAA FISHERIES CONCURRENCY – BIOLOGICAL ASSESSMENT
7. WASHINGTON STATE DOT (ACCESS)
8. WASHINGTON STATE DNR (AQUATIC EASEMETNS AND LEASES)

Construction

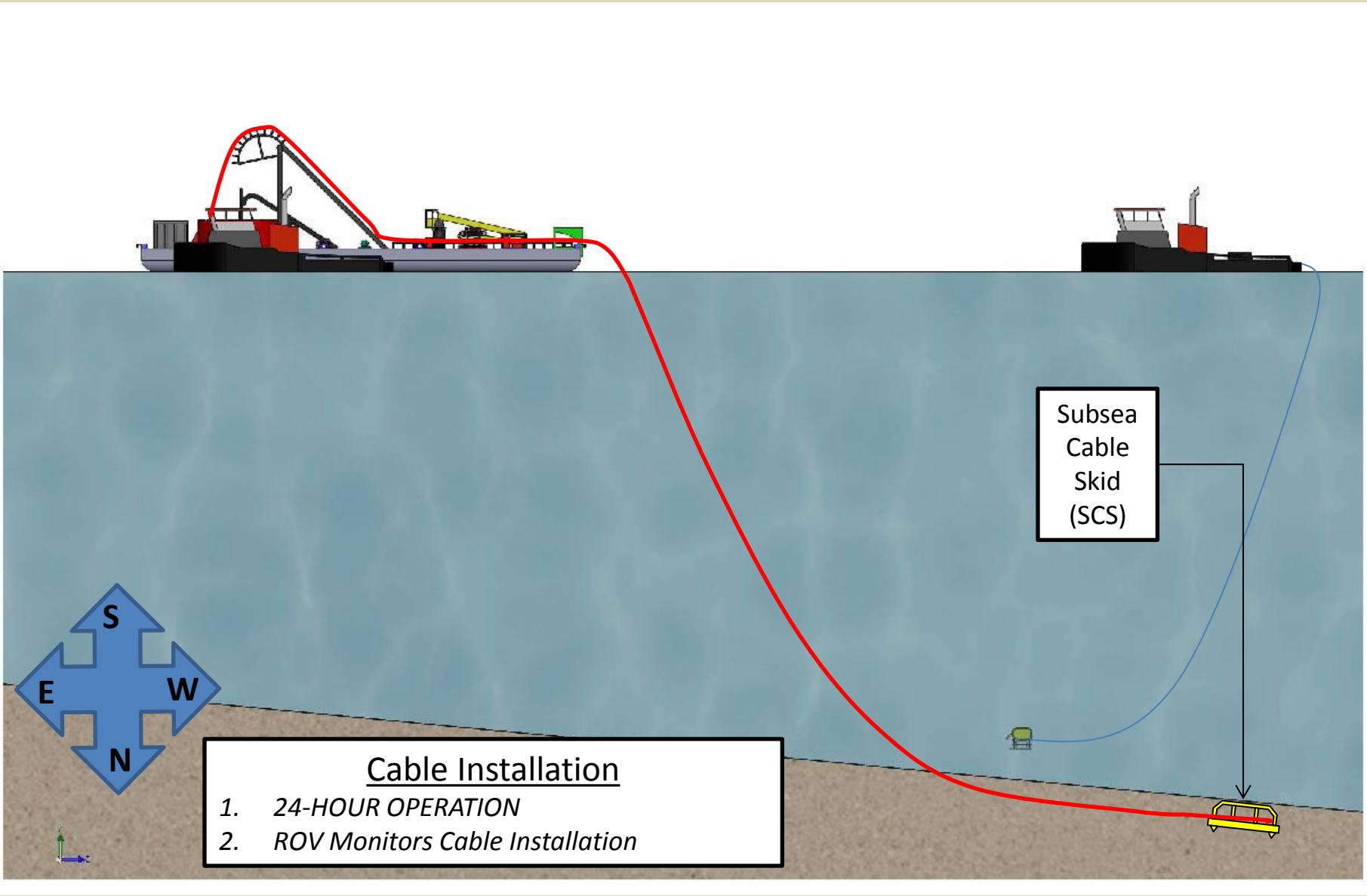
- Marine Operations effectively separated into 3-discrete operations with limited coordination:
    - Cable Installation (Qty-2)
    - Turbine Deployment (Qty-2)
    - Cable Connection (Qty-2)

Cable Installation

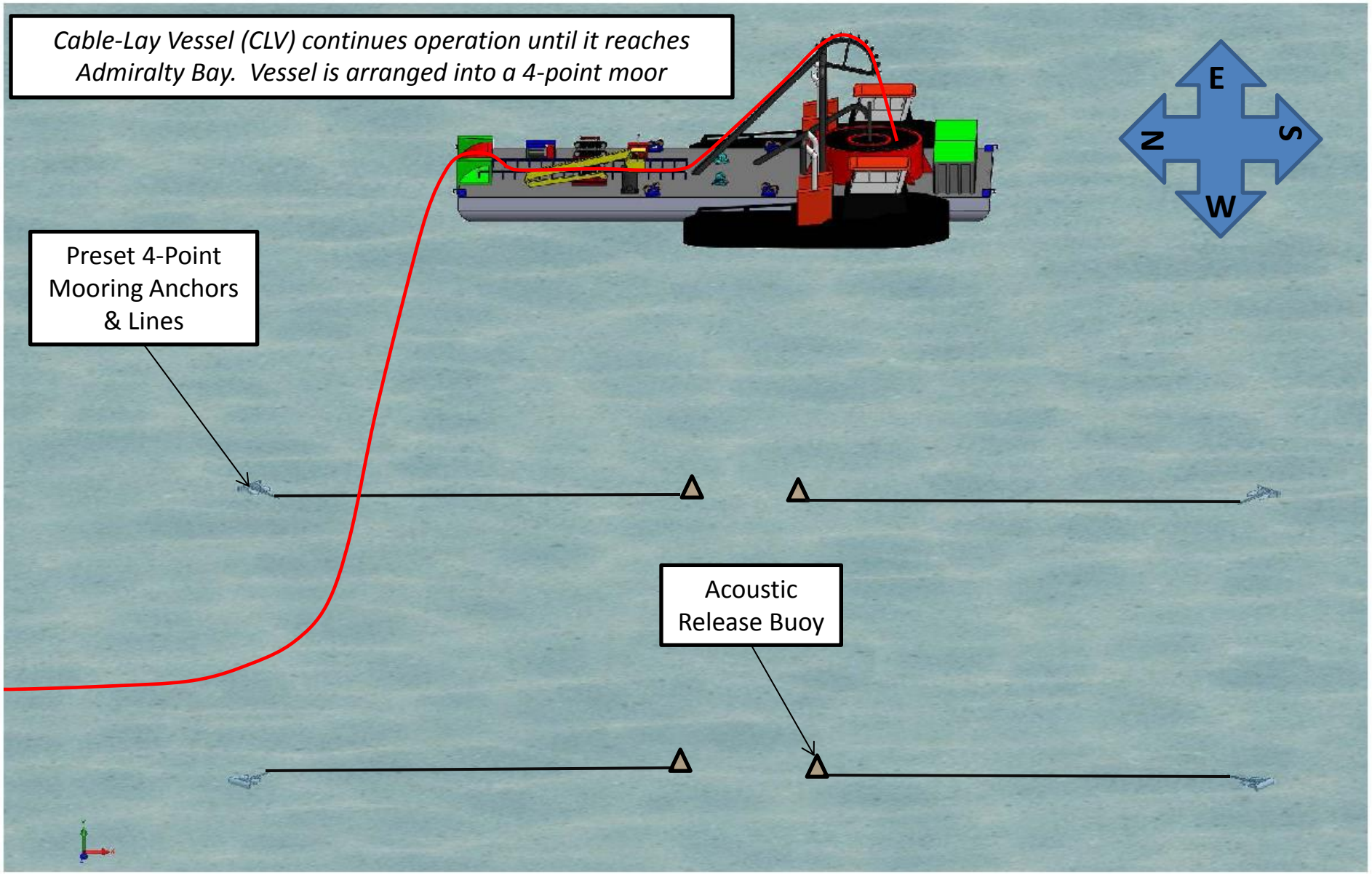
Cable Installation



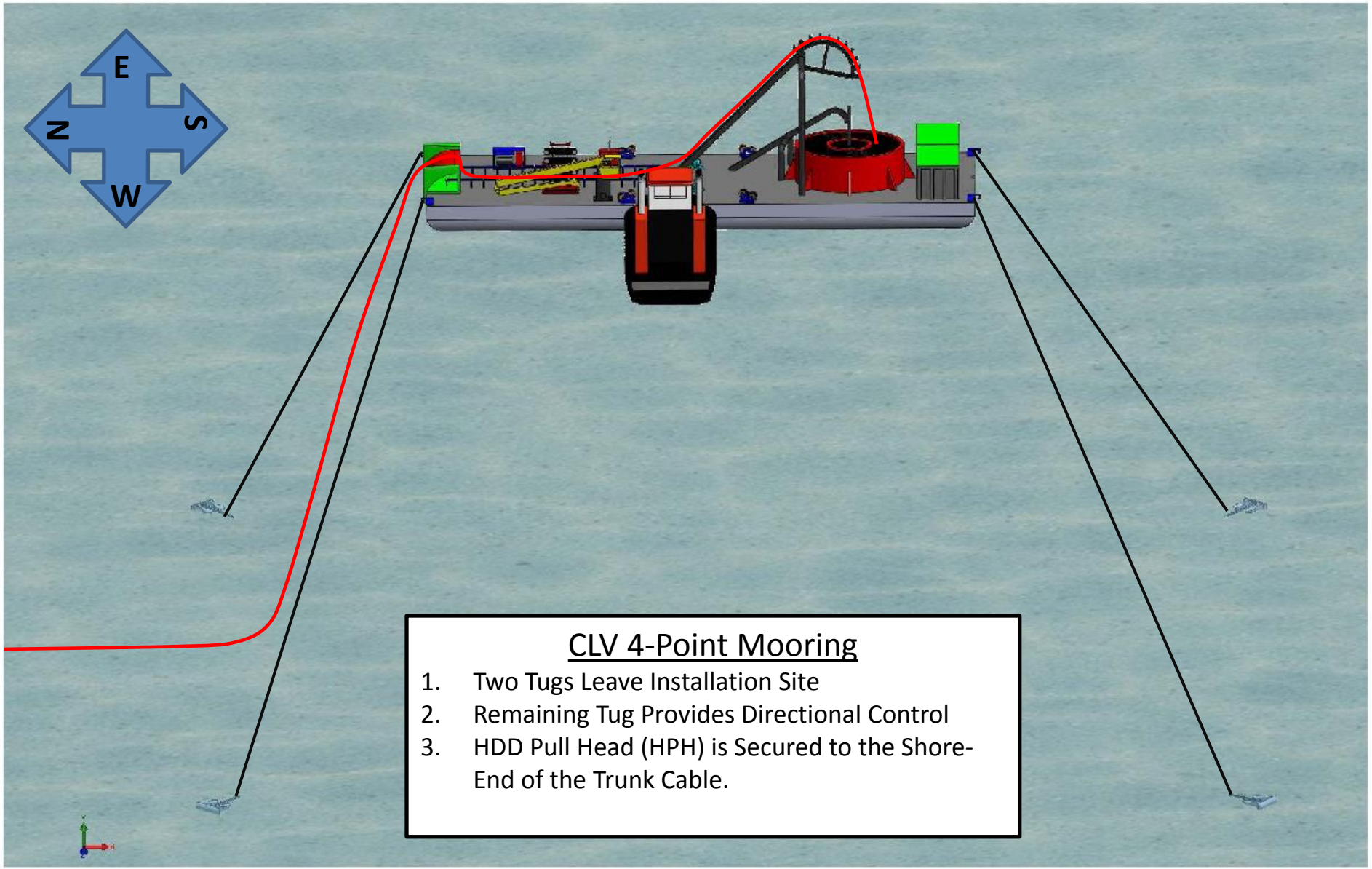
Cable Installation Concept



Cable Installation Concept



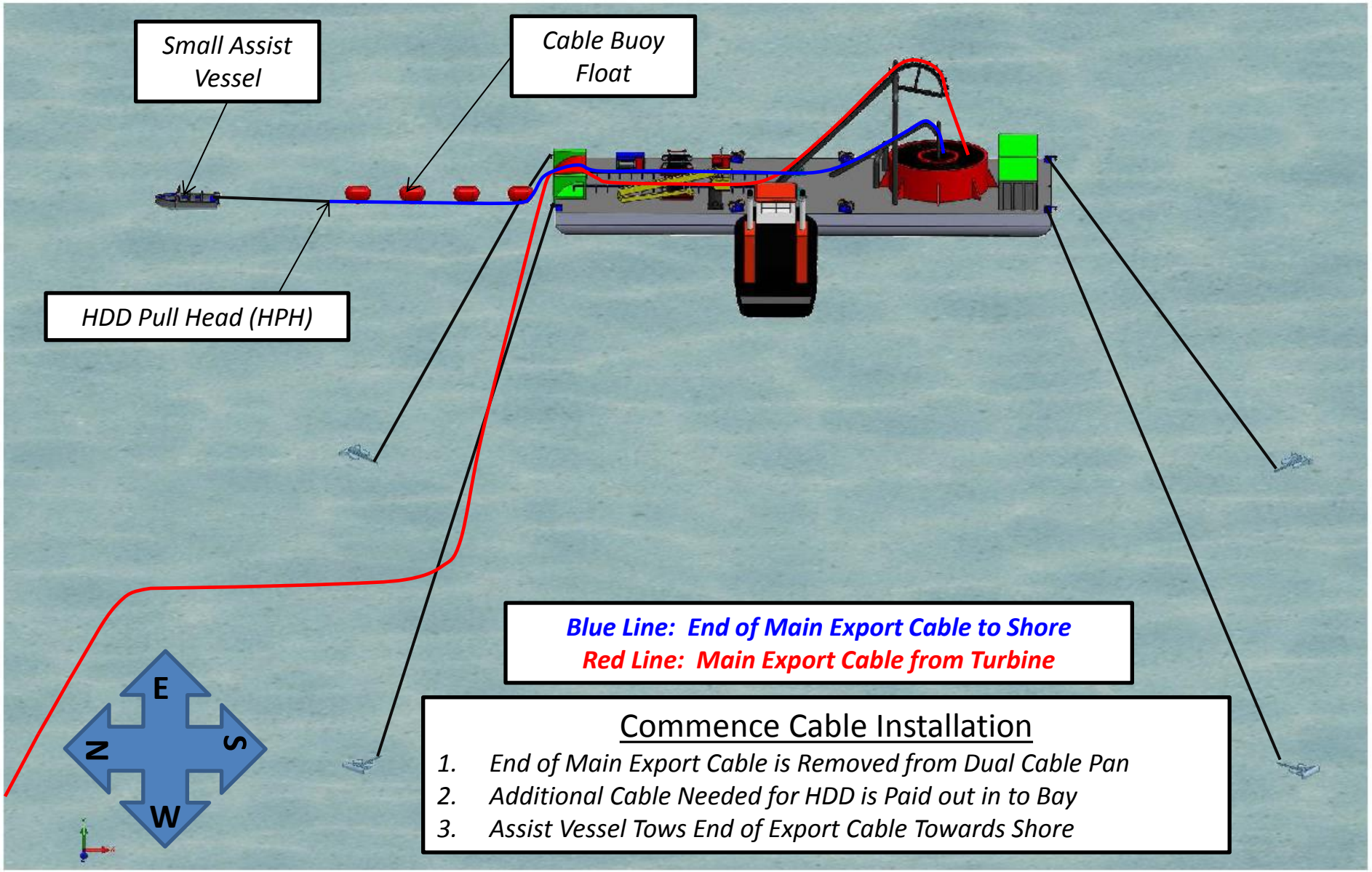
Cable Installation Concept



CLV 4-Point Mooring

1. Two Tugs Leave Installation Site
2. Remaining Tug Provides Directional Control
3. HDD Pull Head (HPH) is Secured to the Shore-End of the Trunk Cable.

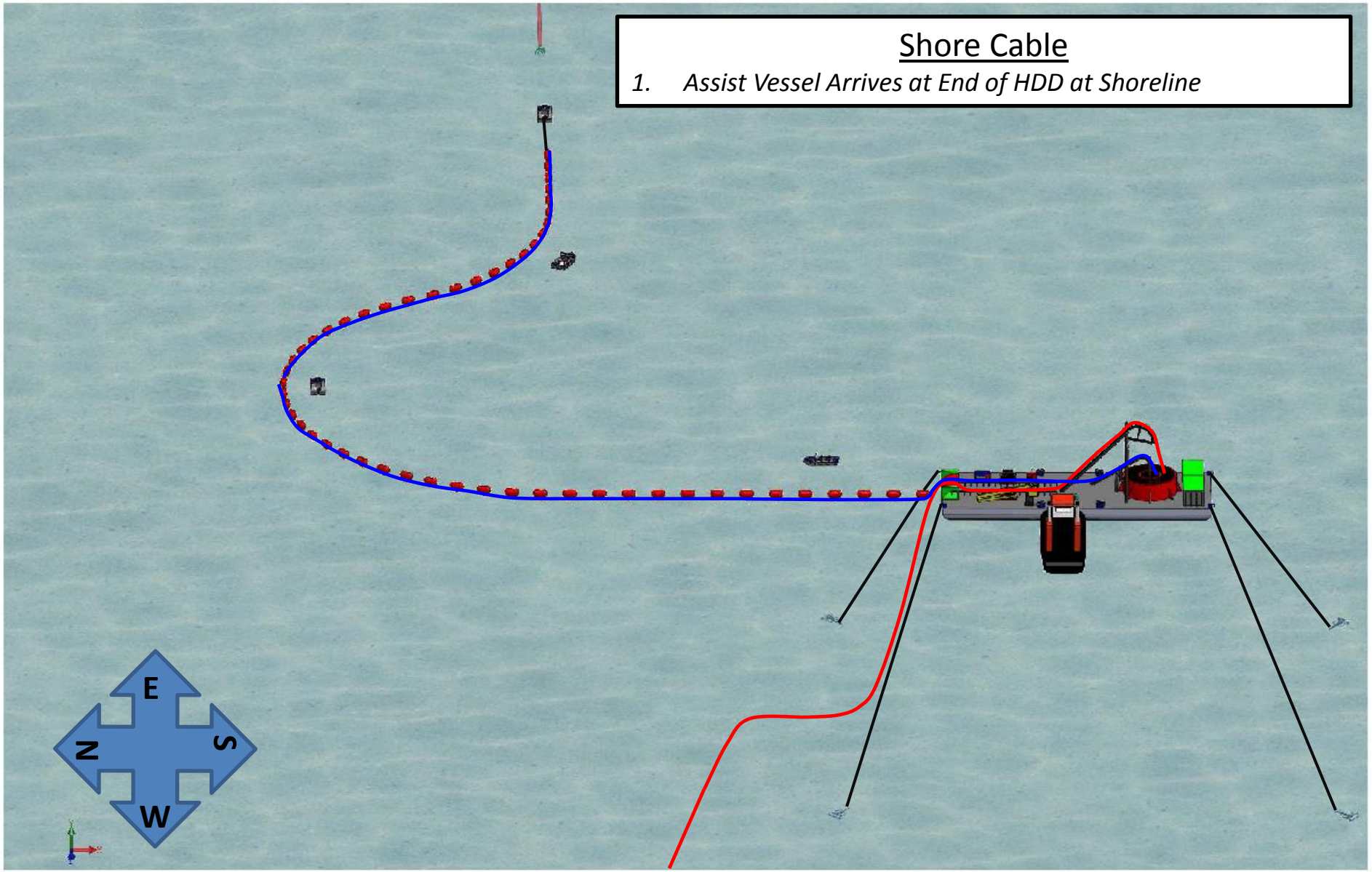
Cable Installation Concept



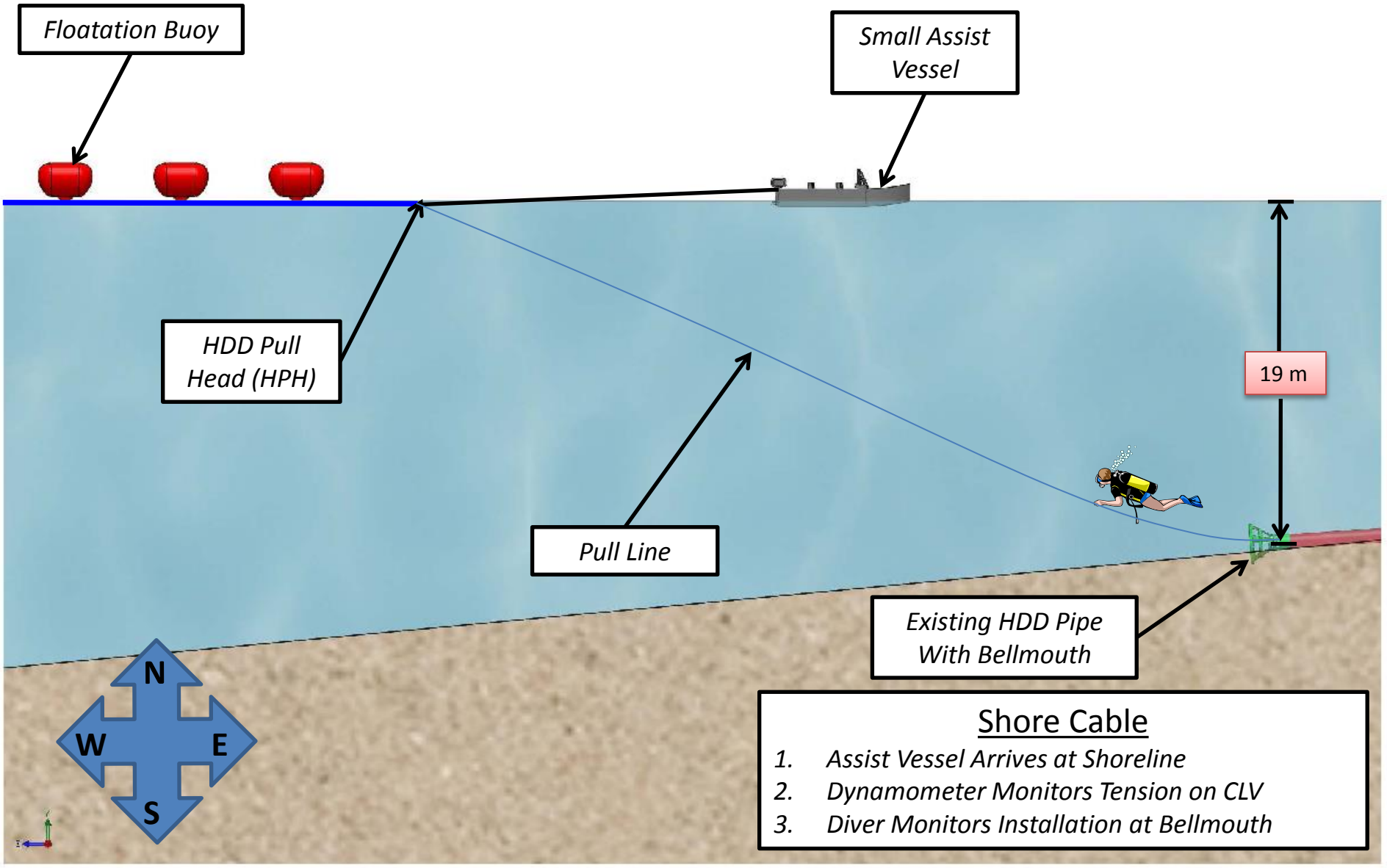
Commence Cable Installation

1. *End of Main Export Cable is Removed from Dual Cable Pan*
2. *Additional Cable Needed for HDD is Paid out in to Bay*
3. *Assist Vessel Tows End of Export Cable Towards Shore*

Cable Installation Concept



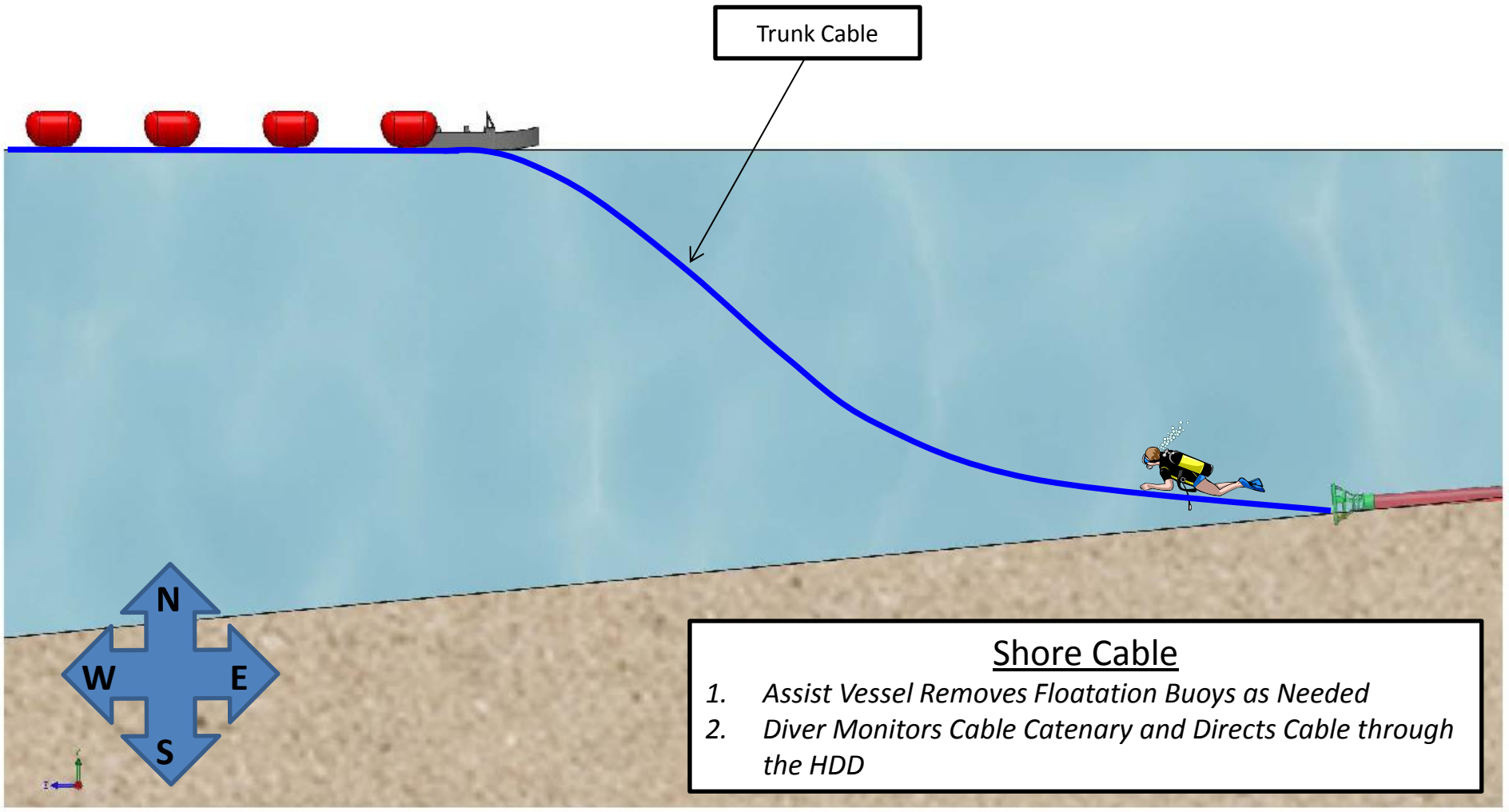
Cable Installation Concept



Shore Cable

1. *Assist Vessel Arrives at Shoreline*
2. *Dynamometer Monitors Tension on CLV*
3. *Diver Monitors Installation at Bellmouth*

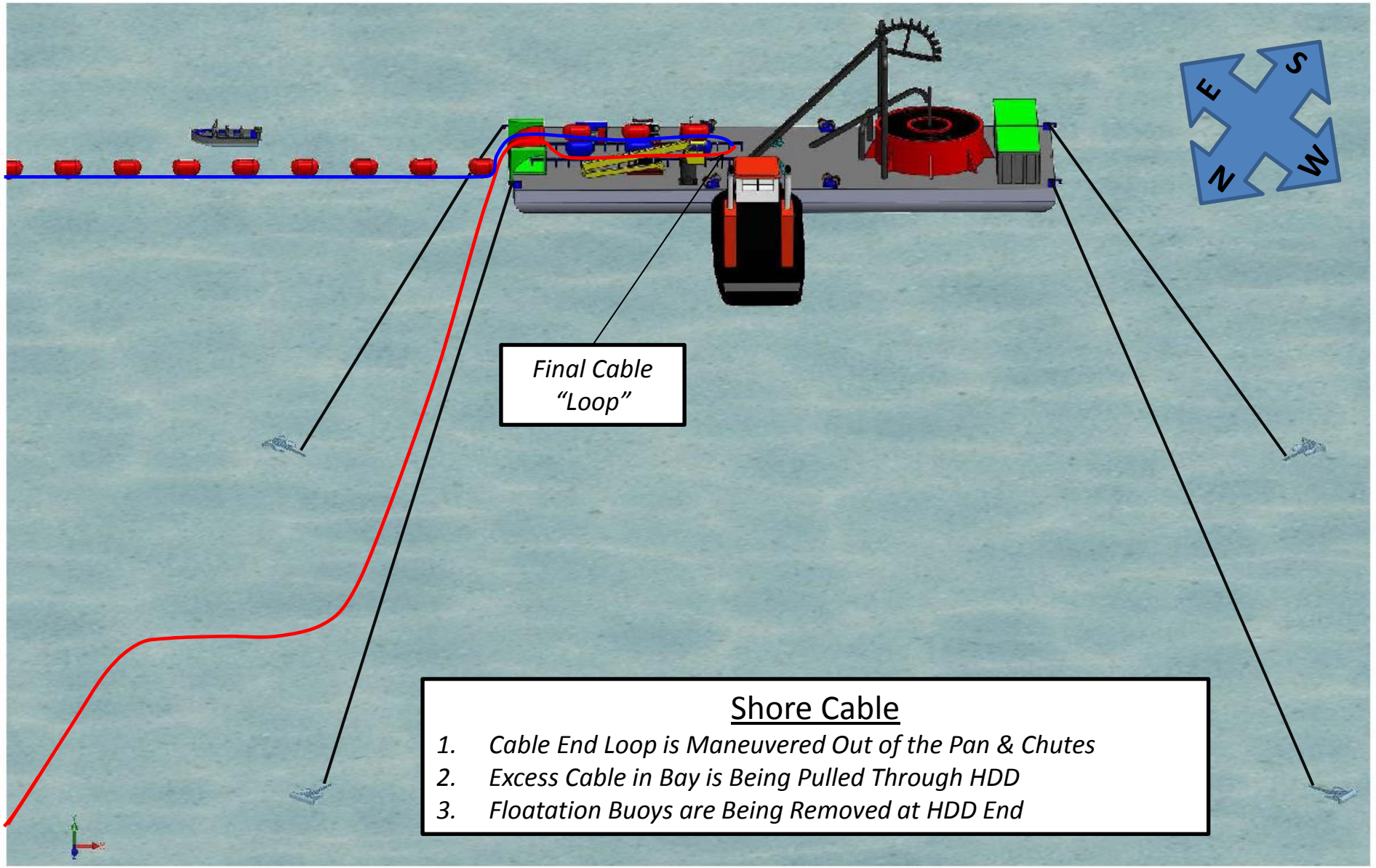
Cable Installation Concept



Shore Cable

1. *Assist Vessel Removes Floatation Buoys as Needed*
2. *Diver Monitors Cable Catenary and Directs Cable through the HDD*

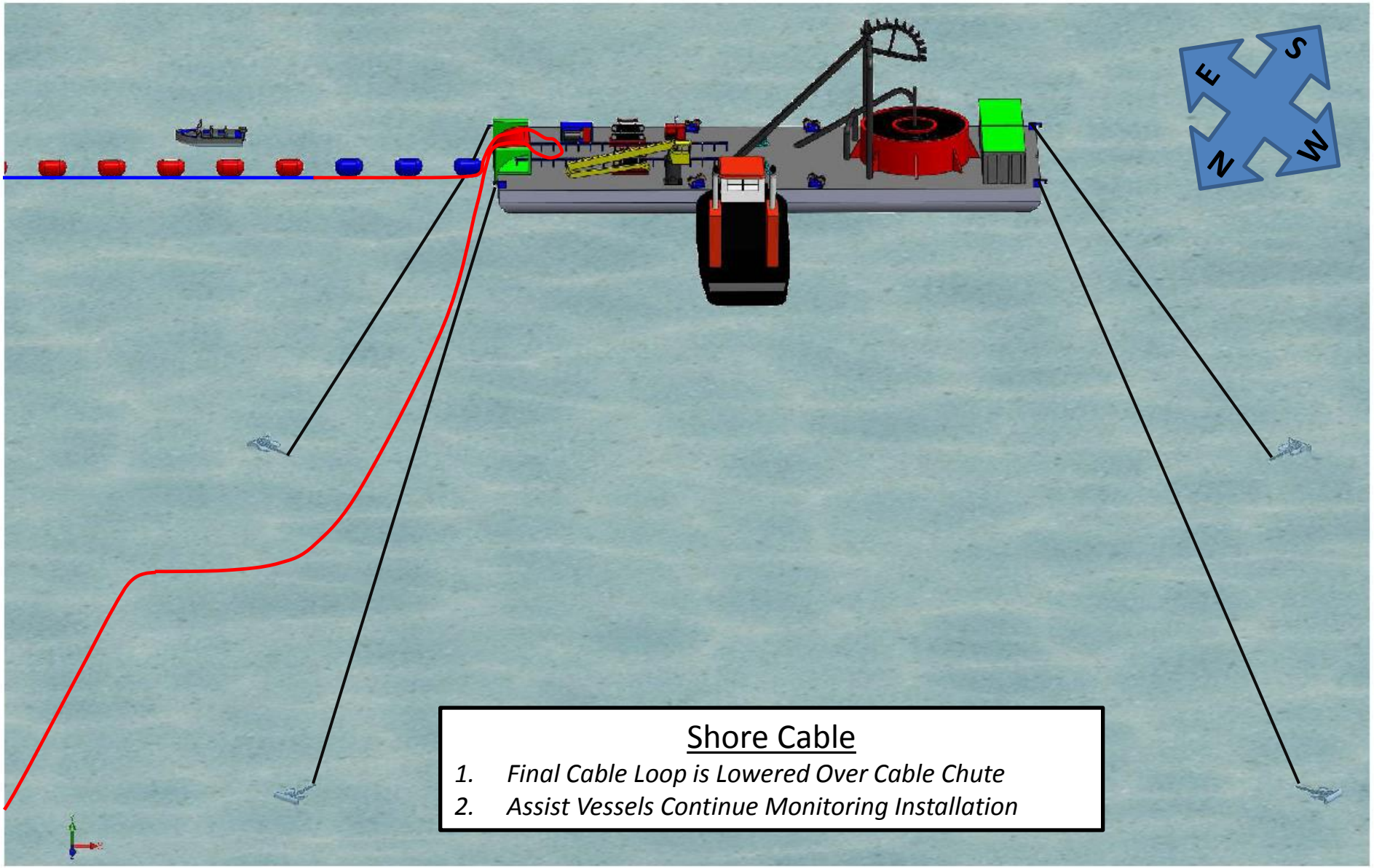
Cable Installation Concept



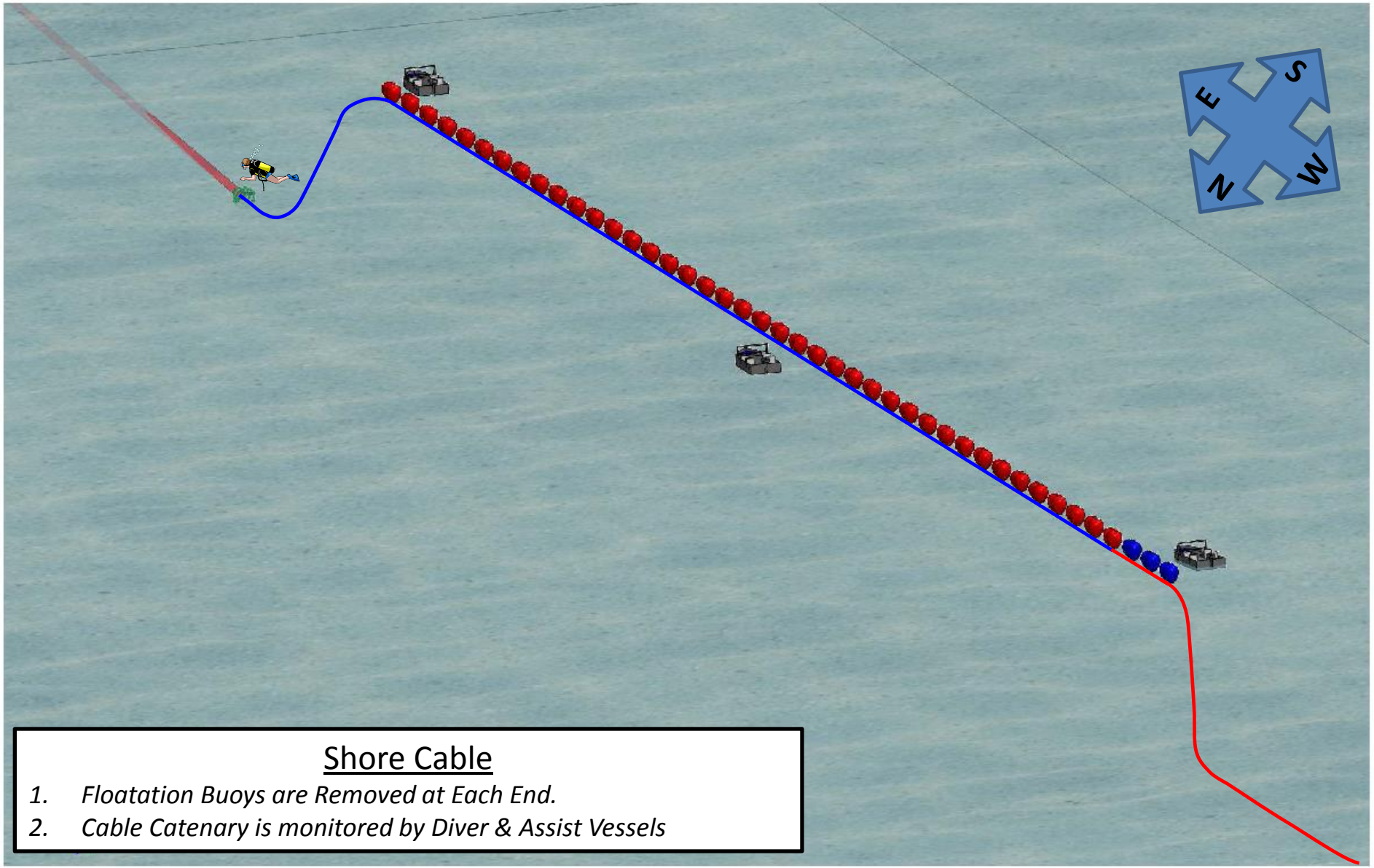
Shore Cable

1. *Cable End Loop is Maneuvered Out of the Pan & Chutes*
2. *Excess Cable in Bay is Being Pulled Through HDD*
3. *Floatation Buoys are Being Removed at HDD End*

Cable Installation Concept



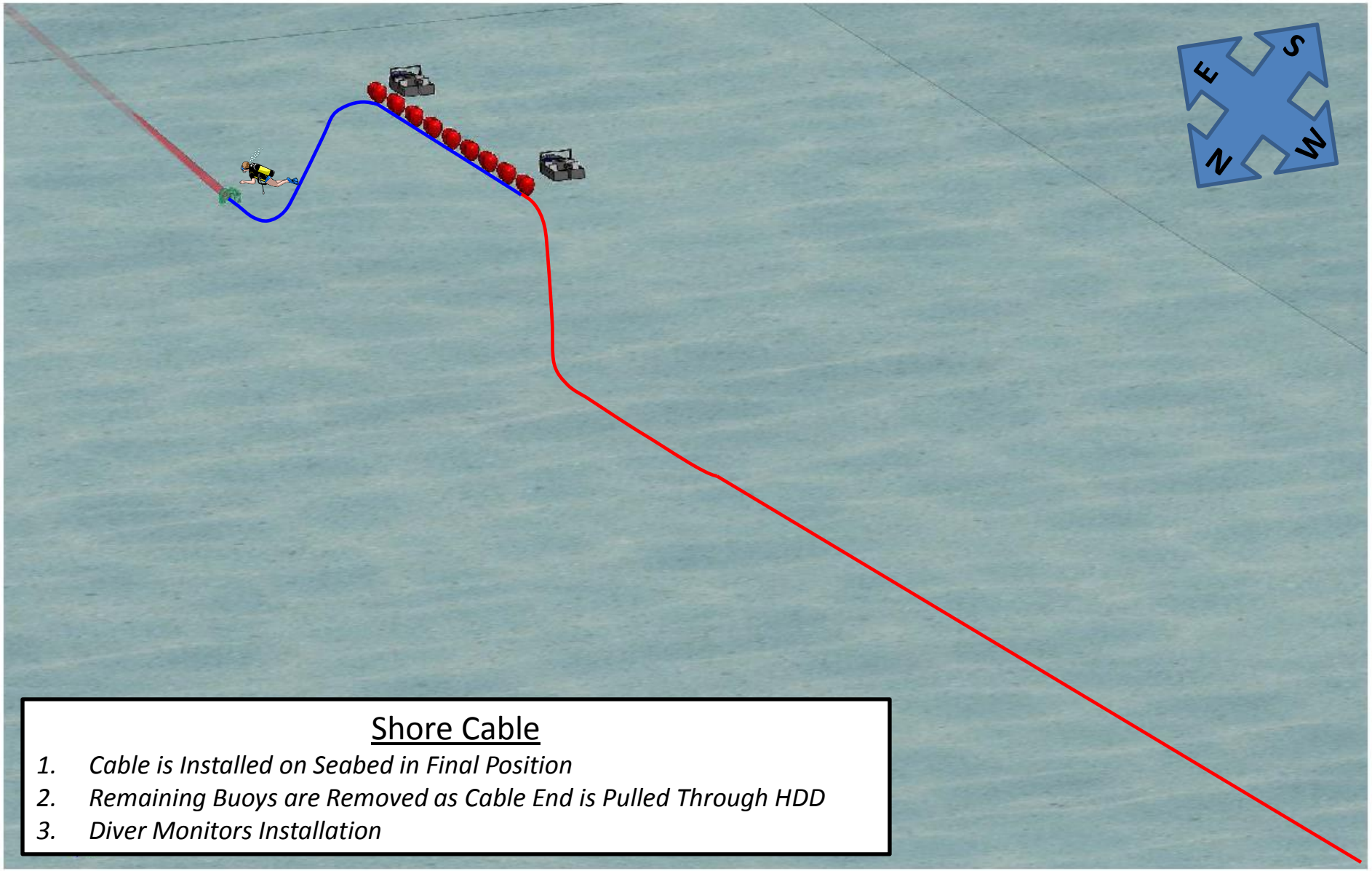
Cable Installation Concept



Shore Cable

1. *Floatation Buoys are Removed at Each End.*
2. *Cable Catenary is monitored by Diver & Assist Vessels*

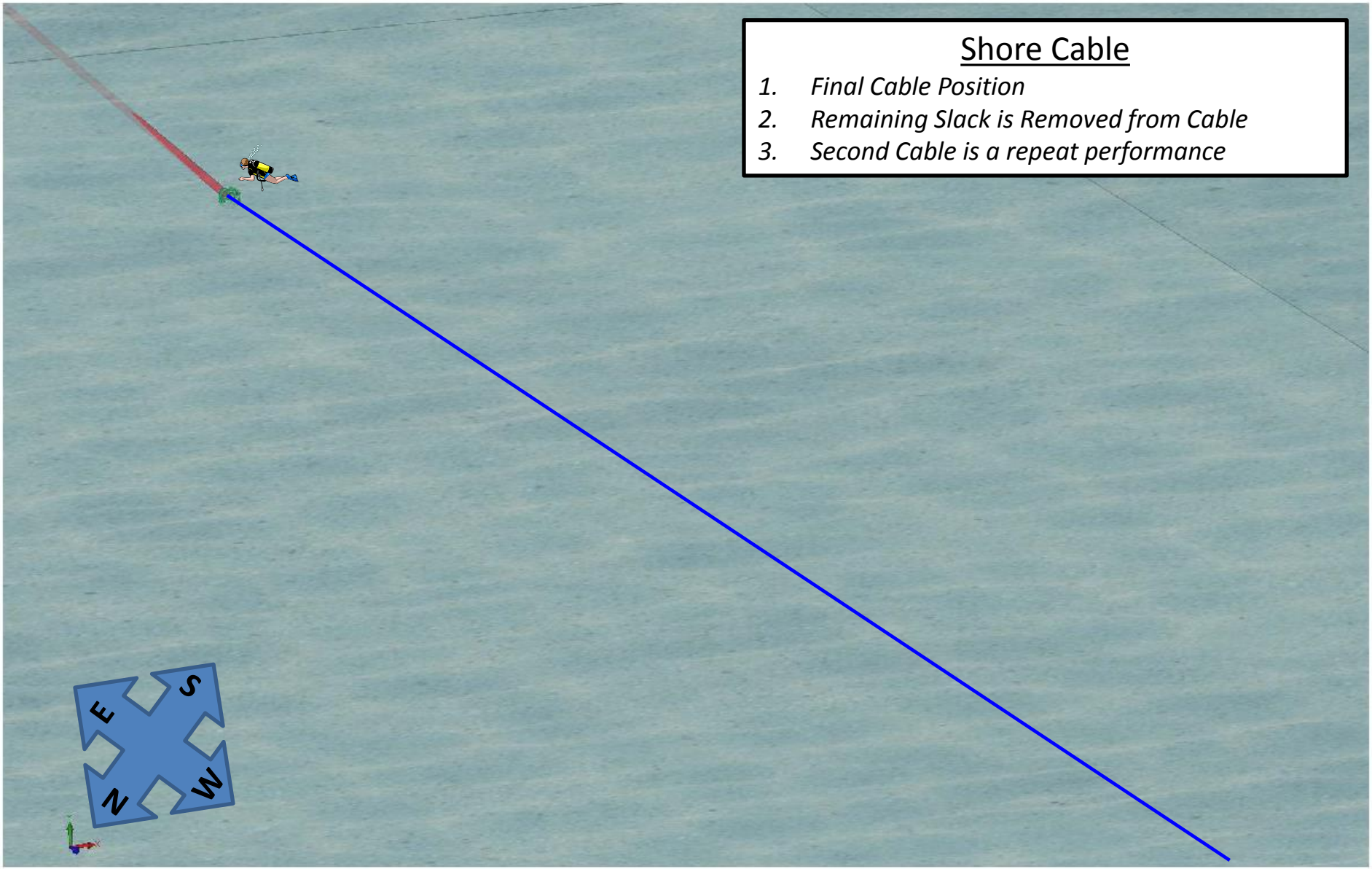
Cable Installation Concept



Shore Cable

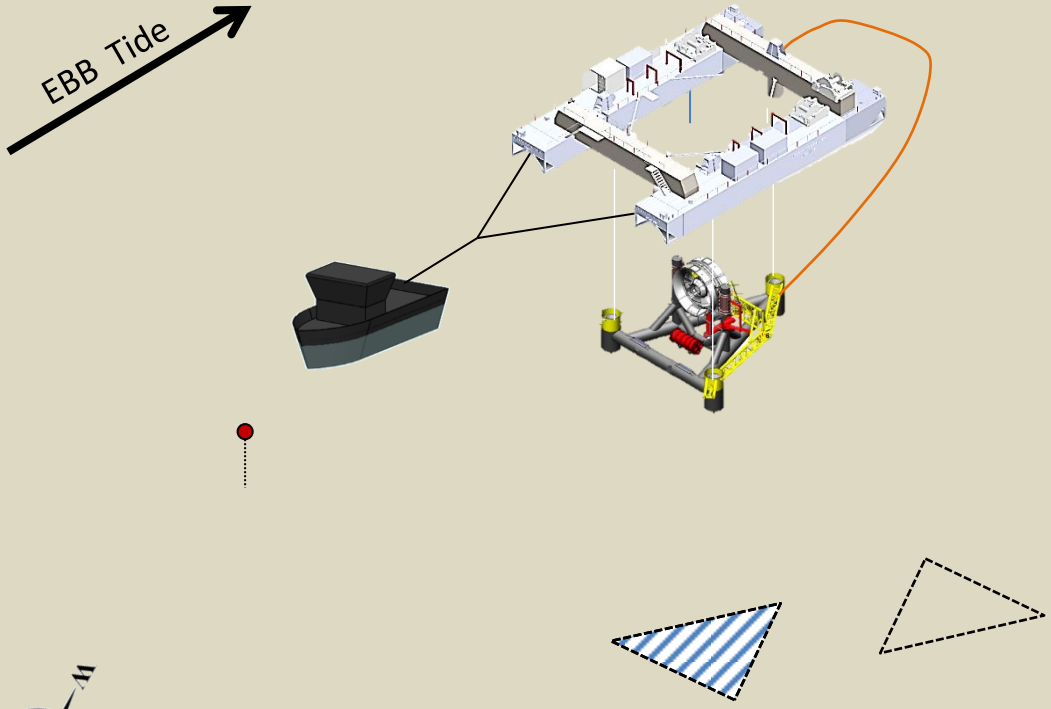
1. *Cable is Installed on Seabed in Final Position*
2. *Remaining Buoys are Removed as Cable End is Pulled Through HDD*
3. *Diver Monitors Installation*

Cable Installation Concept



Turbine Deployment Operation By OpenHydro

OpenHydro Turbine Deployment

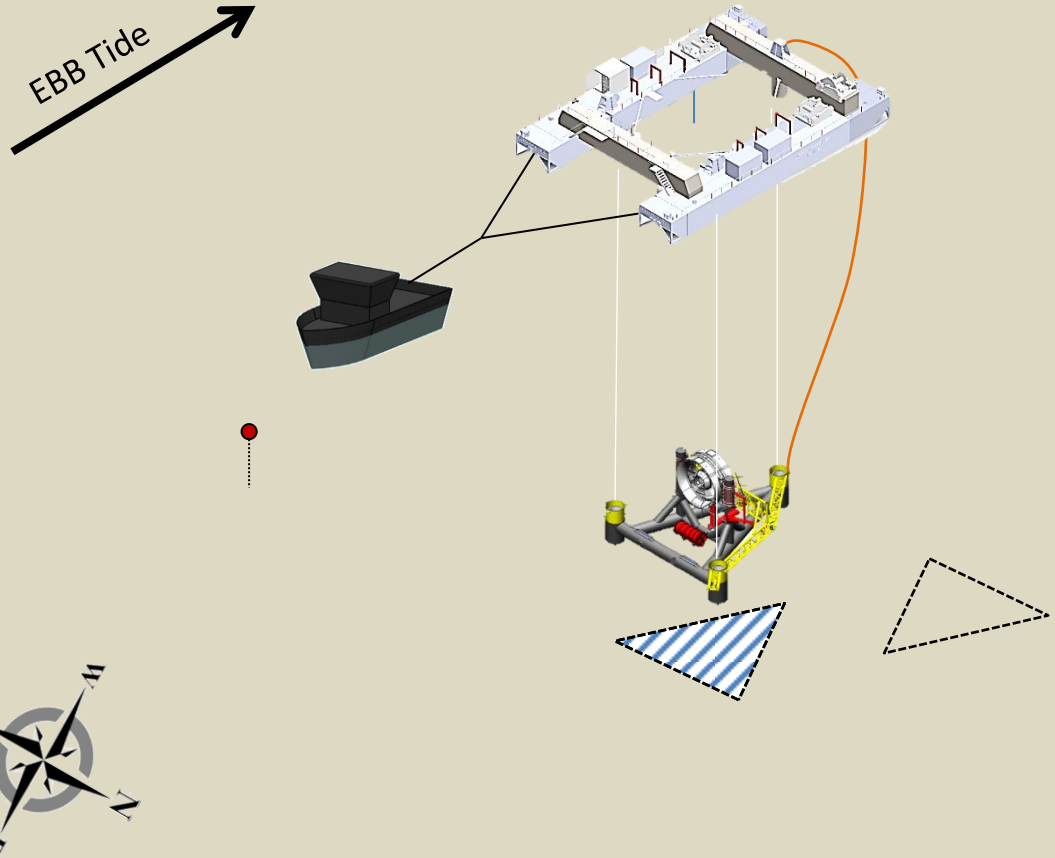


Legend:

- Umbilical Cable
- Barge Winch Cable
- Marker Buoy

OpenHydro Arrives on Station.
Unit positioned over site & lowered.

OpenHydro Turbine Deployment

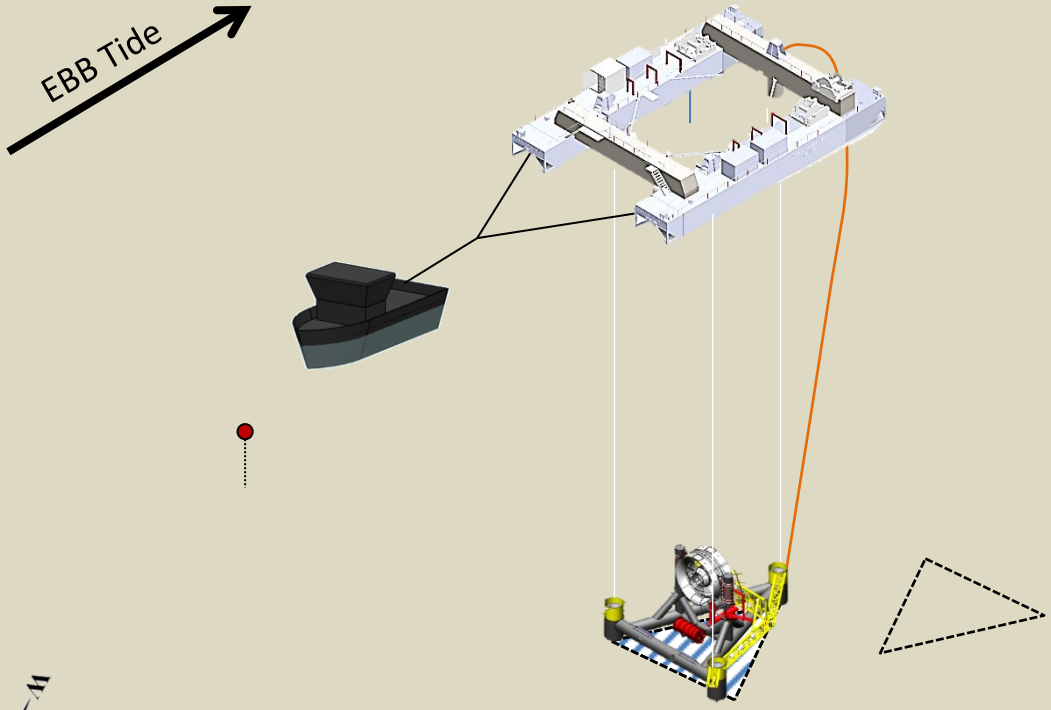


Legend:

- Umbilical Cable
- Barge Winch Cable
- Marker Buoy

Fine timing of positions using tug tow line & 2-drives. Direction of tide & flow is measured & monitored closely as assembly approaches sea floor.

OpenHydro Turbine Deployment

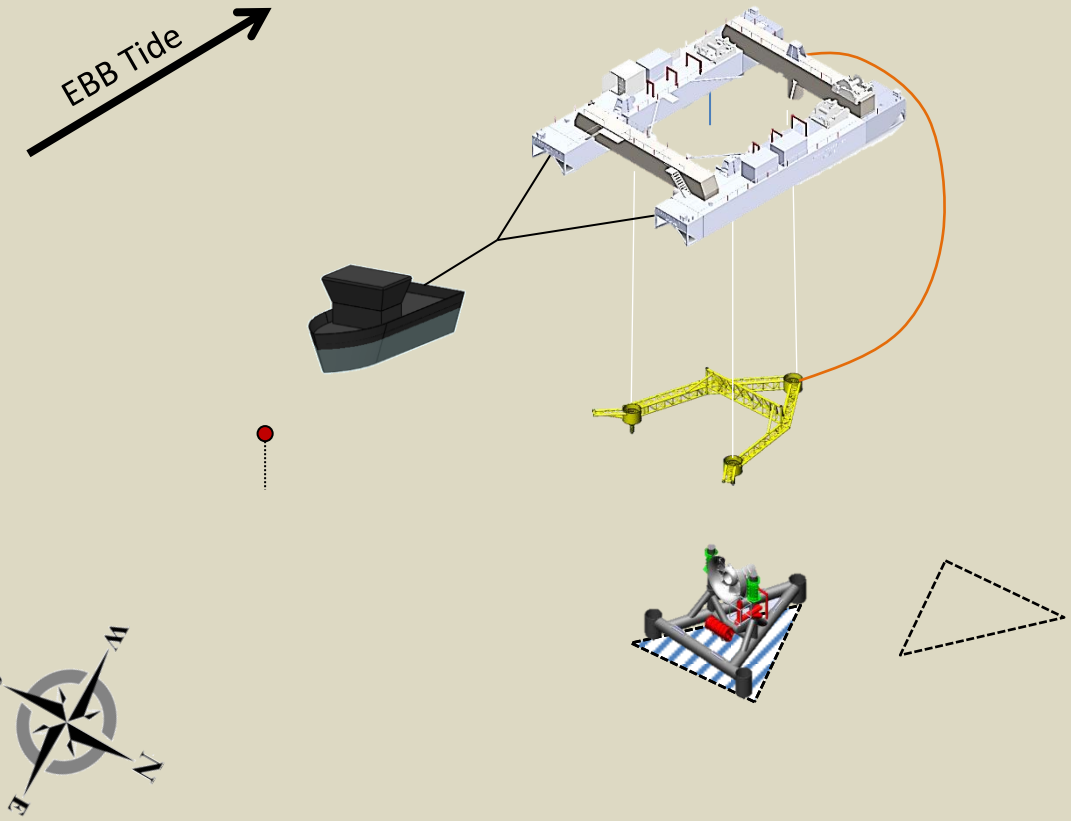


Legend:

- Umbilical Cable
- Barge Winch Cable
- Marker Buoy

On bottom – Confirmation of positions, ensure unit is level & feet have not sunk. Release of hydraulics.

OpenHydro Turbine Deployment



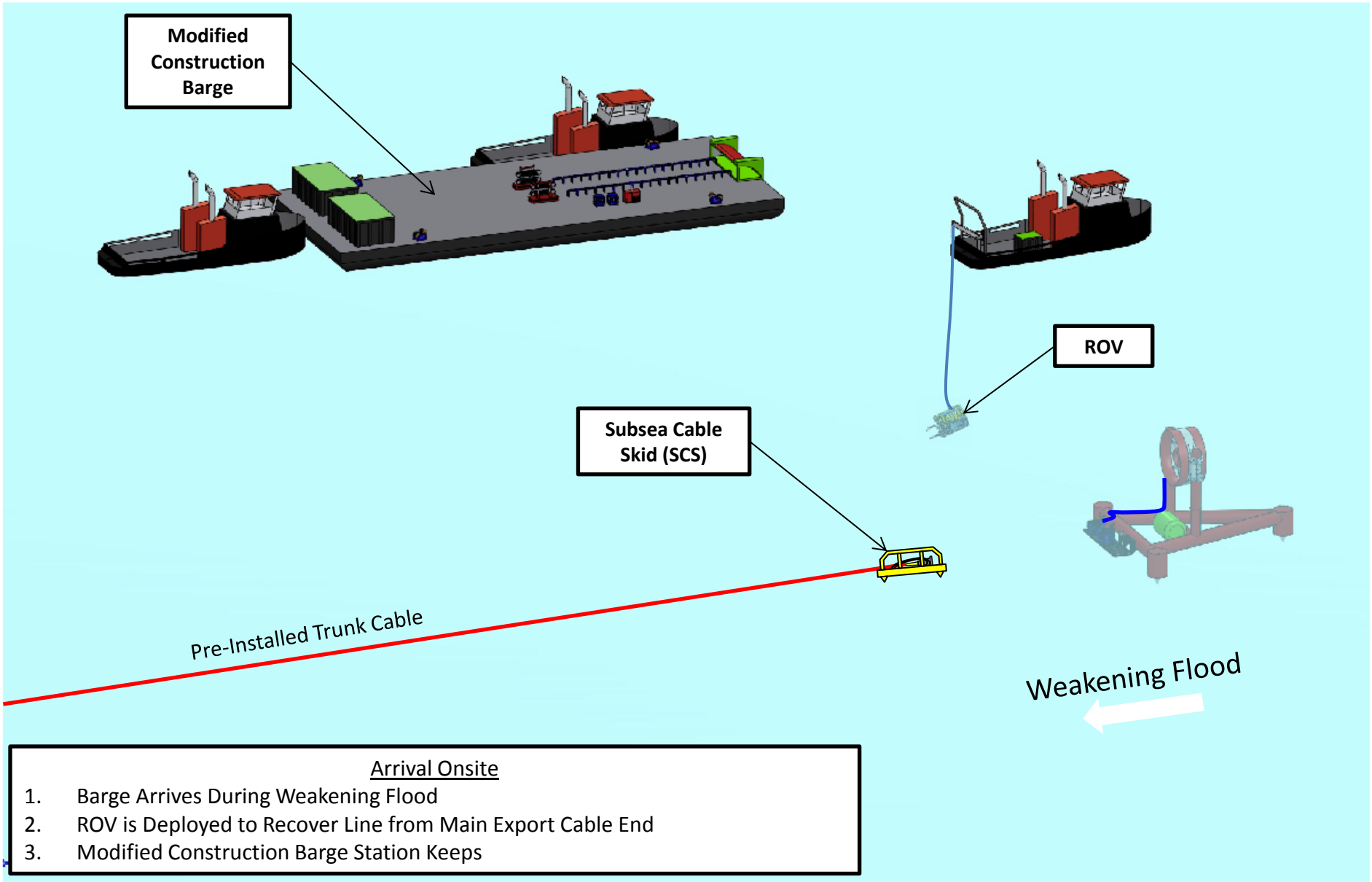
Legend

- Umbilical
- Barge Winch
- Marker Buoy

Recovery frame is now disconnected from the subsea base & raised back up to the barge.

Cable Connection

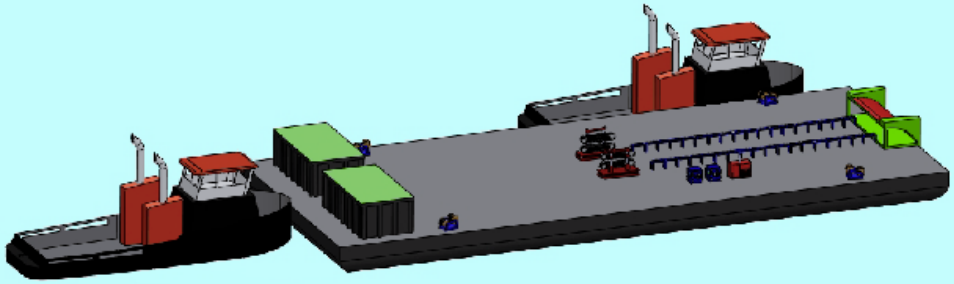
Cable Connection Concept

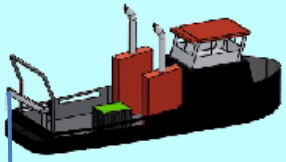


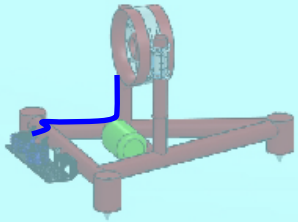
Arrival Onsite

1. Barge Arrives During Weakening Flood
2. ROV is Deployed to Recover Line from Main Export Cable End
3. Modified Construction Barge Station Keeps

Cable Connection Concept







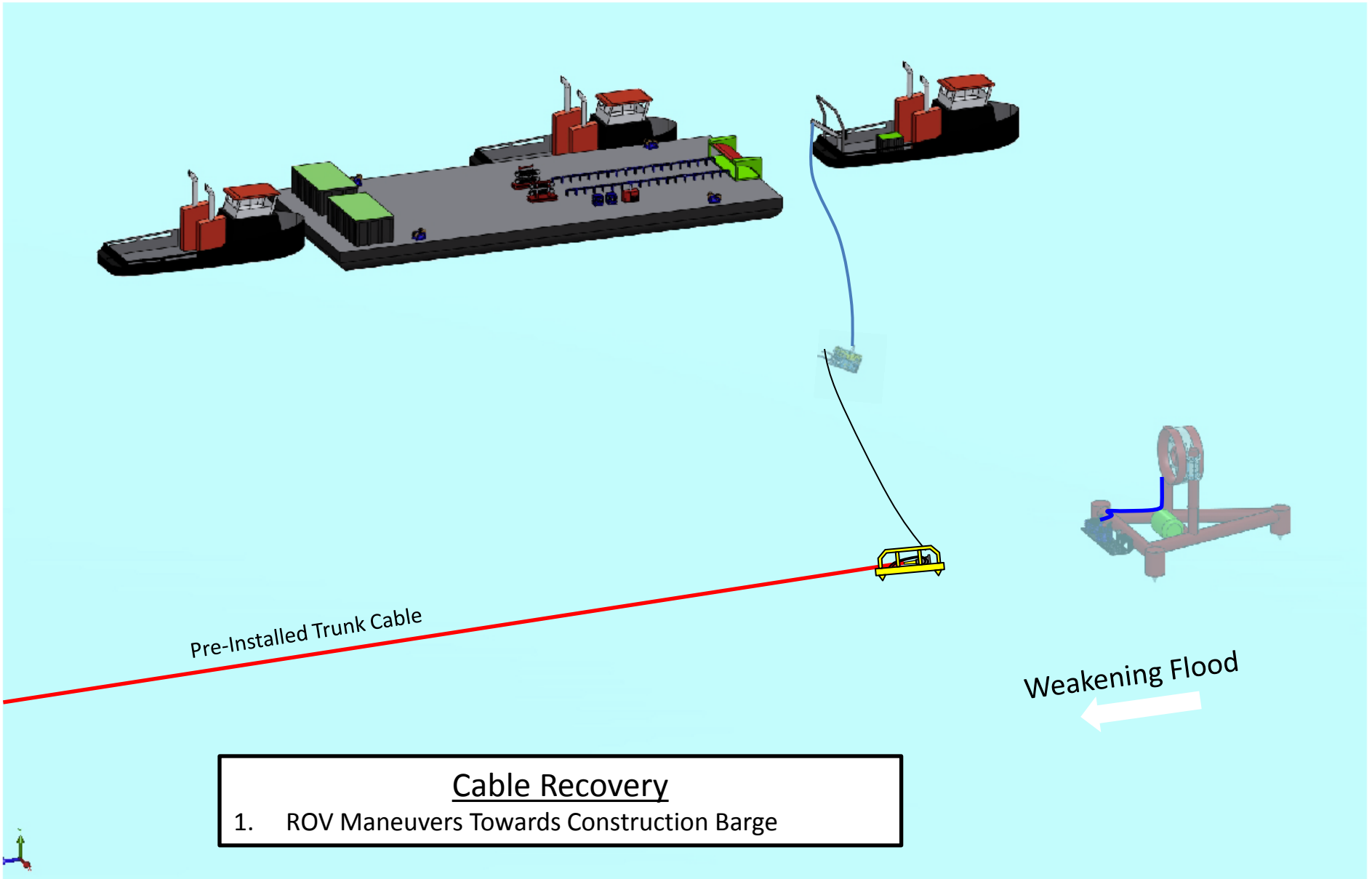
Pre-Installed Trunk Cable

Weakening Flood

Cable Recovery

1. ROV Docks on Seafloor Next to Subsea Skid
2. ROV Recovers Line from Main Export Cable End
3. ROV Releases Dry Mate Housing from Skid

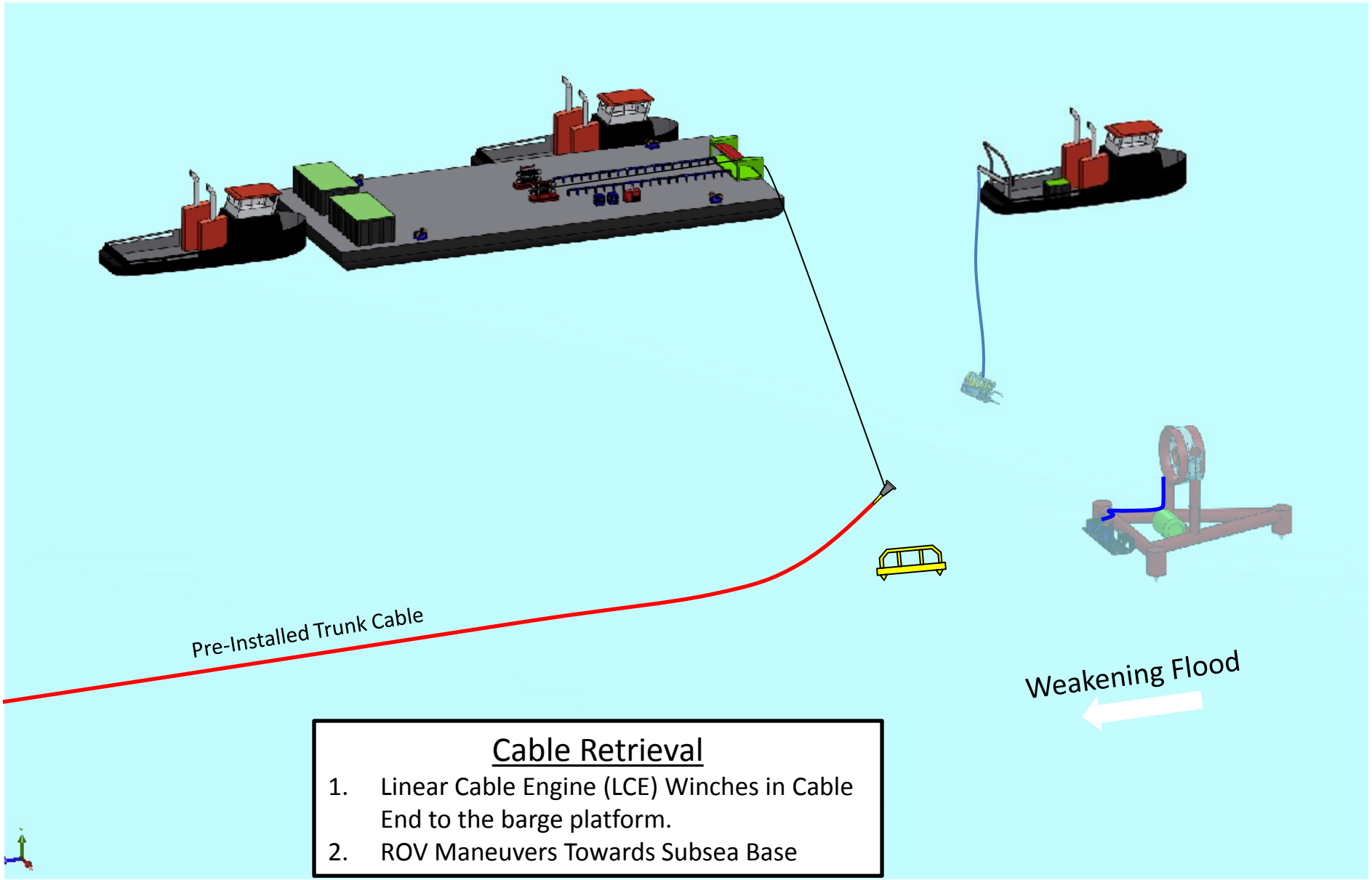
Cable Connection Concept



Cable Recovery

1. ROV Maneuvers Towards Construction Barge

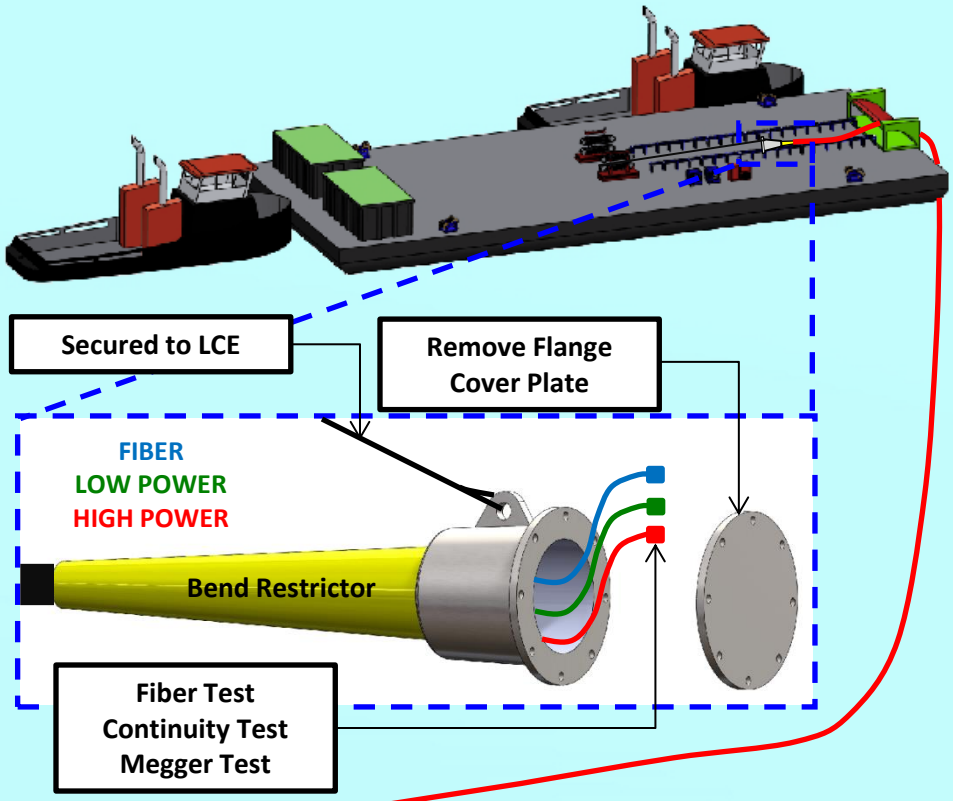
Cable Connection Concept

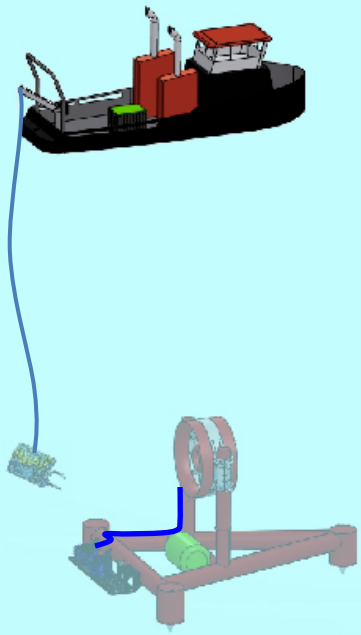


Cable Retrieval

1. Linear Cable Engine (LCE) Winches in Cable End to the barge platform.
2. ROV Maneuvers Towards Subsea Base

Cable Connection Concept



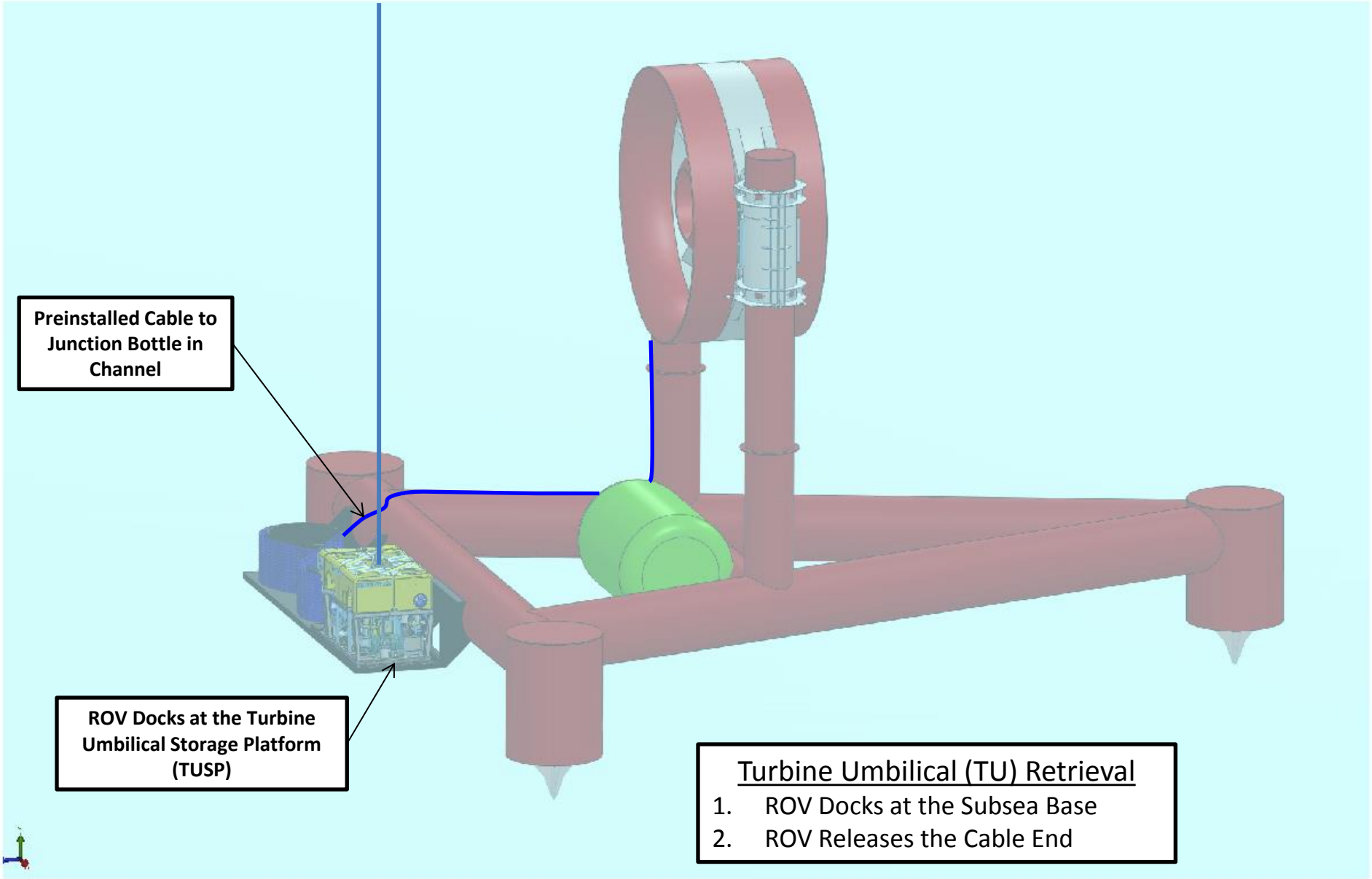


Weakening Flood

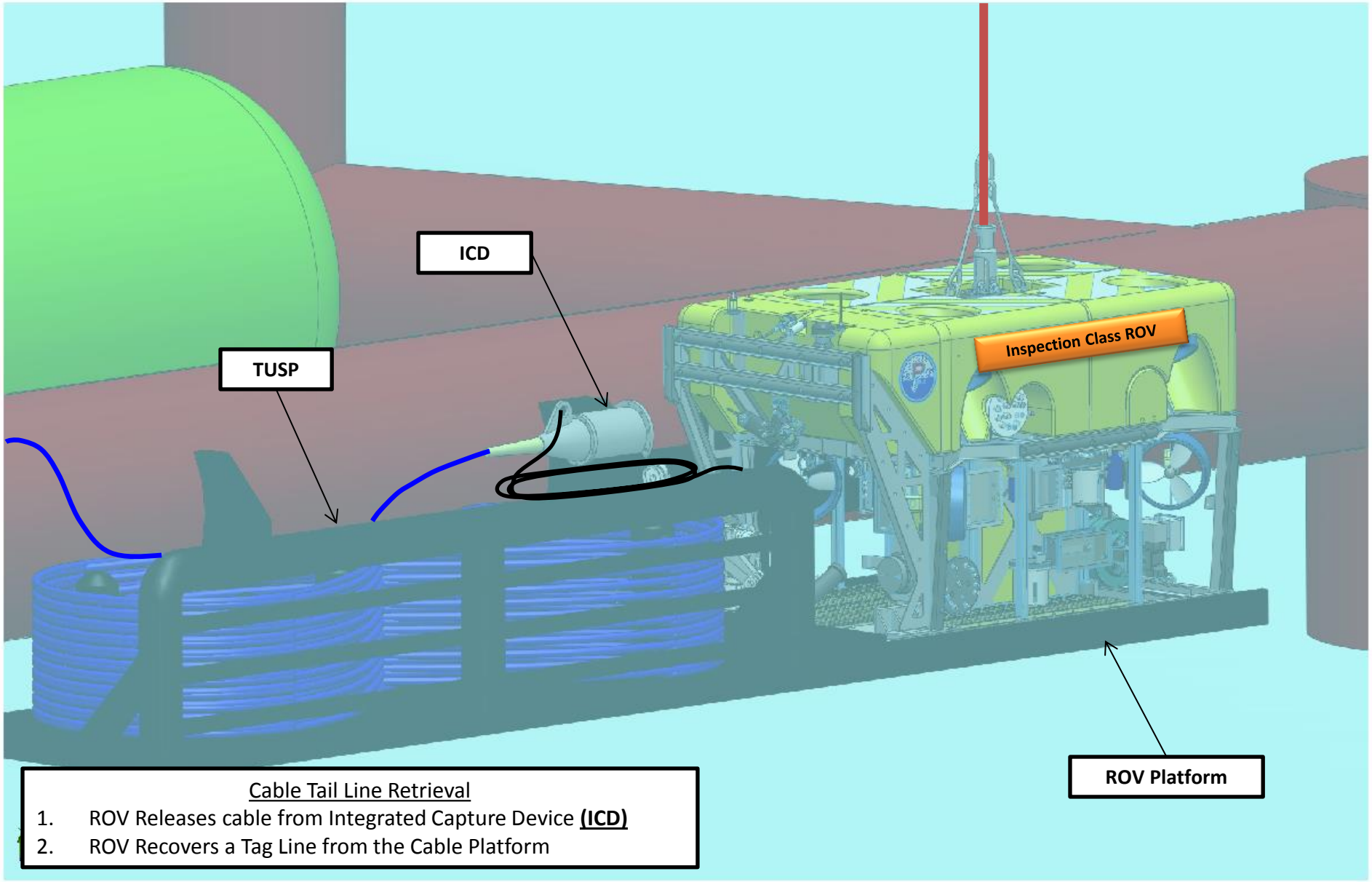
Cable Retrieval

1. LCE Secures Cable End Aboard the Barge
2. System Health Check is Performed on Main Export Cable
3. Subsea Skid Remains on Seafloor for Future Use

Cable Connection Concept



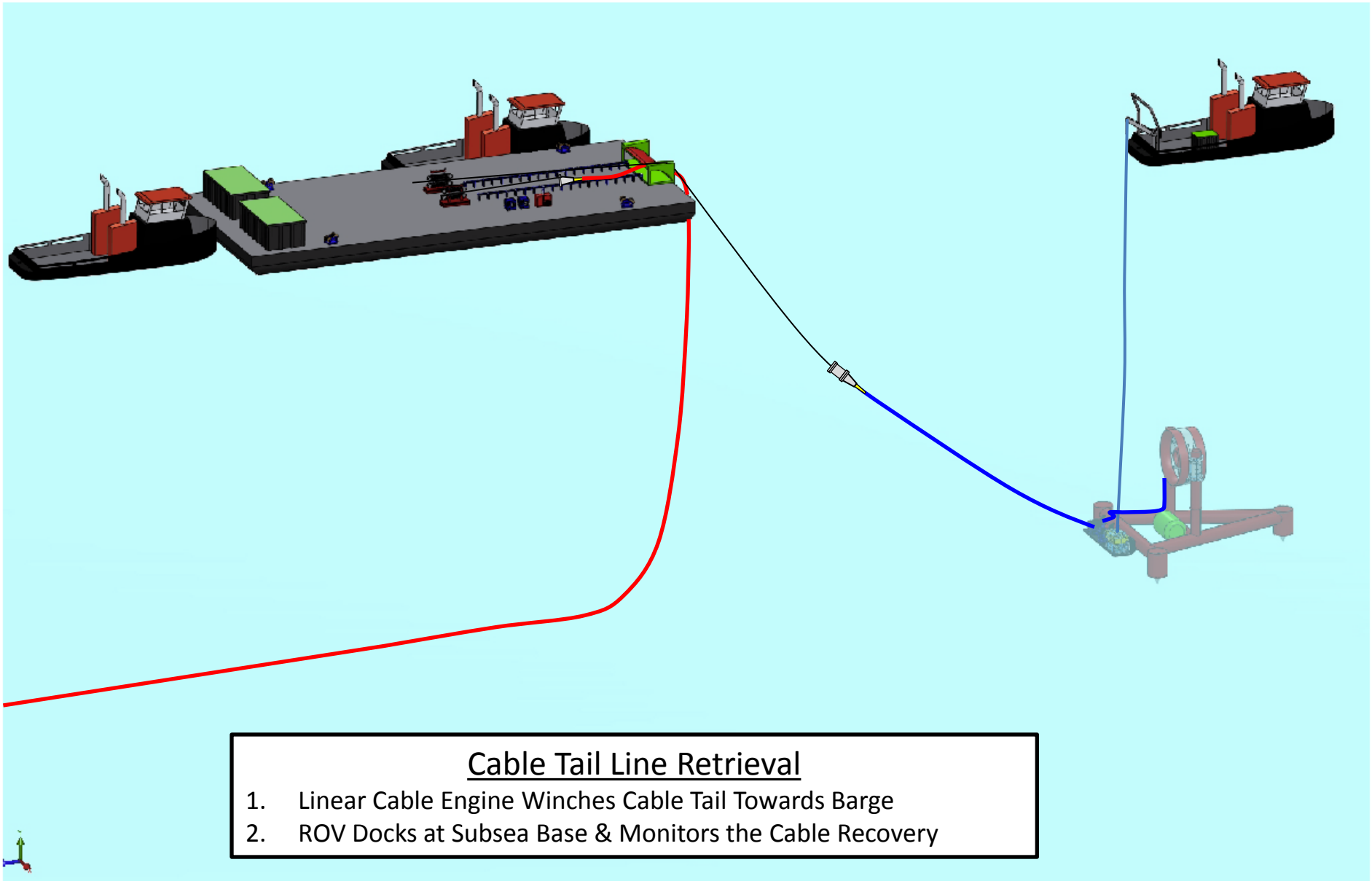
Cable Connection Concept



Cable Tail Line Retrieval

1. ROV Releases cable from Integrated Capture Device **(ICD)**
2. ROV Recovers a Tag Line from the Cable Platform

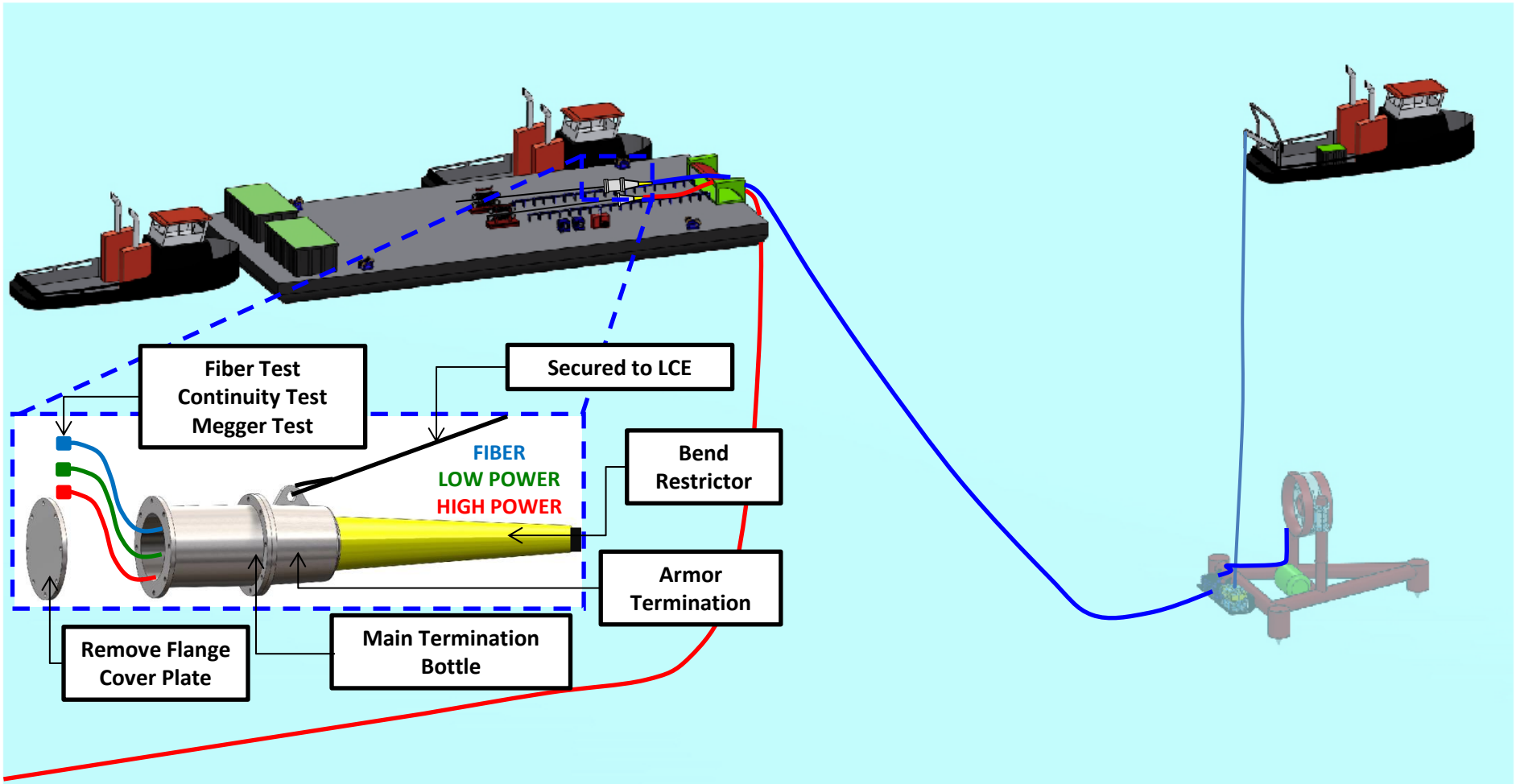
Cable Connection Concept



Cable Tail Line Retrieval

1. Linear Cable Engine Winches Cable Tail Towards Barge
2. ROV Docks at Subsea Base & Monitors the Cable Recovery

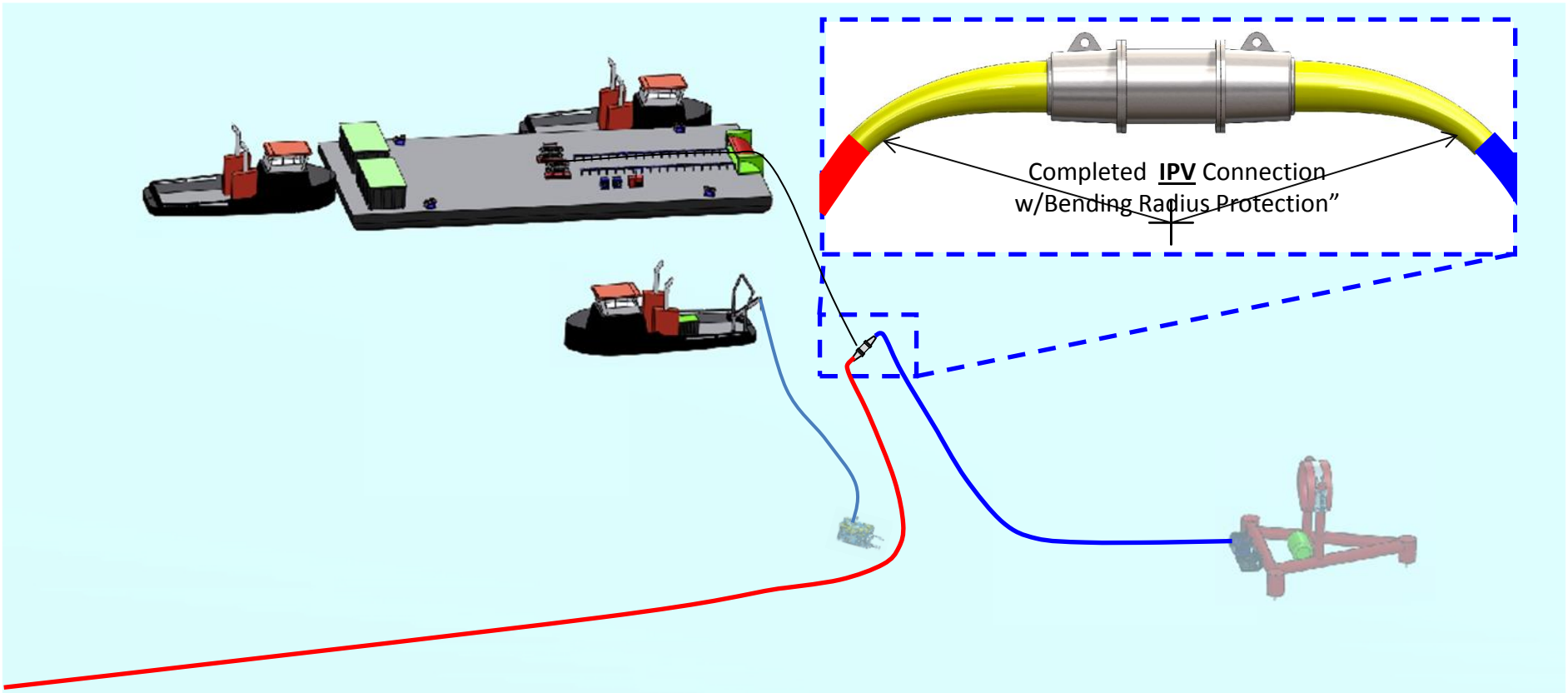
Cable Connection Concept



Cable Tail Line Retrieval

1. Cable Tail is Brought Aboard the Barge
2. System Health Check is Performed on Cable Tail

Cable Connection Concept



Cable Redeployment

1. Barge Begins Lowering Cable in “S” Pattern
2. ROV Monitors Cable Placement on the Seafloor

Cable Connection Concept

Cable Redeployment

1. Connector Housing is Deployed on Seafloor
2. ROV Monitors Final Placement

MONITORING OBJECTIVES

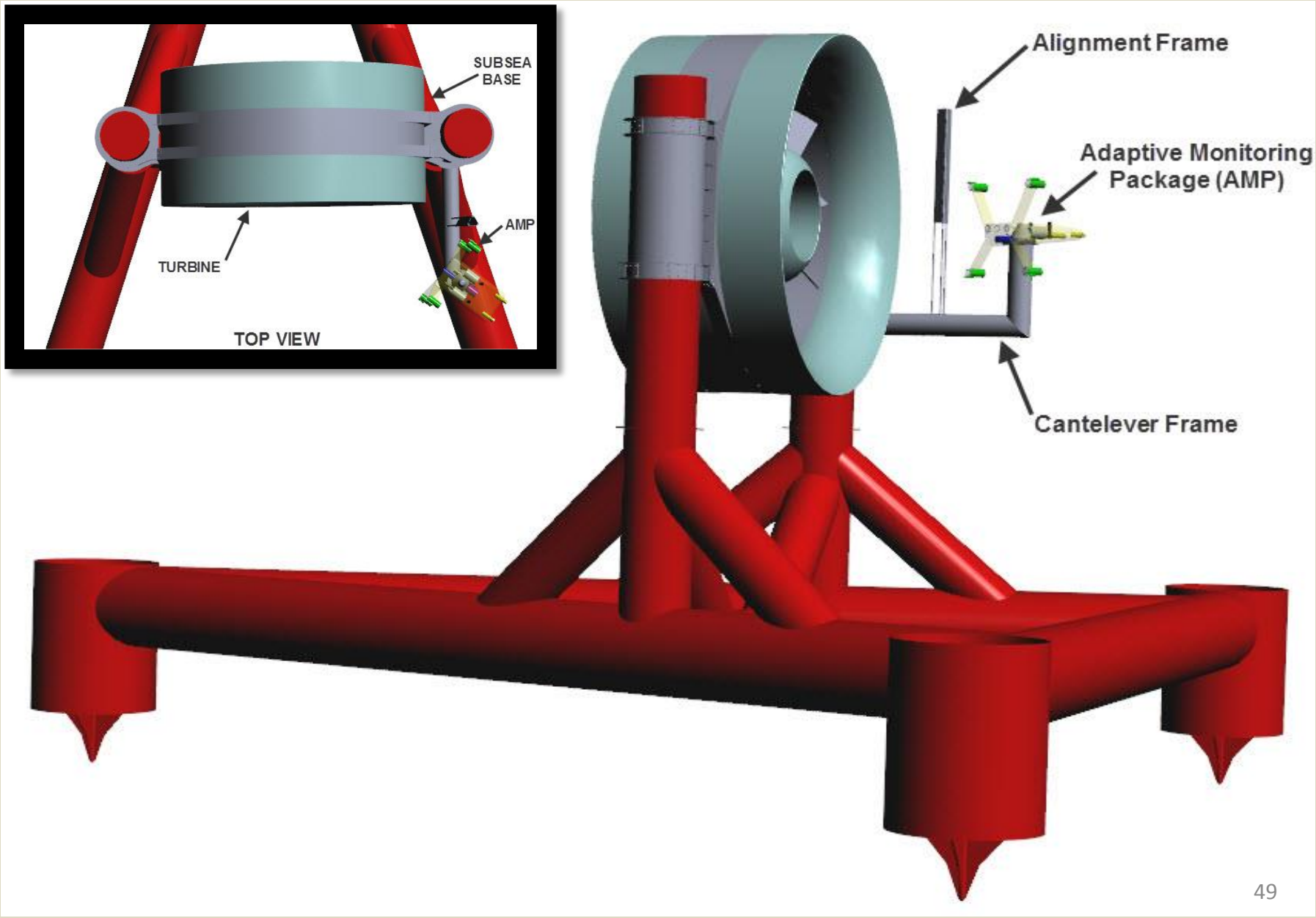
Monitoring Objectives

1. Those that are required for our FERC license mitigation
2. Those above and beyond the minimum that will add value to the future of Tidal Energy

All together can be summarized as:

- Studies evaluating Sea-Mammal Interactions
- Studies evaluating Turbine Noise
- Studies Evaluating the Impact to the Benthic Habitat – near field
- Water Quality

ENVIRONMENTAL MONITORING EQUIPMENT



ENVIRONMENTAL MONITORING EQUIPMENT

Optical Camera System

Acoustic Monitors

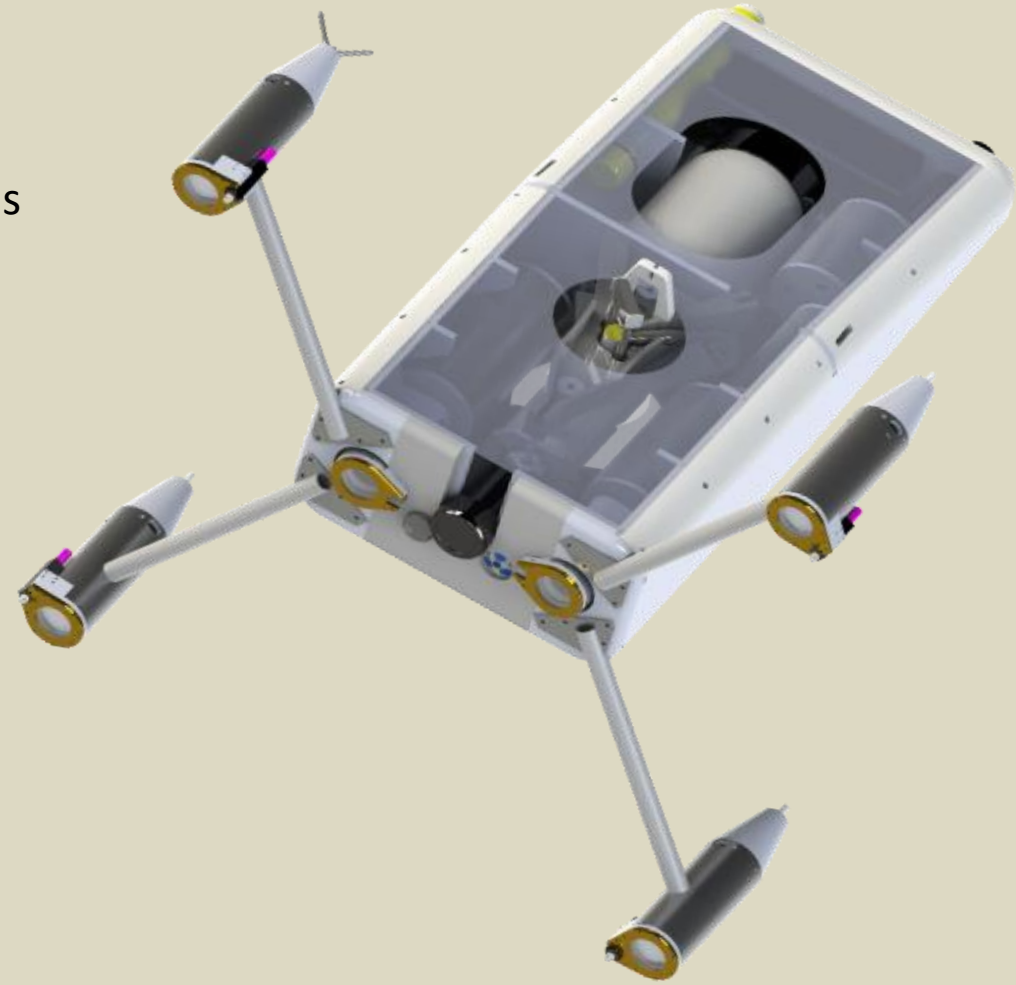
1. Mammal Vocalizations
2. Turbine Sound

Hydrophones

1. Cetacean clicks
2. Fish Tags

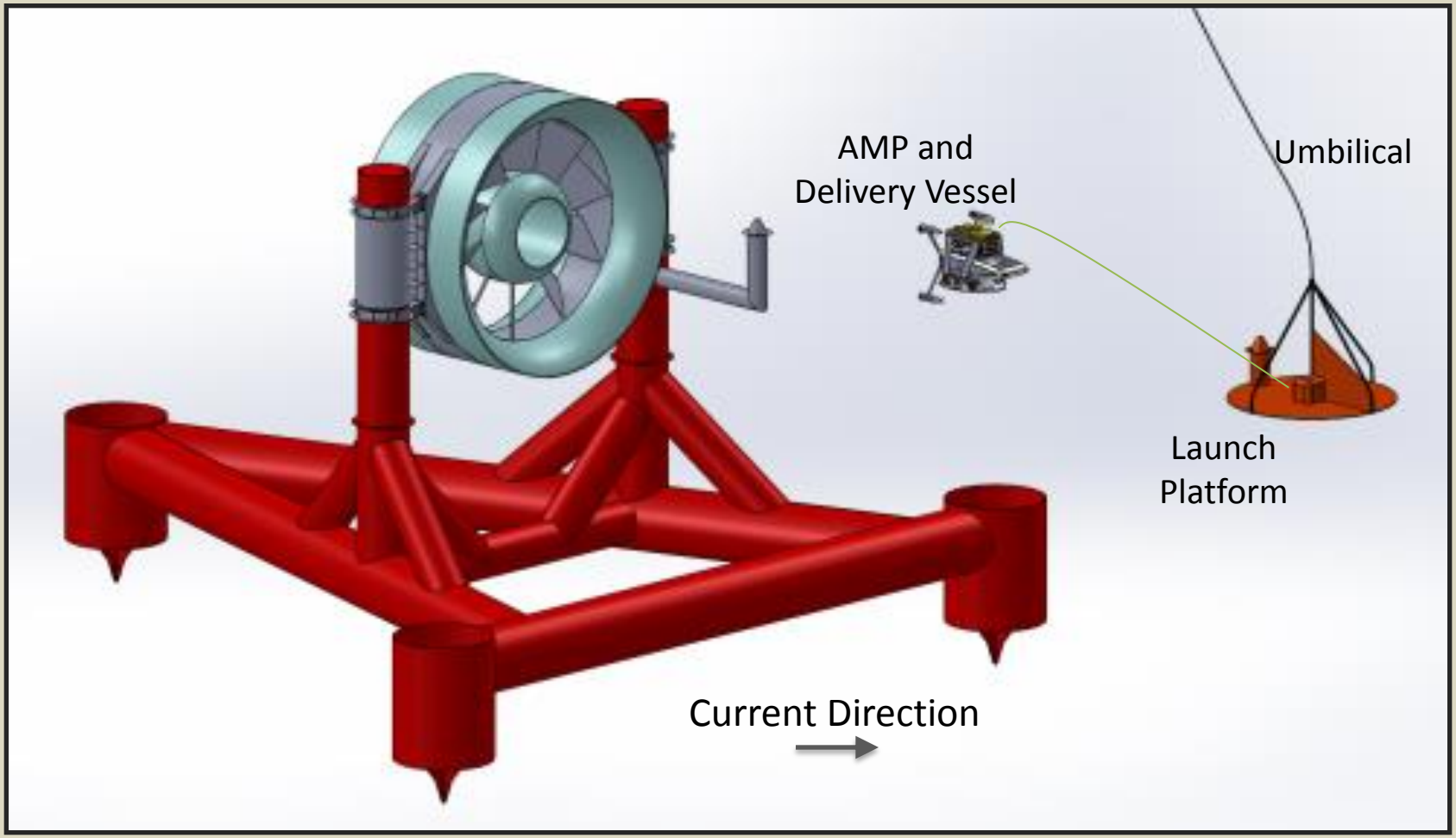
ADCP/Velocimeter

Water Quality Sensor

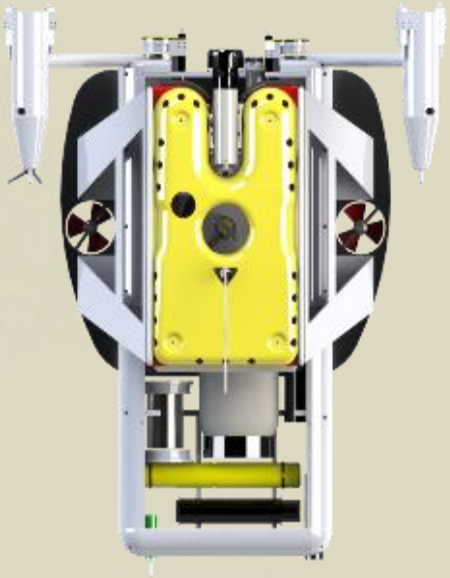


ADAPTIVE MONITORING PACKAGE (AMP)

ENVIRONMENTAL MONITORING EQUIPMENT



ENVIRONMENTAL MONITORING EQUIPMENT



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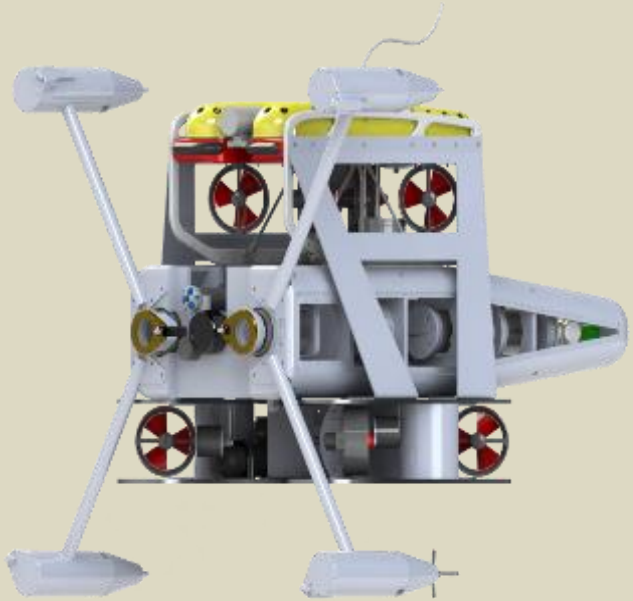
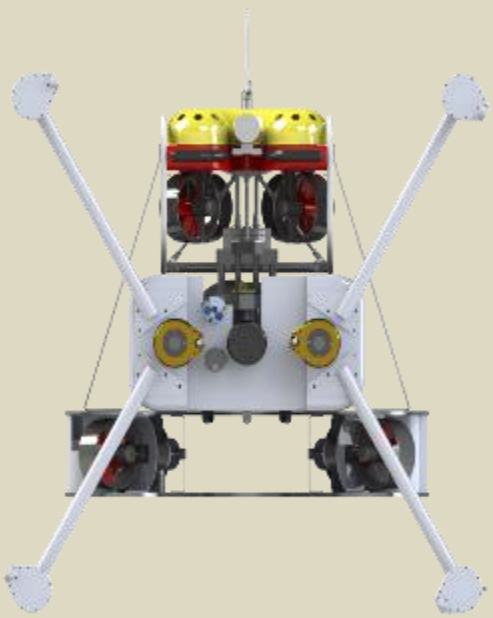


SIDE



FRONT

6m EMEC Deployment

6m EMEC Deployment

Contacts / Links

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- **Brad Spangler, (425) 783-8151, brspangler@snopud.com**

PUD IRP & Tidal Power Development

- http://www.snopud.com/PowerSupply/irp.ashx?p=1161
- http://www.snopud.com/PowerSupply/tidal.ashx?p=1155

OpenHydro

- http://www.openhydro.com/technology.html

Ua Mau Ke Ea O Ka Aina I Ka Pono