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ANBARIC
EXPORT CABLES INTO NEW YORK HARBOUR

Cable routing through The Narrows and Export Cable Installation

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ANBARIC
EXPORT CABLES INTO NEW YORK HARBOUR

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- repair scenarios
- assessment of cable routes
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- Typical OSW Export Cable Installation Scenario
- Outline of analogous HTP cable installation design 2017

INTRODUCTION

- Intertek Energy & Water (Intertek) have analysed and reviewed the potential for the maximum number of cables to be routed through The Narrows.
  - Points considered include:
    - Planning for cable repairs and depth dependent maintenance separations
    - Engineering solutions for reduced cable separation
    - Anchorage areas and risk to installed cables

- Intertek's analysis was informed by a separate cable routing assessment by ESS (Offshore Wind Transmission Routing through The Narrows Upper and Lower New York Bay, New York, 28 May 2020), which came to similar conclusions

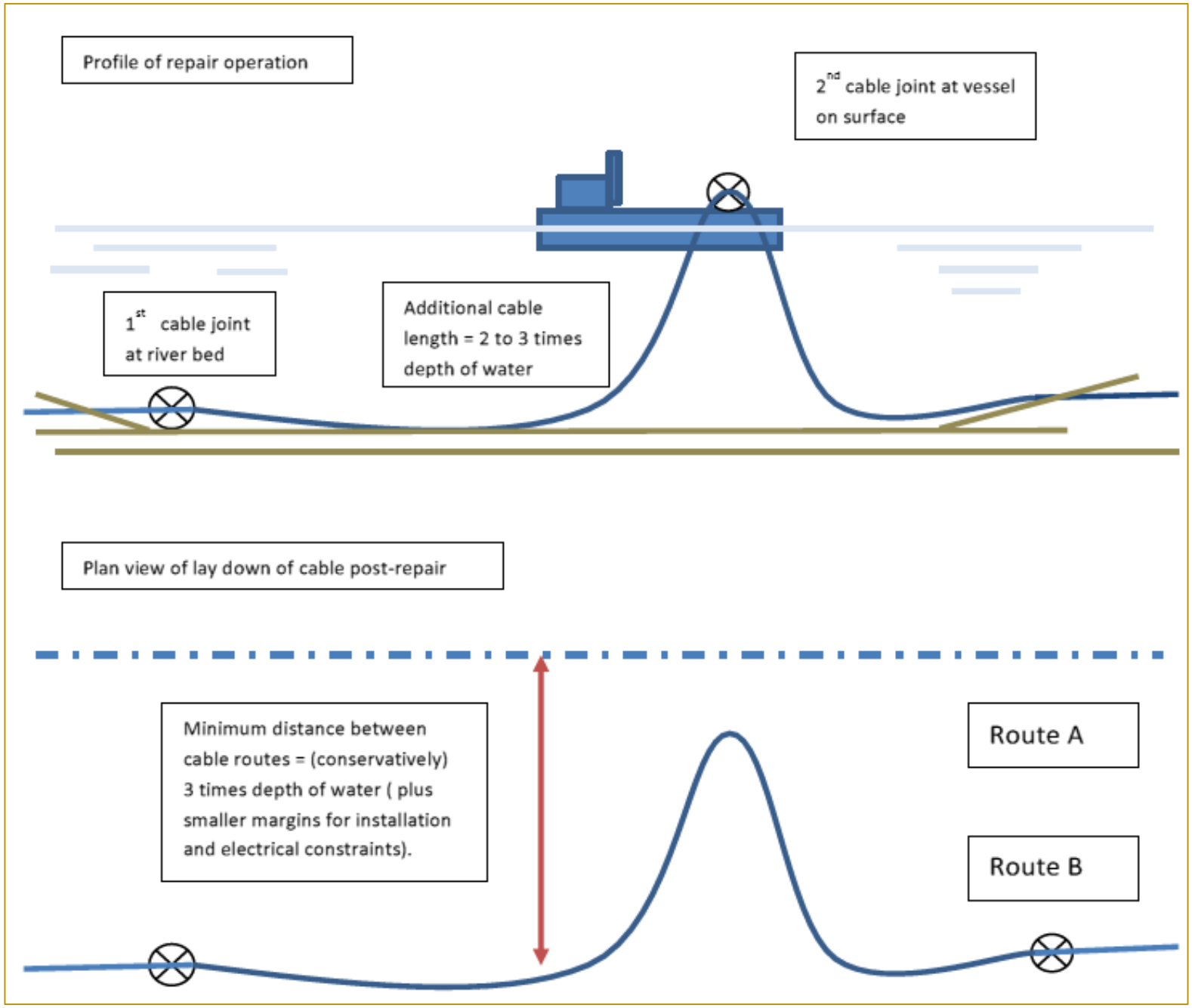
- Intertek have also examined typical OSW Export Cable Installation Scenarios:
  - The HTP 345kV system was laid in the Hudson River in 2017. This is used an example to demonstrate installation techniques as it is comparable to the OSW export cable systems proposed for NYC harbour.

ROUTING EXPORT CABLES THROUGH THE NARROWS IN NYC HARBOUR

ROUTING SCENARIOS FOR OSW EXPORT CABLES IN NYC HARBOUR

- It is required to connect a number of OSW farms to Substations in NYC via subsea cables, which may be HVAC (installed as a trefoil bundle) or HVDC (installed as two-cable bundle).
- Subsea cable routes must pass through The Narrows to access the Upper Bay where Substations are located.
- Production and installation defects do affect submarine cables; contingency planning for repair is essential.
- Cable repairs are undertaken onboard a vessel and additional cable is introduced into the repaired section, which must be laid to the side of the route in an ‘omega’ configuration.
- The extent of the omega is determined by the water depth (plus smaller margins for installation and electrical constraints), which extent determines Subsea cable route separation.

Cable Repair Scenario



ASSESSMENT OF CABLE ROUTE NUMBERS IN THE NARROWS – ESS GROUP REPORT

- Space in The Narrows is constrained by navigable depth of water, the Verrazano-Narrows bridge piers and the Ambrose Channel Federal Navigation Project (FNP).

- ESS studied the depth profile at the narrowest point and assessed the number of possible cable routes. Routing in the Ambrose Channel was excluded on permitting grounds.

- This estimation portrayed in the following figure does not take account of feasibility of routing to the north of The Narrows where numerous constraints to routing exist.

ESS ESTIMATION OF CABLE ROUTE NUMBERS IN THE NARROWS

- Based on conservative depth-dependent maintenance separations of 150’ to 250’, it is estimated that The Narrows could accommodate:
  - Three routes to the East of the Ambrose channel
  - Four routes to the West of the Ambrose channel

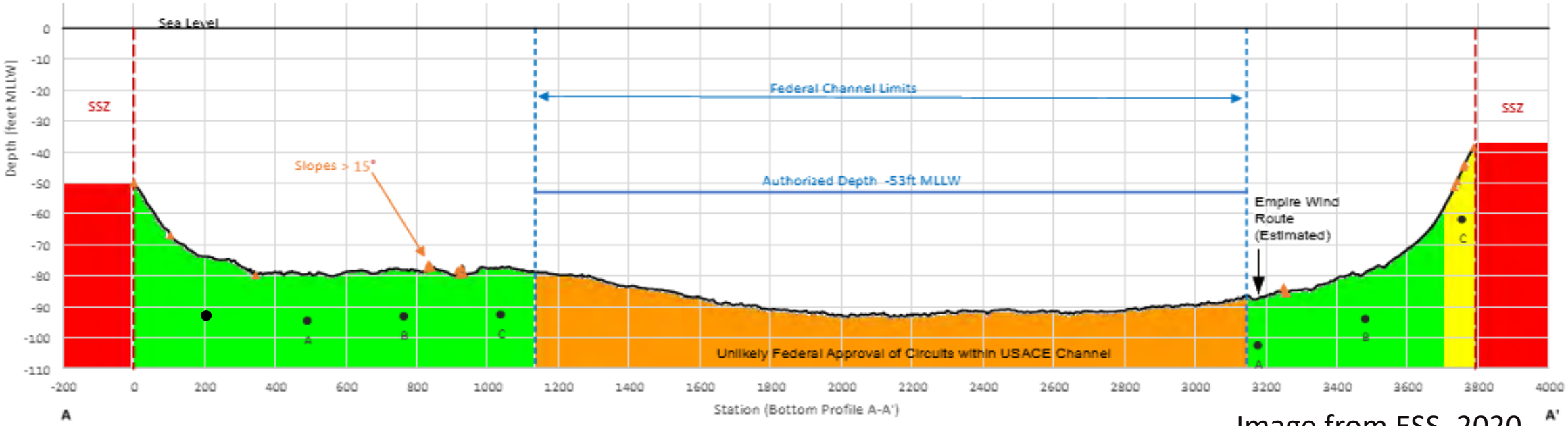
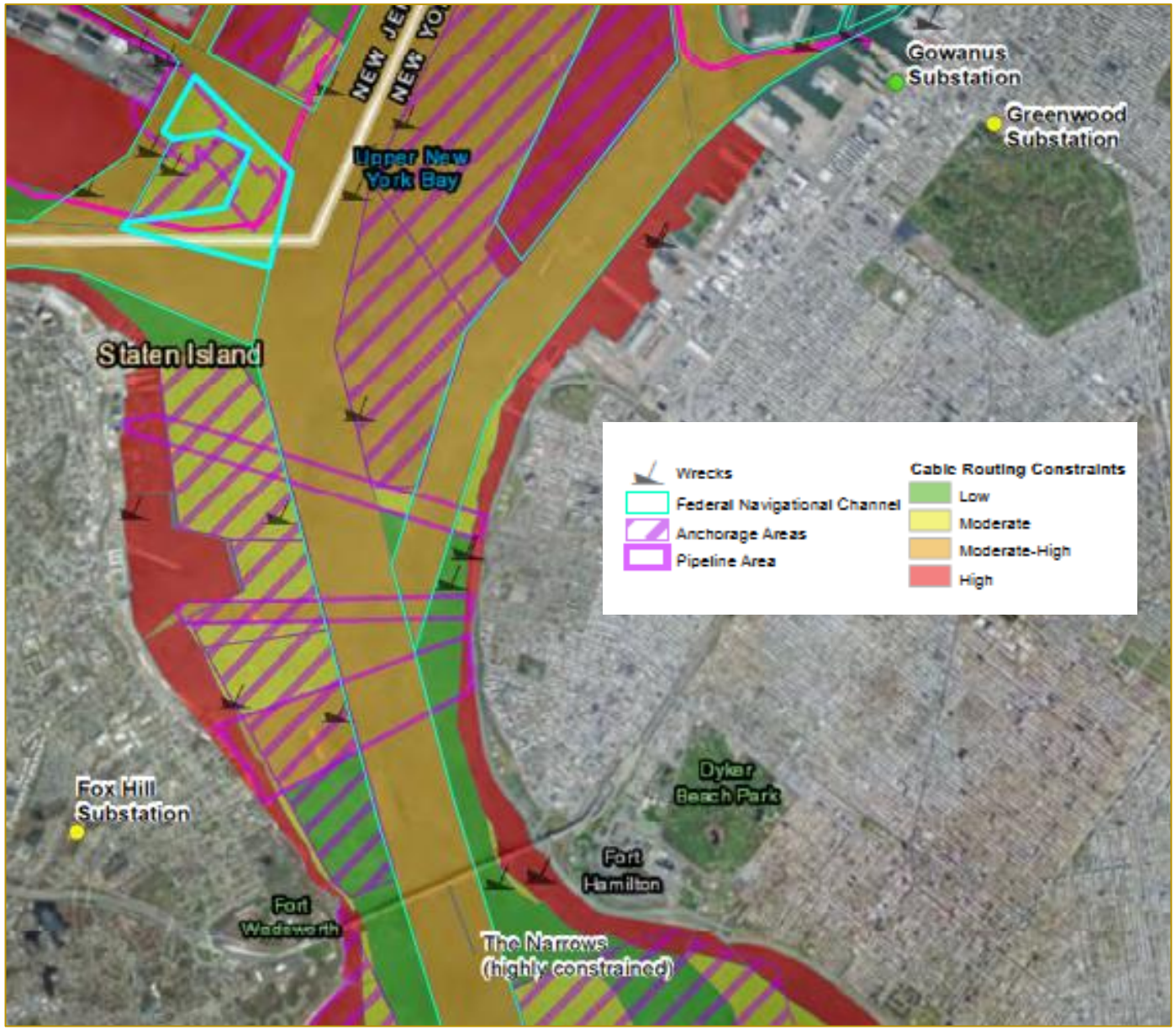


Image from ESS, 2020

CONSTRAINTS TO ROUTING MAPPED BY ESS (ESS FIGURE 3)



INTERTEK ASSESSMENT OF NUMBER OF CABLE ROUTES

- Industry standard surface repair operations require routes to be separated; depth-dependent maintenance separations of 150’ to 250’ are industry standard. Repair technology to allow riverbed or below-mudline repairs is not proven and risk-laden.

- Engineering solutions used for repair of smaller cable systems that might allow reduced separation are not considered practicable for large, deeply-buried, bundled cable systems.

- The estimate of 7 cable routes in The Narrows based on depth-dependent maintenance separations is conservative but is considered to be reasonable.

- The number of routes in the Narrows may ultimately be constrained by the feasibility of routing through the Upper Bay.

CABLE ROUTING IN THE UPPER BAY

- Assumption is that Gowanus Substation is the primary destination for wind farm export cables. Routing to other destinations will be more difficult.

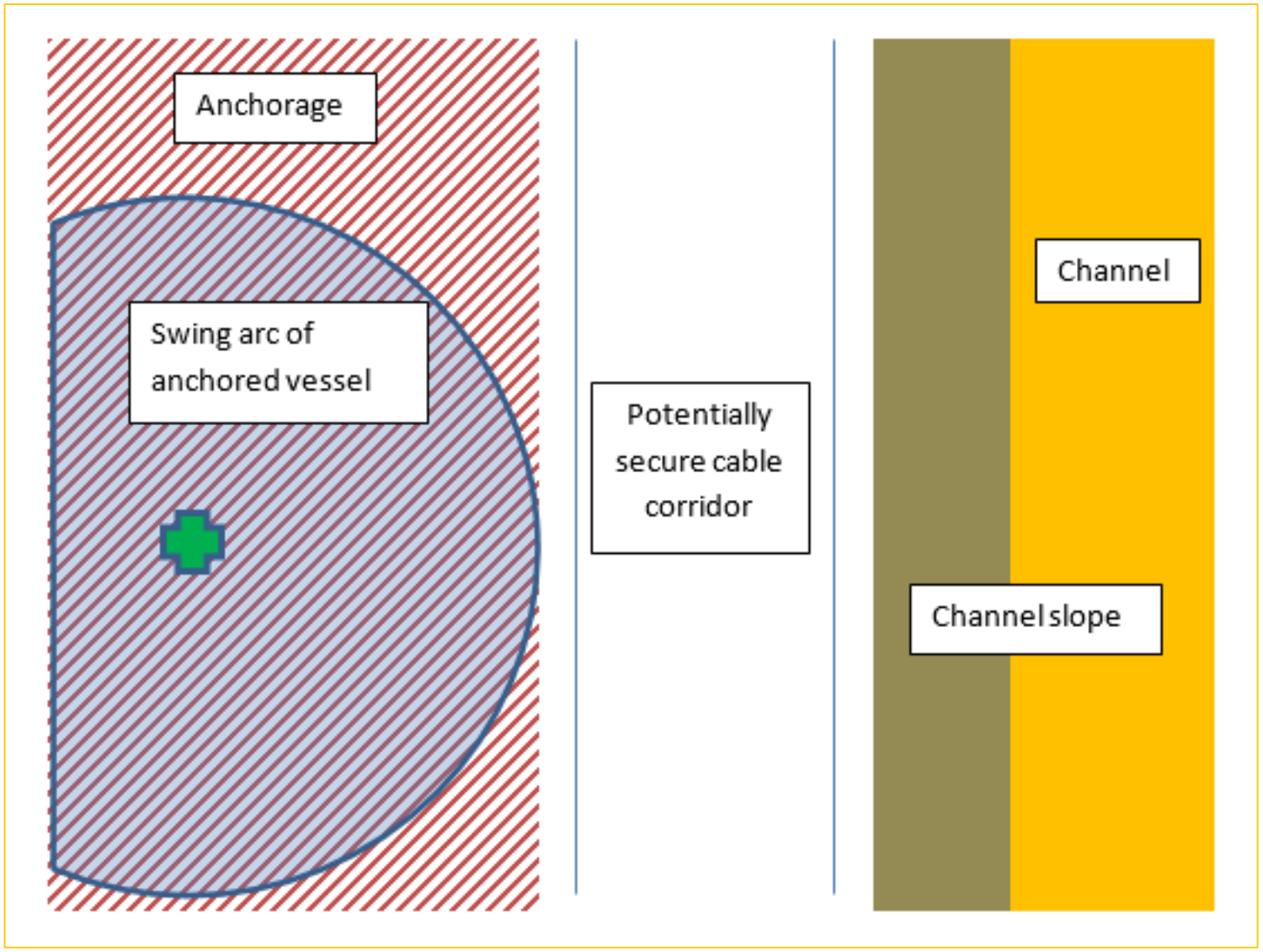
- Virtually all parts of the harbour have a high number of constraints – principally due to channels and anchorages subject to FNPs.

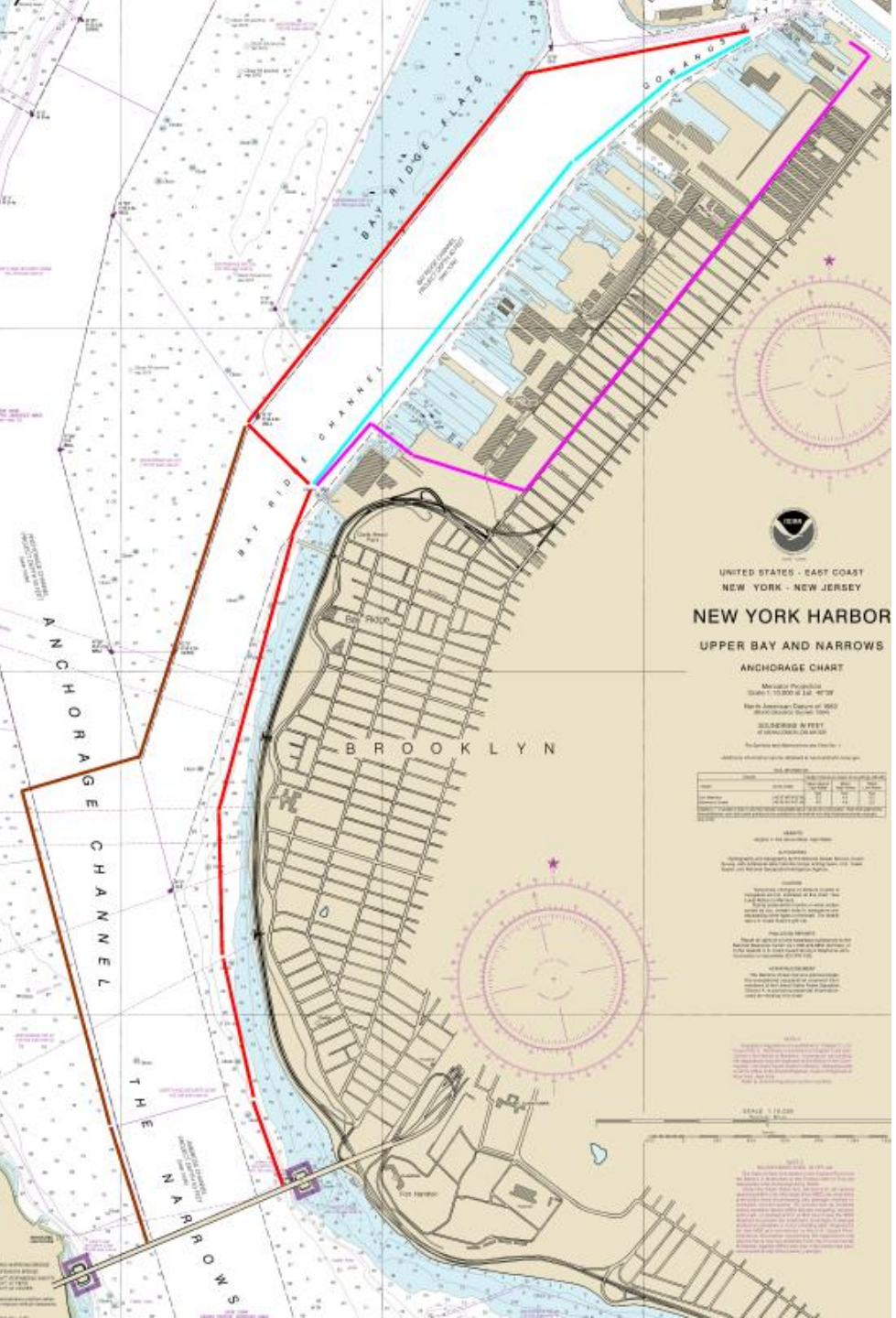
- All potential routes to Gowanus, or other Substations in NYC, will face challenge from authorities and maritime interests - compromises will be needed to access such routes

POSSIBLE ROUTE ALIGNMENTS IN UPPER BAY (1 OF 2)

Subject to formal risk assessment, some route alignments may present less physical risk to an installed cable.

- Parts of channel adjacent to shallows
- Parts of channel away from port infrastructure and main thoroughfare
- Potentially secure cable corridor between channel and anchorage, where vessels cannot anchor without encroaching on channel when they swing

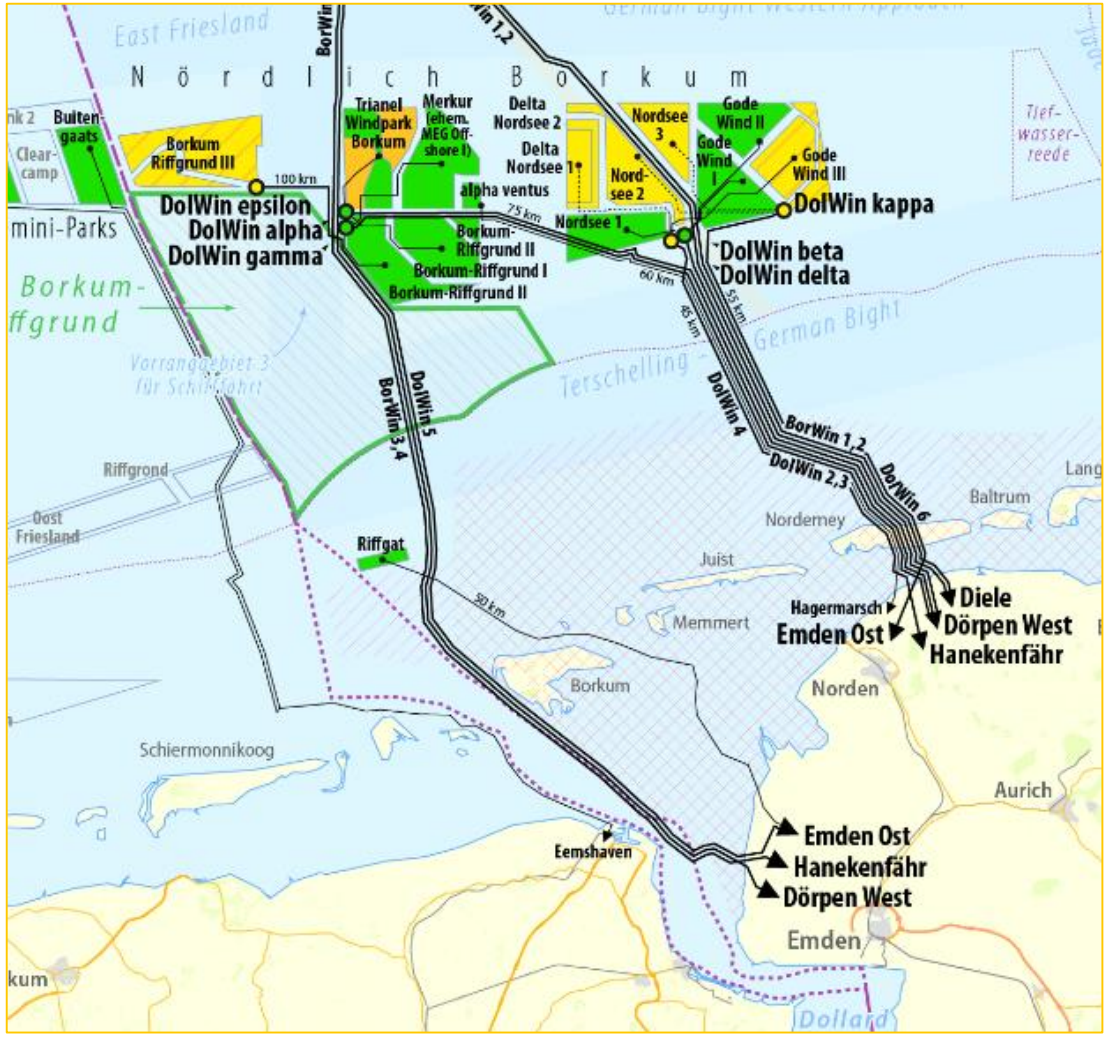




POSSIBLE ROUTE ALIGNMENTS IN UPPER BAY (2 OF 2)

- Brown : Western route runs in corridor between channel and anchorage, crosses Anchorage Channel at right angles, runs in corridor between channel and anchorage.
- Red : Eastern route runs in low risk waters, then crosses Bay Ridge Channel at right angles and combines with Brown route.
- Light Blue : extension of Red route, constrained and possibly compromised by port infrastructure and debris.
- Vermillion : land alternative to Light Blue route.

EXAMPLE OF OFFSHORE GRID EXTENSION – GERMAN NORTH SEA



- HVDC systems serve clusters of Offshore Windfarms; standard circuit capacity is 900MW
- All routes are constrained by Federal Marine Spatial Planning
- Routes are spatially constrained in the Ems estuary to the South West due to the shipping channel.
- Routes in the North East are constrained due to national park designation in the Waddensee.
- The offshore grid is planned and developed in a structured way under the control of a single entity, minimising impacts on third parties and the Permitting Authorities.

MAXIMISING USE OF AVAILABLE SPACE

- High capacity, three-phase HVAC cable systems may become too physically large to install, except as three single conductors, which is wasteful of space.

- HVAC Trefoil bundles are heavy and difficult to install, bury and repair.

- HVDC cable systems need additional land and offshore infrastructure in the form of converter stations, but can offer substantially higher transmission capacity in a more compact bundle.

- Extending the HV grid offshore, limits the number of export cables landing in sensitive areas of the coast or transiting congested estuaries. The German Offshore Wind connection model in the North Sea is an example of this.

- In The Narrows and Upper Bay of NYC Harbour, maximal transmission capacity in the available space may be achieved most efficiently by using HVDC technology to connect clusters of OSW farms to a grid that has been extended offshore.

SUMMARY OF KEY CONSIDERATIONS AND NUMBER OF CABLES INTO NY HARBOUR

- Major constraints to routing through the Narrows and the Upper Bay are physical width of suitable seabed, federal navigation projects (FNPs) (channels and anchorages), cable spacing requirements, and competing uses

- All potential routes are heavily constrained by navigational aspects in the Upper Bay: primarily the inner harbour anchorages and federal navigational channels

- Based on conservative depth-dependent maintenance separations it is estimated that The Narrows could accommodate:
  - Three routes to the East of the Ambrose channel
  - Four routes to the West of the Ambrose channel

- However given the constraints in the Upper Bay a more realistic estimate is that 4 routes could access NY Harbour.

OFFSHORE WIND EXPORT CABLE INSTALLATION

TYPICAL OSW EXPORT CABLE INSTALLATION SCENARIO

- Direct connection of OSWs is typically via HVAC cables, usually laid as a single trefoil cable.

- For system capacities of ~500MW or more, independent phase cables is the most likely solution. On confined routes phase cables will be bundled at installation, laid and simultaneously buried.

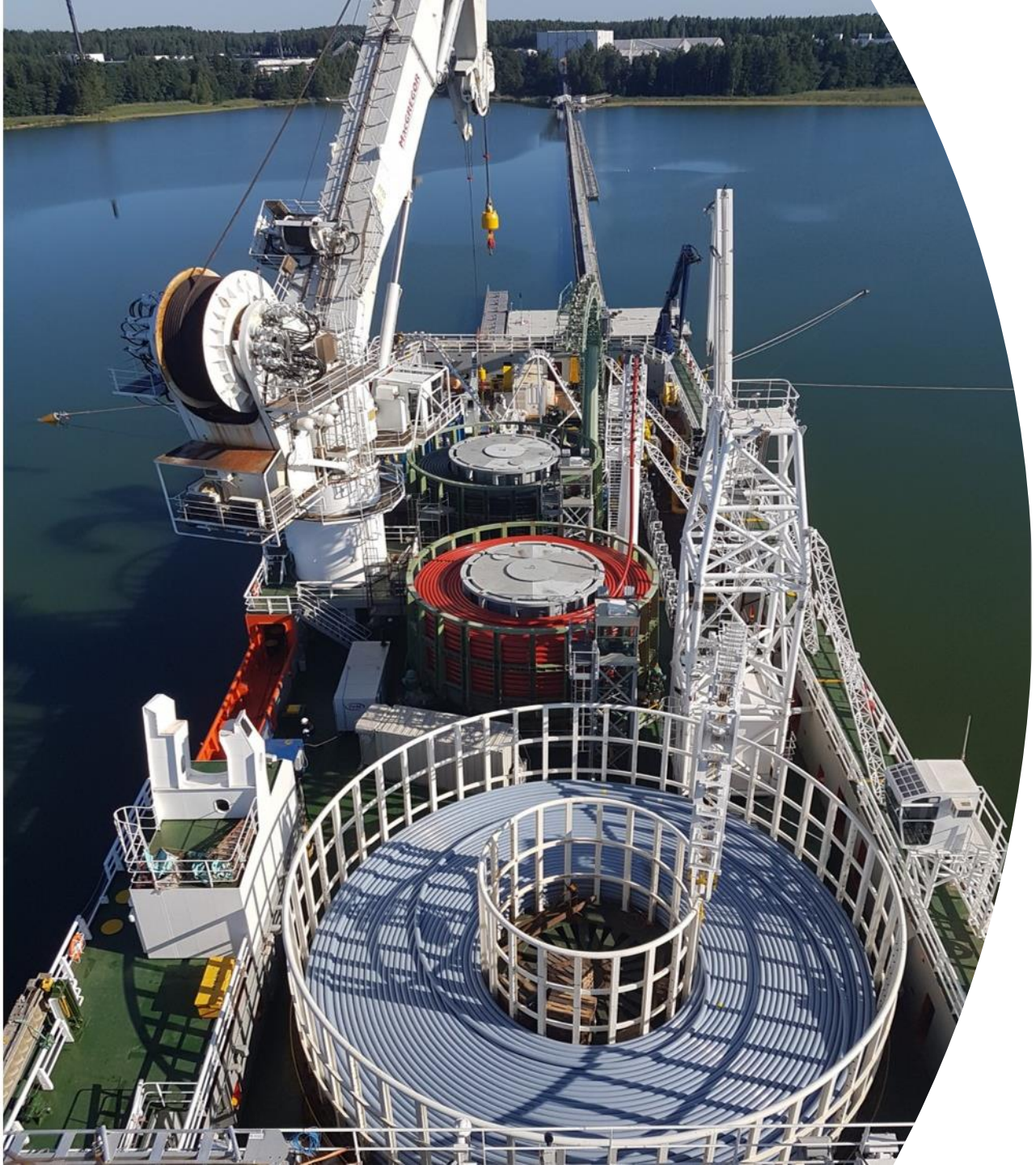
- The HTP 345kV system was laid in the Hudson River in 2017. This is used as an example as it is comparable to the OSW export cable systems proposed for NYC harbour.

- The techniques described will in most respects be the same for a two-cable HVDC cable system.

OUTLINE OF ANALOGOUS HTP CABLE INSTALLATION DESIGN 2017

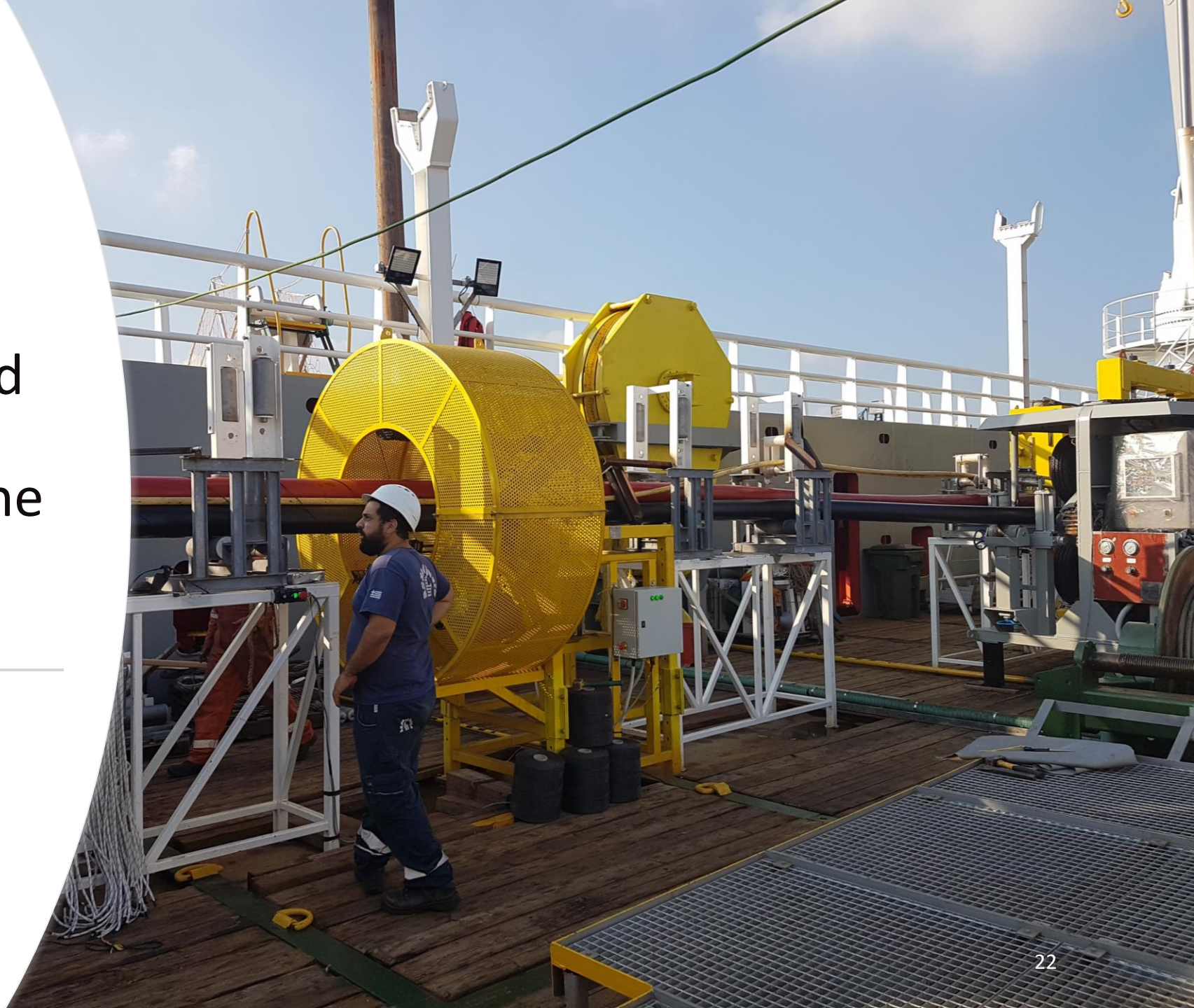
- HTP is 345kV 660MW system comprising 3 * 2000mm XLPE phase cables and two Optical Fibre cables.
- ~ 1600mt/~7km of cable transported from Finland and laid by CLV "*Ariadne*" in simultaneous lay and burial (SLB) mode.
- Phase and OF cables were bundled into a trefoil configuration
- Bundle buried to 15'/10' with Prysmian 6.2m "Hydroplow", jet-sled.
- CLV was dynamically positioned throughout; anchors were not used.

HTP Installation Cable Lay Vessel (CLV) “Ariadne” (Hudson River, 2017)



CLV “Ariadne” loaded with approx. 1600mt of 345kV HVAC cable for HTP 2017; each phase stored in its own rotating basket or carousel.

Three 345kV phase and two OF cables merged in the bundling machine at the stern of “Ariadne”.

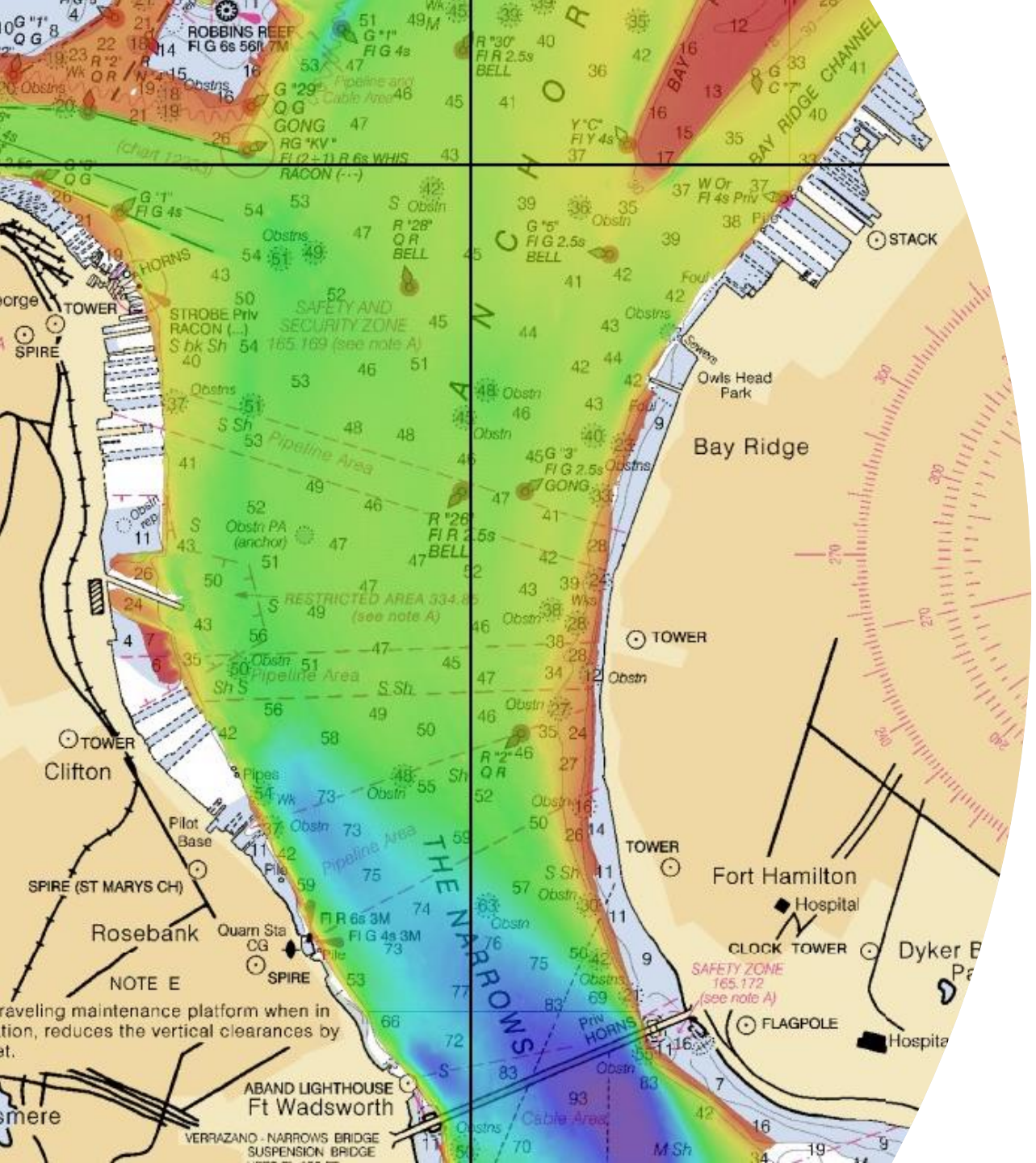


HTP cable bundle exiting the stern chute of “Ariadne”; Hydroplow support barge alongside (note black water hoses running to Hydroplow)

6.2m Hydroplow on deck and suspended from the support barge crawler crane being calibrated.

“Weeks 2223” support barge with 6 x water pumps and Hydroplow water pump and pressure test

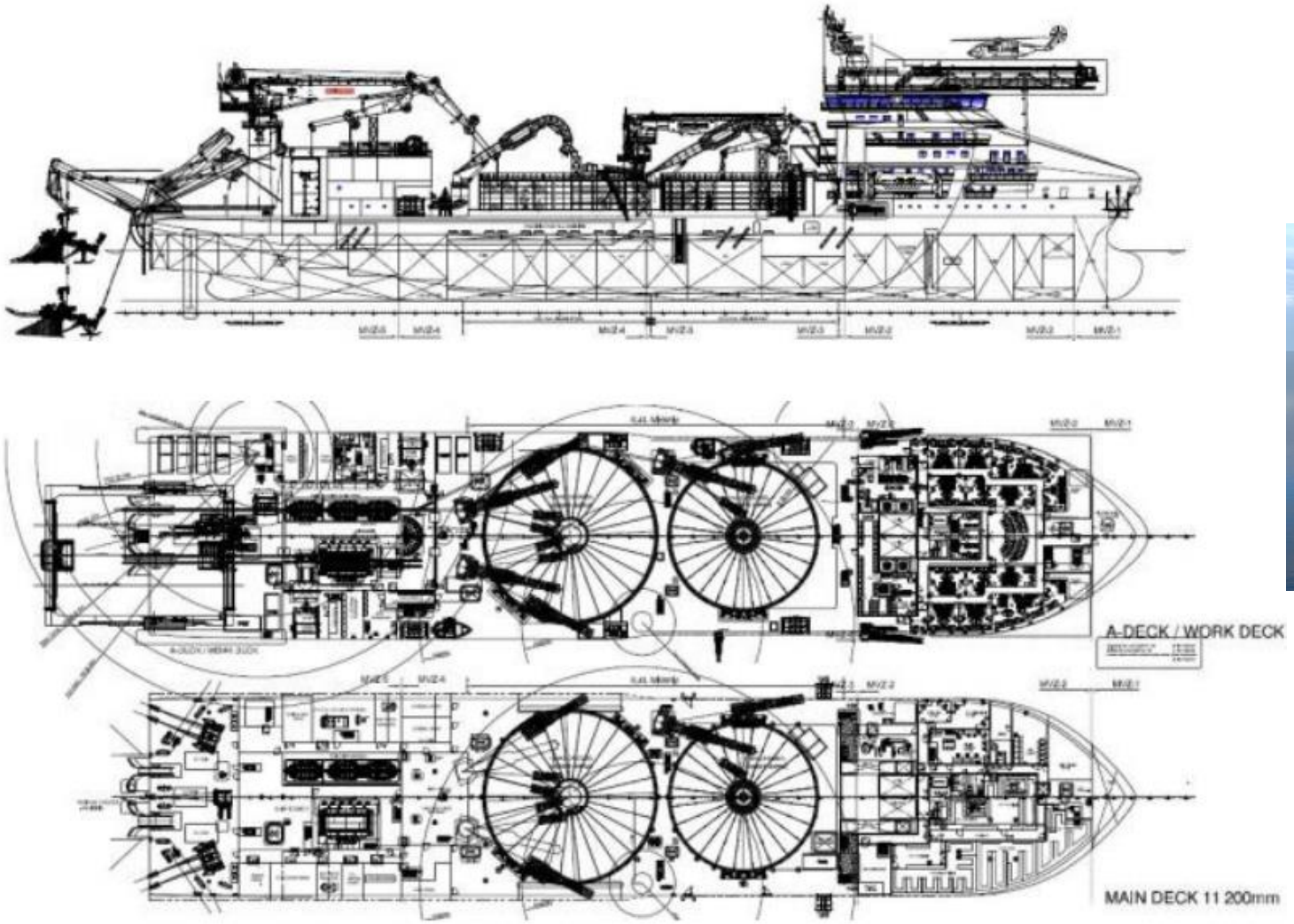
CLV “Ariadne” with “Weeks 2223” alongside, laying cable and towing the Hydroplow jet-sled.



CABLE INSTALLATION IN THE NARROWS AND UPPER BAY

- Installation technique was “simultaneous lay and burial” (SLB) with “Ariadne” and support barge moving as one unit on DP.
- SLB ties up the CLV for an extended time but this was considered the optimum method for safely achieving the 15’ burial depth requirement in anchorages and FNPs.
- It was considered improbable that such deep burial could be achieved using a post-lay burial technique whilst safeguarding the integrity of the cables.
- Installation design in The Narrows and Upper Bay would be expected to be very similar to HTP, regardless of whether the cable system were an HVAC trefoil bundle or HVDC bundle.
- Installation would suit one of the new range of CLVs coming into the market such as Prysmian’s “Leonardo da Vinci”

CLV “Leonardo da Vinci”



Prysmian Group

Dr Andy Page, Intertek Energy & Water

+44 1428 729570

andrew.page@intertek.com

http://www.intertek.com/energy-water/

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