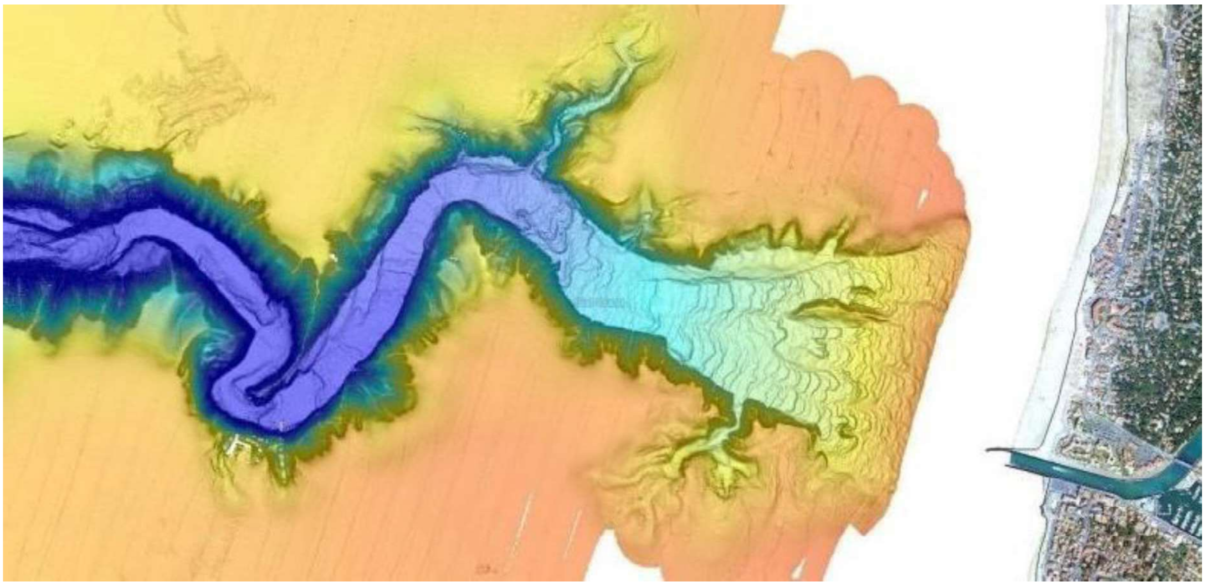
Marine Drilling Feasibility Studies under "Le Gouf de Capbreton"

Feasibility study report



Feasibility study report HDD crossings					
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1 SUMMARY AND CONCLUSIONS

Visser & Smit Hanab B.V. and INTECSEA B.V. as subcontractor have assessed the feasibility study for the Horizontal Directional Drilling (HDD) under the Capbreton canyon for a cable connection between France and Spain through the Bay of Biscay. This report covers the study of two scenarios for the crossing of the canyon. A summary of the findings and conclusions is given in this section.

This report is based on desktop information and general feasibility concepts are assessed. This report assesses concept feasibility only and further detailed engineering is required prior to construction.

Horizontal Directional Drilling

A typical HDD is either performed from an onshore to an onshore location or from an onshore to an offshore location. The following steps are normally executed:

- Pilot drilling – follow the designed trajectory
- Pre-reaming – enlarge the borehole to the required size
- Pullback – installation of the product pipe

For this project, where an HDD is required from an offshore to an offshore location, novel concepts have been examined to determine the feasibility.

Construction Platform

A subsea HDD construction will differ significantly from the onshore HDD construction. The subsea environment introduces a number of challenges that significantly increase the complexity of HDD construction. One of these challenges is to perform the HDD construction from a stable offshore platform. A jackup platform is selected for the construction platform for the Capbreton canyon crossing, as jackups form a reliable and stable construction platform and are used worldwide for diverse and complex offshore construction work.

Support Construction

A second challenge for the offshore HDD is the need to span the distance between the jackup topsides and the entry point of the HDD at the seabed. An extended casing needs to be constructed from the seabed to the jackup, guiding the drill string, transporting drill mud and drill cuttings. Two potentially feasible structural concepts to support the casing are assessed, as the casing itself is too flexible to withstand the environmental conditions. Both concepts are assessed for a 15 degree borehole entry/exit angle and 45 degree entry/exit angle. The two support construction options, steel pipe and steel truss, are listed in Table 1-1.

Table 1-1 Support Construction Concepts

Entry/Exit angle	Steel Pipe Support Construction	Steel Truss Support Construction
45	Concept 1: Steel pipe support construction in single span from topsides to seabed	Concept 2: Steel truss support construction in single span from topsides to seabed
15	Concept 3: Steel pipe support construction supported by one row of piles	Concept 4a/4b: Steel truss support construction supported by two rows of piles

The harsh environment in the Bay of Biscay results in wave slamming on the steel pipe and it is believed that the operational window is reduced in such way that weather downtime for concept 1 and 3 will be large. Furthermore it is expected that dynamic analyses will show an unfeasible solution due to fatigue. Therefore concept 1 and concept 3 are not regarded as feasible solutions.

Concept 2 comprises a steel truss to improve the robustness and increase the strength and stiffness of the support structure. A steel truss must be custom made and requires further design effort; however a steel truss is a proven concept in the pipeline installation industry and therefore the selected as the support construction for the 45 degree angle option. More steel area will be exposed to wave loads and therefore the support reactions on the jackup will increase; however, it is believed that the larger construction jackups can handle these forces.

Concept 4 comprises a steel truss, 155 m in length, positioned between two rows of piles with a steel I-beam in between. The triangular truss is 4 m in width and 2.8 m in height. Two calculations are performed, for expected maximum summer conditions (concept 4a) and all-year environmental conditions (concept 4b). The supporting pipes of the steel truss are heavier for the concept 4b than for concept 4a. HDD construction using the support construction concept 4a is limited to the spring/summer period. Support construction 4b is a heavier construction and resists all-year environmental conditions and requires substantial heavier installation work. Concept 4b is heavier and the supporting piles are a factor 1.5 larger in diameter (1.4 m in diameter) than Concept 4a. Although the heavier supports construction (concept 4b) may resist the environmental impact forces, it may not result in a continuous HDD operation. Other factors such as on-deck safety or limited logistics, resulting in downtime could be significant in the winter time. As such, demobilization of the jackup before the winter and remobilization in the spring could be a better economical solution. Compressing the construction time within the summer months should be taken into consideration, however this is only possible within 2 jackups drilling from both sides. Optimization of these construction scenarios is a typical design case for further studies, but does not influence the technical feasibility and as such is not elaborated in this study.

HDD design

Crossing location 3a is regarded as most feasible. A combination of drill length, water depth and distance to erosion areas show that this location is suitable for HDD construction.

The 15 and 45 degree entry angles have been chosen, because of the suitability for HDD construction, but also for cable installation. The steeper the angle, the more risk on the cable sliding in the duct resulting in undesirable compressive forces in the cable core. One of the major cable suppliers has confirmed that 45 degrees is a feasible option; however, it requires further examination in a next phase.

Cable pull calculations combined with information obtained from cable suppliers indicates that a feasible cable configuration and installation method is present in the market.

Mud management is achieved by using a casing that is installed into the seabed and reaches to the jackup where the mud recycling unit and drilling rig are situated. For both the 5 borehole option as the 2 borehole option, measures can be taken to minimize mud loss during the operations by minimizing the time that there is a connection between the borehole and the sea or to have a closed system during the pilot and reaming phase. Mud loss during pullback cannot be completely avoided; however, it is expected that displaced volumes have a negligible impact on the environment.

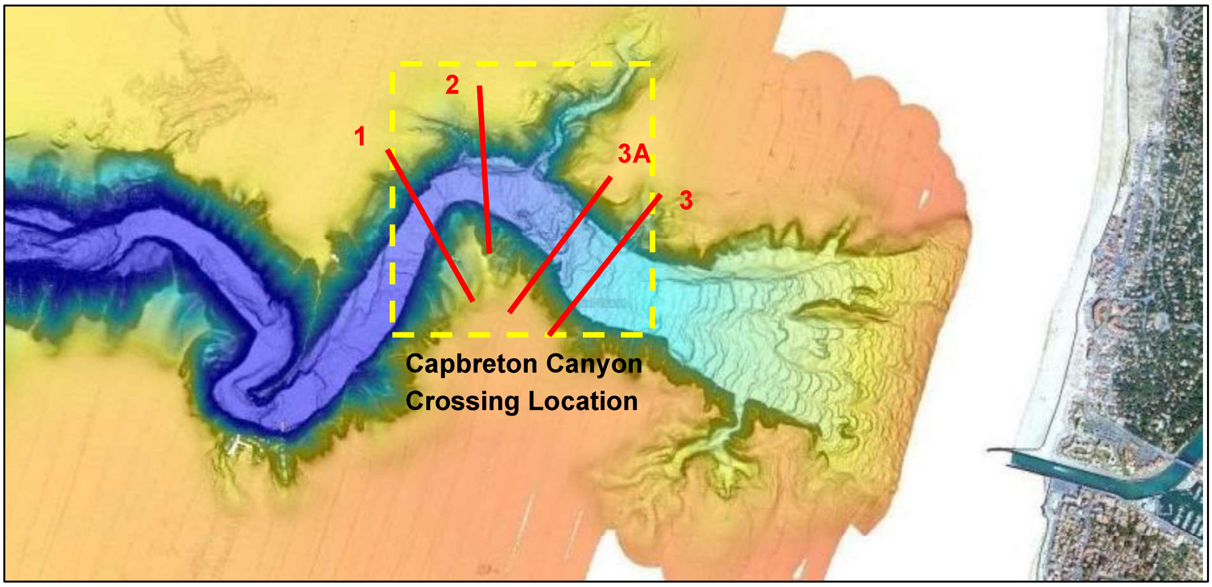

Figure 1-1 Crossing Locations. Crossing 3A is chosen as the most feasible crossing route.

Risks and opportunities

Main risks identified for this project are:

- Availability of suitable jack ups
- Sensitivity of offshore operations to weather/sea conditions
- Cable transition and jointing
- Complexity of the support structure
- Unforeseen geological/geotechnical conditions

Main opportunities are:

- Cable configuration optimization
- Economic feasibility of steel pipeline with inner HDPE liner
- Integration of FOC in power cable
- Schedule optimization

Schedule and costs

Depending on the use of an additional jackup for piling and/or support structure placement, the runtime of the project on location may differ between [redacted] days (base case) for the 2 borehole and 5 borehole option respectively. A schedule has been added where the project is executed in [redacted]. The corresponding estimated costs at screening level for both options are € [redacted] and € [redacted] respectively, including [redacted] weather downtime, excluding a € [redacted] estimate for contingencies.

For the basis and assumptions of the costs, please refer to section 8. Optimization of the installation method and schedule in the next phase may reduce the total costs involved in this project.

Conclusion

Two scenarios have been examined and are deemed technically feasible, [redacted] Detailed engineering and optimization of methods has to be performed before construction, but a geophysical and geotechnical survey could be a first step to reduce the uncertainty in the cost estimate to be able to make a decision on the feasibility of the HDD project. The examined scenarios are interchangeable and could be optimized. For example, the 5 borehole option could also be drilled under an angle of 45 degrees and vice versa. However, for the cable installation, the 15 degree option is more favourable. For the support structure installation, the 45 degree option is more favourable. For mud management purposes (reduction of mud spill), drilling from two sides is more favourable, but for the project costs it could be interesting to examine the option of 2 boreholes under 45 degrees, while drilled from one side.

Based on the Client’s priorities and the defined risks and opportunities, an optimal solution may be found in a next phase.