WP2 Activity 1 Progress report

Summary

In the framework of the DIOL project, the partner port and Brest Port in particular carry out technical studies to adapt the offshore wind terminals to the requirements of the industry, aiming at satisgying the fast deployments targeted by the governments.

Due to its particular geographical location, BrestPort focuses on floating wind technologies. These technologies have specific characteristics in terms of size and weight of the components. These characteristics also induce specific adaptations of the terminal to support these weights, of the logistic equipment which must be able to transport and load/ unload the components, and of the sea areas where the wind masts will be stored .

The WP2.1 studies are divided in five themes:

- Transhipment: details the most convenient means to unload the components from a service vessel
- Terrestrial spatial planning: studies to optimise the land spaces required for the floating wind industry to produce, store and integrate the floaters, masts and rotors, considering forms, sizes of components.
- Launching systems: details means of launching the components at sea and on board a vessels
- Maritime Spatial planning: studies the storage of the components at sea
- Adaption of the berths (the Offshore Wind berth and the "energy" berth that could be used for transhipment and storage of components. The adaptation requires heavy works (a proposal has been submitted to the EU CEF call in January 2025).

Below are provided summary tables of the main study results of these “feasibility studies”. The report presents more details of results of these studies that will be the bases for further works.

Results of the theme 1: transhipment

Table VI-1 below summarises the conclusions of Theme 1-phase 1 [1] and the additions in §I of this note.

In a nutshell:

Subject to the **refurbishment of QR5** by the creation of a heavy zone capable of accommodating harbour cranes, SPMTs and Reachstackers, and subject to **confirmation of the possibility of routing** SPMTs and Reachstackers between this heavy zone and the polder, the transhipment of all 25 MW components (floats and wind turbine) is possible without limitation according to the following arrangements:

- **Unloading possible at** heavy **QR5** for cargo ships with harbour cranes (up to around 300 t) or by bulk vessel.
- **Unloading possible at the berth "EMR" (berth of the offshore wind terminal)** for the same vessels and with the same resources, plus possibility of using a project crane for larger packages.

  and finally the possibility of unloading by side RORO using a semi-submersible vessel.

Table VI-1: Summary of solutions Stage 1 - Theme 1: Transhipment

THEME 1	QR5	Rear quay QR5	Route QR5 4 QEMR	QEMR
Dimensions (L x b)	• 200 m x 30 m	• 290 m x 47 m	• 500 m x 17.6 m	• 400 m x 100 m
Minimum load-bearing capacity of platform	• **Increase to 4 t/m²**	• **Increase to 10 t/m²**	• **Current capacity: 10 t/m²**	• **Current capacity: 10 t/m²**
Ships				
HLV	• **Length of quay available: 200 m** • **Dimensions of pit: 90 m x 200 m** • **Sub-base : between -9.00 and -10.50 m CM**			• **Length of quay available: 400 m** • **Dimensions of pit: 100 m x 390 m** • **Bottom of pit: -12.00 m CM**
General cargo				
Semi-submersible **vessel**	• **Length of quay available: 200 m** • **Dimensions of pit: 90 m x 200 m** • **Deepening of pit to -10.30 m CM possible if dredging carried out**			
Horizontal handling equipment + Lifting equipment				
Wheeled cranes + skids (LHM)	• **Local reinforcements: up to 40 t/m² locally over 10 m²** **"Heavy zone": 80 x 20 m** centred on the 200 m of quay and 5 m from the quayside			• **Adapted quay** outside the 5 m quayside strip
SPMT / Reachstacker	• **Localised reinforcements: 10 to 12 t/m²** **"Heavy zone": 80 x 20 m** centred on the 200 m of quay and 5 m from the quayside	• **Local reinforcements: 10 to 12 t/m²** to join the route	• **No rigid inclusions required** • **Apply a thicker layer of form** • Traffic at a distance of 6.40 m from the retaining wall	• **Current capacity: 10 t/m²**
CONCLUSIONS	**Refurbishment of Poste North**, 200 m long	**Floor reinforcement of the back platform**	**Apply a thicker layer thicker**	**No work required**

Caption:

- **Red**: work to be carried out
- **Orange**: work possible if the limits set by the Port for Stage 1 are exceeded
- **Green**: No work required 4 suitable infrastructures

\- Out of scope

Results of the theme 2: Spatial planning of the terminal

Table VI-2 below summarises the conclusions of Theme 2-phase 1 [2] and the additions in §II of this note. In summary:

- Work to be carried out by the port to create a heavy roadway serving the entire length of the polder and capable of handling all SPMT shipments.
- Provision of a construction area, to be developed by project owners according to their own needs.
- Significant possibility of dry storage of assembled floats in the same area, subject to arrangements by the PPs.

Table VI-2: Summary of solutions Stage 1 - Theme 2: Terminal development

THEME 2	Heavy roadways	Rainwater management	Strip near the gabionade	Construction and dry storage
Surface concerned	• 9 ha		TOTAL made available: 4 ha	TOTAL made available: 21 ha
Load-bearing capacity	• Increase to 10 t/m^2	-	• Maximum permissible load: 4 t/m^2	• To be defined by the developer
Horizontal handling equipment				
SPMT / Reachstacker	• Subgrade: minimum thickness 2.3 m • Rigid inclusions under the subgrade (130 m wide strip)	-	• No heavy traffic permitted above 4 t/m^2	• At the developer's expense
Mobile vacuum cranes	• Excluded use			
CONCLUSIONS	Reinforcement of a lane for SPMT and Reachstacker traffic			At the developer's expense

Caption:

- Red: work to be carried out
- Orange: work possible if the limits set by the Port for Stage 1 are exceeded
- Green: No work required□ suitable infrastructure

\- Out of scope

Results of the theme 3: Launching the floaters

Table VI-3 below summarises the conclusions of Theme 3-phase 1 [3] and the additions in §III of this note. In summary:

- Possibility of loading onto a vessel / semi-submersible barge from the QEMR and via SPMT without any infrastructure modifications (except for relocation of the sand dock).

All other launching solutions are excluded from this stage.

Table VI-3: Summary of solutions Stage 1 - Theme 3: Launching floats

THEME 3	QEMR1	QEMR 2
Length of quay	• 200 m	- 185 m
Current capacity	• 10 t/m²	- 10 t/m²
Launching system		
Ring Crane	• *Reinforcement at 25 t/m(2) (slab on piles)* • *Maximum crane load: 3000 t – not realistic for launching floats*	- *No reinforcement possible – insufficient space for piles*
Semi-submersible vessel	• Sufficient quay capacity for SMPT / Reachstacker traffic • No dredging required - 74% operability window • Moving the sand dock	
CONCLUSIONS	No work required on the quay Relocation of the sand dock	

Caption:

- Red: work to be carried out
- Orange: work possible if the limits set by the Port for Stage 1 are exceeded
- Green: No work required suitable infrastructure

- Out of scope

Results of the theme 4: maritime storage

Table VI-4 below summarises the conclusions of Theme 4-phase 1 [4] and the additions in §IV of this note. In summary:

- No storage facilities in the harbour
- Possibility of positioning a float under the integration crane subject to repair of the berthing table and within the depth limits of

  The (100 m)
- Possibility of storing 2 floats on QR3 (including 1 pre-commissioning float if TE=10.5 m max) subject to frontage arrangements.

  a wider berth (currently 70 m) and a solution, to be provided by the manufacturer, for the interface between the floats and the pile dock

Given the low storage capacity obtained in Stage 1, it is recommended that the development of mooring areas afloat or along the QR2 presented in Phase 1 be reconsidered [4].

Table VI-4: Summary of solutions Stage 1 - Theme 4: Maritime storage

THEME 4	QR2	QR3	QEMR	Zones 1 and 2 (Port of Brest)
Depth of pit	• -9 m CM	• -11.5 m CM	• -12 m CM	• **Zone 1:** -7 to -8 m CM • **Zone 2:** -9 to-10.5 m CM
Length of quay / zone	• 288 m	• 320 m	• 400 m	• **Zone 1:** 670 m + 400 m • **Zone 2:** 870 m
Maritime storage of floats				
Dockside mooring	• **Reinforcements / Development of the berthing front** • **TE max: 7 m** without dredging **insufficient for bare floats** • **Maximum float width --g 75 m** 4 **Possible widening of the trench if dredging is carried**	• **Reinforcements / Development of the berthing front** • **TE max: 9.5 m** without dredging **OK for bare floats** • **Maximum float width --g 75 m** 4 **Possible widening of the**	• **Development of the berthing front** • **TE max: 11 m** without dredging **OK for bare floats** • **Max float width --g 95 m**	
Mooring				Without dredging : • **TE max < 5 m** **Insufficient for bare floats** 4 **Possible deepening if dredged** • **Minimum width: 100 m**
Grounding				• **Only if soil reinforcement with ballast**
CONCLUSIONS	**Not recommended without reconstruction QR2 + deepening of pit**	**Reinforcements / Development of the berthing front** **+ possible widening of pit**	**Development of the berthing front**	**No solution without dredging**

Caption:

- **Red**: work to be carried out
- **Orange**: work possible if the limits set by the Port for Stage 1 are exceeded
- **Green**: No work required 4 suitable infrastructures

- Out of scope

Results of the theme 5: Turbine integration

Table VI-5 below summarises the conclusions of Theme 5-phase 1 [5] and the additions in §V of this note. In summary:

-The integration of wind turbines is possible at the East part of the OW terminal berth, subject to the construction of the crane pad (and the relocation of the sand dock).

already requested in Theme 3 "launching") with dimensions adapted at least to the footprint of 3000 t cranes. Further consideration to be given to the benefits of extending this crane pad to accommodate 6000 t cranes.

Table VI-5: Summary of solutions Stage 1 - Theme 5: Turbine integration

THEME 5	QEMR 1
Length of quay	- 200 m
Turbine integration system	
Ring Crane	- Reinforcement of a crane pad at 25 t/m(2) (slab on piles) -* 75 m square or 100 m square - Moving the sand dock
Temporary storage of components	- Waiting on SPMT before integrating 4 quay capacity at 10 t/m^{2}Local reinforcements if necessary at developer's expense -
Home to an integrated float	
Float mooring	- Development of the berthing front - TE max: 11 m without dredging -* OK for bare floats 4 Deepening for integrated floats (TE: 12 m) subject to further studies and reinforcement work Max float width ≈ 95 m -
CONCLUSIONS	Platform reinforcements + Development of the berthing front

Caption:

- Red: work to be carried out
- Orange: work possible if the limits set by the Port for Stage 1 are exceeded

Table of content

INTRODUCTION

Purpose of the note

The purpose of this note is to supplement the feasibility studies carried out as part of phase 1 of the INFLOW project. Each part of this note is a complement to the feasibility notes previously written:

- Theme 1 : Transhipment [1]
- Theme 2: Terminal development [2]
- Theme 3: Launching floats [3]
- Theme 4: Maritime storage [4]
- Theme 5: Turbine integration [5]

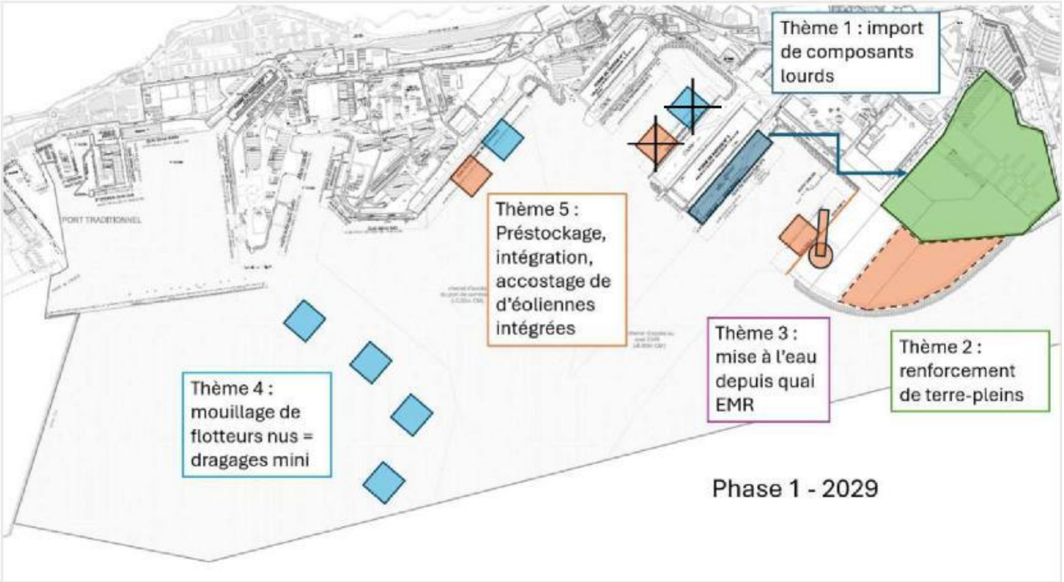
On the basis of the developments proposed in phase 1 and the additions of this phase 2, the choices for each of the themes will be determined by the project owner: this constitutes the stopping point of Stage 1. The selected developments will make up a Logistics Scenario [6], which will be accompanied by the following deliverables:

- Planning Project [7]
- General plan [8]
- Plan Masse [9]
- Provisional timetable for the operation [10].
- Estimated quantity of work + Costing of studies and work [11].

Scope of the study

This note summarises the developments studied for Stage 1 - Horizon 2029. As a reminder, the "CCTP - Complément phase 2 v1" provides for developments to be divided into 2 stages:

- Stage 1 - target in 2029: investments made before AO5, metal or concrete floats
- Stage 2 - target in 2032: investment carried out post AO5, depending on the turbine targeted in the ph1 studies; metal or concrete



Stage 1: Indicative illustration ("CCTP - Complément phase 2 v1")

Abbreviations

AHTS	*Anchor Handling Tug Supply*
CM	Marine rating
CSV	*Construction Support Vessel*
CTV	*Crew Transfer Vessel*
EMYN	Wind turbines at sea Yeu-Noirmoutier
HLV	*Heavy Lift* Vessel
LOA	*Length Overall*
NGF	General levelling of France
QR	Repair wharf
RORO	*Roll On Roll Off*
ROV	*Remotely Operated Vehicle*
SGRE	*Siemens Gamesa Renewable Energy*
SHOM	French Navy Hydrographic and Oceanographic Service
SOV	*Offshore Vessel Service*
SPMT	*Self Propelled Modullar Transporter*
TE	Draught

Reference

The reference system used in this report refers to the sea level in the area (CM Brest). According to SHOM, the land levelling (IGN 69 level) is at -3.635 m in relation to the hydrographic zero at Brest, i.e.: **0 m CM = -3.635 m NGF (IGN 69), rounded to 3.64**.

It should be noted that prior to 1996, the 0 CM corresponded to -4.136 m NGF, which should be taken into account when analysing archive documents.

As some of the structures studied were built before 1996, the plans and sections of the structures dating from their construction are annotated using the old reference system. To avoid any ambiguity, we will specify in this report when a CM (pre-1996) is involved.

The planimetry will be based on the Lambert 93 projection and the RGF 93 geodetic system.

A summary of the water levels can be found in the Framework Note - General Assumptions [12], as these data are cross-cutting for the different Themes.

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I. THEME 1 : TRANSSHIPMENT

I. 1 Functionality

I. 1. 1 Overview of functional requirements Phase 1

The nature of the packages to be transshipped in the "25 MW" scenario is defined in the logistics appendix to the feasibility note [13], reproduced in the document referred to in [1], and is presented below.

Table I-1: Steel float components Table I-2: Wind turbine components

LISTE DES COMPOSANTS			
NO.	DESIGNATION	QT.	Masse (t)
FSS			
1	COLONNE CENTRALE	3	900
2	BRACE 1	6	200
3	BRACE 2	3	75
4	BRACE 3	6	75
5	BRACE 4	6	200
			5775

S1	1	550
S2	1	500
S3	1	400
S4	1	350
S5	1	200
NACELLE	1	1100
PALE	3	150
		3600
WTG		
DESIGNATION	QT.	Masse (t)

The functional requirements in terms of port infrastructure are summarised in the table below: *Table I-3: Summary of transhipment facilities and associated port constraints*

Transhipment solution	Use	Port constraints
HLV	Can be used for float sub-assemblies and wind turbine components Possible up to 2*800 t, more exceptional 2*1500 t	200 m of quay with 9 m of TE 12 t/m^{2}carrying capacity at the back of the quay (SPMT and Reachstacker)
RORO	Highly suitable for wind turbine components, particularly nacelles	RORO ramp (fixed or floating) adapted to SPMT
Semi submersibles used in RORO	Used for the heaviest sub-assemblies and long-distance journeys (Asia)	260 m of quay 10 t/m^{2}carrying capacity at quayside (SPMT)
Harbour cranes	All parcels up to 352 t currently and potentially 616 t subject to the purchase of 2 LHM 800s	Portion of platform supporting 3 t/m^{2}evenly distributed and 15 t/m^{2}under the skids 10 t/m^{2}load-bearing capacity at back quay (SPMT)
Crawler cranes	Depending on the capacity of the crane, all packages up to around	Area of approximately 42*42 m located 5 m from the quayside
Ring Crane	For parcels up to around 3,000 t	80*80 m zone located 5 m from the quayside reinforced to 25 t/m^2

I. 1. 2. Transfer to QR5 a)

Description

QR5 (for quai de réparation n°5) is located to the south. It is currently used as an oil and gas wharf on the western side and a scrap yard on the eastern side. It could soon be used by sand vessels if the dedicated wharf is relocated there (see §III. 2. 1).

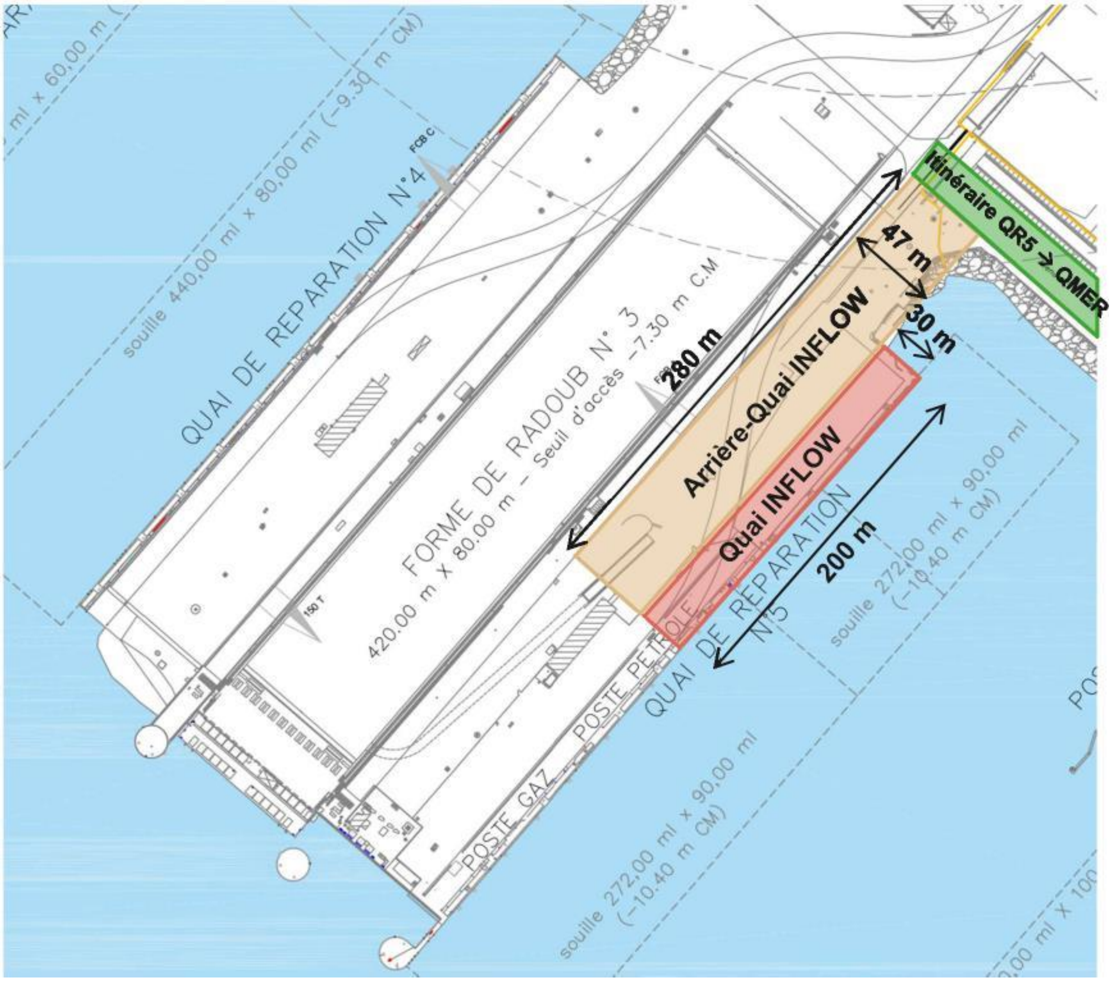


Figure I-1: QR4/QR5

QR5 is 390 m long (plus 30 m to the gabion). It has a trench 540 m long and 90 m wide at a depth of -10.4 m CM. The bathymetry provided shows shallower water in the north-eastern part of the quay.

From south to north, it includes a gas substation, an oil substation and a scrap metal substation currently being redeveloped.

The future of QR5 is under study. It could become a multi-purpose quay, retaining its gas berth and oil berth, while also accommodating the hourglass berth and heavy parcel activities.

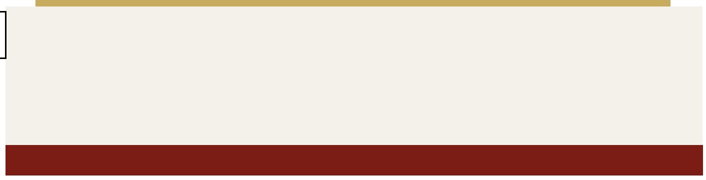
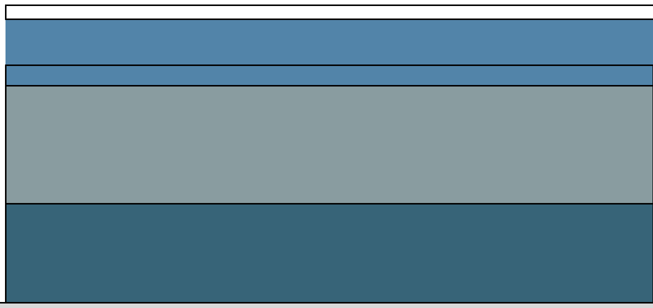
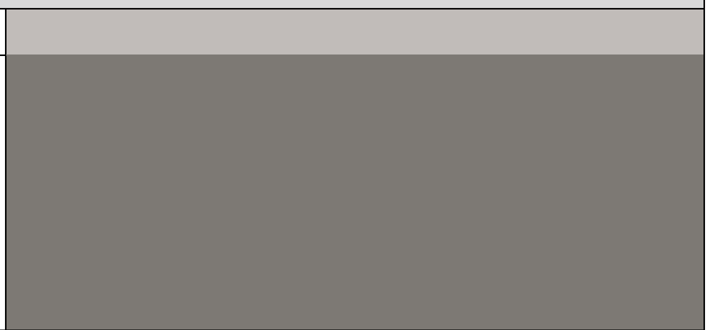
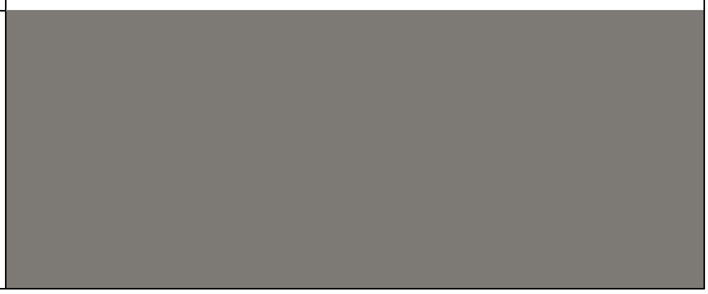
These Heavy Parcel activities would be housed on the northernmost 200 m of the quay (shown as the 'INFLOW quay' in Figure I.1).

This is a pile dock with a continuous berthing face 5.50 m high, equipped with 150 t bollards every 32 m.

b) Transport vessels

The transport vessels likely to deliver the target packages to the northern part of QR5 are either Heavy Lift Vessels (HLV), using their own cranes for unloading, or General Cargo vessels requiring the use of quayside cranes for unloading the heaviest packages, or Semi-submersible vessels used in RORO. The table below gives some examples of these categories.

Table I-4: Transport vessels

HLV	
Jumbo K3000 class - Dimensions: 152 x 27 m - Tonnage: 14,000 t - Draught: up to 8.1 m - Tandem lift: 2 x 1,500 t	
Sal 183 - Dimensions: 161 x 28 m - Tonnage: 12,500 t - Draught: up to 9.1 m	
ORCA* class - Dimensions: 150 x 27 m - Tonnage: 14,600 t - Draught: up to 8.5 m - Tandem lift: 2 x 800 t * Vessels under construction chartered by	
General Cargo	
MACS Blue Master II - Dimensions: 200 x 31 m - Tonnage: 30,500t - Draught: 11.1 m	
Star Java - Dimensions: 198 x 32 m - Tonnage: 30,500t - Draught: 11.1 m	

Semi submersible	
Blue Marlin - Dimensions: 225 x 63 m - Deadweight tonnage 76,000 t - Draught: 10, 24 m	

Comments :

Figure I-2: Blue Marlin and Jumbo at the heavy station

Because of its size (> 200 m), but above all its draught, access for the Blue Marlin to the future heavy lift station seems difficult. Although there are smaller semi-submersible vessels (and larger ones), the Blue Marlin was selected at La Rochelle for the RORO unloading of the 1,000 t monopiles because of both its ballasting capacity and its unique ability to rise above the water. Furthermore, RORO unloading could be made impossible by the installation of the sand pipe in a gallery under the quay. **We therefore propose to exclude this option from the QR5 transshipment possibilities.**

Given the depth of the trench (just over 9 m north of QR5), access for some of the General Cargo vessels identified in the table could be restricted to certain draught values or tidal conditions.

c) Use of port cranes

Wheeled cranes

The dimensioning characteristics in terms of ground loads are, for existing mobile cranes :

- LHM 550
  - 8 x 1.2 = 9.6 m^2skate
  - Distance between front and rear skid centres: 13.5 m
  - Maximum dynamic pressure: 329.2 t under skid, i.e. 34.3 t/m^2
- LHM 600 (104 t)
  - Skate 5.5 x 1.8 = 9.9 m^2
  - Gap between front and rear skid centres: 14 m
  - Maximum dynamic pressure: 365 t under skid, i.e. 36.9 t/m^2
- LHM 600 (208 t)
  - Skate 5.5 x 1.8 = 9.9 m^2
  - Gap between front and rear skid centres: 14 m
  - Maximum dynamic pressure: 400 t under skid, i.e. 40.5 t/m^2

The most powerful model in the range currently offered by Liebherr is the LHM 800 with a capacity of 308 t at 16 m, whose ground loads are determined by :

- LHM800 (308 t)
  - Skates 8 x 2 = 16 m^2
  - Gap between front and rear skid centres: 15 m
  - Maximum dynamic pressure: 496.3 t or 31 t/m^2in the heaviest configuration.

The capacities accessible with the existing tandem cranes are a maximum of 352 t (144+208) with the use of a coupling system. It would be 616 t if two LHM 800s and the same coupling system were acquired, subject to confirmation of the possibility of operating such cranes at full load on these quays.

These values obviously depend on the radii of use, as shown in the LHM 800 curve below.

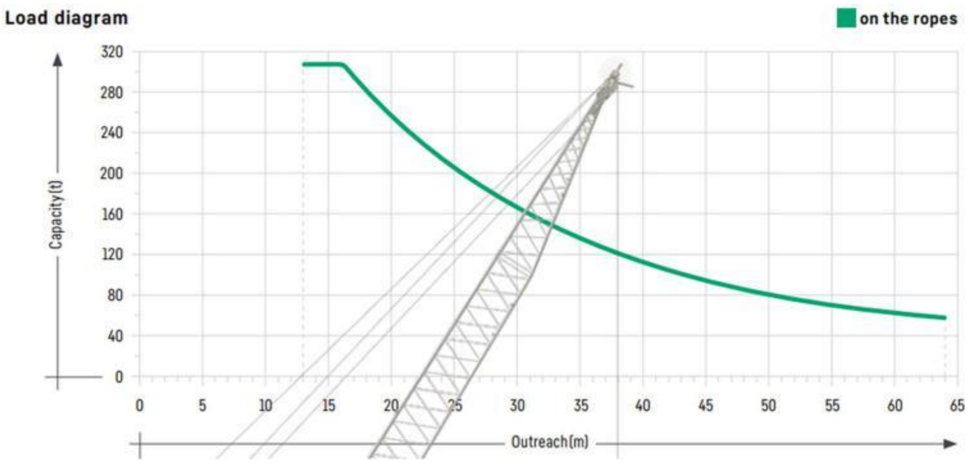


Figure I-3: LHM 800 capacity curve

Taking the positioning of the cranes in Figure I-7 as a reference, a package in the centre of the ship is 33 m from the cranes. At this distance, the capacity of the LHM 800 is around 150 t and 105 t for the LHM 600.

These capacities are estimated in the "25 MW components" table below, with those that can already be transshipped with existing port cranes shown in green, those that could be transshipped with the most powerful mobile port cranes on the market shown in yellow, and those that are beyond the reach of existing port cranes shown in red.

LISTE DES COMPOSANTS			
NO.	DESIGNATION	QT.	Masse (t)
FSS			
1	COLONNE CENTRALE	3	900
2	BRACE 1	6	200
3	BRACE 2	3	75
4	BRACE 3	6	75
5	BRACE 4	6	200
			5775

S1	1	550
S2	1	500
S3	1	400
S4	1	350
S5	1	200
NACELLE	1	1100
PALE	3	150
		3600
WTG		
DESIGNATION	QT.	Masse (t)

Figure I-4: List of components for a 25 MW wind turbine

d) Crawler crane

For parcels that are beyond the capacity of port cranes, a **crawler crane** can be mobilised on the QR5, subject to compatible load-bearing capacity.

As stated in the document referred to [1], a **CC 8800-1 BB crane** is needed to lift packages weighing around 1000 t.

The dimensions, characteristics and load-bearing requirements of this crane are specified in the same document. In this case, the crane pad is a square with a side length of 42 m, designed to support uniformly distributed loads of 25 t/m^2.

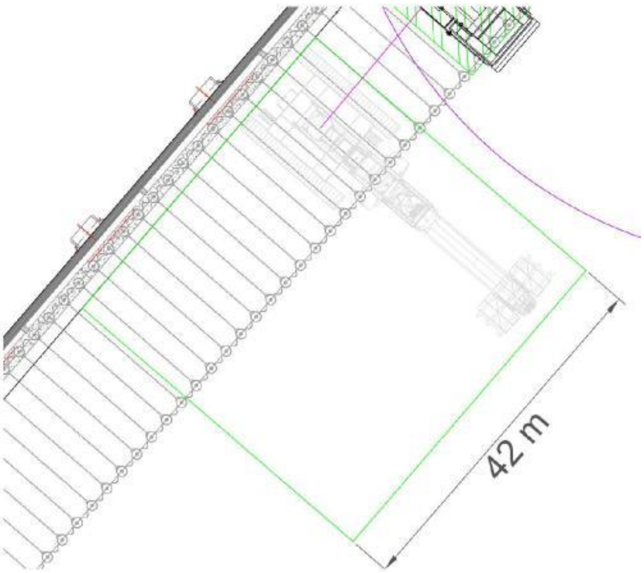


Figure I-5: Crane pad for CC 8800

Given that the QEMR is already compatible with the use of such a crane, the port will have to assess the benefits of making the QR5 compatible for its use as well.

e) Rail-mounted crane

Part of QR5 is equipped with rails for the movement of 15 t cranes. These rails are no longer in use and do not concern the northern part of the quay. However, at a time when the scrap yard is being refurbished, the installation of rails and a crane is a possible option for giving the port the capacity to lift heavy parcels.

Table I-5: Example of a rail-mounted crane

For example, the Liebherr plant in Rostock is equipped with a 1600 t capacity rail-mounted crane.

This is a 'made-to-measure' product that is certainly very expensive.

This crane runs on two double rails and exerts the vertical and horizontal forces shown below.

This crane has the capacity to unload all the components presented in the logistical hypothesis note [13].

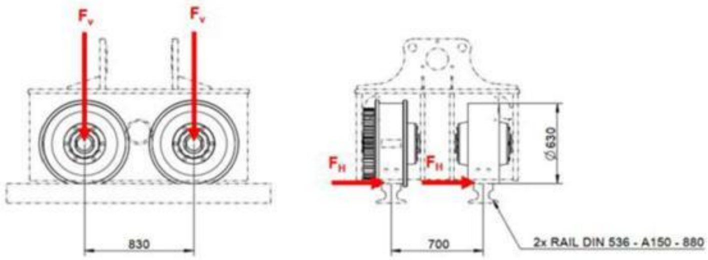
1. Maximum vertical wheel loads * F_V

quay loadings hook	seaside			landside		
	max. corner load	max. wheel load	max. load/metre	max. corner load	max. wheel load	max. load/metre
dynamic incl. wind	3200,0 t	115,0 t	160,0 t	3200,0 t	115,0 t	160,0 t

2. Maximum horizontal wheel loads* F_H

Maximum horizontal transversal load per wheel = (seaside, 40 wheels per corner) = **20,0 t**

Maximum horizontal transversal load per wheel = (landside, 40 wheels per corner) = **20,0 t**



f) Use of SPMT and Reachstacker.

As indicated in the reference document [1], the SPMT is the ideal vehicle for moving parcels from 45 t to almost 10,000 t.

The necessary bearing capacity of the ground beneath the SPMT is defined by the following elements:

- The pressure exerted by the axles on the ground through the tyres, which are inflated to 12 bar.
- The load-bearing capacity required at ground level without load distribution is the ratio of the load maximum of 48 t on the surface area covered by a line (2.43 * 1.4 m), i.e. 14.1 t/m^2
- The load-bearing capacity required at a depth of 560 mm with a 45° load distribution is 9.8 t/m^{2}for axles loaded to 48 t each

The figure below shows the load distribution at 45° to ground level.

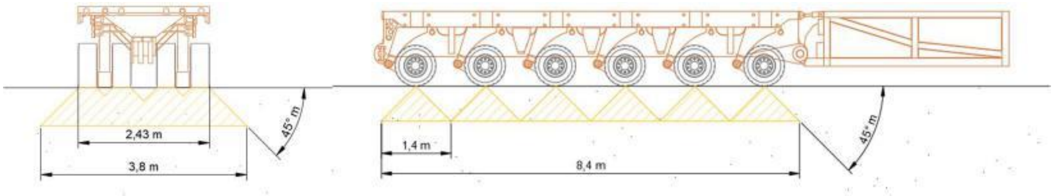


Figure I-6: Bearing capacity under SPMT

If the lift does not reach these values, it may still be possible to use an SPMT, but this would mean reducing the load per line, and therefore multiplying the number of lines for the same load.

For parcels weighing less than 45 t, and in particular for containers and tools which often accompany deliveries of wind energy equipment, the Reachstacker, although not essential, is very convenient to use. Its ground load is of the order of 12 t/m^{2}below the surface layer.

g) Sizing the "heavy" zone, excluding crawler cranes. It is clear from

the previous chapters that a "heavy zone" is required for :

- Positioning two port cranes in tandem
- SPMT access to the point where components are unloaded by ship cranes or cranes port
- Reachstacker access to the point where containers are unloaded by ship's cranes or the port cranes

To characterise this "heavy zone", the following factors are taken into account:

- The first 5 metres from the quayside are in principle excluded, but if this distance is reduced, it is as much capacity gained for cranes.
- SPMT and Reachstacker must be able to access the right of the two HLV cranes
- A crane pad must be sized and positioned in such a way that it can accommodate two LHM 800s at the same time.

  tandem and that the vessel can be shifted in front of this pad if necessary.
- The distance between the cranes must allow the blades to be unloaded.

A proposed layout is shown below:

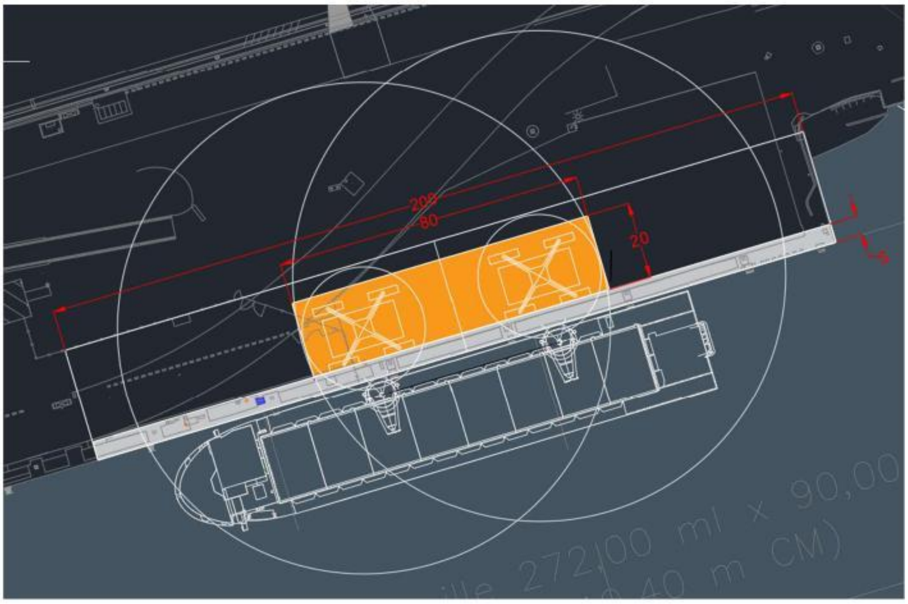


Figure I-7: QR5 heavy zone

The "**heavy zone**" **measures 80 x 20 m and is centred on the middle of the 200 m of quay**, so that ships can be unshipped in either direction. This zone is designed to accommodate LHMs, SPMTs and Reachstackers. The **traffic zone** to the north (back quay) must allow SPMT and Reachstacker traffic.

If the port wishes to have an area for a crawler crane, a square measuring 42 m on each side, 5 m from the quayside, must be marked out in the middle of this heavy zone.

Outside **heavy zones**, the load-bearing capacity can be reduced but without falling below 4 t/m^2.

h) Routing of components

The route between the northern part of QR5 and the EMR polder is simpler than from QR2/3 and allows traffic to pass through

of all the packages, with no impact on the Form 3 control station, but with the possible relocation of one or two lighting masts (to be confirmed).

Furthermore, this solution removes the need to reinforce the routing path from QR2/3 identified in the reference document [1].

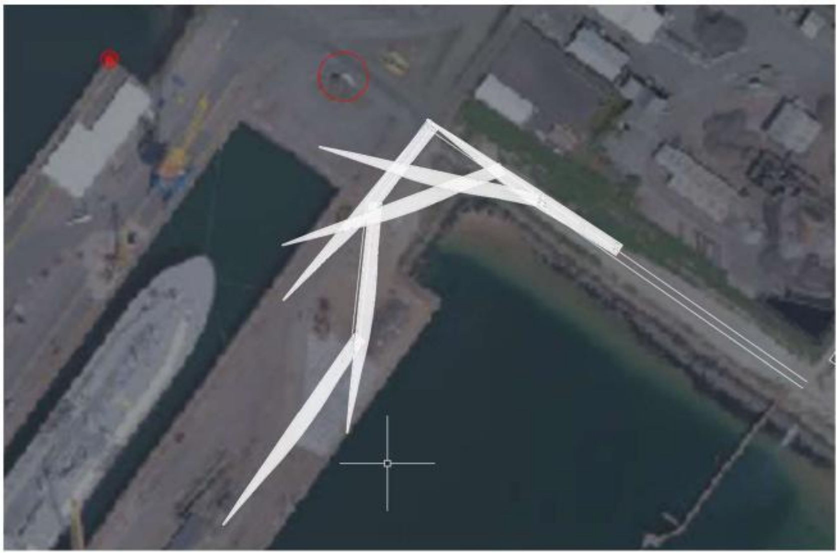


Figure I-8: Path of the blades towards the Polder

I. 1. 3. RORO

a) Background

Roll On Roll Off transhipment of heavy parcels is widely practised in Northern Europe, in ports with low tidal ranges. This method of transhipment offers significant advantages in terms of :

- **Safety:** "rolling" is statistically safer than "lifting". This has led some operators

  like Siemens to impose this solution as soon as it is feasible.

- **Operability (excluding tidal range):** the RORO solution is subject to few wind restrictions, whereas a wind of

  10 m.s^{-1}generally limits the operation of crawler cranes, and 20 m.s^{-1}that of harbour cranes.

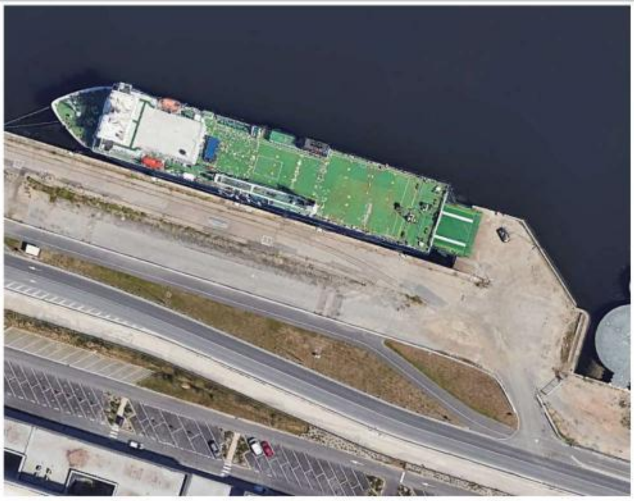
- **Cost:** excluding the cost of infrastructure, the mobilisation of a crane for packages weighing 1000 t, such as the

  CC 8800 BB represents almost €500k on top of a weekly cost of €60k. This compares with an SPMT of around twenty lines, whose mobilisation cost will be around €30 k for a weekly cost of €25 k.

Some ports in Western Europe have "horizontal" RORO capacity, thanks to a basin sheltered from the tidal range.

- SGRE's nacelle/blade factory in Le Havre has a RORO loading ramp that is accessible to

  ships up to 27 m wide (compatible with the Rotra Ventre and the future Rotra Futura). This allows it to serve ports with identical capacities using RORO. This ramp is located in the Bellot basin, sheltered from the tides behind the Quinette lock.



- Similar arrangements are envisaged at St-Nazaire, with RORO unloading of heavy packages.

  towards the quai des charbonniers, at the bottom of the Penhoet basin, not subject to the tides.

Alongside these horizontal fixed ramp solutions, which are unusable outside the short period of high tide in our Atlantic ports, there are RORO solutions based on inclined fixed ramps or floating ramps. These solutions, which are widely used for unloading cars (idem RORO station in Brest), come up against two technical problems when it comes to unloading parcels weighing close to 1,000 tonnes.

- Pontoons and floating ramps are generally not designed for such large packages.

  mass. For example, the pontoons and ramps used at Montoir de Bretagne for unloading cars or Airbus sections are limited to 200 tonnes. It is probably possible to design ones with greater capacity, but to the best of the author's knowledge, none are currently in service.

- The slope of the ramp is a major constraint for the SPMT. A package weighing almost 1000 t requires an SPMT

some twenty lines. A feasibility study carried out by NaRval for the 6% fixed ramp in a Mediterranean port showed that unloading was impossible because the limits of the clearance had been reached.

lines. A slope of 1.5% would have been required for the parcel to be unloaded, which leaves little room for tidal variations.

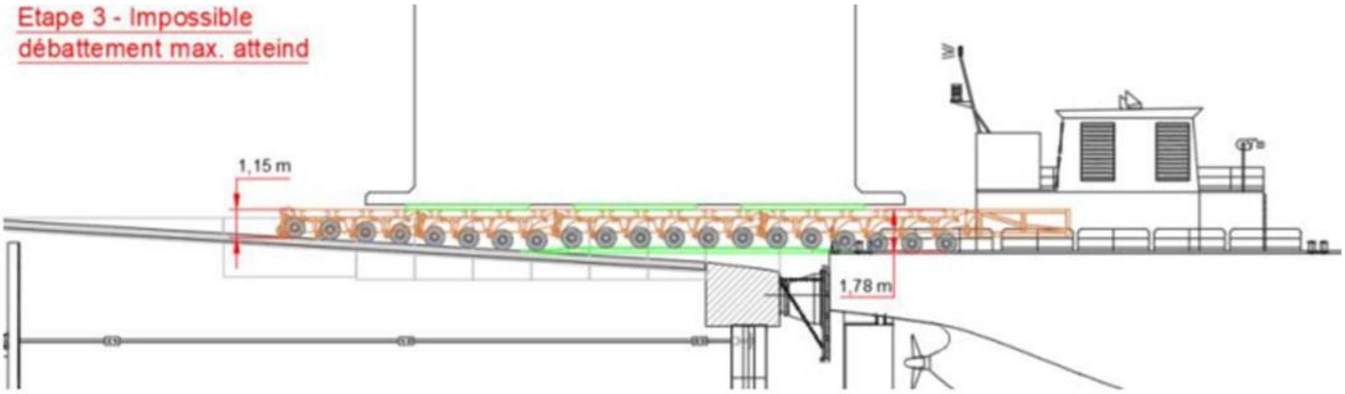


Figure I-9: Extract from a RORO study on a 6% ramp

Consequently, the use of RORO vessels/ramps for heavy parcels is not realistic in Brest. However, it is conceivable to use a semi-submersible heavy load carrier to unload heavy parcels laterally in RORO, taking advantage of the capacity of these vessels to partially compensate for the tidal range. This capability was detailed in chapter I.2.3 Heavy load carrier and semi-submersible used in RORO of the document in reference [1]. Although it is subject to tidal constraints, its operational use has been proven in La Rochelle for the lateral unloading of monopiles for the EMYN project. In particular, such a solution could be envisaged for the transport and unloading of the heaviest float parts, such as the central column, at the EMR quay.

For the pods, it would seem advisable to look into the possibility of unloading a Rotra Vente / Rotra Futura type vessel into one of the existing forms after the lock has been closed.

Figure I-10: Rotra Futura, future RORO SGRE transport vessel, 167 x 26 m

I. 2 Infrastructure

I. 2. 1 Structure of the QR5 pile dock

QR5 is already the subject of a project management contract for the repair and reconstruction of the quay. However, the structural description of the quay and the main conclusions of the diagnostics carried out on this structure are given below.

a) Description of the works

The description of quay QR5 is taken from the report of the technical expertise mission carried out by SCE [14], which is based on the diagnosis carried out by ACCOAST/LERM.

Repair quay no. 5, built in 1980, is a pile dock 390 m long and 30.5 m wide. Its upper level is +9.50 m CM. It is made up of 7 independent piles separated by expansion joints.

- The North berth (formerly the scrapyard) has a 130 m long quay and a

  185 x 90 m with a bathymetry of -9.00 m CM to -10.00 m CM
- The South substation (Gas and Hydrocarbons substation) has a 270 m long quay and a

  272 m x 90 m with a bathymetry of -10.00 m CM to -12.5 m CM.

The quay was initially designed for an operating overload of 3.0 t/m^{2}as well as loads from rail cranes, mobile cranes and distribution arms.

Reinforced concrete superstructure

The superstructure of the platform is made up of a 60 cm thick slab (25 cm of pre-slab + 35 cm of compression slab), which rests on 6 beams, themselves supported by rows of metal piles filled with concrete (except for the piles in row A). The row spacing is shown in the cross-section (Figure I-11). The characteristics of the beams and piles are summarised in Table I-6.

Table I-6: Characteristics of QR5 beams and piles

		Beams			Piles	
File	Function	Geometry	Base dimension upper	Diameter	Centre-to-centre	Base dimension upper
A	Docking front	L1.00 m x H5.50 m	+9.50 m CM	Ø 609 mm thickness 10.5 mm	5,35 m	+3.50 m CM
B	Reinforced running beam	L1.00 m x H3.35 m	+9.50 m CM	Ø 660 mm, 11 mm thick	5,35 m	+5.90 m CM
C	Longitudinal running beam	L1.00 m x H1.60 m	+7.50 m CM	Ø 609 mm thickness 10.5 mm	5,35 m	+5.90 m CM
D	Reinforced running beam	L1.00 m x H3.35 m	+9.50 m CM	Ø 609 mm thickness 10.5 mm	5,35 m	+5.90 m CM
E	Longitudinal running beam	L1.00 m x H1.60 m	+7.50 m CM	Ø 609 mm thickness 10.5 mm	5,35 m	+5.90 m CM
F	Rear beam	L1.75 m x H1.60 m	+7.50 m CM	Ø 609 mm thickness 10.5 mm	5,35 m	+6.00 m CM

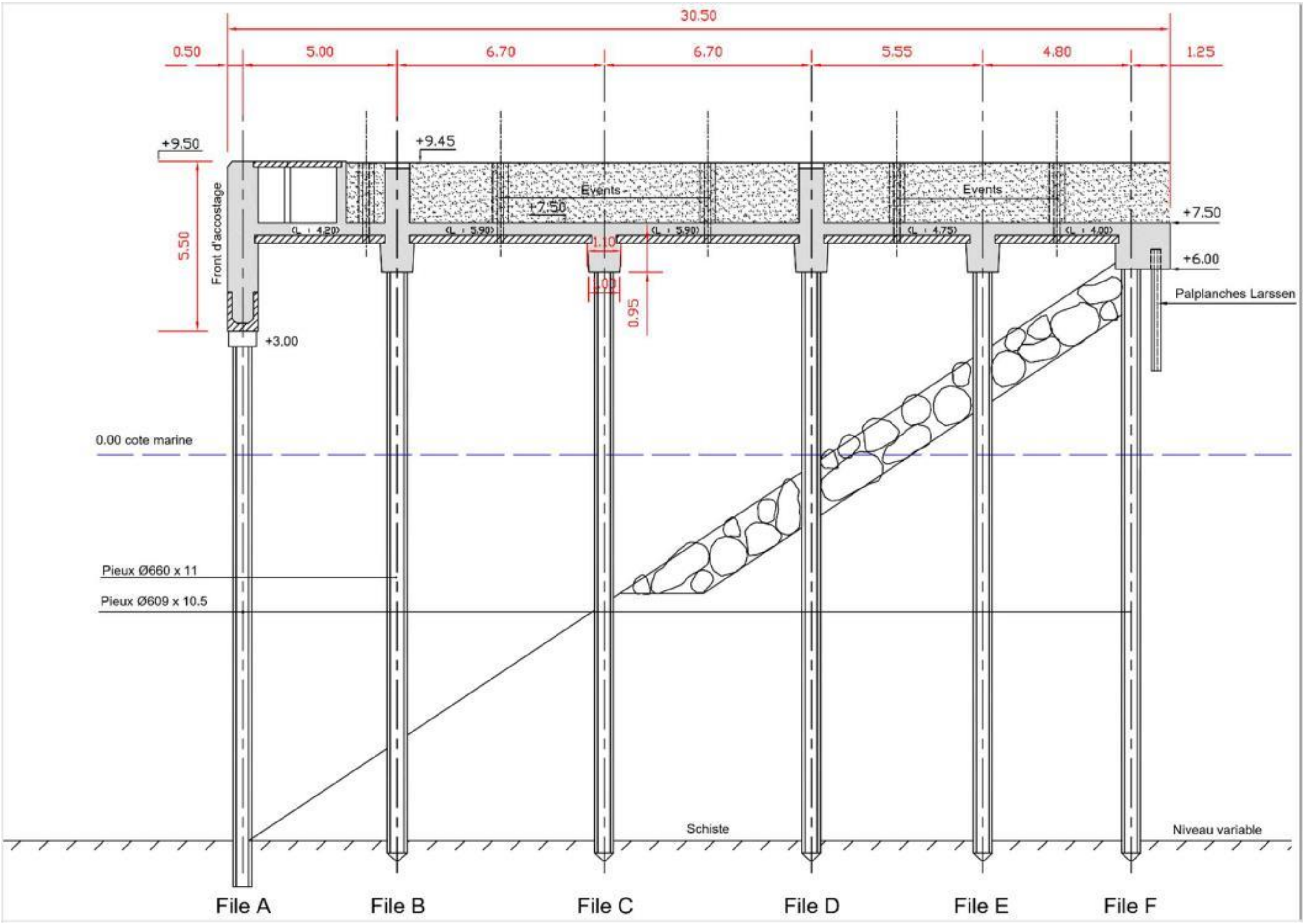


Figure I-11: Cross-section of the reinforced concrete superstructure of QR5 (pdf extracted from the dwg in reference [15])

Geotechnical data

According to GEOTEC's 2014 geotechnical studies as part of the development of the Port of Brest (see Figure I-12), boreholes have been drilled in the QR5 quay right-of-way. The AMO therefore advises BrestPort to collect the geotechnical data available from the Brittany Region in order to provide the MOE with information at the start of its studies.

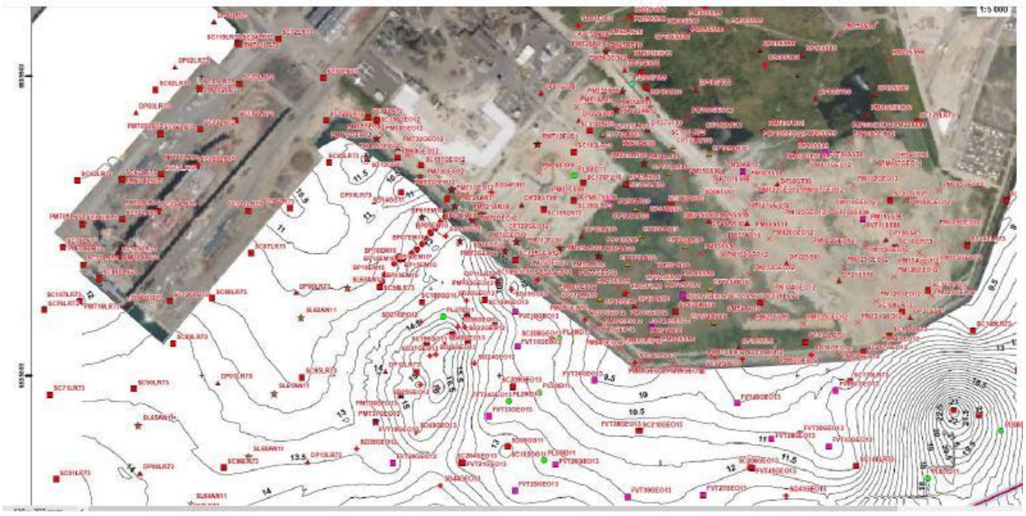


Figure I-12: Map of geotechnical surveys carried out in 2014

This data will be analysed in order to verify the need to carry out additional investigations, and to adapt/redirect, if necessary, the additional investigations to be carried out by the contractor. Given our knowledge of the area, it is anticipated that we will have sufficient geotechnical information at the level of the bank and the dyke enclosing the historic polder. Information on the shale roof is already available, as shown in the figure above. Once the altitude of the bedrock roof of the EMR quay has been superimposed on the rest of the available information, it will be necessary to check whether it has deepened at the end of quay QR5. At this stage, we can anticipate that **the main missing data will be the nature and mechanical characteristics of the materials** making up the embankment crossing the pile dock and those located between the form and the rear support of quay QR5.

Foundations

In all, QR5 is made up of 74 transverse rows of 6 piles (rows A to F) spaced at 5.35 m from the bedrock. The level of the bedrock is not detailed for the different rows of piles in the documents provided. However, the cofferdam stability calculation note indicates the following levels:

- Roof of weathered rock (weathered schist) : -11.50 m CM
- Top of rock : -13.0 m CM

Extracts from the period review (see §3.2.1 of the SCE mission report [14]) mention anchoring the piles 1.5 to 2.5 m into the shale.

Link with the back quay

The connection between the QR5 structure and the back quay is made up of :

- A curtain of sheet piling with larssen IIn and IIIs safety barriers
- Anchor bolts at each transverse row of piles (spacing 5.35 m):
    - Diameter Ø95 mm delivered 110
    - Anchored in the embankment by reinforced concrete slabs set at a distance of 12 to 16.3 m from the rear of the quay.

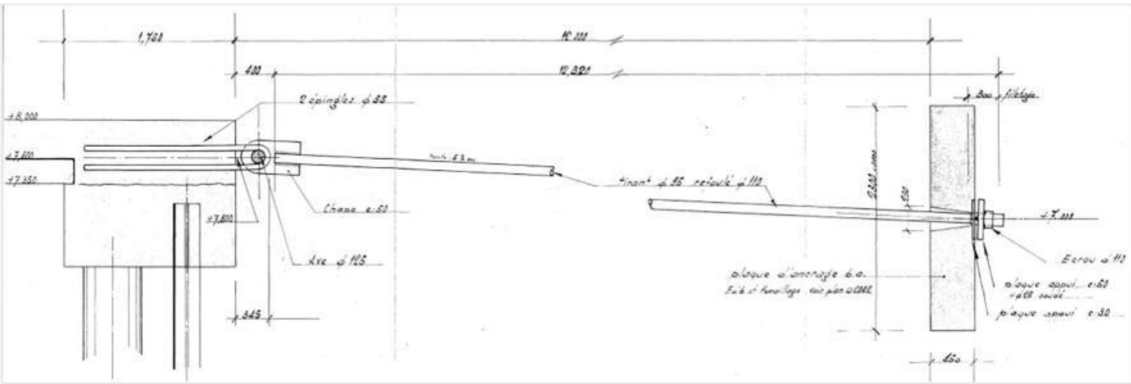


Figure I-13: Cross-section of a tie rod [14].

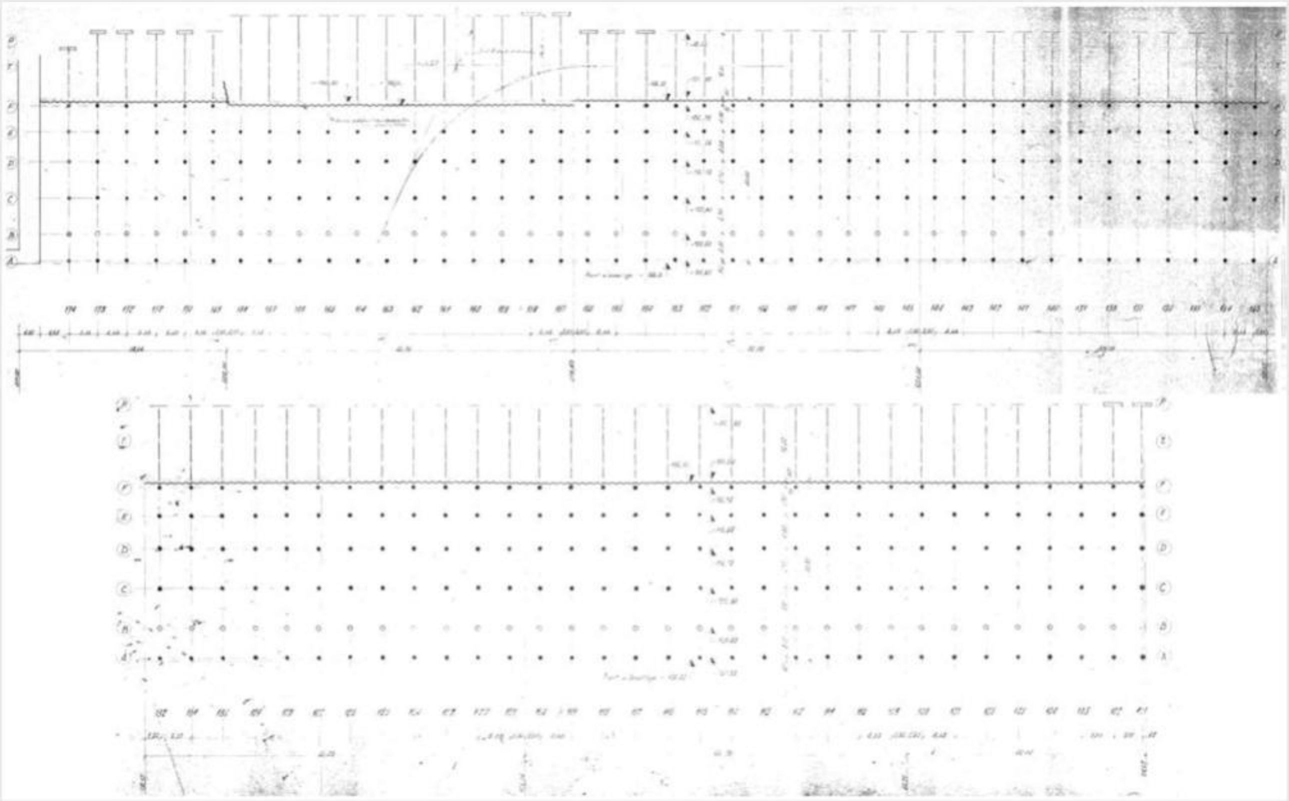


Figure I-14: QR5 - Layout of piles and tie rods - Top view and cross-section (extract from plan N°76-7863-Q- 2004_D)

b) Maintenance work

On the basis of the archive documents made available, the work carried out on the structure since it was commissioned appears to be as follows:

- 2005: The structure's foundation piles were cathodically protected using galvanic anodes, and an anti-corrosion coating was applied by CTS to the upper part of the piles, above elevation +2.50 m CM (Figure I-15).
- 2005: A 20 cm thick, lightly reinforced slab was laid by Guyot Environnement in the area of the scrapyard storage areas,
- Late 2015 and early 2016: replacement of the berthing shields by MARC SA;
- Anode replacement work planned for 2022/2023

We have no data on any interventions prior to 2005.

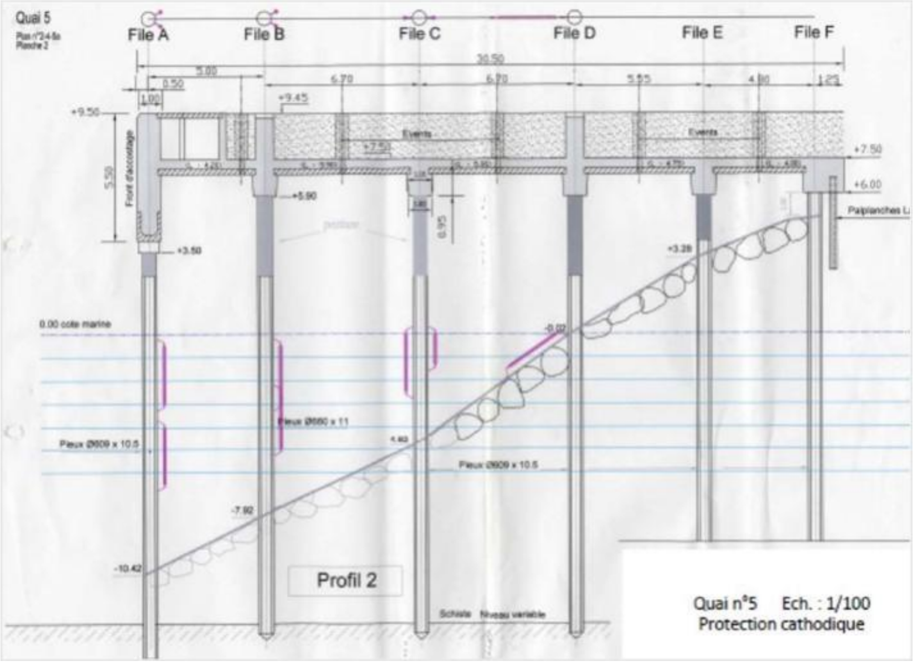


Figure I-15: Layout of the cathodic protection of the QR5 piles (current levels CM96) [14].

c) Current state of structures and load-bearing capacity

According to SCE [14], recalculation of the bearing capacity in the original mode shows that in order to comply with the crack opening limitation criteria (criterion limited to 0.2 mm in a marine environment), the bearing capacity should have been limited to 1.7 t/m^{2}at the low value (instead of the 3 t/m^{2}announced in the original note).

The load-bearing capacity of the longitudinal beams is significantly greater than 3.0 t/m^2, so they are not a limiting factor for the load-bearing capacity of the quay (subject to the absence of corrosion of the reinforcement as observed during the 2022 investigations). However, it is limited by the bearing capacity of the piles: the piles in rows C and D are not justified for capacities of 3.0 t/m^2.

In addition, given the state of deterioration of the structure (around 85% of the slabs between the BC/CD lines, and for the gas and hydrocarbon substations: around 50% of the slabs between the BC/CD lines), the same study considers that :

- In degraded areas (slabs with exposed reinforcement), the theoretical residual load-bearing capacity is zero due to the loss of cross-section and the absence of concrete cover.
- For "healthy" beams and slabs, the capacity can be considered similar to that of the original and should therefore be limited to 1.7 t/m^2.

It has been agreed between the Brittany Region and Brest Port (meetings in November 2022 and February 2023):

- To order the shutdown of QR5 - Poste Ferrailles from [1]July 2023, particularly in view of the fact that the structure is not justified in terms of vertical load transfer, and to take the appropriate measures (relocation of the Guyot activity).
- For gas and hydrocarbon substations, limit vertical overloads to 1.7 t/m^2, and set up cartographic monitoring of disorders by the APB/RB.

I. 2.2 Compatibility of the QR5 quay structure with lifting and horizontal handling equipment

In view of the condition of the structures and the load-bearing capacities identified as necessary for unloading heavy packages (Table I-3), quay QR5 is not suitable for transhipment activities in its current state.

As an EIA on QR5 is already underway, we propose that the following assumptions be taken into account in the studies, in order to meet the transhipment needs of the INFLOW project (Table I-7).

Table I-7: Loading assumptions to be taken into account for transhipment in QR5

Assumptions		Compatibility with the northern part of QR5 (status current)
Minimum load-bearing capacity all along the quay	Minimum 4 t/m²*	Refurbishment of North substation
Wheeled cranes + skids (LHM)	Up to 40 t/m² locally over 10 m²	Local reinforcement of a "heavy zone" : 80 x 20 m centred on the 200 m of quay and 5 m from the quayside
SPMT / Reachstacker	10 to 12 t/m²	
Maximum length of quay required	200 m	OK up to 200 m - North station (INFLOW perimeter)
Maximum trench depth (without dredging)	Actual bathymetry (2022) on the 200 m of the INFLOW quay (North to South): between -9.00 m CM and -10.50 m CM	HLV : OK General Cargo : OK Semi-submersible vessel: Option ruled out
Dimensions	90 m x 200 m	HLV : OK General Cargo: OK Semi-submersible vessel: OK *if overtaking overtaking the vessel on the anchorage Oil berth*

**It should be noted that the QR5 project management contract requires a minimum of 6 t/m²for the reconstruction of the North Substation (value corresponding to a stock of crushed or sheared scrap metal).*

I. 2. 3 Development of heavy parcel transport route + back quay QR5

Additional studies (audit of complementary infrastructures) will be required to check the back quay (including the existing dry dock) in order to accept this route, and any reinforcements required to ensure the transition between an existing rigid structure (quay on piles) and the back quay. This is therefore not costed in the present study.

With regard to the traffic lane, document PDB-EXT-SYN-PLA-006-C ([16]) indicates a 17.6 m lane available for 10 t/m²traffic, i.e. with a 6.4 m traffic lane where only a 1 t/m²load is possible (see [17]).

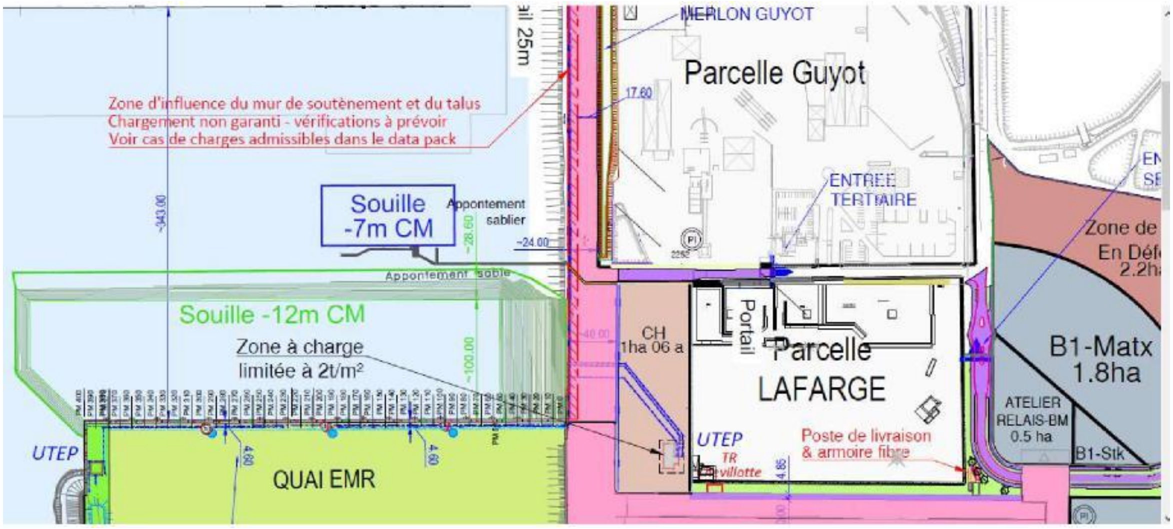


Figure I-16: Extract of admissible loads for the EMR terminal [16].

From the existing heavy roadway, in order not to jeopardise the stability of the existing slopes, a geotechnical diagnosis of these structures will be carried out once additional geotechnical surveys are available. At present, with the data available (in particular the G3 mission for the stability of the slope of polder 124 in connection with the EMR quay - [18]), it seems possible not to damage the current stability of the slopes with the SPMTs running 4.5 m from the edge of the slope, which leaves the 17.6 m wide band of traffic with the right of way of the plots currently available. Without this distance, deep reinforcement of the embankment would be necessary. Once the additional surveys have been carried out, a geotechnical analysis of these embankments will have to be carried out to confirm these conclusions.

From a logistical point of view, this width of support on the heavy roadway is sufficient for all heavy goods traffic.

In addition, at the right of this road, this use must respect the regulatory verifications of Eurocode 7 (NF P 94-261) both at the ELS-Cara and at the ELU. This requires a minimum subgrade thickness of 2.3 m in order to respect the bearing capacity of the surface soils, as well as the soils at depth after diffusion (materials making up the dyke of the old polder). The geotechnical diagnosis will also need to address this point.

Finally, the existing pavement will also need to be checked.

II. THEME 2 : TERMINAL LAYOUT

II. 1 Functionality

II.1.1 Overview of functional requirements, phase 1

The document in reference [2] sets out the likely characteristics of the various areas involved in steel float assembly: assembly spots, storage areas, traffic lanes and concrete float production lines.

The fact remains that the geographical layout of these different zones, and the precise requirements of each of them, responds to the specific needs of each industry and each project. Imposing strict constraints on the design of the entire polder runs the risk of over-investment and rigidity in the use of the site.

We were therefore asked to propose, for the **polder as a whole within the framework of this Stage 1**, the minimum characteristics that are both desirable in terms of use, and accessible in technical and financial terms, that the old and new polders should meet in order to carry out as many activities as possible.

II. 1. 2. Proposed bearing capacity

The minimum common requirement for most of the areas under consideration is the ability to move heavy parcels. As explained in section I. 1. 2.f), this is mainly done by SPMT for parcels over 45 t, and via other solutions such as Reachstacker, port trailers, trucks or forklift trucks for parcels under 45 t.

The load-bearing characteristics allowing a loaded SPMT to circulate are given in the same chapter (9.8 t/m^{2}under the surface layer). The SPMTs must be able to serve the float or wind turbine component storage areas, the assembly areas and all the circulation routes between these areas, whatever the size/power of the wind turbine in question.

The load-bearing capacity of a loaded Reachstacker is slightly higher, at around 12 t/m^2. However, their use is focused on transhipment and movement of containers and "project" equipment. Their use can therefore be limited to the routes between the transhipment quay and the entrance to the polder.

It is therefore proposed to aim for "SPMT" load-bearing characteristics for an area of the polder to be defined as part of this Stage 1, i.e. 9.8 t/m^{2}under the surface layer and a soil ideally consisting of concrete, asphalt or level gravel (Norway gravel type).

This is a "non-permanent" bearing capacity, since it is dedicated solely to the movement of SPMTs.

In terms of traffic, considering that the 24 components making up the theoretical float and the 9 components making up the wind turbine are consumed every week for 15 MW machines and every 12 days for 20 MW machines, we are therefore talking about 3 to 5 "loaded" SPMT passages and as many empty ones every day. For the AO5, this represents one year's use of the terminal.

II.1.3 Limitations of a trip by SPMT and consequences for Theme 2

In theory, and provided that the package to be transported has the necessary support surfaces, there is no limit to what a large combination of SPMT lines can carry. However, the following points mitigate against this statement.

- The world record for the weight of parcels transported by SPMT, previously held by Mammoet, will be broken in 2022.

  for the unloading of a 20,300 t FPSO (748 lines) was recently beaten by the transport of 23,000 t of Fagioli (800 lines). Each of these was a one-off operation, not a repetitive activity.

- An SPMT is a combination of lines, each with a maximum capacity of around 45 t (depending on the

  models), but for various reasons its actual use is closer to 30 t / line.

Figure II-1: World record for transport by SPMT in 2022 (left) and 2023 (right)

- As a result, **around 200 lines would be needed to transport the 6,000 t of steel float and over**

  700 lines to transport the 21,000 t of the reference 25 MW **concrete float**.

- It is estimated that there are currently around 5,000 SPMT lines in use worldwide by all companies.

  1,500 of them in Europe. Moving one concrete float would therefore require half of Europe's fleet during the entire construction phase.

- In a study (not available) carried out by Mammoet at the request of one of its customers for the loading of 20,000 t floats, the foreseeable cost of SPMT logistics (792 lines) was €4.5 million for mobilisation, plus €2.5 million for equipment hire per month. By comparison, the 'Skidding' option, excluding the cost of infrastructure modifications, cost €1.9 million to mobilise and €600,000 in monthly rental. Over the duration of the project, the SPMT cost was 6 to 7 times higher than the Skidding cost.

- In this Stage 1, only loading at the QEMR is envisaged. However, installing skidding rails

  capable of supporting 110 t/ml on the southern part of the QEMR (the northern part being designed to accommodate the integration crane), presents a **certain complexity given the existing structure.**

- Moving, and therefore loading, a skidding vessel is a very slow operation, which could lead to a serious accident.

  have very limited operability given the tidal range.

- In addition, Stage 1 offers few or no afloat storage solutions. Dry storage (on the polder) is

  a possibility for floats moved by SPMT, but not for floats moved by skidding, which must remain on the rails.

Technically, skidding floats does not seem feasible in Stage 1. All floats must be moved by SPMT, which in the case of concrete floats could come up against the cost constraints of the associated logistics.

II. 1. 4 Concrete scenario Stage 1

Without skidding, a concrete float manufacturing process will probably be carried out, as for steel floats, on fixed spots with identical consequences:

- A spot uses the same float from start to finish
- All spots must remain individually accessible for the movement of floats once they have been manufactured.

As a result, the overall "steel float" and "concrete float without skidding" plans will be very similar.

II. 2 Infrastructure

II. 2. 1 Soil improvement/reinforcement of the EMR terminal

a) Additional geotechnical assumptions (new polder)

In addition to the previous note on theme 2, we were provided with additional data concerning the M21 contract. Annex 2 of stage 1 [19] therefore supplements the information provided to mission G1-PGC [20], as well as the previous note on theme 2. This paragraph summarises this information:

Topographical surveys were carried out by ECR Environnement between October 2023 and April 2024 [21] on the new polder using photogrammetry. The results of these measurements are shown in the figure below:

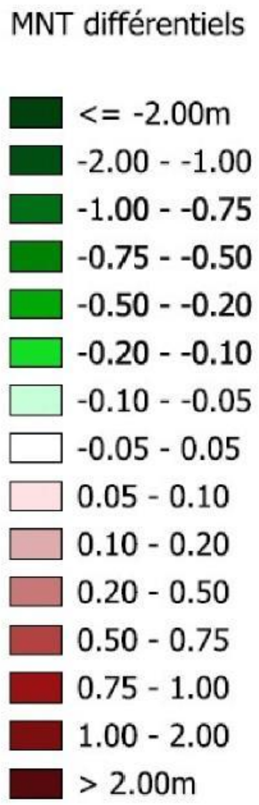


Figure II-2: Topographic survey legend

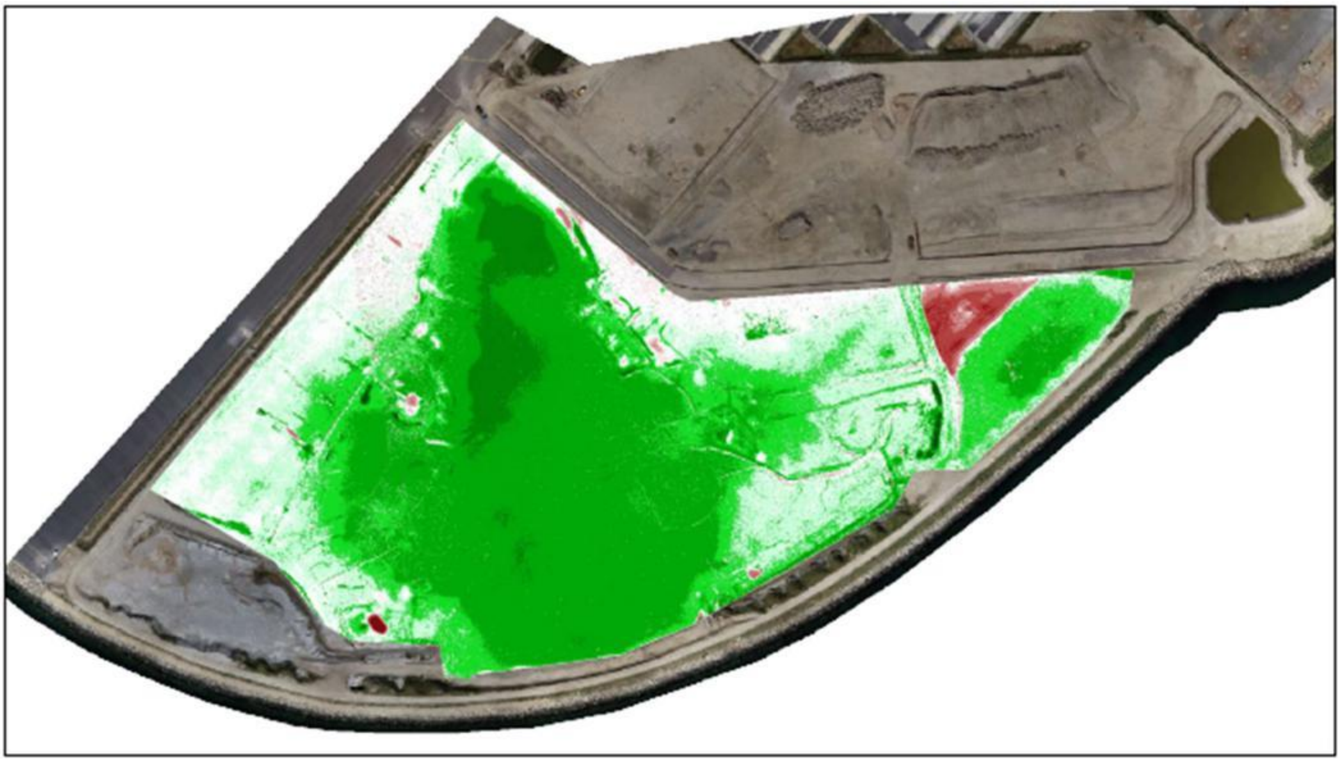


Figure II-3: Topographic survey - Differential DTM between October 2023 and February 2024 - New Polder [21].

These topographical surveys show that the materials pushed back settle by 30 to 70 cm under their own weight in 5 months. This amounts to a settlement of around 5 to 15 cm per month.

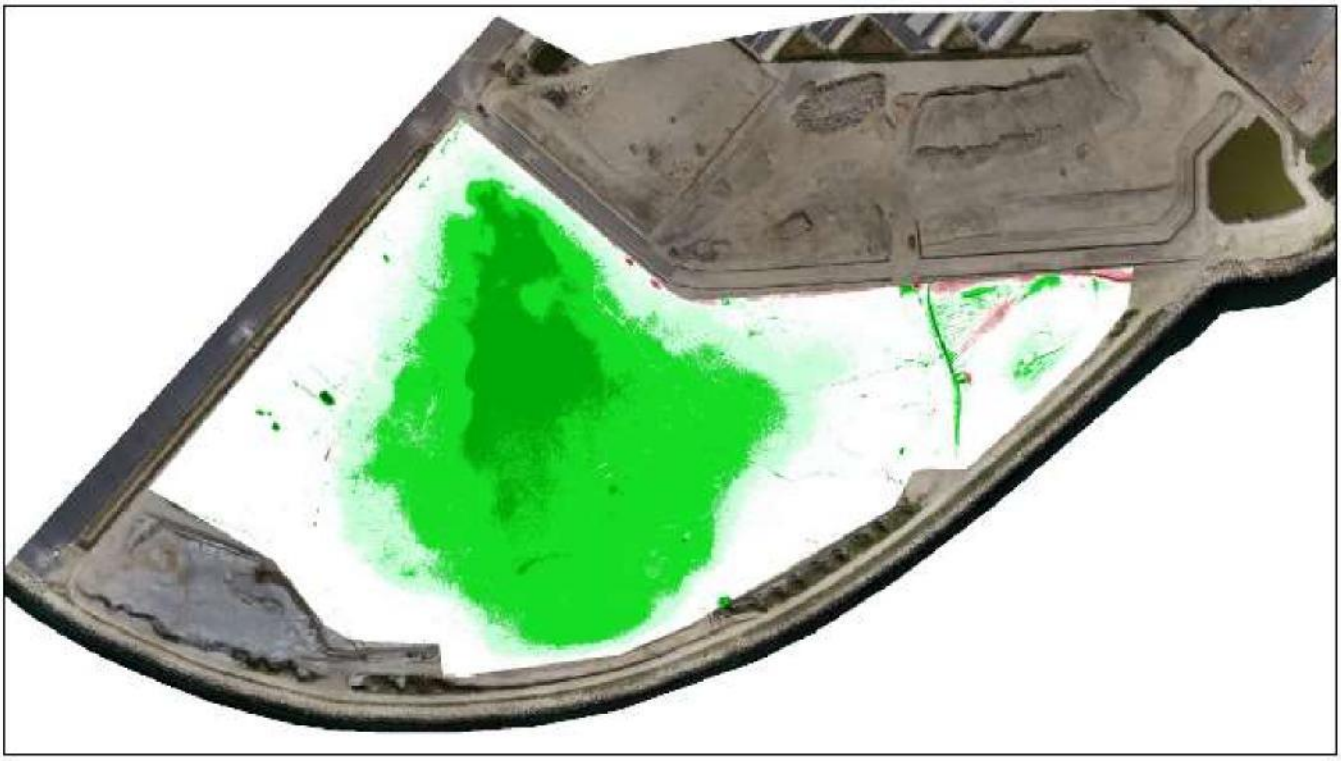


Figure II-4: Topographic survey - Differential DTM between February 2024 and April 2024 - New Polder [21].

Between February and April 2024, i.e. in 3 months, the settlement observed is lower over the whole polder. However, it was around 20 cm in the light zone and around 50 cm in the dark zone. This amounts to a settlement of between 6 and 17 cm per month. As a result, these settlements have not yet stabilised.

Figure II-5: Topographic survey - Differential DTM between October 2023 and April 2024 - New Polder [21].

The cumulative settlement observed on the new polder between October and April 2024 is around 80 to 120 cm. It is therefore difficult to predict the load-bearing capacity of these as yet unstabilised areas without the necessary observational monitoring of the work under contract M21.

Similarly, analysis of the CPTu carried out in 2023 by Ginger has made it possible to sketch out zones with different mechanical behaviours. Here is an example of the zones that can be defined:

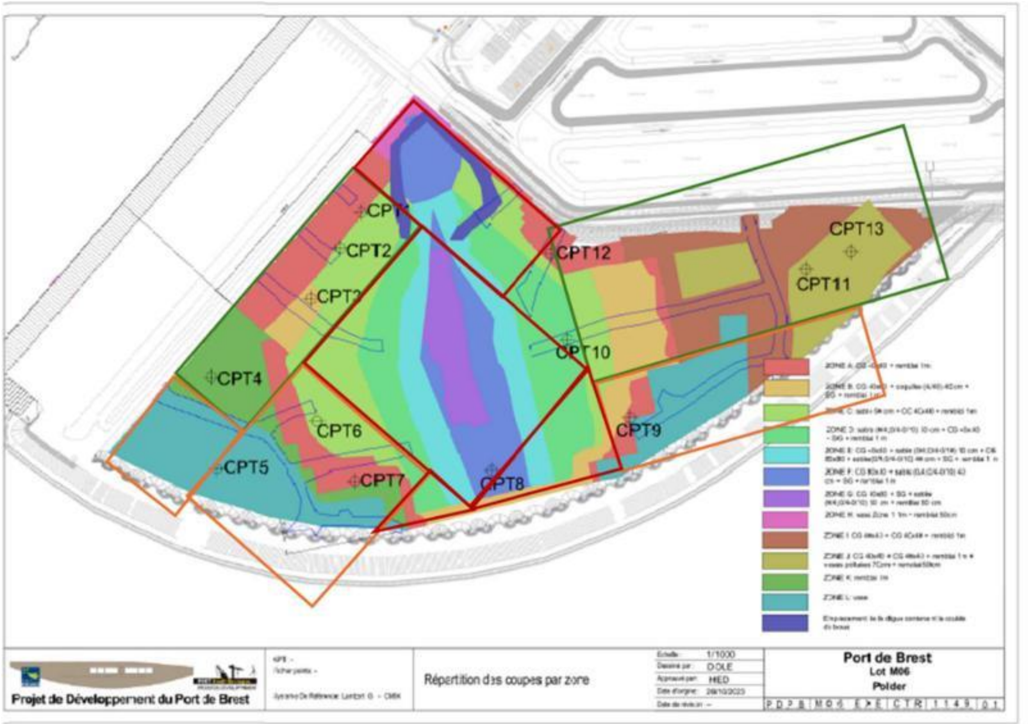


Figure II-6: Zoning of the proposed polder

3 zones have been identified:

- Red: "weak" zone;
- Orange: "medium" zone ;
- Green: "good" zone.

These different zones are likely to reveal differences in behaviour during and after pre-consolidation work.

A complementary geotechnical model for the new polder is provided in Appendix 2 [19]. At present, the assumptions made are consistent with the data provided for contract M21 [22], but will need to be confirmed with the observational monitoring for contract M21.

b) Surface soil improvement for traffic loads

Within the framework of this feasibility study, only the work to be carried out by BrestPort to allow the circulation of SPMTs, Reachstakers and mobile vacuum cranes on all or part of the polder is being considered. Additional work will be carried out by manufacturers to assemble/manufacture floats, store a certain number of them, and store wind turbine components according to their own needs. This work will probably require soil reinforcement and/or deep foundations in the areas selected for storage and assembly. In order to minimise additional costs, the main lever is obviously to reduce the footprint of these areas.

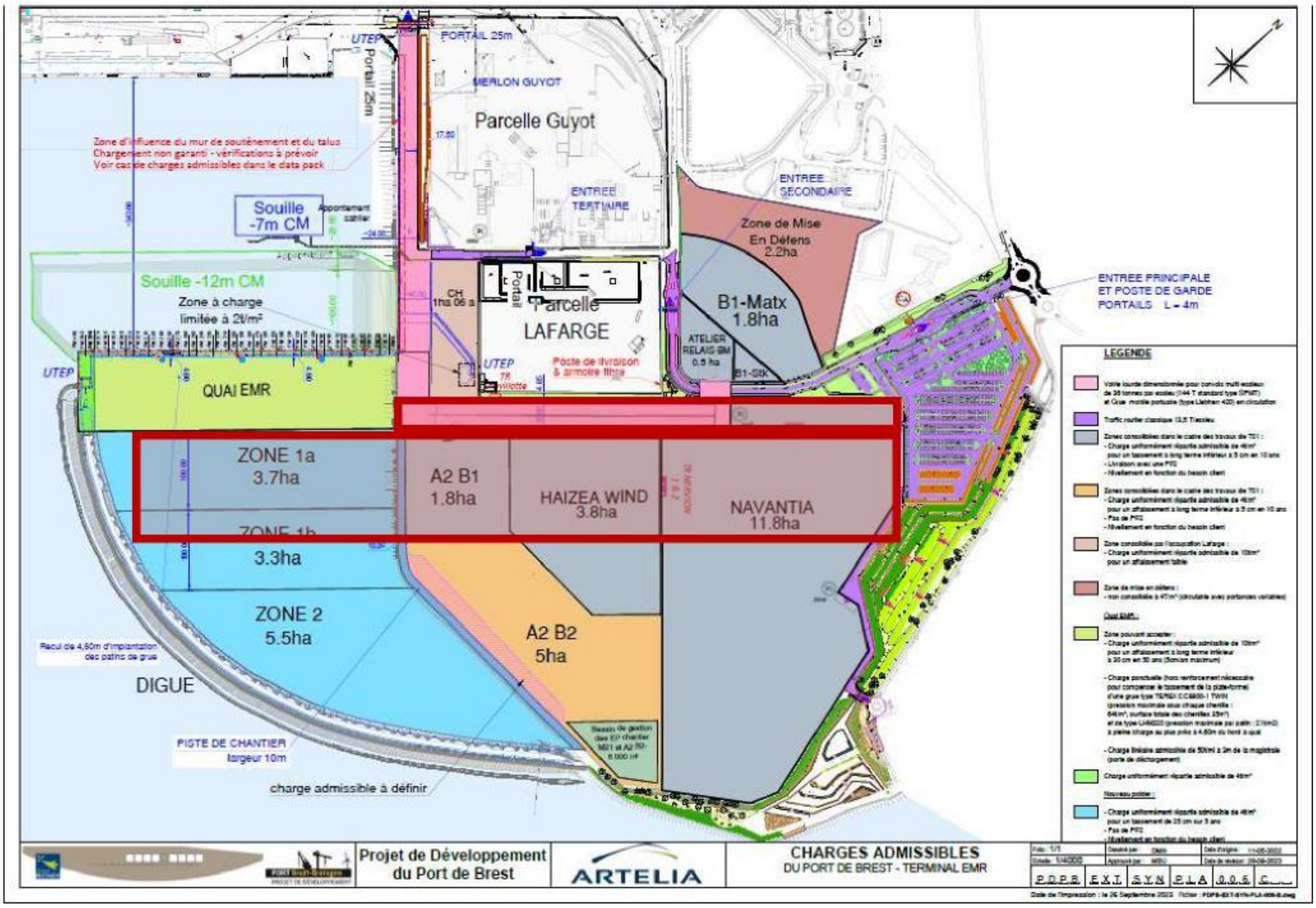
In order to limit investment by BrestPort, a compromise was sought to make traffic loads acceptable. The geotechnical analysis is provided in appendix 3 [23].

The following minimum investments are recommended:

- The need for a **subgrade with a minimum thickness of 2.3 m and a limit pressure of 2.5 MPa** to guarantee the circulation of SPMTs and Reachstakers (without fully complying with the safety levels of NF P 94-261 of Eurocode 7);

- The use of **mobile cranes when empty is not guaranteed**, even at the unweighted ELU without soil reinforcement, and should therefore be avoided by manufacturers;
- The recommendation to carry out additional studies on the transport of bare floats from the assembly area to the water. additional studies. At this stage, it is proposed to provide a **130 m wide strip reinforced with rigid inclusions under the** currently planned **subgrade**.

  The dimensioning of this reinforcement will have to be the subject of a specific geotechnical study considering the maximum loads brought by the float supports while limiting the differential settlements between these supports during transport. This study should preferably be carried out in conjunction with the AO5 contractor.



Lastly, certain provisions of the M21 contract should be reviewed (minimum performance of the subgrade, thickness, etc.) to avoid having to purge a filler material that is insufficiently compact for the terminal's future uses.

The applicability of these conclusions will need to be updated when the additional surveys to be carried out on the terminal and the results of the observational method under contract M21 are received. **As part of the M21 works contract, the central zone of the recent polder may not be suitable without additional constructive measures (if its weakness is confirmed during future works).**

II.2.2 Summary of zoning on the polder

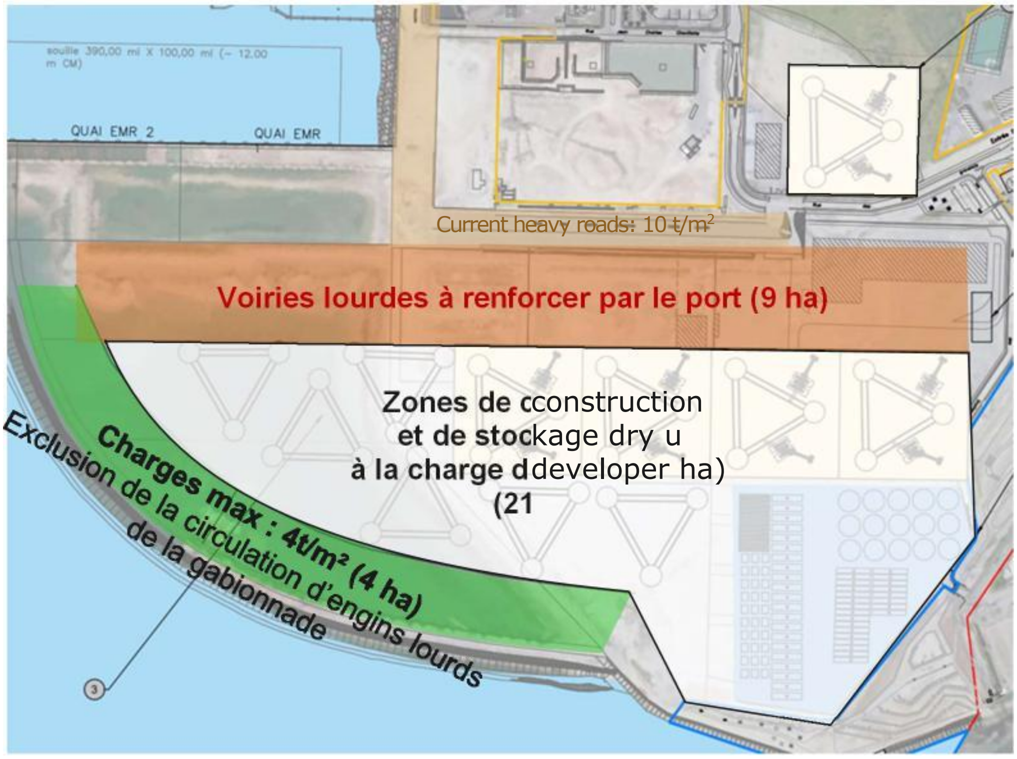


Figure II-7: Zoning of reinforcement work to be carried out on the old and new polders

The diagram is presented here without any geotechnical considerations. It can be optimised, and the different zones reorganised, once the additional geotechnical surveys have been carried out.

II.2.3 Facilities and equipment for managing rainwater and accidental pollution on industrial sites

a) Existing situation

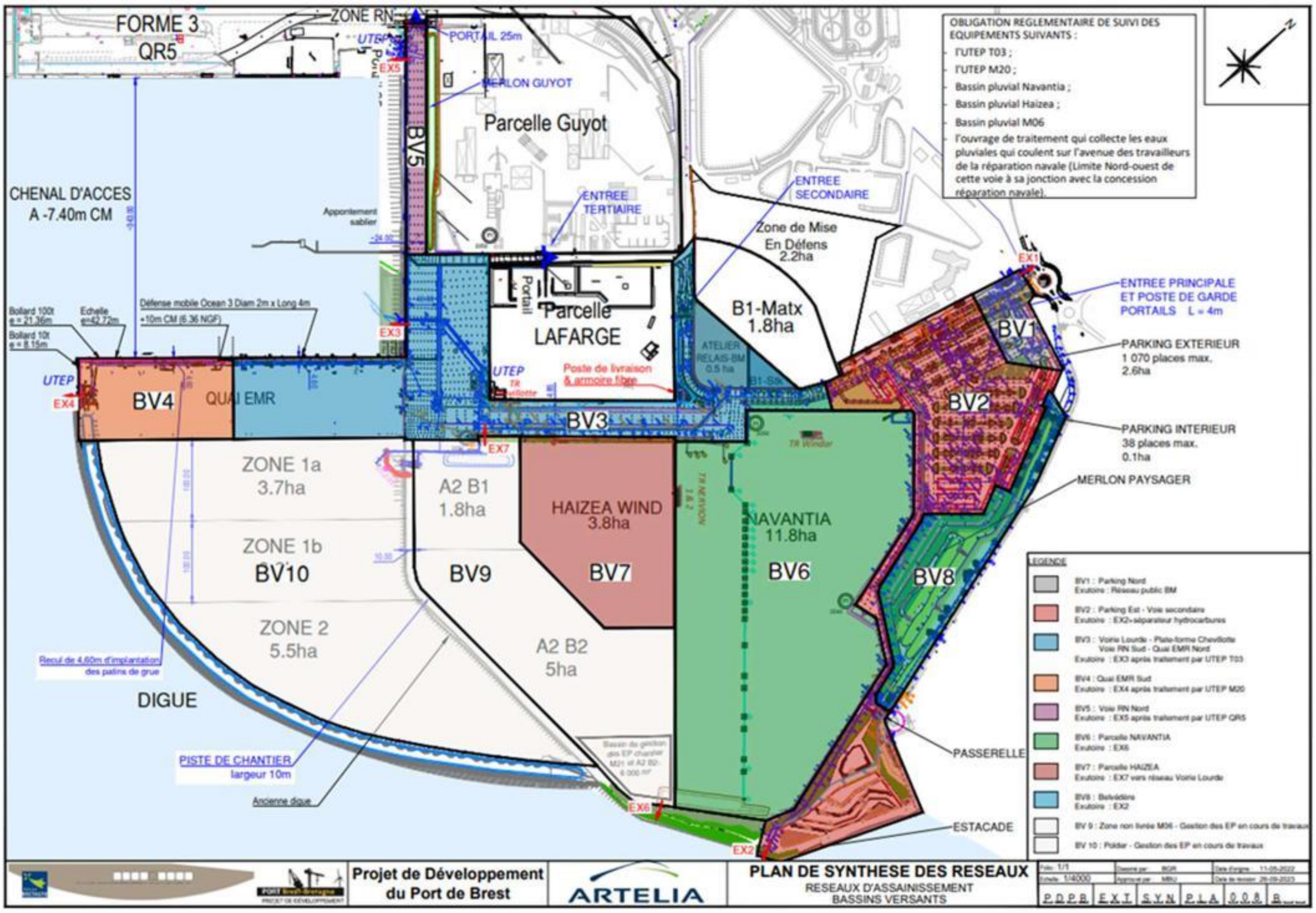


Figure II-8: Breakdown of the EMR polder catchment areas (extract from the network summary plan)

The entire EMR polder area is divided into several catchment areas:

- **BV1 "North Car Park" :**
  - Rainwater collection through 750 mm x 300 mm and 400 mm x 400 mm gullies;
  - Gravity EP network with PVC DN250 to Reinforced Concrete DN400 pipes;
  - Rainwater management with a 210 m^{3}retention and infiltration basin + hydrocarbon separator before discharge into Brest Métropole's public drains (Outfall No. 1).
- **BV2 "East car park & secondary road" :**
  - Rainwater collection through 750 mm x 300 mm, 400 mm x 400 mm and 500 mm x 500 mm gullies;
  - Gravity EP network with PVC DN250 to Reinforced Concrete DN800 pipes;
  - Rainwater management with watertight retention basin + hydrocarbon separator before discharge into the sea (Outlet n°2);
  - It should be noted that an ancillary DN300 reinforced concrete network collects drainage water from neighbouring non-traffic areas and discharges downstream into the same outlet No. 2.

- BV3 "Heavy roadway - Chevillotte platform - RN South roadway - EMR North quay" :
    - Rainwater collection using 750 mm x 300 mm gullies and gutters with grids (dimensions not specified);
    - Gravity EP network with reinforced concrete pipes DN300 to DN1200. There are 3 networks:
        - A network to recover heavy roadways to the north along the BM relay workshop and the Lafarge plot;
        - A network for the recovery of discharges from the Haizea Wind and Navantia private plots;
        - And a network to collect rainwater gutters from the north EMR quay.
    - Rainwater management with treatment at UTEP 3 before discharge into the sea (Outfall n°3);

- BV4 " Quai EMR sud " :
    - Rainwater collection using gutters with grids (dimensions not specified) ;
    - Gravity EP network with reinforced concrete pipes DN300 to DN600 ;
    - Rainwater management with treatment at the M20 UTEP plant before discharge into the sea (Outfall No. 4);

- BV5 "RN Nord lane" :
    - Rainwater collection using channels with grids 400 mm x 400 mm ;
    - Gravity drainage network with DN400 reinforced concrete pipes;
    - Rainwater management with treatment at the QR5 UTEP plant before discharge into the sea (Outfall No. 5).

- BV6 "Navantia Industrial Estate" :
    - Rainwater collection through manholes and gutters (dimensions not specified) ;
    - Gravity EP network with reinforced concrete pipes DN300 to DN600 ;
    - Rainwater management treatment basin of approximately 1,200 m(3) (data to be confirmed following M06 consolidation work?) before discharge into the sea (Outfall No. 6);

- BV7 "HAIZEA WIND industrial plot" :
    - Rainwater collection with ditches and drainage system (dimensions not specified) ;
    - Gravity EP network with pipes (type and dimensions not specified) ;
    - Discharge into BV3 networks with discharge into the sea (Outfall n°3).

- BV8 "Belvedere" :
    - Landscaped berm with drains and recovery ditches and discharge into the sea without treatment (Outfall No. 2).
    - Network with DN300 reinforced concrete pipe running alongside the BV2 pipes.

- BV9 and BV10: Provisional water management Post M06 consolidation batch
    - Management by ditches and discharge stations with 1 retention basin before discharge into the sea of 2925 m(3) (basin A2B2) - see Figure II-8.

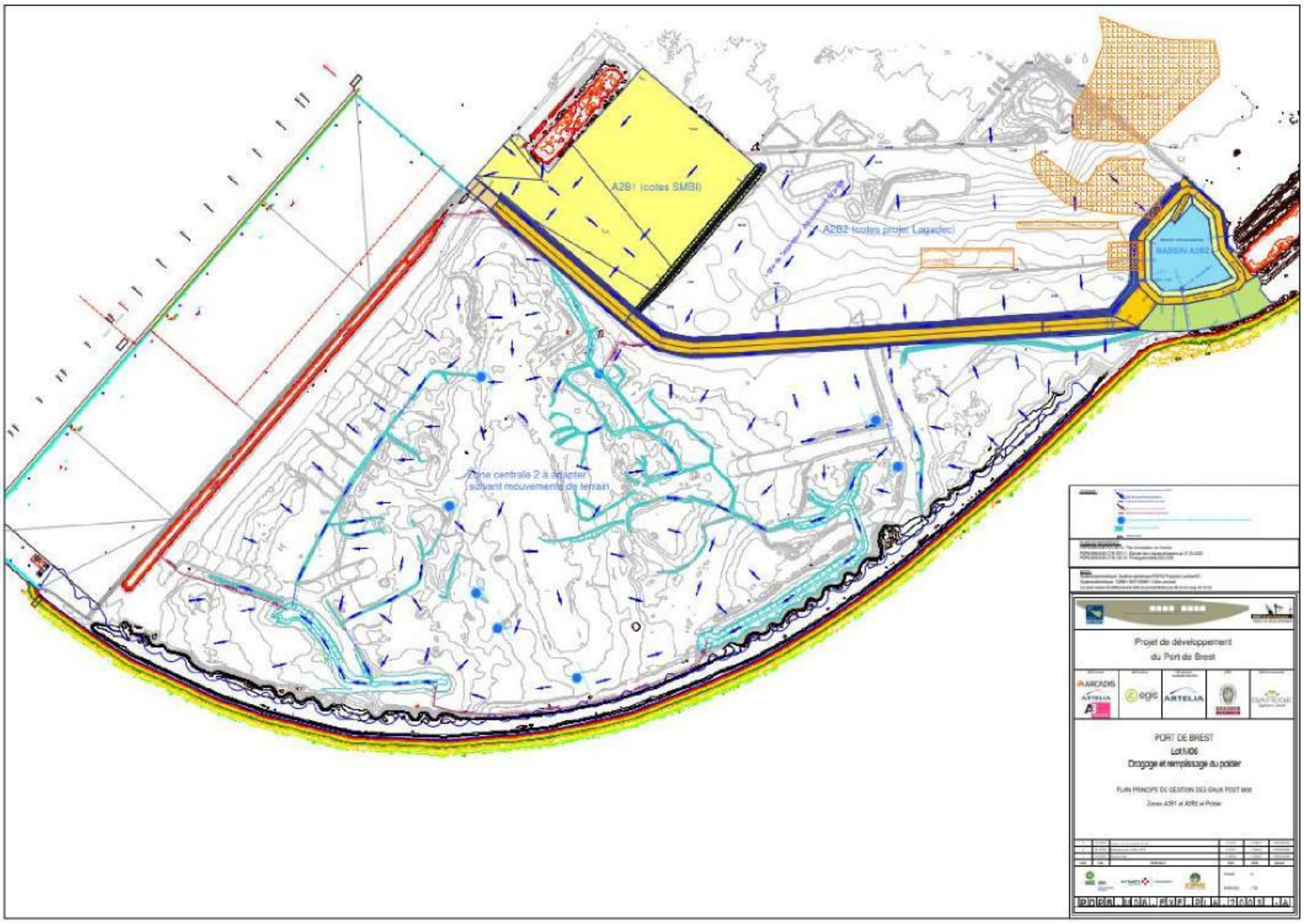


Figure II-8: Principle of PE management in the Polder

(extract from the SDI-Vinci-IDRA consortium's EP management principle EXE plan dated 12/12/2023)

b) Regulatory constraints

The rainwater collection system must be sized for a ten-year rainfall. The peak flow rate Q(t) is calculated using the rational formula :

$$Q(t) = C.i(t).A$$

Avec :

- C : coefficient d'imperméabilisation du sol
- A : surface du bassin versant, en ha
- i : intensité de la pluie de durée t,

$$i(t) = a.t^{-b}$$

Montana coefficients from the Brest-Guipavas weather station for a 10-year period:

- For a duration of 6 min to 30 min :
  - a : 2,909
  - b : -0,445
- From 30 minutes to 6 hours:
  - a : 5,644
  - b : -0,642

Land-based effluents must be treated before discharge into the sea, in accordance with Amending Prefectoral Order No. 2017 080-0002 of 21 March 2017, amending Order No. 2015 212-0008 of 31 July 2015, which sets out the following recommendations:

5.2 – Gestion des eaux de ruissellement

5.2.1 – En phase chantier

Plusieurs bassins de rétention, dont un déjà existant (réalisé lors des travaux sous maîtrise d'ouvrage SMBI) sont positionnés en fonction des bassins versants et des contraintes liées au phasage du chantier. La collecte et l'évacuation des eaux pluviales sont assurées par un réseau de fossés périphériques raccordés à ces bassins tampon.

Le rejet se fait normalement en mer après être passé par un ouvrage de traitement, et un contrôle des eaux de rejet est réalisé une fois par semaine pendant les phases de rejet sur les paramètres prévus au tableau ci-dessous.

Paramètres	Concentration
MES	35 mg/L
DBO5	30 mg/L
DCO	125 mg/L
PCB	0,05 mg/L
As	0,05 mg/L
Cd	0,2 mg/L
Ni	0,5 mg/L
Cu	0,5 mg/L
Hg	0,05 mg/L
Pb	0,5 mg/L
Zn	2 mg/L
Cr	0,5 mg/L
Hydrocarbures totaux	10 mg/L
Total 16 HAP	0,05 mg/L
E. Coli	-

Les surverses des bassins sont aménagées afin d'éviter tout phénomène d'érosion et les rejets en rade de Brest se font par le biais de canalisations équipées de clapets anti-retours.

En cas de rejet au réseau pluvial existant le débit moyen proposé par le permissionnaire est validé par Brest Métropole, gestionnaire du réseau. Une convention pourra être rédigée pour ce rejet.

5.2.2 – A l'état final

Il est prévu une gestion des eaux pluviales en fonction des lots c'est-à-dire en distinguant les espaces publics et les lots privés dédiés à l'accueil des industriels.

Les lots privés dédiés à l'accueil des industriels relèveront de la réglementation des Installations Classées pour la Protection de l'Environnement (cas des industries classées ICPE) et les prescriptions d'aménagement figureront dans les cahiers des charges. Ils devront également réaliser une étude de dangers qui définit la nature des risques, l'évaluation de leurs conséquences, de leur probabilité d'occurrence, de leur cinétique ainsi que de leur prévention et des moyens de secours. Elle décrira les installations et de leur environnement ainsi que des produits utilisés, identifier les sources de risques internes (organisation du personnel, processus, ...) et externes (séismes, foudre, effets dominos, ...) et justifier les moyens prévus pour en limiter la probabilité et les effets, notamment en proposant des mesures concrètes en vue d'améliorer la sûreté. A ce titre, ils devront prévenir tout déversement accidentel et procéder à son confinement par le biais d'un système de rétention et d'un vannage permettant d'isoler la pollution avant le rejet. L'ouvrage devra être équipé d'un raccord « pompier » permettant le pompage et l'évacuation des matières polluantes en filières agréées.

Les industries non classées ICPE ne sont pas soumises à la réglementation des Installations Classées pour la Protection de l'Environnement.

c) Impact of the development scenario on existing facilities

Watersheds BV1, BV2, BV5 and BV8 should not be affected by the proposed development scenario. The existing networks and associated treatment plants can therefore be maintained as they are.

Drainage basins BV3 and BV4, which relate to heavy roadways, the EMR quay and the Chevillotte platform, could be impacted by the works under the development scenario.

The facilities on the Navantia "BV6" and Haizea Wind "BV7" industrial estates will have to be dismantled to make way for the new installations. The associated sewage networks will also be abandoned and removed as part of the work on the various scenarios envisaged.

The temporary drainage facilities in catchment areas BV9 and BV10 (drainage, ditches and retention basins) of the new consolidated polder will be impacted by the works in the development scenario.

It should also be noted that the perimeter of the "B1-Matx" and "Zone de Mise en Défens" parcels needs to be extended.

There are 3 zones:

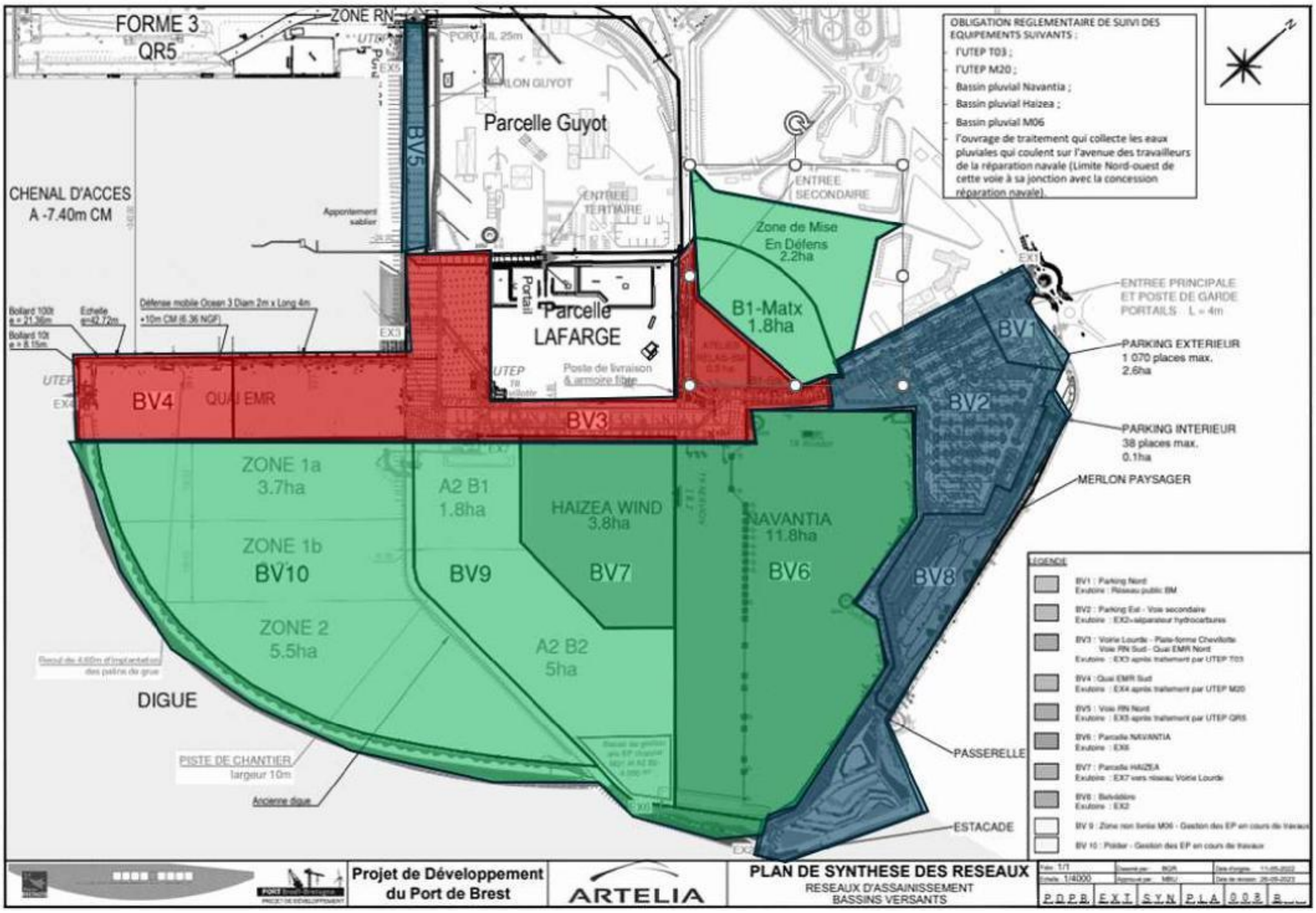


Figure II-9: Sewerage networks in the polder (extract from the summary plan of existing networks)

- In blue, the areas kept as they are;
- In red, areas likely to be affected by new facilities;
- In green, the areas to be dismantled and the new collection, storage and treatment networks to be installed before stormwater is discharged into the sea.

With regard to the existing networks in BV3 and BV4 that could be affected by the new facilities, we unfortunately do not have any data (technical sections, calculation notes, installation methodology, etc.) concerning the mechanical design and installation method. It is therefore difficult to understand how these networks have been sized and whether they are capable of handling the anticipated operating loads of the future facilities, as well as the risks of backfill settling. Investigations will need to be carried out to gain a better understanding of this problem and the cost of any associated protective structures.

As it stands, we consider that the BV3 and BV4 networks have been correctly sized for SPMT operating loads of 10 t/m^{2}and do not require any reinforcement or protection works for these networks.

d) Rainwater management with open-air retention basins relating to catchment areas BV6, BV7, BV9, BV10 and the "B1-Matx" and "Zone de Mise en Défens" right-of-way extensions

On the basis of the regulatory sizing assumptions set out in section II.2.3.b, we have sized the retention volume required for all the areas relating to the projected BV6, BV7, BV9, BV10, B1_Matx and Zone de Mise en Défens (**39 Ha**), according to 3 surface development sealing scenarios:

- **Scenario 1:** 100% of impermeable surfaces with asphalt or concrete surfacing **runoff coefficient of 1**;
- **Scenario 2:** 100% of permeable surfaces with unpaved subgrades **runoff coefficient of 0.6**;
- **Scenario 3:** mixed solution with 50% impermeable surfaces and 50% permeable surfaces **runoff coefficient of 0.8**.

The leakage rate imposed and taken into account is **3 l/s/Ha**.

Scenario 1 corresponds to what is already in place on the EMR quay. However, according to those involved in the offshore wind industry, the logistical activity associated with the storage and loading of nacelles, towers and blades can only be carried out on an uncovered earth structure. In view of the operating loads generated by the tracked machines and the soil in place, there will still be significant settlement despite preloading to 4 t/m². As a result, the conventional surface coverings (asphalt-type) will be severely cracked or even destroyed. On the Brest site, the main advantage of keeping the asphalt at the EMR quay is to limit infiltration behind the retaining wall and to remain below the design water level of the EMR quay.

Scenario 2 is similar to what has been done in Le Havre around the Siemens Gamesa factory for the storage of wind turbine components and at the Joannès-Couvert heavy wind docks.

This second scenario has the advantage of not being too restrictive in terms of settlement criteria. Regular maintenance operations (every 6 months to every year) would, however, have to be planned by the operator to adjust the height of the median and realign the slopes for the needs of traffic and rainwater drainage.

The disadvantages relate to controlling the quality of rainwater discharged during the construction phase, as well as selecting drainage systems and management methods for the operating phase that can withstand the traffic loads to be carried. For example, a hydrogeological study will have to be carried out to ensure that the impact of not sealing the recent platform on water levels does not affect the design levels of the EMR quay. Another disadvantage is the creation of dust, which can be limited by an appropriate choice of surface material.

Sizing of the retention volume for scenario 1 :

Rainfall method (not to be confused with the volume method in IT 77-284)

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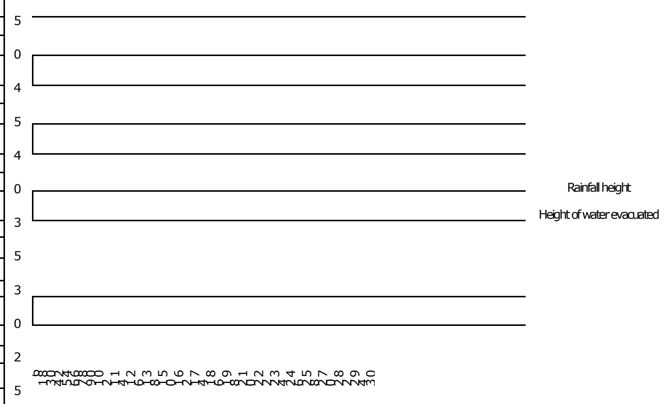
To be filled To be

Site data				
Total S (ha)	39			
Cr	1,00			
$Q_{leakage}$ (L/s)	117	Qinf (L/s)	-	Qdischarge 117
Sa (ha)	39,00			
Montana coefficient				
Station	Brest-Guipavas system (29)			
Rain duration	6min to 30min	30min to 6h		
Return time	10years	10years		
a	2,909	5.644		
b	0,445	0.642		

Results :			
Max. height of water to be	$h_{max} = (h_{(p)}(t) - h_f(t))$	**40**	mm
Volume to be stored	$V = Max(h_{(p)}(t) - h_f(t)) \times Sa \times 10$	**15 578,1**	m3
Draining time	$T_{(v)}(h_f = h_{max})$	2219	min or 1 day 12 hours 59 minutes



	$h_{(p)}(t)$(mm)	$h_f(t)$(mm)	$(h_{(p)}(t)-h_f(t))$(mm)	t (min)
Rainfall height				
$h_{(p)}(t) = a \times t^{(1-b)}$				
To be calculated for the duration of the rain	12	0,2	11,3	12
	14	0,3	14,1	18
	17	0,4	16,5	24
Discharge height	19	0,5	18,7	30
$h_f(t) = ((Q_{(leakage)} \times t)/Sa) \times (6/1000)$	20	0,6	19,7	36
	22	0,8	20,8	42
Height of water to be	23	0,9	21,7	48
$(h_{(p)}(t)-h_f(t))$(mm)	24	1,0	22,6	54
	24	1,1	23,4	60
	25	1,2	24,1	66
	26	1,3	24,8	72
	27	1,4	25,4	78
	28	1,5	26,1	84
	28	1,6	26,6	90
	29	1,7	27,2	96
	30	1,8	27,7	102
	30	1,9	28,2	108
	31	2,1	28,7	114
	31	2,2	29,2	120
	32	2,3	29,6	126
	32	2,4	30,0	132
	33	2,5	30,5	138
	33	2,6	30,8	144
	34	2,7	31,2	150
	34	2,8	31,6	156
	35	2,9	32,0	162
	35	3,0	32,3	168
	36	3,1	32,7	174
	36	3,2	33,0	180
	37	3,3	33,3	186
	37	3,5	33,6	192
	37	3,6	33,9	198
	38	3,7	34,2	204
	38	3,8	34,5	210
	39	3,9	34,8	216
	39	4,0	35,1	222
	39	4,1	35,3	228
	40	4,2	35,6	234
	40	4,3	35,8	240
	41	4,4	36,1	246
	41	4,5	36,3	252
	41	4,6	36,6	258
	42	4,8	36,8	264
	42	4,9	37,0	270
	42	5,0	37,2	276
	43	5,1	37,5	282
	43	5,2	37,7	288
	43	5,3	37,9	294
	43	5,4	38,1	300
	44	5,5	38,3	306
	44	5,6	38,5	312
	44	5,7	38,7	318
	45	5,8	38,9	324
	45	5,9	39,1	330
	45	6,0	39,2	336
	46	6,2	39,4	342
	46	6,3	39,6	348
	46	6,4	39,8	354
	46	6,5	[illegible]	360

Sizing of the retention volume for scenario 2 :

Rainfall method (not to be confused with the volume method in IT 77-284)

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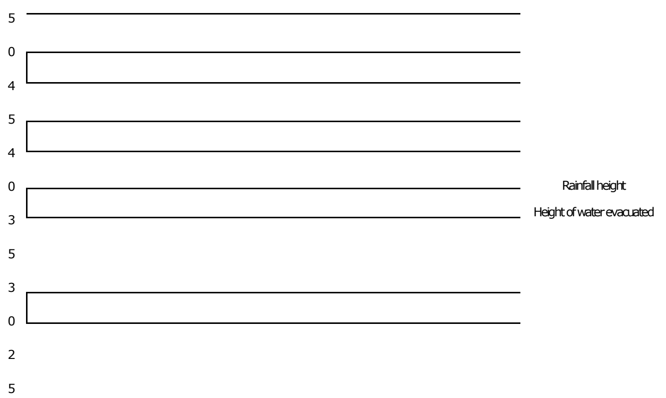
To be filled To be

Site data					
Total S (ha)	39				
Cr	0,60				
Qleakage (L/s)	117		Qinf (L/s)	-	Qdischarge 117
Sa (ha)	23,40				

Montana coefficient		
Station	Brest-Guipavas system (29)	
Rain duration	6min to 30min	30min to 6h
Return time	10years	10years
a	2,909	5.644
b	0,445	0.642

Rainfall height	$h_{(p)}(t)$(mm)	$h_f(t)$(mm)	$(h_{(p)}(t)-h_f(t))$(mm)	t (min)
$h_{(p)}(t) = a \times t^{(1-b)}$				
To be calculated for the duration of the rain	12	0,4	11,2	12
	14	0,5	13,9	18
	17	0,7	16,3	24
Discharge height	19	0,9	18,3	30
$h_f(t)=((Q_{(leakage)} \times t)/Sa) \times (6/1000)$	20	1,1	19,3	36
	22	1,3	20,3	42
Height of water to be	23	1,4	21,1	48
$(h_{(p)}(t)-h_f(t))$(mm)	24	1,6	21,9	54
	24	1,8	22,6	60
	25	2,0	23,3	66
	26	2,2	23,9	72
	27	2,3	24,5	78
	28	2,5	25,1	84
	28	2,7	25,6	90
	29	2,9	26,0	96
	30	3,1	26,5	102
	30	3,2	26,9	108
	31	3,4	27,3	114
	31	3,6	27,7	120
	32	3,8	28,1	126
	32	4,0	28,5	132
	33	4,1	28,8	138
	33	4,3	29,1	144
	34	4,5	29,4	150
	34	4,7	29,7	156
	35	4,9	30,0	162
	35	5,0	30,3	168
	36	5,2	30,6	174
	36	5,4	30,8	180
	37	5,6	31,1	186
	37	5,8	31,3	192
	37	5,9	31,5	198
	38	6,1	31,8	204
	38	6,3	32,0	210
	39	6,5	32,2	216
	39	6,7	32,4	222
	39	6,8	32,6	228
	40	7,0	32,8	234
	40	7,2	33,0	240
	41	7,4	33,1	246
	41	7,6	33,3	252
	41	7,7	33,5	258
	42	7,9	33,6	264
	42	8,1	33,8	270
	42	8,3	33,9	276
	43	8,5	34,1	282
	43	8,6	34,2	288
	43	8,8	34,4	294
	43	9,0	34,5	300
	44	9,2	34,6	306
	44	9,4	34,7	312
	44	9,5	34,9	318
	45	9,7	35,0	324
	45	9,9	35,1	330
	45	10,1	35,2	336
	46	10,3	35,3	342
	46	10,4	35,4	348
	46	10,6	35,5	354
	46	10,8	[illegible]	360

Results :				
Max. height of water to be	$h_{max} = (h_{(p)}(t)-h_f(t))$	**36**	mm	
Volume to be stored	$V = Max(h_{(p)}(t)-h_{(f)}(t)) \times Sa \times 10$	**8 336,0**	m3	
Draining time	$T_{(v)}(hf = h_{max})$	1187	min or	0 days 19 hours 47 minutes



Sizing of the retention volume for scenario 3 :

Rainfall method (not to be confused with the volume method in IT 77-284)

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To be filled To be

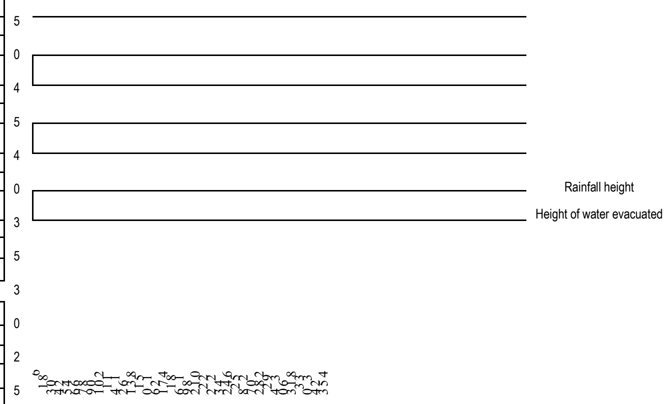
Site data					
Total S (ha)	39				
Cr	0,80				
$Q_{leakage}$ (L/s)	117	Qinf (L/s)	-	Qdischarge	117
Sa (ha)	31,20				

Montana coefficient		
Station	Brest-Guipavas system (29)	
Rain duration	6min to 30min	30min to 6h
Return time	10years	10years
a	2,909	5.644
b	0,445	0.642

Results :

Max. height of water to be	$h_{max} = (h_{(p)}(t) - h_f(t))$	**38**	mm
Volume to be stored	$V = Max (h_{(p)}(t) - h_f(t)) x Sa x 10$	**11 957,1**	m3
Draining time	$T_{(v)} (h_f = h_{max})$	1703	min or **1 day 4 hours 23 minutes**

	$h_{(p)}(t)$(mm)	$h_f(t)$(mm)	$(h_{(p)}(t) - h_f(t))$(mm)	t (min)
Rainfall height $h_{(p)}(t) = a x t^{(1-b)}$				
To be calculated for the duration of the rain	12	0,3	11,3	12
	14	0,4	14,1	18
	17	0,5	16,4	24
Discharge height $h_f(t) = ((Q)_{leakage} x t/Sa) x (6/1000)$	19	0,7	18,5	30
	20	0,8	19,5	36
	22	0,9	20,6	42
Height of water to be $(h_{(p)}(t) - h_f(t))$(mm)	23	1,1	21,5	48
	24	1,2	22,3	54
	24	1,4	23,1	60
	25	1,5	23,8	66
	26	1,6	24,5	72
	27	1,8	25,1	78
	28	1,9	25,7	84
	28	2,0	26,2	90
	29	2,2	26,8	96
	30	2,3	27,3	102
	30	2,4	27,7	108
	31	2,6	28,2	114
	31	2,7	28,6	120
	32	2,8	29,0	126
	32	3,0	29,4	132
	33	3,1	29,8	138
	33	3,2	30,2	144
	34	3,4	30,6	150
	34	3,5	30,9	156
	35	3,6	31,2	162
	35	3,8	31,6	168
	36	3,9	31,9	174
	36	4,1	32,2	180
	37	4,2	32,5	186
	37	4,3	32,7	192
	37	4,5	33,0	198
	38	4,6	33,3	204
	38	4,7	33,6	210
	39	4,9	33,8	216
	39	5,0	34,1	222
	39	5,1	34,3	228
	40	5,3	34,5	234
	40	5,4	34,8	240
	41	5,5	35,0	246
	41	5,7	35,2	252
	41	5,8	35,4	258
	42	5,9	35,6	264
	42	6,1	35,8	270
	42	6,2	36,0	276
	43	6,3	36,2	282
	43	6,5	36,4	288
	43	6,6	36,6	294
	43	6,8	36,7	300
	44	6,9	36,9	306
	44	7,0	37,1	312
	44	7,2	37,3	318
	45	7,3	37,4	324
	45	7,4	37,6	330
	45	7,6	37,7	336
	46	7,7	37,9	342
	46	7,8	38,0	348
	46	8,0	38,2	354
	46	8,1		360



Summary of the 3 scenarios :

Scenario	Surface area (Ha)	Runoff coefficient	Active surface area (Ha)	Required retention volume (m3)	Leakage (l/s)
Scenario 1 (100% sealed)		1,0	39,0	15 578,19	117,0
Scenario 2 (100% permeable)	39	0,6	23,4	8 336,03	117,0
Scenario 3 (50/50)		0,8	31,2	11 957,11	117,0

Depending on the scenario selected, the overall retention volume required is between 8,336 $m^3$and 15,578 m^3, with a total leakage rate of around 117 l/s (3 l/s.Ha).

Points to check:

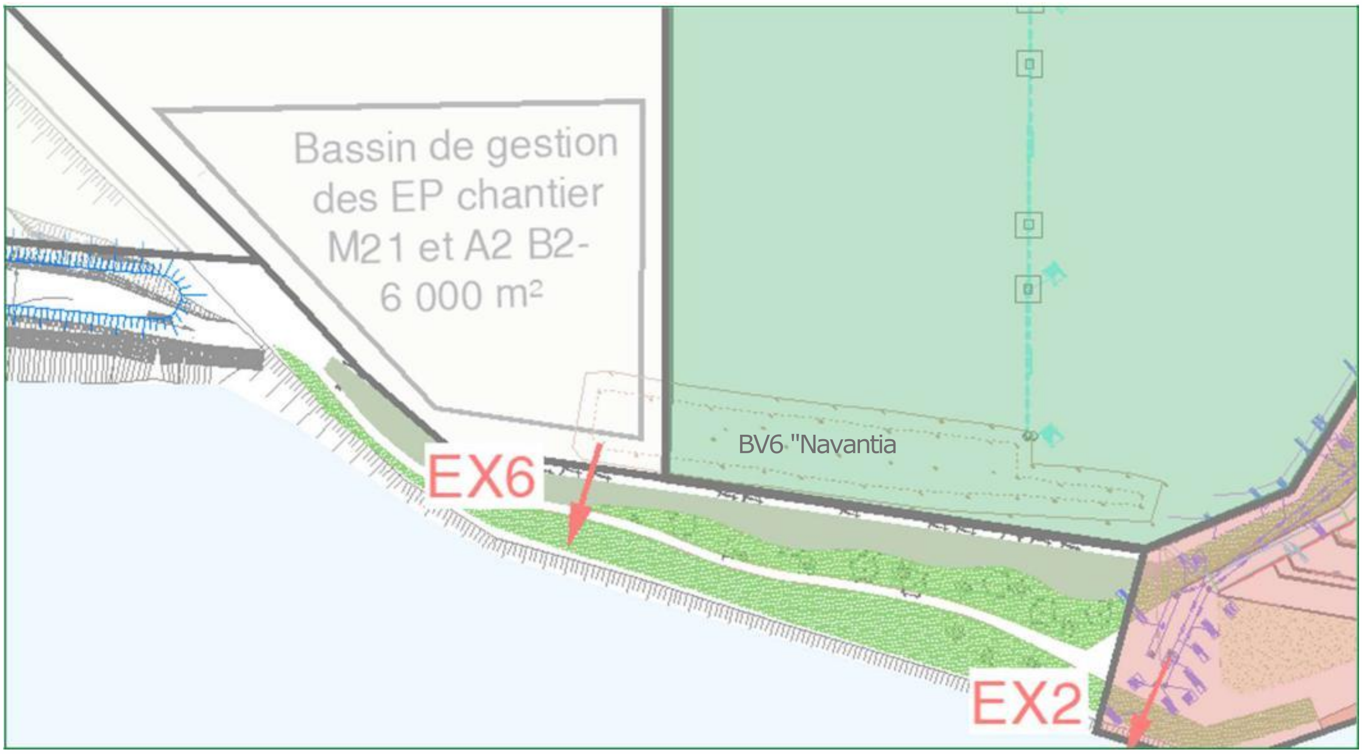
With regard to so-called permeable surfaces, particular attention must be paid to regulations concerning the risks of accidental pollution associated with the planned activities.

Some surfaces may need to be sealed with asphalt or concrete pavement structures, as well as watertight collection systems (gutters, pipes, watertight ditches) to convey run-off water to watertight retention basins with controlled leakage rates that are treated downstream before being discharged into the sea.

e) Analysis of the reuse of the existing A2B2 and BV6 "Navantia" retention basins

According to the data provided by the Brest Port Authority, the existing BV6 "Navantia" retention basin and the temporary M06 consolidation basin of the new polder could be reused as part of the operation:

Figure II-10: Extract from the summary plan of Artelia studies *on 26 September 2023*



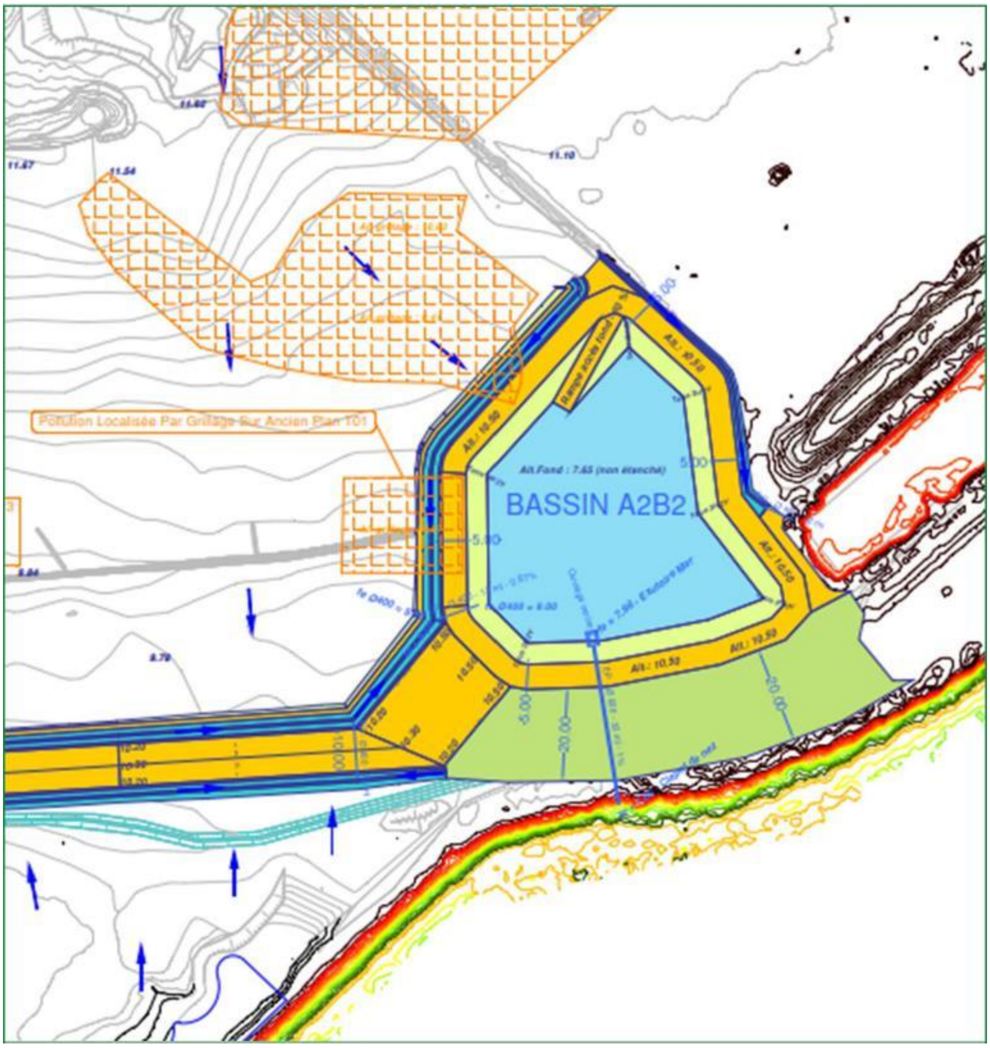


Figure II-11: Extract from the EXE plan of the A2B2 basin finally planned by the SDI-Vinci-IDRA consortium on 12/12/2023

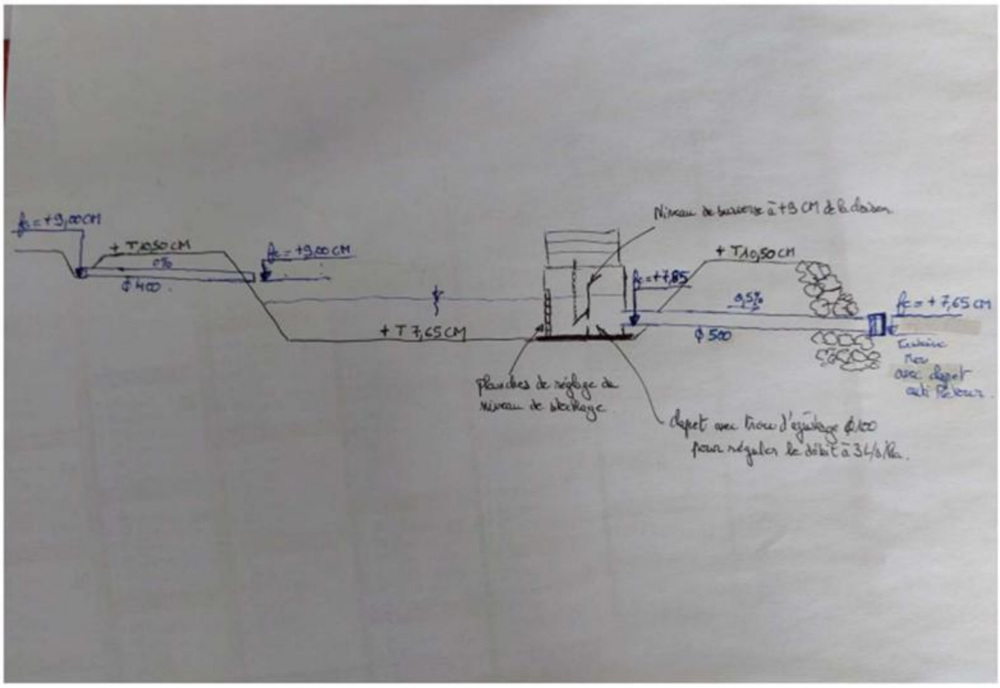


Figure II-12: Schematic cross-section taken from the EXE design manual for the A2B2 basin finally planned by the SDI-Vinci-IDRA consortium
SDI-Vinci-IDRA consortium of 12/12/2023

Each of these retention basins is fed by a collection network consisting of underground pipes, ditches and a lifting station that collects run-off water.

It is very likely that all these collection networks will have to be dismantled and replaced by new systems appropriate to the new surface developments.

Table II-1: Summary of data collected and transmitted by Brest Port.
Please note that the data for the BV6 Navantia basin have yet to be verified.

Designation of the retention basin existing	Surface collected (Ha)	Runoff coefficient	Return period for sizing using the rainfall method	Leakage rate taken into account	Retention volume including surcharge settling (m3)	Surface area (m²)	Useful height height (m)	Altimetry NGF bottom	Altimetry NGF edge basin	Fe NGF discharge
Basin A2B2	17,6	0,6	5 years	8	2925	4700	1,35	7,65	10,5	7,95
Basin BV6 Navantia	11,8	Data not available?	Data not available?	Data not available?	1200	3700	1,85	3,5	6,35	3,75

Impact of the scenarios envisaged on existing temporary retention volumes:

Scenario	Retention retention required (m3)	Retention retention existing (m3)	Retention volume to be required (m3)	Leakage rate (l/s)
Scenario 1 (100% sealed)	15 578,19	4 125,00	11 453,19	117,0
Scenario 2 (100% permeable)	8 336,03		4 211,03	117,0
Scenario 3 (50/50)	11 957,11		7 832,11	117,0

So, depending on whether or not the existing retention basins are to be retained for the future surface developments, additional retention facilities of around 5,000 to 13,750 m(3) (including a safety and settling margin of around +20%) would be required, depending on the waterproofing scenario for the planned surface developments.

f) Proposed development and stormwater management facilities to be provided

For a 10-year rainfall event and a leakage rate of 3 l/s.Ha, it is therefore necessary to plan one or more retention basins in addition to the 2 A2B2 and BV6 "Navantia" basins, for an additional volume of 5,000 to 13,750 m^3.

These additional structures could be located in the area where heavy machinery is excluded from the gabionade along the embankment (green zone):

Taking into account the same principles of altimeter setting as for the A2B2 provisional basin and a maximum useful width of 30 m at the right of this exclusion strip, it would be necessary to provide the following linear retention basins, according to each surface sealing scenario:

Surface sealing scenario	Volume required (m3)	Altimetry NGF bottom	Altimetry NGF edge basin	Fe NGF discharge sea	Useful height height (m)	Usable basin width with 3/2 embankment and surrounding	Useful length required (m)
Scenario 1 (100% sealed)	13 750,00						339,51
Scenario 2 (100% permeable)	5 000,00	7,65	10	7,95	1,35	30	123,46
Scenario 3 (50/50)	9 400,00						232,10

With regard to the division of the catchment areas that can be attached to the existing and planned retention basins, we have determined these surfaces by iteration of the rainfall method, taking into account a ten-year rainfall and a leakage rate of 3 L/s.Ha, according to each of the sealing scenarios for the surface developments:

	Collected surface capacity (Ha)		
Designation of the existing retention basin	According to scenario 1 100% waterproof	According to scenario 2	According to scenario 3 50/50
Basin A2B2	7,3	13,5	9,5
Basin BV6 Navantia	3	5,5	4
Remaining catchment area for additional retention works	28,7	20	25,5

Particularity of the "B1-Matx" catchment area and "Zone de Mise En Défens" :

The catchment area for the "B1-Matx" and "Zone de Mise En Défens" sectors is approximately 700 m from the nearest existing retention basin (BV6 "Navantia") and the seawall at the edge of the polder. Taking into account a minimum slope of 0.5% for the connection pipes and a minimum pipe cover of around 0.8 m, connection to the retention basin would be feasible at around 5 NGF, but would require a significant length of pipe at a depth of around 2 to 5 m. At this stage, we feel it would be wiser to plan a specific retention basin for this catchment area within the associated right-of-way, connected downstream to the Brest Métropole public sewer network located near BV1 (Outfall No. 1).

Proposed division of the catchment areas and location of the planned retention basins:

For the worst-case scenario 1, we obtain the following plan for dividing up the catchment areas and installing the retention basins:

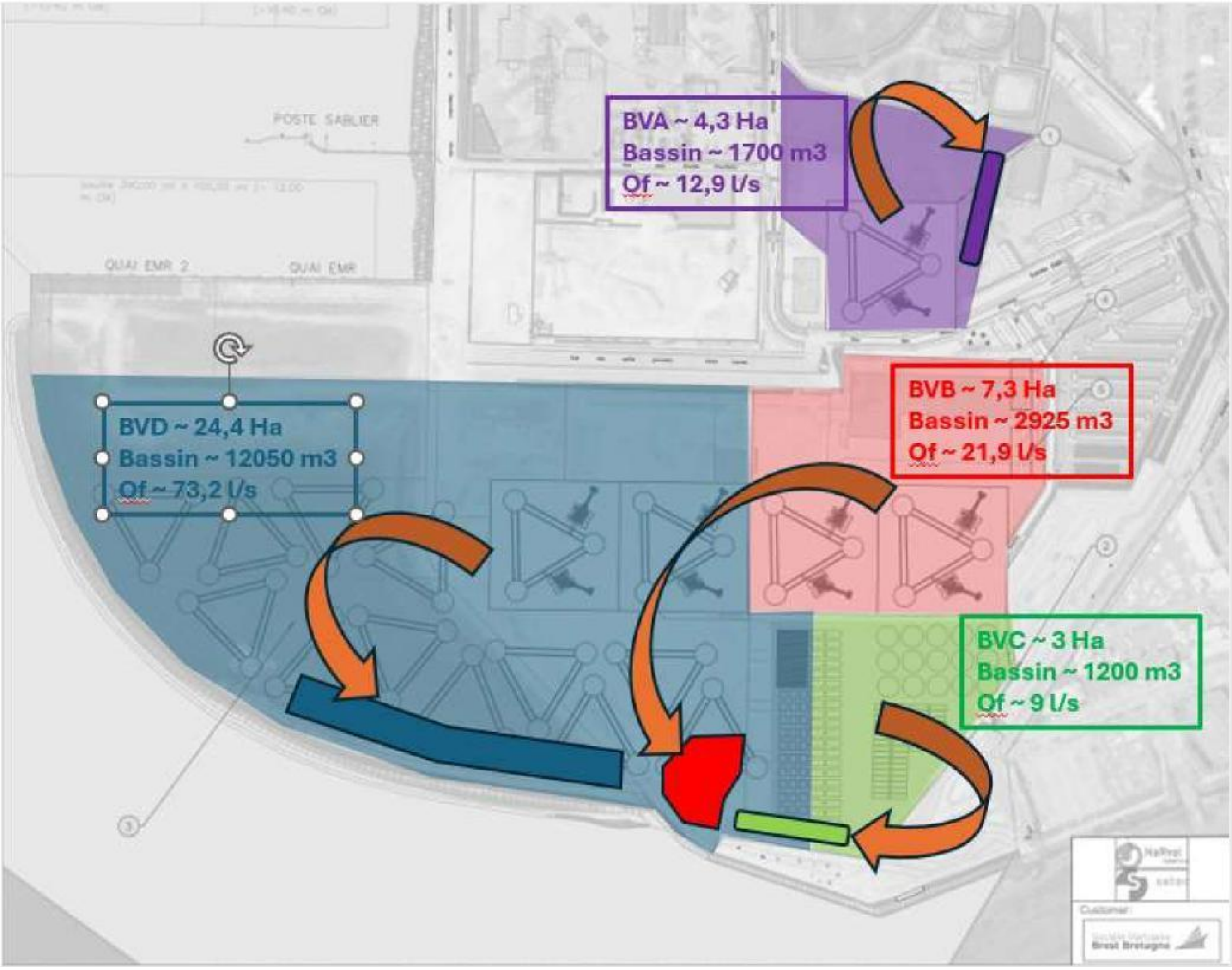


Figure II-13: Plan of the proposed catchment areas and retention basins

Proposed rainwater management equipment:

As we proposed in our previous study, the site will have to be equipped with collection and treatment facilities before discharge into the sea:

- Rainwater runoff is collected in earthen ditches in areas that cannot be used by vehicles;
- Rainwater harvesting using a system of drainage trenches (permeable surfaces) or

  cast-in-place concrete gutters (impermeable surfaces) in line with surfaces that can be used by machinery. By incorporating an integrated slope, this type of system makes it possible to limit variations in slope on the surface installations for crane and SPMT handling;
- Collection of rainwater by a gravity network of reinforced concrete pipes class 135A ;
- Treatment of rainwater before discharge into the sea in compliance with the treatment recommendations of the decrees

  prefectures.

The channels could be sized to take the equivalent of an assembly unit, i.e. around 17,000 m^2. As a first approach, 40 cm wide channels with an integrated slope would be required to cover a surface area of 17,000 m^2.

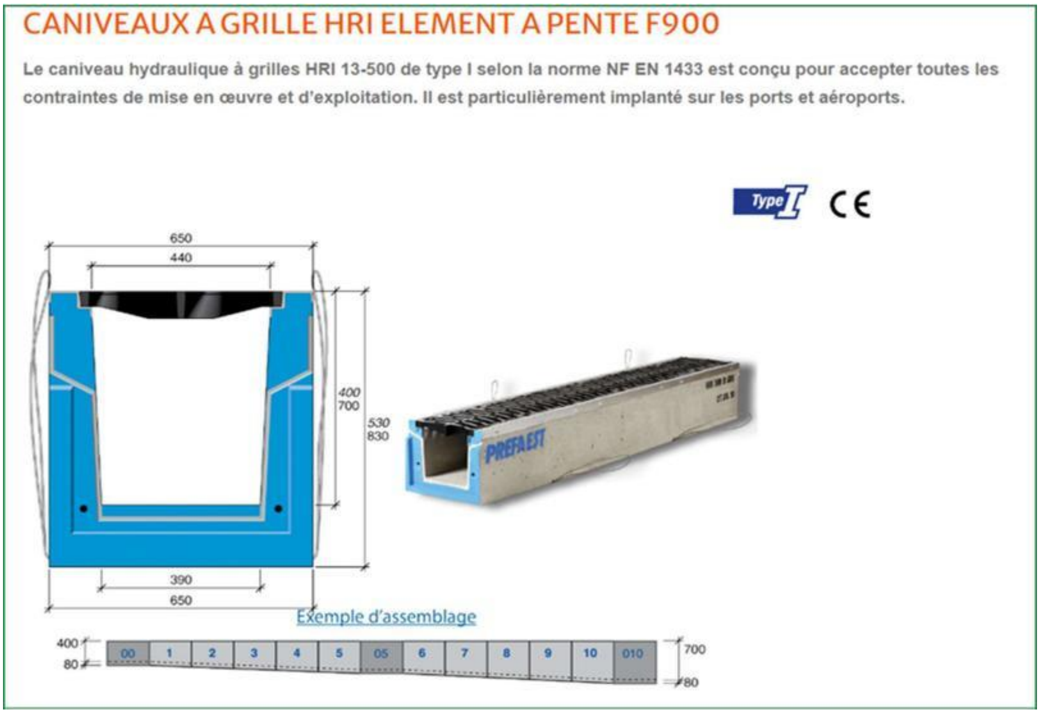


Figure II-14: Example of class F900 drainage channels with integrated slope

To treat these surfaces, the rainwater recovery pipes will have to be of variable diameters DN300 to DN1200.

Retaining above-ground retention basins with a regulated leakage rate before discharge into the sea also makes it possible to optimise the size of the treatment facility required before discharge into the sea or connection to existing public networks. In line with our previous conclusions, it would therefore be necessary to provide hydrocarbon separators with lamellar decantation capable of handling leakage flows ranging from 9 to 73 l/s.

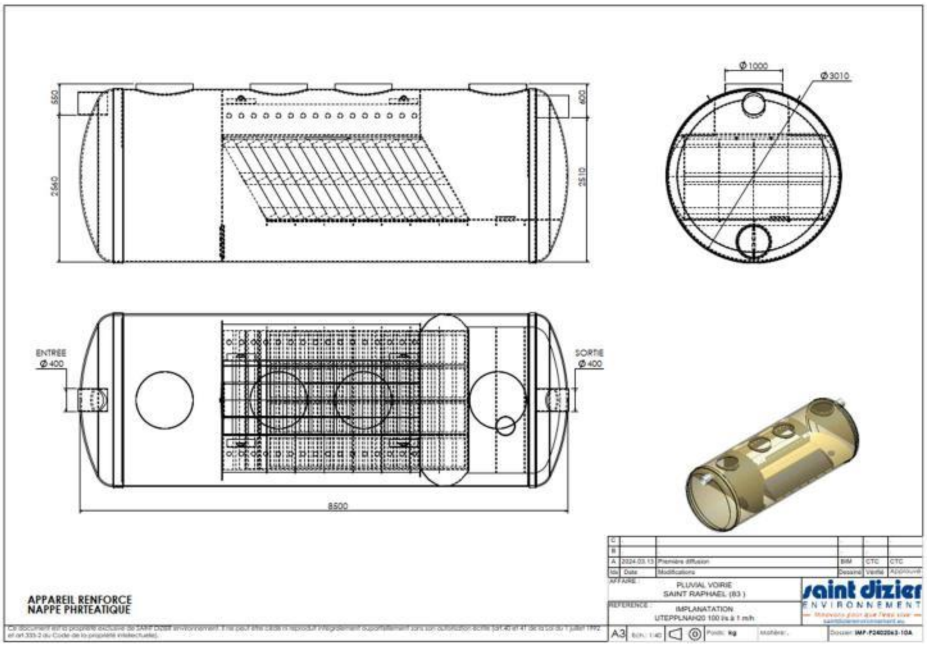


Figure II-15: Example of a hydrocarbon separator with lamellar settling of up to 100 l/s

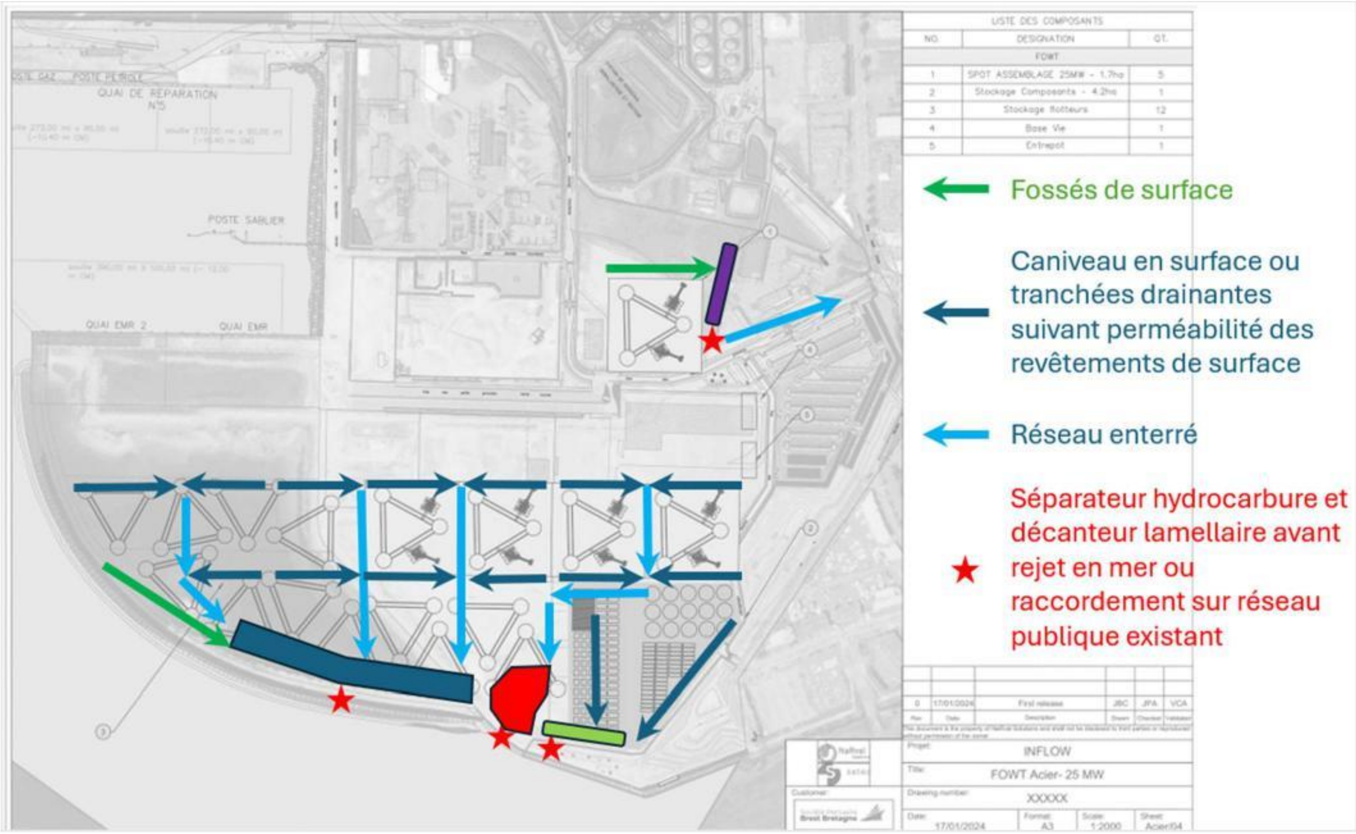


Figure II-16: Proposed stormwater management scheme

Points of attention :

Depending on the environmental study still to be carried out, it may be necessary to seal the ditches and retention basins against the risk of accidental pollution linked to the planned activities.

It may also be necessary to install non-return valves downstream of the treatment systems, particularly to protect against the risk of tides.

III. THEME 3: LAUNCHING THE FLOATS

III. 1 Functionality

As part of Stage 1, BrestPort specified that the scope for launching concerned the EMR quay only.

III.1.1 Launching a Ring Crane

We propose here to study the launching of the float, considering the same Ring Crane used for the integration of the turbine (Theme 5 - §V) with a boom configuration adapted for this operation.

The following parameters are considered for the lifting study:

- Ring Crane : **PTC-210-DS (MAMMOET)**
- Configuration : **88 m boom**
- Float : **Generic steel 25 MW (see note on assumptions** [13]**)**
  - Float weight : **6000 t**
  - Float height : **31.1 m**
  - Float width : **100 m**
- Lifting radius : **74 m**

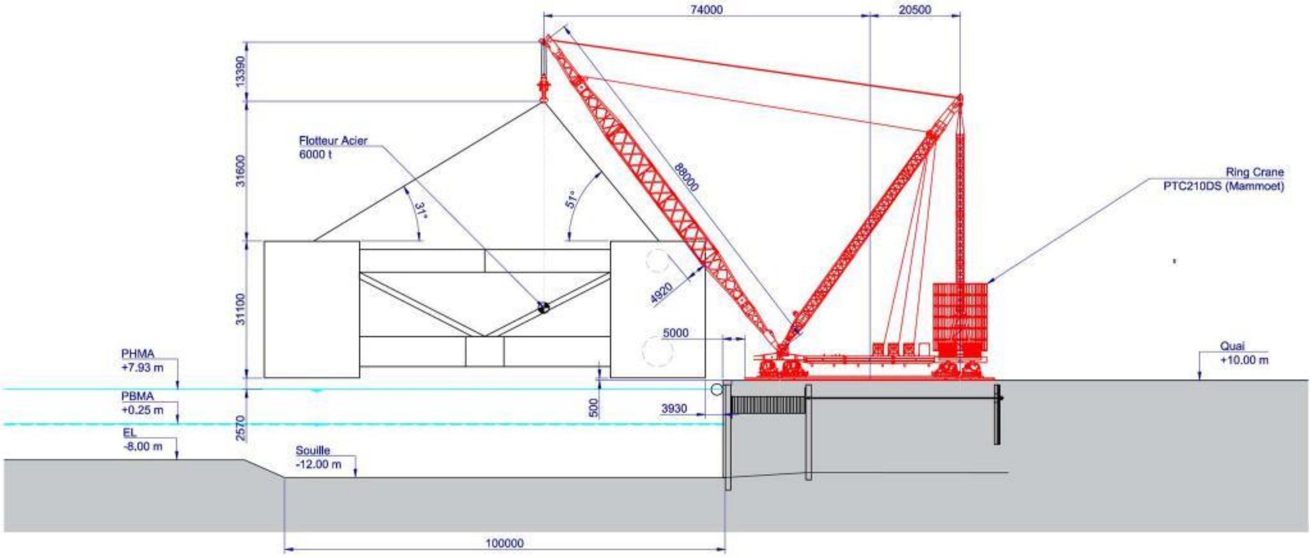
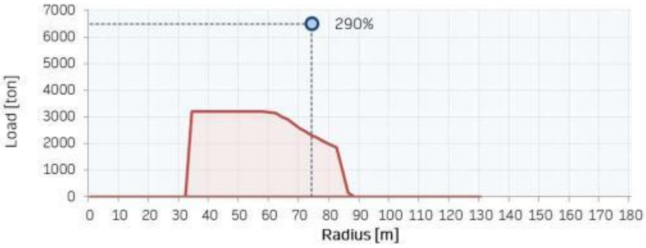


Figure III-1: Lifting plan for a steel float using the PTC-210-DS

STEEL FLOAT LIFT 25MW	
CRANE MODEL	**PTC-210-DS**
ARROW LENGTH	88.0 m
FEATHER LENGTH	-
FEATHER ANGLE	-
COUNTER WEIGHT	-
LIFTING RADIUS	74.0 m
LIFTING CAPACITY	2316.0 t
HOOK AND REEVING WEIGHTS	80.0 t
NET LIFTING CAPACITY	**2236.0 t**
NET PACKAGE WEIGHT	6000.0 t
WEIGHT OF PARCEL WITH MARGIN	6000.0 t
SLINGING WEIGHTS	180.0 t
STATIC HOOK LOAD	6180.0 t
MARGIN**	309.0 t
DESIGN LOAD ON THE HOOK	**6489.0 t**
CRANE OPERATING FACTOR	**290%**
WEIGHT MARGINS	1.00
COG FACTOR	1.00
TILT FACTOR	1.00
DAF FACTOR	1.05



*PACKAGE WEIGHT WITH MARGIN: WEIGHT MARGINx NET WEIGHT

**COSTS FOR ONSHORE: FCOG x FDAF

***DESIGN LOAD ON HOOK: MARGINS + STATIC LOAD ON HOOK

Consistent with the results of Phase 1, it appears that the Ring Crane PTC-210-DS is largely incapable of lifting the Float.

More generally, the table below shows the maximum float weights for different Ring Cranes:

Table III-1: Maximum lifting capacity (float weight) for various Ring Crane models

Ring Crane	Configuration	Lifting radius	Net capacity	Maximum net weight of Float
HCR-3000 (BMS)	SB Main Boom 135 m	60.6 m	1086 t	928 t
PTC-140 (MAMMOET)	SSL2 Main Boom 88 m	74 m	1381 t	1204 t
SGC-140 (SARENS)	MB Main Boom 88.7 m	74 m	1566 t	1375 t
PTC-210-DS (MAMMOET)	SSL2 Main Boom 88 m	74 m	2316 t	2069 t
SK-6000 (MAMMOET)	M Main Boom 130 m	60.6 m	3309 t	2985 t
SK-10000 (MAMMOET)	M Main Boom 89.6 m	60.6 m	3661 t	3310 t

These results are based on the following assumptions:

- Position of the Ring Crane : Crane distribution plate located 5 m from the quayside
- Rigging weight : 3% of the net weight of the float
- Weight of hook and reeving : 80 t
- DAF lifting factor : 1.05
- Weight factor : 1.00

NB: These results are preliminary and will need to be refined depending on the actual geometry of the float, its weight and technical details (sizing of lifting points and slinging, adjustment of the position of the crane and float, final lifting factors, etc.).

III. 1. 2. Launching a semi-submersible vessel

We consider here the launching of the generic 25 MW steel float on a semi-submersible vessel at the EMR quay in order to study in a preliminary way the feasibility of the loading operation by SPMT.

The Blue Marlin semi-submersible vessel (Boskalis) is considered to be representative of the largest vessels on the market, with the following characteristics:

- Name of ship : **Blue Marlin**
- Total length (LOA): **224.8 m**
- Total width (Breadth) : **63.0 m**
- Depth : **13.3 m**
- Deadweight : **76 292 t**
- Maximum operating draught (summer draft) : **10.2 m**
- Lightship draft : **4.36 m** (estimated)

To keep the ship's deck level with the EMR quay, the theoretical maximum and minimum tide levels are deduced:

- Maximum tide level : **+6.90 m CM** (=10.2-13.3+10.0)
- Minimum tide level : **+1.06 m CM** (=4.36-13.3+10)

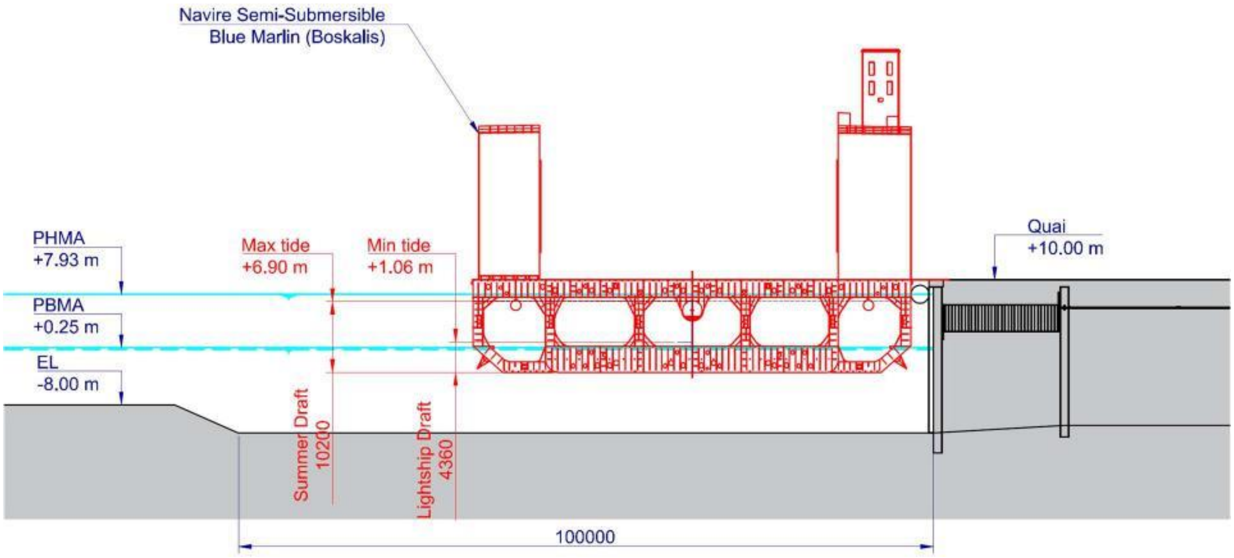


Figure III-2: Cross-section of a semi-submersible vessel at the EMR quay

Based on the data available from the tide gauge for 2018 (Figure III-3), we can deduce the percentage of operability required to comply with the minimum and maximum tides defined above.

This represents theoretical operability of 95.2% for 2018.

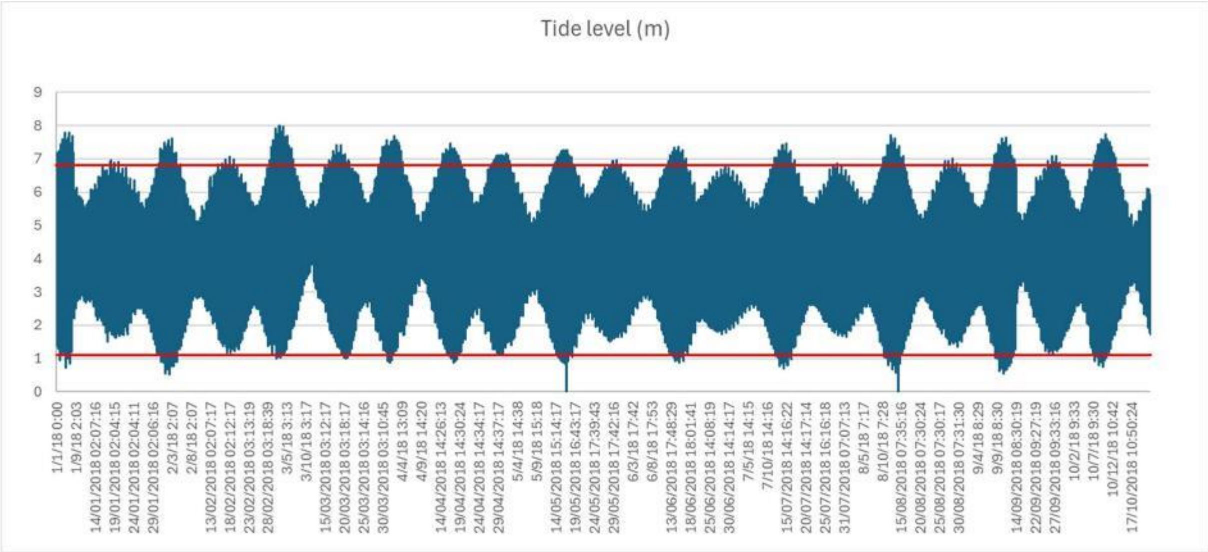


Figure III-3: Tide gauge data for 2018 - Tide levels

(in red: the maximum and minimum levels considered, giving a theoretical operability of 95.2%)

For the Boskalis Blue Marlin, the surface area of the vessel is 13,010 $m^{(2)}$ $^{(}$206.5 m x 63 m), which means that a sinking of 1 m corresponds to 13,010 $m^{(3)}$ ^{of}water, or 13,270 t for a seawater density of 1,020 kg/m^3.

For the 6,000 t steel float, we deduce a theoretical depth of 0.45 m.

Given the vessel's ballasting capacity (4 pumps of 3,300 m^3/h), giving a total ballasting capacity of 13,200 m^3/h, a displacement of 1 m can be achieved in 1 hour.

- The ballast capacity can be used to compensate for the float load, which could theoretically be fully compensated in 27.5 min.
- The ballast capacity can also be used to compensate for the tide at a theoretical maximum rate of 1 m per hour.

Taking into account the data available from the tide gauge for 2018, we can deduce the percentage of operability required to comply with the maximum tidal speed.

This represents "real" operability of 73.6% for 2018.

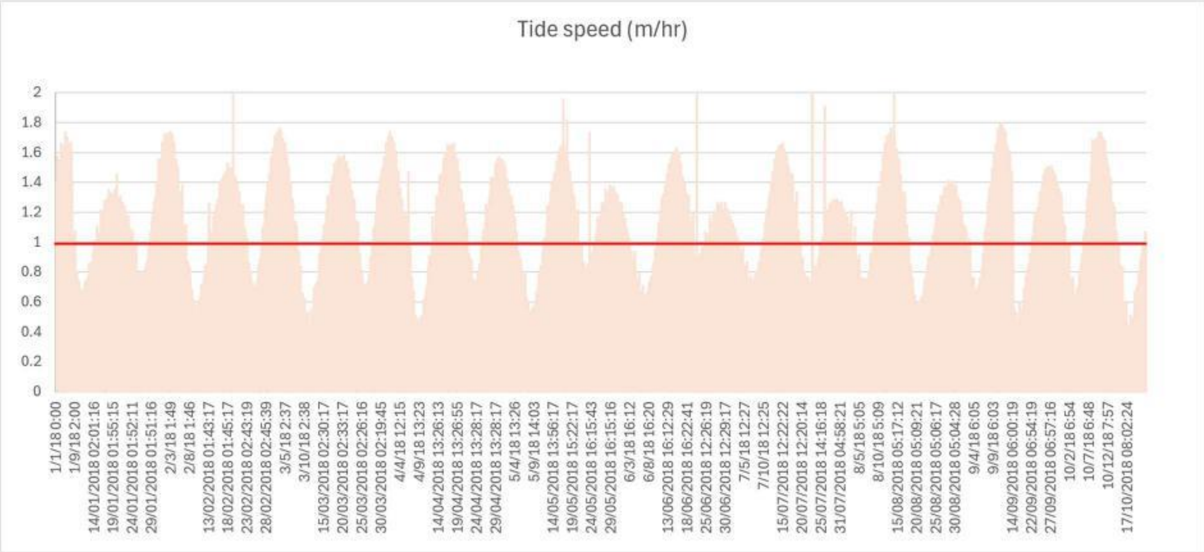


Figure III-4: Tide gauge data for 2018 - Maximum tidal speeds

(in red: the vessel's ballasting capacity, giving real operability of 73.6%)

III. 2 Infrastructure

III. 2. 1 Relocation of the sandpit to quay QR5 a)

Current sandpit pipe

The current Sablier substation is located at the Sablier jetty, a steel structure on piles between the QR5 quay (200 m away) and the EMR quays (130 m away).

To enable the floats to be launched at the EMR quay, it will be necessary to move this Hourglass berth. The new location chosen is quay QR5, a structure for which an engineering design contract is underway, and in which this use has been identified.

The current sand dock was connected to the Lafarge plot by a sand pipe, protected by a concrete gutter in the areas where it passed under the heavy roads. Plans and cross-sections of these structures are shown in the following figures.

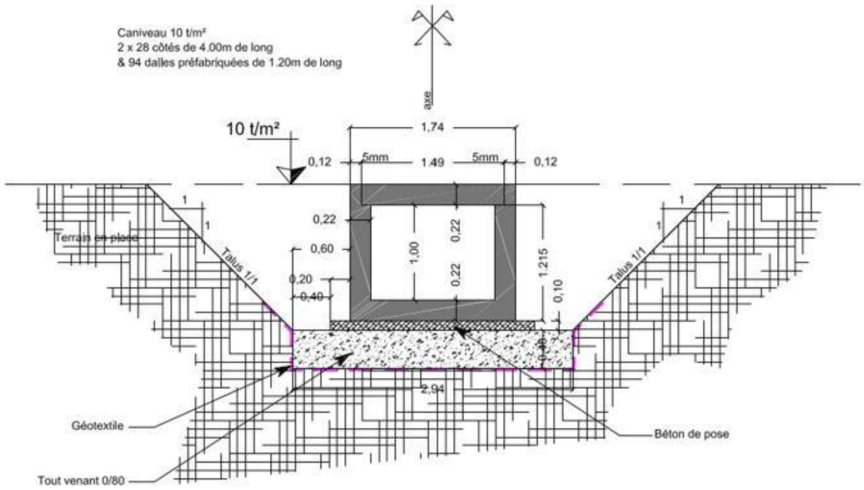


Figure III-5: Cross-section of the concrete culvert under the heavy roadway between QR5 and the EMR quays [25].

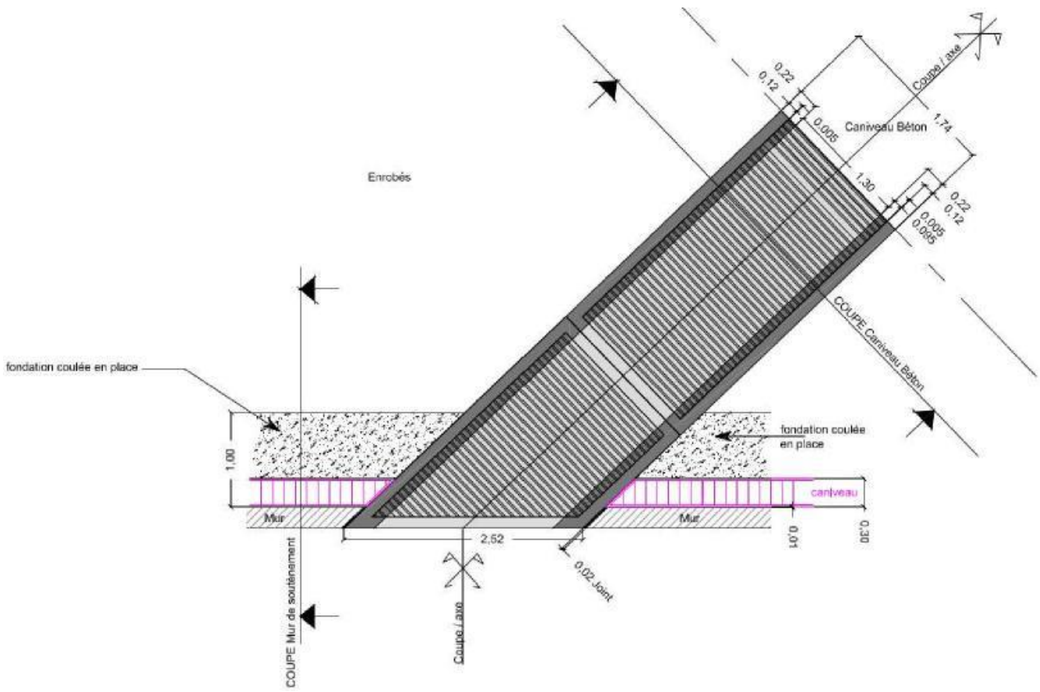


Figure III-6: Plan of the concrete culvert under the heavy roadway between QR5 and the EMR quays [25].

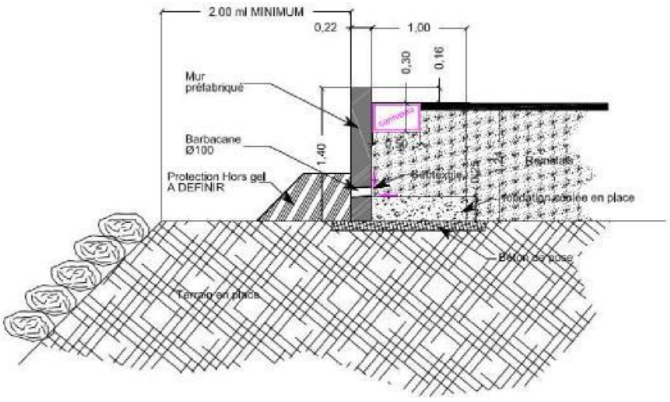


Figure III-7: Cross-section of the retaining wall along the heavy road between QR5 and the EMR quays [25].

The elevations of the retaining wall are given on the longitudinal profile of the structure [26]. The elevation of the lower level of the retaining wall varies between +8.32 m CM (i.e. +4.78 m NGF) at the end of the QR5 side, and +10.63 m CM (i.e. +6.99 m NGF) near the intersection of the wall and the concrete channel for the sand pipe. With the PHMA at +7.93 m CM (Table IV-3), the structure is therefore above water for all tidal configurations.

b) Proposals for relocating the Hourglass pipe Relocating the

Hourglass substation involves carrying out the following work:

- Demolition of the metal structure (sand wharf + integrated pipe)
  - Option 1: Total extraction of the piles
  - Option 2: Re-digging the piles at the current bathymetric depth

- Preservation of the concrete gutter under heavy roadways
- Continuation of the hourglass pipe to QR5
  - Option A: Concrete culvert under heavy roadway (similar to the current culvert) along the retaining wall + Continuation of the concrete culvert to the quayside of QR5
  - Option B: Concrete culvert under heavy traffic (similar to the current culvert) along the retaining wall + Creation of an aerial landing stage up to the QR5 quayside
  - Option C: Creation of an overhead pipe on the embankment along the retaining wall + Creation of an overhead jetty up to the quayside of QR5
  - Option D: Concrete culvert under heavy roadway (similar to the current culvert) on the other side of the roadway + Continuation of the concrete culvert up to the quayside of QR5

  For Options A, B and C, the load-bearing capacity of the retaining wall and embankment must be verified.

- Integration of the hourglass pipe into the 5 m quayside strip of the QR5

The proposals (see following figures) are based on the Permissible Loads plan [16]. *NB:*

- *As mentioned in §I. 1. 2.b), the inclusion of the pipe in the 5 m quayside strip will have no impact on the use of the quay for transhipment of heavy goods. As the RORO unloading option has been ruled out, this strip will not be loaded to 10 t/m(2) (unloading by mobile cranes).*
- *Similarly, the sand unloading arm will have to be located within this 5 m strip: in this configuration it will not interfere with the use of the quay for transhipment.*

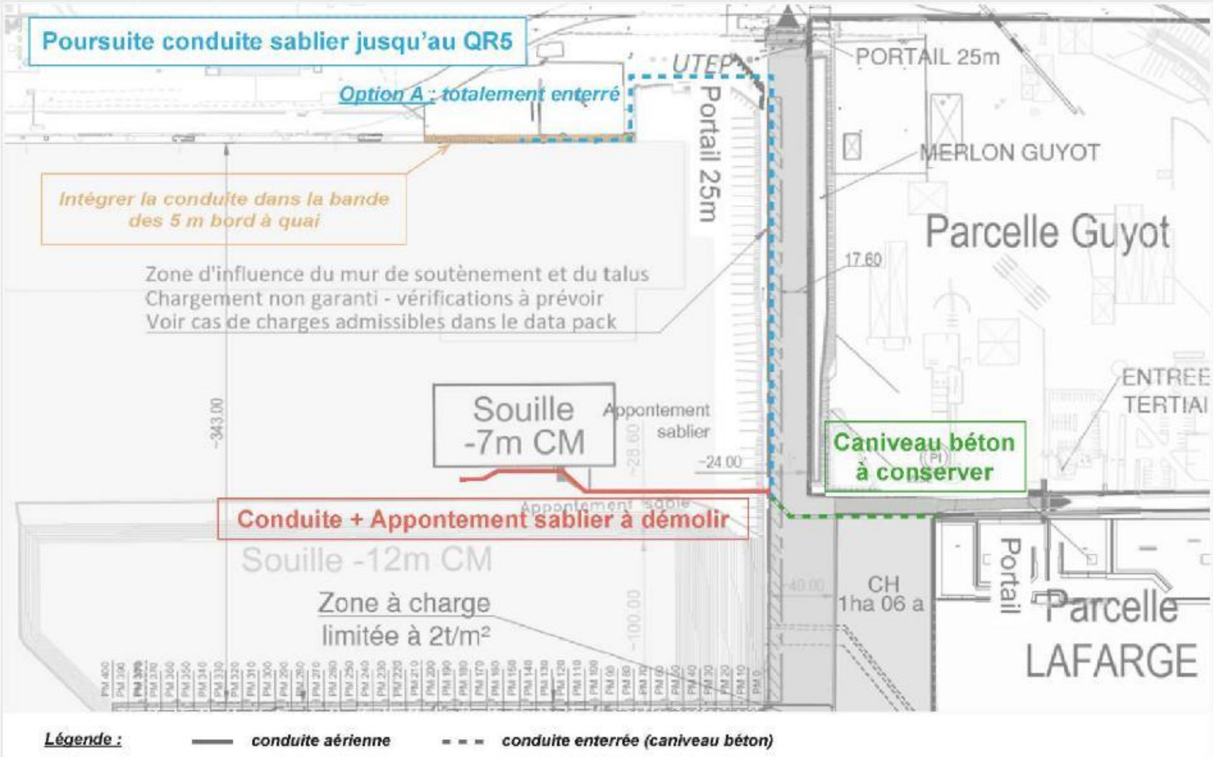


Figure III-8: Relocation of Sablier substation to QR5 - Option A

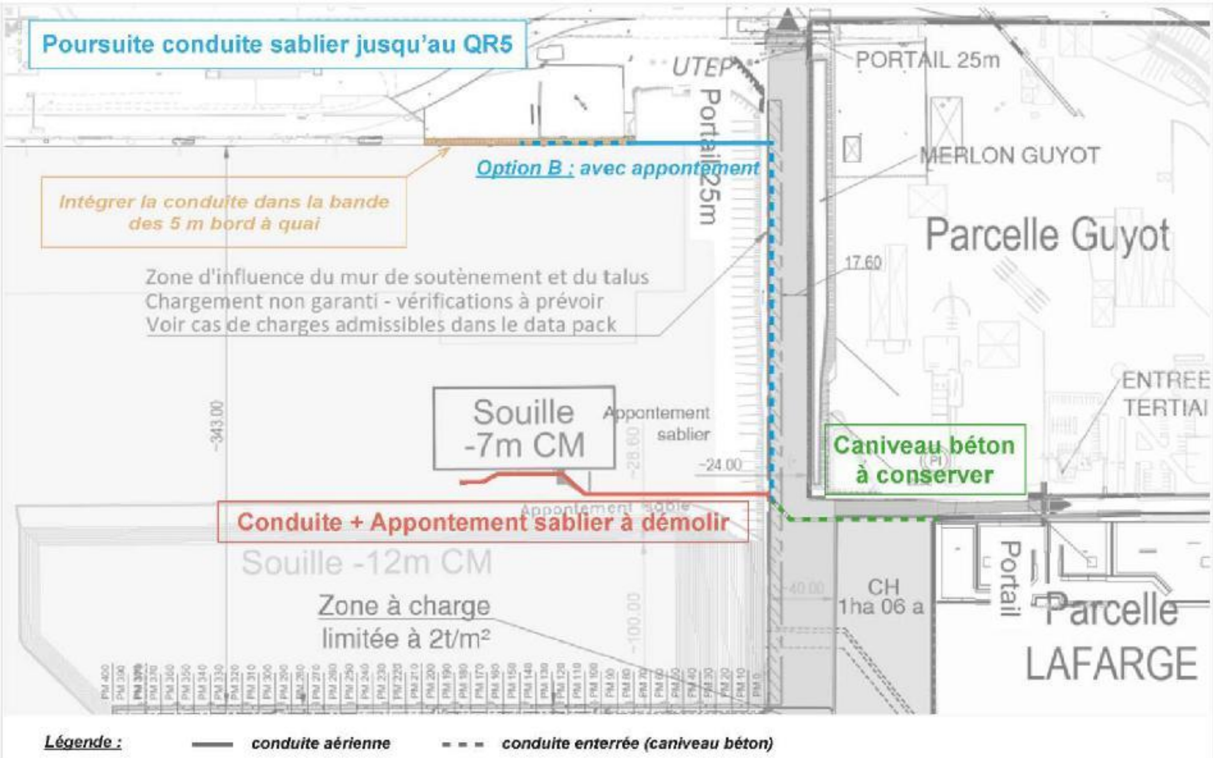


Figure III-9 : Relocation of Hourglass substation to QR5 - Option

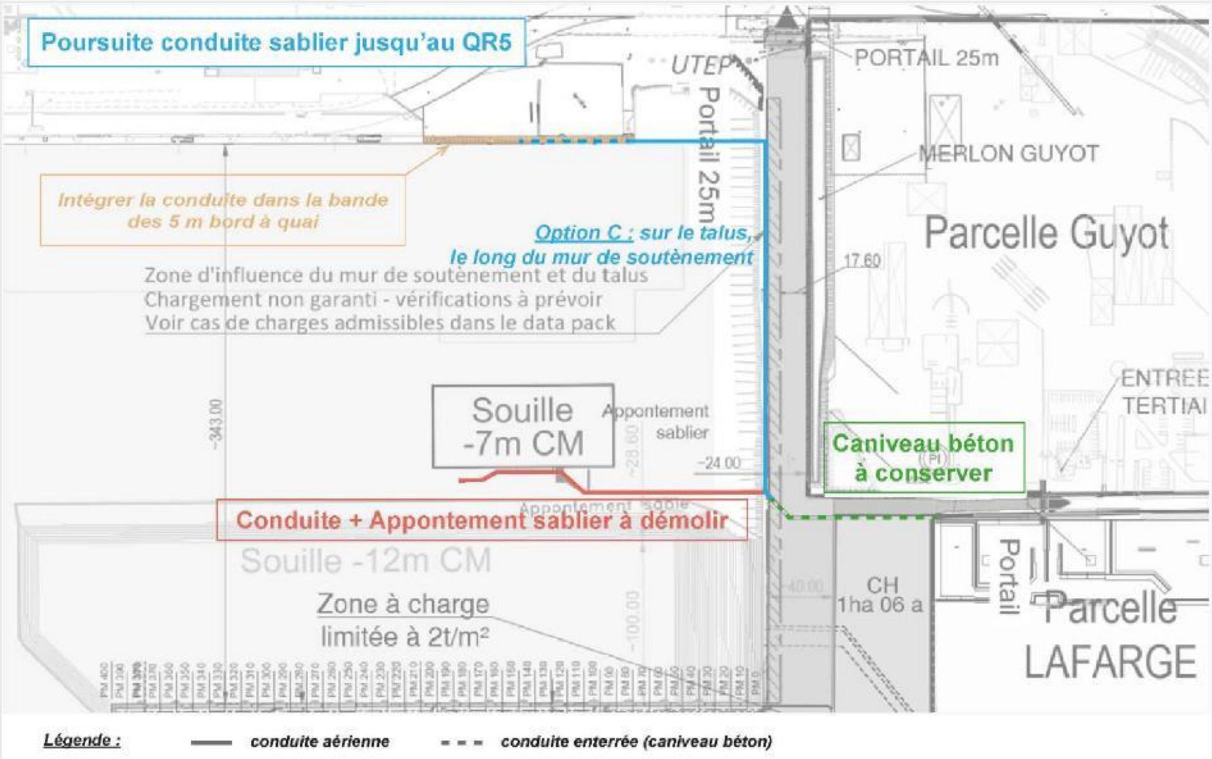


Figure III-10 : Relocation of Sablier substation to QR5 - Option C

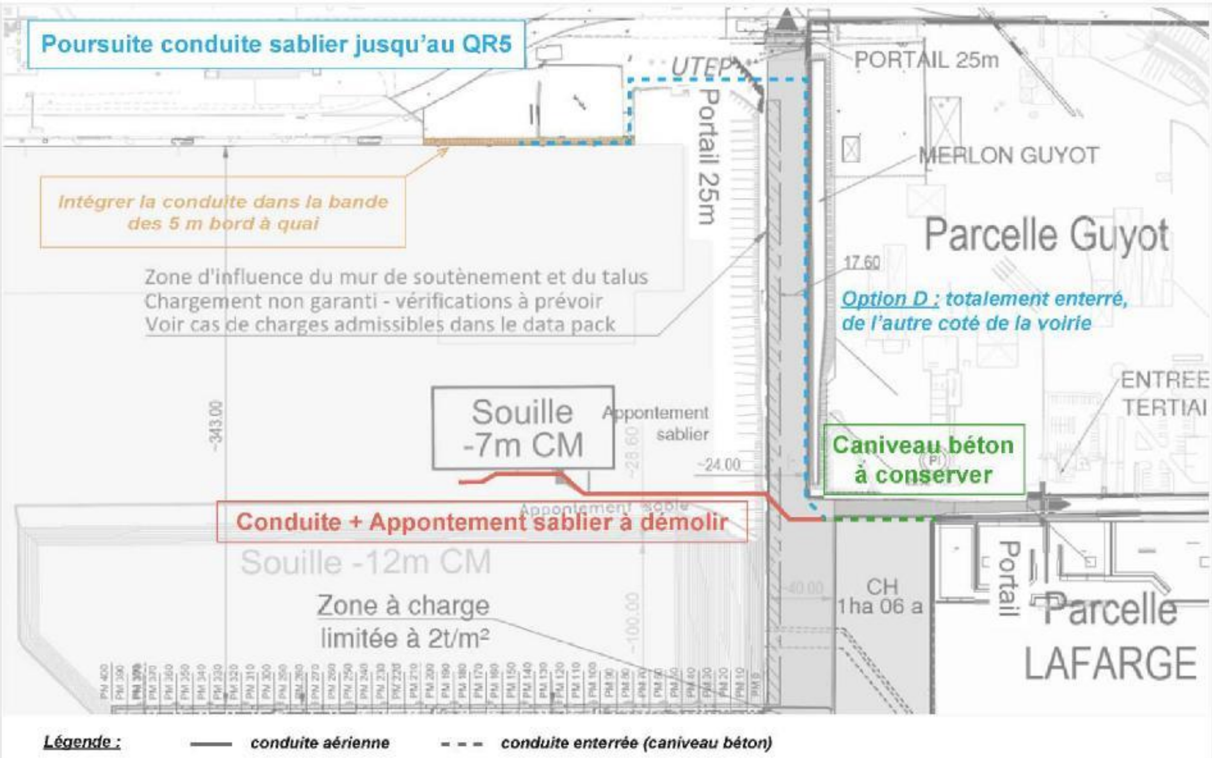


Figure III-11 : Relocation of Sablier substation to QR5 - Option D

III. 2. 2 Reinforcing the EMR quay for the Ring Crane

The reinforcement of the EMR quay to accommodate the Ring Crane is detailed in Theme 5 (§V. 2. 1).

IV. THEME 4: MARITIME STORAGE

IV. 1 Functionality

IV.1.1 Overview of functional requirements Phase 1

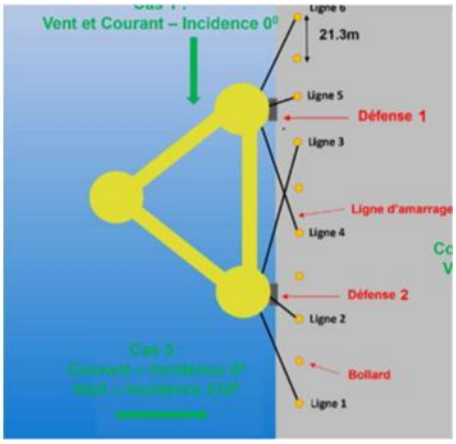
Table IV-1 shows the assumptions for the height of water under the float to be respected depending on the type of marine storage (assumptions defined in Theme 4 of phase 1 [4]).

Table IV-1: Height of water under the float to be respected according to the type of maritime storage

		Mooring at quayside Float mooring	
Minimum water under the float	Bare floats (long-term storage)	2 m	4 m
	Integrated floats (storage < 1 month)	1 m	No mooring of integrated floats

For mooring at the quayside, it is also necessary to have :

- With a berthing length of around 50 m greater than the length of the float (ie 150 m for a 100 m float)
- A continuous berthing table allowing either Yokohama-type floating fenders to be fitted at any point along the quay, or these fenders to be attached to the berthing table, and the table to withstand the reaction forces induced.
  along the quay, or to attach these same fenders to the berthing table, and for the table to be able to withstand the reaction forces induced
- A sufficient number of bollards (i.e. 5 to 6 per float as shown in the figure below) and in capacity to absorb the dynamic stresses induced



- Ditches of a length and width compatible with the size of the floats, and of a depth of water allowing floats with a TE of around 9 m (bare float) to 12 m (integrated float) at any tide.

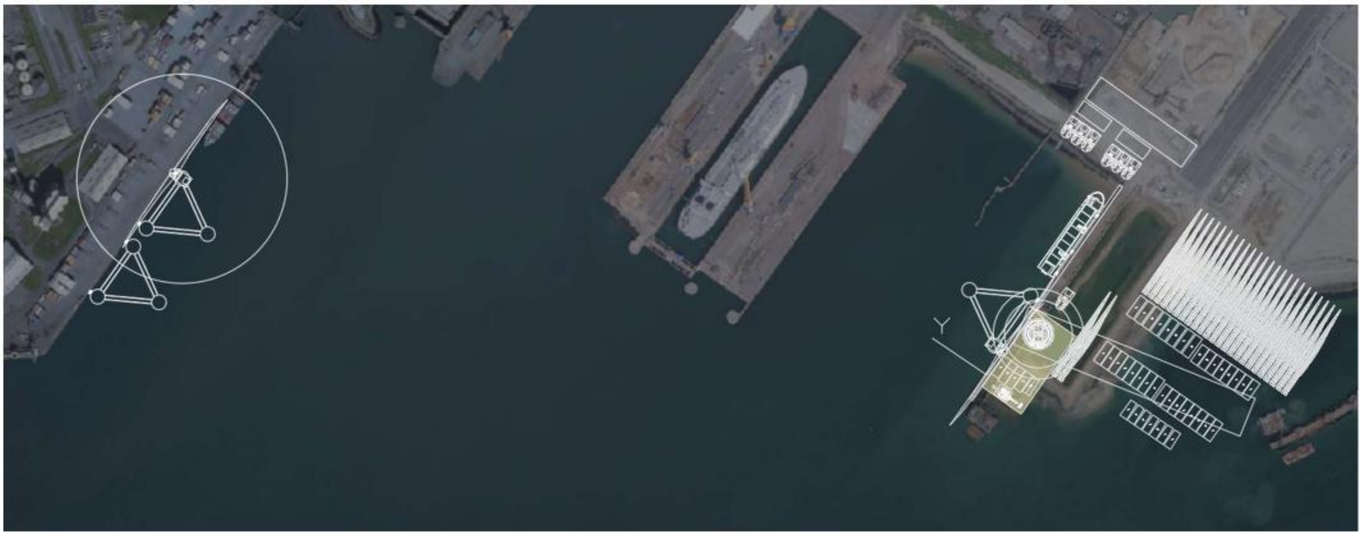


Figure IV-1: Storage of 2 floats in QR3, 1 of which is pre-commissioned in one float
+ 1 float in QEMR under the Ring Crane

IV.1.2 Identification of support vessels

The vessels supporting the construction and operation of a floating wind farm are mainly :

- Harbour tugs, for moving bare or integrated floats within the port. They are used in groups of 3.
- Vessels known as CSVs, capable of operating ROVs and installing suction batteries, if used anchoring systems.
- Anchor handling tugs, used both for towing the integrated float to the farm and for the anchor line installation campaign (generally called AHTS for Anchor Handling Tug Supply). the farm and for the anchor line installation campaign (generally called AHTS for Anchor Handling Tug Supply)
- Cable-laying vessels, to install cables between wind turbines and for export
- Rock dumping" vessels for sinking cables
- SOV-type support vessels, enabling teams of technicians to be on stand-by at

  the sea and wind turbine maintenance
- Crew Transfer Vessels (CTVs) for transferring technicians between land and wind turbines on a daily basis. between land and wind turbines on a daily basis.

The main characteristics of these vessels are shown below. They include vessels in operation, as well as vessel concepts currently being developed for future projects.

Table IV-2: Support vessels

Port tugs	
	Qty : 3 Capacity: minimum 30 t BP Light displacement: 350 t
CSV	
	Type Skandi Acergy Dimensions: 157 x 27 m TE: 7 m Gross tonnage: 16,500 t
AHTS	
	Type Luzolo (Bourbon) Dimensions : 69 x 17 m TE : 6.1 m Gross tonnage: 2300 t
	Concept type : UT 7800 Dimensions : 110 x 28 m TE : 9 m Gross tonnage: 6000 t
Cable and rock dumping	
	Type: Olympic Triton Dimensions: 95 x 20.5 m TE: 6.5 m Gross tonnage: 4900 t
	Concept Type: Nexans Aurora Dimensions: 150 x 31 m TE: 9 m? Gross tonnage: 22,000 t

	Type Living Stone (DEME) Dimensions: 161 x 32 m TE: 6.5 M Gross tonnage: 19,000 t
SOV	
	Type : Acta Auriga Dimensions: 94 x 18 m TE: 5.6 m Gross tonnage: 6000 t
	Concept Type : Enydra (Gusto) Dimensions : 140 x ? m TE: 9 m? Gross tonnage: tbd
CTV	
	Type : LDA Dimensions: 27 x 10 TE: 1.8 m Displacement: 100 t

It should be noted that these ships are compatible with most of Brest's quays.

IV.2 Infrastructures and port areas IV.2.1

Reminder of water levels

The tide in the study area is semi-diurnal. The tidal range varies from 2.8 m during the average neap period to 5.9 m during the average spring period. The theoretical water level in the tidal basins and in the Rade de Brest can vary according to tidal coefficients between +0.25 m CM and +7.93 m CM. The average water level in the Rade de Brest is +4.13 m CM. The SHOM data for the port of Brest are defined in the following table:

Table IV-3: SHOM data - Port of Brest

Water levels	In m CM
PHMA: Highest Astronomical Sea	+7.93
PMVE: Full spring tide	+7.05
PMME: Full neap seas	+5.50
NM: Medium level	+4.13
BMME: Stillwater low tide	+2.70
BMVE: Low spring tides	+1.15
PBMA: Astronomical Lowest Sea Level	+0.25

Tides

280m

690m

768m

NB: The Port of Brest is subject to coastal risks through marine submersion and coastline erosion. The sea level rise projections adopted by the Brittany Region, and to be taken into account in the detailed studies to follow, are :

- *By 2050: + 0.30 m*
- *By 2100: + 1.00 m*

IV.2.2 Bathymetry of marine storage areas

a) QR2/QR3 pile docks

According to the bathymetry (Figure IV-2), the depths of the pile docks are :

- **QR2**: on average at -9 m CM
- **QR3**: on average at -11.5 m CM

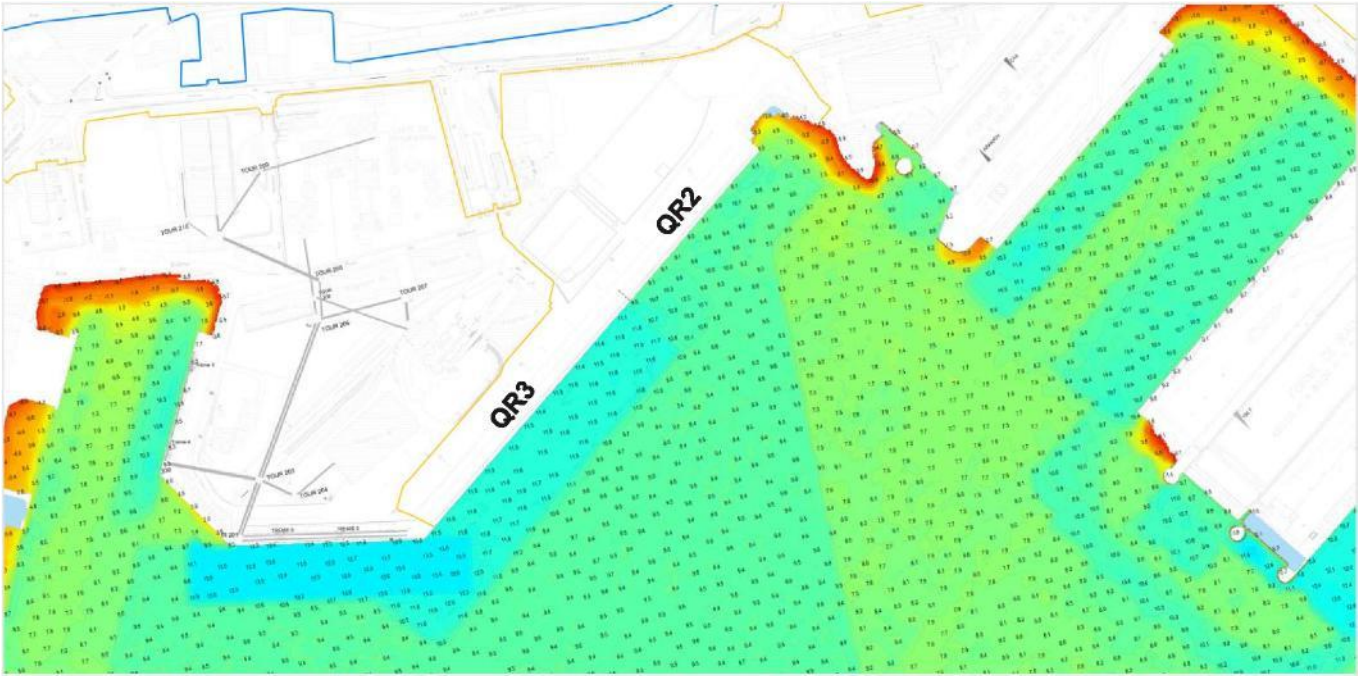


Figure IV-2: Bathymetry of the QR2 and QR3 quay basins - taken from the Port of Brest base map (x2022_BR_bathy 20m.dwg)

b) Mooring areas in the port

According to the bathymetry (Figure IV-3), the water depths in storage zones 1 and 2 are :

- **Zone 1:** between -7 and -8 m CM
- **Zone 2:** between -9 and -10.5 m CM.

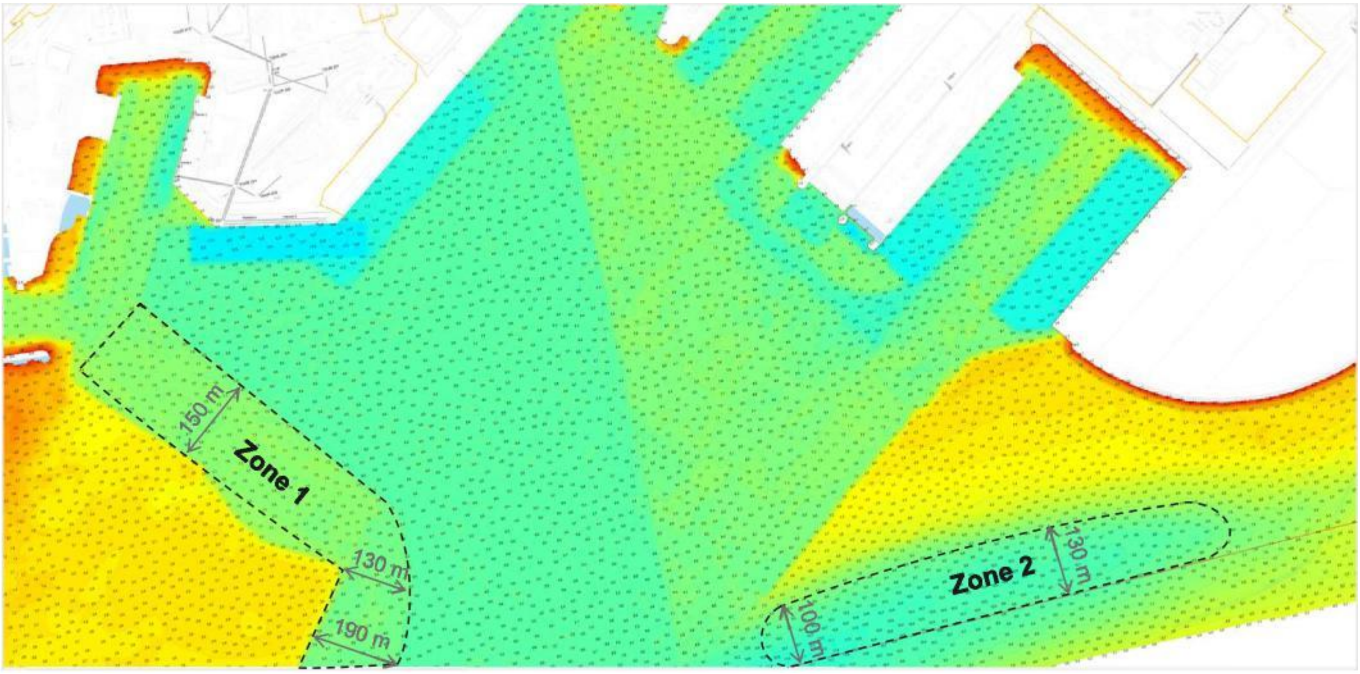


Figure IV-3: Bathymetry of storage areas 1 and 2 - taken from the Port of Brest 2024 base map (x2022_BR_bathy 20m.dwg)

IV.2.3 Maritime storage of floats at docks QR2/QR3

For Stage 1 - Horizon 2029, we **assume that no dredging work will be carried out for the storage of floats at sea**. On the basis of bathymetric data (§IV. 2. 2), the required water depths under floats (Table IV-1) and the current trench widths for pile docks, we determine the maximum draught and the maximum area of floats that can be stored in each of the identified zones:

Table IV-4: Maximum geometric stresses for floats as a function of storage area (without dredging)

Water level under float	Mooring QR2 2 m (bare) 1 m (integrated)	docked QR3 2 m (bare) 1 m (integrated)	Zone 1 4.5 m (bare)	Mooring Zone 2 4.5 m (bare)
Bathymetric background	-9 m CM	-11.5 m CM	-7 m CM to -8 m CM	-9 m CM to -10.5 m CM
Dock/area length	288 m	320 m 670 m + 400 m		870 m
Maximum float draught	**7 m (bare)** **8 m (integrated)**	**9.5 m (bare)** **10.5 m (integrated)**	**2.5 to 3.5 m**	**4.5 to 5 m**
Maximum tank/area width	**80 m**	**80 m 150 m** (average)		**100 to 130 m**
Maximum mooring / anchoring length	**288 m**	**320 m**	**670 m + 400 m**	**870 m**
Maximum possible float length *	**238 m**	**270 m**	**Not rated** (depends on the length of the lines)	

** Float length = Maximum mooring length minus 50 m (required for mooring line layout)*

Given that the assumed draught of the bare floats is 9 m and that of the integrated floats is 12 m, and taking into account the heights of water under the corresponding floats, the bathymetric bottom required for float storage (for all tidal conditions) is -11 m CM (bare floats) and -13 m CM (integrated floats) respectively.

Without dredging the bottom of the bunker, <u>only QR3</u> has a bunker depth suitable for storage.

Furthermore<u>, no mooring area</u> within the port is possible without dredging.

<u>NB:</u>

- *The maximum float draughts given by the float operators are given for the operational phases.*
- *In future studies, a better understanding of the floats to be stored in the port will certainly make it possible to reduce the height of water under the float by up to 1 m.*
- *As a reminder, in phase 1, we estimated a dredging requirement of 770,000 m^3 for the mooring of 4 bare floats.*

IV.2.4 Compatibility with QR2/QR3 platform structures

For QR2/3, several layout solutions are proposed below.

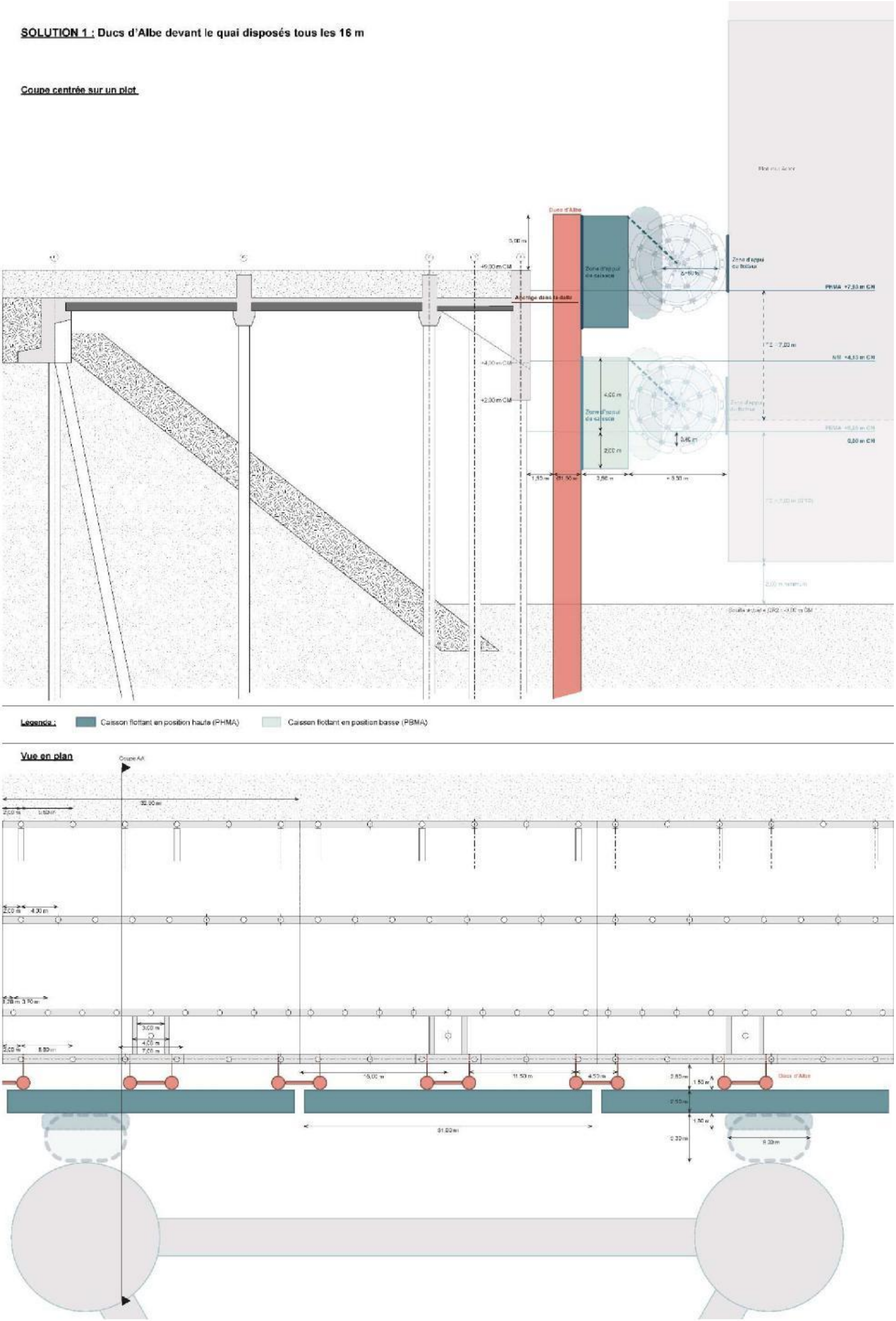


Figure IV-4: Solution 1 - Ducs d'Albe in front of the quay, spaced at 16 m intervals

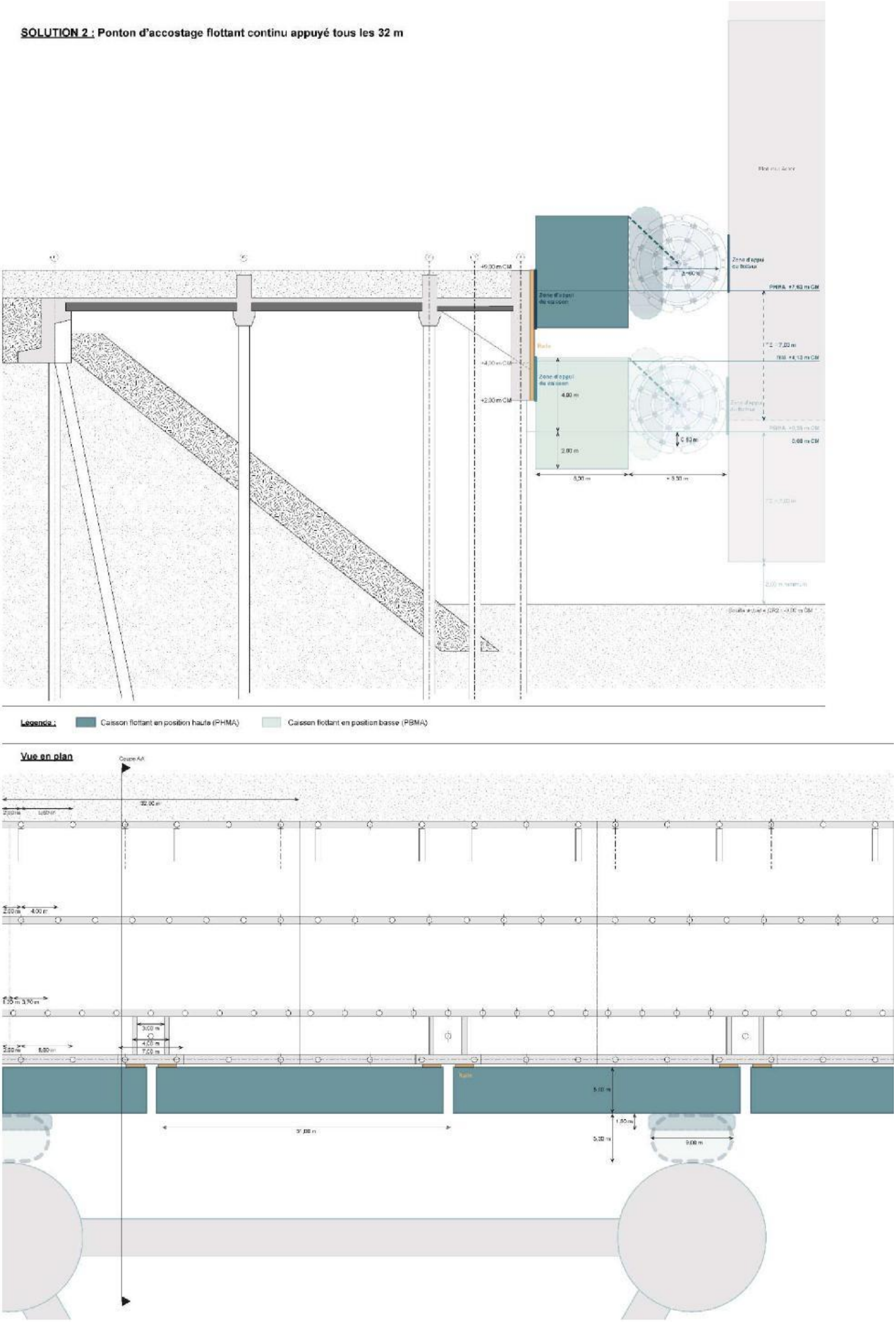


Figure IV-5: Solution 2 - Floating berthing pontoons, supported every 32 m

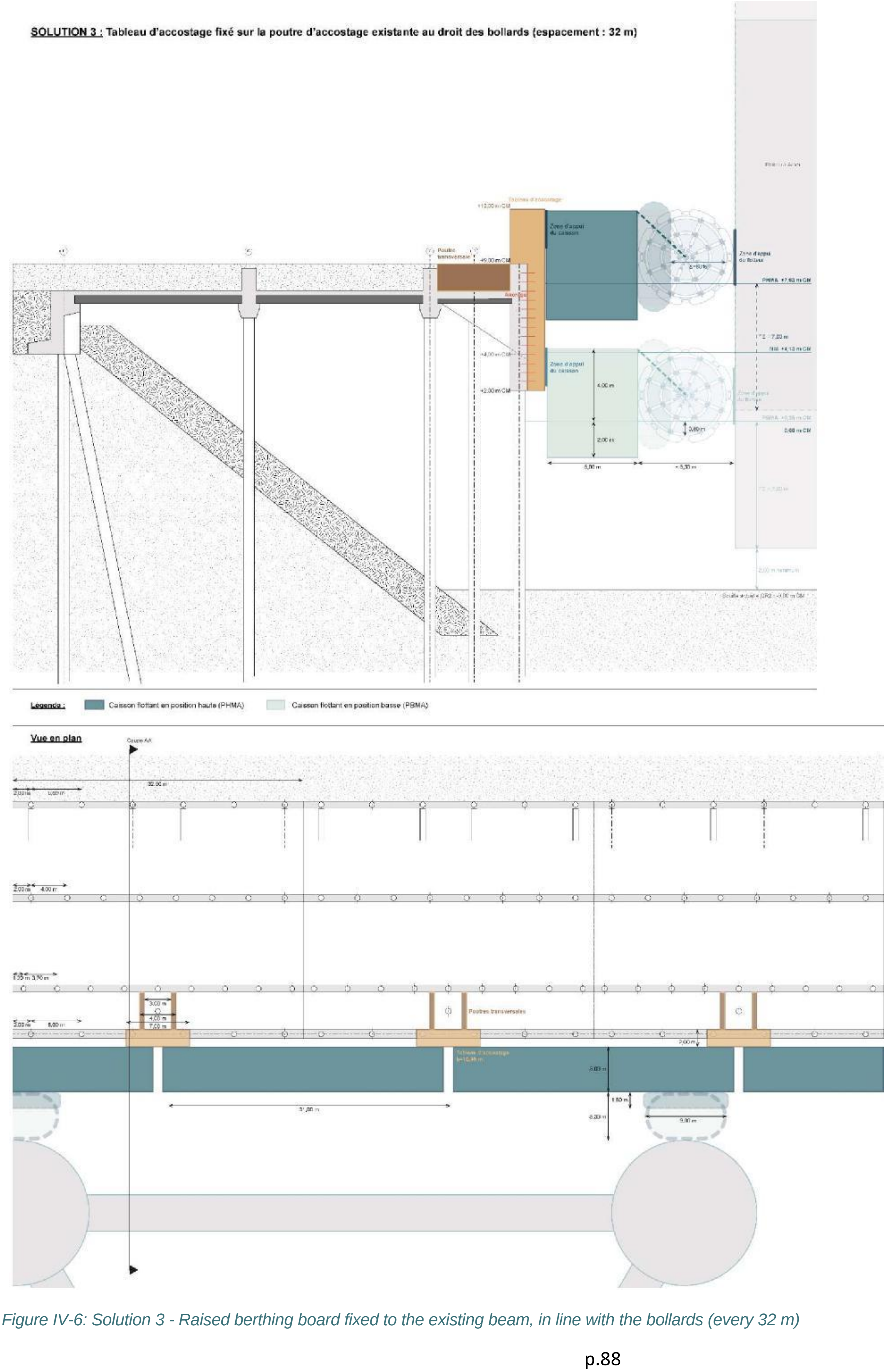


Figure IV-6: Solution 3 - Raised berthing board fixed to the existing beam, in line with the bollards (every 32 m)

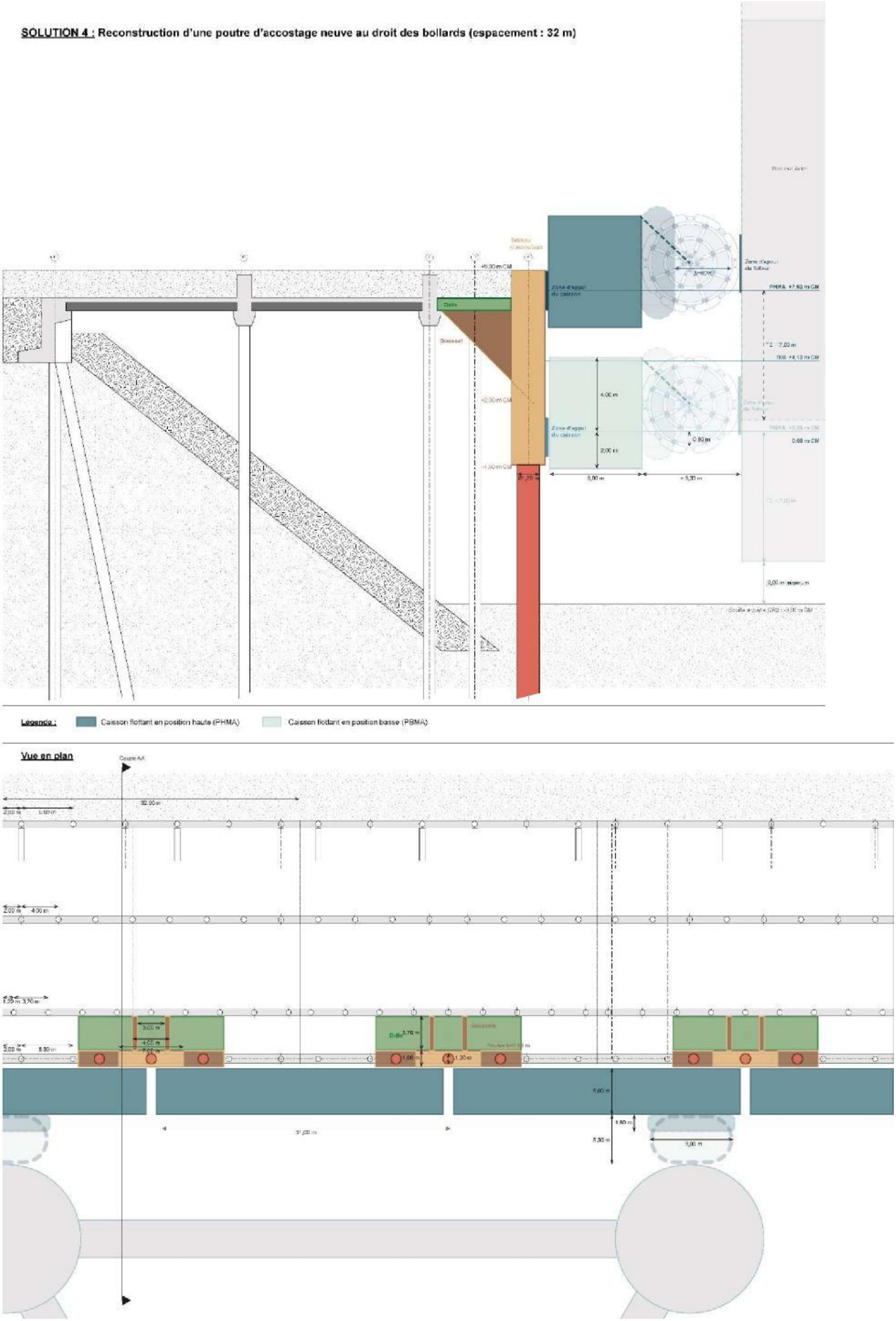


Figure IV-7: Solution 4 - Reconstruction of a reinforced berthing table at bollards (every 32 m)

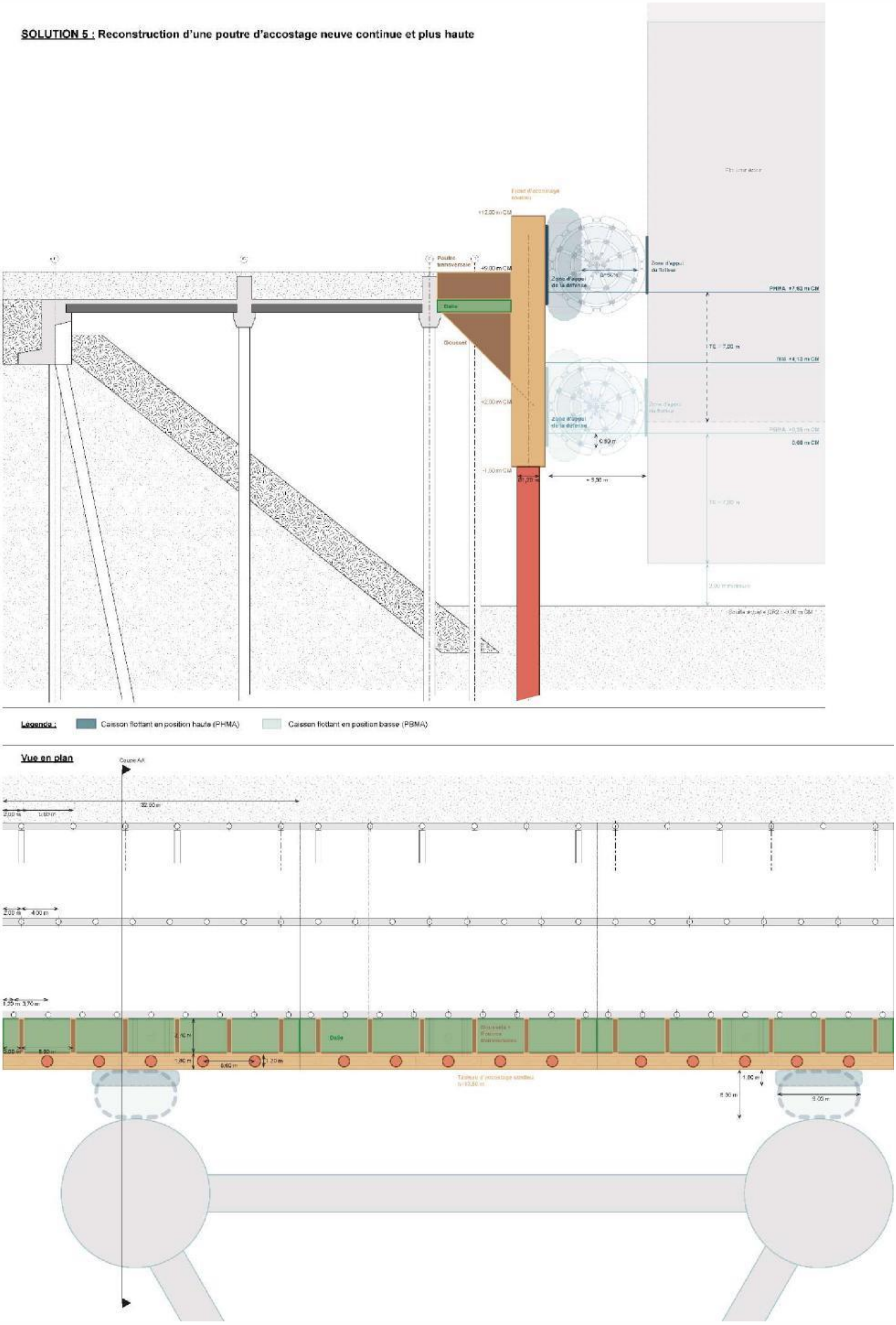


Figure IV-8: Solution 5 - Reconstruction of a raised, continuous berthing table

Table IV-5: Comparison of proposed solutions for mooring bare floats at QR2/QR3

	Solution	Advantages	Disadvantages
1	Ducs d'Albe in front of the quay, at 16 m intervals	• No major work on the existing platform Only point anchors in line with the platform slab • The floating caissons are mobile and can be dismantled. They create a continuous support Docking to suit any size or shape of float • The layout of the double dolphins every 16 m ensures better load distribution in the existing slab and optimised sizing of the dolphins and floating caissons.	• The dolphins on the quayside are fixed structures, spaced every 16 m, with an upper level that exceeds that of the existing quay. Can no longer be docked directly onto the beam • To return the quay to its original use, the dolphins will have to be cut back or removed completely. • This device reduces the width of the available ditch (without dredging) The maximum possible float width is 70 m
2	Floating mooring pontoons, supported every 32 m	• No major work on the existing platform Only point fixings or anchors at gusset plates • The floating caissons are mobile and can be dismantled. They create a continuous support Docking to suit any size or shape of float • The rails do not interfere with the use of the platform in its current configuration (provided that the fixings for the current cylindrical fenders are compatible with the rail system)	• The floating caissons are wider than the previous solution. This is due to the doubled span. • This device reduces the width of the available ditch (without dredging) The maximum possible float width is 69.5 m • The area where the caisson rests on the mooring beam differs according to the tide level considered This can generate bending moments in the beam + reinforcements specific requirements for boxes
3	Raised berthing board fixed to the existing beam, in line with the bollards (every 32 m)	• The floating caissons are mobile and can be dismantled. They create a continuous support Docking to suit any size or shape of float • The area where the caisson rests on the mooring beam is identical whatever the tide level considered. Constant flow of forces in the caisson • The reinforcement is punctual (every 32 m), but with a heightening of the board Use of the platform in original mode may be forced, but with a	• The berthing area in line with the bollards is raised and thickened, and turned-up transverse beams are positioned above the gussets. The piles must be checked for this dead load • This device reduces the width of the available ditch (without dredging) The maximum possible float width is 68.5 m

4	Reconstruction of a docking table strengthened to bollards (every 32 m)	• The floating caissons are mobile and can be dismantled. They create a continuous support Docking to suit any size or shape of float • The area where the caisson rests on the docking beam is identical whatever tide level considered Constant force flow in the box • The upper level of the new painting is identical to the original one No impact on use of the platform in original mode • Identical reconstruction of sections of slab and gussets No surcharge on the piles in row C	• Demolition + Reconstruction of the central half of the forequay of each block (slabs, gussets, berthing table, piles) Major work to modify the platforms • Re-cutting of existing piles or total extraction Recognition and studies geotechnical studies required for design of new piles in-outside the pile right-of-way existing • This device reduces the width of the available ditch (without dredging) The maximum possible float width is 69.5 m
5	Reconstruction of a raised, continuous docking table	• Continuous 13.50 m high transom, turned up by 3 m and lowered by 3.50 m in relation to the original beam Docking to suit any size or shape of float No constraints on use in relation to tides • This device does not reduce the width of the available ditch (without dredging) The maximum possible float width is 74.5 m • The layout and number of bollards may be reconsidered depending on the functional requirements for these quays	• Demolition + Total rebuilding of the of each berth (slab, gussets, transverse beams, berthing table, piles) Major work to modify the platforms • Re-cutting of existing piles or total extraction Surveys and geotechnical studies to be carried out for the design of new piles outside the existing pile right-of-way • Continuous berthing board turned up 3 m from the upper level of the current quay Use of the platform in the original mode will be restricted by this 3 m "acrotorial"

NB:

- *The float widths indicated for each solution are valid without dredging.*
- *QR3's trench could be widened to accommodate the size of the floats, without affecting the stability of the quay.*

The QR2/QR3 quays, which make up the multimodal platform of the Port of Brest, must retain this multifunctionality, and thus accommodate both floats and conventional ships. Therefore, of the options proposed above, we propose to retain solution no. 5 for the Stage 1 scenario, with the following constraints:

- Reconstruction of the new berthing front (on a 5 m strip from the main road) on a 320 m long (QR3 only)

  NB: The raising of the berthing face by 3 m will have to be taken into account for other uses of the quay.

- Widening of the trench by 30 m (compared with the original width of 80 m) over a length of 320 m, implying a minimum dredging of 19,200 m^3. The final dimensions of the QR3 trench will be 110 m by 320 m.

The dredging of 19,200 m^2will require sediment analyses to characterise the quality of the sediment according to the thresholds that will be in force when the regulatory dossier is drawn up. These results will also be used to refine the regulatory framework for section 4.1.3.0. "Dredging and/or related discharge into the marine environment" of article R.214-1.

Knowing the geochemical characteristics of materials is crucial to adapting technical resources and treatment processes to environmental challenges.

The interministerial decree of 9 August 2006 establishes N1 and N2 classification thresholds for a given set of contaminants, making it easier to assess the potential impact of mobilising dredged materials for dumping.

Circular no. 2000-62 of 14 June 2000 on the conditions for using the quality reference system for marine or estuarine sediments present in the natural environment or in ports defines the number of samples to be taken for analysis.

Finally, a specific study of the operating chain from sediment extraction to its final destination will also have to be carried out. In particular, this involves defining a suitable process for managing dredged sediments, which depends mainly on the volume and characterisation of the sediments (grain size, contamination).

The principle of sediment reclamation should be studied, in particular the possibility of reusing sediment in future structures to be adapted or created.

With regard to health risks, it is recommended that a campaign to characterise *Alexandrium minutum* cysts be carried out in the project area where sediments may be remobilised, particularly during dredging operations and/or the installation of piles.

Dredging operations should be avoided between 1 May and 30 September when conditions for cyst development are optimal (to avoid the risk of *Alexandrium minutum* blooms).

The schedule of maritime works, including dredging, will have to be adapted and made consistent with the monitoring of the REPHY network. In the event of an alert for exceeding a threshold, weekly monitoring of phytoplankton and phycotoxins must be carried out. The same applies to filter-feeding bivalves. Quarterly monitoring is recommended, as is additional monitoring in the event of an alert.

In addition to continuous in situ measurements of physical parameters (turbidity), it is recommended to continuously monitor chlorophyll *a* concentrations via a network of buoys in the work zone (see § **Error! Reference not found.**).

-

IV.2.5 Grounding in zones 1 and 2

As a preamble, before examining grounding in zones 1 and 2, we should first consider whether developers' floats are suitable for grounding. Many of them are not. All marine structures, including floating wind turbines, are primarily designed to float, with buoyancy forces balancing the stresses induced by gravitational forces. When a marine structure enters dry dock, it rests on blocks placed all along the underside in line with internal structural elements designed and reinforced for this purpose. This ensures that the stresses induced are correctly distributed throughout the structure. This is also necessary for grounding.

This type of manoeuvre requires a flat platform, the absence of hard points and pyrotechnic risks, and a suitable support surface. The latter is usually sandy to avoid the risks of punching and uncontrolled sinking.

Finally, the main reference that comes closest to the grounding configuration of wind-powered floats is found in the oil and gas industry. NF EN ISO 19901-6 ([27]) states in §11.8 :

"If soils are soft and consolidation or settlement is expected to be significant, this must be taken into account when loading. Where environmental conditions allow, the barge can be positioned in advance and pre-loaded with ballast to try to induce settlement before loading. The designer is warned that the consolidation of deep-sea clays can take a long time. In any event, grounding on soft clay should be considered with care, taking into account the implications of adhesion and suction when removing the barge." This is entirely in line with the developments proposed under theme 4 in stage 1.

In view of the muddy seabed in the harbour, the environmental constraints (*Alexandrium* cysts, marine habitats) and the loads on the ground that could potentially be caused by ballasting the floats and their foundations**, this operation cannot be recommended by our ACA without the work recommended in phase 1** (ground reinforcement topped with ballast). In particular, the suction effect generates the risk of having to intervene with high-pressure hoses, and the dissemination of particles and harmful organisms depending on the season, which does not seem acceptable.

IV.3 Conclusion for float storage

Under Stage 1, which restricts the storage of bare floats to the perimeter of the port, the minimum possible investments are :

- **QR3: Reinforcements / Development of the berthing front + Possible widening of the bunker to accommodate floats over 70 m wide**
  - Maximum storage capacity for 2 floats, including 1 pre-commissioning float (with TE max = 10.5 m for the integrated float)
- **QEMR: Development of the berthing front**
  - Maximum storage capacity for 2 floats, including 1 pre-commissioned float (with TE max = 11 m for the integrated float) float)

In addition, **dry storage** of floats is possible at the terminal at the developer's expense (see Theme 2 - §II. 1. 3).

Given the low storage capacity obtained in Stage 1, it is recommended that the development of mooring areas afloat or along the QR2 presented in Phase 1 be reconsidered [4].

V. THEME 5 : INTEGRATION TURBINE

V. 1 Functionality

V. 1. 1 Reminder of phase 1 functional requirements

The document in reference [5] specifies the functional requirements associated with the various stages of integrating the wind turbine on the float, as well as the particular requirements associated with accommodating a jack-up vessel.

These needs relate to :

- Removal of the sand dock
- A storage area for wind turbine components: It is assumed that for this Stage 1, this storage

  would be carried out on the former polder, made available by the port after minimal development, as defined in theme 2 of this document (chapter II. 1. 2)
- A Ring Crane main crane and a secondary crane on the EMR quay

  crawler. The type of main crane and its ground constraints will be determined in the next chapter. For the secondary crane, it was verified during the previous phase that the EMR quay has the capacity to accommodate a high-powered crawler crane.
- A capacity to accommodate floats integrated along the quay. This translates into length requirements

  of the quay, the shape and capacity of the berthing table, the number and capacity of the bollards, and the size and depth of the bilge as described in Chapter IV. 1. 1
- A capacity to receive at least one float in Commissioning on a quay meeting the same requirements as the integration quay in terms of receiving floats.
- The capacity of the trench in front of the quay to accommodate the pre-loading forces of positioned *spudcan*

  15 m from the quayside.

V. 1. 2. Integration cranes

Various Ring Crane models are presented in the reference document [5]: PTC-140 from Mammoet, SGC 140 from Sarens and HCR 3000 from BMS. These existing models, which have a capacity of around 3000 t, are perfectly suited to the 15 to 20 MW wind turbines currently appearing on the European market, as shown in the two lifting plans below using the PTC-140 for two models of float / 20 MW wind turbine.

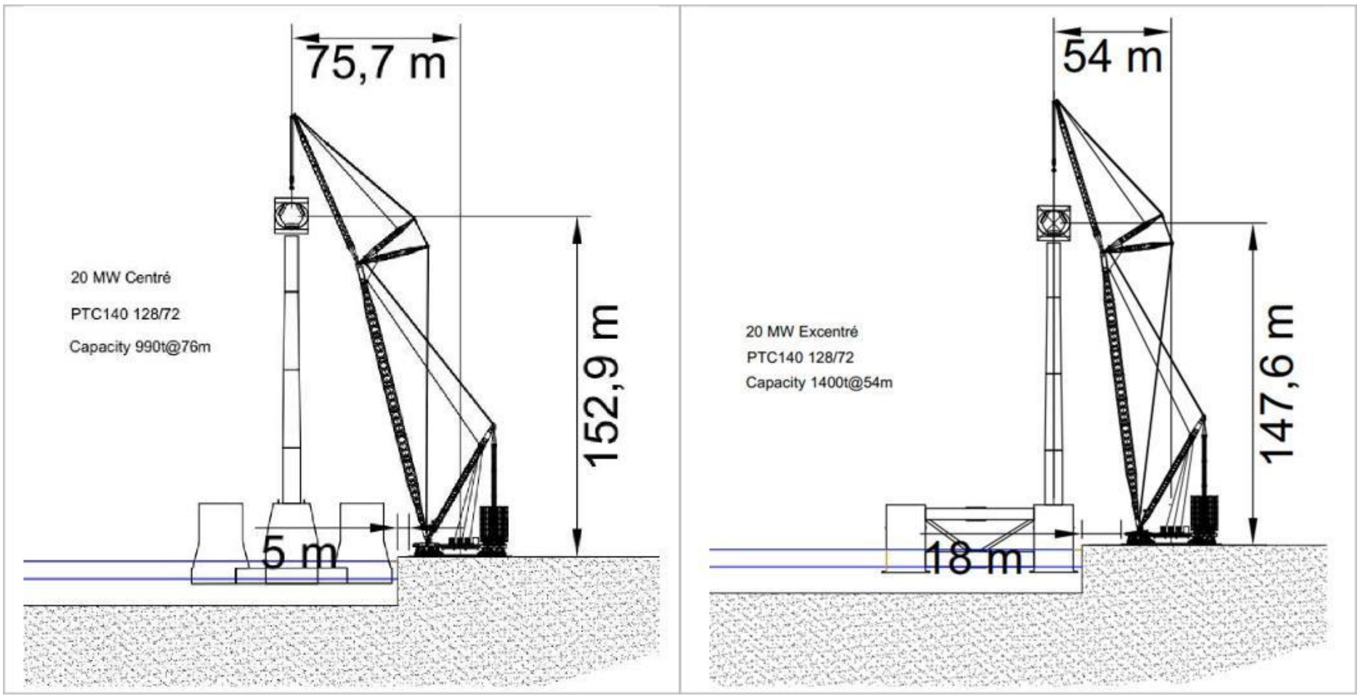


Figure V-1: 20MW lift by PTC-140 in 128/72 version

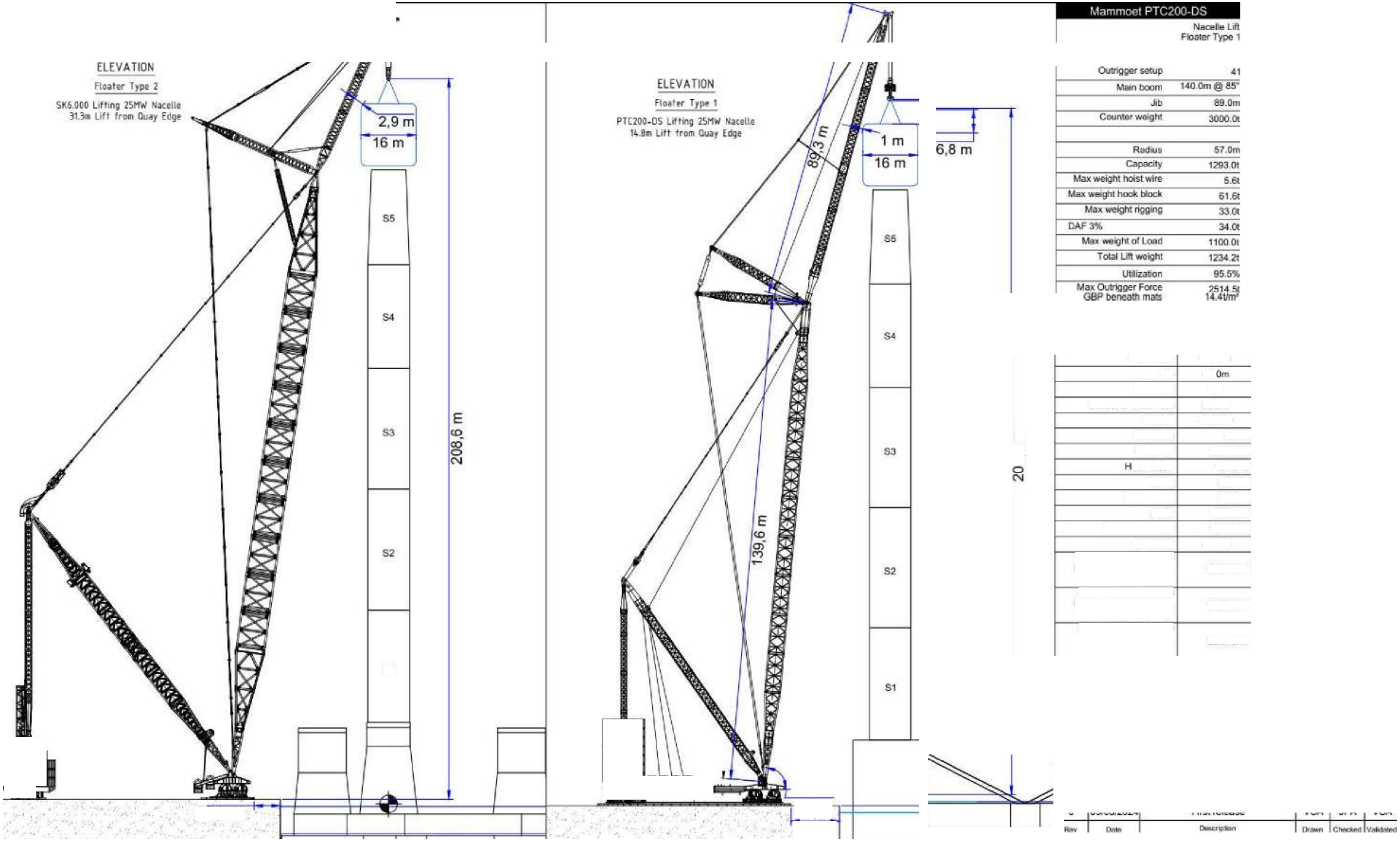
Note that the geometry of the float and the minimum radius of the crane (specific to each configuration) may require the crane to be set back from the quayside (from 5 m to 18 m here), or the float to be offset laterally from the crane axis.

We also note in the report referred to [5] that the footprints of these different models are different.

As can be seen from the lifting plans for our 25 MW model on the two types of floats, these cranes are reaching the limit of their capacity for our off-centre 25 MW floats (represented by the steel float) and are no longer able to cope with the centred floats (represented by the concrete float). The lifting plan for the eccentric float (see Appendix 1 of stage 1 [28]) therefore calls for a 6000 t capacity crane, the SK6000, a unique model currently being built by Mammoet.

The conditions represented are :

- PHMA (+7.93 CM)
- Float at 10 m draught (taking into account 1 m sinking due to the weight of the tower)
- Float 4 m from quayside


ELEVATION
Floater Type 2
SK6.000 Lifting 25MW Nacelle
31.3m Lift from Quay Edge
2,9 m
16 m
S5
S4
S3
S2
208,6 m
ELEVATION
Floater Type 1
PTC200-DS Lifting 25MW Nacelle
14.8m Lift from Quay Edge
89,3 m
1 m
16 m
6,8 m
S5
S4
S3
S2
S1
139,6 m
20
H
0m
Mammoet PTC200-DS
Nacelle Lift
Floater Type 1
Outrigger setup 41
Main boom 140.0m @ 85°
Jib 89.0m
Counter weight 3000.0t
Radius 57.0m
Capacity 1293.0t
Max weight hoist wire 5.6t
Max weight hook block 61.6t
Max weight rigging 33.0t
DAF 3% 34.0t
Max weight of Load 1100.0t
Total Lift weight 1234.2t
Utilization 95.5%
Max Outrigger Force 2514.5t
GBP beneath mats 14.4t/m²
Rev
Date
Description
Drawn
Checked
Validated

BrestPort	Date: 09/08/2024	Format: A3	Scale: 1:1000	Sheet: 1

V. 1. 3 Shape and position of the crane pad

The footprints of the various cranes mentioned in the report are shown below:

Ring cranes

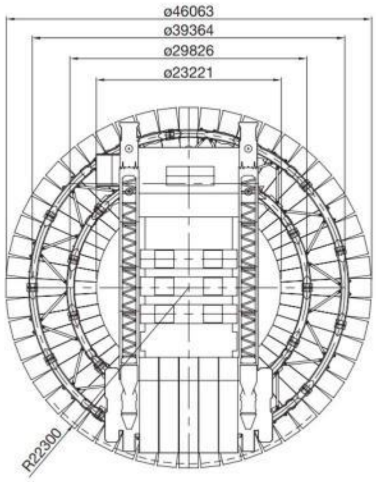


Figure V-2: PTC-140

Circle ground diameter 46 m Max GBP 25 t/m^2

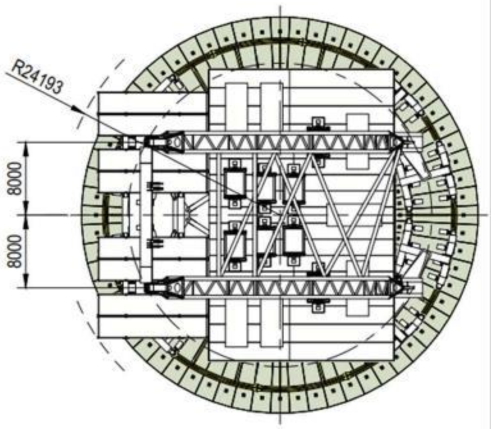


Figure V-3: SGC-140

Circle ground diameter 44 m Max GBP 25 t/m^2

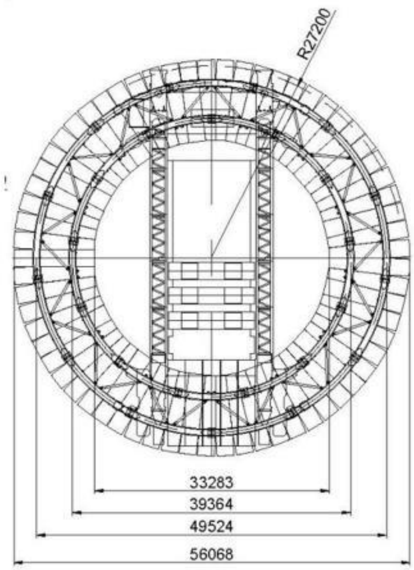


Figure V-4: PTC-210

Circle ground diameter 56 m Max GBP 25 t/m^2

Cranes with centred

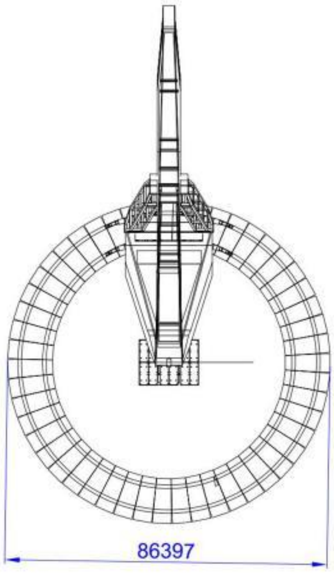


Figure V-5: HCR 3000

Circular arc, ground diameter 86.4 m
Max GBP 25 t/m^{2}under ballast and plates

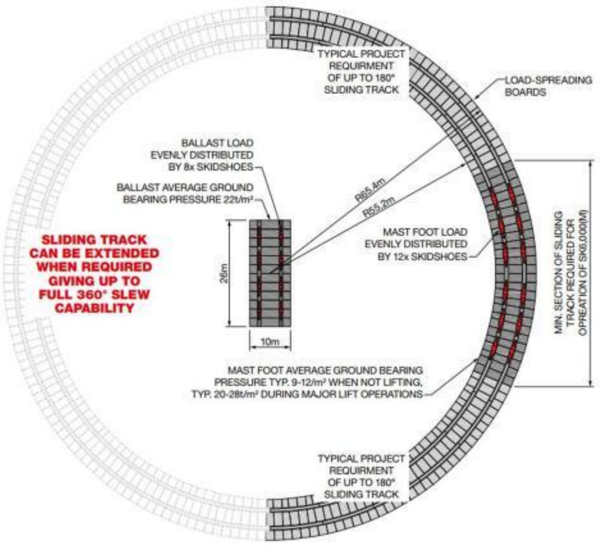


Figure V-6: SK 6000

Arc of circle ground diameter 130.8 m
Of the order of Max 25 t/m^{2}under the ballast and plates

If we superimpose the footprints of the PTC-210 (red circle), the HCR 3000 (small ring) and, in the drawing on the left, the SK6000 (large ring), limiting the rotation possibilities of the latter to a sector of 150° (for a possible crane rotation of around 120°), we obtain the diagrams below.

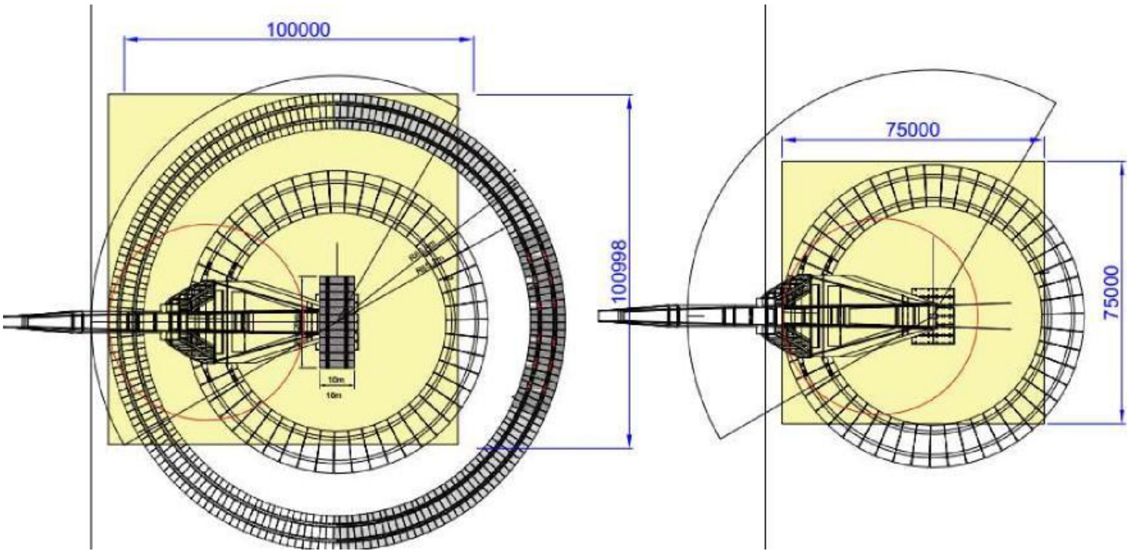


Figure V-7: Ring Crane footprint with SK6000 (left) and without SK6000 (right)

The **crane pad** is therefore a square of 100 m if the SK 6000 is included, and otherwise 75 m for the other cranes mentioned.

V. 1. 4 Access channels and integrated float reception

The reception of floats in commissioning or in storage at QR2/3 was studied in theme 4 (chapter IV. 2. 3). The restrictions on accommodating bare or integrated floats in the QEMR are determined by :

- the rules cited in chapter IV. 1. 1: 1 m of pilot under the float when integrated, 2 m of pilot under the float when integrated.

  float in long-term storage

- the dimensions of the pit: a rectangle 390 m long by 100 m wide and -12 m CM)

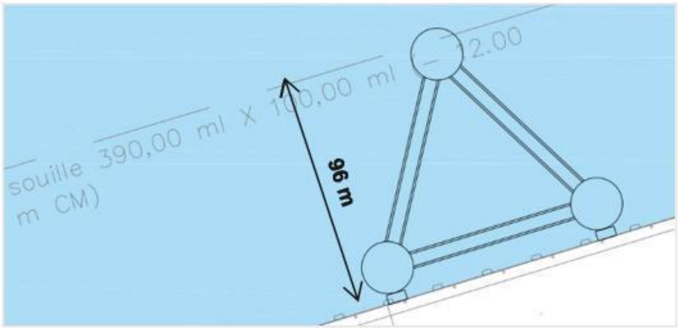
- the typical diameter of a fender likely to be placed between the float and the quay, estimated at 4 m

- the unknown margin that the port or manufacturer is likely to take.

According to these elements, the reception of floats at the QEMR without additional dredging work is limited by :

- Integrated floats 96 m wide and 11 m TE (for 100% operability)

- Bare floats 96 m wide and 10 m TE



As the floats can be moved under tidal restrictions, there are no identified constraints on the access channels.

V. 2 Infrastructure

V. 2. 1 Load distribution devices for Jack-up type ship's feet

The hypotheses and conclusions of the study carried out in phase 1 [5] are recalled.

To limit the effects of spudcans on the quay, it is recommended that the feet of the Jack-ups be moved 15 m away from the quay, as made possible by the functional analysis in theme 5. It is recommended that the silt be replaced by a gravel blanket in order to maintain the operating level of the EMR quay at -12 m CM. Further studies will be required to examine the temporary phases of the works in more detail. Operating constraints during the replacement works will have to be anticipated so as not to degrade the stability of the EMR quay. The impact on the EMR quay is difficult to predict at this stage, given its history. A risk and liability analysis is strongly recommended.

Furthermore, if we examine the longitudinal sections of the front row of the QMR quay, we can see that the intermediate sheet piles of the combiwall are just laid on the healthy schist bedrock, or even 1 to 2.1 m above it in places. Thus, the purging of the mud could have consequences on the level of safety of the solid backbone of the retaining structure, which will need to be monitored in subsequent studies.

Another solution would be to reinforce the mud and weathered shale by jet grouting, combined with light dredging to lay ballast 50 cm to 1 m thick. This would have the advantage of eliminating the temporary works phase, which could have a negative impact on the stability of the EMR quay.

In addition to our previous study, it is specified that vigilance will be necessary with regard to the position of the spudcans so as not to be positioned in a zone of deepening of the healthy shale.

V. 2. 2 Localised reinforcement of the MRE quay to accommodate a Ring Crane

We recall the conclusions of the study carried out in phase 1 [5].

To accommodate a Ring Crane, the structure of the EMR quay needs to be reinforced by creating a crane pad. This structure consists of a slab on piles topped with an embankment that can accommodate a load of 25 t/m^2.

- The dimensions of the crane pad to be reinforced depend on the model of crane chosen: 100 x 100 m if it is an SK 6000, and otherwise 75 x 75 m for the other cranes mentioned in §V. 1. 3.
- The crane pad must be at **least 8.5 m from the edge of the quay** (and not 5 m as required).

  initially presented in §V. 1. 2), in order to respect the constraints of the existing system (bars + ties).

As a reminder, the design height of the EMR quay is -12 m CM. In order to integrate a Ring Crane, it should be noted that the developers will have to respect tidal constraints in order to comply with this design height. The MRE quay will therefore not be 100% operable. However, we feel that the % of operability is reasonable enough for us not to envisage any work in the area of the pit for this development.

V. 2. 3 Localised reinforcement of MRE quays for the storage of heavy components

The assumptions and conclusions of the study carried out in phase 1 [5] are recalled.

EMR docks have a load-bearing capacity of 10 t/m^2. The manufacturer will have to determine whether the quay is compatible with temporary storage of these heavy components, or leave the components on SPMT before they are integrated.

VI.1 Theme 1: Transhipment

Table VI-1 below summarises the conclusions of Theme 1-phase 1 [1] and the additions in §I of this note.

In a nutshell:

Subject to the **refurbishment of QR5** by the creation of a heavy zone capable of accommodating harbour cranes, SPMTs and Reachstackers, and subject to **confirmation of the possibility of routing** SPMTs and Reachstackers between this heavy zone and the polder, the transhipment of all 25 MW components (floats and wind turbine) is possible without limitation according to the following arrangements:

- **Unloading possible at** heavy **QR5** for cargo ships with harbour cranes (up to around 300 t) or by bulk vessel.
- **Unloading possible at the QEMR** for the same vessels and with the same resources, plus possibility of using a project crane for larger packages.

and finally the possibility of unloading by side RORO using a semi-submersible vessel.

Table VI-1: Summary of solutions Stage 1 - Theme 1: Transhipment

THEME 1	QR5	Rear quay QR5	Route QR5 4 QEMR	QEMR
Dimensions (L x b)	• 200 m x 30 m	• 290 m x 47 m	• 500 m x 17.6 m	• 400 m x 100 m
Minimum load-bearing capacity of platform	• **Increase to 4 t/m^2**	• **Increase to 10 t/m^2**	• **Current capacity: 10 t/m^2**	• **Current capacity: 10 t/m^2**
		Ships		
HLV	• **Length of quay available: 200 m** • **Dimensions of pit: 90 m x 200 m** • **Sub-base : between -9.00 and -10.50 m CM**			• **Length of quay available: 400 m** • **Dimensions of pit: 100 m x 390 m** • **Bottom of pit: -12.00 m CM**
General cargo				
Semi-submersible **vessel**	• **Length of quay available: 200 m** • **Dimensions of pit: 90 m x 200 m** • **Deepening of pit to -10.30 m CM possible if dredging carried out**			
		Horizontal handling equipment + Lifting equipment		
Wheeled cranes + skids (LHM)	• **Local reinforcements: up to 40 t/m^2 locally over 10 m^2 "Heavy zone": 80 x 20 m** centred on the 200 m of quay and 5 m from the quayside			• **Adapted quay** outside the 5 m quayside strip
SPMT / Reachstacker	• **Localised reinforcements: 10 to 12 t/m^2 "Heavy zone": 80 x 20 m** centred on the 200 m of quay and 5 m from the quayside	• **Local reinforcements: 10 to 12 t/m^2** to join the route	• **No rigid inclusions required** • **Apply a thicker layer of form** • Traffic at a distance of 6.40 m from the retaining wall	• **Current capacity: 10 t/m^2**
CONCLUSIONS	**Refurbishment of Poste North**, 200 m long	**Floor reinforcement of the back platform**	**Apply a thicker layer thicker**	**No work required**

Caption:

- **Red**: work to be carried out
- **Orange**: work possible if the limits set by the Port for Stage 1 are exceeded
- **Green**: No work required 4 suitable infrastructures

- Out of scope

VI. 2. Theme 2: Terminal layout

Table VI-2 below summarises the conclusions of Theme 2-phase 1 [2] and the additions in §II of this note. In summary:

- Work to be carried out by the port to create a heavy roadway serving the entire length of the polder and capable of handling all SPMT shipments.
- Provision of a construction area, to be developed by project owners according to their own needs.
- Significant possibility of dry storage of assembled floats in the same area, subject to arrangements by the PPs.

Table VI-2: Summary of solutions Stage 1 - Theme 2: Terminal development

THEME 2	Heavy roadways	Rainwater management	Strip near the gabionade	Construction and dry storage
Surface concerned	• 9 ha		TOTAL made available: 4 ha	TOTAL made available: 21 ha
Load-bearing capacity	• Increase to 10 t/m²	-	• Maximum permissible load: 4 t/m²	• To be defined by the developer
Horizontal handling equipment				
SPMT / Reachstacker	• Subgrade: minimum thickness 2.3 m • Rigid inclusions under the subgrade (130 m wide strip)	-	• No heavy traffic permitted above 4 t/m²	• At the developer's expense
Mobile vacuum cranes	• Excluded use			
CONCLUSIONS	Reinforcement of a lane for SPMT and Reachstacker traffic			At the developer's expense

Caption:

- Red: work to be carried out
- Orange: work possible if the limits set by the Port for Stage 1 are exceeded
- Green: No work required suitable infrastructure

- Out of scope

VI.3 Theme 3: Launching floats

Table VI-3 below summarises the conclusions of Theme 3-phase 1 [3] and the additions in §III of this note. In summary:

- Possibility of loading onto a vessel / semi-submersible barge from the QEMR and via SPMT without any infrastructure modifications (except for relocation of the sand dock).

All other launching solutions are excluded from this stage.

Table VI-3: Summary of solutions Stage 1 - Theme 3: Launching floats

THEME 3	QEMR1	QEMR 2
Length of quay	• 200 m	- 185 m
Current capacity	• 10 t/m²	- 10 t/m²
Launching system		
Ring Crane	• *Reinforcement at 25 t/m[2] (slab on piles)* • *Maximum crane load: 3000 t – not realistic for launching floats*	- *No reinforcement possible – insufficient space for piles*
Semi-submersible vessel	• Sufficient quay capacity for SMPT / Reachstacker traffic • No dredging required - 74% operability window • Moving the sand dock	
CONCLUSIONS	No work required on the quay Relocation of the sand dock	

Caption:

- Red: work to be carried out
- Orange: work possible if the limits set by the Port for Stage 1 are exceeded
- Green: No work required suitable infrastructure

- Out of scope

VI.4 Theme 4: Maritime storage

Table VI-4 below summarises the conclusions of Theme 4-phase 1 [4] and the additions in §IV of this note. In summary:

- No storage facilities in the harbour
- Possibility of positioning a float under the integration crane subject to repair of the berthing table and within the depth limits of

  The (100 m)
- Possibility of storing 2 floats on QR3 (including 1 pre-commissioning float if TE=10.5 m max) subject to frontage arrangements.

  a wider berth (currently 70 m) and a solution, to be provided by the manufacturer, for the interface between the floats and the pile dock

Given the low storage capacity obtained in Stage 1, it is recommended that the development of mooring areas afloat or along the QR2 presented in Phase 1 be reconsidered [4].

Table VI-4: Summary of solutions Stage 1 - Theme 4: Maritime storage

THEME 4	QR2	QR3	QEMR	Zones 1 and 2 (Port of Brest)
Depth of pit	• -9 m CM	• -11.5 m CM	• -12 m CM	• **Zone 1:** -7 to -8 m CM • **Zone 2:** -9 to-10.5 m CM
Length of quay / zone	• 288 m	• 320 m	• 400 m	• **Zone 1:** 670 m + 400 m • **Zone 2:** 870 m
Maritime storage of floats				
Dockside mooring	• **Reinforcements / Development of the berthing front** • **TE max: 7 m** without dredging **insufficient for bare floats** • **Maximum float width --g 75 m** 4 **Possible widening of the trench if dredging is carried**	• **Reinforcements / Development of the berthing front** • **TE max: 9.5 m** without dredging **OK for bare floats** • **Maximum float width --g 75 m** 4 **Possible widening of the**	• **Development of the berthing front** • **TE max: 11 m** without dredging **OK for bare floats** • **Max float width --g 95 m**	
Mooring				Without dredging : • **TE max < 5 m** **Insufficient for bare floats** 4 **Possible deepening if dredged** • **Minimum width: 100 m**
Grounding				• **Only if soil reinforcement with ballast**
CONCLUSIONS	**Not recommended without reconstruction QR2 + deepening of pit**	**Reinforcements / Development of the berthing front** **+ possible widening of pit**	**Development of the berthing front**	**No solution without dredging**

Caption:

- **Red**: work to be carried out
- **Orange**: work possible if the limits set by the Port for Stage 1 are exceeded
- **Green**: No work required 4 suitable infrastructures

\- Out of scope

VI. 5 Theme 5: Turbine integration

Table VI-5 below summarises the conclusions of Theme 5-phase 1 [5] and the additions in §V of this note. In summary:

- The integration of wind turbines is possible at the QEMR East, subject to the construction of the crane pad (and the relocation of the sand dock).

already requested in Theme 3 "launching") with dimensions adapted at least to the footprint of 3000 t cranes. Further consideration to be given to the benefits of extending this crane pad to accommodate 6000 t cranes.

Table VI-5: Summary of solutions Stage 1 - Theme 5: Turbine integration

THEME 5	QEMR 1
Length of quay	- 200 m
Turbine integration system	
Ring Crane	- Reinforcement of a crane pad at 25 t/m(2) (slab on piles) -* 75 m square or 100 m square - Moving the sand dock
Temporary storage of components	- Waiting on SPMT before integrating 4 quay capacity at 10 t/m^{2}Local reinforcements if necessary at developer's expense -
Home to an integrated float	
Float mooring	- Development of the berthing front - TE max: 11 m without dredging -* OK for bare floats 4 Deepening for integrated floats (TE: 12 m) subject to further - studies and reinforcement work Max float width ≈ 95 m
CONCLUSIONS	Platform reinforcements + Development of the berthing front

Caption:

- Red: work to be carried out
- Orange: work possible if the limits set by the Port for Stage 1 are exceeded

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