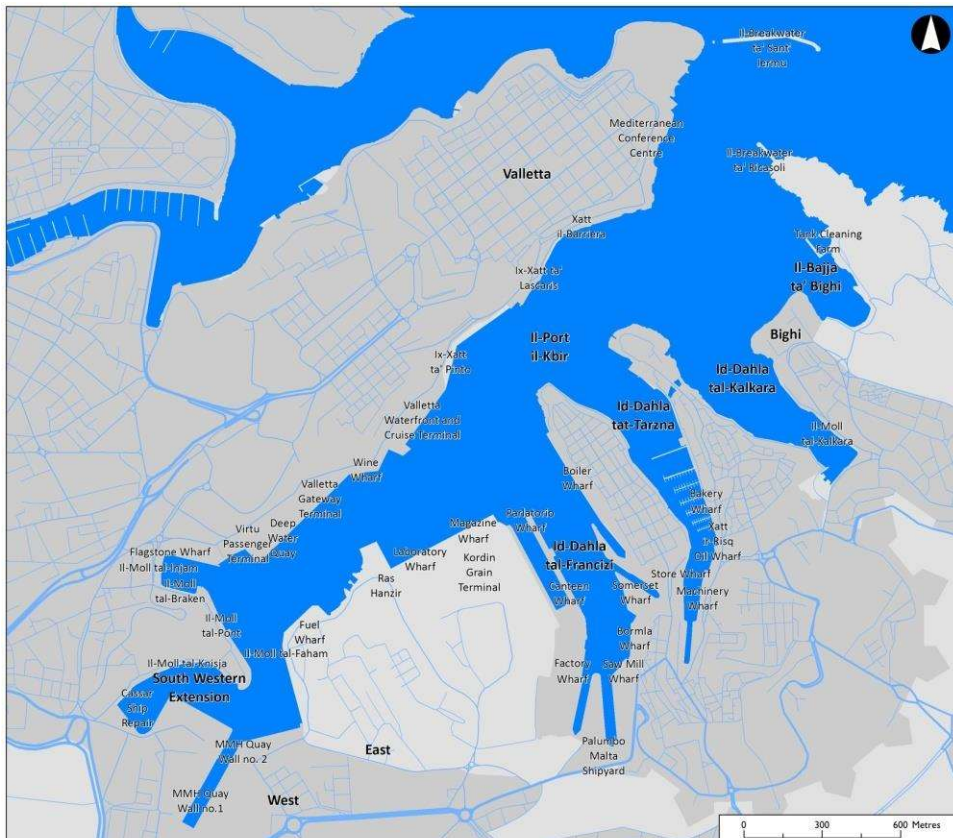


## UPGRADING OF THE VALLETTA BREAKWATER SYSTEM TO IMPROVE THE WAVE CLIMATE IN THE PORT

### GRAND HARBOUR WAVE CLIMATE IMPROVEMENT

---

#### PROJECT DESCRIPTION STATEMENT



Version 4 (May 2021)



**Report Reference:**

**Adi Associates Environmental Consultants Ltd, 2021. Upgrading of the Valletta Breakwater System to Improve the Wave Climate in the Port. Grand Harbour Wave Climate Improvement. Project Description Statement, Version 4. San Gwann, May 2021; vi + 39pp + I Appendix.**

**THIS IS A DIGITAL COPY OF THE REPORT.  
RESPECT THE ENVIRONMENT – KEEP IT DIGITAL**



## Quality Assurance

### Grand Harbour Wave Climate Improvement Project Description Statement May 2021

Report for: **Infrastructure Malta**

#### Revision Schedule

Rev	Date	Details	Prepared by:	Checked by:	Approved by:
00	Oct 2017	Draft to client	<b>Krista Farrugia</b> Senior Consultant	<b>Rachel Xuereb</b> Director	<b>Adrian Mallia</b> Managing Director
01	Sep 2019	Submission to client	<b>Adrian Mallia</b> Managing Director	<b>Krista Farrugia</b> Senior Consultant	<b>Rachel Xuereb</b> Director
02	June 2020	Submission to client	<b>Krista Farrugia</b> Senior Consultant	<b>Adrian Mallia</b> Director	<b>Rachel Xuereb</b> Director
03	May 2021	Submission to ERA	<b>Adrian Mallia</b> Director	<b>Rachel Xuereb</b> Director	<b>Rachel Xuereb</b> Director

File ref: G:\\_Active Projects\Planning Services\Public Sector Planning Support\TM0021 - Valletta Breakwater\PDS\PDS Valletta Breakwater\_Revision\_2021\_Final.docx



This document has been prepared in accordance with the scope of Adi Associates' appointment with its client and is subject to the terms of that appointment. It is addressed to and for the sole and confidential use and reliance of Adi Associates' client.

Adi Associates accepts no liability for any use of this document other than by its client and only for the purposes for which it was prepared and provided. Except as provided for by legislation, no person other than the client may copy (in whole or in part) use or rely on the contents of this document, without the prior written permission of Adi Associates. Any advice, opinions, or recommendations within this document should be read and relied upon only in the context of the document as a whole. The contents of this document do not provide legal or tax advice or opinion.

© Adi Associates Environmental Consultants Ltd 2021

**Kappara Business Centre  
113 Triq Birkirkara  
San Gwann SGN 4197  
MALTA**

**Tel. / Fax: 21378172**

**Email: [info@adi-associates.com](mailto:info@adi-associates.com)  
Web: [www.adi-associates.com](http://www.adi-associates.com)**



## CONTENTS

Introduction.....	1
Background.....	1
Objectives of the Scheme .....	1
Description of the Scheme .....	2
Location and characteristics of the Scheme site.....	2
Description of the area surrounding the Scheme site.....	4
Scheme Description.....	10
Berm design.....	11
Layout and design updates – 2019 .....	16
2020 Scheme updates including new proposed breakwater .....	17
Seabed Excavation / Dredging.....	18
Raw Materials and Resources.....	33
Berm / revetment / breakwater construction .....	33
Dredging and seabed excavation .....	34
Waste Management.....	36
Employment.....	36
Potential Environmental Impacts .....	36
Mitigation Proposals .....	38

## FIGURES

Figure 1: Location of Scheme site.....	3
Figure 2: Land uses.....	6
Figure 3: Images of the surrounding area .....	7
Figure 4: Valletta Peninsula Policy Map (Grand Harbour Local Plan).....	8
Figure 5: Cultural heritage designations.....	9
Figure 6: 2017 layout of berm (Design Option 1) .....	13
Figure 7: Typical cross-section through Design Option 1 berm (2017).....	14
Figure 8: Typical cross-sections through Design Option 2 berm (2019).....	15
Figure 9: Fixed navigational marker .....	16
Figure 10: Berm and revetment plan at Mean Sea Level .....	19
Figure 11: Berm and revetment plan at - 0.5 Mean Sea Level.....	20
Figure 12: Berm section BN .....	21
Figure 13: Berm section BC1 .....	22
Figure 14: Berm section BC2 .....	23
Figure 15: Berm section BS.....	24

Figure 16: Revetment section RE .....	25
Figure 17: Revetment section RW .....	26
Figure 18: St Elmo North Breakwater Site Plan.....	27
Figure 19: St Elmo North Breakwater Site Plan above Mean Sea Level .....	28
Figure 20: St Elmo North Breakwater Plan below Mean Sea Level.....	29
Figure 21: Breakwater section BW1 .....	30
Figure 22: Breakwater section BW2.....	31
Figure 23: Breakwater section BW3.....	32
Figure 24: Sediment Sampling Stations .....	35

## TABLES

Table 1: Estimated amounts of raw materials required.....	33
Table 2: Coring results .....	34
Table 3: Equipment.....	36

## APPENDICES

Appendix I: Photomontages

---

# GRAND HARBOUR WAVE CLIMATE IMPROVEMENT

---

## INTRODUCTION

1. This Project Description Statement (PDS) describes a proposal by Infrastructure Malta to provide a solution to reduce wave agitation in the Grand Harbour through upgrading of the Valletta breakwater system.
2. The project's overall aim is to improve the operational and extreme wave climate within the port, especially in the outer eastern part, which is earmarked to be a hub for commuter maritime traffic and within the Cottonera Creeks. The project is hereinafter referred to as 'the Scheme'.

## BACKGROUND

3. Maritime traffic in the Grand Harbour is increasing. Cruise line traffic, Ro-Ro and other cargo services, commercial vessel services are all expected to grow in the future. Construction material imports are expected to increase significantly in the next 15 years. As the Freeport terminal reaches full capacity, Ro-Ro cargo currently handled there is likely to shift to Valletta.
4. Aside from predicted increase in traffic, ships are becoming increasingly larger and this constrains maritime access, navigation, and safety, which reduces port flexibility and efficiency.
5. The entrance to the Grand Harbour is currently exposed mainly to waves entering between the two breakwaters (St Elmo and Ricasoli breakwaters) from an easterly direction. To a lesser extent waves also enter from the north and north-west beneath the St Elmo bridge. Such waves reflect off the complicated shoreline into the Port along Barriera Wharf and into Rinella Creek, Kalkara Creek, Dockyard Creek, and French Creek. During storm conditions the outer half of the Port can be dangerous to navigate and to berth, especially for smaller vessels. Furthermore, storm damage to vessels, boats and property in the creeks is common. Originally, the system of breakwaters and coastal defences in outer Grand Harbour included a berm along the Valletta shoreline between Mgerbeeb Point and the St Elmo Bridge as well as a revetment along the St Elmo breakwater. However, these were not adequately constructed and were eventually destroyed by successive storms.

## OBJECTIVES OF THE SCHEME

6. Upgrading of the Valletta coastal defence system is thus required to improve the wave climate within the Port, in particular in the outer eastern part, where currently reflections of incoming waves enter the various creeks on the south side and expose the north side along Barriera Wharf to wave conditions that are not suitable for multi-seasonal access for all commuter services by sea. Importantly, the provision of such services is envisaged in the National Transport Master Plan 2025 and is also in keeping with the 2002 Grand Harbour Local Plan, in particular policy GT12, which promotes the increased use of ferry services and the identification of potential new

landing points at suitable locations within the Grand Harbour; a measure that is also envisioned in the National Transport Master Plan 2025.

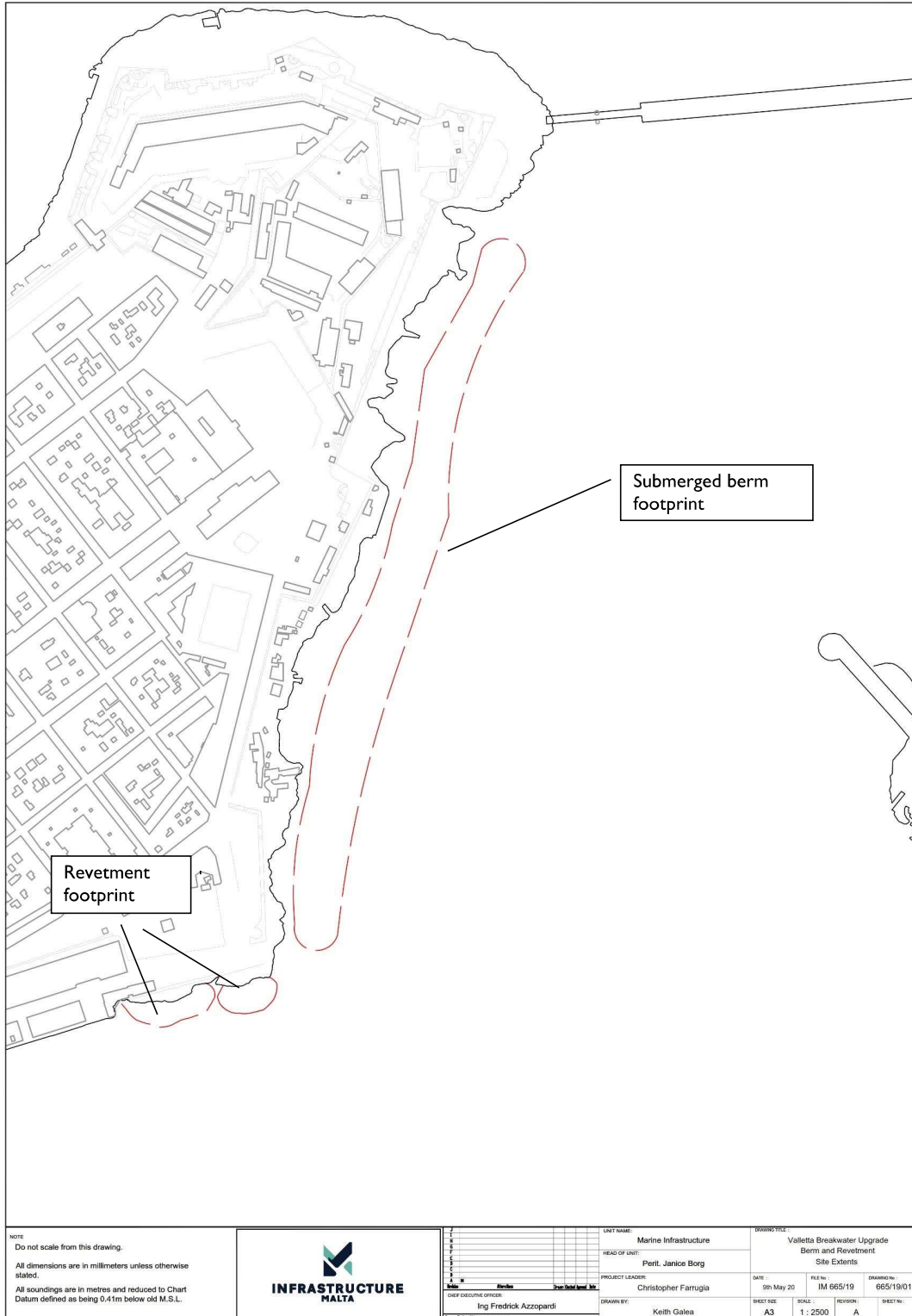
7. The Scheme aims to accrue the following benefits:
  - Improved reliability, safety, and ‘access for all’ for commuter ferry services;
  - Improved operating conditions for commercial vessels and related port activities in their servicing (including improved operating wave conditions);
  - Safer navigation within the port fairway and turning circles;
  - Increased climate change resilience of the Grand Harbour; and
  - Reduced wave reflections into the port and improved conditions in the creeks of the Three Cities, especially during easterly storm conditions.
8. Overall, the Harbour will allow for safer navigation, safer operations, improved access for all, reduced downtime, reduced risk of damage and incidents during storms, long term performance of the breakwaters, and more opportunities to expand port activities in the outer half of the Port, which is relatively underutilised.

## **DESCRIPTION OF THE SCHEME**

### **Location and characteristics of the Scheme site**

9. The Scheme site is located at the mouth of the Grand Harbour, perpendicular to the St Elmo breakwater running between St Elmo, to and around Mgerbeb Point and up to the start of Barriera Wharf, as shown in **Figure 1**. The concrete blocks and other debris from the previous berm are still present on the seabed. Although part of a separate planning application, this PDS also describes the proposed new breakwater at St Elmo as requested by the Environment and Resources Authority (ERA) in order to allow a holistic consideration of the proposed interventions. This latter intervention was devised as a result of detailed hydrodynamic modelling studies of the berm and revetment, which showed that under certain wave conditions, additional shelter through the construction of a small breakwater at St Elmo Point would also be required.

**Figure I: Location of Scheme site**



## **Description of the area surrounding the Scheme site**

### ***Land uses***

10. **Figure 2** and **Figure 3** illustrate the land uses within a selected Area of Study (AoS). The proposal is located within the marine environment, close to the shoreline below Fort St Elmo, the Mediterranean Conference Centre (MCC), and up to the former fish market.
11. The AoS includes a number of museums. These consist of the National War Museum at Fort St Elmo, the Malta Experience, Casa Rocca Piccola (a sixteenth-century Maltese Palazzo) and The Knights Hospitalliers at the MCC. Other features include the Lower Barrakka Garden and the Siege Bell War Memorial.
12. The AoS is predominantly residential and includes Il-Fossa, L-Arcipierku and Il-Camerata neighbourhoods. The cityscape is characterised by a grid shaped development. The high residential blocks are either old buildings or more modern post-war developments, which were built during the reconstruction phase or as a result of slum clearance. The area includes a number of palazzi. Overall, the area requires regeneration and there are a number of derelict and vacant dwellings together with run-down residential units.
13. Notwithstanding the residential nature of the area, there are also a number of commercial outlets or buildings. These include convenience shops like grocers, butchers, and stationers, and bars and restaurants. These are typically located at the ground level within a residential block. The area also includes professional offices.
14. There are a number of churches in the AoS, including, Our Lady of Porto Salvo (St Dominic) Parish Church, St Nicholas Church, St Mary Magdalene Church and Christ the Redeemer Church (Sagramentini), St Lucy Church, St Ursola Church, St Roque Church and the Jesuit's Church. A Greek-Orthodox Church is located in a mixed block on Merchant Street.
15. The AoS includes various community facilities, including a primary school, an examinations centre, Dar l-Ewropa, the old University (including the MITP theatre) and the German-Maltese Circle. Administrative premises include the Austrian embassy, Heritage Malta offices, and Identity Malta (Evans Building).
16. The MCC includes a theatre, halls, and conference rooms.

### ***Natural and Cultural Heritage***

#### Natural Heritage

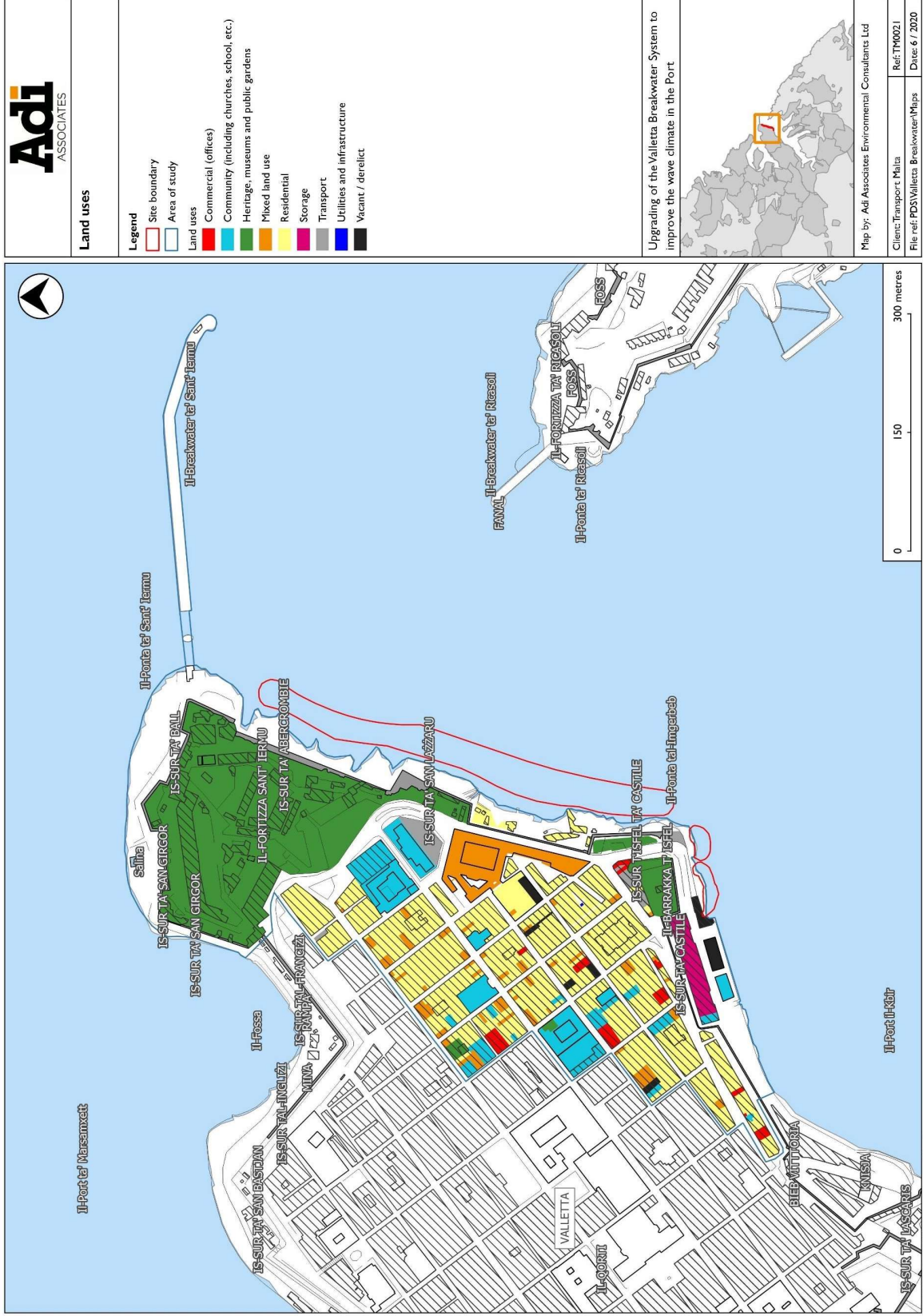
17. The site does not include any protected natural heritage designations. However, it is located within a Coastal Water Body (MTC105, Grand Harbour up to Marsamxett Port) as designated under the Water Framework Directive (lying within 1 nm from the coast). In addition, the natural rocky coast that still exists in this area and along

St Elmo Point is identified in the Grand Harbour Local Plan as a Site of Scientific Importance (Geology) and an Area of Ecological Importance (see **Figure 4**).

Cultural Heritage

18. The Harbours area is designated an Area of High Landscape Value (AHLV) as per Government Notice 133 of 2001.
19. The area includes a number of other scheduled buildings, including:
  - The fortifications and Fort St Elmo;
  - The 'Sacra Infermeria' (now the Mediterranean Conference Centre);
  - Our Lady of Porto Salvo (St. Dominic) Parish Church (including the Dominican Priory), St Nicholas Church, St Mary Magdalene Church, Christ the Redeemer Church (Sagramentini) and Nibbia Chapel (Chapel of the Bones) remains; and
  - The granaries next to Fort St Elmo;
20. The scheduled features closest to the Scheme are the Grand Harbour Boom Defence and the Grand Harbour Breakwater (GN 276 of 2008). Both features are classified as Grade I scheduled features.
21. The closest fortifications to the Scheme are Is-Sur ta' San Lazzru and Fort St Elmo (GN 133 of 2001). Both features are classified as Grade I scheduled features.
22. **Figure 5** illustrates the scheduled areas.

Figure 2: Land uses



**Figure 3: Images of the surrounding area**




		
<p>Our Lady of Porto Salvo (St. Dominic) Parish Church</p> 	<p>Typical streetscape of a residential area in Valletta</p> 	<p>Block of flats built in the 1950s over the former Slaves Prison</p> 
<p>Mediterranean Conference Centre (Sacra Infermeria)</p>	<p>St Elmo Primary School</p>	<p>St Elmo Examination Centre</p>

Figure 4: Valletta Peninsula Policy Map (Grand Harbour Local Plan)

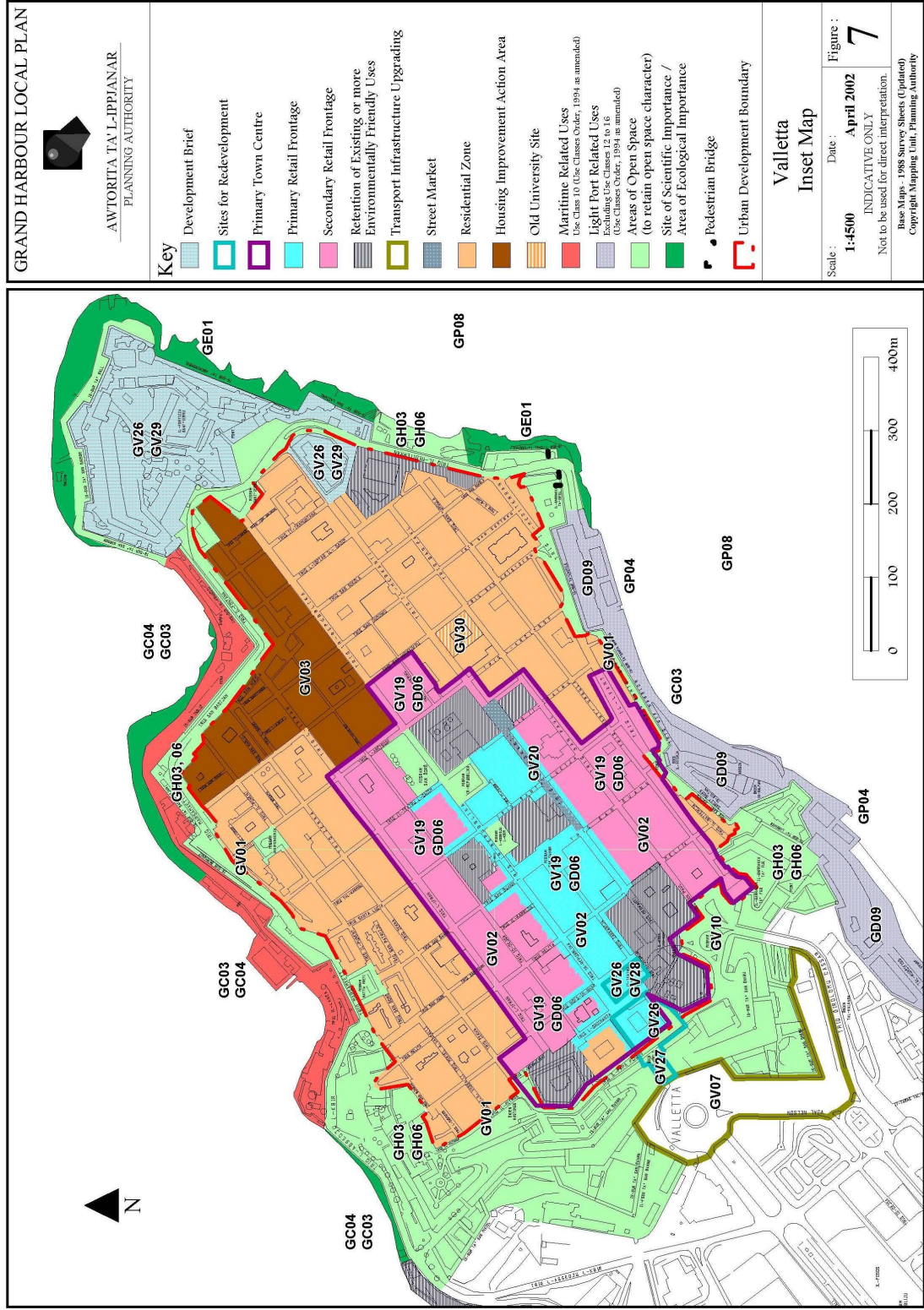
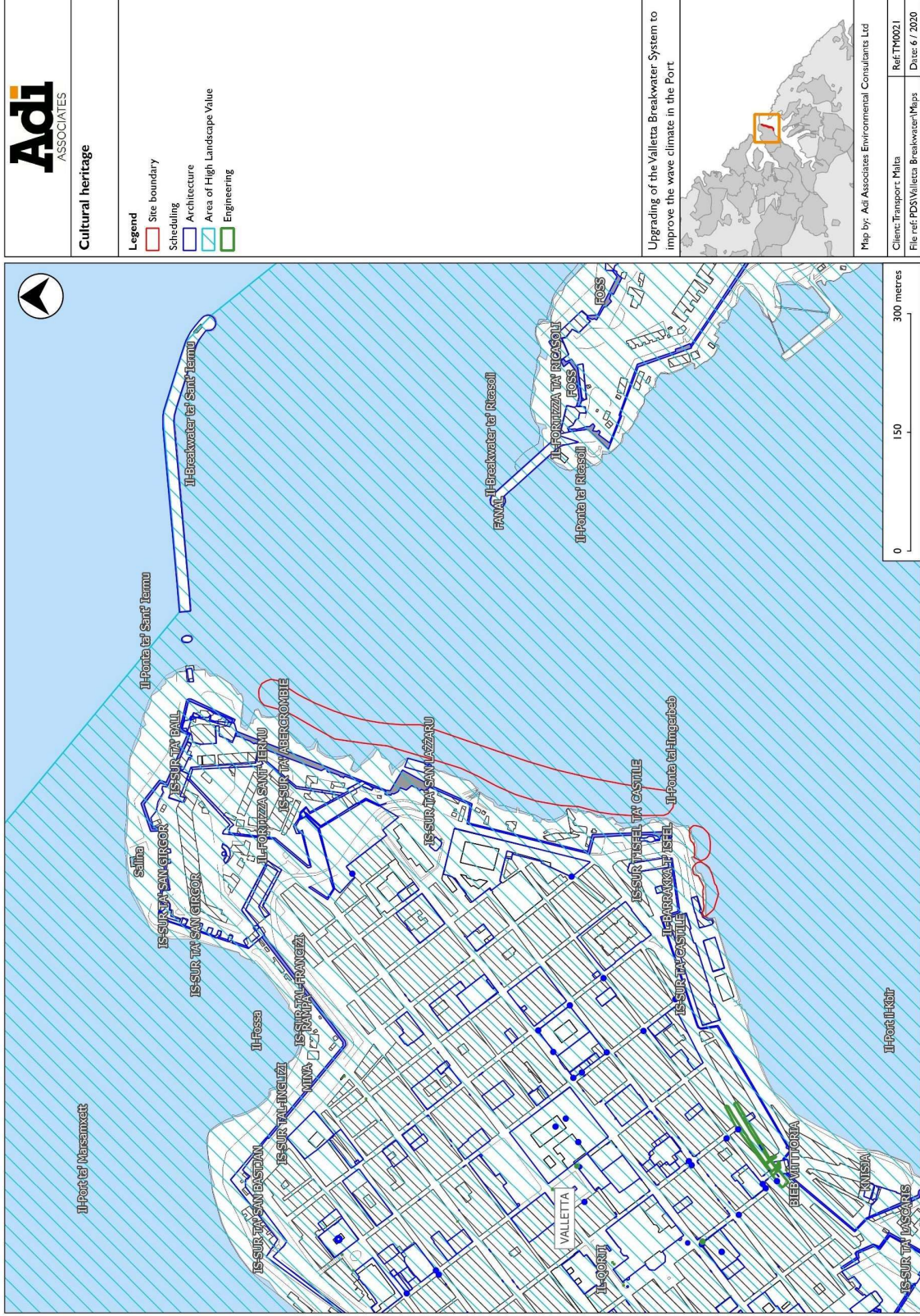


Figure 5: Cultural heritage designations



## **Scheme Description**

### ***Alternatives***

23. In order to achieve the above-listed objectives, over the past two years Infrastructure Malta has been exploring a number of options in detail through mathematical wave modelling studies. In addition, a 3-D seabed scan, sub-bottom profile, and magnetometry surveys were carried out. Marine archaeology data was also collected during the remote sensing surveys.
24. The alternatives originally considered in 2017 included:
- **Option 1:** To reconstruct a berm along the south eastern tip of Valletta between Mgerbeb Point and the St Elmo bridge. This was intended to diffuse waves entering from the eastern direction to which the port is exposed thus reducing reflections towards the Three Cities and towards Barriera Wharf. This berm would be constructed off the existing coastline, which will enable the continued use of the southern section of this part of the coast, mainly as a bathing area.
  - **Option 2:** To construct an ‘offshore’ berm east of the Ricasoli breakwater. This was intended to reduce waves entering the Port from the eastern direction as well as to diffuse waves from the north.
  - **Option 3:** To construct an ‘offshore’ berm at the tip of the Valletta peninsula to diffuse waves from the NW to N directions from entering the Port beneath the St Elmo bridge and reflecting within the Port towards the Three Cities and Barriera Wharf.
  - **Option 4:** To re-construct a revetment on the seaside and leeside of the St Elmo Breakwater arm between the bridge and the breakwater kink. The revetments will be on either side of the breakwater to balance the forces on the structure as well as to diffuse waves incident on the breakwater and those that manage to overtop. These revetments could work for waves incident from both the northern and eastern directions.
  - **Option 5:** To construct a new breakwater beneath Fort Ricasoli over a shallow strip of seabed found in the area. This breakwater was intended to reduce waves entering the port from the East.
25. Mathematical modelling indicated that some of the options listed above, in particular Option 5, would not be effective. Financial considerations also acted against some of the proposed options. Following the initial round of modelling, the results indicated that Option 1 would be the most feasible to pursue in greater detail since it provided the greatest improvement in wave climate when compared to the other options. However, on consultation with the Environment and Resources Authority (ERA) and the Superintendence of Cultural Heritage (SCH), the inclusion of the revetment and its design was re-evaluated. After various mathematical analysis, the final solution included the removal of the largest section of the revetment to be replaced with an extension of the already proposed berm. However, to ensure effectiveness, the two

small revetments on the west side of Mgerbeb Point were retained as part of the Scheme, as shown in **Figure I**. No technical solution was found to remove the full length of the revetment. The design has ensured that the entrance to the existing cave at Mgerbeb Point will not be visually obstructed. In addition, the studies have shown that a new breakwater arm needs to be constructed on the external part of the existing St Elmo breakwater to ensure that waves from the North West do not propagate into the harbour. This breakwater arm features in the photomontages, however, it is the subject of a separate development permit application. The photomontages are presented in **Appendix I**.

26. Two design options were considered for the berm and are described hereunder.

### **Berm design**

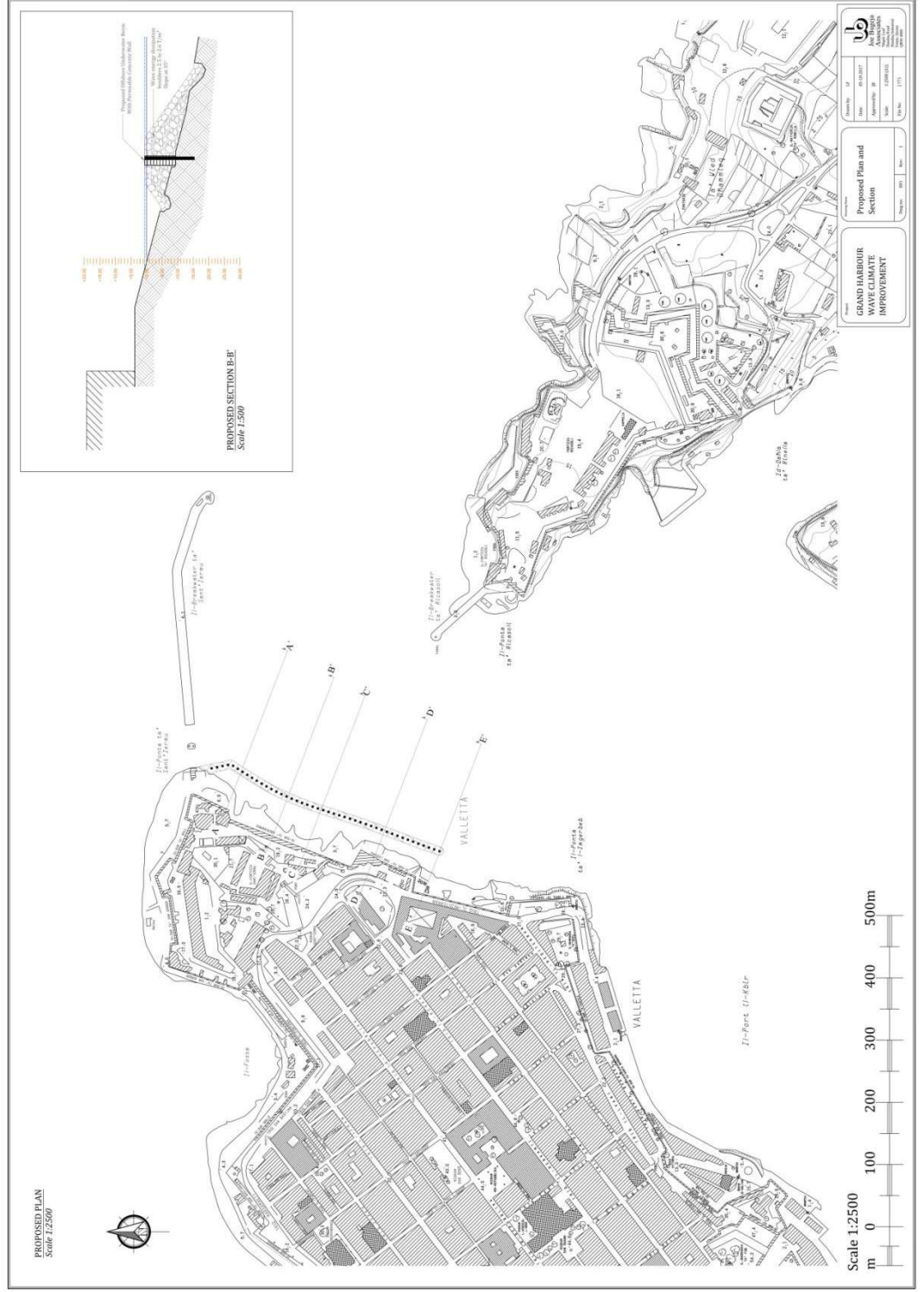
#### ***Design Option 1.***

27. This option involves having intermediate pre-cast hollow concrete columns pinned into the rock by piles. There would be a space between the columns to give permeability to the berm. Their function would be to counter the wave forces and thus assist the individual boulders to remain in place by a combination of gravity and arching effects.
28. Excavation of loose sediment from the footprint of the berm and laying of the core of the berm, which would be composed of 5 tonne blocks having a density of at least 2 tonnes per cubic meter (1 tonne per cubic meter submerged density).
29. The outer armour would be made of 16 tonne blocks having a density of 2.5 tonnes per cubic meter. Its general slope would be of 35 degrees.
30. The armour will have a toe at both extremities of the berm. The toe would be formed in the rock sea-bed surface by means of an excavated trench in the rock itself with dimensions 2 m wide by 2 m deep.
31. All rock placing would be carried out by qualified and experienced divers.
32. Examples of similar constructions already exist in Malta, eminently the natural rock rubble mound breakwater at Mgarr, Gozo. This has been protecting Gozo's main harbour since its construction in 1971. It has been designed to withstand waves of the same magnitude as those inputted in the Valletta breakwater models.
33. Considering the uniqueness of the design and the wave exposure during storms, a 2D physical model flume test would need to be carried out to confirm the design from an operational perspective (whereby improved wave climate would be the desired result) and an extreme weather perspective (survivability during extreme storms conditions). Considering possible sea level rise of 0.5 m during the berm's design life, it has been determined that in general, wave crest level should be at mean sea level.
34. **Figure 7** shows a cross-section through the berm as proposed in 2017.

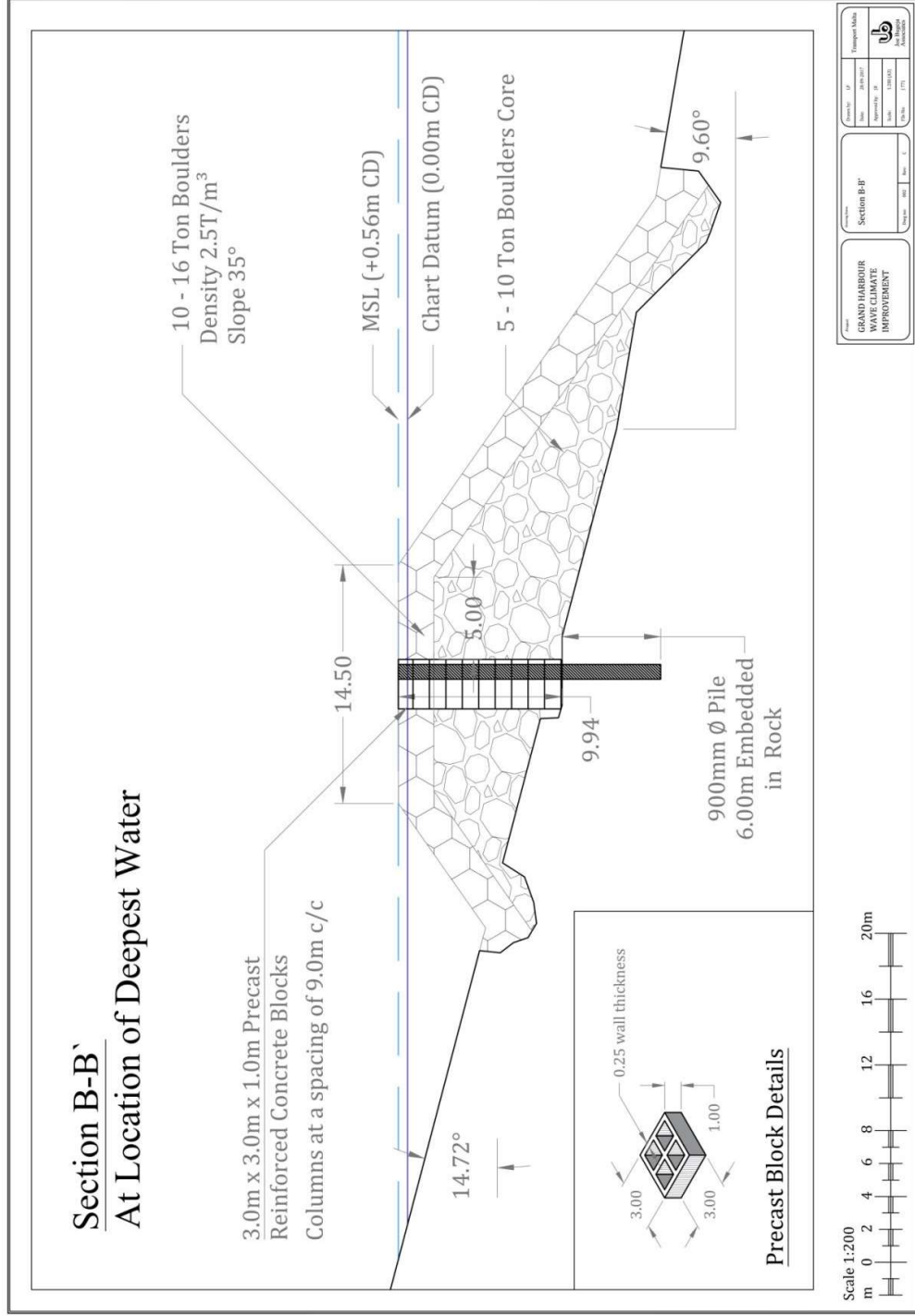
***Design Option 2***

35. The second design option considers the use of interlocking single-layer concrete armour units (e.g. Accropodes®) instead of rock boulders and columns (**Figure 8**).
36. Following assessment of the two design options by specialist companies in the sector, Design Option 1 was considered to have a higher technical performance and cost risk due to the fact that it is an unconventional design and one which has not been tried before. Considering the exposure of the Scheme location to frequent gregale storms and the failure of the original berm (which did not feature interlocking armour) to survive such conditions, Infrastructure Malta was advised to stick to a tried and tested design concept. Hence, Design Option 2 was chosen as the preferred Scheme design going forward. This will require:
- Excavation of loose sediment from the footprint of the berm;
  - Excavation of trenches for the forward and rear footings of the slopes (entire perimeter);
  - Engineered rock core construction of berm and revetment; and
  - Fabrication (off-site) and installation of single-layer concrete armour units over rock core of berm and revetment.

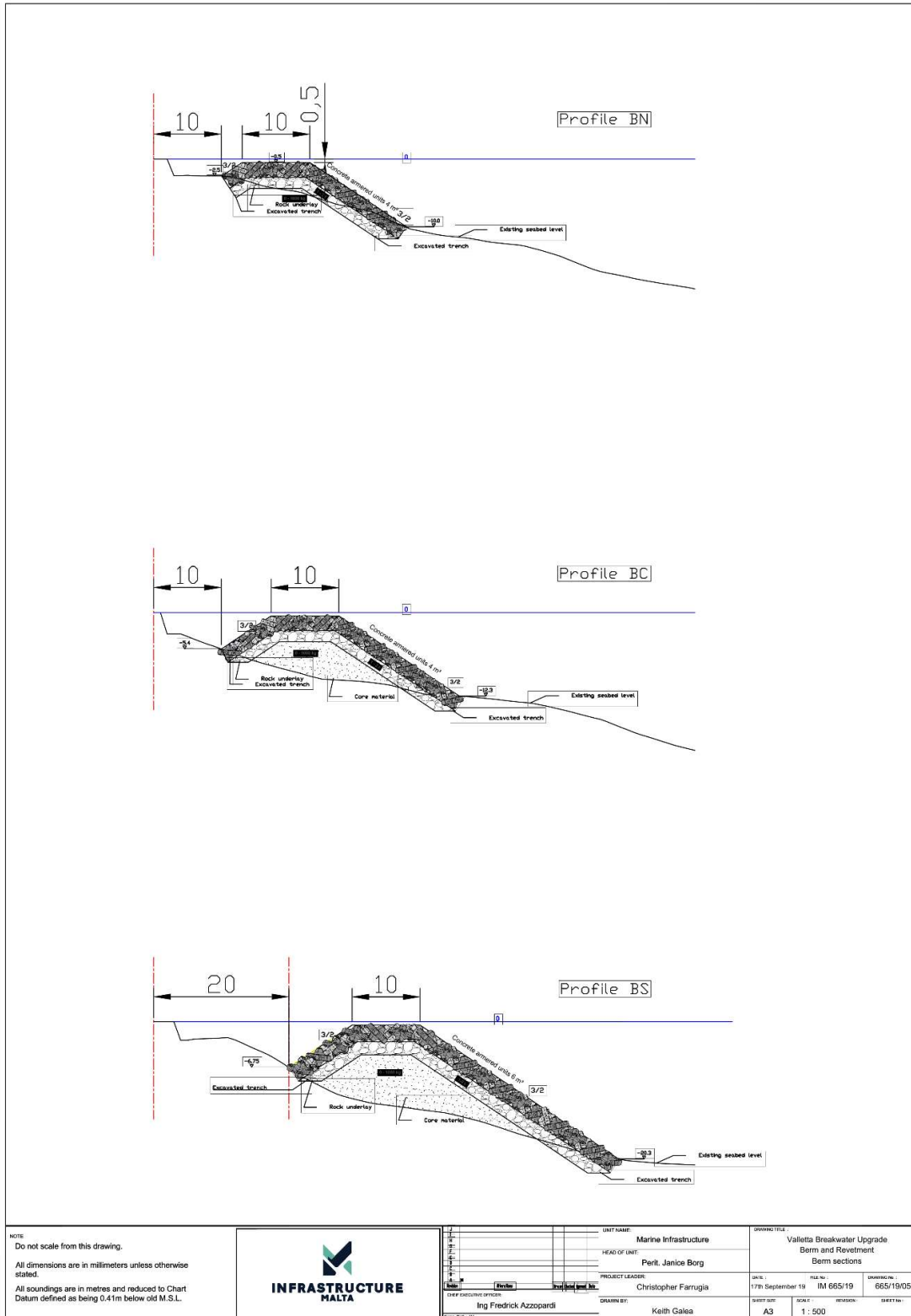
**Figure 6: 2017 layout of berm (Design Option I)**



**Figure 7: Typical cross-section through Design Option I berm (2017)**



**Figure 8: Typical cross-sections through Design Option 2 berm (2019)**



### Layout and design updates – 2019

37. Since the shortlisting of the preferred design (see above), the focus of the modelling was to optimise the layout and the berm design. The studies were aimed at identifying the best position of the berm relative to the coastline for maximum beneficial effect in reducing wave reflections into the port.
38. The options studied were for a berm offset 10 m, 20 m, and 25 m from the shoreline. Results from the modelling studies undertaken in 2019 indicated that the berm would be most effective if submerged with a crest level at -0.5 m MSL (approximately at Chart Datum). This will mean that the berm will generally not protrude above the water line and hence will need to include navigational markers to denote its position and alert mariners. These will likely be fixed markers consisting of a column rising about 3-5 m above MSL<sup>1</sup> with a maintenance platform, daylight navigational top-mark, and navigational light on top (see **Figure 9**).

**Figure 9: Fixed navigational marker**



39. The choice of position for the berm will depend on social, environmental, and economic considerations. The further offshore the berm is located would provide a wider area for swimming and related activities between the berm and the shoreline; however, it would also overlap into the navigational channel and result in a wider footprint (in view of the increasing depth of water), with increased environmental impacts, significantly increased costs and negative impacts on navigational safety. In this version, the revetment was designed to have a crest at 3.0 m above MSL to match the waves predicted at this location by the mathematical model without the

---

<sup>1</sup> It is noted that waves can reach 5 m in this part of the harbour in the 100-year storm scenario.

berm. It was identified that this design could result in visual and heritage concerns given that the revetment protrudes above sea level. As a result, the ERA requested a re-evaluation of the revetment with a view to replace as much of it as possible with a submerged berm.

### **2020 Scheme updates including new proposed breakwater**

40. Since all the above, drawings have been updated (in May 2020) following the conclusion of further mathematical wave analysis of the harbour. The studies (Artelia, 2020<sup>2</sup>) showed that the port is affected mainly from three wave directions (NW, NE and E), each of which significantly affecting the wave climate in almost equal proportion. The project objective is to reduce the wave impacts within the port from these directions. The berm and revetment provide a secondary defence against those waves (NE and E) entering between the two existing breakwaters. On the other hand the proposed new breakwater at St Elmo Point provides a primary defence against the NW waves entering under the bridge.
41. There was also the consideration to reduce the size and height of the revetment as far as technically possible so as to reduce visual and cultural heritage impacts. After various mathematical analyses, the final solution that ensured effective results included the removal of the largest section of the revetment, which will be replaced by an extension of the already proposed berm. As a result, the originally planned rock dredging at Mgerbeb Point is no longer included as part of the Scheme because of the proximity to the berm's footprint. However, for the proposal to be effective, the two small revetments on the west side of Mgerbeb Point will still need to be constructed as shown in the new drawings as there is no technical solution to remove the full length of the revetment. The design ensures that the existing cave is not obstructed. **Figure 10 to Figure 17** present the new drawings for the Scheme.
42. The studies have also shown that a new breakwater arm needs to be constructed on the external part of the existing St. Elmo breakwater to stop North West waves from propagating into the harbour. This breakwater arm features in the photomontages presented (see **Figure 18 to Figure 23**); however, as mentioned, this new breakwater is the subject of a separate development planning application. Also, the photomontages feature two options for each viewpoint. One option shows concrete armour units cast from normal concrete, while the other features pigmented concrete. The pigment is included to provide concrete with a beige hue mimicking the local stone. Infrastructure Malta has opted for the latter option to reduce visual impacts.

---

<sup>2</sup> Artelia, 2020. Wave disturbance in Valletta Harbours. Phase 3 – Improvement of Wave Disturbance in Grand Harbour by a berm and revetment. Report RI: Hydraulic Studies and pre-concept design (Rev. 2) (Ref.: 87I 4537). Echirrolles, France; vi + 104pp + 14 Appendices

### **Seabed Excavation / Dredging**

43. Part of the construction of these structures will involve excavation / dredging along their entire perimeter for the formation of a toe trench that will be required to anchor the armour units. Most of this intervention is expected to take place in bed rock because studies have shown that the seabed on the footprint of the structures is almost devoid of sediment. The estimated volume of excavated / dredged material (mostly rock) for the construction of the berm is 13,313 m<sup>3</sup>, whereas for the construction of the south revetments at Mgerbeb Point, excavations are expected to generate 469 m<sup>3</sup> of rock. The construction of the breakwater at St Elmo Point is expected to generate approximately 3,017 m<sup>3</sup> of rock.

**Figure 10: Berm and revetment plan at Mean Sea Level**



**Figure 11: Berm and revetment plan at - 0.5 Mean Sea Level**



Figure 12: Berm section BN

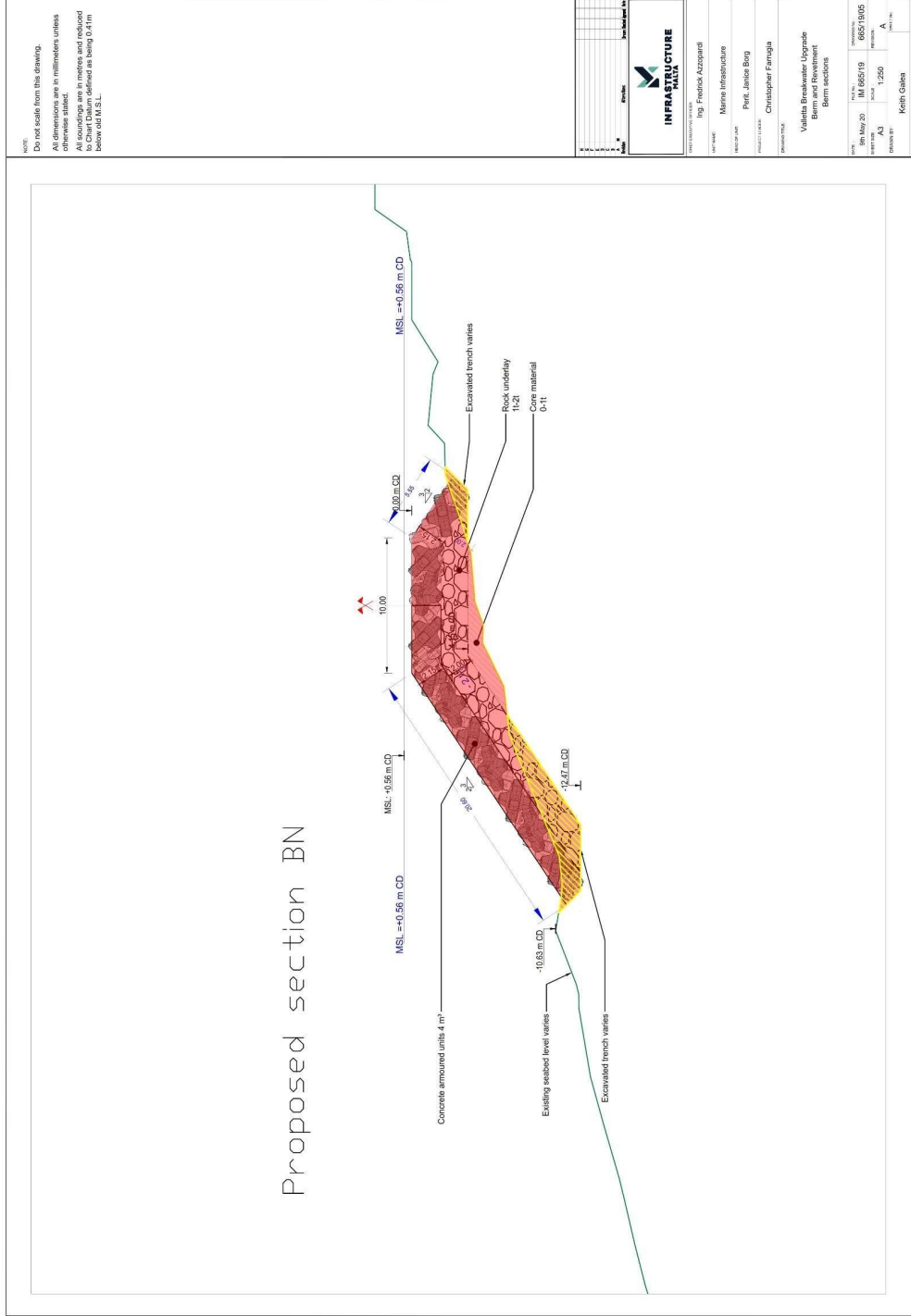






Figure 15: Berm section BS

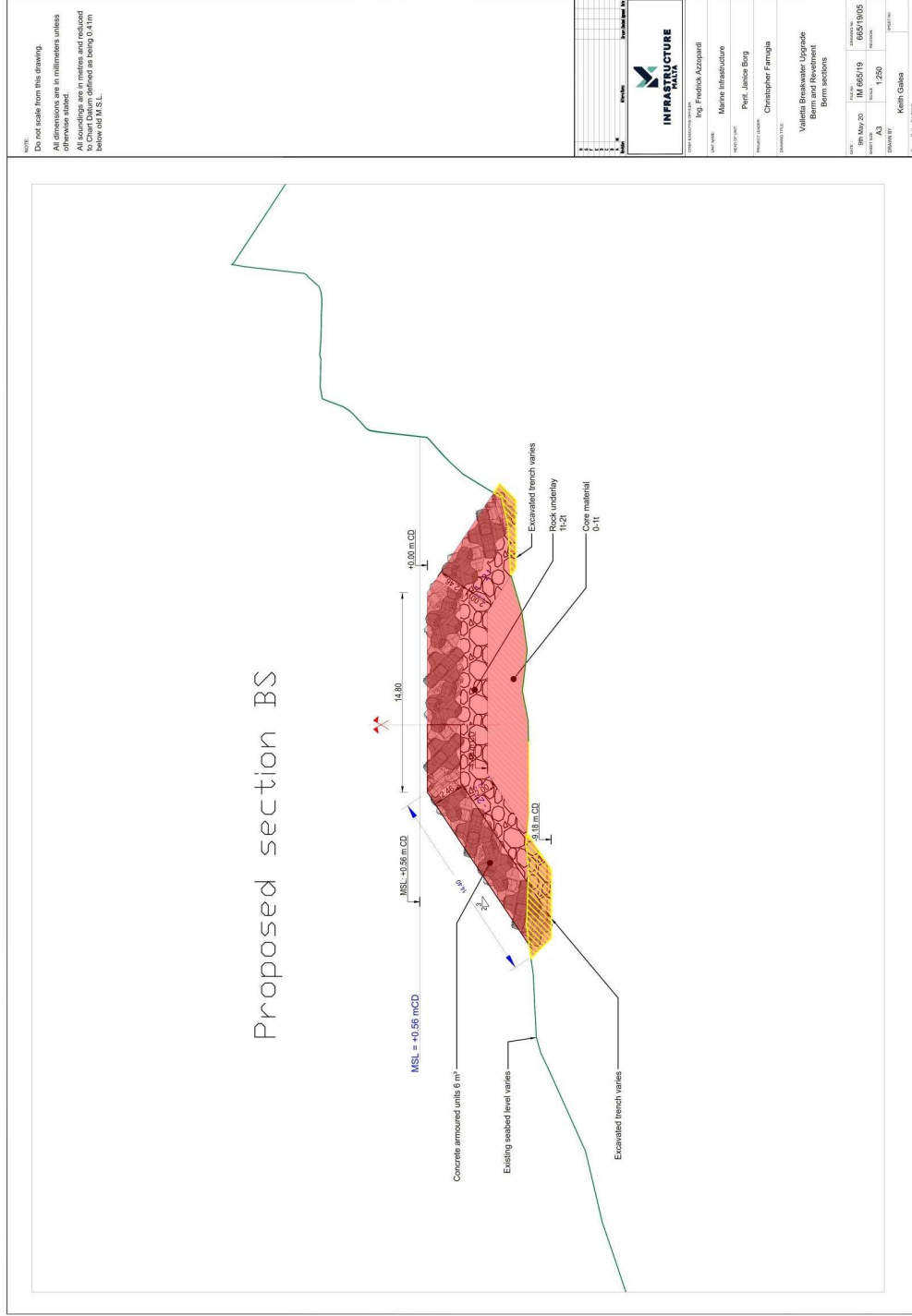
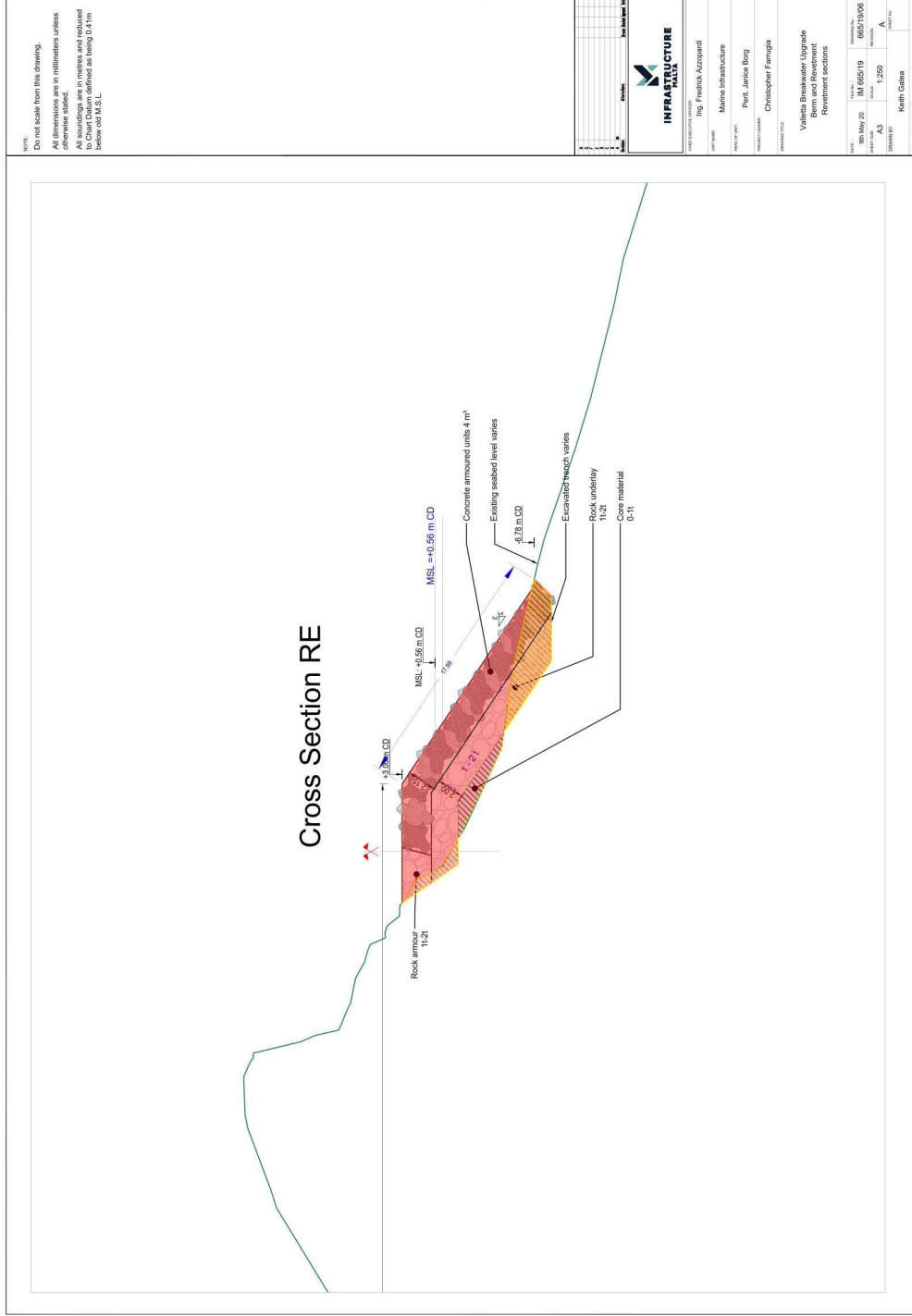


Figure 16: Retevment section RE





**Figure I8: St Elmo North Breakwater Site Plan**

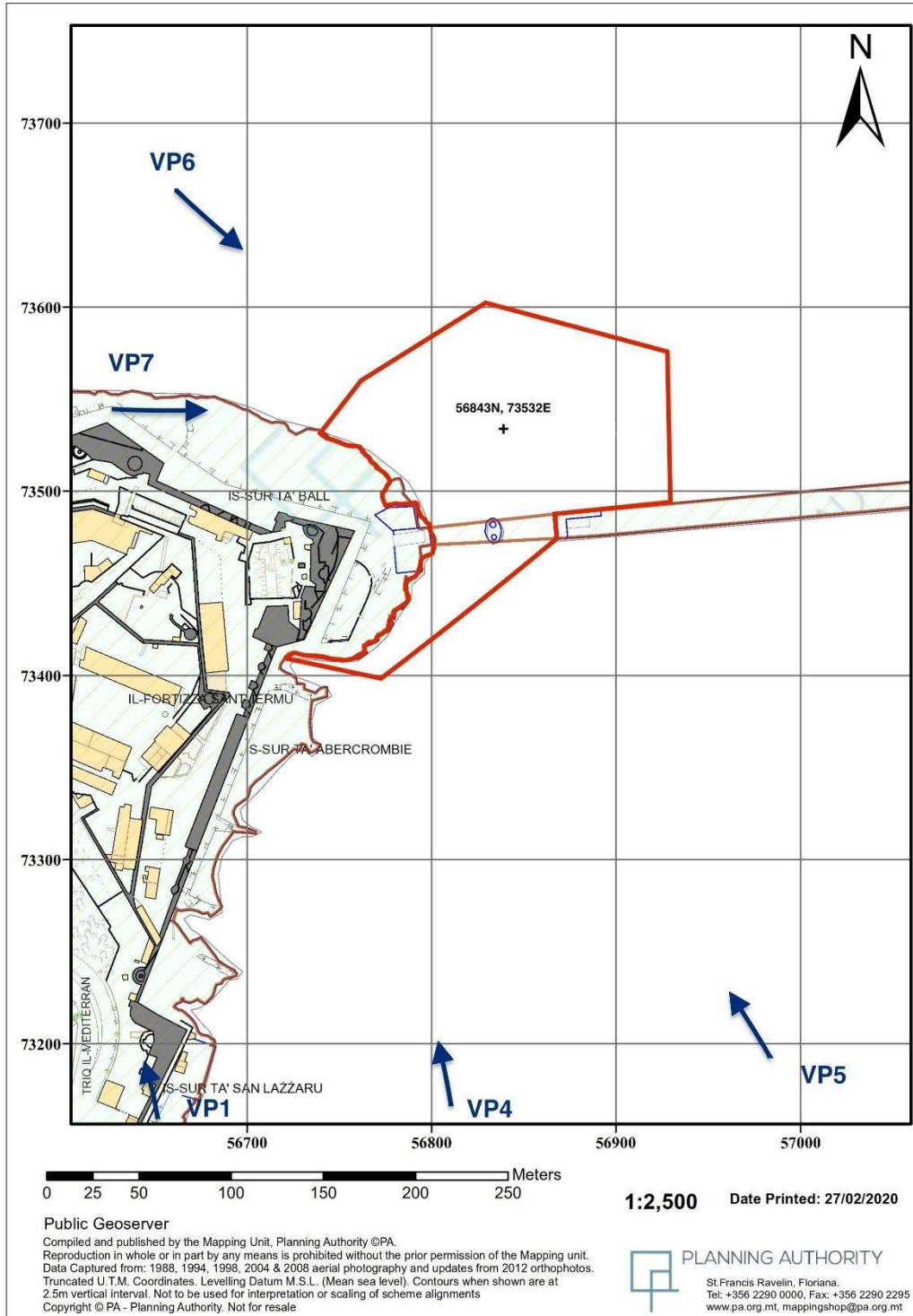


Figure 19: St Elmo North Breakwater Site Plan above Mean Sea Level

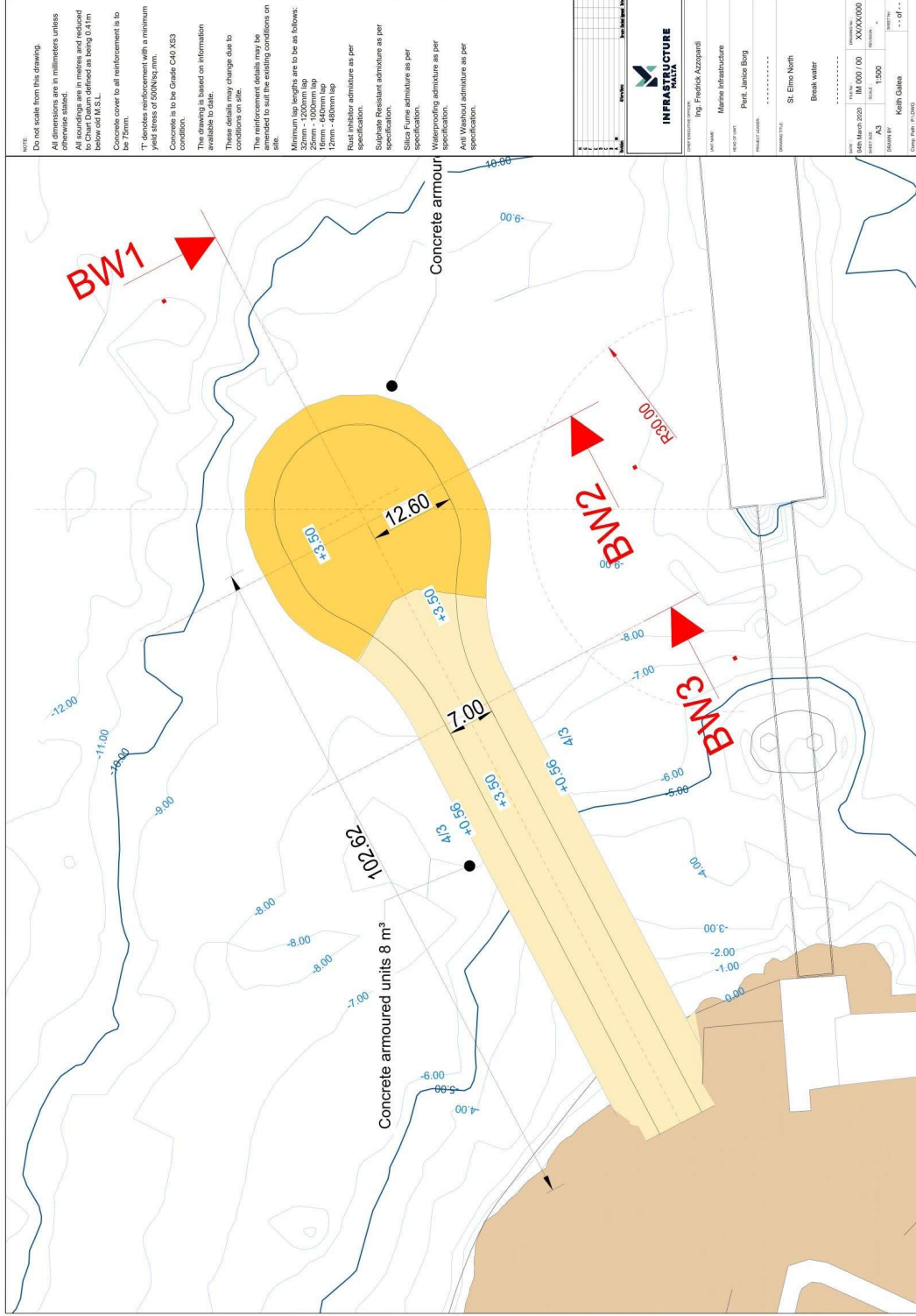


Figure 20: St Elmo North Breakwater Plan below Mean Sea Level

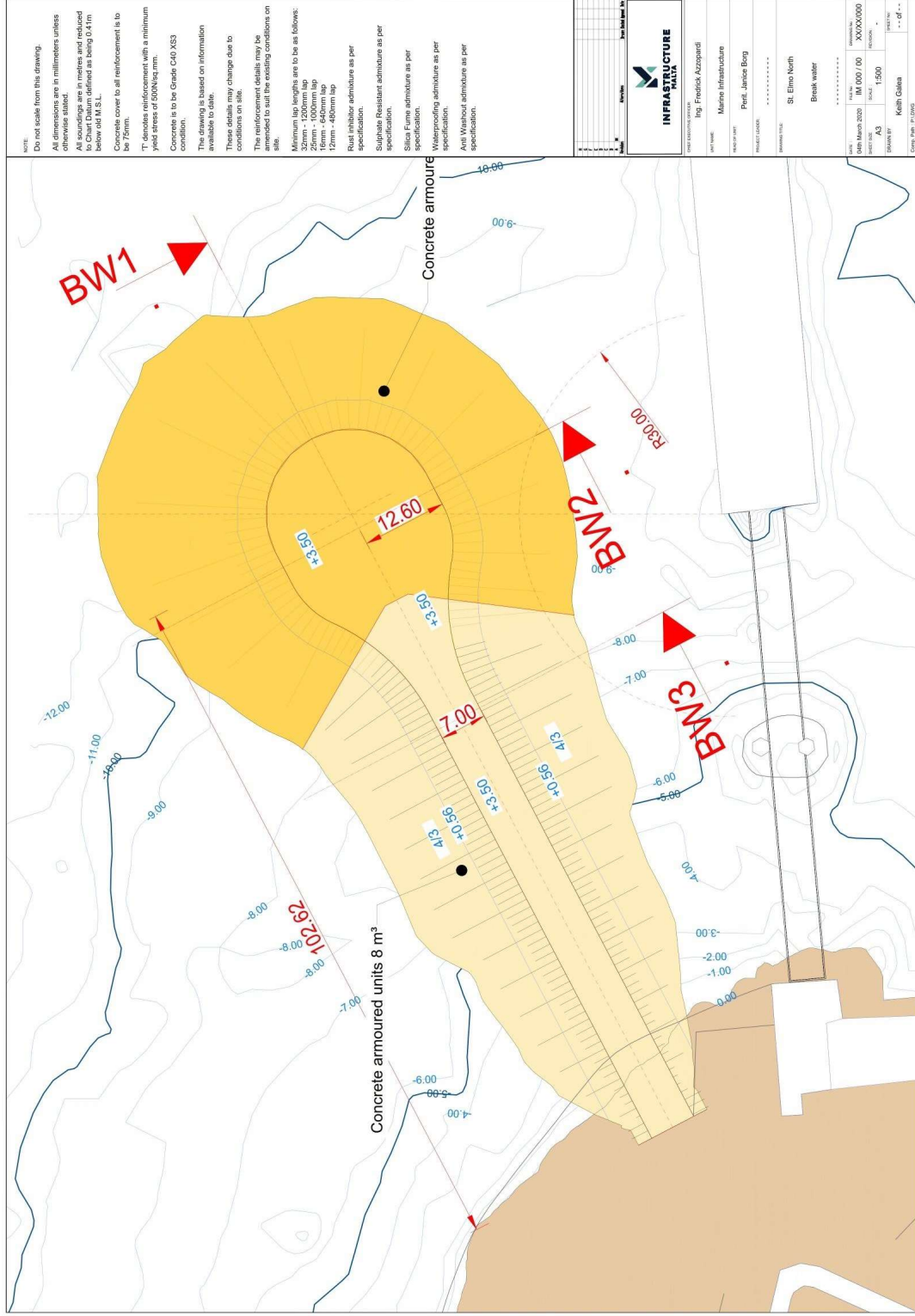


Figure 21: B breakwater section BW1

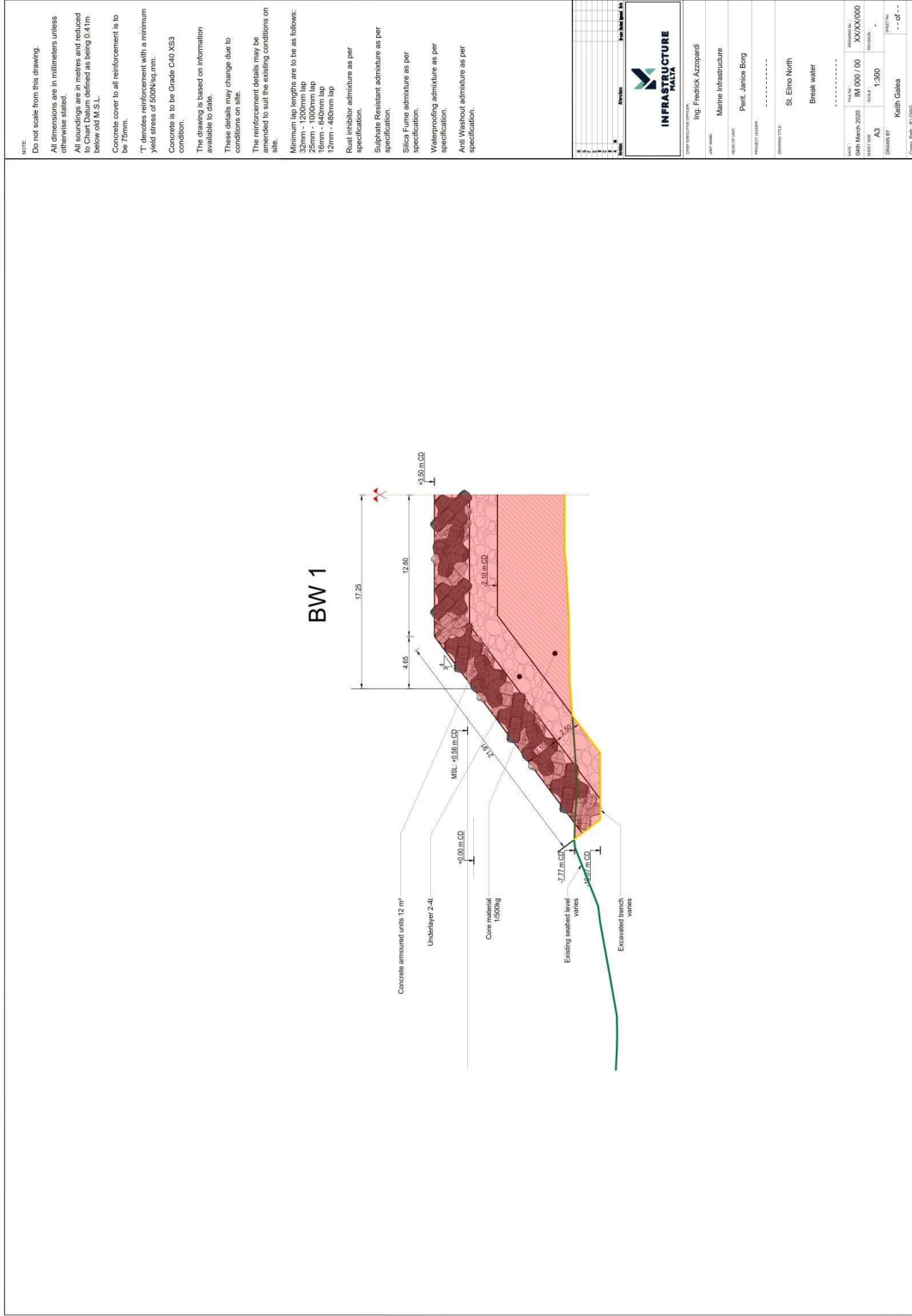


Figure 22: B breakwater section BW2

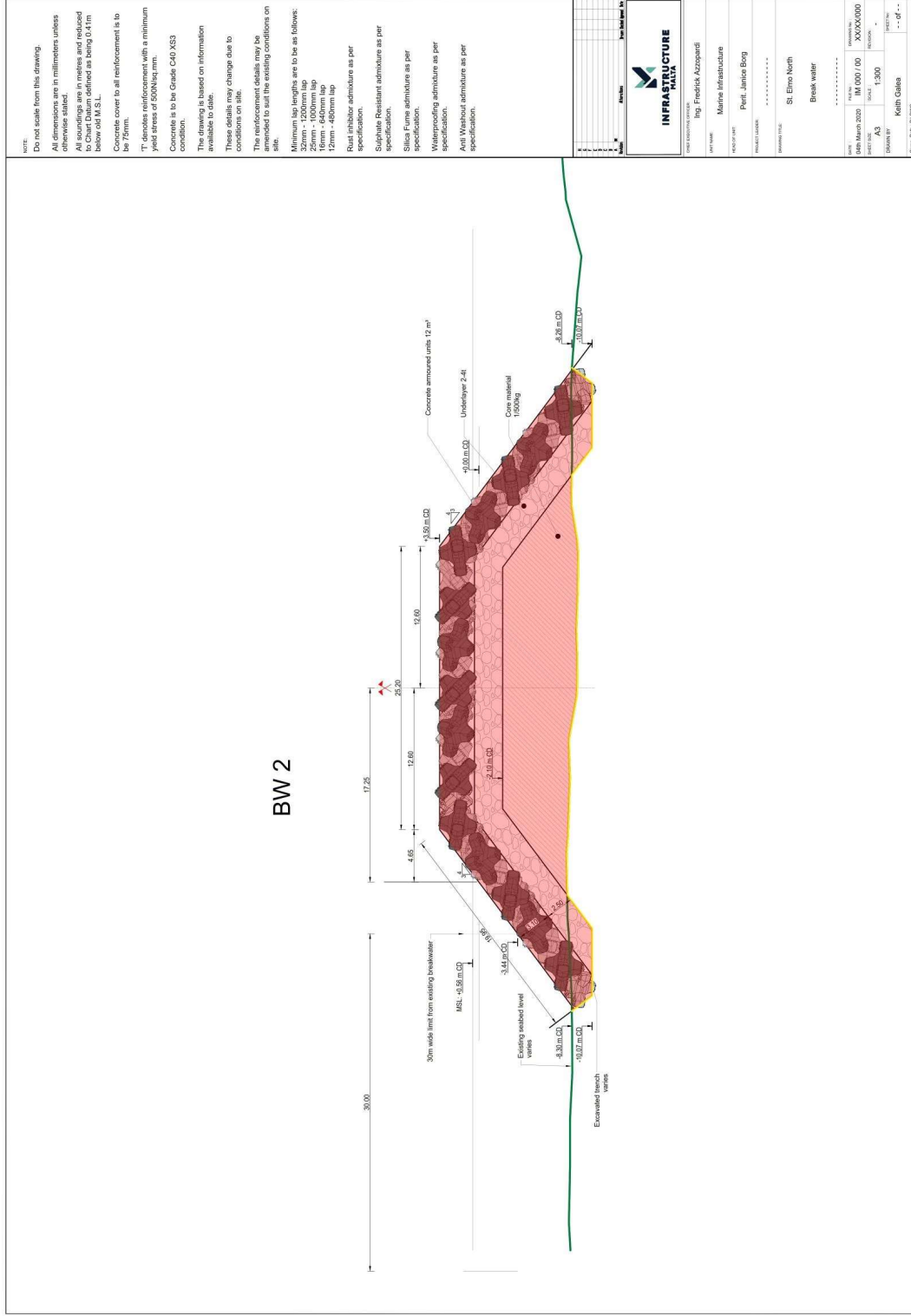
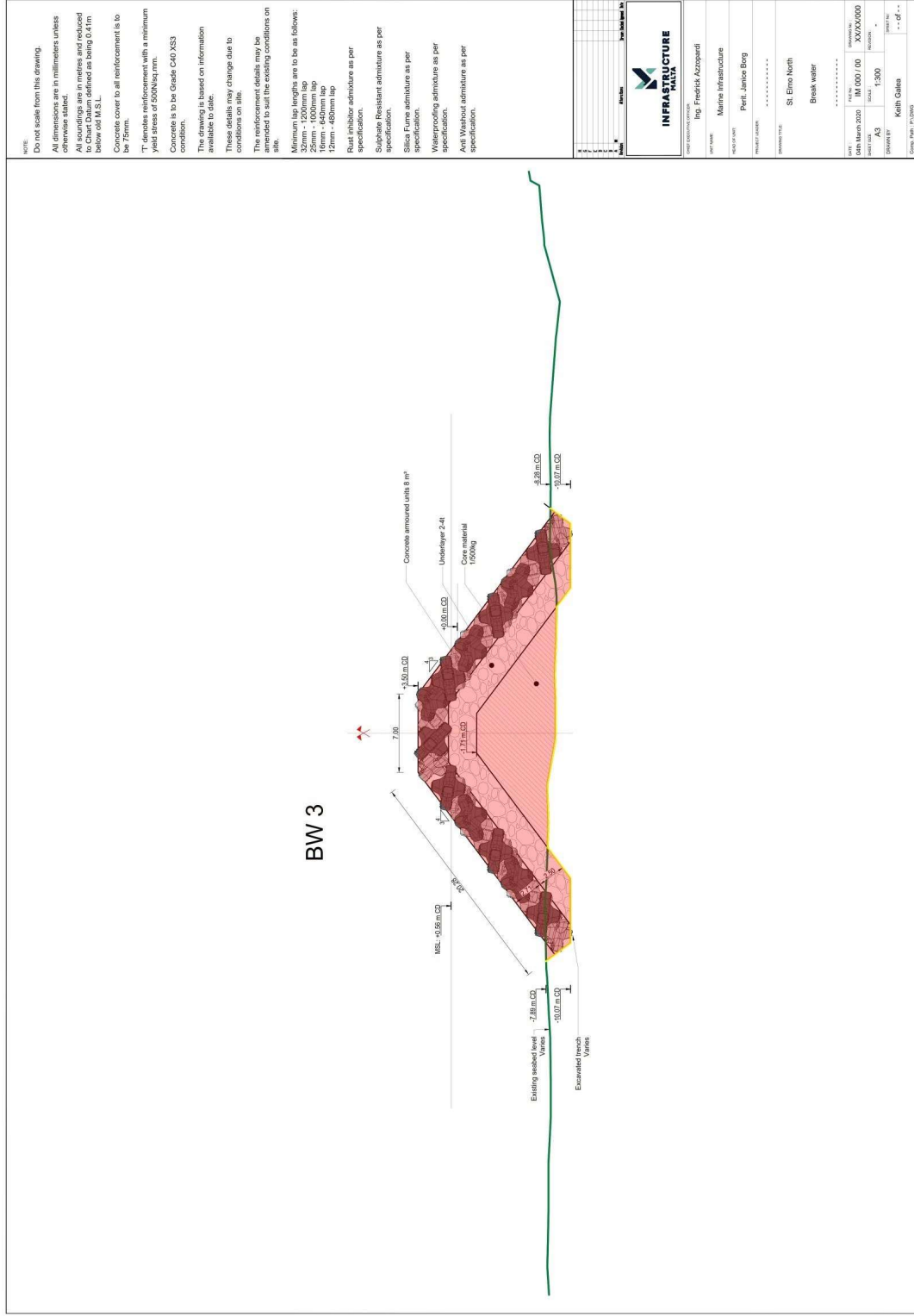


Figure 23: B breakwater section BW3



## RAW MATERIALS AND RESOURCES

### Berm / revetment / breakwater construction

44. The contractor will make arrangements to use a berth in order to shelter marine equipment during storms and a jetty or quay with landside access to load/discharge construction and waste materials.
45. A silt curtain will be placed to contain the work footprint and prevent any silt from dispersion, where practical to do so and subject to the approval of the Harbour Master and Transport Malta (TM). This is because the construction site is very close to the navigational channel and located in an exposed sea area. There is therefore a risk that a silt curtain deployed in this location could obstruct navigation or cause a navigational incident that would have serious repercussions.
46. In order to prepare the seabed for the construction of the breakwater, berm and revetment, dredging will be carried out (see above). This will involve the removal of any sediment and loose material for the footprint of the breakwater, berm and revetment followed by the excavation of foundation trenches along the entire perimeter for the forward and rear footings of the slopes of the breakwater, berm and the slope of the revetment.
47. Once the excavations are completed, the breakwater, berm and revetment will be constructed in line with industry best practice. These structures will be built in a similar manner will consist of an engineered rock core, larger rock boulder underlay and finished with interlocking single layer concrete armour units. Based on the results of the wave studies, the engineers determined that the armour layers must be made of interlocking concrete units. These units will be of various sizes according to the extreme waves impacting the structures at various locations. It is also possible that the revetment may not have any core material since its cross section might be too small. The core material will likely be placed by split barge or crane with grab and formed using barge-based excavation equipment.
48. Armour concrete units will be fabricated off-site and delivered to the site by barge. Rock underlay and concrete armour units will be placed more precisely using grab and lifting equipment mounted on barges (jack-up or spud/leg mounted barge) and assisted by divers.
49. **Table I** presents the estimated amounts of raw materials required.

**Table I: Estimated amounts of raw materials required**

Raw material	Estimated amounts (m <sup>2</sup> / m <sup>3</sup> )
<b>Berm</b>	
Core engineered stone material	24,664 m <sup>3</sup>
Rock boulder underlay	32,763 m <sup>3</sup>
Concrete armour units	21,984 m <sup>3</sup>

Raw material	Estimated amounts (m <sup>2</sup> / m <sup>3</sup> )
<b>South Revetments</b>	
Core Material	123 m <sup>3</sup>
Rock boulder underlay	2,514 m <sup>3</sup>
Concrete armour units <sup>3</sup>	1,578 m <sup>3</sup>
<b>North Breakwater</b>	
Core Material	11,070 m <sup>3</sup>
Rock boulder underlay	11,822 m <sup>3</sup>
Concrete armour units <sup>4</sup>	7,545 m <sup>3</sup>

### Dredging and seabed excavation

50. In anticipation of the dredging and seabed excavation, a sediment sampling exercise was undertaken to determine the presence of seabed sediments and to test these for heavy metals and other contaminants in order to characterise the sediments and hence determine the management measures that may need to be applied. **Figure 24** shows the sediment sampling stations<sup>5</sup>. **Table 2** identifies the amount of sediment encountered at each sampling location relevant to this study (stations SI, A, B, C, D, E, F, G, N, and P). As can be seen practically no sediment is found along the Scheme site and the outer breakwater. In the only two stations where sediment was encountered, this was limited to a few centimetres.

**Table 2: Coring results**

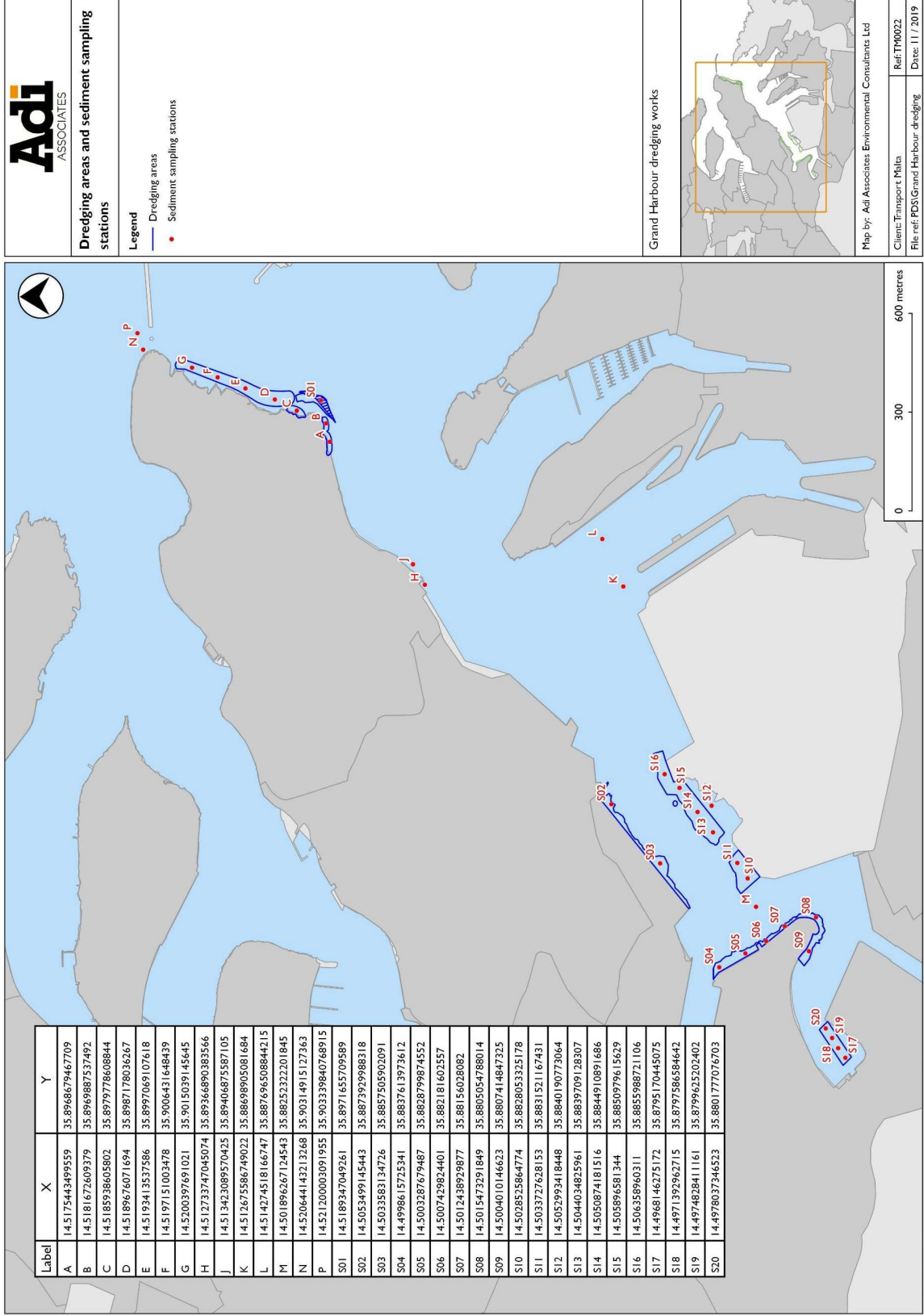
Sampling Station	Thickness of Layer (m)	Target Depth (m) below CD	Depth reached during coring (m) below CD	Comments
SI	0	12	n/a	Bedrock; no samples taken
A	0	5.5	5.1	Bedrock; no samples taken
B	0	5.5	6.3	Bedrock; no samples taken
C	0.2	5.5	7.1	Bedrock; only surface sample retrieved
D	0	10	12.1	Bedrock; no samples taken
E	0.1	10	10.25	Bedrock; only surface sample retrieved
F	0	10	11.25	Bedrock; no samples taken
G	0	10	11.05	Bedrock; no samples taken
N	0	5.5	5.05	Bedrock; no samples taken
P	0	5.5	9.55	Bedrock; no samples taken

<sup>3</sup> The suitability of rock or concrete will be determined after the wave studies are complete

<sup>4</sup> The suitability of rock or concrete will be determined after the wave studies are complete

<sup>5</sup> Note that the sediment sampling exercise was part of a wider sampling strategy that included several other locations within the Grand Harbour.

Figure 24: Sediment Sampling Stations



INDICATIVE ONLY - Not to be used for direct interpretation

51. The chemical characterisation of the sediment samples from stations C and E showed that station C is not contaminated, whereas station E showed some contamination of Mercury (exceeding the Level 1 Dumping Limit) and a higher contamination with PAHs (exceeding the Level 2 Dumping Limit). Unfortunately, the limited amount of sediment recovered did not allow the taking of replicate samples so that it is difficult to conclude the nature of this contamination and whether it is a statistically significant result.
52. In view of the widespread presence of bedrock at the Scheme site, excavation will be carried out by back-hoe with cutter attachment and bucket lifting of the broken rock or by cutter suction.
53. **Table 3** lists the type of equipment expected to be used during the construction of the Scheme.

**Table 3: Equipment**

Equipment	Number
Jack-up / spud mounted barge	1-2
Backhoe dredger with cutter attachment or Cutter Suction dredger	1
Crane (on barge)	1-2
Tug with trailer	2
Split barge	2

### **Waste Management**

54. Waste generated during construction of the berm, revetment and breakwater will largely be dredged rock (EWC 17 05 06). An estimated volume of approximately 17,000 m<sup>3</sup> will be generated. This will be disposed of at the offshore dumping site.
55. In view of the limited amounts of sediment present, the use of an airlift or similar pumping system is advisable if this will need to be dredged separately from the bedrock.

### **EMPLOYMENT**

56. The number of workers that will be on site during construction is expected to be no more than 25 at any one time.

### **POTENTIAL ENVIRONMENTAL IMPACTS**

57. Environmental impacts can be both negative as well as positive, and their assessment is important so as to better define the effects that a proposal may have on its receiving environment. This Project Description Statement identifies a preliminary list of the potential environmental impacts of the Scheme; the list identifies only those impacts that may be potentially significant.

- **Impacts on the geo-environment**

- Construction will require the excavation of a toe trench along the entire

perimeter of the berm footprint and the seaward perimeter of the revetment footprint.

- ***Impacts on terrestrial and marine archaeology and cultural heritage, from the construction of the Scheme***
  - During preliminary investigations for this project, an archaeology survey of the seabed at the Scheme site was carried out using side-scan sonar, sub-bottom profiler, and magnetometer. No potential archaeological targets were identified through these surveys. Notwithstanding, there remains a remote possibility that during Scheme construction, works could potentially uncover and / or disturb unrecorded archaeological artefacts. Hence, the Scheme could potentially impact on unrecorded archaeological and cultural heritage features in and in the vicinity of the Scheme site. However, it is noted that in this area of the Harbour, given the wave exposure, there is a relatively thin layer of sediment such that the likelihood of the presence of undiscovered artefacts within the seabed is not high.
  - In November 2020, an archaeology baseline survey for the Scheme was prepared on instruction from the Superintendent of Cultural Heritage. The study used remote sensing data and archival information to quantify and assess the cultural heritage assets within the area. The study did not uncover any archaeological material and the information from the sediment sampling exercise seems to indicate that the possibility of any such material being uncovered is remote at best and any archaeological remains that might be discovered would likely be small scale and of an isolated nature.
  - The submerged berm may at times (e.g. during extreme low tides and during storms) be visible above the water. Such occurrences will be rare and temporary and are hence considered unlikely to have a significant impact on the cultural landscape of the area given that the port is a functioning one and the structure was already in existence and a presence in the landscape prior to its collapse. There may be an impact on the cultural landscape from the construction of the south revetments.
- ***Impacts on the marine environment, including on water quality and currents***
  - The potential impacts arising as a result of the change in configuration of the seabed could impact on the hydrodynamics further in the Harbour, including circulation and currents. However, these are not expected to be significant. Firstly, the proposed berm is submerged to the lowest possible tide level and will be completely detached from the foreshore to allow circulation of water around it. The revetment is not expected to

affect water circulation. The disturbance of any contaminated seabed material that may be present also has the potential to impact on water quality. However, the presence of minimal amounts of sediment in this part of the Harbour means that such effects are expected to be insignificant. During the excavation of trenches to accommodate the berm and revetments, temporary deterioration in the water quality from turbidity is expected in the vicinity of the works.

- **Impacts arising from construction activities, in relation to noise, vibration, dust emissions**
  - Whilst the potential impacts arising during construction are likely to be short-term and temporary, given the nature of the construction works (including the dredging works and excavation), there is the potential for impacts from noise (including underwater noise), dust plume and possibly also vibration emissions.
- **Traffic impacts, during construction (including heavy-vehicle traffic)**
  - The potential impacts arising from construction traffic emissions and other related disturbances are likely to be short-term and temporary. It is to be noted that all site works will be carried out from the marine side.
- **Impacts from waste, generated during construction**
  - During the construction phase, parts of the previous berm may be removed and/or reused on site.
- **Landscape and visual amenity impacts**
  - On rare occasions (especially during storms and extreme low tide) the berm may be temporarily visible above the sea level to a relatively small degree. Given that the Scheme site is located within the context of a functional harbour, the impact of the berm on the landscape is not likely to be significant. Visual impacts are also likely to be mostly insignificant as at most times, depending on the water level, the berm will in fact be submerged. Visual issues are, however, expected from the proposed revetments south of Mgerbeb Point.

## **MITIGATION PROPOSALS**

58. Potential mitigation measures will include:

- Ensuring the adoption of best practice environmental measures throughout construction and including monitoring of works and ensuring the disposal of any waste material in accordance with ERA's requirements.

- Careful attention to measures in the Construction Management Plan (CMP) for mitigating noise, vibration, and impacts on the marine environment from the construction works, and implementation of appropriate operational monitoring regimes throughout the dredging and construction phase to mitigate impacts;
- Careful archaeological monitoring of the excavations and dredging (where seabed sediments might be present) to ensure against the loss or / damage to any unrecorded archaeological artefacts uncovered during the works;
- Compliance with all relevant waste management regulations, including for dredged material, hazardous wastes, and the adoption of best practice in relation to waste management;
- Coordination with TM Harbour Master and port operations to minimise interference with routine activities and to ensure safety;
- Ensuring material used for construction of revetments is similar in colour to bastions to reduce visual impact.

## **Appendix I Photomontages**



**VIEWPOINT REFERENCE 1**

EXISTING VIEW

Distance to proposed development: NA

Camera height: 1.5m

Date: 2-March-2020

Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg

Sheet number: NA



**VIEWPOINT REFERENCE 1**

Year 0 / 10 Distance to proposed development: NA

Camera height: 1.5m

Date: 2-March-2020

Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg

Sheet number: NA

PROPOSED VIEW (PIGMENTED); This image must be viewed at a comfortable arm's length



**VIEWPOINT REFERENCE 2**

EXISTING VIEW

Distance to proposed development: NA

Camera height: 1.5m

Date: 2-March-2020

Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg

Sheet number: NA



**VIEWPOINT REFERENCE 2**

Year 0 / 10 Distance to proposed development: NA

Camera height: 1.5m

Date: 2-March-2020

Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg

Sheet number: NA

PROPOSED VIEW (PIGMENTED); This image must be viewed at a comfortable arm's length



**VIEWPOINT REFERENCE 3**

EXISTING VIEW

Distance to proposed development: NA

Camera height: 1.5m

Date: 2-March-2020

Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg

Sheet number: NA



**VIEWPOINT REFERENCE 3** Year 0 / 10 Distance to proposed development: NA Camera height: 1.5m Date: 2-March-2020 Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg Sheet number: NA

PROPOSED VIEW (PIGMENTED); This image must be viewed at a comfortable arm's length



**VIEWPOINT REFERENCE 4**

EXISTING VIEW

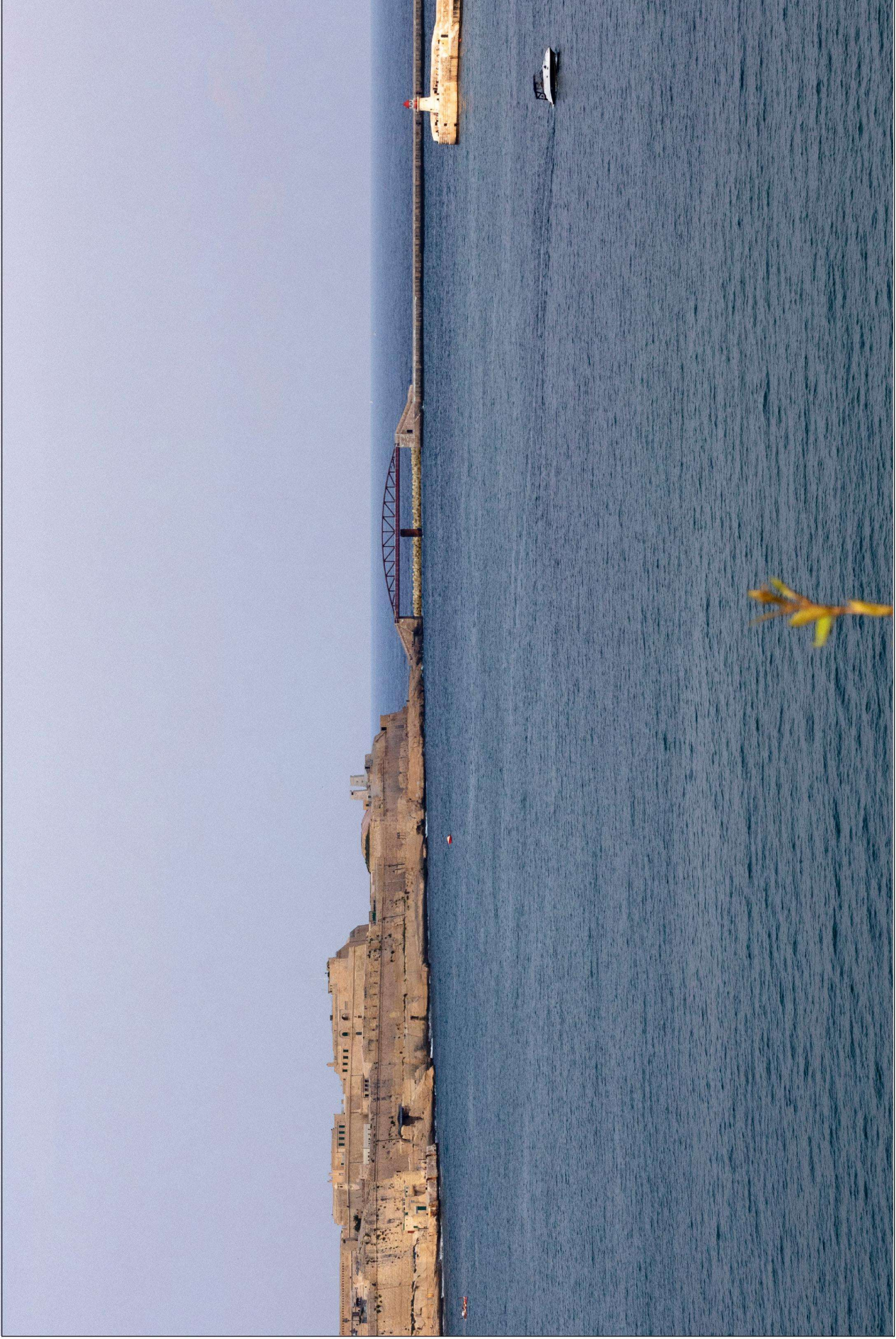
Distance to proposed development: NA

Camera height: 1.5m

Date: 2-March-2020

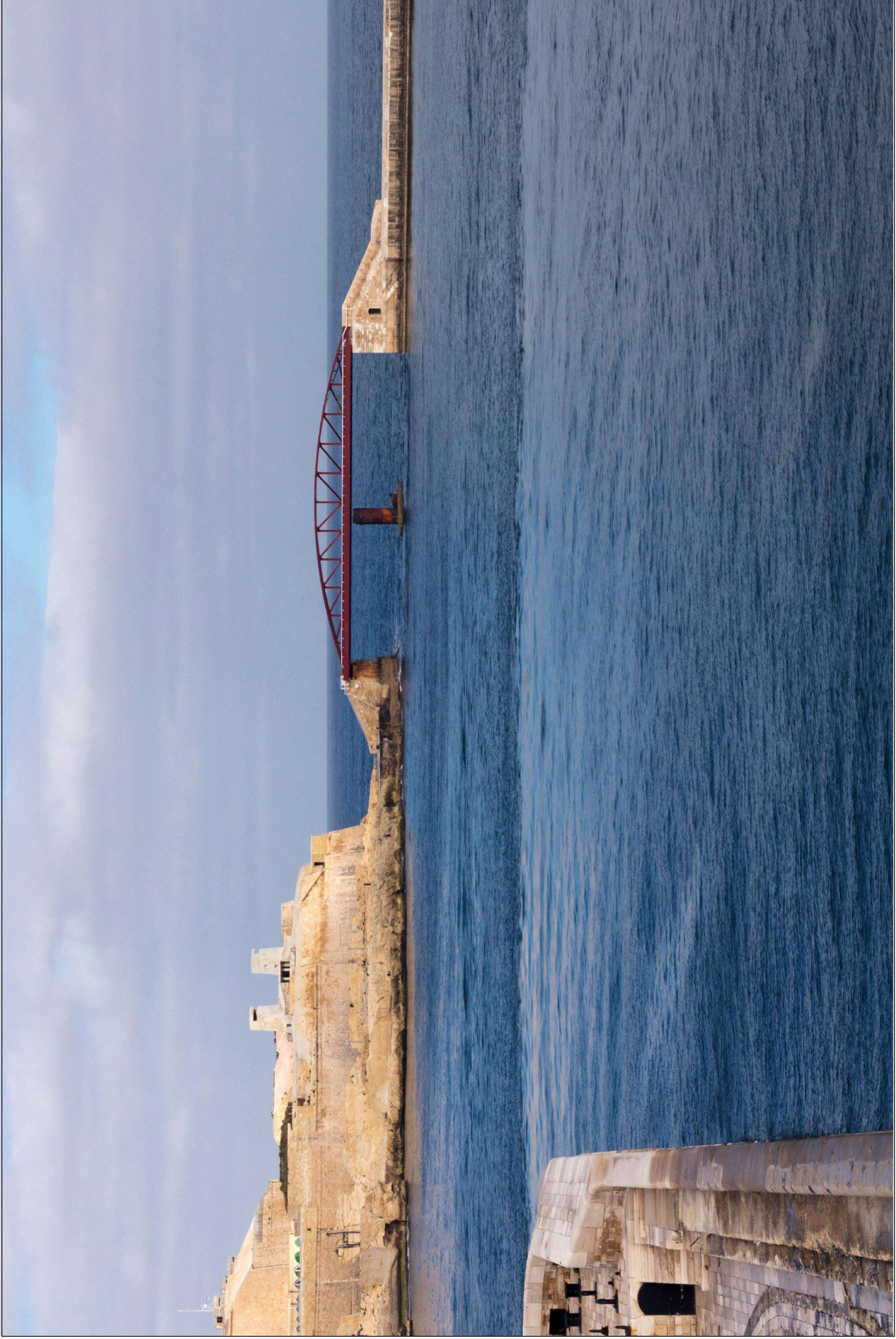
Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg

Sheet number: NA



**VIEWPOINT REFERENCE 4** Year 0 / 10 Distance to proposed development: NA Camera height: 1.5m Date: 2-March-2020 Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg Sheet number: NA

PROPOSED VIEW (PIGMENTED); This image must be viewed at a comfortable arm's length



**VIEWPOINT REFERENCE 5**

EXISTING VIEW

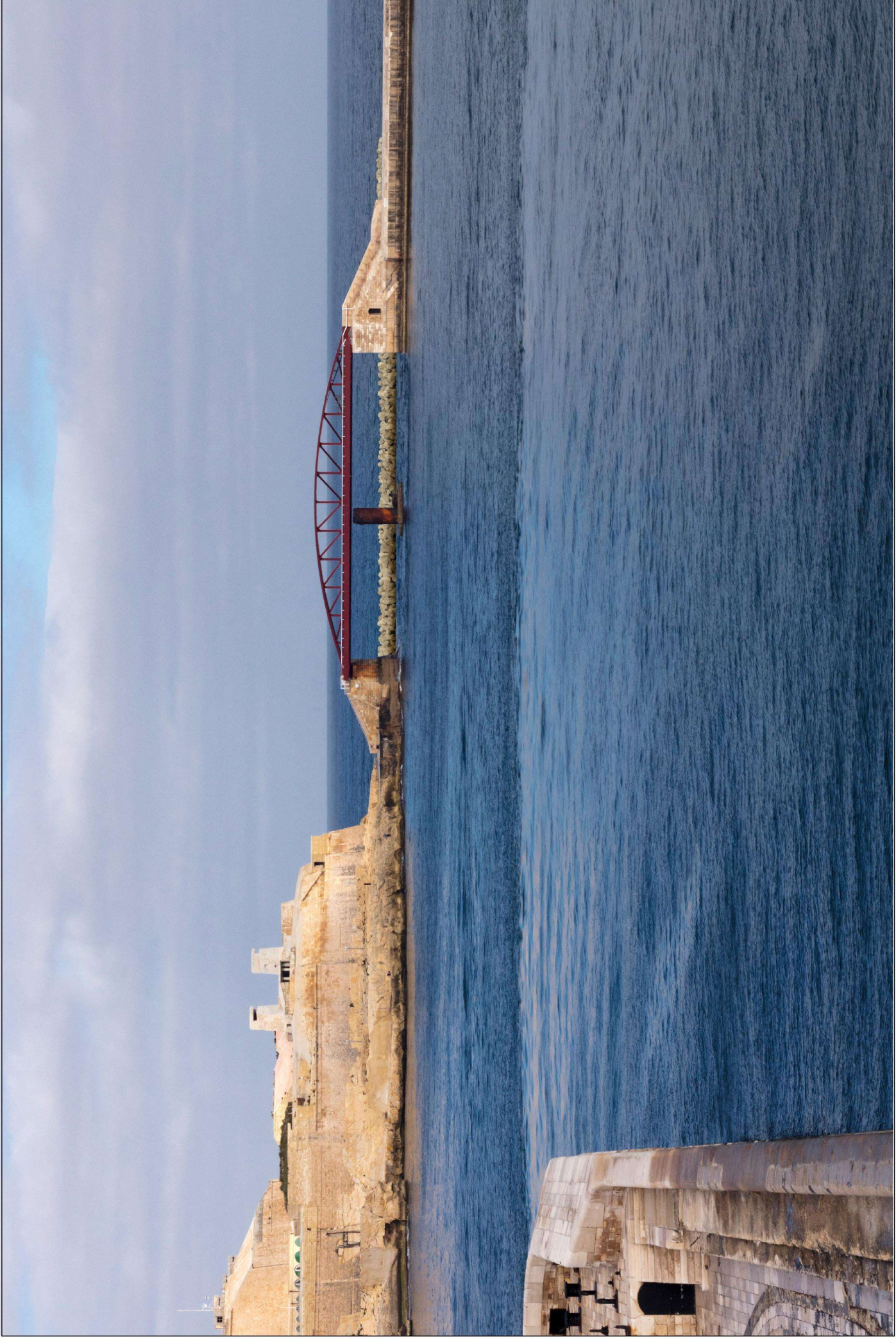
Distance to proposed development: NA

Camera height: 1.5m

Date: 2-March-2020

Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg

Sheet number: NA



**VIEWPOINT REFERENCE 5** Year 0 / 10 Distance to proposed development: NA Camera height: 1.5m Date: 2-March-2020 Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg Sheet number: NA

PROPOSED VIEW (PIGMENTED); This image must be viewed at a comfortable arm's length



**VIEWPOINT REFERENCE 6**

EXISTING VIEW

Distance to proposed development: NA

Camera height: 1.5m

Date: 2-March-2020

Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg

Sheet number: NA



**VIEWPOINT REFERENCE 6** Year 0 / 10 Distance to proposed development: NA Camera height: 1.5m Date: 2-March-2020 Camera type: EOS 5DS; VFOV: 18.2deg HFOV: 27deg Sheet number: NA

PROPOSED VIEW (PIGMENTED); This image must be viewed at a comfortable arm's length