Operation and maintenance manual - EN

DOCUMENT NUMBER: 64210030-XBN-ENG-PL-022

PROJECT NAME: Reduction of costal erosion Stage II (2014-2020) Lot 2 - Mamaia Area
PROJECT NUMBER: 64210030

CLIENT NAME: Administrația Bazinală de Apa Dobrogea (Dobrogea Water Basin Administration)

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CONTENTS

1. INTRODUCTION

1.1. Project context

The Romanian coast along the Black Sea is subjected to erosion. The coastal erosion causes the loss of extremely valuable land surfaces, loss which can affect the coastal ecosystems and which can lead to economic and social damages to the area. As such, Administrația Bazinală de Apa Dobrogea Litoral (Seaside - Dobrogea Water Basin Administration) (ABADL) attached to the National Administration of Romanian Waters (ANAR) defines the “Protection and Restoration of the Coastal Area” Masterplan. The Mamaia area (Lot 2) is one of the 11 lots identified as part of reducing the costal erosion in Stage II (2014-2020) within this Master Plan.

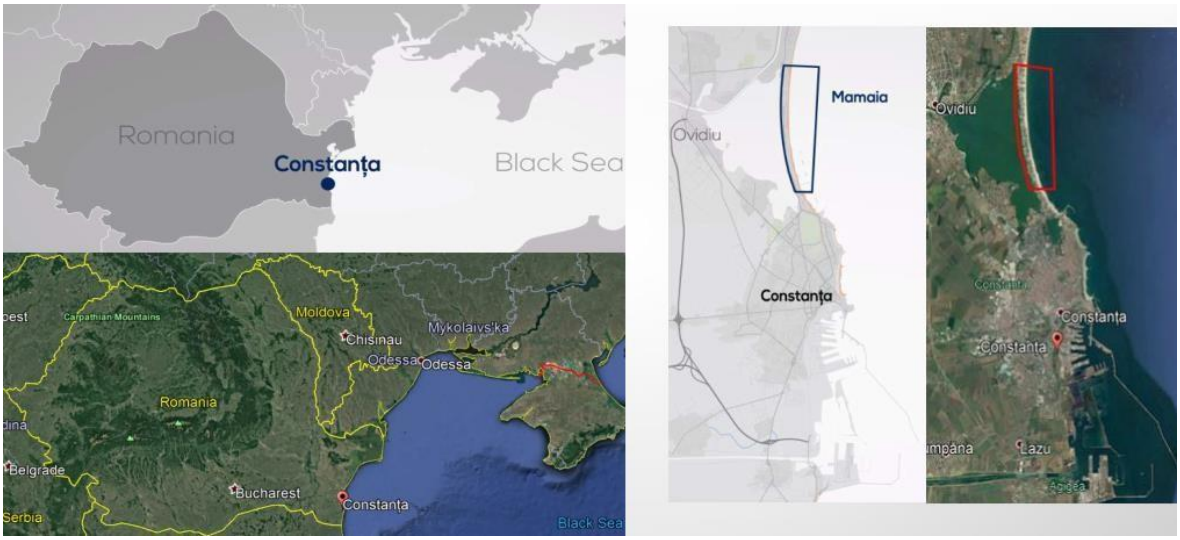

Figure 1-1 - Project placement

The objective of this project is that of protecting and rehabilitating the Romanian costal area and the environmental factors by means of engineering works aimed at fighting against costal erosion, supporting the intention of refreshing the marine ecosystem and developing certain species which, at a certain point, were gone from the ecosystem, protecting marine biodiversity and the seaside area, as well as ensuring a sustainable development of the costal area.

The works shall be funded from the European Union Cohesion Fund - Large Infrastructure Operational Program (LIOP) 2014-2020.

1.2. Scope of works

The project area is located between the Constanta and Midia ports, delimited by the placement of the Arcadia Restaurant in the north, and the Mamaia Sud perpendicular groyne, RJ1.

The initial scope of the works is represented by the design and construction of the following elements (see Figure 1-2 as well):

- Removal of coast marine structures MM5, MM6, and MM7 (detached breakwaters)
- Expansion of the costal structure RJ1 by 65 m in order to create RJn1
- Removal of the concrete moment of the Casino foot-bridge
- Providing sand to the beach north of the RJn1 costal structure over a length of 6.950 m, so as to create a beach with a 100 m width

- Temporary works, such as project offices, site fences, and other activities to facilitate the permanent works

Similarly, in accordance with the urban planning certificates, the documentation was drafted in order to obtain the permits.

1.3. Modifications brought to the project scope

After the submission of the auction documents, a project optimization plan was presented and approved. This optimization of the project includes the following modifications to the project:

- The concrete foot-bridge of Casino shall not be removed
- The coast marine structures MM5, MM6, and MM7 shall not be removed
- Optimizing the connection of the expansion of the coastal structure RJn1
- Additional provision of sand for the beach instead of removing MM5, MM6, and MM7

A detailed description can be found:

- 64210030-GEN-PMT-RE-017 Proposal for project optimization

Figure 1-2 - Placement and structure names

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1.4. Scope and objective of the present document

The works for the project were designed and built robustly, with the purpose of requiring only substantial maintenance after 25 years for the beach, and no substantial maintenance for the RJn1 costal structure throughout the 50-year designed life expectancy. However, the costal environment is a dynamic area in which severe hydrodynamic conditions occur regularly, it also being a public recreation area as well. Therefore, periodic inspection, monitoring, reporting, and maintenance are required so as to ensure the execution of works.

In accordance with the request of the Contracting Authority (Tender book) §2.7.2 [A.1], this document represent the Beach maintenance manual. This manual includes, among others:

- Works performance definitions and criteria
- Inspection, monitoring, reporting, and maintenance procedures for the entire beach system, which includes the beach with sand and the expansion of the RJn1 coastal structure.

Prescription of inspection, monitoring, reporting, and maintenance activities for the other structures outside of the Update Scope of Works, such as MM4, MM5, MM6, MM7, the concrete foot-bridge at the casino, the existing RJ1, and the steel pedestrian footbridge do not fall under the Contractor's scope. The inappropriate maintenance of these structures could affect the performance and safety of the Contractor's works.

The Beach Maintenance Manual is prepared in accordance with the Beach Management Manual CIRIA C685 [C.1.].

Aside from the Contract requirements, for the rest of the designed life expectancy of the beach and the RJn1 costal structure, the ABADL shall be responsible for the maintenance of Works in accordance with the Beach Maintenance Manual (drafted by the Contractor) in order to ensure the adequate protection level against erosion, excluding the situations in which the Contractor has not fulfilled its obligations according to the Contract. Violating the inspection, monitoring, reporting, and maintenance obligations described in the Beach Maintenance Manual shall impede the Contracting authority from formulating any claim against the Contractor.

The designed life expectancy of the beach and the coastal structure is of 50 years from the completion of works. The project objective is protecting the rehabilitating the Romanian seaside in the Mamaia area, which is done mainly by expanding the existing beach. The performance of the elements within the scope is divided as follows:

1. <u>Beach performance</u>
   The beach performance is defined by the presence of a minimal beach area. The beach is a hydrodynamic environment resulted from natural, hydrodynamic conditions due to waves, currents, and water level. As a result, in order to record the beach performance, this implies the need to monitor these hydrodynamic conditions.

2. <u>Performance of costal structure (RJn1)</u>
   The performance of the costal protection structure is defined by the stability of the material of the RJn1 structure in extreme conditions, as well as by the possible occurrence of erosion around the structure, which shall not lead to the instability of the coastal structure. As a result, in order to record the RJn1 performance, this implies the need to monitor the occurrence and severity of extreme conditions.

3. Other operational and monitoring activities

The monitoring and maintenance activities for the beach are not limited to the beach and the RJn1 structure. The water quality, the safety of the swimmers, and beach hygiene are also essential aspects.

1.5. Document sketch

The following subject cover the scope of the Beach Maintenance Manual:

Chapter no.	Contents
1	Introduction Description of project scope and the Beach Maintenance Manual
2	Works performance criteria Explanation of the definitions of works performance
3	Project area characteristics Description of anthropic and physical (hydrodynamic) characteristics of the project site
4	Summary of design characteristics A summary of the projects for the beach and RJn1
5	Beach inspection, monitoring, reporting, and maintenance activities
6	RJn1 costal structure inspection, monitoring, reporting, and maintenance activities
7	Other monitoring and maintenance activities
8	General presentation of inspection, monitoring, reporting, and maintenance activities O table presentation of chapters 5, 6, and 7
9	Conclusion

2. WORKS PERFORMANCE CRITERIA

The works have been projected so as to conform to the functional and technical requirements of the Contract by assuming certain natural and artificial limit conditions which are reasonable and expected throughout the life expectancy of the works (50 years). It is expected that the works be performed within the limits of this set of approved hypotheses, and the Contractor limits its performance based on this set. The inspection, monitoring, reporting, and maintenance activities listed under chapter 8 must verify if the real state of the works still fulfills the performance criteria, and to monitor and verify if the natural and anthropic conditions meet the hypotheses. Violating these activities implies the fact that it cannot be established if the works performance is in accordance with the Contract and it shall impede the Contracting authority from requesting any kind of repairs or compensations during or after the Defect notification period.

The natural and anthropic limit conditions are described and detailed in the Detailed Design Documents (see the list of documents referred to under B, Chapter 10). The most important are resumed bellow:

Natural Conditions

- Increase of sea level
- Water levels
- Medium climate of waves in the long run
- Extreme wave conditions with designed wave conditions up to a recurrence period of 100 years
- Freezing conditions

Anthropic conditions

- The immediate project site configuration, as is. The modifications made by man to this configuration, such as the expansion or construction of port breakwaters north and south of the project, or the depth of the port proximity canal which negatively influences the hydrodynamic conditions near the shoreline, have not been taken into account.
- No activities that reduce the beach performance, such as, among others, lowering (parts of) the beach, sand export, large excavation works and/or inadequate sediment placement.
- No removal of surface shells that function as a natural armor, with the exception of the case in which there are large spots of deposit near the water line, in which case they can be redistributed in the immediate vicinity and within the project.
- No construction of structures on or near the float line, such as beach bars, in locations in which these could influence the natural dynamic, now or, possibly, in the near future.
- No removal of the RJn1 rocks.
- No vandalizing the RJn1.
- No works that affect the sustainability of the concrete plates on RJn1, such as drilling or using maintenance vehicles heavier than 50 tones, or without protection measures.

2.1. Beach performance criteria

As long as the natural and anthropic conditions are verified so as to fall under the assumed limits within the Detailed Design Documents, the beach performance can be assessed. The verification process follows a traffic light system. The traffic light can be determined by calculating annually the beach's surface area towards dryland compared to the contour +2 m MN75, as is described under section 5.7 of this document.

Green (beach performance in accordance with expectations)
If the beach area towards dryland against the contour +2 m MN75, towards to sea against the Designed Reference Line, and between the northern (Arcadia Hotel) and southern (RJn1) limits of the project is greater than
646,000 m^2, the beach is sufficiently wide, as is defined under Ref. [B.14].

Yellow (potential exceptional values)
A single annual occurrence of an area of the beach smaller than 646,000 m^2 is considered an exceptional value. From a historical point of view, there has been a year with extremely severe erosion due to bad weather or frequent storms, above average expectations. In such a case, the beach has the capacity to repair itself naturally in the following years. Only in the case in which the sole occurrence is part of a continuous three-year tendency, the occurrence of a beach surface area smaller than 646,000 m^2 is considered an exceptional value.

Red (the beach might require maintenance)
If, for three consecutive years, the beach surface area is smaller than 646,000 m^2, then the beach requires maintenance beyond the scope of the Beach Maintenance Manual. In this case, an investigation must be carried out so as to identify the causes and establish the best solution.

The Contractor shall be informed in writing with regards to the results and the traffic light color before the end of each year throughout the duration of the Defect Notification Period.

2.2. RJn1 performance criteria
The RJn1 structure was designed so as to be statically stable for a designed life expectancy of 50 years. However, this does not include the damages that have taken place during this time due to a storm of a greater magnitude than the designed storm. In the case of such an extreme event, that exceeds the number of damages according to the Detailed Design of the Costal Structure B.4], the Contracting authority may decide to perform maintenance works that are beyond the scope of this manual.

3. PROJECT AREA CHARACTERISTICS

As it has been explained in Chapter 2, the works performance is determined by the hypotheses of the limit conditions throughout the projected life expectancy of the project. This chapter presents an overall picture of these limit conditions and the references to the Detailed Design Documents on which they are based. Please see the list of documents referred to under B, Chapter 10, as well.

3.1. The configuration of the project surroundings

The project area is defined as being the configuration of the bathymetry and the structures as present between 2019-2020 (see Figure 3-1). The project configuration is defined by the presence of breakwaters in Midia port in the north, and Tomis Nord in the south, as well as the presence of coast structure that define south Mamaia. Furthermore, the Offshore bathymetry influences the Nearshore hydrodynamic conditions.

If this configuration is modified in relation to a claim made by the Contracting authority regarding the works performance, then it must be established through numeric or physical models that the modifications of this configuration are not the cause of certain negative Nearshore hydrodynamic conditions.

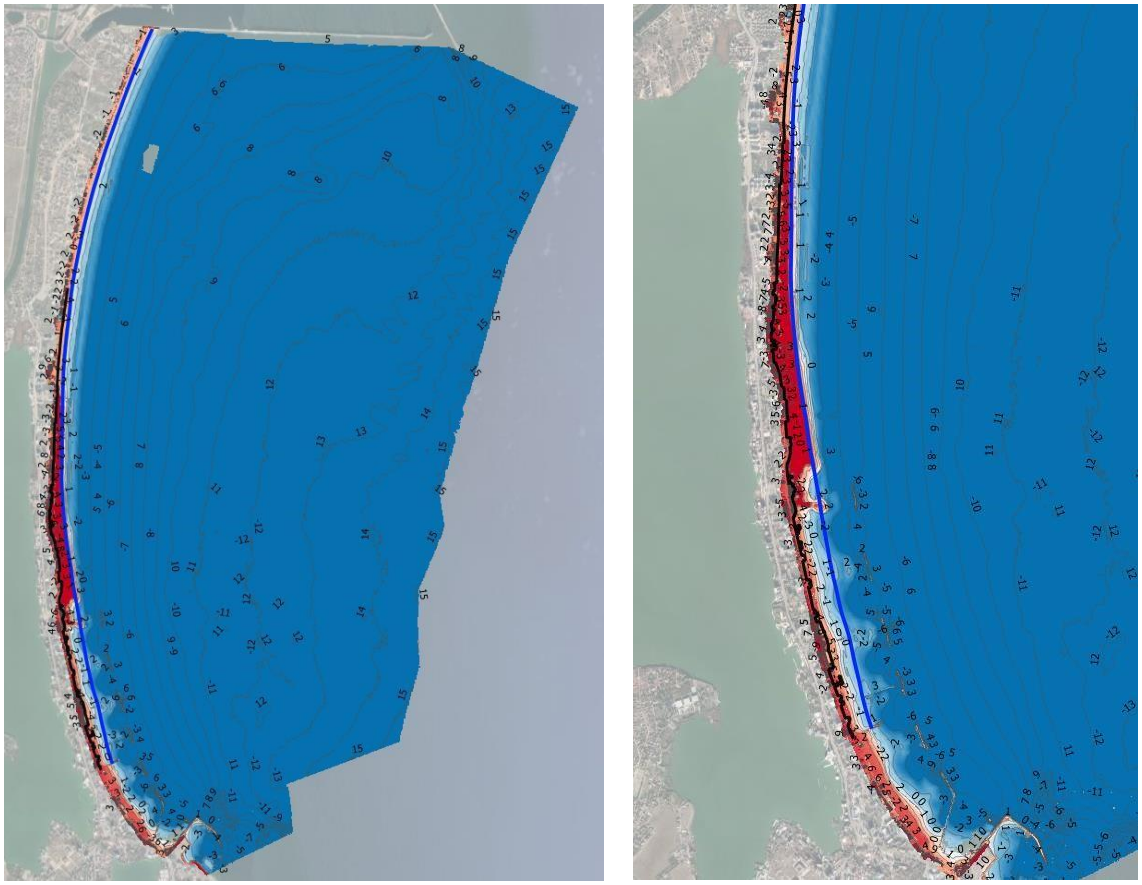


Figure 3-1 - The configuration of the project surroundings

3.2. Hydrodynamic conditions

All hydrodynamic conditions that are the basis of the design are described in:

- 64210030-EBD-ENG-RE-004 Modelling study of wave transformation [B.2]
- 64210030-EBD-ENG-RE-005 Design basis[B.1]

A short general presentation of the most important parameters and the manner in which they affect design and performance is given below.

- Increasing the sea level Increasing the sea level is one of the influence factors that determine moderate and extreme water levels.
- Water levels
  The water levels in moderate and extreme conditions influence the propagation of waves near the shore, and, as such, affect the conditions of the waves for the beach and RJn1.
- Medium climate of waves in the long run
  The wave climate that was used for design was established with historical timelines. These data are captured in a medium wave climate. This wave climate determined the long-term morphological development of the beach. The individual years that can be considered abnormal do not directly influence the long-term medium climate of the waves, and the consequences (morphological) are, therefore, considered exceptional values, as explained under section 2.1.
- Extreme wave conditions
  The extreme wave conditions directly determine the short-term answer of the beach and, indirectly, the long-term answer of the beach. RJn1 is affected by the extreme wave conditions with regards to the stability of the armor, berm, and concrete plate, as well as for the discharge and transmission of waves.

The design of the works is based on the hydrodynamic conditions mentioned above. In consequence, in order to record the beach and RJn1 performances, these hydrodynamic conditions require monitoring.

4. SUMMARY OF DESIGN CHARACTERISTICS

As mentioned under sections 1.2. and 1.3., the scope of the works is as follows:

- Providing sand to the beach north of the RJn1 costal structure over a length of 6.950 m, so as to create a beach with a 100 m width
- The RJ1 costal structure shall be extended by 65 meters in order to create RJn1 using geotextile, quarry rocks, and a layer of rock armor, as well as concrete plates. The design conditions are elaborate under Ref. [B.2].

4.1. The detailed design of the beach sand filling

Numerical model simulations were performed in order to design and verify the sand filling on Mamaia beach. The verification was performed for both the beach profile perpendicular on the shore (short-term requirements), as well as for the position of the shoreline's parallel line (long-term requirements), as described under the Detailed design of beach sand filling [B.6].

For the completed and approved drawings of the construction and design profiles, we refer to:

- 64210030-EBN-ENG-RE-001 The detailed design of the beach sand filling [B.3]

4.1.1. *Final designing*

The final project shall represent a transversal beach profile fulfilling the Client's requirements and including a sufficient volume to create the predicted natural theoretical balance profile. With this transversal design profile, the shoreline position was calculated and verified using a numerical mode (Unibest). The final project with the in-plane view of the beach bears in mind the future erosion rates and includes additional sand volumes to compensate the model's uncertainties, the unmodelled processes and uncertainties pertaining to the not demolishing MM5-MM7 (see Figure 4-2 and Table 1).
This is a dynamic solution, which means that, in accordance with the offer project, the feasibility project, and the clarification for number 20 during the auction process [A.1], the beach width shall be 100 m at +2 m MN75 on average and, as such, in certain sections of the shoreline, an absolute width of the beach shall be reached that exceeds 100 m at +2 m MN75 (for example, in the southern part of the project area), while in other sections, the absolute width of the beach at +2 m MN75 shall be narrower than 100 m (for example, in the center of the project area).
The final project is detailed within the technical drawings in the Detailed design of the beach sand filling [B.3].

4.1.2. *Construction design*

A construction profile is carried out which shall be remodeled in time due to natural processes, in its natural balance profile (see section 2.2.1 under the Detailed design of the beach sand filling [B.6]). The volume of the design profile and the construction profile are identical. The sole difference is the place in which the material shall be placed initially (the area marked with yellow under Figure 4-1). Due to this placement change, the initial position of the construction profile's shoreline is displaced more towards the sea (up to approximatively 40 m), compared to the theoretical design profile, which means that, initially, the beach shall have a greater width. The in-place view drawings and the transversal section of the project with the final plan and the construction design can be found under the Detailed design of the beach sand filling [B.3].

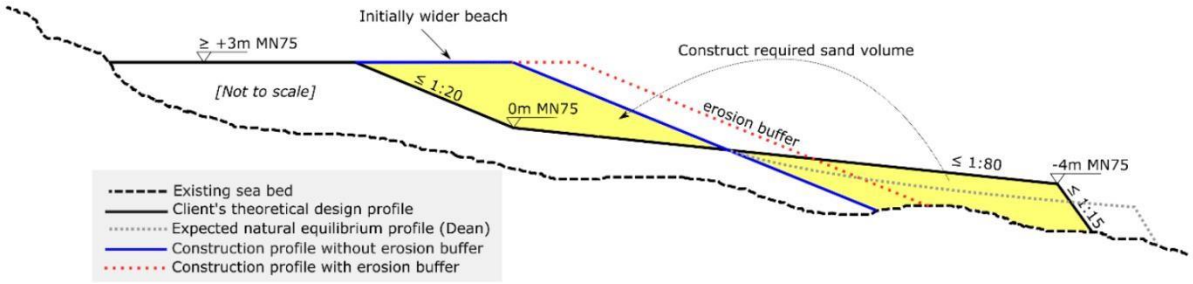


Figure 4-1 - The definition of the design profile and the construction profile

Figure 4-2 - Designing the in-plane view: designing the basic case (red line) and the final design of the in-plane view (white line)

Table 1 - The summary of the composition of the sand filling volume

Sand filling component	**Volume [m^3]**
1. Basic volume	2,649,000
2. Erosion buffer	477,000
Subtotal (basic case design)	3,125,000
3. Additional volume for non-demolishment of detached structures	600,000
4. Additional volume to compensate model imprecisions and non-modelled processes	575,000
Total sand filling volume	4,300,000

4.1.3. *Predicted withdrawal of the beach throughout the designed life expectancy*

Figure 4-3 conceptually shows the dynamic of the sediments on Mamaia beach. The net direction of the entry wave is so that, on average, the sediment transportation is oriented towards the north. This implies that, in time, sediments shall be lost from the beach and transported north and/or in an offshore direction. The beach was designed in such a way that, in 25 years, there will still be a sufficient volume for an additional sand filling to be necessary using a maximum volume of 505,000 m^3 so as to fulfill the design criteria throughout the designed 50-year life expectancy.

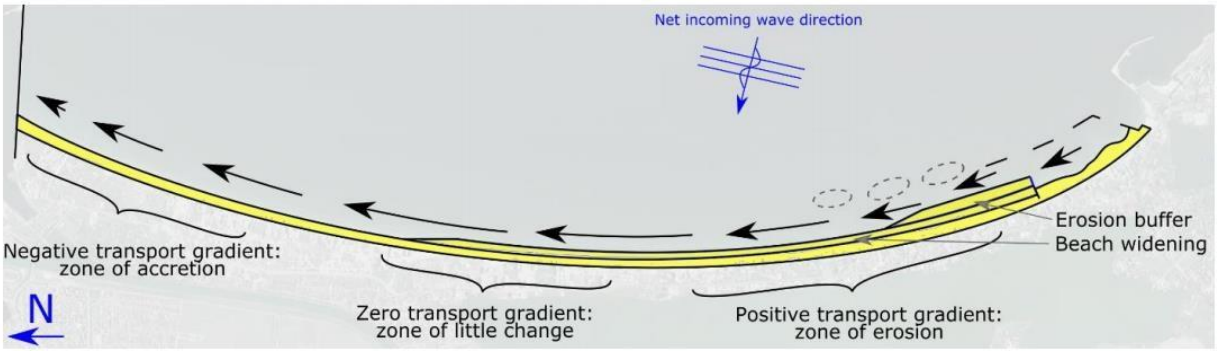


Figure 4-3 - The conceptual drawing of the position of the erosion buffer taken into consideration in the feasibility/offer stage

4.1.4. ***The predicted behavior of the transversal throughout the duration of the project's life expectancy*** When the waves near the shore, these determine the water currents to go into various directions along the shoreline and transversal to the shore (see Figure 4-4). When the currents are strong enough, these determine the movement of sand particles. The larger-sized particles resist these forces in a greater proportion compared to smaller sand particles, thus being more resistant to erosion. The combination between the wave form and the profile form determines the sand transportation direction: towards or away from the coast. This process acts both at small scale (centimeters), as well as at a large scale (whole profile), however, it never ceases.

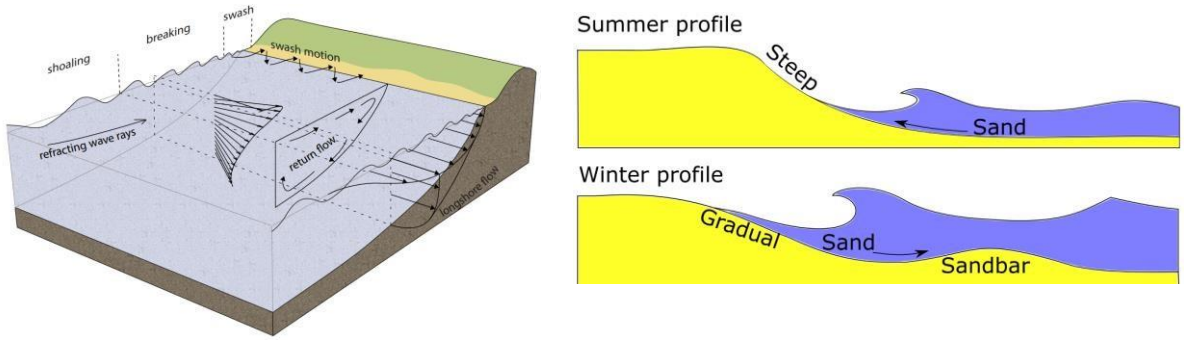


Figure 4-4 - Left: The 3D scheme of the wave determining currents near the shoreline
Right: The difference between the sea profile during summer and during winter (from Borsboom and Stive, 2021)

As wave conditions change constantly, the profile shall also change constantly (see figure 4-4).

Minute by minute, hour by hour, day by day. However, when we look at this process at a larger scale, in years, certain patterns can be observed:

- Cumulative conditions determine the formation of more abrupt profile during summer
- The erosion responsible conditions determine the flattening of the profile during winter.

These are the result of the waves form throughout the storm season and throughout the calm season. When we look at this process at a larger scale in time, in decades, we can observe a stable and predictable behavior of the profile, within the limits determined by the extremes of the measured profile. The beach profile modifies its form within these limits. The medium profile within these limits is called

dynamic balance profile. This medium profile can be approximated through a relatively simple formula, based on:

- Wave conditions
- Sand particle size

The form resulted from this formula is known as the “Dean Profile” (Profile, 1977) (see *Figure 4-5*).

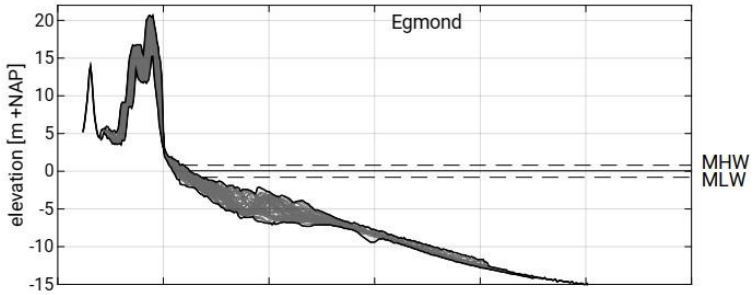


Figure 4-5 - 54 years od transversal measurements at Egmond (NL) (source: Jarkus)

This means that, for Mamaia, due to the predominant action of the waves, the profile of the transversal section shall be remodeled from the construction profile (built profile), in the direction of the dynamic balance profile. This process, inherently, shall never be completed, the dynamic balance profile being a conceptual method to capture captions of the transversal profiles in various circumstances, in the long term. However, depending on the intensity of the storm season, it is to be expected that most of the remodeling activity must take place in the first years after construction.
Regarding this process, the rougher the sand placed on the beach is, the more complementary it is to the project, as it ensure a better resistance to the wave force’s actions, and, in consequence, shall aid in prolonging the period in which the beach shall maintain its sizes as it was built, that is it shall reduce the coastal erosion in order to help maintain the beach’s width.

In a short time interval, it is expected that two more phenomena occur:

- Slope formation, during storm conditions (see Figure 4-6). As previously explained, during the storm periods, the sediment is transported from the shoreline out to sea, in order to create a more dissipated profile. The withdrawal of the sediment could lead to the formation of the slopes known in the general literature as beach escarpments. These slopes shall disappear naturally through mechanisms, as they are described in Sherman and Nordstrom (1985), of which the sediment tries to return to its natural at rest angle, being the most probable mechanism for Mamaia. However, if we focus on the visual observations, the slopes that are considered too tall can be remodeled as described under Section 5.4 and
  5.9.1.
- Sediment sorting: the gradients in transversal current shall determine the sorting of the sediment (see Figure 4-6). This is frequently seen on beaches that were subjected to interventions through sand placement, as the sand mixture brought to the shore is relatively uniform in composition after it was placed. In time, generally, the sediment near the shoreline is considered to be relatively rough and the size of the sediment particles is descendent on the direction towards the sea (Bagnold, 1954). Additionally, the sand washing process shall determine the deposit of
  lighter and more porous particles on the water line. The intensity of the water rising upon the waves breaking on the beach has a speed that is sufficient to transport seashells

towards the upper part of the beach. However, its intensity while withdrawing is reduced due to the fact that it mostly infiltrates into the porous seashell layer. On a saturated sand slope, the withdrawing intensity is not lost as much, which determines the sediment sorting as presented under figure
4-6 (Turner, Masselink, 1988). As the transversal profile remodels, it shall, in time, become more efficient in dispersing the energy of the waves and, as such, shall also reduce the intensity of the washing process which, in turn, shall modulate the sorting process.

Figure 4-6 - ***Left:*** *Formation of the slopes on the beach / escarpments.* ***Right:*** *Sorting the sediment in transversal direction*

4.2. Detailed design of the RJn1 coastal structure

The RJn1 costal structure is connected to the existing RJ1 costal structure. The design of this expansion is elaborated in the Detailed design of the costal structures (ref. [B.4.]). These sections offer a summary of the respective report.

4.2.1. *In-plane view*

The in-plane view of the RJn1 costal structure is presented under Figure 4-4. The length of the costal structure is in accordance with the Contracting authority's project, measuring 65 m at a vertical rate of +1.5 m MN75, with the exception of a round head tip.

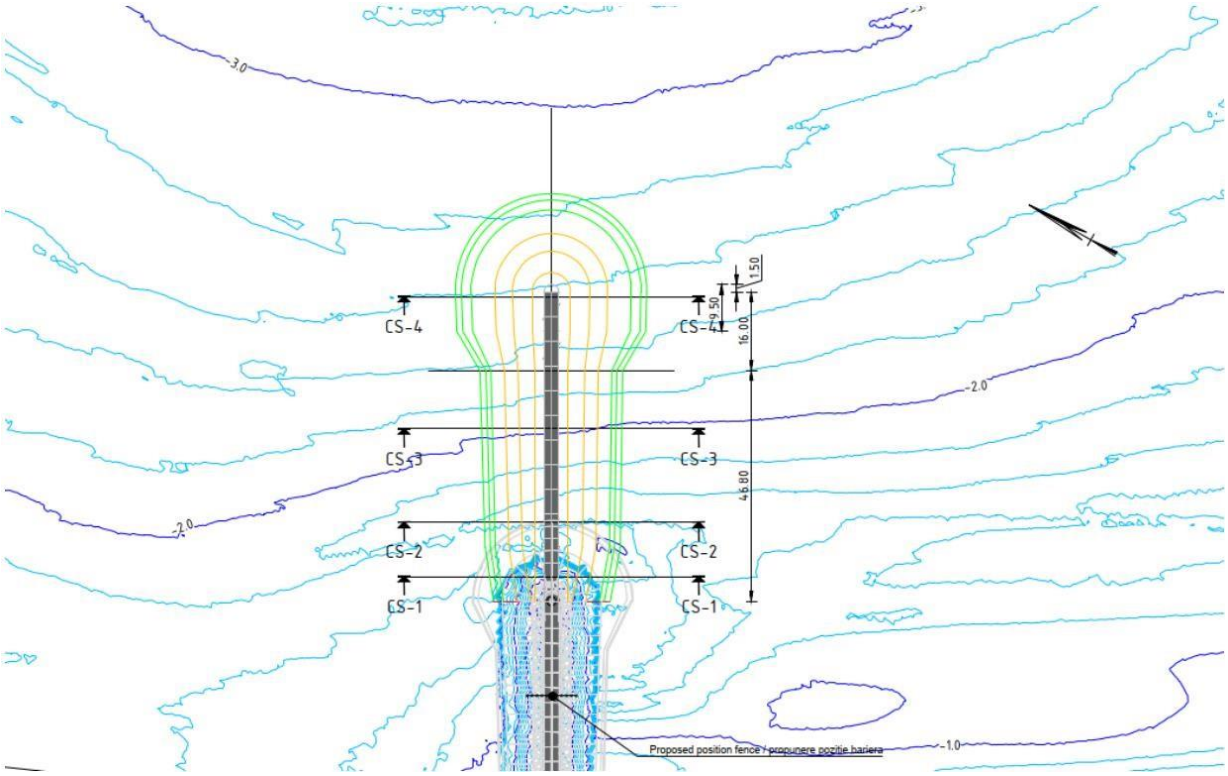


Figure 4-4 In-plane view of the RJn1 costal structure

4.2.2. *Transversal body section*

Figure 4-5 shows a transversal section of the body, with its ridge rate at +2.6 m MN75. The thickness of the concrete plate is 1.0 m, with a 3.0 m width, and a 5.0 m length. The total width of the ridge is of 6.7 m. The armor layer is built with a sort of 1000-3000 kg rock on a 1:1.5 (V:H) slope. The thickness of the armor length is of 1.85 m (2 Dn50). The armor layer is placed directly above the non-sorted stone core. The foot has a width of 3 Dn50 and is built with the same type of stone as the armor layer.

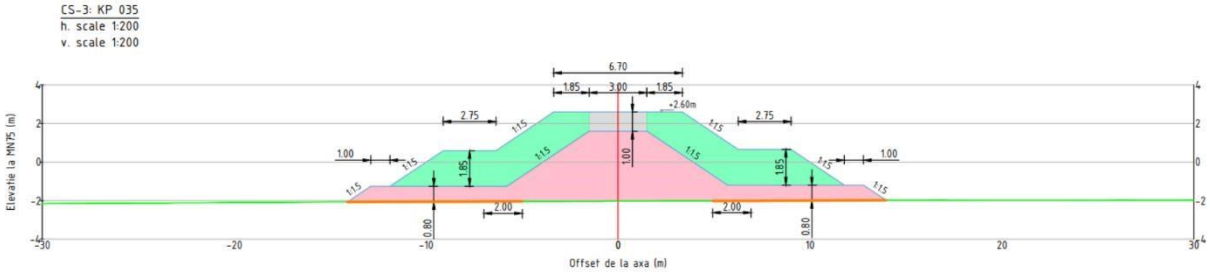


Figure 4-5 Transversal body section RJn1

4.2.3. *Round head transversal section*

A larger type of armor rock is placed on the round head section (3000-6000 kg), which is built on a 1:2 (V:H) slope. The thickness of the armor length is of 2.40 m (2 Dn50). The armor layer is placed directly above the non-sorted stone core. The foot has a width of 3 Dn50 and is built with the same type of stone as the armor layer. The concrete place measures 1.0 m in thickness, 3.0 m in width, and 5.0 m in length. The total width of the ridge is of 7.8 m. The ridge rate remains at +2.6 m MN75.

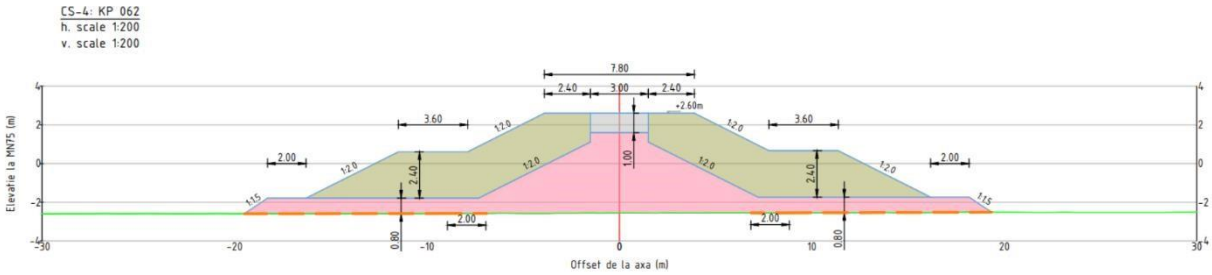


Figure 4-6 - Round head transversal section RJn1

For the design calculations and the completed and approved drawings, such as the transition sections between the body and the round head and the RJ1 - RJn1 transition, the following reference is made:

- 64210030-ECS-ENG-RE-002 Detailed design of the coastal structure [B.4]

5. BEACH INSPECTION, MONITORING, REPORTING, AND MAINTENANCE ACTIVITIES

This chapter lists the efforts that are the responsibility of the Contracting Authority in order to demonstrate and ensure the beach performance.

5.1. Recording hydrodynamic conditions

Throughout the designed life expectancy of the structures, measurements should be constantly recorded with a minimum frequency of once per hour, including (among others) the following:

- Water level;
- Significant wave heights;
- Peak periods;
- Average wave direction;
- Directional wave spectrums;

A continuous record of the water levels and of the data of the waves must be kept and shared with the Contractor in a format that is acceptable for the Contractor. The water level must be measured through a manometer at a representative spot for the Mamaia area's conditions, for example the T9 Tomis Nord breakwater. A directional wave buoy must be placed in an offshore location that is representative for the conditions in the Mamaia area indicated at Figure 5-1. The wave buoy must have the capacity to send wireless data, together wit ha notification system, so as to signal when OLS and SLS conditions occur, as they are defined in the Detailed Design Documentation. The final placement of the wave buoy must be communicated to the Contractor after installation, so that the OLS and SLS conditions in that respective place can be established by the Contractor.

The responsibility for monitoring, storing, and reporting the data belongs to the Contracting authority. The hydrodynamic data shall be shared with the Contractor quarterly, in September and April.

Figure 5-1 - The position of the wave buoy (within the yellow ellipsis)

5.2. Maintaining the survey marks

The Contractor installed 20 survey marks, please see Appendix A. The Contracting authority shall be responsible for maintaining these marks and shall have to present a mark assessment report at each topographic and bathymetry inspection.

5.3. The periodic bathymetric and topographic measurements

Each year, during September and October, throughout the beach's designed life expectancy, topography and bathymetry measurements must be performed on the Mamaia area, Lot 2.

Both the topographic measurements and the bathymetric ones shall be performed at least along the same preestablished lines, which were measured during the execution of the works, that is at 100 m intervals, starting with RJn1 as KP0.000. The data resulted from the measurements must be presented in a transversal profile at the sea bed level / soil level and must be distributed in the gross format of the X, Y, Z data. all data resulting from the measurements must be stored as described under section 5.8.

The used measuring equipment is an echo-probe with a sole beam or with multiple beams for bathymetric measurements and a laser, RTK-GPS, or a drone for topographic measurements. The probe must perform the measurements along the line placed up to the minimal depth that allow the safe use of the equipment without deteriorating it. As of this limit, the measurement must be performed with the aid of a soil measurement equipment (for example, RTK-GPS rucksack).

The Contracting authority is responsible for performing the topo-bathymetric measurements, as well as for data storage. During the Defect Notification Period, the Contractor shall be invited to assist in making the measurements by means of a notification sent with at least two weeks prior to perform the measurements.

5.4. Monitoring storms

After storms or a period of strong waves, the beach must be visually checked for:

- Debris that floated over to or accumulated on the shore
- Abrupt slopes/mounds around the water line
- Local erosion holes

During the designed life expectancy, a topographic-bathymetric measurement must be performed after each storm with a significant maximum height of the wave at or over the OLS conditions (recorded by the offshore wave buoy), including a visual inspection of the beach.

5.5. Daily beach monitoring

The beach must be regularly monitored through visual inspection with regards to cleanliness and, if necessary, the debris or plastic materials accumulated on the beach must be removed.

5.6. Warning and emergency procedures

In the case of certain events of an equal or greater magnitude than OLS, the public must be warned and the beach (and RJn1) must be monitored with regards to public safety. The public must be warned with indicators in the access area, these indicating the non-favorable meteorological conditions.
The beach protections must be present during the summer season and during calm conditions. Drift currents can form and the public must be educated and warned through signaling.

The Contracting authority is the sole responsible for the warning system and limiting public access in case of storms.

5.7. Analysis of bathymetric and topographic periodical measurements

The following analyses must be carried out after performing the bathymetric and topographic measurements:

- Determining the position of the 0M MN75 contour towards the sea
- Determining the position of the +2m MN75 contour towards the sea
- Determining the area between the +2 m MN75 contour, the Designed Reference Line, and the limits of the project, in the north (Arcadia Hotel) and in the south (RJn1), as defined under Ref. [B.14], in order to calculate the beach's average width.

The Contracting authority is the sole responsible for analyzing the measurements.

5.8. Storing and reporting the data

The following data must be stored for at least 50 years from the completion of the works, in a data file adequately saved on a server with a sufficient data capacity:

- The X, Y, Z data for each measurement performed along the traced line;
- Visual inspection reports, including photographs;
- Water levels;
- Wave data parameters according to specifications;
- Water quality parameters.

The data set that must be added must include, among others:

- The name of the data element (water level, base level, wave height etc.);
- Data type;
- Localization in the X, Y coordinates;
- Measurement date;
- The date on which the data was introduced in the database;
- The institution that performed the measurement;
- Comments

The continuous recordings defined under Section 5.1 must be shared through digital data transfer with the Contractor throughout the duration of the Defect Notification Period, with a frequency of once per quarter, at the end of each meteorological season. The topographic and bathymetric measurements shall be shared with the Contractor within four weeks from carrying out the measurements.

5.9. Maintenance

5.9.1. *Short-term maintenance of the beach after a storm*

After storm greater than OLS or after a prolonged period (two weeks) of strong waves and wind, the following measures must be taken:

- Removing debris that were through or accumulated on the shore, if they are present after the visual inspection.
- Removing certain abrupt slopes / mounds around the water line, if they are present after the visual inspection.

- Restoring the slopes towards dryland, which can be affected by the eolian erosion and the sand deposit. We recommend investigation the use of vegetation, protection barriers to limit wind effect, and to not remove surface seashells that act as a natural armor layer.

5.9.2. *Long-term beach maintenance*

The project for the Mamaia area was conceived in such a way so that the sole maintenance performed as sand filling throughout the beach's designed life expectancy be carried out with a frequency of at most 25 years and a maximum sand volume of 505,000 m^3. According to the numerical models, a sand filling volume of ≤505,000 m^3 after 25 years is enough to result in a 646,000 m^2 width and an average beach width of 100 m at +2 m MN75 after 50 years.

Monitoring the real morphological behavior of the beach, as is described in this Beach Maintenance Manual, and comparing it to the estimated erosion, as described in [B.3][B.6], is essential for determining the real necessary sand filling volume.

5.9.3. *Measurement equipment maintenance*

Both the wave buoy, as well as the water level measurer and the data storage device must be periodically maintained.

5.9.4. *Work methods for long-term beach maintenance*

The beach sand filling done in 2020/2021 adds a significant sand volume in the project area between Mamaia-Sud and the Midia Port. For substantial maintenance activities, either after 25 years, or in case of unexpected conditions within 25 years identified through the monitoring activities described under this chapter, the Contractor recommends first investigating the possibilities of fulfilling the requirements by the local redistribution of the sand instead of importing it from external sources, such as at sea extraction spots.

The described monitoring activities shall offer the credible information about the sedimentation and erosion models in the entire Mamaia area. This may lead to identifying certain consistent sedimentation areas, of which the northern head near the Midia Port breakwater can be identified as the most promising at the present time. Redistribution can be done as dry digs above the sea level, in places in which the beach has a sand surplus, and transportation to a deficient profile. The excavation activities of which can be reasonably presumed that they have an impact on the costal hydrodynamics, such as, for example, digs under the sea level, must first be investigated by experts in the field so as o establish that the activities do not affect the long-term beach maintenance.

Throughout the Defect Notification Period, the Contracting authority must notify the Contractor with regards to these plans and to organize technical meetings on the matter to establish the volumes and solution that can bring benefits to the project. Furthermore, it is important that, when undertaken, the Contracting authority ensure that these activities are well documented with photographic proof, equipment descriptions, and work methods and topographical or bathymetric surveys to produce historical data in order to follow up on the results and the efficiency of this solution.

If the local maintenance described above is not possible, we recommend a work method similar to the current work method used in sand filling the beach, as described under [B.10].

6. RJn1 COSTAL STRUCTURE INSPECTION, MONITORING, REPORTING,

AND MAINTENANCE ACTIVITIES

This chapter lists the efforts that are the responsibility of the Contracting Authority in order to demonstrate the RJn1 performance. Prescription of inspection, monitoring, reporting, and maintenance activities for the other structures, such as MM4, MM5, MM6, MM7, the concrete foot-bridge at the casino, the existing RJ1, and the steel pedestrian footbridge do not fall under the Contractor's scope.

6.1. Recording hydrodynamic conditions

The same requirements apply as under Section 5.1.

6.2. Inspection

It is necessary that the RJn1 be inspected each September, after the summer season. Visual inspections are necessary, recorded with photographs. If there are visible damages, they need to be photographed, showing them in their entirety. Furthermore, the extent of the damages must be reported exactly in writing and notified to the Contractor, including the quantity of moved rocks, as well as the location on the structure. The responsibility of monitoring the RJn1 belongs exclusively to the Contracting Authority. The Contractor shall monitor the armor layer of the RJn1 groyne only in the August-October 2021 season by measuring the position of the selected stone, and shall compare the measurements in the as-built stage, and the results shall be sent to the Client.

6.3. Monitoring storms

Measurements must be performed after each storm that exceeds OLS conditions at the placement of the offshore wave buoy, as well as a visual inspection of the beach and the structures.

As the existing RJn1 structure is smaller than the new RJn1 structure, the Contractor cannot guarantee access alone to the RJn1 in the OLS conditions. As such, based on the notifications from the offshore wave buoy, the fence on RJ1 must be closed.

The responsibility of monitoring the RJ1 and RJn1 safety belongs exclusively to the Contracting Authority.

6.4. Maintenance

The RJn1 structure was designed so as to be statically stable for a life expectancy of 50 years. However, this does not include the damages that have taken place during this time due to a storm of a greater magnitude than the designed storm. In the case of such an extreme event, that exceeds the number of damages according to [B.4], the Contracting authority can decide carrying out the maintenance.

In case of maintenance, the following important aspects must be taken into consideration:

- Depending on the nature of the required maintenance or repair, various types of equipment shall be needed in order to carry them out.
- When the use of heavy machineries such as excavators is required to access the RJn1 structure, the deterioration of the concrete way must be avoided/diminished, for example, by placing wooden carpets, as indicated under Figure 6-1.
- When the nature of the repair does not require a large and wide machine, a small excavator should be chosen with a width that shall match the concrete road.
- When an excavator of a sufficient size in order to lift or place stones on the structure peak, the road shall probably not be sufficiently wide for the vehicle to enter the breakwater. As such, the road must be widened. For example, a small cup excavator may be used to remove the rocks on the ridge, until the road is sufficiently wide to enter the breakwater. Subsequently, this row of rocks must be brought to its initial size and shape.

Furthermore, the Work Method Statement for the Expansion of the Existing Costal Structure RJ1 [B.11] may be consulted so as to be used as reference or guide for carrying out maintenance activities.

Figure 6-1 - Wooden carpet for the excavator to protect the subjacent area.

The responsibility for RJn1 maintenance belongs solely to the Contracting Authority.

7. OTHER MONITORING AND MAINTENANCE ACTIVITIES

Other point of use and monitoring include (among others):
- Water quality
- Swimmer safety
- Beach hygiene
- Land draining / Leaks

7.1. Swimmer and navigational safety

Beach marking buoys must be installed during the tourist season. The buoys must be adequately maintained and stored during winter. Furthermore, the lifeguards must be present on the beach in order to monitor the swimmers that receive recommendations to observe the lifeguards' instructions. Special attention must be granted to swimmers near the coastal structures and to water currents.

The responsibility for swimmer and navigational safety belongs to the competent local authorities.

7.2. Beach hygiene and water quality

During the summer seasons, at the end of each day, after sunset, the beach must be cleaned to remove the waste resulted after the recreative use of the beach and the commercial activities. After storms, waste, algae, and crustaceans deposits may appear on the water line and/or on shore. During the summer, the degradation of the biomass can lead to unpleasant smells and to a risk of illness, as the biomass rots and facilitates bacteria development. As such, measures must be taken after all meteorological event with a high wave energy (storms). The algae must be collected with adequate equipment. This can be done both on dryland and on water. Furthermore, the actual project does not have any effect on the water quality.

The Contracting authority is the sole responsible for beach hygiene.

The responsibility for the water quality belongs to the local relevant authorities.

7.3. Draining/leaks

Interaction between the beach and existing or future leaks/discharges must be avoided.

7.4. Maintaining the surroundings of the Casino Monument

A corrosion-resistant cover layer must be applied on the surroundings of the Casino Monument annually.

8. GENERAL PRESENTATION OF INSPECTION, MONITORING, AND MAINTENANCE ACTIVITIES

Activity	Term / frequency	Responsibility	Comments
Installation of directional wave buoy	Before 1 September 2021	Contracting Authority	Representative spot as indicated under Figure 5-1. Spot which must be communicated to the Contractor to establish OLS and SLS conditions
Installing the instrument to measure water level variations	Before 1 September 2021	Contracting Authority	Representative spot
Recording data regarding: Water levels, significant wave heights, peak periods, average wave direction, and the directional wave spectrums	Continuous	Contracting Authority	
Bathymetric and topographic measurements	In September and October of each year, the transmission of data before 1 November	Contracting Authority	
Data analysis	In September and October of each year, the transmission of data before 1 November	Contracting Authority	
Monitoring storms through topo-bathymetric measurements	After each storm that exceeds the OLS conditions at the wave buoy Offshore	Contracting Authority	
Visual inspection and additional measurements after storms: • **Removal of debris** • **Removal of abrupt slopes/mounds**	Whenever necessary, after events with high wave energy	Contracting Authority	

Planned maintenance or sand filling	At 25 years after the completion of works	Contracting Authority	
Recording all activities, repairs, and maintenance works in the area	After each such activity	Contracting Authority	Throughout the designed life expectancy
Notification, investigation, and documentation of plans, work method, and local sand redistribution efficiency	Within 30 days after the annual bathymetric and topographic measurements	Contracting authority	

Figure 8-1 - General presentation of the beach maintenance and monitoring activities

Activity	Frequency	Responsibility	Comments
Structure monitoring and, if necessary, maintenance • **RJ(n)1 Structure**	Each year in September, after the tourist season, and in March, before the tourist season	Contracting Authority	Throughout the designed life expectancy
Storm monitoring and, if necessary, maintenance	After each storm that exceeds the OLS conditions	Contracting Authority	
Recording data	Throughout the designed life expectancy	Contracting Authority	
Recording all activities, repairs, and maintenance works in the area	After each such activity	Contracting Authority	Throughout the designed life expectancy

Figure 8-2 - General presentation of the RJ1 structure monitoring and maintenance

Activity	Frequency	Responsibility	Comments
Water quality monitoring, if removal of the following is necessary: **Waste, algae**	After two tall wave events	Contracting Authority	
Swimmer and navigational safety	Throughout each day, during the tourist season	Contracting Authority	
Beach hygiene and cleaning	Every day after sunset, during the tourist season	Contracting Authority	

Figure 8-3 - General presentation of other monitoring and maintenance activities

9. CONCLUSION

The works for the project were designed and built robustly, with the purpose of requiring only substantial maintenance after 25 years for the beach, and no substantial maintenance for the RJn1 costal structure. However, the costal environment is a dynamic area in which severe hydrodynamic conditions occur regularly, it also being a public recreation area as well. As such, the inspection, monitoring, reporting, and periodical maintenance must be carried out as described in this Beach Maintenance Manual. Violating the inspection, monitoring, reporting, and maintenance obligations described in the Beach Maintenance Manual shall impede the Contracting authority from formulating any claim against the Contractor.

Furthermore, the 13-year Defect notification period and the actual monitoring and maintenance are valid for the beach's situation as it was delivered by the Contractor upon completing the works. In the case in which this situation is modified during this period, the rights of the Contracting of requesting damages and/or repairs are prohibited. Examples of such situation modifications, which are not permitted, are listed under Chapter 2.

10. REFERENCES, ABBREVIATIONS, DEFINITIONS

10.1. References

Client document		
No.	**Document no.**	**Document title**
[A.1]	-	Contractual agreement no. 219 from 5 September 2019 for Lot no. 2 works

Boskalis documents		
No.	**Document no.**	**Document title**
[B.1]	64210030-EBD-ENG-RE-005	Design basis
[B.2]	64210030-EBD-ENG-RE-004	Modelling study of wave transformation
[B.3]	64210030-EBN-ENG-RE-001	The detailed design of the beach sand filling
[B.4]	64210030-ECS-ENG-RE-002	Detailed design of the coastal structure
[B.5]	64210030-ECS-ENG-RE-018	Liquifying study
[B.6]	64210030-ECS-ENG-RE-019	Geotechnical study
[B.7]	64210030-EBN-QLT-RE-022	Soil ratio in the loan area
[B.8]	64210030-EBN-ENG-RE-023	Hydro-sedimentation modelling study
[B.9]	64210030-GEN-PMT-RE-017	Proposal for project optimization
[B.10]	64210030-XBN-OPS-PL-017	Work method statement for beach sand filling
[B.11]	64210030-XCS-OPS-PL-016	Work method statement for the expansion of the costa structure RJn1
[B.12]	64210030-GEN-SHE-PL-021	Environmental management and monitoring plan
[B.13]	64210030-EBN-ENG-RE-001-2	Technical execution project
[B.14]	64210030-EBN-ENG-DG-013	Beach area definition

Third party documents	
No.	**Document reference**
[C.1]	CIRIA "Beach Management Manual" (C685)

10.2. Definitions

Definition	Complete meaning

Contracting Authority	Administrația Bazinală de Apa Dobrogea Litoral (ABADL) / Seaside - Dobrogea Water Basin Administration
Contractor	Boskalis SRL
Project	Reduction of costal erosion Stage II (2014-2020) Lot 2 - Mamaia Area
Team leader	Project Manager
Defect notification period	A period of 13 years after completion of works

Definition	**Complete meaning**
OLS	Operational limit status, that is design conditions with a recurrence period of 1 year
SLS	Service limit status, that is design conditions with a recurrence period of 100 years

APPENDIX A - PLACEMENT OF SURVEY MARKS

Boskalis
Dredging & Marine Experts

SURV-205a Test sheet for DGNSS			Rev: 08-Oct-2018 / 07
Location and details DGNSS			
Project No. / Name:	642-10030 / Mamaia		
Object/Vessel:	BOSKALIS BS	Location/Site:	BM - 06
Make:	Trimble	Type:	TSC3 / SPS855
Date (dd-mm-yyyy):	17/01/2021	Time (hh:mm):	10:00
SY number:	SY405014352/ SY405013956	Serial number:	RS2NC55335/ 5342K46506
DGNSS corrections:	CMR		

Reference is made to procedure Field Check DGNSS (SURV-205)

The Field check has been performed according to one of the following procedures:
b. Benchmark check
The following position is observed
B06 789154.002E 313137.597N 2.146h

Calibration tool	Make/type	Serial No	Boskalis ID
RTK GPS	Trimble SPS855	RS2NC55335/	SY405014352/

Field Check results:			Results
	Easting	Northing	Elevation
BM coordinates	789,154.002	313,137.597	2.146
Manpack measurement	789,154.026	313,137.588	2.167
Difference	-0.024	0.009	-0.021

Remarks			
bm6-001	789154.023	313137.588	2.169
bm6-002	789154.03	313137.589	2.168
bm6-003	789154.029	313137.587	2.17
bm6-004	789154.024	313137.589	2.177
bm6-005	789154.031	313137.581	2.168
bm6-006	789154.035	313137.595	2.166
bm6-007	789154.032	313137.595	2.167
bm6-008	789154.026	313137.588	2.164
bm6-009	789154.023	313137.587	2.168
bm6-010	789154.024	313137.593	2.16
bm6-011	789154.027	313137.595	2.172
bm6-012	789154.019	313137.587	2.162
bm6-013	789154.02	313137.587	2.17
bm6-014	789154.025	313137.588	2.167
bm6-015	789154.026	313137.589	2.168
bm6-016	789154.023	313137.581	2.167
bm6-017	789154.022	313137.581	2.167
bm6-018	789154.028	313137.588	2.163
bm6-019	789154.027	313137.589	2.166
bm6-020	789154.026	313137.587	2.169

Field check found satisfactory:	YES

Tested by (name/function):	Approved by (name/function):
Bo Weiland / Surveyor	Ion Gheorghescu
Signature: 	Signature: 

Boskalis
Dredging & Marine Experts

Location and details DGNSS			
Project No. / Name:	642-10030 / Mamaia		
Object/Vessel:	BOSKALIS BS	Location/Site:	BM - 06
Make:	Trimble	Type:	TSC3 / R10
Date (dd-mm-yyyy):	17/01/2021	Time (hh:mm):	10:00
SY number:	SY405014154/ SY405014147	Serial number:	RS2XC64317/ 5442481116
DGNSS corrections:	CMR		

Reference is made to procedure Field Check DGNSS (SURV-205)

The Field check has been performed according to one of the following procedures:
b. Benchmark check
The following position is observed
B06 789154.002E 313137.597N 2.146h

Calibration tool	Make/type	Serial No	Boskalis ID
RTK GPS	Trimble SPS855	RS2XC64317/	SY405014154/

Field Check results:			Results
	Easting	Northing	Elevation
BM coordinates	789,154.002	313,137.597	2.146
Manpack measurement	789,154.002	313,137.593	2.137
Difference	0.000	0.004	0.009

Remarks			
BM6-001	789154.006	313137.585	2.141
BM6-002	789154.003	313137.585	2.138
BM6-003	789154.011	313137.59	2.135
BM6-004	789154.012	313137.599	2.137
BM6-005	789153.996	313137.586	2.14
BM6-006	789154.009	313137.585	2.139
BM6-007	789154.005	313137.596	2.139
BM6-008	789154	313137.598	2.145
BM6-009	789153.994	313137.591	2.14
BM6-010	789154.003	313137.595	2.137
BM6-011	789154.003	313137.589	2.14
BM6-012	789154.007	313137.586	2.131
BM6-013	789153.993	313137.589	2.136
BM6-014	789154.002	313137.603	2.14
BM6-015	789153.999	313137.59	2.135
BM6-016	789154.001	313137.596	2.132
BM6-017	789153.998	313137.596	2.136
BM6-018	789154.001	313137.589	2.139
BM6-019	789154.001	313137.596	2.135
BM6-020	789153.998	313137.607	2.133

Field check found satisfactory:	YES

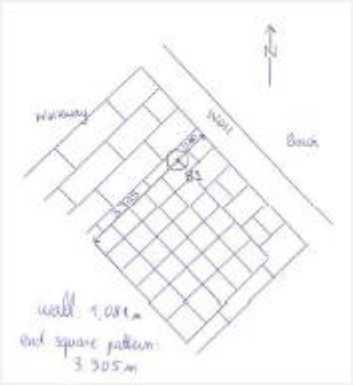
Tested by (name/function):	Approved by (name/function):
Bo Weiland / Surveyor	Ion Gheorghescu
Signature:	Signature:

Boskalis
Dredging & Marine Experts

642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area **Date of installation: 1/12/2019**	**B1**
Location Description	Located on Mamaia beach promenade walkway. Northern most corner of dark pavement blocks, 1.081m southwest from beach wall.

Map

Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 13 08.87035	0.0184
Longitude	28 38 12.18934	0.0185
Height	35.766	0.0192
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	790679.697	0.0184
Northing (m)	308685.415	0.0185
Elevation (m)	1.993	0.0192

Signature (name/function): BCEZ	**Date** 02/12/2020

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642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area Date of installation: 1/12/2019	B2
Location Description	Located on Mamaia beach promenade walkway. 0.850m west from beach wall.

Map

Sketch

Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 13 29.81192	0.0293
Longitude	28 37 53.39453	0.0294
Height	35.857	0.0306
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	790233.663	0.0293
Northing (m)	309312.704	0.0294
Elevation (m)	2.07	0.0306

Signature (name/function): BCEZ	Date 02/12/2020

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642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area Date of installation: 1/12/2019	B3
Location Description	Located on Mamaia beach promenade walkway. Southern most corner of dark 'wave' patterned pavement blocks, 3.966m southwest from beach wall.

Map

Sketch

Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 14 14.33090	0.0143
Longitude	28 37 30.51230	0.0144
Height	36.175	0.0161
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	789664.396	0.0143
Northing (m)	310663.306	0.0144
Elevation (m)	2.371	0.0161

Signature (name/function): BCEZ	Date 02/12/2020

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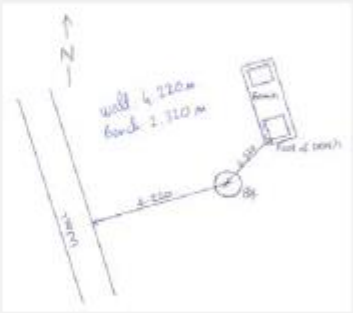
642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area Date of installation: 1/12/2019	B4
Location Description	Located on west side of Mamaia beach promenade walkway. 4.220m east from wall separating the promenade from the hotels and apartments.

Map

Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 14 39.83068	0.0178
Longitude	28 37 21.69348	0.0179
Height	35.919	0.0201
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	789433.509	0.0178
Northing (m)	311441.19	0.0179
Elevation (m)	2.109	0.0201

Signature (name/function): BCEZ	Date 02/12/2020

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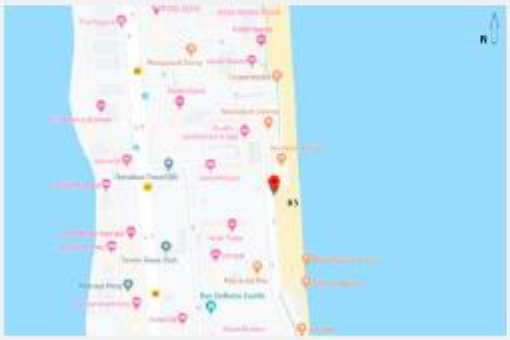
642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area Date of installation: 1/12/2019	B5
Location Description	Located on Mamaia beach promenade walkway. South east corner of dark 'wave' patterned pavement blocks (first block in), 0.562m west from beach wall.

Map



Sketch

Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 15 12.10761	0.0087
Longitude	28 37 18.25998	0.0087
Height	35.879	0.0101
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	789312.702	0.0087
Northing (m)	312433.5	0.0087
Elevation (m)	2.067	0.0101

Signature (name/function): BCEZ	Date 02/12/2020

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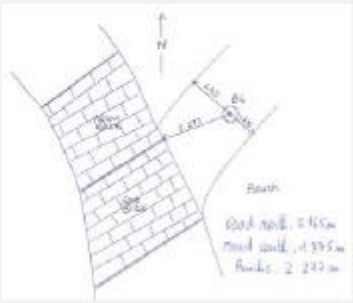
Dredging & Marine Experts

642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area Date of installation: 1/12/2019	B6
Location Description	Located in centre of beach tarmac path east of Orfeu hotel complex and south of playpark.

Map

Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 15 35.11549	0.0137
Longitude	28 37 12.53757	0.0138
Height	35.961	0.0154
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	789154.002	0.0137
Northing (m)	313137.597	0.0138
Elevation (m)	2.146	0.0154

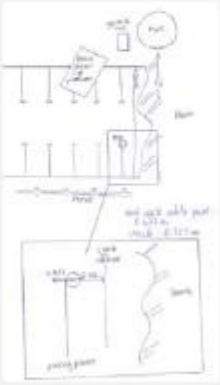
Signature (name/function): BCEZ	Date 02/12/2020

Boskalis
Dredging & Marine Experts

642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area Date of installation: 1/12/2019	B7
Location Description	Located on a painted parking marque.

Map

Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 16 06.73640	0.0143
Longitude	28 37 15.22150	0.0143
Height	35.803	0.0155
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	789169.772	0.0143
Northing (m)	314115.757	0.0143
Elevation (m)	1.991	0.0155

Signature (name/function): BCEZ	Date 02/12/2020

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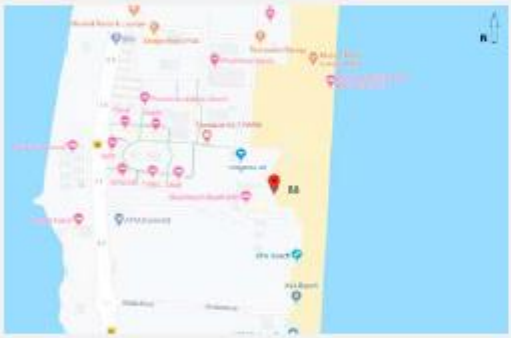
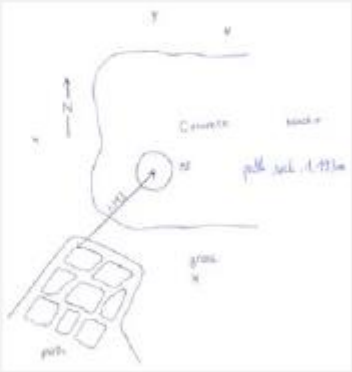
642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area **Date of installation: 1/12/2019**	**B8**
Location Description	Located on a small piece of concrete east of Blue Beach Apartment complex and west of beach edge.

Map



Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 16 40.64708	
Longitude	28 37 15.99946	
Height	35.194	
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	789140.11	0.0143
Northing (m)	315162.662	0.0145
Elevation (m)	1.384	0.0162

Signature (name/function): BCEZ	**Date** 02/12/2020

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642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area **Date of installation: 1/12/2019**	**B9**
Location Description	Located on the walkway next to the beach

Map

Sketch

Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 17 32.06269	0.0137
Longitude	28 37 25.79841	0.0138
Height	35.752	0.0158
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	789286.107	0.0137
Northing (m)	316758.549	0.0138
Elevation (m)	1.949	0.0158

Signature (name/function): BCEZ	**Date** 02/12/2020

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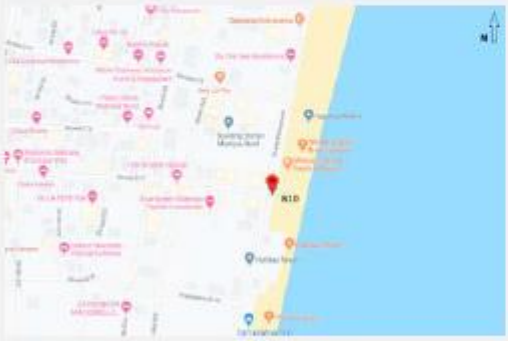
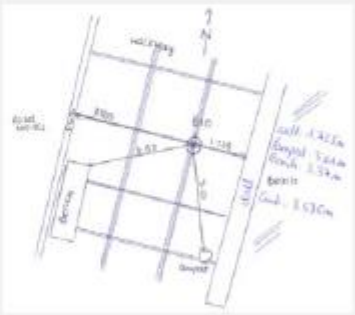
Dredging & Marine Experts

642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area **Date of installation: 1/12/2019**	**B10**
Location Description	Located on the walkway next to the beach

Map



Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 17 53.42960	0.0088
Longitude	28 37 31.77804	0.0088
Height	35.319	0.0094
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	789389.007	0.0088
Northing (m)	317423.653	0.0088
Elevation (m)	1.521	0.0094

Signature (name/function): BCEZ	**Date** 02/12/2020

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642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area **Date of installation: 1/12/2019**	**B11**
Location Description	Located on the walkway next to the beach

Map

Sketch

Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 18 11.50501	0.0124
Longitude	28 37 38.17840	0.0124
Height	35.13	0.013
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	789505.76	0.0124
Northing (m)	317987.637	0.0124
Elevation (m)	1.336	0.013

Signature (name/function): BCEZ	**Date**	**02/12/2020**

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642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area **Date of installation: 1/12/2019**	**B12**
Location Description	Located on the walkway next to the beach

Map

Sketch

Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 18 43.41136	0.0142
Longitude	28 37 52.68631	0.0142
Height	35.475	0.0155
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	789782.892	0.0142
Northing (m)	318986.372	0.0142
Elevation (m)	1.69	0.0155

Signature (name/function): BCEZ	**Date** 02/12/2020

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642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area Date of installation: 1/12/2019	B13
Location Description	Located on the walkway next to the beach

Map

Sketch

Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 19 16.54188	0.0135
Longitude	28 38 10.26811	0.0136
Height	35.244	0.0146
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	790126.298	0.0135
Northing (m)	320025.949	0.0136
Elevation (m)	1.471	0.0146

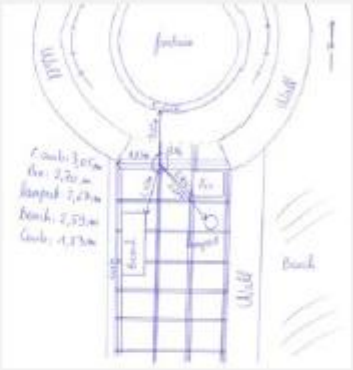
Signature (name/function): BCEZ	Date 02/12/2020

Boskalis
Dredging & Marine Experts

642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area **Date of installation: 1/12/2019**	**B14**
Location Description	Located at the end of the walkway next to the beach. There is a fontain

Map

Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 19 27.18929	0.0071
Longitude	28 38 15.70796	0.0071
Height	35.626	0.0074
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	790231.972	0.0071
Northing (m)	320359.84	0.0071
Elevation (m)	1.856	0.0074

Signature (name/function): BCEZ	**Date** 02/12/2020

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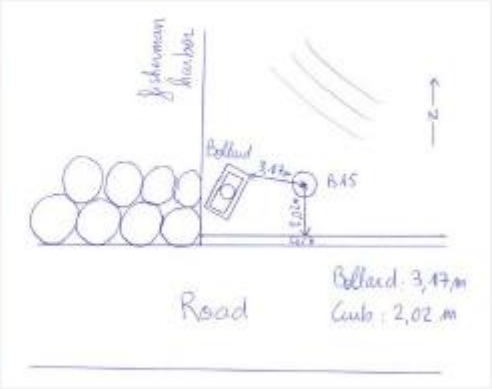
Dredging & Marine Experts

642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area Date of installation: 1/12/2019	B15
Location Description	Located on the break water all the way north from the project

Map

Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 19 26.50346	0.0094
Longitude	28 39 11.74557	0.0094
Height	36.115	0.0098
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	791473.908	0.0094
Northing (m)	320394.701	0.0094
Elevation (m)	2.379	0.0098

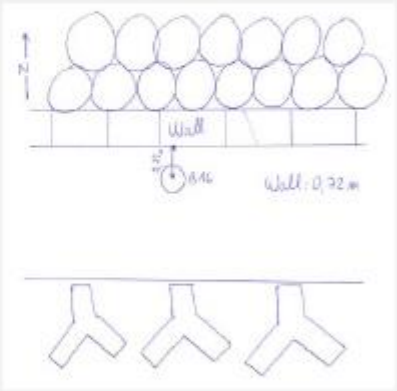
Signature (name/function): BCEZ	Date 02/12/2020

Boskalis
Dredging & Marine Experts

642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area Date of installation: 1/12/2019	B16
Location Description	Located on the break water all the way north from the project

Map

Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 19 25.33611	0.0068
Longitude	28 39 51.95946	0.0068
Height	36.83	0.0071
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	792366.105	0.0068
Northing (m)	320399.052	0.0068
Elevation (m)	3.12	0.0071

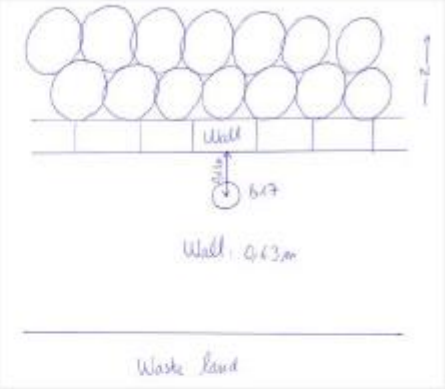
Signature (name/function): BCEZ	Date 02/12/2020

Boskalis
Dredging & Marine Experts

642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area **Date of installation: 1/12/2019**	**B17**
Location Description	Located on the break water all the way north from the project

Map

Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 19 24.17535	0.0064
Longitude	28 40 35.11378	0.0064
Height	36.708	0.0069
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	793323.424	0.0064
Northing (m)	320406.703	0.0064
Elevation (m)	3.023	0.0069

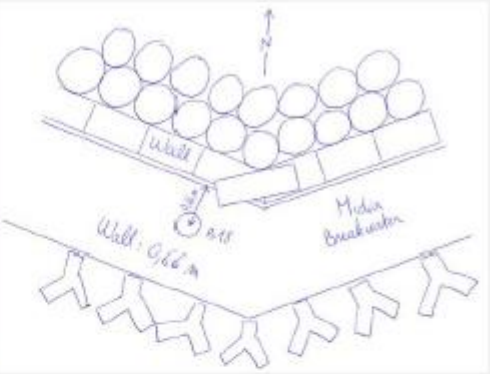
Signature (name/function): BCEZ	**Date** 02/12/2020

Boskalis
Dredging & Marine Experts

642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area **Date of installation: 1/12/2019**	**B18**
Location Description	Located on the break water all the way north from the project

Map

Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 19 22.98530	0.0063
Longitude	28 41 17.82812	0.0063
Height	37.349	0.0065
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	794271.048	0.0063
Northing (m)	320413.147	0.0063
Elevation (m)	3.692	0.0065

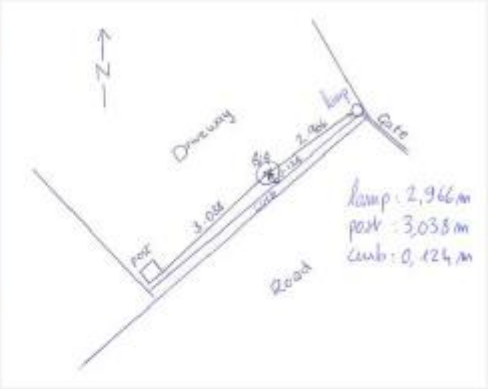
Signature (name/function): BCEZ	**Date** 02/12/2020

Boskalis
Dredging & Marine Experts

642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area Date of installation: 1/12/2019	B19
Location Description	Located on the curb next to a gate. The driveway leeds to a fish restaurant

Map

Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 13 00.90530	0.009
Longitude	28 38 29.27274	0.009
Height	35.189	0.0094
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	791069.791	0.009
Northing (m)	308456.763	0.009
Elevation (m)	1.428	0.0094

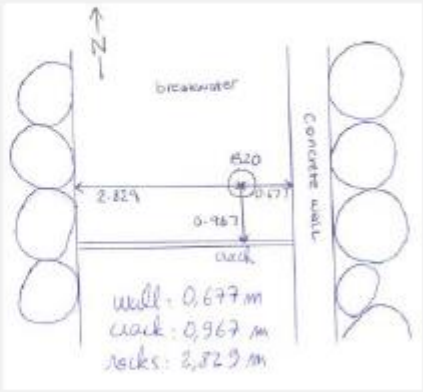
Signature (name/function): BCEZ	Date 02/12/2020

Boskalis
Dredging & Marine Experts

642-10030-Reduction of costal erosion phase II LOT2-Mamaia Area Date of installation: 1/12/2019	B20
Location Description	Located on the breakwater south from the project

Map

Sketch



Overview

Benchmark Image

ETRS89 Coordinate System ETRF2000_R05 at Epoch 2000		
	Value (DMS)	Precision (m)
Latitude	44 13 10.78107	0.0108
Longitude	28 38 59.74182	0.0108
Height	37.642	0.0112
Krasovski 40 ellipsoid (SK-42)		
	Value (m)	Precision (m)
Easting (m)	791732.043	0.0108
Northing (m)	308791.917	0.0108
Elevation (m)	3.901	0.0112

Signature (name/function): BCEZ	Date 02/12/2020