Professional Consultancy Services for Coastal Engineering Infrastructure
Proclaimed Fishing Harbours Western Cape

HARBOUR MAINTENANCE
CHECKLIST FOR SUBMISSION TO DEA
STILBAAI HARBOUR

Stilbaai Harbour

Prepared by:
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On behalf of
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Cape Town 8001

For:
Coega Development Corporation

Date: 7 February 2017

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1 Project description & proposed works

Please note that the overall project has been divided into four consultancy contracts. Since the project is for the same client information generated by other consultants have been used as applicable to compile this document. Further extracts have been made from technical reports compiled by Mott MacDonald Consulting Engineers (MM).

1.1 Background information

1.1.1 Project Background

The National Department of Public Works (NDPW) has appointed the Coega Development Corporation (CDC) as implementing agents for the repair, maintenance and upgrade of the 13 proclaimed Western Cape fishing harbours. The 13 fishing harbours have been split into four separate work packages. MM have been appointed by CDC for the professional consulting services required to repair, maintain and upgrade the marine infrastructure for Work Package 4, which includes Stilbaai, Arniston, Gansbaai and Struisbaai.

Stilbaai is located about 300 km east of Cape Town. The mouth of the Goukou Estuary is located approximately 850 m north from the harbour and is permanently open. The coastline can be characterised as sandy beached with rocky outcrops and is in pristine condition. Figure 1.1.1 below illustrates the harbour location with regards to the Goukou Estuary as well as the general coastline characteristics.

Figure 1.1.1: Location map

1.1.2 Hydrographic and Geophysical Characteristics

During November 2016 Tritan Survey conducted a hydrographic geophysical survey of Stilbaai Harbour. The extent of the survey area is illustrated in the Figure 1.2.1 below. The dark blue area represents 1.5 m CD (Chart Datum) and the red areas between represent 0 m CD.

The entire area is very shallow, as illustrated by the green areas shown in the Figure 1.2.1 which represents seabed levels between 0 and -0.5 m CD.

The site comprises of mainly Sandstones from the Table-mountain Group, overlain by calcarenites of the Bredasdorp Group. The results from the seismic survey suggested that the whole area is covered with a layer of sediment with average sediment thickness varying between 0.3 and 1.0 m. (Tritan, 2016).

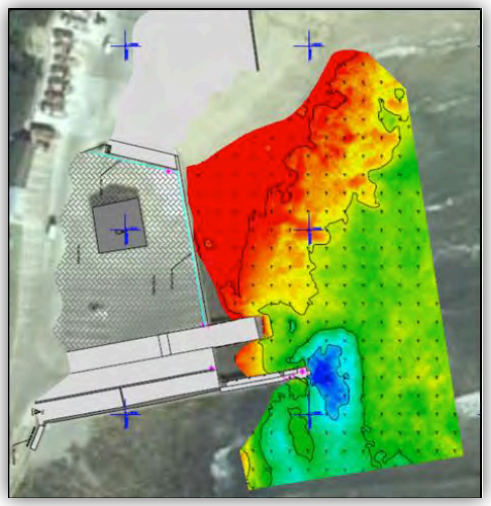


Figure 1.2.1: Geophysical survey

1.1.3 Tides

South Africa tides are semi-diurnal (two tides per day). Table 1 lists the predicted tidal levels for Mossel Bay, which are assumed to be applicable to the Stilbaai, Arniston and Struisbaai sites. The above Table indicates that the maximum tidal variation is approximately 2.44 m, with the mean tidal variation being about 1.2 m.

Table 1: Mossel Bay tidal levels (San 2016)

Description		Level (m)	
		Relative to Mean Sea Level	Relative to Chart Datum
Highest Astronomical Tide	HAT	1.507	2.44
Mean High Water of Spring Tide	MHWS	1.167	2.1
Mean High Water of Neap Tide	MHWN	0.527	1.46
Mean Level	ML	0.237	1.17
Mean Low Water of Neap Tide	MLWN	-0.053	0.88
Mean Low Water of Spring Tide	MLWS	-0.673	0.26
Lowest Astronomical Tide	LAT	-0.933	0

1.1.4 Offshore Wind and Wave characteristics

The wave height and wave period roses in the Figures below were created from historical wave conditions sourced from the NOAA WAVEWATCH III Model (WWIII). The historical wind conditions was sourced from the National Centres for Environmental Prediction (NCEP) Global Forecast System (GFS) Atmospheric Model.

The location of the representative wind and wave offshore extraction points are listed in the Table 3 below:

Table 3: Location of offshore wind and wave extraction points

Location	Data grid point coordinates		Wind			Wave		
	Lat	Long	Record start	Record end	Nr entries	Record start	Record end	Nr entries
Gansbaai	35°S	18.5°E	2011/05/07	2016/02/07	16227	2010/11/08	2016/02/08	41580
Struisbaai	35°S	20°E	2011/05/07	2016/02/07	16227	2010/11/08	2016/02/08	41580
Arniston								
Stilbaai								

Representative offshore wind and wave conditions at Stilbaai, Arniston and Struisbaai are illustrated in the Figures 1.4.1 to 1.4.3 below.

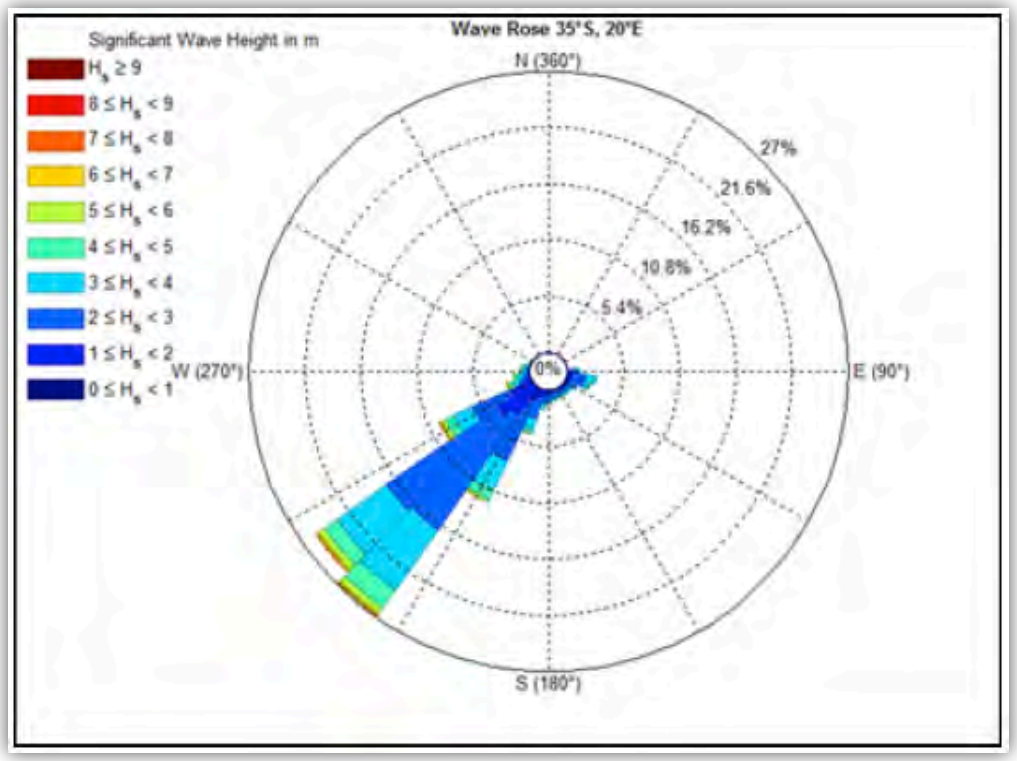


Figure 1.4.1: Deep water wave height (WWIII)

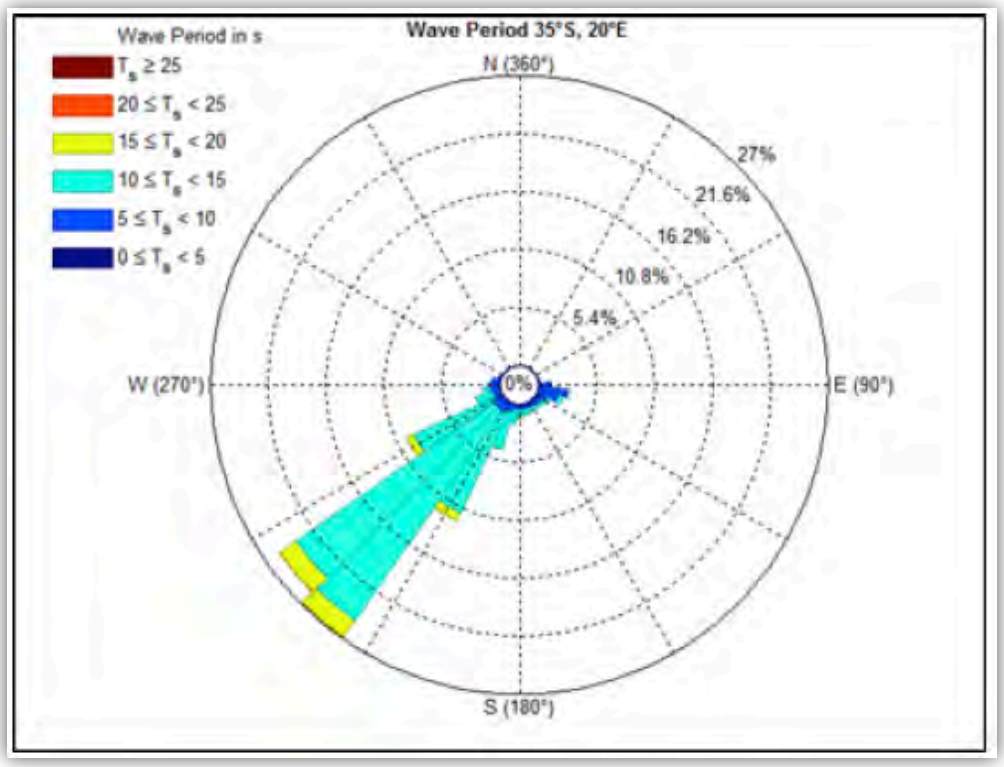


Figure 1.4.2 Deep water wave period (WWIII)

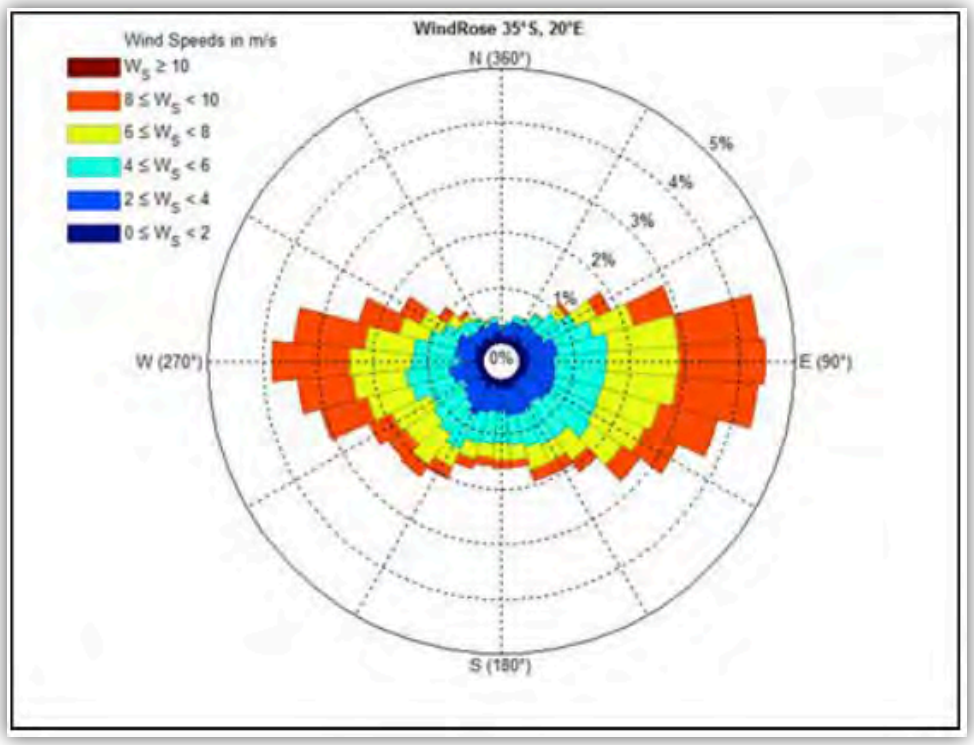


Figure 1.4.3: Annual wind rose (NCEP)

1.1.5 Nearshore currents and circulation

Nearshore waves, wind and tides predominantly govern the nearshore circulation pattern (nearshore currents). The nearshore hydrodynamics are generally complex and expensive to

simulate in a numerical model. For the design of the repair/upgrade of the various harbour structures, the modelling of the detailed nearshore hydrodynamics is not considered feasible. This shall be confirmed during detail design phase.

1.1.6 Sediment transport

Since the site is located on an exposed coastline, longshore transport rates are assumed to be medium to high. In addition, the Goukou Estuary experiences regular river floods that flush out the sediments and contribute to the sediment in suspension

1.1.7 Sediment sampling

Sediment sampling was undertaken by Lwandle Marine Environmental Services (see full report in Appendix 3.1). The report concluded as follows:

> *The comparisons show that Arniston, Gansbaai, Stilbaai and Struisbaai sediments are uncontaminated by heavy metals or the measured organic compounds and would qualify for unconfined open ocean disposal. Nevertheless, should harbour dredging be required, the dredge spoil disposal site(s) will need to be carefully selected.*

1.2 Project General Scope of Work and Maintenance

The marine infrastructure for Stilbaai Harbour shown in Figure 1.2.1 below consists of a 70m long breakwater, with a small lead-in quay for offloading, two slipways and a quay/seawall. The seawall does not offer mooring or offloading facilities. Slipway 2 cannot be used during low tide due to the sediment build up directly in front and on the slipway. Slipway 1, the smaller of the two slipways, located close to the breakwater is currently the "active" slipway.

Figure 1.2.1: Harbour layout

1.2.1 Breakwater 1

1.2.1.1 Investigation and findings

This 24m long breakwater (see Figure 1.2.1.1) consists of concrete precast caisson/gravity blocks with minimal rocks serving as armour/toe protection. A navigation light is positioned at the end of the breakwater. A small quay is situated, on the landside of the breakwater, in close proximity to the end of the breakwater.

Figure 1.2.1.1: Stilbaai Breakwater 1

Observed condition of existing structure

Erosion of the seabed at the toe or in front of the foundation may have caused the vertical breakwater to move and tilt vertically. Precast caissons/gravity units are not fully seated. The cap of the breakwater is uneven. The structure shows signs of severe cracking, spalling and corrosion and, notably, there is large vertical structural crack running through the entire structure (see Figure 1.2.1.2 below). Bollards are showing signs of advanced corrosion. The lower section of breakwater is severely abraded on the seaside with possible undermining of toe structure.

Figure 1.2.1.2: Large structural crack to be pressure pointed (cement grout) Similarly, vertical cracks to be cement grouted

Conceptual design

Breakwater 1 is identified as a critical item that requires remedial work as it provides protection to the slipways from the open ocean sea swells. It was mentioned by the Doc Master that overtopping of the breakwater does occur and in some instances during winter storm events the harbour is not safe to use. To adequately understand and describe the frequency that the harbour is not safe to use would require a coastal zone study. From the coastal zone study the breakwater would be assessed against allowed overtopping rates and concept design realised. It is noted in the detailed Special and Economic Development Plan (SEDF) that a new breakwater would be built in the long term and typically a coastal zone study would then be required.

It is envisaged that a solution is found that could be carried out in the short term, that would provide protection to the harbour in the long term while not jeopardising harbour operations.

The most important design consideration is to ensure structural stability of the structure, especially at the head of the breakwater. It is assumed that the breakwater is founded on bedrock, however, considering the significant settlement, it is assumed the founding material (i.e. possibly stone screed) has been scoured away.

The remedial works envisaged is to stabilize and strengthen the existing breakwater. This is to be done by:

- Stabilising the toe using tremie concrete.
- Horizontal and vertical cracks to be filled by pressure grouting/pointing (cement grout)
- Reinforced concrete cap as well as encasement, anchored into the existing breakwater
- Replacement and rehabilitation of existing bollards.

1.2.1.2 Construction methodology and concept drawings

The construction methodology and concept design shows that the footprint of the existing structures are not increased and therefore no listed activity is activated.

Construction methodology:

- Use geo-bags or similar to form cofferdam.
- Tremie concrete between geo-bags and structure to full voids
- Where required encase the structure with concrete anchored back
- New capping slab as required
- Scour protection to be rehabilitated to original design function

The concept design showing the original design to proposed design is shown below in Figure 1.2.1.2.1.

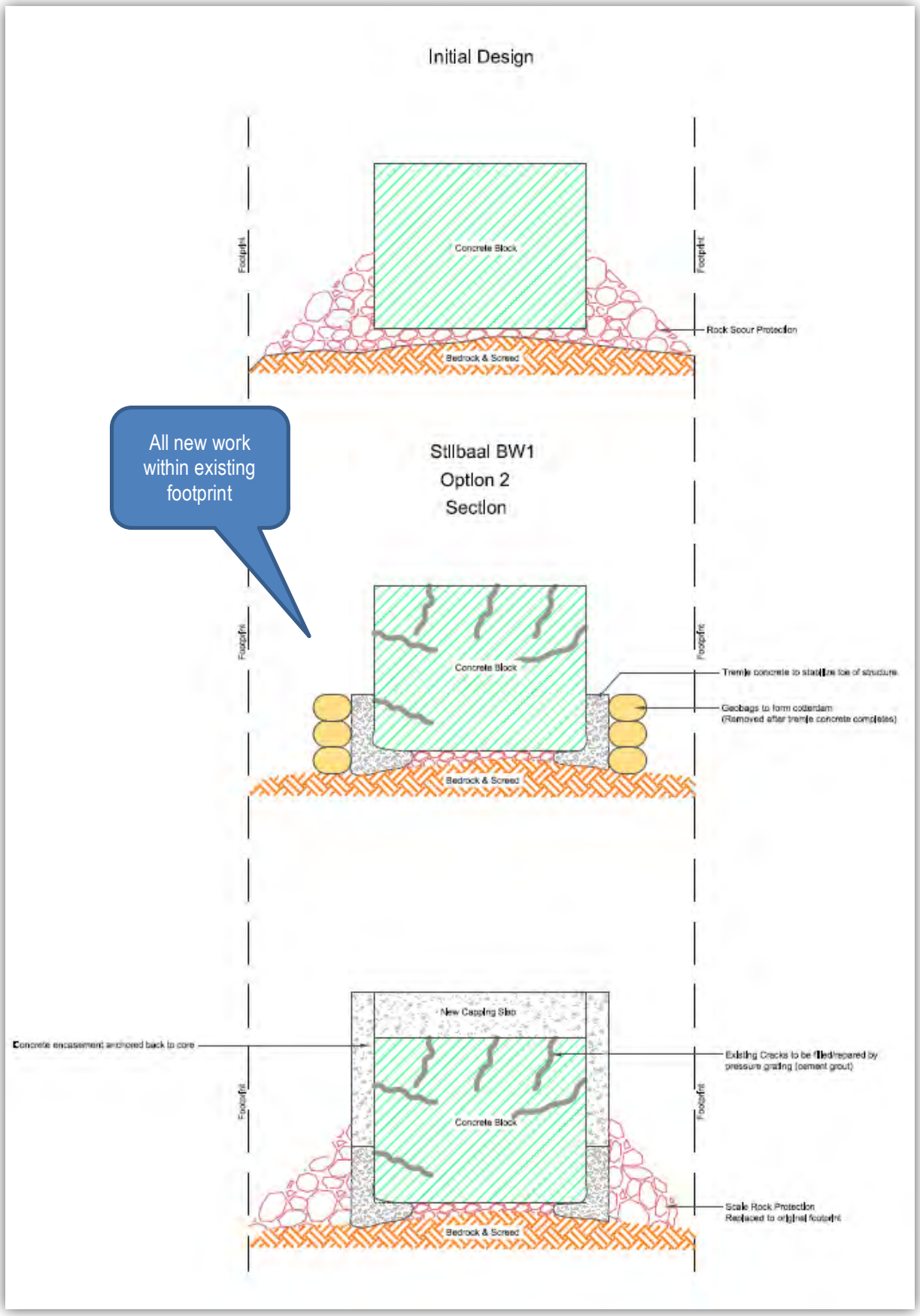


Figure 1.2.1.2.1: Breakwater 1 – concept design

1.2.2 Breakwater 2:

1.2.2.1 Investigation and findings

This part of the breakwater (48m long) consists of a vertical concrete wall and recurved copings as shown in Figure 1.2.2.1 together with examples of damage. This coping will be replaced with a new coping as shown in Figure 1.2.2.2.

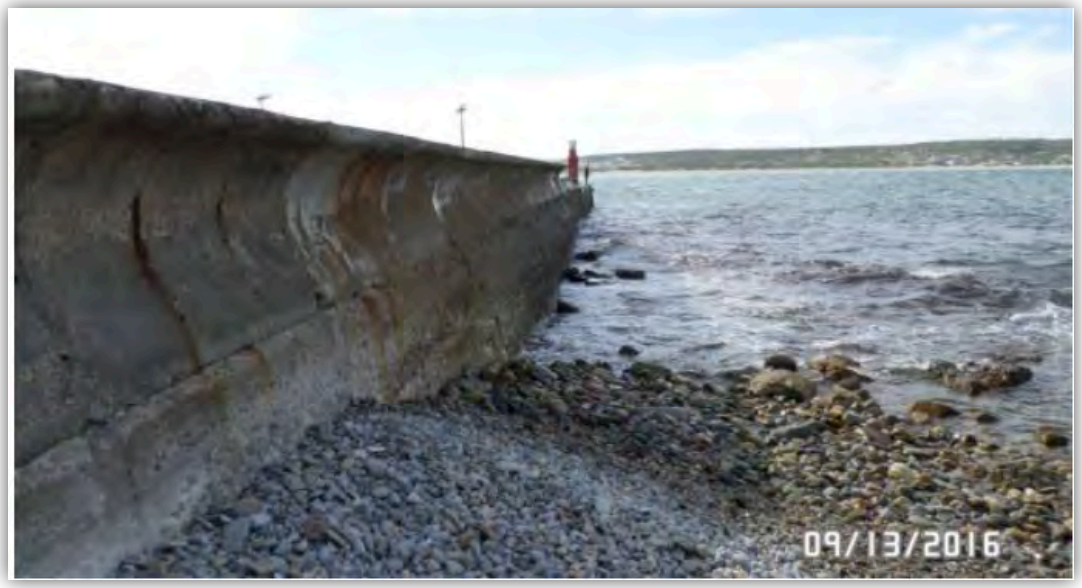


Figure 1.2.2.1: Stilbaai Breakwater 2

1.2.2.2 Construction methodology and concept drawings

The construction methodology and concept design shows that the footprint of the existing structures are not increased and therefore no listed activity is activated.

Construction methodology:

- Existing copings demolished and removed
- Galvanised bars dowelled into existing structure to anchor new RC beam and coping
- New precast concrete coping to have same crest level as existing
- New precast coping/beam to be designed for enhanced durability
- General maintenance and repair to existing concrete required (see generic repair methodology chapter 9)

Outcome: replacing “like for like” with enhanced stability and durability.

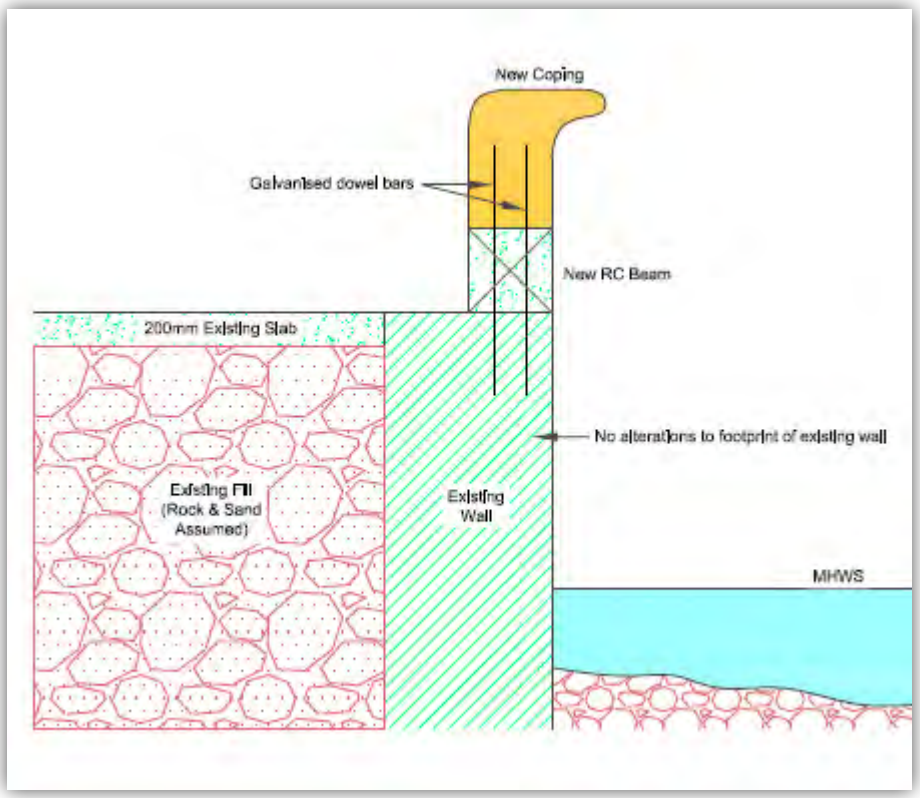


Figure 1.2.2.2: New coping on existing wall

1.2.3 Seawall 1 & 2

1.2.3.1 Investigation and findings

The location of the seawalls is shown in Figure 1.2.3.1a with views of the walls in Figure 1.2.3.1b. The existing seawalls comprise typical precast concrete blocks as shown in the Figure 1.2.3.1.

Seawall 1: The loss of backfill material is evident as the slipway sidewall and concrete slab behind the seawall has subsided by approximately 80mm. Although the sections behind the seawall underwent settling, the upper and lower concrete blocks of the seawall seem to be standing firm. Due to no visual evidence of recent settlement, it can be assumed that the loss of backfill material has not accelerated over time.

The integrity of the toe of the seawall could not be viewed for scour, but it is assumed that the cause of the settlement behind the wall is most likely due to loss of backfill material leaching through the wall.

Abrasion of concrete was noted on the lower blocks, below the high water mark. Significant staining, minor cracking and spalling is evident throughout.

Seawall 2: The seawall above the high water mark is in good condition, however the lower section in the tidal zone indicates that abrasion is taking place. There is visible settlement, unevenness, and collapse of the paving blocks behind the seawall. There is a void under the paving, probably caused by a loss of fill material leaching out under the seawall and/or alternatively through the joints. The integrity of the toe of the seawall with regards to scour is not confirmed,

However, the surface landward of the walls require maintenance as shown in Figure 1.2.3.2 as well as improved toe protection within the existing footprint.

Figure 1.2.3.1a: Seawalls 1 and 2

Figure 1.2.3.1b: Views of Seawalls 1 and 2

1.2.3.2 Concept design

Seawall 1: Repair works is required to resolve the continuing settlement behind the seawall. Further investigation is required to establish whether settlement is continuing or has been arrested. This is to done through site investigations by excavating behind the seawall and analysing the toe of the structure.

At the time of the site visit the toe could not be observed due to sediment build-up. It has been assumed that the base of the structure is on bedrock, but this will require verifying through receiving the bathymetric, geophysical and site surveys.

The envisaged extent of the repair works required is likely to include the following: repair of toe protection, replacement of backfill material, sealing of joints between concrete blocks and concrete paving slab.

Seawall 2: The likely reason for the loss of backfill material behind the wall is the leaching of sediment through the joints in the structure. This is deduced on the bases that the crest of the wall is even and is showing no signs of settlement. However, sediment may also be leaching through the toe and this requires further investigation. To verify the extent of the voids/settlement behind the wall further site investigations are required where a strip behind the seawall will be opened and profiling of the sections along the seawall will be completed.

Repair works envisaged: repair of toe protection, sealing of backfill against leaching paths, replacement of backfill material and reinstatement of paving.

In the coordination meeting with the Civils service provider (Bosch Projects) it was agreed that Mott Macdonald would replace the paving like for like and would open up a strip of 5 to 8 metres behind the wall for remedial works.

The protective fencing to the edge of the seawall 1 requires replacement and same details as seawall 2 will be used (concrete bollards with chains).

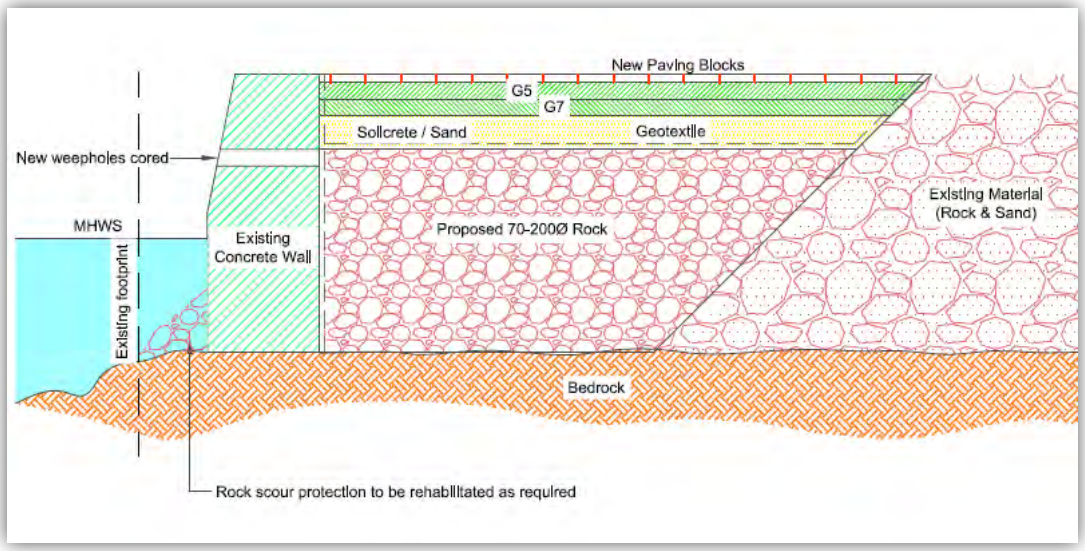


Figure 1.2.3.2: Maintenance of seawalls 1 and 2.

1.2.3.3 Construction methodology and concept drawings

Construction methodology:

- Excavate landside of seawall
- At joints in seawall add geotextile layer
- Backfill with rock, and layer works
- Replace existing paving as required
- Rehabilitate toe of the structure
- Provide new wheepholes

Outcome: no increase of footprint.

1.2.4 Slipway 1 & 2

1.2.4.1 Investigation and findings

Slipways 1 and 2 requires localised concrete repairs and maintenance (see Figure 1.2.4.1 for locality).

Both slipways require varying degrees of concrete repairs. For generic approach to concrete repair methodology for marine structure see Section 9.

Current repairs at the joints to Slipway 1 have failed and the repair methodology and product used is to be improved upon. The hazard mentioned by the Doc Master concerning damage to trailers passing over open slipway joints will be resolved by casting a new concrete strip.

Sediment and rock hazards on and surrounding the slipways is noted and will be addressed as part of the dredging activity.

The work will be done on the surface of the slipways and no expansion of footprint will take place and therefore no listed activity is activated.

Figure 1.2.4.1: Locality of Slipways 1 and 2.

1.2.4.2 Construction methodology and concept drawings

No concept drawing is available because repair work will be undertaking as identified on site.

Construction Methodology

Localised concrete repair and maintenance to the slipway

Outcome: repair and maintenance, no listed activity activated.

1.2.5 Dredging

The proposed area for dredging is shown in Figure 1.2.5.1. It is estimated that approximately 4000m^3 dredging will be required and to be deposited outside the harbour area. The actual deposit position must still be finalised. For these small volumes the cost for depositing on a beach south of the harbour compared with containment and re-use on the land (see Figure 1.2.5.2) will have to be evaluated.

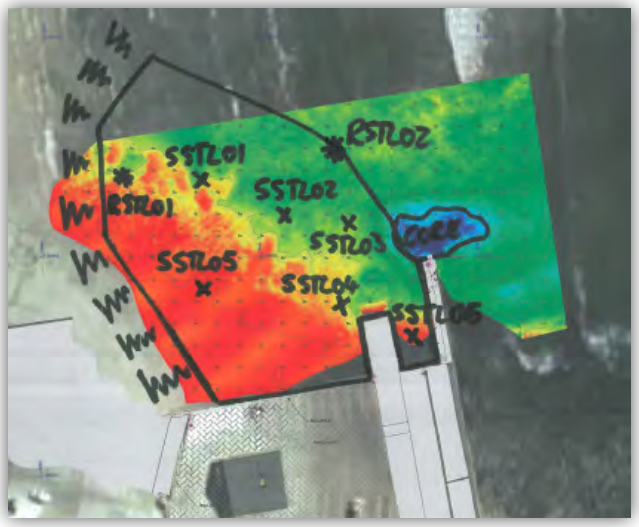


Figure 1.2.5.1: Proposed area for dredging in Stilbaai harbour

Figure 1.2.5.2: Proposed spoil areas for dredge material

2 Stilbaai checklist - DEA

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

Chief Directorate: Integrated Environmental Authorisations

Minimum requirements for the determination of Environmental Impact Assessment (EIA) applicability

The information requested in this form consists of the minimum requirements that this Department requires to address your query. The information below is required to assist the assessing officer in responding to your query. All fields are compulsory. Please note that if the requested information is deemed insufficient, this Department may request additional information to be submitted.

Any queries related to this form may be addressed to 012 399 9371.

Please submit the completed form in one of the following ways:

(1) **Post:**

The Director: Integrated Environmental Authorisations
Department of Environmental Affairs
Private Bag X447
Pretoria
0001

(2) **Hand Deliver:**

Department of Environmental Affairs
Environment House
473 Steve Biko Road
Arcadia
Pretoria

(3) **E-mail :**

EIAAdmin@environment.gov.za

COEGA DEVELOPMENT CORPORATION

2.1.1 BACKGROUND INFORMATION

Name of Contact person	Pieter Badenhorst	
Postal Address	PO Box 1058, Wellington 7654	
Telephone Number	W: 021 8737228	C: 0827763422
Fax Number	0866721916	Email: pbps@iafrica.com

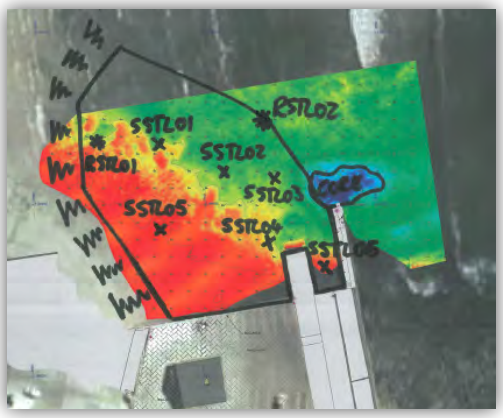
2.1.2 GEOGRAPHICAL INFORMATION

Property Description	Stilbaai Fishing Harbour	
Physical Address where the development will take place	Off Main Road, Stilbaai	
Farm name(s)/ Erf No	The locality of harbour is shown below with surrounding property boundaries. No erf indicated for the harbour. 	
Local Municipality	Hessequa	
District Municipality	Eden	
SG21 Digit code(s) for the proposed site	The harbour does not seem to be on an identified erf.	
Co-ordinates of the proposed site/s (DDMMSS)	Latitude (S)	Longitude (E)
	34° 23' 08,88"	21° 25' 29,26"

2.1.3 DETAILS OF THE PROPOSED ACTIVITY AND ENVIRONMENTAL CONTEXT

Does the proposed development involve the construction of a new facility or the expansion of a new facility?	No
Have any activities physically commenced? If so, provide the date of commencement of these activities.	No
What is the current zoning and current land use of the site(s)?	According to available information Stilbaai Harbour is not on an erf and has no zoning.

	The property is used as a small fishing harbour, a few fishing vessels and a ski boat launch.
State the extent of proposed development (ha/m^2)	The exact footprint of the works within the harbour has not yet been finalised, but all activities are proposed inside the cadastral boundaries of the Harbour as indicated on Figures 1 and 3 below. Dredged sand (about 4 000m^3) will be either deposited on land or on the beach as indicated below (see Figure 2 below). Proposed works inside the harbour (upgrades and repairs to harbour infrastructure) will remain within the existing footprint of the relevant infrastructure.  Figure 1  Figure 2

	 Figure 3
Describe the proposed development in detail (include capacities, output, etc.) and provide a concise description of all associated infrastructure with respect to the proposed development (e.g. the diameter and lengths of pipelines that may be required)	The description of work is shown in section 1 (starting page 1) of the report. The proposed works all constitute repairs and maintenance to existing infrastructure in the harbour and maintenance dredging. Although only the dredging exercise (activity 19 of Listing Notice 1) could activate a listed activity the listed activity indicates that it is excluded should the work by for maintenance purposes under a Maintenance Management Plan (MMP). It is therefore the intention, should DEA agree, to submit a (MMP) addressing relevant activities for DEA's approval (this MMP will be compiled as per the requirements of DEA&DP but will be submitted to DEA for approval).
Will the proposed development result in waste generation, effluent discharges, air emissions or impacts on the natural or cultural environment - briefly explain?	The project largely involves repairs and maintenance to existing infrastructure in the harbour, which are not expected to result in any waste effluent or emissions, other than those normally associated with construction activities and which will be managed on site. The project includes maintenance dredging within the harbour, for which the it is proposed to submit a MMP. Sampling of sediments to be dredged (see report by Lwandle as Appendix 3.1 (page 22) indicates that sediments are not contaminated (contaminants are well within guideline levels) and as such are suitable for offshore disposal (i.e. onshore disposal at a hazardous waste facility is not required). As indicated above the intention is to temporally "store" the relatively small volume of sand on land to be used as fill material or to replenish the beach to the south as shown in Figure 2 above. Correspondence between other consultants for this project with DEA: Oceans and Coasts regarding the proposed project confirms that no Coastal Waters Discharge Permit (or any other application) will be

	required in terms of the NEM:Integrated Coastal Management Act 36 of 2014. At this stage it is not clear whether the Breakwater, Seawalls and slipways are older than 60 years but should it be the case the necessary permit application will be made to the South African Heritage Resources Agency (SAHRA) in terms of the National Heritage Act 25 of 1999.
Does the site(s)/route(s) form part of the Critical Biodiversity Area - If so, provide details	No
Are there any watercourses on the site(s)/route (includes rivers, wetlands, drainage lines, streams etc.) or does the site fall within 32 m from the edge of a watercourse. If so, provide details.	No
Does the site fall within 100 m of the high-water mark of the sea or an estuary?	Yes. The majority of the works will take place below the high-water mark of the sea.
Does the proposed development fall inside an urban area?	This is unlikely since the harbour is on the edge of town as shown below. 
Describe what investigation or assessment have already been undertaken (if any) to inform this request. Provide attachment herewith.	Engineering assessments and studies were undertaken to assess the requirements for maintenance. These are described in section 1 of this report. A sediment specialist study has been undertaken by Lwandle (Appendix 3.1, page 22) to determine the level of contaminants in the sediment to be dredged.

2.1.4 PROVIDE A DETAILED DESCRIPTION OF POTENTIALLY LISTED ACTIVITIES THAT MAY BE APPLICABLE TO THE PROJECT

Listed activity as described in GN R. 983, GN R. 984 and GN R.985	Description of project activity that may trigger the listed activity
e.g. GN R.983 Item XX(x): The development of bridge exceeding 100 square metres in size within a watercourse	***e.g. A bridge measuring 110 square metres will be constructed within the watercourse***
GN R.983 Activity 19: The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from – (i) a watercourse; (ii) the seashore; or (iii) the littoral active zone, or a distance of 100 m inland of the high water mark of the sea, whichever distance is the greater – But excluding where such infilling, depositing, dredging, excavation, removal or moving – (b) is for maintenance purposes undertaken in accordance with a maintenance management plan.	Maintenance dredging is required in the harbour basin and entrance channel, as indicated Figure 3 above. The intention is to temporally "store" the relatively small volume of sand on land to be used as fill material or to replenish the beach to the south as shown in Figure 2 above. A MMP will be compiled for ongoing maintenance dredging in the harbour basin and at the entrance channel and the deposition/disposal thereof and submitted to DEA for approval prior to the start of dredging activities. Should DEA agree that the activity can be undertaken under a MMP then it is not activated.
GN R.983 Activity 52: The expansion of structures in the coastal public property where the development footprint will be increased by more than 50 square metres, excluding such expansions within existing ports or harbours where there will be no increase in the development footprint of the port or harbour.	Strenghtening/repair of the breakwater and seawalls as well as repair of the slipways will be required. Section 1 describes how this work will be undertaken within the existing footprint and thus no increase in development footprint will take place. The activity is therefore not activated.
GN R.983 Activity 55: Expansion (i) in the sea; (iii) within the littoral active zone; and (v) within a distance of 100 m inland of the high water mark In respect of: (d) breakwater structures; (f) coastal harbours or ports But excluding the expansion of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour.	Strenghtening/repair of the breakwater and seawalls as well as repair of the slipways will be required. Section 1 describes how this work will be undertaken within the existing footprint and thus no increase in development footprint will take place. The activity is therefore not activated.
GN R.983 Activity 65: The expansion and related operation of an island, anchored platform or any other permanent structure on or along the sea bed, where the expansion will constitute an increased development footprint, excluding expansion of facilities, infrastructure or structures for aquaculture purposes.	As described above maintenance and repair work is required on permanent structures in the harbours and on the sea bed, however, none of these are considered to increase the footprint of the actual structures and this activity is thus not applicable.

Identified Competent Authority to consider the application:	Department of Environmental Affairs
Reason(s) in terms of Sec 24C of NEMA 1998, as amended	The activity is proposed by a national department: The National Department of Public Works

DECLARATION BY THE PROPONENT / ENVIRONMENTAL PRACTITIONER

I…**Pieter Badenhorst**…in my personal capacity or duly authorised thereto by hereby declare that I:

- regard the information contained in this checklist to be true and correct;
- am fully aware of my responsibilities in terms of the National Environmental Management Act (NEMA) Act No. 107 of 1998), the Environmental Impact Assessment Regulations (EIA Regulations), 2014 in terms of NEMA (Government Notice No. 982 refers) and the relevant specific environmental management Acts, and that failure to comply with these requirements may constitute an offence in terms of the environmental legislation;
- am fully aware that the Department's determination of the applicability of the EIA Regulations,2014 is based on information at my disposal that is relevant to this request;
- aware that the response from the competent authority, to this request, is specific to the EIA Regulations, 2014 and does not exempt me from my legal obligations in terms of any other applicable legislation; and
- am aware that a false declaration is an offence in terms of regulation 48 GN R No. 982

14 February 2017

Signature of the proponent / environmental practitioner: Date:

PBPS for Mott MacDonald

Name of company (if applicable):

3 Appendices

3.1 : Sediment sampling report

Conditions of Use of This Report

1. This report is the property of the client who may publish it provided that:
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EXECUTIVE SUMMARY

As part of the National Department of Public Works (NDPW) Small Harbours Programme, Tritan Surveys has been awarded the work package covering the proclaimed fishing harbours in the Western Cape at Arniston, Gansbaai, Stilbaai and Struisbaai. Sediment properties were measured at sites in each of the four harbours and then compared against the National Action List (DEA 2012) and the BCLME (2006) sediment quality guidelines.

The comparisons show that Arniston, Gansbaai, Stilbaai and Struisbaai sediments are uncontaminated by heavy metals or the measured organic compounds and would qualify for unconfined open ocean disposal. Nevertheless, should harbour dredging be required, the dredge spoil disposal site(s) will need to be carefully selected.

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1 INTRODUCTION

The Coega Development Corporation is responsible for the implementation of the National Department of Public Works (NDPW) Small Harbours Programme. The aim of this programme is to accelerate projects pertaining to the improvement of infrastructure, day-to-day operations and aesthetics at 13 proclaimed harbours in the Western Cape. These projects include repairs of existing infrastructure, dredging of harbour basins, characterisation of basin sediments and identification of suitable disposal locations for the dredged material. The 13 proclaimed harbours were divided into several work packages and the contracts for services in each work package awarded separately.

Tritan Surveys (Tritan) has been awarded the work package covering the proclaimed fishing harbours at Arniston, Gansbaai, Stilbaai and Struisbaai in the Western Cape, and envisage the need for dredging at all four. As such, Tritan has contracted Lwandle Technologies (Lwandle) to analyse the sediment composition and levels of contaminants within the sediments, in order to determine whether the dredge material can be safely disposed at sea.

2 BACKGROUND

Sediment is an important sink for many contaminants that are anthropogenically introduced into the water column, and any form of disturbance to this sediment may have ecological effects through re-suspension. Hence sediments removed from one area and disposed of elsewhere can lead to detrimental environmental impacts. The 1996 London Protocol, to which South Africa is a signatory, regulates the disposal of dredged sediments and other waste materials in the marine environment. This protocol requires the screening of target dredge sediments based on their constituents and potential effects that they may have on the environment, to determine whether the material can be dredged and disposed of without further testing. As part of this screening process, contaminants of concern therefore need to be tested within target dredge sediments.

Consequently, sediment measurement campaigns were carried out in Arniston, Gansbaai, Stilbaai and Struisbaai harbours, where dredging activity is envisaged, during November 2016. Samples were collected by Tritan and were analysed for particle size (PSA), heavy metals, total organic carbon and total oxidised nitrogen. This document presents and discusses the results of the sediment surveys conducted at the three harbours and concludes whether or not the sediments present at each harbour comply with the requirements for unconfined open ocean disposal of dredge material.

3 ARNISTON

Arniston Harbour is located on the south coast of the Western Cape. Sediment grab samples were collected by Tritan from three sites located adjacent to the slipway (Figure 3.1). One sample was obtained from each site and was analysed for sediment particle size distribution (PSA), heavy metals, total organic carbon content (TOC), and total oxidised nitrogen (TON). Results are detailed below.

Figure 3.1 Arniston Harbour sediment sampling sites for the November 2016 field trip.

3.1 PARTICLE SIZE ANALYSES

Sediment texture classes are defined as **clay** (< 0.002 mm), **silt** (0.002 - 0.075 mm), **sand** (0.075 – 4.75 mm) and **gravel** (>4.75 mm) (Wentworth 1922). Sediment samples obtained during the survey in Arniston harbour consisted mainly of sand (Table 3.1). The median particle size (D_{50}) of the samples ranged between 0.14 mm and 0.35 mm, classifying the sediment as fine to coarse sand.

Table 3.1 Sediment texture classification (% by weight) for Arniston Harbour.

Site	Percentage Gravel	Percentage Sand	Percentage Silt	Percentage Clay	D50 (mm)

AGS 1	0	94	0	6	0.140
AGS 2	0	97	0	3	0.350
AGS 3	0	94	0	6	0.140

3.2 Heavy Metals

Concentrations of aluminium, arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc were analysed for in the sediment samples. The three sample sites were treated as replicates and the mean of the measured metal concentrations were compared against the recommended environmental quality guidelines for the BCLME region (BCLME 2006) and the National Action List values (DEA 2012) (Table 3.2). It is evident that measured heavy metal concentrations from Arniston harbour did not exceed the probable effect concentration (BCLME) or the low action level (National Action List) thresholds.

Table 3.2 Heavy metal concentrations (mg/kg) measured in sediments at the three sites at Arniston harbour, during the November 2016 field survey. The probable effect concentration (BCLME) and the low action level (LAL) and upper action level (UAL) (National Action List) are also shown.

	AGS 1	AGS 2	AGS 3	Mean	PEC	LAL	UAL
Aluminium	6660	4070	3760	4830			
Arsenic	0.9	0.8	1	0.9	41.6	30	150
Cadmium	0.2	0.1	0.1	0.1	4.21	1.5	10
Chromium	6.8	4	8	6.3	160	50	500
Copper	<1	1	<1	1.0	108	100	500
Lead	<5	<5	<5	<5	112	100	500
Mercury	<0.1	<0.1	<0.1	<0.1	0.7	0.5	5
Nickel	2.9	0.7	1.4	1.7	42.8	50	500
Zinc	15.4	9.6	8.6	11.2	271	150	750

3.3 Organic Compounds and Total Oxidised Nitrogen

Sediment samples from each site were analysed for their weight percentage of total organic carbon (TOC) and total oxidised nitrogen (TON). TON levels in all samples were below the detection limit (<2.5 mg/kg). Low levels of TOC were detected (Table 3.3) suggesting that there is minimal organic matter present in the sediment.

Table 3.3 Total Organic Carbon percentage concentrations for all sites in Arniston Harbour.

	AGS 1C	AGS 2C	AGS 3C	Mean
Total Organic Carbon (%)	0.03	0.04	<0.02	0.04

4 GANSBAAI

Gansbaai is located is located on the south coast of the Western Cape, South Africa. Grab samples were obtained, by Tritan, from six sites within the harbour, during a field survey in November 2016 (Figure 4.1). One replicate was obtained from each site and samples were analysed for PSA, heavy metals, TON and TOC. Results are detailed below.

Figure 4.1 Gansbaai sediment sampling sites for the November 2016 field trip.

4.1 PARTICLE SIZE ANALYSES

Sediment samples obtained during the survey in Gansbaai harbour consisted mainly of sand (Table 4.1). The median particle size (D_{50}) of the samples ranged between 0.10 mm and 0.20 mm, classifying the sediment as fine to medium sand.

Table 4.1 Sediment texture classification for Gansbaai Harbour.

Site	Percentage Gravel	Percentage Sand	Percentage Silt	Percentage Clay	D50 (mm)
GS 1	0	93	0	7	0.200
GS 2	0	76	16	8	0.100
GS 3	3	77	12	7	0.150
GS 4	3	91	0	6	0.180
GS 5	1	86	3	10	0.150
GS 6	0	87	7	6	0.120

4.2 Heavy Metals

Heavy metal analyses (for concentrations of aluminium, arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc) were conducted on samples obtained from all six sites. The six sample sites were treated as replicates and the mean of the measured metal concentrations were compared against recommended environmental quality guidelines for the BCLME region (BCLME 2006) and the National Action List values (DEA 2012) (Table 4.2). The concentrations of the measured heavy metals in the sediment samples from Gansbaai did not exceed any of the recommended values (BCLME and National Action List).

Table 4.2 Heavy metal concentrations (mg/kg) measured in sediments at the six sites in Gansbaai harbour, during the November 2016 field survey. The probable effect concentration (BCLME) and the low action level (LAL) and upper action level (UAL) (National Action List) are also shown.

	GS 1	GS 2	GS 3	GS 4	GS 5	GS6	Mean	PEC	LAL	UAL
Aluminium	4590	7480	4530	4540	3940	3620	5533			
Arsenic	0.9	2.9	3.7	3.6	4.7	9.1	2.5	41.6	30	150
Cadmium	0.2	0.16	0.6	0.5	0.6	0.9	0.3	4.21	1.5	10
Chromium	2.3	18.9	9.1	18.3	4.3	13	10.1	160	50	500
Copper	2	7	16	14	20	62	8.3	108	100	500
Lead	<5	<5	<5	10	<5	10	<5	112	100	500
Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.7	0.5	5
Nickel	0.7	7.7	3.5	4.5	1.2	3.2	4.0	42.8	50	500
Zinc	9.1	41.1	49	38.4	27.1	82.9	33.1	271	150	750

4.3 Organic Compounds and Total Organic Nitrogen

Sediment samples from each site were analysed for their weight percentage of total organic carbon (TOC) and Total oxidised nitrogen (TON). TON levels in all samples were below the detection limit

(<2.5 mg/kg). Low levels of TOC were detected (Table 4.3) suggesting that there is minimal organic matter present in the sediment.

Table 4.3 Total Organic Carbon percentage by weight concentrations for all sites in Gansbaai Harbour.

	GS 1	GS 2	GS 3	GS 4	GS 5	GS 6	Mean
Total Organic Carbon (%)	0.13	1.63	1.01	0.34	0.43	0.45	0.67

5 STILBAAI

Stilbaai harbour is located on the south coast of the Western Cape, South Africa. Grab samples were obtained from three sites located within the vicinity of the harbour (Figure 5.1), with one replicate obtained at each. All samples were analysed for PSA, heavy metals, TON and TOC.

Figure 5.1 Stilbaai sediment sampling sites for the November 2016 field trip.

5.1 Particle Size Analyses

The particle size analysis results show that the median particle size (D_{50}) of the sediment samples ranged between 0.180 mm and 0.300 mm, classifying the sediment as medium to coarse sand (Table 5.1).

Table 5.1 Sediment texture classification for Stilbaai Harbour.

Site	Percentage Gravel	Percentage Sand	Percentage Silt	Percentage Clay	D50 (mm)
StGS 1A	19	74	2	5	0.300
StGS 2A	0	90	3	7	0.180
StGS 3A	0	90	4	6	0.200

5.2 Heavy Metals

Heavy metal analyses (for concentrations of aluminium, arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc) were conducted on samples obtained from all three sites. The three sites were treated as replicates and the mean of the measured metal concentrations were compared against recommended environmental quality guidelines for the BCLME region (BCLME 2006) and the National Action List values (DEA 2012) (Table 5.2). The concentrations of the measured heavy metals in the sediment samples from Stilbaai did not exceed any of the recommended values (BCLME and National Action List).

Table 5.2 Heavy metal concentrations (mg/kg) measured in sediments at the seven harbour sites in St Helena Bay harbour during the November 2016 field survey. The probable effect concentration (BCLME) and the low action level (LAL) and upper action level (UAL) (National Action List) are also shown.

	StGS 1	StGS 2	StGS 3	Mean	PEC	LAL	UAL
Aluminium	3760	3200	3640	3533			
Arsenic	4.7	4.3	4.6	4.5	41.6	30	150
Cadmium	0.1	0.2	0.2	0.2	4.21	1.5	10
Chromium	5.4	4.9	4.4	4.9	160	50	500
Copper	1	1	<1	1.0	108	100	500
Lead	<5	<5	<5	<5	112	100	500
Mercury	<0.1	<0.1	<0.1	<0.1	0.7	0.5	5
Nickel	2.2	1.1	0.9	1.4	42.8	50	500
Zinc	8.7	9.6	8.4	8.9	271	150	750

5.3 Organic Compounds and Total Organic Nitrogen

Sediment samples from each site were analysed for their weight percentage of total organic carbon (TOC) and Total oxidised nitrogen (TON). TON levels in all samples were below the detection limit (<2.5 mg/kg). Low levels of TOC were detected (Table 5.3) suggesting that there is minimal organic matter present in the sediment.

Table 5.3 Total Organic Carbon percentage by weight concentrations for all sites in Stilbaai Harbour.

	StGS 1	StGS 2	StGS 3	Mean
Total Organic Carbon (%)	0.12	0.12	0.09	0.11

6 STRUISBAAI

Struisbaai harbour is located on the south coast of the Western Cape, South Africa. Sediment grab samples were obtained from three site located within the harbour, with one replicate obtained at each (Figure 6.1). Particle size, heavy metals, TOC and TON were analysed for all three sites.

Figure 6.1 Struisbaai sediment sampling sites for the November 2016 field trip.

6.1 Particle Size Analyses

The particle size analysis results show that the median particle size (D_{50}) of the sediment samples ranged between 0.150 mm and 0.500 mm, classifying the sediment as medium to coarse sand (Table 6.1).

Table 6.1 Sediment texture classification for Struisbaai Harbour.

Site	Percentage Gravel	Percentage Sand	Percentage Silt	Percentage Clay	D50 (mm)
StrGS 1	0	91	2	7	0.150
StrGS 2	0	94	3	8	0.500
StrGS 3	0	94	4	6	0.500

6.2 Heavy Metals

Heavy metal analyses (for concentrations of aluminium, arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc) were conducted on samples obtained from all three sites. The three samples were treated as replicates and the mean of the measured metal concentrations were compared against recommended environmental quality guidelines for the BCLME region (BCLME 2006) and the National Action List values (DEA 2012) (Table 6.2). The concentrations of the measured heavy metals in the sediment samples from Struisbaai did not exceed any of the recommended values (BCLME and National Action List).

Table 6.2 Heavy metal concentrations (mg/kg) measured in sediments at the three sites in Struisbaai harbour during the November 2016 field survey. The probable effect concentration (BCLME) and the low action level (LAL) and upper action level (UAL) (National Action List) are also shown.

	StrGS 1	StrGS 2	StrGS 3	Mean	PEC	LAL	UAL
Aluminium	3320	2710	3510	3180			
Arsenic	0.8	0.9	0.8	0.8	41.6	30	150
Cadmium	0.2	0.1	0.1	0.1	4.21	1.5	10
Chromium	2.4	0.9	0.7	1.3	160	50	500
Copper	1	<1	<1	1.0	108	100	500
Lead	<5	<5	<5	<5	112	100	500
Mercury	<0.1	<0.1	<0.1	<0.1	0.7	0.5	5
Nickel	0.8	0.5	<0.5	0.7	42.8	50	500
Zinc	8.7	7.3	9.5	8.5	271	150	750

6.3 Organic Compounds and Total Organic Nitrogen

Sediment samples from each site were analysed for their weight percentage of total organic carbon (TOC) and total oxidised nitrogen (TON). TON levels in all samples were below the detection limit (<2.5 mg/kg). Low levels of TOC were detected (Table 6.3) suggesting that there is minimal organic matter present in the sediment.

Table 6.3 Total Organic Carbon percentage by weight concentrations for all sites in Struisbaai Harbour.

	StrGS 1	StrGS 2	StrGS 3	Mean
Total Organic Carbon (%)	0.14	0.1	0.11	0.12

7 CONCLUSIONS

The values reported above are below the set guidelines according to the South African National Action List for the screening of dredged sediment for disposal. Therefore, sediments from Arniston, Gansbaai, Stilbaai and Struisbaai harbours can be safely disposed of at an authorised location with low probability of associated contaminants generating negative effects on the receiving sediment body. At the sites analysed within each of the harbours, no chemical substances were present at higher than 'normal' concentrations. Although these sediments are safe to be disposed of, effort needs to go into the investigation of a suitable dredge disposal location and disposal should only occur at an authorised site. Potential disposal sites should be inspected to assess whether they are suitable for disposal and that there will be limited, mainly physical, detrimental impacts caused by the dumping of sediments.

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