

# CAPE OF STORMS

*Cabo das Tormentas*

Exploring Natural Events at the Breakwater



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PREVIOUS PAGE

FIGURE 1

Concept photomontage for the Cape Town Breakwater.

**CAPE OF STORMS**  
*Cabo das Tormentas*

**Exploring Natural Events at the Breakwater**

Design Research Project APG 5058S

Submitted in partial fulfilment of the requirements for the degree

**Master of Architecture (Professional)**  
MCLHEI001

By

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October 2012

University of Cape Town

# CONTENTS

DESIGN REPORT .....	2
CONTENTS .....	4
PREFACE .....	6
QUOTE .....	8
INTRODUCTION .....	10
<b>1. THE EVENT</b> .....	<b>12</b>
The Event : Landscape / systems / atmosphere ...ineffable place .....	14
Landscape .....	16
Natural Systems .....	19
Atmosphere .....	24
The Event .....	28
Ineffable Place .....	36
<b>2. CONTEXT</b> .....	<b>40</b>
Cape of Storms .....	42
Natural Systems - Wave Patterns and Weather ..	49
<b>3. SITE</b> .....	<b>64</b>
Investigations .....	65
Constructed Landscape - A Barrier into the Sea .....	86

<b>4. DESIGN PROCESS</b> .....	<b>90</b>
Programme selection .....	92
Concepts and Ideas .....	96
Event .....	100
Wall .....	102
Ruptures .....	104
Route .....	106
A walk along the Breakwater .....	107
Storm Invasion .....	112
Finding Form .....	114
Wave Power .....	116
Roughness and Rust .....	118
Sketch Design .....	120
<b>5. TECHNICAL INVESTIGATIONS</b> .....	<b>130</b>
Wave Walls .....	132
Dock Construction ..	136
Breakwater Construction .....	144
Materiality .....	152
<b>CONCLUSION</b> .....	<b>154</b>
<b>THANKS</b> .....	<b>156</b>
<b>REFERENCES</b> .....	<b>158</b>
<b>PICTURE REFERENCES</b> .....	<b>160</b>

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# PREFACE

This project began with an interest in the ocean and its natural power and beauty. I have always had a strong connection to the sea and this led me to investigate the space between the land and the sea.

This design report begins with a theory piece that was written near the beginning of the year. The ideas explored in the theory paper were integral to my choice of context, site and, later, the programme and design.

The next part of the paper will look at the context of the Cape Town Harbour at different scales and through different lenses such as wave action, wind direction and swell heights. These investigations, though not 'architectural', did provide key ideas that could be explored through design. These investigations deal with natural systems, atmosphere and the harbour landscape. The chosen site, the Cape Town Breakwater, was then studied through site investigations and explorations.

The project at the breakwater is one that explores the natural events linked to the ocean. The building will be an Antarctic Museum and the new SANAP research centre. This project can be broken down into five programmes:

1. The Antarctic Museum and Information Centre
2. SANAP Research Centre
3. Breakwater Power Station
4. Docking Points
5. Breakwater Rehabilitation

The report will then deal with the concept and ideas explored through the design process. These will be in the form of short meditation topics. The last part of this document will deal with technical investigations, construction and materiality.

*I would like to acknowledge Professor Jo Fiebert and Professor Nic Coetzer who have guided me throughout the entire process and helped me think about architecture in new ways.*

*I would also like to thank my mom, Catharina, who has always encouraged us as children to play in and next to the ocean, and who has provided the opportunity to undertake this investigation this year.*

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*"The existential purpose of building (architecture) is therefore to make a site become a place, that is, to uncover the meanings potentially present in the given environment."*

(Norberg-Schulz, C. 1996: 422)

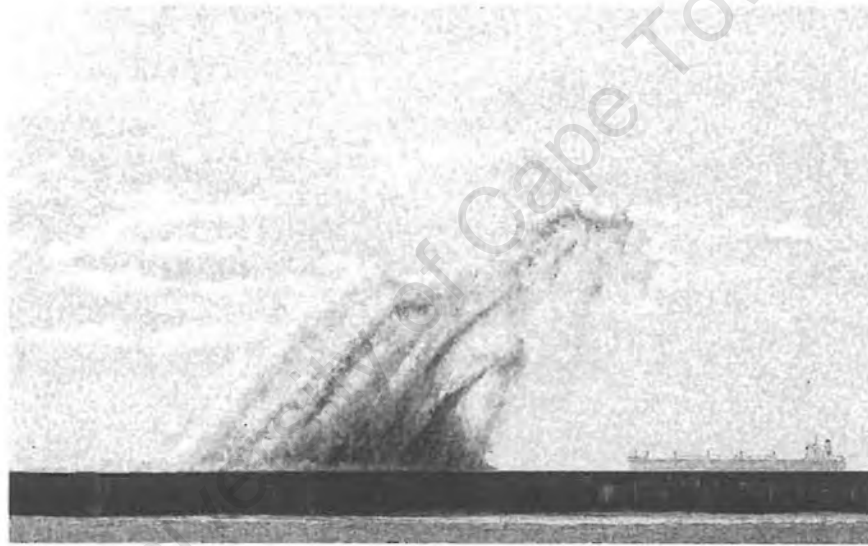


FIGURE 2

The Cape Town Breakwater in rough sea conditions.

# INTRODUCTION

This project is about uncovering natural events in the Cape Town Harbour landscape.

My fascination with the natural event began when I was a child. Living on and near the sea has created an awareness of these natural cycles. One experiences storms, tides, the wind and waves. I am interested in the space between land and sea and where this line overlaps and blurs. This led me to the breakwater site at the Cape Town Harbour. I always imagined what it would be like to experience a storm. The waves would crash against concrete and a spectacular spray would extend towards the heavens. The wind would be blowing the salty spray into my face. The rumbling of the storm surge would be heard, the washing away of earth and stone would erode – all one's senses would be alive. This would be exhilarating terror – this is an event.

This project is about storms, walls, surge, sea spray, sublime experience, ruptures, water explosions, power, route, weather, rust, roughness ... and how these invade our human experience and space.

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# 1. THE EVENT



FIGURE 3

The Great Wave off Kanagawa.

# THE EVENT :

LANDSCAPE / SYSTEMS / ATMOSPHERE ... INEFFABLE PLACE

The purpose of architecture is to create meaningful place. This is done through transforming and revealing the hidden qualities that may be dormant on the site. Before one even begins to conceptualise architecture I believe there needs to be a greater and deeper understanding of site. The site consists of the landscape, natural systems and the atmosphere. Together they can create an event, a moment in time, an experience greater than the ordinary occurrence. When we uncover these special layers of a site and give them presence in our architecture...then an indescribable place comes into being.

One can illustrate this bringing together of elements by using the analogy of a theatre production. The landscape acts as a stage set for the event to take place. The natural systems which augment a site can be seen as stage props that enhance the set. The atmosphere in a way acts as the stage lighting, it provides ambiance. People are either the actors or viewers. All these different pieces create a theatrical event and together create a place. This event place can be called phenomena.

What will happen when there is a collision between architecture and nature? What will happen when static architecture collides with dynamic forces... would not something indescribable happen?

There has been an increased interest in buildings exploring the natural event. This can be seen as a desperate attempt to reconnect the body with planet earth. Space and architecture should be created to experience the power of nature.

An architectural event will take place when one reveals and uncovers the landscape, systems and atmosphere. Space receives its essence and significance from its setting. When natural elements inhabit and invade our buildings the event will occur. This will create a place indescribable, sublime, breathless ...ineffable. Let us create the event.

These ideas of event and architecture will be briefly discussed through a series of short meditations. These meditation topics include: landscape, natural systems, atmosphere, event and ineffable space.

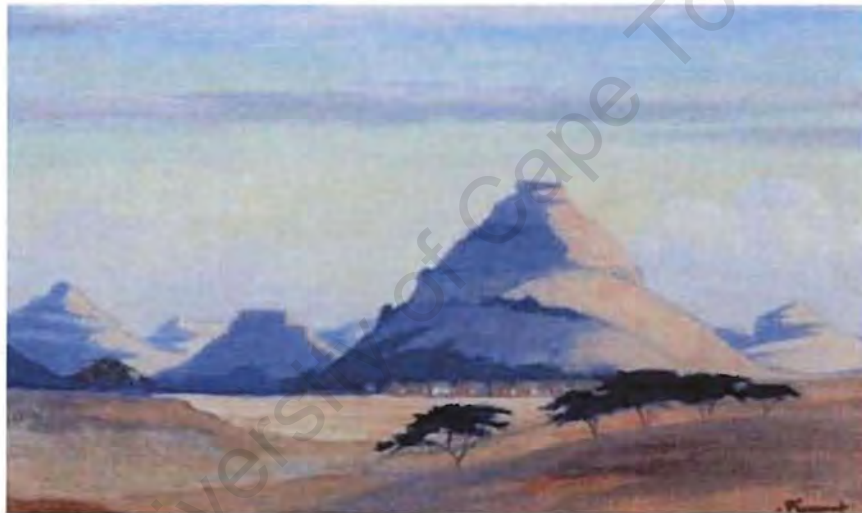


FIGURE 4

A Pierneef painting – Landscape with Trees.

# LANDSCAPE

*"Although we are accustomed to separate nature and human perception into two realms, they are in fact indivisible. Before sunrise, landscape is the work of the mind. Its scenery is built up as much from strata memory as from layers of rock." (Schama, S. 1985: 6-7)*

There has always been a strong connection between man and the landscape. What Schama states above is true. There is a link between human perception and nature. When people spend most of their time in a certain type of landscape it shapes their intellect and affects how they perceive space. For example people who grow up in open, vast landscapes often feel claustrophobic in dense urban settings. They perceive their surroundings based on the connection to their domicile landscape.

The landscape is the stage setting for architecture, where man and events are to be expressed and experiences to be acted out. The landscape of plains, mountains, rivers and forests has impacted man's imagination and inspiration, and man has in turn transformed the natural landscape into one supporting his needs.

The route of the word "landscape" comes from the German word "Landschaft". Landschaft indicates a unit of human occupation, or a zone of jurisdiction, but a pleasing area of representation. The Netherlands people modified this word to "Landschap", using it to describe their flood plains, which required human engineering and intervention, but also expressing the picturesque. In English the word developed to "Landskip" which later changed to "landscape". (Schama, S. 1985: 10)

There are three types of landscapes one can work within, the natural, man-made and the augmented landscape, which is a combination of the two. A case study that deals with landscape will follow.



FIGURE 5

Elevation of the geofluidic landscape. Notice how layers built up in the elevation relate to the strata of the rock in the landscape.

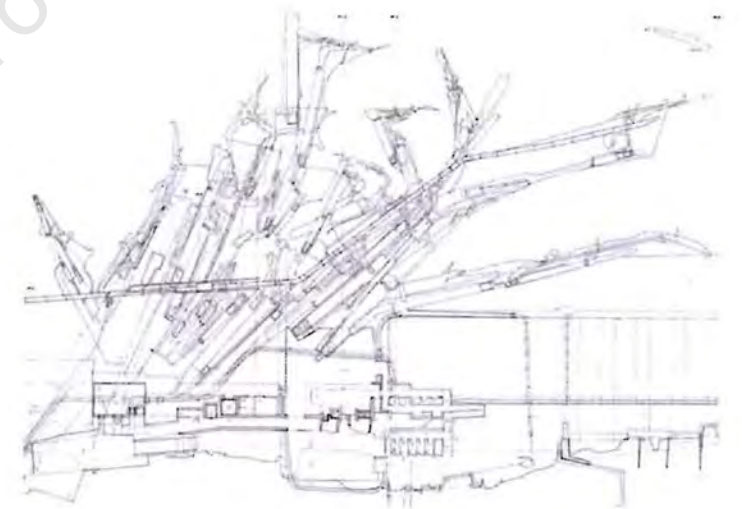


FIGURE 6

Plan of the geofluidic landscape project by Smout Allen Architects.

# CASE STUDY:

## THE GEOFLUIDIC LANDSCAPE by SMOUT ALLEN

The site of this architectural proposal is in the Nessodden Peninsula in Southern Norway. It sits at an edge between landscape and seascape. The architects' intention for the building was to blur this boundary between land and sea. They were seeking architecture that becomes embedded in and a part of the landscape. Ideas of geology and topography informed and inspired the design. The two main elements that were augmented and given presence in the project were rock and water.

Rock speaks of the fixed landscape – the facade and levels are a build-up to highlight the topographical layers. There is also the idea of shifting topography, i.e. continental plates, as pieces of the building shift and move by the clever use of counterbalances and weights.

The water speaks of the dynamic system acting on the landscape. This was given a presence by letting it invade the architecture. This building gives presence to the landscape by highlighting the surrounding tides, water systems, textures and light qualities.

*"The building explores the natural cycles and processes that are present in the surrounding landscape and apparent in the ambient and latent qualities of the site." (Smout, M. Allen: L. 2007: 11)* Through augmenting the landscape, genius loci has been created.

# NATURAL SYSTEMS

If landscape is the stage of the event, then natural systems can be considered as the props that act and move on the stage. These systems enhance and bring life to the landscape. While the landscape speaks of a fixed environment, natural systems are in a constant state of shifting, moving and changing. Natural systems have the essence of time and duration.

These systems can bring life or destruction to the landscape. Rivers, tides and springs bring life to landscape, erosion speaks of weathering of landscape, and deposition builds the landscape up.

Through architectural devices these systems can be made known or given presence, and our human connection to the land strengthened. For example windmills are a common site on the South African landscape; they bring presence to the natural systems that occur underneath the ground.

A case study that deals with tides will follow.

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FIGURE 7

Aerial view of a river cutting into the landscape - the amazing patterns almost do not seem real.

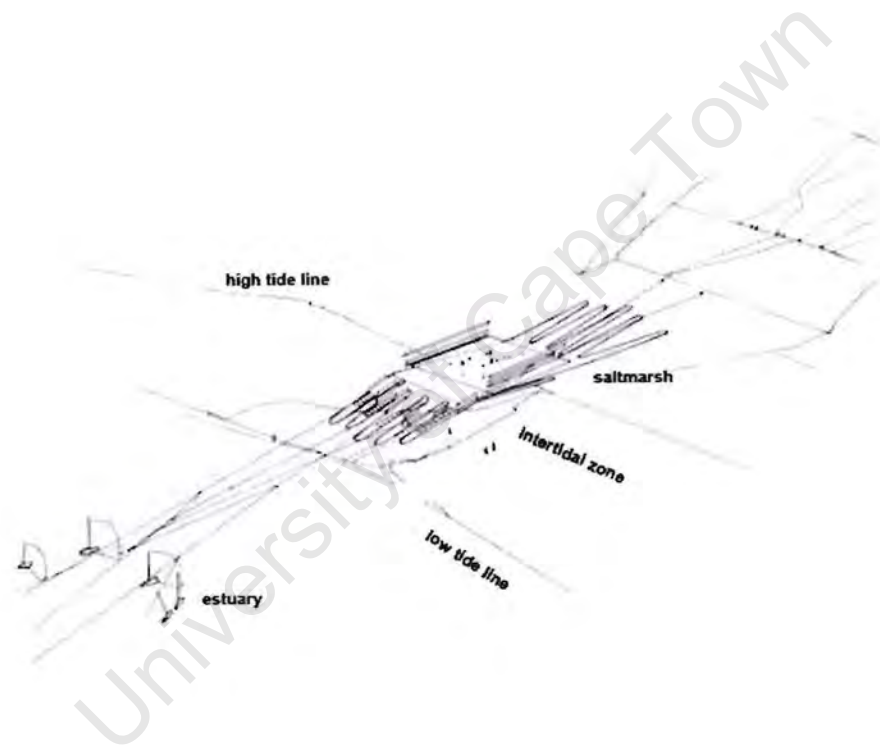


FIGURE 8

Perspective drawing of the proposal for the market platform. By Smout Allen Architects.

## CASE STUDY:

### THE MARKET IN THE MARSHES by SMOUT ALLEN

The site of this project is in Essex. The landscape is characterised by estuaries which form a type of blurred boundary between water and land as the tide moves up and down. This boundary is always shifting. The project tries to connect the land with the sea.

The platform with its extension fingers sits in the inter-tidal zone. This will allow the tide to ebb and flow up parts of the structure, revealing the changing conditions of tide throughout the day. Therefore this market platform changes in terms of space and activity depending on the tide. By harnessing the tidal flows, I believe the genius loci of the site and project have been established.

(Smout, M. Allen, L. 2007: 31)

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FIGURE 9

Laugier's primitive hut revealing the origins of architecture. Shelter is the starting point of architecture.

# ATMOSPHERE

*"The sky is the vaulting path of the sun, the course of the changing moon, the glitter of the stars, the year's seasons, the light and dusk of day, the gloom and glow of night, the clemency and inclemency of the weather, the drifting clouds and blue depth of the ether..." (Norberg-Schulz, C. 1996: 417).*

The atmosphere speaks of the heavens or the sky. The atmosphere controls the climate of the earth and creates the weather systems that move across the landscape. Weather can be a gentle breeze, a temperate climate or a raging storm that brings destruction. One of architecture's primary aims is to keep the weather outside, but there is a new interest in what will happen if the weather comes inside our buildings.

## **WEATHER – THE IMMATERIAL REALM**

*"Weather and weathering are metaphors for the outside pouring into architecture, blurring its boundaries, disturbing its contents." (Hill, J. 2006: 192)*

Weather is invisible in form yet visible through its actions. It is hard to distinguish where it starts and where it ends. Hill questions what will happen if weather disturbs our architecture. One of architecture's functions has been to protect against the atmosphere. What will happen if the invisible invades architecture?

Weather, atmosphere, and horizons all play a part in the design of architecture and its experience. The daily cycle of the sun, the shelter from rain, the wind and ventilation are all aspects that affect and shape architecture and space.

Architecture has limited contact with the weather and atmosphere; buildings are sealed off from air, light and natural climate. The window was created as a device that connects one to the outside world – but one still remains safe and disconnected from the weather. The window allows one to witness the weather but still remain separate.

We exist in a new and interesting period, one obsessed with the atmosphere and global warming conditions. The interest has moved from the visible to the invisible. The concern of the world has become atmospheric and meteorological.

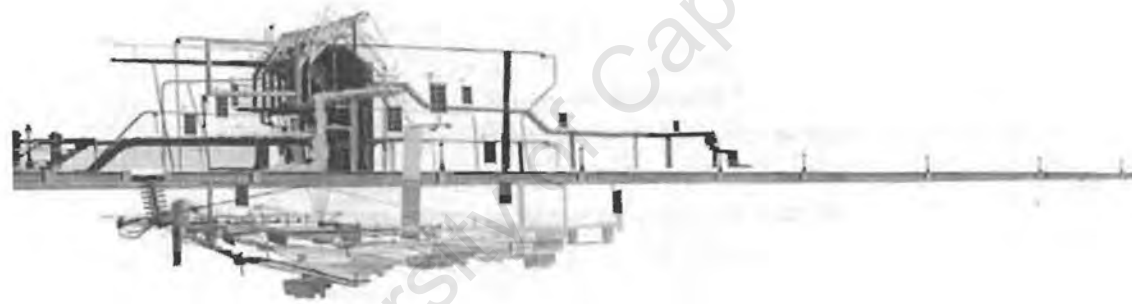


FIGURE 10  
Elevation perspective from the river.

# CASE STUDY:

THE (UN)NATURAL HISTORY SOCIETY by ANTON AMBROSE

This is an experimental project that challenges our concepts of architecture and weather. It is to be located on a site next to the Thames River in London. Instead of designing a building to house people, this building was designed for the weather to inhabit it. The idea is that as the building ages and grows, there will be a continual blurring between what is inside and outside, what is natural and artificial. This building aims to highlight the different weather conditions throughout the year, treating them like guests inside a house. (Hill, J. 2006: 195)



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FIGURE 11

A writing desk for the tide, a mist carpet and window for the wind.

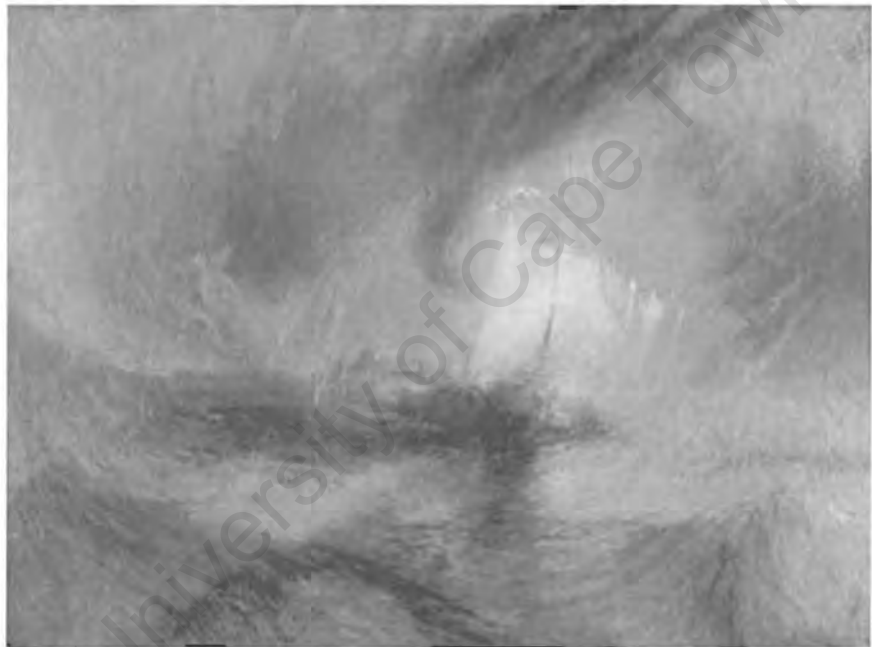


FIGURE 12

Turner's painting, the Snow Storm: Steam-Boat off a harbour's mouth. Turner was in this storm on the night the Ariel left Harwich in 1842.

## THE EVENT

Natural events are explosions of nature that happen in the landscape; human events are those things that happen in the realm of the daily occurrence. The manufactured event can be seen as a device that encourages events through human intervention. Events are moments in time which are memorable; you can remember the way the place felt, what it looked like, and the smells in the air. Events are connected to the senses and our perception. They mark a point in time that is not forgotten.

Turner also shares this fascination with the event – the natural and man-made. He once asked some sailors to tie him to their ship's mast during the coming storm. This was so he could experience the event, so he could really understand the storm. He then painted what he experienced. His work is filled with memory and expression and takes the viewer to that moment in time in which the event transpired.

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# THE NATURAL EVENT

Man has always had a fascination with the natural event – often these events were attributed to the gods. Lightning was the striking anger of Zeus, a biblical rainbow was a new promise to a nation, and the stormy waves were from the god Poseidon having his revenge. The event has mythical and sublime qualities.

Natural events are the collision of weather, natural systems and landscape. These are normally spectacular displays of nature's fury and power. A tropical cyclone, floods, stormy sea waves, tornados, an avalanche, earthquakes or a volcanic explosion - these are the natural events. People are fascinated with these destructive forces and readily watch them unfold and look on in awe as they observe their television sets.



FIGURE 13

The waves crash against a pier wall creating a dramatic spray. This is an event.

# THE HUMAN EVENT



Human events are things we consider special in our daily experiences. These can be things such as watching ships enter and leave the harbour, watching aeroplanes rise into the sky, or the arrival of friends and family from a long sea voyage. These types of events will be different from person to person, but they still speak of special moments in time.

FIGURE 14

The arrival of a ship is an example of a human event – people waiting for loved ones to return to land.

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# THE MANUFACTURED EVENT

The manufactured event is an event which is encouraged or created by human intervention. Examples of these include when dam walls open and the river below fills up, or when the lightning rods on buildings direct where the bolts will hit inside the urban setting.

Manufactured events are linked to their location and their surroundings. These events can bring power and meaning to a site; manufactured events enhance and bring out the qualities that already exist in the landscape. Through architecture I believe there is the possibility to create and manufacture potent events that will be remembered and enjoyed. The concept for the Turner Gallery is an example that explores the idea of the manufactured event.

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FIGURE 15

The Turner Contemporary Art Gallery on the Margate pier in the UK.

## CASE STUDY:

### THE TURNER CENTRE by SNOHETTA SPENCE

This is a conceptual project that was undertaken by Snohetta Spence Architects. It is located in the small seaside town of Margate which is in the eastern part of Kent. The brief was for an art gallery that would house the William Turner collection. The connection with the sea is an important quality that the project seeks to explore. This sea connection is also important as many of Turner's paintings depict seascapes, storms and natural events.

Turner used to visit Margate as a child and his sketch-books are filled with drawings of the area. The conceptual proposal places the building on one of the Margate piers. This site is very vulnerable to wave action and sea spray. The architects wanted to uncover these natural occurrences. There is a massive structure which protrudes from the sea and acts as a landmark for the surrounding area. This sculptural wall acts as a surface against which the waves crash.

When there is a storm, the wave spray becomes a theatrical and sublime experience. The power of nature is displayed both inside and outside the building. Unfortunately, due to cost implications, this project was never built.

This is a perfect example of architecture manufacturing an event. This project speaks about the weather, systems and the landscape that collide to create something breathless.

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# INEFFABLE PLACE

*"The phenomenon of ineffable space refers to the maximum intensity and the quality of exaltation and proportion - an experience becomes infinite. Dimensions alone do not create this space: rather, the space is a quality bound up in perception. (Holl, S. (2000): 31)*

The realm of the ineffable is hard to explain. It's hard to pin point the pieces that make this type of place. Certain places move me while others do not. The question "why" is important to ask but the answer is different from person to person. For me ineffable place could be on the top of a mountain I just climbed, or standing in a seaside cave listening to the sound of the waves roar; it is the first rays of light entering my living room in the cold winter months. Ineffable place in architecture is difficult to create. I do believe there has to be a connection with the outside realm - the natural world which invades spaces. Ineffable place is experienced through our own perceptions and understandings.

## MEANING OF INEFFABLE

Incapable of being expressed; indescribable or unutterable.

Too great or intense to be expressed in words. From the Latin ineffabilis which means unutterable, from in + effabilis, from effario – to utter, from fari – to speak. (Oxford Dictionary 2000)

Places all have a certain temperament. This essence of place can change from time to time. While the site is fixed, it is the unfixed that can change the feeling of a place. For example a site can feel completely different in overcast conditions or in bright morning light. The feeling of places is therefore transient in nature and constantly changing.

I am not saying that every building or place has to be ineffable. That would mean we would live in a wordless, indescribable place, constantly in awe of our surroundings. I am saying that these types of places need to be scattered across our landscape so that man can feel connected to the earth (man's realm) and the sky (the realm of the gods).

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We need places that move us, where our bodies can witness phenomena and beauty, places where our senses and emotions come alive. Peter Zumthor seeks the type of architecture that moves one. He believes the only way to create these spaces is by first evaluating a place and, after understanding it well, working out its underlying purpose and significance.

He states that *"quality architecture is not to let a building manage to overcome the space but to let it breathe."* (Zumthor, n. 2006: 10).

Certain places have certain atmospheres; a place that has an ability to move us is ineffable. These places we perceive through emotions and the way they make us feel, the way we experience these emotions.

For me, ineffable place is a collision of landscape, systems and atmosphere – these make an event present, and through event an effable place is born. A place may not be ineffable all the time; this moment can come and go. For example, most of the time a simple pier wall is just a nice place to walk and view the sea water swell.

But when the atmosphere (wind) collides with a natural system (waves) that collides with the landscape (the pier), an event is formed and the previously mundane place is transformed into something indescribable.

So why can't architecture sometimes create these types of places, allowing for these types of events? Architecture can enliven our daily experiences. When architecture touches the realm of the sensory, our experience is intensified. When I hear the ocean rumble, smell the sea air and feel the sea spray, my sensory realm comes alive. Architecture should harness the natural environment and make our senses come alive. It is through our senses that we perceive the feeling of place.

Where atmosphere invades the building, where natural systems rise through the cracks, where landscape is given presence – this would be to create a beautiful moment, an event, a moment where a new type of place is experienced.

*"Ineffable place is the coming together of earth, sky and world. The concept of genius loci denotes to the essence of place." (Norberg-Schulz, C. 1991: 111)*

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## 2. CONTEXT



FIGURE 16

Prince Alfred tips the first wagon of rubble to commence the start of the Cape Town breakwater construction. 17 September 1860.

# CAPE OF STORMS



Cape Town was first called 'Cabo das Tormentas' (Cape of Storms) by the Portuguese sailors who rounded the Cape. These waters are filled with myths, stories and sheer destruction. Once the settlers had arrived, more ships sought shelter during their voyage to India, the Cape acting as a refreshment station. The bay of Cape Town, with its rough winter seas, saw many hundreds of shipwrecks that resulted in lost lives. Ships washed onto shoreline rocks and were battered for days by storm surge. At one point the international company Lloyds of London refused to offer insurance to ships that docked in Table Bay. The Cape shoreline is littered with remnants of old wrecks claimed during violent storms; even today ships are still wrecked along this violent coastline.

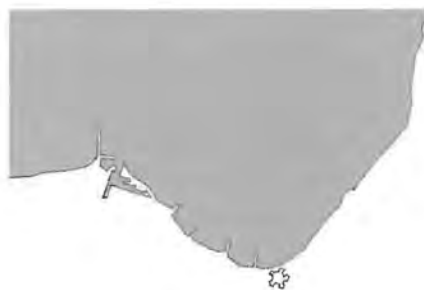
It took 200 years before the settlement agreed on building the harbour and breakwater. Building commenced on 17 September 1860 when Prince Alfred tipped the first truck of rubble to officially start the construction of the breakwater.

The Cape Town Harbour has enjoyed the arrival of many ships; this has become a part of the Cape Town culture. For example, the song "Daar kom die Alabama" is a traditional festival song about the famous confederate ship that docked in the harbour. There are also many sea myths attached to the Cape of Storms such as the Flying Dutchman, which is a ship that sank in a tragic storm. Many swear of its existence.

Storms are entangled with the history and development of Cape Town as a harbour city. The Cape of Storms is a violent, exhilarating context to work in; it is an unpredictable realm, always shifting as the atmosphere takes control.

FIGURE 17

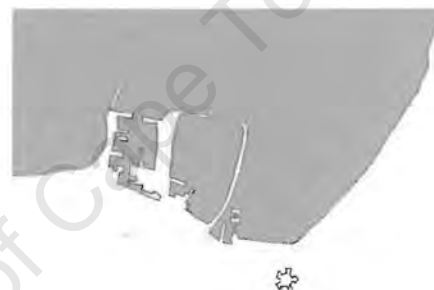
The famous ghost vessel - the Flying Dutchman on the high seas.



YEAR 1860



YEAR 1860 - 1920



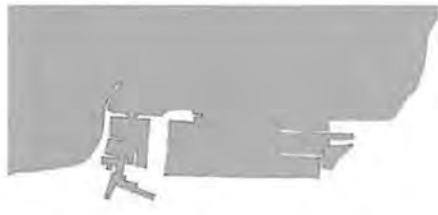
YEAR 1920 - 1933



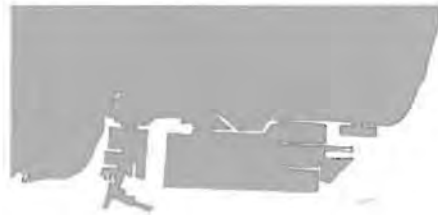
YEAR 1933

FIGURE 18

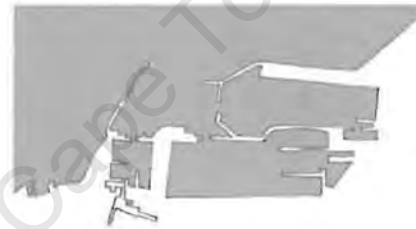
The development of the Cape Town Harbour from 1860 - 1933.



YEAR 1933 - 1945



YEAR 1945 - 1966



YEAR 1966 - 1985

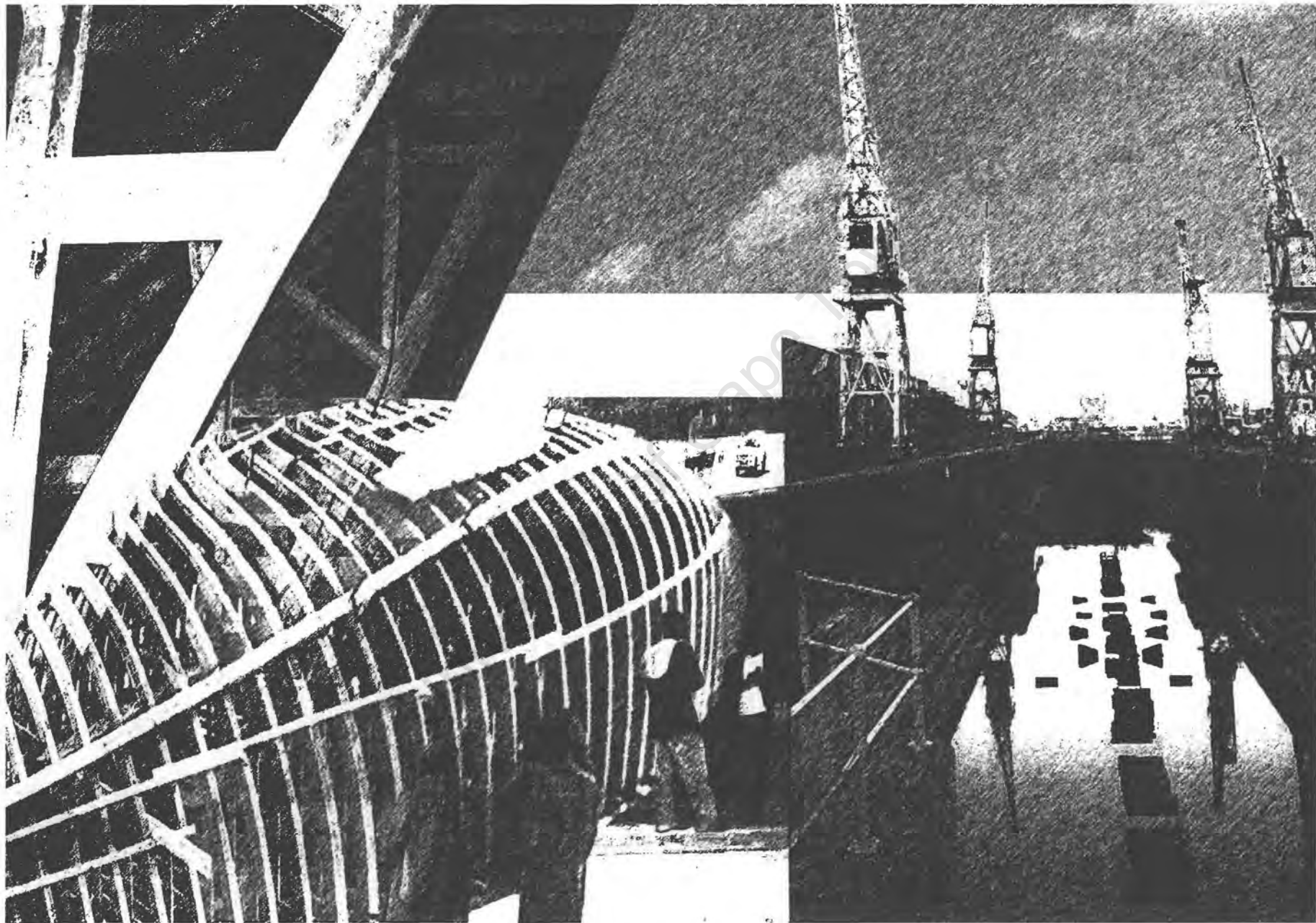


CURRENT CONDITION

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FIGURE 19

The development of the Cape Town Harbour from 1933 - current date.



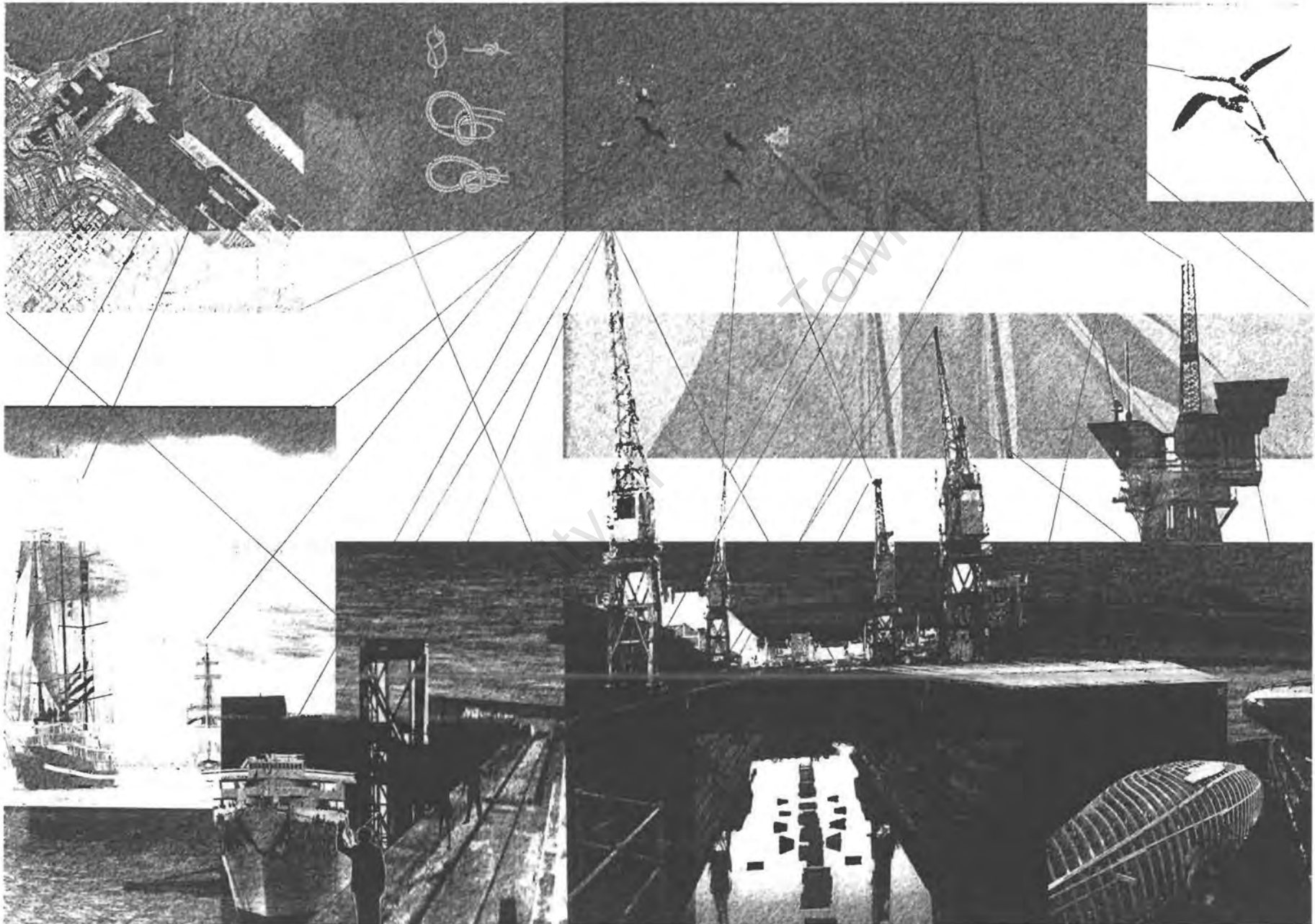
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FIGURE 20

Conceptual photomontage of the harbour environment.

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FIGURE 21  
Conceptual photomontage of the harbour conditions and activity.



# NATURAL SYSTEMS

## WAVE PATTERNS AND WEATHER

It is important to realise that storms that hit the Cape are generated down below in the Antarctic region. These cold movements of air can be seen on satellite imagery and can give one the scale of these immense storms. It is through this air movement and these pressure systems that huge swell patterns develop out in the Atlantic and then move towards land, creating destruction in its path.

Out in the open seas, sailors have told stories of rogue waves that are to immense too imagine. These monster waves occur during a storm and almost always result in a wreck; they are classified as a natural phenomenon. Oil rigs and ships that have survived these waves have measured waves of up to 48 meters. Rogue waves are most common in the South Atlantic Ocean and they diminish as they travel landwards towards South Africa.

On the following pages are a series of storm, wind and swell direction data. These mappings add an extra layer to the understanding of the context that is the Cape Town Harbour.

The dominant wind directions for Cape Town are the southeaster and the northwest wind patterns. The southeaster is most dominant in the summer and spring months, as can be seen on the wind rose. The northwest wind is usually accompanied by a storm or cold front and is typical for the winter months. The wind plays a huge roll in swell that is generated far out at sea.

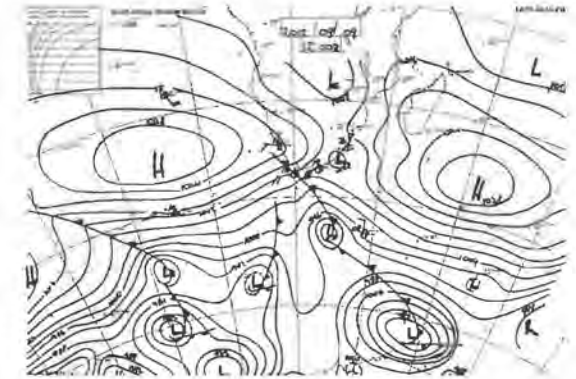
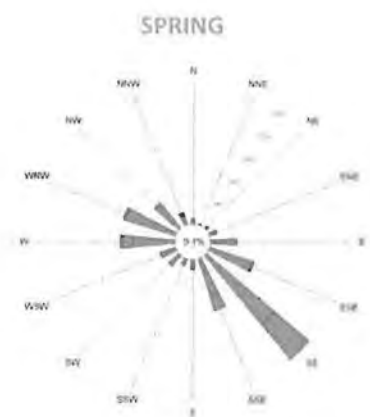
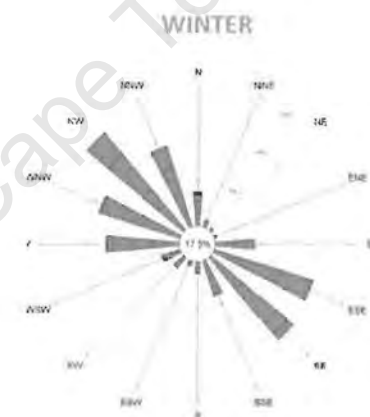
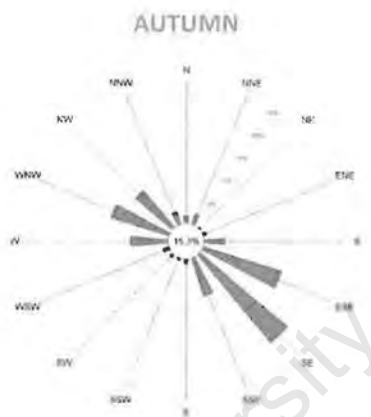
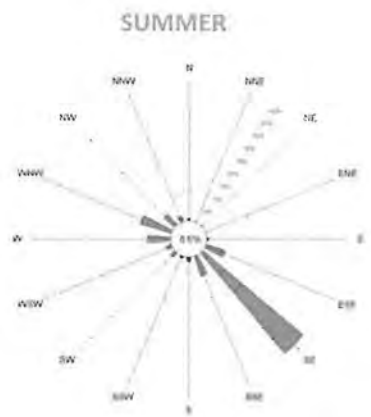


FIGURE 22

Synoptic weather chart showing a cold front progression towards SA.



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**FIGURE 23**  
Seasonal wind direction data for Cape Town Harbour.

This is a series of swell progression mappings. Also revealed is how swell patterns are reflected along the edges of Table Bay. The strongest swell direction is the northwest wave progression. This is a typical swell that occurs during the winter storm season. Other prominent swell directions are west and southwest directions.

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FIGURE 24

Ocean Topography - soundings.

FIGURE 25

North-West Wave progression.

FIGURE 26

West Wave progression

OCEAN TOPOGRAPHY - SOUNDINGS



NORTH - WEST WAVE PROGRESSION



WEST WAVE PROGRESSION



FIGURE 27

South-West wave progression.

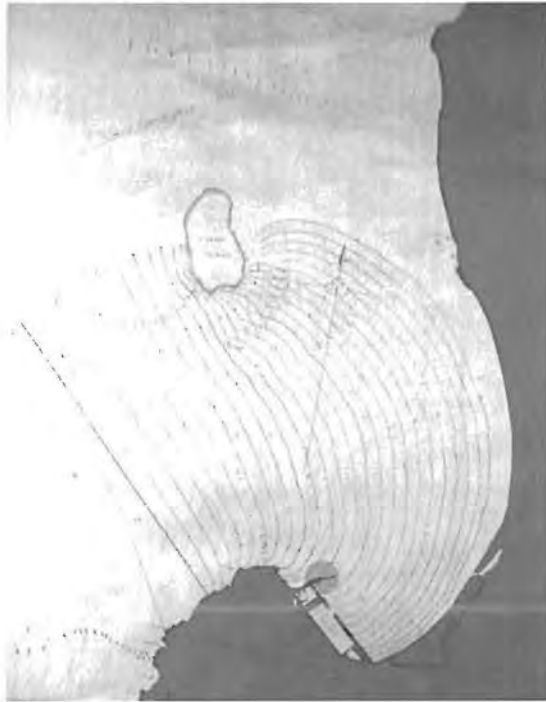
FIGURE 28

West wave reflection from west channel.

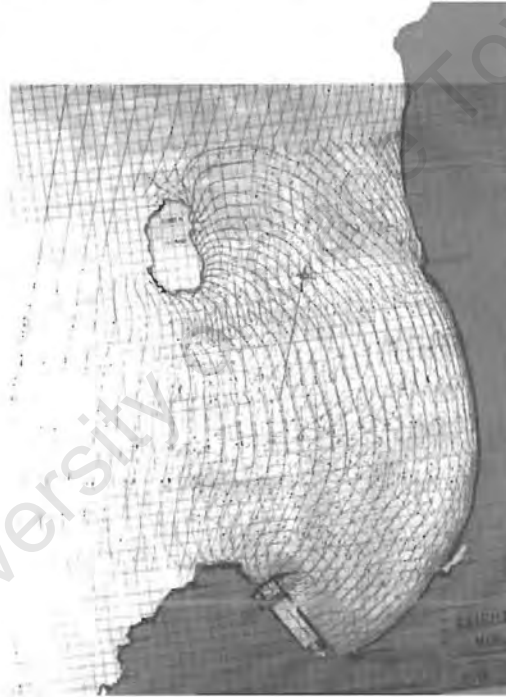
FIGURE 29

West wave reflection from north channel.

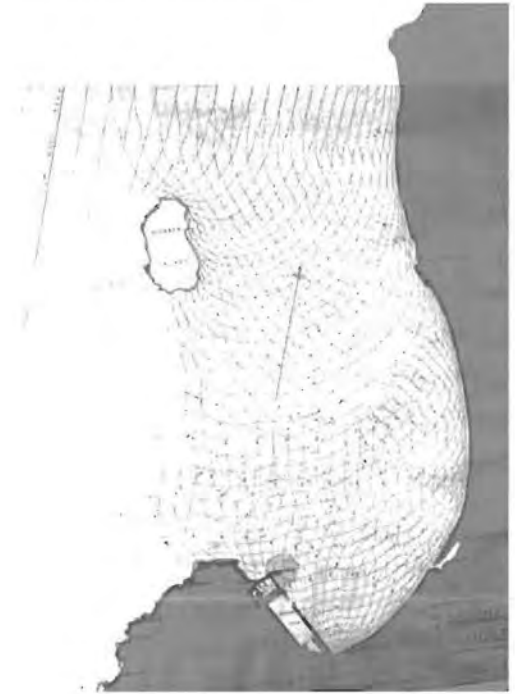
SOUTH - WEST WAVE PROGRESSION

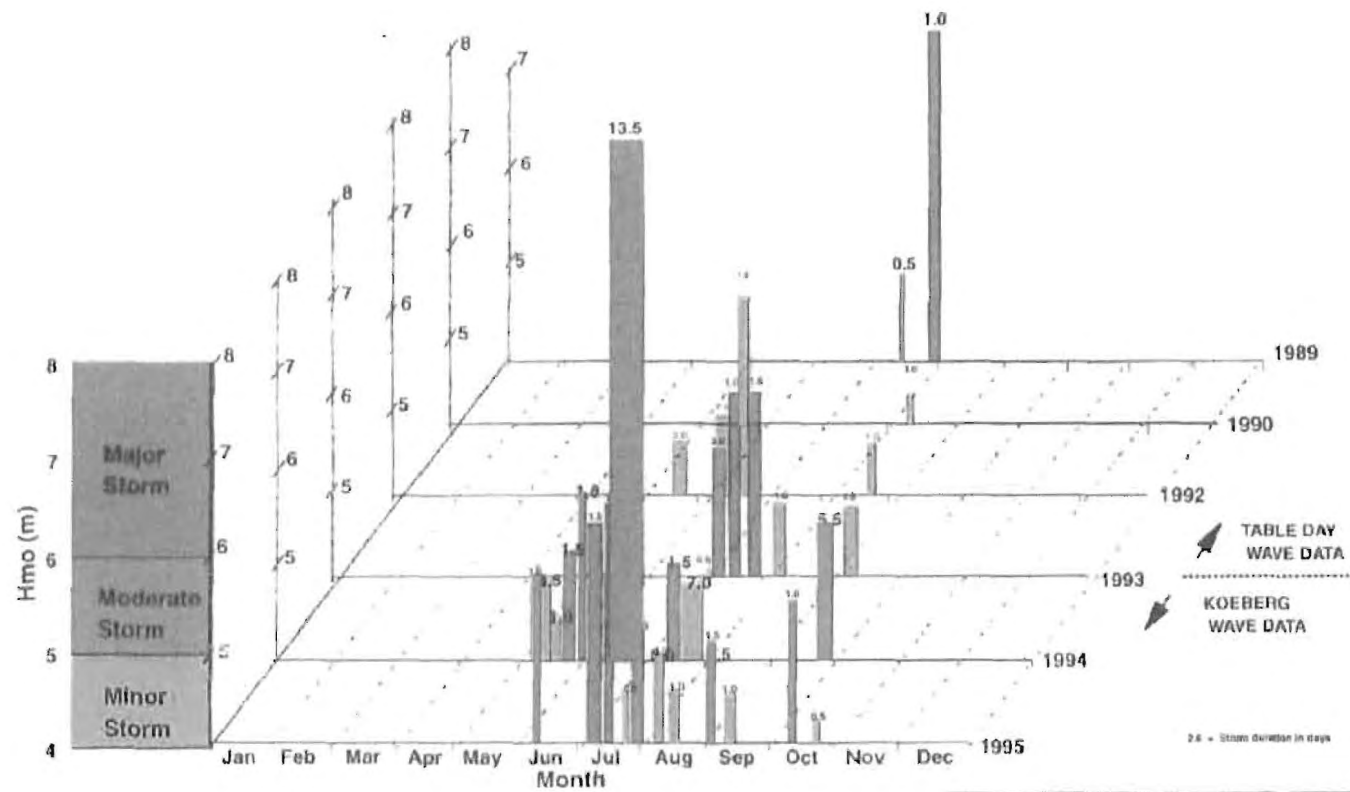


WEST WAVE REFLECTION FROM WEST CHANNEL



WEST WAVE REFLECTION FROM NORTH CHANNEL





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FIGURE 30  
Storm data for Cape Town 1989 - 1995.

On the right is a drawing of Table Bay which includes the harbour. This drawing shows the three dominant swell directions and how they act against the land and man-made structures. One can see that the Cape Town Breakwater plays a huge role in deflecting waves away from the harbour interior. This structure bears the brunt of the storms on behalf of the harbour.

On the following pages are sections that deal with a portion of the breakwater site. These sections each show how swell heights affect and act on the landscape. Swell heights are shown at mean sea level as well as spring high levels. The chosen heights are 2 meters (average swell), 4 meters (rough seas), 8 meters (large winter storm) and 13 meters (100 year storm). The sea spray heights are also displayed. This height will be two times the swell height. These sections also reveal the depth of water penetration into the site. During large storms, water can spill over the breakwater and into the harbour.

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FIGURE 31

Three dominant swell patterns for Cape Town Harbour.

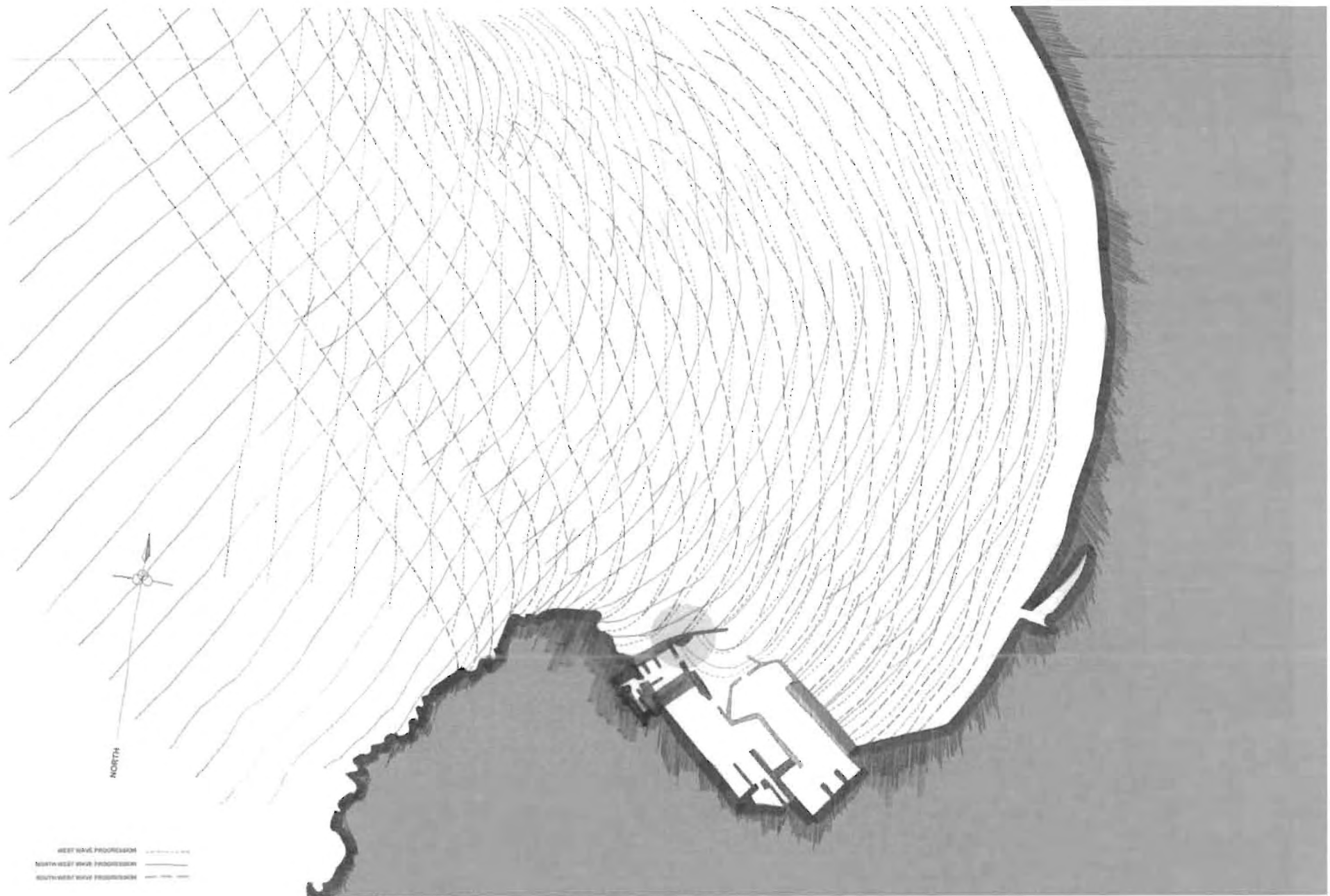
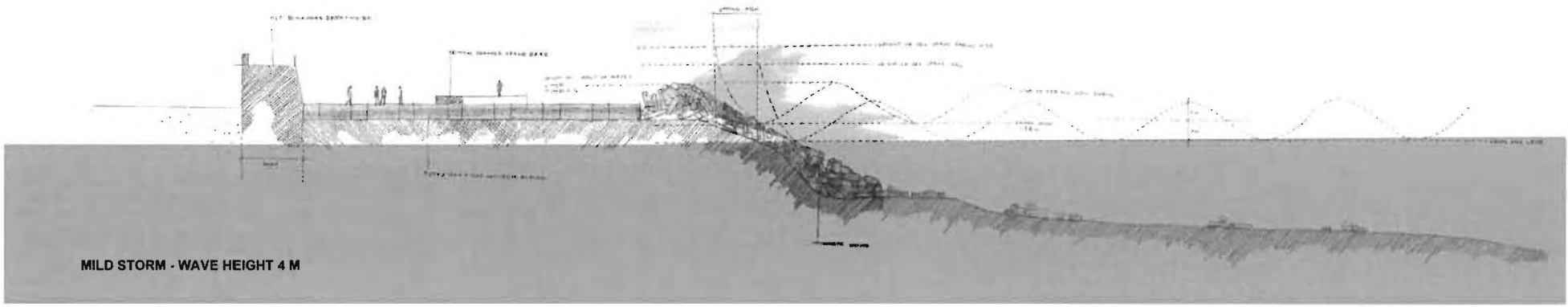
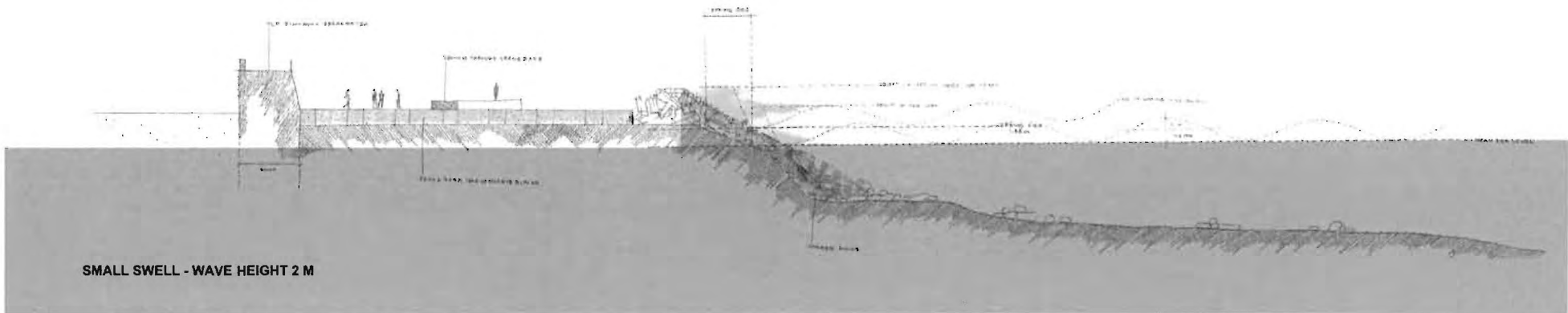


FIGURE 32

Small swell - Wave height 2 m.

FIGURE 33

Mild Storm - Wave height 4 m.



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FIGURE 34

Large storm - Wave height 8 m.

FIGURE 35

100 year storm - Wave height 13 m.



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### 3. SITE

# INVESTIGATIONS

The breakwater that extends from the eastern pier has been chosen for investigation. This site offers unique challenges that will help inform and guide the design. Due to the location of the site, the type of architecture will need to be robust to cope with its surroundings. A series of site investigations and mappings were done to uncover greater detail and meaning on this constructed landscape.

On the following pages are a series of site plans that are drawn at different scales to show greater detail of the surroundings, activities and textures that are present on the location. The two long site sections drawn reveal the immense scale of this breakwater site. There is always this contrast between the rough seas, the structure that extends into the sea and the resultant calm waters of the harbour interior.

FIGURE 36

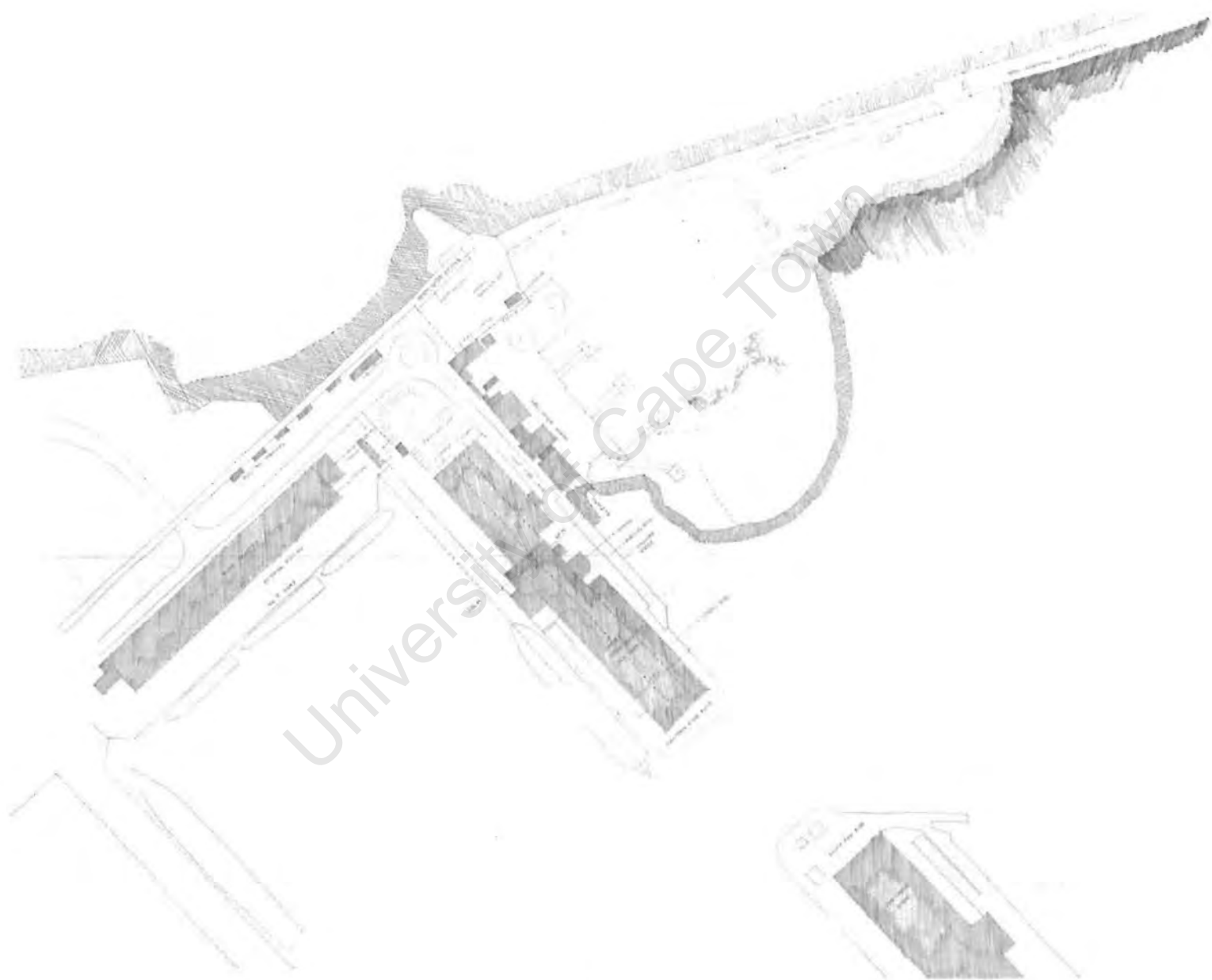
Contextual Aerial map showing the greater Cape Town Harbour.

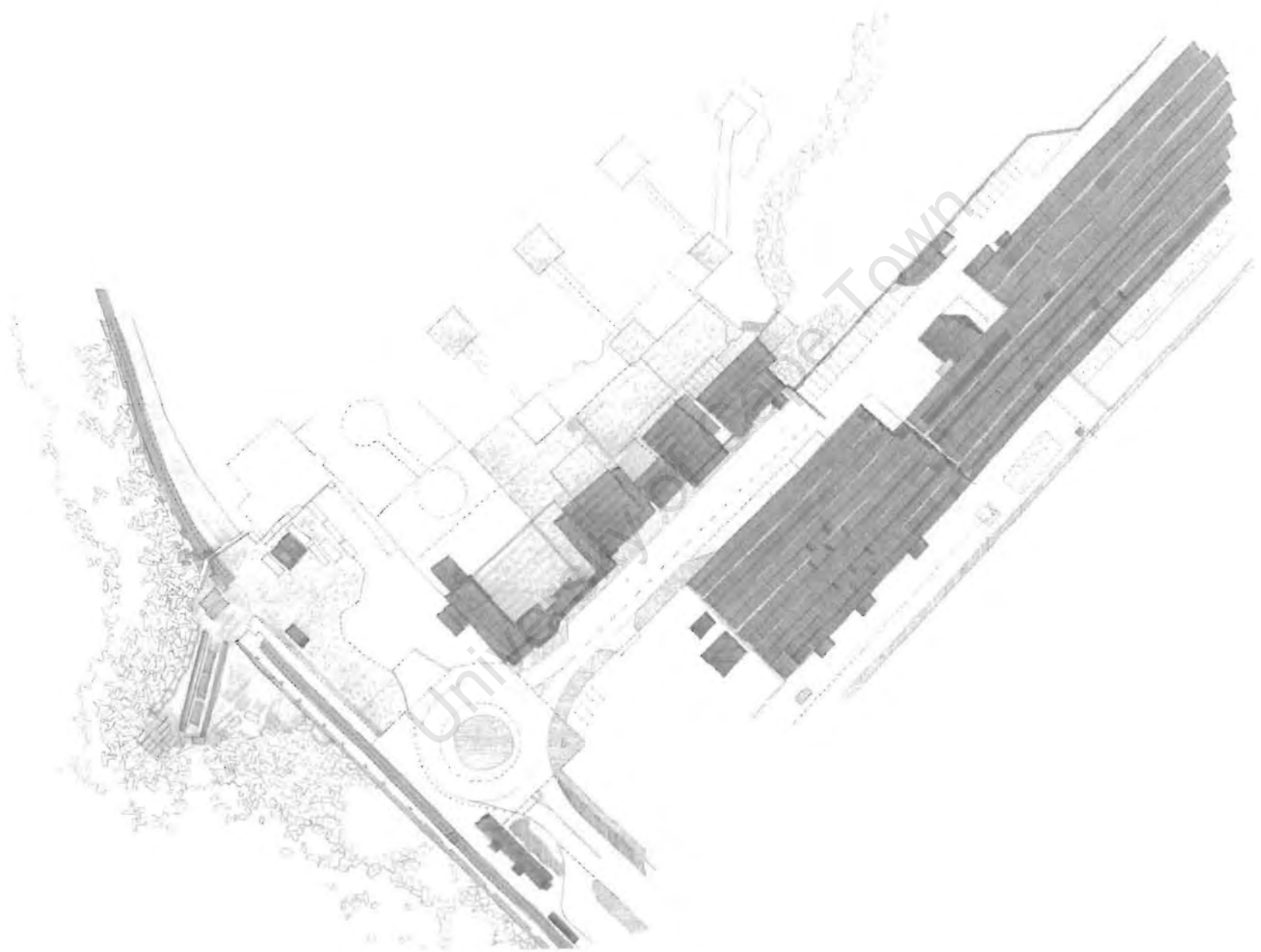


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FIGURE 37

Site Plan showing the immediate context.





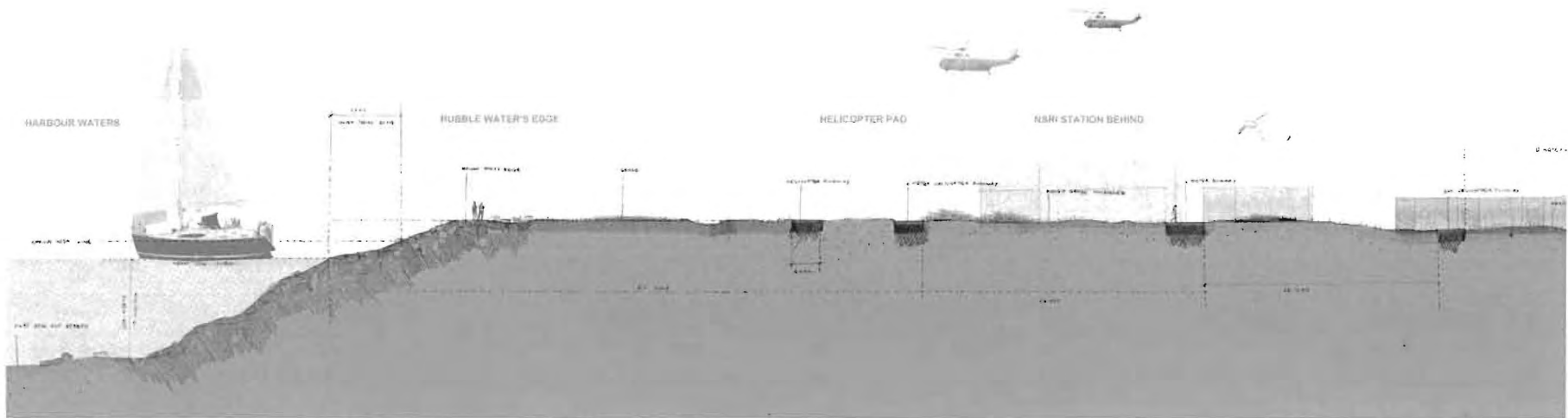
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FIGURE 38  
Site Plan zoomed in.

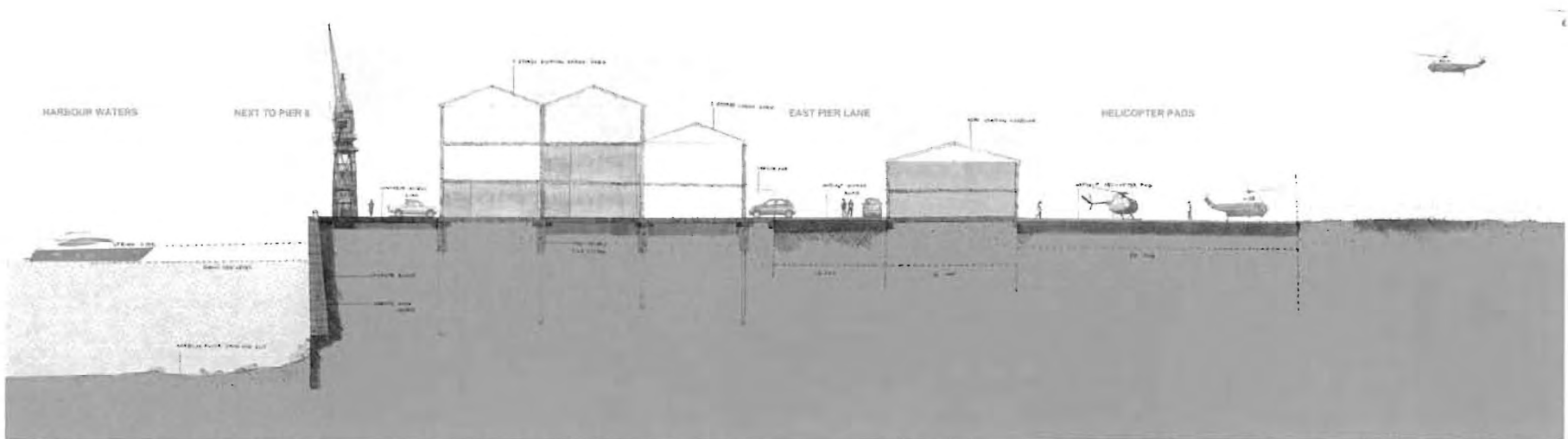
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FIGURE 39  
Site Plan composite drawing.





SECTION A : A



SECTION B : B

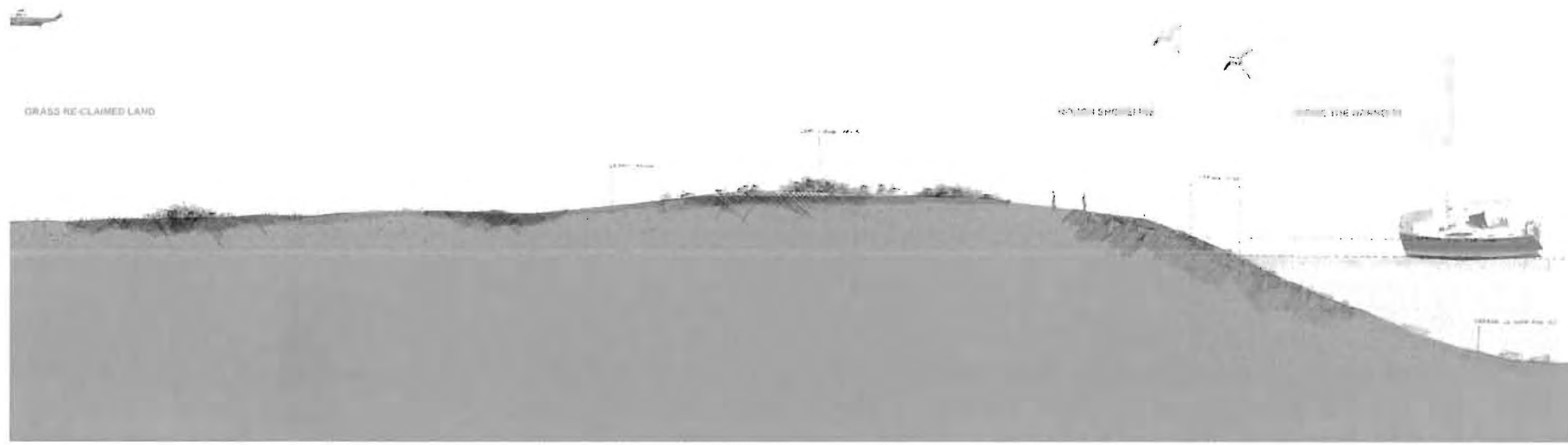
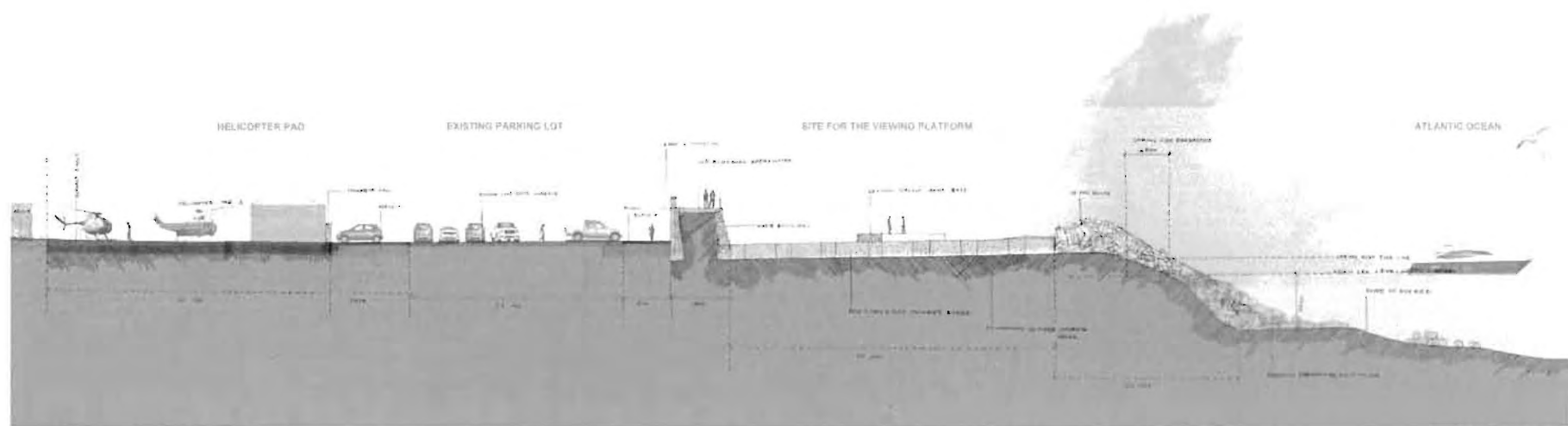
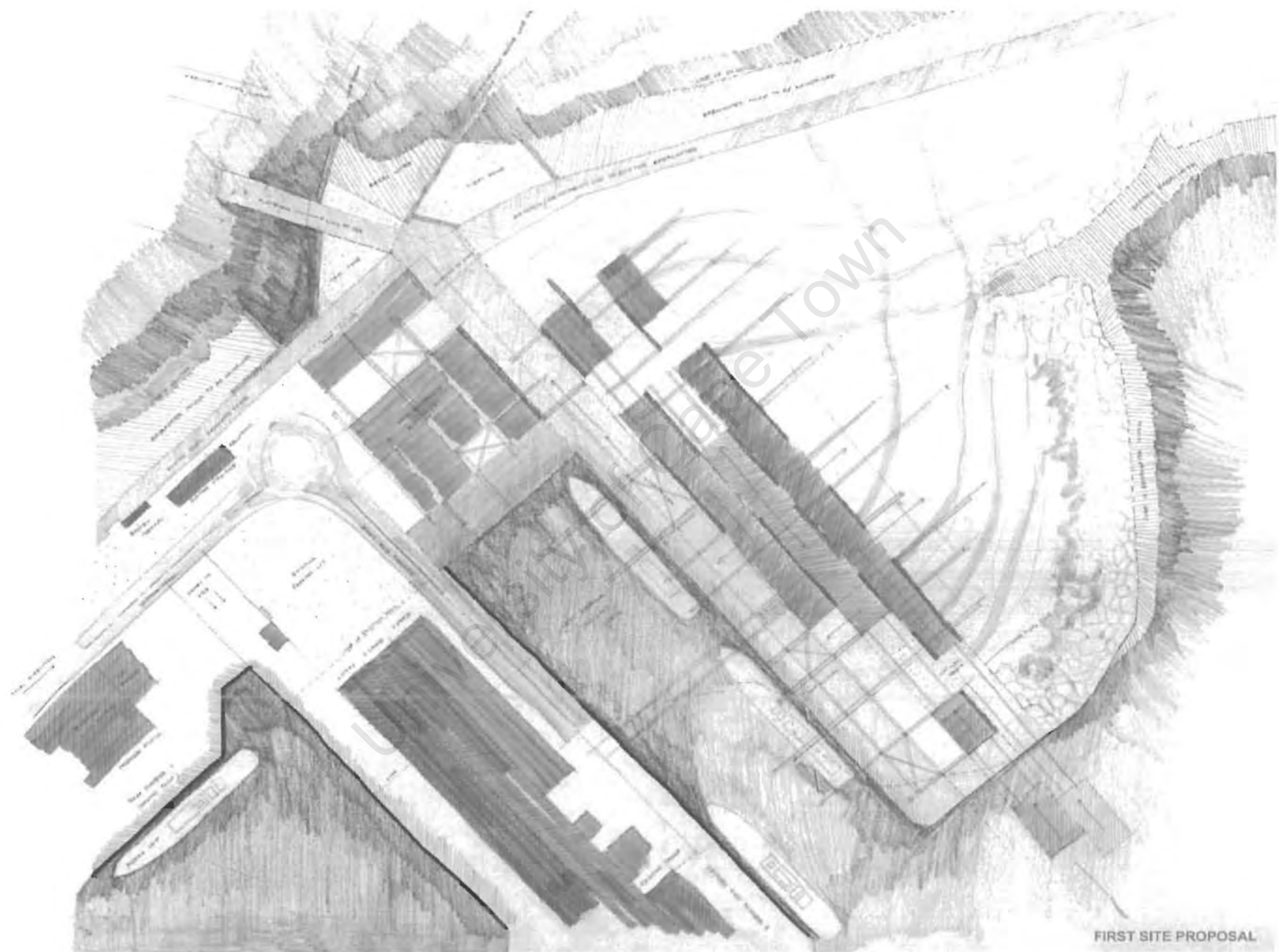


FIGURE 40 + 41  
Site Sections.

Additional site explorations included en loge exercises which zoomed into certain areas on the site. These exercises included model building, detail components and drawings. They aimed to uncover possible uses, massing as well as locating zones of importance for further development.

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FIGURE 42  
En Loge exercise.



FIRST SITE PROPOSAL

FIGURE 43

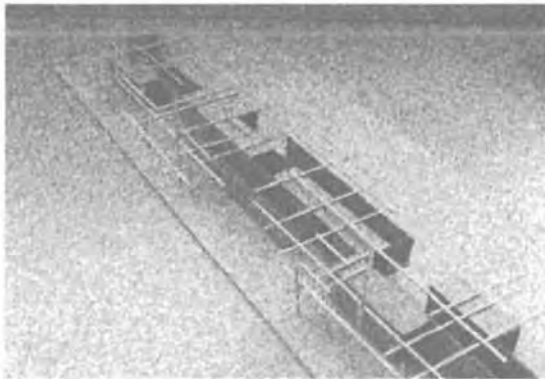
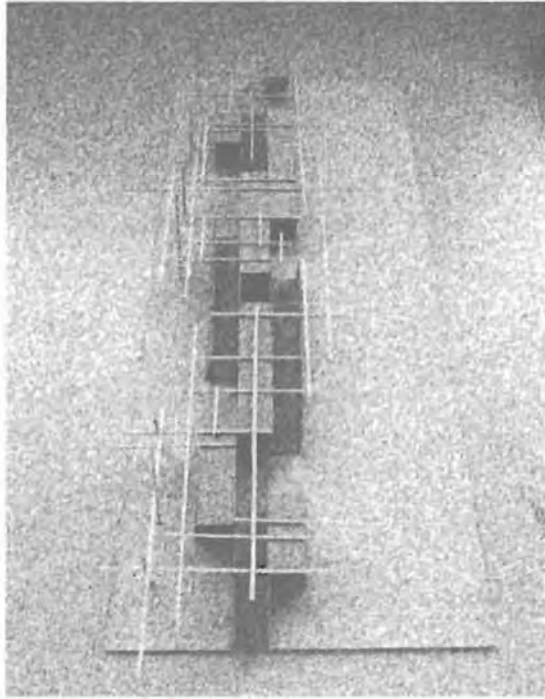
En Loge exercise model building.

FIGURE 44

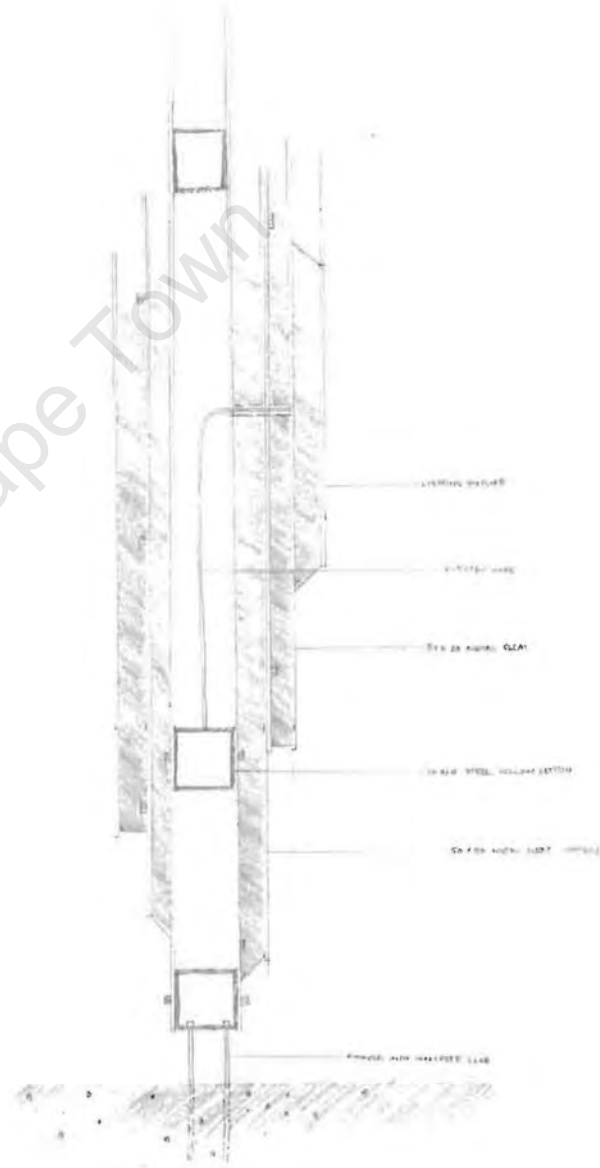
En Loge exercise model building.

FIGURE 45

En Loge exercise detail component.



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FIGURE 46  
En Loge exercise 2 - zoomed in.

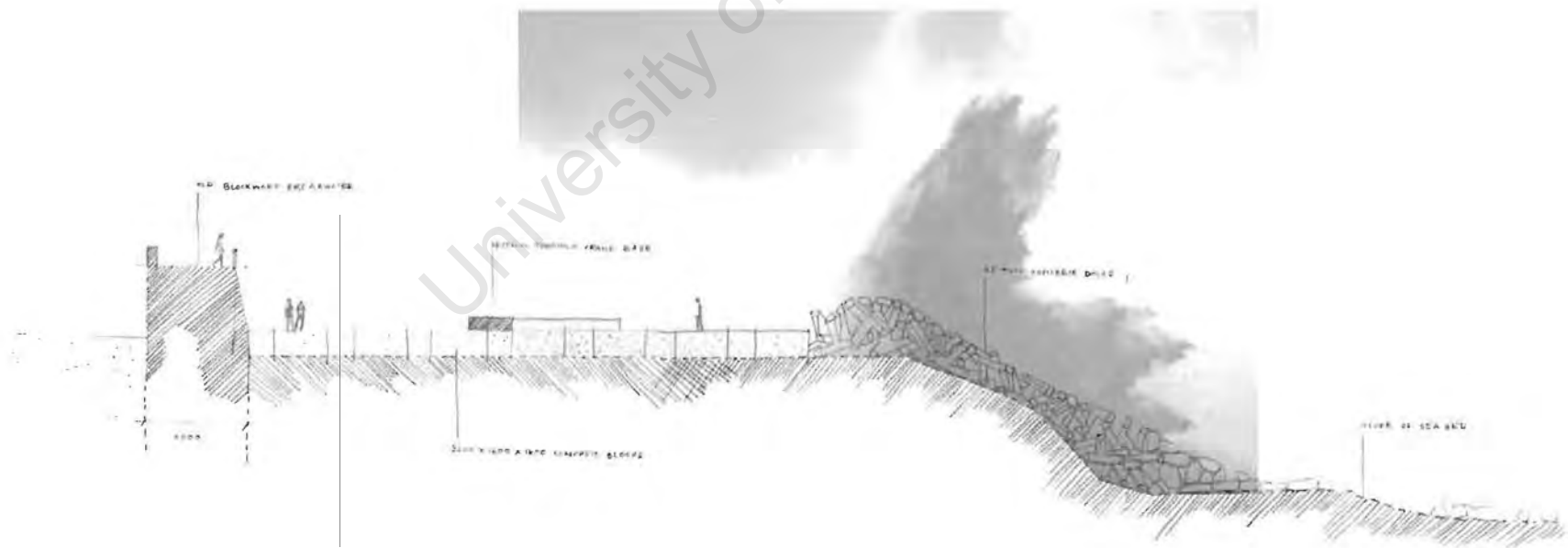
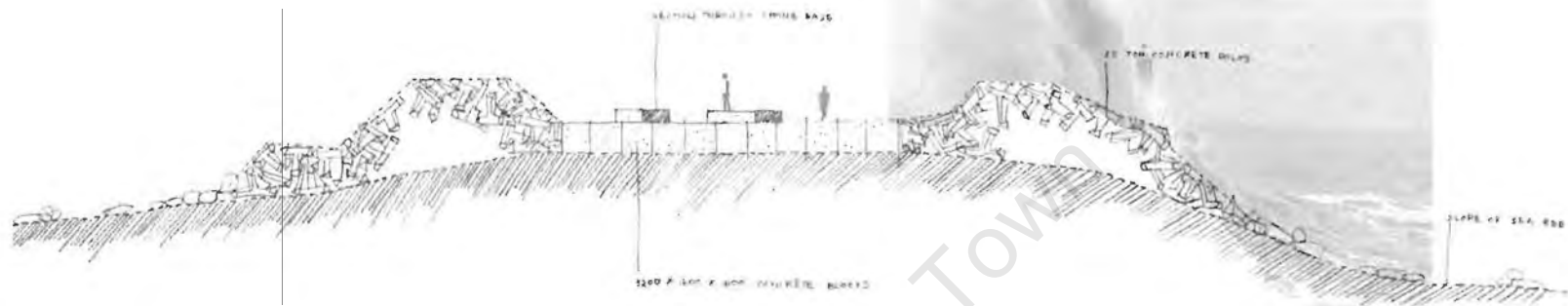
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FIGURE 47

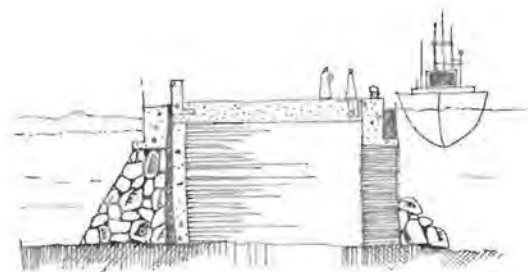
En Loge exercise 2 – section study 1.

FIGURE 48

En Loge exercise 2 – section study 2.



Trying to uncover the elements and language of the harbour was also an investigation that could help aid the design process. The harbour can be characterised by steel components and structures (such as cranes and gantries), as well as concrete mass (breakwaters and docks) that makes up the ground plain.



PIERS AND DOCKS



HARBOUR CRANES



CONTAINER YARD



SHIP BOLLARDS



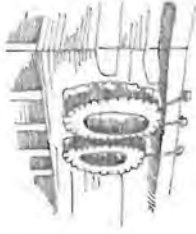
SAILS AND ROPES



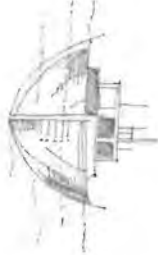
SKELETON STRUCTURES

FIGURE 49  
Elements and language of the harbour and sea.

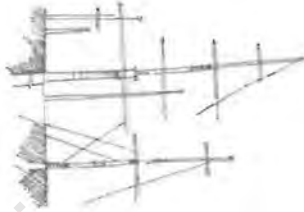
FENDERS



SHIP HULLS



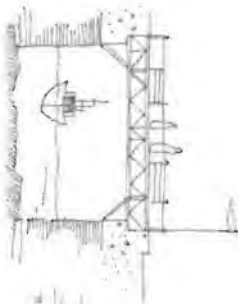
MASTS AND POLES



CONCRETE BREAKWATER



HARBOUR BRIDGES



RAILWAY TRACKS



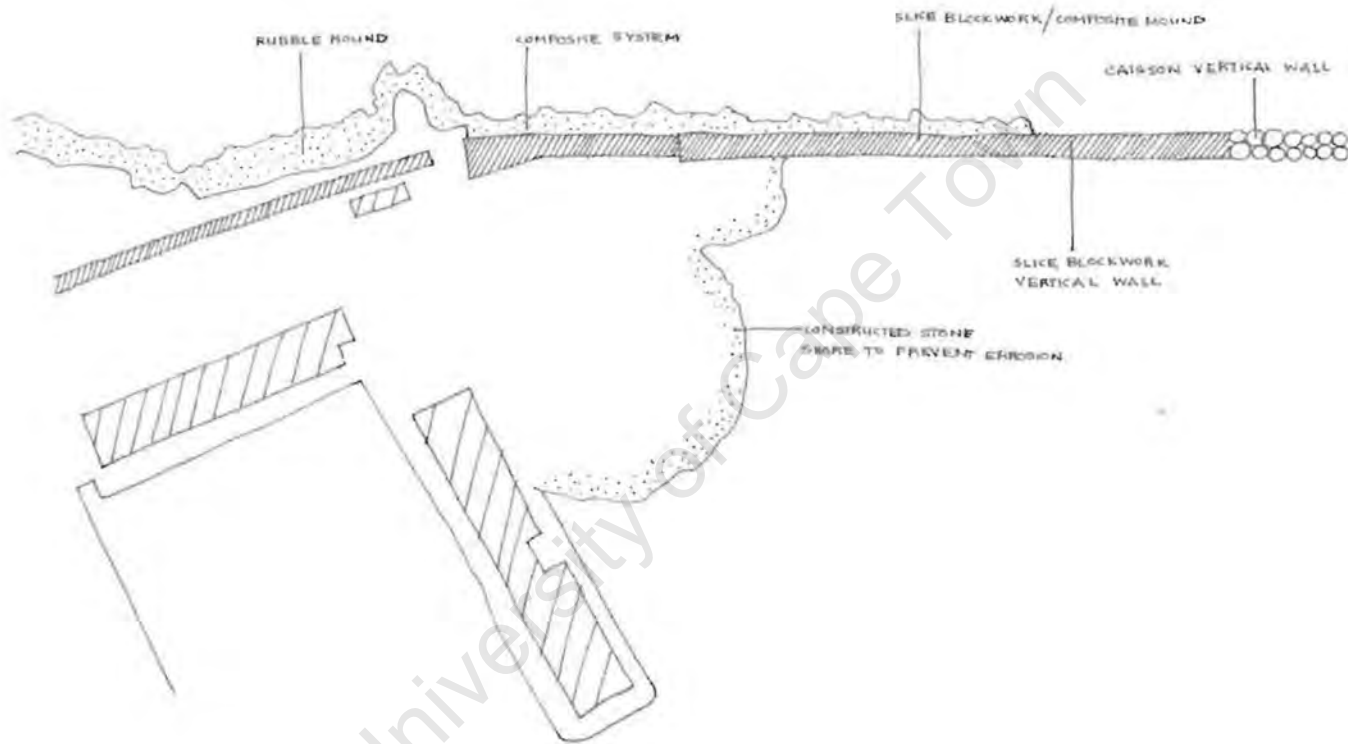


FIGURE 51  
 Different construction systems used at the Cape Town breakwater.

# CONSTRUCTED LANDSCAPE

## A BARRIER INTO THE SEA

The Breakwater is built as a wall that extends into the sea to deflect waves away from the inner harbour. This structure is the harbour's first line of defence and its most important structure. The Breakwater is a constructed landscape, nothing about it is natural. It's built up of either stone or concrete mass, which has to withstand violent storm conditions. The Cape Town Breakwater is made up of reclaimed land and structure.

The Breakwater also reveals different stages of time through its collection of constructed pieces. Each phase of construction indicates a change in the harbour's form. As the harbour grew, so did the length of the Breakwater which now stands at around 960 meters long, nearly 1 km. In a way, the Breakwater can be seen as a timeline revealing the development of the Cape Town Harbour.

As said earlier, the Breakwater's purpose is to break up and disperse heavy waves, and prevent them from entering the harbour and causing destruction.

A breakwater can do this in two ways. Firstly, it can be a construction of a high wall with strength from which waves will be totally reflected. Secondly, waves can run up a constructed slope; this way their energy is broken up as they move over loose and porous material. (Cornick, H.F. 1969: 116)

There are two main classifications of breakwaters. There is a vertical breakwater, which consists of a wall of masonry/concrete blocks or concrete mass; or there is a mound breakwater, which consists of rubble and stone. There can also be a combination of the wall and mound; these are called composite breakwaters. Sometimes the mound dominates and is simply capped with a masonry superstructure; sometimes the mound becomes a foundation layer for a massive wall structure. (Cornick, H. F. 1969: 116)

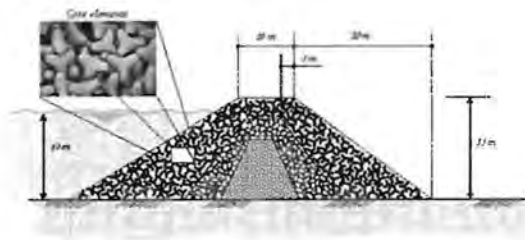


FIGURE 52

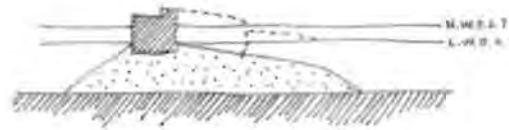
Rubble mound breakwater with protective layer consisting of concrete dolos.

FIGURE 53

Composite breakwater - there is a balance between mound and wall.

FIGURE 54

Example of a vertical wall breakwater.



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Wave action on these two types of breakwaters acts differently and structural failure can be due to different things. The mound breakwater is susceptible to the movement of wave action. It is these concussion and suction forces of the waves that constantly act on the breakwater mound. As the rubble is smoothed and rounded by the waves it can easily be sucked and rolled away. The slope of the mound is therefore always gradually eroding away. Because of this, breakwater mounds need to be continually maintained with additional material. The vertical wall breakwater receives waves before any conversion of oscillation into translation has occurred. Therefore, walls must be extremely strong as they will receive the maximum wave force. This is when a wave is deflected upwards and falls back downwards. (Cornick, H. F. 1969: 117)

The Breakwater at the V&A Waterfront in Cape Town has developed over time. There is a combination of systems that were used to build it. Parts are mound, composite and vertical breakwaters in the form of concrete block work and caisson methods.

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# 3. DESIGN PROCESS



FIGURE 55

SA Agulhas In Antarctica.



FIGURE 56

SANAP explorers on an Antarctic expedition.



FIGURE 57

SANAP base in Antarctica.

# PROGRAMME SELECTION

This building will be an Antarctic Museum and the new SANAP (South African National Antarctic Programme) Research Centre. This new research facility will act as the main base point for the three SANAP bases in Antarctica, Marion and Gough Islands. It will act as a public information centre for the work SANAP does, climate change and Antarctic tourism. The SA Agulhas, which has now been replaced by a new research vessel, could act as a floating museum display as there is adequate space for it to dock alongside the museum building.

Since SANAP prides itself on research and living sustainably, this new building will also house a power station which will generate electricity from wave action along the breakwater. This will be discussed in greater detail further on. The breakwater itself will also need to be made safe for people to experience, as it is currently closed to the public due to safety issues.

This project can be broken down into five programmes:

1. The Antarctic Museum and Information Centre
2. SANAP Research Centre
3. Breakwater Power Station
4. Docking Points
5. Breakwater Rehabilitation

## ANTARCTIC MUSEUM AND INFORMATION CENTRE

1. Entry foyer / waiting area
2. Reception
3. Visitor / Information Centre
4. Museum Curator's office
5. 3 x small staff offices
6. Staff kitchen and toilet
7. Small museum cafe
8. Public toilets
9. Display spaces (General Antarctic Information / History and Exploration / Wildlife / Flora / Weather and Climate / Research and Science / 3 SANAP Bases / SA Agulhas / History of the Cape Town Breakwater)
10. Rentable exhibition space

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#### **SANAP RESEARCH CENTRE**

1. Reception / office
2. 10 x small offices for permanent staff
3. Meeting Room
4. Open-plan office area / library space
5. 2 x laboratory workspaces
6. Small kitchen and social space
7. 8 x offices for visiting researchers / temporary staff
8. Staff bathrooms
9. Weather Centre / Control Room

#### **POWER STATION**

1. Turbine beds / access passages
2. Maintenance Room
3. Wave Power Control / Research Centre
4. Power Station Manager's office

#### **DOCKING POINT**

1. Docking points for SA Agulhas (111.95 m) / temporary ships
2. Ticket booth
3. Seating for arrivals / departures of ships

#### **BREAKWATER REHABILITATION**

1. Robust walls / handrails along ocean side of the breakwater
2. Public seating
3. Kiosks
4. Series of ramps / viewing platforms

SITE QUALITY AND POSSIBILITY

END OF A ROUTE



PART OF A TRANSPORT TERMINAL



PART OF THE HARBOUR LANDSCAPE



PART OF THE PEDESTRAIN BREAKWATER ROUTE



A POINT OF RUPTURE / BREAK



IN-BETWEEN ROUGH / CALM EDGES



FIGURE 58

Site qualities and possibilities.

# CONCEPTS AND IDEAS

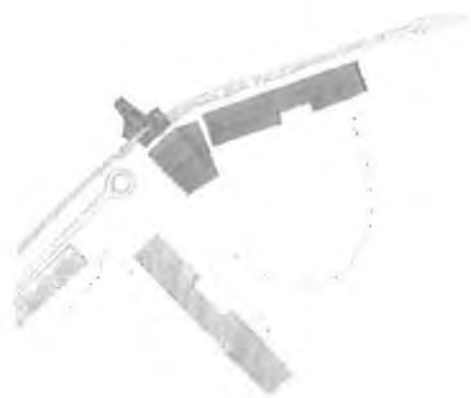
It is always a challenge to make the first step towards a design intervention. One has to first uncover the site's qualities and possibilities. On the left are a series of diagrams that try to summarise the potentials the site has.

Due to the breakwater's awkward shape, one comes to the conclusion that one either follows the line of the breakwater or the cargo sheds, or one does a combination of the two. Following the line of the breakwater was chosen as most suitable for this project as it provides more opportunity for natural events along the ocean.

What follows further on is a set of short meditation topics that deal with the concepts and ideas behind this project. These include topics such as: event, wall, ruptures, route, a walk along the breakwater, wave power, storm invasion, finding form, roughness and rust.

CONCEPTUAL MASSING

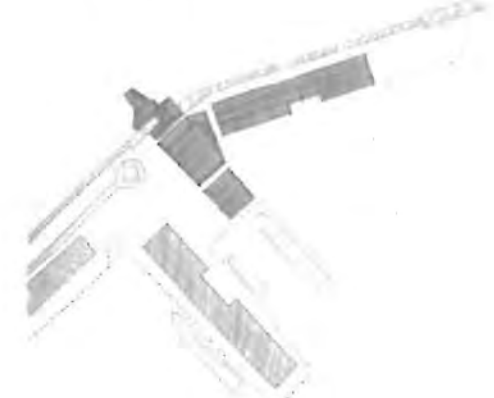
FOLLOW LINE OF THE BREAKWATER



FOLLOW THE LINE OF THE CARGO SHEDS



FOLLOW BOTH BUILDING LINES



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FIGURE 60

Conceptual photomontage of the event.

# EVENT

*"A significant occurrence or happening. A phenomenon or occurrence located at a single point in space-time."*

(The American Heritage Dictionary, 2000)

The entire building and route is about experiencing the natural events this site has to offer. Storm surges bring wind, sea spray displays, tidal fluxes, and mist - these are all examples of events that are heightened on a site such as a breakwater. People have a fascination with these natural events, and providing a platform to experience and be close, yet remain in relative safety, will be the purpose of such an investigation.

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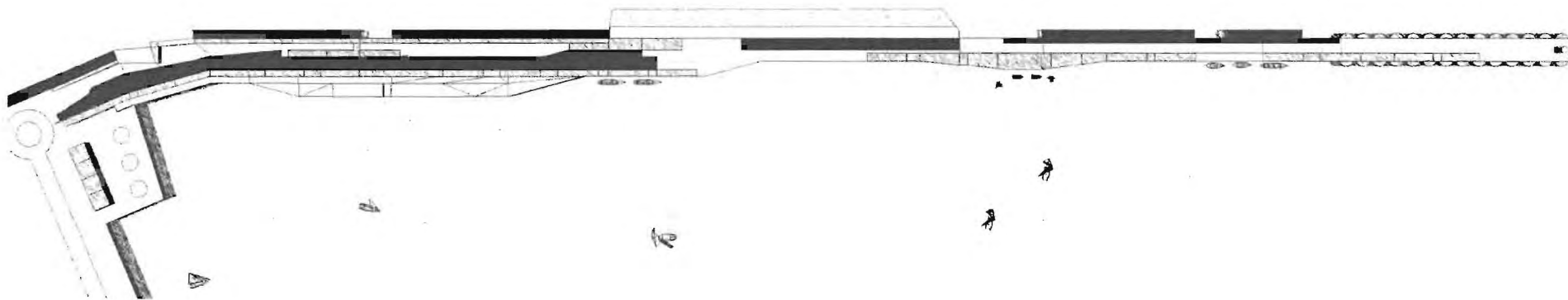


FIGURE 61

Drawing showing the walls as highlighted in black.

# WALL

*"A continuous structure of masonry or other material forming a rampart and built for defensive purposes. To divide or separate."*

(The American Heritage Dictionary, 2000)

The breakwater acts as a wall that extends into the sea to protect the inner harbour waters. The main idea is that the building acts as a wall or a defensive barrier against rough seas. All natural events act along or are heightened along this wall. Sometimes this wall is thickened to form a double wall with a passage in-between. In a way, this building and intervention acts as a secondary breakwater as it further protects the inner harbour waters.

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# RUPTURES

A rupture can be defined as *"the process or instance of breaking open or bursting."* (The American Heritage Dictionary, 2000)

Every now and then this wall ruptures and opens up to the sea. These ruptures allow for one to experience the event. Each rupture point marks a change in the breakwater structure below giving a visual indication of the timeline of the harbour construction.

Each rupture has a slightly different make-up. Sometimes, one steps down towards the water's edge, other parts are level with the breakwater ground plain; sometimes you move underneath the building and at other ruptures you are elevated above the ground to have access to surrounding views. Each rupture point therefore offers a slightly different view point or perspective to experience the ocean's events.

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# ROUTE

The breakwater site forms part of a larger scale route. This route forms part of the ocean promenade that starts in Sea Point, extends around Mouille Point and Granger Bay, and moves along the V&A Waterfront's edge. This route eventually leads one to the old vertical breakwater wall. As you walk along this wall, it ends in a dead end that is my chosen site, the breakwater.

The project and building act as a passage of experience that allows movement in swells. The route often ramps up or down, which allows access to the water's edge in different ways. This allows for the ground plain to be more fluid as opposed to just being flat.

The project allows for different paths of movement and therefore different experiences of space. One has access inside and through the museum corridors, over the roof of the building, underneath the building, or along the sea edge that is marked by ramps and the turbine galleries.

Along the route, there are ramps that either ramp up to allow for better views and fishing opportunities, or ramp down to allow one to touch the water and to permit small boat access. Smaller and larger spaces are created along this route to allow for public seating, activities and gathering. The route ends at the tip of the breakwater where the harbour light beacon is situated. This place is ideal for views of the harbour and city.

To follow will be a series of perspectives that will give one an idea of what a walk along the breakwater could be like.

# A WALK ALONG THE BREAKWATER

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FIGURE 63

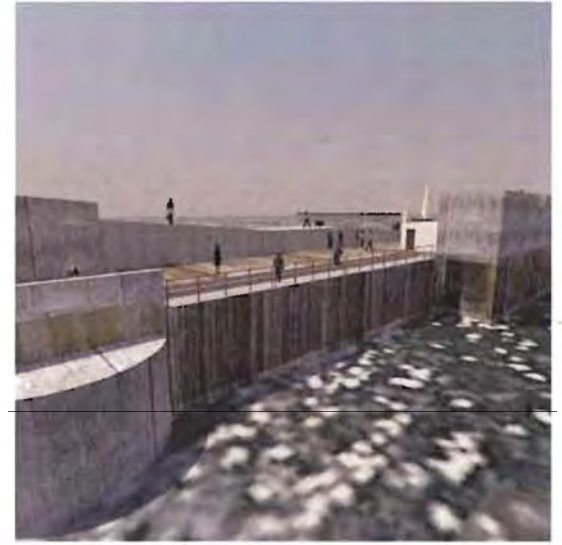
The tip of the Breakwater with seating facing towards the harbour.

FIGURE 64

Viewing ramp and seating facing out towards the ocean.

FIGURE 65

Change of handrail system, a step down, indicates a rupture space and change in breakwater construction.



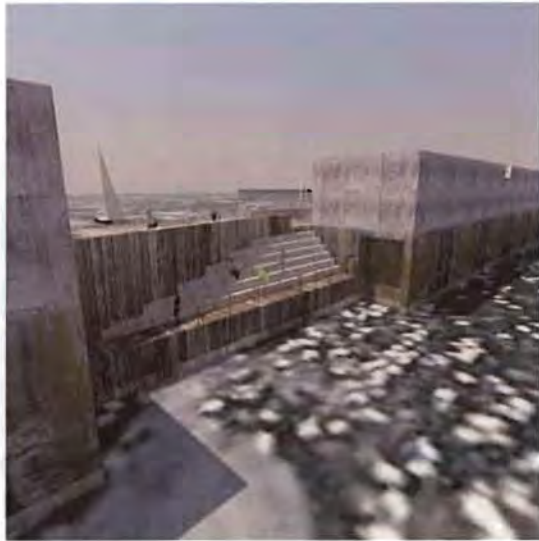


FIGURE 66

Rupture space steps down towards the water for a fishing platform and seating.



FIGURE 67

Turbine power station in background.

FIGURE 68

Ramp that leads down towards the water.



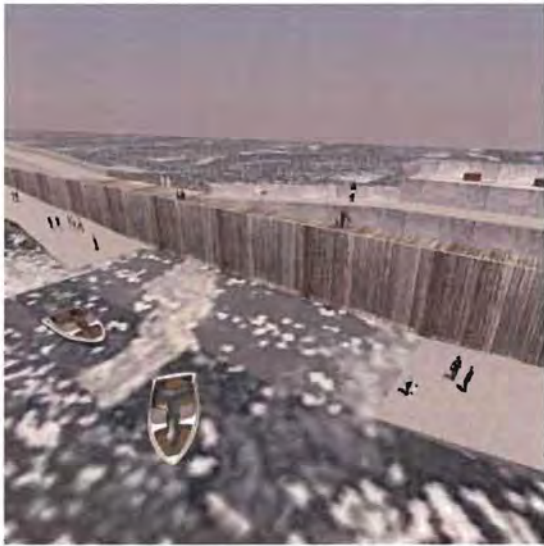


FIGURE 69

Ramp that leads to the calm harbour water's edge. Allows for possible small boat access.

FIGURE 70

Another rupture place and change in breakwater construction indicated in surface treatment.

FIGURE 71

SA Agulhas docking point with ticket booth and kiosks in background.



FIGURE 72

Internal perspective inside the museums storm chamber. Sunken space flooded with storm waters.

# STORM INVASION

Wouldn't it be amazing to allow the natural event to invade architecture? Imagine a storm invasion where parts of the building allow storm waters to penetrate the museum space.

Parts of the Antarctic Museum's interior spaces are sunken to allow storm waters to spill inside. This will help solve the problem of storm water management. Either one can create a submarine-type building that is impervious to storm water, or allow the water to run through the building and exit on the calm side of the breakwater. Storm water is a huge problem on this site, as during rough seas the water literally surges over the breakwater. Water is allowed access through permeable walls that are made from perforated Corten steel. The rupture space under the building also allows water full access into the storm chamber during rough conditions.

Allowing this invasion of the storm waters inside the building will allow for a different experience of museum space and the viewer with access to the power of the sea. Just imagine a wave surge breaking on the breakwater and flooding the floor with storm waters while one observes this from a steel mezzanine safely above. The museum will therefore transform into a cold, wet, salty experience that can remind one of the Antarctic storms down at the tip of the world. This is an event. This is an invasion of natural power. Waves break onto the wave walls, waves break over the roof, and waves surge through the building.

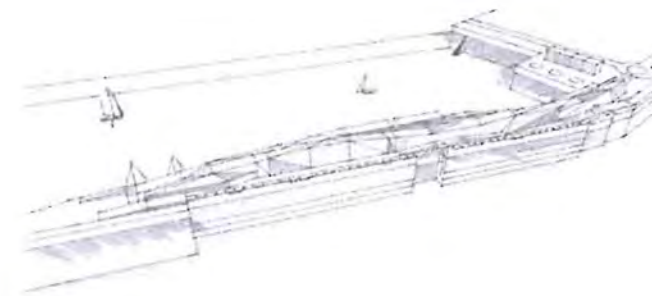
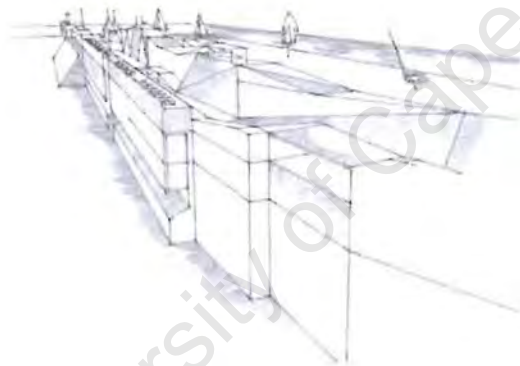


FIGURE 73 + 74 + 75

External perspective drawings showing the building's faceted form.

## FINDING FORM



Finding form for this building has been a challenge. The building needs to sit relatively low on the site, as this will minimise the impact of wind and waves on the structure. On such a visible and prominent site, the building's form needs to be expressive in quality. The first attempt at form was very horizontal and planar. The scheme didn't express the nature of the programme it housed.

New inspiration was drawn from the jagged qualities of icebergs. This resulted in a faceted form that creates the outer shell of the building. These facets speak of the rugged nature of Antarctica. The facets also allow for storm waters to break over the building in a more dynamic way, as opposed to just a series of vertical, straight walls.

The interior spaces are experiential and rich as a result of the expression of the outer form.

FIGURE 76

Faceted iceberg a piece of inspiration.

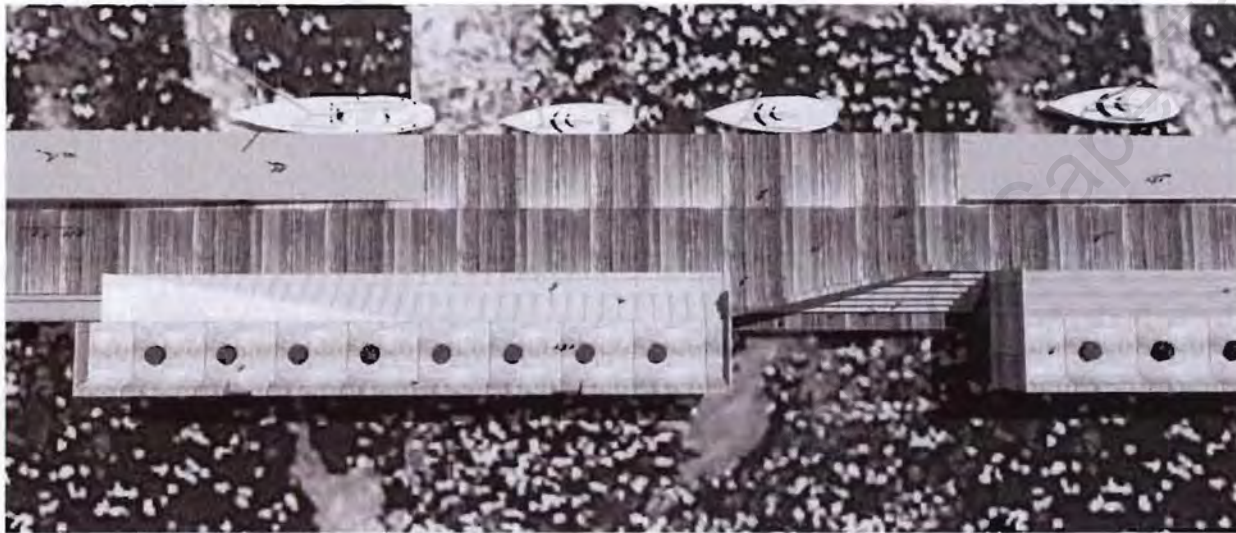


FIGURE 77

Plan view of a typical turbine power center. 8 turbines inside this structure.

# WAVE POWER

All the previous research done on waves and swell patterns led the project in a new direction, one concerning wave energy. Wouldn't it be great to allow people to experience the power of waves, but also allow waves to generate power.

Two very recent projects, the Limpet Project in the UK and the Mutriku Project in Spain, deal with wave energy on shoreline or breakwater conditions. These power plants demonstrate how wave energy can be converted into electricity using the oscillating water column. Technical details will be discussed in the next chapter.

These wave walls will be integrated into the existing breakwater structure as well as acting as a vertical face to encourage sea spray.



FIGURE 78  
Rusty interior render of the entry foyer.



FIGURE 79  
Rough concrete dolos found at the Cape Town Breakwater.

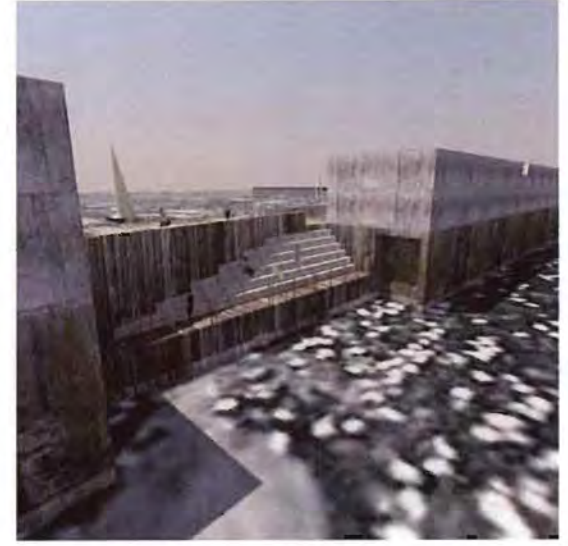


FIGURE 80  
Weathered concrete walls stained with algae. This is the fishing platform intervention.

# ROUGHNESS AND RUST

Building on the breakwater at the most extreme tip of the harbour is a place of roughness and weathering. I envisage this building to show this aging, to show the character of the harbour landscape. Rough concrete covered with barnacles and algae reaches into the sea. Steel members rust and show the marks of time.

The harbour environment has a rich source of textures, colours and materials. The predominant materials are concrete, stone, steel and wood. All these materials are used for different pieces that make-up this landscape.

There is tension between the stereotomic (stone and concrete) and the tectonic (steel and wood). Stone and concrete speak of mass, weight, landscape and ground plain. These materials have to withstand the brute force of the waves, tides and harbour traffic.

Steel and wood speak of the tectonic realm, joints and assembly. They are fixtures that attach to the concrete landscape. These materials are assembled to form cranes, gantries, wooden fenders and other fixtures.

This building will be built from concrete and steel. The concrete will be rough off-shutter construction while the steel work will be Corten steel components that rust to a rich red colour. The building will speak of the tectonic nature of harbour structures and the concrete mass of the harbour ground plain.

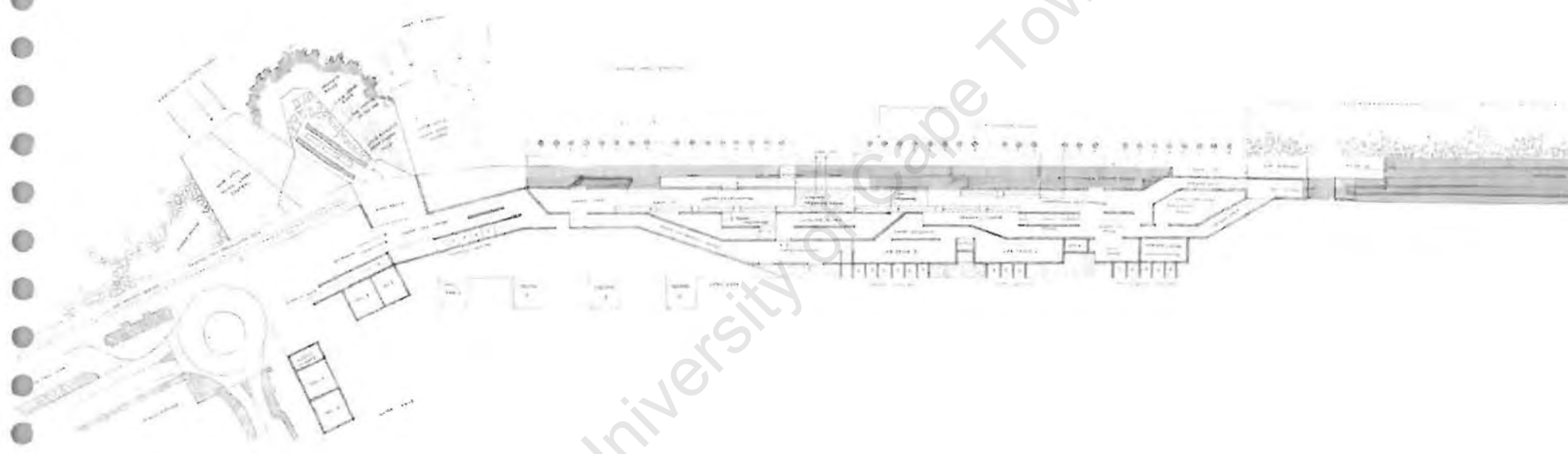


FIGURE 81  
First rough plan scheme.

# SKETCH DESIGN



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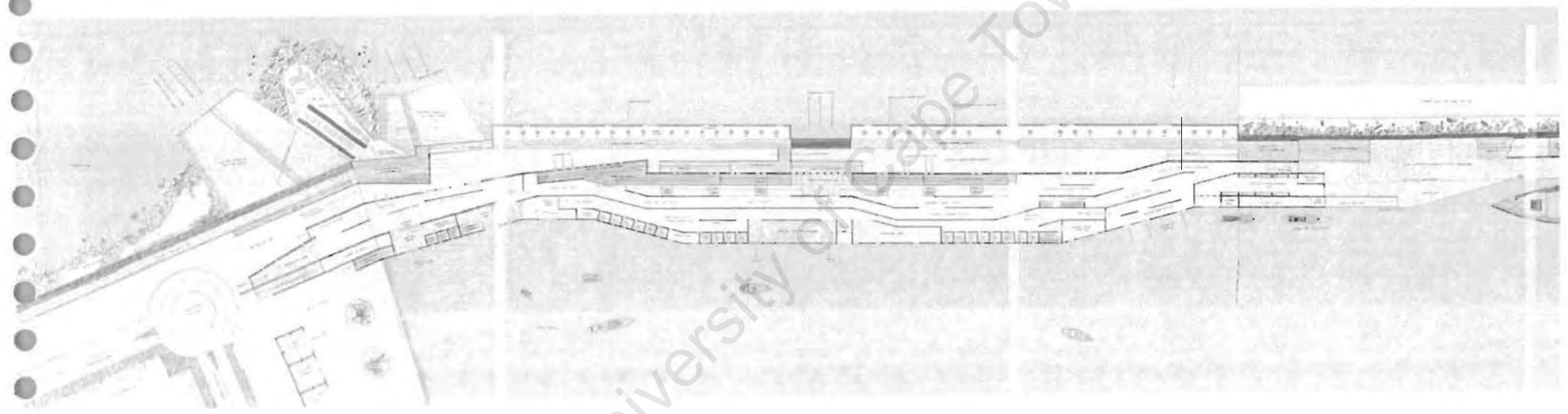
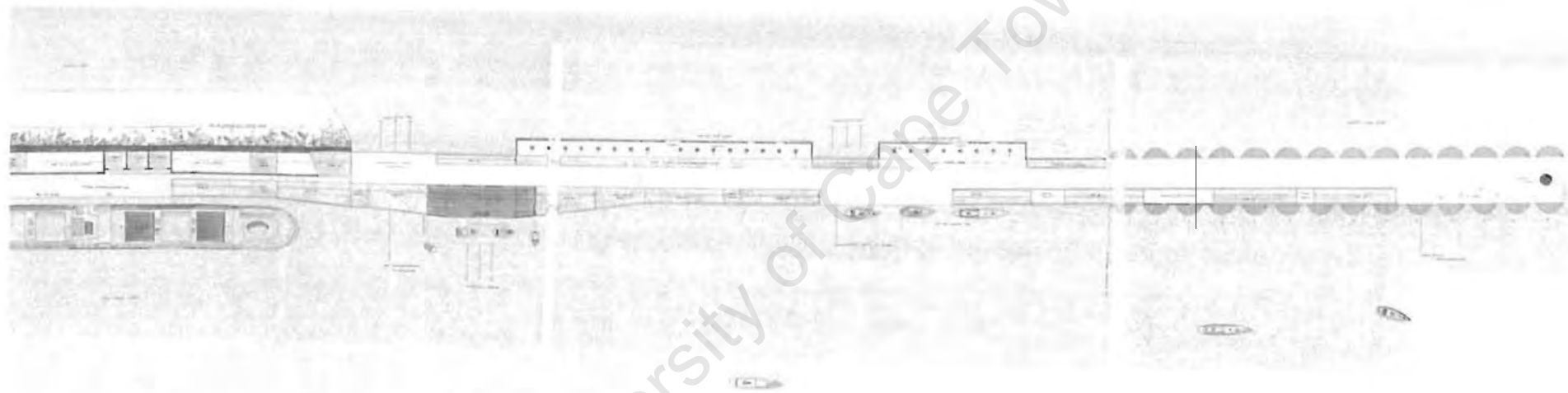


FIGURE 82  
Sketch design plan.



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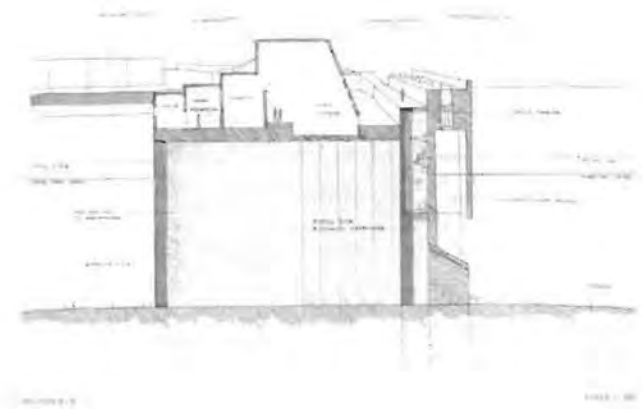
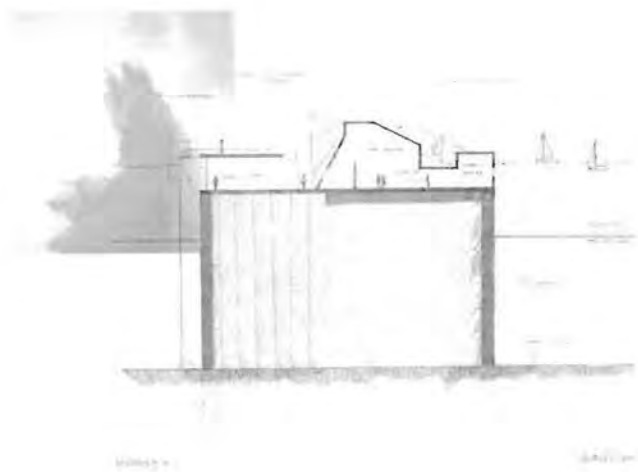


FIGURE 83

Section through entry foyer space.

FIGURE 84

Section through museum space.

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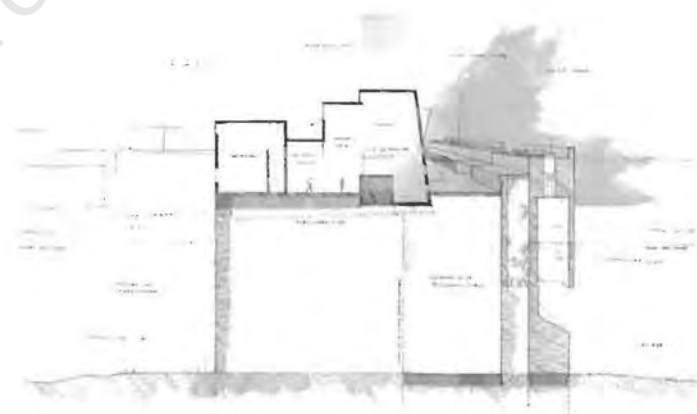
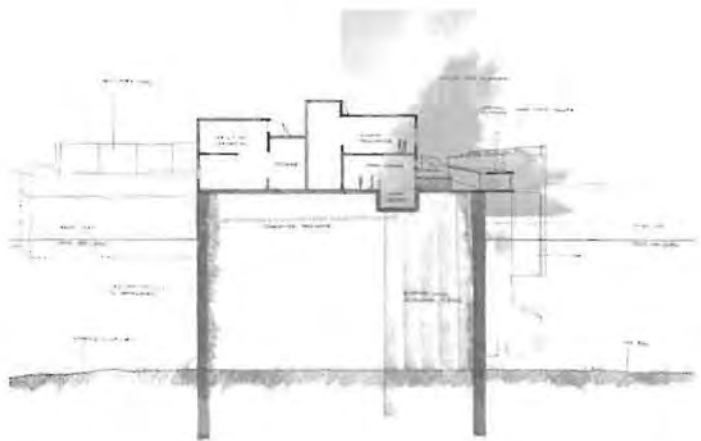


FIGURE 85

Section through storm chamber with mezzanine.

FIGURE 86

Section through lab space and museum interior ramp.

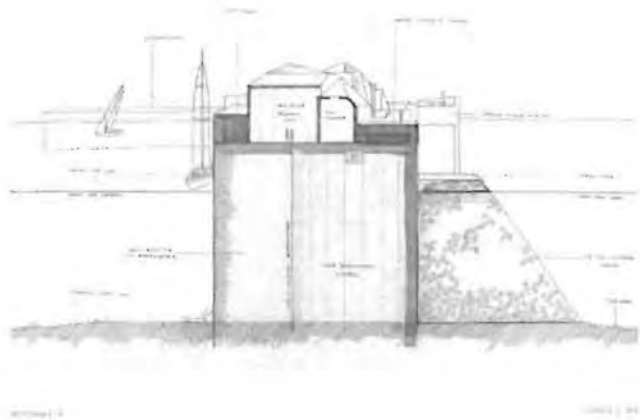
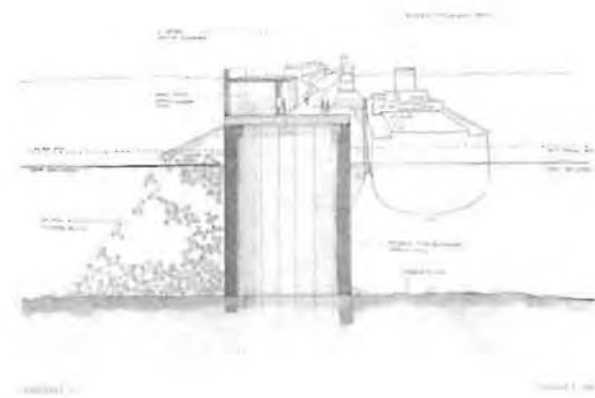


FIGURE 87

Section through museum space.

FIGURE 88

Section through SA Agulhas docking point.



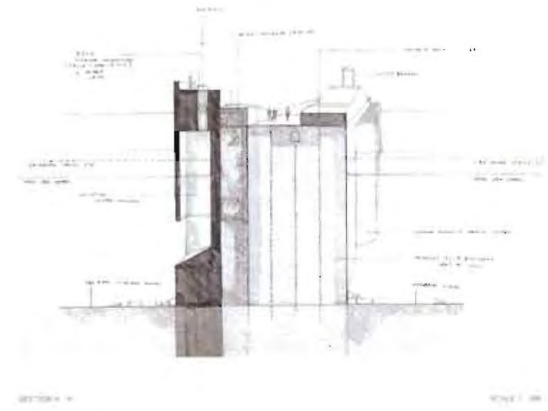
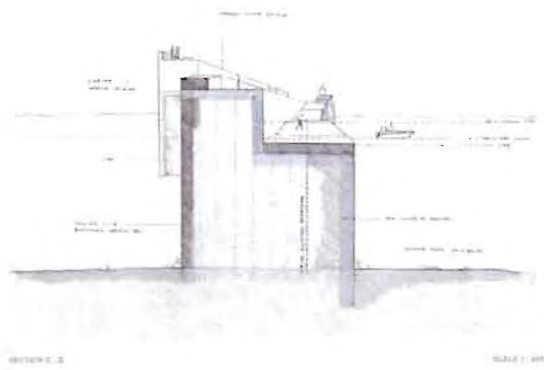


FIGURE 89

Section through the ramp down to the water's edge.

FIGURE 90

Section through viewing ramp at the end of breakwater.

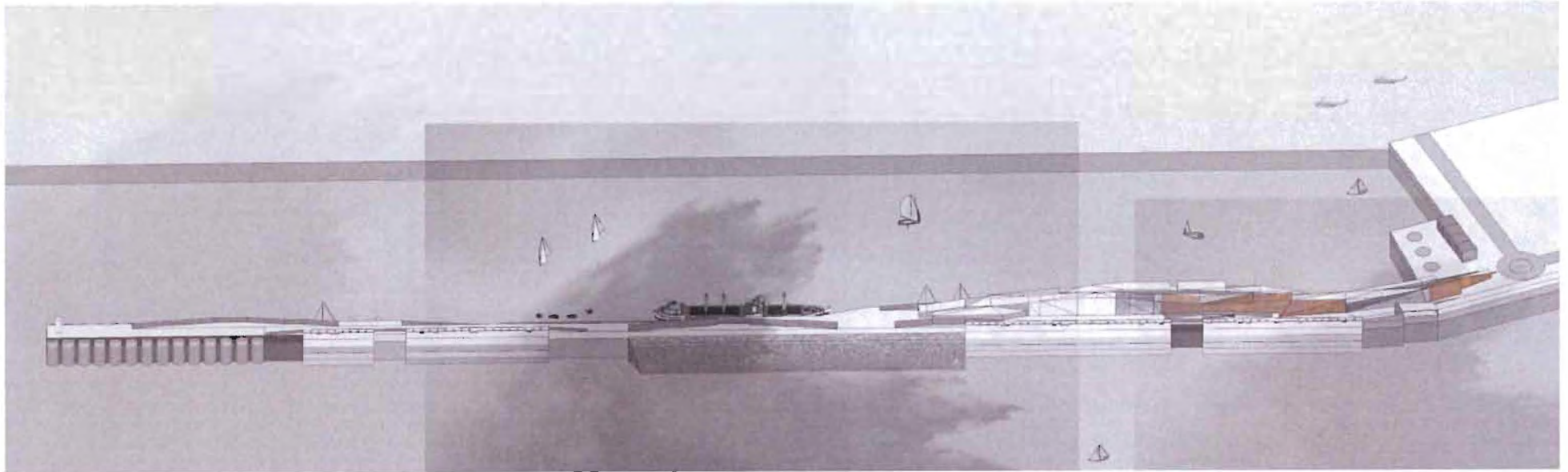


FIGURE 91

Sketch design rough 3-D perspective of entire length of the breakwater.

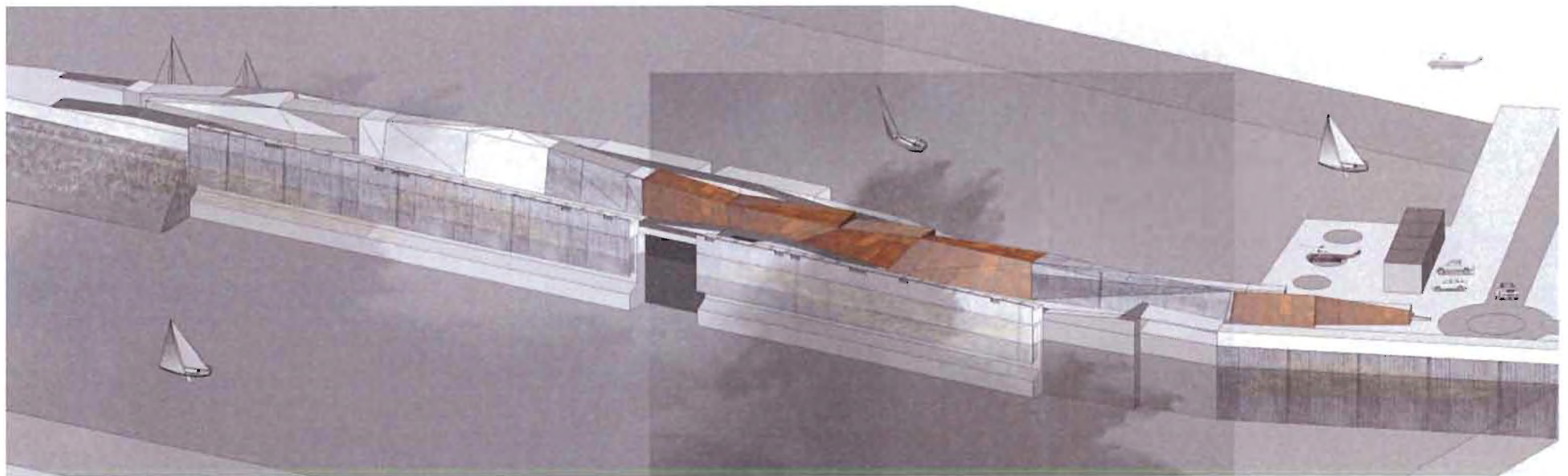


FIGURE 92

3-D perspective of building showing facets and possible material palette.

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## 5. TECHNICAL INVESTIGATIONS



FIGURE 93  
Isley LIMPET power station during rough seas.



FIGURE 94  
Section through the LIMPET system.

FIGURE 95  
Isley LIMPET power plant - side elevation.

# WAVE WALLS

The use of wave power is not a new concept; however, wave generators were usually located further out from the coastline. In recent years there has been increased interest in wave energy that can be captured on the shore. Two innovative projects explore shoreline wave power. The first is the Islay Limpet Wave Power Plant in the UK and the second is the Mutriku Wave Power Plant in Spain.

## ISLAY LIMPET WAVE POWER PLANT

The Islay Limpet plant was the first structure to capture wave energy right on the shoreline. This plant was developed as a prototype for future shoreline wave structures. The LIMPET (Land Installed Marine Energy Transformer) uses the idea of the oscillating water column to generate electricity. This can also be called pneumatic energy, as it uses the compression of air to drive the turbine. (Heath, T. 2009: 2)

As a wave moves up the inner chamber, air is compressed and forced through a turbine that turns and generates power. As the wave moves down, this causes suction and air moves from the turbine chamber down the column, therefore driving the turbine a second time. The turbine, known as the Wells Turbine, was specially developed for this wave power plant as it can generate energy with the rise and fall of the wave. (Heath, T. 2009: 3)

This wave power plant is constructed out of in situ concrete and has a beautiful rough appearance. As the wall is at an angle, this wave wall can generate powerful displays of sea spray.

## MUTRIKU WAVE POWER PLANT

The Mutriku power plant is the first wave power plant to be built into a breakwater system. This is revolutionary, as future breakwater constructions can now incorporate a power plant that can generate electricity for the city grid right into its infrastructure.

This project also uses the oscillating water column as a means to drive the turbine generator. What is different is that it is a vertical system that saves on space, as well as the massive concrete form work needed to create a ramped system.

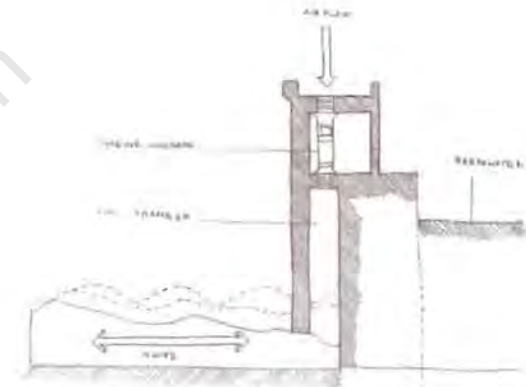


FIGURE 96

Mutriku power station - Spain.

FIGURE 97

Section through the Mutriku vertical OWC system.

### **BREAKWATER POWER PLANT**

In the Cape Town Breakwater, it is intended to use the vertical wall system similar to the Mutriku power plant. The wall system latches onto the existing breakwater structure that is built from massive concrete block slice-work.

The wave walls not only generate sea spray as they are vertical walls, but also help protect the pathway that extends along the entire breakwater. There are four wave walls each, with beds of turbines generally in groups of six or eight. Each turbo-generator can generate 18.5 kW per hour.

Wave wall 1 – 16 turbines = 296 kW

Wave wall 2 – 22 turbines = 407 kW

Wave wall 3 – 16 turbines = 296 kW

Wave wall 4 – 8 turbines = 148 kW

Total power = 1147 kW per hour (in average wave swell)

The turbines are 2.83 meters in height with a diameter of 1.25 meters. There is an access door and passage so maintenance can be conducted inside the turbine chamber. It is important that the lip that extends down into the sea is at least 5 meters below the spring tide low water mark. The wave walls have been incorporated into the design of the breakwater rehabilitation; they offer steps and ramps up onto the power plant, public seating is carved into the power station, and one can experience the air suction and upward movement as the turbine functions.

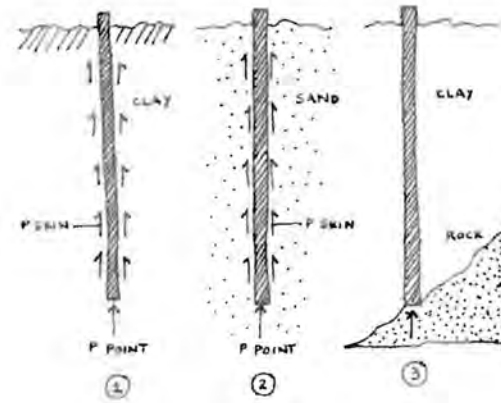
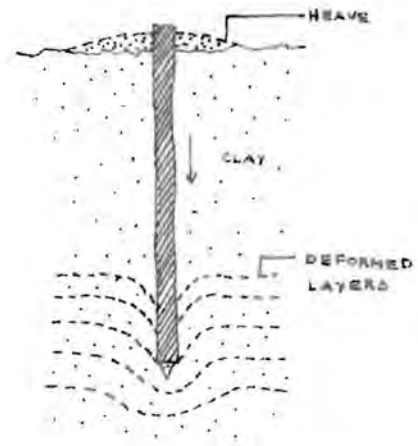


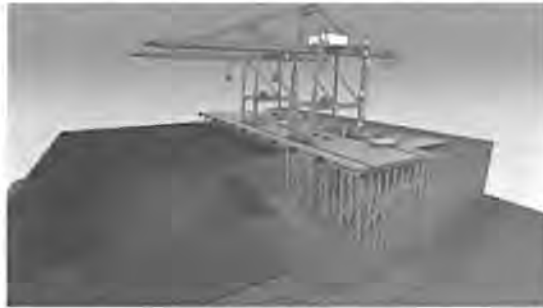
FIGURE 98

The deformation of soil around a driven pile in clay.

FIGURE 99

Pile types with respect to the bearing capacity.

# DOCK CONSTRUCTION



The technology of building the ground plain was also investigated as a new extension to the breakwater needed to be built for part of the building to sit on. This extension is in the harbour and therefore not subjected to the pounding of the rough seas, as it is protected by the breakwater. It does however need to be strong and read as separate to the heavy breakwater structure. The use of a concrete pile system was investigated.

This system of building is known as open-type construction. These types of docks are built up of decks that are supported by piles or cylinders. (Van der Merwe, A. 1984: 4)

Different types of pile systems are used depending on the soil conditions of the seabed. End-bearing piles are piles driven into a layer with good bearing capacity such as rock. The load will be transferred directly to the surrounding soil from the pile toe. Friction piles act differently in cohesionless and cohesive soils. In cohesionless soils, such as sand and gravel, the load is transferred to the surrounding soil through friction along the surface of the piles. Some of the load is carried by the pile toe. In cohesive soils, such as clay, the whole load is transferred to surrounding soil, with only a tiny part of the load carried on the toe. (Van der Merwe, A. 1984: 5)

FIGURE 100

Dock construction - pile system.

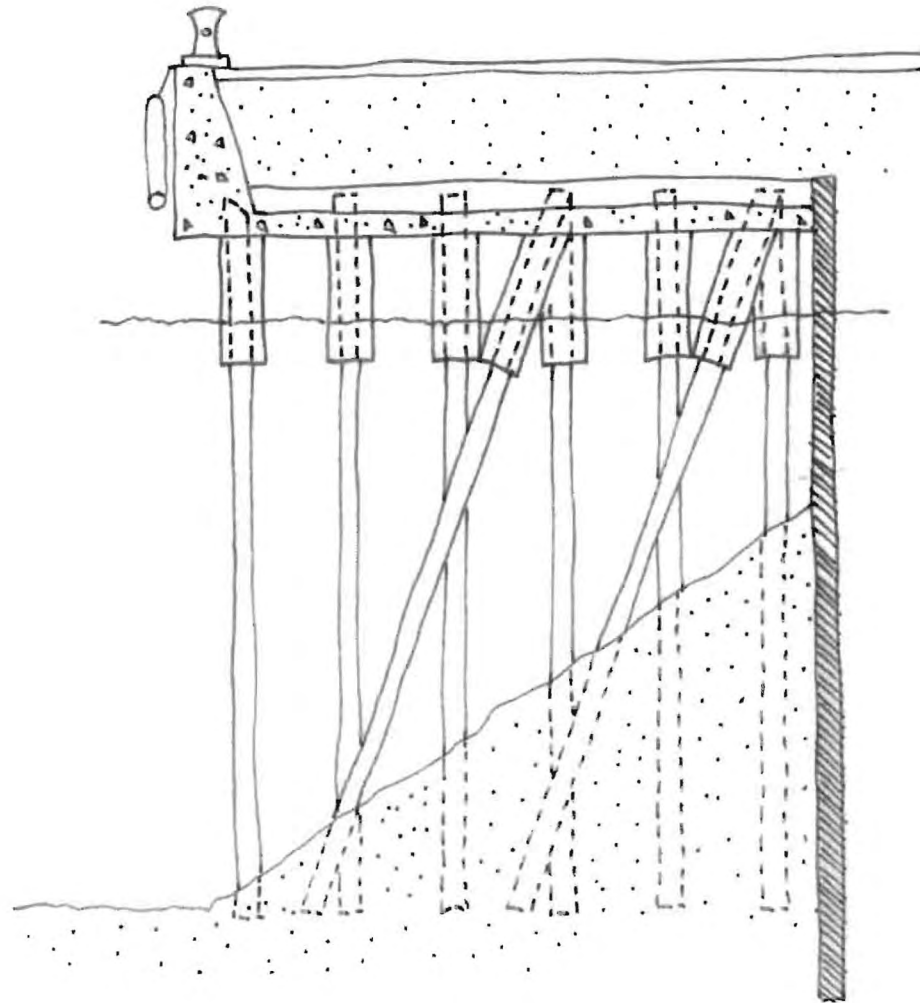


FIGURE 101  
Precast concrete pile system.

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#### **PRECAST CONCRETE PILES**

Precast concrete piles are the most commonly used pile systems for harbour construction. They are used in the Cape Town Harbour as they are appropriate for the soil conditions below. The seabed in Cape Town consists of Malmesbury Shale, and the piles are driven through these layers to rest on the rock base below. These piles are good to use as they are economical, more resistant to weathering, and low maintenance. The only difficulty in using these piles is that they are short in length and have to be connected together which is complicated. Another hindrance is that concrete piles have a larger displacement area, which is not good for soils with clay content, as they do not remould themselves easily. (Van der Merwe, A. 1984: 10)

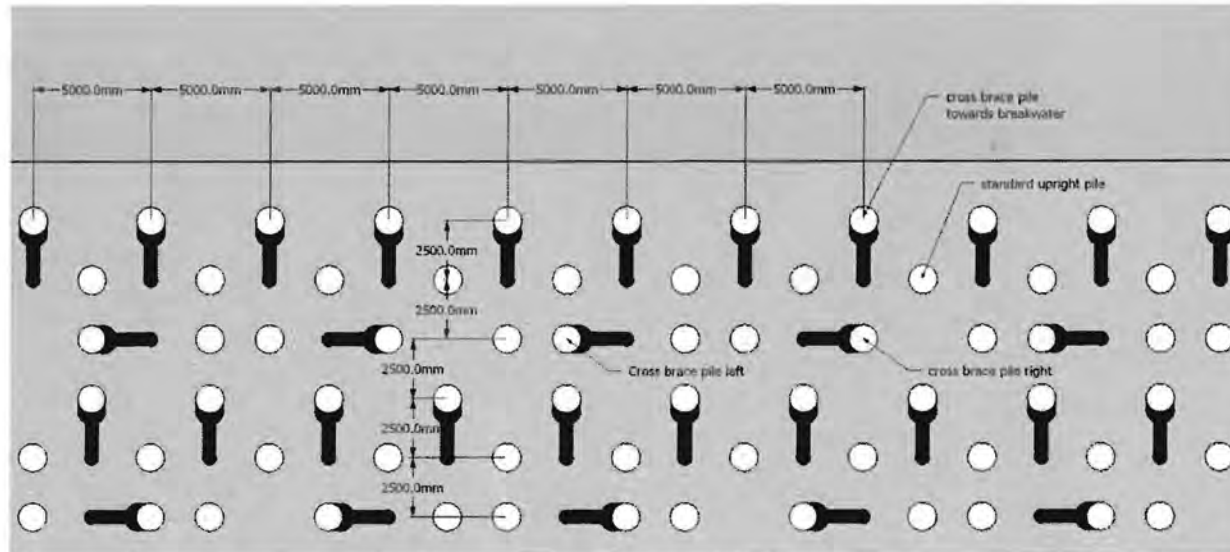
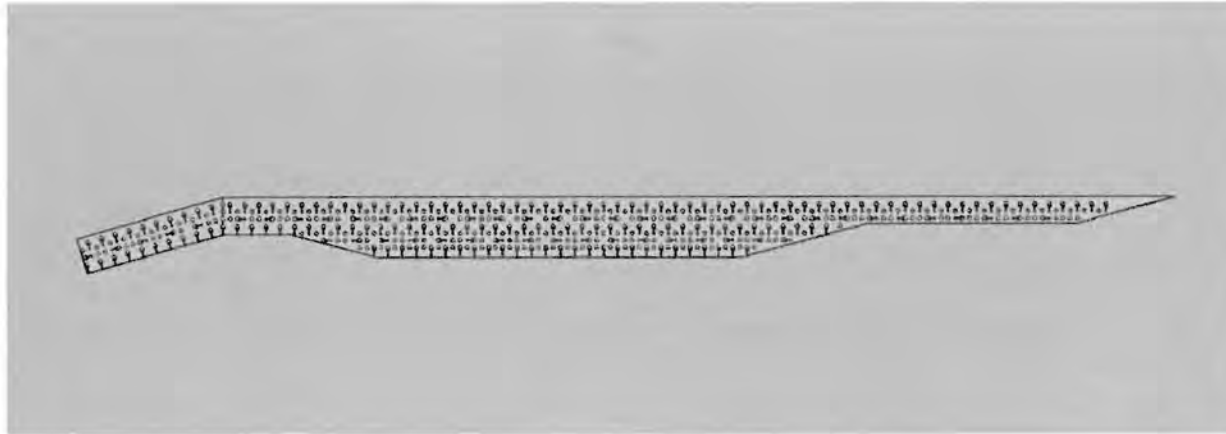


FIGURE 102

Plan showing the extent of the extension with pile layout.

FIGURE 103

Plan showing pile spacing as well as cross bracing system.

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#### **BREAKWATER PILE DESIGN**

The pile design used to create the ground plain for the extension uses concrete precast piles that are driven into the harbour bed. They are 600 mm in diameter with a concrete capping of 1200 mm in diameter to help spread the load. This system needs cross bracing in three directions. Firstly, this happens inwards towards the breakwater, and then secondly, to the left and right. The pile spacing is 5 m x 2.5 m with cross bracing piles happening at every second spacing interval. See pile layout plan for the extension. A 1500 mm reinforced concrete slab is laid on top of this pile system onto which the building can be built.

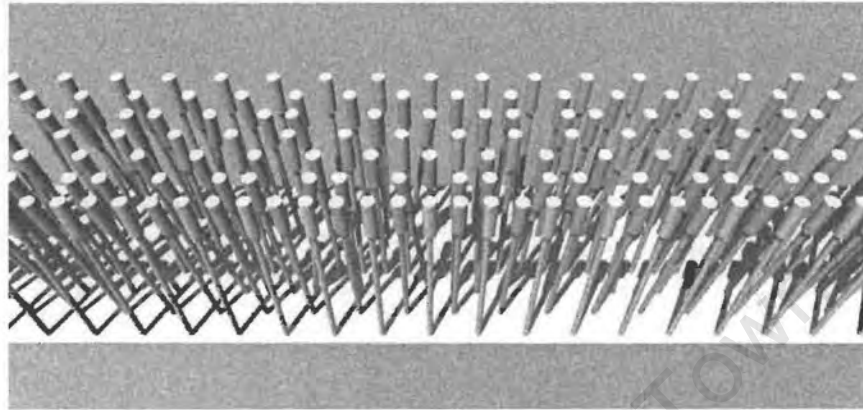


FIGURE 104  
Perspective top view of pile system.

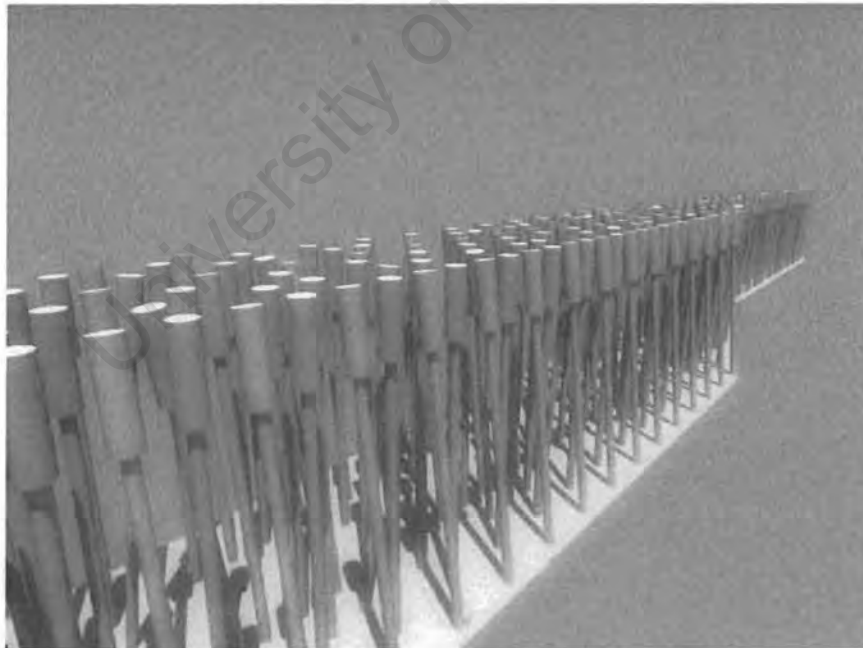


FIGURE 105  
Perspective of the pile system.

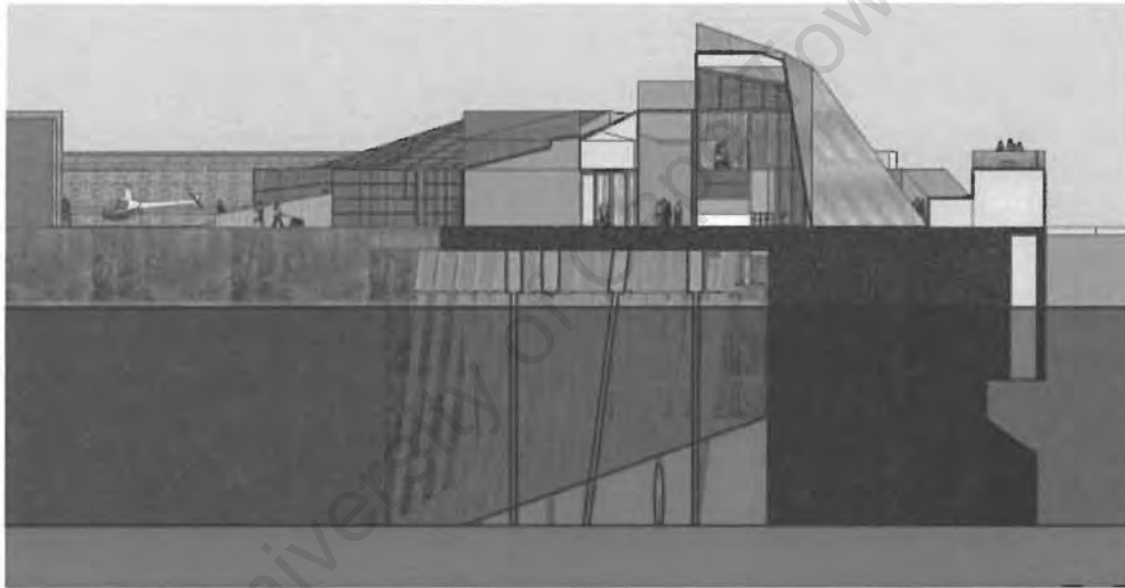


FIGURE 106

Section through building and the extension platform with pile system.

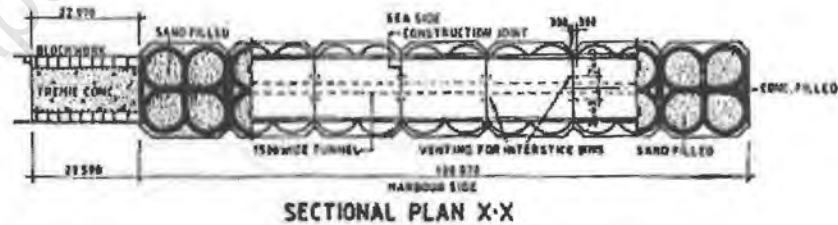
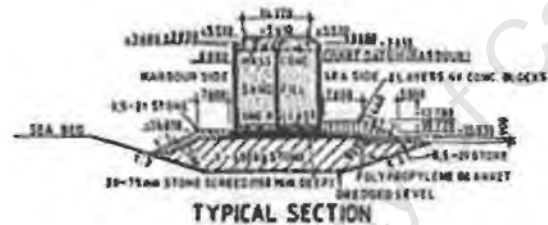
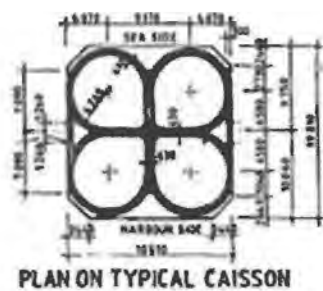


FIGURE 107

Plan of the Caisson system used at the breakwater.

FIGURE 108

Section through the Caisson structure.

FIGURE 109

Overall plan of the Caisson structure at the Cape Town Breakwater.

# BREAKWATER CONSTRUCTION

The two main construction methods used in the Cape Town Breakwater are concrete slice blockwork systems and the Caisson Monolith construction system. These are used in combination with beds of concrete dolos to form composite systems of breakwater construction.

## CAISSON MONOLITH CONSTRUCTION

*"The caisson system is an adaption of the power of natural buoyancy to transportation purposes."*  
(Cornick, H, F. 1969: 124)

Large reinforced concrete boxes are constructed in the harbour. These are then lowered into the water and floated to the required location. Once at location, they are filled with concrete, stone and sand until they form a solid-filled caisson.

*"The caissons are very unyielding; they call for powerful towing and directing appliances, but once in position and rendered solid throughout, they offer a most powerful resistance to heavy sea."* (Cornick, H, F. 1969: 124)

## BOND IN BLOCKWORK

These systems of bonding blockwork together can create problems. In theory it is a strong system and the interlocking of blocks will strengthen the breakwater by binding everything into one structure. However, if unequal settlement occurs on the seabed, a sinking piece of breakwater could cause a fracture from the whole system. This problem has been solved by using vertical or sloping joints, and not horizontal ones. The two joints most commonly used are the dowel joint and the joggle joint. (Cornick, H, F, 1969: 128)

Only when the seabed is firm, for example, made from hard shale or rock, can horizontal joining be used. The most common horizontal joining is dove tail joints or rectangular blocks used in various lengths that overlap. (Cornick, H, F, 1969: 129)

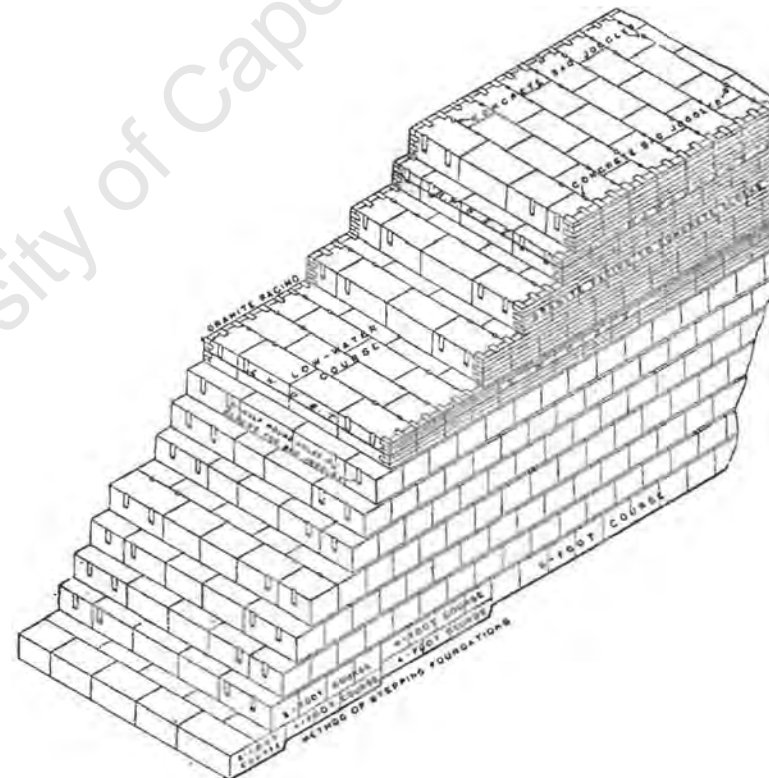
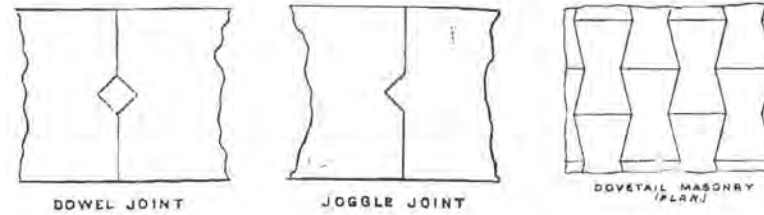
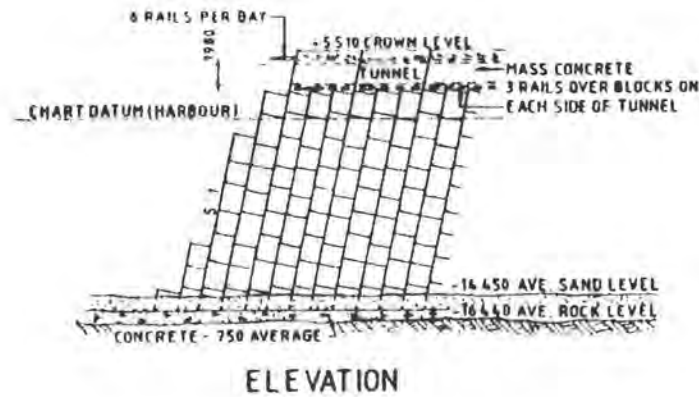


FIGURE 110

Different joints used in bond in blockwork construction.

FIGURE 111

Bond in blockwork construction.



### SLOPING BOND OR SLICE-WORK

Sloping bond or slice-work is an arrangement of blocks that lie tilted off the vertical line, usually 60-70 degrees. This system is clever because the blocks can slide between each other in the case of settlement, without disturbing the block courses next to them. Sloping bond involves careful management of the setting of the blocks. The bottom course is usually laid on a concrete bed. This concrete was deposited under the sea or in concrete bags. The rest of the courses are ordinary rectangular blocks that are tilted and laid. The overlap joint is varied. (Cornick, H. F. 1969: 130)

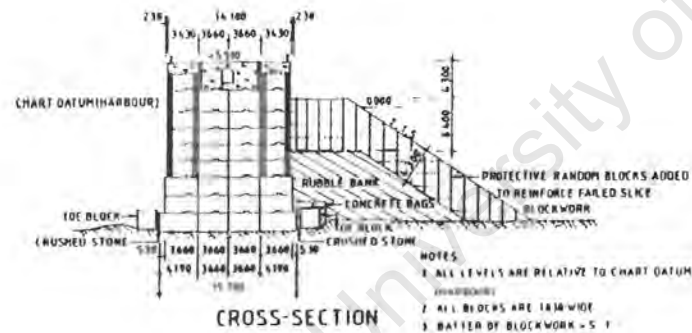


FIGURE 112

Slice blockwork system in elevation used at the Breakwater.

FIGURE 113

Cross section through slice blockwork system.

## DOLOS

The concrete dolos was designed in South Africa to deal with vulnerable coastlines that are affected due to harbour construction. In other countries they are called groynes, and come in many different shapes. Their purpose is to break up and dissipate waves. Dolos are stacked randomly along the shoreline; however, in some places where the sea is particularly rough, they have to be chained to the seabed.

### CONSTRUCTION DRAWINGS

Following are some of the original breakwater construction drawings for the Cape Town Harbour. They were kindly supplied by Portnet South Africa.

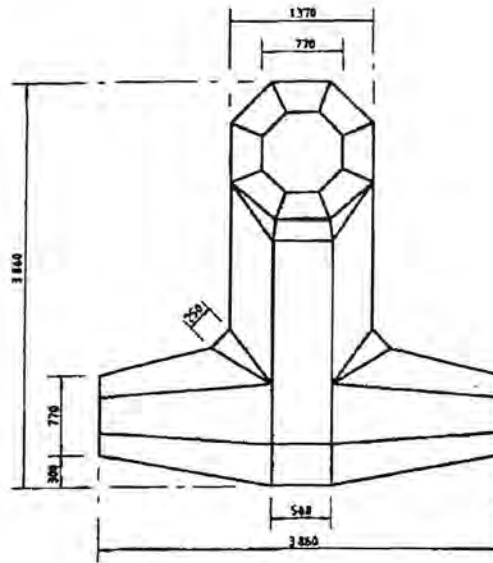


FIGURE 114

Concrete dolos design found at the Cape Town Breakwater.

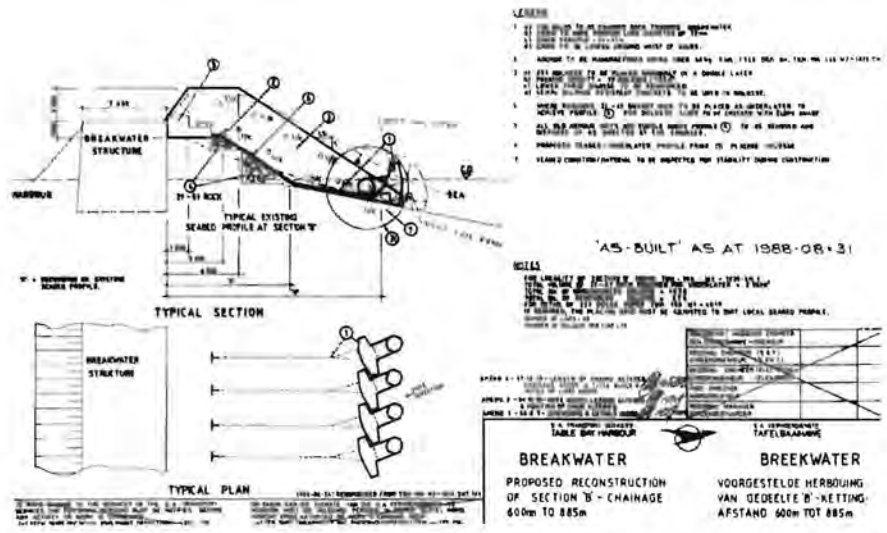


FIGURE 115  
Construction drawing of the composite breakwater system.

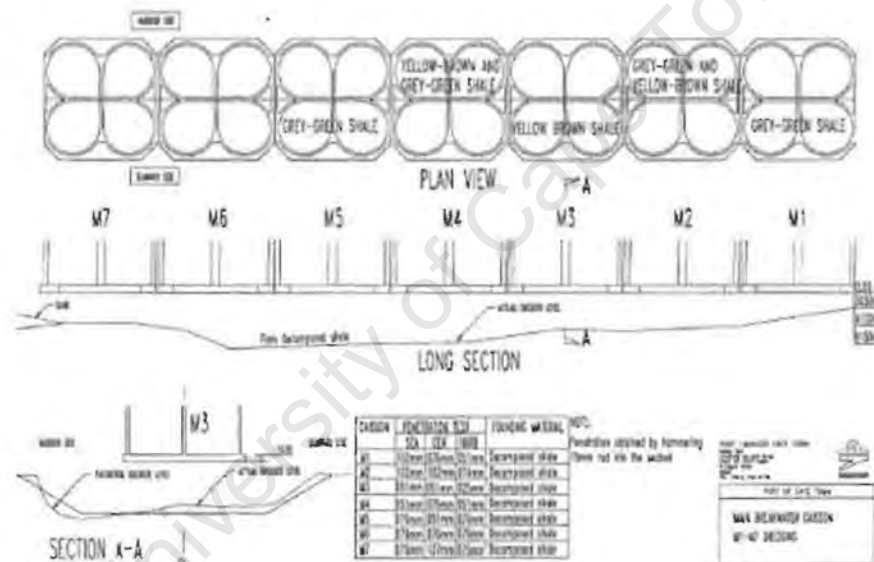


FIGURE 116  
Construction drawing of the caisson monolith system.

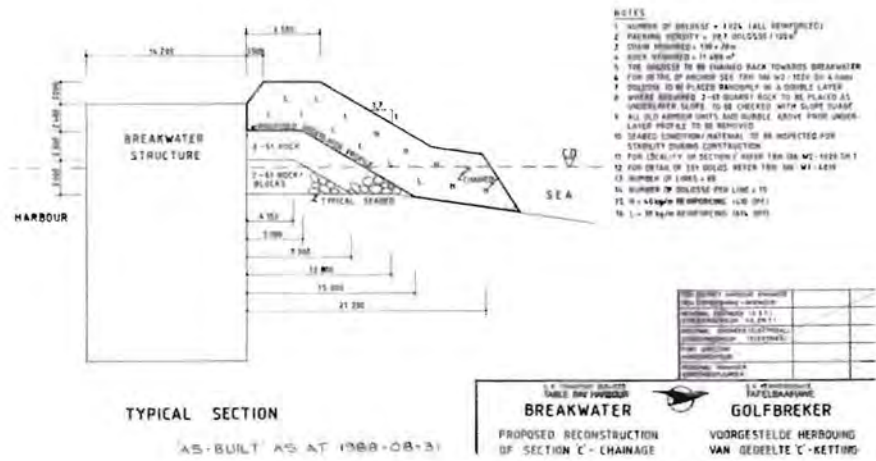


FIGURE 117  
Section through breakwater showing the dolos mound and its slope.



FIGURE 118

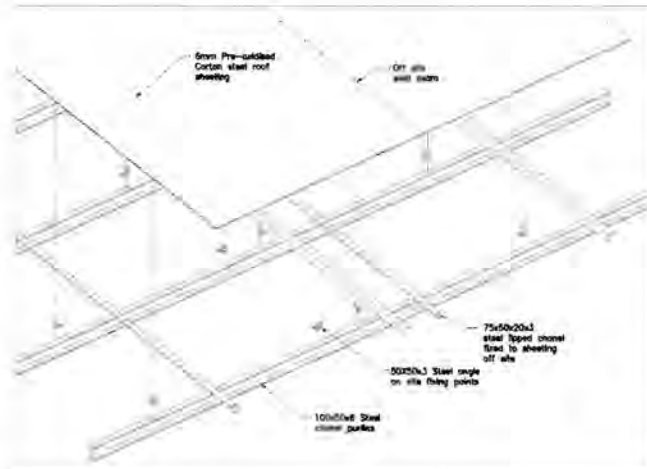
View from the mezzanine level.

FIGURE 119

View of metal ramps and interior roof.



# MATERIALITY



The museum interior needed to be a rich, tactile space. The expressive form on the exterior needed to be highlighted in the interior realm.

The inspiration for this came from ship construction. The interior is created to have a skeleton-like quality with many ribs that reminds one of being in the hull of ship.

The structural system is made up of a series of steel columns and beams that are spaced at 4 metre intervals. These members don't have to span very far as the maximum span is 8 metres. Therefore, 200 x 200 mm members were chosen. These steel members are cross braced every four bays to provide stiffness.

The secondary structure is made up of metal cleats 50 x 50 mm that are spaced at 1000 mm spacings onto which the Corten steel sheeting is bolted.

The decision to use Corten steel sheeting as a covering was due to its rusty quality that speaks of the harbour environment and weathering. Corten steel is an excellent choice, as the layer of rust that forms on it provides protection against corrosion, which happens almost immediately when steel is placed in marine conditions.

The sheeting is also perforated in key areas to allow light, as well as storm waters, to enter inside the storm chamber of the museum.

The ground plain is rough concrete work that provides the base onto which the steel structure latches. Overall, these materials have created the weathered and rough nature that is so evident in harbour landscapes.

FIGURE 120

Possible Corten detail solution - from previous project investigating Corten steel.



FIGURE 121  
The approaching storm.

# CONCLUSION

I believe that through a deeper understanding of site, a richer architecture can emerge. It is evident that the relationship between landscape, natural systems and the atmosphere is inseparable, and can be something that guides design as opposed to being thought of as a hindrance. Architecture can be a device that allows for amazing events and experiences to take place.

Through this project, I have tried to uncover possibilities, build in a blurry boundary between land and sea, tried to connect man with the power of the ocean. This project is about uncovering natural events at the Cape Town Breakwater. My dream is that it becomes a place for people to experience what it is like to be next to the sea.

Through investigations, I have tried to uncover things that are not normally seen and examined in architecture; wave progressions, wind, swell directions and storms. These have led me down a path to a much richer architecture than I could have imagined. I have tried to uncover these invisible and natural forces, and have given them presence in and around my building.

After all, the purpose of architecture is to uncover the *genus loci* of a site and create meaningful place...the Breakwater has now become that special place.

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# THANKS

I would like to dedicate this thesis project to my mother, Catherine McAllister, who has sacrificed so much for me, who has worked just as hard as I have to get me through my architectural studies. Without her encouragement and support through all the trials, I would never be where I am today or have become who I am now. Finally, after six long, difficult years, I get this Masters degree.

I would also like to thank Professor Jo Noero and Professor Nic Coetzer for their guidance through this entire project.

Thank you to my dear friends Kathleen Strijdom and Lynn Nowers who helped edit all three thesis papers. You are truly extraordinary individuals and true friends.

And finally, I would like to thank the Lord my God who has blessed me, and kept me, and provided for me throughout these six years of studies. Thank you Jesus.

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**FIGURE 11** - Hill, Jonathan. 2006. *Immaterial Architecture*. Routledge: Oxon. Page 196.

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FIGURE 18 – McAllister, H. 2012. *The development of the Cape Town Harbour from 1860 - 1933*. [Drawing] (Heidi McAllister Private Collection)

FIGURE 19 – McAllister, H. 2012. *The development of the Cape Town Harbour from 1933 - current date*. [Drawing] (Heidi McAllister Private Collection)

FIGURE 20 – McAllister, H. 2012. *Conceptual photomontage of the harbour environment*. [Drawing] (Heidi McAllister Private Collection)

FIGURE 21 – McAllister, H. 2012. *Conceptual photomontage of the harbour conditions and activity*. [Drawing] (Heidi McAllister Private Collection)

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FIGURE 24 – McAllister, H. 2012. *Ocean Topography – Soundings*. [Drawing] (Heidi McAllister Private Collection)

FIGURE 25 – McAllister, H. 2012. *North-west wave progression*. [Drawing] (Heidi McAllister Private Collection)

FIGURE 26 – McAllister, H. 2012. *West wave progression*. [Drawing] (Heidi McAllister Private Collection)

FIGURE 27 – McAllister, H. 2012. *South-west wave progression*. [Drawing] (Heidi McAllister Private Collection)

FIGURE 28 – McAllister, H. 2012. *West wave reflection from west channel*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 29** - McAllister, H. 2012. *West wave reflection from north channel*. [Drawing] (Heidi McAllister Private Collection)

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**FIGURE 31** - McAllister, H. 2012. *Three dominant swell patterns for Cape Town Harbour*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 32** - McAllister, H. 2012. *Small swell – wave height 2m*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 33** - McAllister, H. 2012. *Mild storm – wave height 4m*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 34** - McAllister, H. 2012. *Large storm – wave height 8m*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 35** - McAllister, H. 2012. *100 year storm – wave height 13m*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 36** - Google earth. 2012. *Contextual Aerial map showing the greater Cape Town Harbour*. [Electronic print] Available at: [www.googleearth.com](http://www.googleearth.com) [Accessed 29 May 2012]

**FIGURE 37** - McAllister, H. 2012. *Site plan drawing showing immediate context*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 38** - McAllister, H. 2012. *Site plan drawing zoomed in*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 39** - McAllister, H. 2012. *Site plan composite drawing*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 40** - McAllister, H. 2012. *Site sections*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 41** - McAllister, H. 2012. *Site sections*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 42** - McAllister, H. 2012. *En Loge exercise*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 43** - McAllister, H. 2012. *En Loge exercise model building*. [Photograph] (Heidi McAllister Private Collection)

**FIGURE 44** - McAllister, H. 2012. *En Loge exercise model building*. [Photograph] (Heidi McAllister Private Collection)

**FIGURE 45** - McAllister, H. 2012. *En Loge exercise detail component*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 46** - McAllister, H. 2012. *En Loge exercise 2 – zoomed in*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 47** - McAllister, H. 2012. *En Loge exercise 2 – section study 1*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 48** - McAllister, H. 2012. *En Loge exercise 2 – section study 2*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 49** – McAllister, H. 2012. *Elements and Language of the Harbour and sea*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 50** - McAllister, H. 2012. *Elements and Language of the Harbour and sea*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 51** - McAllister, H. 2012. *Different construction systems used at the Cape Town breakwater*. [Drawing] (Heidi McAllister Private Collection)

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**FIGURE 53** – McAllister, H. 2012. *Technical Drawings – Dock construction*. [Drawing] (Heidi McAllister Private Collection)

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**FIGURE 58** – McAllister, H. 2012. *Site qualities and possibilities*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 59** - McAllister, H. 2012. *Conceptual massing investigation*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 60** - McAllister, H. 2012. *Conceptual photomontage of the event*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 61** - McAllister, H. 2012. *Drawing showing the walls as highlighted in black*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 62** - McAllister, H. 2012. *Diagram showing the ruptures along the Breakwater*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 63** - McAllister, H. 2012. *The tip of the Breakwater with seating facing towards the harbour*. [Render] (Heidi McAllister Private Collection)

**FIGURE 64** - McAllister, H. 2012. *Viewing ramp and seating facing out towards the ocean.* [Render] (Heidi McAllister Private Collection)

**FIGURE 65** - McAllister, H. 2012. *Change of handrail system, a step down, indicates a rupture space and change in breakwater construction.* [Render] (Heidi McAllister Private Collection)

**FIGURE 66** - McAllister, H. 2012. *Rupture space steps down towards water. Fishing platform and seating.* [Render] (Heidi McAllister Private Collection)

**FIGURE 67** - McAllister, H. 2012. *Turbine power station in background.* [Render] (Heidi McAllister Private Collection)

**FIGURE 68** - McAllister, H. 2012. *Ramp that leads down towards the water.* [Render] (Heidi McAllister Private Collection)

**FIGURE 69** - McAllister, H. 2012. *Ramp that leads to the calm harbour water's edge. Allows for possible small boat access.* [Render] (Heidi McAllister Private Collection)

**FIGURE 70** - McAllister, H. 2012. *Another rupture place and change in breakwater construction, indicated in surface treatment.* [Render] (Heidi McAllister Private Collection)

**FIGURE 71** - McAllister, H. 2012. *SA Agulhas docking point with ticket booth and kiosks in background.* [Render] (Heidi McAllister Private Collection)

**FIGURE 72** - McAllister, H. 2012. *Internal perspective inside the museums storm chamber. Sunken space flooded with storm waters.* [Render] (Heidi McAllister Private Collection)

**FIGURE 73** - McAllister, H. 2012. *External perspective drawings showing the buildings faceted form.* [Render] (Heidi McAllister Private Collection)

**FIGURE 74** - McAllister, H. 2012. *External perspective drawings showing the buildings faceted form.* [Render] (Heidi McAllister Private Collection)

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**FIGURE 77** – McAllister, H. 2012. *Plan view of a typical turbine power center. 8 turbines inside this structure.* [Render] (Heidi McAllister Private Collection)

**FIGURE 78** – McAllister, H. 2012. *Rusty interior render in the entry foyer.* [Render] (Heidi McAllister Private Collection)

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**FIGURE 80** - McAllister, H. 2012. *Weathered concrete walls stained with algae. This is the fishing platform intervention.* [Render] (Heidi McAllister Private Collection)

**FIGURE 81** - McAllister, H. 2012. *First rough plan scheme.* [Drawing] (Heidi McAllister Private Collection)

**FIGURE 82** - McAllister, H. 2012. *Sketch design plan.* [Drawing] (Heidi McAllister Private Collection)

**FIGURE 83** - McAllister, H. 2012. *Section through entry foyer space.* [Drawing] (Heidi McAllister Private Collection)

**FIGURE 84** - McAllister, H. 2012. *Section through museum space.* [Drawing] (Heidi McAllister Private Collection)

**FIGURE 85** - McAllister, H. 2012. *Section through storm chamber with mezzanine.* [Drawing] (Heidi McAllister Private Collection)

**FIGURE 86** - McAllister, H. 2012. *Section through lab space and museum interior ramp.* [Drawing] (Heidi McAllister Private Collection)

**FIGURE 87** - McAllister, H. 2012. *Section through museum space.* [Drawing] (Heidi McAllister Private Collection)

**FIGURE 88** - McAllister, H. 2012. *Section through SA Agulhas docking point.* [Drawing] (Heidi McAllister Private Collection)

**FIGURE 89** - McAllister, H. 2012. *Section through the ramp down to the water's edge.* [Drawing] (Heidi McAllister Private Collection)

**FIGURE 90** - McAllister, H. 2012. *Section through viewing ramp at the end of breakwater.* [Drawing] (Heidi McAllister Private Collection)

**FIGURE 91** - McAllister, H. 2012. *Sketch design rough 3-D perspective of entire length of the breakwater.* [Render] (Heidi McAllister Private Collection)

**FIGURE 92** - McAllister, H. 2012. *3-D perspective of the building showing facets and possible material palette.* [Render] (Heidi McAllister Private Collection)

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**FIGURE 95** - Wavegen. 2009. *Isley LIMPET power plant - side elevation.* [Electronic print] Available at: <http://barnabys.blogs.com/kio/renewable-energy/> [Accessed 4 May 2012]

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**FIGURE 97** – McAllister, H. 2012. *Section through the Mutriku vertical OWC system*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 98** – McAllister, H. 2012. *Technical Drawings – Dock construction*. [Drawing] (Heidi McAllister Private Collection)

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**FIGURE 102** – McAllister, H. 2012. *Plan showing the extent of the extension with pile layout*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 103** – McAllister, H. 2012. *Plan showing pile spacing as well as cross bracing pile system*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 104** – McAllister, H. 2012. *Perspective top view of pile system*. [Render] (Heidi McAllister Private Collection)

**FIGURE 105** – McAllister, H. 2012. *Perspective of the pile system*. [Render] (Heidi McAllister Private Collection)

**FIGURE 106** – McAllister, H. 2012. *Section through building and the extension platform with the pile system*. [Drawing] (Heidi McAllister Private Collection)

**FIGURE 107** – Portnet. n.d. *Caisson construction drawings*. [Drawing] (Portnet Private Collection)

**FIGURE 108** – Portnet. n.d. *Caisson construction drawings*. [Drawing] (Portnet Private Collection)

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University of Cape Town

**FIGURE 115** – Portnet. 1988. *Breakwater construction drawing*. [Drawing] (Portnet Private Collection)

**FIGURE 116** – Portnet. n.d. *Caisson construction drawing*. [Drawing] (Portnet Private Collection)

**FIGURE 117** – Portnet. 1988. *Breakwater construction drawing*. [Drawing] (Portnet Private Collection)

**FIGURE 118** – McAllister, H. 2012. *View from the mezzanine level*. [Render] (Heidi McAllister Private Collection)

**FIGURE 119** - McAllister, H. 2012. *View of metal ramps and interior roof*. [Render] (Heidi McAllister Private Collection)

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**CAPE OF STORMS**

*Cabo das Tormentas*

**Exploring Natural Events at the  
Breakwater**

By

**Heidi Jené McAllister**

October 2012