



## **CHANGING TIDES:**

Sculpting heterogeneity through exposing and submerging form in tidal pool design

by Roché de Villiers

Supervisor: Tarna Klitzner

2019

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## CHANGING TIDES

Sculpting heterogeneity through exposing and submerging form in tidal pool design

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DVLROC003

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Dissertation  
120 Credits

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Supervisor: Tarna Klitzner



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# EXECUTIVE SUMMARY

This project highlights the dynamic processes, systems and ecological interactions of the intertidal landscape. The tidal pool sits at this intersection of land and water, known as the intertidal zone. They are site specific social spaces where people can interact with marine life and they are valuable public places that can connect people to nature. As such it's in the unique position to raise awareness about the dynamism of natural systems and ecological processes which can be particularly well observed in tidal flux. In the context of climate change and associated sea level rise this awareness of change and flux will be particularly important in fostering adaptation capabilities.

Although tidal pool design respond to site in their engineering and are mostly built on rocky substrates, I have noticed that not much form inspiration is drawn from the unique geologies of tidal pool sites. As a result the natural heterogeneity and delight inherent in rock pools is lost and somewhat mono-functional human-centered spaces result. As a design strategy, I considered the core importance of specificity to site as a strategy to build in this rather unusual landscape. The intent is to find and establish a new set of criteria for tidal pool design within the Table Mountain Sandstone geology.

In this thesis I'm exploring whether the process of designing with intimate attention to the host rocks can provide better opportunities and a more sensitive approach for creating heterogeneity in tidal pool design that make vibrant space for both social and ecological functions. Sculpting heterogeneity in the rocky intertidal zone of St. James' rocky outcrop will enhance the co-habitation of human and marine life and hold the opportunity to celebrate the ecological value of this rich and sensitive environment through environmental education through experience.

# **ECOLOGY AS A DRIVER OF FORM IN DESIGN**

THE RESEARCH STUDY

# STUDY ABSTRACT

My study is composed of a set of inquiries in order to discover and interpret form found in the wonder and workings of the intertidal zone. I seek to find a language expressed through form which is revealed in the actuality of the intertidal zone, and can be measured by its individual, interrelated and dynamic components.

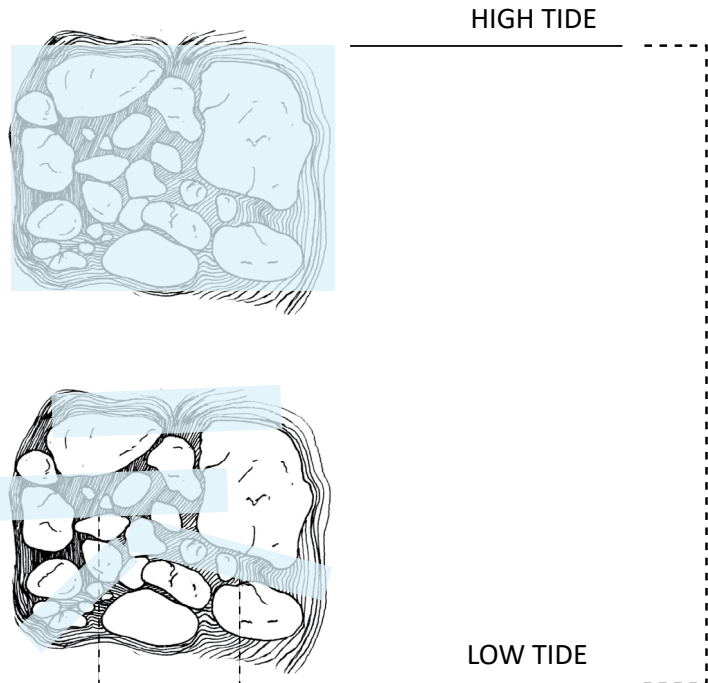
It is here, in the littoral landscape, where the affiliation of these components manifest rich ecological and magical conditions which is nothing short of being laudable. The active phenomena of tidal flux and hydrological processes is temporal and ever changing. It is a place where aquatic life flourish at a spectrum of scales. Rocks which are linked to the larger geological context is fixed in nature, but is mortal to the natural processes of weathering over time. It is home to complex ecological communities and when man occupies this landscape, the opportunity of infinite observation enables the user to be engulfed by its nature allowing one to be intimately familiarized with its workings and view the intricacy and diversity of natural tidal pools.

The intertidal zone is healthier, more stable and more capable of adaptation when it has a heterogeneous nature. The built tidal pool in this zone reflects a controversy, as it creates homogeneity and blandness because the bodied structure overrules diversity by replacing what's underneath with sameness instantly or over time. This sameness (homogeneity and mono-experience) is directly linked to the scale and size of the built structure.

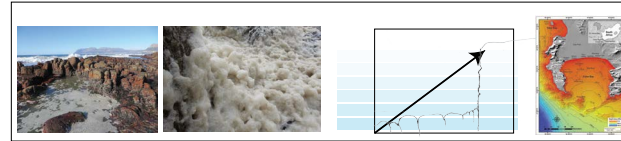
It is proposed that the traditional built tidal pool, with its homogeneity, becomes a recipient of more layers, which I believe is absent. These layers include meticulous ecological and sociological components which may enrich the needs and delights of both and restore heterogeneity. It is therefore proposed that these layers, when in conjunction, an agreement of finding form can be found within these components.

# STUDY METHODOLOGY

An initial section of studying tidal change with its associated intricacy (wonder) and then distilling it into four observations around relationships in rock pools and existing form, functioning, coastal systems, ecology and geology.



Visual inspiration : Functions, processes and magic



Strict, specific and what is: Extrapolate shape from photographs

Analysis of current form: A way into form

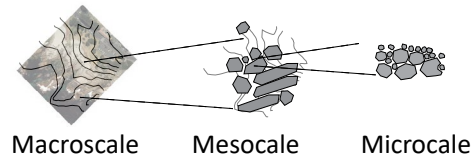


DISCOVER

ABSTRACT

UNDERSTANDING THE NATURE OF ROCK POOLS AND ECOLOGICAL RELATIONSHIPS

Rock: Geology and topography

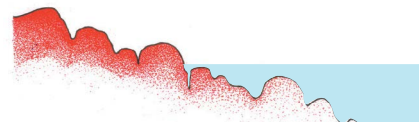


Macroscale

Mesoscale

Microscale

Ecology: Coastal habitat and functions



THE WONDER

Interrogating the intricacy.

Exploring the fun, beauty and ever changing aspects of natural tide pools.


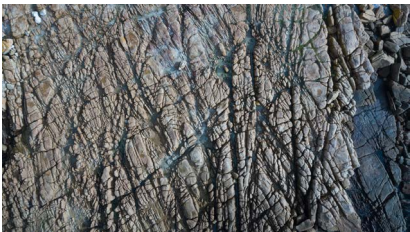
















## A VISUAL INQUIRY

of 3 geologies and associated life forms

*"When I look at natural arrangements in space I am always amazed by how right they are, how stones in the bottom of a tidepool seem arranged just right and their relationships to each other cannot be improved upon. When I see rock forms carved by wave action they move me as great works of form-making."*



Image source: Halprin, L. (1988). Nature into Landscape into Art. *Athens Center of Ekistics*, 55(3), 349-354.

GEOLOGY	DYNAMIC SYSTEMS	TOPOGRAPHY	MORPHOLOGY	SEA LIFE
<p><b>Table Mountain Sandstone</b></p>	 <p>wave action</p>	 <p>macroscale</p>  <p>mesoscale</p>	 <p>texture</p>  <p>color</p>  <p>pattern</p>	 <p><i>Plum anemone</i></p>  <p><i>Fan worm</i></p>  <p><i>False plum anemone</i></p>  
	 <p>high tide</p>  <p>low tide</p>	 <p>microscale</p>	 <p>shape</p>	 <p><i>Barnacle</i></p>  <p><i>Sea star</i></p>  <p><i>Sea urchin</i></p>

*Nature of rock pools explained*

The **heterogeneous nature** of the sandstone geology at **mesoscale** **disperse water evenly** on the rock beds, subsequently surrounding series of rocks with water, **forming pools with multiple inlets/outlets**.

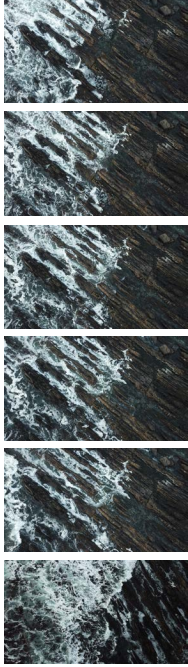
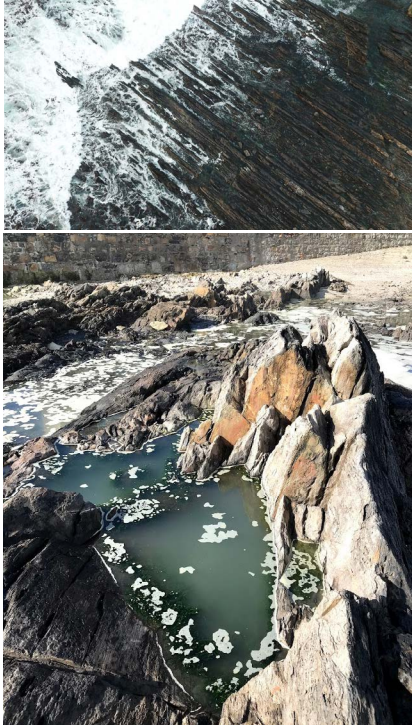





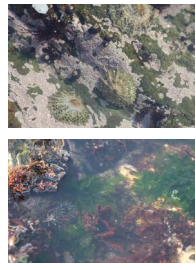
Fluctuation of water levels **fills pools organically** with varying volumes of water.






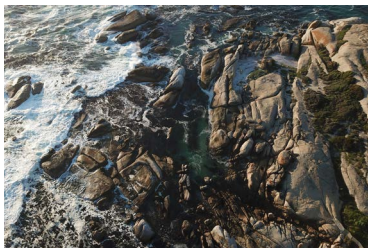







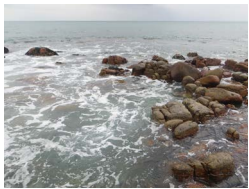


**Spatial heterogeneity: High topographical heterogeneity at all scales.** This adds to the **habitat complexity** and is central to why there's a **high diversity of marine species found here**. The topographic variation evident in the pattern in elevation over an area on microscale **impacts the distribution of species** over a given area and increases the three dimensionality of the intertidal zone.

**Rough, granular texture** and a variety of shapes, overall being more **rounded and organically shaped**.

Three dimensionality created by individual sandstone units and many small, medium and large rock pools are defined during the different tides. **Morphologically attractive for anchoring by species with many cracks and crevices to protect species against harsh coastal conditions.**

**Heterogeneity in abiotic conditions enables a rich amount and diversity of fauna and flora species and diverse niche spaces** along the sandstone intertidal zone. From observation there seems to be more fauna than flora per area/unit. **High ecological performance is apparent** along the False Bay coast.

GEOLOGY	DYNAMIC SYSTEMS	TOPOGRAPHY	MORPHOLOGY	SEA LIFE
<i>Malmesbury Shale</i>	 <p>wave action</p>	 <p>macroscale mesoscale microscale</p>	 <p>texture color pattern shape / strata</p>	 <p><i>Algae</i> <i>Periwinkle</i> <i>Sea anemone</i> <i>Limpet</i> <i>Sea weed</i></p>
	 <p>high tide low tide</p>	 <p>microscale</p>	 <p>shape / strata</p>	 <p><i>Limpet</i> <i>Sea weed</i></p>
All images by author	<p>The <b>linear and angular nature (due to stratification)</b> of the shale geology receives water in a almost <b>channel-like fashion</b> on the rock beds, subsequently filling series of pools.</p> <p>Fluctuation of <b>water levels fills angular pools</b> with varying volumes of water.</p>	<p><b>Spatial heterogeneity: High topographical heterogeneity at all scales.</b> This adds to the <b>habitat complexity</b> and is central to the <b>diversity of marine species.</b></p>	<p><b>Smooth, fine texture. Series of angular and geometric shapes</b> and sizes. The layers of <b>strata is apparent in its geomorphology</b> and explains the lack of three dimensionality in rock pools.</p> <p><b>Morphologically attractive for anchoring by species with many cracks and crevices to protect species against harsh coastal conditions.</b></p>	<p><b>Rich amount and diversity of fauna and flora species</b> inhabiting the intertidal zone. From <b>physical observation</b> there seems to be a lot of flora (algae) growth in comparison to the fauna, and also <b>less life than on the sandstone shores.</b></p>
<i>Nature of rock pools explained</i>				

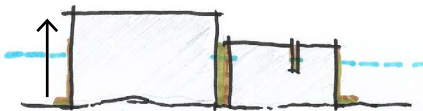
GEOLOGY	DYNAMIC SYSTEMS	TOPOGRAPHY	MORPHOLOGY	SEA LIFE
<p><b>Cape Granite</b></p> <p>All images by author</p>	 <p>wave action</p>	 <p>macroscale</p>  <p>mesoscale</p>	 <p>texture</p>  <p>color</p>  <p>pattern</p>  <p>shape</p>	 <p><i>Sea star</i></p>  <p><i>Mussle</i></p>  <p><i>Limpet</i></p>  <p><i>Sand anemone</i></p>  <p><i>Kelp</i></p>  <p><i>Barnacle</i></p>
	 <p>high tide</p>  <p>low tide</p>	 <p>microscale</p>	<p><b>Granular, coarse texture.</b> Large sized <b>boulders</b>, overall being more <b>monolithic and organic by nature</b>.  <b>Morphologically attractive for anchoring by species but few cracks and crevices to protect species against harsh coastal conditions.</b></p>	<p>Heterogeneity in abiotic conditions enables a rich amount and diversity of fauna and flora species and diverse niche spaces along the granite intertidal zone. From observation there seems to be more fauna than flora per area/unit.  <b>High ecological performance is apparent</b> along the Atlantic coast.</p>
<p><i>Nature of rock pools explained</i></p>	<p>The <b>bulk nature and scale</b> of the granite geology does not cause tides and waves to fill large pool bodies.</p> <p>Fluctuation of water levels generally <b>fill large pools</b> with varying volumes of water.</p>	<p><b>Spatial heterogeneity: High topographical heterogeneity at macro-and-mesoscale</b>, however at microscale topographical heterogeneity appears to be less.</p>		

## Conclusion: ROCK AS HOME

Sessile: *adjective*  
biology

(Of an organism, e.g. an barnacle)  
fixed in one place; immobile.

Many fauna and flora sea creatures, rely on rock surfaces as anchor points to survive. Rocks also provide shelter and refuge for mobile sea creatures and it's these variety and high number of "homes" that allow species and communities to thrive as aquatic ecosystems in the rocky intertidal zone. Marine organisms prefer to attach / "grow" on vertical rock surfaces.



Vertical anchorage

### Anchorage pattern (principle)

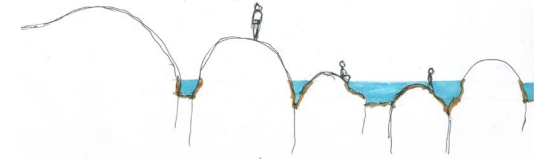
*Principle develops into important criteria for design.*

### Granite

**Rough and textured surfaces** make successful anchor points but the **lack of cracks, fissures and crevices** leaves sea life exposed rather than sheltered. Organisms are **predominantly anchored vertically**, along the joints of adjacent boulders.

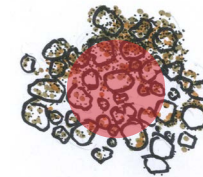


boulders - round



### Sandstone

**Granular and textured surfaces** make successful anchor points and the **abundance of cracks, fissures and crevices** shelters sea life. Organisms are predominantly **anchored in, vertically** around individual and adjacent rocks.



cobbles/rocks - round



### Shale

**Smooth surfaces** make limited anchor points and the **lack of cracks, fissures and crevices** leaves sea life exposed rather than sheltered. Organisms are predominantly **anchored linearly along angled** strata layers.



layered strata - line



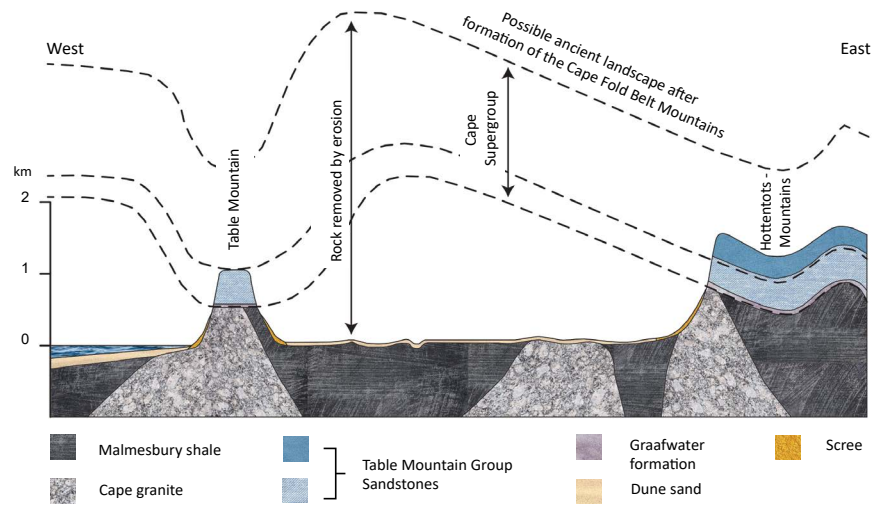
# GEOLOGY

Rock typologies



Image source: by author

# CAPE PENINSULA GEOMORPHOLOGY

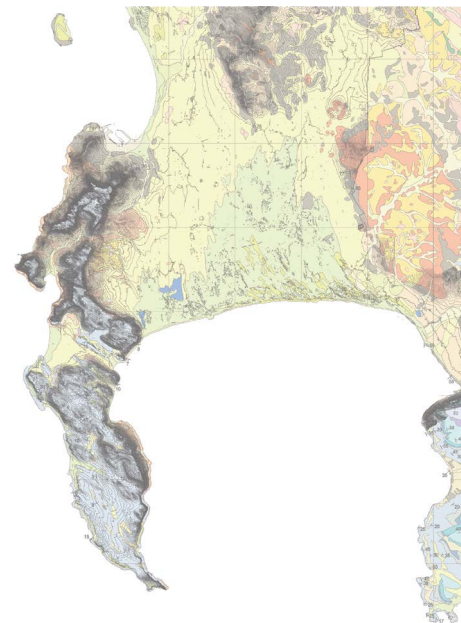


**Figure 1:** A geological cross section (West-East) of the Cape Fold Mountains.

The oldest rock formation here is the late-Precambrian Malmesbury Group, made up of alternating layers of almost vertical, dark grey fine-grained grey-wacke sandstone and shale. These sediments were deposited 560 million years ago and metamorphosed the sediments into tightly folded rock layers as a result of heat and pressure. Molten rock (magma) crystalized deep in the earth and it intruded into the Malmesbury Group more or less 540 million years ago, known as the batholithic Peninsula Granite. The granite is known for its rounded shapes of boulders which is a result of preferential weathering. Its texture is characterized by coarse-grained rock consisting of white chunky pieces of feldspar crystals, glassy quartz. Intense physical and chemical weathering has changed the shape, form and composition of some of the granite boulders.

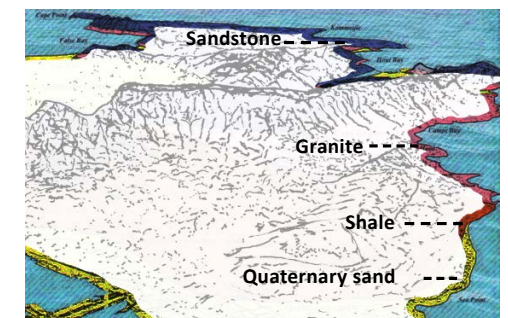
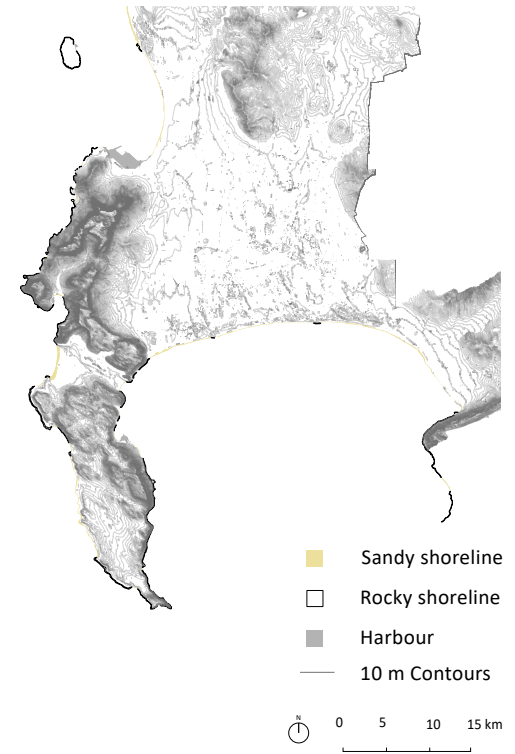
The Table Mountain Group is situated on top of the Malmesbury shale and granite bed rock, where the sedimentary rocks have been deposited in braided stream channels and the tidal flats of the coastal plains known as the Cape Flats about 500-440 million years ago.

Today, the landscape of the Cape Peninsula is a result of the ongoing erosion having carved out deep valleys, which is eliminating sections of the Table Mountain Group sandstone which used to be a continuous cover from west to east.



Geological section and map adapted from John Compton's work. <http://www.geology.uct.ac.za/cape/town/geology>, 2019

Sandy beaches and rocky shores dominate the coastal edge. The coastline is exposed to heavy wave action and as a result of weathering and erosion, changes its physical characteristics over time. One can clearly see the difference in the scale and size of the different geological rocks and how different coastal habitats exist when one comes in touch with the rocks.



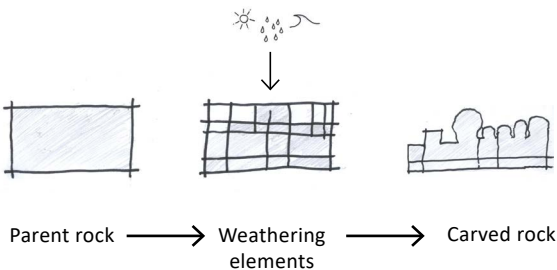
**Figure 2:** An illustration of the geology of the coastal edge of the Cape Peninsula.

Conclusion:  
**SHAPED**

“Weathering describes the breaking down or dissolving of rocks and minerals on the surface of the Earth. Water, ice, acids, plants, animals and changes in temperature are all agents of weathering. Once a rock has been broken down, a process called erosion transports the bits of rock and mineral away. No rock on Earth is hard enough to resist the forces of weathering and erosion. Weathering and erosion constantly change the rocky landscape of Earth.”

Weathering constructs the heterogeneous facilities for ideal ecological homes.

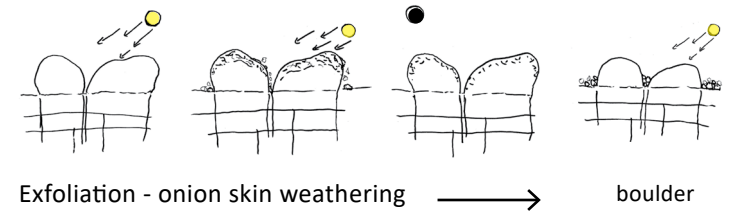
<https://www.nationalgeographic.org/encyclopedia/weathering/>



*Weathering pattern (principle)*

**Cape granite**

Weathers mechanically into rounded boulders as a result of exfoliation due to continuous heating (expansion) and cooling (contraction) of rock.



**Peninsula formation sandstone**

Weathers in blocky, highly resistant rocks, that typically form cliff faces.



**Malmesbury shale**

Weathers as a 'washerboard' on steeply dipping beds of different resistance



Erosion - Wave action and tides

# TIDES AND COASTAL SYSTEMS

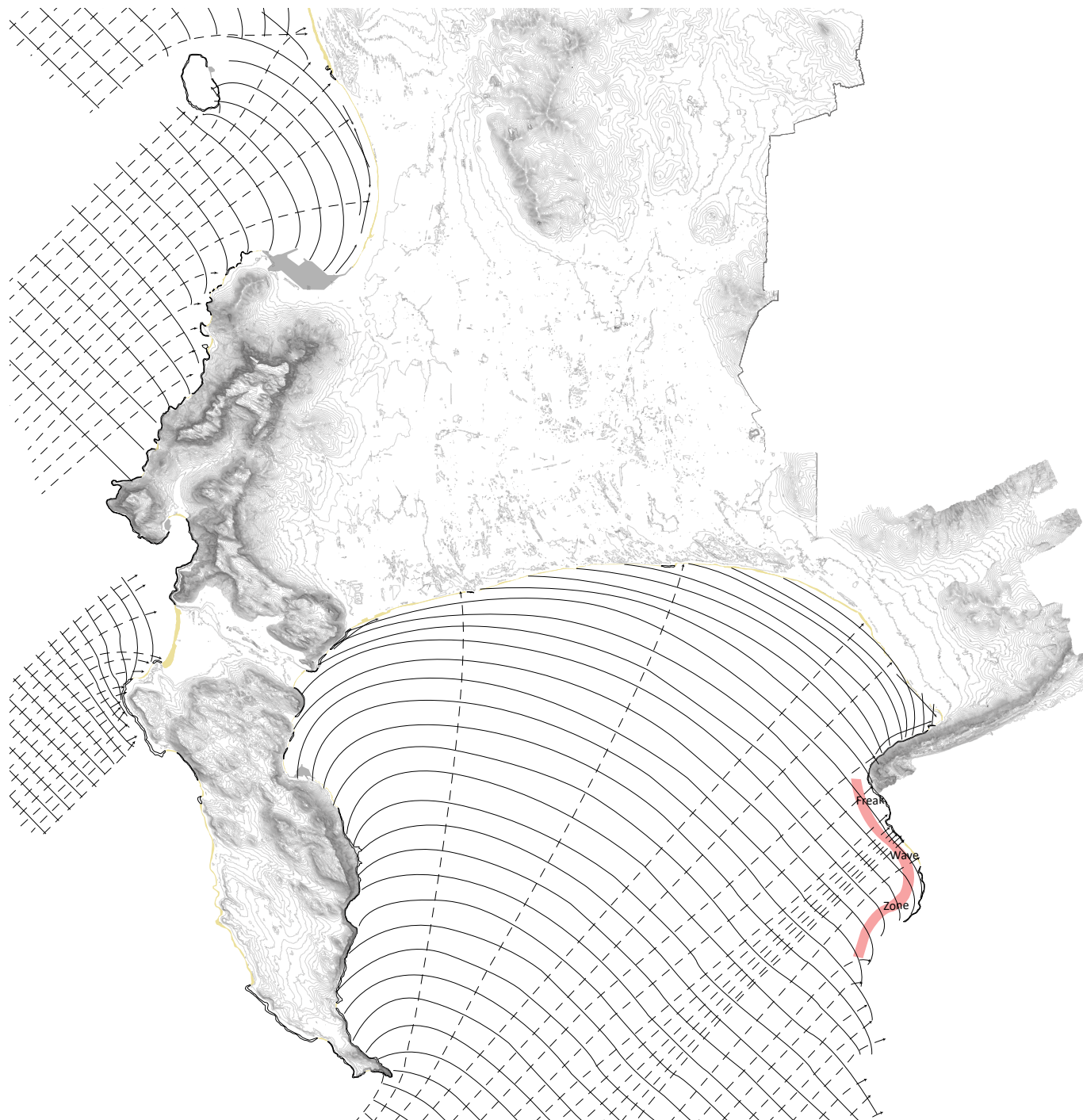
A system in flux



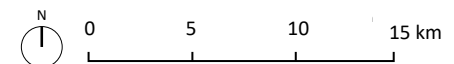
Fish traps of Stilbaai, 2019.  
Images source: by author

## HYDROLOGICAL PROCESSES: COASTAL WATERS

The Cape Peninsula is exposed to ocean swells and beating waves which can take its toll on the natural and man-made shoreline. The character of the shoreline plays a big role in its stability and kind of coastal habitat it creates. Sandy areas, for instance beaches, lagoons and wetlands are most malleable and unstable. Limestone, like rock-like shelves and cliffs are relatively malleable. The most stable shoreline is that with a rock foundation. Thus, granite, shale and sandstone is the most stable and resistant to the hydraulic forces along the shoreline. The orientation and degree of shelter of the shoreline also plays a role in how it responds to the forces. The Atlantic side of the Peninsula is more exposed to the forces due to the predominant swell direction and lack of bay protection compared to the False Bay side, which is more protected and sheltered.



- Sandy shoreline
- Rocky shoreline
- Harbour
- 10 m Contours
- Wave fronts
- Longshore drift
- Orthogonal (wave energy)



# TIDES

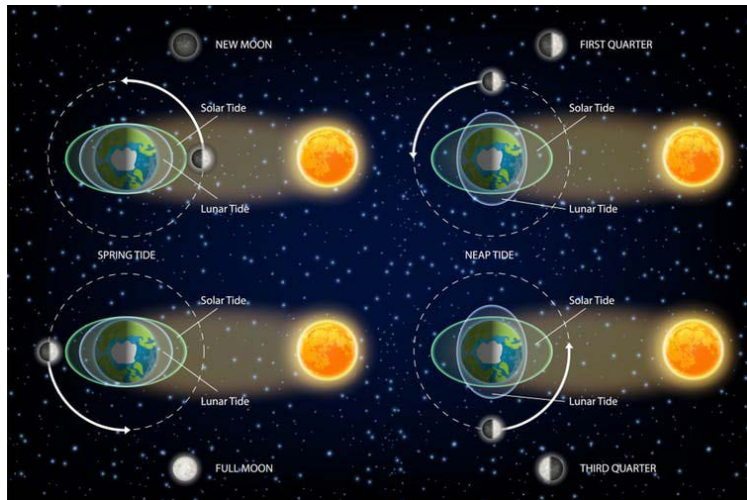


Figure 3: Diagram explaining the lunar and solar tides.

Lunar and solar tides diagram, shutterstock.  
 (<http://theconversation.com/curious-kids-how-does-the-moon-being-so-far-away-affect-the-tides-on-earth-105371>, 2019)

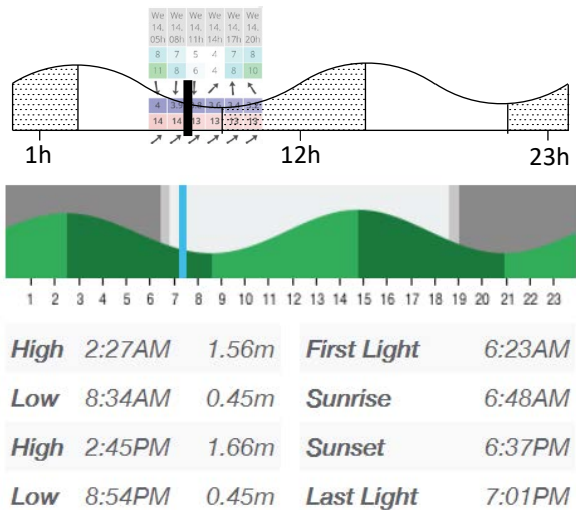


Figure 4: Diagram showcasing Cape Town's semi-diurnal tide over 24 hours.

Imagery from : magicseaweed, 2019

Tides is the occurrence of rising and falling levels of water due to the gravitational forces of the sun and the moon. Even though the sun and the moon is far away from the earth, they still have a gravitational impact. Different intensities of tides occur.

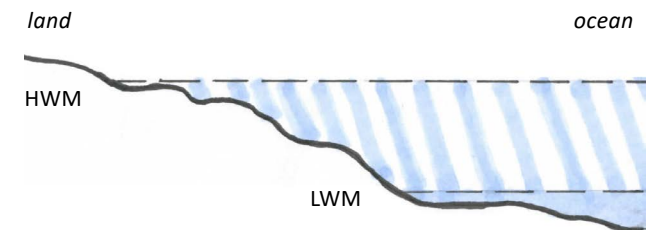
**Spring tides:** When the sun and the moon align with the earth the combined effect of the gravities pull the sea water and create extra high and low tides.

**Neap tides:** When the sun and the moon do not align and form a right angle between the two, then the gravity of the sun cancel the gravitational pull of the moon, which create much less of a high and low tide.

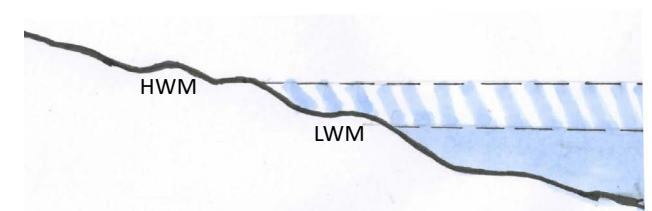
## Tides generates wave action



Images source: by author



**Spring tide:** Big level difference between high water and low water.



**Neap tide:** Small level difference between high water and low water.

Tidal diagram: South Africa experience semi-diurnal tides. This means 2 low tides and 2 high tides within 24 hours. 6 hour tidal intervals means, every 6 hours it's either a full high tide or full low tide.

The average tidal difference between low tide and high tide: 1, 1 meter.

**Neap tide:** Very small difference between high water and low water levels.

**Spring tide:** Big difference between high water and low water level.

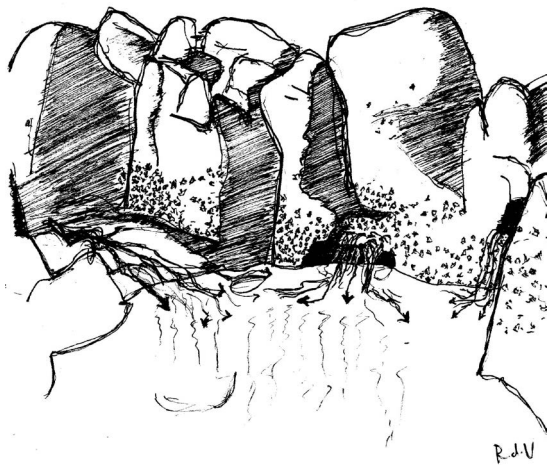
## WATER MOVEMENT

The way the tides and waves move water over and through the rocks highlights the life and dynamic atmosphere of the rockscape.

The rocks, with the help of tides and waves, choreograph the movement of water with in distinct and different ways. Lawrence Halprin talks about the ecology of form and it is truly displayed within the intertidal zone. If the coastline is observed particularly well,

then patterns become clear and natural processes come about at regular and irregular intervals. The flux and force of water reveals changes at immediate and deep time, and it's the very active and dynamic movement of water which chisel away the geology, sculpting and composing the natural rockscape. As a **design principle** I draw inspiration from this natural phenomena to help find and create form.

*"The origin of natural form-making comes from mountain building, from erosion generated by wind or water or freezing and thawing. I call these processes the ecology of form" - Halprin, L. (1988)*



### Cascading

At low tide, a miniature waterfall constantly trickles from the joints and crevices of a rather vertical chunk of sandstone as it's fed by a higher adjacent rock pool, while the wave action fills the rock pool at a slower interval.



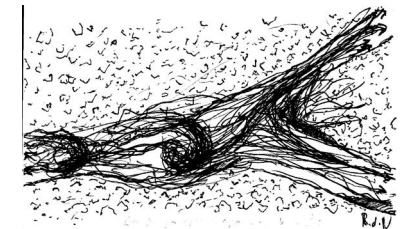
### Convergence

Water flows in a meandering fashion in between rocks, forming concentration points and causing increase in velocity and turbulence.



### Jumping

Waves bashing against a sandstone rock shelf, causing water to jump over and fill the pool on the other side.

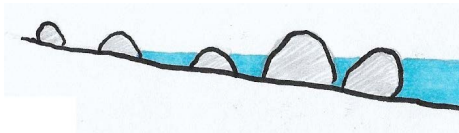
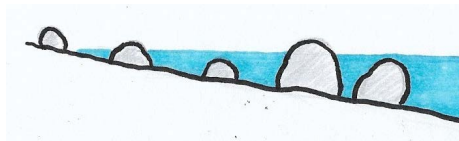


### Compression

Wave action force water into every crack and crevice. Rock pools flushed with a twirling load of water, suspending sediments and carves away rock as it enables physical weathering.

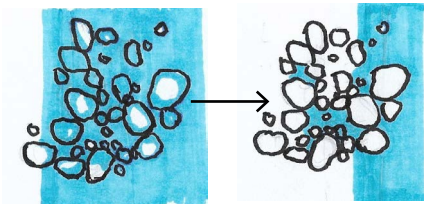
Conclusion:  
**EPHEMERAL & DYNAMIC**

The intertidal zone is in constant symbiosis with the **resource of the tide**. Natural pools appear and disappear due to the lunar, solar - Earth cycle. The gravitational force of the Moon and Sun on the Earth has an ephemeral water effect of void and submersion.



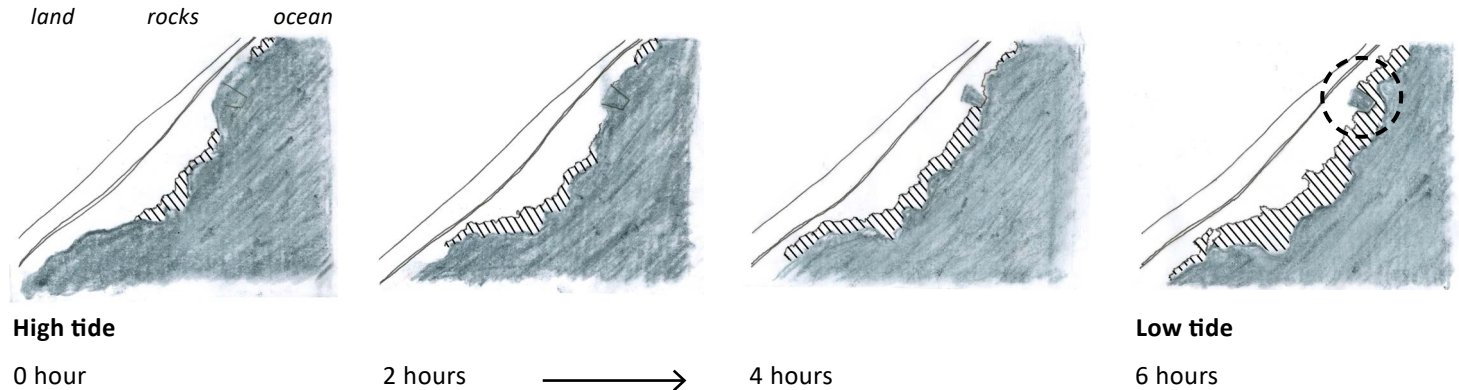
High tide

Low tide



Water: hold/retreat

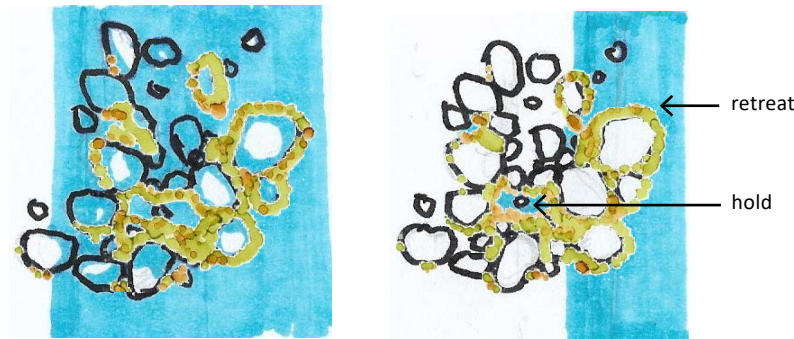
*Tidal pattern (principle)*



Ephemeral - Calculated and consistent tidal change every 6 hours. Different portions of rock bed are submerged as the water fills in over the intertidal zone for high tide and retreats back into the ocean for low tide leaving exposed rock bed.

Natural composition of rocks create tidal pools. Some **drain during low tide** (permeable), while some **remain filled** (not-permeable).

Man-made tidal pool filled with water regardless of high and low tide.



**Marine life is more apparent** and evident in and along vertical rock surfaces of pools, where **water is contained for longer time periods** due to the resource qualities of the water: It provides protection, life and is a vehicle for the transporting of food (particles) for many sessile organisms.

# ECOLOGY

A robust and resilient system



Image source: by Author



## The environmental gradient

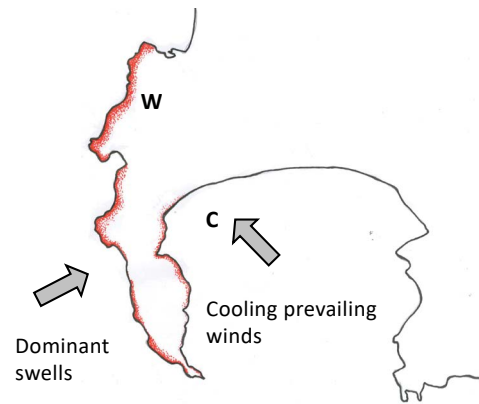
Tides plays an important role in the way ecosystems function along the intertidal zone. It has an effect on the physical zonation and spatial organization of aquatic species in this zone.

Rocky intertidal zones are exposed to harsh climatic, oceanic, hydraulic and biological factors, which is associated with a gradient of physical stress.

**Top:** Granite boulder with a distinct horizontal line of seaweed growing at the high water mark.  
**Bottom:** Sandstone rocks covered with aquatic life forms.

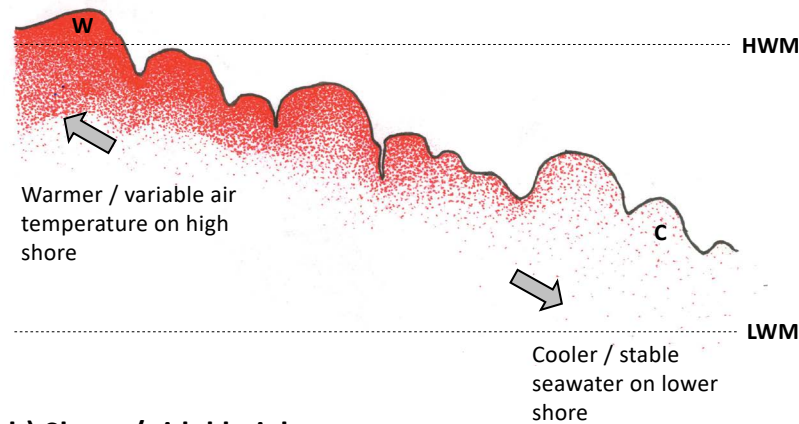


**Figure 5:** High numbers of barnacle, limpet and welk species on a Sandstone boulder competing for space during low tide along the False Bay coast.



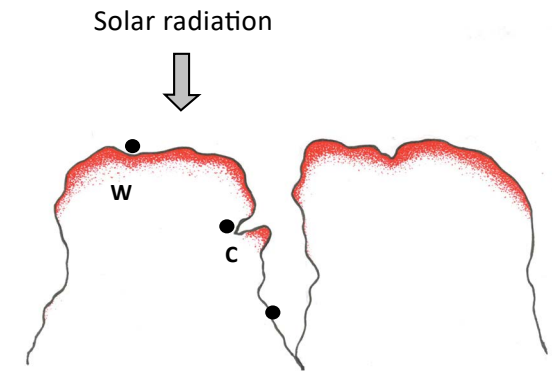
**a) Shoreline / permanent**

0 — 10 km



**b) Shore / tidal height**

0 — 5 m



**c) Microhabitat / daily-monthly**

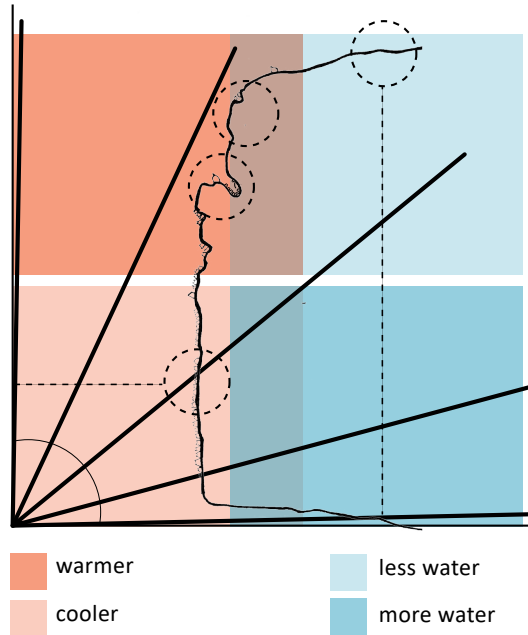
0 — 500 mm

**Figure a - c.** Illustrates the effect of climatic factors on spatial organisation of animal species along the rocky shoreline. Animals prefer to anchor on cooler surfaces where exposure to seawater is more stable, generally on the lower shore and hidden in cracks and crevices.

### Vertical zonation:

The vertical or horizontal angle of the rock surface has a major effect on the spatial organization of sessile species on rocky substrates. Vertical rock surfaces are more favorable over horizontal surfaces due to climatic factors being harsher.

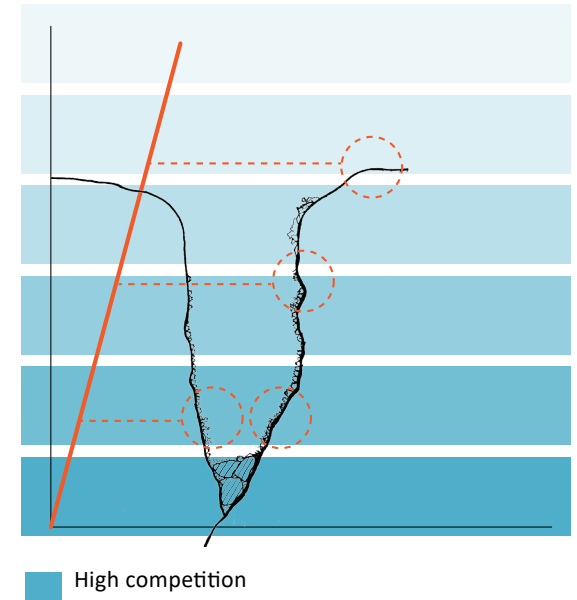
Less heat, more water = greater number of organisms, species and lower desiccation rates.  
 More heat, less water = lower number of organisms, species and higher desiccation rates.



**Figure 6:** Diagram illustrating the effect of habitat preference of sea life on rock surface, due to sun and water exposure.

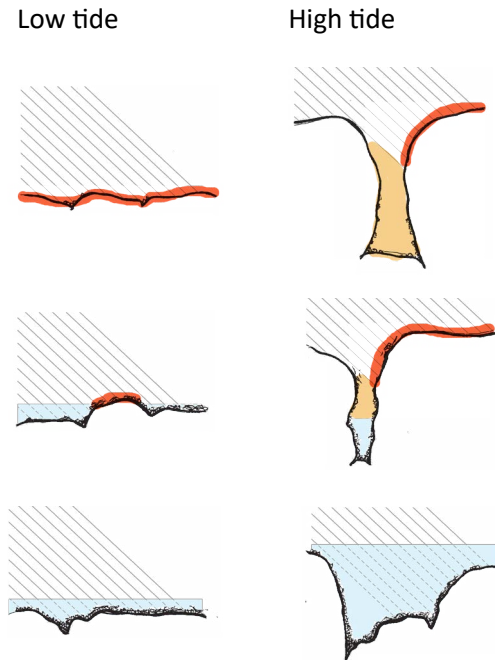
### Biological interaction:

Competition from mussels ousts barnacles, because they are more dominant to claim space in deeper water (stable temperature), and to have less exposure to climatic stress factors.



**Figure 7:** Diagram illustrating the growth hierarchy of animal species on rocks.

As one moves along the intertidal zone from a higher point (land) to a lower point (ocean), one will find that the local temperature decreases and the biological interaction increases, meaning there is more species and number competing for space to inhabit the ideal cooler, stable aquatic conditions.



### Habitat ecology

- **high tide-zone**
- **Mid tide-zone**
- **Low tide-zone**

**Figure 8:** Diagram explaining the zonation scheme along the intertidal zone, dictated by climatic and biological factors.

McLachlan A. (2018) Africa, Coastal Ecology. In: Finkl C., Makowski C. (eds) Encyclopedia of Coastal Science. Encyclopedia of Earth Sciences Series. Springer, Cham. DOI: [https://doi.org/10.1007/978-3-319-48657-4\\_2-2](https://doi.org/10.1007/978-3-319-48657-4_2-2)

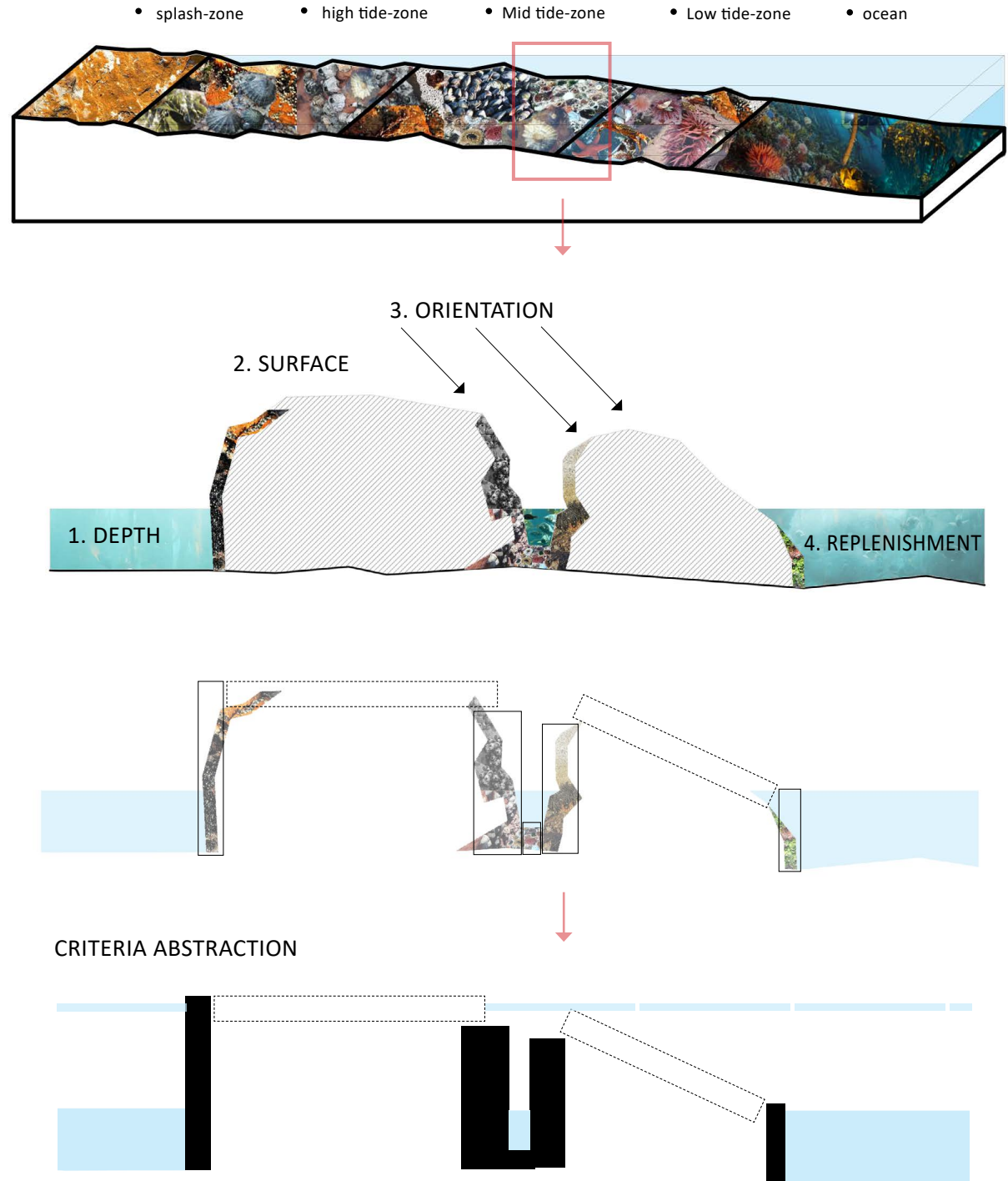
Conclusion:

## FINDING FORM IN INTERTIDAL ECOLOGY

Due to the tidal variation in the intertidal zone (from low water to high water mark) along with climatic conditions, a very specialized organization pattern of marine habitat zones exist. This pattern of species abundance and organization reflects the ecological functioning of the intertidal zone. The identified criteria constitute a healthy and functional ecological performance when the criteria is at an optimal state. The criteria work together as a whole rather than individual components.

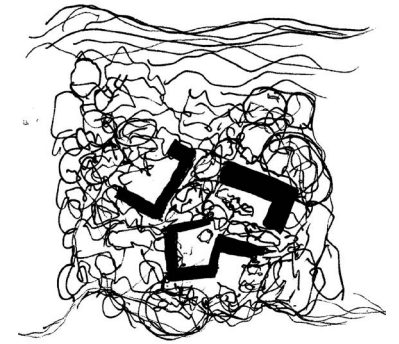
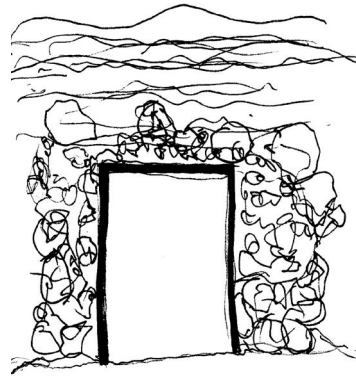
The identified horizontal and vertical surface speaks to both ecological and human functioning. Humans tend to gravitate to horizontal surfaces and marine life occupy vertical surfaces. By taking this criteria into consideration it enables a strategy to find form and a design method in tidal pool design in a more environmentally sensitive manner.

Spatial organisation of marine organisms - minimum attachment on horizontal surfaces; maximum attachment on vertical surfaces.



# CHANGING TIDES

## DESIGN DISSERTATION



The evolution of the tidal pool

# DESIGN DISSERTATION ABSTRACT

My dissertation consists of a design proposal for the intertidal zone of the rocky outcrop of St. James. It is home to an exquisite, large-scale built tidal pool with its own inherent implications on the natural bedrock and associated marine life. Its scale prescribes an interior of a mono-experience and mono-habitat as it permanently pools water.

The very specific nature of bedrock as site, showcase very distinct heterogeneous properties. These properties hold many complexities, but at the same time they enrich this environment and intrigues the human, often drawing us near to experience this raw environment in un-prescribed ways. When we visit this environment we find ourselves amongst the permanent marine residents, and while ecological performance thrive in a heterogeneous nature, we are safeguarded by a homogeneous nature. I intend to design a set of interventions which work together, in order to celebrate the dynamic nature of the site and to establish placemaking along the rocky zone.

But can homogeneity and heterogeneity coexist? By framing the scale of maximum heterogeneity and maximum homogeneity, as designer I'm aiming to manage this spectrum and to consolidate a neutral territory in this environment in amongst the tidal flux. I'm employing a strategy of finding form in socio-ecological communities through the carefully selected use and application of materials and its spatial arrangements to enhance the livelihoods of both parties. It may be seen as a gesture to challenge the properties of the traditional, built tidal pool.

As design principle, I take on a firm position that the unique geologies inherent to tidal pool sites requires a specific set of criteria for design intervention. This intent of the design process is to maximize water-body experiences for marine life and people through submerging and exposing form.

# EVALUATION OF MAN-MADE TIDAL POOLS



Image source: by Author

## COMPARATIVE STUDY

### Ecological section:

Comparing the growth and presence of sea life along natural rock pools with the concrete wall of St. James tidal pool.

There is significantly less sea life on the made tidal pool wall. This is due to the homogeneous nature (flat surface) of the wall and cleaning protocols, where sea life is actively removed from all surfaces.

Along the natural rock pools there is a significant amount of heterogeneous forms and shape, which support the rich and abundant sea life on the rocks.

The sedimented nature of the pool's interior compared to the clean/exposed rock of the pool's exterior is due to the purpose of the pool to contain water "permanently". Sediment deposition in the undisturbed interior occurs over time as water gets replenished and sand/fine particles wash over the pool wall and remains trapped.



**Homogeneous** ■■■■■■

**Heterogeneous** ■■■■■■



**Coastal hydrology**

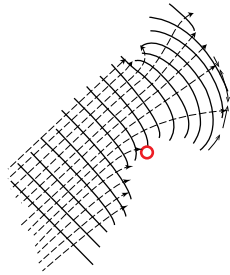
**Form**

**Underlying bedrock**

**Altered bedrock**

**Tidal pool**

*Milton Beach*



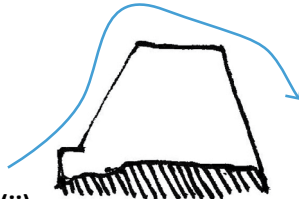
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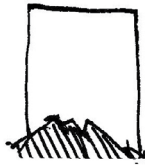
Imagery from Cape Farm Mapper, 2019

Impact of form on underlying bedrock. The **bedrock within and around the pool's constructed parameter has been altered over time.**

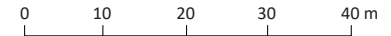
The constructed enclave acts as **sediment trap** and lines the bedrock with sand, sediment and water for long periods of times. **This eliminates and limit the existence of sea life and ecological performance** in the pool's interior.



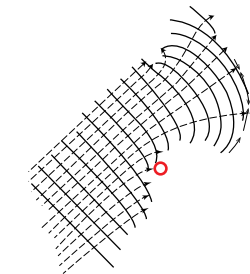
(ii)



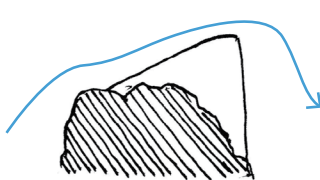
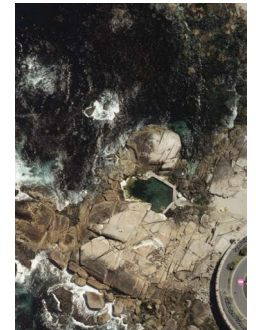
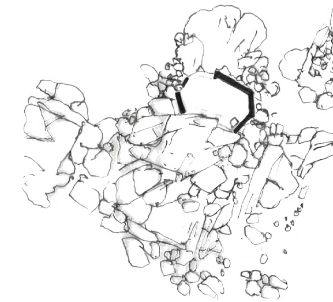
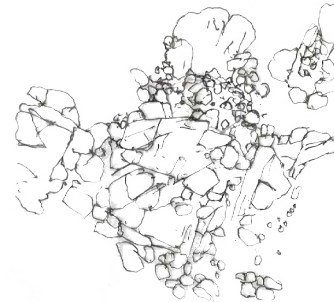
Simple structural and geometric design philosophy on Malmesbury Shale rock, where the shape and form is accustomed to the scale and function which the pool serves. Angled armoured wall to soften wave action and allow water replenishment.



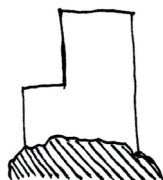
*Saunders Rock*



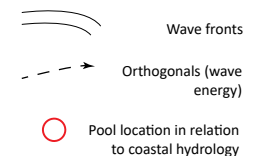
(i)



(ii)



Simple structural and geometric design philosophy on Cape Granite rock, where the shape and form is accustomed to the scale and function which the pool serves. Angled armoured wall to soften wave action and allow water replenishment.





Coastal hydrology

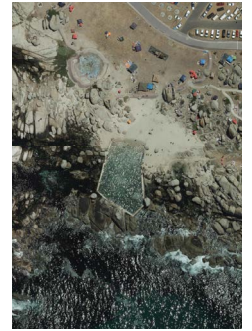
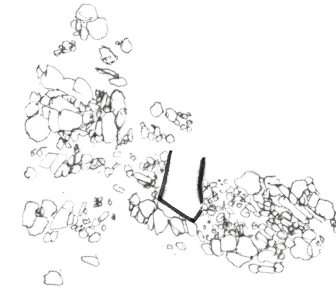
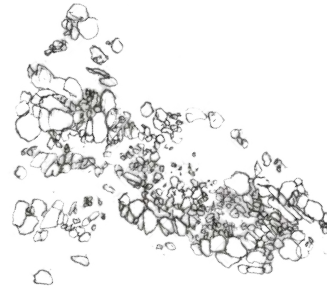
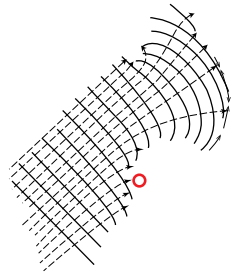
Form

Underlying bedrock

Altered bedrock

Tidal pool

Maidens Cove

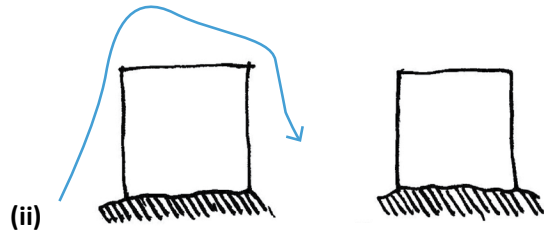


Imagery from Cape Farm Mapper, 2019

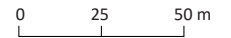
Impact of form on underlying bedrock. The **bedrock within and around the pool's constructed parameter has been altered over time.**

The constructed enclave acts as **sediment trap** and lines the bedrock with sand, sediment and water for long periods of times. **This eliminates and limit the existence of sea life and ecological performance** in the pool's interior.

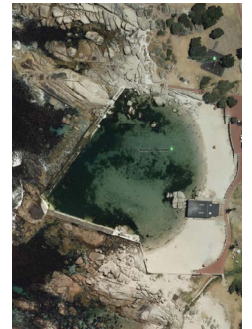
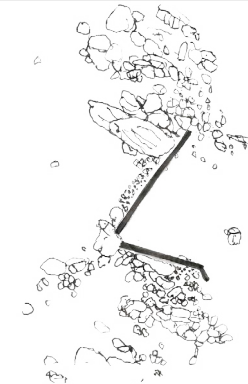
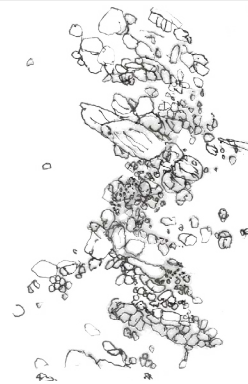
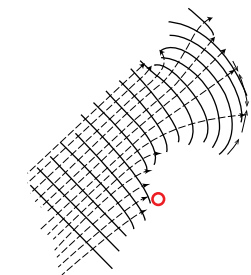
(i)



Simple structural and geometric design philosophy on Cape Granite rock, where the shape and form is accustomed to the scale and function which the pool serves. Angled armoured wall to soften wave action and allow water replenishment.

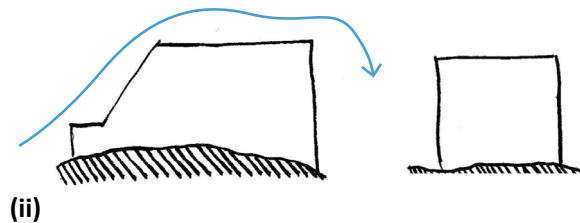


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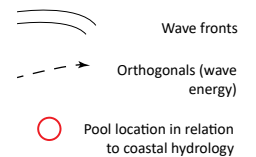


Camps Bay Pool

(i)



Simple structural and geometric design philosophy on Cape Granite rock, where the shape and form is accustomed to the scale and function which the pool serves. Angled armoured wall to soften wave action and allow water replenishment.





Coastal hydrology

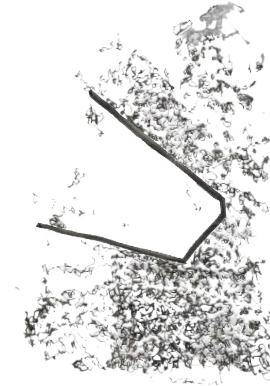
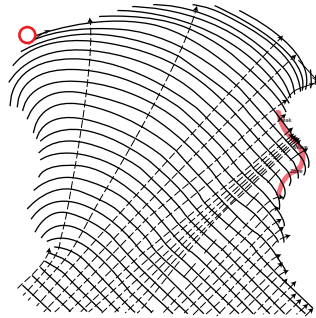
Form

Underlying bedrock

Altered bedrock

Tidal pool

St. James

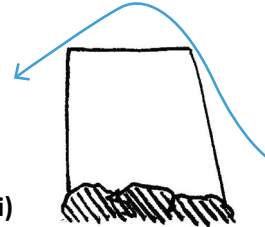


Imagery from Cape Farm Mapper, 2019

(i)

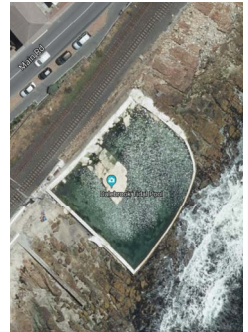
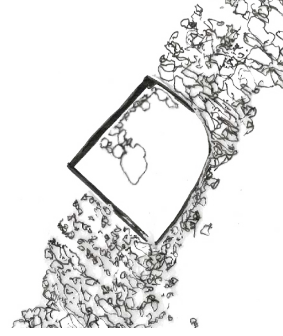
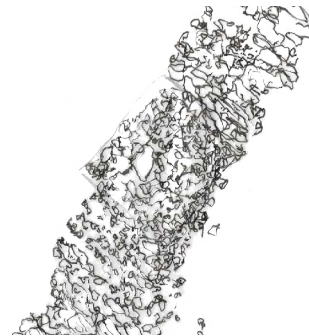
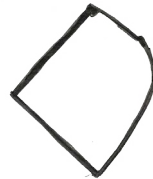
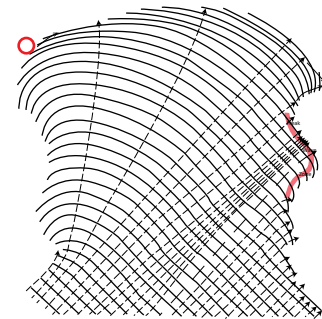
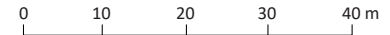
Impact of form on underlying bedrock. The **bedrock within and around the pool's constructed parameter has been altered over time.**

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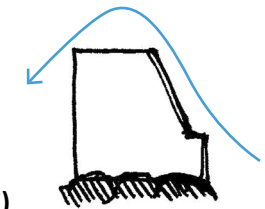
(ii)

Simple structural and geometric design philosophy on Table Mountain Sandstone, where the shape and form is accustomed to the scale and function which the pool serves. Angled armoured wall to soften wave action and allow water replenishment.



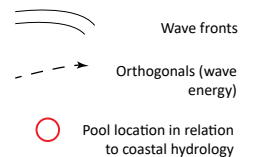
(i)

Dalebrook Pool



(ii)

Simple structural and geometric design philosophy on Table Mountain Sandstone, where the shape and form is accustomed to the scale and function which the pool serves. Angled armoured wall to soften wave action and allow water replenishment.





Coastal hydrology

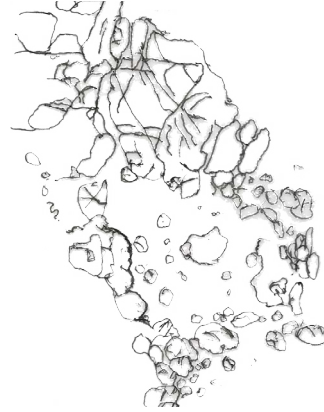
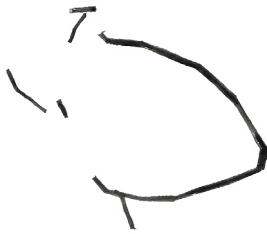
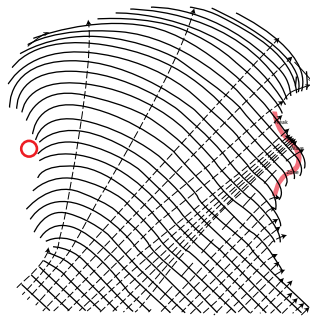
Form

Underlying bedrock

Altered bedrock

Tidal pool

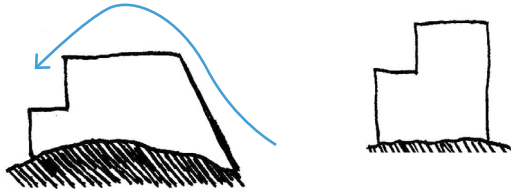
Millers Point



Imagery from Cape Farm Mapper, 2019

Impact of form on underlying bedrock. The **bedrock within and around the pool's constructed parameter has been altered over time.**

(i)

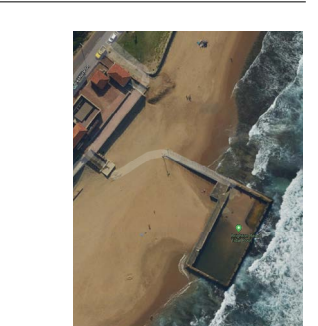
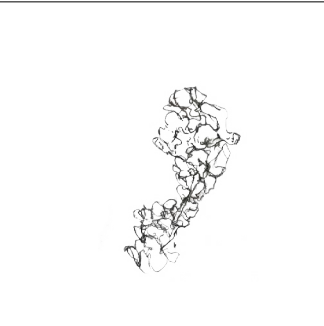
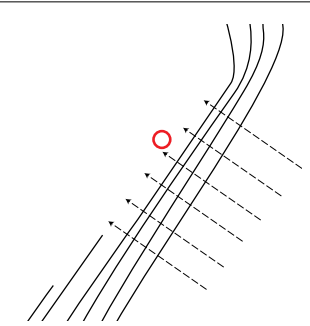


Simple structural and geometric design philosophy on Table Cape Granite, where the shape and form is accustomed to the scale and function which the pool serves. Angled armoured wall to soften wave action and allow water replenishment.



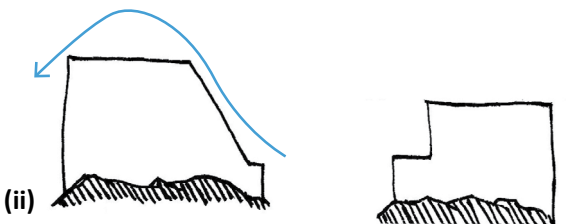
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(ii)

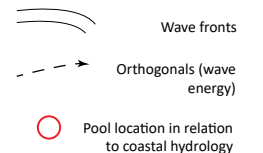


Brighton Beach

(i)



Simple structural and geometric design philosophy on Ecca Group Shale and Sandstone, where the shape and form is accustomed to the scale and function which the pool serves. Angled armoured wall to soften wave action and allow water replenishment.



Conclusion:  
**SCALE & CONSTRUCTION**  
**SPECIFICATIONS OF POOL**  
**TYPES**

Scale principle - The bigger the built parameters of the pool, the higher the sedimentation build up in the pool's interior because active water movement is retarded and vice versa. However, the nature of sedimentation is dependent on the surrounding rock/sand/wave energy environment.

Construction - The height of pool walls determine the rate, frequency and volumes of water replenishment, which directly correlates to sedimentation and water temperature of pool's interior: Higher pool walls = higher sedimentation.

Water temperature: Speeds / slow down growth of aquatic plants.

**Ecological pattern (principle)**

Ecological response:

- sedimentation: creates certain environments
- fresh water replenishment / stagnation: creates specific aquatic conditions



**Shale**



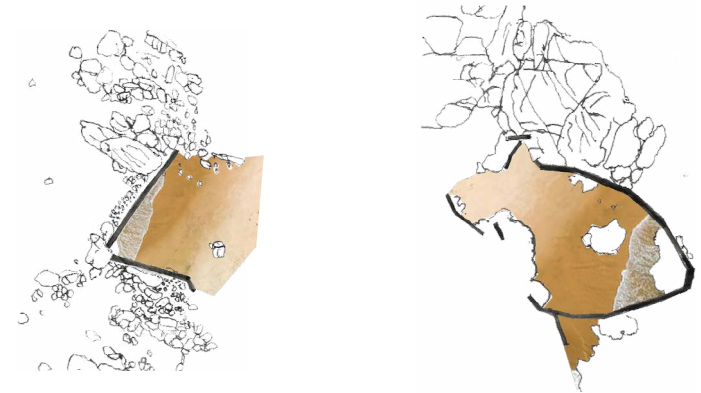
Pool size = **Medium**: Maximum sedimentation. Heterogeneous layered shale **rock bottom is permanently cover with fine beach sand** and inhibits anchorage for sessile, rocky adapted sea life.

**Sandstone**



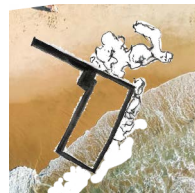
Pool size = **large**: Maximum sedimentation. Heterogeneous sandstone at bottom of pool is permanently cover with fine beach sand and **inhibits anchorage for sessile, rocky adapted sea life.**

**Granite**

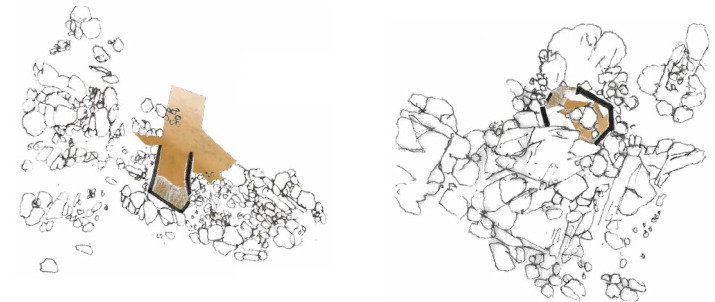
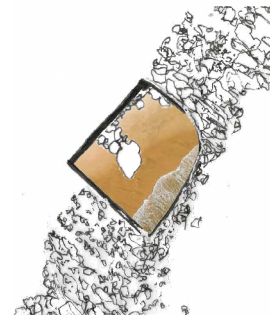


Pool size = **large**: **maximum sedimentation**, bedrock covered with sand and inhibits anchorage for sessile, rocky adapted sea life.  
 - Water generally cooler (large body of water).  
 - Less algae growth.

**Sand**



Pool size = medium, built on **sandy shoreline**, thus **sedimentation is natural** in pool's interior.



Pool size = **small**: **hardly any sedimentation**. Bottom of pool has majority exposed granite which **accommodates sessile, rocky adapted sea life.**  
 - Water generally warmer (small body of water)  
 - More algae growth.

## THE COASTAL EXPERIENCE OF 3 ROCK TYPOLOGIES

### Shale

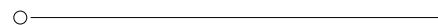
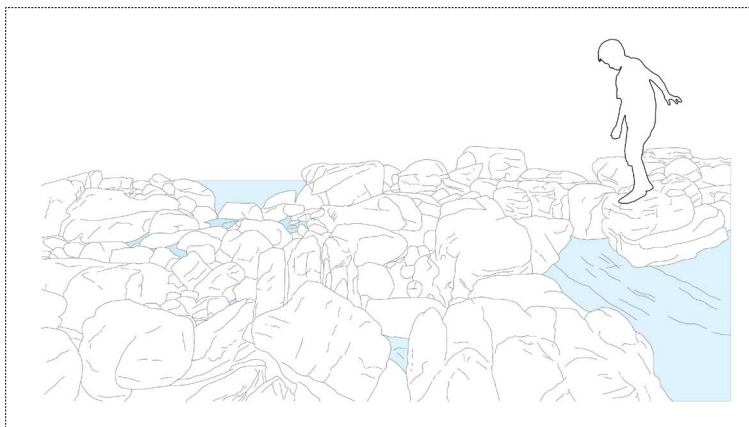
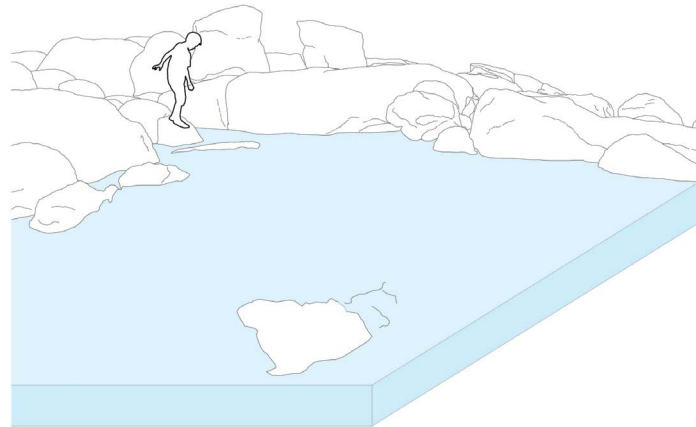
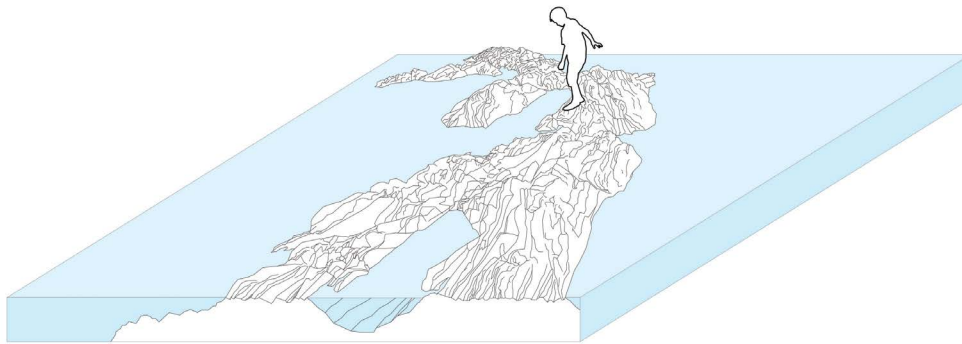
The layered stratification of the rockbed make it easy to occupy and move over the rocks, but its angular edges is uncomfortable for the user. A pattern of linear and shallow natural tide pools is experienced. Contact with the water is easy and direct at the rock-water interface and create an intimate experience.

### Granite

The large boulders create deep natural tide pools and the large size of boulders make it difficult to occupy and navigate on and around. Contact with the water is indirect and difficult at the rock-water interface and can create an overwhelming experience.

### Sandstone

The organic, individual and rounded rocks create multiple natural tide pools of all shapes and sizes. Its round edges make it comfortable to occupy and navigate over. Contact with the water is easy and direct at the rock-water interface and creates an intimate experience.



## THE COASTAL EXPERIENCE OF SANDSTONE AS FORM

Each piece of plastic resembles an individual sandstone rock. It celebrates the diversity of organic shapes and sizes of the geology and together it creates a complex heterogeneous rock-scape supporting many life forms. These “rocks” set the scene for an ever changing intertidal landscape of appearing and disappearing pools driven by tides. At the same time it reflects the frightening topic of pollution and how we are negatively changing the oceanic landscape and tides as a whole, as each of these plastic pieces were found within a small area along the intertidal coastline as washed up plastic waste.



Images: by Author

## SITE

St. James - a coastal edge with Table Mountain  
Sandstone bedrock shelf

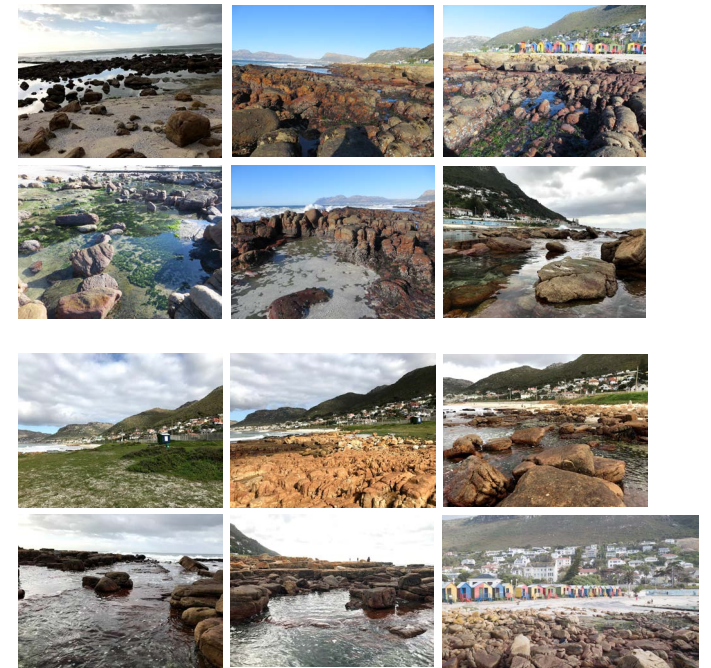
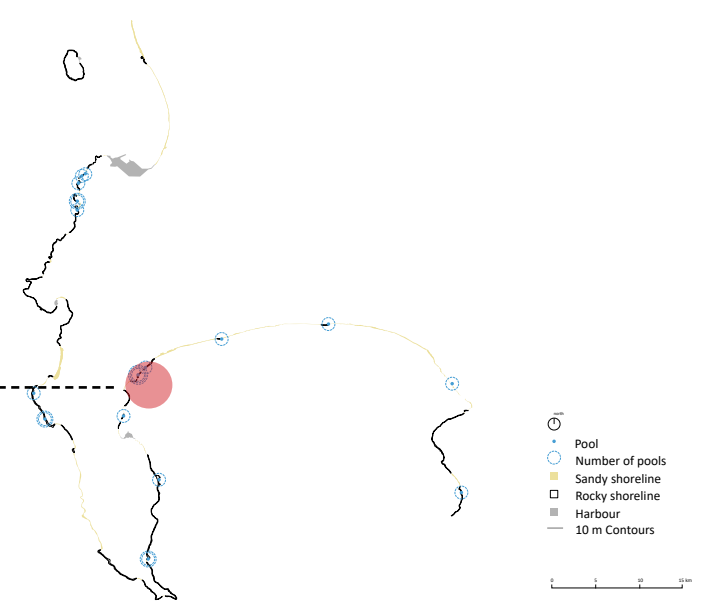
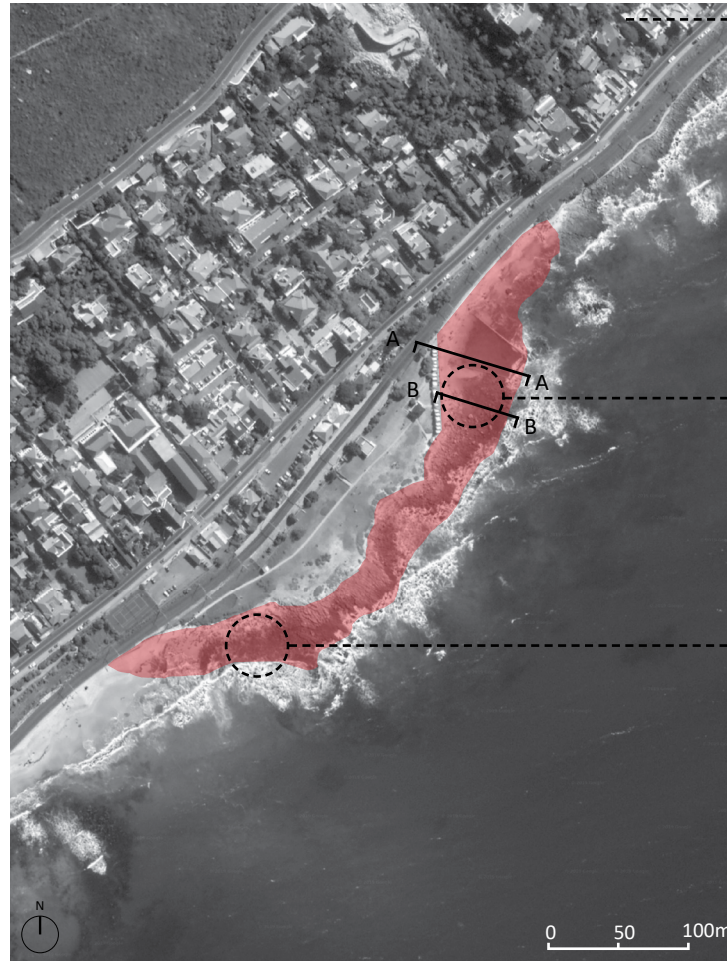


Image source: by Author

# ST. JAMES

Tucked in along the False Bay coastline. Situated within the Agulhas Bioregion and Marine Protected Area.

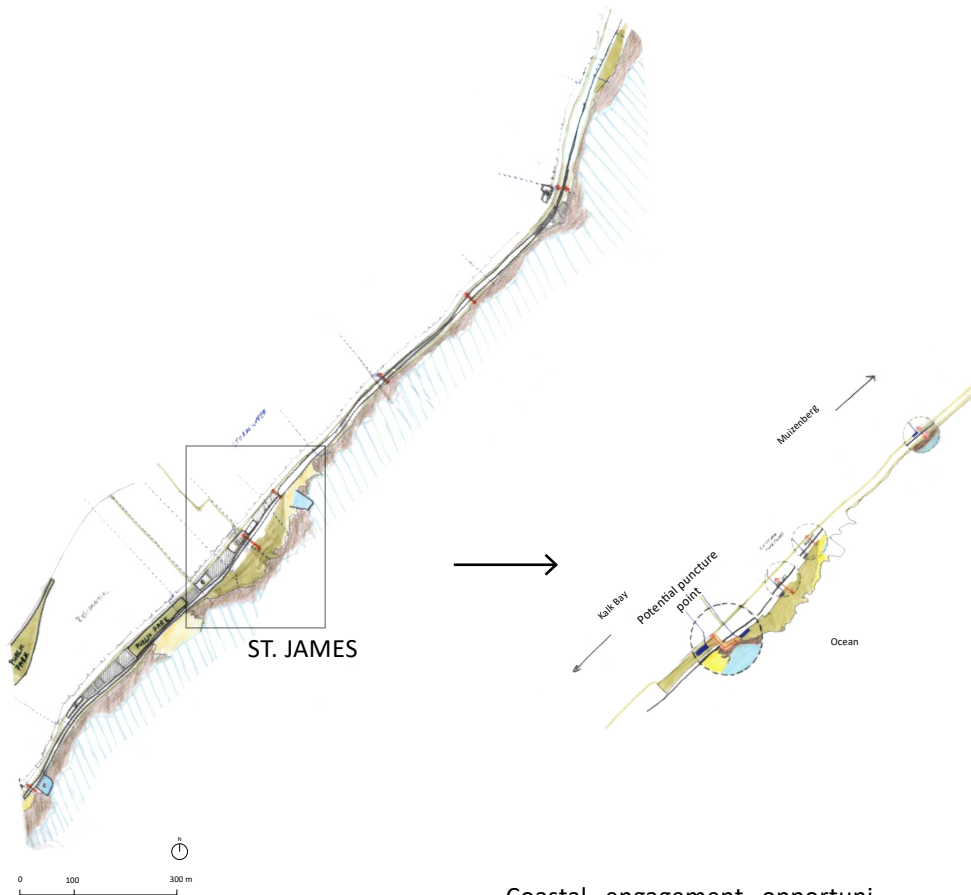
The existing Table Mountain Sandstone bedrock is relatively flat with a gradual topography. It slopes gently from the foot of the mountain into the ocean. However, there's a diverse topographic variation in height amongst individual rocks and slabs, ranging from 0 - 1,6 meter. The transition from bedrock to land consists of beach sand and lawn.



Images: by Author

# CONTEXTUALIZING SITE

## FALSE BAY COASTLINE



Coastal engagement opportunities and informants

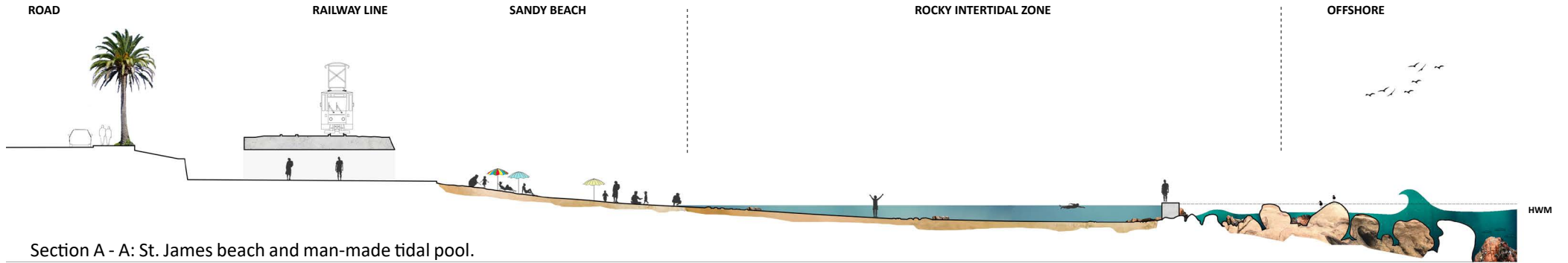
- stormwater outlets
- major public access point
- sea activities
- MPA: environmental education
- coastal experience

## FRAMEWORK



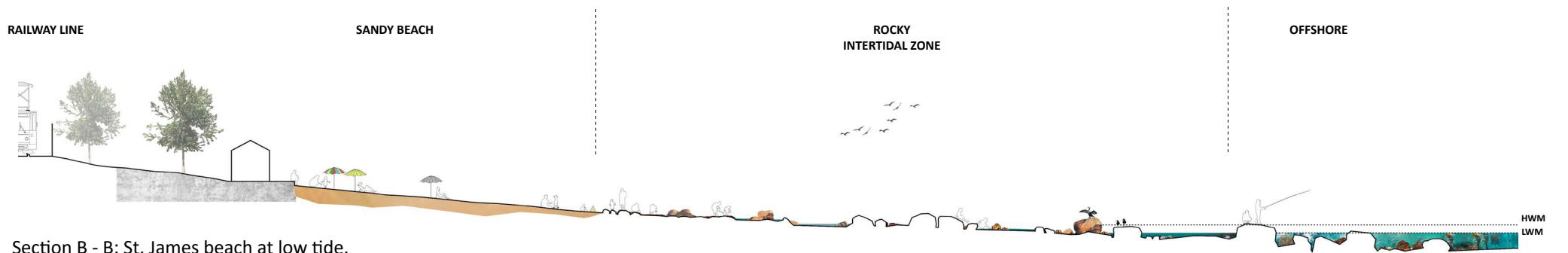
Potential to connect the coastal landscape with the urban fabric which is a result of the railway line, which act as a barrier and divide. A new railway crossing is proposed on ground level, situated next to the railway station. This will activate a node and allow permeability and easy access from the street transitioning onto the rocky coast of site. The stormwater runoff point into the ocean enables the opportunity to utilize stormwater as natural irrigation by greening the soft adjacent landscape. This puncture point will reinforce the circulation within and around this landscape and attract and encourage users to engage with the local sandstone rockscape.

# EXISTING SITE SECTIONS



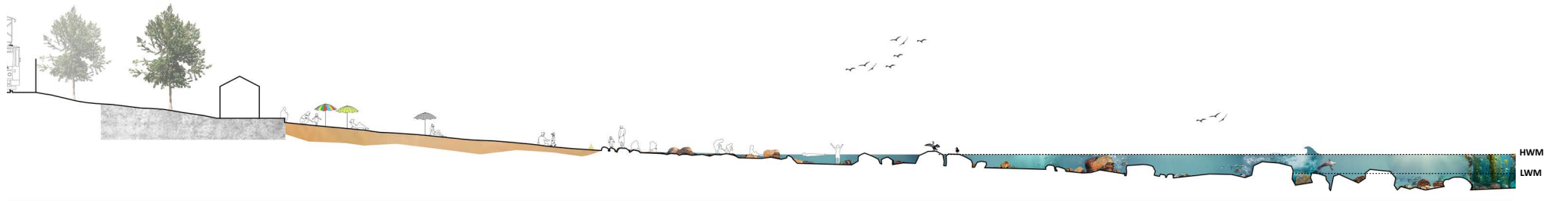
Section A - A: St. James beach and man-made tidal pool.

Scale 1 : 200



Section B - B: St. James beach at low tide.

Scale 1 : 200



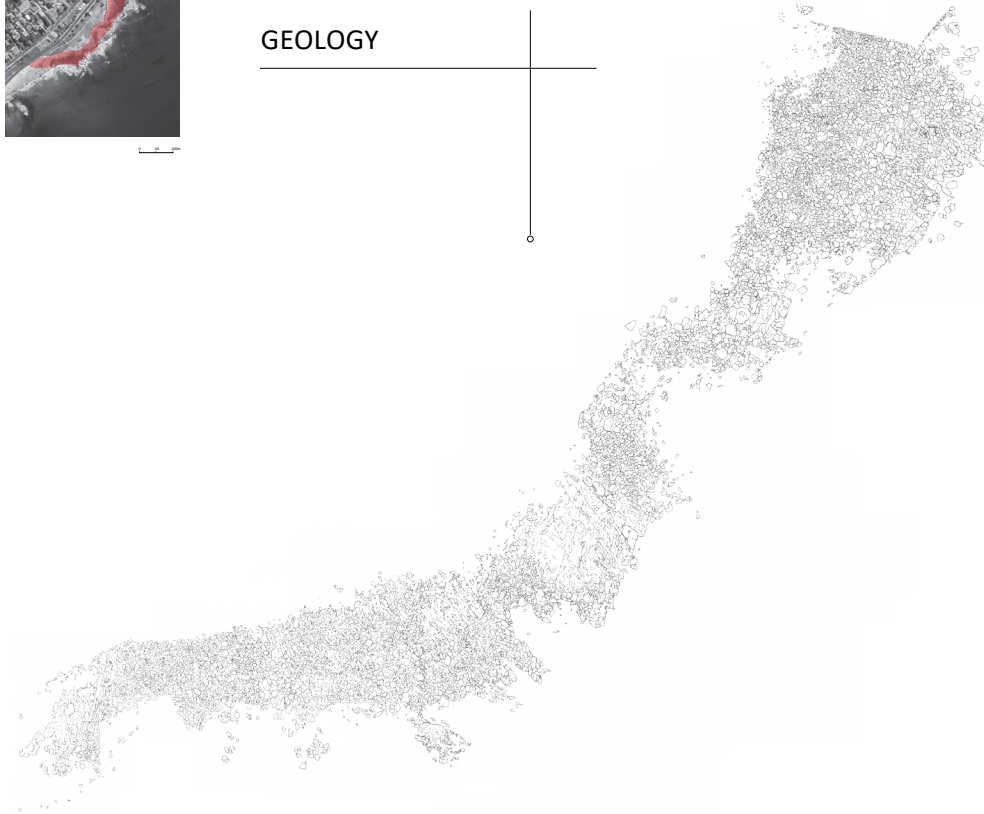
Section B - B: St. James beach at high tide.

Scale 1 : 200

# SITE SPECIFICITIES

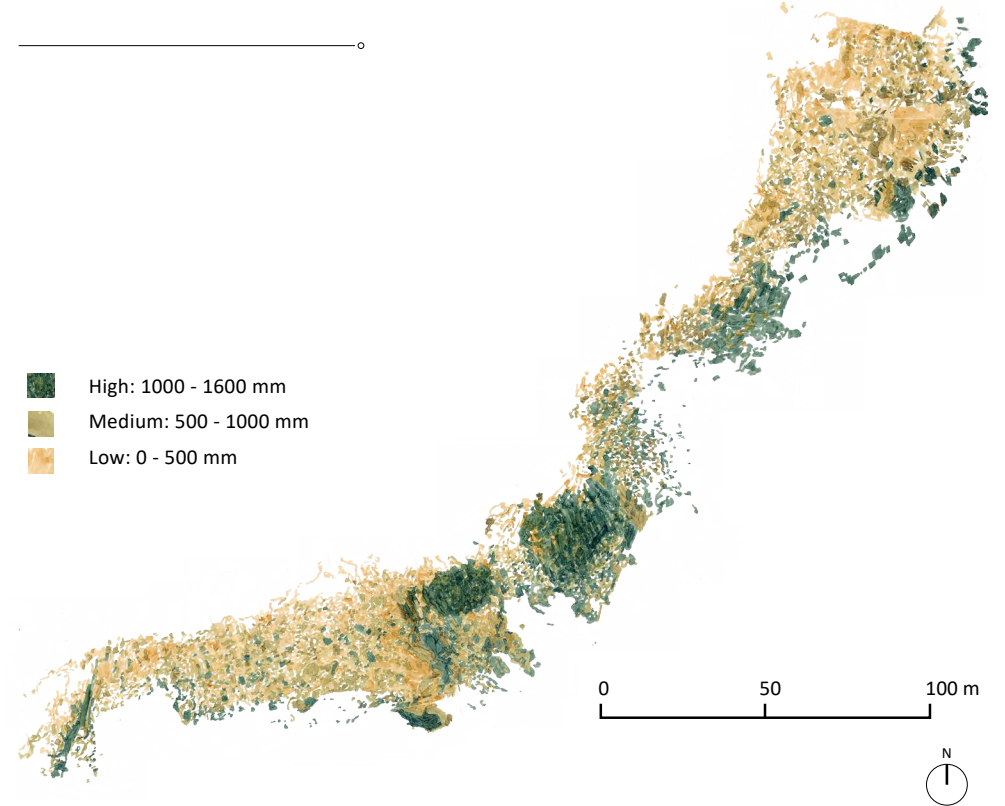


## GEOLOGY



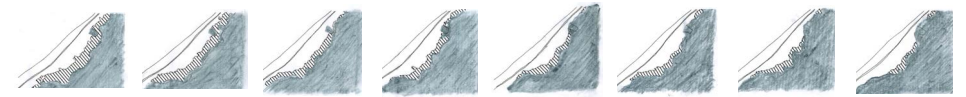
## THE BEDROCK

Reveals the intricacy and spatial organisation of rocks in the intertidal zone. It means understanding the site to project potential and opportunities for pool intervention into the design process.



## HEIGHT VARIATION

Rock heights were determined by allocating low, medium or high categories to individual rocks in relation to the flat parent bedrock during low tide. Collectively they form height patterns and groups which enables a practical and feasible approach to determine site specific locations for pool interventions along the intertidal bedrock. Higher rocks create important pool edges, while lower rock areas create "deeper" pool interiors during high tides.



Spring low tide

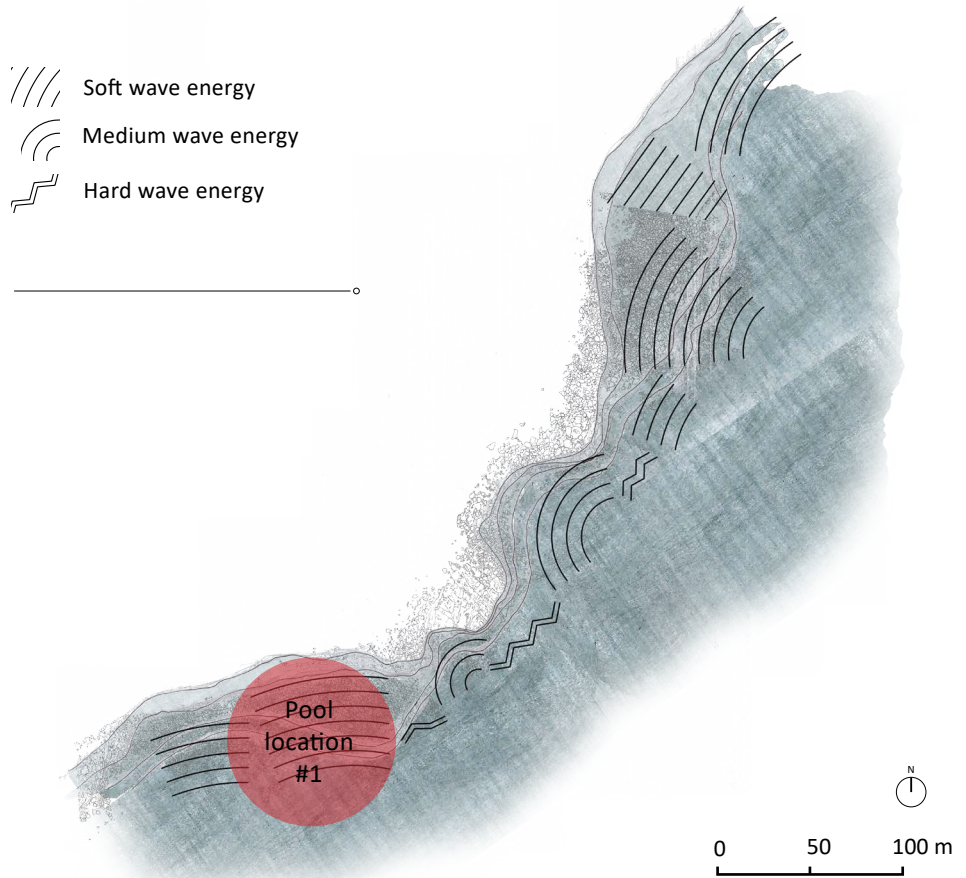
Spring high tide

- Soft wave energy
- Medium wave energy
- Hard wave energy



### Topographic surface

Distinguishing between flat/smooth and rough surfaces reveals the feasibility for intervention. It is more practical and easier for users to occupy flat surfaces over rough surfaces. Flatter surfaces create less obstruction and more opportunity for water-body (submersion) experiences. Flat and low rocks enhance this opportunity, while rough and high rocks limit this opportunity.



### Tide and wave energy composite

The bedrock of St. James consists of small bays, gullies and flat bedrock. These variations in topography create different conditions in response to tides and in coming wave action. Gullies create hard, rough and turbulent hydrolic conditions by compressing water up channels, while the flatter rock surfaces receive wave action in a softer manner. Water is evenly dissipated across the bedrock. Hard and dangerous wave action is felt bashing against steep rock faces.

# FORM AS ENABLER

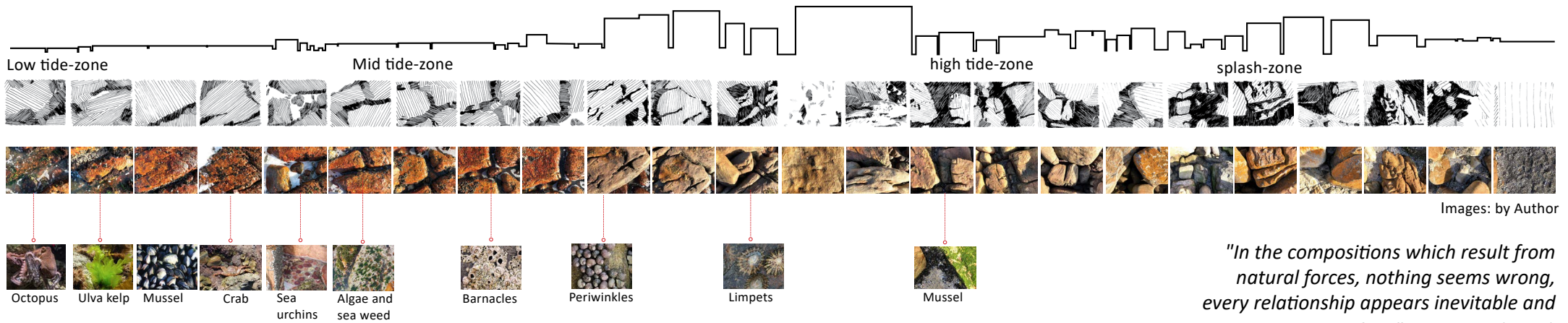
Form discovery in the unique geology of site

## Static form:

I conducted a **clinical observation** of the rocky intertidal zone. I walked a straight line documenting a section from the low water mark up until the high water mark. Through photography I captured the **intricacy of individual rock pools** in plan view while being strict with my camera orientation. This method was used to ensure thorough and consistent data collection. From the **photographs I started to analyze** and pick up on **clues and patterns**, among these very heterogeneous rock pools. **Abstracting** through drawing.

## Conclusion:

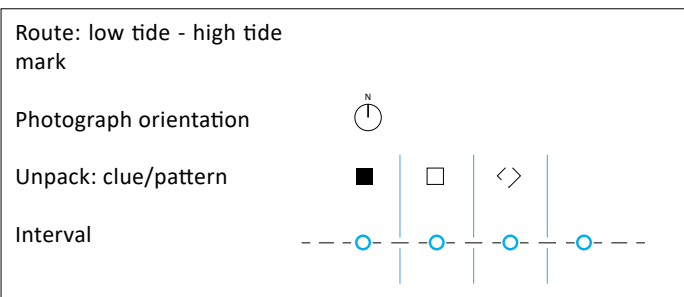
I found that no single rock pool has the same shape or form. I picked up a large **variation of forms, shapes and sizes**. These distinct forms emphasize the **richness and diversity** along the intertidal zone. What I mean by finding form is that I'm observing the patterns that are inherent in the rock structure, in order to find the factors that contribute to their form and I'm going to use that projected forward as a design process.



Images: by Author

*"In the compositions which result from natural forces, nothing seems wrong, every relationship appears inevitable and perfect." - Halrin, L. (1988)*

## Strategy



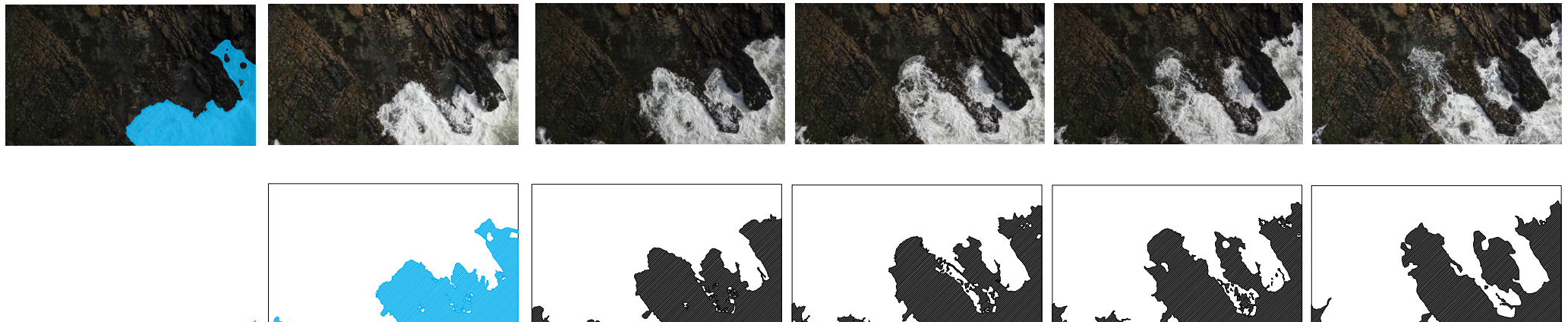
### Form in flux:

Drone photography allowed me to observe the wave energy from above. It's a display of the **temporal nature of the coastline**. Things move and change all the time. To me, movement means life.

Below, I documented the temporal form of water. Photography enables pause and a stop frame series of water moving over the bedrock. It reveals pattern and how **water is dispersed as a result of the existing rock morphology**. Through abstraction I picked up the detail and **energy stored in these forms**.

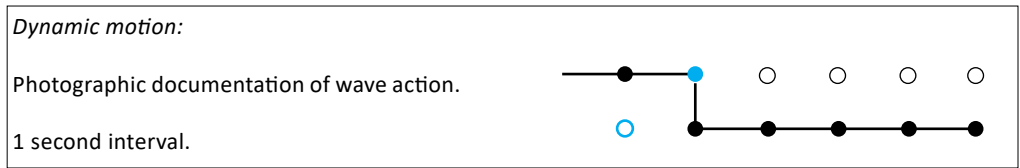
### Conclusion:

I found that there is no exact same repetition of water movement. It is different every second of every day. The active forces are evident and I find that one's curiosity and natural attraction to the coast is partly due to the dynamism of the coast. The magical changes allows us to translate form into a different language, by harnessing these forces. This language will reveal itself later on in design.



Images: by Author

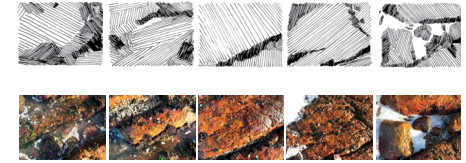
### Strategy



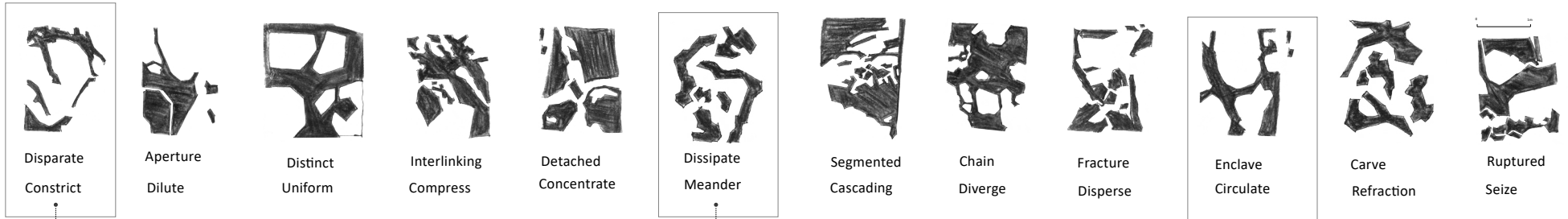
# EXPLORATION OF FORM TYPOLOGIES

APPLYING CRITERIA FOR DESIGN THROUGH  
FORM ABSTRACTION

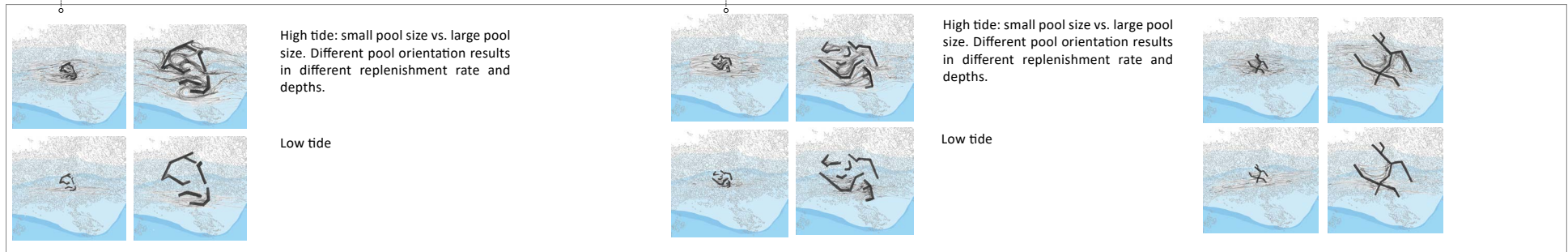
Abstracted  
catalogue



FORM  
COMPOSITION  
EFFECT OF FLUX



TESTING FORM CRITERIA IN  
THE DYNAMIC SYSTEM

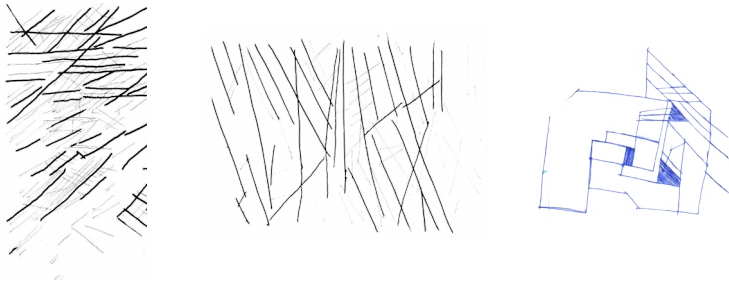


## Creating form:

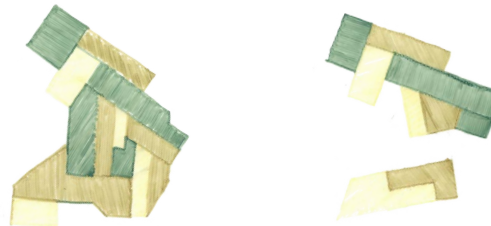
There is a strong response to the local character of place. It is supported and substantiated by rational analysis and scientific data. It is revealed in the site's physicality and actuality, thus understanding the working of the intertidal zone is crucial. The concept is further supported by artistic and intuitive exploration and development in order to find form, shape and space for both the sociological and ecological realms by integrating inspiration, emotion and imagination into the design development. The result is a strategic language of abstractions with associated meaning which is then translated throughout the project's development phases.

# PROCESS: criteria explorations

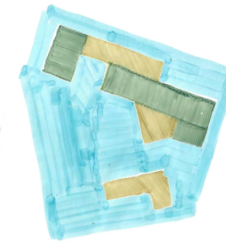
## SURFACE



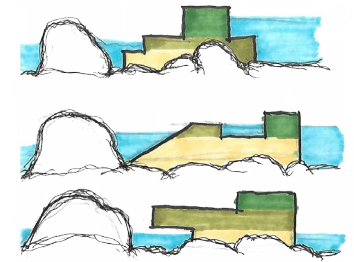
① Inspiration drawn from unique geology weathering pattern in sandstone.



② Abstraction taking form



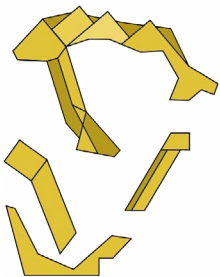
③ Manipulating depth and replenishment through surface orientation and form



steep  
seat



④ CONCEPT: surface imposed onto abstracted catalogue (remaining criteria)



## FACETED ABSTRACTIONS



Heterogeneous - All different, diverse.  
→ Managing the spectrum of heterogeneity to homogeneity.

⑤ PRODUCT: sculpting a controlled environment for social and ecological functions

CONCEPT  
Ecology + Human

Managing the Spectra  
People: Homo

SAFE, good flow orientation i.t.o. sun. Flat surface to occupy and engage with water.

sedimentation encouraged  
- surface - floors - dunking  
niche created to give ecology.  
sedimentation happens because of wall orientation.  
good (safe) for people to stand on (use).



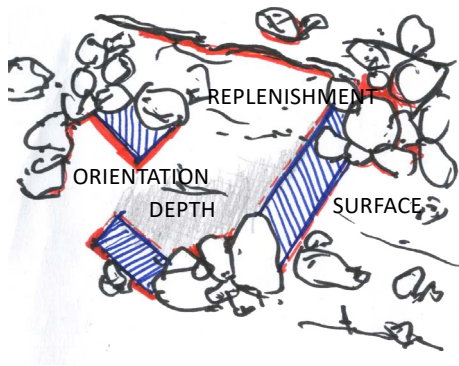
Area reserved for Ecology.  
- good micro-climate, nooks, sheltered from sun.

Cont'd →

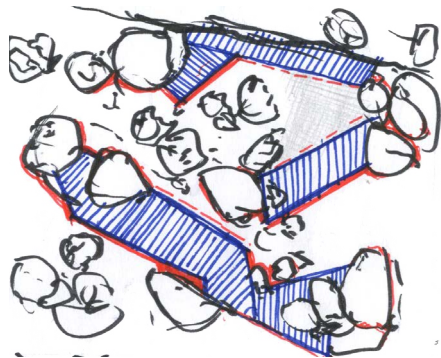
# APPLIED CRITERIA

*Configuration process evaluated by criteria*

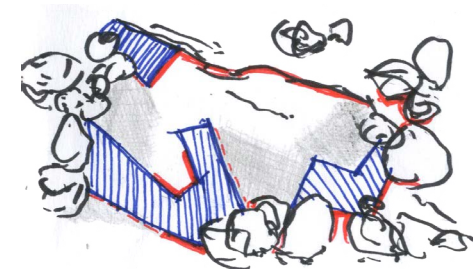
*Criteria*



1. Ecology
  - Sedimentation as result of sand deposits by wind and water.
  - Heterogeneous form type and solar orientation, facilitates habitat
2. Social
  - Comfort, orientation in relation to solar position and wave energy

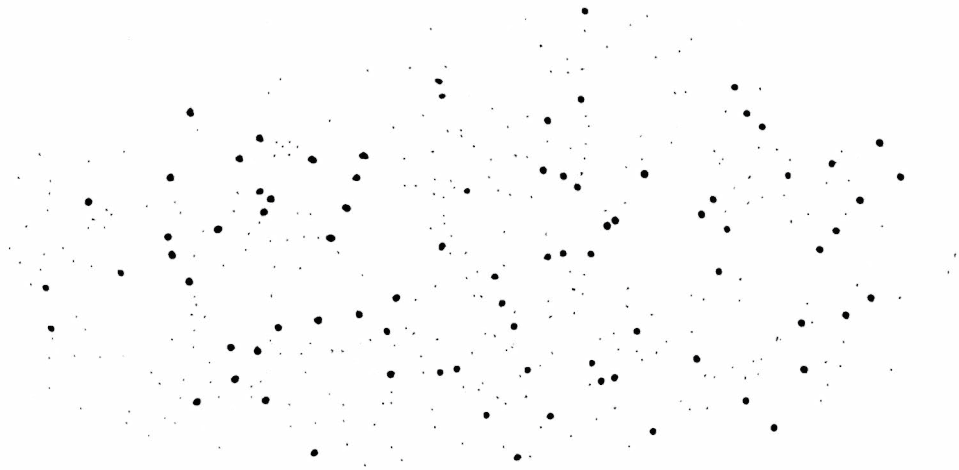


1. Ecology
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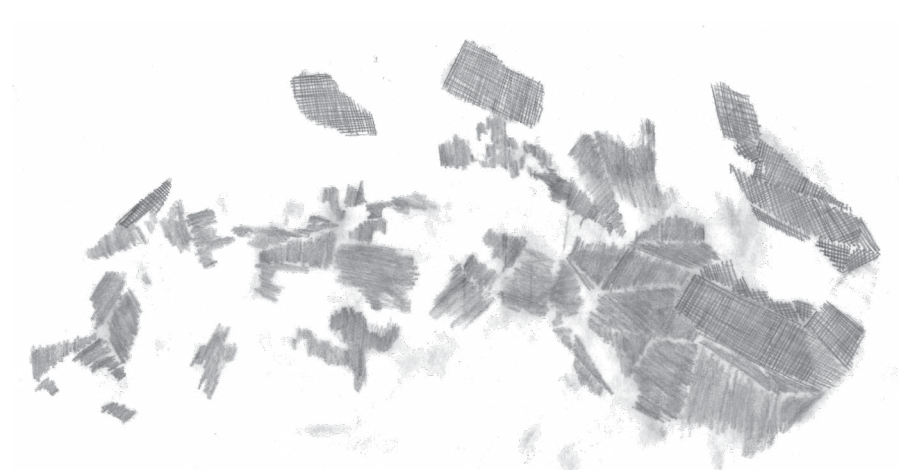


1. Ecology
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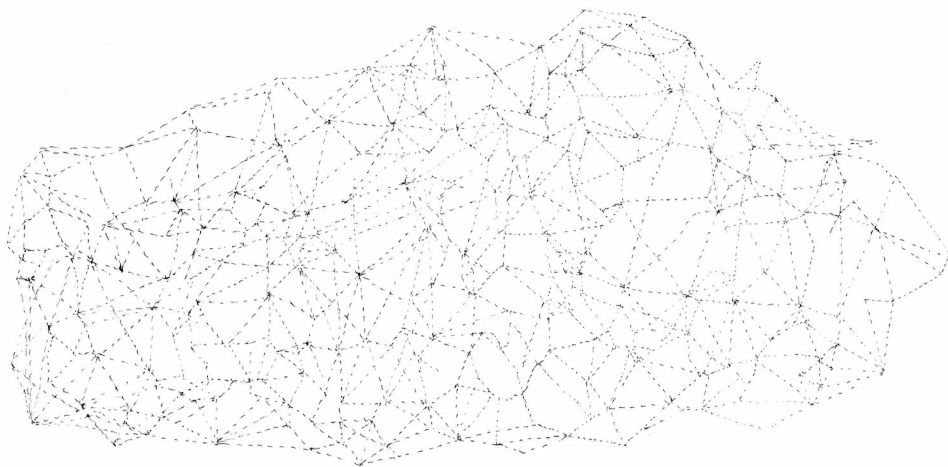
# DESIGN DEVELOPMENT DIAGRAMS



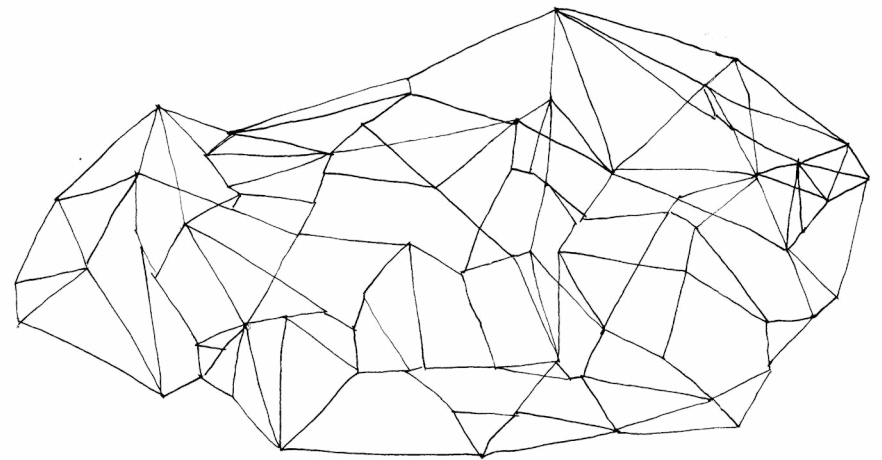
KEY ROCKS: EXISTING ROCK VOLUME



SURFACE TOPOGRAPHY: FLAT / LEDGE



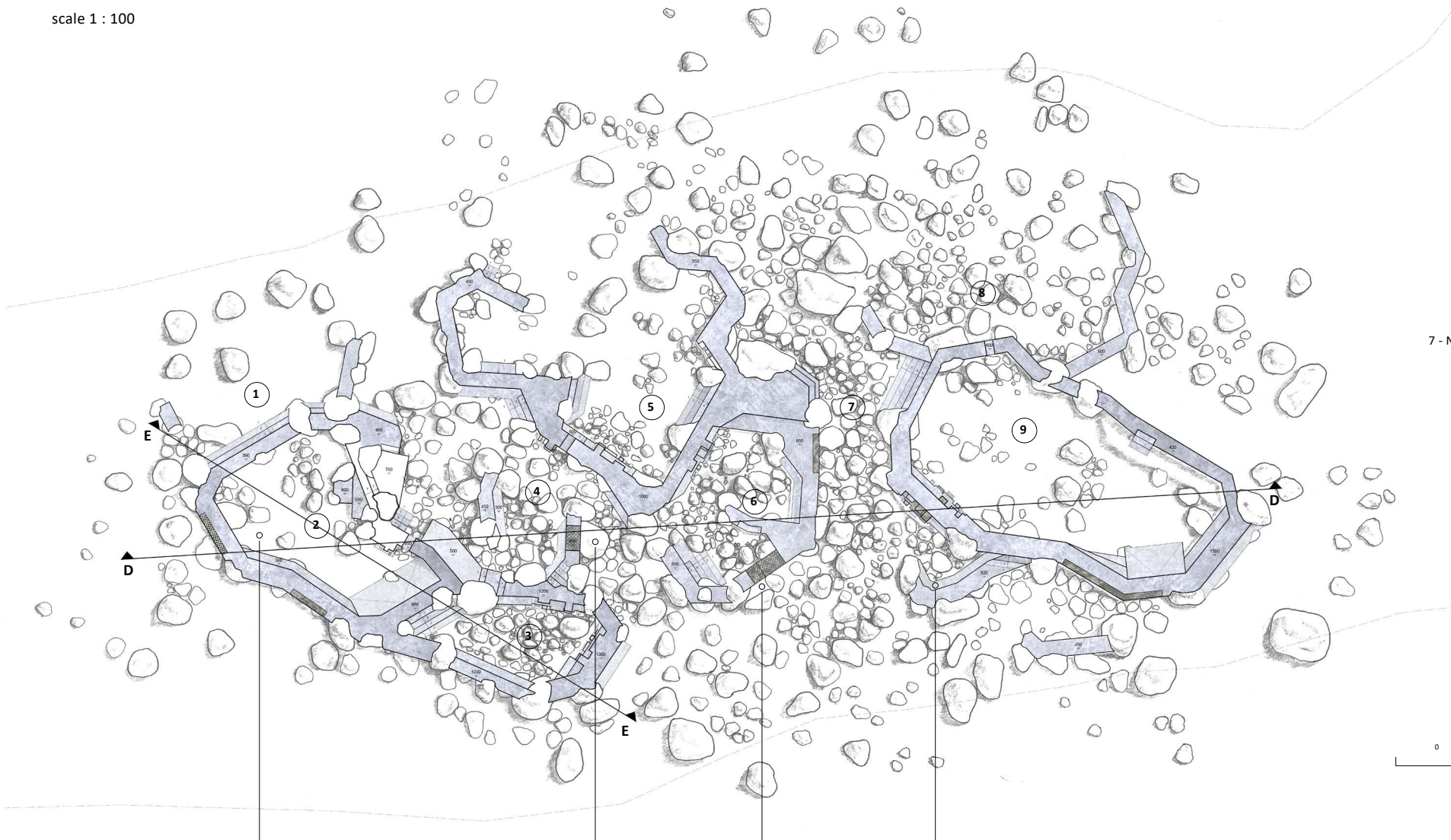
CONNECTING THE DOTS



SPATIAL NETWORK: FRAMING POOL SITE

# INTERTIDAL POOLS - PROPOSED DETAILED PLAN

scale 1 : 100

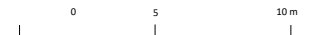


## LEGEND

- 1 - Spring tide pool enclave
- 2 - Shallow dunking pool
- 3 - Pool of habitats
- 4 - Intimacy with tides
- 5 - Sandy pool
- 6 - Breathing pool
- 7 - Natural explorative pools zone
- 8 - Overflow splash pool
- 9 - Body submersion pool

## KEY:

- All units in millimetre
- All measurements with symbol are top of concrete markers
- 2 meter contours



### SEDIMENTATION

Working intimately with the design criteria, a controlled environment is shaped by selecting a top-of-wall height higher than 1000 mm and arranging and orientating the pool enclave where the process of water and wind deposit sand in the interior of pool enclave. Favorable conditions are sculpted for people to embody a softer, sandy bottom finely tuned to balance the ecological functioning of the space.

### INTERLINKING POOL SYSTEM

Series of pools are carefully arranged and sized, allowing dynamic processes to occur without interruption. Pools are located so that they receive a fresh flow and body of replenishment around them with each high tide. Pool orientation acknowledge the wave and tide pattern to further accommodate the exchange of fresh water and marine life between pools.

### PERMEABLE LIVING EDGES

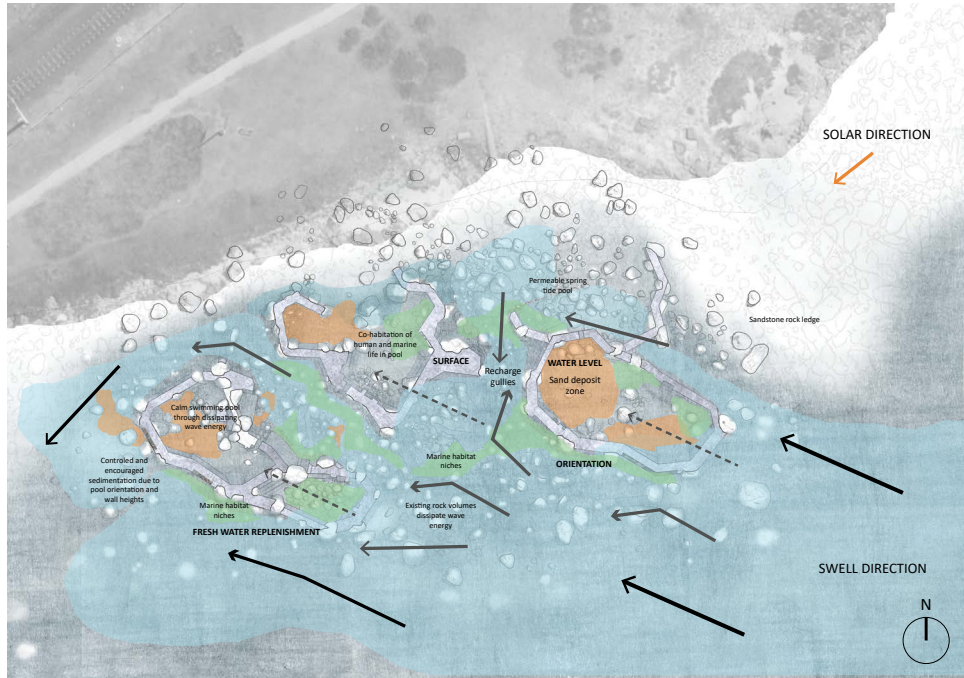
Habitat-able walls - Concrete walls come to life for both people and marine life. People embody the pools and walls by sitting or hanging on it depending on the level of water-body interaction. The juxtaposition of specialised gabion baskets create a living edge for marine life by facilitating spaces for different ecological intertidal conditions. A socio-ecological engagement opportunity of education through experience.

### PARTIAL ENCLAVES

Walls of different and comfortable heights provide spaces for intimate moments and education, as one walks along the interconnecting intertidal pools during different tides, revealing the wonders and rich life forms of the intertidal zone along with different spots for water-body experiences.

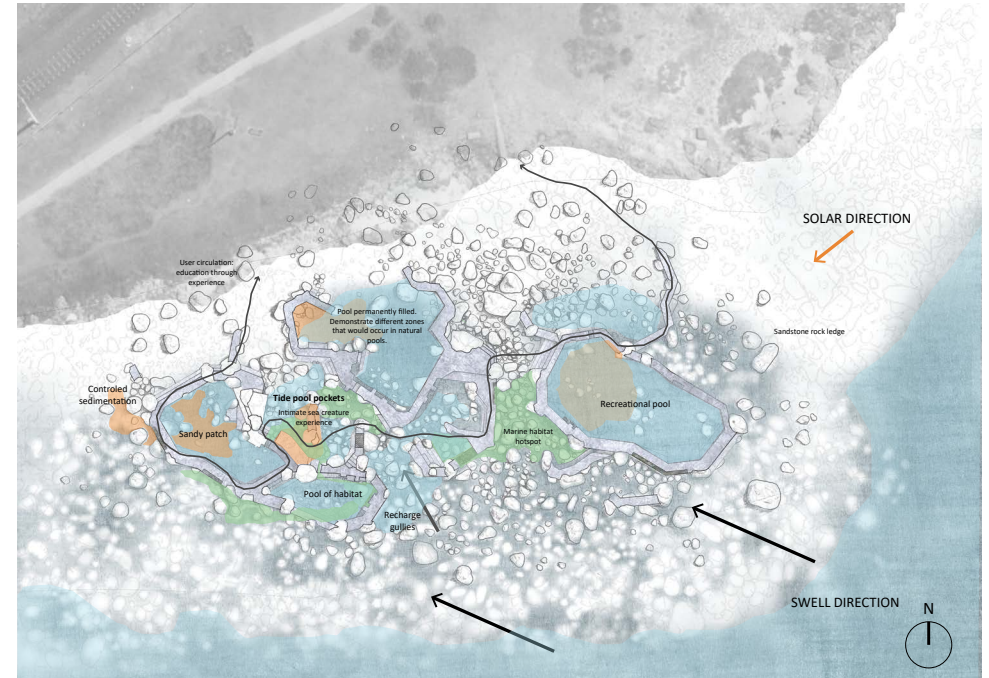


# TIDAL FLUX: FUNCTIONAL DESIGN DIAGRAMS



**HIGH TIDE: INTERLINKING POOL FUNCTIONING ALONG THE SANDSTONE INTERTIDAL ZONE**

- comfortable human spaces
- marine habitat



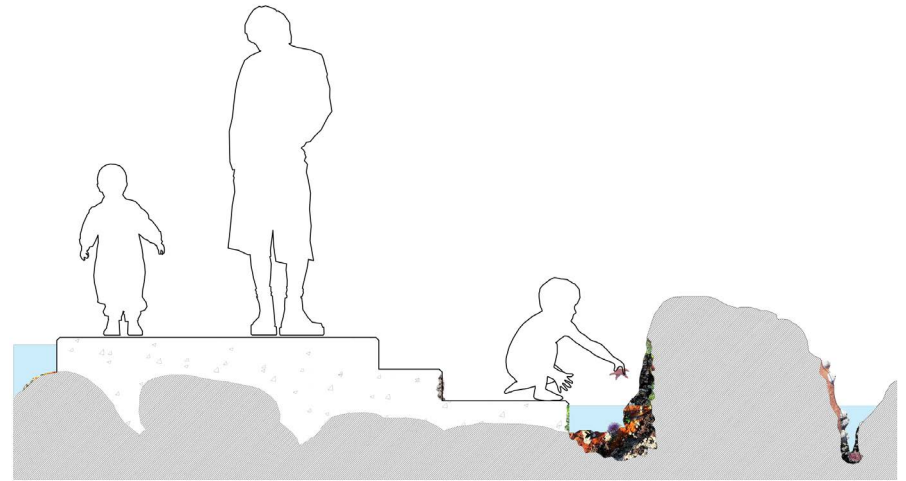
**LOW TIDE: INTERLINKING POOL FUNCTIONING ALONG THE SANDSTONE INTERTIDAL ZONE**

The pool system illustrates how the functioning of ecological and social spaces are enhanced as a sense of delight by revealing the coastal dynamic processes and working form criteria found in the natural intertidal zone to arrange and create variety of intimate spaces which are connected through a series of experiences in different function zones.

# THE LOW TIDE EXPERIENCE

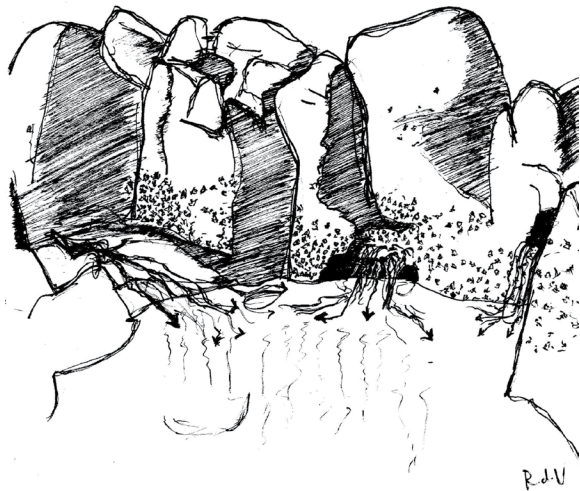


PLAN IN MOTION

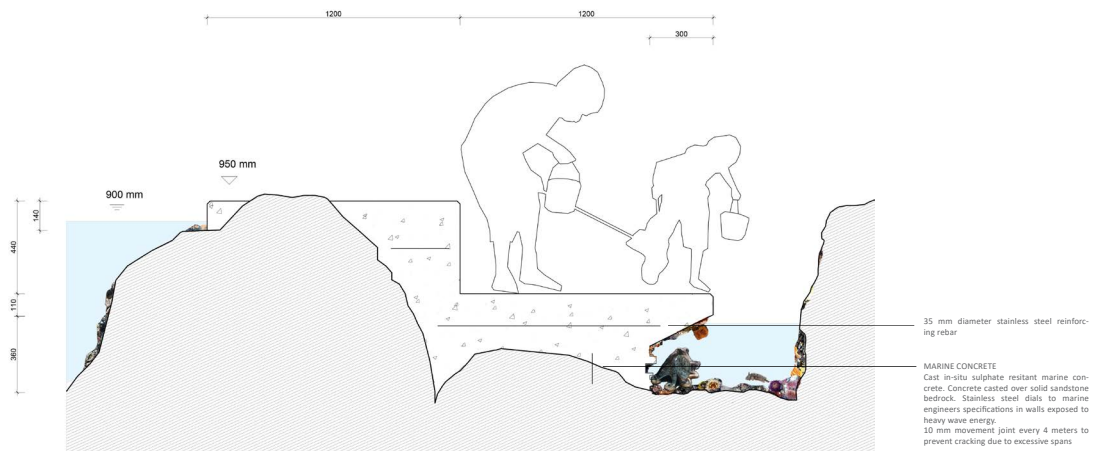


## WONDER AND LEARN

The intention of the designed pools is to allow a free flow of people and water movement across all pools as a series of interlinking pools of different functions. Here the 4 criteria's can be assessed and explored and creates the opportunity of environmental education through experience.



Observing the dynamic living waters where magical moments of life is revealed.



DETAIL: THE EXPLORATIVE LEDGE 3

Scale 1 : 10

# LONG SECTION: LOW TIDE



NATURAL SANDSTONE  
POOLS  
natural tide pool experience

PERMANENT RECREATION  
POOL  
for playing and splashing in the  
presence of many interesting  
sea creatures

WONDER POCKET  
comfortable view and touch pool  
area under ledges built to further  
establish marine habitat

LIVING WALLS

WALKING EXPERIENCE  
wow moments of the diverse beauty  
and wonder of the natural pools  
walking from one pool to the next

COHABITATION  
WALL

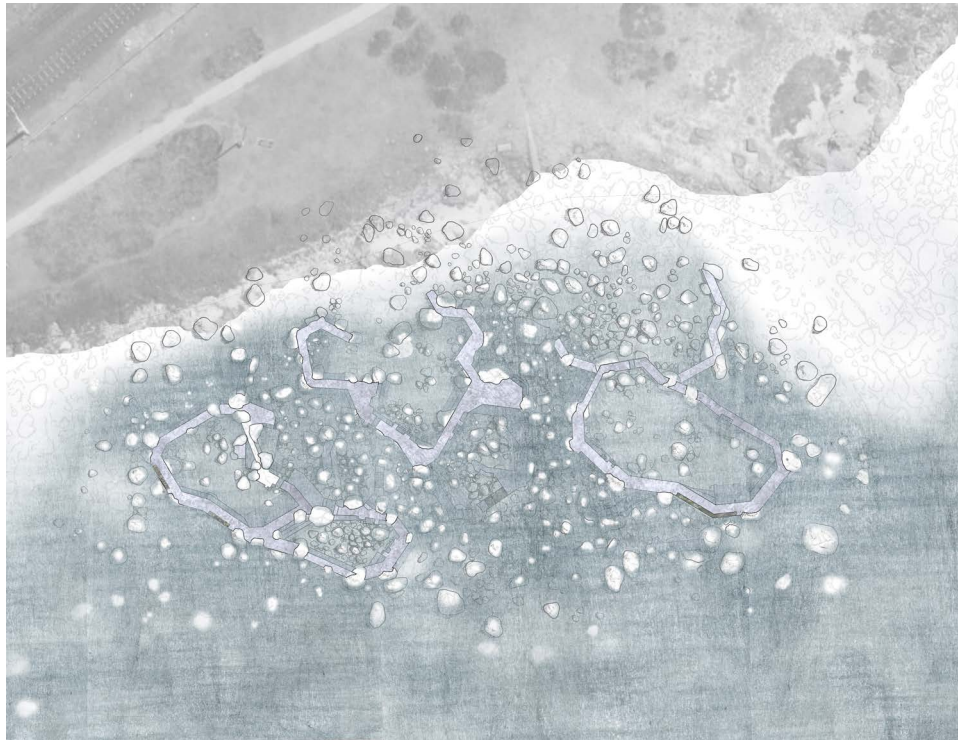
SWIMMING AND  
SNORKELING POOL

SANDSTONE LEDGE  
tanning and relaxation area

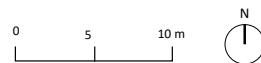
SECTION D - D: **LOW TIDE SANDSTONE INTERTIDAL EXPERIENCE**

Scale 1 : 50

# THE HIGH TIDE EXPERIENCE



PLAN IN MOTION

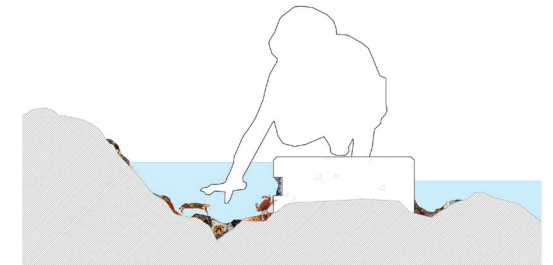


## MULTI-FUNCTIONAL POOLS

The intention of the designed pools is to create multiple spaces which enables a variety of water-body experiences through engaging with pools of different water depths. The pools of habitats brings one into close contact with the existing marine life and accommodates and encourage marine life to flourish and grow inside and outside of the pools. In totality, the interlinking pool system has a healthy water replenishment rate which allows life to flourish and create multiple opportunities to become aware of the dynamic and alive marine system when we embrace the intertidal landscape.

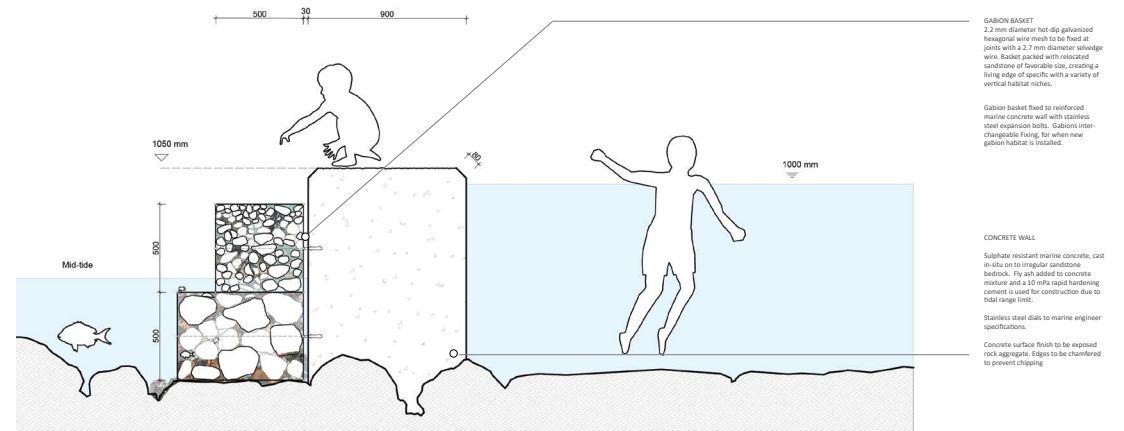


Living waters



## TOUCH AND TEXTURES

Active engagement with water and marine life is encouraged in sensitive ways. The desing promotes active learning through experience.



LIVING WALL DETAIL  
Scale 1 : 20

**GABION BASKET**  
2.2 mm diameter hot-dip galvanized hexagonal wire mesh to be fixed at joints with a 3.7 mm diameter stainless wire. Basket packed with relocated sandstone of favorable size, creating a living edge of specific with a variety of vertical habitat niches.

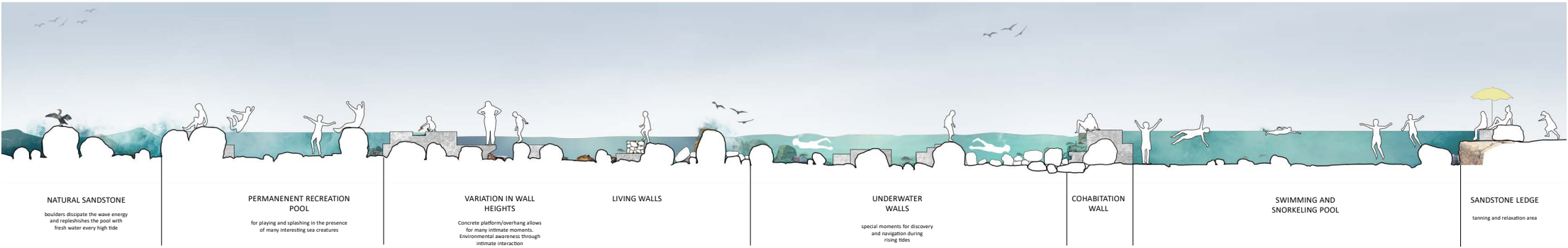
Gabion basket fixed to reinforced marine concrete wall with stainless steel expansion bolts. Gabions interchangeable fixing, for when new gabion habitat is installed.

**CONCRETE WALL**  
Sulphate resistant marine concrete, cast in-situ on to irregular sandstone bedrock. Fly ash added to concrete mixture and a 10 mpa rapid hardening cement is used for construction due to tidal range limit.

Stainless steel disks to marine engineer specifications.

Concrete surface finish to be exposed rock aggregate. Edges to be chamfered to prevent chipping.

# LONG SECTION: HIGH TIDE



**NATURAL SANDSTONE**  
boulders dissipate the wave energy  
and replenishes the pool with  
fresh water every high tide

**PERMANENT RECREATION  
POOL**  
for playing and splashing in the presence  
of many interesting sea creatures

**VARIATION IN WALL  
HEIGHTS**  
Concrete platform/overhang allows  
for many intimate moments.  
Environmental awareness through  
intimate interaction

**LIVING WALLS**

**UNDERWATER  
WALLS**  
special moments for discovery  
and navigation during  
rising tides

**COHABITATION  
WALL**

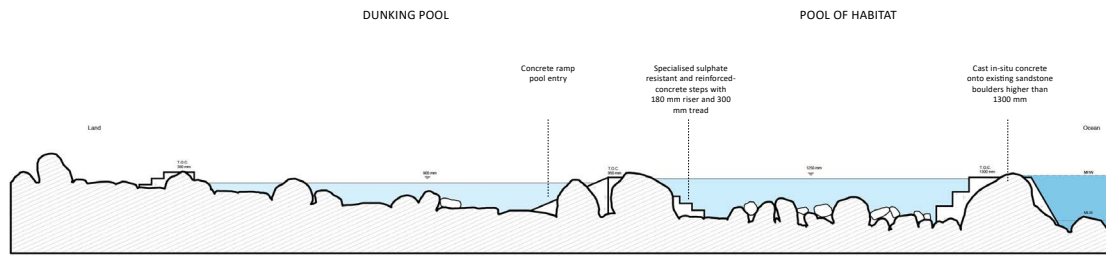
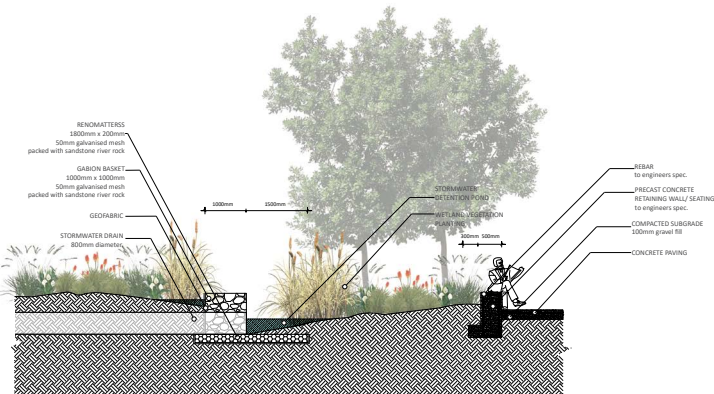
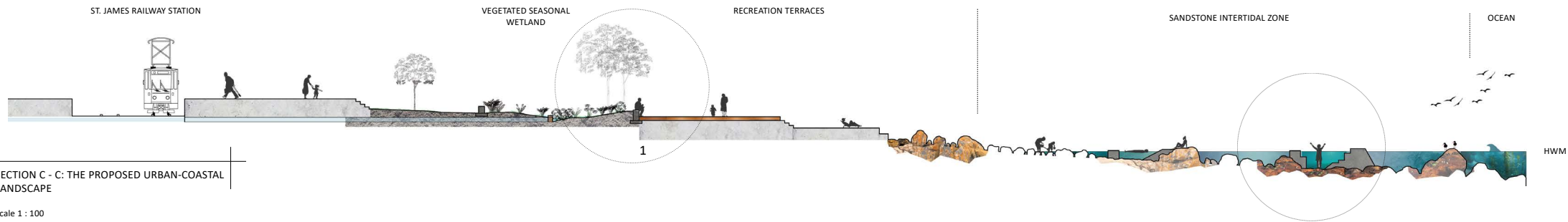
**SWIMMING AND  
SNORKELING POOL**

**SANDSTONE LEDGE**  
tanning and relaxation area

SECTION D - D: **HIGH TIDE SANDSTONE INTERTIDAL EXPERIENCE**

Scale 1 : 50

# LONG SECTION: CONTEXTUALISING SITE



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# APPENDIX

## DECLARATION OF FREE LICENSE AND PLAGIARISM DECLARATION

### **DECLARATION OF FREE LICENSE**

I, Roche de Villas, student number DVLR00.003, hereby:

- a) Grant the University free license to reproduce the above thesis in whole or in part, for the purpose of research.
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# APPENDIX

## ETHICS CLEARANCE

Application for Approval of Ethics in Research (EIR) Projects  
Faculty of Engineering and the Built Environment, University of Cape Town

### APPLICATION FORM

**Please Note:**

Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form **before** collecting or analysing data. The objective of submitting this application *prior* to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the **EBE Ethics in Research Handbook** (available from the UCT EBE, Research Ethics website) prior to completing this application form: <http://www.ebe.uct.ac.za/ebe/research/ethics1>

APPLICANT'S DETAILS	
Name of principal researcher, student or external applicant	Click here to enter text. <i>Roche' de Villiers</i>
Department	Click here to enter text. <i>APG</i>
Preferred email address of applicant:	Click here to enter text. <i>rochedeville@gmail.com</i>
If Student	Your Degree: e.g., MSc, PhD, etc. <i>MLA</i>
	Credit Value of Research: e.g., 60/120/180/360 etc. <i>120</i>
Name of Supervisor (if supervised):	Click here to enter text. <i>Clinton Hindes</i>
If this is a research contract, indicate the source of funding/sponsorship	Click here to enter text.
Project Title	Click here to enter text. <i>Tidal Pools as adaptive public spaces: choreographing resilience by exposing and submerging Form</i>

**I hereby undertake to carry out my research in such a way that:**

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

SIGNED BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	Click here to enter text. <i>Roche' de Villiers</i>	<i>Signed by candidate</i>	Click here to enter a date.

APPLICATION APPROVED BY		Signature	Date
Supervisor (where applicable)	Click here to enter text. <i>Clinton Hindes</i>		Click here to enter a date.
<b>HOD (or delegated nominee)</b> Final authority for all applicants who have answered NO to all questions in Section 1; and for all Undergraduate research (Including Honours).	Click here to enter text.		Click here to enter a date.
<b>Chair : Faculty EIR Committee</b> For applicants other than undergraduate students who have answered YES to any of the above questions.	<i>R Behrens</i>		<i>17 Apr 2019</i>