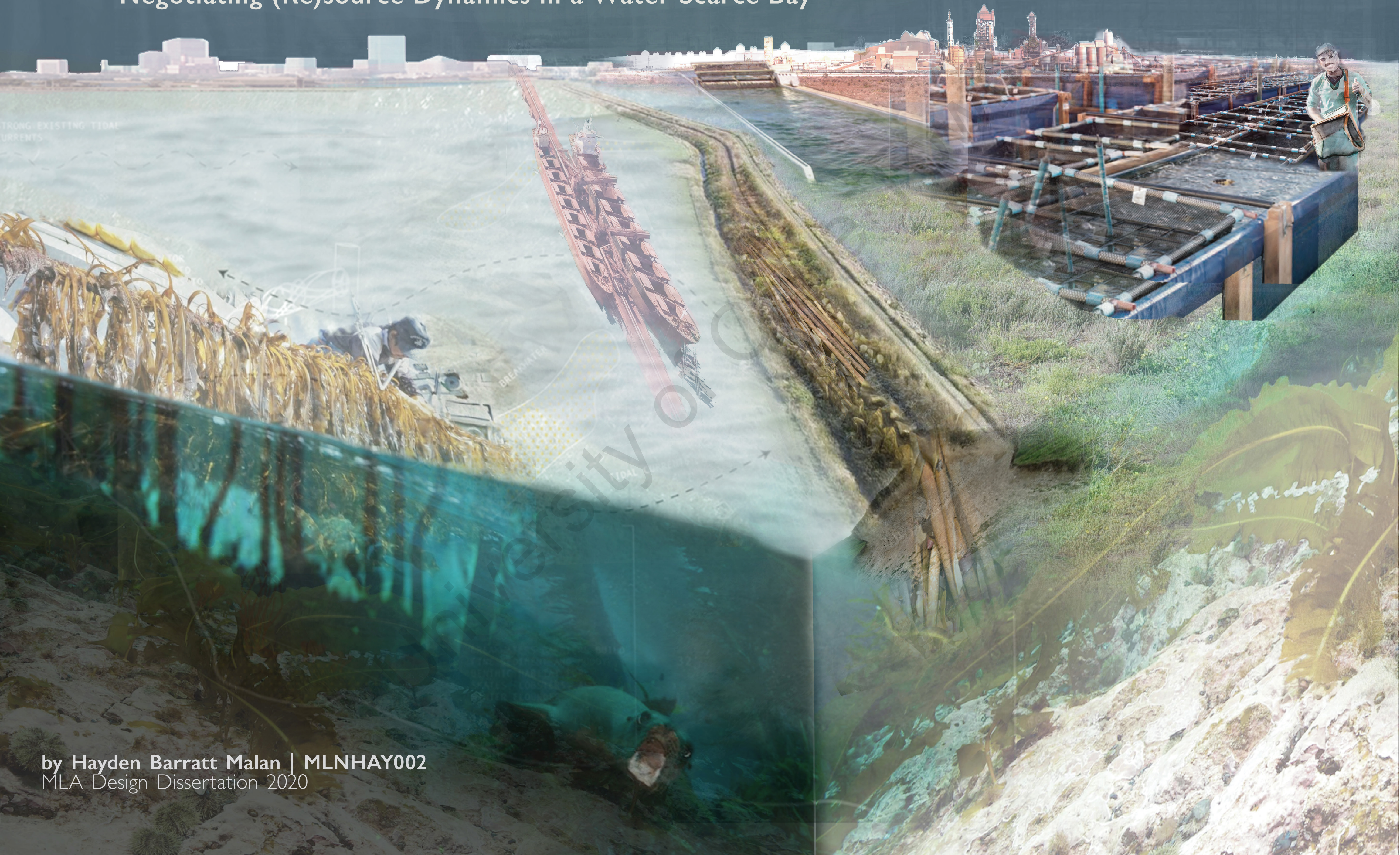
SALDANHA BAY AS A LIVING SPACE
Negotiating (Re)source Dynamics in a Water Scarce Bay



by Hayden Barratt Malan | MLNHAY002
MLA Design Dissertation 2020

SALDANHA BAY AS A LIVING SPACE
Negotiating (Re)source Dynamics in a Water Scarce Bay

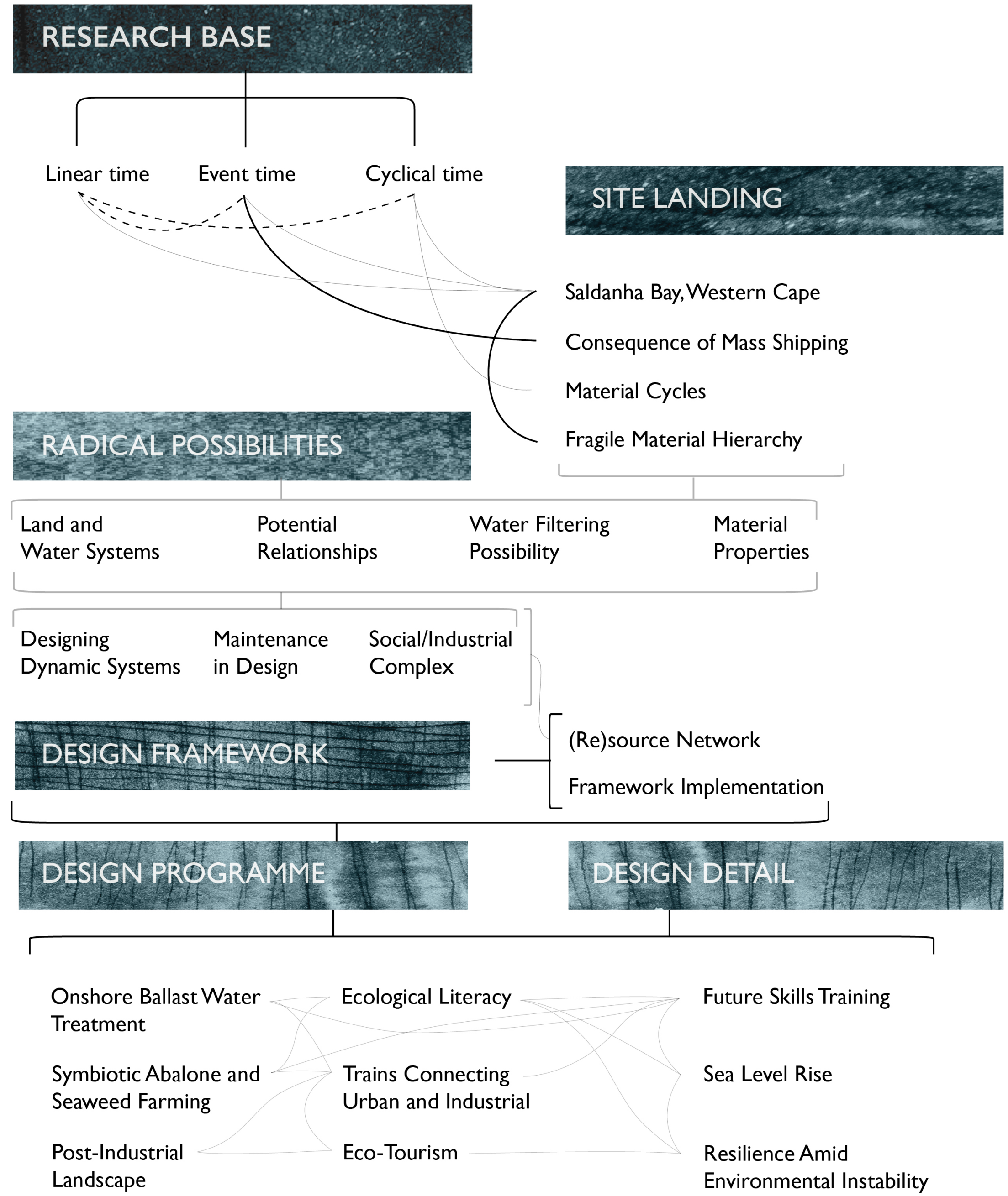
Hayden Barratt Malan
MLNHAY002

Submitted in partial fulfilment of the Master of Landscape Architecture Degree
120 Credits
Supervisor: Tarna Klitzner

Signed: Signed by candidate

December 2020
University of Cape Town

TABLE OF CONTENTS



DESIGN THEORY AND OVERVIEW

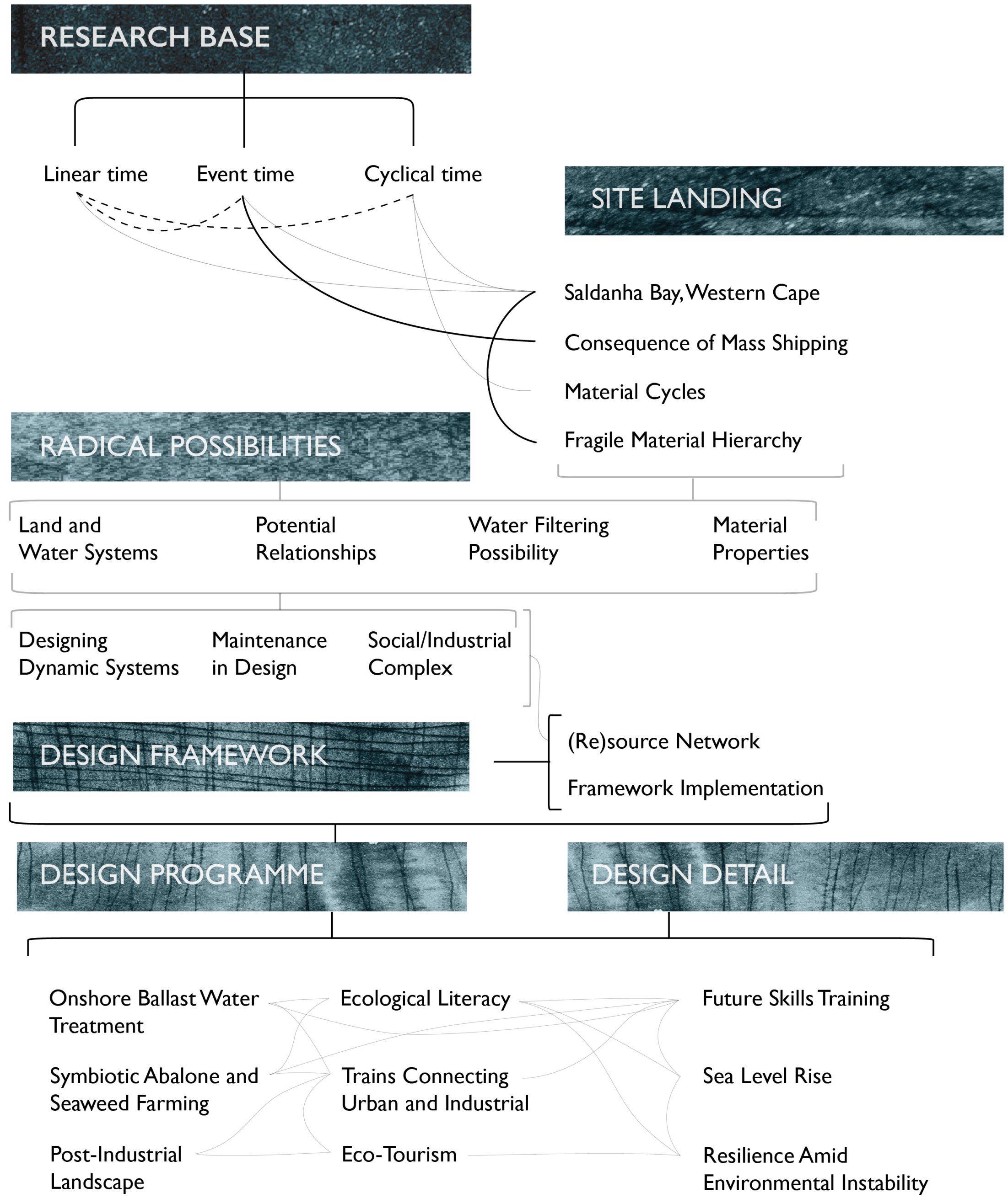
Saldanha Bay, South Africa's second busiest port, exists as a complex set of living systems, poised at the interchange between land and water. Because of its role as a port city, it is a place where water systems, transport routes, and industrial activity meet and intermingle. This thesis focuses on the threat that is posed to the ecosystems of the bay through repeatedly introducing copious amounts of ballast water from the holds of international cargo ships (Duncan, 2014; Marangoni, Pienaar, & Sym, 2001). Paradoxically, it is the entangled routes and systems that led to the disastrous degradation of marine life that suggest Saldanha Bay's potential for sustaining a more symbiotic water system. Imagining and designing such a solution is the aim of this project.

The main design objective is to mitigate the degradation of the marine environment by filtering ballast water to rid it of invasive non-indigenous species (NIS). The central design proposes to filter ballast water through onshore abalone farming and concurrently generate onshore seaweed feed and farming. Such filtration would rely on the environment created by naturally occurring seaweeds, *Ecklonia maxima* and *Gracilaria*, which have great potential to further support ecological functioning. The site of this project is an abandoned iron ore factory, which is well-situated to be repurposed for water filtration.

It is not only the saline water system that will benefit from such an intervention: to repurpose the factory site in a way that rejuvenates both the health of the bay's waters and the economy, would be to fulfil the promise of job security that the community was led to expect when the factory was originally constructed. Furthermore, if the ballast water were desalinated and reintroduced as a source of much needed fresh water, it would support other living systems in the town and surrounding community. The interdependent industries of ballast water maintenance, fresh water sourcing, and fishing would work together to make each more resilient and provide opportunities for people to be *grounded* in their environment.

The functioning of these offshoots is based on the proposition that seaweed is an important design material for future living spaces. There are significant precedents for seaweed use, as a pre- and post-processed material, which posits seaweed as an underused resource in a country where it is abundant (Blamey & Bolton, 2018). These include the following: dike creation for sea level rise risk; eco-roofing for future skills development; sustainable harvesting to support marine environments and generate biomass; and fertiliser as a by-product.

Although social systems, industrial (in)activity and water systems in Saldanha Bay invariably influence and modify one another by sheer proximity, this is unplanned and each system is perceived as independent. A systemwide reconfiguration is required for broader ecological transparency, literacy and health. These radical possibilities do not present static solutions for land and water systems, but rather suggest anti-fragile interventions that increase metabolic stability.



Some framing is needed in order to contextualise the spatial design presented in this project. This document introduces the past and present spatial configuration of the area as part of a larger narrative of global resource management.

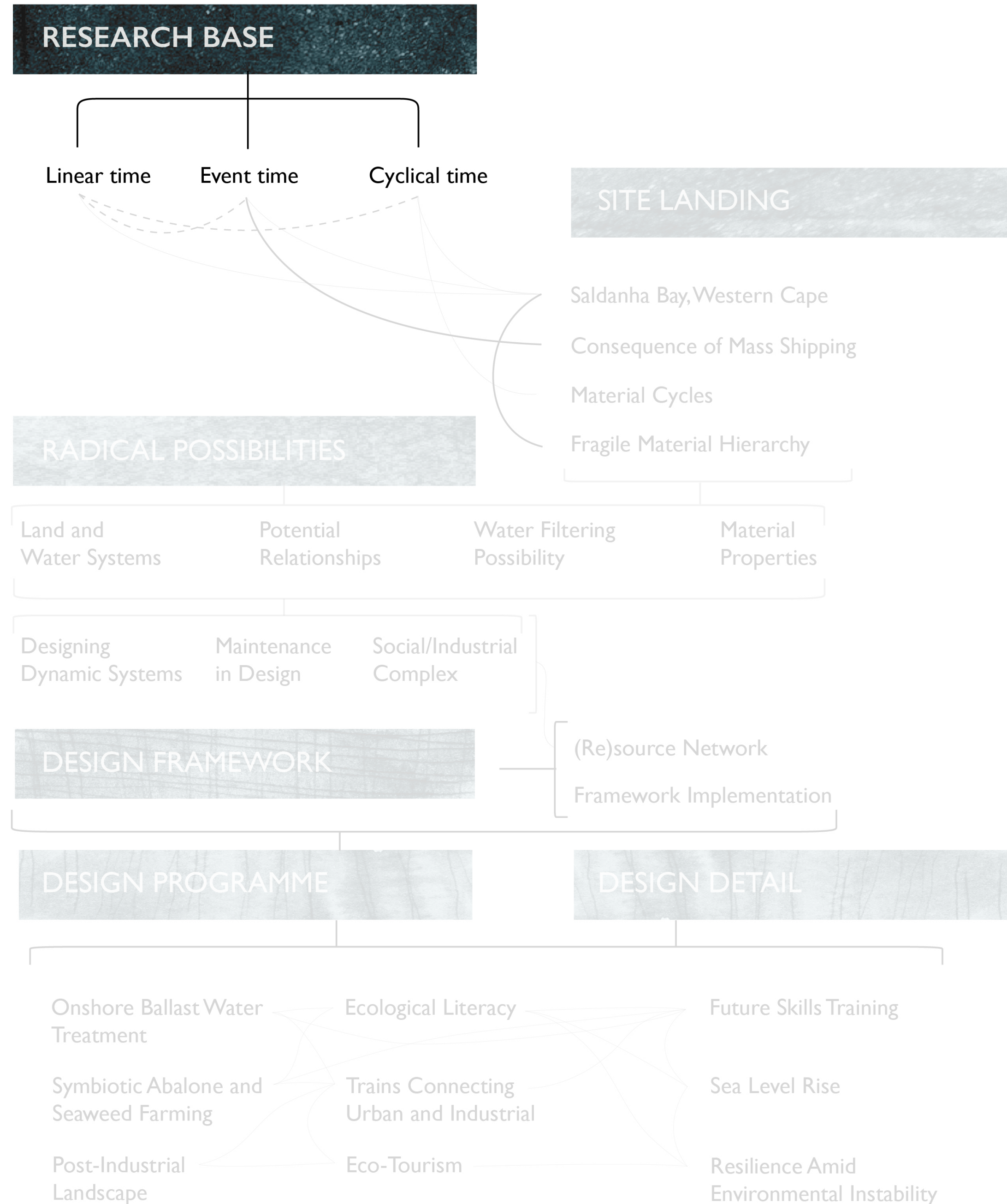
'Research Base' unpacks a resultant negotiation between static and cyclical systems: the large and the small, the giving and taking of resources, and past, present and future states.

'Site landing' shows the residues and trajectories of these dynamics as they exist in Saldanha Bay.

This is followed by 'Radical Possibilities', which details site-specific remediations for living systems, such as the human settlement, existing industries (land and ocean based) and the naturally occurring ecosystems.

Within 'Symbiotic Relationships' these possibilities are linked to the human activity in the bay.

Once the area is contextualised and the importance of kelp has been asserted, the last chapter leads us to imagining a new interconnected design framework, showing how specific iterations of the 'radical possibilities' can be practically realised to produce feasible design goals.

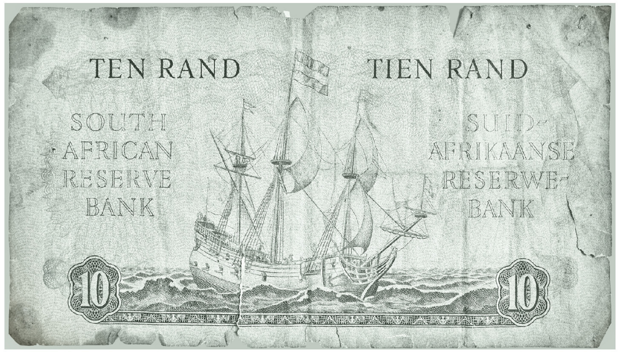

RESEARCH BASE
Linear time
Event time
Cyclical time
SITE LANDING
Saldanha Bay, Western Cape
Consequence of Mass Shipping
Material Cycles
Fragile Material Hierarchy
RADICAL POSSIBILITIES
Land and Water Systems
Potential Relationships
Water Filtering Possibility
Material Properties
Designing Dynamic Systems
Maintenance in Design
Social/Industrial Complex
DESIGN FRAMEWORK
(Re)source Network
Framework Implementation
DESIGN PROGRAMME
DESIGN DETAIL
Onshore Ballast Water Treatment
Ecological Literacy
Future Skills Training
Symbiotic Abalone and Seaweed Farming
Trains Connecting Urban and Industrial
Sea Level Rise
Post-Industrial Landscape
Eco-Tourism
Resilience Amid Environmental Instability

LINEAR TIME
Transport and Water Systems

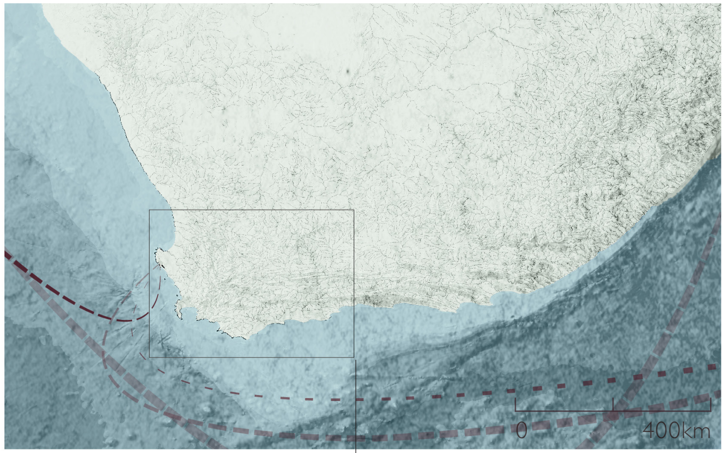
Globalisation, which was brutally packaged in South Africa as colonialism, thrived by projecting static states (Mitchell, 2002), exploitative labour practices, and ultimately with a goal of extracting distant resources (Kameri-Mbote & Cullet, 1997). The initial large-scale human activity in the bay relied on the health and abundance of the marine environment, but the trajectory of finite-resource exploitation has led to the downfall of the functioning of the ecosystem (Welman & Ferreira, 2016).

International transport routes, which distributes both people and materials around the world, have been expanded and refined over many centuries. Saldanha Bay is a former British Colony in South Africa, which has its origins as both a trade stop and a site of brutal exploitation of people and natural resources for European empires (Kameri-Mbote & Cullet, 1997). Thomas Mitchell (2002, pp. 90-92) expands on the complex dynamic between empire and satellite colony by unpacking the mechanisms that enabled resource exploitation: mapping was first used to facilitate control of space and materials, regional monoculture crop farming was widely implemented to easily quantify and project the future export of materials, and stock exchanges could provide anonymous crowdfunding strategies (Mitchell, 2002). In this sense, colonialism thrived off of imagining states of land as static, controllable and unchanging, from which resources could be removed, but little or no consideration was given to the effects that such interventions had on the local ecosystems (Mitchell, 2002).

This dissertation probes into the consequences of a disconnection between resources and users and the often overlooked residue that removing objects leaves on the environment.



A South African banknote from 1961, depicting trade and satellite resource interdependency.
(Image author's own)



Saldanha Bay, South Africa's second busiest port (Marangoni, Pienaar, & Sym, 2001, p. 466),a historic stop for international trade.

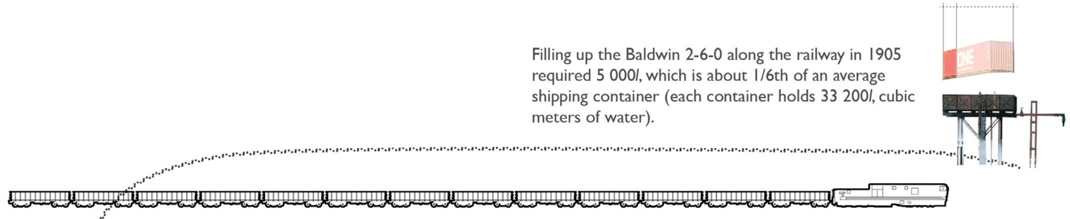
Major rivers and coastal seaweed growth along the Western Cape coastline. (Saldanha Bay highlighted)

All maps point north unless stated otherwise

LINEAR TIME
Transport and Water Systems

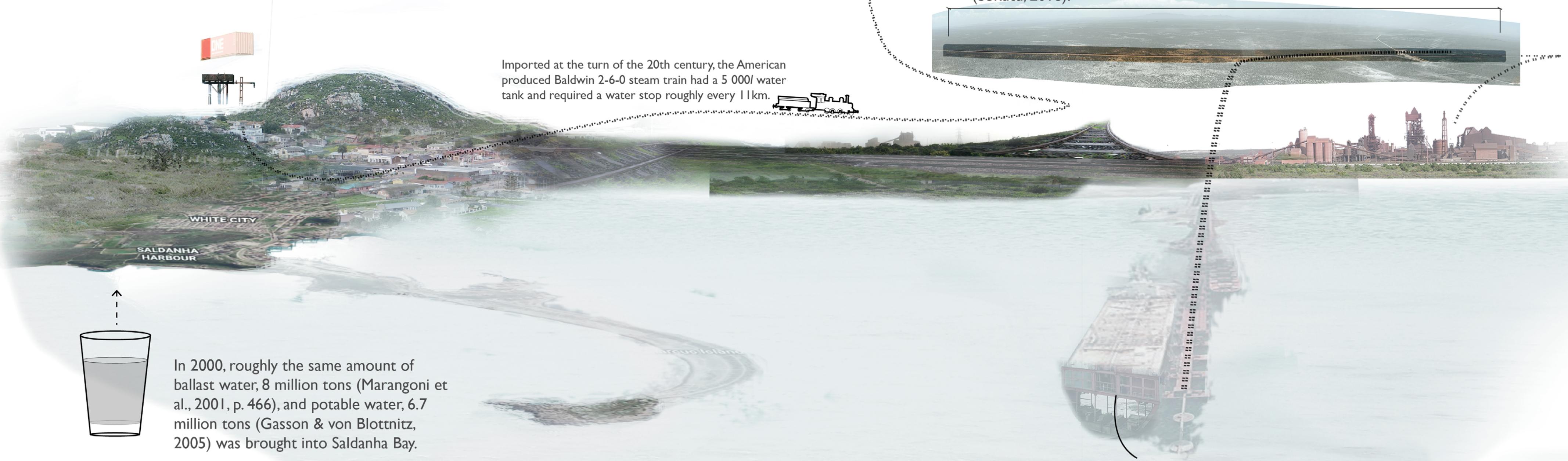
In South Africa's now second busiest port (Marangoni, Pienaar, & Sym, 2001, p. 466), we see immense volumes of material, especially water, siphoned in and out of the space. It was historically both close enough to Cape Town to support trade and close enough to be a threat from foreign forces (Welman & Ferreira, 2016).

Filling up the Baldwin 2-6-0 along the railway in 1905 required 5 000l, which is about 1/6th of an average shipping container (each container holds 33 200l, cubic meters of water).



Transnet's 4km-long, 375-wagon train is the longest production train in the world, connecting Sishen iron-ore mine with Saldanha's deep-water jetty (Sokutu, 2018).

Imported at the turn of the 20th century, the American produced Baldwin 2-6-0 steam train had a 5 000l water tank and required a water stop roughly every 11km.



In 2000, roughly the same amount of ballast water, 8 million tons (Marangoni et al., 2001, p. 466), and potable water, 6.7 million tons (Gasson & von Blottnitz, 2005) was brought into Saldanha Bay.

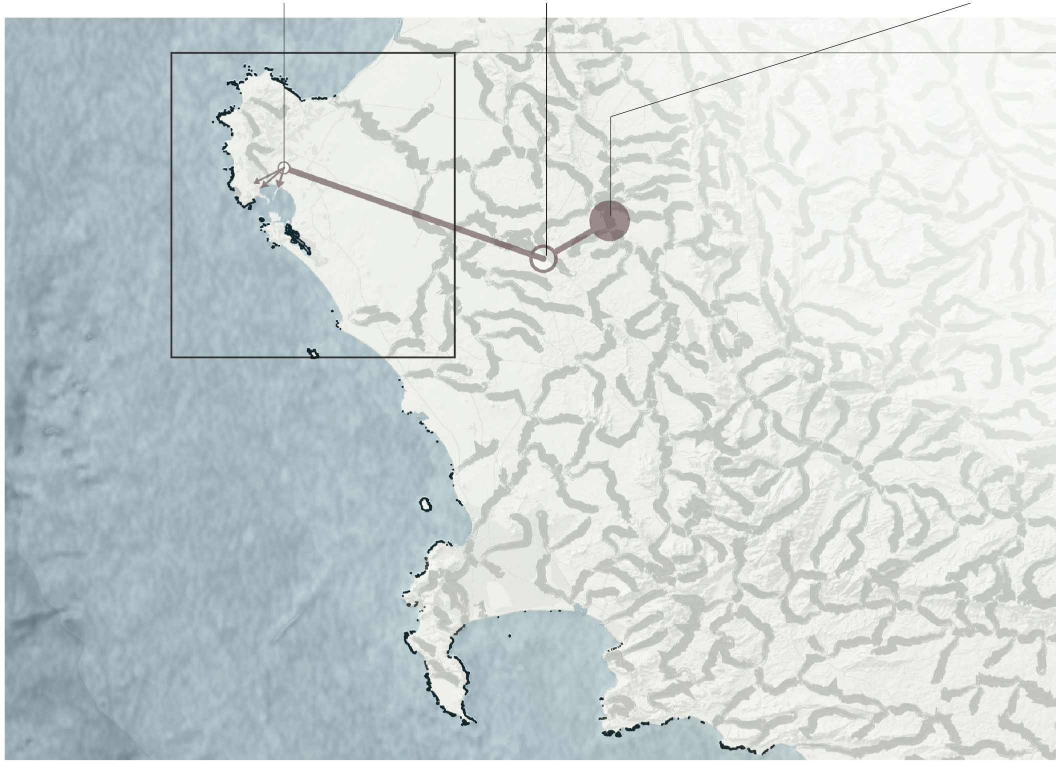
4km is the equivalent of 16 x 250m long cargo ships in a row.

11.6 million tons of ballast water introduced in 2019 alone, stacked upon 16 cargo ships across 4km. The amount of water is extrapolated from the 8 million tons that were introduced in 2000 (Marangoni et al., 2001).

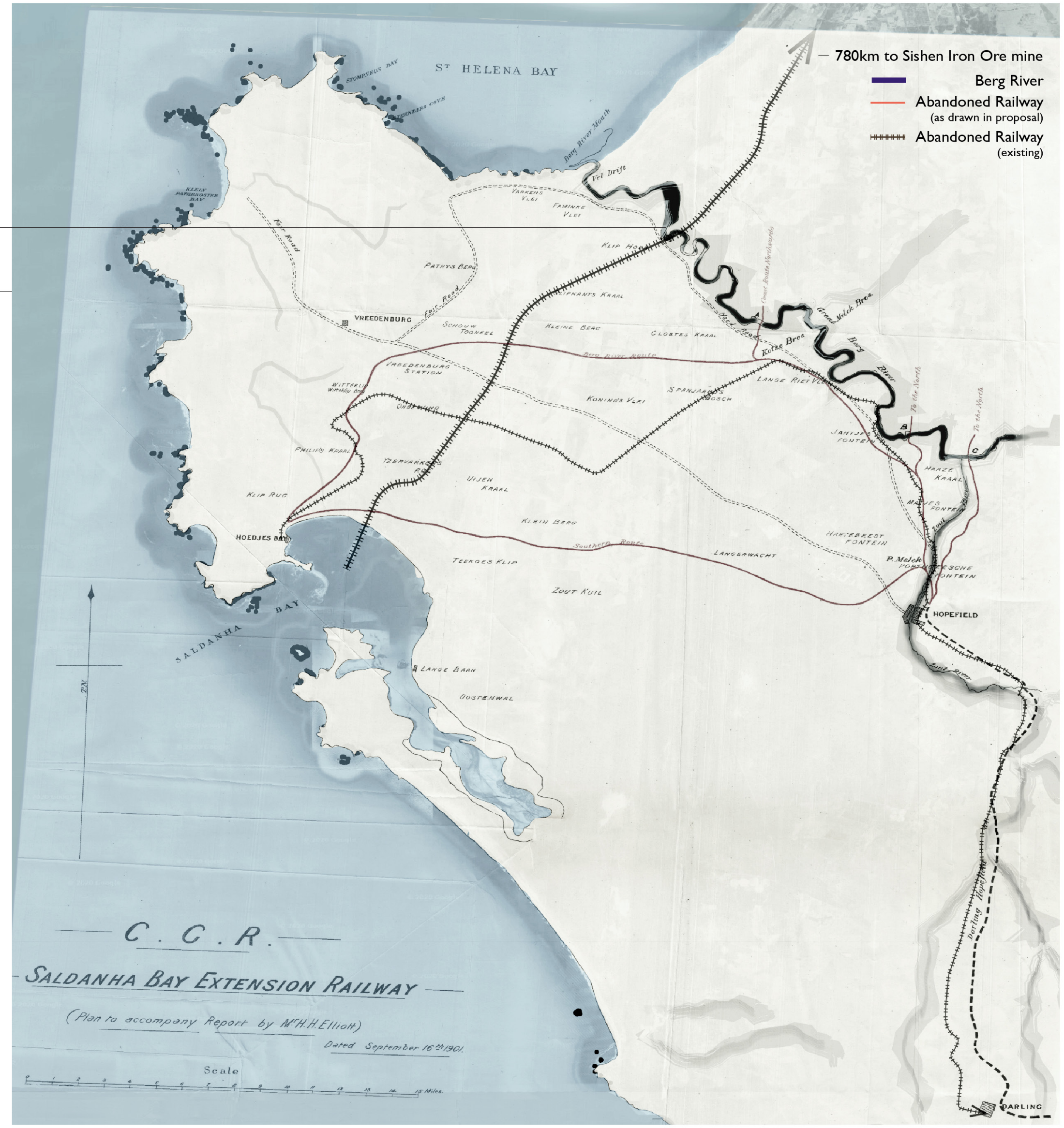
350 000 containers (each a '20 foot intermodal' cargo shipping container holding 33.2 cubic meters of water). At 1 row deep, there are 21 875 containers on each of the 16 ships.

EVENT TIME
Water Systems

The first major railway was drawn away from the bay, towards the Berg River. This continues to be the major source of fresh water, which is piped 88km from this river to the bay (Saldanha Bay Municipality, 2019).



Major rivers, Saldanha Bay's fresh water supply, and seaweed



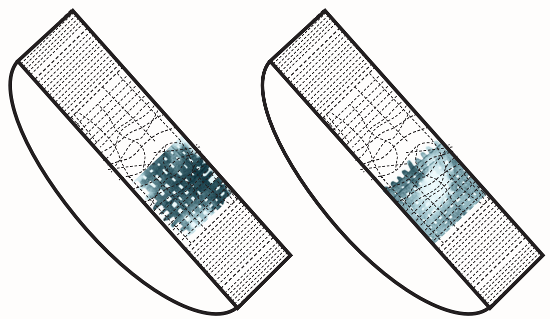
Naturally deep Bay and its historic connection to steel railways

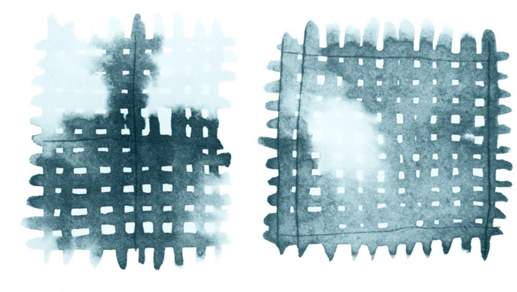
CYCLICAL TIME
Resource Growth and Extraction

> **“If I were to capture some urban water in a glass, retrace the networks that brought it there, “I would pass with continuity from the local to the global, from the human to the non-human” (Latour, 2012, p. 121). These flows would narrate many interrelated tales: of social and political actors and the powerful [and unequal] socio-ecological processes that produce urban and regional spaces.” (Swyngedouw & Swyngedouw, 2004, p. 461)**

In unpacking these interrelated tales Saskia Sassen (2016) calls for more grounding and less worlding (Ernstson & Sörlin, 2019), noting that global conversations about climate change are often too broad and can be easily warped by the storyteller. Within excessive worlding “destroyed air, land and water become a generic condition, a facticity disembodied from the geopolitical landscape of countries and mainstream politics”; multinational players can focus on carbon trading as the lowest common denominator to control the system, “either to augment the right to pollute or augment what they can sell to governments that want to pollute more” (Sassen, 2016, pp. 34-35).

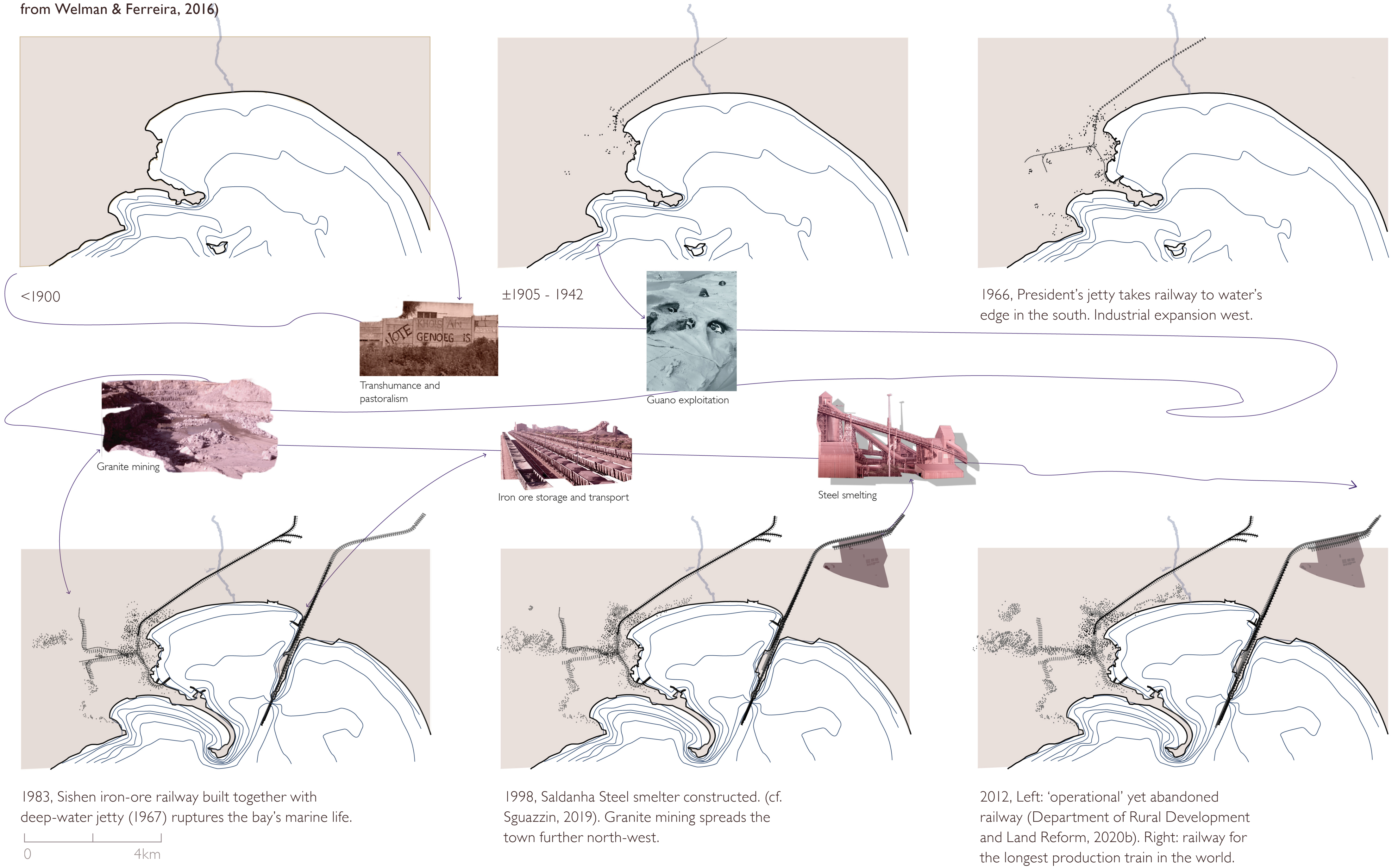
These ideas are pertinent to the context, where a glassful of saline water from Saldanha Bay would show a mix of international waters containing foreign organisms, competing with local marine life (expanded on in detail later), while a glass of fresh water would embody a history of importing fresh water from the Berg river. The glasses of water are sites of unseen contestation, but which must be brought to light in order for ecological health to be restored.





International waters containing foreign organisms, compete with local marine life.

Resource extraction, railway, and population patterns (adapted from Welman & Ferreira, 2016)



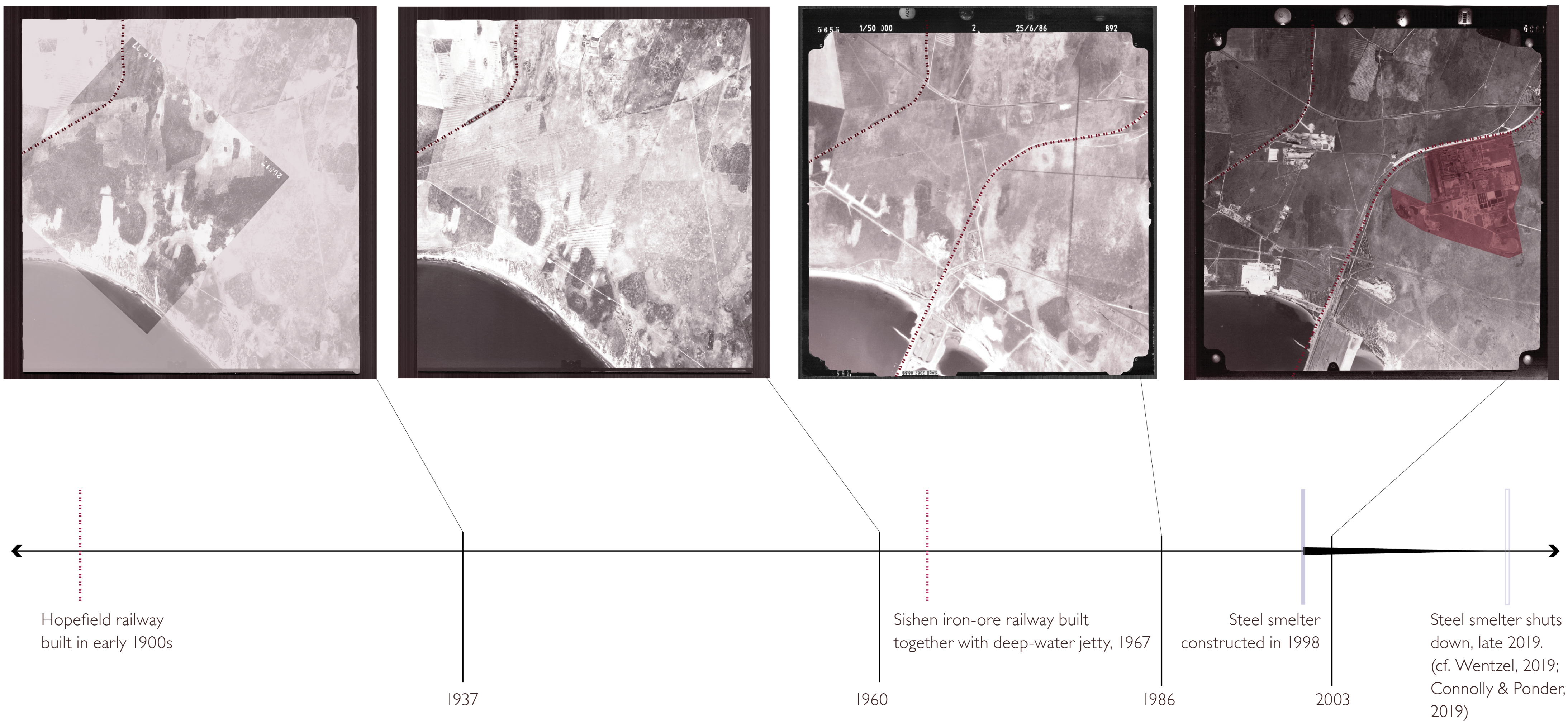
1966, President's jetty takes railway to water's edge in the south. Industrial expansion west.

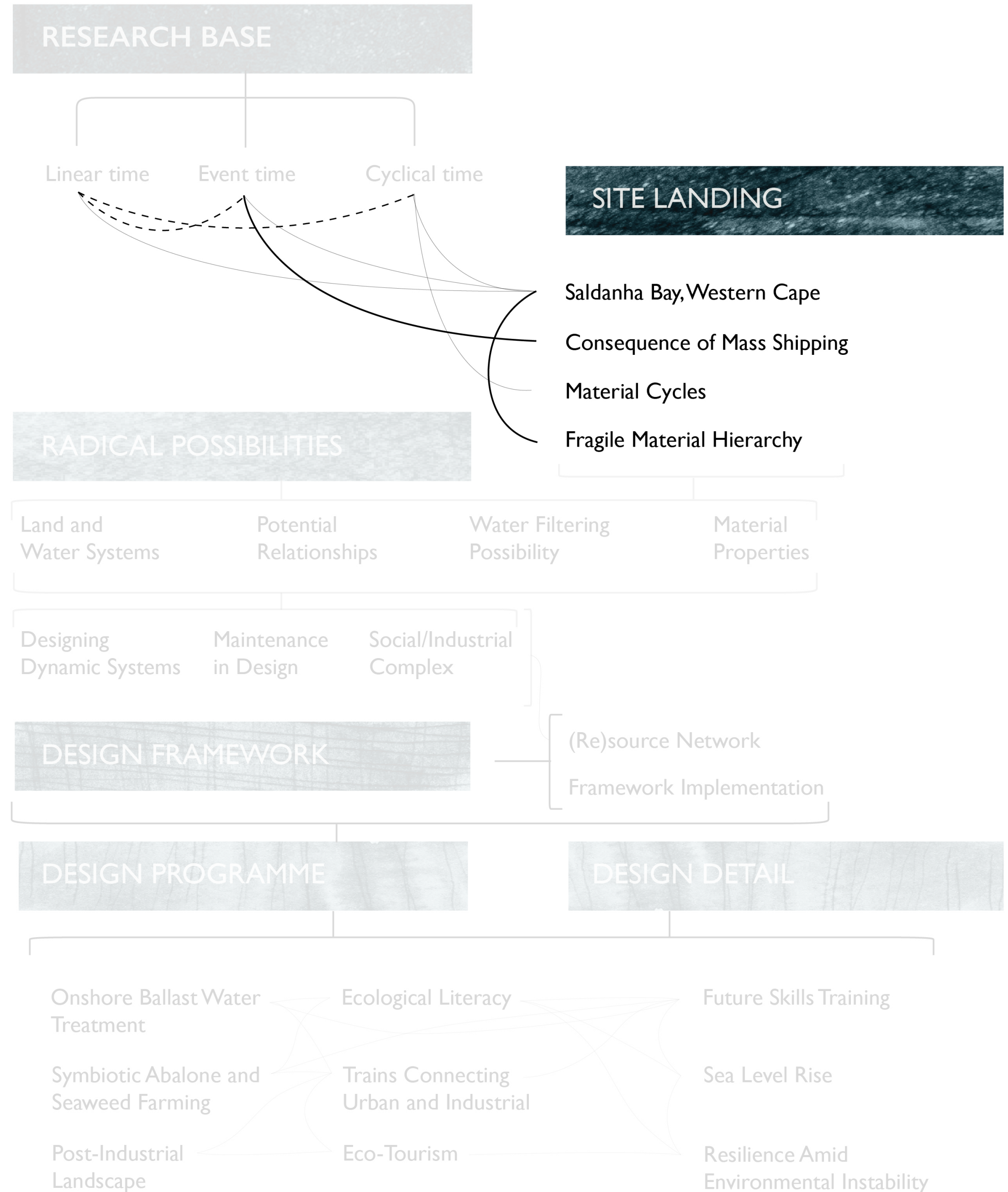
1983, Sishen iron-ore railway built together with deep-water jetty (1967) ruptures the bay's marine life.

1998, Saldanha Steel smelter constructed. (cf. Sguazzin, 2019). Granite mining spreads the town further north-west.

2012, Left: 'operational' yet abandoned railway (Department of Rural Development and Land Reform, 2020b). Right: railway for the longest production train in the world.

The Saldanha Steel smelter was constructed as late as 1998 as part of a post-apartheid mega-project meant to bring social upliftment to the bay.
(Images adapted from the Department of Rural Development and Land Reform, 2020a)




RESEARCH BASE
Linear time
Event time
Cyclical time
SITE LANDING
Saldanha Bay, Western Cape
Consequence of Mass Shipping
Material Cycles
Fragile Material Hierarchy
RADICAL POSSIBILITIES
Land and Water Systems
Potential Relationships
Water Filtering Possibility
Material Properties
Designing Dynamic Systems
Maintenance in Design
Social/Industrial Complex
DESIGN FRAMEWORK
(Re)source Network
Framework Implementation
DESIGN PROGRAMME
DESIGN DETAIL
Onshore Ballast Water Treatment
Ecological Literacy
Future Skills Training
Symbiotic Abalone and Seaweed Farming
Trains Connecting Urban and Industrial
Sea Level Rise
Post-Industrial Landscape
Eco-Tourism
Resilience Amid Environmental Instability

SITE LANDING
Saldanha Bay, Western Cape

The bay as a living system; existing hierarchy within multiple resource cycles.

CONSEQUENCE OF MASS SHIPPING
Ballast Water Introduction

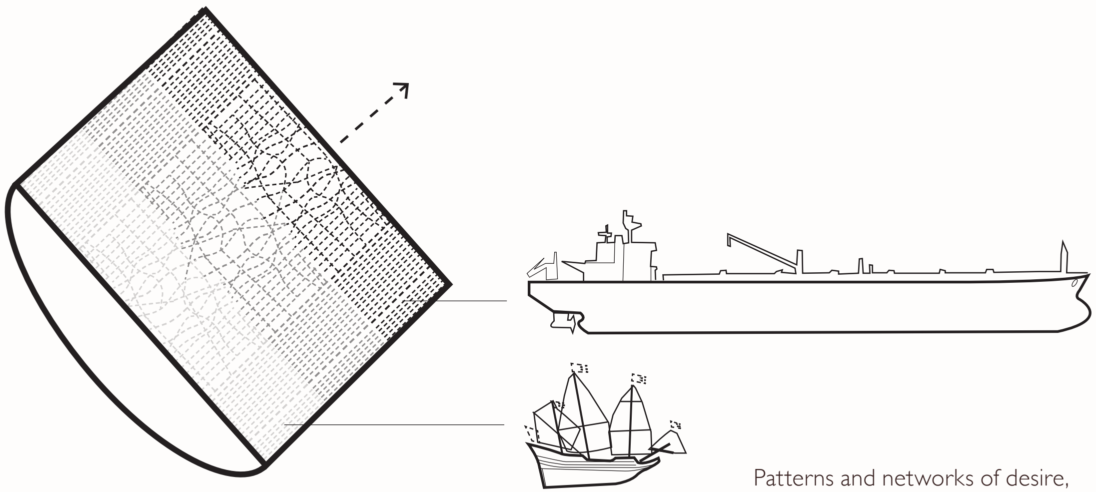
Because of mass cargo shipping, the rapid introduction of non-indigenous species (NIS) in ballast water has devastated local marine ecosystems. As a result of ballast water exchange the inner bay's water is completely replaced roughly every five days and invasive NIS continually out-compete local species. Furthermore, in 1979, the ecosystems were ruptured by the construction of a deep-water jetty which calmed and deepened the bay.

Ballast water has been described as "extremely convenient for the shipping industry but disastrous for coastal waters and the environment" (Duncan, 2014). It controls ships' stability and trim, but as it is exchanged across natural geographic boundaries, it causes the transmission and invasion of NIS (Pereira & Brinati, 2012). These transported organisms include "microbes, plants and animals, eggs, larvae and juveniles of larger organisms" (Duncan, 2014, p. 6).

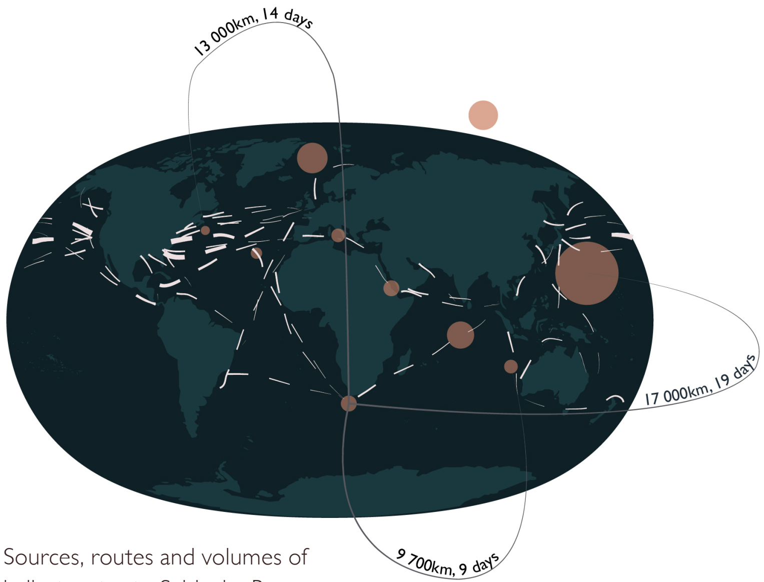
This problem has been exponentially exacerbated by the increased efficiency and expansion of the shipping industry. Spurred by demand and cost efficiency, 90% of international trade involves the movement of goods by sea freight (Liu, Chang, & Chou, 2014, p. 187). As journey lengths become shorter, more species survive the journey between ports, resulting in more alien species that are unlikely to have natural, local predators (Scriven, DiBacco, Locke, & Therriault, 2015).

International Ballast Water Management (BMW) began in the late 1980s due to the threat of invasion and structural damage caused by increased biomass (Scriven et al., 2015). As a temporary solution, Mid-ocean Exchange (MOE) was introduced and remains the most common method employed for BWM worldwide, despite being originally considered as an interim solution (Scriven et al., 2015). It was considered temporary because MOE is based on a Canadian model that only lowers the risk of species invasion for vessels transiting between freshwater and salt water systems and was not designed for vessels traveling between (or within) salt water ecosystems (Scriven et al., 2015). Shortfalls and opportunities within contemporary BWM will be discussed in a later chapter,Water Filtering Possibility.

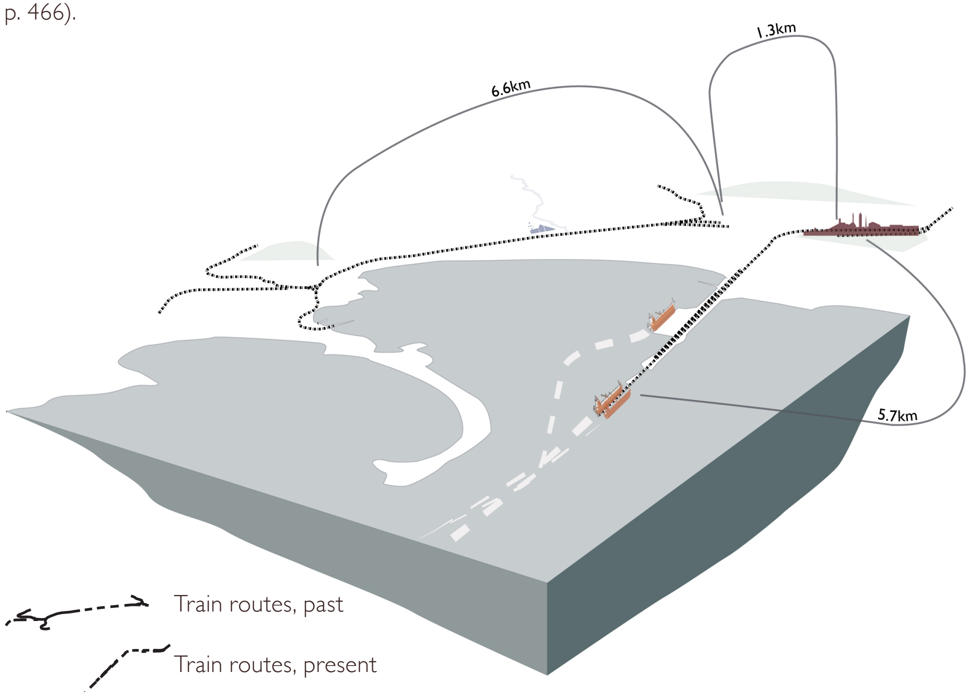
Although the government has signed and ratified international conventions that deal with ballast water, South Africa does not have legislation or regulation that deals directly with the issue and it has been disastrous for our coastal waters (Duncan, 2014). Saldanha Bay, specifically, has an endangered marine ecosystem in large part due to the accumulated introduction of NIS and artificial land reconstruction. *Mytilus galloprovincialis* (Mediterranean mussel), a prominent NIS case in South Africa, was first noted in Saldanha Bay in 1979 and has since spread so extensively that is now found along the entire west coast of South Africa (Duncan, 2014, p. 33). The extensiveness of this problem requires an imaginative and pragmatic solution. Furthermore, this water could be used for the region becomes a more grounded, independent entity that is less reliant on external resources. Presenting such a solution is the aim of this project.

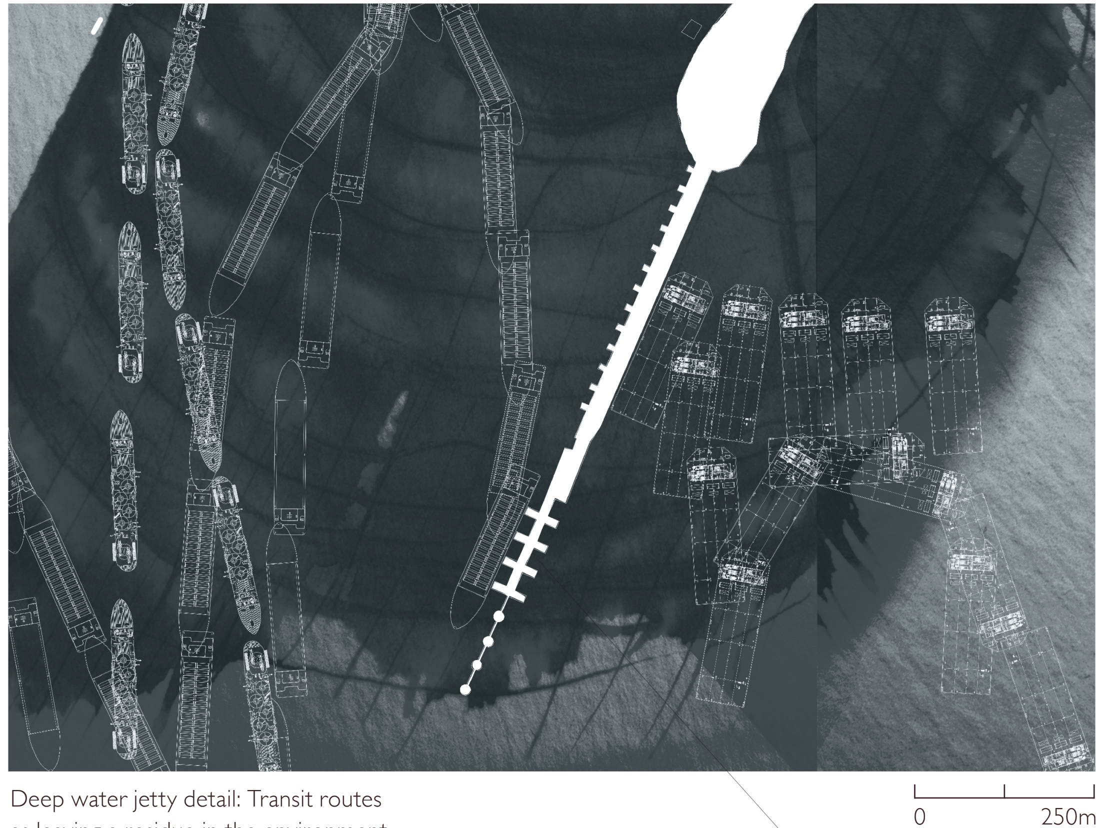


Patterns and networks of desire, distribution and disruption.

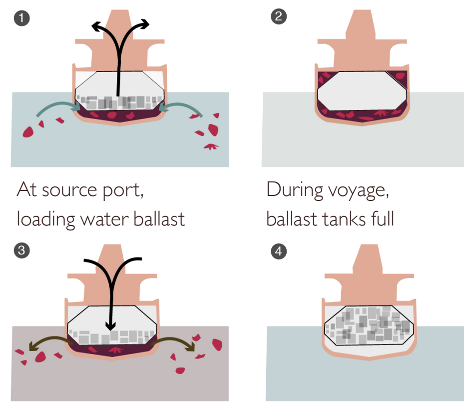


Sources, routes and volumes of ballast water to Saldanha Bay (Marangoni, Pienaar, & Sym, 2001, p. 466).

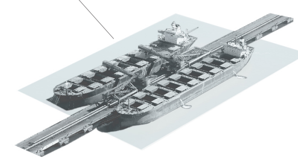




Deep water jetty detail: Transit routes as leaving a residue in the environment

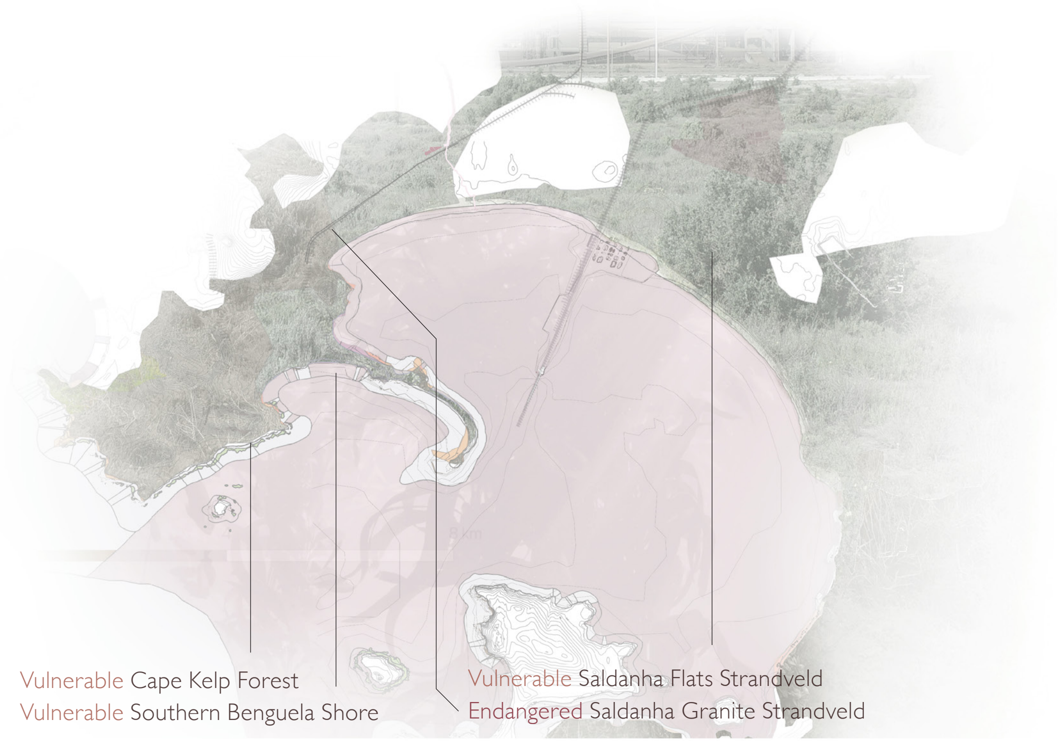


1. At source port, loading water ballast
2. During voyage, ballast tanks full
3. At destination port, discharging water ballast **Non-Indigenous species introduced from ships' hulls**
4. During voyage, ballast tanks empty



Richards Bay and Saldanha Bay are South Africa's busiest ports, and "the bulk cargo carriers entering these ports discharge almost 30 million tonnes of ballast water while receiving their cargo of coal and iron ore." (Marangoni, Pienaar, & Sym, 2001, p. 466)

MATERIAL CYCLES
Change and Environmental Instability



5m contours, above and below waterline, and sea level rise risk

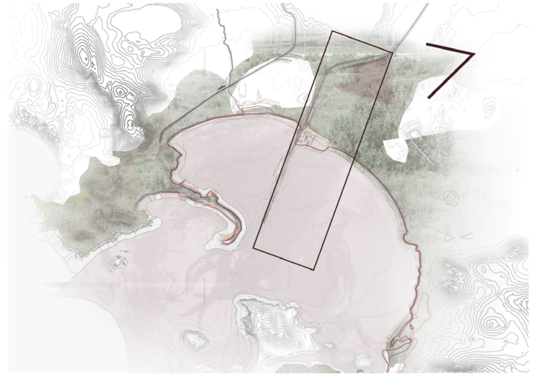
Sea level rise risk: Low
Medium
High
Very High

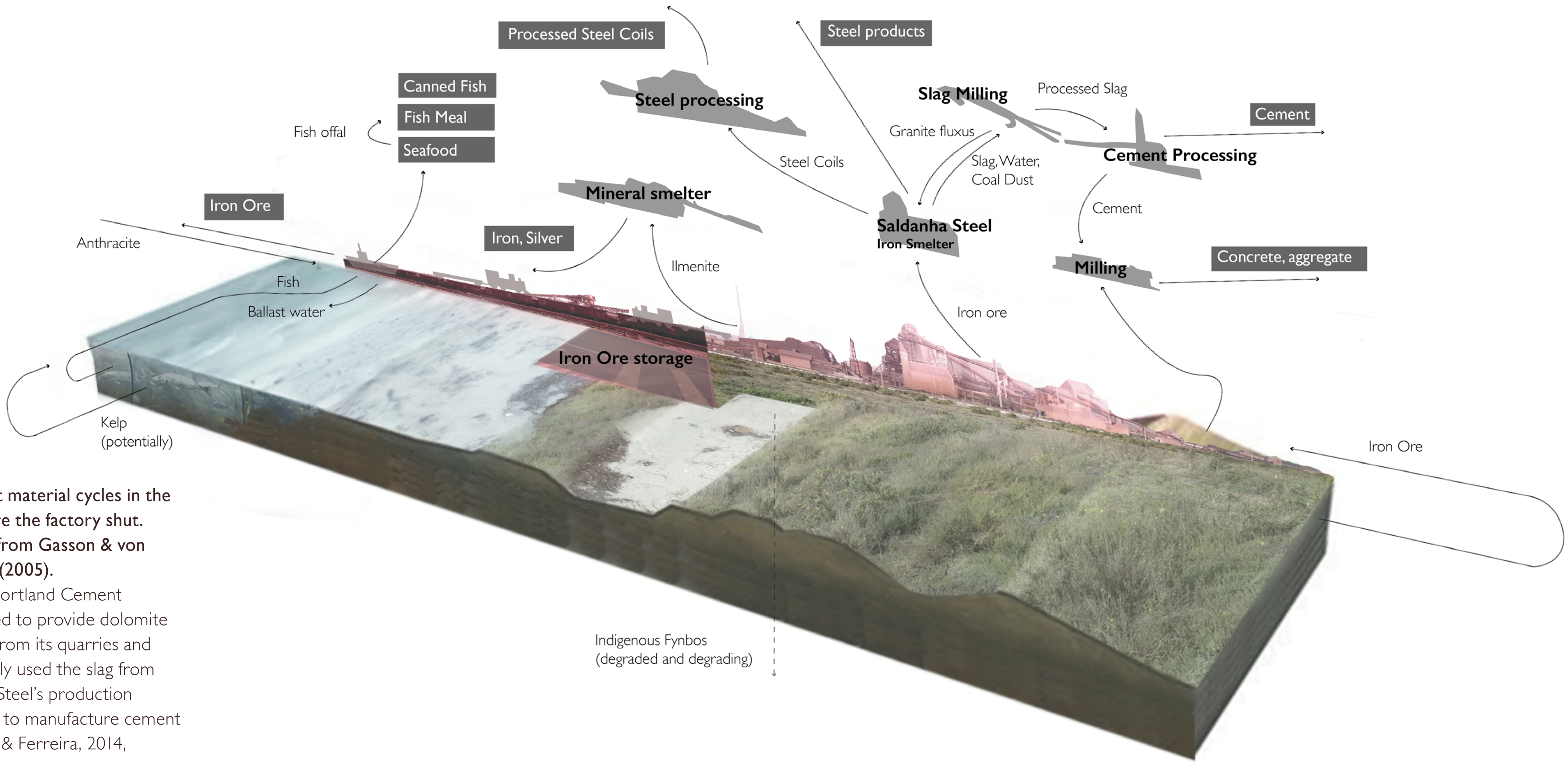
Perspective 1:

Abandoned railway (extends left and in foreground)
Saldanha Steel Iron Smelter (horizon, left)
Deep-water jetty and cargo ships (horizon, right)

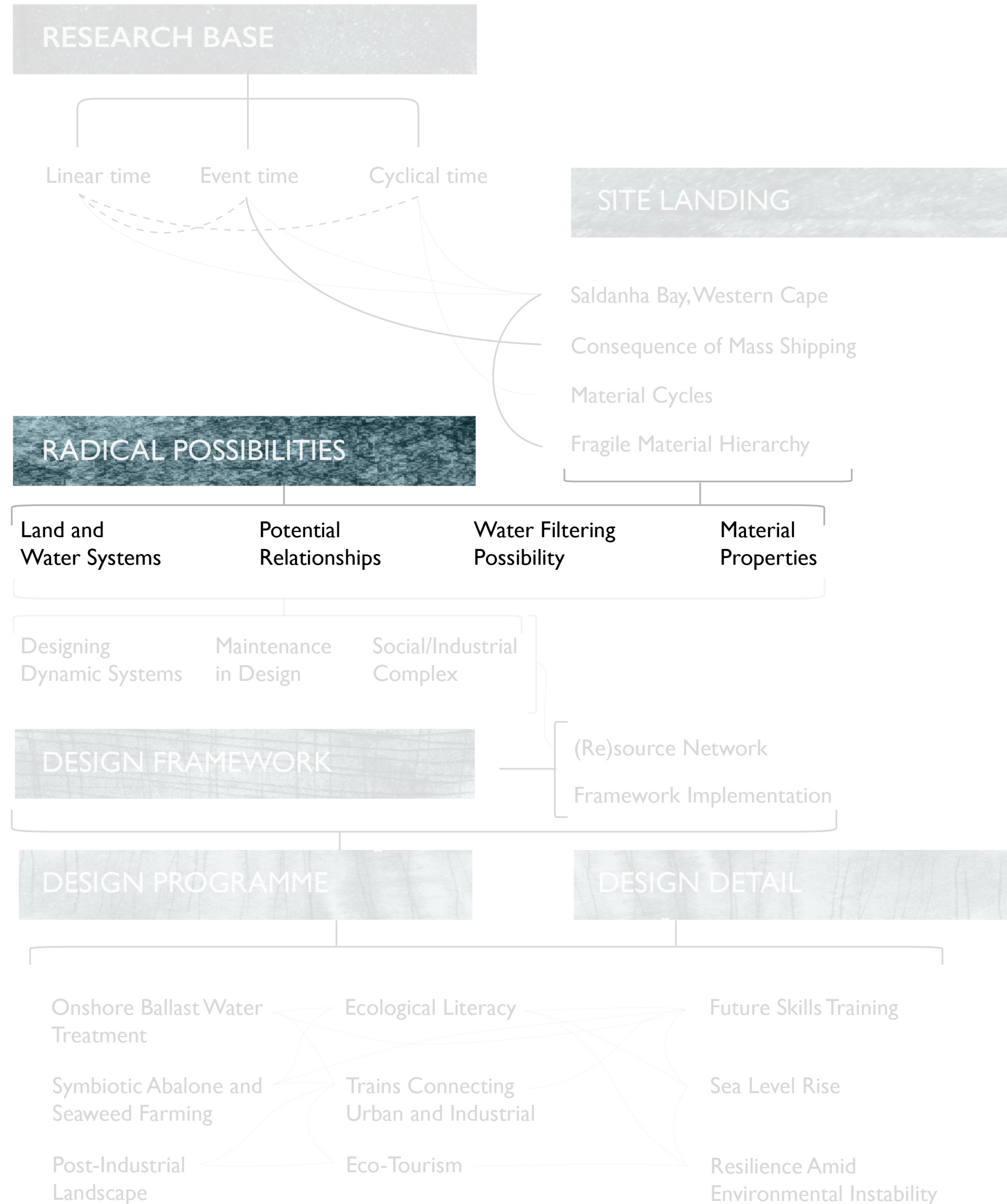
FRAGILE MATERIAL HIERARCHY

The Saldanha Steel smelter is at the heart of the space and of the design; it has shut down and its future is uncertain (Wentzel, 2019). It was seen to bring social inequality as well as negatively effect the environment in the bay.





Dominant material cycles in the bay, before the factory shut. Adapted from Gasson & von Blottnitz (2005).
Pretoria Portland Cement (PPC) used to provide dolomite and lime from its quarries and reciprocally used the slag from Saldanha Steel's production processes to manufacture cement (Welman & Ferreira, 2014, p. 226).


RESEARCH BASE
Linear time
Event time
Cyclical time
SITE LANDING
Saldanha Bay, Western Cape
Consequence of Mass Shipping
Material Cycles
Fragile Material Hierarchy
RADICAL POSSIBILITIES
Land and Water Systems
Potential Relationships
Water Filtering Possibility
Material Properties
Designing Dynamic Systems
Maintenance in Design
Social/Industrial Complex
DESIGN FRAMEWORK
(Re)source Network
Framework Implementation
DESIGN PROGRAMME
DESIGN DETAIL
Onshore Ballast Water Treatment
Ecological Literacy
Future Skills Training
Symbiotic Abalone and Seaweed Farming
Trains Connecting Urban and Industrial
Sea Level Rise
Post-Industrial Landscape
Eco-Tourism
Resilience Amid Environmental Instability

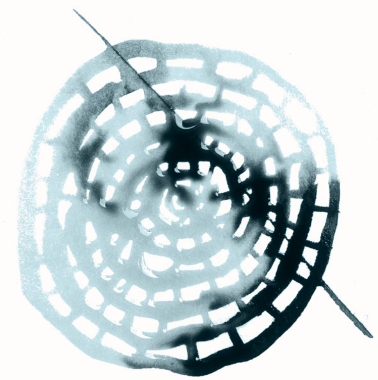
RADICAL POSSIBILITIES

The issue of ballast water maintenance can be imagined as an acupuncture point for addressing issues in many interlinked systems and multiple actors between Saldanha and the ocean. There is the potential for the naturally occurring seaweeds, *Ecklonia maxima* and *Gracilaria*, ballast water and residual transport systems to become symbiotic, as opposed to their current dysfunction.

In order to design a solution, it is necessary to explore and negotiate between many seemingly opposing forces: large and small scale industry, linear and cyclical resource use, immediate benefits and deep time ramifications. The current functioning of these systems polarises these forces and puts excessive stress on the natural environment, All of which, above and below water, are already either threatened or endangered (SANBI, 2018).The design proposes seaweed as central to the design, but which has many tangential benefits and which can help to establish symbiosis between water systems and socio-economic systems.

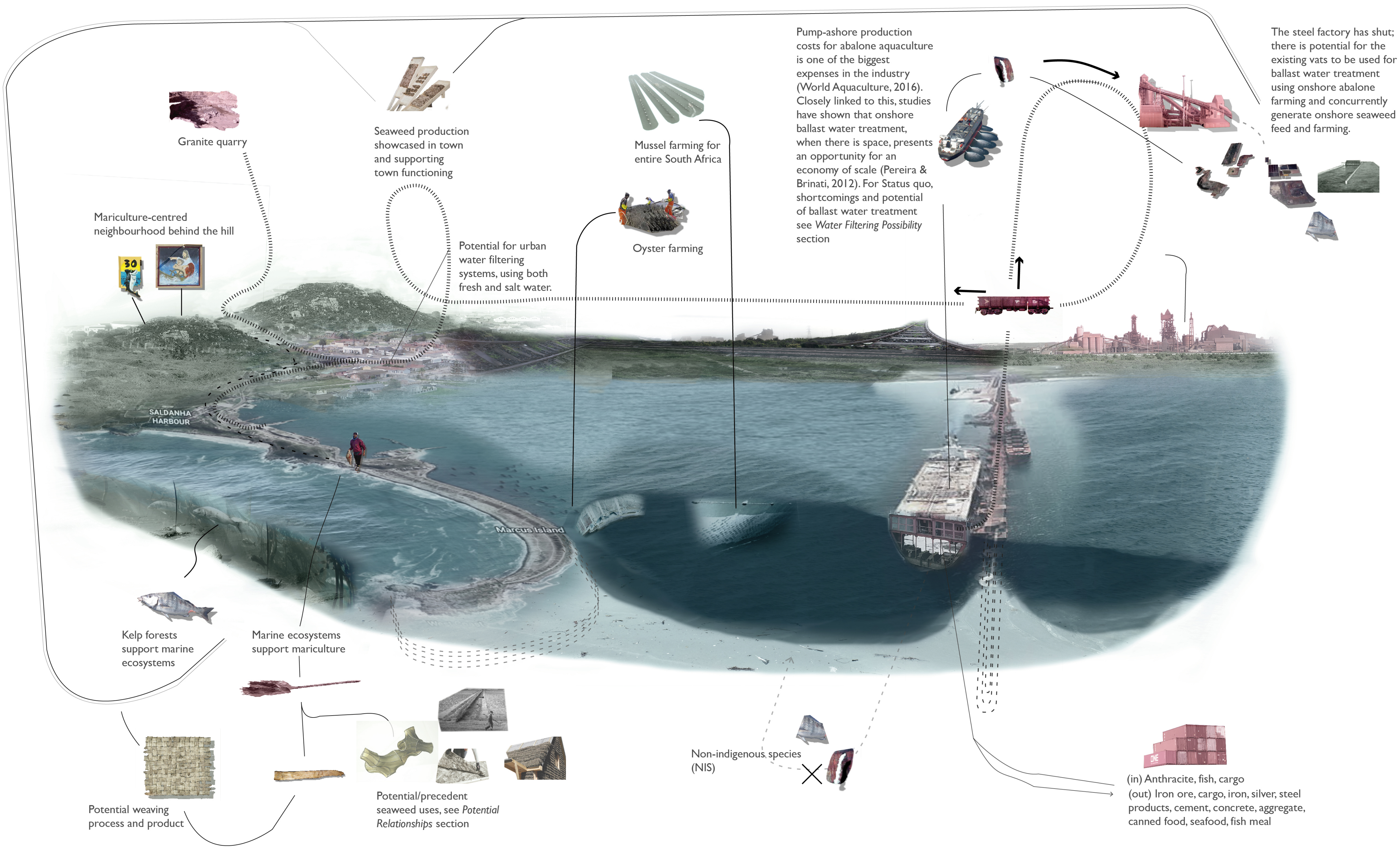
As a plant material seaweed traverses many scales and processes: existing above and below our field of view, surviving in both wet and dry environments, existing on a mass scale while also harbouring life for the smallest of ecosystems. It is an abundant resource in South Africa, specifically along the west coast, with over 593 000 tons (fresh weight) of *Ecklonia maxima* available for sustainable harvesting (Rothman, 2018; Anderson, Rand, Rothman, Share, & Bolton, 2007), while also reproducing far faster than land-based plants (Anderson, Rand, Rothman, Share, & Bolton, 2007).

This project will propose radical as well as precedented possibilities for industries that share the bay. It also suggests that through design ecological transparency and literacy can aid or prevent destruction of natural environments by over-exploitation.

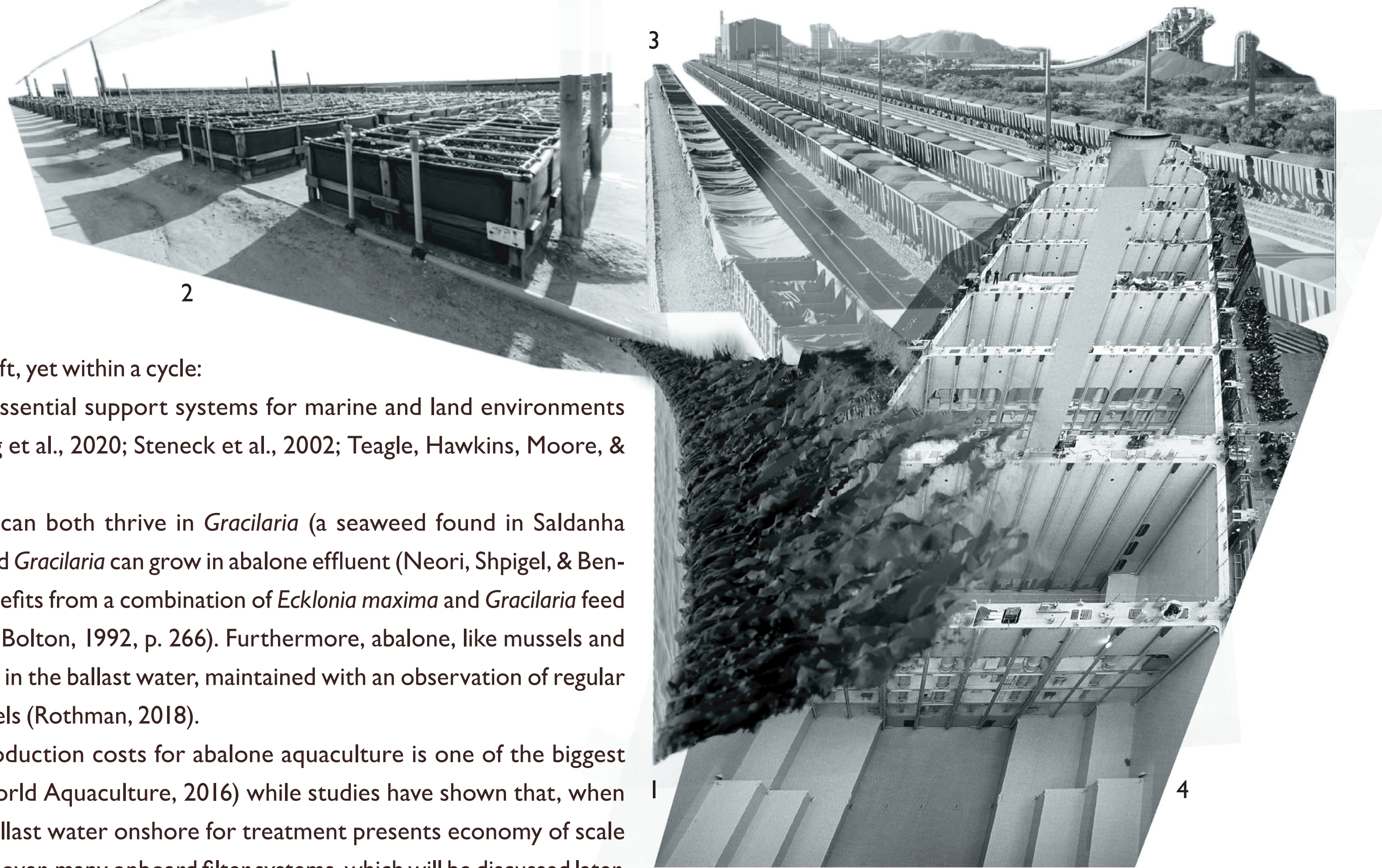


The water-based pattern and imposing ink line could be seen as opposing forces, though in many ways they are not.

RADICAL POSSIBILITIES
Land and Water Systems



POTENTIAL RELATIONSHIPS



Clockwise from bottom left, yet within a cycle:

Firstly, Kelp forests are essential support systems for marine and land environments (Blamey & Bolton, 2018; Jiang et al., 2020; Steneck et al., 2002; Teagle, Hawkins, Moore, & Smale, 2017).

Secondly, abalone farms can both thrive in *Gracilaria* (a seaweed found in Saldanha (Engledow & Bolton, 1992) and *Gracilaria* can grow in abalone effluent (Neori, Shpigel, & Ben-Ezra, 2000). Abalone also benefits from a combination of *Ecklonia maxima* and *Gracilaria* feed (Rothman, 2018; Engledow & Bolton, 1992, p. 266). Furthermore, abalone, like mussels and oysters in the bay, could grow in the ballast water, maintained with an observation of regular feed, pH and temperature levels (Rothman, 2018).

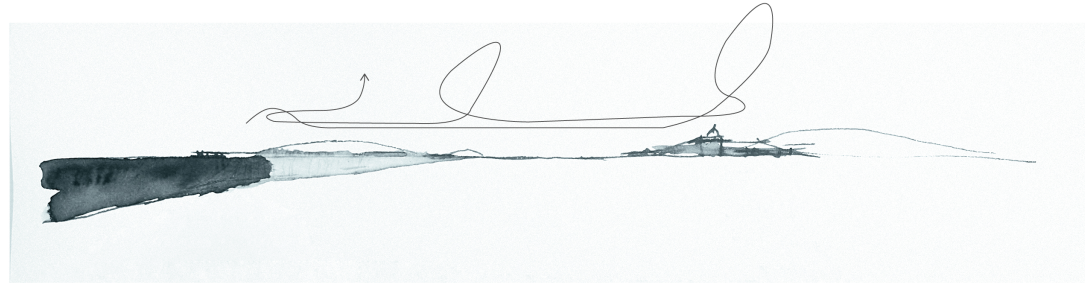
Thirdly, pump-ashore production costs for abalone aquaculture is one of the biggest expenses in the industry (World Aquaculture, 2016) while studies have shown that, when space is available, pumping ballast water onshore for treatment presents economy of scale (Pereira & Brinati, 2012). Moreover, many onboard filter systems, which will be discussed later, cannot be applied to all ships due to great limitations of space on board, available power and retrofitting capacities (Kazumi, 2007).

Lastly, sunlight and ultraviolet radiation has proved to be one of the most effective means of filtering NIS (Nosrati-Ghods, Ghadiri, & Früh, 2017), with mainstream methods of ballast water management having many shortcomings (shown in the subsequent chapter).

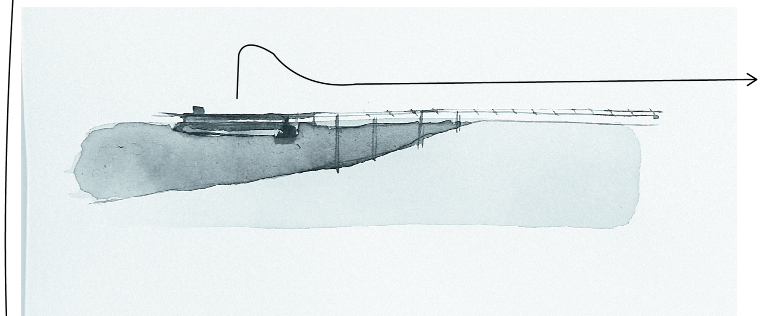
Here, there is the opportunity for abalone to grow in and treat ballast water, with the pump-ashore costs being shared between the various industries, and seaweed to be a useful by-product of the process.

WATER FILTERING POSSIBILITY
Status Quo, Shortcomings and Potential

This section will expand on the existing spectrum of ballast water treatments and how alternative treatments are needed to remediate the existing shortfalls of Ballast Water Management (BMW). The design will envision a renegotiation between multiple actors in Saldanha and the ocean.



Section AA

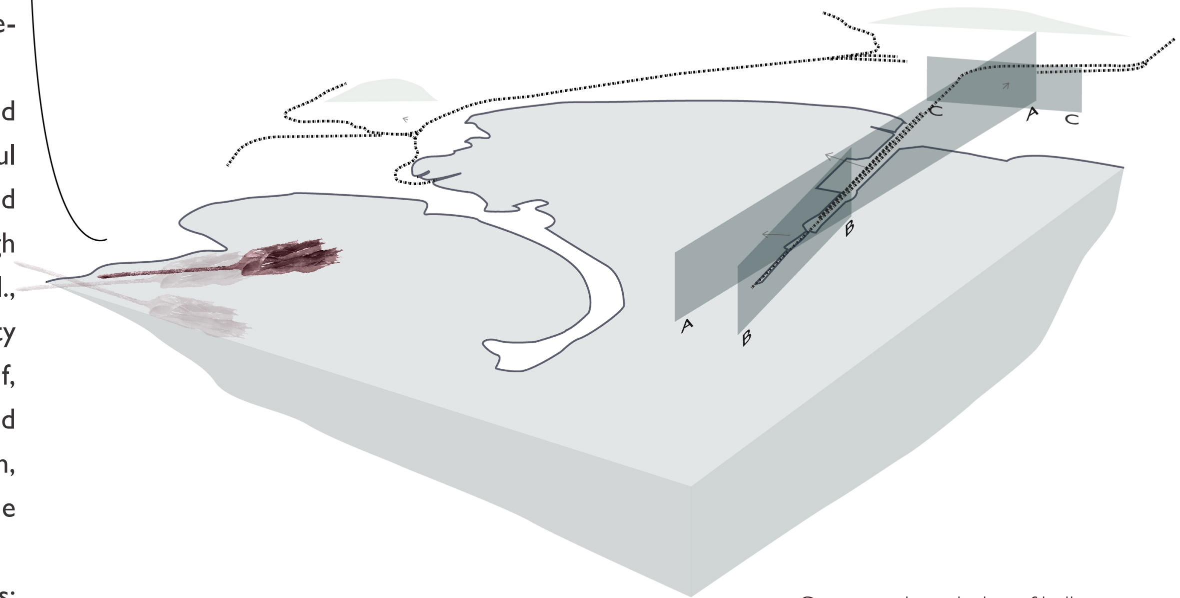


Section BB

There are 23 methods of filtering ballast water to levels required by International Maritime Organization (IMO). The main four are: mid-ocean ballast exchange, filtration, UV radiation, and separation through hydrocyclones and biocides (Pereira & Brinati, 2012), though a single BWT method usually cannot meet the requirements of the IMO in a way that is safe, effective and economical (Wu, You, Du, Chen, & Jin, 2011). Thus a combination of two or more treatment systems of ballast water is usually more practical and efficient (Pereira & Brinati, 2012, p. 4). This section will explain prominent BMW techniques and their documented shortcomings, before advocating for a means of effectively layering techniques for a site-specific remedy.

The major BWM systems fall into two categories, Ballast Water Exchange (BWE) and Ballast Water Treatment (BWT). BWE is the most common and is about 97% successful when conducted. Within this process there are three methods: "i) to discharge the tanks and subsequently refill, ii) to discharge and refill simultaneously, and iii) to release water through the bottom of ships and simultaneously pump water into the tank" (Nosrati-Ghods et al., 2017, p. 4). However, BWE's effectiveness is questioned in terms of ship operational security (Endresen, Behrens, Brynestad, Andersen, & Skjong, 2004). Put simply by Kathy Metcalf, director of maritime affairs for Chamber of Shipping of America, "because of the stability and stress factor of a ship, if you've got bad weather conditions or a certain cargo configuration, you can't do [BWE] all the time" (Christen, 1999). This means that even as a questionable interim method it is an inconsistent strategy.

The second category, ballast water treatment, is divided into three major categories: chemical, mechanical and physical (Airahuobhor, 2010). The chemical treatments generally



Conceptual rendering of ballast water treatment; water pumped, exposed to sunlight, aerated and filtered (continued on next page).

leave a toxic residue in the environment making them undesirable. For more detail regarding chemicals typically used in BWT refer to Nosrati-Ghods et al. (2017) and Cooper, Jones, Whitehead, & Zika (2007). Though for most of these the shortcomings relate to biological effectiveness and possible residual toxicity of the discharged ballast water (Wu et al., 2011). The opinion that BWT should follow precedent from the sewage and industrial waste treatment systems is widely held, yet this persistent 'residual toxicity' is often overlooked because of the allure of complete filtering. To continue this analogy, and relating it to the landscape architecture field, deadening sewage and industrial wastewater by harshly filtering is the norm, even if it is often more costly and less effective than well maintained natural wetland systems (Breaux, Farber, & Day, 1995; Ernstson & Sörlin, 2013; Department of Environmental Affairs and Development Planning, 2019). The last subsection is mechanical and physical treatment, and it is the most important for grounding the conversation in Saldanha Bay. Firstly, heating ballast water is effective in decreasing counts of zooplankton and phytoplankton, though not all organisms are filtered in this process. Secondly, ozone is widely used for water disinfection but maritime microorganisms have also shown resistance and it sometimes causes corrosion (Liltved et al., 2006; Oemcke and Hans van Leeuwen, 2005; Wu et al., 2011).

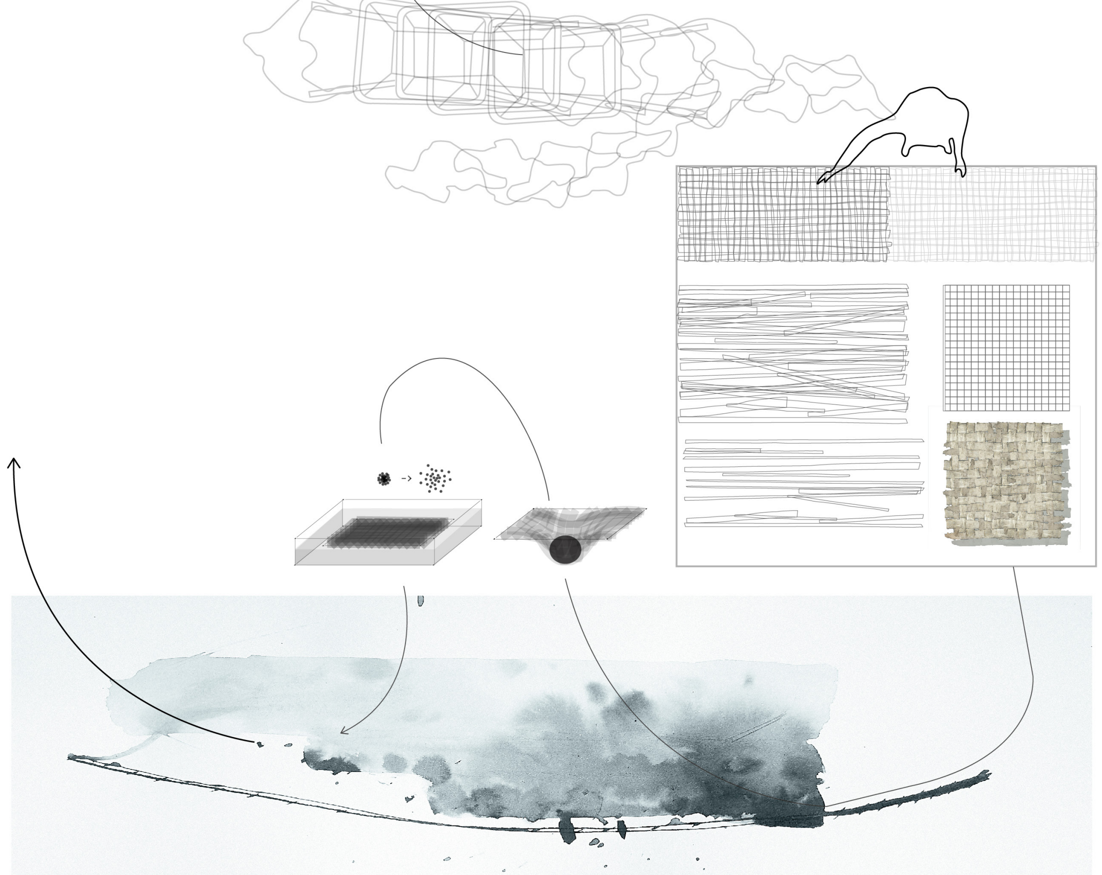
This brings us to the most natural, effective and relevant treatment method: using ultraviolet radiation. It is relevant to us because it forms the basis of this project, realising the opportunities provided by existing infrastructure and treatment effectiveness.

As ships' onboard ballast tanks have gotten larger and faster the organisms and the water are not exposed to photochemical decomposition (effectively sunlight). Exposing microorganisms to ultraviolet radiation is a practical and effective way to inactivate microorganisms and filtering ballast water (Tang et al., 2009).

However, when particles are suspended, the effectiveness of ultraviolet is diminished through the attenuation of the radiation and, for that reason, a combination of filtration and ultraviolet should be used (Perakis and Yang, 2003; Tang et al., 2009).

The proposed onshore abalone farm could provide circulation and agitation to stimulate ultraviolet exposure and ensure maximum effectiveness. Moreover, a site specific physical filtration, as Perakis and Yang (2003) have deemed necessary, could be the desalination plant at Shelly Point. Desalination, or physical filtering, is effective in removing cloudy particles, viruses, bacteria and parasites (Nasser et al., 2002; Tang et al., 2009). At Shelly point, just north of Saldanha Bay, approximately 8.2 million rands of municipal money will have been

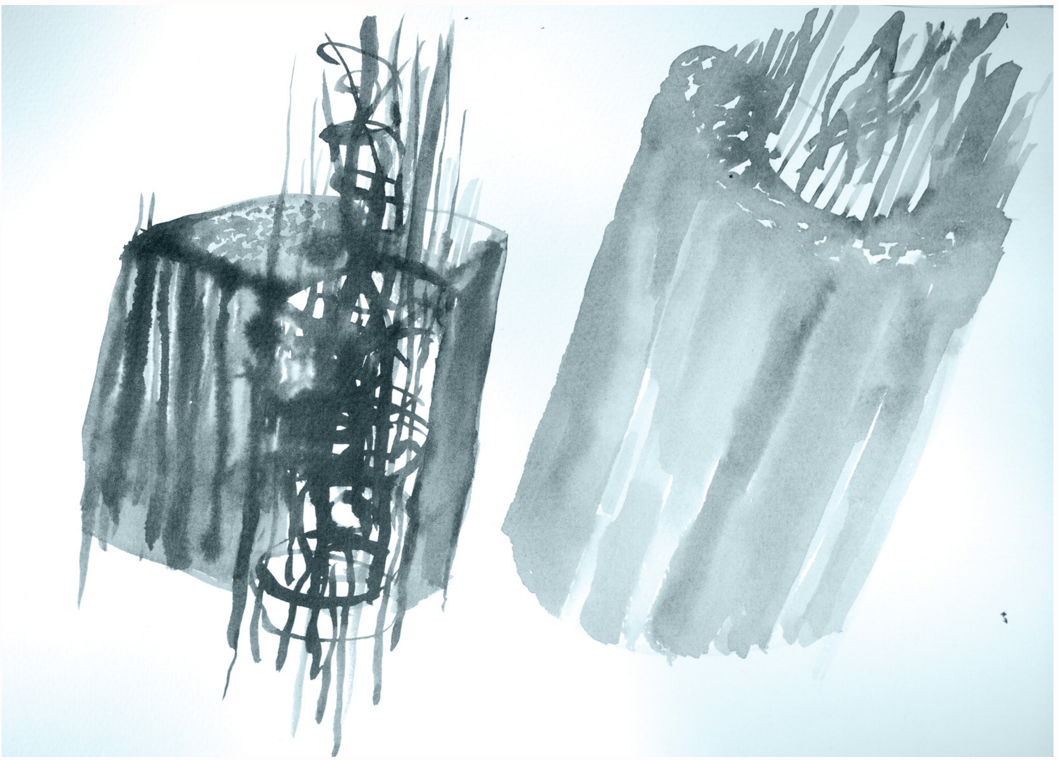
Section CC



Section CC
(conceptual detail)

spent to refurbish the desalination plant which previously supplied fresh water to Saldanha Bay (RSA National Treasury, 2020).

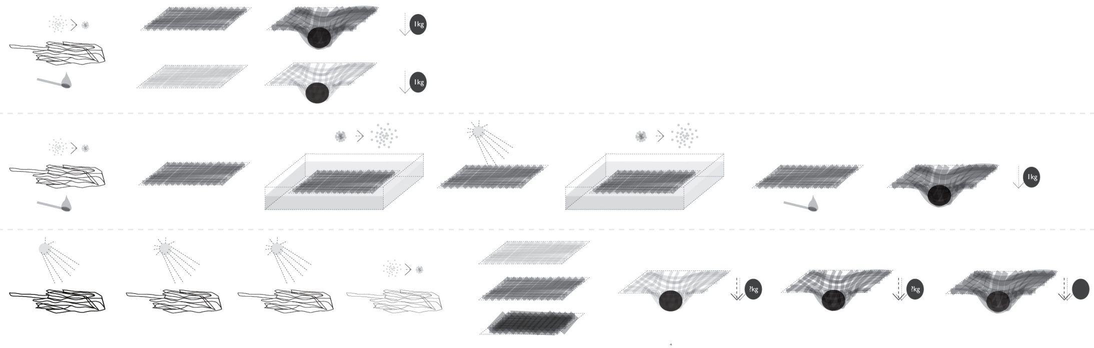
This would reflect the efficiency of multiple filtering systems advocated for by Pereira & Brinati (2012, p. 4). Providing desalinated water to a water scarce bay would also improve the metabolism of Saldanha Bay, so that the region becomes a more grounded, independent entity that is less reliant on external resources.

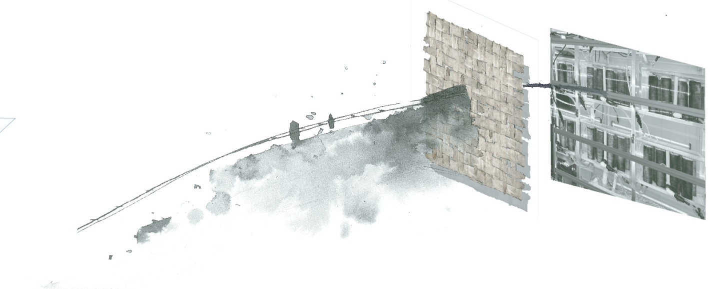


"The bulk cargo carriers entering these ports discharge almost 30 million tonnes of ballast water while receiving their cargo of coal and iron ore." (Marangoni, Pienaar, & Sym, 2001, p. 466). This water could be used for the region becomes a more grounded, independent entity that is less reliant on external resources.

MATERIAL PROPERTIES
Exploring and Appreciating Cycles

The possibility for ballast water treatment and seaweed designs (shown later) build on the dynamic properties of seaweed. The project uses this dynamism as a source of intrigue and inspiration. Maintenance (explored in *Maintenance in design*) and experimentation generate an understanding and appreciation of the various life cycles.



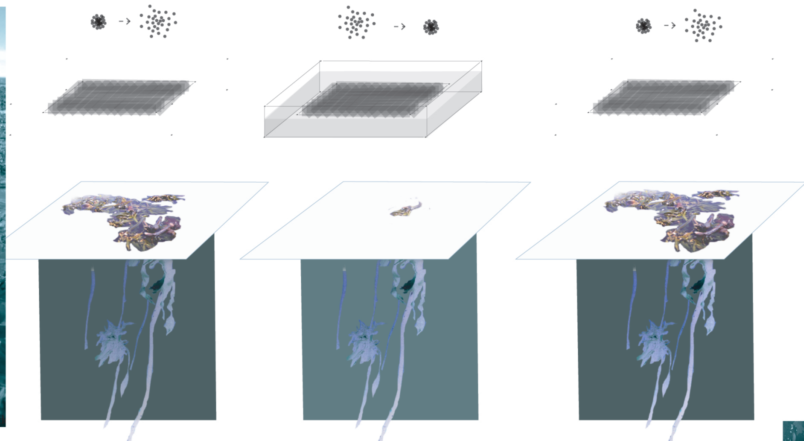


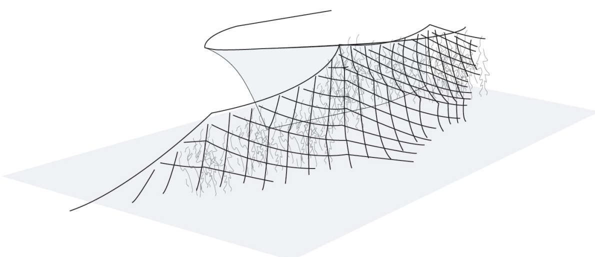
Ozone treatment and UV radiation
With and without agitation

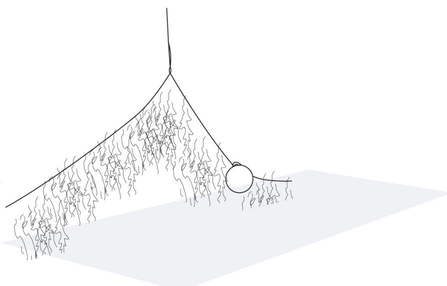
Fresh and saline water nutrient exchange

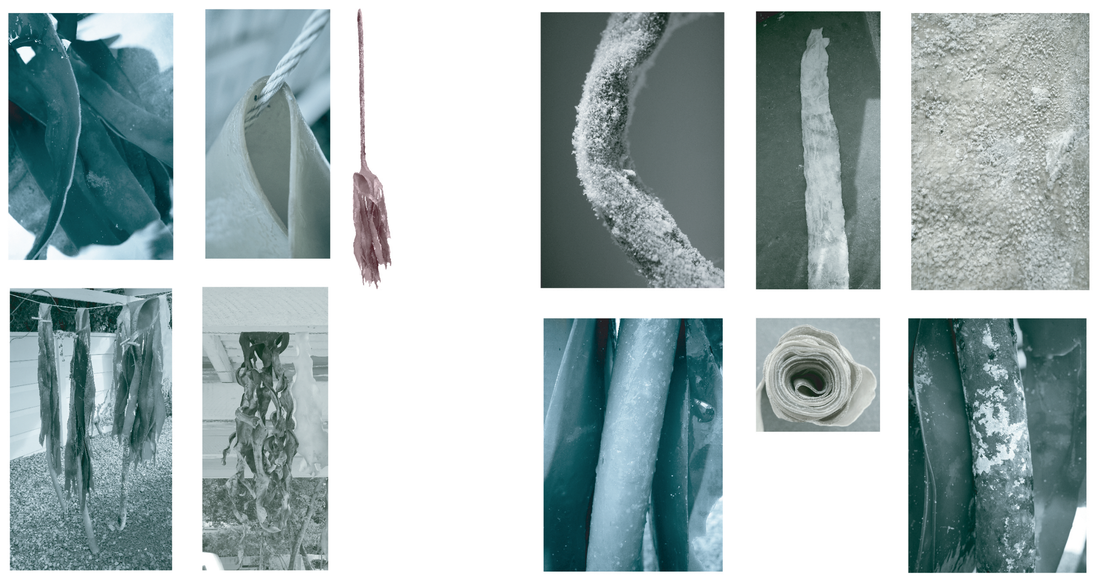
Salt as an important by-product

Image: Rothman (2018)

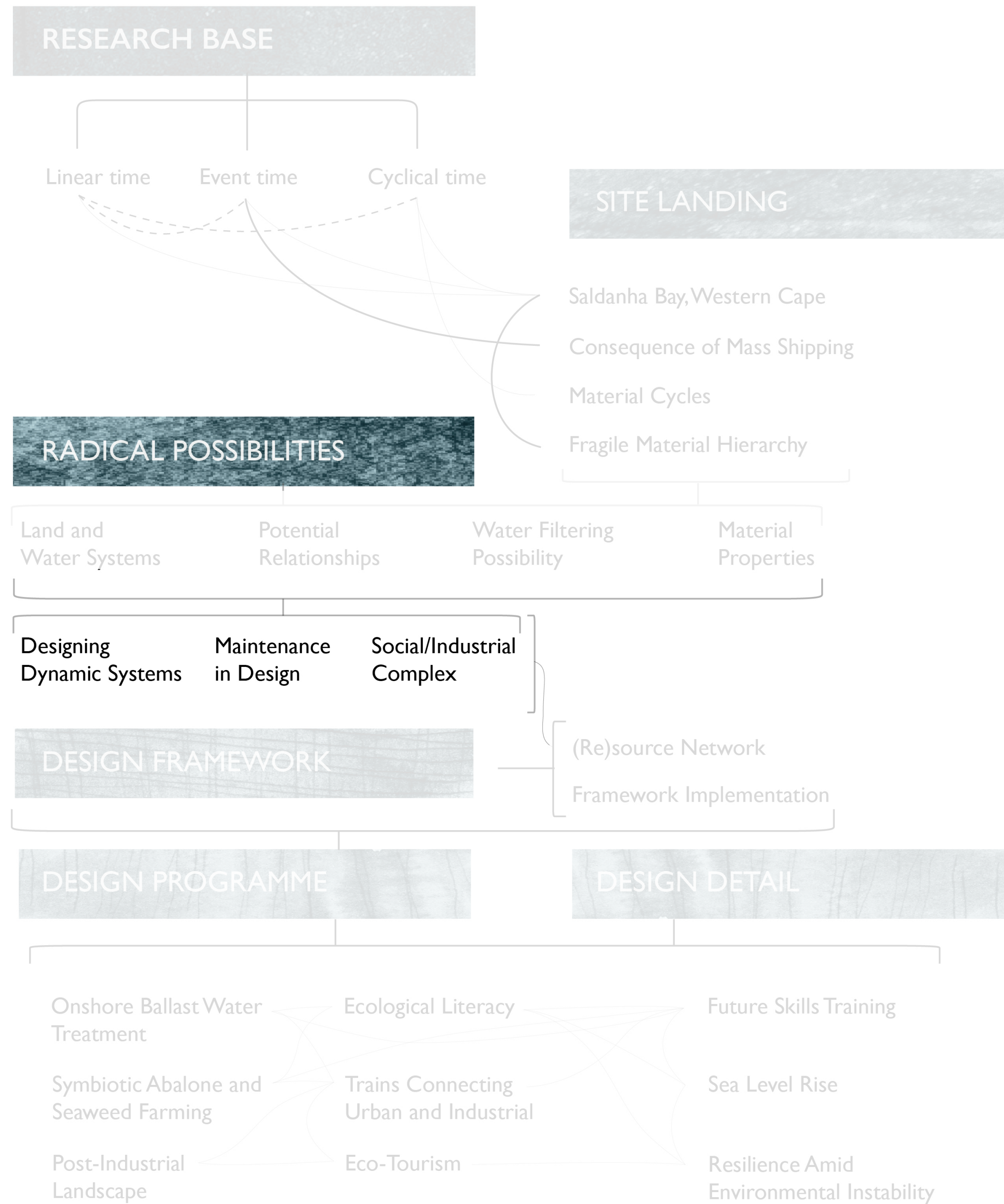








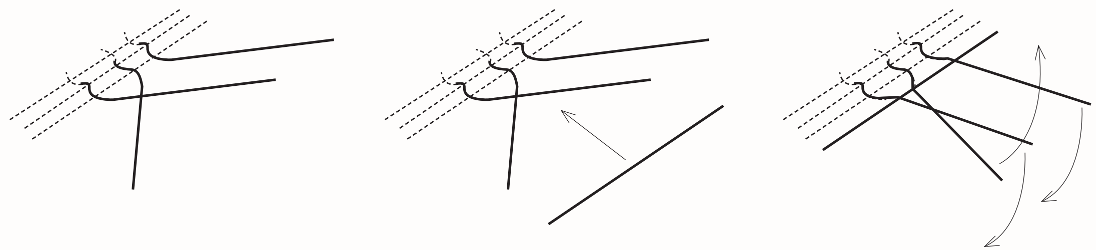
Material studies and
photographs as part of
author's own experimentation.


RESEARCH BASE
Linear time
Event time
Cyclical time
SITE LANDING
Saldanha Bay, Western Cape
Consequence of Mass Shipping
Material Cycles
Fragile Material Hierarchy
RADICAL POSSIBILITIES
Land and Water Systems
Potential Relationships
Water Filtering Possibility
Material Properties
Designing Dynamic Systems
Maintenance in Design
Social/Industrial Complex
DESIGN FRAMEWORK
(Re)source Network
Framework Implementation
DESIGN PROGRAMME
DESIGN DETAIL
Onshore Ballast Water Treatment
Symbiotic Abalone and Seaweed Farming
Post-Industrial Landscape
Ecological Literacy
Trains Connecting Urban and Industrial
Eco-Tourism
Future Skills Training
Sea Level Rise
Resilience Amid Environmental Instability

DESIGNING DYNAMIC SYSTEMS

Cycles Within Larger Systems

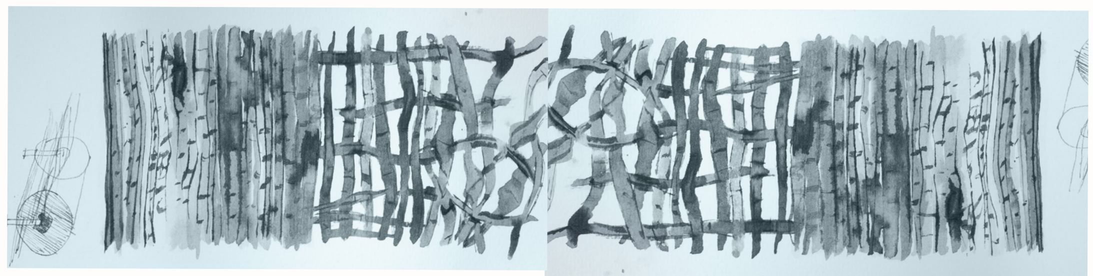
Designing for multiple cycles of growth, use and decay is essential for resilient design practice, as reflected in the flexibility and change inherent in natural systems.

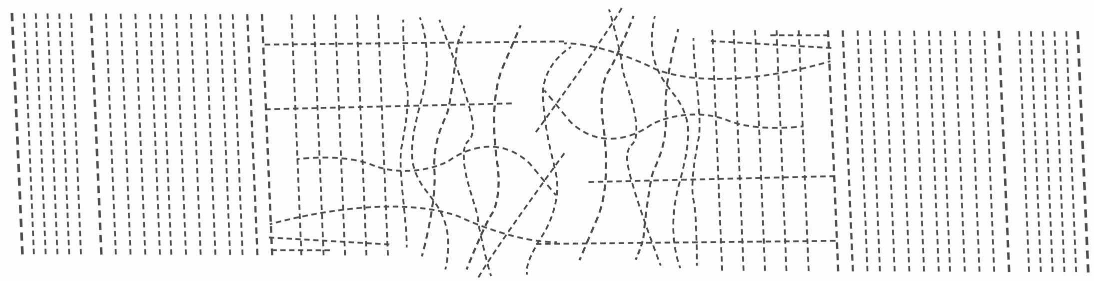


In managing non-finite materials as well as material degradation, maintenance is generally implicit and assumed in projects but not recognised (Raxworthy, 2019). Within the Landscape Architecture field, "due to the assumption of a mature plant in specifying location in plan, growth is implicit but unacknowledged in planting design" (Raxworthy, 2019, p. 326). A mature wetland plant, which can filter effluent wastewater, may remove nutrients from the water but the nutrients do not leave the system without maintenance and subsequent displacement. Raxworthy (2013) notes the role of the maintenance and the active designer in allowing growth and death to inform a site's constant restructuring. Static representations can only provide a start to designing and plans should convey principles to accommodate contingencies.

My implementation of this approach in the design proposal is also inspired by Bessie Head's fictional novel *When Rainclouds Gather* (1968), which can be read as a manual for radical design strategies during ecological crises. Similar to Raxworthy's (2013, 2019) theories this is done by acknowledging design as a part of a dynamic narrative. *When Rainclouds Gather* is a fictional story of a black South African going into self-exile in Botswana during apartheid who begins working with a farmer. The predominant and rigid farming strategy in the area is subsistence farming, whose hegemony is linked to an inheritance of oppressive colonial power structures (Bayer, 2019). During a severe drought we learn that a drought resistant grain is not grown owing to political reasons: certain minority tribes were associated with this grain and thus superior tribes would not grow or eat it (1968, 41).

Throughout the narrative Head continuously draws our attention to the "ontological flexibility" inherent in natural systems, which reminds us of the need to accept and negotiate change. The drought and grain resilience form part of the narrative of change. This perspective acknowledges that natural elements create distinct and graspable patterns in the world (ridges and watersheds form clear borders, boulders create shadows, etc.), which we are eager to use for "book knowledge", but that these are deceptively dynamic and unpredictable (Bayer, 2019; Head, 2013). Head's perspective does not suggest that nothing can be projected and that we should not design for the future, but rather draws attention to the allure and downfall of rigid design plans (Bayer, 2019).





Ontological flexibility inherent in natural systems. Bottom: a microscopic seaweed structure. Top: weaving, and the process of incorporating novel elements.

MAINTENANCE IN DESIGN

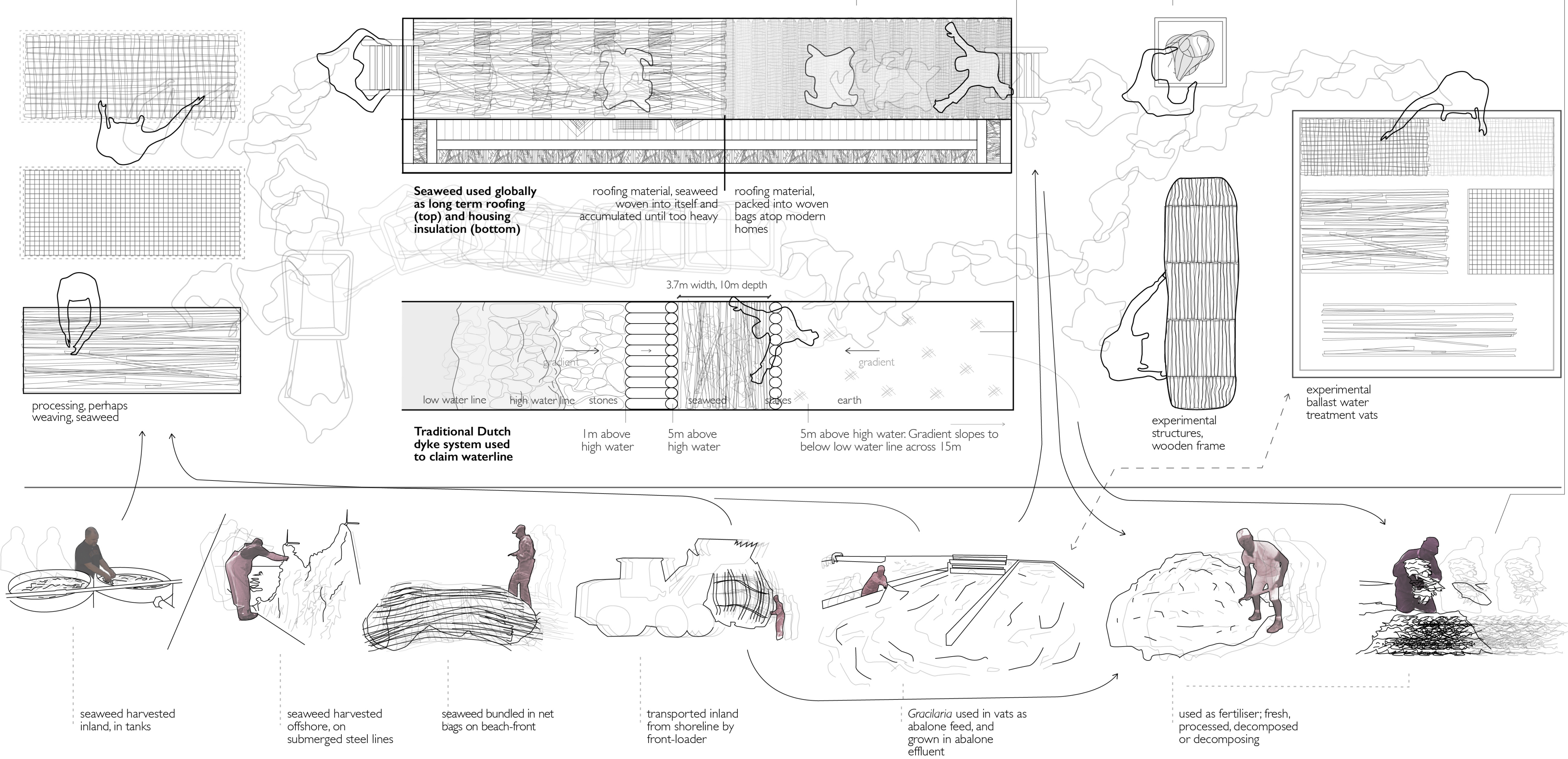
This "ontological flexibility" is inherent in water, seaweed, and all materials proposed for this project, presenting radical possibilities for harvesting, implementation and decay. Not all of these designs are at the forefront of the proposed design, but with enough time they could all ideally be realised. Resource representation style references Elao Martin's *Reimagining Kitintale's landscape through clay brick making* (2018).

Its lifespan as a harvested material is significant: seaweed eco-roofing and insulation can last 100 years or more based on it being a moisture battery, pulling water out of the air during humid periods and releasing it as the air dries (Widera, 2014); Larsen, 2019), with a fireproof quality which is significant in fire-prone South Africa (Larsen, 2019; Van Wilgen, Higgins, & Bellstedt, 1990).

For similar reasons it was effective in traditional Dutch dykes (concept and detail below: Raxworthy, 2018),

The moulded form has been used as a lightweight building material for walls and shelters, stunning translucent panels in creating spaces. (Larsen, K. 2019)

As a decayed, disposed, or even fresh material it can be used as an outstanding, organic fertiliser. This is noteworthy as the trouble with artificial fertiliser is fast becoming apparent (cf. Milledge, Nielsen, & Bailey, 2016, pp. 69-72).



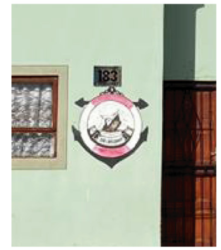
Saldanha Bay's beaches.
Clockwise from top-left: Deep-water jetty in the distance, *Glacilaria*, and sand stabilisers (Photographs author's own).

SOCIAL/INDUSTRIAL COMPLEX

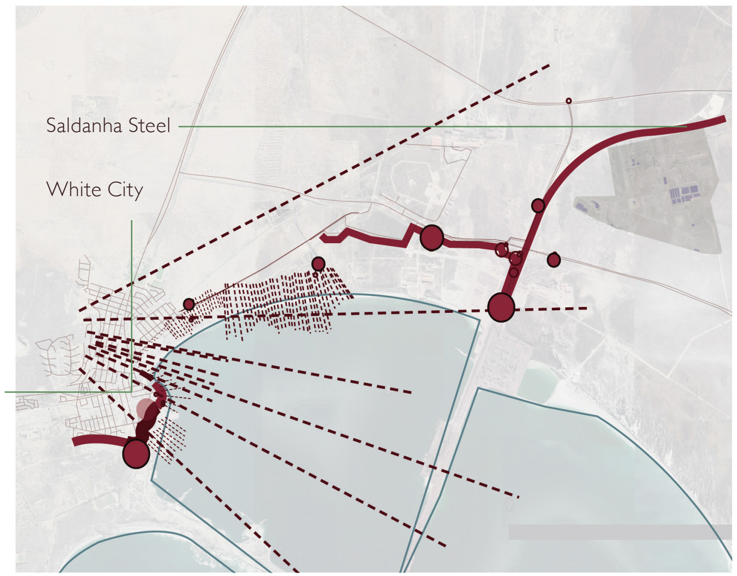
This central design is informed by the idea of industrial systems being arteries for human life in the bay, as reflected in the spatial history of the bay and currently in the proposal for widespread industrial expansion in the Saldanha Municipality Spatial Development Framework (CNdV, 2017; shown right).

It is significant in the SDF that current urban and industrial activity are grouped together, which is both shocking and cutting edge. Cutting edge because it emphasises the interconnectedness between the two systems, and perhaps also the mechanical, mass-consumptive patterns in contemporary urban life. Though the industrial processes in the bay are not as public as the urban areas; physical access to the Saldanha Steel and iron ore storage is limited, and the visual access to Saldanha Steel is contrived by a roadside lookout point.

This project suggests that a similar collaboration is urgently needed between spaces and parties in Saldanha Bay, a kind of 'landscape literacy' and 'ecological democracy', to avoid environmental and political stagnation, and generate adaptive responses to climate change (Spirn, 2019).



Positive sentiment of the ocean in White City, perhaps in spite of *Hoedjieskop* blocking views of the ocean (shown later).



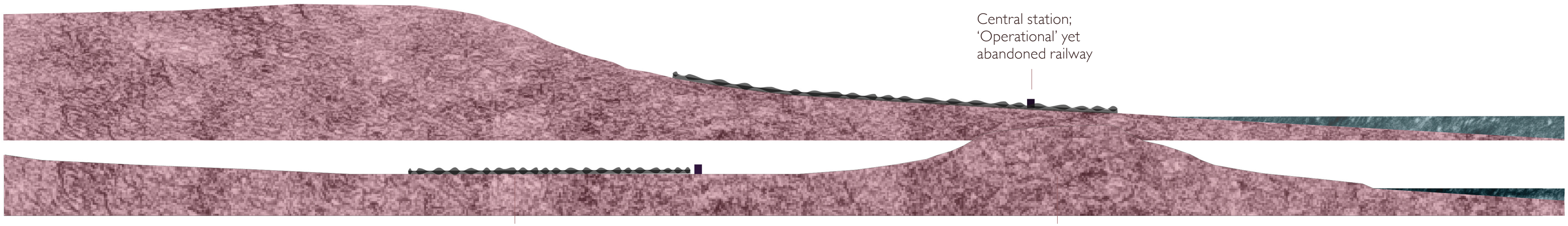
Bottom: view-lines (dashed), boundaries (solid) and controlled access (circled, intensity varies) separating people from the ocean

Top: Proposed urban and industrial expansion (yellow and purple respectively) (CNdV, 2017)

(Photographs author's own)

Elevation A: Saldanha Steel Smelter

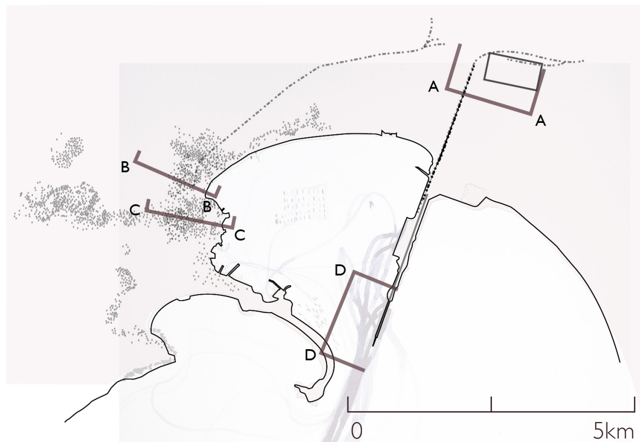
Elevation B: Central Saldanha town



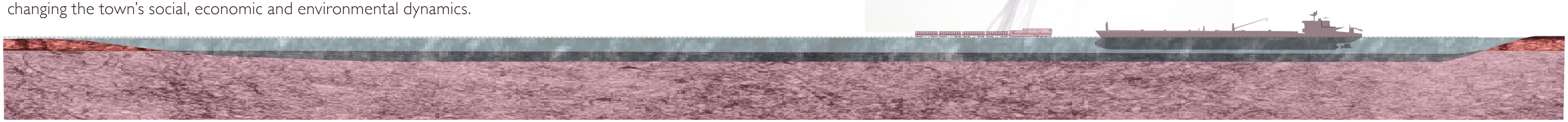
Elevation C: Cutting through Hoedjieskop

White City, alongside the abandoned railway, blocked by Hoedjieskop. There are extensive desire lines by locals on public open space alongside railway (shown later), highlighting the past and present importance of the railway.

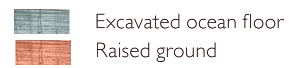
Hoedjieskop



Elevation D: Deep-water jetty ruptures bathymetry in 1967, forever changing the town's social, economic and environmental dynamics.



0 200m All elevations at same scale



SOCIAL/INDUSTRIAL COMPLEX
"We cannot have another Saldanha Steel"

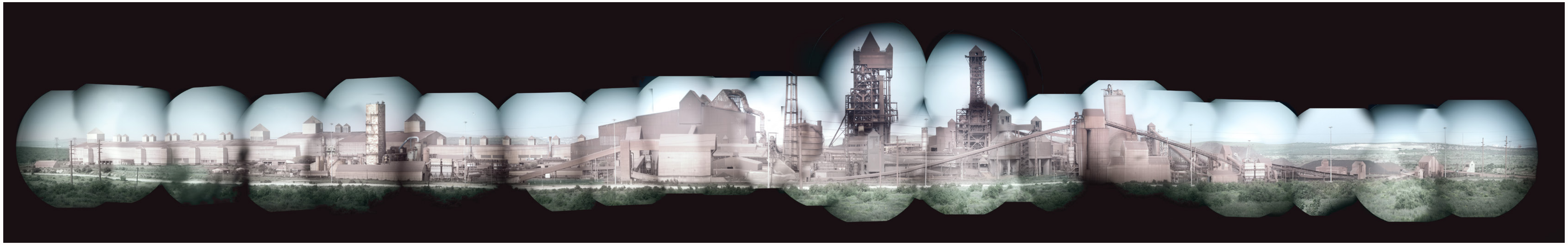
The Saldanha Steel smelter is at the heart of the space and of the design; it is close to the town and almost as large as the entire residential area, serving as a stunning cathedral in the flat landscape. It has its downfalls though: it has shut down and its future is uncertain (Wentzel, 2019; Connolly & Ponder, 2019); and it was seen to bring social inequality as well as negatively effect the environment in the bay.

Anger and frustration on a public wall in White City, an area in Saldanha Bay with a strong connection to the ocean. (Photographs author's own)

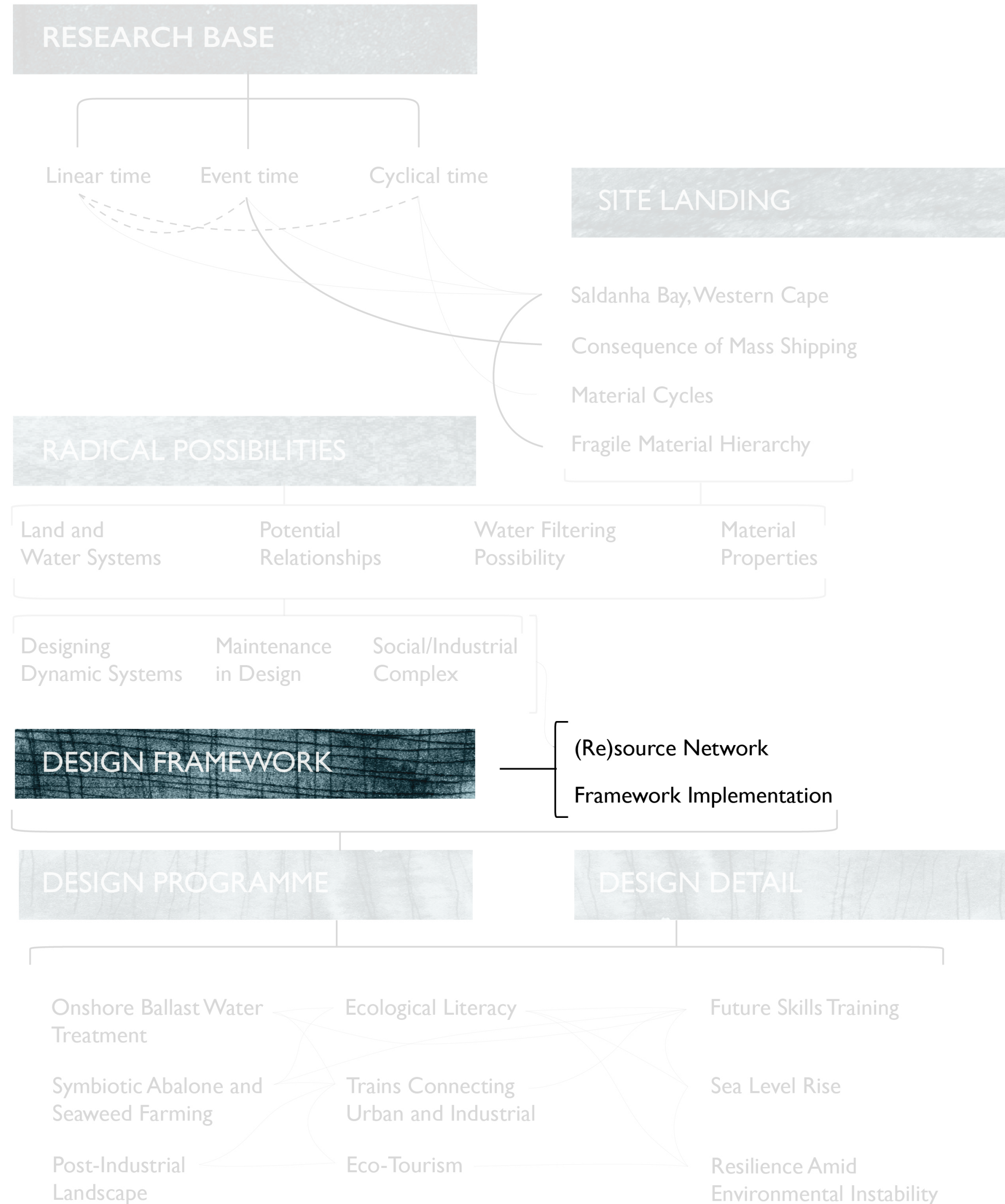
The quote below the heading was voiced by locals through interviews conducted by Denver Moses (2017, pp. 37-38). It expresses that unfulfilled job and skills creation by the factory had "not filtered down to them". This later became known as the "Saldanha Steel Effect" (Moses, 2017). To counter this programmes are being formed within the ever-expanding Saldanha Bay Industrial Development Zone, as part of the municipal SDF, to incorporate greater community consultation and skills development (Moses, 2017). Subsequent to Moses' study the factory has shut due to the competitive international market, linked to "raw material costs and regulated prices", meaning "an estimated 900 workers will be left jobless by the end of the first quarter of 2020" (Ponder & Connolly, 2019).

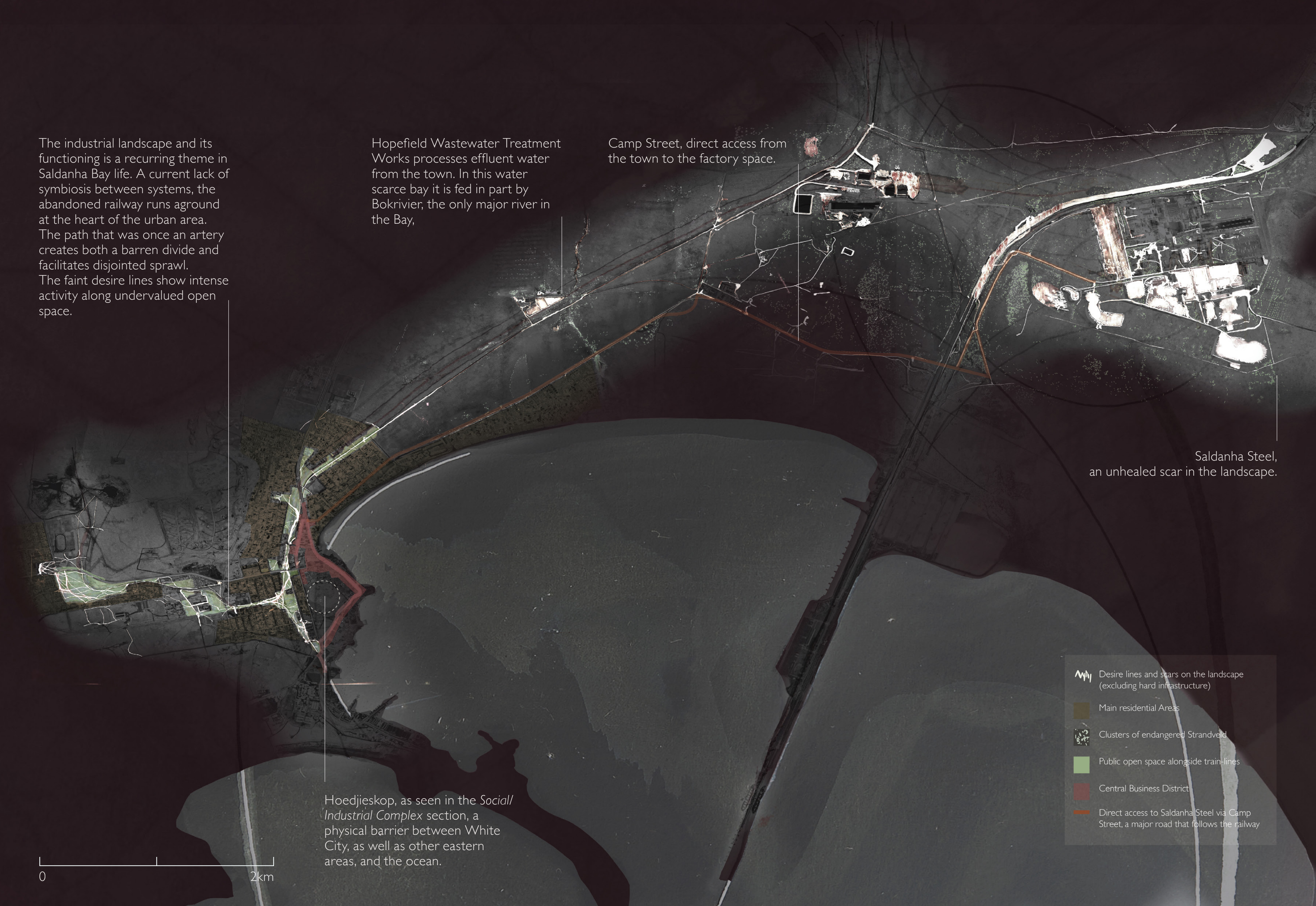
Concurrently the industrial processes have been detrimental to the bay's ecosystems. This has serious ramifications for the healthy functioning of the marine life upon which many people have otherwise relied on for their livelihoods. Among other mariculture industries, there are historically prominent fishing industries, both small and large scale, that function in the bay (as expressed in the wall paintings seen earlier). Adding to this "blue economy", tourism, which also relies on the health of the ecosystem, is one of the top four industries for the regional economy, alongside harbour-related industries, fishing and (previously) steel manufacturing (Welman & Ferreira, 2016, p. 220).

As a most dysfunctional and leaving the largest gash on the landscape, this dissertation focuses on the steel factory; remedying its toxic residue, abundant space and grand legacy. The design bears human life and human scale in mind, ensuring that the suggested framework is just as beneficial for local residents as it is for the rehabilitation of the ecosystem in the bay. Re-imagining the factory becomes the "acupuncture point" or nucleus from which multiple other systems are healed or repaired.



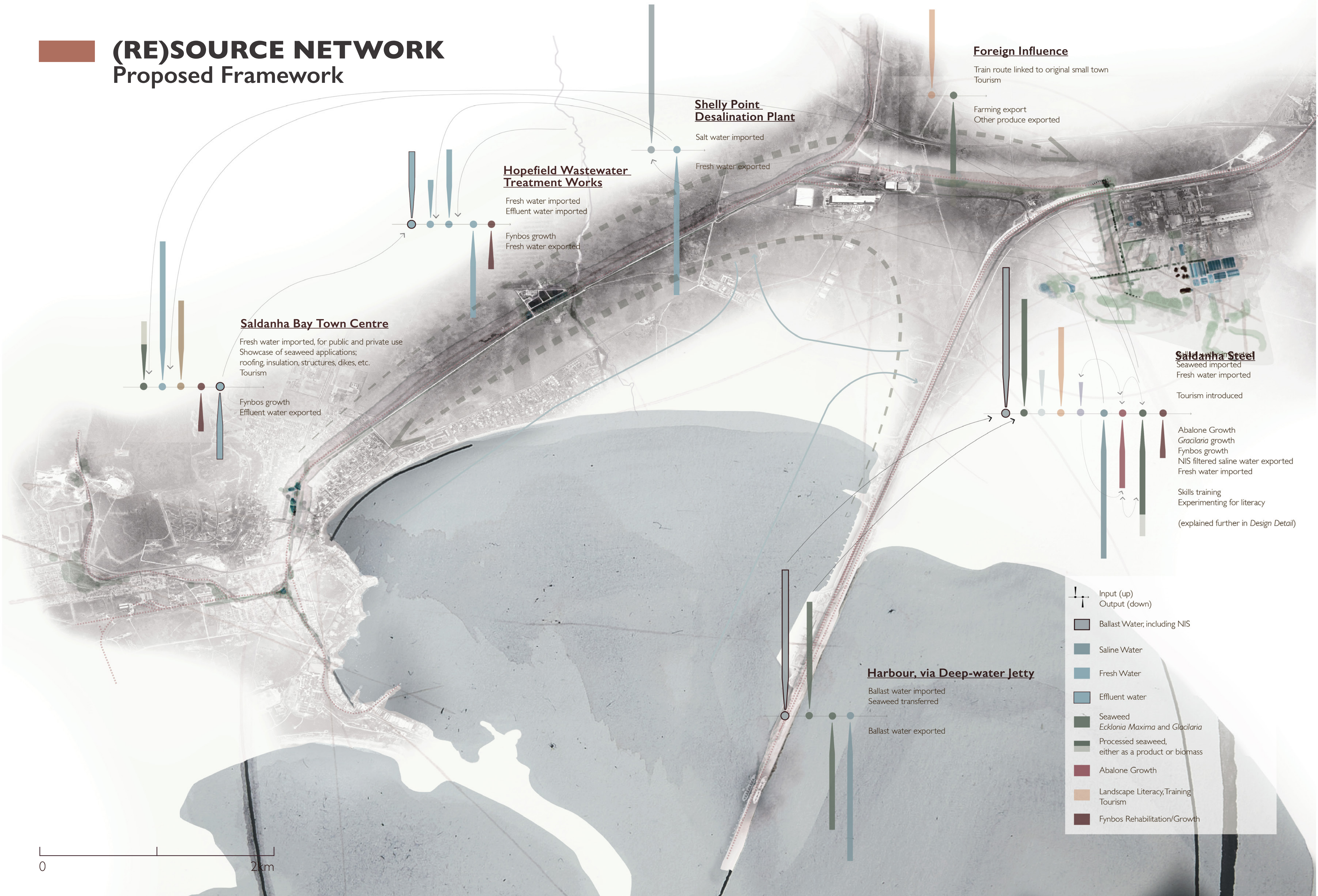
At 110m tall it *penetrates* the sky and the ground. It was designed by Hannes Meiring in 1998 to look like a medieval mountaintop village (Ponder & Connolly, 2019).

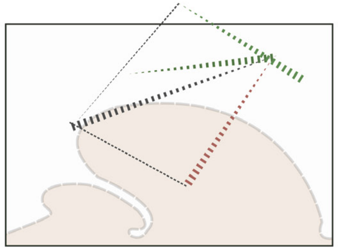

RESEARCH BASE
Linear time
Event time
Cyclical time
SITE LANDING
Saldanha Bay, Western Cape
Consequence of Mass Shipping
Material Cycles
Fragile Material Hierarchy
RADICAL POSSIBILITIES
Land and Water Systems
Potential Relationships
Water Filtering Possibility
Material Properties
Designing Dynamic Systems
Maintenance in Design
Social/Industrial Complex
DESIGN FRAMEWORK
(Re)source Network
Framework Implementation
DESIGN PROGRAMME
DESIGN DETAIL
Onshore Ballast Water Treatment
Symbiotic Abalone and Seaweed Farming
Post-Industrial Landscape
Ecological Literacy
Trains Connecting Urban and Industrial
Eco-Tourism
Future Skills Training
Sea Level Rise
Resilience Amid Environmental Instability



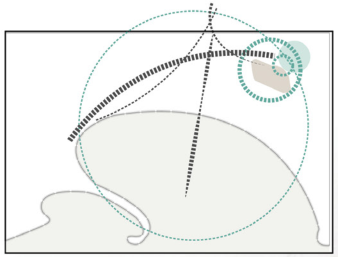
The industrial landscape and its functioning is a recurring theme in Saldanha Bay life. A current lack of symbiosis between systems, the abandoned railway runs aground at the heart of the urban area. The path that was once an artery creates both a barren divide and facilitates disjointed sprawl. The faint desire lines show intense activity along undervalued open space.
Hopefield Wastewater Treatment Works processes effluent water from the town. In this water scarce bay it is fed in part by Bokrivier, the only major river in the Bay,
Camp Street, direct access from the town to the factory space.
Saldanha Steel, an unhealed scar in the landscape.
Hoedjieskop, as seen in the *Social/ Industrial Complex* section, a physical barrier between White City, as well as other eastern areas, and the ocean.
Desire lines and scars on the landscape (excluding hard infrastructure)
Main residential Areas
Clusters of endangered Strandveld
Public open space alongside train-lines
Central Business District
Direct access to Saldanha Steel via Camp Street, a major road that follows the railway
0
2km

(RE)SOURCE NETWORK
Proposed Framework

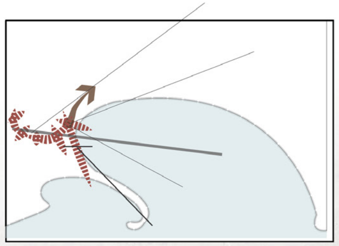




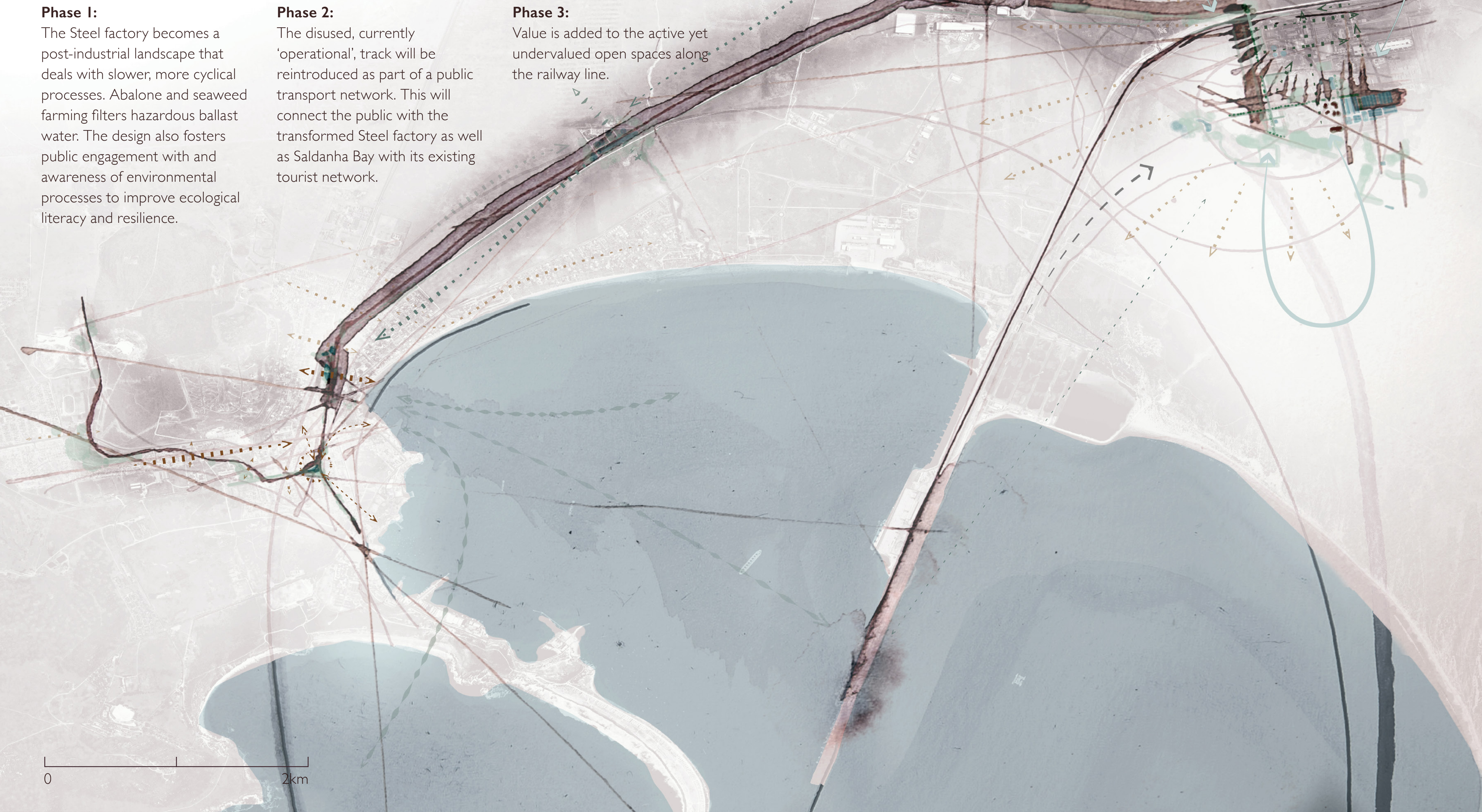
Phase 1:
The Steel factory becomes a post-industrial landscape that deals with slower, more cyclical processes. Abalone and seaweed farming filters hazardous ballast water. The design also fosters public engagement with and awareness of environmental processes to improve ecological literacy and resilience.



Phase 2:
The disused, currently 'operational', track will be reintroduced as part of a public transport network. This will connect the public with the transformed Steel factory as well as Saldanha Bay with its existing tourist network.

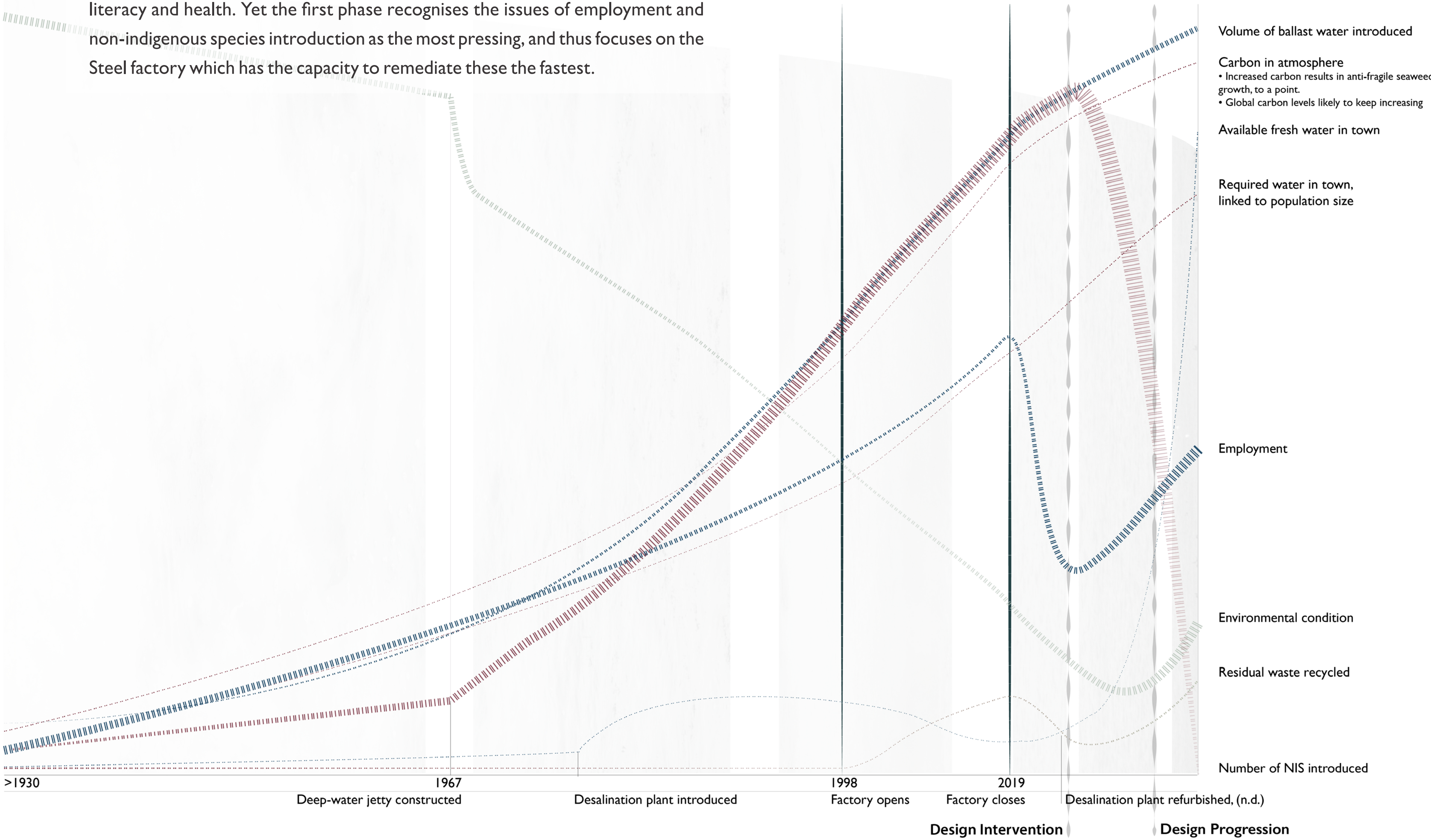


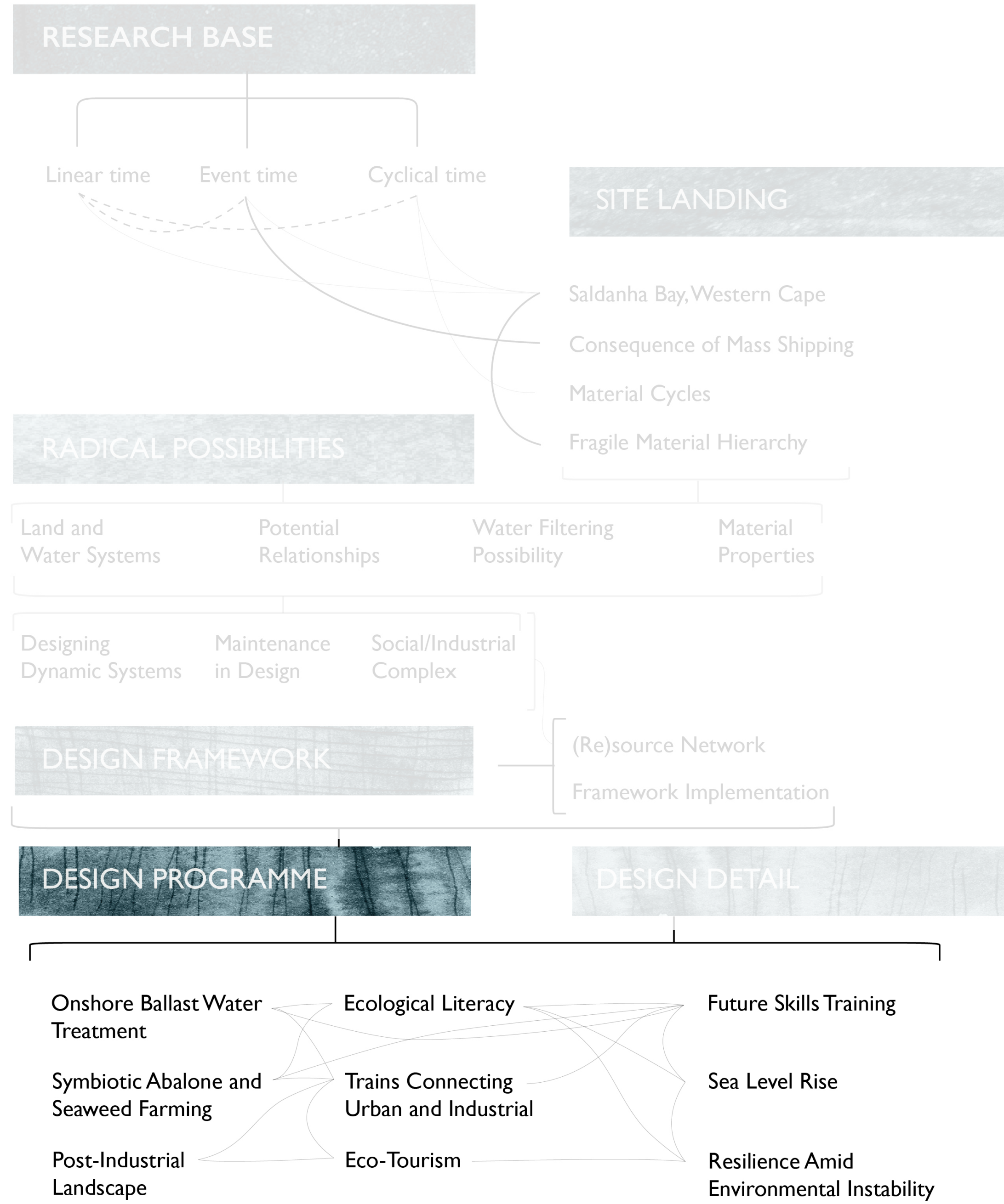
Phase 3:
Value is added to the active yet undervalued open spaces along the railway line.



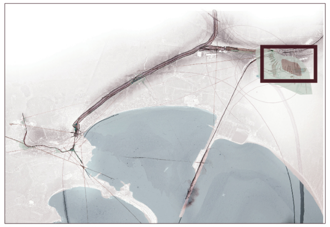
DESIGN IMPLEMENTATION
Emphasis on Factory Rejuvenation

A system-wide reconfiguration is required for broader ecological transparency, literacy and health. Yet the first phase recognises the issues of employment and non-indigenous species introduction as the most pressing, and thus focuses on the Steel factory which has the capacity to remediate these the fastest.

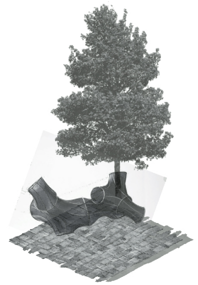



RESEARCH BASE
Linear time
Event time
Cyclical time
SITE LANDING
Saldanha Bay, Western Cape
Consequence of Mass Shipping
Material Cycles
Fragile Material Hierarchy
RADICAL POSSIBILITIES
Land and Water Systems
Potential Relationships
Water Filtering Possibility
Material Properties
Designing Dynamic Systems
Maintenance in Design
Social/Industrial Complex
DESIGN FRAMEWORK
(Re)source Network
Framework Implementation
DESIGN PROGRAMME
DESIGN DETAIL
Onshore Ballast Water Treatment
Ecological Literacy
Future Skills Training
Symbiotic Abalone and Seaweed Farming
Trains Connecting Urban and Industrial
Sea Level Rise
Post-Industrial Landscape
Eco-Tourism
Resilience Amid Environmental Instability

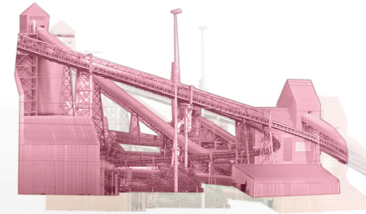
FACTORY PROGRAMME
An Overview

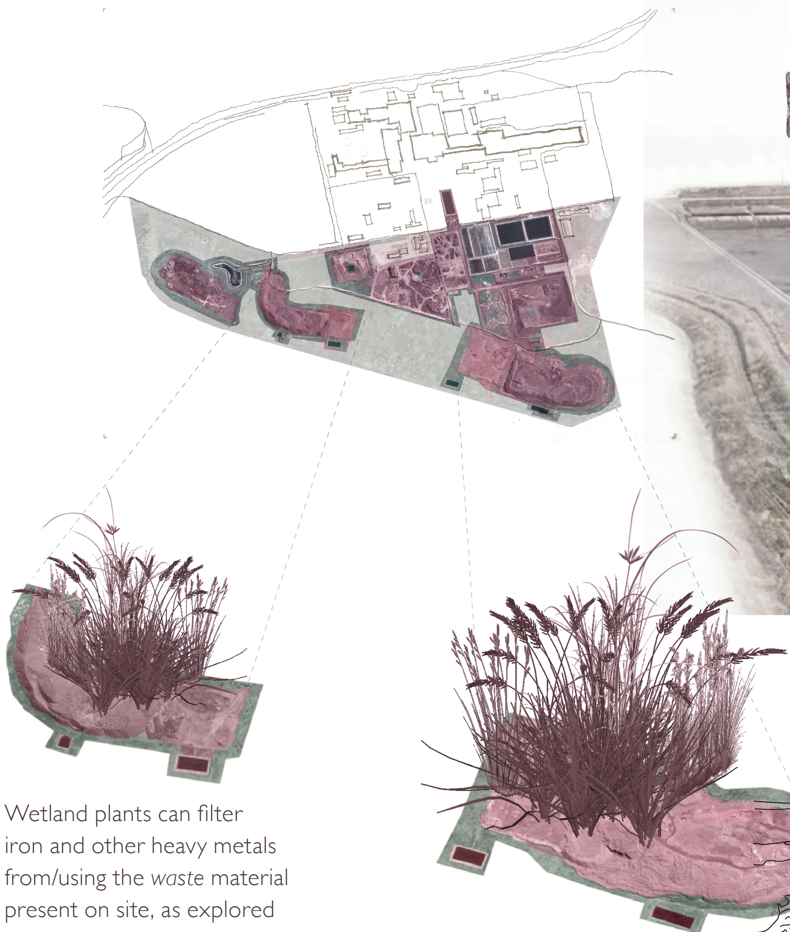


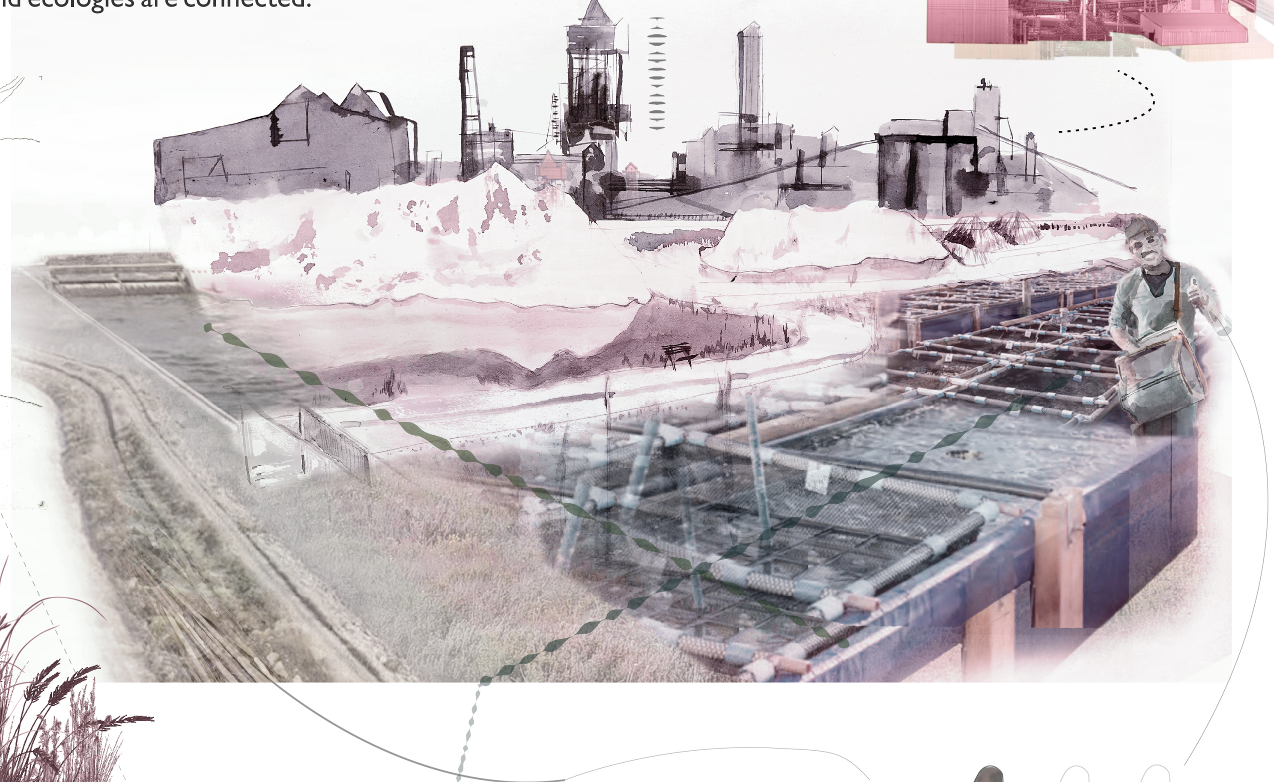
Within the proposed factory redesign existing structures, infrastructure and residual material are incorporated. This builds on the idea of reusing resources to further explore how industries, by-products and ecologies are connected.

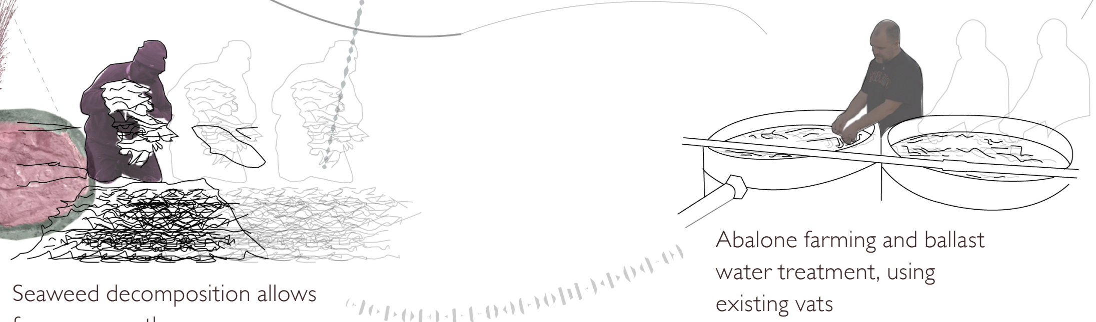


New growth can reflect farming character of greater Saldanha area, and provide new skills development









Wetland plants can filter iron and other heavy metals from/using the *waste* material present on site, as explored throughout the *design programme* and *design detail.*

Seaweed decomposition allows for new growth.

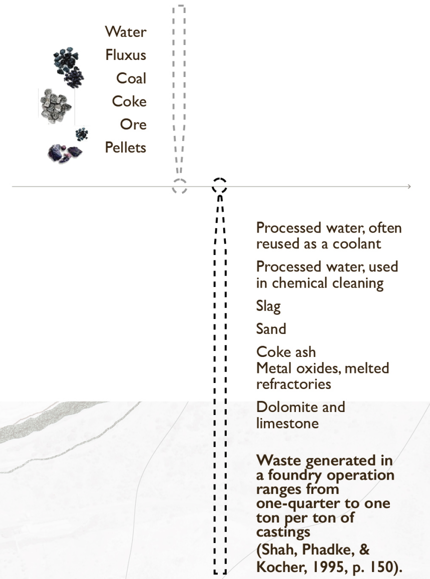
Abalone farming and ballast water treatment, using existing vats (expanded on later).

RESIDUAL POTENTIAL
Layered Informants

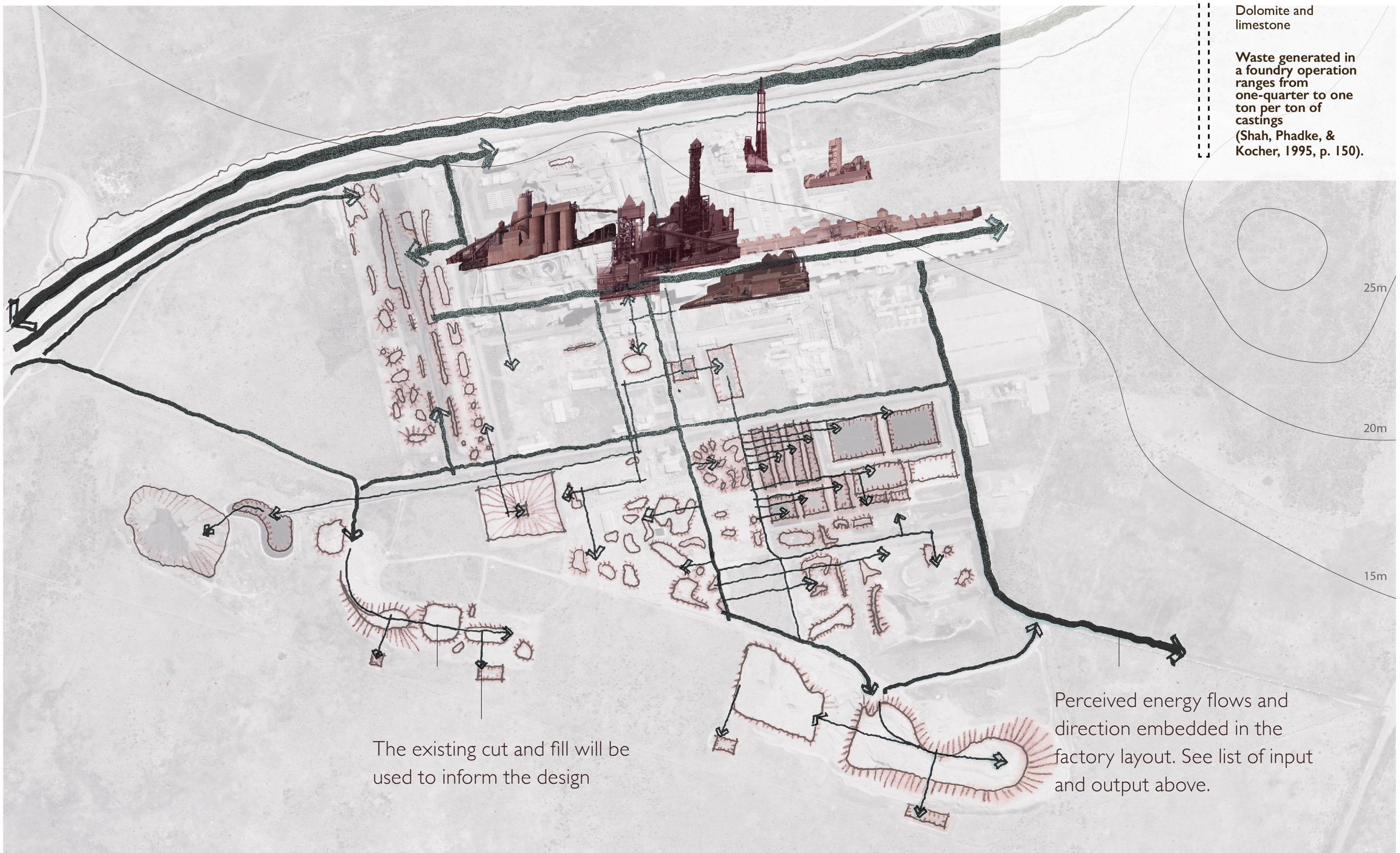
EXISTING RESIDUE

Informants and Opportunities for Phase 1

The steel smelter has generated a lot of residual waste material that requires remediation, and this too can provide rejuvenated life to benefit the community. The site of waste and treatment can be the site of new and healthy growth for this site, the surrounding ecosystems, and the community.

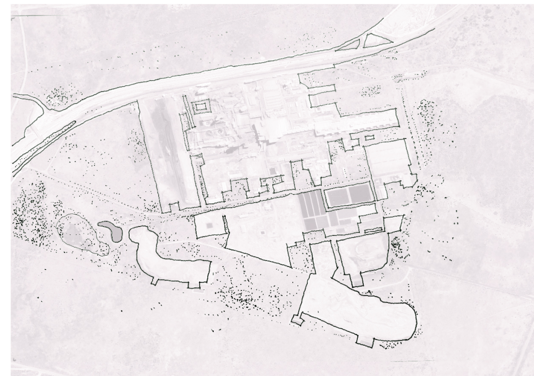


Input/output of steel smelting informing existing residue within the factory. The cut and fill imagery spatialises this data. Currently both the processing ability and waste material have been abandoned.



The existing cut and fill will be used to inform the design

Perceived energy flows and direction embedded in the factory layout. See list of input and output above.

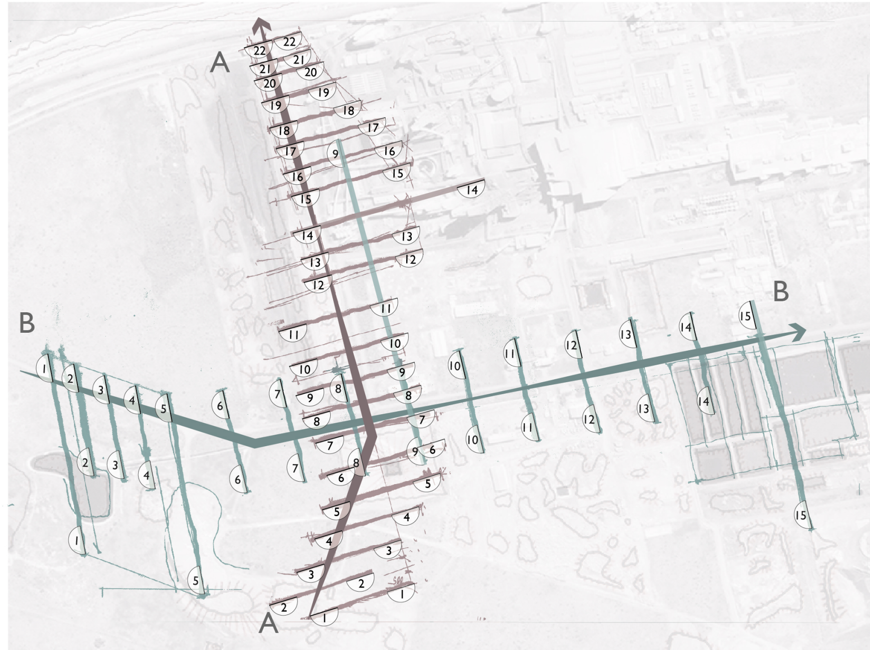


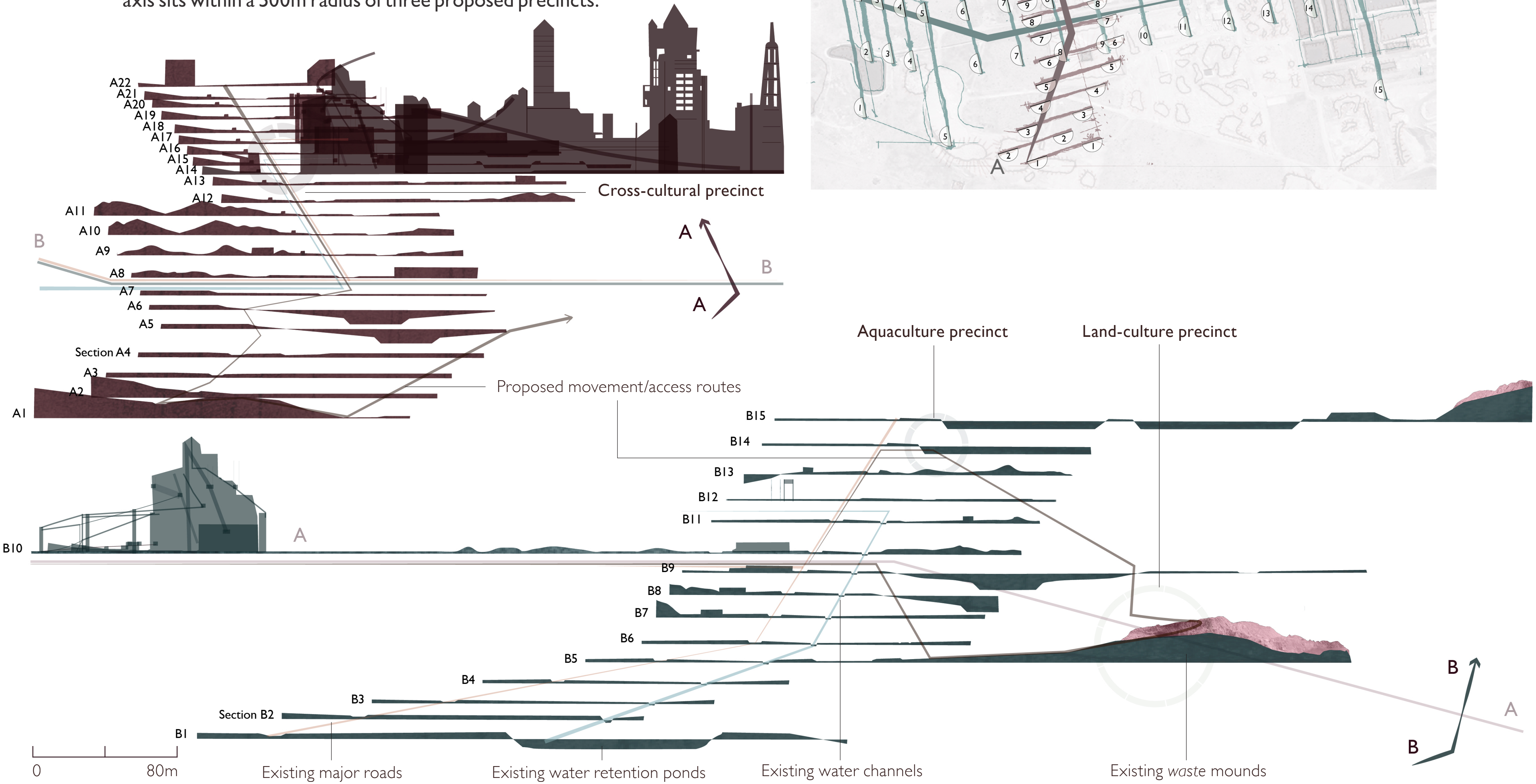
Hardened, softened, cut, scarred spaces; and natural areas

Aerial imagery highlighting divide between hardened areas (drawn) as *productive* space and *waste* areas (imagery) as abandoned space.

REPEATED CYCLE OF ACTIONS
Existing Infrastructure and Design

These sections imagine spatial snapshots of someone traversing the landscape. The two routes lie on existing major roads that create perceived divides in the space, which the overall design seeks to remediate. Route A explores the existing divide between the factory (north) and *waste* (south). Route B explores access by the community (west) and proposed employment at the aquaculture vats (east). The axis sits within a 500m radius of three proposed precincts.



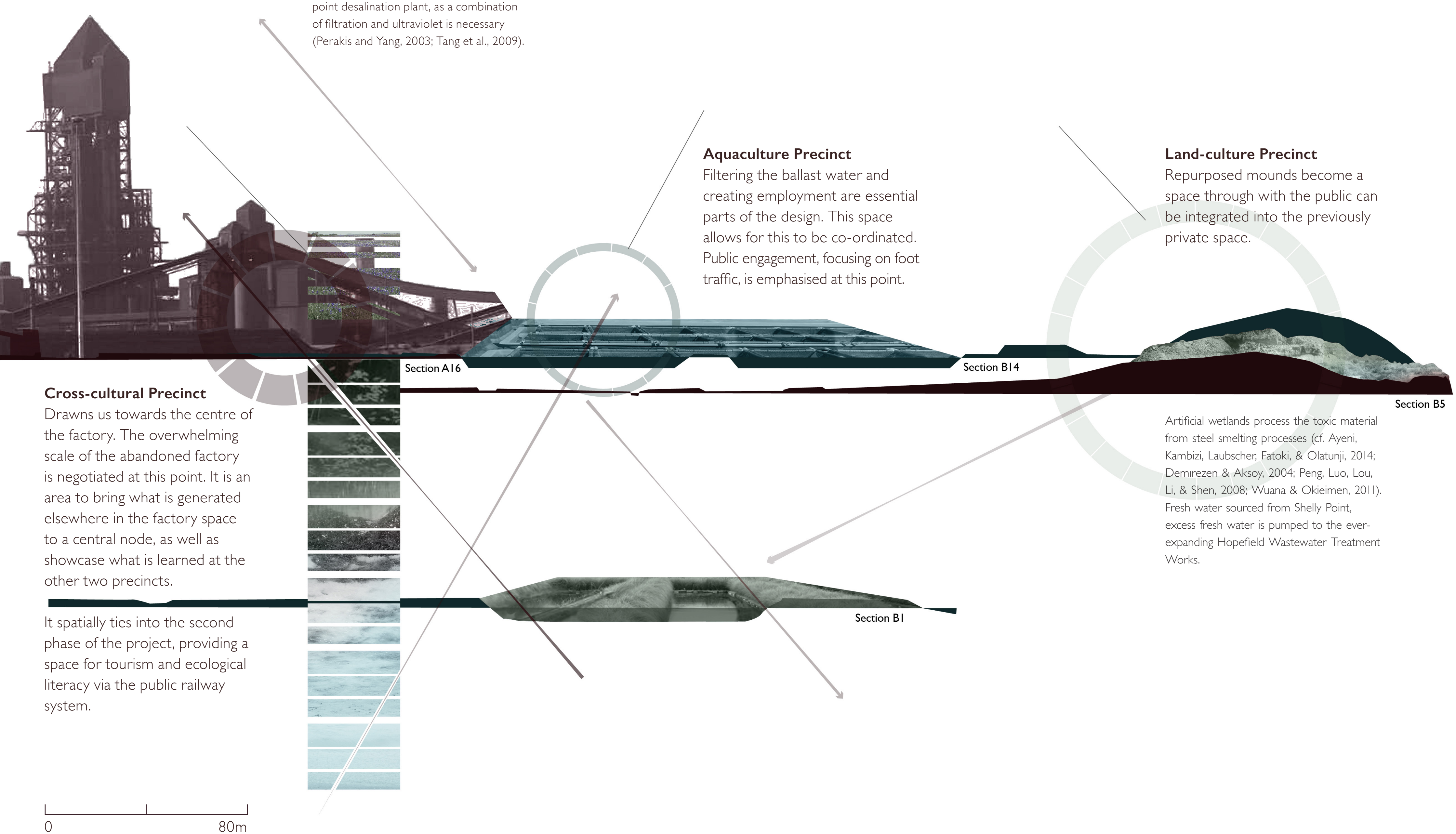


INTRODUCING THE PRECINCTS
Aquaculture, Land-culture and Cross-cultural Precincts

Ballast water further treated at Shelly point desalination plant, as a combination of filtration and ultraviolet is necessary (Perakis and Yang, 2003; Tang et al., 2009).

Aquaculture Precinct
Filtering the ballast water and creating employment are essential parts of the design. This space allows for this to be co-ordinated. Public engagement, focusing on foot traffic, is emphasised at this point.

Land-culture Precinct
Repurposed mounds become a space through with the public can be integrated into the previously private space.



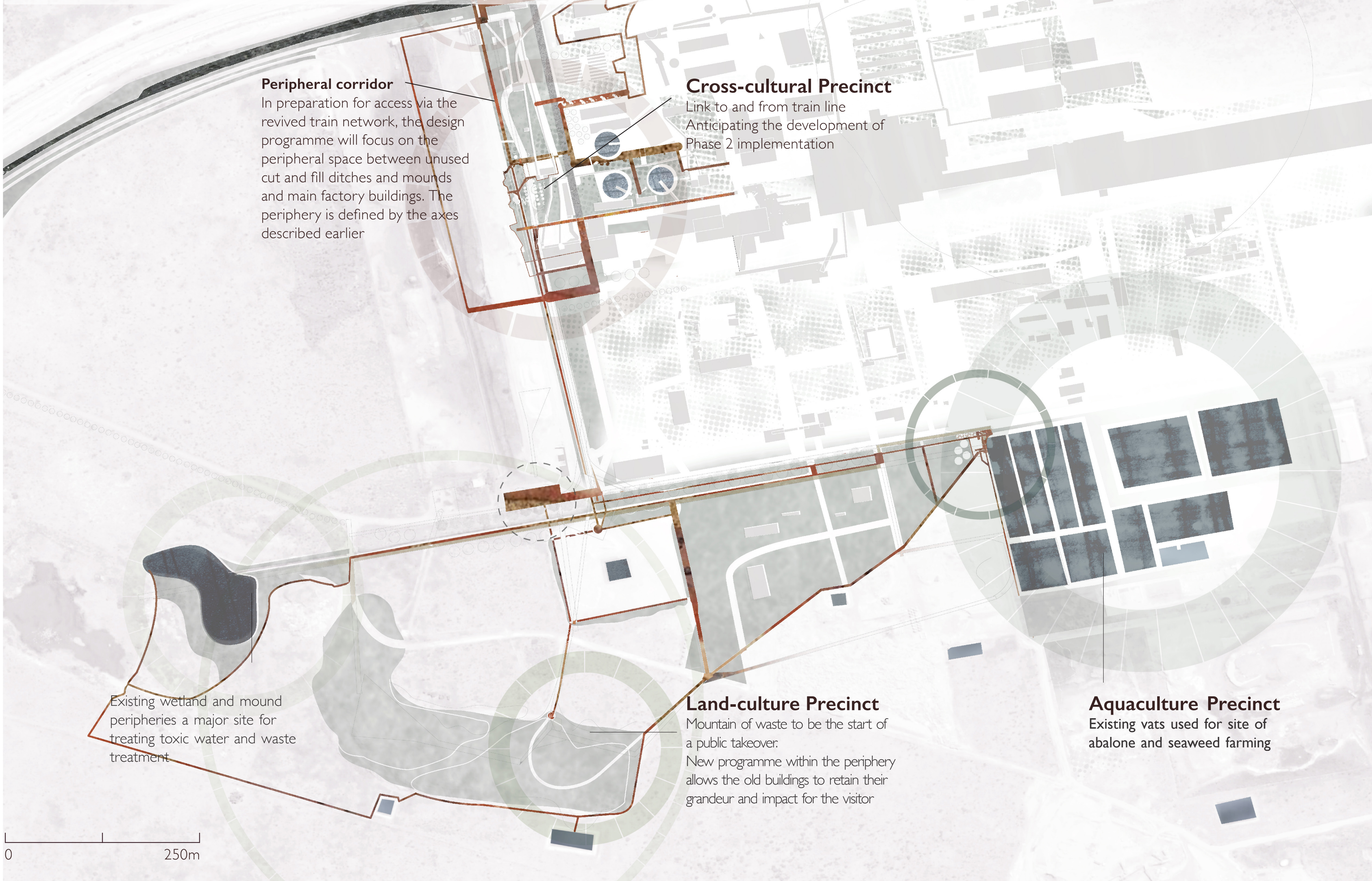
Cross-cultural Precinct
Drawns us towards the centre of the factory. The overwhelming scale of the abandoned factory is negotiated at this point. It is an area to bring what is generated elsewhere in the factory space to a central node, as well as showcase what is learned at the other two precincts.

It spatially ties into the second phase of the project, providing a space for tourism and ecological literacy via the public railway system.

Artificial wetlands process the toxic material from steel smelting processes (cf. Ayeni, Kambizi, Laubscher, Fatoki, & Olatunji, 2014; Demırezen & Aksoy, 2004; Peng, Luo, Lou, Li, & Shen, 2008; Wuana & Okieimen, 2011). Fresh water sourced from Shelly Point, excess fresh water is pumped to the ever-expanding Hopefield Wastewater Treatment Works.

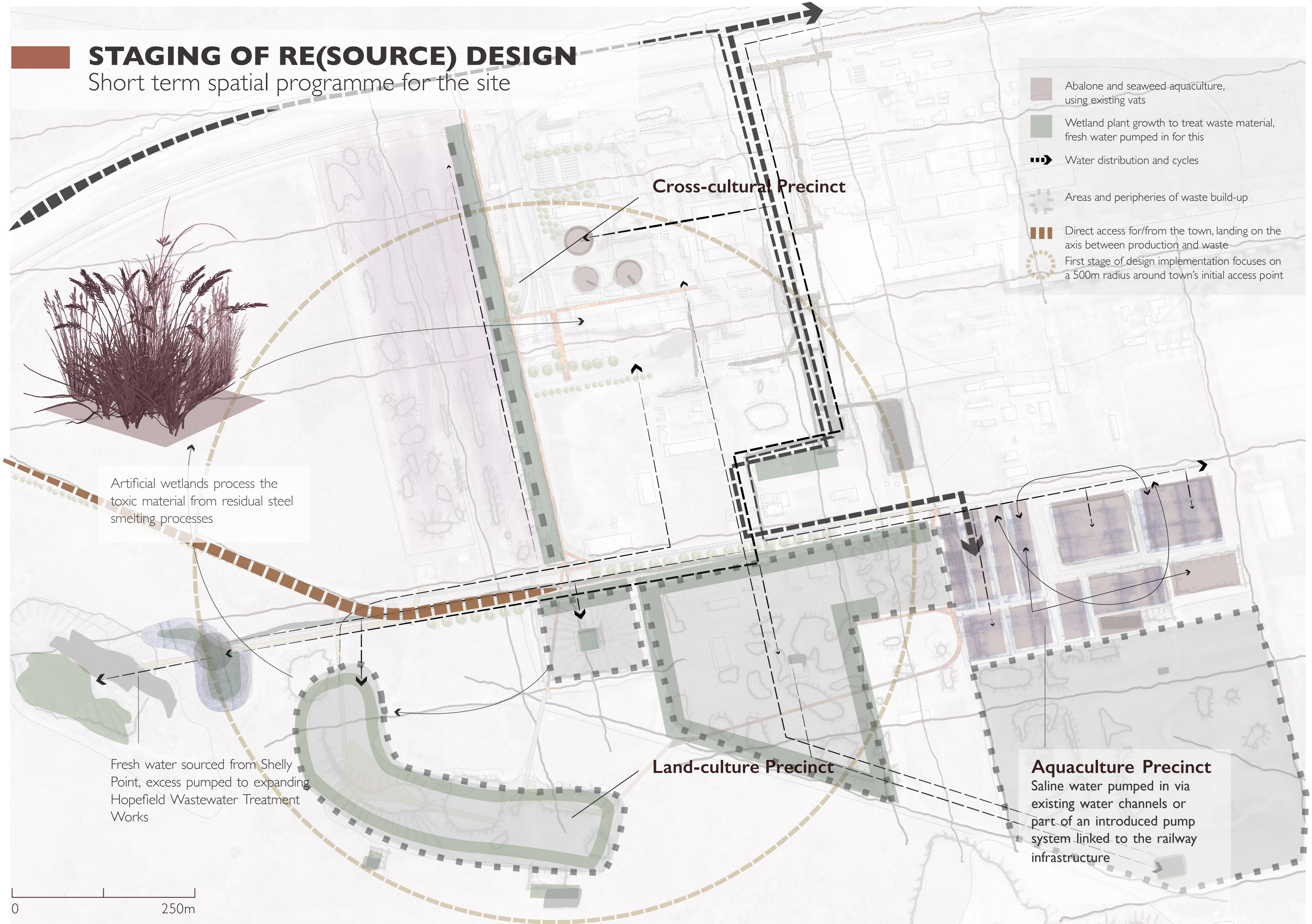
STAGING OF RE(SOURCE) DESIGN

Short term spatial programme for the site



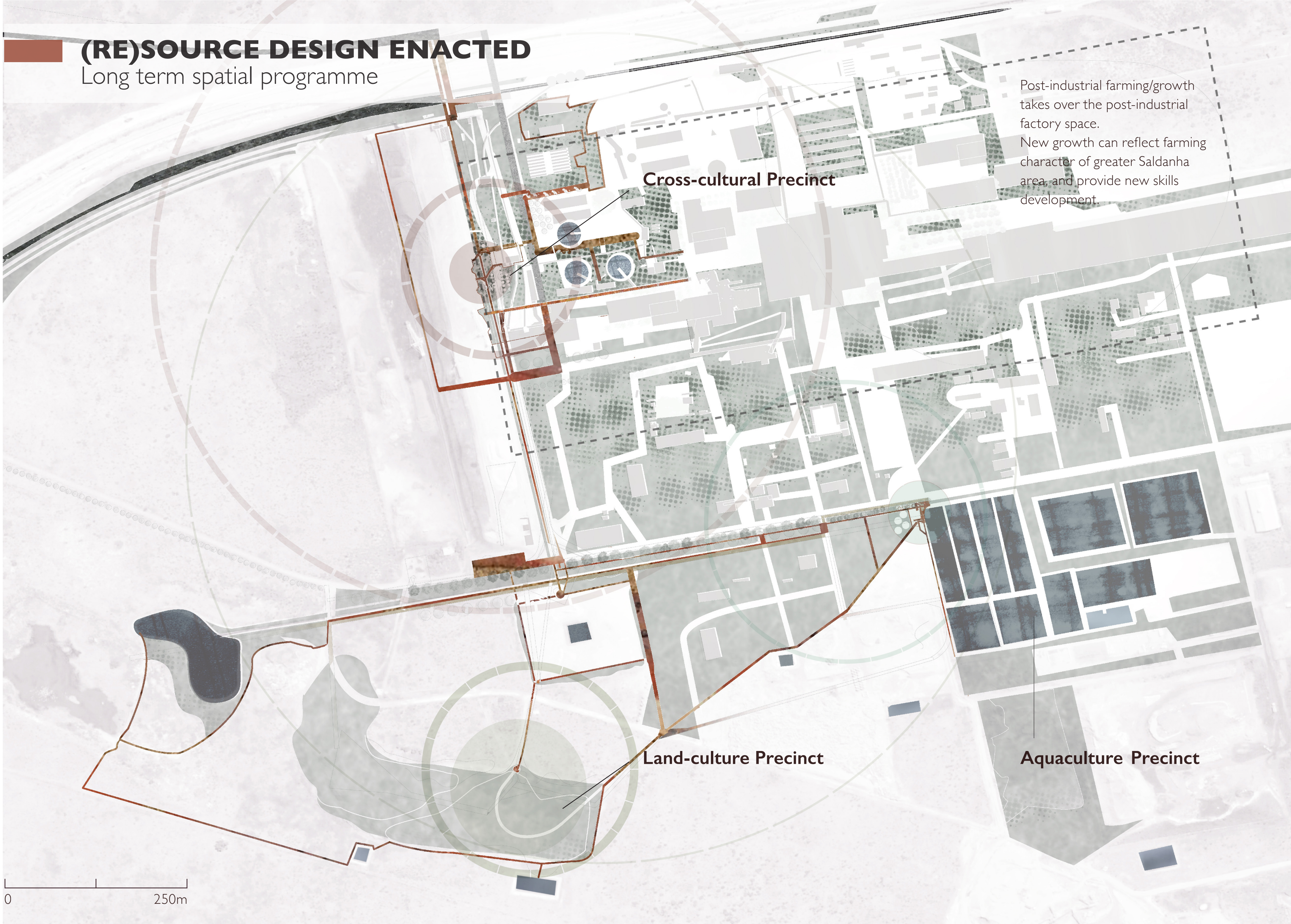
STAGING OF RE(SOURCE) DESIGN

Short term spatial programme for the site

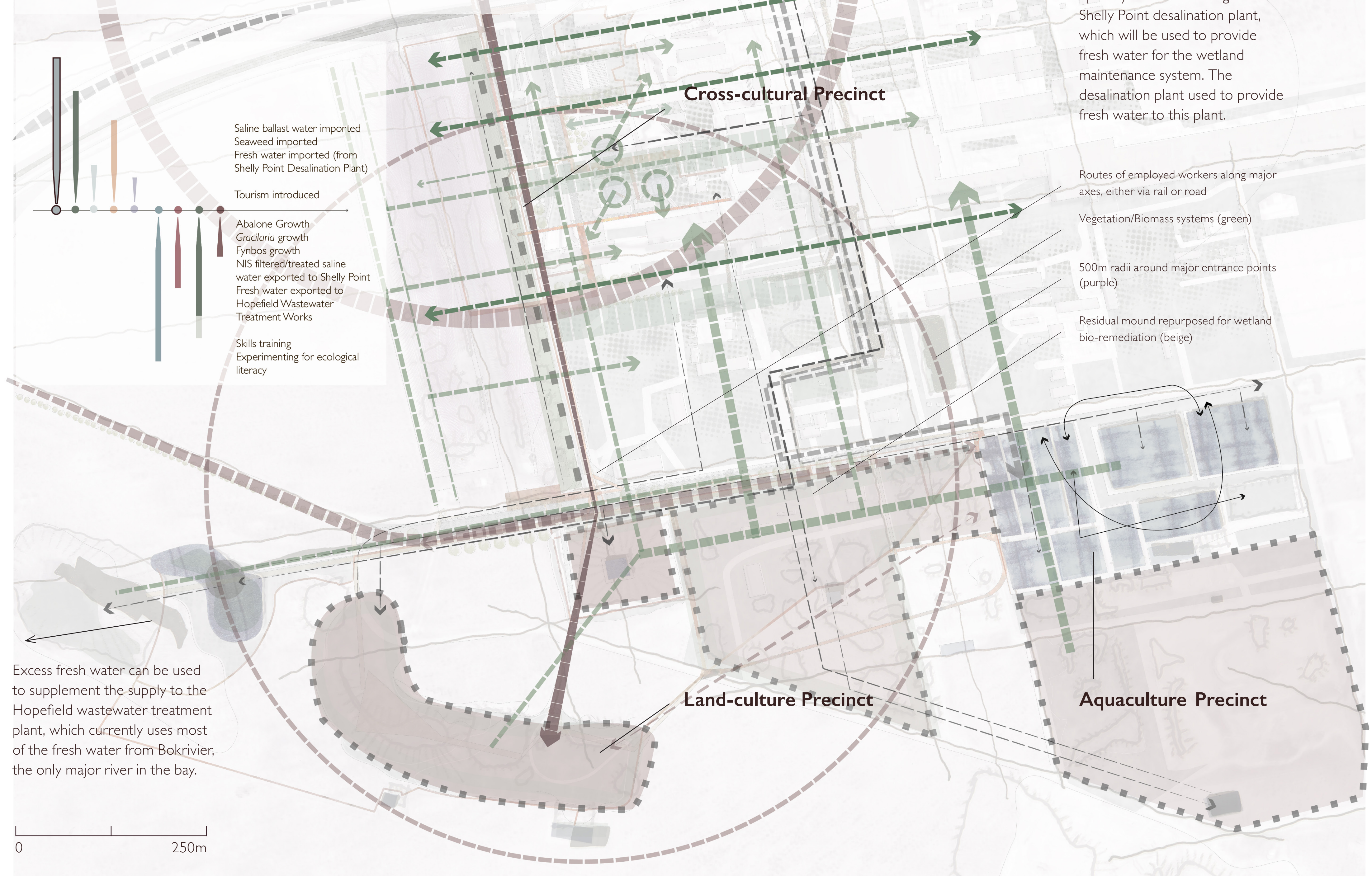


(RE)SOURCE DESIGN ENACTED

Long term spatial programme

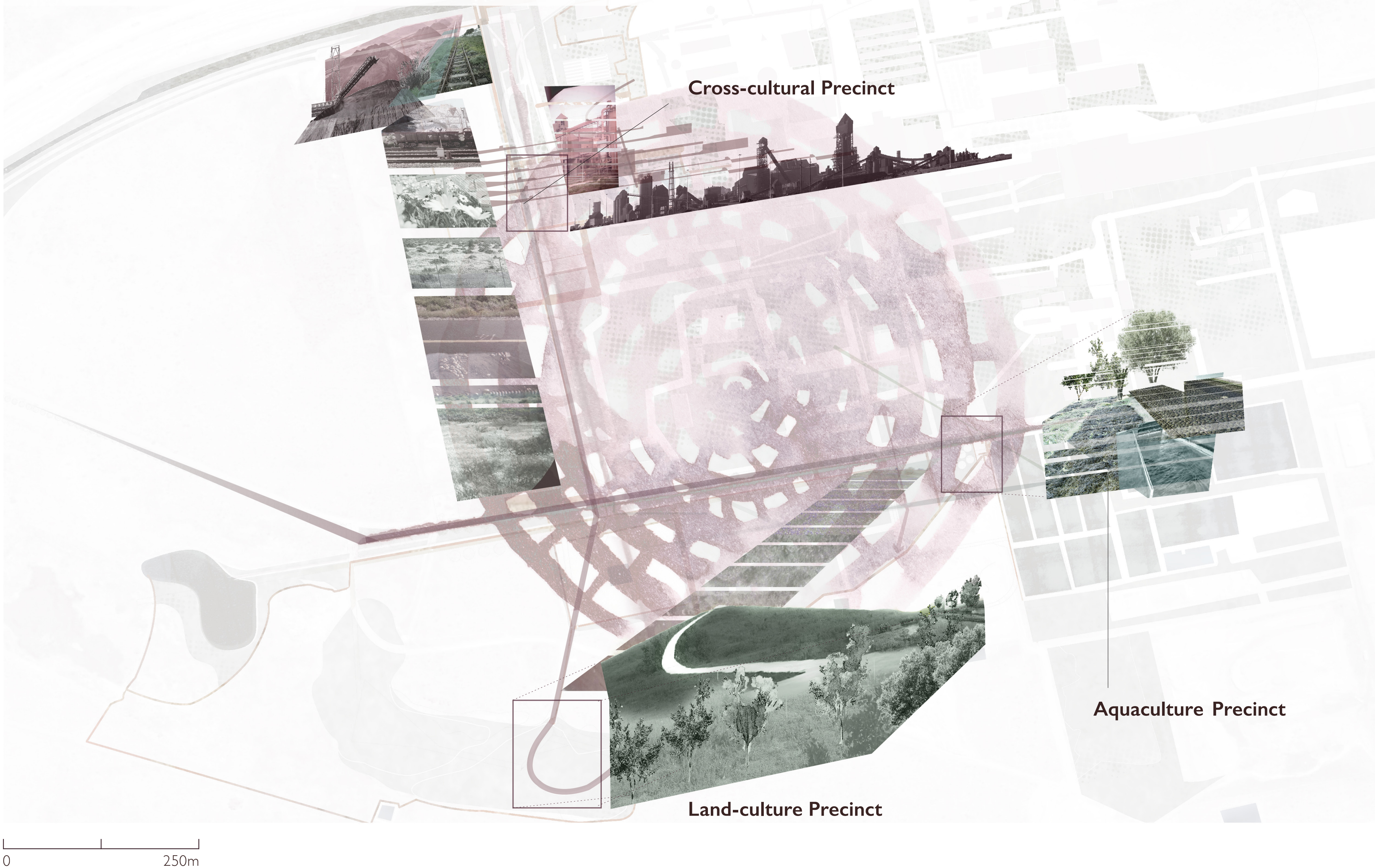


(RE)SOURCE DESIGN ENACTED
Long term spatial programme

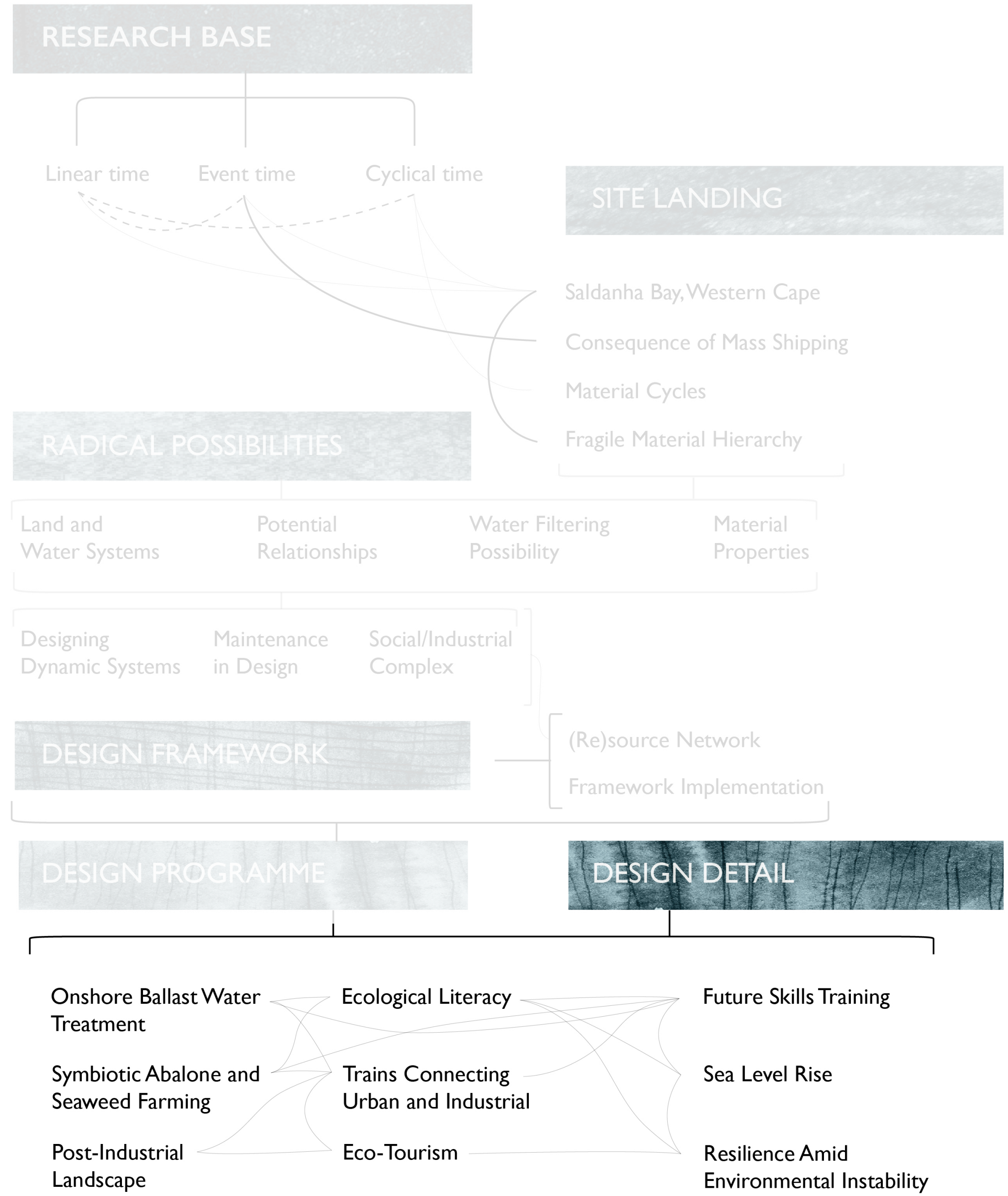


CONNECTION BETWEEN PRECINCTS

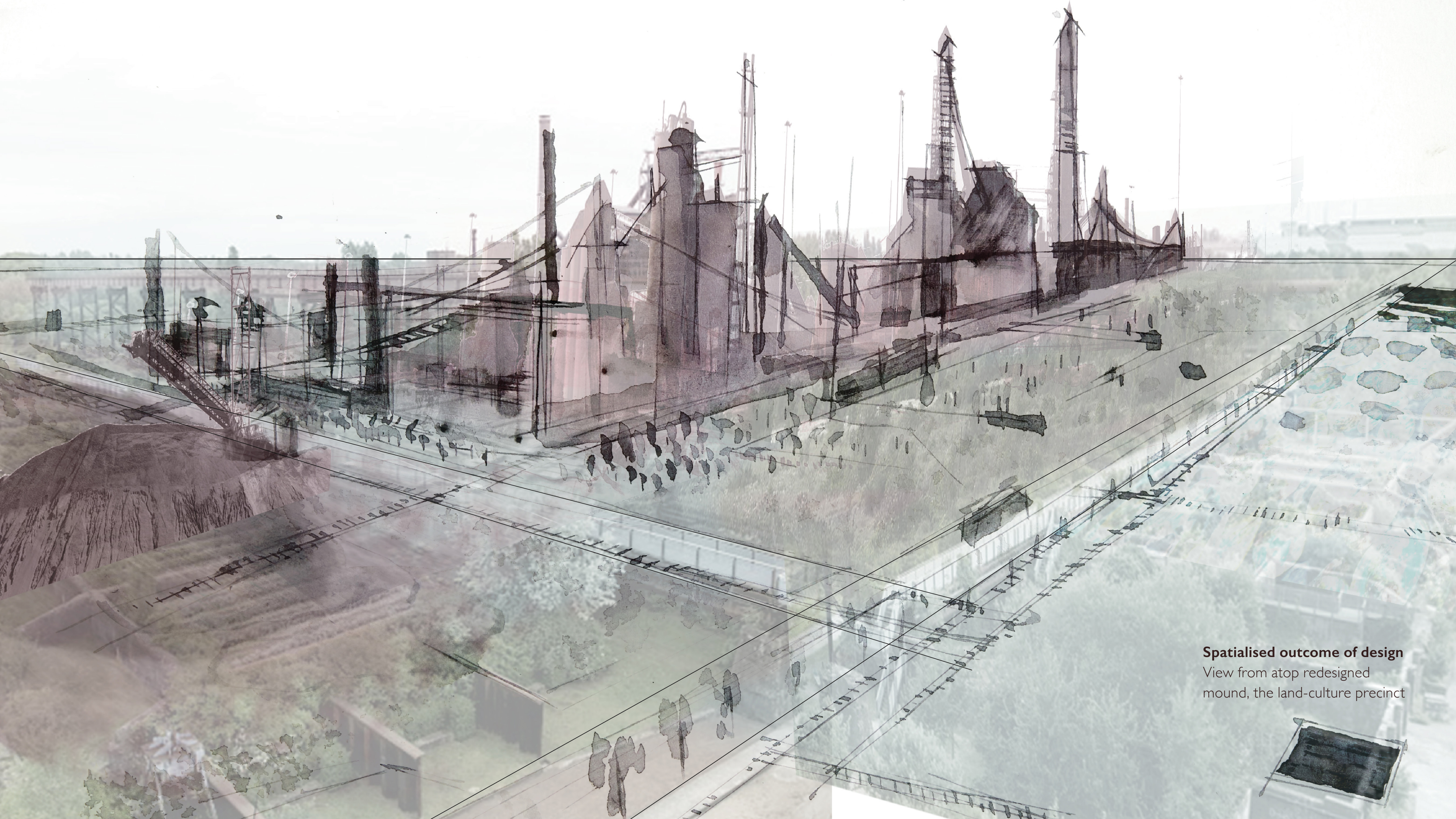
Aquaculture, Land-culture and Cross-cultural



Existing public engagement with industrial materials and areas, showing need for better engagement between public and private, social and industrial. Clearly the designs were ad hoc instead of really ever being intended for public use. One of the main design goals is to change this.
(Photographs author's own)

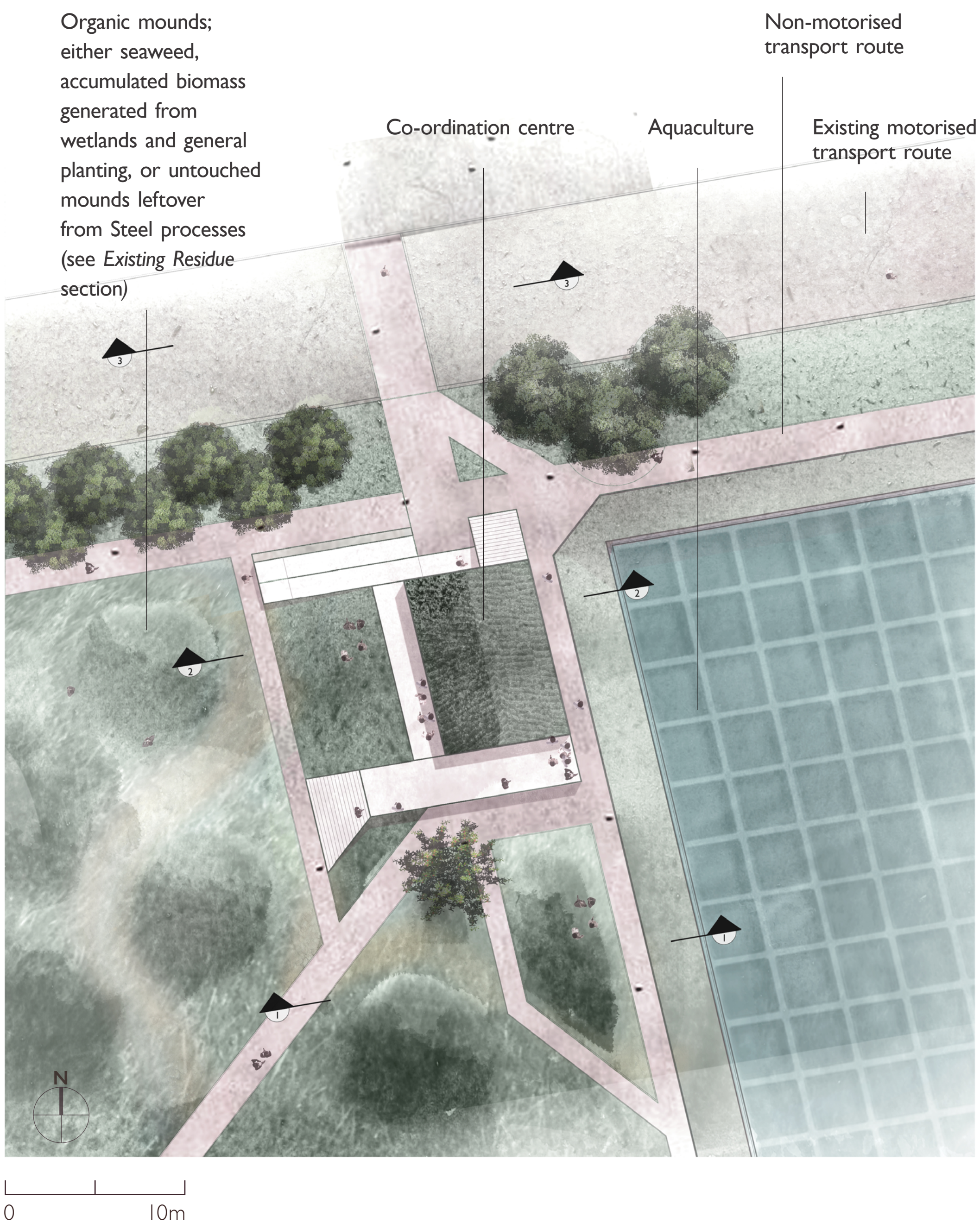

RESEARCH BASE
Linear time
Event time
Cyclical time
SITE LANDING
Saldanha Bay, Western Cape
Consequence of Mass Shipping
Material Cycles
Fragile Material Hierarchy
RADICAL POSSIBILITIES
Land and Water Systems
Potential Relationships
Water Filtering Possibility
Material Properties
Designing Dynamic Systems
Maintenance in Design
Social/Industrial Complex
DESIGN FRAMEWORK
(Re)source Network
Framework Implementation
DESIGN PROGRAMME
DESIGN DETAIL
Onshore Ballast Water Treatment
Symbiotic Abalone and Seaweed Farming
Post-Industrial Landscape
Ecological Literacy
Trains Connecting Urban and Industrial
Eco-Tourism
Future Skills Training
Sea Level Rise
Resilience Amid Environmental Instability

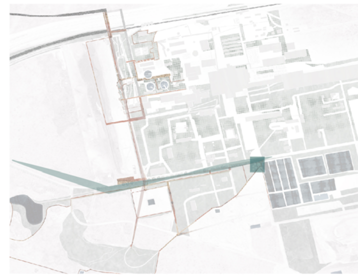
Conceptual outcome of design
Connection between steel structures, previously wasted material, abalone farming and wetland treatment

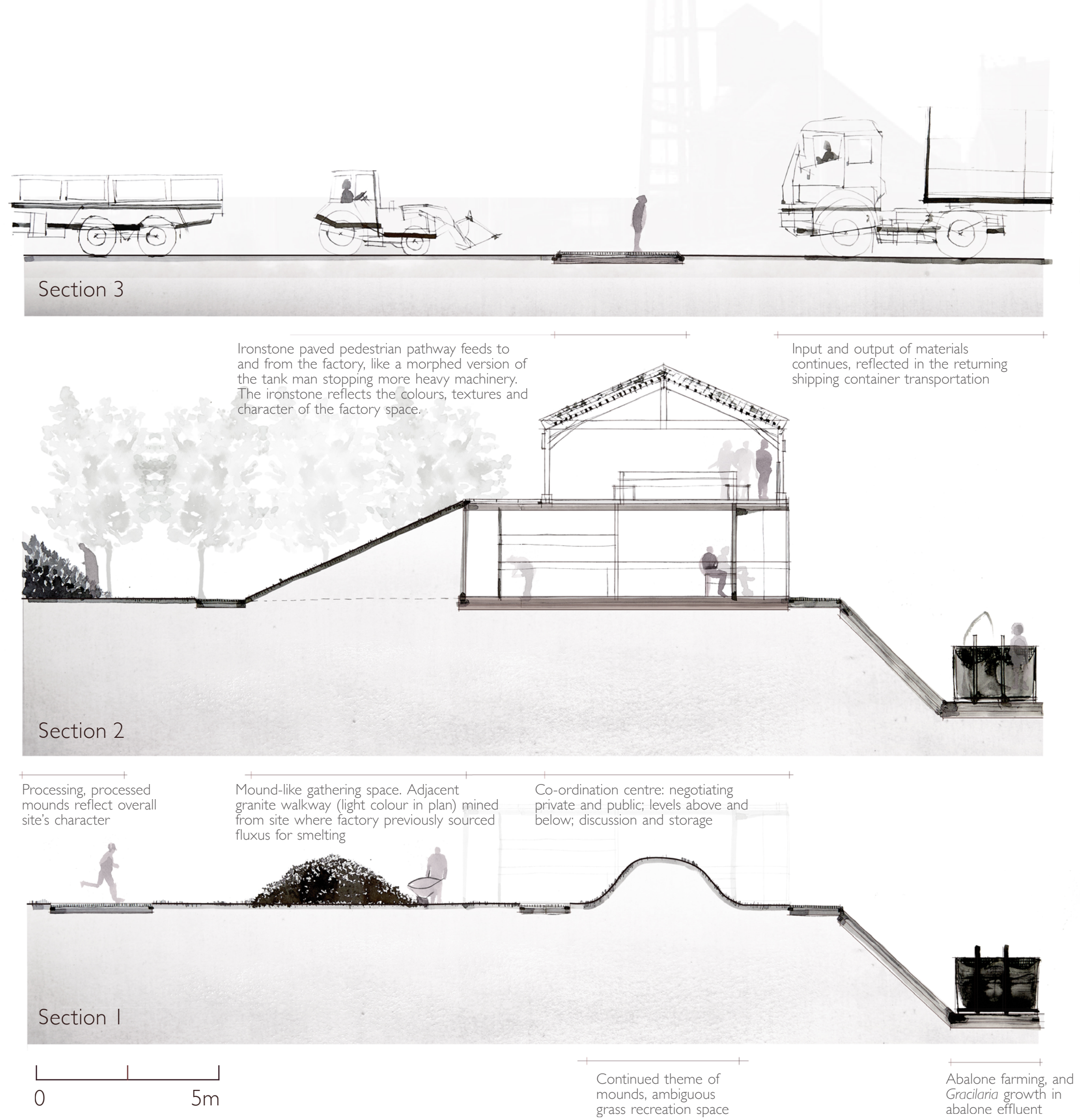


Spatialised outcome of design
View from atop redesigned mound, the land-culture precinct

AQUACULTURE PRECINCT







Designing a working node that reveals the opportunity for ballast water, abalone farming and kelp processing as vital (re)sources in the greater Saldanha Bay area.

Private vehicles edge in and out of the pedestrian-orientated node.

Cargo carriers also edge in and out.

An line of *Syzygium cordatum* celebrates the pathway along the aforementioned community/aquaculture route.

A cyclist parking in the shade, between journeys and spaces.

Monitoring abalone and abalone effluent on foot.

Monitoring abalone and abalone effluent from a vantage point.

Co-ordination and meeting point is not prescribed to specific application. The space will be able to house ablution facilities, storage of tools and machines, an information centre, meeting and workshop spaces.

Play on ambiguous grass mound.

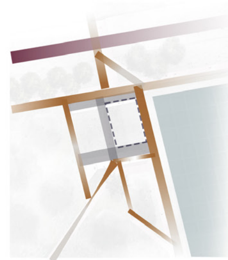
More serious use of mound for processing organic materials.

These could be distributed by hand, wheelbarrow or front-loader.

Varied materials provide interesting backdrop for node. Mounds consist of decomposing seaweed, leaves and other biomass in various states of living. Alternatively it could be untouched mounds leftover from Steel processes (see *Existing Residue*).

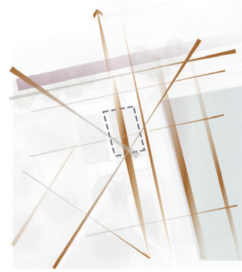
Landscape Traces (existing)

The junction between massive water bodies and major roads provides opportunity for access to the new factory system. The scarred landscape and waste mounds mean that the space is largely disturbed and unnatural.



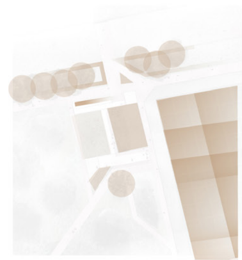
Surfaces

The existing access routes are supported, focusing on the introduced foot and non-motorised pedestrian traffic. Ironstone brick paving (orange) formalises these routes. Ironstone, granite and seaweed roofing celebrate the overall site's character.



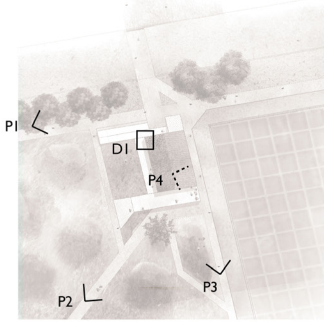
Structure

The co-ordination point as node provides the basis for this junction. Access is limited to non-motorised transport while trees and planting buffer the nearby vehicle access.



Planting

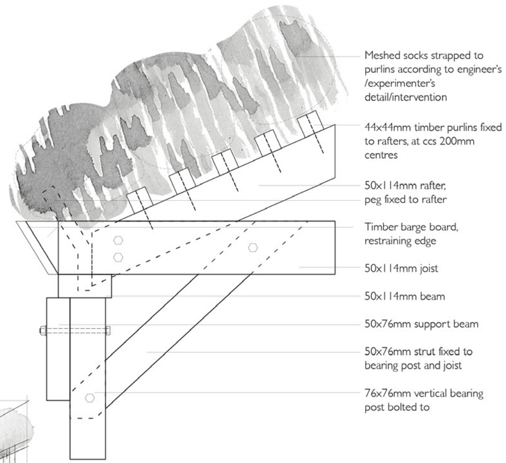
The focal growth in this area is abalone and seaweed, so the focus is on their status. The mounds grow, move and decay as an interaction between the vegetation and biomass decay. Plant species are decided based on these dynamics. *Syzygium cordatum* grow well in sandy soils like the underlying Saldanha Strandveld.



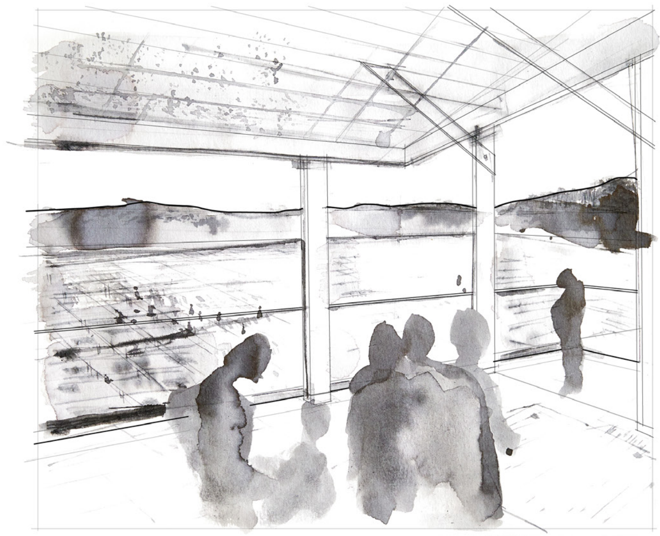
Details (D) and Perspectives (P)

P1: Pedestrian entrance alongside major road.
Trees buffer industrial activity.

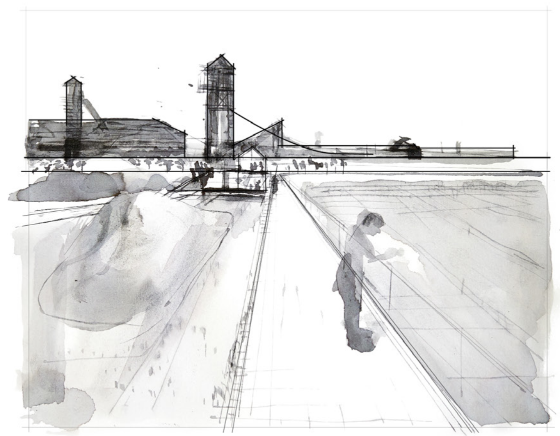
P2: Pedestrian entrance via land-culture precinct.
Mounds reflect the character of the overall site.



D1. Detail of seaweed roof, adapted from Larsen (2019)



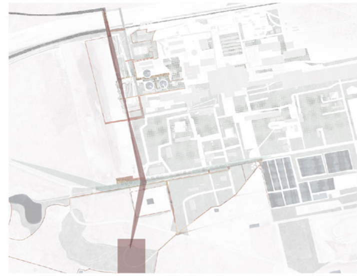
P4: Meetings about aquaculture overlook the vats.
They are situated below the seaweed roof.

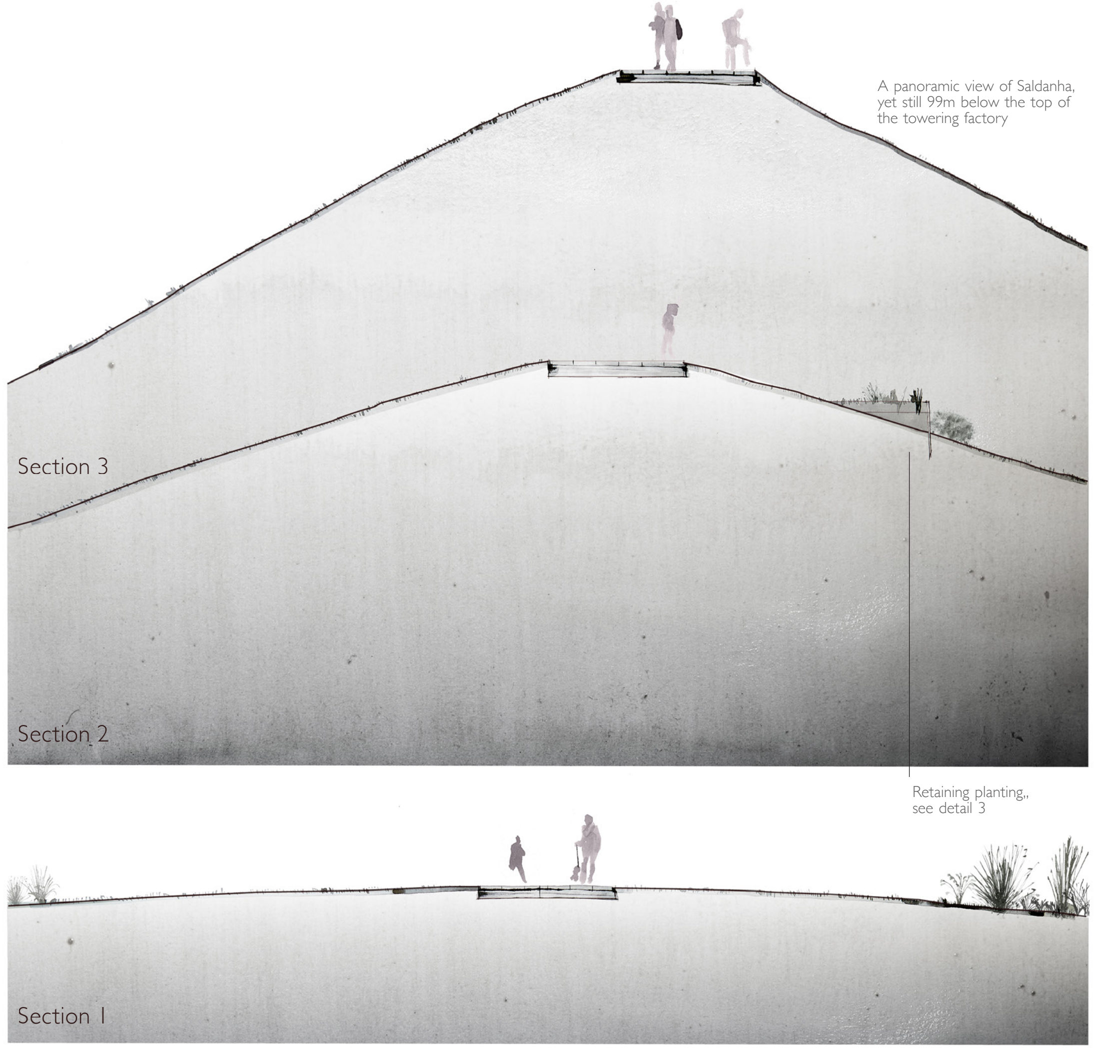


P3: Spaces informed by original factory layout.
Lookout along aquaculture edge.

LAND-CULTURE PRECINCT

0 20m





A panoramic view of Saldanha, yet still 99m below the top of the towering factory

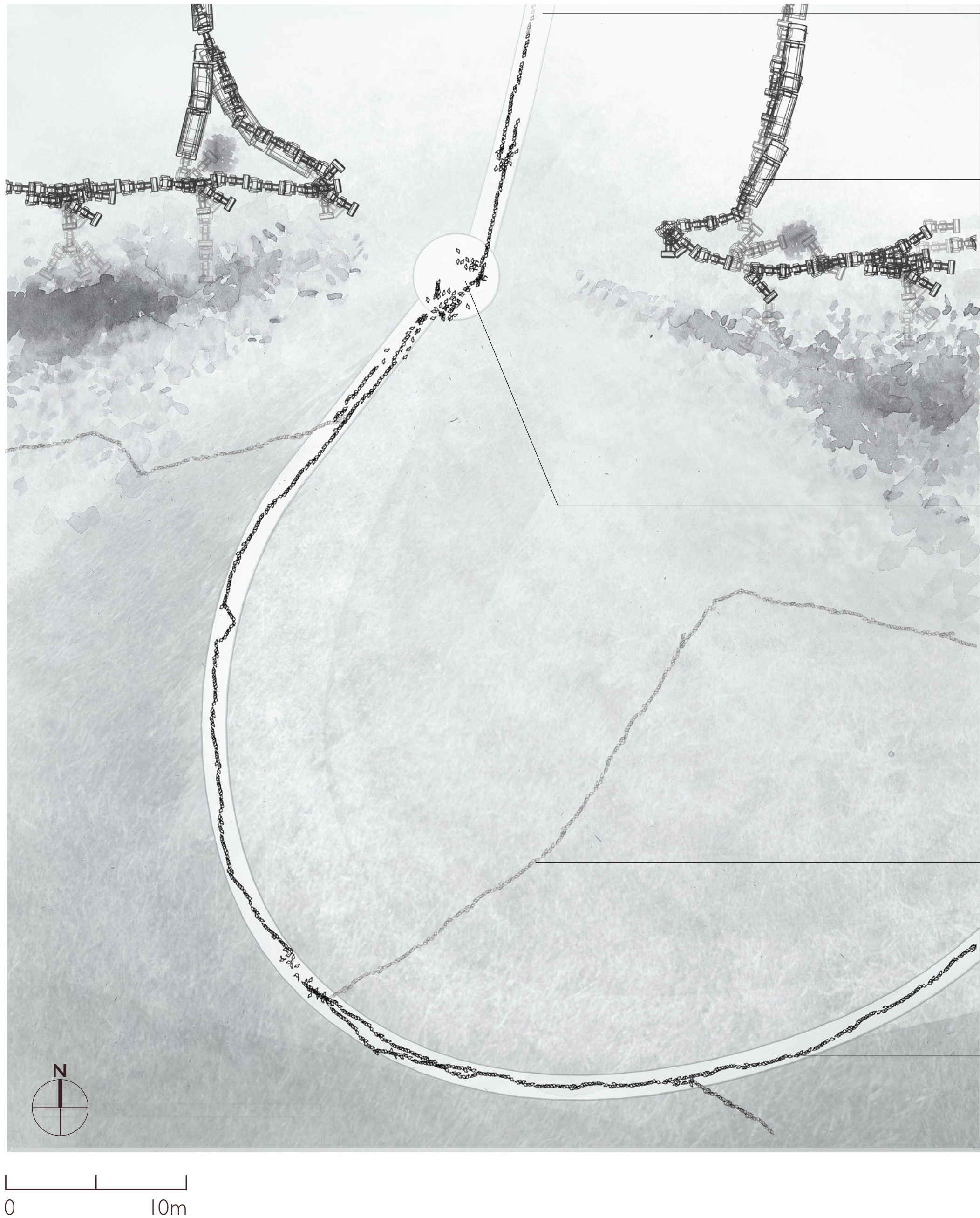
Retaining planting,, see detail 3

0 5m

Wide and expansive pathway, showing potential and possibility along an otherwise flat landscape

Wetland bio-remediation, within walking distance

Based on the form and function of Moerenuma Park in Sapporo, this repurposed mound serves as a space for new life: pedestrian access simple and essential, resources reused and biomass mounds generated.



Ironstone paving follows existing desire line to and from the mound, now a route to and from other two precincts.

Wetland maintained using heavy machinery.

Water for wetland uses existing water channels to and from peripheral water bodies. Wetland planting and level changes informed by mound properties. Farmed seaweed provides organic fertiliser and biomass for plant growth.

Machinery for wetland access unprescribed, defined later by vehicle storage and convenience. A consistent route and schedule is advised.

Marked by a large landing, the wide granite pathway stands out as a light line against the dark and expansive fynbos surroundings.

The light tone of the granite reflects the underlying sand prevalent in the area.

Play on ambiguous grass mound.

A rebel leaving the granite pathway

A plethora of processes within view.

(see perspective 3)

Landscape Traces (existing)

This mound is either sand, slag, dolomite, limestone or granite. Pretoria Portland Cement (PPC) used to provide dolomite and lime from its quarries and reciprocally uses the slag from Saldanha Steel's production processes to manufacture cement.

Surfaces

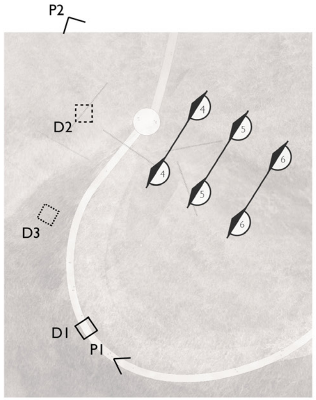
The existing access routes, as desire lines, are formalised. The ironstone paving emphasises the pedestrian within the space. The granite pathway sits flush with the landscape, yet its tone stands out

Structure

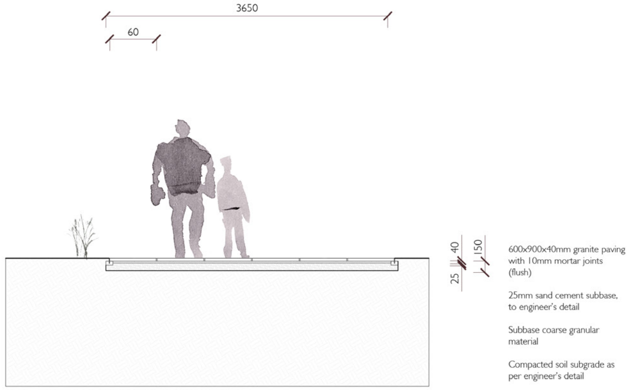
The structure is informed by the existing mound and the flat, degraded spaces surrounding it. The space taps into the surround water and material networks via unprescribed industry routes.

Planting

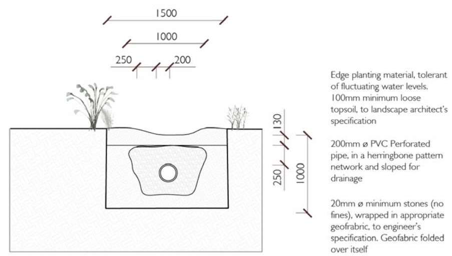
The focus of the site is its metabolism, and how it processes the toxic material left over from smelting processes. Thus the bio-remedial planting is base-material specific. (cf. Ayeni, Kambizi, Laubscher, Fatoki, & Olatunji, 2014; Demırezen & Aksoy, 2004; Peng, Luo, Lou, Li, & Shen, 2008; Wuana & Okieimen, 2011). Planting on following page.



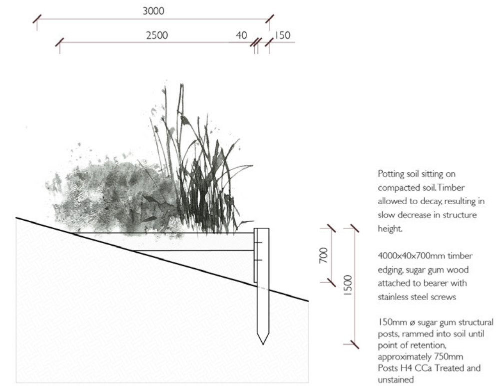
Details (D) and Perspectives (P)



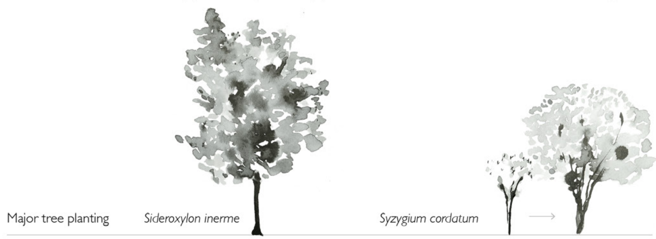
D1. Granite route along mound ridge



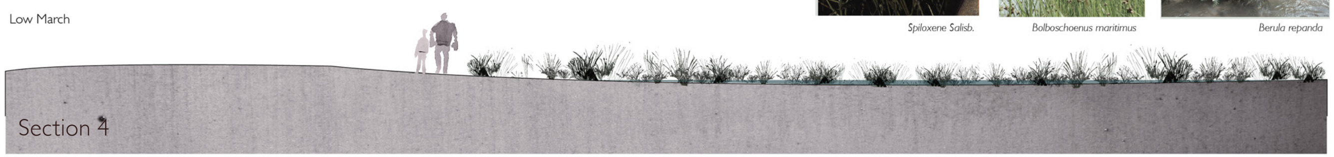
D2. Agricultural drain within herringbone drainage network

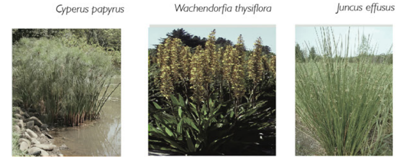


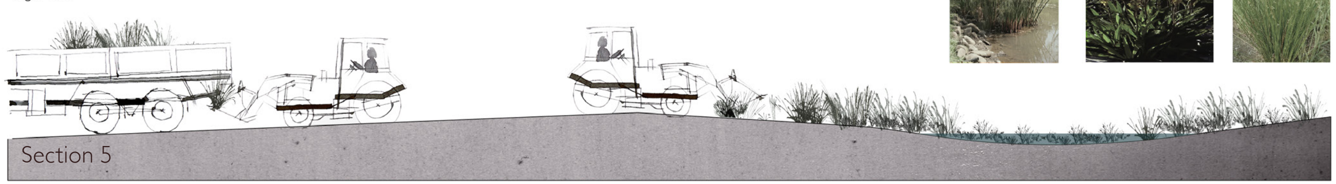
D3. Typical detail of slope retention

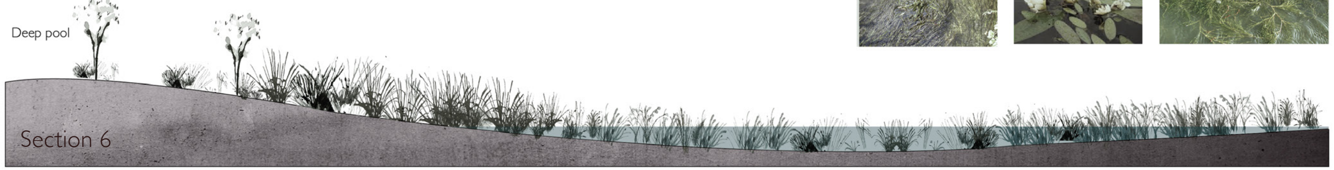


Basis for bio-remediation
Adapted based on base material



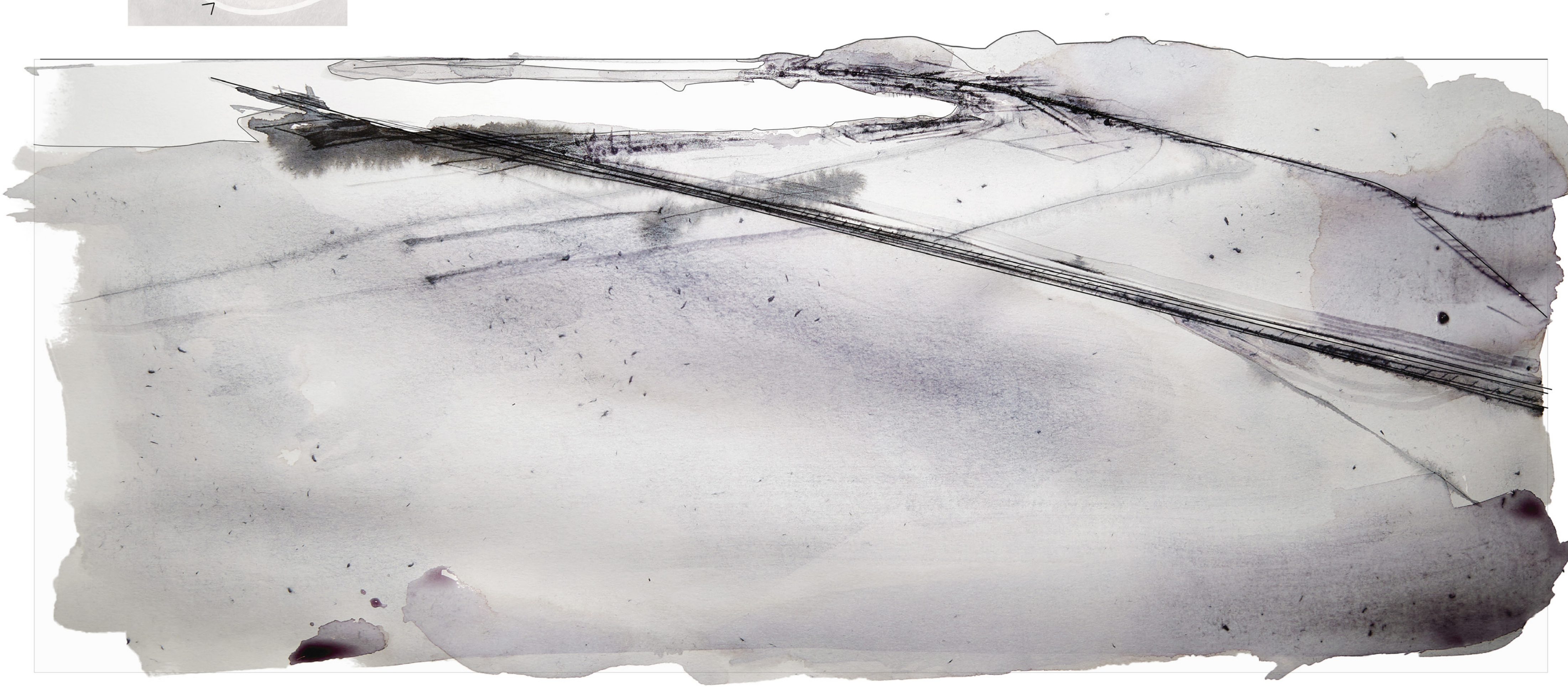






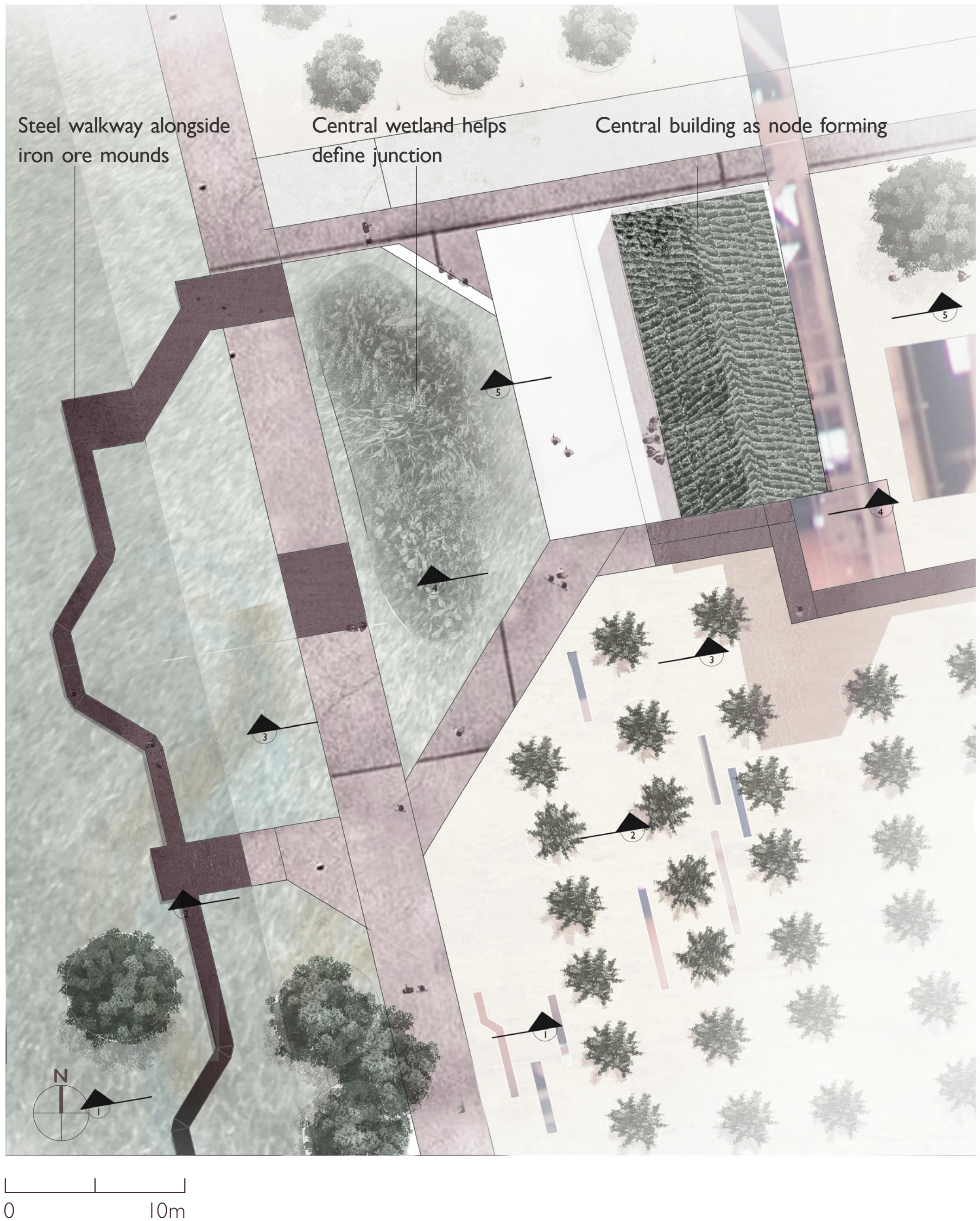
P1: View from the top towards neighbouring mounds. Other mounds might remain unchanged as grand exposed scars.

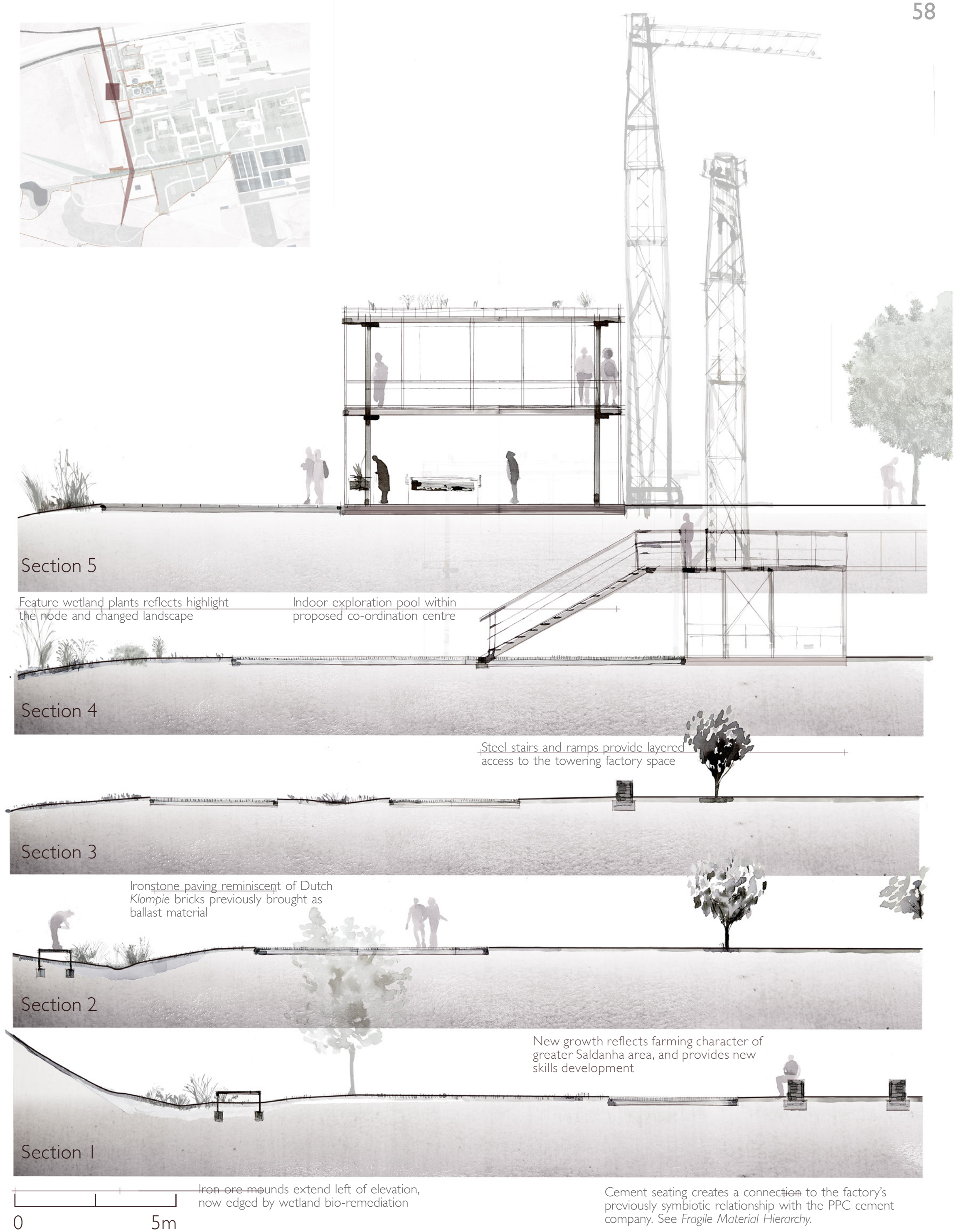
P2: The pathway and bio-mediating wetlands creates a subtle shift from how the space was accessed and used.



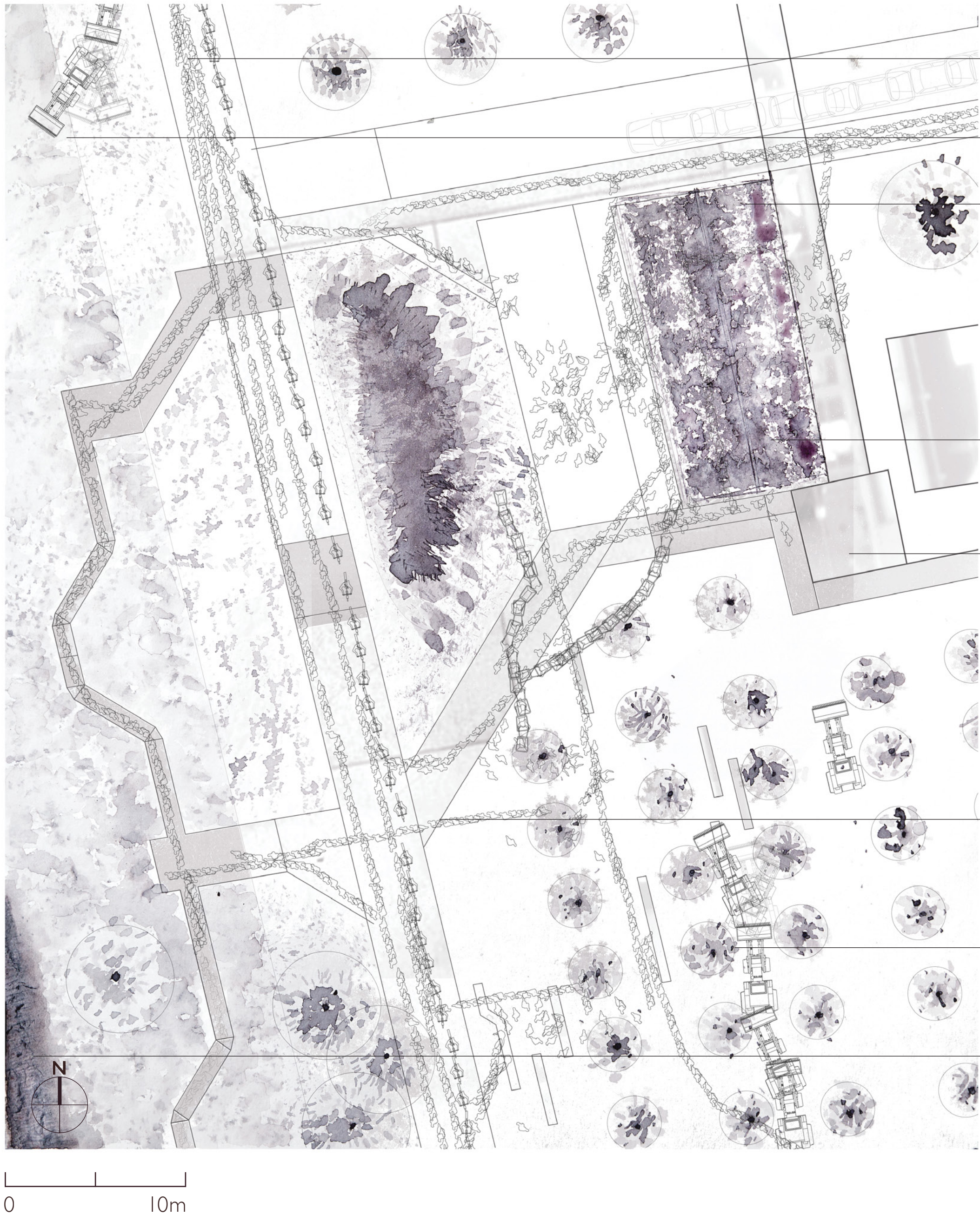
P3: Atop the 11m tall redesigned mound, looking back towards Saldanha Bay. The adjacent railways a prominent feature in past and present resource cycles/systems.

CROSS-CULTURAL PRECINCT





The cross-cultural precinct acts as a central node between aforementioned spaces and processes. It lies on a major crossroad along the periphery of the factory and feeds into the public train-line as part of the second phase of the broader design. This site references Duisburg Nord in Germany.



Entrance via train-line to the north, along existing route.

Wetland maintenance.

Central structural component, drawing the public from the periphery and marking access to the factory space.
The two storey building provides visual and spatial grounding for the node co-ordination. It is a space for an information centre, meeting and workshop space. It is also a space to showcase designs that incorporate seaweed and other natural materials.

Rooftop garden.
The harsh angles of the steel factory are broken by subtle changes in the skyline

Existing factory building towers overhead.

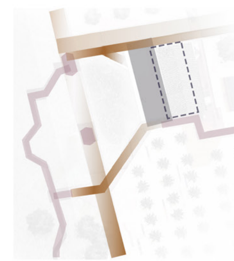
Locals and tourists exploring the previously inaccessible factory space by foot or by bicycle.

Post-industrial small-scale farming takes over the periphery and later the rest of the factory.

Iron-ore mounds surrounded by wetland bio-remediation.
Iron is soluble in water and thus taken up most effectively by wetland plants. (cf. Ayeni, Kambizi, Laubscher, Fatoki, & Olatunji, 2014; Demırezen & Aksoy, 2004; Peng, Luo, Lou, Li, & Shen, 2008; Wuana & Okieimen, 2011)

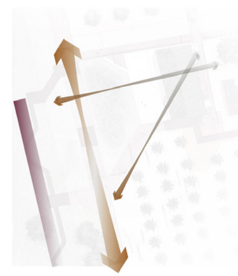
Landscape Traces (existing)

The vast stretches of purple iron ore to the east serve as a background for using the space in its new form. This precinct is at the periphery of the factory but the towering steel structures dominate the air and ground.



Surfaces

The building acts as a structuring anchor along the two axes. Ironstone paving once again creates a space for pedestrian use and NMT traffic. A steel walkway extends across the wetland and allows wonder in and around the stunning, purple iron-ore mounds.

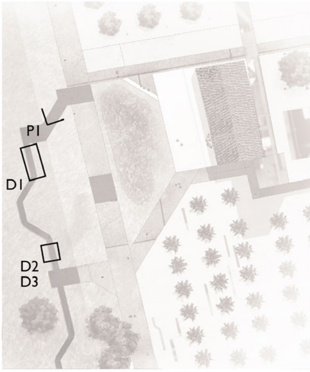


Structure

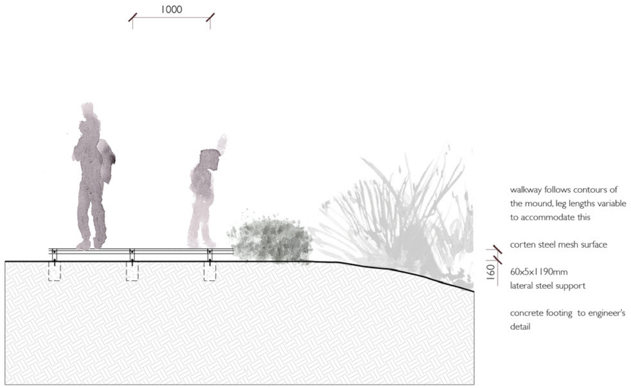
The building acts as a structuring anchor along the multiple axes. The route is along the major entrance from the public train-line. This point is within 500m of the train-line and the abalone farm and thus acts as an centralised node.

Planting

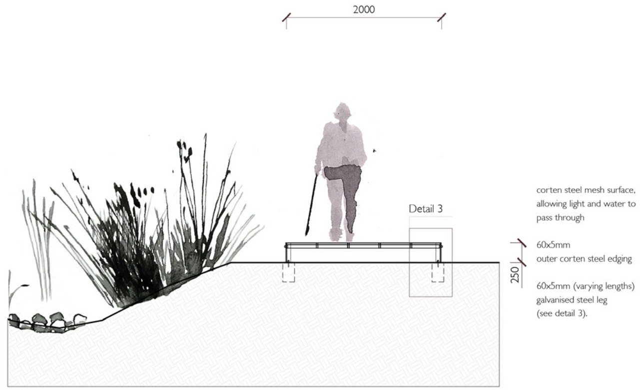
Area specific small-scale farming is promoted here This could include the celebrated wild flowers from this region. The building creates a central space around which planting radiates. A small wetland includes feature plants; rooftop planting showcases the possibilities for green designs; and indoor interaction with natural growth (shown in a later detail) further explores design possibilities. Lastly, wetland mound treatment is once again essential and accessed at the western periphery of the site.



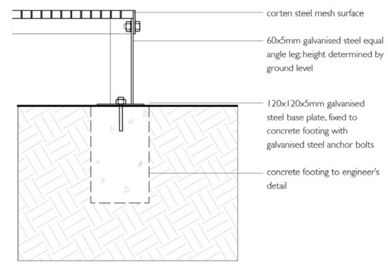
Details (D) and Perspectives (P)



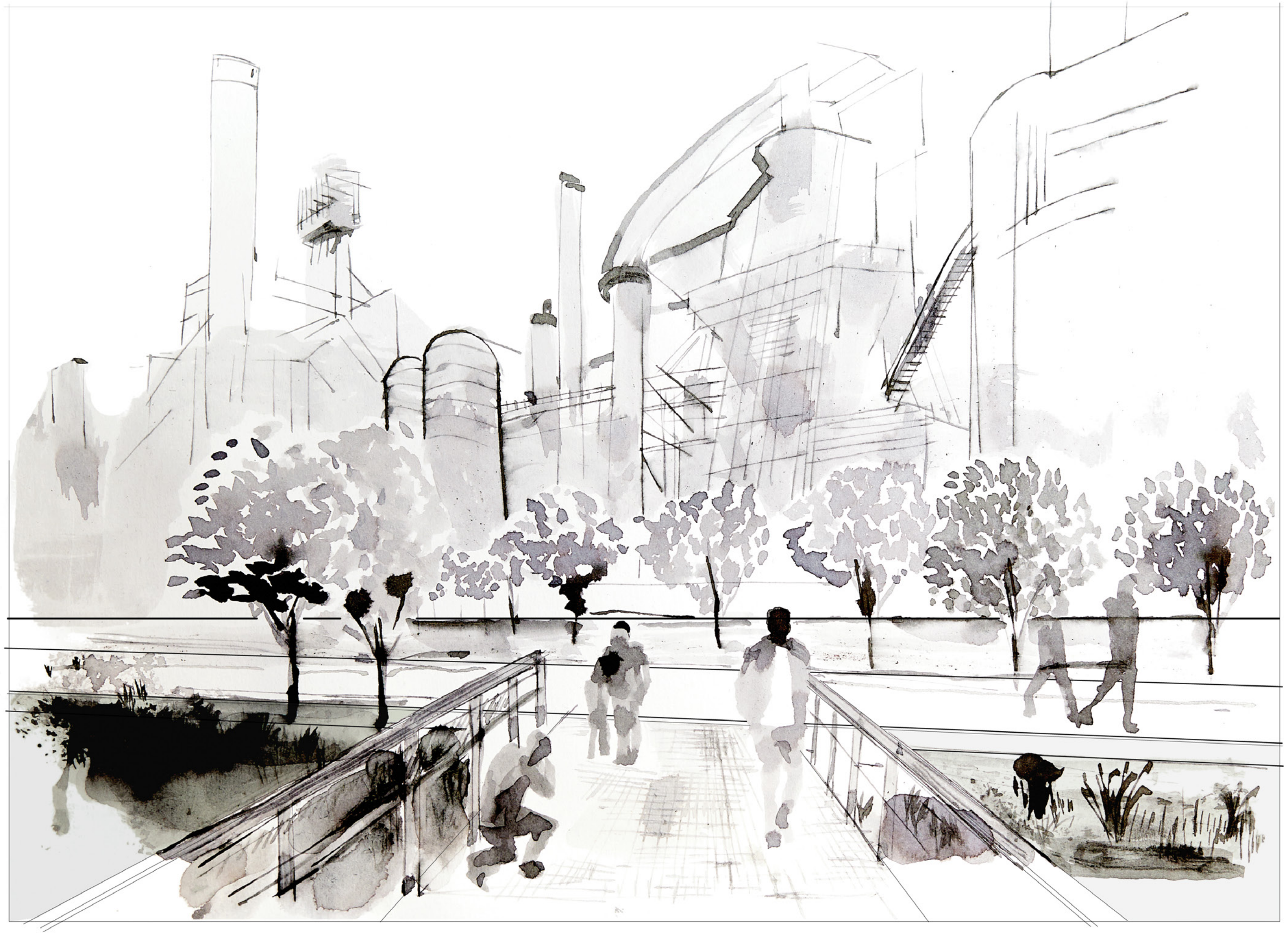
D1. Steel walkway following topography of residual mounds.
Adapted from Dahlberg (2019)



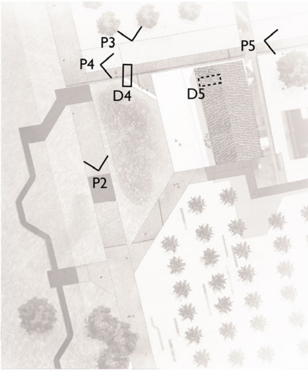
D2. Steel walkway integrating factory's industrial character, iron-ore mounds and wetland bio-remediation.

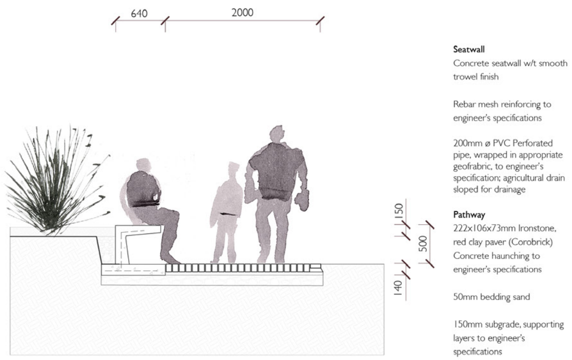


D3. Detail of steel walkway

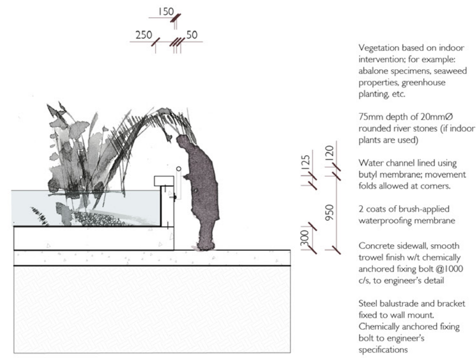


P1: Experiencing the wetland, elevated steel walkway and towering factory on foot.





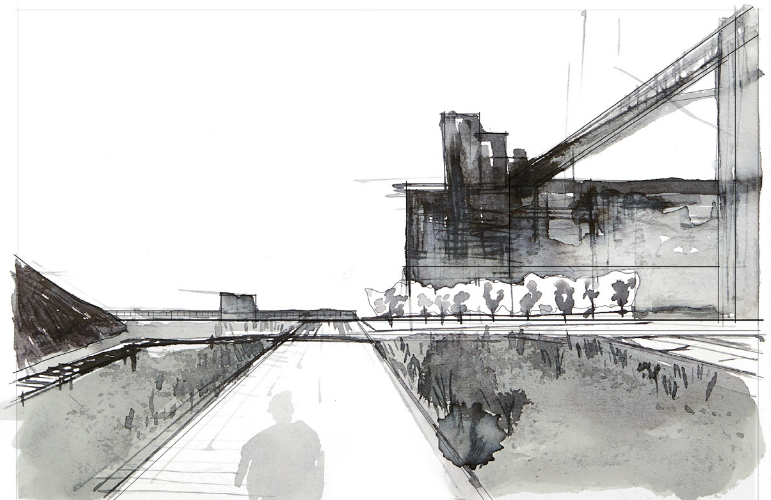
D4. Plant backed seatwall



D5. Indoor exploration pool

P3: The buildings frame the landscape, and vice versa.

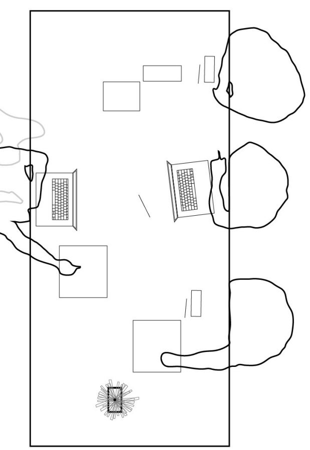
P4: Introduced building as structuring element within node.



P2(-P5): New programme along the periphery allows the old buildings to retain their grandeur and impact for the visitor.

P5: Inside the transformed factory space, now a post-industrial landscape for new growth and development.

Finally, a meeting, either housed at the aquaculture or cross-cultural precinct; discussing recent designs.



RESEARCH BASE
Linear time
Event time
Cyclical time
SITE LANDING
Saldanha Bay, Western Cape
Consequence of Mass Shipping
Material Cycles
Fragile Material Hierarchy
RADICAL POSSIBILITIES
Land and Water Systems
Potential Relationships
Water Filtering Possibility
Material Properties
Designing Dynamic Systems
Maintenance in Design
Social/Industrial Complex
DESIGN FRAMEWORK
(Re)source Network
Framework Implementation
DESIGN PROGRAMME
DESIGN DETAIL
Onshore Ballast Water Treatment
Symbiotic Abalone and Seaweed Farming
Post-Industrial Landscape
Ecological Literacy
Trains Connecting Urban and Industrial
Eco-Tourism
Future Skills Training
Sea Level Rise
Resilience Amid Environmental Instability

BIBLIOGRAPHY

Airahuobhor, A. (2010) Nigeria: International Collaboration to Protect Marine Environment From Ballast Water. *All Africa*. Retrieved from http://allafrica.com/stories/201006180445.html

Anderson, R., Rand, A., Rothman, M., Share, A., & Bolton, J. (2007). Mapping and quantifying the South African kelp resource. *African Journal of Marine Science, 29(3)*, 369-378.

Ayeni, O., Kambizi, L., Laubscher, C., Fatoki, O., & Olatunji, O. (2014). Risk assessment of wetland under aluminium and iron toxicities: A review. *Aquatic Ecosystem Health & Management, 17(2)*, 122-128.

Bayer, G. (2019). When Earth Matters: Bessie Head's When Rain Clouds Gather. *Open Cultural Studies, 3(1)*, 448-455.

Blamey, L. K., & Bolton, J. J. (2018). The economic value of South African kelp forests and temperate reefs: past, present and future. *Journal of Marine Systems, 188*, 172-181.

Breaux, A., Farber, S., & Day, J. (1995). Using natural coastal wetlands systems for wastewater treatment: an economic benefit analysis. *Journal of environmental management, 44(3)*, 285-291.

Christen, K. (1999). Environmentalists, water agencies seek stricter controls on ballast water discharges. *Environmental science & technology, 33(7)*, 151A-152A.

CNdV. (2017) *Saldanha Bay Municipality Spatial Development Framework: Saldanha Bay Municipality*. Saldanha Bay Municipality

Cooper, W. J., Jones, A. C., Whitehead, R. F., & Zika, R. G. (2007). Sunlight-induced photochemical decay of oxidants in natural waters: implications in ballast water treatment. *Environmental science & technology, 41(10)*, 3728-3733.

Dalberg, J. (2019). *A River Remembered: Reconnecting to landscape, memory and place-making through water routes*. M.L.A. Dissertation (Landscape Architecture). University of Cape Town.

Demırezen, D., & Aksoy, A. (2004). Accumulation of heavy metals in *Typha angustifolia* (L.) and *Potamogeton pectinatus (L.)* living in Sultan Marsh (Kayseri, Turkey). *Chemosphere, 56(7)*, 685-696.

Department of Environmental Affairs and Development Planning. (2019). *Economic Valuation of Selected Wetlands in the Breede Catchment*. Cape Town, South Africa. DEA&DP

Department of Rural Development and Land Reform. (2020a). *Aerial Imagery* [Data file]. Department of Rural Development and Land Reform.

Department of Rural Development and Land Reform. (2020b). *Shapefile* [Data file]. Department of Rural Development and Land Reform.

Duncan, J. (2014). *Ballast Water: Extremely Convenient for the Shipping Industry but Disastrous for Coastal Waters and the Environment: A Study on the Effect of Ballast Water on Various Coasts and the Laws and Regulations in Place Regarding Ballast Water*. University of Cape Town,

Endresen, Ø., Behrens, H. L., Brynestad, S., Andersen, A. B., & Skjong, R. (2004). Challenges in global ballast water management. *Marine pollution bulletin, 48(7-8)*, 615-623.

Engledow, H., & Bolton, J. (1992). Environmental tolerances in culture and agar content of *Gracilaria verrucosa* (Hudson) *Papenfuss* (Rhodophyta, Gigartinales) from Saldanha Bay. South *African journal of botany, 58(4)*, 263-267.

Ernstson, H., & Sörlin, S. (2013). Ecosystem services as technology of globalization: On articulating values in urban nature. *Ecological Economics, 86*, 274-284.

Ernstson, H., & Sörlin, S. (2019). 13 Grounding and Worlding Urban Natures: Configuring an Urban Ecology Knowledge Project. *Grounding Urban Natures: Histories and Futures of Urban*

Ecologies, 365. Penguin Random House.

Gasson, B & von Blottnitz, H. (2005) *Sustainable Cities and Regional Metabolism - Lessons from two case studies of Regional Metabolism in a Developing Country Context*. Poster paper presented at ISIE International Conference, Royal Institute of Technology, Stockholm, June 12-15, 2005.

Head, B. (2013). *When Rain Clouds Gather*. Waveland Press.

Jiang, Z., Liu, J., Li, S., Chen, Y., Du, P., Zhu, Y., . . . Yan, X. (2020). Kelp cultivation effectively improves water quality and regulates phytoplankton community in a turbid, highly eutrophic bay. *Science of The Total Environment, 707*, 135561.

Kameri-Mbote, A. P., & Cullet, P. (1997). Law, colonialism and environmental management in Africa. *European Comparative & International Environmental Law, 6*, 23.

Larsen, K. (2019). *Seaweed Thatch Re-imagined*. Presentation, South African Design Indaba. [Video]. YouTube. https://www.youtube.com/watch?v=ouoYHDaPlhY

Latour, B. (2012). *We have never been modern*. Harvard university press.

Liu, T.-K., Chang, C.-H., & Chou, M.-L. (2014). Management strategies to prevent the introduction of non-indigenous aquatic species in response to the Ballast Water Convention in Taiwan. *Marine Policy, 44*, 187-195.

Marangoni, C., Pienaar, R., & Sym, S. (2001). Possible introduction of alien phytoplankton via shipping ballast water: a South African perspective. *South African journal of botany, 67(3)*, 465-474.

Martin, E. (2018). *Reimagining Kitintale's landscape through clay brick making*. M.A. (Architecture). University of Johannesburg.

Milledge, J. J., Nielsen, B. V., & Bailey, D. (2016). High-value products from macroalgae: the potential uses of the invasive brown seaweed, Sargassum muticum. *Reviews in Environmental Science and Bio/Technology, 15(1)*, 67-88. doi:10.1007/s11157-015-9381-7

Mitchell, T. (2002). *Rule of experts: Egypt, techno-politics, modernity*. University of California Press.

Moses, D. (2017). *Saldanha Bay Industrial Development zone: Co-ordination as a determining factor of opportunity lost or gamechanger*. University of Cape Town.

Neori, A., Shpigel, M., & Ben-Ezra, D. (2000). A sustainable integrated system for culture of fish, seaweed and abalone. *Aquaculture, 186(3-4)*, 279-291.

Nixon, R. (2011). *Slow Violence and the Environmentalism of the Poor*. Harvard University Press.

Nosrati-Ghods, N., Ghadiri, M., & Früh, W.-G. (2017). Management and environmental risk study of the physicochemical parameters of ballast water. *Marine pollution bulletin, 114(1)*, 428-438.

Peng, K., Luo, C., Lou, L., Li, X., & Shen, Z. (2008). Bioaccumulation of heavy metals by the aquatic plants *Potamogeton pectinatus L.* and *Potamogeton malaianus Miq.* and their potential use for contamination indicators and in wastewater treatment. *Science of The Total Environment, 392(1)*, 22-29.

Ponder, J. & Connolly, M. (2019, November 13). Saldanha steel plant closure will be 'catastrophic' for West Coast. *The Sunday Times*. Retrieved from https://www.timeslive.co.za/news/south-africa/2019-11-13-saldanha-steel-plant-closure-will-be-catastrophic-for-west-coast/

Pereira, N. N., & Brinati, H. L. (2012). Onshore ballast water treatment: A viable option for major ports. *Marine pollution bulletin, 64(11)*, 2296-2304.

Piao, S., Sitch, S., Ciais, P., Friedlingstein, P., Peylin, P., Wang, X., . . . Cong, N. (2013). Evaluation of terrestrial carbon cycle models for their response to climate variability and to CO2 trends. *Global change biology, 19(7)*, 2117-2132.

Raxworthy, J. (2013). *Novelty in the entropic landscape: Landscape architecture, gardening and change*. The University of Queensland.

Raxworthy, J. (2019). *Overgrown: Practices Between Landscape Architecture and Gardening*. MIT Press.

Rise, M. S. L. (2010). *Sea level rise and flood risk assessment for a select disaster prone area along the Western Cape coast*. Department of Environmental Affairs and Development Planning

Rothman, M. (2018). *Biological Sciences BIO3017S Marine Resources: Lecture on seaweed use*. Presentation, University of Cape Town.

RSA National Treasury. (2020). *Water Treatment Works: Refurbish Shelly Point Desalination Plant*. Retrieved from https://municipalmoney.gov.za/infrastructure/projects/84282/

Saldanha Bay Municipality. (2019). *Water Sources. Water Services Development Plan For 2017-2022. Executive Summary*, xxxix. Retrieved from: https://sbm.gov.za/wp-content/uploads/Pages/Saldanha-Bay-WSDP-2017-2022-RevC-Exec-Summary.pdf

Sassen, S. (2016). *Land as Infrastructure for Living*. New York: Princeton Architectural Press.

Schimel, D., Stephens, B. B., & Fisher, J. B. (2015). Effect of increasing CO2 on the terrestrial carbon cycle. *Proceedings of the National Academy of Sciences, 112(2)*, 436-441.

Scriven, D. R., DiBacco, C., Locke, A., & Therriault, T. W. (2015). Ballast water management in Canada: a historical perspective and implications for the future. *Marine Policy, 59*, 121-133.

Shah, D., Phadke, A., & Kocher, W. (1995). Lead removal from foundry waste by solvent extraction. *Journal of the Air & Waste Management Association, 45(3)*, 150-155.

Sokutu, B. (2018, October 12). Transnet sets new world record with 4km-long manganese train. *The Citizen*. Retrieved from https://citizen.co.za/news/south-africa/2021838/transnet-sets-new-world-record-with-4km-long-manganese-train/

Sondak, C. F. A., Ang, P. O., Beardall, J., Bellgrove, A., Boo, S. M., Gerung, G. S., . . . Chung, I. K. (2017). Carbon dioxide mitigation potential of seaweed aquaculture beds (SABs). *Journal of Applied Phycology, 29(5)*, 2363-2373. doi:10.1007/s10811-016-1022-1

South African National Biodiversity Institute (SANBI). (2018). *National Biodiversity Assessment Threat Status*. Shapefile [Data file]. SANBI.

Spirn, A. W. (2019). 4 Landscape Literacy and Design for Ecological Democracy: The Nature of Mill Creek, West Philadelphia. *Grounding Urban Natures: Histories and Futures of Urban Ecologies,* 109. Penguin Random House.

Sguazzin, A. (2019, November 11). Saldanha Steel, an Apartheid-Era Conceived Mega-Project, Closes. *Bloomberg*. Retrieved from https://www.bloomberg.com/news/articles/2019-11-11/saldanha-steel-an-apartheid-era-conceived-mega-project-closes

Steneck, R. S., Graham, M. H., Bourque, B. J., Corbett, D., Erlandson, J. M., Estes, J. A., & Tegner, M. J. (2002). Kelp forest ecosystems: biodiversity, stability, resilience and future. *Environmental conservation*, 436-459.

Swyngedouw, E., & Swyngedouw, E. (2004). *Social power and the urbanization of water: flows of power*. Oxford University Press.

Teagle, H., Hawkins, S. J., Moore, P. J., & Smale, D. A. (2017). The role of kelp species as biogenic habitat formers in coastal marine ecosystems. *Journal of Experimental Marine Biology and Ecology, 492*, 81-98.

Timeslive. (2019, November 17). Architecture of Another Era. *The Sunday Times*. Retrieved from https://www.timeslive.co.za/sunday-times/business/2019-11-17-architecture-of-another-era/

Van Wilgen, B., Higgins, K., & Bellstedt, D. (1990). The role of vegetation structure and fuel chemistry in excluding fire from forest patches in the fire-prone fynbos shrublands of South Africa. *The Journal of Ecology*, 210-222.

Welman, L., & Ferreira, S. L. (2016). The co-evolution of Saldanha Bay (town and hinterland) and its Port. *Local Economy, 31(1-2)*, 219-233.

Wentzel, A. (2019, November 14). Saldanha community to pay heavy price as 568 steel jobs disappear on West Coast. *Daily Maverick*. Retrieved from https://www.dailymaverick.co.za/article/2019-11-14-saldanha-community-to-pay-heavy-price-as-568-steel-jobs-disappear-on-west-coast/

Widera, B. (2014). *Possible Application of Seaweed as Building Material in the Modern Seaweed House on Læsø*. Paper presented at the 30th International Plea Conference.

World Aquaculture. (2016) *Spotlight on Africa at World Aquaculture 2017, December 2016*. South African International Marine Institute (SAIMI).

Wu, D., You, H., Du, J., Chen, C., & Jin, D. (2011). Effects of UV/Ag-TiO2/O3 advanced oxidation on unicellular green alga Dunaliella salina: implications for removal of invasive species from ballast water. *Journal of Environmental Sciences, 23(3)*, 513-519.

Wuana, R. A., & Okieimen, F. E. (2011). Heavy metals in contaminated soils: a review of sources, chemistry, risks and best available strategies for remediation. *Isrn Ecology, 2011*.

DECLARATION OF FREE LICENSE and PLAGIARISM DECLARATION

I, Hayden Barratt Malan (MLNHAY002), hereby:

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

b) Declare that:

1. The above thesis is my own unaided work, both in composition and execution, and that apart from the normal guidance of my supervisor, I have received no assistance apart from that stated below;

2. Except as stated below, neither the substance nor any part of the thesis has been submitted in the past, or is being, or is to be submitted for a degree in the university or any other University.

3. I am now presenting the thesis for examination for the Degree of Master of Landscape Architecture.

I, Hayden Barratt Malan (MLNHAY002), hereby acknowledge that;

1. Plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own.
2. I have used the APA convention for citation and referencing.
3. Each contribution to and quotation in, this project from the work(s) of other people has been attributed, and has been cited and referenced.
4. This project is my own work.
5. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his, her or their own work.

Signed: Hayden Barratt Malan

Signed by candidate

Date: 18/12/2020

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

ETHICS 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		HAYDEN BARRATT MALAN
Department		LANDSCAPE ARCHITECTURE
Preferred email address of applicant:		HBMALAN@GMAIL.com
If Student	Your Degree: e.g., MSc, PhD, etc.	MLA
	Credit Value of Research: e.g., 60/120/180/360 etc.	120
	Name of Supervisor (if supervised):	CHRISTINE PRICE
If this is a researchcontract, indicate the source of funding/sponsorship		UCT POSTGRADUATE MERIT, 10 A
Project Title		RESOURCE MANAGEMENT POSSIBILITIES IN SALDANHA BAY

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.

APPLICATION BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	HAYDEN BARRATT MALAN		21/05/2020

SUPPORTED BY	Full name	Signature	Date
Supervisor (where applicable)	Christine Price		21/05/2020

APPROVED BY	Full name	Signature	Date
HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section 1; and for all Undergraduate research (Including Honours).			
Chair: Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the questions in Section 1.	R Behrens		18 Aug 2020