

Bee-cause



Designing to receive:

Designing landform and soils to receive and support a variety of flowering species in strategically located corridors; bridging the boundary between the Cape Honey Bee's foraging grounds and bee pollinated farmlands. As a result building valuable socio-economic, educational and environmental relationships whilst solving an ever increasing bee crises.

by Roux Lubbe

Univ



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Bee-cause

Designing to receive: a project which explores designing landform and soils to receive and support a variety of flowering species in strategically located corridors; bridging the boundary between the cape honey bee foraging grounds and bee pollinated farmlands, as a result creating other socioeconomic, educational and environmental relationships.

Submitted in partial fulfilment of the
Master of Landscape Architecture Degree
120 Credits

December 2017
by Roux Lubbe (1bbrou001)
Thesis supervisor Clinton Hindes

University of Cape Town
Faculty of architecture, planning and geomatics
Masters of Landscape Architecture Dissertation

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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):	Clinton Hides
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Project Title	Transitional Ground	

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Principal Researcher/ Student/External applicant	Roux Lubbe		09 Dec 2017



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EXECUTIVE SUMMARY

“Land Mosaic” is a term often referred to by Richard Forman as the fundamentally different ecotopes which play out within a landscape forming a spatial juxtaposition of landscape patchworks. Each ecotope is defined by a variety of factors such as landform, soils, hydrology and weather. In a natural setting, the relationship between two different ecotopes tend to be less abrupt than that of an urban setting. When two different ecotopes meet, a gradual gradient is formed called an Ecotone. A sort of “mosaic” or gradient of ecotopes entwined within the boundary of the ecotone. Gradient is a critical characteristic of many healthy ecotope edges. In the book “Urban Ecology” by R. Forman a comparison is made between this ecological theory and the functioning of an urban setting.

This study uses Formans theory in Section A. to analyse the zoning, land use and function of the urban fabric within the diverse neighbourhood of Elsieskraal, CT, following the rapid changing zones along the public river corridor, to reveal relationships between the spatial qualities of ecotope boundaries and the success of the ecotopes functioning. The study finds an interesting process is hindered by an unconventional boundary, perhaps the type of boundary a city planning or urban design method of analysis might have overlooked. The process of crop pollination by Cape honey bees (*Apis mellifera capensis*). The study found that

although no physical conventional barrier stops the bees from flying into the desired agricultural land from their more permanent foraging grounds, they are restricted by the spatial quality of the two ecotopes edges. The lack of curve linear “lobed” edges prevent the interaction between the two ecotopes through short flight range by the bees.

In Section B. the document further continues to investigate the process of pollination, bee life cycle and desired nectar-rich plant palette to design system which encourages the interaction whilst assisting the devastating bee crises, increase crop yield. The design lays out a network of proposed corridors in a specific off-set from one another, running through the agricultural land, linking schools environmental, tourism and economic activities as a “spin-off” effect. Emphasis is placed on designing landform and soils within the network of corridors to help grow the largest variety of colourful, nectar abundant and scented flowering species possible, all which are carefully chosen for their desire by the cape honey bee and their flowering time in comparison to local crops. By the morphing the boundary of nectar-rich foraging grounds into the mono-cultural farm land in the form of lobes the project creates an essential relationship between crop and foraging ground, reintroducing a critical process of pollination and bridging the boundary between socioeconomic and environmental aspects.

RESEARCH STUDY ABSTRACT

The use of analytical techniques on maps to test the multifunctionality of material and organisms, permeability and use of boundaries of the Elsieskraal River corridor, Cape Town as a ecotope of the urban fabric and its relationship to its adjacent urban ecotopes. The study uses ecological principles of land mosaic, gradient and boundaries by Richard Forman, a landscape ecologist as a base to analyse the identified portions of the river corridor. The areas identified for further analysis are defined by using the breakdown of major ecological patch functions by R. Forman; Filter, Conduit, Source and sink. Once identified, the study uses principles set out by R. Formans books; Land Mosaic and Urban Ecology to analyse the relationships between urban ecotopes. Emphasis is placed on the edge between urban ecotopes, the function of the edge, the general structuring elements and form thereof as the study seeks to explore the influence the form of edge has on the way the ecotope functions in entirety.

The intention behind the research study is to identify a process or organism which is essential to the health of the ecotope or ecotopes it is found within and how the spatial form of the ecotopes boundary effects the function thereof. The study therefor takes the form of a sort of scoping project, exploring elements which can further be used in the manner of a design response.

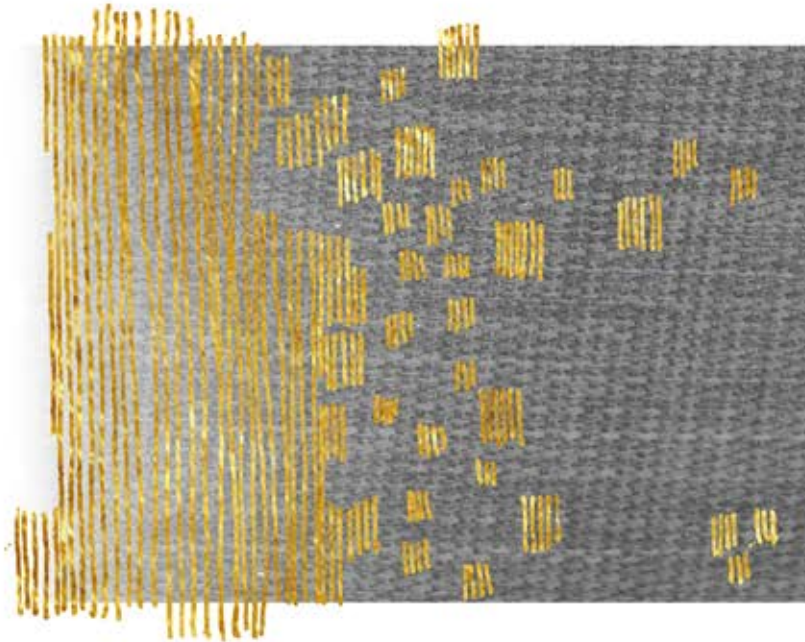
ECOLOGY: ECOTOPES & ECOTONES

1.1 The ecology of landscapes

Ecology is generally defined as the study of the interactions among organisms and their environment (Forman, R. 1995). Forman (1995) describes a landscape as “kilometres-wide mosaic over which local ecosystems recur”. Thus, landscape ecology is simply the ecology of landscapes, and similarly at a larger scale, regional ecology is the study of regions. The spatial elements in landscapes that forms patterns have been called landscape elements, local ecosystems and more commonly land-units or ecotopes. An ecotope or land unit is the smallest ecologically distinct/homogenous tract of land (Zonneveld, I. 1989). The homogenous characteristics of a single ecotope is defined by its external forces; landform, soils, hydrology, weather etc. in combination these factors define the structure which in turn results in a spatial characteristic of that ecotope. Over the distance of larger landscapes, distinctly different external factors result in a heterogeneous mosaic of ecotopes (Forman, R. 1995).

1.2 Spatial qualities of ecotopes

According to Forman, R. (1995) spatial heterogeneity occurs in two different ways. A *gradient* or *mosaic*. A *gradient* is a gradual variation over space of the objects present (Forman, R. 1995). Thus, a gradient has no boundaries, no patches and no corridors, but is heterogeneous nonetheless. (refer to dwg. 1.0)



(Drawing 1.1) Interpretation of forest edge as gradient where a dense forest ecotone edges a grass field and slowly dissolves with no distinct boundary.

The alternative form of spatial heterogeneity, *mosaic*, is where objects are aggregated, forming distinct boundaries (Forman, R. 1995). Land mosaic may contain only patches or, may contain patches or corridors in a sort of a matrix (Forman, R. 1995) (refer to dwg.1.2).

Three mechanisms create these patterns. Substrate heterogeneity, such as hills, wet spots or different soil types, causing the vegetation to respond in a patch like pattern. Natural disturbance, including fires, landslides and heavy rainstorms may create heterogeneous patterns. Thirdly, human activity, such as ploughing fields, cutting woodlots, building roads etc. creates patches, corridors, boundaries, and mosaic patterns.

A general way to understand form is to relate it to movement and change (Forman, R. 1995). Thus, one might say form is a resultant diagram of sorts, driven by force. E.g. the rectangular vineyard formed by the tractor and the dendritic stream corridor by water erosion. In addition, a linkage between structure and function manifests. Not only do flows create structure, but structure determines flows (Forman, R. 1995). The arrangements of ecotopes; patches or corridors determines the flow of vertebrates, water, and humans across the land. Finally, the movement and flows also change the land mosaic over time (Forman, R. 1995).



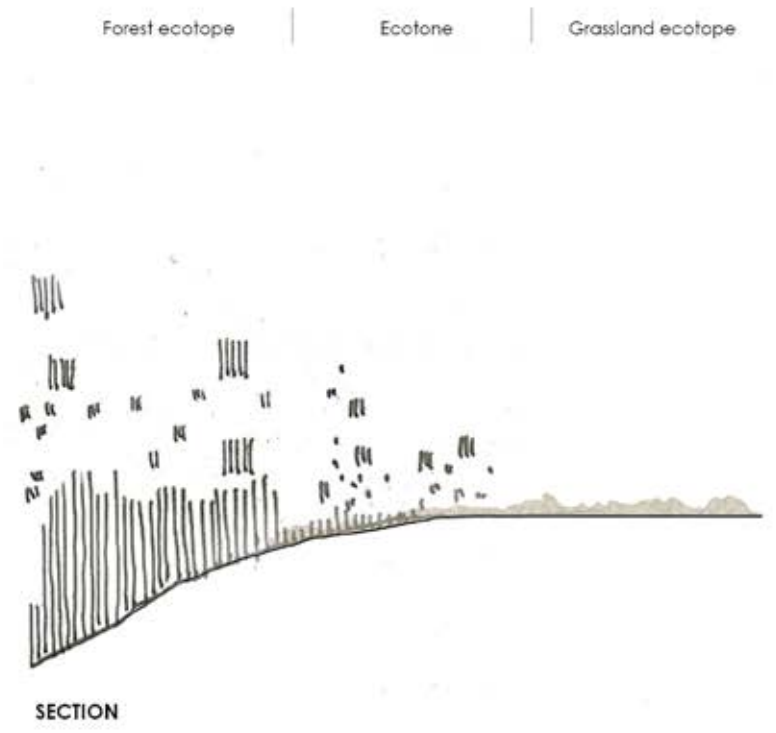
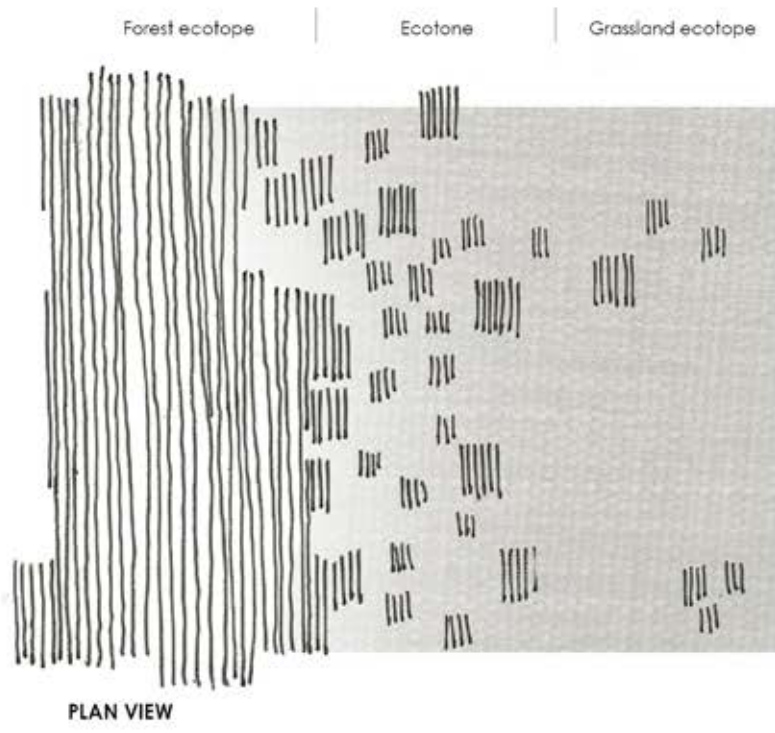
(Drawing 1.2) Matrix of indigenous vegetation corridors and isolated patches with abrupt boundaries defined by agricultural land. Interpretation of Google aerial image of Bergriver farms, Moorreesburg area, Western Cape (Googlemaps, 2017).

1.3 Edge Value

The repetition of a ecotopes across a landscape means that there is limit on the variety of habitats available for organisms. A landscape extends in any direction until the recurring cluster of ecotopes significantly changes (Forman, R. 1995).

For example, one moves from cultivated landscape to urban landscape where the combination of fields, vineyards, farmsteads, tracks and rivers changes to a combination of grassy park areas, gardens, housing and apartment blocks, roads and river corridors. The sharpness of the boundary or edge between the ecotopes is the central concern of this study, the gradient or transition, as this plays a major part in the diversity of material and organisms, movement and flow across the boundary.

In ecology, an ecotone is the transition between two biomes or ecotopes. It is where two communities meet and integrate. It may be narrow or wide, and it may be local (the zone between a field and forest) or regional (the transition between forest and grassland ecosystems). Naturally ecotones occur as non-abrupt boundaries, often as mosaic or gradient, or a solution thereof (Forman, R. 1995). An ecotone can thus be seen as an edge or boundary at gradient, a sort of gradual, non-abrupt boundary of a land-unit or type (refer to dwg.1.3).



(Drawing 1.3) Visual interpretation in plan and section of an ecotone between forest and grassland ecotopes. Information interpreted from Zonneveld, I.(1989) definition of ecotopes and ecotones.

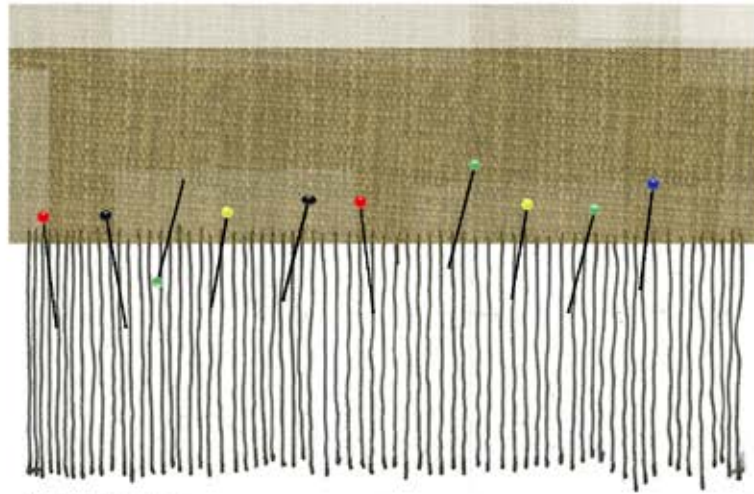
1.4 Edge Effect

In ecology, edge effects are changes in population or community structures that occur at the boundary of two ecotopes. References on page 85. Areas with small habitat fragments exhibit pronounced edge effects. In ecology, the result of this is often increase in biodiversity, activity, material flow and general health of the ecotone (refer to dwg.1.4).

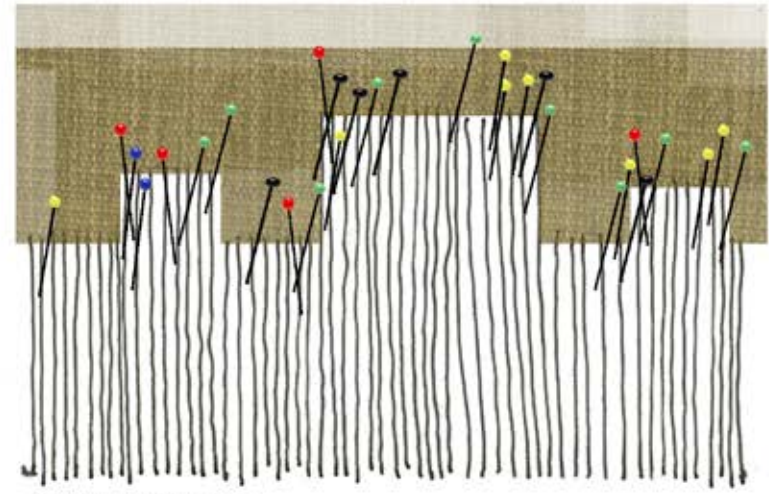
In wildlife management edges typically have abundance of game that move along and across boundaries. In land fragmentation, the ratio of edge to interior habitat is critical. In aesthetics views are often dominated by edges. In agriculture edges are often the source of pests but also predators of those pests. In urban sustainability issues humans are edge species (Forman, R. 1995).

As discussed previously, introducing a force or energy into a landscape makes it spatially heterogeneous in one of two ways, a gradient (bleeding and gradual difference in concentration of existing components of ecotopes over a distance) or mosaic (patches and/or corridors). In this sense, if boundaries are present in mosaic but not in gradient. Boundary and gradient are mutually exclusive (Forman, R. 1995).

Three mechanisms produce ecological boundaries in a landscape: patchy physical environment such as heterogeneous soil structure; natural disturbances like fire, storms and erosion; and human activities (Forman, R. 1995).



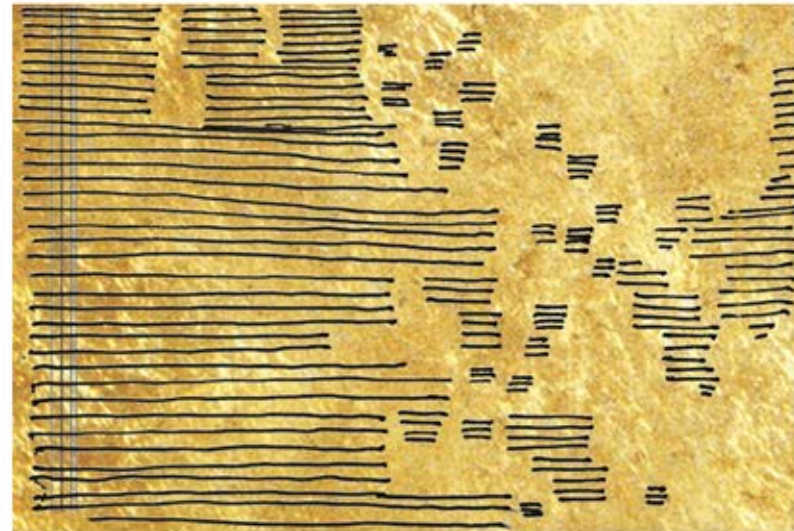
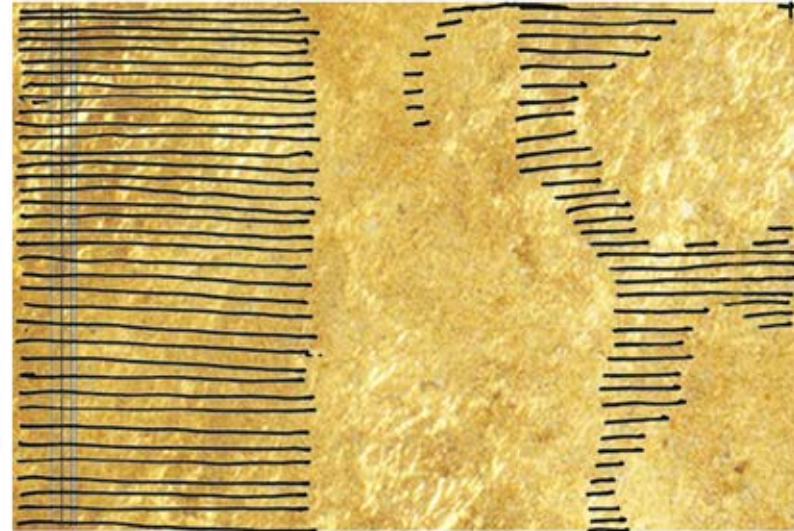
Straight boundary



Curve-linear boundary

(Drawing 1.4) Visual interpretation in plan of forest edge form and its effect on organism diversity and population along the edge. Information interpreted from Forman, R. (1995) *Land Mosaic*.

Human activities such as clear cutting and development for housing tend to drastically sharpen boundaries, thus increasing contrast between Urban ecotopes (Forman, R. 1995). In a natural scenario boundaries formed tend to bleed into one another (refer to dwg 1.5) Considering the integration this suggests that there is substantial interaction between the ecotopes (Forman, R. 1995). Studies have shown vertebrate, plant species and other organisms crossed soft or curvilinear boundaries in greater numbers than the straight abrupt boundaries, and penetrated further into the adjacent ecotope. This study hypothesizes that non-curve linear or straight boundaries are most frequent in human imprinted areas, diminishing integration and thus interaction.



(Drawing 1.5) Visual interpretation of contrast between forest edge in human imprinted area (Paarl winelands, Western Cape) and natural forest gradient (Paarl mountains, Western Cape). Information interpreted from Forman, R. (1995) *Land Mosaic*.

2.0 URBAN ECOTOPES OF THE CAPE

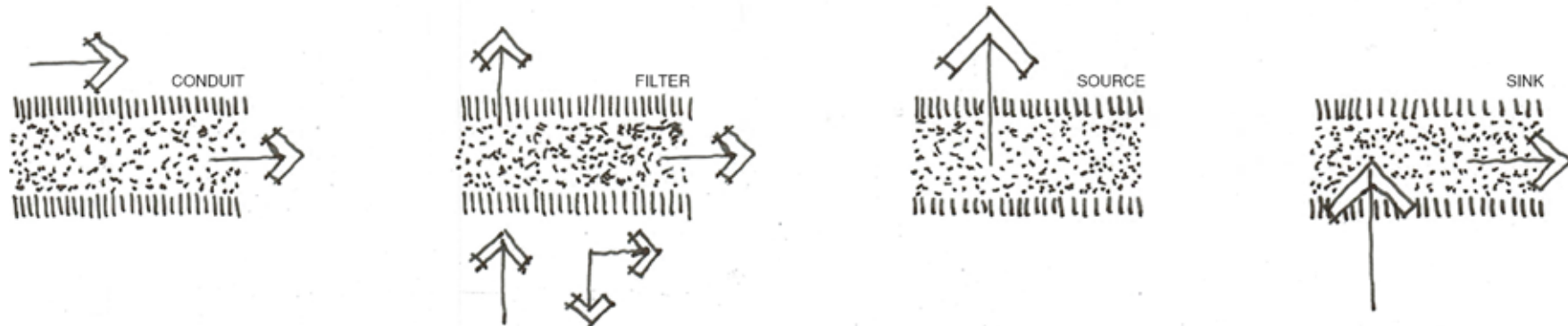
Chapter two of the study seeks to analyse relationships between urbotoxes: an urban ecotope, across their boundaries as a variety of corridors of the urban environment. Principles of Landscape Mosaic by Richard Forman studied in chapter one based of curve-linear and straight boundaries with patches on either or both sides of the boundary is used to do the analytical studio.

For the purpose of consistency throughout the study, chapter two only looks at corridors within the urban environment as boundaries between urbotoxes.

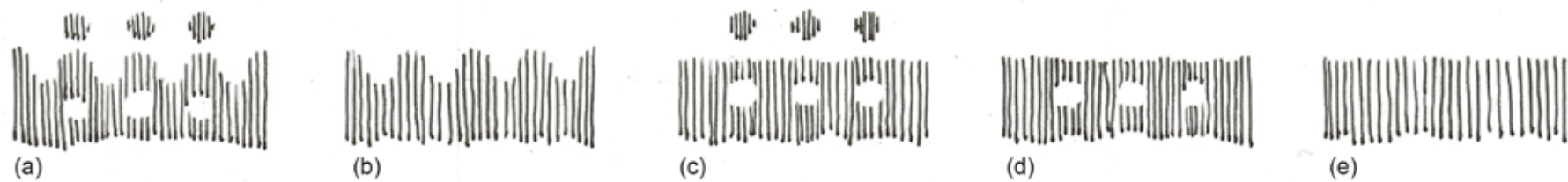
The analytical study will be done on different scales, potentially revealing the relationships across and along the boundaries edges, the flow of materials and organisms and identify processes which adhere or do not adhere to the spatial characteristics of the boundary. To do so, the analysis will be done in both plan and section.

The study will first look at urban corridors as the boundary between urbotoxes at macro/neighbourhood scale to reveal the effect of the spatial qualities the corridors have on the adjacent urbotoxes functioning. At a smaller scale, micro/local scale, the study zooms in to looks at the edge between the corridor and its adjacent urbotope. The purpose of using Formans theory of to analyse the urban ecotoxes is to identify lack of integration between ecotoxes, flow of material, movement of organisms and the relationships between them. According to Forman R. (1995) there are four basic structural characteristics that determine the membrane function or physiology; Conduit, Filter, Source and Sink (refer to dwg. 1.8). The key function is a permeable membrane, allowing certain materials to flow through but not others. The permeability of the boundary between urban ecotoxes are critical to allow interaction between them, a function which should be present in all boundaries regardless of the type of the ecotope structure.

The extent of boundary permeability is dependent on that of, but not exclusive to the form of the boundary and extend integration between ecotoxes (refer to dwg 2.0.b - boundary form).



(Drawing 2.0.a) Visual representation of four basic functional characteristics of permeable ecotone boundaries. Information interpreted from Forman, R. (1995) *Land Mosaic*.



(Drawing 2.0.b) Boundary pattern between ecotopes, Border may be curve-linear or straight with patches of one or both ecotopes. Information interpreted from Forman, R. (1995) *Land Mosaic*.

2.1 Boundary as urban corridor at a macro/neighbourhood scale.

Corridors in the urban fabric of Cape Town are present in many different forms. Regardless the corridors initial design intents, they often act as boundaries between different urbotopes within the fabric. The spatial qualities of these corridors as boundaries influence the adjacent fabric and thus effect the functioning of material flow, organism movement and relationships between the urbotopes across the boundaries. Ch 2.1 identifies four distinctly different urban corridors as boundaries based on Formans basic functional characteristics of boundaries, boundary as Filter, Conduit, Source and Sink.

2.1.1 Conduit: Railway Corridor as boundary

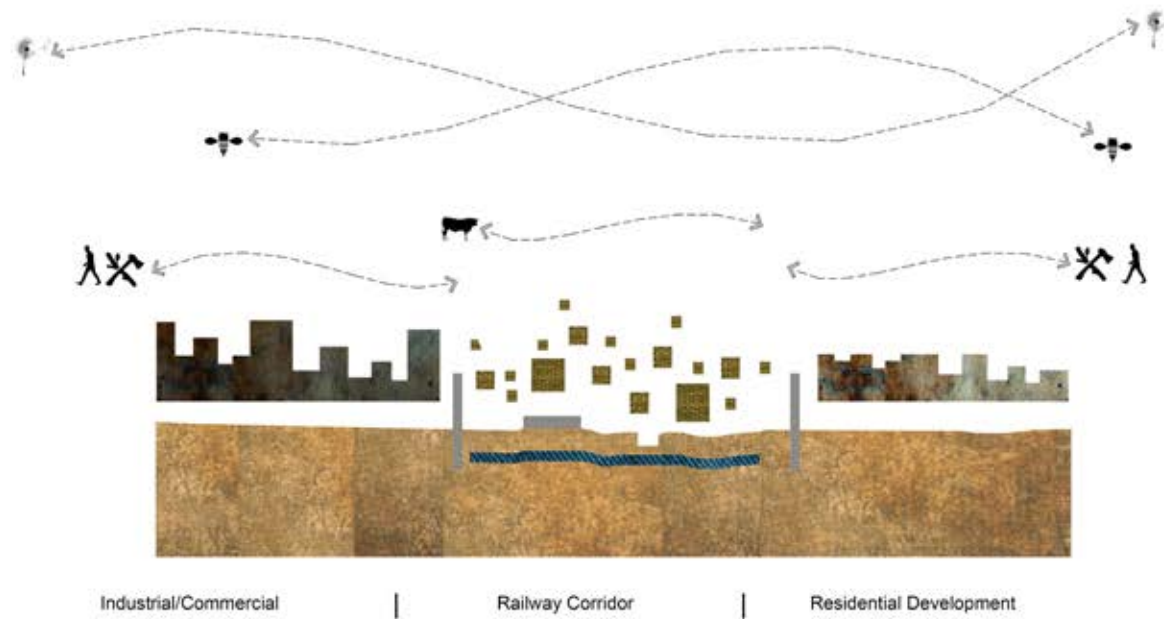
Railway corridors are structured as routes of movement for trains. The danger associated with moving trains mean that the corridors are often fenced off or nudged between tall building walls or residential boundary walls. The result of this is that the corridors often separate the urban fabric, acting as a barrier, impermeable to some organisms and processes. Subsequently allowing the movement of trains but preventing the movement of other materials and organism within, across and along the boundary.



(Drawing 2.1) Interpretation Forman, R. (1995) "Land Mosaic" on Railway corridor (Google maps, 2017).

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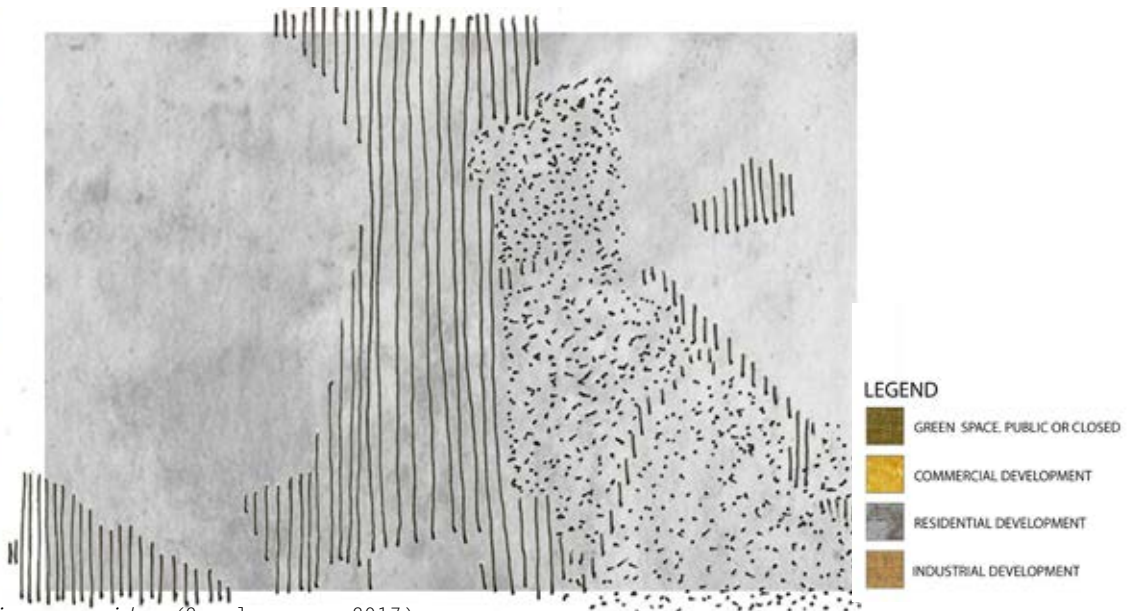
-  GREEN PUBLIC OPEN SPACE
-  EXTENT OF SEDIMENT MOVEMENT
-  WATER MOVEMENT AND INFILTRATION
-  BUILT STRUCTURES AND HARD SURFACES
-  DEVELOPED INFRASTRUCTURE
-  UNDERLYING GEOLOGY
-  HUMAN MOBILITY
-  LITTER/POLUSION
-  RESOURCE MOBILITY
-  MOBILITY OF MAMMALS AND SMALLER ORGANISMS
-  FLYING INSECTS AND BIRDS
-  WIND DISPERESED SEED



2.1.2 Source: Public Open Space River/Stream Corridors

River corridors make up part of the Capes Open Green Infrastructure Network System; a network of green open spaces generally in the form of corridors from hill tops to lower flats. River corridors in the cape are a result of development set back lines from the edge of the watercourse, not as an environmental conservation method but as a tactic to prevent adjacent development from flooding. The result is public open space buffers ranging from 50m to 1m wide on either side of the streams.

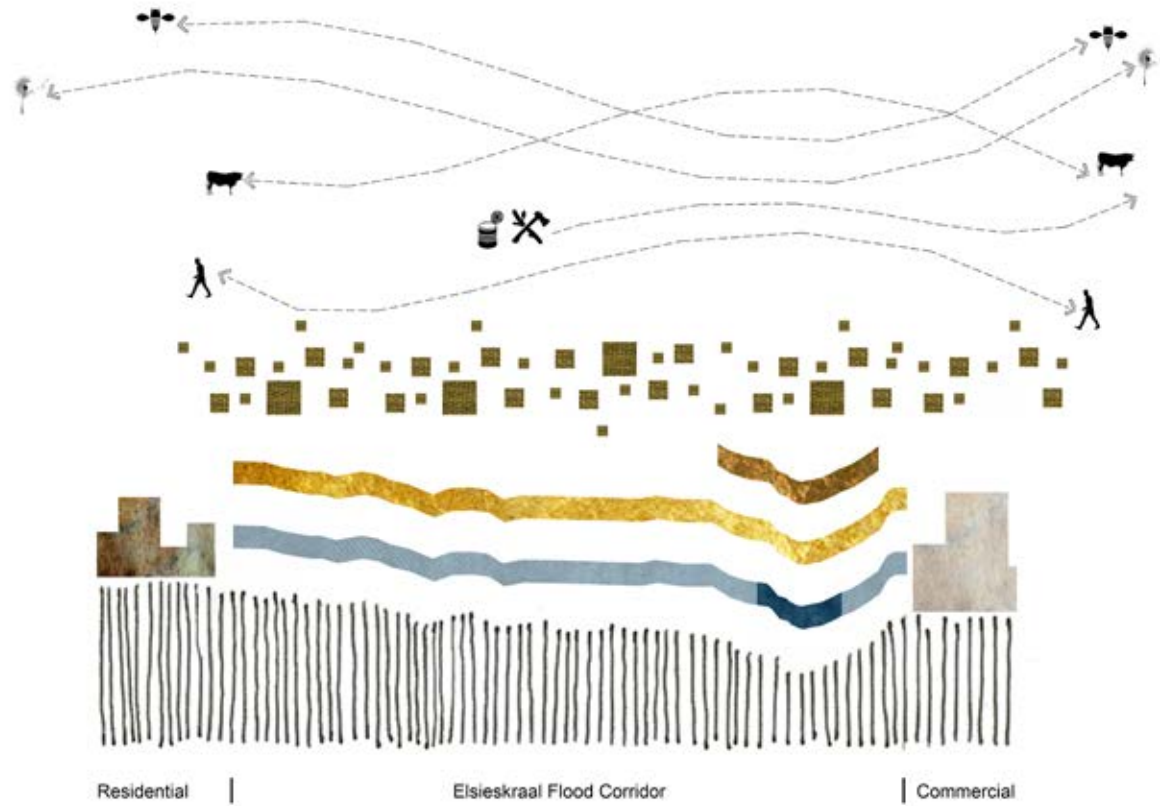
Often flanked by industrial or residential development, rarely commercial development, the corridors tend to be difficult to infiltrate. Subsequently, the corridors become boundaries between different urban fabrics or urbotopes, prohibiting potential relationships between the urbotopes. River corridors bordering commercial activity or high density residential fabric tend to be more accessible and less of a barrier between urbotopes. These types of boundaries become resourceful spaces, catering for social activities, habitat for organisms and areas of interaction and connection.



(Drawing 2.2) Interpretation Forman, R. (1995) "Land Mosaic" on River corridor (Google maps, 2017).

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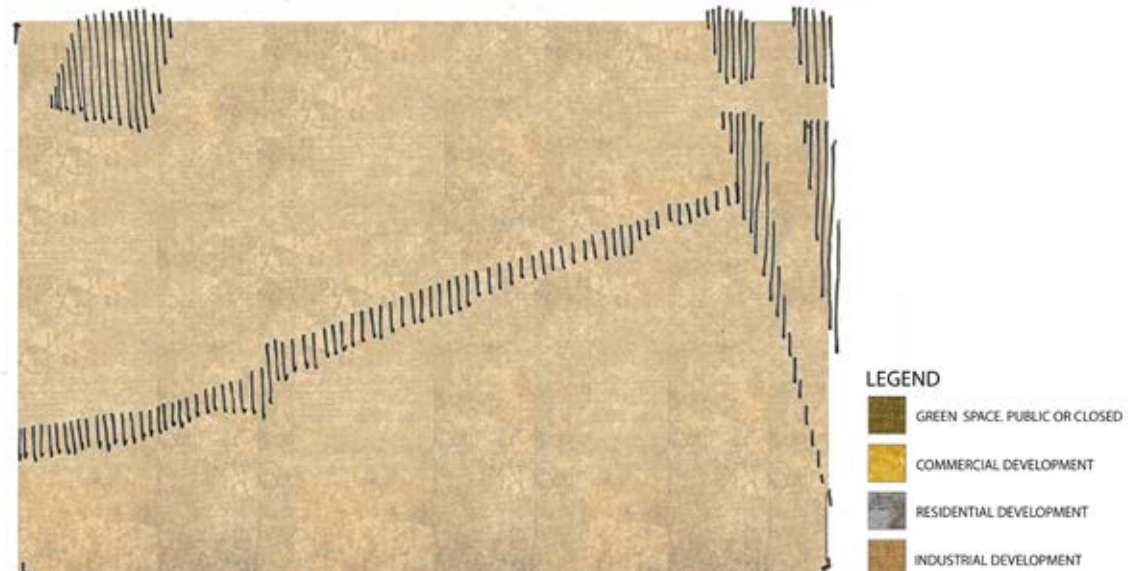
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2.1.3 Sink: Canal Corridors

Because of the capes seasonal rain fall, unexpected instant downpours mean flooding is a reality. Streams and rivers are often canalised with steeply edged concrete canals to both, rid of storm water as quickly as possible to prevent flooding and free up more space for development. Often fenced or positioned along the back facades of Industrial, commercial or residential developments, out of sight, the canal corridors become vacant, polluted spaces.

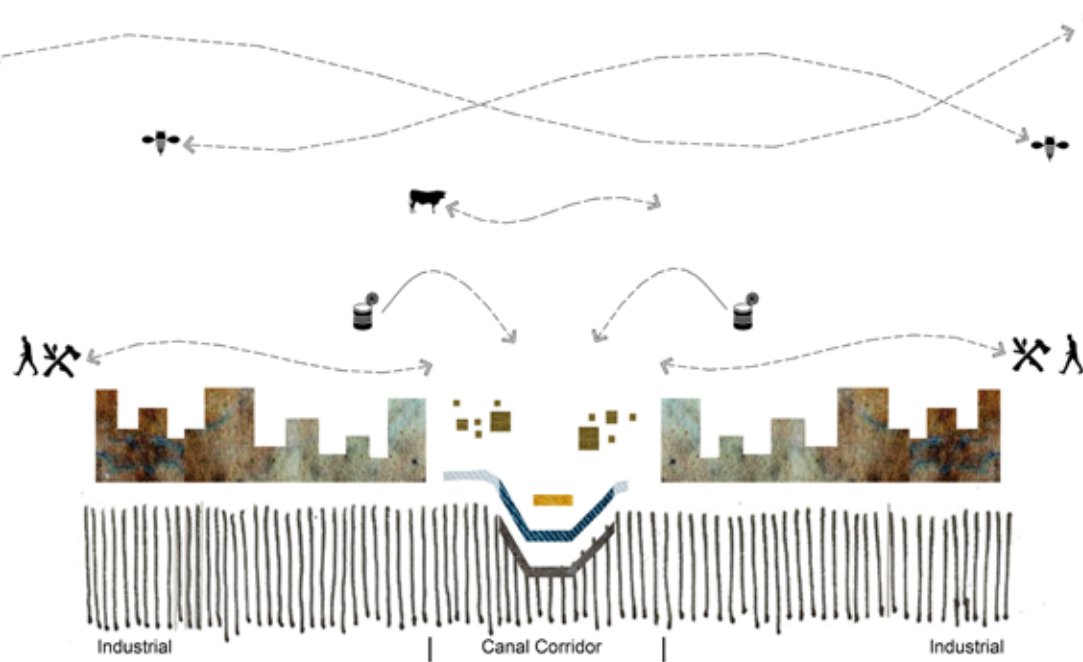
The canal systems tend to form a very strong boundary between urbotopes, acting as a distinct barrier. Seldom being resourceful and offering anything to the community, these elongated barriers become a sink to all kinds of sources of pollutants. The spatial qualities of the canals also prevent the cross flow of material and organism movement that would normally take place across a stream.



(Drawing 2.3) Interpretation Forman, R. (1995) "Land Mosaic" on Canal corridor (Google maps, 2017).

LEGEND

-  GREEN PUBLIC OPEN SPACE
-  EXTENT OF SEDIMENT MOVEMENT
-  WATER MOVEMENT AND INFILTRATION
-  BUILT STRUCTURES AND HARD SURFACES
-  DEVELOPED INFRASTRUCTURE
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-  WIND DISPERSED SEED



2.1.4 Filter: Highway Corridors as Barrier

Although characterised by its ability to quickly move vehicles from point A to B, acting as a strong conduit. Highways may often create strong barriers between or around neighbourhoods. Restricting organisms from moving freely across its path. In the case of the highway being on the edge of a neighbourhood, the boundary of the neighbourhood becomes a barrier to itself, restricting the flow of organisms and material both in and out of the urbotope.

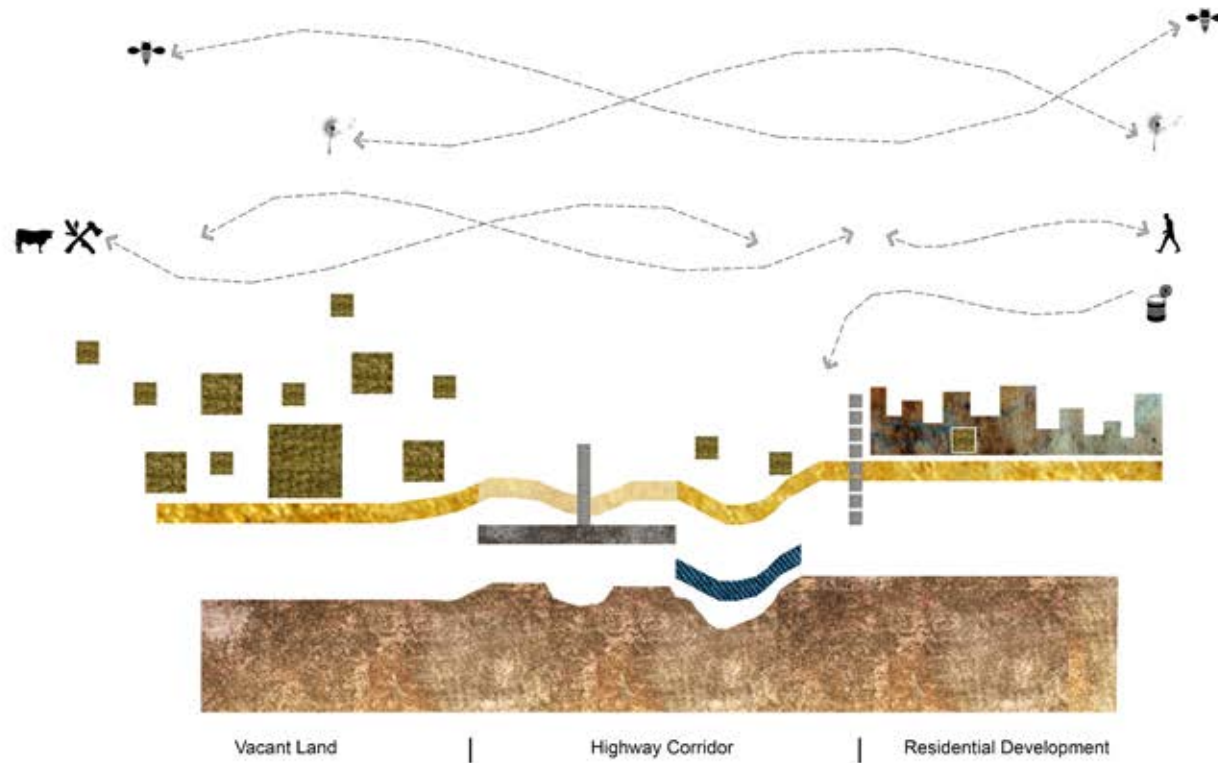
Thus, building a healthy relationship with its adjacent urbotope becomes problematic. Some materials and organisms of course are bound by other spatial or chemical boundaries and move across or through this boundary freely.



(Drawing 2.4) Interpretation Forman, R. (1995) "Land Mosaic" on Highway corridor (Google maps, 2017).

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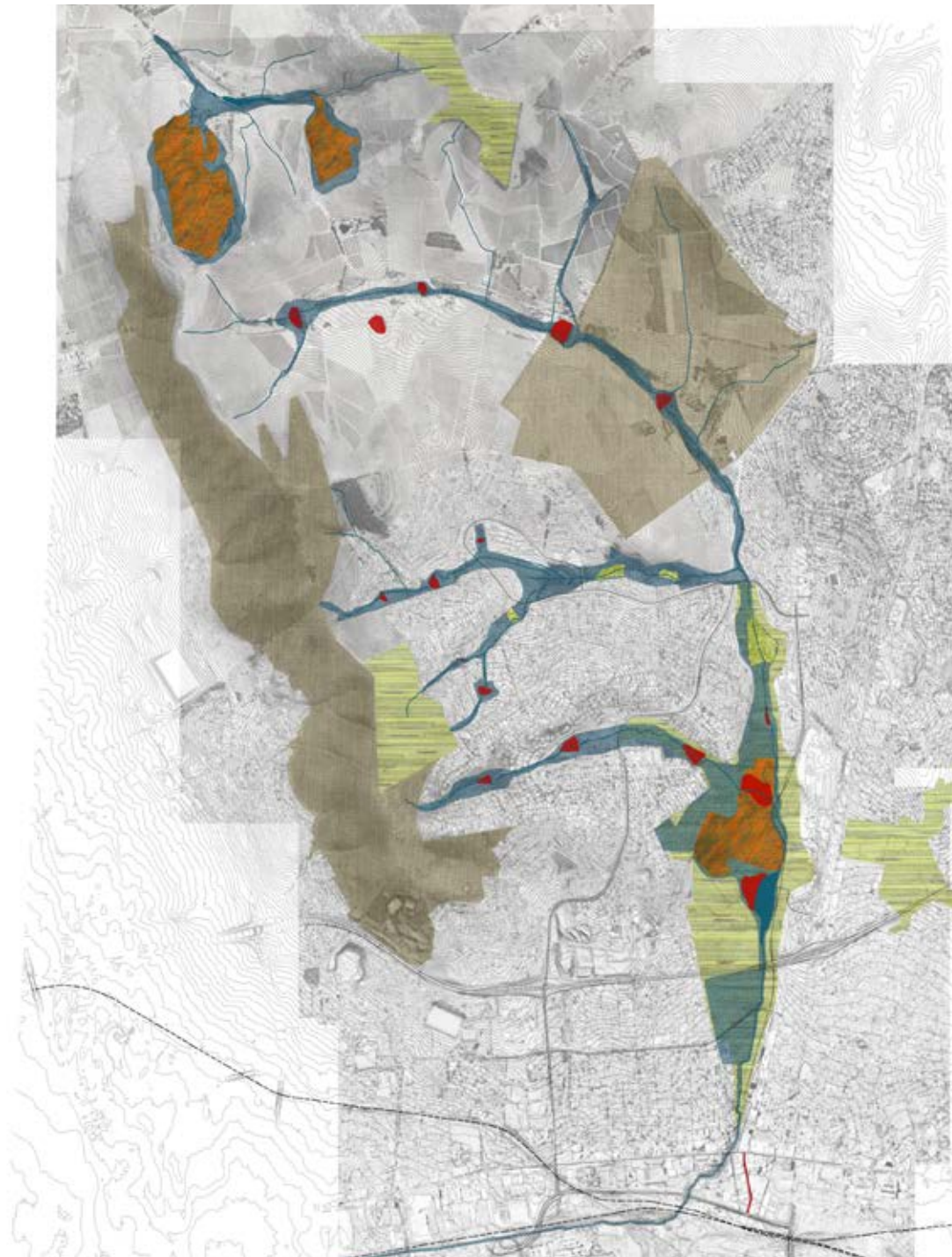
-  GREEN PUBLIC OPEN SPACE
-  EXTENT OF SEDIMENT MOVEMENT
-  WATER MOVEMENT AND INFILTRATION
-  BUILT STRUCTURES AND HARD SURFACES
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-  HUMAN MOBILITY
-  LITTER/POLUSION
-  RESOURCE MOBILITY
-  MOBILITY OF MAMMALS AND SMALLER ORGANISMS
-  FLYING INSECTS AND BIRDS
-  WIND DISPERESED SEED



3.0 Elsieskraal River Corridor

The Elsieskraal corridor was chosen as a site to further investigate the relationship between boundary and function due to its large variation in ecotope types, characteristics and functions.

From the Eastern slopes of Tygervalley hill to the flats of Pinelands the Elsieskraal River flows. Here, at its lower slopes it surrenders its energy to the Black River. Between the upper most slopes where the Elsieskraal River starts and the lower reaches around Tygerberg Metro-station the river morphs into distinctly different forms, ranging from upper rocky streams to dams and concrete canals. Hydrologically; the flow of the water changes drastically between upper high energy flows, slower flowing middle streams with opportunity for interaction and almost still standing dammed areas with great prospect for both social and ecological functions. Ecologically the site varies as much as the topography, as this depicts its water flow and plant growth. Land-use and urban infrastructure along the sites edges vary considerably from soft industrial, commercial to residential areas. Each of which have an impact on the site directly adjacent ecotope it edges.



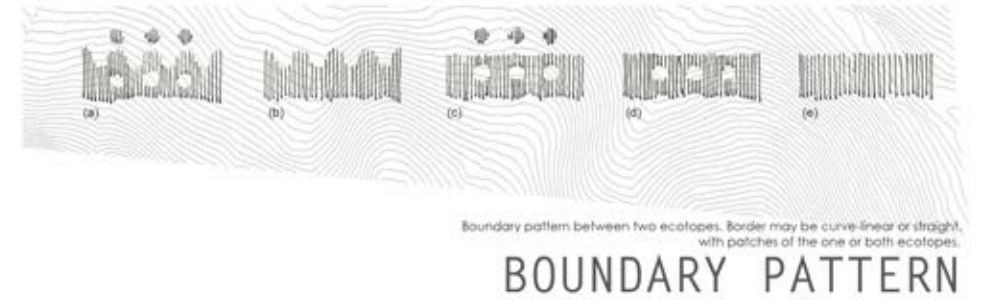
LEGEND

-  STANDING WATER BODIES
-  RIVER CORRIDOR/SITE
-  PUBLIC PARKS
-  LOCAL QUARRIES
-  NATURE RESERVE

(Drawing 3.0) Graphical representation of Elsiekraal River Corridor location from upper Tygervally streams to lower bellville concrete canal.
 (Interpretation from ArchGIS, CoCT Data, 2014).

3.1 Ecotope Boundary

The study looks at permeability of the edge between the urban ecotopes. The edges are defined by the change of character from built form to open space. The study seeks to find the relationship between the physical form of the edge and how or if the form effects the major functional characteristic of that urban ecotope or any other function that is essential to its functioning.



1 Some weeds between crop



Physical barrier to people in the form of a fence protecting the farm from theft. The fence as a boundary however does not stop many other processes or organisms and is not the cause of the lack of ecotone integration. This would possibly be an effect of the desire to maximise crop growth in the area. The lack of other flowering vegetation and crop grow areas have an effect on the efficiency of the grow areas.

High public open space ratio between residential area and continuation of trees from forest area into residential area merges the edge between the green corridor and the residential area.



The integration between the two urban ecotopes may potentially assist the use of the public open space, social behaviour flows across its gradient of a boundary. Water infiltration and movement takes place easier and less water is forced into a sudden release within the POS ecotone. Birds and insects can move between them easily. The visual permeability also assists with the safety of the area.

River as canal and conduit.



The spatial quality of a river may effect how the river itself is used and how its adjacent areas are used with the river being a spatial divider or barrier. Whilst rivers in cape town are often dividers, spatially changing their form can potentially release functions not visible at the moment. More so integrate the ecotopes in transverse.

Boundary wall on either side of the corridor prevent movement of most organisms and processes from taking place across the corridors edges..



The safety factor associated with railways and concrete canals means that the corridor is physically walled off to prevent pedestrian access. The result of this is the prevention of other processes taking place. A spatially more integrated system through the use of permeable boundaries or more integrated lobes or patches may assist the continuation of these processes. Ironically the visual impermeability of its edges means that the the very corridor created to be secure has no become the source of safety issues.

Visually permeable but physically entirely abrupt and inaccessible to people.



The edge between the narrowed channel corridor as a conduit of flood water and urban commercial development is very distinct. Defined by road verge in few areas and tall residential buildings in most areas, the movement of materials process and organisms seldom cross its boundaries. Some material such as water ignores boundaries through the use of piped systems. Safety, social interactions and possible socio-economic opportunities are lost through the lack of interaction.

Functionally well integrated- not spatially.



Boundary between commercial building front and public open space. Area is well utilised and accessible to some degree from access points adjacent to commercial buildings. Front of building faces open space but does not allow for a physical connection. Visual appeal of the public open space drives property value of the restaurants and commercial property. Despite an spatially abrupt edge - "form", functions of social use transfers across its boundaries "function".

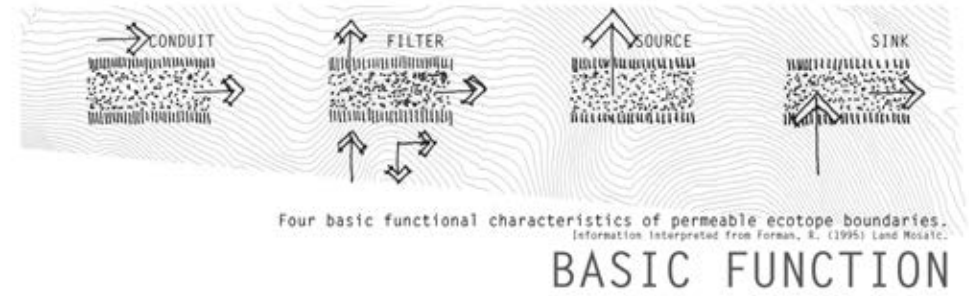


GENERAL SCORING EXERCISE CONCERNING BOUNDARY PERMEABILITY

(Drawing 3.1) Sketch of boundary pattern in Elsiesriver Corridor (Google maps, 2017).

3.2 Ecotope Function

The study looks at permeability of the edge between the urban ecotopes. The edges are defined by the change of character from built form to open space. The study seeks to find the relationship between the physical form of the edge and the how or if the form effects the function.



1 SINK
As its adjacent crop land the river corridor is required to work full time. The corridor absorbs large quantities of leached fertilisers, spontaneous flood events and constantly foresees the crop with year round pollinators. In that sense the corridor becomes the sink absorbing by-product formed through farming. Whilst the farm is a source of food to people, the corridor is a vital source to the farmland. Entirely codependent, the integration and interconnection is vital.

2 FILTER
The 100m wide indigenous vegetation buffer acts as an essential source of public open space to the neighbourhood, means of moving to and from the Tygerberg Nature Reserve and as a visual/ dust buffer between the residential neighbourhood and farm area. In its very design it functions as a filter, characteristics such as conduit and source of leisure came about public use thereof.

3 SOURCE
The form of the corridor is a result of river offset lines to prevent flooding of the adjacent housing and thus one can say it functions mainly as a source safety. The corridors function by design is to capture, absorb and move floods downstream. As a result of its linear continuity it functions as biological route between the main lower valley and upper nature reserve. Manners in which water flows from the urban fabric into the river system can be further analysed.

4 SINK
Whilst other material and processes may continue across its edges, the private residential erven which defines the corridor's edge is also the cause of physical impermeability to locals and potential users of the space. Creating a potential "dead-zone" and lowering the safety factor. Ecologically the corridor absorbs energy in the form of street run-off and is an essential part of the storm-water system.

5 SINK
High residential blocks turned their backs onto the portion of public open space siding the stream which flows through the residential neighbourhood. Lack of integration between the nearby commercial activity and the open space means the area has few users. In combination with its impermeable edges the area resulted in a sink of trash and unwanted activities. Lack of visual continuity allows for such activities to continue. The integration between commercial, residential and open space may potentially assist all three in functioning better.

6 CONDUIT
Canal and railway corridors are designed to function as a conduit, a route of movement, of both water, and people. The dangers associated with it means the entire corridor is off limits and either fenced or edged by private property. The result of this is a large portion of land that's both a waste in the sense of it only having a single function and a divider between urban ecotopes. Due to visual impermeability it becomes a sink for trash and unwanted activities and potential safety threat. The lack of multiple uses may be the cause of the community not valuing the corridors potential and as a result mistreat it. The corridors need requires visual continuity, a sense of resourcefulness and possible links with adjacent ecotopes.

7 CONDUIT
Voortrekker road and Kruskal Avenue are two distinctive commercial corridors. The function as conduits, moving people from store to store, as source; a platform of sale, making a living and purchasing. The manner in which it is connected with its surrounding ecotopes is poor. Softer more absorbent ecotope qualities with filtration qualities are not existent. The result is a hard landscape, producing noise, by product and polluted water that require much maintenance to rectify. Connecting the urban corridors to river corridors have the potential to reveal their underground relationship and open up new opportunities.

8 SINK
The river system is forced into a small concrete canal system. Its function is to capture adjacent ecotopes run-off and as a conduit, transport the water downhill. The position of the canal at the lower part of the slopes means it captures street and storm water from the urban ecotopes, both residential and commercial. The result of this is that it acts as a division between two opposite slope aspects, dividing the land but merging their water. Filter and source aspects can be applied to the canal system whilst maintaining its function as a conduit.

9 SOURCE
The widest part of the corridor splits Willowbridge from Soor De Kraal, two residential neighbourhoods. Made up of a series of cycling paths, walkways, dams, viewing points, large lawn areas and planted patches the area is a source of leisure to the community. Although valued by the adjacent residents, the boundary between the area and its adjacent ecotopes is not promoting interaction between the two. More integrated relationships may assist in highlighting the interconnected relationship between urban areas and natural systems. Physical movement (access) can be improved, relationships between adjacent fabrics to be approved across and non physical relationships between source and sink to be highlighted.

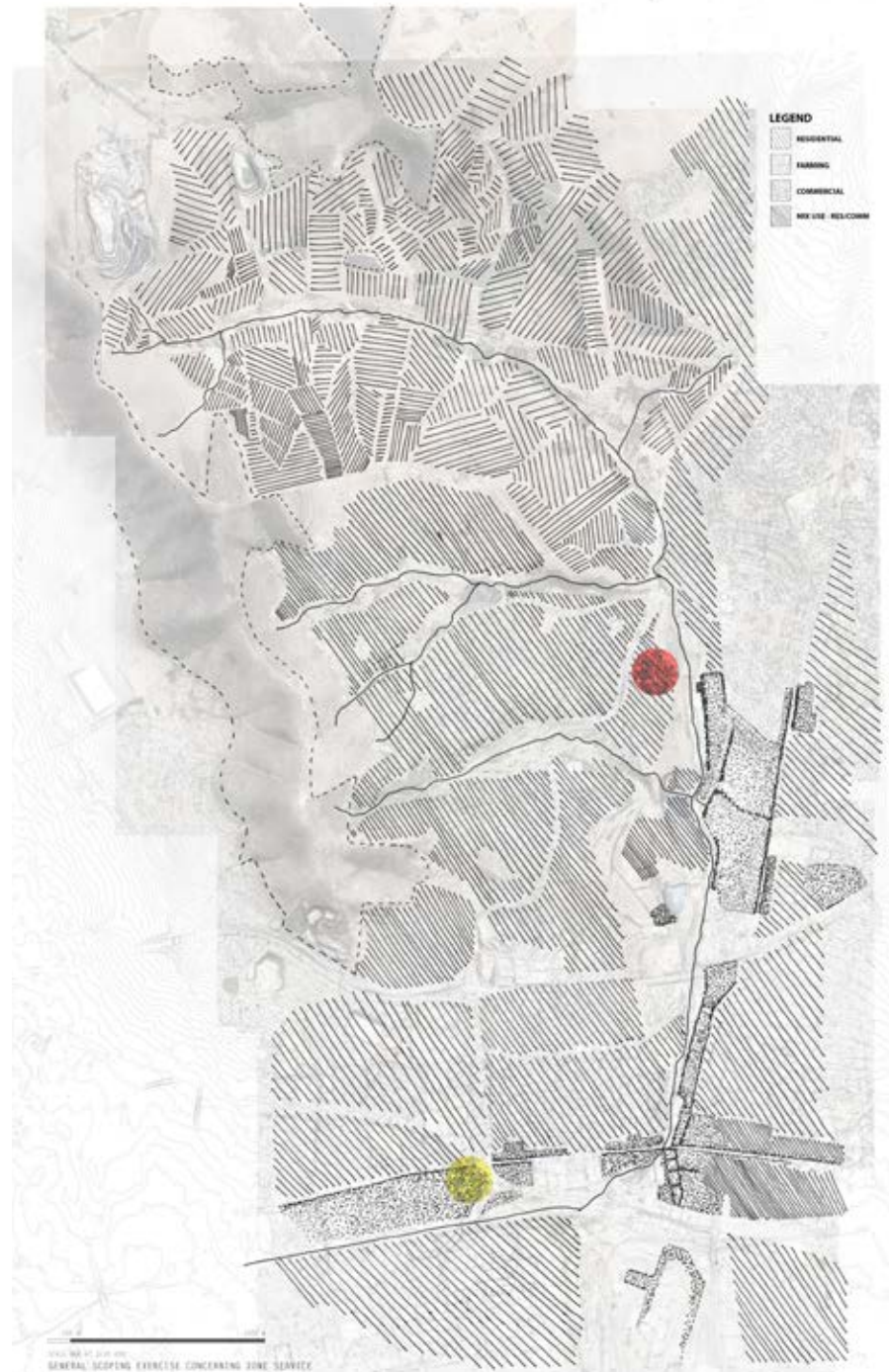
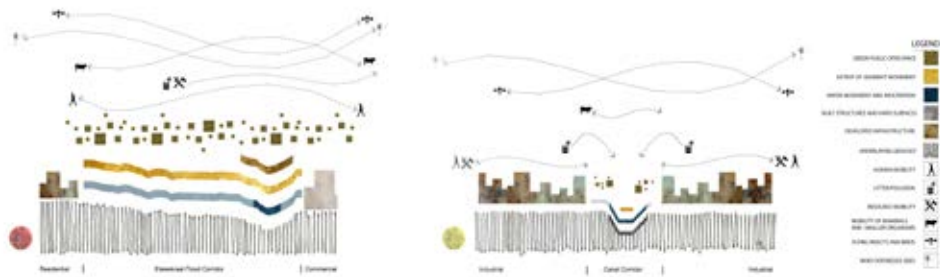


(Drawing 3.2) Sketch of basic function in Elsiesriver Corridor (Google maps, 2017).

3.3 Ecotope Type

The study maps general urban services (zoning) and their intensity in order to identify which of the services spatially run into each other at a 1:10 000 scale. In combination with the boundary and function maps; the set identifies how the spatial form effects the functions between urbotopes and thus identify relationships between one another.

Although each of the above presented maps might seem like they portray conventional urban design mapping techniques, it is the combination of the e maps that revealed processes and relationships between the ecotopes and layers mapped. The study found that using conventional urban design mapping techniques revealed similar information to the found by using Formans methods. The valuable aspects to interpreting Formans ecological methods to the urban environment of EKRC was that the lense forced the scoping phase to pay much more attention the relationship between the ecotopes mapped rather than on the ecotopes mapped. It was these relationships the study hopes to find and could only be done by looking at ecotopes or zones through Formans lense.



DESIGN DISSERTATION ABSTRACT

Bee-cause

Designing to receive:

The cape honey bee (*Apis mellifera capensis*), an essential crop pollinator in the western cape is restricted by its flight distance from hive to foraging ground. The restriction due to vast monocultural crop in combination with the lack of integration between foraging ground and farmland means not all crops are pollinated as successfully as they might be, the result is poor harvest. In the urge to assist the process and help the growing honey bee crises; the project designs a set of highly vegetated flowering corridors which meander through the farms of Durbanville hills. Landform and soil design is experimented with to create the largest variety of growing conditions within the corridors. The soil is designed to receive and nurture a variety of flowering plant species. Emphasis is placed on bridging the boundary between forage and crop pollination by bees. Research done on which flowering species are ideal for the conditions, desired by bees, have high nectar production and

flower exactly at the right time to support the honey bees between the birth from pupa form and the time of crop pollination.

The time is critical for the bee to build up a healthy immune system and strength for good crop pollination. Because of revealed environmental, social and economic potential because of the proposed corridors the project further explores 2 key points within the framework design to elaborate on the concept. Knoll grounds and calibrated depressions are two fundamental design mechanisms use to manipulate the soil within proposed corridors with different characteristics. Where different corridors meet, other socioeconomic aspects are highlighted and nodes are formed the study goes further to present sketch plans and details to showcase the concept of bridging boundary and designing to receive. Although much emphasis is placed on the soil and plant pallet, the design also very much takes the people of the areas into consideration. The landscape is formed for both hyper efficiency and takes on a sculptural, colourful and dramatic appearance, one for the people to enjoy.

Bee-cause

1.1 Agricultural pollination limited due to honey bee boundaries.

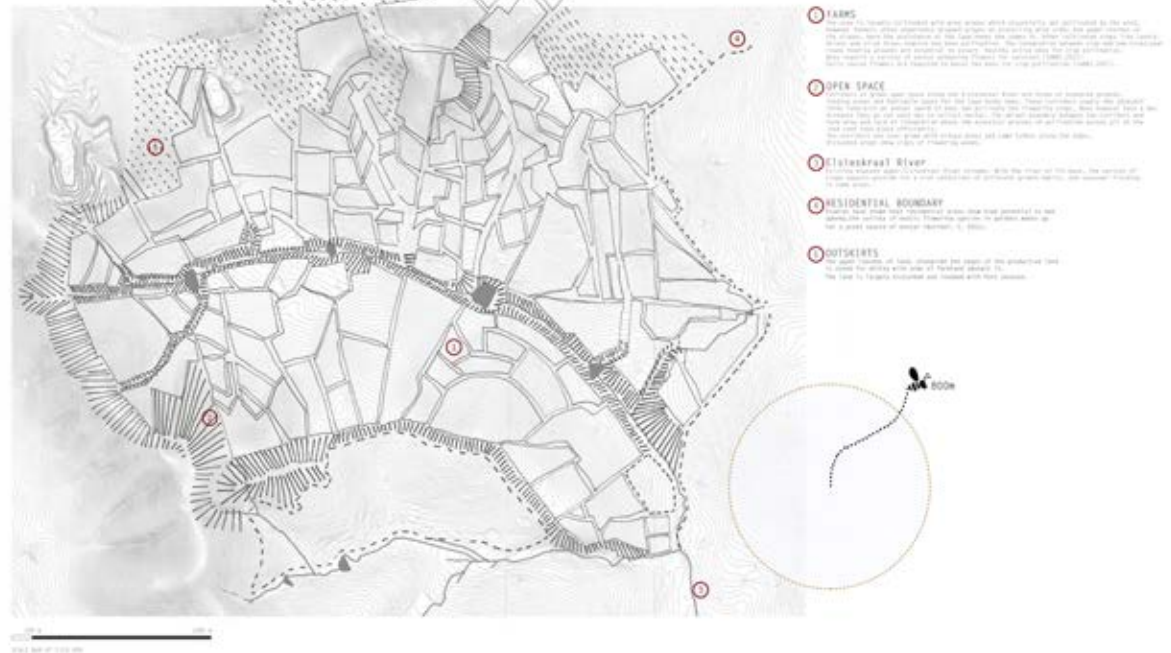
The study found an interesting relationship between local pollinators (cape honey bee) and the edge between bee foraging ground and agricultural land which is required to be pollinated by the bees.

Wild bees and other pollinating insects need continuous supply of flowers and places to nest. These two features must not be too far apart for daily movements between to be possible. Thus, pollination requires good dispersal routes. These can take the shape of corridors and be established within the green arteries through the agricultural land. Such corridors should contain a continuity of flowering plants throughout the season, from the end of October to end of April. Plants flowering early are especially important for the pollinators. Pollinators need places where they can nest, and nests can be built easily and placed along the green arteries. These two measures together would provide a spatial support for the migration of pollinating insects.

This could serve to assist with healthy bees throughout the farmland and assure the bees are ready and healthy when required for crop pollination.

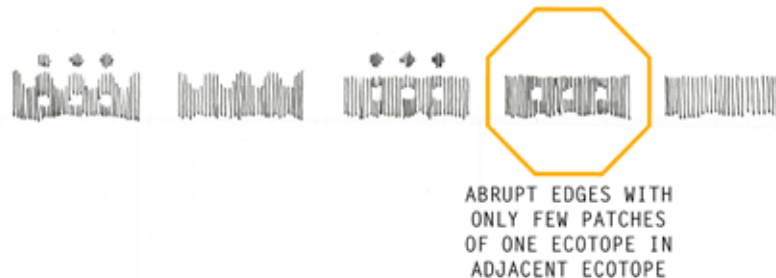
EXISTING BEE SUPPORT AREAS

The study maps areas which may support the local honey bee (*Apis mellifera capensis*). The Cape honey bee is an essential pollinator for many locally grown crops and its support is of essence to our economy. However its importance to crop, the crops pollen is a mere few days of food supply to the bee. A honeybee forages on nectar (carbohydrates) and pollen (protein) of flowering plants, and they require a large diversity of pollen and nectar from different plants sources to be healthy. The spatial relationship between bees feeding grounds and where "to be pollinated crop" is situated is of importance to the farmer.



EXISTING BOUNDARY FORM

The existing abrupt changes between agriculture and foraging ground (current public open space) with some weeds spreading from the one ecotope into the other (Open space to farmland) assist pollination to some extent but can be much more successful if promoted through the morphing of the boundary form.



(Drawing 4.1) Sketch of existing bee support areas in Durbanville agricultural area (Google maps, 2017).

- 1 Sports Activity**
 Durbansville quarry is actively being used for sports and live shows. Has potential to be linked to other sports like cycle routes.
- 2 Tourism**
 Maastricht wine estate can has the potential to link up with flowering corridors reaching up to a potential look out point and further more link up to the nature reserve which may drive tourism.
- 3 Existing Cycling Vegetated Buffer**
 Existing 100m wide indigenous vegetation buffer with cycling route accessible from upper residential area only. Area remain as is in terms of vegetation but links to be made between cycling track and larger routes.
- 4 Commercial Activity to be linked**
 Existing commercial activity with visual connection to active public open space has potential for an area where links between education, resolution for environmental issues and spin off from this come together. Boundary between commercial and public open space will have to be morphed to allow for physical interaction and movement.
- 5 Community engagement**
 The lower wine farm of the three, Altydgedact, is already active in the local community with teaching vegetable farming and actively promoting community engagement. In combination with environmental issues, grassing honey bee crisis and a potential link with the school may drive the farm to up take an educational twist and develop a potential education centre and even seed banks for future use.
- 6 Educational link**
 School situated on the edge of the upper reaches of a low lying wet valley has the potential to link up to the honey bee corridors. Linking education with pressing environmental issues through educational walks implemented amongst the flowering corridors.
- 7 Cycling Hub**
 O'Arle wine farm already has existing facilities to attract weekend visitors. The restaurant and outside kids area is a common breakfast area amongst local cyclists and is well used. A small existing cycling track runs along the rivers edge and has potential to link up to a much larger system.
- 8 Possible lower valley corridors**
 Low lying valley bottoms tend to be wetter than upper ridges and are more appropriate for planting flowering species in a time of drought.



(Drawing 4.2) Bee pollination analysis (Google maps, 2017).

1.2 Proposed boundary - "Lobed".

To achieve the desired cover over the agricultural areas to assure the bees can reach all crops; the study suggests a lobed network of high flowering corridors stretching over and through the farmed land.

The locations for these corridors are largely defined by:

- areas most ideal for flowering species
- spread approximately 800m apart to assure safe flight distance for cape honey bee.
- link up with existing infrastructure to unleash further potential such as socioeconomic or environmental benefits.



FLOWERING CORRIDORS

City of Cape Town provides the public with a list of plant species to plant to assist with the Cape Honey Bees management but landscapes at this scale are required to be developed with very low maintenance requirements and not all these plants are appropriate. Some species also require different growing conditions than others, the result of the two aspects in combination is that no single plant palette can be applied everywhere. Species chosen are picked for their low maintenance, high flower exposure and good nectar output. Not only do bees require a large variety of nectar to promote health, but they require it at specific time periods. In order to achieve the desired 800m to 1000m max spread of "diverse flower surface" within the farming area the study looks at which areas are most suitable for the coverage of "diversified" application. Lower valley bottom are often, slightly more protected from harsh wind conditions, more importantly these valleys tend to stay damp for longer periods of time. The map identifies valley streams within the farmland, these are currently being ploughed with crop rows on either side. The objective is to widen these streams and inject a array of appropriate flower varieties for nectar production.



- 1. FYNBOUS RIDGES**
Dry Fynbos populated with indigenous Fynbos species almost serve as a source of nectar during late spring to summer months. The well-drained nature of the existing corridor means the other early bloom wild species grow amongst the fynbos, a positive result of fynbos management, and for the Cape honey bee health but not great for crop pollination.
- 2. LOWER STREAM CORRIDORS**
The existing lower seasonal Fynbos river provides suitable habitat for a variety of flowering species to grow. Disturbed areas tend show more variety and higher plant density. Regardless of the "seed" classification, some exotic species are much more suitable for nectar production and more hard in disturbed landscapes at such.
- 3. EXPOSED STREAMS**
The upper reaches of the streams where water is of lower risk to cause flooding, crop rows tend to encroach onto the seasonal streams. The value of the streams as open exposed waterways are of critical importance to the pollination of the adjacent crops. The study proposes the widening of these demarcated streams and the coverage of appropriate early blooming species for the production of nectar. By following the lower damper bottoms as a guideline for areas to be planted with flowering species the project entirely achieves the 800m max distance flowering patches.

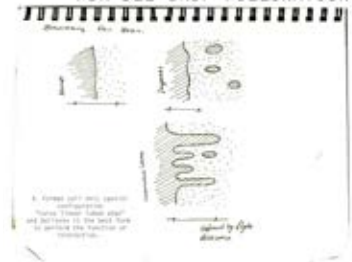
PROPOSED BOUNDARY FORM

Flowering corridors with suffice variety of rich pollen and nectar producing flowers are offset approximately 800m apart through the farmlands can assist the survival of bees year round. The offset distance is to assure the bees are capable of flying from proposed foraging grounds to all agricultural land when pollination is required.



Proposed flowering corridors through farmland at 800m intervals

SPATIAL CONFIGURATION FOR BEE CROP POLLINATION



ECOSYSTEM SERVICES THROUGH LINKAGES

Case study on social ecological urbanism (Albano campus, Stockholm)

Butterflies, pollination is currently using a decline caused by changes in landscape and habitat loss (Steffan-Dewenter et al., 2005; Albano 2011). Current studies stress the importance of landscape connectivity on pollination. Some plants are dependent on pollinators for their dispersal and sustained survival. With a network of well-planned and connected green spaces, the diversity of all kinds of pollinators is dispersing through urban landscape to increase production. This is critical for societal development and economic services. The pollination will become important dimension of urban services with bees and other pollinating insects to a butterfly supply of flowers and plants to visit. These two features need not be too separate because to be effective, they, pollination requires good crop row space the shape of corridors and be established within the green landscape. Such corridors should consist a combination of flowers the season, from the end of April to October (Möller 2011). Space is especially important for the pollinators. Pollinators need places where they can do their nesting and provide along the green network. These areas provide a spatial support for the migration of pollinating insect

Whilst most of the agricultural crop in the areas only flowers for a short amount of time during November, the cape honey bee requires pollen and nectar during different time periods but most importantly directly after pupa stage which in Western Cape is around August.

Plant species have been research to assure the bees specific needs as follows, are fulfilled: (refer to dwg. 4.5).

- Foragin Beesource (2017) g within 800m of crop required for pollination.

- High variety of flowering species within foraging grounds.

- High nectar and pollen producing species.

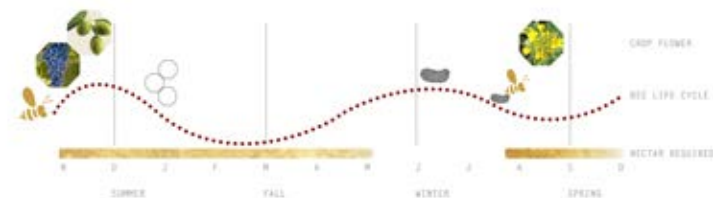
- Variety of flowers year-round.

- High flower production spring to early summer (September to November)

HONEY BEE ANALYSIS

FEEDING TIME vs. POLLINATION TIME

The Cape honey bee is first in bee form, ready for nectar collection during late August - early September. Full maturation of pollen, grains and seeds are required slightly later than this time. Whilst some flowering takes place early the others are to be pollinated only during October to November. Large quantities of nectar is to be collected during the first month or so after larval stage for the bees to gain strength to fly and collect nectar for the rest of the summer.

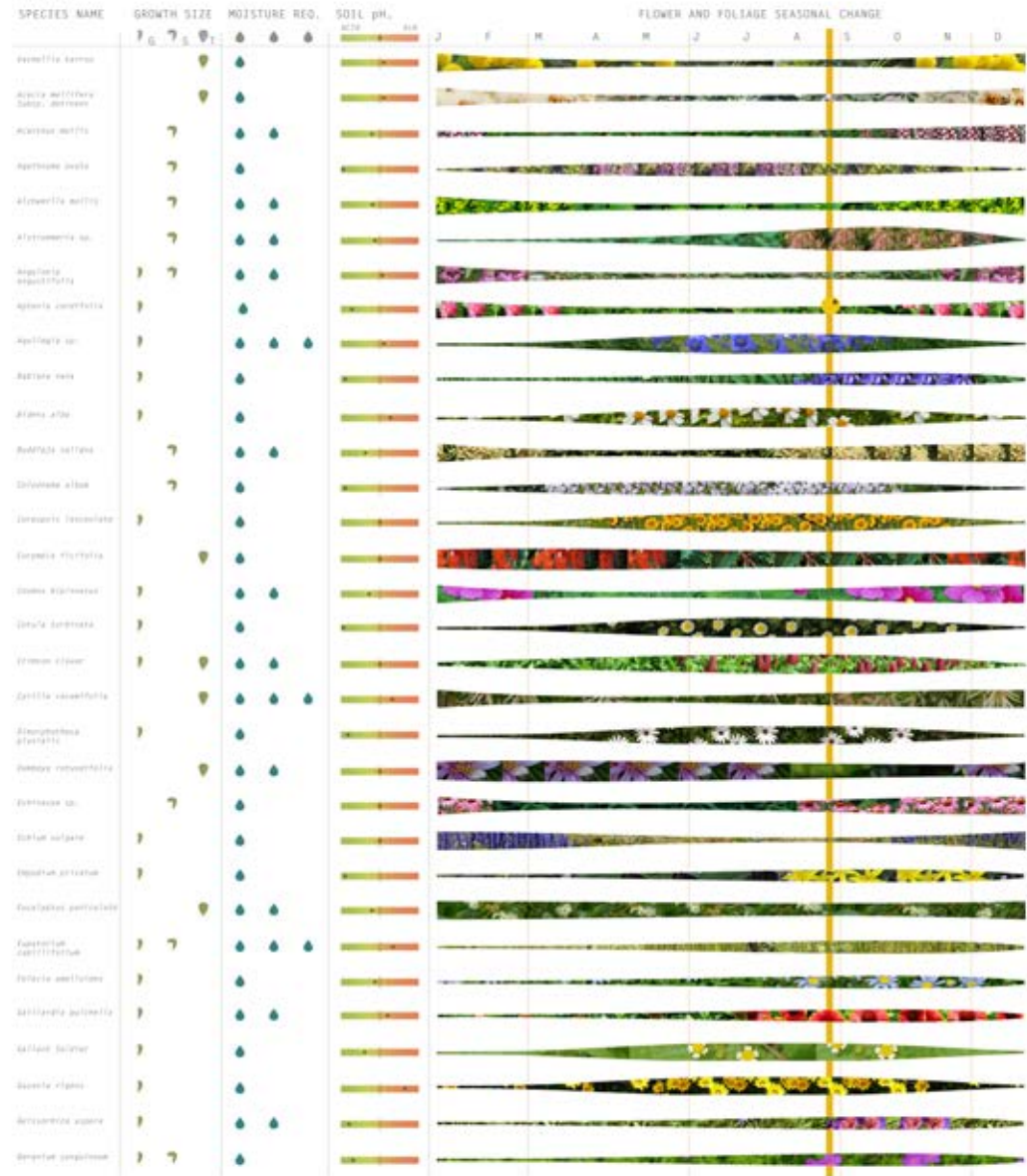


(Drawing 4.4) Diagrammatic representation of honey bee life cycle in Western Cape (Beesource, 2017).

NECTAR PALETTE

The graphic shows both the flowering patterns and the essential requirements by the plant species to create Honey Bee highways of high vegetation, soil moisture content and soil acidity directly affect the survival of species and often failure to germinate of other species. Timing of nectar producing flowers are essential to the survival of the bees and so to a highly integrated complex mix of species.

Pollen Composition:
 water (10-15%)
 protein (30-35%)
 other extract (10-14%)
 carbs (including reducing sugars) (10-15%)
 starch (10-15%)
 lipids (10%)



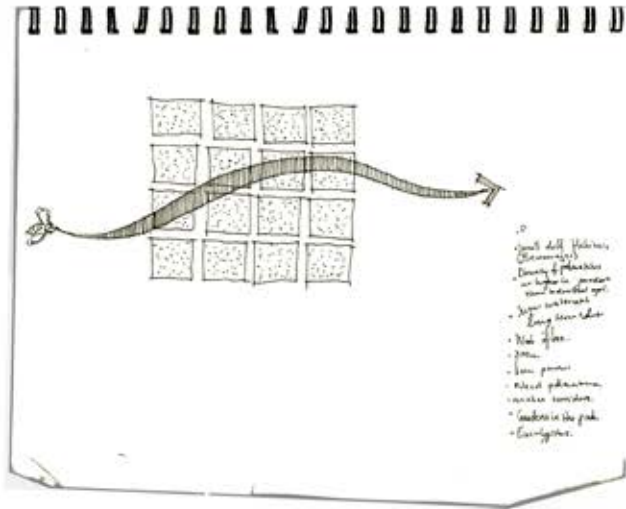
(Drawing 4.5) Diagrammatic representation ideal nectar flower palette (Numerous sources).

2.0 Designing to receive:

DESIGNING SOILS IN STRATEGIC FORMS AND PATTERNS IN PREPARATION TO RECEIVE AND NURTURE A VARIETY FLOWERING SPECIES FOR THE GROWTH OF HEALTHY BEE POPULATIONS WITHIN AGRICULTURAL LAND.

To achieve desirable conditions (integrate variety of flowers over very large areas) and remain low maintenance and suppress implementation costs the project recommends seeding the required species, potentially in the form of hydro seeding. The mix of seed then covers the desired landscape area equally. If the form and combination of plant patches are not achieved through designing a planting plan then one would imagine the foundation of the palette (the soil) to predict the patch form.

The planting plan then becomes a soil manipulation exercise. Creating a collage of sorts of soil types, aspects, slopes and conditions which in turn will control which seeds survive and which don't, thus forming a matrix of different plant patches.



FORM-LOBES FUNCTION-CORRIDOR

Manipulating the spatial form of bee supporting corridors to extend the function thereof and thus promote further interaction. By drawing on the functional aspects of pollinating honey bees farmers can increase crop production up to 40% through decrease flower drop. The form of the bee corridors however are required to be of a specific form, width and made up of particular content to allow for successful interaction between the lobes and the adjacent crops.

Requirements:

- continuous stretch of flowers
- early season flowers (early September)
- all year round flowers
- high nectar content
- large variety of nectar producing flowers
- within 800m range from one another

PLANTING PROCESS - SOIL DESIGN

To achieve desirable conditions (integrate variety of flowers over very large areas) and remain low maintenance and suppress implementation costs the project recommends seeding the required species, potentially in the form of hydro seeding.

The mix of seed then covers the desired landscape area equally. If the form and combination of plant patches are not achieved through designing a planting plan then one would imagine the foundation of the palette (the soil) to predict the patch form.

The planting plan then becomes an soil manipulation exercise. Creating a collage of sorts of soil types, aspects, slopes and conditions which in turn will control which seeds survive and which don't, thus forming a matrix of different plant patches.



(Drawing 5.1) Abstract representation of landform and soil design corridor concept.

2.1 Corridor framework

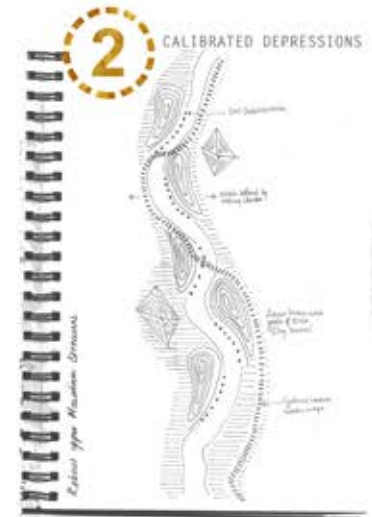
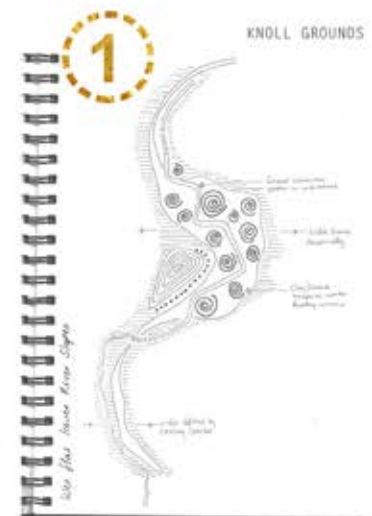
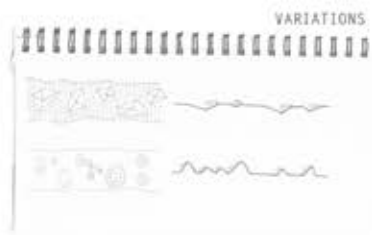
The proposed framework shows both existing corridors for bee forage and new flowering corridors proposed for “soil design intervention” to be entwined through existing farm blocks. The essence of the proposal is to promote pollination of the local crops by the cape honey bees. This is achieved by strategically extending the boundaries of nectar producing flowering species into the farming areas. Educational, economical, sustainability and social benefits are spin off effects of the process. Links are made between these aspects, promoting the physical integration of spatial and non-spatial aspects Including but not restricted to socioeconomic and environmental issues.

The framework plan shows two different corridor types;

- 1) **Knoll grounds** and
 - 2) **Calibrated depressions**,
- each with a specific set of principles to be taken forward in the design.

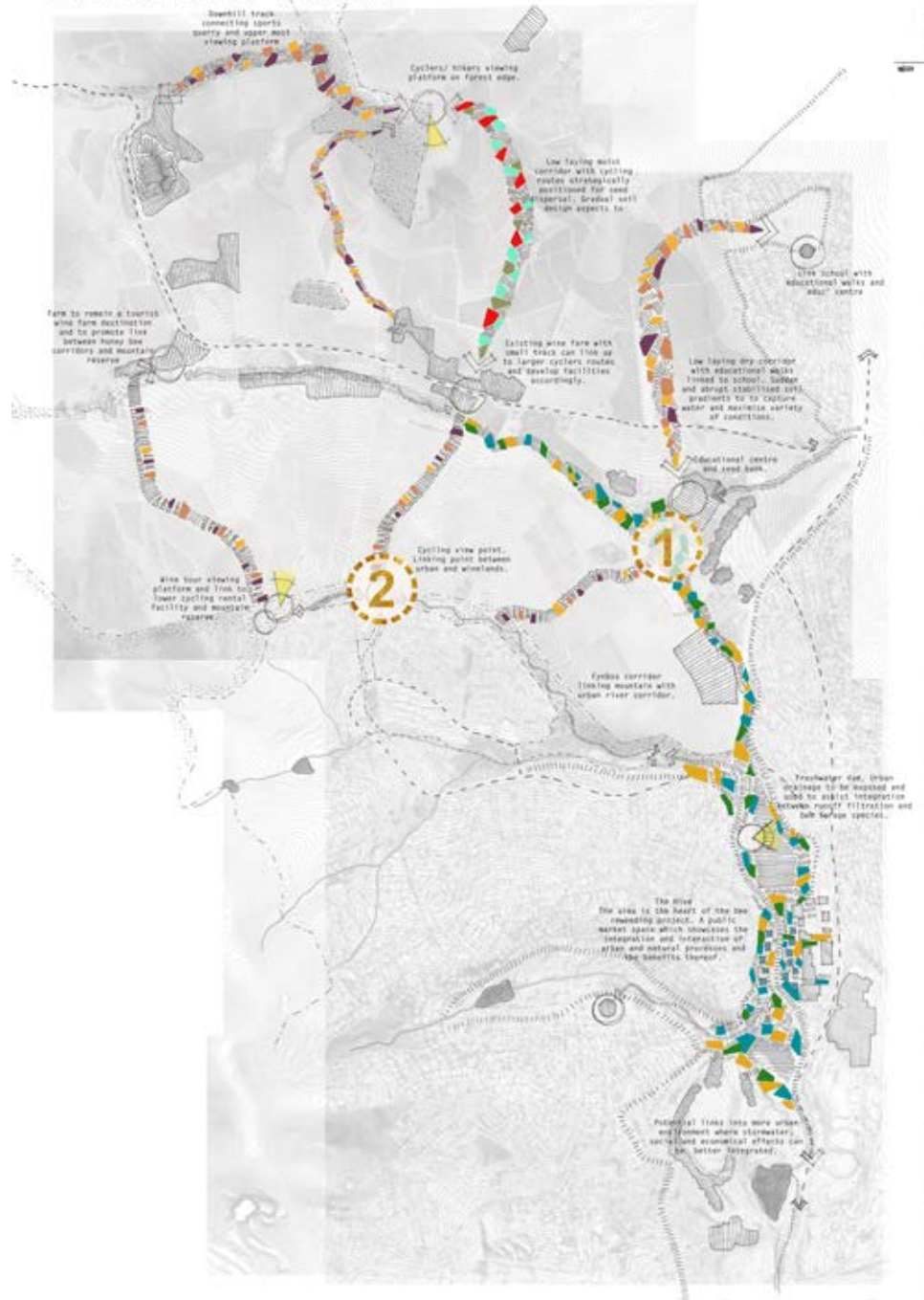
2.2 Detail design exploration

Each of the following design concepts are associated to the framework plan shown on next page. Whilst the concept of design; creating a variety of different soil conditions to support a diverse palette of flowering species is similar, the way the designs are executed are distinctly different, based on the principles set out by each designs framework. Knoll grounds being mounds of soil in lower wetland conditions to create dry flowering conditions, and calibrated depressions being water capturing ditches in upper dry reaches of the hills. Both concepts are executed within a larger framework which forms a network of corridors,



(Drawing 6.1) Conceptual representation of two different methods of designing landform and soils at a framework level.

PROPOSED CORRIDOR VARIATIONS



(Drawing 6.2) Framework proposal: corridor variations.

1 KNOLL GROUNDS

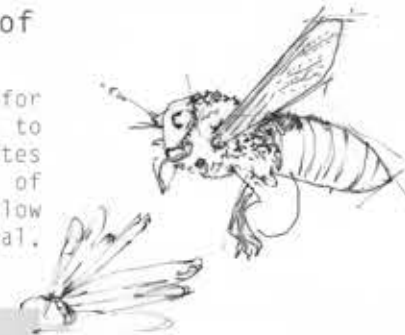
Highly vegetated flowering mounds designed to receive seeds of self spreading flowering species in wet conditions.

The knolls are a balance between sand and clay. Clay for water holding ability and a low percentage of sand to allow the the slow erosion thereof which in turn creates a larger variety of soil conditions for a variety of flower growth. The position of the knoll grounds allow for a node to be created, linking economical, educational, environmental and social activities.



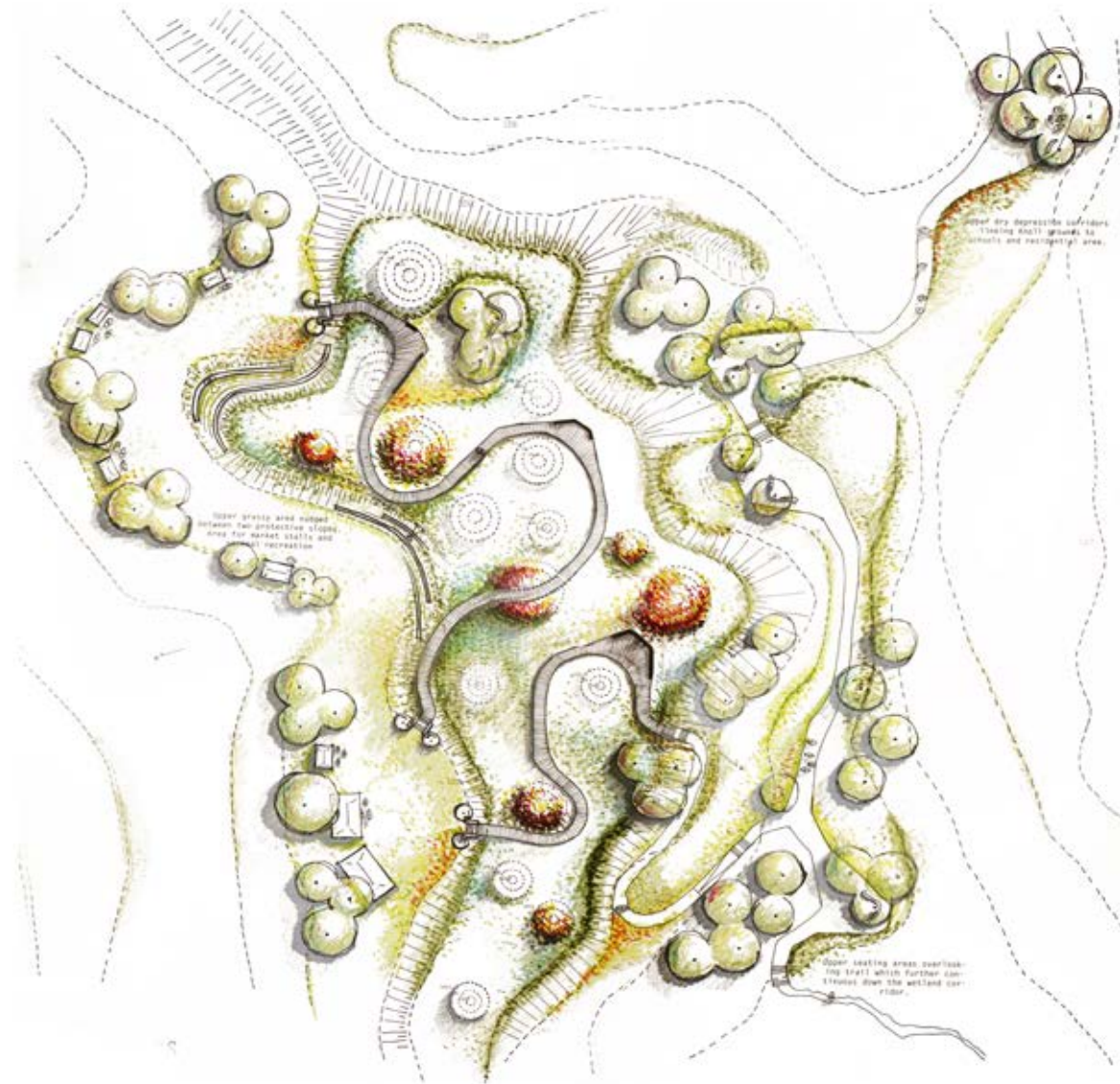
 **KNOLL GROUNDS PROPOSAL**
Contextual Concept Plan

(Drawing 7.1) Contextual drawing of proposed knoll grounds.



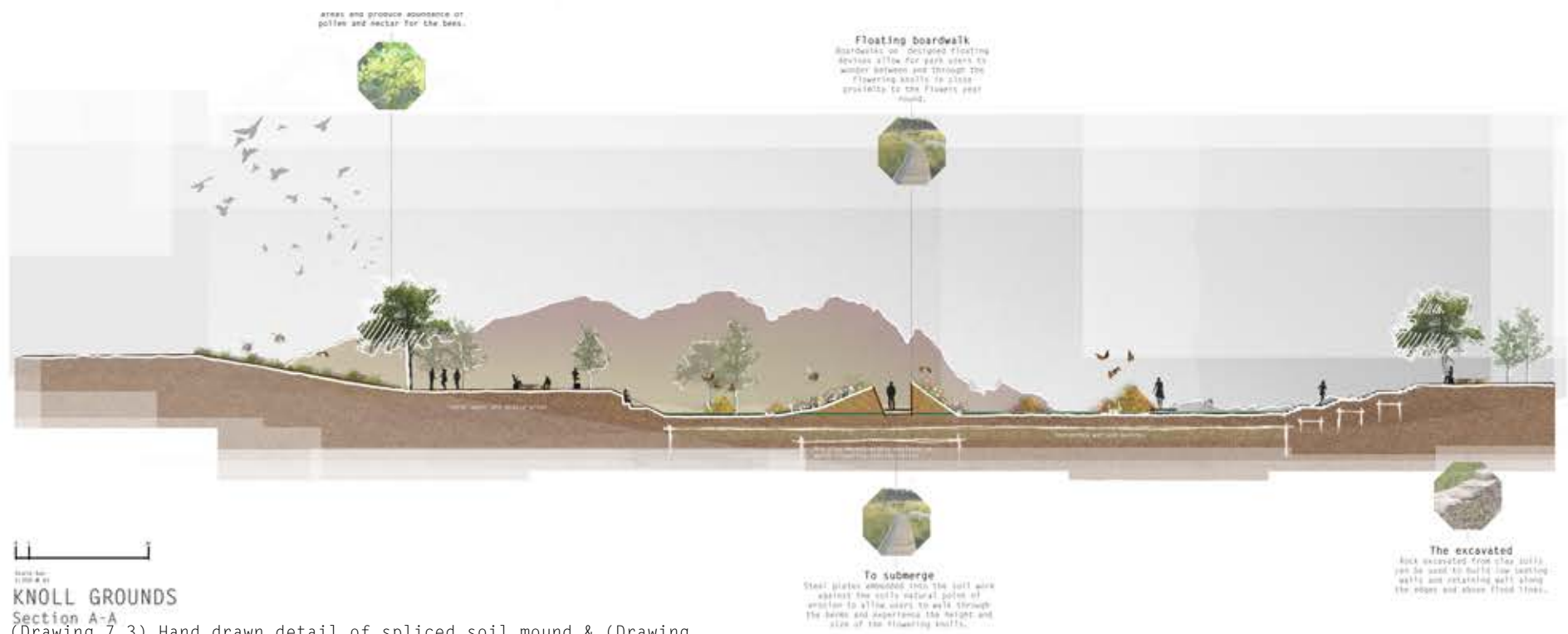
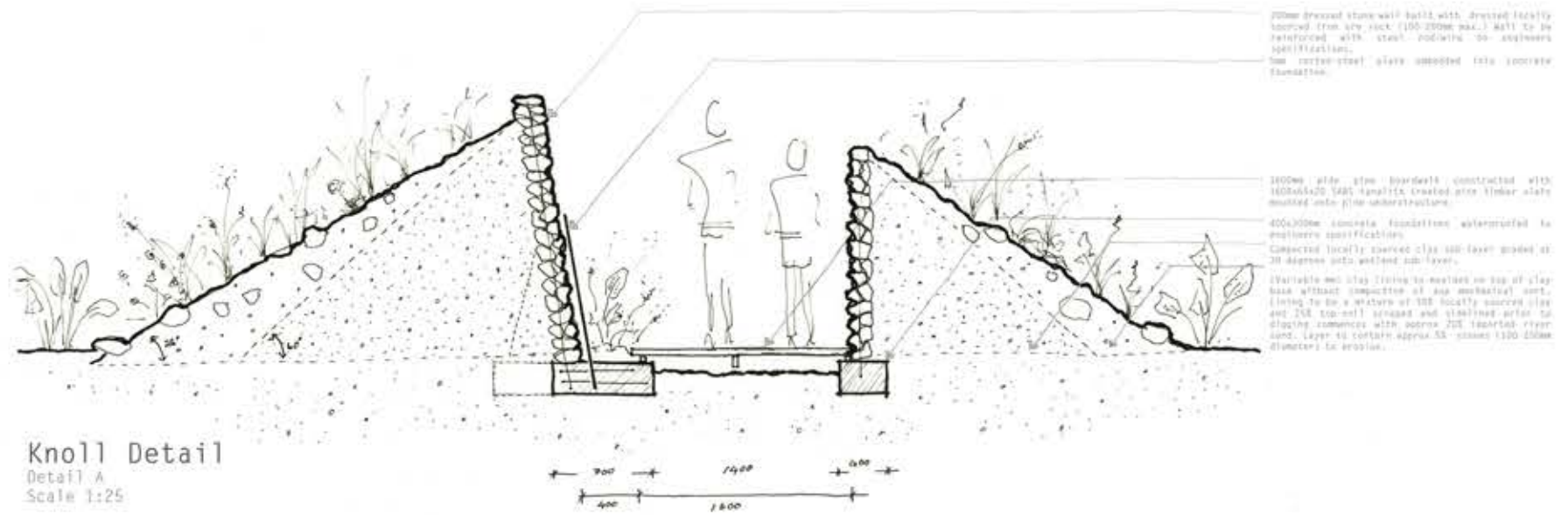
2.3 Knoll grounds

The sculpted mounds of soil extrude from the wetland below to create a space with a sculptural sense. Slow eroding, colourful and scented mounds are scattered in the wetland bowl created through earthworks. A boardwalk linking the space with a school on its North-Eastern corner continues down from the upper slopes with distant views. At the base, the wooden walkway floats above the wetland, meandering in between and every so often cuts through the colourful mounds of flowering and scented species, submerging the user in the essence of the project. The upper dry slopes of the embankments are dedicated to weekend markets and recreational activities.



KNOLL GROUNDS
Sketch Plan

(Drawing 7.2) Knoll ground hand rendered sketch plan.



(Drawing 7.3) Hand drawn detail of spliced soil mound & (Drawing 7.4) Photoshop rendered section through wetland.



(Drawing 7.5) Conceptual photomontage portraying the knoll grounds concept and core principles.

2 CALIBRATED DEPRESSIONS

Maximised flowering soil depressions forming a pollinator rich corridor through agricultural land

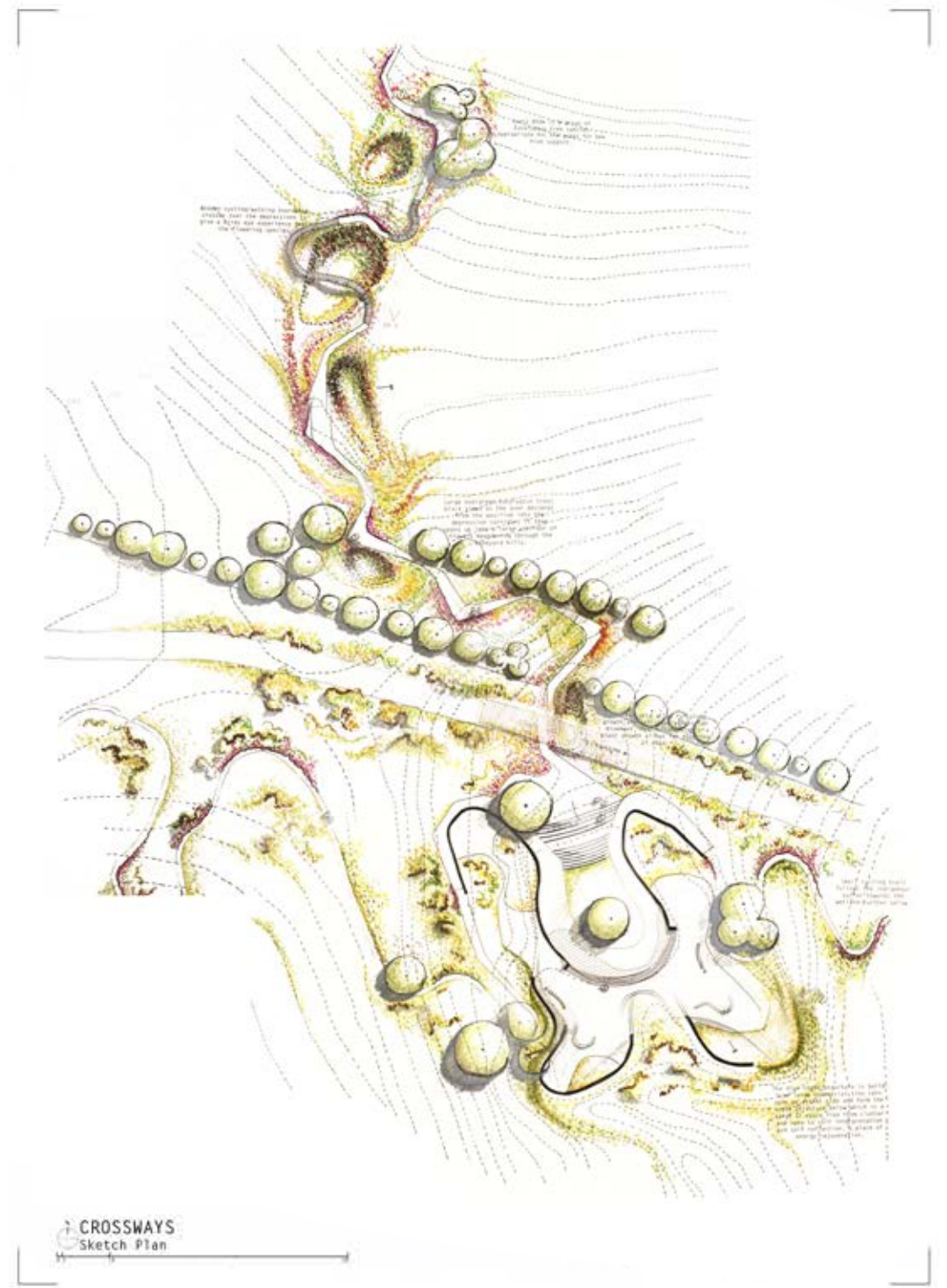
Crossways; a node between two corridors, an existing indigenous buffer used as a cycling route and an proposed corridor which follows the low laying contours through the vineyards. The proposed corridor is made up of a set of depressions orientated in such a manner to expose maximum surface area to full sun for maximum flower production. Cycling routes meandering between and over the depressions and through the bee flowers become the link between the lower popular wine and cycle destination and the upper existing cycle route which connects to the built environment. At the connection a look out point and structure creates shade and a space of reflection, a place of rest and rejuvenation.



 CROSSWAYS PROPOSAL
Contextual Concept Plan

(Drawing 8.1) Contextual drawing of proposed crossways.

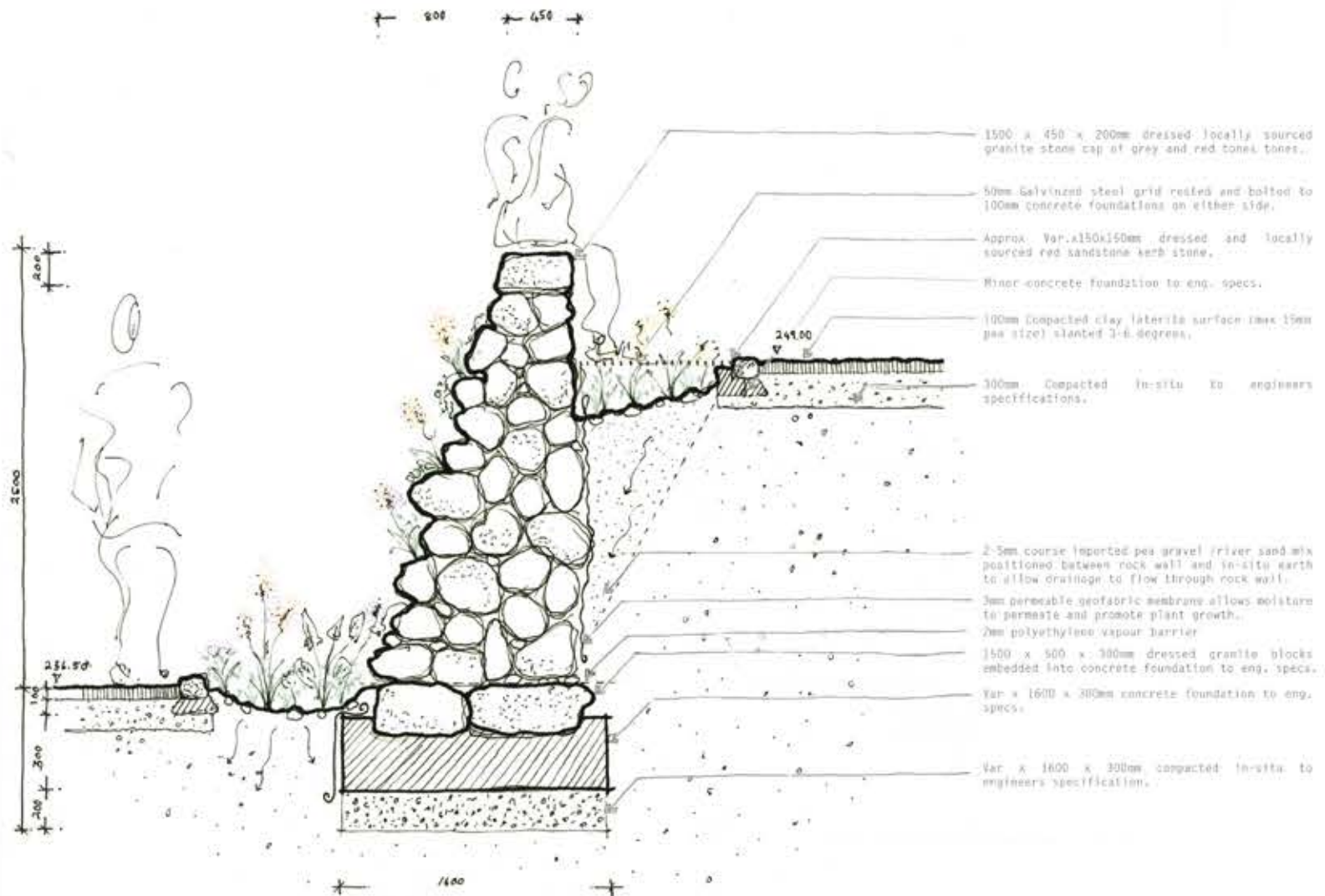
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(Drawing 7.2) Crossways hand rendered sketch plan.



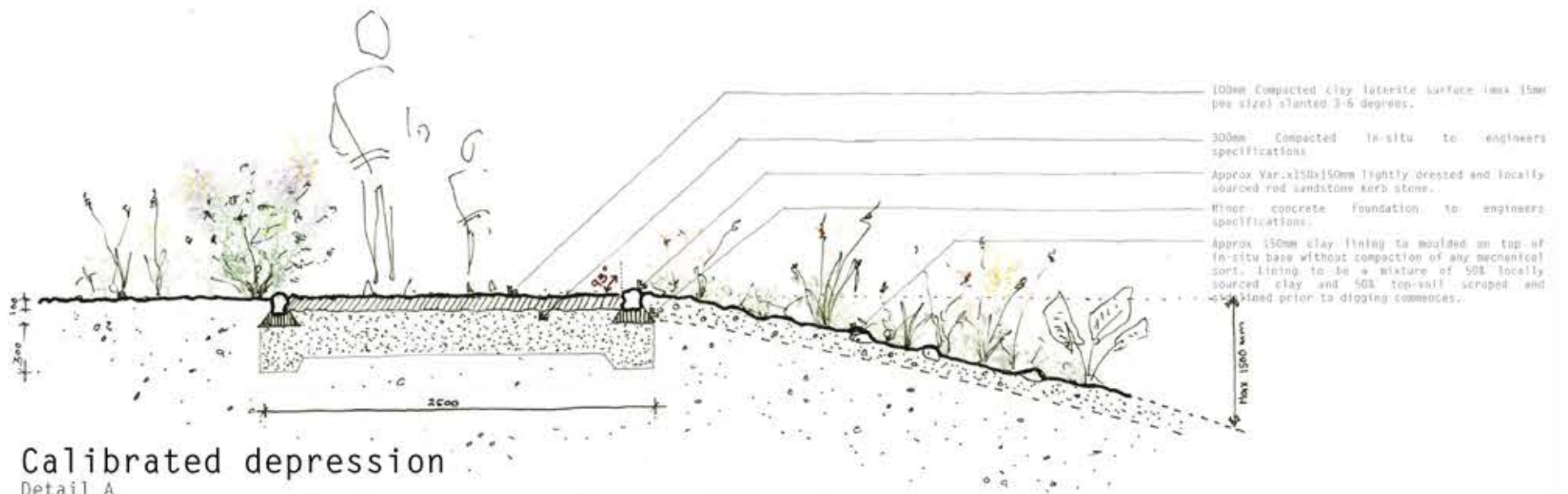
(Drawing 8.5) Conceptual photomontage portraying the crossways concept and core principles.



Chronological Flower Wall

Detail B
Scale 1:25

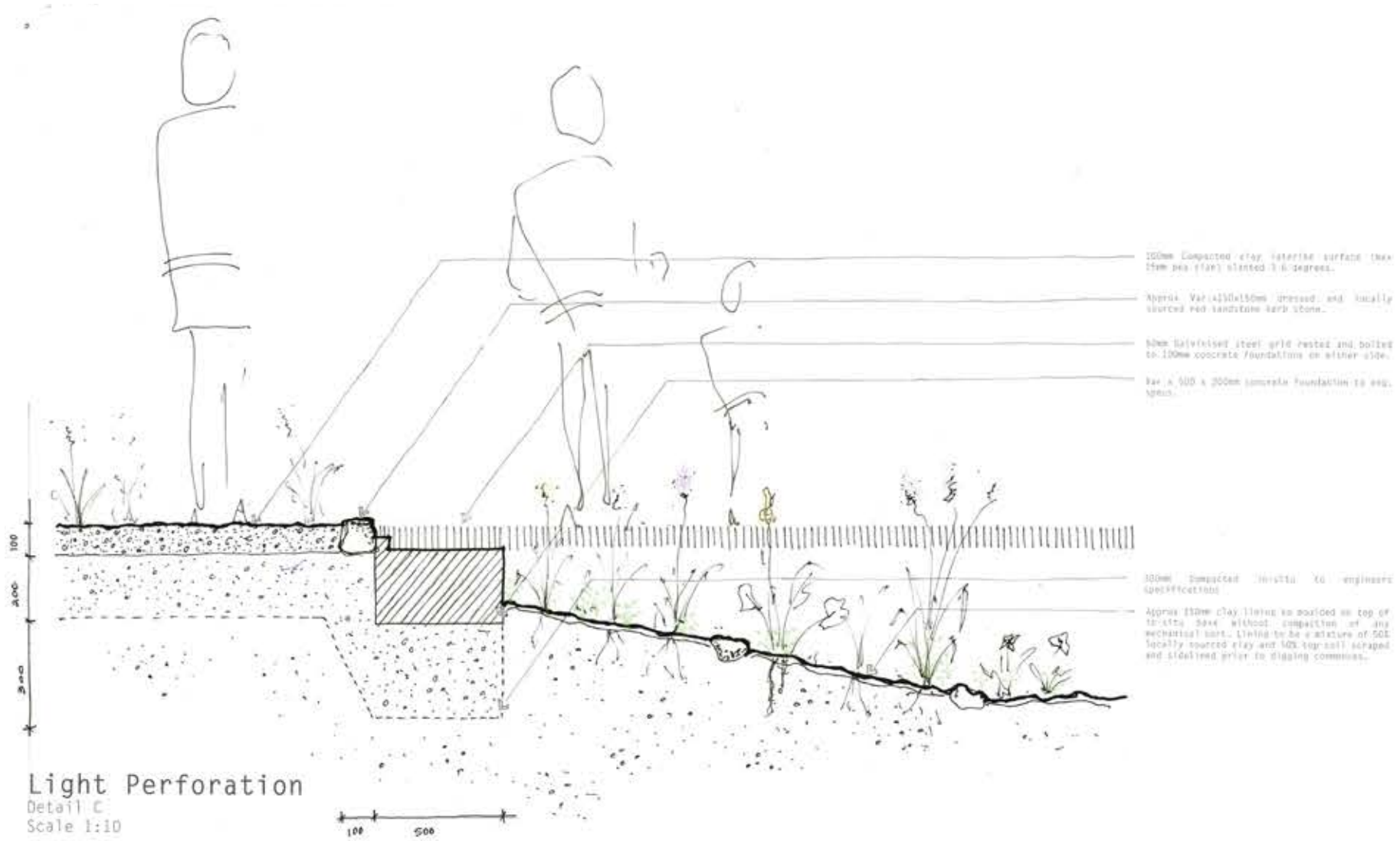
(Drawing 8.6) Detail of Seasonal flower wall.



Calibrated depression

Detail A
Scale 1:25

(Drawing 8.7) Detail of calibrated depression.



(Drawing 8.8) Detail of transparent ground - blurring boundary.

CONCLUSIONS

The project in entirety, including the research study found that it is valuable to look at the urban fabric through the lense of an ecologist. The distorted view allowed the project to place much more emphasis on relationship, process and links between functional characteristics, as many studies in biology, ecology or botany often do. Because of this, the research study picked up on processes which are often overlooked when using conventional methods of urban design and city planning. Processes which are essential and have both an environmental and monetary impact. Through the proposal, an international honey bee crises might be aided, bees no longer have to be driven to farms during pollination period, new social, economic and environmental relationships are revealed and released much potential for growth and use thereof. The sculptural aspect of the project may attract many users and assist the economic growth of the area, and so could by-products of the bee industry.

The concept has more potential than that which has been tested within this study. I believe it can be further explored to become a key framework structure in the layout of bee pollinated crop farms. Potentially go as far as to test the concepts ability to be the armature for urban growth into agricultural land as the cities edge grows outward.

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APPLICATION FORM


Please Note:

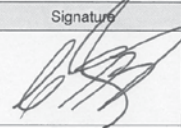
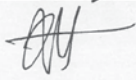
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APPLICANT'S DETAILS		
Name of principal researcher, student or external applicant	Roux Lubbe	
Department	APG	
Preferred email address of applicant:	rouxlubbe@gmail.com	
If Student	Your Degree: e.g., MSc, PhD, etc.	MLA
	Credit Value of Research: e.g., 60/120/180/360 etc.	120
	Name of Supervisor (if supervised):	Clinton Hindes
If this is a researchcontract, indicate the source of funding/sponsorship	Click here to enter text.	
Project Title	Transitional Ground	

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