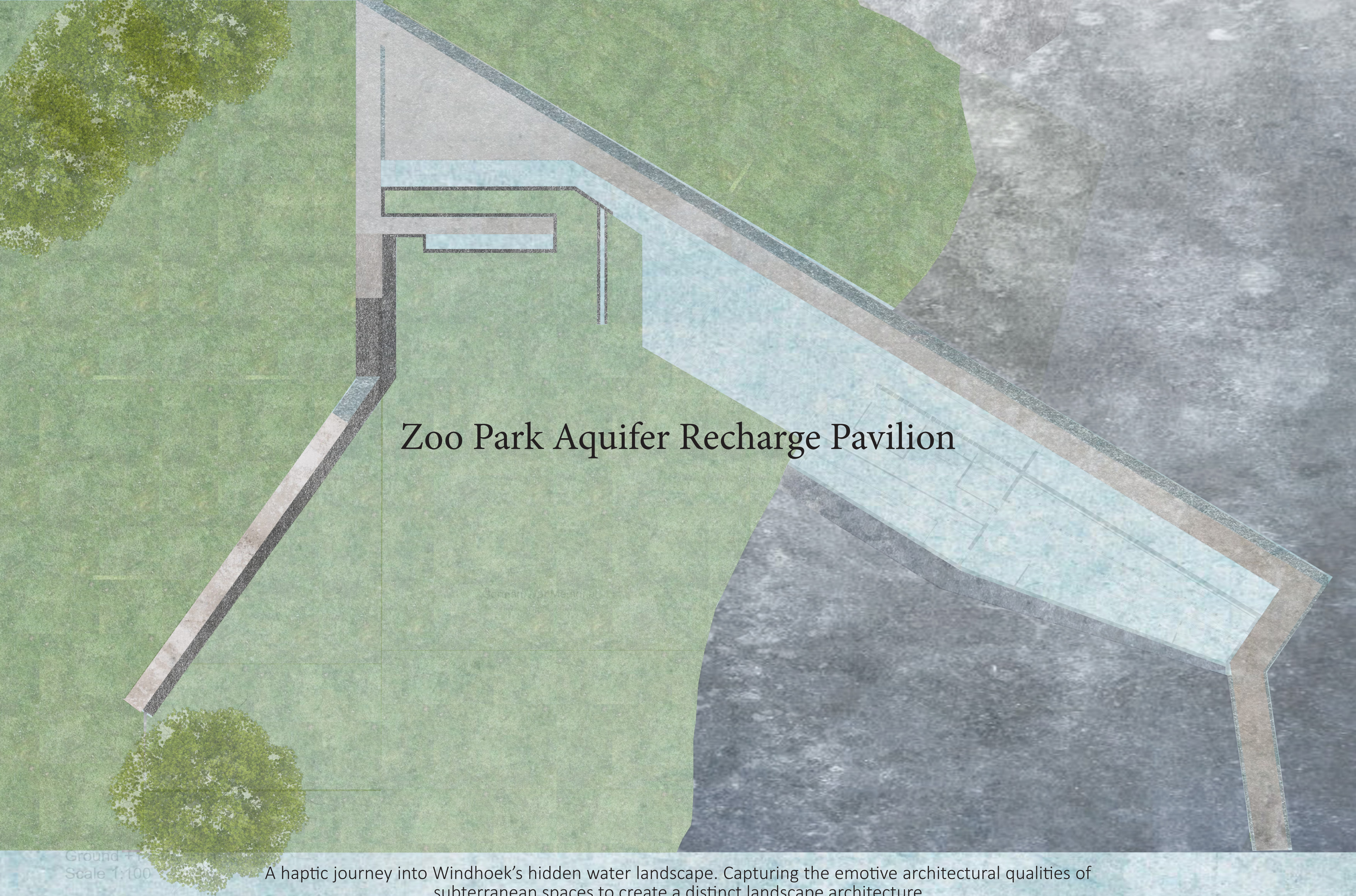
Zoo Park Aquifer Recharge Pavilion



A haptic journey into Windhoek's hidden water landscape. Capturing the emotive architectural qualities of subterranean spaces to create a distinct landscape architecture

IVAN NEETHLING 2016090165

This Dissertation is submitted in partial fulfillment of the requirements for the degree M. Arch. All the work contained in this document is my own except where otherwise acknowledged.

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Deceleration of original authorship:
The work in this dissertation has not been previously submitted to meet requirements for an award at this or any other institution of higher education. To the best of my knowledge, this dissertation contains no material previously published or written by another person except where due reference is made.

PREAMBLE

This design dissertation proposes Aquifer Recharge Pavilion on the site currently known as Zoo Park. Situated in the central business district and heart of Windhoek, Namibia. Located on the corner of Independence avenue and Fidel Castro street, it is surrounded by several German colonial era structures and contemporary major financial institutions. Zoo Park hosts a history spanning 130 years and was found around the natural spring and wetlands which lies on a fault line exposing the underlying aquifer to the surface. The water source has been closed off and the park has become dilapidated and under used.

The project aims to achieve several objectives, with ancillary goals resulting from their implementation- On a functional level the project aims to rejuvenate the natural spring and underlying aquifer, through the 'Managed Aquifer Recharge Scheme'. (A process of storing excess water in the underground aquifers). To use the spring as the source for the park's rejuvenation and bring the recreational element back into the city, while exposing the subterranean spaces through the scarring of the landscape to become the anchor that facilitates the connection of other nearby public spaces with one another, as the pavilion is ideally located to branch out into the surrounding public circulation walkways. Encouraging pedestrian movement in the city and towards the park.

To act as an educational space for the public, with the focus on water use and storage which also provides the necessities for public occupation of the pavilion, such as ablutions, seating and resting spaces with water outlets and dining points:Establish the technicality behind changing the aquifers to into storage units for surface and dam water, to assist in alleviating the persistent water crisis faced by the city. These elements culminate in a hybrid expression of functional, recreational, educational and landscape designs tied to-gether around the premise of preservation and expression of water which drives the typology, mor-phology and tectonics of the pavilion.

CONTENTS

DOCUMENT FRAMEWORK

This Dissertation investigates the role of landscaping, architecture, water and how the play on various thresholds can be synthesized into a proposal which ultimately rejuvenates the city centre of Windhoek. The project is proposed in Zoo Park, the oldest park in the City. The dissertation briefly explores the history of Windhoek's origin around natural springs found all over the city and how it shaped the original settlement and the creation of Zoo Park, which lies on-top of an aquifer.

An investigation into the practicality of storing water in the aquifer is undertaken, to establish the basic functional requirements to effectively inform the typology of the design.

The aim of this Design proposal will be to restore the natural landscape and environment with an interpretation of what a park could be and the role it plays in the urban context, to encourage the re-emergence of city living. While remaining sensitive to nature and the *genis loci* of the park, included with an overarching sense of sustainability should be the guiding factors for the de-sign and the approach taken.

There are Five Parts in this book, Starting with Part1: Discussing the Topology of the project, as this is the basis for the entire design and all considerations for the design that follows. Investigating the history, natural conditions and the site. This is followed by an overview of the Typological, morphological and tectonic challanges and aims.

Part 2: Breaks down the conceptualization of the project through various phases of exploration rooted in a conceptual and theoretic framework guiding the proposal and sets the framework in place that guides the chapters which follow.

Part 3: Elaborates on the theoretical discourse, which provides guidance regarding what the thesis is about, the major issues and topics beings used to rationalize the design.

Part 4:Presents the reader with the development of the proposal up to its refined phase and explores and identifies the design and structural soltions found for the design

Part 5: Looks back at overall findings and proposals with a focus on whether the desired outcome has been achieved.

RESEARCH METHODOLOGY

Research Question

How can pavilion spaces be submerged into the landscape with the aim of exposing not only the natural resources and aid in the preservation, but bring to light the subliminal qualities of water, nature and architecture to create a distinct sense of being with nature and promote social awareness

The research contained in this document focuses on the aims and challenges for this specific intervention. Looking at what the design should accommodate and whom is it centered around. The functional requirements for its physical expression are investigated, as well as the purpose and function behind the design and how this is translated into the typology, morphology and techtonics of the project. The exploration can be broken down into the following sections:

Historical Research and analysis: This is the investigation of Windhoek's past, as a settlement and town founded along natural springs and the impact this has had on the cities development .

MAR technical research: (MAR-Managed Aquifer Recharge) An in-depth research around the process of storing additional water in the underground aquifers, with relation to the technicalities, geographical conditions and processes involved.

Touchstone and Conceptual investigation: This is a abstract model building exercise which aims to establish the footprint that underpins the essence of the design. The threshold that exists between nature, water and the built environment and the conceptual exploration of how they can be brought together through 1) Scarring the natural landscape: 2) The liminality of nature and 3) the stretching of threshold spaces.

Precedent analysis: Similar architectural interventions, based on similar morphological and subterranean designs are investigated as well as park designs and the circulation patterns which span their surface weaving them into the urban fabric.

Theoretical and cognitive research: The critical analysis and creative interpretation of theoretical literature with reference to architectural concepts are explored and discussed on their implementation.

Qualitative analysis: An analysis of the macro, meso and micro conditions of the city centre to generate a comprehensive understanding of the possibilities for the design to improve the urban fabric, enhance pedestrian movement and revive Zoo Park.

INTRODUCTION

Rationalising a landscape design and subterranean injection station at Zoo Park

Zoo Park was once the jewel of public life in Windhoek and the fact that is lies on-top of the faultline from which the spring emerges, makes it the ideal location for the injection station and landscape pavilion.

The pavilion design not only brings the park back to life, but also serves as the conduit for the MAR system which mechanically rejuvenates the aquifer and thus the spring. Landscape and water provide the two key elements that shape and guide the design. The first for recreational and urban movement and water for the functional accommodation.

The aim of this Design proposal will be to restore the natural landscape and environment with a interpretation of what a park could be and the role it plays in the bigger urban context areas, to encourage the re-emergence of city living. While remaining sensitive to nature and the *genis loci* of the park, included with an overarching sense of sustainability should be the guiding factors for the de-sign and the approach taken.

The emphasis placed on rejuvenation, recreation, functional necessity, circulation and education becomes physically manifest as they are expressed in the thresholds of the pavilion stretching to the far corners of the site, which carries the visitor across various spaces above and below ground. The scarring of the landscape to place the design within the earth, which results in the creation of the subterranean space and the journey which the water takes from the spring to the injection point, the educational and narrative value of the design.

Culminating in a typology of the pavilion design which is a hybrid between water management systems and urban living/recreation spaces with an additional emphasis placed on exposing the inherent natural environment back into the cities overall character. Functionally this is achieved by creating a link to the underground aquifer where the space then serves as the injection and extraction points.

The Morphology of the design, expressed as a subterranean and site sensitive ground level pavilion, is mainly influenced by water circulation pasterns and movement of pedestrians across the site.

The typology of the design comes from the pavilion's walkability through traversable ramps, expressed as scars in the landscape. This becomes the physical expression of the threshold approach towards exposing the hidden, and bridging the divide, while creating the subterranean space where the liminal journey towards the aquifer takes place in conjunction with the mechanics of the injection station.

The *genis loci* of the park, is subtle character, dominated by sky-scraping trees, and small architectural interventions. These include a modest collection of german era architectural buildings including a cafe and butchery. The pavilion design thus takes a more hidden and landscaped approach towards the subterranean world of the aquifer. This approach connects with the ability of the park to remain predominantly free to be used by the public and allows the connections to be made with the larger urban fabric.

Project Rationale

statement and aims

This proposal rests on four key factors. Namely, water as the thread throughout the project, landscape, and thresholds and finally urban circulation and public awareness or education.

When investigating these factors it becomes clear that each one demands an in depth analysis and investigation into how they function and influence the build environment independently, but the investigation then needs to extend into how these factors relate to one another, how they can be brought together, or synthesized, in a successfully and identify what challenges arise as a result of their collective implementation in a proposed architectural intervention.

Due to increasing water scarcity beomming more of a reality it is essential that the project should achieve a broader social impact through 1) The designs ability to successfully pre-serve water and bring about awareness within the public sphere as to what the water situation in Windhoek looks like and what should be done to ensure a water secure future.

2) Become a precedent for more MAR projects of a similar nature to be implemented where water is incorporated into a design around a centralized water source and then re-injected, with relation to its unique context and if feasibility allows for it.

3) That the design inspires creative thinking towards alternative and smart ways of working with water and create a ripple effect nationwide.

A brief contextual introduction

Windhoek was founded around and because of natural springs which dotted the landscape of the cenntral highlands plateau where it is located. These springs emerged as a result of a graben fault line running below the city which exposed the underground aquifers. Native tribes grazed the lands with their livestock for hundreds of years, after which German colonial settlers set up base and made use of the water source for agriculture and recreation in what became the capital of Namibia.

Years of overuse and droughts forced the South African government, during the time that the country administerated Namibia as a protectorate, to close of the springs to preserve the scarce commodity in this arid region. As water has always played a role in the history and development of Windhoek, it is no surprise that it is a primary focus of the city and nation's today. To combat the effects of drought caused by global climate change and to secure the nations water security, the aquifers once again make their appearance in the survival of Windhoek. Therefore, to reduce the loss of water through evaporation at the dams throughout the country, a new system has been introduced in recent years called MAR or managed aquifer recharge, where the dam water is channelled to the aquifers for storage and is extracted when needed. Due to its high success rate this water storage project is being expanded and the potential for more injection points across the city becomes a possibility.

Part 1

Introducing the Project

Topology
Windhoek & Water
History of Zoo Park
Introduction to MAR
Problem Statement

Topology: Exploring Windhoek & the Site
Macro Analysis
Aims
Micro Analysis
Windhoek & Zoo Park-geology

Typology
Building Type
Client and users
Problem Statement
Aims

Morphology
Problem Statement
Aims

Tectonics
Problem Statement
Aims

A Timeline: History of Wind-hoek, Zoo Park & Water

1884 Windhoek founded by Germans

1897 Zoo Park Founded

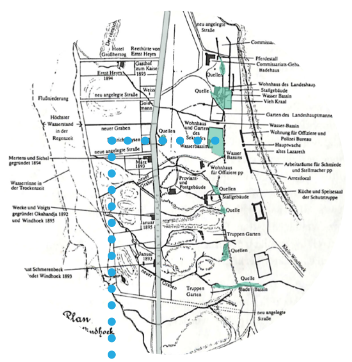
Windhoek expands as a commercial hub for the next 100 years

Water sources from dams and reservoirs since 1960's

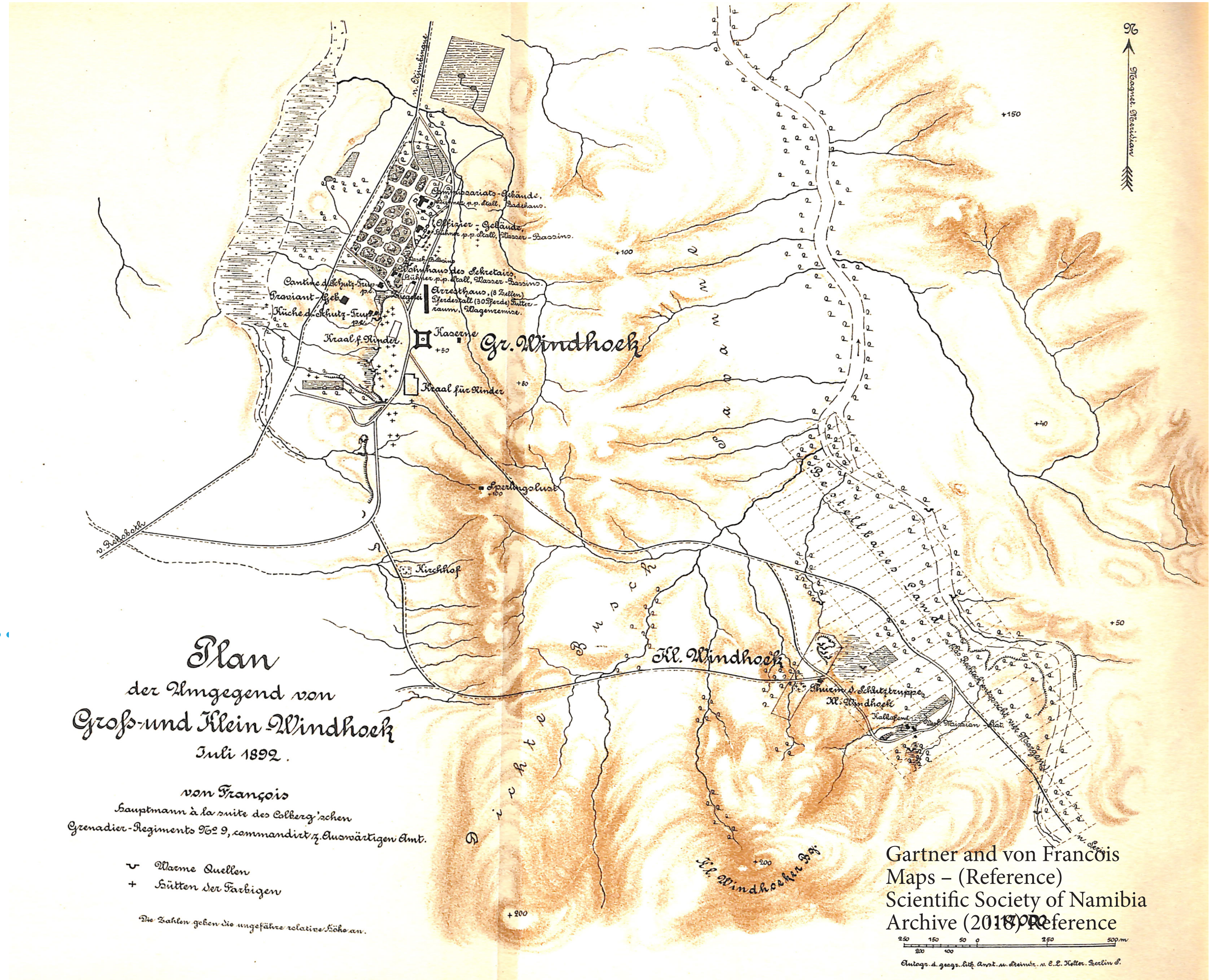
Early 2000's Managed Aquifer Recharge Started

Present Day Windhoek

Zoo Park Pavilion 2019
MAR & Green Corridors



1884 Windhoek founded by Germans

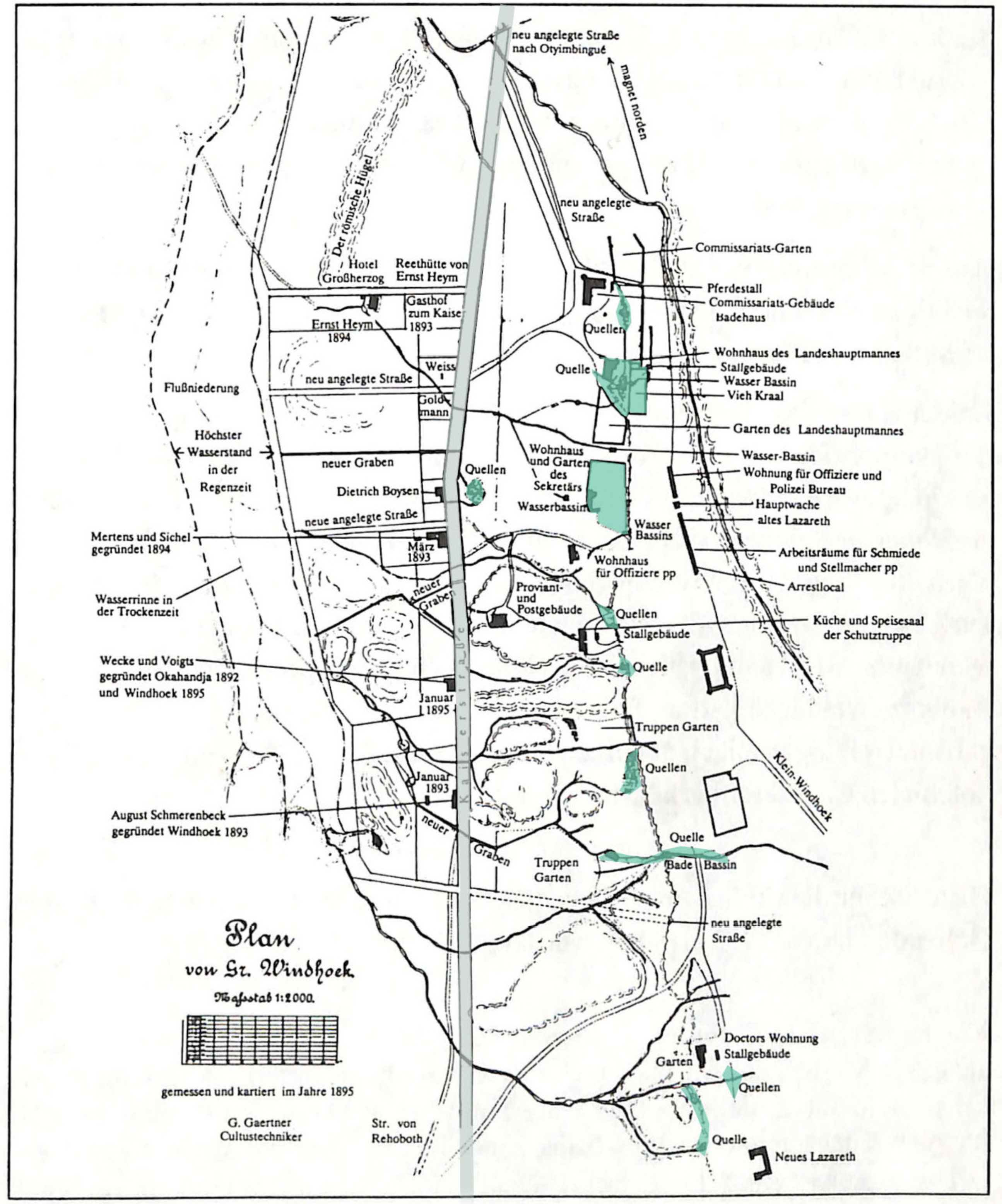


Gartner and von François Maps – (Reference) Scientific Society of Namibia Archive (2018) Reference

The first traces of human activity in the area of Windhoek has been traced to 5000 years ago. The fact rests on the discovery of elephant carcasses hunted by early stone age men which were unearthed in what, is the central city bowl today.

Historians and palaeontologists conclude that the traces of human activity found of ancient human is most likely due to the natural springs found in the area. The springs are fed by shallow aquifers that are exposed to the surface as a result of a graben fault line running along this zone. The aquifers were formed when the Windhoek area was still a prehistoric lake.

These aquifers feed Windhoek to this day and was the main reason that the Herero and Nama settled here in the early 19th century, where "Water management in the pre-colonial era relied on surface/ rainwater, springs (which consist of groundwater reaching the surface), and utilisation of groundwater by sinking wells and cisterns." (Stern, 1990:4)



The Pre Colonial Phase

The pre-colonial era of Windhoek and its aquifers can be defined by the interactions of the Herero and Nama with this area's natural resources.

Called Otjimuise (place of rising steam) by the Herero, AiGams (hot water) by the Namas and finally Windhoek by the Witboois, as there is on average 28% wind calm days annually. Figure 4 indicates the trench excavations done by the native tribes of Namibia for channeling the spring water.

The German Colonial phase 1895-1915

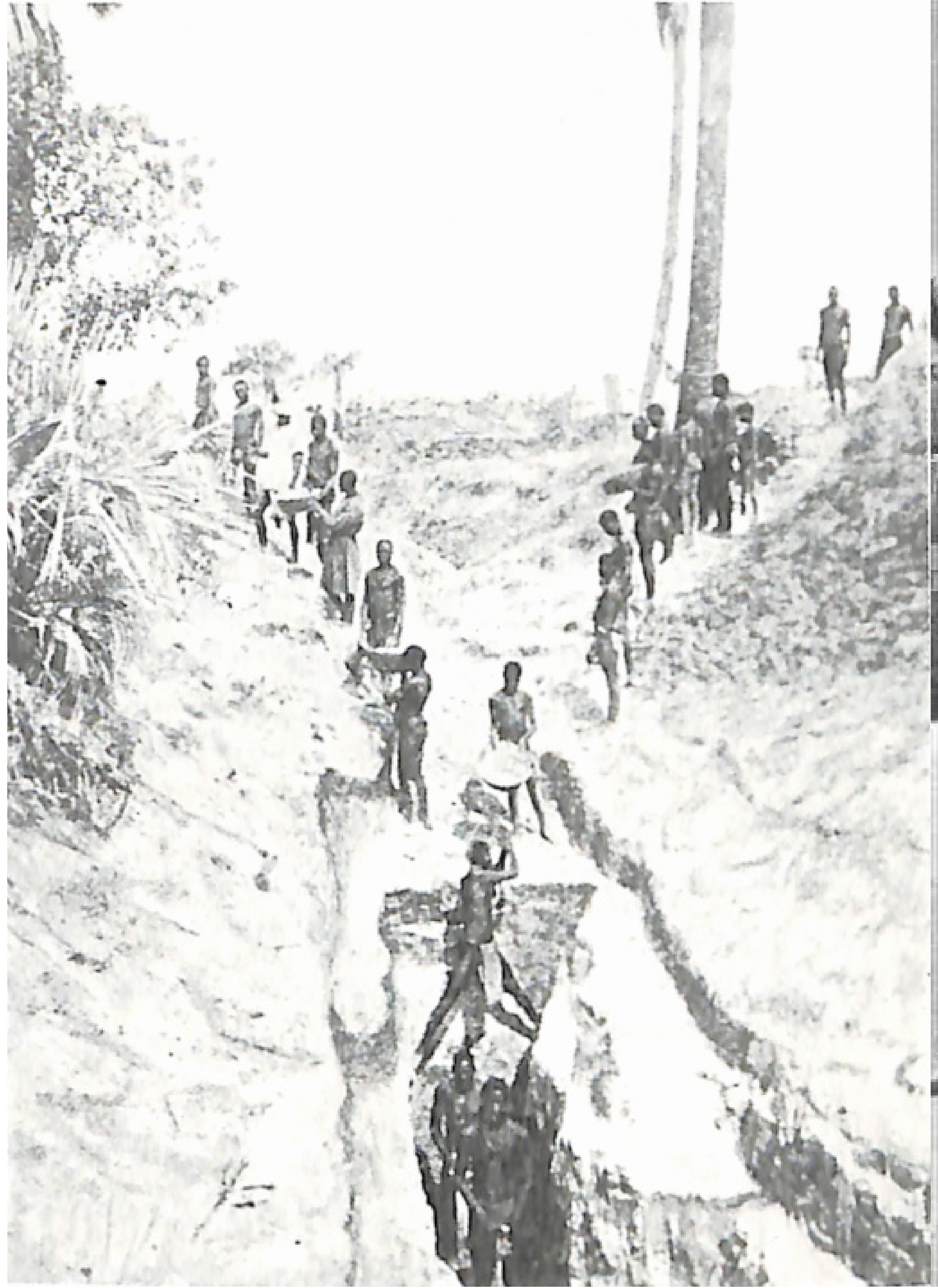
The second major phase in the history of Windhoek is linked to the influence of Germany. After the Germans settled and built the first fort in 1894 and started using the natural springs for agriculture as it was reported by official records that "The utilisation of springs – apparently predomi-nantly for the purpose of fruit and crop production – was eagerly encouraged by the German admin-istration." (Christel Stern, 1990)p.5 Furthermore the Germans developed industrialized water supply systems and recreation around the wetlands. "Other prominent schemes developed the Klein Wind-hoek valley." (Stern 1990:5)

The intermediate phase 1915-1955

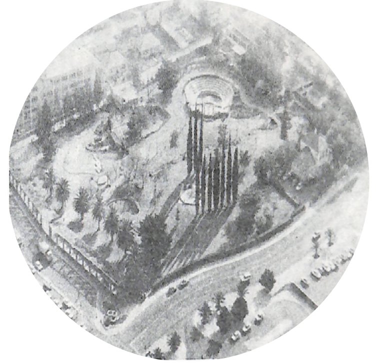
The area that is known today as Zoo Park was one of the first to be designed around these natural springs and when the South African Government took control of Namibia (South West Africa) after the First World war, as a mandate territory, "The Windhoek Municipality published a detailed scientific study on Windhoek's water resources and climate with special emphasis on using its hot springs for medicinal purposes and establishing a tuberculosis sanitorium." (Stern 1990:9) Unfortunately, the sanatorium was never established and the study of the water did not have any meaningful impact. The park remained relatively unchanged during this period resulting from little adminitrative oversight.

The springs were eventually closed to the public and fed into the municipal water system, as the resource was being over extracted. "The active springs in Windhoek were concreted over and closed off; Klein Windhoek's orchards, vineyards and vegetable fields were destroyed by luxury settlement development for the ever growing colonial administrative elite." (Stern 1990:25)

Since Independence in 1991, Namibia has focused on water security, reclamation and MAR (Managed Aquifer Recharge systems) which have been implemented to rejuvenate the aquifers' water quantity and to act as reserves in time of need, as well as reducing the up to 70% evaporation that occurs at the dams where water is primarily stored.



1.2 Zoo Park History



1897 Zoo Park Founded

Zoo park has a history spanning more than 100 years and has changed several times over that period. The fist record of the site dates back to the late 19th century when "In 1897 the German colonial administration selected a central site in Windhoek and established a memorial there honouring the German soldiers who fell in the war against Hendrik Witbooi. This was the beginning of today's Zoo Park" (Stern 1989: 2) Water collection systems was then put in place as "The site had a strong natural fountain; surplus water was channelled to basins on surrounding sites." (Stern 1989:3)

After the South African administration took control of the German colony the park once again aquired a new function, when "In August 1916, the council applied to the South African Occupation Forces for permission to establish a zoo in the park." and gained its name as Zoo Park (Stern 1989:3) The parks popularity continued to grow and slowly the "The Town Council began to develop the park more systematically, albeit on a small scale: supporting walls, steps and railings were built; the council also employed a gardener to expand the nursery." (Stern 1989:3)

After several years the park once again expanded when an overhaul of the area was underway and "In 1929 new, extensive buildings were erected which, for 30 years, served many functions in addition to providing a spacious, cool area in which Windhoekers refreshed themselves." (Stern 1989)

The park became the social hotspot of the city for the rest of the first half of the 20th century as "Regular concerts were held, and the café remained open until 10 pm every night." (Stern 1989) It is mentioned that "Throughout this period, weekly or even daily concerts were held." and "In addition to the activities surrounding Café Zoo, the park itself also expanded into a social centre." (Stern 1989)

The park has a rich history and was frequented by the public for all manner of functions and events. "Throughout the 1920s, 1930s, 1940s and 1950s it accommodated official receptions for famous guests such as general Smuts, regular school and church bazaars, an open air gymnastics school, exhibitions, charitable garden fetes, and the staging of plays or puppet shows." (Stern 1989)

In the 60's the park once again changed when the Zoo was finally closed, and the animals moved due to the gradual reduction in the original size of the park. Many of the trees were felled as they were exotic and added to the draining of the water source , when new management tried to remediate the effects of almost 80 years of excessive use of the aquifer water in the city. When again in the 1980's the park had its second to last overhaul, with a covered colonnade added and a new water feature and stream leading to a pond was erected.

After independence in 1991 the last alteration was brought about, when some structures were removed, and the park continued to have a generally popular place in public life

After independence the last alteration was brought about, when some structures were removed, and the park continued to have a generally popular place in public life

1960's Zoo Park

1.3 An overview of Windhoek's Managed Aquifer Recharge Scheme WMARS

Water sources from dams and reservoirs since 1960's

The managed Aquifer Recharge scheme implemented by the city of Windhoek and Nam Water under the guise of government aims for water security and management, is a system where additional surface water from surrounding dams are treated and injeected into the aquifers for storage

This scheme forms the basis of the functional element within the design. It is this process which will not only assist the rejuvenation of the park, but also help alleviate the cities water demands and bring water as the focus into Zoo park once again.

The City of Windhoek (CoW) has started to investigate the viability of this scheme to store additional dam water and assist the water reclamation plants in meeting the city's water needs. The studies were started because."Underneath Windhoek and its surroundings is located a sizable aquifer that holds considerable groundwater reserves." (Remmert 2017:9)

The studies found that the aquifer can indeed become a viable source of water for the city as "The use of the Windhoek aquifer as a water bank to augment Windhoek's water supply was assessed and proven to be viable by a feasibility study and the water quality assessment accepted in 2004 and 2005 respectively." (Remmert 2017:9)

"the aquifer can also serve as a natural reserve by pumping surplus water back into the aquifer a process termed 're-charging'." (Remmert, 2017) P.9 extracted in times of severe drought or high demand.

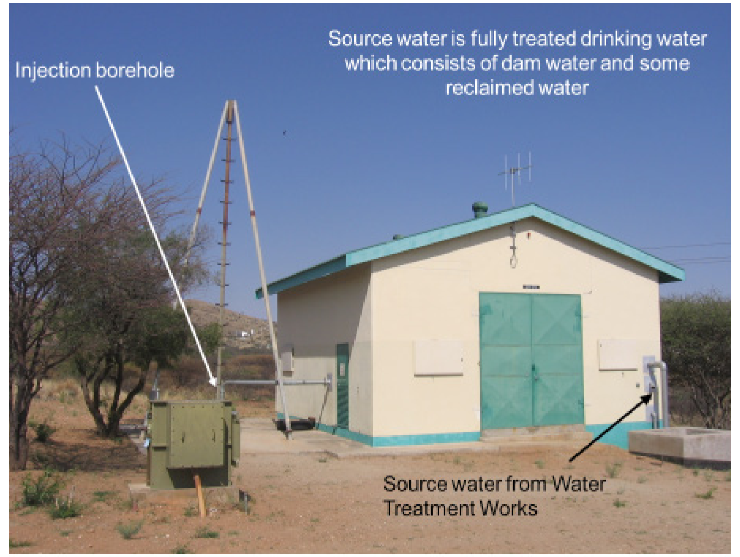
The benefit of using this scheme is since the "Aquifers don't need to be constructed at high-cost and the groundwater is not exposed to evaporation." (Remmert 2017:9)

"Aquifers can be considered as a boon to water resources as they can serve essential as a natural 'water bank'." (Remmert, 2017) P.9 and "with appropriate infrastructure groundwater can be abstracted from the aquifer when needed." (Remmert, 2017) P.9

The March 2017 Democracy Report "Managing Windhoek's water crisis" the cities current water security state is discussed with several findings and recommendations. Some of the findings indicated that the "water crisis has spawned a range of management response and the mitigation efforts from different institutions." (Remmert 2017:8) The report also recommends the fast tracking of infrastructure development for the Windhoek aquifer.

More detail is provided under the geological analysis of the topography and what the conditions on site mean for the implementation of the MAR, and the technical report, discusses in depth the factors which determine which methods to use and what the practical requirements are.

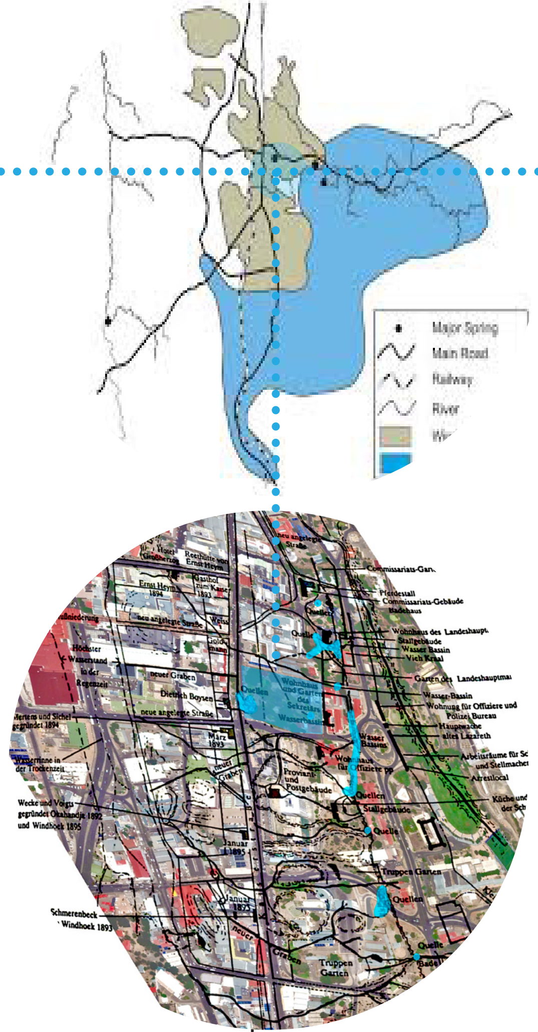
Early 2000's Managed Aquifer Recharge Started



Picture 2.7 (Murray, 2017, 1)

Picture 2.8 (Murray, 2017, 13)

Present Day Windhoek



Zoo Park Pavilion 2019
MAR &
Green Corridors

1.4 Zoo Park Today

Zoo park in its current state has become under used and left unattended with very little to no public recreation in the park. The dilapidated state means almost no one makes use of the park. It has been partly maintained and not developed for over 20 years. This was due to increasing abandonment of the city by night and increasing security concerns. leading to underdeveloped public spaces and a focus on making them places for the public to frequent.

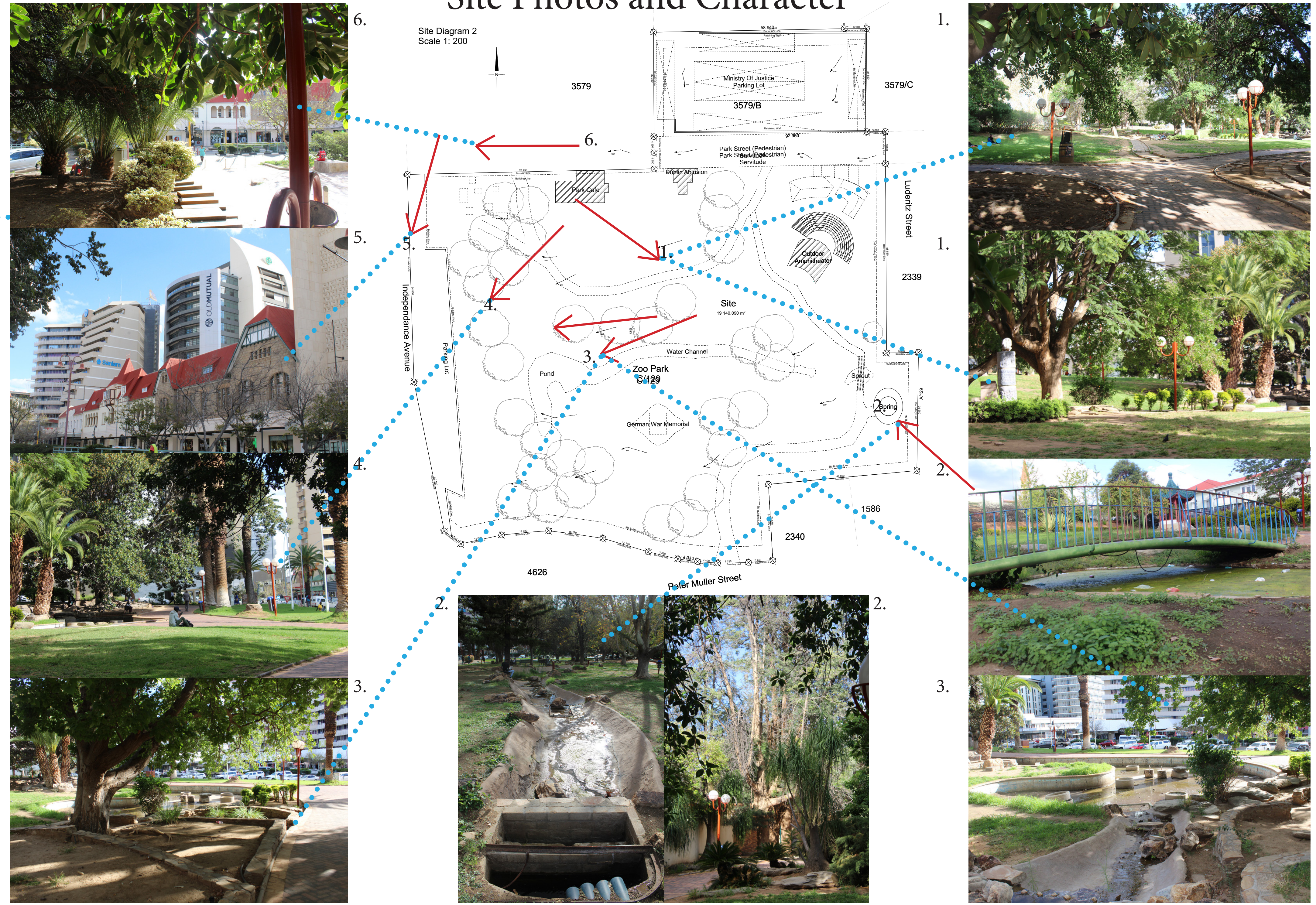
Situated in the CBD, on top of a shallow aquifer which reaches the surface in the form of a natural spring, the park lends itself to be redesigned and reactivated using the natural resources found in the area. Because the park has evolved from so many varying functions and functioned as a social heart of the city, the site offers itself to a new role on it. The site can become a measuring stick for the community's wellbeing while re-emerging as a recreational space.

Physical Aspects

Topography - The park has a west to east inclination of 14 meters with the natural spring reaching the surface at the highest point. The lower edge of the site sits directly on top of the underground aquifer. The park consists of several paved walkways and many old trees, some reaching heights of up to 20 meters.

Typography - The site is surrounded by Business complexes and old German heritage buildings. There are some existing functions on the site such as the Zoo Cafe, Public ablutions, an amphitheatre and a Chinese pavilion. These are all situated on the periphery of the site with the central area kept with trees, a dried-up water channel and pond.

Site Photos and Character



1.5 Sustainability Agenda

The context of water in Namibia and Windhoek as explained in chapters 1.1-1.5 and the processes being implemented discussed in chapter 5.2.3 of the technical report, clearly indicates that the purpose of the proposed injection pavilion with MAR technology, reaches further than only the basic principals of sustainability in architecture.

The intentional considerations with regards to the reduction of the design's carbon footprint forms a part of the overall sustainability, but the emphasis is placed on the role that the pavilion plays in aiding the sustainable use and storing of water as a natural resource.

Sustainable water use in a building forms a major part in the role that any buildings plays in terms of being environmentally friendly. The premise of the functional aspect of the injection pavilion is that it injects and stores more water than it uses, and this too is addressed, through the design. The design allows some of the water, channelled to the site, to be used in its own water needs as a public recreation space, before it is treated and injected into the aquifer. The spring as a source of water, encloses the demand and supply loop between the pavilion and the aquifer, requiring no additional sources of water.

The pavilion, continuasly contributing to the environmental maintenance of the aquifer's health through the injection process, as a source reduces the demand placed on water reclamation plants to deliver the bulk of the supply. The pavilion thus, in turn reduce the carbon footprint of those reclamation plants through a sharing of the water-demand load.

1) No evapotranspiration takes place inside the aquifer, compared to 70 percent of Namibia's water being lost in this manner as a result of dam storage. Making the pavilion a vital part of preserving these scares natural resource.

2)The pavilion further rejuvenates the natural environment of the park and sustains it, needs no water supply, and reduces the carbon footprint associated with clean water supply to a city.

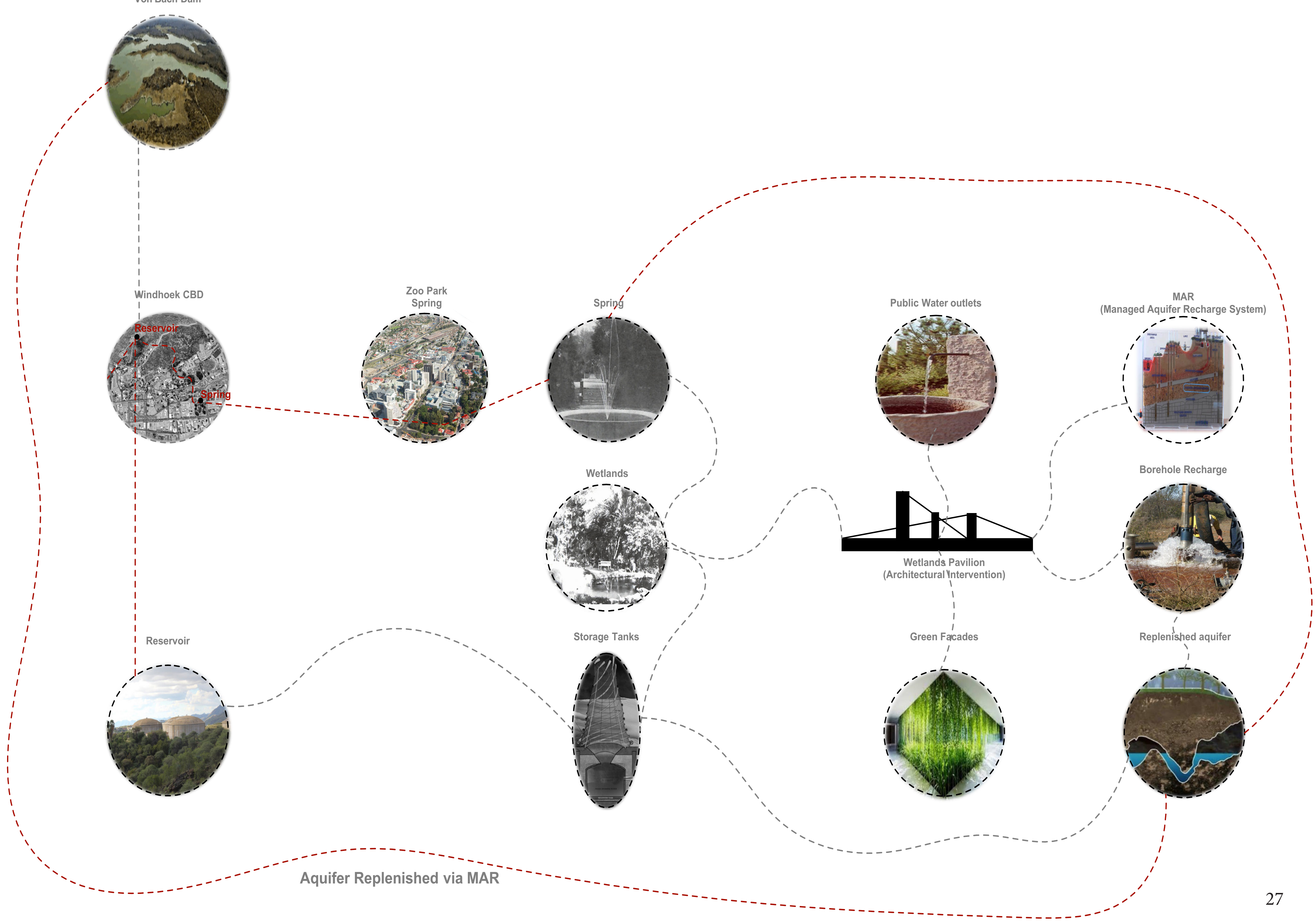
The intentional design considerations for a reduced carbon footprint implemented are many fold.

3) The subterranean nature of the pavilion almost completely eradicates the need for additional temperature control, as the ground is a natural insulator that keeps a cool mean temperature that will permeate through the skin into the spaces inside.

4) Natural ventilation is encouraged through the sculptural morphology of the pavilion, with numerous openings in the skin, secured with perforated screens at the north, east and western sides.

5) The maintenance of the building is also kept to n minimum, through the chased construction materials. Rammed earth, gabion walls, in situ concrete ribbed wall and shell contractions all require little maintenance over long periods of time.

6) The injection method chosen for the MAR scheme in conjunction with the natural slope of the site as a carrier of the water down into the injection pits all reduces the machinery required for the industrial role of the design.



1.6 Accommodation and Client

Clients

NamWater, a parastatal institution that is responsible for bulk water supply

The Department of Water Affairs (DWA) within the Ministry of Agriculture, Water and Rural Development

The National Development Corporation (NDC) that executes new government developments and also manages schemes.

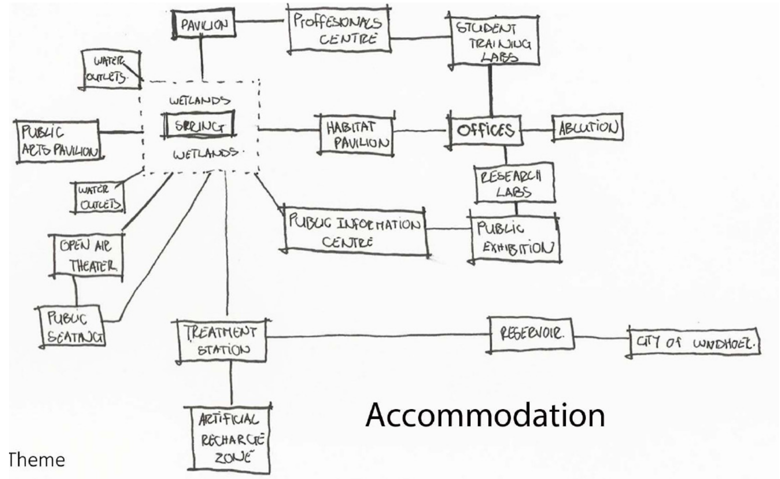
Federal Ministry for Economic Cooperation and Development

German Cooperation

Public pavilion- fountain zone (Recreational)
Resting and eating Zone (Public recre ational – pavilion area)
Lighting fixtures across site causeways
Shallow pond and channeled water
Water points- public

Subterranean Pavilion – Injection pump station
Water treatment pond
Filtration tanks
Injection zone
Operational Room
Water testing lab
Storage tanks
Cafe

Fountain- Extraction mechanism room

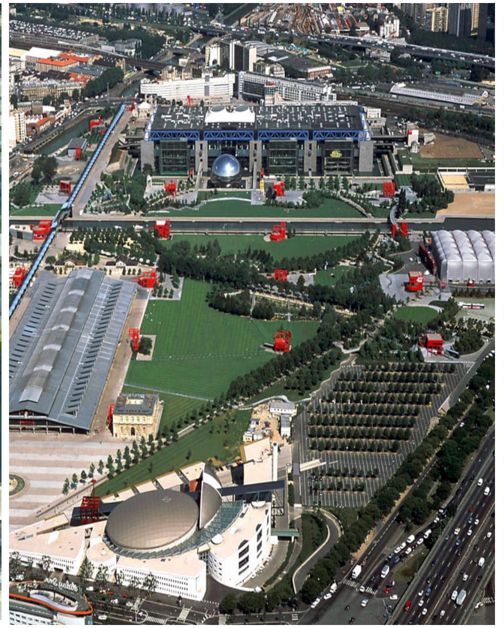


Accommodation

1.7 Precedent synthesis

This chapter investigates architectural precedents which addresses the key objectives of the proposed pavilion design. Looking at how they relate to the pavilion and analysing the way similar problems, challenges and conditions were treated and implemented

1	2	3	4	5
The Necessity of water	Landscape sensitivity	Encouraging movement	Exposing the Hidden Thresholds	The Architectral Narritive


1

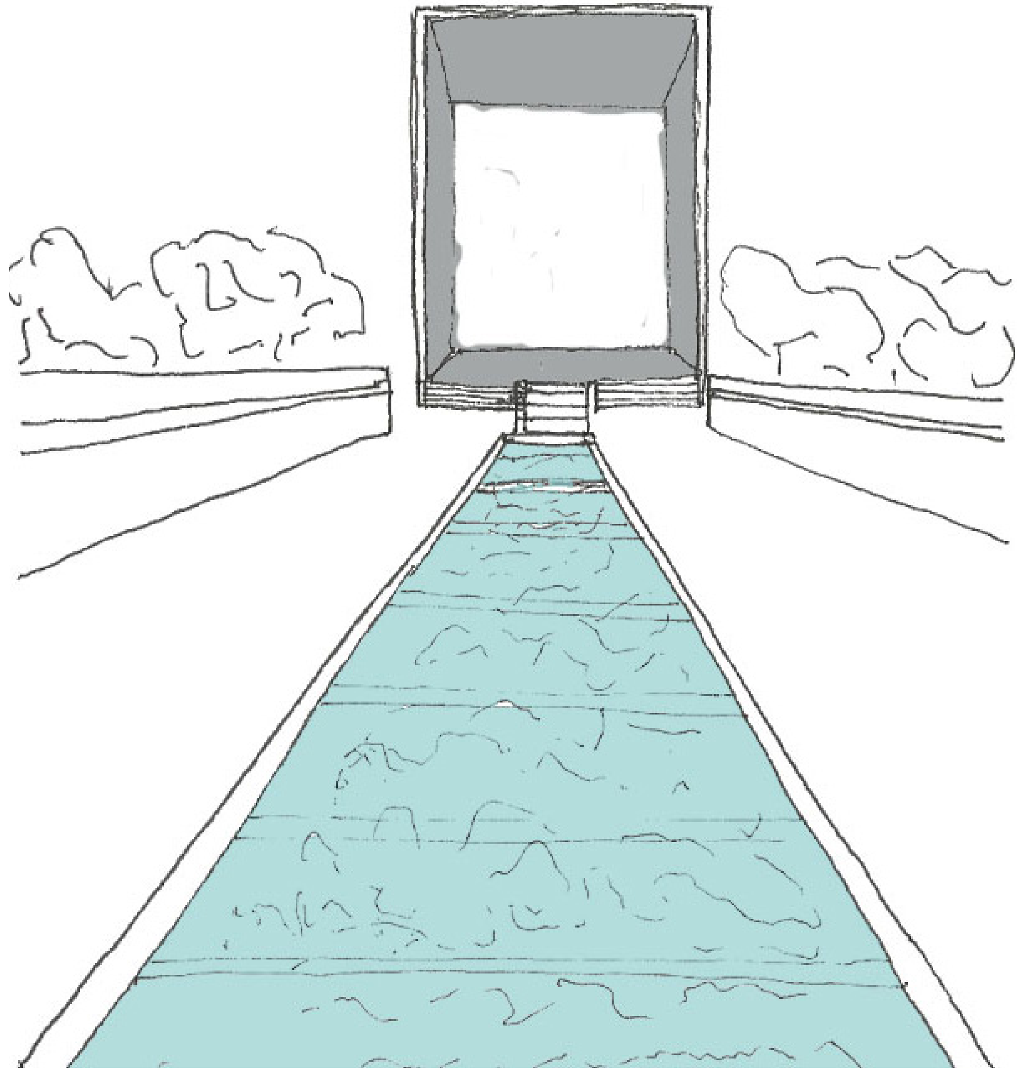
Parc Andre Citroen

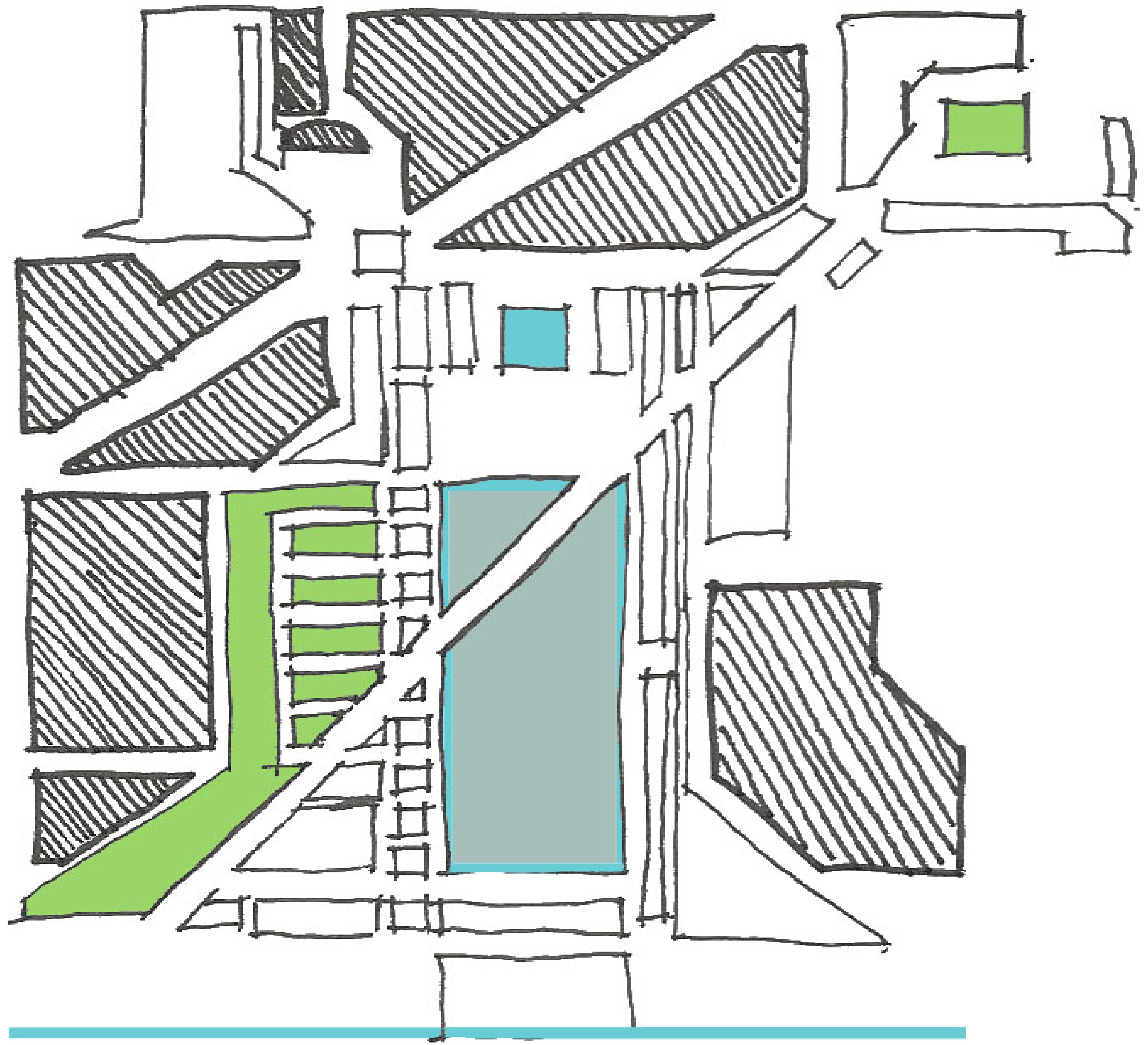
Landscape designers: Gilles Clément and Alain Provost

Architects: Patrick Berger, Jean-François Jodry and Jean-Paul Viguier.

Paris

1.8 Precedents





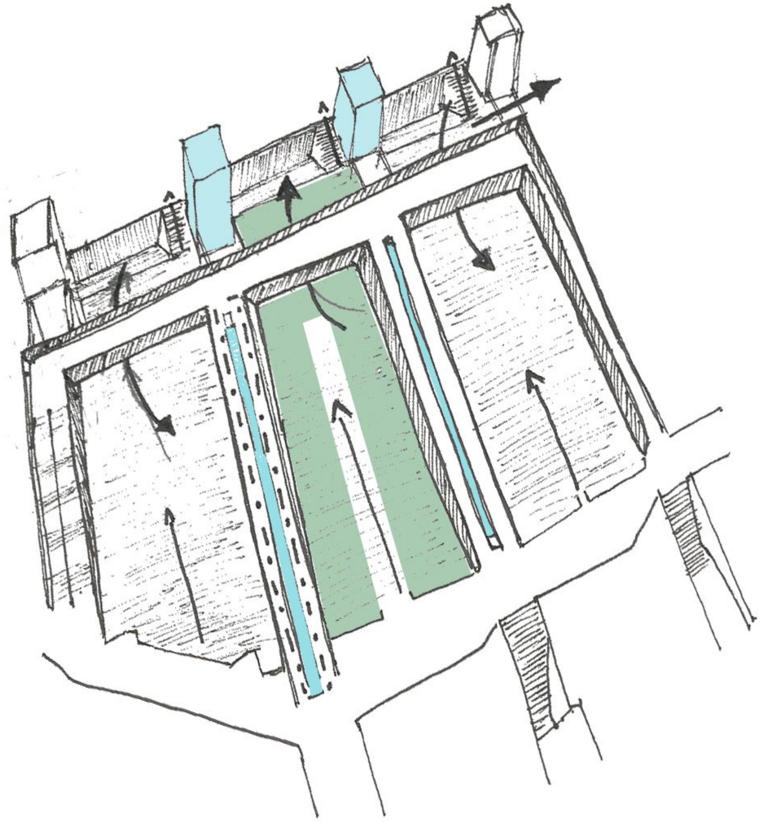
Sustainability is the starting point for the rationalization of this proposal for Windhoek, as water is the key factor around which the entire intervention focuses and is also the driving force. With MAR on the site being the main function, this spring can be revived, and become the focus of the design, driving the aesthetic, recreational and functional element of the site intervention. This is where the project starts and everything else follows.

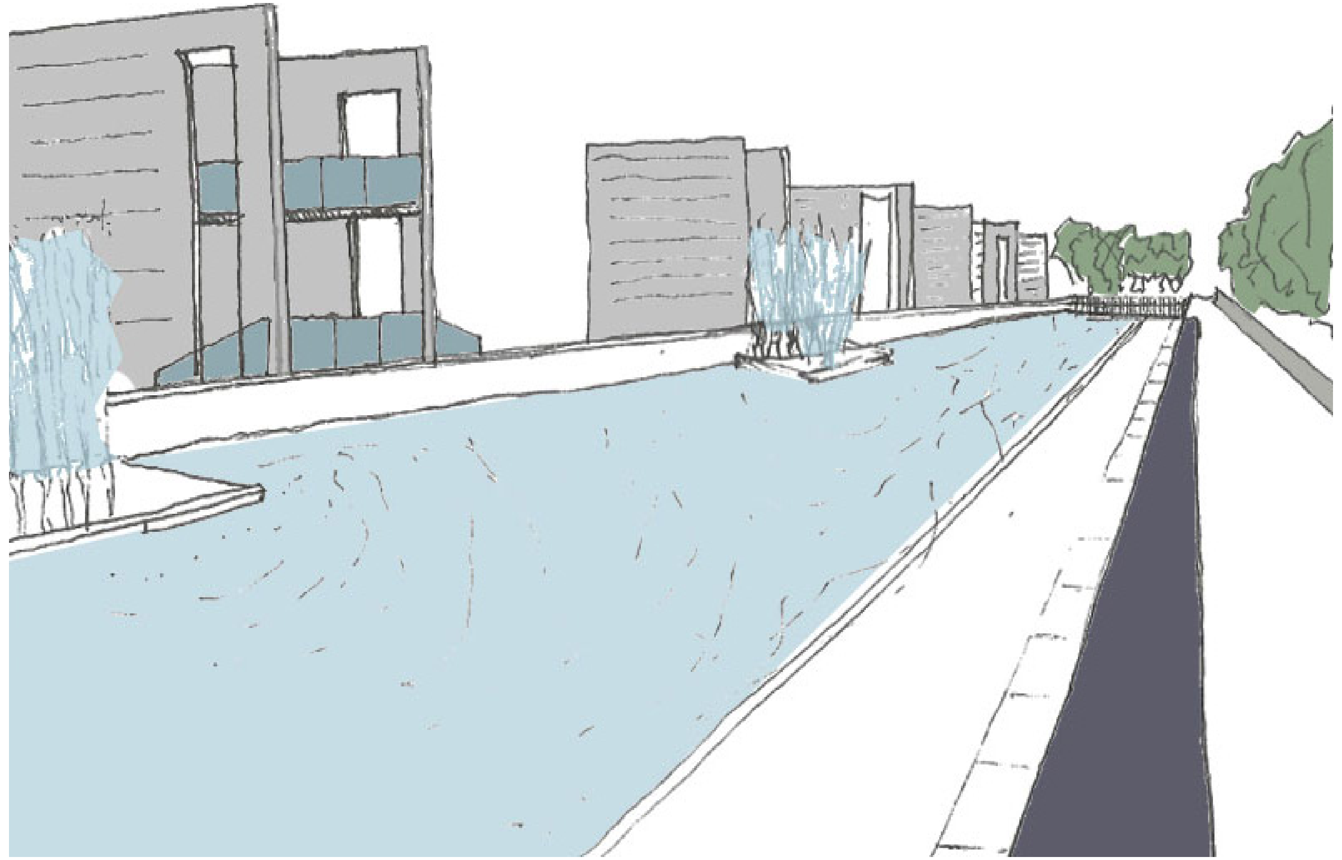
Design considerations of parc Andre Citroen

The interaction with the water channels are emphasized with pavilions that are positioned along its length, allowing relaxation and vantage points of the park and water feature. Seating designed along the channel and pavement is laid at a fall to allow gradual movement and interaction with the body. The water also forms the central element of the long walkways in the park. This constantly creates the potential for interation and play as the water is carried all over the design of the park.

Circulation

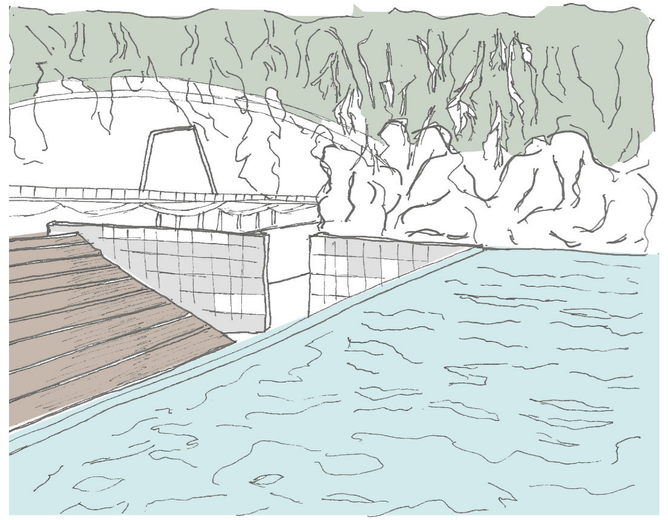
The sketches reveal that the park works along two core axes. The primary axis runs diagonally through the site. This axis connects the two corners of the site which lead out into the city. This allows the pedestrians to move across the entire site and can branch off into the ancillary spaces of the park. The diagonal path intersects with the second axis running in the center of the site from the top of the diagram and ends where the park meets the Seine river. This axis carries the water element of the site, starting at the water pavilion, and carries the water channels through the length of the park.

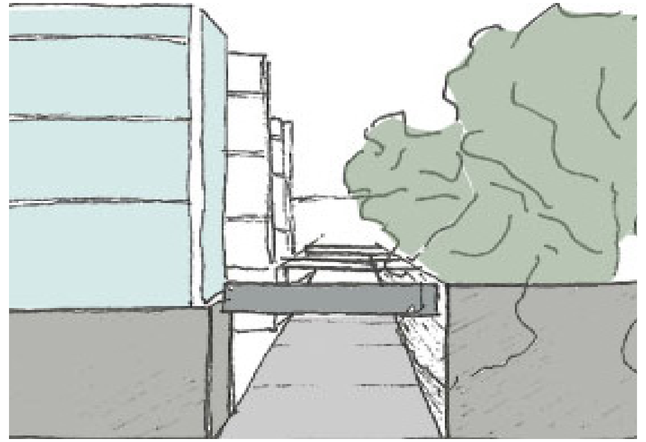


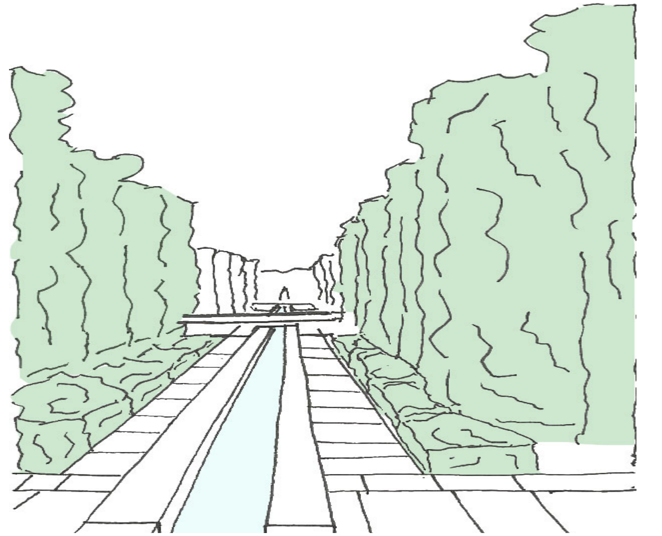


Landscaping and thresholds

Along with the main axis that channels movement across the park, the landscaping determines the experience of spaces and scale throughout the park. Visitors are taken on several level changes, which allows the design of the space to alternatively enclose, dwarf and create a sense of privacy. In other instances, the park opens up with large level expanses, which are framed by structural interventions such as follies, pavilions and greenhouses. This play on levels creates the framework for two key elements in architectural design, firstly the framing of spaces and then setting the desired focus where the designer wants the visitor's attention to be drawn towards. Secondly, gravity can be used to carry water across these levels and create several forms of interaction with water. This dorms of interaction can be horizontal, vertical or fully immersed level.







2

Thames Barrier Park

Landscape architect: Allain Provost (Groupe Signes) of Paris

Architects: Patel Taylor

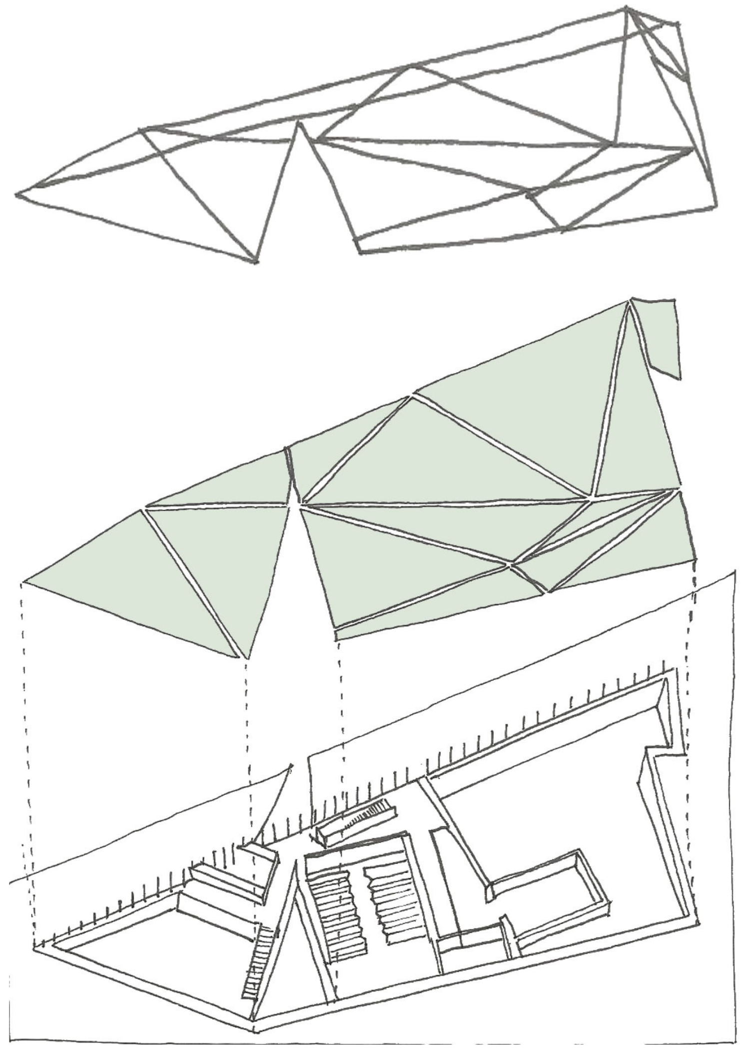
London

KCEV- Krkonose Mountains Centre for Environmental Education

Architect: Petr Hajek

Vrchlabí, Czech Republic

Landscape sensitivity



1.8 Precedents

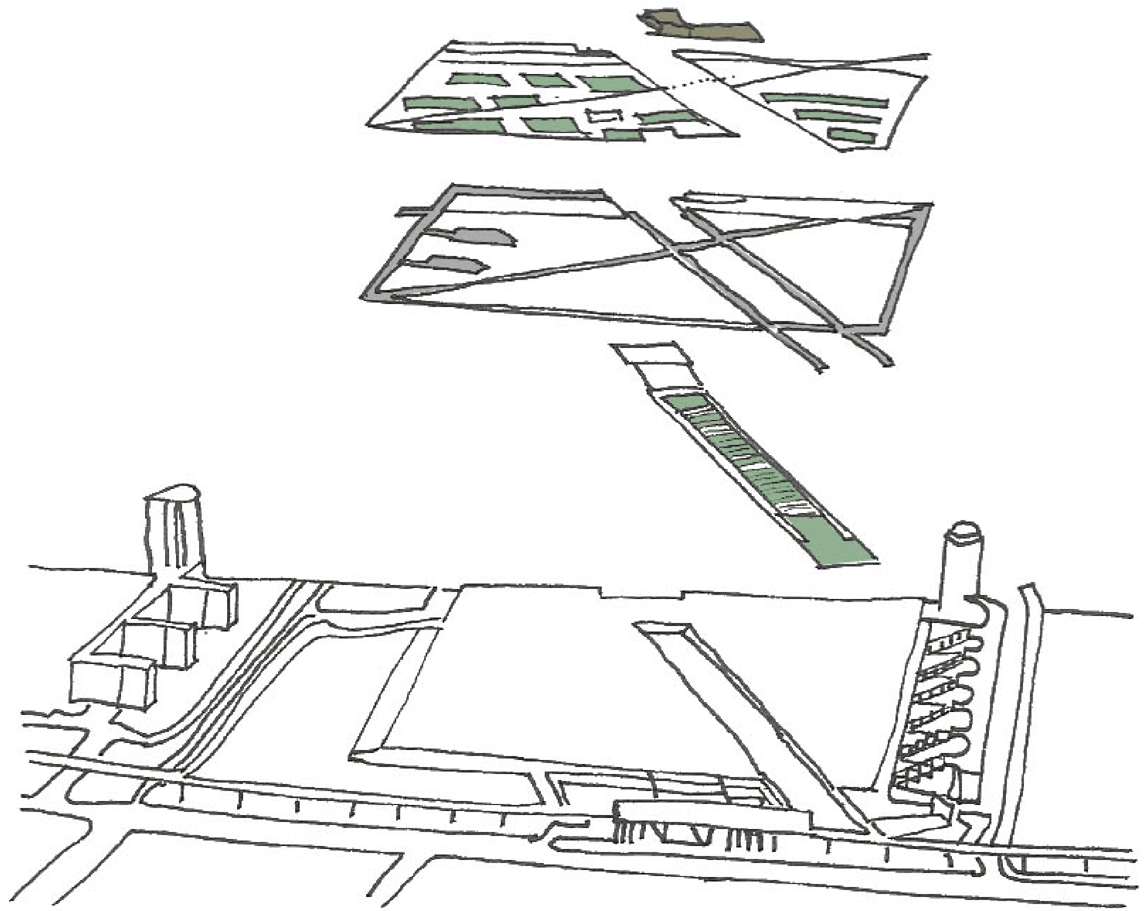
The existing layout of Zoo Park follows a simple formula. Most functions are arranged around the periphery with a water feature situated at the center with seemingly random walkways across the site. The terrain Slopes and has a 14 m level difference at the extreme and is scattered with several old trees. Centrally located in the city and with potential connections in all directions, the landscaping and fall of the site should assist in strengthening these connections. It is essential to stay true to the natural conditions of the park and a large-scale architectural in-tervention is not what the site requires for its rejuvenation. Thus, the pavilion needs to be added in a very gentle manner to the park, that keeps the trees untouched, the views from the park and circulation potential unobstructed, and brings the visitor closer to nature.

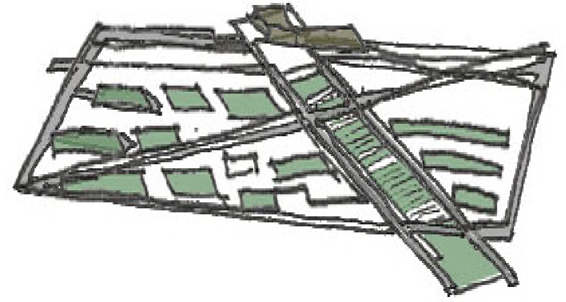
Pavilion Structure

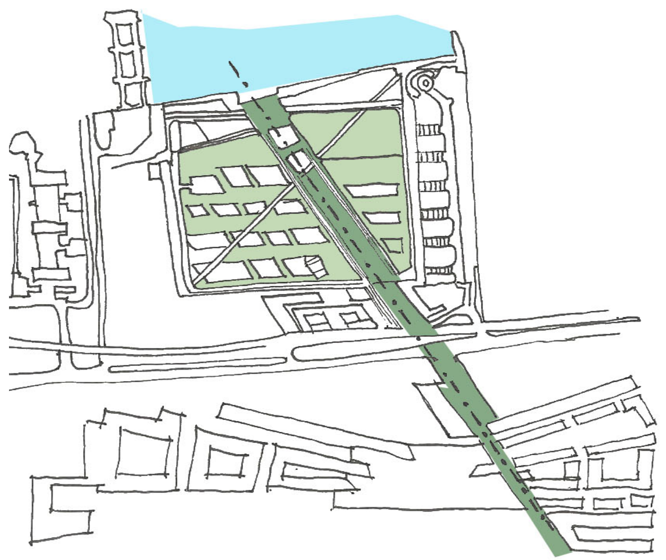
The mountain education centre, in its structural form mimics the landscape and has a roof design which can be traversed by people. The pavilion fits seamlessly into the ebvironment becoase it is sunken into the site, forming a subteranean space.

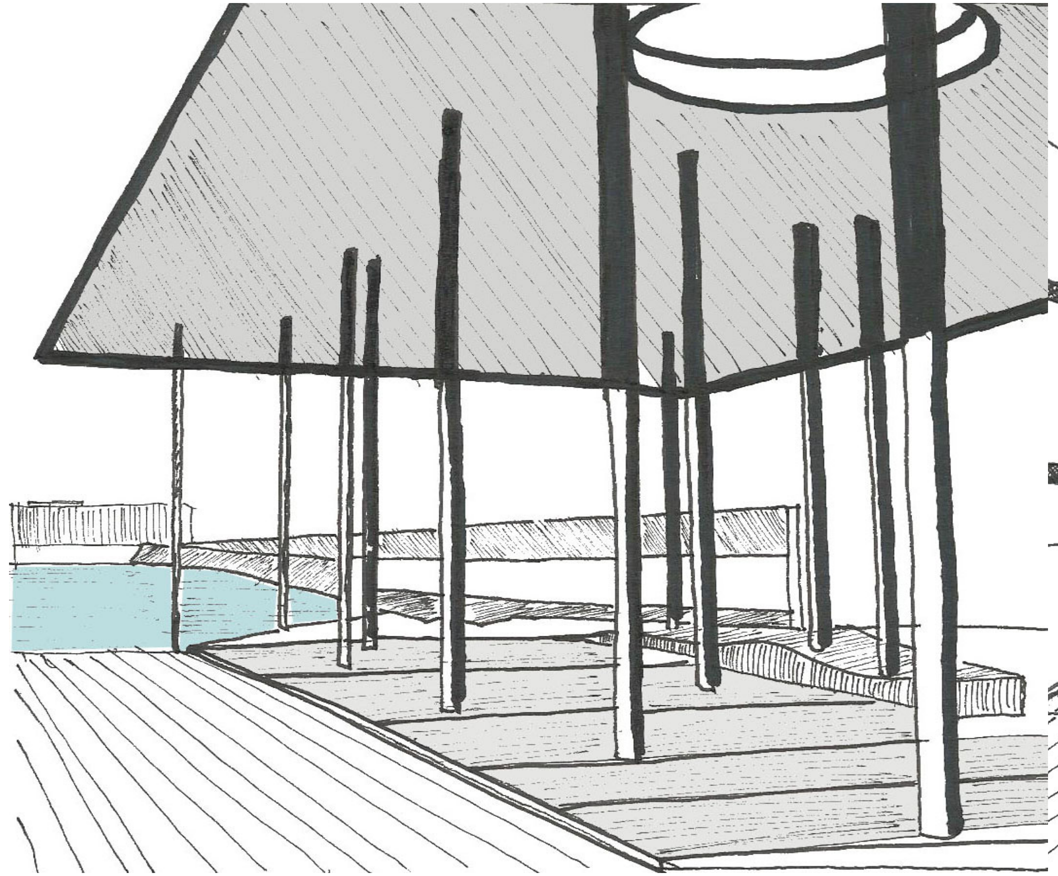
Unobstructed Park views

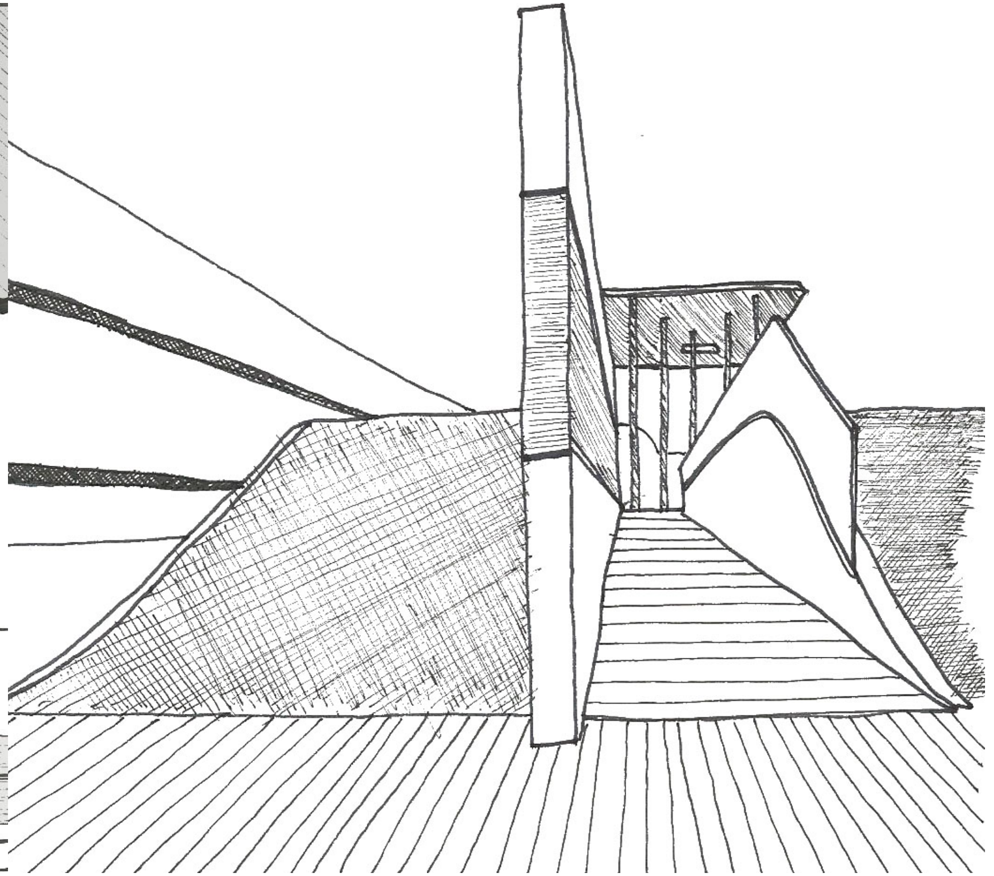
The Thames Barrier Park is based on a concept of creating "'a clear urban and park framework which envis-ages contrasting spaces for different uses in the park'. The park thus stays true to not obstructing the visual links created. One gets a sense of the attention given to the site and landscape. Furthermore, the layering of elements that comprise the park is done in a compact and intertwined manner, giving reason to the close layering of thresholds.











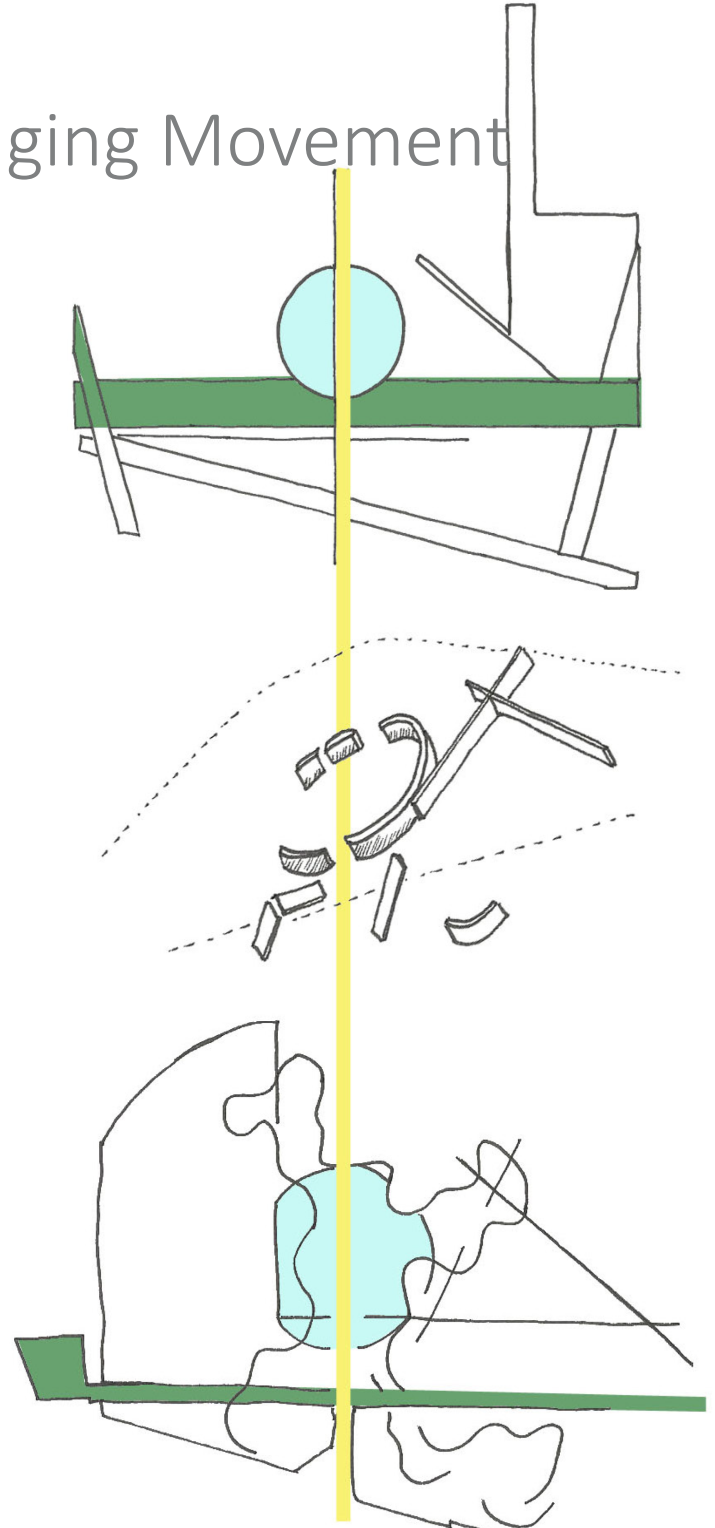
3

Encouraging Movement

Park De la Vallee

Architect: Bernard Tschumi

Paris



1.8 Precedents

It is essential for revival that pedestrian movement is encouraged across the site. For the existing functions on the site to be revived, people traverse the park. Apart from movement across the site, that links the various access points of the city and the site with each other, the designed pavilion and Injection station links into these movement patterns. In this way it keeps the pavilion active and encourages interaction. The points of entry remain unobstructed, creating the visual cues which focus on the landscaping and the design, guiding people towards it.

Parc de la Villette was designed with the idea of non-conformity and "a continuation, rather than a re-jection, of the city "and Tschumi made use of 3 elements. A system of points, surfaces and lines. The points are a continuation of the city's grid, this informed the placement of the follies found across the site and assists in the visitor's orientation. The lines follow the main circulation patterns of the park and the surfaces are the various interactions and functions across the site. This system helps any designer to rationalize a design, making use of these in a layout creates clear movement, place making and framing with visual cues.

4

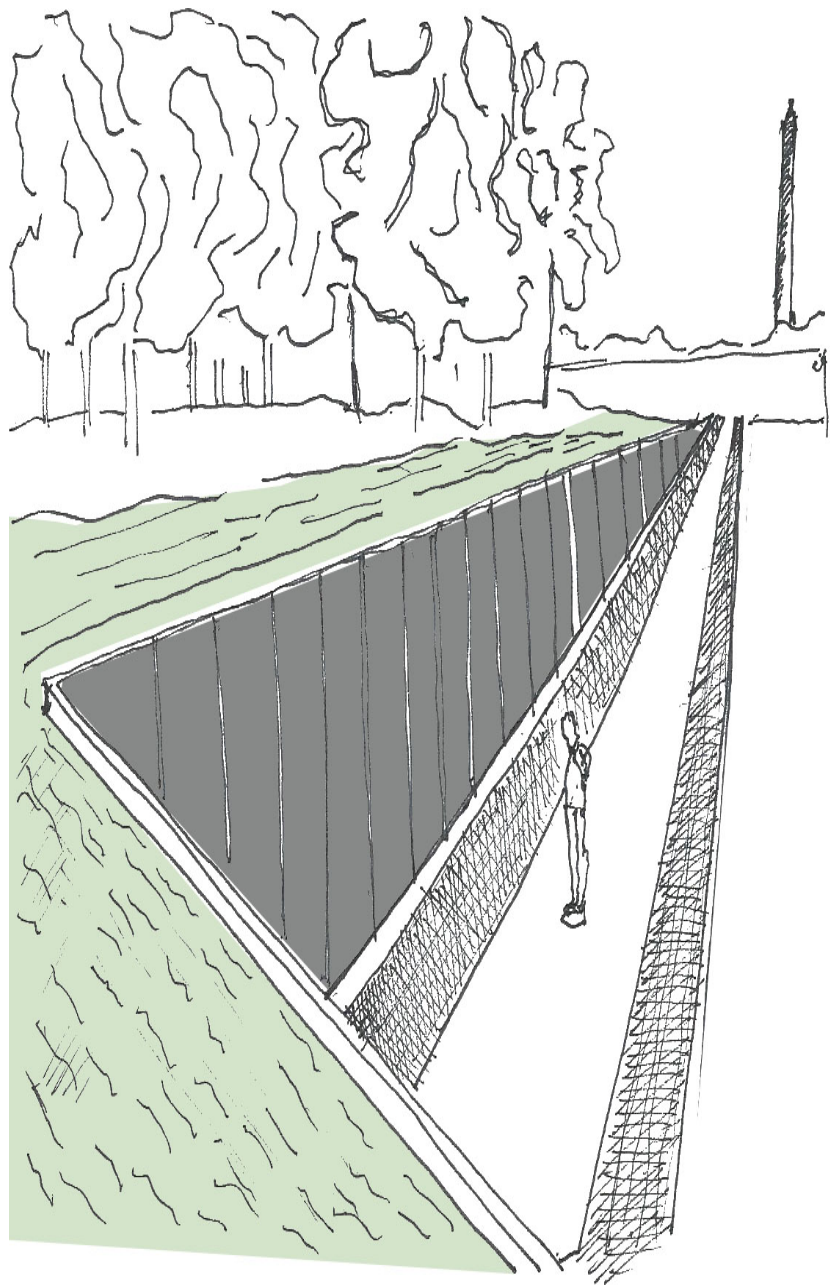
Exposing the hidden thresholds

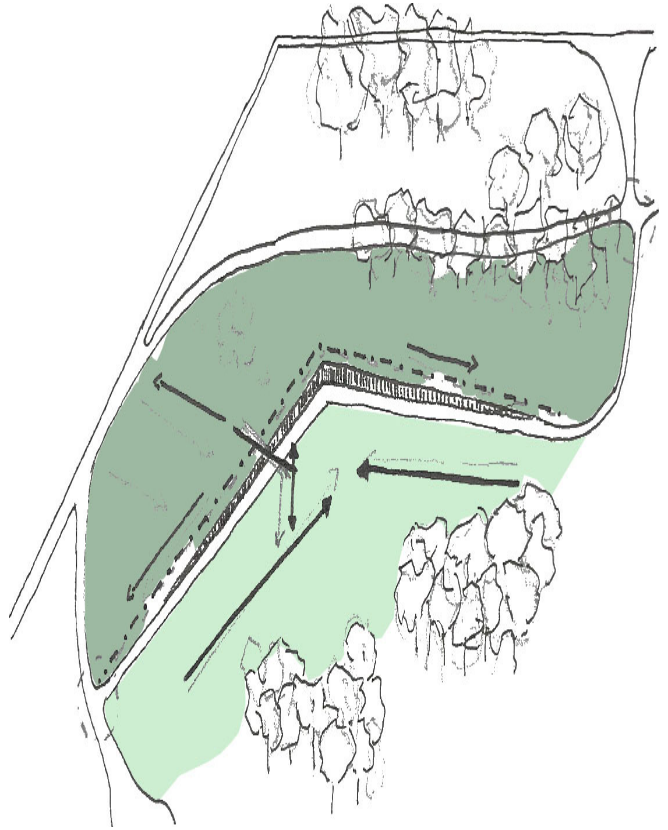
1.8 Precedents

Vietnam War Memorial

Architect: Maya Lin

Washington DC





Vietnam war memorial is a suitable example of scaring the site and working with level changes to achieve a subtle architectural intervention, that takes people on a journey and yet respects the site and the surrounding area. This increase in size of the project as one descends past it, also play on scale and the visitors' emotions when experiencing something monumental which at first seemed small and insignificant.

5

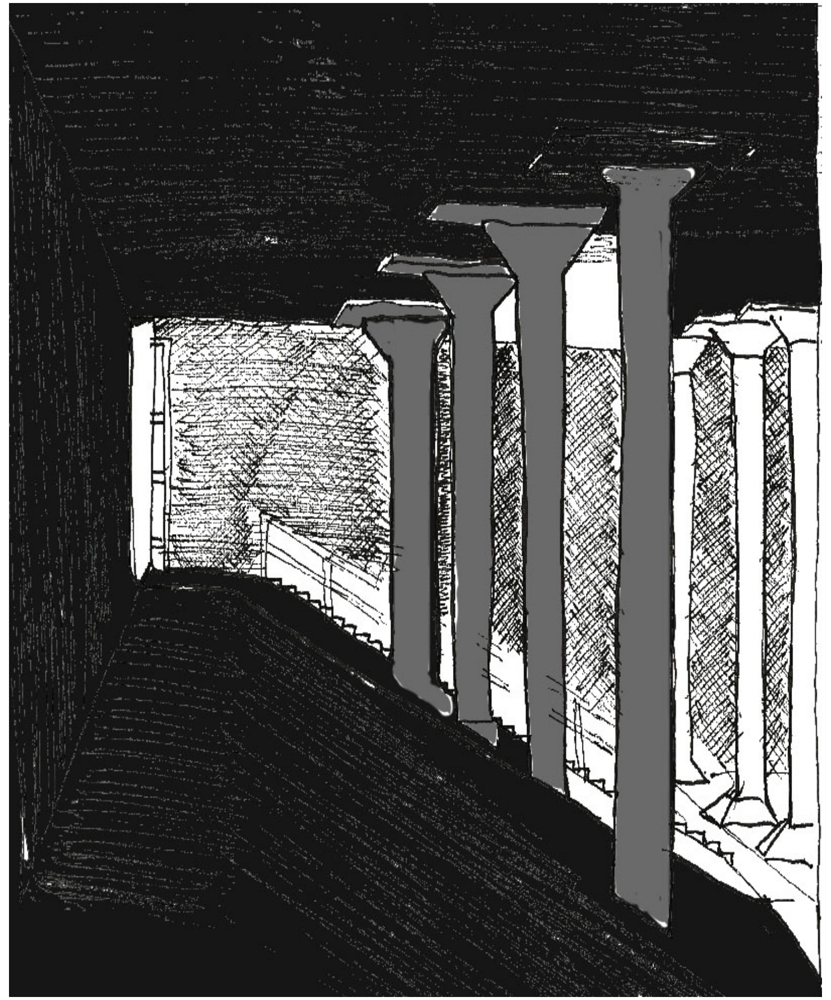
The architectural Narrative

Buffalo Bayou Park

Architect: SWA Group

Houston

Furthermore, the Cisterns used in Buffalo Park are a great example of ingenuity for storing water, creating dark and hidden spaces as an experience. Water below ground, light and reflections makes for an inspiring space. Similarly, RCR's winery is an example of how to connect passages in the landscape with subterranean spaces.



These are the primary factors that makes the project a plausible proposal for Zoo park. With the idea of revealing the unknown and connecting people with the hidden wealth of the springs and aquifers, thresholds starts creeping into the mind. This creates thresholds of all types above to below ground, between the park and the city, people and nature, access and interaction possibilities. Thus, the design leans towards following the natural scape of the park, and incorporate architecture into the park, rather than on top. The question of how to expose what is below the surface, can be anwsered by using the scar metaphor. This leads the design into opening the ground, exposing the subterranean and allowing people to explore the spaces they never have access to. Fitting the architecture and movement around the idea of traversing the various levels on the site and taking visitors on a journey of discovery and interaction with water starts to form the framework for the architectural intervention to follow.

Working below the surface, allows the MAR system to be implemented below the surface, and allows the mechanics of the process to take place outside public view. On the other hand, aspects of the MAR can be seen and experienced when journeying into the subterranean zone of aquifers and water. The cycle of water into the architecture and back into the aquifer adds to the sustainability of water use on the site. The subtle appraoch respects the existing site conditions.

The Brion tomb Cemetery by Carlo Scarpa shows how a narrative can be told through architectural expression. Similar concepts can be applied to the narrative told in the subterranean space.

Part 1.2

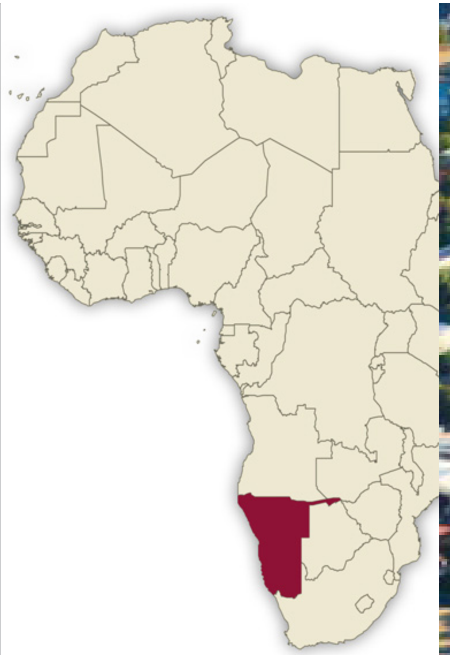
Project Locality:

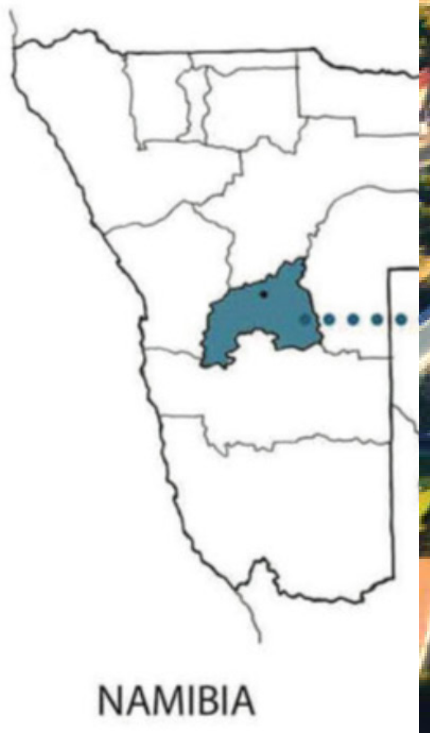
Windhoek Namibia
CBD - Zoo Park

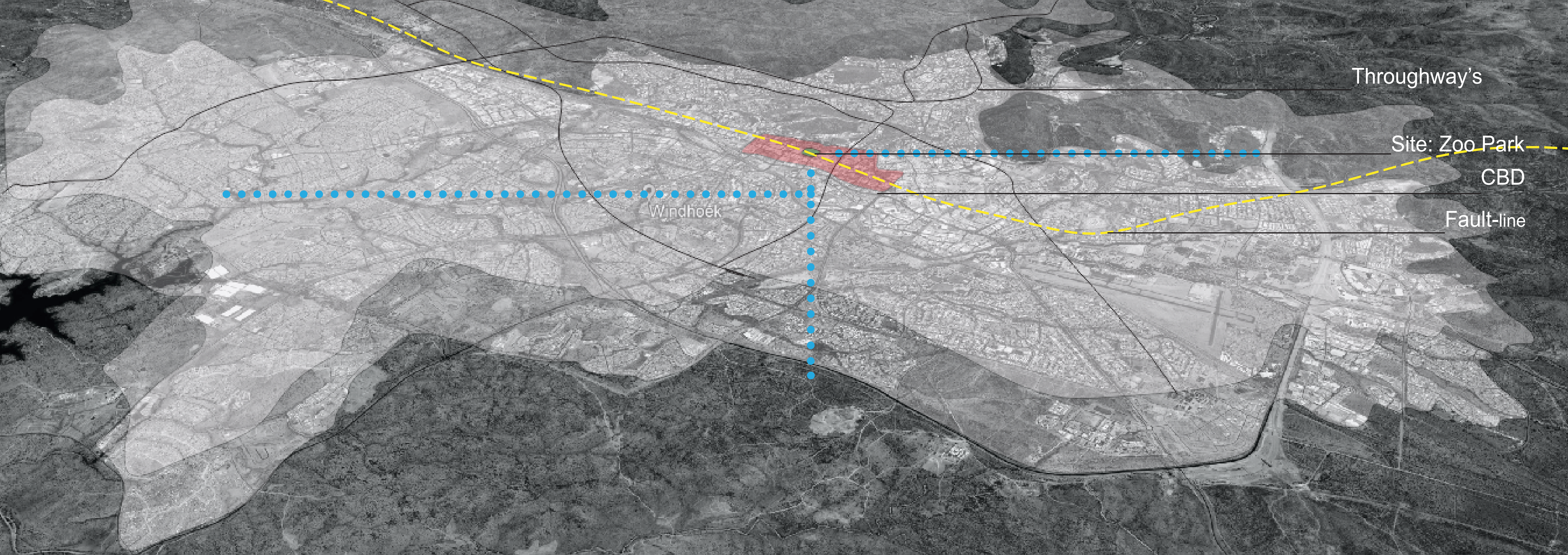
WINDHOEK TOPOGRAPHY

Macro Site Analysis

TOPOLOGY







Throughway's
Site: Zoo Park
CBD
Fault-line
Windhoek

1.2.1 Locality Diagrams

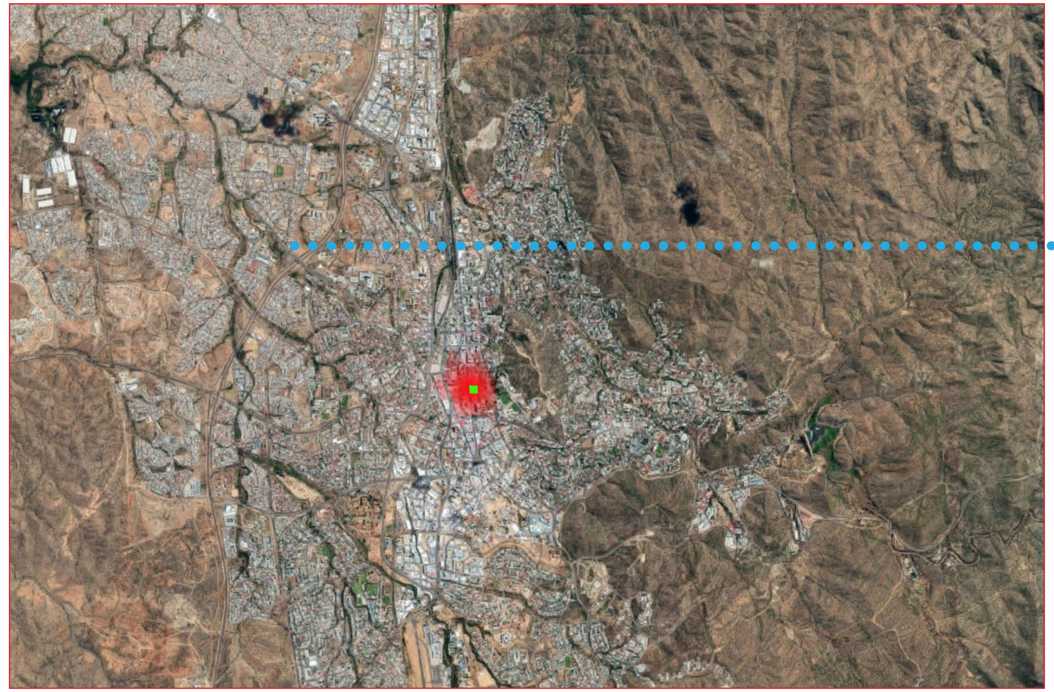
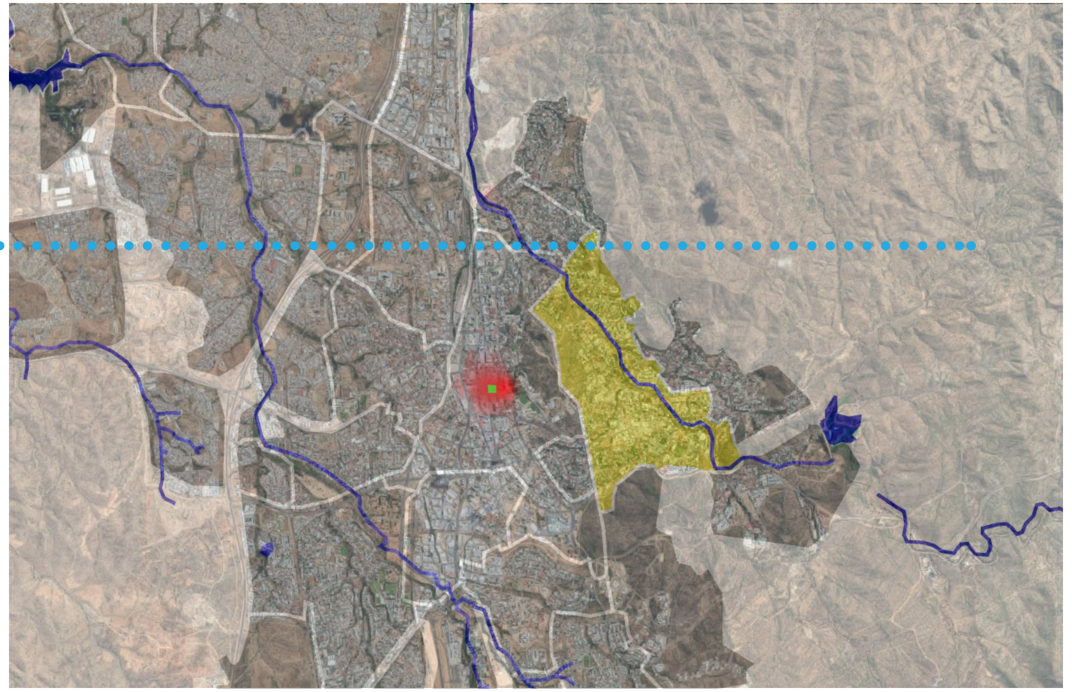
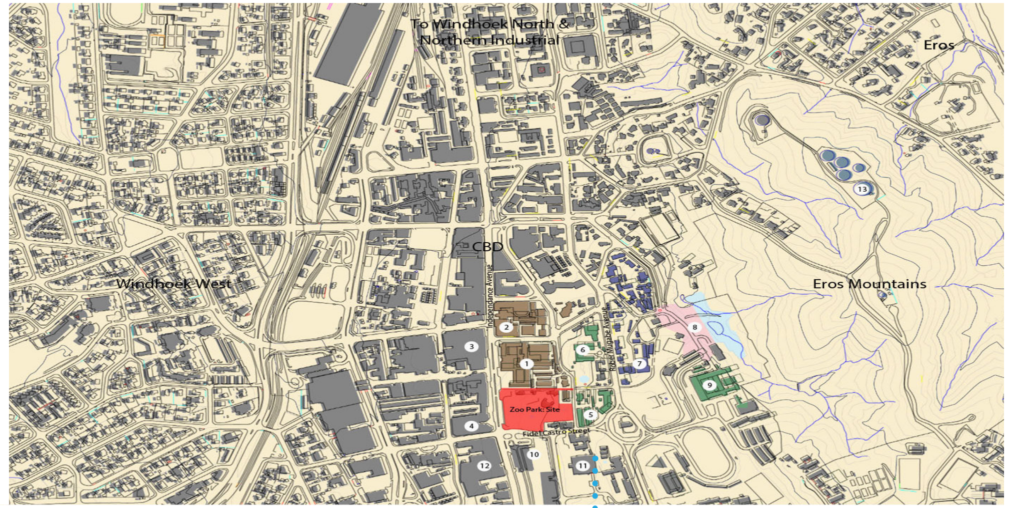


Figure 1.1 Windhoek Satelite Image (Google Maps)



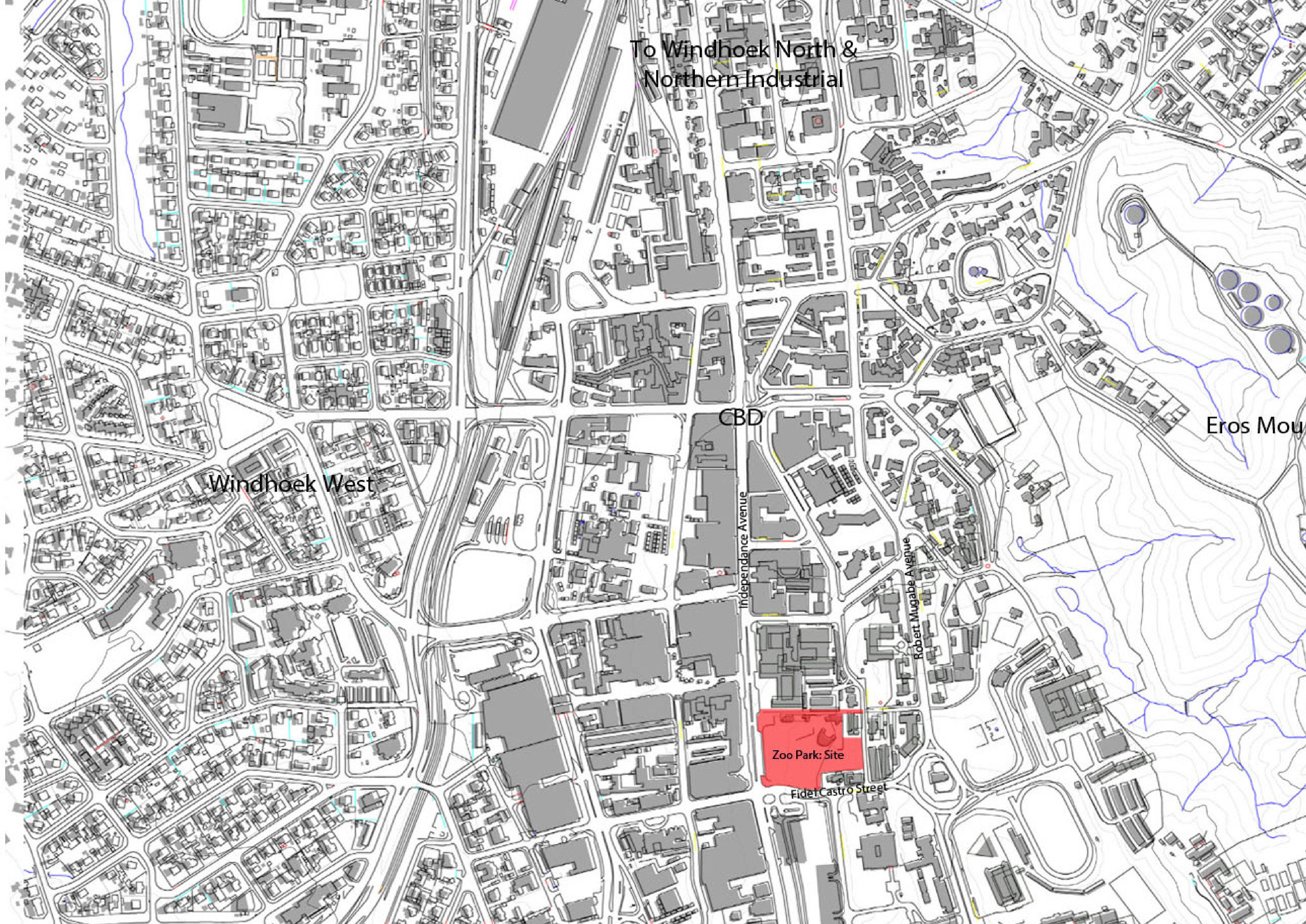
Firgure 1.3 Windhoek Suburb and Satelite overlaid

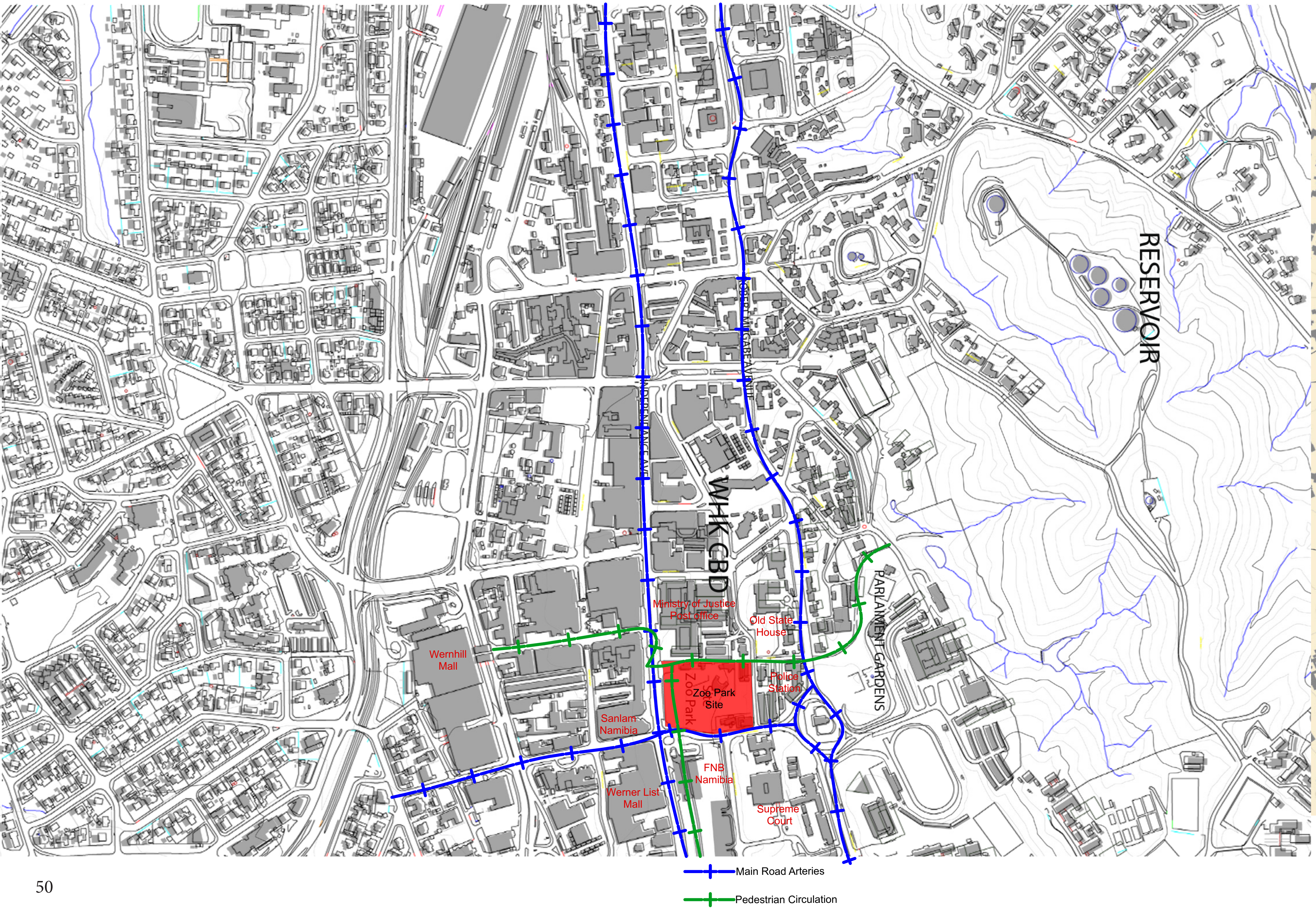
1. Nam-Post & Telekom Namibia
2. Bank Windhoek
3. Frans Indogo Towers
4. Sanlam & Mutual Towers
5. Police Station
6. Old State House & Gardens
7. Parliament Garden Residence
8. Catchment Zone - Eros Mountains
9. Tintenpalast - Parliament
10. FNB Namibia
11. Supreme Court Of Namibia
12. Karl List Mall - Kalahari Sands Hotel
13. Windhoek CBD Reservoirs

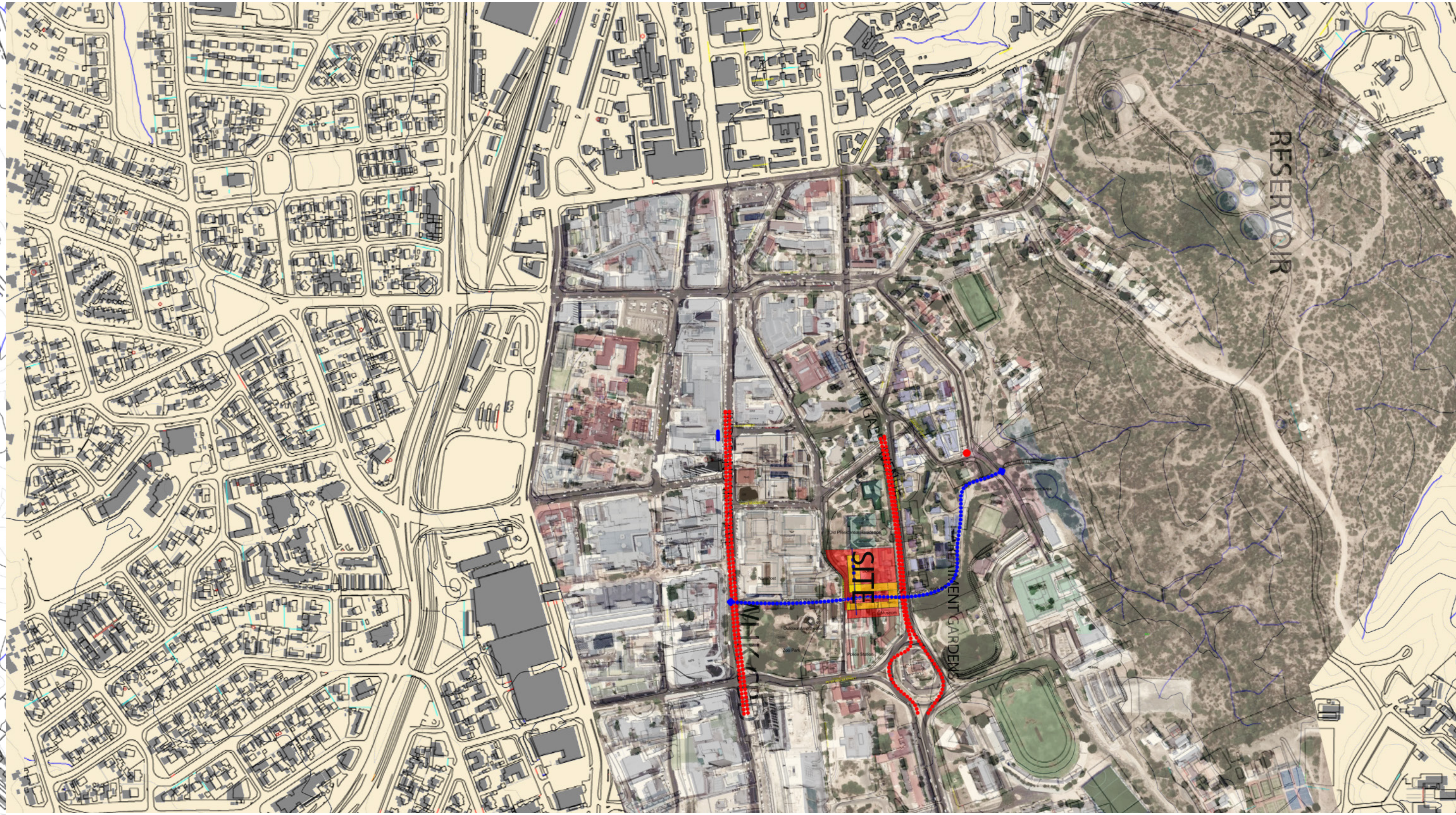


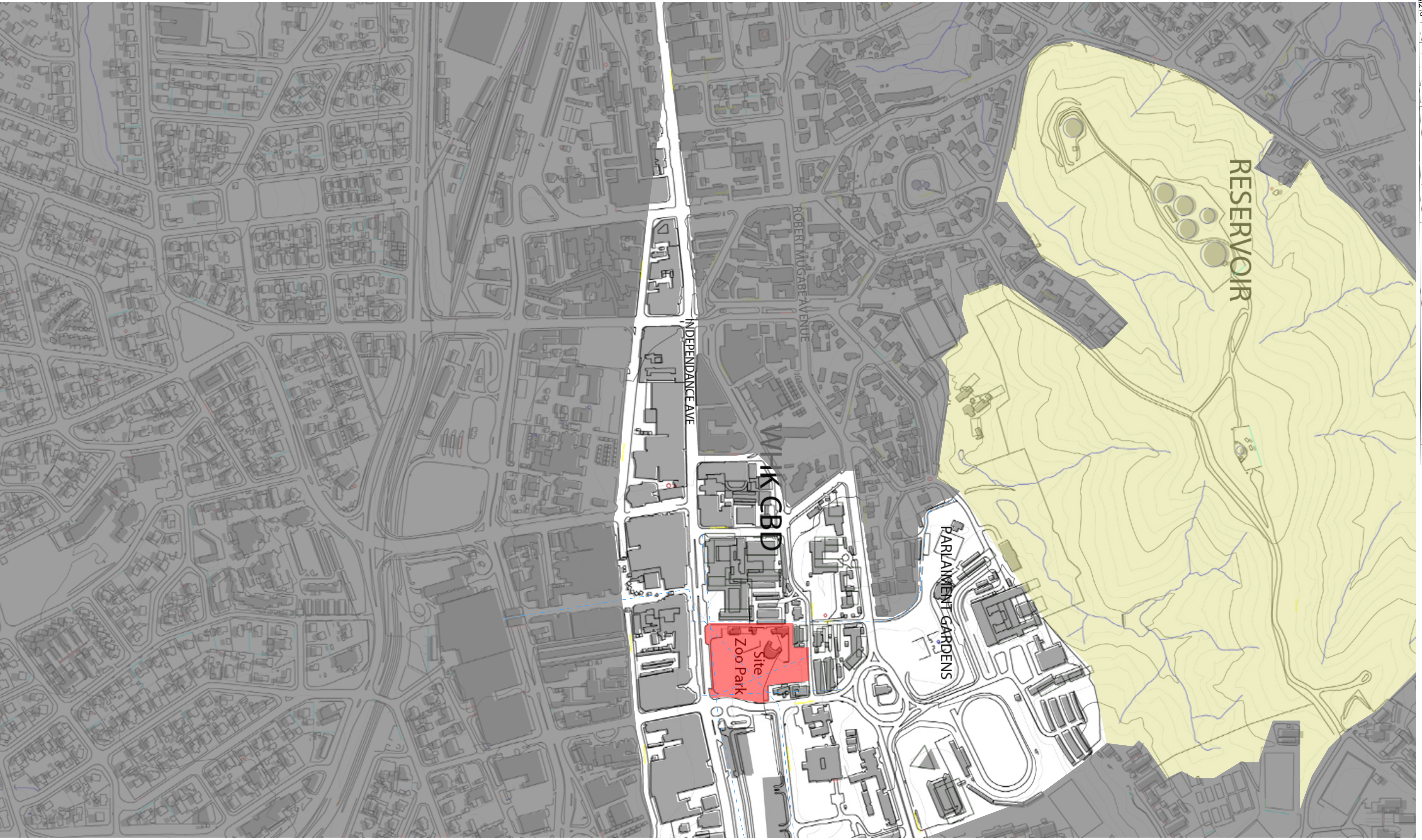
1.2.2 Site Analysis

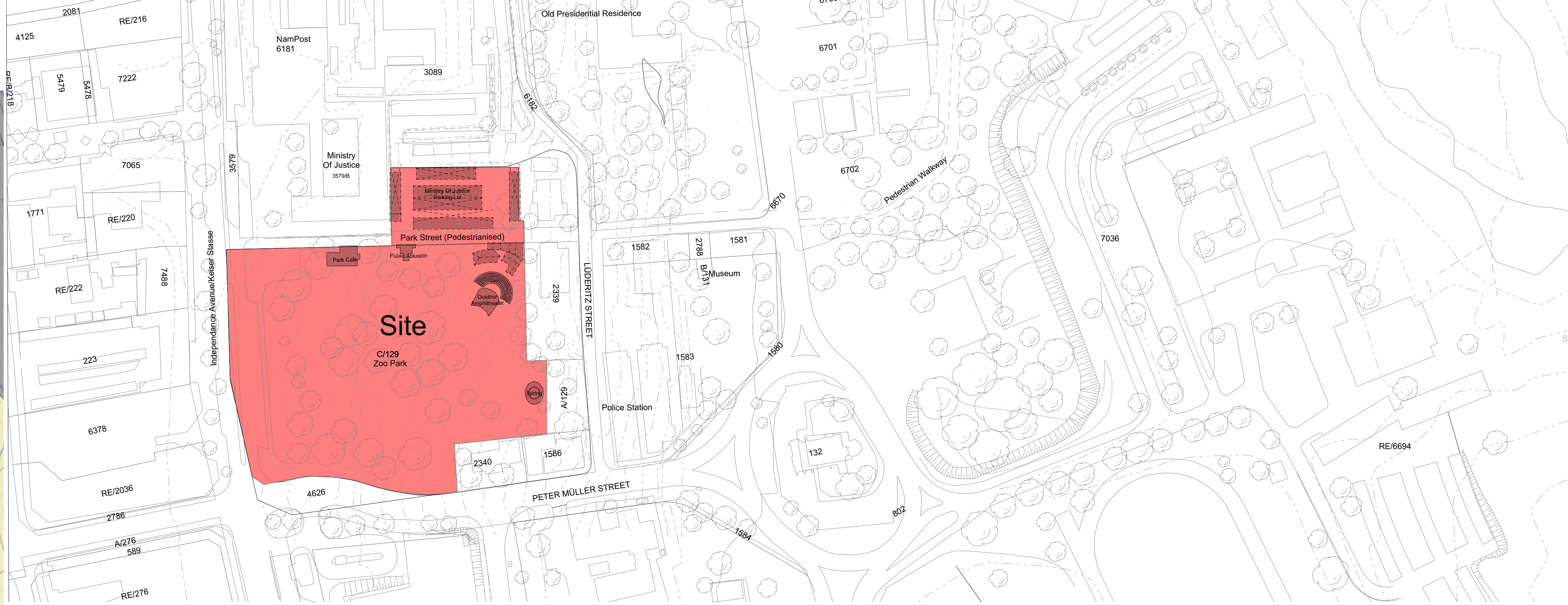

Post Office
Parking
Zoo Cafe
Pump Station
Fountain
Amphitheater
GRN

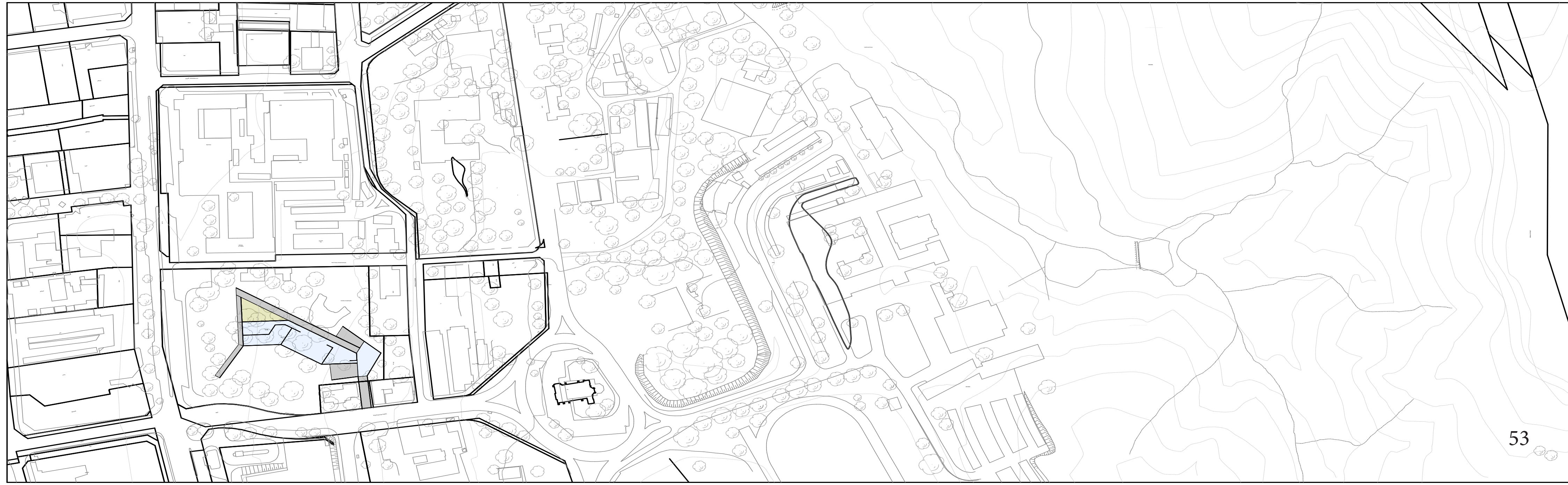

To Windhoek North &
Northern Industrial
CBD
Windhoek West
Eros Mou
Independance Avenue
Robert Mugabe Avenue
Zoo Park: Site
Fidel Castro Street

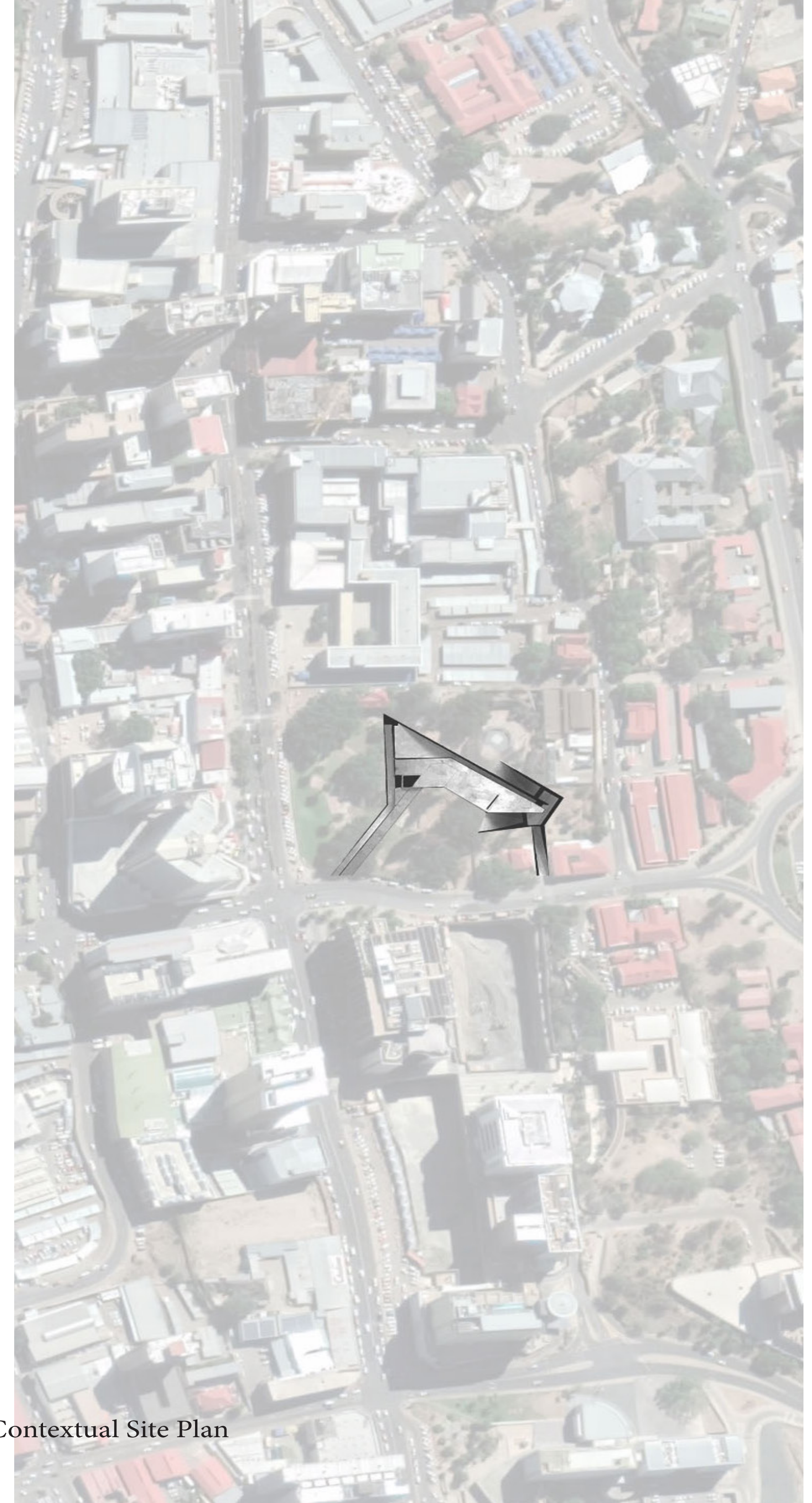

RESERVOIR
WHK CBD
PARLIAMENT GARDENS
Wernhill Mall
Ministry of Justice
Post office
Old State House
Police Station
Zoo Park Site
Zoo Park
Sanlam Namibia
FNB Namibia
Werner List Mall
Supreme Court
Main Road Arteries
Pedestrian Circulation


RESERVOIR
SITE


RESERVOIR
WHK CBD
PARLAIMENT GARDENS
INDEPENDANCE AVE
ROBERT MUGABE AVENUE
Site
Zoo Park


Old Presidential Residence
NamPost
6181
Ministry
Of Justice
Park Street (Pedestrianised)
Site
C/129
Zoo Park
Independance Avenue/Kaiser Strasse
LÜDERITZ STREET
PETER MÜLLER STREET
Museum
Police Station
Pedestrian Walkway





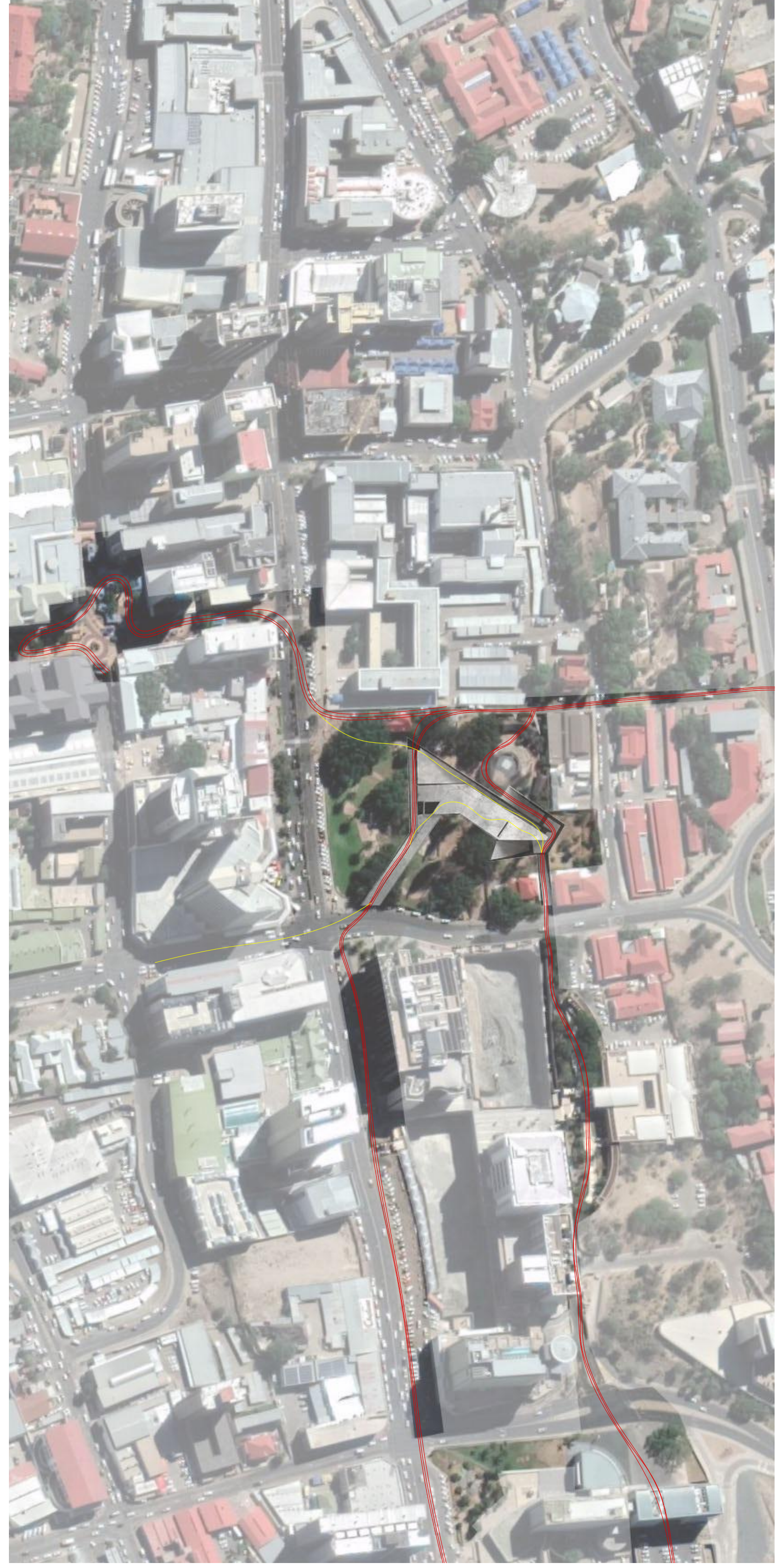
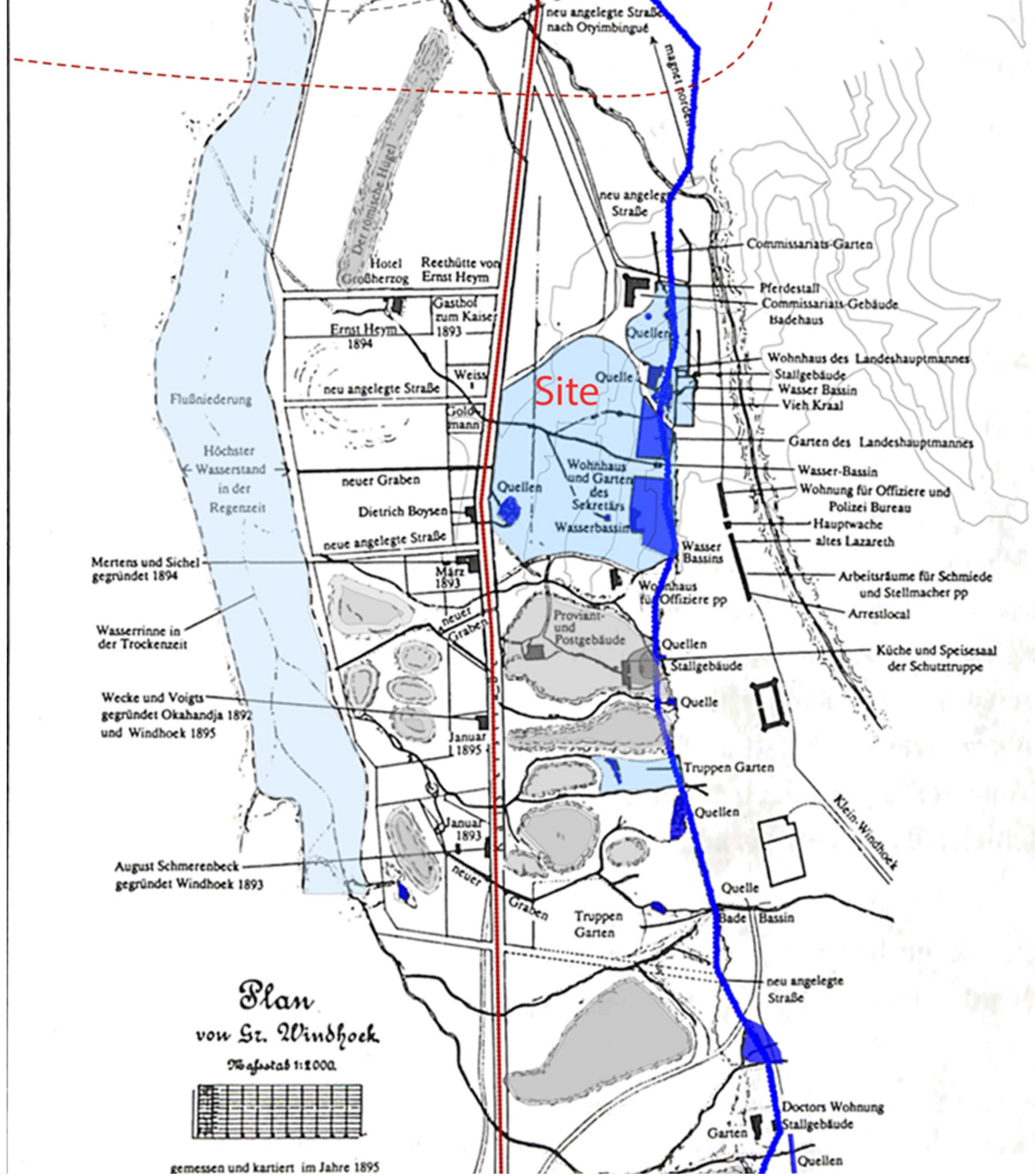
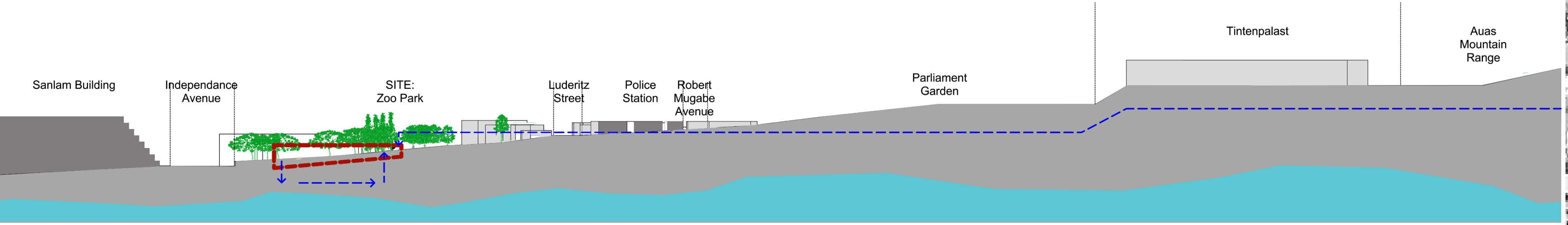


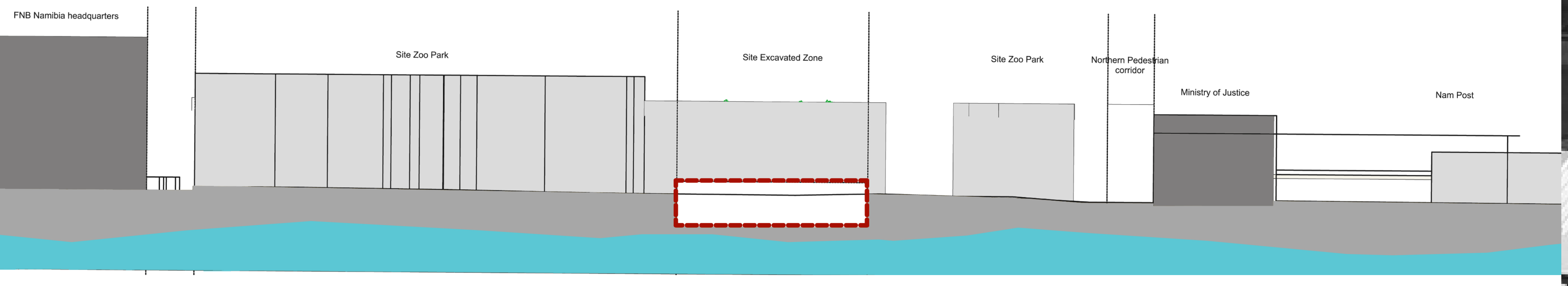
Figure 1.12 Contextual Site Plan

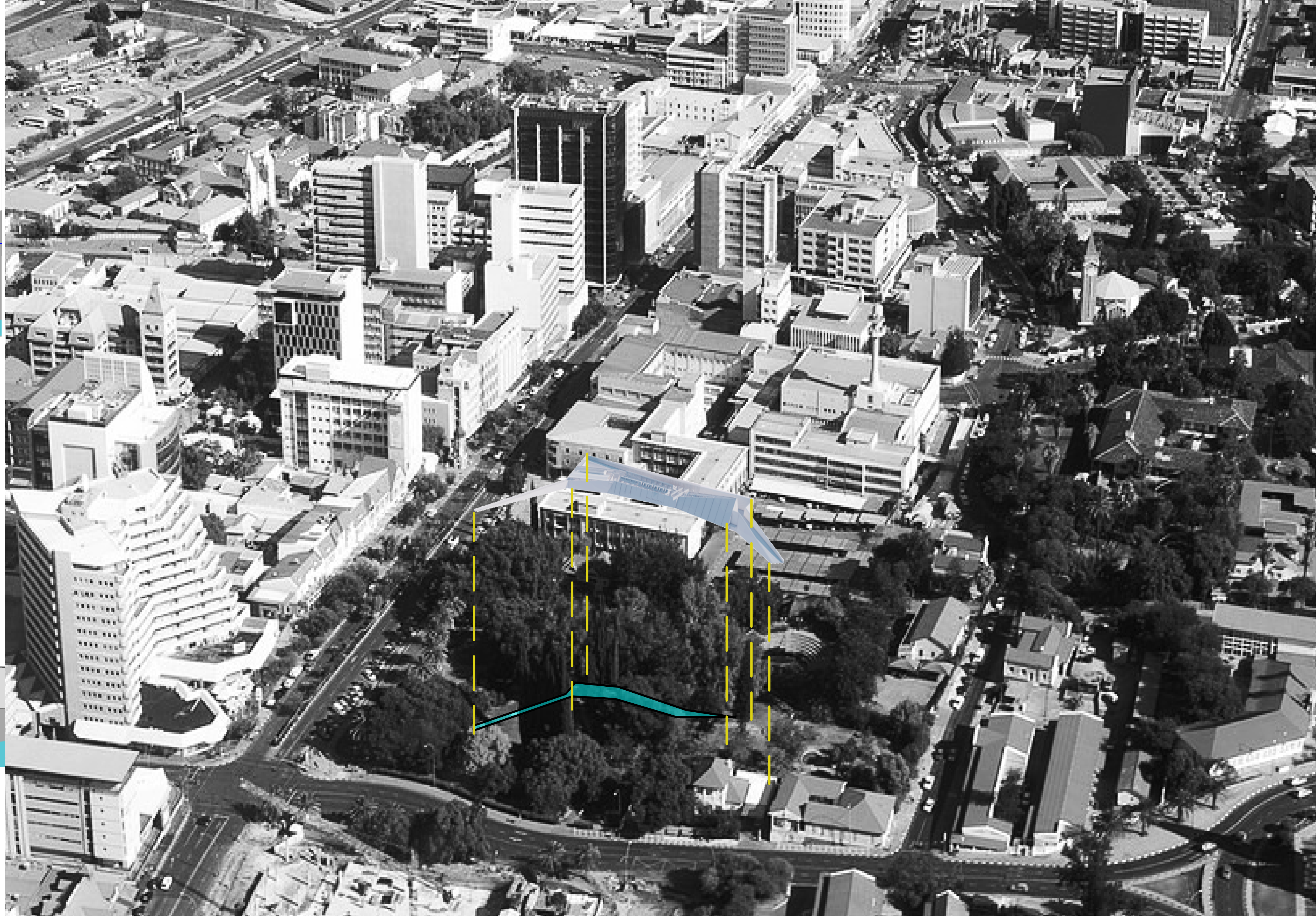


Zoo Park forms part of a green corridor that runs through the CBD. Initially the corridor runs from East to West, following the topography of the city that slopes downwards to the West. It starts at the Tintenpalast, through Parliament Gardens, past Zoo Park, leading into Independence Avenue (The main street in Windhoek) then enters Post Street Mall and ends at the entrance of Werhill Mall.

Today, newly constructed pedestrian corridors running from the city of Windhoek head office past the Supreme court and ending at Zoo Park, creates one of two new North-South connections that run past the site. The second corridor runs along Independence Avenue, starting at Auas Pann Plats and ending at the park again.

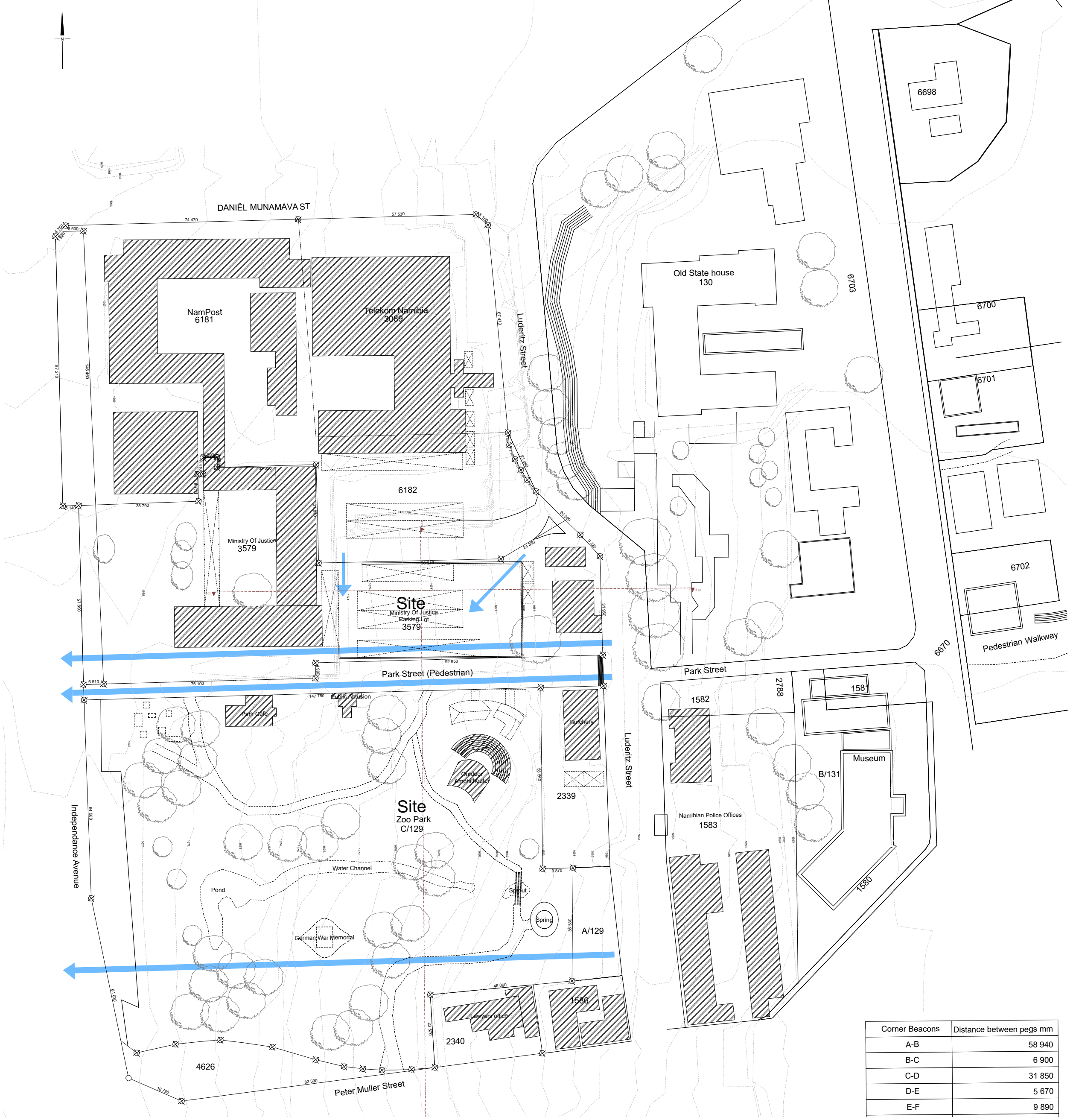

Sanlam Building
Independance Avenue
SITE: Zoo Park
Luderitz Street
Police Station
Robert Mugabe Avenue
Parliament Garden
Tintenpalast
Auas Mountain Range


FNB Namibia headquarters
Site Zoo Park
Site Excavated Zone
Site Zoo Park
Northern Pedestrian corridor
Ministry of Justice
Nam Post



1.2.4 Contextual Site Plan

Topographical Contectual Site Plan
Scale 1: 500



Corner Beacons	Distance between pegs mm
A-B	58 940
B-C	6 900
C-D	31 850
D-E	5 670
E-F	9 890

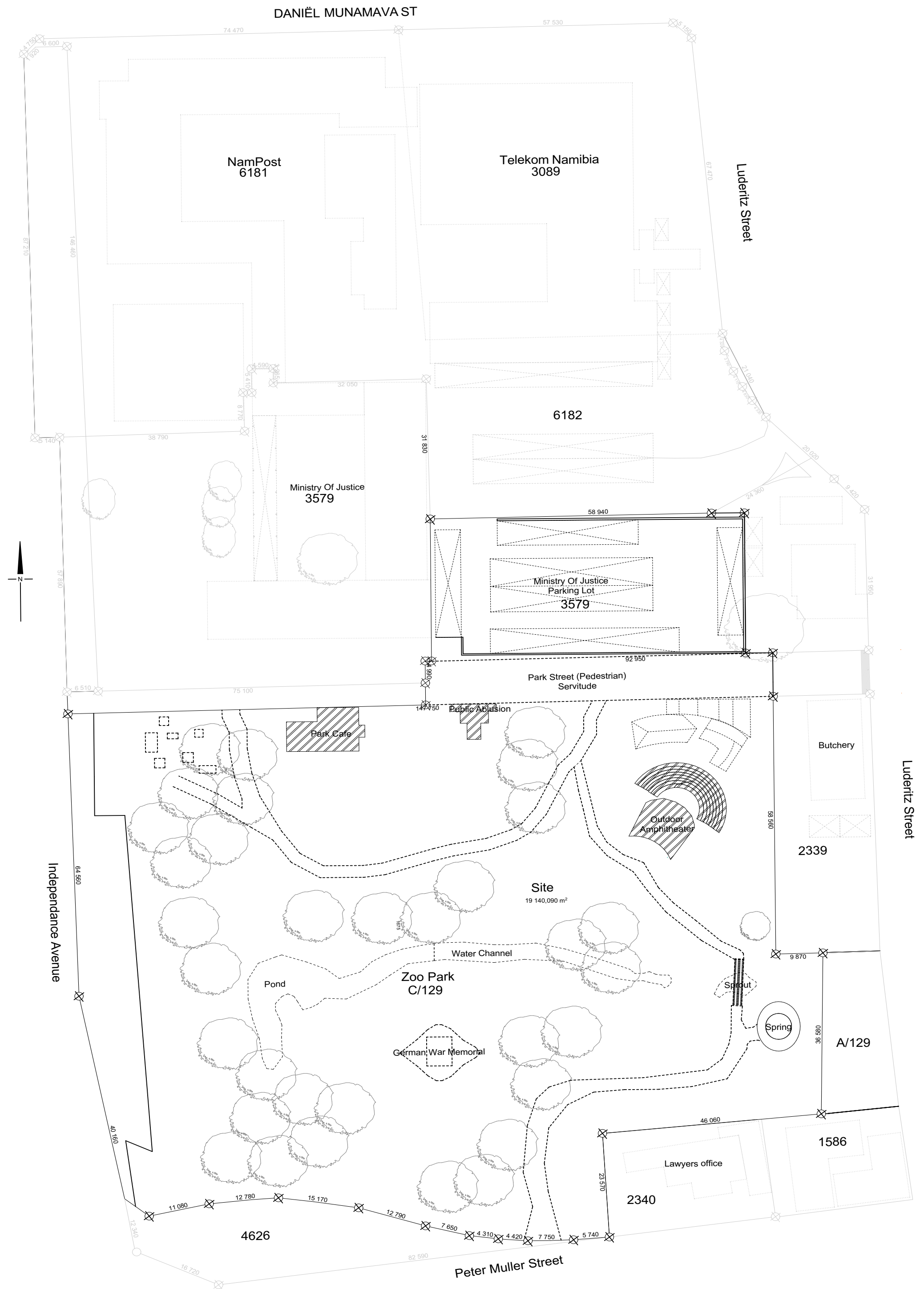
SCHEDULE OF RIGHTS			
PROPERTY DESCRIPTION			
Erf/Portion	Consolidated 3579/B & C/129	Site Area	Windhoek
Township	CBD	Title Deed No.	------
ZONING INFORMATION			
Town Planning Scheme	Windhoek	Amendment Scheme No.	------
Use Zone	Public/GRN Conservation	Annexe no.	------

DEVELOPMENT CONTROL MEASURES		
Permissible	Control	Actual
55 m	Height of buildings	------
70%	Coverage	------
------	Floor Area Ratio	------
------	Floor Area	------
4.2	Density Zone	------
------	Building lines	------

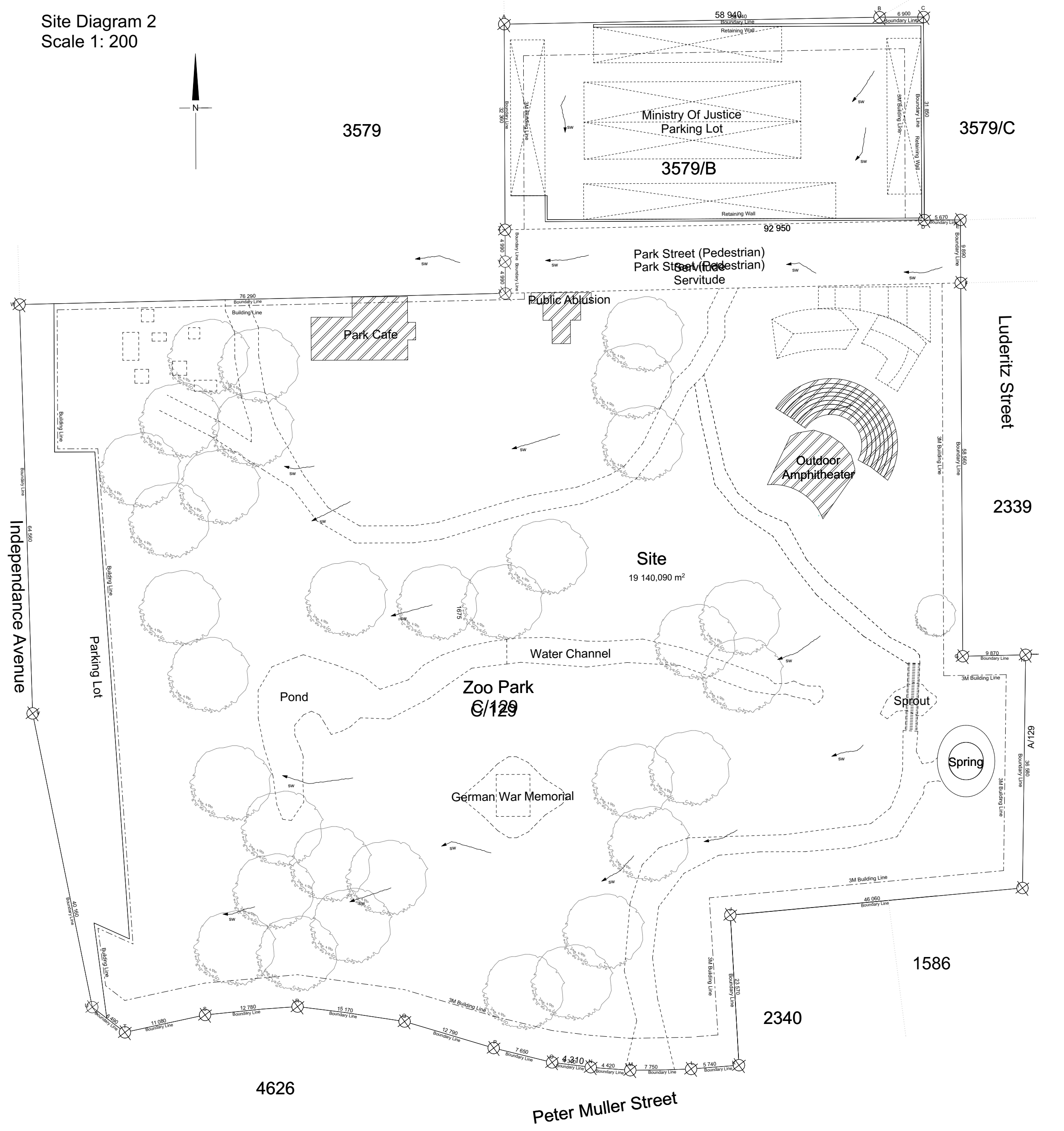
Sanitary Population Schedule							
Retail		Area ------		Retail population ------			
				Male	------	Female	------
Office				Office Population			
				Male	------	Female	------
REQUIRED							
MALE				FEMALE			
WC	U	WHB	S	WC	U	WHB	S
------	------	------	------	------	------	------	------
PROVIDED							
MALE				FEMALE			
WC	U	WHB	S	WC	U	WHB	S
------	------	------	------		------	------	------

Cadastral Information

Schedule of Rights



1.2.5 Micro Site Analysis



Windhoek CBD Topology

Windhoek lies in the heart of Namibia. The city developed along the main street (Kaiser strasse/ Independence Avenue) which in turn was created due to its proximity to the aquifers and natural hills found in the city bowl, which initially acted as a fort for the German troops. Klein Windhoek and the CBD formed around the Eros mountains, and all resulting extensions occurred as the cities population grew.

The terrain of the city follows a steep slope inclining from east to west, up to the foot of the Eros mountains. A fault line runs through the city which results in the shallow aquifers breaching the ground and creates the natural springs and wetlands. Today they are all closed off. Zoo Park in the heart of the city had one of the strongest natural springs.

Site Geo technical Analysis

Windhoek is situated in the Khomas Hochland region of Namibia. Positioned in a valley "surrounded by the Auas, Eros and Otjihavera mountains, which form the country's central watershed from where larger river systems radiate in all directions." (Christelis et al, 2001, 79 Groundwater Namibia)

The Windhoek valley is a "geological graben structure bounded by north-south striking fault systems in the east and west" ((Christelis et al, 2001, 77) According to the encyclopedia Britannica, a Graben is defined as "elongate fault blocks of the Earth's crust that have been raised and lowered, respectively, relative to their surrounding areas as a direct effect of faulting" https://www.britannica.com/science/horst

Windhoek is situated above the Damara Sequence and the rocks are "overlain by thick schists of the Kuiseb Formation" (Christelis et al, 2001, 77)

The city was found due to the natural springs covering the area which provided ample water for the initial settlers. The springs "emerged from deep-seated faults in the quartzite that form the main aquifer." (Christelis et al, 2001, 78) The natural spring on the site is caused by the north south graben and "form the major water conductors in the Windhoek area" (Christelis et al, 2001, 79) additionally the aquifer is replenished through "Direct infiltration of rainwater over areas of quartzite outcrop." (Christelis et al, 2001, 79)

with a general yield of about 9 cubic meters per hour. Due to this geology, the city of Windhoek have implemented managed aquifer recharge, where "treated water from Von Bach Dam is pumped into the Windhoek production boreholes and stored underground to reduce water losses from evaporation." (Christelis et al, 2001, 80)

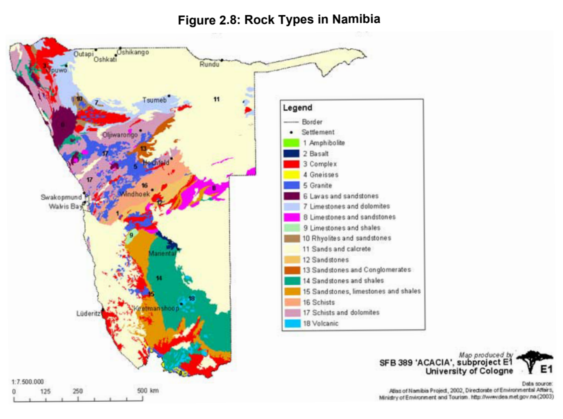


Figure 2.1 (Christelis et al, 2001, 24)

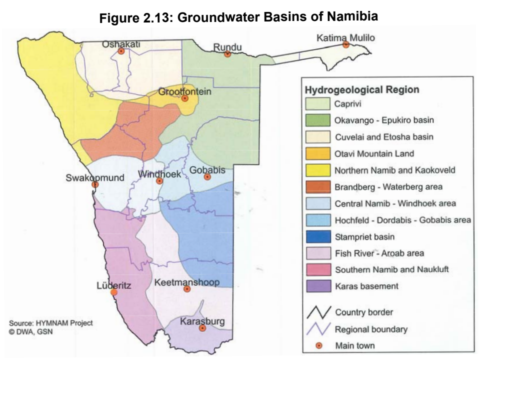


Figure 2.2 (Christelis et al, 2001, 25)

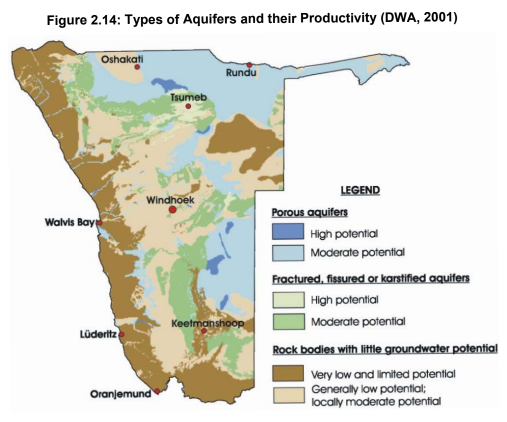


Figure 2.3 (Christelis et al, 2001, 44)

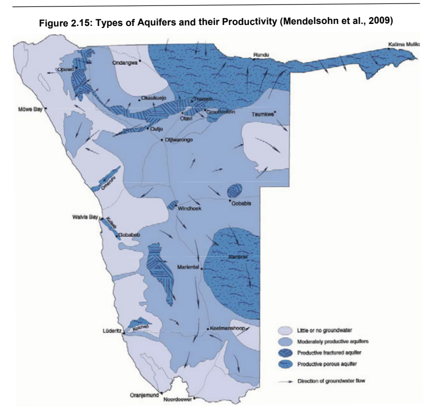


Figure 2.4 (Christelis et al, 2001, 45)

1.2.6 Managed Aquifer Recharge

Aquifers – "Are permeable geological strata that contains water and are normally replenished by rain permeating through soil and rock or by infiltration from lakes and rivers" (Declan Page, 2018)P.2

Managed recharge – "Through purpose-built recharge structures, such as injection wells and infiltra-tion basin, for subsequent recovery and use or for storage to provide environmental benefit to the aquifer." (Declan Page, 2018) P.2

"The concept essentially involved transferring treated surface water to the aquifer for safe storage and use when needed." (Murray 2017:4)

Quartzite and schist are the main soil types that comprise the aquifer. The city centre falls within an increased mica content in the quartzite which decreases fracturing and protects the aquifer. Parts of the Aquifer "are presently tens of meters lower than initially when the boreholes were drilled." (Tredoux, 2009)

There are several ways to implement the MAR system, but the most efficient for Windhoek is the bore hole approach due to the geological conditions.

The technology is simple to implement and the filtration process of water on site can be done with basic filtration mechanisms. These could all be re-designed to work with the architecture and structural elements of the design. .

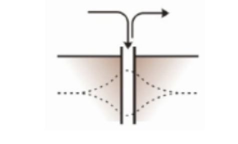
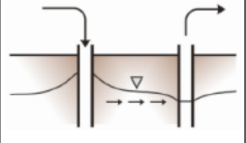
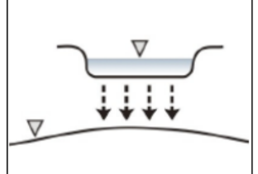
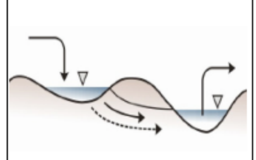
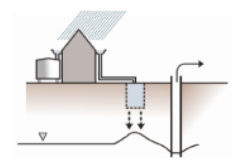
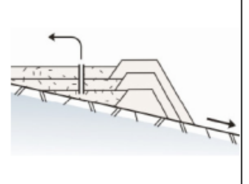
The system requires injection boreholes where the water is to be pumped to the underground aquifer. "Injection through a deep borehole at depth will be the preferred technique as the cascading of the water through the unsaturated zone will exacerbate any adverse reaction, such as the oxidation of pyrite." (Tredoux, 2009)

Currently Windhoek makes use of water from the three surrounding dams for injection, treated surface run-off and now the proposal to implement treated water from the Water treatment facility in Windhoek. "The sources of water for injection are the Von Bach dam and the reclaimed water." (Tredoux, 2009)

With every bore hole added, the capacity for underground water storage increases, water loss due to evaporation reduces and the city's reserves increase for times of drought, or as the population increases.

The filtration systems can be created via storage pools filtering through compacted walls, to achieve the same purity. The water is channeled through the architecture's surfaces such as feature walls and by allowing water to fall small distances as it changes levels, oxidation occurs, making the water suitable for injection. This system requires injection boreholes where the water is to be pumped to the under-ground aquifer.

Windhoek has a concealed and accessible aquifer at a depth of about 70m and the soil and geological conditions allows for the direct infiltration system to be used. This direct infiltration has several benifits compared to alternative methods.

	**Aquifer Storage and Recovery (ASR)** *The Injection of Water into a borehole for storage and recovery from the same borehole.* Suitable in both confined and unconfined aquifers.
	**Aquifer Storage Transfer & Recovery (ASTR)** *The Injection of Water into a borehole for storage and recovery from a different borehole, generally to provide additional water treatment.* Suitable in both confined and unconfined aquifers.
	**Infiltration Pond** *Ponds constructed usually off-stream where surface water is diverted and allowed to infiltrate (generally through an unsaturated zone to the underlying unconfined aquifer).* Suitable in unconfined aquifers.
	**Dune Filtration** *The infiltration of water into a sand dune system and extraction from boreholes, wells or ponds at a lower elevation for water quality improvement and to balance supply and demand.* Suitable in unconfined aquifers.
	**Local Rainwater Harvesting** *Surface water runoff from roofs or localised paving is diverted into a borehole, well or a caisson filled with sand or gravel and allowed to percolate to the water table where it is collected by pumping from a well or borehole.* Suitable in unconfined aquifers.
	**Sand Dam** *Built in ephemeral streams in arid areas on low permeability lithology. They trap sediment when flow occurs and following successive floods, the sand dam is raised to create an "aquifer". Vertical boreholes or horizontal outlets to the face of the dam can be used to extract water in dry seasons*

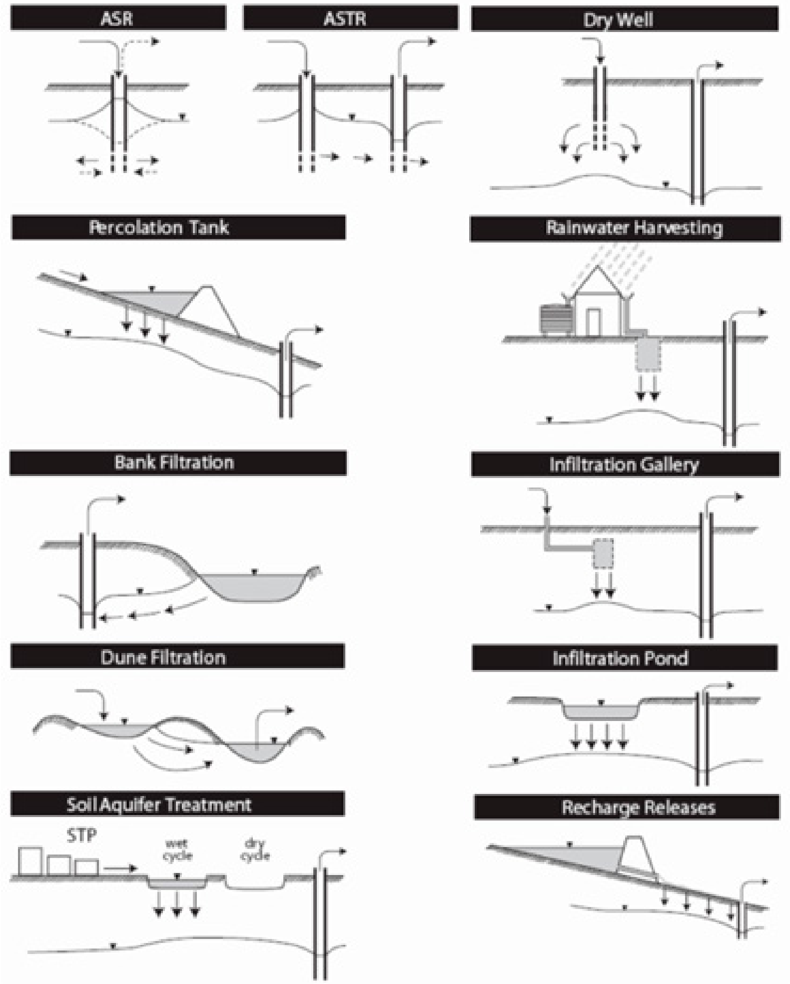


Figure 1. Schematic of types of MAR suited to urban water management (modified from: Dillon, 2005 [2]). ASR—Aquifer Storage and Recovery; ASTR—Aquifer Storage Transfer Recovery; STP—Sewerage Treatment Plant.

Part 2

CONCEPTUAL EXPLORATION

2.1 Touchstone Theory

The purpose of the touchstone is to capture the essence of the project and is seen as the thread that can be drawn through the entire project. This implies that the tread should be a visible influence in all the decisions made in the development of the project.

The touchstone for this urban landscape pavilion focuses on that hidden yet known space between the natural environment and that of the cities where we work and live. This is the space in which architecture and landscape design are incorporated to bridge the disconnect that exists between these spaces in the city.

The model represents the physical urban environment in the form of a city skyline silhouette, which has been cut into section, creating the impression of the remaining structural elements reaching out into the distance.

Nature is portrayed using wire, weaved together to create the impression of growing ferns or vegetation. With nature and the urban environment sharing a threshold, but not completely intertwined. Yet the reaching arms of the structural elements seam to stretch into the nature element where nature starts to use the structural elements as a foundation and support on which to grow.

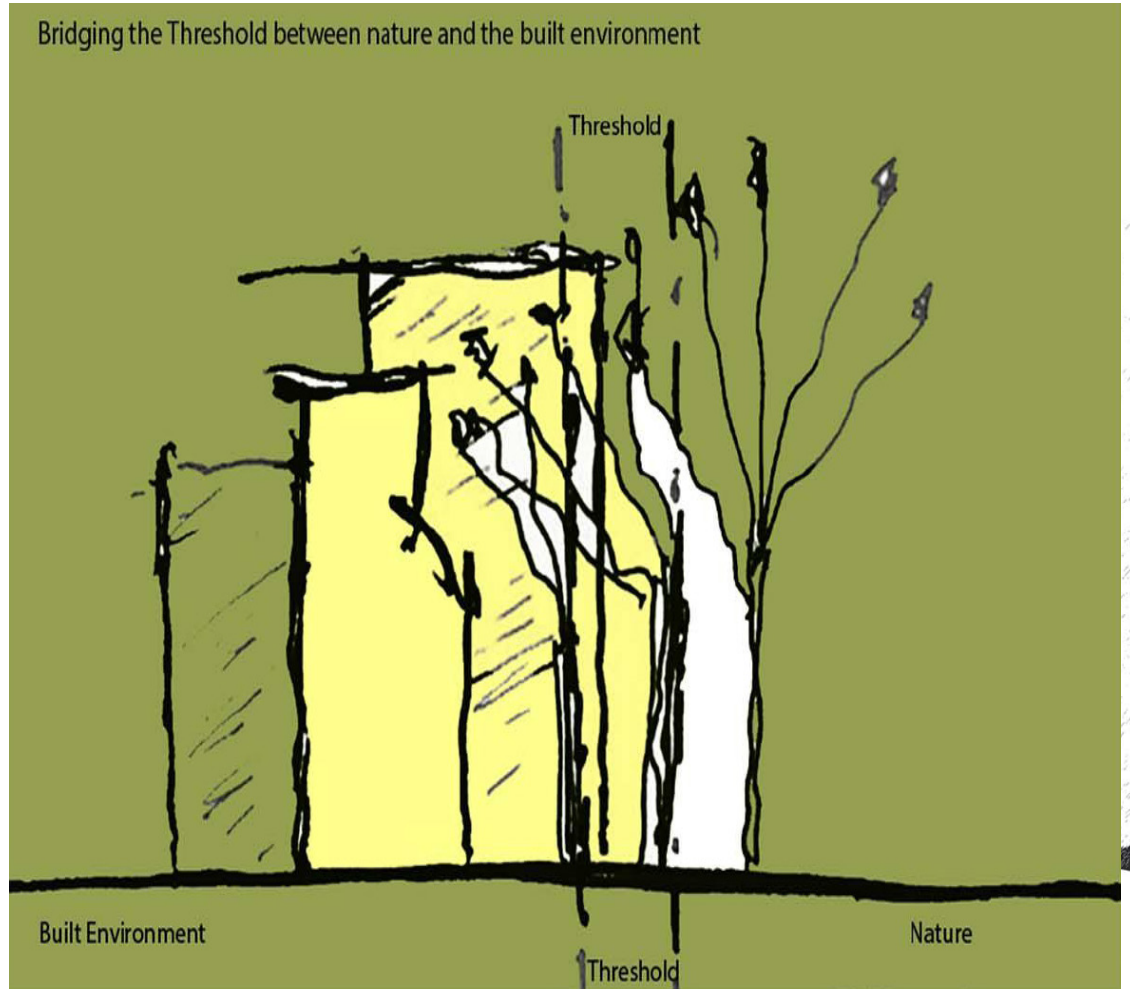
Nature is portrayed using wire, weaved together to create the impression of growing vegetation. This indicates nature and the urban environment sharing a threshold, but not completely intertwined. Yet the reaching arms of the structural elements seem to stretch into the natural element where nature starts to use the structural elements as a foundation and support on which to grow.

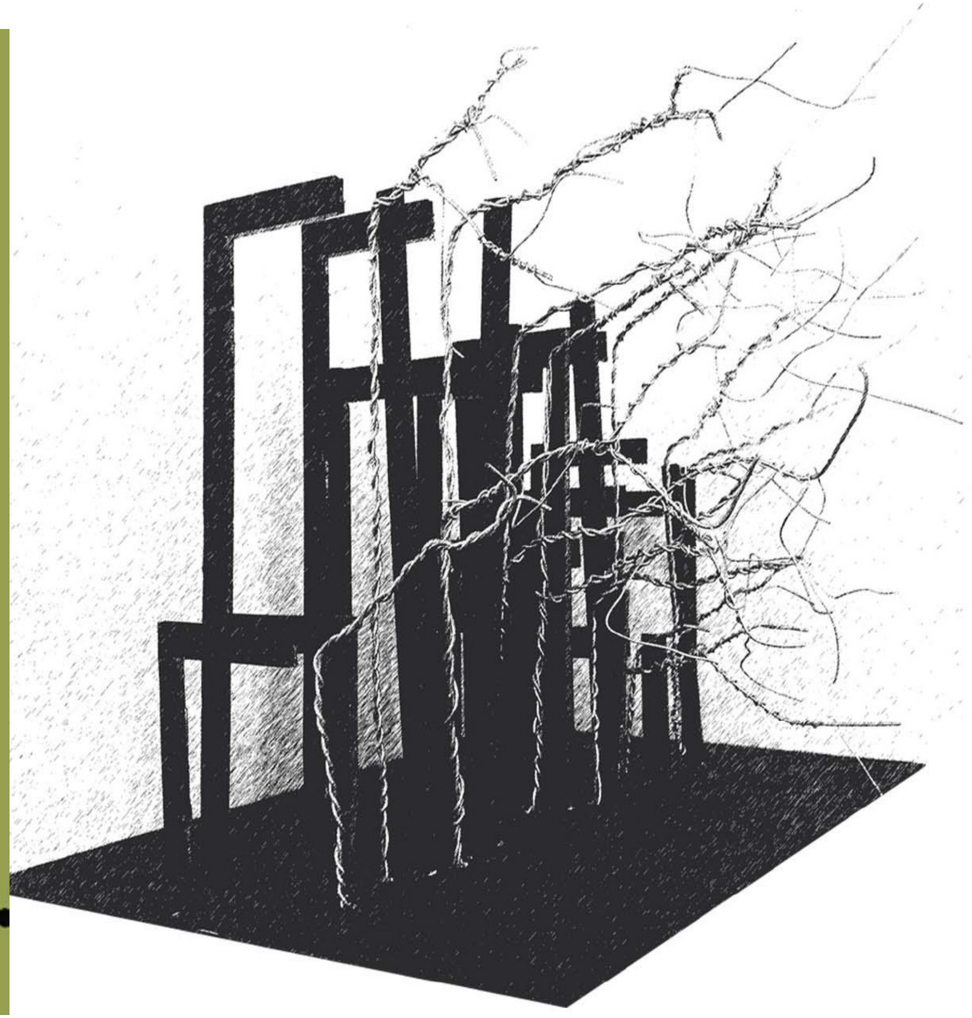
Although the natural and constructed worlds are mostly separate in contemporary cities, this touchstone indicates that emphasis should be given to the threshold zone where the two can overlap, and rest on one another, to create new urban spaces. .

Thus, this central line represents, physical, mental, emotional and functional thresholds, where the barriers between them need to be blurred and should become the main focus that needs to be addressed throughout the project. By placing emphasis on this thread running through the project, the design can become a fully integrated natural space for the public within the urban concrete jungle.

2.2 Touchstone Model

The sketch below indicates the threshold that exists between nature in all its forms and the built environment as an invisible thread that lies between the two, or the subliminal space where the two meet and intertwine. It is a marker for the space where nature, in the form of earth, water and vegetation ,can meet and integrate with the city in its concrete form through architectural and landscape design.



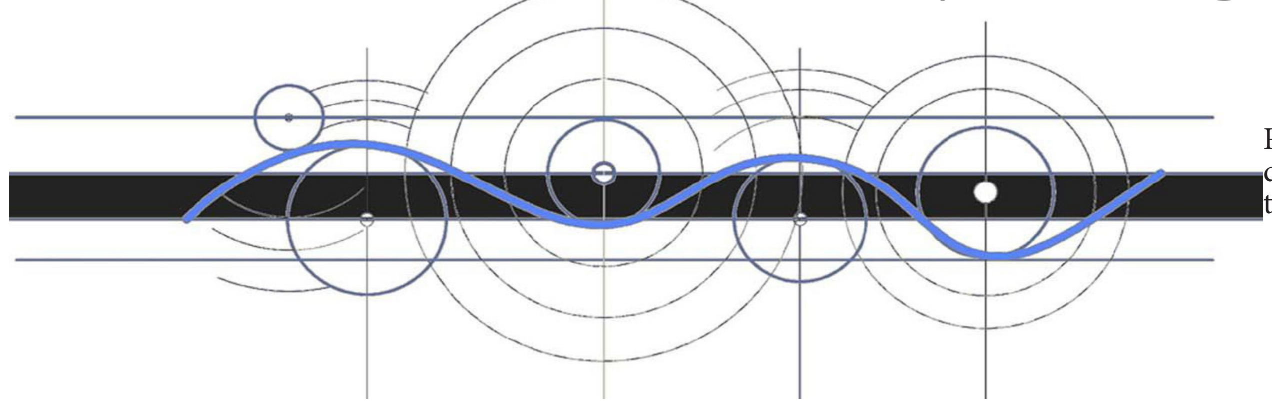


2.3 Conceptualising the Project

Cues within the design

Extending Thesholds

puncture
ripple
fragmentation
interface

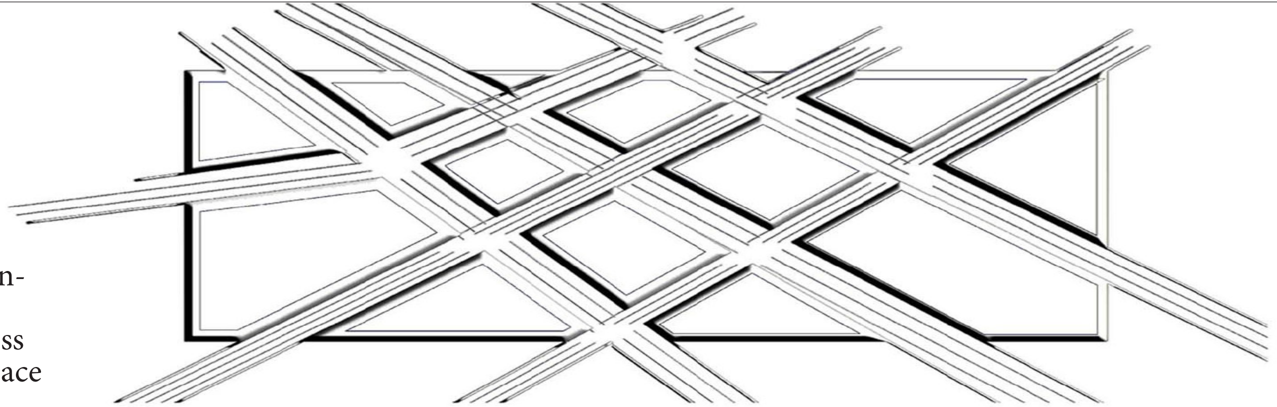


Represents the narrative which the design captures in its overall execution.

1. The first concept looks at how the design could take cues from water and start to inform the design in a more fluid manner. The extension of thresholds' effects on water and the puncturing of the aquifers and ground surface, looks at breaking down the physical thresholds between what lies above ground as well as below. Further investigating how nature and the city can be weaved into each other's fabric through the design. Circulation, repetitive movements and expansion were the main drivers which influenced this concept it informs not only the physical nature of the design but guiding the programmatic and functional aspects as well.

Scaring nature

Threshold disillusionment
Urban responsiveness
Fracturing urban space
Imprinting Nature
Expanding footprint
Heterogeneity
In-between spaces

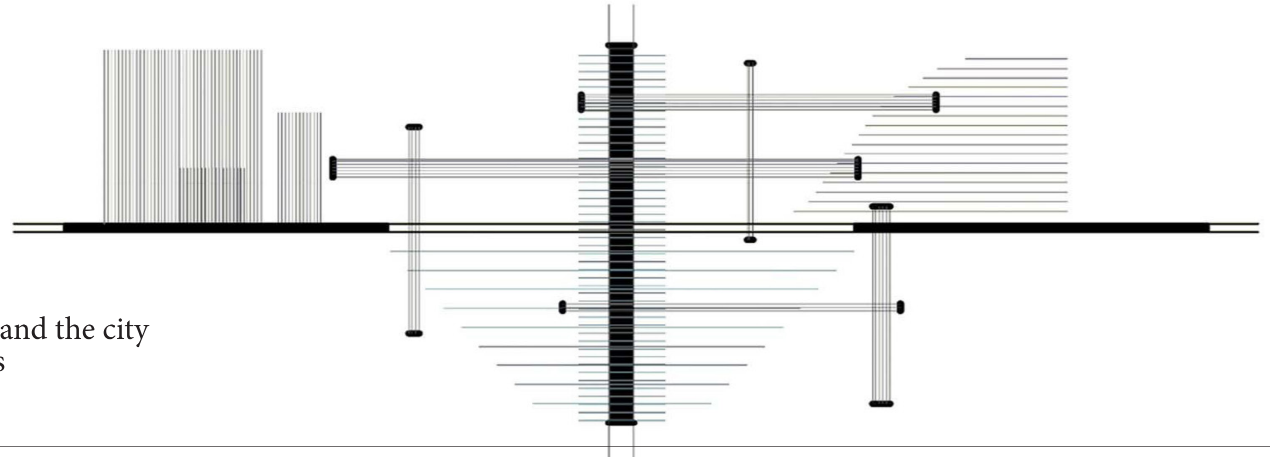


Represents the physical queues and pathways created within the landscape to house the architecture within nature or more specifically the earth and water below ground.

2. The second question is how to address the nature component and how it could be imprinted onto and within the urban landscape. With a key focus on how to infuse the morphology and typology in the premise which is the expanding of the natural footprint with the aim of the design having a broader impact than merely the site itself.

Liminal Geography

Revealing Nature
Connection nature and the city
Bridging the fringes
Water as a link



The various connections indicates the collection of queues which interconnect to give form and function as well as a sense of place to the design.

3. Here the concept is focused on an already opened or exposed terrain, where the natural elements can be combined with the architecture and become infused with the landscape. Together the hybrid of nature and architecture becomes a bridging element that connects and carries the people, water and surrounding areas through the inclusion of the design in the park.

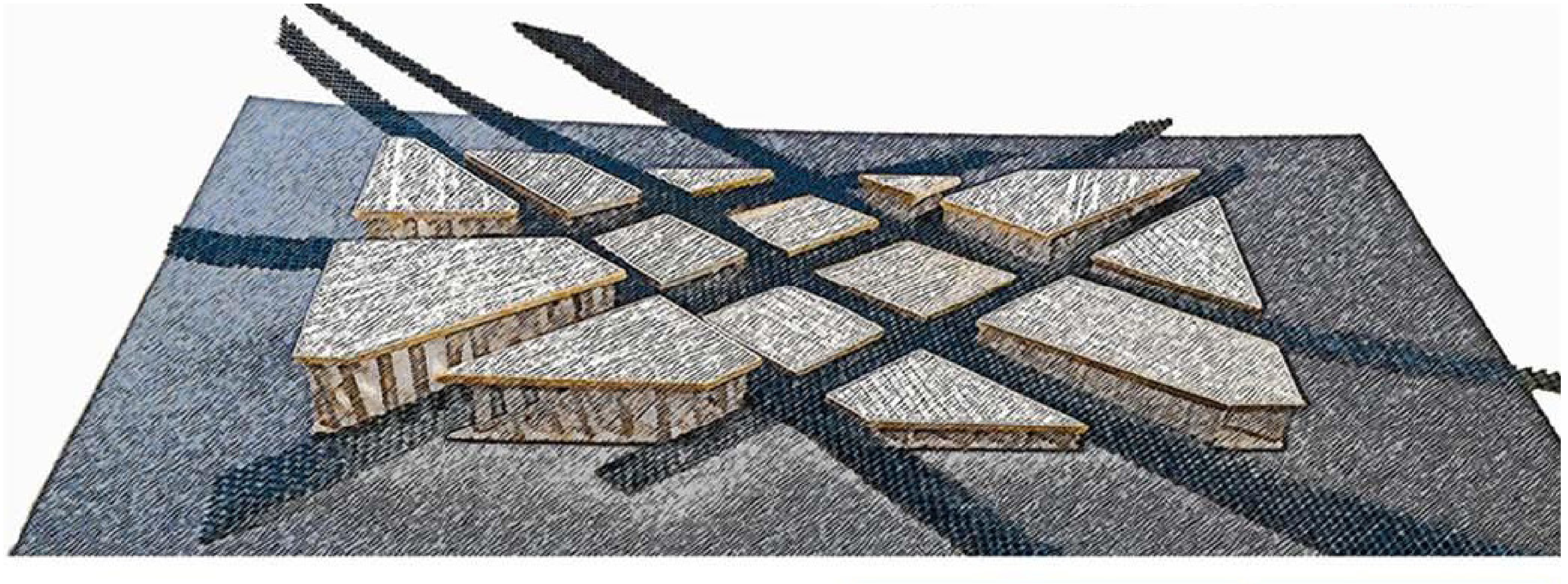
The pavilion design focused on three key considerations.

Conceptualizing the design starts the evolution of the project from an idea combined with the chosen site to an expression into physical form.

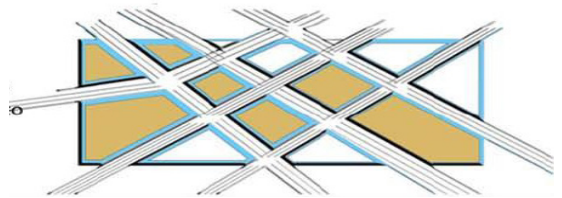
The basis of the touchstone along with the key factors de-scribed as the foundation of the pavilion's typology is used to assist the design development of the project, from a theoretical to a morphological expression.

Each concept expresses the key design con-siderations and requirements with relation to the overarching theoretical basis. The aims are to start exploring how these ideas can become physically manifest.

2.3.1 Scarring Nature



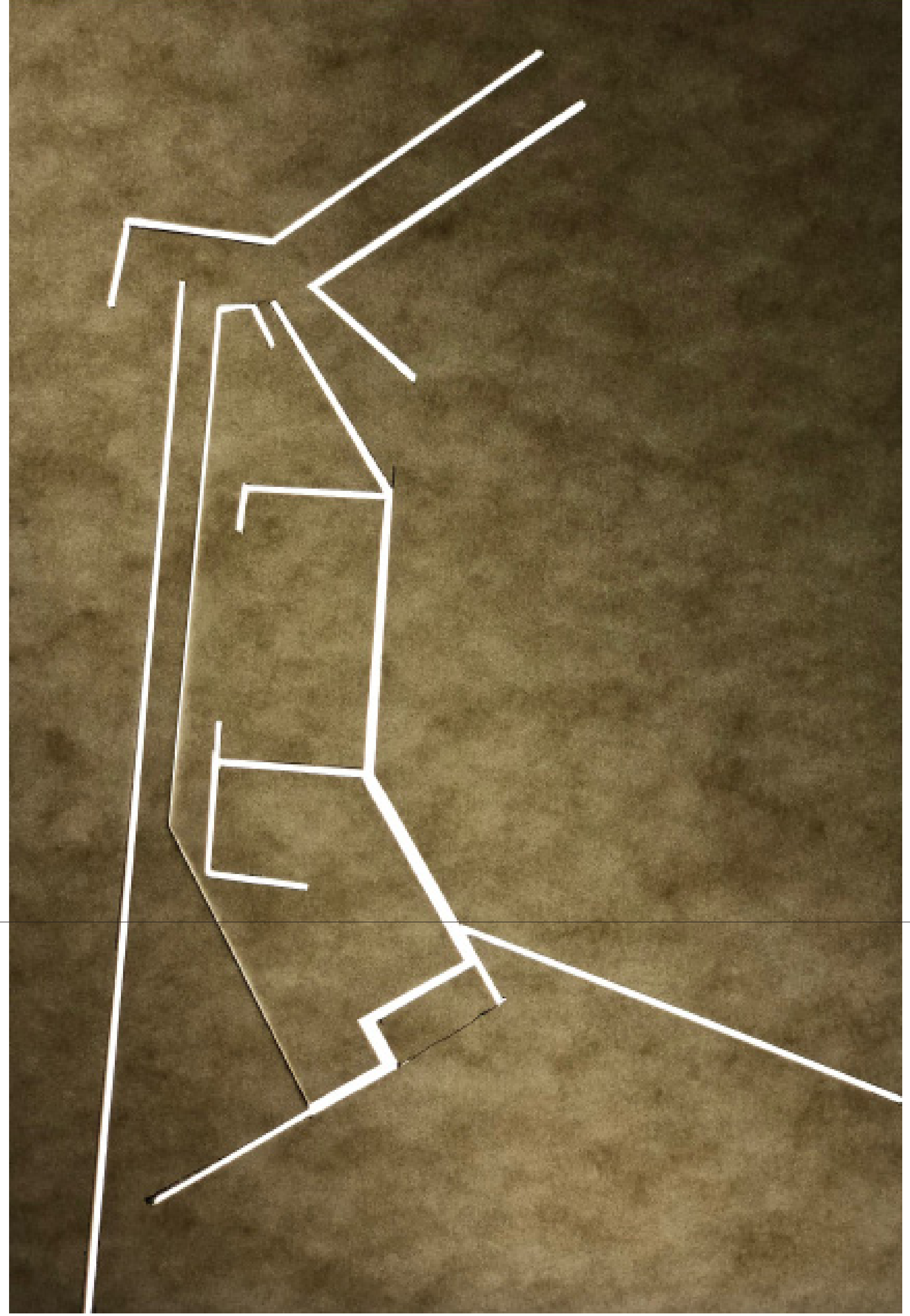
Threshold disillusionment

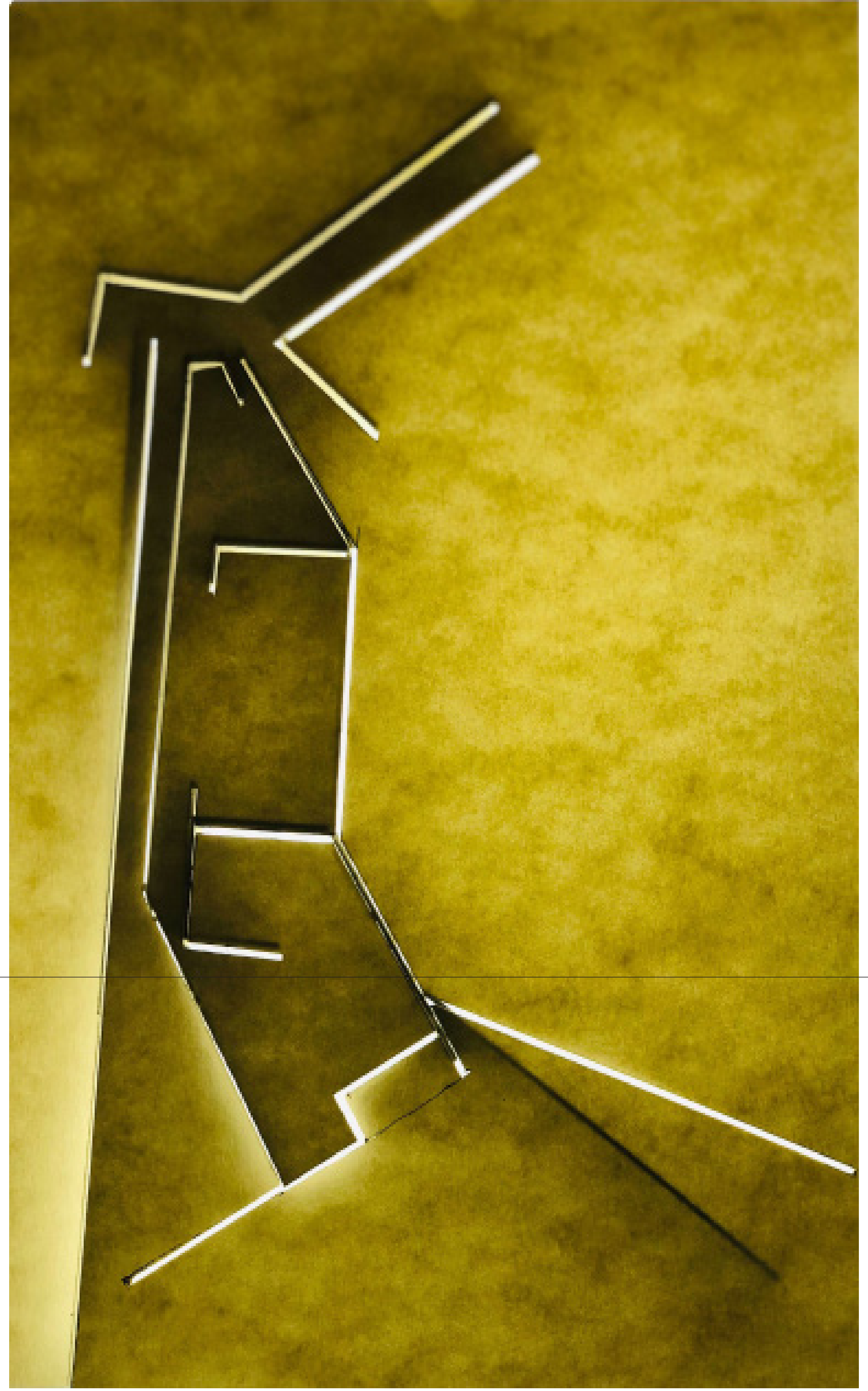


Blurring the lines or boundaries that exist is essential to the success of the design. As can be seen in the model above, the idea behind scaring the nature is to impose edges, volumes and spaces where previously there were none. Resulting in additional thresholds which start to define the design and which the visitor can interact with. What used to be a simple square block now has increased dimentions and complexity, the varying levels further creates opportunities for incorporating nature and architecture.

Heterogeneity

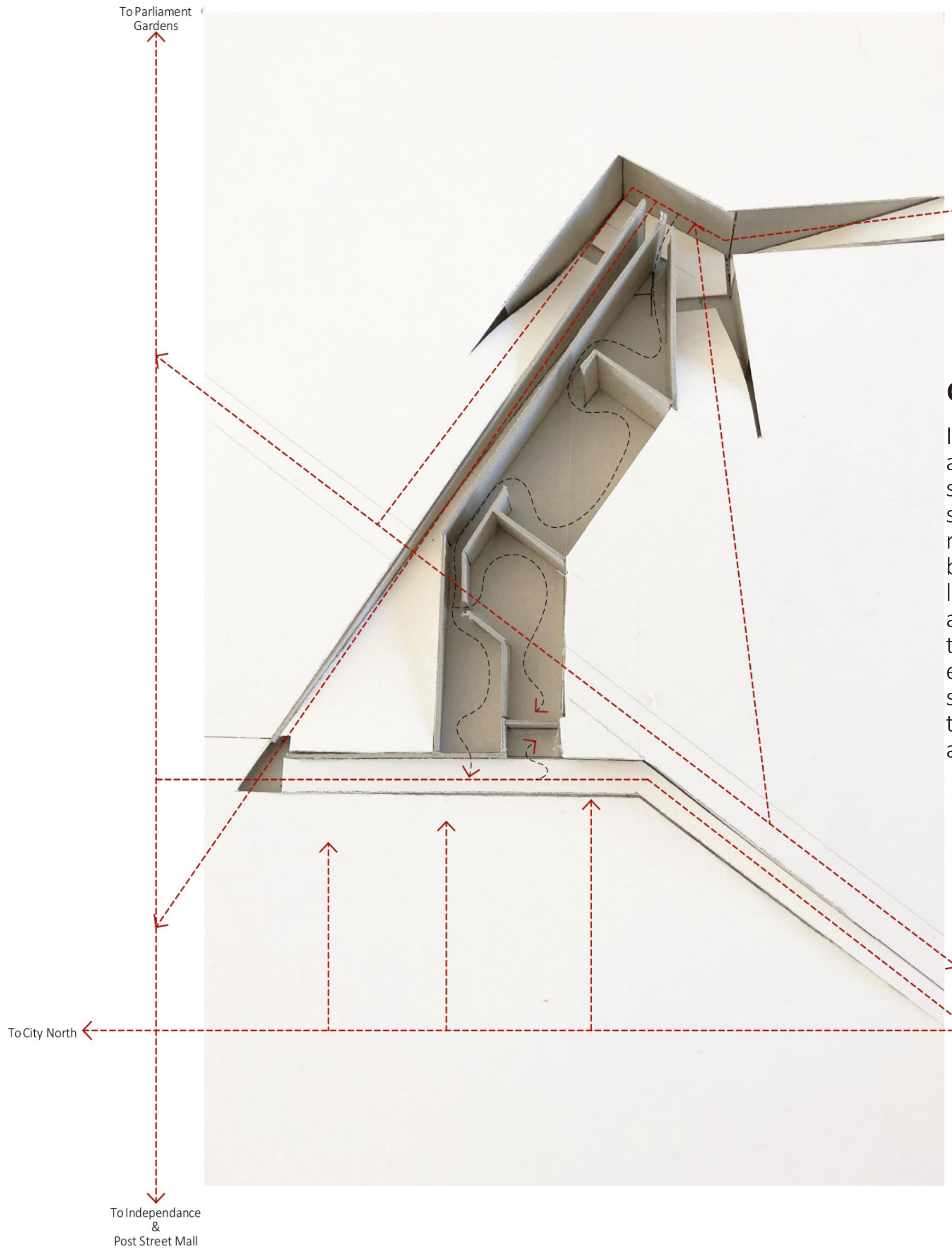
The alchemical idea of transitioning from solid to liquid to gas. The integration of transitioning elements that together form a whole. This leads to the implementation in the design where creating porous boundaries and skins could leave the threshold free of mental edges and create a feeling of unity amongst very different edges and materials.





Scars and exposing the subterranean

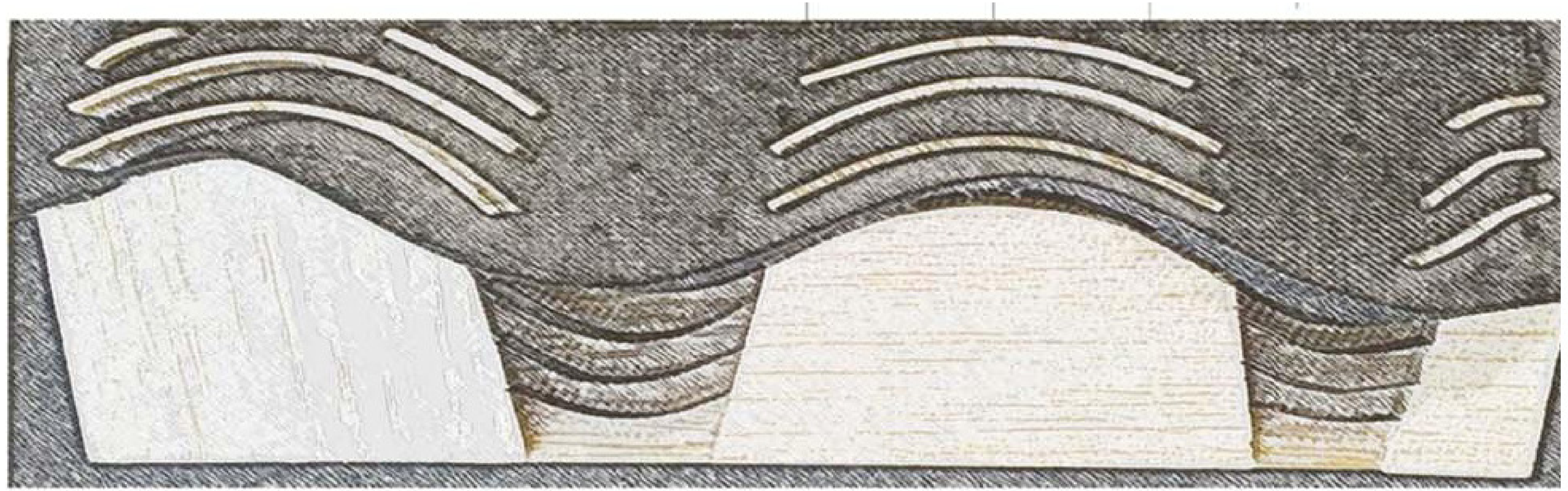
Concept evolution - Circulation & Functional Arrangement

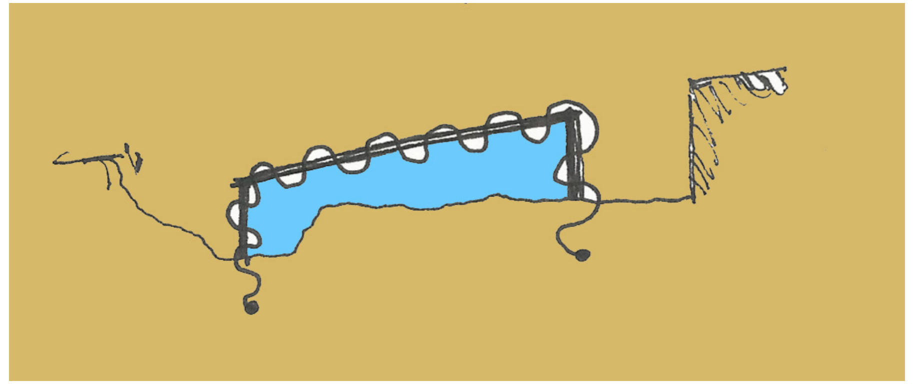


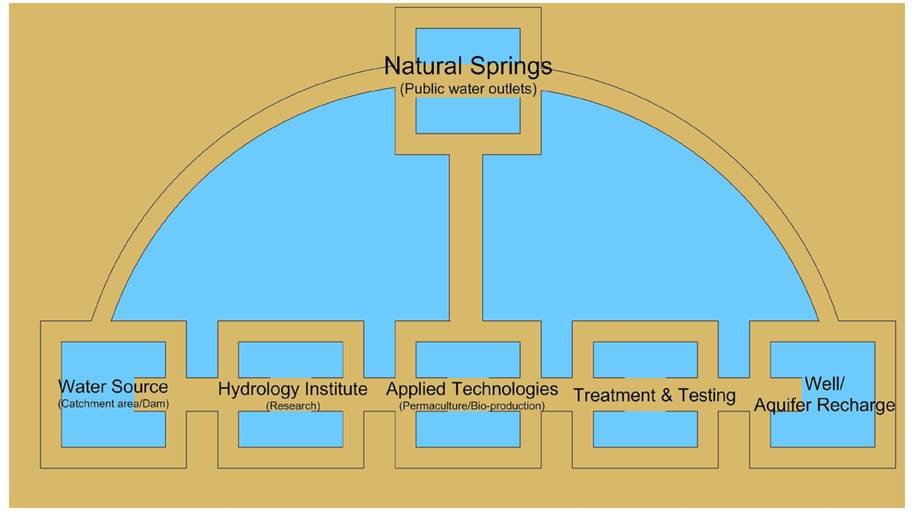
Circulation Links/city corridors

It becomes clear that the scaring and level changes create interesting subterranean spaces as well as subtle surface markings which relates the subterranean spaces below to the external surface land-scaping. In terms of physical architecture, it allows the designs' thresholds to facilitate the haptic experiences of light, darkness, sound, silence to become part of the play and journey with water as the narrative of the pavilion.

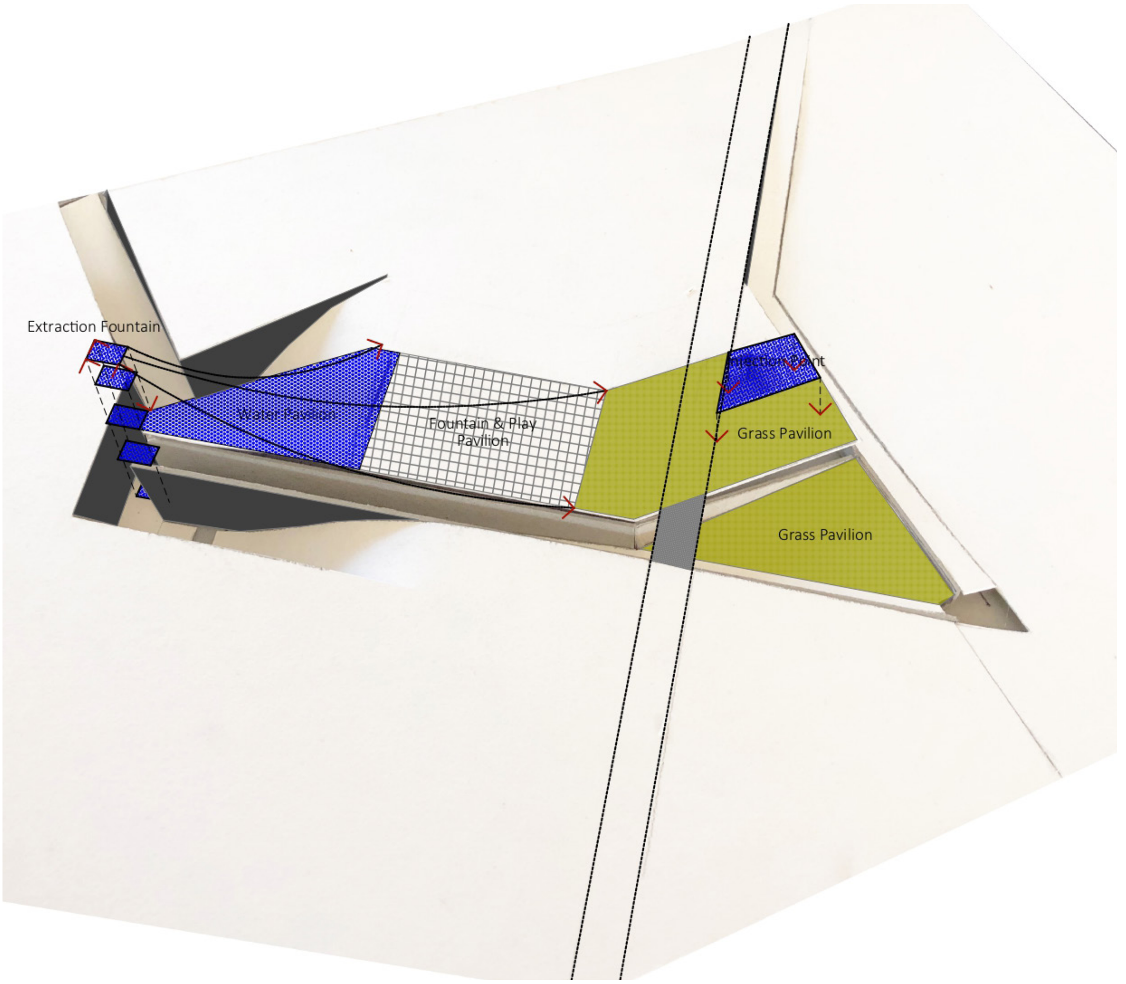
2.3.2 Extending the Threshold







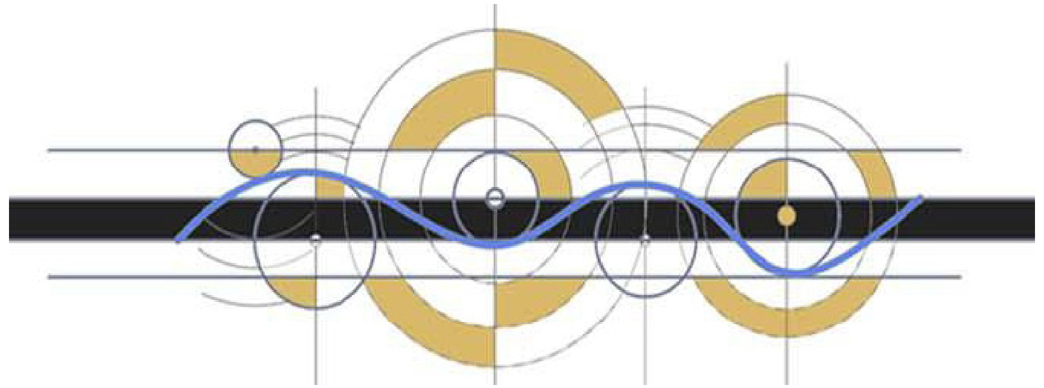
Extraction & injection + surface pavilion



Extraction & injection + surface pavilion

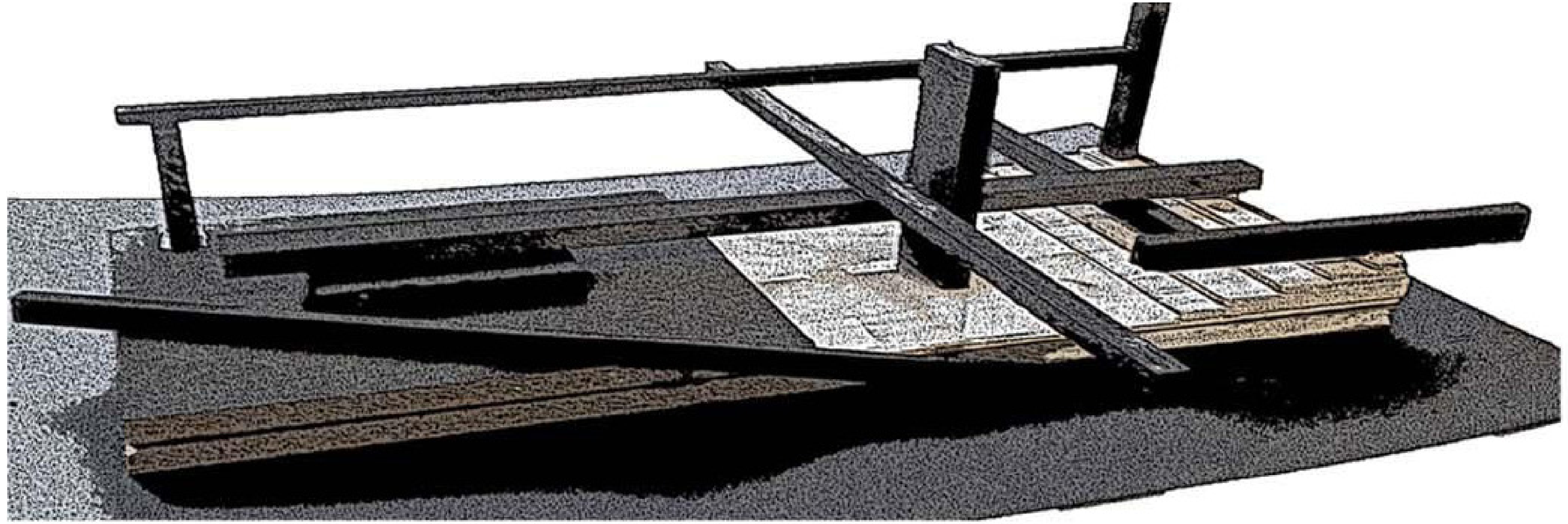
The model conveys the concept of rippling in a physical form to create an ever increasing or decreasing interference between two opposing elements. In this case, nature and structure, coming together as a whole. The concept can impact both the inside and outside of the design. By allowing the weaving of environments and architecture together with the aid of natural elements.

The thresholds become blurred and intertwined and creates an interface of the design that is multifaceted and layered, which encourages movement along and with the design, by subliminally guiding and channelling the visitor.

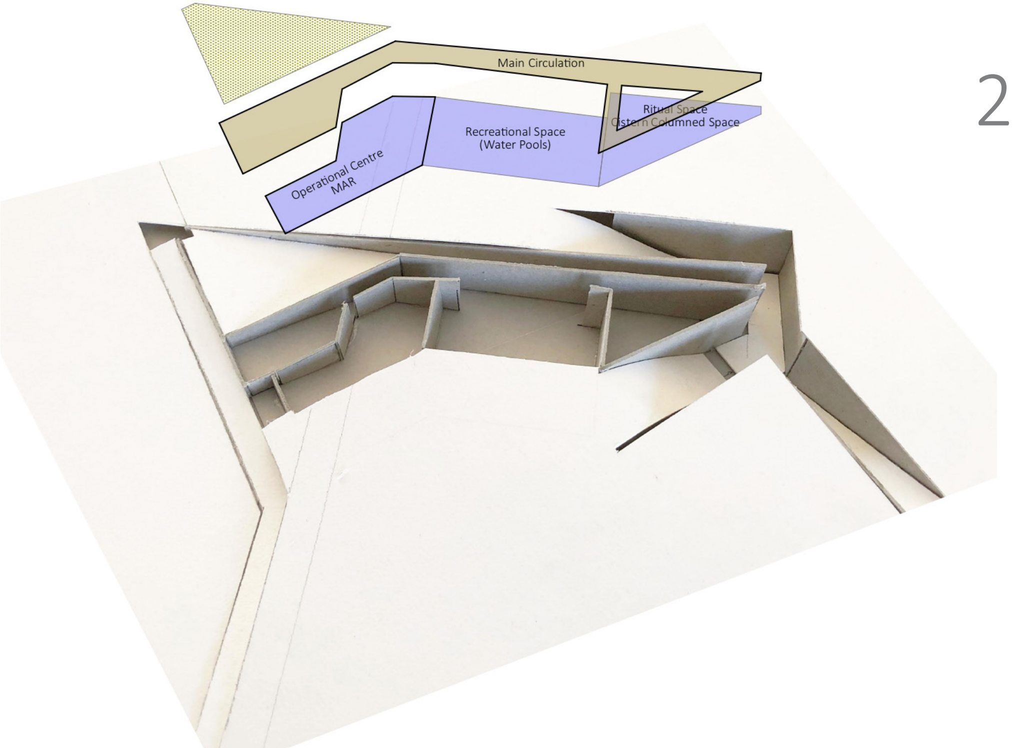


These elements show the interconnectedness of all the factors that comprise the design. Just like a ripple extending outwards, yet always creates new points of origin where they intersect. The puncturing and continuity of the waves creates a flow and circulation that is ever generating. The proposed concept model creates endless and unobstructed circulation through the design from all access points, where visitors can start the journey regardless of where they interacts or becomes part of the pavilion with relation to its

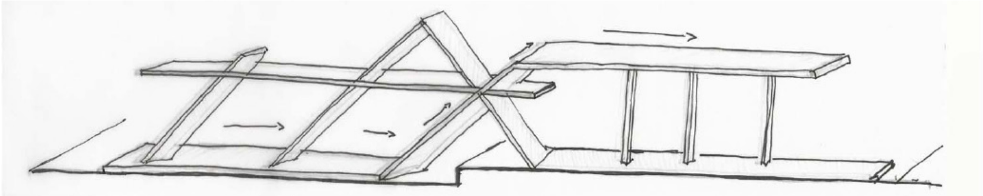
2.3.3Liminal Geograpahy

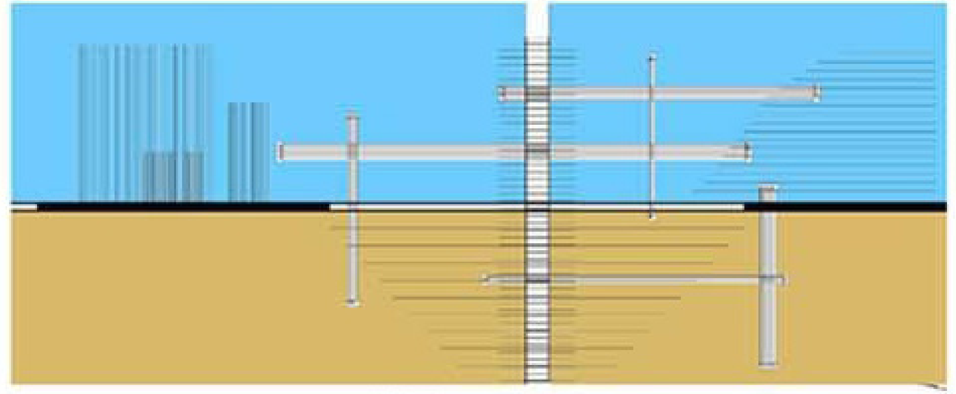


The concept of liminal geography presents the potential for play and interaction with the natural envi-ronment once the multiple thresholds have been created through the disillusionment of edges through scaring. The Connections, revealing of nature and the channeling of water can all be done across various planes. Vertically, horizontally and diagonally. Creating a playful space of movement throughout the design which creates surprise and aw and interaction around any corner, yet at the same time does not restrict the movement of the visitor. Thus, the design is based on planes of con-nectivity and playing with the natural elements on the site.



Subterranean Spaces and circulation





2.3.4 Conceptual-Theoretical Link

The overarching consideration within the conceptual expression of the projects comes down to thresholds.

Thresholds which encourage movement

Thresholds which exposes the hidden

Thresholds which blur the lines between nature and ur-ban

Thresholds that create physical and non physical links and interaction

All these thresholds are expressed in various manners, from scarring to playing on the senses of the visitor and the liminality of geography, from fracturing, sensitive transitions and memory of the physical.

The sketches and models show that the elements are all interconnected and so too should the movement be over the site. The movement up and down levels, through the subterranean space and unrestricted movement makes for the creation of many varying experiences with the underground natural environment, which is usually unaccessible to people, and so doing creates the bridging elements that take people into these experiences.

3

THEORETICAL DISCOURSE

Understanding the Argument

Before starting the theoretical discourse on the Zoo park pavilion, this introduction aims to first relate a breakdown of the main imperatives and order of thinking which guided the project to its final expression. Followed by a closer look into the primary theoretical interpretations and their relation to the fi-nal architectural morphology. With an overall theoretical basis included within these topics as they relate to the influences that saw the projects' inception.

The discourse investigates the concepts and theories associated with 'thresholds' and the embodied translation thereof into physical architecture, while eluding to the use of threshold to impact the cognitive perceptions of humans by capturing its essence within design. Thus, emphasising the connection between habitation and dwelling, and how this affects the haptic experience of the user within the pavilion.

3. Theory and Building

The project is rooted in the conservation and sustainable use of water on a functional level, including how the designs' experienced reality can affect, on a cognitive level, the publics' long held attitudes and perceptions towards water use. Additionally, how the design impacts the broader urban environ-mental landscape, regarding the recreational quality of the pavilion space within the park, while simul-taneously functioning as the catalyst for improved pedestrian movement throughout the city. These mentioned factors forming the premise of the design ultimately becomes the driving elements to the designs' morphological expression as a synthesised threshold of these parts.

It can therefore be said that the design of the Zoo park pavilion rests on a multiplicity of forms, which thresholds can take. These forms are defined by (Muzzonigro, 2013) as the "link between theory and practice" namely 'Border', 'Circle' and 'Interstices' which "act as spatial metaphors of thresholds." These metaphors form the introduction of the discourse as they are identified first on the macro or urban level then on the micro or pavilion level.

Heidegger's and others' discourse on the role that the act of dwelling plays in shaping our realities becomes the conduit towards physical architectural expression. It is here where the connection is made between the aims of the design and the practical implementation thereof, by allowing the characterisation of the pavilion as the bridging element between water and nature as live giving and worth pre-serving and dwellers or humans as dependants who should preserve over the stream that is life or survival in itself.

Heidegger's analogy of the bridge further defines and gives credence to the chosen architectural style and language used, as well as the deeper spatial expresses ion and meaning, used to evoke the in-tended haptic experiences. With the emphasis on threshold as the 'in between' and its connection with the morphological expression and meaning of the journey taken into the subterranean space. The in-between in the design of the pavilion becomes the subterranean space which divides and con-nects what is hidden below the ground or in the aquifer and that which is experienced above or the natural landscape of the park. Whereas the morphology takes its ques from the message of the con-nection between water as the source of life and their interdependence. Expressed in the planed lay-out, on the three perceptions that make up our lived reality, which is the past, present and future.

The narrative being captured within this architectural journey expressed through liminal spatial design is grounded in the concepts of visual, physical and subliminal ques as they are defined in the Brion cemetery by Carlo Scarpa. Giving the architecture a clear design pattern of linear and diagonally intersecting spaces in order to play with the various visual and physical ques and Increasing and decreasing volumes and sizes of spaces underground to reflect the past, present and future narrative. These are combined under the mythological ques resting primarily on the haptic experience of the user, done through strategically adding meaning to space and function with the treatment of the puncturing of the internal and external skins or envelopes, along with a play on light and darkness as well as materi-ality and then finally water as the thread that holds the pavilion together.

The design premise and Thresholds investigation

The project is rooted in the conservation and sustainable use of water on a functional level, including how the designs' experienced reality can affect, on a cognitive level, the publics' long held attitudes and perceptions towards water use. Additionally, it is rooted in the question of how the design impacts the broader urban landscape, regarding the recreational quality of the pavilion space within the park, while simultaneously functioning as the catalyst for improved pedestrian movement throughout the city. These factors form the premise of the design, ultimately becomes the driving elements to the designs' morphological expression as a synthesised threshold of these parts.

Practical basis of the theoretical discourse

Architecture as liminal geography: A haptic experience revealing Windhoek's Aquifer water: An investigating into the abstract and physical dynamics of limi-nality on landscaped and subterranean spaces and its influences on one's sense of being/ Proprioception.

Linking the premise with thresholds

Before starting the theoretical discourse, the following characteristics given to the pavilion, which form the fundamental factors that give rise to the design premise, must be stated and understood. Threshold as a theory drives the design due to the functional and social role a multi-layered threshold.

On an urban level, it is the threshold between the park and the surrounding city scape. On a macro level the threshold between the edge of the park and the pavilion. On the geological level the threshold, between the aquifer and spring that lies beneath the site and that of the ground level of the park and broader city above. On a regional level it becomes the threshold which carries water between the dams and reclamation plants to the aquifer into which it is pumped, and finally, on a designed spatial experience, the threshold connects water and life.

The theoretical evolution of thresholds in architecture and design from a macro scale down to the finer details are investigated and discussed chronologically by. The first part focuses on identifying different thresholds and the forms that they take as well as how they are experienced. Followed by the 'in-between' spaces, connections which can be made, and the concepts bridging the divide, be it mental or physical. These are further synthesised along with the functional requirements of the pavilion into the architectural typology and morphology. Lastly the subliminal effects of thresholds are discussed with regards to their embodied perception through the haptic experiences of the user. The theory rests on the concepts of liminality, expressed in a narrative

An introduction to thresholds

It is human nature to make sense of the world through identifying the thresholds around us and distinguishing where one thing starts and the other ends. It is this subconscious activity, as explained by (Muzzonigro, 2013) where we "find those words with which we speak of ourselves and other." Yet thresholds are not merely the border that separates two spaces, but also the space that exists in-between. It can be a transcending or connective element on a journey towards the next identifiable sperate space. It also manifests in the rituals of living, and in architecture or space making, meaning it is often granted to a space as a direct result of the activity or ritual which takes place within its confines. Sometimes called the 'third space' which is defined as "the site and moment of hybridity, of ambivalence, of reworking and renaming, of subverting and recreating identity" (Muzzonigro, 2013)

The variety of thresholds, and threshold spaces that exists must first be understood and the intention behind their creation be clear in the mind of the designer when creating spaces, as it ultimately informs the typology and morphology of the architecture, as it is a form giving concept.

The way in which it 'in-forms' the design lies in its expression, usually found between two spaces such as the openings within the envelope of the building to create connections between what is inside and outside. As stated by (Bhabha, 1988) it is "the space of the entre, that carries the burden of meaning." or Similarly, the connecting quality of corridors, atriums and waiting rooms which directly impact the morphology and the quality of a space.

3.1 Theory and Building

Ritual and Embodiment – Narrative and Landscape

The act of portraying rituals through art, such as theatre, allows one to see the potential of architecture to function as a stage to reflect ritual in its expression.

The threshold of water and architecture, solid and liquid can be brought together under the guise of social theatre, a stage is set for an embodied experience based on the intertwined and ritualized journey of the users with the water as they move through the pavilion. Further expression to the embodied experience is given along the journey through a variety of architecturally designed water features.

Along the course of our lives we encounter rituals that allow us to cross the threshold from one space in time to the next. The ultimate thresholds are that of life and death, and architecture as a theater can be used to metaphorically represent these states. Life's dependence on water, allows the pavilion to become an expression of these thresholds, alive through the narrative that embodies the journeys through the pavilion.

The subterranean world in which these rituals are experienced is due to the factors that influenced the landscape design appraoch. Firstly, in order to leave the park free of obstruction to fulfill the linking of the pavilion to the urban circulation footprint and secondly housing the functional necessities of the infrastructure that drives the aquifer recharge. The pavilion is rested with-in the earth becoause this leaves the park and landscape free of obstruction we invoke a feeling of emptiness within the user, which inherently starts a journey of discovery.

This sets the stage for the subterranean design which follows and for the metaphorical expressions which are embodied as the connection between water and life. Working within the ground and going down into the subterranean spaces becomes the start liminal quality of the journey.

Liminality – space, form and narrative

"The liminal space is defined as "a no man's-land betwixt-and between the structural past and the structural future as interpreted by society's normative control of biological development." (Turner, 1969)

Liminal geography can be explained as spaces that are created and experienced as a result of transitioning or the passage of a being. This can be looked at as a being on a journey and how this effects the spaces that we experience as we are on the move. Within geography, liminality refers to how we interact and move across its space. movement is a fundamental aspect of the design as well as the liminal spaces created within geography. The inevitable interactions with the new thresholds assissts the expression of the design.

3.2 Typology- Identifying thresholds

Borders

The earth beneath our feet is most likely the strongest border that we experience. Yet there is an argument to be made around borders and what a deeper interpretation thereof could mean. (Clément 2004:62) argues "Think to the borders as a thickness, rather than as a line. Think to the margins as a field of research on the richness that arise from the encounter of different environments." Looking at the border in this manner makes us aware that it can be a place to be crossed, a world that needs to be explored for the possibility of encountering different environments. Muzzonigro, (2013) continues to say that "Crossing the frontier means to leave behind what is known, familiar and reassuring towards the unknown and the uncertain."

Thus descending into the ground, in order to reach the world of the aquifer which lies hidden, will affect the user's experience and perceptions as "The frontier is the space where differences meet and influence each other on the process of transforming social identities." (Muzzonigro, 2013) The descent into the subterranean world will transform the user as, "This passage, to go beyond the frontier, also transforms the character of an individual: beyond it one becomes a stranger, emigrant, different not only to other, but also to oneself." (Zanini 1997:10-11) The stripping of identity allows one to become vulnerable and influenced. This places the user in the right state of mind to be perceptive to the narrative of the pavilion.

Circle - Spaces of Play

Within the subterranean world, the embodied narrative of traveling with the water as well as moving from the depths to the surface, acts as a metaphor for moving from the past to the future and takes the user on a journey past many thresholds. These circular thresholds act "a catalyst for encounter" (Muzzonigro, 2013) and relates to the sense of play, ritual and theatre. Thus, it becomes pause spaces or spaces of interaction and activity. They are spaces that embody the past to present narrative, which are connected through this journey as one moves from the one to the other, on the journey to the surface of the pavilion.

The overarching narrative associated with the journey is focused on changing people's approach to ,and perception of, water and its importance in our lives and is told through the dwelling of these liminal circle thresholds. Muzzonigro, (2013) explains that "dwelling the circle has the magic potential of creating social and cultural transformation."

Ultimately, the aim is to instill an appreciation and understanding around the importance to preserve water as a resource, which in the end is the functional aspect of the pavilion. Turner defines liminal spaces as "a space that, in its formal separation from the rest of the world, presents a realm of instability and possibility." (Turner 1969: 20-60)

Each of these liminal spaces, where the story of Windhoek's past, the aquifers and the preservation thereof are explained, in the journey through time, becomes the 'catalysts for encounter'.

Interstices

Interstices or the in-between of threshold becomes another element of the concept. Interstices can be defined as "fragments of different spatial orders" (Cenzatti 2008: 75) or as elements that make up the 'Third landscape' referred to by Clement (2004) as a composition of space made up of "undecided spaces, without function, which are uneasy to name.", or as a "shared fragment of collective consciousness" (Clément, 2004) They have no beginning or end and no hierarchical order but rather focuses on encounters that exists in between spaces that occupy more defined function, and less on the start and end of the journey alone.

The pavilion is comprised of several passages which as stated in the rest of the discourse, embody the narrative within the design these corridors of threshold space connect different functions and act as thresholds in themselves. These spaces do not necessarily have functions but rather serve to enact play.

3.3 Creation of meaning – The 'in-between' and the separate

The proposed pavilion represents the dwelling space of water, and the unknown journey, which is present all around us, and forms the foundation for life. The design thus aims to bring the hidden narrative into presence for humans. Bringing the world of the underground water systems to life, for our comprehension and attention implies a bridging of the gap between ourselves and the other and shows our interconnectivity and interdependence which demands our attention and awareness for our own survival. The project blurs the separation between us and that which gives us life, breaking the mental and physical thresholds.

The scarring of the natural terrain in order to create the potential for the third space where manifestation of space and the emotions it evokes can become tangible. The revealing of the hidden, of what lies below, which is known but not seen or experienced, now becomes a reality. Something comprehended, a third space revealed. In this case its less the addition of a solid element that creates this space for pause, but the removal of mass, of earth that reveals a threshold.

The art of dwelling and bridging the divide

Since the building becomes the object that brings the two worlds of the subterranean and the surface together, it can be labelled a metaphorical bridge between the two, previously separate ends. In the analogy of the bridge crossing the stream Heidegger, states that "The bridge swings over the stream with case and power. It does not just connect banks that are already there. The banks emerge as banks only as the bridge crosses the stream." (Heidegger 1971: 150) The creation of these banks brings into life the place where dwelling can happen, which is essential as "Only something that is itself a location can make space for a site" (Heidegger 1971) The building becomes something that unifies and gives new meaning to the subterranean space on the site.

The way this bridge is crossed is in the form of dwelling its many spaces, through a journey of discovery and learning. To understand our relationship between dwelling and the spaces in which we do this we have to understand the relationship. "we take dwelling and building as two separate activities, an idea that has something correct in it. Yet at the same time by the means-end schema we block our view of the essential relations." (Heidegger 1971: 144)This statement is relevant as it speaks to the inseparability of dwelling from place, and what constitutes a dwelling. "We attain to dwelling, so it seems, only by means of building. The latter, building, has the former, dwelling, as its goal. Still, not every building is a dwelling." (Heidegger 1971:143)

Dwelling of the narrative around water has now become the sparing and saving of it too. We understand water as a unity with us, the other side of our life. What does the pavilion bridge? It bridges our dwelling on earth. Us being mortal and experiencing ourselves as separate by bringing us in contact with water, through the act of preservation and sustainability.

3.4 Practical implementation

Macro perspective – The urban Fabric

To understand the role of the pavilion design, on a macro context, as a catalyst to rejuvenate activity in the park through the better utilization of the space, two main factors should be discussed.

The first opportunity lies in the park's centralised location in the city as well as its size. A simple analysis of the area makes it clear that the pavilion can be incorporated into to the city's existing urban circulation patterns. Doing this, assists in easing movement throughout the city, as the linkages created- connects existing public spaces into a stronger grid. This along with the topographical considerations of the site, determines the placement, orientation and footprint of the pavilion and creates corridors which will be used to move through, past and over the pavilion.

The pavilion extends its internal and external circulation patterns to the ends of the site and lends itself to the movement of pedestrians in the city. It becomes the connecting cog that links the existing surrounding passages, which are disconnected due to the city blocks forcing movement along the edges or sidewalks.

The second, lies in the geology of the site makes it a viable place for the injection of addition water into the aquifer. Including the use of water on site the facilitate the rejuvenation and recreational activities here.

Micro Perspective – Landscape and design

The corridors and the boundaries on the site become the first practical threshold with which the design interacts and starts to influence the experience of the user. Built as ramps that follow the topography of the site and starts to carry the visitor to the area below ground.

Water rising to the surface in the form of a fountain also influences the movement within the design as the user is, carried up with the water from the subterranean area to the surface of the pavilion.

Most of the design, below the surface, with ground level left mostly free of obstructions, the roof structure of the injection chambers below, the walkable landscape on top. Secondly the roof accommodates many functional elements which gives the internal thresholds an embodied experience, such as allowing light and ventilation to penetrate this skin, further acting as a carrier for surface water to find its way to the aquifers below, the roof also allows for the creation of visual cues from the outside to the world below.

3.5 Pavilion design- Practical Implementation

Zoo park pavilions intentionally designed passageways and circulation patterns on the site encourages movement by the user, and carries them over, across and through the design. Starting with the four key descending passageways into the subterranean recharge station, the user slowly descends into the ground. This has a significant effect on embodied experience, because they start descending from the highest point, which is ground level, the gradual change in scale is unexpected. The passageways are open to the top and the retaining wall is at first only ankle height, and as the user progress down into the station, the wall increases in scale until it dwarfs the user and causes a shift in status or perception of one's size in the world. This gives the user a sense of entering the unknown realm of the ground below our feet. The opposite is true as one leaves the station and ascends to the ground level where the natural order is replace.

As life, living and survival is the premise for the construction of this design, the architectural expression almost naturally takes on that of a place of worship. The spaces we associate with the worship of the divine are always special experiences. Evoking sensations through light, shadow, art and sculpture similar to churches, cathedrals, mosques, theatres, synagogues and temples. The architecture takes on a form of temple and of sculpture and becomes an ode to water and life.

With messages on how we should live. The building conveys preservation, sustainability and taking care of tomorrow today. Part of the water and life narrative throughout the liminal pause spaces. The concept of moving through the past to the future is expressed through moving underground into a state of submersion then to an in-between and then finally surfacing to the light. This process provides character to the embodied experience of each space.

Water becomes the major element that ties the design together on both a functional and lived experience level. Water becomes the golden thread discussed in the touchstone. It is the invisible element that is exposed when breaking the surface threshold. It also becomes the luring factor that gives purpose to the pavilion and brings life back to the park. Therefor it dictates the embodied experience of each of the three major designed narrative cues in the pavilion.

3.6 Morphology – The past, present and future as thresholds

The surface of the site is punctured or scarred and allows people to enter the subterranean world of the aquifer but at the same time leaving the park as untouched and unchanged as possible.

Looking at the layout of the site, there are clear orientations of the existing buildings and the pathways that lead to them. Using these, the design layout works with the slope of the site and the predominant circulation patterns as well as, orientation and natural elements such as t, the trees and spring, to create the footprint of the design.

The design forms part of physical and mental pathways on the site, to carry people through this world of exposed water features that plays on the human scale and takes them underground where the mechanics of the Artificial recharge system are exposed all the way to the injection zones and out into the site again. The designed loop for the water also creates a cyclical process for how the building can be explored and experienced. The surface of the design does not obstruct the movement on the site and allow people to enjoy the park in its natural form.

Creating these ritualized scars catches one's attention through visual connections to what is happening on the inside. This creates glimpses of focal points inside that creates a sense of curiosity and intrigue. The subterranean spaces introduce the user to the realm of water and earth, where water, light, sound and sight is used to create an experience of an embodied aquifer space. Light coming through crevices, the sound of water moving behind walls or around the corner in a yet to be revealed chamber of the hidden world, all form part of the haptic experience

3.7 Typology – The Liminal journey as a narrative

The proposed design should have the effect to evoke the liminality liminality of the 'third space' or threshold stems from the layering of spaces. The seemingly double sidedness of the elements that comprise the physical structure constantly challenges the user's perception of the space which they occupy. As is the case with the door and its potential to be a portal to limitless directions, the roof of the subterranean spaces in the pavilion becomes the ground beneath a users feet at park level. The plane which submerged the user into an enclosed and foreign space, also carries the user across the light and tranquil ambiance of the park.

The pavilion takes the user into and through the created world of the aquifer and emphasises the journey that water takes. "Thresholds mark passage through distinct moments of architectural transformation. Formal episodes are thus created which constitute chapters in a possible architectural narrative." (Bell 1991:343) Similarly from below ground, up through the fountain to the surface and ultimately down into the ground again. This journey is expressed with the purposefully designed cues that exist within the recharge station. These cues create distinct experiences of space and transition. From visual, to physical, functional and recreational.

The three narratives that are expressed in Scarpa's Brion chapel indicates how narrative can be included into architectural design, through the physical expression and purposely designed details of the thresholds. "The physical travel through the cemetery encounters a rich set of architectural events, providing clues for the definition of different episodes." (Bell 1991:341)

Functionally the pavilion space host the mechanics that channels the water across the site, where it is extracted at the point of the fountain, that has been revived all the way to the point where injection takes place. These are key factors in the design. They become the physical embodiment of water and life itself. The extraction point showing water thrusting out from below to the surface in a strong and in-timidating manner. .

The water becomes the architecture itself. And becomes the focal point in the lower levels of the pavil-ion but also at the surface, which is one of only two only visible elements on the surface the other be-ing the pavilion on top of the injection pit. This point becomes the representative storage and falling away of water for storage, represented as a waterfall to the abyss, never overflowing yet never being wasted. Only extraction takes place at the fountain and this is the same water that was injected, this creates a closed water loop.

3.8 Functional, Visual, physical and Subliminal queues

Each cue is designed to represent a layer, or threshold within the earth's strata. The lowest level expressing darkness and submersion or being inside the aquifer, The middle level represents the journey and the in-between, and lastly the highest level which emerges at the surface, represents the exit and re-emergence into light.

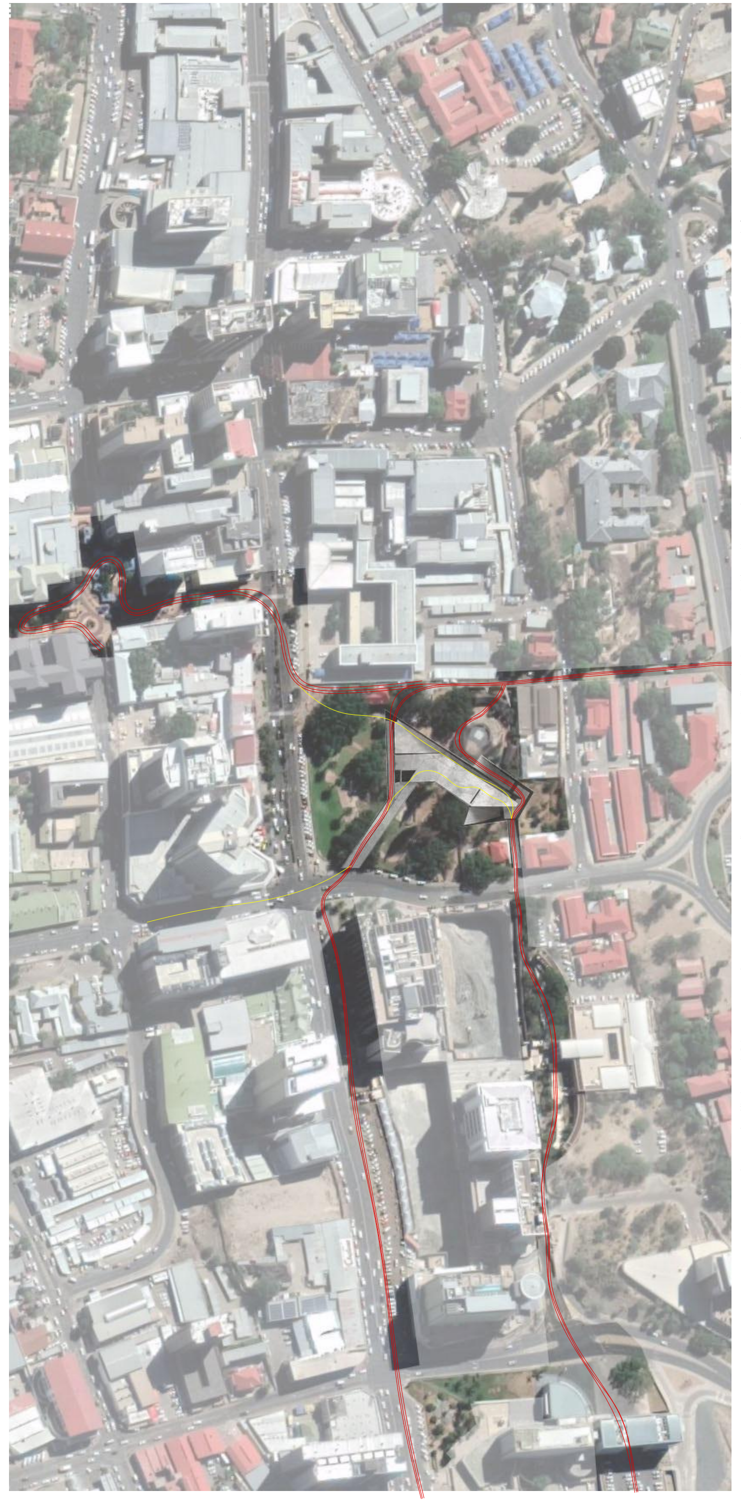
These, are also manifestly represented in the parts of the design aimed at public education, as with the Brion cemetery where "In this case the narrative is an architectural event, providing narrative clues for the definition of different eschatological ones" (Bell 1991:431) The pavilion too uses the same effect where the lowest level takes the user on a journey into Windhoek's past, its founding around water and springs and that of the park. The middle represents the present and informs the public on the challenges and current state of water and water scarcity in this arid country. The last portrays the future and shows the public the necessity and workings of the MAR to ensure a future in Windhoek. The horizontal lines representing the layers, created by the rammed earth construction of the retaining walls, further extends the users gaze forward and towards the end of the passage, which becomes the entrance to the recharge station, which is also the final threshold that divides inside from outside, above from below, from exposed to submerged.

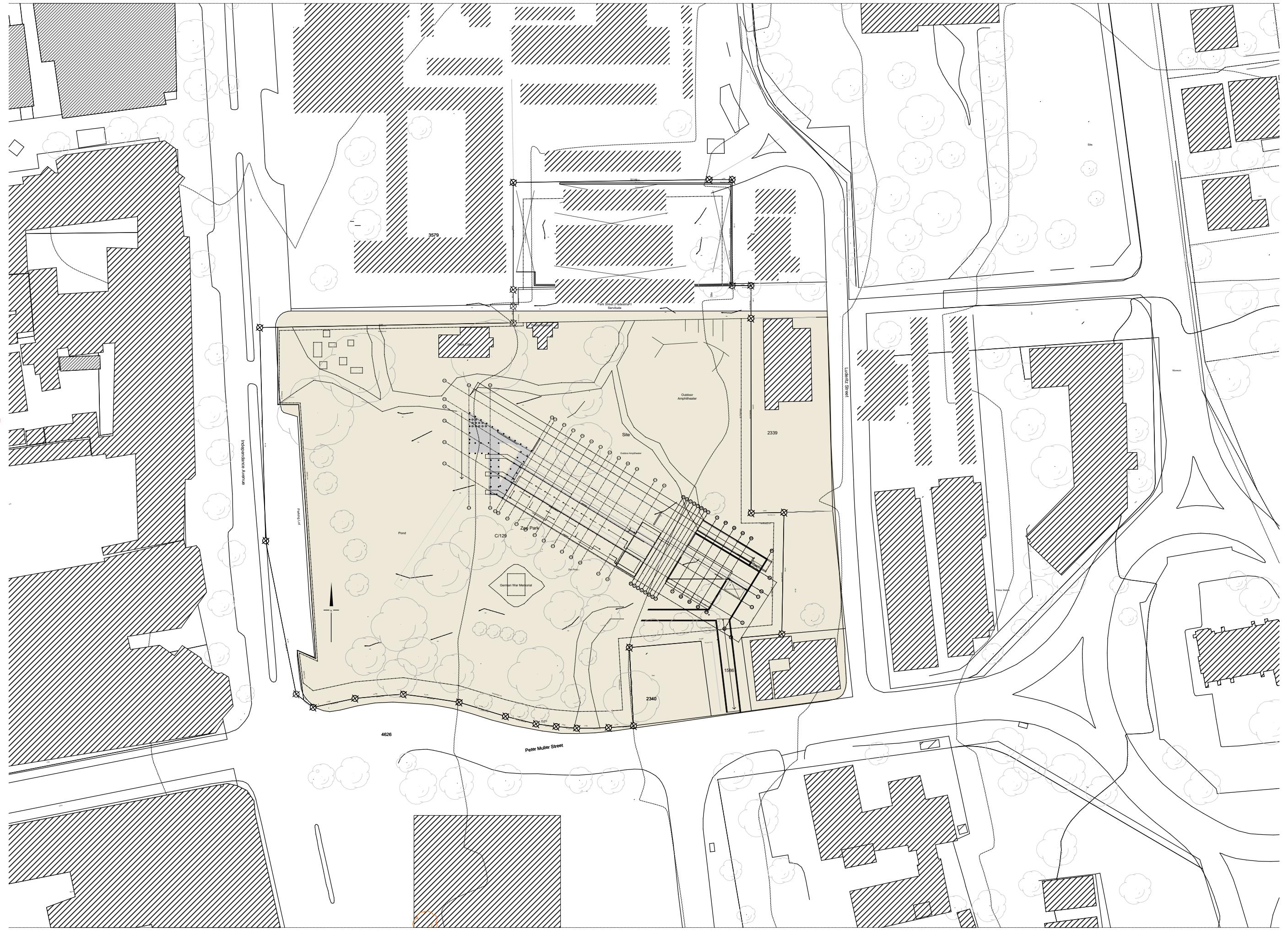
The physical structure of the recharge station is comprised of concrete ribs and caisson excavated struc-tures, with designed punctures to allow for the entry of natural light to enter and create unique expression to the spaces. These ribs take up the form of an increasing angulation of what as almost an tunnel structure. Leading the user to a larger space which ultimately becomes pinnacle of the roof structure and is representative of many spiritual designs, with the intent of giving water the platform of being the life-giving element and its rightful place in the hierarchy of things.

Inside the station, there exists an array of plays on material to evoke a sense of being submerged, with natural rocks, rough stone finishes, gabion walls and infill, rough textured corridors floors, light from above and features of falling water.

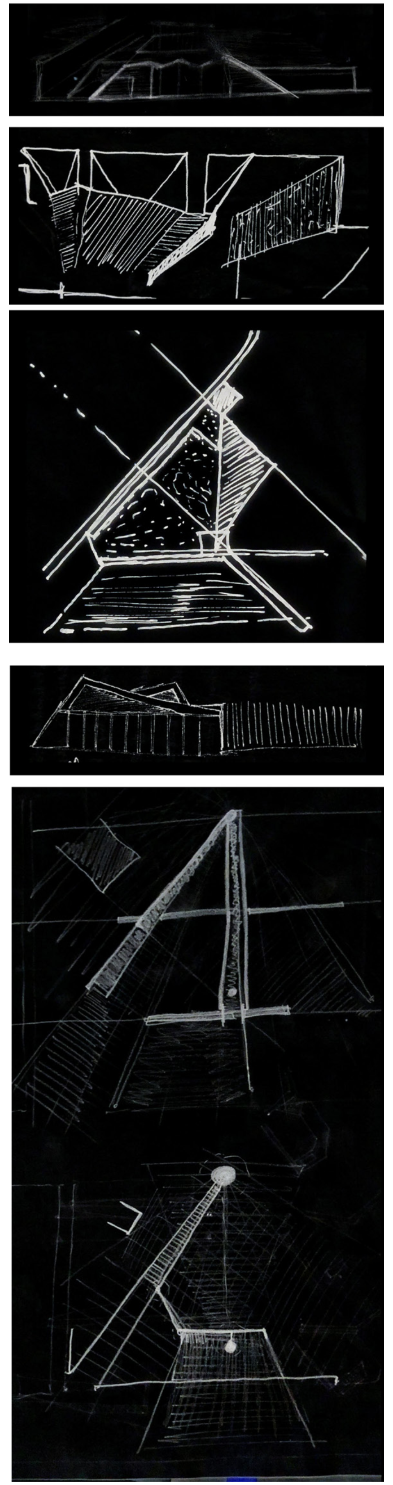
Passages are visible, some accessible and multiple journeys possible and the user is guided by visual cues to help orientate the use of the station. "In a literary work or episodic way the cemetery uses passage as a structuring principle, creating the thread of a plot." (Bell, 1991) This is deliberately done to further enhance the feeling of going below ground and the journey of exploring and finding the direction to take as in a cave or maze. Yet the passages are not merely a line leading towards an end but filled with threshold and pause spaces to the sides, above and below, revealing the internal works and character of the station.

4. Design Development

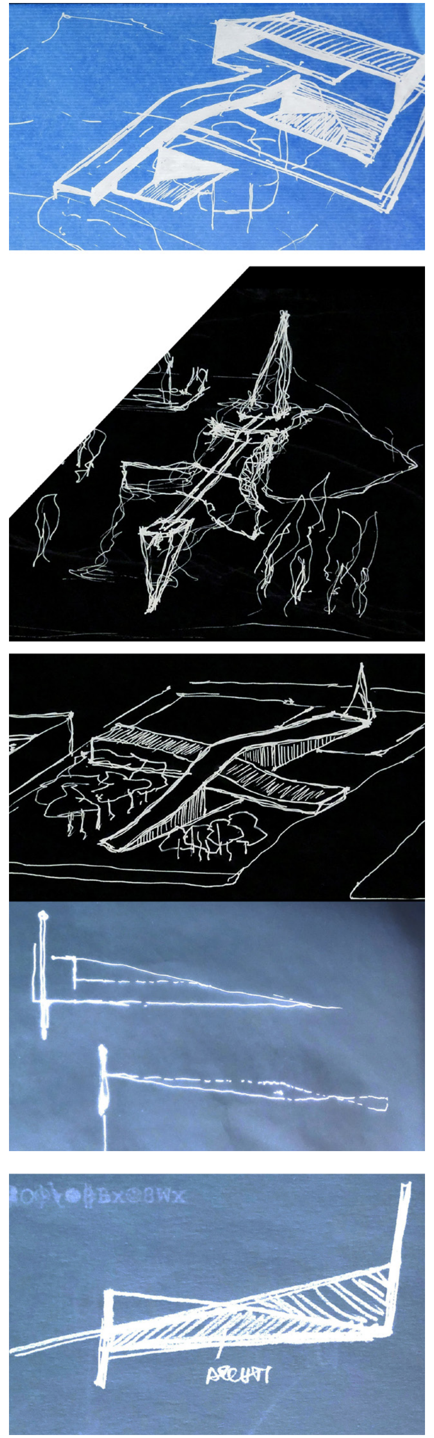




Contextual Site Plan
Scale 1:500

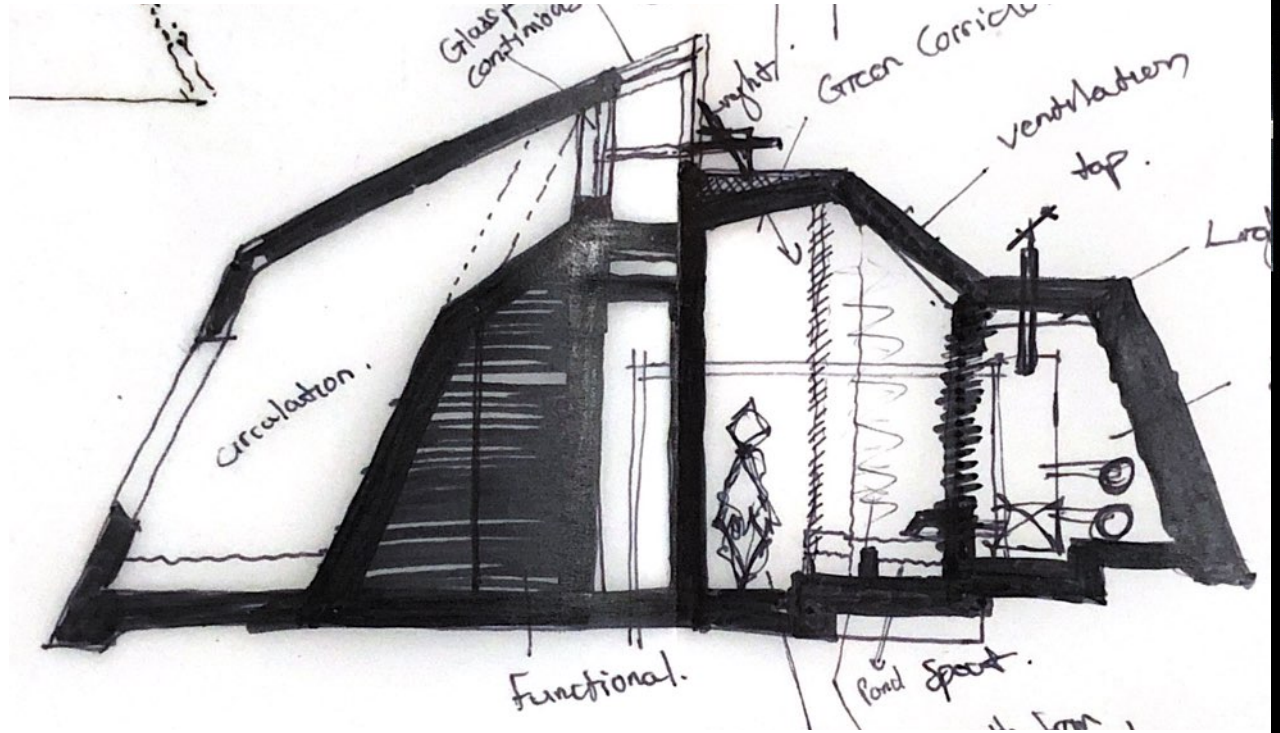


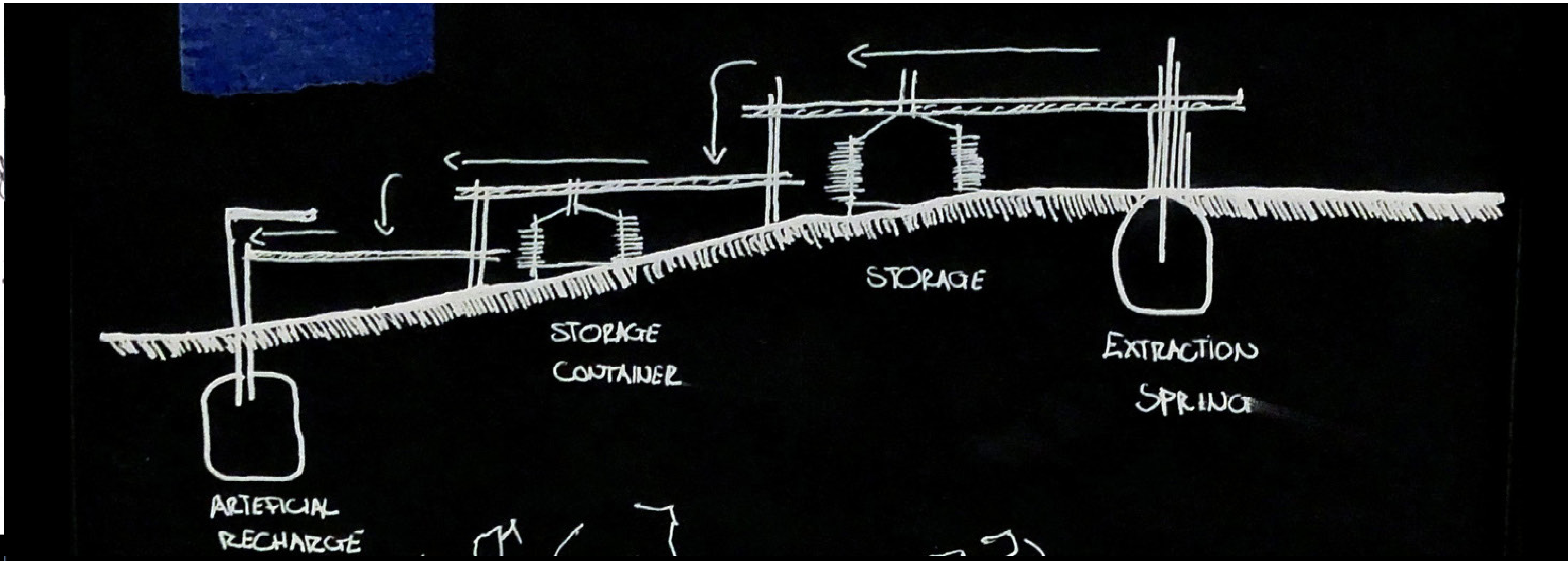
4. Sketch Investigation

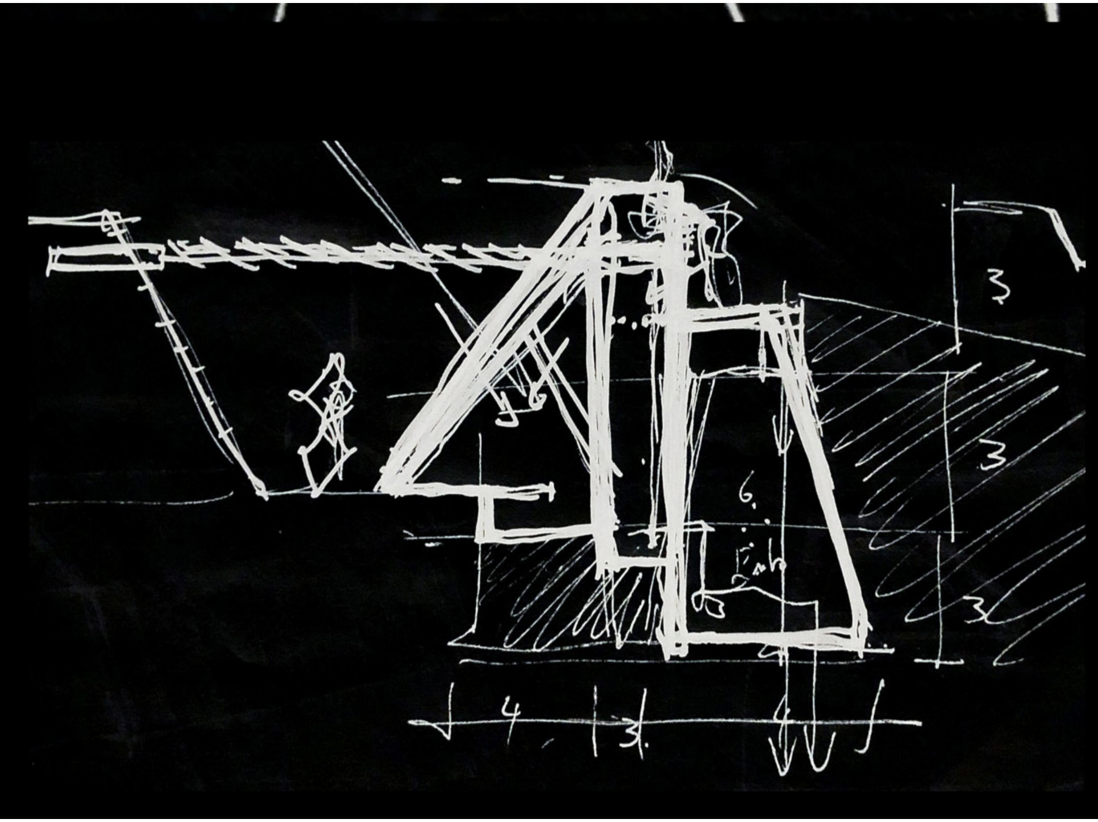


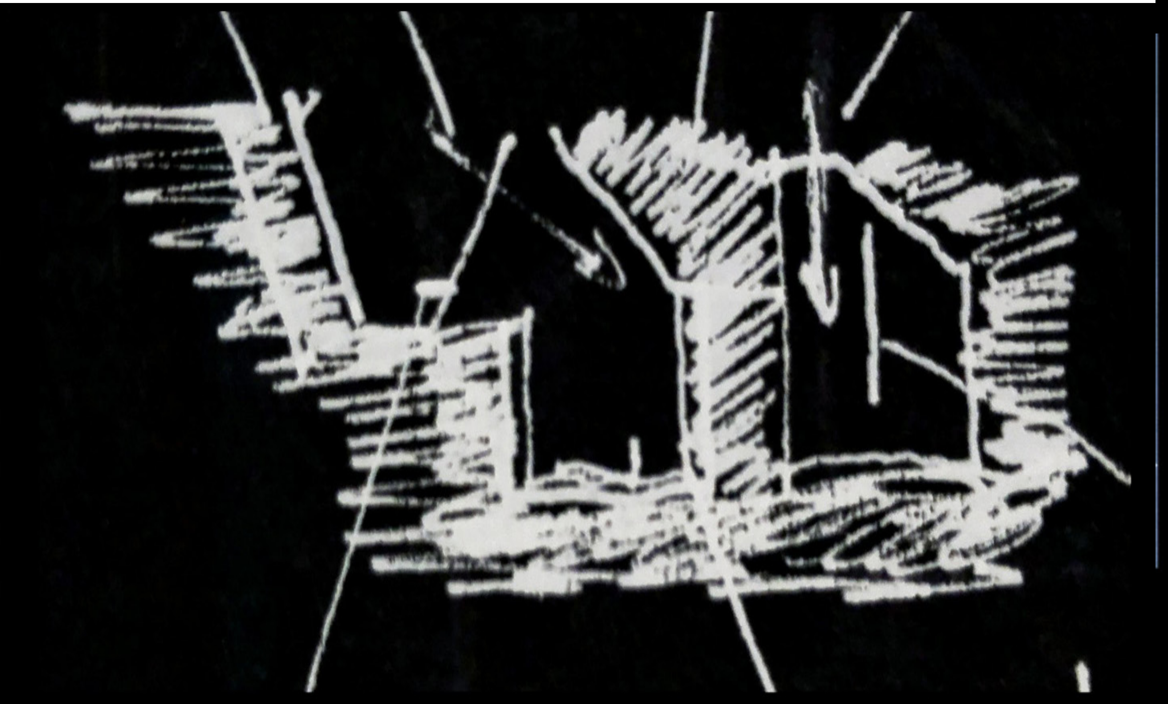
Sketch investigation looking into the aesthetic feel, functional arrangement of the injection process, overlaid into plan development with model investigation culminating into the foundation for the projects development onwards.

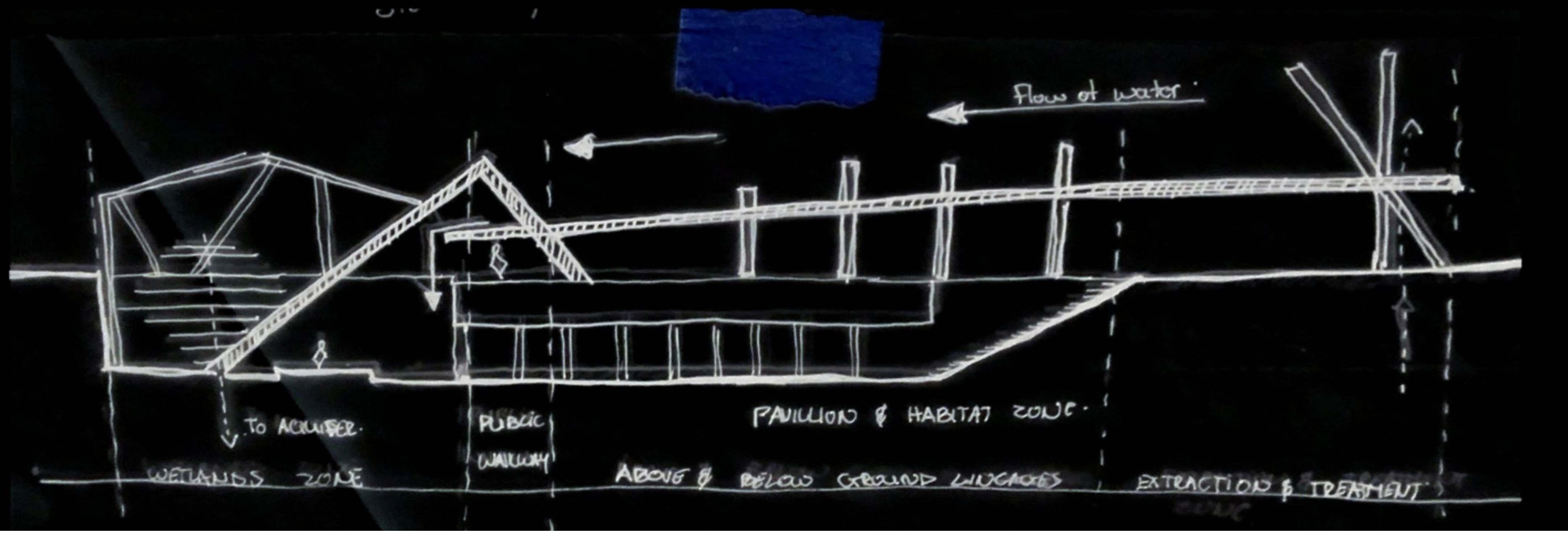
Subterranean
Design approach

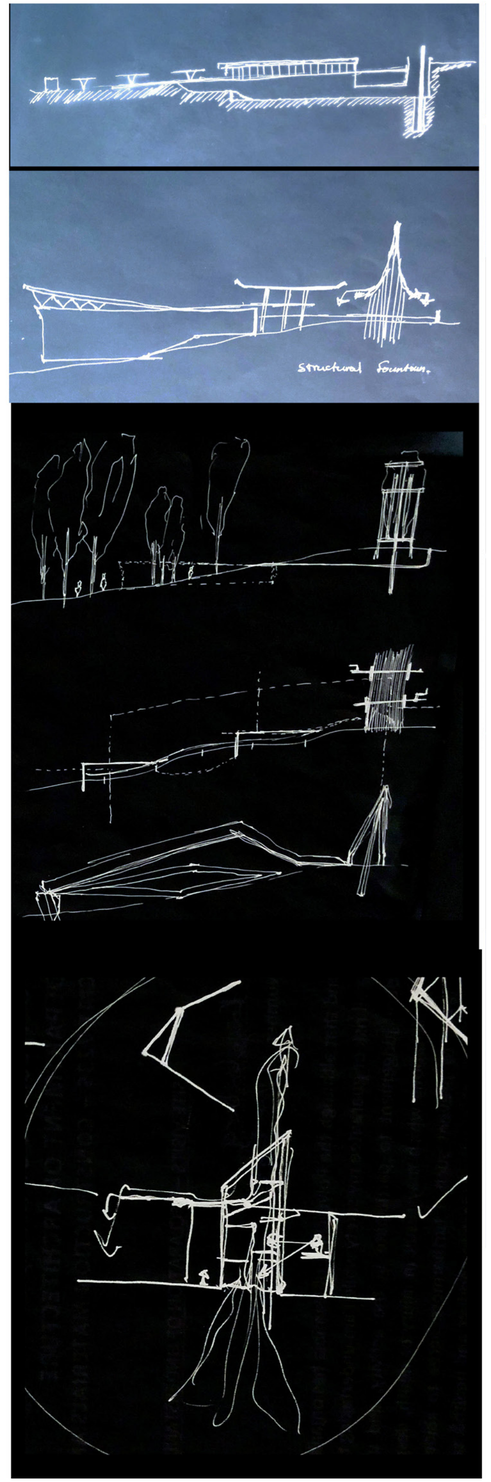


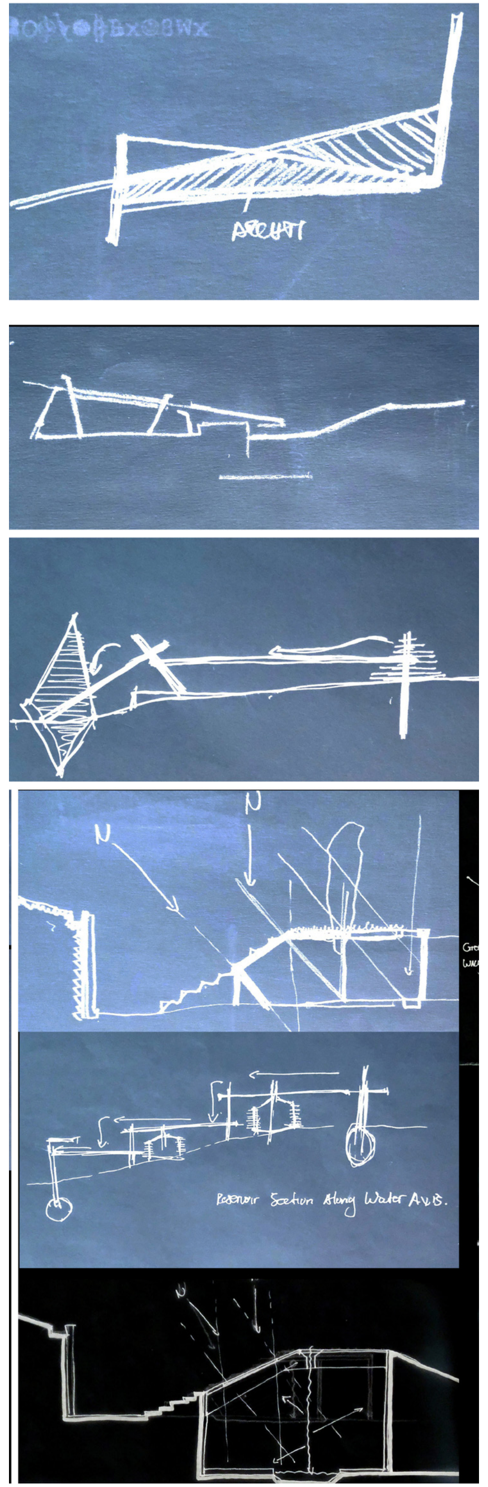




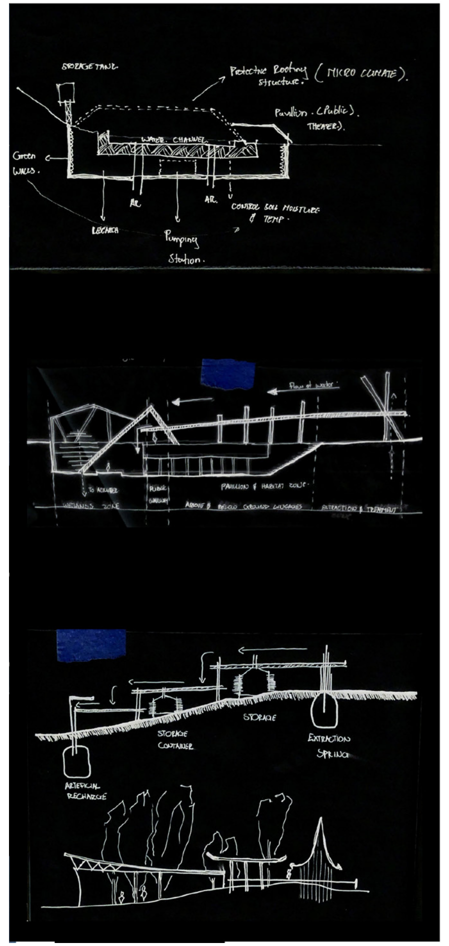


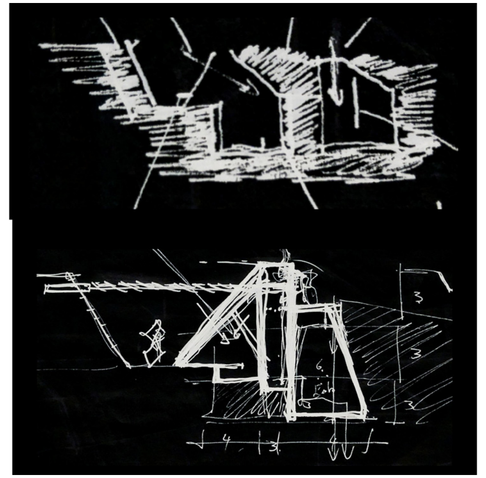


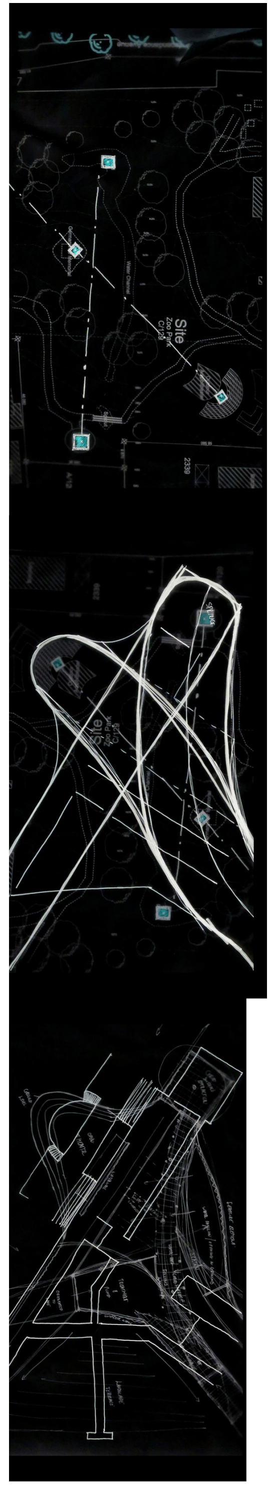


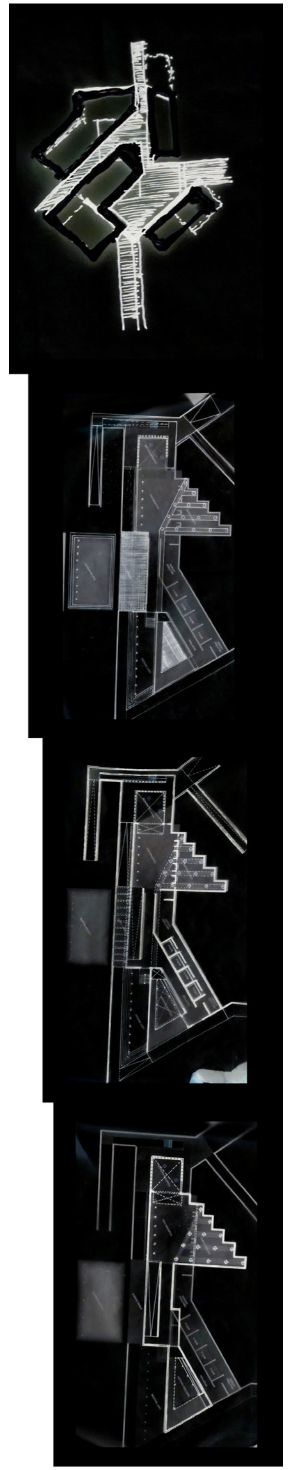


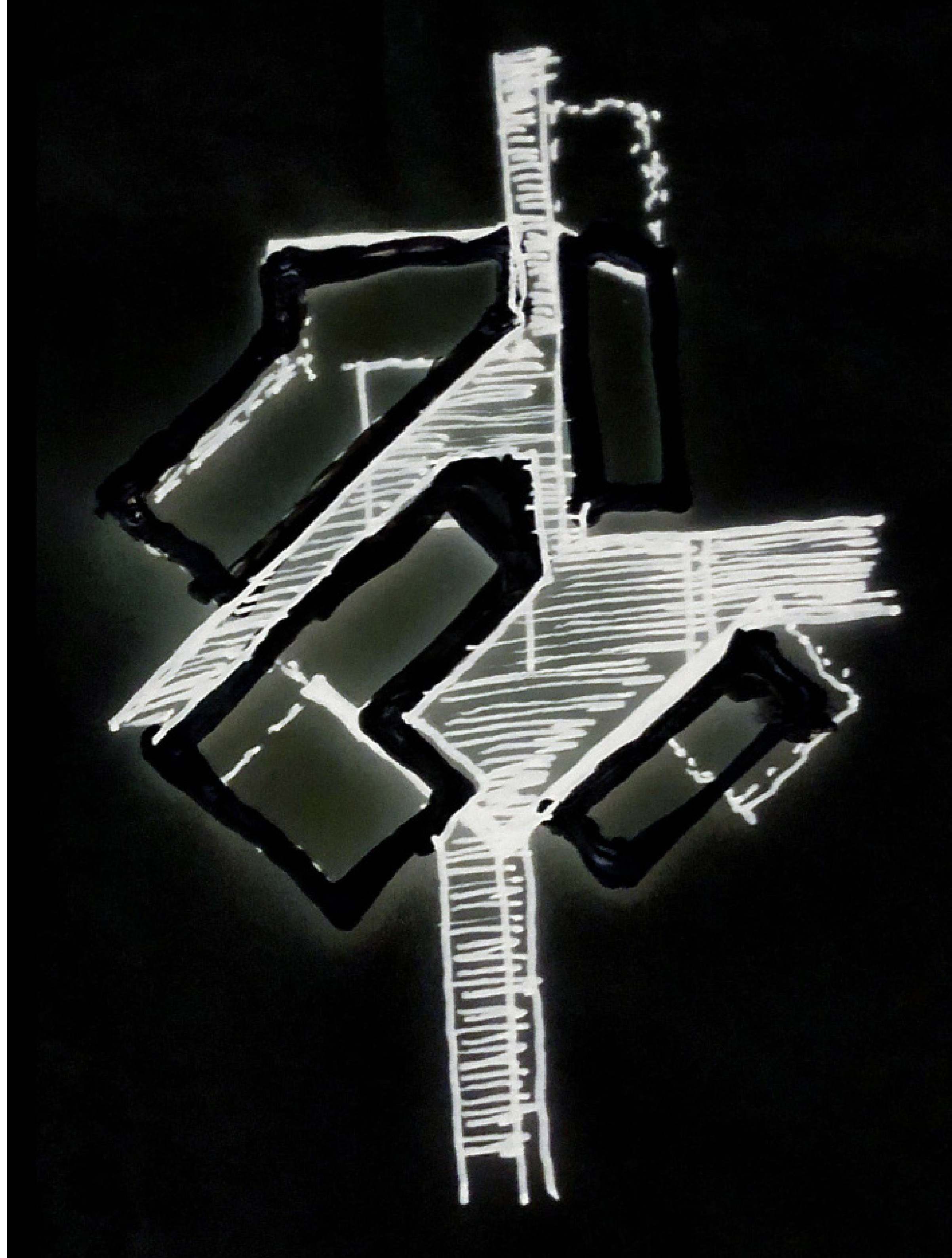
4.1 Sectional and functional





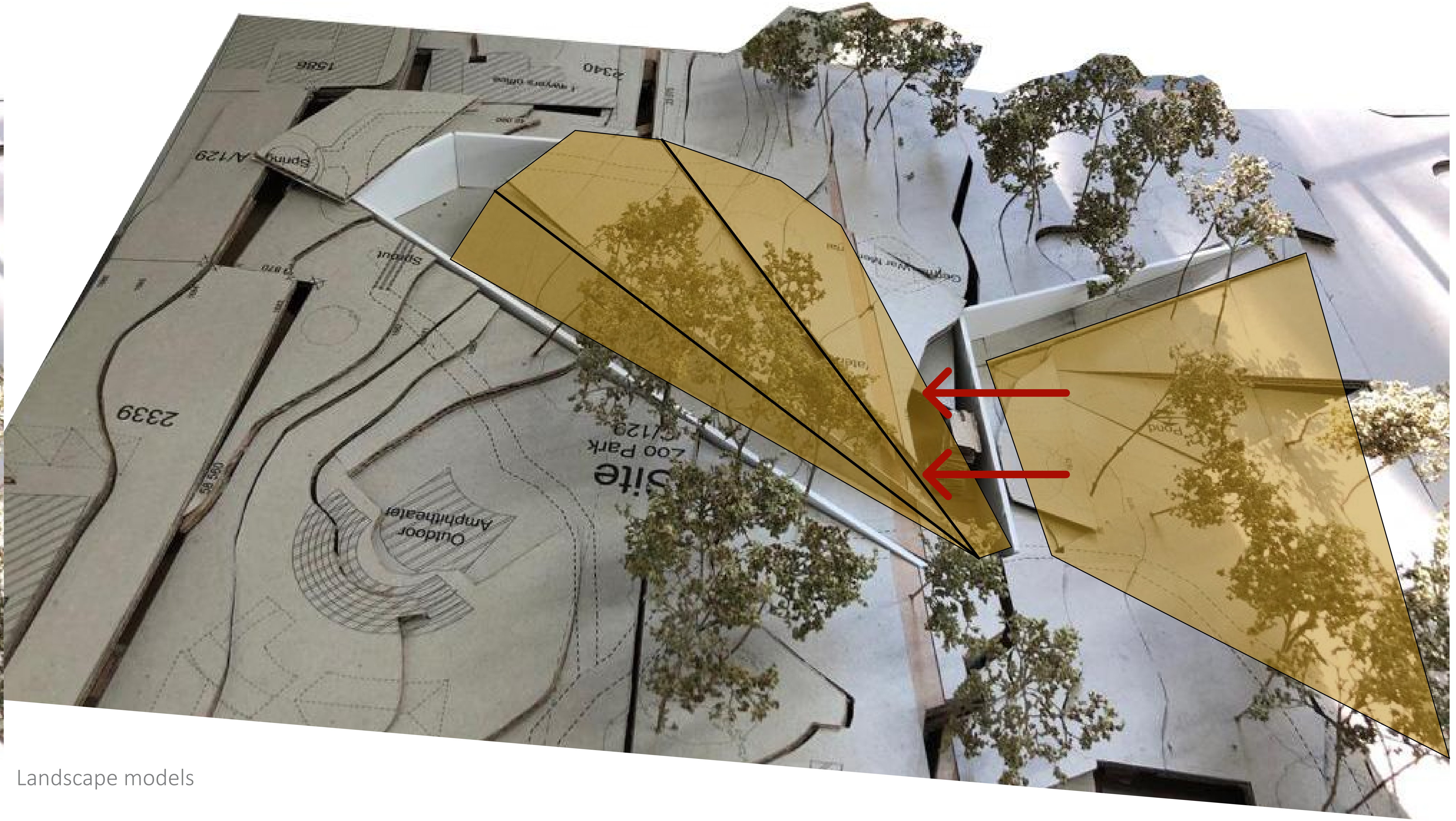




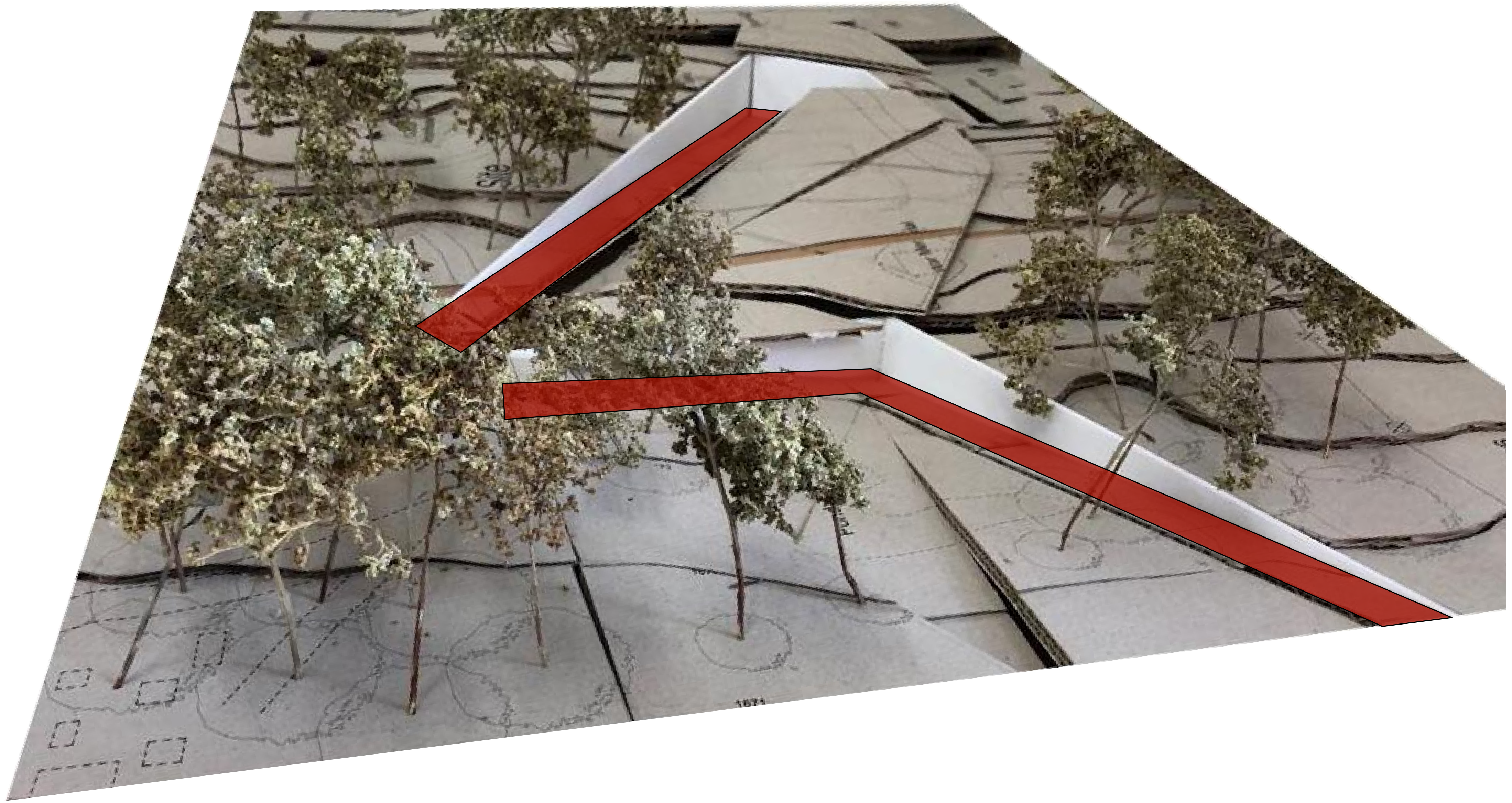


Concept evolution - Revealing nature & creating thresholds

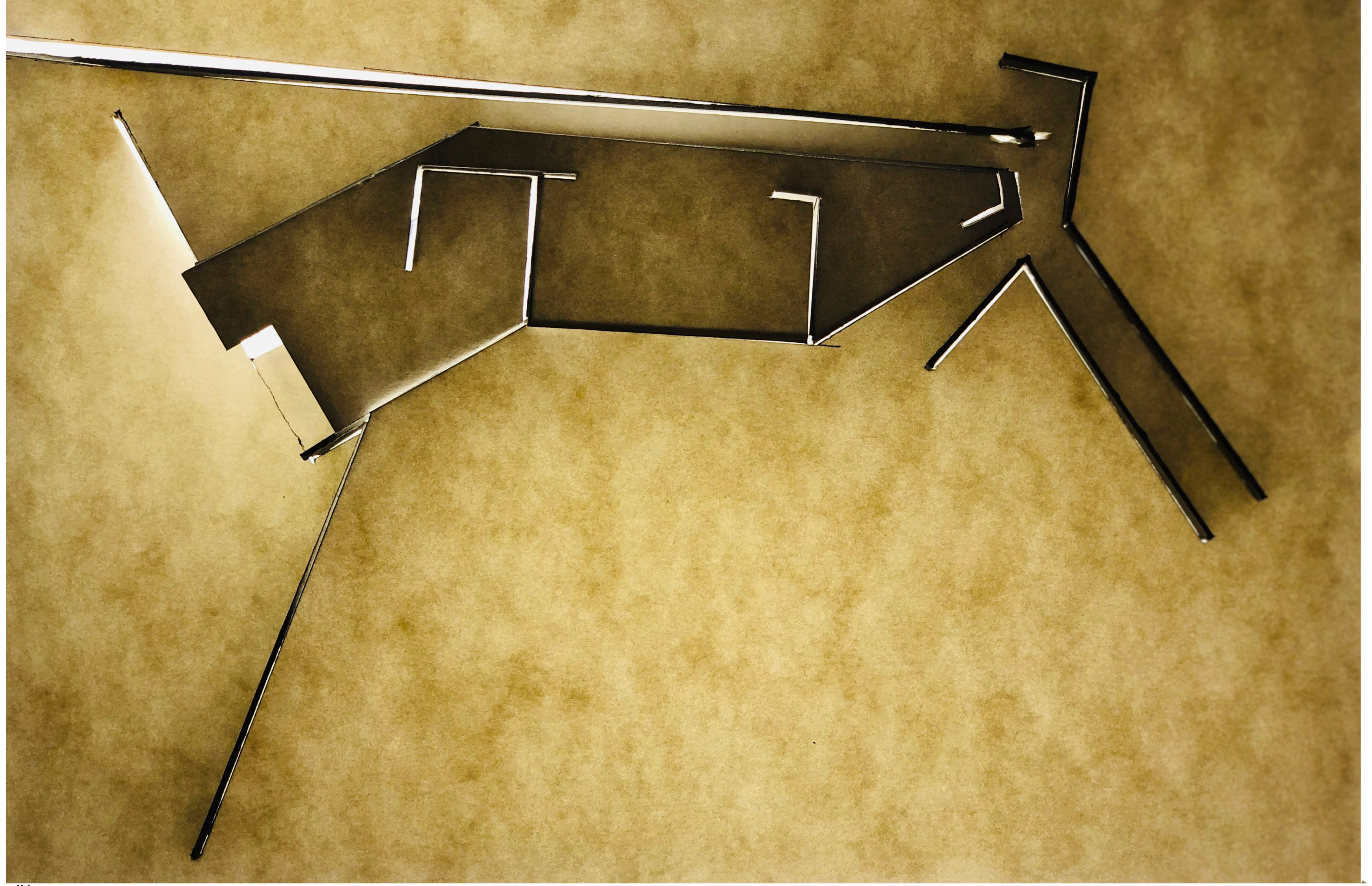
Landscape models

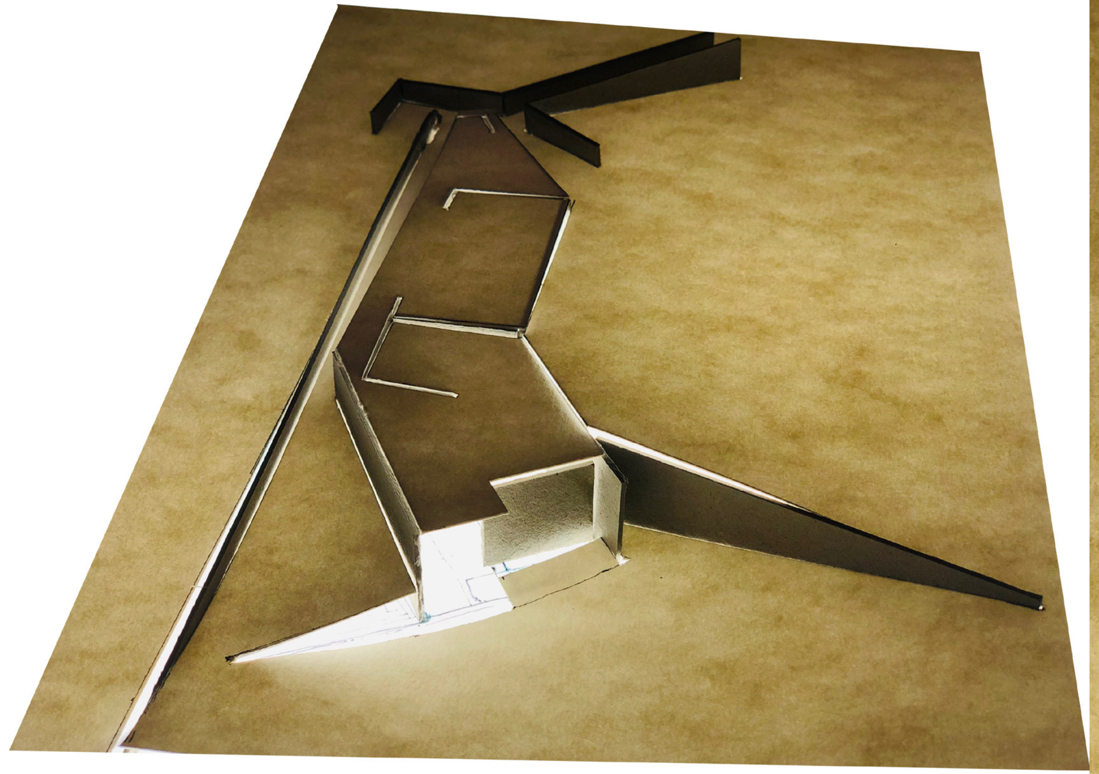


Landscape models

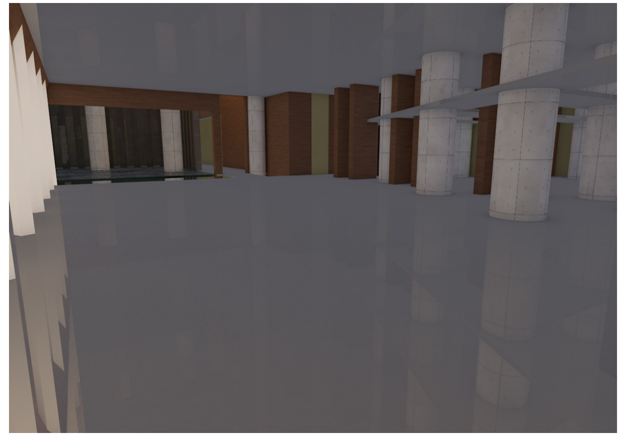


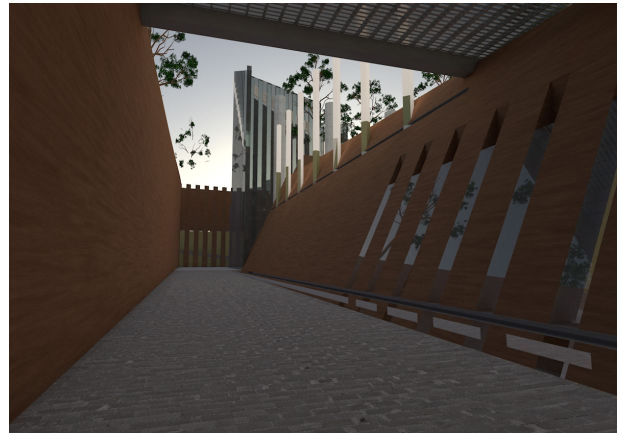
Concept evolution - Scars in the landscape

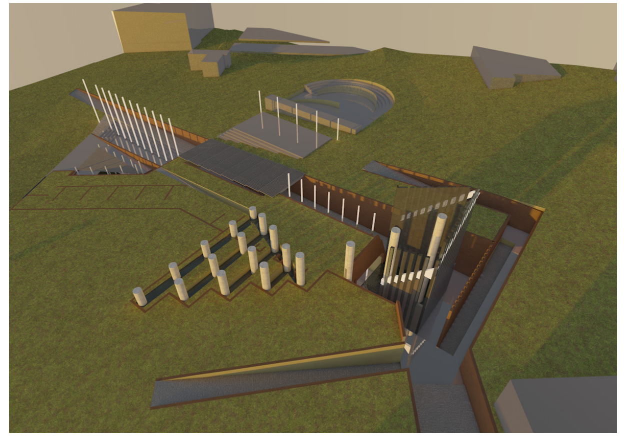


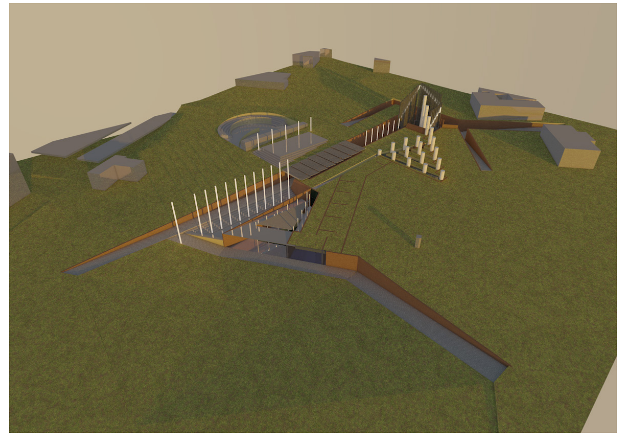


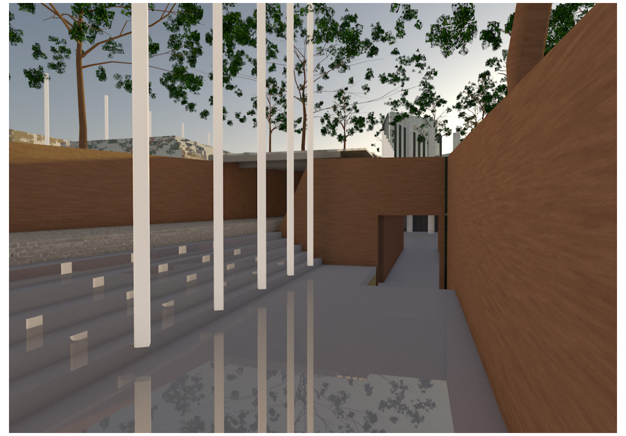
4.8 Phase 2



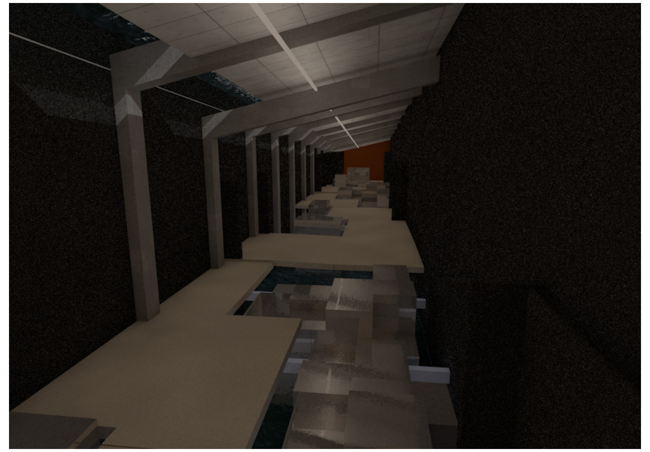


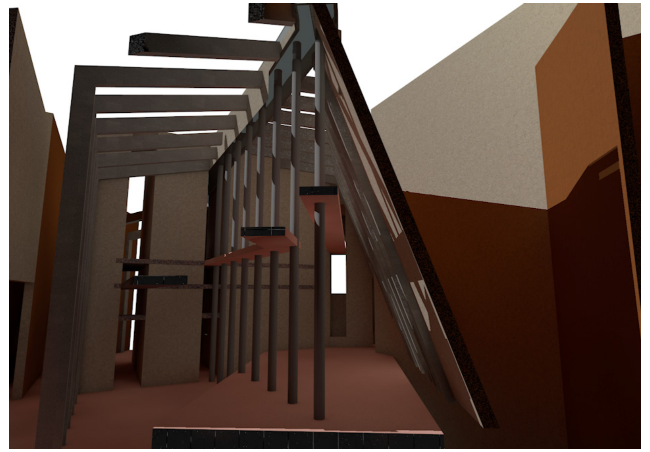


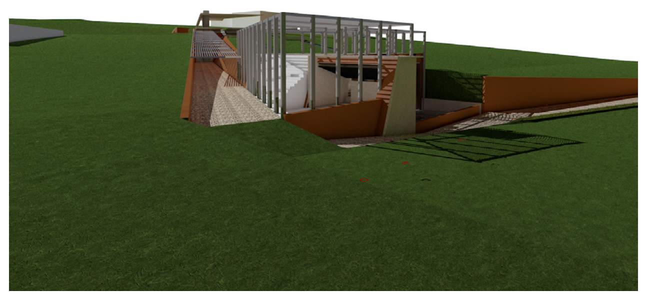


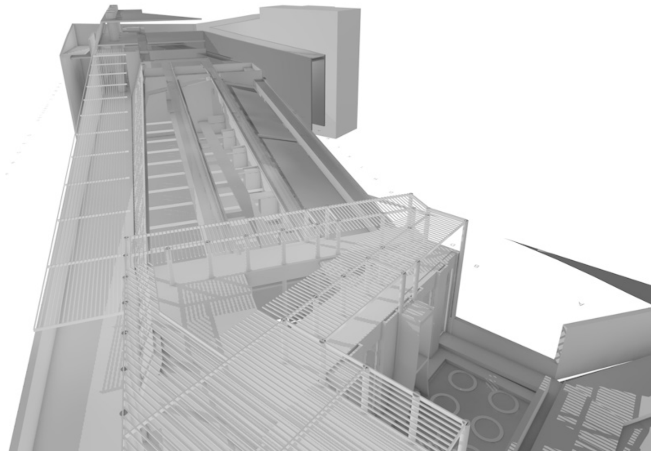


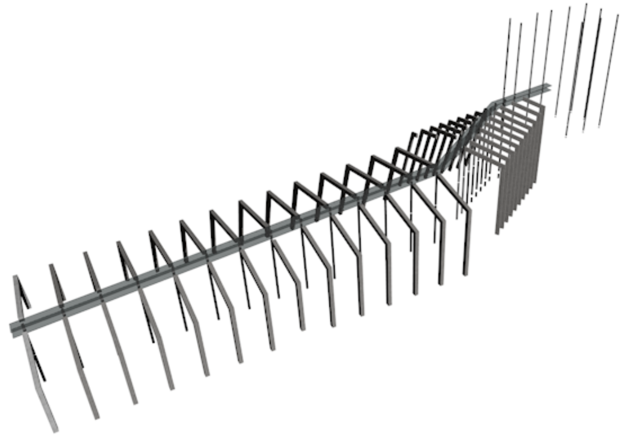
4.9 Phase 3

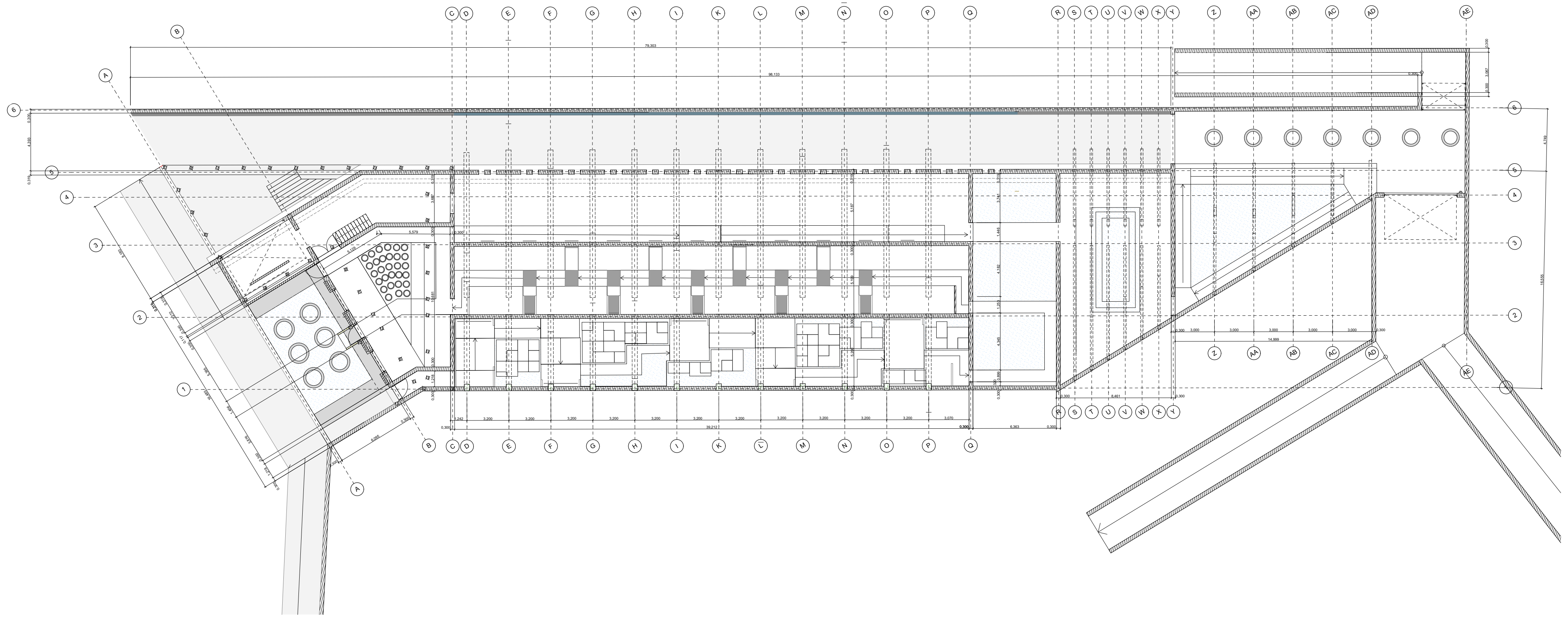


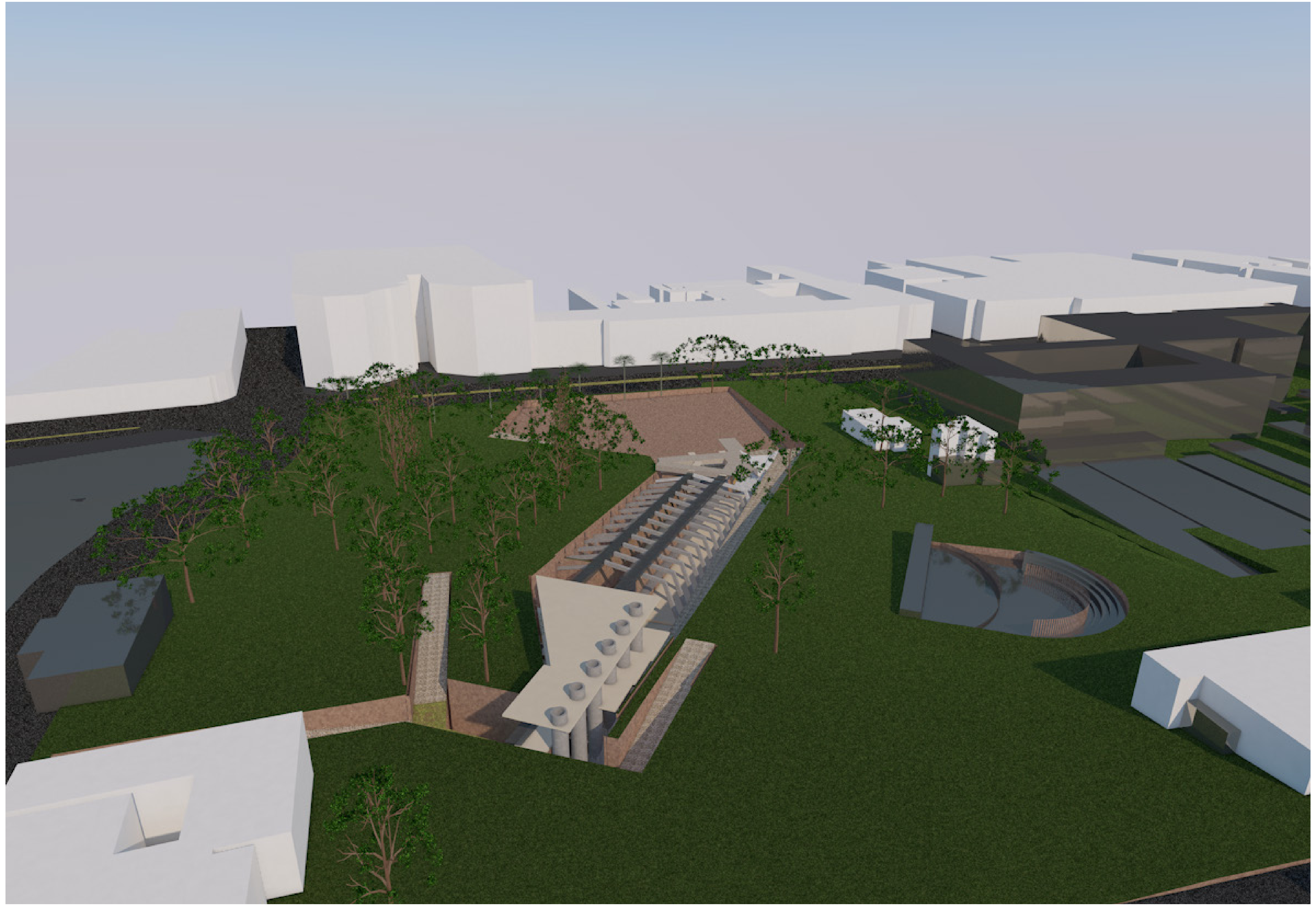
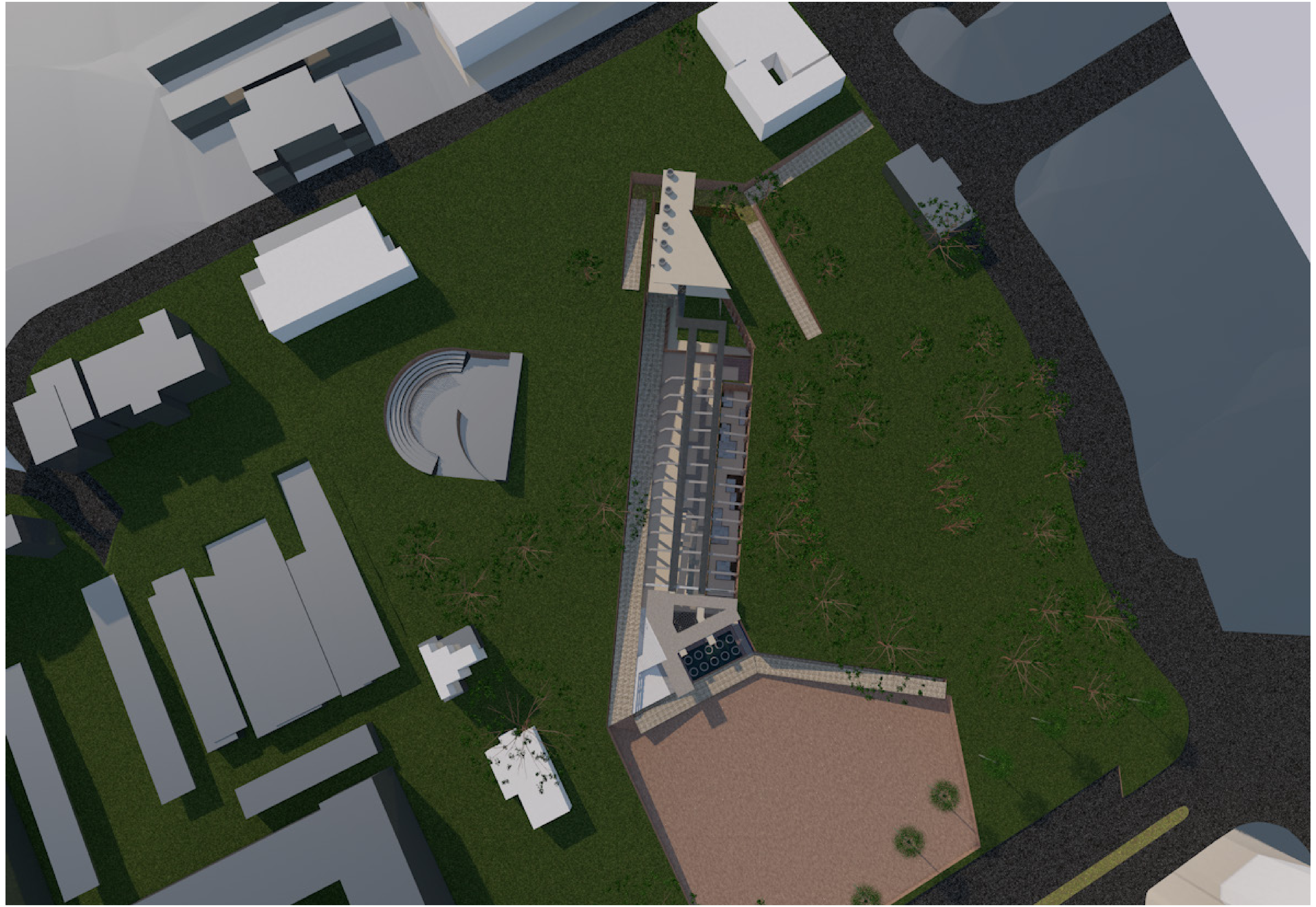


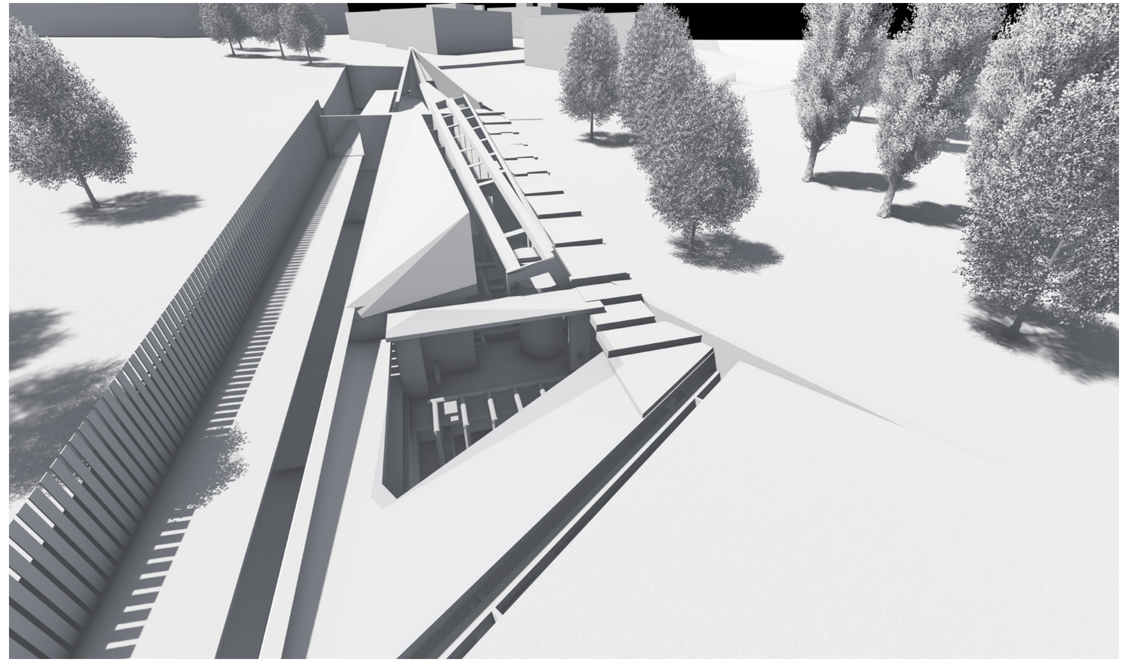
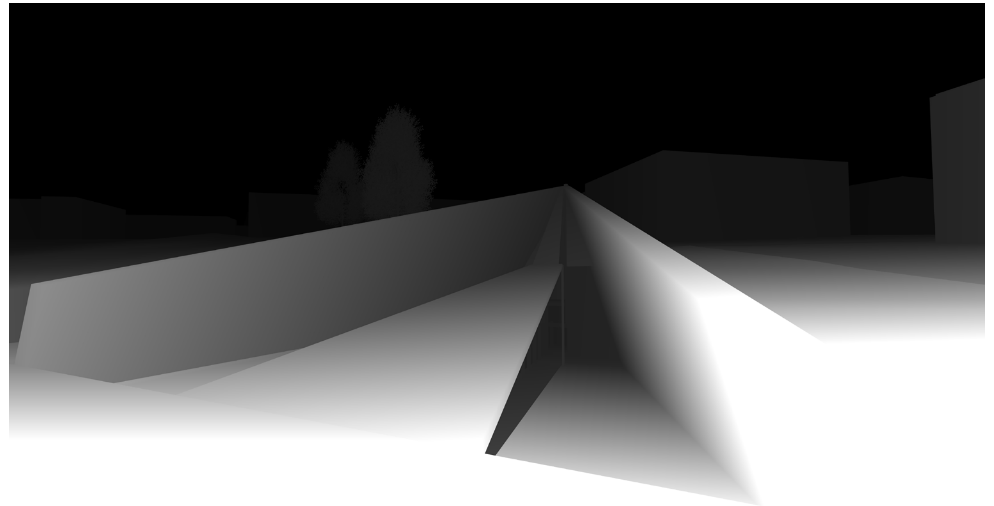
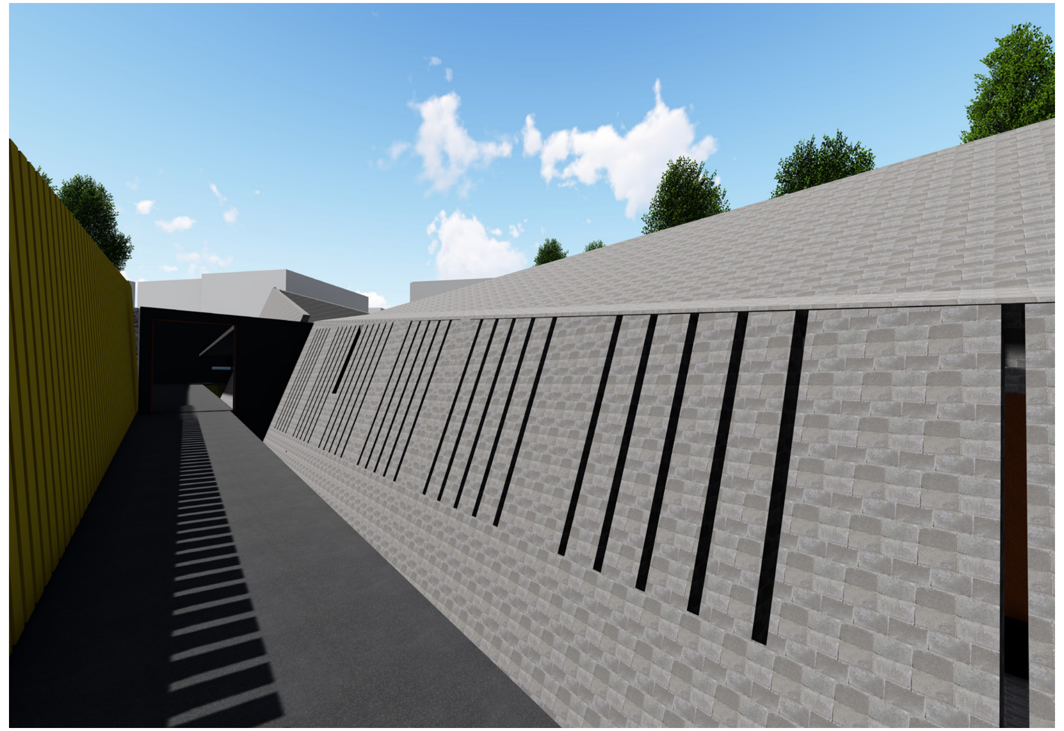
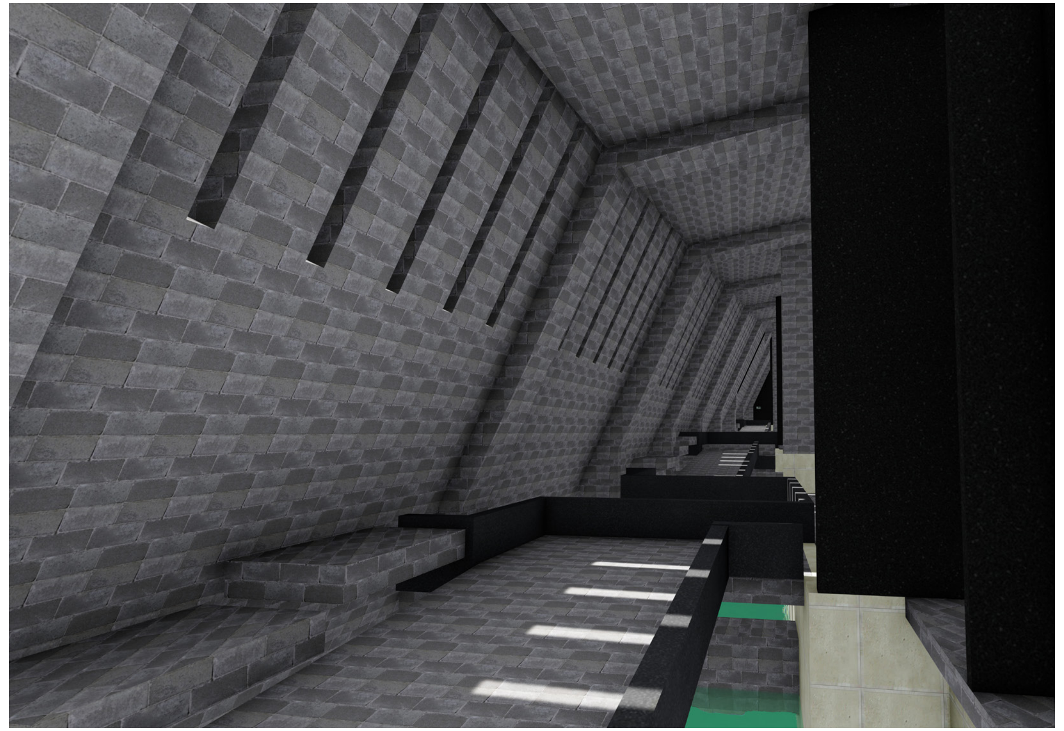
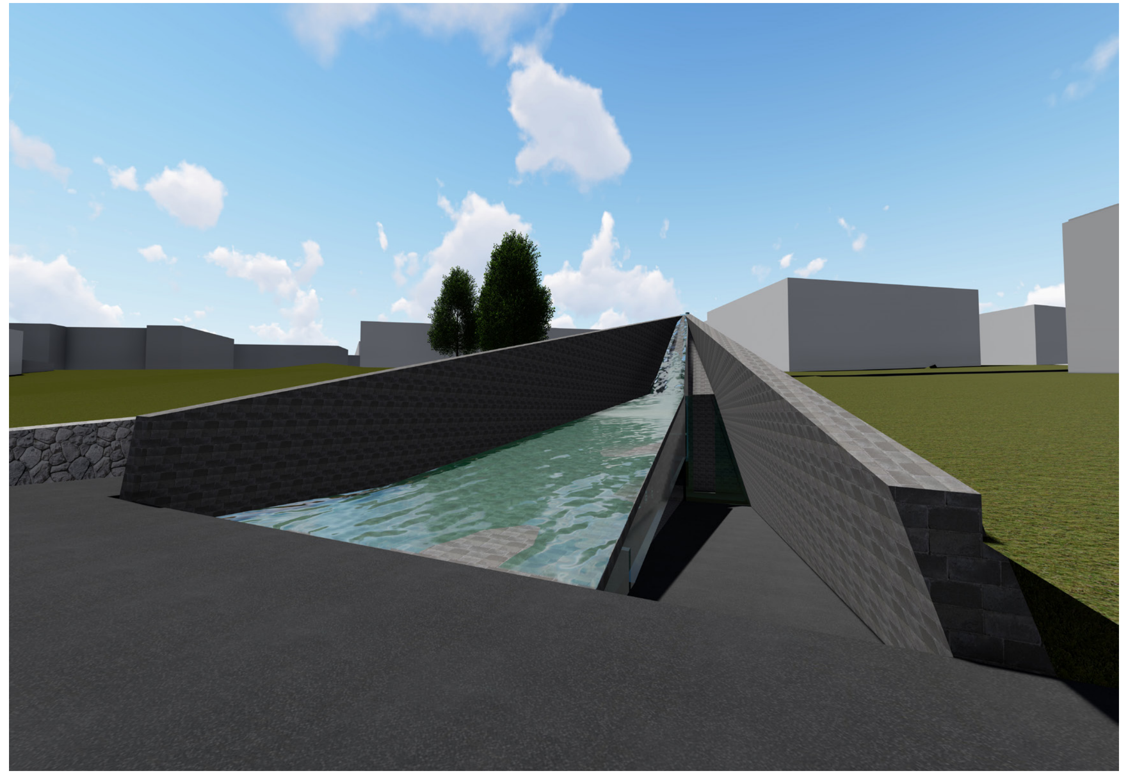
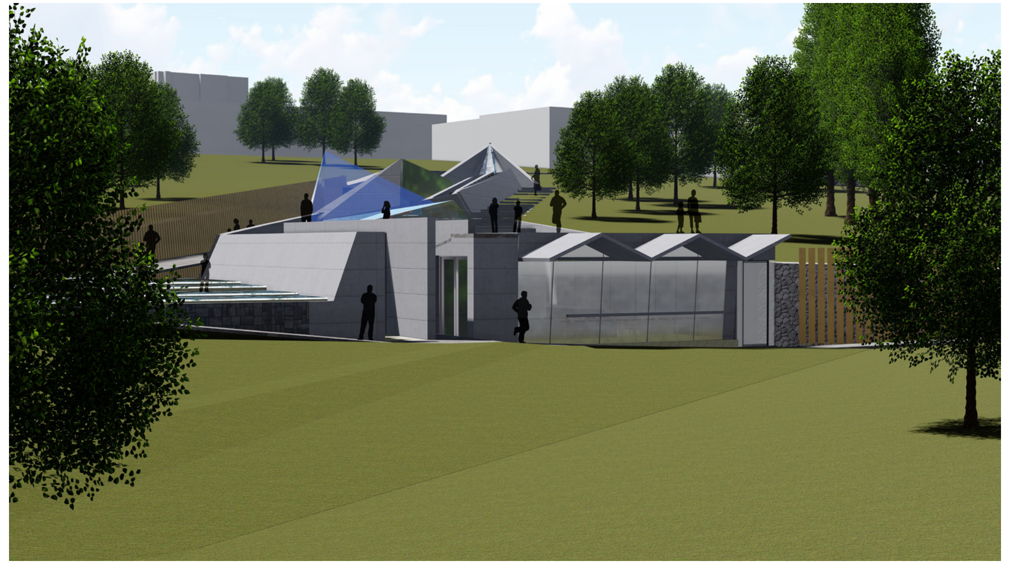
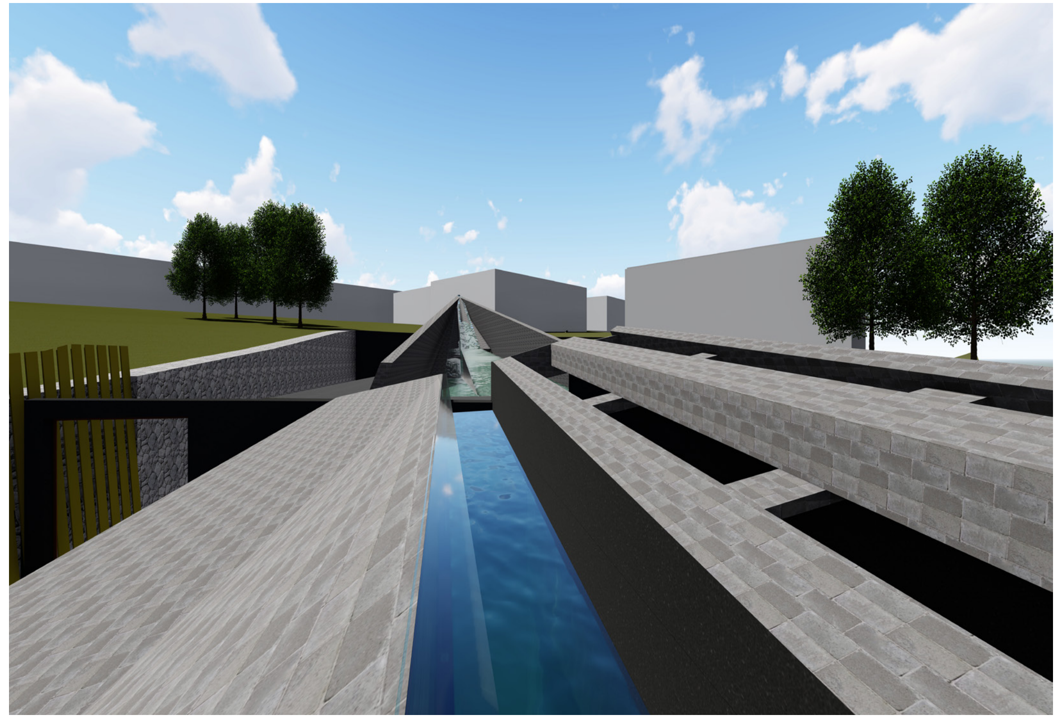
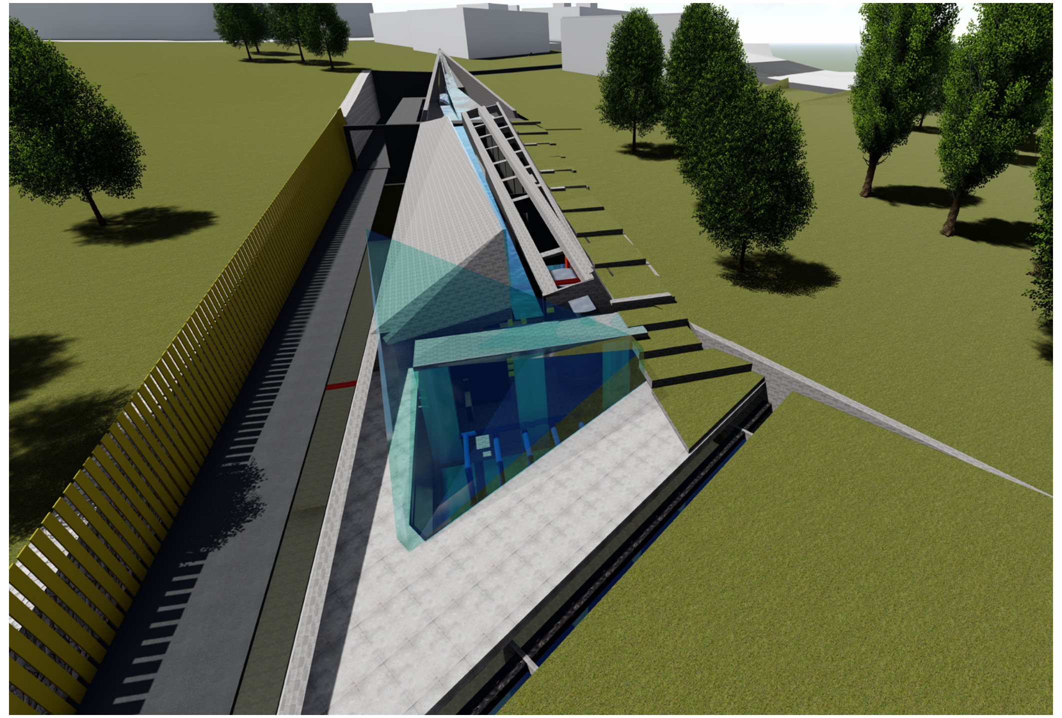


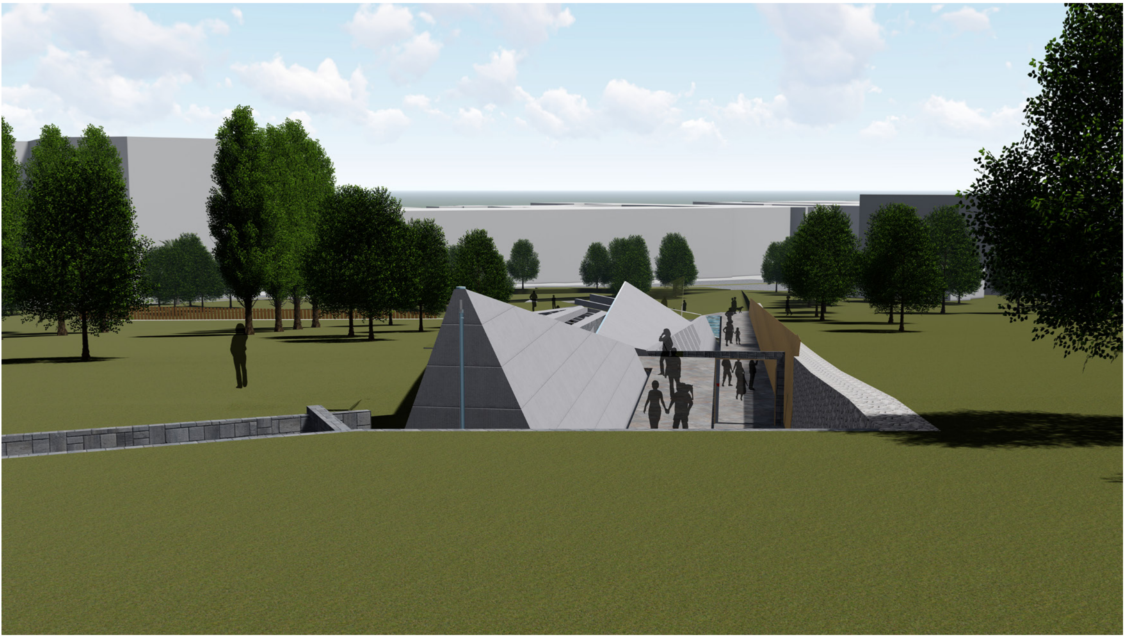
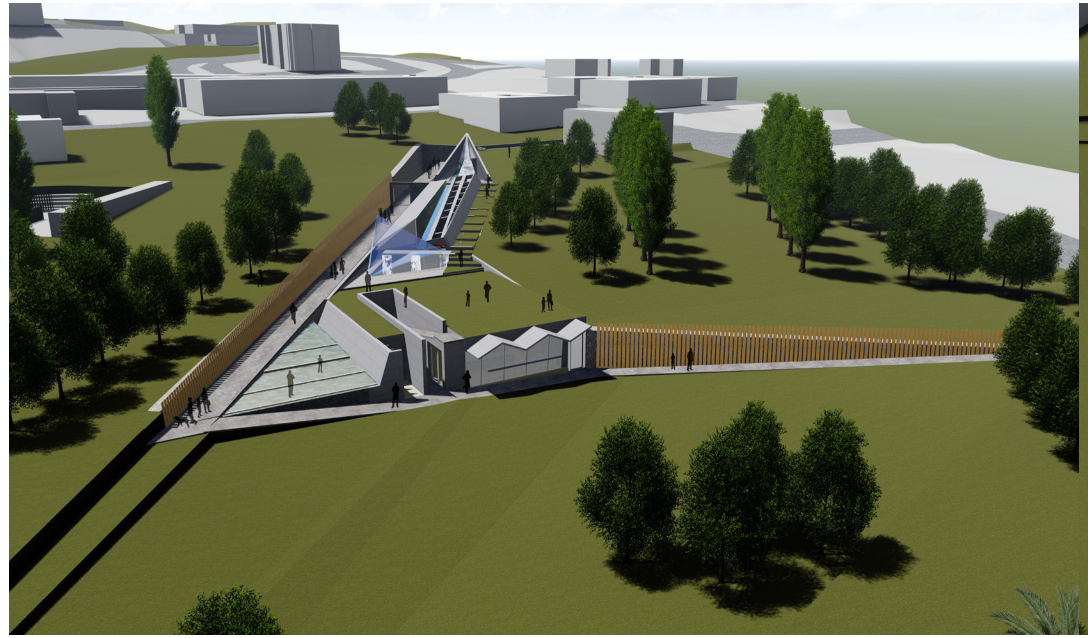
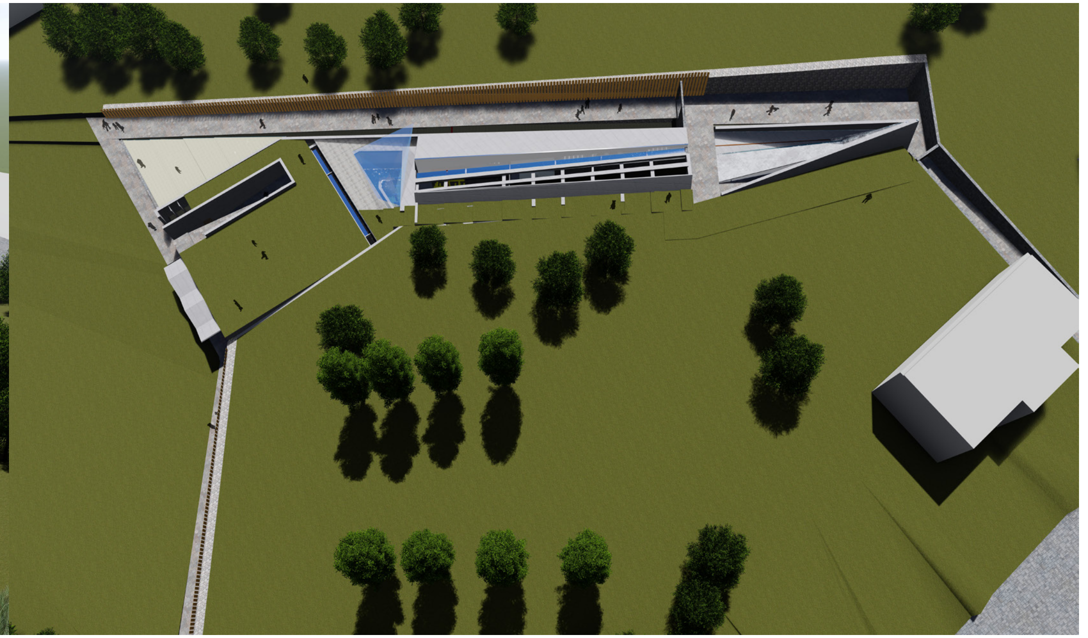
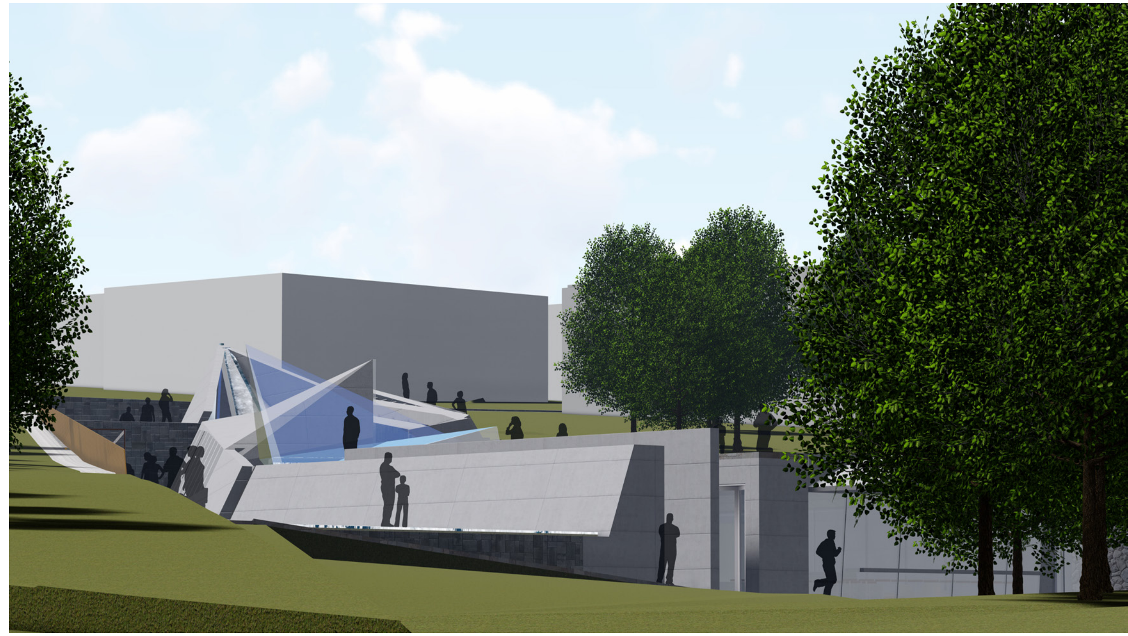
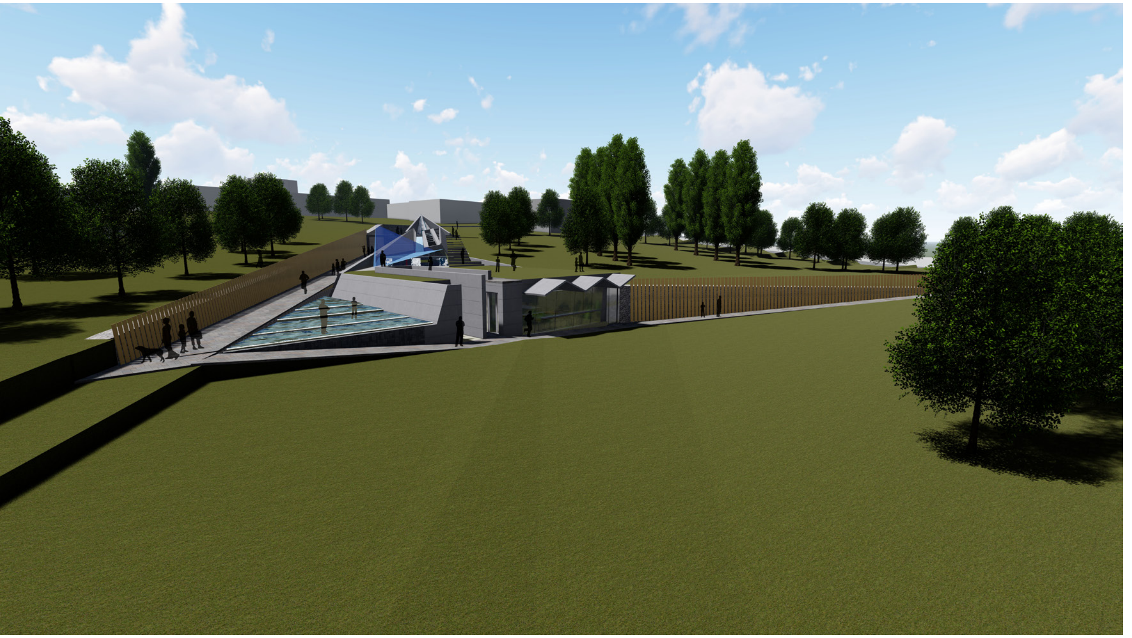
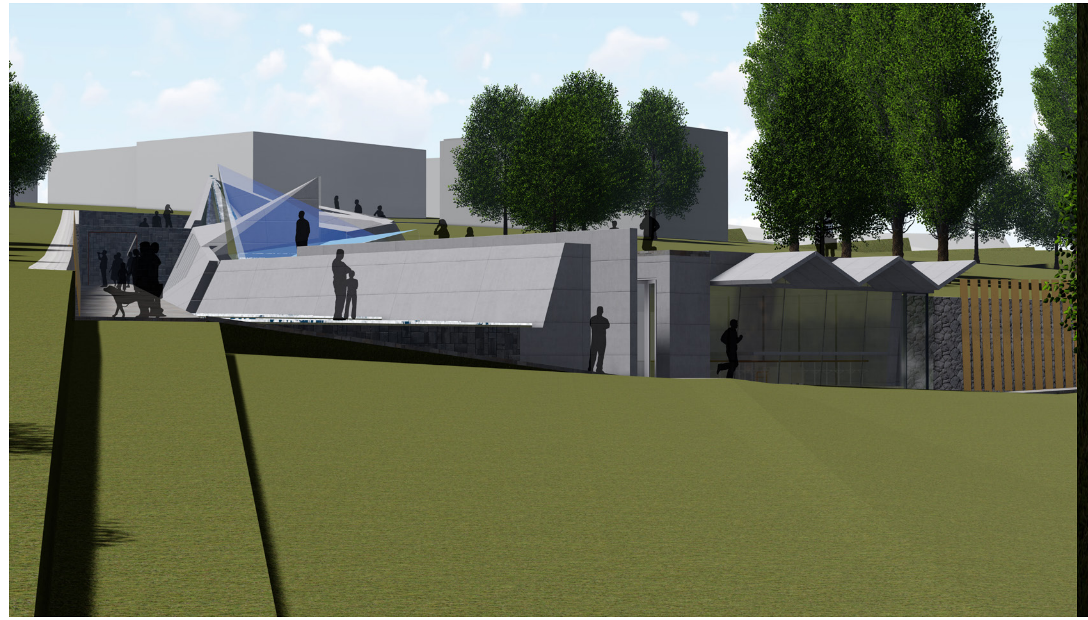




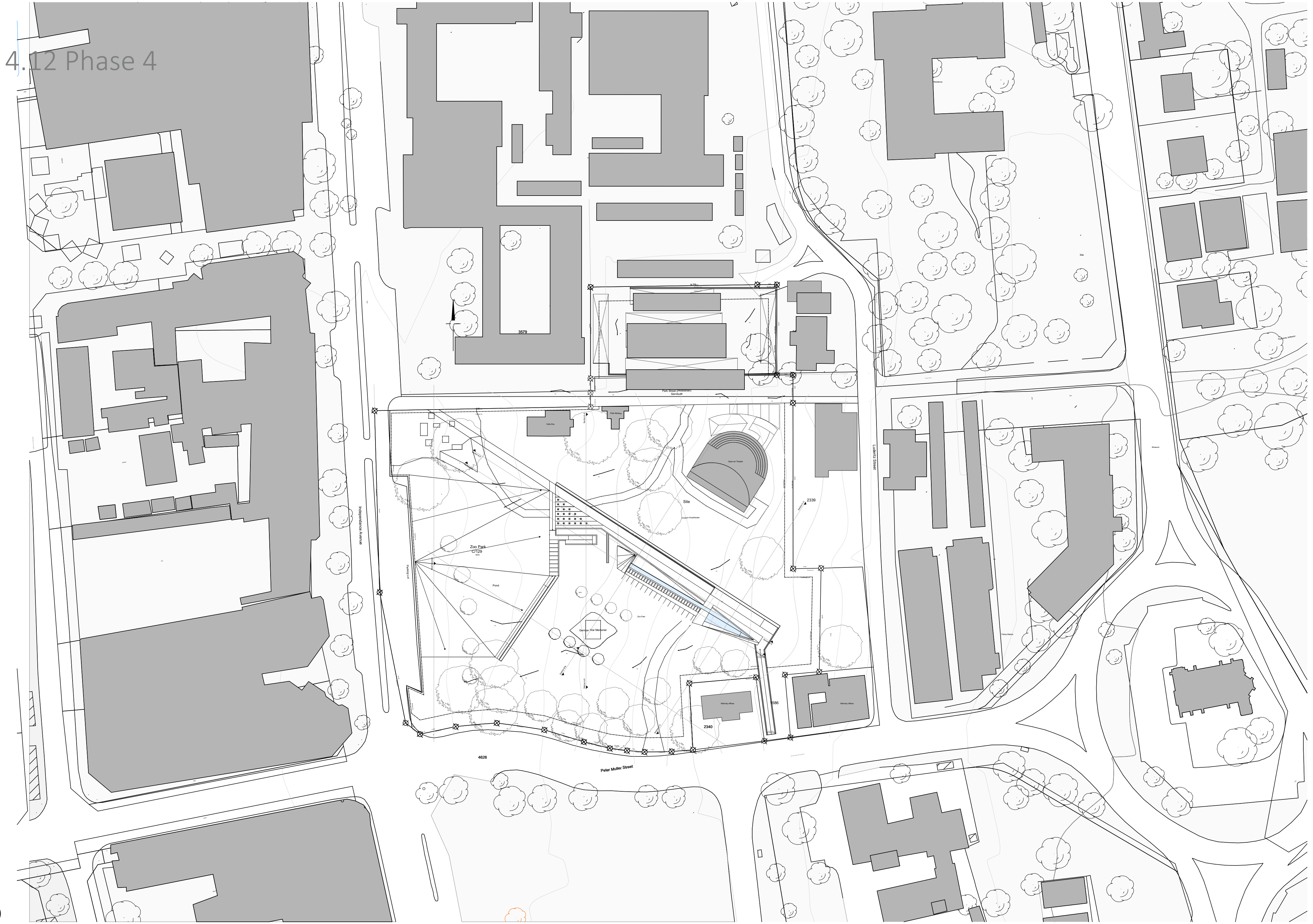


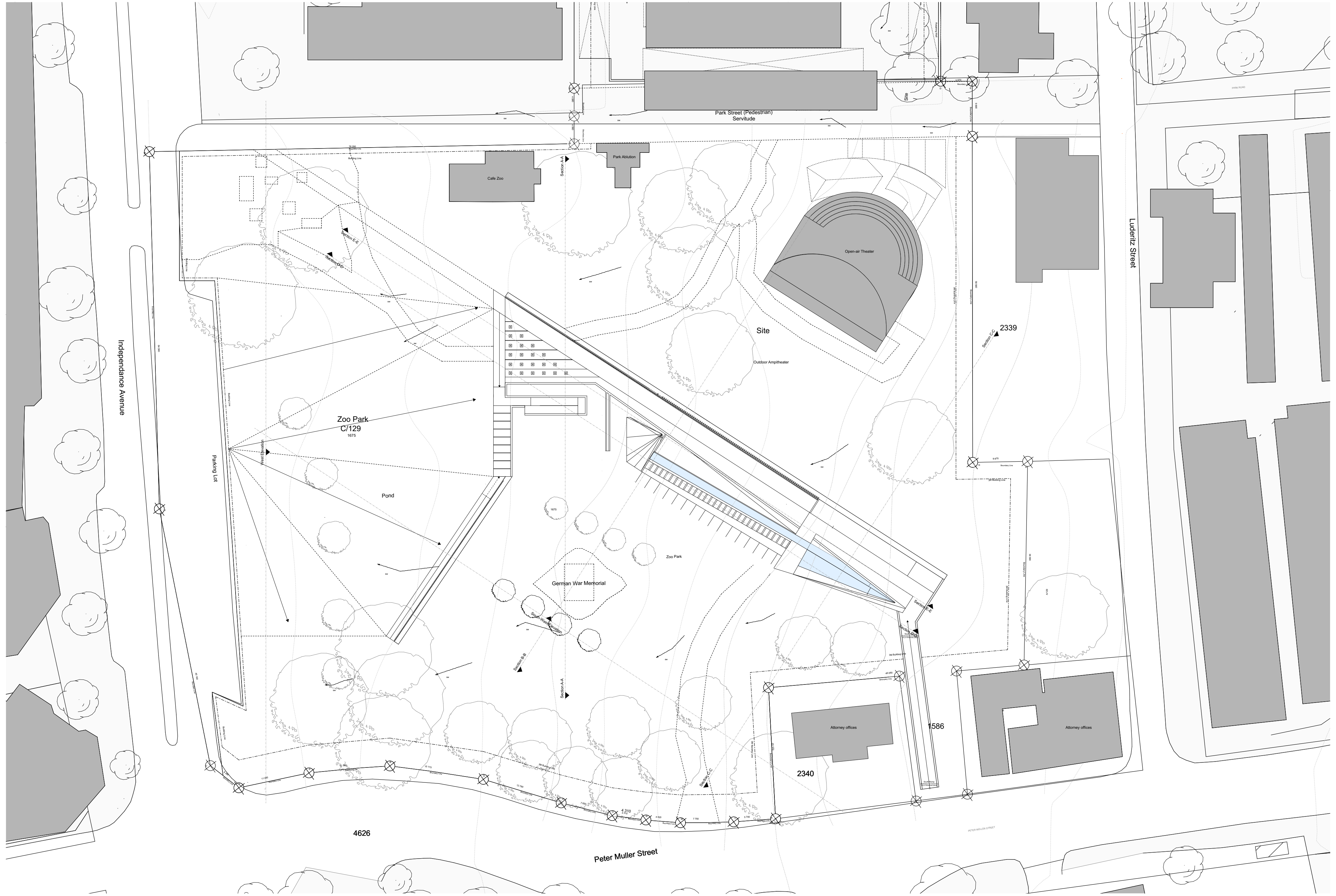



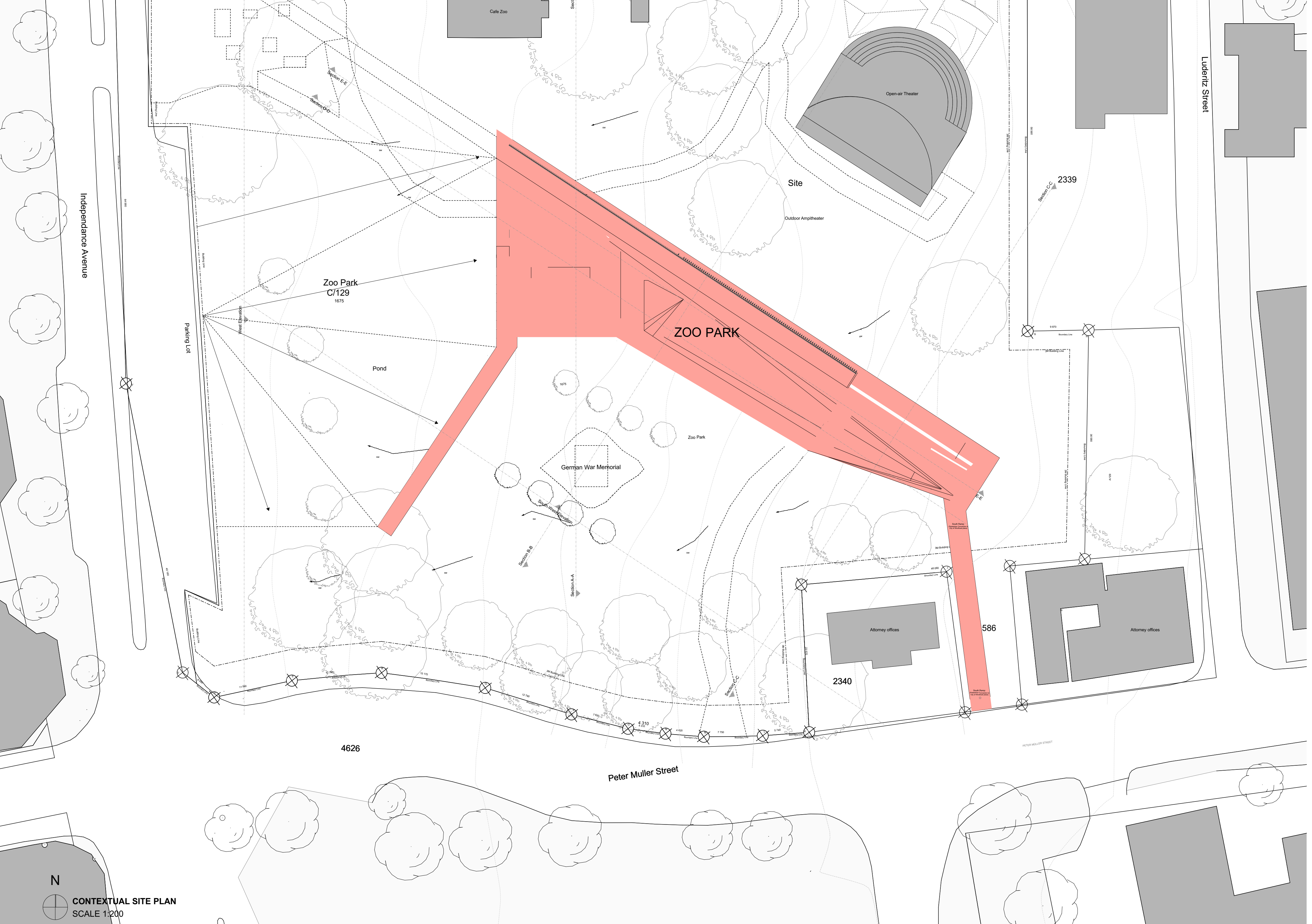







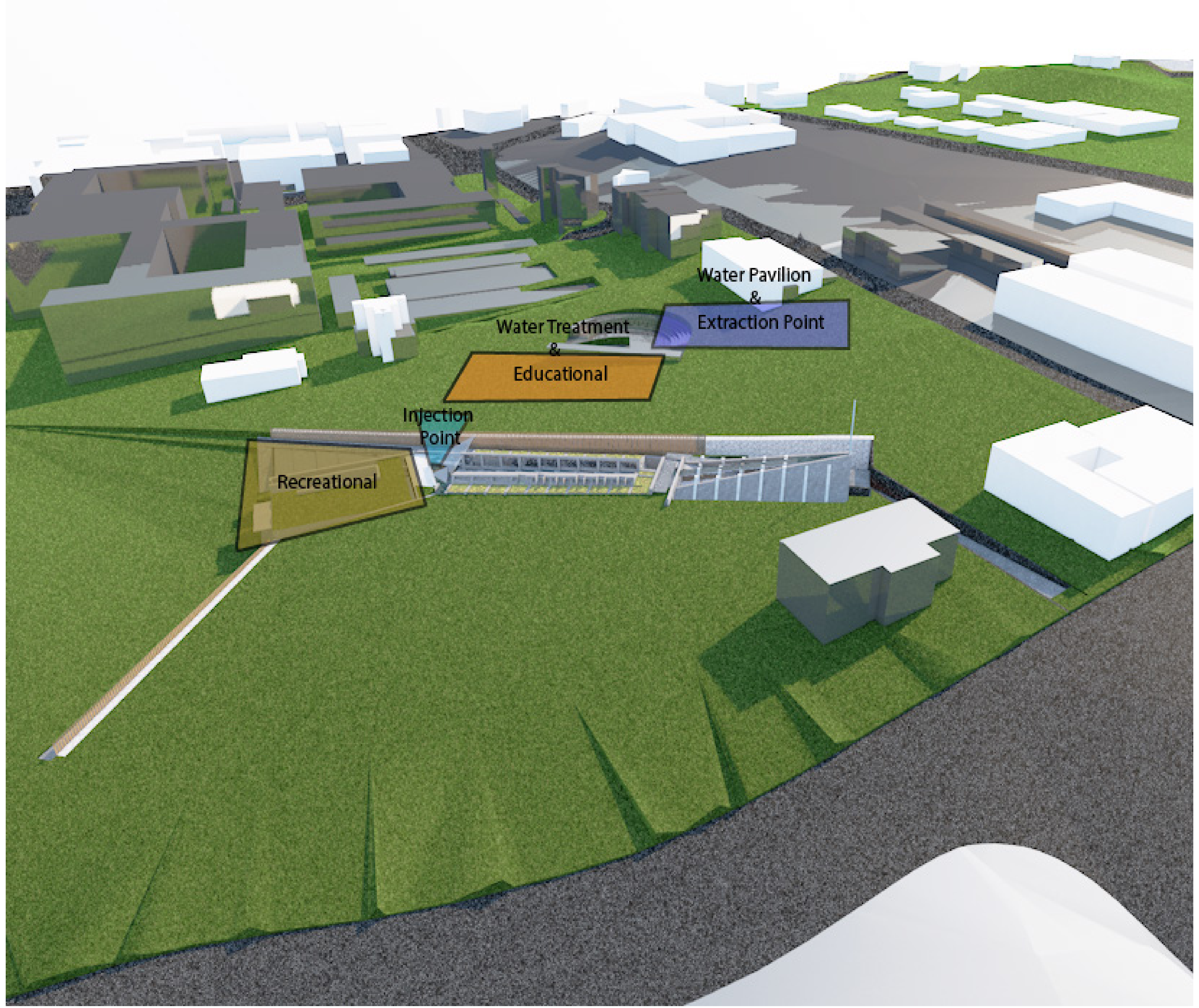

4.12 Phase 4

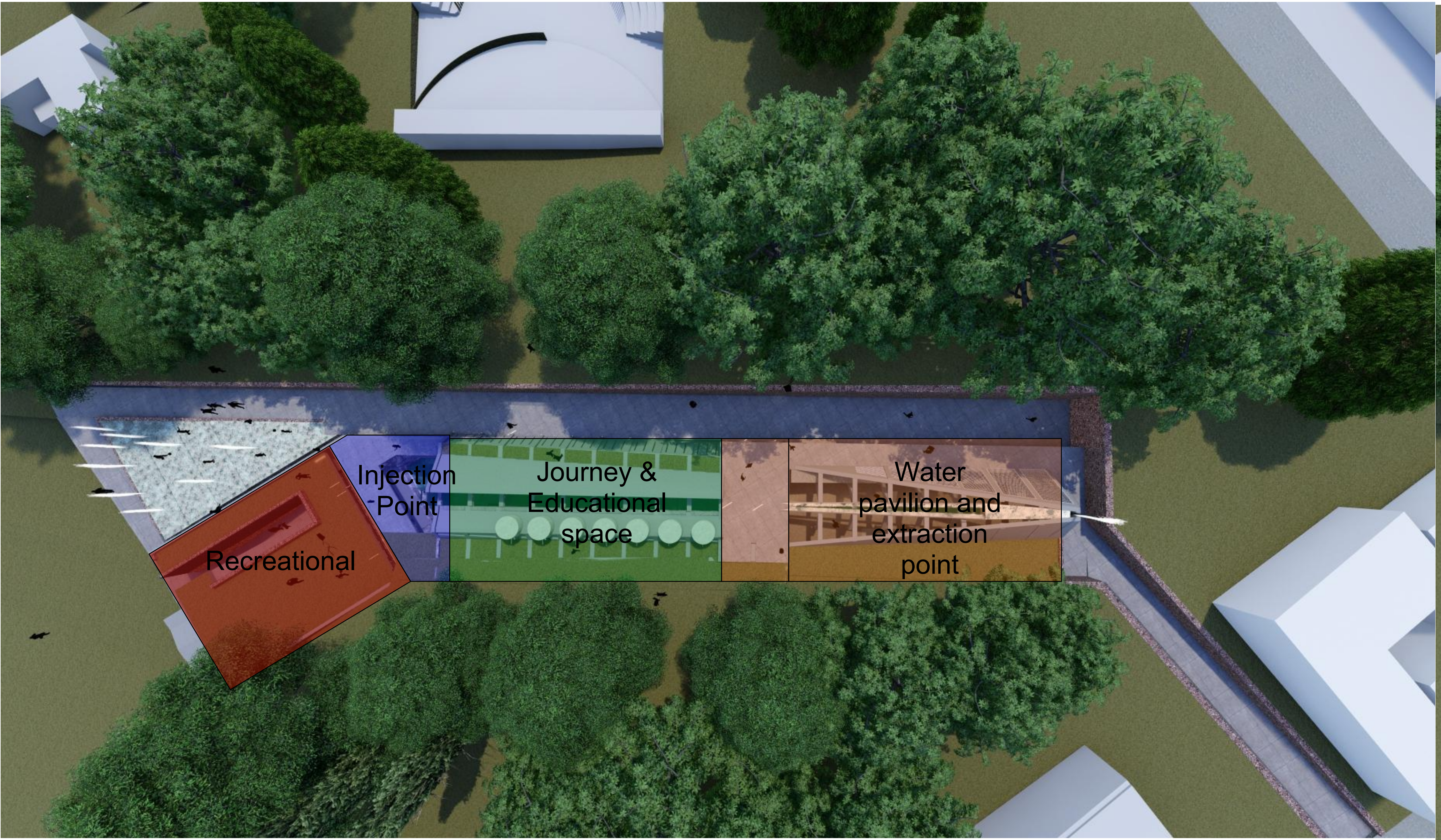




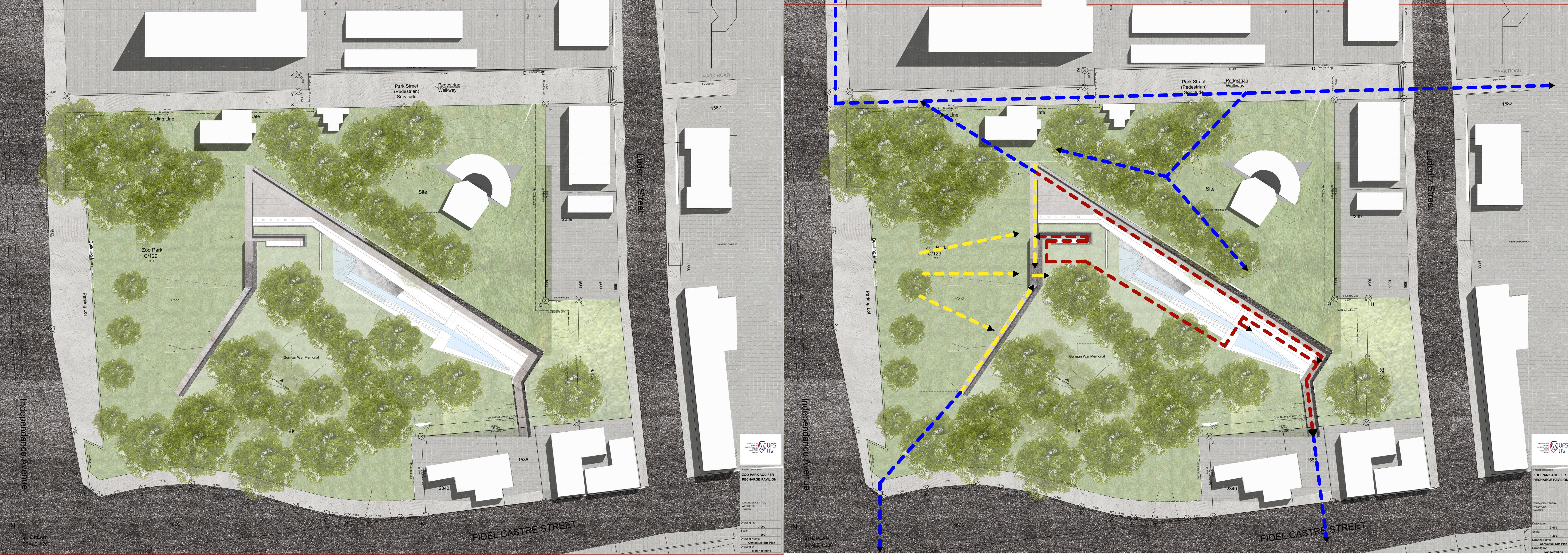
Park Street (Pedestrian)
Servitude
Cafe Zoo
Park Ablution
Section A-A
Open-air Theater
Luderitz Street
Independance Avenue
Section E-E
Section D-D
Site
Outdoor Ampitheater
2339
Section C-C
Zoo Park
C/129
1675
West Elevation
Parking Lot
Pond
Zoo Park
German War Memorial
South-West Elevation
Section B-B
Attorney offices
1586
Attorney offices
2340
4626
Peter Muller Street


Independance Avenue
Parking Lot
Zoo Park
C/129
Pond
Site
ZOO PARK
2339
Luderitz Street
German War Memorial
Zoo Park
586
2340
4626
Peter Muller Street
N
CONTEXTUAL SITE PLAN
SCALE 1:200

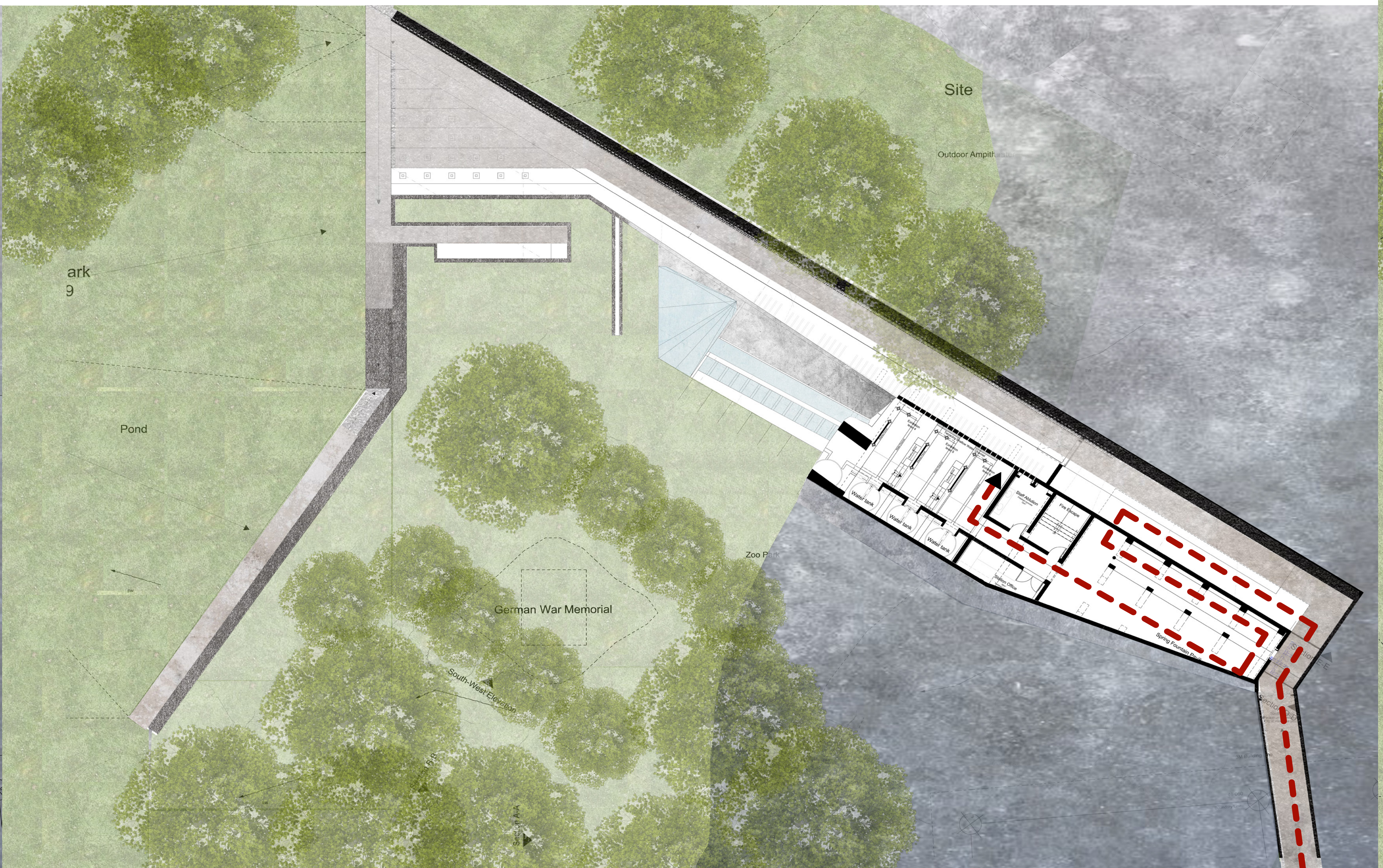

Water Pavilion
&
Extraction Point
Water Treatment
&
Educational
Injection
Point
Recreational


Injection Point
Journey & Educational space
Water pavilion and extraction point
Recreational

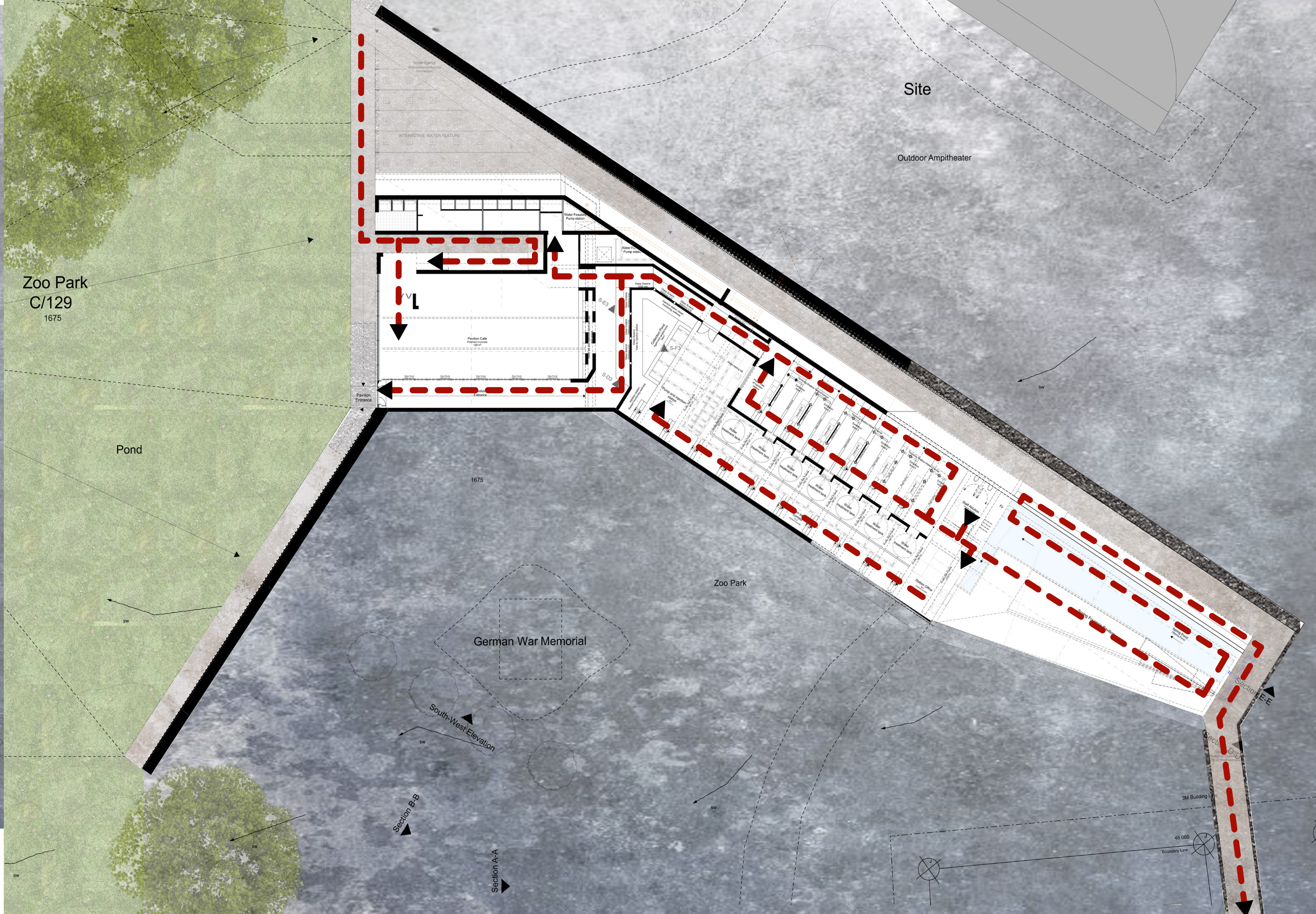

Exhibition space
Treatment Station
Extraction Borehole
Cafe & Ablutions



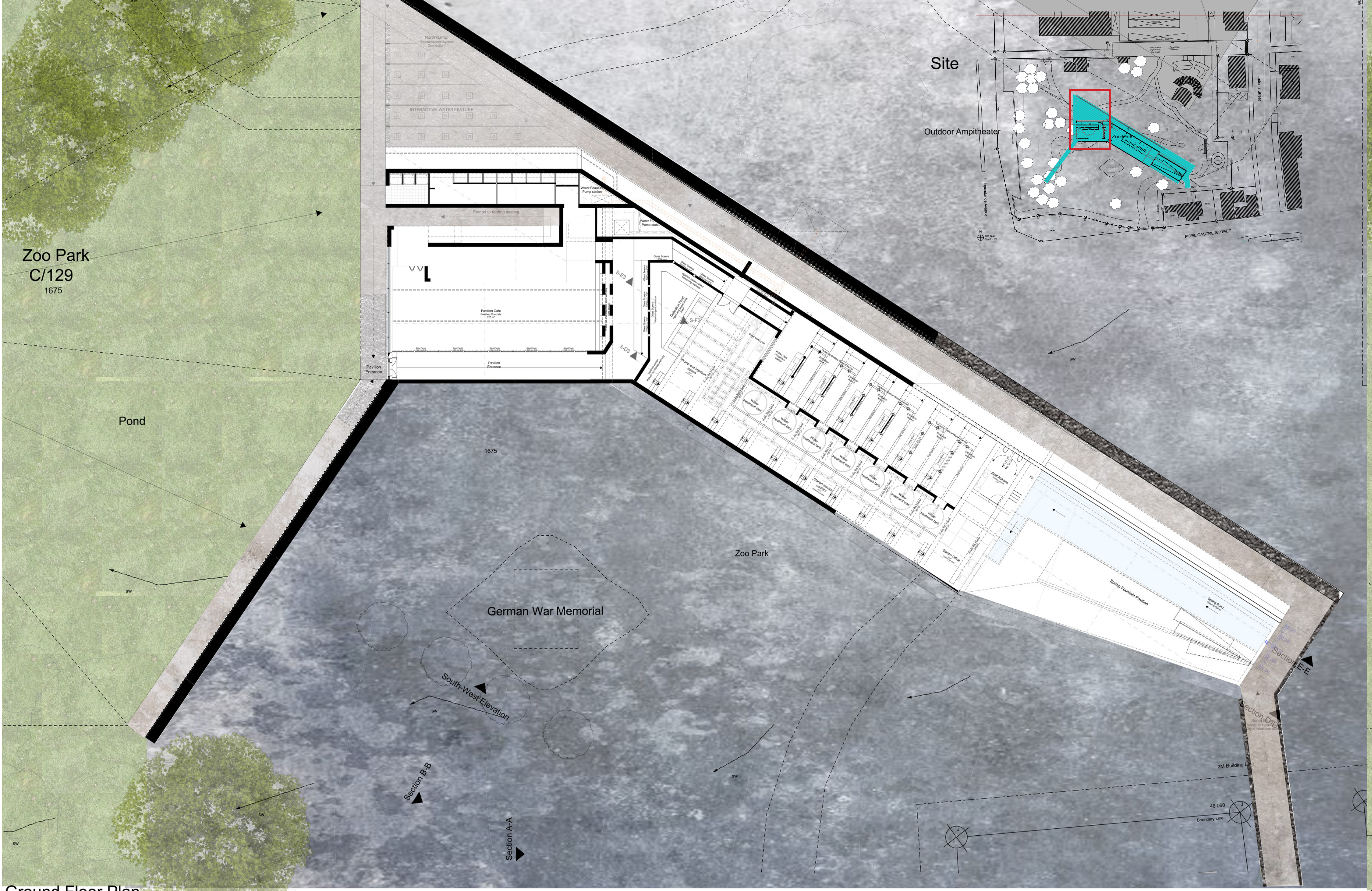
Park Street
(Pedestrian)
Servitude
Pedestrian
Walkway
PARK ROAD
Building Line
Cafe
Site
Zoo Park
C/129
Pond
Parking Lot
German War Memorial
Independance Avenue
FIDEL CASTRE STREET
Ludentz Street
1582
2339
1586
2340
SITE PLAN
UFS UV
ZOO PARK AQUIFER RECHARGE PAVILION



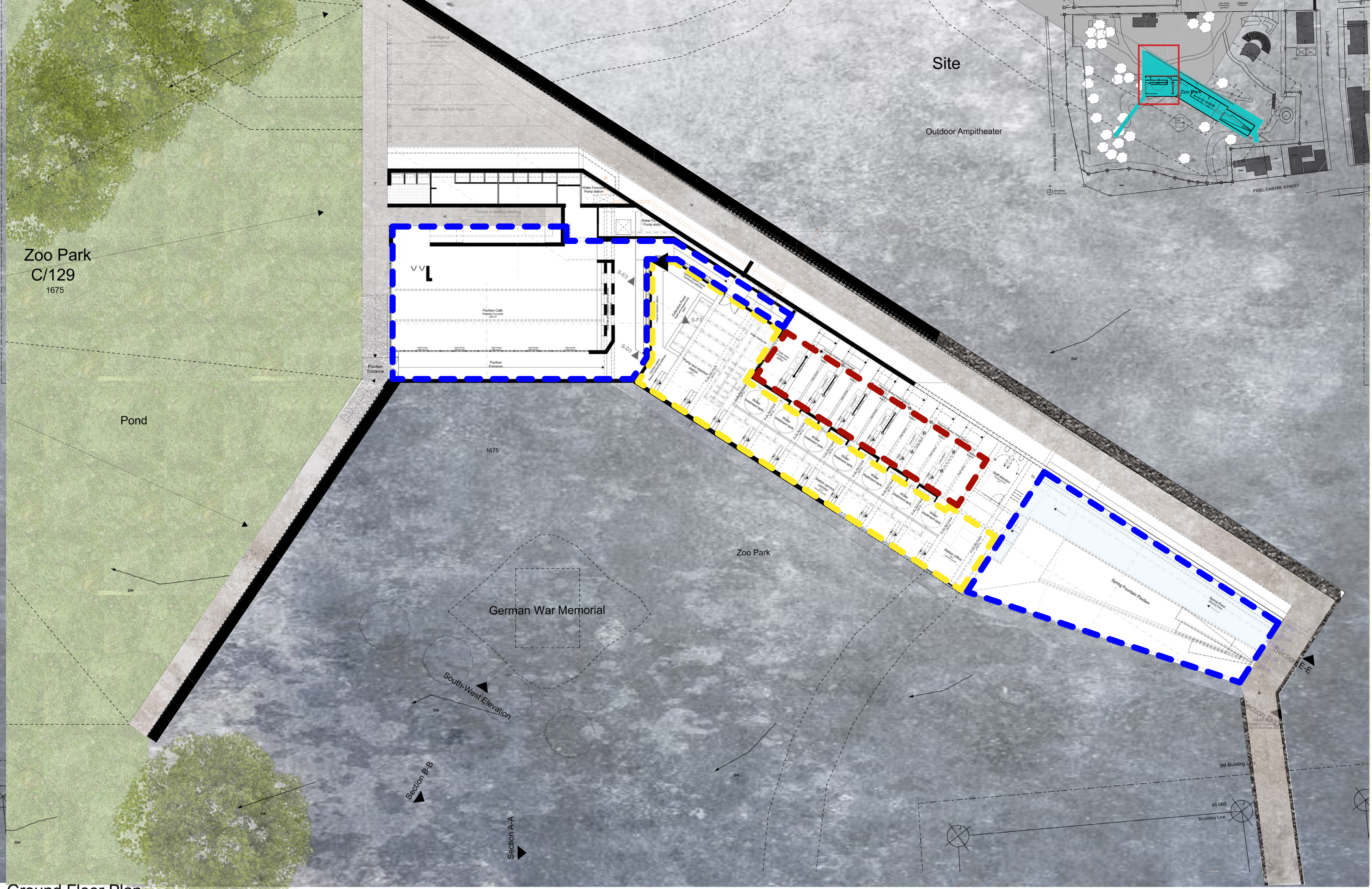
Ground +1 Floor Plan
Scale 1:100



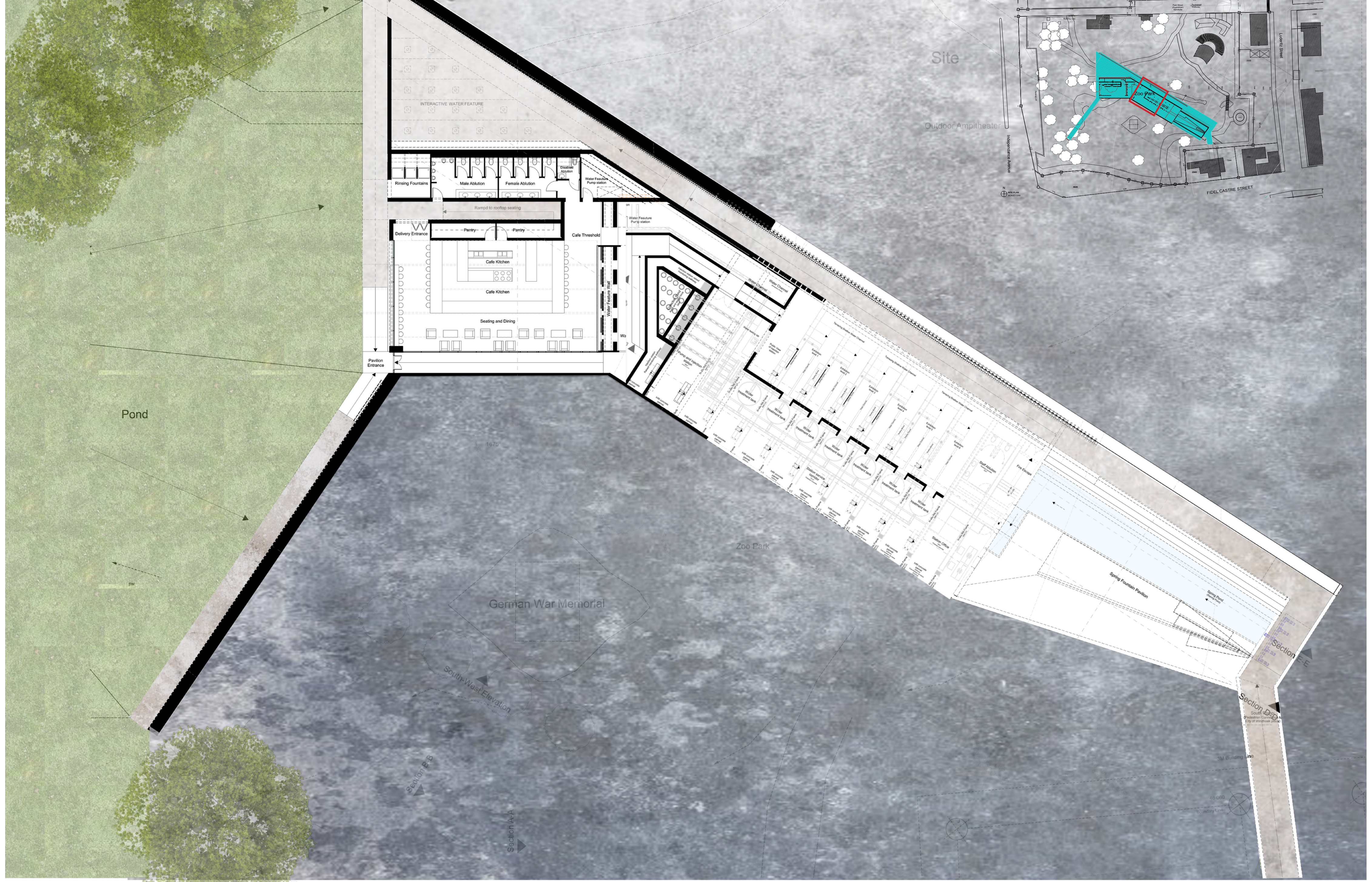
Ground Floor Plan



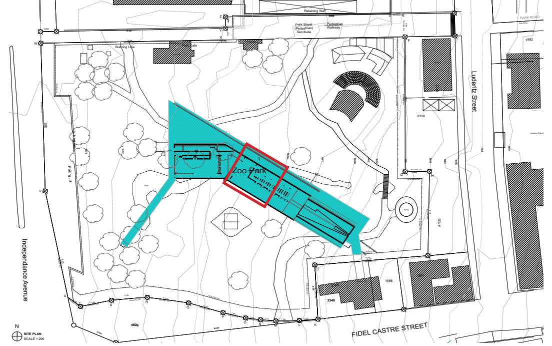
Ground Floor Plan
Scale 1:100

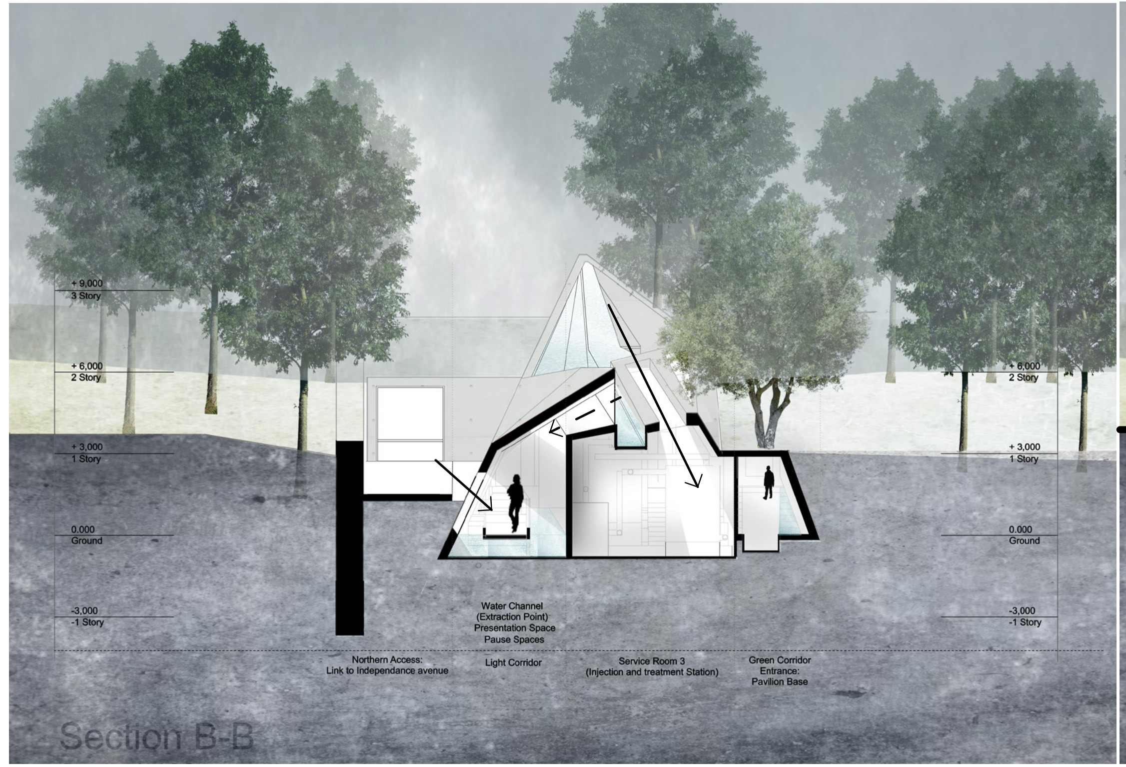


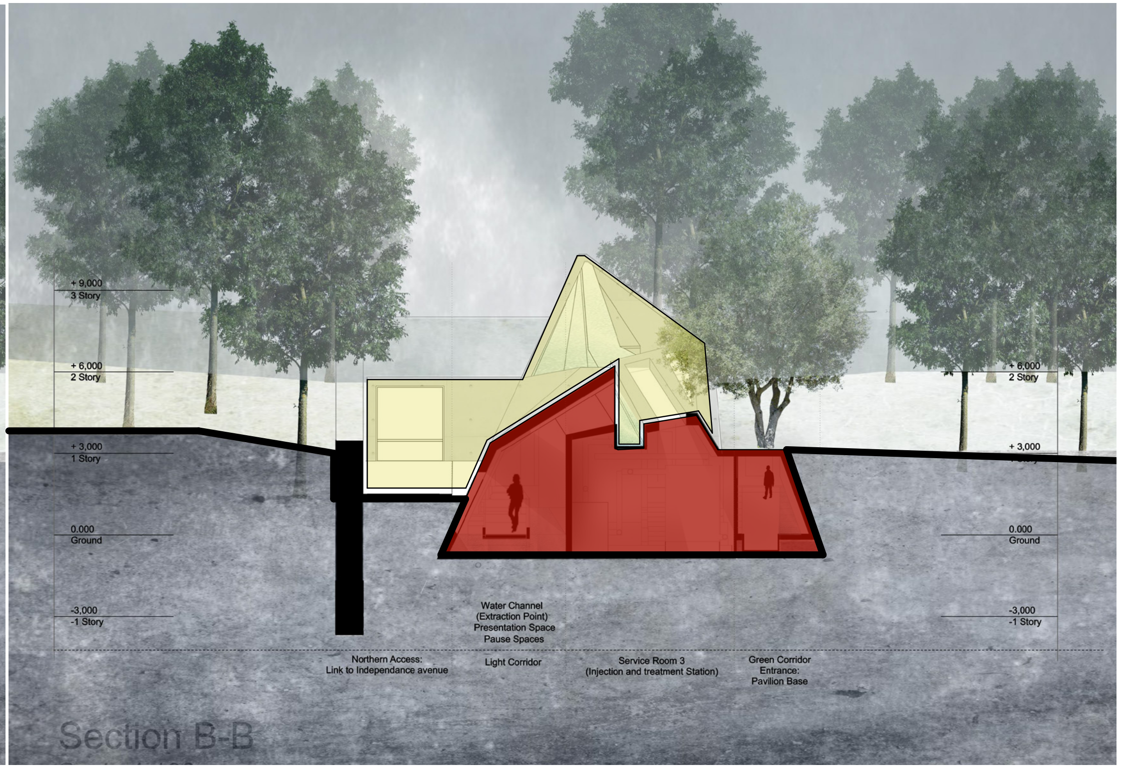
Ground Floor Plan
Scale 1:100

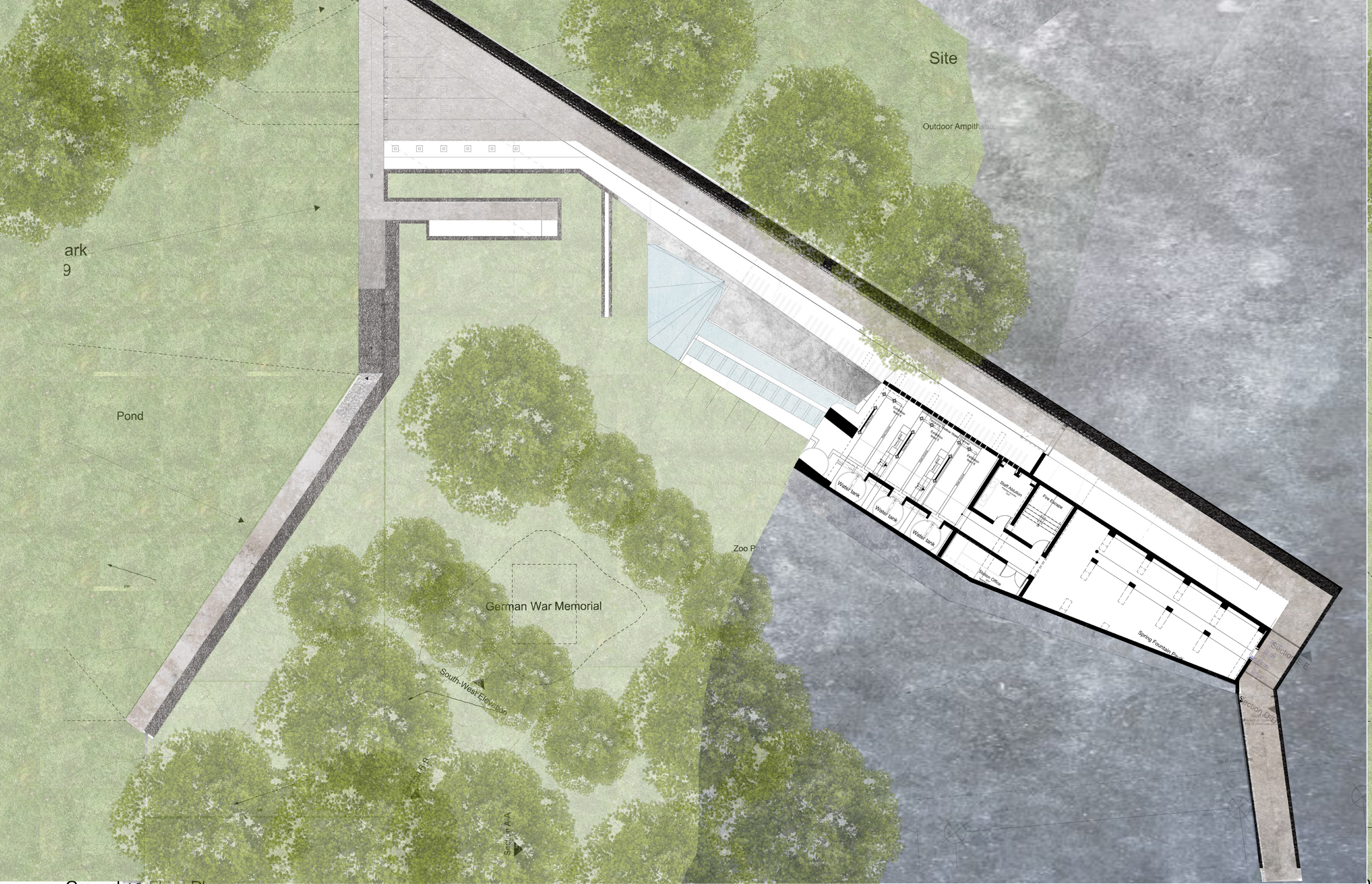


Ground -1 Floor Plan
Scale 1:100

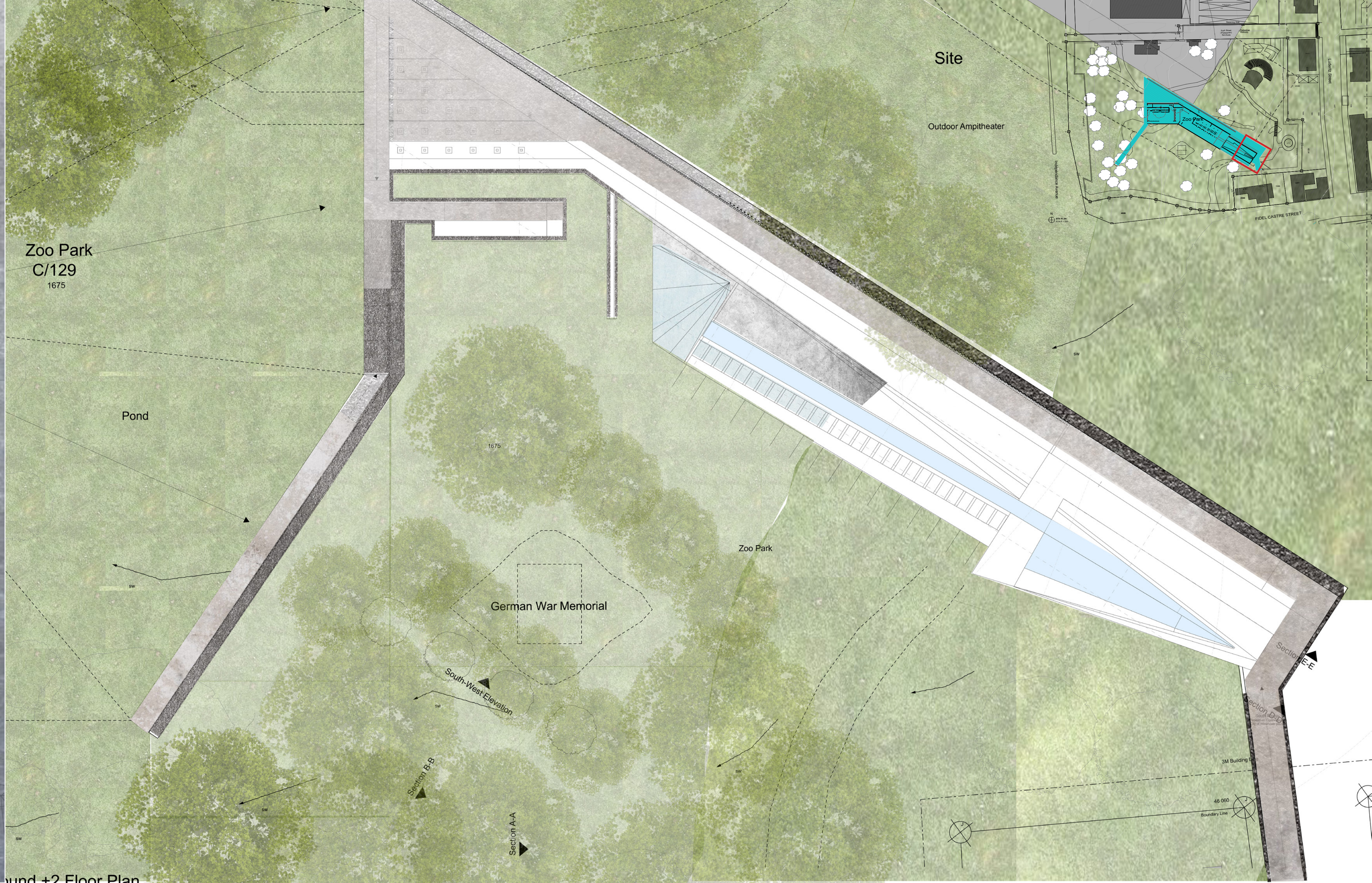




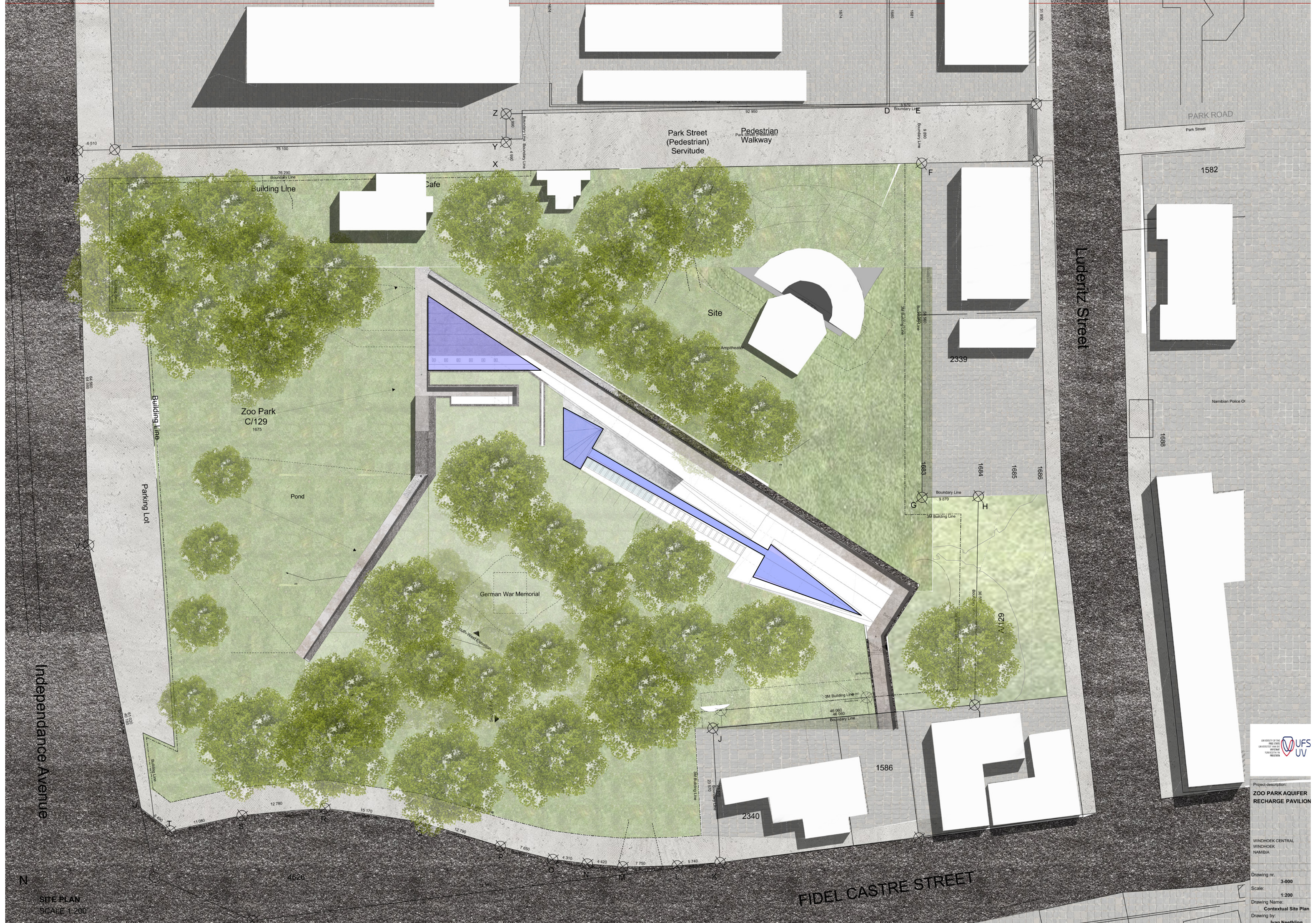




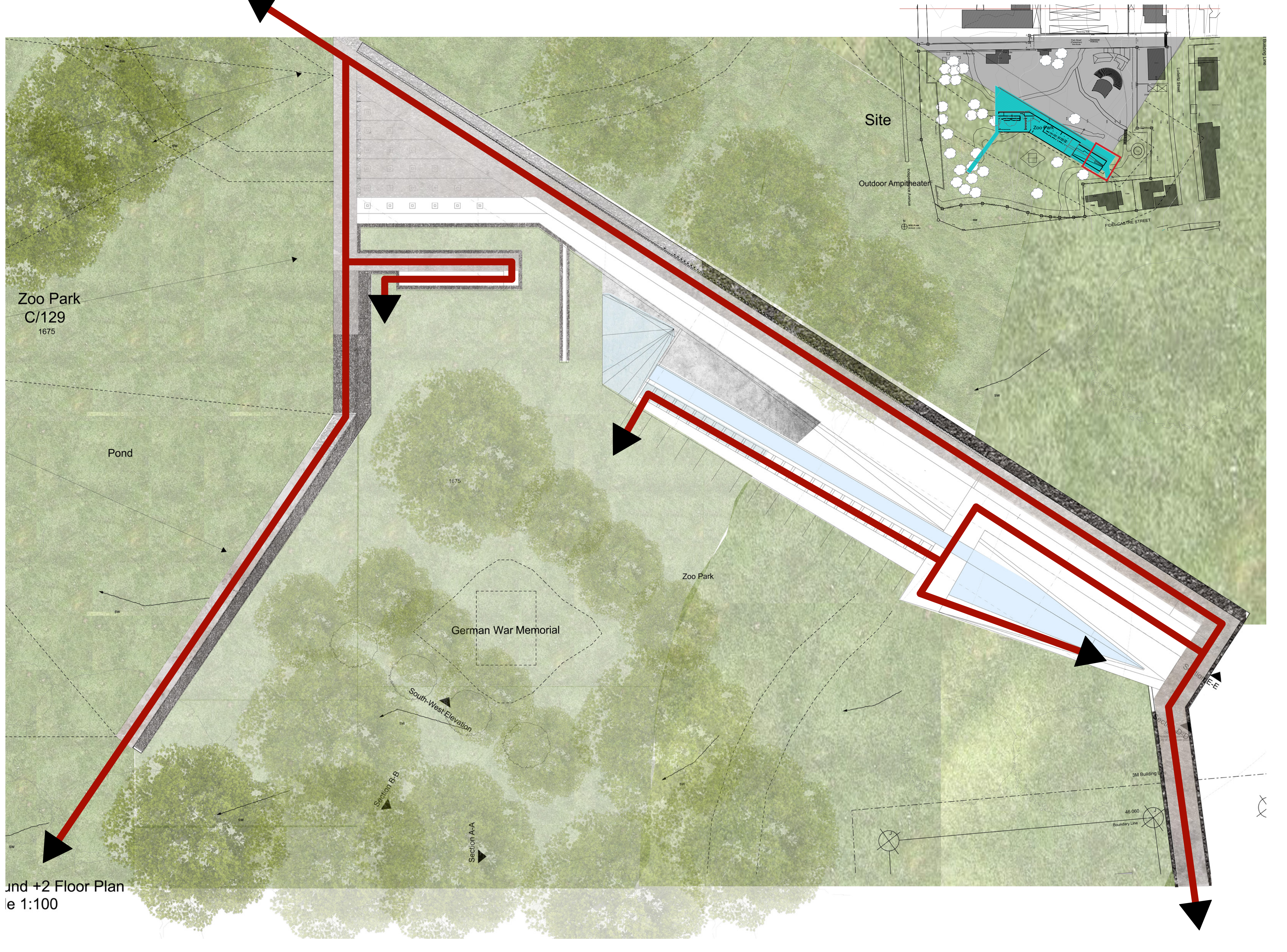
Ground +1 Floor Plan
Scale 1:100



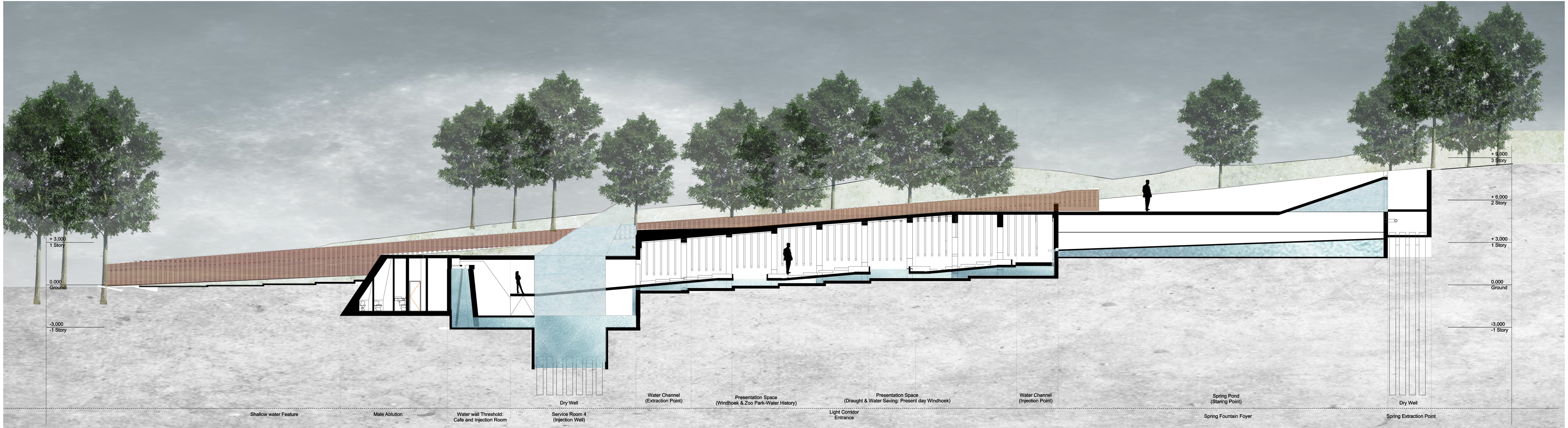
ound +2 Floor Plan
ale 1:100



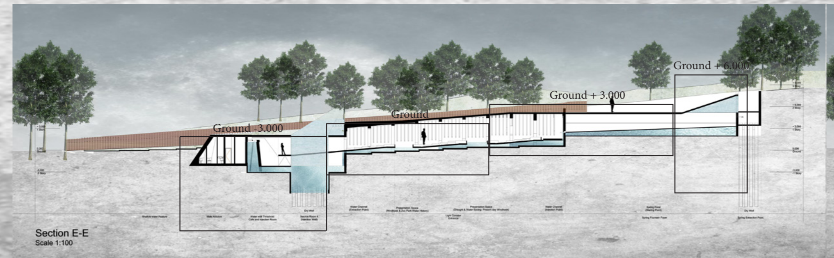
Park Street (Pedestrian) Servitude
Pedestrian Walkway
Building Line
Cafe
Site
Zoo Park C/129
Pond
Parking Lot
German War Memorial
Independance Avenue
Luderitz Street
FIDEL CASTRE STREET
1582
2339
1586
2340
PARK ROAD
SITE PLAN
ZOO PARK AQUIFER RECHARGE PAVILION
UFS UV

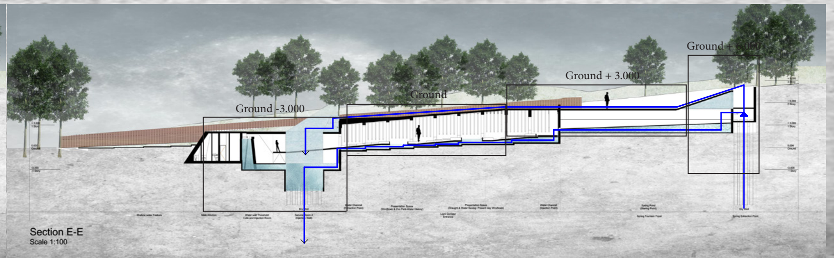


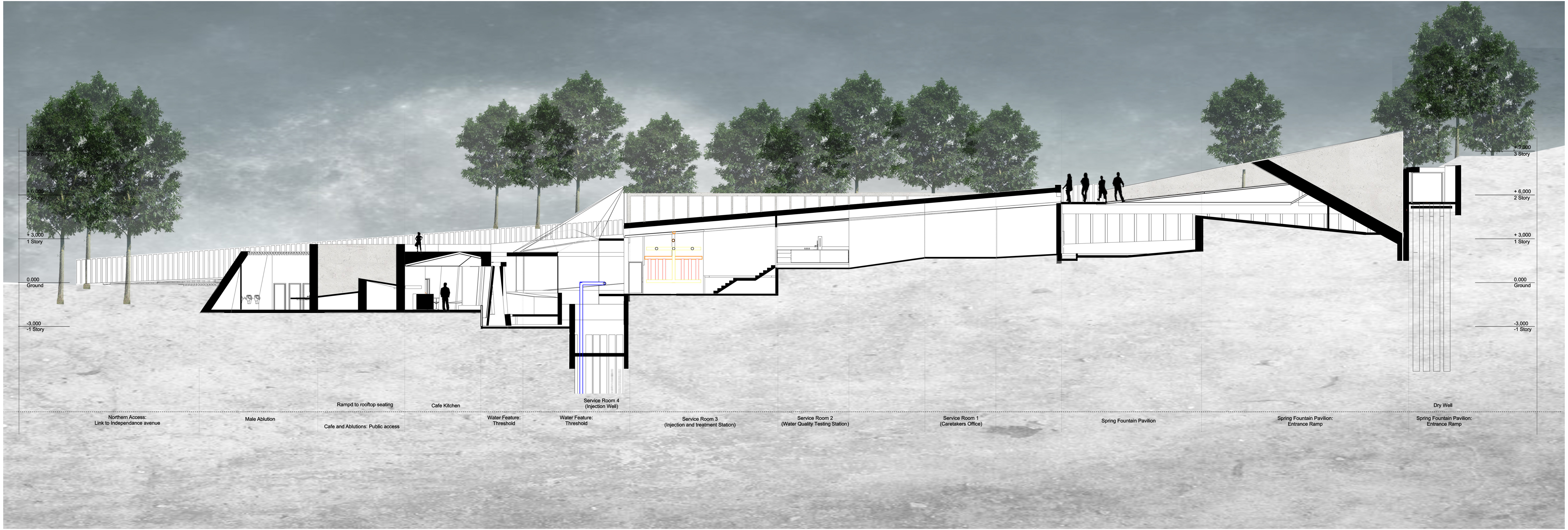
Zoo Park C/129
1675
Pond
German War Memorial
Zoo Park
South-West Elevation
Section B-B
Section A-A
Site
Outdoor Ampitheater
und +2 Floor Plan
e 1:100



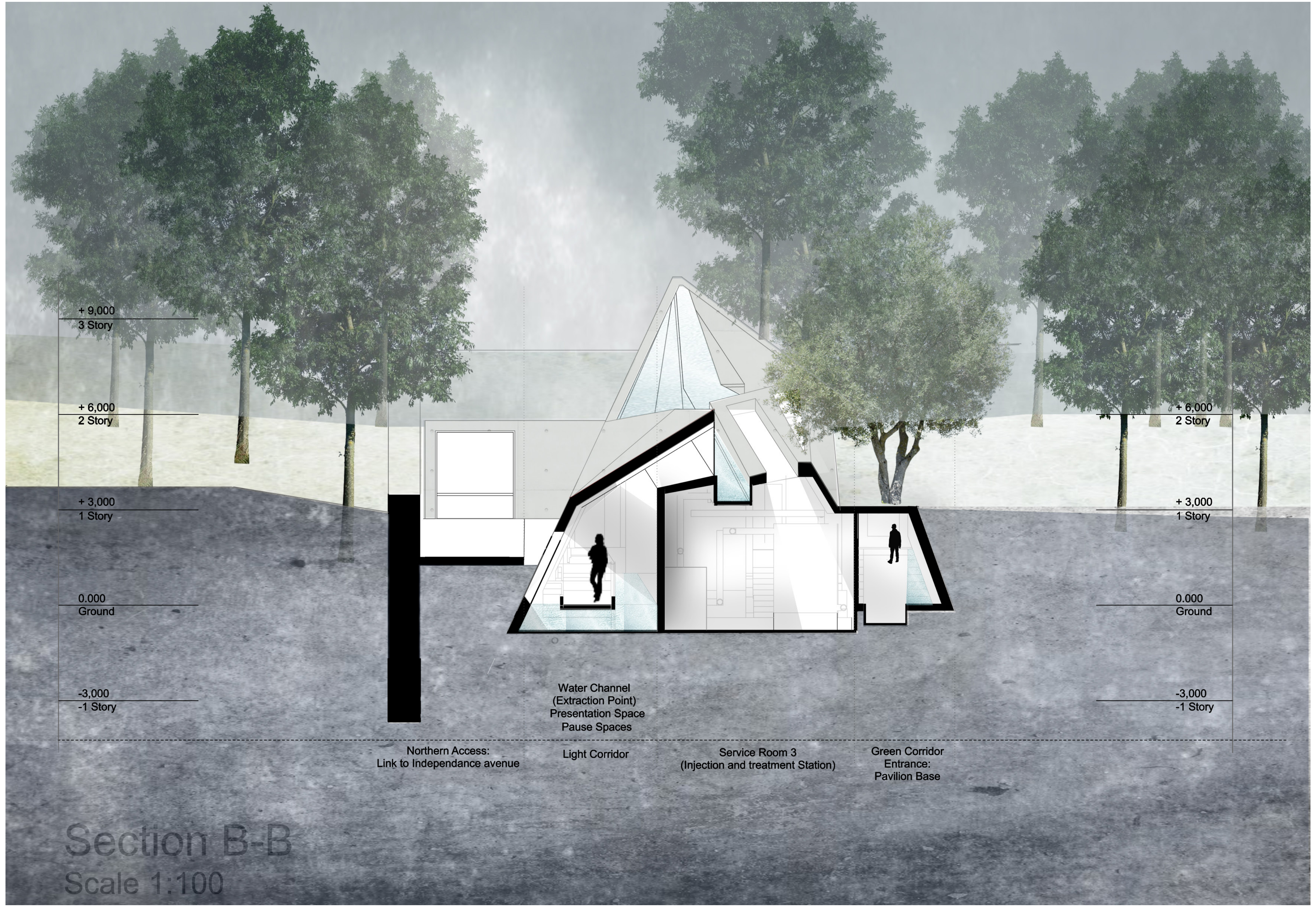
Section E-E
Scale 1:100



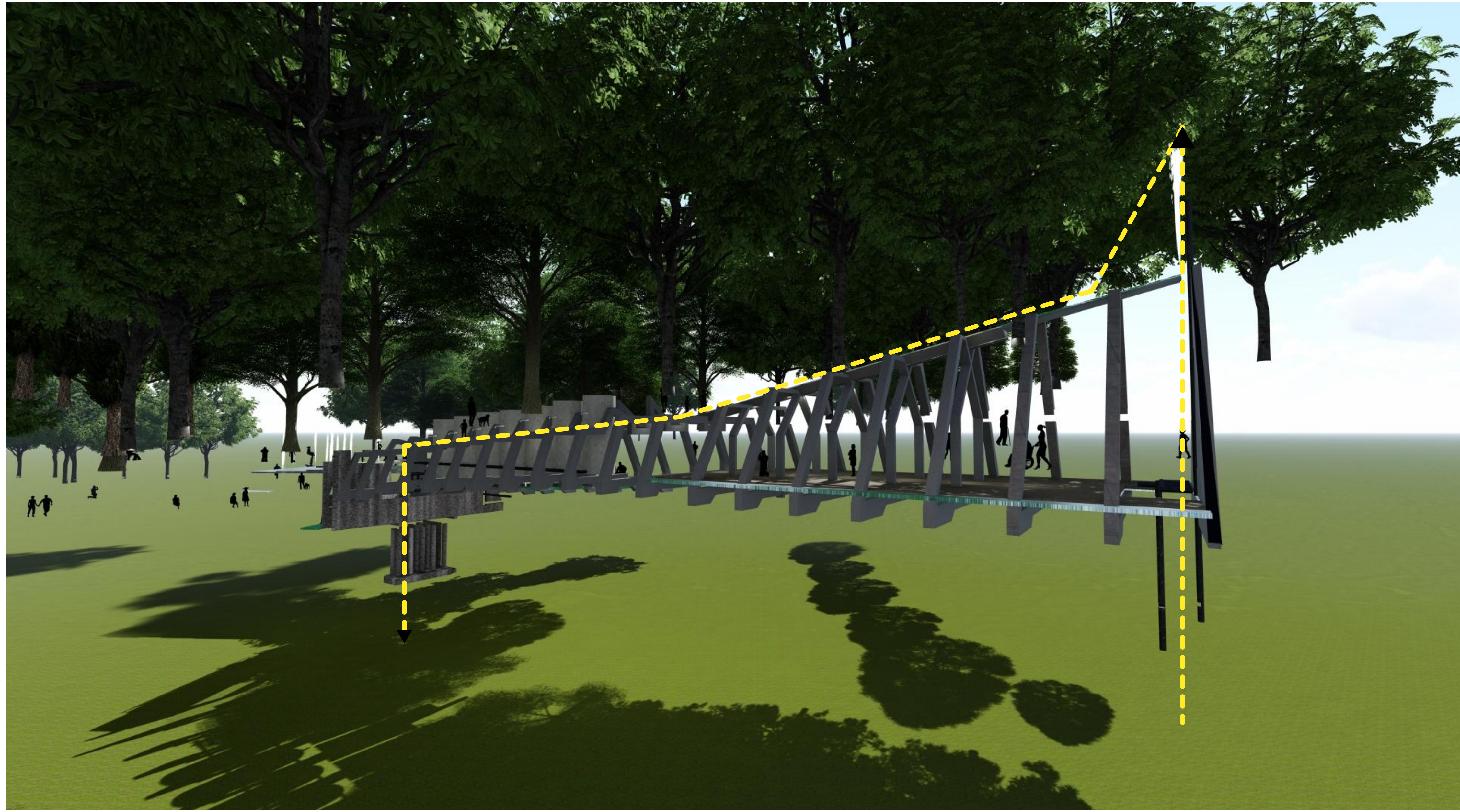


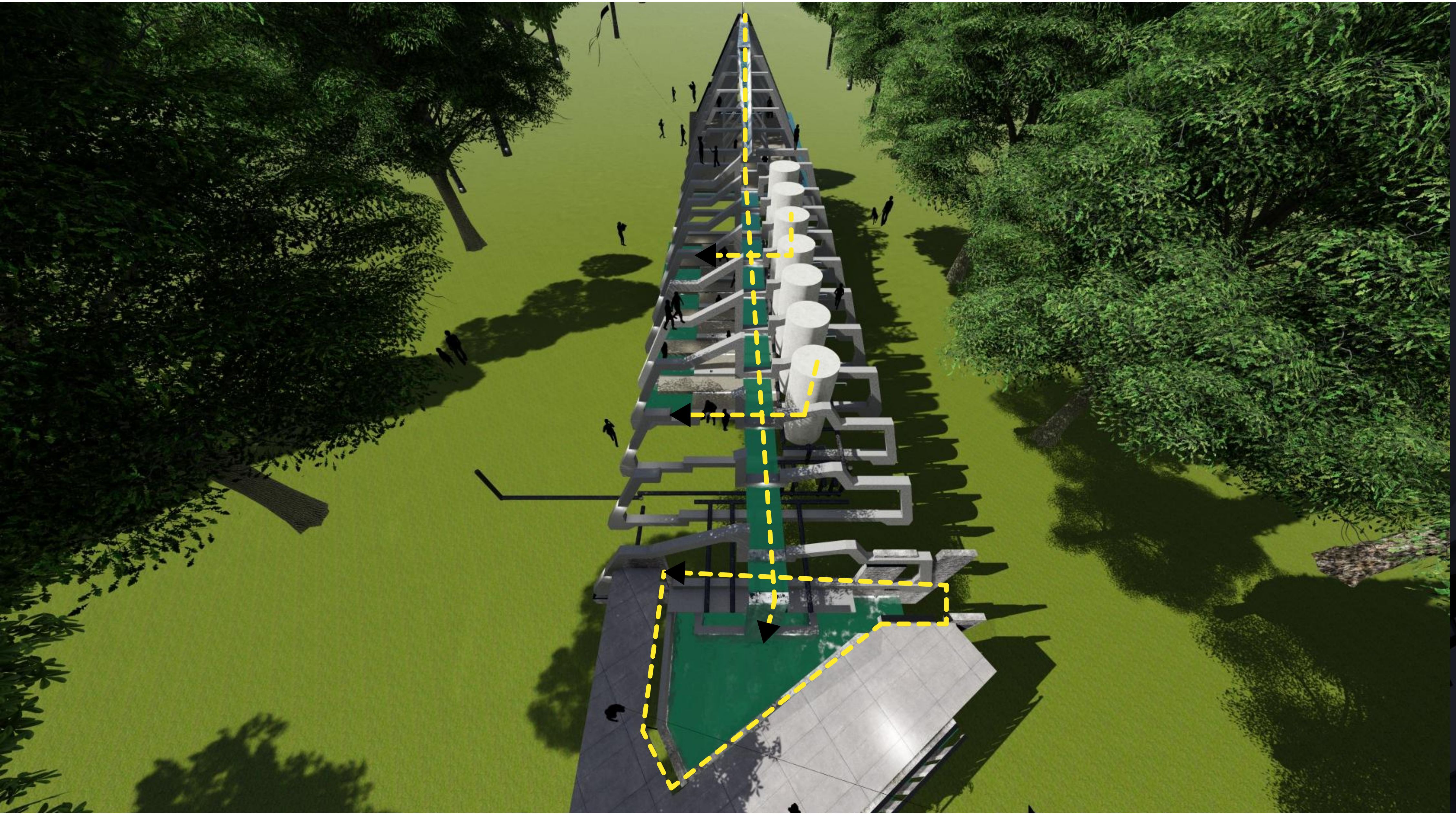


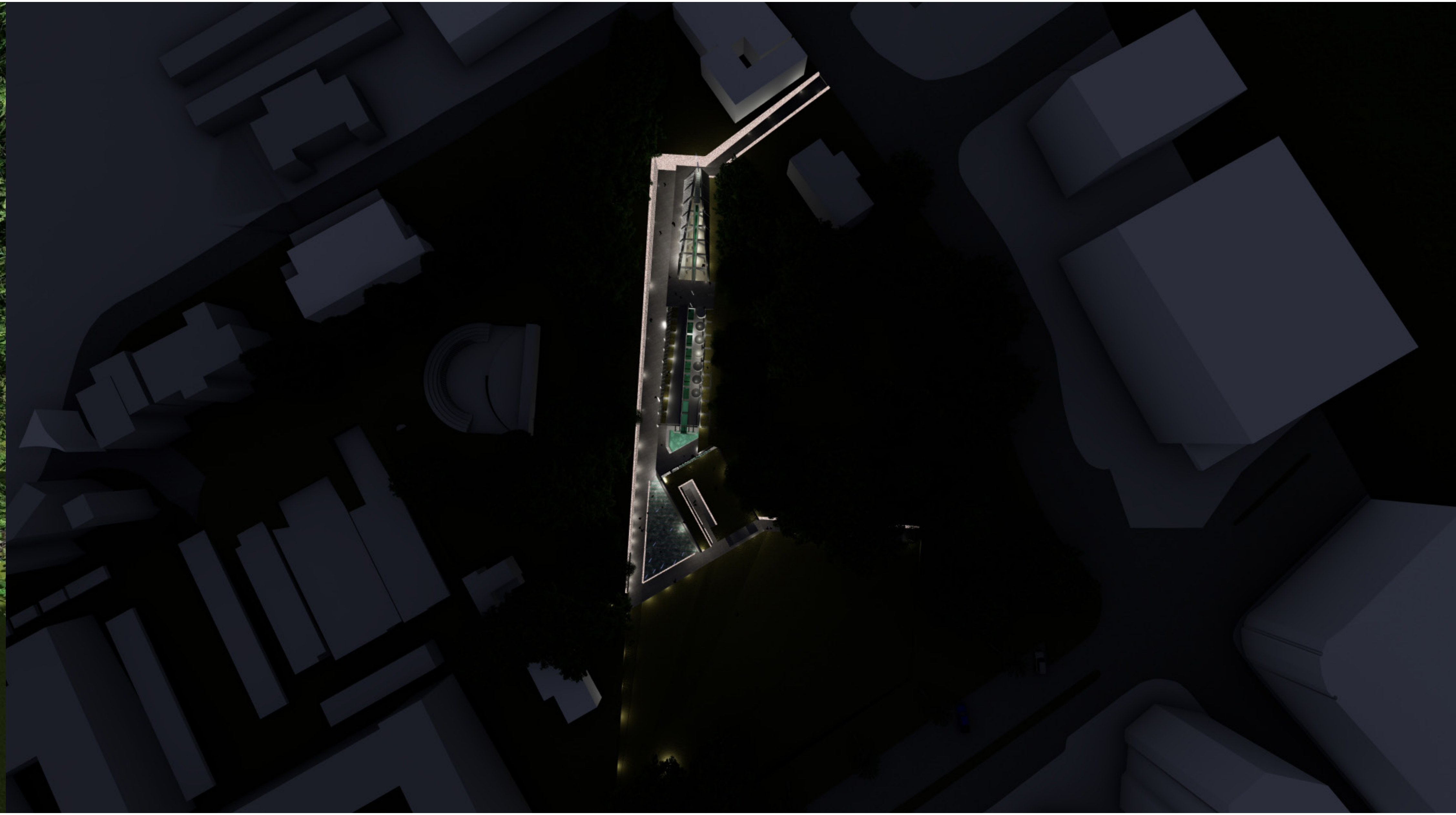
+ 9,000
3 Story
+ 6,000
2 Story
+ 3,000
1 Story
0.000
Ground
-3,000
-1 Story
Northern Access:
Link to Independance avenue
Male Ablution
Rampd to rooftop seating
Cafe and Ablutions: Public access
Cafe Kitchen
Water Feature:
Threshold
Water Feature:
Threshold
Service Room 4
(Injection Well)
Service Room 3
(Injection and treatment Station)
Service Room 2
(Water Quality Testing Station)
Service Room 1
(Caretakers Office)
Spring Fountain Pavilion
Spring Fountain Pavilion:
Entrance Ramp
Dry Well
Spring Fountain Pavilion:
Entrance Ramp

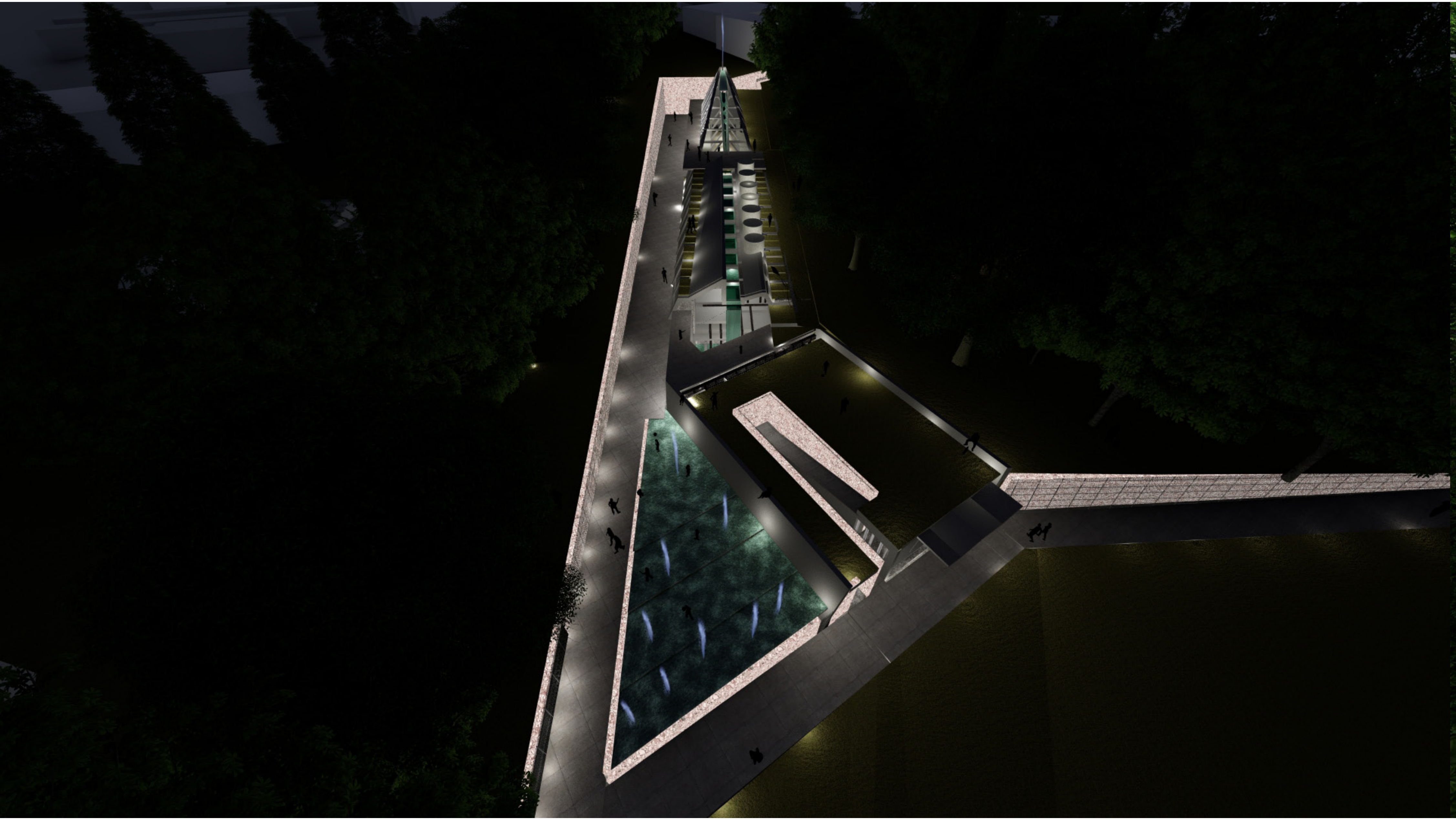


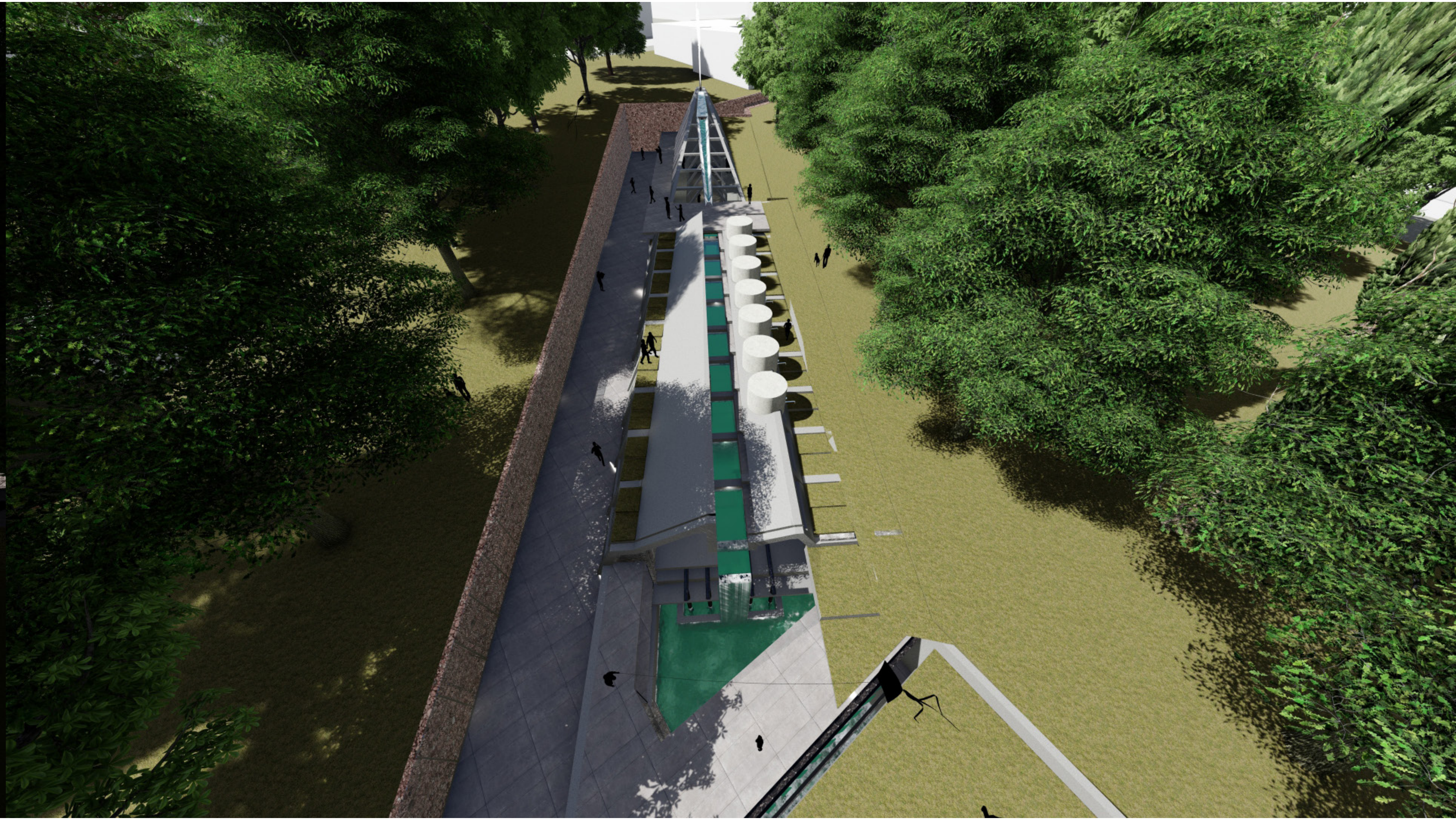
+ 9,000
3 Story
+ 6,000
2 Story
+ 3,000
1 Story
0.000
Ground
-3,000
-1 Story
+ 6,000
2 Story
+ 3,000
1 Story
0.000
Ground
-3,000
-1 Story
Water Channel
(Extraction Point)
Presentation Space
Pause Spaces
Northern Access:
Link to Independance avenue
Light Corridor
Service Room 3
(Injection and treatment Station)
Green Corridor
Entrance:
Pavilion Base
Section B-B
Scale 1:100

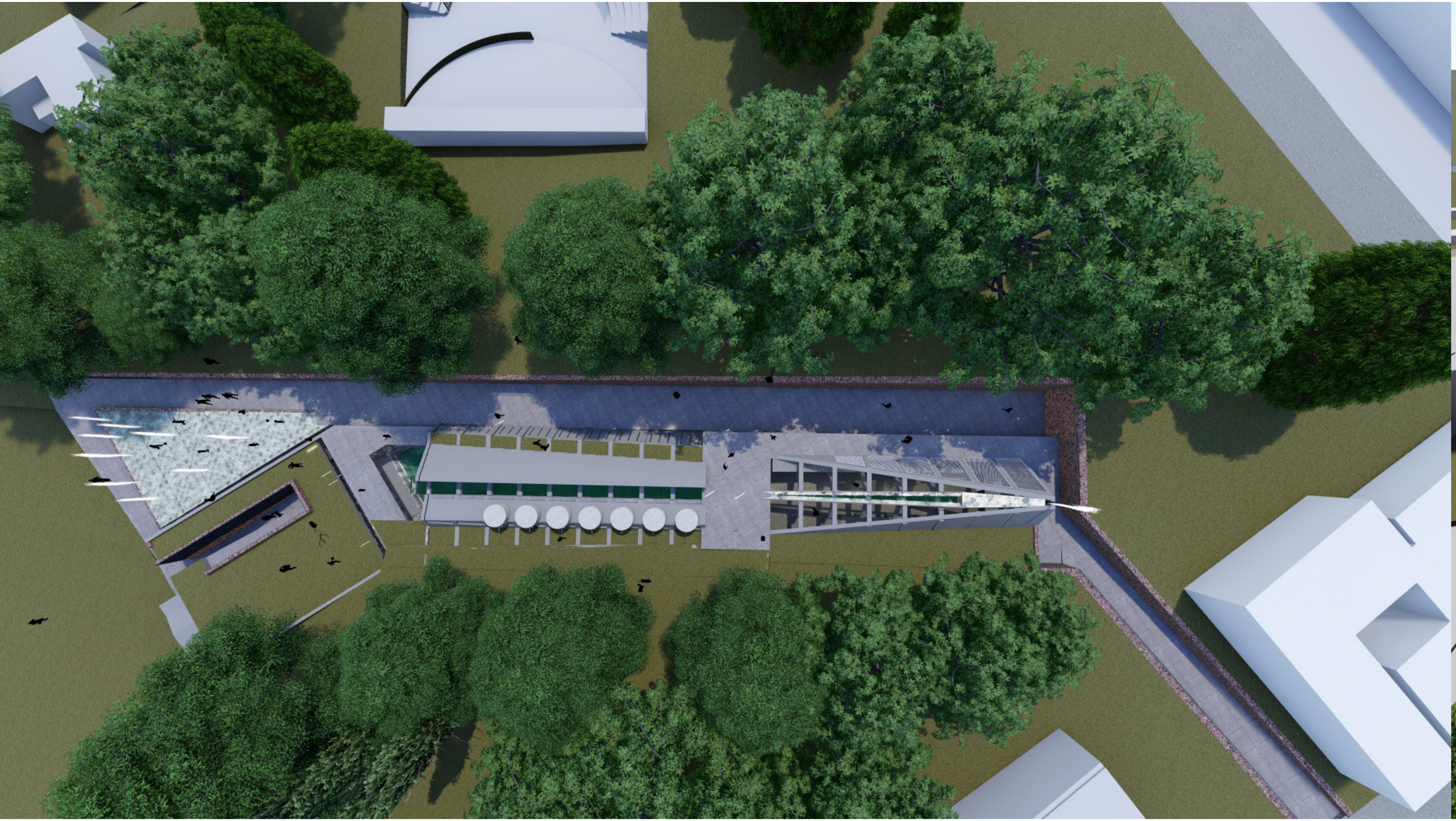


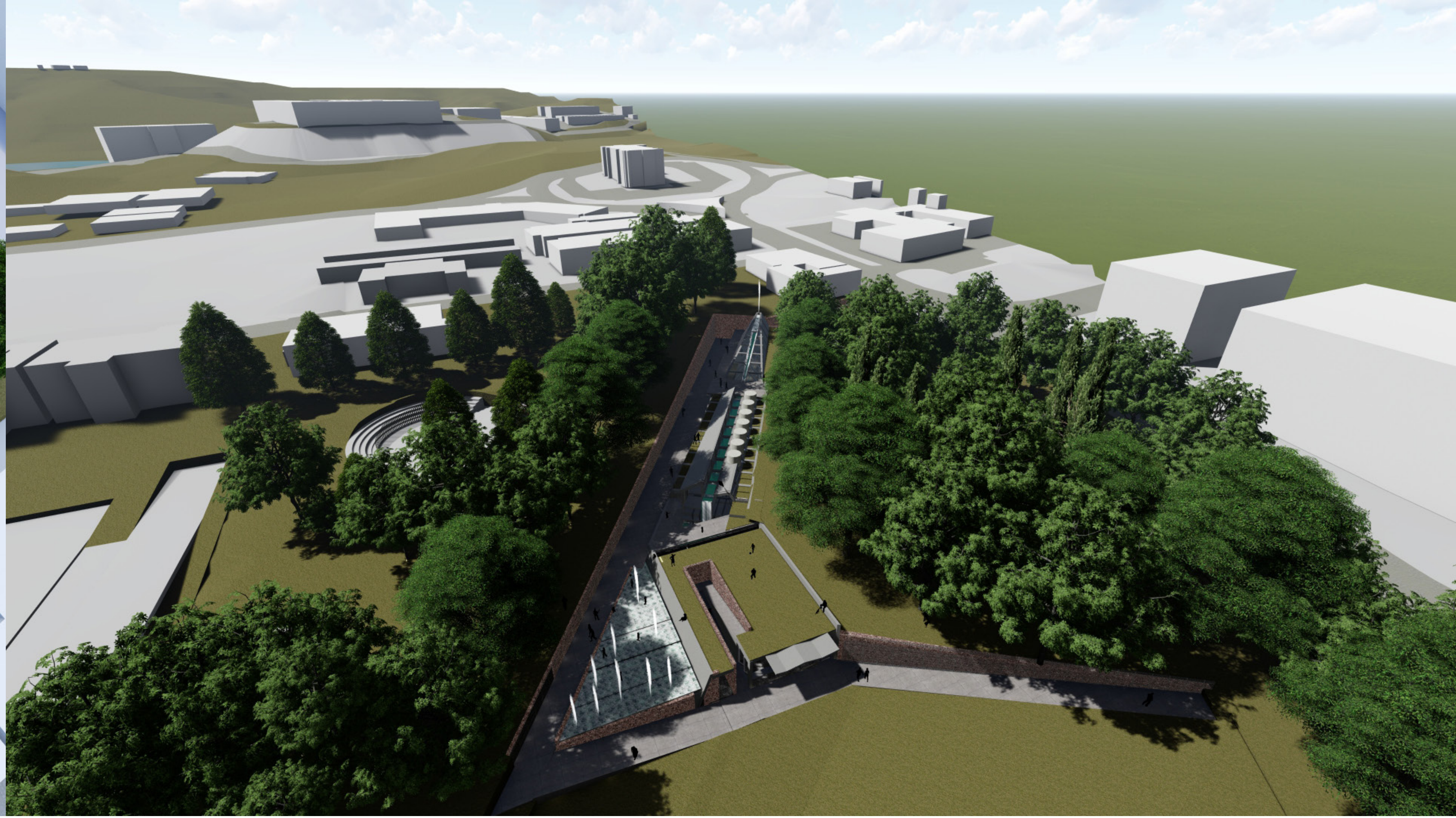


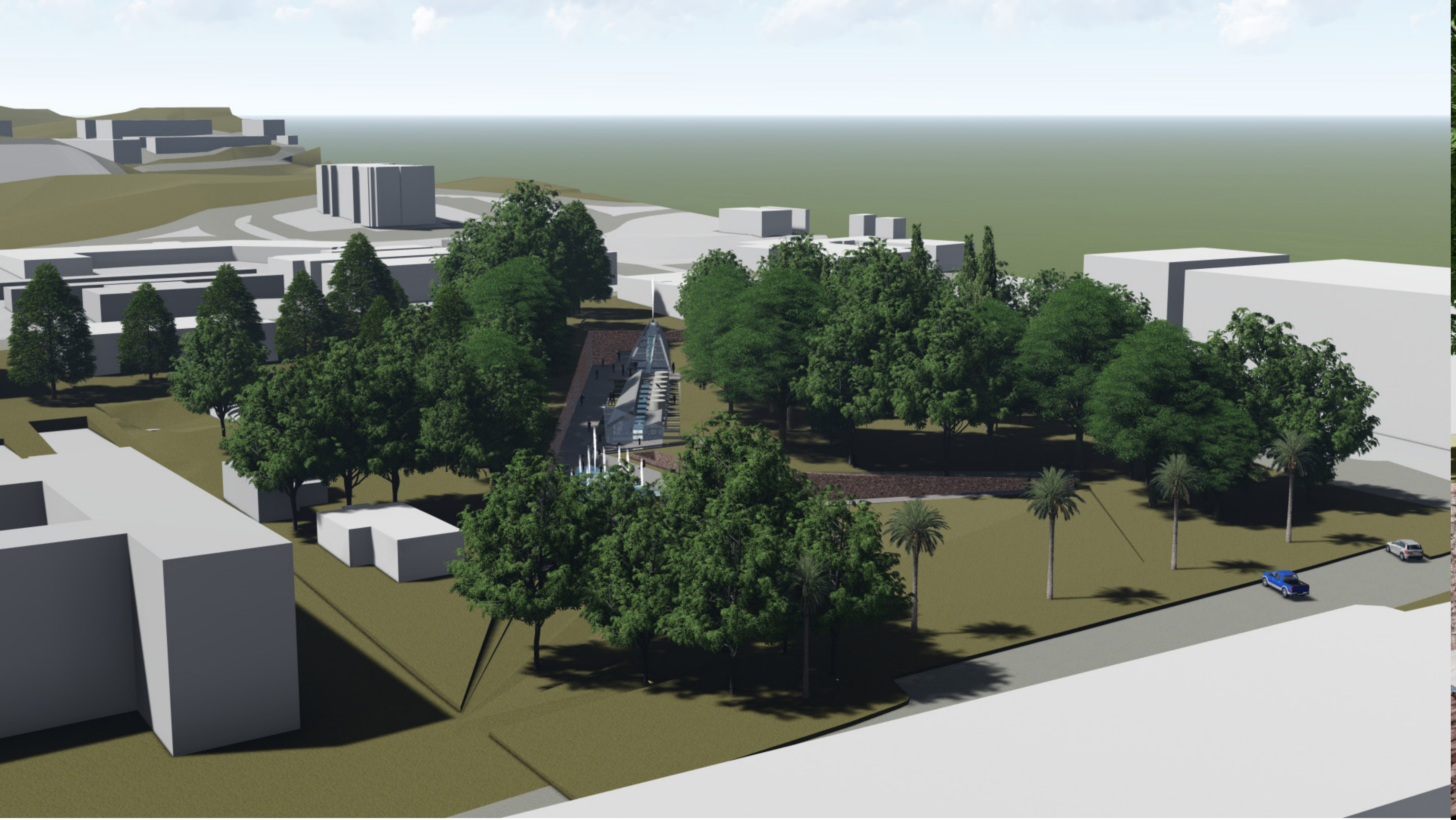


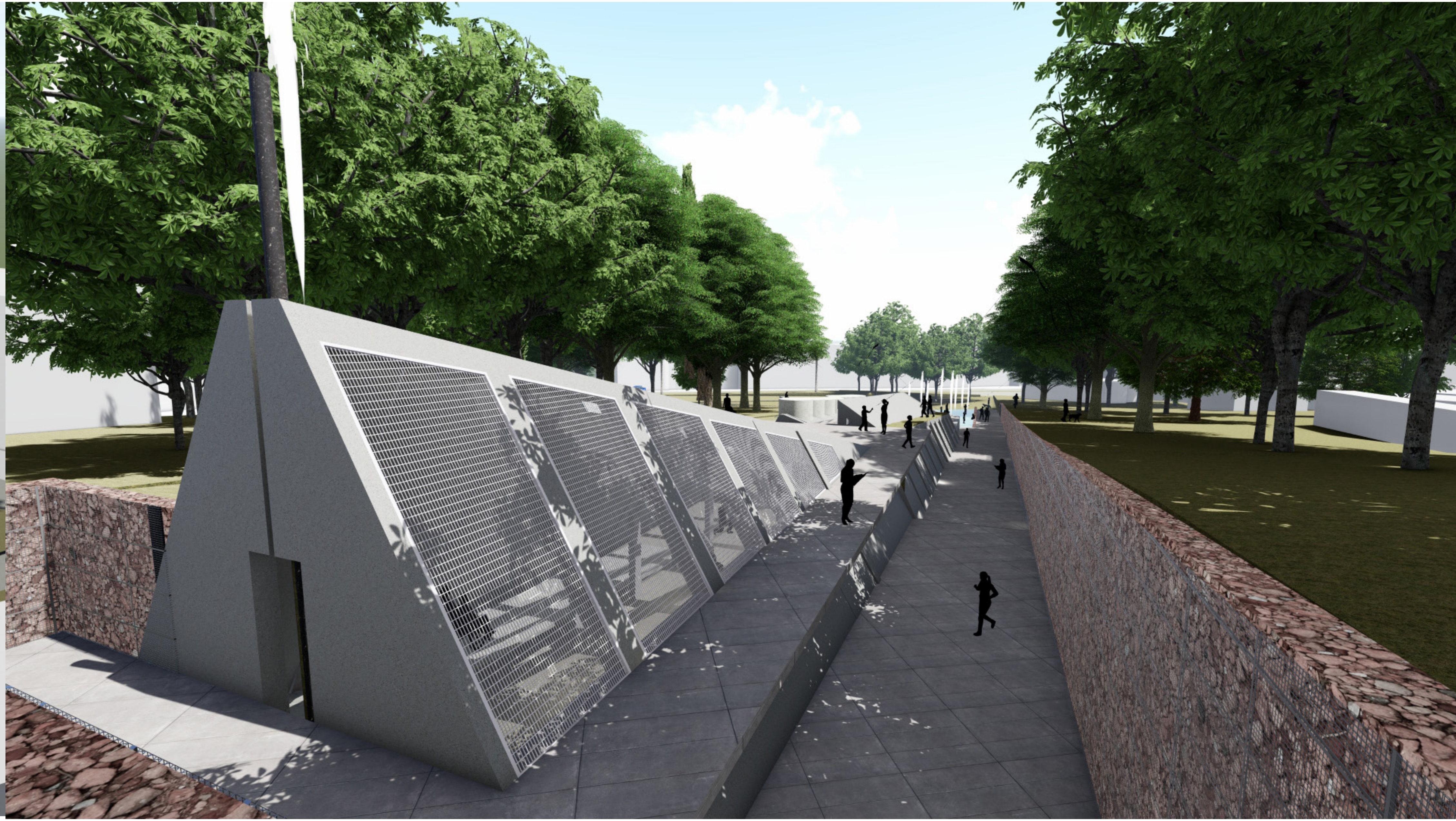


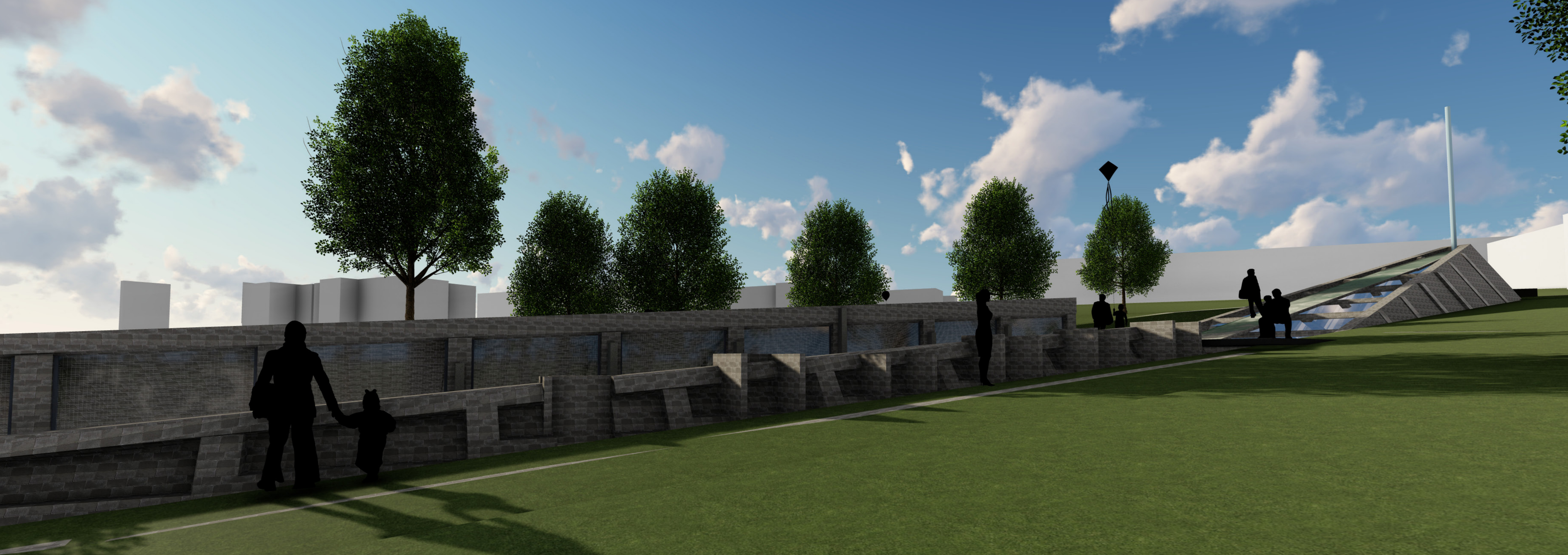


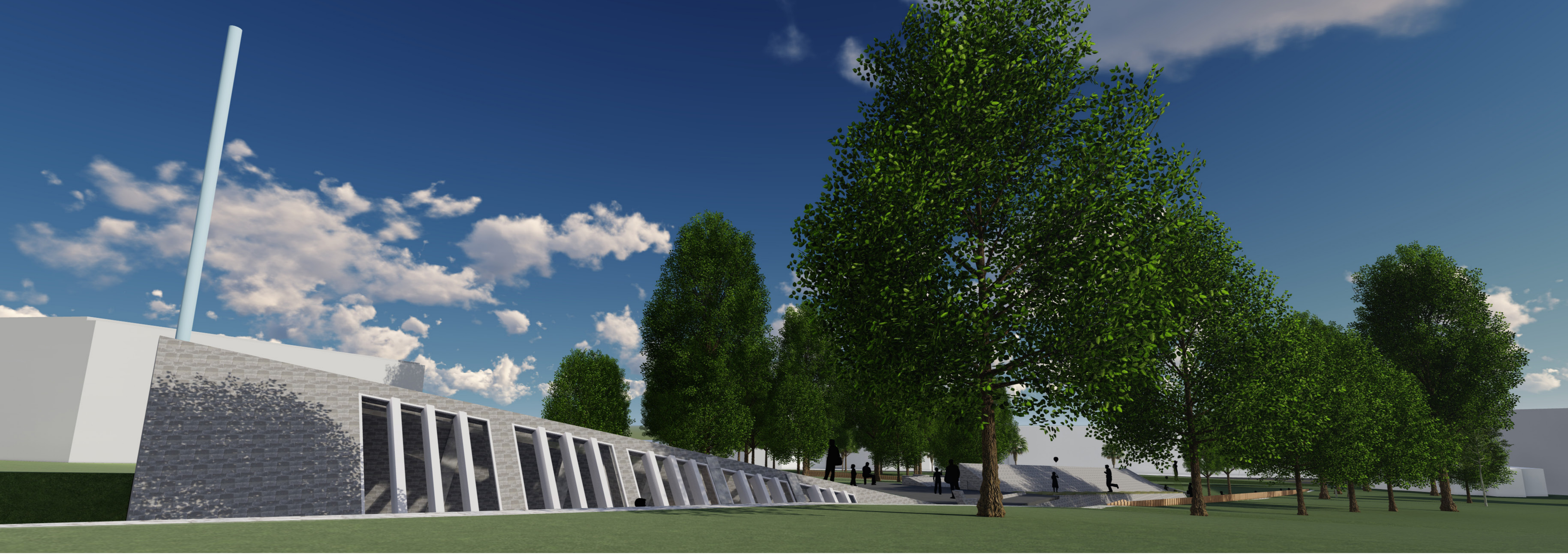


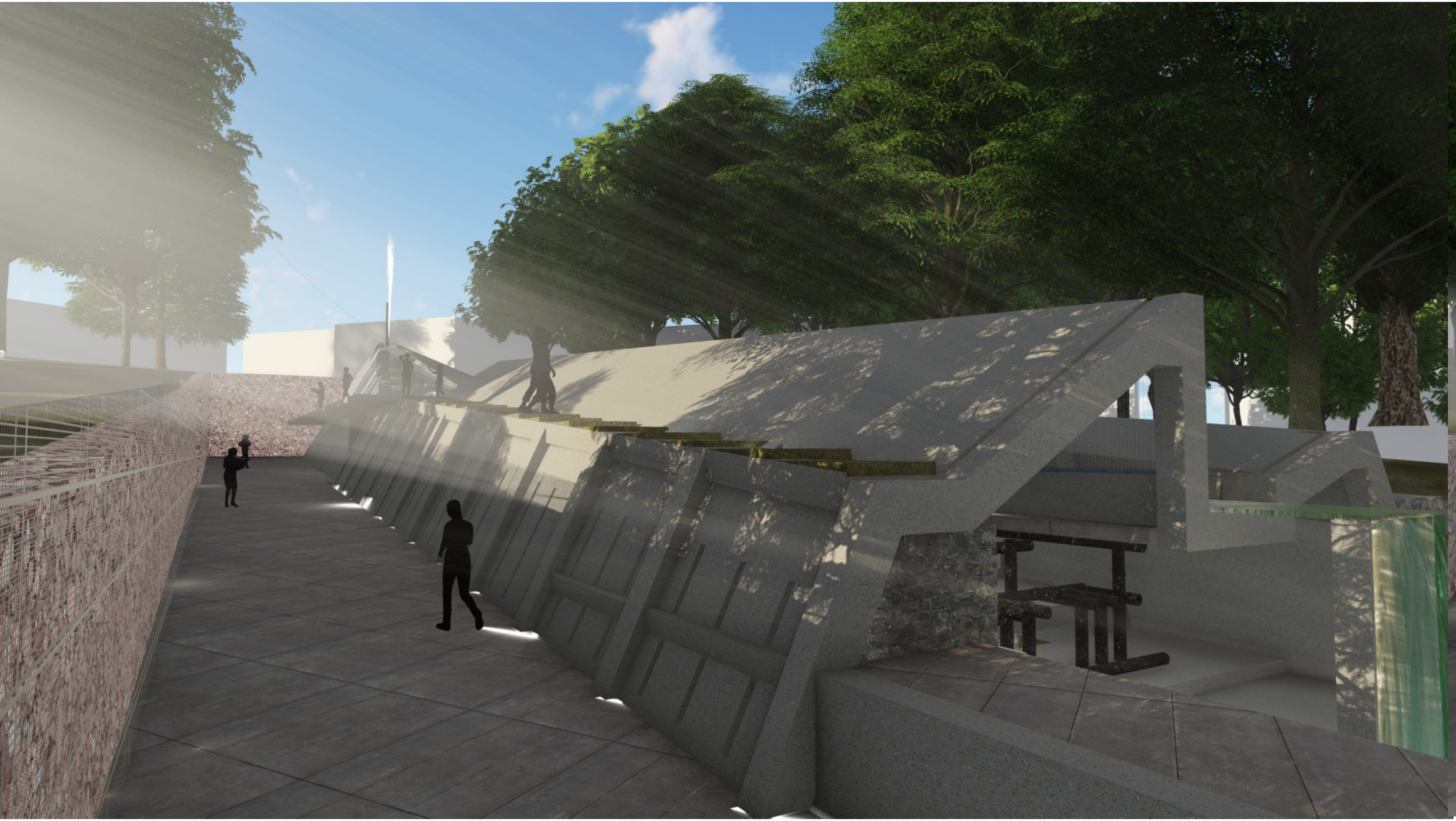


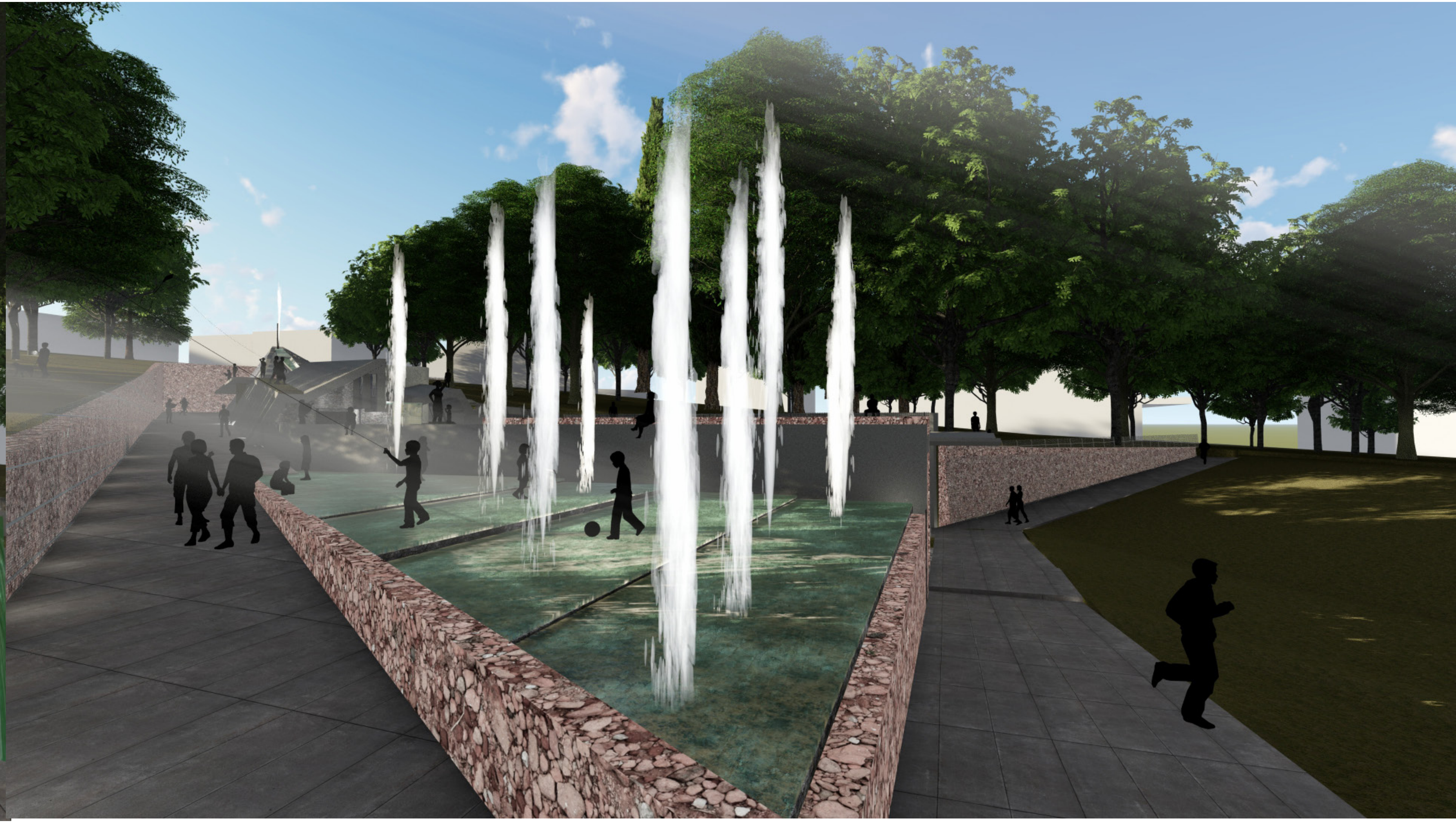


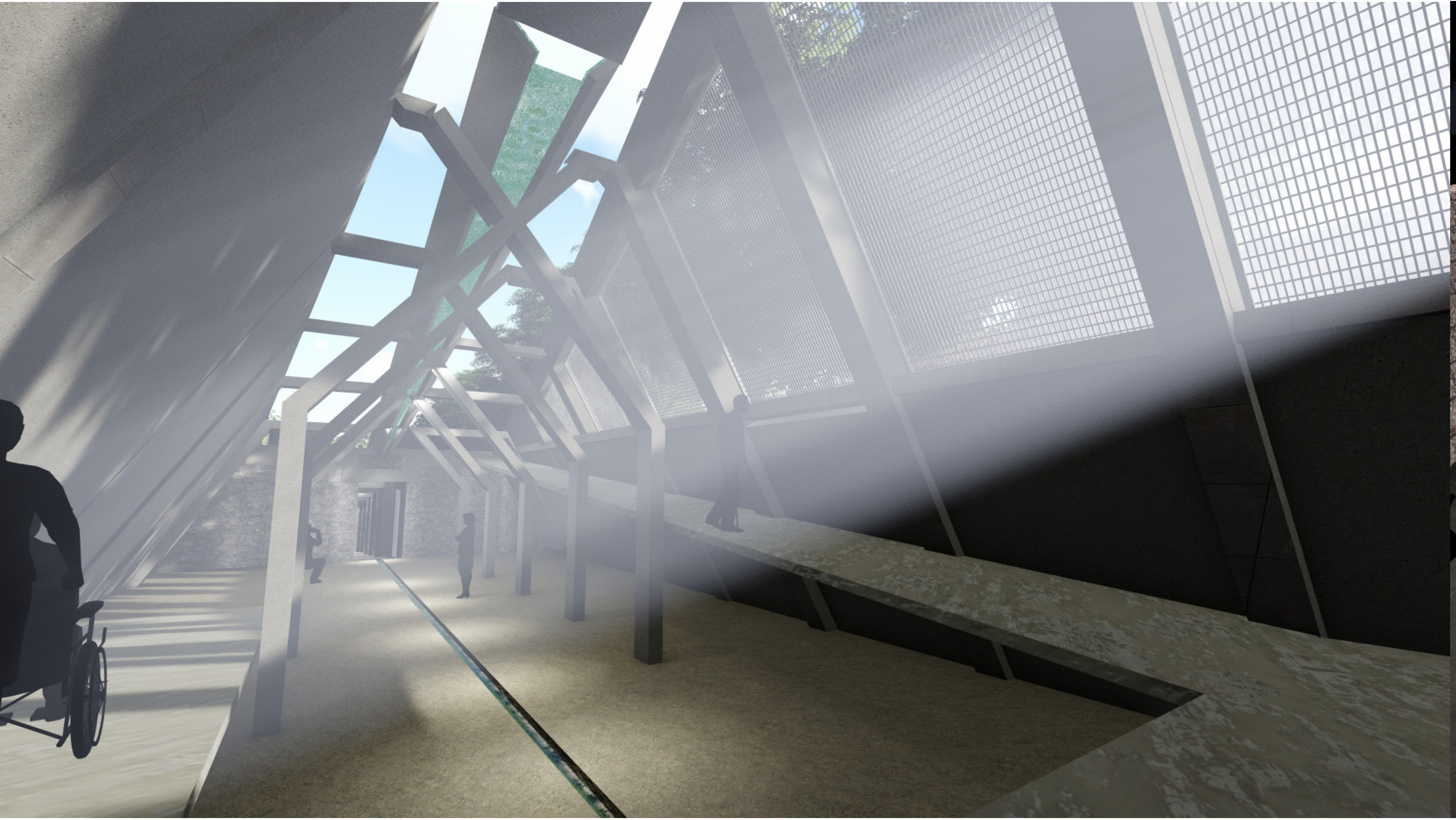


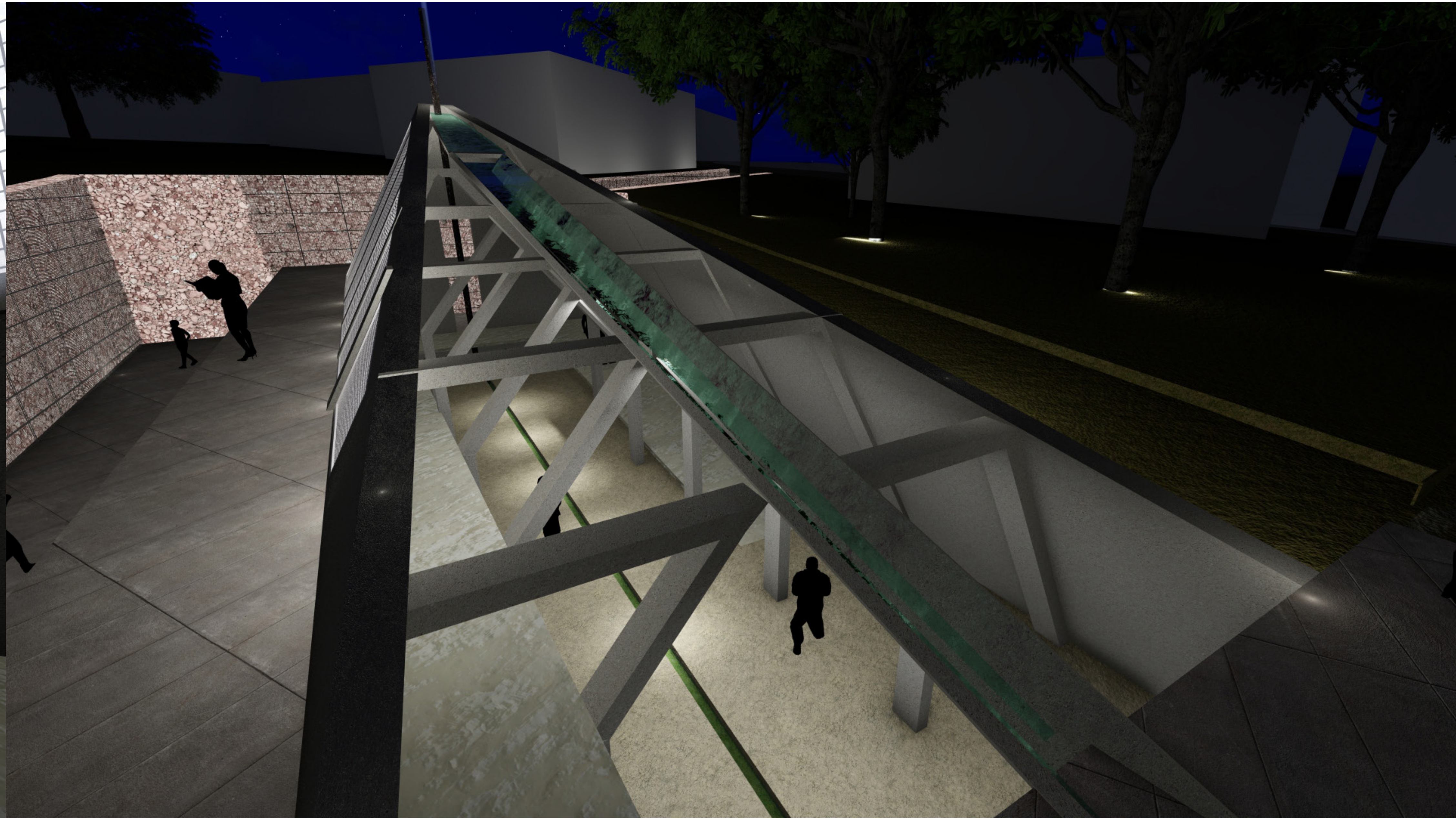


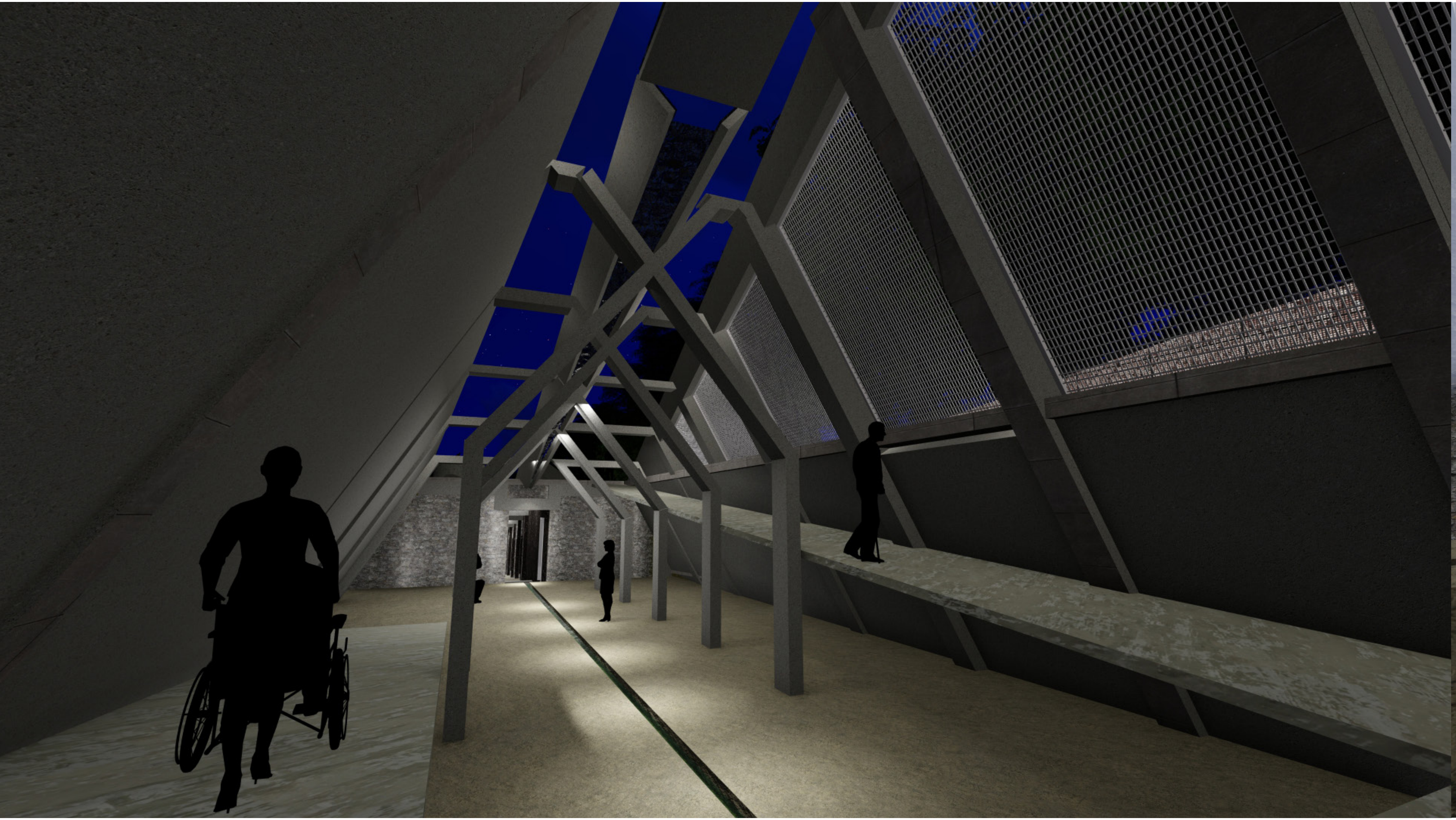


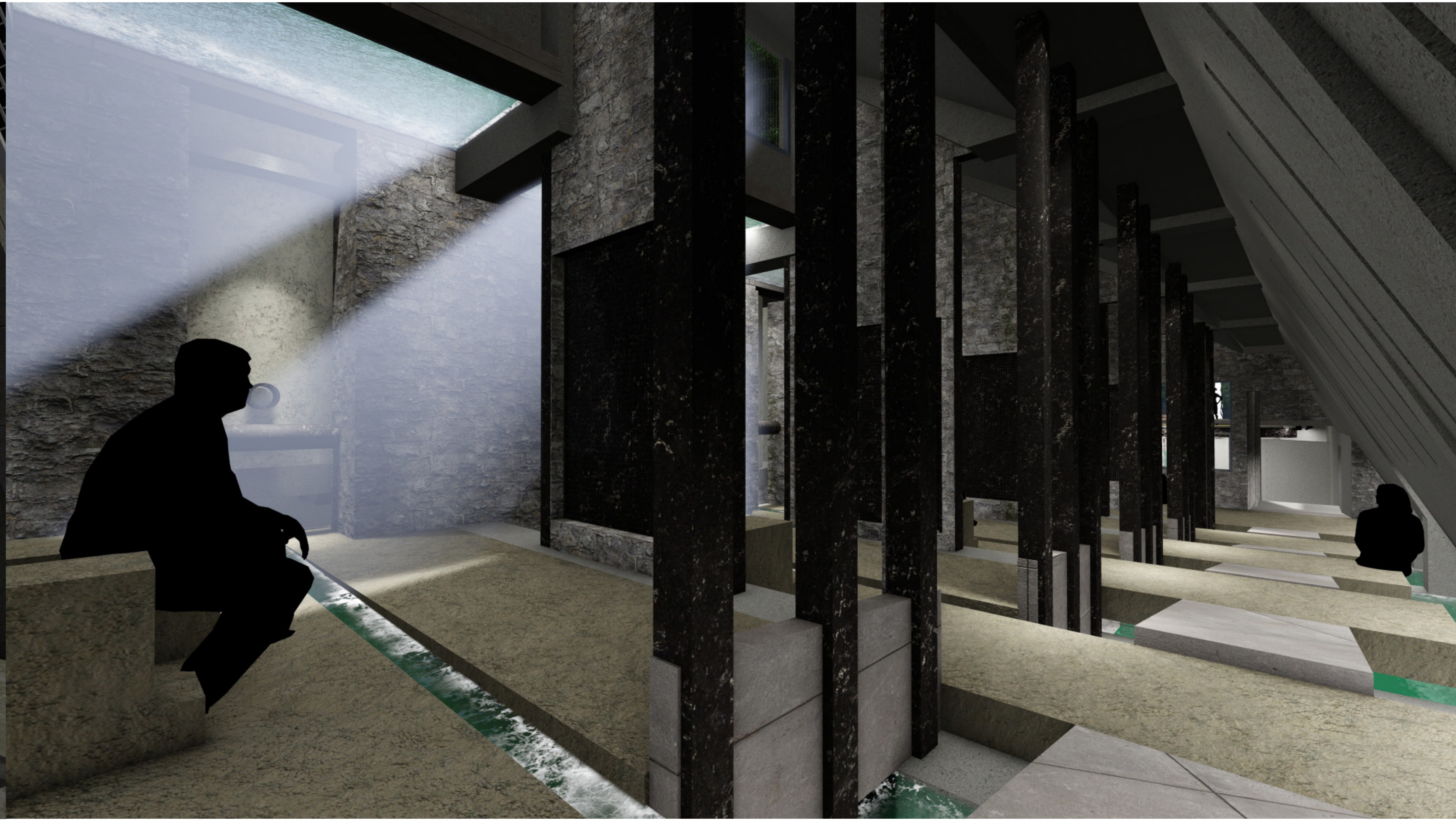


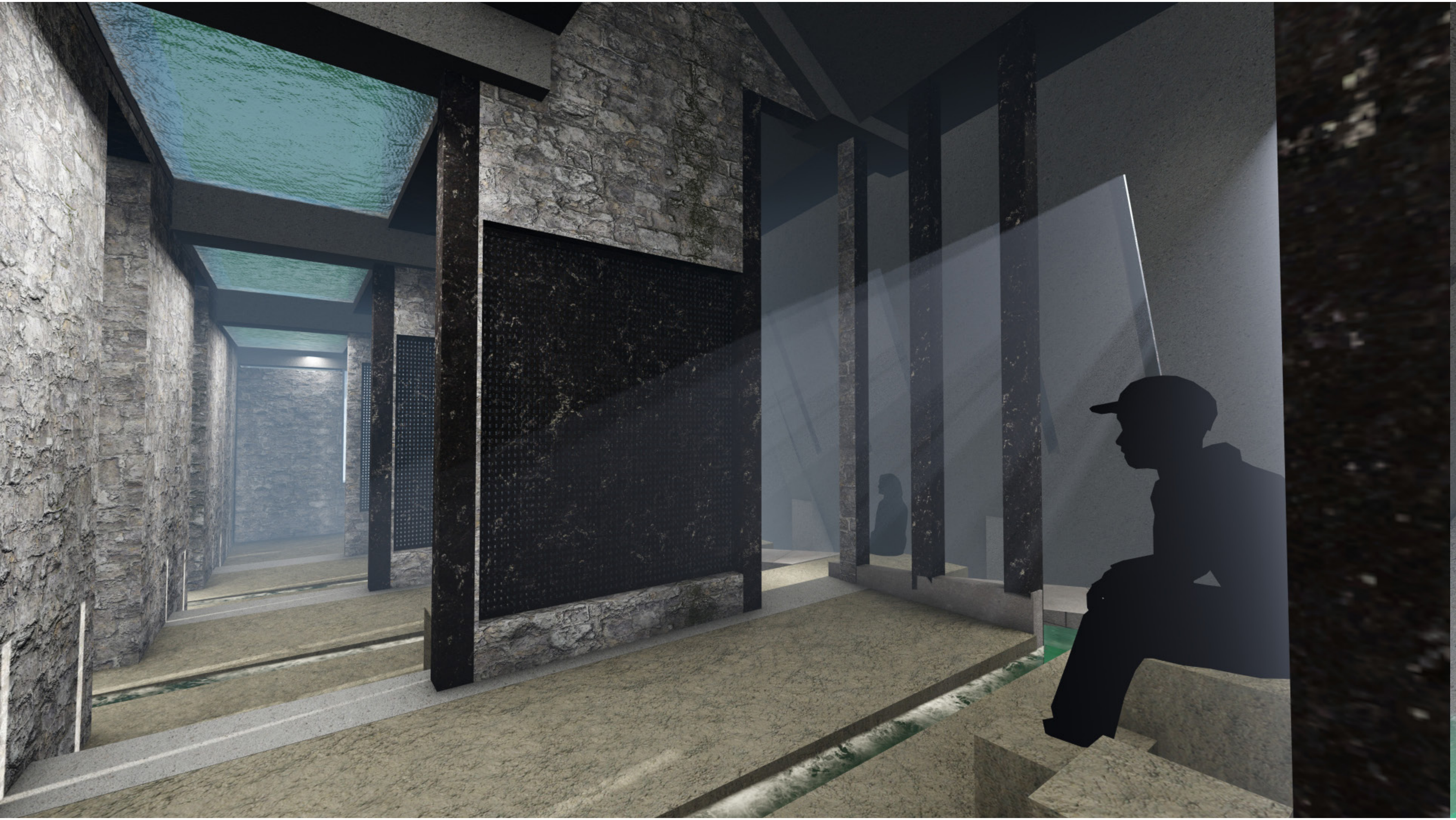


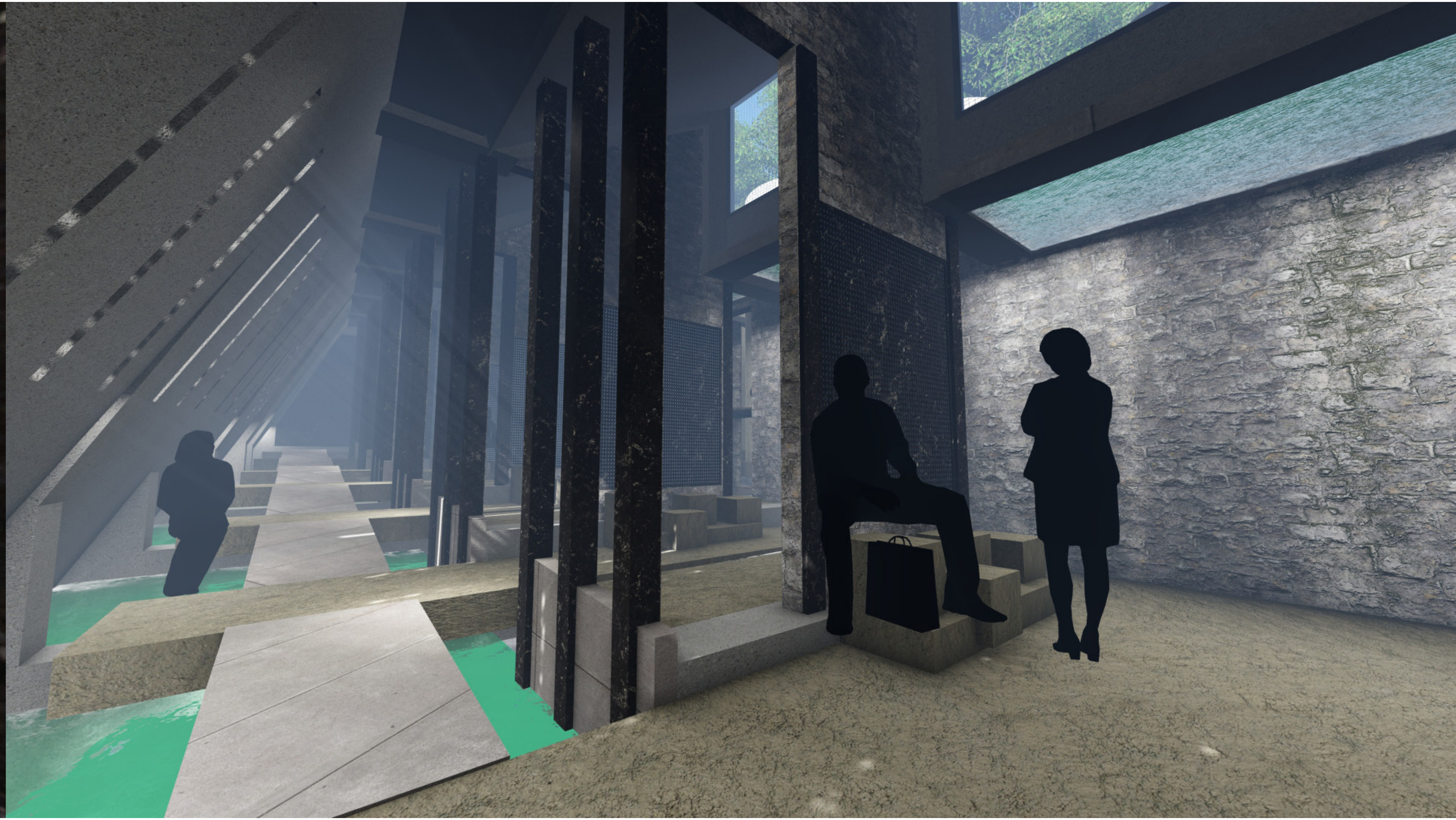


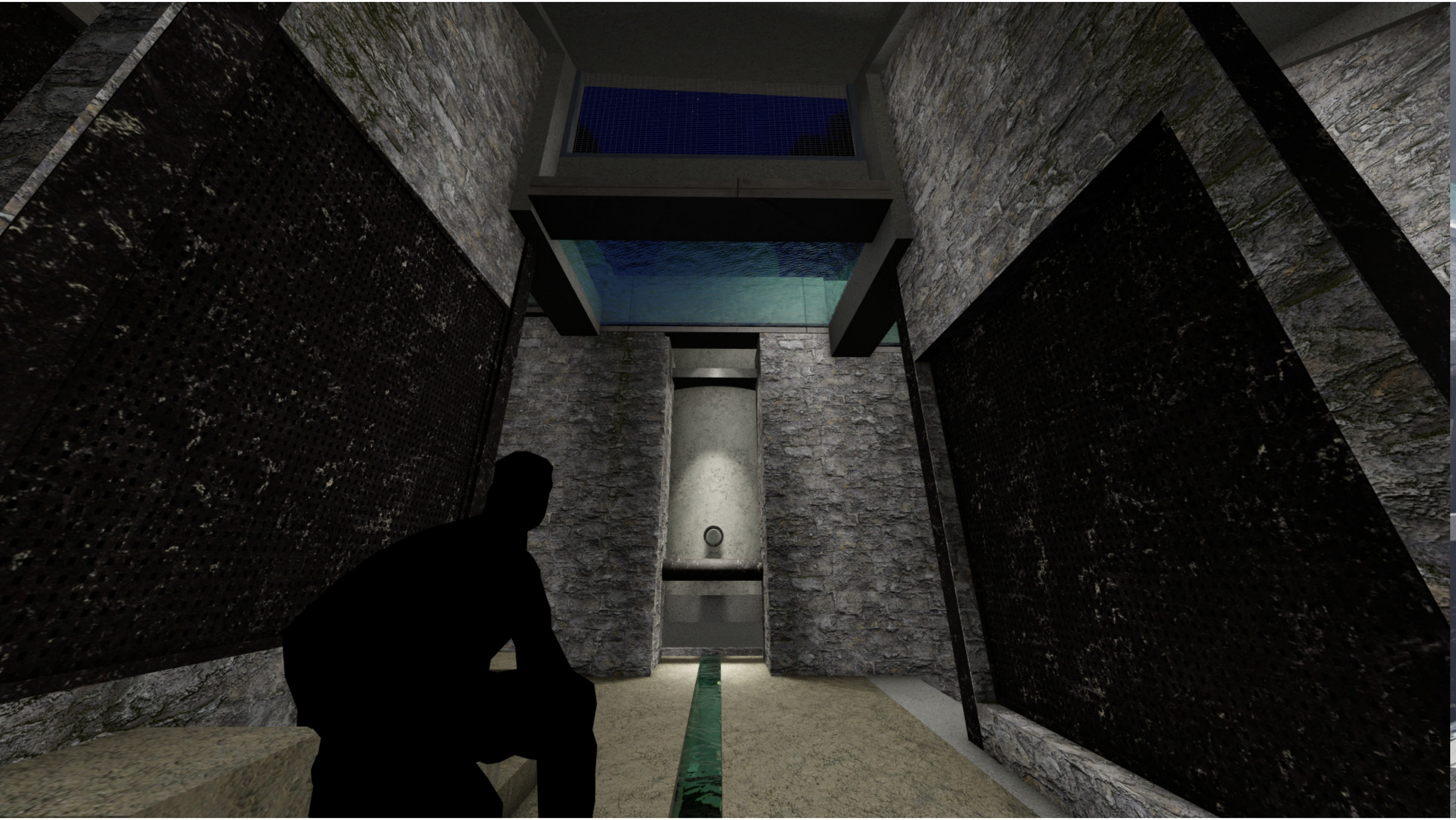


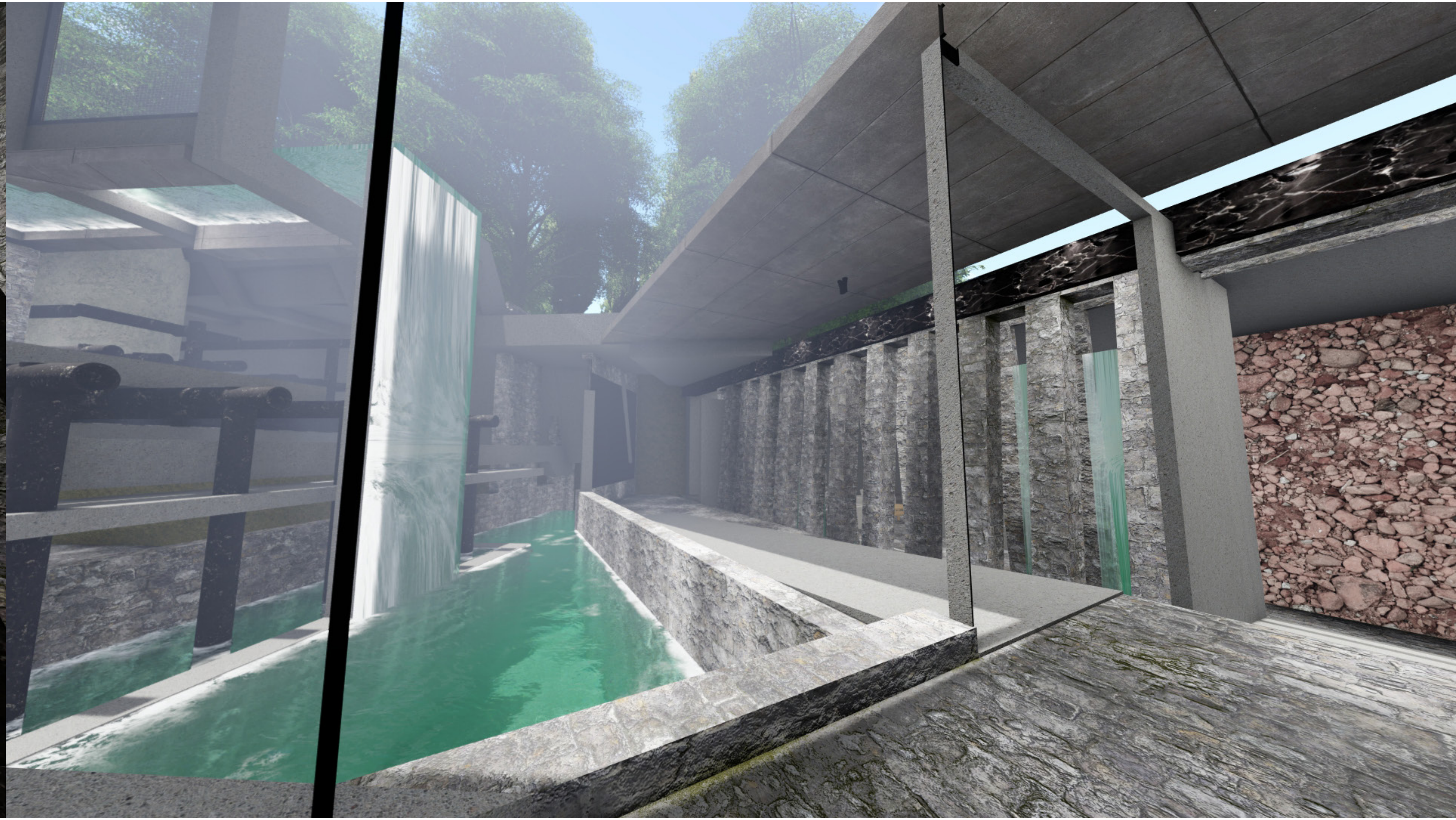


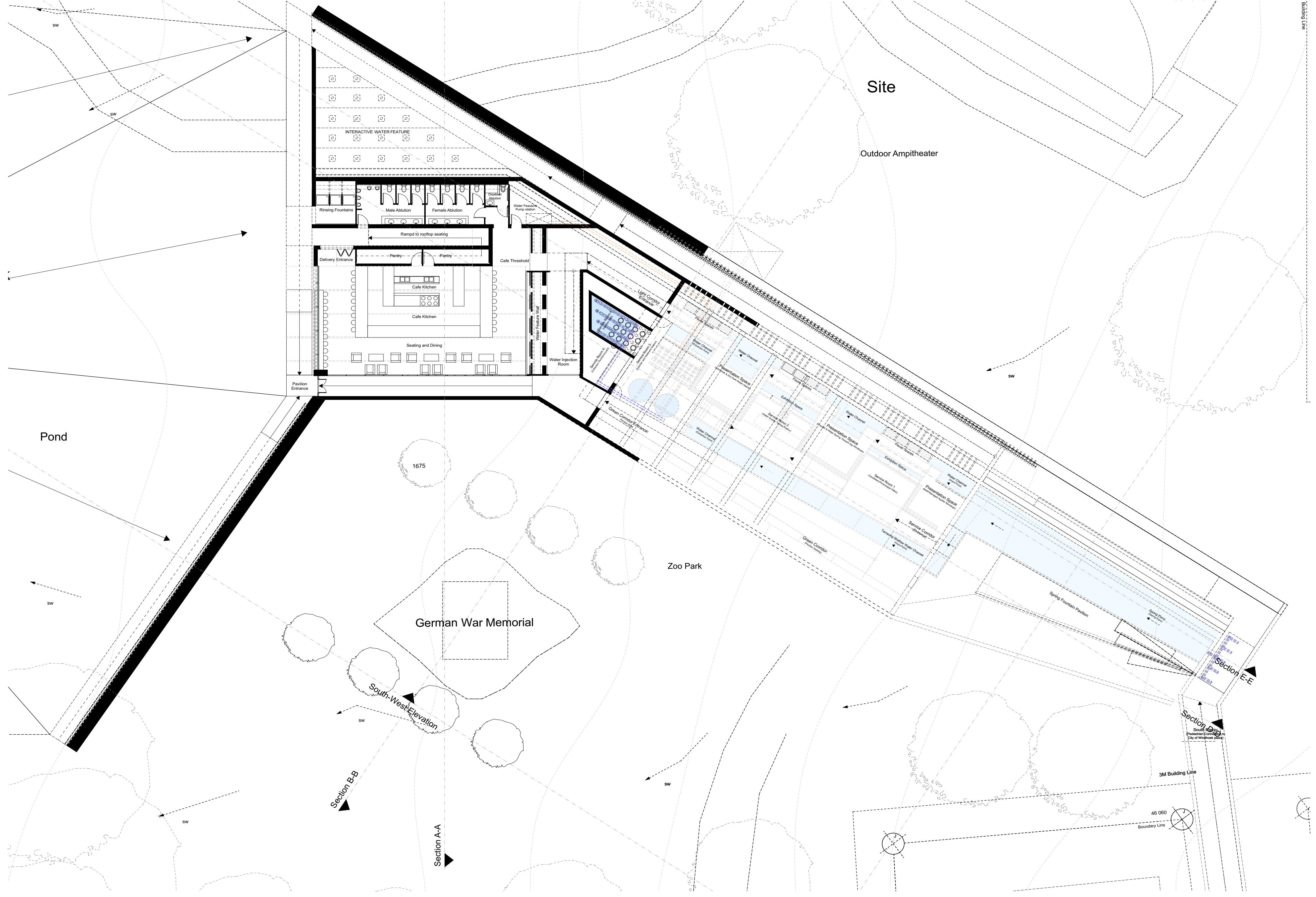




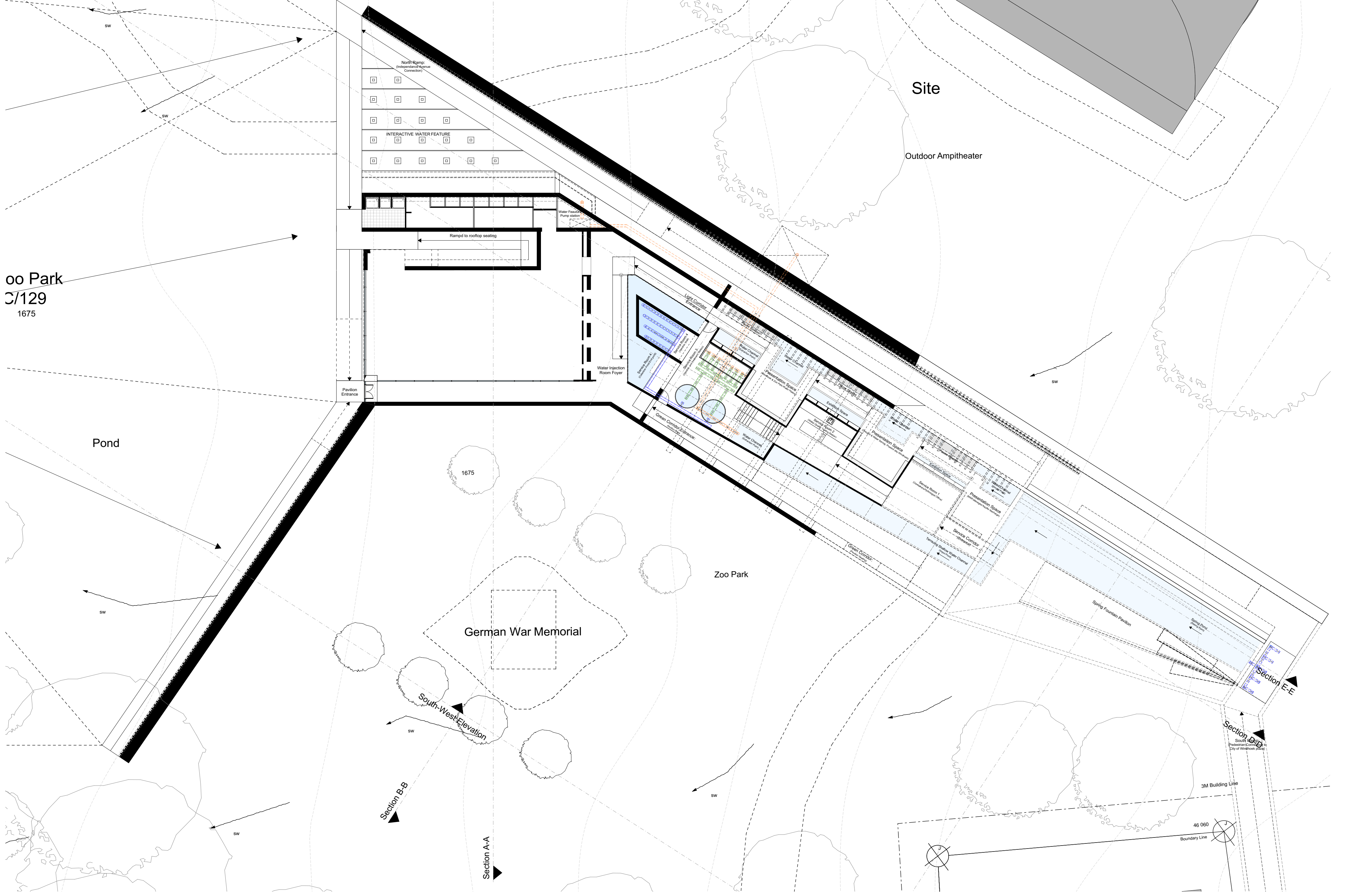




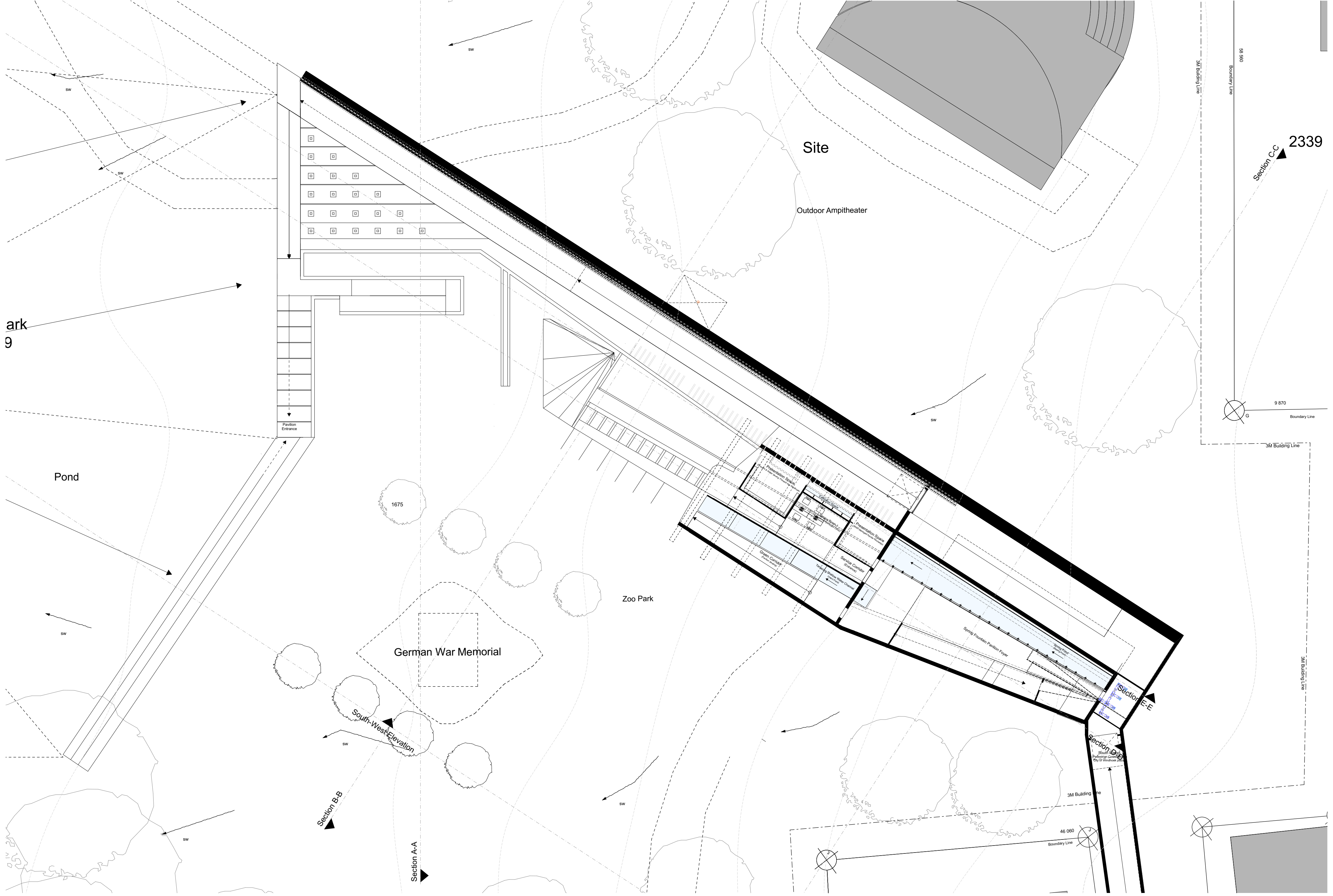




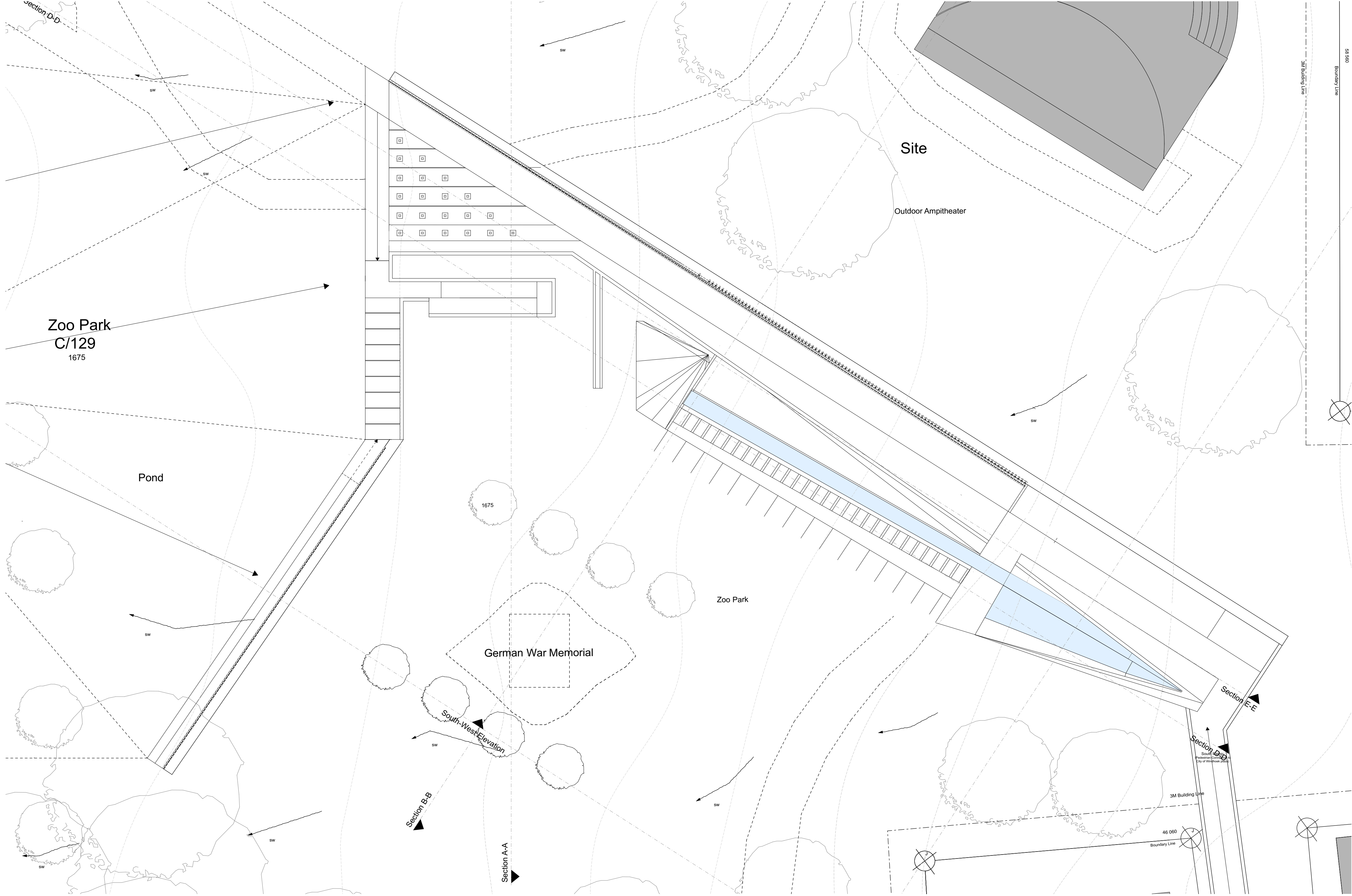
Ground -1 Floor Plan
Scale 1:100



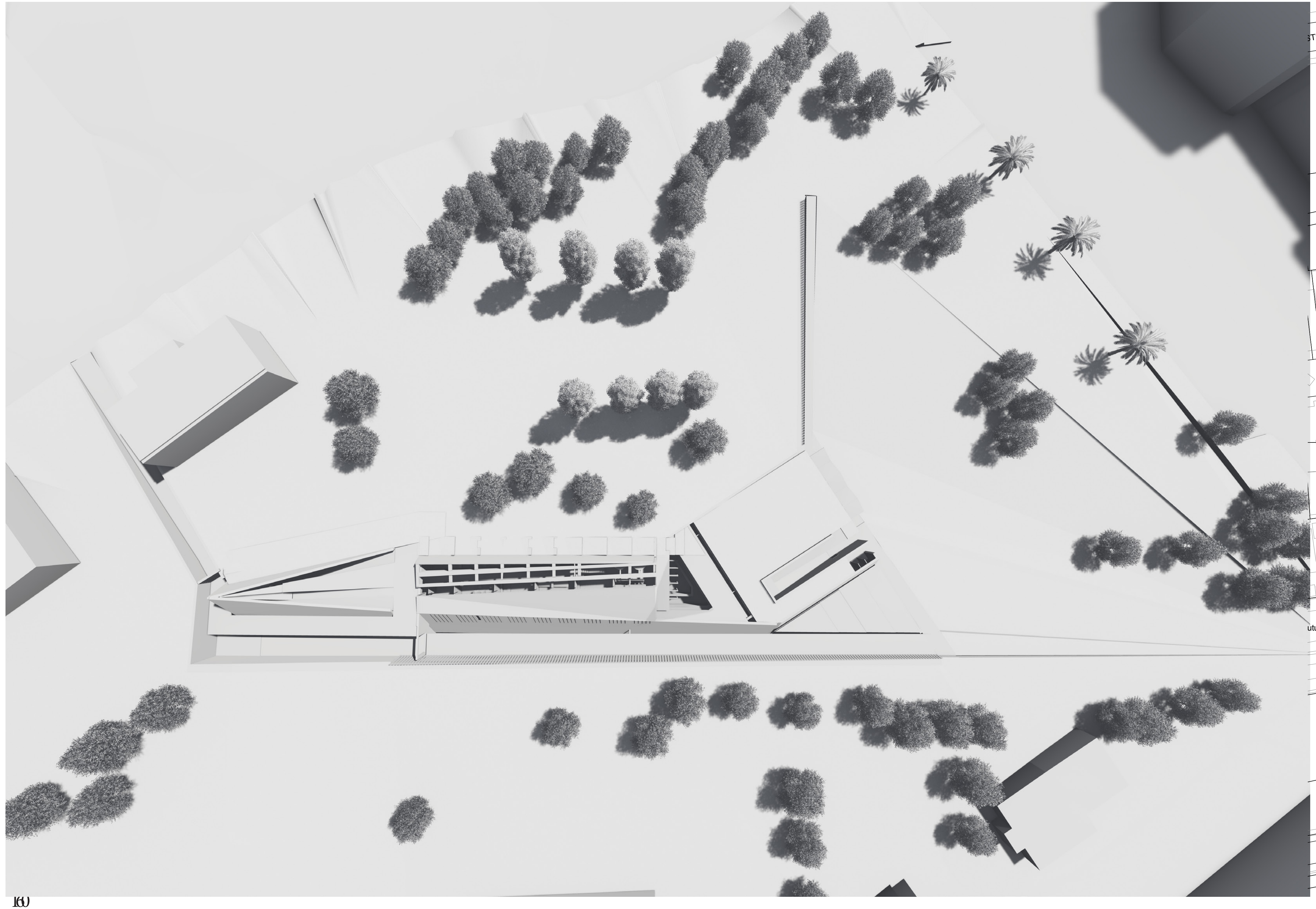
und Floor Plan
le 1:100

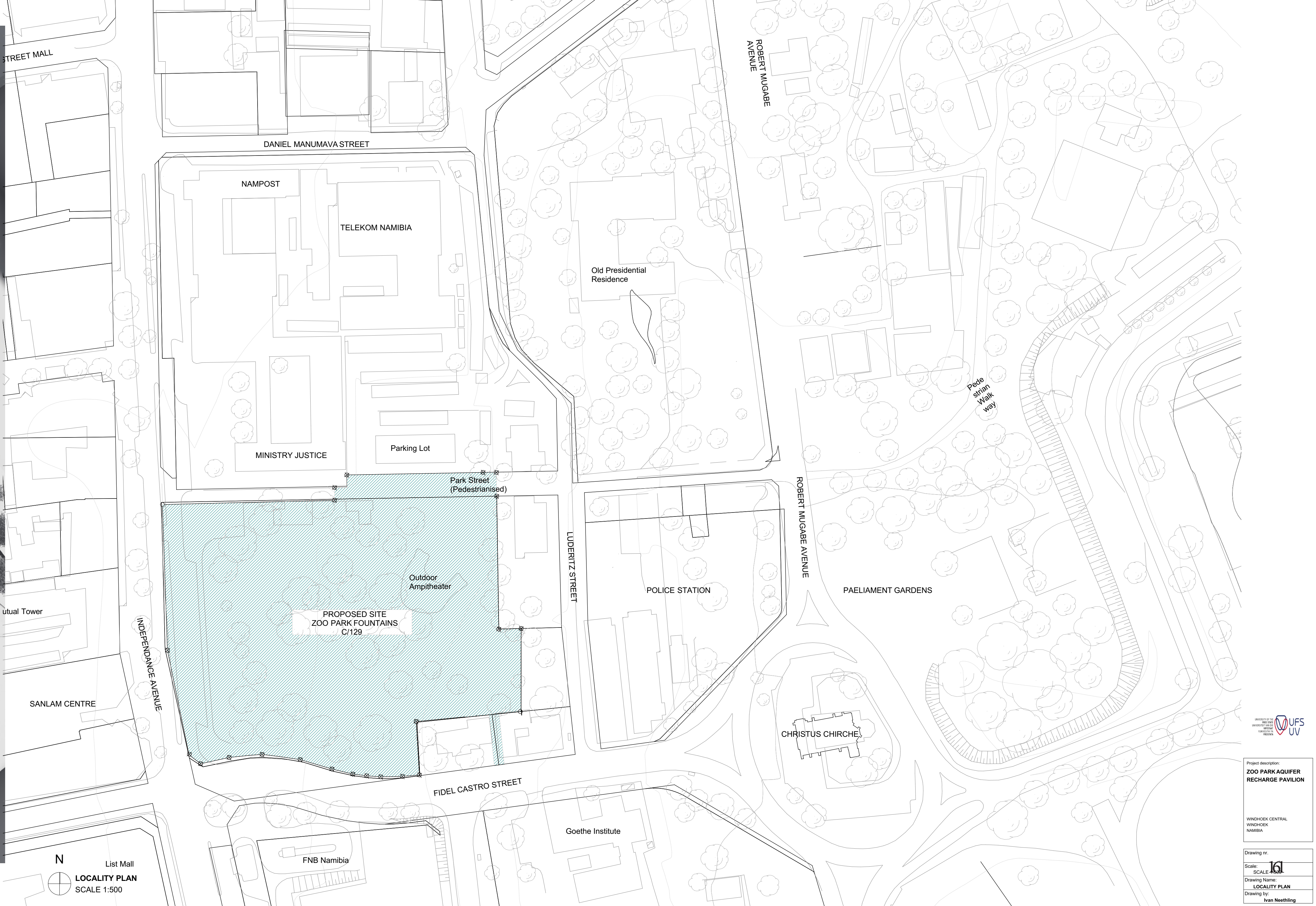


Ground +1 Floor Plan
Scale 1:100

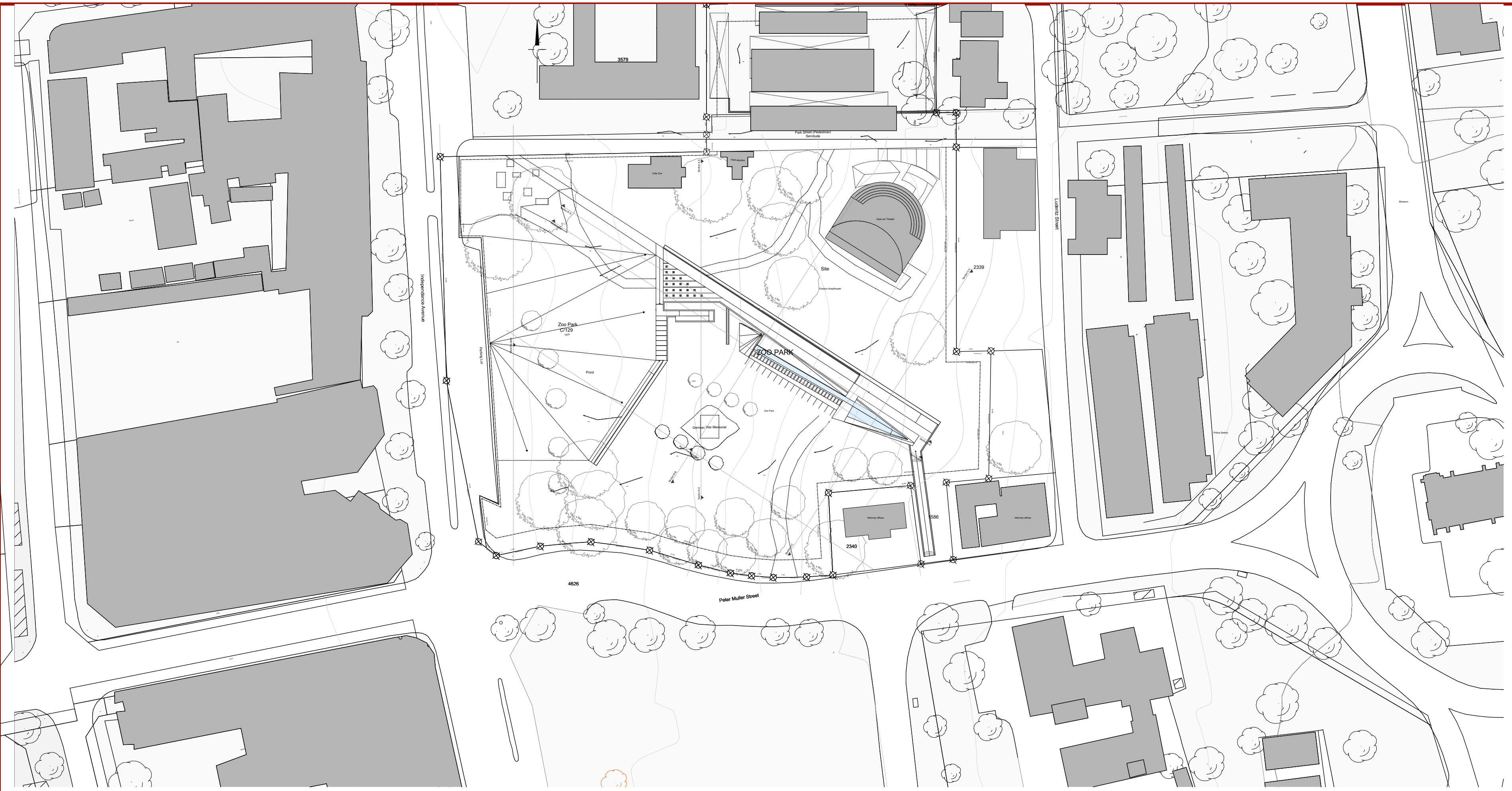


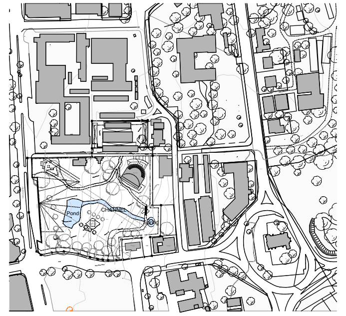
Ground +2 Floor Plan
Scale 1:100

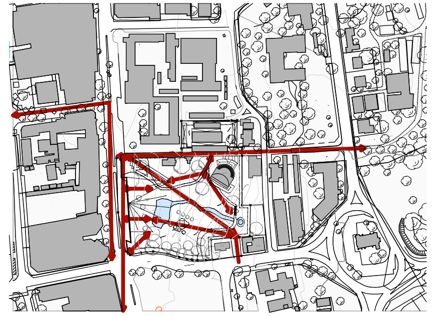


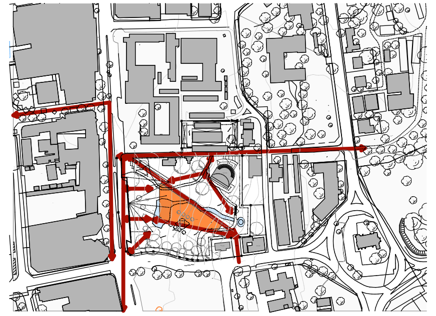


STREET MALL
DANIEL MANUMAVA STREET
NAMPOST
TELEKOM NAMIBIA
ROBERT MUGABE AVENUE
Old Presidential Residence
MINISTRY JUSTICE
Parking Lot
Park Street (Pedestrianised)
Pede strian Walk way
LUDERITZ STREET
ROBERT MUGABE AVENUE
Outdoor Ampitheater
PROPOSED SITE
ZOO PARK FOUNTAINS
C/129
POLICE STATION
PAELIAMENT GARDENS
utual Tower
INDEPENDANCE AVENUE
SANLAM CENTRE
CHRISTUS CHIRCHE
FIDEL CASTRO STREET
Goethe Institute
FNB Namibia
List Mall
N
LOCALITY PLAN
SCALE 1:500
UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV
Project description:
ZOO PARK AQUIFER RECHARGE PAVILION
WINDHOEK CENTRAL
WINDHOEK
NAMIBIA
Drawing nr.
Scale:
SCALE 1:500
Drawing Name:
LOCALITY PLAN
Drawing by:
Ivan Neethling







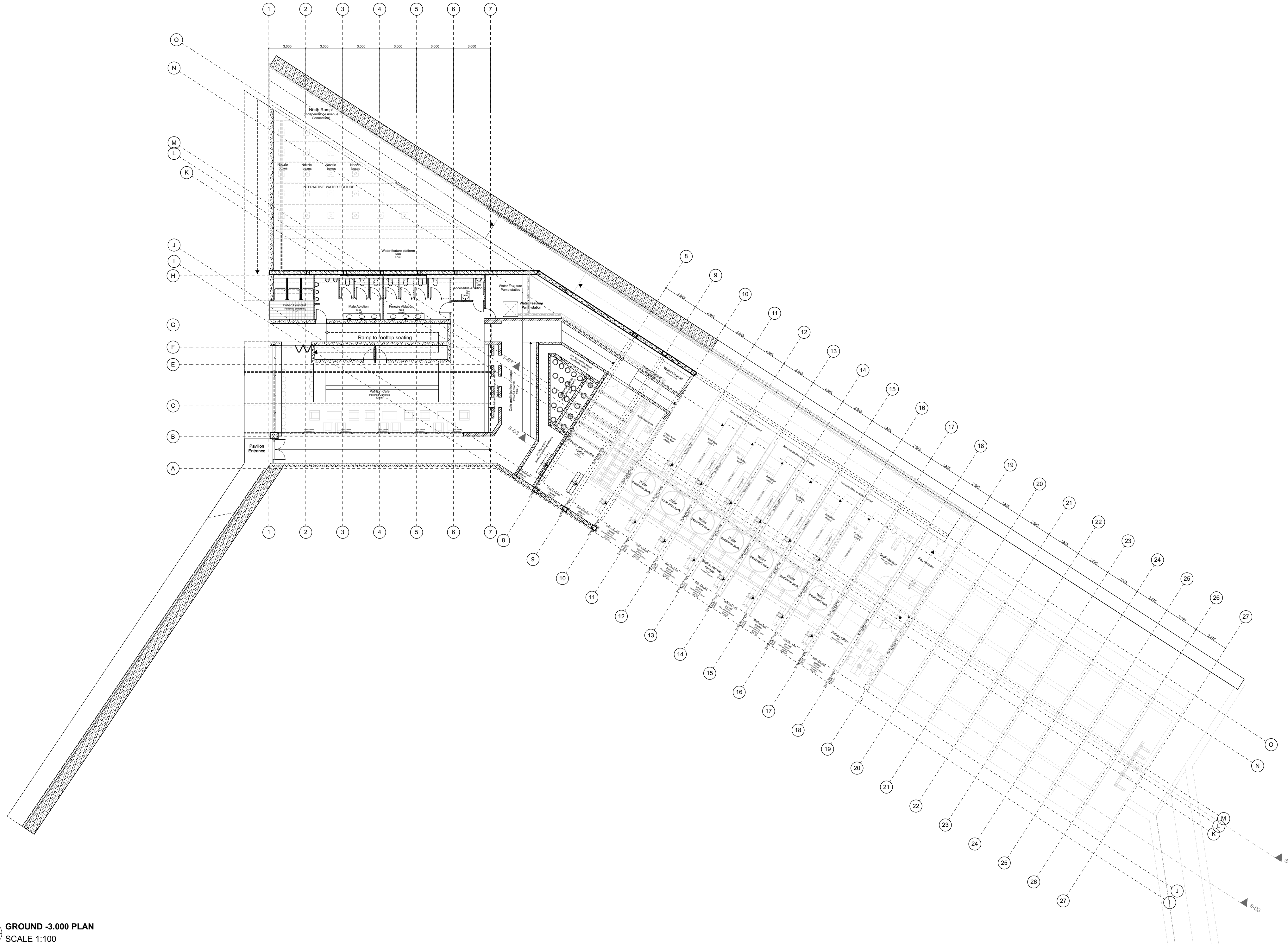


Project description:

ZOO PARK AQUIFER RECHARGE PAVILION

WINDHOEK CENTRAL
WINDHOEK
NAMIBIA

Drawing nr.	
Scale:	1:200
Drawing Name:	**CONTEXTUAL SITE PLAN**
Drawing by:	**Ivan Neethling**



N

GROUND -3.000 PLAN
SCALE 1:100

Project description:

ZOO PARK AQUIFER RECHARGE PAVILION

WINDHOEK CENTRAL
WINDHOEK
NAMIBIA

Drawing nr.	
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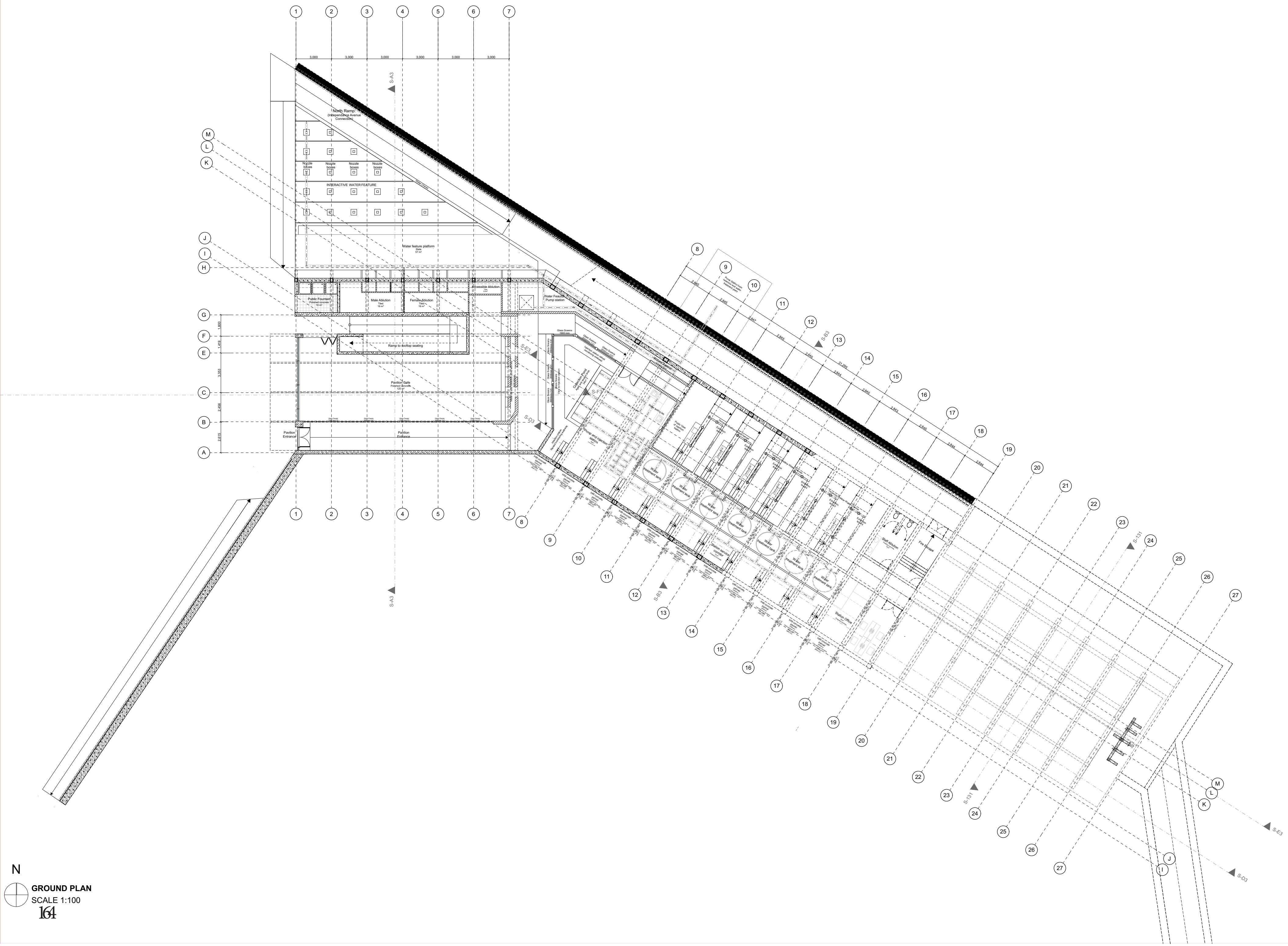
Drawing Name:	**GROUND -3.000 PLAN**
Drawing by:	**Ivan Neethling**



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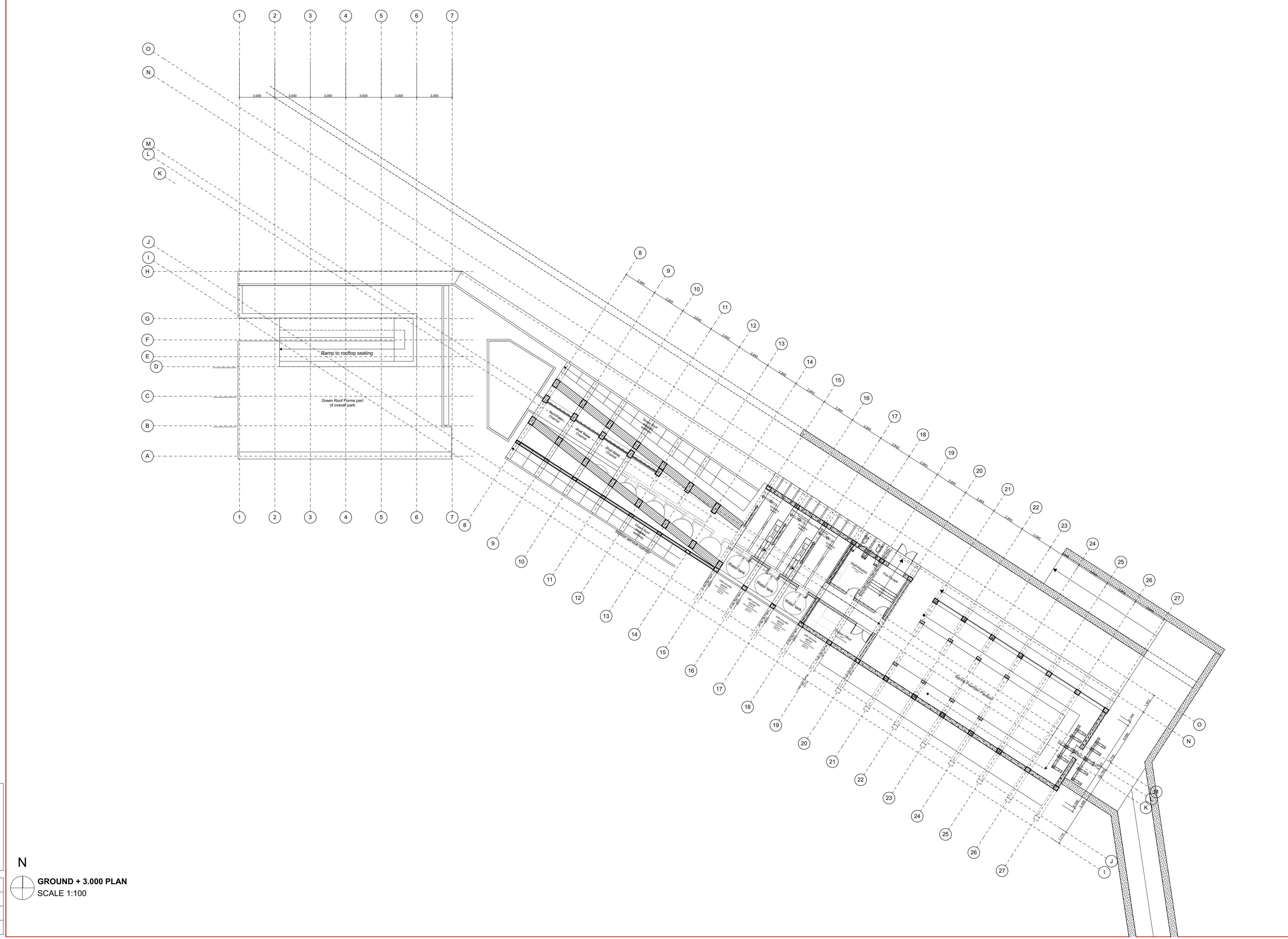
GROUND PLAN
SCALE 1:100

Project description:
ZOO PARK AQUIFER RECHARGE PAVILION

WINDHOEK CENTRAL
WINDHOEK
NAMIBIA

Drawing nr.	
Scale:	SCALE 1:100
Drawing Name:	**GROUND PLAN**
Drawing by:	**Ivan Neethling**



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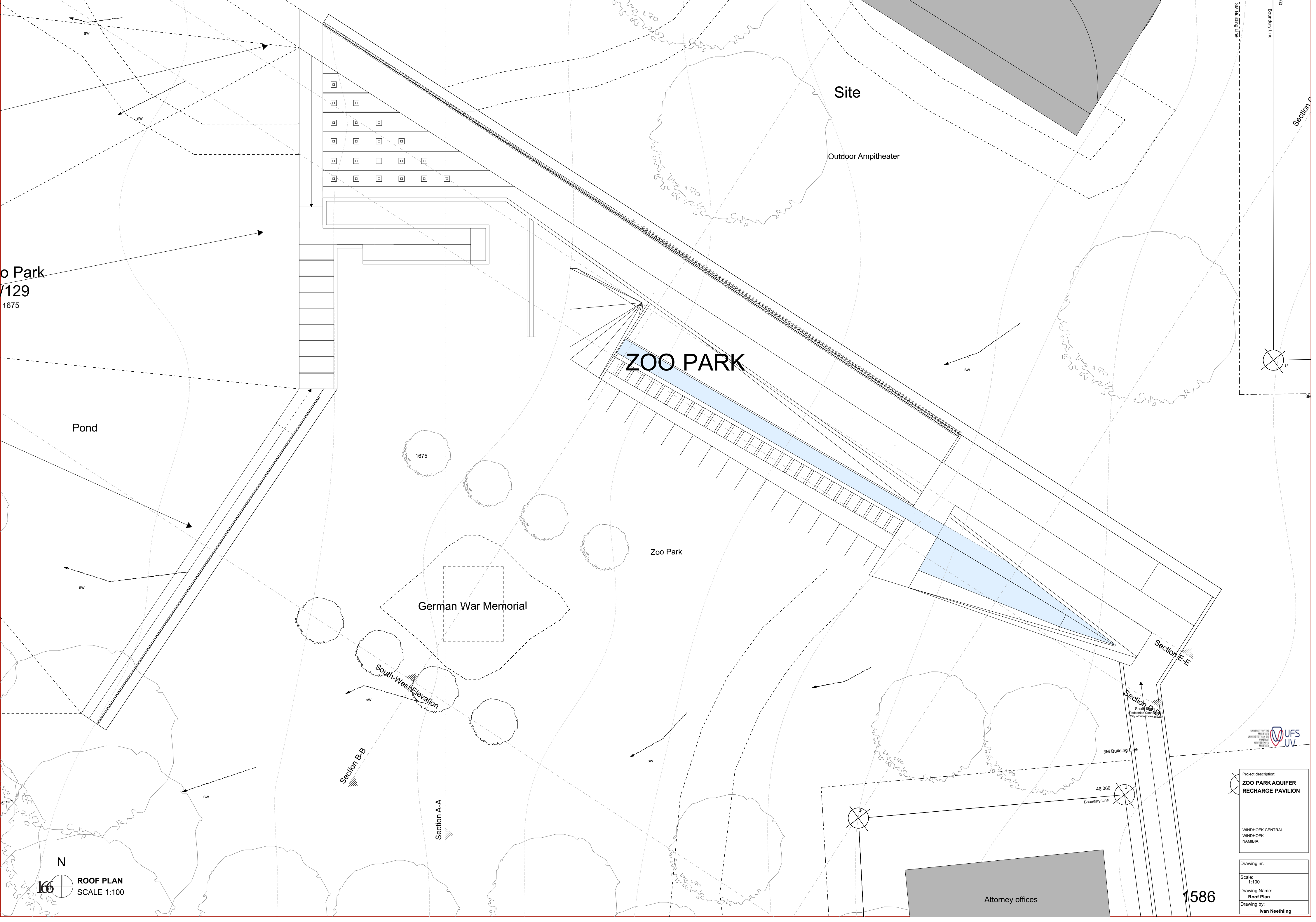
GROUND + 3.000 PLAN
SCALE 1:100

Project description:
ZOO PARK AQUIFER RECHARGE PAVILION

WINDHOEK CENTRAL
WINDHOEK
NAMIBIA

Drawing nr.	
Scale:	SCALE 1:100
Drawing Name:	**GROUND +3.000 PLAN**
Drawing by:	**Ivan Neethling**



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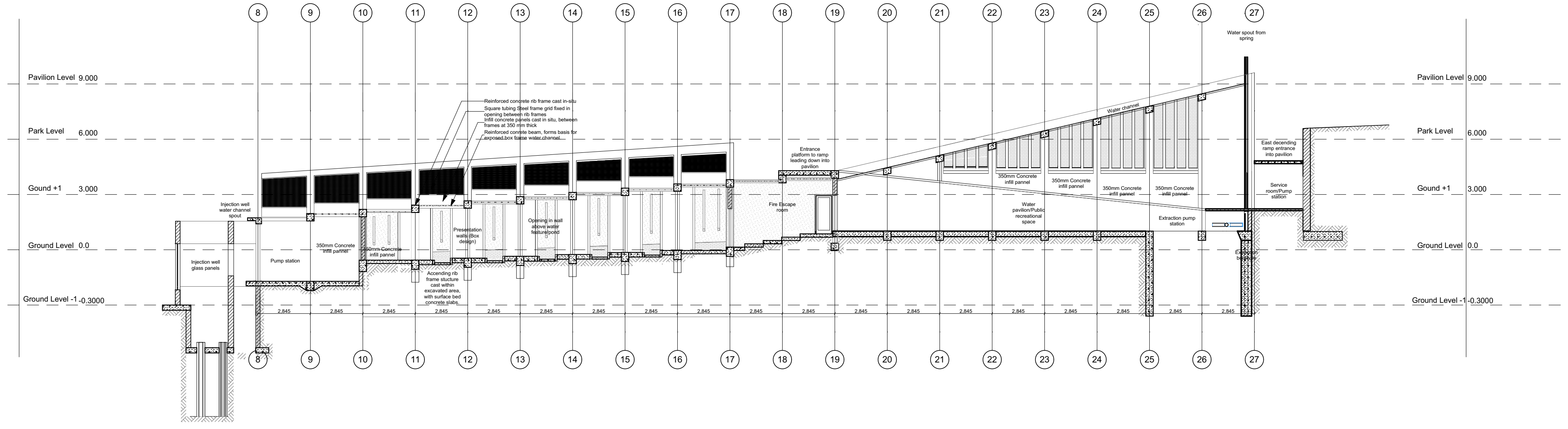

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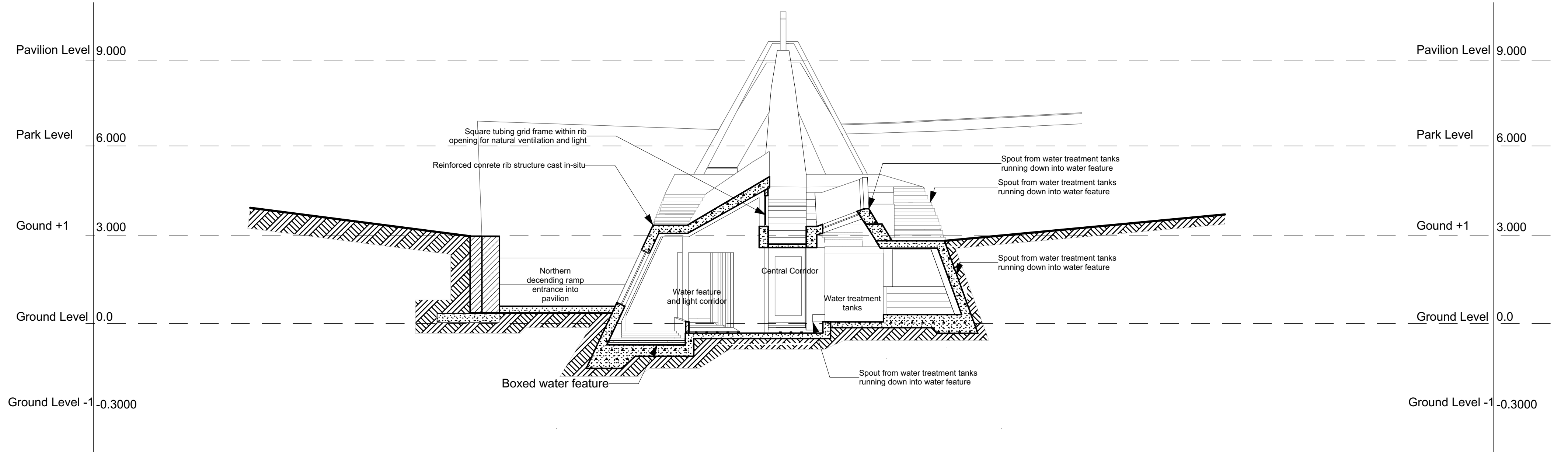

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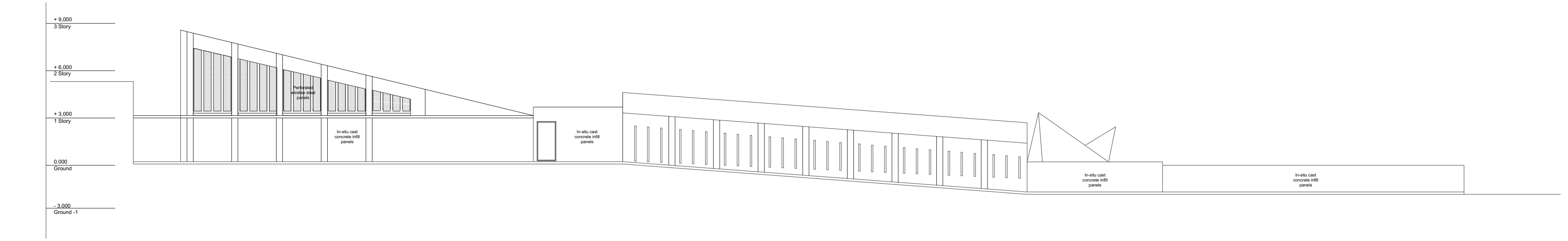

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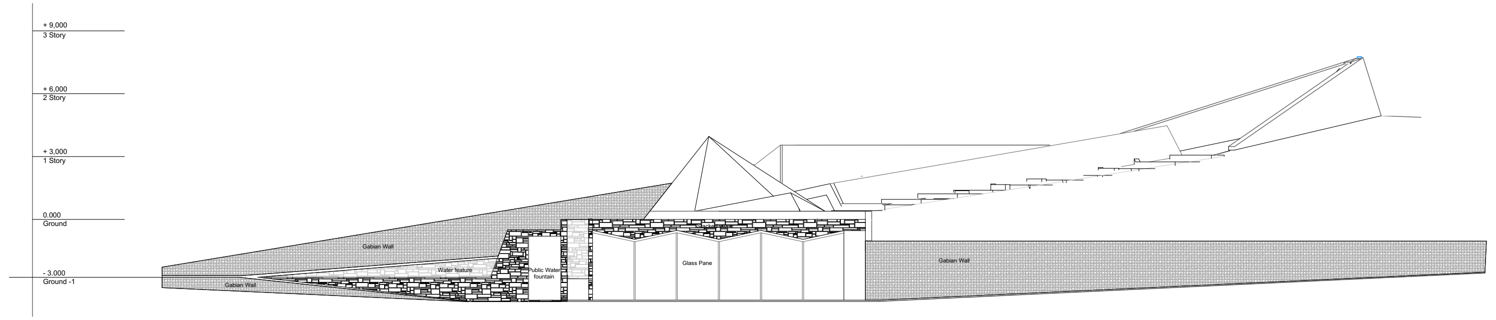

WEST ELEVATION
SCALE 1:200

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Project description:
ZOO PARK AQUIFER RECHARGE PAVILION

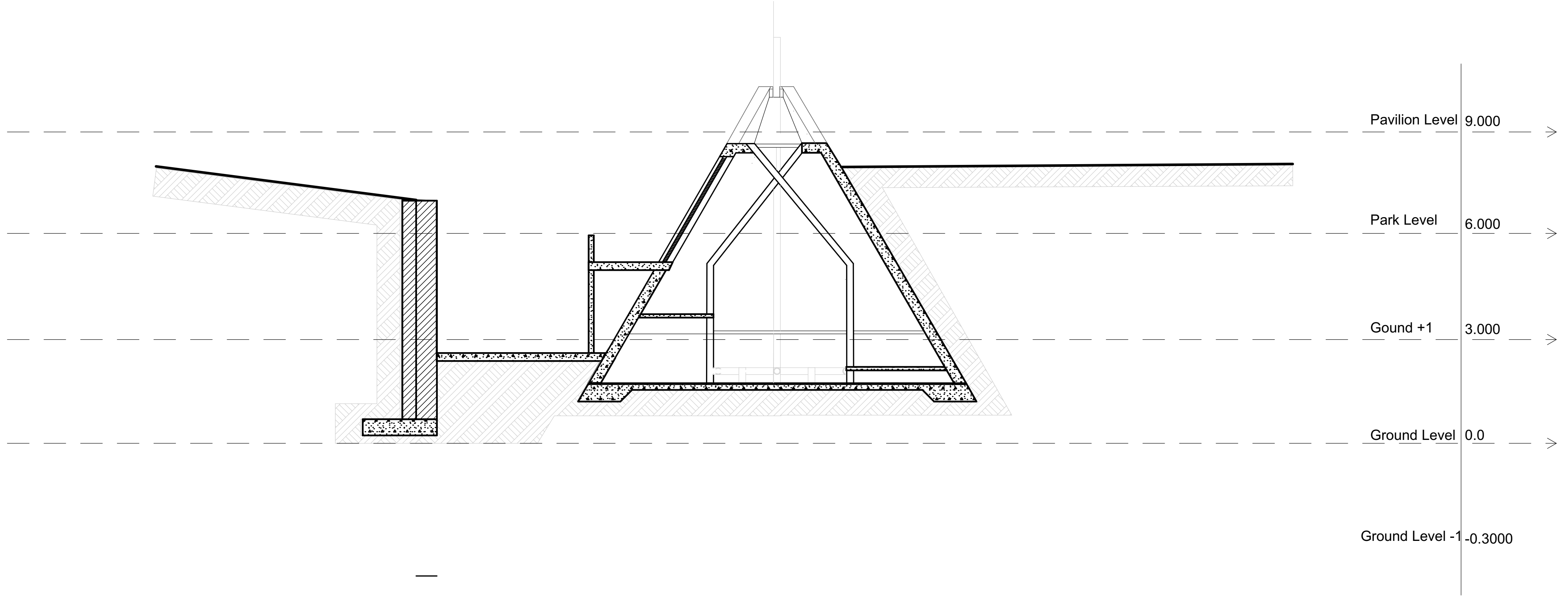
WINDHOEK CENTRAL
WINDHOEK
NAMIBIA

Drawing nr.

Scale:
Indicated

Drawing Name:
SECTIONS & ELEVATIONS

Drawing by:
Ivan Neethling



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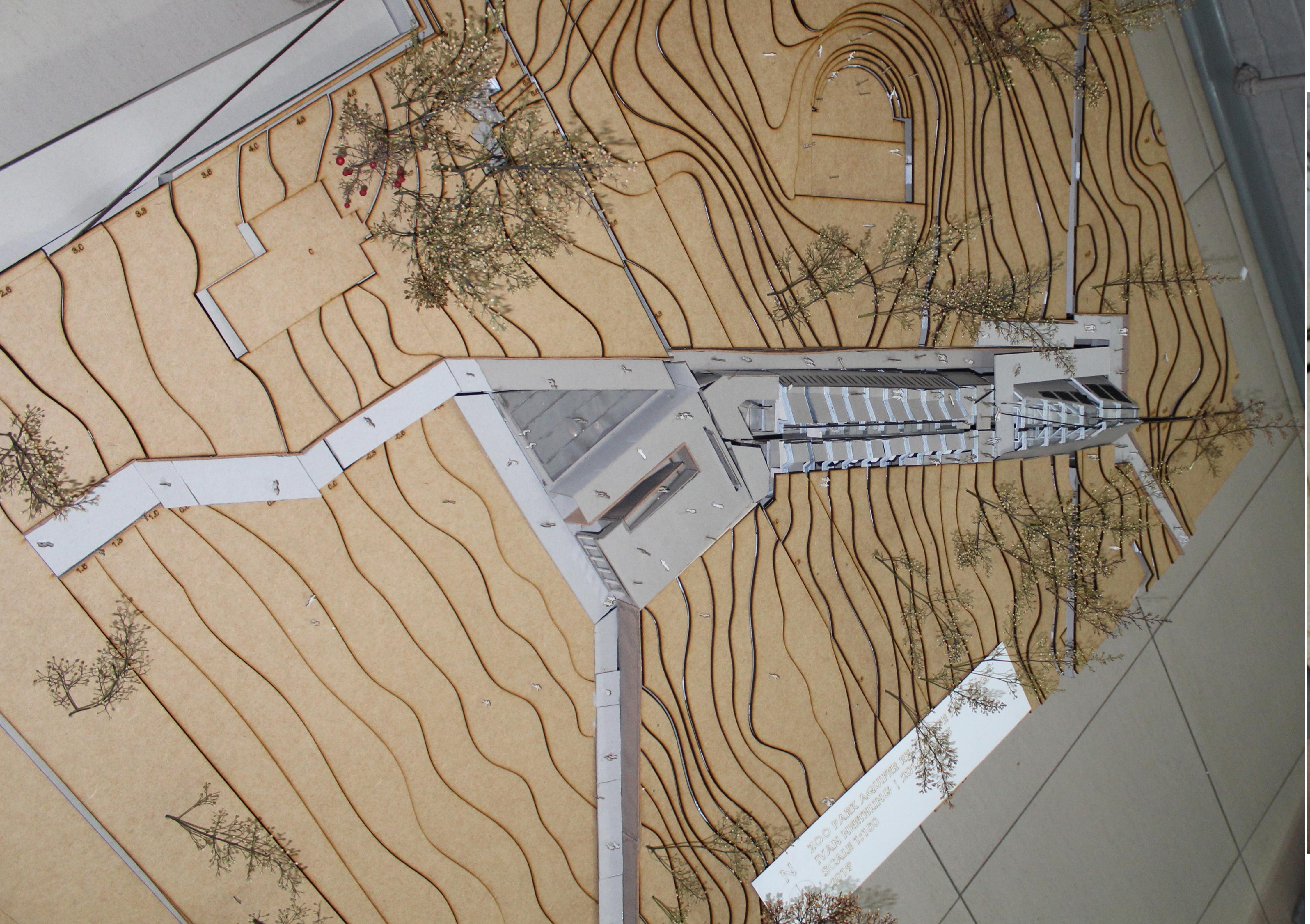

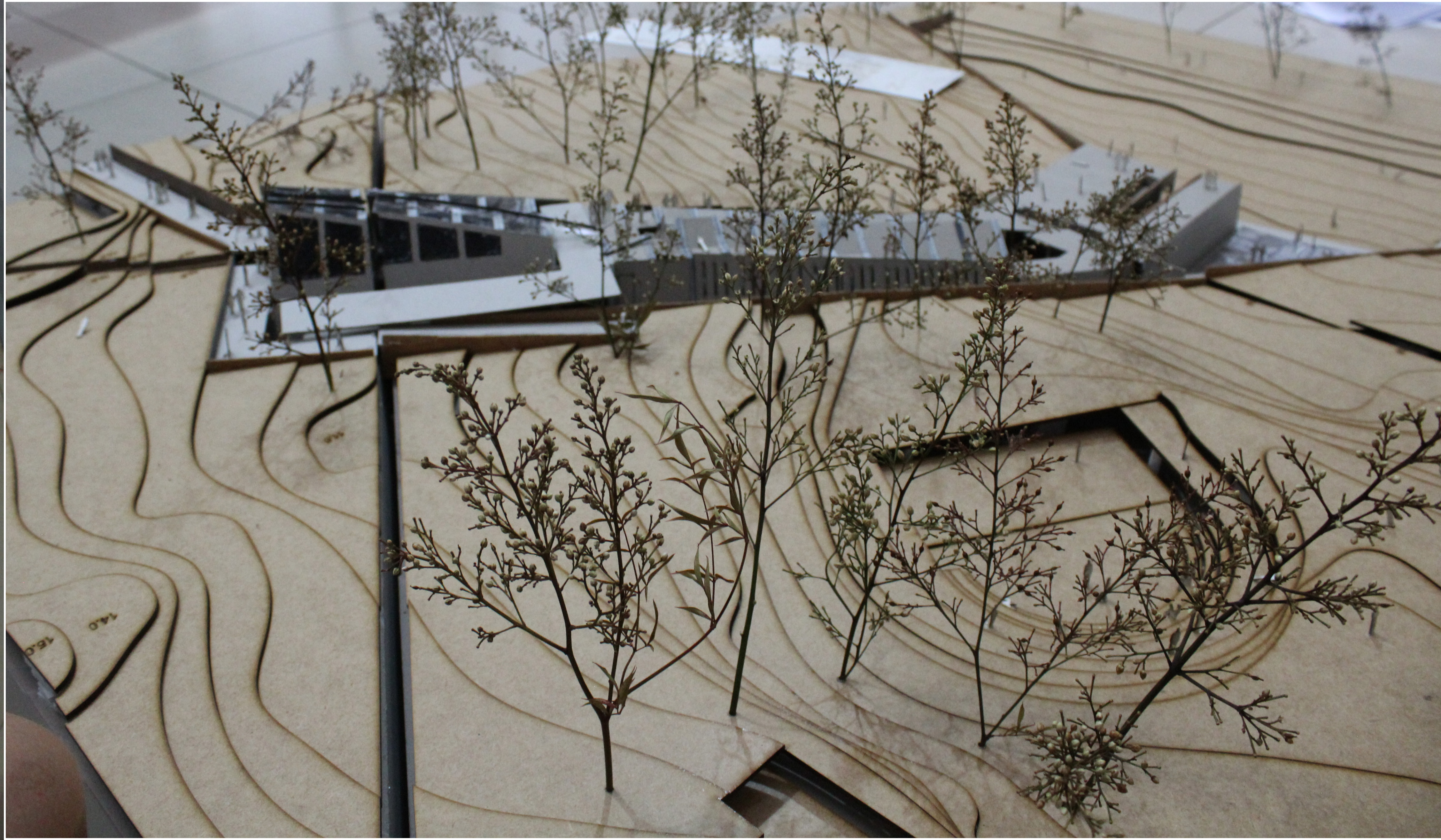

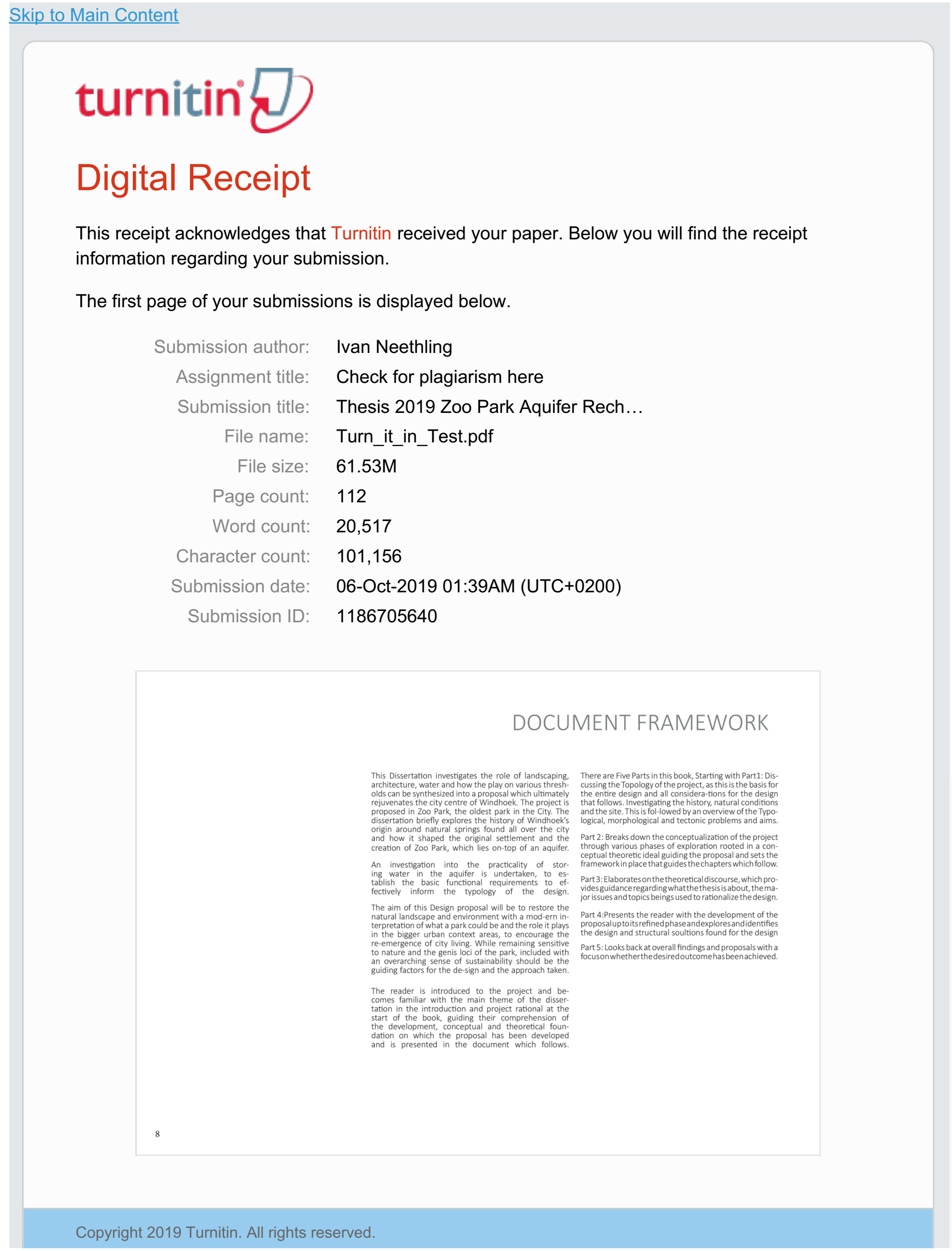

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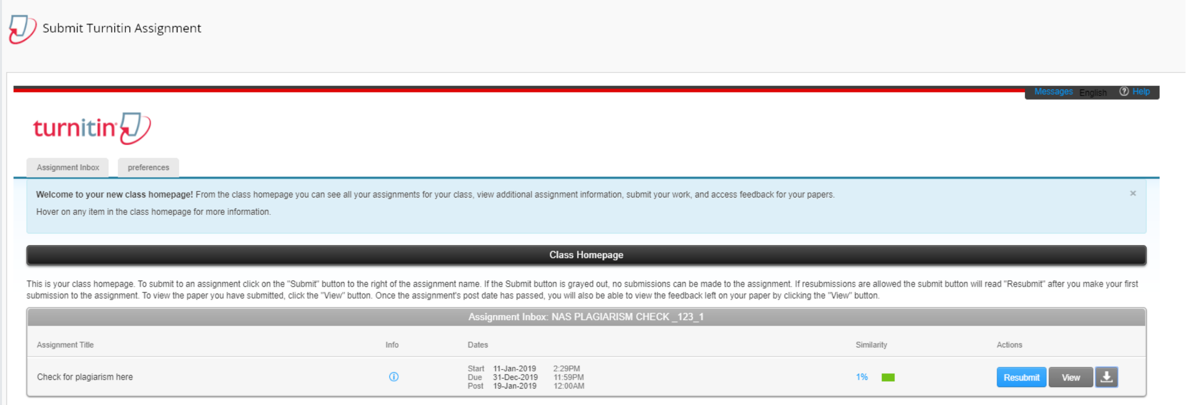

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PART 5

Technical Report

Part 5

Technical Report

5.1.1 Introduction

The aim of the proposed landscape pavilion and subterranean water injection station, is to combine the rejuvenation of the aquifers with that of the park, making use of water as the driving force behind the design and the technical considerations for both.

The process through which the recharge of the aquifer is done is called the MAR or Managed Aquifer Recharge. The Functional process of the MAR begins with the sourcing of water of adequate quality for recharge into the aquifer. The water is then channeled to the station ready for injection via the chosen system best suited for the geography of the area where the injection occurs.

For the sacksful implementation of the MAR system at Zoo park the technical report investigates a number of factors to ensure the appropriate techniques and technologies are used. This includes but is not limited to researching:

1) The geological conditions found in the area of Windhoek where the park is located.

2) the various techniques used for the MAR and

3) determine the best method of injection for the site as it is informed by the geological analysis.

4) Look at the specific terrain conditions in connection with the injection process chosen, to establish what this means for the typology and structural morphology of the pavilion design.

The source of the water in Windhoek is from the surrounding dams and the reclamation plant, all tested and confirmed as ready for injection, with minimal treatment of the dam water, which will be done at the pavilion's injection station.

The research shown in the report is based on already available information and considerations as several other injection schemes are already operational in Windhoek. With an ever-increasing demand for more MAR systems to be implemented in order to alleviate the water supply demand due to the population of the city which continues to grow and droughts becoming more prevalent.

The pavilion houses the MAR scheme and becomes the conduit for the water to move into the aquifer. The pavilion is submerged into the ground and the structure for the design is informed by several factors.

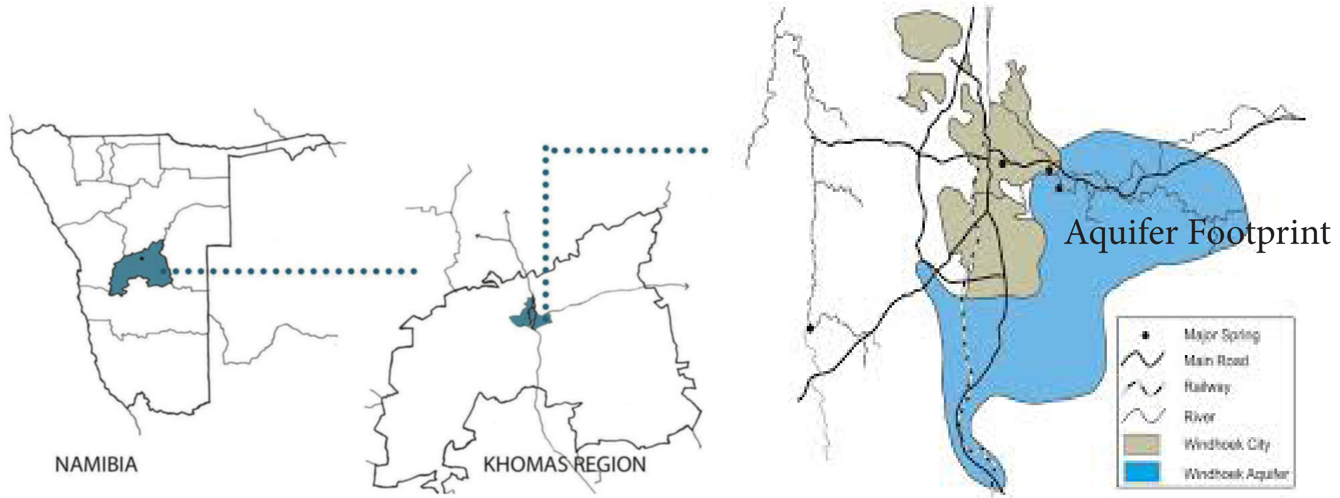
1) The slope of the site can be used to channel the water via gravity reducing the mechanical and pump installations required on site.

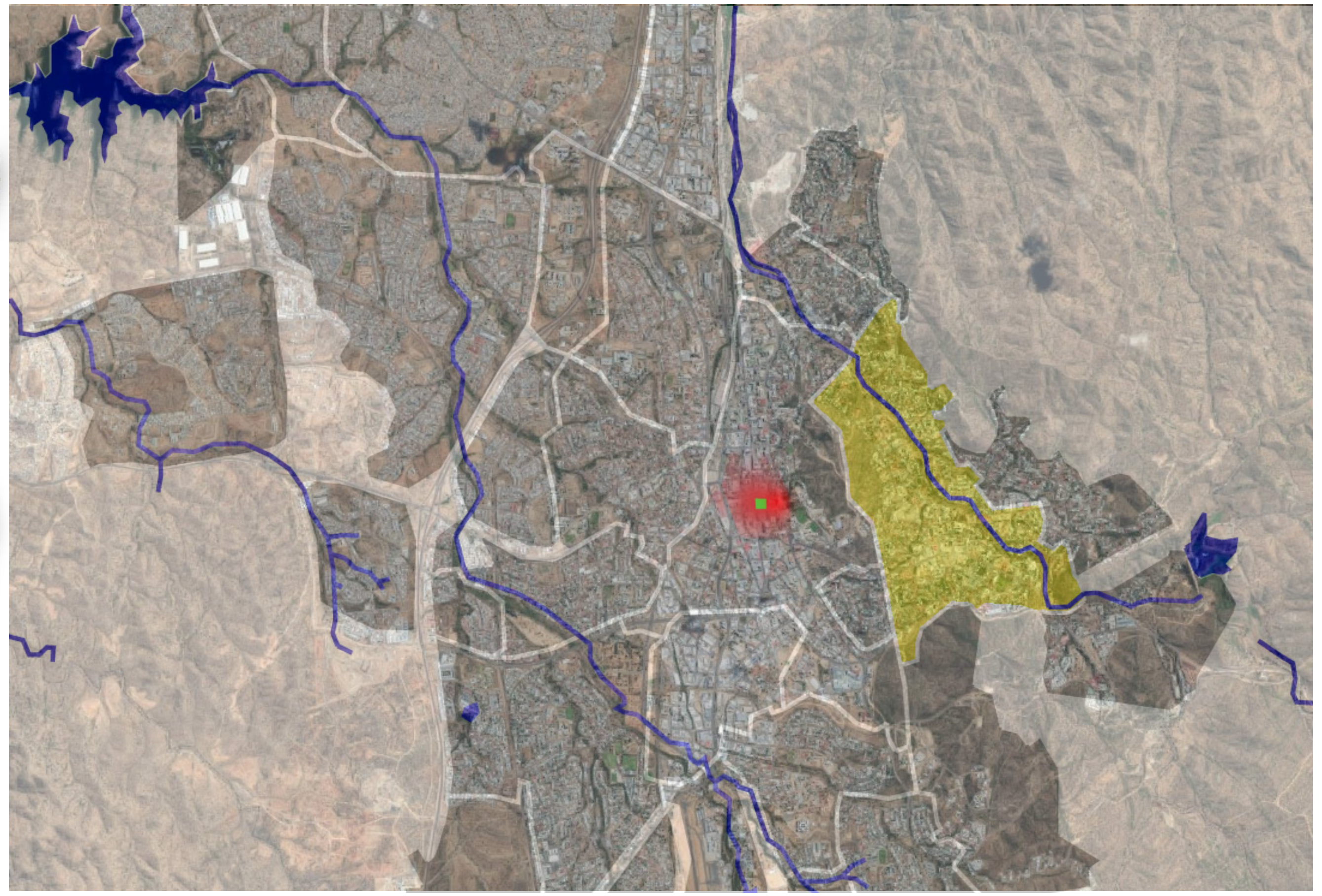
2)The structure should then at roof level stay true to the slope of the site.

3)The setting of the pavilion into the ground, further informs the excavation and construction methods including the structure of the envelope.

5.1.2 Project Location

Figure 1.1 Namibia Locality





Firgure 1.2 Windhoek Suburb and Satelite overlaid

Windhoek CBD

Figure 1.3 Windhoek Nolly Map

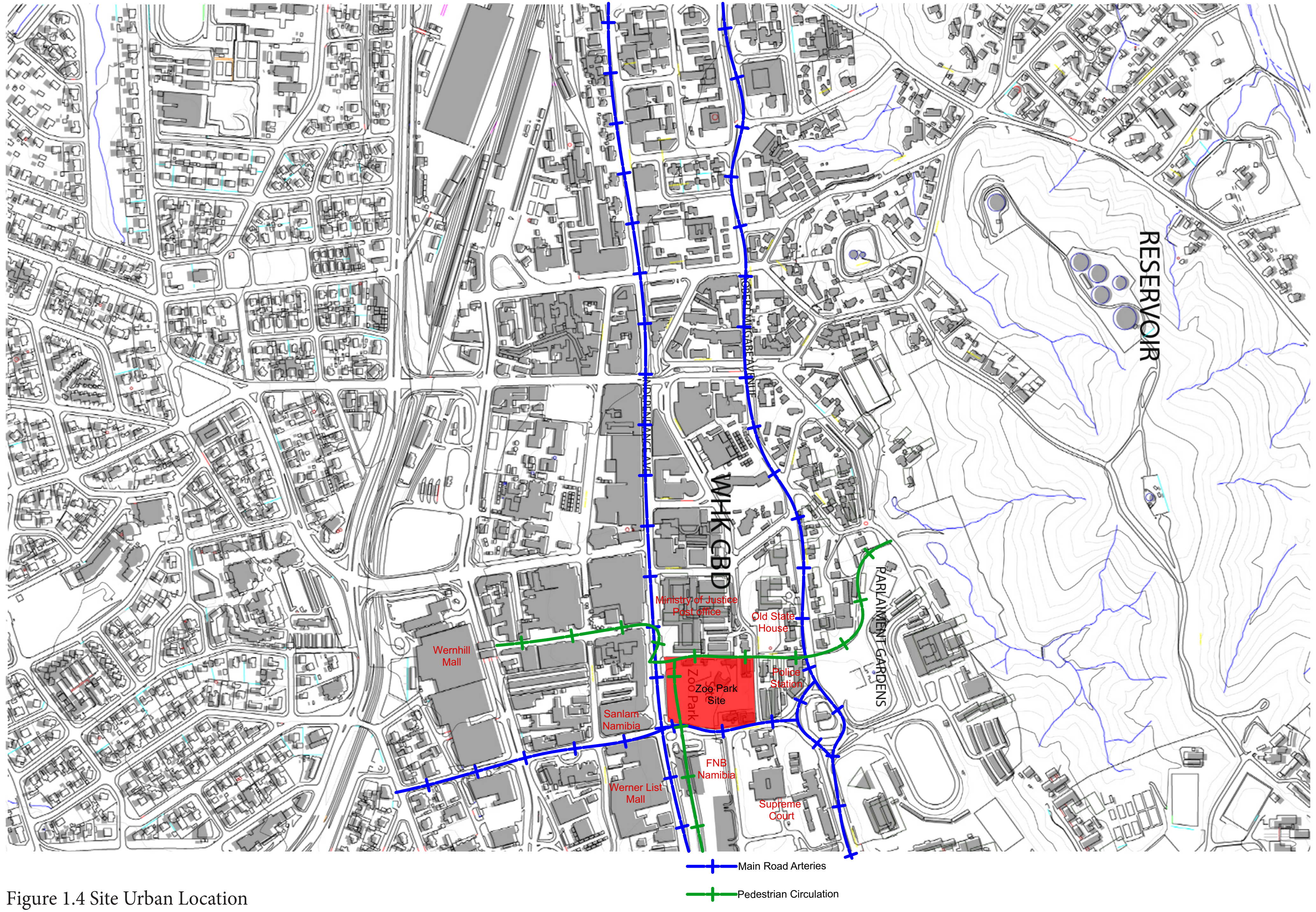


Figure 1.4 Site Urban Location

5.1.3 Site Investigation

ures

Figure 1.5 Site Perspective

The property has a permissible height control of 55 meters, as it falls within the central business area and if flanked by several high-rise buildings. With a 70 coverage and a density zone of 4.2.

The pavilion covers 40 percent of the parks surface and does not infringe on the height restriction due to its subterranean nature.

The Site covers an area of 16 400 square meters or 1.5 acres, covered by no less than 40 different trees, most of them foreign to the county. These are primarily scattered around the periphery of the site, creating an enclosed circle and then a second inner circle of trees, creating a collective canopy in the middle. Most of the trees are located outside the footprint of the proposed pavilion design. The parks is flanked by many commercial and business buildings and within walking distance of many of the city's major tourist attractions and site of historical value.

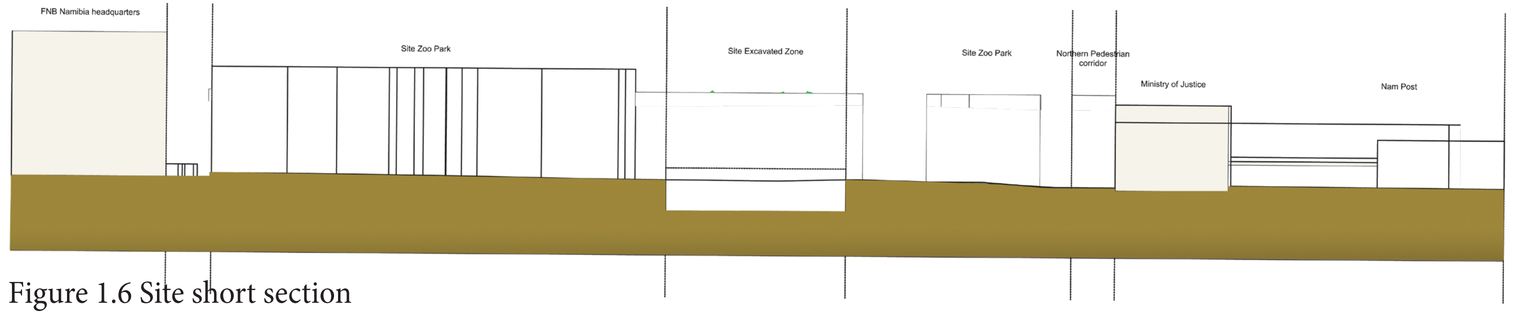


Figure 1.6 Site short section

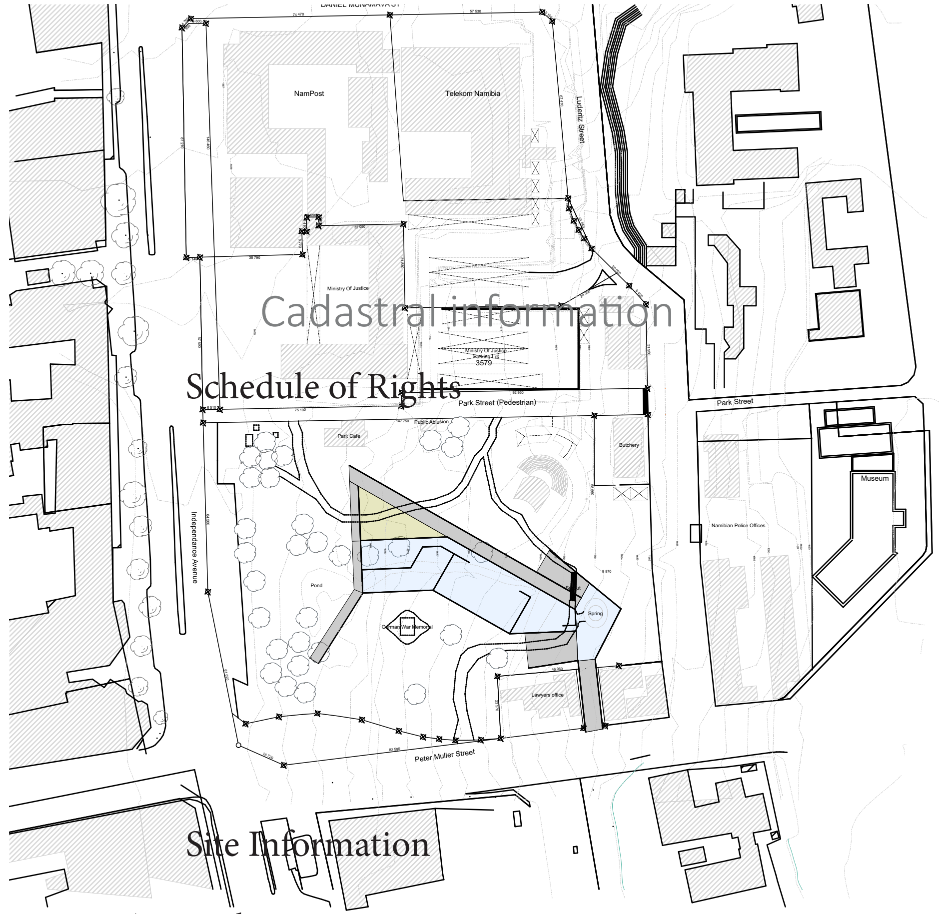


Figure1.8 Zoo Park Location Diagram

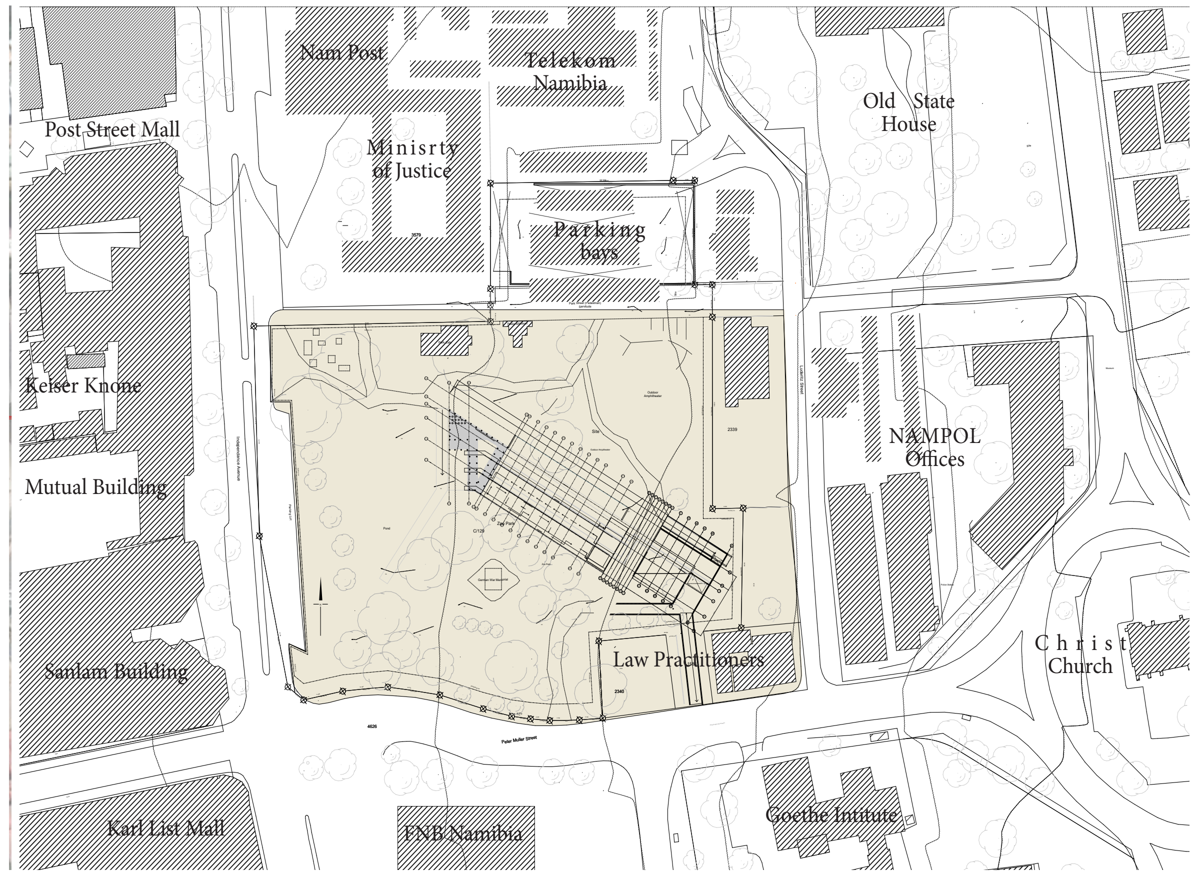


Figure 1.9 Locality Plan

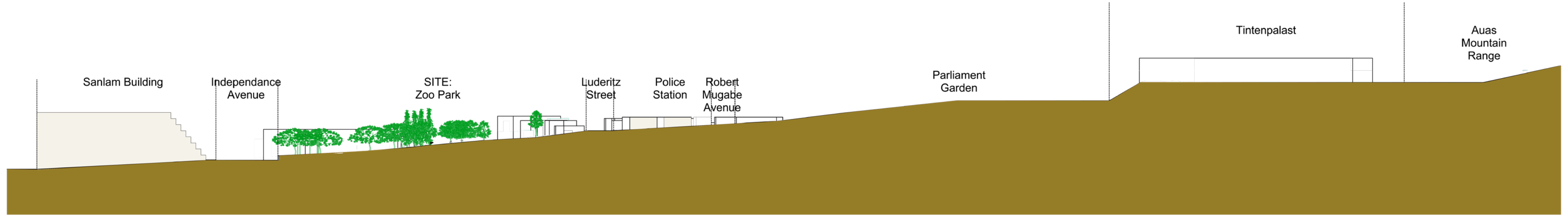


Figure 1.10 Site Long section

5.1.4 Topography; Climate; Geology

Site Topographical analysis

The site follows the prevailing terrain conditions of the surrounding area, and slopes down towards the west, by 14 meters over a 130 m distance. The park has a natural spring due to the underlying aquifers which used to create a wetland area but has been closed off and by the municipality.

The reason the proposal is positioned in Zoo park is based more on its topological history than its current condition, and the pavilion intend, at least to a certain extent, to recover this topological history. This is done by bringing the site back to life using water, which made up a major part of its character and quality. The slope of the site aids the designs minimal approach with regards to mechanical intervention and rather make use of the slope to move water across its surface before reaching the treatment basins.

The existing man-made influences are the walkways that dot the parks landscape, which have been standing in the park for almost have a century and will not be removed. A shallow watercourse and pond (dried up) along with park benches, playground, and open-air theater has slightly affected the natural topography.

Physical Aspects

Topography - The park has a west to east inclination of 14 meters with the natural spring reaching the surface at the highest point. The lower edge of the site sits directly on top of the underground aquifer. The park consists of several paved walkways and many old trees, some reaching heights of up to 20 meters.

Figure 1.11 Surrounding Buidlings on Independance avenue

Figure 1.12 Western perspective to independance avenue

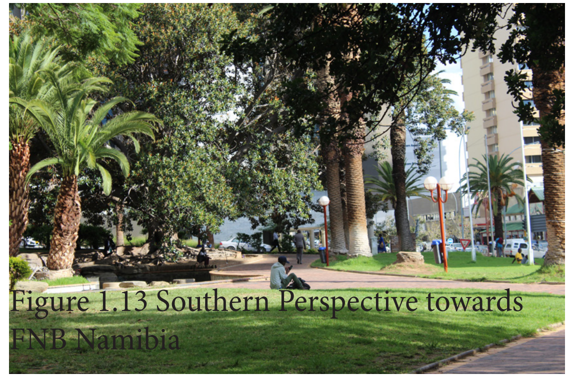


Figure 1.13 Southern Perspective towards FNB Namibia

Typography - The site is surrounded by Business complexes and old German heritage buildings. There are some existing functions on the site such as the Zoo Cafe, Public ablutions, an Amphitheatre and a Chinese pavilion. These are all situated on the periphery of the site with the central area kept with trees, a dried-up water channel and pond.

The park is covered by some existing buildings, such as the cafe, small theater and ablution block.

Towards the east at the highest point of the site, the concrete slab that closes of the spring can be seen. All the existing structures are positioned on the pheriphery of the park and leaves the center viod of super-structures.

Figure 1.14 Eastern Perspective of Extraction point

Figure 1.15 Water Feature

Climate and geotechnical data

The city of Windhoek is positioned in the highlands at around 1600 meters above sea level with a moderate climate. Temperatures reach the middle to high 30's in the summer with minimums below freezing point and an average of almost 20 degrees. Rainfall data shows an annual average of 360mm. The majority of Windhoek's water is harvested from higher rain yielding areas of the country in dams. The city has strong wind currents ranging between 9-12 km per hour throughout the year.

Ground or soil conditions in Windhoek are quite stable with quartzite comprising the majority of the landscape. Windhoek is situated above the Damara Sequence and the rocks are "overlain by thick schists of the Kuiseb Formation" (Christelis et al, 2001, 77) Below this level the city lies on an aquifer spanning almost 35 km in a north south direction and is directly related to the Graben fault line formation that runs above the aquifer. The springs "emerged from deep-seated faults in the quartzite that form the main aquifer." (Christelis et al, 2001, 78) A graben fault is caused when fault block is lowered or raised with relation to its surrounding. This is what allows the water to filter into the aquifers at a rate of 9 cubic meters per hour.

Figure 1.16 Aquifer and spring positions in Windhoek CBD

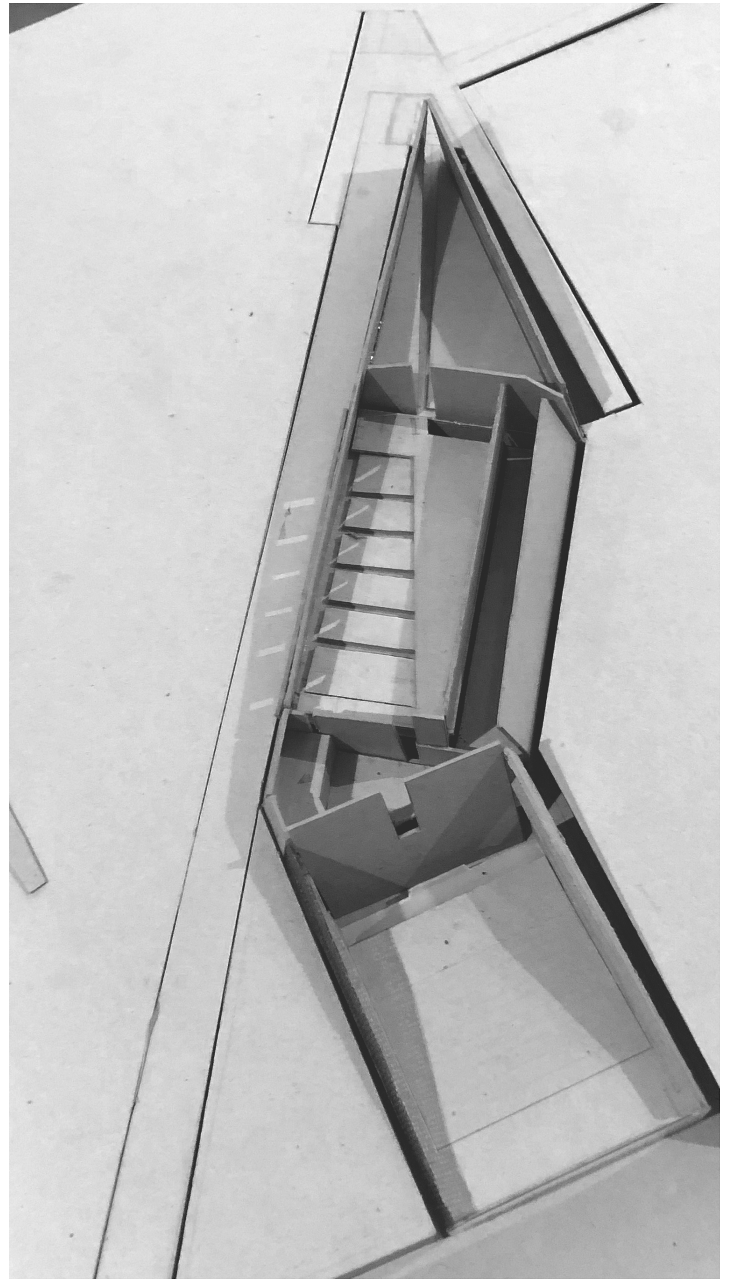
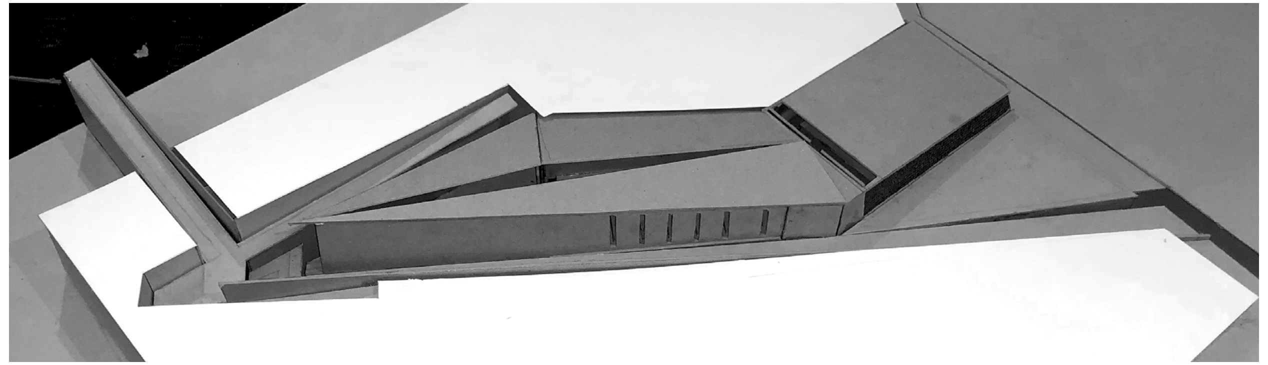
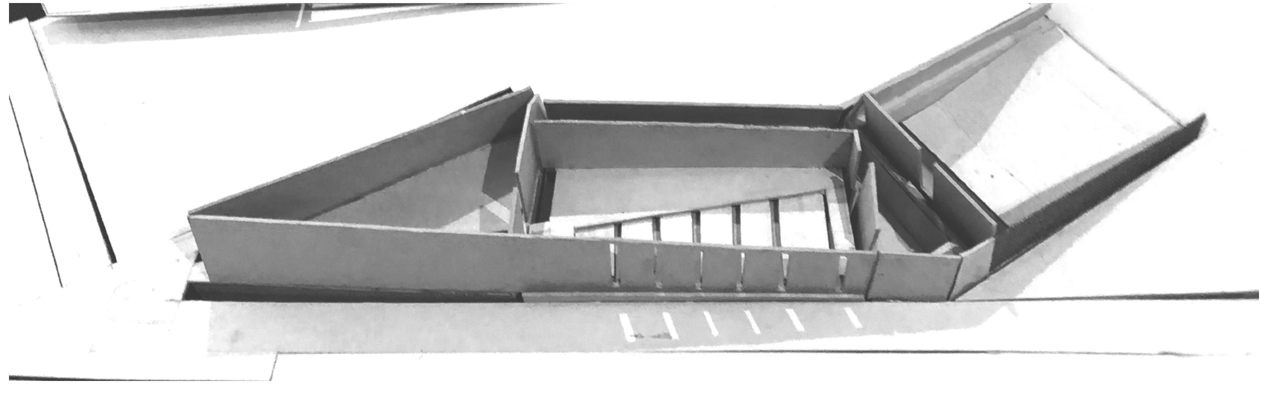


Figure 1.25 Model giving form to subterranean spaces of pavilion

Spatial model, investigating the inclined wall and opening both on the facades and the roofing systems of the design.





The structural development of the pavilion stems from its subterranean nature. The excavation of the site using the caisson method and pilling system creates the box within which the structure is erected. The 3 sides of the excavation pit set the foundation for the shape that the structure takes at its base. The walls constructed in-situ through a concrete off shutter method to obtain the ribbed concrete wall and shell. The shell's form is shaped according to the angle and fall of the site, allowing no obstruction at the parks surface.

The structure follows the geometrical principals of a circle, as is used when constructing tunnels, explained as the axial load movement within curve like structures, which allows it to be a continues skin from the foundation, to the walls and the roof.

The inclined walls of the subterranean spaces are functional and sculptural. It is done as an expression and a play with form to achieve the desired spatial qualities once inside. These qualities are determined by a play with natural light that enters the building through the opening left in the facade. Thus, the in-clined wall of the northern façade toward the sky on the outside allows the natural light to have its strongest possible effect on the inside.

The inclined walls of the subterranean spaces are functional and sculptural. It is done as an expression and a play with form to achieve the desired spatial qualities once inside. These qualities are determined by a play with natural light that enters the building through the opening left in the facade. Thus, the in-clined wall of the northern façade toward the sky on the outside allows the natural light to have its strongest possible effect on the inside.

The shape evolved from these driving factors to additionally compliment the atmosphere of a cave that the design replicates combined with the intentional change in volume influenced by the fall of the site. Theoretically the spaces should affect an embodied experience of the aquifer and its preservation as a source of life. Thus, religious architecture and structure also informed the shape. From the ribbed vaults of cathedrals to the large spans, buttress supports and linear configuration.

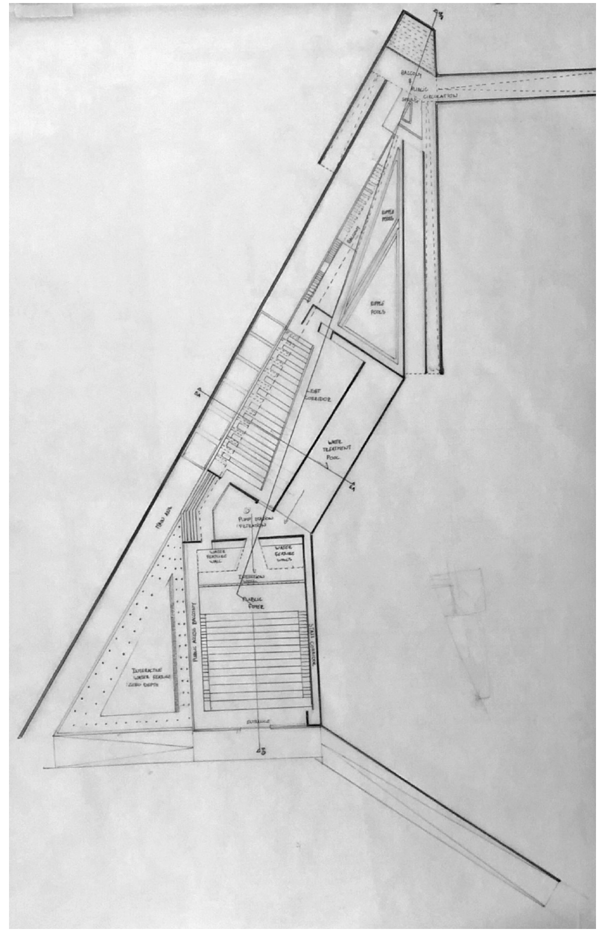


Figure 1.26 Sketch Plan

Ultimately the forms become sculptural, with unique form and spatial proportions, which is best ex-pressed through a concrete structure, due to its plasticity for creating forms and its rigidity once settled and cured along with reinforcement.

Several functional considerations further informed the shape and layout of the design. The design anal-ysis also looks at the circulation pattern which based on a journey across the site as well as below, into the subterranean spaces and finally back to the surface. In order to achieve this, ramps are placed across the circulation grid of the design, which descend into the ground with the top exposed.

The design emphasizes the effect of moving between these thresholds, by playing on the haptic senses of the visitor. Structurally this is achieved by allowing light to puncture the top of the pavilion roof struc-ture, the retaining walls and concrete ribs, allowing light to penetrate selected spaces. As the water is carried across the horizontal, vertical and diagonal roof and other structural elements where people are in contact with it, these surfaces are to be waterproofed and cast at slopes to allow gravitational flow.

The roof of the subterranean space becomes the ground level for the park above and carries the weight of the visitors on top. The principals of a tunnel system underground are used in this construction. Con-crete ribs are cast to form at set centers with infill materials allowing light to penetrate the surface and slabs where this effect is not desired.

Sketch plan sections indicating the cathedral shaped subterranean spaces created by using the concrete rib structure. Spaced at centers to allow for openings in the facade and roof system, where water will fall through into the space and skylights used for additional lighting and ventilation throughout.

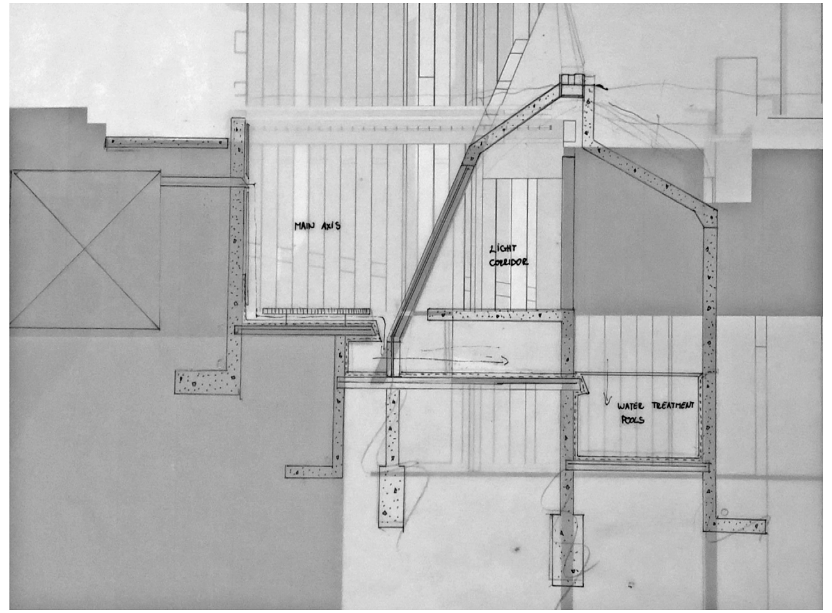


Figure 1.27 Developmental structural section

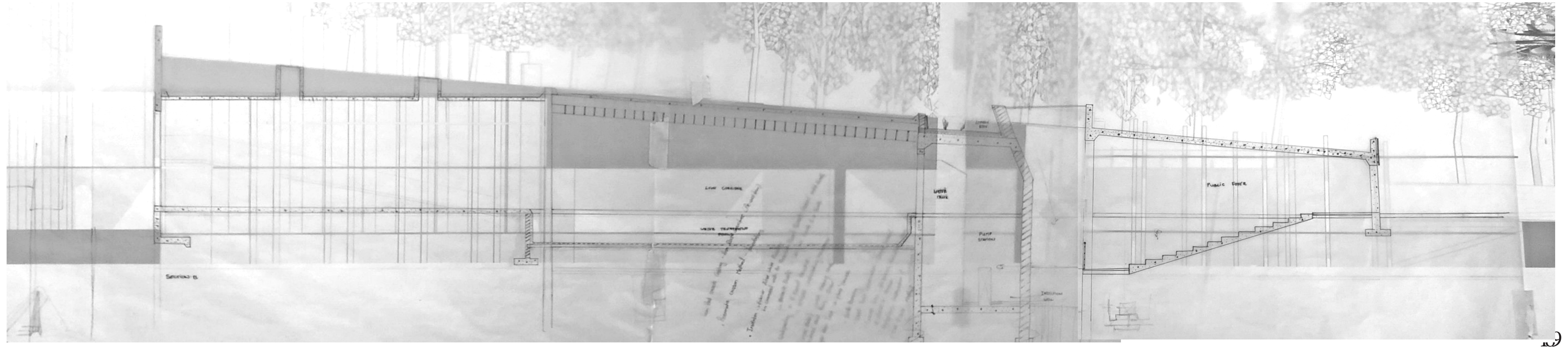
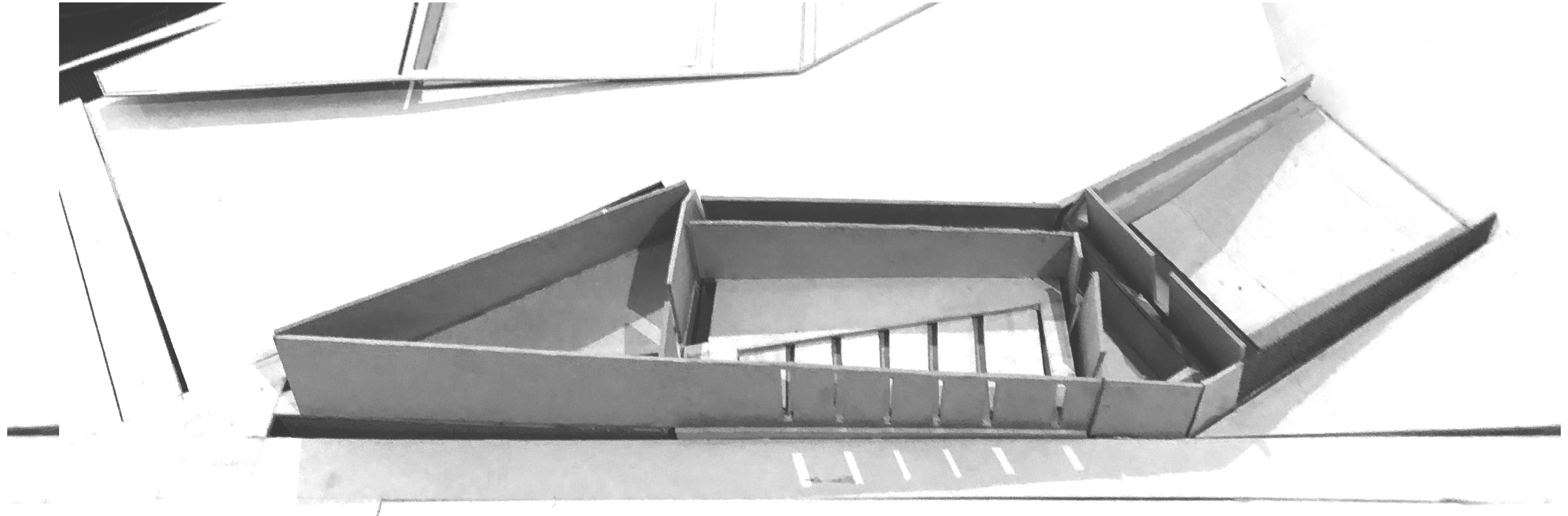
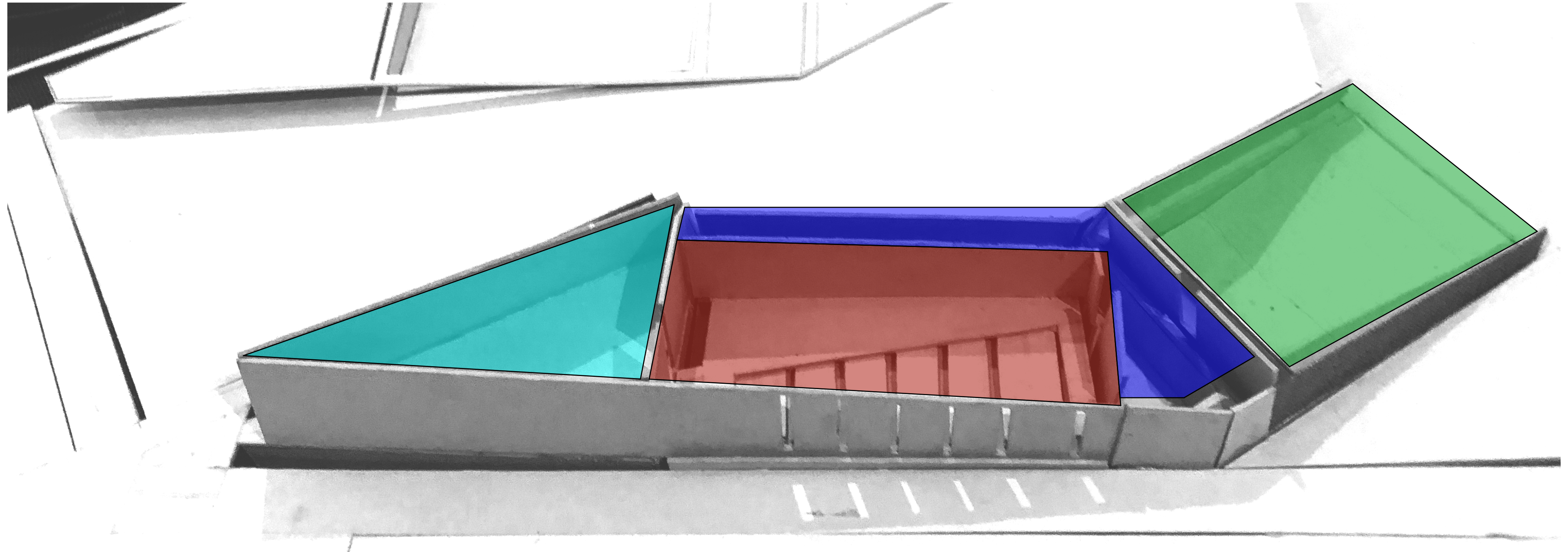
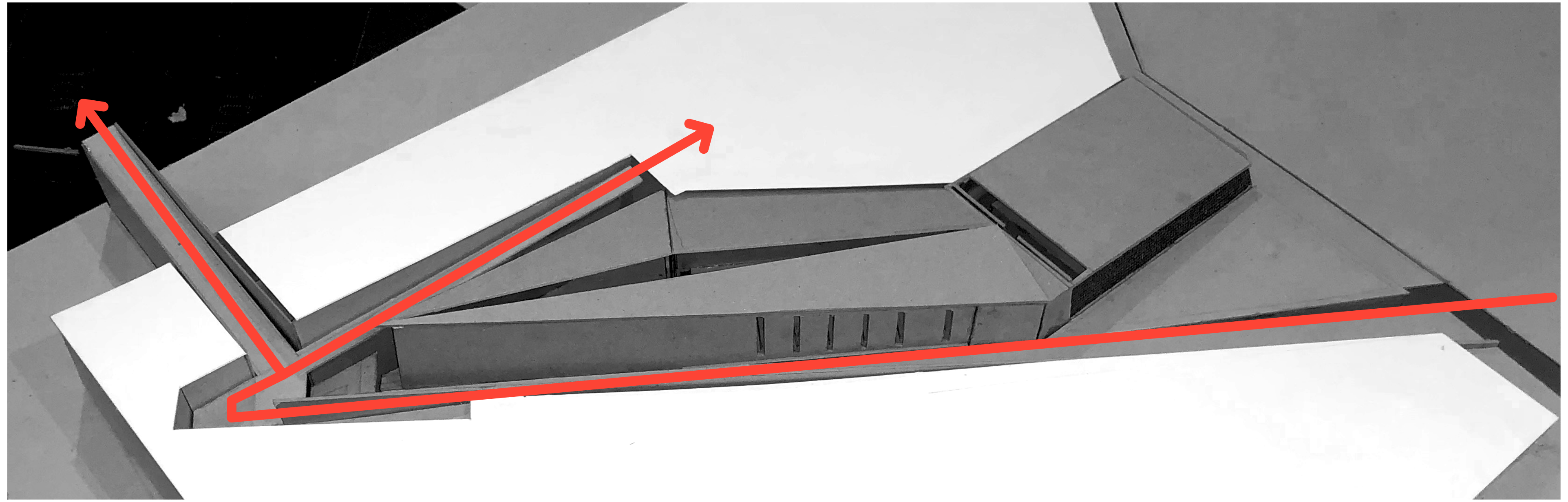
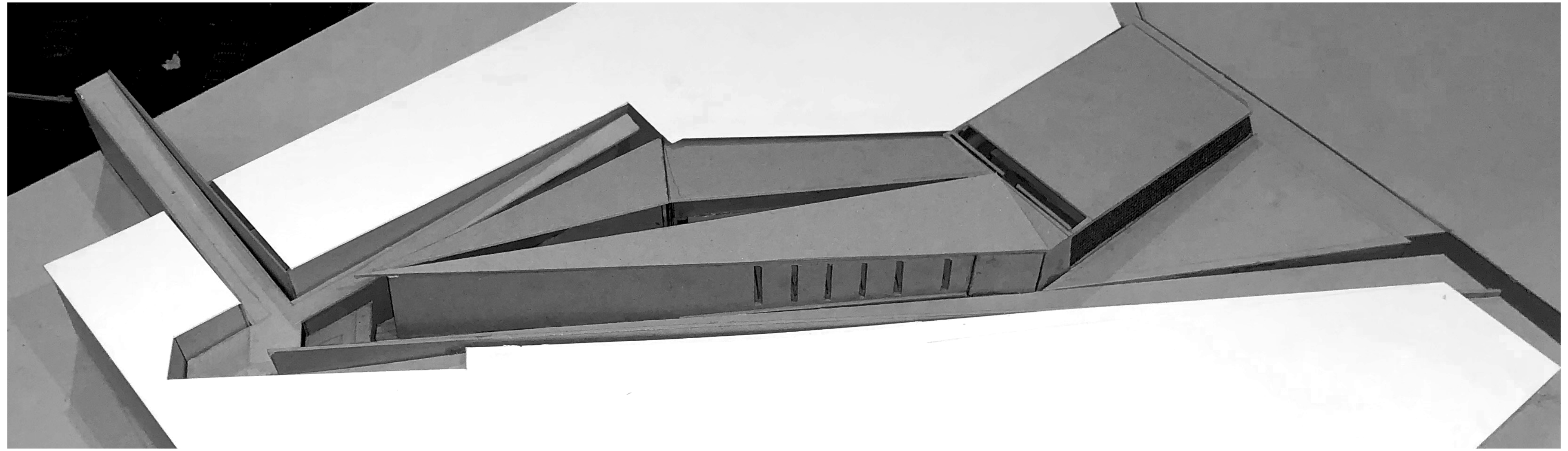


Figure 1.28 Developmental structural section

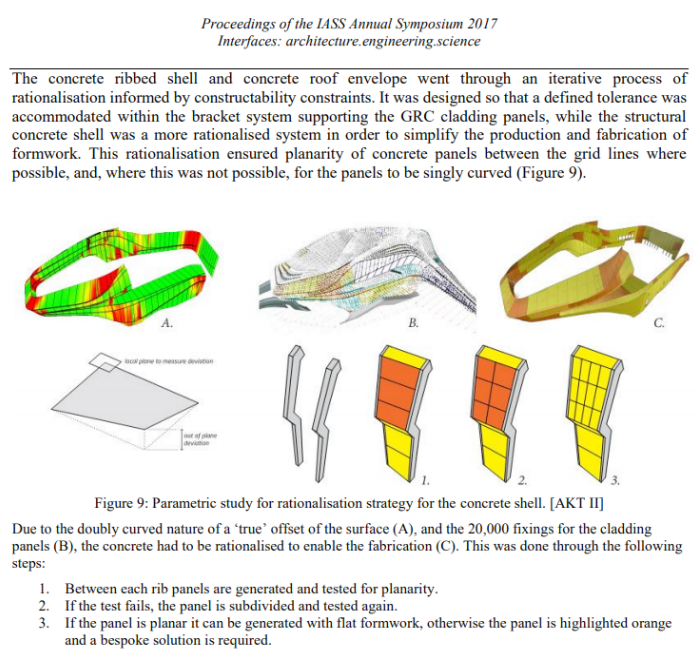








5.1.8 Structural investigation & Materiality



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The concrete ribbed shell and concrete roof envelope went through an iterative process of rationalisation informed by constructability constraints. It was designed so that a defined tolerance was accommodated within the bracket system supporting the GRC cladding panels, while the structural concrete shell was a more rationalised system in order to simplify the production and fabrication of formwork. This rationalisation ensured planarity of concrete panels between the grid lines where possible, and, where this was not possible, for the panels to be singly curved (Figure 9).

Figure 9: Parametric study for rationalisation strategy for the concrete shell. [AKT II]

Due to the doubly curved nature of a 'true' offset of the surface (A), and the 20,000 fixings for the cladding panels (B), the concrete had to be rationalised to enable the fabrication (C). This was done through the following steps:

1. Between each rib panels are generated and tested for planarity.
2. If the test fails, the panel is subdivided and tested again.
3. If the panel is planar it can be generated with flat formwork, otherwise the panel is highlighted orange and a bespoke solution is required.

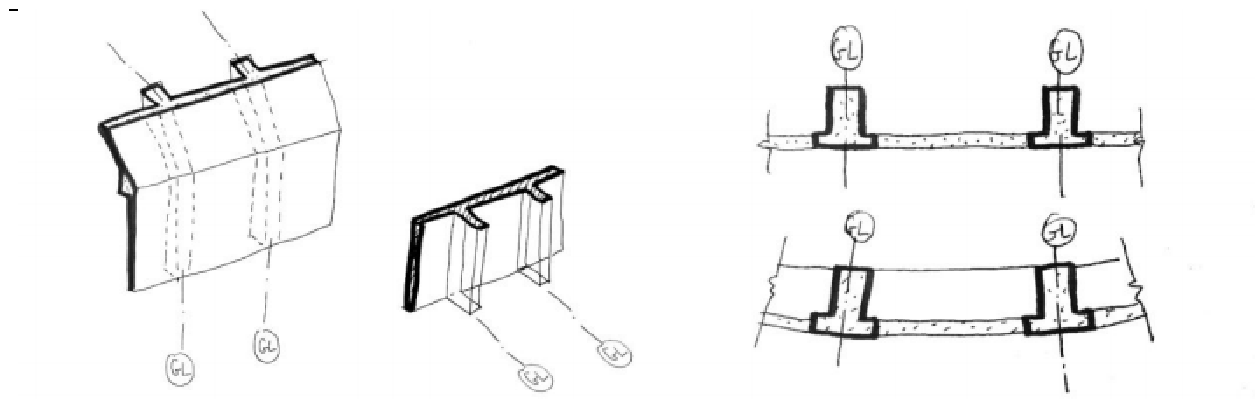


Figure 1.29 Rib and infill pannel construction

Sheet Pilling trench Excavation to be used for to create the space where the subterranean spaces are to be designed. The retaining walls are cast in-situ and is erected behind a non-load bearing gabion wall. This is to provide the sense of ground and earth as the design descends into the underground

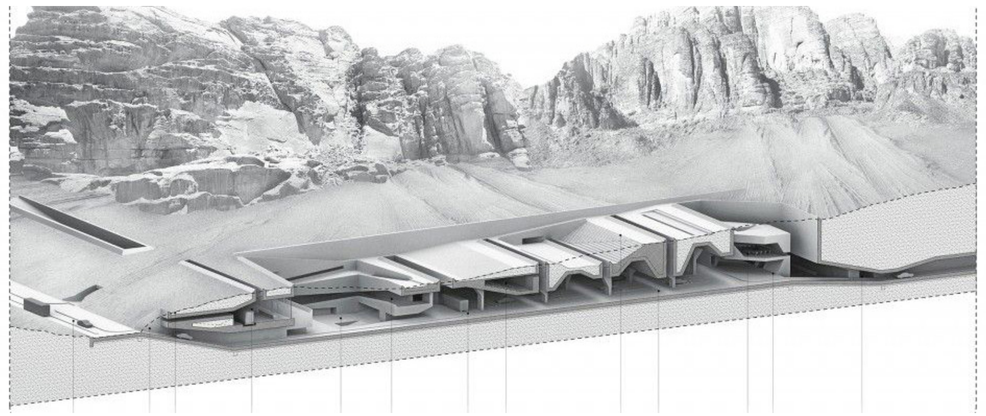
Diaphragm walls are considered due to their flexibility in shape and structural strength in retaining soil. They can be braced and tied back. In-situ concrete rib structures at indicated centers will be cast to form the internal spaces of the subterranean spaces, which will allow for unique shapes to be formed below ground while providing the necessary load bearing capacity of the soil above.

The rib structures forming the super structure of the deigns functions on the principal of a circle in how it manages loads. Similar examples can be seen in tunneling construction. Explained in image 1.37

The Sub structure comprises of the infill wall panels cast in-situ and reinforced to enclose the structure. These are cast at 400mm width, as this is the minimum thickness for subterranean structures that need to withstand the forces of the earth pressing down on it.

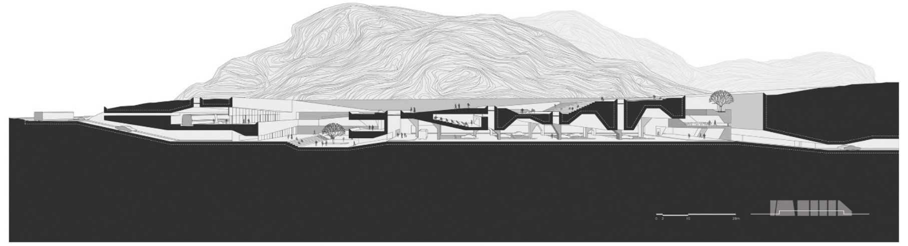
Excavation Techniques

5.1.9 Case study



Circulation tubes © Rasem Kamal

Manipulated longitudinal section – Hotel and museum © Rasem Kamal



Longitudinal section – Train substation © Rasem Kamal

water chaneling elements

The water channeling systems will be concrete form-waork incorporated into the design of the roof/ pavilion level.

5.1.10 Structural implementation

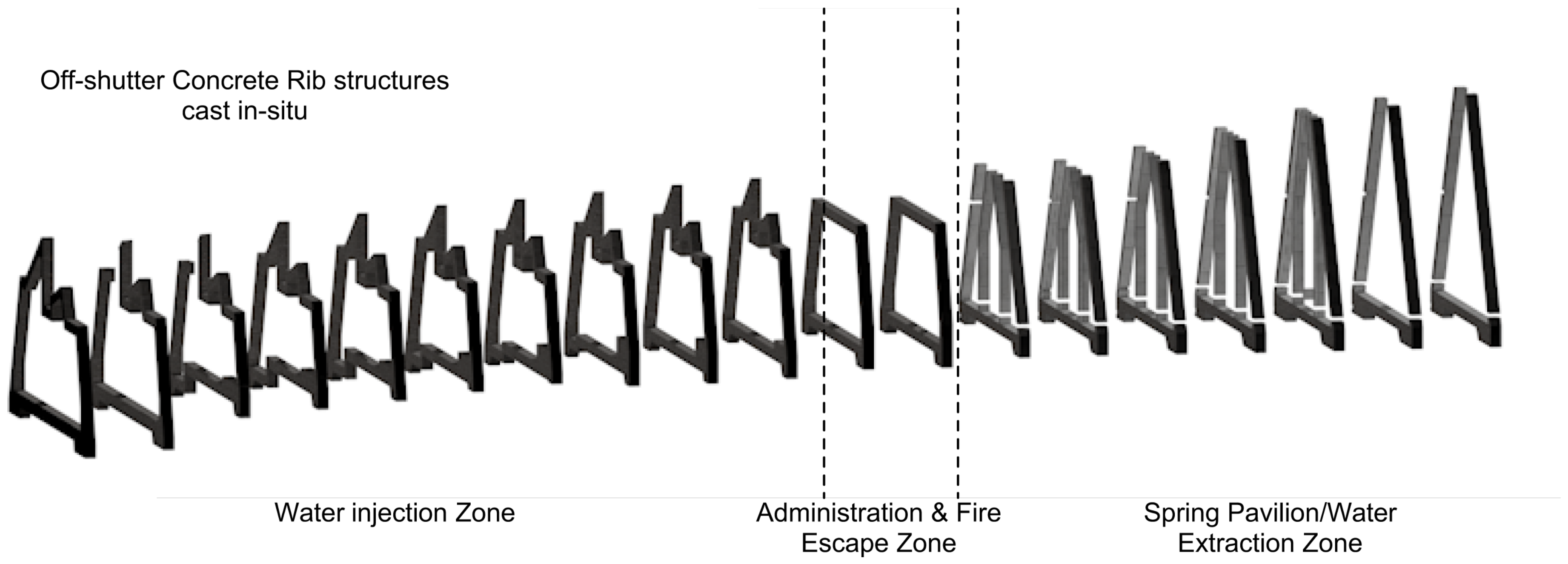


Figure 1.30

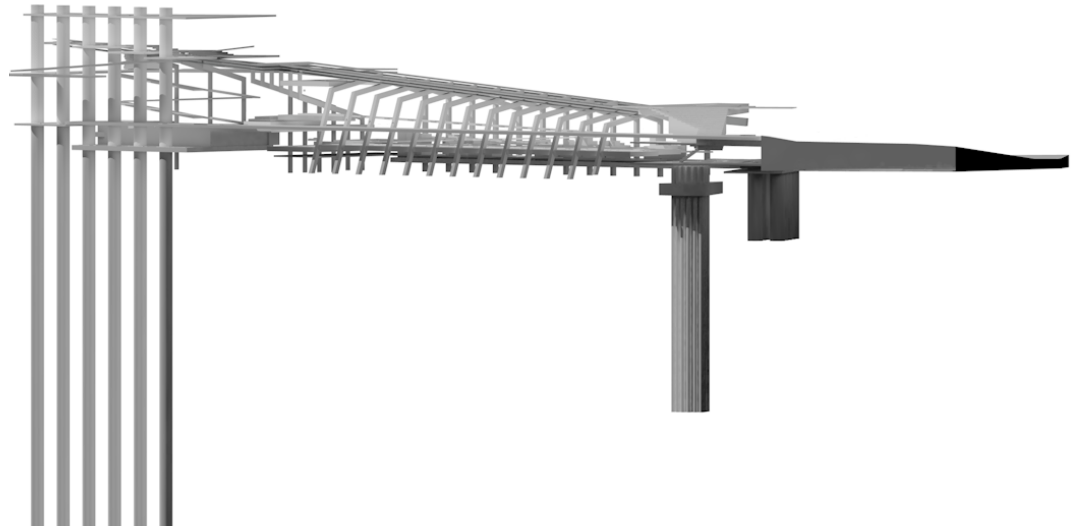


Figure 1.31 Rib and well structure combined

Figure 1.30 shows the 3 types of rib structures that make up the pavilion design. The ribs differ in shape and size depending on the function of the zone in which they are used, yet they are also shaped for aesthetic purposes and to evoke a sense of place.

The rest of the figures show s only the rib structure as it is constructed within the excavated area of the site. this is only the super structure before any of the infill or other tectonics are added to the design.

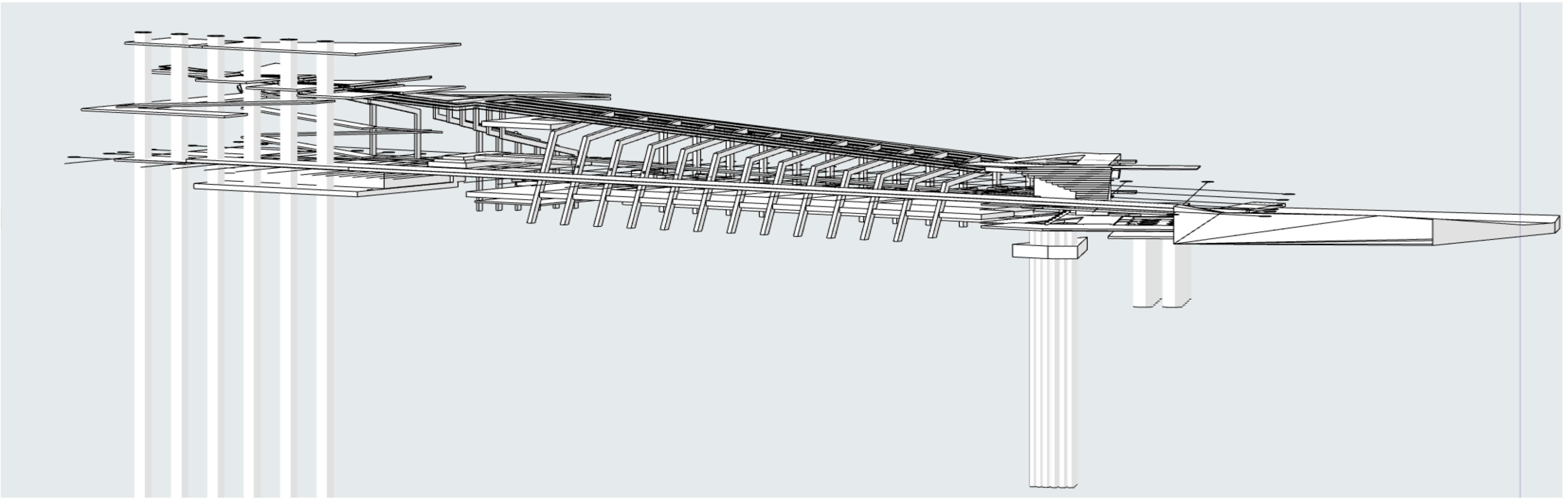


Figure 1.32 Rib and well structure combined

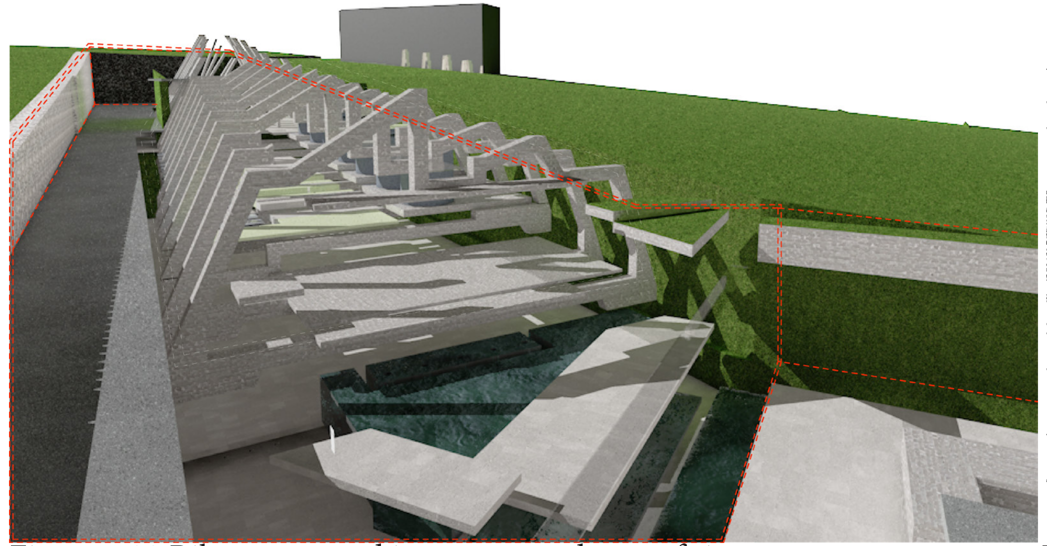


Figure 1.33 Rib consturcted into excavated part of site

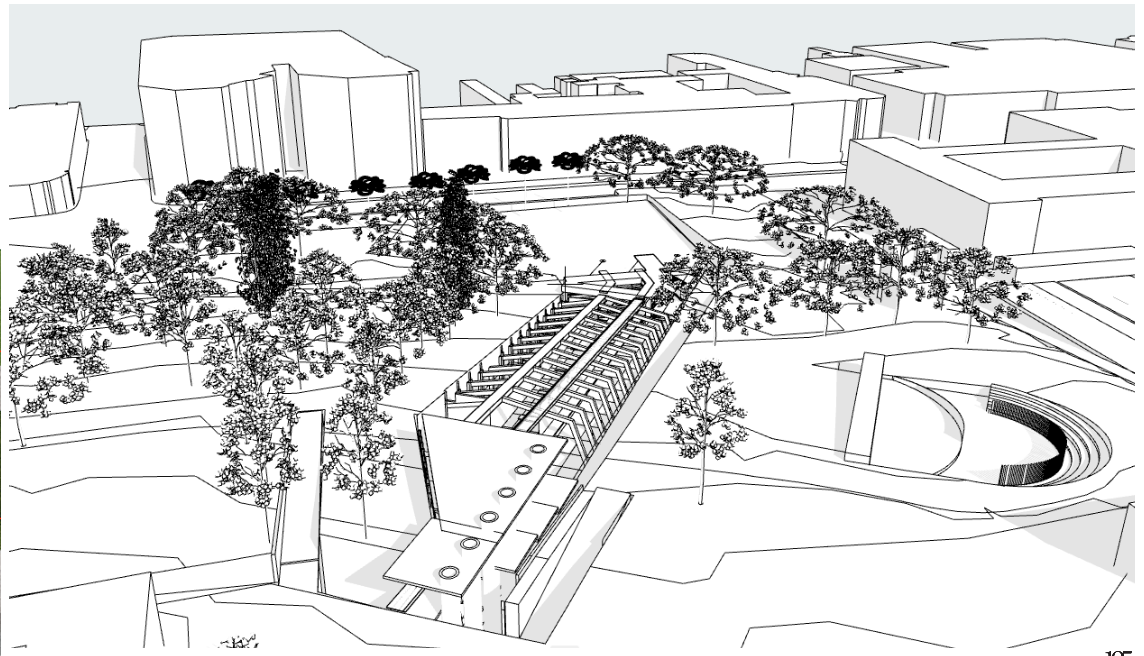
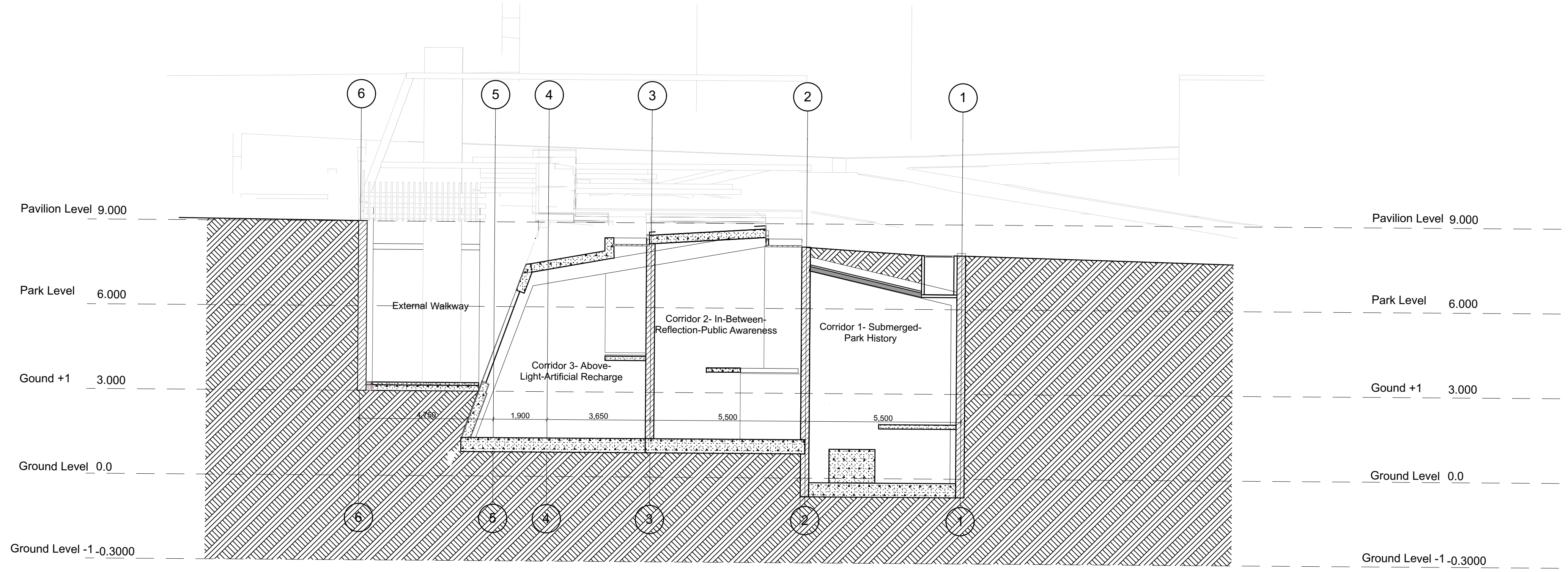


Figure 1.34 Rib consturcted into excavated part of site



Cross Section
Scale 1:100

Figure 1.30 shows the 3 types of rib structures that make up the pavilion design. The ribs differ in shape and size depending on the function of the zone in which they are used, yet they are also shaped for aesthetic purposes and to evoke a sense of place.

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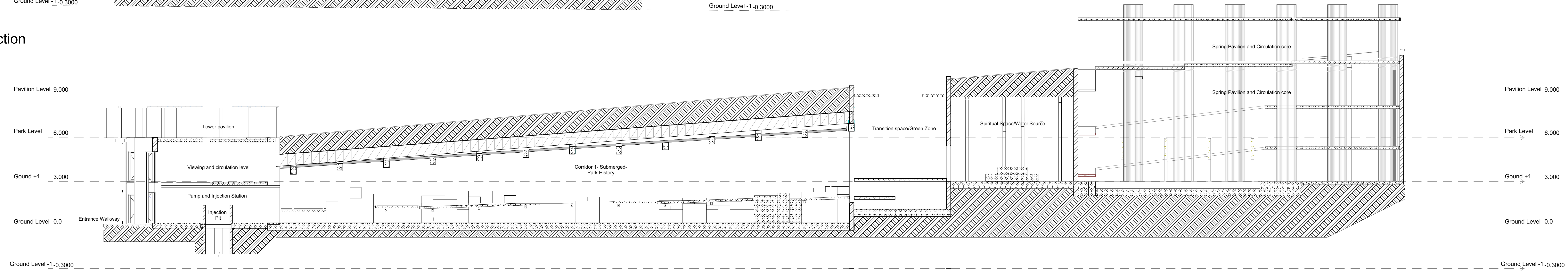


Long Section
Scale 1:100

Figure 1.35 Developmental Structural sections long and short

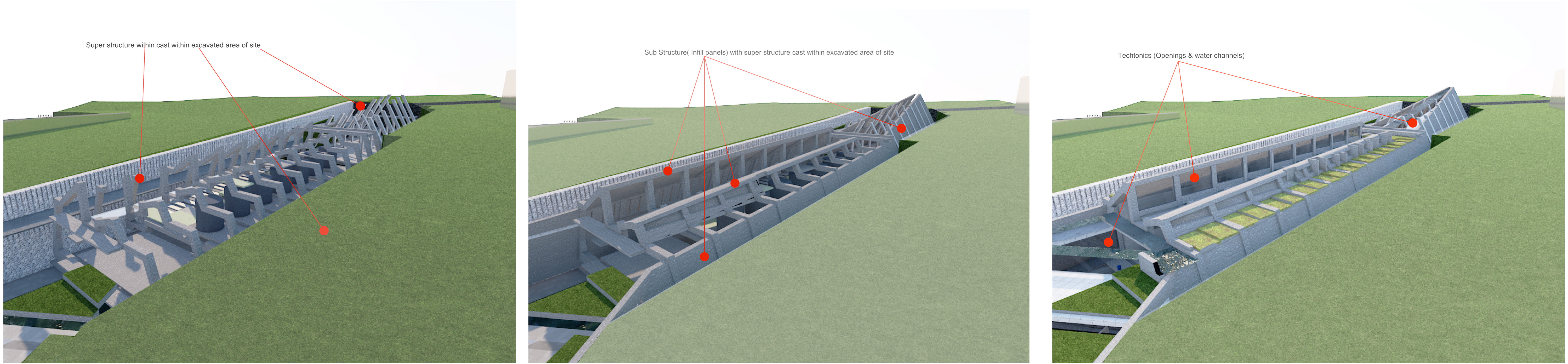


Figure 1.36 Super, sub and techtonic structures within excavated space

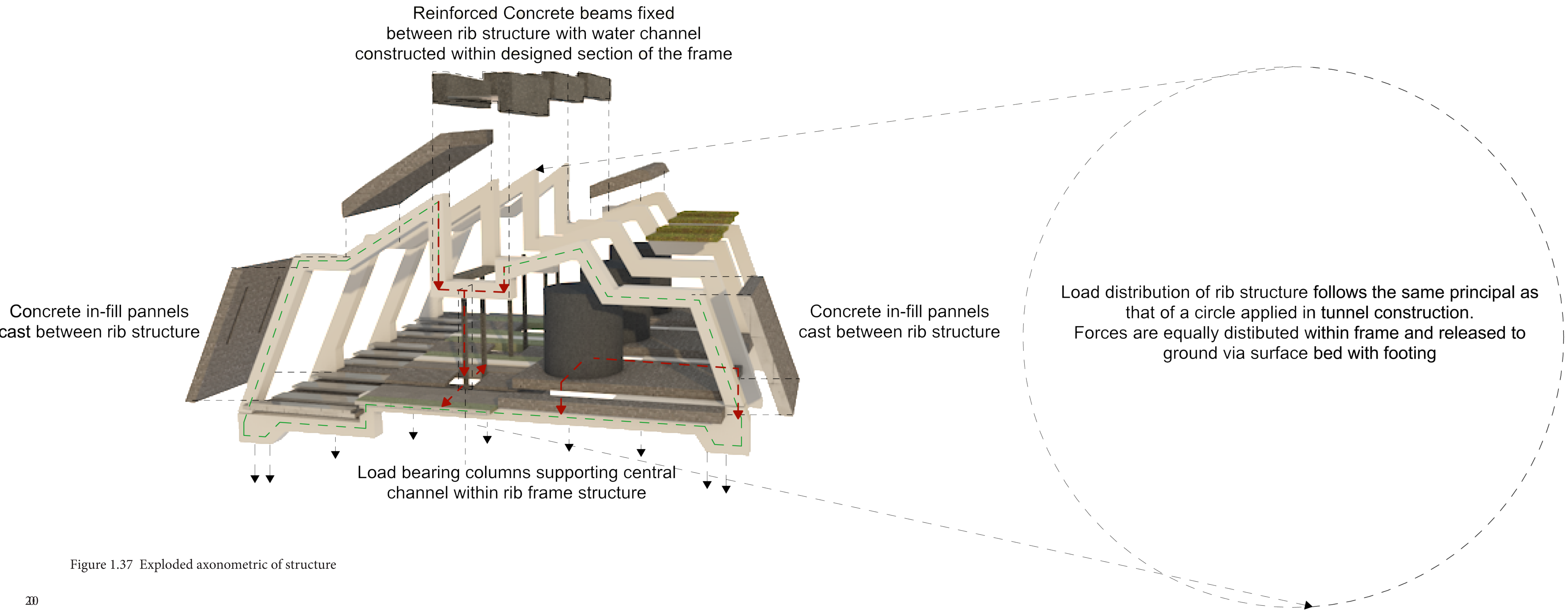
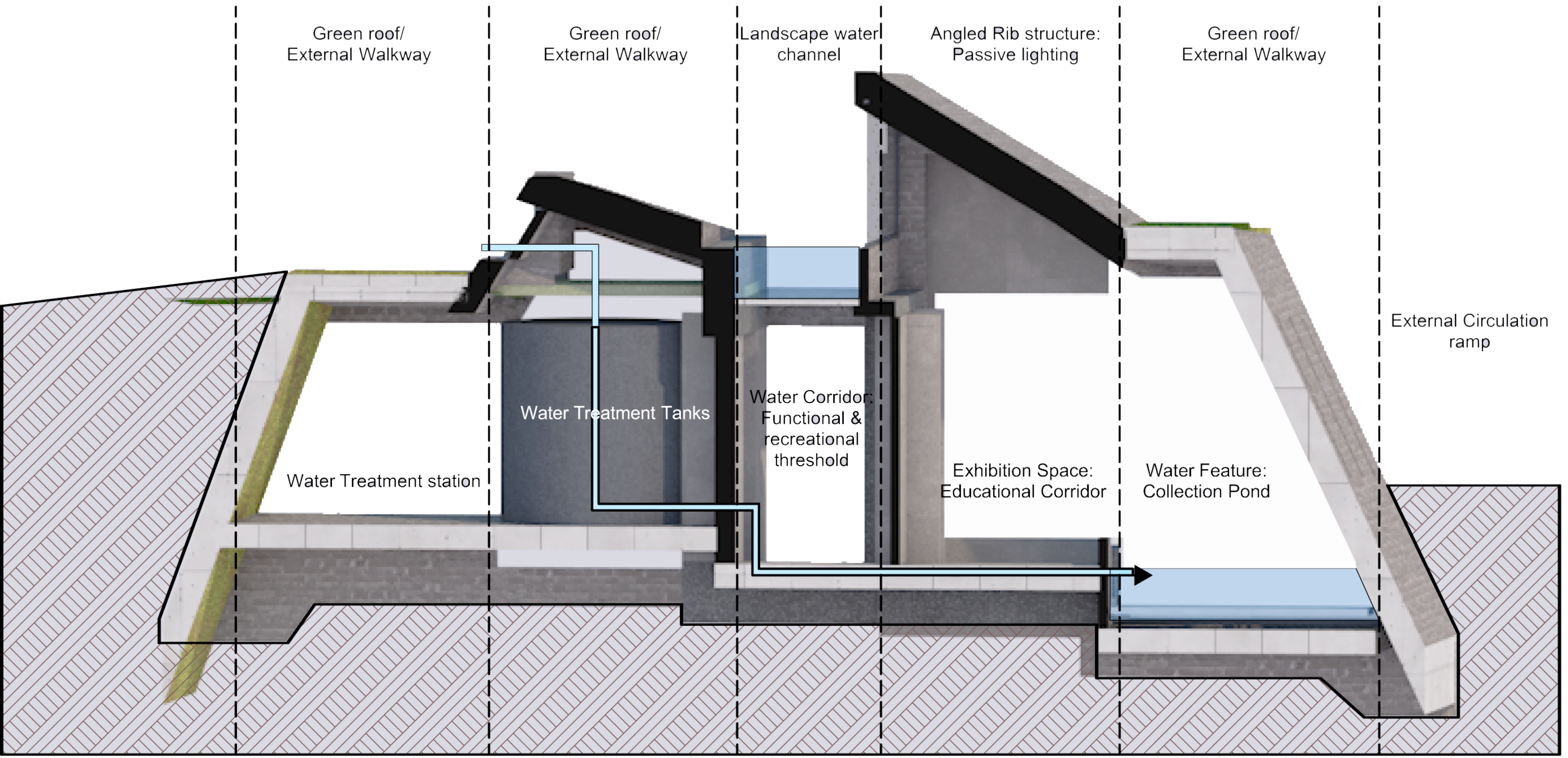


Figure 1.37 Exploded axonometric of structure

Service and passive design sections



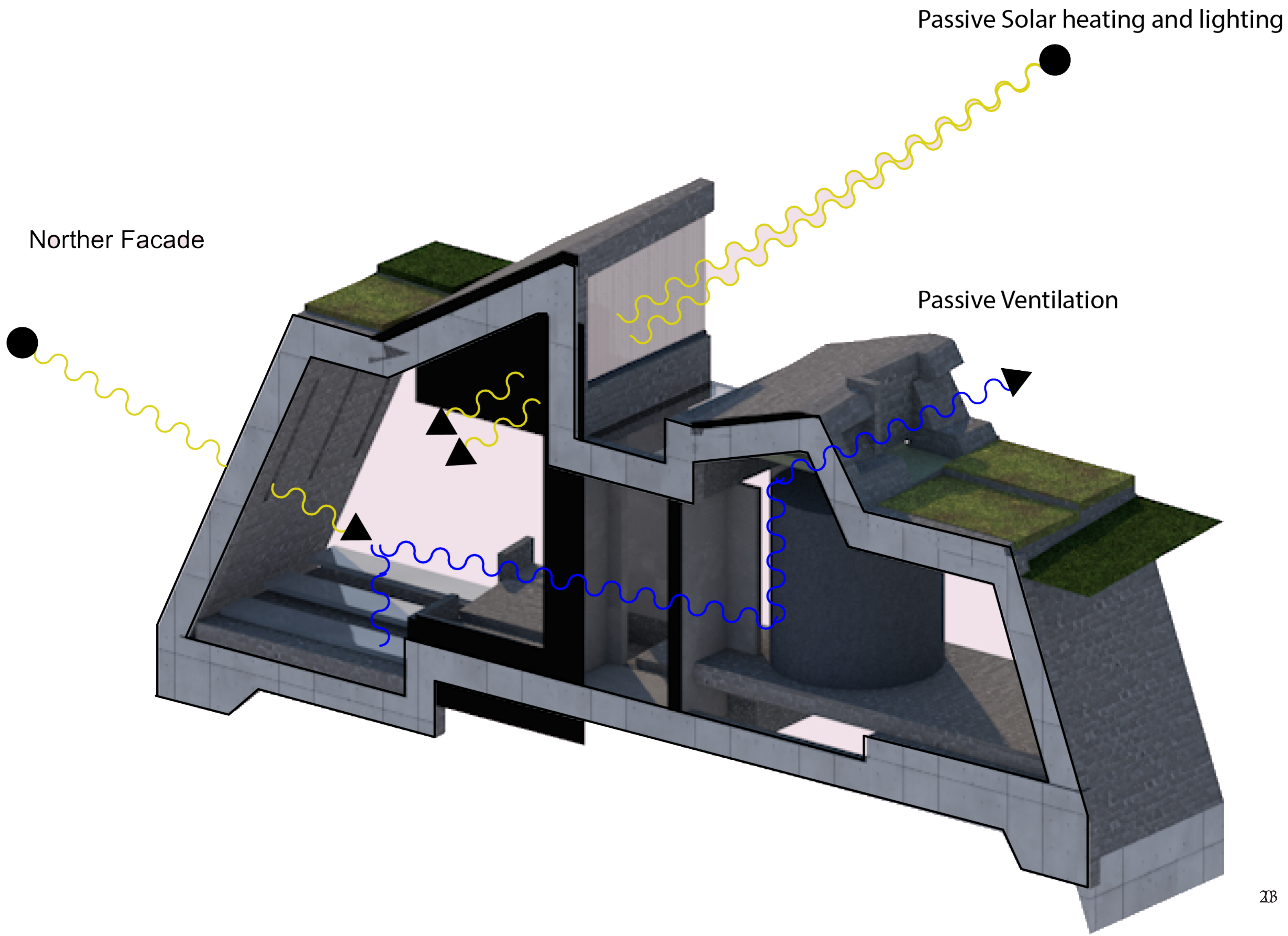
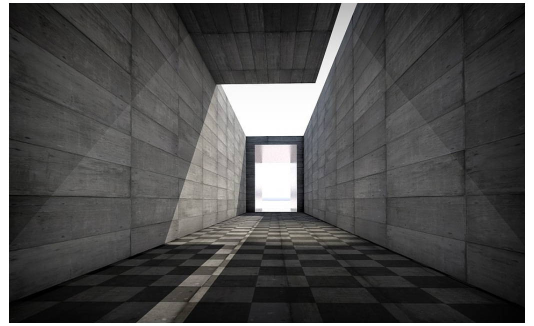


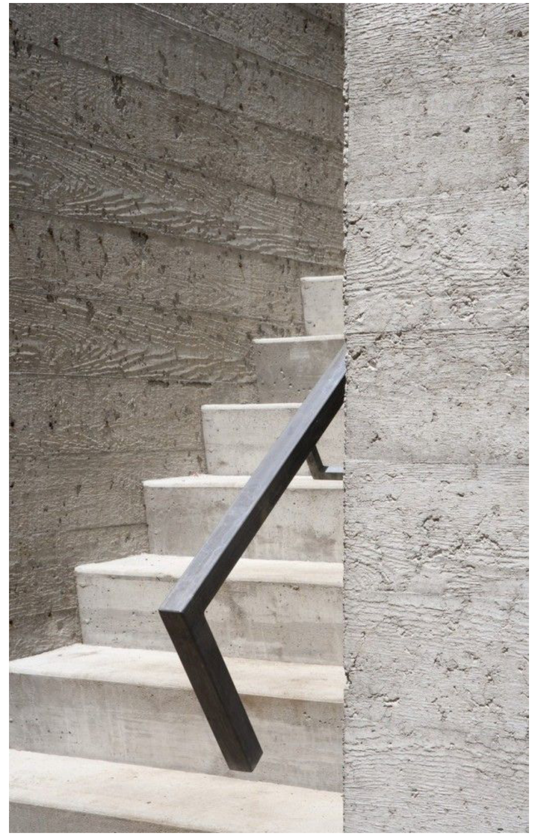
 Figure 1.38 Zonal section of water treatment zone

Materials

Expanded sheet metal facades

Sawn Concrete Finish





Stone Cladding

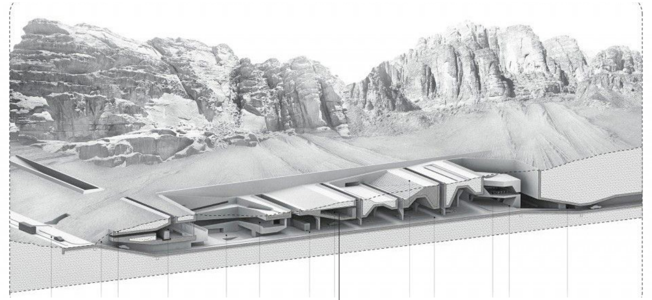
Rammed Earth

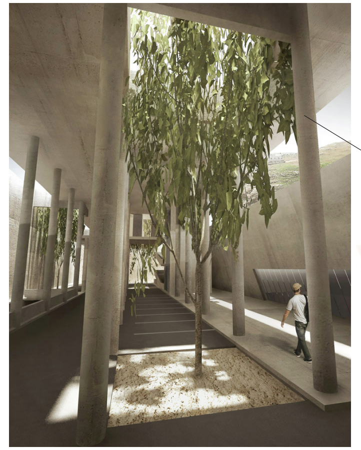
Perspective view of desired material and construction use

Internal Wall

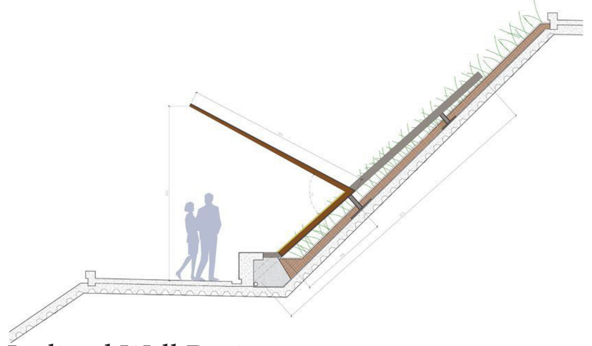
Subteranean Zone

Concrete Formwork





Cistern Chamber of Columns



Inclined Wall Design

Rammed Earth Wall

Water Channels and falls

Managed Aquifer Recharge System

Pavilion movement and ramps

Water Circulation

Passive design

Figure 1.39 Windhoek CBD potential water movement to site

5.1.11 Services

The CoW (City of Windhoek) and Nam Water have expressed their concern for aquifer recharge within the city and the potential for pollution of the underground aquifers, yet due to the variability of aquifers and the methods of injection, many of these concerns can be addressed directly.

"The Windhoek aquifer is located to the south of the city extending northwards from the Auas Mountains for 20 to 25 km as far as the city centre." (G. Tredoux, 2009) Zoo park is positioned in the city centre where the majority of the hot springs used to be. The natural spring on the site makes it clear that the park still falls within the proximity of the aquifer.

According to (G. Tredoux, 2009) "Elevated water levels occur in the north at the hot springs in the city centre of the city.", and the overall geology of this area puts the aquifer at no deeper than 70 meters.

Other injection points in the city have already successfully recharged part of the aquifer and between 2006 and 2012 "A total of 3.3 million cubic meters was injected and this resulted in some of the well-field areas being fully replenished. This is about twice the estimated annual natural recharge rate." (Dr Murray, 2017) p.7 This scheme started with 6 existing boreholes that was found to the south of the city with a high injection rate potential. These were "converted into injection boreholes" (Dr Murray, 2017) p.7

Due to the shallow nature of the aquifer below the site the conditions on site are thus adequate for injection purposes, yet as "There are a myriad of potential combinations of water sources, water treatment methods and recovered water end uses." (Declan Page, 2018) Further investigation into the water sources, treatment and end use thereof need to be considered.

Managed Aquifer Recharge

As explained in the Advances in water Resources journal, aquifers are classified as "surface, vadose zone and direct injection infiltration system (e.g., infiltration basins, detention basins, vegetated swales, and managed aquifer recharge ponds)" (Salini Sasidharan, 2018)

The first two are impractical for this proposed project as they require large infiltration surface areas, permeable sediment and result in high water losses due to evapotranspiration.

Where Dry wells "extend either vertically or horizontally under the ground surface." Where injection wells such as MAR "transmit water directly into the aquifers." The journal makes it clear that these two methods "have no or only minimal evapotranspiration losses, do not require large installations area, and may employ large water ponding depths to facilitate rapid infiltration." (Salini Sasidharan, 2018) P.168

Additionally the direct injection method of the drywell "provide no chance for contaminant attenuation in the vadose zone." (Salini Sasidharan, 2018) P.168 With the technology around this process developing due to its increase use and popularity. "Modern drywell design includes a fully permeable well that is located above the water table and may have pre-treatment systems such as single/double sedimentation chambers to remove sediment and sponges to absorb hydrocarbons in stormwater." (Salini Sasidharan, 2018) P.168

With comparison to other techniques shown in the chart, Drywells are popular "because they have a relatively low installation and maintenance cost in comparison to other engineered infiltration systems." (Salini Sasidharan, 2018)P.2 The conditions of the vadose zone above the Windhoek aquifer and its proximity to the surface, all injection bore holes/drywells should extend at least 10 meter past the waterline to prevent contamination from dissolved elements in the soil above.

Figure 1.40 Borehole pump

Figure 1.41 Treatment Station

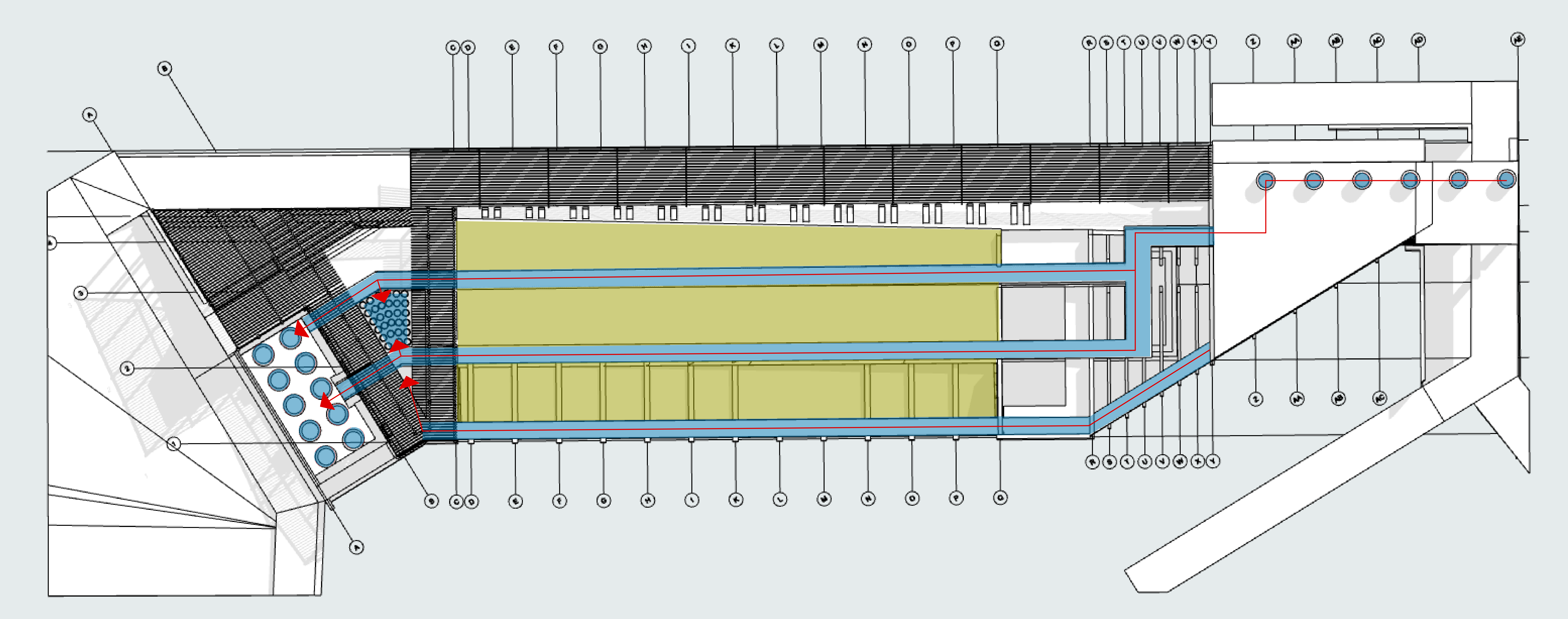
Water quality

The degree of pre-treatment will usually be driven by the source after and the aquifer type, while the post-treatment will be driven the end use." (Declan Page, 2018) The injected water is fully treated and follow the quality guidelines set out to "minimize clogging of the boreholes and aquifer. The injectant is blended at a ratio of 3 to 1 from surface/dam water with reclaimed water." (Dr Murray, 2017) p.8

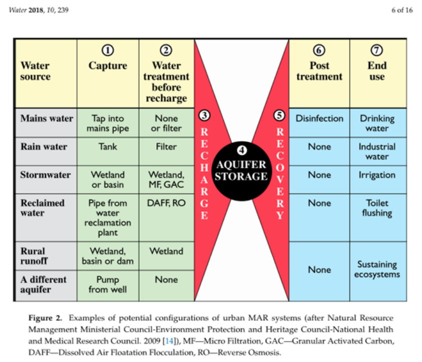
Thus, pre-treating the injected water in order to remove all the suspended solids through settling is required. To avoid any case of irreversible clogging, there will be need to remove suspended particles and chlorination. A very useful option to elevate deposition of suspended solids is to increase the distance covered by recharge water before injection. This option can be implemented with walls built into big settling-basins. "In this case water speed decreases improving deposition of particles." (Antonio Jódar-Abellán, 2017)

Operation and Maintenance

An injection attendant needs to take care of the settling basin, by cleaning it of vegetation and accumulated sediment once every four to five months.



Pavilion MAR System



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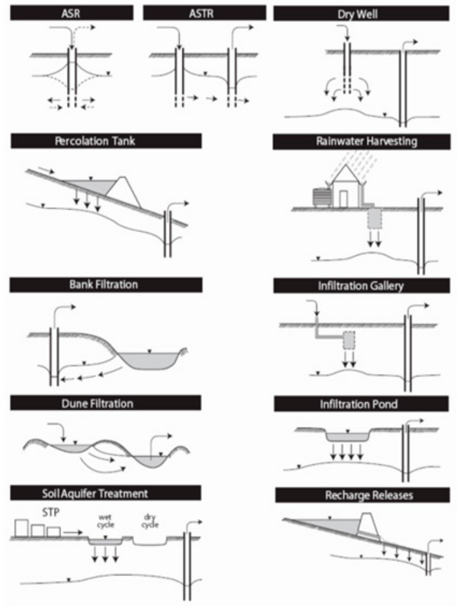
Water source	① Capture	② Water treatment before recharge	⑥ Post treatment	⑦ End use
Mains water	Tap into mains pipe	None or filter	Disinfection	Drinking water
Rain water	Tank	Filter	None	Industrial water
Stormwater	Wetland or basin	Wetland, MF, GAC	None	Irrigation
Reclaimed water	Pipe from water reclamation plant	DAFF, RO	None	Toilet flushing
Rural runoff	Wetland, basin or dam	Wetland	None	Sustaining ecosystems
A different aquifer	Pump from well	None		

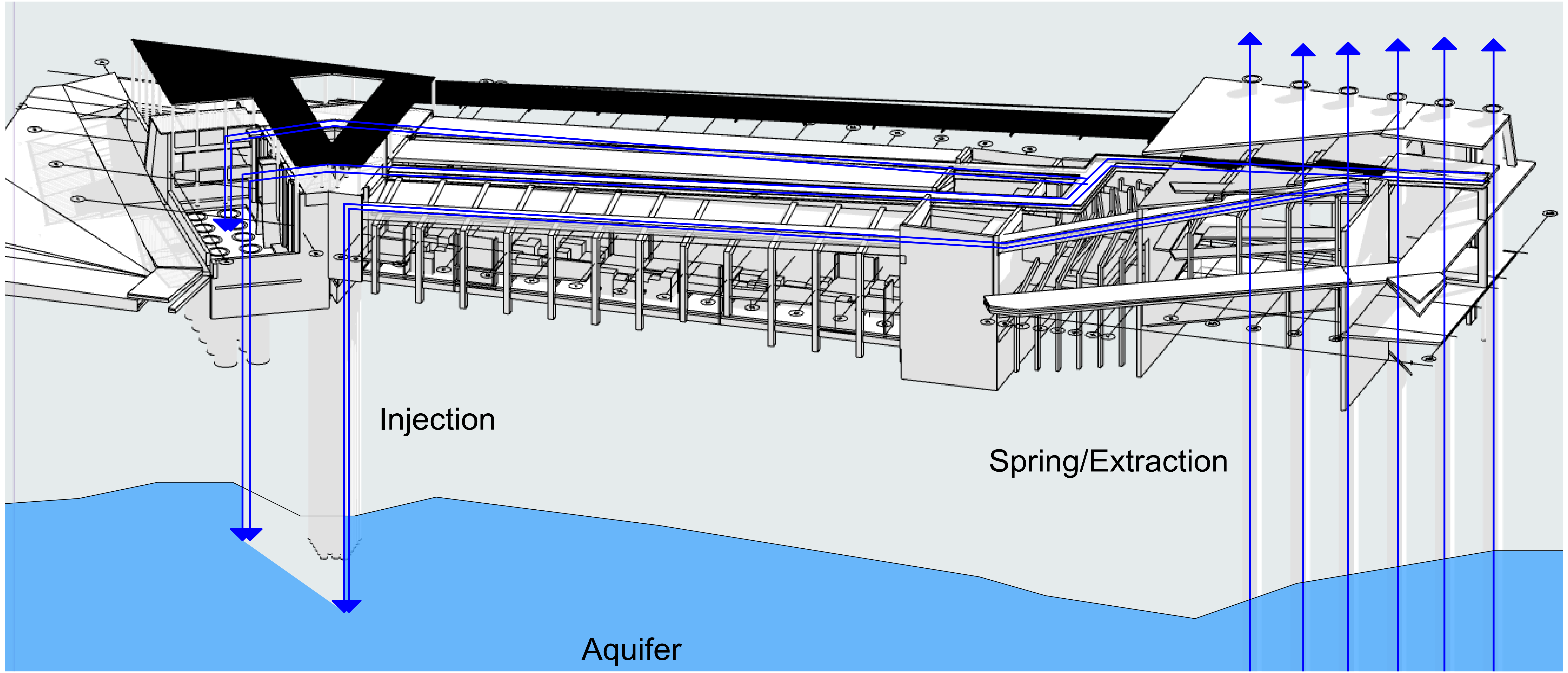
③ RECHARGE ④ AQUIFER STORAGE ⑤ RECOVERY

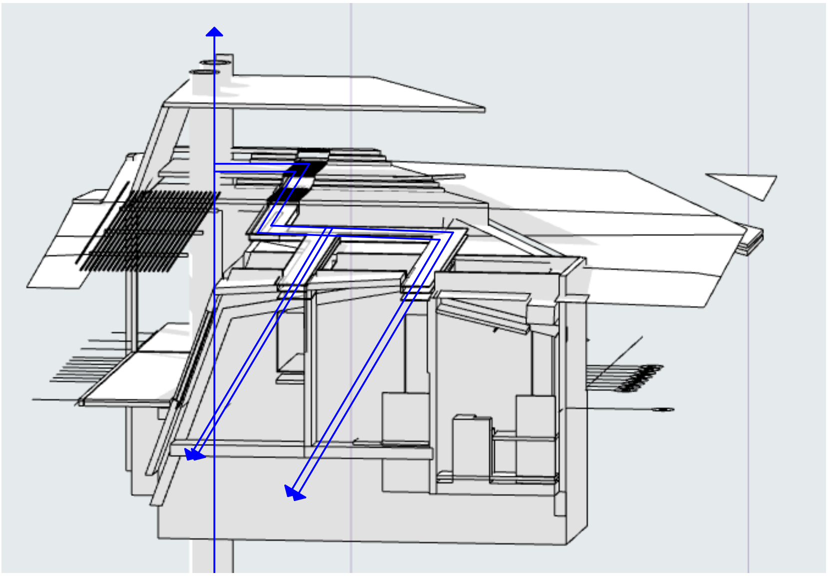
Figure 2. Examples of potential configurations of urban MAR systems (after Natural Resource Management Ministerial Council-Environment Protection and Heritage Council-National Health and Medical Research Council. 2009 [14]), MF—Micro Filtration, GAC—Granular Activated Carbon, DAFF—Dissolved Air Floatation Flocculation, RO—Reverse Osmosis.

(Declan Page, 2018)

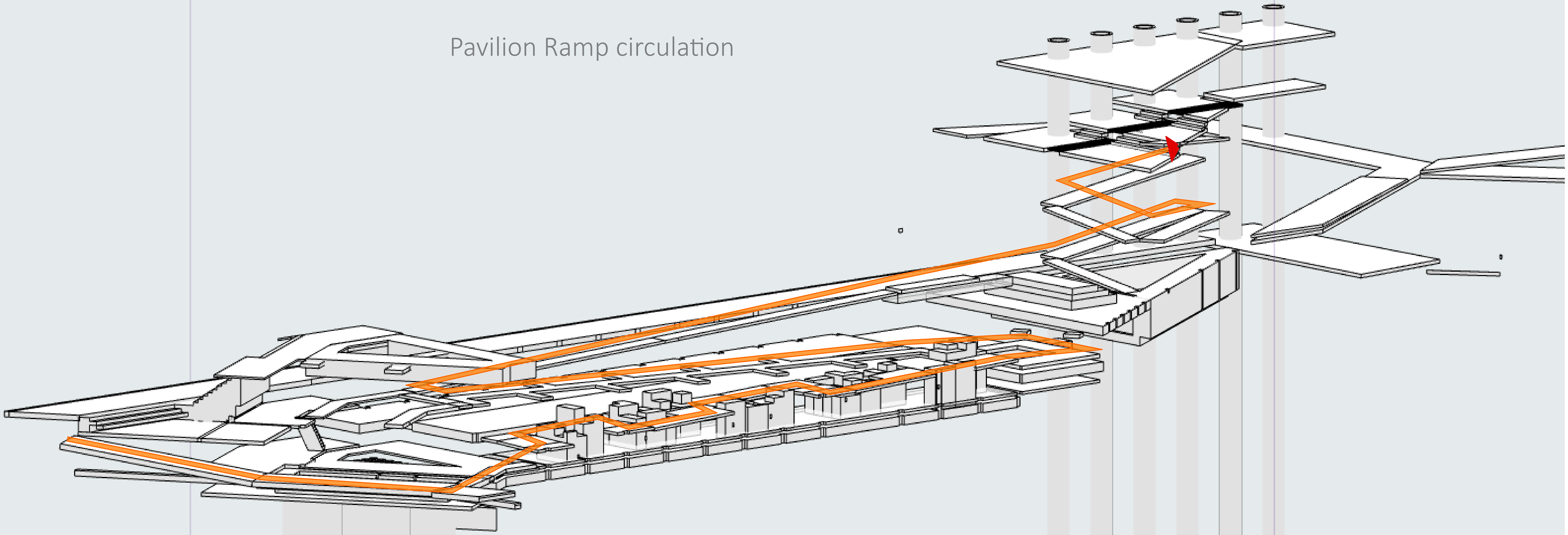


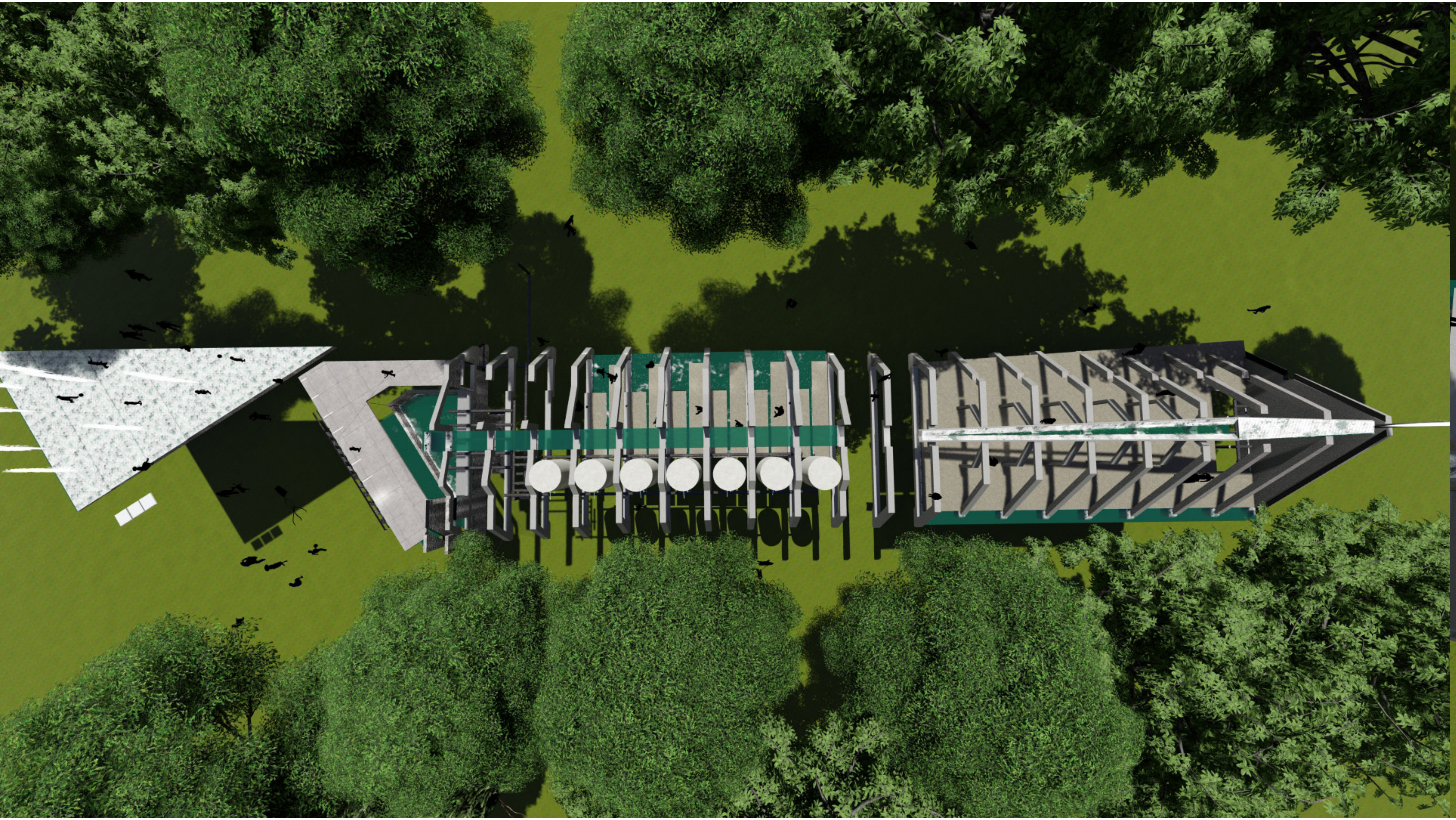
(Declan Page, 2018)

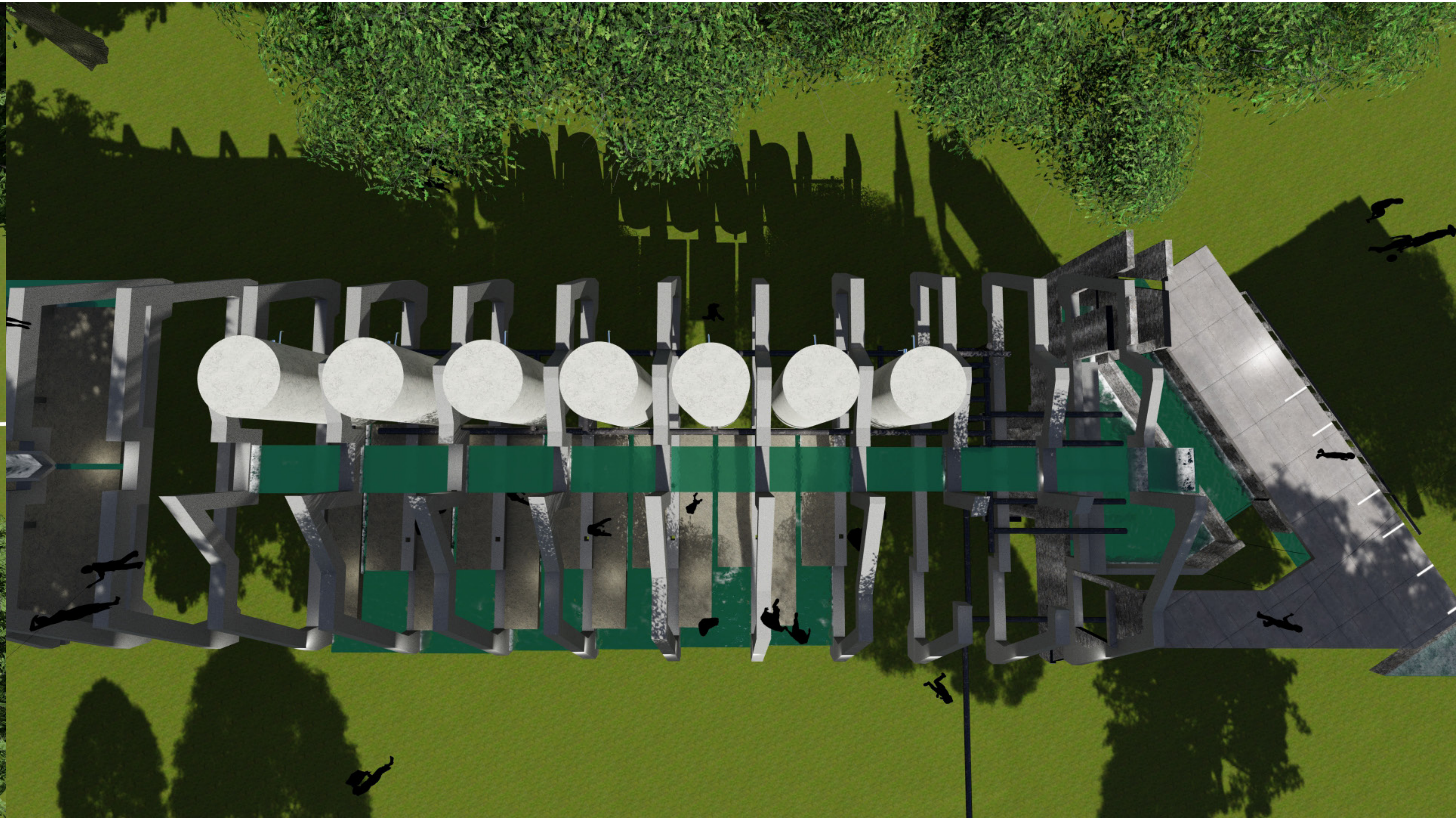


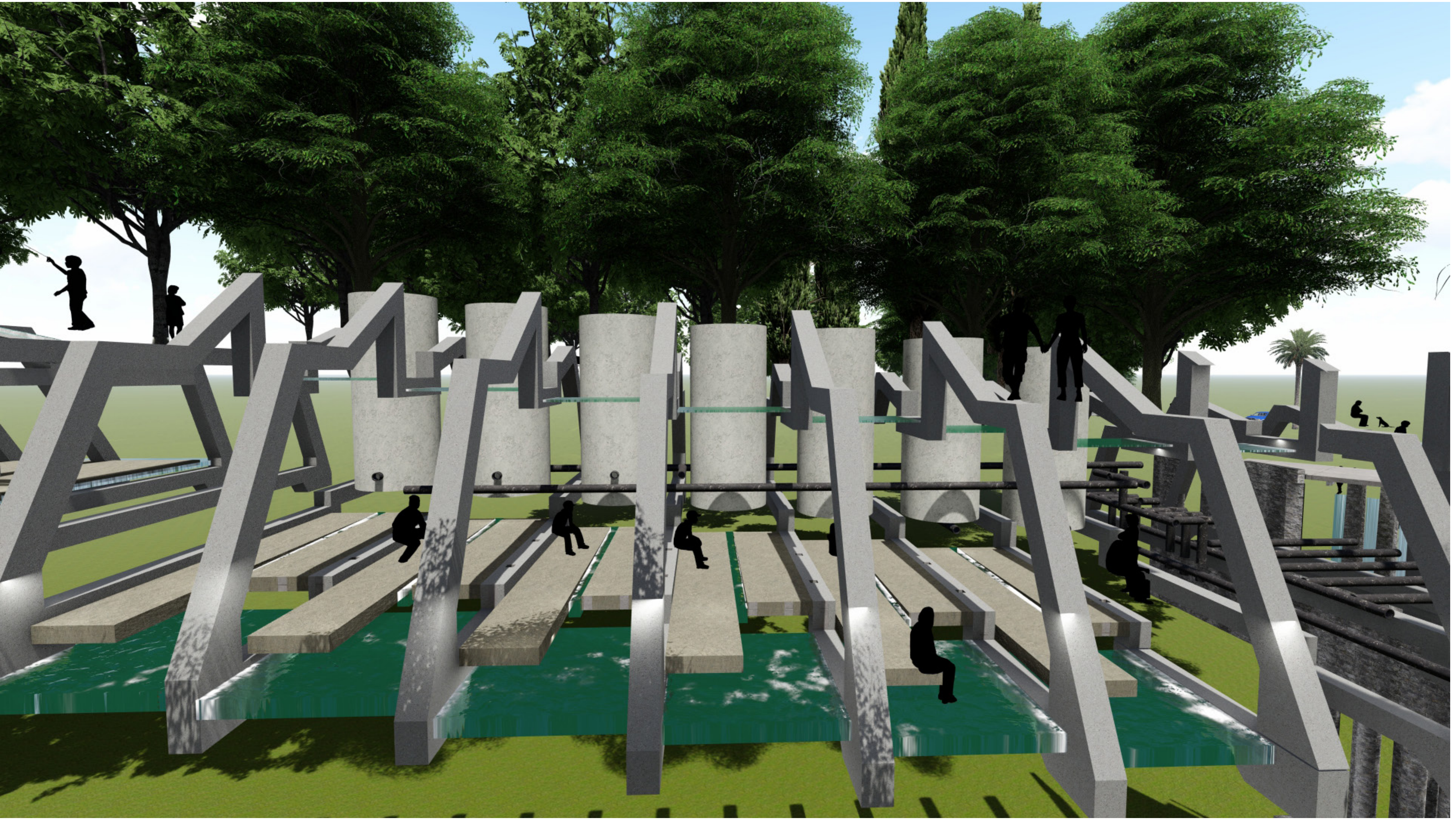


Pavilion Ramp circulation









5.2 Reflection

The compilation of this document played a key role in the design development of the project. As the book assisted me in the design process and ensured that all the relevant stages were investigated and completed, resulting in an overall finalised design proposal.

The site and the design differed drastically from any project proposal of my previous years of study. The goal was to challenge myself, to think outside the standard programmes usually compiled for thesis projects. The aim was to bring together a hybrid of functionality, aesthetic, construction and terrain. Challenging me throughout the year to bring all these together holistically with the overarching narrative of water security and how architecture could play a role in the implementation thereof.

Grounding the design in theory also presented several challenges, especially with the aim of taking the users into subterranean spaces and not only adding functionality to the proposal, but to create a journey, and environment unique to this project.

The research into the use of water and how the design can, in a passive manner, channel and inject the resource, informed the entire projects final design along with the detailed development thereof. These include an emphasis given to the slope of the site, the water carrying elements and channels within the structure, facade and internally and the exportability of the pavilion. With further emphasis given to the natural and passive cooling and lighting, that was the driving force behind the form giving.

Given the opportunity to do the deign again, the site and programme would remain the same, yet the integration with the urban environment would be given more attention and importance, as well as some of the spatial characteristics within the subterranean spaces, which could be more diverse and unique to each stage of the journey as is discussed in the theoretical discourse.

5.6 References

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