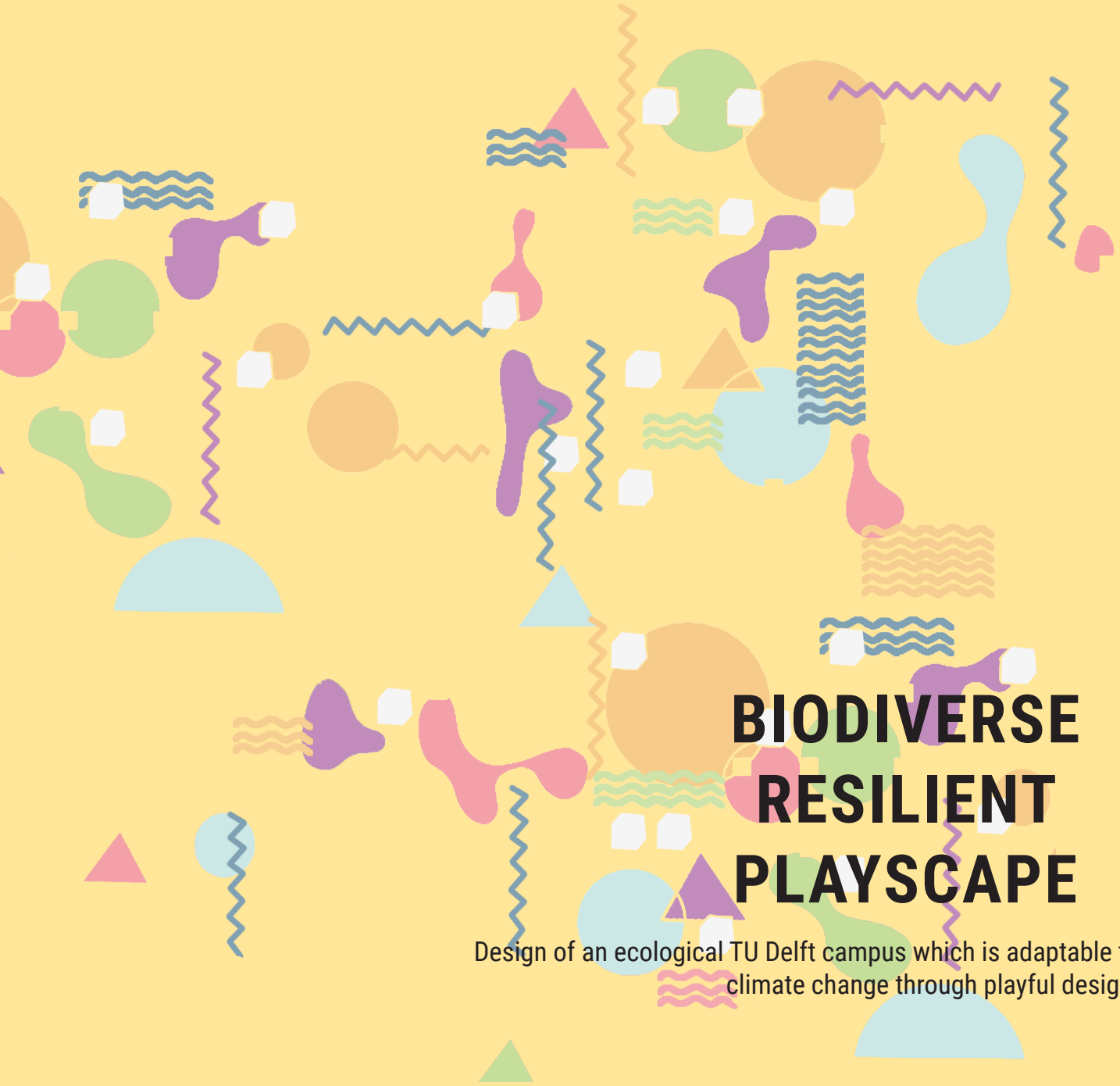


BIODIVERSE RESILIENT PLAYSCAPE

Design of an ecological TU Delft campus which is adaptable to climate change through playful design.

Biodiverse, Resilient Playscape

Design of an ecological TU Delft campus which is adaptable to climate change through playful design.

MSc Architecture, Urbanism and Building Sciences
MSc track Landscape Architecture
Graduation Studio Flowscapes 2020-2021
Delft University of Technology

Msc Thesis- P5 Report
July, 2021

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First mentor • Dr.Ir. Nico Tillie
Second mentor • Prof.Dr.Ir. Andy van den Dobbelsteen
Special Thanks to René Hoonhout

All images in this report are made by the author, unless further specified.



Figure 0-1. Early spring in TU Delft, 2021. Picture by author.

TU Delft Delft University of Technology
Faculty of Architecture
and the Built Environment

URBAN
ECOLOGY

Tu Delft Zones & Site Pictures

TU NORTH



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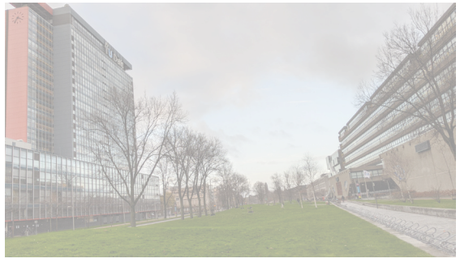


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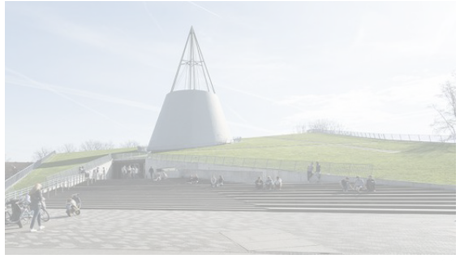
TU MIDDLE



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TU SPORTS



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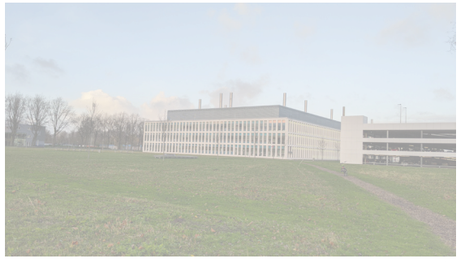


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TU SOUTH



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Figure 0-15. Parkeergebouw TNW
Figure 0-16. Dry swale
Figure 0-17. Wet meadow
Pictures by author. 2020-2021.

Preface

In front of you lies my graduation thesis report “Biodiverse Resilient Playscape”. It was written during my Master study in Landscape Architecture track in the Faculty of Architecture and the Built Environment at Delft University of Technology, with the context of restrictions and readapted academic structure due to the COVID pandemic. Despite so, I tried to make the best out of it. This thesis is the reflection of my fascination on biodiverCity (biodiversity in the city), sustainability and play.

I hope this report will strengthen TU Delft’s position on climate action. Apart from striving towards being energy neutral, the campus can also become a place for a diverse range of animals with solutions towards sustainable and vibrant campus.

Foremost, I would like to take this opportunity to thank my mentors Nico and Andy for their patience in guiding me through this graduation thesis, and the encouragement and support provided. The constructive commentary and different perspectives of my project given during the discussions were pivotal for the development of the project. I genuinely enjoyed the exchange of ideas with my mentors and discussions we had.

A special word of thanks goes to Rene Hoonhout who has been incredibly supportive of onsite activities in the campus and his enthusiasm in creating a more sustainable and ecological environment is inspiring. I am grateful for being able to share my thesis project with him. Also, the collaboration opportunity provided by him to redesign the canal in campus is special, fun and exciting. I am glad to be able to play a part in creating a more livable environment.

I would also like to thank Anna Fink, Sjef Jansen and Gabriël Geluk for broadening my perspective on different topics of my project through fruitful zoom discussions. Above all, my gratitude goes to my family for providing me with this enriching opportunity to embark on this meaningful journey of Landscape Architecture. Lastly, I would like to thank my course mates for their inspiring works, care, company, and fun despite the strange context of the pandemic. I was refreshed and heartened to meet up with them in and out of the Bouwkunde and recharged through our fun and inspiring excursions.

Have fun reading this report!

Delft, June 2021

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Abstract



Figure 0-18. Sheep grazers at TU South, 2021. Picture by author.

With rapid urbanisation and urban sprawl, biodiversity in the Netherlands is rapidly declining with a 70% reduction of species since 1900s. The TU Delft campus is part of The Hague-Rotterdam metropolitan region and an important green-blue connector with the surrounding forest-meadow-river landscape. However, there are limited opportunities in the human-centric campus to accommodate other species. Also, with the added pressure of climate change, the campus experiences more intense precipitation and longer drier periods. The lack of a stimulating environment falls short in igniting a sense of environmental stewardship which would contribute to sustainable practices for the urban ecosystem.

In view of the situation, TU Delft is envisioned as a **biodiverse, climate resilient** and **playful** campus. Play is not only for children, it is for everyone since it encourages engagement amongst humans, the built environment, plants and animals. The approach of the project is guided by the key principles and tool kits generated from case studies and theories. 20 existing fauna species in Delft are identified to allow for the consideration of potential species to be accommodated on the campus.

Strategies of different scales are implemented to achieve the redefined campus. Through understanding the landscape characteristics on the regional scale, the surrounding landscape characteristics of forest, river and wet meadow is extended and introduced into the campus. Patches and corridors are improved and increased through methods such as multi-tiered planting. Helophyte filters are designed along waterways and a cleansing biotope system is added along the Schie to ensure good quality water for habitat creation and play. Mobility network is restructured to transform streets into parks. Buildings are involved in the creation of vibrant campus by providing opportunities for human play, hosting habitats, and storing water.

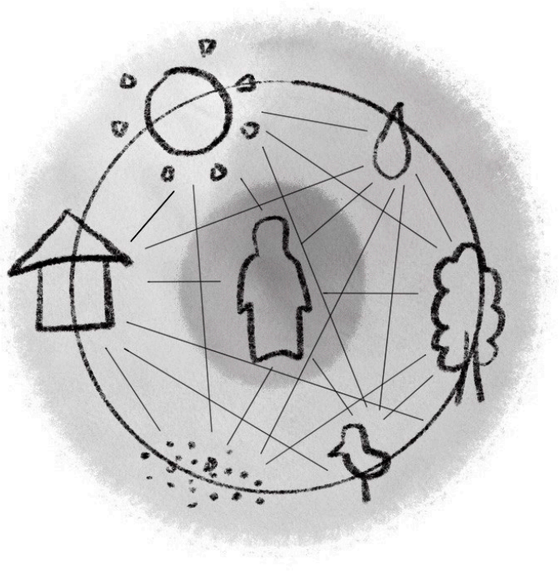
With that, the TU Delft campus shall become a vibrant and fun campus city for all, with an ecosystem that supports other species apart from humans. During extreme climate scenarios, the campus is also able to cope with heat and water stress with its self-regulating system.



Figure 0-19. Framing landscape, Abtswoudsehoeve.
Picture taken by author.

Play

play is for all



1.PLAYFUL HUMANS

A playful human interacts with his environment through his own interpretative manner that activate his 5 senses or curiosity.

2.PLAYFUL LANDSCAPE

A playful landscape evokes a playful human by crafting a stimulating interaction experience with man.

3.PLAYFUL CITY

A playful cities rethink the relationship of its building blocks.

Figure 0-19. Play is for all, not only children.

01

INTRODUCTION

*M*otivation
Project background
Historical timeline
Natural landscape
Challenge I. Dwindling biodiversity
Challenge II. Vulnerability to climate change
Challenge III. Disassociation of people with their environment

“Play is a natural instinct for humans”

- Huizinga



Growing up in a hustle and bustle city, every opportunity to be outdoors for leisure and fun becomes really treasured. Be it climbing an adventure tower to get close to the rustling leaves or building a little sand dike only to let it be taken away by the waves the next moment. The light-hearted nature of play brings me comfort, peace and connects me with my environment. I feel that I am part of nature. That is the power of play. It is simple and innate. Can play do more? The benefits of play for children development have been established by comprehensive research. But I wonder about the potential of play in mitigating the problems of today’s cities. With the current problems of climate change, dwindling biodiversity and disassociation of people and their environment, play might just be the solution.

My fascination for ecological playscapes and research theme of ecological design with a balanced city ecosystem direct me towards this Urban Ecology and Ecocities studio. I am interested in finding out how we can look for opportunities in urban settings to integrate biodiversity and to allow flora and fauna to flourish. From large scale green networks to mesoscale infrastructure network and building integration, there are many opportunities for habitat creation and diversity inclusion. I strongly believe that the benefits of ecosystem services would allow us to reimagine the quality of urban living. Also, to understand urban metabolism as an interweaving network of humans, flora, fauna, and our environment and seek the benefits reaped.

Figure 1-1. Author climbing a tree in Whanganui, New Zealand during her volunteer farming, 2017.

Project background



(key map) The Netherlands, Randstad Region



Figure 1-2. (top left) Population change of cities in the Randstad Region between year 2000 to 2004 (CBS, 2019)

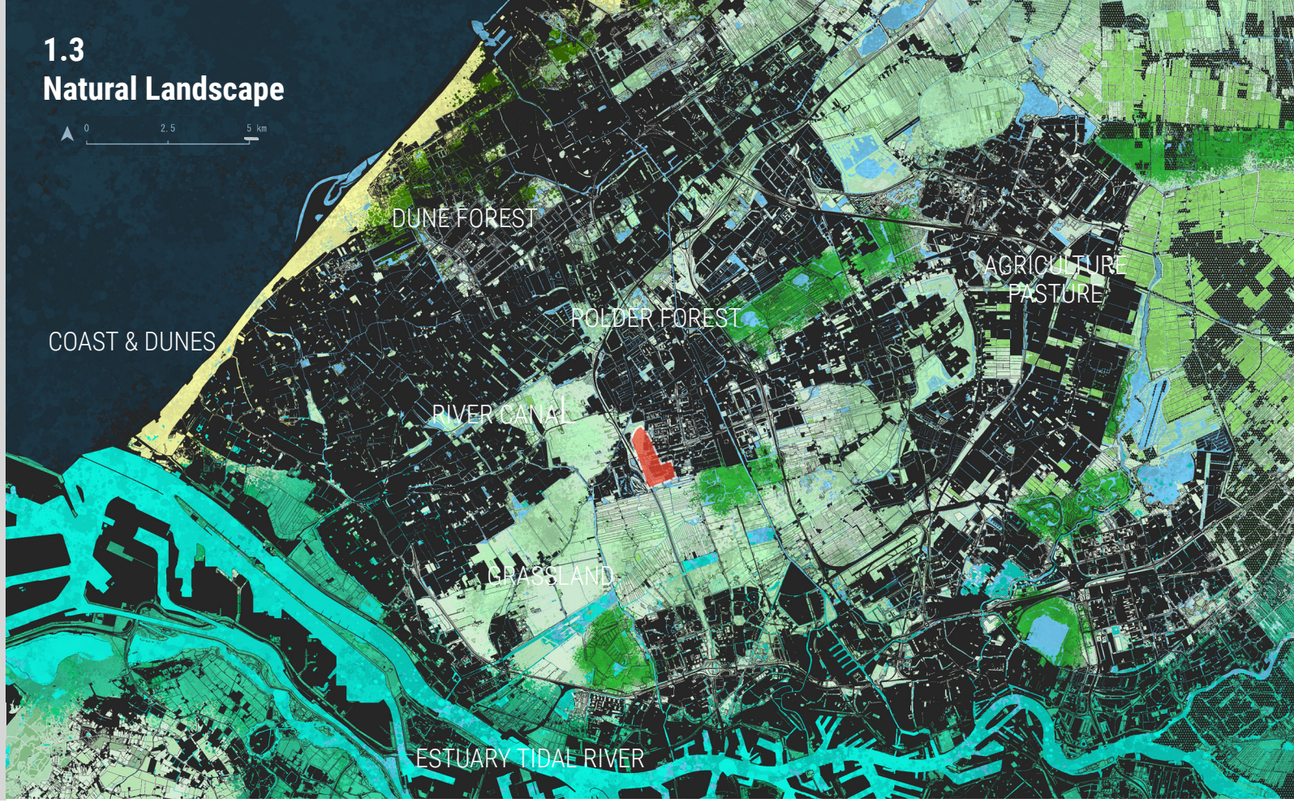


Figure 1-3. (top right) Landscape characteristics of South Holland Province. Data from QGIS. Redrawn by author.

Location

In the Netherlands, 91% of the population live in urban areas (H. Plecher, 2020) and this number is rising. Randstad is the most densely populated region with an increase of 217,000 people living in the city from the year 2000 to 2004. City centres, in particular, have enjoyed a resurgence of population growth, especially regarding families with children (Evers, D., Tennekes, J. and van Dongen, F., 2015). Zuid-Holland province is the most populated province in the Netherlands (CBS, 2019) With more and more people living in cities, the planning and design of cities becomes important in influencing urban lifestyle and how people perceive nature.

Delft is part of the Rotterdam–The Hague metropolitan area and together with other Randstad cities, they collectively surround the Groene Hart. The Groene Hart is a protected wet lowland zone with limited urban sprawl and it is important to Dutch meadow birds. There is a connection through sporadic patches and corridors of agriculture pastures and nature meadow towards and around Delft city centre and beyond towards the polders in Maasland.

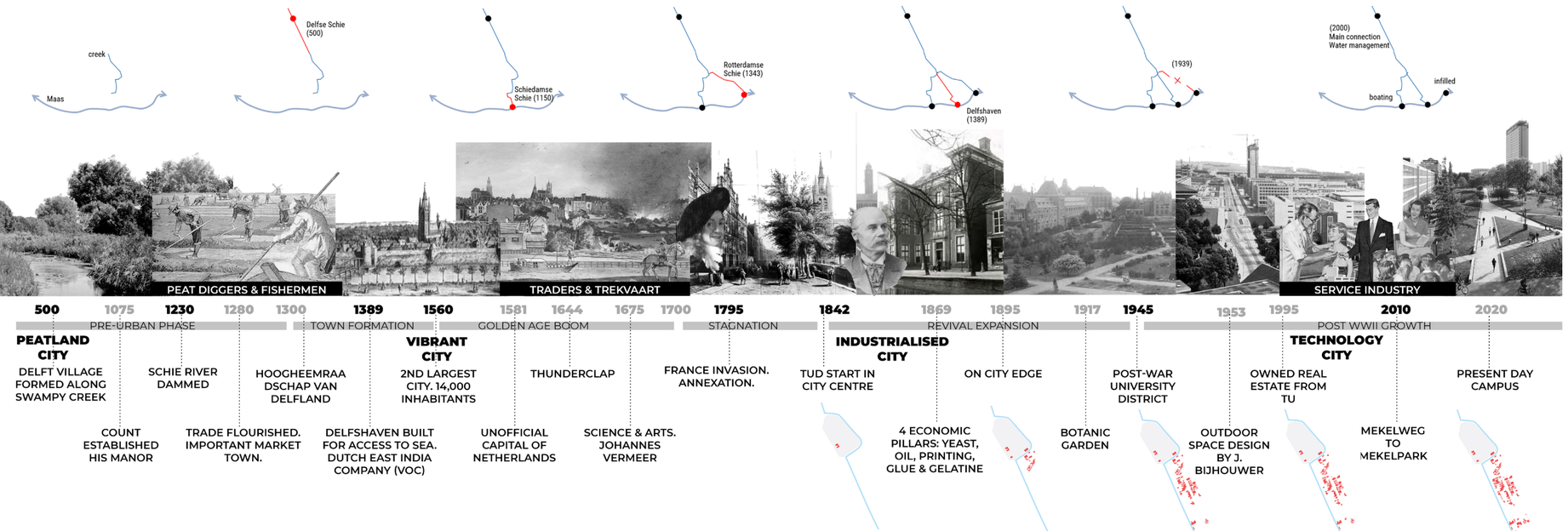
Regional Landscape Characteristics

Just within 2km from Delft city centre, one can already gain access to natural landscapes. There are different landscape characteristics surrounding Delft. Towards the North of Delft, around The Hague lies the coastal and dunes strip with subsequent patches of dune forest. Towards the South of Delft lies Rotterdam which is characterised by the estuary tidal river landscape. There is also the open agriculture grassland and nature meadows between Delft and Rotterdam.

Delft was formed on higher ground along a creek and its' development was closely linked with the transformation of the Schie and its neighboring city Rotterdam. The historical timeline of Delft in this report (figure 1-4) will explain the key historical events of Delft city, the development of the water channels and the physical expansion of the TU Delft campus.

Historical timeline

Development of Delft and the TU Delft Campus



Delft derived its name from 'Delf' or delven which means dig. Back in Roman times, Delft was formed on a higher ground along a canal which was dug from the original Schie, swampy creek. As Delft developed into a city, the Schie was extended southwards and dammed, forming Schiedam in 1150. Schiedam was an important city as it levied toll on ships.

In 1246, Delft flourished as an important market down with the city charter granted by Count Willem II. The Hoogheemraadschap van Delfland, Delfland waterboard was formed in 1317.
With the construction of Rotterdamse Schie in 1343, there was a split of power over the connection to the northern hinterland. To better compete with Rotterdam, the Delfshaven was built in 1389 to connect Delft to the sea through river Maas. Delfshaven thrived on ship building, distilleries, and fishing activities.

In 1400, vibrant and prosperous Delft was 3rd largest city with 6,500 inhabitants. Delft as one of the leading cities of the Netherlands in 1572, was equipped with necessary city walls to serve as headquarters during the Eighty Years' War against Spanish occupation. In 1581, Delft was an unofficial capital of Netherlands.

During the Golden age of 1665, Delft was known as 'the Mona Lisa of the North', with the great works of Johannes Vermeer. In the 17th century, the Dutch East India Company was formed. Delft grew and dug peat forming large lakes in the surrounding landscape.

In 1842, Delft University of Technology (TU Delft) was started as one of the four universities of technology in the Netherlands with strong tradition in water management and hydraulic engineering. The first facility was located in the city centre. Delft eventually expanded southwards into the agricultural polders.

During the WWII in 1939, the rubble from Rotterdam city was used as a backfill for Rotterdamse Schie. The post war period of 1950 was revitalized by harbor trading activity to drive the economy.

Today, Delfshavense Schie is used for water management and as the main shipping connection with the Nieuwe Maas while Schiedamse Schie is little used for boating.

Figure 1-4.Delft historical timeline. Drawn by author.

Delft city

On the macro scale, Delft city is decomposed into its different basic structure: geological soil type, palimpsest patterns, mobility patterns, water management system, district zones, green structure and housing types.

The historic Delft city centre comprise mainly commercial programs in historical buildings and squares. Towards the south of the city centre across the Schie, the TU Delft campus begins and extend alongside the Schie, is intersected by the N470 regional road and ends with the Akkerdijkse Bos nature reserve. There are plans for TU South to develop into a business park (Technopolis). The campus is separated from the Schie by a dense arrangement of industrial buildings. To the east of the A13 are the Emerald residential area in Pijnacker and Ruyven business park. To the east of this is a greenhouse horticulture area. The southeastern part of the Zuidpolder mainly consists of grassland and nature, with a few scattered houses and greenhouses.

Green structure reveals the surrounding green ring network and the main blue Schie canal connecting northwards to The Hague and southwards to Rotterdam.

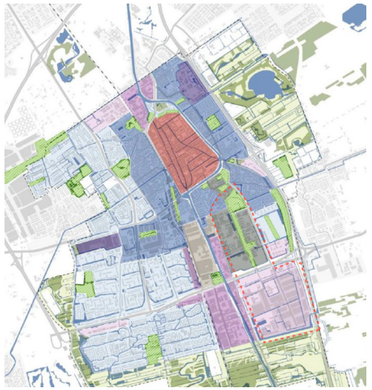
TU Delft is located in the Zuidpolder from Delfgauw. Zuidpolder is drained by two pumping stations, both located along the Schie within the campus area on the western polder border, namely the Balthasar van der Pol pumping station and the Zuidpolder pumping station. The Delftse Wippolder has a mixed sewer system, known as 'Zuidplantsoen'. Wastewater and rainwater are both collected in this system and transported through the sewage pumping station to the Delft collector sewer. The TU district has a separate sewer system. Domestic wastewater is collected and disposed of separately, and rainwater is discharged locally via the rainwater drainage system within the polder. (Hoogheemraadschap van Delfland, 2014)

The layered analysis reveals the previous polder alignment patterns in the campus and historical creek during 250 BC.



Historic alignment & Soil type

- Water canal
- Polder lines
- Road infrastructure
- *250 BC soil type*
- Peat
- Heavy clay (river plain)
- Sandy clay (mudflat)



Building Types

from ("Nota Groen Delft",2013), Redrawn by author

- Park
- Peat meadow
- Forest
- Historic city centre
- Urban work zone
- Green urban transformation
- Urban residential
- Green urban residential
- Care area
- Education campus



Transit Orientation

- Highway
- Provincial road
- Minor road
- Train route



Water Management

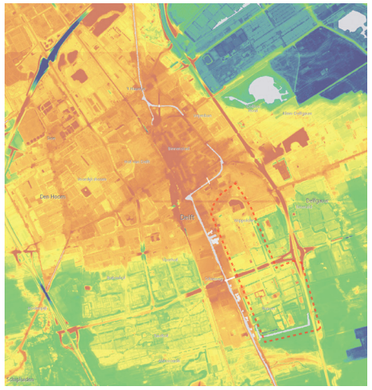
- Water pump

Waterboard NAP Level

- -0.4
- -1
- -1.3
- -1.6
- -2.0
- -2.9
- -3



Districts



Height

from ahn



Green Structure



Historic creek 250BC

Paleogeografischekaarten from RCE, Redrawn by author

Figure 1-5. Series of Delft City layers, TU Delft campus outlined in red. Adapted and drawn by author.

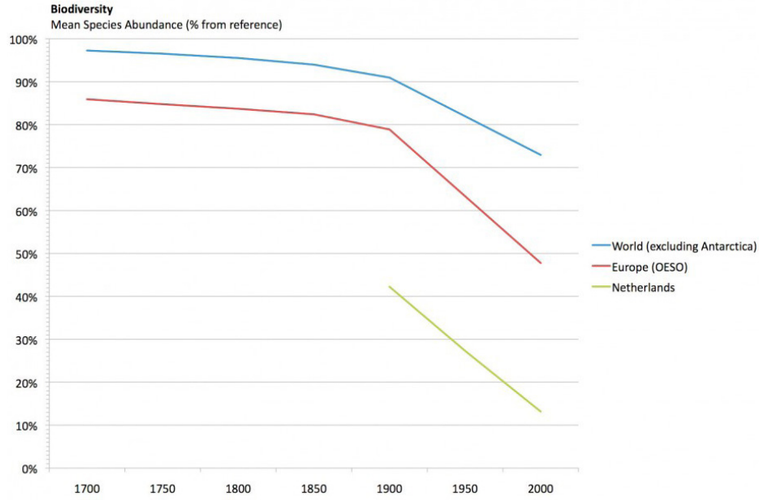
Problem field

Challenge I. Dwindling biodiversity

With rapid urbanisation and urban sprawl, natural habitat areas are disappearing from and around cities. Biodiversity in Netherlands is rapidly declining with a 70% reduction of species since the 1900s. (PBL, 2010) The Anthropocene presents a human-centric approach in designing cities. This perspective of urbanisation affects biodiversity adversely by habitat loss and degradation. Surfaces are paved to drain off water efficiently, building facades are sterile glass for visibility and water systems are canalised with hard edges for the efficient discharge of water. There are limited opportunities to accommodate other species in cities as there is a pre-defined perception of how nature should exist in cities; green structure should be of a certain defined form and nature should only be allowed at certain bounded area such as parks or road verges.

TU Delft is part of the Randstad region which surrounds the Groene Hart and an important green-blue connector between The Hague and Rotterdam. Within TU Delft, areas around the faculties are extensively paved while green areas are mostly monoculture lawn with a few trees. A neat and well-maintained lawn is actually less biodiverse than a spontaneous plot. (Robinson & Lundholm, 2012) There is a lack of biodiversity in TU Delft due to the limited opportunities to accommodate other species. With the loss of habitat and lack of consideration of other species within the built environment, the urban fabric takes form as a rocky biotope with harsh conditions which allow only limited species of flora and fauna, such as the pigeons, to survive.

Urbanisation is unavoidable. But if we can strive for eco-receptive oriented urbanisation, perhaps the habitat transformation can provide novel opportunities for other species and related services. Cities are able to host a high number of species and also rare species (Roos, 2020) and we should capitalise on this capacity.



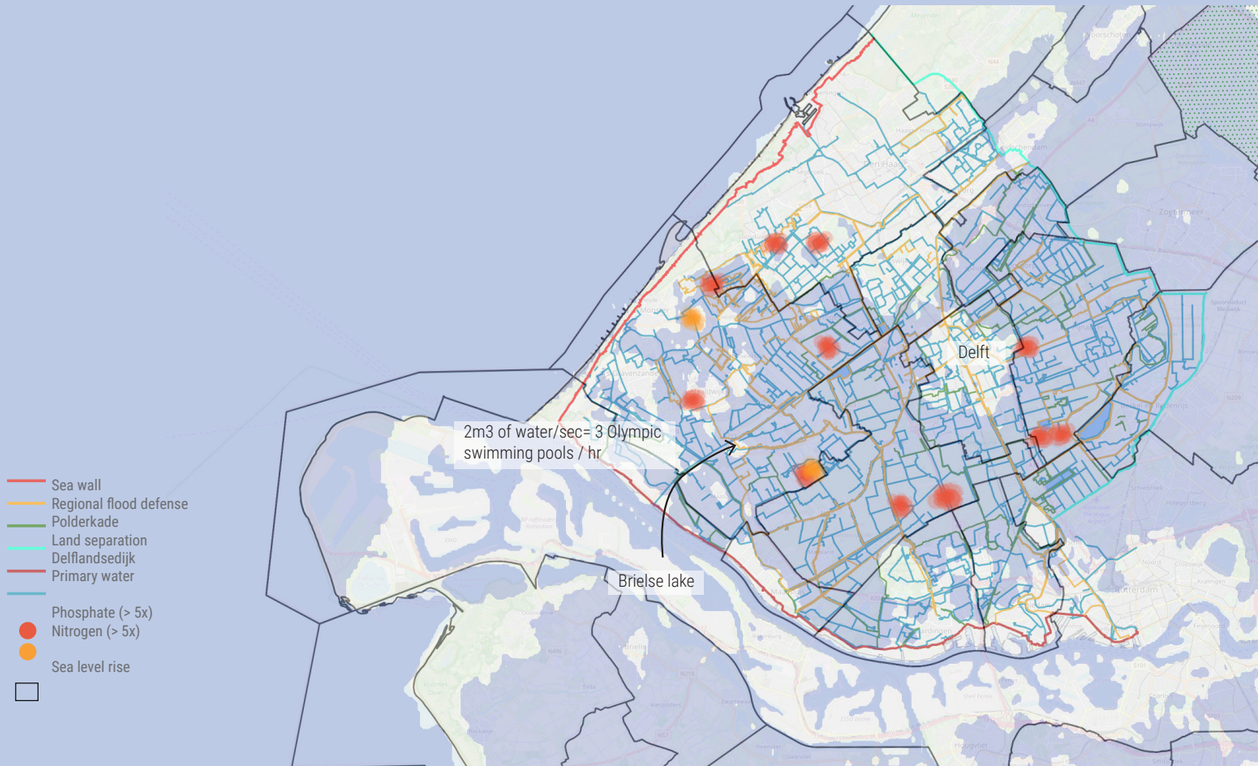
left:
Figure 1-6. Declining biodiversity mean species abundance between 1700-2000 © PBL, 2010

right:
Figure 1-7. Rotterdam region Extreme Weather Of Drought And Rising Sea Level
Adapted from https://www.hhdelfland.nl/inwoner/klimaat-en-water/droogte-actuele-stand. Redrawn by author.

Challenge II. Vulnerability to climate change

With climate change, the Netherlands is experiencing more intense precipitation and longer drier periods. (Eden et al., 2018) Over the years, the annual precipitation in the Netherlands increased by 26% from 1910 to 2013 and the intensity of weather conditions has significantly increased. (KNMI, 2015) The inability to cope with the increase in stormwater would lead to flooding and damage to life and property.

The effects of climate change that the metropolitan region and TU Delft campus face is very real. In the Hague-Rotterdam Metropolitan region, salinization pressures with seawater flowing further into the Nieuwe Waterweg. During dry periods in summer, there is the problem of drought and low water level on the campus. These not only threaten water quality with blue-green algae growth but also affect health and productivity level. The heatwave during summer also affects health and mortality rates and impacts the economic by lowering the productivity level. (Daanen et al., 2013)



Challenge III. Disassociation of people with their environment

With a lack of a stimulating environment, people might not realise that they are part of nature, but rather, see themselves as a unique entity independent from their environment. With the lack of appreciation and ownership for their environment, unhealthy practices for the urban ecosystem continues leading ultimately to an unsustainable living environment.

There is decreasing contact and engagement of people with their natural environment with changing landscape and jobs. In Roman times, Delft was formed along a canal which was dug from the original swampy creek. People engage physically with their land, dug ditches and drained the land for productive use and dammed river. In the 17th century, with flourishing trade, there were many traders and trekvaart, where people pulled boats along the canals with horses. Eventually, cities grew through densification and urban sprawl. People's relation to their environment change as occupation shifts. More than one-quarter of these jobs are in public administration, education and healthcare. The nature of desk-bound jobs reduces the interaction of people and their environment and, overtime, people lose the ability to read and understand their landscape. Literature suggests that little time spent in a natural environment decreases the feeling of connectedness with nature (Mayer et al. 2009). Concepts such as natural processes and the interconnected relationship between species become distant and irrelevant to city dwellers. People might not realise that they are part of nature, but rather, see themselves as a unique entity independent from their environment. With the lack of appreciation and ownership for their environment, unhealthy practices for the urban ecosystem continues leading ultimately to an unsustainable living environment.

As such it is crucial that nature should be in proximity within the city and also it should be engaging, stimulating and fun for people such that there can be a meaningful reconnection with their environment. Can cities spark excitement and curiosity? Can entities of a city, such as buildings, play and interact with the environment? Perhaps though methods such as a polder roof top to detain water and play with the water cycle or a green facade to host flora and fauna?

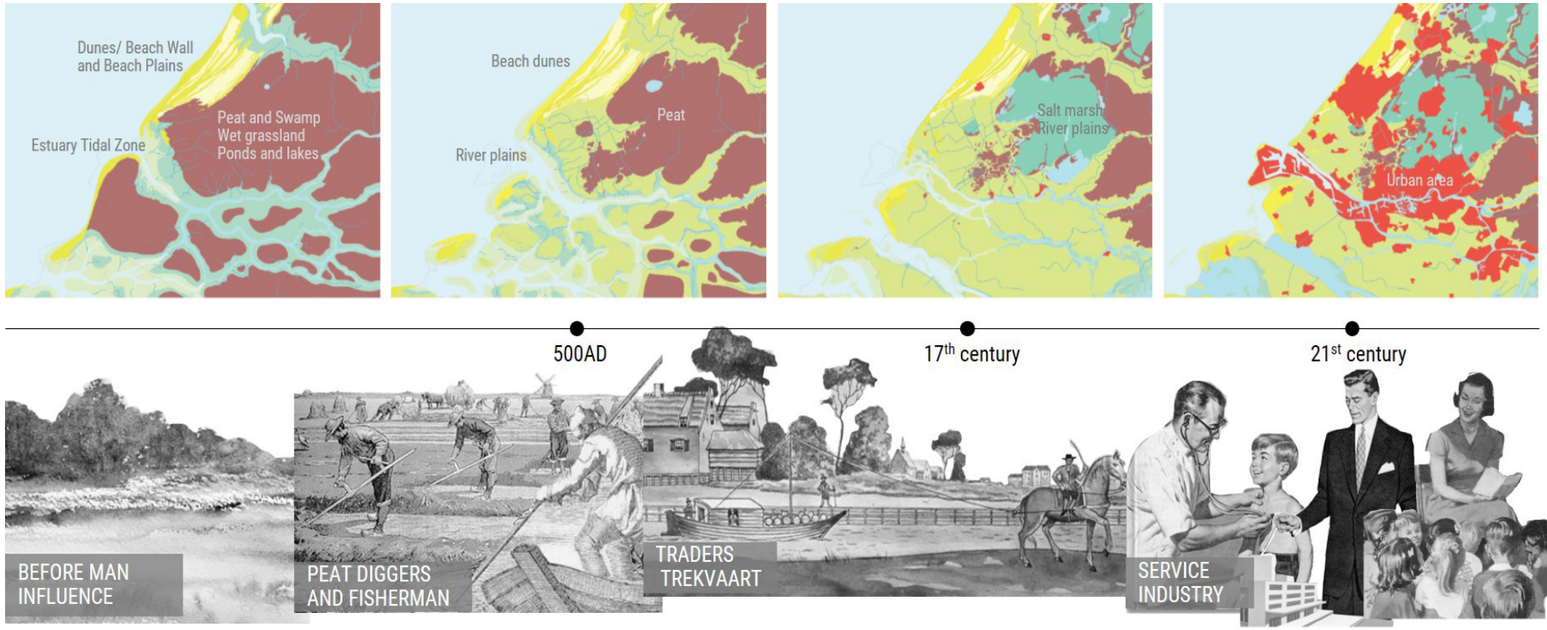


Figure 1.8.
Top: Landscape evolution of Rotterdam–The Hague metropolitan area. From https://rce.webgispublisher.nl
Bottom:
Evolution of jobs, decreasing association with environment.
Collage by author.

02

DEFINING

Problem field
Research question
Methodology and time schedule
Approach
Project relevance
Aim

Problem statement

With rapid urbanisation and urban sprawl, natural habitat areas are disappearing from and around cities. Biodiversity in Netherlands is rapidly declining with a 70% reduction of species since the 1900s. TU Delft is part of the Randstad region which surrounds the Groene Hart and an important green-blue connector between The Hague and Rotterdam. Within TU Delft, areas around the faculties are extensively paved while green areas are mostly monoculture lawn with a few trees. There is a lack of biodiversity in TU Delft due to the limited opportunities to accommodate other species.

With the added pressure of climate change, TU Delft is experiencing more intense precipitation and longer drier periods. The inability to cope with the increase in stormwater result in flooding and damage to life and property. Meanwhile, during dry periods in summer, there is the problem of drought and low water level. These not only threaten water quality with blue-green algae growth but also affect health and productivity level.

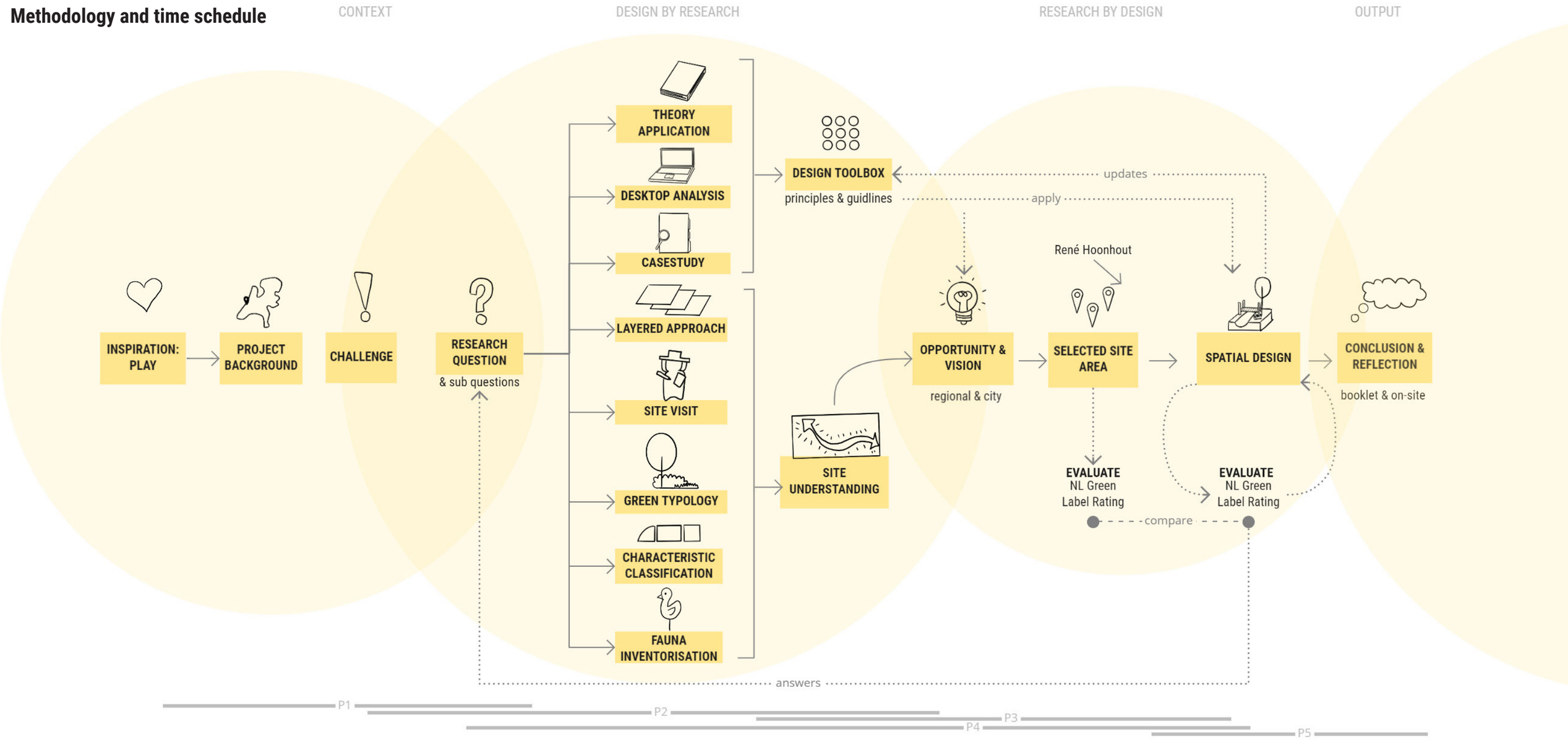
With a lack of a stimulating environment, people might not realise that they are part of nature, but rather, see themselves as a unique entity independent from their environment. With the lack of appreciation and ownership for their environment, unhealthy practices for the urban ecosystem continues leading ultimately to an unsustainable living environment.

Research question
project framing

> “What is a possible **spatial** (what) **framework** to create a **biodiverse, climate resilient** (what) **TU Delft campus** (where) using **‘playful’ design**? (how)”

MAIN RESEARCH QUESTION	SUB QUESTION	METHOD	APPROACH
a possible framework for biodiversity and climate resilience...	1. What are the **principles/ theories** concerning resilience and biodiversity?	Literature review and research to formulate guiding principles	• Importance of urban ecology and ecosystem services, (Stads Natuur Maken) • Matrix-Patch-Corridor Theory (Forman, 1995) • Ecological Resilience Theory, (Wu & Wu, 2013)
using ‘playful design’...	2. What is **play**? **Why** should we have ‘playful’ design?	Literature review and research to formulate guiding principles	• Literature review of Homo Ludens and Aldo van Eyck • Understand Urban Play design through journal of The playful city constructing a typology for urban design interventions, (Gabrielle Donoff & Rae Bridgman, 2017) • Manifesto for a Playful City (Carma Masson, n.d.) • Benefits of play (Gordon, 2014)
creating a biodiverse, climate resilient using ‘playful’ design...	3. How can **‘playful’ design** bring about **biodiversity and climate resilience**?	Case study analysis and data inventorisation Research by design	• Case study of playful, ecological and resilient design • Form tool kit from the case studies • Classification of helophytes design based on spatial form types and 5 senses
TU Delft campus...	4. What is the **current situation** in **TU Delft**?	Research Site Observation Data inventorisation Evaluation	• Readings to understand the historical context of Delft • Layered approach- Dirk Harmen Frieling • Macro regional scale mapping • Meso Delft city scale mapping • Flora and fauna inventorisation • Habitats • NL Green Label Scoring
a framework for the TU Delft campus...	5. How do we **apply** landscape architectural frameworks to TU Delft? How would a biodiverse, resilient and playful campus look like?	Scenario building Design experiment Feedback	• Research by design: Scenario-based design, Design through scale • Engage stakeholders

Methodology and time schedule



Project relevance

The project is situated in the theme of sustainable ecocities. As cities expand rapidly throughout the world, the importance of urban ecology becomes more urgent than ever. The project aims to promote a new way of transforming and designing our cities and discover new ways of approaching urban nature through an ecological perspective. It bridges across different disciplines of hydrology, landscape architecture, sociology, environmental engineering, climate design and sustainability. With the case studies, the project supplements the research data on ecological and resilient playscapes. The project aims to generate a framework which becomes relevant as a guide to be applied to other areas when striving for a biodiverse, climate adaptive playscape. Using TU Delft site, the project provides an insight on the application of the framework and showcases how a biodiverse and resilient campus might look together with its potential.

The project's research and the design component approach landscape architecture as an interdisciplinary field with many interacting components of the complex relationship between entities. The project employs a multi-layered understanding of landscape, by accounting for the design across time and scale, the palimpsest layers and the spatial structure. The project respects and builds upon the Genius Loci and translates relevant ecocity principles and biodiversity challenges into the specific site in TU Delft.



Figure 2-1. Six Sustainable Development Goals (SDGs) tackled by project

Aim

The aim is to create a vibrant and fun campus city for all with an ecosystem that supports other species apart from humans. The biodiverse design of the campus helps to cope with heat and water stress with its self-regulating system. The result of the design assignment can be described as following:

- A guideline and design toolkit for a biodiverse and resilient playscape. This is formulated by literature reviews and case studies and can be applied to other site areas as a general guideline.
- Scenario based design, envisioning of TU Delft as a biodiverse campus through a few scenarios of climate diverse campus, water campus, forest campus, etc…
- An ecological masterplan vision for the TU Delft campus.
- Specific site design of a chosen area with more elaborate detail design of materialization and flows.
- Green NL scoring for pre and post design
- Future proofing hypothesis through testing design with situations of extreme flood and heat condition.

Guideline

CLARIFY MOTIVATION	- State inspiration and have a supporting ideal image visualisation
UNDERSTANDING CURRENT SITUATION	- **Landscape historical development.** Mapping the evolution of the greater region (The Hague-Rotterdam region) to understand the changes in landscape type and the human relation to their surroundings. - **Site historical development.** Mapping the history of the site (TU Delft) to understand the significant moments that shaped the campus to what it is today. - **Layered approach** on (Delft) city level and (campus) site level. Understand the workings of different components: Historic alignment, historic creek feature, soil type, transit mobility, built structure, green structure, water management - **Mapping Ecology (environment)** Landscape types & habitat mapping in the regional and city scale. To identify existing habitats and potential network connection. Mapping of different green types and trees in the site to have a richer understanding of the green infrastructure on site. - **Mapping Ecology (species)** Inventorisation of 20 fauna species, their habitat types and food web for selected species. - **Site typology**: Landscape characteristics classification of site. To simplify the site into a set of main features - **Categorisation of built environment.** Evaluation of buildings in (campus) site based on their contribution to green and blue structure - **Mapping of spatial quality and experience.** To understand how people interact with their environment. - **Creating design principles & toolbox.** The design principles are generated from case studies and literature reviews. The toolbox is a set of spatial design from small to regional scale influenced by the different typologies of the site. - **NL Green Label rating** of a selected area. To identify areas for improvement.
SYNTHESISING CURRENT SITUATION	- Map out the **opportunities and challenges** of the site
GOAL AND VISION SETTING	- Selection of **opportunities and challenges** to work on - State **vision** for the broader context and also the aim of the project
DESIGNING	- **Vision mapping exploration** for regional scale and campus with consideration of design principles - **Scenario-based design exploration** (diverging) by prioritising certain design principles. Choose and refine an overall masterplan. - **Selected site area and engagement of stakeholders**. Specific area in the campus is identified with stakeholder, Rene Hoonhout the Green Manager of TU delft. - **Consideration of site specificity.** React to the abiotic and biotic factors on site. - **Application of design principles & toolbox** and appropriate **iteration.** - **Resilience evaluation**. Evaluation of ability to cope with extreme heat and water stress. Explained with flow diagrams and plans. - Consider the **4Vs for ecology**: voedsel, veiligheid, voortplanting, variatie (food, safety, breeding, variety). - **Use natural and existing materials onsite** for design to activate the five senses. - **Get users response**. To understand if design creates a ludic and stimulating environment, get user input through design implementation and observation and if not possible, a survey using before and after images. - **NL Green Label rating**. Evaluate the performance of design intervention

03

THEORETICAL FRAMEWORK

Theory 1- Urban ecology and ecosystem services
Theory 2- Matrix-patch-corridor
Theory 3- Ecological resilience
Theory 4- Exploratory play and affordance

Case Study 1- Poptahof
Case Study 2- Speeldernis
Case Study 3- Roombeek

Research by design- Water patterns
Research by design- Spatial helophytes

The following theories, literature review, case studies and research are studied and conducted to formulate guiding principles and design toolbox. The results serve as a guideline for the 3 main themes of biodiversity, climate adaptiveness and playfulness and they also expand the possibilities to enrich the project. The theory shall also help to answer the initial research question to form the basis of the project.

Theory I
Urban ecology and ecological approach

City as an Ecosystem

The city is a place not only for people to work, live and enjoy, but it also is a home for many other animals and plants. The city can be seen as an ecosystem with different biotopes and a complex relationship between different organisms and their abiotic environment. (Vink et al., 2017) In most cities, they are mainly characterised by a rocky environment, due to the intense built elements, interrupted by green and blue patches and lines of differing sizes. Despite the sparse area in cities allocated for other species, certain flora and fauna adapt and thrive with the urban warmth, the abundance of food and the lack of predator. For instance, martens, hedgehogs, foxes, goshawks and peregrine falcons are increasingly sighted in cities. The city is diverse with both stable zones, especially in heritage sites and parts, and dynamic zones due to disturbances of traffic, construction and maintenance. Species that depend on pioneering stages benefits the most from the dynamic conditions.

Apart from the biotic factor, abiotic flows in action within the cities. It is important to consider the flows like water, nutrient and carbon because an imbalanced cycle becomes apparent with problems such as flooding or algae bloom.

With that, the city as an ecosystem approach prompts the project to frame the site as an ecosystem of biotopes and green and blue network and allow for multiple uses of space to accommodate nature in the urban fabric.

Biodiversity

Biodiversity comprises 3 main concepts of genetic diversity, species diversity and ecosystem diversity. (Vink et al., 2017) Biodiversity is important due to the interconnected relationship between species and with their environment. Also, the diversity and complexity of an ecosystem contribute to the resilience and stability of the system. The project focuses on accommodating diverse biotope to support a range of different species.

Ecosystem Services

A healthy ecosystem provides many benefits for the human population. (Elmqvist et al., 2015) There are four broad categories: provisioning services, such as the production of raw materials like typha are used for construction; regulating services, such as air, soil and water purification through pollutant assimilation and nutrient filtering; cultural services, such as science and educational benefits; supporting services, such as soil formation and primary production. Ecosystem services influence many components of human well-being, and beyond that, contribute to employment and economic activity. (Millennium Ecosystem Assessment (Program), 2005)

The Ecological Approach

The map-overlay method was key to McHarg's ecological approach (McHarg et al., 1969) He considered a layered approach for landscape architecture and regional planning. First, to understand the history of the place; the physical, biological and cultural palimpsest. Then the understanding of the processes in the environment: climate, physiography, water, soil, plants, animals and land use. The inventorisation of the different factors were also supplemented by technical reports so that there can be a holistic understanding of the site through not only the historical and physical lens but also the social and futuristic aspects. This method shall help to guide the analysis of the campus across different scales.



Figure 3-1. Examples of ecosystem services in the Netherlands. Source: PBI, WUR, CICES 2014. www.pbl.nl

Theory II
Patch-matrix-corridor

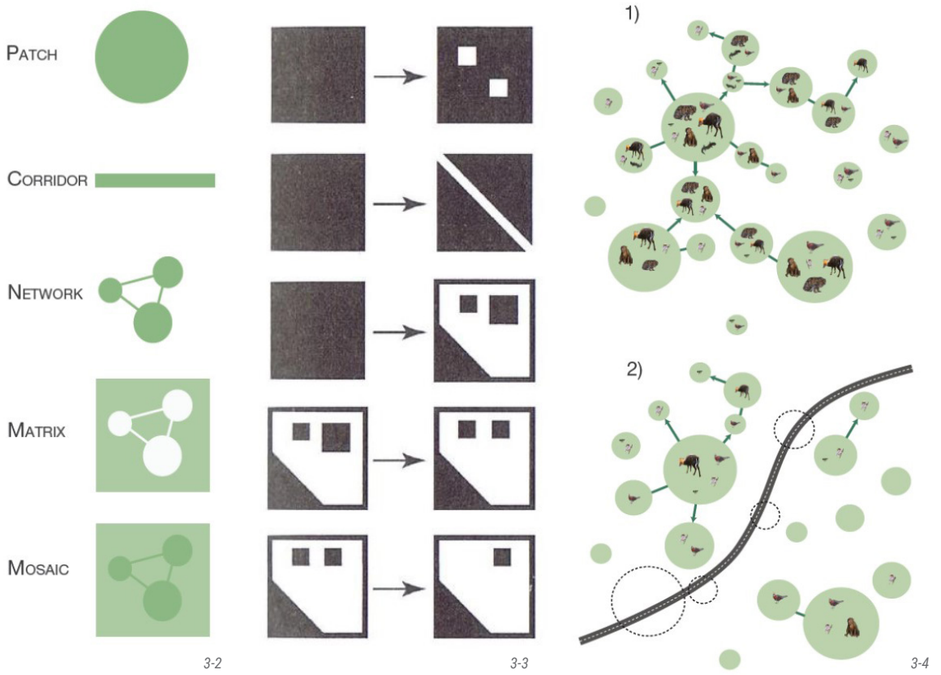


Figure 3-2. Representation of landscape structure Patch matrix model (PMM). Redrawn after Dramstad 1996 by Caitlin Smith, 2012

Figure 3-3. Five ways of landscape spatial alteration. Image derived from Forman (1995) by Lindenmayer and Fischer (2006)

Figure 3-4. Landscape with high patch connectivity (top) vs Landscape fragmented by road (bottom). Image by Caitlin Smith, 2012

Forman and Godron (1981, 1986) represent the patch matrix model which explains a landscape with three basic elements: patch, matrix, and corridor. (figure 3-2) Patches of habitats are connected by habitat corridors, forming networks of regional connectivity. These are embedded in a matrix which is a dominant background land cover. (Forman et al., 1995) An optimum landscape is one with both large and small patch sizes since large patches provide major ecological roles while smaller ones act as stepping stones for dispersal and provide for heterogeneity. An ideal patch shape is generalised to be one with a large core and curvilinear boundaries and thin lobes.

There are 5 main ways where a landscape can be changed and in order of perforation, dissection, fragmentation, shrinkage and attrition. (figure 3-3) These spatial processes have their own distinctive effect on the spatial pattern and all result in increased isolation and habitat loss. Habitat patches should be connected with corridors of a similar habitat to mitigate habitat fragmentation.

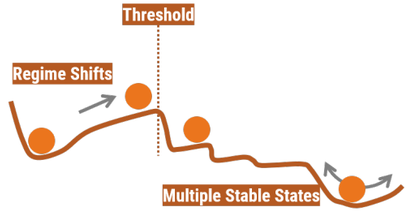
In addition, since land mosaics is dependent on the scale that is being considered, there is a need to acquire information on the broader region and on the finer-scale local ecosystems so as to understand a landscape.

Theory III
Ecological resilience

"From a resilience perspective, sustainability is not about maintaining a system at its equilibrium state but rather sustainability should focus on the system's capacity to create and test opportunities and maintain adaptive capabilities" (Holling, 2001). A resilient system is not necessarily a stable one. Holling shifted away from the idea of stability and viewed an ecologically resilient ecosystem to have multiple stable states, with the ability to absorb and react to change and disturbances without alteration of its basic structure and function. There is persistence, change and unpredictability and therefore a need for redundancy. (Holling, 1996) This prompts us to rethink how we design a system.

There are many factors that contribute to the adaptability of social-ecological systems. A high diversity, individuality of elements and complexity helps to build resilience. In situations of low diversity, a loss of a few taxa of genetic variation would greatly affect the cycles such as the food chain and result in an unstable ecosystem. (Roos, 2020; Holling, 2001)

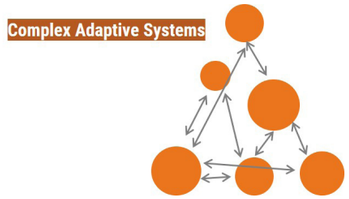
Another key concept about resilience theory is the "Complex Adaptive Systems". There is self-organisation within the system through nonlinear interactions among heterogeneous components, and these structural arrangements determine (and are reinforced) by the flows of energy, materials and information among the components. (Levin 1998, 1999) Cities are complex adaptive systems as the cities are integrative in function, comprise of a multitude of spatial qualities and are constantly evolving and changing with time. (Wu and David 2002).



3-5



3-6



3-7

Figure 3-5. Illustration of some key concepts of ecological resilience: multiple stable states, basins of attraction, threshold, and regime shift. Regime shift may occur du eto disturbances.(Modified from Folke et al. 2004) Drawn by author.

Figure 3-6. Diagrammatic representation of diversity of genetic variation supporting ecosystem (Roos, 2020). Redrawn by author.

Figure 3-7. Schemetic representation of complex system with non-linear relationship and flow between heterogenous elements. Drawn by author.

Theory IV
Exploratory play and affordance

Play for All

Play is an instinct and innate to humans; Huizinga (2000: Foreword) described us as 'Homo Ludens, Man the Player'. Play is older than civilisation itself, 'Play is not an activity that developed as civilisation became more sophisticated; rather play was at the heart of the start of civilisation' (Cohen,1993:20).

Exploratory Play

According to the play manifesto by Carma Masson, there are many different types of play; play experiences such as but not limited to frivolous play, creative play, intellectual play, imaginative play, exploratory play, active play, and social play. Since the project seeks to connect people to their environment, it shall focus on exploratory play, where a person engages his or her 5 senses to experience the surrounding world. Play is a way for one to explore, understand and appreciate the natural occurrences and his place within his environment.

Affordances

The concept of affordance is coined by psychologist James J. Gibson.

"The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill."

(Gibson, 1977)

Affordances are opportunities for action, and it describes the relationship between the object and the user. A flat rigid surface affords support while a gently sloped surface affords for lying, rolling or imbalances. Affordance is dependent on the observer and is subjected to interpretation. Individuals find opportunities for action or attune to affordances. The obvious affordance of a roadside curb is the separation of spaces, but it also affords for balancing and squatting. The value of a well-design object is whether it has a rich set of affordances such that users interpret it in such a way unimagined by the designer. A great example would be the playgrounds of Aldo van Eyck who designed hundreds of playgrounds during the period of 1947 to 1978. His playgrounds were an opportunity to test his ideas on architecture, relativity and imagination. (Withagen & Caljouw, 2017) The minimalist and simple design not only stimulate imagination and creativity, but also provided multifunctional possibilities, interpretation, and modularity. This is a reminder for the project to steer away from complicated designs, but instead, design to provide for the basic requirements of the intended use.

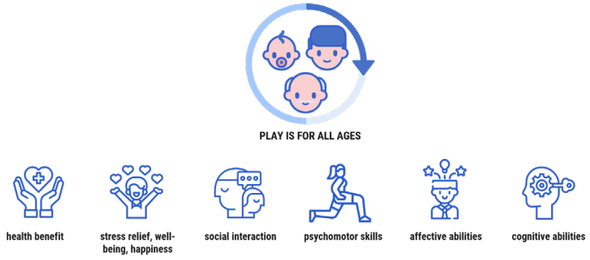


Figure 3-8. Benefits fo Play. Icons retrieved and adapted from https://www.flaticon.es/

Benefits of Play

Play is not only for children but rather, it cuts across all ages, from adults to children. (Glynn and Webster, 1992) 'Play should be developed from womb to tomb.' (Huizinga, 2000:192) Play is universally linked to benefits such as building build individual psychomotor, social, affective and cognitive abilities and promoting health and well-being. The benefits of play have been established by comprehensive research; a playful adult lives an average of 10 years longer than their peers. (Diener and Chan 2011)

The understanding of the innate nature of play, its types and the concept of affordance help to develop the following key terms for the project

1. Playful human

A playful human seeks fun and enjoyment without necessarily a purpose. A playful human interacts with his environment through his own interpretative manner that activates his 5 senses or curiosity. A playful human has a heightened sense of awareness or understanding of his environment and his relationship with his environment. It might be a physical body connection such as the sense of balance with the play of gravity or the spiritual connection such as the appreciation of nature.

2. Playful landscape

A playful landscape evokes a playful human by providing affordance and crafting a stimulating interaction experience with mankind.

3. Playful city

A playful city rethinks the relationship of its building blocks. A wasted or unutilized space or element can be a valuable resource for another. The underbelly of a bridge can become a home for bats. A wall can host plants and insects by becoming a green wall.



Figure 3-9. Boy be like water, learning from Water. Picture from Cities Alive 2020 Webinar, Water & Climate: Threat to Opportunities for Resilient, Liveable and Healthy Cities, Herbert Dreiseitl, 22 Oct 2020.

5 Key principles

application to design

The literature studies and research result in these guiding principles for biodiversity, climate adaptiveness and playful design.



INTERCONNECTEDNESS

-Increasing patch area and corridor network
-Habitats of different sizes and types
-Different forms of connection- stepping stones, tree line, narrow stretched habitat
-Respond to surrounding landscape or draw inspiration from the past



GRADIENTS

-Intermediate disturbance theory
-Expand range of possible conditions
-Between habitat types
-Layered vegetation structure



PROVOCATIVE AFFORDANCE

-Affordance, strip down to basic quality, opportunity for action
-5 senses, provocative
-Experiential, vertigo
-New perspective, provides a frame for landscape process



ADAPTABILITY

-Multiple stable states
-Sponge concept (store, filter, release)
-Climate resilient species
-Scenarios for different time frames
-Make use of ecosystem services to clean water
-Redundance/ Capacity for change/ adaptive capacity to accommodate disruptions
-Diversity builds resilience. Diversify choice of plant species and for larger areas, types of ecosystems.



INCLUSIVE

-Accommodate other species, especially local ecology
-Provide for their needs (food, shelter, and nesting place)
-Reduce threats (eg. bird-safe windows)
-Consider the biotic and abiotic factors
-Capitalise on opportunities to integrate species into urban fabric (eg. depaving)
-Multi-functional urban infrastructure (eg. building, streets, poles)
-Allow natural development and succession

Case studies on biodiverse, resilient play

To generate a series of design tool for biodiversity, water resilience and play, 3 projects were selected and analysed. There is a short description of each project and a uniform scoring by Urban Green Blue Grids. The design process and features of the case studies were considered and illustrated by representative axonometric drawings. Each design tool is also evaluated on its contribution to the 3 themes of biodiversity, resilience, and play.

There was a site visit to Poptahof to gain first-hand experience of the user interaction and workings of the design. It was interesting to note that elements designed for interaction and play, such as the movable weir, appealed to younger kids (age around 3-6). For older kids, they are not too keen on predictable play mechanism and thier attention for it faded away quickly. Instead, they are excited by imaginative play by inventing their own games such as stomping on a 3cm deep water or using a stick to skim against the water surface to create splash effects. Apart from conveying water for cascading effect, the element of the wide water surface provided for a wide range of affordance.

Unfortunately, Speeldernis was closed from Oct to Feb 2021 due to COVID 19.

Poptahof, Delft

An Ecological Playscape in a Residential Area



With an area of 18.6 hectares, Poptahof is designed to create a healthy and resilient water system. Part of the water system was designed to be visible. A water playground was built, the design for which was based on the winning idea from a children's competition. All impervious surfaces were disconnected from the water system. (Palmboom & van den Bout, 2004)

■■□ Water | ■□□ Heat | ■□□ Biodiversity | ■□□ Urban agriculture | ■□□ Costs

■□□ Air Quality | ■■■ Social and economic importance | ■■□ Multifunctional use

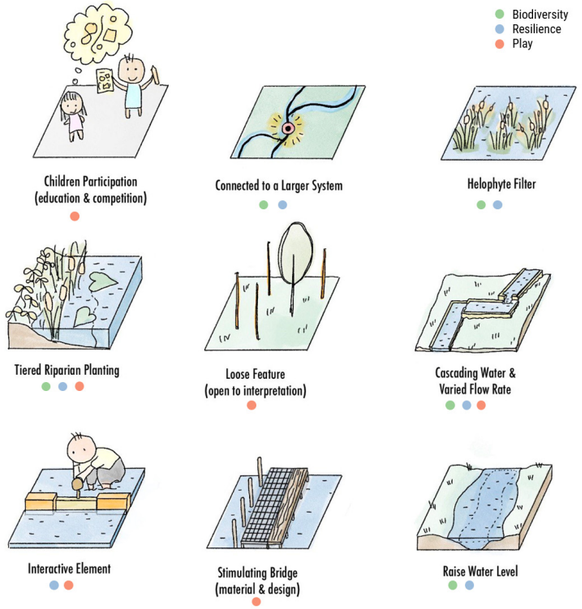


Figure 3-10. Poptahof. Photo from Urban Green Blue Grid . Icons drawn by author.

Speeldernis, Rotterdam

An Ecological Playscape in a Park



Speeldernis is a natural playground where children are immersed with nature's varied material of water, sand, stones, and wood. Children learn to take risks and develop a sense of ruggedness. The varied topography hosts great biodiversity and allow children to learn more about flora and fauna as well as natural processes and cycles. Biotopes are included: a fast-flowing brook, a gentle brook in a meadow, a marsh, steep banks, shaded banks, and ponds of varying depths.

■■■ Water | ■■□ Heat | ■■■ Biodiversity | ■□□ Air Quality | ■□ Costs

■■■ Social and economic importance | ■■□ Multifunctional use

The Roombeek, Enschede

An Ecological Playscape in the City Centre



The Roombeek is a resurfaced and restored stream. The rough base reduces water speed and creates reflective water pattern. The Roombeek has fluctuating water levels and gets its water supply from rainwater or drainage water from some districts. Where the old stream flows underground, a ribbon of blue tiles marks its path aboveground.

■■□ Water | ■□□ Heat | ■□□ Biodiversity | ■■□ Costs

■■□ Social and economic importance | ■□□ Multifunctional use

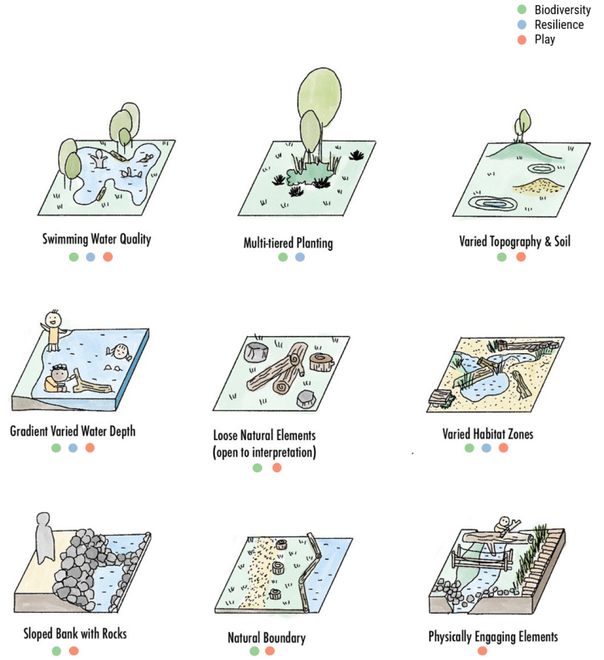


Figure 3-11. Speeldernis. Photo from Urban Green Blue Grid . Icons drawn by author.



Figure 3-12. The Roombeek. Photo from Landzine . Icons drawn by author.

Research by design

Water Experiment Study

A high-quality water condition (unpolluted and oxygenated) is crucial for a healthy ecosystem. A well-oxygenated and unpolluted water supports biota and is safe for humans to swim and play. As such, ahelophyte filter is an appealing technique as it is known as nature's water purifiers. Helophyte vegetation is effective in the uptake of nutrients such as nitrogen and phosphorus and also filter out large-sized pollutants. With the ability to purify and improve water quality, they promote water resilience by ensuring clean water for many alternate uses.

This is coupled with the consideration of exploratory play, where designers are prompted to consider the engagement of the five senses.

As such, the research by design is focused on water, to create high quality and interesting water patterns. There is 2 parts:

1. 8 SENSORIAL HELOPHYTES
8 chosen helophytes which are safe and non-toxic to humans are chosen and analyzed based on their spatial quality. The arrangement and sequence of different species can form closed, open or intriguing spaces. Then they are classified based on their engagement of the 5 senses and also their ability to oxygenate water. The animals that they support are also tagged to each species. There is also the indication of the abiotic condition of water depth as the most preferable growing condition.

2. WATER PATTERNS
In nature, there are different types of water flows. The visual and auditorial water flow types are influenced by factors such as the water speed, channel slope, profile and height and material. Experiments are conducted to investigate how we can create interesting water patterns. A simple channel model is set up with various obstacles to visualize the effects on water surface patterns.

The idea is to utilise the runoff during rain events by controlled release of water within the retention systems or a controlled release of water from a higher elevation such as the Schie for the purpose of water recirculation.

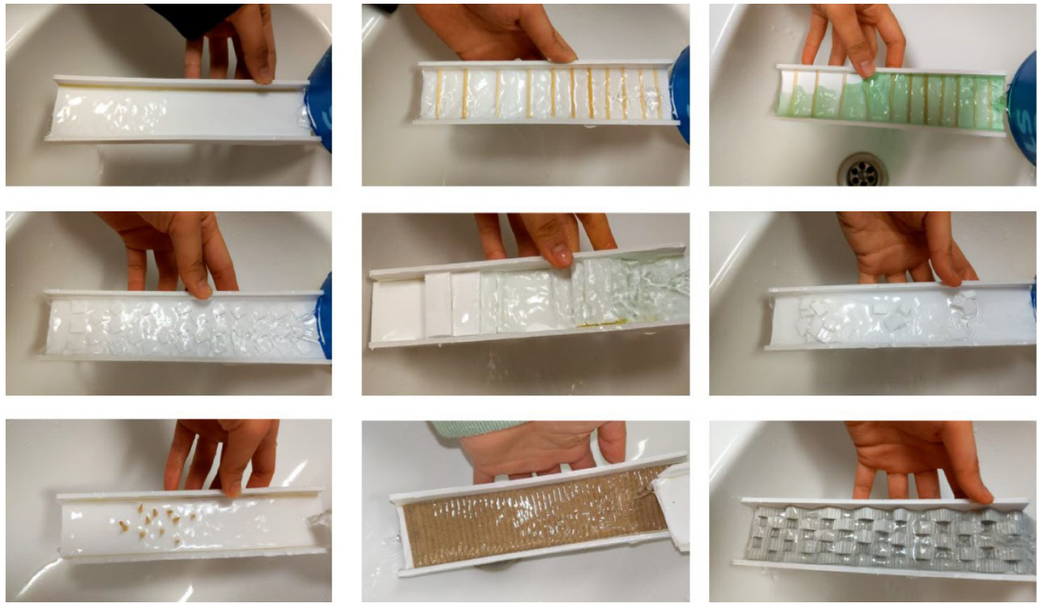


Figure 3-13. Model experiments to test and create interesting water patterns . Photo by author.

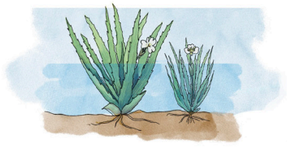
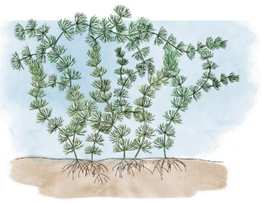
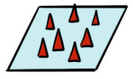
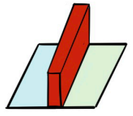
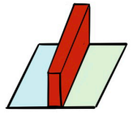
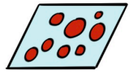
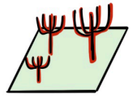
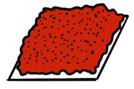
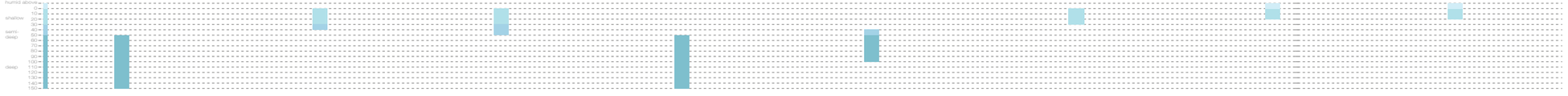
	WATER SOLDIER *Stratiotes aloides*	BULRUSH *Typha latifolia*	COMMON REED *Phragmites australis*	WHITE WATER LILY *Nymphaea alba*	HORNWORT *Ceratophyllum demersum*	FLOWERING RUSH *Butomus umbellatus*	YELLOW LOOSESTRIFE *Lythrum salicaria*	FORGET-ME-NOT *Myosotis palustris*
SPECIES								
SECTION								
SPATIAL QUALITY								
	spikes out of water (adds to water texture)	wall	wall	geometric circles on water	underwater furry green carpet	structural sticks	tall cones	dreamy ground cover
COLOUR	 may-aug	 jun-aug	 jul-nov	 jun-sep	 jun-sep	 jul-aug	 jul-aug	 may-aug
	-above water only when in flower	-sausage on sticks	-sticks with furry tips -furry tips emphasise wind	-planar broad leaf emphasizes water surface -rain drops collects and run off leaf surface		-umbrella branched stalks -thin, sword-life leaf	-vertical accent -striking yellow cones	-sea of blue pixels
FIVE SENSES	-sharp serrated leaf edges -slimy secretion	-rough leaf blade -dry hollow-like flower	-feathery flower head	-	- fluffy leaf strips	-leaf has triangular cross-section	-sticky flower stalks -soft hairy leaf undersurface	-rough hairy leaf -fragile small flower
	-foul	-	-	- soft delicate scent	-	-slight almond smell	-	-
	-	-rustle in wind	-rustle in wind	-	-	-	-	-
	-	-cooked flowering stem taste like corn -young shoots taste like asparagus	-raw sap from stem taste sweet	-medicinal bitter roots	-	-	- slightly acrid medicinal herb	-tasteless edible
WATER DEPTH (CM)								
OXYGE-NATES								
BIODIVERSITY	 flower: dragonfly, flies, butterfly	 food:geese, muskrats habitat: waterfowl	 food:geese, muskrats habitat: waterfowl	 habitat: fish, amphibians	 food: ducks, fish habitat: fish	food: waterfowl flower: bees and insect	flower: Macropsis bee, butterfly	flower: butterfly, bee

Figure 3-14. 8 Sensorial helophytes with special characteristics. Information of plants are obtained from Water Purification , 2013, and online resources such as Ebben and Botanical. Images of plants are drawn by author.



Figure 4-1. Chilren climbing the TU Delft Sculpture, photo taken by author, 30 Mar 2021

04

TU DELFT CAMPUS

Overview
Key characteristics and building typology
Green management plan 2020
20 existing fauna
Onsite 2020
Challenge and opportunity 1- Water & heat
Challenge and opportunity 2- Biodiversity
Challenge and opportunity 3- Play



Figure 4-2. Research area of TU Delft map from google.

Delft University of Technology (TU Delft) is one of the largest training institutes in the Netherlands. Before the COVID 2019 pandemic, about 27,000 people live on its campus every day: students, scientists, visitors and employees of the university and companies on campus. In addition, about 300 companies, 4,000 student residences and a diverse range of shops and restaurants are located on the TU campus. Apart from the campus users, TU Delft has also added value for surrounding residential areas. With an area of over 161 hectares, the campus is larger than the city centre of Delft and one of the largest university campuses in the world. In other words: TU Delft is a city in itself. (Delft University of Technology, n.d.)

There are parallels between a university and a city. Both support a sizable population, have an independent organization system, multi-use infrastructure, programmatic diversity, structured real estate and utilities, sanitation, land usage and transportation systems. (Finlay et al., 2012). Since a university resembles cities on a smaller scale, the TU Delft campus is an ideal site to apply and test out the spatial framework. The municipality of Delft is envisioning an oasis between Rotterdam and The Hague with greener buildings and public spaces, sustainable energy usage with biomass plant and electric car usage and a woonerf playable living streets for children. To achieve a sustainable Delft by 2030, the city plans to improve the living environment by introducing more nature and water in and around the city, focusing on biodiversity and climate adaptive measures. (Gemeente Delft & KEPCOM Creatieve Communicatie, Delft, 2010)

In line with Delft municipality, TU Delft aims to make the campus more sustainable by 2030 with 4 spearheads: (Campus and Real Estate, 2019)

- CO 2- neutral campus
- Circular campus
- Healthy campus
-Biodiversity and Ecology.

To completely compensate for the CO2 emissions from TU Delft in 2018, a forest size of 3,552 hectares is required. That is about 22 times the size of the campus. As such, carbon reduction in the campus would be better compensated and reduced in other methods such as renewable energy source and sustainable green buildings. (Blom & Dobbelsteen, 2019)

The ecosystem services of a biodiverse and climate adaptive campus contribute towards a sustainable campus. The eco-campus approach represents an opportunity to initiate a cultural paradigm shift, whereby university and colleges become global leaders in sustainability. There are existing spatial development recommendations for a campus with better spatial quality and a more sustainable outlook. (Posad Spatial Strategies, 2019)

TU Delft campus overview
background of site

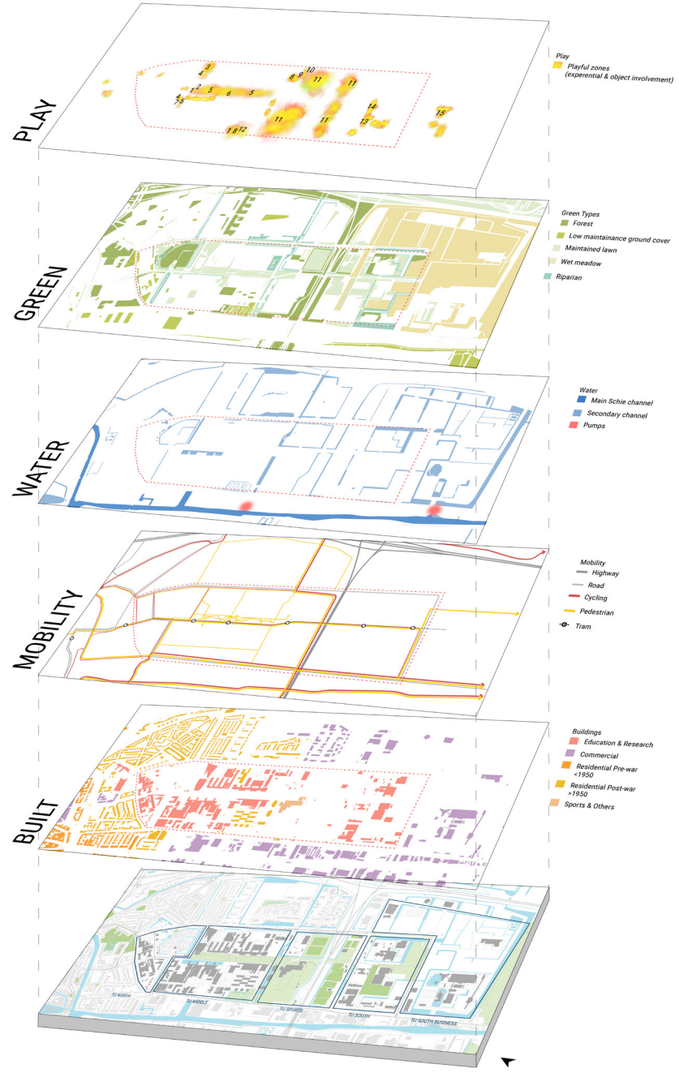


Figure 4-3. Exploded axonometry of layers of the TU Delft Campus, Data from Qgis, Delfland Water Board, Drawn by author.

Landscape development
TU Delft

The landscape of TU Delft has changed with time, reflecting the shifting priorities of the campus.

With the expansion plan of 1915, TU Delft shifted out from the city centre to acquire more space and started to build its own spatial identity. Green was valued for its scientific education purposes as a Botanical garden of approximately 2.5 ha was created in 1917 for research in tropical agriculture in the Dutch East Indies.

Mekelweg for Accessibility
In 1953, the core outdoor district of TU Delft, Mekelweg, was designed as an urban industrial landscape to give structure to the buildings. Then, accessibility and convenience by car was priority since Hans Warnau of the Buys, Meijers, Warnau office, created spacious layout with large traffic intersections and parking spaces. Green lines followed the orientation of Wippolder and was seen as an ornament between building and paving. There was a consensus about the lack of life in the campus. In contrast to Warnau's approach, Mien Ruys designed certain smaller areas, such as the ones around the Architecture building then, to be cozier and with more details and planting. (SteenhuisMeurs BV, 2018)

Mekelweg to Mekelpark for Social Cohesiveness
In 2000, Mecanoo created a new identity for the campus by developing the Mekelweg into a car-free Mekelpark. The new central area of the campus is interwoven with pedestrian circulation connecting surrounding faculties. Together with the large rolling lawn and wide plaza, Mekelpark serves as gathering spaces for students from different disciplines for a range of activities from discussions to leisure and sports.

Mekelpark for Biodiversity and Climate
Mekelpark was designed as a manicured rolling lawn with sparse clusters of trees. This is ideal for humans use but not so for non-human species. Today, there are plans for Mekelpark to be more biodiverse and inclusive; trees with higher nature and ornamental value are added, flower and herb-rich grass are seeded, and nest boxes are installed throughout the campus.



Figure 4-4.
Top: Mekelweg, 1972 (Image bank TU Delft)
Middle: Mekelpark (Mecanoo, 2019)
Bottom: Mekelpark Spring Blooms (TU Delft, 2018)

Current management plan
TU Delft

Aligning to the "Green Delft Memorandum 2012-2020" drawn up by Delft municipality, the TU Delft Green Management Plan 2020 aims to increase the bio receptiveness of the campus, addresses climate change, and achieve clean water. This is done through measures such as periodic mowing and sowing of flower herb varieties and improving the water quality. In January 2021, 30 bird boxes have been set up around the campus.

The University is aware of the importance of biodiversity and is slowly moving away from a manicured and productive lawn and rethinking the "tidy" image of the campus facility. TU Delft has decided to maintain the campus in accordance with the scenario where the campus allows for slightly more natural growth control over the form while the entrances are kept in a manicured and neat form. There is still a need to change the norm perception of the "tidiness" and improve the understanding of the benefits of natural processes.

From discussion with Rene Hoonhout, the Green Manager of the campus, there has been several acupuncture eco-projects in several parts of the campus and more upcoming ones too. For instance, there is an on-going project to increase biodiversity, water quality and nature experience within the campus through the selection of climate resilient and ecological trees and nature-friendly banks. Chemical weed management is also substituted with sheep grazing and there are plans for phased mowing management.

The Campus & Real Estate department of (CRE) of TU Delft plans for the campus to expand southwards with the focus of more business campus partnerships and also the consolidation of car parks in multi-story buildings. CRE also wants to contribute to the sustainable development of the TU Delft campus.

Figure 4-5.
Top: Pony grazers in TU South (photo taken by author, 2021)
Middle: Prunus blooms in TU Middle (photo taken by author, 2021)
Bottom: SInus grazing management (redrawn by author)

Characteristics and landscape types
TU Delft

Campus Zonings

The campus is classified into 4 different zones: TU North, Middle, Sports and South. The respective landscape characteristics of forest, rolling meadow, functional green and wet meadow are influenced by the site topography, higher at the north and lower southwards.

The next step is to identify the landscape element type unique to each zone. When local qualities which are specific to the zones are identified and enhanced, this could potentially contribute to a variety of biotopes and microclimates on a larger scale. Meanwhile, the less desirable features such as paved areas can be improved.

Features

TU North is characterised by the forest biotope with a mix of diverse tree species in the Botanic Garden, Climate Arboretum, and cemetery. The high rocky tower of the Boukunde is home to the peregrine falcon. Next, Mekel Park contributes to the rolling lawn typology in the heart of TU Middle. Alongside, the detention pond at the 3ME faculty forms a wet ecological corridor. The back-of-house areas of TU Middle are neglected with less desirable with extensive paved areas. Moving on, the TU Sports zone might look green but, in fact, around 50% of the fields utilises artificial grass for functional sports and recreational needs. There are pocket parks and recent eco-inclusive buildings. There is also the main outlet into the Schie with student housing over the primary water channel. A major part of TU South is currently undergoing development into an integrated educational business park. There are temporary plots of extensive swampy wet meadows and wide-open water channels. The campus facility, AP South is situated along a dry swale and boulevard.

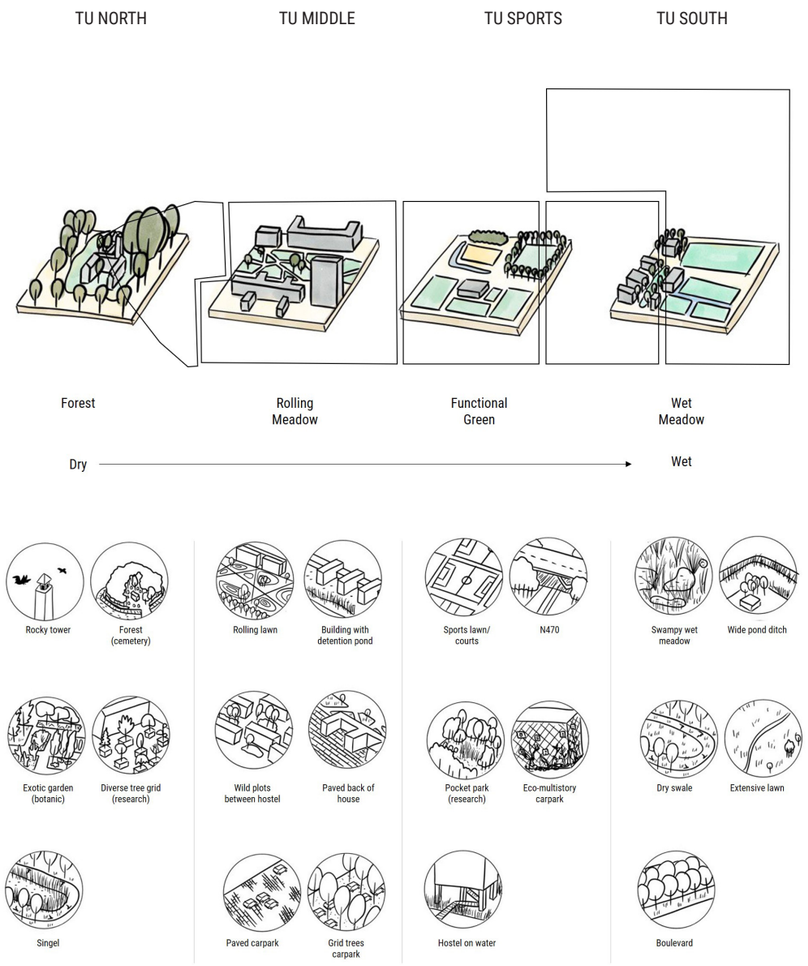


Figure 4-6. Zones of Landscape Characteristics and Elements of TU Delft Campus. Drawn by author.

The Built and its Environment

16 buildings are classified according to the 4 campus zones and arranged according to the size of their building footprint. As compared to other zones, TU Middle houses the most educational and student housing facility and naturally, support the bulk of the campus population. The inner ring rating reflects the height of the buildings. This could be useful when thinking about the connection of vertical biotopes. Lastly, each building is rated according to the type of green, brown and blue feature that it supports. Buildings with a larger footprint have the potential to create a substantial habitat size with nature-friendly rooftops. Smaller buildings can capitalise on their larger surface to volume ratio by having bio-receptive walls.

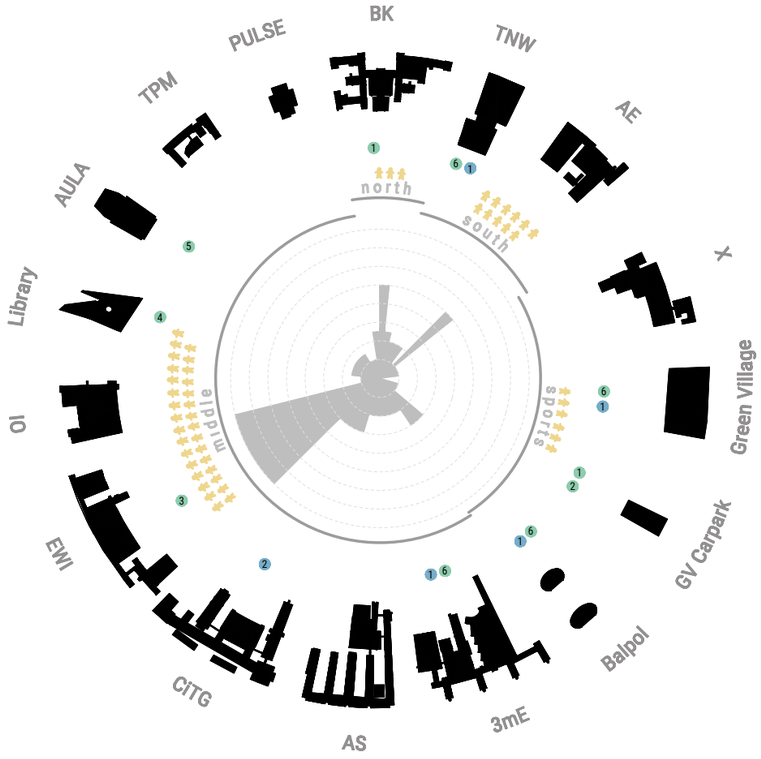
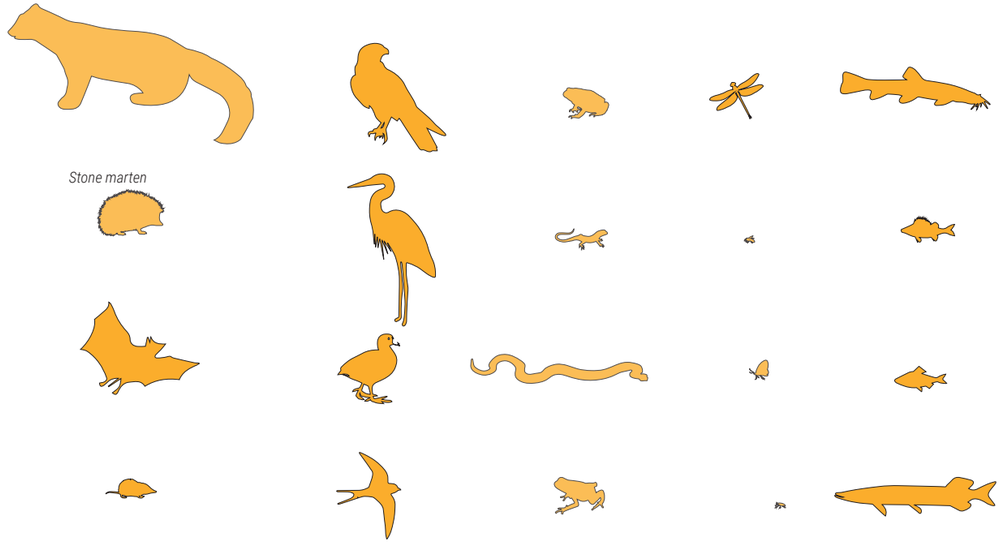


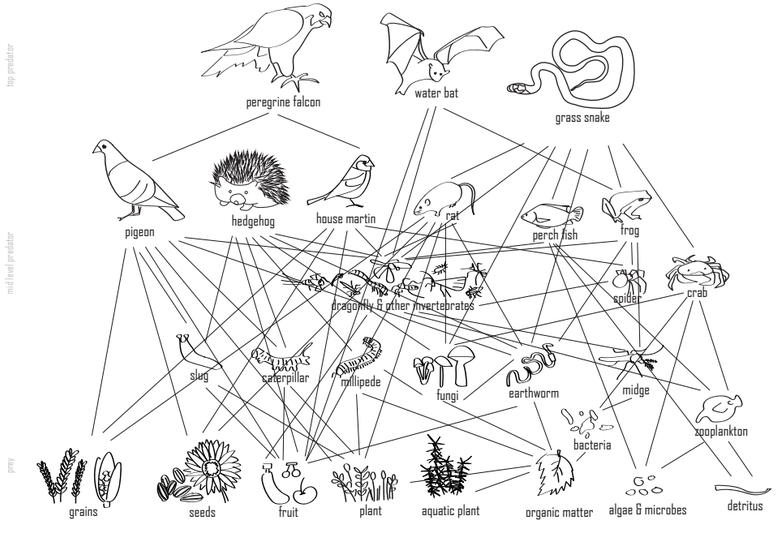
Figure 4-7. Building classification according to its characteristics and involvement with its environment. Drawn by author.

Existing fauna

TU Delft

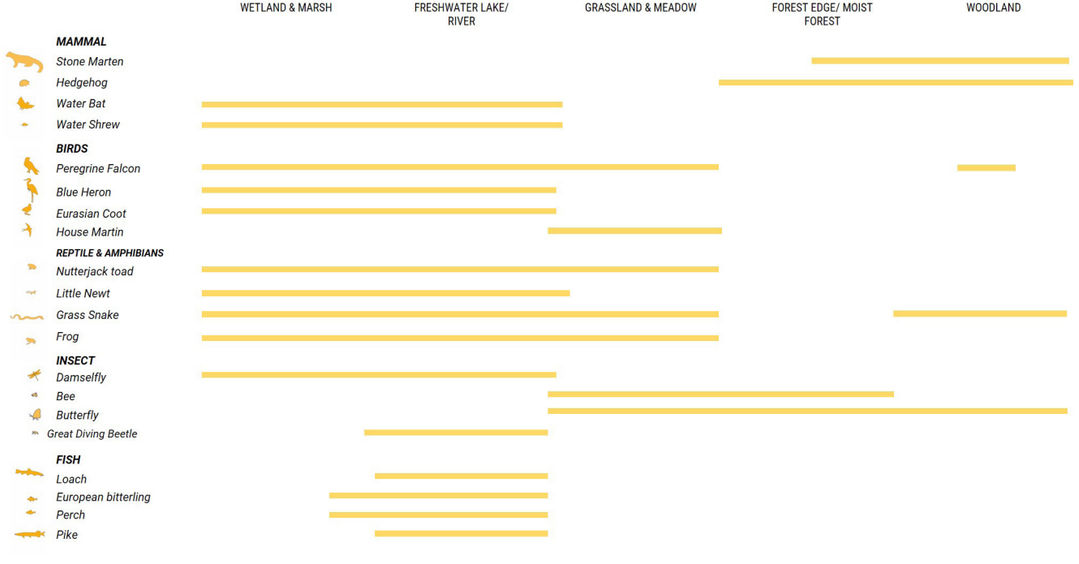


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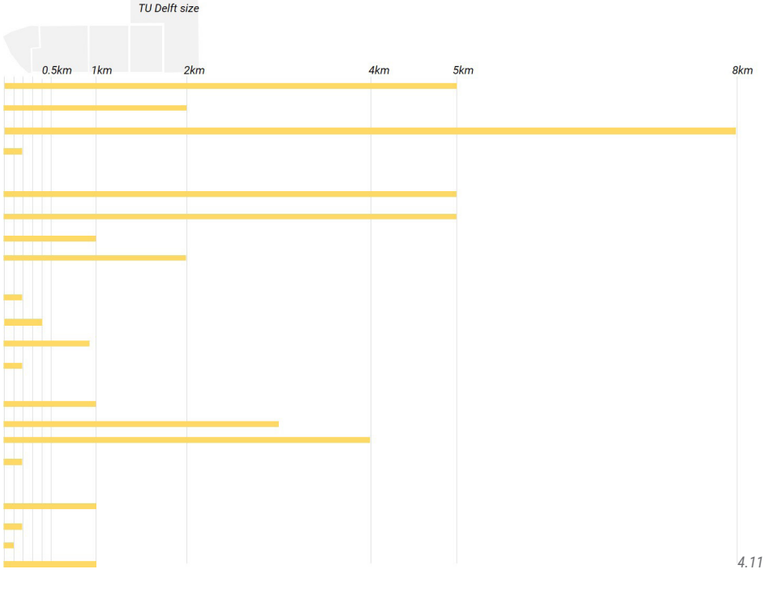


4.9

From an ecological report on Delft by Marion Scherphuis, 20 species of 5 different categories of mammals, birds, reptiles, insects and fish were extracted. (Scherphuis, 2013) The target species are analysed based on their biotopes and foraging areas. Since certain species have a foraging area that is larger than the campus, it is important that the campus connects to the biotope of the surrounding areas. The diverse biotopes of these animals represent the variety of landscape types that are found in Delft and more specifically, around, and even within the campus. There is a complex relationship between species, as illustrated by the interconnected food web, and the complexity of an ecosystem contributes to the resilience of the system and a stable supply of ecosystem services. (Landi et al., 2018)



4.10



4.11

Figure 4-8. Twenty existing fauna in Delft.
Figure 4-9. Complex food web relationship.
Figure 4-10. Habitat classification of existing fauna.
Figure 4-11. Foraging range of existing fauna with relation to TU Delft campus size.
Drawn by author.

Landscape ONSITE 2020
a perspective of TU Delft

TU Delft Campus for All Species

Landscape Architecture ON SITE is a Master elective course by the Landscape Architecture Department at the Faculty of Architecture and the Built Environment of TU Delft and it is conducted during the 4th quarter in 2020.

Among other exercises, the first was to look at the TU Delft campus from a non-human lens. With 27 students from different master tracks, 27 different fauna and flora that existed on the campus were selected and analysed based on their perception of the world around them. A diary of each species was produced to understand the basic and unique characteristic of each species and a short film of the experience by each species was made to experience the campus or the world through another lens.

Later, the campus was reimagined as a paradise for the specific chosen species. This is a collection of some of the paradise imagined by the students.

This series of exercise enabled a deeper understanding of other species and is useful to prompt designers to relook at the site from another point of view and perhaps gain new understanding and insights about the approach to the site.



Beech paradise by Gary Gilson



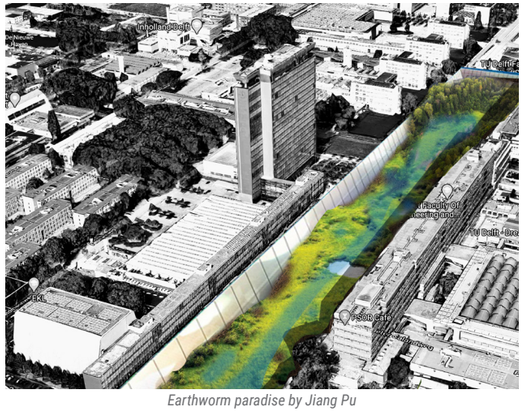
Great Tit paradise by Jelle Dekker



Water campus by Team E-Colab



Butterfly paradise by Emmanouela Amoutaki



Earthworm paradise by Jiang Pu



Cherry Blossom paradise by Zheng Yu



Dragonfly paradise by Ioanna Kokkona



Yew Tree paradise by Hanvit Lee



Mekel park with Hawthorn by Anne Leltz

Figure 4-12. Collection of spatial imagination of a campus catered to other species. Students work from ONSITE 2020.

Water & heat

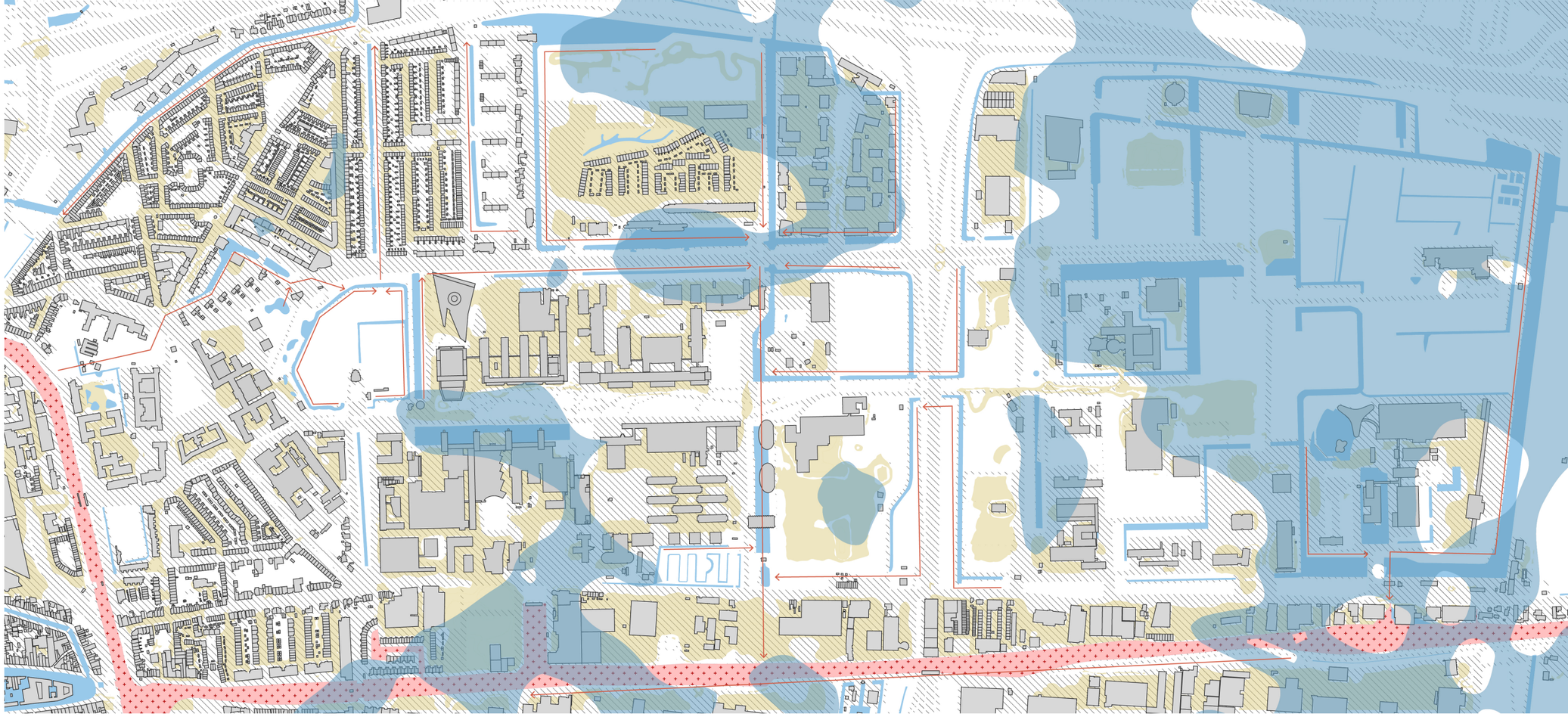
challenge and opportunities

The campus lies in the Zuidpolder which discharges water into the Schie through the 2 pumping stations which are located on the campus along Rotterdamseweg.

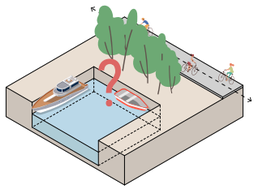
When it rains, the glasshouse towards the east of the Zuidpolder discharges water quickly into the canal. Together with other run-offs from the grassland, water is being channelled towards the 2 outlets on the campus. TU Delft has a disconnected grey water management system; the overflow would be collected by the sewage system. The vulnerable flood areas are obtained from FloodMap with data sources from Mazpzen, TNM, SRTM, GMTED, ETOPO1. It shows that TU South is more prone to flooding and also a part of TU North. Local retention storage solutions should be considered especially for lower-lying TU South and subsequently cleaned for reusing purposes.

A large proportion of the campus, especially the back-of-house areas comprises sealed surfaces. The overlay of the surface sealing map and the heat stress areas reveals that paved surfaces contribute to the urban heat island effect and this is worse for areas without shading and evapotranspiration by trees.
The profiles of the water canals are illustrated in the small axonometric drawings. The harbour along the Rotterdamseweg is isolated and disconnected from the campus. Also, the wadi profile is generic with uniformed steep slopes that do not allow for much riparian vegetation growth nor for people and animals to be engaged. More can be done to strengthen the water identity and water channel profile on the campus. The Schie is also polluted with high nitrogen levels. (Hoogheemraadschap van Delfland Waterkwaliteit op de kaart, 2020) In addition, water quality within the campus ought to be improved.

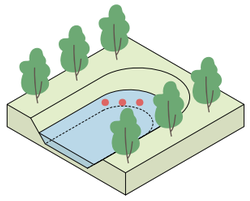
Figure 4-13. Water and Heat Key Challenge Mapping. Drawn by author.



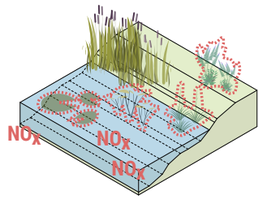
Water flow direction
Flood zones
Surface water
Heat stress
Paved areas
nitrogen 3x normal value (6mg/l)



Forgotten Harbour



Generic profile



Polluted water

PROBLEM

Polluted Schie | Flood prone areas | Disengaged profiles | Paved

OPPORTUNITY

Living Machine | Retention Squares | Reuse water| Activation | De-pave

Biodiversity

challenge and opportunities

The campus is reimagined as a natural biotope with rocky building features surrounded by green and blue patches. Applying the Matrix-Patch-Corridor theory, there is a green connection between the forest patch at Delftse Hout into TU North. TU North is characterised by big and small patches of forest (cemetery and botanic gardens respectively) and also green connectors of roadside Platanus tree planting and Prunus tree along the Mekel park. The green connection by the dense forest planting along the highway is not continued along TU South. There is a disconnection from the green patch of Abstwoudse Bos.

TU South is characterised by wet meadows with sparse rock clusters since TU South is yet to be fully developed. The sand piles and log piles (because of construction) beside water channels might be home to birds such as the sand martins.

The blue connection stems mainly from the ditches. The ditch width varies across the campus with different bank conditions. The major water channel of the Schie is disconnected to its surrounding landscape by the rocky waterfront industries and its hard banks.

OPPORTUNITY

Activate areas to host nature | Expand river biotope | Gradient | Green buildings | Patches and corridors | Accommodate more species | Improve aquatic plants

PROBLEM

Stony sterile buildings | Paved areas | Limited habitat opportunity

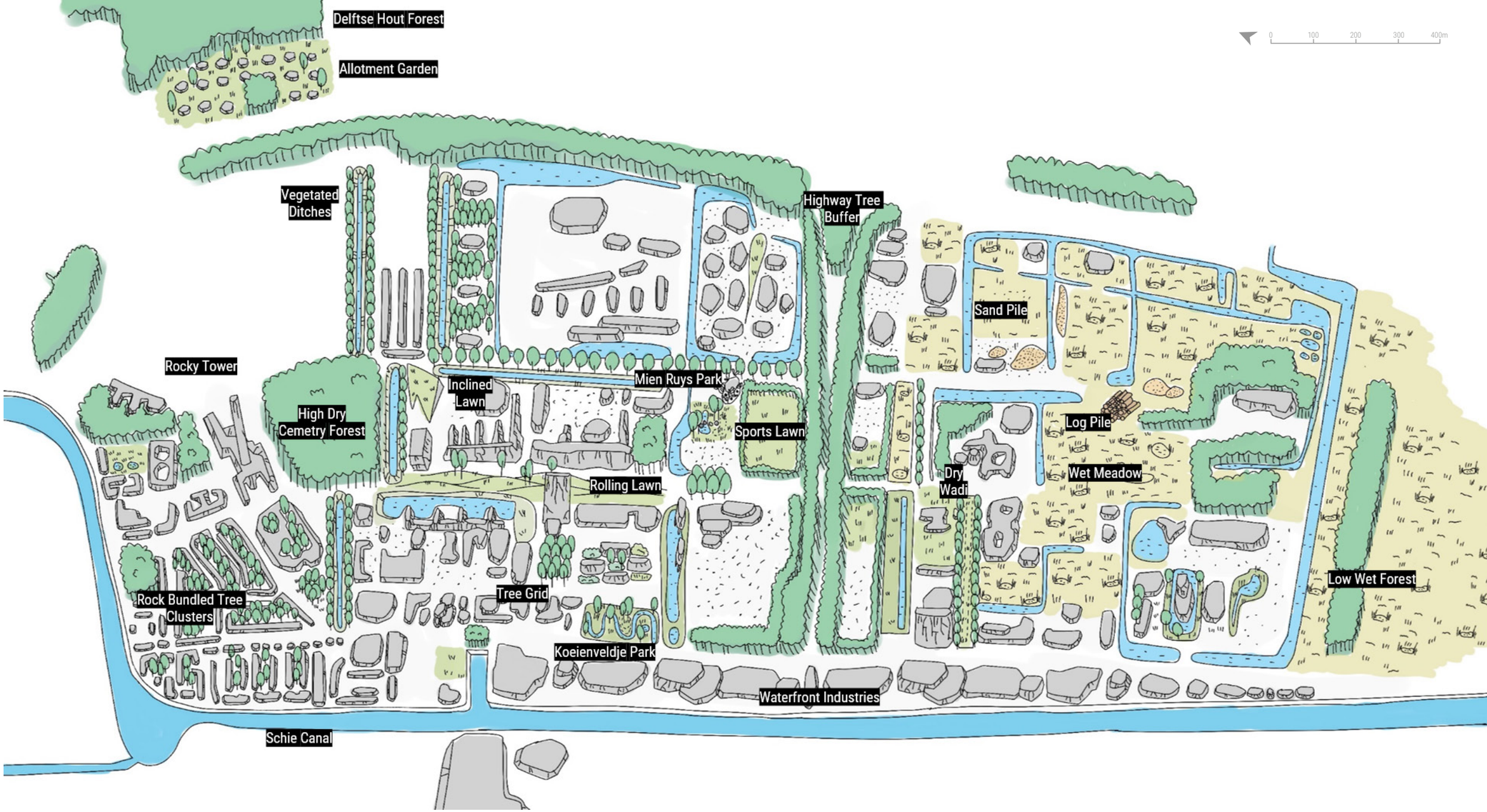


Figure 4-14. TU Delft Campus as a Natural biotope. Drawn by author.

Play

challenge and opportunities

The engagement activities within the campus are mapped out. Play is defined as the interaction amongst people, built elements and nature. Through experience, site observation and photo archives, the active zones in the campus are mapped out and the accompanying engagement type is elaborated in the smaller illustrations. The way people interact with their environment depends on the interpretation of the affordance provided to them. Users would sit on steps, lie on sloped grass, hop on rocks, climb onto sculptures, balance along curbs. Possibilities by open-ended human-scale elements encourage engagement through imaginative interpretation. Apart from human-surrounding interaction, there is also engagement between the built environment and its biotic and abiotic surroundings. Multi-story parking with green facade and nesting houses for bats, the CME back-of-house shed that has a modular pitched roof for natural day-lighting, dry swale in TU South that becomes a stream during rain events. More can be done to spur engagement between the physical environment, people, biotic and abiotic factors through sensorial engagement ,for example using striking colours, and possibilities for multiple use and interpretation.

OPPORTUNITY

Vibrant campus | New area for play | Play network

PROBLEM

Play concentrated at sports fields | Limited playful opportunities | Buildings can be more involved in play



Figure 4-15. Play Engagement Key Challenge Mapping. Drawn by author.



Figure 5-1. Exploratory render of a resilient campus with green climbers on AS building, water detention plaza in Mekelpark, wetland infront of 3ME faculty. Drawn by author.

05

VISION

Regional Concept
Research by Design Scenario 1
Research by Design Scenario 2
Research by Design Scenario 3
Campus Design Concept
Campus Masterplan

Delft city vision

meso scale green nodes and potential connection



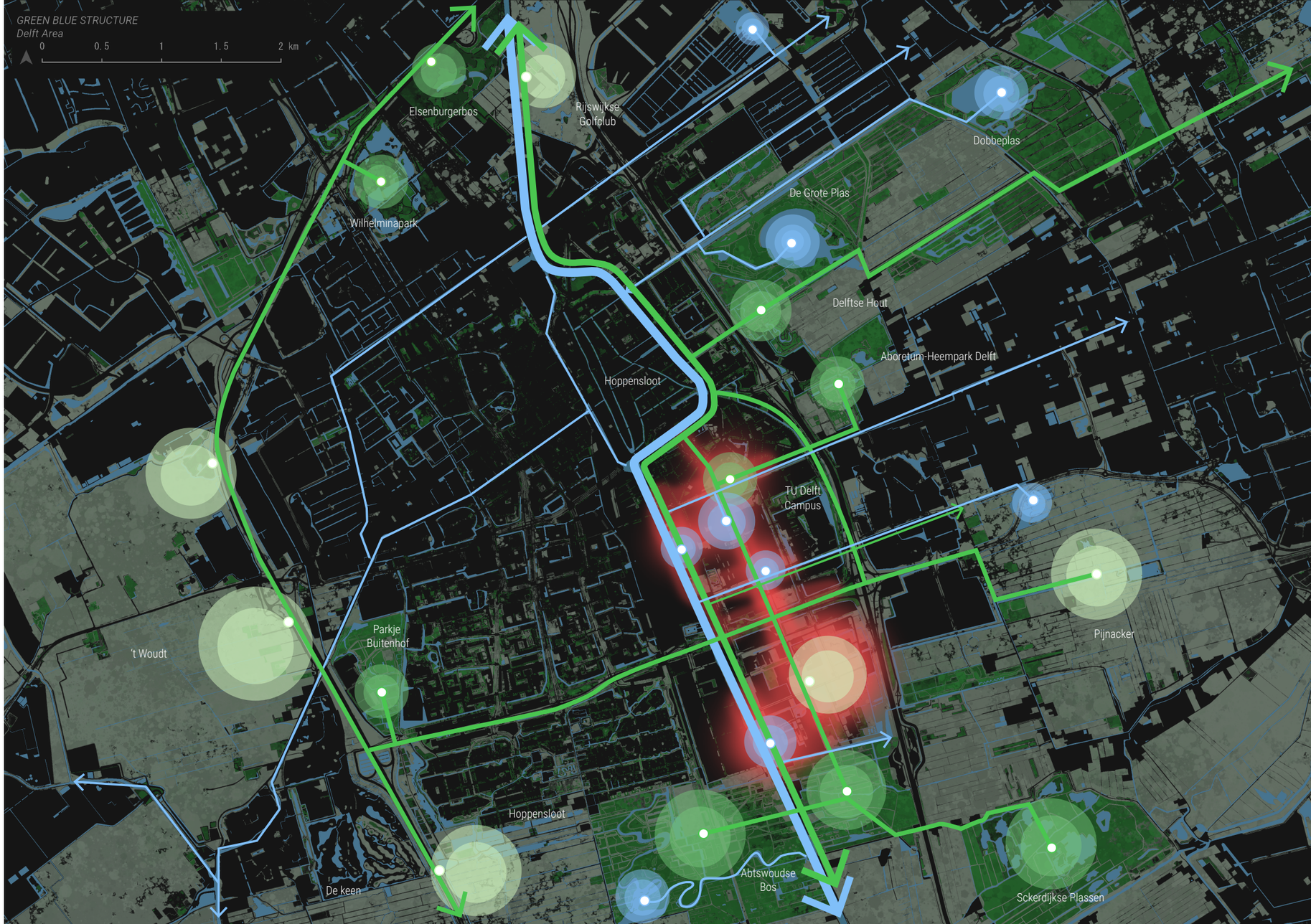
The vision for Delft city is informed by the plans set out by the municipality. The surrounding green and blue facilities such as parks and agriculture fields are identified mapped. The vision is to connect them and hence forming a green and blue ring around the city core. It is also ideal to find opportunities within the tight urban fabric of the city core to interweave the connection network. TU delft campus can not only connect the green and blue patches, but it can also become a hotspot with quality habitats and provision of the basic requirements of food and shelter for wildlife.

By understanding the regional landscape characteristics, to the north and south of TU Delft campus lies the forest patch and the wet meadow and grassland patch respectively. There is also the Schie canal alongside the campus. The project aims to extend the patches into the campus and create smaller connecting patches within the campus.

Figure 5-2.(right)
Delft city green-blue network vision. Drawn by author.

Figure 5-3. (top)
Campus vision to incorporate and expand surrounding landscape types. Drawn by author.

- Polder Forest
- Wet meadow & Grassland
- River Chanel Veins



The River Campus

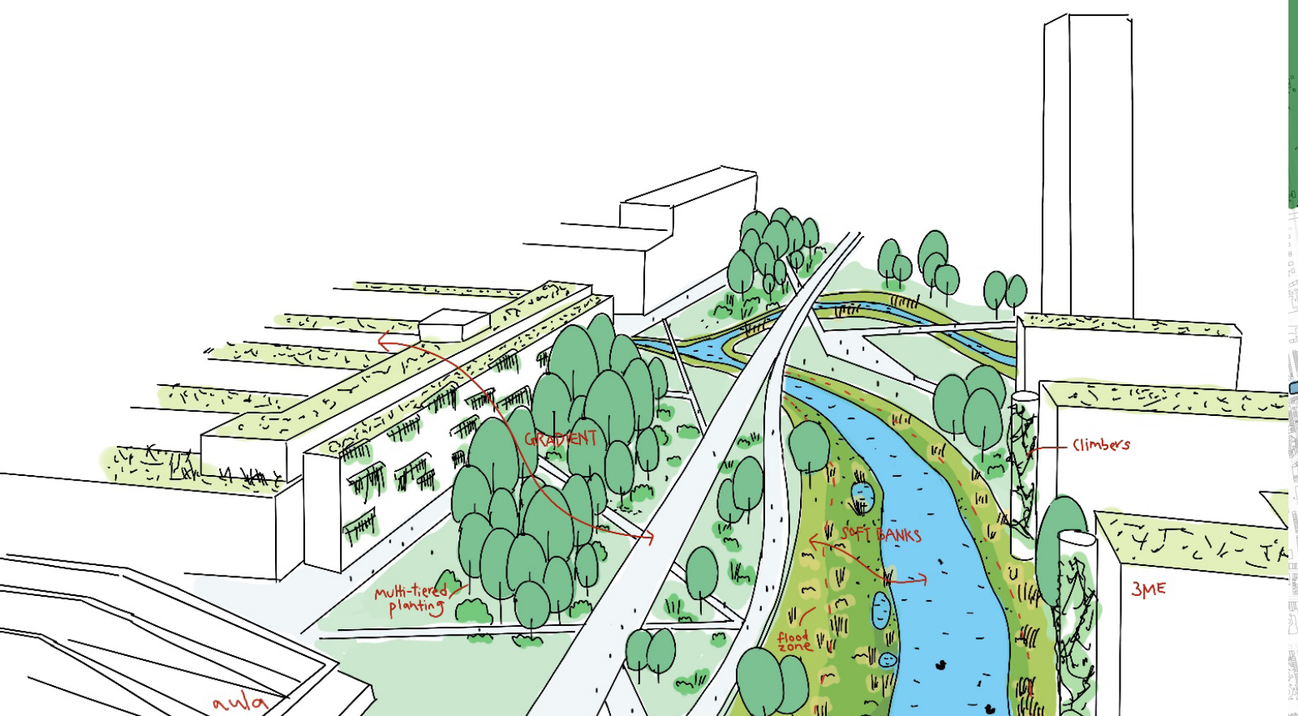
CONNECTED

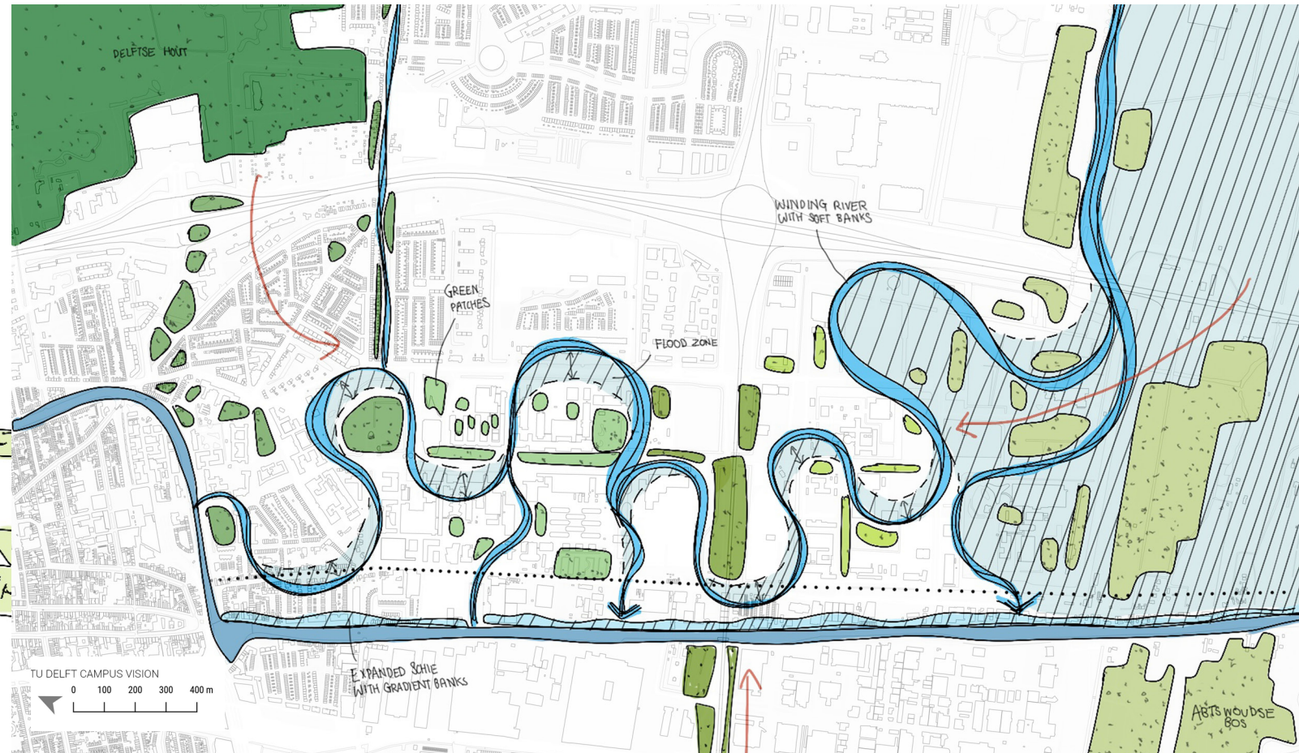
CONNECTED
The campus is reimagined as a natural landscape with the incorporation of a major river channel from the Schie that connects the North and the South campus. The campus connects the north forest of Delftse Hout to the south wet forest of Abtswoudse Bos through patches of different sizes and types. Also, the wetland meadows of the Abtswoudse Bos region is extended northwards into TU South.

GRADIENT

GRADIENT
With reference to the topography, the Schie canal is expanded within the area of the same elevation to have a more diverse and sloped banks condition. The bank edges of the campus river is a flood plain, rich with a gradient riparian zone which allows for flooding during a heavy rain event. The terrain of the campus from north to south is from a gradient of high to low. As such, the green patch throughout the campus is also of a dry to wet typology from the north to south. There is also a transition of the profile from the built environment to the surrounding natural conditions through the incorporation of green roof, walls and multi-layered planting.

Figure 5-4. (bottom) Bird eye view of winding river in Mekelpark. Drawn by author.
Figure 5-5. (right) Conceptual plan- river campus. Drawn by author.





The Elevated Flooded Campus

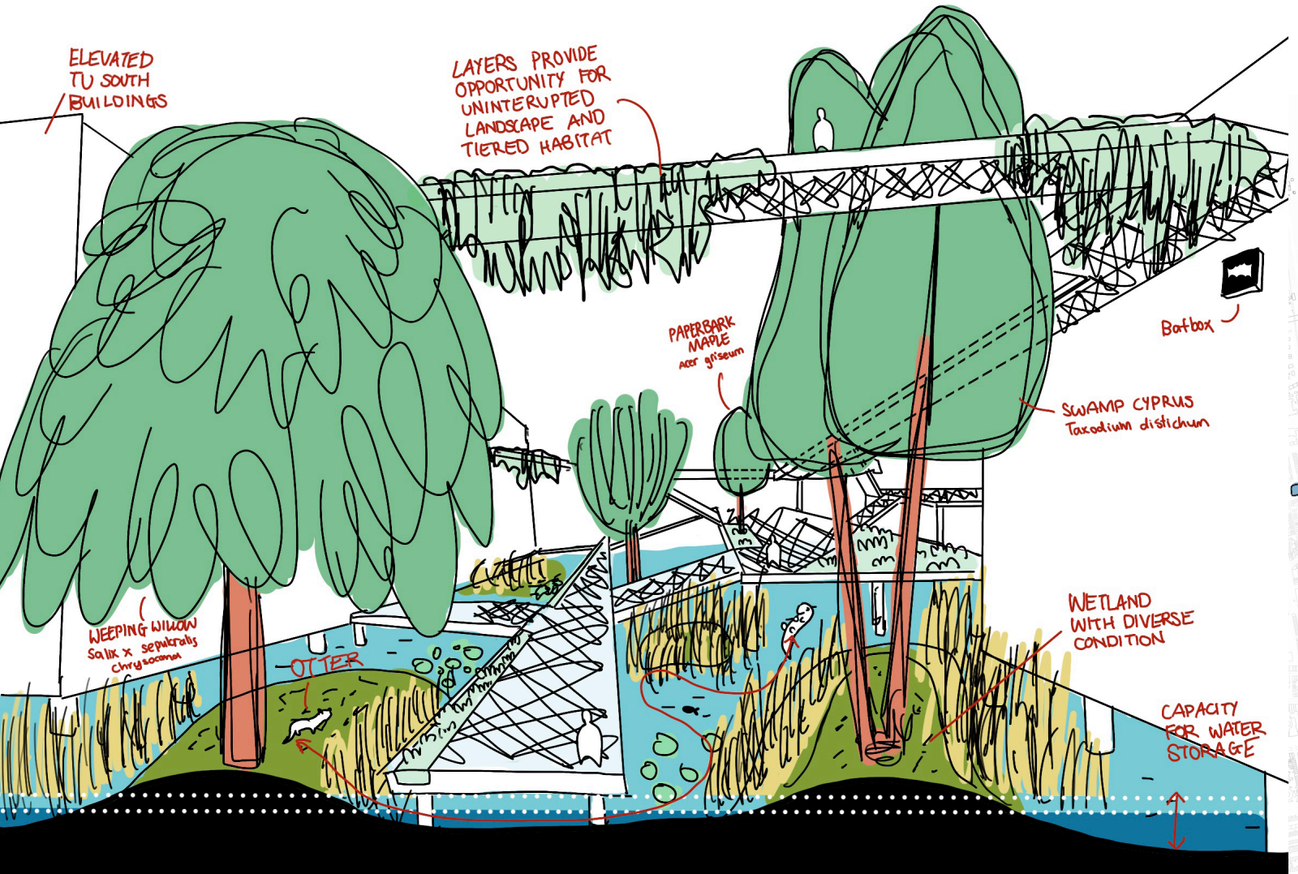
RESILIENT

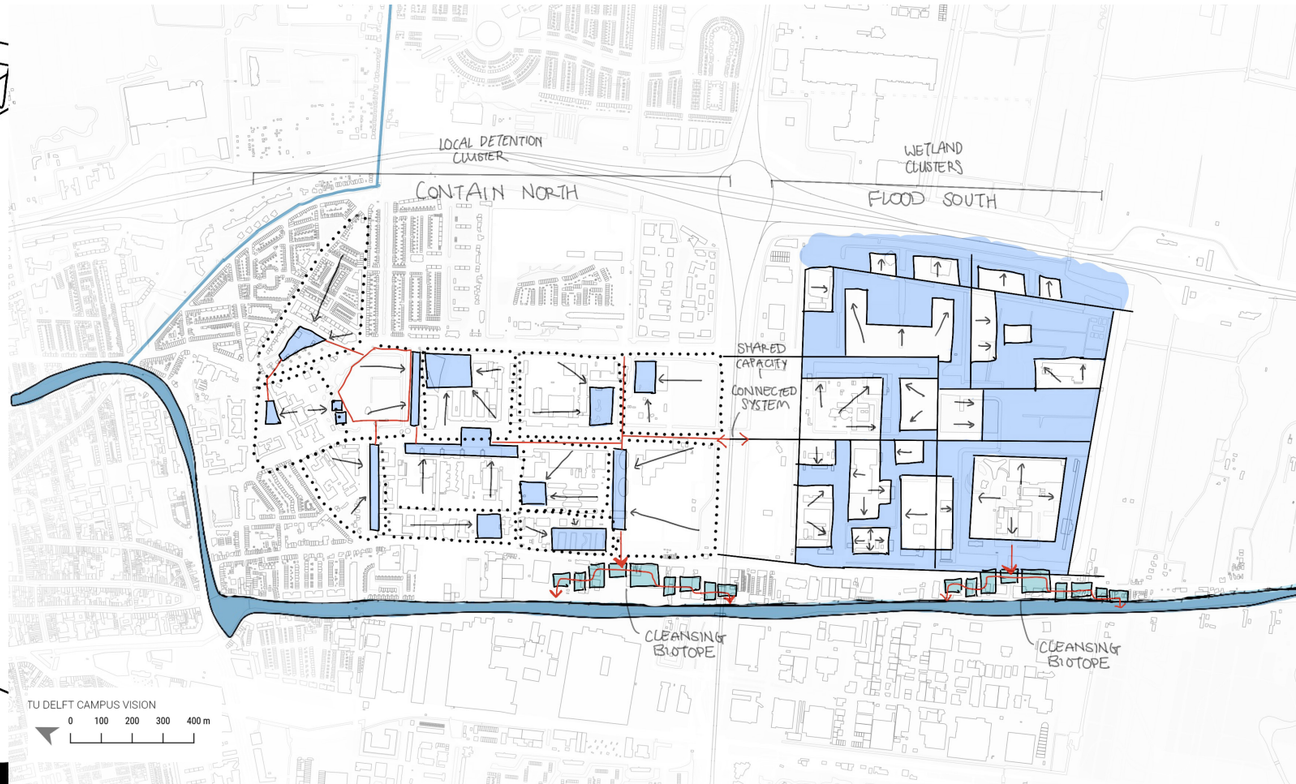
Being situated in a lower elevation, TU South is flooded to become a wetland with water storage capacity and fluctuating water level. Meanwhile, at TU North, more local rainwater garden areas are created. The water capacity redundancy for the campus is increased by approximately 80K m3 of water. To improve water quality, water is also being treated by a cascading cleansing biotope situated at the outlets with a 2m elevation difference.

INCLUSIVE

Human activity and mobility network are lifted in the campus to free up space on the ground level to create an uninterrupted and undisturbed continuous base plane for flora and fauna. Also with the different plane levels created, there can be layers of vegetation of different biotope. The human experience is also enriched through vertigo stimulation and the interaction with the surrounding at different elevations.

Figure 5-6. (bottom) Bird eye view of lifted mobility and seamless wetland biotope in TU South.
Figure 5-7. (right) Conceptual plan- flooded campus.
Drawn by author.





Research by design scenario 3

The Fun Campus

AFFORDANCE

INCLUSIVE

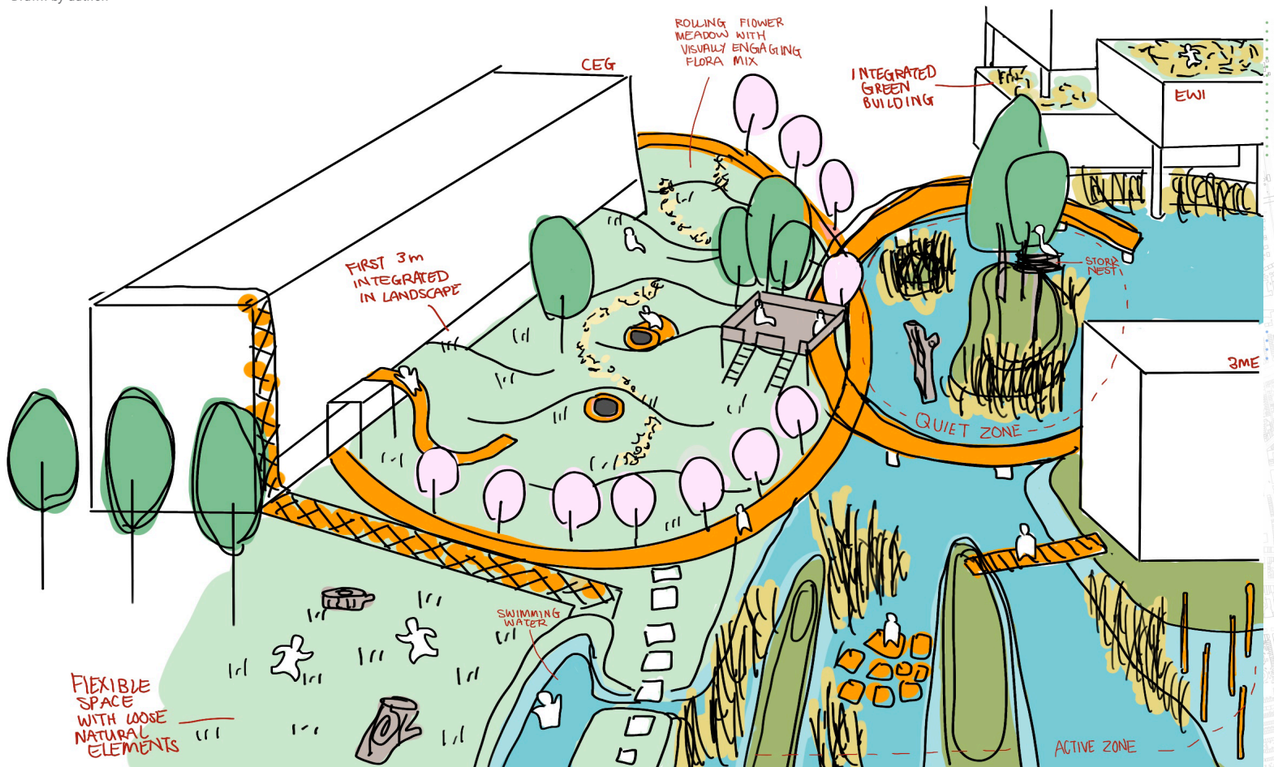
PROVOCATIVE AFFORDANCE

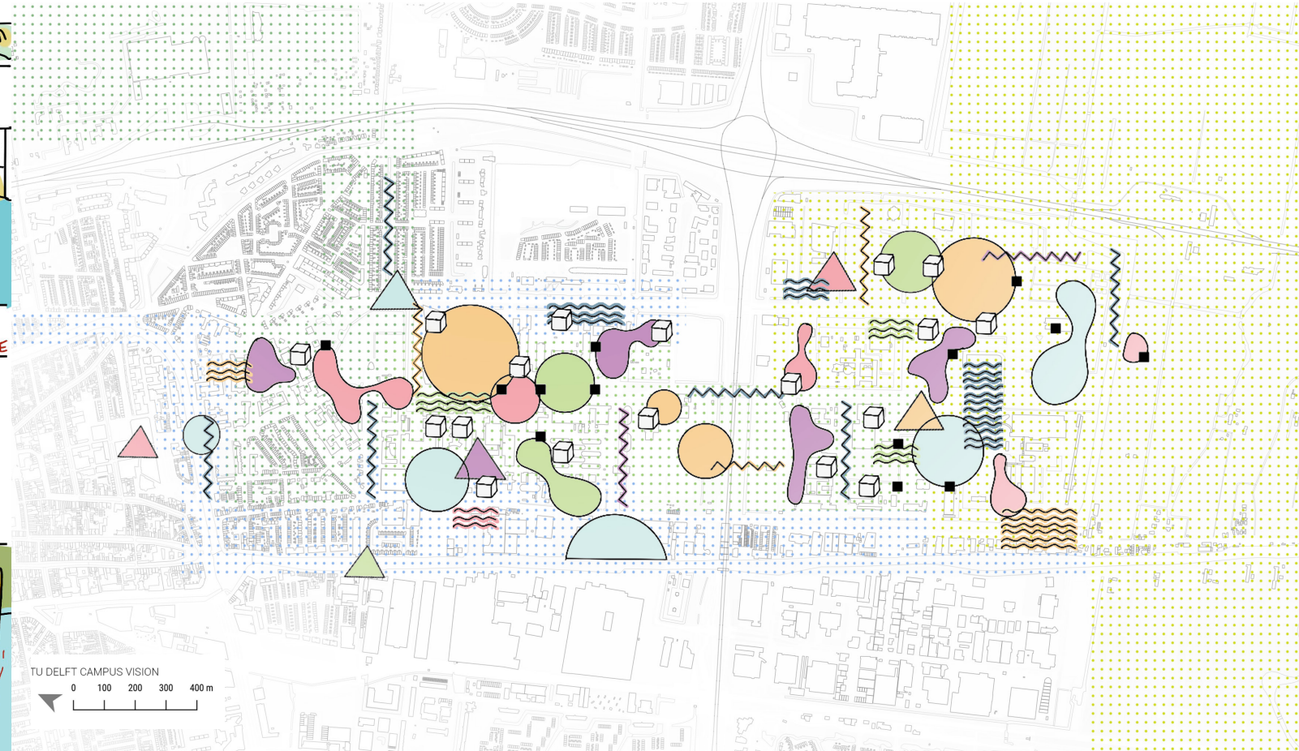
The playful campus is being divided into clusters of different landscape and spatial qualities. Natural structures and elements provide affordance and the opportunity for use, spontaneity and interpretation. The five senses are engaged. The striking and provocative colour prompts users to take notice and engage with abiotic and biotic factors such as the light condition, water flow and flora. The relationship between elements in the campus (eg. buildings, pavement, planting, water, etc) is connected and strengthened through methods such as accessible green roofs and conveying interesting water conveyance methods.

INCLUSIVE

The play equipments are naturally friendly and organic materials. Areas are categorised and allocated to cater to flora and fauna with differing needs. (eg. sensitive fauna that requires quiet zones.) In active zones, human activities cause disturbances.

Figure 5-8. (bottom) Bird eye view of playful and engaging TU Middle, Mekelpark.
Figure 5-9. (right) Conceptual plan- fun campus. Drawn by author.

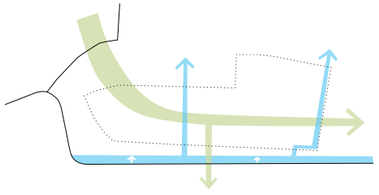




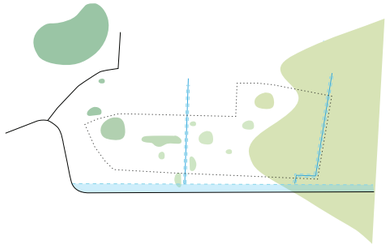
Design approach

5 steps approach

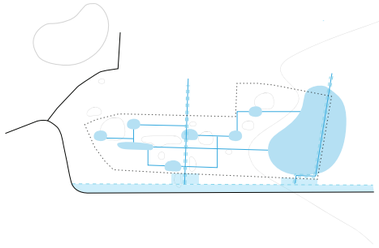
1. Connected & expanded



2. Gradient soft banks & patch type

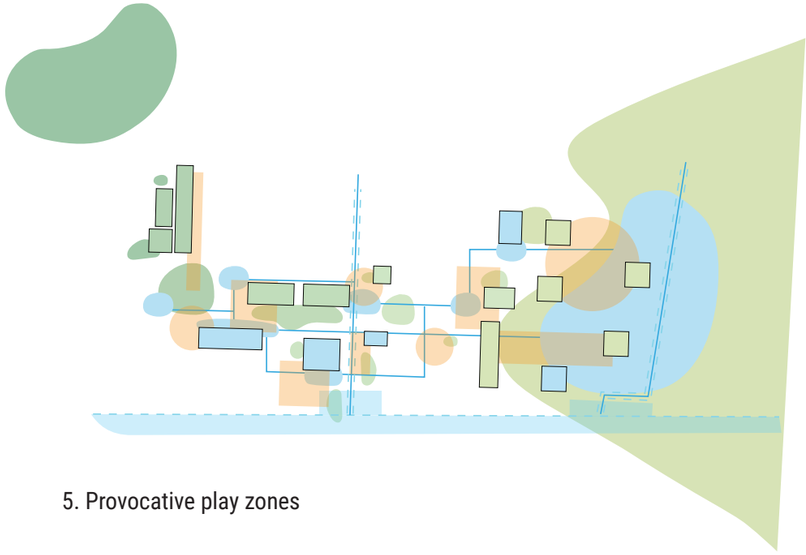


3. Connected local detention & purify



4. Buildings involved with habitat creation





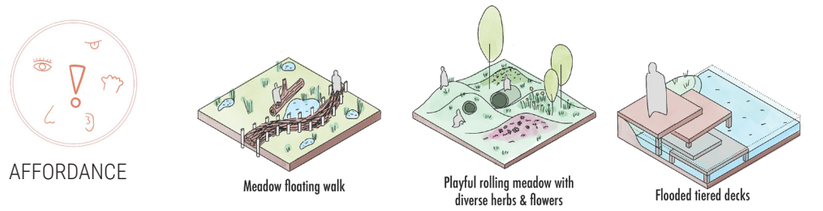
5. Provocative play zones

Figure 5-10. Diagrammatic illustration of the design steps for campus masterplan. Drawn by author.

Build-up of TU Delft masterplan

proposed steps for campus masterplan

The 5 steps approach is applied to the TU Delft campus. Each step is being elaborated by the overarching main design principles and also some design toolbox.
1. First, the green and blue types of the current situation is analysed. As a response, the existing patches are expanded and also new patches are added to create a gradient connection of the landscape types.
2. The built environment, such as the buildings, is involved in habitat creation through methods such as green and brown roofs. To strive towards a circular water system, the roofs collect 80% of rainwater so as to fully meet the water demand of the campus.
3. With the new green and blue patches, the campus is well connected to the surrounding landscape and provides not only a passageway but also quality habitat types for the needs of different species.
4.The campus is envisioned to have a resilient water system through increased storage and retention capacity and also good quality water. The water system at north and south campus is connected ot have shared capacity. There are also zones of flexible water level to allow for water level fluctuation.
5. With the basis of unique landscape types, playful areas are strategically injected through designing for the five senses and allowing for multiple usage and interpretation. These areas are stitched together to form a network in the campus.



5. Inject Provocative Playful Areas

4. Resilient Water System

3. Green Blue Connection Corridor

2. Involve Built Environment

1. Expand and Create New Patches

Current situation- Green and blue types

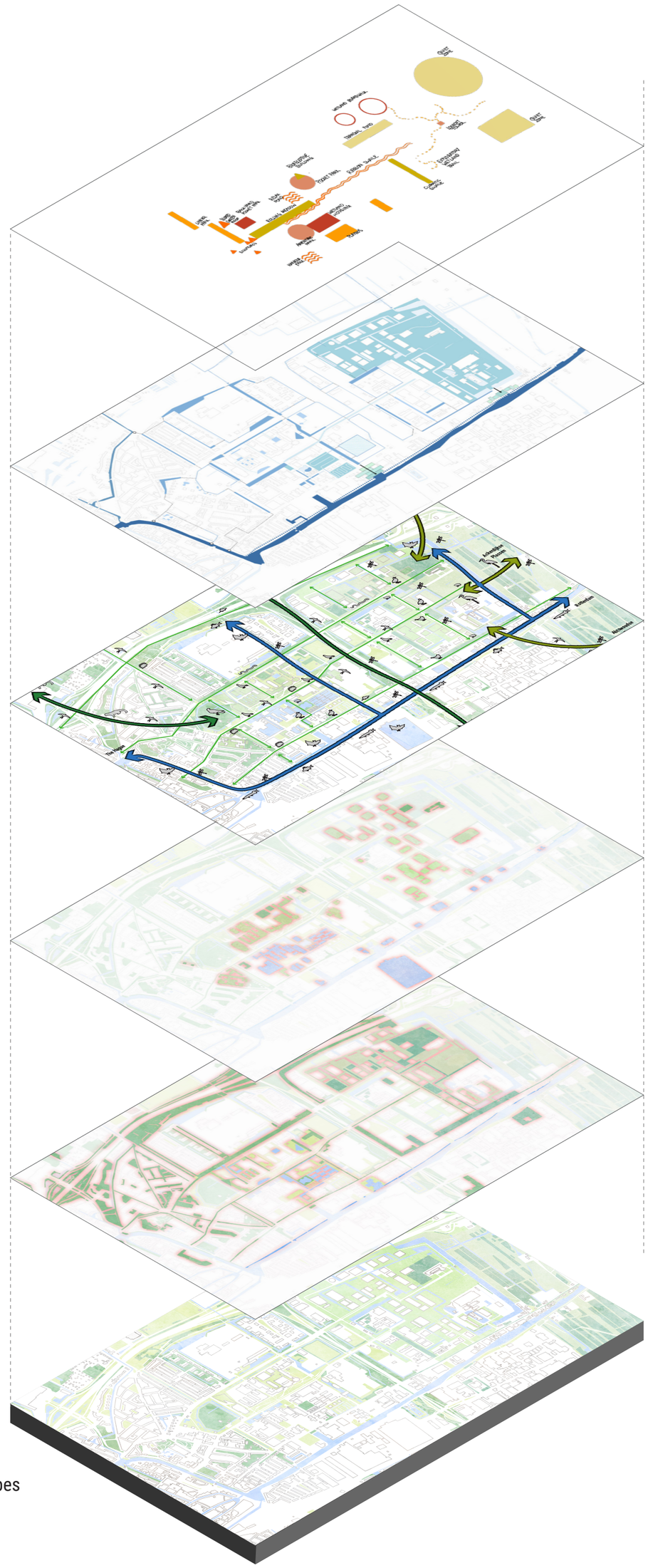
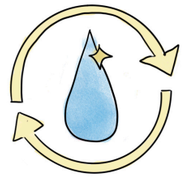


Figure 5-11. Layered steps applied onto the campus. Drawn by author.

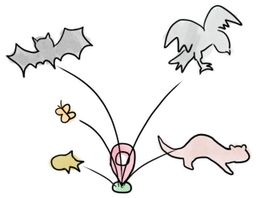
Vision for TU Delft

proposed campus masterplan

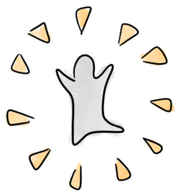
The master plan integrates the campus in the greater context and strengthens the different landscape characteristics within the campus.



Resilient Water System



Ecological Hotspot



Engaging Play

Figure 5-12. (top) Key design concepts.
Figure 5-13. (right) Proposed TU Delft masterplan.
Drawn by author.

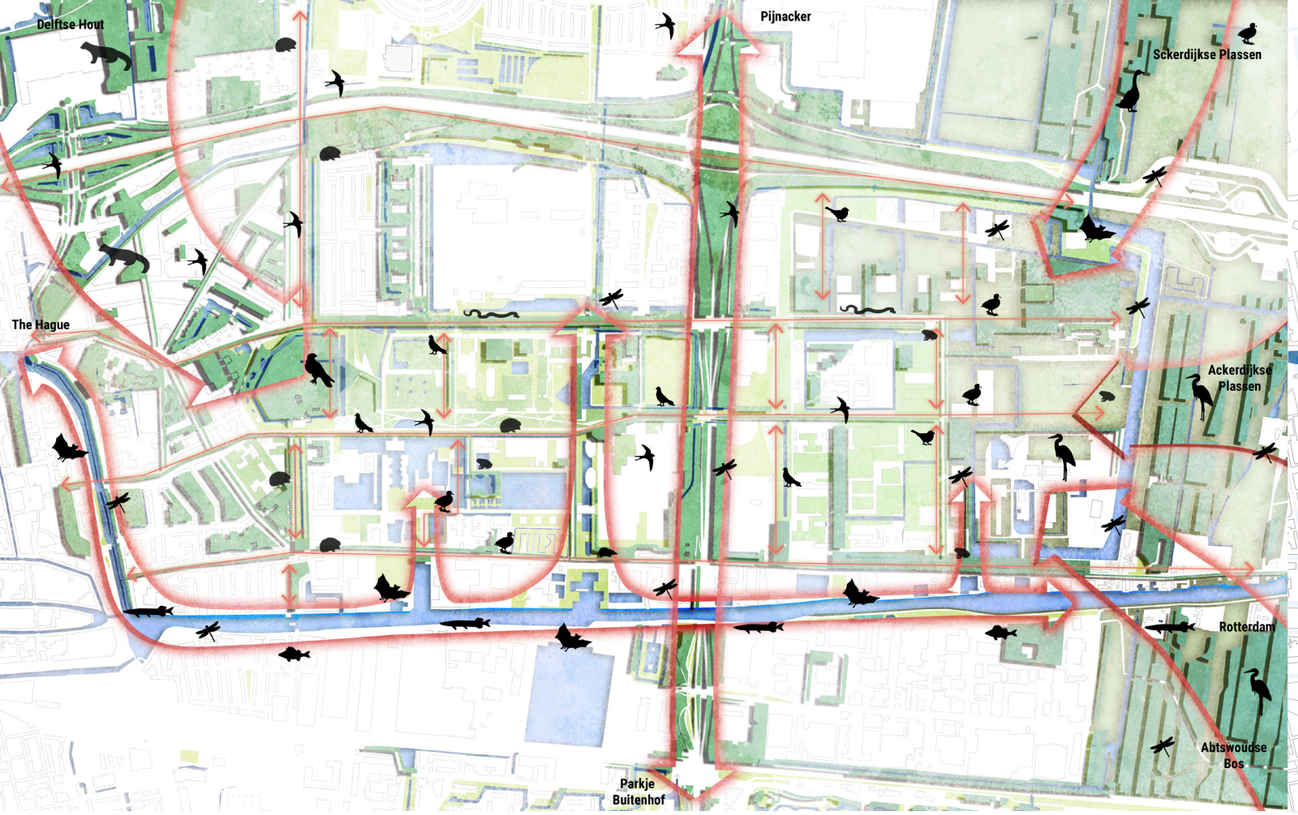


Figure 6-1. Imaginative collage of biodiverse, adaptive and playful campus.(left to right) Green climbers on AS building, multi-stemmed climbing tree and urban detention plaza in Mekelpark, swale along Mekelweg, wetland stepping stones in TU South. Drawn by author.

06

MASTERPLAN ELABORATION

Campus Masterplan Elaboration
Cluster Design Strategies
Cluster flora and fauna
Campus design toolbox
Campus Ribbon Swale
Campus Water Cycle
3 sites



Habitat zones & green blue connection

elaboration of campus masterplan

Existing green and blue patches have been identified and improved in terms of quality and size. The surrounding landscape has been connected into the campus and green blue biotopes and corridors within the campus are strengthened. The campus connects the north forest of Delftse Hout to the south wet forest of Abtswoudse Bos. Following the terrain of the campus from north to south of high to low, the green patches throughout the campus are of a dry to wet typology. Also, the wetland meadow of the Abtswoudse Bos region is extended into TU South. Also, river characteristics of Schie "overflows" into TU middle.

Existing infrastructure such as road networks and rooftops are used to form either connectivity or perforated island continuity. Each faculty has its active area and inactive back-of-house or cargo area. Wherever possible, depaving is done and space is given to natural processes. Studies have shown that spontaneous vegetation contributes to valuable ecosystems too (Robinson & Lundholm, 2012).

The Schie canal has improved eco-friendly banks with a greater range of partially submerged vegetation. Within the campus, the canals banks are also naturalised with a gradient riparian zone.

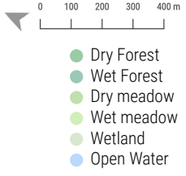
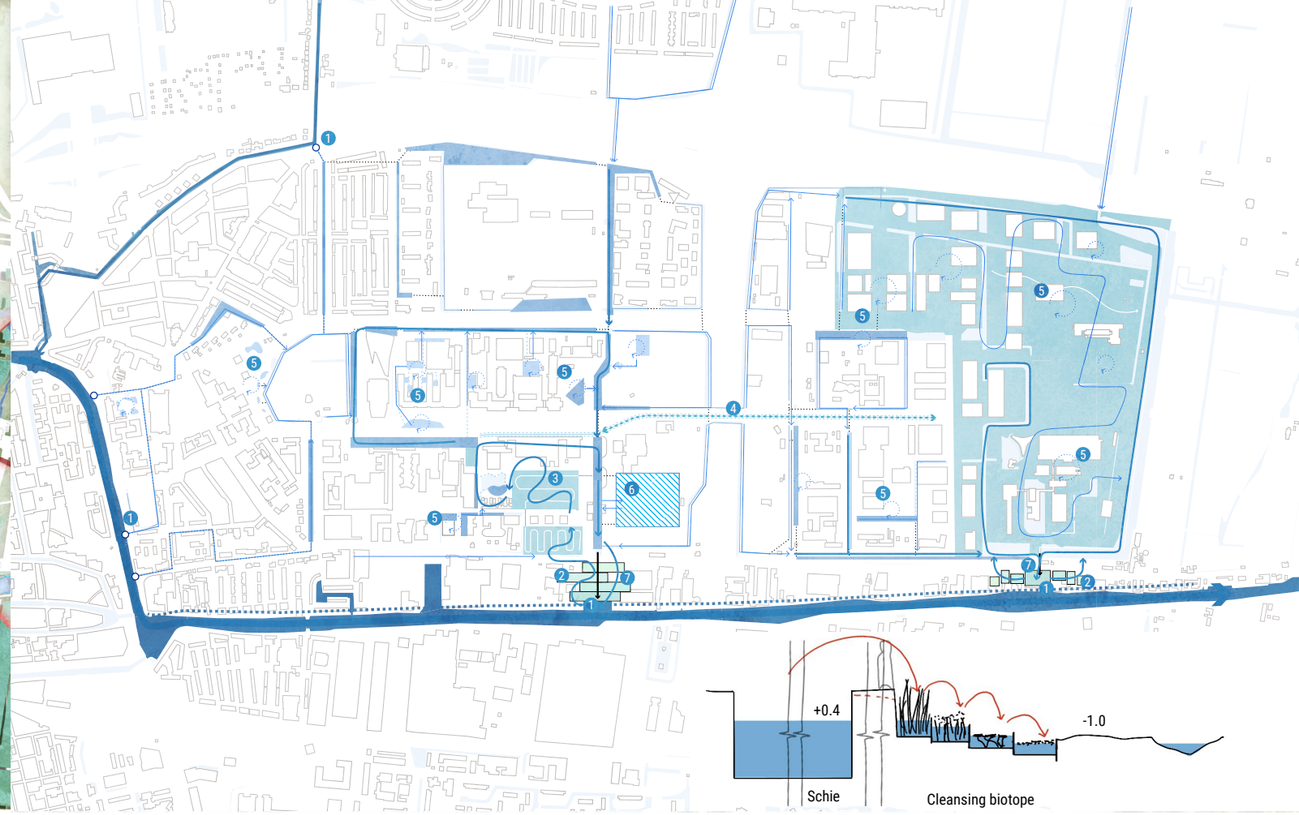


Figure 6-2. Ecological campus map. Drawn by author.



Water system

elaboration of campus masterplan

The circular water system in the campus is designed towards a closed-loop cycle. Using the principles of local storage, purification, storage and reuse, the whole campus becomes a living water machine. It is also adaptive since it is able to transit to different states during heat stress and extreme rain events.

The campus is divided into zones of flexible water level system. During heavy rain event, the canals and surface water is allowed to fluctuate within a threshold of 30cm. The north and south campus is connected with a swale to allow for shared water capacity during heavy storms.

1. Inlet flow from Schie (during dry season)
2. Cascading helophyte filter
3. Meandering flow in wetland for water cleansing
4. Connected to have shared detention capacity (especially during wet season)
5. Local collection, detention, and infiltration
6. Underground storage below sports fields
7. Pump out to Schie

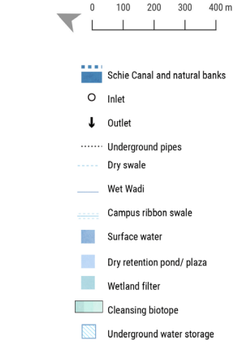
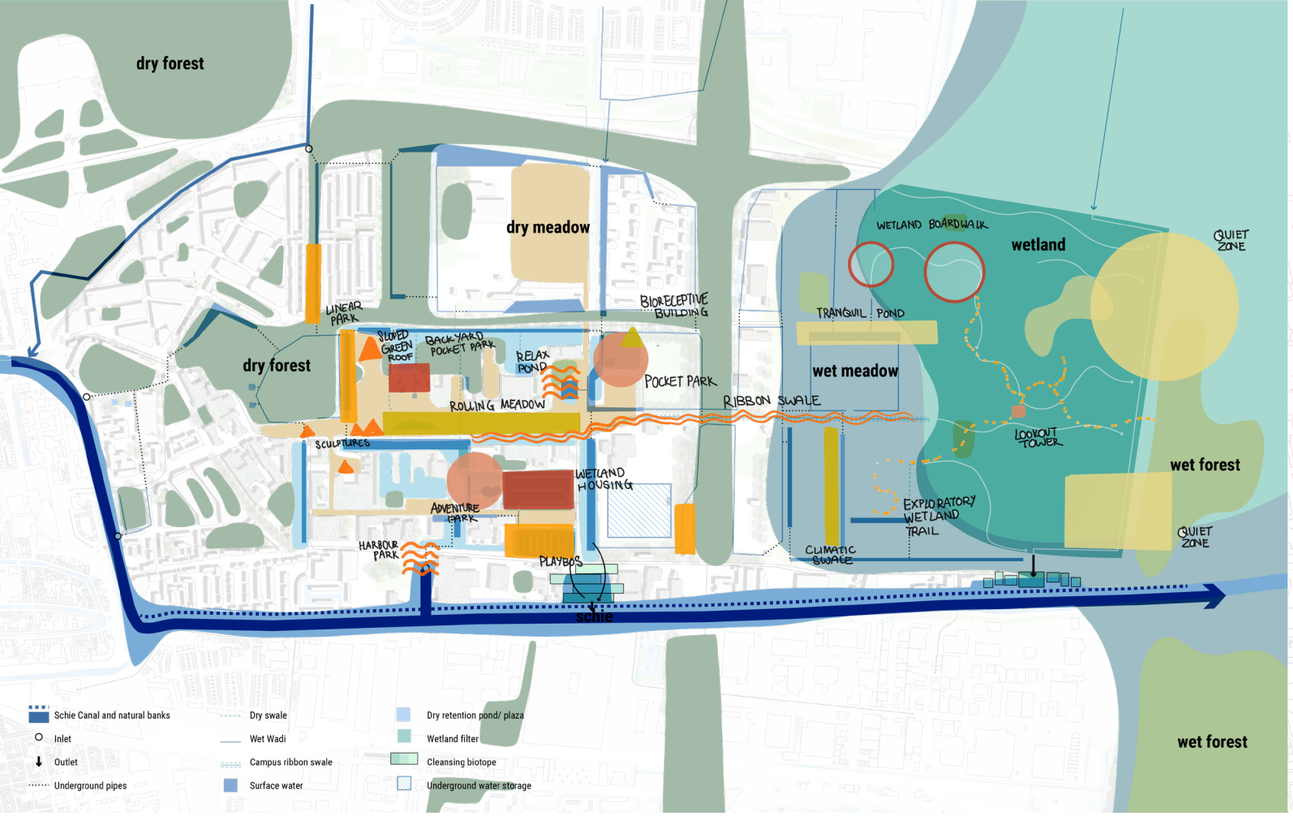


Figure 6-3. Campus water system map. Drawn by author.





Programmatic play
elaboration of campus masterplan

0 100 200 300 400 m

The landscape types (forest, meadow, river, etc) have their unique characteristics and spatial quality. They form the basic spatial zones within the campus. Additional spaces and new layers of programs are added to create more opportunities for engagement and activating spaces. The varied spatial qualities provides a range of different experiences and activities.

The playful strategy is applied across scale, from large scale landscape variance, to spatial curation of close and open spaces, to human-scale objects that engage their five senses and even vertigo.

Play on campus is aimed at not only providing a fun experience but also it provokes the association and relation of the biotic and abiotic factor by drawing relations and bring people and built-up environment closer to nature.

Elements in the landscape such as buildings are also engaged and integrated with the environment through novel architectural design. For instance, the faculty facility in TU South is a unique wetland building typology which will be elaborated in design site 3.

Figure 6-4. Campus play map. Drawn by author.

Campus clusters
elaboration of campus masterplan

0 100 200 300 400 m

The campus scheme is divided into distinctive 'clusters' with specific local landscape types. Each cluster have their own strategy to increase biodiversity, achieve water resilience, provide unique habitats and contribute to a distinctive sense of place.

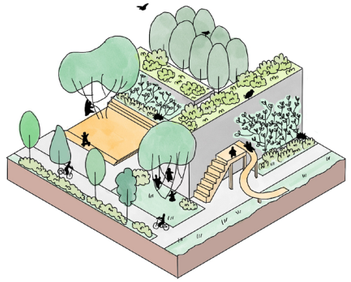
For TU South, apart from providing a rich swamp ecosystem and cleaning water, the wetland also helps to sequest carbon. Globally, peatland helps to store carbon store one-third of global soil carbon. In addition, by retaining water, peatlands often prevent drought. (Harenda et al., 2018)

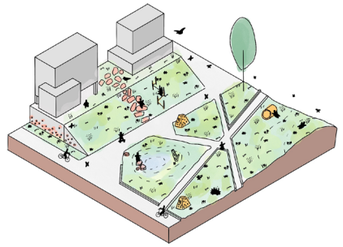
Figure 6-5. Campus clusters. Drawn by author.

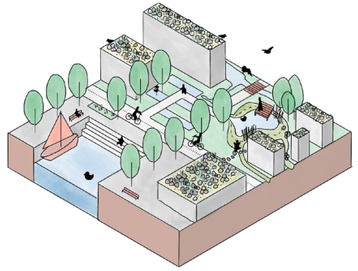
TU North

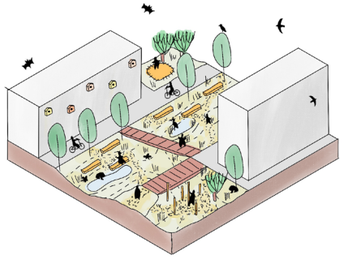
TU Middle

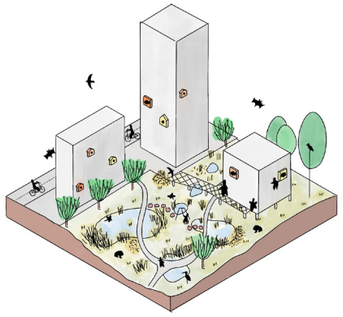
TU South











	Urban Woodland	Urban Dry Meadow	Urban River	Urban Wet Meadow	Urban Wetland
BIODIVERSITY	-Diverse tree species -Multi-layer planting -Continuous hedge row -Organic debris pile (nesting) -Bird box (nesting)	-Mixed flower and herb ground cover -Insect hotels (nesting) -Periodic mowing -Sloped green roof	-Gradient banks -Good water quality -Sand piles (nesting)	-Consolidated buildings to free up space for open wet meadow -Water tolerant trees, shrubs and ground cover	-Consolidated buildings to free up space for wetland -Smaller blocks on stilts
RESILIENCE	COLLECT		CLEAN		STORE
	-Local detention plaza or ponds -Dry swales	-Local detention plaza or ponds -Dry swales	-Flood plain zone -Helophytes -Cleansing biotope	-Ability to flood -Capacity to account for groundwater level fluctuation	-Ability to flood -Wetland filter
AFFORDANCE	-Climbable multi-stem trees -Vertigo -Ascend, descend	-Rolling topography -Colour -Openness	-Approach to water -Connected linked system -Water patterns -Swimming water	-Haptic pleasures of soft bouncy ground-feel	-Openness -Vantage point









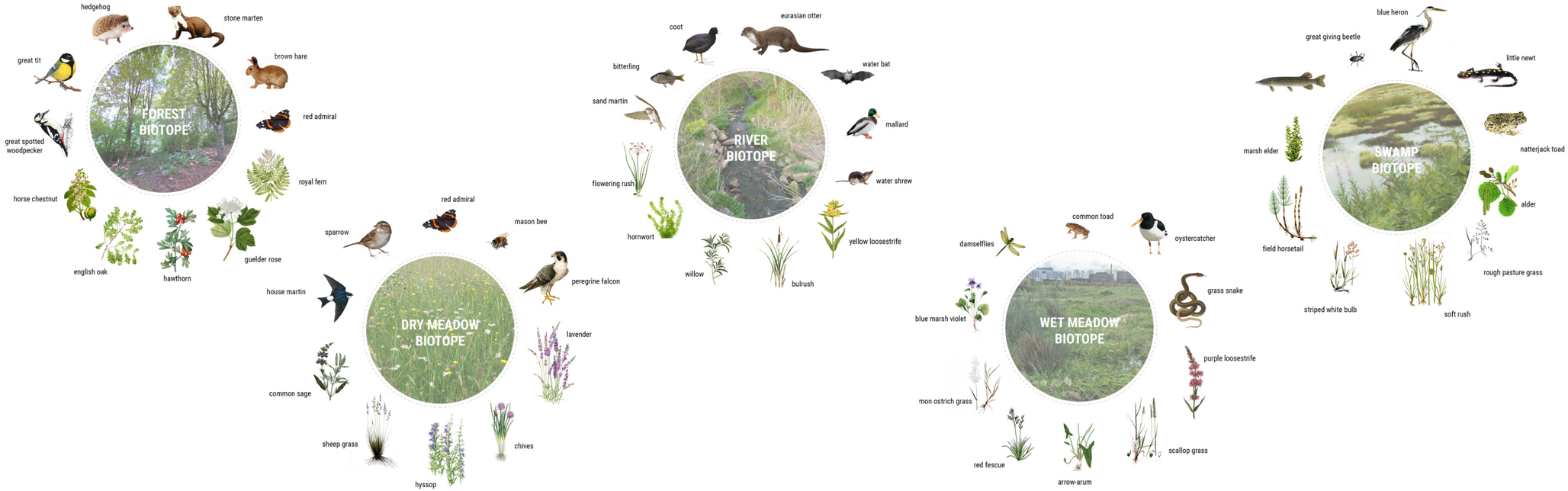


Cluster design strategy

framework application

The framework of the 5 guiding principles to promote biodiversity, resilience and affordance is applied to the clusters. Each cluster has its own strategy to strengthen the landscape type through planting, maintenance, water management and engagement of people. Collectively, the five clusters form a diverse habitat condition with a resilient water system and varied experience.

Figure 6-6.(left) Campus clusters design approach. Drawn by author.
Figure 6-7. (top) Five design principles from chapter 3.

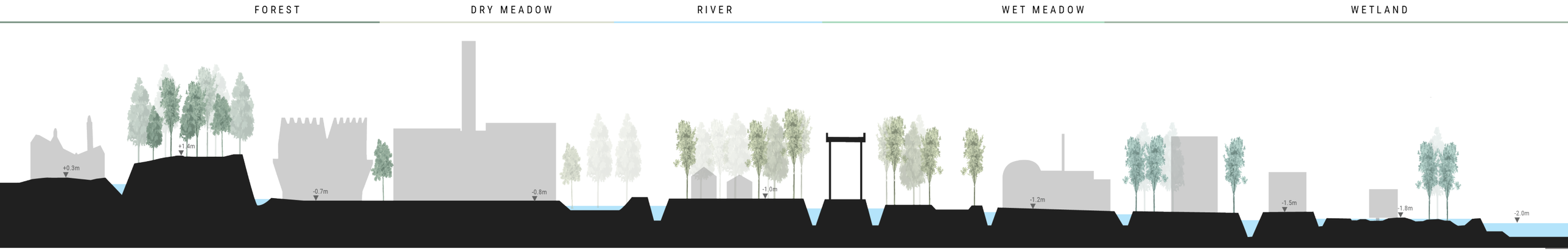


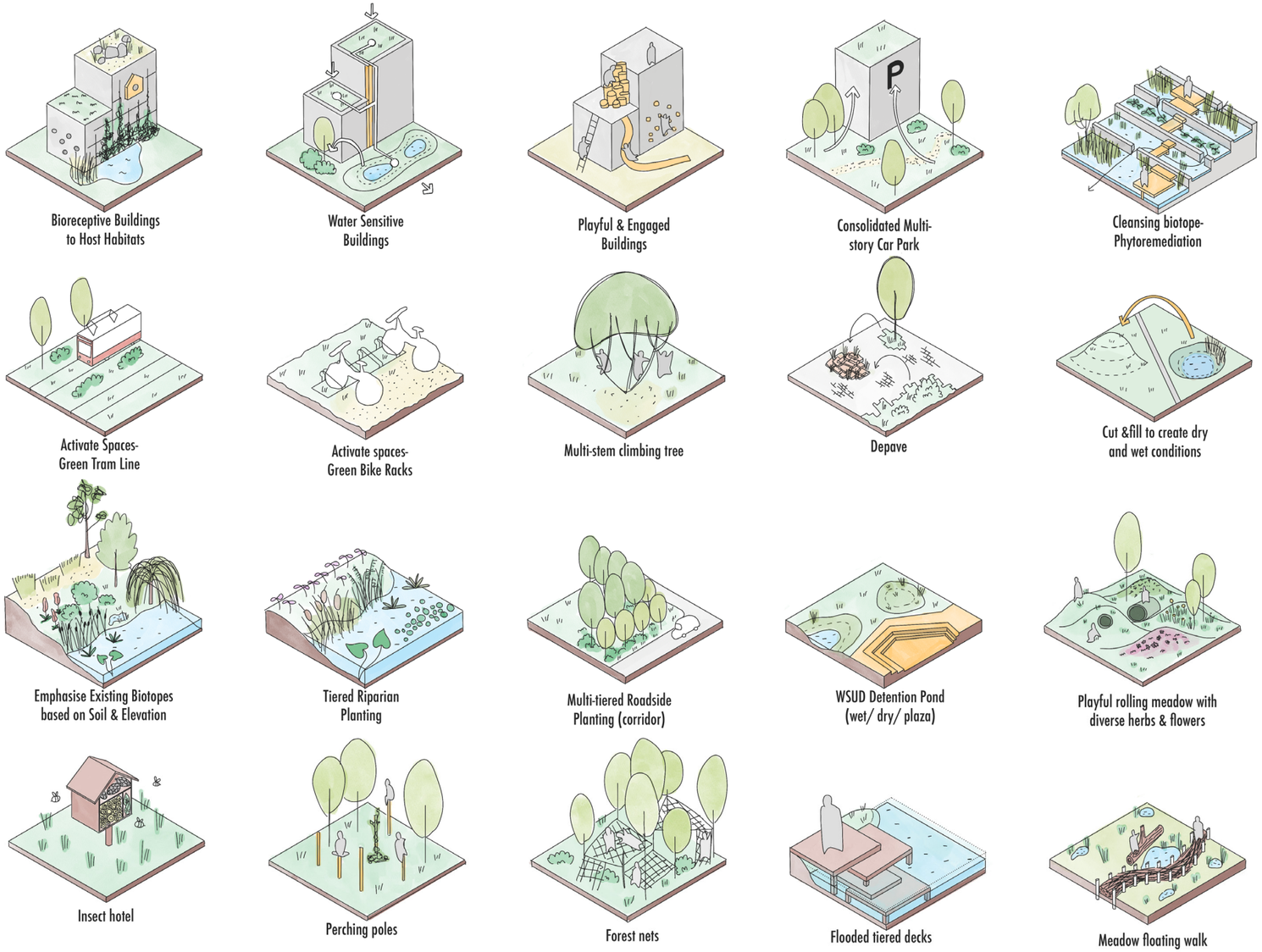
Cluster flora and fauna

framework application

The clusters aim to provide the basic materials and conditions for the survival of animals: food, safety, nesting and variety. For instance, the birds such as the great tit, require 8000 insects to feed their juvenile. Nesting and reproduction are catered for with bird boxes located at the right height and angle from the sun. The multi-layered planting provides a good foraging environment and foliage cover from predators or an easy escape. Together with organic debris of leaf and logs, the variety of flowery and herb planting types caters for a range of insects such as bees, flies and butterflies.

Figure 6-6. (top) Flora and fauna supported in each cluster.
(bottom) Long section across TU North to TU South.





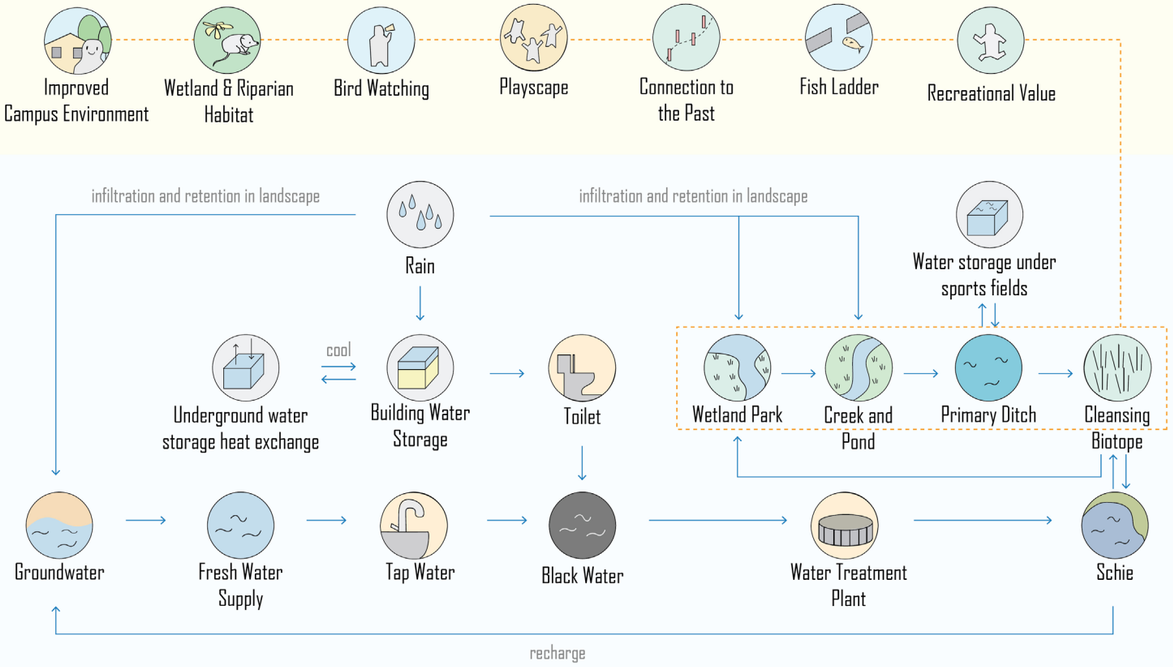
Campus design toolbox
framework application

Figure 6-7. Adapted design toolbox for campus. Drawn by author.

Campus ribbon swale
impression



Campus water cycle
ecosystem services



3 Sites
design elaboration

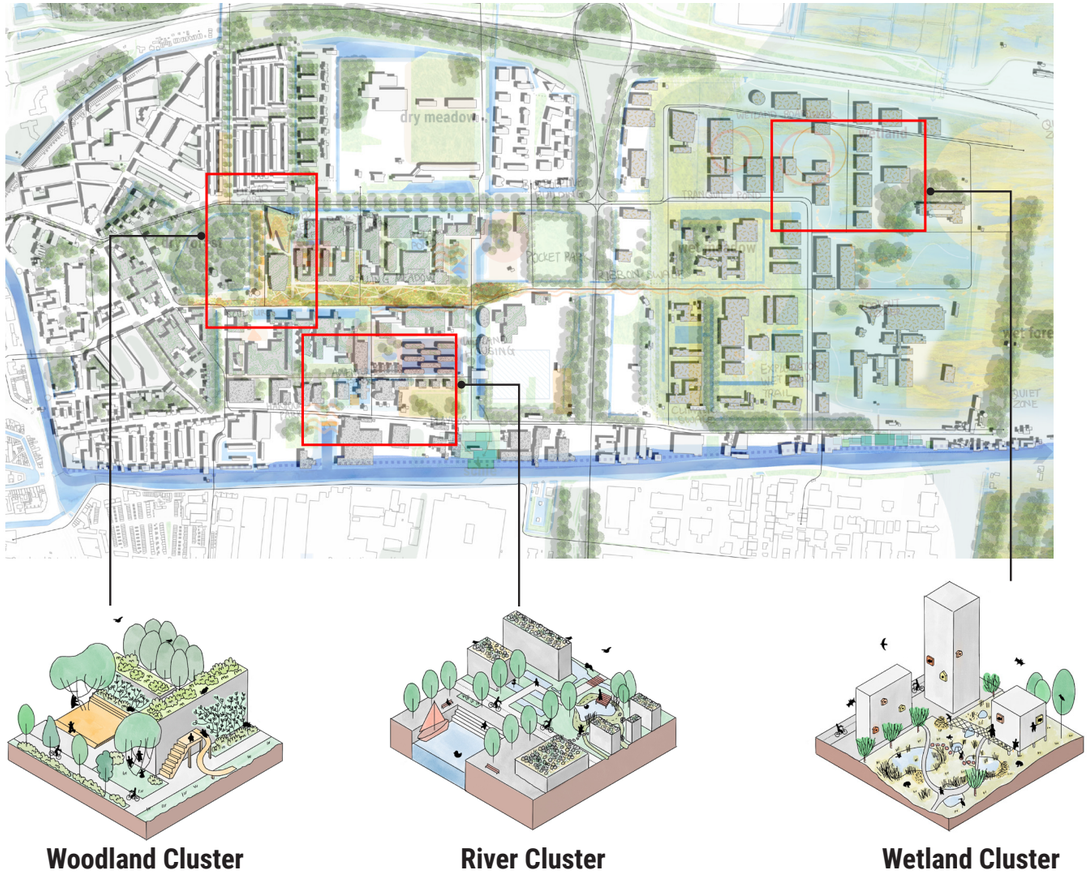
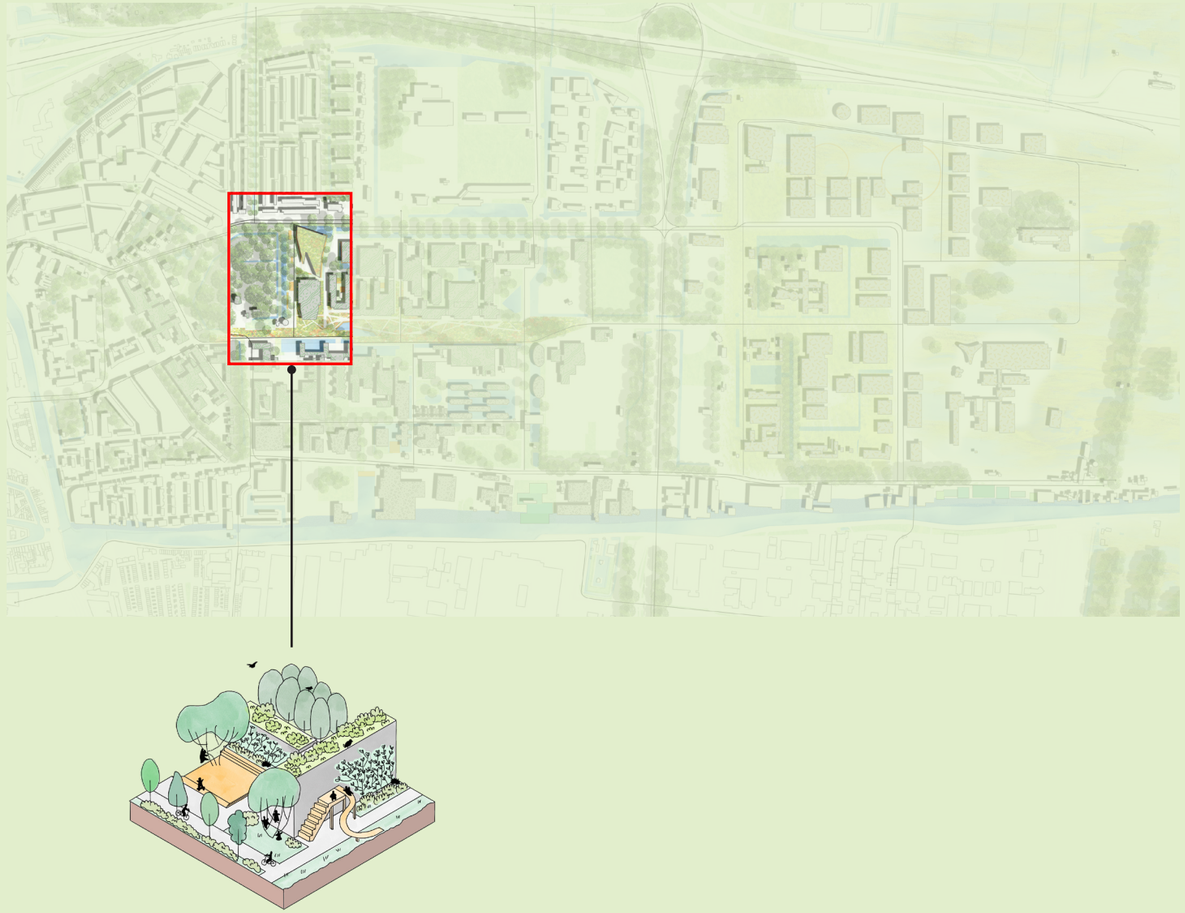


Figure 6-7. (left) Campus water cycle and ecosystem services gained from it..
Figure 6-8. (right) Adapted design toolbox for campus. Drawn by author.



07

DESIGN ELABORATION
SITE 1-WOODLAND CLUSTER

Proposed design plan
Shadow analysis
Planting plan
Detail design
Model
ONSITE construction plan
Design rating evaluation
Impression





1. Library
2. Aula
3. CEG
4. New multi-story car park
5. Residential housing

6. Jaffa cemetery
7. Linear park
   - Expanded nature-friendly banks
   - Mounds
   - Step sitting
   - Play features
8. Park extension
9. Backyard garden
   - Dry detention pond
   - Dry swale
10. Mekelpark
11. Water detention plaza

11. Drop-off roundabout & Proposed car mobility

0 20 40 60 80m

Woodland cluster design

proposed design

Mobility

The mobility in the campus gives priority to pedestrians and cyclists. The low-car scheme promotes active travel. The Christiaan Huygensweg is proposed to be converted into a slow traffic park as it is an excess connection. Current bus and car traffic can be shifted to Zuidplantsoen 13, the road across the cemetery. Current parking along the Huygensweg is shifted to the new future multi-story car park beside the library.

Aula linear park

With the closure of the Huygensweg, the Aula linear park is introduced. Being an extension of the Jaffa cemetery's forest characteristics, the woodland cluster consists of a high percentage of tree canopy coverage with multi-layer planting of trees, shrubs and ground cover of various species and age. There is shade and tranquility with frequent songs from woodland birds. There are scattered patterns of logs and natural material. The park continues into Kon. Emmalaan canal and connects the residential area to Mekelpark and TU middle. The natural structures provide opportunities for users of the campus (students, staff and surrounding families) to physically engage with, interpret and get higher and closer to trees and across water.

Topography

The Jaffa cemetery is 1.5m higher than the campus ground level. The design aims to create a height transition by elevating the ground level of the linear park with mounds. The mounds are created with soil excavated from the expand-ed banks and also infilled with paving from the car park and logs.

Backyard garden

With the consolidation of car parking into the multi-story car park, the back-of-house area of the AS building is depaved, shallow depressions are dug to create dry retention ponds. Together with the green roof substrate and water detention roof, rainwater will be infiltrated and stored locally for potential reuse such as flushing the toilet. The increased water retention capacity contributes to the climate resilience of the campus.

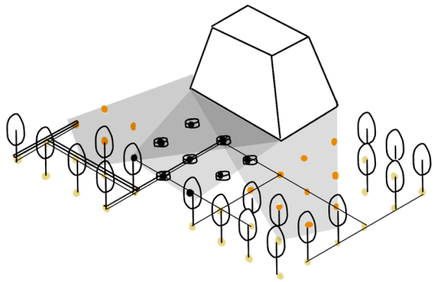
CO2

Each tree absorbs 20kg of CO2 annually. With the additional 60 trees in the linear park and backyard garden, 1.3 ton of CO2 can be sequestered.

Figure 7-1. Proposed plan for site 1.
Drawn by author.

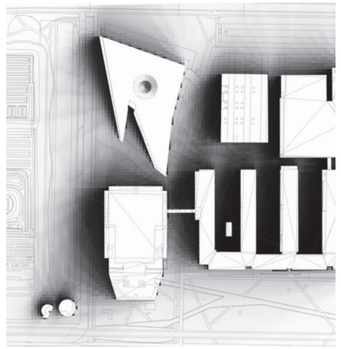
Annual shadow analysis

ladybug simulation

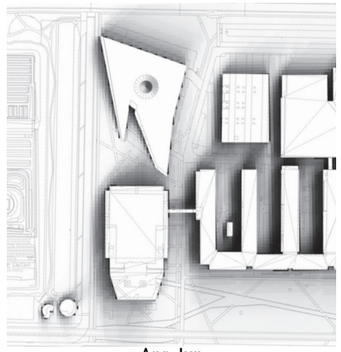


Considering abiotic factors

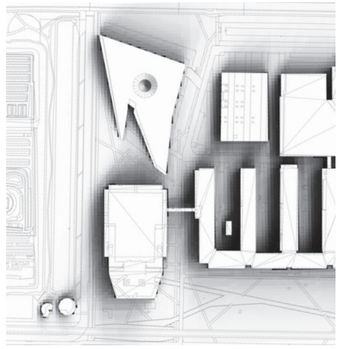
This shadow analysis is generated with the Grasshopper and Ladybug plug-in from the 3D Rhino model. It makes use of the Amsterdam weather data from Energy Plus to generate the sun path for the duration of 24 hours split in periods of 3 months. The resulting shadow is generated with the sunlight hour analysis battery with a grey scale chart.



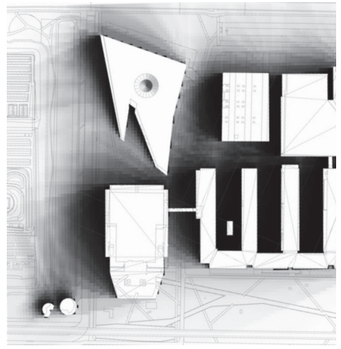
Jan-Mar



Apr-Jun

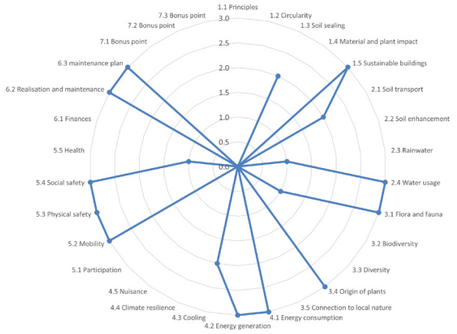


Jul-Sep

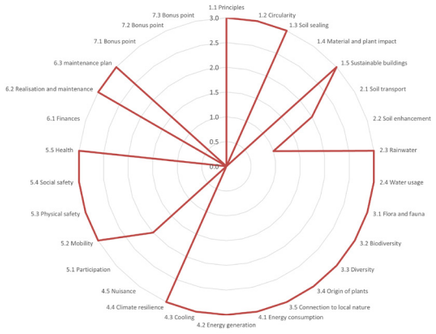


Oct-Dec

Figure 7-2. Annual shadow analysis of site over 24 hours split in 3 months period. Amsterdam weather data obtain from energyplus.



rating of current situation



design rating of proposed design

Rating evaluation

nl green label

The NL Terrain Green label aims to assess the sustainability of project and provide insights into the local qualities and opportunity to promote sustainability. The design proposal is rated from 6 themes: (1) design, (2) soil and water, (3) biodiversity, (4) energy and climate adaptation, (5) humans and environment, and (6) assurance.

Figure 7-3. NL Green Label assessment of before and after design.

Linear Park Planting Plan

A rich palette of new planting will help to emphasize the character of the spaces. Plants will be selected for their suitability for shade, sun, drought and waterlogging, fruiting and flowering as well as tolerance to pollution. There is horizontal and vertical planting types with the choice of climate resilient and native species as much as possible. Domestic wild plants are chosen as it brings more animals to the city. Nutrient poor soil supports rich colorful species diversity. There is also diversity of age in the plants with planned planting and management of trees. This will provide an ecologically diverse habitat as well as structural diversity through trees, shrubs, herbaceous planting and ground flora. A strong theme has been developed for pollinator friendly planting, in particular to support habitats for bees and the rare butterfly population and to positively contribute to the city's urban ecology. Local logs, leaf piles and wood chips are allowed in the site for greater biodiversity of species.

- Shade tolerant eco trees
- Eco trees
- Shade tolerant shrubs and ground cover
- Flower and herb meadow
- Helophyte riparian plants

SHADE TOLERANT ECO TREES


Acer campestre
(Field maple)


Aesculus flava
(Sweet buckeye)


Celtis 'Magnifica'
(Hackberry)


Tilia cordata
(Little-leaf Linden)

ECO TREES


Acer platanoides
(Norway maple)


Alnus glutinosa
(Common alder)


Prunus avium
(Sweet Cherry)


Fraxinus excelsior
(Common ash)

SHADE TOLERANT SHRUBS & COVER


Crataegus monogyna
(Common Hawthorn)


Ilex aquifolium
(Holly)


Osmunda regalis
(Royal Fern)


Viburnum opulus
(Cranberrybush)

FLOWER AND HERB MEADOW


Allium schoenoprasum
(Chives)


Hyssopus officinalis
(Hyssop)


Bellis perennis
(Daisy)


Salvia officinalis
(Sage)

HELOPHYTE RIPARIAN PLANTS


Butomus umbellatus
(Flowering Rush)


Peltandra sagittifolia
(Arrow Arum)


Lythrum salicaria
(Purple Loosestrife)


Lysimachia punctata
(Yellow Loosestrife)

Figure 7-4.Planting plan of site. Proposed species classified according to category.

Linear park design elaboration

forest cluster landscape elements

GRADIENT ECO-FRIENDLY BANKS

The current steep canal banks are converted into nature-friendly banks. The riparian zone with gradient transition from shore to water accommodates zones of different water depth that supports a range of shore vegetation, flowery grassland, vegetation from moist soil, marshy herbaceous plants, floating plants and submerged plants. The 250m canal banks have different sunny and shaded zones, windy and less windy areas to create a range of microclimate.

The water quality is also improved with reeds which trap smaller particles and absorb nutrients. The reeds are harvested as biofuel and animal feed at planned intervals to "reset" their nutrient absorbing capacity.

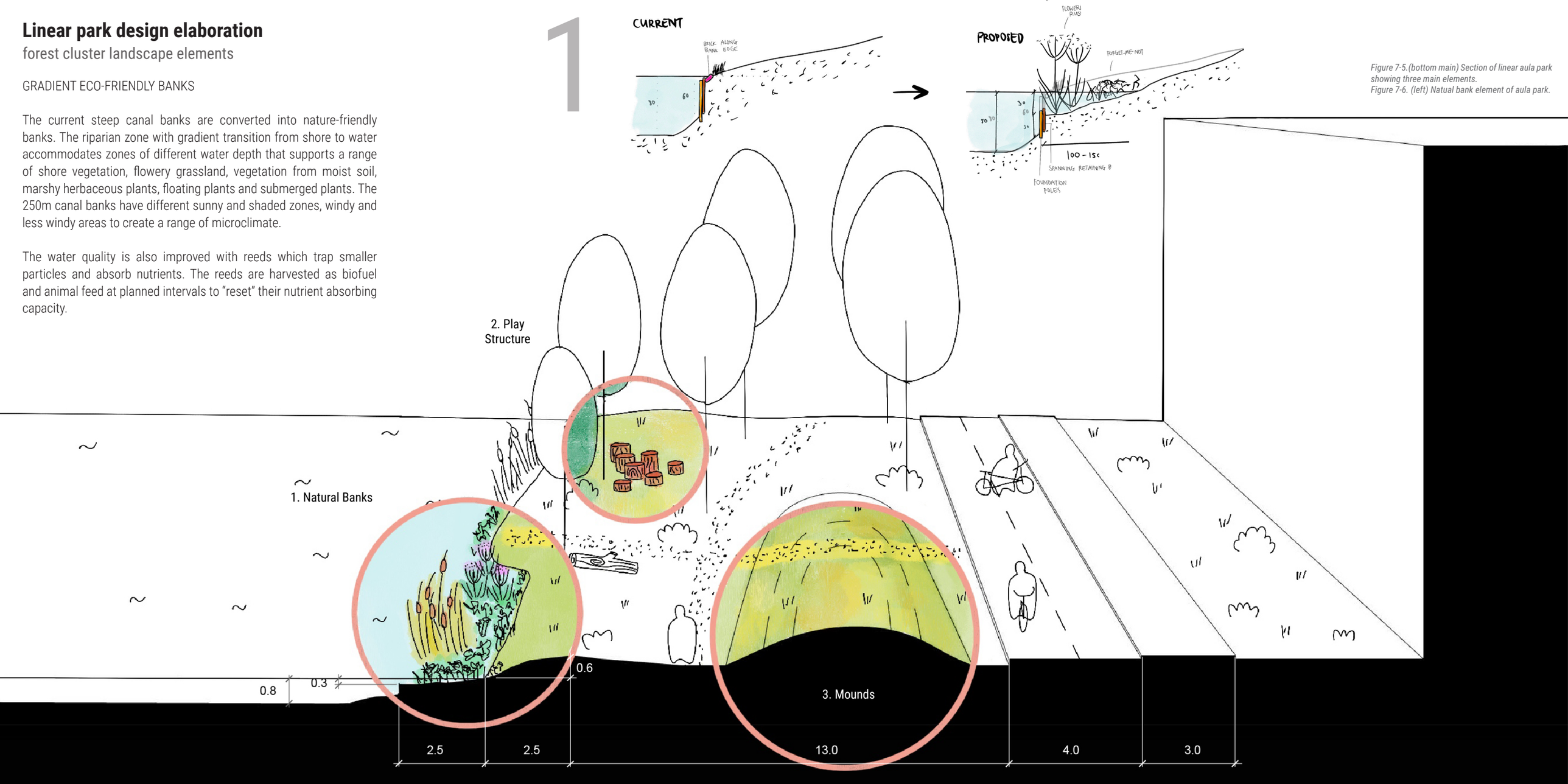
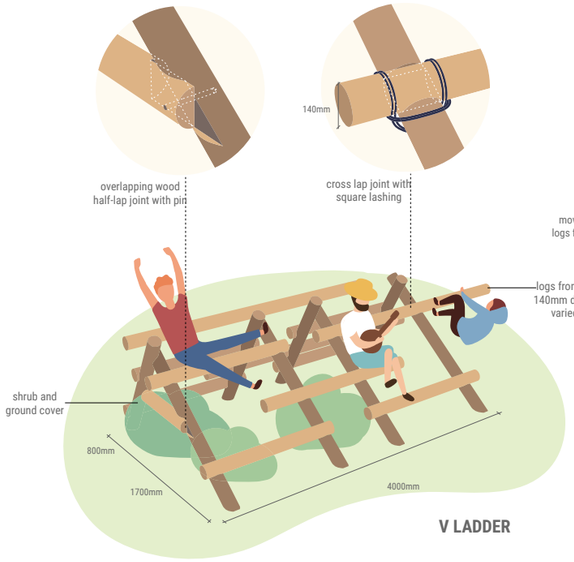
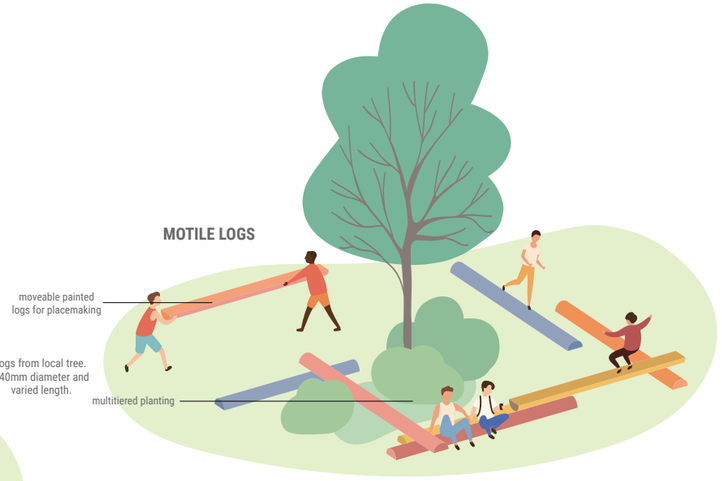
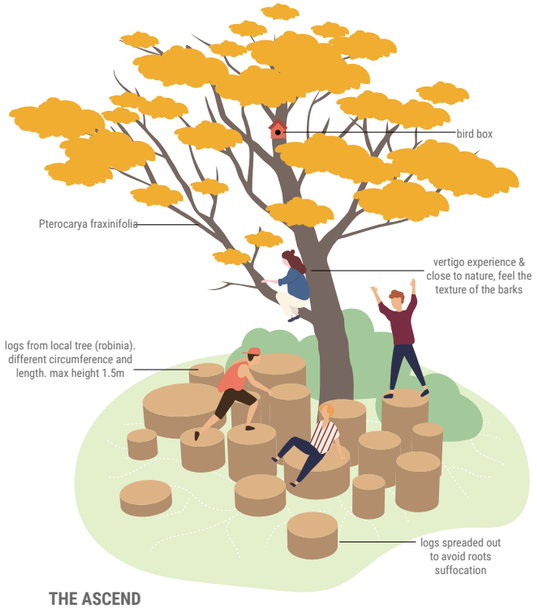


Figure 7-5.(bottom main) Section of linear aula park showing three main elements.
Figure 7-6. (left) Natual bank element of aula park.





2



THE ASCEND

Logs from local trees of differing diameter and length are spread out around the Fraxinus excelsior. They are spaced apart with gaps to not suffocate the tree roots. The arrangement of the logs provides the opportunity for users to get closer and higher to the tree trunks, branches and canopy. There is the possibility of sitting, climbing, and hopping around the logs. With time, shrubs and ground cover can grow around and even over the logs.

V LADDER

Local logs are used to form a V ladder structure. The 2 incline angles are different to offer different opportunities for engagement. Users can climb and sit on the irregular arrangement of horizontal bars or hang from the protruding log. The structure uses wooden joinery technique of half-lap joint and square lashing.

MOTILE LOGS

Local logs are split in half and painted with different colours. Heavier longer logs are arranged and permanent. Smaller pieces are movable and can be configured by users into unique arrangements. They can be lined up, stacked, or crossed. It affords balancing, sitting, and place-making.

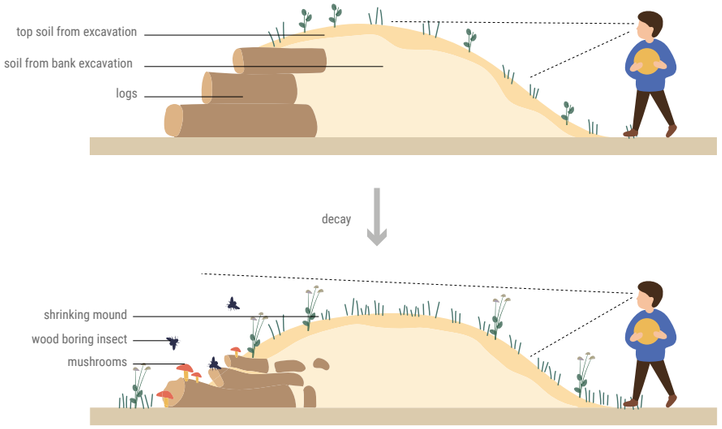
Figure 7-7. Play structure element of aula park.

ORGANIC LIVING MOUND

Logs from local fell trees are used as a fill for the mound. The microclimate of wood decomposition provides a wealth of biodiversity such as mushrooms and fungi, log boring insects and snails. The natural decay process not only helps to close the circular nutrient cycle but also engage people through the gradual change in the mound's shape and size as it "breathes" over time.

HABITAT MOUND

The paving from the road and car parks are stacked and sloped to become the face of the mound. There is an integrated insect hotel on the face of the mound. The crevices and gaps of differing sizes offer living spaces for species such as ferns, moss, beetles, salamander, and hedgehog in the shade or sunlight.



3

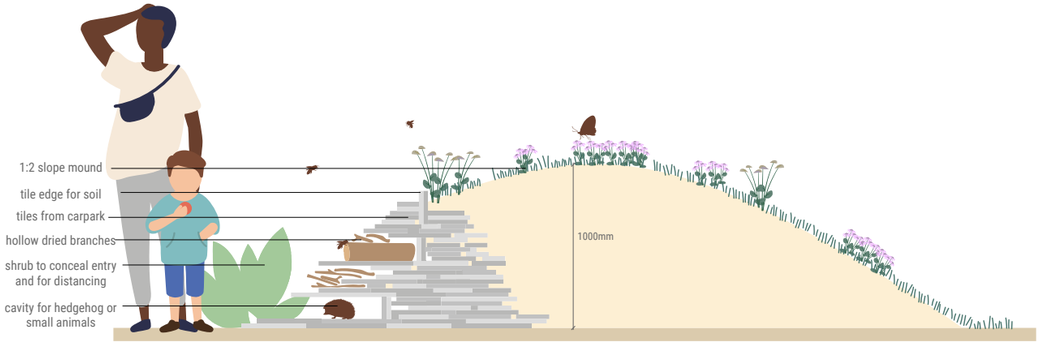


Figure 7-8. Mound element of aula park.











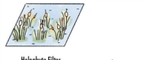

A 1:30 model was made to show the process of growth and decay of the mound. The documentation of the mound model was 6 weeks over spring.

Figure 7-9. Model of mound, 1:40 scale. Made with natural materials of logs and soil. Seeded with mix wild flower mix. Documented from May to June.

1. Vegetated Banks










GRADIENT


AFFORDANCE

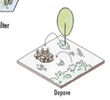

INCLUSIVE

2. Linear Swale Edge










RESILIENT


INCLUSIVE


AFFORDANCE

3. Depave Carpark & More Trees



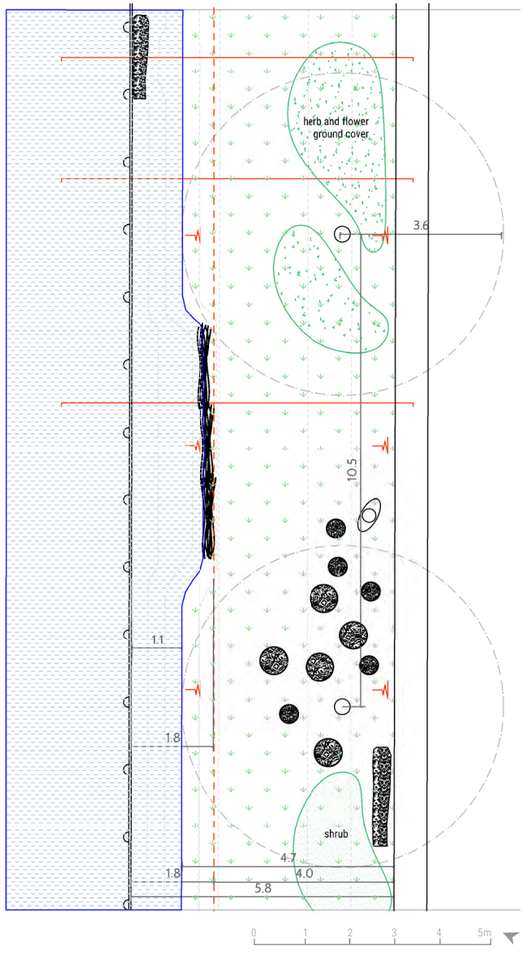





RESILIENT


INCLUSIVE


CONNECTED



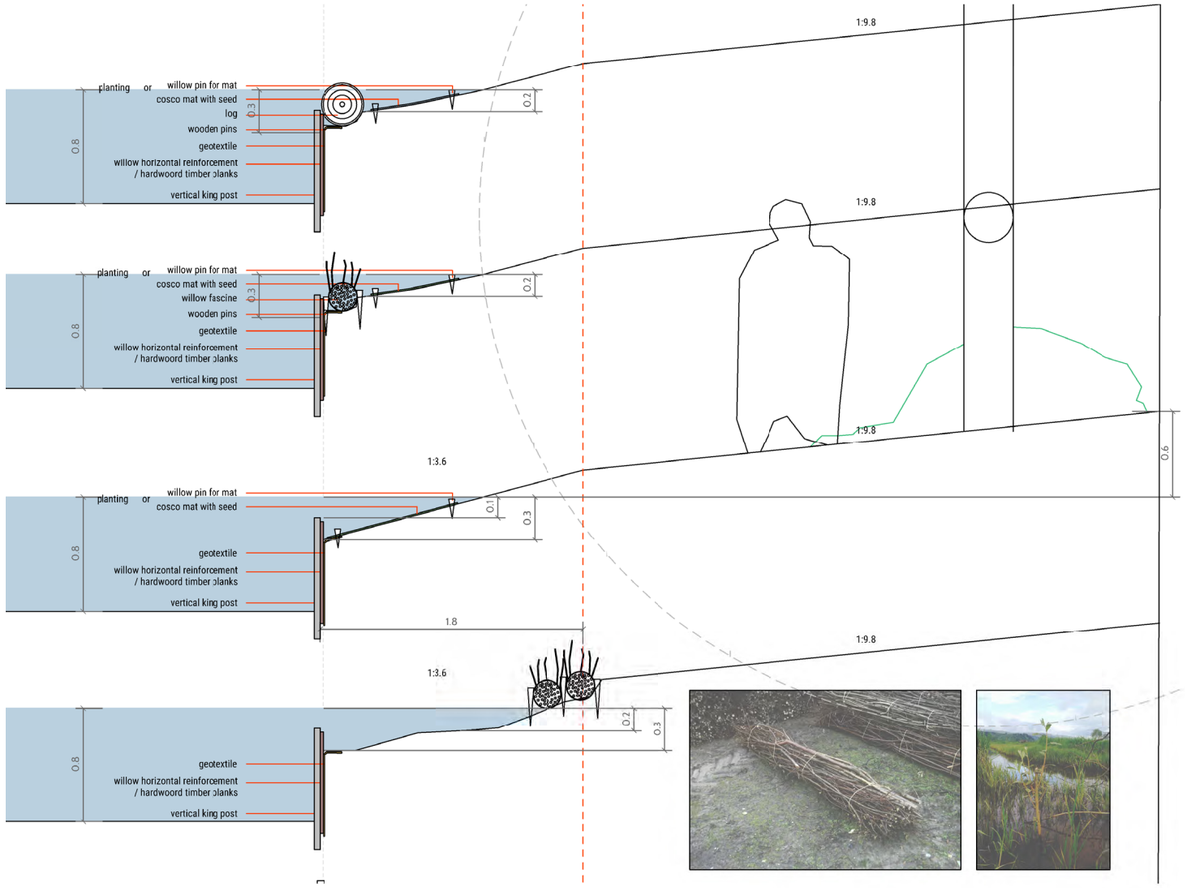


Figure 7-10. (left) Application of design principles and toolbox. visualisation of improvements.
Figure 7-11. (middle) Plan for canal bank improvements.
Figure 7-12. (right) Sections of different bank conditions.

Understanding that the forest cluster proposal is a long-term design, a shorter-term plan is prepared. These are achievable steps and serves as a slow transition towards the larger plan. This land preparation works to gradually change the ecologial conditions and also to slowly influence human's perception on nature. The bank improvement is a work in discussion with Rene Hoonhout and it is expected to be carried out in the summer 2021 and planting in later part of the year.

AS building backyard garden
impression of rain rain gardens and green buildings

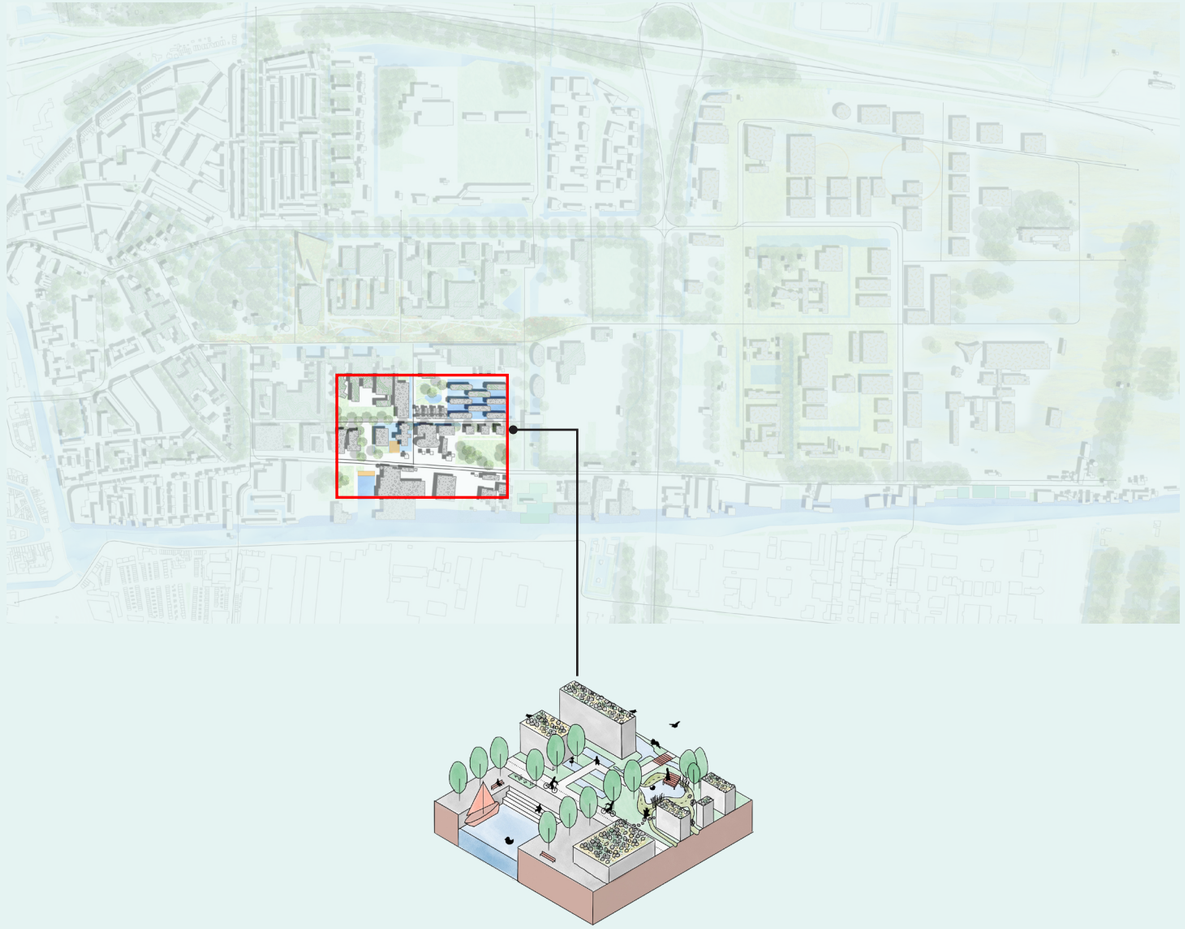


Figure 7-13. Impression of backyard garden behind Applied Science building.



Figure 7-14. Impression of backyard garden retaining water and dry swale activated during rain event.


Linear aula park
impression



08

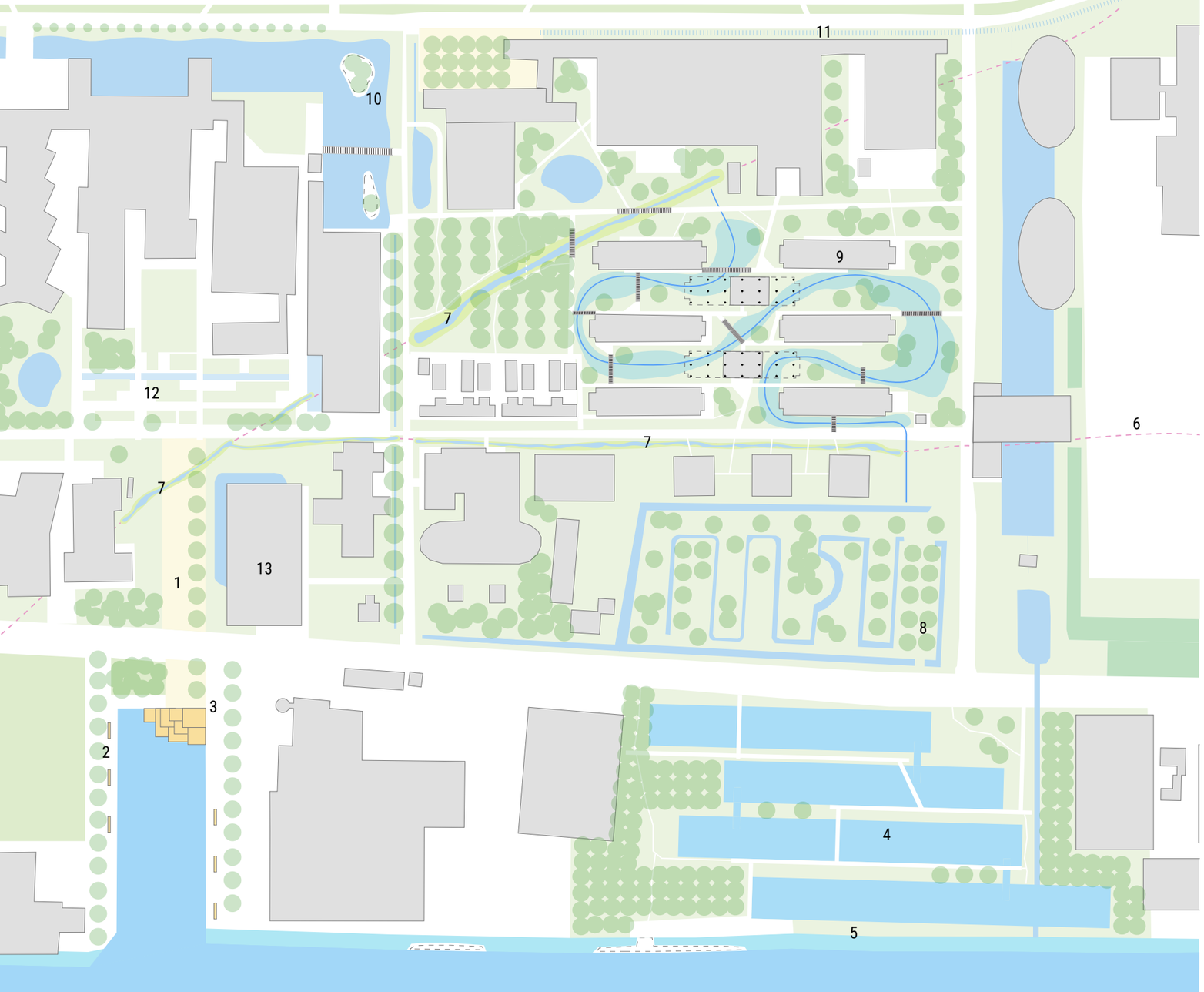
DESIGN ELABORATION SITE 2- RIVER CLUSTER

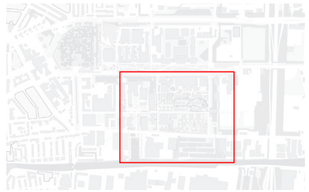
Proposed design plan
Water system
Section and elaboration of design
-Cleansing biotope
-Eco-islands
-Creek park
-Wetland hostel
Design evaluation
Impression

River cluster design

proposed design

The river cluster in TU Middle is an expansion of the river characteristics of the Schie. The river cluster aims to promote a circular water system. It is designed to allow controlled amounts of water in from the Schie and convey more water through a rich variety of tributaries, wetland, drainage channels and open water bodies. The river cluster purifies the inflow of water with the cascading cleansing biotope, helophytes in Speelbos and wetland area. The design also aims to resurface the 250BC creek in the form of a flowing stream or tributary ditch. With the shift of cars to the multistory car park, the abandoned parking lot is depaved fully. Existing water features, such as the pond along the 3ME, are expanded while new swales and detention ponds are created. Relation between the campus and the Schie is strengthened by the continuation of spatial quality and the activation of the harbor.





key plan of TU north and middle

1. Continuous plaza connecting harbour to TU Campus
2. Habour tiered platform
3. Benches

4. Cleansing biotope park
5. Expanded Schie with eco-friendly banks (shallow depth and island)

6.Historic creek lines
7. Resurfaced creek
8. Speelbos
9. Wetland housing
10. Quiet island zone
11. Dry swale
12. Depave car park pattern for planting

13. New multi-story car park

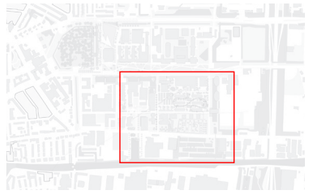
0 20 40 60 80m

Figure 8-1. Proposed plan for site 2, River cluster. Drawn by author.

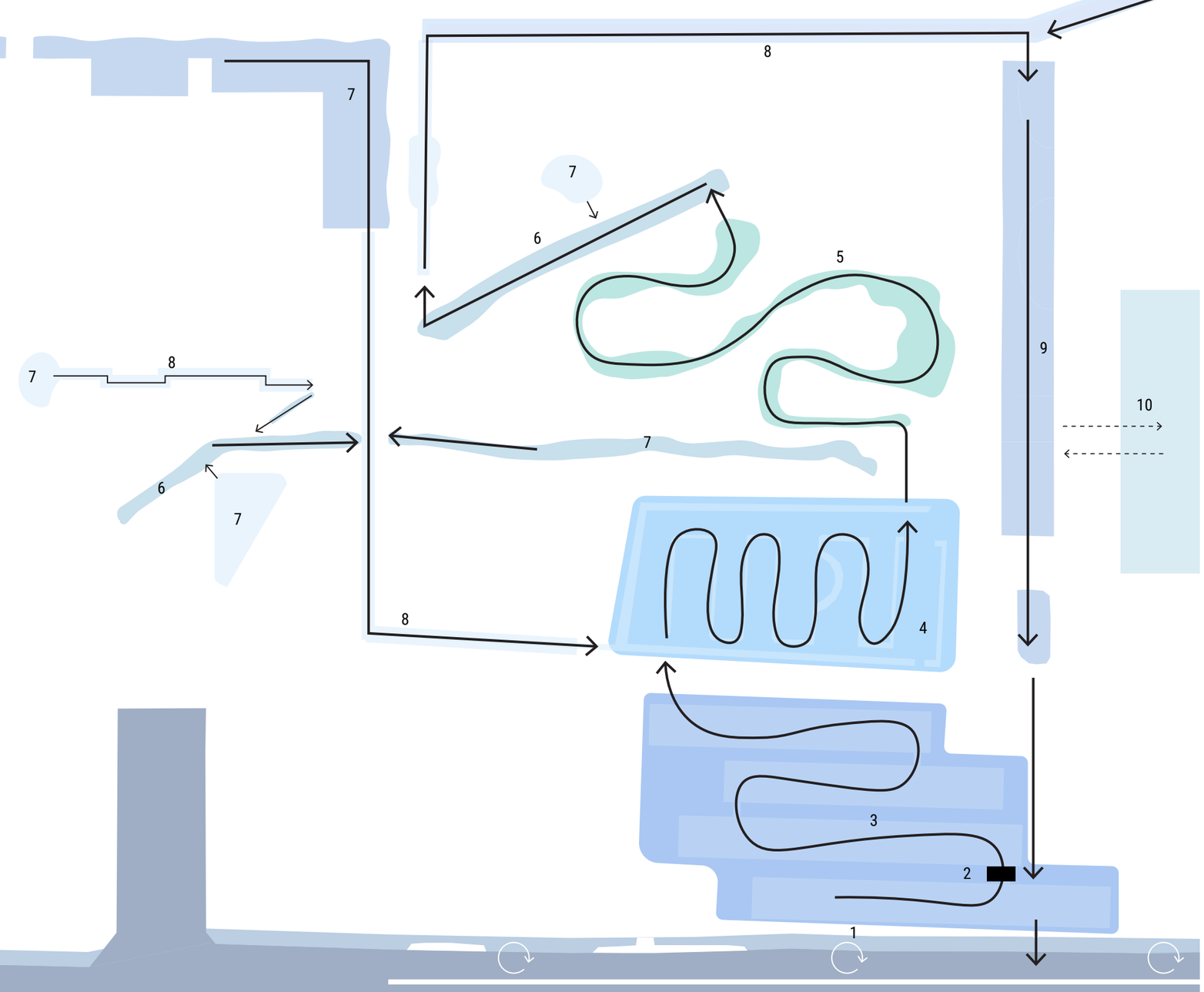
River cluster water system

proposed design

The river cluster houses one of the two outlets of the polder water system. Instead of aiming to discharge water quickly into the primary ditch within the polders and pumping it out to the Schie boezem, it is proposed that water should be stored locally, filtered and reuse. In addition, controlled amounts of purified water from the Schie is allowed into the campus especially during dry spells. Through several design iterations, a water purification system is created.



key plan of TU north and middle



1. Eco-friendly Schie banks with helophytes for water purification
2. Open inlet gates (during dry season)
3. Natural gravitational flow down cleansing biotope compartments
4. Water purification in Speelbos
5. Water purification in meandering wetland (floodplain area activated during storm event)
6. Water conveyance along resurfaced creek (especially during wet season)
7. Local water detention
8. Water conveyance along swale
9. Primary polder ditch
10. Underground water storage/ release below sports fields
11. Pump out to highest cleansing biotope compartment and out into Schie

0 20 40 60 80m

Figure 8-2. Water system for site 2, River cluster. Drawn by author.

Cleansing biotope

section

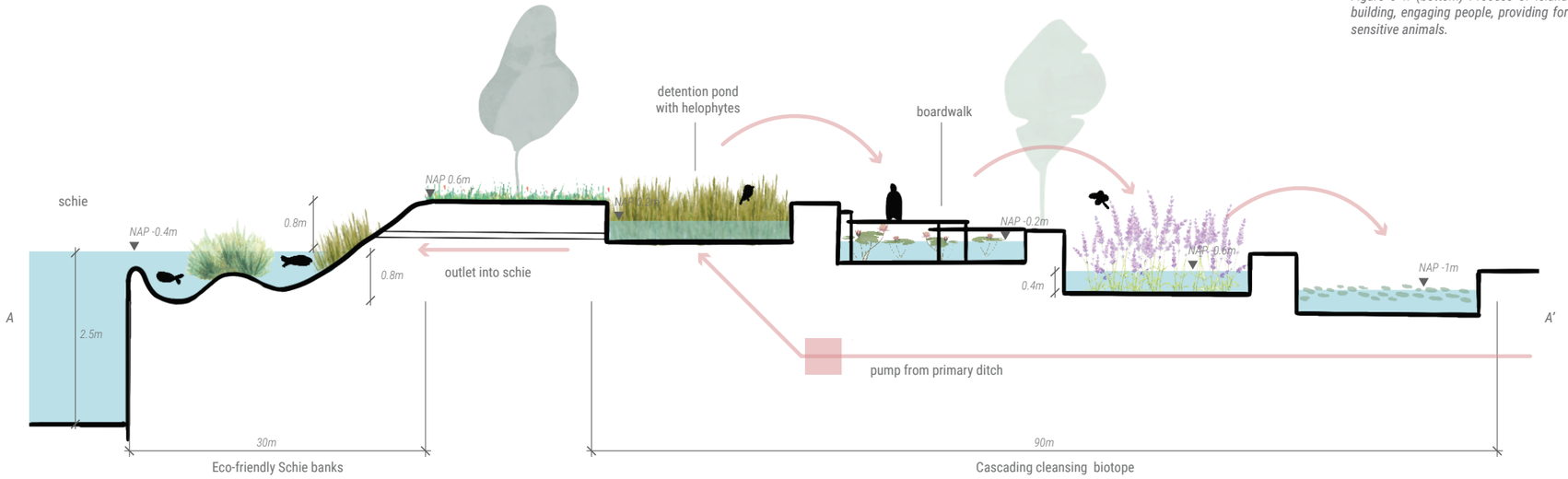
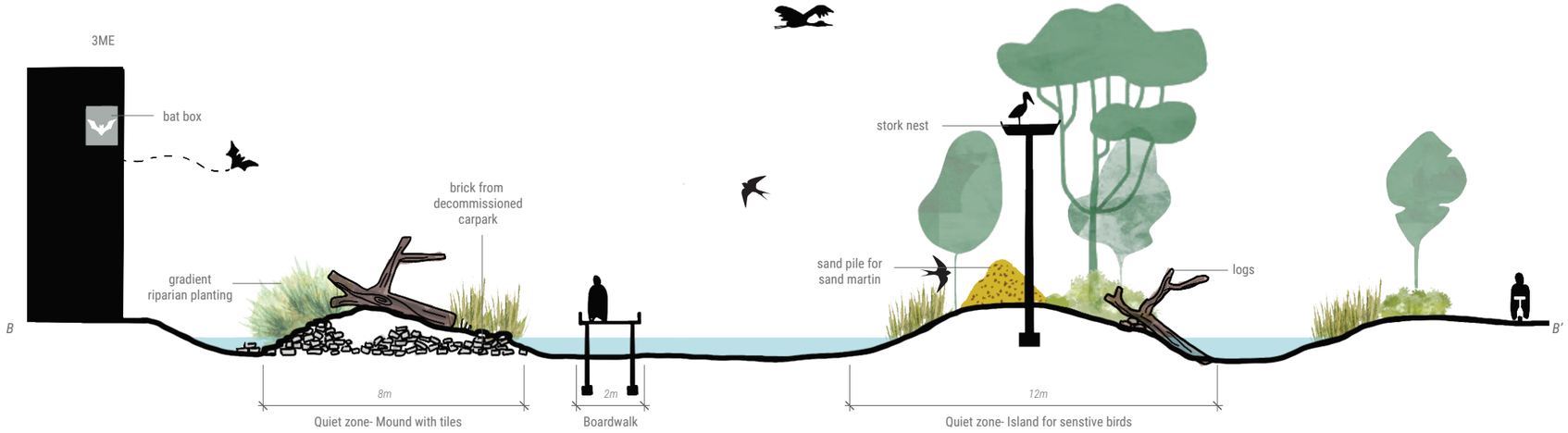


Figure 8-3. (left) Section of cleansing biotope and eco-islands.
Figure 8-4. (bottom) Process of island building, engaging people, providing for sensitive animals.

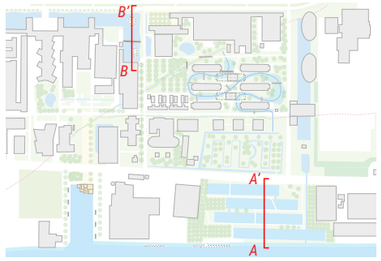
Eco-islands

section

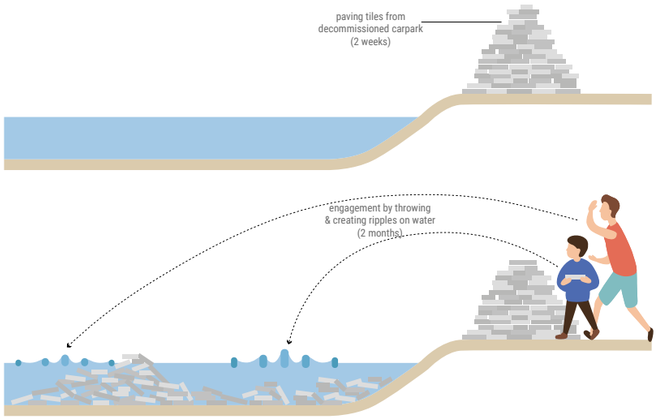


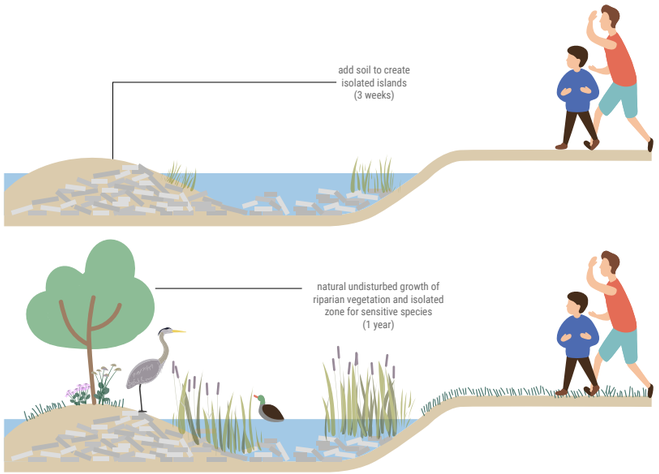
ECO-ISLANDS BUILDING

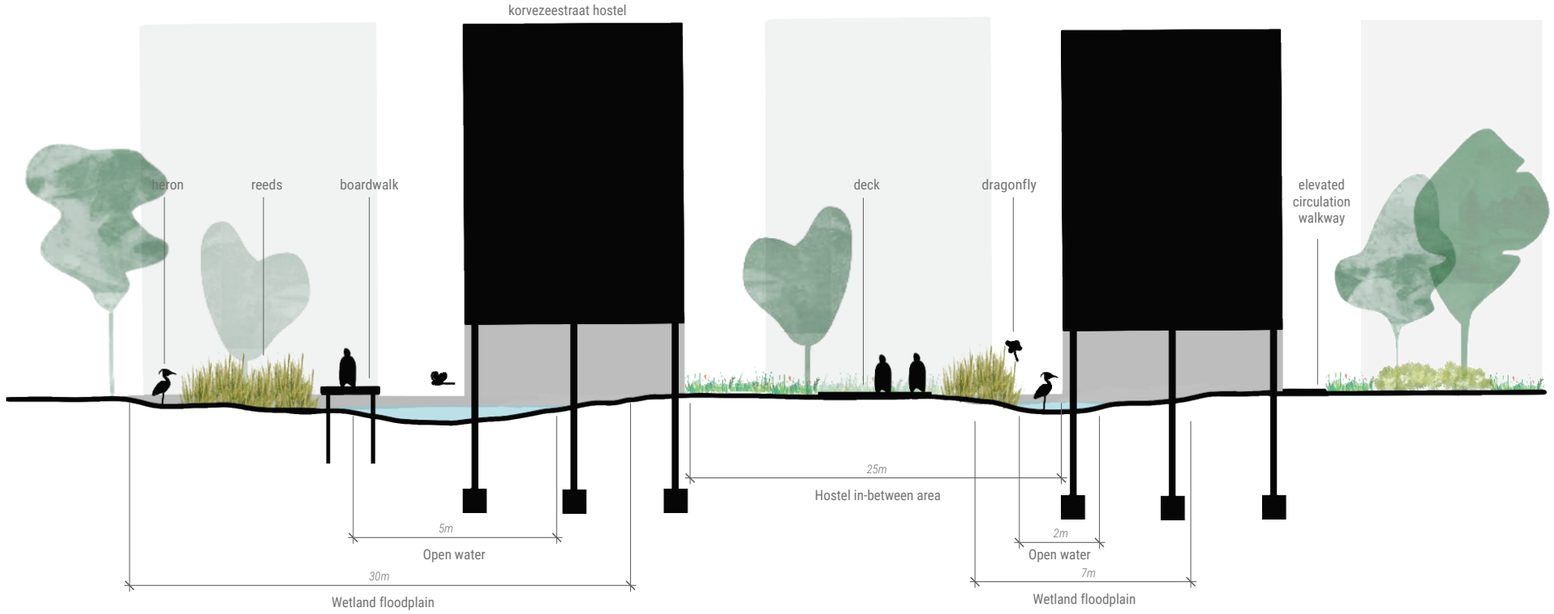
The entire design process is not static but is constantly changing with the actions of users, sediment runoff and accumulation, maturing of planting and weathering of structures.

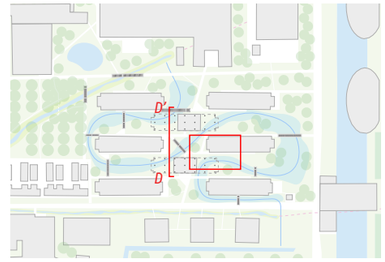


key plan of river cluster









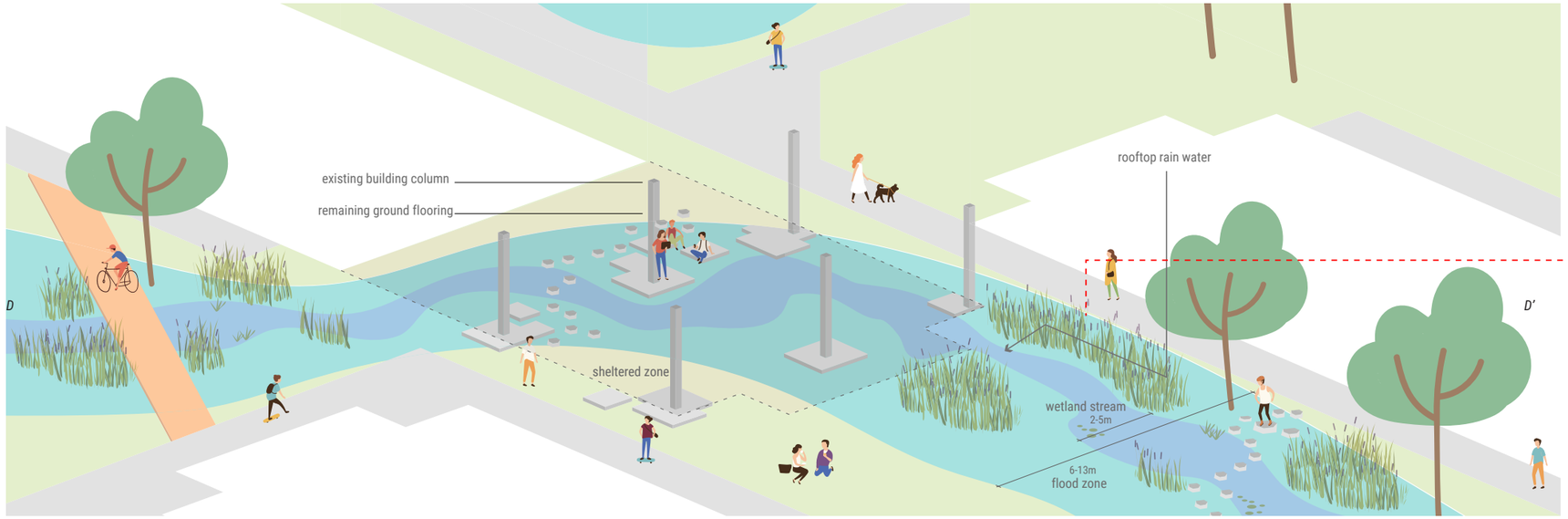
key plan of wetland hostel

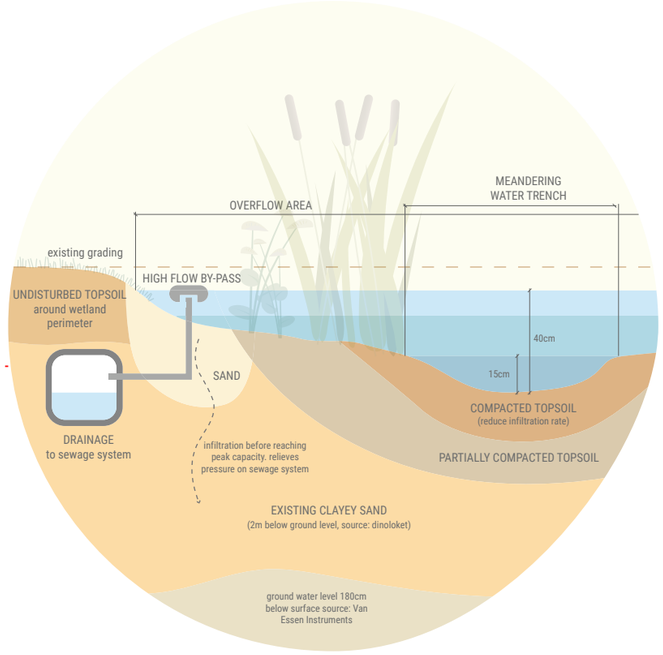
Figure 8-5. (top left) Section of across wetland hostel.
Figure 8-6. (bottom right) Axonometric view of integrated stream with readapted buildings.
Figure 8-7. (bottom right) Detail of overflow by-pass.

Wetland hostel

design elaboration and detail

The Korvezeestraat hostel wetland design is readjusted for minimal modification; a part of the ground floor walls of the sandwiched hostels blocks are removed. The structural columns are retained. This gives space for the wetland to meander around the blocks. The hostel rooftop collects rainwater and channel it into the wetland.

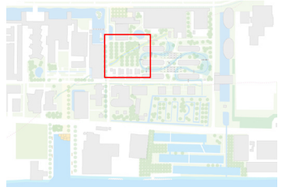




Creek park design

plan

The area behind the EWI currently houses 0.5ha of parking lot with a tree grid of Platanus x hispanica. Within this area, the proposed design aims to resurface the old creek and enhance the natural habitat condition of the ecologically-devoid trees. (Plane trees supports only 3 species while the oak tree supports over 700 species) The abandoned parking lot is depaved fully and areas of enclosed and open spaces are created at separate ends of the area to cater to activities with different spatial needs. At the enclosed area, more eco-friendly trees such as Alnus glutinosa and Quercus robur are planted while the plane trees located at the open area are removed and the logs are used to design the creek. There shall be a scheduled interval replacement of platanus to ensure tree age and species diversity.

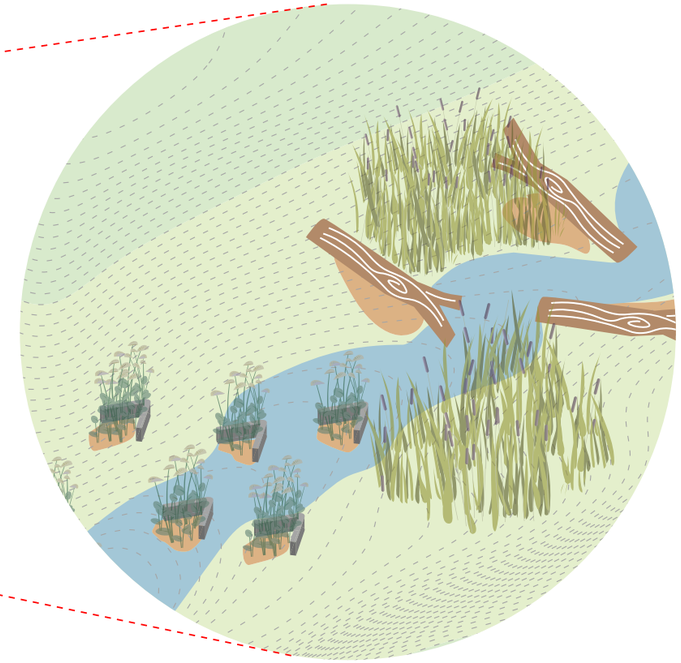


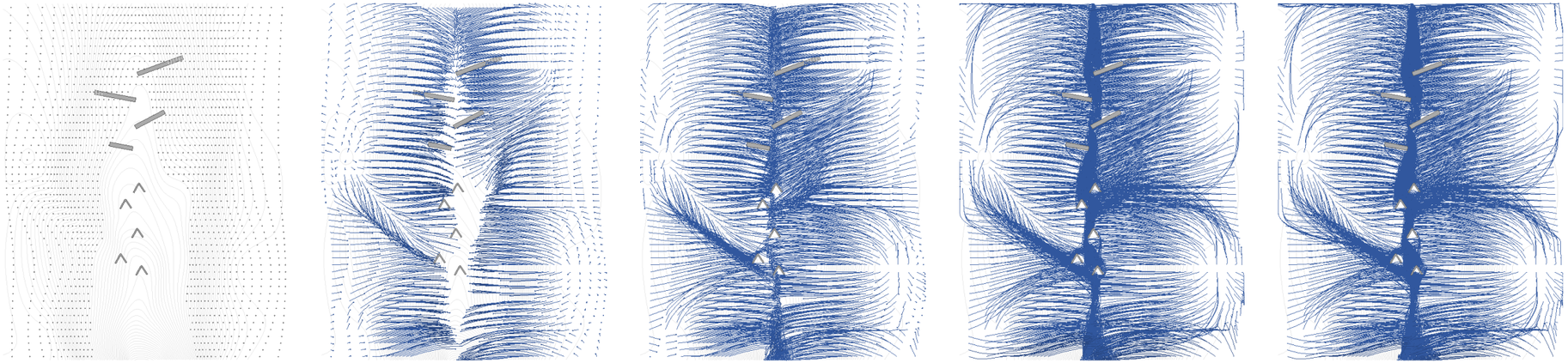
key plan of river cluster

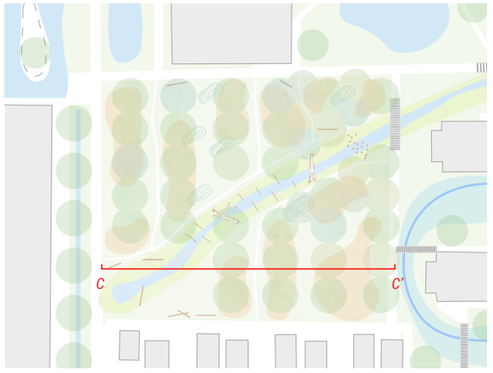


Figure 8-8. (left) 1:500 plan of creek park.
Figure 8-9. (right) Creek design elements.



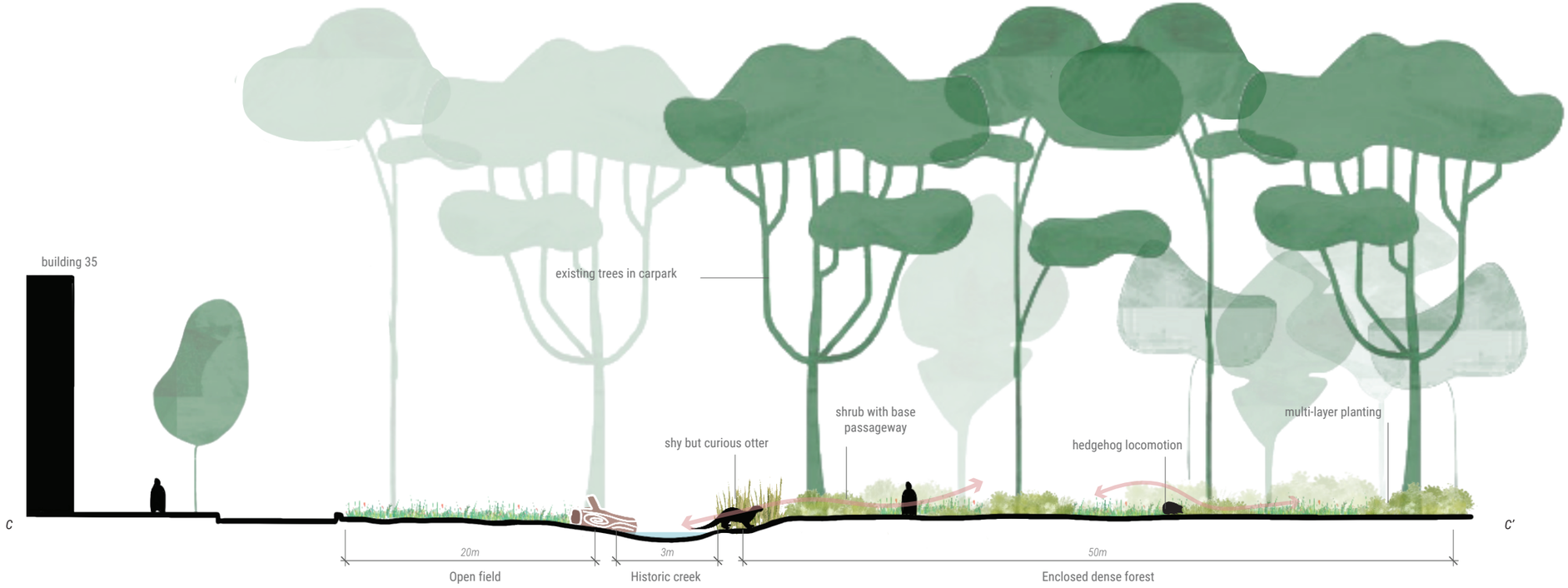






key plan of creek park

Figure 8-10. (top) Water flow simulation.
Figure 8-11. (bottom) Creek park section.



Creek park section

water pattern

With the gradient of tree shade from enclosed to open area, the creek trickling water have different shade conditions. Aesthetics is not important to animals but rather, it is important for engaging humans and creating playful spaces. As such, the concept of engagement of people through different water patterns from research-by-design in chapter 3 is applied. The creek design aims to create interesting water patterns with natural and existing materials on site (logs, paving and excavated soil) by arranging them in an engaging manner.

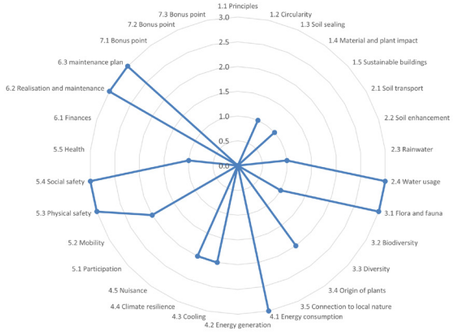




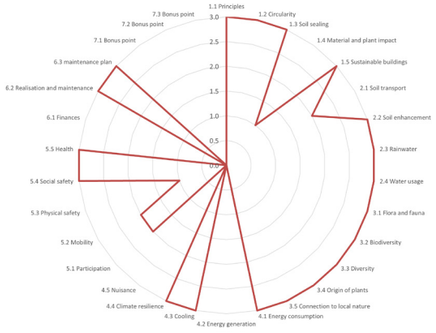


Creek model 1:40
stream modelling

Figure 8-12. Photos of creek model with running water stream.



rating of current situation



design rating of proposed design

Rating evaluation
nl green label

The NL Terrain Green label aims to assess the sustainability of project and provide insights into the local qualities and opportunity to promote sustainability. The design proposal is rated from 6 themes: (1) design, (2) soil and water, (3) biodiversity, (4) energy and climate adaptation, (5) humans and environment, and (6) assurance.

Figure 8-13. NL Green Label assessment of before and after design.

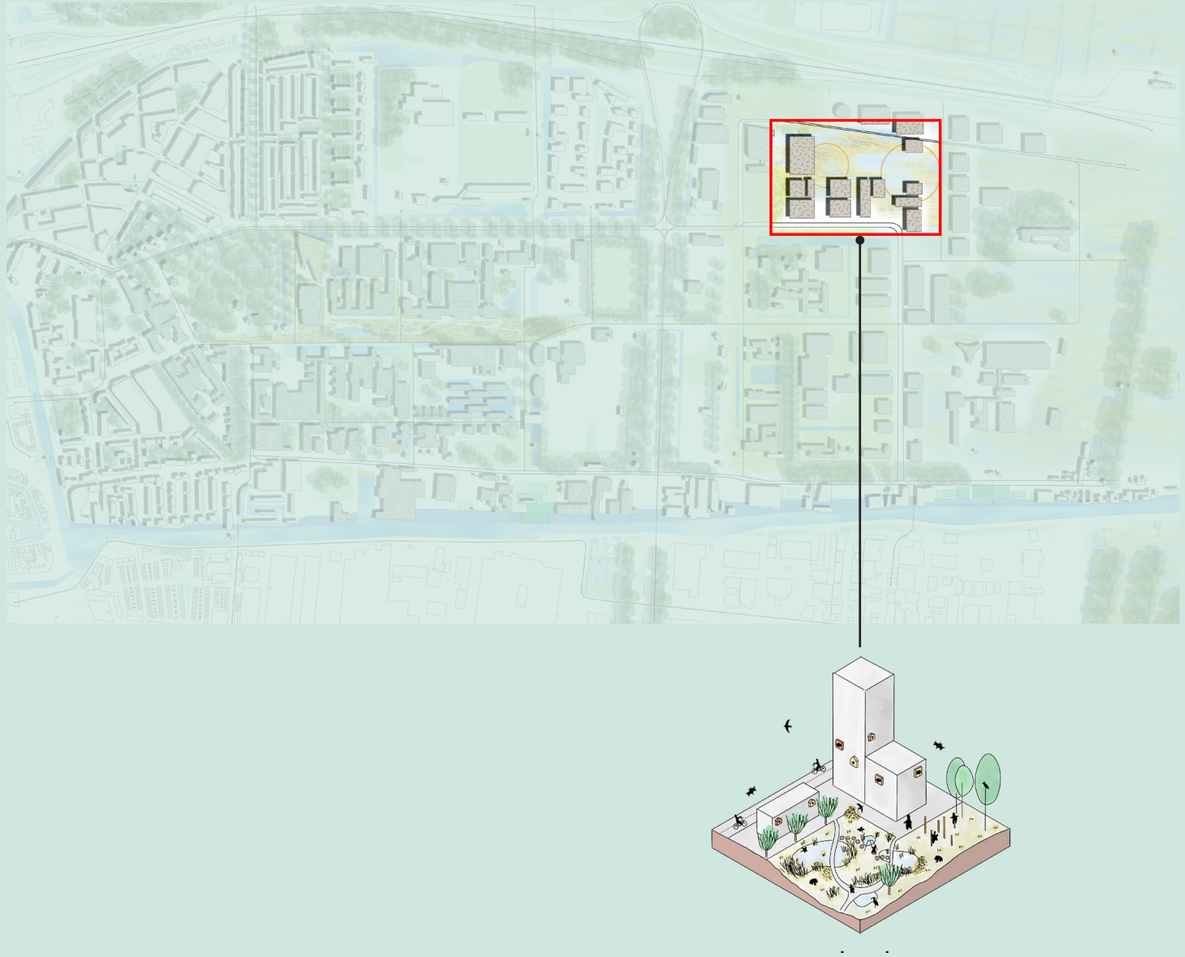
Korvezeestraat Student Housing
impression of integrated wetland hostel







Creek park
impression



09

DESIGN ELABORATION SITE 3-WETLAND CLUSTER

Proposed design plan
Design strategy
2 types of building blocks
Impression





1. Wetland
2. Wetland forest
3. Infinity boardwalk
4. Existing river pond

5. Cluster Plaza
6. Consolidated towers
7. Adaptive buildings on stilts
8. Green village south
   - Existing buildings
   - New buildings

0 20 40 60 80m

Figure 9-1. Wetland cluster plan

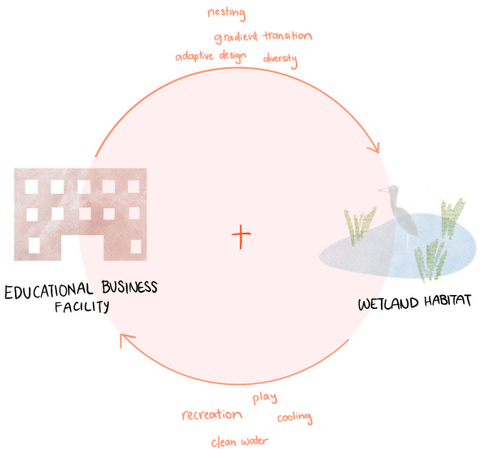
Wetland cluster design

proposed design

The wetland cluster in TU South makes up 55% of the campus water storage capacity. It houses the new business-education district. The adapted buildings are strategically positioned in the wetland landscape. The area is ecologically rich with wet meadows and swamp. There is a gradient and harmony between the built and nature. The wetland is a level land form with small clusters of water tolerant trees and a wide open skies.

There is a distinctive architectural style with local timber building material which contributes to around 60% of the carbon sequestration in campus. The buildings react and plays with the wetland environment, bringing up a dialogue between the buildings and its biotic and abiotic factors. The adaptive and responsive built environment also promotes the biophilic nature amongst people.

The short elaboration of the design of the wetland cluster is aimed at highlighting the relationship between the building blocks and the landscape. Also, the ambience of the new development in the TU South is illustrated.



Wetland cluster buildings

buildings engage/play with the environment

To preserve the wetland characteristics of the TU South, building programs are consolidated along the primary mobility route in the form of high compact towers. It surrounds the cluster plaza. All building adopts a circular water reuse strategy with rain collection and grey water recycling. this strategy frees up area for the

Along the edges of the wetland, there is the transitional mid-sized blocks which are partially on stilts as it approaches the water. It offers a open view of the wetland and a pleasant immersive experience. The stony roof provides a safe haven for the Scholekster. Buildings has a green facade interface with integrated nesting design for the bats and sand martins. With the inclined building facade, the droppings of the bats and the birds falls into the riparian zone and are naturally absorbed by the helophytes. There is also natural day lighting to reduce energy usage and to bring in external conditions.

The smaller research huts on stilts are located in the wetland and they are the extension of the green village. The circular water cycle is observable through features designed in themed colour. The walls and the overhang roof accommodate sand martin nesting boxes.

With the concentration of programming in localised area, zones of active and quiet areas are created for sensitive animals and varying recreational uses.

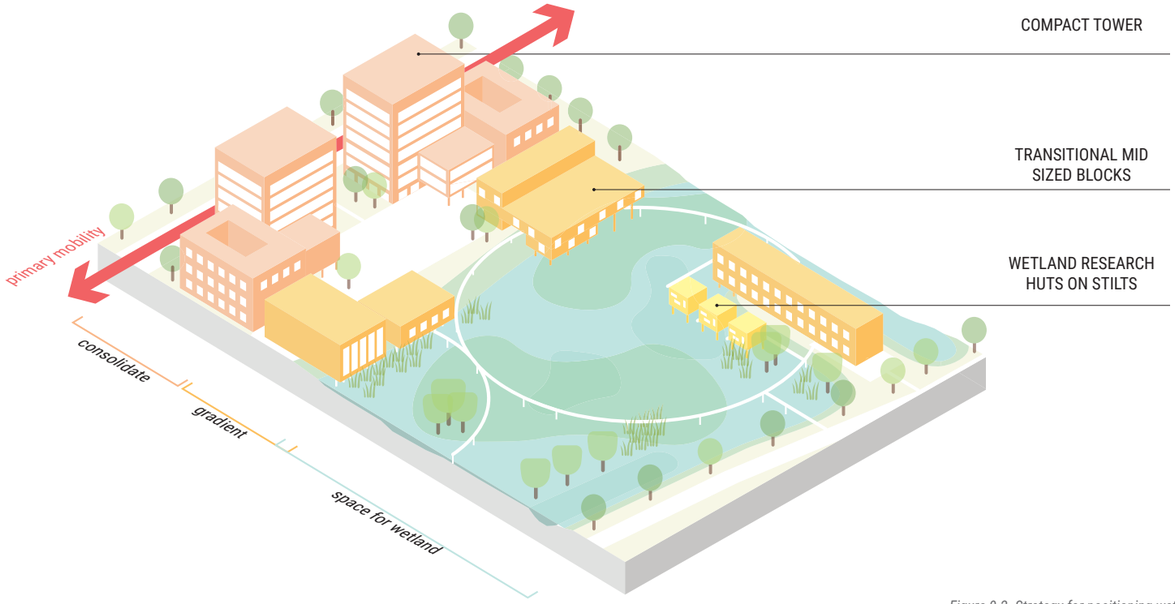
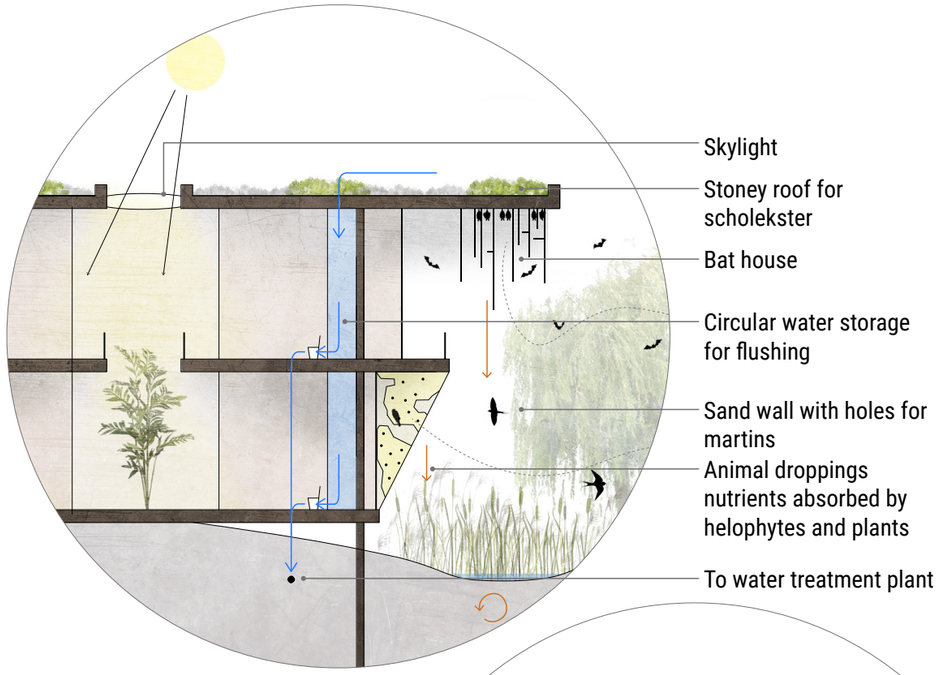


Figure 9-2. Strategy for positioning wetland building blocks and building types.



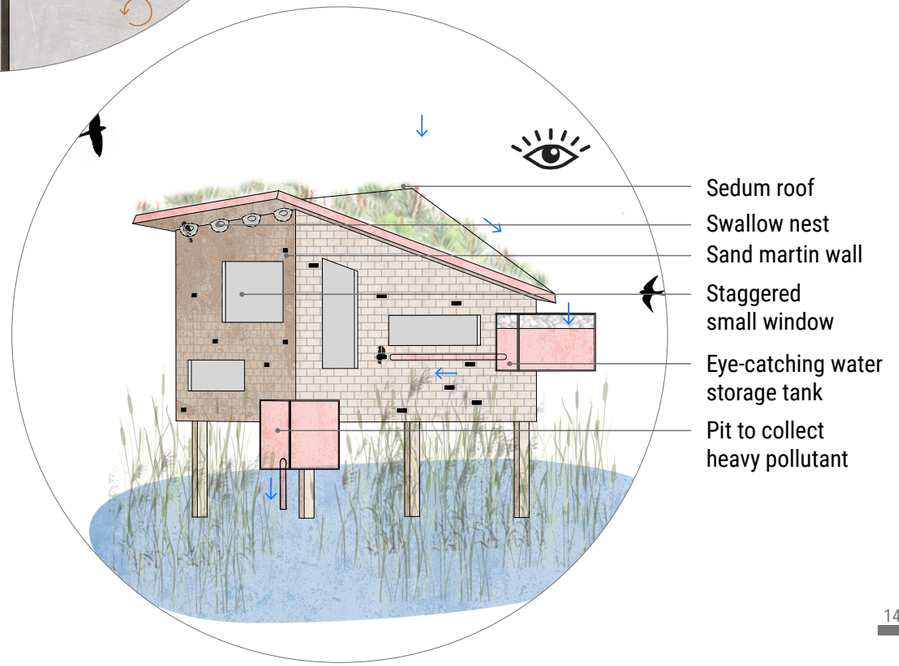


Figure 9-3. (top) Sectional detail elaboration of transitional mid-sized blocks.
Figure 9-4. (bottom) Design elaboration of research hut.

Wetland cluster
impression



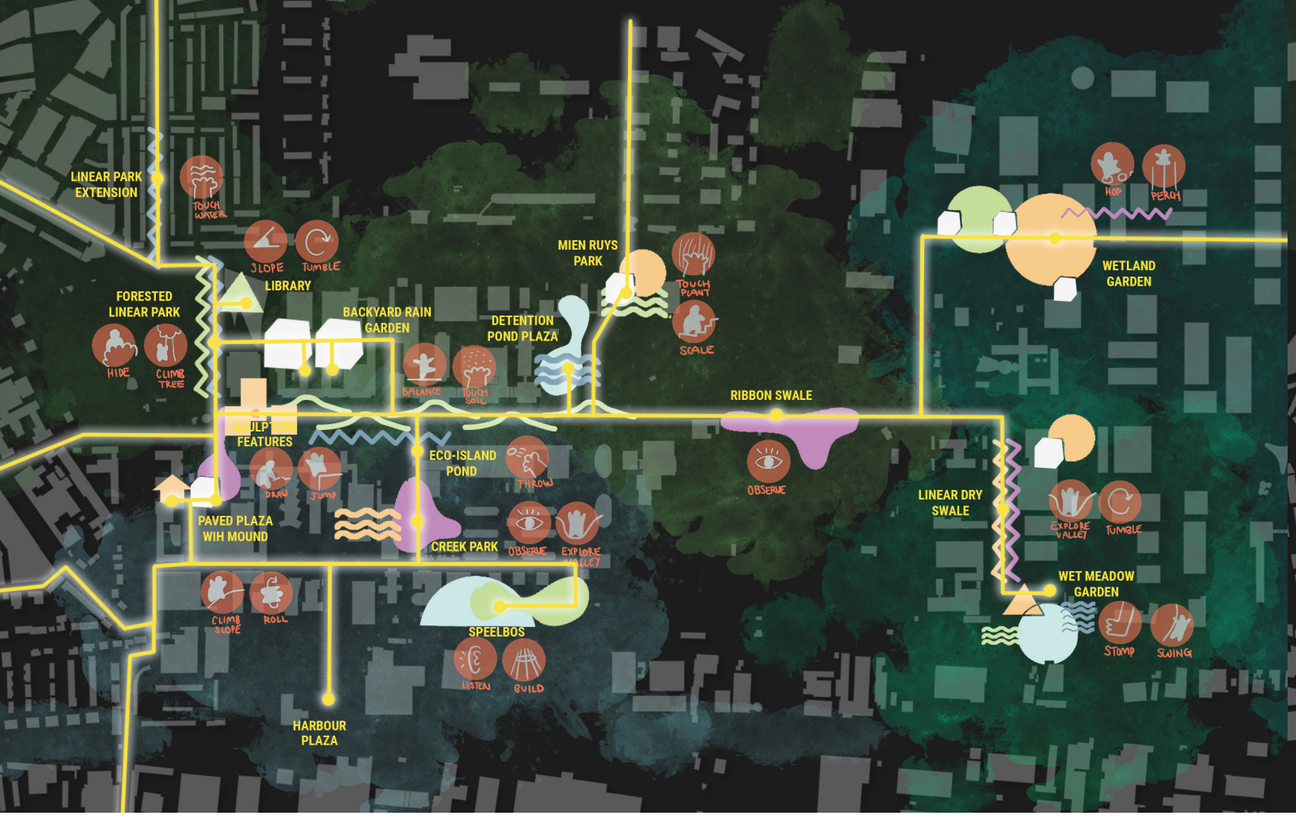




10

CONCLUDING

Routing value for campus
Implications for metropolitan region
Strategic plan
Recommendations
Design evaluation & reflection



Routing
fun loving explorers

The campus not only caters to students and staff for educational needs but it also provides for the surrounding neighbourhoods and the adventure seekers regardless of age. This could be a great asset especially for the yound families living beside the campus and also the International School Delft which is located in TU Middle, beside the TPM building with children of age 4-11.

The campus is designed to provoke relationship amongst people, animals and the abiotic and biotic environment. The areas of different spatial qualities and opportunity for engagement are well connected with pedastrian pathway to form a network within the campus and it also extends beyond the campus to the surrounding playful areas.

Figure 10-1. Routing map for children.



Routing
runner, hiker and dog walker

There are different routes in the campus with different distance for runners to choose from. Running and walking loops ranges from 2km to 8km. The 5km hiking route starts from the northern Delftsehout forest and passes through all the characteristic clusters and connects to the southern wetland Ackerdijksplassen area. There are rest stops, interesting campus features and also look out points along the proposed routing.

Figure 10-2. Routing map for runner, hiker and dog walker.



Figure 10-3. Expanded green and blue network in Rotterdam-The Hague region

- Coast & Dune
- Dune forest
- Estuary
- Polder Forest
- Grassland
- Agriculture Pasture
- River Chanel Veins

Implications for metropolitan region

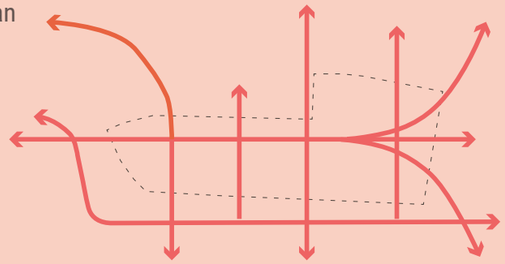
extrapolating design to The Hague-Rotterdam region

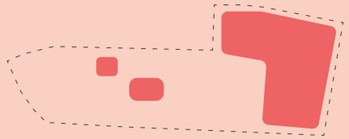
A campus functions just like a city. Cities have a lot of potential in becoming biodiverse, adaptive areas through playful design.

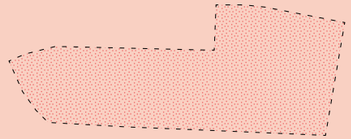
Through engaging, and reacting to surrounding landscapes, existing habitats are expanded forming regional connectivity and patches. Major canal water can be cleaned by various cities. The entire Rotterdam-The Hague metropolitan region enjoys flourishing biodiversity that is local and native, giving more opportunities for smaller-scale 'playful' network.
Play strategies are localised according to local characteristics, giving the metropolitan region a unique identity linked to its genius loci.

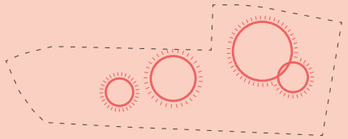
Strategic implementation plan

campus action plan











KEY ACTION

1 Strengthen green-blue corridor

2 Improve water quality (along Schie and within campus)

3 Flood TU South

4 Create detention pond and rain garden at flood prone areas

5 Transform one building (EWI?) into an eco-building and to collect and reuse rain water.

6 Enhance planting scheme

7 Depave and soil improvement

8 Allocate active and quiet zones

9 Localised park design and execution

10 Sustainable TU South development

STAKEHOLDER

Delft Municipality · *TU Delft*

+ In line with Green Delft memorandum
+Quality water is an important basis for habitat creation

Delfland Water Board · *TU Delft*

+ Wetland takes time to establish
+ Allow gradual peat formation
+ Make full use of TU South temporary land: low effort, high reward

TU Delft Green Maintenance

+ Benefit of circular water system in building tested and seen
+ TUD biodiversity assessment to raise support and funds to create patches for next step
+ Deployable small scale interventions

TUD Spatial group · *BK Landscape and Urbanism* · *Design Studio Office*

+ Collaboration for design

Developer · *TU Delft CRE*

+ Motivation for sustainable and eco-friendly building design with precedence of TU Middle
+ Take inspiration from Green Village projects for TU South

IMPACT

Biodiversity: *connecting and setting the right basic ecosystem requirements* → *creating right conditions* → *improving habitat quality* → *creating new patches*

Resilience: *cleaning water* → *storing water* → *infiltration* → *circular water system*

Play: *temporary design structure* → *temporary design structure* → *participatory design* → *buildings engage with environment*

Recommendations

In summary, urban areas such as the campus provide many opportunities for wildlife. Through increased awareness of the impact of climate change, we can better management of scarce resources and achieve more sustainable flows.

Applying the framework to create a biodiverse and climate adaptive play, the campus was analysed and reimagined.

1. To look beyond the campus to serve and impact a greater region. (connecting green-blue patches and improving the polder water system)

2. To react to campus topography and incorporate Delft's 5 landscape characteristics within the campus: the forest, dry meadow, river, wet meadow and wetland.

3. Circular water system within the campus with more local retention and purification. And if possible, a living water machine (purification of wastewater for reuse). TU South campus being lower, is to store water and be allowed to flood to become a wetland. This can be achieved through a separated flexible water system with a fluctuating water level of 30cm.

4. Flood prone areas can be converted into multi-use water detention plaza.

5. Since the TU North and TU Middle is relatively built-up, it is important to make use of the interstitial spaces, building facades and roofs by deploying methods as suggested by the design toolbox such as de-paving. With the consolidation of car park, the extensive parking spaces can be activated for natural climate adaptive solutions and wildlife.

6. Incorporating strategy of extensive water retention capability into the planned development of TU South. Unique biophilic architectural styles with flexible usage to minimize the builtup area. New buildings should have a nature-friendly and water sensitive design.

7. It is also important to have the support of Campus Real Estate, planning and management team, maintenance team and municipality. The importance of a biodiverse, climate resilient and playful design should be conveyed to stakeholders and students as a biodiverse, climate adaptive and playful design requires planning and execution across all scales.

8. Creating different types of spatial qualities, experiences and opportunities of play and activities within the campus. This can take the form of building design, play structures or landscape features.

9. Plan for private inaccessible zones for sensitive wildlife. Patches with different degrees of disturbances for wildlife with different needs and shyness.

Design evaluation & reflection

This document represents a reflection of the graduation project "Biodiverse. Resilient. Playscape" through the process, outcome and the relationships to other related fields. The discussion will be analysed from the product, limitations and further elaborated on the future plans of the project.

Relationship between research and design

The project aims to create a spatial framework for a biodiverse and climate adaptive playscape. The framework is applied to the TU Delft campus as a test case. Design and research are the essential processes for the graduation project. During different stages, one might take more precedence than the other, but they are always influencing each other. The first part of the project involved intensive research on theoretical knowledge and subsequently transforming them into a design toolbox through the design process. The next part of the research is more about designing the campus through the application of the research outcome in the campus. Throughout the entire project, the design-research process is not a linear nor straightforward one. But rather, research was also conducted by design while design was researched in the form of an iteration of design scenarios. The interconnected relationship between research and design is strongly represented in the process of this graduation project. It is an iterative process and hardly operated separately.

Approach

There is a systematic approach to the project. The theoretical research would generate a set of guidelines and toolbox which is to be applied to a test case site, the TU Delft campus. The process is once again not a linear one as the designing of the campus would also generate feedback to improving the guidelines and toolbox. The non-linear process works to clarify and strengthen the spatial framework through trial-and-error testing on the campus.

For instance, the design toolbox, which was created from case studies and ideas for the site, provides a wealth of design approaches. However, it is still crucial to consider the local site conditions as some design toolbox cannot be applied to the context. Interestingly, the adaptation of the design toolbox to the site limitation results in even more new design ideas.



design toolbox *new toolbox ideas*

Also, there were plans to obtain a thorough analysis of the site, but this depends on the availability of data. As such a mix of approaches was used, ranging from online research, documented books, site visit and QGIS analysis data processing software. For instance, in particular, the plan to perform a hydrology test on the campus and sites 1 and 2 did not work out. This is due to the difficulty in finding terrain models of the campus. With that, other approaches were used to understand the flood-prone areas even though this does not reveal the sources of water accumulation.

There are limitations of the research-by-design. The project acknowledges that the water pattern experiment and spatial helophyte categorisation are not extensive. There are still unexplored iterations and endless possibilities. With that in mind, the research-by-design should not be treated as limiting options for other projects but rather, they serve as a starting point for the possibility of creating interesting water patterns and using helophytes to engage the 5 senses.

Conundrum

It is a blessing that the TU Delft campus recognises the importance of sustainable design and the campus green manager Rene Hoonhout is also supportive of green initiatives on the campus. However, this might not always be the case. More often than not, there is a dilemma of the programmatic use of the space. Especially in cities, it is not easy to sacrifice practical spaces for human activities to nature needs. To solve this puzzle, it is important to first recognize the importance and value of nature. The valuation of natural capital and ecosystem services have been demonstrated by The Economics of Ecosystems and Biodiversity (TEEB) initiative. Win-win solution through multi-use programming that promotes sustainable usage helps to ease the planning dilemma of urban space.

Mentor's feedback

It was really handy and helpful to obtain other perspectives for the project and receive guidance for the research structure and direction. For instance, during P1, Nico suggested defining key terms in order to set out a common understanding since readers might have their own definition based on their own experience. This resulted in the development of the glossary which was mentioned early in the presentation. During P2 and the thesis consultations, Andy and Nico pointed out the missing steps of the project to ensure the coherence and flow of the project; when there was too much focus on details, the project was prompted to take a step back to establish a clearer link to the bigger vision frame. They also prompted the consideration of other design options which translated into the design research by design scenarios. The engagement with the mentors resulted in a more holistic development of the project from the theoretical studies to framework application and designing.

Also, external commentaries were sought through consultation with guest lecturers, Anna Fink, Sjef Jansen, and Gabriël Geluk. Their expertise in play engagement, ecology and landscape engineering respectively provided guidance for representation and tips to fine-tune the project across the scale. Working out the technical detailing of certain design features, such as the nature islands in front of 3ME, presented the opportunity to involve and engage people and nature in the island-building process. Also, the discussion with Delfland Water Board reaffirmed the project's circular water approach and prompted the focus of site 3. With that, the next site design for TU South for P5 shall be about nature-inclusive and circular design of the buildings.

Final plans for graduation period

Between P4 and P5, the final part of the project of the design of the wetland cluster will be developed. Currently TU South has yet to be developed but there are plans for it to become an educational business park. The design shall serve as a possibility of the architectural style on a wetland landscape. There will be a focus on the integration of water resilient solutions and nature-inclusive in buildings. In addition, there are plans for the modelling of the habitat mound in site 1 and the resurfaced creek in site 2. Lastly, there are plans to further the plans of the Christiaan Huygensweg Canal with Rene Hoonhout. The construction of the canal is planned to start in 2-3 months in the summer.

Relevance

The project is situated in the theme of sustainable ecocities. As cities expand rapidly throughout the world, the importance of urban ecology becomes more urgent than ever. The project aims to promote a new way of transforming and designing our cities and discover new ways of approaching urban nature through an ecological perspective. It bridges across different disciplines of hydrology, landscape architecture, sociology, environmental engineering, climate design and sustainability. With the case studies, the project supplements the research data on the ecological and resilient playscape. The project aims to generate a framework which becomes relevant as a guide to be applied to other areas when striving for a biodiverse, climate adaptive playscape. Using the TU Delft site, the project provides an insight into the application of the framework and showcases how a biodiverse and resilient campus looks together with its potential. The project's research and the design component approach landscape architecture as an interdisciplinary field with many interacting components of the complex relationship between entities. The project employs a multi-layered understanding of landscape, by accounting for the design across time and scale, the palimpsest layers and the spatial structure. The project respects and builds upon the Genius Loci and translates relevant ecocity principles and biodiversity challenges into the specific site in TU Delft. A university resembles cities on a smaller scale and hence the design principles and spatial frameworks would also be relevant to cities.

Landscape architecture- 4Ps

The project is part of the Flowscapes studio, the graduation studio of the MSc Landscape Architecture. There are four essential perspectives on analysis and design—perception, palimpsest, process, and scale continuum.

Perception focuses on the link between people and the landscape through a physical experience of the environment. This is most visible in the smaller and zoom-in area design scale. The project designs from the users' perspective through the engagement of their five senses and creating relatable spatial variations of enclosure and openness through tools such as the spatial helophytes categorisation. The human's perspective is especially important in 'playful' design and the project explored different configuration of elements (natural materials and existing materials onsite) to provoke creative interpretation, a range of affordances and relation to the natural environment. The physical experience of the different landscape clusters is also unique. The forest cluster is characterised by a multi-layered dense canopy with rich tiered undergrowth and short hindered view lines. Meanwhile, the wetland cluster has sparse trees and an open unhindered view and restricted but elevated accessibility.

Palimpsest builds on physical traces left behind. It is highly related to the specificity of the site. The unique topography gradient of a higher TU North to lower recessed TU South is key to the different landscape types within the campus. The physical historical trace is also revealed through resurfacing the 250 BC creek in delft. The creek design was elaborated in the river cluster and emphasised through interesting water patterns. Also, the history of the campus's landscape was studied, and it informed the development of TU Delft's landscape vision.

Process is about changes with time. The project considers process through the development of a three-year short-term plan and ten-year long-term plan of the Linear Aula Park along the Christiaan Huygensweg Canal. On a smaller scale, for instance the quiet nature islands in front of the 3ME building, there is consideration of how a design is executed with time and how the vegetation changes with time. The process of how water flow in the campus is also redesigned to become more circular with longer detention in localised areas and purification.

Scale-continuum. The design principles of ecology, resilience and play are applied through the scales from meso city scale to macro campus scale and micro specific site design and detail design. Each cluster specific elaboration aims to improve and expand its unique landscape characteristic. At the same time, they work together to form a larger network of patch connectivity within the campus. The concept of connecting green-blue corridors and patches means that the impact of the campus expands beyond its boundaries. The campus vision aims to strengthen nature infrastructure and integrate its surrounding: the Schie, residential areas and wet meadows/ wetlands of Abtswoudsehoeve. Together with green plans of the Delft municipality, the green and blue ring around delft shall be interweaved and connected into the city core.

Thoughts

Ecosystem is complex in its relationships and requirements yet basic in what we can do for it; to give it space and work with processes. The urban area has a dense configuration but we can incorporate habitat creation in to built environment.

GLOSSARY

Affordances
Affordance is what the environment offers the individual.

James J. Gibson

Biodiversity
Biodiversity is a complex term with 3 main concepts of genetic diversity, species diversity and ecosystem diversity. Biodiversity is important due to the interconnected relationship between species and with their environment. Also, the diversity and complexity of an ecosystem contributes to the resilience and stability of the system.

Making Urban Nature, Vink et al., 2017

Biophilic Play
playscapes that include natural elements (plants, water, stone,...) and topography, which provide open ended play opportunities that support creative discoveries.

Cengiz & Boz, 2019

Climate Resilience
Resilience is the ability to adapt to a change or stress on the system and the ability absorb disturbances. The disturbances brought about by climate change are heat stress and more frequent extreme rain patterns. A system responds to extremities by reorganizing itself to retain its function, structure and identity . To be climate resilient is to account for the extremities in the future in the current design intervention. This leads to the term "future proofing". The resilience in coping with extreme changes not only minimizes the loss of lives and properties but also serves as an opportunity to improve qualities of the social aspect and biodiversity in a city.

Stads Natuur Maken & Resilient Cities Network

Ecocity
An ecocity is an ecologically healthy city that provides healthy abundance to its inhabitants without consuming more (renewable) resources than it produces, without producing more waste than it can assimilate and without being toxic to itself or neighboring ecosystems.

https://ecocitybuilders.org/

Ecology
The study of how organisms interact with their environment. All organisms must interact with both living and non living things that surround them. All organisms are interdependent.

Nico Tillie-20200901 Lecture

Ecological resilience
Ecosystems have multiple states, ecological resilience is the ability of a system to absorb change and disturbances without changing its basic structure and function. There is persistence, change and unpredictability.

Holling, 1996

Ecosystem Services
Ecosystems provide services to humankind. Those may involve the provision of a product (e.g. drinking water), a regulatory authority (e.g, pollination of crops), a cultural service (e.g, providing opportunities for recreation), or a service that supports the services mentioned earlier (e.g the cycle of nutrients in an ecosystem).

https://www.wur.nl/en/Dossiers/file/Ecosystem-services.htm

Ludic City
Ludic is an adjective of spontaneous and undirected playfulness. Ludic city understands play as an important aspect of urban society and supports playful (spontaneous, irrational or risky) uses of urban spaces.

Ludic City, Quentin Stevens, 2007

Playful humans
A playful human seeks for fun and enjoyment without necessarily a purpose. A playful human interacts with his environment through his own interpretative manner that activate his 5 senses or curiosity.

Playful landscape
A playful landscape evokes a playful human by crafting a stimulating interaction experience with man.

Playful city
A playful cities rethink the relationship of its building blocks. A wasted or unutilized space or element can be a valuable resource for another. The underbelly of a bridge can become a home for bats. A wall can host to plants and insects by becoming a green wall.

Urban Nature
City is an ecosystem with diverse habitats. It is characterised mainly by the stony environment with buildings and streets and also green and wet places in between. The city is warm with an abundance of food and there is a presence of dynamic and stable areas.

Stads Natuur Maken

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APPENDIX

Water retention capacity & adaptability

calculation for new proposed design

WATER USAGE IN CAMPUS

water use on TU Delft campus in 2018:
(Blom & Dobbelsteen, 2019)

167,116m3

annual average rainfall:
800mm

annual rain water amount on campus roof :
211,000m3

80% rain water collected on roof and stored in detention tanks:

176,000m3

WATER USE OF CAMPUS CAN BE FULLY MET BY COLLECTING 80% OF RAINWATER ON ROOF

ANNUAL RAIN STORAGE CAPACITY

annual average rainfall in the Delft:
840mm

annual rainfall volume on TU Delft campus:

1,800,000m3

area of surface water and underground storage with new design:
740,000m2

volume, assuming 0.5m depth:
370,000m3

total rain storage volume of proposal,

703,000m3

30% TO 40% OF ANNUAL RAIN IS RETAINED IN CAMPUS

FLEXIBLE CAPACITY DURING HEAVY RAIN EVENT

Delft highest precipitation amount (aug):
83mm

aug rainfall volume on TU Delft campus:

180,000m3

area of surface water and underground storage with new design:
740,000m2

assuming 30 cm allowance of fluctuation depth, additional storage capacity with new design:

222,000m3

able to hold 165% of aug heaviest rainfall

CAPACITY (120%) SUFFICIENT TO PREVENT FLOODING DURING WET SEASON.

Carbon Sequestered in Campus

calculation for new proposed design

CARBON SEQUESTRATION METHODS

1.Trees and shrubs

Carbon capture factor of:
tree entity- 70kg CO2/ st
trees clusters- 1.3 kg CO2/m2
grass- 0.3 kg CO2/m2
shrubs- 0.3 kg CO2/m2
(Sharma et al., 2020) & (Blom & Dobbelsteen, 2019)

Trees in campus:
2,600 (current) + 800 st (new design)
(238 t CO2)

Forest in campus:
56,000m2 (current) + 6,000m2 (new design)
(80 t CO2)

Shrubs in campus:
8,500m2 (current) + 3,600m2 (new design)
(3 t CO2)

Lawn in campus:
457,000m2 (current) + 60,000m2 (new design)
(155 t CO2)
(source for existing campus data: Groenbeheer plan, 2020)

Total CO2 captured by greenery annually:

477 t CO2

2.Peatland & peat moss

Globally, 3 million km2 of peatland sequest 0.37 gigatonnes of CO2 a year
(https://www.iucn.org/resources/issues-briefs/peatlands-and-climate-change)
370 t CO2/0.3 km2
1.233 kg CO2/m2

Sphagnum peat moss sequesters 98.7g CO2 / year / m2
(source: nico tillie)

Peat area in TU South:
0.8km2
(100 t CO2)

Assuming peat moss 50% of peat area
0.4km2
(40 t CO2)

Total CO2 captured by greenery annually:

140 t CO2

3.Timber building material

Metsä Wood building carbon storage:
204 kg/m2 of floor area
(https://www.metsawood.com/global/news-media/articles/Pages/carbon-storage.aspx)

Assuming buildings in TU South are 5 story high:
500,000 m2
(100 t CO2)

Average timber building lifespan is 100 yrs.

Total CO2 captured by building annually:

1,000 t CO2

CARBON SEQUESTERED ANNUALLY: 1,600 t CO2

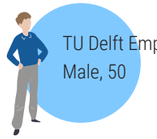
CO2 footprint of campus: 49,000 tCO2

Survey response

To get an understanding of how others perceive the project and design, a short survey was conceived to get input from the public. The 4 respondents are users of the campus and hence were familiar to the area. There were 4 inputs from an employee with children, an enthusiastic nature lover, a local student and an international student. First, a general overview of the project was described and together with the aim. The design was split into three areas and each design area was explained before the respondent filled in their survey form.

In general, the designs were well-received with expected different interpretation and uses of the design. The different levels of engagement is a result of people's varying degree of comfort with the "dirtiness" or perceived danger of nature and their comfort level to for physical motion. The main concerns were relating to feasibility and health regarding nuisance by unwanted nature such as mosquitos. Resistance was felt most strongly when it involved a change in their normal lifestyle which they are used to. Participation and activity have a spillover effect. Clear signs and communication with users of the space through signage or design workshops will be helpful in the participation process. so, once the pioneer users are encouraged to leave their comfort zones and norms, more possibility can be unlocked as further users can break free of stigmas and go along with their own interpretation.

RESPONDENTS



TU Delft Employee
Male, 50



Nature enthusiast
Female, 24



Dutch student
Male, 24



International student
Female, 30

1

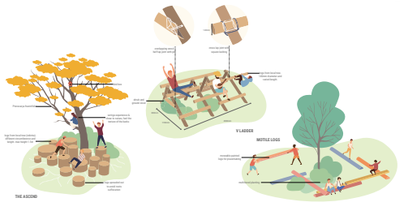
first thoughts

family houses nearby with young couples and children. this design not only serve campus but great for others. adventurous equipments available for all.

atractive and i'd like to go out there during lunch breaks if I study at the library.

i love forest. I would sit on the mound and logs to relax after studying.

open air meeting could be conducive for discussion especially with COVID. great place to read in summer.





like

much more green without paving. adds to big green connection across campus to schie. engagement. forest vibe and coloured logs. great place instead of Mekel Park.

rating

dislike

should continue and expand further into surrounding. too few structures to sit on. moving logs might be a lot of work and maybe dirty. area might be too narrow for a park.

#

#green #connection #adventure #natural #scientific #colourful #log #forest #sitting #shade #gathering #outdoors

2

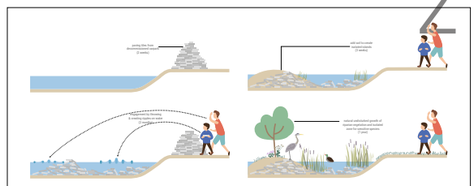
first thoughts

good idea.

ecological. take a walk after dinner to watch birds.

walk around and sit. i think the stone throwing is interesting but i would probably not do it myself.

easily executed. great for short term feasibility.



like

historical creek. store more water. connection to city and south. very ecological with green and water. pleasant ambience. tall trees and board walk. has art and sculptural value. experience being close to water



dislike

could have more connections to old farm. tram line might be a barrier to continuity of creek. nothing. tiles might be dirty. not sure if allowed or illegal to throw tiles. mosquito.

#

#creek #connection #ecological #participate #micro-climate #log #water #art #sculpture

rating

3

first thoughts

amazing for students.

this design brings many possibilities to student housing area, more activities and scenery

i like the places to sit, but i am scared loiterers will be smoking near the student housing

i imagine cascading water. currently this area is dull. nice landscape.





like

green at proximity of door. pleasant living atmosphere. water is interesting as water management is a large problem now. pleasant environment. greenery good for eye and health.

dislike

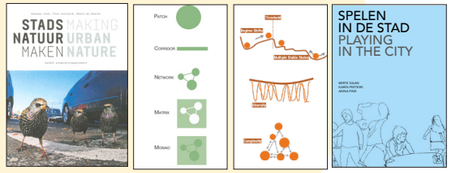
accessibility to building by vehicles for maintenance. green could be up till door. feasibility. nothing. as it is between building, it is quite closed off, which has its risks. should be well lit. no place for sports activity (badminton, volleyball, frisbee)

#

#lifestyle #natureliving #resilient #palimpsest #neighbourhood-friendly #closed-off #housing #wetland #waterflow #beautiful #well-breing

rating

Overall project process



1. THEORY

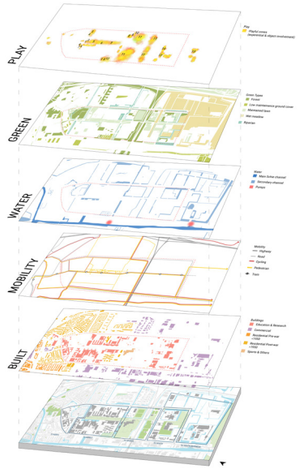
2. FRAMEWORK









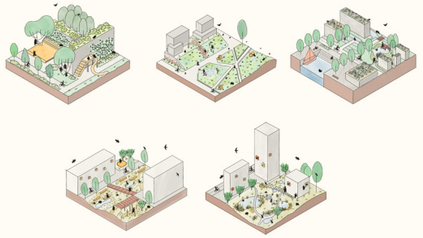


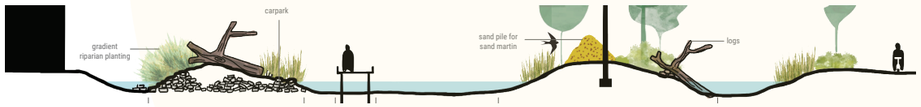
3. ANALYSIS

4. EXPLORATION









5. DESIGN

6. TESTING & EVALUATION



