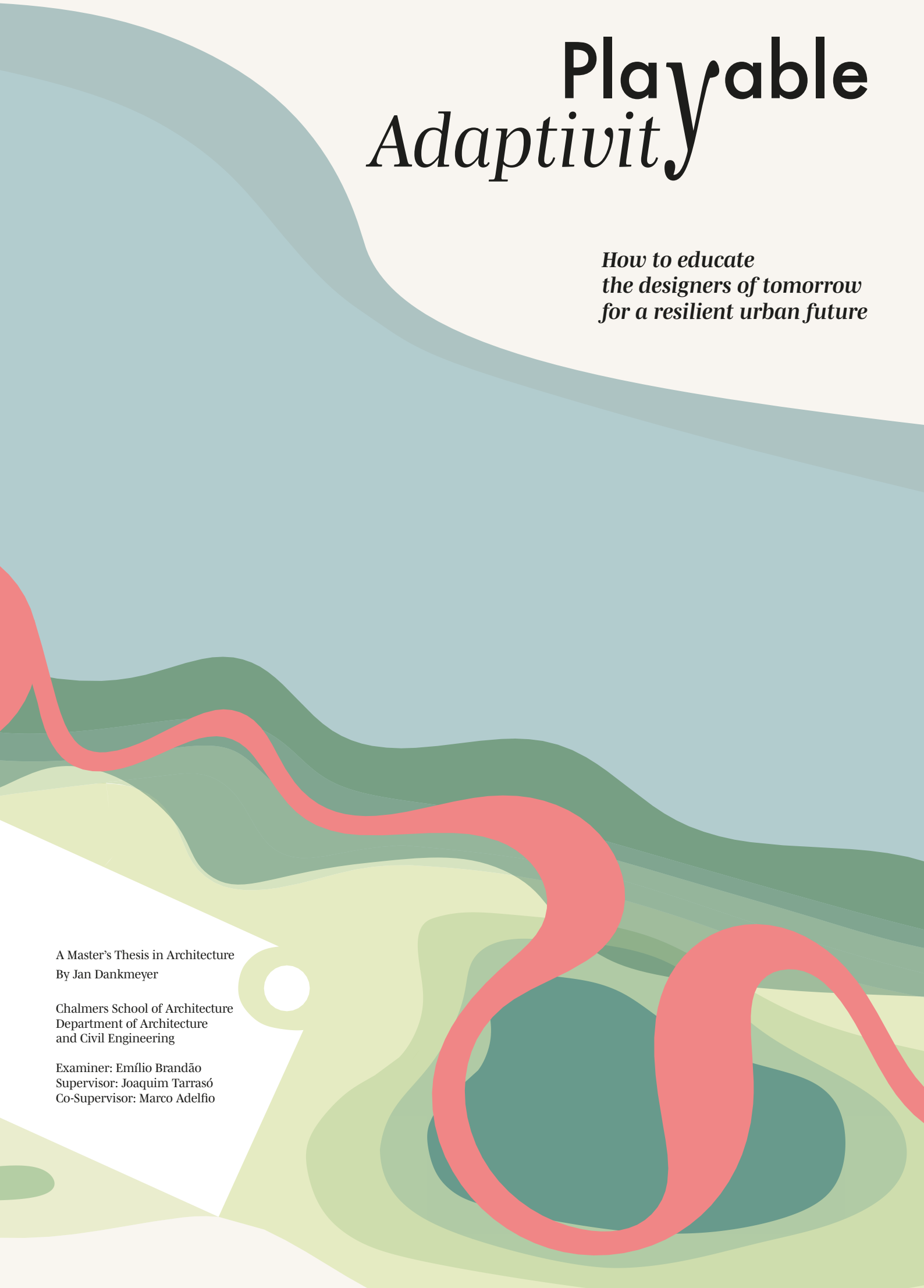
Playable *Adaptivity*

How to educate the designers of tomorrow for a resilient urban future



A Master's Thesis in Architecture

By Jan Dankmeyer

Chalmers School of Architecture
Department of Architecture
and Civil Engineering

Examiner: Emílio Brandão
Supervisor: Joaquim Tarrasó
Co-Supervisor: Marco Adelfio

Playable
Adaptivity

How to educate
the designers of tomorrow
for a resilient urban future

CHALMERS
UNIVERSITY OF TECHNOLOGY

A Master's Thesis in Architecture
by Jan Niklas Dankmeyer

Direction: Urban Challenges
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Chalmers School of Architecture
Department of Architecture and Civil Engineering

Master Programme:
Architecture and Planning Beyond Sustainability

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jan.dankmeyer@gmx.de

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Für Emil

Was eine Kinderseele
aus jedem Blick verspricht,
so reich ist doch an Hoffnung
ein ganzer Frühling nicht!

Hoffmann von Fallersleben

Abstract

Children in our cities will account for 60% of urban dwellers by 2030 (United Nations, 2016). There is a necessity to educate an ever more increasing urbanised society about the complexity of Earth's natural systems in order to achieve environmental and social resilience.

The rapid process of urbanisation combined with climate change threatens children to grow up on an inhabitable planet. For many decades, urban planning and architecture have been giving low priorities to children's perspective in the built environment. Since children are the most unbiased part of society, yet the most vulnerable one in terms of climate change impacts, the urge to integrate them has to be seen as an inherent part of urban planning.

This Master's Thesis focuses on the children's perspectives within the urban fabric by investigating how child-responsive spatial design can be combined with environmental education. Correspondingly, the concept of environmental psychology and built environment education will be introduced to combine pedagogy and architecture. Thereby, the concept of play needs to be integrated into everyday urban life in order to promote outdoor activity and to nurture children's personal development.

The context of the design proposal is Gothenburg, Sweden, which will be facing significant climate change challenges, due to flooding caused by both the rise of sea water level and increase of precipitation. Conformable to environmental education, water sensitive design is introduced as a method to couple context-based urban challenges with environmental education as a pedagogical and playful element to educate about urban resilience.

In compliance with the research-for-design method, this work aims to create a spatial interface for children where the experience of space and movement in relation to climate adaptivity breaks ground for a new perspective on public spaces. The design outcome of this Master's Thesis strives to contribute to environmental awareness and urban resilience through child-responsive design.

Keywords

children
children's perspective
climate adaptivity
climate resilience
designing for children
environmental education
environmental psychology
playable architecture
public space
social resilience
storm-water management
water sensitive urban design

About the Author

Educational Background

Master of Science
"Architecture and Planning Beyond Sustainability"

Chalmers University of Technology
Gothenburg, Sweden, 2018 - 2020

Bachelor of Science
"Architecture"

Bochum University of Applied Sciences
Germany, 2012 - 2017

Professional Experience

RKW Architektur +
Düsseldorf, Germany, 2017 - 2018

Junior Design Architect

ACMS Architekten
Wuppertal, Germany, 2017

Student assistant

a|sh architekten
Düsseldorf, Germany, 2015- 2016

Student assistant

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I want to say thank you to my flatmates Jairo and Thamy who gave me more than just a place to live in a strange country, but a home and a lifelong friendship.

Last but not least, this Master's Thesis is dedicated to my parents. Thank you for everything. Without your love and support, I would have never been there where I am today.

Tack Sverige!

Reading Instructions

Chapter 1 introduces the subject and purpose of this Master's Thesis, and outlines its relevance to the profession of architecture and sustainability. The chapter completes with presenting the delimitation of this work and a schematic overview of theories and methods that have been investigated.

Chapter 2 introduces the child's perspective in the built environment, explaining why play is vital for childhood development and how this connects to environmental education. The concept of Built Environmental Education outlines why there is a need for a new perspective on urban playgrounds.

Chapter 3 presents Gothenburg as the location of the case study and introduces water as the context-based urban challenge. It outlines Water Sensitive Urban Design as a pedagogical asset for child-responsive urban planning.

Chapter 4 graphically communicates how the research findings translate into design strategies and their dependencies. A toolbox provides an overview of pedagogical water management.

Chapter 5 and introduces Pusterviksplatsen in central Gothenburg as the project site. It demonstrates the design proposal and illustrates the application of theory, while taking into account the main related site issues and characteristics in relation to child-responsive design and stormwater treatment.

Finally, this work reflects on the process and conclusions drawn from the research, theory and design. It provides a summary of further issues and questions to be discussed and culminates with a written manifesto.

Contents

Figure 1

"Make a splash!"

Chapter 1
Introduction

> *"If we can build a successful city for children, we will have a successful city for all people."*

Enrique Peñalosa,
Mayor of Bogotá, Columbia
(quoted in Arup, 2017, p. 4)

Preface

The point of departure for this Master's Thesis was to formulate an architectural approach to raise environmental awareness and educate the general population on climate change, thereby promoting sustainable behaviour. Investigations into the field of behavioural design defined the target group and strategies for promoting sustainability through design.

As it is widely acknowledged, the climate crisis is the greatest challenge in the history of humankind (Kalmus, 2019). Taking action against climate change is complex, uncomfortable for many, and requires systemic societal changes. Change begins with educating our children, as they will shape the course of the world in the future.

In their joint report, "A future for the world's children?" (2020), the World Health Organisation (WHO), United Nations International Children's Emergency Fund (UNICEF) and *The Lancet* state that children will face existential threats. According to the report, only a few countries have recorded progress in achieving the UN sustainability goals since their agreement in 2015. Furthermore, the report also points out that the disproportionate number of wealthy versus poor countries that can ensure a liveable planet for children. While scoring high in providing the ability to live a healthy life, wealthy countries are falling behind in meeting emissions targets, thereby threatening the future of all children. This Master's Thesis focuses on the children's perspectives by considering how the built environment (in the form of public spaces) can be used as a pedagogical asset to teach about sustainability and resilience. The location of the case study is Sweden's second-largest city Gothenburg. The World Bank classifies Sweden as a "high income" country. According to the report, Sweden has a high rank in the child flourishing index (13 out of 180) but is only on sustainability rank 116 due to its high CO2 emissions (Clark et al., 2020). This unbalance must be addressed, starting with educating the general population on the complex environment, in order to ensure that every child can thrive, regardless of their location.

The climate crisis might not be solved by the author's generation (Generation Y*), nor by the generation before (Baby Boomers**), but perhaps by the current generation (Generation Z***). Hopefully, there will be another letter after "Z", metaphorically spoken. Nevertheless, the least we can do is to lay down the foundation for the next generation to come. That is why this Master's Thesis targets first and foremost the youngest and least biased members of society: children.

*Referring to the generation of people, born in the 1980s and 1990s ("generation y", n. d.)

**Referring to the generation of people, born 1946 to 1964 ("baby boomer", n. d.)

***Referring to the generation of people, born in the late 1990s and early 2000s ("generation z", n. d.)

Research Question

Can playgrounds be integrated into everyday urban life as a tool to educate children on climate resilience?

Purpose

This Master's Thesis is driven by the desire to find an architectural approach towards environmental education, and at the same time, to explore playful year-round outdoor activities in the Nordic context. By rethinking the concept of playgrounds and seeing play as a necessarily integrated part of everyday urban life, we have the chance to make an impact on our children, who will be the designers of tomorrow.

Shape, movement and flows influence our behaviour, consciously or unconsciously (Kopec, 2018). This investigation combines theories of environmental education and children's perspectives to inform an integrated urban landscape design proposal that combines both playful and pedagogical elements. It provides an alternative narrative to a playground's function in an urbanised society facing its strongest natural enemy, climate change.

This work also aims to inspire everyone to revive their inner child when it comes to shaping the built environment.

Relevance

Figure 2

United Nations Sustainable Development Goals (UNSDGs) 6, 11 and 13. United Nation (2020)

To the Profession and to Sustainability

Despite the economic, ecological and social constraints ever-present in their work, architects and urban planners have the power to change the environment. With this power also comes great responsibility. Throughout their careers, Jan Gehl, Jane Jacobs and many more have advocated for re-implementing the human-centred approach to the profession since the "human dimension has been an overlooked and haphazardly addressed urban planning topic" (Gehl, 2010).

As urban planning is mostly carried out by adults, it is essential to see the city through the eyes of a child and to implement the child's perspective in spatial planning: "as children's behaviour is moulded by their ongoing interaction with the urban environment, children's participation in shaping sustainable cities will be a determinant for the future of our cities and our planet" (UNICEF, 2018). The child's perspective should be at the heart of urban planning to ensure that every child has the opportunity to experience a good childhood, shaping them into an empowered adult who will design the city of the future.

In 2015, the United Nations (UN) published their 17 Sustainable Development Goals to be achieved by 2030. They relate to challenges such as poverty, inequality, climate change, environmental degradation, peace and justice. This work touches upon goal 6, 11 and 13 (see figure 2).

Given that climate change is not exclusively a technological challenge, addressing the issue requires first and foremost a change in society. It is inevitable that education and knowledge must be prioritised as key drivers for sustainable development. To educate children on climate change and raise awareness about the human impact on the planet is a crucial aspect in shifting society towards a sustainable and resilient behaviour.

Several studies have shown that the amount of time children get to play outside is decreasing while obesity rates are increasing. Limited time outside not only accounts for physical impairment but also for mental and sensory impairment, causing feelings of loneliness and depression at a young age (Moss, 2012).

This Master's Thesis addresses existing social and environmental issues by incorporating playful activities into an urban context and aims to showcase the impacts of climate change in an unique physical and visual experience.

Glossary

BEE, Built Environment Education
Interdisciplinary field that combines the fields of architecture, urban planning, arts, environmental education, educational studies and pedagogy (Dodig, 2018).

child-responsive urban planning
The concept to bring children to the foreground of urban planning to create thriving and equitable cities where children live in healthy, safe, inclusive, green and prosperous communities (UNICEF, 2018).

cloudburst
A sudden and very heavy rainfall ("cloudburst", n. d.).

discharge
A volume of fluid (e.g. water) passing a point per unit of time (Watson & Adams, 2011).

EE, Environmental Education
The process of giving students and the public the knowledge they need to protect the environment ("environmental education", n. d.).

EP, Environmental Psychology
Bridge between the fields of design and psychology that take into account biological, social, and environmental causalities (Kopec, 2018).

evaporation
The process by which substances are converted from liquid state into vapour, e.g. evaporation of water (Watson & Adams, 2011).

Feskekôrka (engl.: "fish church")
An indoor fish and shellfish market. It was built in 1874 by the city architect Victor von Gegerfelt, who was inspired by the wooden Norwegian stave churches and Gothic stone churches (www.goteborg.com).

flood, flooding
A temporary condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waters; unusual and rapid accumulation or run-off of surface waters (Watson & Adams, 2011).

flood risk
"Flood risk = hazard x value x vulnerability
The hazard characteristics, such as flood depths and extent, flood duration or flow velocity (Aerts, J. C. J. H., Botzen, W., Bowman, M. J., Ward, P. J., & Direke, P., 2011).

groundwater
Water that is located in soil and rock below-ground (Watson & Adams, 2011).

groundwater recharge
Process by which external water is added via rainwater infiltration (Watson & Adams, 2011).

impervious surface
Surface that cannot infiltrate rainwater, such as rooftop, pavement, sidewalk, driveway, and compacted earth (Watson & Adams, 2011).

infiltration
Water moving downwards from the surface of the land to subsoil (Watson & Adams, 2011).

metacognitive
The conscious planning, monitoring, and evaluating one's own learning. It often comprises the two following dimensions; knowledge and skilfulness (Education Endowment Foundation, 2018).

playscape
A play area or structure for children, such as arrangement of natural elements or equipment such as slide,s swings, climbing walls, etc. ("playscape", n. d.).

resilience
The ability of a system "to absorb disturbances and recognise to retain essentially the same function, structure, identity, and feedbacks". A resilient city is defined by its ability either to adjust or to adapt in the face of change (Pearson, L. J., Newton, P. W., & Roberts, P., 2014)

run-off
Precipitation that drains into a water body from the surface of the surrounding land (Watson & Adams, 2011).

self-regulation
The management of one's own motivation towards learning and the development of dispositions (Education Endowment Foundation, 2018).

stormwater
Rainwater that occurs during a storm ("stormwater", n. d.).

subsidence
A gradual sinking of land with respect to its previous level (Watson & Adams, 2011).

transpiration
The process of losing water to the atmosphere by evaporation from plants, facilitating flow of nutrients and water from roots to plant steams and leaves (Watson & Adams, 2011).

Västlänken (engl.: The West Link)
Is a railway tunnel project under central Gothenburg to increase capacity and reduce travel times. Gothenburg Central Station will be transformed to a underground transit station. The two new underground stations, Haga and Korsvägen, are part of the project (Trafikverket, 2018).

Water Sensitive Urban Design
Interdisciplinary field that combines water management, urban design, and landscape design while enhancing ecological, economic, social, and cultural sustainability (Hoyer et al., 2011).

100-year-event (500-year-event)
Flood that has a 1% (0,2%) probability of being equalled or exceeded in any given year (Watson & Adams, 2011).

Theory & Method

The chosen method for this Master's Thesis is research-for-design. This work combines the themes of child-responsive urban planning, environmental education and sustainable urban water treatment, and extensive theoretical was carried out to create a knowledge base to conduct the design.

The point of departure was to investigate the child-responsive urban planning to recognise the importance of the children's perspectives in the city. To understand how urban planning and architecture can be a tool to educate children about the environment, knowledge from environmental education and environmental psychology for design were accumulated. Sustainable water solutions were explored as a method to educate children about water and resilience. Furthermore, the conditions in Gothenburg were part of the research to understand the specific challenges the city is facing in terms of water treatment and flooding.

Besides literature studies, examples of finished and unfinished projects that incorporate play in the urban environment, respectively in combination with sustainable water treatment elements in public spaces were investigated. Especially projects from Denmark, Germany, the Netherlands and Sweden were suitable sources of inspiration.

Meetings and workshops with local stakeholders from the City of Gothenburg and Chalmers University of Technology were conducted as well.

The project site was chosen after an analysis of areas that are rich in children, and at the same time are susceptible to flooding.

Figure 4 (p. 18 and 19) illustrates the different research and exploration steps of this thesis and visualises interdependencies between the fields of research and challenges along the way.

Delimitation

The complexity of the topic needed the establishment of investigative boundaries, which has been developed and re-adjusted throughout the research and design processes. Instead of solving all issues in terms of technical and economic feasibility, solutions that create synergies and leave room for imagination and interpretation were prioritized.

The following diagram visualises the focus and scope of this Master's Thesis. It defines the aim and fields of research while limiting the work to that which it includes. The size of the three circles depicts the extensiveness of the research fields investigated in this work. The size of the different concentric rings resembles the priority of subtopics in relation to each other within the specific field of research.

The more rings a particular subtopic obtains, the more attention has been given. No rings mean that the topic has been investigated but has not been developed further due to time constraints.
The areas where the circle overlap each other symbolises synergies among the research fields.

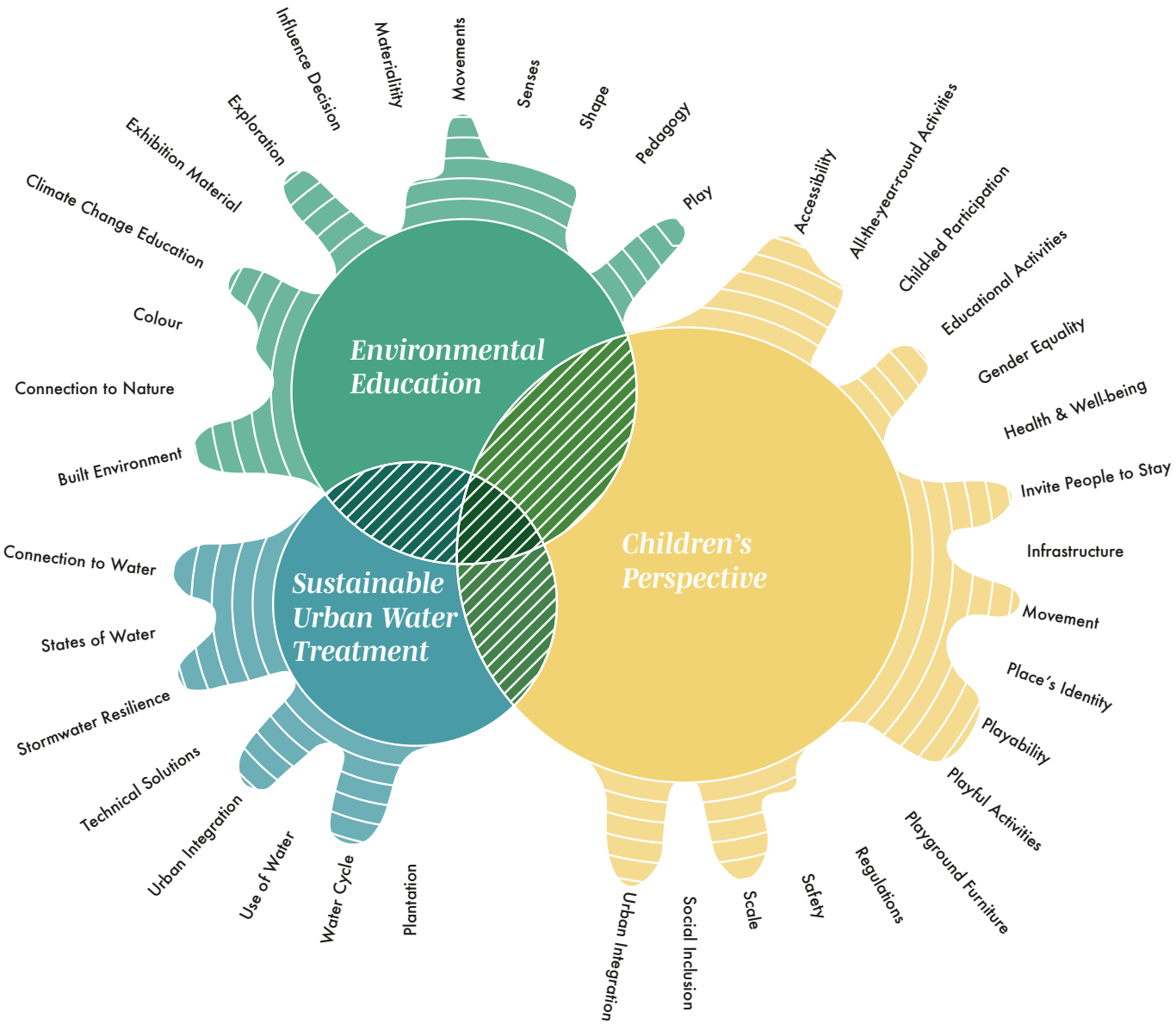
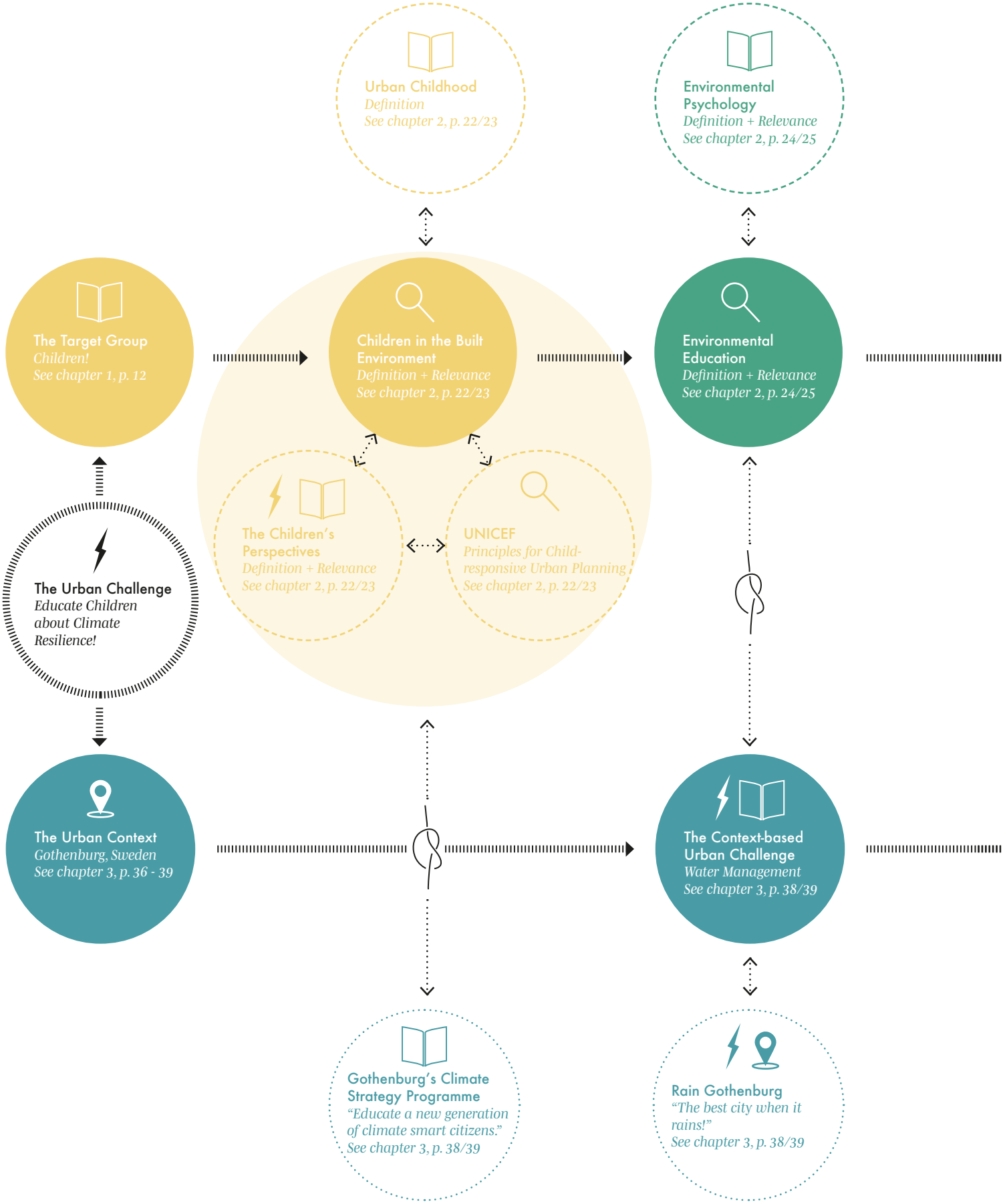


Figure 3

Delimitation Diagram


Urban Childhood
Definition
See chapter 2, p. 22/23
Environmental Psychology
Definition + Relevance
See chapter 2, p. 24/25
The Target Group
Children!
See chapter 1, p. 12
Children in the Built Environment
Definition + Relevance
See chapter 2, p. 22/23
Environmental Education
Definition + Relevance
See chapter 2, p. 24/25
The Children's Perspectives
Definition + Relevance
See chapter 2, p. 22/23
UNICEF
Principles for Child-responsive Urban Planning
See chapter 2, p. 22/23
The Urban Challenge
Educate Children about Climate Resilience!
The Urban Context
Gothenburg, Sweden
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The Context-based Urban Challenge
Water Management
See chapter 3, p. 38/39
Gothenburg's Climate Strategy Programme
"Educate a new generation of climate smart citizens."
See chapter 3, p. 38/39
Rain Gothenburg
"The best city when it rains!"
See chapter 3, p. 38/39

Symbol Key


Context-related
Deeper Investigation
Interrelated Elements
Main Track
Architectural Examples
Water Treatment
Challenge
Definition
Translated Information
Additional Research
Children Perspective
Environmental

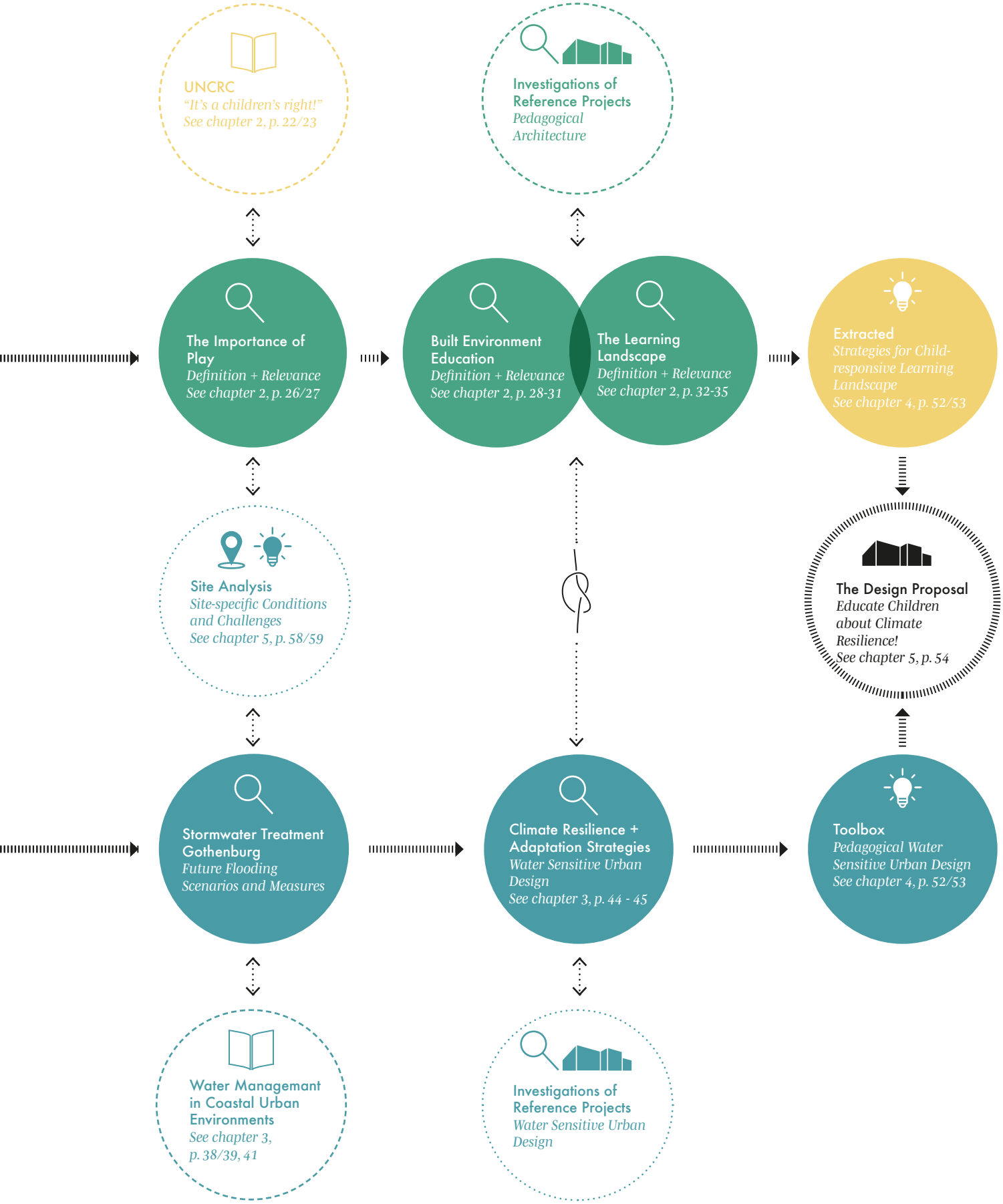


Figure 4

The Research Scheme
- A Visual Representation of the Master's Thesis Process

Chapter 2
Designing Urban Childhoods

childhood [chahyld-hood]*

noun

1. the state or period of being a child.
2. the early stage in the existence of something: *the childhood of the human race.*

urban [ur-buh n]**

adjective

1. of, relating to, or designating a city or town.
2. living in a city.
3. characteristic of or accustomed to cities; citified: He is an urban type.

*"childhood" (2020)
**"urban" (2020)

Left: Figure 5

From "Small in the City"
Sidney Smith (2019)

The Built Environment
A Child's Perspective

We are living in the urban age, and according to Alejandro Aravena, architect and Pritzker prize laureate this is great news "because cities hold the prospect of greater opportunity, education and jobs." Nevertheless, he stresses that "the problem of the scale and speed with which the urbanisation process is taking place has no precedent in human history" (Aravena, 2016 as cited in UNICEF, 2018, p. 12).

By 2030, it is expected that cities will contain 60% of the world's population (Arup, 2017). Additionally, 60% of all urban inhabitants will be between the age 0 and 17, which is the definition of being a child, according to proceedings from the United Nations Convention on the Rights of the Child (UNCRC) (United Nations, 1989).

Three Perspectives

There are three different perspectives when dealing with children in the built environment. The first one is the adult's knowledge of what children need and want in the built environment. Secondly, one must consider the child's own perspective, and last but not least, the rights of children.

The United Nations Convention on the Rights of the Child (UNCFC) is the framework for UNICEF's work. It is comprised of 54 articles "that cover all aspects of a child's life and set out the civil, political, economic, social and cultural rights that all children everywhere are entitled to." (UNICEF, 2020) Since 1 January 2020, the UNCRC articles are also incorporated into Swedish law (Government of Sweden, 2020).

Urban Planning Principles

The rapid process of urbanisation in recent decades has long overlooked the children's perspectives, providing insufficient consideration to the youngest, most vulnerable members in society. Consequently, the United Nations (UN) have developed a planning framework for sustainable urban development focusing on children's rights which comprises ten "Children's Rights and Urban Planning Principles" (UNICEF, 2018). This Master's Thesis will touch upon three out of ten principles:

Principle 3 - Public Amenities:
Provide infrastructure for health, educational and social services for children and the community, which they have access to, to thrive and to develop life skills.

Principle 4 - Public Spaces
Provide safe and inclusive public and green spaces for children and the community, where they can meet and engage in outdoor activities.

Principle 6 - Integrated Water and Sanitation Management Systems
Develop safely managed water and sanitation services and ensure an Integrated Urban Water Management system for children and the community, so they have adequate and equitable access to safe and affordable water, sanitation and hygiene.

Principle 8 - Waste Cycle Systems
Develop a zero waste system and ensure sustainable resource management, so children and the community can thrive in a safe and clean environment.

The Lack of the Child's Perspective

Ignoring the child's perspective in urban design results in a number of adverse effects on children's mental and physical development, health and well-being (Moss, 2012). Due to urban densification and greater traffic density, children move and play less independently in the city. Statistics show that the range of children's movements has reduced, consequently reducing the average amount of time spent playing outside. This trend has led to a wide range of health issues for adolescents. It is projected that by 2025, the number of overweight children under five will reach 70 million globally, compared to 41 million in 2016 (WHO, 2019). Moreover, fewer opportunities for outdoor play, insufficient physical activity and the stresses of urban life account for rising rates of mental health problems among children and adolescents (WHO, 2018). The World Health Organisation (2018) points out several environmental factors that discourage children from outdoor urban activity, such as fear of violence and crime, high-density traffic, poor air quality, and lack of public spaces for recreation and sport.

0-17

Definition of children Based on the United Nations Convention on the Rights of the Child (UNICEF, 1989).

60%

of all urban dwellers will be under the age of 18 by 2030 (United Nations, 2014)

80%

of the world's adolescent population is insufficiently physically active as a result of urbanisation (WHO, 2018).

+US$8

return to society for every US$1 invested in early play-based education, which promotes healthy child development (Carneiro, P. and Heckman, P. , 2017; Arup, 2017).

> *"The choices we make in the built environment can help to ensure children are given respect, fair treatment, a healthy life and the best chances of tackling the challenges of tomorrow. By highlighting children's needs, we will be helping to solve other urban challenges, leading to cities that are better for everyone"*

Jerome Frost
Director, Global Planning and Cities Leader,
Arup (cited in Arup, 2017, p. 7)

In addition, less independent mobility in the city reduces the opportunity for children to participate in social interaction, chance encounters, experience playful journeys and discovery (Arup, 2017). Therefore, spatial planners must design the urban fabric according to children's needs and desires to ensure equity and social coherence, as well as sustainable and resilient city life. Children must be regarded as valuable citizens, with equal rights to access the urban environment. They must be given the opportunity to experience clean and safe cities that facilitate access to nature, sufficient mobility, the freedom to see friends and a sense of belonging. According to Arup (2017), these are the key indicating factors in determining successful urban performance.

To avoid risking the perception of nostalgia, or a desire to return to an idealized past era, it must be said that children have never been entirely safe. However, until the 1950s and 1960s, they were free to play on their neighbourhood streets under the watchful eyes of neighbours and familiar people (Day, 2007). This no longer occurs today due to drastic changes in modern life. Increased vehicular traffic and the lack of self-supervising street communities have reduced the opportunities for children to safely play outside in cities. Consequently, "... we must specifically design places where they can play safely without over-restrictive control" (Day, 2007, p. 25).

Child-responsive Urban Planning

The emerging field of child-friendly and child-responsive urban planning focuses on systematically planning and designing cities that foster children's development, health, and well-being, improving the potential for independent mobility. This calls for taking a holistic approach, rather than merely providing stand-alone playgrounds, and instead focusing on promoting a multifunctional and intergenerational urban fabric that can be enjoyed equally by families and communities (Arup, 2017).

According to Arup (2017, p. 15), the child-friendly city approach is comprised of two fundamental concepts; "everyday freedoms" and "children's infrastructure". Everyday freedom "combines the ability to play and socialise with high levels of independent mobility", and thereby defines the freedom to move around in the neighbourhood or parts of the city without being accompanied by an adult. Independent mobility is affected by the availability, proximity and choice of activities in the city, while being simultaneously determined by traffic conditions, the child's age and gender, as well as the child's and adult's perceptions of safety (Arup, 2017).

A network of multifunctional, intergenerational and sustainable public spaces, streets, nature and interventions are vital elements of child-friendly infrastructure, and thus "can generate a substantial range of benefits for all urban citizens" (Arup, 2017, p. 17). Everyday routes to school, preschools, community facilities, parks and public spaces offer the potential to incorporate the concept of child-friendly infrastructure, ultimately making long-lasting impacts on their development and behaviour. The impacts of climate change account for a whole new dimension in urban planning. Rapid urbanisation and climate change require innovative solutions to create environments that are both resilient and foster positive development and sustainable urban experiences. Notably, children from low-income families are among the most adversely affected by the two-fold threat of climate change and urbanisation (Arup, 2017).

Children - the Designers of Tomorrow

Children will shape the world of tomorrow, and it is crucial for their development as future designers that we lay the foundation on which they may thrive to ensure a sustainable and resilient urban future for all generations to come. What if we can design the urban realm in such way that it provides common support and freedom for children to get around, and at the same time, facilitates sustainable behaviour, is pedagogical, inclusive and aesthetically pleasing?

Ultimately, the child-friendly city has the potential to function as a "catalyst for urban innovation" (Arup, 2017, p. 7). If cities provide children with everyday freedoms through urban resilience, children will develop into resilient and "climate-smart" citizens with a greater capacity to handle the urban challenges of tomorrow.

Environmental Education
Designing Behaviour?

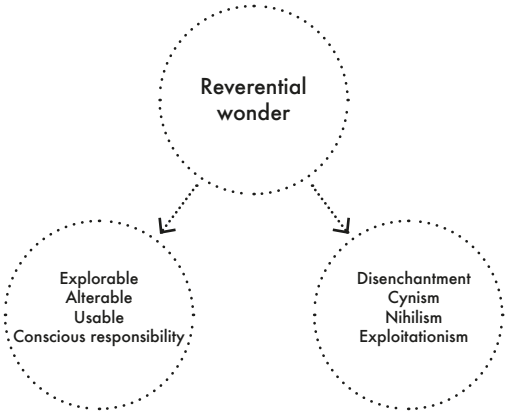


Figure 6

Which route will we encourage?
Adapted from Day (p. 209, 2007)

Humankind and the Environment

According to Kopec (2018), the relationship between humans and the environment is symbiotic. Everything that surrounds us has an impact on our behaviour, and, in turn, our actions have an impact one the environment. Throughout human history, humankind has adapted to a broad range of environmental conditions. Fear, necessity, or response to reoccurring weather events, such as extreme temperatures causing droughts and flooding, have shaped the course of humanity over thousands of years (Kopec, 2018).

The very first environmental studies were comprised of basic elements, such as examining weather patterns, interpreting animal behaviours, and identifying fertile soils to ensure continued existence. They resulted "into human responses such as stockpiling food and water, seeking shelter or high ground, and harvesting crops" (Kopec, 2018). Nevertheless, our way of life has changed drastically since then. We no longer move as nomads from one habitable place to another but have evolved into urban dwellers, who "spend most of the time indoors, make products that linger in the environment, and live in mega-cities with massive populations (Kopec, 2018).

According to some scientists, we are living in a new geological era, the so-called anthropogenic era (Schneider, 2019). The impact of the humankind on planet Earth's geology and ecosystems is so significant that the course of the planet is determined by human lifestyles and associated behaviour. It is indisputable that current lifestyles are in conflict with the finite capacity of the planet, consequently determining the extent of their environmental impact. However, despite extensive knowledge concerning limited resource availability, there is a vast discrepancy between having the knowledge and its actual application, as behaviour is slow to change (Schneider, 2019).

Environmental Psychology as Point of Departure

Transitioning to sustainable behaviour requires individuals to be aware of the economic crisis. Paradoxically, the Western world, in particular, continues to disproportionately destroy the environment compared to non-Western countries, despite the high-level of ecological awareness. Schneider (2019) concludes that one reason for the slow transition to a sustainable lifestyle is, that harmful behaviour interrelates with external factors, such as spatial and infrastructural aspects. It is here that environmental psychology comes into play.

The field of environmental psychology bridges the disciplines of design and psychology, and premises holistic thought processes that take into account biological, social, and environmental causalities (Kopec, 2018). By investigating issues linked to the human-environment experience, emotional and physical reactions to environmental attributes can be predicted to a certain extent. Thus, environmental psychologists analyse environmental cues that induce individual perceptions about a community. They apply methods of environmental modification and design to enhance or diminish a particular behaviour (Kopec, 2018).

Built Interventions as Pedagogical Interface

According to the theory of environmental psychology, a high level of environmental awareness leads to environmentally friendly behaviour (Schneider, 2019). Apart from personal measures, it requires structural measures which focus on architecture and urban planning to encourage environmental behaviour. Schneider (2019) argues that "interventions in the built environment can impact the social structure, and vice versa, changes to social structures can impact the built environment". Interventions in the urban fabric that incorporate the child's perspective and function as a pedagogical platform to increase environmental

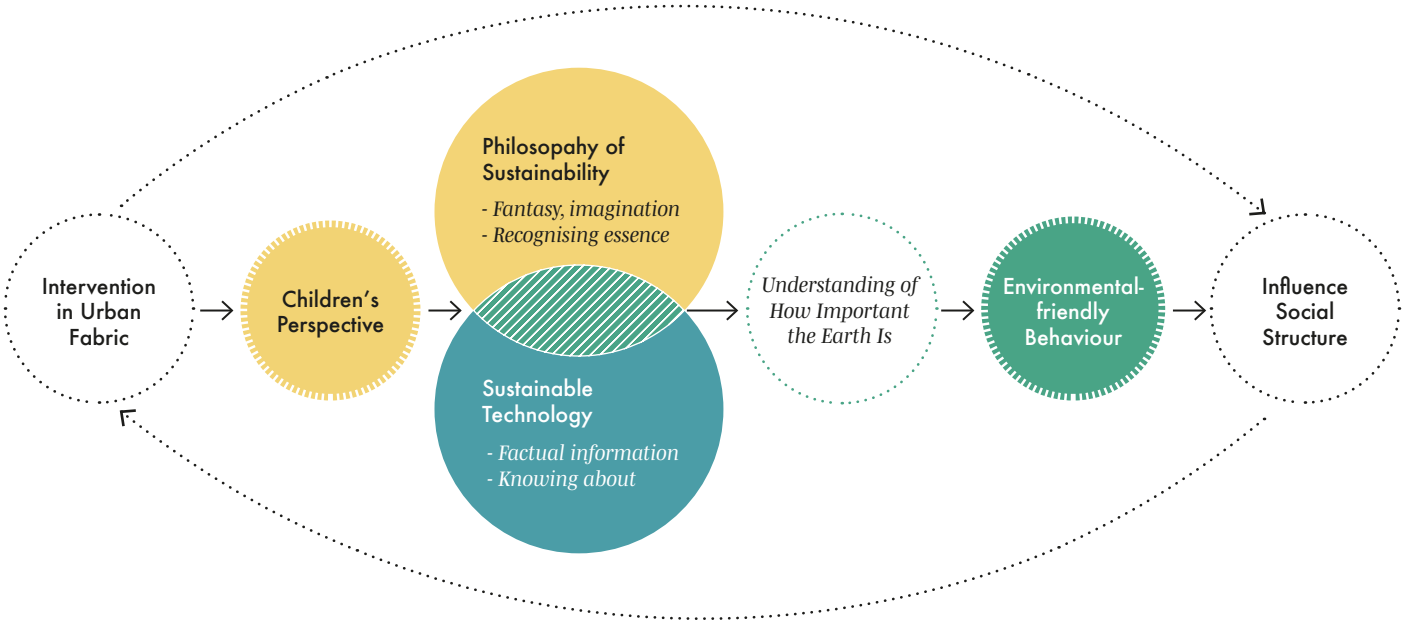


Figure 7

How to influence the social structure through spatial Interventions.

awareness can be a strategy with long-term impacts on a child's personal development. Schneider (2019) states that these spatial interventions will be more successful the more specifically and personally they are designed. In this sense, children who are eager to explore and learn about their environment become the recipients "who are willing to receive and process the message" (Schneider, 2019).

Technology and Philosphy in Public Spaces

Kopec (2018) states that the human brain comprises three basic features; the ability to think (intelligence), the ability to feel (emotions/desire), and the potential for creative thought (environment). The neglection of the latter has a negative effect on the other two. The emphasis, therefore, is to plan environments that facilitate children to grow mentally, physically, emotionally and creatively (Kopec, 2018). This connects to Taylor's (2009, p. 31) argument:

> ***"Architects have a reciprocal responsibility to teach the public that the design of physical spaces matters, and that they can be read and translated by our minds into ideas for better understanding of our relationship with the environment"***

Taylor (2009, p. 31)

Thus, sustainable technologies, coupled with a philosophy of sustainability, allow children to understand how important the Earth is to us. This can translate into a new architecture and a new visual language (Taylor, 2009). Wines (cited in Taylor, 2009, p. 364) concludes that the greatest challenge for the humankind "is not so much trying to understand nature, but re-learning how to intuitively, organically, and cosmologically live on its terms."

There is a need to incorporate a philosophical approach in implementing sustainable technologies in public spaces, respectively, learning environments for children. It matters how we approach design since it has always been reflecting cultural and societal ideals and values. Thus, shifting to a sustainable lifestyle requires also a shift in how we approach designing for children, as Van der Ryn (as cited in Taylor, 2009, p. 50) states "In many ways, the environmental crisis is a design crisis. It is a consequence of how things are made, buildings are constructed, and landscapes are used. Design manifests culture, and culture rests firmly on the foundation of what we believe to be true about the world."

The Importance of Play
Or How Children Learn

> ***"There are opportunities for play everywhere. Curiosity is playful; ideas can be playful; asking questions can be playful."***
>
> Toy designer Cas Holman in the documentary "Abstract" (Netflix, 2019)

If we want to educate and sensitise children about sustainability and its entire complexity, it is essential to understand how children learn. Only by understanding the concept and organisation of child education, we can develop appropriate learning environments that foster and spread sustainable behaviour.

The Definition of Play

Children learn through play. This is universally accepted among experts around the entire world (Whitebread, Coltman, Jameson & Lander, 2009). However, due to its spontaneity and unpredictability, play is a phenomenon that is difficult for researchers to define. Although opinions in the academic world vary regarding the impacts of play on the learning outcome, there is a consensus of the value of play for children's learning within the early years' educational community (Whitebread, 2009). Additionally, the United Nations have recognised "Play" as a fundamental human right (United Nations, 1989).

Play Fosters the Development of Problem-solving and Creativity Skills

Several studies have shown the involvement of play fosters the development of self-regulation and meta-cognitive processes including representational abilities, which are particularly significant in intentional learning involved in the development of problem-solving and creativity skills (Whitebread et al., 2009)

Meta-cognition is conscious planning, monitoring, and evaluating one's own learning. It often comprises the two following dimensions: knowledge and skilfulness. Self-regulation includes the management of one's own motivation towards learning as well as the development of dispositions such as resilience and perseverance (Education Endowment Foundation, 2018).

The consequences of children developing such early meta-cognitive or self-regulatory abilities are profound and can be recognised in tasks and aspects of development which include creativity and problem-solving.

Requirements of Play

Results of the "Cambridgeshire Independent Learning in the Foundation Stage" (C.Ind.Le) project (Whitebread et al., 2005; Whitebread et al., 2007; Whitebread, 2007) show evidence of meta-cognitive or self-regulatory behaviours during learning activities initiated by children. These children were involved in pair or small group exercises which required extensive collaborative problem-solving and communication. Following four principles are derived from the study conducted by Whitebread and colleagues' "C.Ind.Le" project:

- Emotional warmth and security,
- Children's initiation and feelings of control,
- Cognitive challenge through problem-solving and creativity, and
- Talk about learning (including private speech and collaborative talk)

Children Control Their own Learning Through Play

Vygotsky (1978 as cited in Whitebread et al., 2009) argues that children create their own "zone of proximal development", children set their level of challenge always appropriate to their level of development. Interestingly, tasks for children set by adults will never meet the appropriate aspiration level. Thus, children are in control of their own learning since play is always spontaneous and initiated by themselves. (Whitebread et al., 2009).

The Importance of Symbolic Representation

Furthermore, according to Vygotsky (1978 as cited in Whitebread et al., 2009), play is an essential

contribution to the development of symbolic representation. It includes "drawing and other forms of visual art, visual imagination, and language in all its various forms, mathematical symbol systems, musical notation, dance and drama." Here, play is recognised as the first tool to explore the use of symbol systems (Whitebread et al., 2009).

According to Kopec (2018), symbolism "is the integration of multiple and sometimes competing for systems of meaning into a single organised message", and the most common sources is the recognition of shape, colour and size. Symbolism also refers to sensations, which are "the translation of ascribed meaning or representation (Kopec, 2018)". That can also be translated to the built environment. Architecture and urban planning that uses symbols to represent a specific message can evoke sensations, and thereby, enhance understanding to the recipient.

Towards Responsible Behaviour

Throughout their childhood, children transition from exploring the environment into trying to manipulate it physically, socially and emotionally. While cause-effect rationality develops, they start to use the world around them as a resource, not yet as a responsibility (Day, 2007). Hence, it is crucial to understand how youth development works in order to let child development thrive sustainably.
From an architectural and urban planning perspective, the aim should be to create spatial interventions that are not only child-friendly but also convey a message of nature's interrelations as a closed cycle. Correspondingly, the more diverse activities and experiences are provided, the higher the opportunities for exploration and creativity, and to expand the play- and social scenarios (Day, 2007). To conclude, Winnicott (1995 as cited in Day, 2007, p. 16)states that "to play is to use imagination, the most important thing a person can do … Play is always an experience of creating, also of uniting time and space - so is fundamental to how we live."

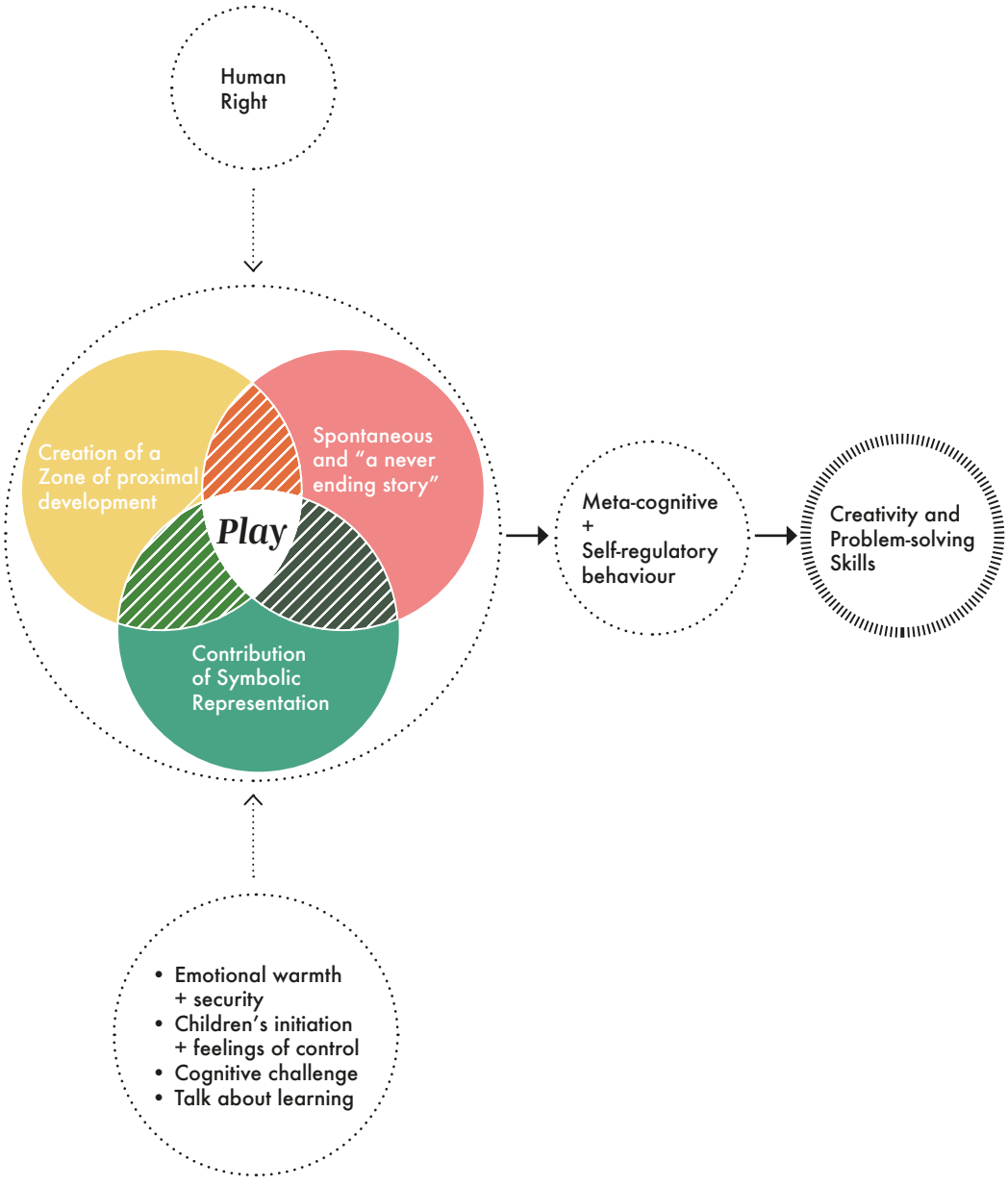


Figure 8

How does play work?

Learning Environments
Built Environment Education

Generally, learning environments are primarily designed by adults, including environments that are designated for children. Although they are the target group, children rarely participate in the design process, raising the question of whether environments planned by adult architects and/or designers appropriately fulfil the needs and desires of children. According to Vergeront (2002 as cited in Kalessopoulou, 2017), one of the most essential factors in designing for children is to regard the child as a "competent actor and enabling its purposeful engagement with the environment."

The Children Museum as Complementing Environmental Education

Firstly, clarification is required regarding the potential appearance and design of the ideal built environment for learning located within an urban context. According to Howard Gardner (as cited in Haas, 1996), an appropriate design model for the learning environment of the future is the children's museum. Museums are public buildings that, if designed appropriately, have an interactive relationship with their urban context. Furthermore, they provide powerful learning places for children, given that they successfully combine education and the opportunity to "explore, observe, and sense a fairly limited set of contextually relevant, highly structured and concrete experiences; all within a socially and physically novel, but safe environment" (Falk, 2002 as cited in Dodig, 2018). Additionally, museums play a valuable role, as they exhibit authentic objects and artefacts which nurture the learning experience (King, 1998 as cited in Dodig, 2018).

Children's museums can become an important cornerstone of their environmental education if partnerships with other educational institutions, schools and architects exist, thereby contributing to versatile education opportunities. Avery (1989) concludes that such a network opens up possibilities to "(...) better preparing them to participate in environmental decision making" (Dodig, 2018). In addition to complementing formal education, museums can be a source of inspiration in regard to building a child's identity, encouraging citizenship, combatting racism and fostering social inclusion, community cohesion and neighbourhood renewal, as empirical evidence in multiple studies have shown (DCMS, 2004). In the study "Project Explore" Haas (1996) concludes that the most effective way for children to learn is to incorporate "something novel, cognitively complex, and generalisable outside the museum walls."

The Concept of Built Environmental Education

In many cases, children's museums put the concept of Built Environment Education (BEE) into practice and have thereby become key sites for BEE. BEE is an interdisciplinary field that combines the fields of architecture, urban planning and design, arts, environmental education, educational studies and pedagogy (Dodig, 2018). The built environment is utilised "as a subject, a context for learning and a curricular resource" (Million and Heinrich, 2014; Dodig, 2018). It has been shown that BEE facilitates the development of analytical and conceptual thinking (Million and Heinrich, 2014 as cited in Parnell, 2011).

In order to design a successful and nurturing learning environment, the interrelationships of psycho-pedagogical aspects and space need to be further investigated. In interviewing exhibitors at children's museums, Marta Dodig (2018) discovered that pre-exhibition introductions and at-the-end workshops, combined with skilled guidance and discussions, provide a crucial framework for understanding topics relating to the built environment. This is correlated with the differentiated learning styles that vary amongst children. The interview data in her study, indicate that BEE exhibitions enable children to learn according to their own pace and field of interest (Dodig, 2018). To meet the needs of all children, Howard Gardner (1991 as cited in Haas, 1996) suggests five "entry points":

1. Foundational or philosophical approach applicable for people who like to pose questions;
2. Narrational view appropriate for persons who learn through a story;
3. Logical-quantitative helpful for those who approach a concept by invoking numerical considerations or deductive reasoning processes;
4. Experiential appropriate for individuals who learn best with a hands-on approach
5. Aesthetic for those who favour an artistic stance with an emphasis on sensory or surface features

Exhibitions that focus on child education incorporate "a broad range of exhibition display and auxiliary

> *"The ideal educational environment is a carefully designed physical location composed of natural, built, and cultural parts that work together to accommodate active learning across body, mind, and spirit."*

Taylor (2009, p. 31)

spaces". These are associated with "diverse psycho-pedagogical qualities to be discovered with movement and senses, feelings and the intellect" (Kalessopoulou, 2017):

1. Energetic spaces; allow manipulation, full body exploration and different body postures, social interaction and cooperation, cognitive challenges, experimentation or freedom to be noisy.
2. Immersive, narrative environments that call for emotional involvement, empathy and a reflective encounter with, e.g. diverse human stories or life in natural environments.
3. 'Treasure coves' that is places full of authentic objects that can be discovered, manipulated, worn or examined in detail. They are usually enclosed spaces that encourage mild movements, conversation, parallel or cooperative play.
4. 'Soft' spaces, suitable for the safe play of children under three and for restorative experiences.
5. 'Child's eye view' spaces that stage children's drawings, photos and opinions on various aspects of their life or offer the space to exhibit their personal collections and memorabilia.
6. Transitional spaces that connect different exhibit areas, providing adequate orientation clues and allowing for glimpses to neighbouring places that enhance the feeling of comfort and control over the forthcoming experience.
7. Orderly spaces where children can participate in workshops and other mediated educational activities, or can enter into open stores and handle reserve colle

In a visual research study (Kalessopoulou, 2017), children, ranging between the ages of 4-12, were equipped with a camera and asked to capture elements of special interest to them during their visits. The photographs were analysed whilst taking into account the content, the angle and framing of the photographs, as well as the children's own selection criteria. From this study, Despina Kalessopoulou (2017) derived seven descriptive categories of important exhibition qualities, as seen from the children's perspective:

1. A wealth of interesting and authentic objects: They are meant to be examined closely by Children. Aesthetic qualities, especially visual and tactile ones are crucial. Elements that are full of surprise whilst being put into context are highly appreciated.
2. Empowering personal identity and personal narrations: Children constantly refer to familiar experiences and aim to enriching their knowledge of interest. The capability to recognise and pursue personal interests applies for all age groups.
3. Embodied experiences: Incorporating the use of their body and performing a wide range of postures is the most important quality for children.
4. Inquiry-based learning: A diversity of exhibition environments fosters children's epistemic behaviour, and enables active exploration and activities that invite them to guess, recognise, match, experiment and engage in problem solving. (REWORD?)
5. Scaffolding interpretation skills: Thematic environments support best the understanding and interpretation of the exhibited material. Children draw connections better when set into context. Atmosphere and environments that speak their fantasy provide to a more personalised experience and interpretation.
6. Play: Exhibition material that invite children to play in order to have a pleasant experience at the museum is key.
7. Social interaction: Interactions with family and friends are crucial for children and enables for a more satisfying experience during their stay. Children are very imaginative when it comes to understanding the relationship of meaning and the power of images. They learn better by scanning their environment and assessing visually according to their personal interests and abilities.

The Parent's Role

Parents play a crucial role in regard to built environment education. Haas (1996) explains that children's intellectual growth is best facilitated and learning affirmed when parents are engaged in interactive and participatory play. Additionally, exhibitions should be playful and enjoyable for children and parents alike. They should contain comfortable and familiar content to increase adult engagement in the learning process (Haas, 1996).

5 Entry Points to meeting the needs of all children's gifts (Haas, 1996):

Foundational/ philosophical

Narrational

Logical-quantitative

Experimental

Aesthetical

Display and auxiliary spaces to be discovered with movement and senses, feelings and the intellect (Kalessopoulou, 2017):

1. Energetic spaces; allow manipulation, full body exploration
2. Immersive, narrative environments
3. "Treasure coves" that is places full of authentic objects
4. "Soft" spaces
5. "Child's eye view" spaces
6. Transitional spaces that connect different exhibit areas
7. Orderly spaces where children can participate in workshops

Pre-exhibition Introduction

Exhibitions

exploring
discussion
doing/making
experimenting
testing
reflecting

At-the-end Workshop

New knowledge is applicable outdoors!

7 Important exhibition qualities seen from the children's point of view (Kalessopoulou, 2017):

1. A wealth of interesting objects
2. Empowering personal identity and narratives
3. Embodied experiences
4. Inquiry-based learning
5. Scaffolding interpretation skills
6. Play
7. Social interaction

The parent's role:

- engage in supportive behaviour
- fascilitate children's personal growth

Partnerships partnerships with other educational institutions, schools and architects between

- Contributing to versatile education opportunities

Various modes of expression, e.g.:

model making
story-telling
dancing
painting
drawing

To overcome:
Emotional, language, cultural, and learning barriers

Figure 9

Prequesites of BBE - Facilities

Space, Shape and Colour
An Exploration of the Senses

Figure 10

Shapes of Nature vs. "Human Thought"
*Retrieved from Day (2007, p. 123)

Day (2007) argues that, for children, that which a place intends to express is crucial in how they perceive and experience it. Collecting information about the environment usually depends on a combination of several senses, such as scent, touch, warmth, sight, balance and movement. Touch is the most critical sense. Multi-sensory exploration facilitates multi-modal relationships with things and allow for a deeper understanding. Small children especially have to be considered as an entire sense organ as their way of thinking is bound to the sense-perceptible world (Steiner as cited in Day, 2007).

Visual Experiences

According to study findings (Kalessopoulou, 2017), harnessing the power of images allowed children to develop their comprehension skills and create their own images to convey meaning in a resourceful manner. They quickly applied their new skills by scanning and visually assessing the surrounding environment and adapted their point of view according to their abilities and personal interests. Kalessopoulou (2017) found that "visual literacy skills proved to be empowering," in particular, as these skills allowed the child to more easily communicate views that they found difficult to articulate, as well as to develop new modes of interpreting the exhibition material.

Tactile Experiences

Aside from the visual experience, the incorporation of tactile features is key. For children, touch is the most critical sense. According to Day (2007) "touching is so essential to learning about the world that "can I see?" usually means "can I touch?" (p. 85). In her study, Dodig (2018) found that BEE exhibitions which incorporate tactile experiences support the development of children's senses and ensure a richer sensory experience. Thus, they potentially lead to increased environmental awareness and sensibility.

Zoning

Large spaces require gentle stimulation and mood balance. A variety of flooring, material, textures, acoustics, clout and lighting can contribute to a diverse environment. Differing floor or ceiling levels, open post frameworks, space-dividers and overhead beams can define spaces, as well. The definition of protected regions encourages imaginative play to flourish and become floor-level territories, while niches, corners and semi-defined spaces offer the potential for occupational play-nests (Day, 2007). In this regard, floors and walls should invite touch, while textures and varied paving should enrich tactile experiences and influence moods (Day, 2007).

Shapes of Nature vs. "Human Thought"

The quality of space for children is determined by an optimum balance according to age, activity, culture and circumstances. Space can also support different childhood development stages. Compositions of space can convey different meanings and suggest a specific atmosphere and corresponding function. Curves, for instance, represent nature as they reflect the movements and shapes of living things. On the other hand, rectangular shapes are the manifestation of human thought and logic, symbolically emboding human intervention. "Thought-up" movements such as up, down, right and left speak to a straight design vocabulary, thereby relating to thought and consequential logic. Day (2007) points out that there must be a balance, as moving towards one of the two extremes is not beneficial (Day, 2007).

Colour

Children are natural artists. While small children (up to six years of age) instinctively paint with bright colours and prefer warm colours such as red yellow and orange, older children prefer blue. Colour is related to emotional expression and affects how children feel. Generally, warm colours promote activity while cold colours suggest quiet and focus (Day, 2007).

The Learning Landscape
A New Perspective on Urban Playgrounds

There is a need for new perspectives on playground design, particularly in the urban fabric. While nature acts as a playground (or a playable landscape / playscape) in rural areas, the urban setting is lacking in sufficient landscapes for children to play and to thrive. Nowadays, playgrounds are increasingly important due to increasing child obesity rates and sedentary lifestyles (Taylor 2009). According to Louv (2011 as cited in Kopec 2018), declining rates of children playing outside is one of the most significant shifts in child development in recent decades.

The rapidly increasing process of urbanisation and an increase of over-generalised fear for child safety and security, coupled with the trend of digitalisation in every aspect of modern life, account for many children remaining indoors instead of exploring the world outside. A study conducted in the UK in 2012 revealed that almost 50% of the parents surveyed prevented their children from playing outside (Paton, 2012 as cited in Kopec, 2018), leading to many children and adolescents growing up "with very little interaction with natural environments" (Kopec, 2018).

The Typical Urban Playgrounds

Playgrounds are typically designed by adults based on their "ideas and notions of what should be fun" (Kopec, 2018). Here, gaps in the knowledge and experience of adults come to light, revealing the lack of the child's perspective. In many cases, playgrounds are paved, with a focus on organised play and sports, which counteracts the original concept of play. Additionally, playgrounds often consist of equipment that is "prescribed and leads to predictable outcomes", and therefore lacks the potential to support children's creativity and critical thinking skills (Kopec, 2018). These types of playground also promote social hierarchies since they feature physical activities instead of intellectual and creative skills (Malone and Tranter, 2003 as cited in Kopec, 2018).

Children as Consultants

Playground designs must internalise the concept of unstructured play, which has neither rules nor expected outcomes but is based on real-time actions and keeps the play going with creativity and imagination (Kopec, 2018). In this regard, children should be consulted, as they are the "clients" and "real experts" of play. Incorporating children in the design process is not a recommendation, rather a requirement, when planning for child-friendly and child-responsive urban design. To play is child's work, meaning that each feature in the playscape should contribute to the child's development and growth across body, mind, and spirit (Taylor 2009).

The Importance of Natural Environments

Hills, canyons, forests, lakes, meadows, lakes and fields were the natural habitat in which children used to play. According to Loud (2006 as cited in Kopec, 2018) these natural settings "facilitate experimental and experiential learning that teaches valuable problem-solving skills." They provide a greater complexity and thereby better support the development of motor and navigation skills (Fjørtoft, 2004 as cited in Kopec, 2018). Kopec (2018) argues that a rich provision of nature-inspired topography and vegetation growth is one key factor for well-designed outdoor spaces. Natural elements expose children to visual, auditory, tactile, and olfactory stimuli that support the development of creativity, intellect, and social skills (Kopec, 2018). Furthermore, many studies have shown that a well-established connection to nature can lead to improvements for children in regard to concentration issues, such as ADHD (attention deficit hyperactivity disorder), or cognitive fatigue (Hudson and White, 2020).

Hudson and White point out that the outdoor environment is "an accessible and inexpensive space". However, to provide freedom of choice, it is crucial to break down the boundaries between interior learning environments and outdoor areas. If learning environments are connected to the outdoors, learners can be more creative, allowing them to construct, build and adapt the space to their needs (Hudson and White, 2020). The external landscape also offers opportunities for defined group spaces, imaginative walks, physical challenges, natural habitats, and amphitheatres for class gatherings or performances (Hudson and White, 2020). In this regard, Taylor (2009) summarises that child play, ambient features, biotic and spatial elements, outdoor classrooms, and therapeutic/ access areas are the best features for childhood playscapes.

> *“Design must tread a narrow path between nourishment and manipulation, between the reverent magical and the dramatically theatrical, fantastical; between the reassuringly secure and the creativity-stimulating challenging; between places that nurture and these that help them grow”*

Christopher Day (2007, p. 18)

Movement and Hands-on Activities Support the Learning Process

Movement is an essential part of the learning process, particularly for pre-school students. While wide-open spaces provide opportunities for activities such as running, romping, and skipping, spaces for hiding and exploring are equally beneficial (Hudson and White, 2020). Studies of children’s behaviour have shown that children play more creatively and considerably prefer spending time in highly vegetated areas compared to open and barren areas (Louv, 2006 as cited in Kopec, 2018). Moreover, hands-on activities increase children’s interest, understanding, and commitment to learning as they facilitate a sense of achievement. In this sense, they “become absorbed planting seeds, seeing flowers grow, producing vegetables, pulling worms from the earth, watching butterflies swarm around flowers and measuring water from rain barrels” (Hudson and White, 2020, p.). Thereby, children become familiar with ecosystems, pollination and weather cycles (Hudson and White, 2020). Day (2007) concludes that if this referential attitude is nurtured on an everyday basis, it can eventually mature into an environmentally friendly disposition.

According to Taylor (2009), learning landscapes should provide the following features:

- Natural elements
- Multi-sensory elements
- Agricultural elements
- Built elements
- Cultural elements
- Transitional elements

Hudson and White (2020) advocate for the following considerations when it comes to playscapes for children:

- Operation of doors, thresholds, lines of security
- Integration of soft landscape: biodiversity, well-being
- Covered spaces
- Use of external resources from the environment of the local climate
- Surface material and zoning
- External furniture to suggest patterns of use
- Direct connections to covered external learning spaces
- Developing learning partnerships

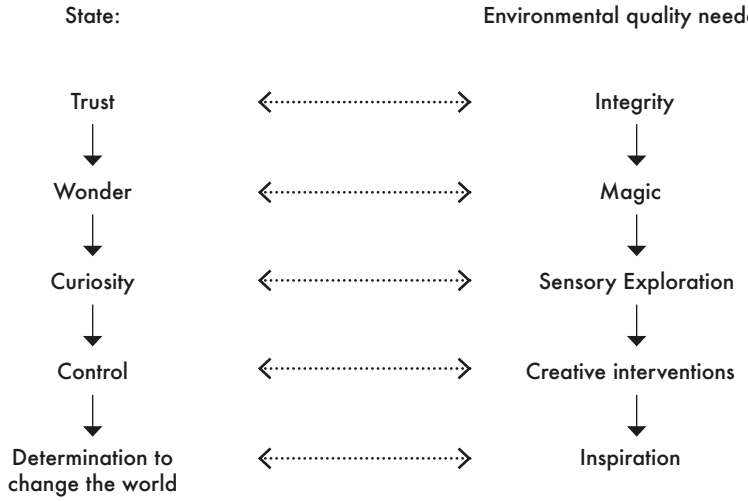
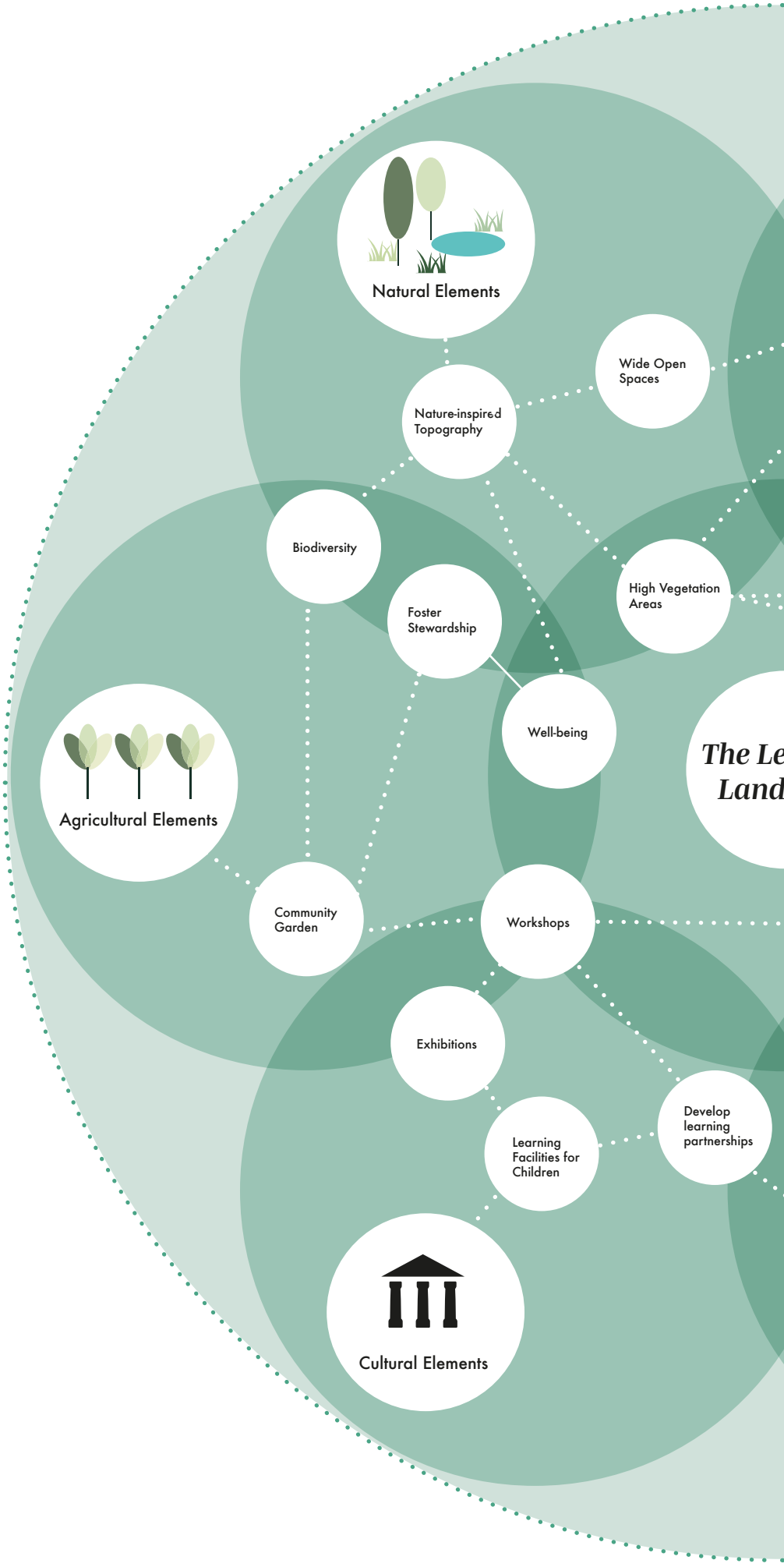


Figure 8

Evolving environmental needs
Adapted from Day (2007, p.19)


Natural Elements
Wide Open Spaces
Nature-inspired Topography
Biodiversity
High Vegetation Areas
Foster Stewardship
Well-being
The Le
Land
Agricultural Elements
Community Garden
Workshops
Exhibitions
Develop learning partnerships
Learning Facilities for Children
Cultural Elements

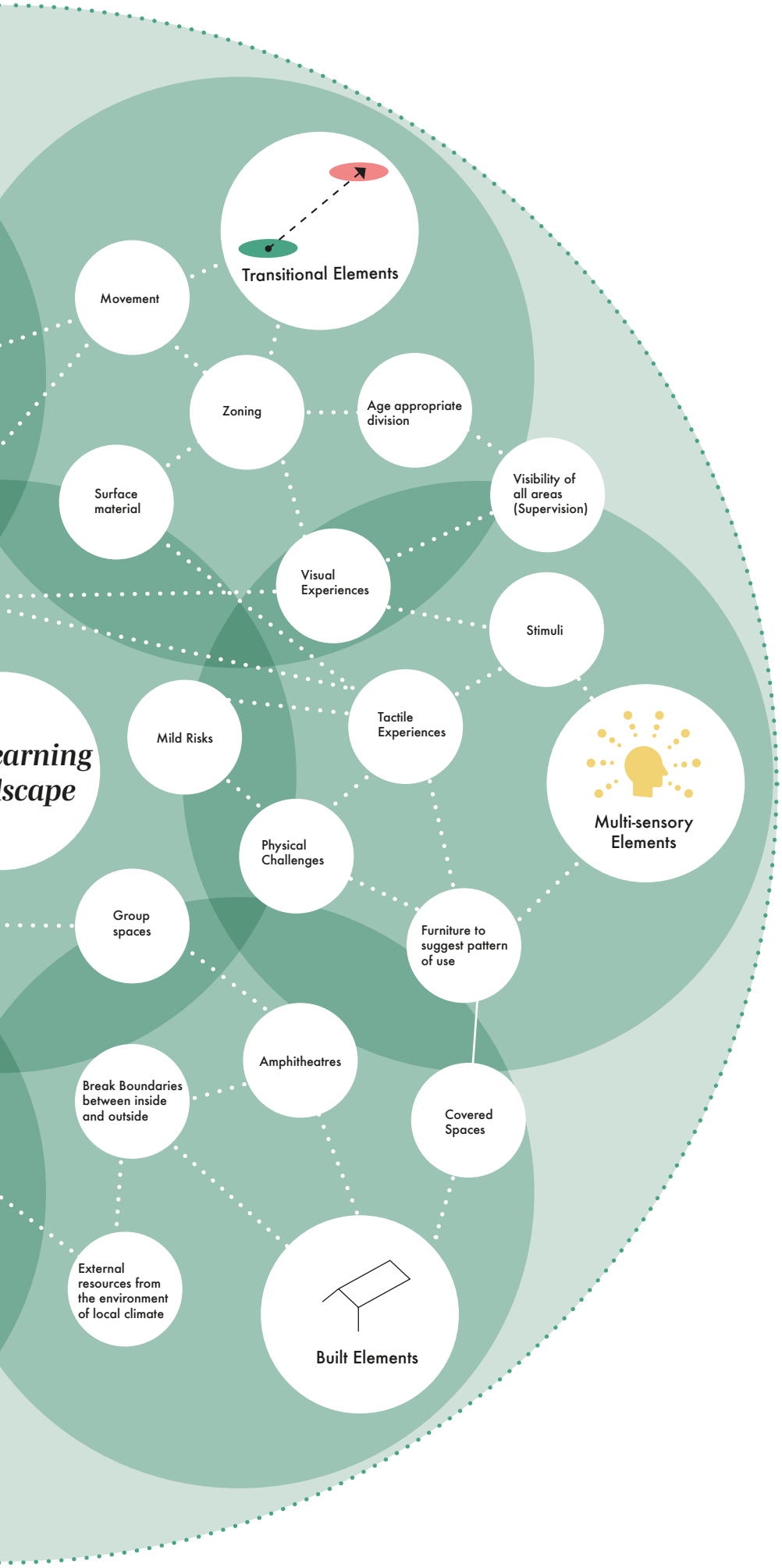
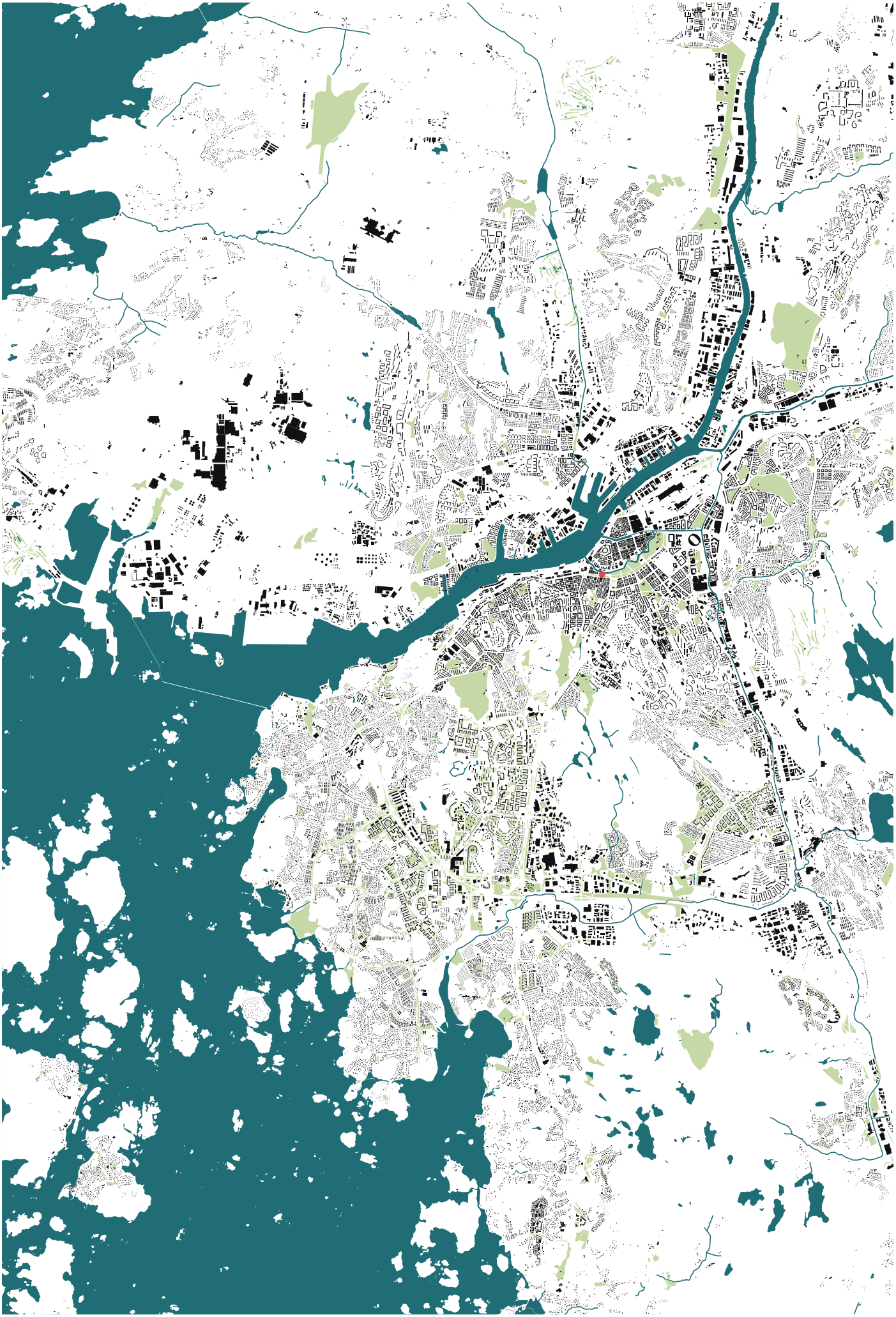


Figure 11

The Learning Landscape
Synergies between Functions and Activities

Categories and sub-categpries
retrieved from Taylor (2009)
and Hudson and White (2020)



Chapter 3
Water
-
Gothenburg's Urban Challenge

water [waw-ter, wot-er]*

noun

a transparent, odorless, tasteless liquid, a compound of hydrogen and oxygen, H_2O, freezing at 32°F or 0°C and boiling at 212°F or 100°C, that in a more or less impure state constitutes rain, oceans, lakes, rivers, etc.: it contains 11.188 % hydrogen and 88.812 % oxygen, by weight.

*"water" (2020)

Figure 11

Figure ground plan of Gothenburg
Scale 1:100.000

● = Project location

Gothenburg
A Rainy City

> ***Gothenburg will be the best city in the world when it rains!"***
>
> www.goteborg2021.com

This is one of the goals formulated by the City of Gothenburg as it approaches its 400-year anniversary in 2021. Founded in the beginning of the 17th century, water has always played a predominant role in the city. On average, is rains every third day in Gothenburg, which is why the city has initiated its anniversary project "Rain Gothenburg" to bring its inhabitants closer to water, turning rain into a resource for public enjoyment. This is a creative approach to implement resilient and attractive solutions for water treatment to be used to change the negative perception of rain, using rain as an asset for environmental and social sustainability (göteborg2021.se). Projects like "Regnlekplats" (engl. rain playground) in Renströmparken and "Näsan i Blöt" (engl. the nose in wetness) in Jubileumsparken, are two existing examples of playgrounds that incorporate rain and water as playful elements. Additionally, the International Water Association (IWA) and the City of Gothenburg are collaborating on an effort to turn Gothenburg into a "water-wise city" by focusing on water sensitive design solutions (WSDS).

According to the Global Destination Sustainability Index, Gothenburg, Sweden's second largest city, is one of the frontrunners for planning for sustainable and resilient cities (www.gds-index.com). In September 2014, the city published its ambitious Climate Strategy Programme, in which it formulated goals and strategies for the future development of Gothenburg. Strategy three

> ***Educate a new generation of climate smart citizens,"***

in particular, is associated with this Master's Thesis' research question *Can playgrounds be integrated into everyday urban life as a tool to educate children about climate resilience?* (City of Gothenburg, 2014, p. 34).

Port Cities and Climate Change

The City of Gothenburg is "Scandinavia's largest urban development project, "Älvstaden" (engl. = River City). According to the city's vision, Central Gothenburg will double in size, while "connecting the city, embracing the water and reinforcing the centre (...) to creating an inclusive, green and dynamic inner city open to the world " (The City of Gothenburg, 2012). With this in mind, it is important to consider that urban growth in coastal cities can have enormous consequences on land use in addition to the effects of climate change. Residents and businesses continue to settle in susceptible locations, increasing their vulnerability to flooding in urban estuarial areas (Aerts, J. C. J. H., Botzen, W., Bowman, M. J., Ward, P. J., & Direke, P., 2011). On the other hand, cities have been adapting to environmental and societal changes for centuries. Due to their importance in regard to future global economy and social systems, port cities offer the possibility to "play a key role in developing climate mitigation and adaptation techniques" (Hanson, S. & Nicholls, R., 2011).

Observations show that increases in extreme water levels correlate with increases in global sea water level (Hanson et al., 2011). Consequently, flood levels will rise and become more frequent, indicating the increased relevance of events such as flooding and erosion, even though storm intensity and behaviour will not change drastically (Hanson, et al., 2011). Eventually, extreme water level events will be composed of tidal conditions, storm severity and regional mean sea level, storm surge, astronomical tides, and climate-induced mean sea-level change (Hanson, et al., 2011).

The Flood Risk in Gothenburg

The City of Gothenburg is currently bracing itself for the IPCC's projected flood scenario RCP 8,5, meaning a potential sea level rise of 1 meter by the year 2100 (Göteborgs Stad, 2019). This scenario also forms the basis for this Master's Thesis. Like many other coastal urban areas in the world, Gothenburg will face a great amount of flooding due to climate change. Flooding caused by rising sea levels and increasingly intense precipitation will affect the city, especially in its central areas (Sörensen, 2014). The city was built in a low-lying swamp area near the Göta River estuary, a strategical site, although it exposes the city to subsidence - another major issue (IWA, 2019). According to an assessment of Sweden by the "Myndigheten för samhällsskydd och beredskap" MSB (Swedish Civil Contingencies Agency, 2011 as cited in Sörensen, 2014), Gothenburg is one of seven cities that is most threatened by flooding.

> *Climate consideration and a sustainable lifestyle will become clearly defined elements in the day-to-day lives of the next generation of Gothenburg inhabitants. It is vital that children and young people acquire knowledge at an early stage about human impact on climate and how they can live in a good, climate-smart way."*

The City of Gothenburg
Extracted from:
Climate Programme for Gothenburg
(2014, p. 34)

The Vulnerable City Centre

One of the city's disadvantages is that, although the city has a high ratio of green spaces, most of them are located where they are needed the least in terms of flood resilience (Sörensen, 2014). The chosen project site (see chapter 4, p. 56-59) situated in proximity to Gothenburg's central green structure "Kungsparken" (engl.: The King's Park) offers potential to compensate the lack of needed flood resilient green area. The site is merely an impervious surface in the form of a parking lot, and the application of a flood adaptive learning landscape could contribute to the city centre's flood resilience. Thus, the concept could be part of the strategy of the city's ambition to becoming a water-wise city that educates their citizens about climate resilience.

As previously mentioned, flooding from extreme precipitation is becoming increasingly relevant to Gothenburg's stormwater management system, particularly in the central city where the sewage system is combined. In case of increased rainfall, this system will not have the capacity to handle the water volume (Filipova, V., Singh, P., & Rana, A., 2012). Especially densely populated areas have limited capacities for rainwater infiltration and delay of stormwater. As a consequence, rainwater will accumulate and cause very high water levels. According to Filipova et al. (2012), in comparison to short but intensive rainfall, the accumulation of rainwater increases the flood velocity because of a higher total volume of water.

Areas in which the flood velocity is very low need special attention, as well. If the drainage system collapses, it will prolong the inundation time. The study states that stormwater must be managed in situ, which implies that appropriate planning needs to be done in advance. Filipova et al. (2012) advise that measures be taken to delay and treat run-off from impervious surfaces, in order to prevent a combined sewer system overflow.

In her study, Sörensen (2014) argues that the combined effects of high water levels and extreme precipitation "give more or less the same amount of flooded land". While inland is affected more severely from heavy rainfall, floods from extreme sea level account for larger effects in the areas by the canals and the harbour. The author (Sörensen, 2014) concludes that extreme precipitation causes spread inundation, while severe inundation is induced by extreme water levels.

Challenges and Opportunities

In terms of water management, the greatest challenge for urban planning is to develop urban environments that minimise impervious surfaces and "resemble the natural water cycles of evaporation, infiltration and run-off as closely as possible" (Stokman, 2019). Correlating to this, water must be seen as an asset in the urban environment than can be experienced and understood, especially in rainy Gothenburg. According to Stokman (2019) the creative integration of water into the design of multifunctional urban and open spaces is "a further overachieving goal."

Stokman (2019) lists the following necessary measures to be implemented for sustainable and resilient water management in cities:

- treating and resting rainwater, and enabling the infiltration and delayed discharge of rainwater
- creating areas to drain and store rain water in extreme rain events and measures for flood resilience
- reducing the need for drinking water, reducing wastewater and recycling treated waste water
- re-naturalising or structurally reconstructing urban waterways

Central Gothenburg offers opportunities to strategically implement resilient solutions for water treatment as a method to educate children playfully about climate change impacts. Thus, to apply the research findings in the form of an architectural project, Pustervikspl atsen (see p. 56 and 57), a neglected public square in Central Gothenburg has been identified as an appropriate site.

Children and Water
A Fairytale?

> ***“Whether in water-design, soft landscape or architectural form, this non-assertive balance between dynamic mobility and restful tranquillity, the life-filled active and the quietly eternal, can only be found by entering into the spirit of wateriness .”***

Quote by
Christopher Day
(2007, p. 227)

In an infinite world, nature's systems are the only true sustainable system. An awareness of sustainable cycles is essential to understanding the environmental interrelation between cause and effect (Day, 2007). In most parts of the world, water is one of the top issues of concern related to climate change and the environmental. While many regions will have to face with water scarcity due to hotter and drier climate, other areas will have to deal with rising sea levels and heavier rainfall.

Water Invites to Playing

Water is about flows and movements. In general, water follows three fundamentals rules: firstly, it always flows downhill. Secondly, anything that can block probably will; anything meant to hold water, will leak. Thirdly, levels are a critical determinant to where and whether water flows. Due to its fluid properties, it exhibits flows, counter-flows, rhythms, energy transfers and, inversions and evolutions (Day, 2007). In this sense, water-play can be the first step to foster sensitivity to fluid movements, helping to understand that life is constantly mobile (Day, 2007). Children love to play with water. They can move things or themselves in it or stomp in puddles. They can reshape its course by placing obstructions, thereby learning about water-flow patterns, waves back-addies and differential speed (Day, 2007). Due to its constant re-adjustment, water flows reflect children's lively and fluid thought processes contributing to their health development (Day, 2007).

The Implication of Water in Design

Apart from its fluid properties, water also offers atmospheric attributes. For instance, the drumming sounds of water drops hitting a roof can provide a feeling of security, it can create the illusion of being somewhere dry and warm, and wet paving reflecting coloured lights reveals an inner glow in the evening gloom (Day, 2007). The flow of water can even be dramatised by using rain-boosted flow forms or riven slabs (Day, 2007).

Natural swimming pools, cross-sectional geological models, and rainwater harvesting are just a few models that offer pedagogical value to address issues such as water quality, climate change and pollution. Together with water sensitive design solutions, water is an excellent tool with which to showcase nature's cyclical systems. Water is the essence of all life on planet Earth. When landscapes and habitats are altered due to changing weather and climate conditions, water can become a pedagogical and playful entity to be explored, helping to understand its importance, values and challenges for humankind and its relationship with the environment.

The Parent's Role Needs to be Considered

In a Nordic context, such as Sweden, the weather must be considered as an additional dimension. From the child's perspective, cold climate and rain do not play such a significant role as they do in their parent's decision-making, but given the power dynamic of the relationship, the role of the accompanying adult must also be considered when designing and planning public spaces for children. For instance, while parents prefer shelter from rain, children love to play and explore water. To lower the threshold for parents to go outside with their children and play, infrastructural and public space functions must be considered in terms of weather protection and adaptivity.

Safe Adventures

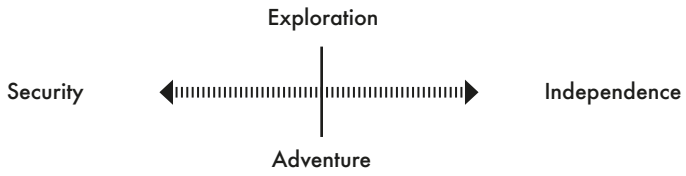


Figure 12

Childhood: a journey of evolving needs
Taken from Day (2007, p.38)

While external environments provide opportunities for structured and unstructured play, they also allow children to experience risk and challenges (Hudson and White, 2020). Kopec (2018) argues that mild risks should be taken into consideration, as they can ensure a feeling of safety while maintaining interest. Transition spaces, for instance, enable children to enter new situations gradually and safely. Moreover, spaces for children need to provide adequate visibility of all areas for adult supervision. The division of areas and equipment according to age level and ascribed development needs need to be taken into consideration (Taylor, 2009).

Safe Danger Approach

Notably, the inclusion of water implies particular risks that must be considered when designing and planning for children. As a certain level of risk is never entirely avoidable, the task for designers is to ensure self-reliance and good self-esteem at an acceptable risk level (Day, 2007). In terms of water, it is important that it appears more dangerous than it actually is. Similarly, invisible danger makes places more dangerous than they truly are. According to Day (2017) this "safe danger" approach is better for both development and survival. Furthermore, including an element of danger also has developmental, social and educational benefits, as it demands children to stay focused and to look out for each other (Day, 2007).

In general, the depth of water should never exceed 200mm and must not have unexpected depth changes (Olds 2001 as sited in Day, 2007). Nevertheless, change of water levels due to rising sea levels and precipitation can be a pedagogical element in spaces for children. It is therefore of the utmost importance that the balance between risk and experience must be designed carefully. Areas where water levels are meant to increase should be used by children who are of an age to anticipate and evaluate the risk. Water levels should be illustrated in the design in such a way that in can be understood by children, as well as by adults.

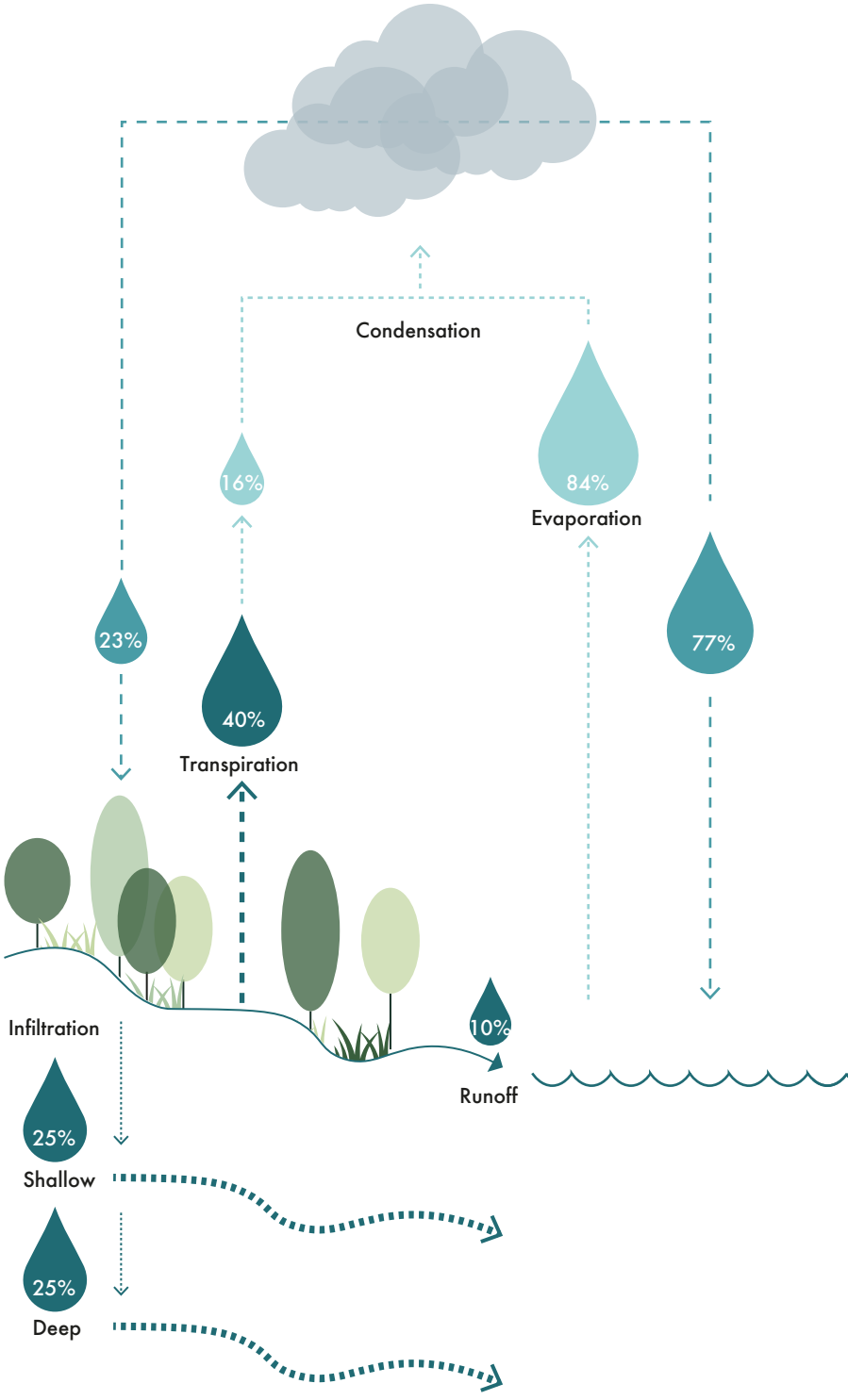
The Logic of Water

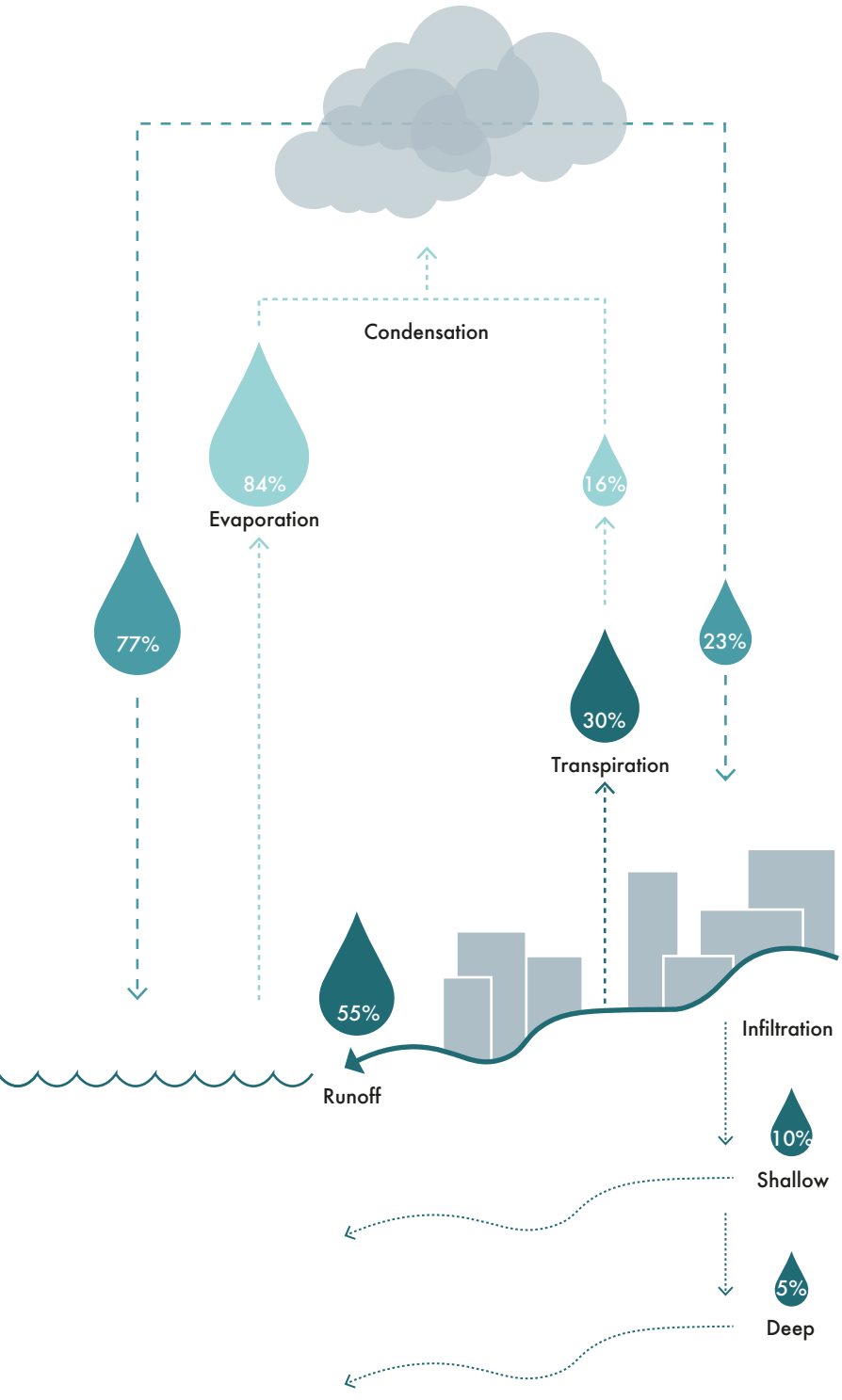
The Natural Water Cycle

Water is the basis for human, animal and plant life. Compared to other resources, water is not a degenerative material but locked into a permanent global cycle driven by solar radiation (Stokman, 2019). However, only approximately 3% of the total volume of water on the planet is natural freshwater, causing water to be considered a scarce resource in many parts of the world (Watson, D., & Adams, M., 2011).

The quality of water and soil is key for human settlements in the landscape . In its liquid form, water continually evaporates, forms clouds, and eventually returns as rainfall to the earth, where bodies of groundwater are formed. Soil acts as a sponge that absorbs and stores rainwater and diminishes surface precipitation run-off, thereby reducing river flooding. The stored water is made available to vegetation, allowing for green and productive landscapes to thrive. Simultaneously, the ground filters harmful substances and nutrients from the water by bonding them to soil particles and removing them through the process of transforming substances. Ultimately, the process of infiltration produces clean groundwater suitable to be used as drinking water (Stokman, 2019).

Through continuous erosion, water flows shape soils and topographies, as well as vice versa, where features in the soil and topography shape bodies of water. Hence, water and soils express the complex natural process of landscape change over periods of time and different spatial dimensions (Stokman, 2019).





The Urban Water Cycle

In the urban environment, the natural water cycle is disturbed, and most people are unaware of the function of water (Hoyer, Dickhaut, Kronawitter & Weber, 2011). Water is used as drinking water and managed by urban sanitation systems in the form of waste and greywater. Natural or artificial water bodies in public spaces are regarded as amenities in cities. Waterways are controlled and channelled to remove stormwater from impervious surfaces, leading to increasingly high flood peaks and greater flood risks further downstream, as well as leaving no time for evaporation (Stokeman, 2019). Rising water levels during floods cause the adjacent soil layer to collapse and to be penetrated by oxygen, causing the soil to decompose. In turn, this subsidence leads to a greater risk of flooding (Stokman, 2019).

A high degree of ground sealing in urban areas lowers the groundwater level, resulting in watercourses drying out during periods of low precipitation. In addition, water in urban areas is polluted and unable to infiltrate the ground due to impervious surfacing. Eventually, these factors negatively affect groundwater recharge, water supplies, the qualitative and quantitative state of receiving rivers, and the urban climate (Hoyer et al., 2011).

Figure 13

The Natural and the Urban Water Cycle

Freely adapted from
Watson and Adams (2011, p. 93)

Water Sensitive Urban Design
Design for Flooding

> *"Take thought, when you are speaking of water, that you first recount your experiences, and only afterwards your reflections."*
>
> Leonardo da Vinci
> Cited in Dreiseitl and Grau (2005, p. 9)

Public spaces, such as squares, playgrounds and streets, have been designed as dry surfaces to be accessed at any given time. However, due to the projected increased frequency of extreme weather events, urban sewer systems will become unable to sufficiently drain greater quantities of water, and flooding in the city will occur more often. Additionally, sewage backflows can lead to floods, even where no water is visible (Stokman, 2019). With many conventional water management systems located underground, people are unlikely to understand and appreciate stormwater management (Hoyer et al., 2011).

Back to a Natural Water Cycle

Consequently, urban spaces must incorporate decentralised rainwater management, combining drainage and retention, as well as water purification systems (Stokman, 2019). If integrated visibly and pedagogically while considering ecological, social, and aesthetic qualities, these systems can change the public perception and induce acceptance, in addition to promoting the intelligent and responsible use of water (Hoyer et al., 2011). Therefore, the objective is to combine the demands of both urban planning and sustainable stormwater management by transitioning the current urban water cycle to a more natural one. The interdisciplinary field of Water Sensitive Urban Design (WSUD) offers strategies to combine water management, urban design, and landscape design while enhancing ecological, economic, social, and cultural sustainability (Hoyer et al., 2011). By implementing these strategies, children can learn about and experience water sensitivity in public spaces or playgrounds that incorporate water sensitive design, thereby developing a greater understanding of water cycles in the built environment. Correspondingly, Hoyer et al. (2011) have formulated the following five principles to ensure successful and decentralised storm-water management: Water sensitivity, aesthetics, functionality, usability, and public perception and acceptance.

Generally, the concept of near-natural rainwater management is comprised of four principles: collection and direct re-use of rainwater, evaporation, infiltration, and reducing run-off. The goal of decreasing rainwater run-off is to cap peak flows of surface water by delaying and releasing drainage as close to the source as possible. Rainwater use, for instance, can lower the annual run-off rates, thereby diminishing peak flows. Finally, evaporation and infiltration of rainwater reduces the quantity of water that must be removed. While evaporation positively affects the microclimate, infiltration recharges the groundwater.

From a child's perspective, stormwater solutions need to be incorporated playfully, pedagogically and safely into the public realm. Water sensitive urban design provides strategies that can be adapted at any scale. In line with the purpose of this Master's Thesis, a selection of pedagogical water sensitive design solutions has been retrieved and visualised in chapter 4 "Design Strategies" (p. 47).

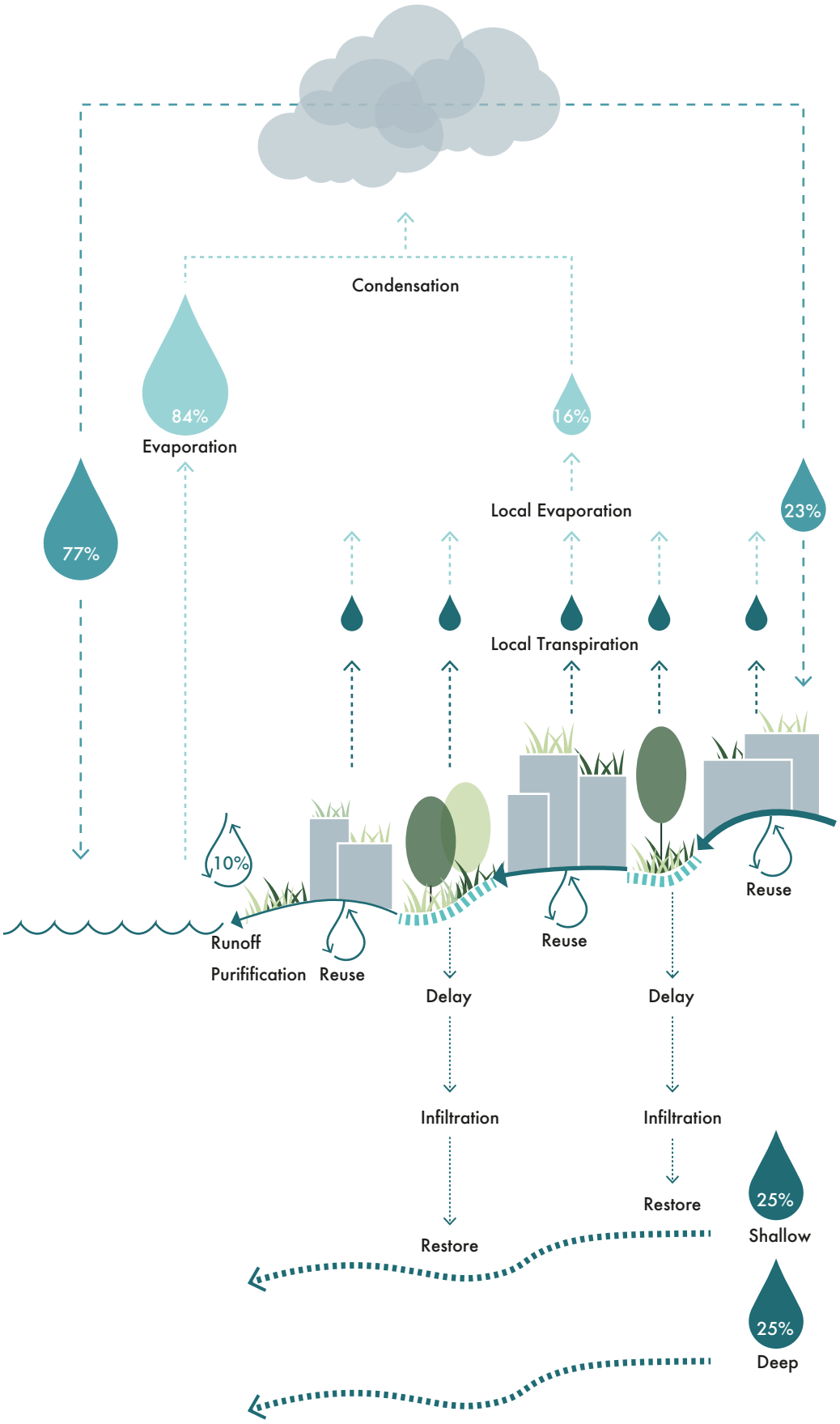


Figure 14

Water Sensitive Urban Design

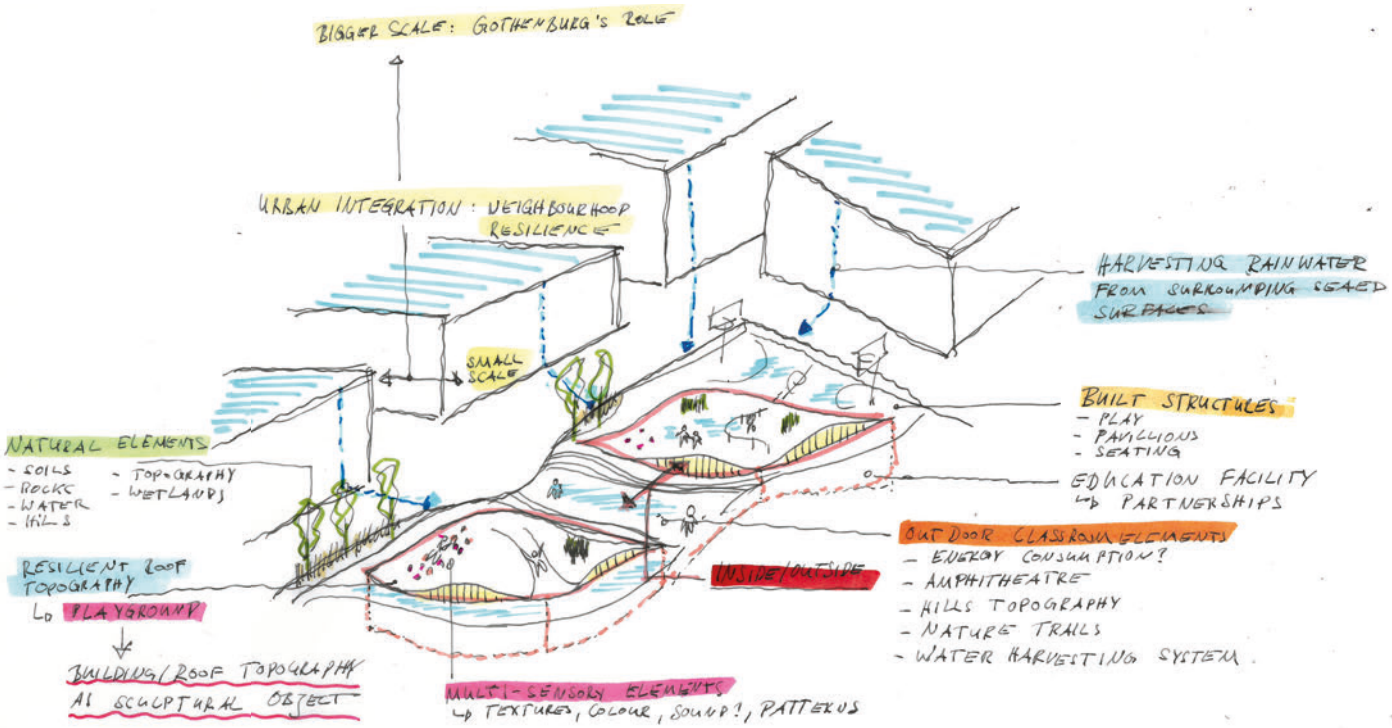


Figure 15

Graphical Manifesto
- Early Sketch of an Idea

Chapter 4
Resilient Strategies for a Child - responsive City

> *"In many ways, the environmental crisis is a design crisis. It is a consequence of how things are made, buildings are constructed, and landscapes are used. Design manifests culture, and culture rests firmly on the foundation of what we believe to be true about the world."*

Van der Ryn & Cowan, 1996 as cited in Taylor, 2009, p. 50)

Design Criteria
Theory-based Design Strategies

As mentioned in chapter 1, research-for-design is the chosen methodology to carry out this Master's Thesis. Knowledge was retrieved from the three main fields of research; children's perspective, environmental education and water sensitive design. Based on the research findings, several theory-based design strategies were developed in order to build up a framework for the design proposal. The aim is to link theories from different research fields and to create synergies among them through spatial design.

Based on the theoretical research for this thesis, generic and site-specific principles were developed to create a learning landscape for children. The design principles are divided into generic and site-specific strategies. The generic strategies focus on the children's perspectives and environmental education and offer the potential to be translated and up-scaled into various contexts and locations in the world. The site-specific strategies result from the exploration of generic information. In this case, the site-specific design principles connect to sustainable and resilient urban water treatment which is Gothenburg's urban challenge. In different contexts, other context-based challenges could become a tool for educating children about the environment, and thereby support social and environmental resilience.

As illustrated in Figure 16 (p. 49) the design strategies are segmented in 4 main categories which describe scale and level of application of theory in the design proposal: The Urban Context, The Playscape, The Water Cycle Pavilion and The Tectonics. The Pages 50 and 51 describe the sub-strategies within the main categories in more detail.

The Urban Context

Here the Children's perspectives are the focus, combined with context-based challenges and the establishment of cross-sectional learning partnerships. They form the framework of any urban development where children are stakeholders.

The Playscape

The creation of an accessible, multi-functional topography that fosters structured and unstructured play and considers the local climate is vital. In the framework of this thesis, water management is the context-based urban challenge.

Water Cycle Pavilion

The concept is a learning facility that complies with Built Environment Education. The structure should blur the borders between inside and outside and showcase the use of water.

The Tectonics

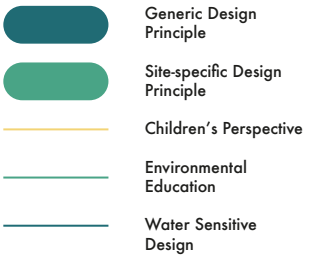
Here the dependencies and interrelations of the strategies mentioned above are tied together in compliance with theories of environmental education and environmental psychology.

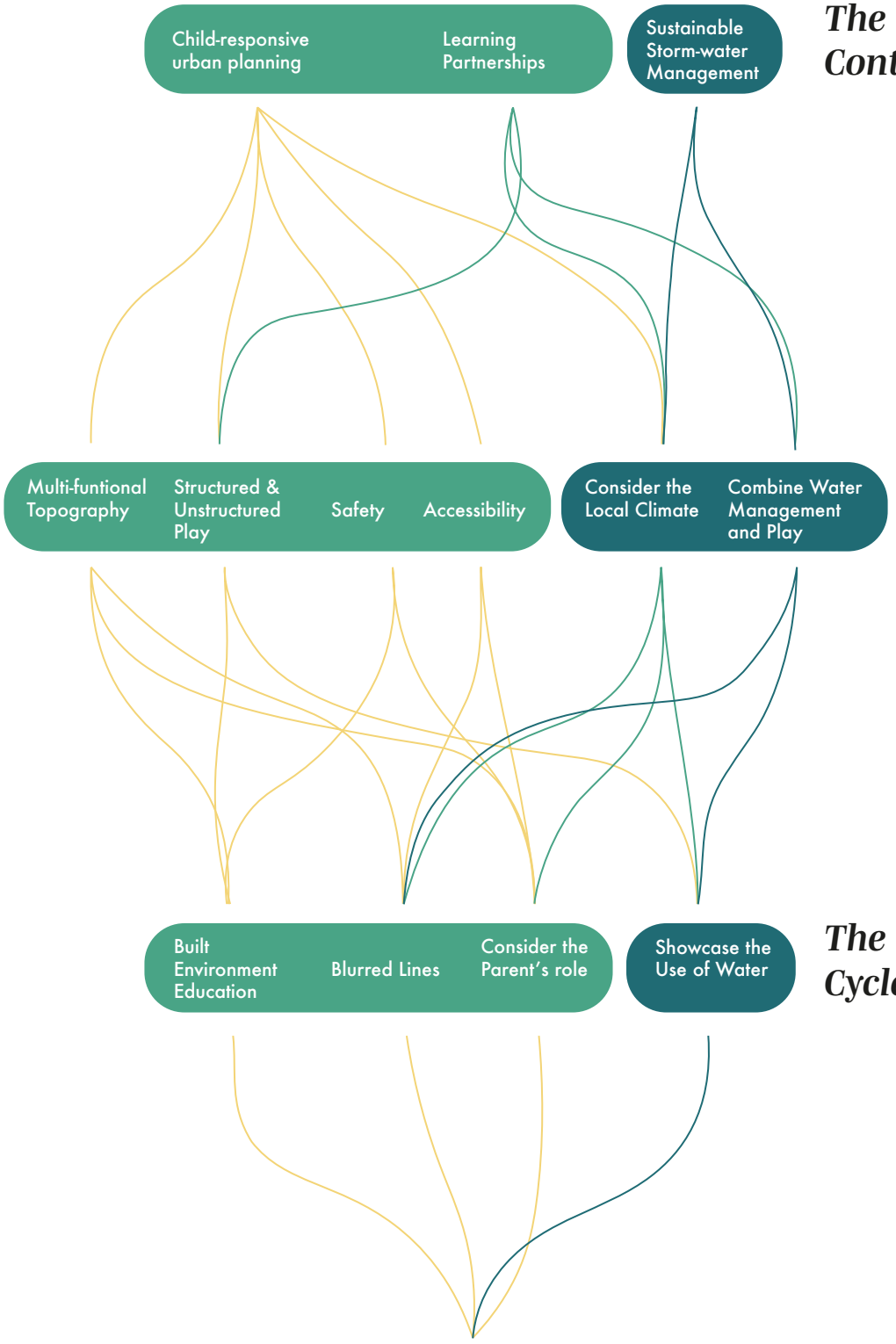
The Toolbox

Finally, a toolbox of pedagogical water sensitive urban design (see p. xx) was created that informs about their function and effectiveness in terms of stormwater treatment, purification and ecological benefits.

Right: Figure 16

Interdependencies of Design Strategies




Child-responsive urban planning
Learning Partnerships
Sustainable Storm-water Management
The Urban Context
Multi-funtional Topography
Structured & Unstructured Play
Safety
Accessibility
Consider the Local Climate
Combine Water Management and Play
The Playscapes
Built Environment Education
Blurred Lines
Consider the Parent's role
Showcase the Use of Water
The Water Cycle Pavilion
Consider all Kinds of Senses
Create Movements
Shape
Symbolism
The Tectonics

Design Categories
A Catalogue for Child-responsive Urban Planning

The Urban Context

Child-responsive Urban Planning

Create a network of multifunctional and intergenerational public spaces, that provide health, educational and social services for children and the community. Design inclusive public and green spaces that are accessible all-the-year-round where children can meet, thrive and engage in outdoor activities.

See chapter 2, p. 22 and 23
Method retrieved from: UNICEF (2020) and Arup (2017)

Learning Partnerships

Establish cross-sectional learning partnerships between schools, pre-schools, children's museums, universities etc...

See chapter 2, p. 28
Method retrieved from: Dodig (2018)

Sustainable Stormwater Managament

Incorporate a visible decentralised storm-water management network to bring the urban water cycle closer to a natural one.
Method retrieved from: Water Sensitive Design (Hoyer et al., 2011)

See chapter 3, p. 44 and 45
Method retrieved from: Hoyer et al. (2011)

The Playscape

Multi-functional Topography

Create a nature inspired topography composed of natural, multi-sensory, built, cultural, and transitional elements.

See chapter 2, p. 32 and 33, and figure 11, p. 34 and 35
Method retrieved from: Taylor (2009)

Structured and Unstructured Play

Nurture children's skill development by providing structured and unstructured play opportunities.

See chapter 2, p. 32 and 33, and figure 11, p. 34 and 35
Method retrieved from: Hudson & White (2020)

Consider the Local Climate

Make use of external resources from the environment of the local climate and provide covered spaces to enable accessibility during all seasons, and to lower the thresholds for spending time outside.

See chapter 2, p. 32 and 33, and figure 11, p. 34 and 35
Method retrieved from: Hudson & White (2020)

Accessibility

Ensure child-friendly infrastructure to enter the learning landscape independently and to attract families, schools and pre-schools.

See chapter 2, p. 22 and 23
Method retrieved from: UNICEF (2020) and Arup (2017)

Safety

Consider visible and mild risks for children to foster valuable life experiences. For instance, water should look more dangerously that it is, and must not have unexpected deep changes. Provide separated areas for different age levels, and transition spaces for children to enter new situations gradually.

See chapter 3, p. 41
Method retrieved from: Kopec (2018)

Combine Water Management and Play

Incorporate water sensitive design solutions that are pedagogical and safe for children to explore and play, e.g. swimming pond, water play, etc.

See chapter 3, p. 44 and 45, and see figure 17, p. 52 and 53
Method retrieved from: Hoyer et al. (2011), Göteborgs Stad (2017), and Stokman (2019; Bott et al., 2019)

The Water Cycle Pavilion

Built Environment Education

Design spaces for pre-exhibition introductions, exhibition and at-the-end workshops according to the principles of BEE. Learning spaces should be designed to facilitate various modes of expression and meet the "5 Entry points to the needs of children's gifts."

See chapter 2, p. 28 - 33, and see figure 9, p. 30
Method retrieved from: Dodig (2018) and Kalessopoulou (2017)

Blurred Lines

Break down the barriers between inside and outside to enrich children's learning experience and give freedom of choice.

See chapter 2, p. 32 and 33, and figure 11, p. 34 and 35
Method retrieved from: Hudson & White (2020)

Consider the Parent's role

Exhibition and workshop spaces need to be designed equally interesting for both children and parents.

See chapter 2, p. 28 - 33, and see figure 9, p. 30
Method retrieved from: Haas (1996), Kalessopoulou (2017) and Kopec (2018)

Showcase the Use of Water

Exhibit the use of water and showcase the water cycle in an architectural appropriate way, e.g. rain water harvesting, cross-sectional geological model.

See chapter 3, p. 40
Method retrieved from: Day (2007)

The Tectonics

Consider all Kinds of Senses

Facilitate a multi-sensory learning and playing experience by providing essential tactile visual stimuli. Use colours according to purpose and age group, and define surface material for zoning.

See chapter 2, p. 32, and figure 11, p. 34 and 35
Method retrieved from: Hudson & White (2020), Day (2007), Kalessopoulou (2017), Kopec (2018)

Create Movements

Movement, as it is an essential part of learning, should be carried out in different ways. Wide open spaces for active movement and spaces for hiding and exploring are equally important.

See chapter 2, p. 33
Method retrieved from: Hudson & White (2020)

Shape

Curves resemble shapes of nature and encourage activity while straight lines and rectangular shapes relate to human thought, logic and focus.

See chapter 2, p. 32, and figure 11, p. 34 and 35
Method retrieved from: Day (2007)

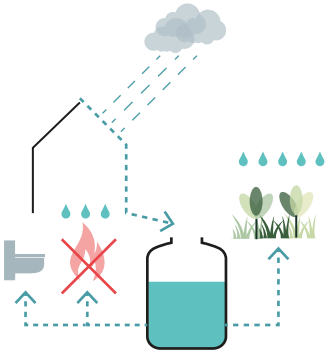
Symbolism

The use of symbols relate to abstract concepts and concrete objects and help children to better understanding.

See chapter 2, p. 26 and 27
Method retrieved from: Kopec (2018)

Pedagogical Water Sensitive Design*

A Toolbox



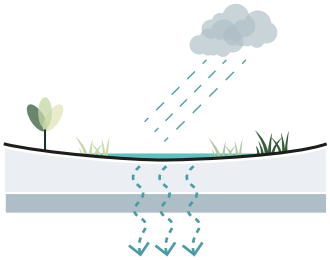


Figure 17 (includes all illustrations on this page and p. 53)

Pedagogical Water Sensitive Design Solutions

- Delay of water flow - dimensioned volume and less
- Delay of water flow - can handle cloudbursts
- Derivation of surface water - dimensioned volume and less
- Derivation of surface water - can handle cloudbursts
- Small to medium purification effect
- Major purification effect
- Ecological benefits

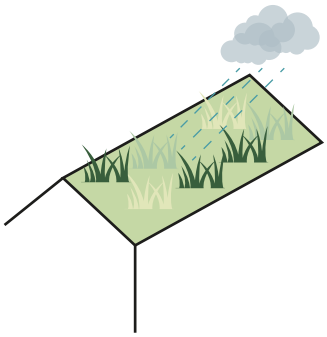
*Information on this pages have been retrieved from Hoyer et al. (2011), and Göteborgs Stad (2017)

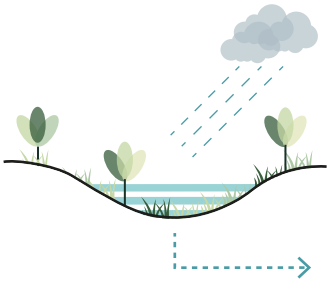
Rainwater Harvesting

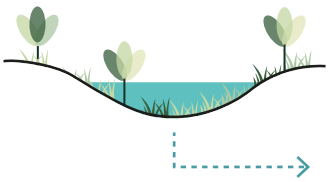
Cisterns that store water and can be used for water supply when treated. Aboveground systems can be incorporated into the architecture and landscape design.

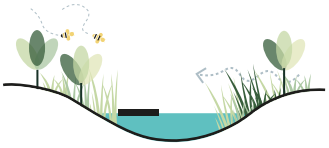
Bioretention

Shallow landscapes depressions with engineered soils to filter and remove pollution. Manages run-off from frequent rainfall. When dry they can be used for recreation.









Roof Retention

Multilayer green roof structures that can be either extensive or intensive. They reduce the stress on storm-water sewers. While evaporation and transpiration is increased they also offer visual improvements in the urban environment.

Detention Pond - dry

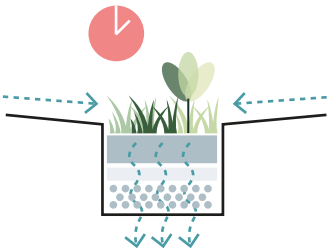
Surface storage basins that delay storm-water run-off. Water is held in the pond, and particles settle. Water is slowly infiltrated or drained into other systems. Can be used for recreational purpose when dry.

Detention Pond - wet

Surface storage that hold water continuously. They can circulate water through filtration devices such as biiotopes. Thereby they improve water quality as required for downstream infiltration. Combined with other solutions it provides irrigation features or appropriate water supply.

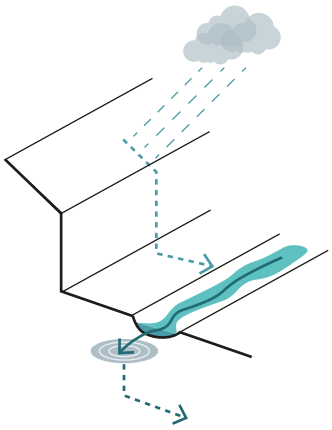
Biotope

As a landscape for plants and animals biotopes also treat storm-water while facilitate ecological stability and improve biodiversity. They improve water quality through natural oxygenation and other processes. Wetlands and reed beds are oftern incorporated.



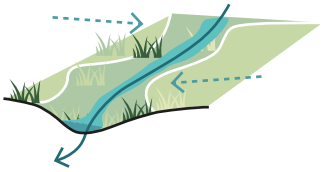
Infiltration Trench / Zone

Concentrated planted spaces for rapid infiltration of surface water. Highly technical systems that feature layers of minerals and substructures for retention, filtration and infiltration.



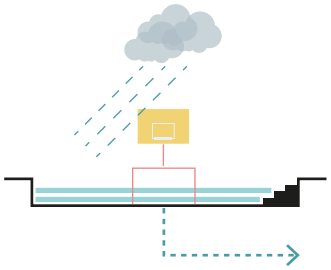
Open Channel

Alternative to underground sewers. They convey surface water from impervious surfaces into underground sewers or decentralised management systems. Can be an education playful feature in public spaces.



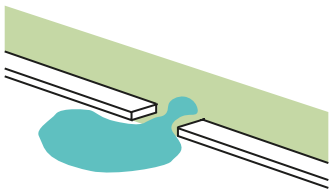
Swale

Linear vegetated drainage depressions that store or convey surface water. They provide either an impermeable base for transportation or permeable for infiltration. Gives Recreation qualities.



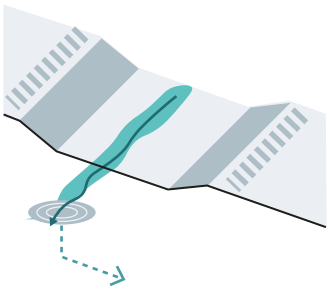
Multifunctional Space

Area that combines storm-water treatment with activities. It could be a for example a playground, sports field, or skatepark that delays run-off and can be flooded in case of a cloudburst.



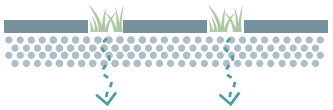
Edge Conditions

Opening in curbstones can replace sewers. Thus, water can be conveyed to further storm-water treatment solutions.



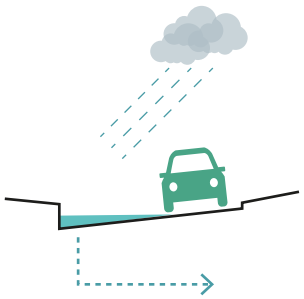
Street Crossing With Ditch

Can be used for both the conveyance of storm-water and a strategy for safe road crossings. Cars are forced to slowed down.



Permeable Pavement

Pavers, asphalt, or concrete that allow water to pass through into a specfically-designed substructure. Can be used to slow or quite traffic. Can enhance the aesthetic values where space is a commodity.



Water Flow Carrying Road

In case of cloudburst, roads can be used to transport bigger volumes of water to further treatment. Can be combined with a blue-green structure.

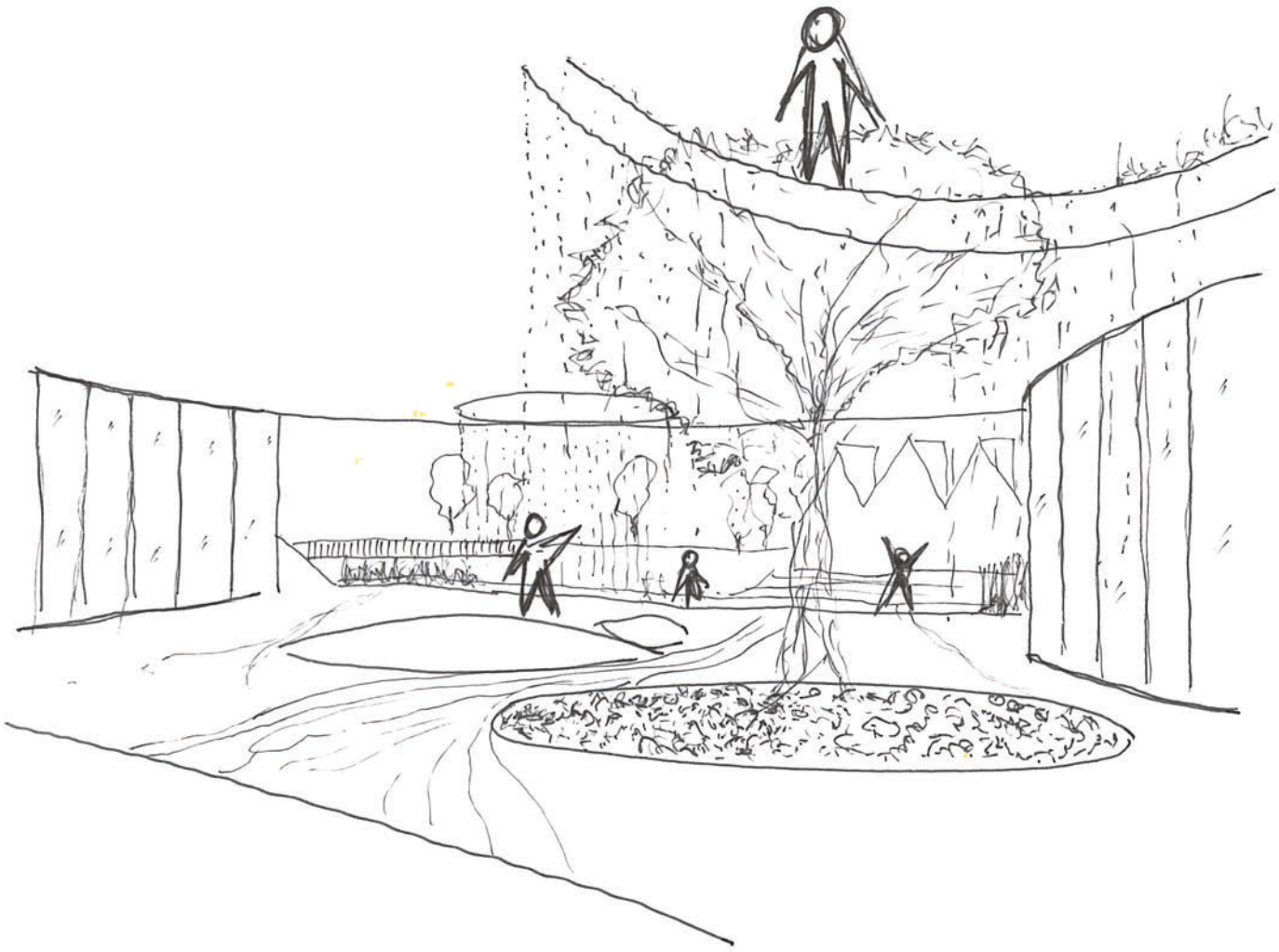


Figure 18

"Under the Rain Roof"

Chapter 5
The Design Proposal

> *"Sustainable technologies must be combined with a philosophy of sustainability, a thorough understanding of how important the Earth is to us, resulting finally in a new architecture and a new visual language."*
>
> Anne Taylor (2009, p. 364)

The Project Site
Pustervіksplatsen

Situated along the city's historic Dutch channels, Pustervіksplatsen marks the end of Gothenburg's central green structure, known as Kungsparken. Located in proximity to the old town (Haga), Hagakyrkan (Haga Church), Järntorget, the Linné area, the adjacent Kungsparken and Feskekörkan (the fish church) on the opposite side of the channel, the chosen area is at the core of Gothenburg's historical heart. Although the square is currently neglected and functions almost exclusively as a parking lot, it is situated in one of the city's most central and attractive areas.

Pustervіksplatsen is facing profound changes due to Gothenburg's major ongoing infrastructure project "Västlänken," which is the new construction of an underground railway extension below the historic city centre. At the time of writing this Master's Thesis, Pustervіksplatsen is under construction, with portions of it designated to accommodate the new underground "Haga station". At this moment, no further plans have been published by the City of Gothenburg regarding the remaining portions of Pustervіksplatsen.

As part of the planning framework, the winning entry for the new site design by the Danish architecture firm, Gottlieb Paludan Architects, and the Swedish design and consulting company, Afry, has been taken into account and adapted to the design proposal.

The new station will have a long-lasting impact on the entire area. In line with this Master's Thesis proposal, the child's perspective will be taken into consideration. Through collaboration with Norconsult AB, Gothenburg's building authority (Stadsbyggnadskontoret) has conducted an impact analysis of the children (Barnkonsekvensanalys) in regard to the Västlänken project and new Haga Station. The purpose of the study is to ensure that the design of Västlänken promotes a socially sustainable environment for the local inhabitants.

The following recommendations have been retrieved and correlate to the aim of this Master's Theses (Norconsult AB, 2014):

- The connection to Järntorget for pedestrians needs to be strengthened.
- By removing the parking lot Pustervіksplatsen and Pustervikskajen offer the potential for sojourn quality and establish a qualitative pedestrian connection towards Järntorget and Esperantoplatsen.
- A new playground in Kungsparken would take down the pressure from Haga Kyrkoplan and strengthen the quality and attractiveness of Kungsparken.
- A new bridge could evoke new movements through the park and give it a more vivid character.

Water in the form of rising sea levels and heavy precipitation will become a problem for the site. On behalf of Göteborgs Krettslopp och Vatten (the local authority for water treatment) and Stadsbyggnadkontoret (the local building authority), Sweco has conducted a cloudburst modelling (Skyfallsmodellering) to two-dimensionally illustrate the accumulation of water and run-off routes within Gothenburg in the case of a 100-year-event and a 500-year-event. In both scenarios, the results for Pustervіksplatsen show that stormwater will flow towards Rosenkanalen, accumulating at depths up to 0,5 meters partially on-site, on the adjacent Nya Allén, and in the streets of Haga due to the topography of the nearby Linné area (see figure 42 and 43 in the appendix p. 96 and 97). This will disturb the area's access and infrastructure, and, in worst-case scenarios, could pose risks to human health and life (Persson, J., Karlsson, A., Jansson, K. & Gustavsson, 2015).

Aside from the flood risks due to heavy precipitation and cloudbursts, the Baltic sea poses an additional threat. Rising sea levels will cause high flooding, affecting the low-lying areas of the city. Due to its location along Rosenkanalen, Pustervіksplatsen will be severely affected in the future, as shown in results from both high flood scenarios: the year 2070 and the year 2100 (see figure 44 and 45 in appendix, p. 98).

Measures to prevent flooding from both rising sea levels and heavy precipitation must be taken. Solutions that incorporate potential flooding scenarios in the playground design can turn water into a pedagogical asset, creating a playful learning landscape in which children may experience climate adaptivity and resilience.

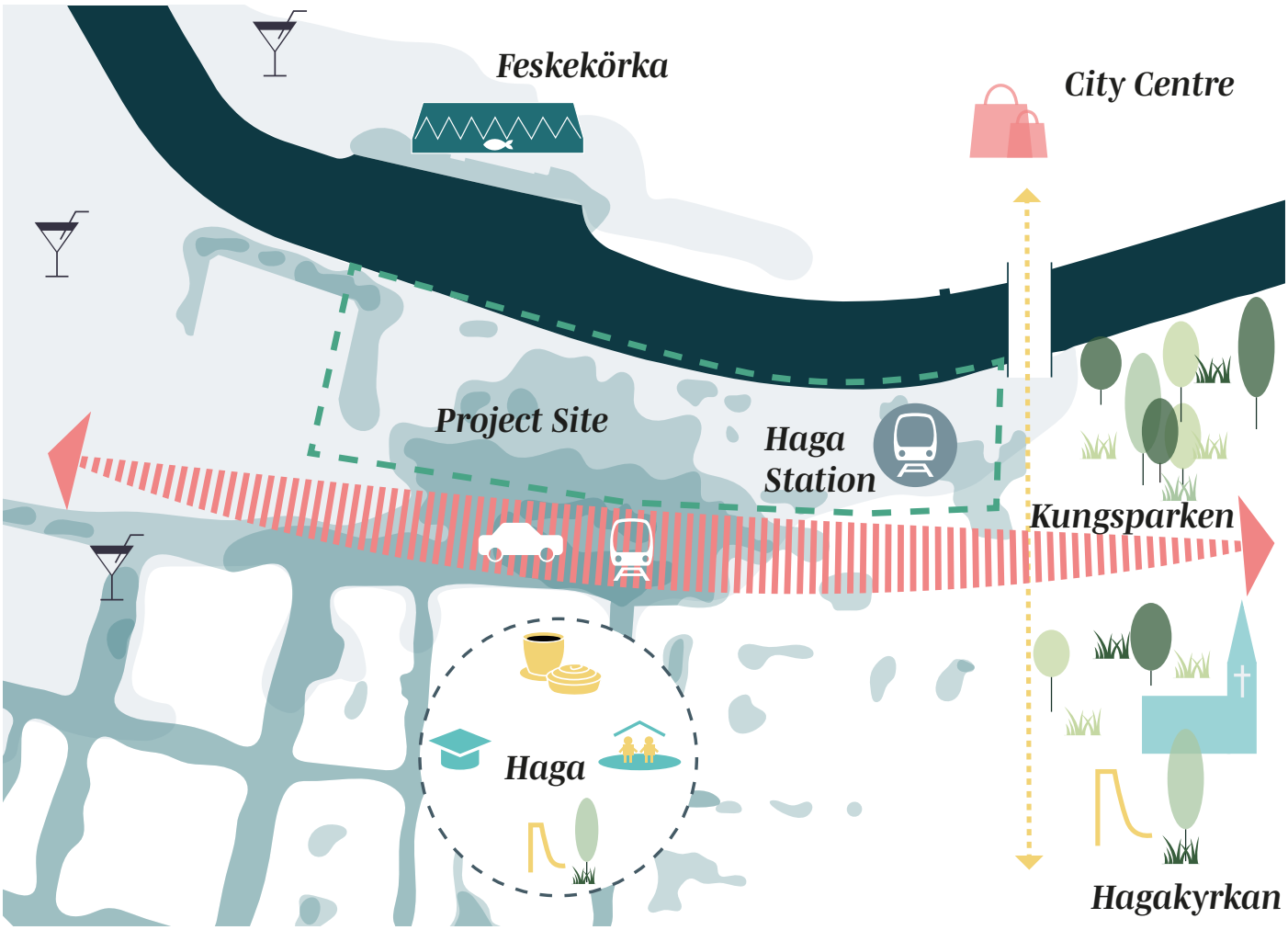


Figure 19

Spatial and Functional Interrelations

N

Symbol Key

- Playgrounds
- Preschools
- Schools
- Coffee culture
- Underground station
- Commercial area
- Nightlife area
- Tram and car traffic
- Flooding due to high flood - 2100
- Flooding due to rain; 100-year-event
- Project site
- Pedestrian flows

Symbol Key

- Playgrounds
- Preschools
- Schools
- Green structures
- Blue structures
- Impervious surfaces
- Cloudburst routes
- Project site
- Area projected to be flooded

Figure 20

Overview Map
Central Gothenburg

Shaping the Learning Landscape
Design Narrative

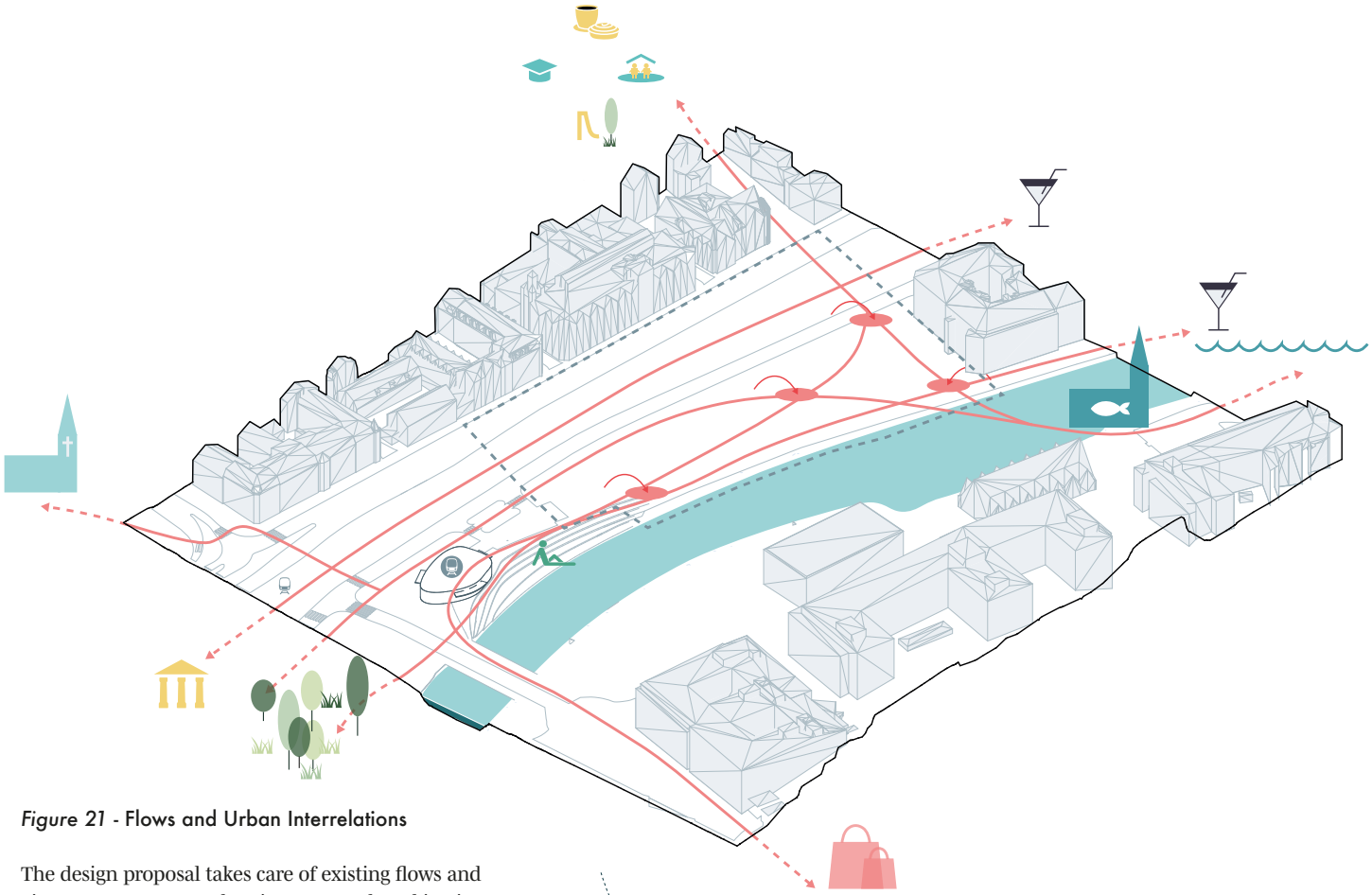


Figure 21 - Flows and Urban Interrelations

The design proposal takes care of existing flows and aims to create new pedestrian streams by taking into account the specific site conditions and potential entry points for children, that are according to theory, important transition spaces for children.

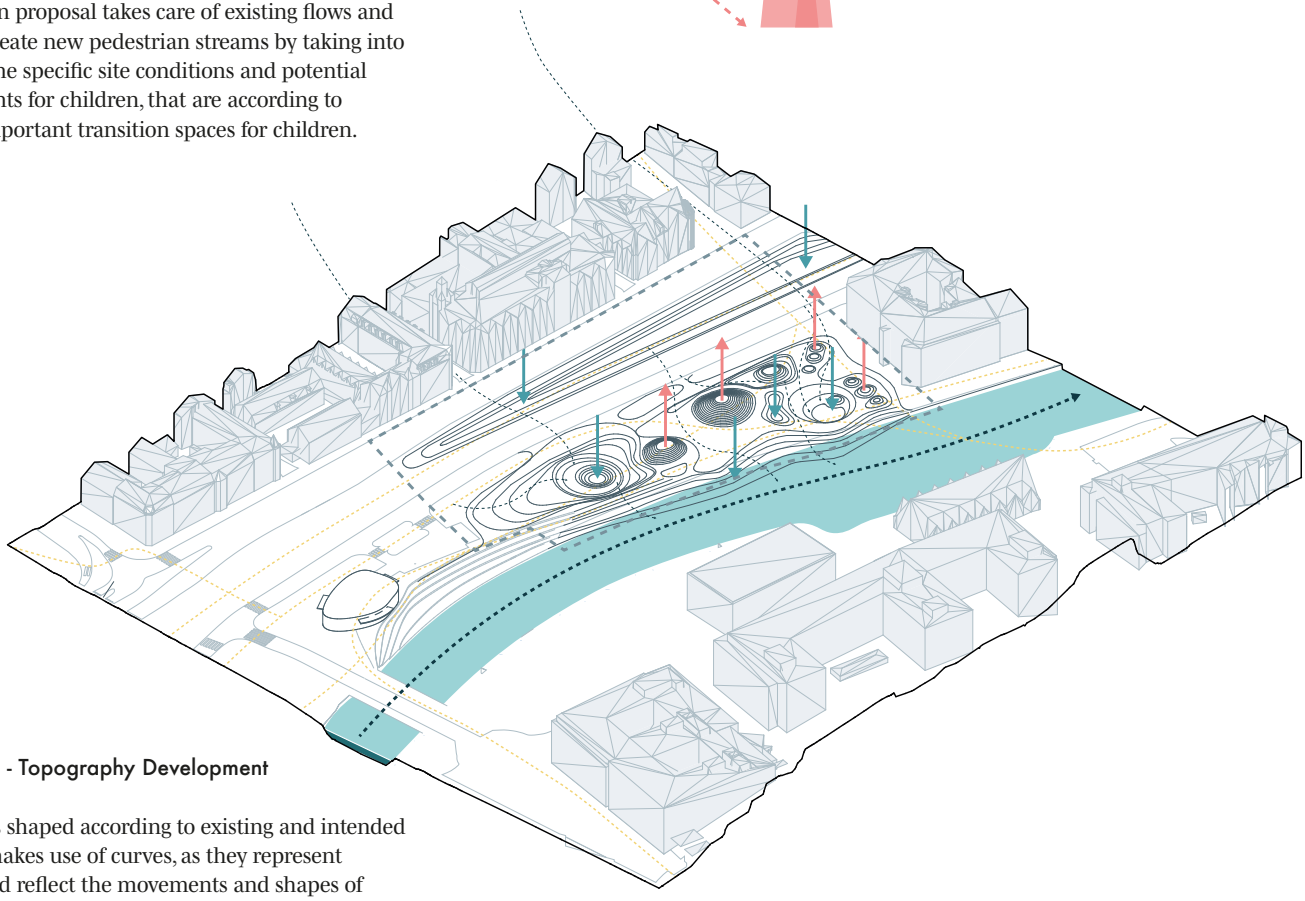


Figure 22 - Topography Development

The site is shaped according to existing and intended flows. It makes use of curves, as they represent nature and reflect the movements and shapes of living things, and thereby symbolises how water alters the environments and vice versa.

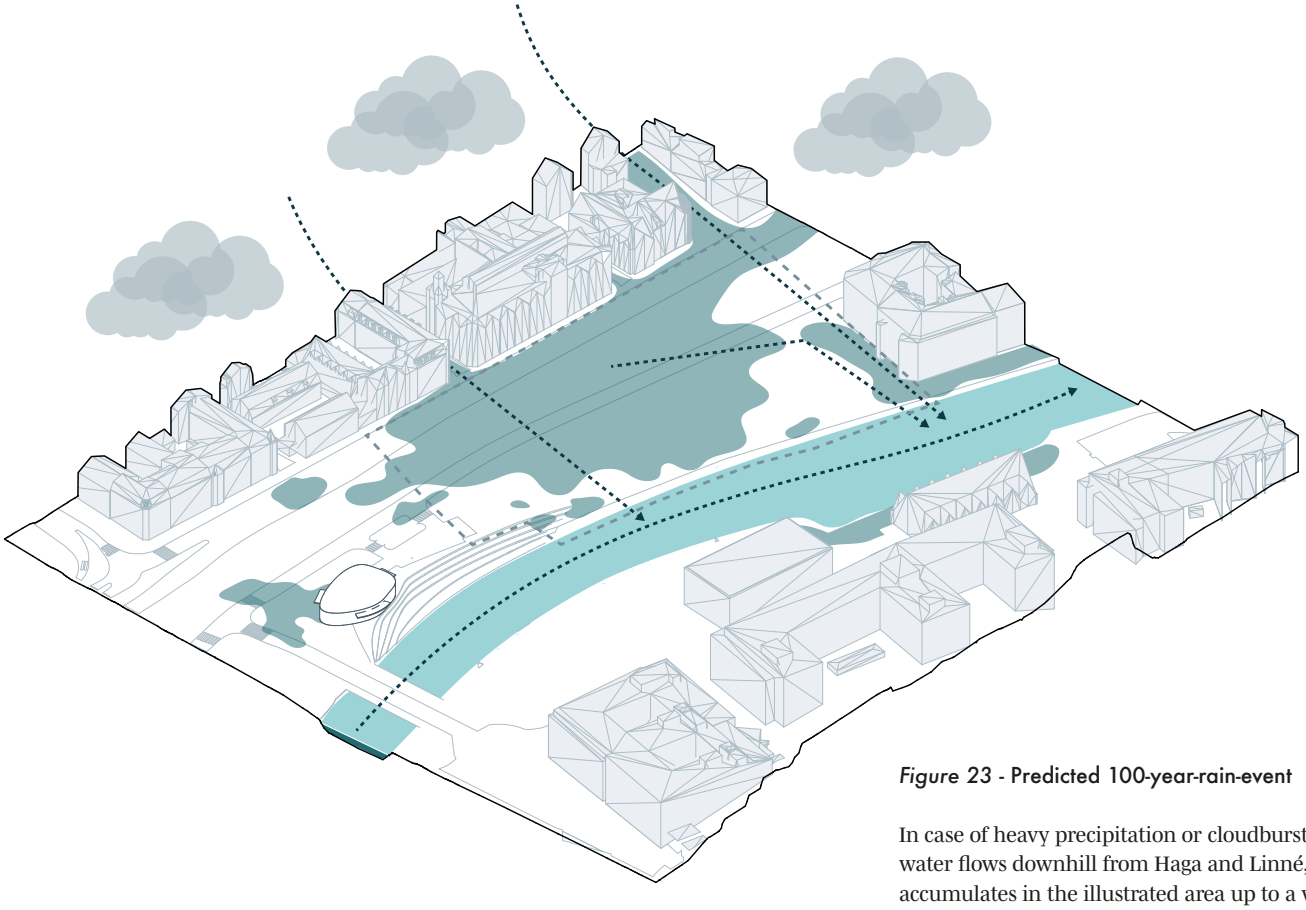


Figure 23 - Predicted 100-year-rain-event

In case of heavy precipitation or cloudburst, the water flows downhill from Haga and Linné, and accumulates in the illustrated area up to a water level of 0,5 m, until it finally flows slowly in the channel or evaporates.

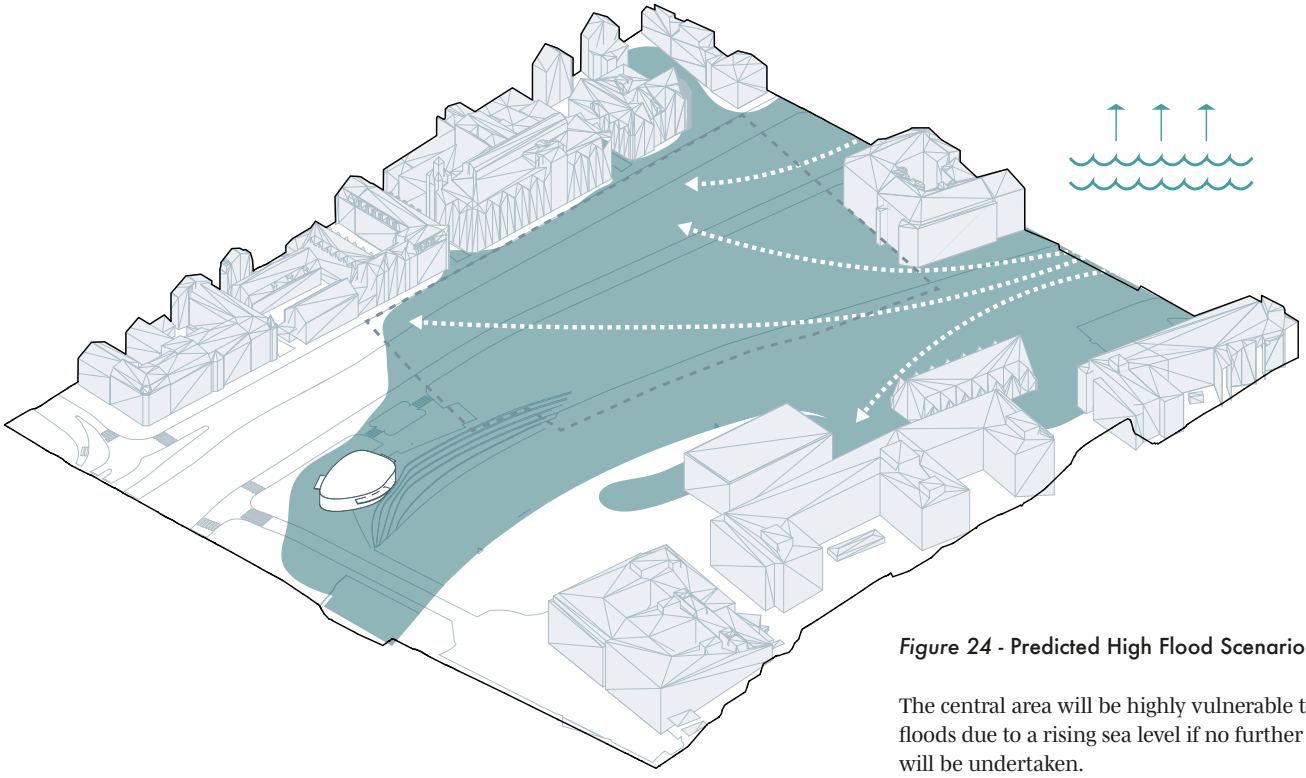


Figure 24 - Predicted High Flood Scenario - 2100

The central area will be highly vulnerable to high floods due to a rising sea level if no further measures will be undertaken.

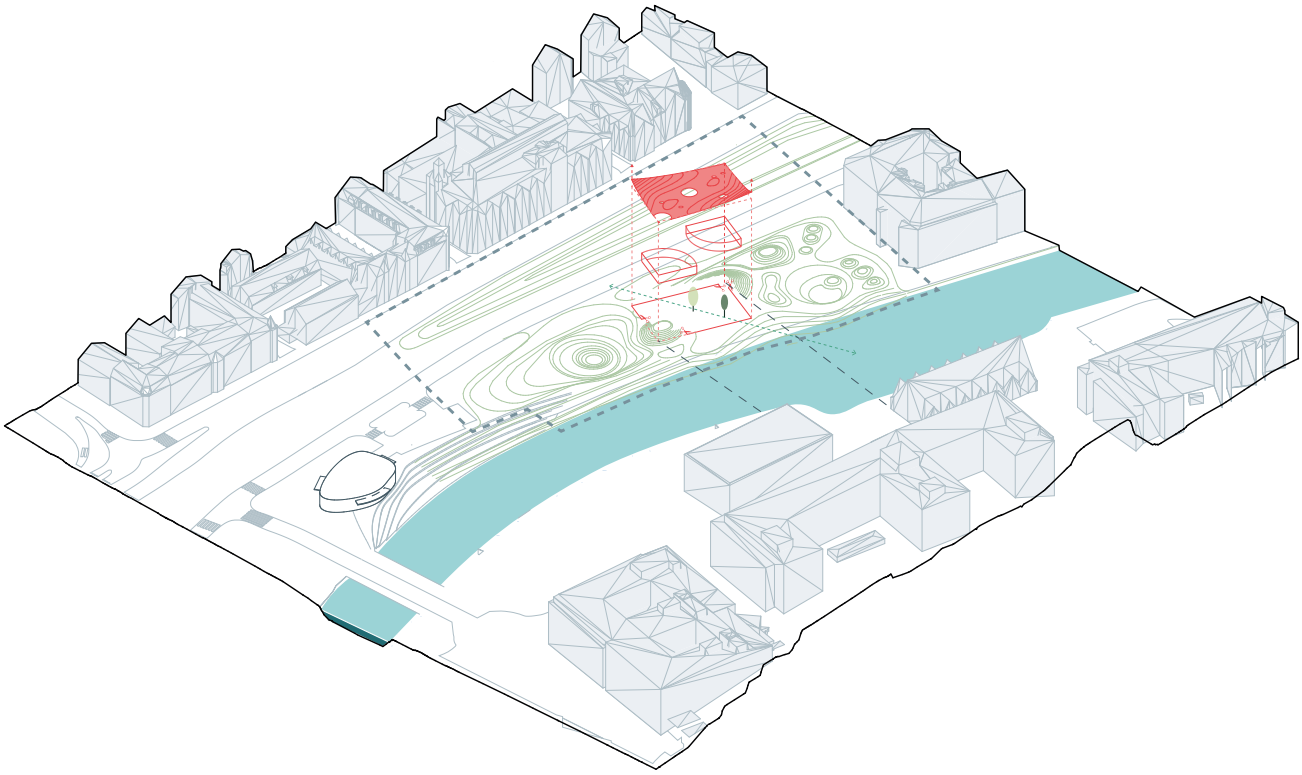


Figure 25 - Shapes of Nature vs "Human Thought"

Rectangular shapes are the manifestation of human thought and logic, symbolically embodying human intervention. The Water Cycle Pavilion, a human structure, contrasts the natural inspired shapes but yet embedded in the topography.

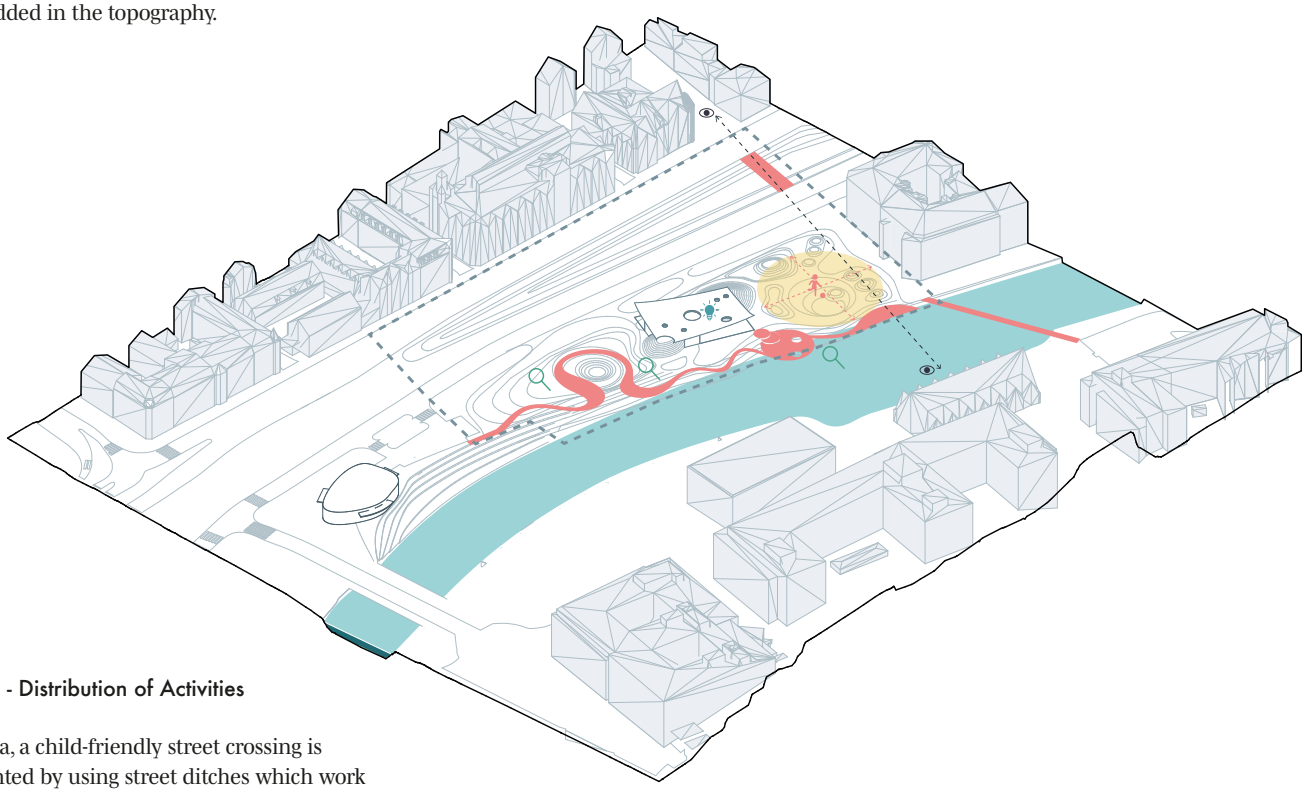


Figure 26 - Distribution of Activities

From Haga, a child-friendly street crossing is implemented by using street ditches which work as stormwater conveyer leading children to the playscape. A bridge over a new retention zone situated between the two-car roads makes the road crossing more appealing and pedagogical. The water square follows the extension from Haga and strengthens the visual connection between the old town and Feskekörka. The added pedestrian bridge connects the urban playground to the other side of the channel and creates new pedestrian streams. The playscape is divided into three main parts: exploring, learning and playing.

Figure 27

The Four principles of near-natural rainwater management. From left to right: Capture, Reuse, Recharge and Clean.

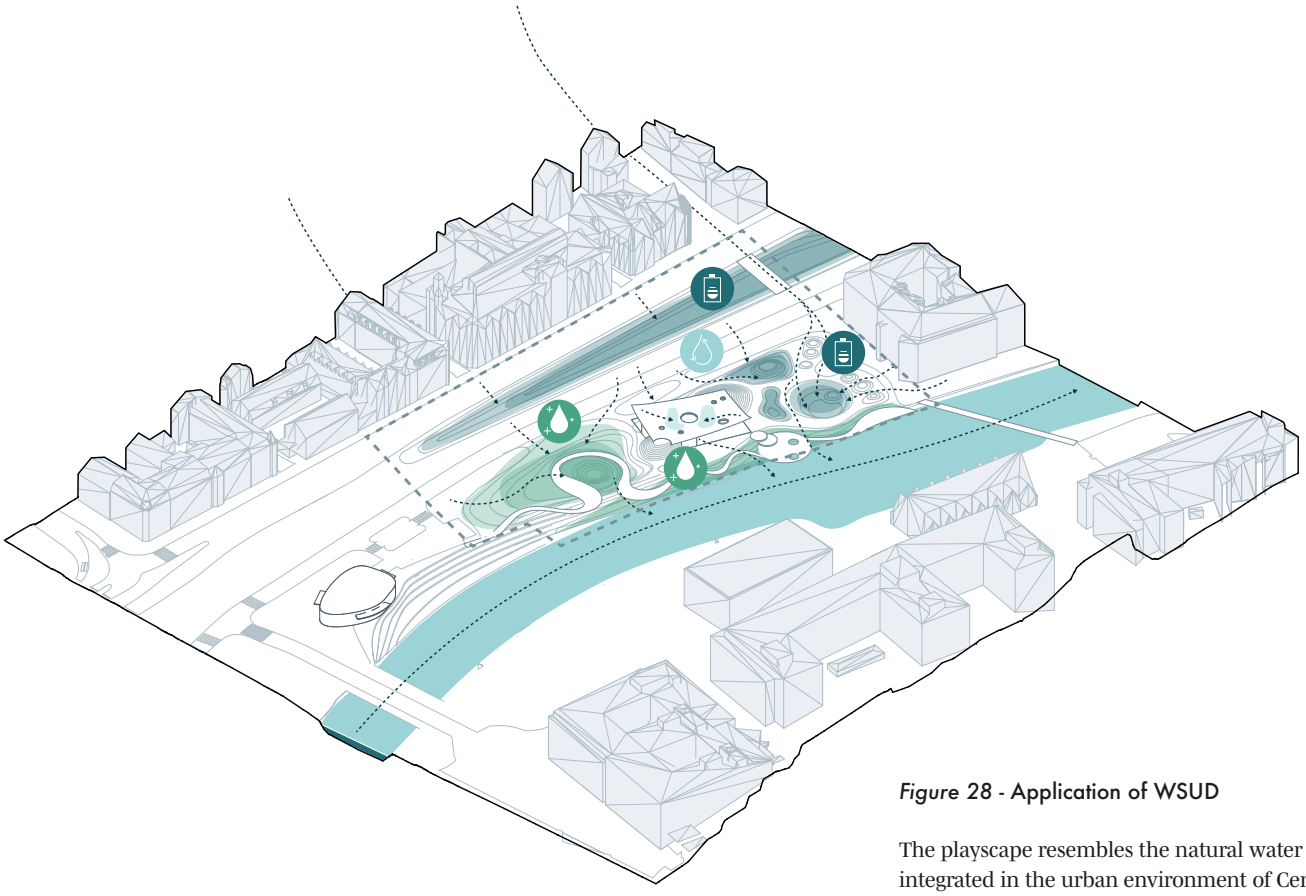
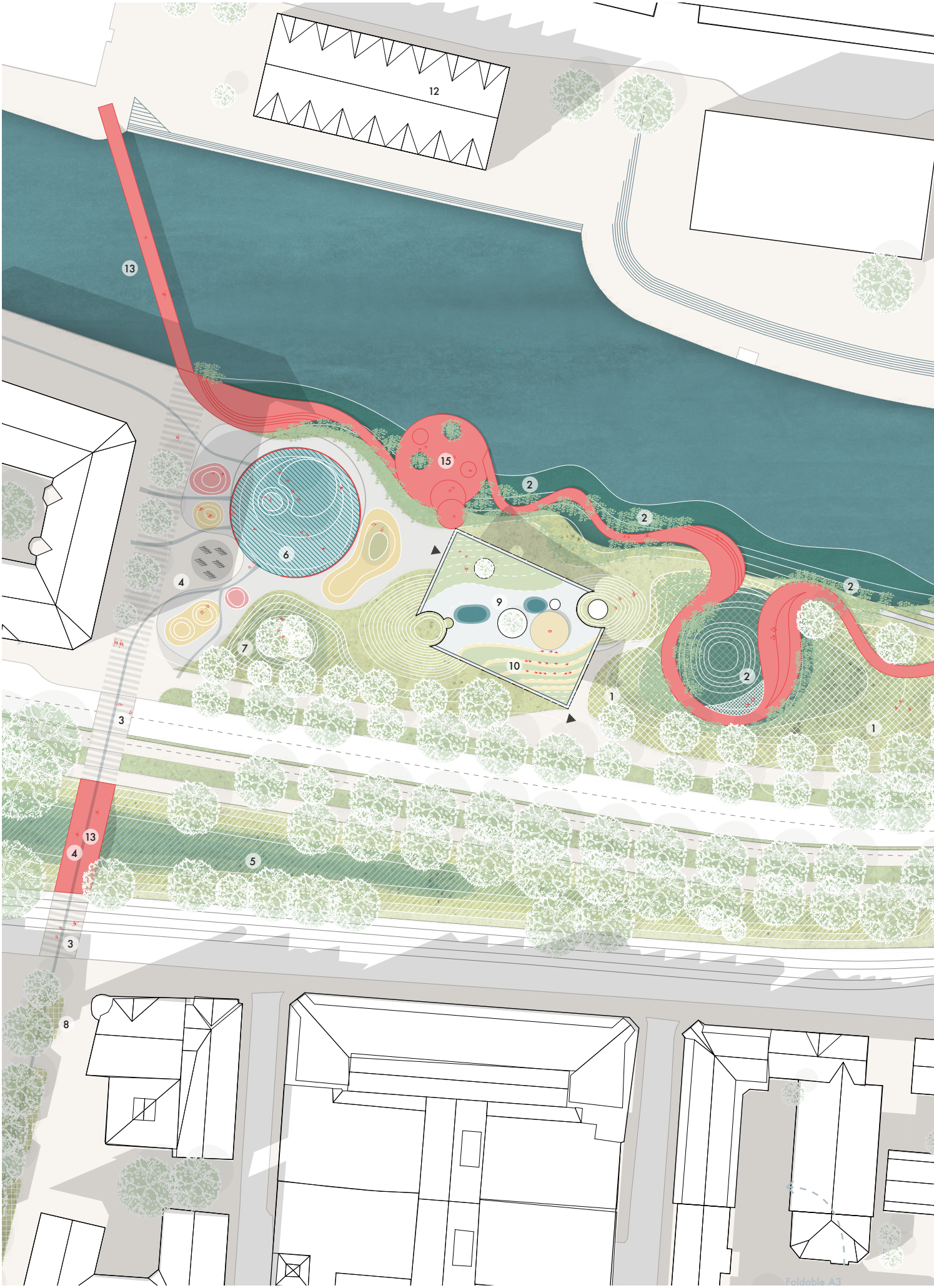


Figure 28 - Application of WSUD

The playscape resembles the natural water cycle integrated in the urban environment of Central Gothenburg. The applied four principles of near-natural water management are interconnected with playful activities.



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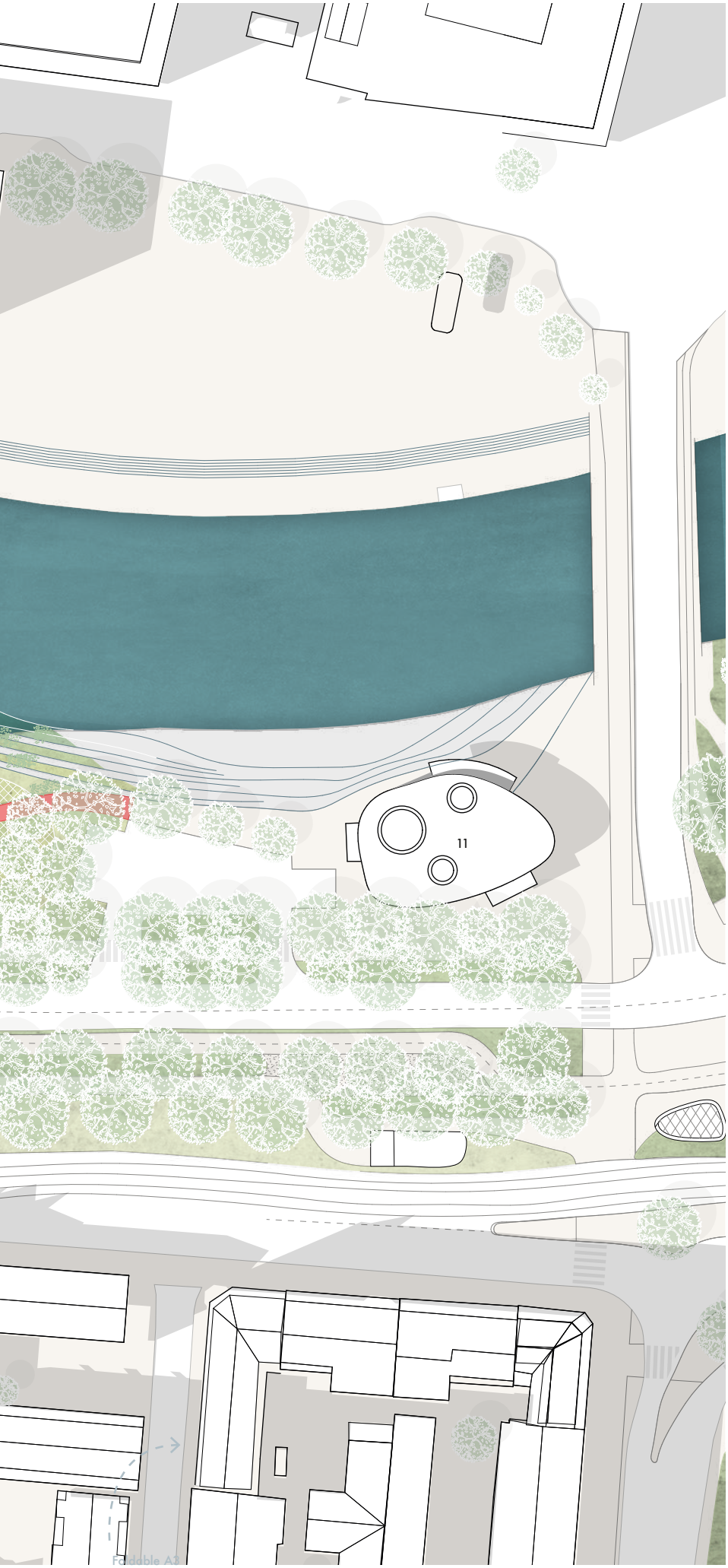


Symbol Key

- Green structures - existing
- Green structures - new
- Blue structures
- Pedestrian area
- Soft pavement for children
- Traffic road
- Tram lines

1 Swale
2 Biotope/Wetland
3 Street crossing ditch
4 Open channel
5 Bioretention
6 Multifunctional space
7 Detention Pond
8 Infiltration Trench

9 The Rain Roof
10 Amphitheatre

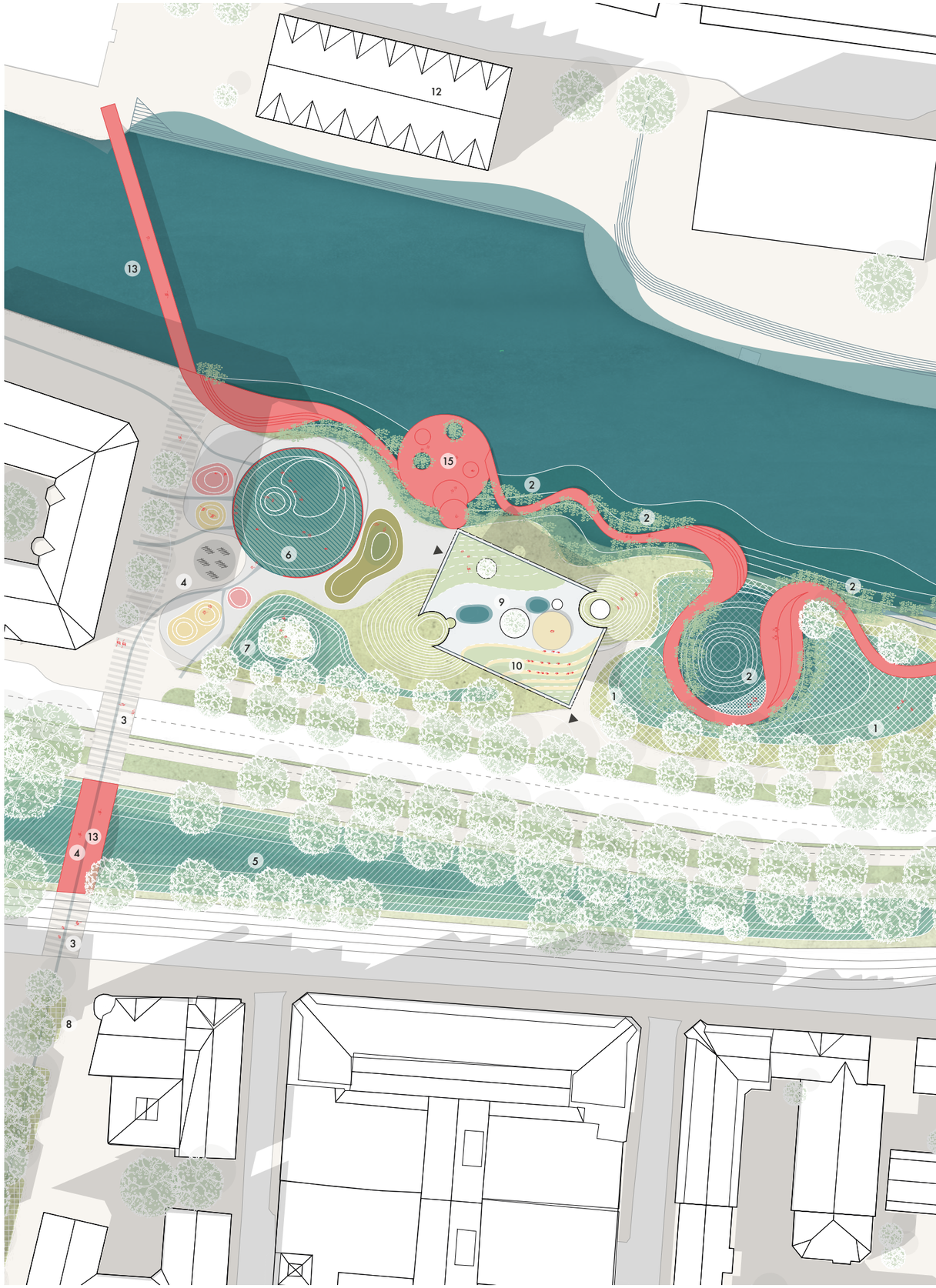
11 Haga Station
12 Feskekörka
13 Pedestrian Bridge
14 Pier (The Red Ribbon)

N

Scale 1:800 5 10 20 40m

Figure 29

Site plan
Scenario 1 - normal condition


12
13
15
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7
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1
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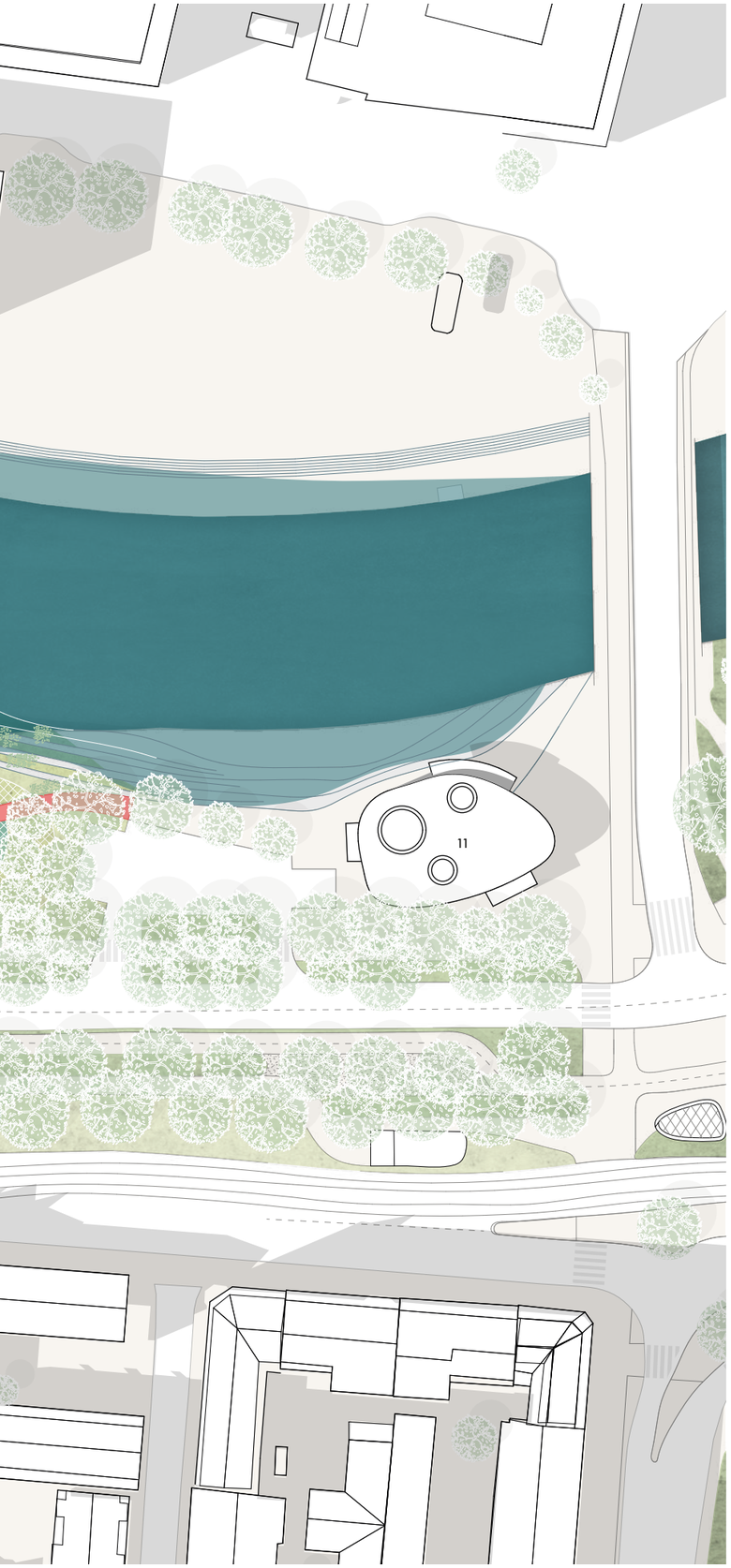
5
3
8



Symbol Key

- Green structures - existing
- Green structures - new
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- Soft pavement for children
- Traffic road
- Tram lines

1 Swale
2 Biotope/Wetland
3 Street crossing ditch
4 Open channel
5 Bioretention
6 Multifunctional space
7 Detention Pond
8 Infiltration Trench

9 The Rain Roof
10 Amphitheatre

11 Haga Station
12 Feskekörka
13 Pedestrian Bridge
14 Pier (The Red Ribbon)

Figure 30

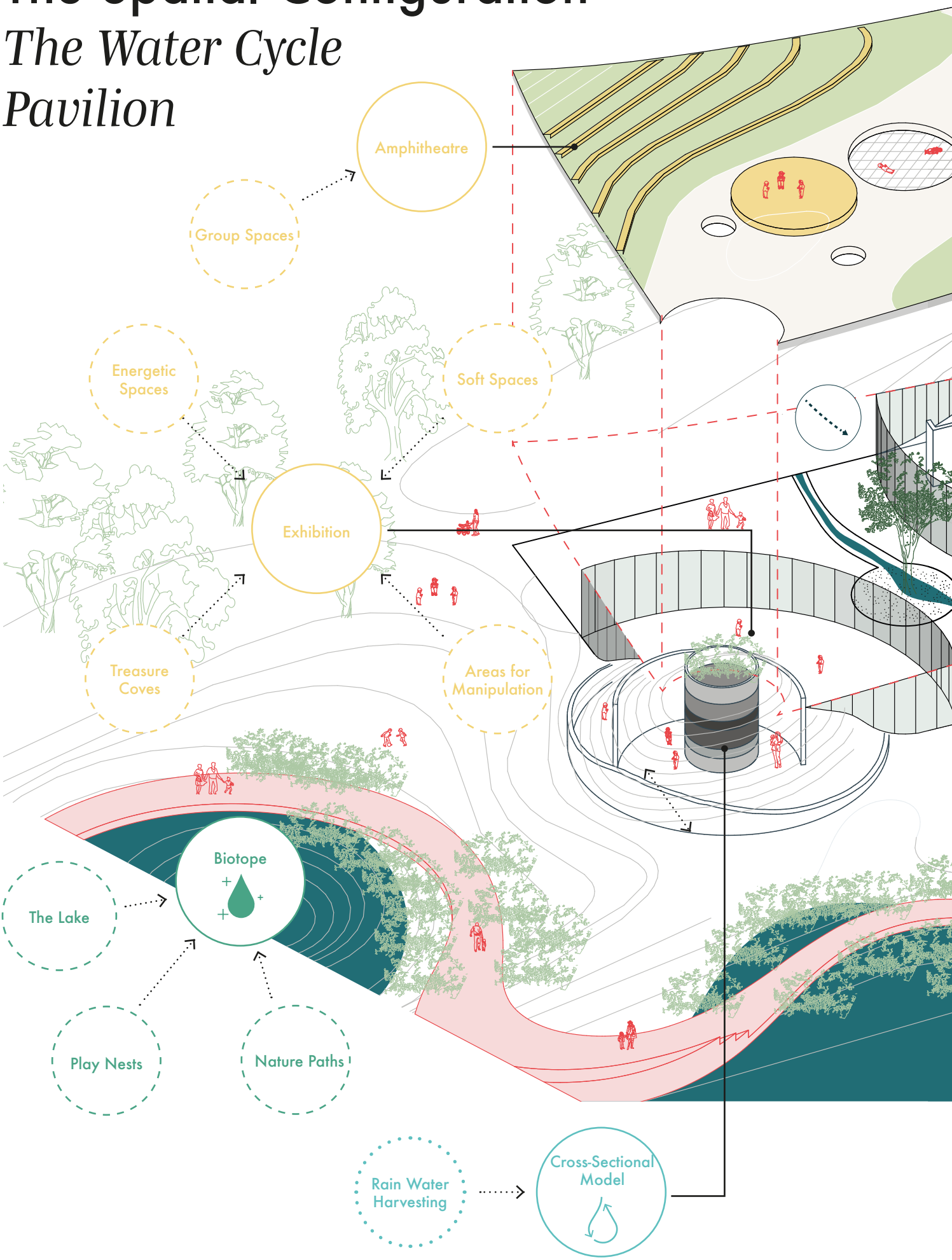
Site plan
Scenario 2 - flooded condition

N

Scale 1:800 5 10 20 40m

The Spatial Configuration

The Water Cycle Pavilion



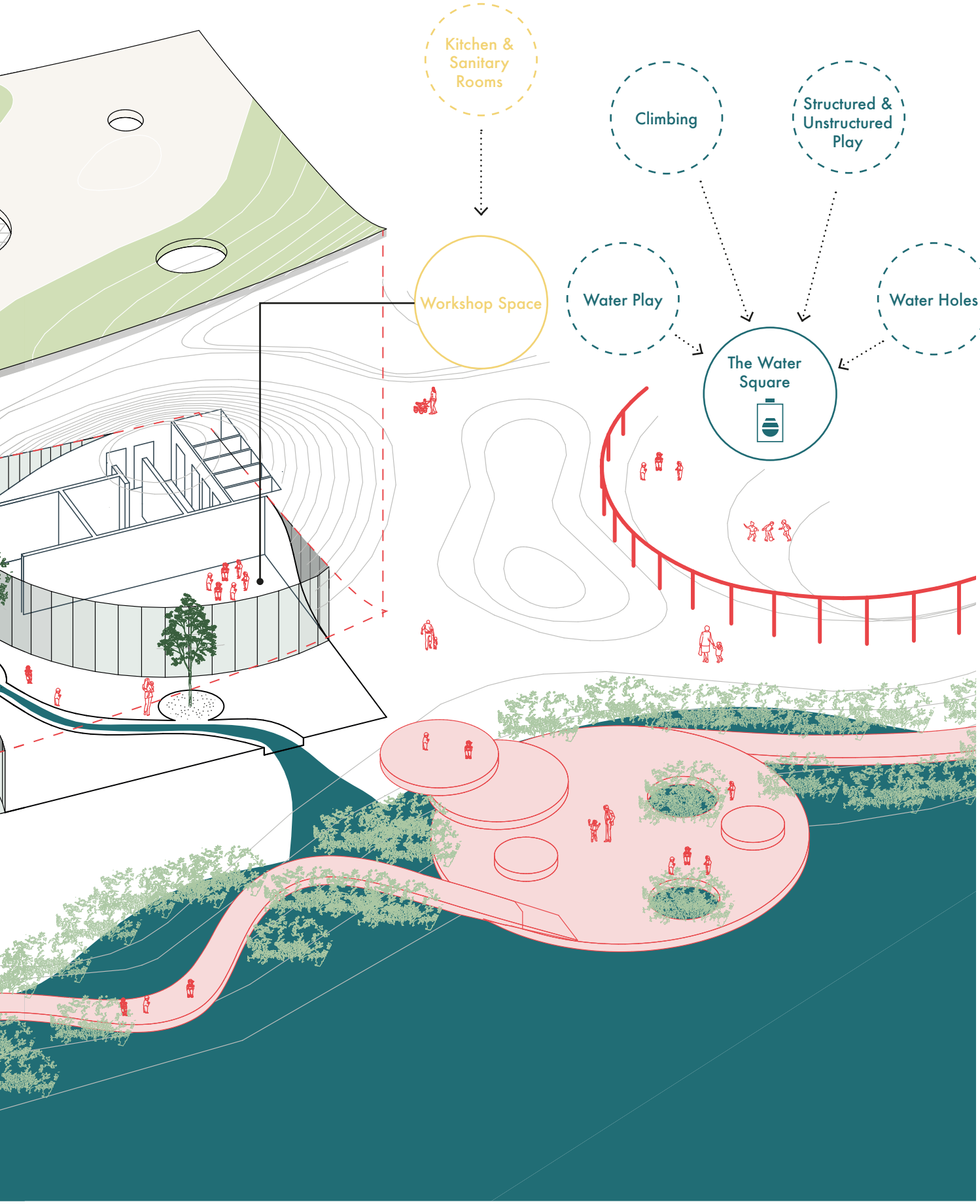


Figure 31

Axonometric Floor plan
Water Cycle Pavilion

N

Scale 1:250 1 2 3 5 7 10

Symbol Key

- Green structures - existing
- Green structures - new
- Blue structures
- Pedestrian area
- Soft pavement for children
- Traffic road
- Tram lines

1	Swale	5	Bioretention
2	Biotope/Wetland	6	Multifunctional space
3	Street crossing ditch	7	Detention Pond
4	Open channel	8	Infiltration Trench

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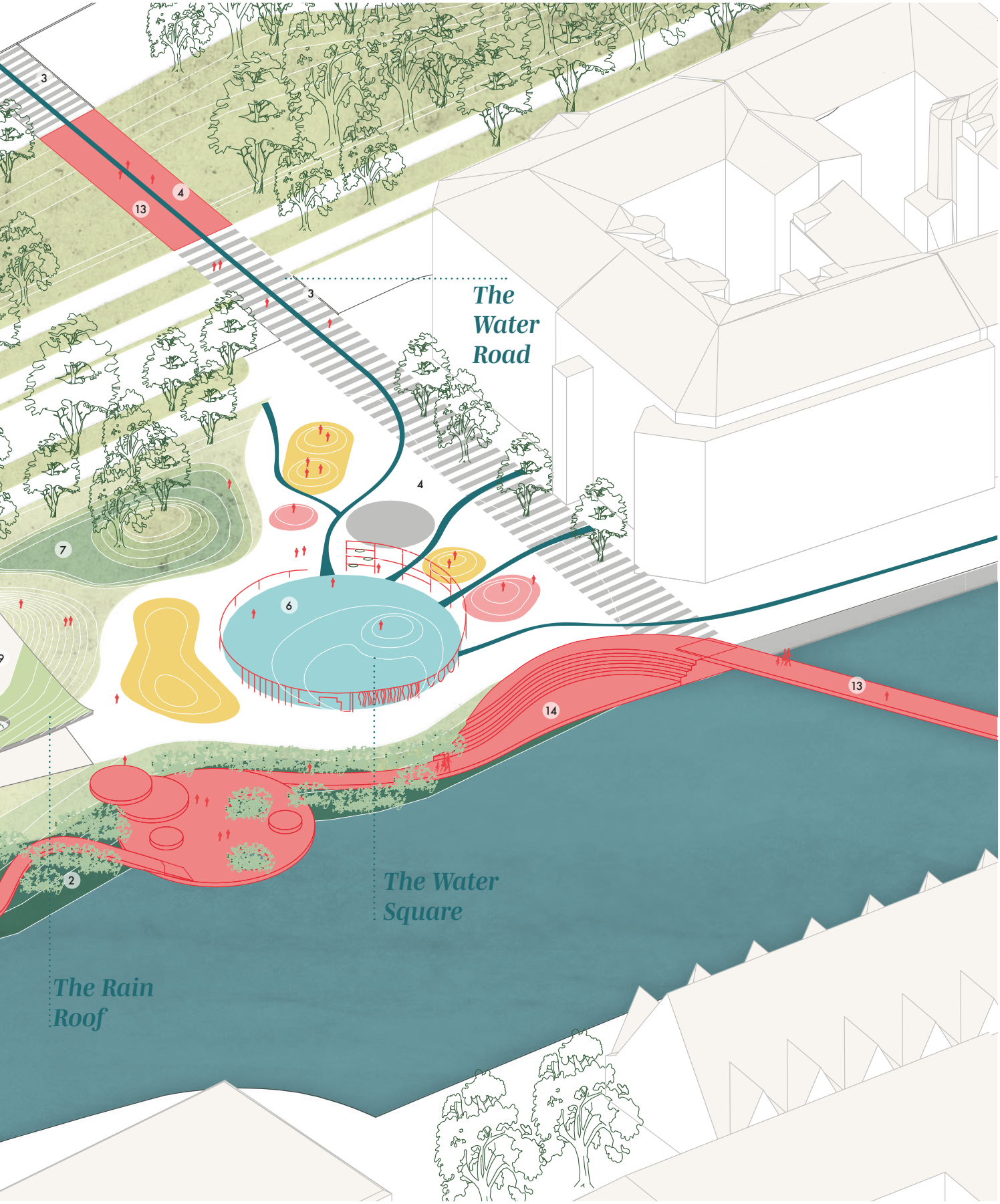


Figure 32

Axonometric Illustration
Scenario 1 - normal condition

9 The Rain Roof
10 Amphitheatre
11 Haga Station
12 Feskekörka
13 Pedestrian Bridge
14 Pier (The Red Ribbon)

Foldable A3

N

Scale 1:500

5 10 15 25m

Symbol Key

- Green structures - existing
- Green structures - new
- Blue structures
- Pedestrian area
- Soft pavement for children
- Traffic road
- Tram lines

1 Swale
2 Biotope/Wetland
3 Street crossing ditch
4 Open channel
5 Bioretention
6 Multifunctional space
7 Detention Pond
8 Infiltration Trench

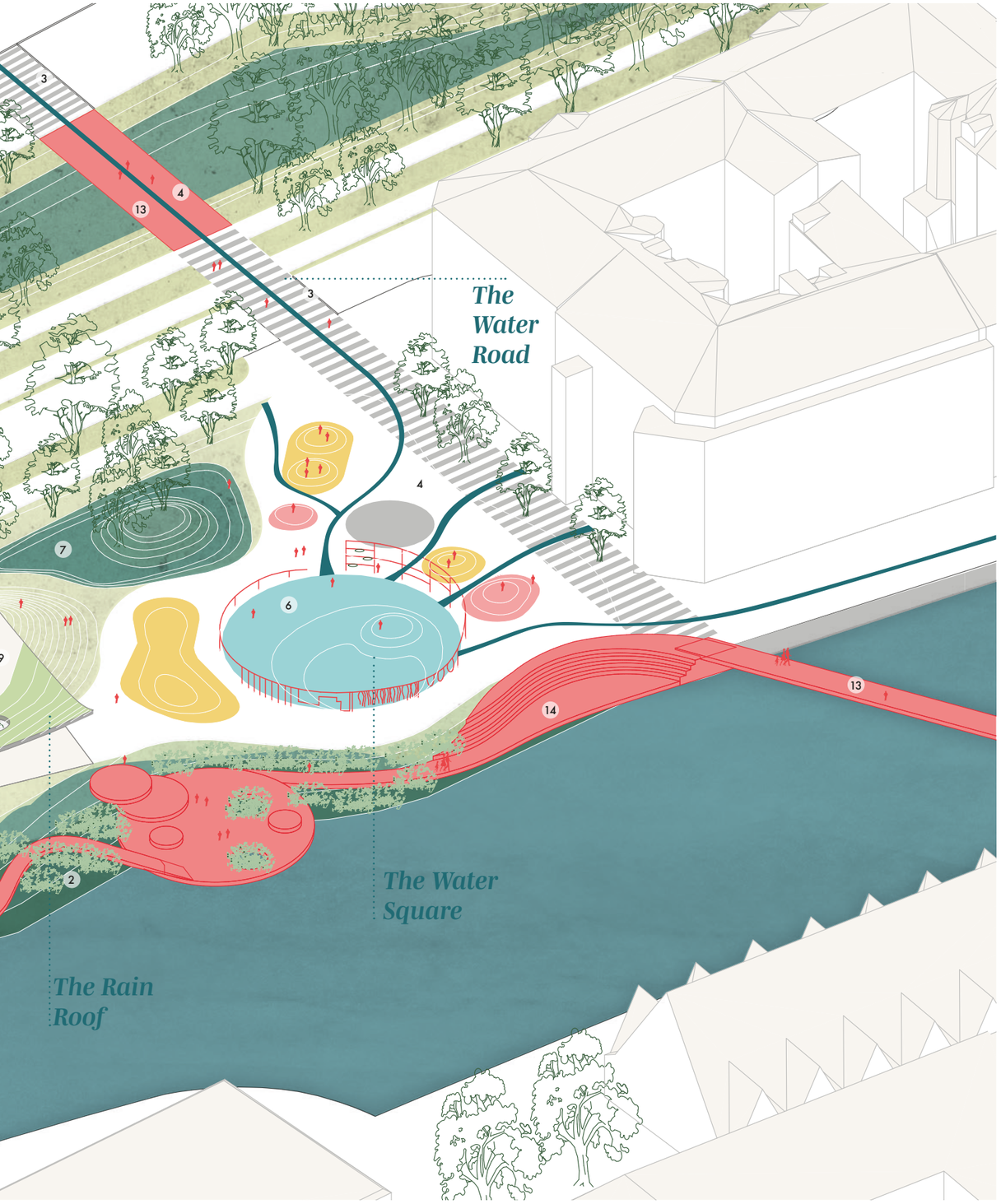


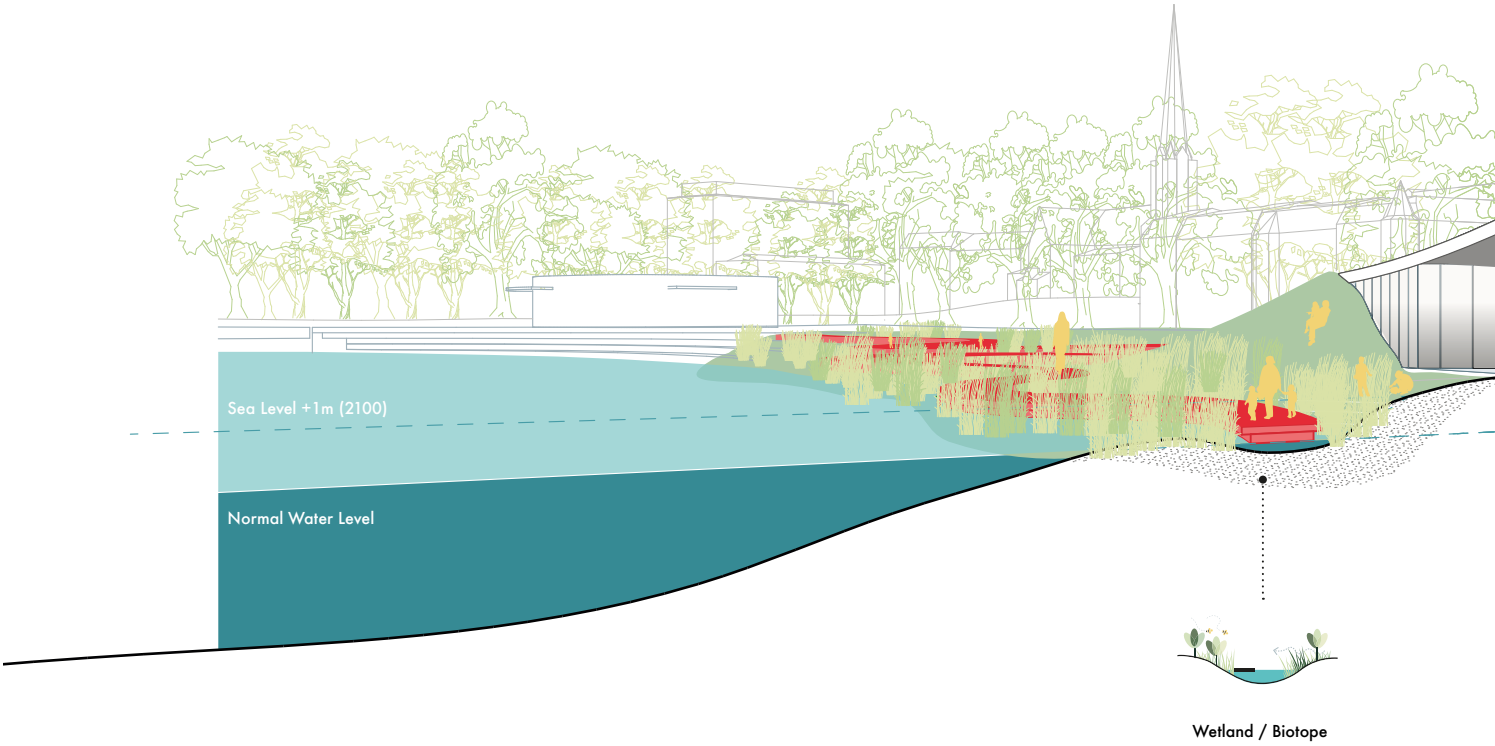
Figure 33

Axonometric Illustration
Scenario 2 - flooded condition

9	The Rain Roof	11	Haga Station
10	Amphitheatre	12	Feskekörka
		13	Pedestrian Bridge
		14	Pier (The Red Ribbon)

N

Scale 1:500 5 10 15 25m



Wetland / Biotope

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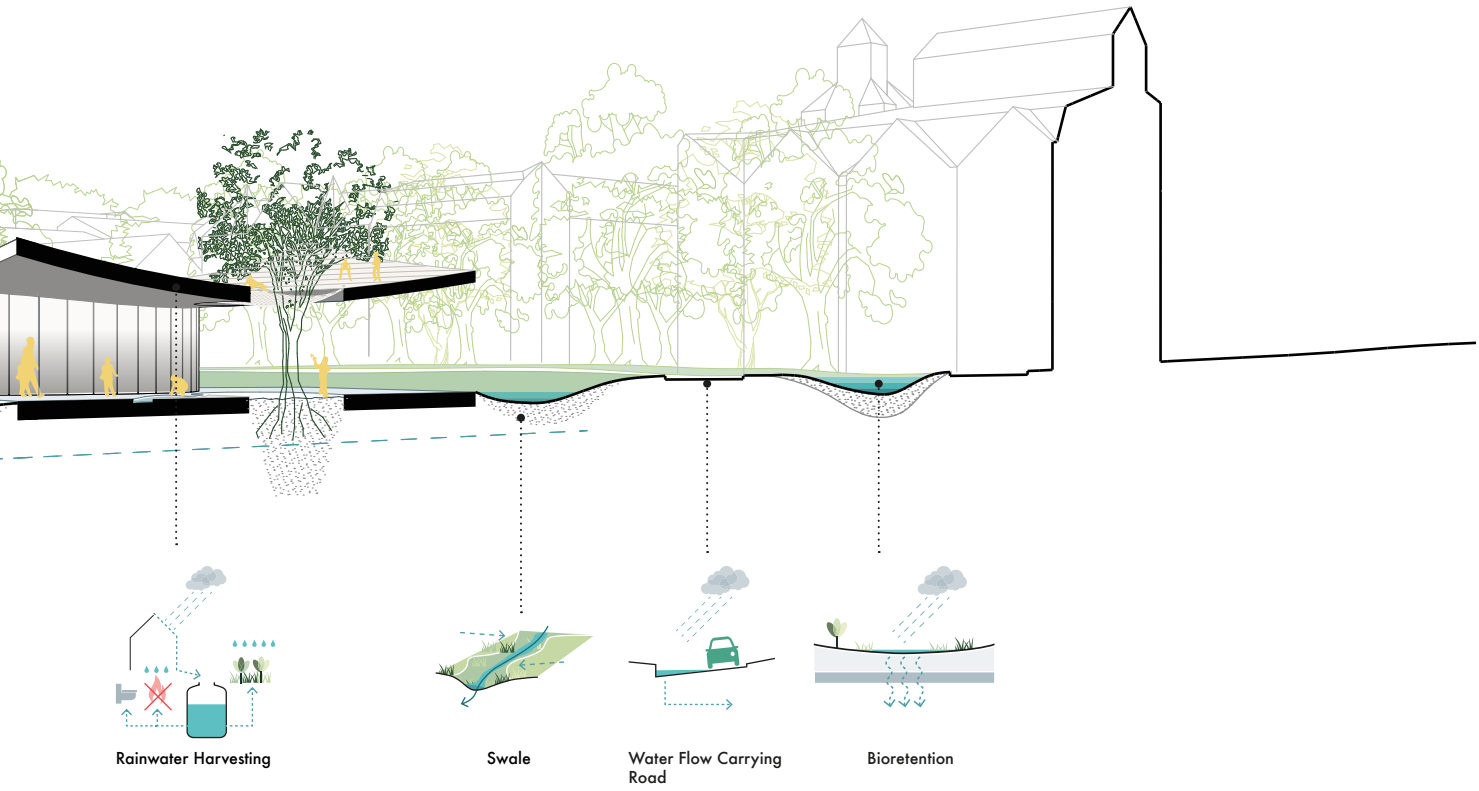

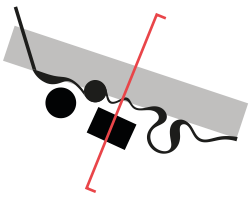

Figure 34

Perspective Section A - A
Scale 1:200

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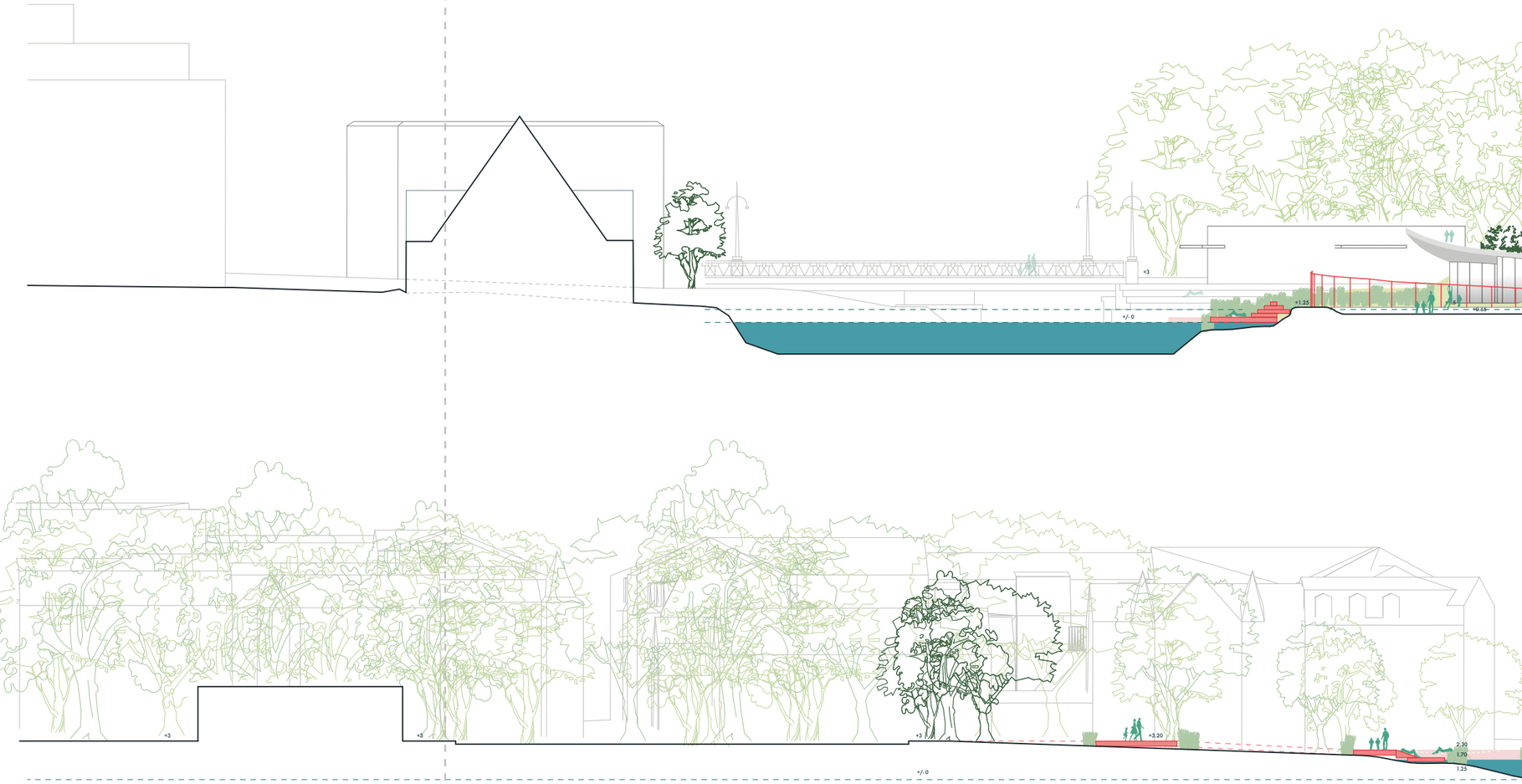
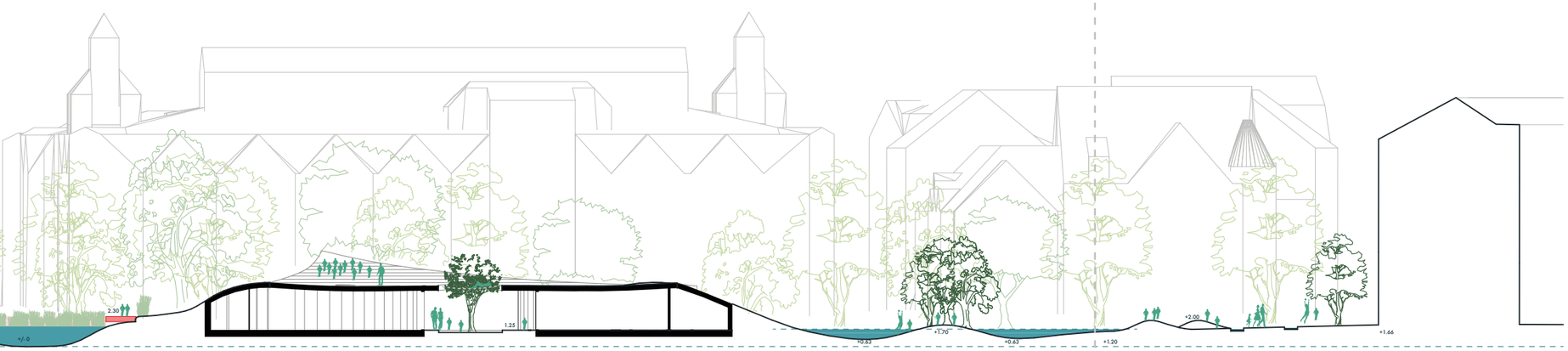
1 2 4 6 10m


+3
+/- 0
+1.25
+0.65
+3
+3
+3.20
2.20
1.70
1.25
+/- 0



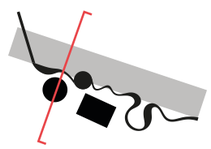


Figure 35

Urban Section B - B
Scale 1:400

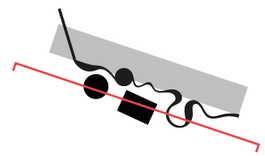


Figure 36

Urban Section C - C
Scale 1:400

5 10 20m

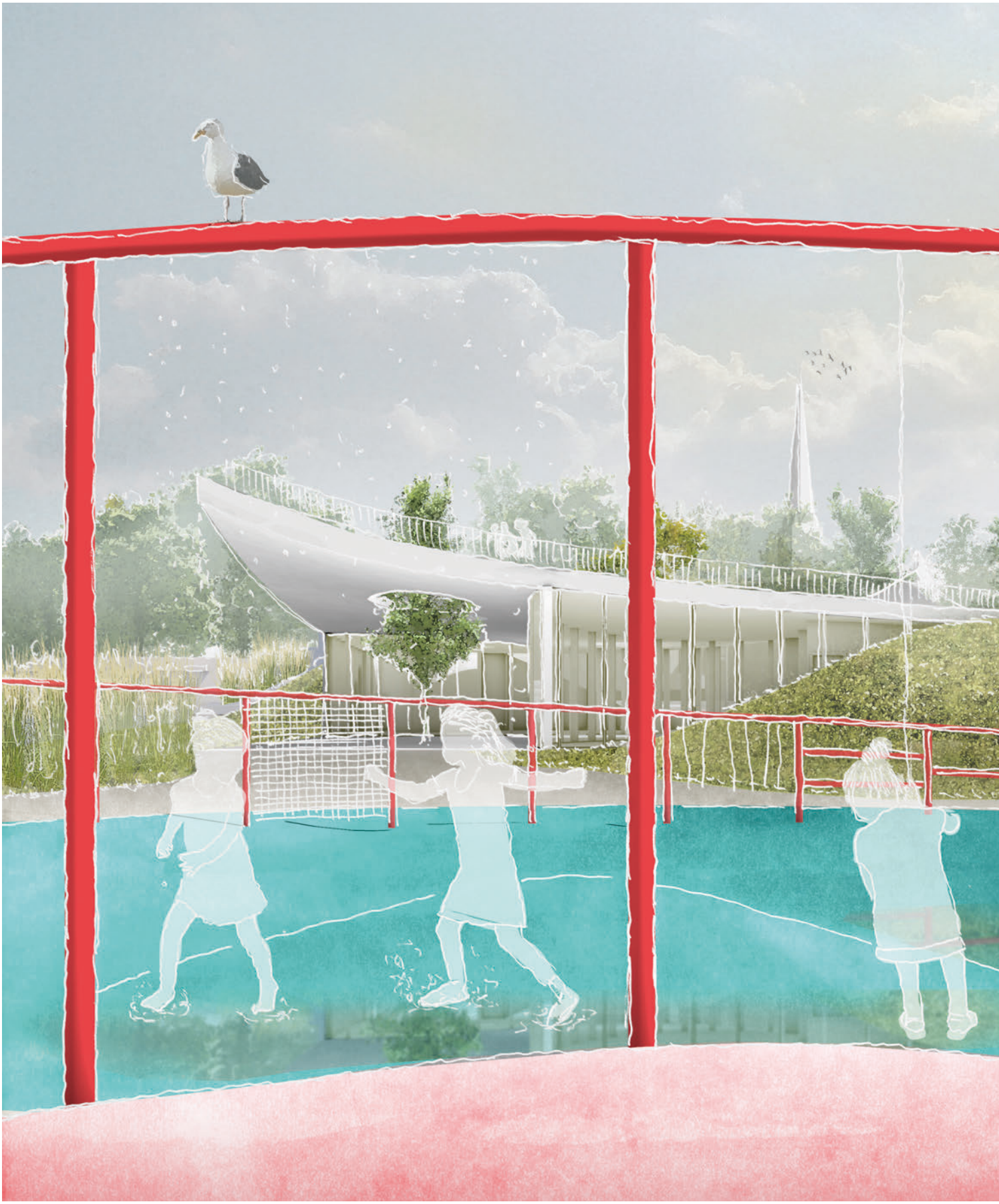


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Figure 37

"The Water Square"
Scenario 1 - normal condition

Foldable A3

Figure 38

"The Water Square"
Scenario 2 - flooded condition

Foldable A3

Figure 39

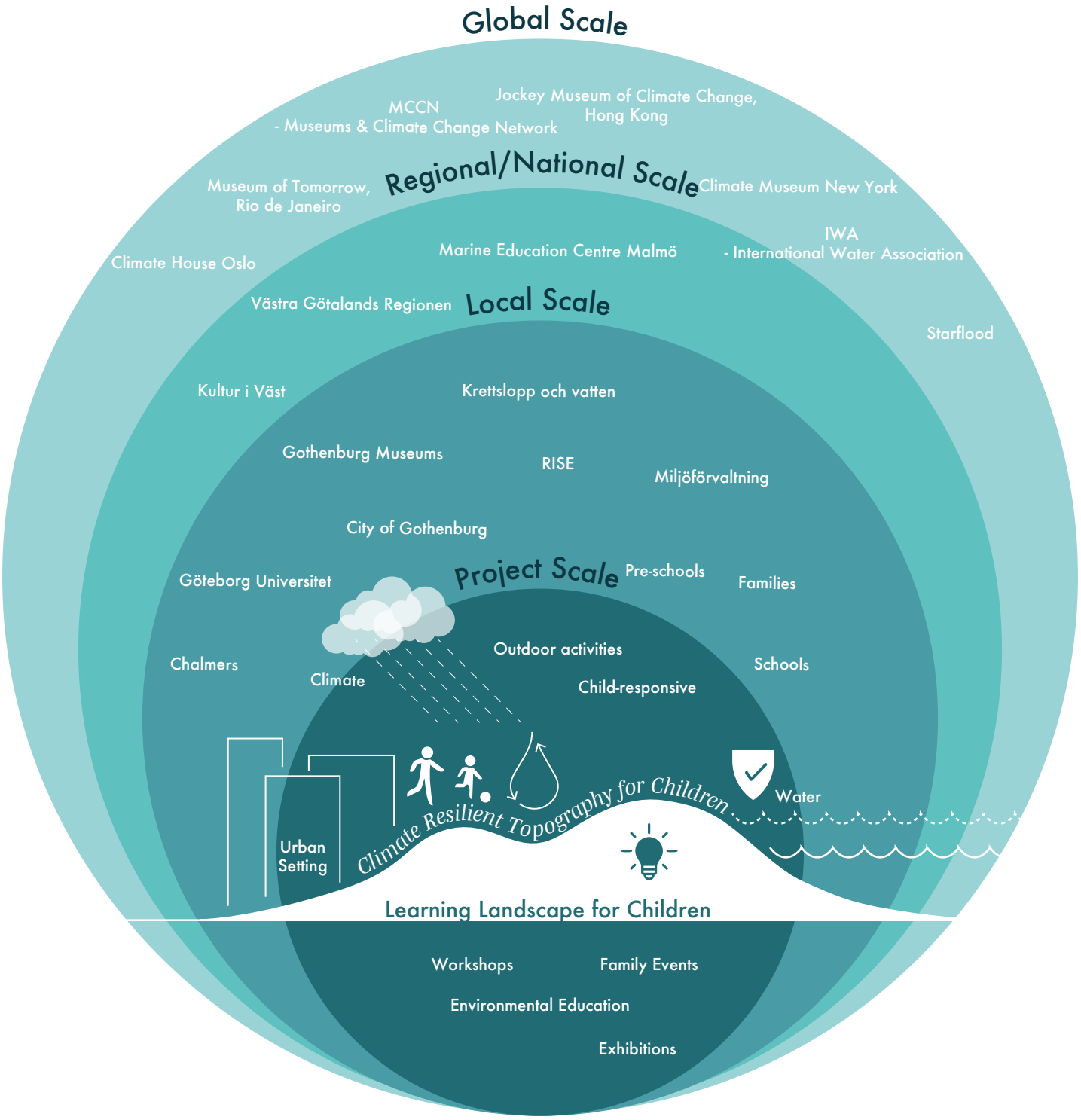
"The Wetland"
Scenario 1 - normal condition

Foldable A3

Figure 40

"The Wetland"
Scenario 2 - flooded condition

The Typology
Stakeholder and Scalability



The concept of the design proposal offers the potential to be exported in different contexts around the globe. Thereby, taking into account the children's perspectives should become a prerequisite in the fields of architecture and urban planning. Public spaces that connect learning environments with context-based challenges coupled with robust local and global partnerships could turn in a catalyst for urban innovation and international collaboration to support sustainable development.

Figure 41

Stakeholders and Potential Partnerships for the learning landscape.

Summary
Discussion and Prospects

The design proposal at hand is an urban design project for the City of Gothenburg. The method has been research-for-design focusing on the children's perspective and how public space specifically designed for children can become a tool in urban planning to educate about the environment. Knowledge about the fields of environmental psychology and built environmental education has been acquired to understand how space, movement, and flows affect children, and why play is such a crucial element in children's development. Water as the context-based urban challenge has been utilised to showcase Earth's water cycle, one of the essential elements for all living things.

The main focus of this thesis is to find synergies. Water Sensitive Urban Design complies with the children's perspective and environmental education as it provides sustainable and technical solutions. If designed appropriately, it can reveal a philosophy of sustainability which in turn can serve as a source of inspiration to solve pressing urban challenges, and challenges to come in the future.

The concept of the design proposal is the literal translation of the urban water cycle seen from a child's perspective, where the border between landscape and the urban are blurred and thereby embodies integrity. The project aims at full independent accessibility for children while telling a story about how challenges turn into playful opportunities. By embracing the logic of water, the learning landscape comes alive during different weather conditions and thus promotes playing outside all year round.

The design proposal is still at a very early stage, and many elements need to be refined and specified. Due to time constraints, aspects like the technical feasibility of the urban stormwater treatment have not been quantified. The planning of stormwater management is a complex field and requires a holistic planning approach. There can never be just one solution for a specific site, instead the entire context needs to be taken into consideration when dealing with water treatment. Thus, to develop the project further, the next steps would be to assess the feasibility of applied water sensitive design strategies, while considering the site as one piece of the puzzle in a complex system.

Furthermore, potential safety issues that occur when children are exposed to water have not been fully addressed. As significant the exposure to mild risks and challenges are for a child's development, as delicate is the topic of safety. In regards to water sensitive design solutions, more investigation about the safety of children needs to be done. The design of the Water Cycle Pavilion is still conceptual. However, together with the learning landscape, it could be developed further to become one of Gothenburg's embodied philosophies of being the best city when it rains.

Referring back to the research question, whether playgrounds can be integrated into everyday urban life as a tool to educate children on climate resilience, the research findings and the application of the design strategies suggest the answer be positive. The idea of a learning landscape integrated into the urban setting can be scaled into any other context since play can take place anywhere where the children's perspective is the starting point.

Children do not require much of a place in terms of furniture or equipment. For generations, children have been playing outdoors in nature without "proper" playground equipment. However, the process of urbanisation has made playing outside more complicated and more dangerous. Hence, a new way of thinking in terms of creating public spaces in the ever more urbanised world has to be established. Public spaces must not any longer be an additional asset to the urban environment, but need to serve beyond that. How can we live a truly sustainable life when we do not understand planet Earth's natural systems? Therefore, public spaces have to become playscapes, that incorporate nature and embrace their unique processes.

By combining sustainable technologies with a philosophy of sustainability, public spaces can tell a story about how everyday life is interconnected and can be a source of inspiration. As the climate crisis is a global problem which requires local solutions, architecture and urban planning can become driving forces, turning context-related issues into urban innovations. Nevertheless, public spaces must always incorporate the children's perspective. They need to leave room for imagination and inspiration and convey a clear message about how our life is connected to the environment that surrounds us. Only by that, we establish truly inclusive places that are multi-functional, multi-generational and contribute to urban resilience. Architecture and urban planning have always been reflections of present societal and cultural streams. It is up to us what kind of values we want to pass on to the next generation.

Reflection
The Process

The design at hand has been carried out by an adult with an adult's knowledge of what a child needs and wants from the environment. Although I did gain a solid knowledge base about how to design for children, I cannot quantify how successful I have been translating theory into the design, since I am not any longer the expert when it comes to playing.

Unfortunately, I could not carry out the design as detailed and developed as I had aimed for in the beginning. However, I learned a lot not only about the subjects at hand but also about myself and how I want to address architecture and urban design in the future. In retrospective, I took many detours that might have limited the final design in its depth of detail. Still, they were inevitable to conclude the project appropriately in its complexity and given time frame.

Before starting the Master's Thesis in February 2020, I had been fairly indecisive about finding and about delimiting the subject for a very long time. Mainly because I approach architecture always with a holistic mindset, and therefore I strive for designs that solve all problems at once. This is, of course, is a very subjective and utopian point of view. Nevertheless, this journey has been an intense but enriching experience. After all, I am glad that I stepped out of my comfort zone, and took the chance to explore new subjects. I am thankful for the given opportunity to experience the interplay of research findings and design solutions which contributed to widen my horizon how to approach a design before I start with my professional career as an architect.

Throughout the process, I only understood at the very end what it means to carry out a Master's Thesis in architecture. It is not about finding the perfect design that solves all problems at once. Instead, it is a given chance to explore what lies beyond the field of architecture and to acknowledge that other fields can become sources of inspiration for pushing the boundaries of architecture and urban design in terms of sustainable and resilient development.

For my future as an architect, I am excited to follow where the discourse on public space in regards to social and environmental resilience is heading. Especially since this Master's Thesis has been conducted during the COVID-19 epidemic, the spreading of worldwide diseases may give the planning of public spaces another dimension. Thus, spaces for children in the city may become ever more important since being outdoors is so crucial for their personal development.

Last but not least, we should strive to revive the inner child every now and then. The easiness of children and their eagerness to explore the world playfully might be exactly what we need to encounter humankind's greatest challenge, climate change.

Manifesto for the Climate Smart Citizen

Principles for a Resilient City

1. Children are the designers of the future. Our behaviour influences their behaviour. Our perception of things paints their image of the world. What kind of image do we want to paint for the next generation?

2. Designing for the future means seeing the world with children's eyes. Again.

3. Children have the right to play. Cities need to internalise this. They need to be playable.

4. Children learn through play. Playing nurtures creativity and the skill of problem-solving. A city which incorporates this is future proof.

5. In this fast pace society our cities are constantly changing shape, and so is the concept of play for children. By combining playability and resilient solutions as a tool for spontaneous change of our perception of the urban landscape, we can enhance engagement and societal cohesion.

6. Climate Change and its threats are real. People, especially children, around the globe are noticing that our impact on the environment is vast. Experiencing change forces people to adapt, denying change is possible but not reasonable.

7. Architects are problem-solvers. Embracing environmental change as an opportunity to experience our influence on the environment can be a powerful tool to change our perception.

8. Acknowledge the threats and embrace the opportunities!

9. Children around the globe are fighting for their future. It is time to join them.

10. We shape our environment. Our environment shapes us. It is a never-ending process. Incorporating the children scale in every aspect of our design will embrace safety and resilience in our built environment.

11. Visual complexity over uniformity.

12. We, as architects, urban planners and designers, need to shift the paradigm. Including the child perspective and scale in our design should be the norm, not the exception.

13. There is not such a thing as bad weather, only bad urban design.

14. Make playing outside great again.

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Appendix I
Theory

Figure 42

Maximal depth of water and surface water flow in the case of a 100-year-event.

Retrieved from Persson et al. (2015, p. 26)

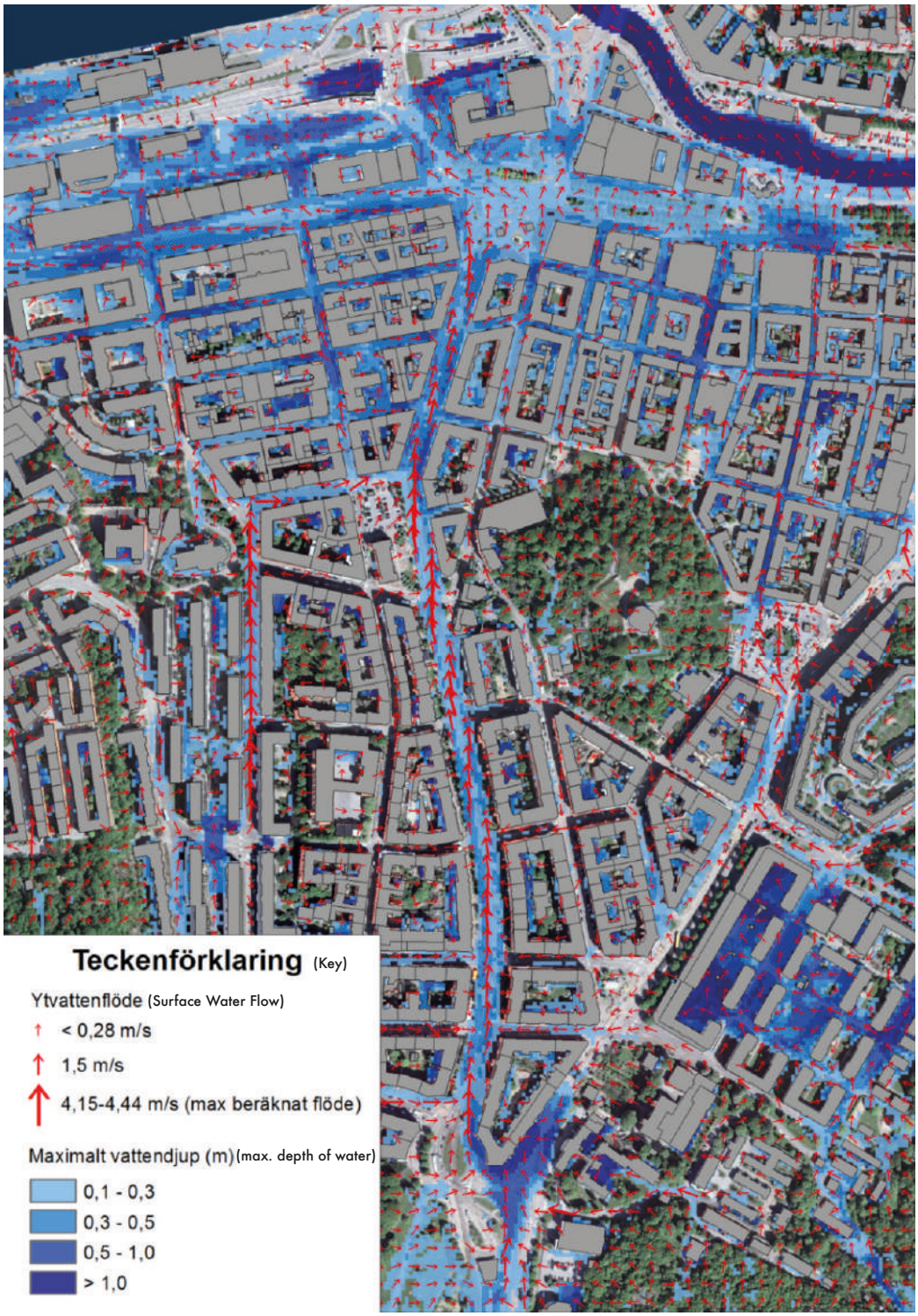


Figure 43

Maximal depth of water and surface water flow in the case of a 500-year-event.

Retrieved from Persson et al. (2015, p. 27)

Figure 44

Flooding caused by projected high flood scenario in the year 2070 with a calculated sea level rise of 2,30m (H200).

Results based on a hydro model of MSB's flooding mapping

(retrieved from vattenigöteborg.se, 2020)

Figure 45

Flooding caused by projected high flood scenario in the year 2100 with a calculated sea level rise of 2,65m (H200).

Results based on a hydro model of MSB's flooding mapping

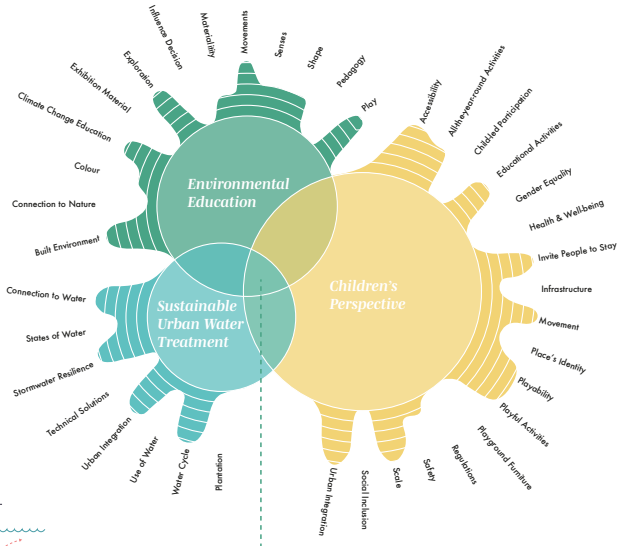
(retrieved from vattenigöteborg.se, 2020)

Appendix II
Final Seminar

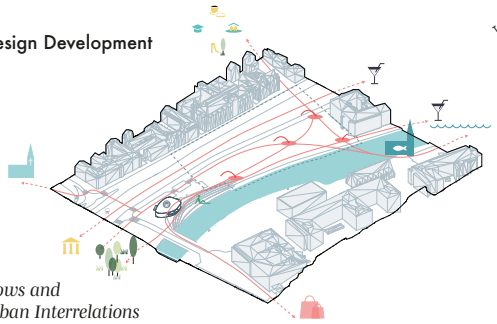
Playable *Adaptivity*

Composition I

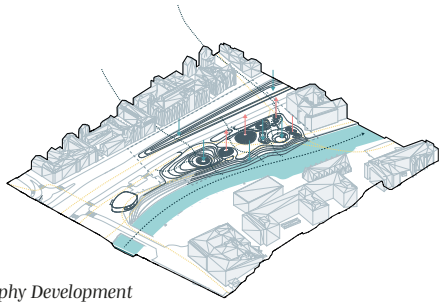
Research-for-design
Context-based Urban Challenges



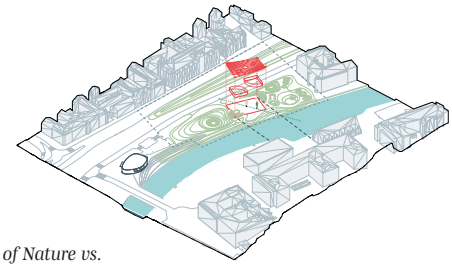
Design Development



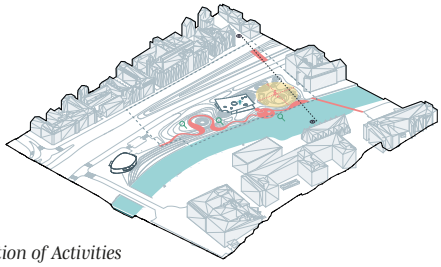
Flows and
Urban Interrelations



Topography Development



Shapes of Nature vs.
"Human Thought"



Distribution of Activities

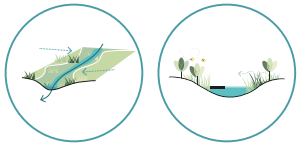
Axonometry

Scale 1:500

Application of Theory

Connection Children
Education
& Water Sensitive
Urban Design

Capture *Reuse* *Recharge* *Clean*



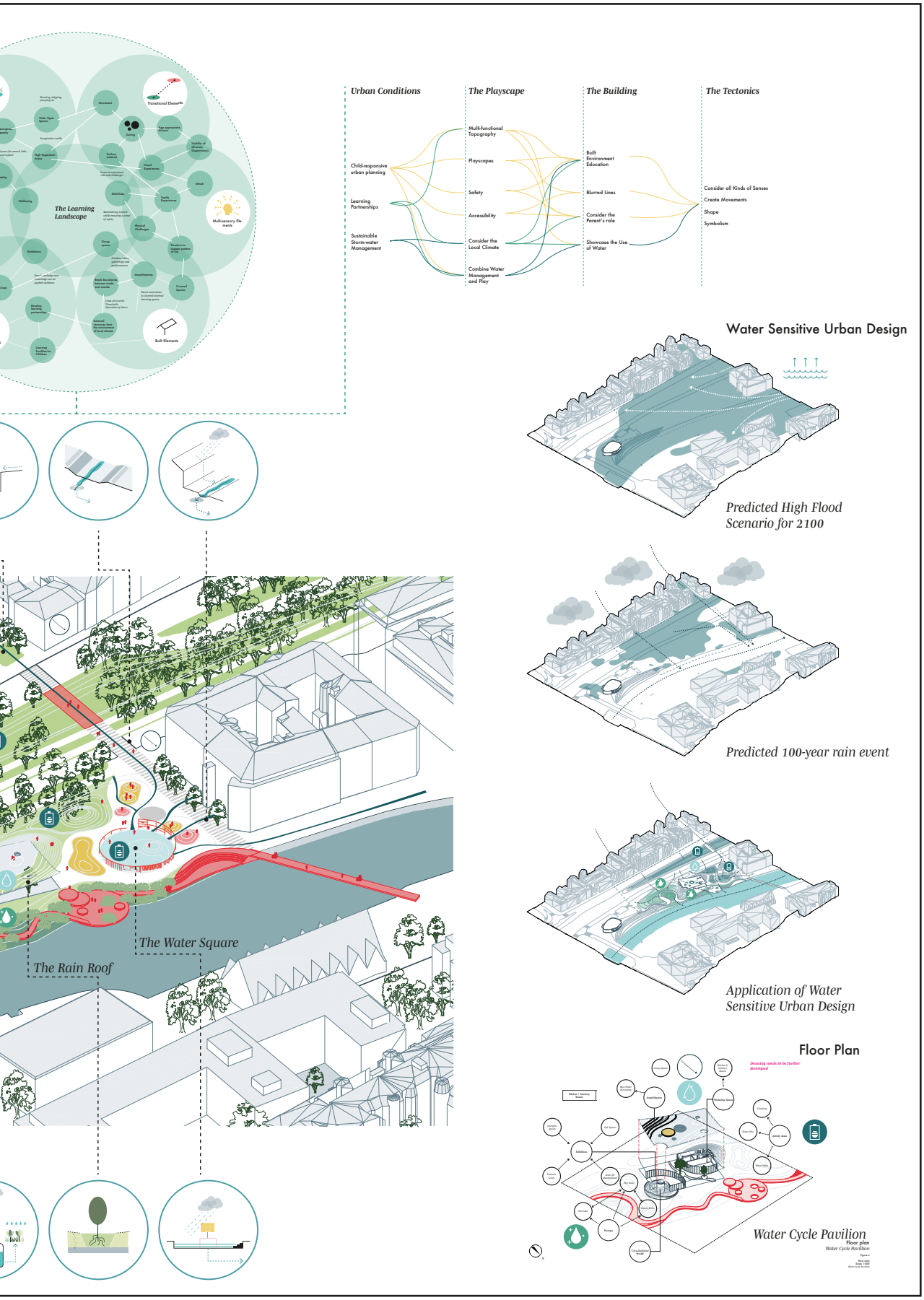


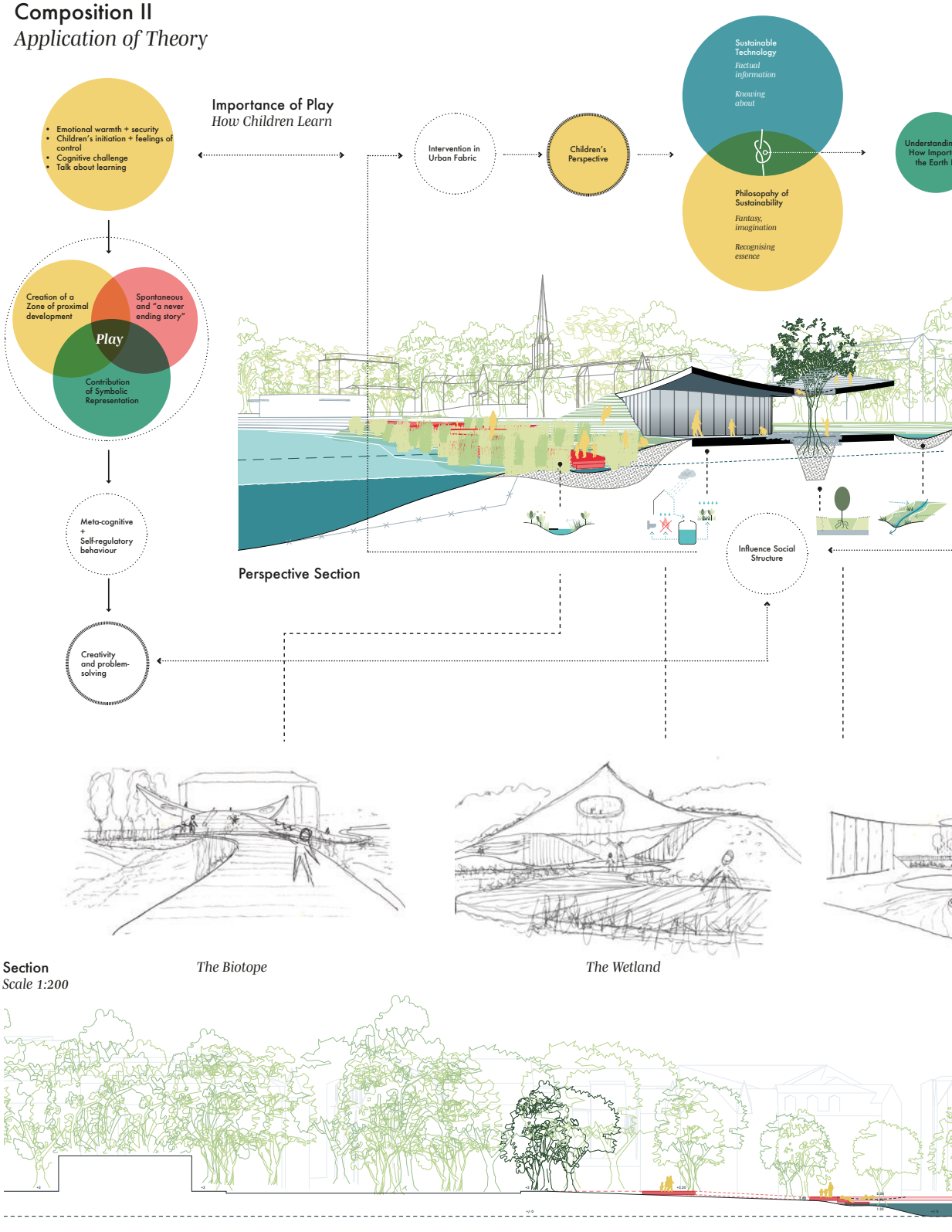
Figure 46

Composition Poster 1
Final Seminar

Playable *Adaptivity*

Composition II
Application of Theory

Environmental Education
Designing Behaviour



The Biotope

The Wetland

Section
Scale 1:200

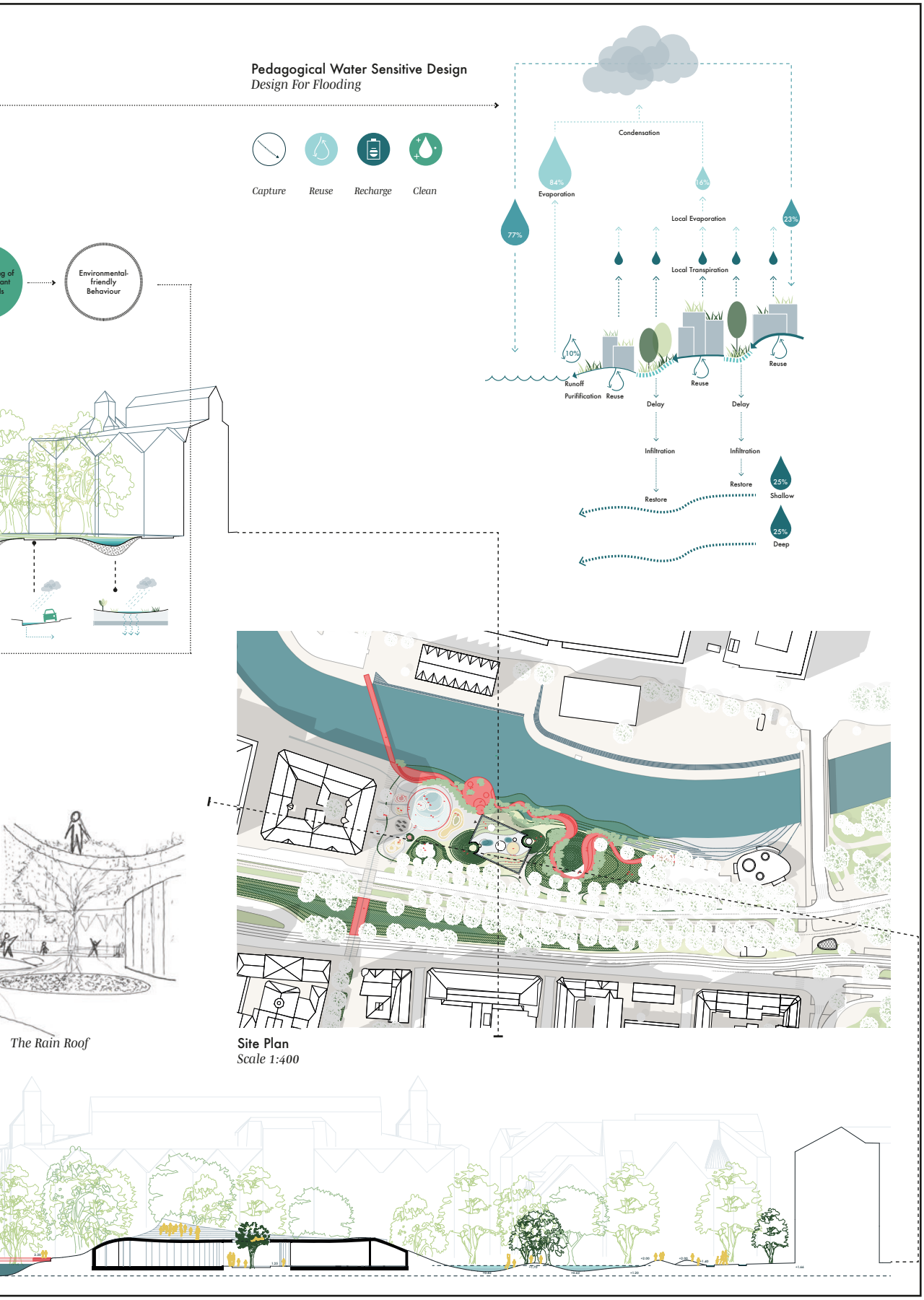


Figure 47

Composition Poster 2
Final Seminar


AVANCEZ
1829
CHALMERS
UNIVERSITY OF TECHNOLOGY