Towards a Water friendly neighbourhood

Introducing a balanced water cycle for new neighbourhoods in Delfland, as an example for future Dutch developments

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Acknowledgement

This report has been written in collaboration with the Waterboard of Delfland. A graduation assignment that is set up within the water networks of Schoon en Gezond water, Netwerk Waterketen Delfland (NAD) and Klimaatadaptatie. In this project, several municipalities, water companies and the district water board are working together, in search of a reliable, future-proof and sustainable water cycle on a neighbourhood level.

Under the guidance of first mentor Kristel Aalbers, second mentor Anne Loes Nillesen and the core team from NAD: Merel Mostert, Ewald Oude Luttikhuis, Nathalie Lorenz, Kitty Vollering, Ruel Blom and Rolf Bloemheuvel, this project has been developed.

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Glossary

Water nuisance
a collective term for situations where people experience inconvenience due to too much water (Encyclo, n.d.-b). In this project, the term stresses water nuisance due to rainfall or seepage.

Water quality
describes the condition of ground and surface water of chemical and biological properties. In respect to its suitability for drinking, recreation and as a habitat for aquatic organisms (Encyclo, n.d.-a).

Water quantity
refers to the amount of water in a waterbody (Waterkwantiteit, n.d.). In this project, the concept is linked with the amount of available drinkable water.

Water cycle
encapsulates the cycle of processes in which water moves between earth's seas, atmosphere and land (Oxford Reference, n.d.).

Water and soil
Refers to the integrated approach to water management and soil use as guiding factor in spatial planning and environmental management.

Green and landscape
Green and landscape are the tangible key elements providing ecosystem services. Therefore sustainable ecological practices are crucial for a resilient and liveable future.

Human and water
Stands for the important relation between human and water, in which awareness, social interaction and participation with water are central.

Liveability
Liveability represents the overall feeling of satisfaction in life. In this project, Liveability will focus mainly on human needs for social interaction, rest and physical movement.

Stuw
A stuw is a hydraulic structure whose purpose is to influence the water level in a stream, brook or river (Nederlandse Hydrologische vereniging, 2002).

Duiker
Sleeve-shaped structure, connecting two water bodies (Nederlandse Hydrologische vereniging, 2002).

Drainage pump
Removing excess water by means of a pumping station (Nederlandse Hydrologische vereniging, 2002).

Open water system
Surface water, above the ground, in which water can flow freely.

Temporary water system
A temporary water system is a water system that is not permanent but contains water only during certain periods of the year.

Abstract

In the face of climate change, water challenges and rapid urbanisation in the area of Delfland, we stand at a pivotal moment where the way we design our cities will have a significant impact on how we will live in the future. As the Water and soil system is reaching its limits in trying to fulfil our human centric needs. A shift towards a water-oriented urban development is needed to safeguard a sustainable future. Therefore the following research question is defined: ***"How to envision a balanced water cycle for new neighbourhoods in Delfland while establishing a synergy between water, ecology and humans?"***

The maximisation method has been used to find solutions for the four challenges of Water and soil, Green and landscape, Human and water and Livability. While exploring scenarios of an open and temporal water system through the Purifying vein and the Urban sponge. The methodology, when combined with the established pattern language, creates a transferable approach for upcoming Dutch developments. With overarching recommendations such as: Integrated approach, Water as metabolism, Design with temporality and be a Team player. In addition, with specific advice to use a temporal water system as a starting point, but consider an open water system when subsidence is problematic, water treatment is required, when there is regular rainfall and sufficient space obtainable. Regarding Fortunapark as a case study, it is recommended that the Urban sponge (temporal water system) forms the fundamental basis that embodies a Water friendly future-proof neighbourhood.

Key words: Water friendly neighbourhood, balanced water cycle, water-oriented design, water soil stirring

List of content

Chapter 0.

Introducing the imbalanced water cycle

The issue of having enough and qualitative water has been an increasing environmental challenge that poses a threat to both the environment of ecosystems as for human health and safety. The Netherlands, and especially Delfland is one of the most vulnerable locations to live, being a delta and located under sea level. While there is also a need to keep building, questions have been raised among institutions such as the National government and Waterboards on how to build sustainably. This pressing matter thus calls for a re-evaluation of the current building practises.

"Een klemmende oproep aan alle partijen in het ruimtelijk domein: kijk naar de consequenties voor de lange termijn bij de keuzes van vandaag."

- Deltacommissaris Peter Glas

Figure 1: Water nuisance de Lier (AD, 2018)

Figure 2: Drought in rivers (NOS, 2018)

0.1 Introduction

The climate is changing (KNMI, 2023b). With major consequences that can be mostly felt in the water cycle. Melting ice caps and intensified rainfall will cause sea level rise that can be felt through water nuisance. As well as, with the rise of droughts, surface water will reduce through evaporation and will give an unstable supply of quantity of water. In both situations where you have an uncontrolled shortage or excess of water, there will also be a risk to the water quality, including salinization, a shortage of oxygen in water bodies etcetera.

These climate conditions create an imbalanced water cycle from a human perspective, but it is the unsustainable behaviours (Plumwood, 2002) that forms the root of the problem. Seeing nature only as a means to maximise the needs of humans has challenged the ecological system and therefore the water cycle.

It can be stated that current water practices are causing an imbalanced water cycle for water quantity and quality. In the context of Delfland, a region that not only has to deal with a water crisis, but is also running into a housing crisis, answers are needed in how the relationship between humans and water will take shape when building new neighbourhoods. Addressing this problem is important in order to ensure a balanced water cycle of new build neighbourhoods, in the Netherlands.

The primary research question of this report is:

"How to envision a balanced water cycle for new neighbourhoods in Delfland while establishing a synergy between water, ecology and humans?

This report seeks to contribute to the development of a new paradigm for neighbourhoods in Delfland in which spatial decisions will be based on the perspective of water in relation to humans and ecology. By examining the interconnected challenges of water quantity and quality, alternatives will be explored in the realm of Water and soil, Green and landscape, Human and water and Liveability.

The case study neighbourhood is Fortunapark (figure 3), located in the city of Vlaardingen in the Netherlands. This neighbourhood falls under the water authority of the Waterboard of Delfland. Fortuna park covers approximately 63.834,51 m2 and is currently a green plot of land situated in a polder landscape.

Figure 3: scales of the project

0.2 Project framework

This project framework structure (figure 4) is based on a systematic approach that addresses the complex issues concerning an imbalanced water cycle to subsequently work towards the transition of a balanced water cycle for new neighbourhoods in Delfland.

Firstly, the report will introduce the premise in the context of climate change in which existing problems of the water cycle on a global level will be exposed. Furthermore, the fundamental environmental culture that has driven climate change in the first place will be discussed. To then zoom into the case study of Delfland in which the imbalanced water cycle will be unpacked. Demonstrating the flow of the water cycle and showcasing the operational foundation through the history of the Dutch water management and the international importance for water.

Following that, the project will look into the ambitions of the different pillars of Water and soil, Green and landscape, Human and water and Liveability. Through the use of scenarios in which the pillars have been optimized towards two water stirring designs in the perspective of water quantity and water quality, while finding synergies between water, ecology and humans. Subsequently an evaluation has been excecuted to assess the different scenarios,that has resulted in an integration for Fortunapark as a Water friendly neighbourhood. The results of this Water friendly neighbourhood can be transferable for other locations.

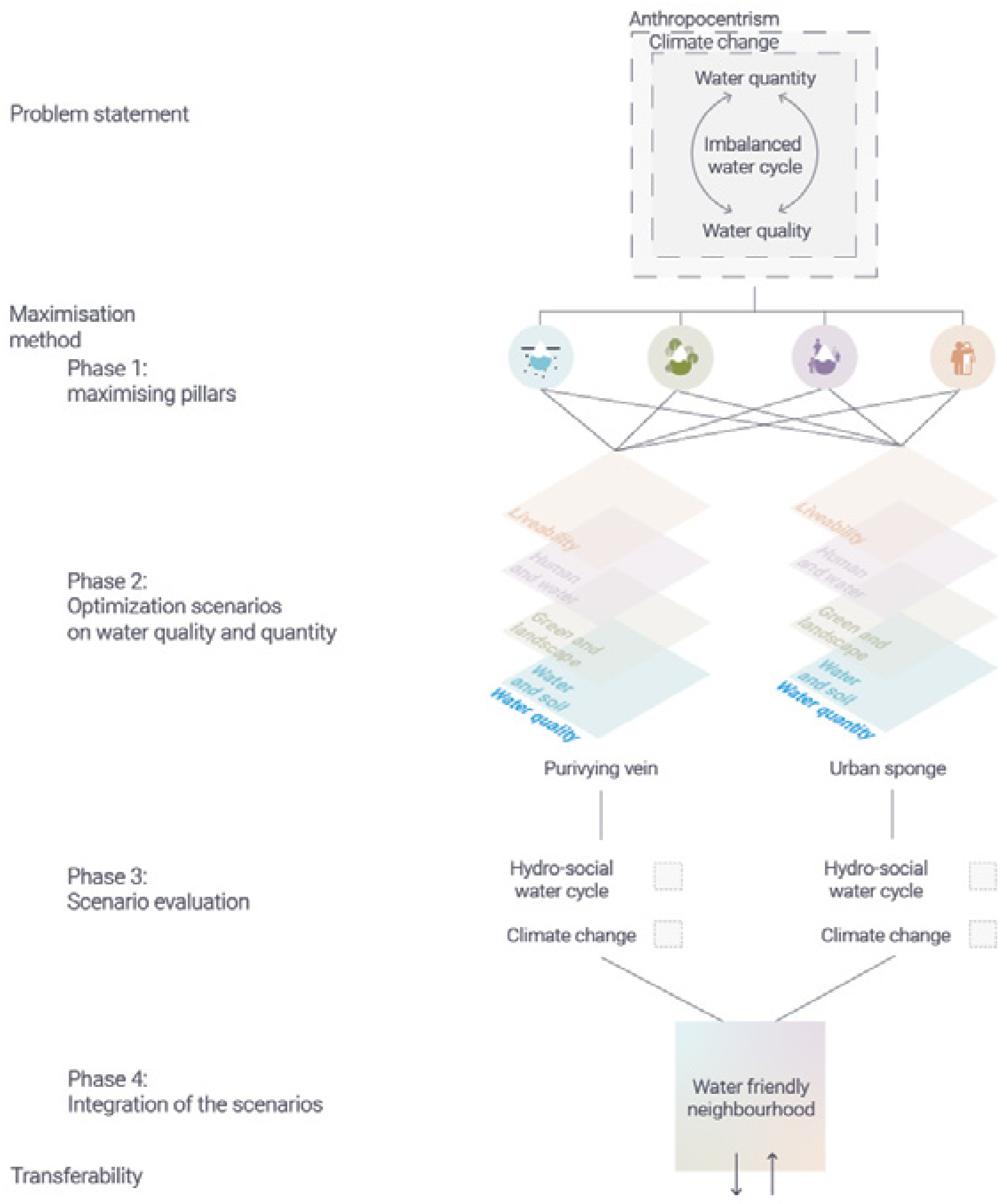


Figure 4: Project framework

Chapter 1.

Unpacking the imbalanced water cycle

This chapter introduces water concerns from both global and regional scales and emphasises the urgency of attaching more importance to sustainable developments regarding water. Then, by giving an overview of the current water issues and the urgency for building houses within the confines of the waterboard of Delfland a problem statement is developed to illustrate why a systemic change is needed.

"I am water

soft enough to offer life
tough enough to drown it away"

- Rupi Kaur

1.1.1 Climate change

Since the industrial revolution, man's influence on climate has rapidly increased. This is mainly due to the emission of greenhouse gases such as CO2 and methane. Greenhouse gases cause heat to be trapped, which causes the earth's temperature to rise. If emissions of greenhouse gases continue at the same rate, the earth will get warmer and warmer (Ritchie & Roser, 2017). According to Nasa Earth Observatory (n.d.) the average global temperature on Earth has increased by at least 1.1° Celsius since 1880. It is predicted that due to human activity the temperatures will rise even more, causing droughts, sea level rise and heavy precipitation (KNMI, 2023b).

With major consequences that can be mostly felt in the water cycle. Climate change and the water cycle are inextricably intertwined. Warmer temperatures stimulate evaporation and reduce surface water. Creating droughts in periods when there is little precipitation. This puts pressure on **water quantity**, which creates an unstable drinking supply (KNMI, 2023b). In addition, droughts also have consequences on the **water quality** by jeopardising biodiversity and human needs. This is mainly because the reduction in water levels creates a higher concentration of contaminants. Additionally, the water is more likely to have higher temperatures that decreases oxygen, promoting the growth of harmful bacterias, making it unsafe for species, consumption, or leisure activities (Mosley, 2015). Sea level rise contributes to salinization by intruding into fresh water sources, harming water quality (Lassiter, 2021). Lastly, sea level rise and heavy precipitation create higher chances of flood risks which also puts pressure on the **water quantity** in terms of water nuisance (KNMI, 2023b).

"Global temperature is projected to warm by about 1.5 degrees Celsius (2.7° degrees Fahrenheit) by 2050" (Wisconsin DNR, n.d.)

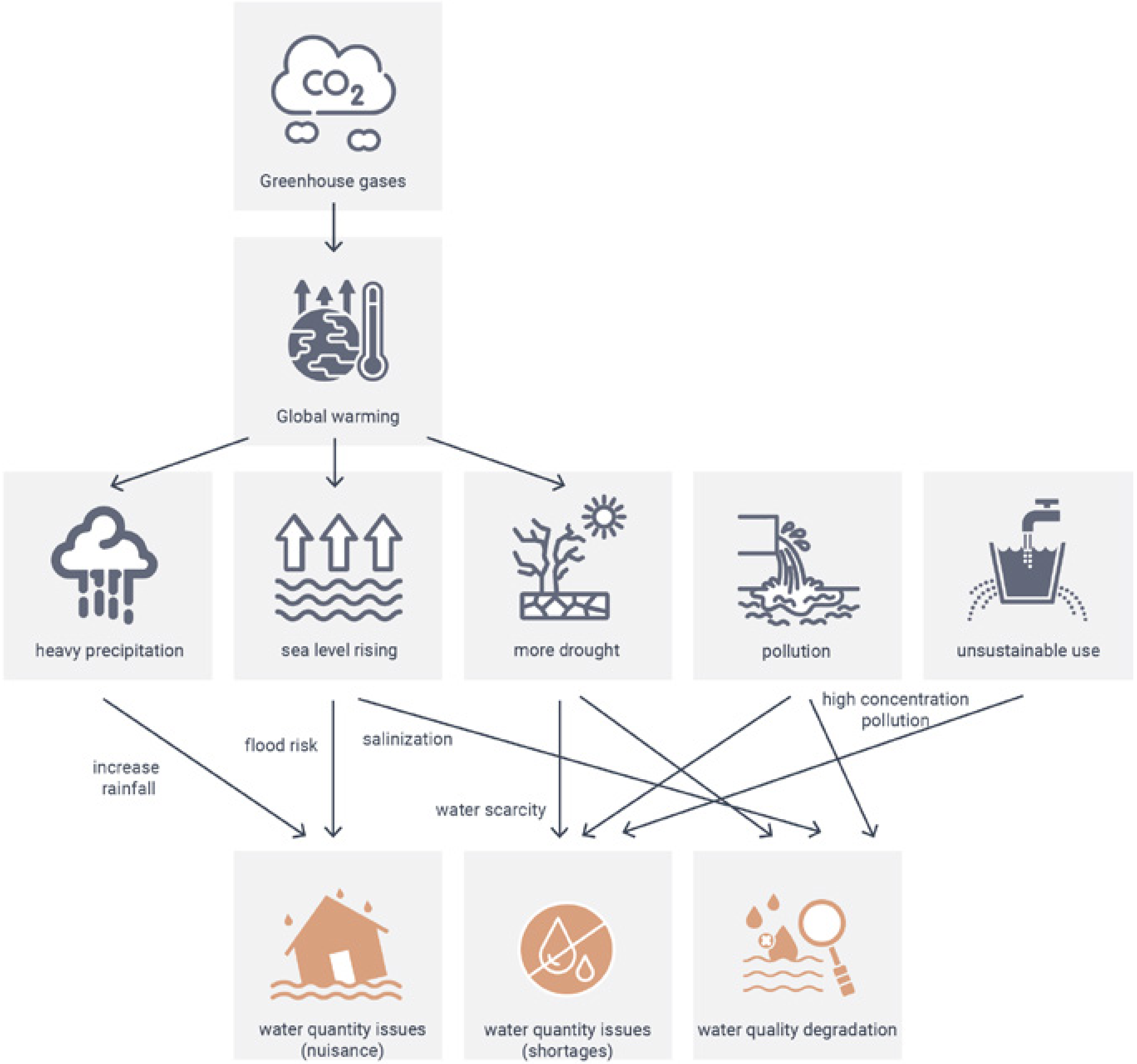


Figure 5: Climate change influence on the water cycle

1.1.2 Global water issues

The consequences of climate change have been identified in water quantity (nuisance and shortages) and quality on a global level (figure 6).

Water nuisance is at risk due to floods, one of the most devastating natural hazards known to humankind. Historically, low-lying areas along rivers and coastlines have been vulnerable to floods. Countries such as the Netherlands are more prone to floods due to their location below sea level rise (KNMI, 2023b). Extreme weather conditions like storms also contribute to floods and account for about 67 percent of the global natural disasters (Padli et al., 2013). These events have caused great damage to society in recent decades. From 1990 to 2019, floods all over the world have caused an economic loss of over $776.9 billion in total (Ritchie & Roser, 2014).

Global average precipitation can increase by 7% for each degree of warming, which means we are looking at a future with much more rain and snow, and a higher risk of flooding to some regions. - (IPCC,2021)

Water shortages are becoming endemic as a result of an increasing demand for water with the spreading of pollution in freshwater. While some places experience water stress all year round there are some that experience it seasonally. Regions with a big water supply like Central Africa, East Asia and parts of South America will experience more seasonal water scarcity. In regions where there is already a shortage of water supply, such as the Middle East and the Sahel in Africa water scarcity will worsen. In most regions seasonal variability in water availability will increase due to climate change (United Nations, 2020).

Currently 10% of the global population on average is living in countries where there is a high or critical water stress. - (unesco, 2023)

Data on **water quality** is sparse on a global level due to weak monitoring and reporting capacity. Especially in least developed countries in Asia and Africa (United Nations, 2021). But according to Damania et al. (2019) the water quality in low-, middle- and high income countries all show symptoms for risks. In low-income countries the low water quality is often related to poor wastewater treatment (WWAP, 2017). While in higher-income countries the water quality is more harmed by agricultural runoff (United Nations, 2021). Hazardous chemicals that have been released from industries still occur across all continents and emerging pollutants including microplastics and pharmaceuticals continue to be a significant concern (WWAP, 2017; United Nations, 2021).

Globally, 2 billion people (26% of the population) do not have safe drinking water and 3.6 billion (46%) lack access to safely managed sanitation, - (United Nations, 2023)

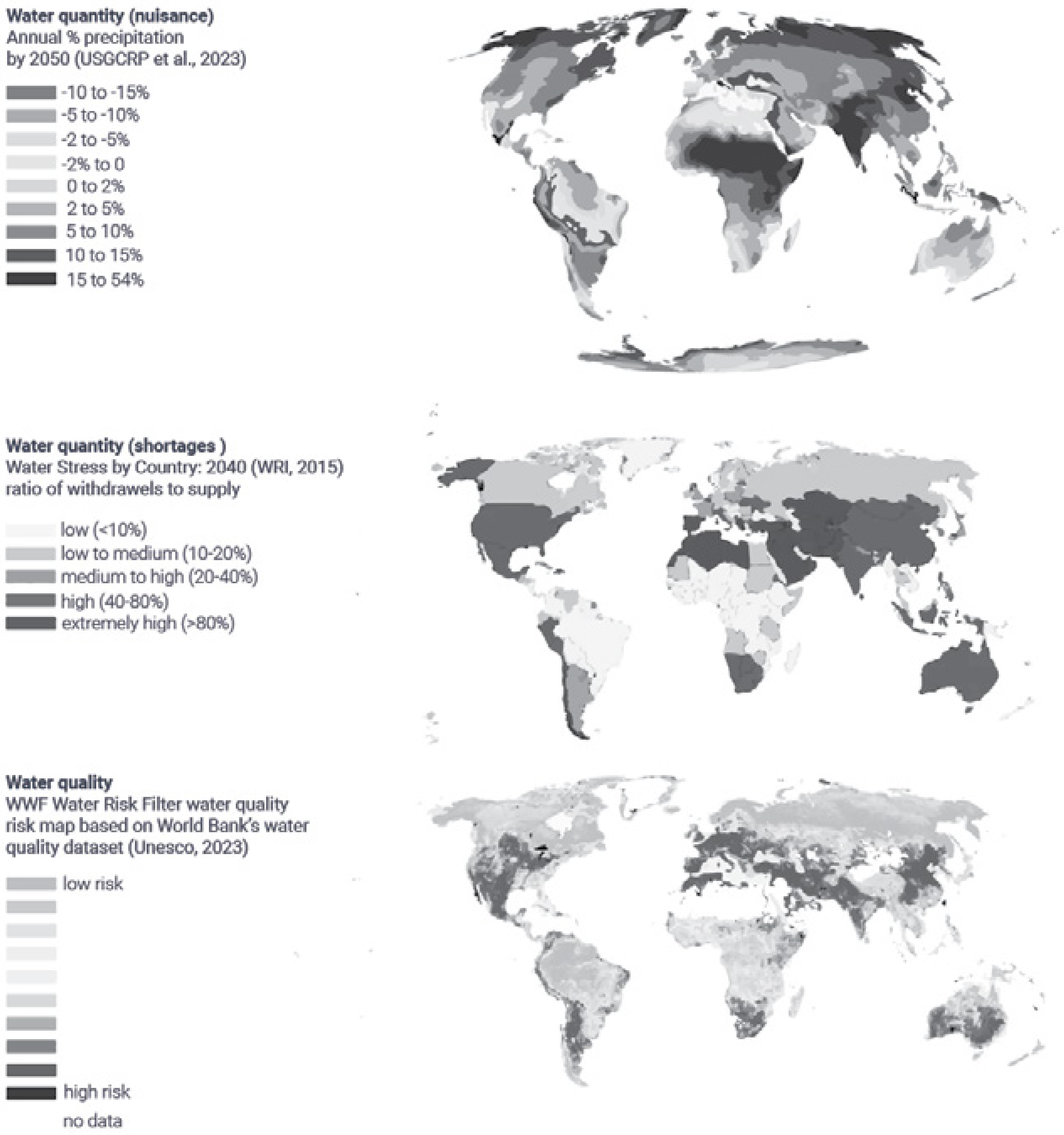


Figure 6: Global water quantity (nuisance and shortages) and quality issues

1.1.3 Environmental culture

The deteriorating water cycle is part of an ecological crisis that demands a response to live more sustainably on and with the earth. Nevertheless, the human species have been unable to acknowledge and adapt themselves to the limits of other kinds of life and have therefore altered the environment to sustain its population. Figure 9 (Diep, 2019) shows the world ecological footprint against biocapacity. Ecological footprint represents the global human demand for biological resources and the biocapacity represents the ability of ecosystems to produce biological materials and to absorb waste generated by humans. It can be seen that humans have been consuming more natural resources than the ecological system that tries to restore from it, creating ecological deficits. In this way humans have been following a cultural behaviour in which nature is used as a means to maximise their own needs without considering the consequences for other forms of life.

Plumwood (2002) describes how the ecological crisis is fundamentally based on a crisis of reason. A way of reasoning which is completely centred in the interest of human beings. Putting human life outside and above inferior nature. It holds that humans are the most significant entity in the universe and nature is only an instrument for sustaining human needs. This hegemonic structure creates a structure in which the dominant 'centre' is represented as universal and experiences from the 'other' are irrational. This means that animals and plants can be disregarded unless they provide a human demand.

This is a way of reasoning that is called Anthropocentrism (figure 7) and has been supported by traditional philosophers like Aristotle and Kant. A view that is deeply embedded in current (mostly western) economic systems, acting out of blindness towards ecological relationships. This has created destroying mechanisms in the context of water, since every human activity has a consequence on water (Figure 10). Like over-consumption (Figure 8) and contamination of fresh water (Morton, 2016). Anthropocentrism has distanced the human relationship with water, distancing humans with nature, where the dependency on a healthy biosphere for other forms of life is being denied.

In an era where we are reaching the biophysical limits of the planet, there is a need for an environmental way of reasoning in which humans are able to make good judgements about how we live and how that affects the non-human world.

To maintain viable long-term populations of most of the Earth's remaining species, approximately 50% of landscapes and seascapes need to be protected from intensive human economic use. - (Noss & Cooperrider, 1994; Locke, 2014)

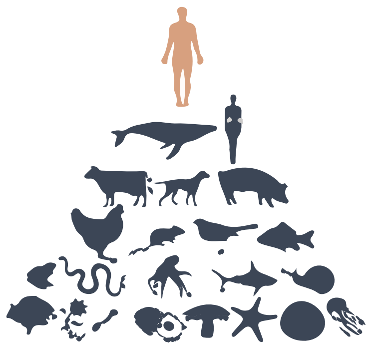


Figure 7: Anthropocentric diagram (Montgomerie, 2016)

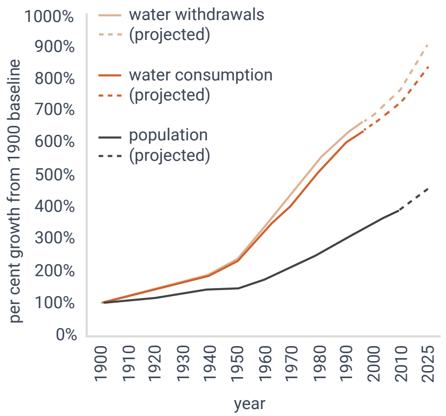


Figure 8: Global water use and global population per cent growth since 1990 (Montgomerie, 2016)

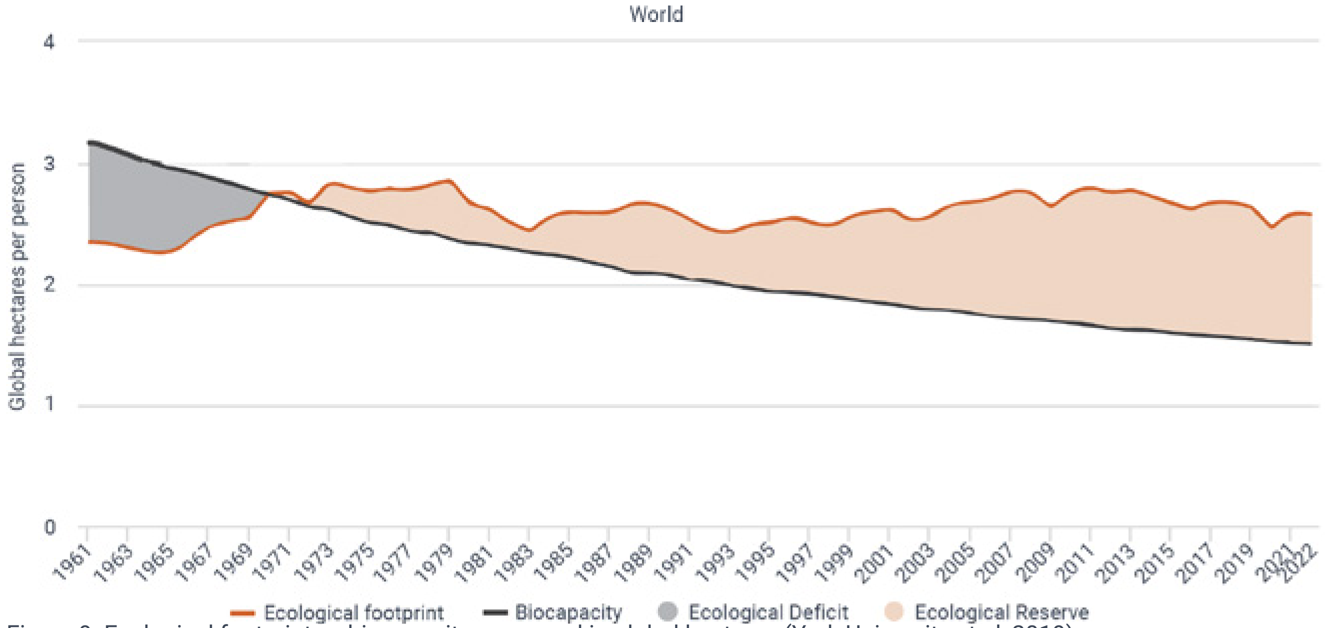


Figure 9: Ecological footprint vs biocapacity measured in global hectares (York University et al, 2019)

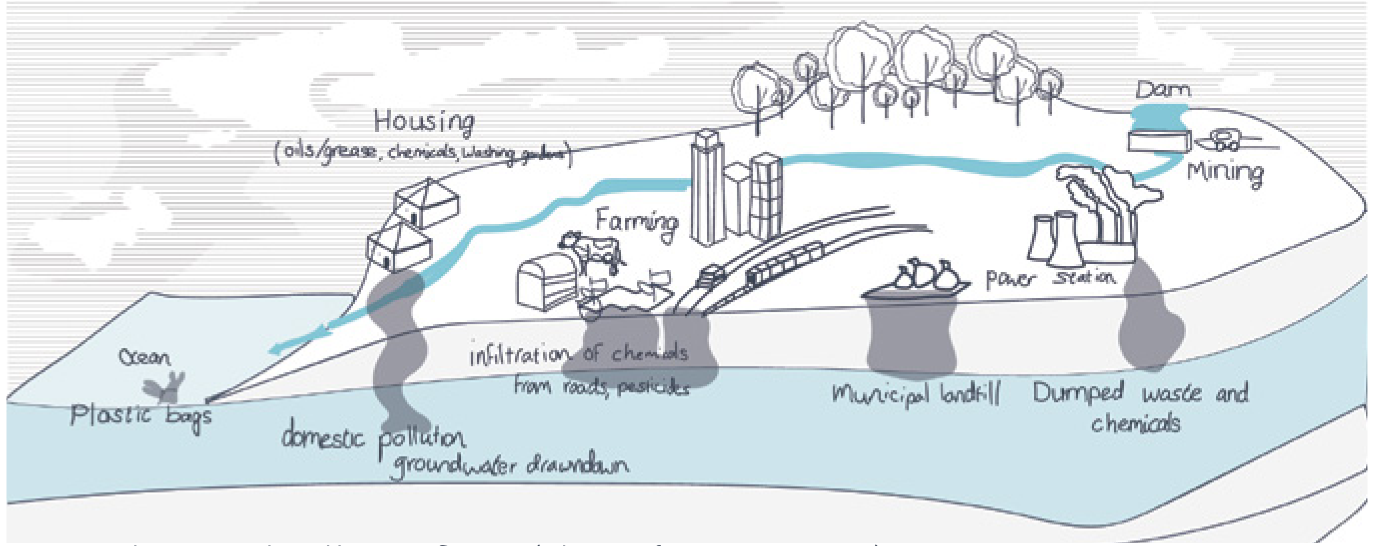


Figure 10: The water cycle and human influences (Education for Community, 2015)

1.1.4 Global importance of water

Luckily, there is already a global agreement on sustainable development goals (SDG) for humans and species in the context of water. In which the definition of sustainable development of Brundtland (1987) has been apprehended. Sustainable development is a type of development that meets the needs of the present without sacrificing the needs of future generations.

The United Nations has set an agenda for seventeen SDGs for 2030 that form a blueprint to establish peace and gain prosperity for both planet and people (UNDP. n.d.). Eight of them emphasise the urgency in relation to water. Those can be seen in Figure 11. Some of these SDG goals carry more weight within the project than others. A few are more clearly integrated within the project such as point 6, clean water and sanitation, point 13, climate action and point 14, life below water. Other goals are more touched upon within this project and since they are not the main goal of improvement.

Although determining which of these SDGS goals come first is difficult, Rockström and Sukdev (2016) argued that the SDGS can be categorised in priority in which the sustainability of the biosphere should be seen as the foundation for society and economy. In figure 12 The 'wedding cake' is illustrated that forms an interpretation of how the SDGS would be prioritised following Rockström and Sukhdev logic. Rockstrom and Sukdev statements highlight a global agreement on prioritising the sustainability of the environmental layer. Therefore balancing the imbalanced water cycle forms the basis to reach a more sustainable future.

Figure 11: 6 highlighted SDG goals that are correlated to water (UNDP, n.d.)

Figure 12: The SDG 'wedding cake'.(Rockström and Sukhdev, 2016)

1.2.1 Getting to know Delfland

Delfland is located against the Noord Zee and has rivers like the Meuse and Rhine flow through. Delfland is the lowest area of its water geography which means that the water will first flow through different countries before it accumulates in Delfland to then flow into the Sea (figure 13). The Meuse is a river that depends on rain water, while the Rhine is also fed by meltwater from the Alps from France and Germany. A big part of Delfland is under sea level, but that did not stop people from inhabiting it. Delfland is an area that consists of eleven municipalities, including the Hague and it is the most urbanised waterboard of the Netherlands (figure 14). With functions such as major cities like The Hague, green house farming and pastures (figure 15). With the densification task of the region of South Holland, even more space for urbanisation is needed (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2023). South Holland expresses its ambition to build nearly 250,000 homes through 2030. A plan that barely has taken the capacity of the soil-water system and the impact of climate change into account will put even more pressure on the water system.

Figure 13: Watergeography Delfland

Figure 14: Delfland landuse

legend

- sea
- waterways
- greenhouse farming
- pastures
- woods
- recreation
- urbanization
- roads
- Delfland border

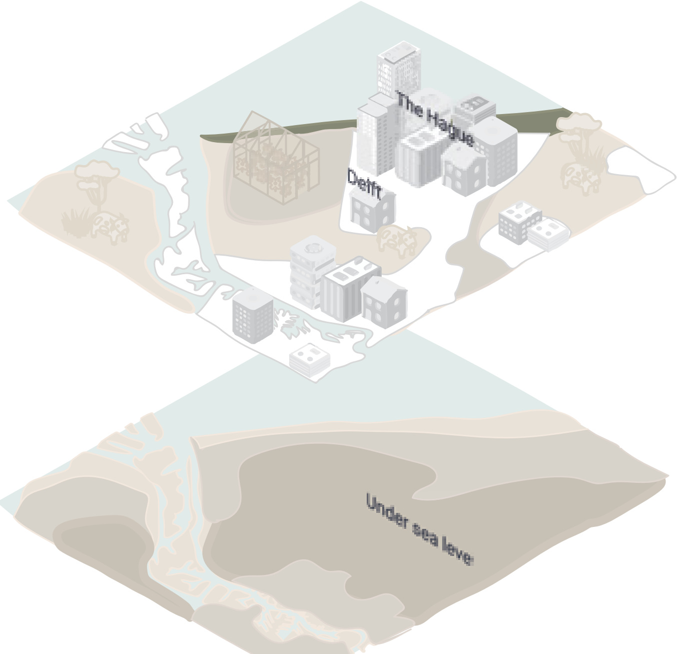


Figure 15: Delfland's urban functions located under sea level

1.2.2 Dutch Climate Scenario

The climate scenario for the future of the Netherlands has been outlined by KNMI (2023). They describe that the Netherlands will have wetter winters and drier summers. This means that more extreme weather conditions will take place. A rising sea level rise, heavy rainfalls and longer hot periods with drought. In the hotter periods, precipitation will decrease (figure 18) and result in a rain shortage for the months of April till September. This can create critical water supply issues with the Meuse, since it is completely dependent on rain. While in the winter periods an increase of rainfalls will occur (figure 17), not only the frequency will rise but also the quantity of water will expand. Scenarios of rain showers above 50 mm in one hour and 100 mm in a day are extreme weather conditions that will occur more frequently in the future (2100 and onwards). The benchmarks used are once every 100 (70 mm/2 hours) or once every 1,000 (140 mm/2 hours) years. These seasons will put more pressure on the water quantity and quality. There are no accurate predictions for the quality of water, but it can be stated that since the water quality has been decreasing over the years (figure 16), the climate conditions will only deteriorate it more in the current system.

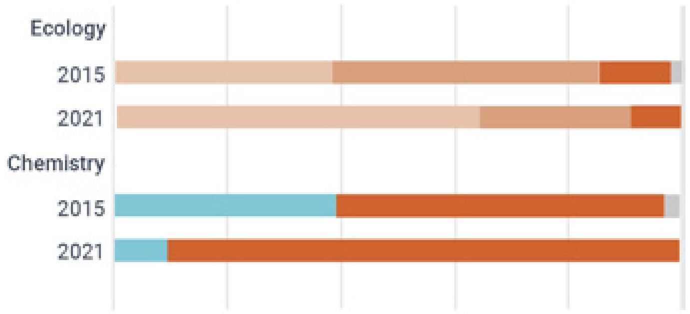


Figure 16: Water quality (IHW, 2022)

Jugement (4 classes)

- excellent
- moderate
- inadequate
- bad

Jugement (2 classes)

- sufficient
- does not suffice

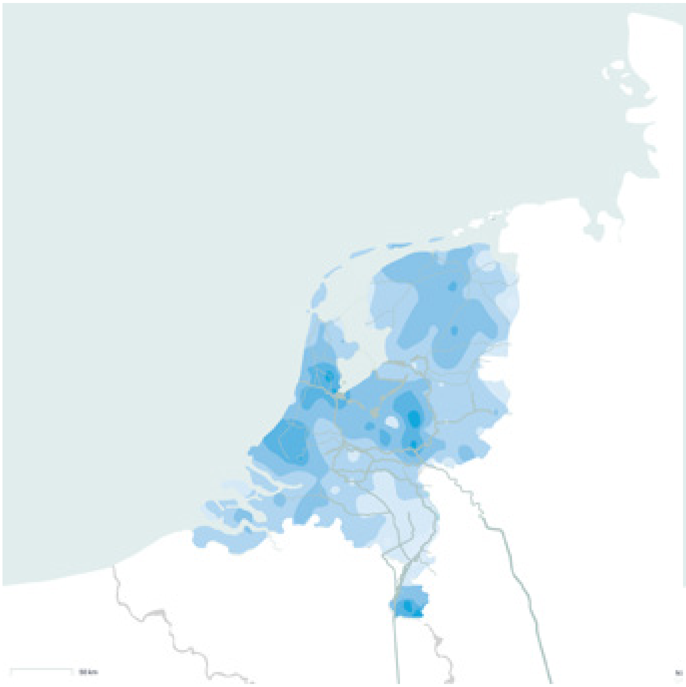


Figure 17: Yearly Rainfall 2050 (KNMI ,2016)

legend (mm)

- 700 - 750
- 750 - 800
- 800 - 850
- 850 - 900
- 900 - 950
- 950 - 1000

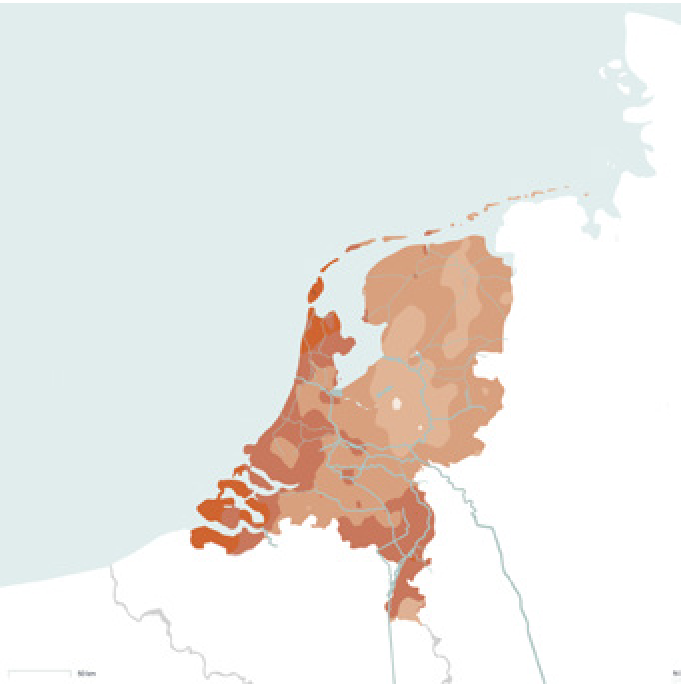


Figure 18: Yearly Rainfall Shortage 2050 (KNMI ,2016)

legend (mm)

- 210 - 240
- 240 - 270
- 270 - 300
- 300 - 330
- 330 - 360
- 360 - 390

1.2.3 Current water cycle

When zooming in on Delfland, it can be seen how there is a system that reacts on water nuisance, water shortages and quality (figure 20).

To tackle water nuisance the polder bosom system has been built. In which dikes, bosoms and polders protect residents from the rising sea level and maintain the supply and discharge of water on land. In wetter seasons, polder water will be discharged through the bosom system and in drier periods water from the bosom will be supplied to the polders to maintain a proper water level.

The water quality is maintained by wastewater treatment, domestic and industrial waste will move through the sewage system to the waste water treatment where it will be treated before it gets discharged back into the sea. This helps to minimise the release of pollutants and contaminants into the environment.

The sources for water quantity are provided by a combination of surface water, such as rivers, canals and reservoirs, as well as groundwater from aquifers. Drinking water is provided by two drinking water companies Verwin and Dunea. Both are mostly dependent on the Meuse. Which will first be treated before it flows into the drinking water pipes.

Delfland contains different land uses that have their own interactions with the water cycle. To better investigate them, a section of the water cycle in Delfland has been made that shows all the flows that move through them (figure 19). If we look at the consumption patterns of the Netherlands in 2021(CBS, 2022 (figure 0.0) it shows that 74% of drinkwater use goes to households practices, whereby 82% goes to practices that can be used with grey water (Arcadis & Berenschot, 2022). As a result there is a lot of potential in gaining drinkwater savings when the focus is on residentials. The water cycle of Delfland and from a residential scale are showcased on the following pages.

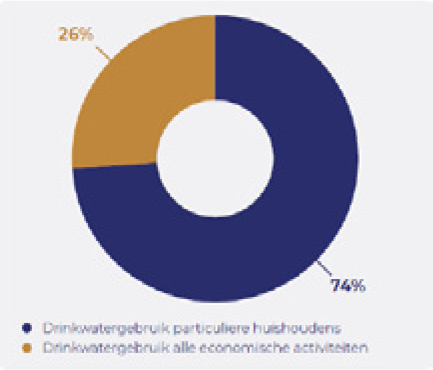


Figure 19: Water consumption in the Netherlands 2021(CBS, 2022)

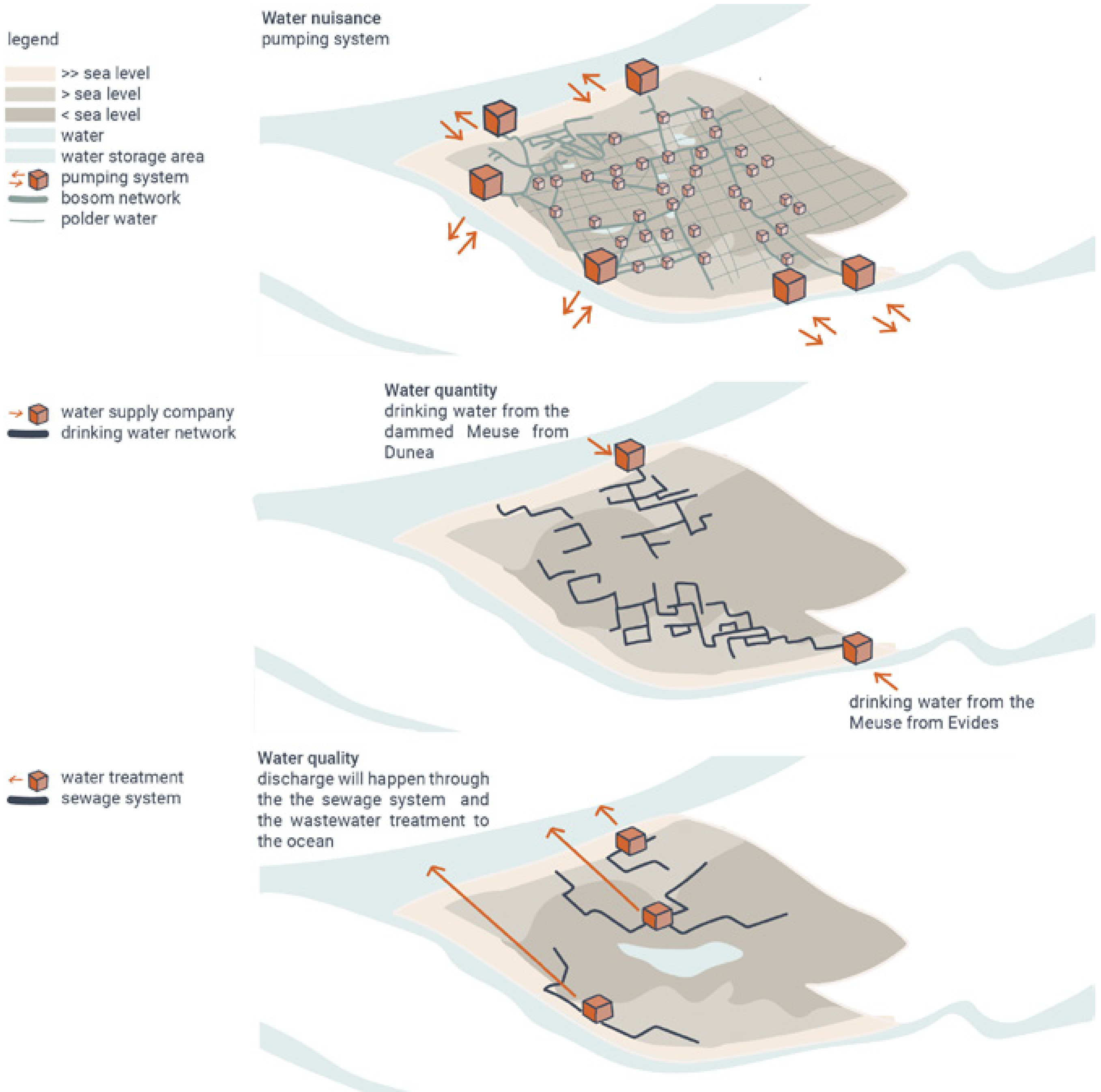


Figure 20: Current water cycle of Delfland

1.2.3 Current water cycle

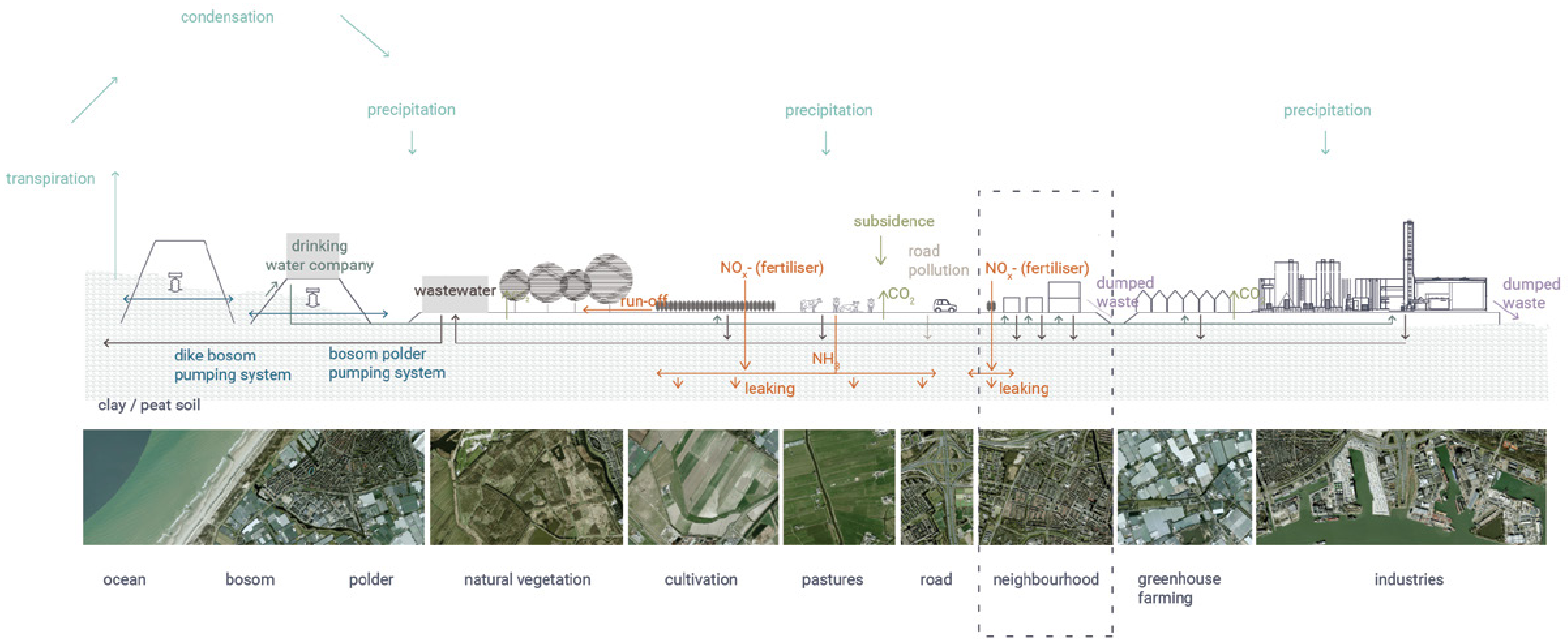


Figure 21: Water cycle Delfland

1.2.3 Current water cycle

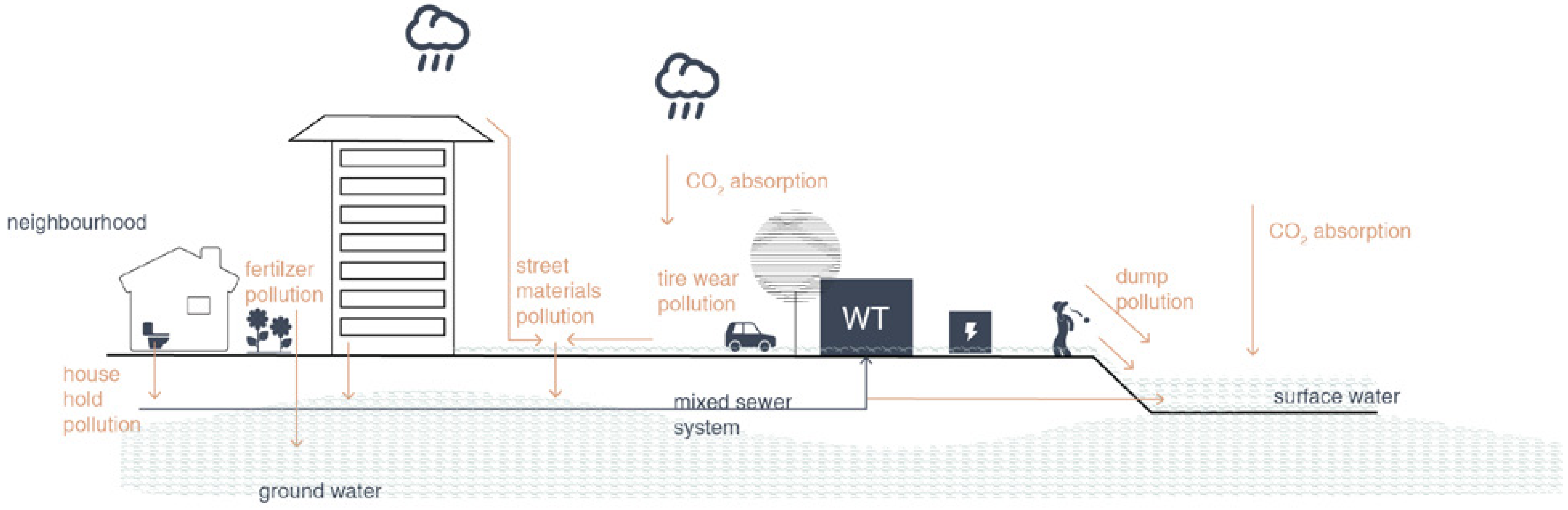


Figure 22: Water cycle Neighbourhood

1.3 Problem statement

In the event of climate change and in the paradigm of anthropocentrism, current water practices are contributing to an imbalanced water cycle in terms of water quantity and quality. In the context of Delfland, a region that on the one hand has to meet a demand for houses and on the other hand has to cope with future water concerns, answers are needed regarding how new neighbourhoods can be developed sustainably from the perspective of living with water in relation to humans and ecology.

The climate is changing (KNMI, 2023b). With major consequences that can be mostly felt in the water cycle. Melting ice caps and intensified rainfall will cause sea level rise that can be felt through **water nuisance**. As well as, with the rise of droughts, surface water will reduce through evaporation and will give **shortages** to our water supply. In both situations where you have an uncontrolled shortage or excess of water, there will also be a risk to the **water quality**, including salinization, a shortage of oxygen in water bodies etcetera.
These climate conditions create an imbalanced water cycle from a human perspective, but it's the paradigm of anthropocentrism that forms the root of the problem (Plumwood, 2002). This entails the unsustainable way of reasoning in which humans have been altering the environment to sustain its population. Using nature as a means to maximise human needs has created a cultural development that has acted faster than the ecological system that tries to restore it. As every human activity has an influence on water, the capacities and limits of the ecological system are being challenged.

These conditions translate for the boundaries in Delfland into wetter seasons in the winter and drier seasons in the summer. Conditions in which problems regarding water quantity and quality will occur (KNMI, 2023b). With the densification task of the region of South Holland, more space for urbanisation is needed (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2023). To be able to understand how the densification task with the future water pressures can sustainably execute answers are needed.

Chapter 2.

Research approach

The aim of this thesis is to build a Water friendly neighbourhood while finding synergies between water, ecology and humans. To establish this, the research constantly shifts between design practices and research. This chapter outlines the research objectives, explains the timeframe and the different methods.

"Design is the act of providing a solution"

- Anonymous

2.1 Research aim

In this graduation project the relationship between human, water and ecology will be explored. The aim is to construct a sustainable future-proof water cycle for the existing climate condition predictions of the year of 2100, while increasing residents' awareness of the value of water, consider ecology as a stakeholder and creating a liveable environment residents in a new neighbourhood of Delfland. In this manner a neighbourhood will be built that can provide all of its own water needs, preserve the quality of its water and can withstand possible pluvial flood risks. The project will give answers to the densification task of South Holland and the climate scenarios regarding water on how to build a sustainable future-proof water cycle for new neighbourhoods.

The desired outcome for this graduation project will be a strategy that consists of a pattern language on the four different topics of Green and landscape, Water and soil, Humans and water and Liveability. Taking into account that balancing the water cycle in terms of water quantity and water quality, is the leading factor. This pattern language will be tested in Fortunapark, Vlaardingen, which will result in a design for a neighbourhood. This strategy could provide transferable knowledge for neighbourhoods with similar circumstances and water issues.

The aim and the intended outcome has led to the following main research question:

"How to envision a balanced water cycle for new neighbourhoods in Delfland while establishing a synergy between water, ecology and humans?

2.2 Research question

2.1 Research question
As already been mentioned in the introduction the main research question of the project is:

"How to envision a balanced water cycle for new neighbourhoods in Delfland while establishing a synergy between water, ecology and humans?

To answer the main research question the whole research has been structured into four sub questions that will entail the premise, diagnosis, impact and realisation of the project (figure 23). Thus, the study consists of four stages with an aim, methods and expected outcome. These stages will be elaborated in this chapter. The research questions will guide the design assignment and enable the following results.

Stage 1| Problematisation
"What are the current and future water issues?"

Establish a solid theoretical foundation and conceptual framework with the main concepts on a Water friendly neighbourhood, that can guide the problematisation, diagnosis and design steps.

Stage 2| Diagnosis
"What are the opportunities and bottlenecks of the existing structures of Fortunapark?"

Identify the opportunities and bottlenecks using the conceptual framework in the location of Fortunapark. The aim is to learn how they can work together in synergy.

Stage 3| Impact
"How would a Water friendly neighbourhood look like in Fortunapark?"

A strategy that consists of a Pattern Language will be built for a Water friendly neighbourhood. In addition, postcard designs of the neighbourhood will be made, with a calculation of the systemic system of the water balance.

Stage 4| Transferability
"How can the water friendly be transferable for other projects?"

Establish how the methodology and the pattern language can be be transferable for other locations.

On the next page (figure 24) the methdological framework is showcased.

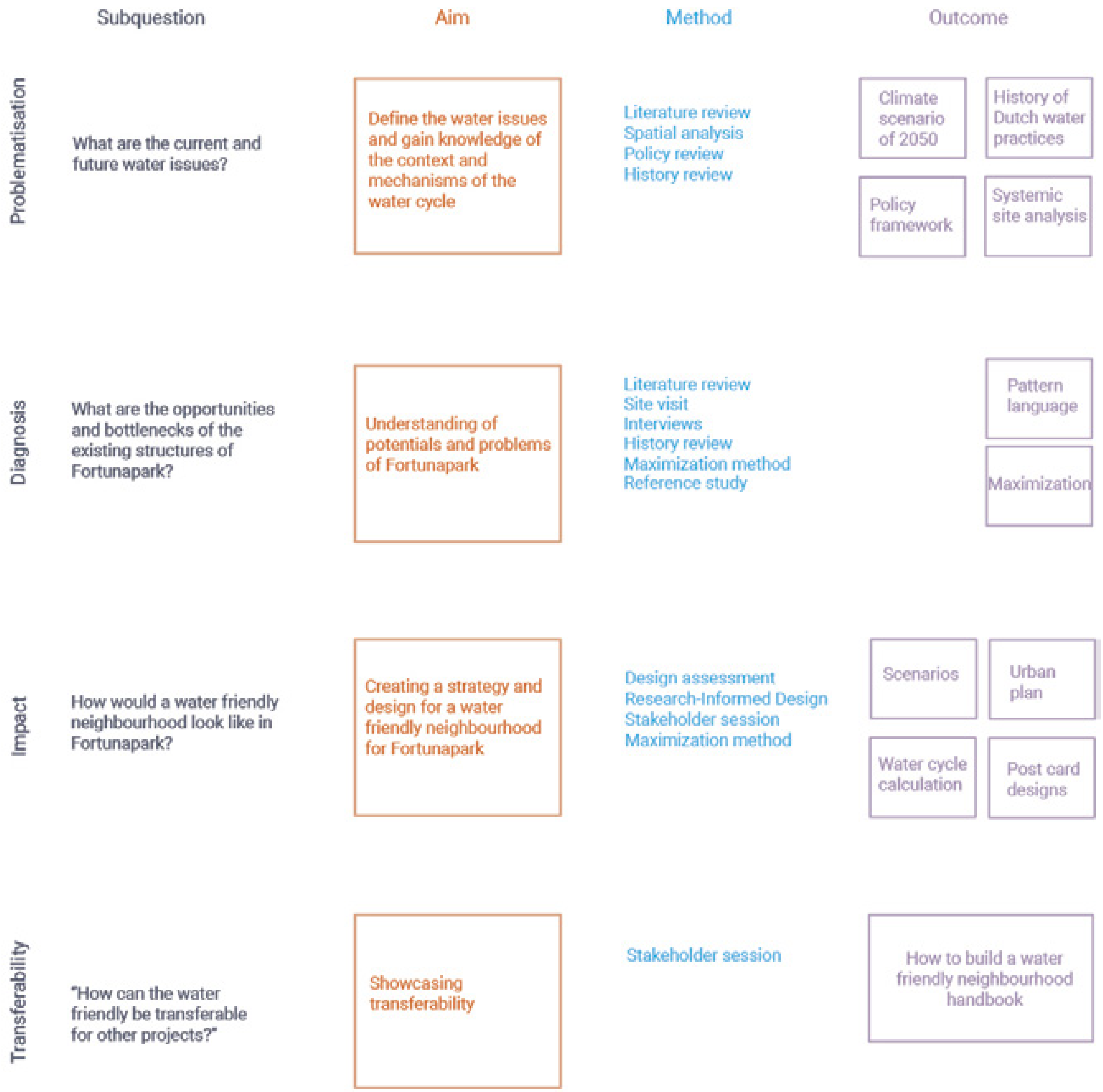


Figure 23: Sub questions

2.3 Methodological framework

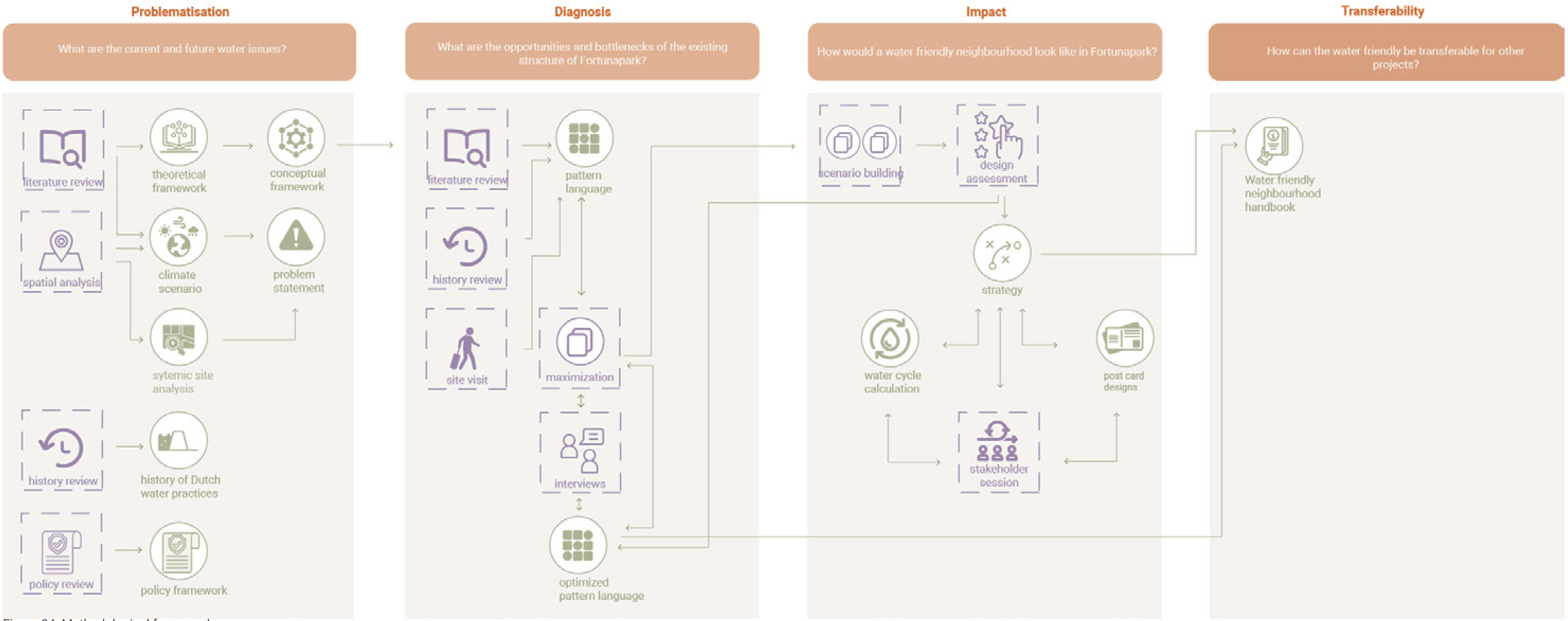


Figure 24: Methodological framework

2.3 Methodological framework

The following text is an elaboration on the design results, using different methodologies. In the methodological timeline (figure 25) it can be seen how long each stage, method and outcome will take.

Stage 1| Problematisation
"What are the current and future water issues?"

In order to create a problem statement and to have an understanding of the importance of a Water friendly neighbourhood in Delfland. Literature review and a spatial analysis has to be done that describes the complexity of the current and future water issues, that are defined by water quantity and quality. In addition, a historical and policy review of the Dutch water management will be made to give an overview of the zeitgeist and showcase the relations between water, ecology and humans.

Stage 2| Diagnosis
"What are the opportunities and bottlenecks of the existing structures of Fortunapark?"

In the second stage the focus is mainly about understanding and assessing the guiding topics in the studied location. The guiding pillars are Green and landscape, Water and soil, Human and water and Liveability. In order to define these themes in their optimised form a literature review, site visit, and interviews will be conducted. Subsequently, the guiding themes will be mapped on different scales, demonstrating the main potentials and problems. After that a maximization of the pillars will be made. Using patterns that form the building blocks for maximizing. The maximization and the pillars will be afterwards discussed with experts on the topic ecology, water and social science.

Stage 3| Impact
"How would a Water friendly neighbourhood look like in Fortunapark?"

The four pillars of maximization will be put together to demonstrate the optimisation for the neighbourhood from which conflicts and overlay will be revealed. Through the creation of an assessment framework, design decisions will be enabled. With the method of research by design a strategy for Fortunapark will be made, post card designs and a calculation of the water cycle.

Stage 4| Realisation
"“How can the water friendly be transferable for other projects?"

The fourth stage includes, making a pattern handbook to stimulate urban designers on building a water stirring neighbourhood. Using sessions with stakeholders to come up with a readable handbook.

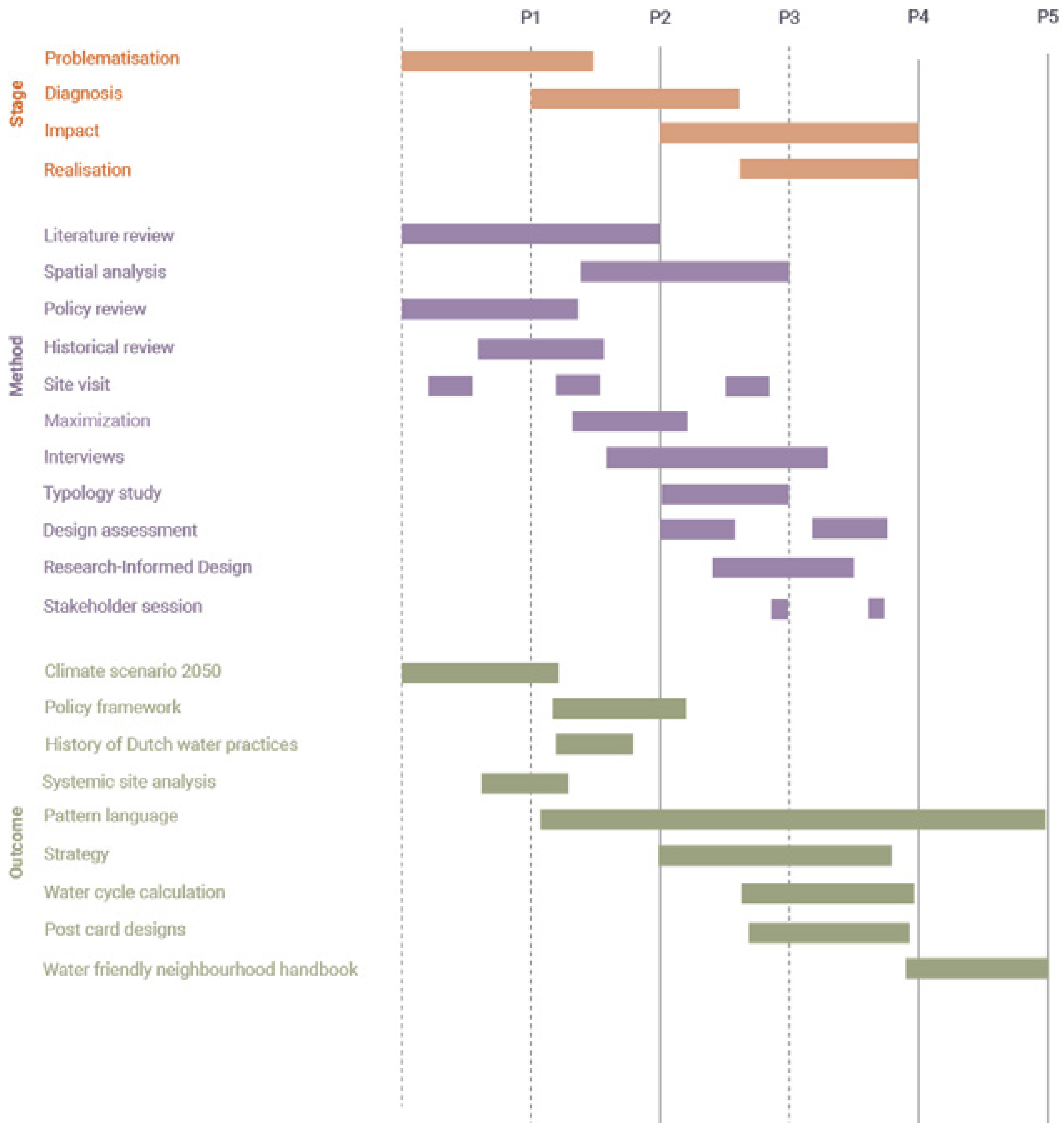


Figure 25: Methodological timeline

2.3 Methodological framework

Different methodologies that are going to be used in this research will be elaborated in this chapter.

Systematic Design Method
A synergy between design thinking and systems thinking by Jones & Kijima (2018). A method that on the one hand focuses on the multi-scalarity of how elements interrelate in a with each other and how they function separately in a system (Alberta CoLab, 2022). On the other hand, design thinking puts the importance on producing solutions while working with uncertainties (Pourdehnad et al., 2011). The integration of these two methods is necessary when dealing with adaptive challenges or value conflicts like in this thesis (Alberta CoLab, 2022).

The Pattern Language
Introduced by Alexander et al. (1977) the pattern language is a systematic approach that can help to understand and communicate complexity in design. In this thesis the pattern language will be used as a set of interconnected design principles that have the aim to solve a specific problem. In which every pattern represents a concise, reusable solution to a common design problem. The description of the context in which the pattern is applicable will be taken into account. Another aspect of the Pattern Language is that it is always an unfinished product that can be redefined by other designers, researchers, policymakers etc.

Maximisation method
The maximisation method consists of three phases: maximisation, optimization and integration. In the first phase the most desirable result will be executed for different topics. Subsequently in the optimization phase, the different maximisation layers will be put on top of each other to make choices between the different maximisations. An assessment framework will be introduced to help with this decision. In this thesis this method will be done integrally with the pattern language.

Chapter 3.

Theoretical underpinning

Showcasing the theoretical foundation and underpinnings of the key concepts that define a Water friendly neighbourhood. It delves into the existing body of knowledge that describes the meaning, and interrelations between water, ecology and humans. It discusses the current operations and explores existing theoretical opportunities. The insights gained from these theories serve as the basis for the conceptual framework and research aim.

"No research without action, no action without research."

- Kurt Lewin

3.1 Conceptual framework

A Water friendly neighbourhood represents a new paradigm in which spatial decisions will be based on the perspective of water in relation to humans and ecology. A paradigm in which Water and soil are stirring, creating an environment that meets the demand and supply for water and is liveable through all seasons. Where ecology is invited as a stakeholder and can flourish while footprints are kept to a minimum. A location where humans practise sustainable behaviours, and in which water is the centre for interactions and activities. This is a place where people can live happily with water.

The neighbourhood that is proposed will have a foundation that is led by Water and soil, in synergy with ecology and humans. The conceptual framework can be seen in figure 26.

The scheme shows the concepts for a Water friendly neighbourhood in which the water cycle is balanced by the guiding themes of Green and landscape, Water and soil and Human and water. In the outer ring the water cycle is defined by aspects of Water Quantity and Water Quality. On the inner ring the three guidelines portray an integral future proof water approach in which the relationship between water, ecology and humans is redefined. Along with the three guidelines, three leverage points have been identified. These will trigger a paradigm shift towards an integral balanced water cycle. Above all, the notion for Livability stands for the type of urban environment in which this balanced water cycle needs to take place.

Water and soil
To be able to create long term liveable environments that are less vulnerable to weather extremes caused by climate change, our water sources need to be protected, the ecologies in the water should be resilient and the built environment should be prepared for extreme rainfall events and droughts. For this reason, Water and soil should form the guiding factor in spatial planning.

Green and landscape
As ecology is essential for maintaining the overall well-being of humans and species, it forms an important stakeholder when designing with the built environment. Green and landscape are the tangible key players for the provision of our ecosystem services. Since every urban intervention has as a consequence on soil and green (vegetation). From sewages to building traffic infrastructures, it all requires space and adaptation in the subsurface and for the vegetation. Therefore, sustainable ecological practices are needed to pave the way for a more resilient and environmentally conscious future.

Human and water
Human activities have a consequence on the water cycle. Therefore, it is important to create a human relationship with water in which awareness is established and social interactions with water can be practised. In this way a shift towards a water friendly social culture is stimulated in which local residents can help to balance the water cycle.

Liveability
Liveability stands for the overall sense of purpose and satisfaction in life. In this project Liveability will be mostly focused on the human needs for social interaction, peace and physical movement. As the built environment can influence these notions, the Water friendly neighbourhood will be designed to satisfy these needs.

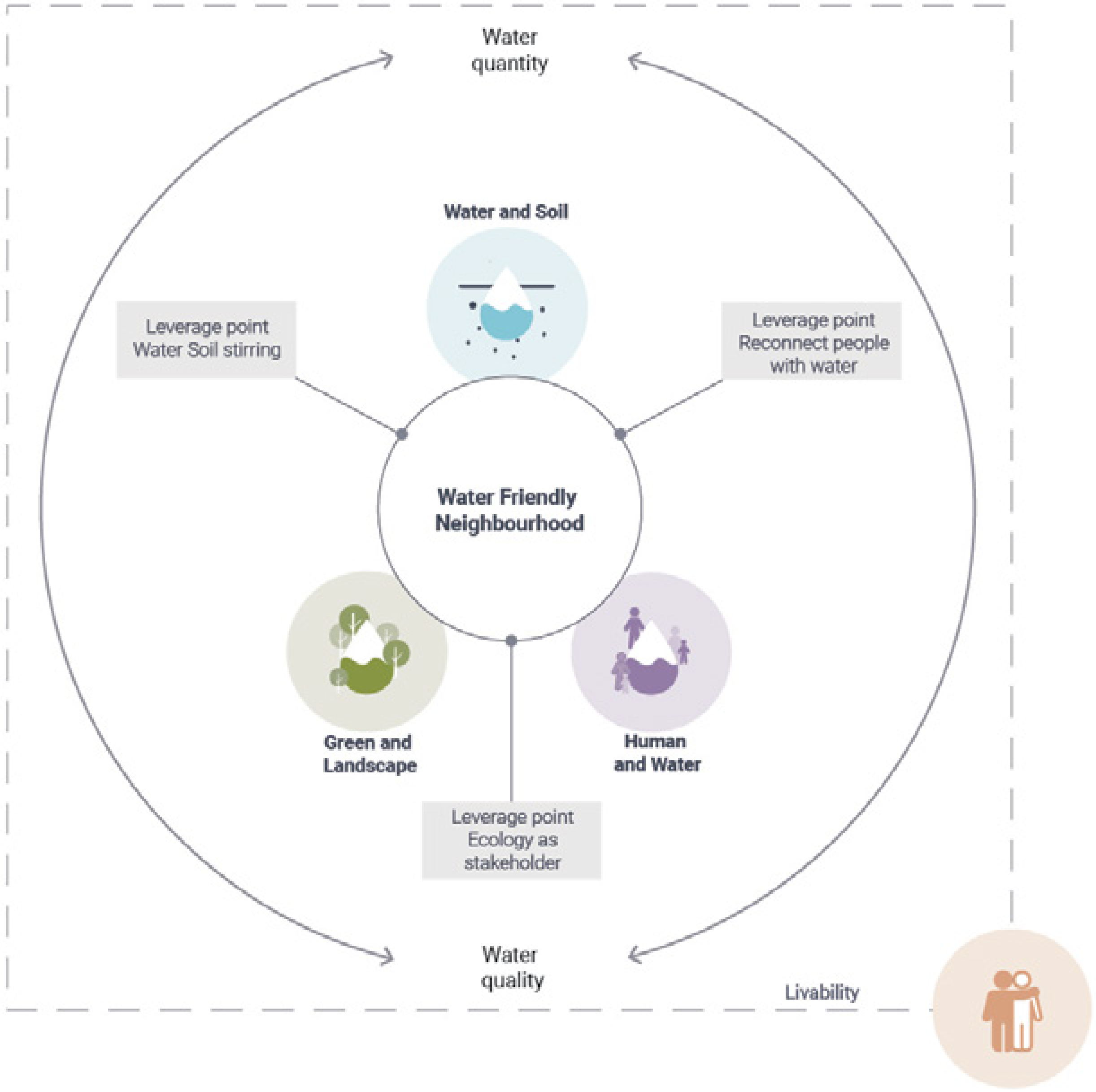


Figure 26: Conceptual framework

3.2 Theoretical framework

To introduce a paradigm shift from a segregated hydrological water cycle to an integrated hydro-social water cycle, theories on concepts of Green and landscape, Water and soil and Human and water form the backbone of this project. Debates on these theories have been critically analysed in order to find a definition of a Water friendly neighbourhood. **Water and soil** highlights the value of the interwoven relationship between water and the urban space. **Green and landscape** addresses how ecology should be seen as a stakeholder as humans have an ecological interdependence. **Human and water** elaborates on the relationship between humans and their environment and how that can foster sustainable behaviours. Finally theories on **Liveability** touches upon the needs that have to be met for a happy existence. A more thorough description of these theories can be found in the following chapter.

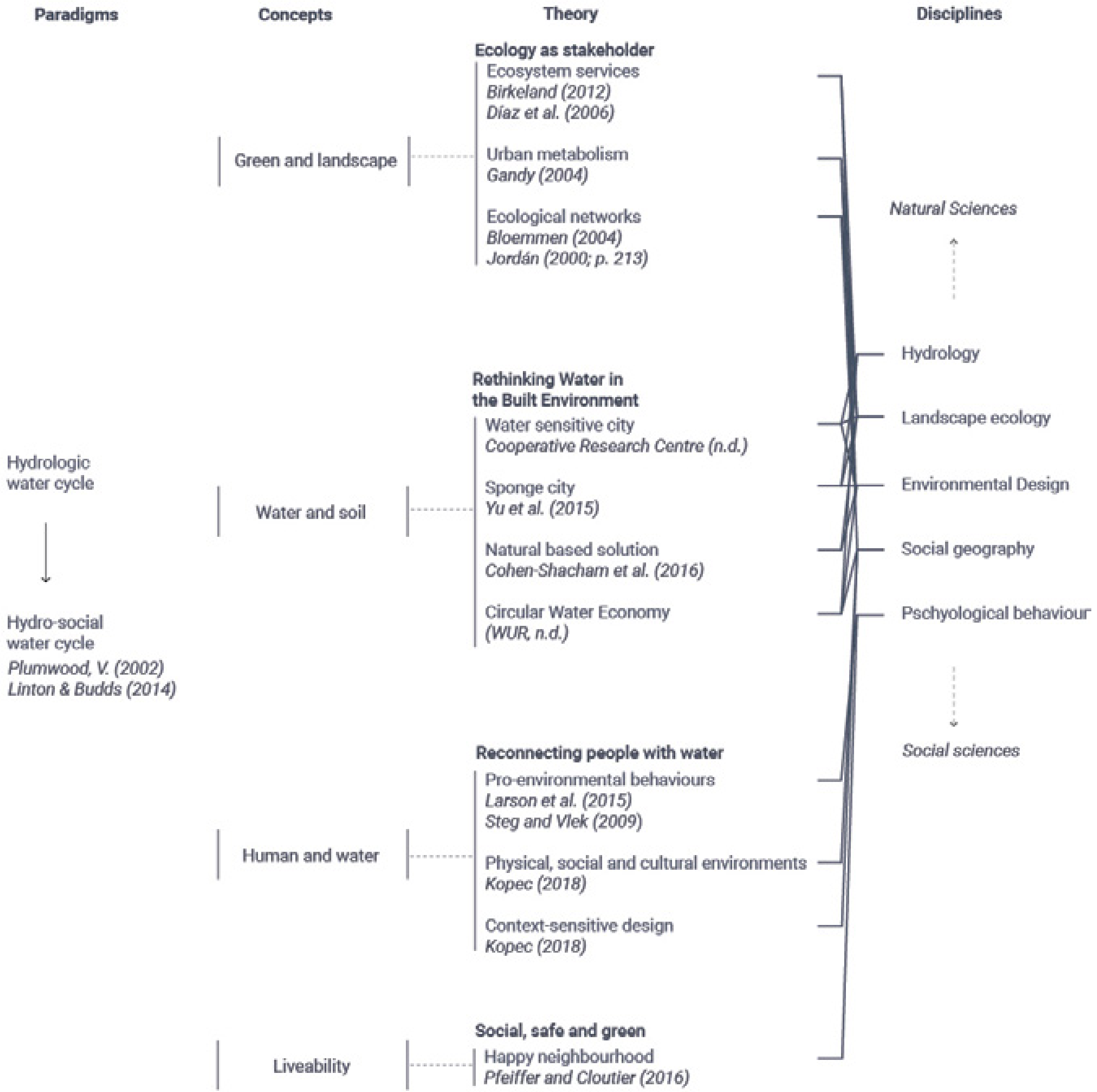


Figure 26: Theoretical framework

3.2 Theoretical framework

Rethinking Water in the Built environment

It is predicted that climates of drought and water nuisance will happen more often and to a greater extent. Therefore, urban areas should become resilient to absorb these disturbances. Natural based solutions can be a key concept to tackle today's environmental challenge in an integral way. **Natural based solutions** are actions that address societal issues in an effective and adaptive manner, while creating benefits for biodiversity and human well-being (Cohen-Shacham et al., 2016). This ties in with the **Sponge City** (Yu et al., 2015), as Sponge cities are emphasising how water nuisance management can be strengthened using green infrastructure instead of relying only on technical drainage systems. As well as with the **Water Sensitive City** that describes the aim to create resilient places is to 'Retreat, Accommodate and Protect' (Cooperative Research Centre, n.d.). This entails making use of both grey and natural based solutions, adapt to climate change and give more room for water. The water sensitive city does not only touch upon a more natural water management but also on the fact that there is a need for human adaptation to its environment. Revaluing water as a resource is part of this narrative resulting in the need for a **Circular Water Economy**. As global water scarcity is a challenge, a circular water economy focuses on maximising the reuse of water resources while reducing an impact on the environment (WUR, n.d.).

Water cycle characteristics (figure 27)

As the water cycle consists of the notions of water quantity and quality, there are different variables that can influence them. Aspects such as human water use and the climate are external factors, while there are also internal aspects that can be used to design with (figure 0). The internal aspects are explained below.

Shape of the waterbody
The shape (width, depth and length) and the connectedness of a waterbody can have an impact on how fast water gets evaporated and how much space there is to catch and collect rainwater. In addition, it has an influence on the circulation of water, as water needs a certain amount of oxygen, which is beneficial for aquatic ecosystems to create a better Liveability for species. When water stands still it becomes vulnerable to algae and duckweed, harming the water quality (Kennisportaal Klimaatadaptatie, n.d.-a). The deeper, wider and smoother the connection the better the circumstances for water is.

Groundwater level
The water level refers to the height of the water surface relative to a set reference point, in the Netherlands that is Normaal Amsterdams Peil (NAP). NAP height of 0 m is roughly equivalent to the mean sea level of the North Sea. The flexibility of groundwater levels can have an influence on the capacity for water catchment and on the moisture content of the soil.

Surface material (Infiltration capacity)
Different surface materials have different Infiltration capacities. As the Infiltration capacity is the rate at which water penetrates into the soils (Stichting RIONED, 2015).

Soil type
The soil type can have an influence on the water cycle, as every soil type has a different infiltration rate.

Height levels
Height differences in the landscape can be cleverly used to determine the flow of rainwater and the places for water to be collected in.

Bank
How the water transitions into land has an influence on the water quality. As a nature-friendly bank will enhance the biodiversity and the resilience of aquatic and terrestrial ecosystems. While a hard edge does not offer any value (Hoogheemraadschap van Rijnland, 2021).

Shadow
When water is exposed by the sun the temperature could increase. Since it is important to keep the temperature at a certain level to safeguard the quality. High temperatures in water bodies create circumstances for algae and duckweed to develop faster, giving nuisance for fish mortality, blue algae etcetera (Kennisportaal Klimaatadaptatie, n.d.-c).

Pollution
Water should have a certain concentration of substances. Pollution is one of the factors that can mess with this balance. High nutrient concentrations that contribute to this are substances from agricultural runoffs, sewer overflows, animal excrements and leaf raids in the water (Kennisportaal Klimaatadaptatie, n.d.-b). Furthermore, other forms of pollution such as traffic or household pollution are also problematic (Hoogheemraadschap van Delfland, n.d.; Ministerie van Infrastructuur en Waterstaat, 2020).

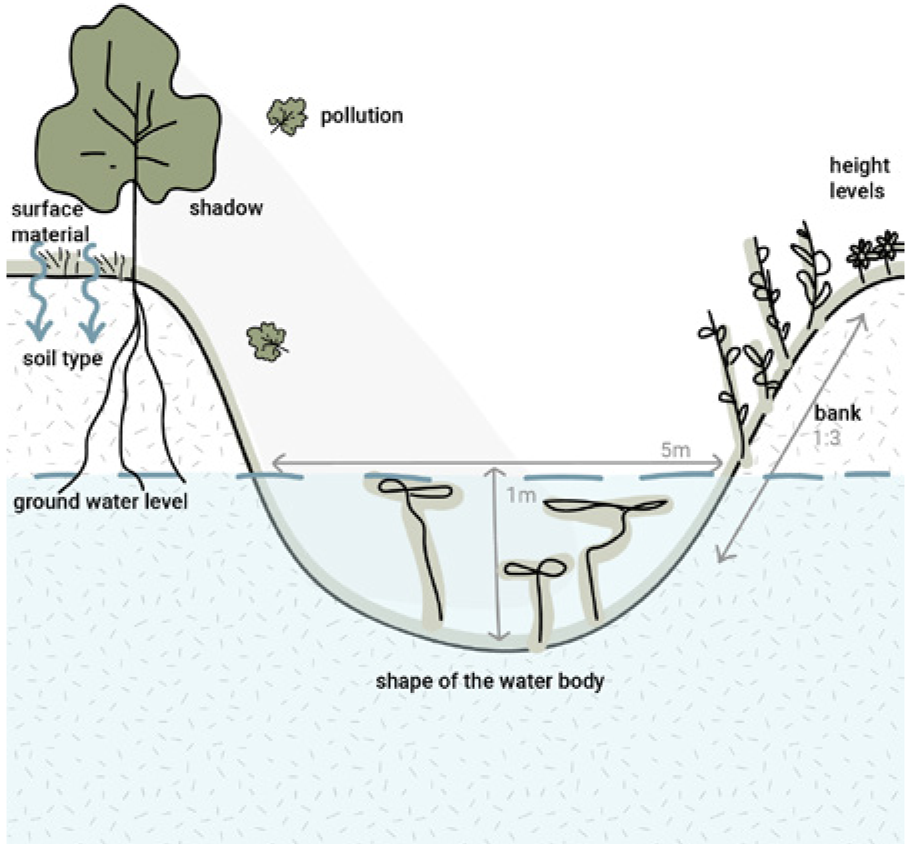


Figure 27: Water cycle characteristics

3.2 Theoretical framework

Ecology as stakeholder
As Fortunapark is located at the edge of Midden-Delfland, a green open landscape, Fortunapark forms a green branch in the urban area. When planning to build on an existing green field it is important to understand the ecological context it is situated in. As the current structure is part of a larger ecological network which is fostering different species. An **ecological network** can be described as "basic components of metapopulation landscapes" (Jordán, 2000; p. 213). They connect and foster local populations. A healthy ecological network usually consists of assigned core areas, corridors and buffer zones (Bloemmen, 2004). In which the corridors play a crucial role in ensuring the connectedness and survival of species. Different forms of connection offer different ecological consequences. Bloemmen (2004) describes how the 'necklace' arrangement can be unreliable for a safe migration whenever a core area is unusable. While the 'loop' arrangement is more reliable since it offers multiple migration possibilities. To elaborate on the ecological corridor, the best consistency would be a diversity of **gradients** (Ruimte met toekomst, n.d.). Gradients stand for the transitions between different landscapes. In Fortunapark these gradients can be found in wetness, vegetation grade or temperature. How these gradients then work together in ecosystems to maintain, balance and support life is what is called **biodiversity.** In which a continuous process occurs of speciation, migration, adaptation of changing environmental conditions and interactions between different species. In this way, biodiversity is dynamic and constantly evolving (World Wide Fund for nature, n.d.). A thriving biodiversity can provide ecoservices for humans. Eco-services are products and services from natural systems that give humans access to essential life support elements including heating, cooling, food, and water (treatment) (Birkeland, 2012; Díaz et al., 2006). For this reason, it is important to design with the natural systems as social and biophysical processes are inseparable and produce the urban environment together (**Urban metabolism)** (Gandy, 2004).

Reconnecting people with water
In the pursuit of a sustainable living environment and thus a sustainable water cycle, human behaviour plays a pivotal role. The relation between people and their environment is characterised as an influential feedback loop (Carmone et al, 2010; Kaaronen, 2020; Kopec, 2018; Larson, Stedman, Cooper and Decker, 2015). Humans shape their own environment, while in return the surroundings shape human behaviour and perceptions. Environments do not exist in isolation, they consist of different meaningful layers that interact with each other. Kopec (2018) has shed light on the socio-spatial exchange by examining the environment through three lenses: **the cultural environment, the social environment and the physical environment**. The interplay between physical, social and cultural environments is a complex multidimensional phenomenon. In urban design, understanding this complexity and acting on the ability to mould this interplay, involves recognising which elements in the feedback loop can be easily altered, as well as identifying those that are more permanent. Firstly, the physical environment consists of the tangible natural or man-made surroundings in which people live, work and interact. Secondly, the social environment stands for the social construct that includes all human relationships and interactions. Finally the cultural environment is shaped by activities of human communities, filled with traditions, language, religion and values. Cultural environments are closely tied to people's core identities, making them more resistant to change. Therefore, with the aim to foster sustainable behaviours, it becomes crucial to focus on the social and spatial mechanisms, when proposing designs. Translating this theory into practical applications, a key execution form is context-sensitive design. **Context-sensitive design** encompasses the importance of recognizing the existing 3 spatial environments and built upon that, when tailoring the fabric for specific communities.
Having gained knowledge on the relationship between humans and their environment, the theory of **Pro-environmental behaviours** (Larson et al, 2015; Steg and Vlek, 2009) elaborates on the positive relations, wherein humans actively participate to conserve, preserve and improve their environment. A relationship that can be established according to psychologist and social science researcher Lincoln Larson (2015) by four different target behaviours: Conservation lifestyle, which emphasises the preservation of resources in day-to-day living, Land stewardship, which emphasises on ecology, Social environmentalism, which emphasises community education and activation and Environmental citizenship, which focuses on political action. Since Environmental citizenship is the least related to space, it falls outside of the scope of this report.

By embracing these theories, urban designers can ensure that their spatial designs align with the existing social and cultural mechanisms of the communities they serve. In addition the patterns of environmentally friendly behaviour gave an understanding in how space could activate this type of behaviour. As a result, urban environments will become more meaningful and effective in the context of water as they foster a sense of ownership and attachment among the residents.

3.2 Theoretical framework

Liveability
According to Pfeiffer and Cloutier (2016), happy neighbourhoods consist of s**ocial interaction, safety and open natural green spaces**. Studies have shown how social relationships can be a force of happiness, a factor that can be spatially stimulated by design. Leyden (2003) describes how compact neighbourhoods may lead to higher levels of interaction. In addition, social relations contribute to the feeling of safety that is important for residents to feel at ease in their home. Physical characteristics like more street frontage and windows facing the street are an elaboration on this. Lastly, access to open natural green space adds to happiness for many reasons. As the colour green is associated with the feeling of serenity (Akers et al., 2012) and invites for physical activity (Brereton et al., 2008). Spatial forms in a neighbourhood can be a window overlooking a forest or a park nearby.

Chapter 4.

Understanding the Dutch water management

In order to design for the future of water it is necessary to have a solid understanding of the traditional methods with the underlying values. For this reason, a review of the Dutch water management has been conducted. Analysing the relationship between the Netherlands and water, through space and policies.

"God created the earth, but the Dutch created the Netherlands"

- René Descartes

Figure 28: Deltaworks (Zeeland, n.d.)

4.1 Dutch water management through time

In figure 29 the history of the Dutch water management has been summarized and will be elaborated in the following chapter.

The Netherlands has always been confronted with severe water related problems. Battling against the sea, the storms, the frequent flooding, and losing land. Water was seen as a threat and had to be controlled and regulated (Van de Ven, 2004; Van Steen & Pellenbarg, 2004). In response the Dutch have reshaped their rivers, minimised their river basins and closed their creeks to replace it with canals. This battle against water, has led to a water management with a technocratic approach to meet human needs, building dikes in order to keep people's feet dry and conquering land from the sea to urbanise on. An action that at first was done locally, but has subsequently become a governmental responsibility. This perspective of the 'battle against water' was widely shared with civil engineers and policy makers of the Ministry for Transport, Public Works and Water management (Bosch & Van der Ham, Lintsen, 2002;1998; Wiering & Driessen, 2001; Van der Ham, 1999;).

From the mid-1980's, there was a gradual shift towards a more integrated water management, taking into account environmental concern, water quality and nature conservation. This shift initiated a new 'system ecology' discourse next to the traditional 'battle against water' perspective (Van Hemert, 1999; Disco, 2002). But when the Dutch faced a near national disaster in 1995, when the nation's main rivers (Rhine and the Meuse) rose to extreme water levels, the discourse of traditional water management was dominating again. In which 'defending ourselves against water' meant creating a division between water and land, by strengthening the dikes (Wiering & Driessen, 2001). On the other hand, the shock event in 1995 significantly influenced the plans and concepts for future water management. Scientists and policymakers realised that the previous approach of dividing land and water was insufficient in order to meet safety goals in the long run (Remmelzwaal & Vroon, 2000; Wiering & Immink, 2003). As a result, water management gradually moved away from building higher dikes towards giving more 'room to the river'. Creating a discursive turn towards the idea of 'accommodating water' (Van Stokkom et al., 2005; Smits et al., 2000).

This history of the Dutch water management (Rijksdienst voor het Cultureel Erfgoed, n.d.) has shown the relationship between nature vs culture in how infrastructure has been built to command and control water. Nature vs culture describes the relationship between the natural world (nature) and human–created world (culture) (Lokman, 2017). In which in the earlier times this relationship was more intertwined. Inhabitants that adapted their life to give space for water and farmers that formed communities to fight water together. Through time the reformation of land became more of a technocratic act. Using infrastructure as an engineered project on how to command and control water. In which nature is engineerable by reclaiming land, normalising rivers and building the Deltaworks. An anthropocentric approach that has not taken into consideration the relationships infrastructure has with other actors and processes in the landscape. These traditional infrastructural systems are therefore disconnected from their immediate environment, while infrastructure forms the whole dynamic of a landscape. Plumwood (2002) symbolises the dam as an infrastructure that embodies human centered water management in which nature and culture have been separated. While dams provide safety, energy and help with our water supply it alters the landscape negatively on an ecological level in flow, temperature and animal habitat. This technocratic model is based on the idea that the needs of humans should be met and water engineers are supposed to fix all problems. Even though the technocratic water system did provide households with a reliable water system by centralising it. It made citizens lose their knowledge over water technologies. Thinking the 'system' will protect all from most extremes. Making people unaware of the relationship between nature and culture. Flood events in 1953 and high water levels in 1995 have raised questions for this existing model, in which the Dutch government has chosen to not continue this path. The Delta program (Rijksoverheid, 2023) shows a new paradigm in which there are more integral solutions and in which Water and soil become guiding factors. As innfrastructures have the potential to integrate social and ecological needs to create a better long lasting impact.

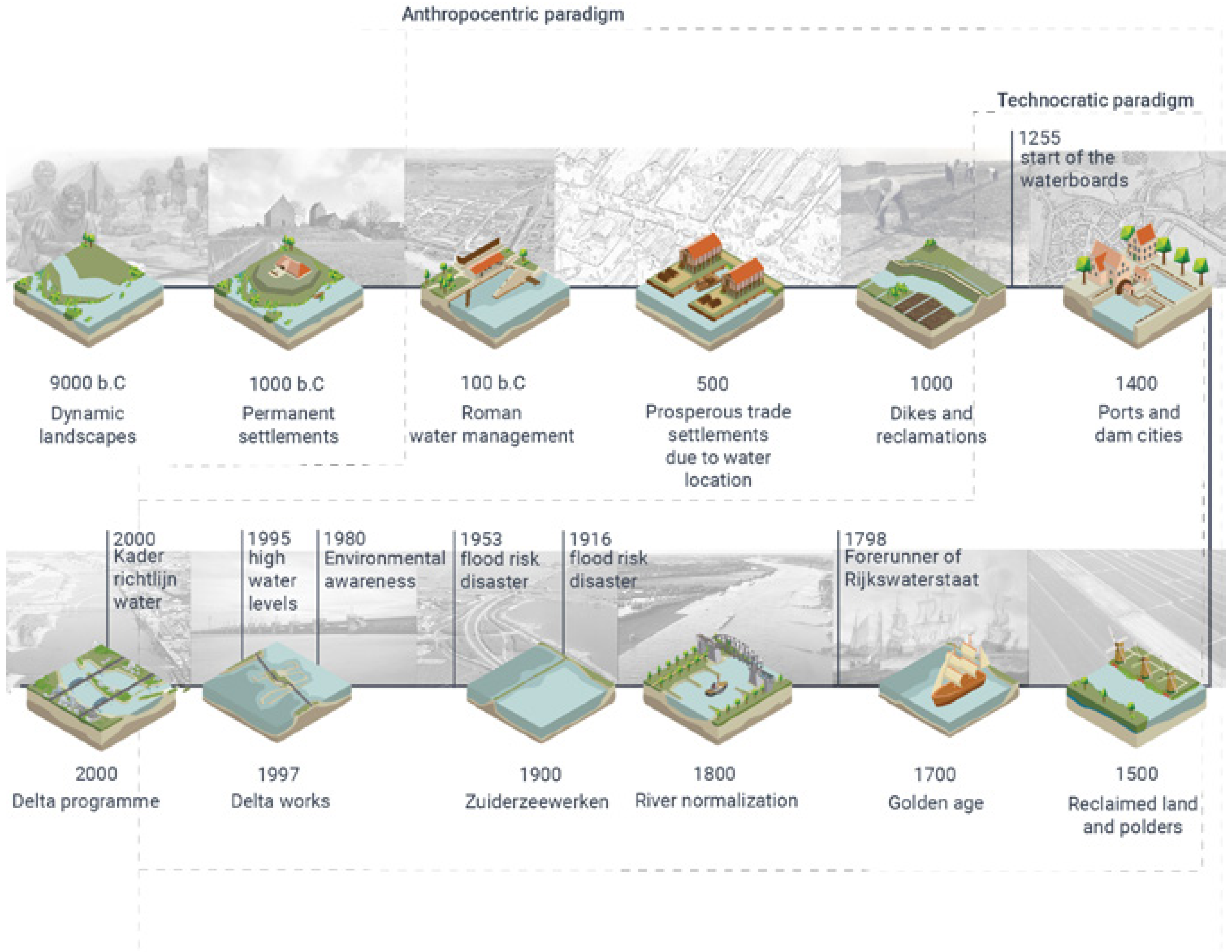


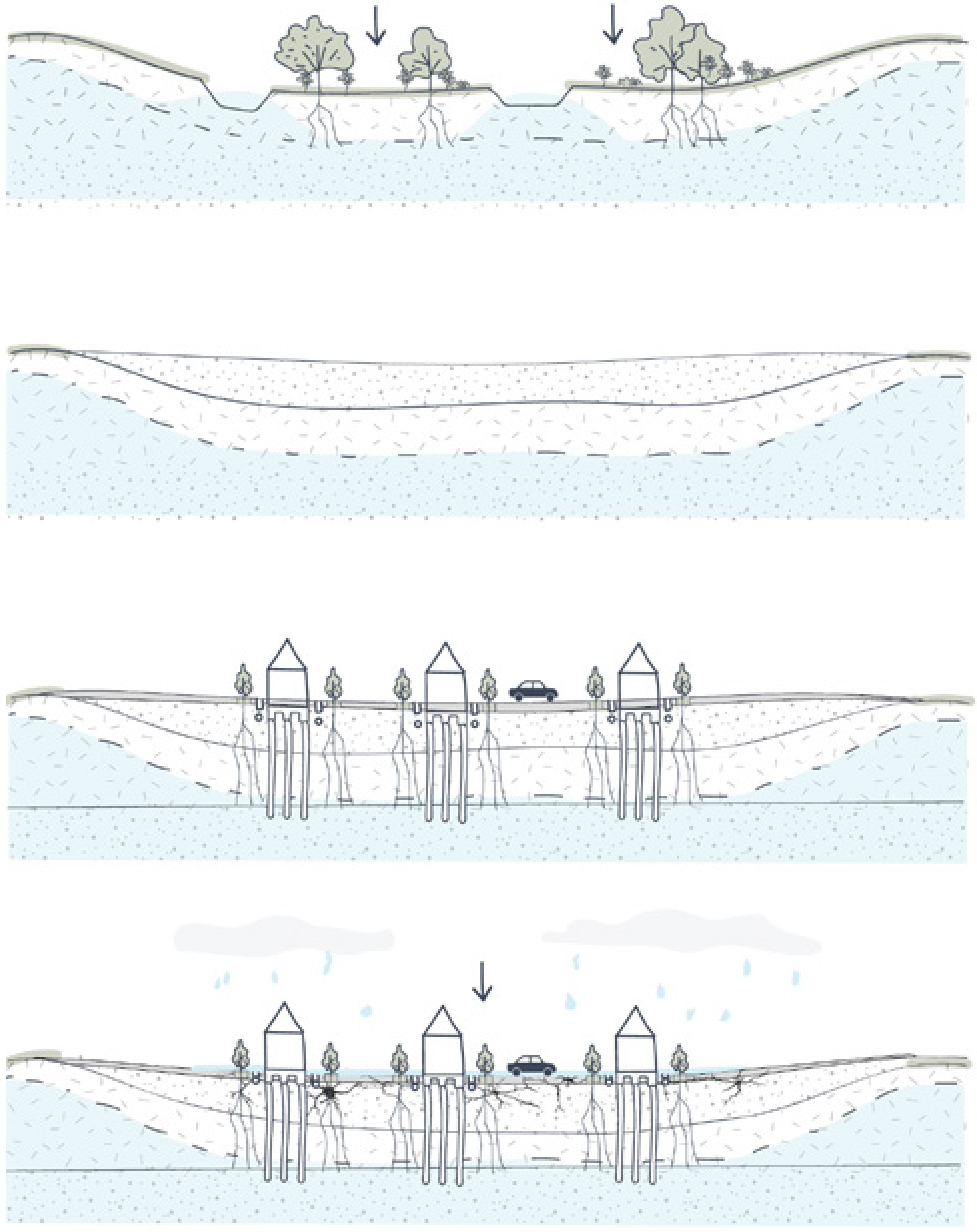
Figure 29: History of the Dutch Water Management (Rijksdienst voor het Cultureel Erfgoed, n.d.)

4.2 Traditional way of building

The traditional way of building in the Netherlands can be seen in figure 30, which will be covered in more detail in the next chapter.

Soft soils are a consequence of subsidence and do not just happen; it is usually the result of human activity. In the Netherlands this is caused by the extraction of minerals such as coal and peat for industry, or due to a low water level, caused by the reclamation of polders. When the water level is low the soft soils, generally consisting of peat, will oxidise causing subsidence (Kenniscentrum Bodemdaling en Funderingen, 2023). The traditional way of solving this issue, when building in these polders with soft soils, is to raise it with filler materials such as sand (Kennisportaal Klimaatadaptatie, n.d.-a). A method that is supposed to create more soil stability for infrastructures and houses.Unfortunately the pressure of the fill material actually compresses the soil underneath, causing it to sink even more. As a result, municipalities and residents in areas have to raise public spaces or gardens due to this type of subsidence. In addition, damage to infrastructure occurs more often and damage to wooden pile foundations is also an issue. Part of this traditional way of building is that there is less space for water and green, as the existing green and blue structures have not been valued in the existing landscape. Creating smaller waterways and adding less green in return. Moreover, water is drained immediately through the sewage system. A method that additionally brings problems during heavy rainfalls.

The social costs due to subsidence for the whole of the Netherlands have been estimated and will approximately reach €22 billion by 2050 by The Netherlands Environmental Assessment Agency (Kenniscentrum Bodemdaling en Funderingen, 2023).



1. Soft soils due to human activity.

2. Sand as refill material for the construction process.

3. Infrastructure and buildings are put, while paving the landscape.

4. Subsidence due to oxidation, creates damage on infrastructures and buildings. In addition, due to lack of infiltration water nuisance will occur.

Figure 30: The traditional way of building

4.3 Current Dutch governmental framework

The current Dutch policies regarding water on a neighbourhood scale, takes place on five levels of regulations (figure 31), since the SDG's are only an aim whereby rules can flow from and therefore are not an obligation. The regulations start on a European level with the **Water Framework Directive** (Water Framework Directive, 2023). This consists of rules that ensure the protection and improvement of water quality for Europe's rivers, lakes and groundwater. On a national scale the water framework directive is translated into the **National Water Plan** (Nationaal Waterplan, n.d.) that provides the structure for regional strategic water plans. Furthermore the **Delta programme** (Rijksoverheid, 2023b) sets the course for the future as it is the implementation of the National Water plan. In addition, the **climate scenarios** that are used as the basis for all these laws are made by KNMI (KNMI, 2023b).

Subsequently the execution takes place on smaller scales, thus the Waterboard of Delfland is responsible for regulating water levels, treating wastewater, managing dykes, managing nature in and near water and controlling the quality of water bodies. While municipalities are responsible for rainwater that falls in the public space. Furthermore drinking water companies are responsible for delivering good quality drinking water and inhabitants are responsible for the rainwater that falls on their plot of land.

Looking at the Delta programme (Rijksoverheid, 2023b) it emphasises the need for quick action in preparation for the impending rainy and dry seasons, which are already noticeable. To be able to protect the Netherlands from floodages, safeguard drinking water and create a climate-proof environment, boundaries have to be set in space and water use.

The advices of the Delta commissioners are:

1. Considering future generations when making decisions
2. Enlarging social engagement with future climate scenarios
3. Be flexible when making decisions regarding climate adaptiveness
4. Build bridges concerning policy themes
5. Put feasibility first

These regulations showcase the shift that the Netherlands have made from a one-dimensional short term water management to a multifaceted long term discourse. Policies to which this project connects to.

Whenever a neighbourhood gets built it has to comply with the **Environmental code** on a national scale, these are regulations that make a statement about every type of space that includes living, working and recreation. In this code it describes how water should be handled. This translates itself in the **Water Assessment** on waterboard scale and the **Rainwater Regulation** on municipality scale. This has taken into account the **Covenant on climate-adaptive building for new neighbourhoods** (Province of South-Holland, n.d.) in South Holland and **The National climate atlas** (Rijksoverheid, 2023a). Both emphasise the importance of less flooding, more biodiversity, reduced prolonged drought and its adverse effects, less land subsidence and fewer adverse effects thereof.

When building a neighbourhood, a collaboration starts between project developers, urban designers, Waterboards and the municipality on the topic of water.

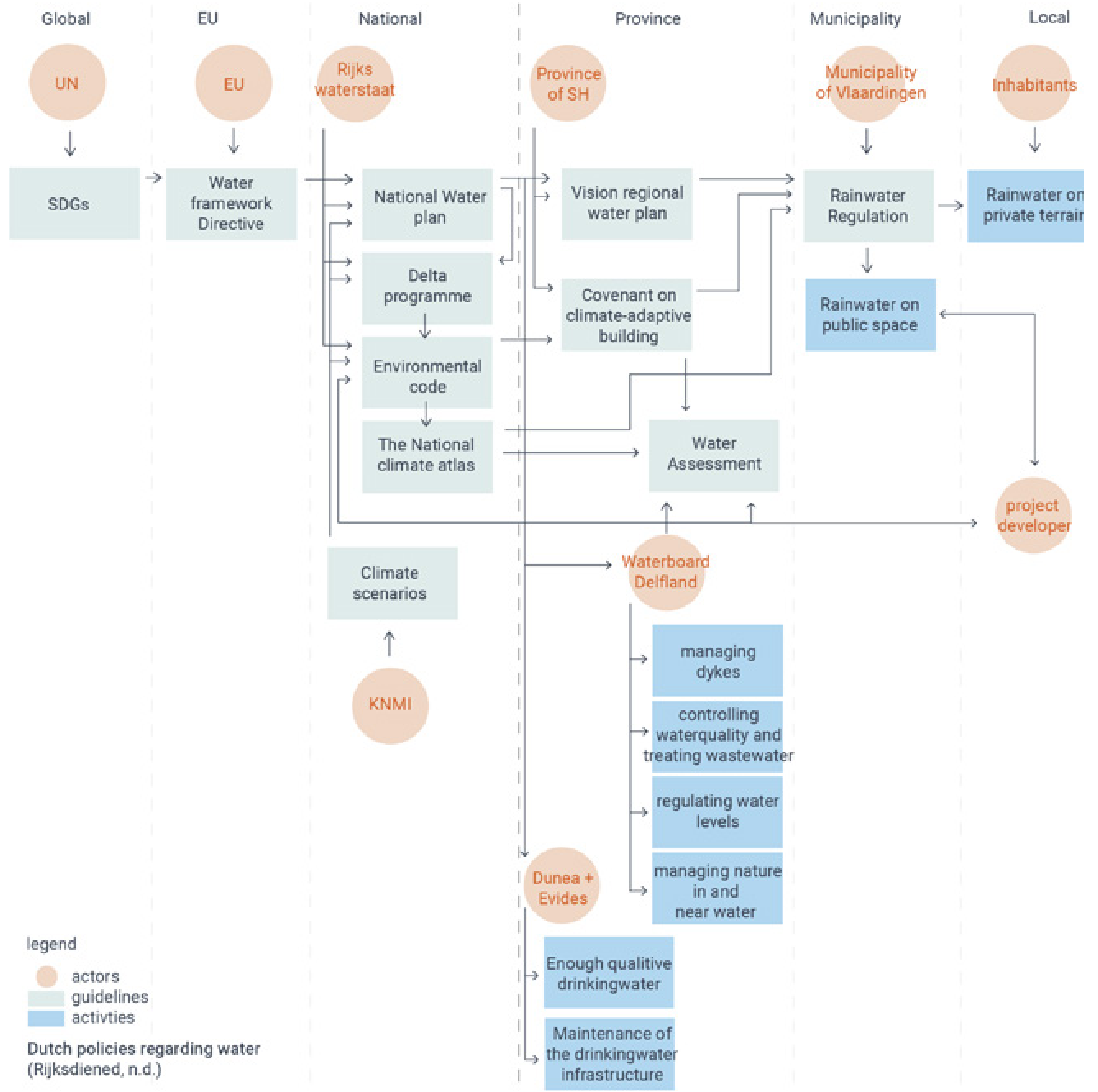


Figure 31: Dutch governmental framework regarding water on a neighbourhood scale

Chapter 5.

Story of Fortunapark

The location has been studied on its spatial character, history, social status and future housing demand.

"Cities are the principal product of civilization."

- Jane Jacobs

Figure 32: Fortunapark

5.1. introducting Fortunapark

Fortunapark is located in Vlaardingen along the A20, at the edge of Midden Delfland and at the Marathonweg Noord, one of the most important entrances to Vlaardingen. The different scales that are used for the diagnosis of Fortunapark are shown in figure 33.

Zooming into a smaller scale in figure 34, it can be seen that Marathonweg Noord is located in between the A20 and the metro line. The Marathonweg Noord forms a connection to the south. To connect the east with the west the Marathonweg has two connecting lines, the Floris de Vijfdelaan - Billitonlaan and the Marnixlaan. Whereby the Marnixlaan is also part of a green zone with parks which moves through the Westwijk and the pre-war inner city. The differentiation between the Westwijk in the west and the pre-war innercity in the east, in form and density, gives clear boundaries to the area. Westwijk has a more green blue spatial character, while the pre-war innercity is dense with less green and more low-rise. Fortuna Park is part of Westwijk and consists of fallow lawns and relics from old sport fields.

Figure 33: Fortunapark through the scales
legend

- pastures
- greenhouse farming
- wet nature
- woods
- recreational green
- water
- infrastructure
- urban
- Midden-Delfland

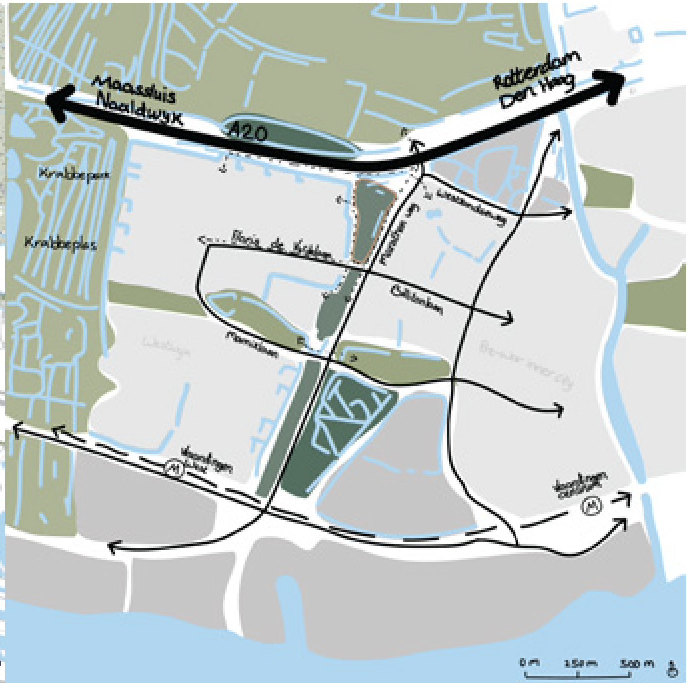


Figure 34: Spatial exploration Fortunapark
legend

- residentials
- high way
- main road
- metro line
- slowtraffic
- metro station
- allotments
- green buffer
- public green
- water
- industry
- Fortunapark

5.2. Spatial exploration of Fortunapark

Zooming in on the direct environment of Fortunapark (figure 36), it can be seen that three busy roads are framing the location and a wide waterbody. Fortunapark is located around the A20, with noise barriers and water in between. On the north side there is a parking for trucks, that will be closed and will be become part of Fortunapark. The petrol station will stay and has a safety contour of 40 metres (Gemeente Vlaardingen, 2022). On the east side of Fortunapark, the Marathonweg Noord is located, along with mainly low-rise residentials. On the the south of Fortunapark the Floris de Vijfdelaan road is the entrance to the Westwijk. On the west side however, a more calm side is situated with a waterbody and a neighbourhood. A variation of buildings are located along this waterbody, with different heights and functions. Fortunapark has wildered through time, with height difference and diverse plants. A forest full of willows has grown through time

In the images of figure 35 a closer view of the area is shown.

Figure 35: Site visit images

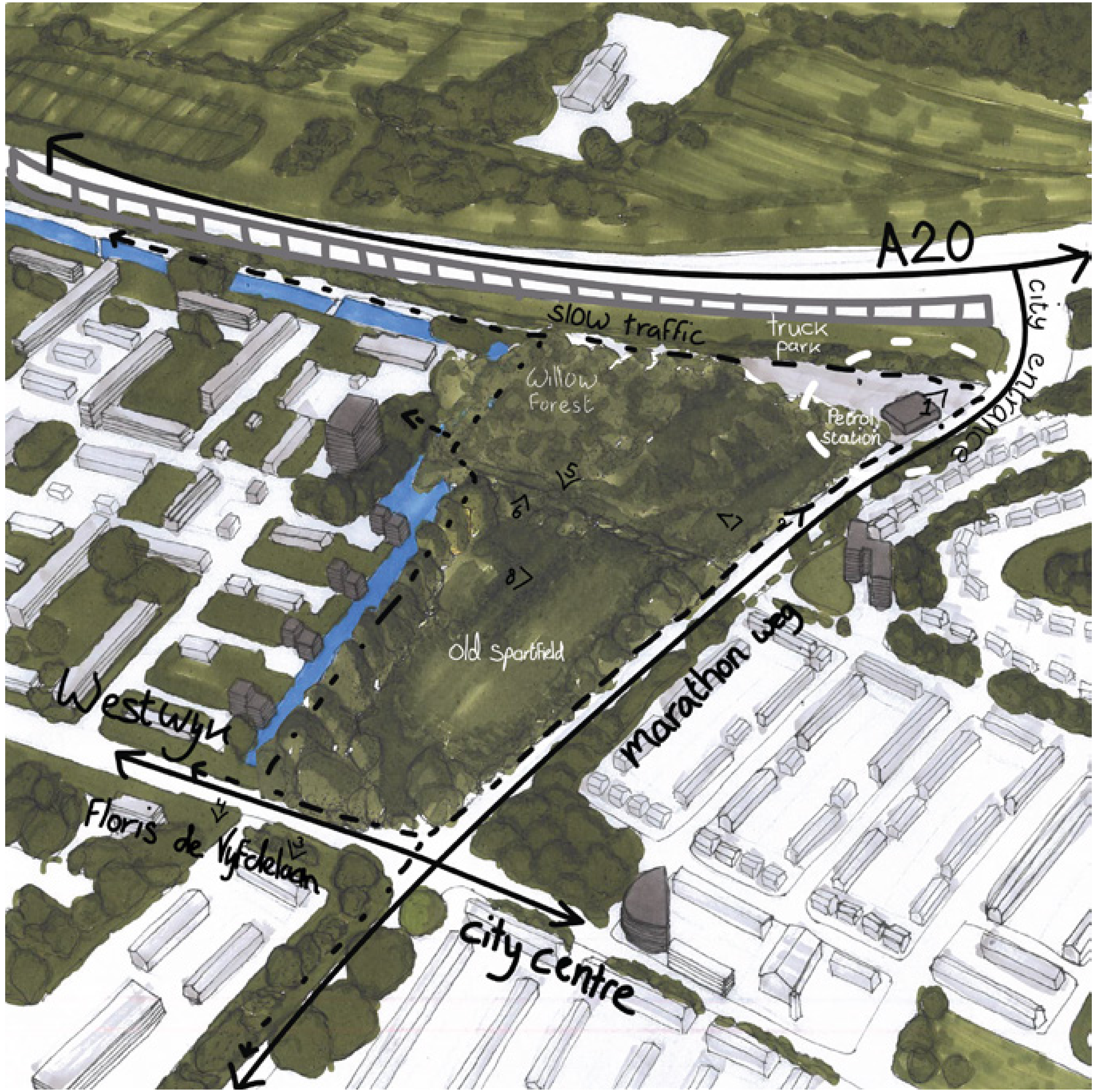


Figure 36: Fortunapark direct environment

5.3. History of Fortunapark

Images of Fortunapark between 1967 and 2020 can be see in in figure 37.

In the 50s (Gemeente Vlaardingen, 2022) Fortunapark used to be part of a green buffer between the Westwijk and the pre-war inner city, since they expected to build a junction for the railway track of Hoek van Holland - Rotterdam. This became a 100 metres wide stroke and has received an infill of soft green functions like sportfields and allotments. Around the 90s, it became clear that the railway track never came and slowly the green sports fields made place for other functions, such as building plots.

Following this narrative the municipality of Vlaardingen (2022) plans to build a minimum of 220 and maximum of 250 residentials in Fortunapark.

Figure 37: Fortunapark through time (Gemeente Vlaardingen, 2022)

5.4. Housing demand of Fortunapark

The municipality of Vlaardingen has the ambition to build more houses in the coming years (figure 38). These new houses should promote a flow from elderly and ensure new homes for first-time buyers and middle-income residences. Therefore, a plan has been made to build a minimum of 220 or maximum of 250 houses. The number of houses is based on the Milieu Effect Rapportage and a traffic study.

Program of requirements (Gemeente Vlaardingen, 2022):
- At least 30% must be ground-level and at least 30% must be flats.
- All dwellings have a minimum area of 50m² GBO.
- Flats have a minimum surface area of 50m².
- Single-family houses have a surface area of 100m² GBO.
- Variation in nave sizes is desired and allowed, with a minimum requirement of a nave size of 4.80m.
- 50 dwellings will be social housing, developed by and managed by a Vlaardingen housing corporation.
-- The remaining homes will be developed in the medium and expensive segments.
-- Medium-priced rental is among the possibilities. A maximum of 20% of the homes may be developed in this category.

		Project/gebied	Indicatie Woningaantal	Planning
Centrum	01	Museumkwartier e.o.	230	2023-2025
	02	Binnenstad	n.t.b.	n.t.b.
Westwijk	03	Marathonweg Noord	250	2025-2027
	04	Floris de Vijfdelaan	64	2022
	05	Frank van Borselenstraat	179	2024
	06	Erasmusplein	60	2023
Ambacht	07	Vijfsluizen	400	2023-2025
	08	District-U	650	2024-2030
		Flexwonen District-U	318	2022
Rivierzone	09	Eiland van Speyk	550	2025-2030
	10	KW-haven	270	2023-2030
	11	Stationsgebied	270	2024-2030
	12	Maaswijk	500	2025-2030
	13	Zwanensingel	165	2025-2030
Holy	14	Park Hooglede	27	2022
	15	Nieuwe Vogelbuurt	159	2023
Totaal			4.092	2021-2030

Figure 38: Vlaardingen area development

Chapter 6.
Maximisation

The maximisation method has been used to study the location and get a grip on the problems, opportunities, and synergies between the pillars of Water and soil, Green and landscape, Human and water and a Happy Neighbourhood. Furthermore, it will show interventions that have been collected to react to the opportunities of Fortunapark. Lastly, the optimization will demonstrate how these maximisations could be overlayed showcasing different forms of Water friendly neighbourhoods.

"Everything in nature is interconnected. When we damage nature, we damage ourselves."

- Vandana Shivers

Chapter 6.1

Maximisation
Water and soil

6.1.1. Soil system

In the following maps (figure 39, 40, 41) the soil condition will be discussed of Vlaardingen and Fortunapark. Vlaardingen consists of a clay peat landscape, the soil of Fortunapark mostly consists of clay with some peat layers in between (TNO Geologische Dienst Nederland, n.d.). Furthermore, Fortunapark is located in a polder under sea level. The green plot itself has height differences that are due to deposited soil. In addition, subsidence occurs in Vlaardingen and Fortunapark as a result of drainage of the peat layers. In Fortunapark it happens around 1.5 mm per year (Delfland, n.d.;SkyGeo, 2024). In addition, salinisation is not a problematic issue for the location of Fortunapark (Bruine, 2024).

Figure 39: Soil map Vlaardingen ()
legend

- clay soil
- peat soil
- sulphur soil
- pastures
- greenhouse farming
- wet nature
- woods
- recreational green
- water
- infrastructure
- urban

Figure 40: Height map Vlaardingen ()
legend

- heigh
- under sea level
- low

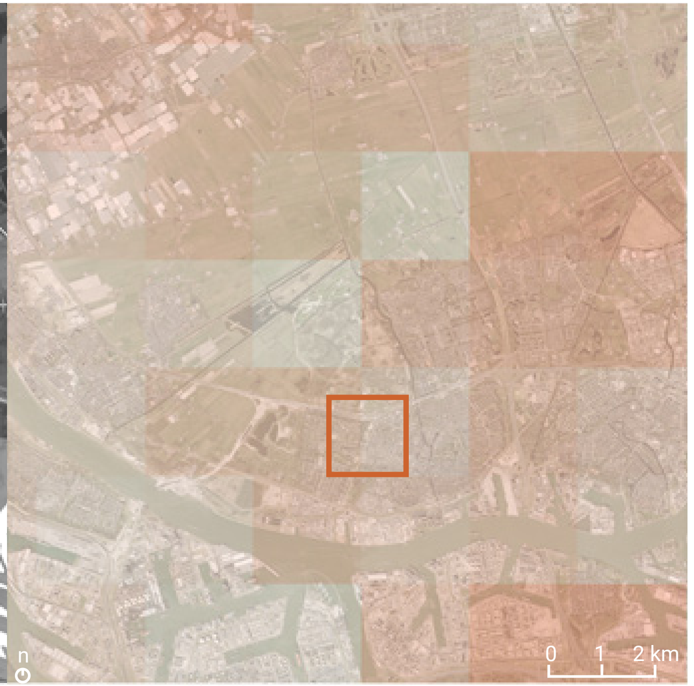


Figure 41: Subsidence map Vlaardingen (SkyGeo, 2024)
legend

- < -5 mm/y
- -5 - -4,5 mm/y
- -4 - -3,5 mm/y
- -3 -- 2,5 mm/y
- -2 - -1,5 mm/y
- -1,5 - -1,0 mm/y

6.1.2 Polder Vlaardingen-West

With the help of Hydrologist Erik de Bruine the water system has been decomposed. Fortunapark is situated in the polder Vlaardingen-West (figure 42), in which water enters the polder via the bosom Vlaardingenvaart letting the water flow from east to west, moving southwards. Furthermore, the Polder Vlaardingen-West is heavily dependent on its sewage system, as it has little open water to catch or store water. Overflows are widely used when there is a significant downpour, contaminating the water.

Figure 42: Water and soil Polder Vlaardingen west

legend
- polder water
- bosom water
- river
- dam
- water levels
- water inlet
- building
- vegetation
- water pump

6.1.1 Polder Vlaardingen-West

To be able to understand what the role is of Fortunapark in the water cycle of the polder Vlaardingen-West the characteristics of the water systems have been analysed, using the physical variables that have been mentioned in the theoretical framework, that have an influence on the water system. Which are: shape of the water body, bank, ground water level, surface materials, shadow and pollution. These variables have systematically been judged (appendix A) resulting in the following characters (figure 43): Concrete business terrain with tiny sporadic water streams, Small unconnected waterways in a green field, Discontinuous grand waterways in the city centre, Large blue singles with residentials in green, Small still water streams in a garden setting and Small waterways in a concrete business area.

Concrete business terrain with tiny sporadic water streams
Before water arrives in Fortunapark, the water from the bosom will flow to the business terrain. Unfortunately, a lot of heavy traffic drives in this area, causing pollution in the surface water. In addition, as the water bodies are small in size, it can not retain as much water which creates water nuisance during heavy rain showers. Furthermore, the sporadic tiny water bodies and paved materials are not beneficial for circulation and the infiltration capacity. Therefore, the water has a low quality.

Small unconnected waterways in a green field
Fortunapark is a green field with vegetation and naturally friendly banks, offering as a location for infiltration, water collection and storage. Unfortunately it has small unconnected waterways which deteriorates the water quality.

Discontinuous grand waterways in the city centre
In the city centre there is a pattern of grand waterways with naturally friendly banks, a beneficial shape, but with a discontinuous character that influences the circulation negatively. In addition, the amount of paved and 'functional' areas decreases the infiltration capacity and water collection possibilities.

Large blue singles with residentials in green
A neighbourhood with a beneficial blue character due to its shape, surface materials and banks. However, water nuisance is experienced in the main streets.

Small still water streams in a garden setting
A location with mostly allotments and a few sportfields. This location forms an island group with small streams of water. Resulting in a low water quality due to agricultural nutrients and the lack of circulation in the water. Furthermore, there is little water nuisance.

Small waterways in a concrete business area
A business area that is fully paved and requires heavy vehicles to drive through. In addition, it has a water body that is small and discontinuous. This creates problems for water nuisance and water quality.

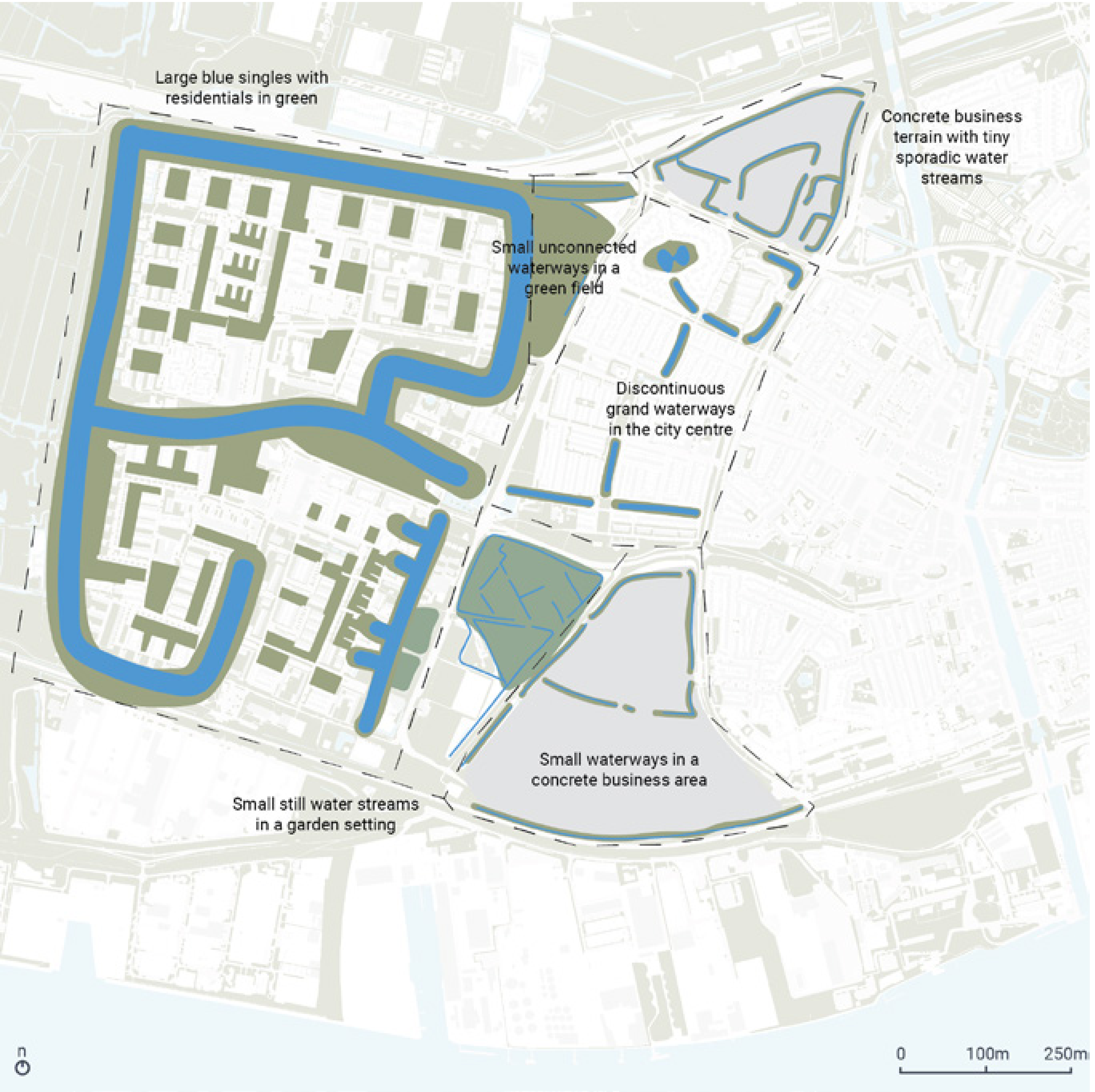


Figure 43: Characteristics of Polder Vlaardingen-West
legend
vegetation
waterway
allotments
heavy traffic

6.1.1 Polder Vlaardingen-West

Within this polder system, Fortunapark is one of the first links in which water from the bosom Vlaardingenvaart can flow to (figure 45). Which is after the 'Concrete business terrain with tiny sporadic water streams'. A location that experiences water pollution due to the heavy traffics and is affected by water nuisance during heavy rain falls. For this reason Fortunapark can experience polluted water through the business terrain and can play a role in contributing to the purification of water and release pressure from the water nuisance in the business terrain. In addition, Fortunapark itself experiences some subsidence (figure 44).

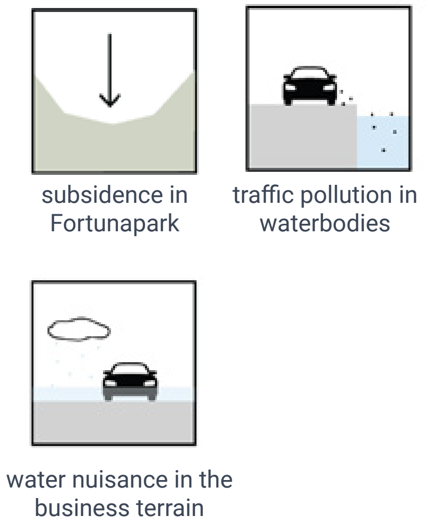


Figure 44: Spatial water characteristics from Polder Vlaardingen-West that influences Fortunapark

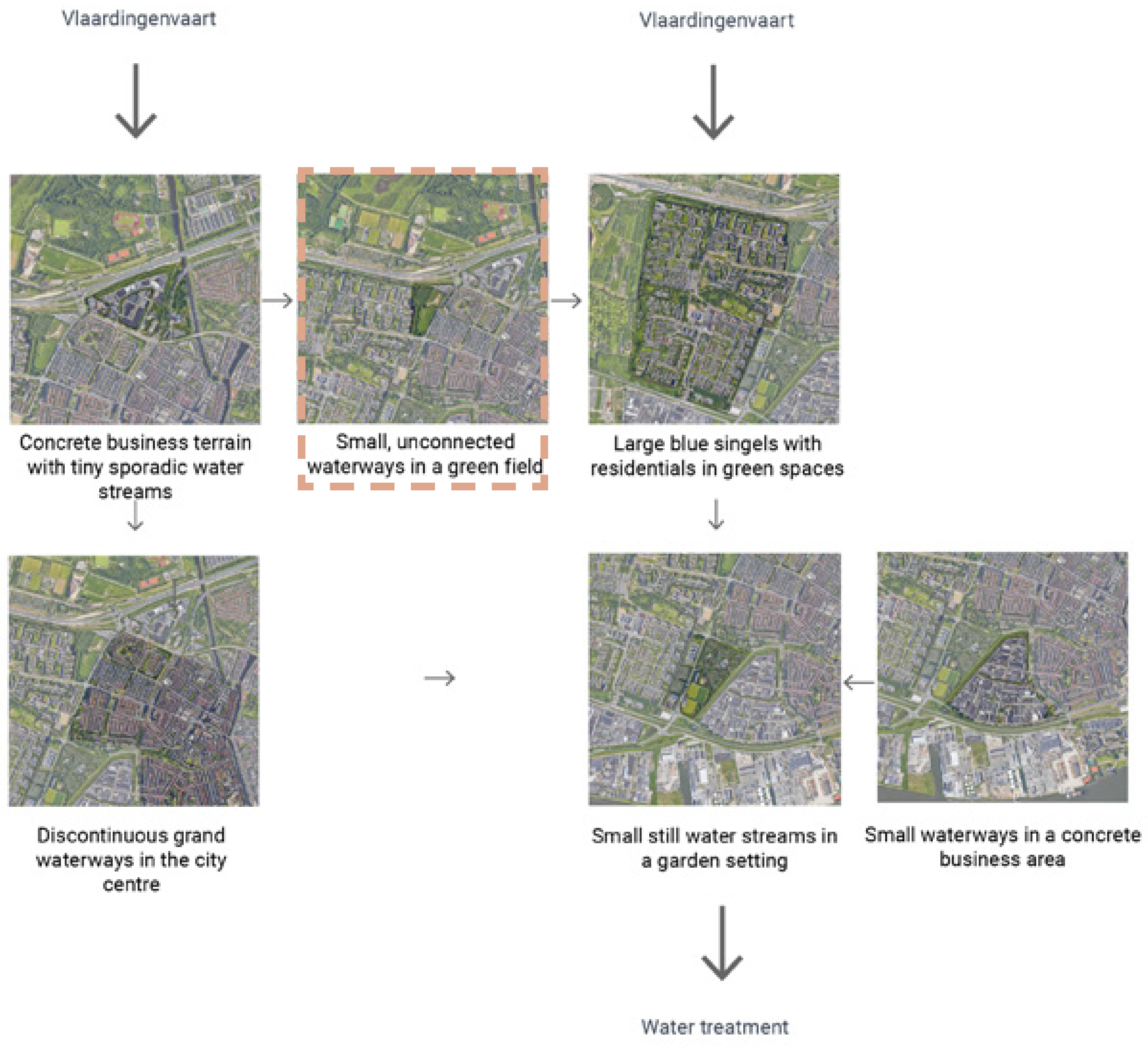


Figure 45: Sequence of water flow through Polder Vlaardingen-West

6.1.2 Fortunaparks Water and soil system

If we zoom into the landscape of Fortunapark (figure 47) it can be seen how it falls under the groundwater level of -2.14. It is a landscape with hills of different height levels and the present waterways are narrow and connected through divers. There is also a willow forest situated on the West side. During heavy rain events that happen once in a hundred or once in a thousand years, an accumulation of water takes place. Using these characteristics four landscape typologies have been identified (figure 46): Disconnected waterways in green, willow forest embraced by hills, hilly areas and a soft water bank with ash trees.

The current Water and soil system is, due to its green character, a location for water collection infiltration and storage. There are also natural friendly banks, but because of the small character and dead- ends of the water bodies, the conditions for water quality are not on its best and some subsidence is experienced due to the low water levels in the peat layer.

Figure 46: Current Water and soil typologies

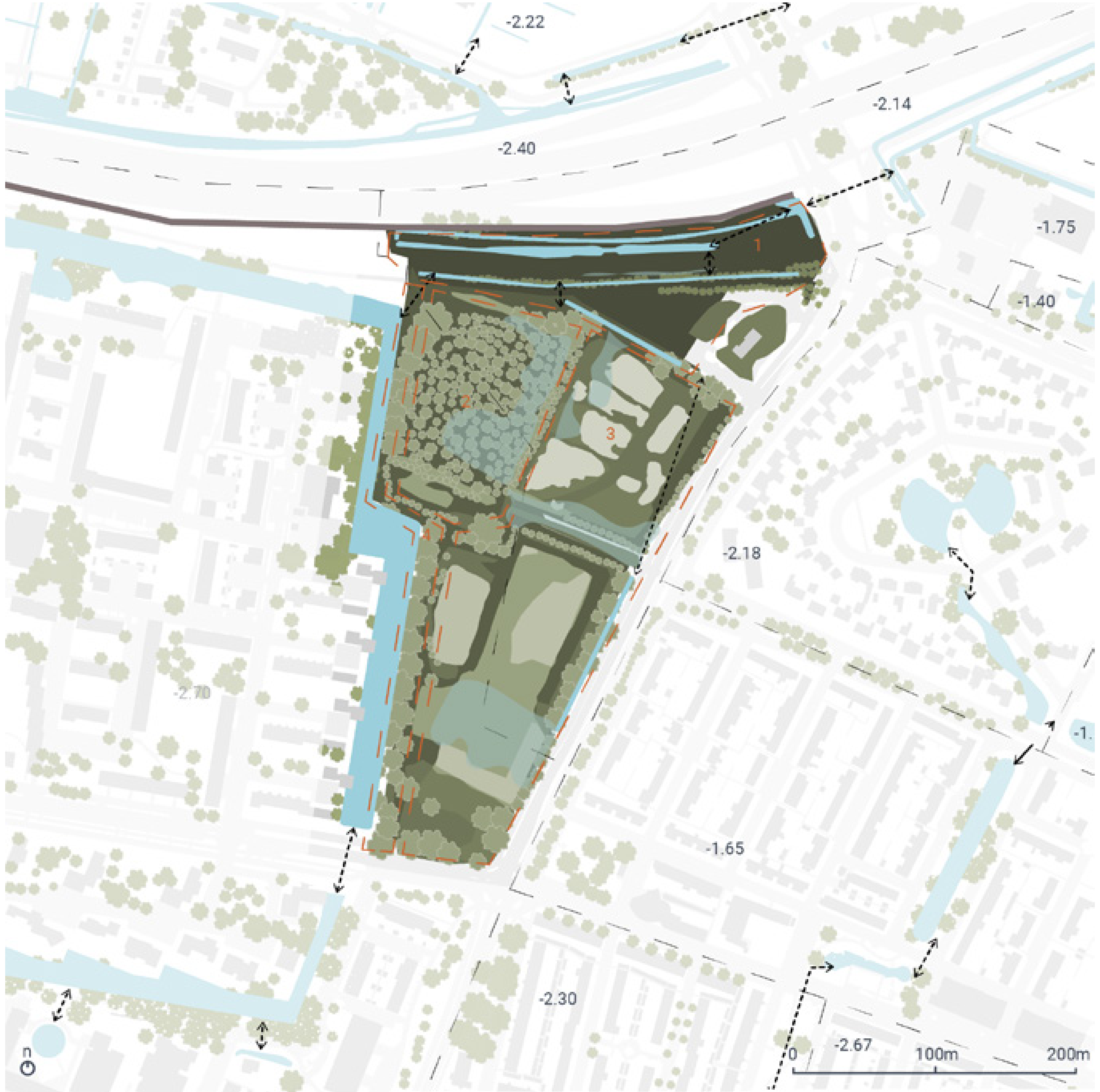


Figure 47: Fortunaparks Water and soil system

legend

polder water
connection
water levels
trees
landscape typologies
water accumulation during 1 in 100(0) rain falls

green height levels
2.23
1.31
0.25
-0.27
-0.51
-1
-1.1
-1.5

6.1.3 Water and soil ambitions

Existing policies and project ambitions regarding water will be discussed in this chapter. The ambitions can be measured qualitatively and quantitatively. The quantitative ambitions have been marked blue.

Convenant Klimaatadaptief Bouwen
- Heavy precipitation: A large proportion of precipitation (50 mm) from a short heavy shower (1/100 years, 70 mm in 1 hour) on private land is collected on this land collected and disposed of in a delayed manner. The repository is empty no sooner than in 24 hours and is available again in a maximum of 48 hours, or is sent.
- Heavy precipitation: No damage to buildings and facilities will occur in the plan area during extremely heavy precipitation (1/250 year, 90 mm/h).
- Severe precipitation: The design of the planning area is tailored to the expected groundwater levels and freshwater availability during droughts.
- Drought: The plan area infiltrates 50% (about 450mm in 'normal' years) of annual rainfall.
- Soil subsidence: Include measures that counteract damage from subsidence and are cost-effective over the lifetime of 60 years.

Hemelwater verordening
- 60 mm of water must be stored per square metre of built-up area
- Stormwater storage shall be designed and maintained so that it is 90% available again between: 1 and 2 days if the captured rainwater is not intended for reuse; or 3 and 4 days if the captured rainwater is intended for reuse."
- The amount of rainwater that cannot be salvaged can be discharged into the public sewer or into the public space.

Landelijke klimaat meetlat
- Flooding: No water damage up to and including a shower occurring once every 100 years, vital and vulnerable functions remain available
- Water flooding: No water damage at 0.2 metres water depth in the street
- Process precipitation on private land on private land or additional facilities intended for this purpose in the plan area or within the water system boundaries
- Prevent run-off
- Natural and above-ground drainage is present in the area as much as possible: Preferred order, Use and save water, Retain and infiltrate water and Store and Drain water.

Ministry of I&W
As the current drinkwater use is 74% used by households (CBS, 2022), there are a lot of gains to be made in saving drinking water. Due to water scarcity, the Ministry

When taking the existing policies into account, three project goals have been set under the pillar of Water and soil with six strategies and corresponding building blocks (figure 48).

Goals
Climate adaptive
To be able to create long term liveable environments that are less vulnerable to weather extremes caused by climate change, the built environment should be prepared for extreme rainfall events and droughts. In the current operation water is moved out of the city as soon as possible, as this is not sustainable for future scenarios we move towards a different approach. The sponge approach will be introduced, in which the flow of water will be delayed and stored within cities as long as possible.

Circular water system
It is important to safeguard our drinking necessities during periods of droughts. Water should be reduced, reused and recycled as much as possible. Currently, clean water is part of a linear chain in which it is only used once and used for non drinking activities. This forms a wasteful process for one of our most valuable resources. This process can be optimised by striving for a circular water system in which the built environment can be designed to foster this process.

Robust water system
A robust water system is defined by creating ideal conditions in which water can circulate its natural behaviour. As water always has to adapt to the built environment by being straightened or discontinued, a decrease in water ecologies have taken place. To shift from this perspective, urbanisation will adapt to water instead. Creating connected, meandering and soft waterways to enhance the water system.

Strategies
1. Circulate
2. Treat
3. Infiltration
4. Water collection
5. Water storage

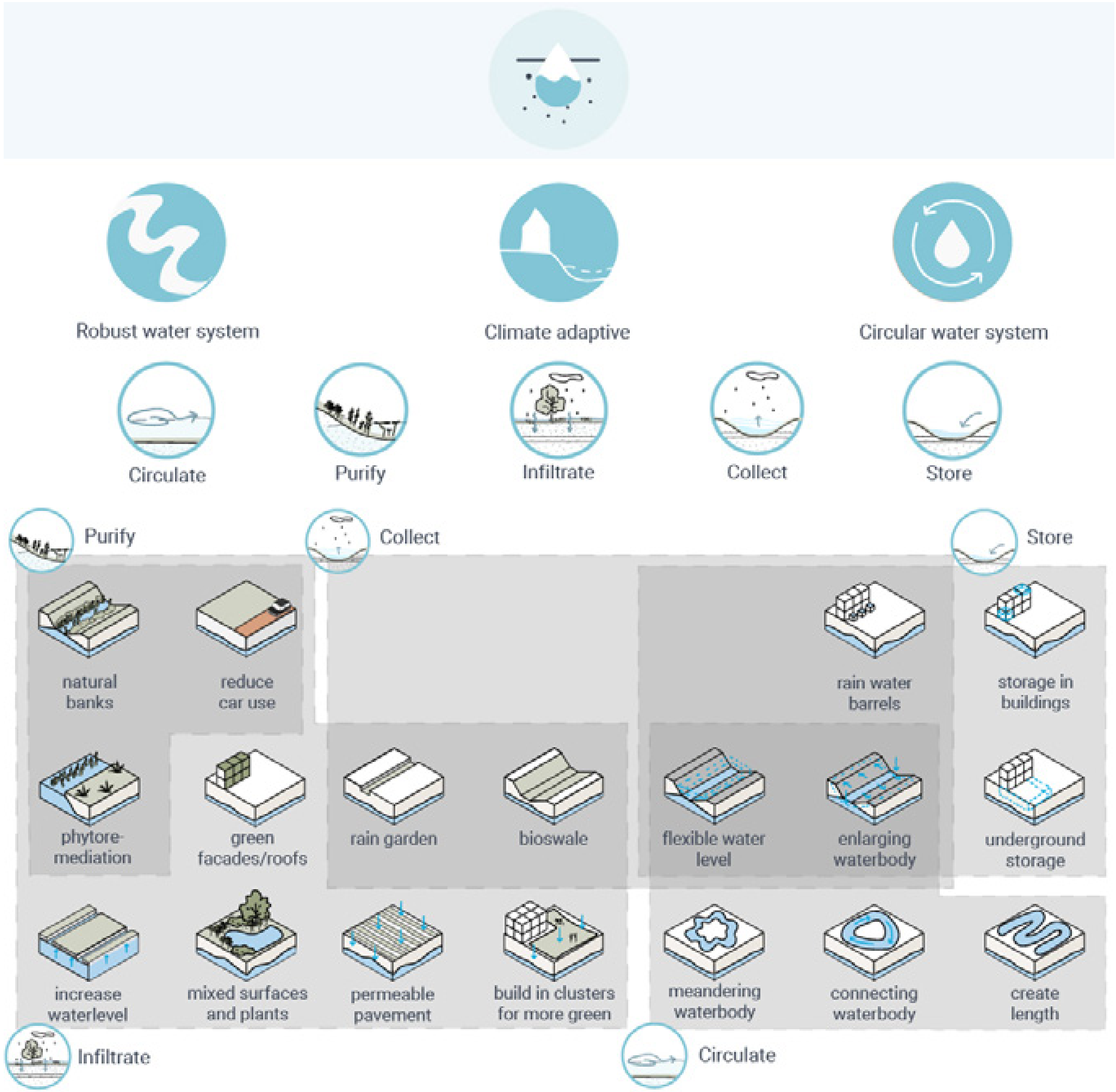


Figure 48: Water and soil patterns

6.1.4 Water and soil vision Polder Vlaardingen-West

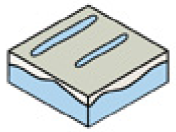
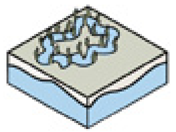
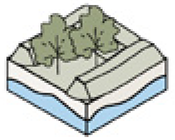
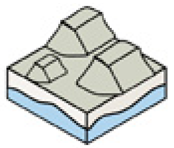
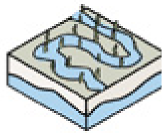
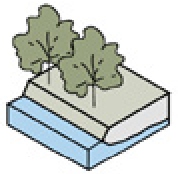
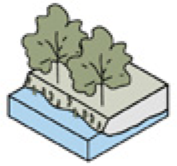
In the vision of Polder Vlaardingen-West (figure 49) the water system can be improved by empowering the existing urban structures. The green character of Westwijk will be used for an open bioswale water system to collect and store water, while using helophyte filters at the surface water. While the pre-war city centre on the other hand will focus more on green acupuncture at locations where water nuisance takes place. This consists of green roofs with phytoremediation plants, permeable pavement and removal of car parkings to create more water storage. Within this system Fortunapark can play a role in purifying the water for the overall water quality in the polder Vlaardingen-West. Moreover, Fortunapark can also help collect water to release water nuisance pressure from the business terrain in the East. These two goals touch upon the goals of a robust and climate adaptive water system. As they both have different spatial consequences, they will be maximised separately to get an understanding of the design. The goal of circularity will be implemented in both explorations.

Figure 49: Vision of Polder Vlaardingen-West

legend

- polder water
- existing park
- connection
- water levels
- open bioswale system
- green acupuncture
- river
- dam
- buildings
- water inlet
- water pump

6.1.5 Fortunaparks Water and soil | SWOT; water quality

Present	Maximisation	Current Strenghts	Current Weaknesses	Opportunities	Threats
 1. disconnected waterways in green	 1. meandering ditch ring with helofyte filters	- use of natural friendly banks - use of divers to connect water flow - Infiltration space due to green - waterbody forms space for water collection and storage	- waterbodies are too narrow for circulation - use of long divers, reduces water quality - fixed water level allow little circulation - polluted water from business terrain will arrive firstly in this water body - subsidence due to drainage of the peat layer	- Add meandering character with maximum length for helofyte filters and connect waterways above ground for better circulation - Enlarge water storage to release pressure from the businenss terrain during heavy rain falls - increase of the water level	- Bad water quality - Vulnerable for subsidence - Vulnerable for evaporation
 2. willow forest embraced by hills	 2. ditch structure with helofyte filters	- Infiltration space due to green - location for water accumulation	- subsidence due to drainage of the peat layer	- Add meandering character with maximum length for helofyte filters - Add helophytenfilters for purification - Create flexible water level for a better circulation and as water storage - Remove trees to prevent pollution - increase of the water level	- Vulnerable for subsidence
 3. hilly area	 3. ditch structure with helofyte filters	- Infiltration space due to green - Waterbuffer above ground - Waterbuffer under ground - location for water accumulation	- subsidence due to drainage of the peat layer	- Add meandering water for circulation and purification - Add helophyte filters for purification - Create flexible water level for a better circulation and as water storage - increase of the water level	- Vulnerable for subsidence
 4. soft waterbank	 4. soft meandering bank with helofyte filters	- Infiltration space due to green - use of natural friendly banks - long and well connected water body - waterbody forms space for water collection and storage	- straight water bodies create less circulation than meandering water bodies - leaves of trees can pollute the water	- Add helophyte filters for purification - Remove trees to prevent pollution	- Vulnerable for subsidence - Vulnerable for evaporation

6.1.6 Fortunaparks Water and soil maximisation; water quality

When maximising water quality in the existing context, a SWOT analysis has been done in which the strategies of circulation and purification stand central as a robust water system is the goal. This has resulted in the maximisation plan (figure 51) with four different landscape typologies (figure 50). Hereby a maximum length is created, to have a maximum surface for helophyte filters and natural friendly banks to purify the water. In addition, the character of the water is meandering with open water connections to stimulate circulation, high water levels to combat the subsidence and trees have been removed to leave pollution in the water.

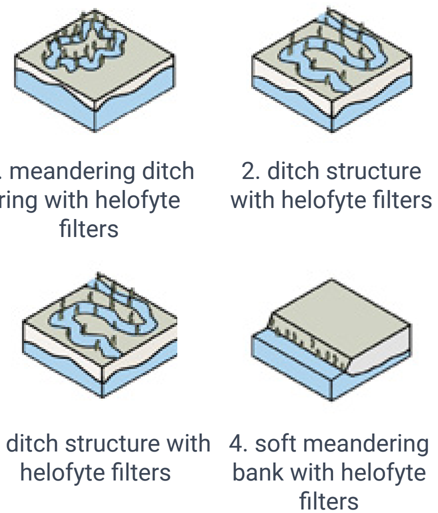


Figure 50: Maximisation typologies on water quality

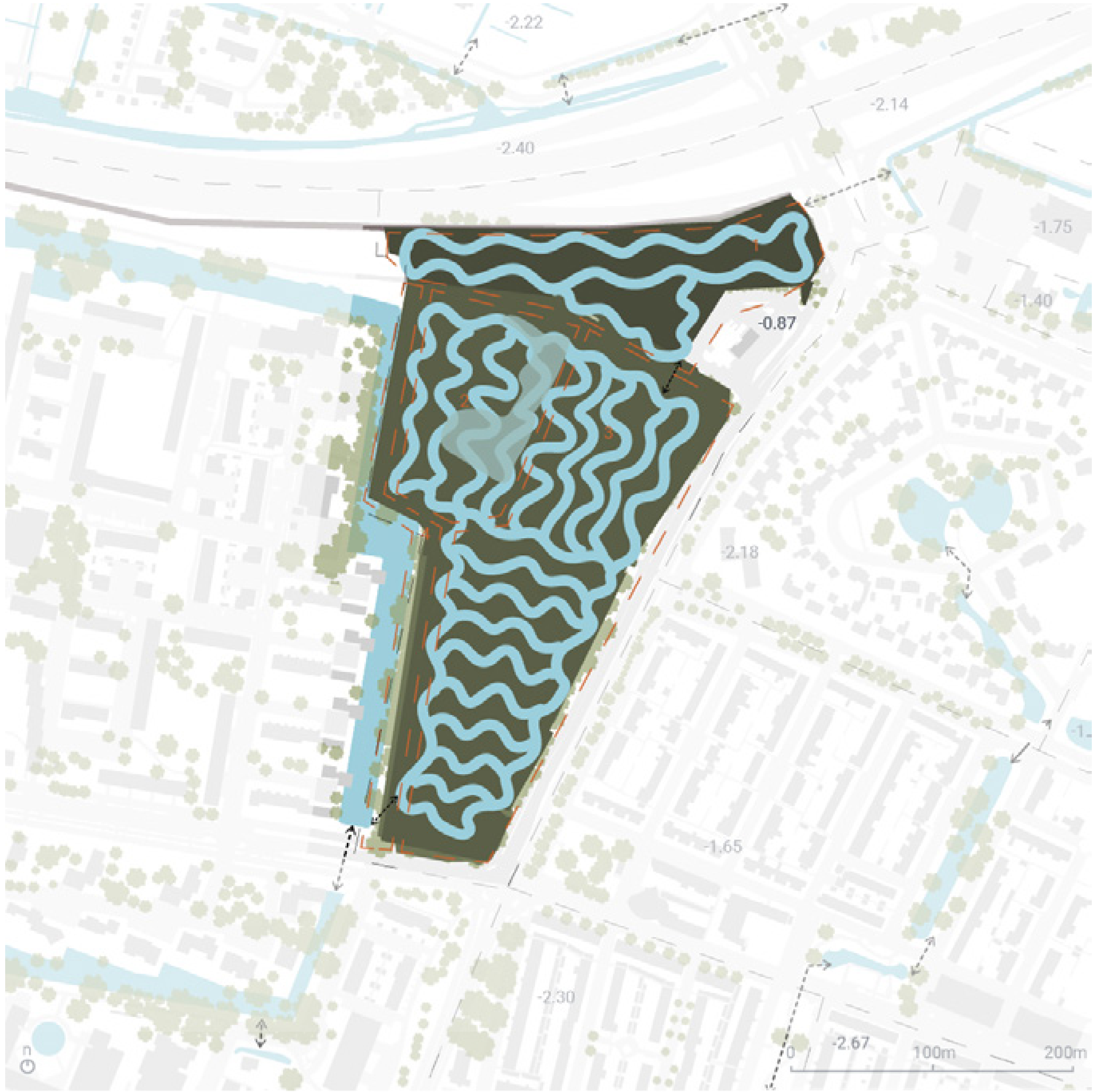


Figure 51: Maximisation Fortunapark for water quality

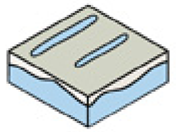
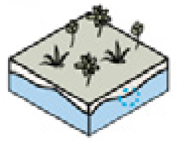
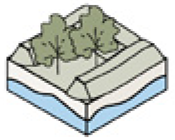
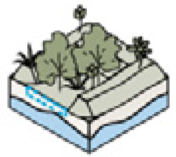
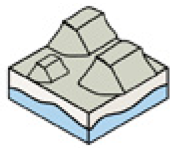
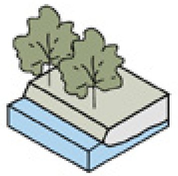
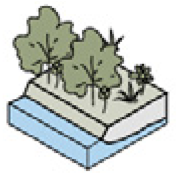
legend

- polder water
- connection
- water levels
- trees
- landscape typologies
- water accumulation during 1 in 100(0) rain falls
- possible water overflow from the pond

green height levels

- 2.23
- 1.31
- 0.25
- -0.27
- -0.51
- -1
- -1.1
- -1.5

6.1.7 Fortunaparks Water and soil | SWOT; water quantity

Present	Maximisation	Current Strenghts	Current Weaknesses	Opportunities	Threats
 1. disconnected waterways in green	 1. biodiverse green with water connection underground	- use of natural friendly banks - use of divers to connect water flow - Infiltration space due to green - waterbody forms space for water collection and storage	- collected water can evaporate	- Close the open waterbody and let the water infiltrate - Enlarge the waterbody for more area for water collection and storage - Add more gradients of green for a better biodiversity that can increase the infiltration rate	- Vulnerable for subsidence - Vulnerable for evaporation
 2. willow forest embraced by hills	 2. biodiverse willow forest with underground storage	- Infiltration space due to green - location for water accumulation - Waterbuffer above ground	- Water that is collected can not be reused	- Water storage under ground can be used to create a circular water system - Add more gradients of green for a better biodiversity that can increase the infiltration rate	- Vulnerable for subsidence
 3. hilly area	 3. hilly biodiverse area with underground storage	- Infiltration space due to green - Waterbuffer above ground - location for water accumulation	- Water that is collected can not be reused	- Water storage under ground can be used to create a circular water system - Add more gradients of green for a better biodiversity that can increase the infiltration rate	- Vulnerable for subsidence
 4. soft waterbank	 4. soft waterbank with biodiverse green	- Infiltration space due to green - use of natural friendly banks - long, wide and well connected water body - waterbody forms space for water collection and storage	- Water that is collected can not be reused	- Add more gradients of green for a better biodiversity that can increase the infiltration rate	- Vulnerable for subsidence - Vulnerable for evaporation

6.1.8 Fortunaparks Water and soil maximisation; water quantity

When maximising for water quantity in the existing context, the current layout is almost already optimal when basing the design mostly on the strategies of infiltration and collection for a climate adaptive and circular environment. A SWOT analysis has been executed and has resulted in a maximisation plan figure (53) with the following landscape typologies in figure 52. The whole terrain forms a biodiverse green space for infiltration as a recharge for the groundwater level. To enhance the quantity of water even more, underground water storage can be created underneath the green landscape for reuse purposes. In addition, to help the water nuisance for the business terrain on a larger scale. The water can be let to Fortunapark underground, as a result the entire landscape can be flooded. Through these interventions Fortunapark becomes a bioswale in which water can move flexibly on a temporal scale.

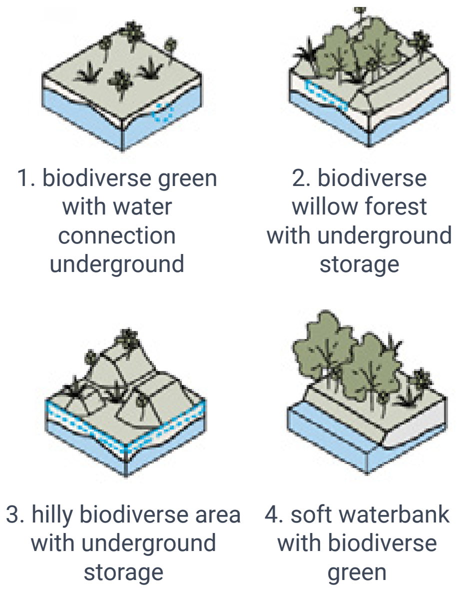


Figure 52: Maximisation typologies on water quantity

Figure 53: Maximisation Fortunapark for water quantity

legend

- polder water
- connection
- water levels
- trees
- landscape typologies
- water accumulation during 1 in 100(0) rain falls
- possible water overflow from the pond

green height levels

- 2.23
- 1.31
- 0.25
- -0.27
- -0.51
- -1
- -1.1
- -1.5

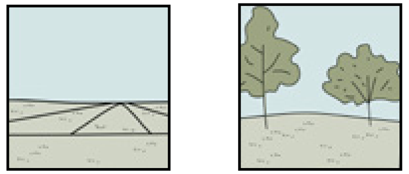
Chapter 6.2

Maximization Green and soil

6.2.1 Green and landscape in Vlaardingen

When looking at the ecological structure of Vlaardingen (figure 55) the landscape can be divided into four ecological gradients; pastures, urban fringe nature, marshland and recreational green.The landscape consists of peat and clay soil in which a degree of subsidence is occurring in both. The peat and clay landscapes (mostly pastures) are experiencing subsidence due to low water levels. When looking at the biodiversity, it can be seen that the marshlands and urban fringes have a rich biodiversity caused by the different use of plants and wetness, while the pastures and recreational landscapes are quite monotonous (figure 54).

Fortunapark is one of these monotonous recreational areas that is low in biodiversity with a peat clay soil that experiences some subsidence.



low biodiversity with subsidence in pasture landscapes

low biodiversity with subsidence in the recreational landscapes

Figure 54: Problematic green landscape spatial typologies

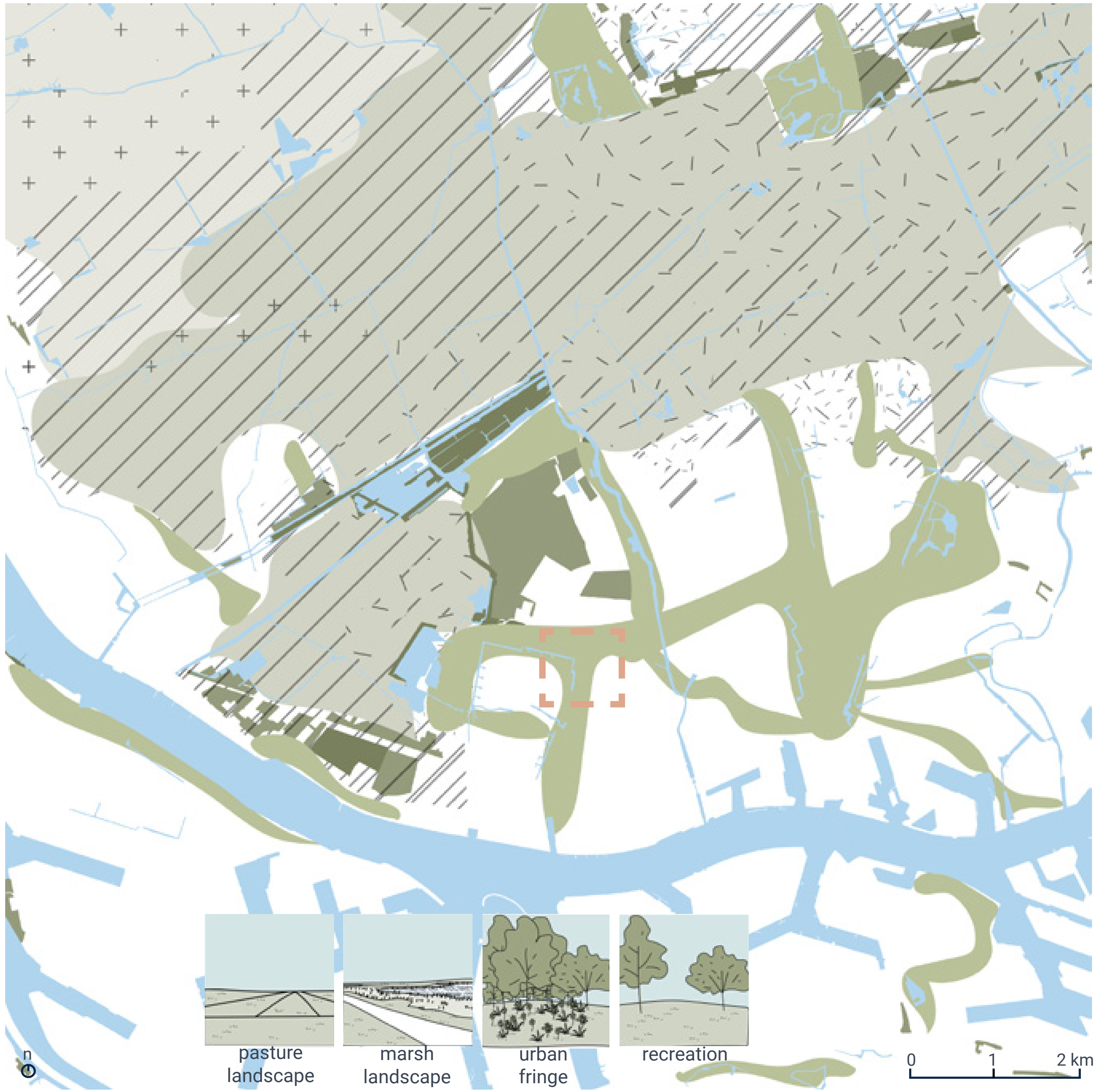


Figure 55: Green and landscape of Vlaardingen

legend

- clay
- sand
- peat
- pastures
- greenhouse farming
- urban fringe nature
- marshland
- recreational green
- water
- Fortunapark

6.2.2 Green and landscape in Fortunapark

When zooming in on the recreational area of Fortunapark (figure 57), it can be seen that the landscape consists of different spatial typologies (figure 56). There are valuable old trees, such as the willow trees in the forest, the ash avenue along the waterbody on the West side and oak trees on the South side. In addition, Fortunapark is part of an ecological network that is connected through the West side.

But, just like is mentioned on the larger scale, Fortunapark, experiences some subsidence due to the drainage of the peat layers. It also has little gradients in vegetation or wetness and is therefore low in biodiversity. In addition, for the willow forest thinning is also desired as they are situated too crowded.

Figure 56: Fortunaparks typologies in Green and landscape

Figure 57: Current Green and landscape of Fortunapark

legend

- polder water
- connection
- water levels
- trees
- valuable trees
- landscape typologies
- green connection
- noise wall

green height levels

- 2.23
- 1.31
- 0.25
- -0.27
- -0.51
- -1
- -1.1
- -1.5

6.2.3 Green and landscape ambitions

The ambitions regarding Green and landscape are elaborated in this chapter. These are both quantitative and qualitative. The quantitative numbers are marked in blue.
Programme of Requirements Municipality Vlaardingen (Vlaardingen, 2022)
- The minimum amount of public green space is set at 47% (33,527 m2) of the plan area.
- When landscaping the landscape of Marathonweg Noord, the assortment to be applied will have to be tailored to the changing conditions and should be able to tolerate both ‘wet feet’ and longer periods of drought. tolerate longer periods of drought.
- Attention should be paid to variety and biodiversity
- The Ash avenue along the west side and the groups of oak trees with on the south side should at least be preserved.
- The water feature(s) will be constructed with nature-friendly banks

Convenant Klimaatadaptief Bouwen (Province of South-Holland, n.d.)
- Green-blue structure and biodiversity: The horizontal and vertical surface is designed in conjunction with the green-blue structures in the wider area and creates high-quality habitat for at least building-dwelling species.
- Preserve and realise valuable habitat and basic quality of nature
- Green solutions based on natural processes and structures are preferred to technical solutions

When taking the existing policies into account, three project goals have been set under the pillar of Green and landscape with three strategies and corresponding building blocks (figure 58).

Goals
Design for ecological biodiversity
To be able to create a healthy ecological system, the notion of biodiversity forms a pre-condition. Ecosystems tend to be more resilient when they are diverse. As different species contribute in their own way to the overall balance and functioning of the ecosystem. This therefore involves designing for landscapes with different character traits in wetness, drieness, open or vegetated and cold or warm spaces.

Preserve existing landscape
Existing landscapes have established their own ecosystem. By acknowledging the value and working with them rather than against, disruption can be minimised and biodiversity can be preserved.

Give space for natural processes
Nature takes place through time. As it is about giving space for species to grow, find relations with others and decompose. Each stage contributes to the development of the ecological system and this process is essential for the regeneration of a healthy ecosystem. Therefore physical conditions should be planned to give room for this cycle.

Strategies
1. Diversify
2. Value existing elements
3. Work with natural processes

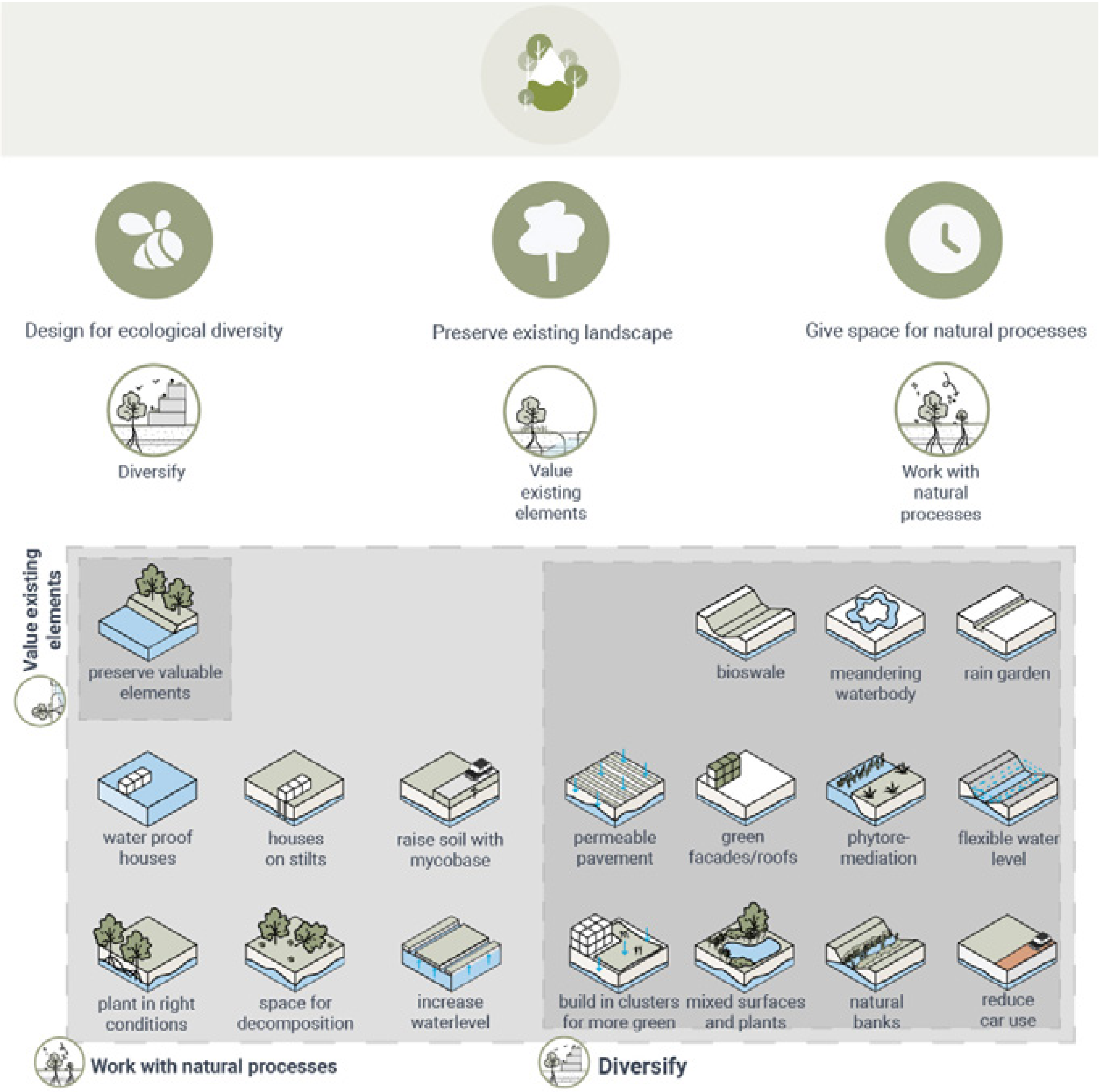


Figure 58: Green and landscape patterns

6.2.4 Green and landscape in Vlaardingen vision

Figure 59 shows the vision of Green and landscape. As there are problems of subsidence due to low water levels, the water level in landscapes with the peat layers will be increased. As a result, these landscapes will become more like marshlands. In addition, more gradients of green will be added to the monotonous landscapes, to create a better biodiversity.

As a result more diversity and an increase of the water level will take place in the recreational landscapes, such as Fortunapark.

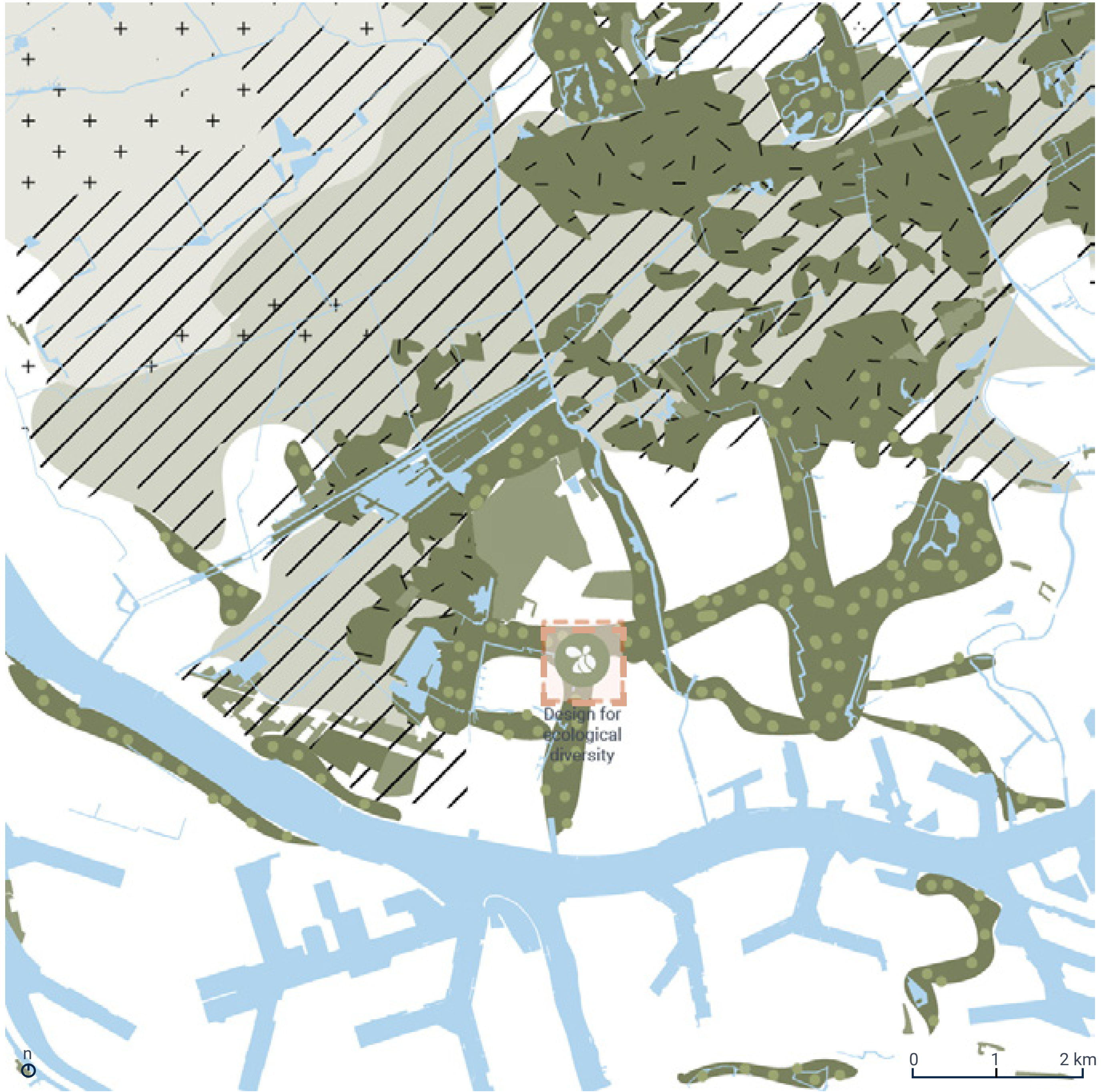
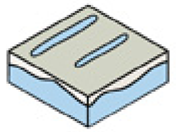
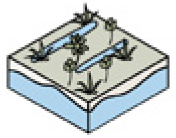
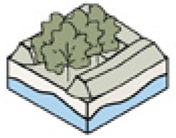
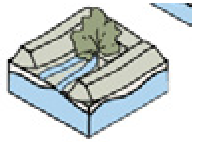
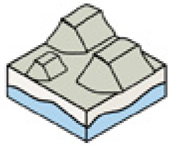
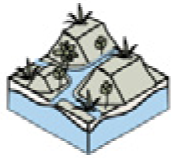
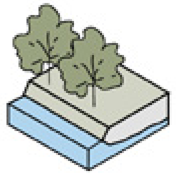
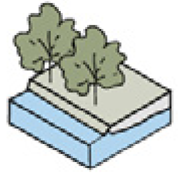
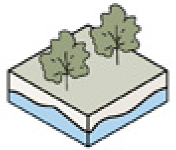
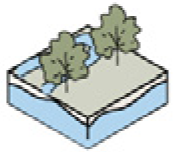


Figure 59: Green and landscape Vlaardingen vision
legend
- clay
- sand
- peat
- pastures
- greenhouse farming
- urban fringe nature
- marshland
- recreational green
- water
- Fortunapark

6.2.5 Fortunaparks Green and landscape | SWOT

Present	Maximisation	Current Strenghts	Current Weaknesses	Opportunities	Threats
 1. water body in green field	 1. water body in diverse green field	- use of natural friendly banks - calm green space - gradients of water and green	- monotenous green -> low biodiversity	- improve biodiversity by diversifying in vegetation	- subsidence of 1.5 mm/year
 2. densified willow forest	 2. willow forest with ditches	- historic old willow forest - calm green space	- monotenous green -> low biodiversity - overcrowded group of trees - no space for decomposition - subsidence due to drainage of the peat layers	- improve biodiversity by diversifying in vegetation - thinning the willow forest - create space for the decomposition of trees - increase water level	- improve biodiversity by diversifying in vegetation - thinning the willow forest - create space for the decomposition of trees - subsidence of 1.5 mm/year
 3. monotenous green	 3. diverse green with ditches	- calm green space	- monotenous green -> low biodiversity - subsidence due to drainage of the peat layers	- improve biodiversity by diversifying in vegetation - increase water level	- improve biodiversity by diversifying in vegetation - subsidence of 1.5 mm/year
 4. ash avenue	 4. ash avenue with higher water level	- strong old ash avenue	- subsidence due to drainage of the peat layers	- increase water level	- subsidence of 1.5 mm/year
 5. group of oak trees	 5. group of oak trees with ditches	- group of oak trees	- subsidence due to drainage of the peat layers	- increase water level	- subsidence of 1.5 mm/year

6.2.6 Green and landscape in Fortunapark

When maximising the typologies of Fortunapark (figure 60 and 61) for Green and landscape, a SWOT analysis (previous page) has been done to get to know the opportunities in the existing landscape. While having in mind the goals for Design for ecological diversity, Preserve existing landscapes and give space for natural processes. In addition, the strategies of Diversify, Value existing elements, work with natural processes.

The existing elements have been valued by preserving the existing waterways, willow forest, ash and oak trees. In addition, biodiversity can be enhanced by planting a mix of different other species. Such as herbaceous plants, like lavender, sage or licorice plants. Furthermore, to improve the biodiversity evenmore, flexible water levels can be introduced, space can be made of the decomposition of leaves. Moreover, working with natural processes will be achieved, as the water level has been raised to combat subsidence and the vegetation that is planted will be selected on the right conditions for drought and wet seasons.

Figure 60: Fortunaparks Green and landscape typologies maximisation

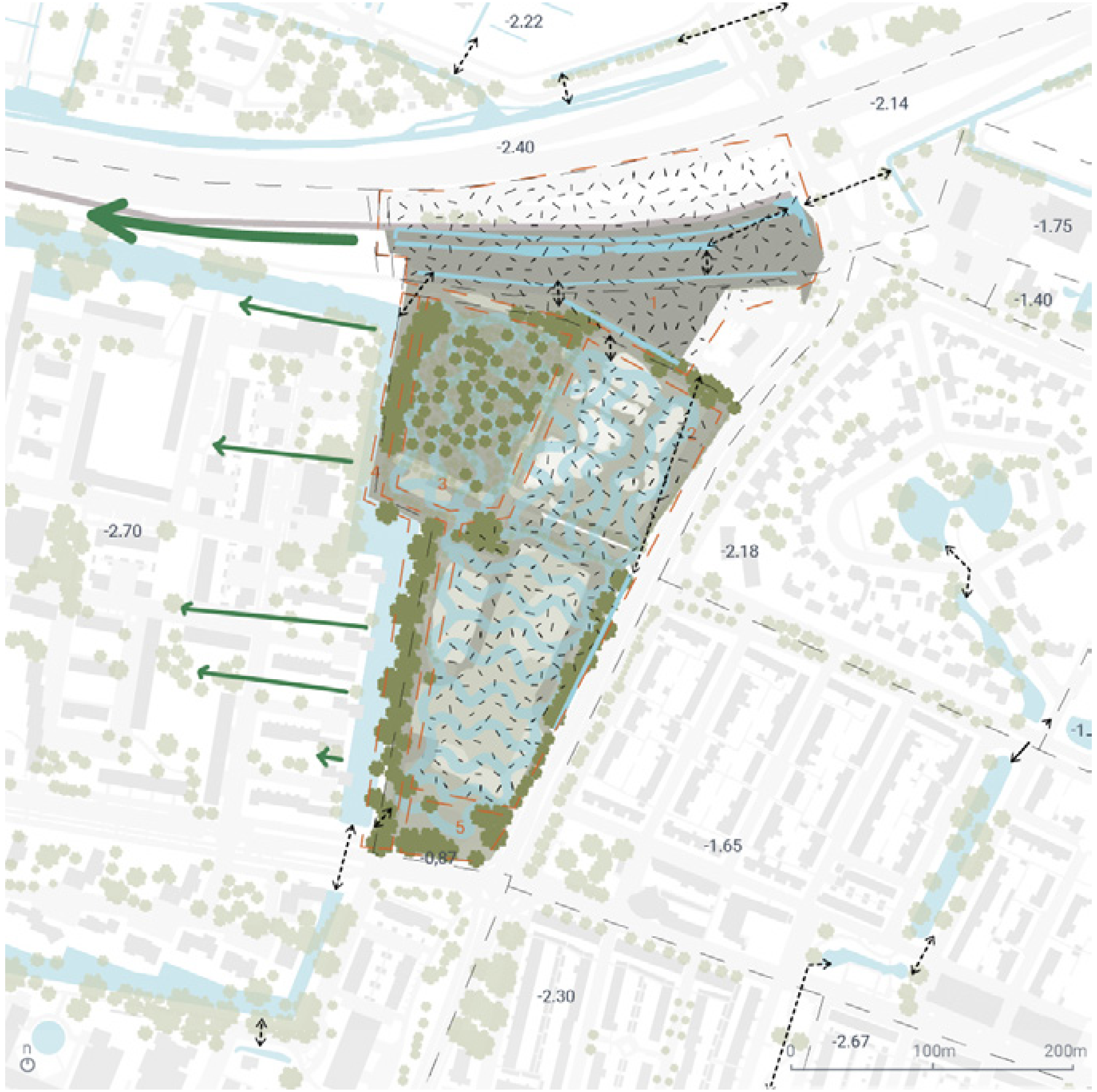


Figure 61: Fortunapark Green and landscape maximisation
legend

- polder water
- connection
- water levels
- trees
- valuable trees
- landscape typologies
- green connection
- noise wall

green height levels

- 2.23
- 1.31
- 0.25
- -0.27
- -0.51
- -1
- -1.1
- -1.5

Chapter 6.3

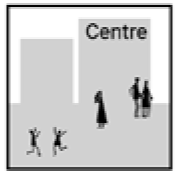
Maximization
Human and water

6.3.1 Human and water relations in Westwijk

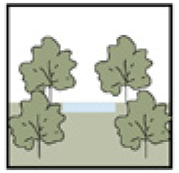
During the site visit the route around waterbodies in Westwijk have been followed to see what the relations are between water and social activities. During this trip informal interviews with residents have been done to get an understanding of the use of these waterways.

This information has been gathered in the analysis for the relationship between Human and water and can be seen in figure 63. Currently, water is embedded in a social structure, as it is used as a view, as a means to mark slow traffic routes or as a destination. Inhabitants stated how the Surfseplas is a location, where a lot of inhabitants go for their walks. Many residential buildings are also situated towards the water, giving it a view value. However, the existing social core such as the local shops, neighbourhood centre and schools do not have any physical relation with water. Furthermore there are typologies in which water becomes isolated and is valued as a 'backside'. An example is that waterbodies are situated next to car parking. These problematic spatial typolgies for the relation between Human and water can be seen in figure 62.

When searching for the role of Fortunapark, it can be seen that it is part of a walking route to Surfseplas. Nevertheless, since Fortunapark is a brackish area, the other water bodies are quite isolated from human interaction.



lack of water interaction in social spaces



isolated water bodies

Figure 62: Problematic spatial Human and water typologies

Figure 63: Human water relations in Westwijk

legend

- no water interaction
- water as a view
- water as slow traffic route
- water as destination
- water
- social function

6.3.2 Human and water relations in Fortunapark

When zooming in on the socio-water structure in Fortunapark (figure 65), three typologies can be found (figure 64). Isolated water bodies that are hidden (2), isolated water accumulation locations (3) and the public water body on the west side (1), that is used as a view for the slow walking route to the Surfseplas.

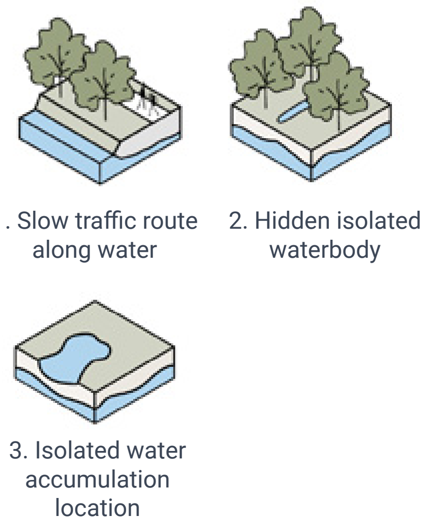


Figure 64: Fortunapark Human and water typologies

Figure 65: Human water relations in Westwijk

legend

- no water interaction
- water as a view
- water as slow traffic route
- water as destination
- water
- social function
- slow route
- landscape typology

6.3.3 Human and water ambitions

Existing ambitions that touch upon the topic of strengthening the relationship between humans are only mentioned in the Nationaal Deltaprogramma 2024 (Rijksoverheid, 2023b). It describes how the social engagement on the topic of climate adaptiveness should be enlarged, in which new forms of participation should be searched such as a citizens councils.

With this national ambition in mind, a Human and water pattern language (figure 66) has been set up to enhance the relation between humans and water, that consists of three goals, three strategies and corresponding building blocks. The goal to enhance the relation between humans and water can only be qualitatively executed. .

Goals

Water is multifunctional
When water is used for purposes other than its primary use (such as drinking, sanitation, and irrigation), people are likely to find more meaning and appreciation in their daily lives for water.

Localize water
When resources of water are localised, communities have a stronger sense of ownership and responsibility over their water management. This empowers people and communities to actively participate in water conservation initiatives.

Water awareness
Understanding the existing and future problems with water is the first step towards change. By spreading awareness, residents can understand the importance of conserving water and implementing sustainable water practices.

Strategies
1. Water interaction
2. Water ownership
3. Community engagement

Figure 66: Human and water pattern language

6.3.4 Human and water vision in Westwijk

In the vision of Westwijk (figure 67), the socio-water structure will be strengthened by including social core functions, as they will receive a form of a social water element. In addition, water will not be seen as an anonymous 'backside' anymore, but will always have a qualitative relation to humans.

In terms of Fortunapark, it will become a core water destination, as social functions and water can be combined. Which is why, on the larger scale the goal for Fortunapark touches more upon making water multifunctional.

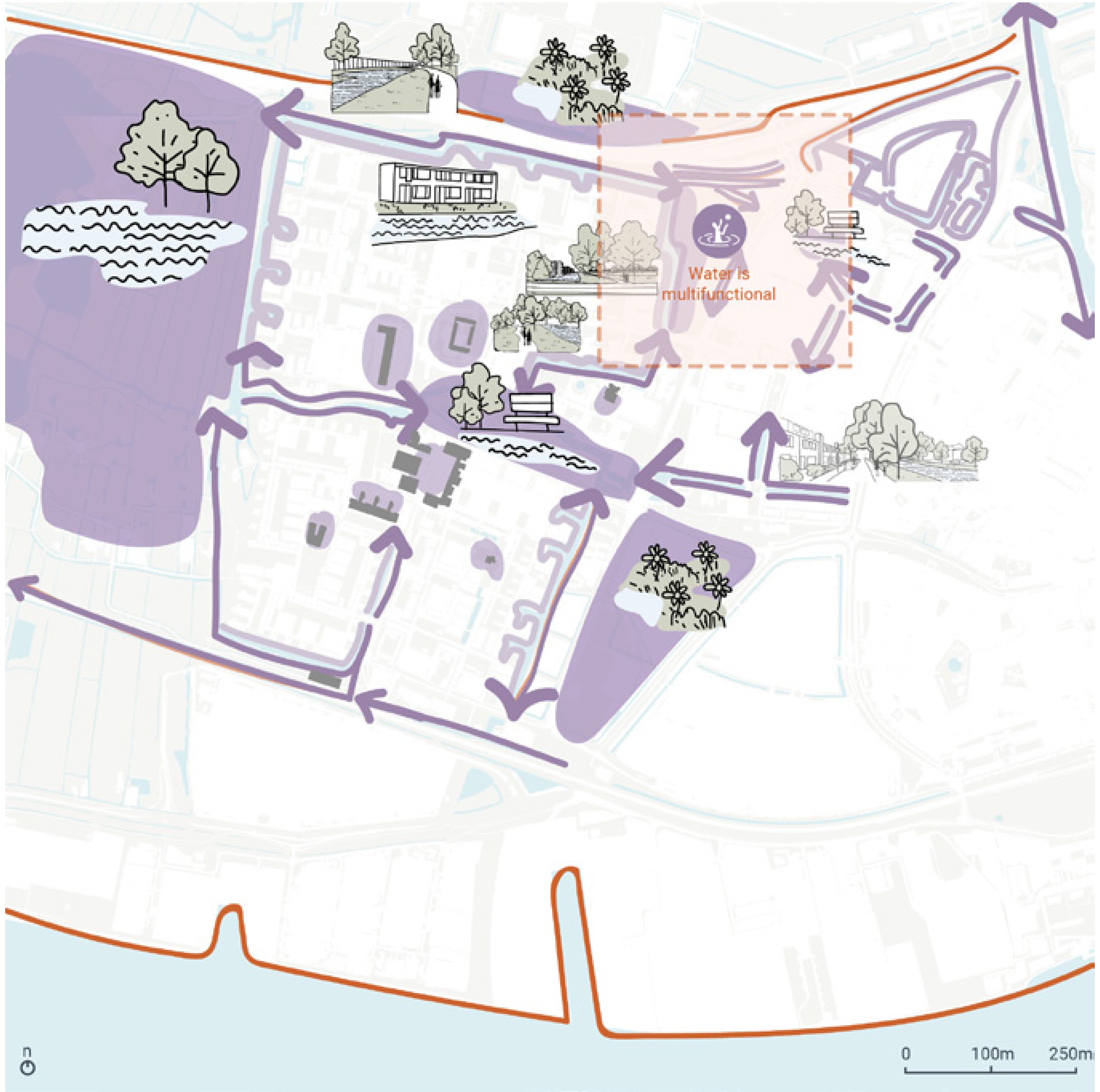
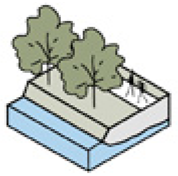
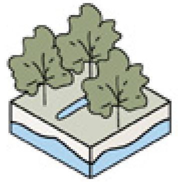
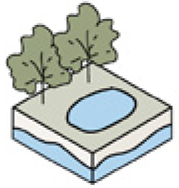
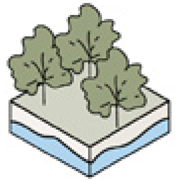
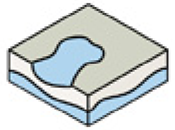
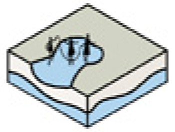


Figure 67: Human water vision for Westwijk
legend
no water interaction
water as a view
water as slow traffic route
water as destination
water
social function

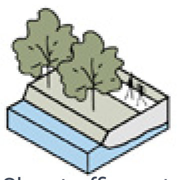
6.3.5 Fortunaparks Human and water relations | SWOT

Present	Maximisation	Current Strenghts	Current Weaknesses	Opportunities	Threats
 1. Slow traffic route along water		- Water is captured above ground - Water is visible for the eye - Water forms a view along a walking route			
 2. Hidden isolated waterbody	 2. Visible open water body  2.subdued waterwater body		- Water is hidden and isolated - Monofunctional water body	- Can be enlarged to become more visible for the eye - Can be part of a walking route - Can be damped	- Less care for this water body, as a consequence can be more polluted
 3. Isolated water accumulation location	 3. Social water space		- Water is hidden and isolated - Monofunctional water body	- Temporary character, can become a social function when it stands dry	- Less care for this temporary water body, as a consequence can be more polluted

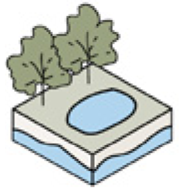
6.3.6 Fortunaparks Human and water maximisation

When maximising Fortunapark to enhance the relation between Human and water, a SWOT analysis (previous page) has been done to get to know the opportunities in the existing landscape. These are translated into the maximised typologies and map (figure 68, 69)

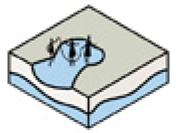
Currently only the west water body has an important social function that has to be maintained in the existing urban structure. Otherwise, there is a lot of flexibility in how the relation between Human and water can be enhanced in the landscape. As the hidden isolated water bodies or the locations where water accumulates do not have any existing meaning yet. Qualitative water bodies, situated in the landscape can be made more visible, become part of a view, become part of a slow traffic route, or become a recreational destination. In which building blocks of the strategies for Water interaction, Water ownership and Community engagement can be used.



1. Slow traffic route along water



2. Visible open water body



3. Social water space

Figure 68: Fortunapark maximisation Human and water typologies

Figure 69: Human water maximisation for Fortunapark

legend

- no water interaction
- water as a view
- water as slow traffic route
- water as destination
- water
- social function
- slow route
- landscape typology

Chapter 6.4

Maximization Liveability

6.4.1 Liveability of Westwijk

Fortunapark is part of an area called Westwijk (AlleCijfers, 2024). It has around 12.430 inhabitants with most ages between 25-45, 45-65 and 0-15. It is known to be a green neighbourhood, in which different nationalities live next to each other. In 2021 it was measured that 48% of the inhabitants have a migration background, which largely consists of Turkisch, Moroccan and East-European backgrounds.

In 2022, Westwijk became part of the twenty focus areas of the National Liveability and Security Programme of the Netherlands (Programmabureau Westwijk, 2022). As it is seen as a vulnerable neighbourhood with many issues at play. Statistics show problems on the topic of health, poverty, education, and stress. As the average income of Westwijk is under the average of the Netherlands, one in four children grow up in poverty, one in six is overweight, almost one in five of young adults do not obtain a starting qualification and one in ten children are at risk of ending up in drug crime.

When analysing the current neigbhourhood (figure 71) a pattern of spatial typologies (figure 70) can be recognized that contributes to the defined problems on the topic of health, stress and poverty by Programmabureau Westwijk. As the typologies of anonymous public green spaces, back to front and blind plinth typologies, car centric public spaces and an outdated community hub discourages people from moving and contributes to a lack of social control and social cohesion. In addition the the homogenous social housing create little economic activity in the neighbourhood.

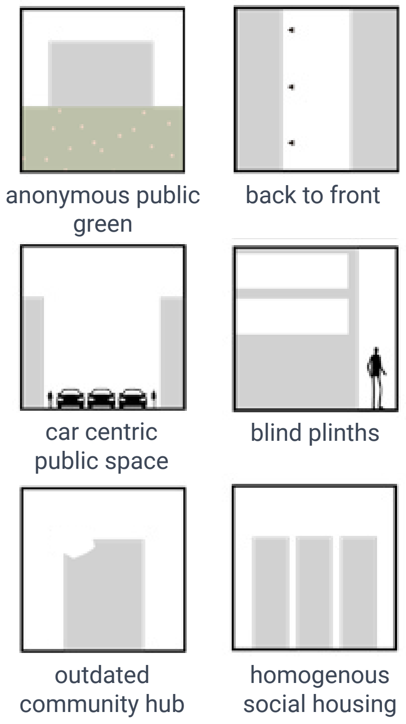


Figure 70: Problematic spatial typologies for Liveability

Figure 71: Liveability in Westwijk

legend

- green spaces
- buildings
- social functions
- community centre
- water
- infrastructure
- plots
- meeting spaces
- anonymous green spaces
- blind plinths typologies
- back to front typologies

6.4.2 Liveability of Fortunapark

When zooming into the existing urban fabric of Fortunapark (figure 73) it can be seen how Fortunapark forms the entrance of Vlaardingen. Since, it is framed by busy traffic roads that contribute to noise and air pollution. Only the west side has a calmer character near the water which also has a pedestrian road. When analysing the area 4 spatial typologies can be found (figure 72). The mundance entrance of the city, a noise edge, peaceful green and an intersection.

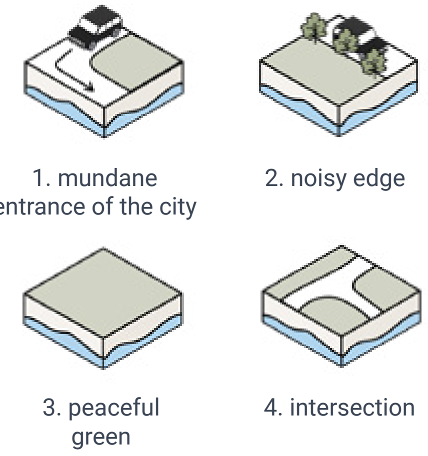


Figure 72: Fortunaparks Liveability typologies

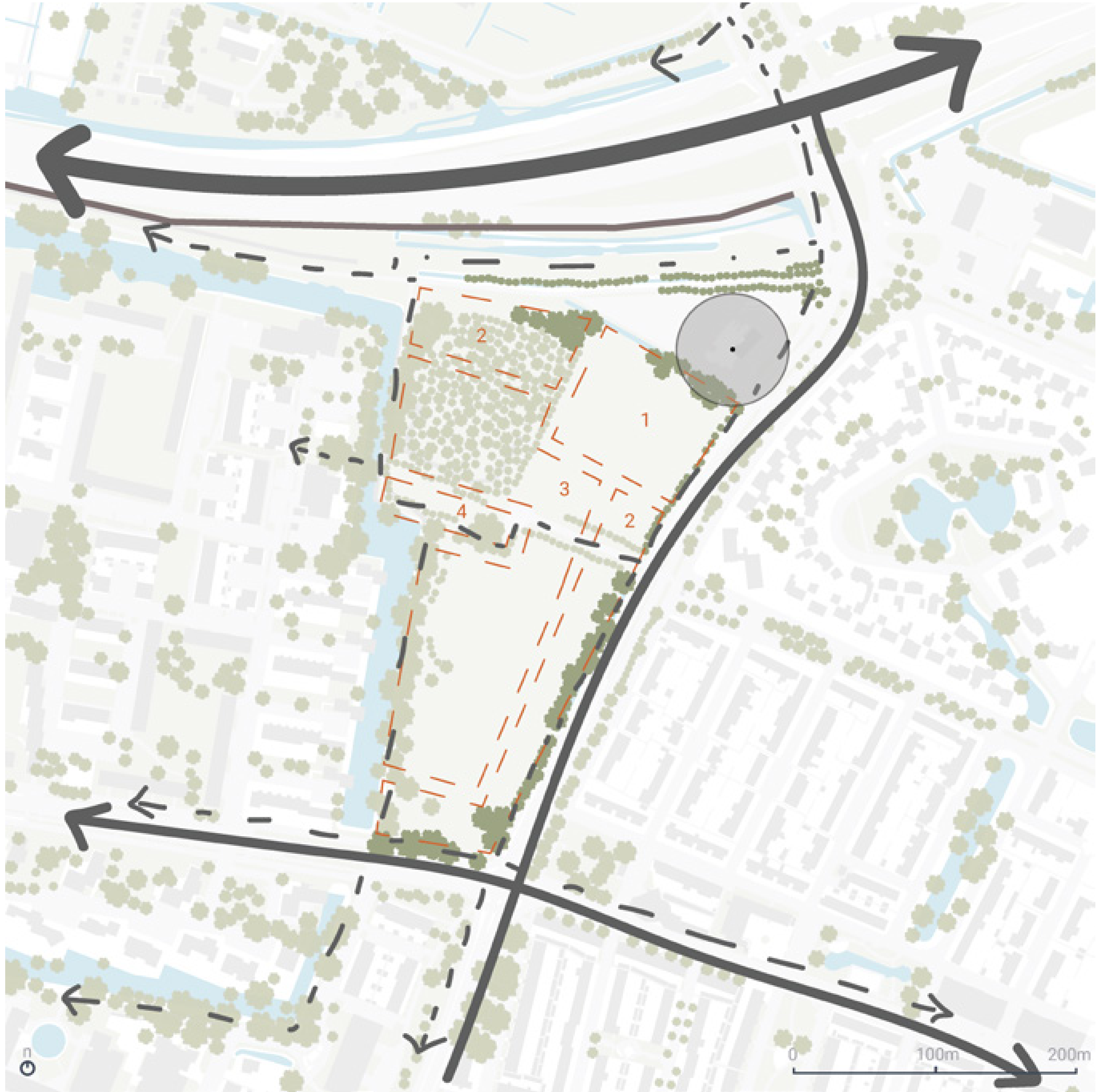


Figure 73: Liveability of Fortunapark
legend

- green
- trees
- buildings
- plots
- water
- infrastructure
- noise wall
- slow traffic route
- main car routes
- Petrol station
- spatial typologies
- buffer trees

6.4.3. Liveability ambitions

There are ambitions regarding Westwijk and the housing program for Fortunapark from the Programme plan Wij de Westwijk (2022) and the municipality of Vlaardingen (2022).

Programme plan Wij de Westwijk (2022)
- Investing in children is investing in the present and future, with the goal to create equal opportunities for children in Westwijk.
- A clean, safe and socially cohesive environment is seen as a basis that has to be improved.
- Stimulating movement.
- Create safe and social environments Create central meeting place for all - residents

Housing program (Gemeente Vlaardingen, 2022)
- At least 30% must be ground-level and at least 30% must be flats.
- All dwellings have a minimum area of 50m² GBO.
- Flats have a minimum surface area of 50m².
- Single-family houses have a surface area of 100m² GBO.
- Variation in nave sizes is desired and allowed, with a minimum requirement of a nave size of 4.80m.
- 50 dwellings will be social housing, developed by and managed by a Vlaardingen housing corporation.
-- The remaining homes will be developed in the medium and expensive segments.
-- Medium-priced rental is among the possibilities. A maximum of 20% of the homes may be developed in this category.

With these local ambitions in mind, a Liveability pattern language (figure 74) has been set up to create a qualitative environment for inhabitants to live in, that consists of three goals, three strategies and corresponding building blocks. The goals of a lively neighbourhood are qualitative.

Goals

Fit residents
Physical movement plays a role for our physical and mental health as it alleviates the risk of chronic diseases and reduces signs of sadness, anxiety and stress. As a result, engaging in physical activity releases endorphins and neurotransmitters that enhances the feeling of happiness and improves the overall quality of life.

Social and safe
Having an environment in which you feel safe is the foundation for happiness and well-being. This allows individuals to have lower stress and anxiety levels and to focus their energy on positive experiences. Such as nurturing relationships, as social networks provide individuals a feeling of acceptance and belonging in their communities. Being part of a community fosters a sense of purpose and identity which contributes to happiness.

Calm spaces
When time is spent in calm spaces, stress levels and anxiety can be reduced and relaxation can be stimulated, which improves our well-being.

Strategies
1. Public space for moving
2. Lively neighbourhood
3. Buffer the noise

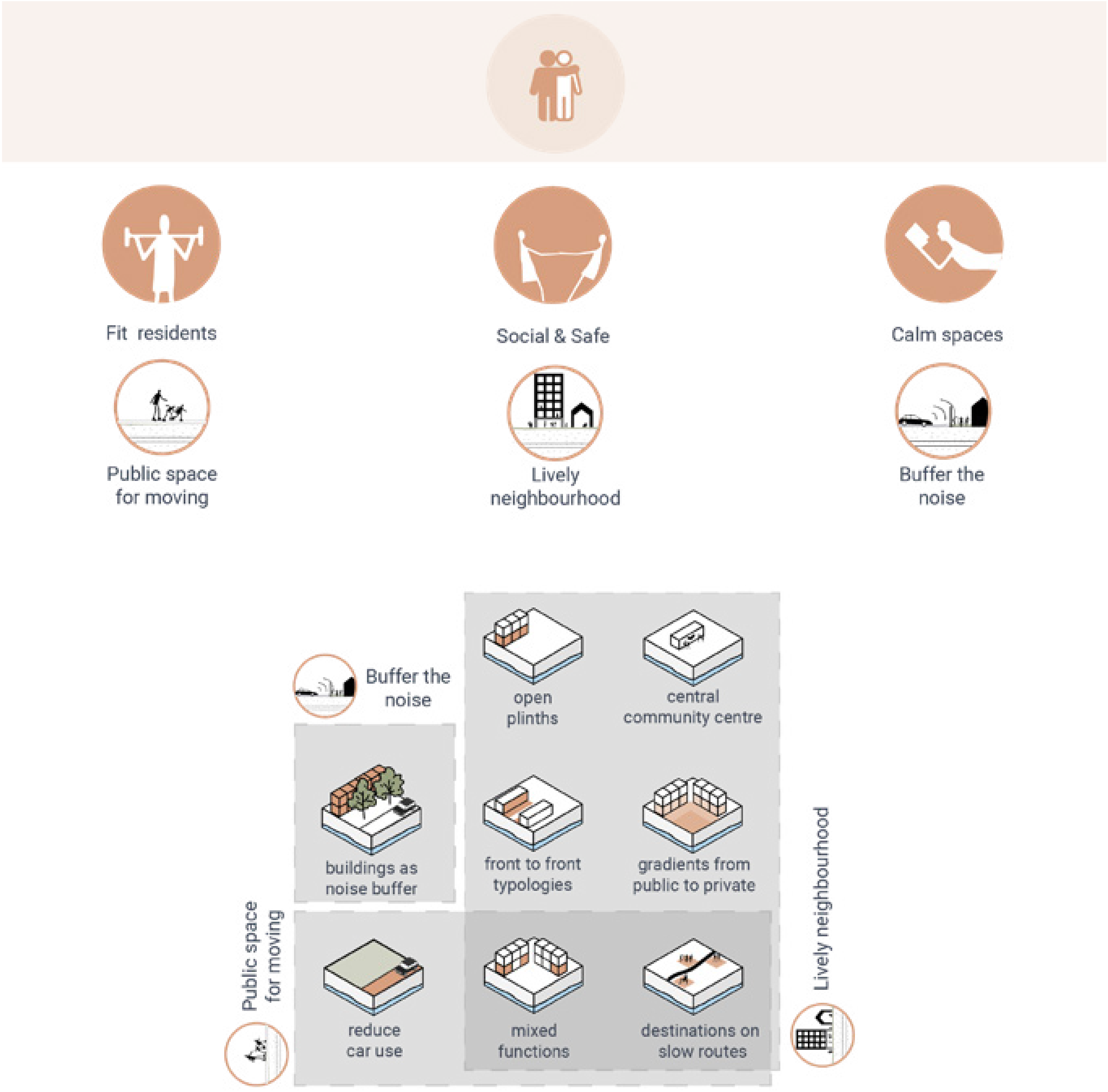


Figure 74: Liveability pattern language

6.4.4. Liveability vision Westwijk

As Westwijk is suffering from issues on the topic of health, stress and poverty, the development of Fortunapark could be a catalyst in contributing to a more liveable environment for the whole of Westwijk. As goals of Fit residents, Social and safe and Calm spaces have been set for Fortunapark to create a qualitative environment for internal and external residents (figure 75).

With the housing program of requirements higher incomes will be attracted. This will create more economic opportunities for the whole of Westwijk. Furthermore, Fortunapark could be a central place where the new community centre can be built. This can serve as a vital hub for inhabitants to meet each other and organise activities. Moreover, public space can be reserved for inhabitants to socialise, play, move and relax.

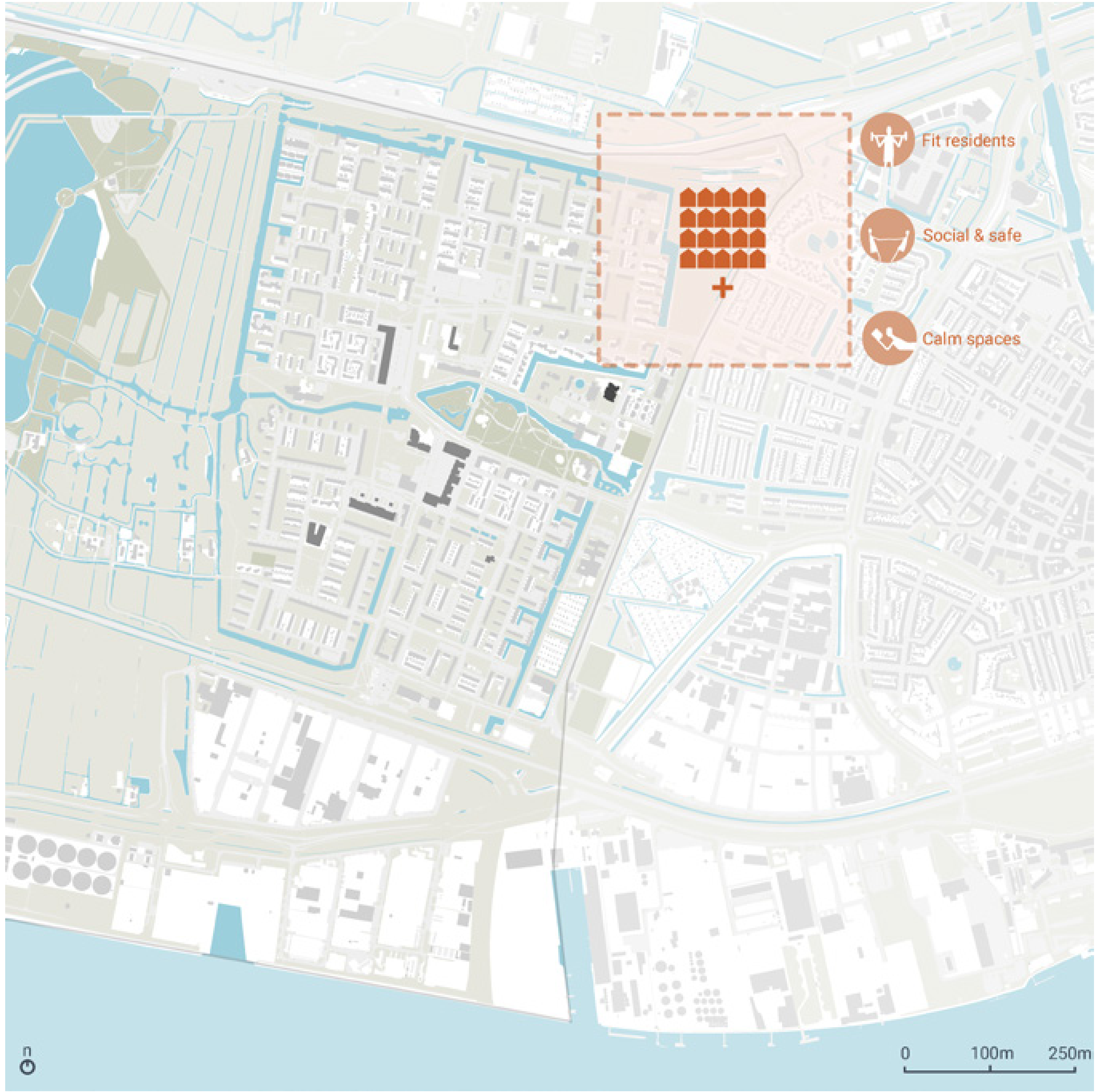
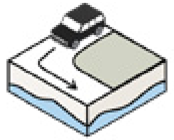
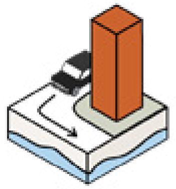
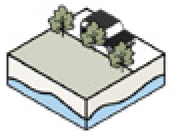
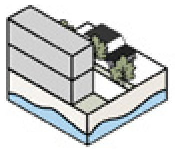
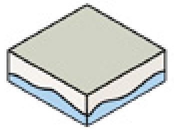
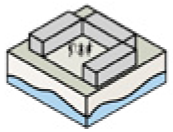
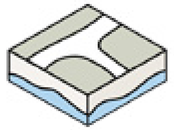
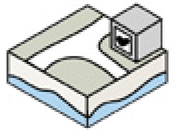


Figure 75: Liveability vision of Westwijk
legend

- green spaces
- buildings
- social functions
- community centre
- water
- infrastructure
- plots
- meeting spaces

6.4.5 Fortunaparks Liveability | SWOT

Present	Maximisation	Current Strenghts	Current Weaknesses	Opportunities	Threats
 1. mundane entrance of the city	 1.iconic entrance of the city	- Entrance of the city	- Not an attractive city entrance	- Location for iconic building, as symbolic entrance for the city	- Unattractive impression of the city / neigbhourhood
 2. noisy edge	 2. cars on the edges with building buffers	- Vegetation is used to conceal roads - Green open landscape	- Excessive noise	- Car parking and roads on the edges of Fortunapark - High rise buildings can act as noise buffers	- Noise stress for residents
 3. peaceful green	 3. small cluster of residentials	- Green open landscape - Concealed from stressfactors	- No incentive for appropriation in the green landscape	- Small clusters of low rise residentials - Shared green space	
 4. intersection	 4. neighbourhood centre	- Central point in the neighbourhood		- Good location for new neighbourhood centre	

6.4.4. Fortunaparks Liveability maximisation

When maximising Fortunapark (figure 76, 77) for Liveability, a SWOT analysis (previous page) has been done to get to know the opportunities in the existing landscape. While having in mind the goals for Liveability of Fit residents, Social and safe and Calm spaces. In addition, the strategies of a Lively neighbourhood, Buffer the noise and Public space for moving have been used to come with a maximisation plan.

To minimise traffic noise, the entrance of the neigbhourhood will take place on the west side. Hereby car use is reduced, by having main roads in which inhabitants can enter and drive to the parking lots on the edges. Where also appartment buildings can be situated to buffer the noise (2). As a result, the neigbhourhood will be focused on slow traffic with more room for shared green spaces in which inhabitants are stimulated to move and meet each other (3). Furthermore, an iconic high rise building can be the first object that is seen when entering the city (1). Lastly, a new community centre can be placed at the intersection to create more social interaction (4).

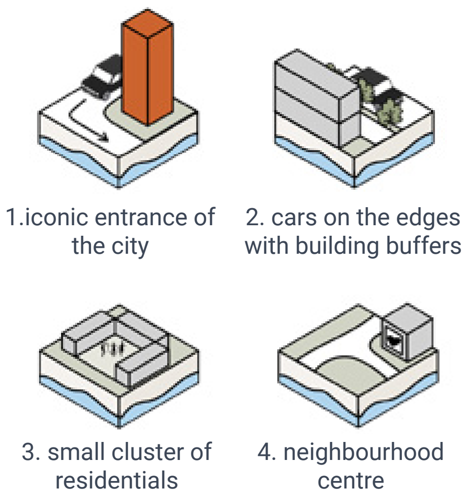


Figure 76: Fortunaparks Liveability maximisation typologies

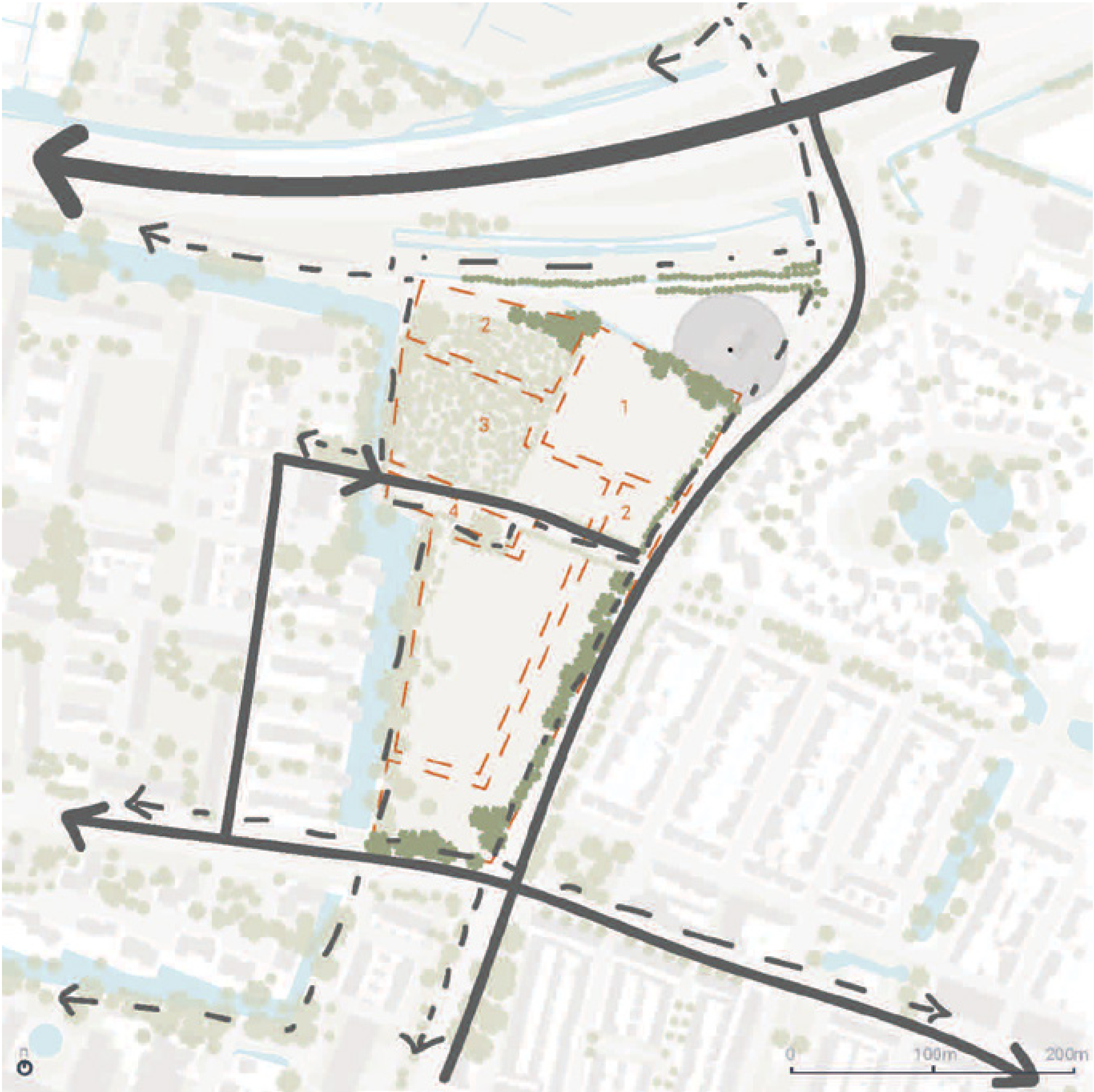


Figure 77: Fortunapark Liveability maximisation

legend

- green
- trees
- buildings
- plots
- water
- infrastructure
- noise wall
- slow traffic route
- main car routes
- Petrol station
- spatial typologies
- buffer trees

Chapter 6.5

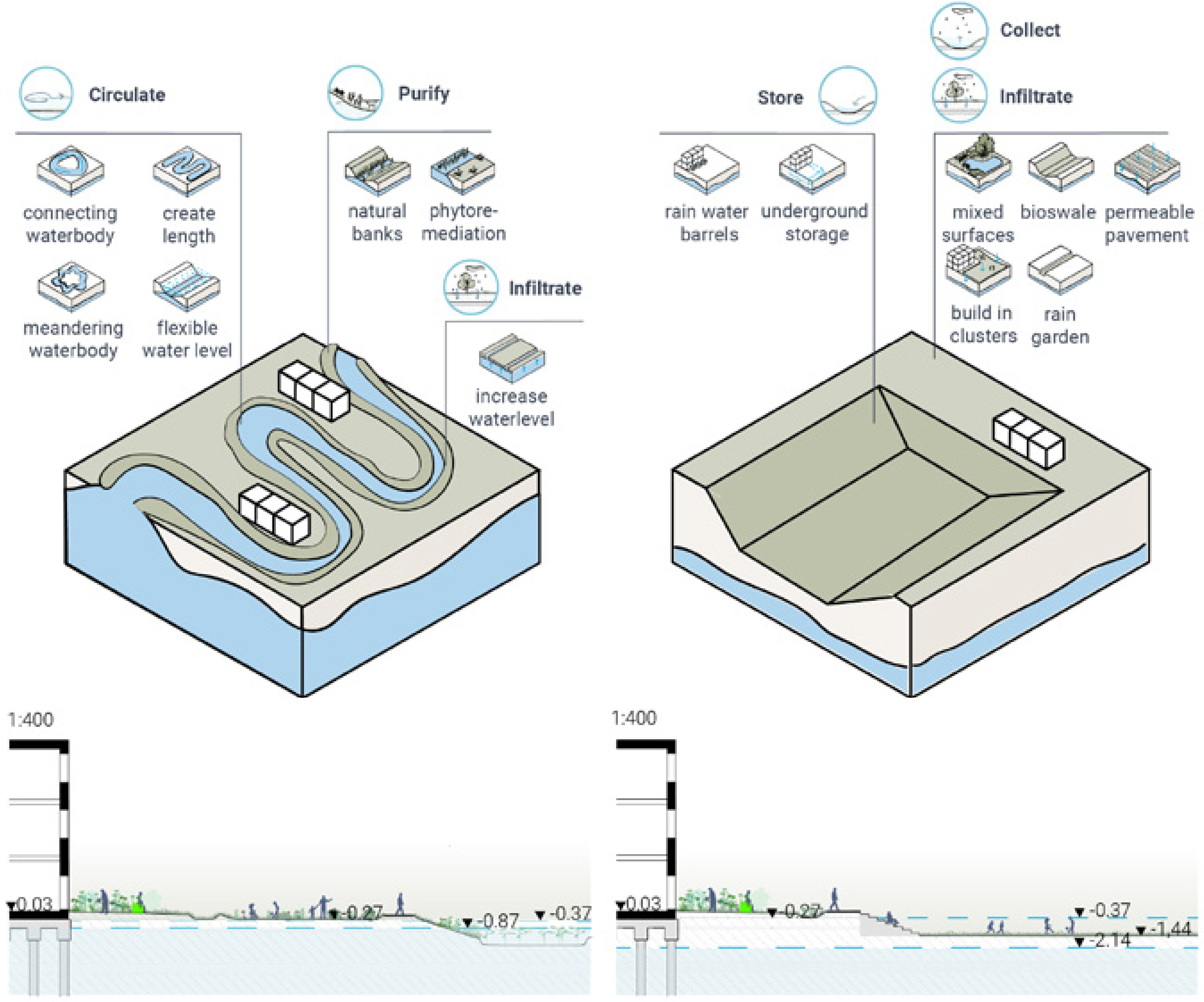
Optimization

6.5 Optimization introduction

With the previous pages, the maximisation per pillar has been shown. As Water and soil has been maximised for water quantity and water quality, two optimization scenarios have been developed (figure 78). The layers of Green and landscape, Human and water and Liveability have been integrated in the two scenarios.

Scenario Fortunapark as Purifying vein
In the scenario of Fortunapark as Purifying vein, the focus is on a permanent water body to give more space in which water treatment can take place. By introducing a water landscape with a flexible high water level that is characterised by a maximum length of meandering water bodies with natural friendly banks and helophyte filters, a robust water system is established.

Scenario Fortunapark as Urban sponge
In the scenario of Fortunapark as Urban sponge, a landscape has been established in which a temporal flexible water cycle has been integrated in the urban environment. Space for water collection, infiltration and storage underground form the climate adaptive strategies that stand central.



Fortunapark as Purifying vein

Fortunapark as Urban sponge

Figure 78: Fortunapark optimization scenarios


Fortunapark as Purifying vein

Chapter 6.5.2

Optimization |
Fortunapark as Purifying vein

6.5.2.1 Optimization synergies and conflicts

When the different maximisations of every pillar are layered on top of each other for the optimization of a Purifying vein it can be seen how synergies and conflicts arise (figure 79). At first glance, it can be seen how the layer of Green and landscape has the most complimentary spatial character with the layer of Water and soil, due to the need to raise the water level and adding more gradients of water. While in the maximisation of Liveability conflicts are present due the conflicts for space between urbanised areas and water.

Two significant examples have been used to showcase how design was used as an agency to find synergies between the different pillars, as the list of must haves and nice to haves formed the guideline in decision making. The two locations are the willow forest in the west of Fortunapark and the main route that includes car and bicycle mobility. These two locations represent the battle for space between mainly Liveability, Green and landscape and Water and soil, since the pillar of Human and water is much more flexible.

With the first location, having in mind how a meandering water network is crucial, the choice has been made to create a waterbody around the buildings instead of letting buildings float, as this is better for the circulation of water and therefore the water quality. With the same argumentation the choice has been made to separate the road and the water bodies, as a road with stilts would affect the water quality. Furthermore, it would be easier for the water bodies to get contaminated.

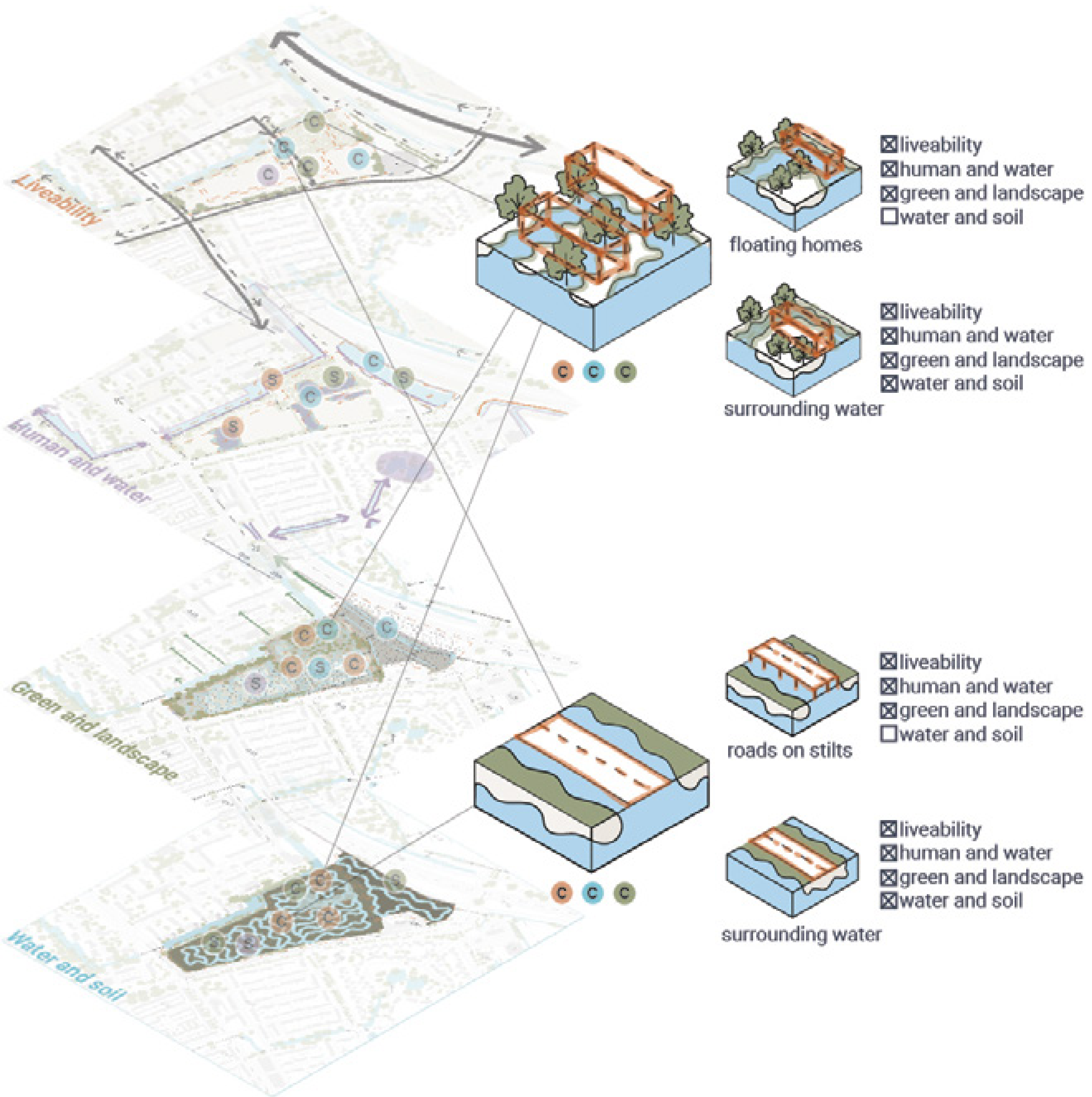


Figure 79: Synergies and conflicts for the Purifying vein

6.5.2.2 Building the Purifying vein

The steps in which the landscape has been transformed into the Purifying vein can be seen in figure 80. As the current layout of Fortunapark has hills of green (1) the landscape needs to remove these hills to create more space for a meandering water network (2). This water body consists of three different open water systems that are connected through duikers. Some trees of the willow forest have been removed to create more space for water and not risk any pollution. While the urban areas occur around the water body (3). The waterbody performs as a catchment and storage area (4).

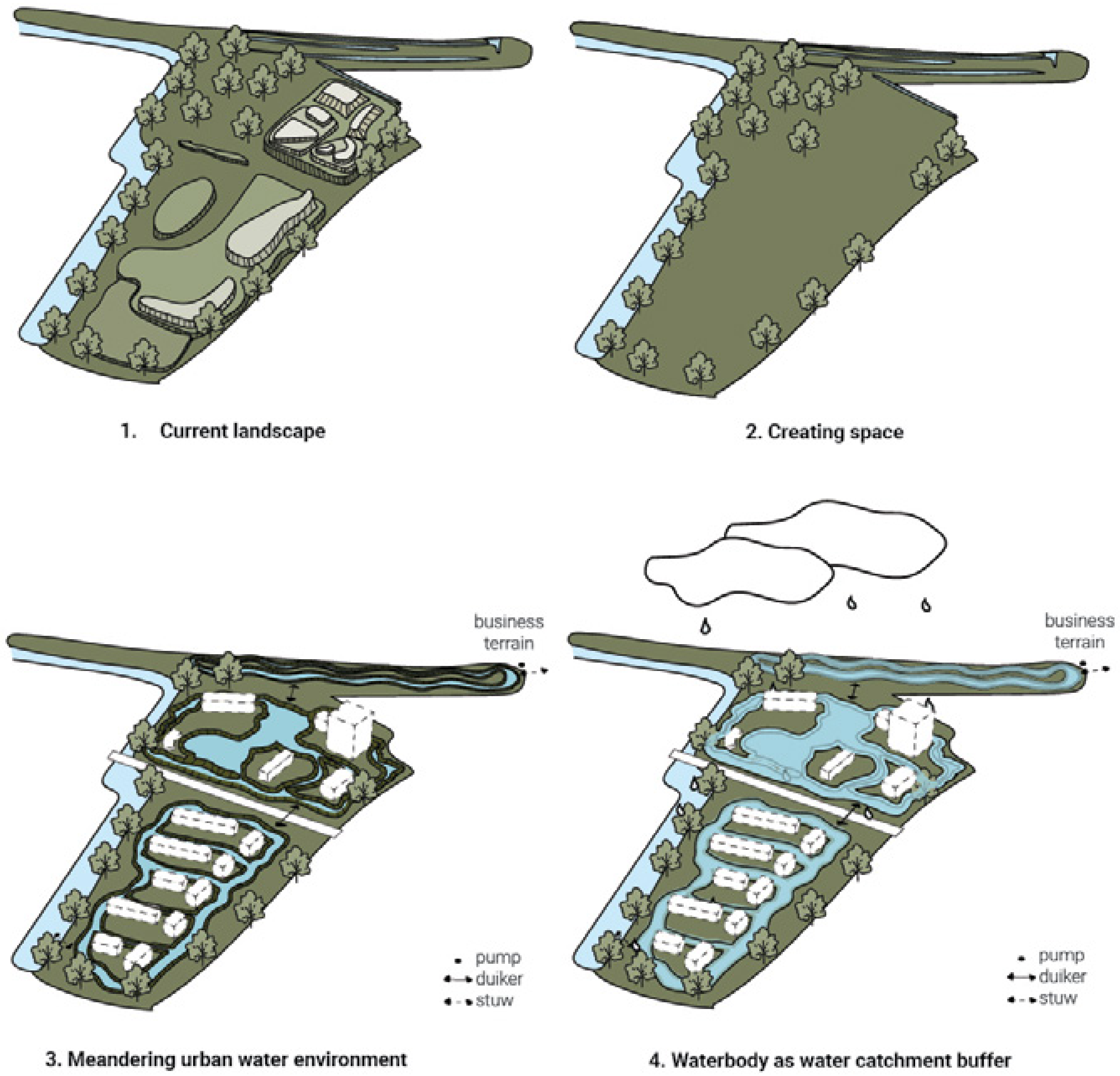


Figure 80: Building the Purifying vein in Fortunapark

6.5.2.3 Fortunapark as Purifying vein integration

The **Purifying vein** (figure 81) stands for an permanent open water cycle in which water can circulate through meandering structures, soft transitions of natural banks and helophyte filters. The water level is increased to combat subsidence, while using flexible water levels for the collection and storage for water. Synergies with **Green and landscape** can be found in the gradients of green and blue that have been added through the character of the Purifying vein. Whilst the relationship between **Human and water** will be enhanced since the edges around the water body are valued as a place, where social gatherings can occur or can be used as a recreational view. In addition, the purifying vein is used as a buffer for grey water, making inhabitants participate and aware of the care that is needed to preserve the communal water quality. The community centre is a place where this information sharing can continue. Lastly, the synergies between **Liveability** and the purifying vein have been found in stimulating movement and creating calm spaces by minimising cars to decrease pollution in the water bodies. Furthermore, by building lively neighbourhoods with daily interactions and mixed uses, more social cohesion can be established in which more communal collaboration between inhabitants can take place on the topic of water.

The different pillars (figure 82) will be decomposed in the following pages.

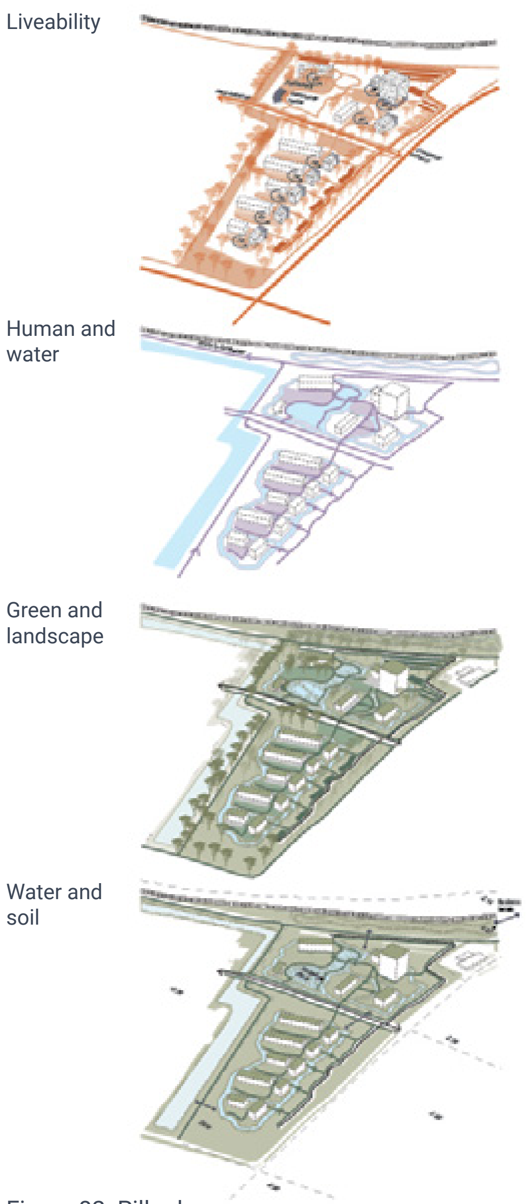


Figure 82: Pillar layers

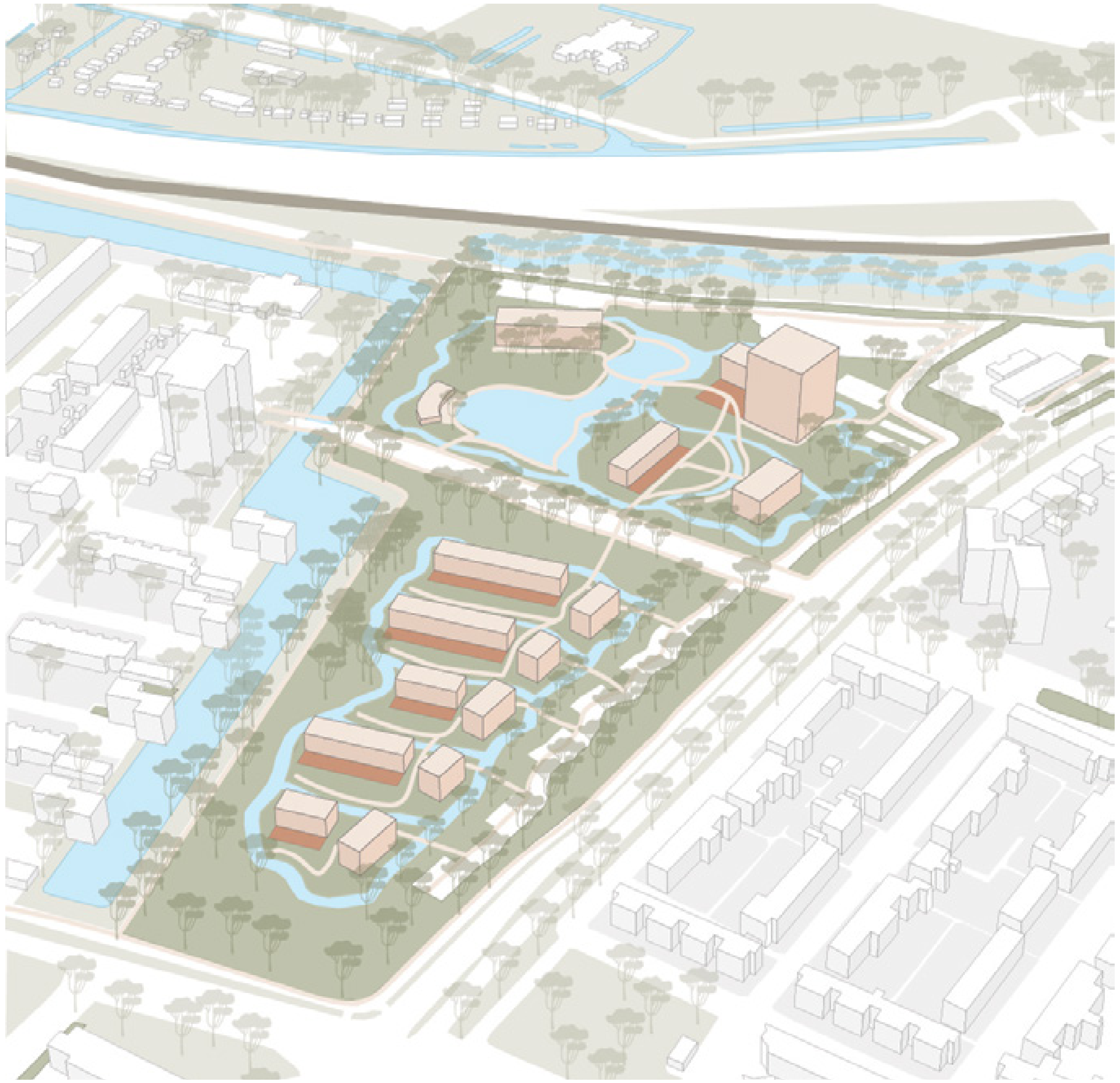


Figure 81: Fortunapark as Purifying vein

6.5.2.4 Water and soil

In this scenario the maximisation of Water and soil with the emphasis on water quality has been the guiding factor for the design of Fortunapark as Purifying vein. Therefore, the strategies of **circulation** and water **purification** stand on the foreground when making design decisions. As the landscape forms one purifying water vein, it can be seen how a maximum length has been created to create as many edges for natural banks and helophyte filters, with a meandering and connecting character for more oxygen circulation. To combat subsidence the water level has been increased throughout the neighbourhood using the established water vein, becoming its own water level area.

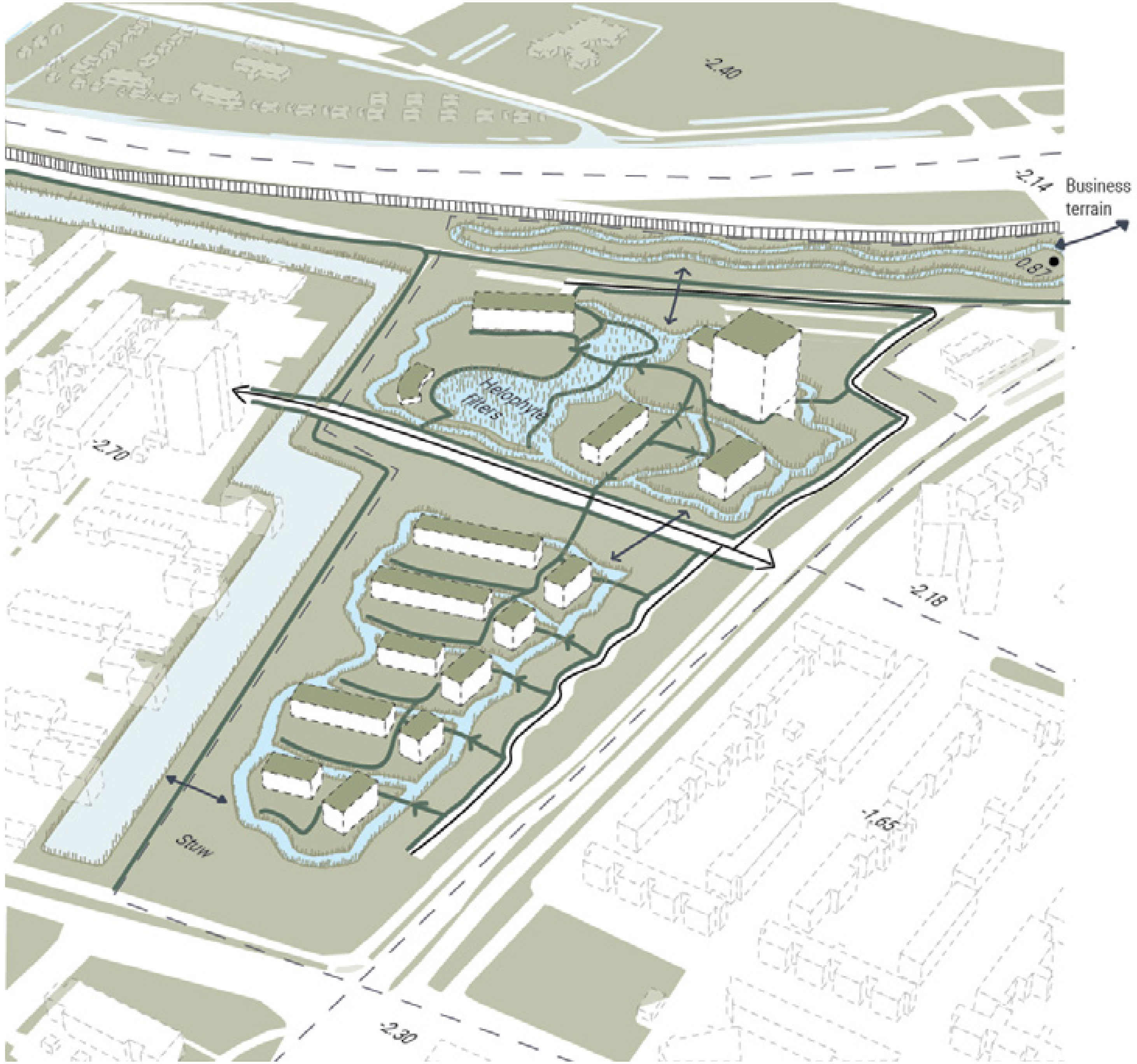
Other strategies such as **collect, store and infiltrate** take place through introducing bioswales and rain gardens that collect water and bring it to the purifying water vein with a flexible water level. In this way the water body will perform as water storage (appendix B).

All these interventions can be seen in figure 82, where the patterns that have been used are showcased with the Water and soil plan of Fortunapark.

As a result of using these strategies in the scenario of a Purifying vein, Fortunapark can contribute to cleanse the waters of the polder Vlaardingen-West on a larger scale.

Figure 82: Fortunapark as Purifying vein | Water and soil

- fixed water
- flexible water (level)
- water levels
- duiker
- stuw
- infiltration green
- rain garden network
- green roofs
- car path / gravel network
- helophyte filters
- natural friendly banks
- drainage pump / circulation pump

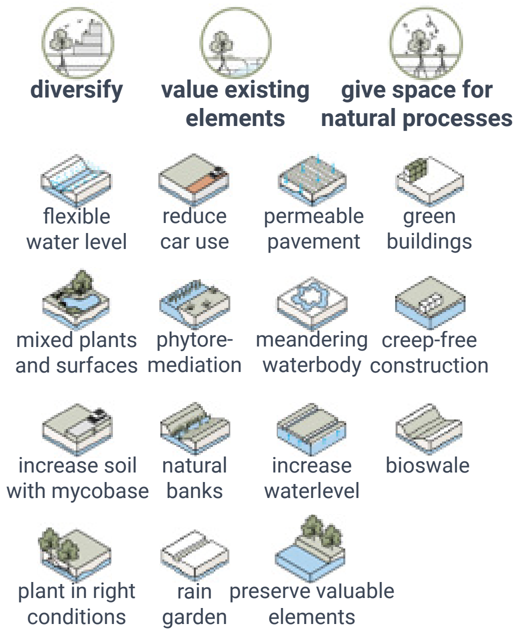


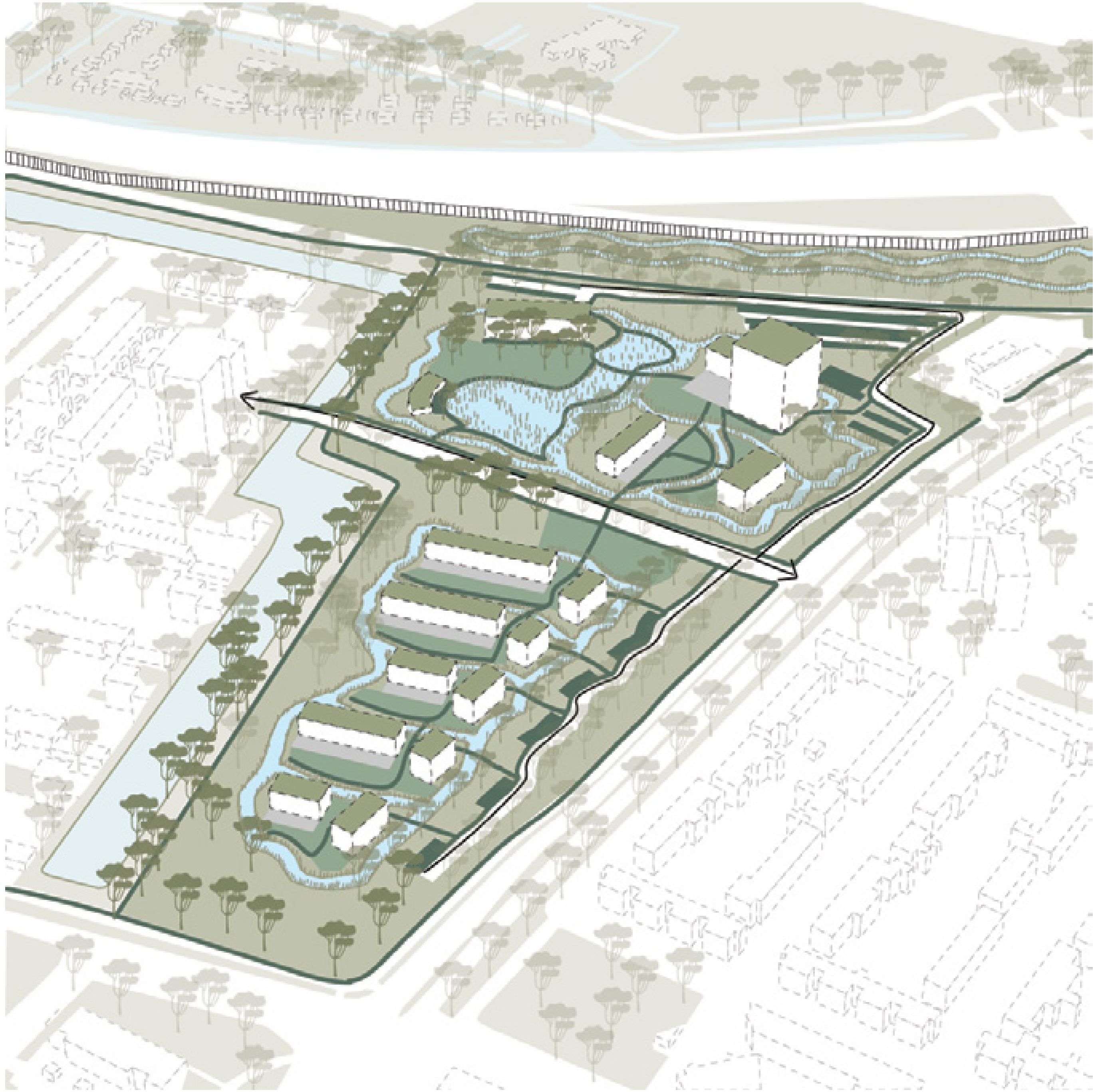
6.5.2.5 Green and landscape

Green and landscape has taken into account when making decisions (figure 83) by preserving **valuable elements** such as existing trees, as the oak, esh and willow trees. Furthermore, more **diversity** in vegetation has been added to the landscape by creating different types of green and reducing car use. Secondly, **working with natural processes** has been included, by choosing plants that can withstand the wetness of the extreme seasonalities that will occur more in the future, this means that plants have to be able to withstand the drier and wetter seasons (appendix C). Furthermore, to combat subsidence the water level has been increased. Therefore, the built environment has to become resilient for that by becoming waterproof and roads have to be stabilised using light organic materials such as mycobase.

Figure 83: Fortunapark as Purifying vein | Green and landscape

- existing trees
- existing valuable trees
- new trees
- private gardens
- green roofs
- biodiverse green for playing
- biodiverse green
- rain garden / permeable network
- car path
- flexible water
- fixed water
- natural friendly banks
- helophyte filters
- surrounding green area





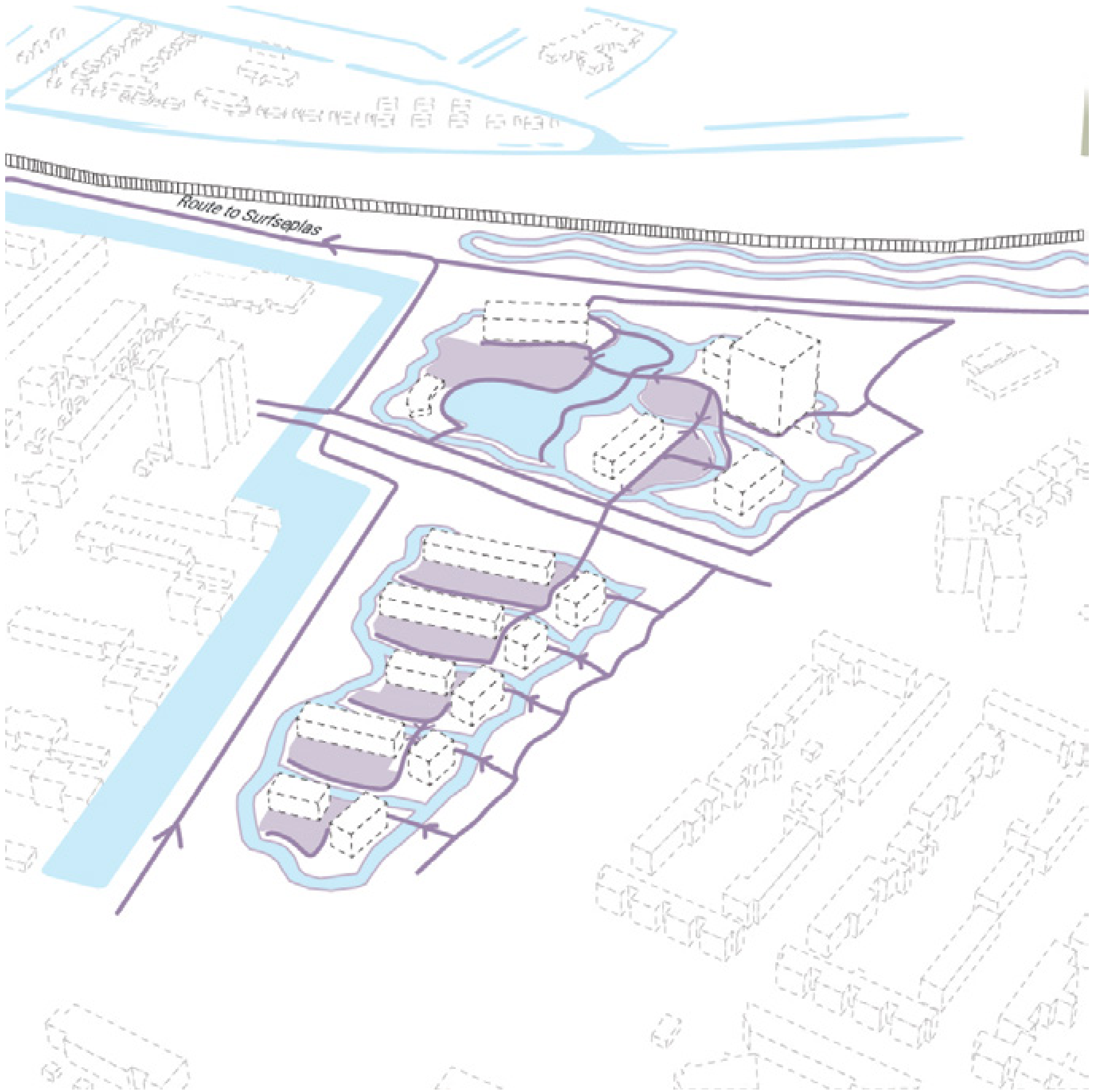
6.5.2.6 Human and water

Figure 84 shows the Human and water relation in the scenario of the Purifying vein and will be further elaborated.

The water body in Fortunapark forms a Purifying vein for the surrounding area, as a result the surface water takes up a lot of physical space in the neighbourhood. Which can be used to enhance the relation between Human and water, by introducing the **multifunctionality** of water. As water can be valued as a view, in which inhabitants can have their social spaces or buildings located around the edges of the water bodies. Hereby, the changing seasonality of water can be experienced through the flexible water levels in the water bodies, which also form the water storage during seasons of drought. In this way, inhabitants can take **ownership** in managing the water quality, since this is their communal water reserve. This is strengthened as inhabitants can also make use of interventions that save water, such as saving water toilets and showers. Furthermore, the **engagement of water** has been incorporated by using the community centre as a key educator to their residences and using signs of information. An example that can be used to inform residents on the topic of water is that the heart of the purification process takes place on the west-side in the willow forest. A water body that is filled with helophyte plants and forms a focus element in the park.

Figure 84: Fortunapark as Purifying vein | Human and water

- water as destination
- water as view
- water storage
- community centre
- water
- buildings



6.5.2.7 Liveability

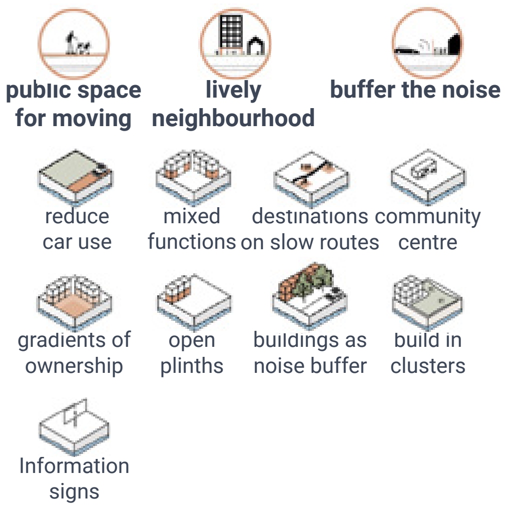
In order to incorporate Liveability (figure 85) the design first highlights that **public space is meant for pedestrians**. Cars and cyclists are only invited as guests. As a result of reducing car roads, more space is freed up for movement, where mix functions (workspaces and nurseries) and communal spaces form destinations. These design interventions also contribute to a **lively neighbourhood**. The combination of functions with different user hours and the stimulation of walking throughout the neighbourhood also increases social control, in which people feel seen. In addition, by using cluster typologies daily interactions are encouraged and different gradients of private and public spaces are established. This variation gives inhabitants more power to appropriate their private and communal spaces. Last but not least, in order to preserve the neighbourhood's peace, buildings have been designed to **buffer the noise** and car movement like mentioned before is reduced.

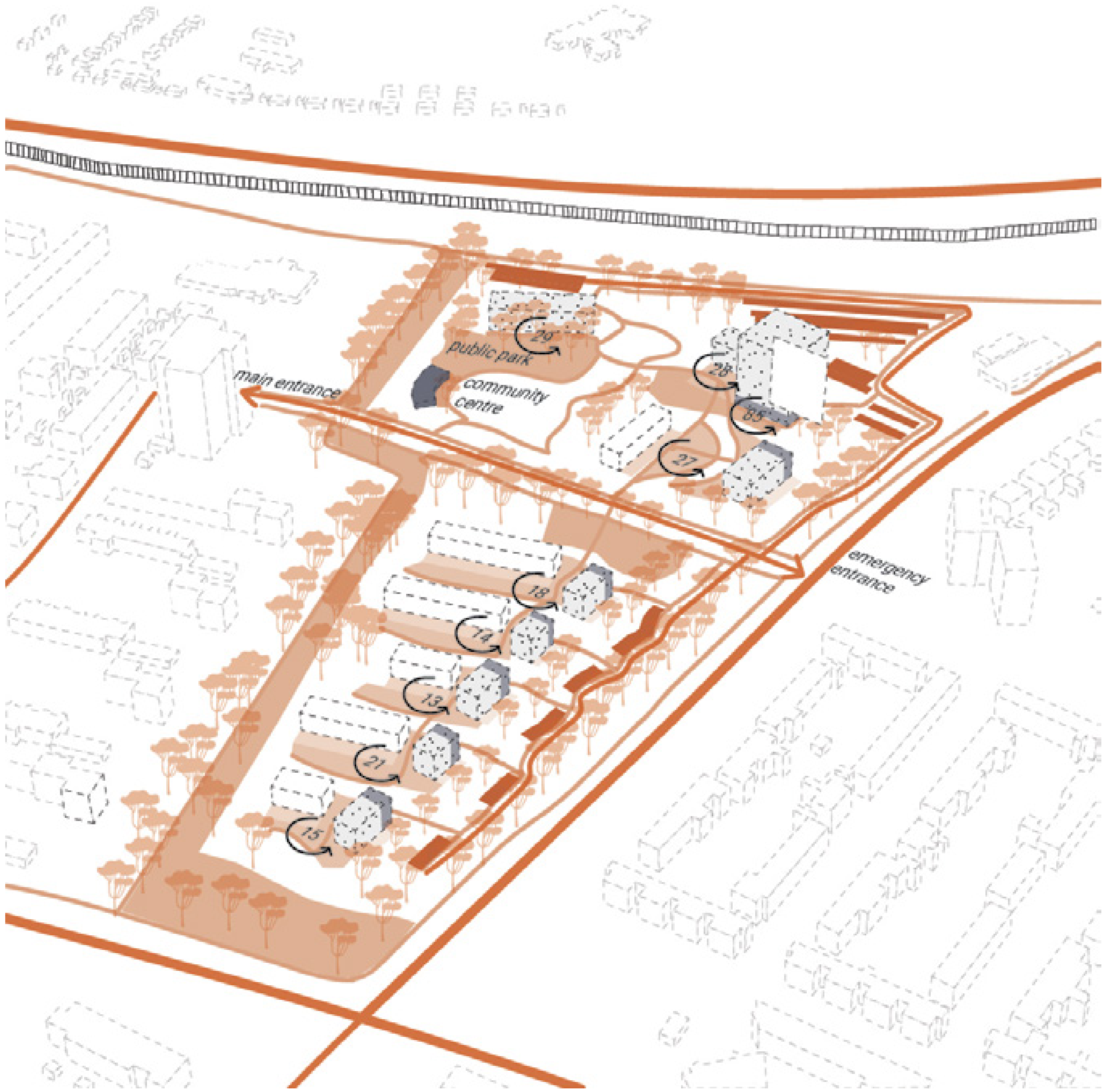
The housing requirement of 250 units has been met and each unit includes a dedicated parking space; please see appendix D for further details.

Figure 85: Fortunapark as purifying vain | Liveability

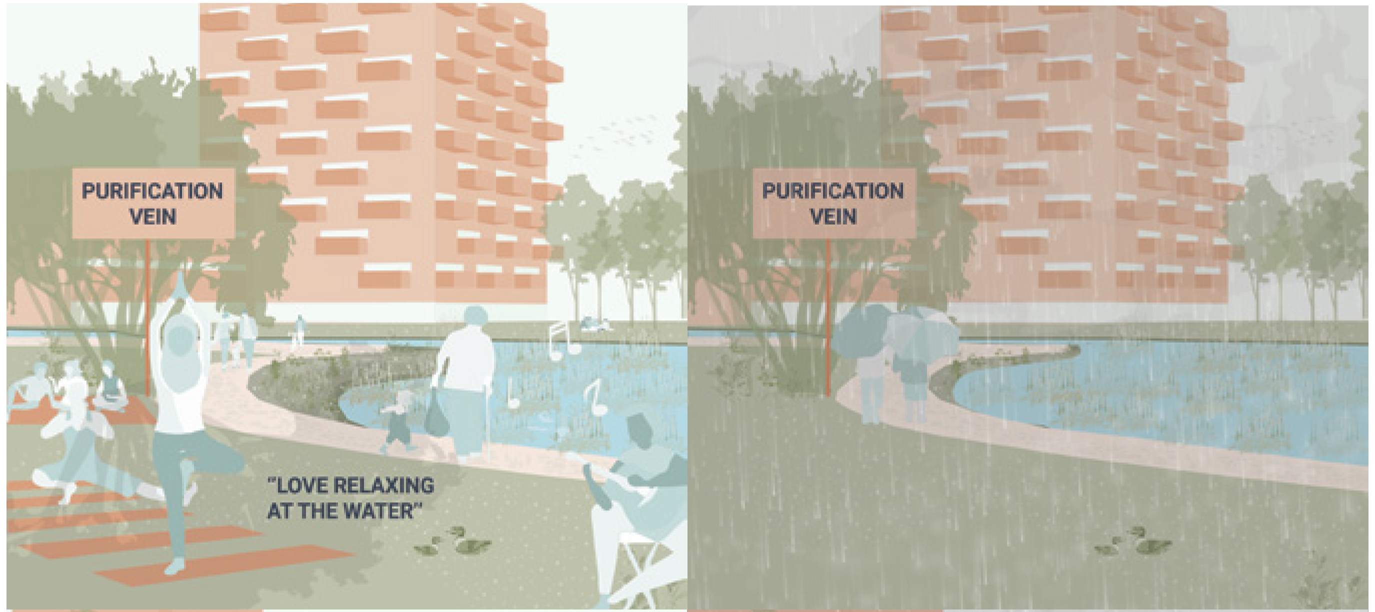
- pedestrian path
- car road / bicycle path
- car parking
- appartment blocks
- single family house
- community centre
- noise buffering buildings
- mixed functions

gradients of ownership
- private hidden outdoor space
- front garden
- front strip
- communal space
- semi public
- public space





6.5.2.8 Mood images



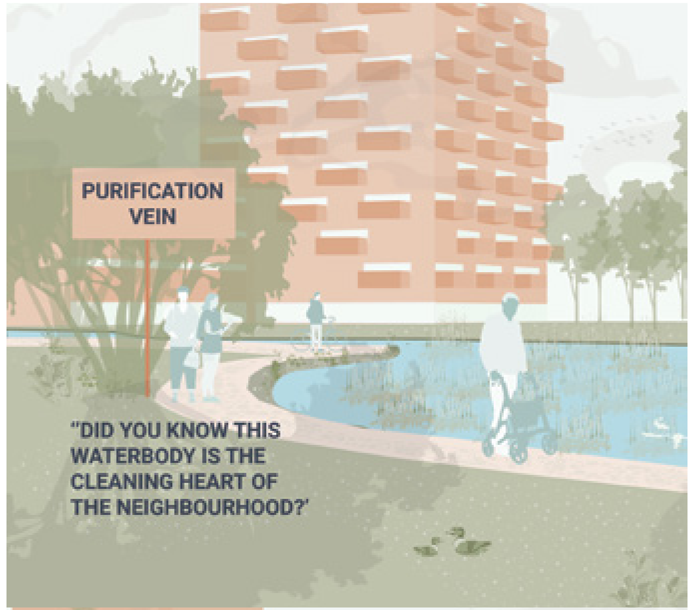


Figure 87: Public park through seasons

Figure 86: Communal garden through seasons


Fortunapark as Urban sponge

Chapter 6.5.3

Optimization | Fortunapark as Urban sponge

6.5.3.1 Synergies and conflicts

Synergies and conflicts can be observed when the different maximisations of every pillar are stacked on top of each other (figure 88). When looking at the different maximised layers together it can be seen how in the optimal situation, they are all very different from each other in layout. Two examples demonstrate how design was used as a means to identify synergies between the different pillars. The two locations are firstly, the willow forest in the west of Fortunapark and secondly, part of the green landscape.

In the first location, conflicts can be seen between Water and soil where a flexible temporal water cycle is crucial versus a permanent water body of Green and landscape in which the water level can be raised. As the groundwater can also stay recharged with a lot of infiltration space Green and landscape is also satisfied with this consensus. While buildings contribute to it with green roofs and humans and water can experience this temporal water cycle through the landscape.

In the second location, having in mind how again, a flexible temporal water cycle is crucial, conflicts can be found in the cluster characteristics that Liveability would like to have in its optimal spatial expression. As a lot more space would go pedestrian streets, which means less space for pure green surfaces. For this reason more compact typologies are introduced, which have more efficient routing to have less streets and more space for green.

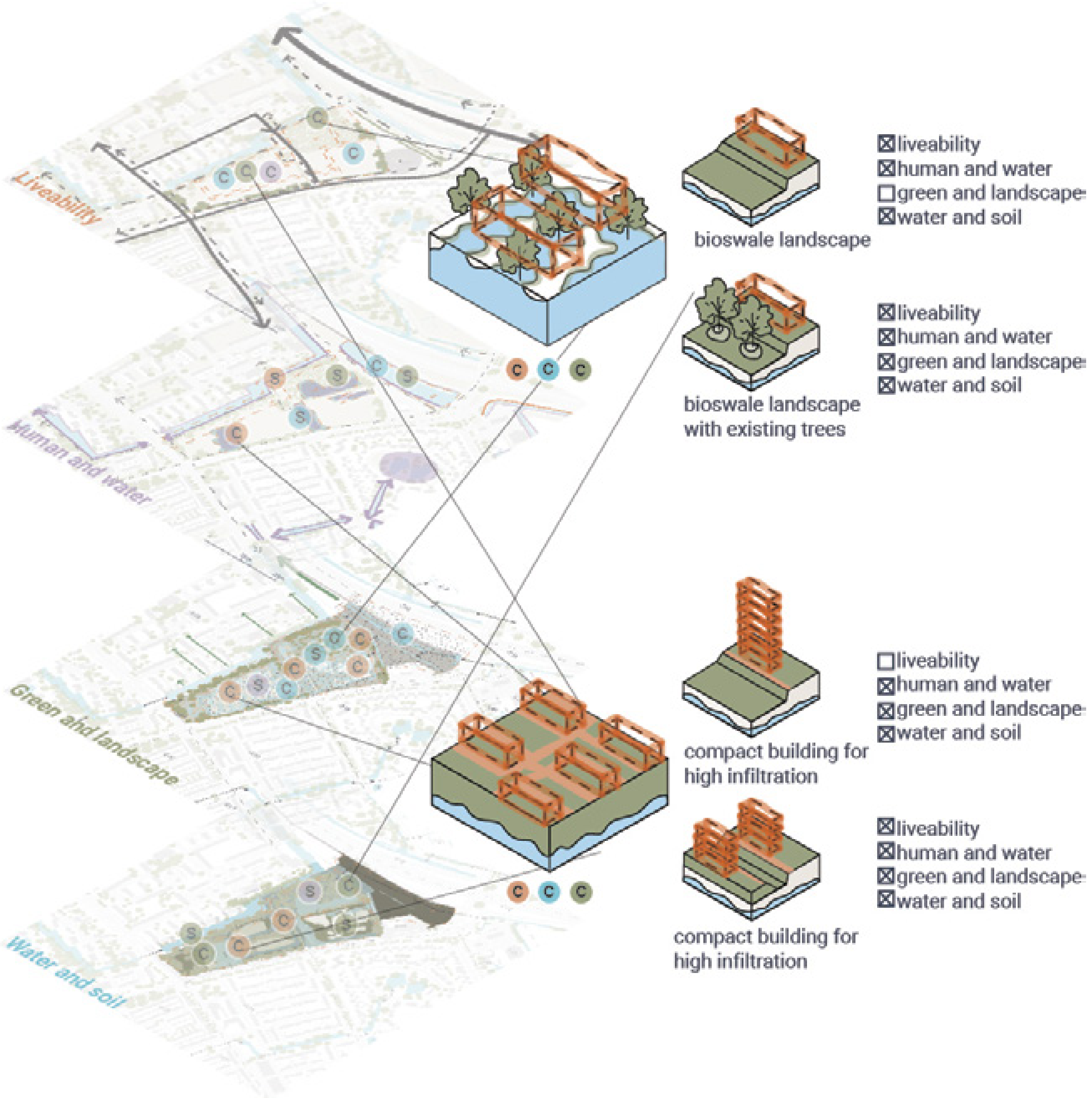


Figure 88: Synergies and conflicts for the Urban sponge

6.5.3.2 Building the Urban sponge

The steps in which the landscape has been transformed into the Urban sponge can be seen in figure 89. The hills of the existing green (1) have been mainly zoned to build the houses (2). While the lower lying areas form social spaces that can flood with precipitation. Furthermore, clustered social spaces near the homes have been dug to give more space for water (3). As a result a network of temporal water catchment has been introduced (4).

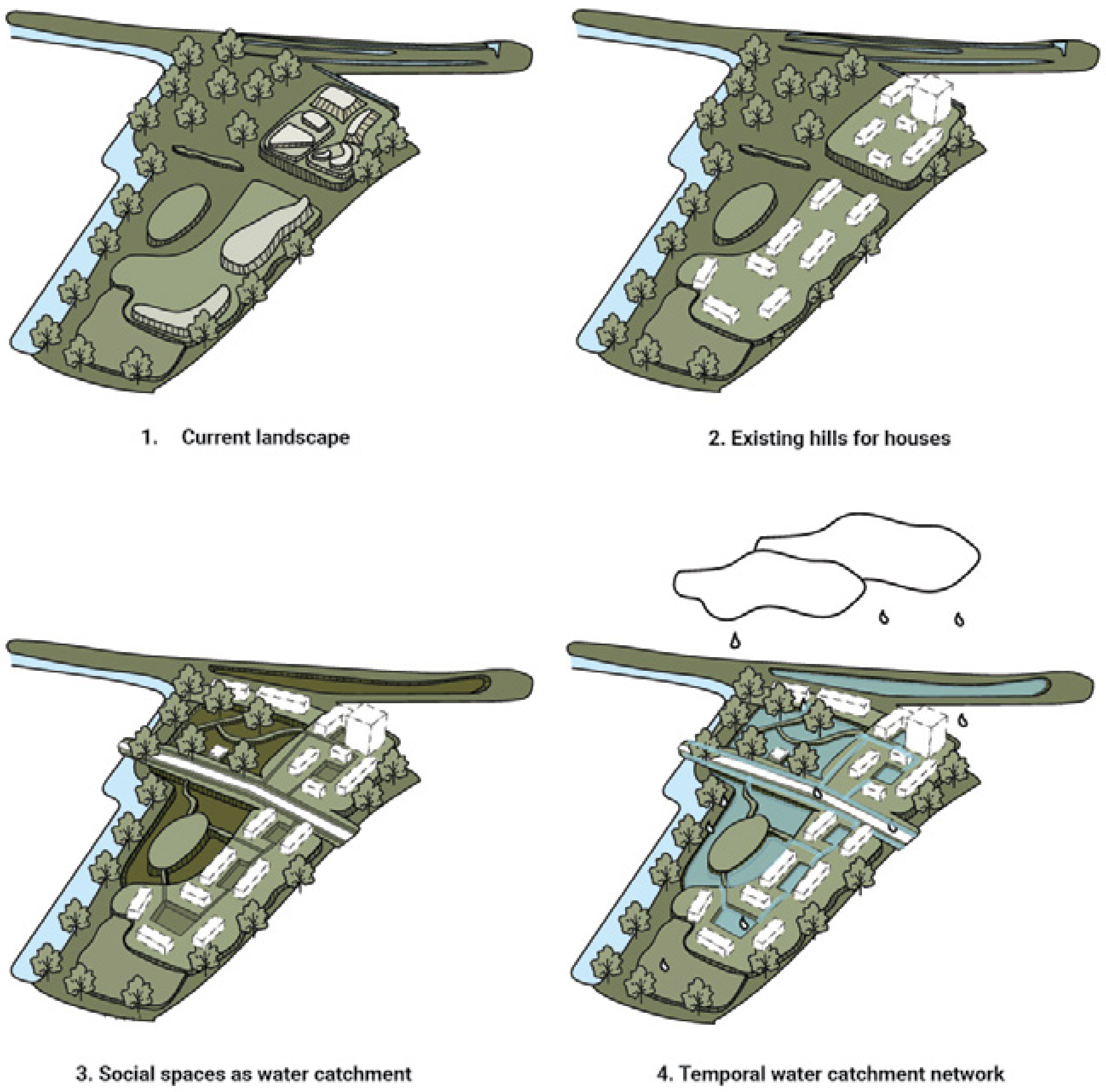


Figure 89: Building the Urban sponge in Fortunapark

6.5.3.3 Fortunapark as Urban sponge integration

The **Urban sponge** (figure 90), emphasises on a temporal flexible water cycle that circulates throughout the green landscape, where it is collected, can infiltrate and be stored. Storing happens underground, or in rain barrels for grey water use. By safeguarding the green landscape and enhancing infiltration rates, subsidence is combatted. Here, synergies on the pillar of **Green and landscape** can be found in improving the infiltration rates by creating more biodiversity in the different vegetation types, by the conservation of existing trees and by creating spaces for decomposition. While strengthening the relationship between **Human and water** by creating the experience of the seasonality of water, as wet and dry conditions have consequences on the urban functions in the neighbourhood. In addition, through letting inhabitants participate in their water ownership, by catching it privately or communally, inhabitants are engaged and informed on the vulnerability of the quantity of water. This knowledge sharing can be extended in the community centre.
Lastly, the synergies between **Liveability** and the urban sponge have been found in stimulating movement and creating calm spaces by minimising cars to create more space for green. Moreover, by establishing lively neighbourhoods with daily interactions and mixed uses, fosters a greater cooperation between inhabitants on water-related issues.

The different pillars (figure 91) will be decomposed in the following pages.

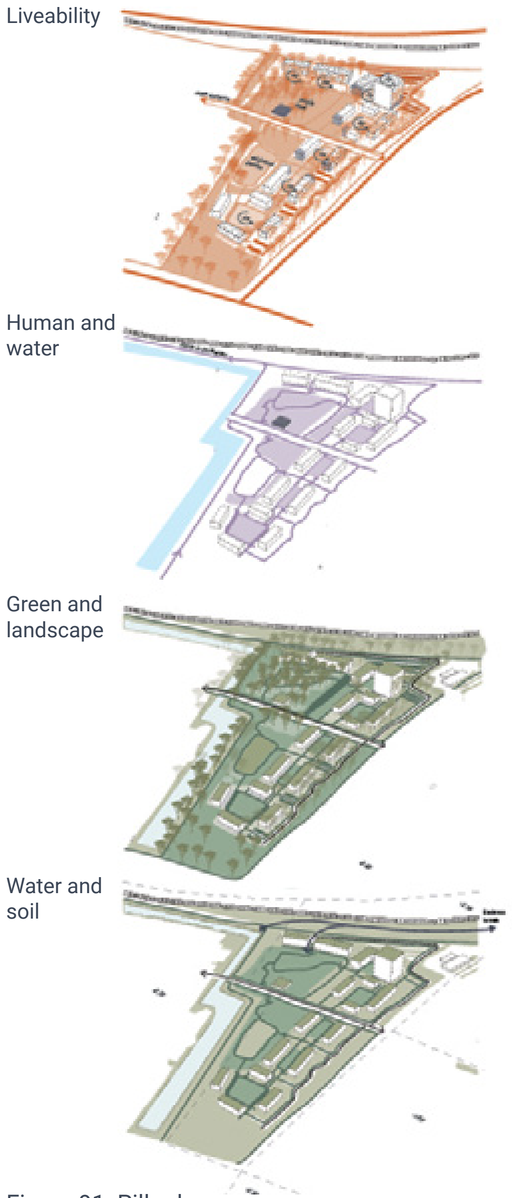


Figure 91: Pillar layers

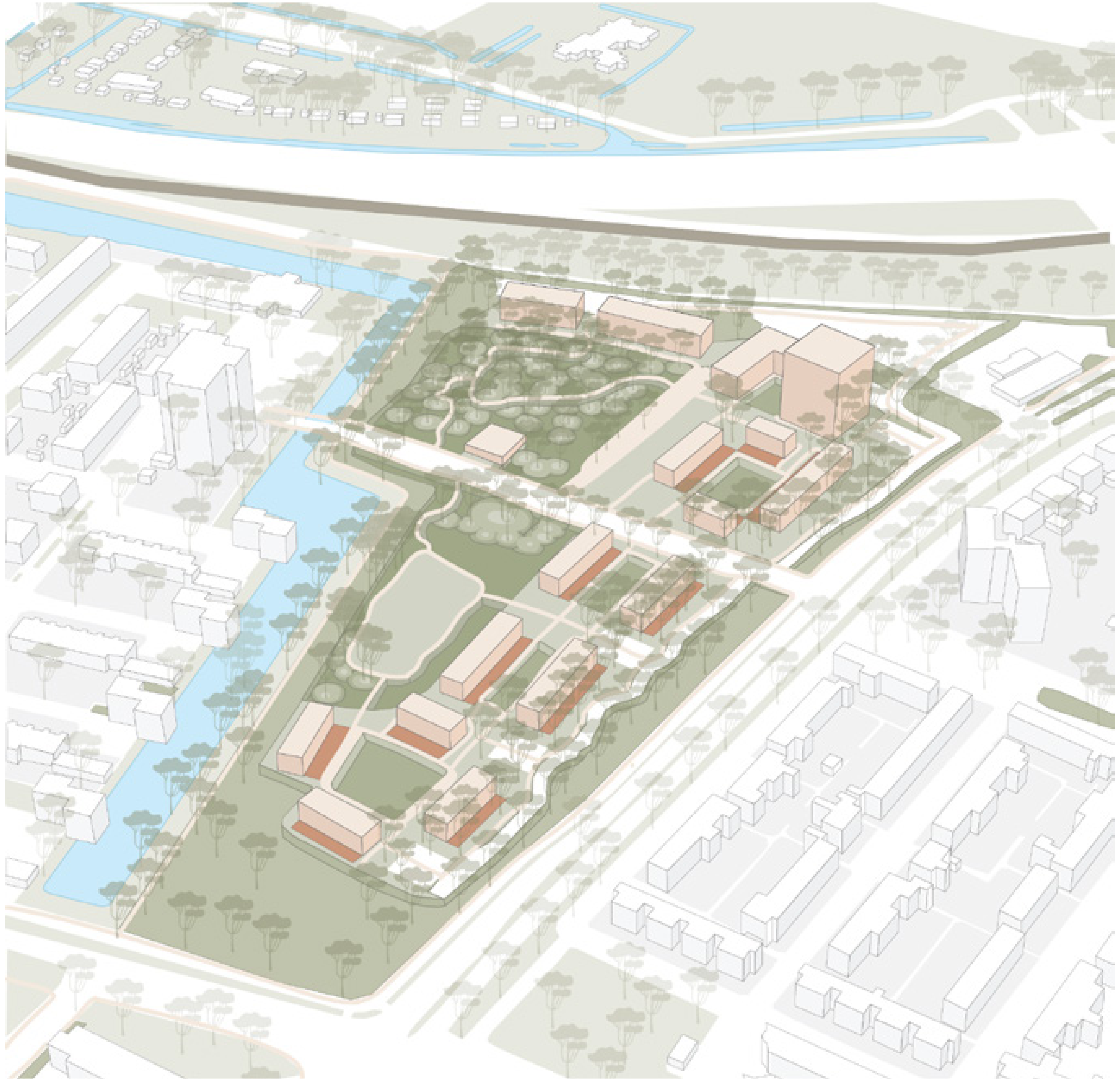


Figure 90: Fortunapark as Urban sponge

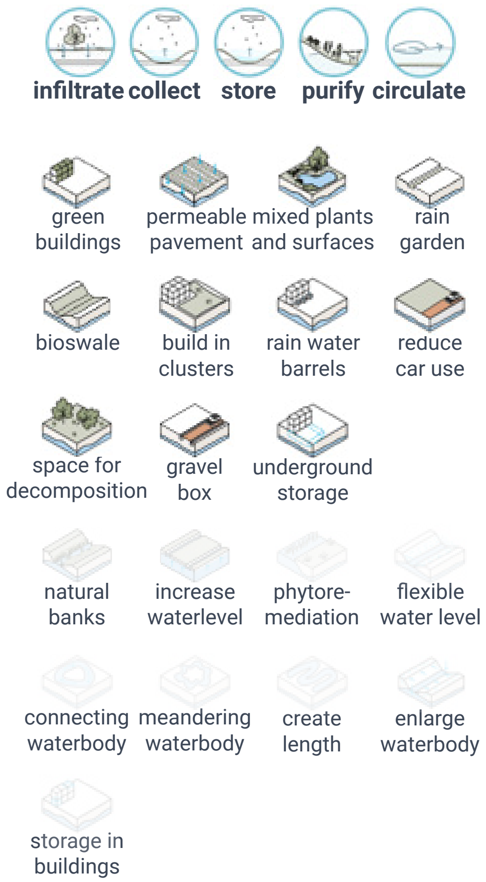
6.5.3.4 Water and soil

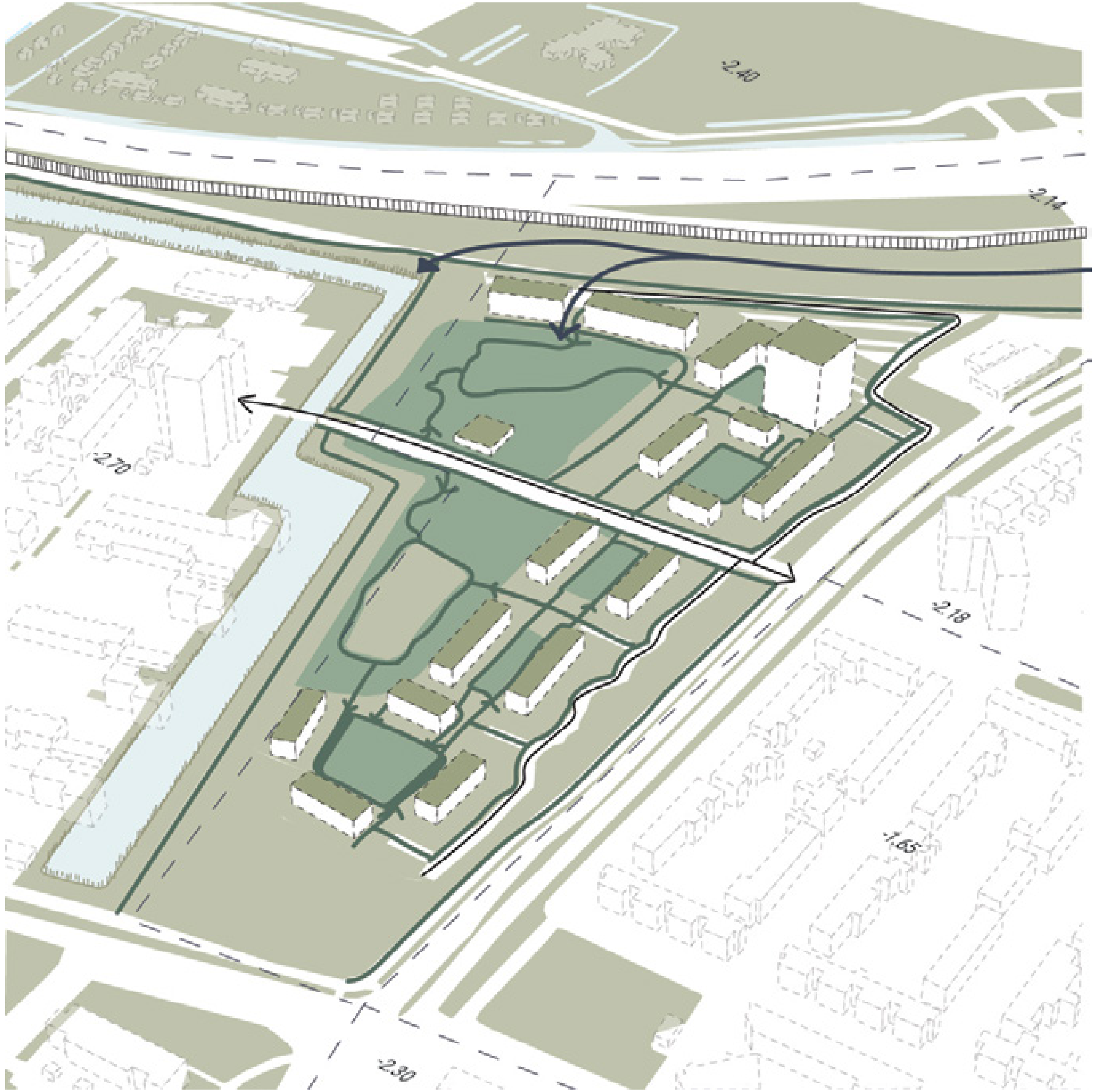
In this scenario the maximisation of Water and soil with the focus on water quantity has been the guiding factor for the design of Fortunapark as urban sponge. Therefore, the strategies of **infiltration** and **water collection** stand on the foreground when making design decisions. As the landscape forms one water metabolism, it can be seen how there are different levels in which water can flow temporarily (figure 92). Whereby different water extremes can take space in the built environment. From private to public spaces, water is always collected, for infiltration or storage purposes. Hereby, throughout the neighbourhood water flows from sedum roofs to rain gardens and to bioswales. Other strategies such as **store, circulate and purify** take place through storing water underground and letting water circulate and purify at areas of surface water by creating length, connecting the waterbody and using natural banks and helophyte filters.

As a result of using these strategies in the scenario of a climate adaptive Fortunapark, the neighbourhood can release pressure for the business terrain on the larger scale, reduce subsidence by focussing on infiltration space and store enough water to save 30 L fresh water every season (appendix B).

Figure 92: Fortunapark as Urban sponge | Water and soil

fixed water
flexible water (level)
water levels
duiker
stuw
infiltration green
rain garden network
green roofs
car path / gravel network



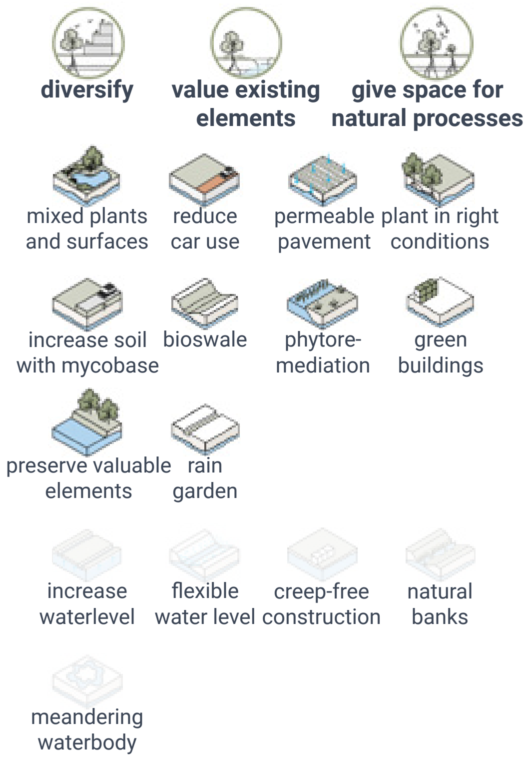


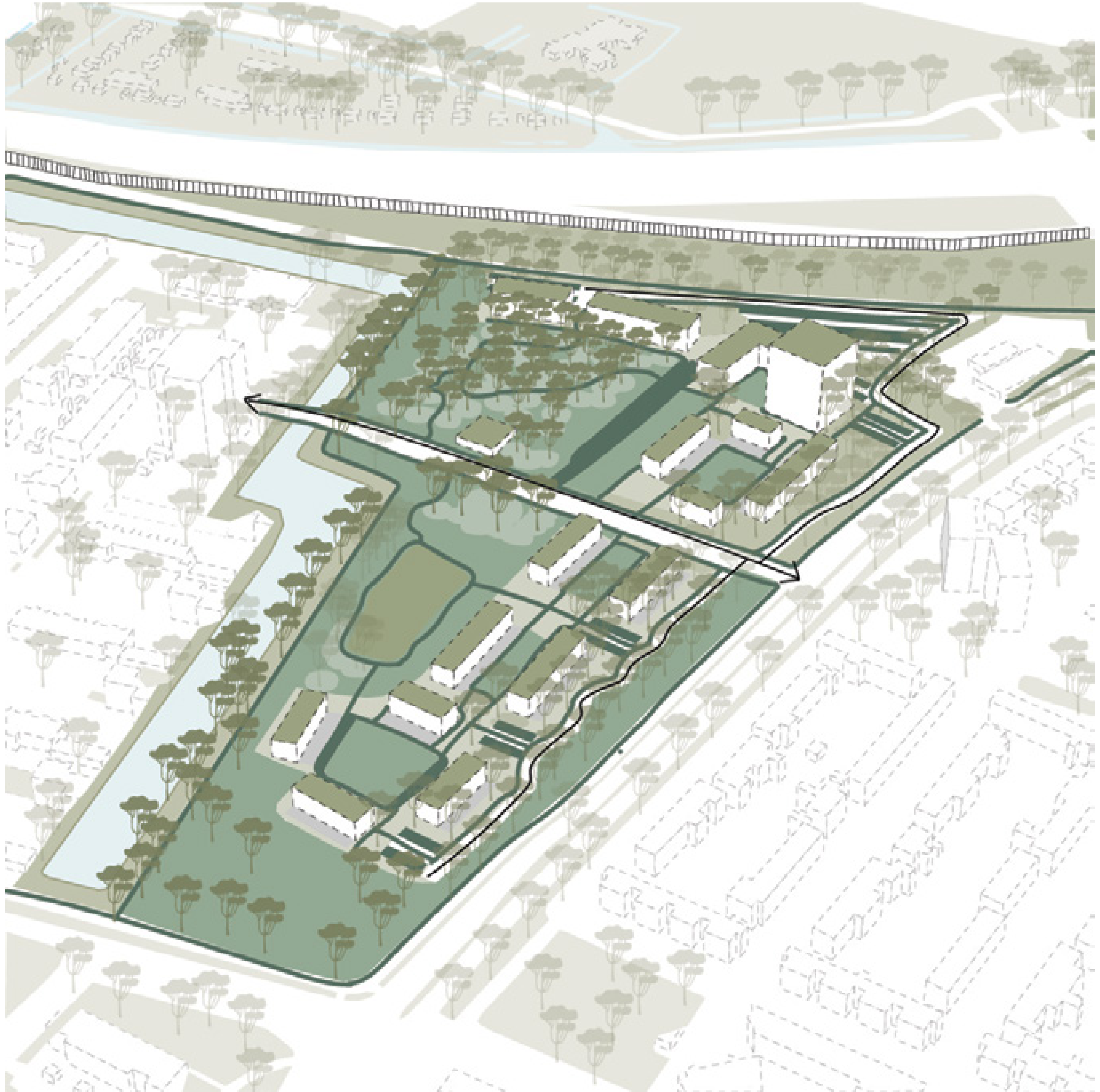
6.5.3.5 Green and landscape

Green and landscape in the Urban sponge (figure 93) has taken into account **valuable elements** by trying to conserve existing trees, such as the oak, esh and willow trees. Furthermore, more **diversity** in vegetation has been added to the landscape by creating different types of green and reducing car use Moreover, **working with natural processes** has been included, by choosing plants that can withstand the wetness of being part of a water metabolic landscape and can withstand the drier seasons that will occur (appendix C). In addition, bioswales can be used as a space for the decomposition of leaves and to not aggravate the occurring subsidence the built environment can be stabilised by having buildings on stilts and using mycobase, an organic and light material to increase the soil.

Figure 93: Fortunapark as Urban sponge | Green and landscape

- existing trees
- existing valuable trees
- new trees
- private gardens
- green roofs
- bioswale for playing
- bioswale
- rain garden / permeable network
- car path
- allotment gardens
- green hills
- surrounding green area
- flexible water
- fixed water



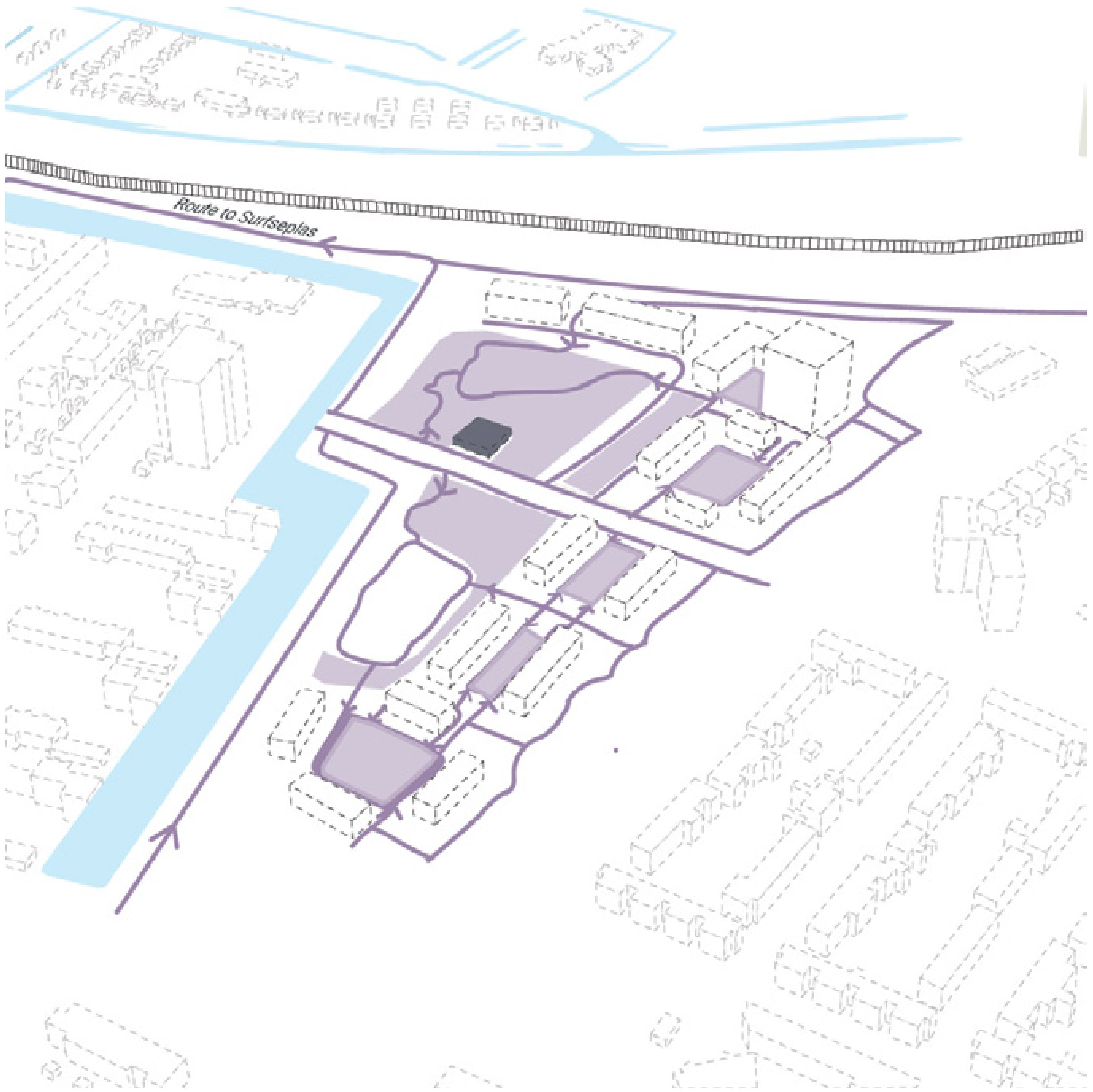


6.5.3.6 Human and water

The relation between Human and water has been enhanced by introducing the **multifunctionality** of water in the water metabolic landscape, as the seasonality of water can be experienced through the changing function of spaces (figure 94). As social spaces can be a space for meeting or a space for collecting water. Whereby, inhabitants can take **ownership** of their water by having communal spaces become locations for local grey water collection and where inhabitants can privately save water in their homes. Lastly, **the engagement of water** has been introduced by using the community centre as a key informer and using signs of information in public spaces to educate inhabitants about the metabolic water system in their neighbourhood.

Figure 94: Fortunapark as Urban sponge | Human and water

- water as destination
- water as view
- water storage
- community centre
- water
- buildings



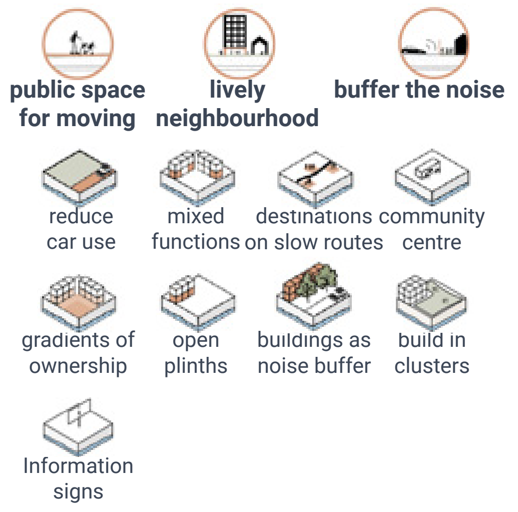
6.5.3.7 Liveability

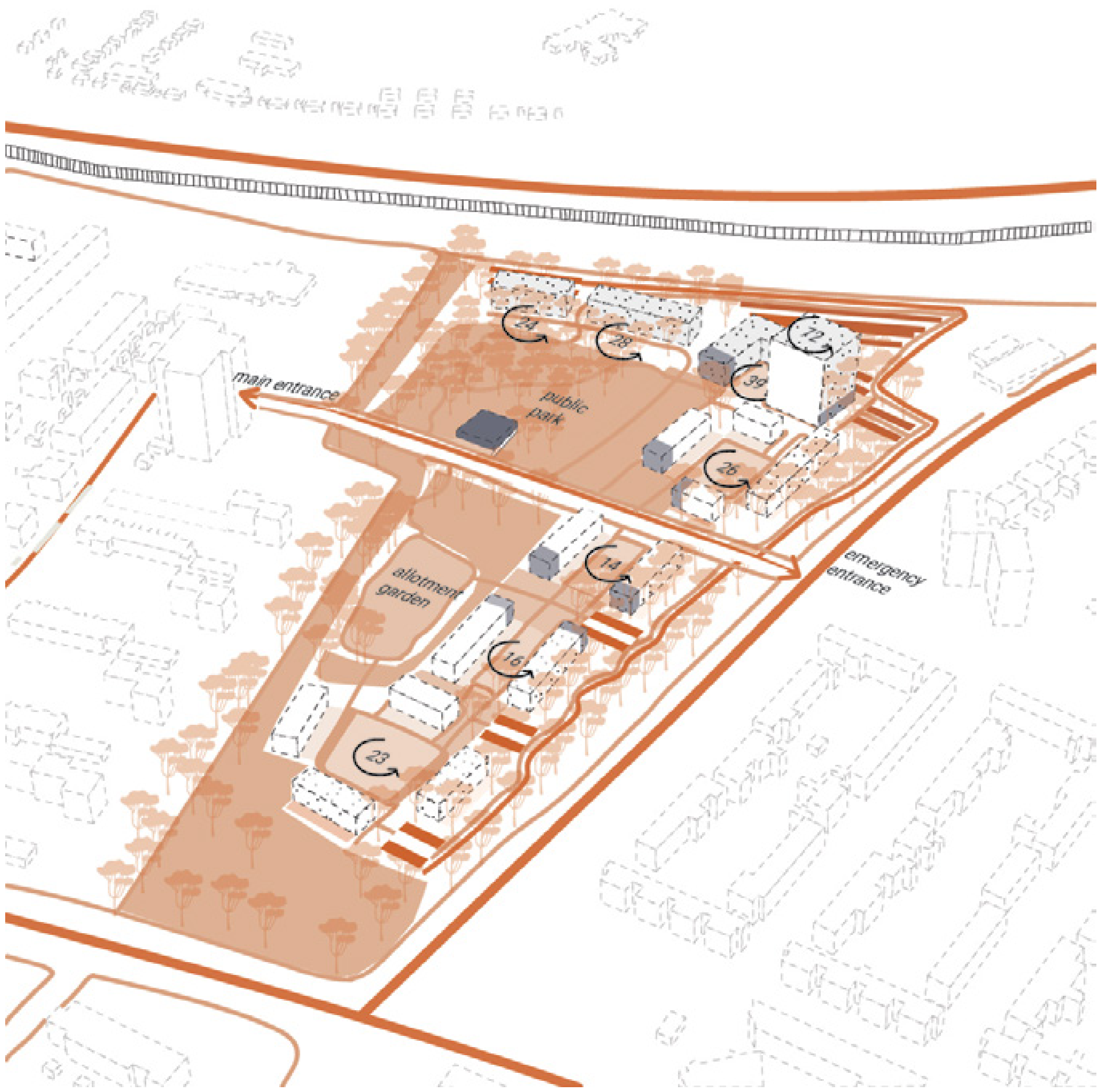
The design has incorporated Liveability (figure 95) by firstly, emphasising on the fact that **public space is intended for walking** and where bicycles and cars are welcome as guests. Therefore, walking has been made more attractive as car use is reduced, mixed functions are present and destinations have been created on the walking route. To elaborate, the car route and car parking has been focused on the east side, to create more freedom for pedestrians. In addition, by adding destinations like mix functions or interesting courtyard environments, walking throughout the neighbourhood is encouraged. Hereby, mix functions can take shape in facilities such as nurseries or workspaces like hairdressers or repair shops. These design interventions also touch upon the second strategy, creating a **lively neighbourhood**. Since mixed functions, reducing care use and creating destinations also contribute to making people feel seen. Furthermore, as most typologies form clusters of residential, daily social interactions are stimulated. Whereby, different gradients of public to private space is present, giving inhabitants more ownership to their private and communal spaces. Lastly, to safeguard the tranquillity of the neighbourhood the heavy traffic **noise has been buffered** by introducing building typologies that can buffer the noise and by reducing car use in the neighbourhood itself

Figure 95: Fortunapark as Urban sponge | Liveability

- pedestrian path
- car road / bicycle path
- car parking
- appartment blocks
- single family house
- community centre
- noise buffering buildings
- mixed functions

gradients of ownership
- private hidden outdoor space
- front garden
- front strip
- communal space
- semi public
- public space





6.5.3.8 Mood images

Figure 97: Public park through seasons

Figure 96: Communal garden through seasons

6.5.4.1 Scenarios evaluation | Fortunapark as Purifying vein

The two scenarios have been evaluated, using an evaluation system (98) that is based on the three different goals of every pillar with the topics of the climate stress test. The climate stress test is a research method developed by Deltaprogramma Ruimtelijke Adaptatie (DPRA), used to assess the vulnerability of a particular system or community in the context of climate change on the topics of water nuisance, heat, droughts and floods (Kennisportaal klimaatadaptatie, n.d.). In this project the evaluation of the stress tests will be simplified, as they are more qualitative speculations than quantitative evidence. Furthermore, as this project only takes into account pluvial flooding and not fluvial floods, the topic of floods has been excluded. In Appendix E an elaborated table can be found with the evaluation, as the summaries are found here.

The **Purifying vein** of Fortunapark, aims to utilise an open water system to create ideal conditions in which water can flow. By incorporating meandering structures and natural banks with helophyte filters and a higher ground water level a **robust water system** is established. This waterbody also serves as a collector and as storage to enhance the resilience against extreme weather events for **climate adaptivity** and **circularity**. As it combats **water nuisance** and **heat** due to the collection of water and contribution to cooling.

In addition, this Purifying vein enables a form of community responsibility and **ownership** on their water quality, supported by raising **awareness** in the community centre and with information signs on this well known Purifying vein. Social activities occur around the **multifunctionality** of the vein, as water takes up a lot of space and is valued as an aesthetic view.

Furthermore, **preserving** the existing green character by giving more space for water, creates gradients of wetness and vegetation which contributes to **biodiversity**. Besides, the vegetation types and the methods of building have been chosen based on the natural conditions that will be created in the landscape, such as the rising water level, and the **natural processes** that will occur during climate change of both drought and wet extremes.

Moreover, when looking at Liveability, inhabitants are stimulated to **walk** due to priorisation on pedestrians, **interact and appropriate** due to layers of mixed functions, ownership and open typologies and are located in a **calm** environment due to the noise buffers and low car activity.

Nevertheless, when evaluating the design some critical notes can be made. By giving more space for water, less space has been reserved for the valuable existing willow trees. As a result more trees have been removed than the pillar of Green and landscape prefers. Another point is that an open water system does not allow for the decomposition of leaves as it can pollute the water. Furthermore, the design of an open water system is extra vulnerable towards the seasonality of **droughts**, due to the risks of evaporation that brings the water quantity and quality at risk.

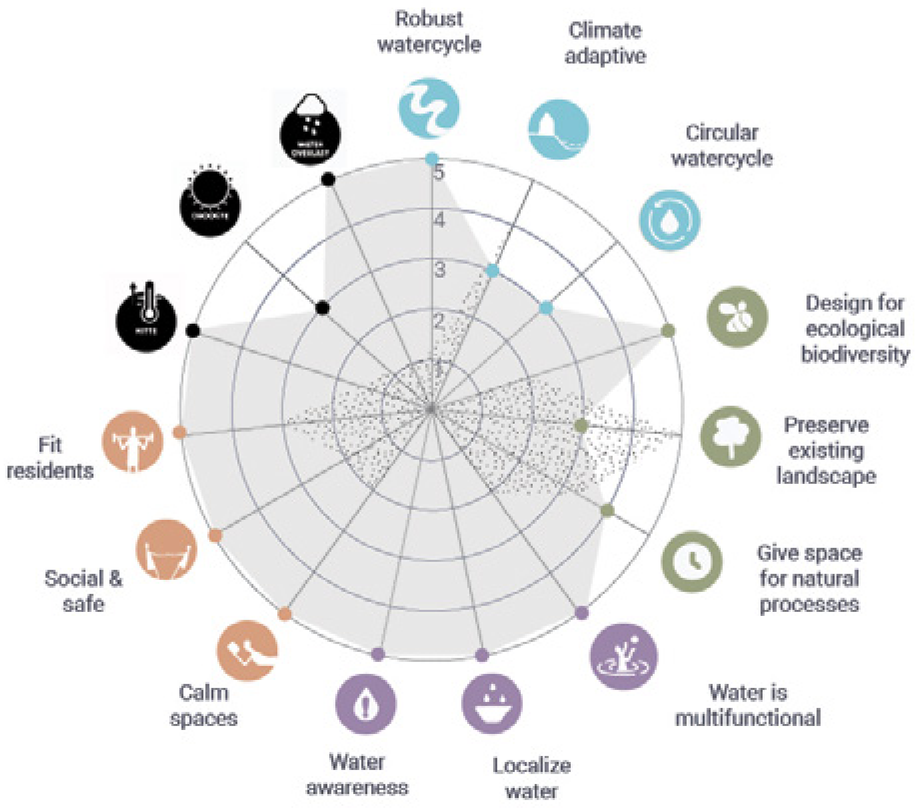


Figure 98: Fortunapark as Purifying vein
legend
existing evaluation
scenario evaluation

6.5.4.2 Scenarios evaluation | Fortunapark as Urban sponge

The evaluation of the Urban sponge can be seen in figure 99. As urban functions have been combined with functions to let water infiltrate, collect and be stored. The urban landscape has become a **climate adaptive, robust** and **circular** metabolic Urban sponge that is resilient for the weather extremes of heat, droughts and water nuisance through a flexible and temporal water cycle. Since, the green character cools down the neighbourhood and water flows from collection, infiltration to possible storage underground. This results in having a greywater buffer throughout the year and a stable ground water level, reducing the occurrence of subsidence. Nevertheless, as this scenario does not have any form of surface water, Fortunapark does not have any characteristics of a **robust water system**.

The seasonality of water extremes can be felt in the landscape, as it flows through different urban spaces, showcasing a **multifunctionality** and creating an **awareness** on the topic of water. In this landscape water communities get formed in which water is collected communally to give inhabitants a sense of **ownership** and responsibility.

As the system is focused on infiltration and collection, a lot of different gradients of vegetation have been created that contribute to **biodiversity**. Furthermore, most of the **valuable** trees have been preserved while adding new types of vegetation that can withstand the **natural conditions** of heavy rainfalls, droughts and the urban use of the space.

Moreover, when examining livability, walking is encouraged by making **walking** attractive and minimising car mobility, **social cohesion** is stimulated by the mixed use of the neighbourhood and the focus on small clusters and **tranquillity** is safeguarded by noise buffers and few roads in the neighbourhood.

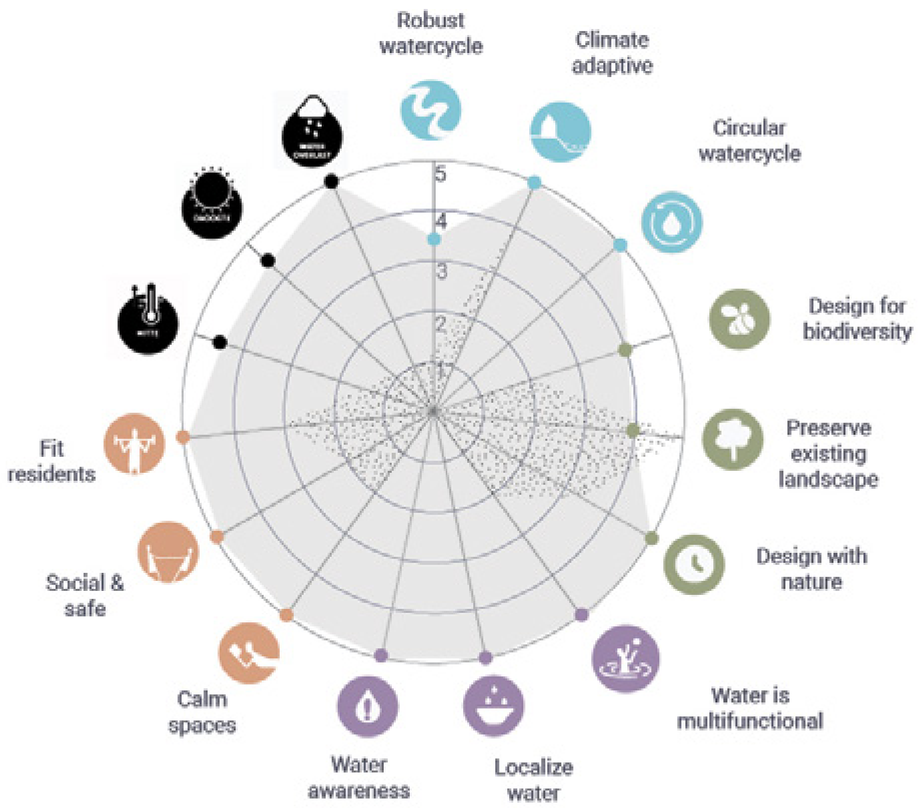


Figure 99: Fortunapark as Urban sponge

legend

existing evaluation

scenario evaluation

6.5.4.3 Scenarios evaluation conclusion

When comparing the two scenarios of Fortunapark as Purifying vain or Fortunapark as Urban sponge, it can be seen how they have been designed to explore different interests from a Water and soil perspective.

In which the Purifying vein has been optimised for water quality, while the Urban sponge has given a greater priority for water quantity. In doing so synergies have been discovered between the other pillars of Green and landscape, Humans and water and Liveability. The spatial expression of these scenarios have resulted in a permanent presence of the water cycle, in which water has a clear destination. Whereas in the Urban sponge the emphasis is on a flexible temporal water cycle that is integrated with the urban environment. When looking at figure 100, it can be seen how both scenarios improve the existing landscape in the evaluation while seeing differences. At first glance it can be seen how the Urban sponge performs better than the Purifying vein in most aspects, with a slightly lower score for the stress test of heat, robust water cycle and the goal of design with biodiversity. As the Purifying vein brings, with its permanent waterbody, more gradients of surfaces of water and natural friendly banks, while cooling down the landscape and offering interventions to purify the water. Nevertheless, in the rest of the assessment, it is evident that the Urban sponge outreaches the Purifying vein. Which can mainly be justified by the fact that an open water system becomes less climate adaptive and circular in the event of droughts and evaporation. In addition, negative consequences can also be found in the removal of more existing trees due to risk of pollution in the water body.

For this reason, it can be said that a flexible temporal water cycle that is incorporated into the urban environment (Urban sponge) is a better representation of a resilient, balanced water cycle for a Water friendly neighbourhood. Then a permanent body of water, flowing through the terrain (Purifying vein).

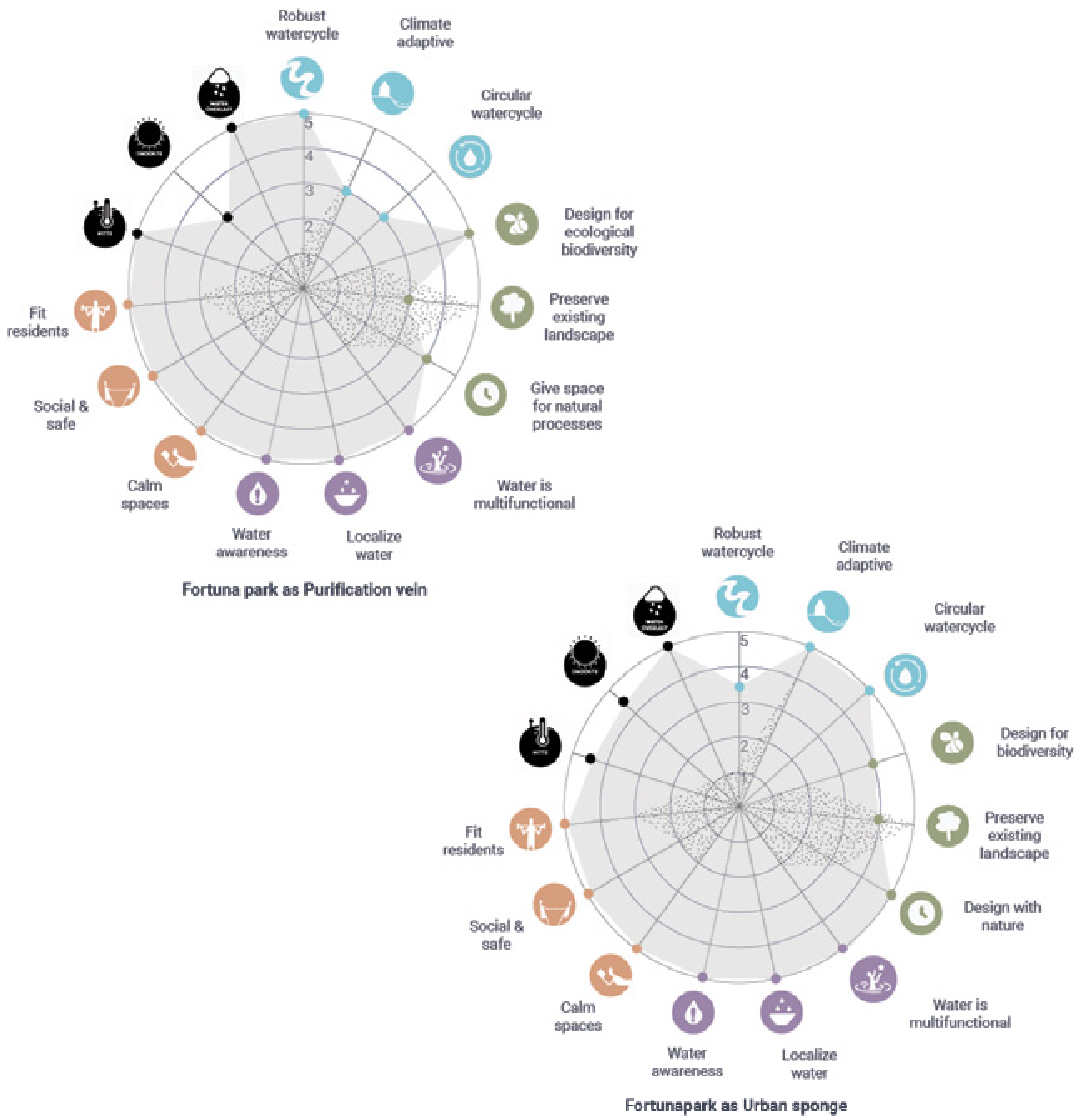


Figure 100: Scenario evaluations

Chapter 7.

Final design

In order to showcase how the synergies between water, ecology and humans can be found, designs throughout the scales have been executed with the integration of Fortunapark as Water friendly neighbourhood.

'"Every aspect of our lives is, in a sense, a vote for the kind of world we want to live in."'

- Frances Moore Lappé'

7.1 Fortunapark as Water friendly neighbourhood

Fortunapark as a resilient Water friendly neighbourhood uses the urban sponge as its main support system to balance the water cycle. While looking for integrations from purifying water interventions and synergies between water, ecology and humans.

When looking at the water and soil conditions on the larger scale, a purification vein is still needed to purify the polder water while helping the surrounding water bodies during water nuisance. Therefore, an integration has been made. Figure 101 shows how water can enter Fortunapark from the business terrain to the purification vein and onwards to the polder. This vein can release pressure from the water nuisance in the business terrain to also purify the polluted water before it moves forwards. While the urban landscape of Fortunapark itself acts as a bioswale in which rain water can be collected to infiltrate the soil or be purified to be reused for grey water purposes.

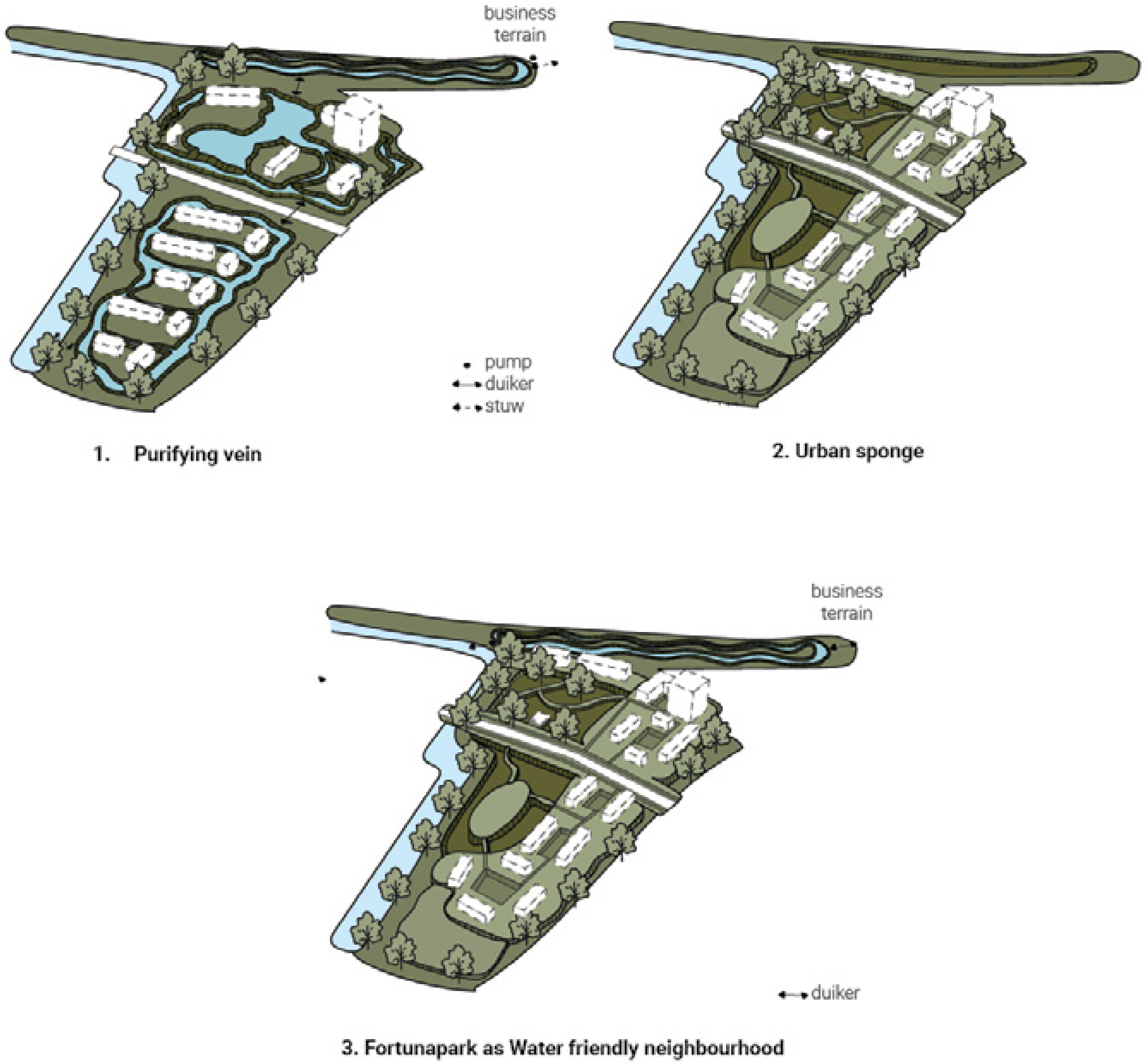


Figure 101: Integration of a the Urban sponge and the Purifying vein

7.1 Fortunapark as Water friendly neighbourhood | macro

In the vision on macro scale (figure 102), Fortunapark will use its open water system to purify the water that flows through the polder. This can also release water nuisance pressure from the business terrain. In addition, through adding a variation of surfaces and plants and preserving enough space for infiltration, subsidence will be reduced and the biodiversity will flourish. This will create a pleasant environment in which higher incomes are attracted. As a result more economic opportunity will be created for the whole of Westwijk. By making Fortunapark a central place, through the public park, new community centre and local facilities, internal and external inhabitants have a place to hang around, meet each other and organise activities. Lastly, through the use of space, inhabitants can experience the forces of water due to the landscape flooding. While learning more about the vulnerability of water through the community centre.

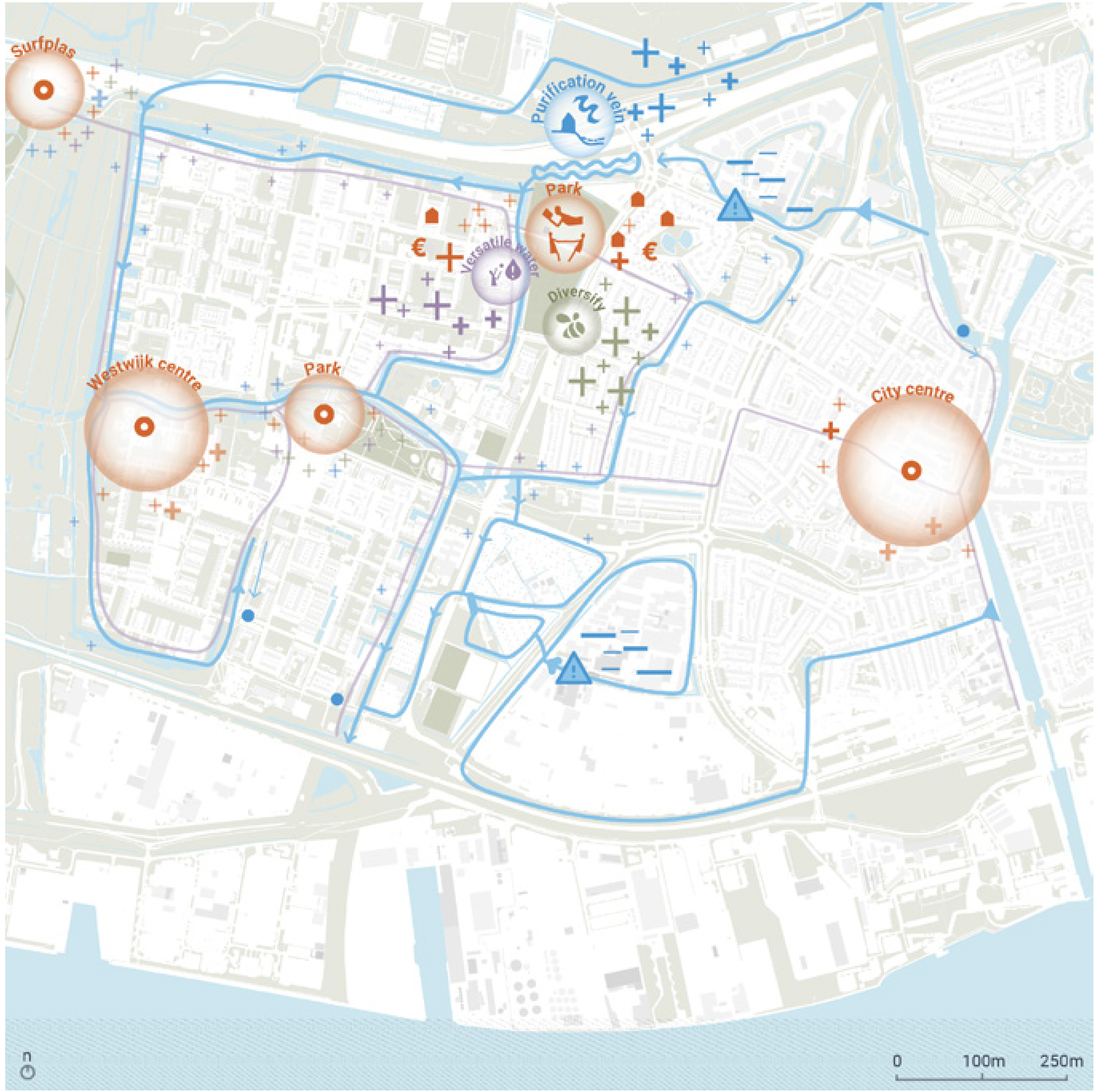


Figure 102 Macro scale Fortunapark as Water friendly neighbourhood: legend

- green
- recreation green
- buildings
- paved
- water
- polder waterbody
- water walking route
- Fortunapark
- water pollution
- positive effects on the pillars through Fortunapark

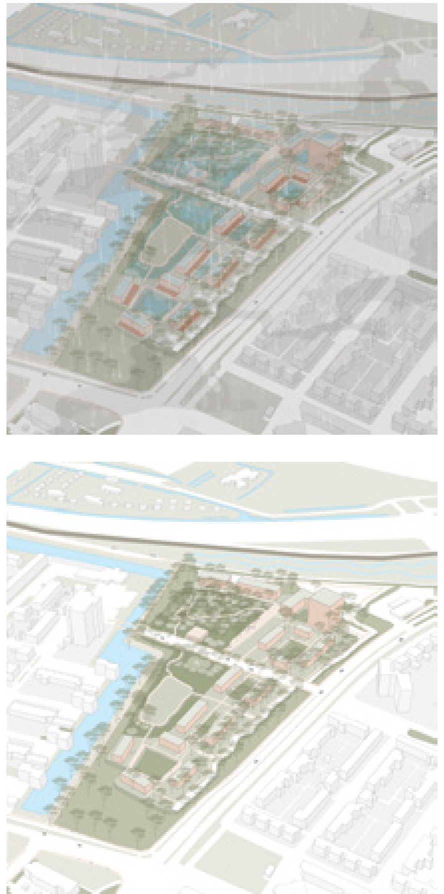
7.1 Fortunapark as Water friendly neighbourhood | meso

By focusing on balancing the water cycle and looking for synergies between water and soil, green and landscape, people and water and liveability, a Water Friendly neighbourhood has been created in Fortunapark (figure 104). Here, a neighbourhood has been established where in wet seasons space has been given for an integrated temporary water flow, where drinking water is saved on a daily basis through water reduction, water reuse and recycling (100-litre homes) and which improves the water quality of the polder.

In Fortuna Park, water will temporarily circulate through the green landscape, where it is collected, can infiltrate and can be stored. Storage for grey water will take place underground in the courtyards or above ground in rain barrels. Diversifying the greenery can increase infiltration capacity and counteract slight subsidence. Here, synergies on the pillar, **green and landschape** and landscape can be found in improving biodiversity by using different vegetation types, preserving existing trees and creating spaces for degradation. While the relationship between **human and water** is enhanced by creating the experience of the seasonality of water, as wet and dry conditions have visible impacts on urban functions, such as the public park or courtyard (figure 103). In addition, residents are involved and informed about water vulnerability by allowing them to participate in their water property. As water can be collected privately or communally. This knowledge sharing can be extended at the community centre in the public park.

Finally, synergies between **liveability** and water and soil can be found in encouraging movement and creating quiet spaces by minimising cars to create more space for greenery. This minimises pollution from heavy vehicles in groundwater and creates more space for infiltration. It also promotes liveliness and social cohesion when creating spaces such as the public park or courtyards. While also providing a place for water collection. Encouraging social interactions also allows for greater cooperation among residents on water-related issues.

The different pillars are further explained in the following pages.



Figuur 103: Fortunapark through the seasons

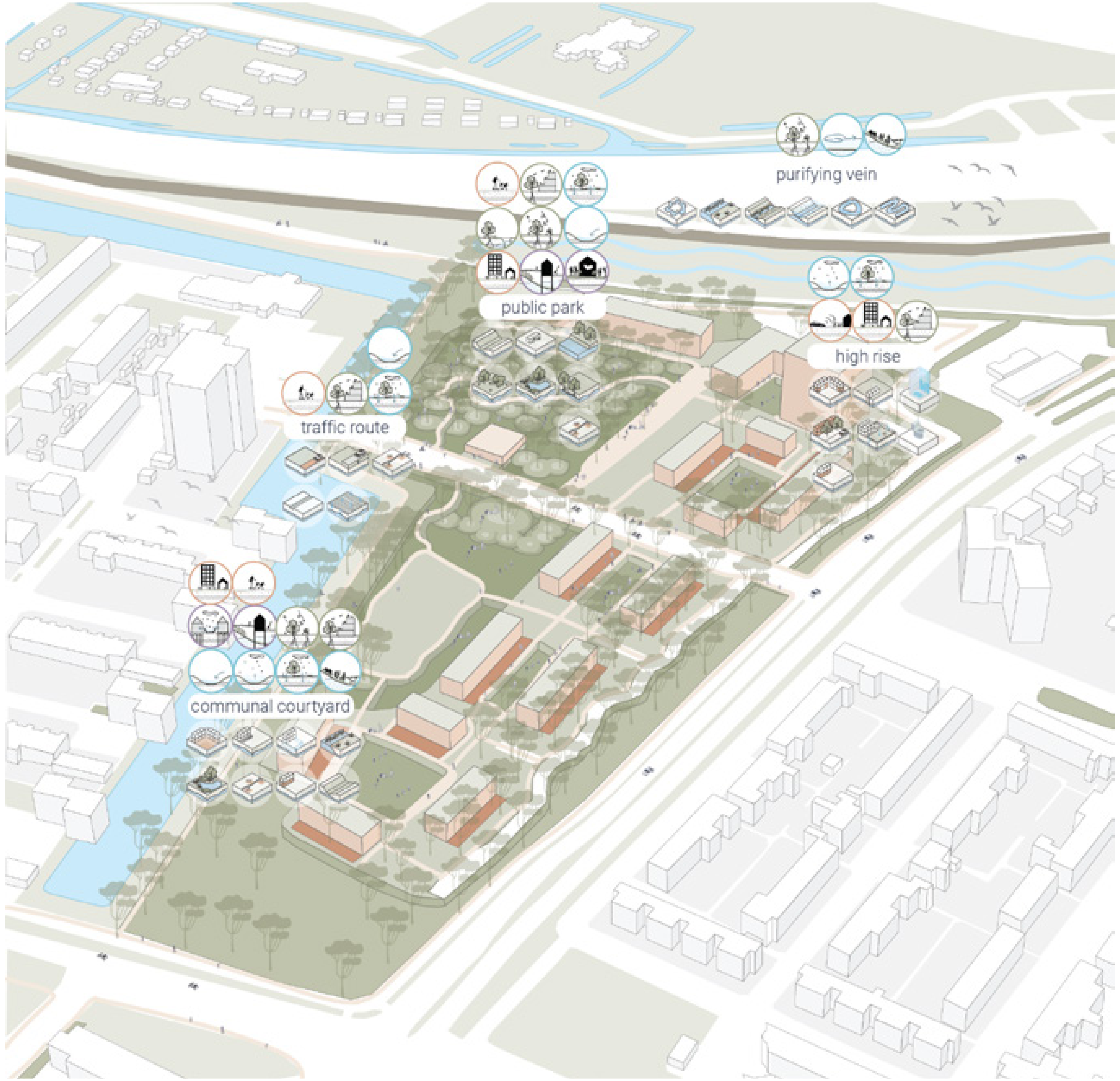


Figure 104: Fortunapark as water friendly neigbhourhood

7.1 Fortunapark as Water friendly neighbourhood | meso

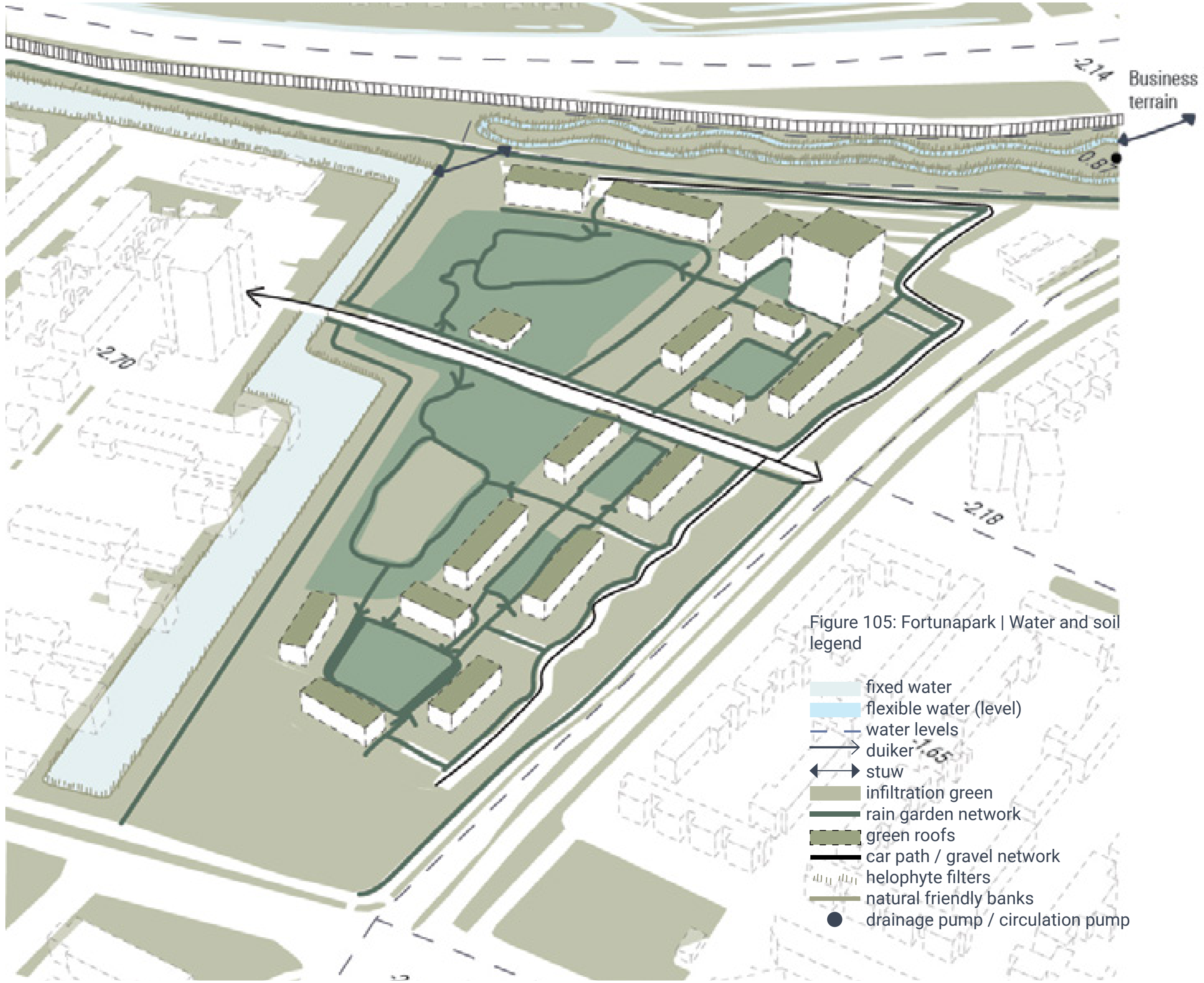


Figure 105: Fortunapark | Water and soil

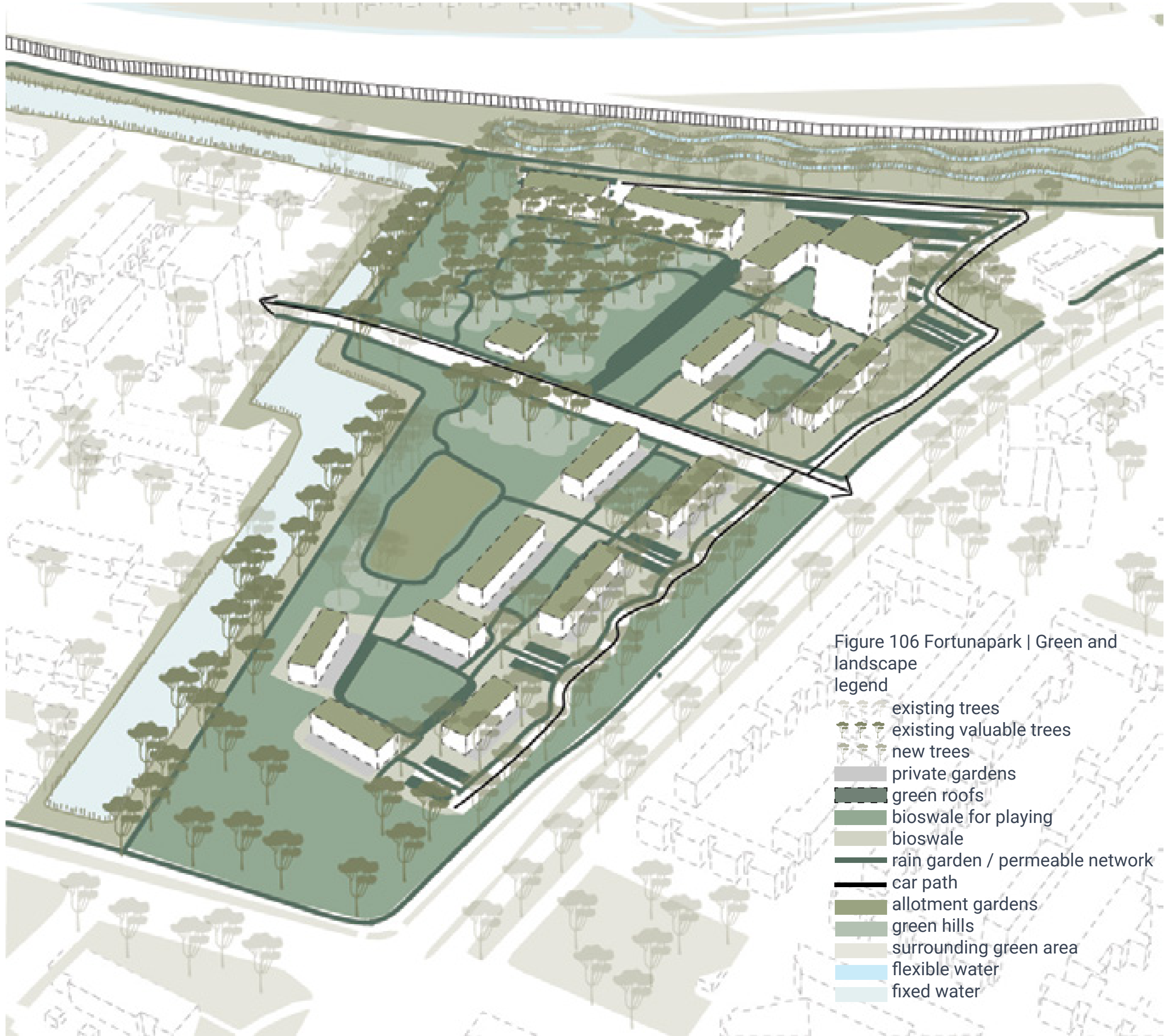


Figure 106 Fortunapark | Green and landscape

7.1 Fortunapark as Water friendly neighbourhood | meso

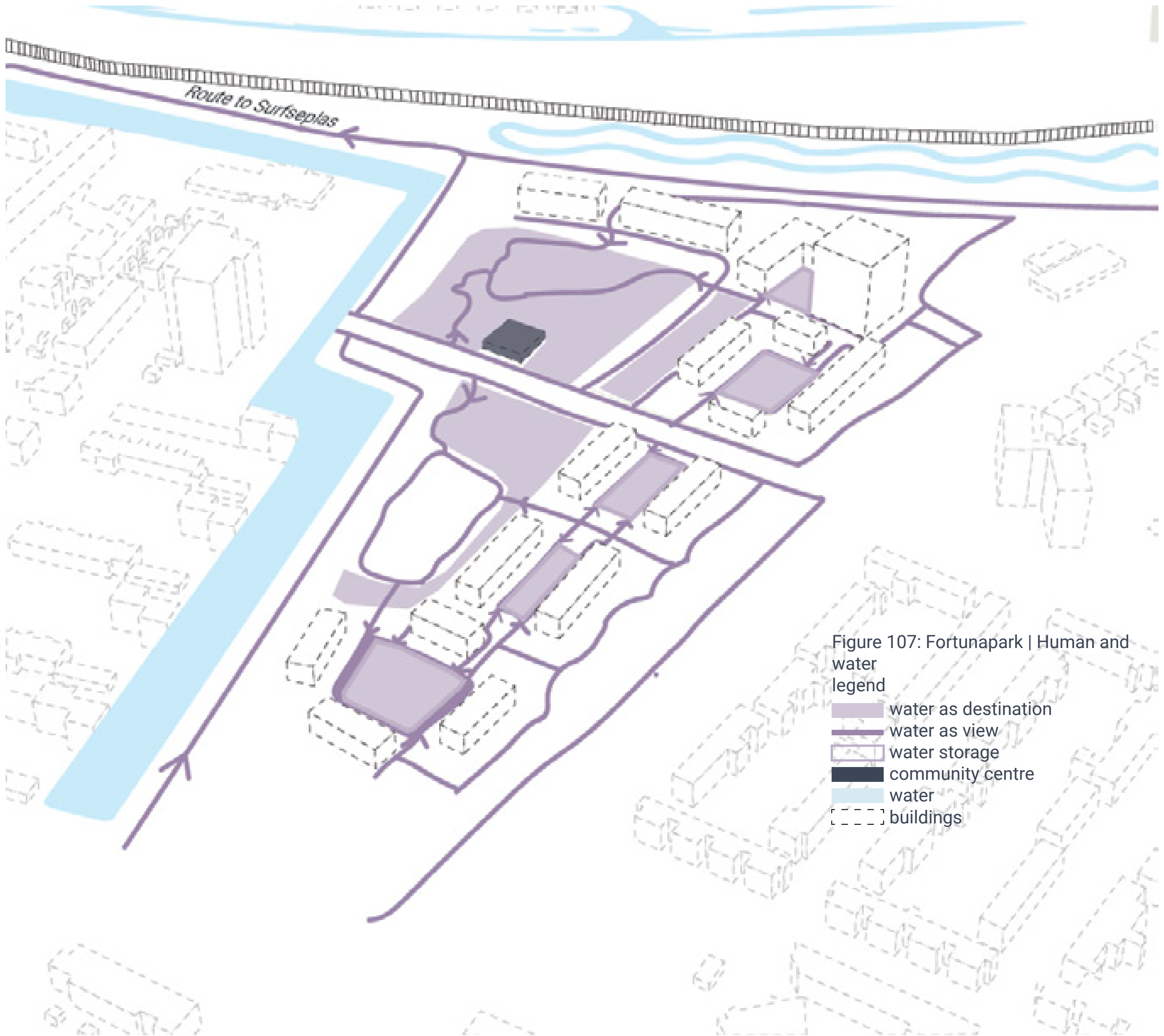


Figure 107: Fortunapark | Human and water

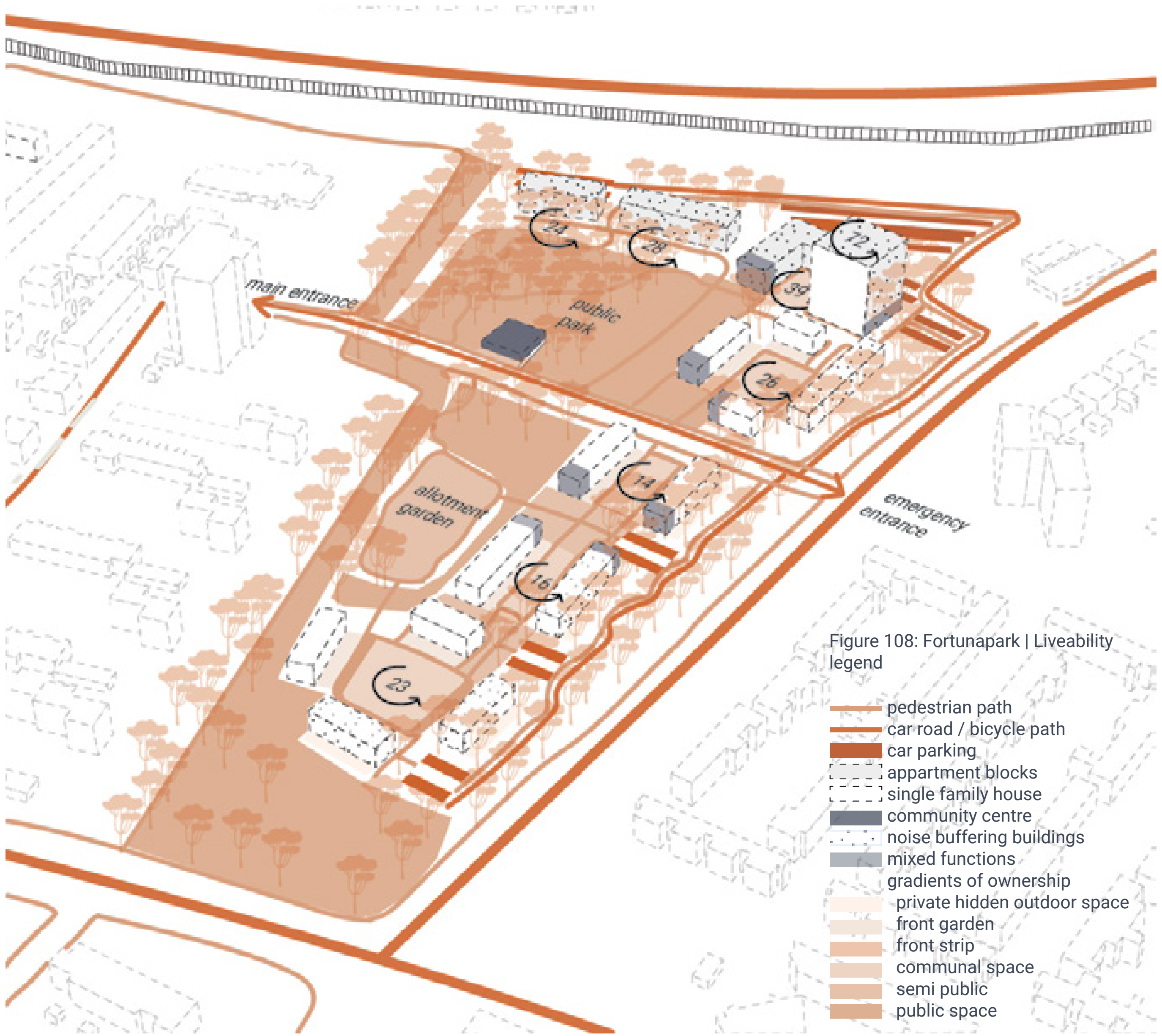
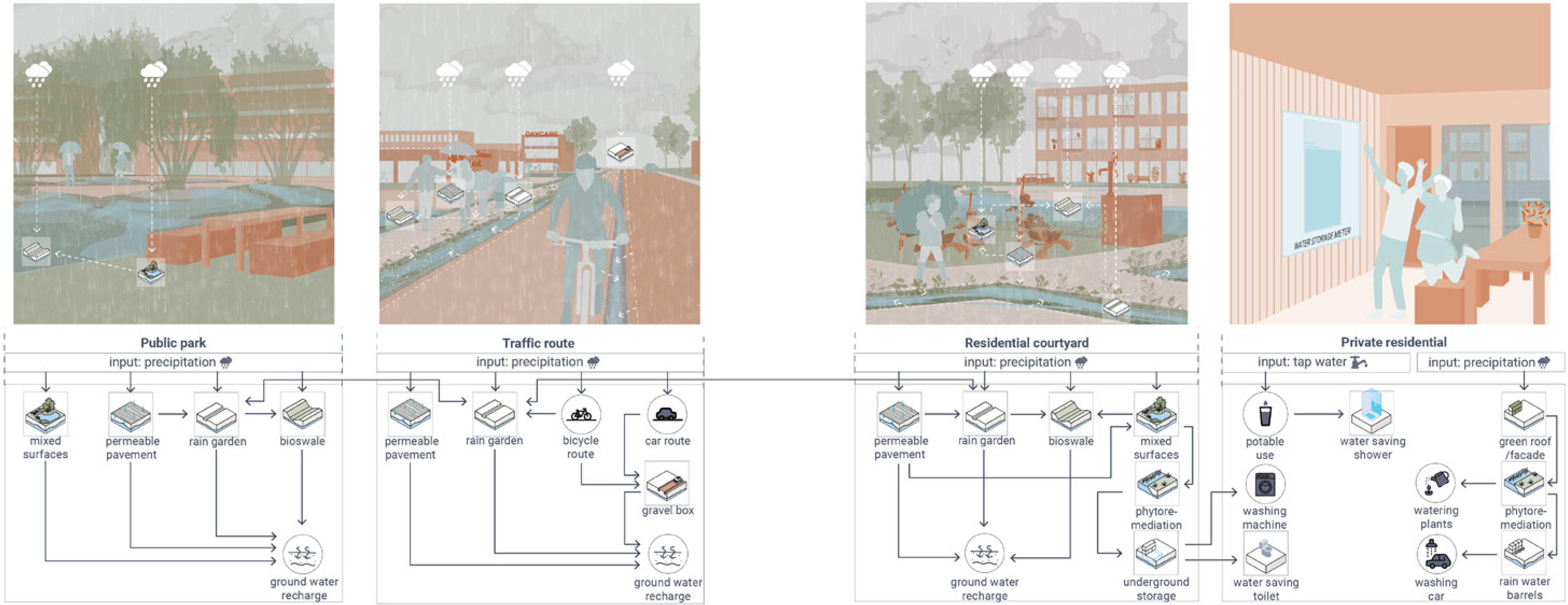


Figure 108: Fortunapark | Liveability

7.2 Water metabolism

Figure 109: Water metabolism through private and public spaces



7.3 Micro scale | Public park

The cross-section in figure 110 shows the water cycle of the public park. Here, the use of space in the seasons of drought, rain and after rain, is shown in figure 111.

The public park forms a green space where inhabitants from Fortunapark and from the area of Westwijk can meet each other, play and find peace. While at the same time becoming a water buffer through seasons of precipitation, to refill the ground water level and add a temporal gradient of wetness to enhance the biodiversity. The preservation of the willow trees has been used as a guiding design principle in which the bioswale landscape has emerged. Creating hills of trees and diverse plants that can withstand the seasonality of water. This seasonality contributes to the relation between humans and water as the multifunctionality of the public park can be experienced through the usage of the spaces.

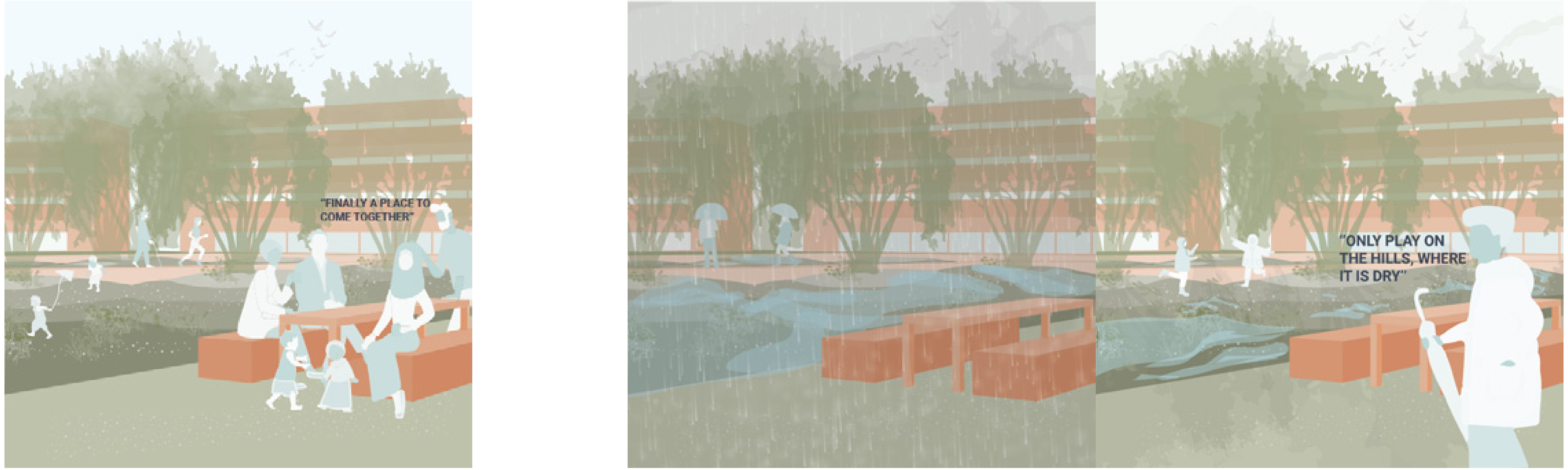


Figure 111: Seasonality of the Public park

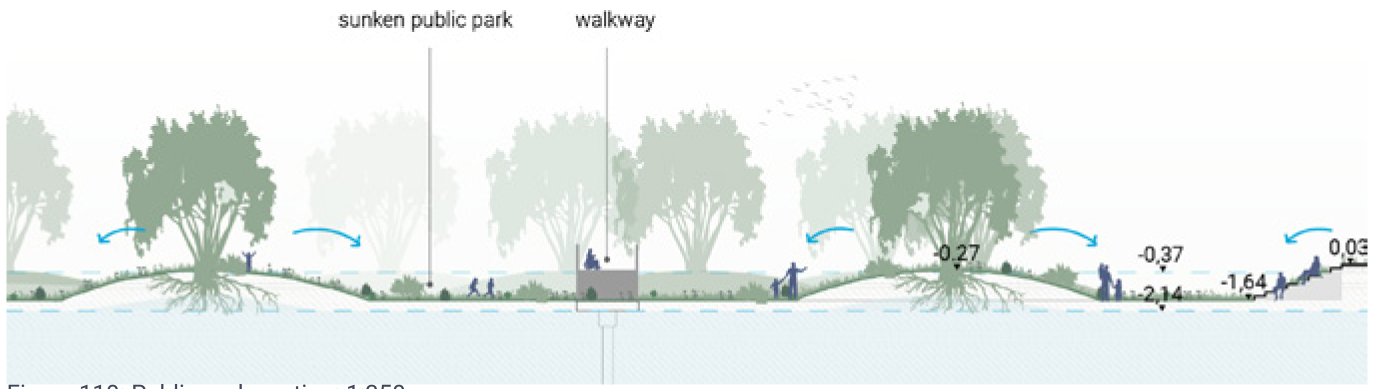


Figure 110: Public park section: 1:350

7.4 Micro scale | Traffic route

The cross-section in figure 112 shows the water cycle of the traffic route. Here, the use of space in the seasons of drought, rain and after rain, is shown in figure 113.

In the main route which you can use to enter Fortunapark with cars, bicycles and pedestrians, water can be infiltrated through the permeable pavements to the groundwater, or let it flow to the bioswales in the surrounding areas or to gravel boxes to let any other form of car pollution be purified before it recharges the groundwater.

Figure 113: Seasonality of the Traffic route

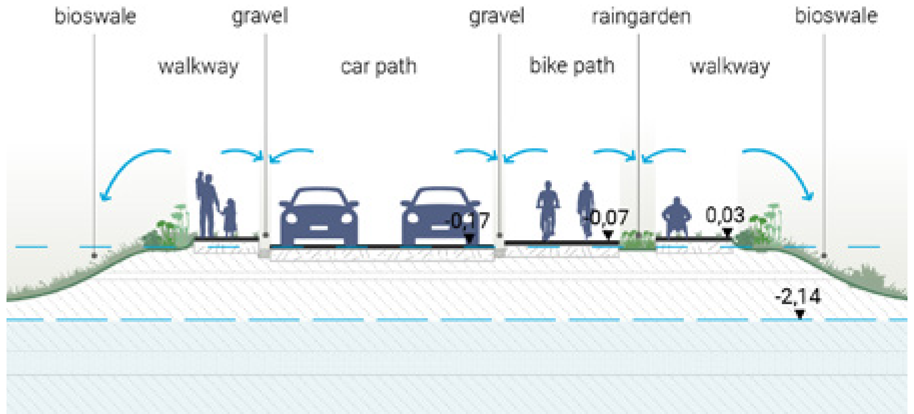


Figure 112: Traffic route section: 1:200

7.5 Micro scale | Communal courtyard

The cross-section in figure 114 shows the water cycle of the courtyard. Here, the use of space in the seasons of drought, rain and post-rainfall, is shown in figure 115.

Just like in the public park, the communal courtyard serves as a space to stay and play, although it has more of an intimate character. Different gradients of ownership can be felt in the residential cluster, through private gardens, communal gardens, the communal courtyard and more semi-public pedestrian paths. This contributes to the appropriation of space and the amount of daily interactions between inhabitants. The communal courtyard functions as a bioswale and can therefore contribute to the recharge of the ground water level. At the same time, water can also pass through helophyte filters before being stored underground for grey water needs of interior activities in the related cluster. Another branch in which water can flow is through the phytoremediation green roofs where it is cleaned and can subsequently be stored in individual rain barrels for grey water use outside. A varied biodiversity can be established through this water-flowing media, while engaging inhabitants in their own water cycle's and letting them observe the multifunctional character of the communal courtyard.

Figure 115: Seasonality of the Communal courtyard

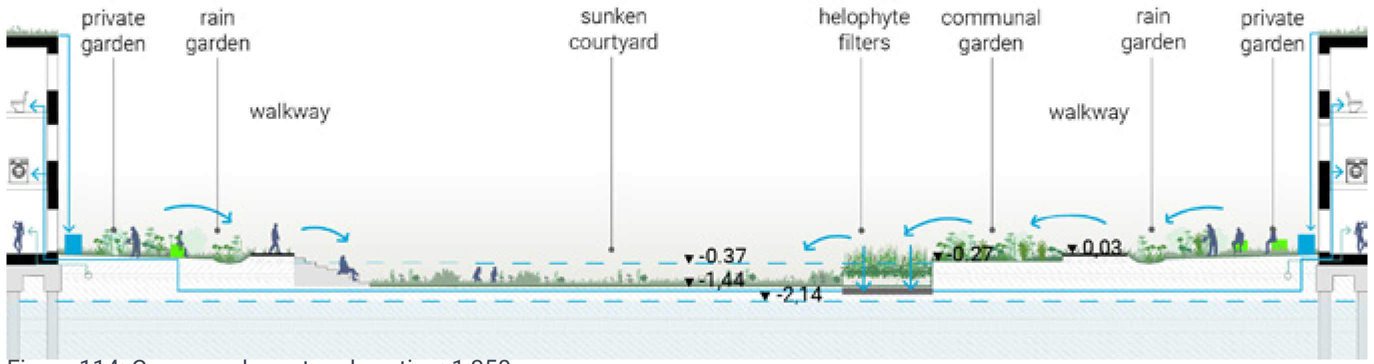


Figure 114: Communal courtyard section: 1:350

7.6 Micro scale | Private home

The cross-section in figure 116 shows the water cycle of the common courtyard, as this also shows the water cycle of a dwelling. The use of space in the seasons of drought, rain and after rain, can be seen in figure 117.

The private homes have an open and front typology towards the communal courtyard for more daily social interactions. In the perspective of water it is reused and conserved. Firstly, the reuse of the purified water from the underground water storage from the communal courtyard can be used to wash clothes, or for toilet use. Moreover, the water that flows through the phytoremediation green roofs can subsequently be stored in individual rain barrels for grey water use outside. While water is conserved using certain showers and toilets that save water during showers and toilet uses.

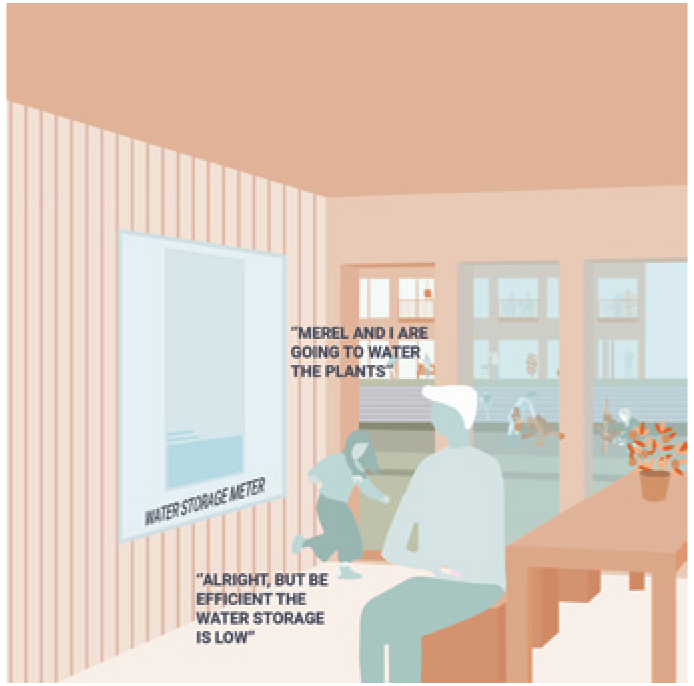


Figure 117: Seasonality of the private home

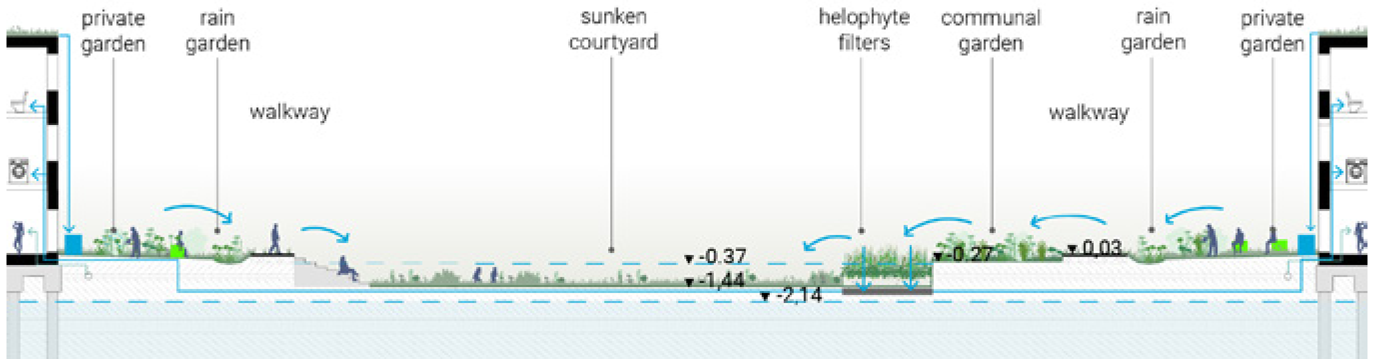


Figure 116: Communal courtyard section: 1:350

Chapter 8.

Transferability

After researching and designing a Water friendly neighbourhood for Fortunapark, key lessons have been learned that are transferable for other location. These have been summarised in the following chapter.

"Collaboration is the essence of life. The wind, bees and flowers work together, to spread the pollen."

- Amit Ray

8.1 Key Takeaways

Focusing on other urban areas in the lowlands of the Netherlands, a few key conclusions are drawn that can help determine how to design future urban developments that lead to water friendly environments. These lessons can be used by different scales for both new and exisiting sites and are divided into overarching recommendations with specific advice on the usage of a open permanent water system versus a temporary water system.

Overarching recommendations:

1. Integrated approach
All problems related to the living environment are linked to those of water and soil. As water and soil are the supporting layers, they are essential to protect our ecosystems and to mitigate climate change effects. It is therefore essential to tackle any problem, with the water and soil system as guiding factor. In doing so, it is important to recognise the interconnected relations between water, ecology and human and to look for a shared synergy between these elemts to create a balanced water cycle for resilient neighbourhoods.

Figure 118: Integrated approach

2. Water as metabolism
Water metabolism refers to the processes of water, how it moves between sea, atmosphere and land. By understanding how water flows and transforms through urban environments, a balanced sustainable metabolism in terms of water quality and quantity can be designed and changes can be dealt with.

Figure 119: Water as metabolism

3. Design with temporality

With expected extreme weather conditions, from wetness to drought, it is important to create conditions in which the temporality of seasons can occur. While adding quality instead of nuisance and in which residents can noticeably experience the conditions of the seasons. This calls for a spatial design that is flexible, multipurpose and visible.

Figure 110: Design with temporality

4. Be a teamplayer
It is necessary to include future and current problems of surrounding areas in the site design. In this way, cooperation towards sustainable urban development can be achieved.

Figure 111: Be a teamplayer

8.1 Open water system versus temporary water system

Choice consideration:

Since a temporary water system is most resistant to the stress of heat, drought and water nuisance, the temporary water system is the starting point for creating a sustainable Water friendly neighbourhood. Nevertheless, an open water system also offers a lot of water, ecology and human benefits. Therefore, when making a choice between the two characters, it is important to consider specific needs and conditions of the site. Factors that can be divided into soil conditions, climatic conditions and spatial possibilities.

For instance, an **open water** system is ideal with the following spatial conditions: problematic land subsidence due to drainage, polluted water, regular rainfall, sufficient space. Moreover, an open water system adds to high species diversity and recreational purposes. The spatial conditions for an open water system are shown in figure 112.

A **temporary water** system on the other hand is suitable for environments with very irregular rainfall, for soils that have a high infiltration rate and can be used in urban environments with limited amount of space. To collect water, space should be reserved on private or communal land. In this way, a green multifunctional water network can be created that is multipurpose and can accommodate both the seasonality of water and social needs. The spatial conditions for a temporal water system are shown in figure 113.

The pros and cons between the two have been summed up on the next page.

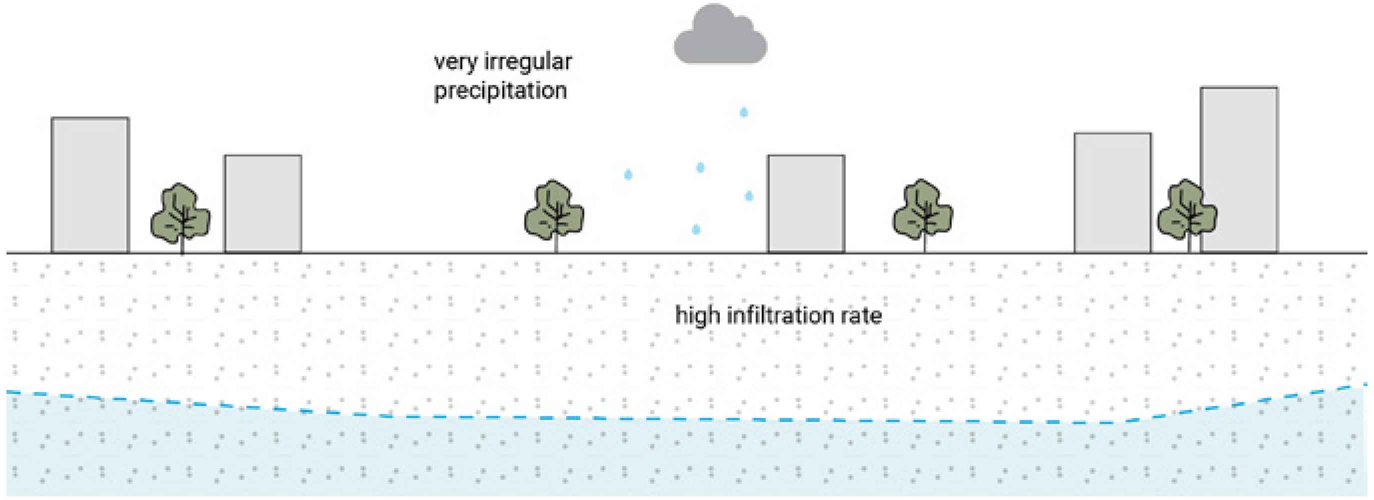


Figure 113: Spatial conditions for an open water system

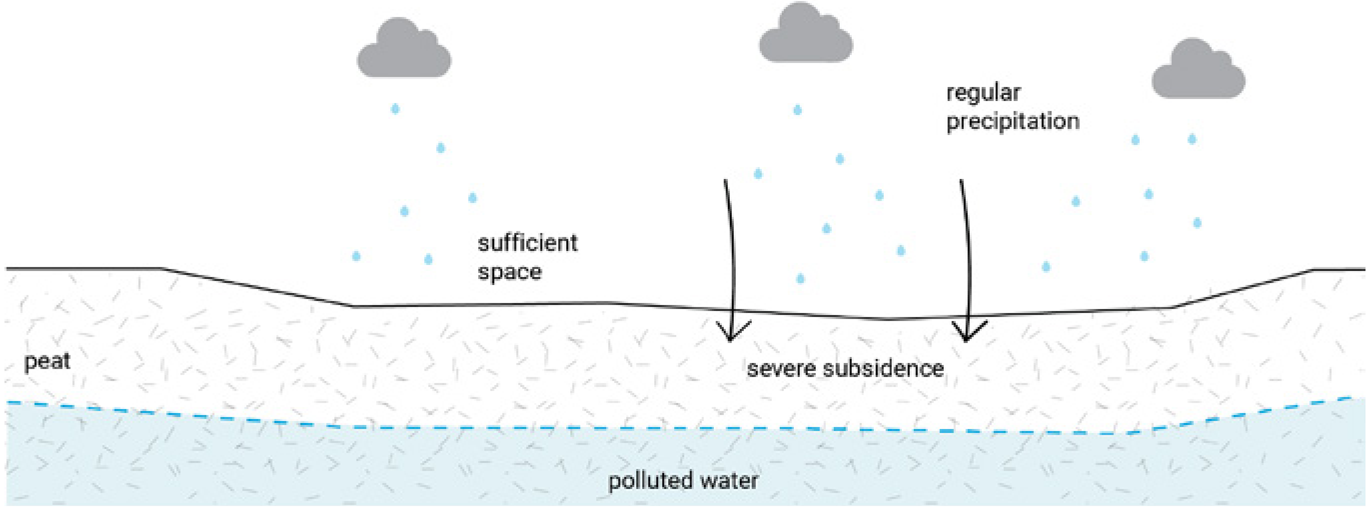


Figure 112: Spatial conditions for a temporary water system

8.2 Pros and cons | open water system

Permanent open water system

Advantages (figure 114):
1. Preventing subsidence
When permanent water bodies are used, it is easier to regulate groundwater levels and thus prevent subsidence.

2. Space for water purification
Open water provides space for conditions in which water can be purified. With the help of meandering structures, nature-friendly banks and helophyte filters, open water can contribute to healthy water quality.

3. Climate regulation
By using a flexible water level, water can be collected and reused as grey water. Moreover, depending on the design open water can bring cooling during seasons of heat.

4. High species diversity
Permanent water systems create habitats for different plant and animal species which promotes biodiversity.

5. Recreational purposes
Open water contributes to the perception of an environment as it is an attractive landscape element and radiates tranquillity. For example, it can be used for fishing or canoeing.

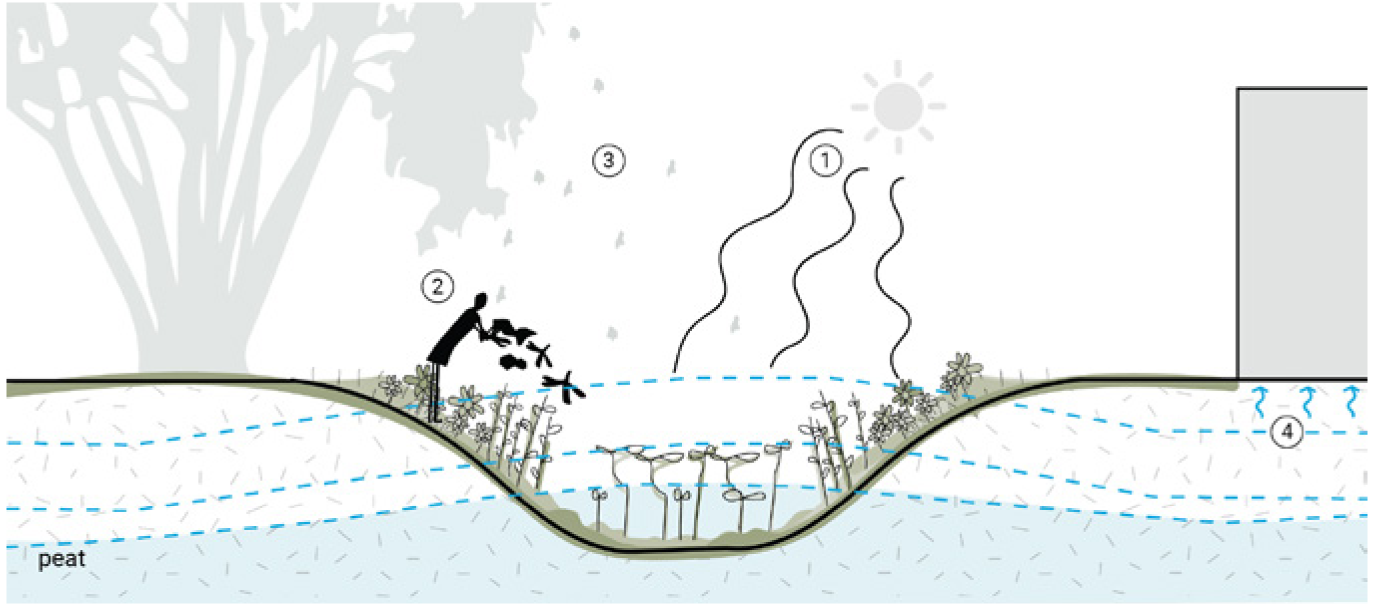
6. Awareness
Through the use of a flexible water level, inhabitants can see the seasonality of water. In addition, as this water body acts as communal water storage, inhabitants have the responsibility in safeguarding their own water quality.

Disadvantages (figure 115):
1. Vulnerable to drought
Higher temperatures with longer periods of drought will be expected in the future. During these periods, evaporation increases sharply. Open water bodies may lose water with this, making them extra vulnerable.

2. Maintenance
Open water systems are prone to algal growth if not well designed, or possible pollution from external factors. This may require external maintenance.

3. Susceptible to natural processes
The decomposition of vegetation cannot take place in open water systems, as digesting leaves remove oxygen from the water. As a result, there is less room for these natural processes.

4. Potential damage to homes
When more space for water is created and space is given for higher water levels, existing homes and current building methods may become extra vulnerable to water damage. This means there is a need for innovative watertight or waterproof homes (floating and amphibious houses) to enable this.



Figuur 115: Disadvantages of an open water system

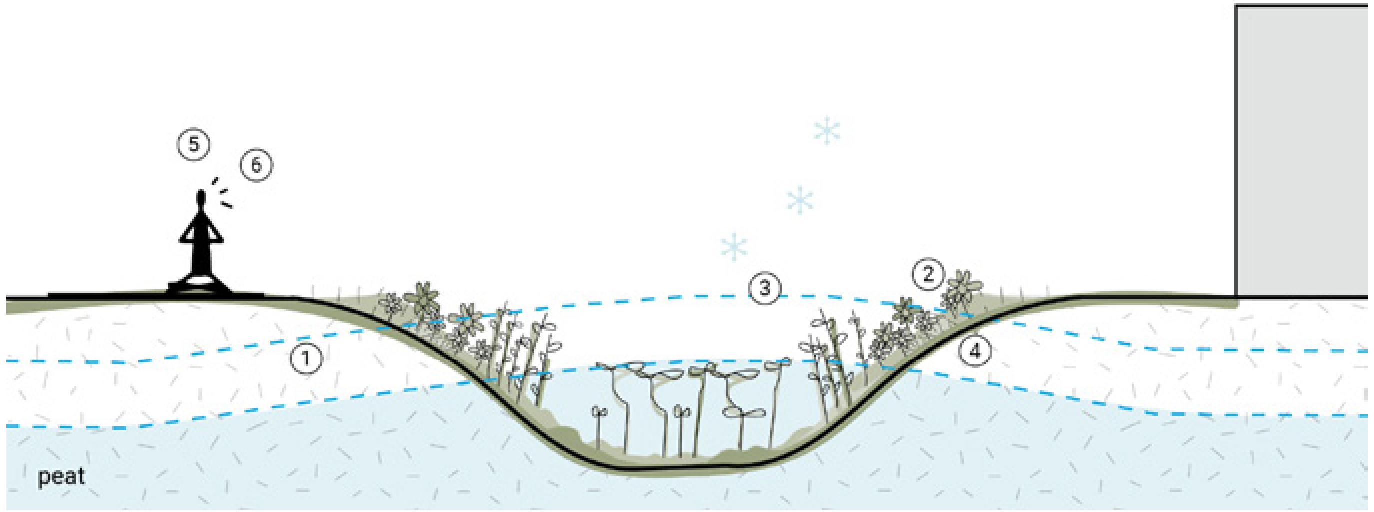


Figure 114: Advantages of an open water system

8.3 Pros and cons | Temporal water system

Temporary water system

Advantages (figure 116):

1. Groundwater recharge
By providing space for a temporary flexible water system, greenery is widely used for infiltration. As a result, groundwater levels can be maintained.

2. Climate adaptive
A temporary water system is resistant to heat, drought and water nuisance. As the green character brings cooling, water collection, infiltration and storage possibilities.

3. Multifunctional water network
A temporary water system can be integrated into the built environment. This offers a multifunctional character where the seasonal nature of water can have a place, biodiverse greenery can exist and social needs can be served.

4.Saving space
Temporary water systems take up less space.

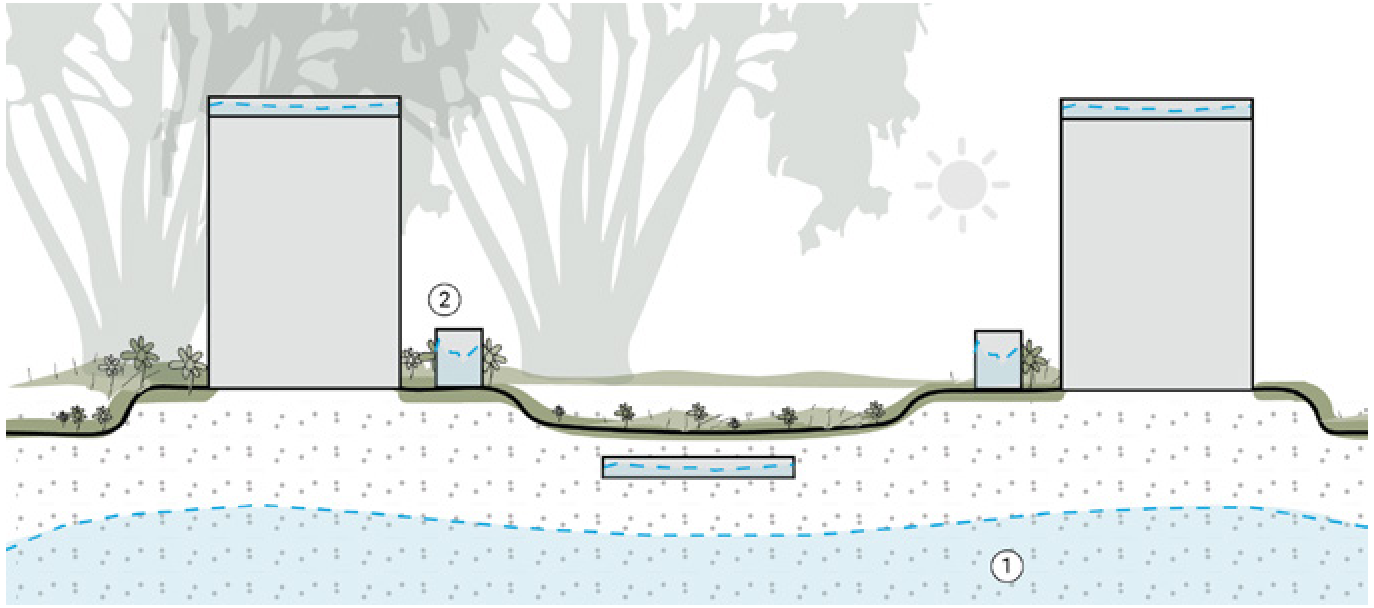
5. Awareness
Inhabitants can experience the vulnerability and the strength of the seasonality of water in space. Furthermore, residents can actively participate in their water ownership for a circular water cycle. As water storage takes place on communal or private land.

6. Safeguard the water quality
By not having open water, the existing water qualities can be preserved, as different water qualities are not mixed.

Disadvantages (figure 117):

1. Less effective regulation of groundwater levels
During periods of drought, groundwater levels cannot be regulated as effectively.

2. Water storage on private or communal land
To save water, water storage should be available on private or communal land for grey water use.



Figuur 117: Disadvantages of a temporary water system

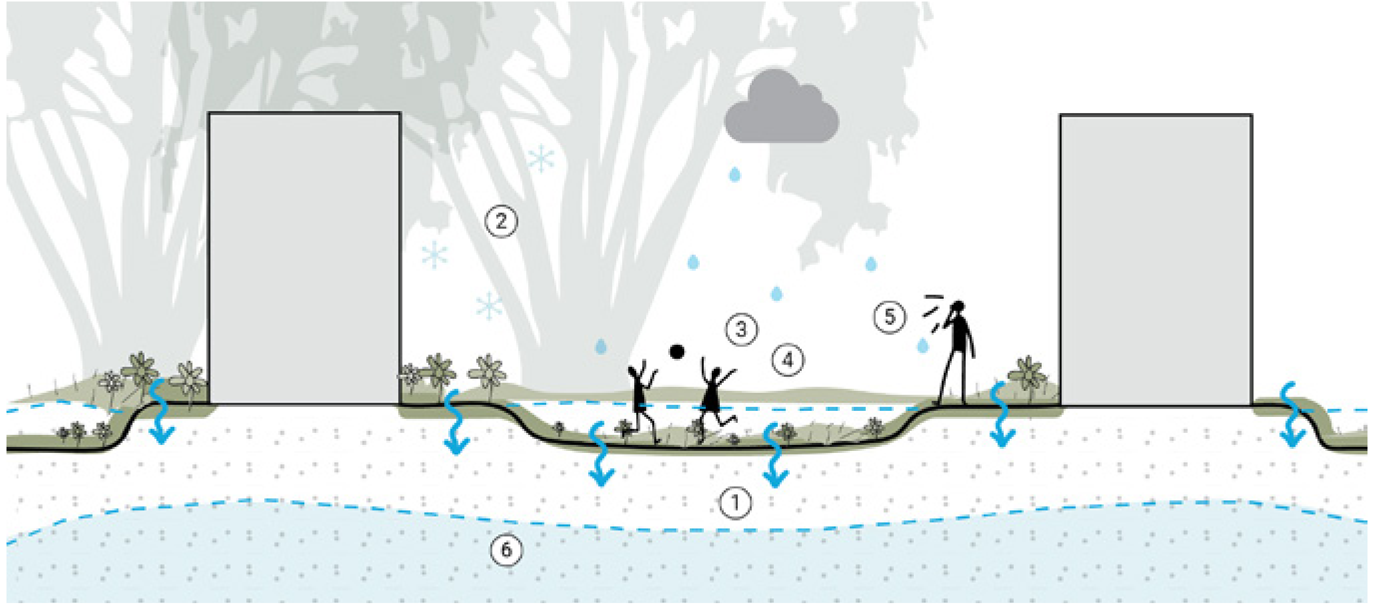


Figure 116: Advantages of a temporary water system

Chapter 9.
Conclusion

In-depth research on an imbalanced water cycle has led us to an integrated approach to reform the water cycle, the ecology, the relationship between humans and water and the establishment of a liveable neighbourhood. The following part will recap the conclusive answers on the main research question and its sub questions.

"Water, in all its forms, is the mirror of our society."

- Vandana Shiva

9.1 Providing answers

When it comes to answering the main research question and the sub-questions of this report, the answers can be summarised as following:

“How to envision a balanced water cycle for new neighbourhoods in Delfland while establishing a synergy between water, ecology and humans?

Through the use of the maximisation method and a pattern language, synergies have been sought between the pillars of Water and soil, Green and landscape, Human and water and Livability for the year of 2100. Which has resulted in a Water friendly neighbourhood that uses the Urban sponge as its main support system to balance a future proof water cycle and is characterised by a flexible temporal water cycle. Where biodiversity can thrive through different gradients of green, inhabitants can experience the water cycle and where the establishment of the Liveability can foster greater cooperation between inhabitants on water-related issues.

By utilising the maximisation method and a pattern language, an in-depth understanding of the stakeholders of water, ecology and humans for the landscape of Fortunapark in Vlaardingen had been established. Goals had been set, strategies had been made and interventions had been collected for the pillars that stand central in a Water friendly neighbourhood. This process and the corresponding findings allowed for informed decision making on the preferences of each stakeholder. This was followed by the optimization of two scenarios where different synergies were explored and in which water and soil was stirring. This led to the scenarios of a Purifying vein that embodies a permanent presence of the water cycle with a focus on water quality and secondly, the Urban sponge that represents a temporal flexible water cycle with an emphasis on water quantity. As the scenarios both improved the current landscape in the evaluation, it turned out that the embodiment of the Urban sponge is more resilient towards climate change conditions and at the same time had more synergies with the other pillars. Therefore, regarding Fortunapark it can be concluded that the flexible temporal character of the Urban sponge should form the backbone of a Water friendly neighbourhood. Where synergies for water quality can be sought.

When we focus on other urban areas, some key take-aways are drawn that can help determine how to design a Water friendly neighbourhood. Overarching recommendations are: Integrated approach, Water as metabolism, Design for seasons and Be a teamplayer. While specific advice on the usage of an open permanent water system versus a temporary water system, is to use a temporal water system as the starting point as it is the most climate stress resilient. But do consider an open water system when subsidence is problematic, water treatment is required and when there is regular rainfall and sufficient space obtainable.

“What are the current and future water issues?”

The event of climate change and in the paradigm of anthropocentrism, the current water practices are contributing to an imbalance of the water cycle. The water cycle can be defined by water quality and water quantity and with rising temperatures and more heavy rainfalls in the Netherlands, major consequences are manifested in the degradation of water quality, water nuisance and water shortages. When zooming in on the Dutch water cycle it can be seen how the relationship between water has for a long time been expressed in an anthropocentric approach. Using infrastructures that have not taken into consideration other actors and mechanisms in the landscape. Which created a distance between the processes of humans, water and ecology, while they are always intertwined. Therefore, this lack of integrality forms the driver for the current and future water issues.

“What are the opportunities and bottlenecks of the existing structures of Fortunapark?”

Fortunapark is a fallow land that is located in Vlaardingen, in an area called Westwijk, which is part of the polder of Vlaardingen West. The existing structure of Fortunapark on the pillars of Water and soil, Green and landscape, Human and water and Liveability has their opportunities and bottlenecks.

In the water cycle of the polder scale it is concluded that Fortunapark can be a key player in contributing to a climate adaptive polder with less water pollution. As the location itself is suffering from subsidence due to peat layers in the clay soil, it has the potential to improve infiltration by raising the water level or creating a better biodiversity. As the current green landscape lacks gradients of species and surfaces it results in a low biodiversity and therefore has the potential to be improved. Furthermore, when looking at the existing relation between humans and water it can be noticed how Fortunapark is part of a recreational walking route which is perceived as an aesthetic view point. This relation in the landscape of Fortunapark can be even more enhanced, since the other current water bodies are quite isolated and invisible. By combining human needs, for the future neighbourhood, with water related processes and involving inhabitants in the water cycle, the relation between humans and water can be strengthened. And lastly, when analysing the livability in Westwijk, it was revealed how Westwijk is part of one of the most vulnerable areas of the Netherlands with issues at play on the topic of health, poverty and stress. Existing spatial expressions that contribute to this phenomenon are building typologies and compositions. For this reason, while creating the foundation for a liveable community in Fortunapark, it also has the potential to combat the issues that already are present in Westwijk.

9.1 Providing answers

"How would a Water friendly neighbourhood look like in Fortunapark?"

Through the use of scenarios, two different Water friendly neighbourhoods have been designed to explore the varieties of Water and soil interests. While finding synergies between the other pillars of Green and landscape, Humans and water and Liveability. Firstly, the Purifying vein embodies a permanent presence of the water cycle with a focus on water quality and secondly, the Urban sponge that represents a temporal flexible water cycle with an emphasis on water quantity.

The Purifying vein stands for an permanent open water cycle in which water can circulate through meandering structures, soft transitions of natural banks and helophyte filters. The water level is increased to combat subsidence, while using flexible water levels for the collection and storage for water. Synergies with Green and landscape can be found in the gradients of green and blue that have been added through the character of the Purifying vein. Whilst the relationship between Human and water will be enhanced since the edges around the water body are valued as a place, where social gatherings can occur or can be used as a view. In addition, the Purifying vein is used as a buffer for grey water, making inhabitants participate and aware of the care that is needed to preserve the communal water quality. The community centre is a place where this information sharing can continue. Lastly, the synergies between Liveability and the Purifying vein have been found in stimulating movement and creating calm spaces by minimising cars to decrease pollution in the water bodies. Furthermore, by building lively neighbourhoods with daily interactions and mixed uses, more social cohesion can be established in which more communal collaboration between inhabitants can take place on the topic of water.

Whereas, the Urban sponge,emphasises on a temporal flexible water cycle that circulates throughout the green landscape, where it is collected, can infiltrate and be stored. Storing happens underground, or in rain barrels for grey water use. By safeguarding the green landscape and enhancing infiltration rates, subsidence is combatted. Here, synergies on the pillar of Green and landscape can be found in improving the infiltration rates by creating more biodiversity in the different vegetation types, by the conservation of existing trees and by creating spaces for decomposition. While strengthening the relationship between Human and water by creating the experience of the seasonality of water, as wet and dry conditions have consequences on the urban functions in the neighbourhood. In addition, through letting inhabitants participate in their water ownership, by catching it privately or communally, inhabitants are engaged and informed on the vulnerability of the quantity of water. This knowledge sharing can be extended in the community centre.
Lastly, the synergies between Liveability and the Urban sponge have been found in stimulating movement and creating calm spaces by minimising cars to create more space for green. Moreover, by establishing lively neighbourhoods with daily interactions and mixed uses, fosters a greater cooperation between inhabitants on water-related issues.

These two scenarios overall improve the current landscape in the goals of the four pillars and the added stress tests, although they do result in different spatial outcomes. When evaluating it can be seen how on a Water and soil perspective the Purifying vein allows for a permanent water body in which less water can be collected and stored in comparison to the Urban sponge. Since, the Urban sponge provides a temporal flexibility for more water collection and storage. Furthermore, as the Purifying vein has a permanent presence of water, also during droughts, it turns out to be extra vulnerable for risks of evaporation. Therefore, The Purifying vein is less resilient to the drier summers and the wetter winters of climate change. When evaluating on Green and landscape it was seen that the Urban sponge scores higher as there was more room for existing trees and natural processes, such as decomposition. Lastly both scenarios score higher in the enhancement of Human and water and Livability of the neighbourhood.

For this reason it can be concluded that the embodiment of the Urban sponge for Fortunapark should form the backbone of a Water friendly neighbourhood, as more synergies have been found and the performance in the stress tests are higher.

"How can the water friendly be transferable for other projects?"

The recommendations made for urban designers that work on the densification task in Delfland, aim to promote the establishment of a sustainable water friendly urban environment in which spatial decisions will be based on the perspective of water in relation to ecology and humans. To address the problems of climate change in terms of water quality and quantity, incentives for these elements have been provided with each their own goals, corresponding strategies and interventions. By adopting this framework while finding synergies, urban designers can contribute to create a Water friendly neighbourhood that is better able to withstand environmental stresses.

The main take-aways of this project can be used throughout different scales and are overarching recommendations with specific advice on the usage of an open permanent water system versus a temporary water system. The overarching recommendations are the importance of an integrated approach, water as metabolism, design for seasons and be a teamplayer. In addition, due to the stress resistant character of a temporary water system, the temporary water system forms the starting point for creating a sustainable Water friendly neighbourhood. Nevertheless, an open water system also offers a lot of water, ecology and human benefits. Therefore, when making a choice between the two characters, it is important to consider specific needs and conditions of the site. Factors that can be divided into soil conditions, climatic conditions and spatial possibilities.

As an open water system is ideal when land subsidence is problematic and there is a need for regulated higher water levels, when water treatment is required, when there is regular rainfall, sufficient space is obtainable and necessary maintenance among residents or external is possible. Moreover, an open water system adds to high species diversity and recreational purposes. While a temporary water system is suitable for environments with irregular rainfall, longer periods of drought and for urban environments with limited space. To collect water, space should be reserved on private or communal land. In this way, a green multifunctional water network can be created that can accommodate both the seasonality of water and social needs.

Through this project a methodology with a pattern language has been created with the intent to create a practical guide for urban designers of the built environment who would like to design a balanced water cycle for new neighbourhoods in the Netherlands. The handbook provides an overview of the importance of water and how it can be integrated better into urban design and planning processes. The handbook will inform the reader to think about the important role that water plays in our urban environments as it hands out the maximisation methodology with the guiding pillars for a Water friendly neighbourhood, distributes a pattern language with local interventions, gives overarching recommendations, specific advice on the usage of a permanent open water system versus a temporarily water system and forms as an inspiration with Fortunapark as case study.

9.2 Limitations of the project

There are several things held outside the framework of the project. First of all, as the project has the intent to create a 'Water friendly neighbourhood', it had the tendency to prioritise climate issues above other challenges, such as the nitrogen crisis or the energy transition. Therefore, the project has not combined all current issues that are needed to take into account when building an integrated realistic neighbourhood.

Secondly, Fortunapark is vulnerable for both fluvial and pluvial floods, as it is located in a Delta, under sea level and with a Dutch climate. However, In this report only pluvial floods, driven by intense rainfall have been taken into account due to the project description of the waterboard of Delfland. Further research can be built upon the risk of fluvial floods to evaluate problems and potentials. Lastly, since the location of Fortunapark and the number of houses that had to be built has been a fixed variable, the project has been executed with these program of requirements. Although efforts have been made to obtain this information, it was not possible to find out why this location and the amount of houses had been selected. Therefore, it is important to note that more research is needed in the context of Water and soil stirring, to make a well informed decision on a suitable neighbourhood location and the amount of houses.

Methodological challenges during this project include the assumptions that have been made about future climate scenarios that can be found in the amount of wetness and drought that will occur. These assumptions are based on the extremes of past events, but can not be seen as a certainty for future climate scenarios. However, since there is no precise information available, these assumptions had to be done to make design decisions. As a result, the graduation project shows the conditions that have been made to maximise the flexibility of the water cycle through systemic design of the three seasons of normal, wet and dry after precipitation, for expected extreme rainfalls of 2100. Demonstrating how water is metabolised. Still, even though the design has included the temporality of water, it did not consider the temporal elements of trees, buildings or the mycobase raising material. Therefore, more research is required on the integral timeline to have an understanding of how developable a Water friendly neighbourhood will be.

The transferability of the Water friendly neighbourhood brings complex governmental concerns as the pattern language has been simplified. More information about specific details on financial weights or how to build certain spatial interventions would have made the patterns more useful for urban designers that can use it in practice. Therefore, there is scope for further research into this. Above all, as a methodology with values has been made, further investigation can be conducted from a governmental perspective on what types of policies are needed to stimulate urban designers to follow the act of designing out of Water and soil.

Chapter 10.

Appendix

A Characteristics of polder Vlaardingen-West evaluation
B Circular water calculation
C Resilient plant scheme
D1 Residential table | Purifying vain
D2 Residential table | Urban sponge
E Scenario evaluation
F Reflection

Appendix A: Water Characteristics evaluation

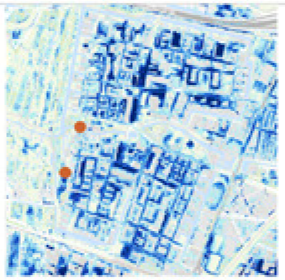
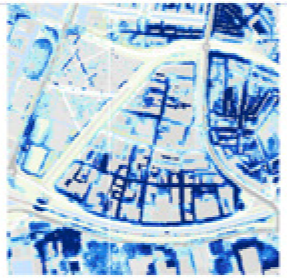
	Concrete business terrain with tiny sporadic water streams	Large blue singels with residentials in green	Small, unconnected waterways in a green field	Discontinuous grand waterways in the city centre	Small still water streams in a garden setting	Small waterways in a concrete business area
Function follows soil						
Provide shade on the waterways						
ensure good wide deep and connecting waterways						
create natural friendly banks						
Retain, store drain						
Minimalize pollution						
Check the soil quality in time						
Water nuisance on the street T100 & T1000						
Legend 5 - 10 cm 10 - 15 cm 15 - 20 cm 20 - 30 cm >30 cm **Water nuisance of waterways overflow T10 & T100** Legend ● location of waterway overflow ("Klimaateffectatlas," 2018)						
Advantages	Waterways have enough shade for a good water temperature, there are natural friendly banks and the soil is in a good state for the current function	The waterways have been well designed for water quality with a good temperature and circulation. In addition, much infiltration space offer room for retaining and storing water.	The green plot offers much space for storing water	Waterways have enough shade for a good water temperature, there are natural friendly banks and the soil are in a good state for the current function	Waterways have enough shade for a good water temperature, the soil are in a good state for the current function and the amount of green offers much space for storing water	Waterways have enough shade for a good water temperature and the soil are in a good state for the current function
Disadvantages	Still water, pollution from heavy vehicles and lack of infiltration creates water nuisance	Problems of subsidence, agricultural functions from gardens contribute to pollution of the waterways	Still water and subsidence occur. In addition the clay soil can not retain much water and the waterways do not have quality natural friendly banks.	Still water, agricultural functions from gardens contribute to pollution of the waterways and lack of infiltration creates water nuisance	Still water and agricultural functions from gardens contribute to pollution of the waterway. In addition the clay soil can not retain much water.	Still water, pollution from heavy vehicles ontribute to pollution of the waterways and lack of infiltration creates water nuisance

Figure 52: Characters of Polder Vlaardingen-West

Appendix B: Circular water system calculation

Just like is mentioned in the ambitions for Water and soil, a lot of gains can be made in saving drinking water. As 74% of the current drinkwater is used by households (CBS, 2022). 82% of residential water use goes towards activities in which grey water can be used instead. Due to water scarcity, the Ministry of I&W has set an ambitious goal to save drinking water. This entails a reduction of the average Dutch person's drinking water consumption from approximately 130 litres to 100 litres per day by 2035. While the 50L Home coalition aims to reduce not thirty but eighty litres per home (50L Home, 2023). Arcadis & Berenschot (2022) have written a report about strategies on how to save water by using efficient technologies. Physical interventions are water-saving showerheads, flushbreakers for toilets and the usage of grey water for toilets, washing machines and watering gardens.

As the precise future water conditions are difficult to predict, the circular water cycle in this project prepares itself for climate conditions that are based on extreme weather events that happened in the past. Koninklijk Nederlands Meteorologisch Instituut.(2023a) has stated that the longest drought in the Netherlands happened in 1976 with twenty days of no precipitation. Furthermore, Koninklijk Nederlands Meteorologisch Instituut. (2023b) also indicates that it rains approximately 850 millimetre per year and that during the warmest months in July water can evaporate 7 millimetre per day (Koninklijk Nederlands Meteorologisch Instituut, n.d.). With this knowledge the following supporting circular water system has been made.

A person in their residential home has to reduce or replace (using grey water) at least 30 litres on a daily basis, however reducing to 80 litres would be ideal. In which the system has to be prepared for a drought of 20 days, in which no refill of precipitation will take place. While considering that in a year it rains approximately 850 millimetre per year. Nevertheless, it was not possible to determine the average period between rainfalls in each season. It was also not possible to determine the amount of rain that falls during a downpour in each season. Consequently, it has been assumed that there will be weekly rain showers that are sufficient to refill the grey water consumption before the next rainfall occurs in the week after. Therefore, the water storage should be able to hold enough water for seven and twenty days without rain. In the sheet on the next page, the calculation for the two scenarios of a Purifying vein, Urban sponge and the integration of both scenarios, towards a Water friendly neighbourhood can be found. In which the focus is on the replacement of drinking water with grey water. This does not include how much water can be saved in addition, if toilet-efficient or shower-efficient technological interventions would be used.
Both the Purifying vein and the Urban sponge comply with both scenarios when a reduction of thirty and eighty litres of water would take place. Nevertheless, in the integration in which homes first have to purify the water through helophyte filters, only scenario A turns out to be sufficient.

Weather Information			
Rain fall per year	850	mm	
Rain fall once in 100 years	70	mm	/2 hours
Rain fall once in 1000 years	140	mm	/2 hours
Drought period	20	days	
Period between rainfalls	7	days	
Evaporation rate during the warmerst months	7	mm	/day
Water saving scenarios			
A	30	L	water saving from the 130L
B	80	L	water saving from the 130L
Water use per person			
Current daily use per person	130	L	
Essential drinking water use per person per day	23.4	L	
Non-essential drinking water use per person per day	106.6	L	
Average household in the Netherlands	2.12	person	
Amount of residentials in Fortunapark	250	homes	
Amount of inhabitants in Fortunapark	530	person	
2.12*250			
A: amount of water saving to be saved in Fortunapark	15900	L	
530*30			
B: amount of water saving to be saved in Fortunapark	42400	L	
530*80			

Scenario explorations				
Bridging period		20 days		
A: amount of water that needs to be stored in Fortunapark	20*530*30	318000	L	/ 530 person
A: amount of water that needs to be stored in Fortunapark per person	20*1*30	600	L	/ 1 person
B: amount of water that needs to be stored in Fortunapark	20*530*80	848000	L	/ 530 person
B: amount of water that needs to be stored in Fortunapark per person	20*1*80	1600	L	/ 1 person
Bridging period		7 days		
A: amount of water that needs to be stored in Fortunapark	7*530*30	111300	L	/ 530 person
A: amount of water that needs to be stored in Fortunapark per person	7*1*30	210	L	/ 1 person
B: amount of water that needs to be stored in Fortunapark	7*530*80	296800	L	/ 530 person
B: amount of water that needs to be stored in Fortunapark per person	7*1*80	560	L	/ 1 person

Purifying vein

Area of waterbody	4754.81173	m2			
flexible waterlevel	0.5	m			
Amount of water that can be stored in the waterbody	2377.405865	m3	=	2377405.865	L
4754.81173*0.5					
water level decrease in 20 days of drought due to evaporation					
7*20	140	mm/20 days	=	0.14	m
Amount of water that can be stored in the waterbody with 20 days of evaporation					
4754.81173*(0.5-0.14)	1711.732223	m3	=	1711732.223	L

Conclusion

A: 1711732.223 L > 111300 L	complies scenario A
B: 1711732.223 L > 318000 L	complies scenario B

Urban sponge

Homes / cluster in Fortunapark

Cluster 1	60	homes
Cluster 2	39	homes
Cluster 3	72	homes
Cluster 4	26	homes
Cluster 5	14	homes
Cluster 6	16	homes
Cluster 7	23	homes

Persons / cluster in Fortunapark

Cluster 1		
60*2.12 =	127.2	persons
Cluster 2		
39*2.12 =	82.68	persons
Cluster 3		
72*2.12	152.64	persons
Cluster 4		
26*2.12 =	55.12	persons
Cluster 5		
14*2.12 =	29.68	persons
Cluster 6		
16*2.12 =	33.92	persons
Cluster 7		
23*2.12 =	48.76	persons

A: Water storage space that is needed per cluster for a bridging period of 20 days

Cluster 1	76320	L	=	76.32	m3
127.2*600					
Cluster 2	49608	L	=	49.608	m3
82.68*600					
Cluster 3	91584	L	=	91.584	m3
152.64*600					
Cluster 4	33072	L	=	33.072	m3
55.12*600					
Cluster 5	17808	L	=	17.808	m3
29.68*600					
Cluster 6	20352	L	=	20.352	m3
33.92*600					
Cluster 7	29256	L	=	29.256	m3
48.76*600					

B: Water storage space that is needed per cluster for a bridging period of 20 days

Cluster 1					
127.2*1600	203520	L	=	203.52	m3
Cluster 2					
82.68*1600	132288	L	=	132.288	m3
Cluster 3					
152.64*1600	244224	L	=	244.224	m3
Cluster 4					
55.12*1600	88192	L	=	88.192	m3
Cluster 5					
29.68*1600	47488	L	=	47.488	m3
Cluster 6					
33.92*1600	54272	L	=	54.272	m3
Cluster 7					
48.76*1600	78016	L	=	78.016	m3

Conclusion

A: courtyard areas / roof areas > Water storage that is needed per cluster for a bridging	complies scenario A
B: courtyard areas / roof areas > Water storage that is needed per cluster for a bridgin	complies scenario B

Water friendly neighbourhood integration

Conclusion

A: courtyard areas / roof areas > Water storage that is needed per cluster for a bridging	complies scenario A
B: courtyard areas / roof areas < Water storage that is needed per cluster for a bridgin	fails scenario B

Appendix C: Resilient plant scheme

Plants that can be used within Fortunapark are categorised in existing trees, plants that can be used for a bioswale, helophyte plants and rain gardens.

		soil conditions	flowering period	maintanance
Trees				
Willow trees		moist and wet	April	annual pruning
Esh trees		sand/clay soil and moist and wet	April	annual pruning
Oak trees		deep (possibly sandy) loam and clay soils. And drained soils	April	annual pruning

Plants

Plants that can handle both wet and dry conditions.

Raingarden/plantsoen vegetation
Grote Kattenstaart - Lythrum sallicaria
Koninginnenkruid - Eupatorium cannibum
Vrouwenmantel - Alchemilla mollis
Smeerwortel - Symphytum officinalis
Daglelie Stella d'Oro - Hemerocallis Stella d'Oro
Prachtriet Silberspinne - Miscanthus Silberspinne
Ooievaarsbek Fruit d'Fleur - Geranium sanguineum

Low maintenance plants endure both dry and wet seasons and are also resilient as playing surface

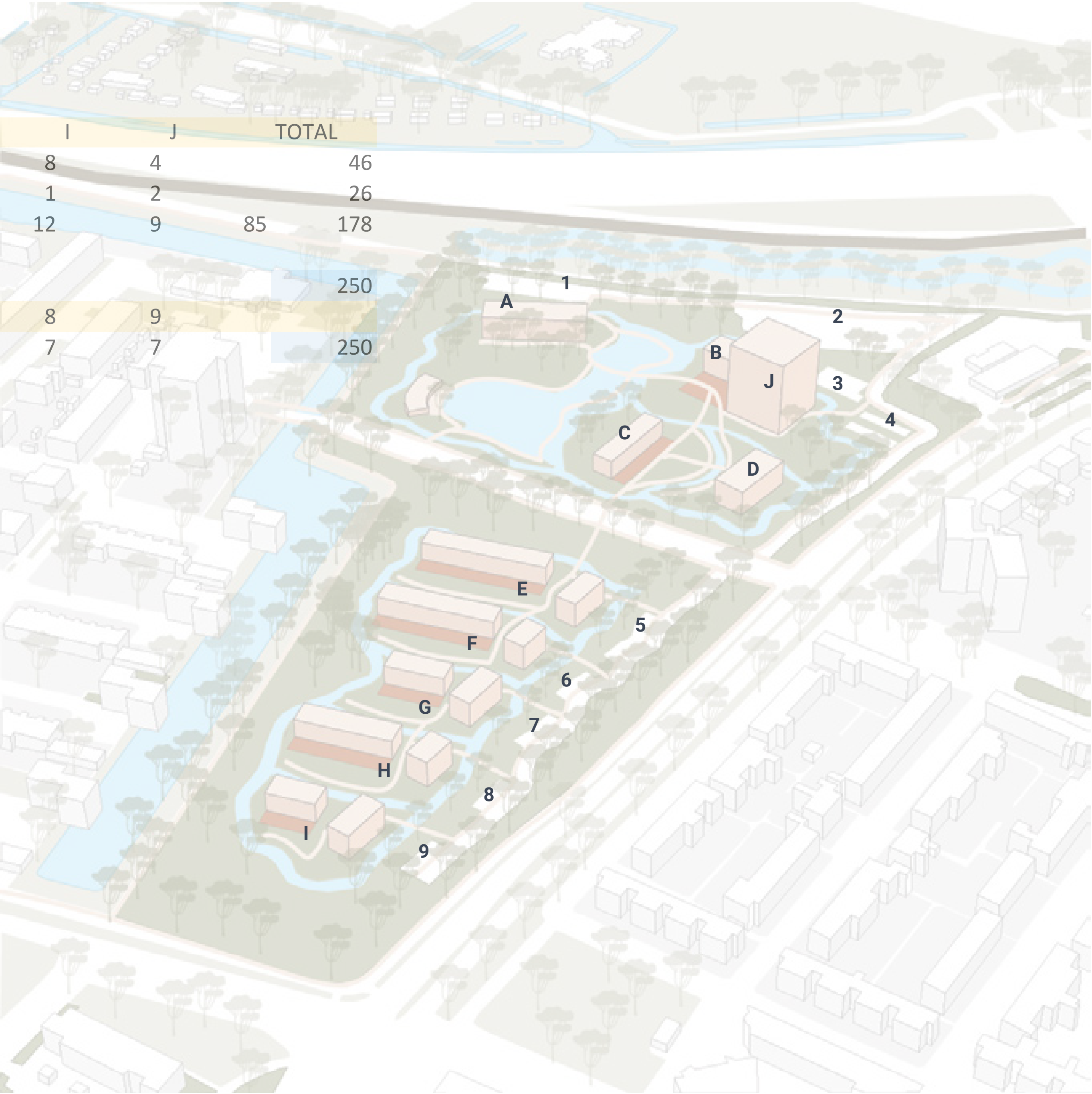
Bioswale vegetation
Moerasiris (Iris pseudacorus):
Zwenkgras (Festuca)
Dwergvlier (Sambucus)
Moerasvergeet-me-nietje (Myosotis palustris)

Helophyte vegetation
Grote waterweegbree
Zwanebloem
Riet
Mattenbier
Grote lisdodde
Kleine lisdodde

Appendix D1: Residential table | robust water system

Residentials Robust Watersystem	A	B	C	D	E	F	G	H	I	J		TOTAL
single family homes 150 m2				8		11	10	5	8	4		46
ground level appartments 50 m2		9	5		4	2	1	2	1	2		26
appartments 50m2		27	15		15	6	3	6	12	9	85	178
												250

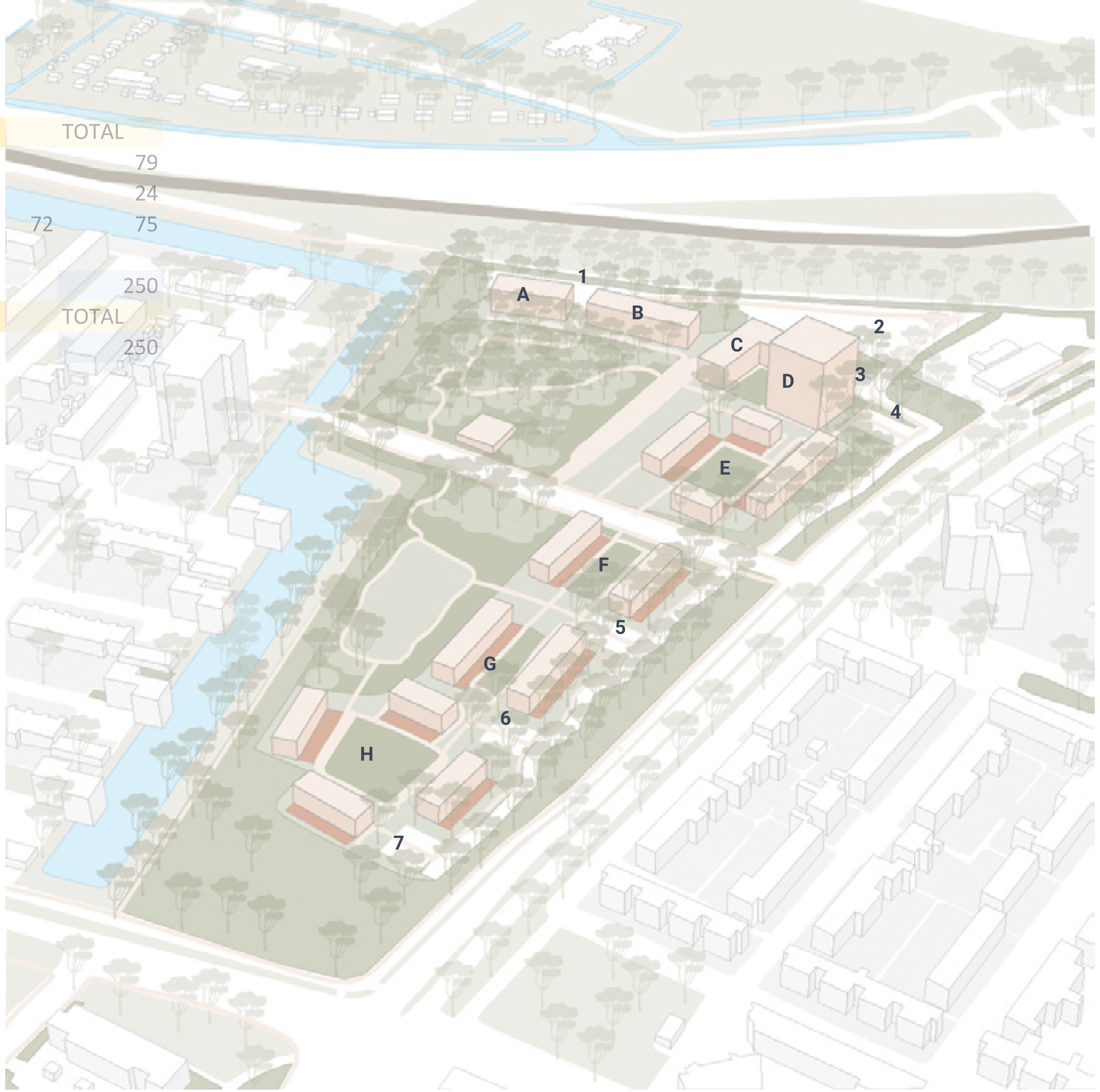
	1	2	3	4	5	6	7	8	9		
Car parking	38	126	20	20	14	7	11	7	7		250



Appendix D2: Residential table | Urban sponge

Residentials Urban drainage	A	B	C	D	E	F	G	H		TOTAL
single family homes 150 m2						26	30	23		79
ground level appartments 50 m2		6	9	4	5					24
appartments 50m2		18	27	15	15				72	75
										250

		1	2	3	4	5	6	7	TOTAL
Car parking		38	126	20	20	18	14	14	250



Appendix E: evaluation

	Robust water system	Climate adaptive	Circular water system	Design for ecological diversity	Preserve existing landscape	Give space for natural processes	Water is multifunctional	Localize water	Water awareness	Fit residents	Social&Safe	Calm spaces	Droughts	Water nuisance	Heat
Fortunapark as purifying vein	As Fortunapark has an open water system, ideal conditions have been created in which water can flow. Using meandering and connecting characters, with natural friendly banks and helophyte filters. Subsidence is combatted by increasing the water level.	While the waterbody performs as purifyer it also acts as water collector, creating a resilience towards weather extremes of water nuisance. However, open water systems are vulnerable for evaporation that occurs during higher temperatures in droughts seasons.	The waterbody also perform as the communal waterstorage for the neigbhourhood, which is used for grey water to reduce the use of drinkingwater.	By creating ideal conditions in which water can flow, using meandering structures and natural banks, gradients of wetness have been established. In addition, using different types of vegetation in the neighbourhood also contributes to ecological diversity.	All the Oak and Esh trees have stayed, unfortunately a lot of the willow trees have been removed to give more space for water.	Vegetation has been chosen accordingly to the extreme weather conditions of wettness and drought and the urban functinality of the space. While the built environment has been build on mycobase and stilts to not disturb the soil as much as possible. However, due to the big water body, space for the decomposition of leaves can not be reserved in an area like Fortunapark, as it can pollute the water.	As the purifying vein will become a well-known water body that is also used as a communal water storage and forms the core where different water activities happen, water has been given multiple functions that can serve humans.	The purifying vein forms communal water storage that gives inhabitants a sense of ownership and responsbility to the quality of their water management.	The community centre and information signs help spreading awareness about water quality.	As car use is decreased and the walkability is made more attractive. Inhabitants are stimulated to walk.	Daily social interaction in the neigbhourhood are stimulated by, creating building typologies in which inhabitants feel seen and in which they can appropriate the space.	Noise has been minimised by creating noise buffers and reducing car use.	Having an open water system creates a vulnerability to events of droughts, due to the evaporation rate. As the design does include a flexible water level, to maintain a high water level through out the warmer seasons, it will still be vulnerable for droughts. As the surface water can experience risks of temperature rise and evaporation. This has negative consequences for the water quality and therefore, for aquatic life. Furthermore, a decrease in water level is also problematic for subsidence.	Excess water during water nuisance can be catched through out the landscape and can accumulate in the purifying vein.	Surface water and the use of vegetation in the landschape can give an cooling effect.
Fortunapark as urban drainage	As there is no surface water, Fortunapark does not have characteristics of a robust water system. As the focus is to let water flow underground and not above.	As the urban functions have been combined with functions to let water infiltrate, collect and store, the location is resilient for weather extremes of drought and extreme rainfall events. Subsidence is combatted by creating as muchinfiltration as possible and by adding different vegetation types to enhance the infiltration capacity.	As Fortunapark has underground water storages located at communal spaces, water is collected and stored to reduce the amount of drinking water use through out the year.	As the urban drainage system is focused on infiltration and the collection of water, a lof of different gradients of vegetation has been created to attract different species.	All the Oak and Esh trees have stayed, and most of of the willow trees have stayed.	Vegetation has been chosen accordingly to the extreme weather conditions of wettness and drought and the urban functinality of the space. While the built environment has been build on mycobase and stilts to not disturb the soil as much as possible. In addition, space for decomposition of leaves has been planned.	As the landscape forms one water metabolism, it can be seen how there are different levels in which water can flow. Whereby different water extremes can take space in the built environment. From private to public spaces, water is always collected, for infiltration or storage purposes. As a result, teh seasonality of water can be experienced through out the landscape.	As the neigbhourhood has been divided in clusters, every cluster forms a water community in which they catch water together in their communal space. This gives communities a sense of ownership and responsbility to the quantity of their water management.	The community centre and information signs help spreading awareness about water quantity.	As car use is decreased and the walkability is made more attractive. Inhabitants are stimulated to walk.	Daily social interaction in the neigbhourhood are stimulated by, creating building typologies in which inhabitants feel seen and in which they can appropriate the space.	Noise has been minimised by creating noise buffers and reducing car use.	When droughts occur, the design can become vulnerable for subsidence as the water level underground might decrease. However, Infiltration space has been maximised to collect water during wetter seasons so there is enough ground water during drier periods.	Excess water during water nuisance can be catched in the landscape, as the whole landscape forms one water metabolism with different levels in which water can be collected.	Through extensive use of vegetation with trees in the landschape, it can give a cooling effect.

Appendix F: Reflection

1. What is the relation between the graduation project topic and the Urbanism master track, and the master programme?

As the climate crisis and the densification task are both under increasing pressure and demanding for space. Design is needed to come up with new imaginaries for future forms of living. Urbanism is an interdisciplinary field that focuses on the (re)creation of sustainable urban landscapes aimed toward themes like climate adaptability (Urbanism, n.d.). This project is aligned with what Urbanism can contribute to society. Given that the project goal is to find answers to the densification task of South Holland and how to build a sustainable future-proof water cycle for new neighbourhoods. Subsequently, the content of the Urbanism Master Track has helped form the methodology and the theoretical framework of this thesis. Valuable lessons that I have learned are designing with uncertainties (Q1), engineering ecological urban environments (Q2), systemic thinking and urban metabolism (Q3) and the interconnected relationships of urban renewal (Q4). These have formed a foundation for creating this project. In addition, as design is multidisciplinary, a designer in the built environment will always have to shift through different disciplines as solutions have to be integrated. Similarly, this applies to the graduation project where Landscape architecture is vital, as the urban design will happen mostly on a landscape scale that has to deal with ecological processes, architecture has to be researched for building typologies, Building Sciences have to be studied for the technical character of a balanced water cycle and thinking in the Management of the built environment helps in making the design developable. Thus, shifting through the different disciplines and scales of the Master Programme is crucial for creating a water friendly Urban design for a neighbourhood.

2. What is the relation between research and design in your graduation project?

Research and design are continuously interacting with each other during this graduation project, as they give each other input to experiment and make a further step. With every line that is drawn, new research questions arise, while research gives a justification to draw a certain line. This was the case when doing the maximisation of the different guidelines. Research and design was needed to understand spatial conditions for social and natural processes to establish design related problems and potentials. In some phases research has been more prominent, such as in the early stages when developing a solid theoretical and conceptual framework. In the optimization phase however, design became more prominent. As design options were explored through the different scales, using the gathered theories.

3. How do you assess the value of your way of working (your approach, used methods, used methodology)?

The project is in collaboration with the waterboard of Delfland and has the aim to create a transferable approach for building new Water friendly neighbourhoods in Delfland. An approach that is focused on finding synergies between water, ecology and humans. This approach is tested for the location of Fortunapark from which a neighbourhood will be designed. Throughout this project I have carried out the role of urban advisor. The methodology within this thesis consists of a systematic approach in which it tries to understand and design with the needs of water, ecology and humans through literature reviews, analyses, site visits, stakeholder discussions and use of reference projects. Whereby the maximisation method forms the overarching method that has brought everything together. When reflecting on the used methods, two aspects played a key role.

An advantage of working with the waterboard of Delfland is the amount of resources that I have had access to. Such as experts on themes of ecology and water and previous research on creating a balanced water cycle. However, it is noted that it can be quite overwhelming, communicating with experts from different fields, receiving references, being surrounded by different viewpoints and being in constant contact with multiple stakeholders. An experience I have not experienced before in other courses during the master track. Through tricks I have learned from my first mentor Kristel Aalbers, such as always bring a map, sketch while speaking as a communication tool and ask clear close ended questions when speaking in the context of design. As a result, I improved my skills on how to navigate through different fields and how to approach specialists and policy workers for guidance.

Secondly, there is a certain uncertainty in designing with the adaptivity of the built environment for climate scenarios (Pendleton-Jullian & Brown, 2018). As it is never exactly clear what the intensity of the climate conditions will be, when it will occur and where the breaking point of the current water system is. The same goes for ecology as an establishment of species or a level of biodiversity is currently impossible to predict. This uncertainty makes design a tool that is more condition driven than result driven, which is why the design will be condition driven with flexible design results.

4. How do you assess the academic and societal value, scope and implication of your graduation project, including ethical aspects?

Social/Societal reflection
Creating neighbourhoods that have a balanced water cycle can ensure the quantity for the inhabitants during droughts, create a safe living environment in the event of heavy rainfall and can contribute to the quality of water. This is all relevant in a societal context since water is a first necessity for humans and can at the same time be our biggest enemy if we do not understand it and are not prepared for its dynamics. The lessons that will be learned in the context of building a new neighbourhood can also be used for making existing neighbourhoods more resilient. New neighbourhoods also have a direct influence on surrounding neighbourhoods which can offer a solution in decreasing existing water pressures.

Professional reflection
Urban design is an essential tool for negotiating and inspiring changes in science, practice and governance. As space is an expression of a zeitgeist or a paradigm and therefore influences all forms of life, urban designers have an ethical responsibility in rethinking the future for a sustainable living environment. By means of their direct and indirect interventions in the urban and non-human fabrics. Since the climate is changing, causing problems in the topic of water, our current systems are reaching their limits. Therefore, there is a need for a systemic shift in our relationship with water which needs to be spatially designed. This graduation project seeks to contribute on the topic of living with water on a neighbourhood scale for the Urbanism field.

Scientific relevance
South Holland expresses its ambition to build nearly 250,000 homes through 2030 (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2023). A plan that barely has taken the water system and the impact of climate change into account. The waterboard of Delfland wants a more future-proof guideline in which the water system becomes the guiding factor in this. This thesis will try to fill this knowledge gap in how new neighbourhoods should be built, in which water systems form the guiding factor for climate scenarios in 2050.

Ethical reflection
Since we are working with new neighbourhoods, it is better to build it perfectly, than to encounter complications later. But it is also important to take into consideration that adaptations can be expensive and it is not realistic to have the most advanced technology in every neighbourhood. Another note to make is that new neighbourhoods bring a certain target group. One that most of the time holds more financial capital. As the financial weight will not be considered when making decisions, this project might not be a proportional reflection of the population of Delfland.

Appendix G: Reflection

5. How do you assess the value of the transferability of your project results?

The primary objective is to establish a transferable approach with guidelines that can be used to build new water-friendly neighbourhoods in Delfland for similar locations and a similar program of requirements. This approach consists of a methodology and a pattern language with interventions that can be used under the umbrella of a Water friendly neighbourhood.

However, this approach does not take into account the financial weight when making a design decision and therefore adds a degree of ambiguity to the developable opportunities and the transferability of the approach. In addition, how the neighbourhood will be maintained by residents or by the municipality is also something that is not part of this project. While, it is important for the functioning and the preservation of a Water friendly neighbourhood.

6. How did my role as an urbanist take shape during the project?

As I set myself to be an urban advisor to the Waterboard of Delfland on how to build a Water friendly neighbourhood. I had to learn how to deal with a lack of information as it was not my intention to become an expert in the fields of water, ecology or social science. My purpose was to have just enough understanding of these fields to be able to translate it spatially in a qualitative sustainable built environment. Knowing when to stop absorbing information, taking my own position after hearing different standpoints and learning how to design with uncertainties due to the lack of information, was challenging. During this process two key factors helped me along the way.

Elise van Dooren (2021) describes how the guiding theme helps you to take position in the design process. My conceptual framework became my 'anchoring' and helped me to only work on what is important and communicate more clearly to others what my project is about and what the type of advice I would give as an urban designer.

In addition, The Delft Approach (Dijkstra et al., 2021) helped me to work more efficiently as the focus was to not spend too much time researching uncertainties, but just accept and start designing.

7. How did I stay focused during the project?

Navigating through the design project, while staying focused on what was important, proved to be the most challenging aspect of this journey. As I am a perfectionist that is prone to overanalyzing my work, I often find myself delving into minor details that take too much time off my plate. This habit has been a recurring pattern in my past design projects as well. A skill that remains a work in process, but has been enhanced throughout this project.

The biggest takeaway is realising the importance of stepping away from the project by taking breaks and doing something completely different. As doing so surprisingly is actually beneficial to the project. This is confirmed by literature such as from Kuehnel et al. (2016) who describes how taking breaks improves focus and productivity, in addition Oppezzo & Schwartz (2014) describe how walking improves creative thinking.

Chapter 11.

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