BRIDGING PAST AND FUTURE

Utilising cultural heritage values to increase resilience in Amsterdam's polder water system

Master thesis
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June 2024

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Faculty of Architecture and the Built environment

Master thesis
MSc Architecture, Urbanism and Building sciences
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Urbanism

De wereld is niet mooi, maar jij kan haar een beetje mooier kleuren
- Herman van Veen (1986)

ABSTRACT

This thesis explores the future of Amsterdam and the broader metropolitan region, all deeply influenced by a rich history of water management practices. Against this backdrop, the rising challenges of climate change are increasingly threatening the Dutch delta region. Recognising the historical significance and heritage associated with Amsterdam's water structures, this research aims to strengthen these assets to integrate a resilient water system with a strategy for sustainable heritage development in Amsterdam.

Qualitative and quantitative research have been combined to gain a better understanding of the water problems caused by climate change, enrich the understanding of contemporary cultural heritage values that are associated with the water system and look for spatial potential for urban transformation regarding water-related heritage. The integrated typology forms the basis for the design project, emphasising which design qualities can be improved in which places in the city.

In the design project, the maximisation method maximises the landscape and cultural resilience and by integrating these extremes it is intended to create the most sustainable urban plan. In parallel a pattern language will be developed that aims to generate design solutions that support the design qualities aimed for in this project.

The maximisation experiments and pattern language are combined into the integrated urban transformation plan and integrated implementation on the neighbourhood scale with two example neighbourhoods which show how different neighbourhood types can strengthen their water identity by integrating resilience water management with sustainable heritage development. Ultimately bridging past and future and creating a resilient urban environment.

Keywords: Resilient water management, sustainable heritage development, socio-ecological integration, climate adaptation, integrated urban design

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CHAPTER

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INTRODUCTION

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Chapter 1 introduces the project. It highlights the personal motivation for the topic and the argumentation for Amsterdam and its Metropolitan Area as the location for a place-based research and design approach. Moreover, it will give a brief overview of the urban development of Amsterdam, which underpins the historical framework of this project.

Figure 1.1: T Hoogh-Heemraetschap vande Uytwaterende Sluysen in Kennemerlant ende West-Frieslant

Source: Stadarchief Amsterdam / Johannes Dou (1682)
Black & White Adaptation

1.1 PERSONAL MOTIVATION

This graduation project starts with my personal fascination for flood risk management in the Dutch delta. For most of my life, I have lived in a traditional Dutch polder landscape, with a historic windmill visible from my bedroom window. Every day while cycling to school over the dike, I was aware of the altitude and water level differences, the last one changing over the seasons. As I got older I started reading about other places in the world, where people got affected by hurricanes and seasonal flooding. Places where urban development had different shapes and sizes. Where different cultural and historical events, shaped the cities differently than what I knew from the Netherlands. Gradually I got more into geography and history courses, understanding the contrasting processes of nature and humanity.

The things I see from my bedroom window today or during my bicycle ride to university have been shaped by hundreds or even thousands of years of natural and human processes, both shaping the world in many different ways. Moreover, what we do now and the steps we take will reshape our future and the future of the next generations. With this graduation thesis, I hope to integrate my childhood fascination with the academic skills I have learned over the past years. Combining heritage studies, strategic planning, water system analysis, scenario building and urban design.

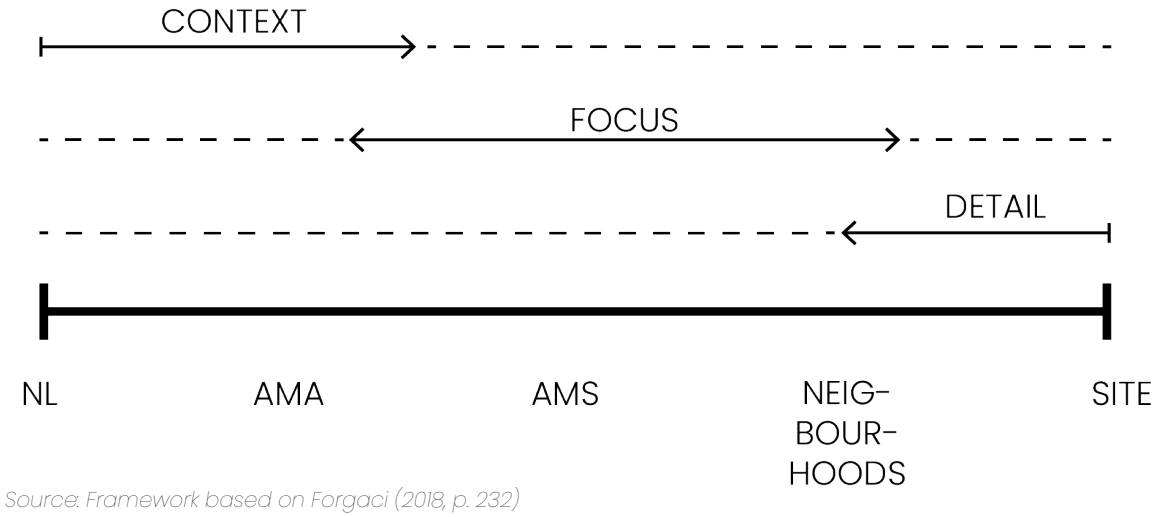
Figure 1.2: A winter day at Molen de Woudaap (2004)

1.2 WHY AMSTERDAM

This research has a place-based approach. The location of this project is the city of Amsterdam and its broader Metropolitan Area. In the book, Atlas of Dutch Watercities Hooimeijer et al (2005) divide Dutch water cities into three categories: coast, river and polder cities. Each has its specific problems and issues. There are multiple research-by-design projects addressing the water problems in the Dutch river landscape. Het Programma Ruimte voor Rivieren resulted in national attention for the flood safety of rivers (Ministerie van Infrastructuur en Waterstaat, 2024). However, the problems that are or will be occurring in the polder city are fairly unknown among the general public. Amsterdam is a prime example of a polder city, consisting of a patchwork of polders. In a polder, the water levels are controlled via pumping stations. In the past, the polder water system was easy to regulate because of its closed system. However, climate change presents multifaceted challenges pressuring the polder water city. The design of the new polder city landscapes can no longer be elaborated on models, which consider the city and the landscape as separate entities. The design of polder cities needs to be realised across the scales integrating the landscape and human layers of the urban landscape.

The second reason to look into the city of Amsterdam is that Amsterdam is one municipality, but it is also a patchwork of historic towns. At the same time, the city is considered a Metropolitan Area, where people daily commute between the other municipalities and the city of Amsterdam. The metropolitan area however is not all Amsterdam, it has many different neighbourhoods, villages and identities. This scale issue creates a highly interesting case for a multi-scalar research by-design project. The focus of the multi-scalar approach is shown in Figure 1.3.

Figure 1.3: Multi-scalar approach to the project



Source: Framework based on Forgaci (2018, p. 232)

1.3 AMSTERDAM METROPOLITAN AREA (AMA)

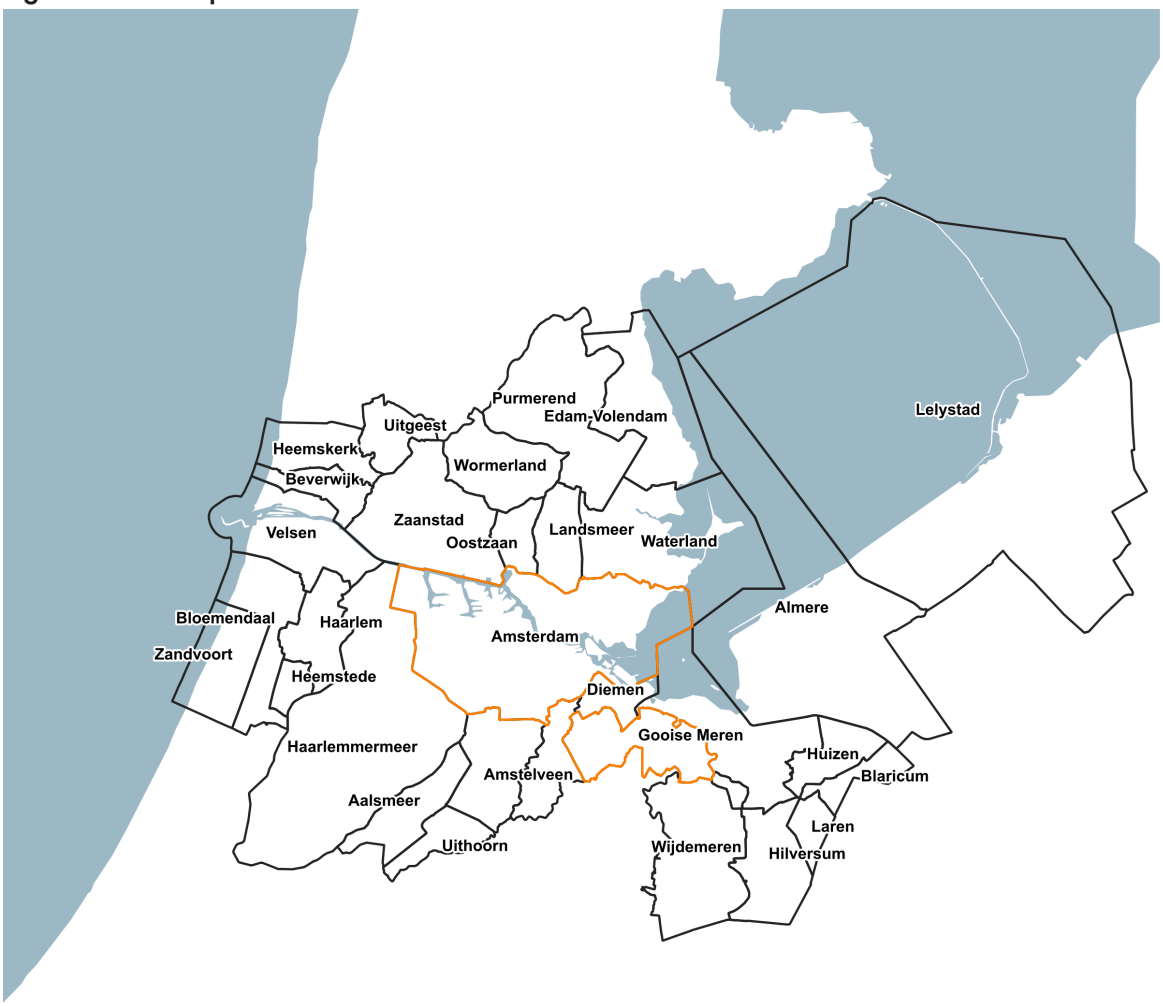
Because the polder water system stretches beyond municipal boundaries it is important to take the regional scale into account in this project. Amsterdam has a regional boundary which is the Amsterdam Metropolitan Area. This is the boundary where most people commute within the region. The Amsterdam Metropolitan Area can come across as one institutional body that is in charge of decision-making. In reality, this is not the case. The AMA is a cooperation between 7 subregions and 30 municipalities stretching over 2 different provinces. The cooperation does not enter the formal policy and decision-making process. It only informs the elected representatives in the provincial and municipal governments (Over De Metropoolregio Amsterdam - Metropoolregioamsterdam, 2023). By combining policies and arrangements on a metropolitan level it is hoped to achieve better alignments on shared goals related to economy, spatial planning and mobility.

Figure 1.4: The AMA in the Netherlands

Scale: 1:1.500.000

Source: Data retrived from CBS (2023)

Figure 1.5: Municipalities within the AMA



Scale: 1:600.000

Source: Data retrived from CBS (2023)

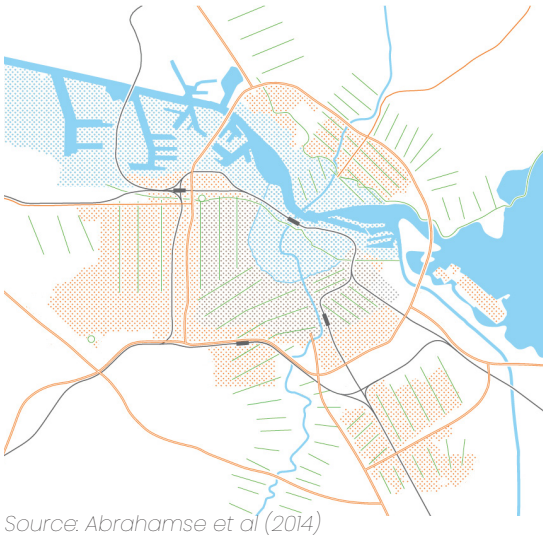
1.4 HISTORIC OVERVIEW OF AMSTERDAM'S URBAN DEVELOPMENT

Around the 11th century, the reclamation of the peat bogs of the Amsterdam region started, and from this moment, agricultural activities started in the region. Already in the 12th century subsidence caused the lowering of the landscape and a bigger vulnerability to floods. This is why from the 12th century onwards dikes and dams were built to protect the land from flooding. Around 1270 the first sources mention a dam built in the river estuary of the Amstel. The city developed quickly realising the Voorburg- and Achterburgwallen for a water drainage system and a defence wall around the city in 1470 (Abrahamse et al., 2014).

When Antwerp was conquered by the Spanish in 1585, many merchants moved to Amsterdam to continue their trade. Amsterdam grew immensely in population and there was a need for new housing development and new harbors for the international trade in the city. The period between 1600 and 1700 is called the Golden Ages and there was great prosperity in the city. Amsterdam was the epicentre of world trade. The canal ring was part of one big expansion plan for the city but was only realised partially in 1603. The palace on Dam Square was realised in 1648 and was at this moment the most important building in the Dutch Republic. In the second half of the 17th century, the half-moon canal ring was completed and new harbours were created on the east side of the city. In 1672 the prosperous period ended when the British and French attacked the Dutch Republic.

A long period of stagnation in city development followed. It was after the industrial revolution, at the end of the 19th century when the city started growing again. Amsterdam was now an industrial city with factories and harbours on the waterfront. The construction of the Noordzeekanaal (1876) and Merwedekanaal (1892) created a new economic boom in the region. The city walls were demolished and made space for the development of new neighbourhoods. The Stelling van Amsterdam, 45 fortresses about 30km from the historic city centre of Amsterdam was created as a new defence structure (Abrahamse et al., 2014). The old town remained the city centre due to the train track leading towards Amsterdam central station. H.P. Berlage designed the expansion plan for the south side of the city, with monumental axes. In the same period, the first garden towns were realised in Amsterdam Noord.

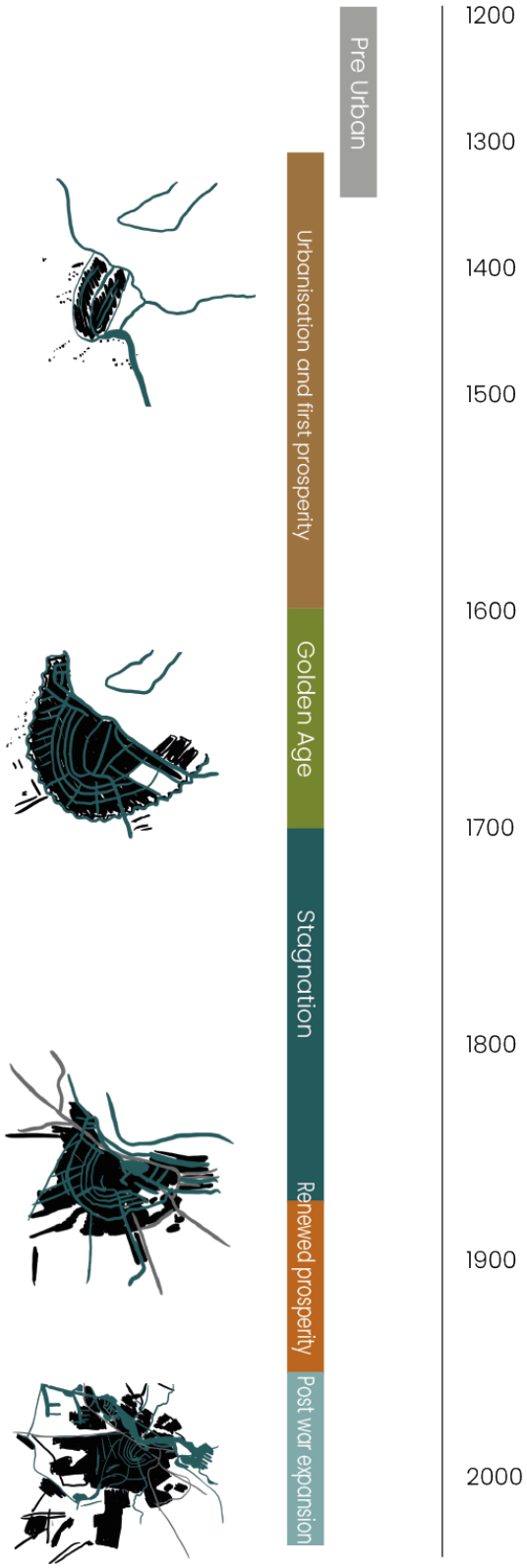
Figure 1.6: Development map of Amsterdam



Source: Abrahamse et al (2014)

For centuries the location of peat reclamation and the river were central in the spatial development of Amsterdam (green stripes for peat reclamation and green lines for dikes along the IJ). For the expansion from the late 19th century (grey dots) the traintracks and station were important as well as the new harbour areas (blue dots). After the second world war the harbours moved west (blue dots) and the city expanded with new residential neigbourhoods (red dots) that were closed off with the ringroad and motorways.
Source: (Abrahamse et al., 2014)

Figure 1.7: Timeline of urban expansion



The General Expansion Plan of Amsterdam was created between 1928 and 1935 by C. van Eesteren. This plan played a major role in the following decades. It was a modernist development plan, where working, living, traffic and recreation were segregated from each other. After the Second World War, more garden towns were developed, within cycling distance from the historic city centre. In 1964 the Bijlmermeer polder became part of Amsterdam with highly modernist segregated high-rise apartments and open green space in between. From this moment, the idea of a decentralised metropolitan region became more important.

Since the 1990s the redevelopment of the IJ waterfront started, it has been a segmented development up until today. Many islands and old harbours are redeveloped into residential areas. At the same time, the Zuidas developed as a decentralised business district. In 1991 the National Vinex plan (Vierde Nota Ruimtelijke Ordening Extra) introduced the principles for suburban housing developments. This resulted in large-scale development plans between 1995 and 2005 that focused on commuting inside the metropolitan region. Nowadays the metropolitan area has over 2,5 million inhabitants, 1,1 million homes and 1,5 million jobs (Over De Metropoolregio Amsterdam - Metropoolregioamsterdam, 2023).

Recently new islands have been developed in the estuary of the IJ, which are the latest large-scale housing development projects in the city.

1.5 THESIS OUTLINE

This report concludes the graduation project for the MSc Architecture, Urbanism and Buildings Sciences, Track Urbanism and Studio Design of the Urban Fabric. The report starts with an introduction to the project, the argumentation for Amsterdam as a place-based research and design approach and a brief overview of the urban development of Amsterdam.

Chapter 2 frames the problem field. It introduces water-related problems in the Dutch Delta due to climate change and the effects this has on the polder water city. Moreover, it introduces why water structures are considered heritage. Chapter 2 concludes with the problem statements, main research question and research aims. The main research question is: How can the needed resilience of the future polder water system be integrated with the sustainable development of water-related heritage, strengthening the water identity of Amsterdam?

In Chapter 3 the research structure explains the sub-questions, corresponding research aims, methods and intended outcomes of the project. Next to that, the theoretical and conceptual framework are introduced. In the theoretical framework, the following theories are defined: Socio-ecological integration, water & soil guiding, resilience, sustainable heritage development, and the two network strategy.

Chapter 4 answers the first sub-question: What are the cultural values of the water identity of Amsterdam? It explains the historical and contemporary values of the water structures in the city. The contemporary values are assessed with the cultural heritage values taxonomy. This is done via a survey of the residents of Amsterdam.

Chapter 5 answers the second and third sub-questions. A literature review combined with spatial analysis is used to determine the needed transformation potential for water management, cultural heritage and the urban network on both the metropolitan and city scale.

Chapter 6 summarises the analysis done in the previous two chapters. A quantitative typology is constructed. The typology results in eight neighbourhood scale types with different existing design qualities. These neighbourhood types are qualitatively assessed through fieldwork and based on this the design potential to improve the design qualities is determined. These design potentials are the start of the design pr

In chapter 7 the maximisation method is used to maximise resilience for the water-landscape and the human-culture city. In parallel a pattern language is constructed that shows design solutions that aim to integrate the design goals in this project. Based on the maximisation on city and neighbourhood scale and the pattern language conflicts and synergies are identified. Chapter 7 concludes with different strategies to guide the decision-making process based on stakeholder considerations and participation.

Chapter 8 shows the integrated urban transformation plan on the city scale and the integrated implementation on the neighbourhood scale. Based on the city scale plan, the typology and results from the survey two representative locations were chosen as zoom-ins to develop a design proposal that shows how the climate adaptation of the water and cultural structures positively contribute to the living environment of the citisens, ultimately building resilience in the water identity of Amsterdam.

Chapter 9 concludes this report. It highlights the aim of the project and the answers to the sub-questions and main research question. Chapter 9 concludes with a personal reflection.

Figure 1.8: A windmill on a polder canal

Source: Paul Joseph Constantin Gabriël (1889) via Rijksmuseum

Black & White Adaptation

Het Leydsche Meer.
HET HAERLEMMER MEER.
Oude Meer
Nieuwe Meer
Spiering Meer
Haerlem
Amstelredam
OUDER KERCK.
Weesp
Muyden
Muyder Aberdergh Sandt
Marken
Hoorn
t Hoornicker Hop.
Medenblick
Wieringer Vlack
Dryfstal
De Kille
Baaken op de Creupel
Ton op de Creupel
Noorder Gat
Texel
Vlieter
Schelling
Vlieland
Terschelling
Ameland
Schiermonnikoog
Rottumer Plaat
Rottumer Zand
Bevervyck
Alckmaer
Purmerent
Beemster
Wormer
Jisp
Zaendam
Edam
Monnickendam
Volendam
Enckhuysen
Stavoren
Workum
Hindeloopen
Molkwerum
Harlingen
Franeker
Dockum
Leeuwarden
Sneek
Bolsward
Workumer Wad
Hollandsche Diep
Vlie
Texel
Marsdiep
Helder
Kamperland
Vlissingen
Walcheren
Zeeland
Zuyder Zee
Noorder Zee
Engelsche Canael
Hollandia
Frisia
Groningen
Drenthe
Overyssel
Gelderland
Utrecht
Zuyd Holland
Noord Holland
Zeeland
Friesland

CHAPTER

2

PROBLEMATISATION

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Chapter 2 frames the problem field. It introduces the water-related problems in the Dutch Delta due to climate change and the effects this has on the polder water city. Moreover, it introduces the way water structures have encompassed urban development and therefore are an important bridge between the past and future of urban development. Chapter 2 concludes with the problem statements, main research question and research aims.

Figure 2.1: Ecclesiastical division of Holland
Source: Carel Allard (1670-1709) via Noord-Hollands Archief / Collectie 560, 302
Black & White Adaptation

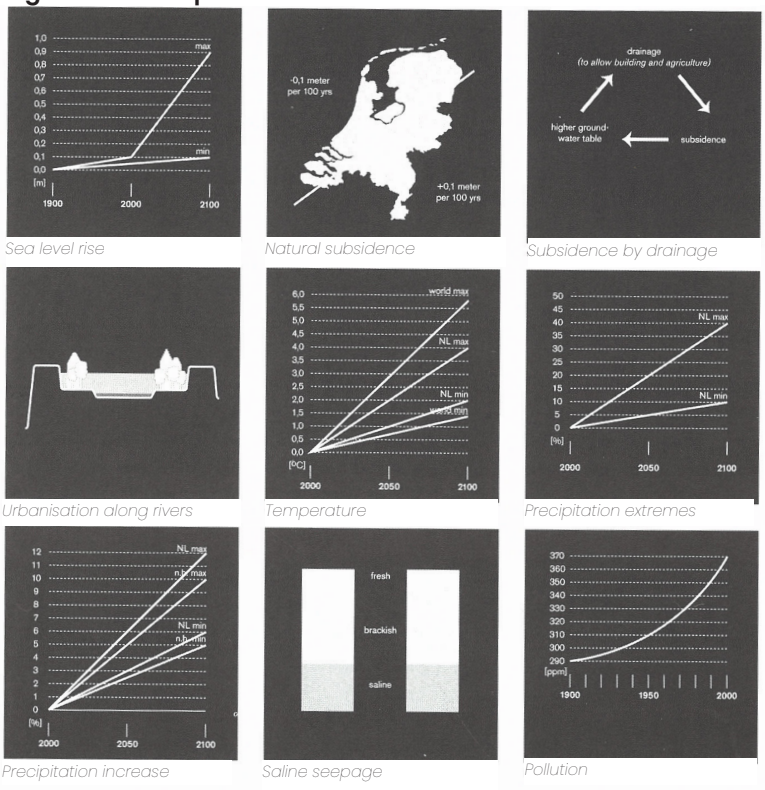
2.1 WATER-RELATED PROBLEMS IN THE NETHERLANDS

Water has always been an important element in Dutch cities and from early on people started settling in the lower-lying areas. Pressure on our water system only started after the population growth in the 19th and 20th centuries. Recently climate change is increasing the pressure on our urban water system. This causes nine problems with the water in the Netherlands,as seen in Figure 2.2 (Hooimeijer et al, 2005).

In the last decade, more research has been done into these water-related problems. All issues cause different problems in different timespans. Some problems are already visible in the landscape today and ask for rapid interventions. Other problems will appear soon (around 2050) and some will emerge later (Deltares et al., 2021). But in all cases, they ask for major changes in our city and landscape design. Unfortunately, we do not know at what moment the situation is intolerable. It is estimated that the sea level will rise 85 cm, but in other scenarios, 2 m is also a possibility. To visualise the future effects of the water problems Deltares, BoschSlabbers and Sweco (2021) made a national map showing the water-related risks now and in the future (Figure 2.3). This map shows the following characteristics of water & soil in order of future occurrence:

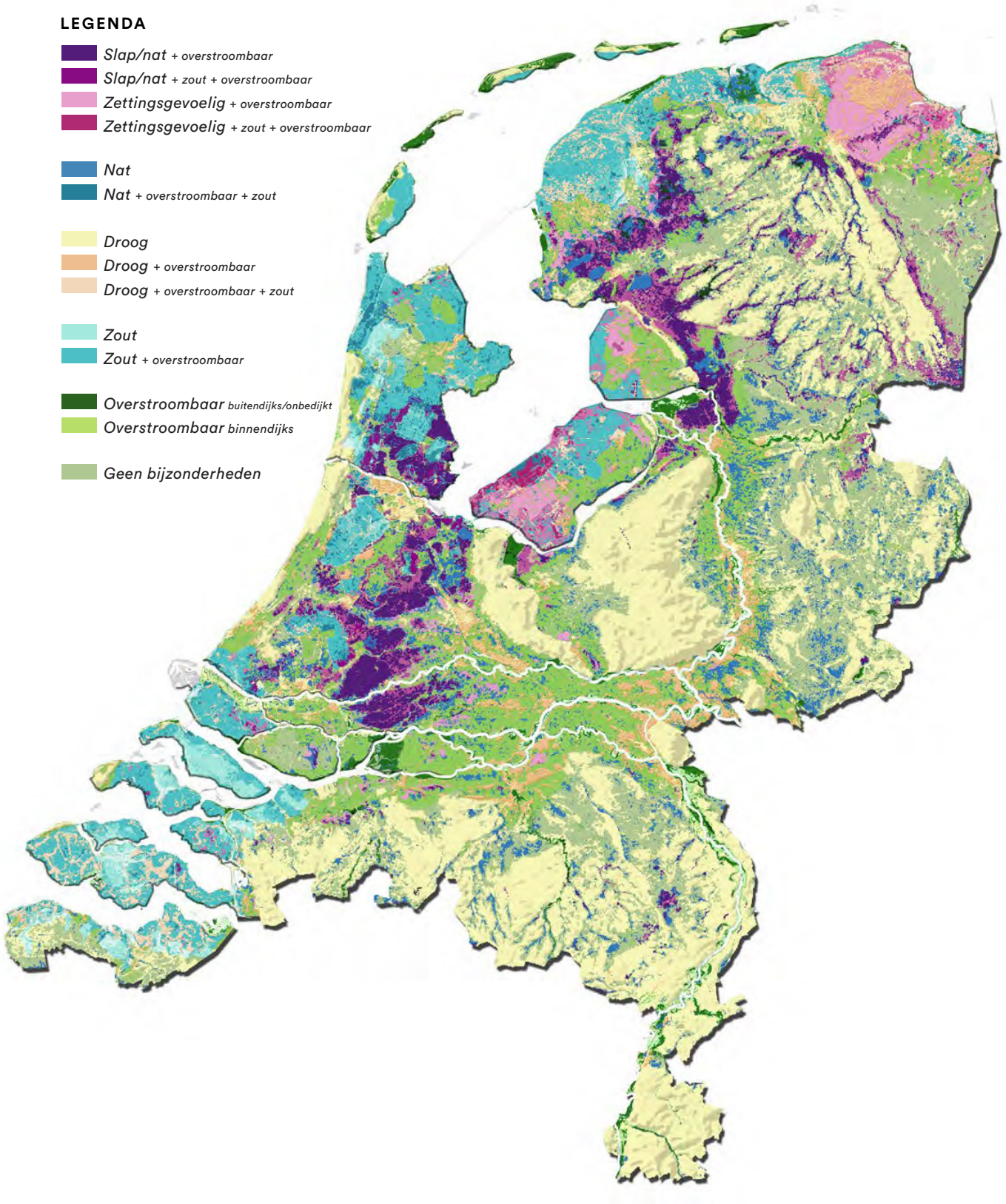
- Already too weak (Slap)
- Increasingly too wet (Nat)
- More often too dry (Droog)
- In the foreseeable future too salty (Zout)
- Eventually too dangerous (Overstroombaar)

Figure 2.2: Nine problems with water in the Netherlands



Source: Hooijmeijer et al (2005)

Figure 2.3: The new physiographic map of the Netherlands

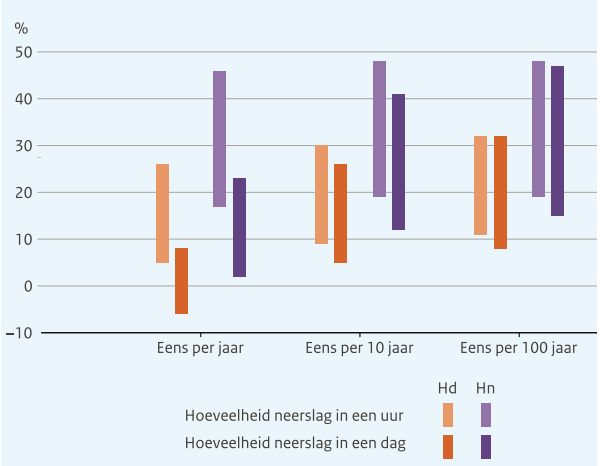


Source: Deltares, BoschSlabbers, SWECO (2021)

2.2 FUTURE OF THE POLDER CITY

According to the physiographic map, the Amsterdam Metropolitan Area risks weak, wet, dry, salty and dangerous soil conditions all at once. Weather extremes will increase due to climate change. Consequently, heavy rainfall events will occur more often. In the Netherlands, a day with 50mm of rain is considered a day with heavy rainfall. An event with >50mm of rain per hour or >100mm in a day is rare and occurs once every 100 years. Nonetheless, this event happens in a specific location in the Netherlands every year. Seemingly rare events happen more often in very small locations than the statistics suggest (KNMI - Extreme Neerslag, n.d.). With global warming and the associated moisture increase, further precipitation intensification is expected (Figure 2.4). This leads to more severe extremes and the more frequent occurrence of extreme amounts of precipitation (KNMI, 2023).

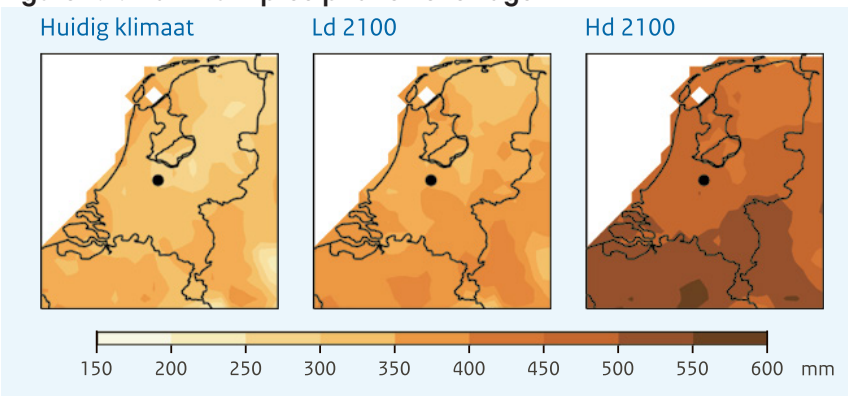
Figure 2.4: Chance of extreme precipitation



Source: KNMI (2023)

Amsterdam is a polder city, which means the soil is made out of peat. Peat is a spongy and moist type of soil. To build on this type of soil a long foundation is needed to support the weight of the buildings. Even the trees in the Vondelpark have a foundation for this reason (Weststeijn, 2023). Amsterdam is basically a big city on top of wooden columns. In the face of climate change, there will be an increase in heavy droughts. Droughts happen usually in summer because there is less precipitation and more evaporation. While extreme rainfall events will increase, the average rainfall will decrease in summer, and at the same time, the temperatures will rise (KNMI, 2023). Resulting in more periods of drought, which will result in a lower groundwater table (Figure 2.5). If the groundwater table is lower, the wooden structure of the foundations will come in contact with oxygen and start to rot, resulting in a vulnerable foundation for all the buildings. Moreover, dike structures dehydrate during droughts and lose their strength (KNM, 2023).

Figure 2.5: Maximum precipitation shortage

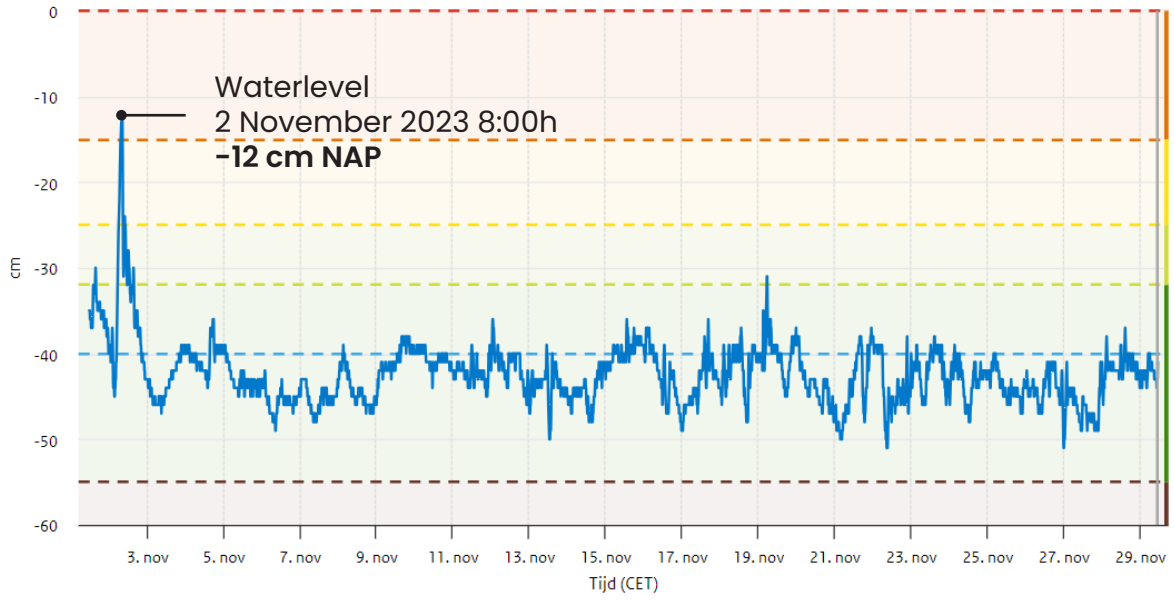


Source: KNMI (2023)

The polder city is a closed water system that is completely controlled at the moment. In the past, the water level was easy to regulate with the polder pumping system. But nowadays periods of drought alternate with periods of extensive rainfall. Therefore the adaptability to future water quantity extremes is more difficult (Hooimeijer et al, 2005).

The storm on 2 November 2023 shows the importance of a well-functioning polder system. During this event the sluice system at IJmuiden was not working probably, limiting the amount of water that was able to leave the Noordzeekanaal. Because of high levels of precipitation and wind the water level in the boezem was extremely high. Consequently, the sluice system between the IJ and the historical city of Amsterdam needed to be closed for the first time in 20 years (Niemantsverdriet, 2023). At the same time, the threat of water came from the polder, because the extreme amount of rainfall caused the rise of the polder water level. Because of the already high water levels in the Noordzeekanaal, it was not allowed to drain water from the polder into the Noordzeekanaal anymore. Luckily the high water levels were under control and did not cause flooding, but the waterboard had a wake-up call (Figure 2.6). High amounts of precipitation in combination with high water levels in the IJsselmeer or North Sea will result in higher quantities of water in the polder and boezem system risking flooding. To adapt the polder city to these extreme weather events there is a need for more infiltration and storage capacity in the polder (Hooimeijer et al, 2005). By increasing the storage capacity it will be possible to store the water surplus in winter to use this in the summer. Crucial for water storage is a multi-scalar approach, where peak, seasonal and regional discharge are taken into account (Hooimeijer et al, 2005).

Figure 2.6: Waterlevel of surface water compared to NAP at Surinamerkade Amsterdam



Source: Rijkswaterstaat (2023)

2.3 WHY WATER IS HERITAGE

Water is inseparable from the Dutch living environment. Especially in medieval polder cities, water always has been at the centre of urban development. Amsterdam is no exception, the central image of Amsterdam is the canals, houseboats, bridges and ferries. Water is seen as a factor that contributes to the identity of the city and therefore to the cultural heritage (Hooimeijer et al, 2005).

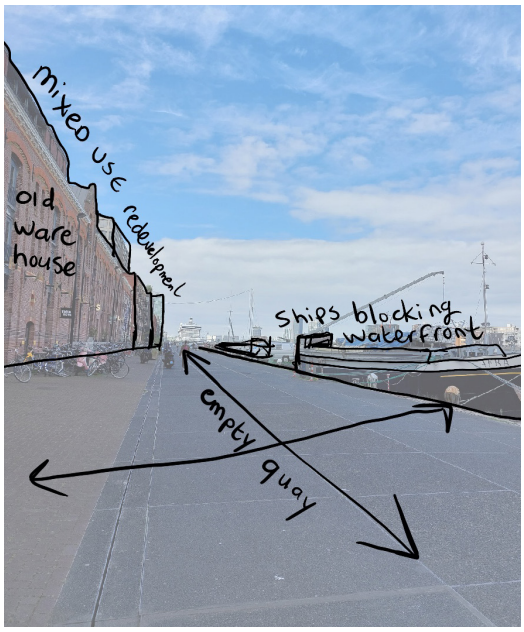
The perception of cultural heritage has evolved over time. We can understand this by looking at the many different types of conventions and documents developed in the last century (Willems & Van Schaik, 2015). Cultural heritage used to be a concept that informed us about the past in the form of a tangible object. In the last few decades, there has been a growing recognition of combining the tangible physical values and the intangible and social values of heritage for the present and the future. Historically the water in Amsterdam has always had a core function. It has been supporting the trade and exchange of goods, used as a defence structure and enabled industrialisation. Nowadays water structures have functions for tourism and recreation, and are central to the cultural identity. In fieldwork, it became visible that access to the urban waterfront is not always as easy as expected. This is due to road infrastructure, the loss of industrial activities at the waterfront and poor redevelopment. This limits the interaction between people and the water (Figure 2.7).

The impacts climate change has on cultural and natural heritage have become a key concern. Although many heritage sites are water-related, water is also the main threat to these heritage sites (Willems & Van Schaik, 2015). In 2013 ICOMOS-Netherlands organised a conference, which resulted in the Stament of Amsterdam that calls for more attention to Water and Heritage. It states that:

- The management of water heritage is dynamic. An understanding of historical continuity is essential to improve future planning processes.
- Heritage is a valuable asset, a source of pride and identification. Preparing societies for the effects of climate change will work best if cultural landscapes are improved.
- There is little relation between heritage, development and sustainability. Spatial planning plays a major role in connecting policymakers, professionals and the public

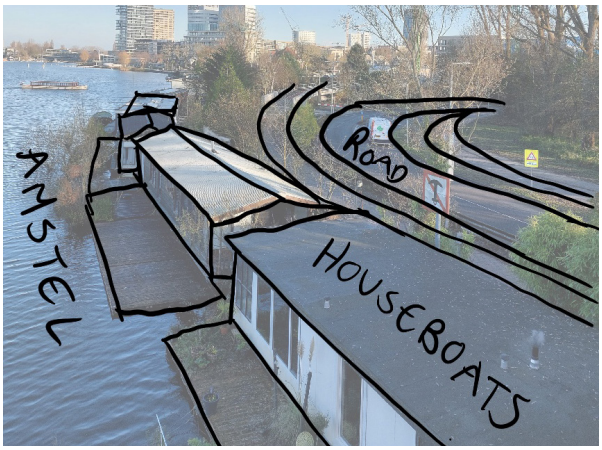
Based on this statement, it can be concluded that Amsterdam's heritage is not only a reflection of its past; it is a valuable asset that fosters pride and identity. The possible disappearance of cultural heritage takes up a position between the level of individual experience and the global climate crisis stretching far into the future (Weststeijn, 2023). It tangibly connects us with the past generation. Especially in the Netherlands our heritage, in the forms of dikes, damns and delta works, is inherently connected to our past and future of water management. And it is this water-related heritage that is most at risk considering climate change. Integrating sustainable heritage development into urban planning will help preserve the cultural identity and help to create a resilient future.

Figrue 2.7: Four underused waterfronts in Amsterdam

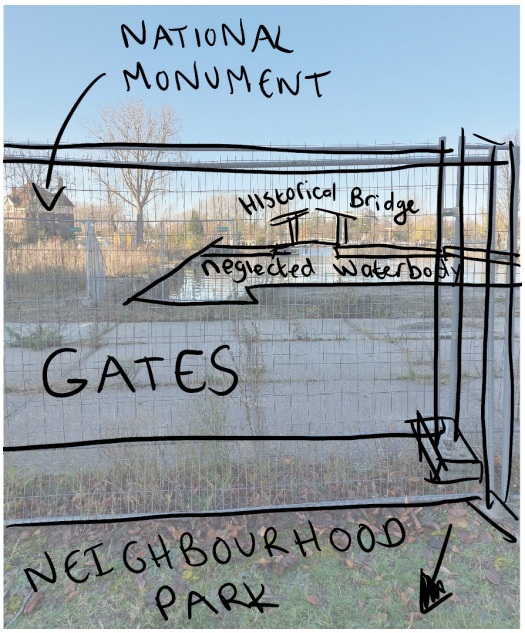


Mixed use area Eastern harbor

Residential area IJplein



View over the Amstel from Utrechtsebrug



New residential area Amstelkwartier

2.4 PROBLEM STATEMENT

Living with water has been at the core of Amsterdam's urban development and results in a source of pride and identification regarding the 'watercity' identity. However, climate change presents multifaceted challenges pressuring the polder water city. Climate change is expected to affect groundwater and sea levels and lead to a higher frequency of extreme weather events. Recent extreme events, like the storm of November 2023 and national floods in December 2023, underscore the urgency of re-evaluating and enhancing the city's water management strategies. Among these climate change challenges, the heritage and cultural identity of Amsterdam, deeply rooted in its water systems, are at risk. Cultural heritage has evolved to encompass not just tangible artefacts but also intangible and social values, emphasizing the dynamic relationship between the past, present, and future. Water, integral to Amsterdam's culture, presents both an asset and a threat to this heritage. There is a necessity to integrate sustainable heritage development into climate adaptive urban planning, ensuring the preservation of Amsterdam's cultural identity while forging a resilient future.

Figure 2.8: High tide at Marken, 7 January 2024
Source: VNL Nieuws (2023

Figure 2.9: Drought in Amsterdam, 23 July 2018
Source: Mol (2018)

2.5 MAIN RESEARCH QUESTION

**HOW CAN THE NEEDED RESILIENCE OF T
INTEGRATED WITH THE SUSTAINABLE DEV
STRENGTHENING THE WATE**

2.6 SUB QUESTIONS

What are the cultural values of the water identity of Amsterdam?

What are the existing and future water problems in the polder water system in Amsterdam and the Metropolitan Area?

Which water-related hertiage structures in Amsterdam are suitable for sustainable development?

How can socio-ecological integration enable an increased capacity for water resilience on a city scale?

How can the sustainable development of water-related heritage increase the resilience of the cultural structure in the city?

How can the climate adaptation of the water and cultural structures in the city postively contribute to the living environment?

THE FUTURE POLDER WATER SYSTEM BE ELOPMENT OF WATER RELATED HERITAGE, R IDENTITY OF AMSTERDAM?

2.7 RESEARCH AIMS

Enrich the understanding of the historic and present day values of the polder water system in Amsterdam

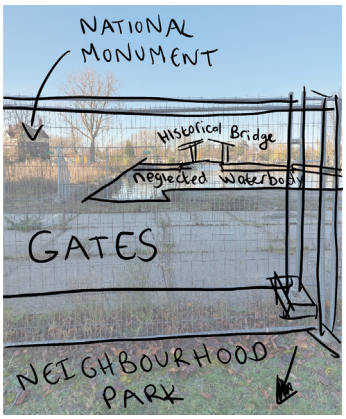
Identify the critical locations and spatial needs to adapt the polder water system to future climate change problems

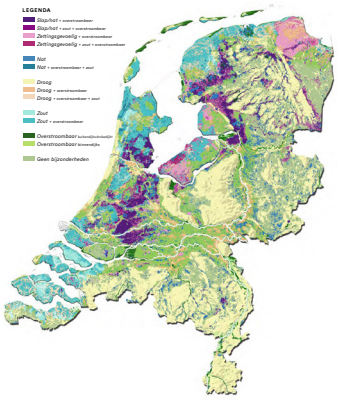
Understand the different types of water-related heritage structures and their location in the urban fabric

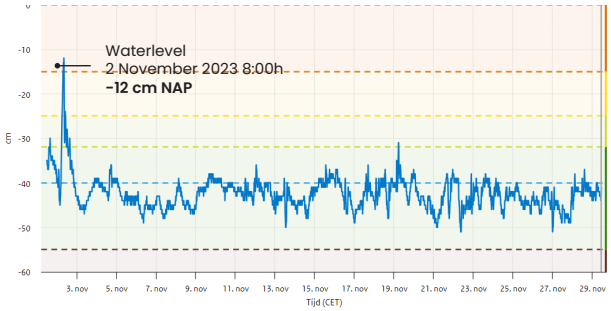
Create a resilient polder water system with a socio-ecologicl urban water management plan.

Use water-related heritage as a catalyst for sustainable development, while increasing the cultural value on neighbourhood- and city scale

Reconnect people with nature to increase the appreciation of the needed climate adaptation in the city


NATIONAL MONUMENT
Historical Bridge
neglected waterbody
GATES
NEIGHBOURHOOD PARK


LEGENDA


Waterlevel
2 November 2023 8:00h
-12 cm NAP
cm
-10
-20
-30
-40
-50
-60
3. nov
5. nov
7. nov
9. nov
11. nov
13. nov
15. nov
17. nov
19. nov
21. nov
23. nov
25. nov
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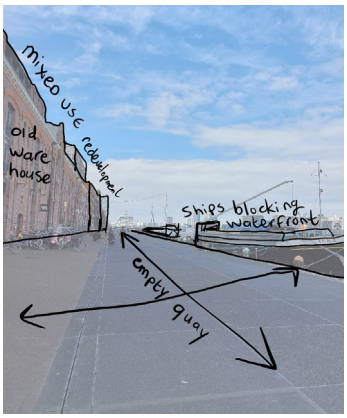
29. nov
Tijd (CET)


mixed use redevelopment
old ware house
ships blocking waterfront
empty quay

CONCLUSION CHAPTER 2

Climate change presents multiple water-related challenges pressuring the polder city. Climate change is expected to affect groundwater and sea levels and lead to a higher frequency of extreme weather events. Among these climate change challenges, the heritage and cultural identity of Amsterdam, deeply rooted in its water systems, are at risk. Cultural heritage has evolved to encompass not just tangible artefacts but also intangible and social values. Water, integral to Amsterdam's culture, presents both an asset and a threat to this heritage. However, in the urban environment, the function of the urban waterfront is often neglected. There is a necessity to integrate sustainable heritage development into climate adaptive urban planning, ensuring the preservation of Amsterdam's cultural identity while forging a resilient future. Therefore the main research question of this thesis is: How can the needed resilience of the polder water system be integrated with the sustainable development of water-related heritage, strengthening the water identity of Amsterdam?

SLOTER- BINNEN EN MIDDEL- VELDSCHE-
SLOTER VAART
GECOMBINEERDE POLDERS
Z.P. + 2.10
RIEKER- POLDER
Z.P. + 1.80
HAAGSCHE WEG
HET NIEUWE MEER
Z.P. + 3.20
JAAGPAD
KOENEN KADE
ROEIBAAN
BUITEN DIJKSCHE
NIEUWE KALFJES LAAN
Z.P. + 4.60
VLIEGVELD WEG
RIETWIJKEROORDER POLDER
Z.P. + 4.50
BUITEN VELDERSCHE
BOVENLANDEN
Z.P. + 1.50
POLDER
KLEINE NOORD- POLDER
SCHINKEL POLDER
Z.P. + 4.70
GEMEENTE AALSMEER
DE POEL
Z.P. + 1.50
BOVENKERK
BOVEN KERKER POLDER
Z.P. 5.40
AMSTELVEEN
ONDER NIEUWER AMSTEL
P.P. + 5.20
MIDDEL POLDER
MACHINEWEG IN DEN MIDDELPOLDER
GEMEENTE NIEUWER-A
BINNENDIJKSCHE BUITENVELDERSCHE
Z.P. + 2.00
BUITENVELDERSCHE WANDELWE
KALFJES LAAN
OUDERKERKER LAAN
SCHINKEL
SCHINKELTOCHT
OUDE TOCHT
OPSTTOCHT
KINDERDIJK
KLEINE TOCHT
KAPELLADIJK HOEVE
HUBERTUS HOEVE
PAULINA'S HOEVE
KLEIN EN REIN
DE GOEDE VERWACHTING
REPOS AILLEUR
VEELUST
KRONENBURG
BUITEN VERWACHTING
DE KLAP
BOUWLUST
REISERSDAAL
VERWACHT
VELDLUST
HET IS ANDERS
ZORGVLIED
ZUIDELIJKE SINGEL
GEINTUURSPOORBAAN
AMSTELLAND
ZELLENRUST
VONDEL
STADION
SPORTTERREINEN
SPORTTERREIN
SPORTVELDEN
SPORTPARK
SPORTLAAN
SPORTWEG
SPORTPLEIN
SPORTTERR.
SPORTVELD

CHAPTER

3

RESEARCH STRUCTURE

3.1	METHODOLOGY	34
3.2	METHODOLOGY FRAMEWORK	36
3.3	PROJECT TIMELINE	38
3.4	THEORETICAL FRAMEWORK	40
3.5	CONCEPTUAL FRAMEWORK	45

Chapter 3 explains the research structure of this project. The research question is divided into six sub-questions, corresponding to the six research aims. Next to that for every sub-questions the methods and intended outcomes are explained. In addition, the theoretical and conceptual framework are introduced. In the theoretical framework, the following theories are defined: Socio-ecological integration, water & soil guiding, resilience, sustainable heritage development, and two network strategy. Chapter 3 concludes with the conceptual framework that shows the conceptual relationship between the used theories and design vision.

Figure 3.1: Kaart van Amsterdam No. 3

Source: Stadsarchief Amsterdam / Dienst Openbare Werken (1936)
Black & White Adaptation

3.1 METHODOLOGY

SUB QUESTIONS	RESEARCH AIMS
What are the cultural values of the water identity of Amsterdam?	Enrich the understanding of the historic and present day values of the polder water system in Amsterdam
What are the existing and future water problems in the polder water system in Amsterdam and the Metropolitan Area?	Identify the critical locations and spatial needs to adapt the polder water system to future climate change problems
Which water-related hertiage structures in Amsterdam are suitable for sustainable development?	Understand the different types of water-related heritage structures and their location in the urban fabric
How can socio-ecological integration enable an increased capacity for water resilience on a city scale?	Create a resilient polder water system with a socio-ecological urban water management plan.
How can the sustainable development of water-related heritage increase the resilience of the cultural structure in the city?	Use water-related heritage as a catalyst for sustainable development, while increasing the cultural value on neighbourhood- and city scale
How can the climate adaptation of the water and cultural structures in the city postively contribute to the living environment?	Reconnect people with nature to increase the appreciation of the needed climate adaptation in the city

METHODS

INTENDED OUTCOME

Literature review: An introduction to cultural heritage management and cultural values
Historical research: Historical research of the changing structure of water over time and the value of water in urban development.
Survey: Determine the cultural values that citizens link to the water structures in their neighborhood.

Literature review: Understanding the need for adaptibility of the polder water system to future water problems that are likely to occur due to climate change
Spatial analysis: Understanding the spatial implications of the polder water system and the future problems that are likely to occur.

Literature review: Understanding the stories behind heritage structures and heritage management
Spatial analysis: Understanding the spatial relationship between water & heritage structures and a spatial analysis of porosity.
Space syntax: Understanding to role of heritage structures in the urban network

Cultural and spatial opportunities for integrated urban transformation of the climate adaptation of the polder water system and the possibility for sustainable heritage development in Amsterdam and the Amsterdam Metropolitan Area.

Spatial analysis: Identifying the potential spaces to increase the water infiltration and storage capacity.
Maximization scenario: Maximise the potential for water infiltration and storage in the city
Pattern language: Explore design solutions that give water structures more ecological and social values

A city scale plan to integrate the sustainable development of water-related heritage and the needed climate adaptation of the polder water system.

A pattern language that explores design solutions which integrate sustainable heritage development, socio-ecological integration and resilient poder water management

Spatial analysis: Identifying the potential spaces to increase cultural value with sustainable heritage development
Maximization scenario: Maximise the potential cultural connections in the city.
Pattern language: Explore design solutions that give historical structures more ecological, social or economic values

Research by design: Make design decisions based on the city scale maximisation scenario
Pattern language: Design examples to show the synergies and conflicts of integration sustainable heritage development and water resilient climate adaptation on a neighbourhood scale
Survey & literature review: Determine stakeholders demands and interests and power relations in governance.

Design proposals on a neighbourhood scale, based on the integrated plan on city and regional scale, that show the implementation of these strategies with the pattern language in the direct living environment.

3.2 METHODOLOGY FRAMEWORK

The methodology framework is a visual representation of the relation between the methods used to answer the sub-questions and the research and design outcomes aimed at in this project. Both research and design study will be done in parallel with the theoretical and conceptual framework at the core of this research. This will result in a city-scale typology which will form the basis to develop maximisation scenarios. The maximisations and typology will inform the integrated urban transformation plan, which will be implemented with design proposals that show the use of the pattern language in the direct living environment.

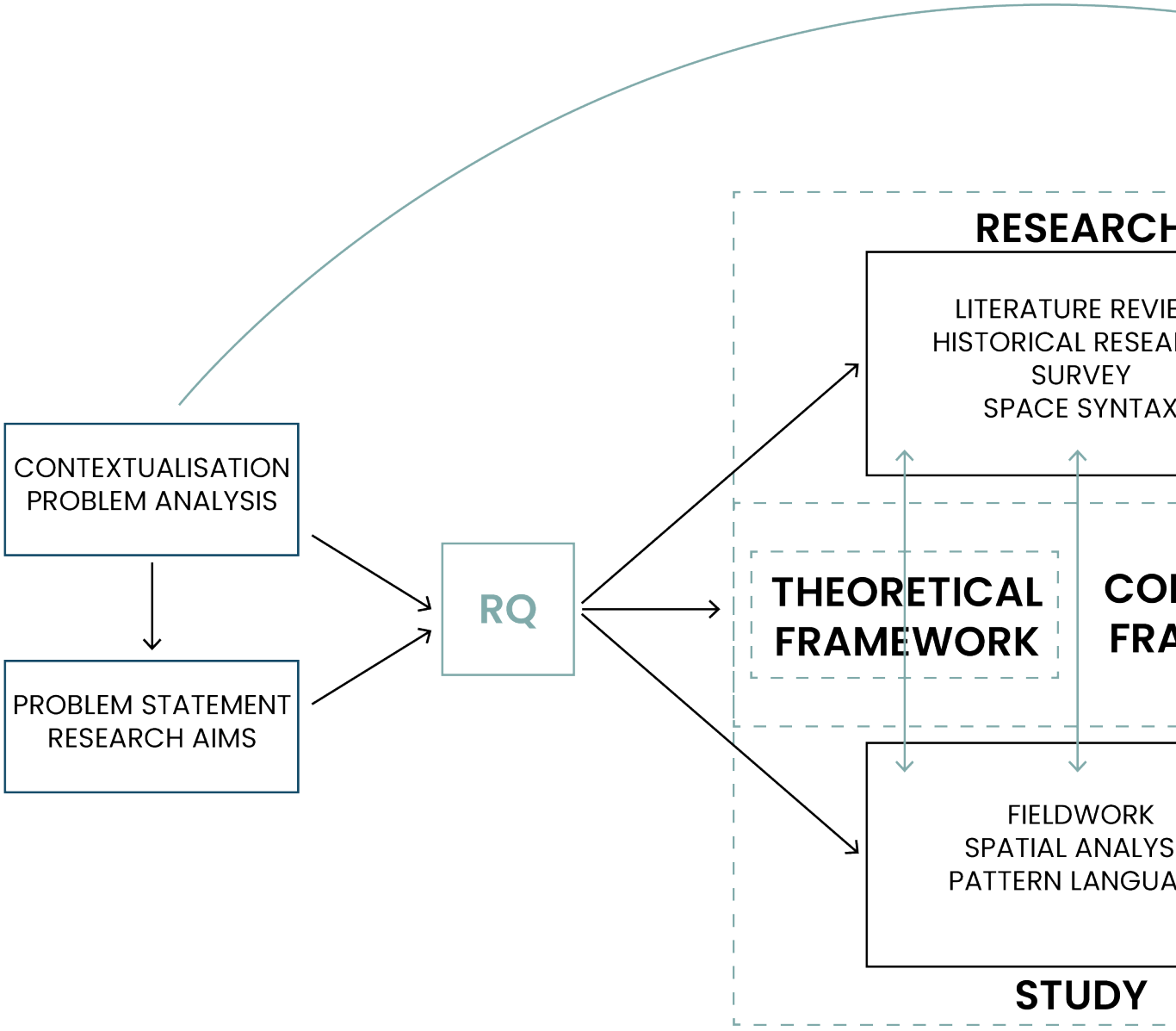
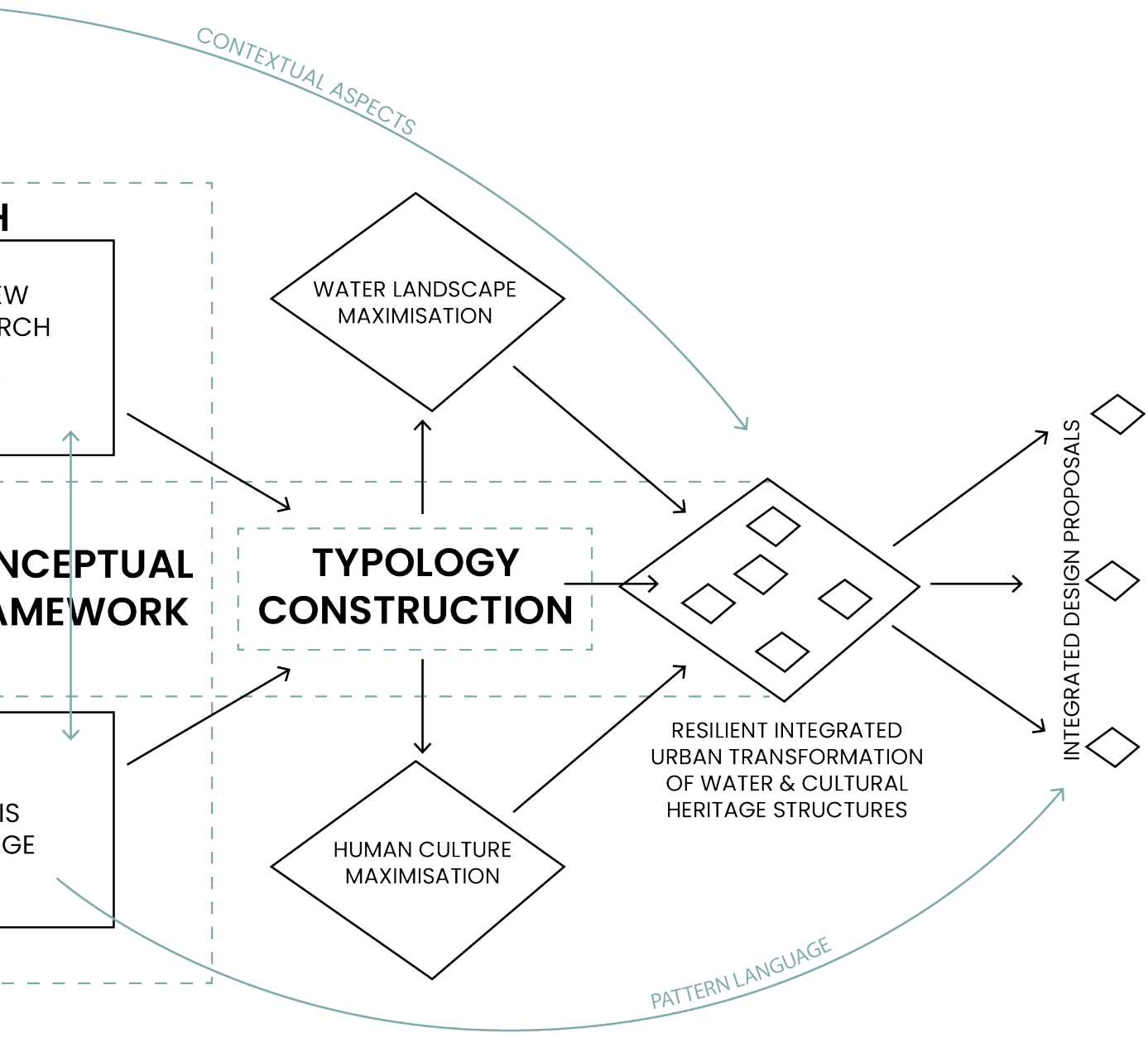


Figure 3.2: Methdology framework


CONTEXTUAL ASPECTS
H
EW
RCH
WATER LANDSCAPE
MAXIMISATION
NCEPTUAL
AMEWORK
TYPOLOGY
CONSTRUCTION
RESILIENT INTEGRATED
URBAN TRANSFORMATION
OF WATER & CULTURAL
HERITAGE STRUCTURES
INTEGRATED DESIGN PROPOSALS
IS
GE
HUMAN CULTURE
MAXIMISATION
PATTERN LANGUAGE

3.3 PROJECT TIMELINE

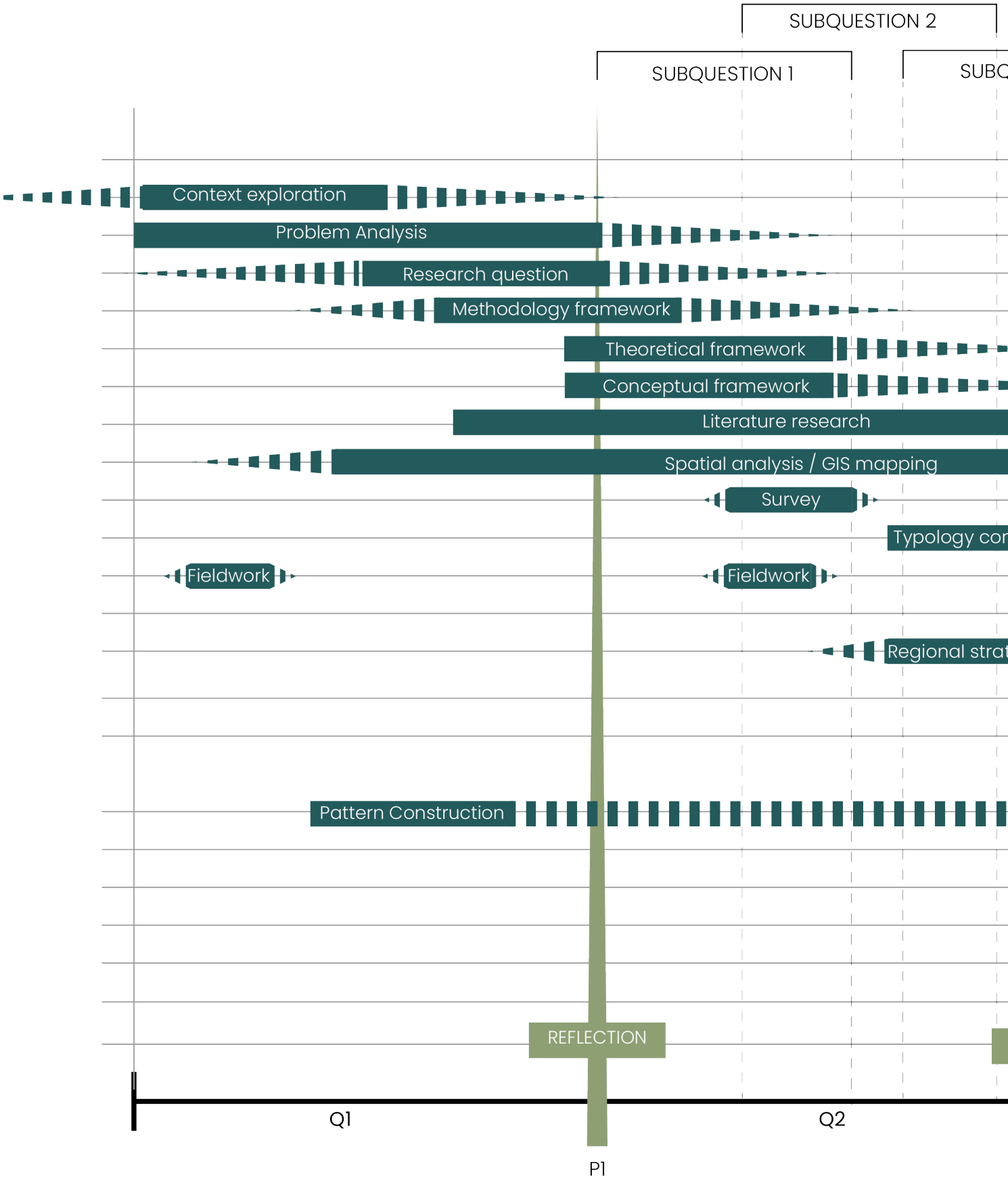
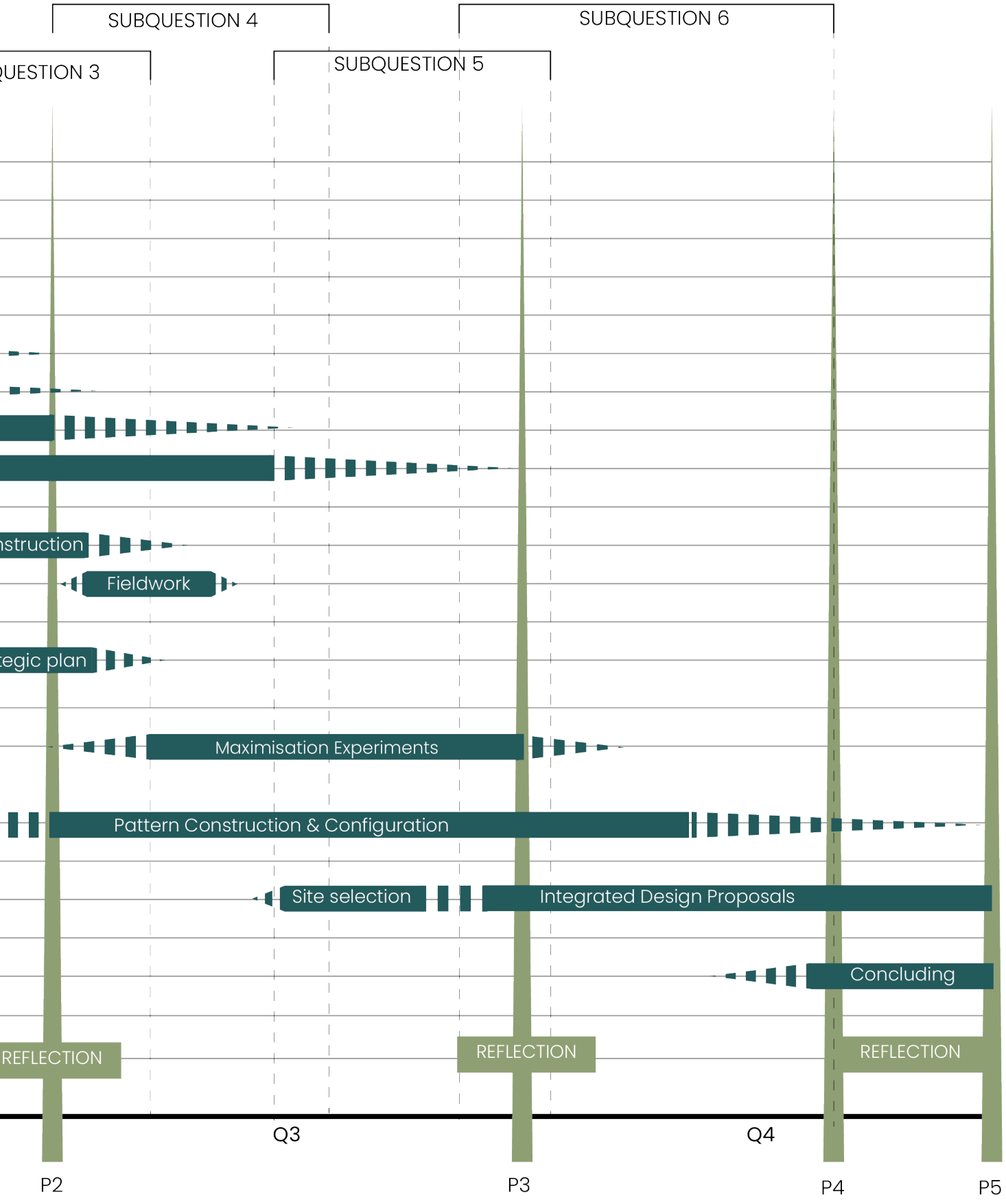


Figure 3.3: Project Timeline


SUBQUESTION 4
SUBQUESTION 6
QUESTION 3
SUBQUESTION 5
nstruction
Fieldwork
tegic plan
Maximisation Experiments
Pattern Construction & Configuration
Site selection
Integrated Design Proposals
Concluding
REFLECTION
REFLECTION
REFLECTION
Q3
Q4
P2
P3
P4
P5

3.4 THEORETICAL FRAMEWORK

The theoretical framework serves as the foundation of this project. It explains a set of existing ideas and concepts that help to understand and explore the complex aspects of urban development, dealing with climate changes, and preserving historic places. It guides the research project and informs how to solve the problems in the design project. A few key theories were chosen to focus on.

The two network strategy focuses on using water and traffic networks as carrying structures in city planning, framing the urgency to balance different needs and uncertainties. The foundation of this research lies in socio-ecological integration, which helps to understand how nature and people work together in cities. The theory of water and soil guiding is used as an important approach, highlighting the important role these natural elements play in deciding how cities should be planned. Resilience, a key goal of this project, is looked at in both socio-ecological systems and the built environment, focusing on how cities can adapt and transform. The theory behind sustainable heritage development explores how cultural assets can lead to sustainable changes in cities. By weaving these theories together, it is hoped to create a comprehensive approach to tackle the various challenges and opportunities where urbanism, climate resilience, and heritage preservation intersect.

TWO NETWORK STRATEGY

In the 1990s there was a big question to balance various needs in local and regional planning. It became more important to balance the local landscape, the city's diversity and the earth's capacity. The concept emerged to address this issue by using water and traffic networks as the carrying structures in the making of strategic plans (Tjallinigi, 2015). Carrying structures are robust structures that can cope with uncertainties, and frame the future urban development in the face of uncertain future phenomena like climate change. Since then the two networks strategy has evolved as a conceptual guiding model for planning and design projects in the urban landscape.

The model comprises a 'slow lane' and a 'fast lane'. In the slow lane, represented by the water network, the focus is on collaboration, landscape and heritage preservation, biodiversity, recreation and safety. On the other hand, the fast lane, symbolised by the traffic network, emphasises competitiveness, efficiency, productivity, and profit orientation. These two lanes complement each other and provide a framework for a parallel and multifunctional organisation of activities, connecting ecology with socio-economic processes (Tjallinigi, 2015). The model allows for flexible infills, however, in places where these two networks run directly next to each other conflicts occur. The fast and slow lanes have different uses. The basic idea is to upgrade and downgrade both networks based on the needs of the community or environment. At the same time, the framework allows for a diversity of comparable qualities in all directions, however, it will be diffuse at a larger scale. Tjallingii identifies three fields of integration between activities on the two carrying structures: area, flow, and actor perspectives. These perspectives consider how activities are situated in space, how they flow or interact, and who the involved actors are (Tjallingii, 2015).

The two network strategy utilises the water and traffic network as carrying resilience structures in urban planning. The structures lead to conflicts where the two networks directly intersect, because of their different uses.

SOCIO-ECOLOGICAL INTEGRATION

The combined term social-ecological system was first used by Berkes and Folke (1998) to emphasise the concept of 'humans-in-nature', arguing that the social and ecological systems are intertwined (Colding et al., 2022). More specifically the term social-ecological urbanism (SEU) has been increasingly researched to improve the resilience of the built environment by integrating the social and ecological systems in cities. It looks at how resilience principles can be linked to urban design. The SEU approach helps gain knowledge about how a multitude of sometimes conflicting social and environmental sustainability goals relate to urban density (Colding et al, 2022). Colding et al (2022) introduce four important characteristics of the SEU-approach

1. The "eye-level" experience of the city: Samuelsson et al (2019) refer to the analytical scale of SEU as the 'eye-level scale'. Which can be understood as the level where people in the street experience the city and where urbanism in its original sense was meant to be enacted (Colding et al, 2022). It recognises that the way people experience the city has a significant impact on their well-being and quality of life.

2. Urban form and accessibility to social services: This characteristic emphasises the importance of urban form in shaping the accessibility of social services. It shows that the physical layout of the city can have a significant impact on people's ability to access social services such as healthcare, education, and public transportation. Adequate planning and configuration of urban form can help to promote social and ecological sustainability. An important analytical theory to understand the configuration of space is the Space Syntax theory. The space syntax theory analyses how spatial configurations and layouts of built environments influence human behaviour and social interactions (Hillier & Hanson, 1984).

3. Ecosystem services in urban planning and design: This characteristic emphasises the importance of considering ecological development in urban planning and design decisions. It recognises that urban areas are part of larger ecological systems and that urban planning and design decisions can have significant impacts on these systems. Considering the ecological consequences of urban planning and design decisions can help to promote climate change-proofing qualities and promote ecological learning in society.

4. The role of institutions in shaping sustainable and resilient cities: This characteristic emphasises the importance of institutions in shaping sustainable and resilient cities. It recognises that institutions play a key role in the management of urban ecosystems and in shaping societal change in more sustainable directions. Adequate institutional frameworks can help to promote social and ecological sustainability.

Socio-ecological integration emphasizes the interdependence of social and ecological systems to enhance resilience. It focuses on the 'eye-level' experience, and integrating social and ecosystem services in urban design.

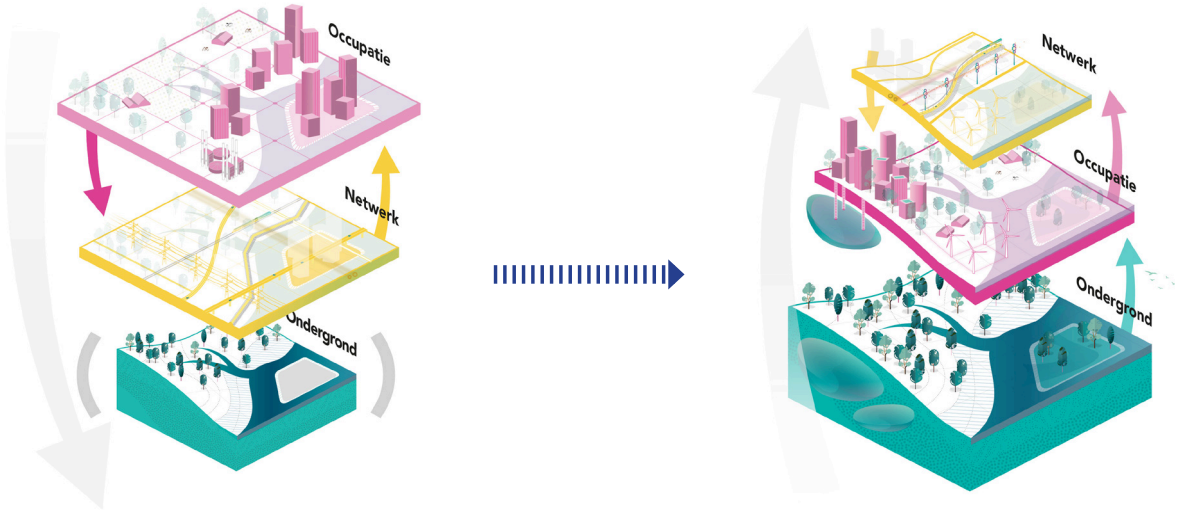
WATER & SOIL GUIDING

Due to technological development, the Dutch landscape is not restricted by natural conditions. The construction of dikes, dams and polders and the creation of new islands have reshaped the land. In the last centuries, urban development has been driven by economic activity, existing infrastructure and the proximity of available space (H+N+S Landschapsarchitecten et al., 2022). This manipulation of natural conditions has led to an imbalance within the conventional layer approach, with the occupation and network layers taking precedence over the natural layer.

Consequently, this transformation has exposed the Dutch landscape to increasing vulnerability in the face of climate change. In the long term, the security of the most vulnerable regions becomes uncertain. Moreover, the use of technological measures creates a static landscape, which limits flexibility and adaptability in the future.

In response to these challenges, the national governments, supported by scientists, announced a new strategy to counter this development: water and soil as guiding principles for spatial planning. Trying to create nature-inclusive solutions and a dynamic and resilient delta landscape. The natural layer is the starting point for spatial planning (Ministerie van Infrastructuur en Waterstaat, 2022).

Figure 3.4: A new perspective on the layer approach



Source: H+N+S Landschapsarchitecten et al. (2021)

Water and soil guiding is the strategic approach in spatial planning that prioritizes the natural layer to create dynamic, resilient solutions in the face of climate change.

RESILIENCE

Resilience science is the academic discourse that addresses and studies disruptions in complex adaptive systems, primarily ecosystems. While there exist several different definitions, the most dynamic interpretation is ecological resilience, which studies the amount of disturbance that can be absorbed before a system changes its structure (Colding et al., 2022). The future of human well-being can be seriously compromised if we pass a critical point that tops the Earth system out of the stability it has been in for the last 10,000 years (Folke et al, 2010). Resilience in this context is the capacity of a socio-ecological system to continually change and adapt yet remain within critical thresholds. Adaptability is part of resilience and represents the capacity to adjust responses to changing external drivers and internal processes and thereby allow for development along the current stability domain (Folke et al, 2010). By contrast, transformability has been defined as "the capacity to create a fundamentally new system when ecological, economic or social structures make the existing system untenable" (Walker et al. 2004). Looking at attempts to quantify resilience different sets of properties can be identified in studies of general resilience (Walker & Salt, 2012). Studies of a variety of social-ecological systems suggest diversity, openness, reserves, modularity, and redundancy are all important characteristics of systems with high levels of general resilience. Systems with rigid, efficiency-driven, top-down control and management, on the other hand, have little adaptive capacity and often have low levels of general resilience (Walke r& Salt, 2012).

In this thesis, there are two systems of resilience to take into account. The first is the resilient polder water system, where the focus is on the adaptability of this system within its current boundaries. The second system refers to the temporal dimensions of the built environment and in particular the cultural heritage sites in cities. The future adaptability or transformability of the polder water system will highly influence the built environment in cities. The resilience of cultural heritage depends on the adaptability of the built form to the adapted polder water system or the transformability of the built form and social structures to determine new resilient socio-ecological systems.

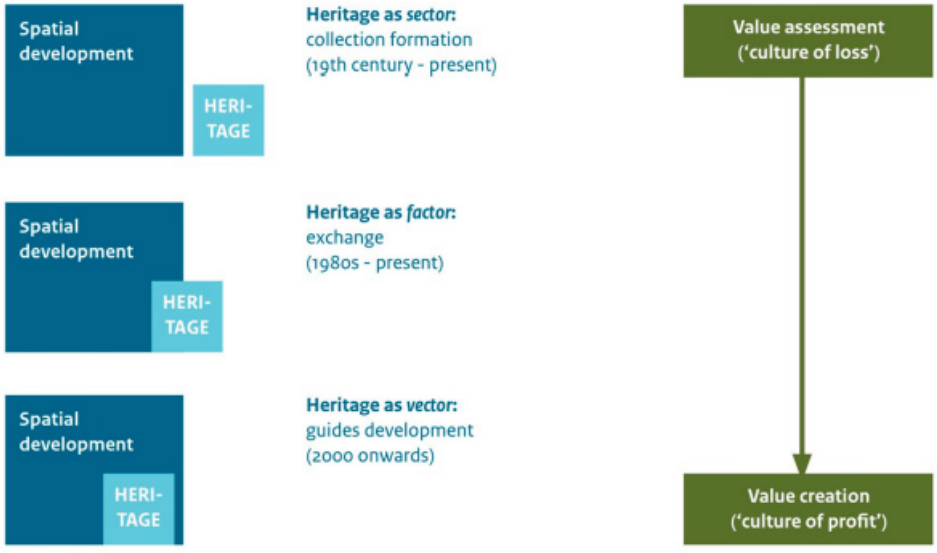
Resilience encompasses the adaptability and transformability of socio-ecological systems to navigate and adjust to disturbances, ensuring the sustainability and well-being of these systems over time.

SUSTAINABLE HERITAGE DEVELOPMENT

Sustainable development, a concept that gained prominence in the late 20th century, represents an approach to societal progress that seeks to balance economic, social, and environmental considerations to meet the needs of the present without compromising the ability of future generations to meet their own needs. The roots of sustainable development can be traced back to landmark events in the 20th century, including the Brundtland Report (1987) the United Nations Conference on Environment and Development (UNCED) and Earth Summit (1992). In 2015 the term sustainable development was operationalised with the 17 sustainable development goals (United Nations, 2015). It provides a shared global blueprint for peace and prosperity for people and the planet, now and into the future. They acknowledge that the ending of poverty and related deprivations should be accompanied by approaches that enhance healthcare and education, reduce inequality, promote economic development, and simultaneously address climate change while striving to protect our oceans and forests (United Nations, 2015).

Sustainable heritage development is a term not commonly used in the academic discourse but can be understood as the process of managing and transforming tangible cultural heritage in a way that ensures its long-term viability and benefits for the social-economic services in Amsterdam, while also balancing the environmental considerations. Heritage can be used as the vector that guides sustainable urban development, supplying it with a historical narrative (Janssen et al., 2017). Using heritage sites as a catalyst for urban transformation focuses on activities aimed at safeguarding heritage assets while considering the broader impacts on the surrounding communities and the environment.

Figure 3.5: The evolution of the Dutch heritage planning nexus



Source: Janssen et al (2017)

Sustainable heritage development involves the management of cultural heritage to ensure it benefits social-economic and ecological services in Amsterdam, using heritage as a guiding vector for urban development.

3.5 CONCEPTUAL FRAMEWORK

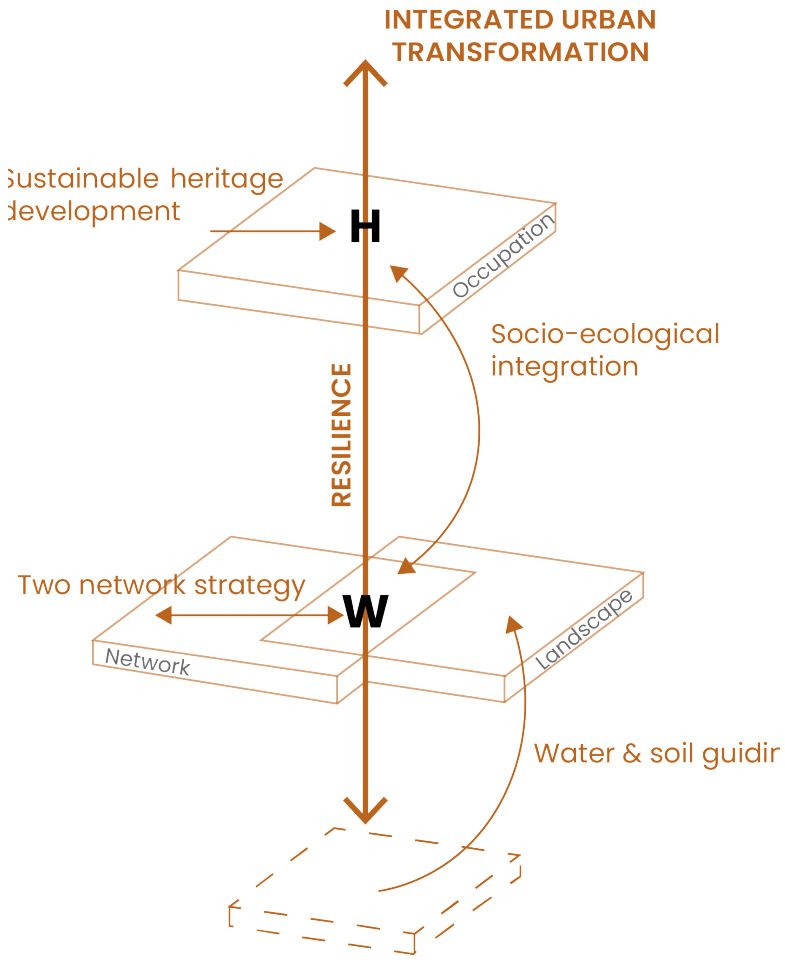


Figure 3.6: Conceptual relationship of the theoretical framework

The conceptual framework represents the relationship between the various theories explained in the theoretical framework and the physical operationalisation in the layers of spatial planning (Figure 3.6). In the context of this project water and soil are guiding principles for spatial planning. They are not just the fundamental neglected bottom layer but are equally important as the network layer. These layers together highlight the carrying structures of the city, the water and the traffic network, these layers have conflicting values as explained in the two network strategies. But together complement each other in the city's network. Together, these layers delineate the foundational structures of urban infrastructure.

This project primarily centres on the city's water structures. The focus is the relation between the landscape and occupation layers, emphasising the symbiotic relationship between human-centric social services and ecological services. Water-related heritage serves as a crucial link between these layers, spotlighting the importance of structures associated with water and historical identity. Heritage values are important in the socio-cultural sphere. However, their physical manifestations and their tangible architectural forms primarily reside within the occupation layer. Sustainable development, derived from cultural values, happens within the occupation layer.

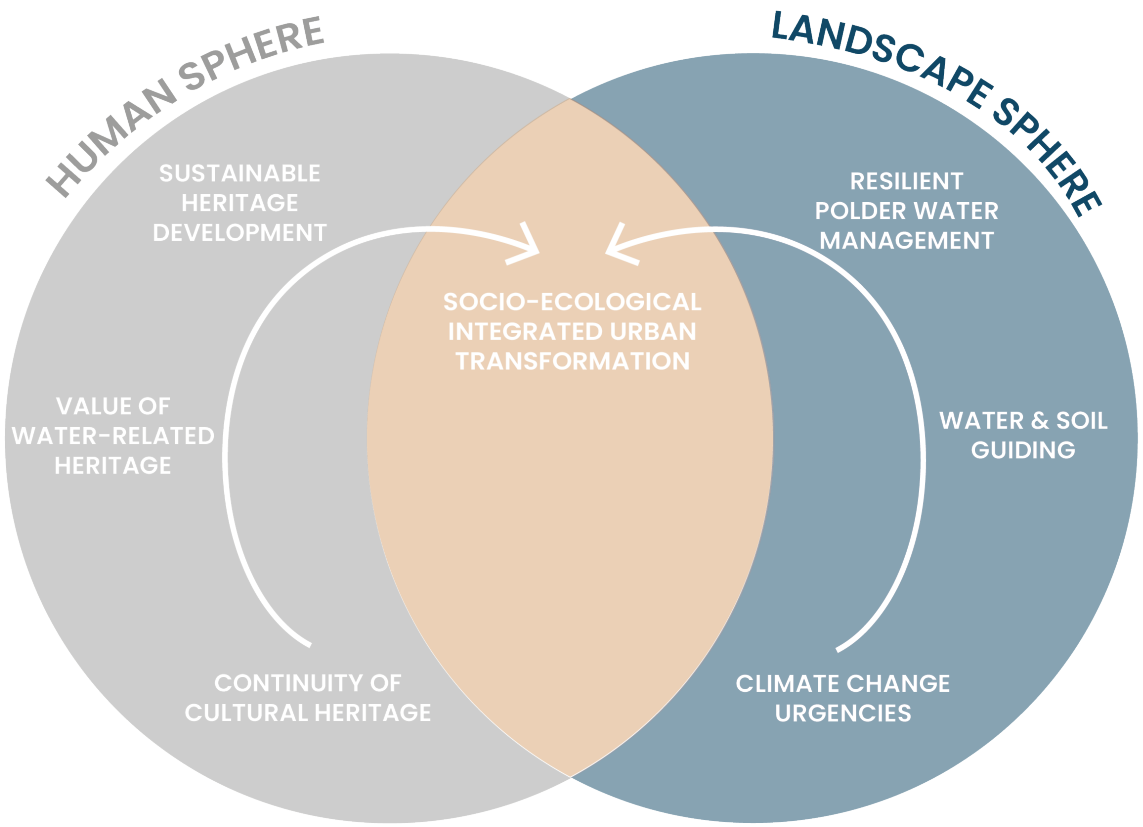


Figure 3.7: Conceptual design vision

The overarching vision of this project is to integrate the human and landscape spheres in the city (Figure 3.7). Both of these spheres hold important values for life in cities, suggesting a potential for mutual evolution. The values often rooted in the cultural history of the city are manifested in the physical built form. The continuity of cultural heritage, results in valued tangible artefacts that humans are emotionally invested in, this allows for the sustainable development of water-related heritage. On the other hand, the increasing climate change urgencies have led to a policy change in which planners must seek the adaptability and thus resilience of the polder water system. Socio-ecological integration meets the needs of the future while adding social and ecological services to the city. This idea of combining socio and ecological values is a key theme in how the city plans for the future. For example, improving the city's water system needs support from the community. At the same time, cultural landmarks linked to water can help the city's water system become more resilient. The three concepts: sustainable heritage development, resilient polder water management and socio-ecological integration can be considered the integrated design goals of this project.

By integrating the theoretical framework and design vision it becomes clear that this project's main focus is an integrated urban transformation throughout all three layers of spatial planning. This is done by combining the landscape and human strengths. Together this will improve the resilience of the water and heritage structure city. The conceptual framework in Figure 3.8, shows this complete image.

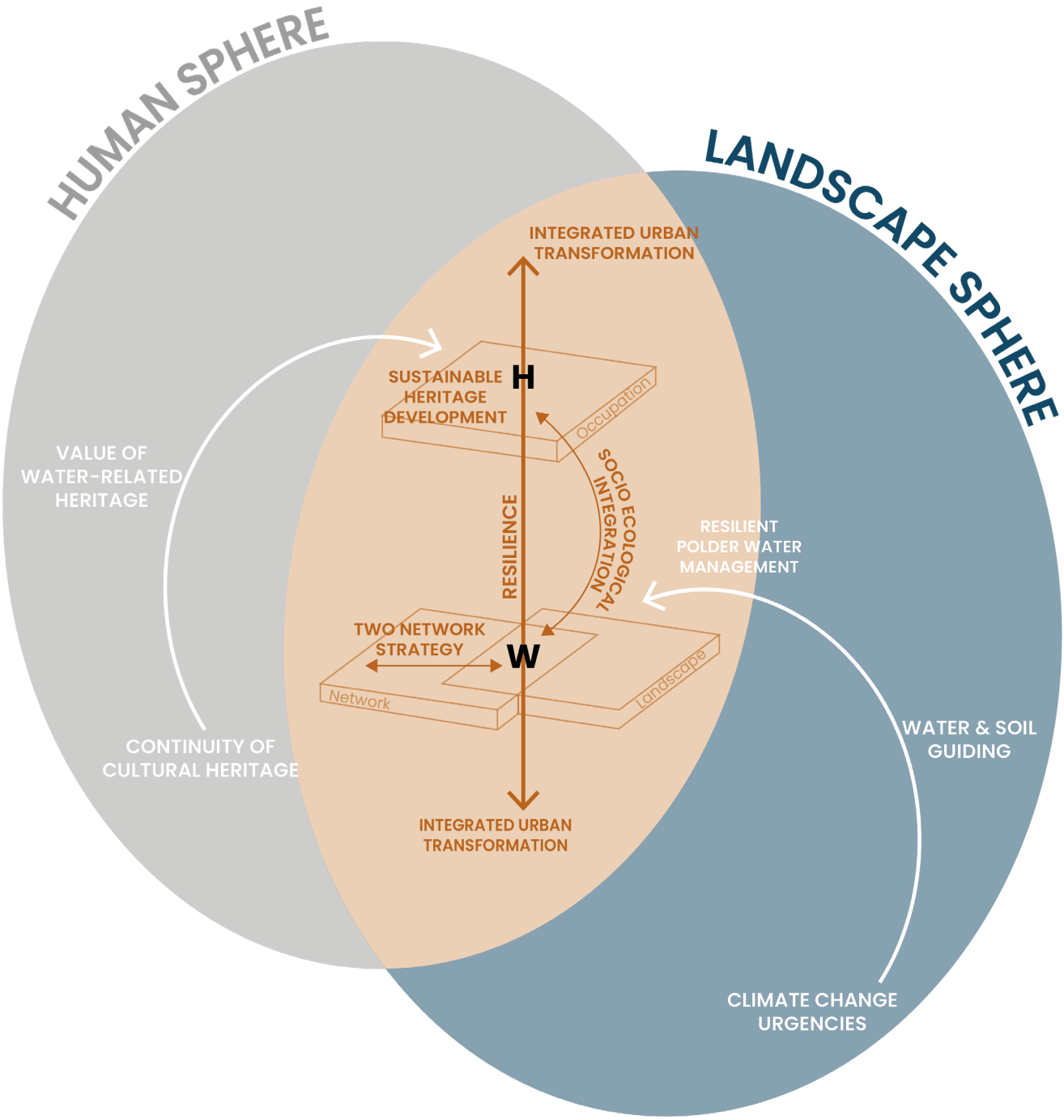
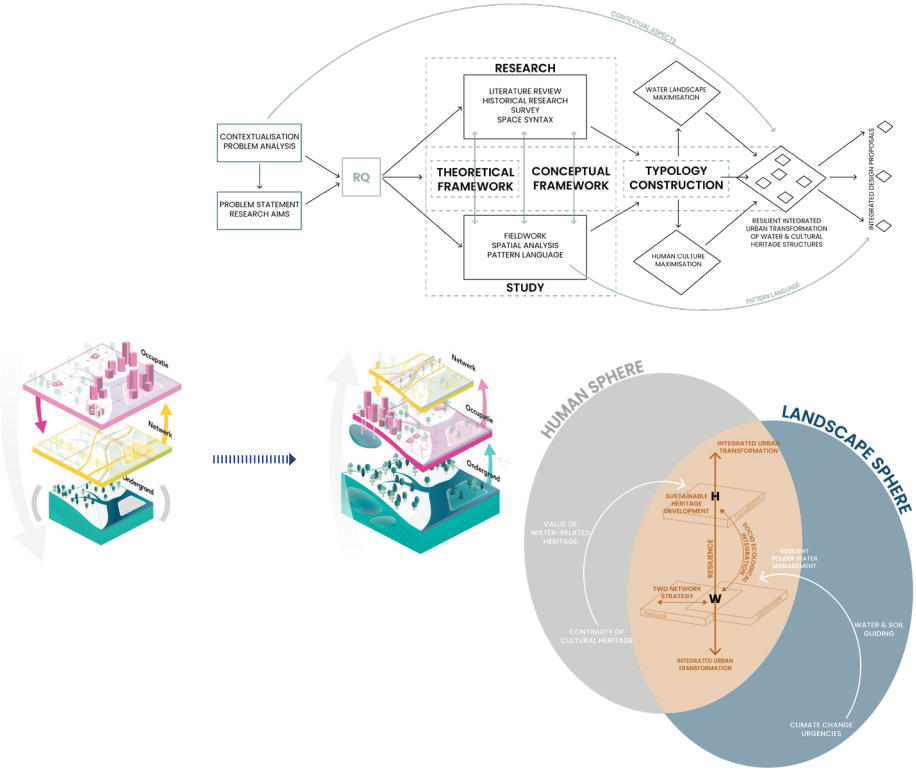


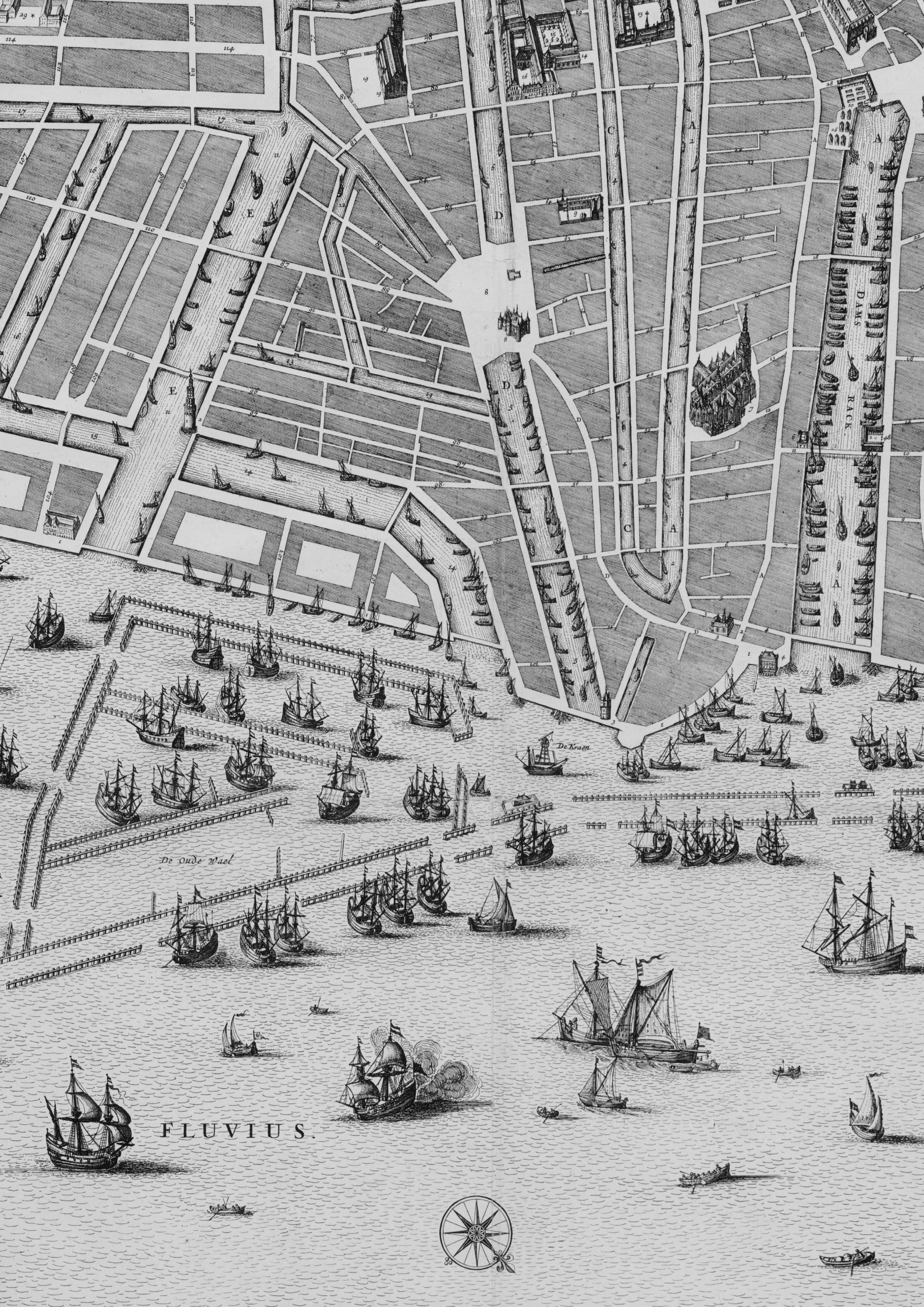
Figure 3.8: Conceptual framework


CONTEXTUAL ASPECTS
RESEARCH
CONTEXTUALISATION
PROBLEM ANALYSIS
PROBLEM STATEMENT
RESEARCH AIMS
RQ
LITERATURE REVIEW
HISTORICAL RESEARCH
SURVEY
SPACE SYNTAX
THEORETICAL FRAMEWORK
CONCEPTUAL FRAMEWORK
FIELDWORK
SPATIAL ANALYSIS
PATTERN LANGUAGE
STUDY
WATER LANDSCAPE MAXIMISATION
TYPOLOGY CONSTRUCTION
HUMAN CULTURE MAXIMISATION
RESILIENT INTEGRATED URBAN TRANSFORMATION OF WATER & CULTURAL HERITAGE STRUCTURES
INTEGRATED DESIGN PROPOSALS
PATTERN LANGUAGE
Occupatio
Network
Underground
Network
Occupation
Underground
HUMAN SPHERE
LANDSCAPE SPHERE
INTEGRATED URBAN TRANSFORMATION
SUSTAINABLE HERITAGE DEVELOPMENT
H
RESILIENCE
ADAPTIVE CAPACITY
RESILIENT POLDER WATER MANAGEMENT
VALUE OF WATER-RELATED HERITAGE
TWO NETWORK STRATEGY
W
WATER & SOIL GUIDING
CONTINUITY OF CULTURAL HERITAGE
INTEGRATED URBAN TRANSFORMATION
CLIMATE CHANGE URGENCIES

CONCLUSION CHAPTER 3

Chapter 3 shows how the main research question is split into six sub-questions that are combined into four intended outcomes: Spatial and cultural opportunities for integrated urban transformation, a pattern language, an integrated city plan and integrated design proposals on neighbourhood scale.

A few key theories were chosen to focus on in the theoretical and conceptual framework. Their relationship is shown based on the three-layer approach in spatial planning. The focus of this project is the relationship between the landscape and occupation layers. Water-related heritage serves as a crucial link between these layers. The overarching vision of this project is to integrate the human and landscape spheres in the city. By integrating the theoretical framework and design vision it becomes clear that this project's main focus is an integrated urban transformation throughout all three layers of spatial planning. With the focus on three design goals: sustainable heritage development, adaptable polder water management and socio-ecological integration


DAMS
RACK
De Kraen
De oude Wael
FLUVIUS.

CHAPTER

4

CULTURAL OPPORTUNITIES

4.1	AN INTRODUCTION TO HERITAGE MANAGEMENT	52
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4.4	RESIDENTS VIEW ON CULTURAL HERITAGE VALUES OF WATER	60
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Chapter 4 answers the first sub-question: What are the cultural values of the water identity of Amsterdam? It explains the historical and contemporary values of the water structures in the city. It introduces heritage values and heritage management. The contemporary values are assessed with the cultural heritage values taxonomy. This is done via a survey of the citisens of Amsterdam.

Figure 4.1: Platte-Grondt Van De Oude En Nieuwe Royinge Der Stede Amsterdam
Source: Stadsarchief Amsterdam / Daniël Stalpaert (1688)
Black & White Adaptation

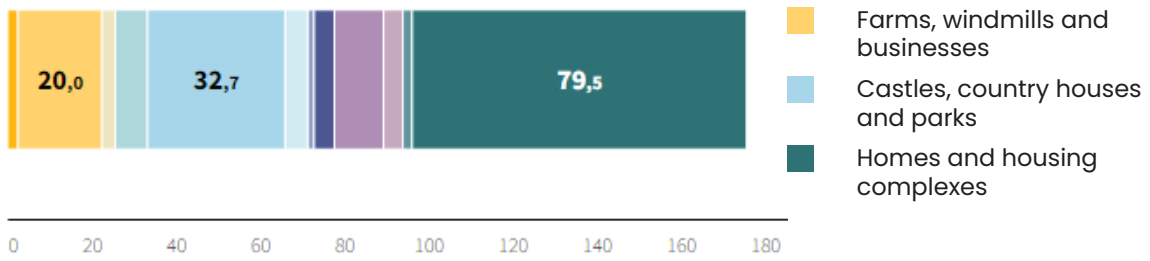
4.1 AN INTRODUCTION TO HERITAGE MANAGEMENT

In the Netherlands, there are different scales in heritage management. Managing and preserving this heritage considers different levels of significance. UNESCO world heritage is the most prominent status, followed by national heritage, provincial heritage and municipal heritage.

- UNESCO World Heritage Sites: The Netherlands is home to several UNESCO World Heritage Sites, globally recognised for their outstanding cultural or natural significance. These sites are for example the historic city centre of Amsterdam and the Hollandse Waterlinie (water and fortification structure). The protection and preservation of these treasures go beyond national boundaries, underscoring a shared responsibility to safeguard humanity's collective heritage (UNESCO World Heritage Centre, n.d.).
- National heritage (Rijksmonumenten en nationaal erfgoed): At the national level, the Netherlands designates certain structures, areas, or objects as national monuments. These carry significance for the entire country, representing pivotal moments in Dutch history, exceptional architectural achievements, or critical cultural symbols. National monuments are protected by national laws and regulations (Rijksdienst voor het Cultureel Erfgoed, 2020).
- Provincial heritage (provinciale monumenten): Two of twelve provinces in the Netherlands have provincial heritage, one of them is Noord-Holland. These heritage sites have a position between municipal and national monuments and consist of for example dike structures, infrastructural elements and windmills (Monumenten.nl, 2023).
- Municipal monument (gemeentelijke monumenten): Municipalities across the Netherlands play a crucial role in heritage preservation by designating specific sites as municipal monuments. These could include buildings, parks, or districts that hold particular importance to the local community. While not carrying the same national or global recognition. Amsterdam has a long list of municipal monuments (Monumenten.nl, 2023a).

Many heritage sites in the Netherlands have a relationship with the water structure. They are dams, dikes, windmills or water engineering objects. Taking a quick look at the three UNESCO world heritage sites in the AMA it is clear that they all tell a part of the history of water values and water management.

Figure 4.2: National heritage in the AMA in main categories



Source: RCE - Erfgoedmonitor (2022)

Heritage in Numbers

	AMA		Amstedam
UNESO world heritage	3		1
National heritage	11.658		7.698
Provincial heritage	323		23
Municipal monuments	N/A		7647

Figure 4.3: UNESCO world heritage in the AMA

Dutch water Defence Lines

Source: Capital Press Schiphol via RCE (1977)

Criterion (ii): The exhibit of an important interchange of human values over time or within a cultural area of the world
Criterion (iv): An outstanding example of an extensive and ingenious system of military defence by inundation.
Criterion (v): The Dutch Water Defence Lines form an extraordinary example of the Dutch expertise in landscape design and hydraulic engineering.

Reclaimed polder De Beemster

Source: Bouma via RCE (1959)

Criterion (i): The Beemster Polder is a masterpiece of creative planning.
Criterion (ii): The innovative landscape of the Beemster Polder had a profound impact on reclamation projects in Europe
Criterion (iv): The creation of the Beemster Polder marks a major step forward in the interrelationship between humankind and water at a crucial period of social and economic expansion.

17th century canal ring Amsterdam

Source: van Gool via RCE (1976)

Criterion (i): It is a masterpiece of hydraulic engineering and town planning.
Criterion (ii): It is witness to an exchange of influences over almost two centuries, it was the capital of the world-economy in its day.
Criterion (iv): The type of Dutch single dwelling with its variety of façades and gables. The city is testimony, at the highest level, to a significant period in the history of the modern world.

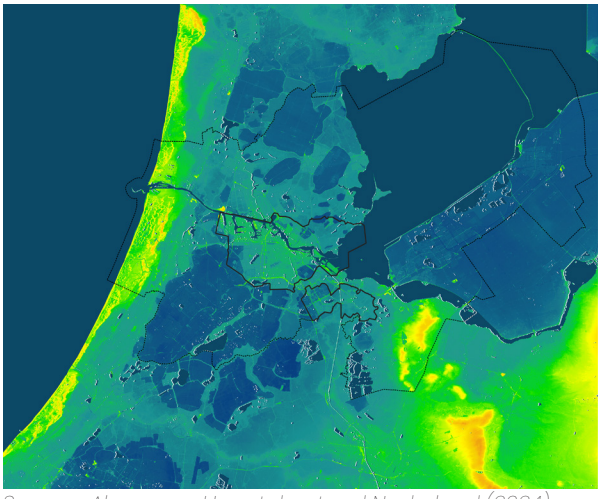
Source: UNESCO world Heritage convention (2023)

4.2 HISTORICAL VALUES OF WATER

Living with natural powers

Before 800 the natural powers were dominant in the delta landscape. It was impossible to build a living environment in the marshlands where the forces of wind and water had free reign (Hooimeijer, 2011). Most early settlements in the Netherlands were founded on higher land, along rivers and on sandy ridges at the coast (Burke, 1956). This is still visible in Figure 4.2. Around these early settlements, the first drainage system in the peat landscape took place, allowing for agriculture and livestock farming. The groundwater from the higher peat landscape drained towards the lower riverbeds through small ditches dug into the landscape. This was possible as long as the river water level was low enough, if the river water level became too high a simple sluice prevented the water from entering the peat landscape. With this technique, it became possible to use large-scale peat landscapes for economic profit (Meyer, 2016).

Figure 4.4: Amsterdam founded on higher grounds



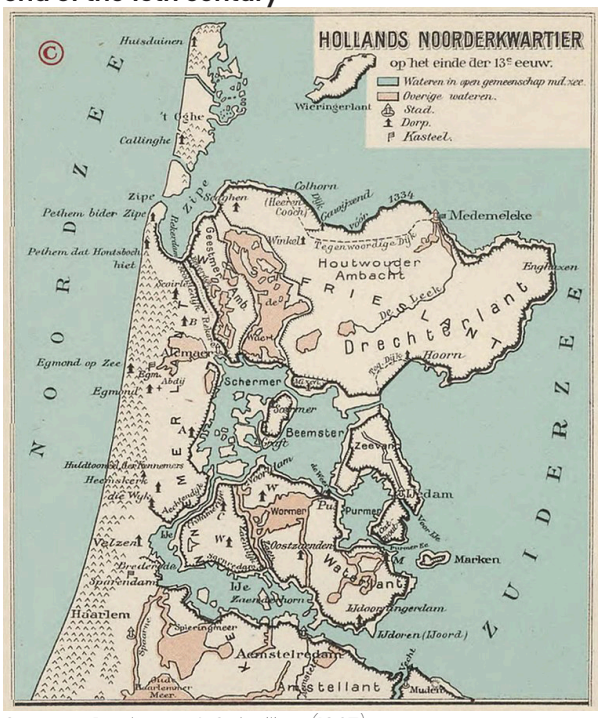
Source: Algemeen Hoogtebestand Nederland (2024)

Water as the driver for urban development

In the 10th century, a change in attitude shifted the focus from acceptance of nature towards the defence against nature. The dike as a means of protection allowed the settlements and their physical-geographical circumstances to be altered to facilitate living. The dike enabled water, in the form of a harbour to be introduced into the settlement (Hooijmeijer, 2011). The period from about 1000 to 1500 is referred to as the 'great reclamation' of agricultural land (Hooijmeijer, 2011). In this era, the windmill was introduced for drainage, which allowed water from ditches to be discharged into peat streams and rivers. However, it is discovered that peat can be used as fuel and therefore peat is mined on a large scale. This results in a landscape with walls and lakes that is very vulnerable to storms and subsidence, and consequently a lot of reclaimed land is lost to the water when storms breach the walls, see Figure 4.3 (Hooimeijer, 2011). This is how the lakes in northwestern Holland were formed.

The dam in the river Amstel dates back to the 13th century. The dam was the central element in the hydraulic system of the city, regulating the water level with the dam sluice. At the same time, the dam was the most important public space, allowing for the transhipment of goods and trade markets (Hooijmeijer et al, 2005). Water formed not only the main structure of the city but also the main transport route between cities. Allowing

Figure 4.5: Hollands Noorderkwartier end of the 13th century



Source: Beekman & Schuiling (1927)

for farmers, traders and merchants from the region to gather in the economic centre of Amsterdam. The first small expansion of Amsterdam was based on the optimisation of the water drainage system, the Achter- en Voorburgwallen. In the 17th century, water was at the core of the economic boom in Amsterdam, with the canals being the centre of world trade. The canal ring, designed in 1612, was meant to show off the technological advancement in water management. The soil extracted by digging the canals in the polder ditches was used to elevate the ground level for building sites. De Jordaan, followed the structure of the peat drainage system, because of time and budget constraints (Abrahamse et al, 2014). The canal ring was an important part of the urban fabric providing space for trade, traffic and housing (Meyer, 2016).

Figure 4.6: Amsterdam city plan 1588

Source: Stadsarchief Amsterdam / Plantijn (1588)

Figure 4.7: Amsterdam city plan 1665

Source: Stadsarchief Amsterdam / Stalpaert (1665)

Water as a defence structure

Early settlements already used water as a defence structure against unwanted invaders. Canals and fortifications were constructed around cities, using existing water bodies. In the war against the Spanish in the 16th century cities often pierced dikes to flood polders (Meyer, 2016). As a follow up the Hollandse Waterlinie was constructed as a major fortification stretching from the Zuiderzee to the Biesbosch, see Figure 4.6. It was constructed by connecting different polders, that could be flooded at the same time, which protected the cities in western Holland from the French armies in 1672. In the 19th century, the fortification was extended with the Stelling van Amsterdam, but this inundation system has never been used.

Figure 4.8: Waterlinies in the Netherlands

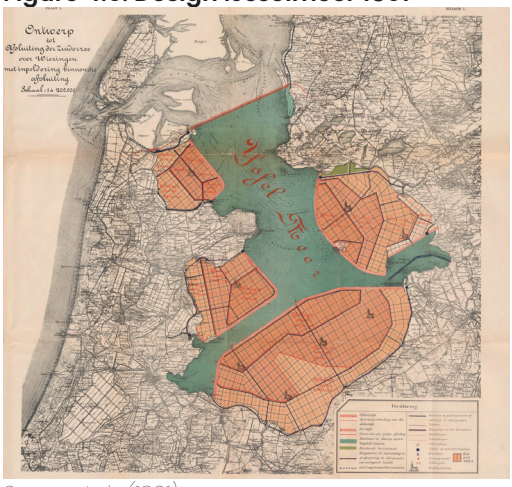
Source: Van Oosten via Ministerie van Defensie (n.d.)

Water losing its function

After 1850 city walls lost their military function and could be removed, allowing for the city to expand to accommodate industrial activities and population growth. With new energy sources like steam and electricity and later petrol, transport modes like the train and car became dominant in urban development (Hooijmeijer et al, 2005). Water lost its function as transport infrastructure. Many canals and lakes were drained to make space for new neighbourhoods or car infrastructure. The urban development followed the logic of the car infrastructure. Amsterdam kept its economic importance with the construction of the Noordzeekanaal, allowing for large-scale harbour and industrial development in the Amsterdam Metropolitan Area (Meyer, 2016). Because the pumping stations were more advanced and solved many of the water problems, the water network in the new residential areas became less dense (Engel et al., 2021)

At the same time protecting the delta from water was now a national concern. The construction of the Afsluitdijk transforming the Zuiderzee into the IJsselmeer was next to water safety also of economic concern. The reclamation of the different polders showed the great feasibility of increasing the agricultural land surface (Meyer, 2016). It would protect Amsterdam and at the same time be a model for a modern economy. The Afsluitdijk was a successful experiment for water management techniques and spatial planning, prominently shaping the whole country. However, the design of the new land was controversial. Was it meant to be purely agricultural land or could it house the new capital of the Netherlands, showing the pride of modern planning? Cornelis van Eesteren, at this moment already known for his Expansion plan for Amsterdam, made different variations for the design of Lelystad, not only focusing on the city being an agricultural centre. Next to that, he designed nature and recreation areas, showing that the polder should be more than an agricultural landscape (Meyer, 2016). At this point the urban design and water management techniques develop separately, water is not a primary part of the urban plan anymore.

Figure 4.9: Design IJsselmeer 1891



Source: Lely (1891)

Figure 4.10: Noordzeekanaal 1886

Source: Stadsarchief Amsterdam / Otten (ca 1876)

Value of water in the contemporary city

At the end of the 20th century, there was renewed attention to water in the city. This had several causes. First of all, there was a lot of protest against the disappearance of ecological valuable nature in cities. Secondly, protests against dike strengthening in the 1980s have led to a more cultural-historical valuation of river landscapes. Moreover, large outer dike areas in cities lost their function due to the relocation of harbour activities. These areas became available for redevelopment. Lastly in the post-modern era, there is a lot of attention to identity. Water is often put forward as a factor strongly contributing to the identity of cities in the Netherlands (Hooimeijer et al, 2005).

The battle against water has been replaced by working with water and building with nature. This not only considers nature as added value but also preserves the resilience of the natural system as a fundamental component of a water safety strategy (Meyer, 2016). This implies that there is way more space needed for water and additionally for gradual transition zones between water and land. The positive contribution of water to the resident's ecological services offers the combination of natural systems with the intensification of economic and demographic activities to ensure the resilience of the urban waterfront. This needs to be combined with the intensification of economic and demographic activities in the urban fabric.

Figure 4.11: Canal pride parade in the 17th century canal ring

Source: De Swart via Metro Nieuws (2020)

Figure 4.12: Summer evening at the Amstel River

Source: Van Soolingen via Het Parool (2016)

4.3 THE CULTURAL HERITAGE VALUE TAXONOMY

To have an informed approach and assessment regarding the preservation of cultural elements, it is important to identify the cultural significance. Attributes are the elements to be conserved (the what) and values are the reason why something should be conserved (Tarrafa Pereira Da Silva & Pereira Roders, 2021). Cultural values are the reasons supporting the classification and conservation of cultural heritage. They form the basis for designating an asset as cultural heritage, which must be preserved for the enjoyment of present and future generations. Values can be extrinsic and, therefore, subjective, but also intrinsic and, therefore, objective. In other words, although perceptions may change, some values remain, changing with time but not in time (Tarrafa Pereira Da Silva & Pereira Roders, 2021). Pereira Roders (2007) introduces the cultural heritage value taxonomy in which she distinguished cultural values, based on publications and charters of international heritage conservation associations like ICOMOS. She identified and described the cultural values mentioned since the Renaissance into eight categories (primary values), which, in turn, are divided into parameters with their respective definitions. The four values recognised in the Convention for the Protection of World Heritage are historical, aesthetic/artistic, scientific, and social (UNESCO, 1972). They are integrated with the three pillars of sustainable development: Ecological, economic, and social values, along with political and age values mentioned multiple times in the analysed document (Tarrafa Pereira Da Silva & Pereira Roders, 2021).

Figure 4.13: Cultural heritage value overview

Source: Pereira Roders (2007)

Figure 4.14: Cultural heritage value taxonomy

	Parameter	Description
HISTORIC	Educational	Important contribution to the development of knowledge and consequently to civilisational progress
	Historic-Artistic	The best example of a mark of a particular individual's work, being unique or best among peer, exceptional
	Historic-Conceptual	Material or concept relates to historical styles or movements
	Symbolic	Milestone of something past (event, milestone etc.)
	Archaeological	They contain archaeological evidence that refers to ancient civilisations
AESTHETIC	Artistic	Original product of creativity and imagination
	Notability	Individual brand of the creator, contains a signature
	Conceptual	Materialisation of concepts related to styles, discourses and artistic movements
	A testimony	Authentic example of a decade, within a style/discourse of the time, positions the building within the history of art and architecture
SCIENTIFIC	Handcrafted	Unique product of human labor, using traditional techniques
	Technological	Ingenuity, technical qualities and materials
	Conceptual	Materialisation of technological and engineering concepts
SOCIAL	Spiritual	Beliefs, religion, collective imagination (stories, legends), organised religion
	Intrinsic emotional	Part of individual identity, relating to memory or personal life experiences
	Collective emotional	Collective memory and experience: cultural identity, motivation and collective pride
	Allegorical	Part of allegory, related to social status, appearance and figurative perception
ECONOMIC	Use	Market value
	Non-use	The former use and non use value must be taken into account, no market value
	Entertainment	Permanent or temporary animation; economically values the building
	Allegorical	Economic status
ECOLOGICAL	Spiritual	Degree of harmony between the building and its surroundings
	Essential	Sustainability piece, determines the identification of ecological ideologies in its design and construction
	Existential	Existence of reusable or recyclable materials, shapes and component. Take into account the human and energy resources used in its transformation and effectively know which contents are in good condition and must be replaced (effective ecological value)
POLITICAL	Educational	Formation of mentalities, didactic political instrument
	Management	Production of an administration strategy, part of urban management plans
	Entertainment	Your role contributes to the civil society, tool to instill pride
	Symbolic	Symbolic piece, related to power, authority and prosperoty
AGE	Handcrafted	Temporality of the materials and construction techniques contained
	Maturity	In contains marks/changes from different users and generations, being the materialisation of their memory
	Existential	Existence of reusable or recyclable materials, shapes and components paying attention to the maintenance

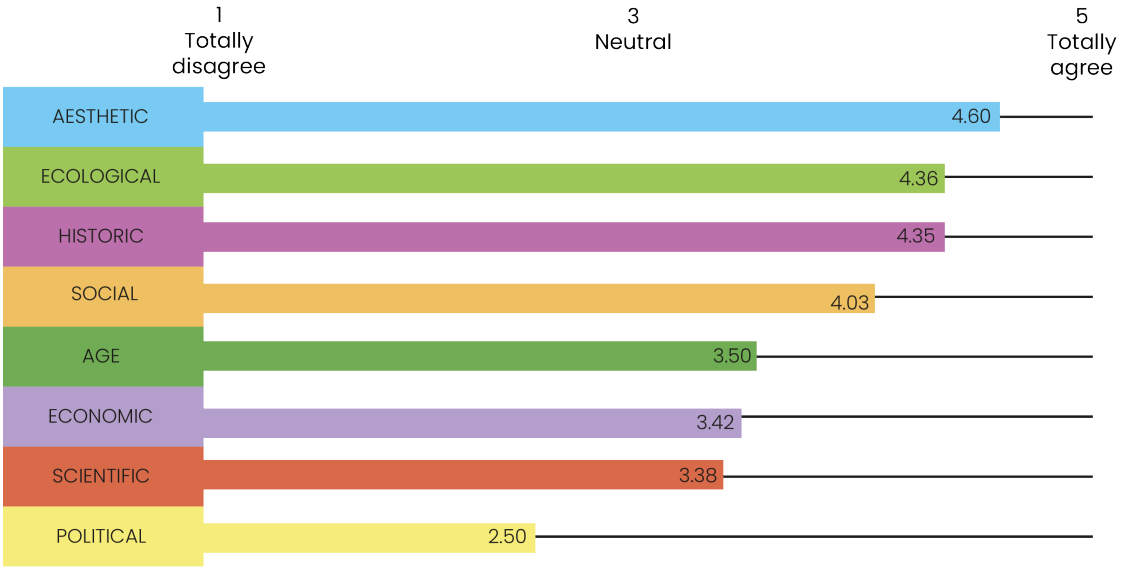
Source: Tarrafa Pereira Da Silva & Pereira Roders, 2021

4.4 RESIDENTS VIEW ON CULTURAL HERITAGE VALUES OF WATER

To determine the cultural heritage values of the water identity in Amsterdam, an online survey was conducted which posed the question to Amsterdam residents how they valued the water in their living environment. In advance, it was explained that cultural heritage possesses cultural value. Water can be a valuable structure in the city, but is not always considered cultural heritage. The participants were asked to rate to what extent they associate one cultural heritage value with the water in the city. They would rate this on a scale from 1 (totally disagree) to 5 (totally agree). In the visualisation, the average responses for every heritage value are shown.

The online survey gained a valuable understanding of how the water structures in the city relate to the cultural heritage values. It becomes clear that water has the most aesthetic value, followed by both historical and ecological value in a joined second place. Thirdly social value scores relatively high. The respondents are neutral about scientific, economic and age values. It becomes clear in the follow-up open question that some respondees have a job related to the water in the city and therefore it is likely that they relate economic or scientific value to the water structures, while other respondees do not. Political value is least associated with the water structures in the city.

Figure 4.15: Cultural heritage values of water in Amsterdam, average rating



This visualisation is based on 109 respondees

In Figure 4.16, the heritage values ratings are split per district. It becomes clear that there are a few different outcomes depending on the district. However, it can't be determined if people kept in mind their local district, their daily commute or the whole city while filling in this question. First of all, there are a few districts with only 1 or 2 responses and consequently, these outcomes are not objective and trustworthy. The most important pattern is that aesthetic value has the highest rate overall. Ecological value is rated higher in many of the neighbourhoods at the edge of the city, while aesthetic and historical value are lower. In the inner city, aesthetic and historical value are rated higher than ecological value. Historical value is rated especially low in some post-war neighbourhoods.

Figure 4.16: Cultural heritage values of water per district

Respondees had the possibility to add or explain why they do or don't value the water in Amsterdam. A selection of these responses is visible on this page. A variety of answers all had some thematic overlaps. It can be concluded that water is part of the historical narrative of the city and plenty of residents feel that as they cycle through the city. On top of that it is the crucial character of the city which both residents and tourists find aesthetically pleasing and therefore brings in money. Many residents value water as nature in the city and as a recreational space. Water is often associated with the essence of life and biodiversity. Healthy water has many benefits while polluted water is strongly detested. Lastly, multiple people mention water being important for the (urban) climate and on top of that respondents mention water creating openness in the urban fabric and therefore providing for a peaceful atmosphere.

In conclusion, the cultural values of the water identity in Amsterdam have evolved. While in the past water had an economic or defence-related value, today it mainly provides nature in the city and contributes to people's health and recreational possibilities. The main cultural heritage values that are associated with the water are aesthetic, historical, ecological and social values. However, as visible on this page, there are many different values associated with water and therefore it proves to be a key urban element that fosters pride in the city and has a positive effect on the living environment of the citisens.

HISTORICAL CHARACTER OF THE CITY

Water is undeniable an integral part of Amsterdam, both in the historical city centre and in the suburbs (where I live).

It is the image of the city!

It is part of the character of Amsterdam.

Without the water Amsterdam would not be what it is today

It always feels special cycling along the historic canals

IMPORTANT NATURE IN THE CITY

It makes the environment interesting and has value for the many animals in the city

I value the water because it provides and protects the nature in the city.

Important nature in the city

Healthy water is amazing for the biodiversity and makes the city prettier.

HEALTH

Water also contributes to people's health. Sometimes the water is really polluted and that is really bad, therefore I do not think it has ecological value

I value to be able to swim in open water in different locations, recreational value

AESTHETIC AND SOCIAL VALUE

It is typical for the city for both its residents and the tourists. The water tells a historical narrative and has been an important contributer to the city's history.

For me the water is also related to having fun (swimming, boating or ice skating)

Pride of the city

Aesthetically pleasing in my living environment

I used to swim in the IJ as a kid and that had a lot of social value for me

ECONOMICAL VALUE

I've had a job as a skipper and now I am a tourist guide, so my job depends on the water

I value keeping my feet dry because I own a house in the city, so the water system also has ec-nomic value for me.

Water brings in money because of all the tourists it attracts

OPENNESS IN THE URBAN FABRIC

Because of the water I don't feel locked up between all the stone buildings in the city

Water in the city creates a sense of open space and peace

Water determines the nice atmosphere in the city

Canals create openness and make the city more peacefull

URBAN CLIMATE

Water is good for the urban climate

It brings coolness in summer

4.5 CULTURAL SPATIAL OPPORTUNITIES IN AMSTERDAM

In addition to the cultural heritage values respondents of the online survey were asked to elaborate on the way they use the urban waterfront. This resulted in a variety of activities people either already do in, on or around the urban water or activities they would wish there was more space available for. These results are used as input for the construction of a pattern language and can eventually be used for the design proposal (Figures 4.17 and 4.18).

Figure 4:17: For what activities do you use the urban waterfront?

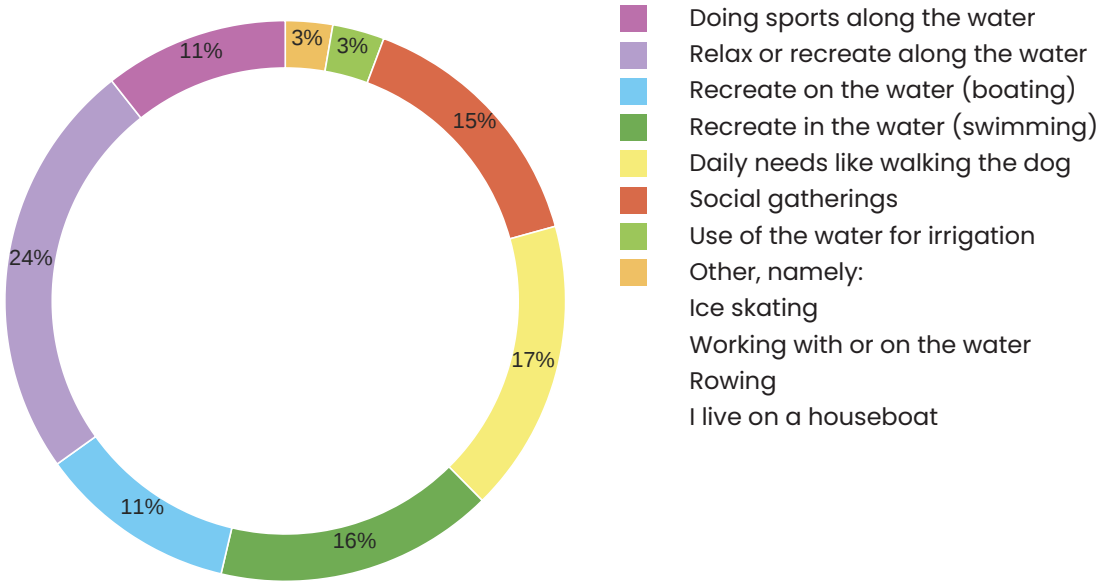
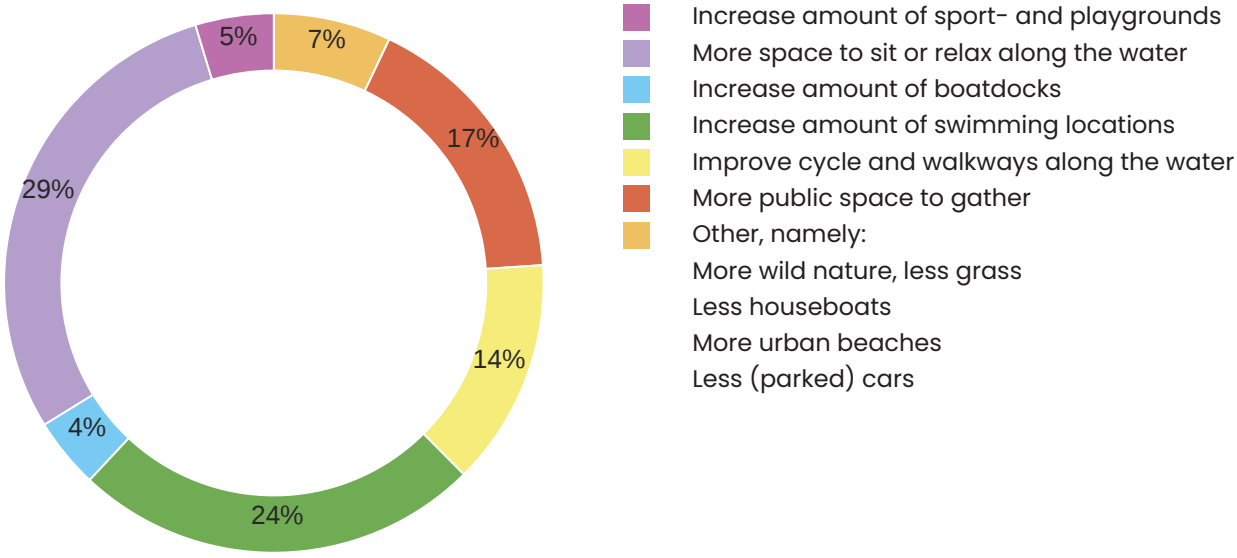


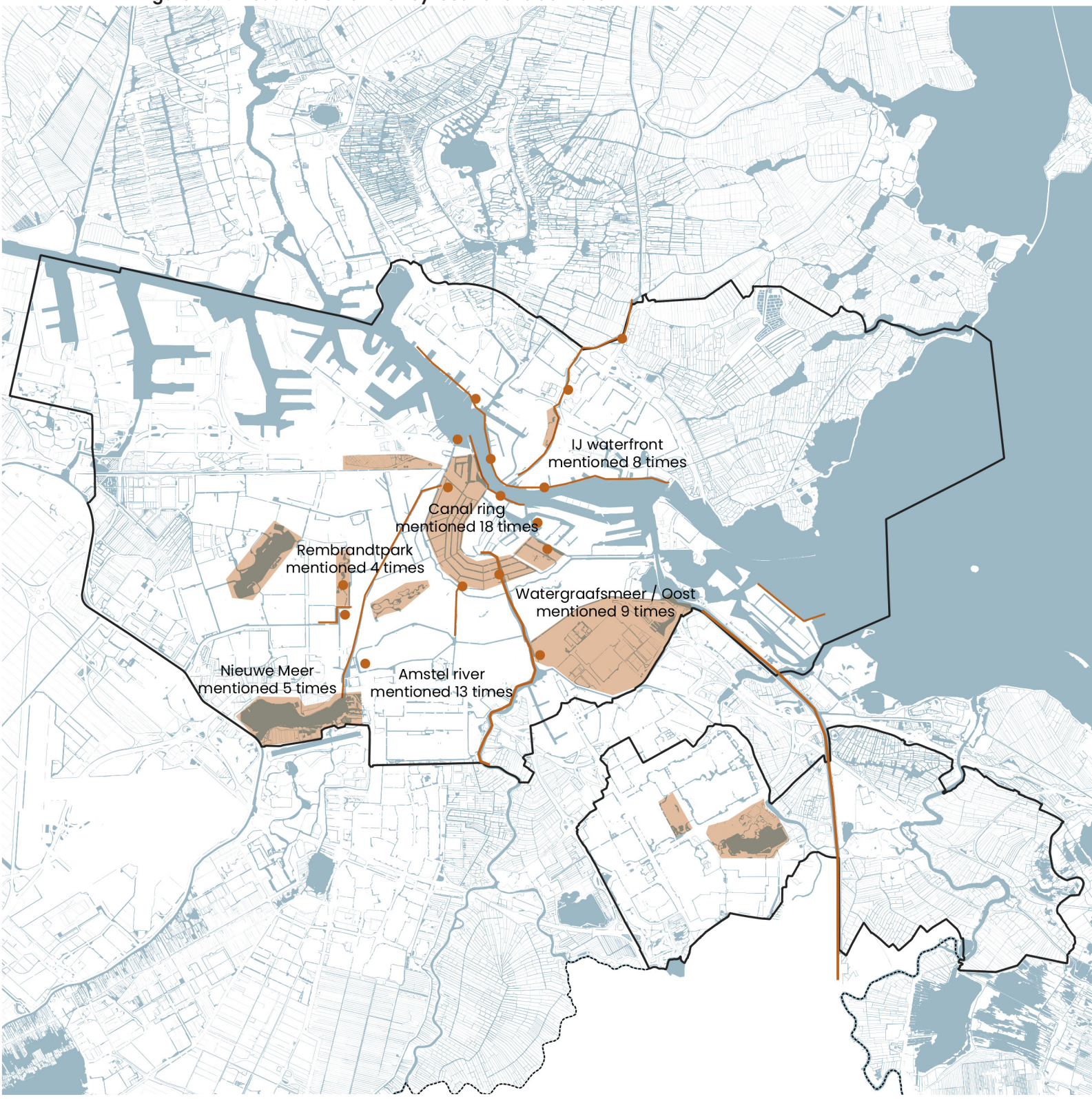
Figure 4.18: For what activities should there be more attention or necessary space?



These visualisations are based on 100 respondees

Finally, people were asked to mention key waterfront locations they would like to improve in the city. From Figure 4.19, It can be concluded that people in general mention the already existing parks and recreational areas and the most historical waterfront like the IJ, the river Amstel and the canal ring. They often mention that these urban waterfronts are underused and car-dominated.

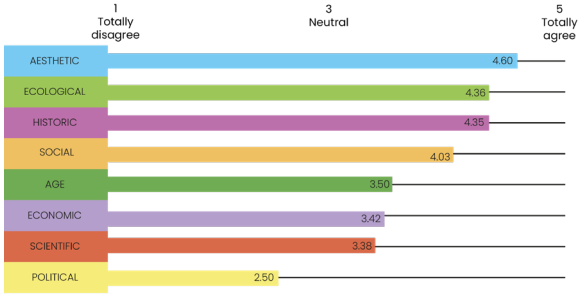
Figure 4.19: Visualisation of the key locations to activate



This visualisations is based 64 respondees

Specific location
Often mentioned areas
Mentioned water structures or waterfront

Scale: 1:125.000


1
Totally
disagree
3
Neutral
5
Totally
agree
AESTHETIC
4.60
ECOLOGICAL
4.36
HISTORIC
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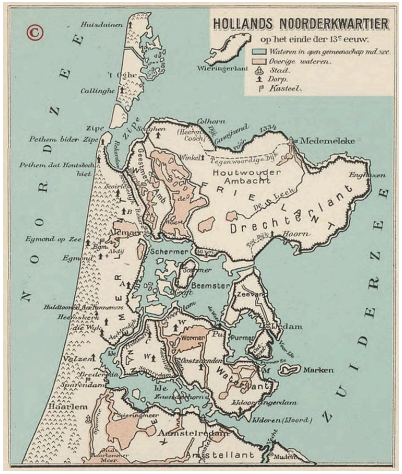
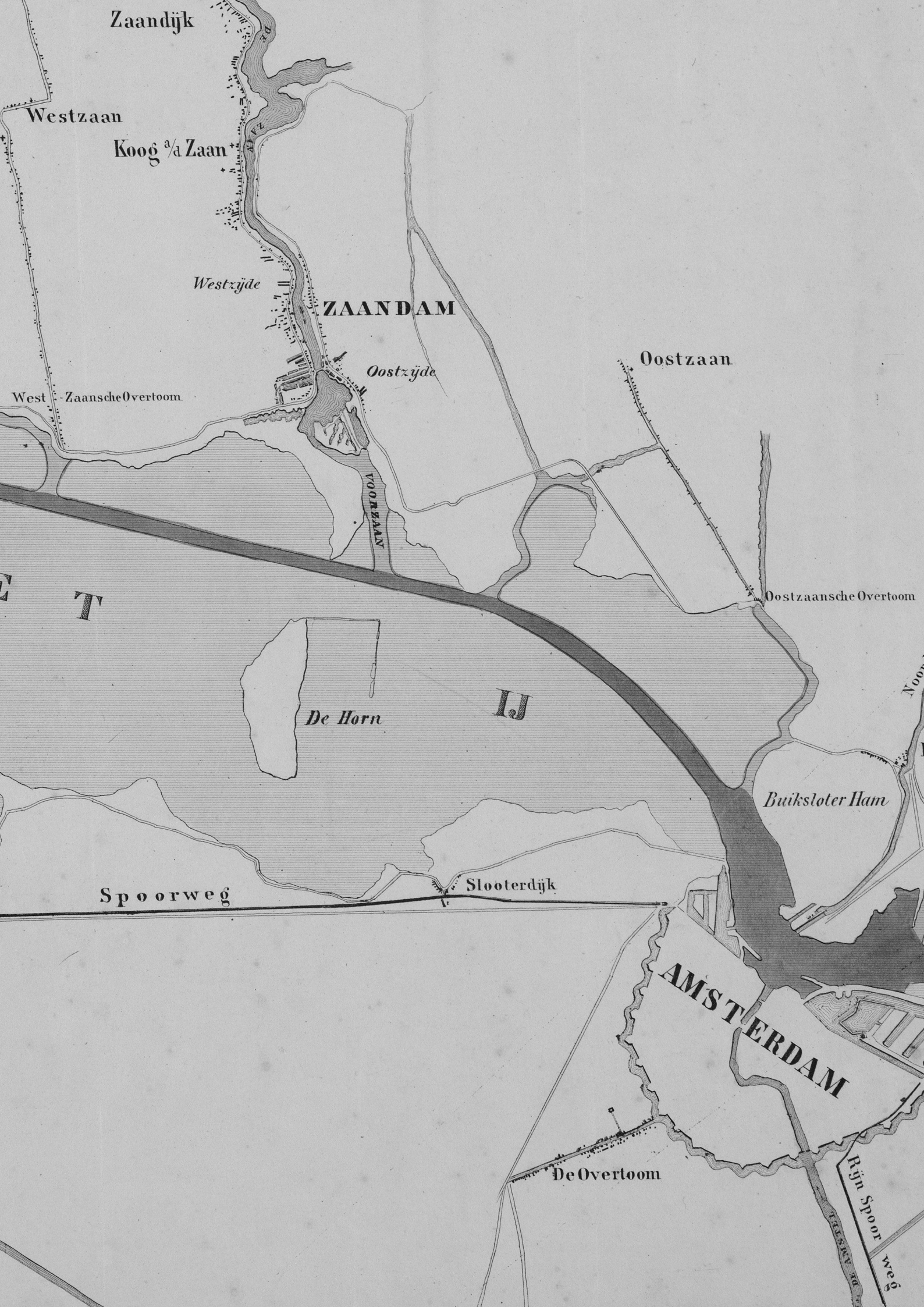
SOCIAL
4.03
AGE
3.50
ECONOMIC
3.42
SCIENTIFIC
3.38
POLITICAL
2.50


HOLLANDS NOORDERKWARTIER
op het einde der 13e eeuw.
Houtwouder Ambacht
Drechterland
Medemelekе
Scharmer
Beemster
Purmer
Markеn
Haarlem
Amstelrecht
N O O R D Z E E
U I T E R Z E E

CONCLUSION CHAPTER 4

Chapter 4 has explored the past and contemporary cultural values of the water identity in Amsterdam. It shows that these values have changed over time. Once water had primarily economic and defence-related values, but nowadays water serves as an important historical element in the urban fabric that is valued for its contribution to the ecology in the city, social activities and recreational opportunities. Water has a multifaceted role in shaping the city's identity and fosters a sense of pride among its residents. Insight into residents' activities related to the urban waterfront highlighted the opportunity to improve access to the urban waterfront improving its cultural heritage values.


Zaandijk
Westzaan
Koog a/d Zaan
Zaan
Westzijde
ZAANDAM
Oostzijde
Oostzaan
West Zaansche Overtoom
VOORZAAN
Oostzaansche Overtoom
De Horn
IJ
Buiksloter Ham
Spoorweg
Slooterdijk
AMSTERDAM
De Overtoom
Rijn Spoor weg

CHAPTER

5

ANALYTICAL FRAMEWORK

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Chapter 5 answers the second and third sub-questions. A literature review combined with spatial analysis is used to determine the needed transformation potential for resilient water management, sustainable heritage development and the urban network potential on both the metropolitan and city scale.

Figure 5.1: The Canal through Holland and the designed land reclaimation
Source: Frans Bouma & Zonen (1863) via Noord-Hollands Archief / Collectie 560, 271
Black & White Adaptation

5.1 ANALYSIS OF THE POLDER WATER SYSTEM

In the historical values of water, it becomes clear that the structure of the polder originated from (1) the subsidence due to peat mining (2) wind and water having free reign and transforming these low landscapes into lakes and (3) the reclamation of this land for urban expansion and agriculture. Due to this process, the polder water eventually became a lot lower in altitude than the boezem. The boezem is the water structure that drains water from the polder to the open water. At first, the boezem was at the same level as the polder water, but due to subsidence and drainage the polder water lowered and a pumping station was needed to pump water from the polder towards the boezem (Bobbink, 2016). To drain the water from the polder to the boezem windmills were used, which were later replaced by steam and electric pumping stations (Figure 5.2). Dams in rivers, like in Amsterdam, transformed the river from an open water body into a boezem. At first, sluices were used to drain the water from the boezem into the open water which had a natural flow during low tide. Later pumping stations were also used to drain the water from the boezem into open water, to make sure consistent drainage was possible from the polders to the boezem into the open water.

Amsterdam consists of a patchwork of polder and boezem structures. The whole system is a closed system (Figure 5.4). The IJ & Noordzeekanaal are part of the boezem Amstelland, Vecht, Noordzeekanaal, Amsterdam Rijnkanaal and can be separated from the North Sea and IJsselmeer with a sluice. However, the Noordzeekanaal has the role of open water for the Schermerboezem and Rijnlandsboezem which drain their boezem water into the Noordzeekanaal (Figure 5.3). This results in the fact that the Noordzeekanaal is a real bottleneck in the water system. The IJsselmeer, while closed off from the sea, is considered an open-water body.

Figure 5.2: Section general polder-boezem system

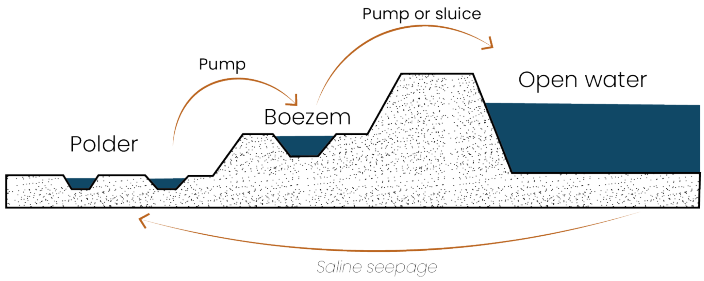


Figure 5.3: Section polder-boezem system in Amstelland-, Vecht-, NZK-, ARK- boezem

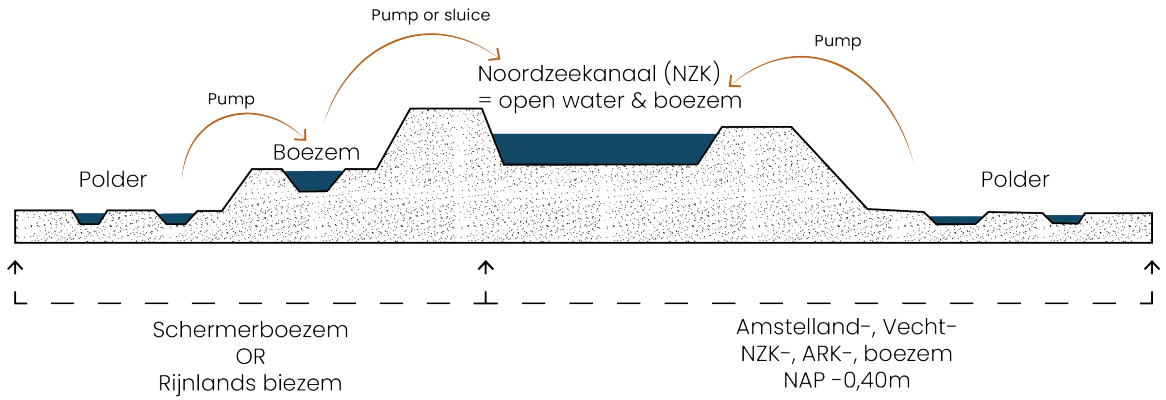
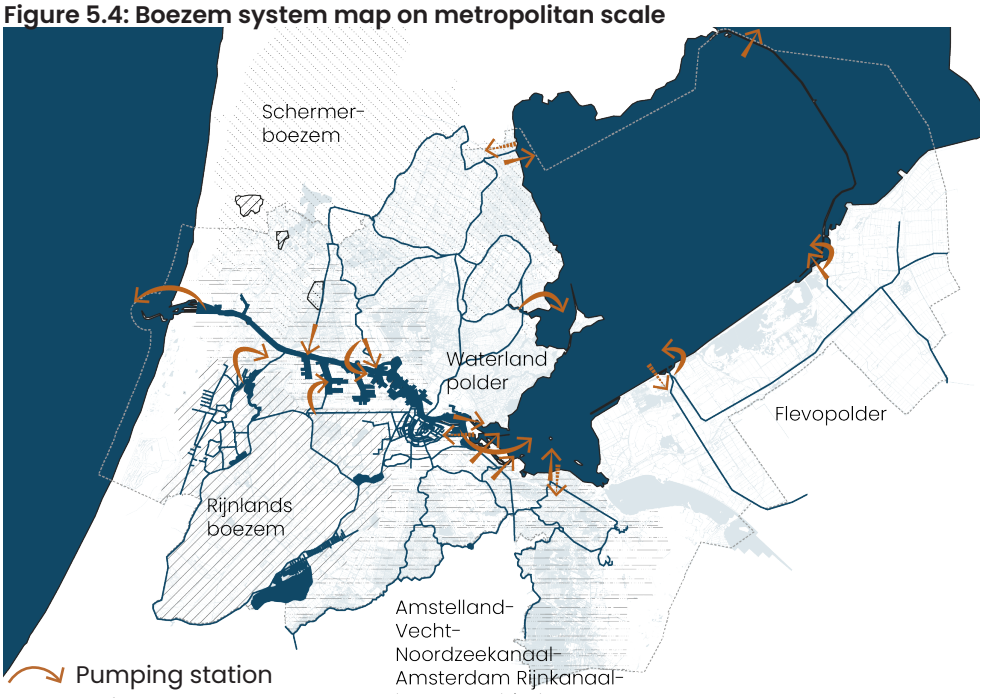
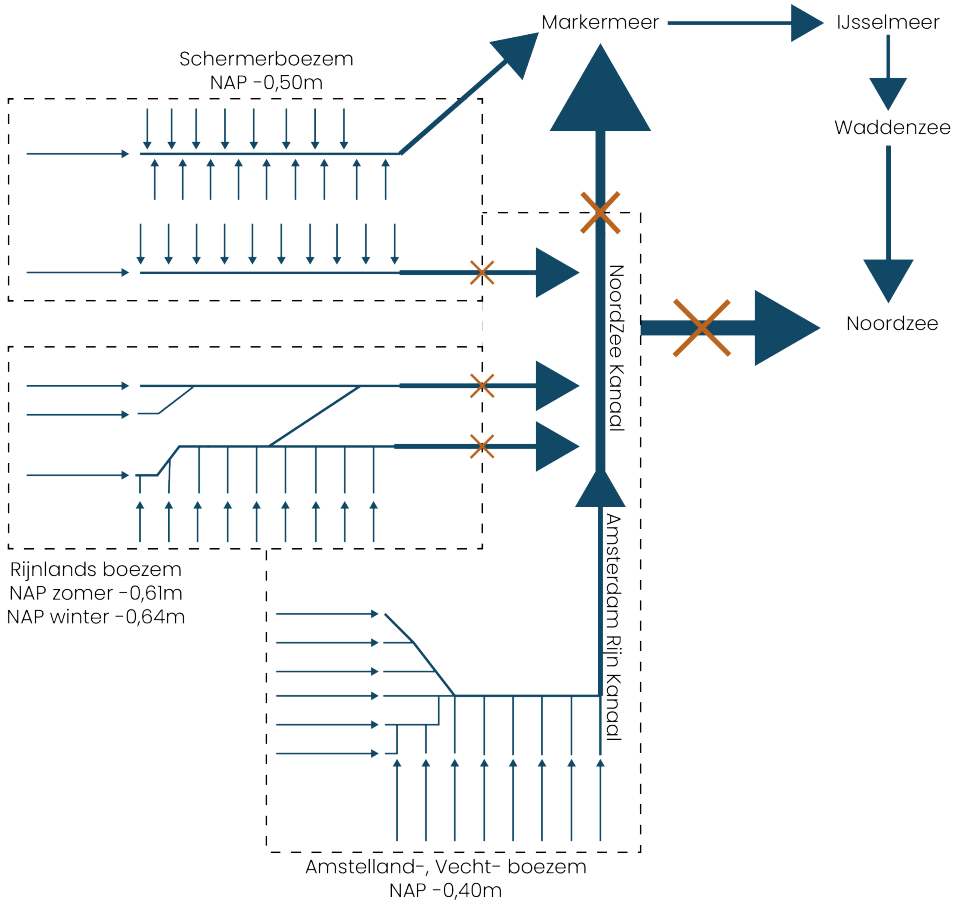


Figure 5.4: Boezem system map on metropolitan scale



Source: Date retrived from Nederlandse Gemalenstichting (2019)

Figure 5.5: Boezem system water flow diagram AMA



The polder water system is dependent on the pumping stations and sluices connecting and disconnecting the different water bodies. The polder water level is the lowest (light blue in Figure 5.10). To control the water level in the polder the surplus of water gets pumped to the boezem water structure (dark blue in Figure 5.10) with polder pumping stations, for example, De Ronde Hoep in Figure 5.9. To allow shipping and recreational sailing sluices, like the Zorgvlied sluice in Figure 5.8, are placed between the polder and boezem water system. The same system exists at the transition from the boezem water structure to the open water. Here the pumping station, like the one at Zeeburg in Figure 5.7, and the sluices are usually a lot bigger. Allowing for more water capacity per hour. There also exists an in-between level where sluices are used within the boezem water structure. This happens in the historical centre of Amsterdam. where multiple sluices can separate the canals from the Noordzeekanaal. This is because the Noordzeekanaal can handle higher water levels than the historical canal structure. From the problematisation, it becomes clear that this whole system depends on every structure and therefore it is vulnerable to technological defect and climate change extremes. One of the most important solutions is to increase the storage capacity of the polder water system, which means that more water should be allowed in this system (Hooijmeijer et al, 2005).

Figure 5.6: Boezem sluice historical centre

Source: ANP (n.d.)

Figure 5.7: Boezem pumping station Zeeburg

Source: Gemaal Zeeburg (n.d.)

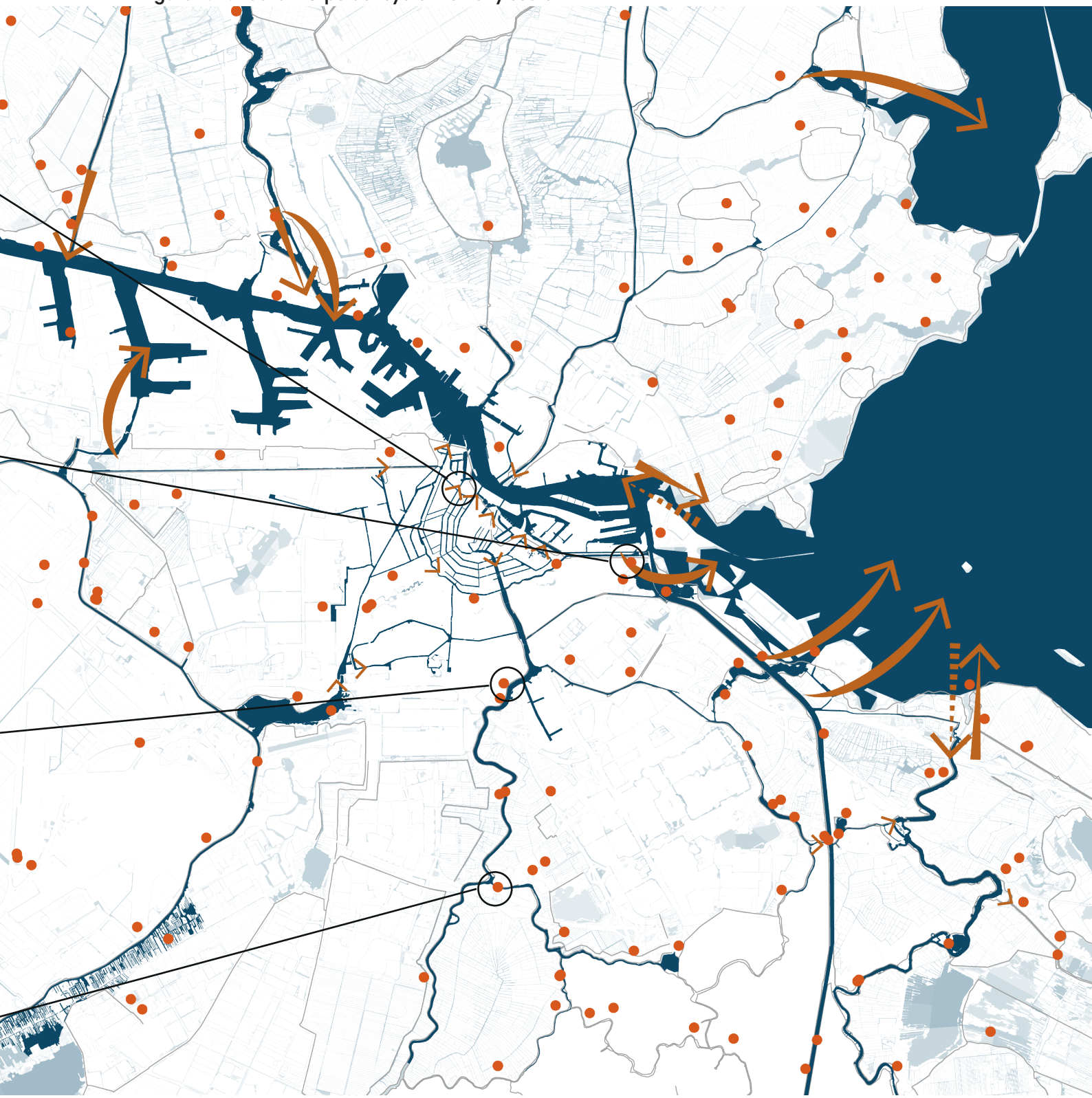
Figure 5.8: Polder sluice Zorgvlied

Source: Millipied (2012)

Figure 5.9: Polder pumping station De Ronde Hoep

Source: Gemaal de Ronde Hoep (n.d.)

Figure 5.10: Boezem & polder system on city scale



Polder pumping station
Boezem structure
Polders structure
Dike
Boezem pumping station
Sluice
Inlet
Small sluice

Scale: 1:125.000

Source: Date retrived from Nederlandse Gemalenstichting (2019)

5.2 A NEW PHYSIOGRAPHIC MAP

Due to climate change, the Netherlands faces different types of integrated water problems. Deltares, Boschslabbers and Sweco (2021) researched the water-related risks now and in the future (Deltares et al, 2021). This chapter is the adaptation of their research on a national scale for the situation of the Amsterdam Metropolitan Area and the city of Amsterdam (Figure 5.11). It shows the following characteristics of water & soil in order of future occurrence:

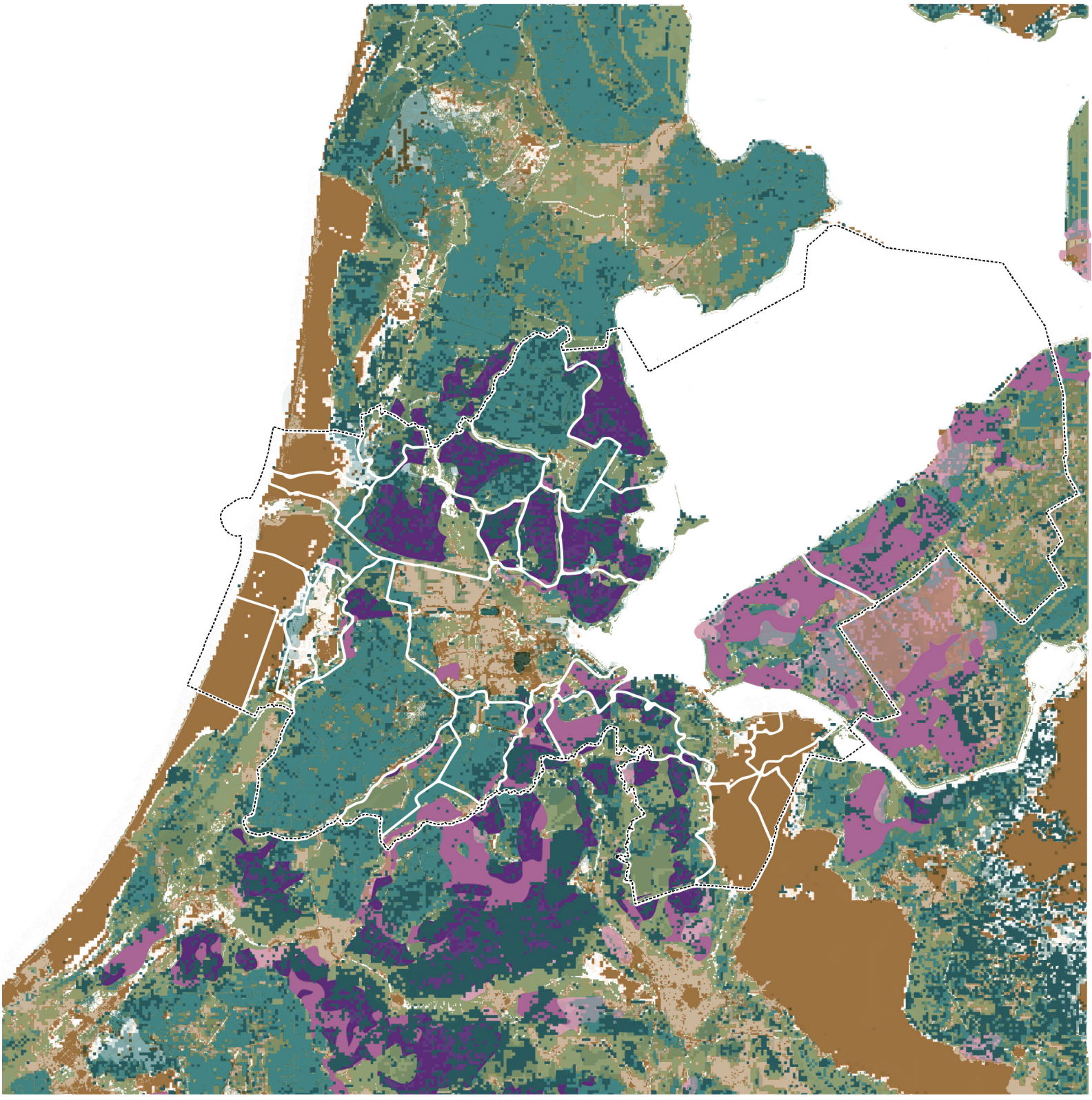
- Already too weak
- Increasingly too wet
- More often too dry
- In the foreseeable future too salty
- Eventually too dangerous because of flood risk

Weak
Peat or clay are weak soil types. Clay compresses under pressure and can shrink under its weight. This leads to subsidence. These are known as settlement-sensitive grounds. Peat is even softer than clay. Peat can oxidise and disappear completely, releasing a significant amount of CO2. This process can only be prevented by keeping the peat soil very wet. Once strongly dried out, the dehydration is almost irreversible. In addition, due to peat extraction, both dry and wet peat, which once covered more than half of the Netherlands, has disappeared in recent centuries mainly due to drainage. Even now, the most significant land subsidence is observed in peat areas where water levels are regulated for agriculture.

Wet
Almost the entire Netherlands was once wet. However, we have established an advanced system of drainage, reclamation, and sewage, with thousands of pumps to pump away water that lies below sea level. Due to land subsidence, sea level rise, increased seepage, and a wetter climate, more pumping will be required, making it more expensive. the Netherlands will be wetter in the areas where groundwater levels are relatively high and the infiltration rate is insufficient. In such areas, there is a high risk of flooding: water above ground level, on the streets, or even in houses. Based on the average highest groundwater level, maps have been generated for areas with low storage capacity in the soil, where water on the ground surface is likely to occur. However, wet natural areas, like wetlands are precious natural environments and are great opportunities to increase biodiversity.

Dry
Some parts of the Netherlands were traditionally dry, such as the ridges with sand. These areas still have permanently deep groundwater levels. There will be an increase in dry conditions in the future caused by: excessive drainage, an increase in groundwater extraction for drinking water and irrigation in agriculture and in addition population growth and rising meteorological drought. The maps presented demonstrate areas where the lowest groundwater levels are more than 1.80 meters below ground level or are expected to be in the future. This depth is far beyond the reach of crops and most trees.

Figure 5.11: Physiographic map on metropolitan scale



Weak/wet + flood risk
Weak/wet
Subsidence + flood risk
Subsidence + salt + flood risk
Flood risk
Wet + flood risk
Salt
Salt + floodrisk
Dry
Dry + flood risk

Scale: 1:450.000

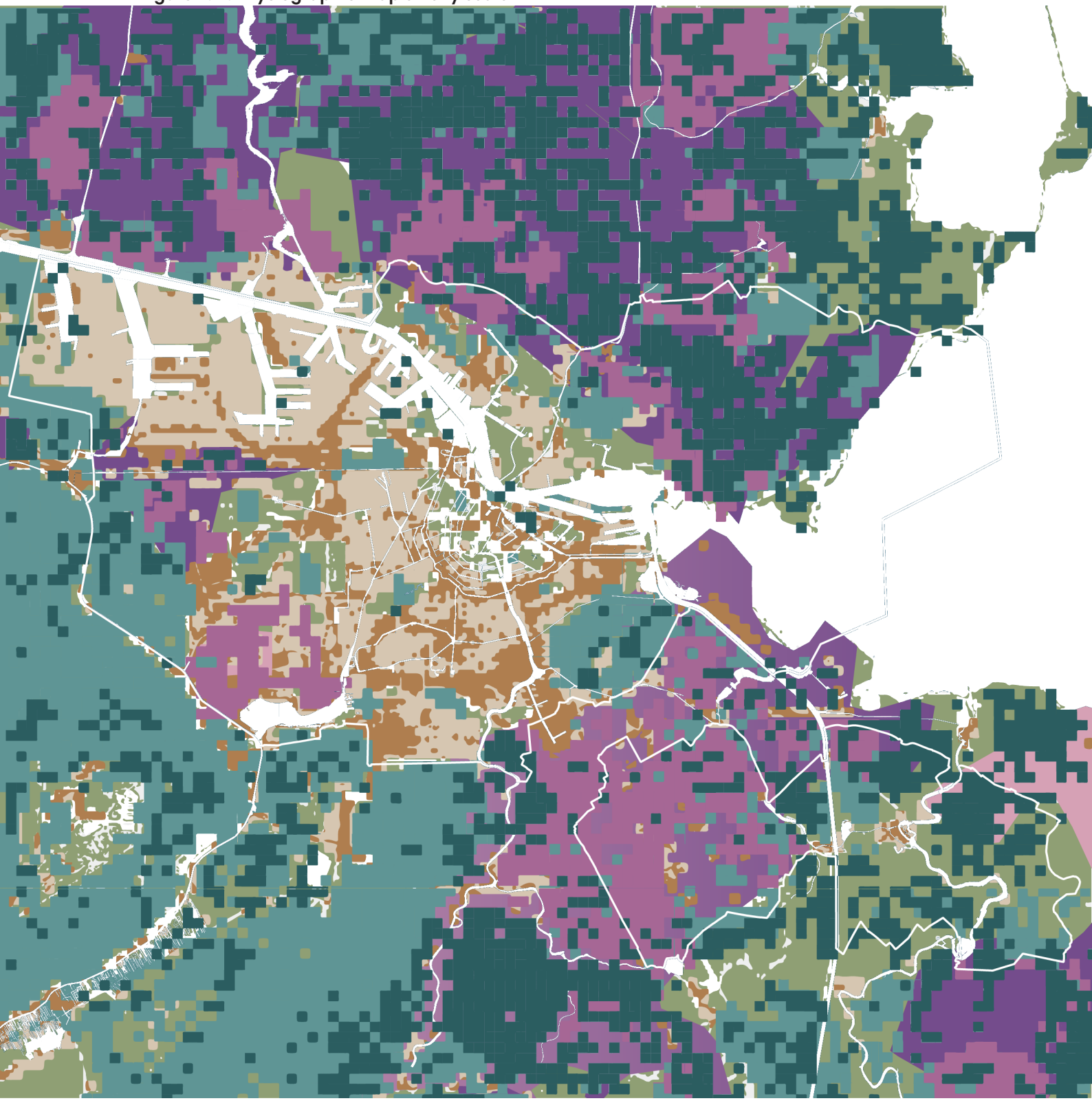
Source: Data retrived from Klimaateffectatlas (2024): Map layers: Subsidence sensitive soils, highest groundwater levels, lowest groundwater levels, seepage, flood risk (very low chance)

Salt
In large parts of the north and west of the Netherlands, groundwater at shallow depths is salty, which is a legacy of the sea's presence. On top of this lies a thin layer of fresh water, which, due to good drainage and land subsidence, is gradually being lost. In deep polders like the Flevopolders and North Holland polders, it is expected that there will be an upward movement of this salt groundwater through the pumping system. The consequences of the salinisation of ditches are currently countered by flushing polders where possible, utilising a lot of sweet water. However, meeting the demand for fresh water in agriculture requires increasing amounts of flushing water, putting significant pressure on the water supply system. The brackish or salty seepage affects the main water system, contaminating it and consequently making it less usable for downstream water users. Thus, there may also be an issue of off-site effects, depending on the location and flow direction.

Flood risk
About a third of the Netherlands lies below sea level, and nearly another third can be subject to flooding from major rivers. The low-lying areas can also be inundated by boezem water if regional water defences fail. The likelihood of this is greater than a dike breach, but the consequences are limited because the amount of water in the boezem system is finite. Dikes are strengthened according to new standards established in 2017, making most flood risk areas safer by 2050. With dikes, we will be able to keep the risk of flooding very low for a long time. However, it is not possible to rely solely on primary water defences; consideration must also be given to all polder dikes. This means that there is a significant space requirement for flood protection. The lower parts of the Netherlands will always be dependent on flood defence structures. A more resilient situation could be created by locating large-scale developments for living and working in non-floodable parts of the country.

All together it is clear that the Amsterdam Metropolitan Area is faced with various and complex water-related problems. Often multiple problems occur in the same location and therefore it is not easy to find perfect solutions. However, on the next page efforts have been made to create a regional strategy that shows the most suitable type of development. This is based on the research from Deltares, Boschslabbers and Sweco (2021) where they divide the Netherlands into three major land uses: large-scale urban development, land-based agriculture and wet natural areas.

Figure 5.12: Physiographic map on city scale



Weak/wet + flood risk
Weak/wet
Subsidence + flood risk
Subsidence + salt + flood risk
Flood risk
Wet + flood risk
Salt
Salt + floodrisk
Dry
Dry + flood risk

Scale: 1:125.000

Source: Data retrived from Klimaateffectatlas (2024): Map layers: Subsidence sensitive soils, highest groundwater levels, lowest groundwater levels, seepage, flood risk (very low chance)

5.3 TACKLING THE WATER PROBLEMS ON THE METROPOLITAN SCALE

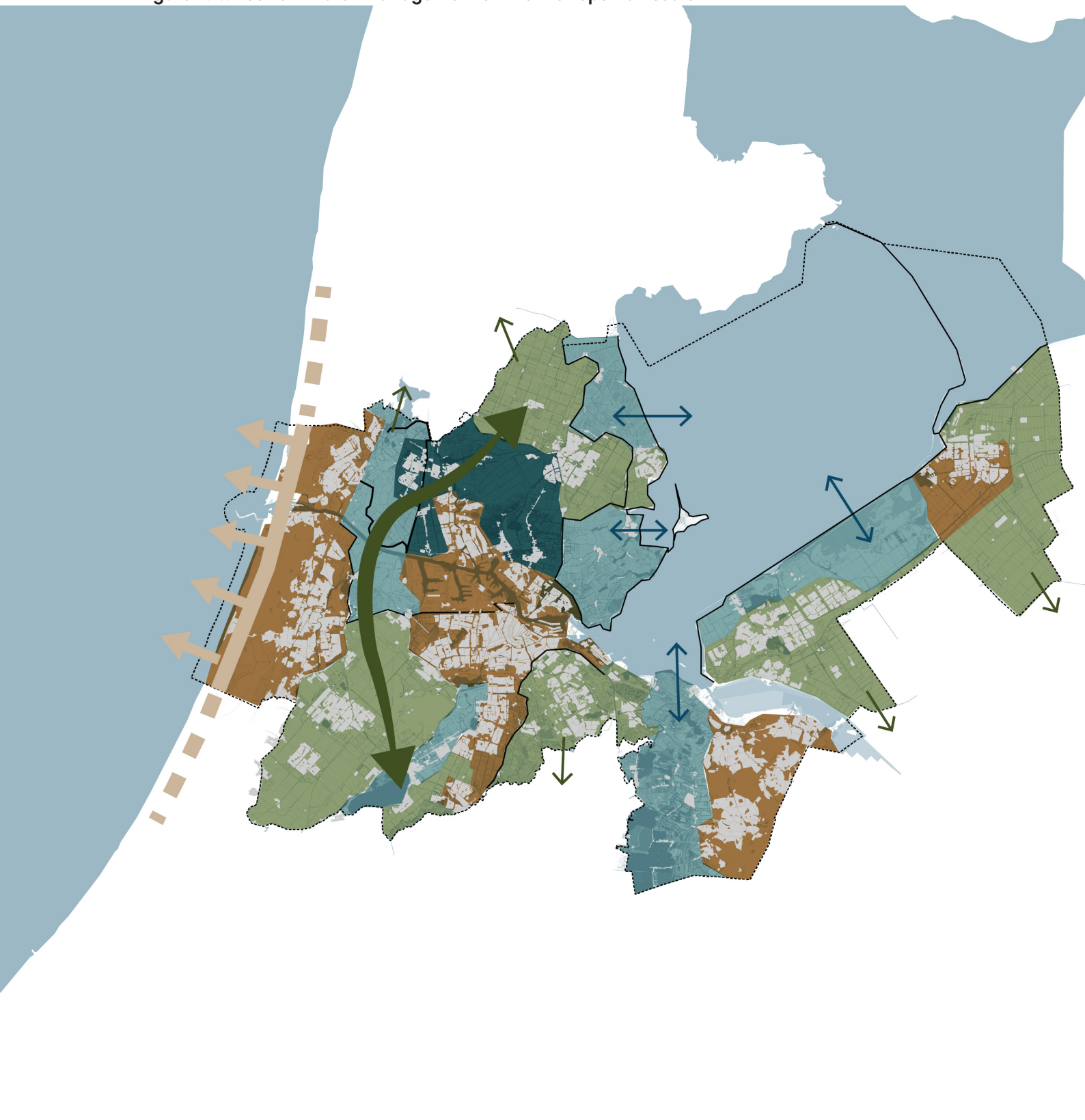
Large-scale urban development is most suitable in the dry areas. However, these urban areas must have enough storage capacity to maintain a sufficient groundwater level. Weak and subsidence-sensitive soil is unsuitable for urban development. Just as the areas outside of the dike where there is higher flood risk. Urban development is no problem in the salt or brackish areas.

Land-based agriculture can be done in areas that flood once in a while. However, it depends on the type and intensity of the practices if this is economically feasible. Salinisation is a risk for agriculture and its fresh water supply however land-based agriculture is possible for livestock and a variety of crops in brackish and salt areas.

Wet natural areas are most suitable in the areas where the soil is weak and wet. These areas are precious ecosystems. Also in salty areas wet ecosystems can exist as long as the vegetation is adapted to the subsurface. In the floodable areas outside of the dike, wet natural areas can also exist. There is no reason for wet natural ecosystems in dry areas

On a large scale, the water problems can be distinguished from each other. This can determine the best possible spatial development based on the water and soil conditions. However on a small scale, in an already existing urban environment, problems occur at the same time. The increased wet circumstances ask for increasing the water infiltration and storage capacity in the polder city. Dry conditions ask for seasonal water storage, limiting the water level differences between wet and dry periods (Hooijmeijer et al, 2005). This results in the need for more presence and acceptance of water in the urban environment (Hooijmeijer et al, 2005). In weak conditions, urban development should be limited, but space can be given back to wet natural areas, also providing seasonal water storage (Deltares et al, 2021). To alter salinisation, fresh water needs to be able to infiltrate and circulate in the surface water (Verzilting - Oorzaken, Gevolgen En Maatregelen, n.d.). To safeguard the Delta against flood risk, dikes need to be strengthened, but this requires high financial and technological investments. Therefore the new trend is to use more dynamic solutions, where more space is given back to the water and nature-based solutions are used to slow down the water during floods (H+N+S Landschapsarchitecten et al., 2022).

Figure 5.13: Resilient water management on the metropolitan scale

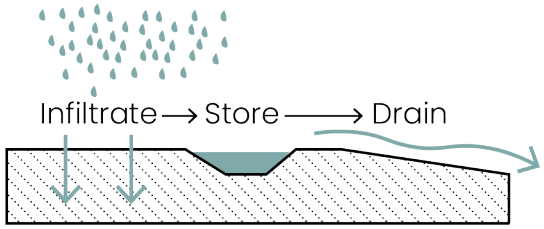


5.4 RESILIENT WATER MANAGEMENT ON THE CITY SCALE

Infiltrate, Store, Drain

Allowing more water in our urban environment is not possible in every location in the city. First of all, the capacity of our current mixed sewer system is not designed for extreme heavy rainfall. However, adapting the sewer system to climate extremes would require very large and expensive pipes that are unused most of the time and for which there is little space in the ground. Therefore, it is better to retain rainwater locally. To do so the infiltrate, store, and drain of principle is important in Dutch polder cities (Extreme Regen - Rainproof, 2023). Hold the water at the source, which means increasing the infiltration capacity. Store rainwater where possible above the surface level and ultimately drain the water by strengthening the drainage system (Figure 5.14).

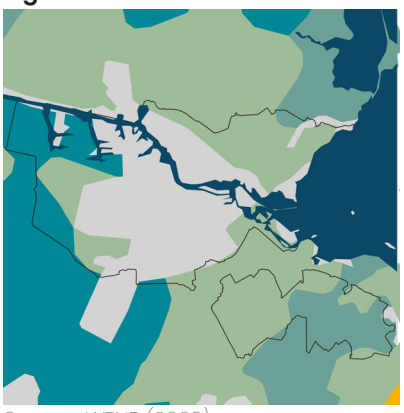
Figure 5.14: Rainproof principle



Soil capacity	Water infiltration capacity	Classification
Peat	0,01 m/day	Bad
Fluvial clay, sand & loam	0,05 m/day	Bad
Marine clay & silts	<0,01 m/day	Very bad

Source: Biron (2004)

Figure 5.15: Soil classification



Source: WENR (2023)

The limited infiltration capacity of the soil in the Amsterdam area means that water infiltration always needs to be combined with increasing storage capacity in the urban environment. Next to that as explained in the previous chapter peat is a weak soil and unsuitable for large-scale urban development.

Ground Space Index

The Ground Space Index is the footprint of the built surface divided by the terrain of a neighbourhood. For this analysis, the gross value has been used which includes tram and bus tracks, parks and waterbodies as terrain surfaces. Areas with a low GSI value have a higher potential for rainwater infiltration (Figure 5.16).

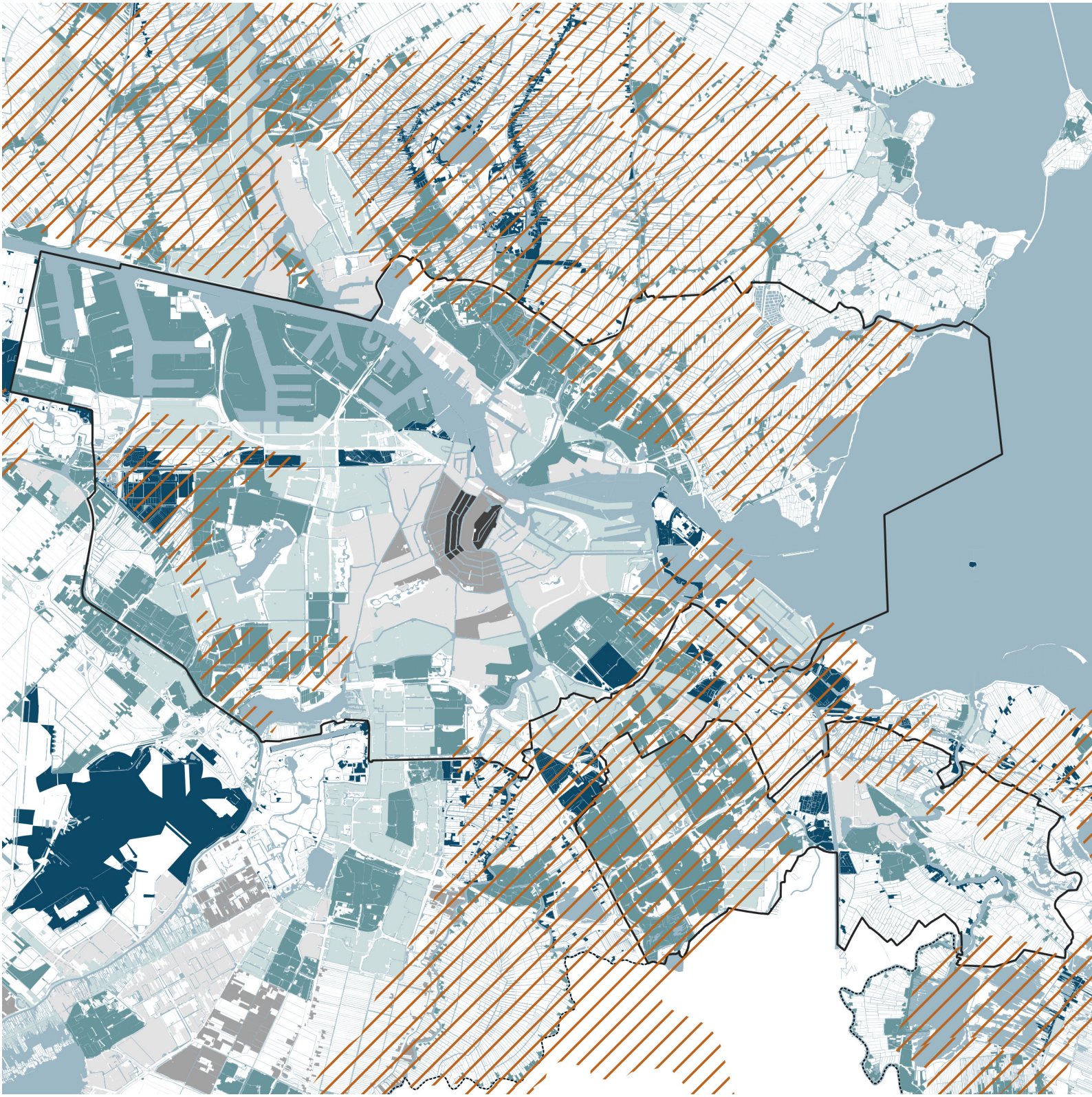
Source: PBL (2022)

Figure 5.16: Ground Space Index

Summary

	Soil type match	Solution for water problems	Urban area
Infiltration	Sand & Loam	Wet, Weak, Salt & Flood risk	GSI: 0 - 0,5
Storage	Not important	Wet, Weak, Salt, Dry & Flood risk	GSI: 0 - 0,4
Drainage	Not important	Wet, Flood risk	GSI: > 0,4

Figure 5.17: Potential transformation opportunities for resilient water management



No large scale urban development
Large sclae storage capacity
Seasonal storage capacity
Increase Infiltration and storage
Infiltration and small scale storage
Stengthen drainage & small scale infiltration
Strengthen drainage system

Scale: 1:125.000

Source: Data retrived PBL (2022) and WENR (2023)

5.5 WATER-RELATED NATIONAL MONUMENTS AND PROTECTED SITES

Water-related heritage serves as an example of the various paradigms guiding our understanding of why our ancestors created specific solutions, such as significant dams, water wells, and windmills (Willems & Van Schaik, 2015). In the Dutch Delta, water structures significantly shaped our landscape, cities and society. Water-related heritage are structures that still exist in today's urban landscapes. It helps communities connect with their past and offers insights into historical practices of water management, which can be valuable for addressing contemporary water-related challenges. Water-related heritage can have both tangible and intangible forms (Willems & Van Schaik, 2015).

On this map, the water-related national monuments are shown, together with the protected townscapes and UNESCO World Heritage sites. It was chosen to only focus on national monuments on the city scale because these are monuments with the highest importance. Moreover, this limits the scope of this project, because the municipal monuments are over 7000 more structures to take into account. The national monuments are categorised into their water-related subcategories. There are three groups of water-related heritage structures to take into account. First, there are the national monuments that are crucial for the polder water system: Bridges, pumping stations and water barriers. Secondly, there are water-related urban structures like coastal marks, city walls and wharves or harbours. Lastly, some buildings have or had a direct relationship to the urban waterfront: Fortresses, industrial buildings, windmills and historic storage units.

These water-related heritage structures and systems have been resilient in modern history. However, the future climate change extremes endanger these structures (Westeijn, 2023). They have to adapt to future climate extremes to be able to survive and bridge the gap between the past and future of urban development. In the past, spatial development tended to disrupt both valued physical structures and the stories and meanings associated with these buildings and landscapes (Janssen et al., 2017). The heritage as vector approach places current actions and plans within a lively spatial and time framework. Cities and landscapes are viewed as layered contexts where historical elements might exist, yet they are also capable of dynamic evolution (Meurs, 2021). In this approach, heritage is seen as the product of a social process and uses it as a place-making tool, which supports sustainable development and socio-ecological integration. The map shows that many heritage structures have a close spatial relationship with the historical waterfront. The background map dates back to 1850, showing the landscape paradigm in which the rivers and canals are a permanent structure. However, land reclamation has proved that water is also a dynamic structure.

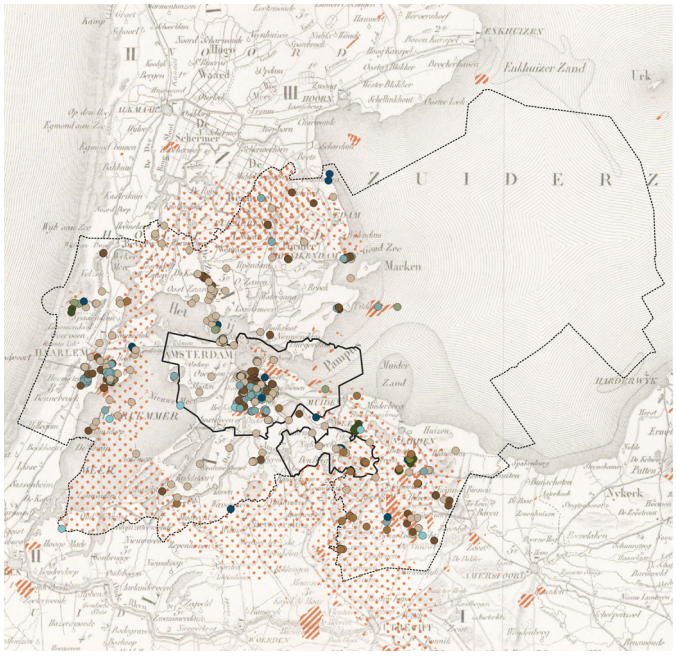
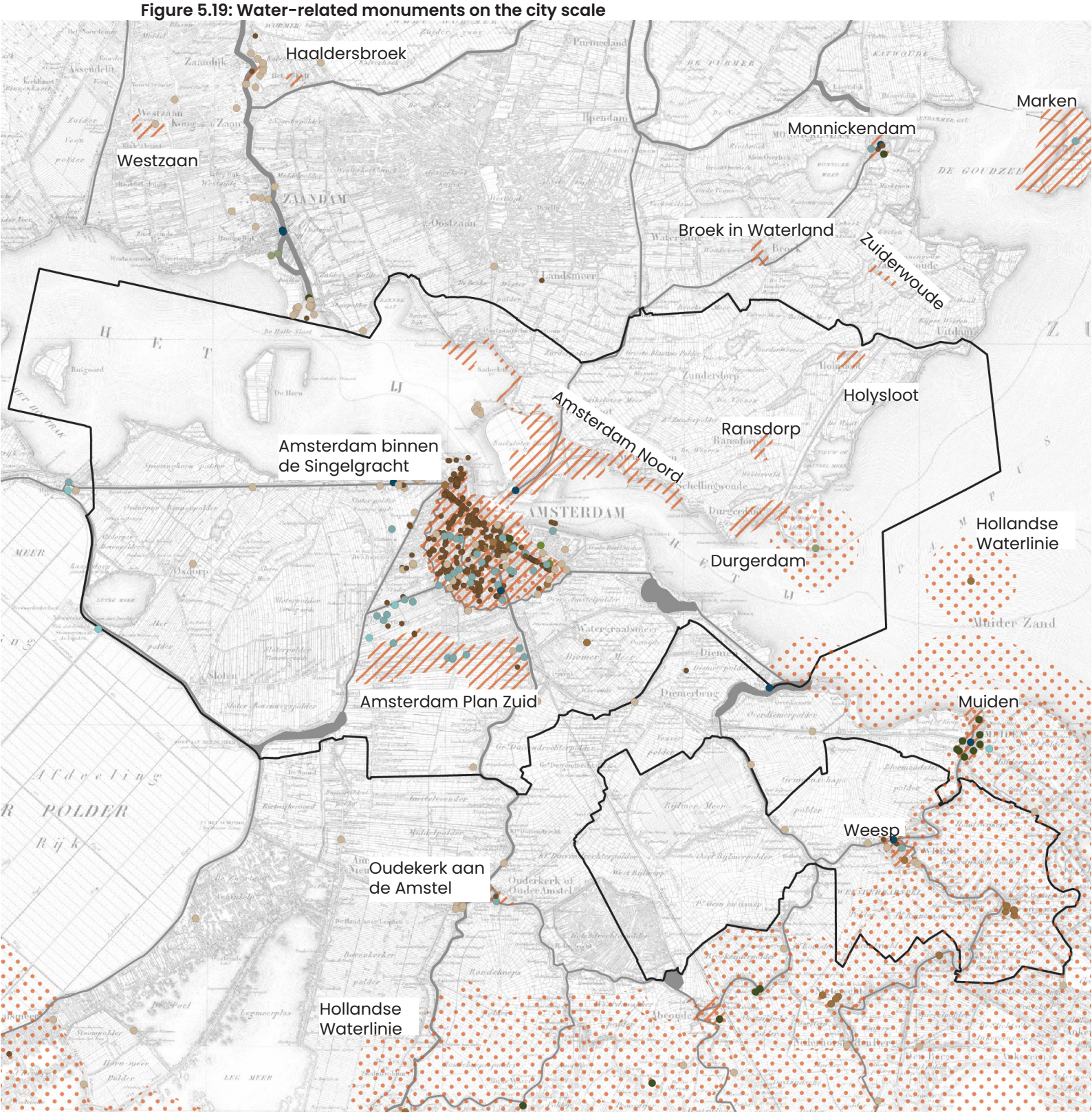


Figure 5.18: Water-related monuments on the metropolitan scale

Figure 5.19: Water-related monuments on the city scale



UNESCO World Heritage
Protected Townscape

Structures in the water system
- Bridge
- Pumping station
- Water barriers or pass

Water-related urban structure
- Coastal mark
- City walls
- Wharf or harbour

Water-related buildings
- Fortress
- Industrial & polder windmill
- Storage

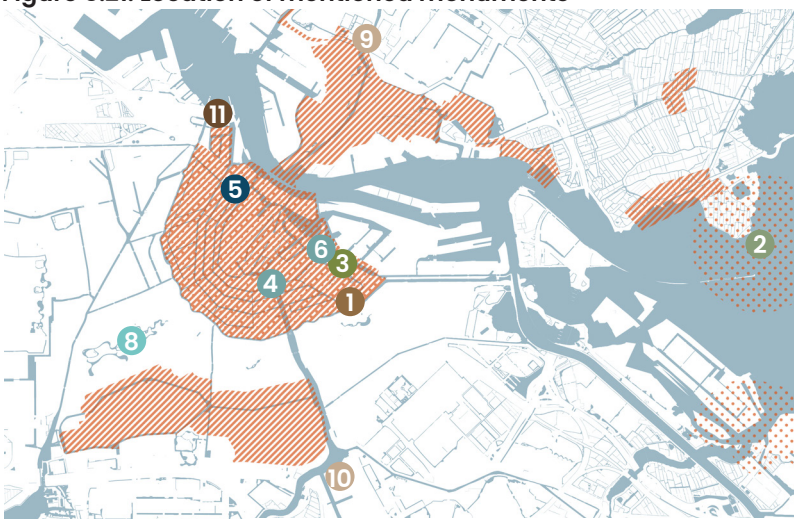
Scale: 1:125.000

Source: Data retrived from Rijksdienst voor het Cultureel Erfgoed (2023) & Background map retrived from Topotijd-reis (1850)

Figure 5.20: Collage of different types of water-related heritage
Source (from left to right): Jvhertum (2012), van Lokven (n.d.), ANP (n.d.), Minderhoud (2005), Museum Werf 't Kromhout (n.d.), Túrelio (2007),

5.6 THE MANY FACES OF WATER-RELATED HERITAGE

Figure 5.21: Location of mentioned monuments



City walls in Muiden not visible on this map

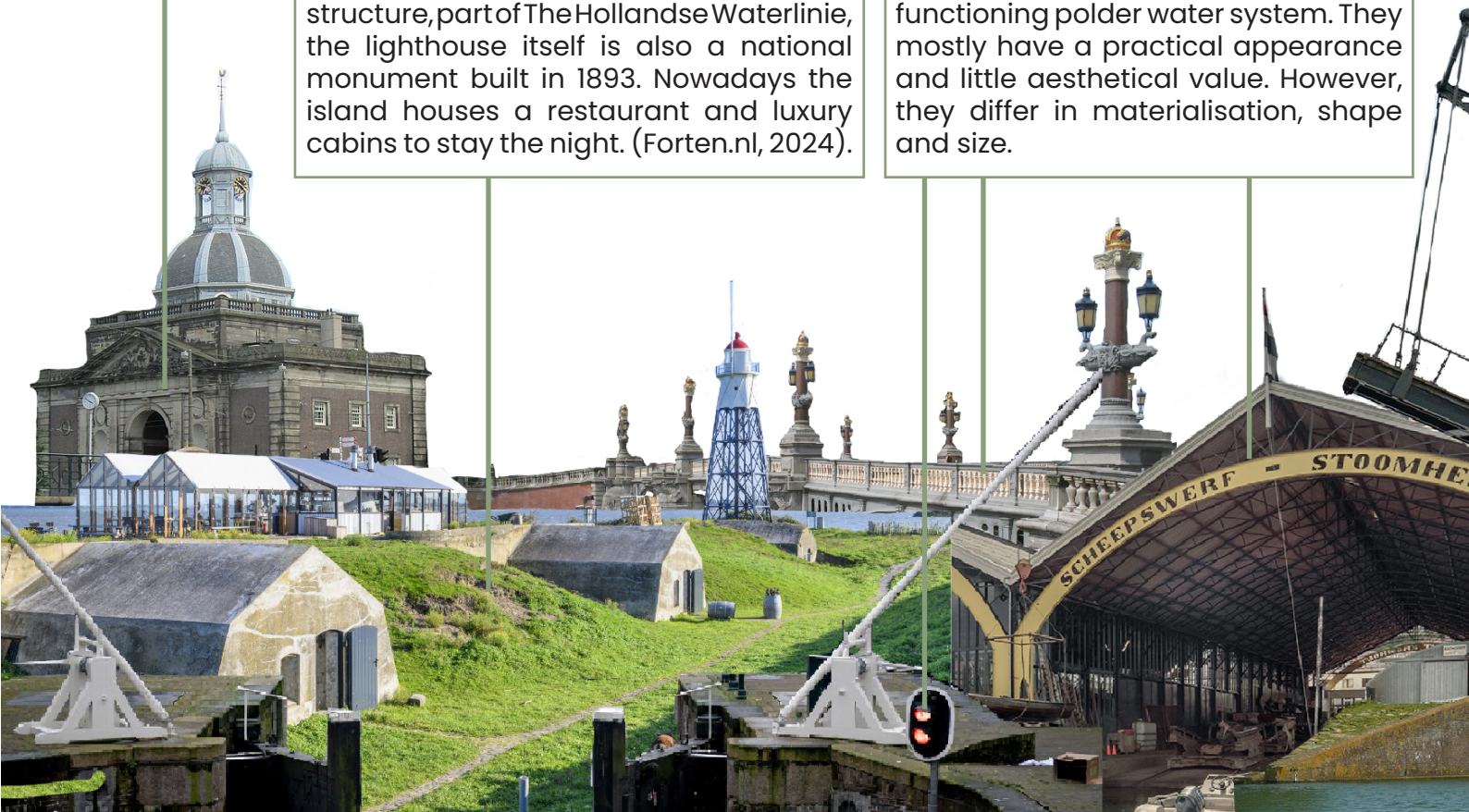
Werf 't Kromhout 3
Wharf
The ship Warf from the Kromhout family has been a family company since 1757. In this wharf, Jan Goedkoop invented a new ship engine that had worldwide success. The wharf was in use until 1967, but got neglected shortly afterwards. Nowadays it is both an event space and a small museum (Stadsherstel Amsterdam, 2023).

Muiderpoort 1
Fortress
The Muiderpoort was part of the city walls built in the 17th century. The first buildings were demolished and rebuilt in 1770 After the gate lost its military function it was used as a post for excise tax up until 1866. The Muiderpoort and Haarlemmerpoort are the only gates that are still present (unknown, 2018).

Blauwbrug 4
Bridges
Amsterdam has a rich history of bridges in different historical styles. The design of bridges follows the dominant styles in architectural history. The Blauwbrug is an example of a neo-classical bridge.

Vuurtoreneiland (Lighthouse island) 2
Coastal mark
The lighthouse island is a fortification structure, part of The Hollandse Waterlinie, the lighthouse itself is also a national monument built in 1893. Nowadays the island houses a restaurant and luxury cabins to stay the night. (Forten.nl, 2024).

Sluice at Prinsengracht 5
Water barrier
Water barriers are essential for a well-functioning polder water system. They mostly have a practical appearance and little aesthetical value. However, they differ in materialisation, shape and size.



Sonty567 (2013), Camel (2019), Rasbak (2008), Mulder (2010)

Scharrebierbrug 6
Bridge
The Scharrebierbrug is named after the cheap beer skippers would buy before going through the scharrebiersluice. The bridge was only build in the 19th century and typically for this era it was build in steel (Gemeente Amsterdam, 2022).

Vondelpark 4 8
Pumping station
In the picture, the historic pumping station in Het Vondelpark is shown. Pumping stations have different aesthetics and are often difficult to identify in the middle of the city because they appear like regular houses. This pumping station is out of order, today there is a child care in the building.

Watertower Zuidergasfabriek 10
Industrial building
The Watertower in the new residential neighbourhood Amstelkwartier was built in 1911 as part of the southern gas factory of Amsterdam. Today the watertower stands in the middle of a park and is vacant (Watertoren, Spaklerweg Bij 24, 2017).

Pakhuis Het Veem 11
Storage building
Pakhuis 'Het Veem' was the first large-scale storage building in the western harbour area. The front side of the buildings borders a regular road and the back side the waterfront of the IJ. Nowadays the building has mixed-use functions like offices and a small theatre (Rijksdienst voor Cultureel Erfgoed, 2003)

Vesting Muiden 7
City walls
All city walls in Amsterdam are demolished. The only remains of military fortification can be found in Muiden and on the lighthouse island which are both parts of The Hollandse Waterlinie (Rijksdienst voor het Culturaal Erfgoed, n.d.).

Krijtmolen d'Admiraal 9
Wind mill
The windmill was built in 1792 and originally used to grind tuff. Around 1900 the windmill started making chalk for the paint industry. It is the last wind-driven chalk mill in the world. These days the windmill, while still in operation is open for visitors and run by volunteers (Krijtmolen D'Admiraal, n.d.).

5.7 CULTURAL HISTORICAL VALUED URBAN AREAS

Next to the national or even internationally listed protected townscapes or protected landscapes, the municipality of Amsterdam has carried out a cultural-historical inventory of the built environment. This resulted in an inventory of special protected urban areas categorised in special provincial landscapes, post-war reconstruction, municipal protected townscapes and green monuments.

Special Provincial Landscapes

Special Provincial Landscapes are landscapes that have special values for humans and animals. The landscapes are protected under environmental regulation NH2020. They often offer natural qualities to humans for recreational use, show a historical landscape narrative and are important open landscapes in the densifying urban environment (Noord-Holland, 2023).

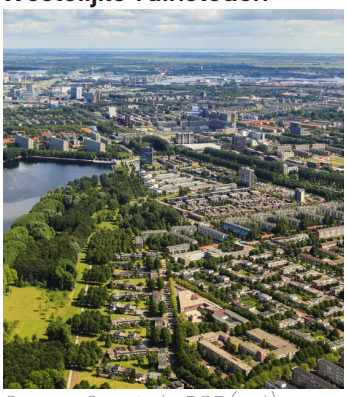
Figure 5.22: Collage of Special Provincial Landscapes

Source: Baart & Provincie Noord-Holland (n.d.)

Post-war reconstruction

In the post-war reconstruction period 'air, light and space' was the motto for urban planning. The areas, like the Western Garden cities, are symbols of this important era. Nowadays, these neighbourhoods are subjects of renewal operations, but at the same time, they house unique historic characteristics. For the Western Garden cities, the unique character consists of: The repetition of building blocks and a combination of low- and high-rise buildings based on the the principles of CIAM, the hierarchical design of infrastructure, balanced build and un-build area (Rijksdienst voor het Cultureel Ergoed, 2016).

Figure 5.23: Aerial view Westelijke Tuinsteden



Source: Swart via RCE (n.d.)

Municipal protected townscapes

Next to the national protected townscapes shown on the previous pages, the municipality of Amsterdam has assigned 8 municipal protected townscapes. They all are unique examples of a certain period in urban planning and design and therefore have important cultural-historic values. In Amsterdam, they vary from 19th-century towns like Oud Zuid, early 20th-century neighbourhoods like Admiralenbuurt and Betondrop, post-war reconstruction and late 20th-century development like IJplein (Amsterdam, 2024).

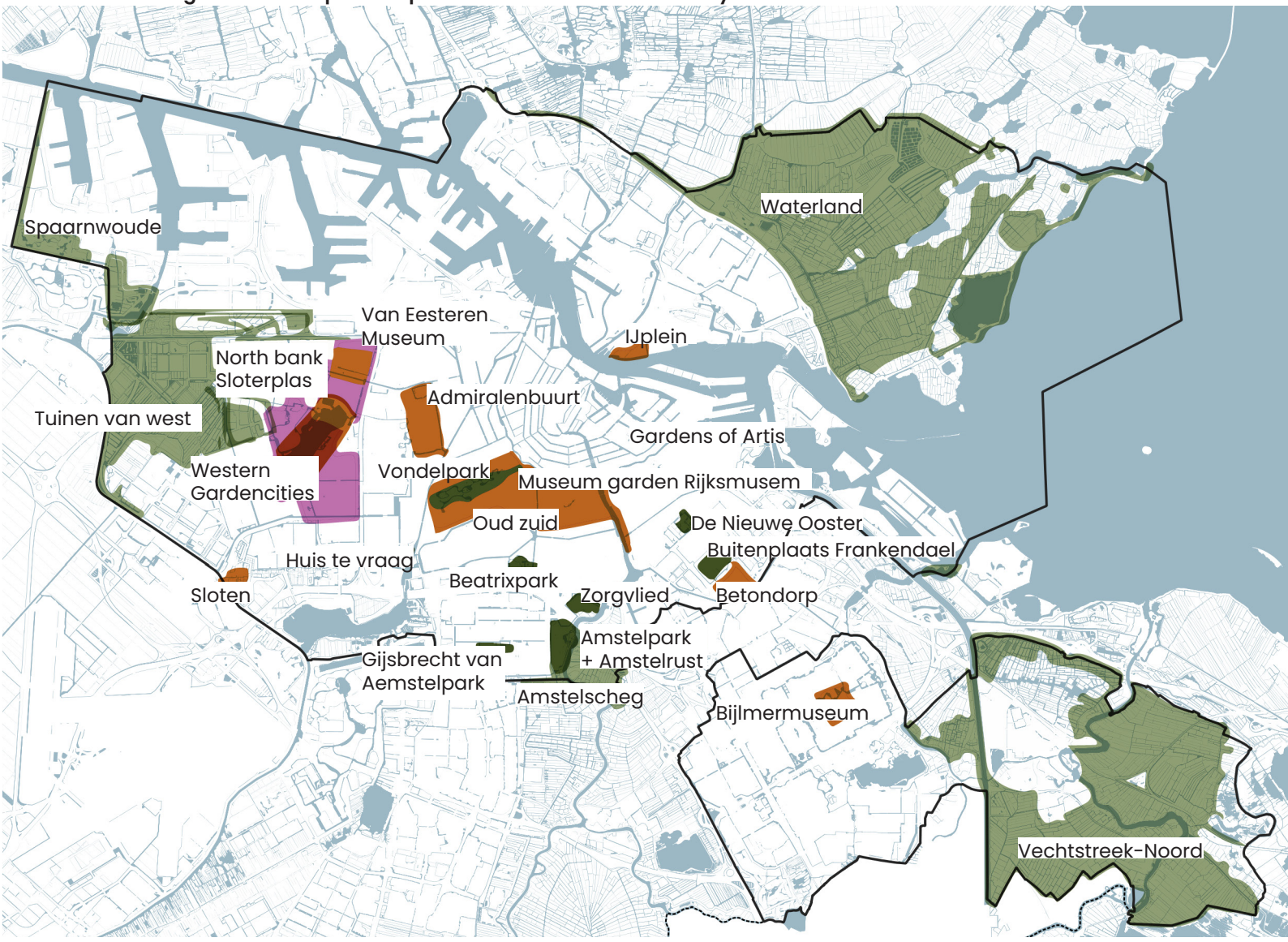
Figure 5.24: Collage of municipal protected townscapes

Source (from left to right): Jane023 (2011), Ceinturion (2008), Mulder (2010), Steenberg (2008), Van Den Bergh (n.d.)

Green monuments

Green monuments are a collective name for man-made natural environments like parks, gardens, country estates and cemeteries. It is considered heritage because it shows the constantly changing relationship between humans and nature. Part of the monuments are national heritage and part of them are municipal heritage. Consequently to the definitions the sites can take different forms and sizes and can both be public and private domain (Ministerie van Onderwijs, Cultuur en Wetenschap, 2019).

Figure 5.25: Adopted map of cultural-historical inventory of Amsterdam



5.8 HERITAGE AS CATALYST ON THE METROPOLITAN SCALE

It has been made clear that build and landscape heritage are not just tangible artefacts but that they tell an important narrative in cities and regions. The cultural shift in understanding heritage this way became important at the start of the 21st century with the introduction of the concept of 'intangible heritage', bringing stories and traditions into heritage planning (Vecco, 2010). Heritage often strongly engages with the local community. Consequently, the traditional distinction between experts and the general public diminishes, and plans are shaped by both local memories and expert insights. This highlights the importance of heritage as a source of inspiration for local and regional development. Heritage can be used as a tool to engage communities and foster collaborative planning processes. It reframes the historical setting as interlinked with current objectives concerning spatial challenges in the fields of economics (rural regeneration, population decline), safety (water management), and sustainability (climate change, energy transition) (Janssen et al., 2017).

On the scale of the Amsterdam Metropolitan Area heritage sites are present in both landscape elements and the built environment. The most important landscape elements are the special provincial landscapes and the UNESCO World Heritage sites. However, these landscapes are highly fragmented in the metropolitan region and therefore can increase their ecological value by landscape stitching: connecting the natural landscapes with ecological corridors.

Most built heritage can be found in the corridor from Zaanstad, through Amsterdam towards the sandy soils of het Gooi. The second place where build heritage is found is on the sand ridge on the coast. Both of these areas have high cultural value and could be exploited as historical sites for tourism. To do so the public transport from Haarlem or Amsterdam should be strengthened to advertise these areas and increase the economic value of the cultural heritage corridor.

Lastly, to improve the relationship between landscape and built environment there is a need for improved accessibility of the provincial landscapes. They are relatively close to the city and can be exploited as recreational areas. To make these areas accessible public transport and bike accessibility should be improved to encourage people to spend their free time in these special landscapes. Which will eventually grow the appreciation and conservation of these natural landscapes.

Figure 5.26: Resilient cultural heritage management on the metropolitan scale

Protected townscapes
UNESCO world heritage
Special provincial landscapes
Water-related heritage structures
Scale: 1:450.000

Cultural heritage corridor
Landscape stitching
Improved accessibility between city and provincial landscapes

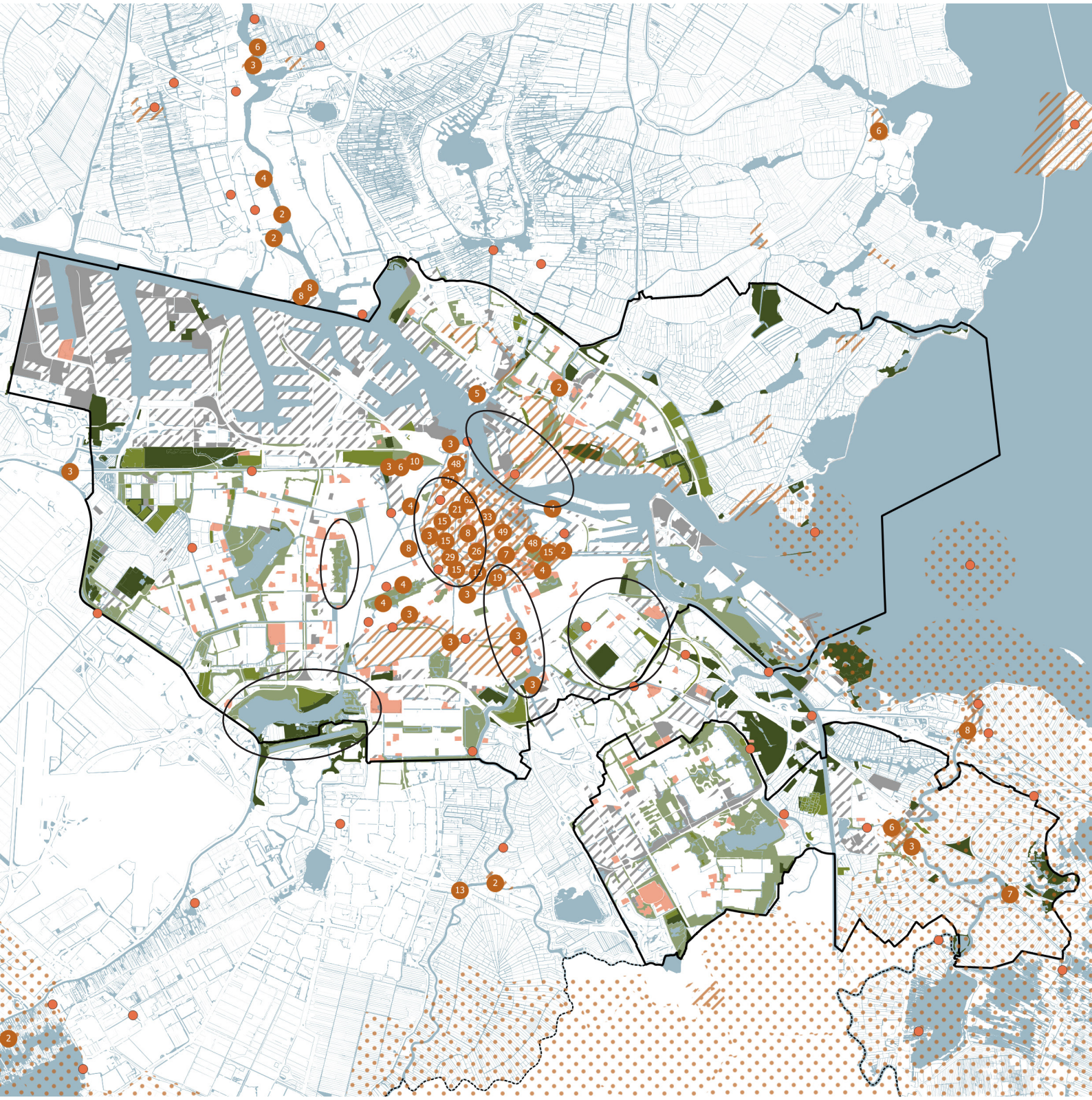
5.9 RESILIENT CULTURAL HERITAGE ON THE CITY SCALE

Concluding from the analysis of water-related heritage structures and protected urban areas, Figure 5.27 shows the potential for urban transformation to expand the cultural heritage values in Amsterdam. The water-related heritage structures are clustered into amounts of structures present in an area. These are places that can be catalysts to increase the cultural values in the city. However, it is important to state that sustainable development does not look the same in every location. It is important to look at the specific context of heritage sites, to determine the best possible strategy (Janssen et al., 2017). Privat-owned buildings, like most of the old storage warehouses along the canal ring, are difficult to redevelop. Other storage buildings, like Pakhuis Het Veem, can be a vibrant place for community engagement. This is where the heritage as a vector approach, in the form of rehabilitation, is most interesting. Moreover, for structures essential to the polder water system, it would be more likely to use a conserving and restoration approach (Pereira Roders, 2007). Bridges and pumping stations must keep or strengthen their functions to gain resilience in the polder water system. On top of that these locations can be compatible with the already existing socio-cultural facilities in the city.

In grey places to invest in social and ecological values are shown, these places have high place-making opportunities. These areas are now or in the direct future potential spaces for urban transformation, showing the porosity in the urban fabric. Therefore they are excellent places to maximise climate adaptation and socio-ecological integration.

Thirdly places with land use that can add to the cultural value of the city are shown in green. These are land-use functions that already have a high social and ecological value for the citisens. These include natural areas like the Amsterdamse Bos, parks, recreation areas and communal gardens. From the literature review and survey, it becomes clear that recreational value is an important asset to anticipate for more water in the urban environment. Moreover, the natural areas are important areas for ecological enhancement to increase the accessibility to nature in the city and increase biodiversity.

Figure 5.27: Potential transformation opportunities for resilient cultural heritage



Historial assets
- Water-related heritage clusters
- Protected townscapes
- UNESCO world heritage site

Place-making opportunities
- Industrial area
- Construction site
- Semi built terrain

Recreational values and social services
- Natural area
- Parks & recreation area
- Communal gardens
- Socio-cultural facility
- Key locations from survey

Scale: 1:25.000

Source: Data retrived from Rijksdienst voor het Cultureel Erfgoed (2023) & CBS (2017)

5.10 SPATIAL MORPHOLOGY ON THE CITY SCALE

A network analysis was used to determine the accessibility potential on a city scale. The Angular Choice analysis with a walking distance of 5000m shows the main roads on a city scale. This shows the most used roads on a regional scale and the accessibility by car.

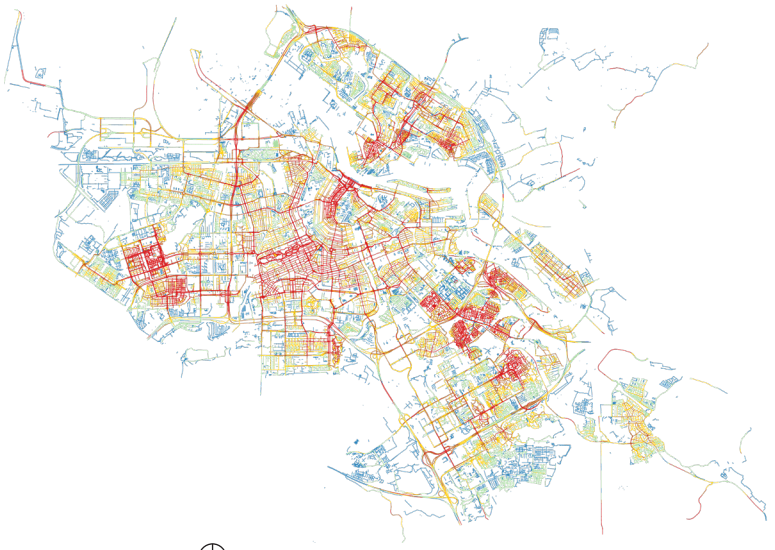
Figure 5.28 : Space Syntax analysis of main roads

Scale: 1:250.000

Source: Data retrived from Openstreetmap (2024)

The Angular Integration analysis with a walking distance of 800m shows the potential for local centres. These areas have a high potential to be an easily accessible destination. These areas have the potential for vital urban functions and are the best places to expand social and economic values on a local scale.

Figure 5.29: Space Syntax analysis of potential local centres

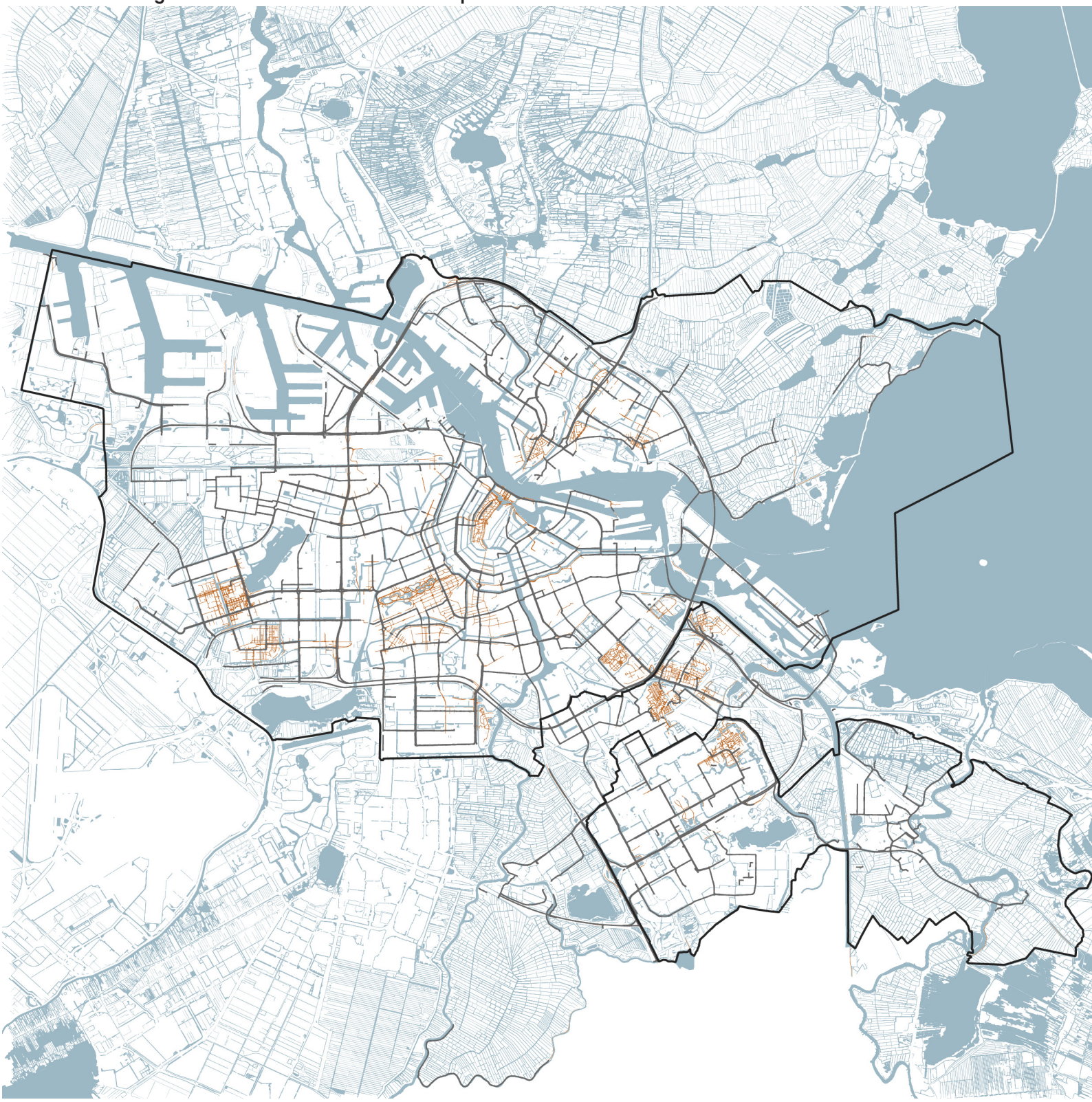


Scale: 1:250.000

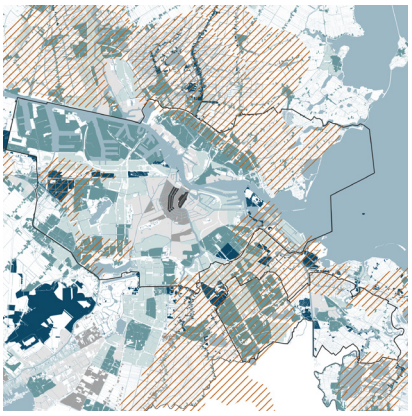
Source: Data retrived from Openstreetmap (2024)

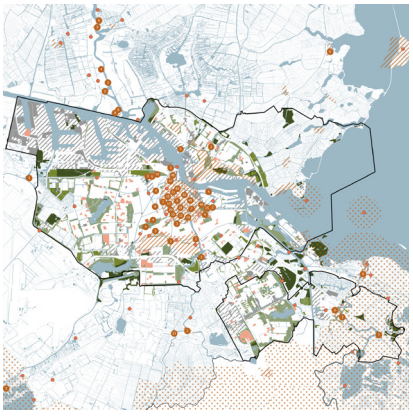
By combining the two types of analysis Figure 5.30 shows the urban network potential for Amsterdam. The main roads are the areas that are easiest accessible on a regional scale, these are the areas most suitable for regional and car-related functions. The potential vital centres are the most accessible areas on a local scale. This shows the potential for economic or social activities because these are the easiest reachable places in the city.

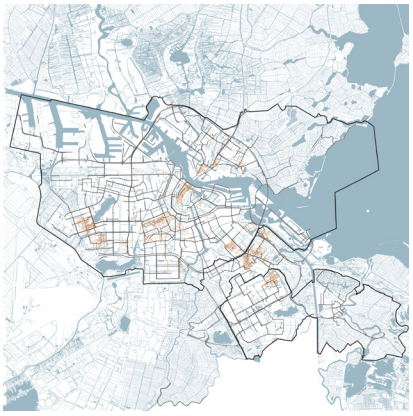
Figure 5.30: Combined urban network potential



— Main roads
— Potential vital local centres
Scale: 1:125.000 (N)
Source: Data retrived from Openstreetmap (2024)







CONCLUSION CHAPTER 5

Chapter 5 has given insight into the future water problems in the city and metropolitan area and it analysed the potential for urban transformation, using the cultural value of water-related heritage to strive for sustainable development.

The first part showed that there are 5 main water problems in the polder water system. These 5 problems are narrowed down to the fact that water needs to be held and stored for as long as possible to allow for sufficient water quantity and water quality. On the city scale, this means that there needs to be more places for water infiltration and water storage. On the metropolitan scale, there is a need for more wet natural areas and adaptive due to flood risk not every area is suitable for urban development.

In addition, chapter 5 gave insight into the different types of water-related heritage and their location in the urban fabric. On the metropolitan scale, this showed which historical landscapes should be connected to increase the ecological value and what areas have the most built heritage that has economic potential. On a city scale, it was concluded which areas are most interesting as cultural-historic catalysts for urban development. In addition, the urban morphology analysis determined which neighbourhoods are most interesting as local economic centres.

KAART VAN HET Y.

waarvan,

de voornaamste OEVER-LINEN en STROOM-PUNTEN,

op nieuw

zijn gemeten over IJs, door J. van Kaurik,

in de

Maand February

1838.

CHAPTER

6

TRANSFORMATION OPPORTUNITIES

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In Chapter 6 a quantitative city-scale typology is constructed. The typology results in eight types that have different design qualities. After which the potential for improvement of the design qualities is qualitatively assessed through fieldwork. This results in a design vision for every type in which it becomes clear that every type has different design qualities and therefore another role in the city-scale integrated urban transformation plan.

Figure 6.1: Map of the IJ

Source: Stadsarchief Amsterdam / J. van Maurik (1838)
Black & White Adaptation

6.1 QUANTITATIVE TYPOLOGY CONSTRUCTION

To generate an overview of the transformation opportunities on a city scale a city typology was constructed with the previous shown thematic potentials: Water management potential, cultural value potential and urban network potential. To construct a quantitative typology the software Geoda was used. It was decided to not add the main roads as a variable in the typology construction because car accessibility is not a goal in this project. However, soil type was used as a variable to make sure areas that are unsuitable for large-scale development would be featured. The best model fit occurred with 8 clusters in Geoda, which resulted in 8 types on a neighbourhood scale that show different types of potential for urban transformation (Figure 6.2).

Figure 6.2: Processing summary from Geoda

```
Method:       KMeans
Number of clusters:  8
Initialization method:      KMeans++
Initialization re-runs:     150
Maximum iterations:  1000
Transformation:      Range Standardize
Distance function:   Euclidean

Cluster centers:
|   |Local cent|GSI_a    |Peat|Heritage c|Cultural l|Transforma|
|---|----------|---------|----|----------|----------|----------|
|C1|3367.76    |0.326324|0    |2.51351    |1.56757    |1.21622    |
|C2|3897.02    |0.101692|8000|0.961538   |6.73077    |2.46154    |
|C3|26189.6    |0.187762|8000|0.714286   |9.2381     |1.85714    |
|C4|4440.04    |0.241857|8000|0.0952381  |3.42857    |1.7619     |
|C5|2541.64    |0.128667|0    |0.611111   |3.83333    |3.27778    |
|C6|3832.5     |0.147923|8000|0.846154   |20.1538    |15.2308    |
|C7|3361       |0.447429|0    |53.5714    |0.571429   |2          |
|C8|31244.4    |0.376    |0    |17.3333    |5          |1.33333    |

The total sum of squares:   60.678
Within-cluster sum of squares:
|   |Within cluster S.S.|
|---|-------------------|
|C1|0.860468           |
|C2|1.14195            |
|C3|0.854568           |
|C4|0.656854           |
|C5|0.78023            |
|C6|1.68971            |
|C7|0.483191           |
|C8|0.258545           |

The total within-cluster sum of squares:  6.72552
The between-cluster sum of squares:       53.9525
The ratio of between to total sum of squares:   0.889161
```

Figure 6.3: Potential maps

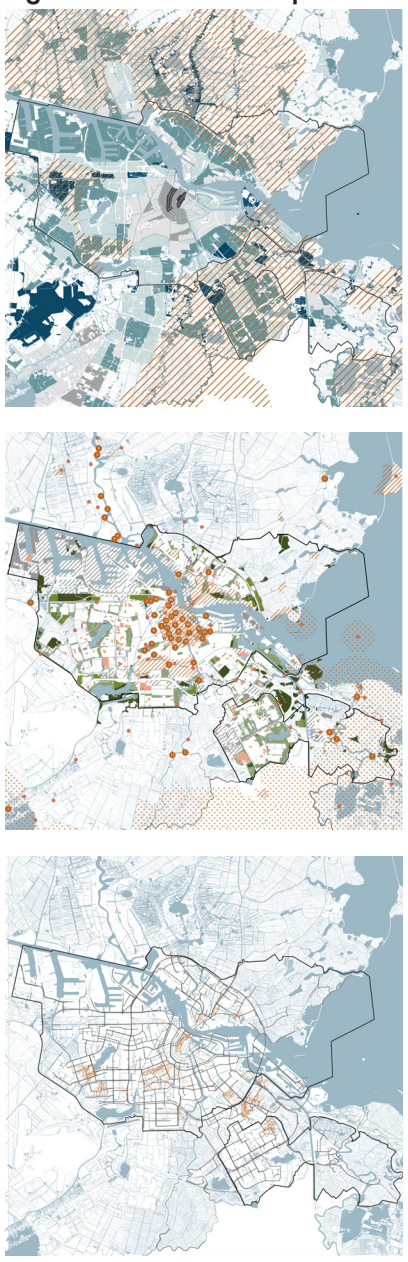
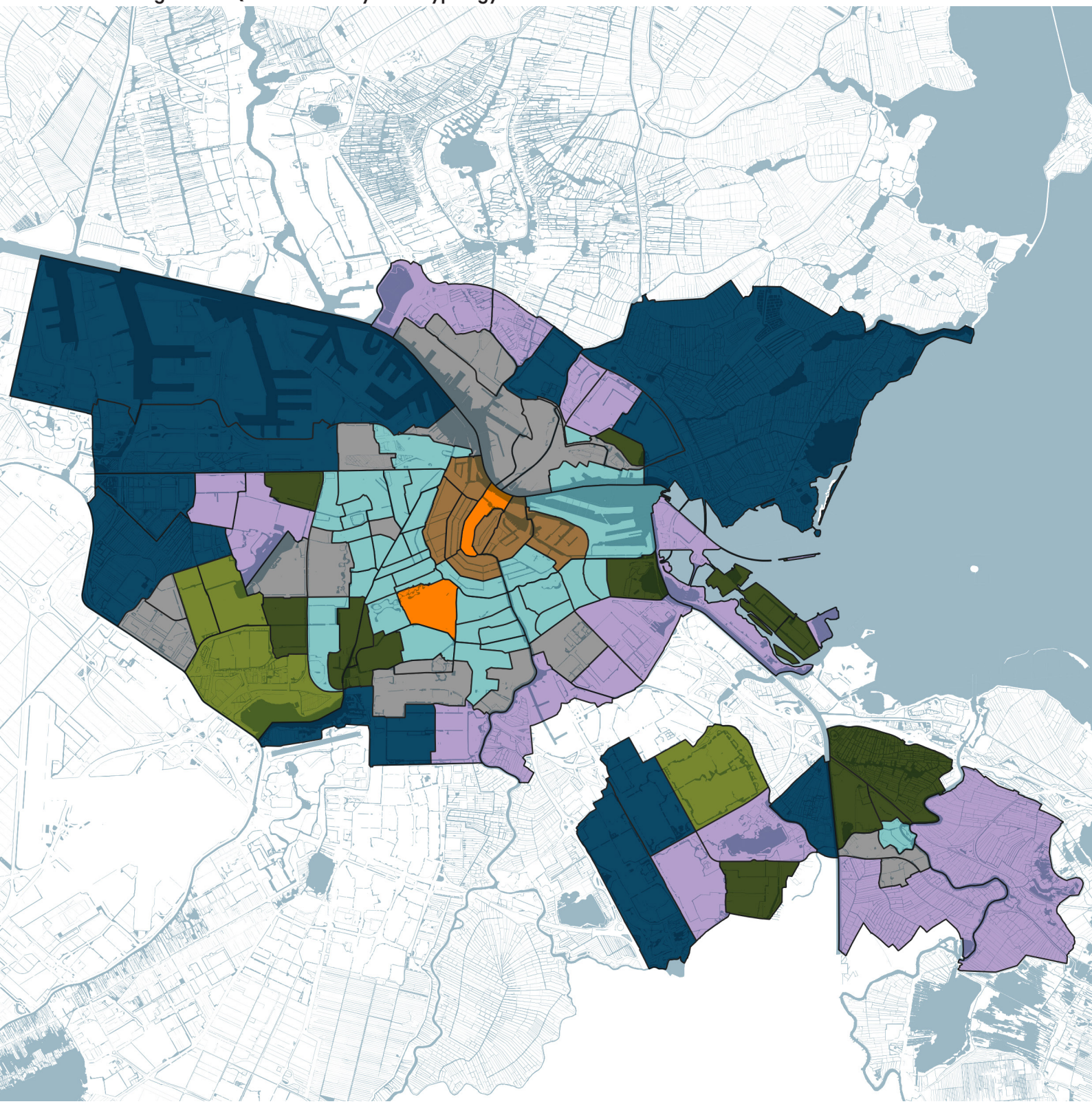


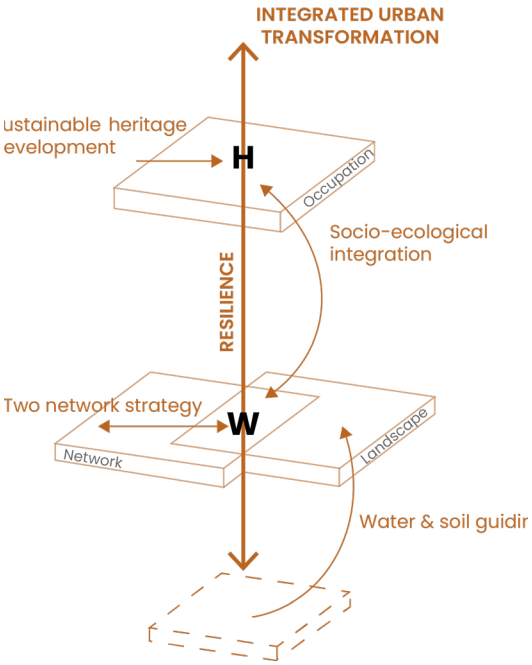
Figure 6.4: Quantitative city scale typology

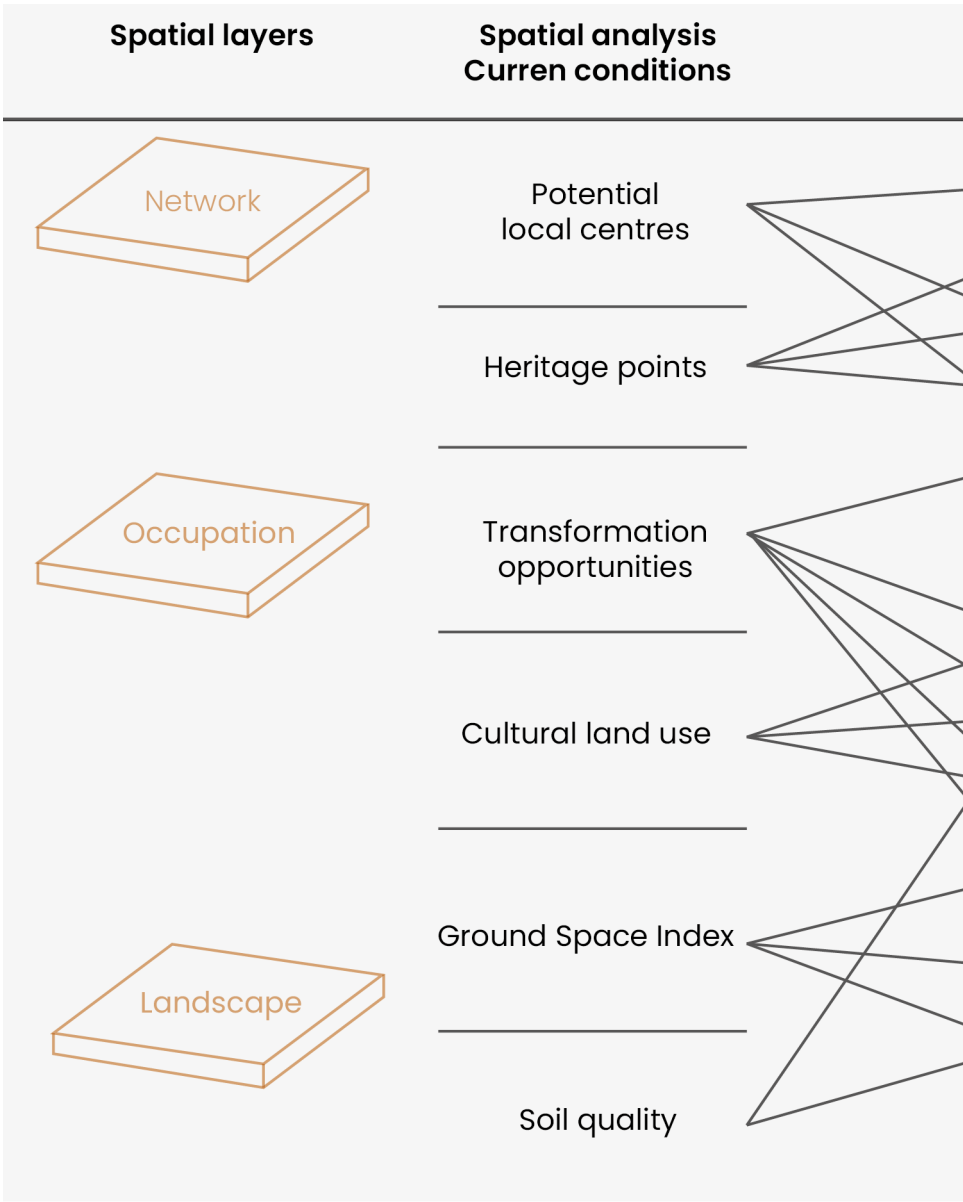


6.2 TRANSLATING THE SPATIAL ANALYSIS INTO A DESIGN ASSESSMENT

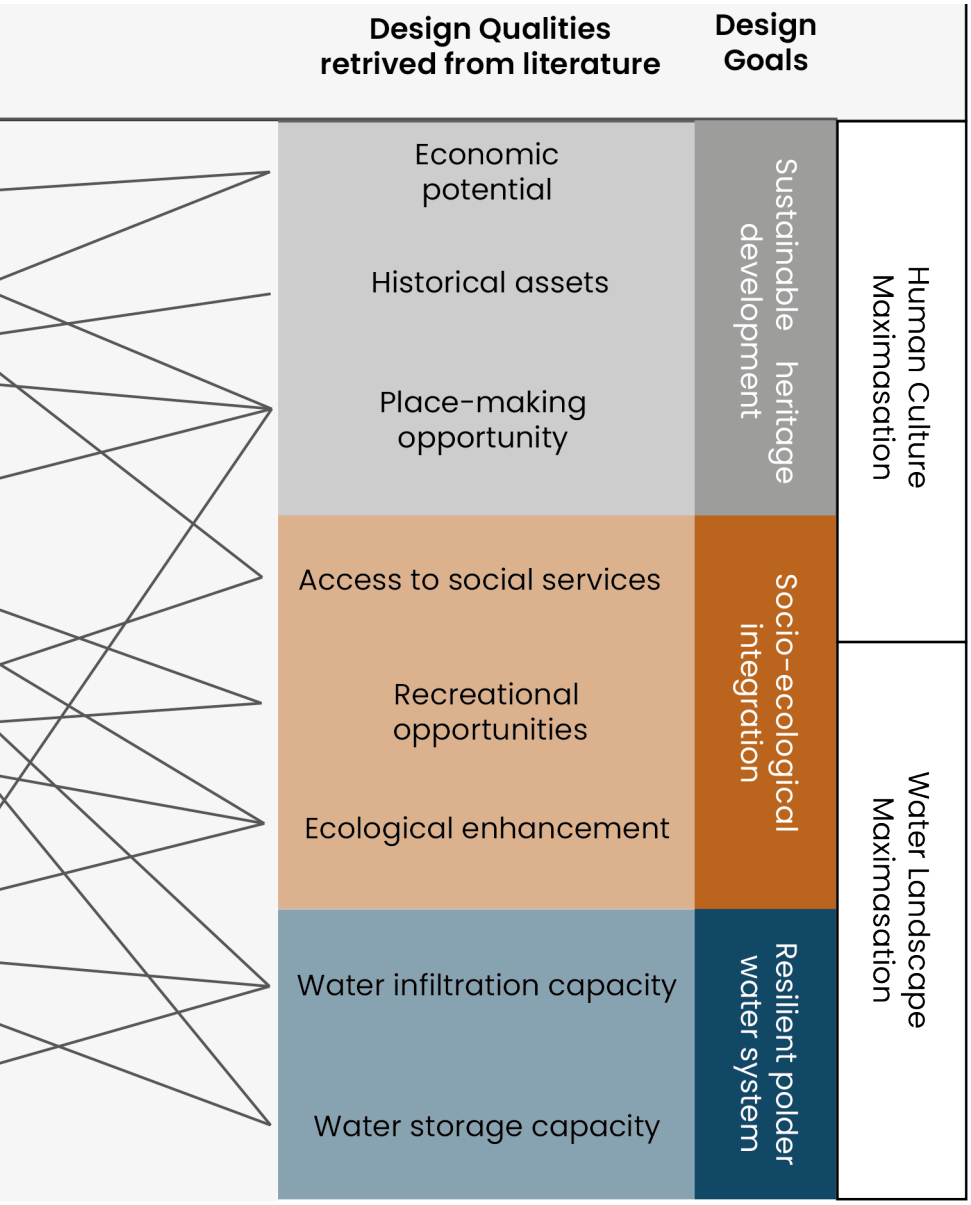
In Figure 6.5, it is shown how the spatial analysis has been translated into a design potential. The variables are results from the spatial analysis, these are used as input for the typology construction. From the literature review and survey design qualities have been formulated based on the design vision that aims for sustainable heritage development, socio-ecological integration and an adaptable polder water system. This all corresponds to the design vision and analytical layers of spatial planning as mentioned in the conceptual framework .

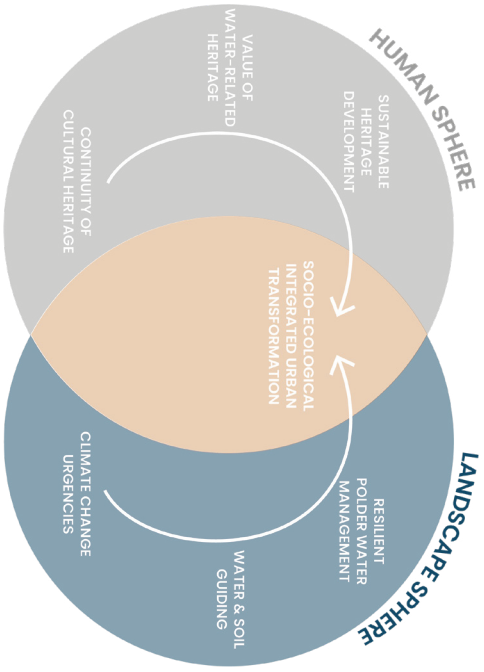
Figure 6.5: Translation from spatial analysis to design vision





With the design qualities the types constructed in the typology can be assessed to generate a design strategy per type. To get an informed approach to the assessment per type, the outcomes of the Geoda have been used as a first assessment, afterwards, the combined average assessments of these values have been used to assess the qualities. For example, the assessment of the economic potential is the average assessment of local centres and heritage points.





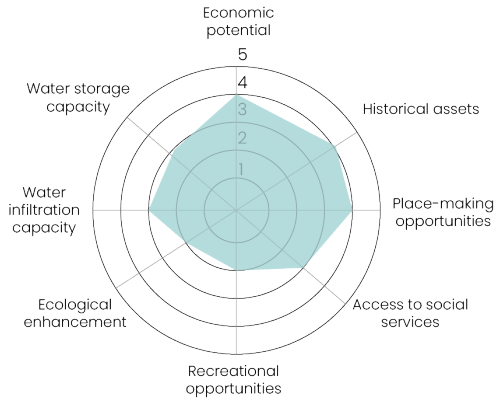
6.3 ASSESSMENT OF NEIGHBOURHOOD TRANSFORMATION OPPORTUNITIES

The assessment of the eight types is shown in the spiderwebs. Every type holds a different set of design qualities. However, in ideal circumstances, all design qualities should be enhanced in a neighbourhood. Based on these spiderwebs in Figure 6.6, it can be determined in which type the design qualities have the most potential for improvement.

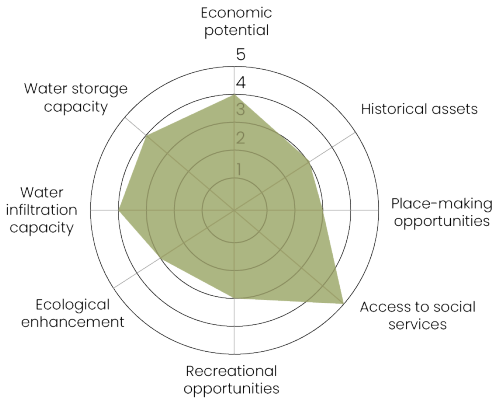
However, these are average assessments and a type can hold variations and exceptions. Therefore the land use map in Figure 6,7 has been used to individually analyse the types based on urban morphology and the design qualities. For every type, an archetype neighbourhood and exceptional neighbourhood have been qualitatively assessed through fieldwork to evaluate if the assessments as shown in the spiderweb and consequently its potentials are correct. This will lead to an informed design potential for every type.

Figure 6.6: Assessment of neighbourhood types

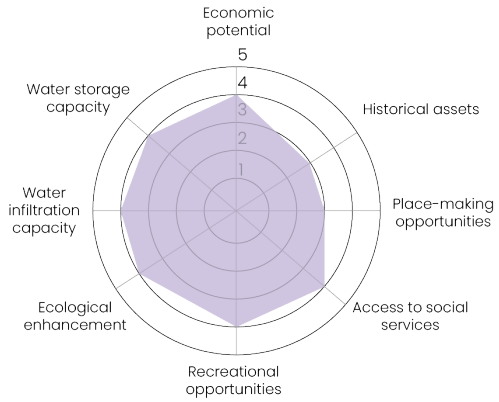
Type 1: Pre-war residential areas



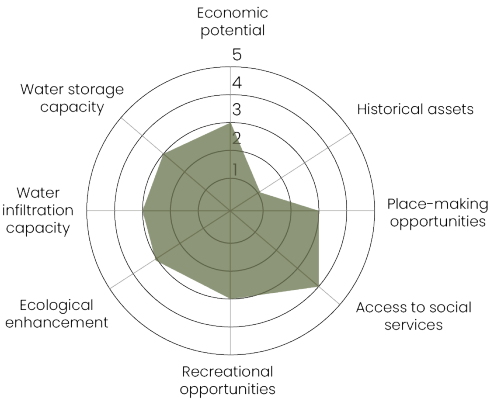
Type 3: Post war areas with high potential as a local centre



Type 2: Ringroad bordering areas with recreational space



Type 4: Post war residential areas that lacks cultural value

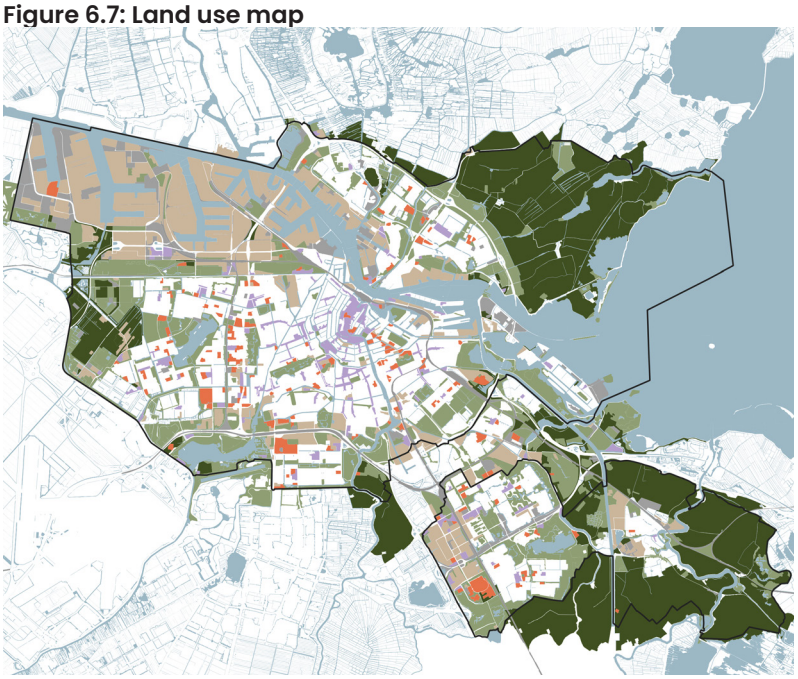


Residential area
Agriculture
Retail
Natural area
Social service
Industrial area
Watercourse
Traintrack

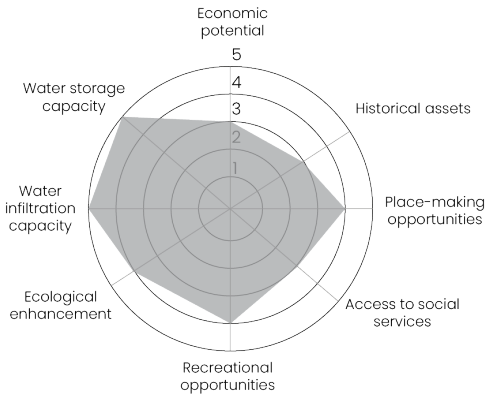
Scale: 1:250.000

Source: Data retrived from CBS (2017)

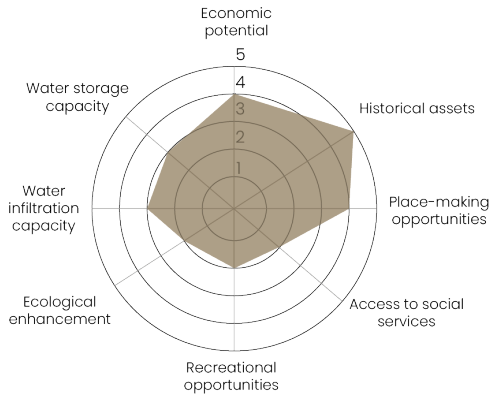
Figure 6.7: Land use map



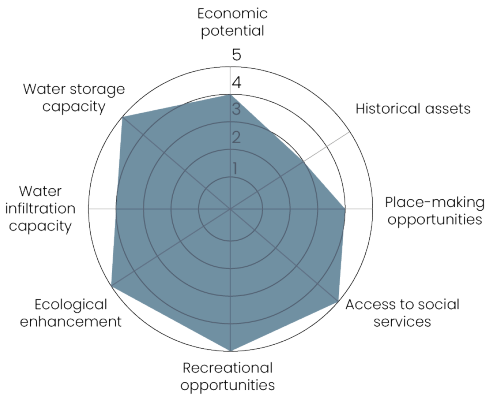
Type 5: High porosity and high access to recreational values



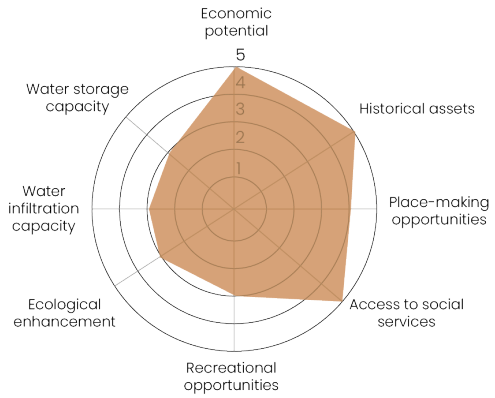
Type 7: Historical inner city



Type 6: City edges, mix of industrial, agricultural and recreational space



Type 8: Touristique core, economic centre



6.4 QUALITATIVE ASSESSMENT OF TYPE 1 VARIATIONS

TYPE 1: 37 NEIGHBOURHOODS

Figure 6.8: Location of type 1 neighbourhoods

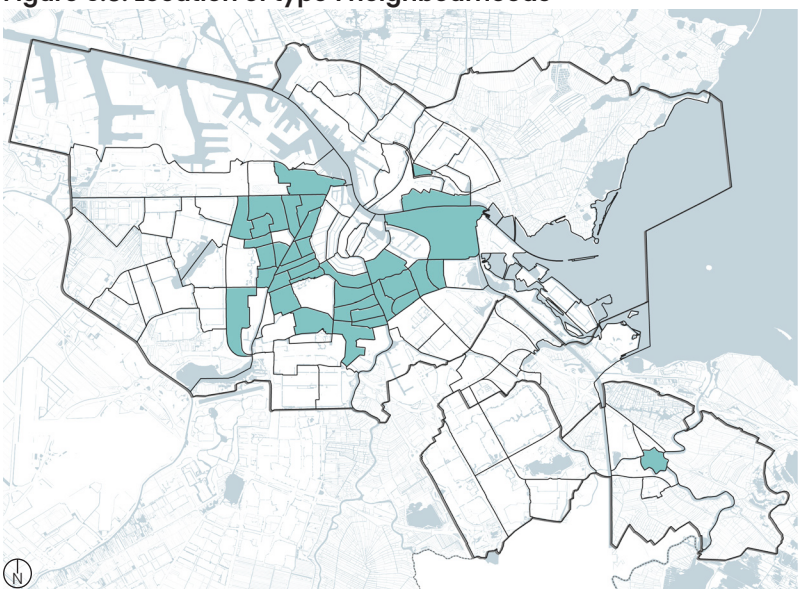
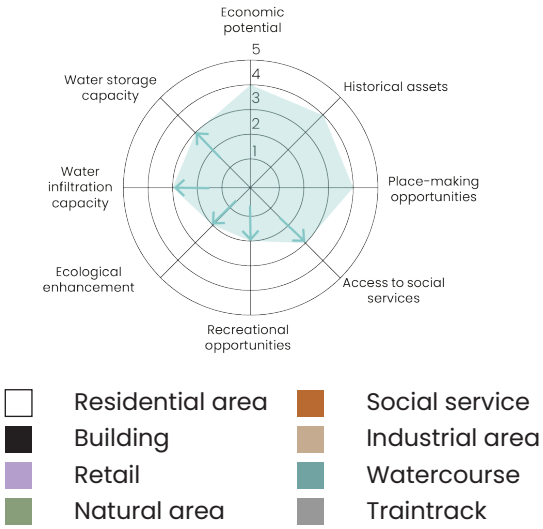


Figure 6.9: Type 1 potential improvement



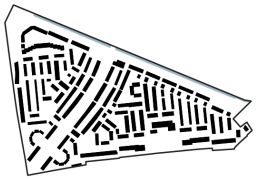
Type 1 neighbourhoods are mostly part of the early 20th-century city expansions. They have closed residential blocks with little to no natural area. Small water courses run through these neighbourhoods. Almost all neighbourhoods have a main street with shops and one or multiple social-cultural facilities. Therefore the neighbourhoods already have economic potential. Most neighbourhoods have one or two heritage sites and therefore have place-making potential. Due to the high proportion of build area, the water infiltration and storage capacity is limited. This needs to be improved with an advanced infiltrate-store-drain system. Through engaging this in the urban environment, ecological values will be strengthened. The historical assets can be used as catalysts for climate adaptation and there is a need to provide for small-scale recreational possibilities of the urban waterfront.

Figure 6.10 : Type 1 exceptional neighbourhoods

Centrale Markt

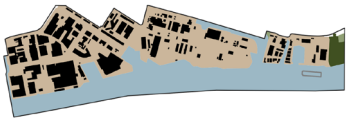
Historical market with high potential for social and economic services, potential for large scale transformation

Tuindorp Buiksloot



Garden city housing with no social or economic potential and no natural area
-> switch to type 4

Noordelijke IJ-oevers oost

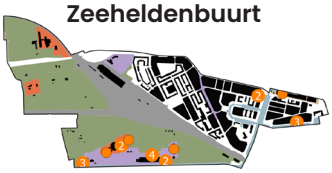


One big industrial area on the northern bank of the IJ, an inaccessible prviate part of the city

Westlandgracht

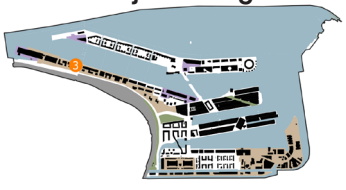
Mixed use area with little historical assest and more water infiltration capacity.
-> switch to type 5

Spaarndammer Zeeheldenbuurt



Pre-war residential closed blocks but with the large natural area of Westerpark

Oostelijk Havengebied



Former harbour as asset for residential development, waterfront as place making tool

Figure 6.11: Archetype 1 neighbourhoods: residential closed blocks with a main street and small watercourses

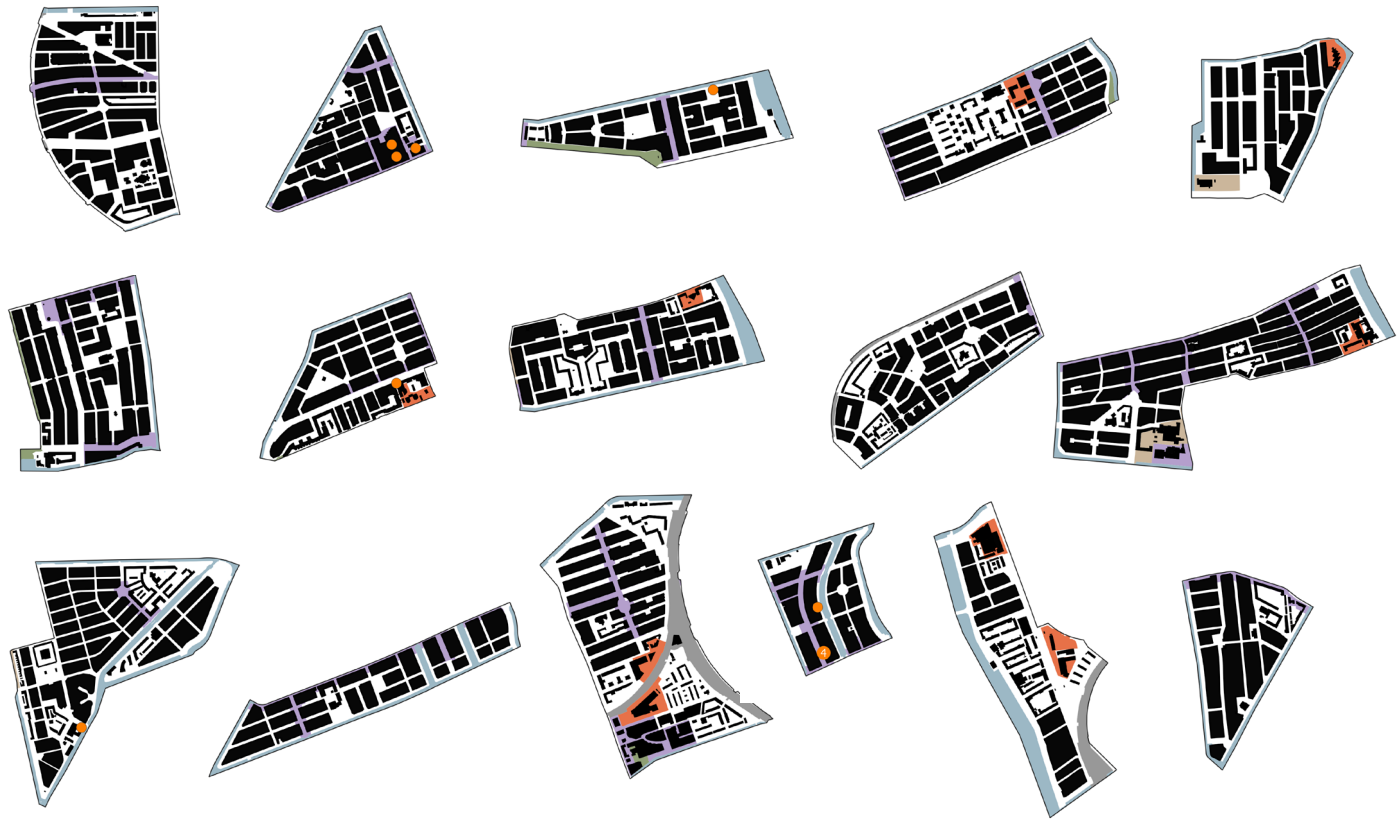


Figure 6.12: Archetype 1 variations: Residential closed blocks with a main street and a small natural area

Figure 6.13: Archetype 1 variations: Residential closed blocks, but more mixed with socio-cultural services

Scheldebuurt

De Scheldebuurt can be considered an archetype of type 1 neighbourhoods. The closed residential blocks are valued residential areas and protected townscape. On the corner of the street, there is often a shop or cafe which catalyses the local social and economic values. The big improvements are in the water management potential and potential for ecological enhancement, as the streets are often impermeable and car-dominated. Small-scale recreational opportunities in small natural areas. would further improve the socio-ecological values.

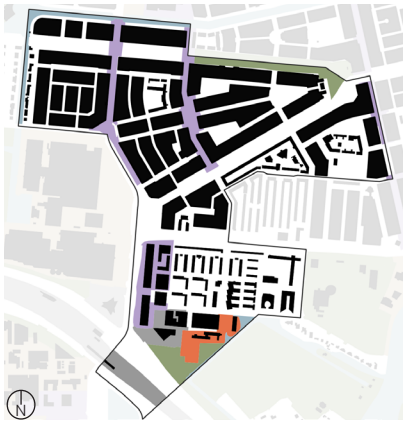


Figure 6.14: Scheldebuurt

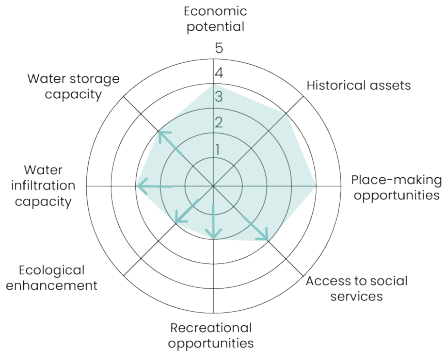


Figure 6.15: Scheldebuurt Maximising local potential

Oostenlijk Havengebied

Het Oostelijk Havengebied is an exceptional neighbourhood in type 1 because it is not a dominant residential area, but a mixed-use area. Partly older industrial buildings and partly new residential developments. Because it borders the IJ this neighbourhood has high water storage capacity, but there is little natural area and therefore slowing down the water runoff is an important potential for water management and ecological enhancement. Because the neighbourhoods border a dominant water body it has unused recreational opportunities and added potential for social services.

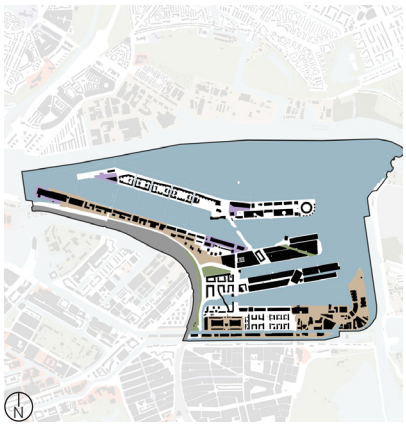


Figure 6.16: Oostelijk Havengebied

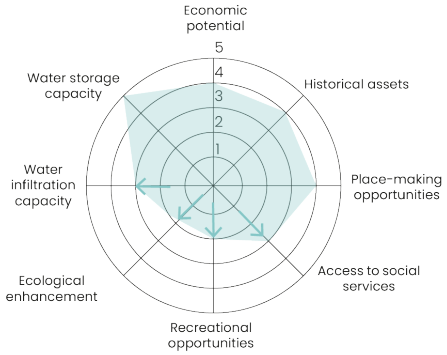
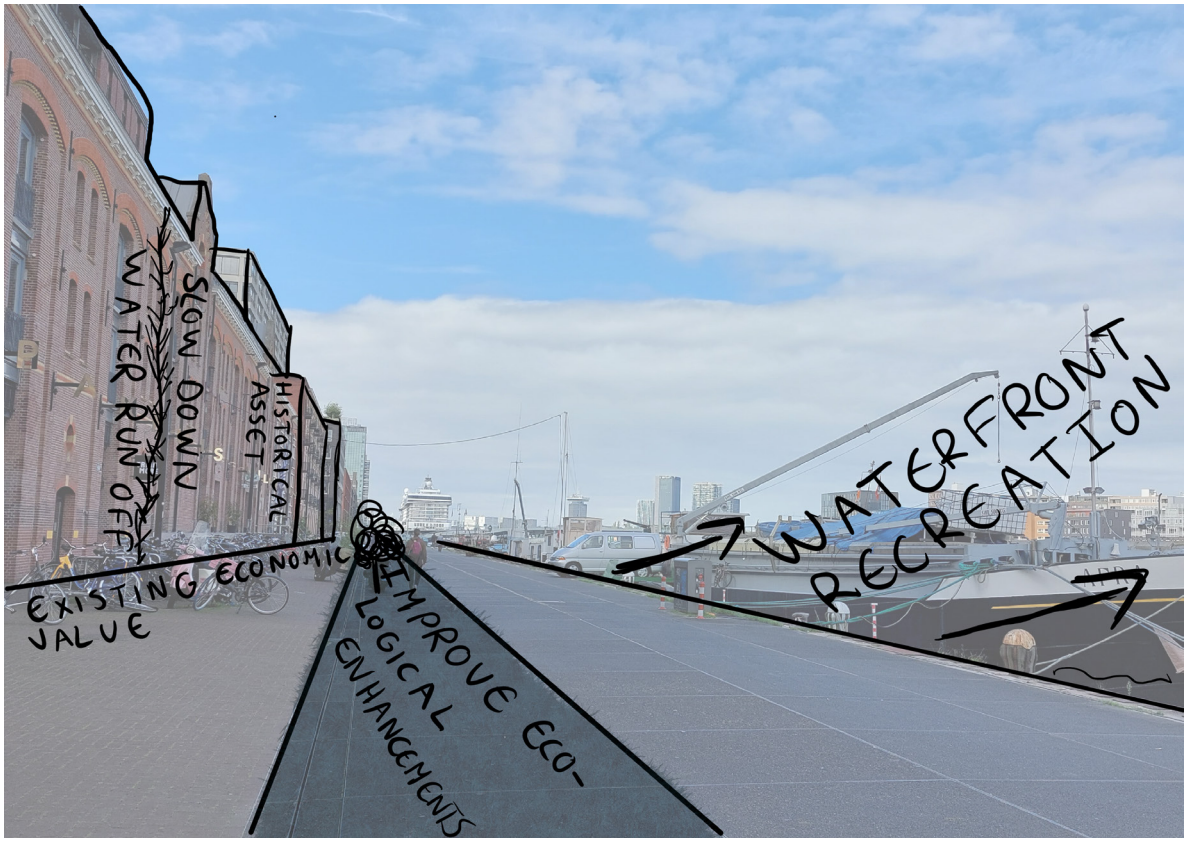


Figure 6.17: Oostelijk Havengebied Maximising local potential

Although the archetype and exception are different urban environments they mostly hold the same potential to improve the design qualities. The only exception is the water storage capacity of Het Oostelijk Havengebied because the neighbourhood contains a big waterbody which is an important part of the boezem system.

Figure 6.18: Scheldebuurt qualitative assessment

Figure 6.19: Oostelijk Havengebied qualitative assessment



6.5 QUALITATIVE ASSESSMENT OF TYPE 2 VARIATIONS

TYPE 2: 17 NEIGHBOURHOODS

Figure 6.20: Location of type 2 neighbourhoods

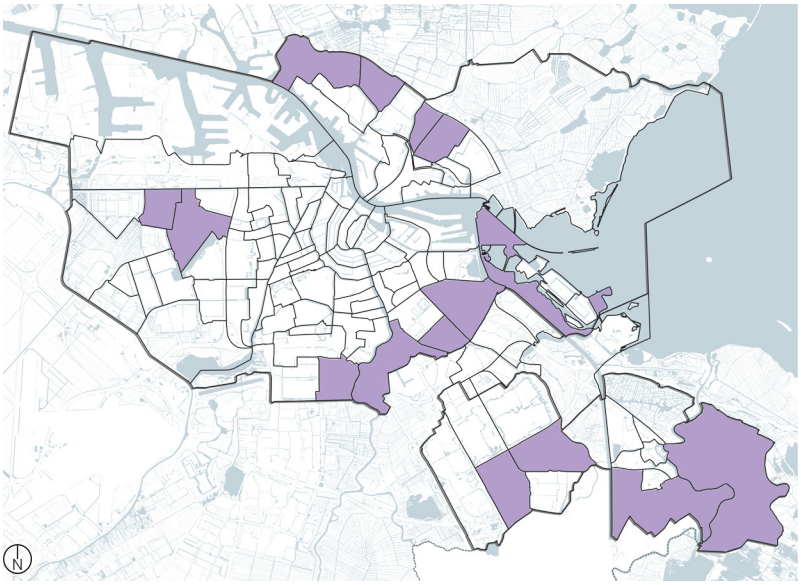
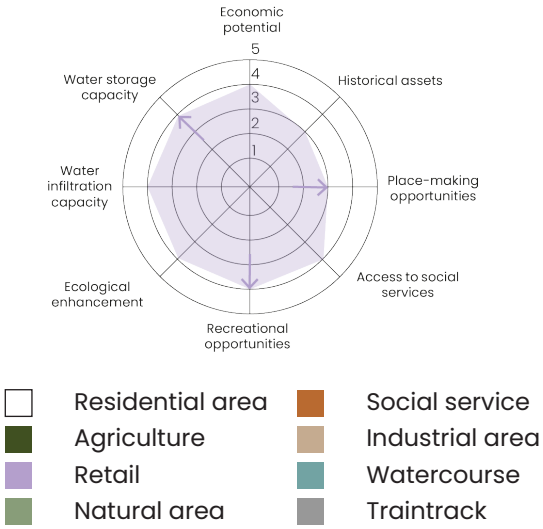


Figure 6.21: Type 2 potential improvement



Neighbourhoods in type 2 are either at the edge of the city or around important natural areas. They have a high potential for climate adaptation for both water infiltration and storage capacity. Moreover, they have high access to recreational space and ecologically valued nature. The neighbourhoods are mostly modernist residential areas. In addition, the newest residential developments and low-density suburban areas are part of this type. The place-making opportunities are catalysing these natural areas for recreation opportunities. The neighbourhoods should be made more accessible by strengthening the green-blue network from and towards the recreational spaces, providing access from all over the city. This could have added social and economic value. Some of these recreational areas can function as wet natural areas for seasonal water storage.

Figure 6.22: Type 2 exceptional neighbourhoods

Omval / Overamstel

Mixed neighbourhood along the Amstel with historical assets

Middenmeer

Mixed neighbourhood with different densities and university campus

Figure 6.23: Arcehtype 2: modernist residential neighbourhoods with direct access to natural areas

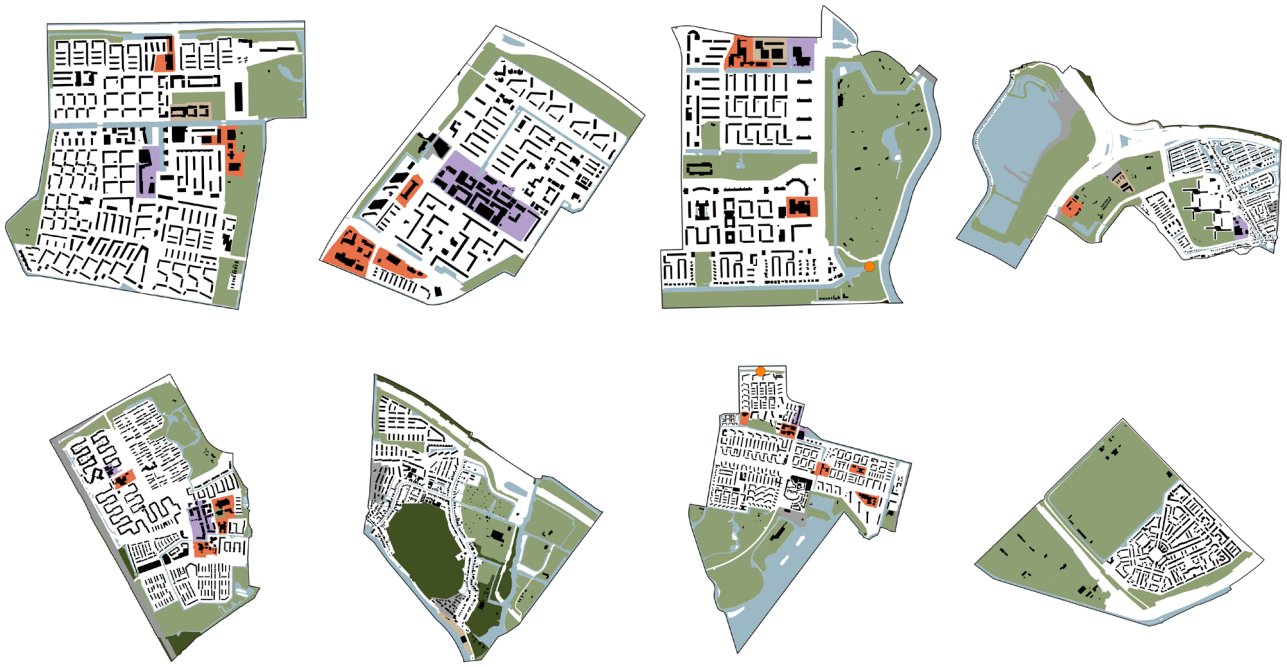


Figure 6.24: New residential development on the city edges, with direct access to natural areas

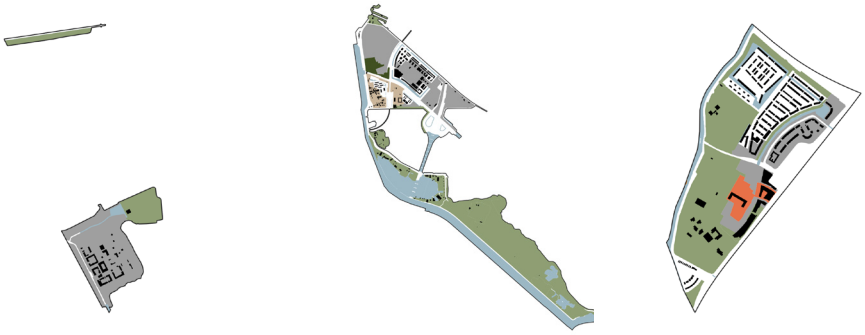


Figure 6.25: Suburban housing with large scale natural area

Buikslotermeer

Buikslotermeer is an archetype neighbourhood for type 2 and already has many of the formulated design qualities. The only quality it lacks is historical assets. The ecological enhancement can be strengthened by connecting it to other neighbourhoods. Many of the natural areas do not have a purpose, therefore these areas could be assets to either have seasonal water storage capacity or recreational value, both adding potential place-making opportunities.

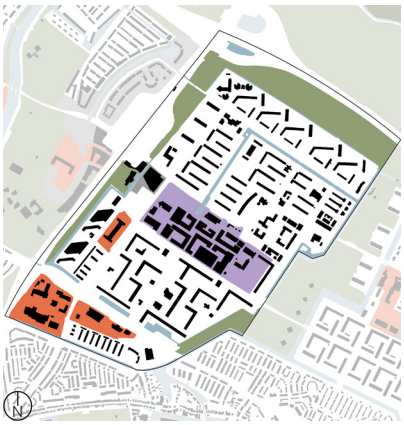


Figure 6.26: Buikslotermeer

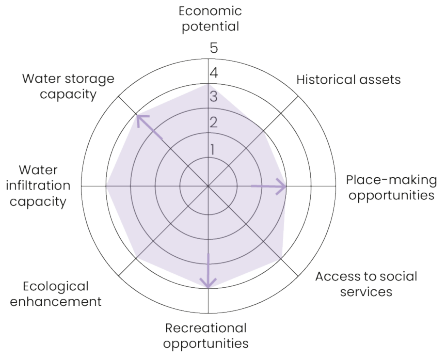


Figure 6.27: Buikslotermeer Maximising local potential

Omval / Overamstel

Omval / Overamstel is an exception in type 2 because there are many different urban environments in this neighbourhood. It is the only neighbourhood in type 2 that has historical assets which can be used as a place-making opportunity. The direct access to the Amstel River has high recreational potential, but in many places, this is still underused. Like the archetype 2, this neighbourhood holds high ecological value and water management potential. Type 2 are key hubs in the city's green/blue network.

Figure 6.28: Omval / Overamstel

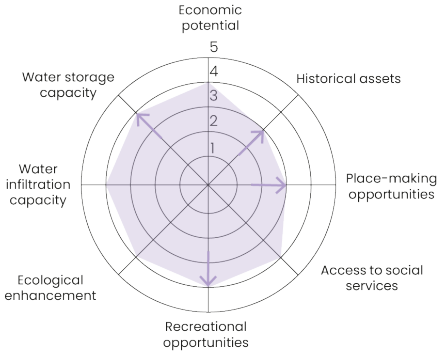


Figure 6.29: Omval / Overamstel Maximising local potential

In conclusion, type 2 already holds many of the design qualities, however, they are often underused because natural areas lack purpose. The natural areas in type two should have a place-specific purpose, but more important are the most important links in the city scale green/blue network and accessibility from all over the city should be improved.

Figure 6.30: Buikslotermeer qualitative assessment

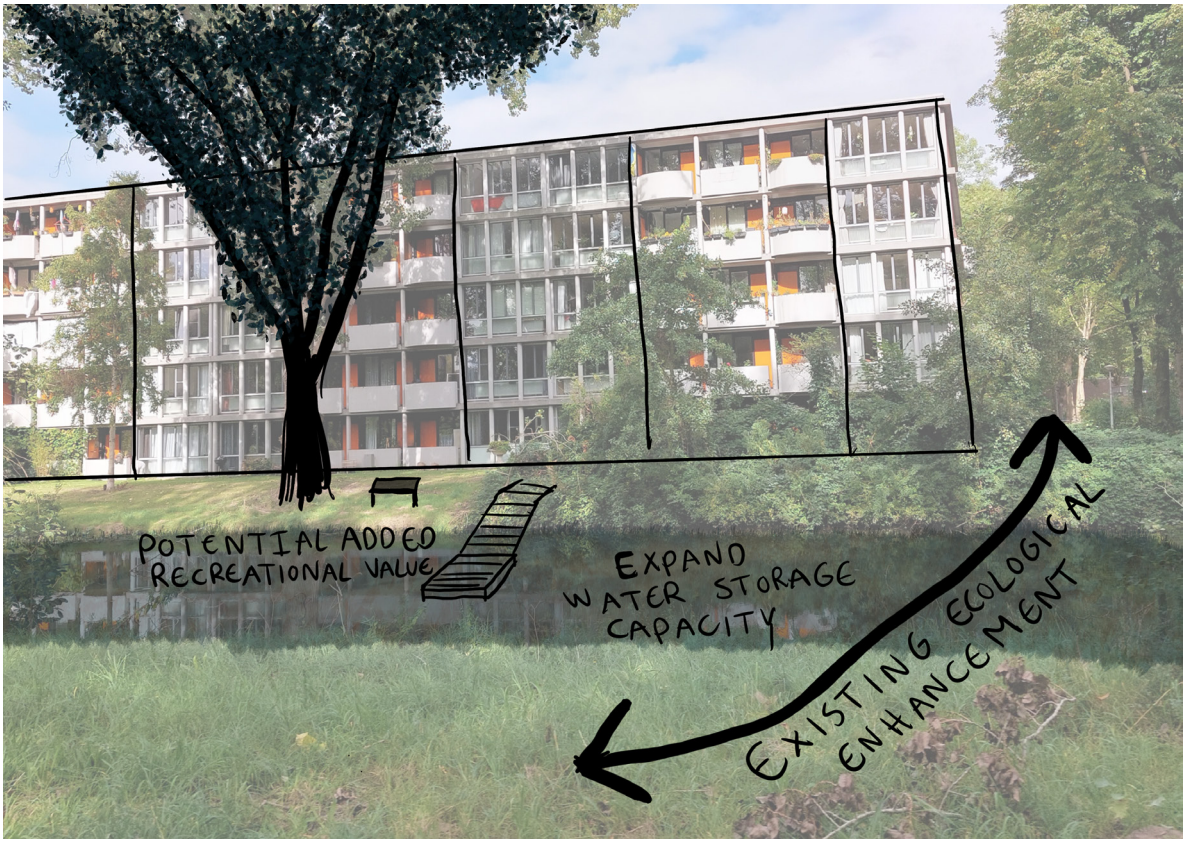
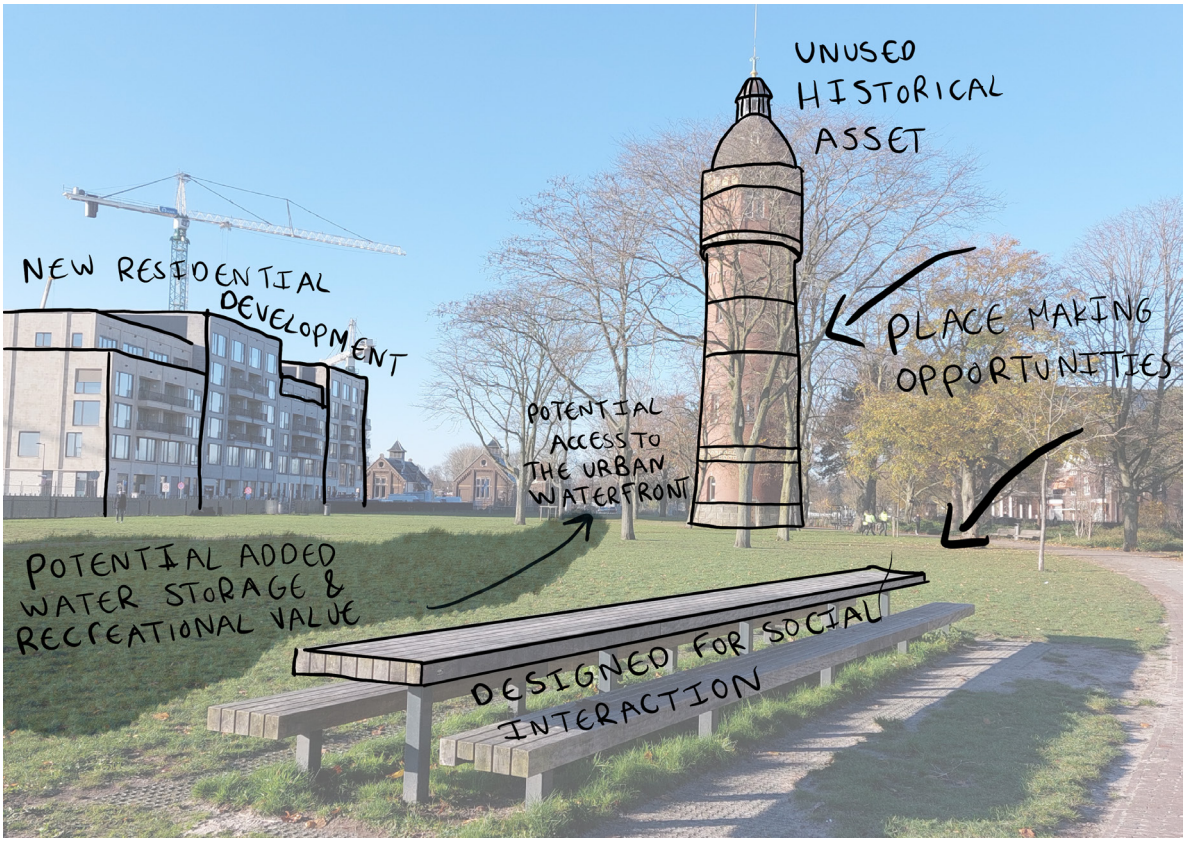


Figure 6.31: Omval / Overamstel qualitative assessment



6.6 CITY SCALE TYPOLOGY CONCLUSION

For all types, a qualitative assessment based on land use and fieldwork was conducted (see Appendix). The qualitative assessment showed the variations and exceptions in the quantitative typology construction. Based on the qualitative assessment the neighbourhoods Tuindorp Buiksloot, Westlandgracht, Geuzenbuurt and Bloemendalerpoder belong to a different type. The new typology map is shown in Figure 6.33. Moreover, the city scale section in Figure 6.32 shows the different urban environments in every type and their metabolism for water and human flows. Based on the qualitative assessment it can be decided which neighbourhoods have the most potential for improvement of the design qualities.

Figure 6.32: City typology in section

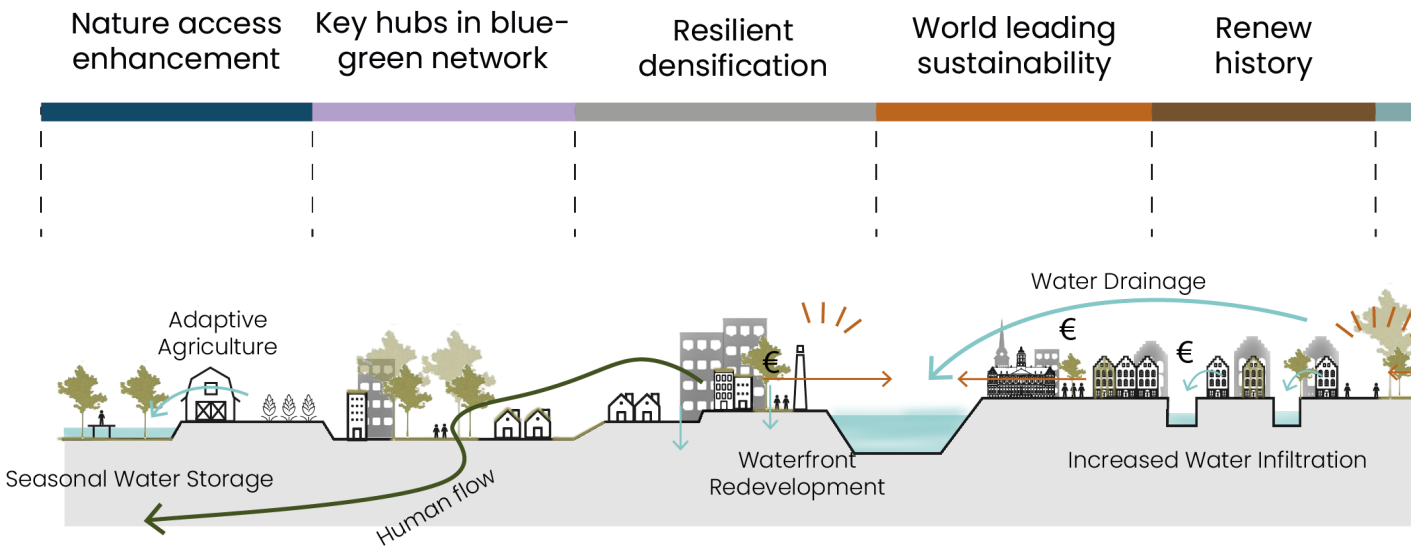
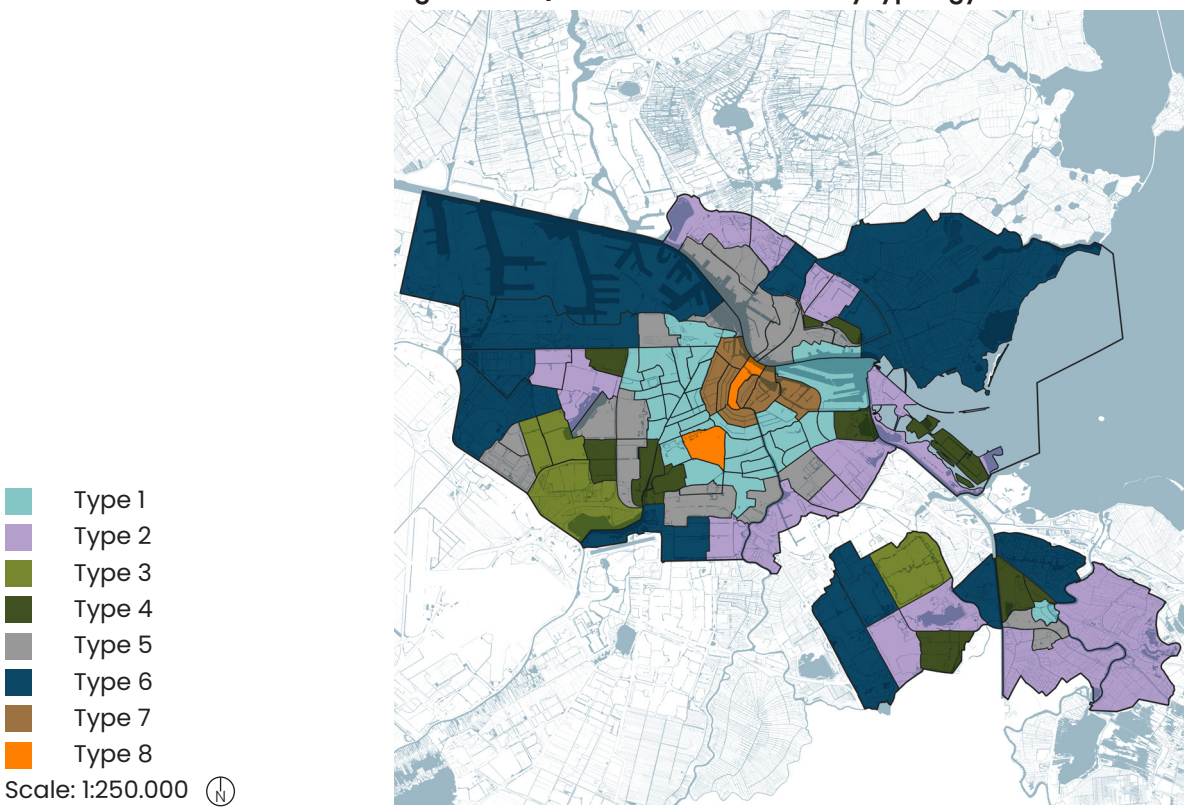
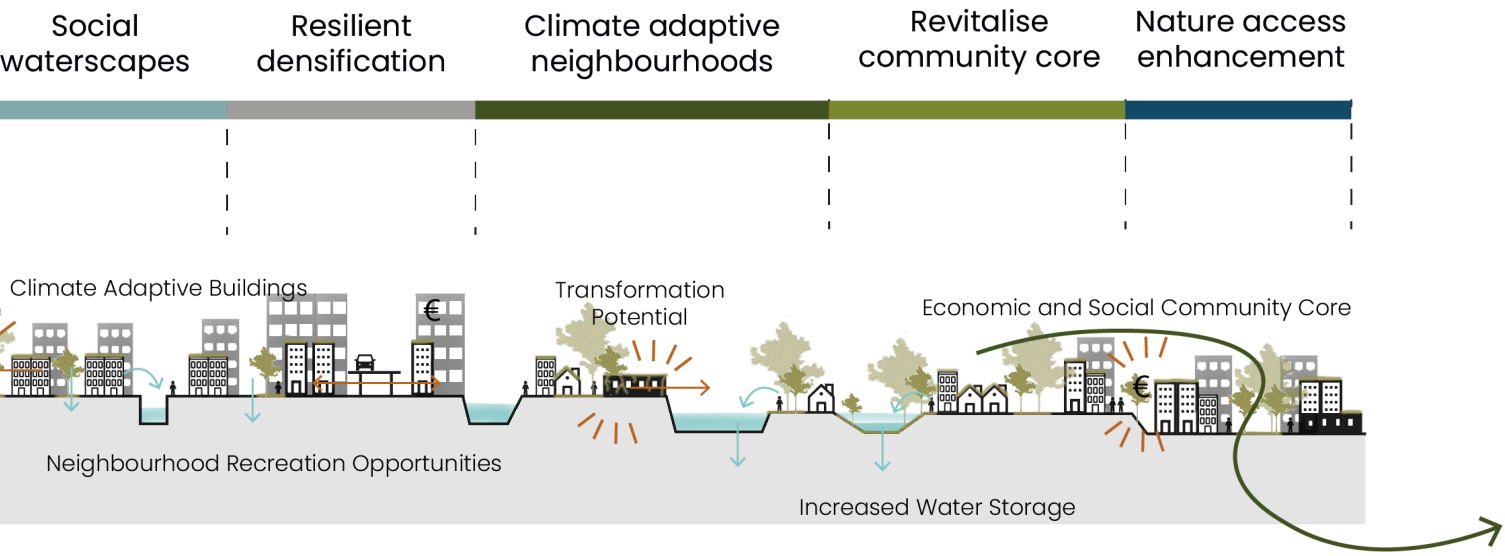


Figure 6.33 Qualitative iteration on city typology

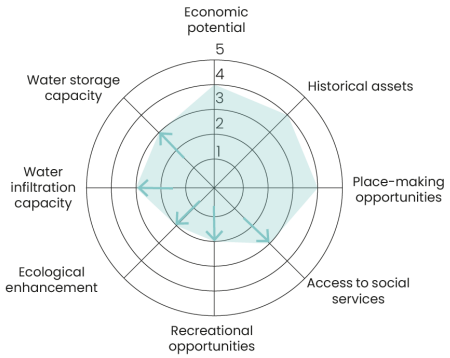




6.7 DESIGN POTENTIAL FOR NEIGHBOURHOOD TYPES

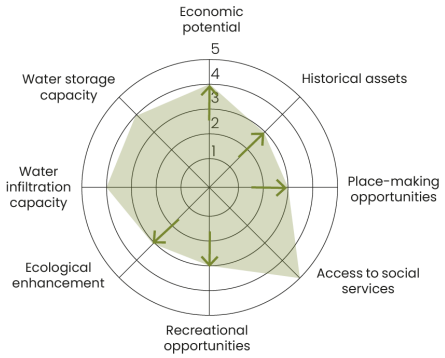
Figure 6.34: Design potential for neighbourhood types

Type 1: Social waterscapes for urban living



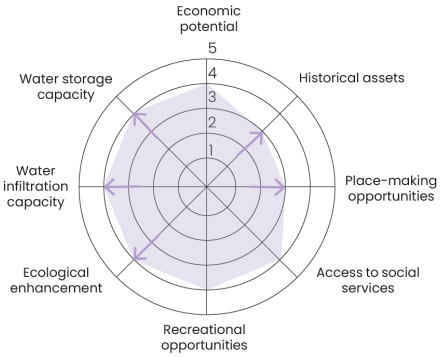
Need for advanced water management amplifying ecological resilience, and unlocking the potential of heritage for climate adaptation for socio-ecological integrated urban living.

Type 3: Revitalise community core



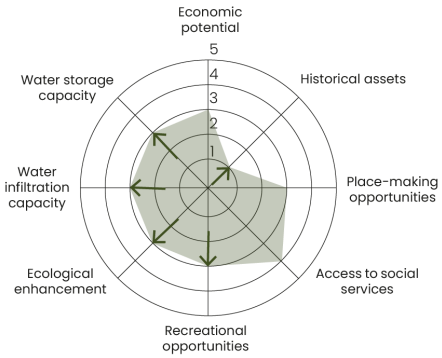
Maximise economic and social potential by strengthening accessibility and adapting local centres for climate resilience and community engagement.

Type 2: Key hubs in blue-green network



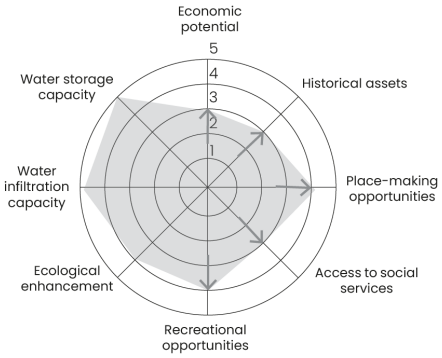
Vital hubs in the blue/green network, enhancing accessibility, and socio-economic value through recreational spaces and climate adaptation.

Type 4: Climate adaptive neighbourhoods



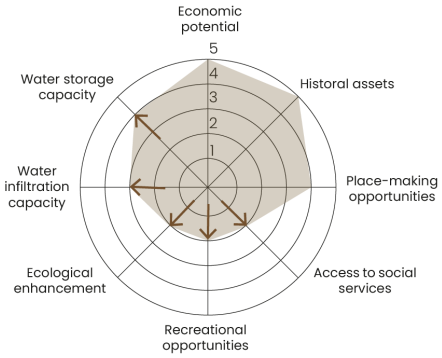
Utilise dynamic water features and neighbourhood-specific cultural values to foster socio-ecological activities in resilient residential areas.

Type 5: Resilient densification



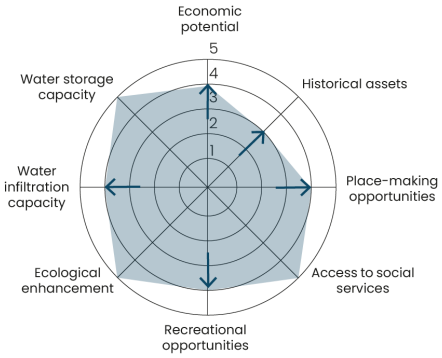
Sustainable urban transformation by catalysing cultural heritage for (re) development with cultural value and climate adaptative place-making in the blue/green urban network.

Type 7: Renew historical legacy



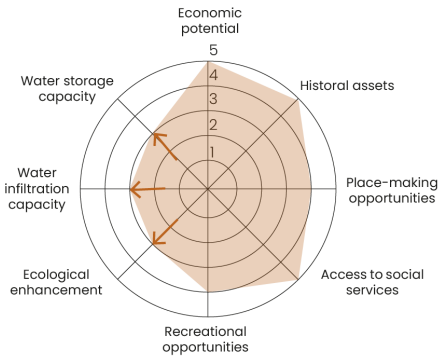
Transform high-density historical areas into sustainable urban landscapes. Integrating economic potential, with ecological values and recreational spaces.

Type 6: Nature access enhancement



Improve access to natural areas for place-making potential and socio-economic benefits. Adapt industrial and agricultural areas to allow for seasonal water storage and wet natural areas.

Type 8: World leading sustainability



Increase economic vitality through innovative climate adaptation of cultural heritage, showcasing the pride of the water city with inspiring global climate action.

6.8 REGIONAL TRANSFORMATION OPPORTUNITIES

In conclusion, the regional plan offers an overview of the integrated transformation opportunities required for climate adaptation in the polder water system and the potential for sustainable heritage development. Figure 6.35 synthesises the regional analyses conducted.

Water management
There is a need for more water storage capacity and therefore for more wet natural areas. To increase the water storage capacity of the metropolitan area it is important to add cultural value to these new wet areas. This can be either by giving it social, economic or ecological purpose with recreational areas or by highlighting the historical landscapes that will emerge from this transformation. Both will emphasise the positive aspects of more water in the metropolitan area. Controlled water in- and outlet will be used for the inundation of the polders as a buffer zone to get the pressure of the national water system.

Ecological enhancements
By stitching the protected landscapes together the ecological value of the metropolitan area will increase and this will improve biodiversity. Nature-based coastal and dike reinforcement will improve the resilience for water safety, while at the same time improving biodiversity.

Agricultural transformation
Because there is a need for more space to store water, parts of agricultural land will have to change their practice. This asks for innovative adaptive techniques for agriculture in both dry and wet circumstances. However, no in-depth research has been done into which practices are most suitable for this region. National strategies are needed to accomplish the transformation of the agricultural sector.

Cultural heritage corridors & densification
The cultural heritage corridors from Zaanstad to Het Gooi and the coastal sand ridge should be exploited as place-making areas for tourism and recreation. Moreover, these are also the areas most suitable for large-scale urban development and therefore are subject to the urgency of densification. The higher density in the cities can only be achieved in combination with climate adaptation of the polder water system.

Transportation and accessibility
The cultural heritage corridors ask for improved accessibility by public transport from and towards Amsterdam and for the cooperation of the municipalities involved. With the cities becoming denser, the accessibility to nature is important for the well-being of the citisens. It is therefore important that the accessibility from the inner city to the special provincial landscapes close to the city is improved by bike networks and public transport. This will strengthen the cultural value of these landscapes

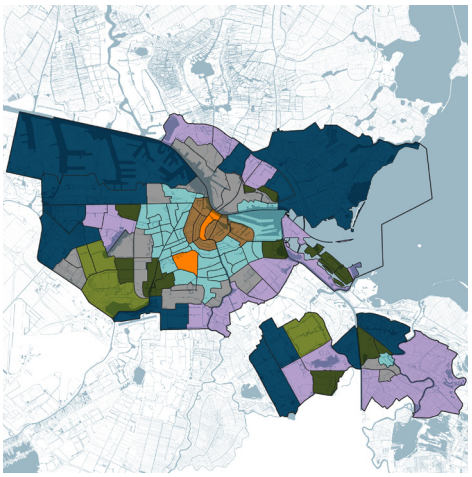
These fields of cooperation underscore the multifaceted nature of the challenges and opportunities in the regional context, emphasising the need for coordinated efforts across various domains. The Amsterdam Metropolitan Area is already a cooperation of all the municipalities and two provinces involved and they could be guiding in the implementation of an integrated strategy.

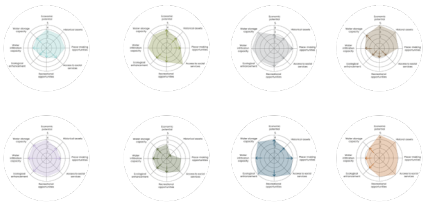
Figure 6.35: Regional transformation opportunities

Build area
Investment area for urban development
Potential wet natural areas
Adaptive agricultural land (mostly dry)
Adaptive agricultural land (partly wet)
Protected townscapes
UNESCO world heritage

Agricultural land continues
Water in- and outlet
Nature based coastal reinforcement
Dike reinforcement
Cultural heritage corridor
Landscape stitching
Improved accessibility between city and provincial landscapes

Scale: 1:450.000





CONCLUSION CHAPTER 6

Chapter 6 six showed how the potential maps retrived from the literature and spatial analysis are transformed into a typology that shows spatial opportunities for urban transformation. Based on the literature review and analysis eight design qualities were formulated and the different neighbourhood types were qualitatively assessed to show to what extent the types possess the design qualities and where there is space for potential improvement. Based on these analyses the design potential can be formulated for every type. Every type has another role in the integrated urban transformation plan. These visions form the start of the design project.

Zooming out a regional cooperation strategy can amplify the city-scale integrated transformation plan. On a regional scale cooperation is needed for large-scale water storage, ecological enhancement, adaptive agriculture, densification and accessibility.

CHAPTER

7

MAXIMISATION EXPERIMENTS

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In chapter 7 the maximisation method is used to maximise resilience for the water-landscape and the human-culture city. In parallel a pattern language is constructed that shows design solutions that aim to integrate the design goals in this project. Different strategies to guide the decision-making process are described based on stakeholder considerations and participation. Chapter 7 concludes with the integrated urban transformation plan on the city scale.

Figure 7.1: Algemeen uitbreidingsplan van Amsterdam

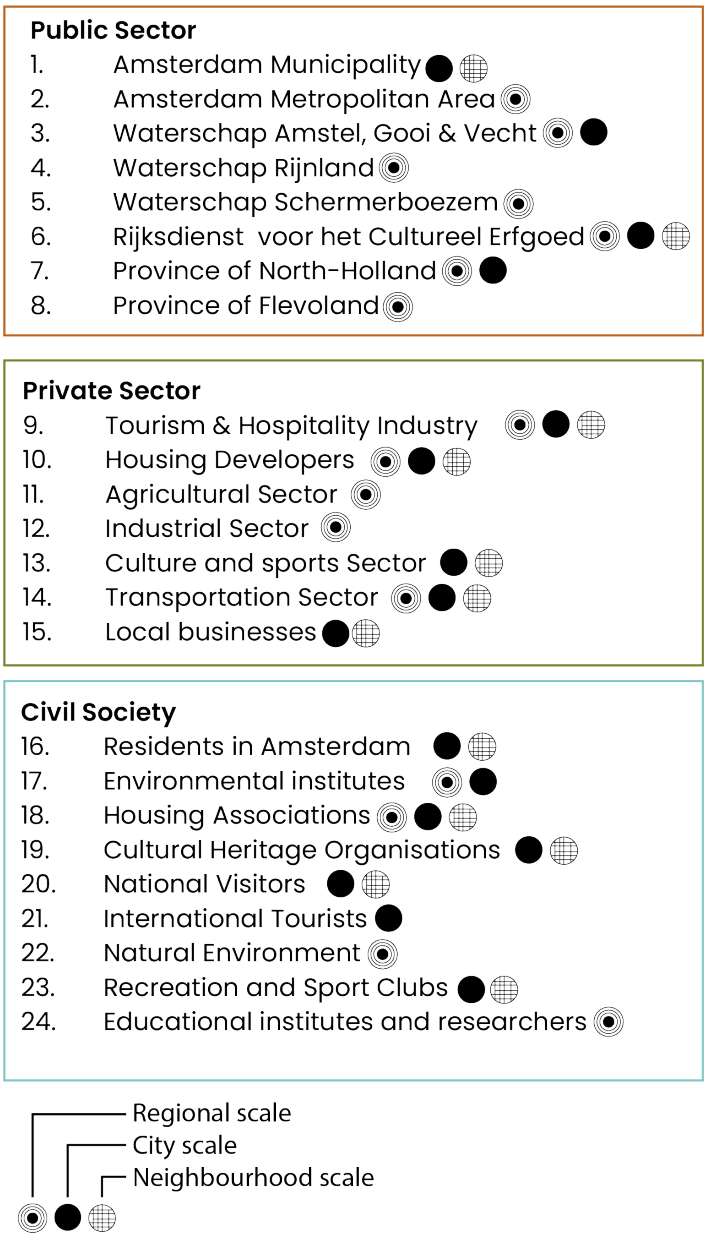
Source: Stadsarchief Amsterdam / Cornelis van Eesteren (1935)
Black & White Adaptation

7.1 STAKEHOLDER ANALYSIS

Because of the multi-scalar integrated approach of this project, there are a variety of stakeholders involved. To get a better understanding of the governance and decision making a list of stakeholders and their corresponding scale of interest was established in Figure 7.2. The main stakeholder in this project is the municipality of Amsterdam. The public sector consists of stakeholders owned or under the control of the National Government. They legislate all the other stakeholders or execute the policies written by the legislatures. The public sector has high power and high interest in this project.

In the private sector are the companies or work areas that are influenced by one or both of the maximisation. The private sector has diffuse interest in the project. They could be divided into large land-based private bodies like housing developers, the agricultural sector and the industrial sector. These sectors have high power because of lobby activities in the public sector, but little interest in this project, because their land-based practices should change to achieve the goals aimed for in this project. The local private sector has less power, but more interest in this project because they could benefit from the socio-ecological integration and increased cultural heritage values in the city.

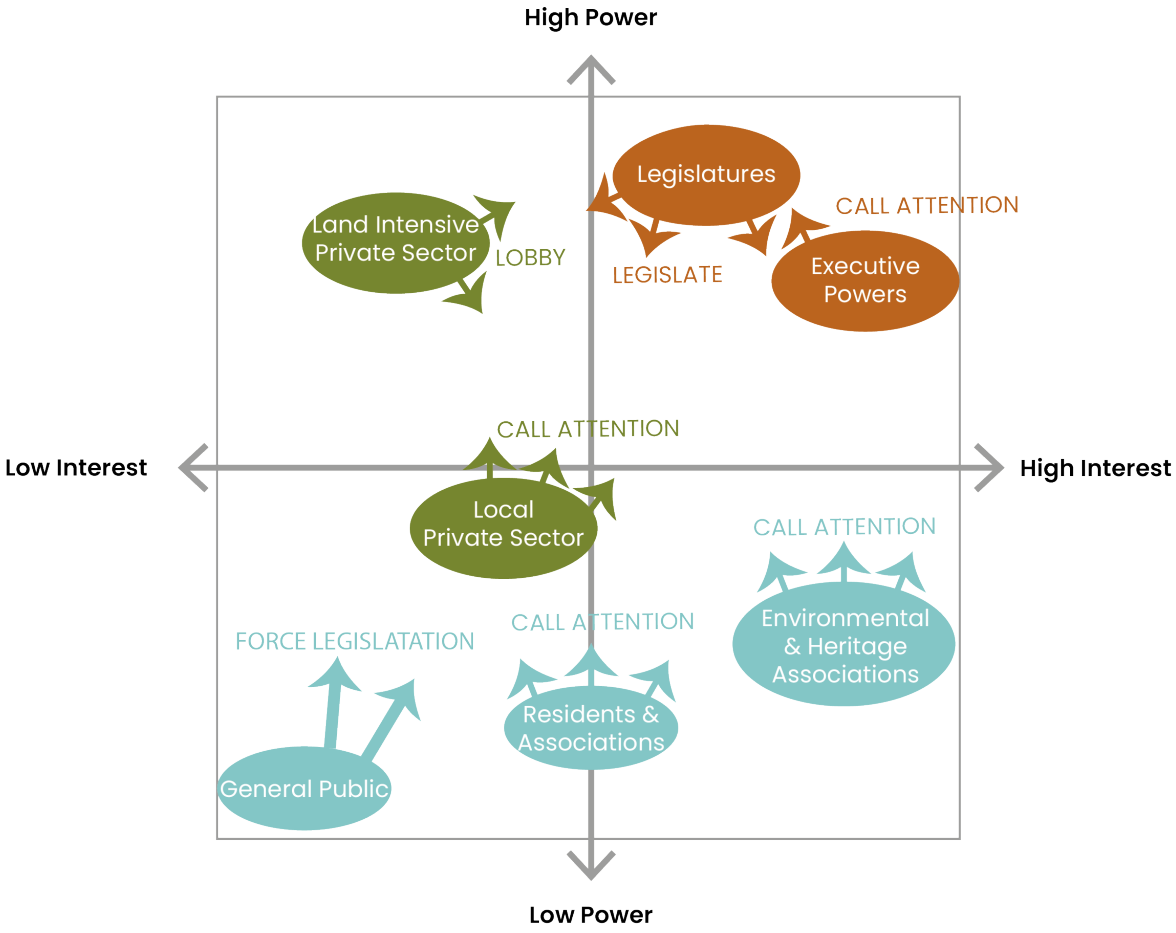
Figure 7.2: Stakeholder overview and scale of interest



Civil society are citisens linked by a common interest or activity. They operate on different scales and have different interests in this project. They lack the power to make large-scale changes but do largely influence the local living environment. Moreover, they call attention to the public sector to strive for needed changes.

The stakeholders have different attitudes towards the two maximisations and therefore taking their power-interest relations into account in the maximisations allows for the identification of conflicts and synergies in the governance and planning of the city.

Figure 7.3: Generalised power-interest matrix



7.2 THE DESIGN OBJECTIVE

In the design project, the maximisation method will maximise the landscape and cultural resilience on a city scale and investigate conflicts and synergies for urban transformation in these systems. The maximisation method allows for the exploration of extreme scenarios and by integrating these extremes it is intended to create the most sustainable urban plan. The maximisation will be combined into the integrated urban transformation plan and integrated implementation on the neighbourhood scale.

In parallel a pattern language will be developed that aims to generate design solutions that support a resilient polder water system, sustainable heritage development and/or socio-ecological integration. The pattern language consists of design solutions (patterns) and their interrelations (the pattern language). The pattern language connects research and design. It bridges scales as the individual patterns can be transferred to different locations, but also allows for context-specific design because of the many different possibilities to combine patterns. This makes the pattern language a welcoming tool in a multi-scalar integrated design project.

7.3 INTRODUCTION TO THE PATTERN LANGUAGE

WHAT IS A PATTERN?

Christopher Alexander introduced patterns and pattern language in his books A Pattern Language: Towns, Buildings, Construction (1977) and The Timeless Way of Building (1979). According to Alexander a 'pattern' represents a solution to a design problem, that arises in a specific context. At the same time, a pattern is a generalised solution and can be applied to different design problems (Alexander, 1977). Alexander's approach emphasises the idea that certain problems in design recur across different contexts, and there are common-sense solutions that can be effective. A pattern is based on research sources like literature, interviews or (spatial) data and therefore it plays a crucial role in systematically connecting research and design. In this project, patterns are neighbourhood-scale solutions that increase social, ecological and historical values, based on the eight design qualities that ought to be increased.

THE PATTERN LANGUAGE

A pattern language shows the interrelations between individual patterns. Each pattern is a self-contained piece of advice, and the language provides a framework for assembling these patterns to create a coherent design. A pattern language is useful to simplify the complexity of integrated urban transformation. A pattern language promotes the replicability of the design solutions across different urban areas, while also being adaptable in a specific location context. The pattern language can have different roles (Cai, 2018):

- It can be a learning tool to have a systematic approach to handling spatial and non-spatial data and organise this in an integrated way, using the same format.
- It can be used as a presentation and communication tool: Patterns visualise different types of information into straightforward solutions. This enables the communication between researchers, designers and stakeholders. In addition, a pattern language could be used in co-creation and co-design tools enhancing collaboration and bottom-up design solutions.

- It can be used as a design tool to structure and combine ideas and generate new ideas. It translates research outcomes into design vocabulary, explores design concepts and generates designs.
- Moreover, the pattern language can be used as an assessment tool to show to what extent the design solutions support the design qualities envisioned for this project.

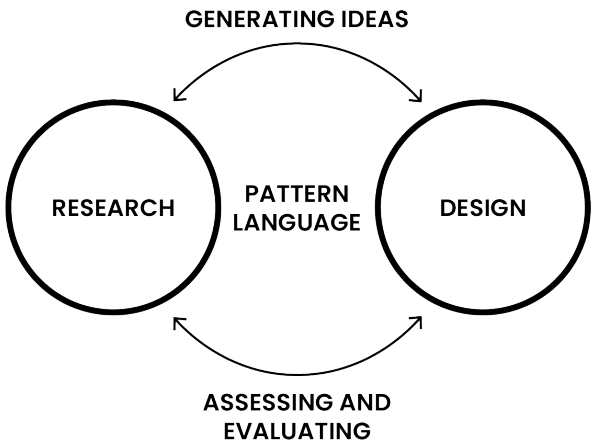
THE USE OF THE PATTERN LANGUAGE IN THIS PROJECT

In this project, the pattern language is mainly used as a design tool. It is a systematic approach to generate and combine design solutions based on the design vision and design qualities (Figure 7.4). At the same time, the patterns allow for context-specific implementations, creating a framework for the integrated resilience of water and cultural heritage systems in different locations. This enables the transferability of knowledge and design solutions, which supports integrated urban transformation initiatives in other locations. The pattern book can be used by designers and decision-makers, like municipalities.

A set of connected patterns provides a framework for an urban design, however the patterns do not determine the design. There is always a large number of possibilities to combine patterns, thus for the design (Salingoras, 2000). The rules by which the patterns connect are just as important as the patterns themselves. The pattern language provides a foundation for design to connect with human beings (Salingoras, 2000). It is an important framework for designing eye-level cities while contributing to bigger present-day urban problems and their solutions. In this project, the combination of patterns allows for the integration of the design goals. A pattern supports a design quality and by combining these in one urban design the pattern language supports the integrated urban plan for resilient polder water management, sustainable heritage development and socio-ecological integration.

In this project, all patterns are equal design solutions. However, they may hold variations or different implications, if this is the case this is explained in the pattern. Patterns are often complementary and can coexist in one urban design. Every pattern card shows other patterns the design solution relates to.

Figure 7.4: Visual representation of the pattern language as design and research approach



7.4 EXAMPLE PATTERN

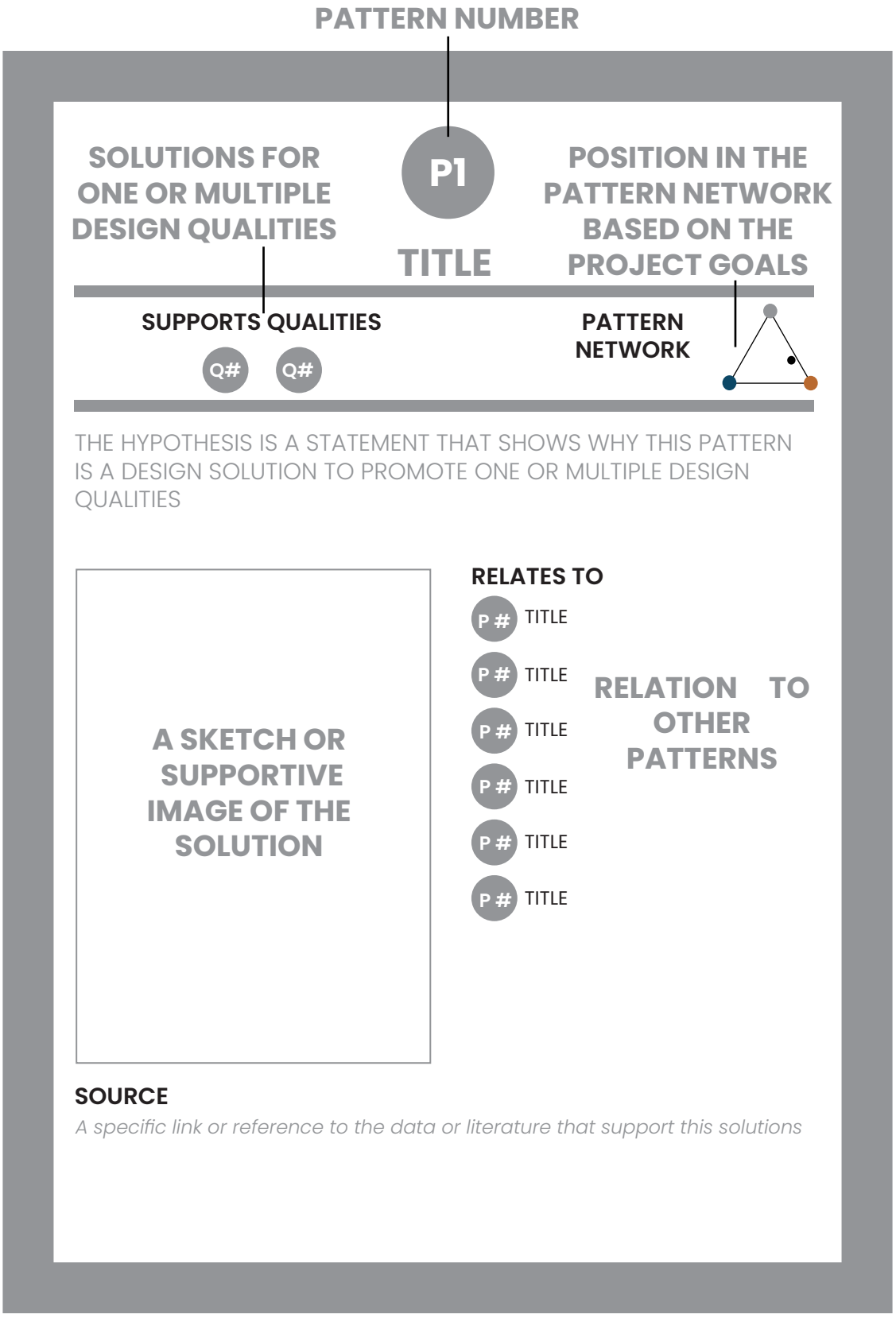


Figure 7.5: Example pattern card front side

THEORETICAL BACK-UP

Clarification of the design solution based on literature research or reference projects

PRACTICAL IMPLICATION

A suggestions for the scale and context this solutions fits in. Possible the explanation of variations or different implementation possibilities.

Figure 7.6: Example pattern card back side

7.5 PATTERN NETWORK

Based on the research and analysis eight design qualities were formulated, they correspond to the three conceptual goals: Sustainable Heritage Development, Socio - Ecological Integration and Resilient Polder Water System. These eight design qualities are used as the starting point for the development of patterns (design solutions). A pattern can contribute to the improvement of one or multiple design qualities and therefore to one or multiple goals, like shown in Figure 7.7. In the pattern network the connection between the patterns indicated which patterns are compatible and can be combined in an urban design (Figure 7.8).

Figure 7.7: Pattern Language in relation to research and design framework

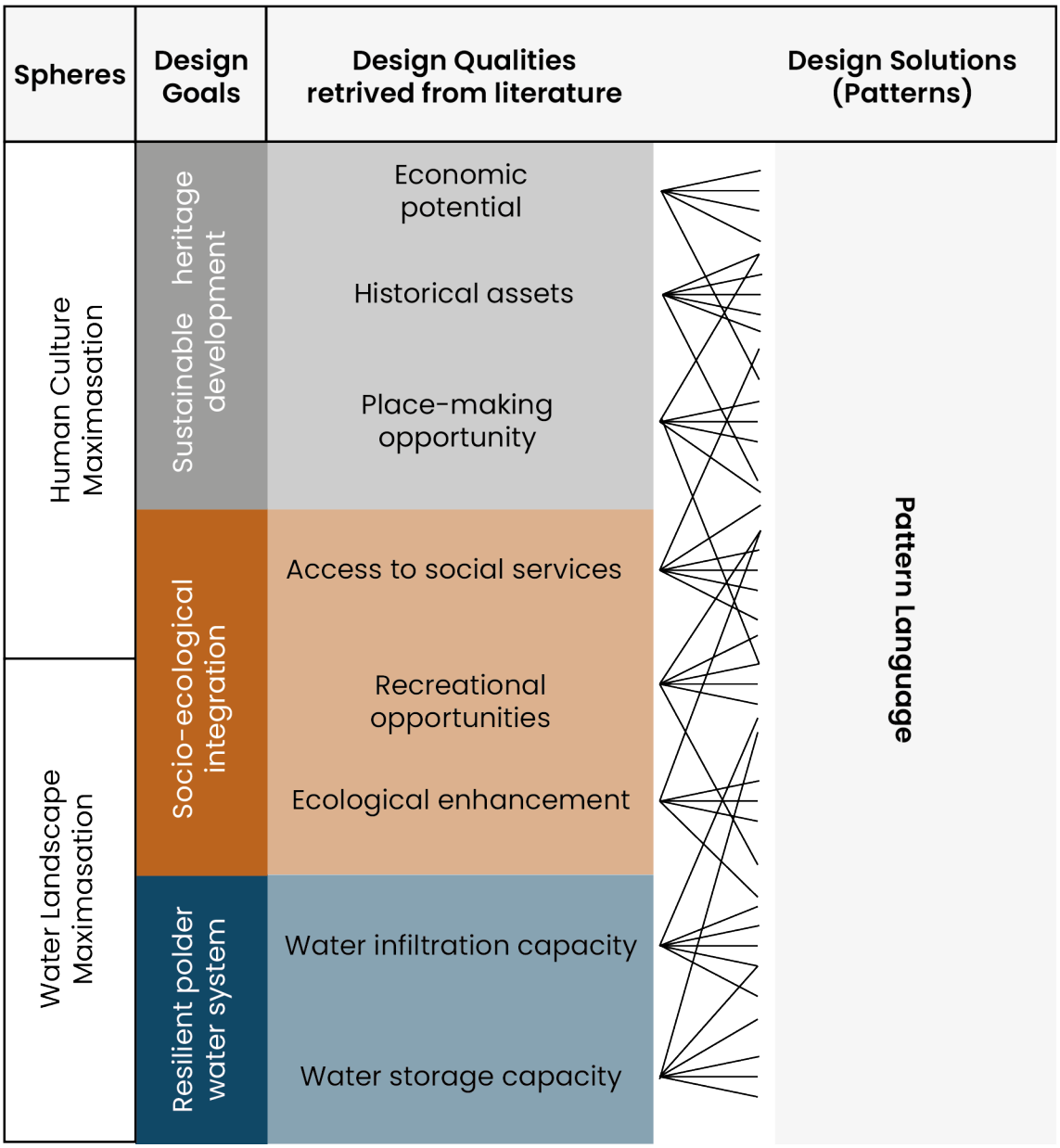
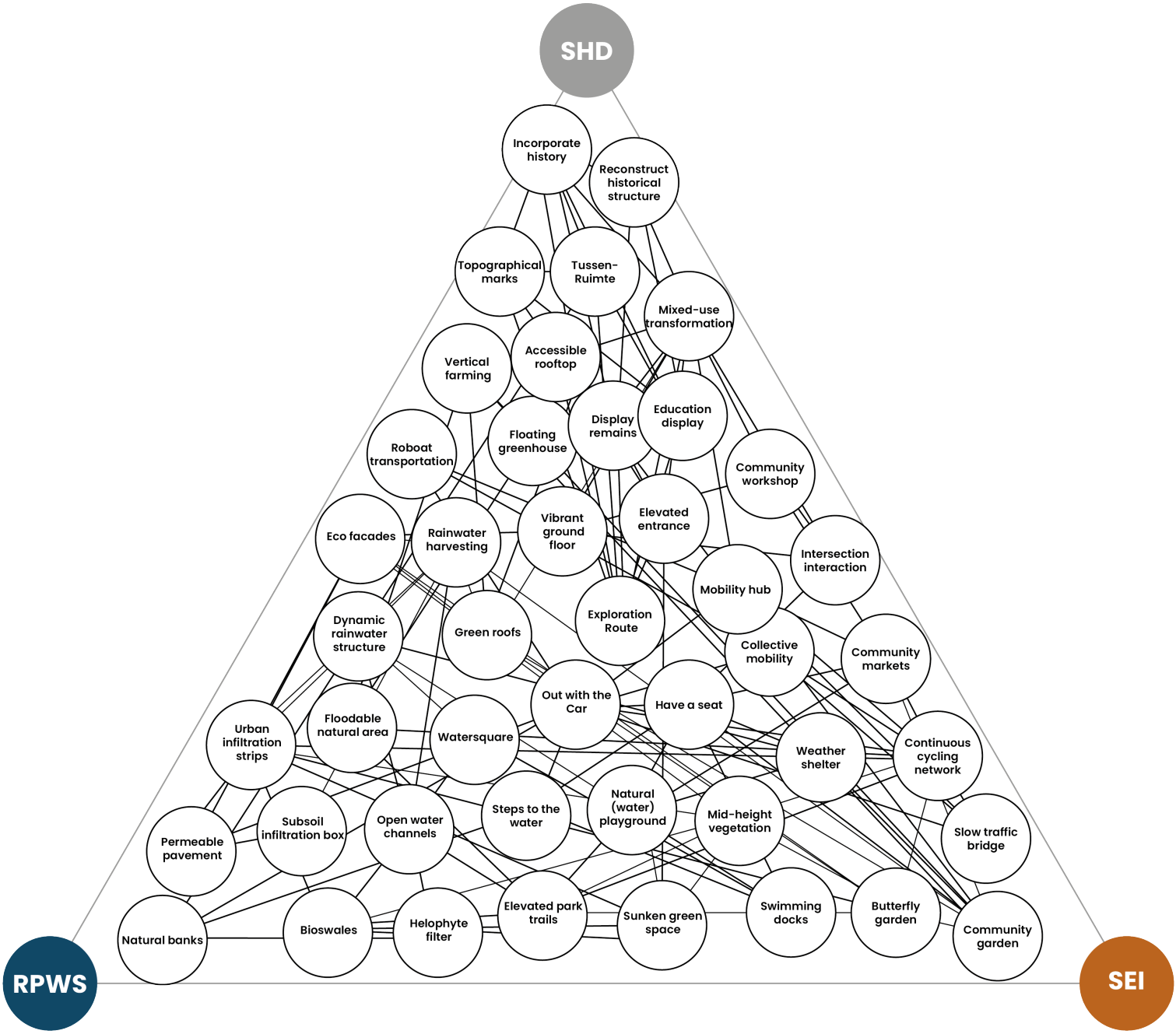


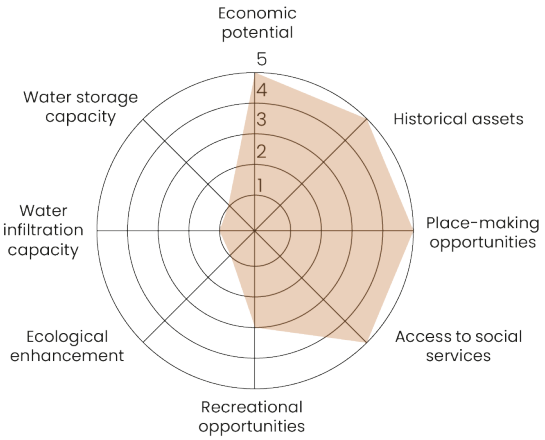
Figure 7.8: Pattern network in relation to three design goals



7.6 THE HUMAN CULTURE MAXIMISATION
CITY SCALE

In the Human-Culture maximisation the city of Amsterdam maximises the accessibility of social services and historical assets, using it as a place-making opportunity to strive for sustainable economic activities maximising the socio-cultural resilience on a neighbourhood and city scale.

Figure 7.9: Focus of the Human-Culture city



In the maximisation scenario for human and cultural resilience, the overarching design strategy is to increase the accessibility of socio-cultural destinations. To determine the accessibility an Open Route Service analysis was conducted for the public transportation network. Figure 7.10 shows the areas that reach a tram or metro station within 5 minutes by foot or a train station within 5 minutes by bike. The areas that are outside these boundaries are the neighbourhoods with little access to public transport. In black dotted lines, it shows potential new tram routes.

Moreover, the attraction reach analysis has determined the accessibility (and missing access) to social services. The accessibility to neighbourhood parks and sportsfields has been calculated to determine the distance to recreational opportunities. This results in the identification of different corridors in the city. The dotted lines are axes that are far from the destinations. Along these axes a destination can be added or new corridors should improve the accessibility to the existing destinations (Figures 7.11 and 7.12).

To maximise the economic potential the intensification of economic activity around socio-cultural services and public transport is important on both a neighbourhood and city scale. To achieve this new mobility hubs are needed in or around these places. For place-making the historical assets are used that have important locations in the urban network. These places have high transformation opportunities to increase economic potential and recreation opportunities.

Figure 7.10: OpenRouteService Analysis
5 min walking to tram/metro station or 5 min cycling to train station

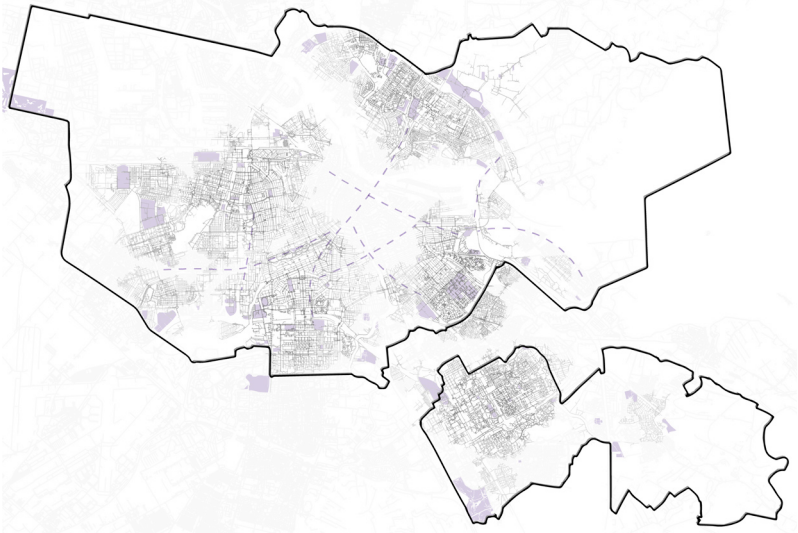
Source: Data retrived from Openstreetmap (2024)

Figure 7.11: Attraction reach for neighbourhood parks
Maximise access to recreation opportunities

Which areas are within a 800m reach of a park or recreational green area? (walking distance)

Where are the missing links? (dotted lines)

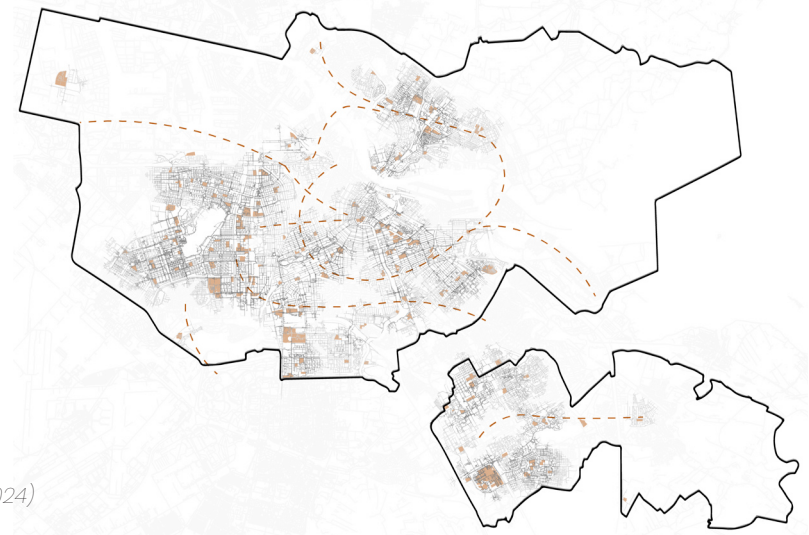
Figure 7.12: Attraction reach for sportsfields
Maximise access to recreation opportunities



Which areas are within a 2000m reach of sportsfields? (cycling distance)

Where are the missing links? (dotted lines)

Figure 7.13: Attraction reach for socio- cultural facilities
Maximise access to social services



Which areas are within a 1000m reach of a socio-cultural facility? (fast cycling distance)

Where are the missing links? (dotted lines)

Scale: 1:250.000

Source: Data retrived from Openstreetmap (2024)

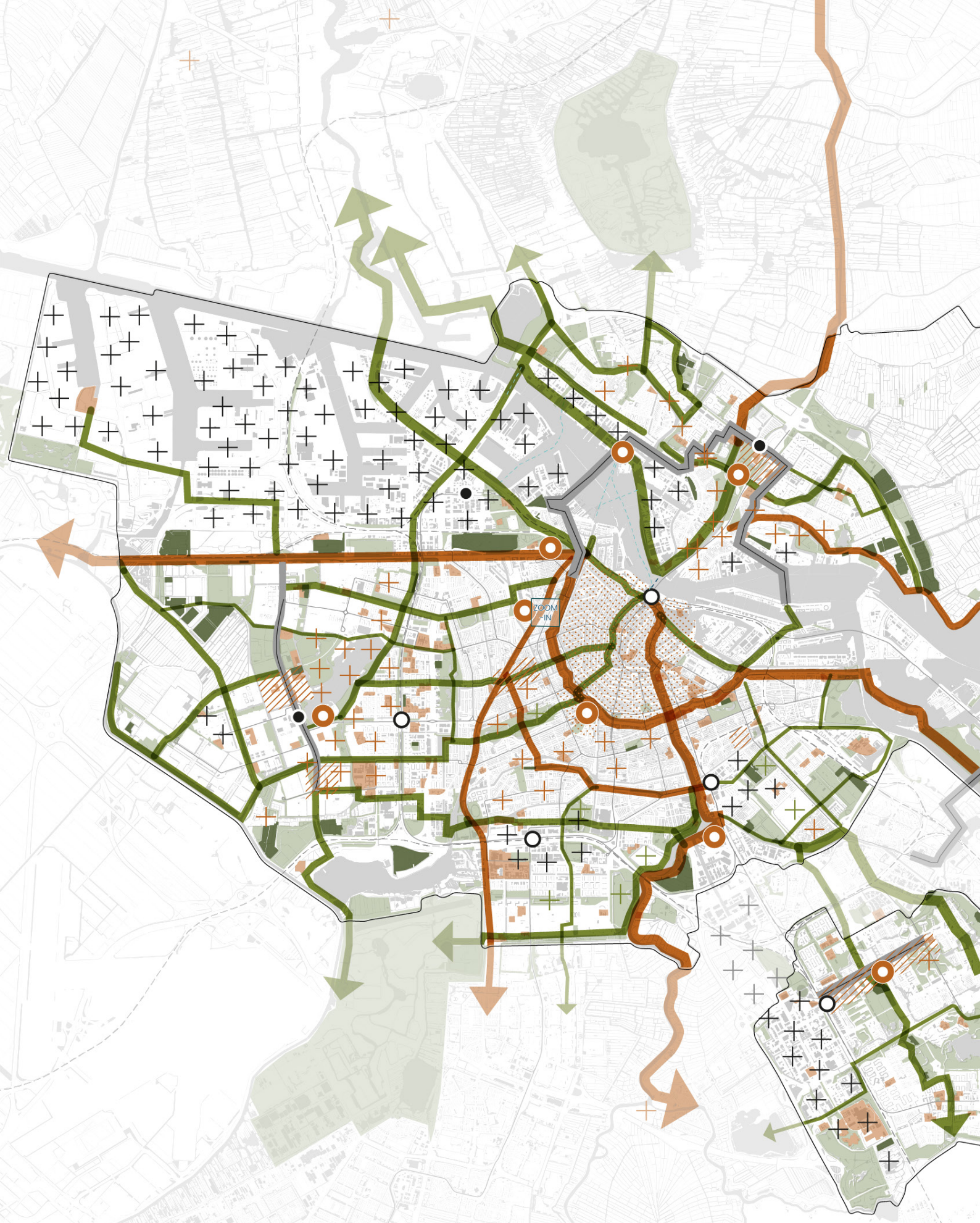


Figure 7.14: Human-Culture maximisation on city scale

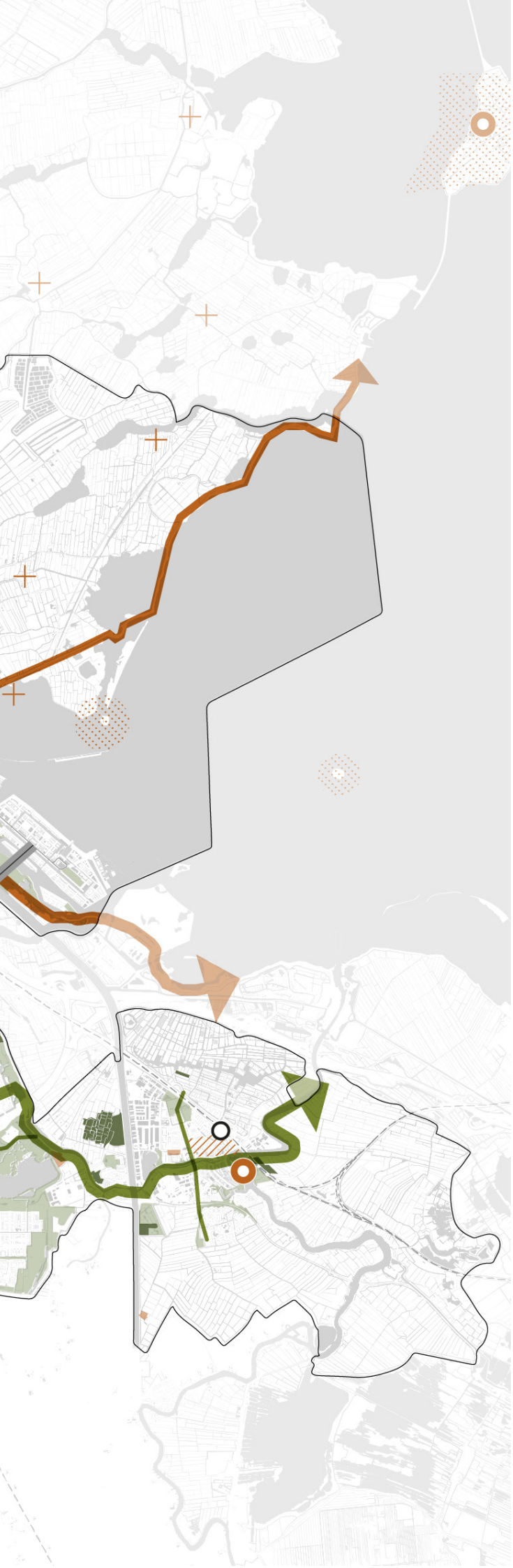
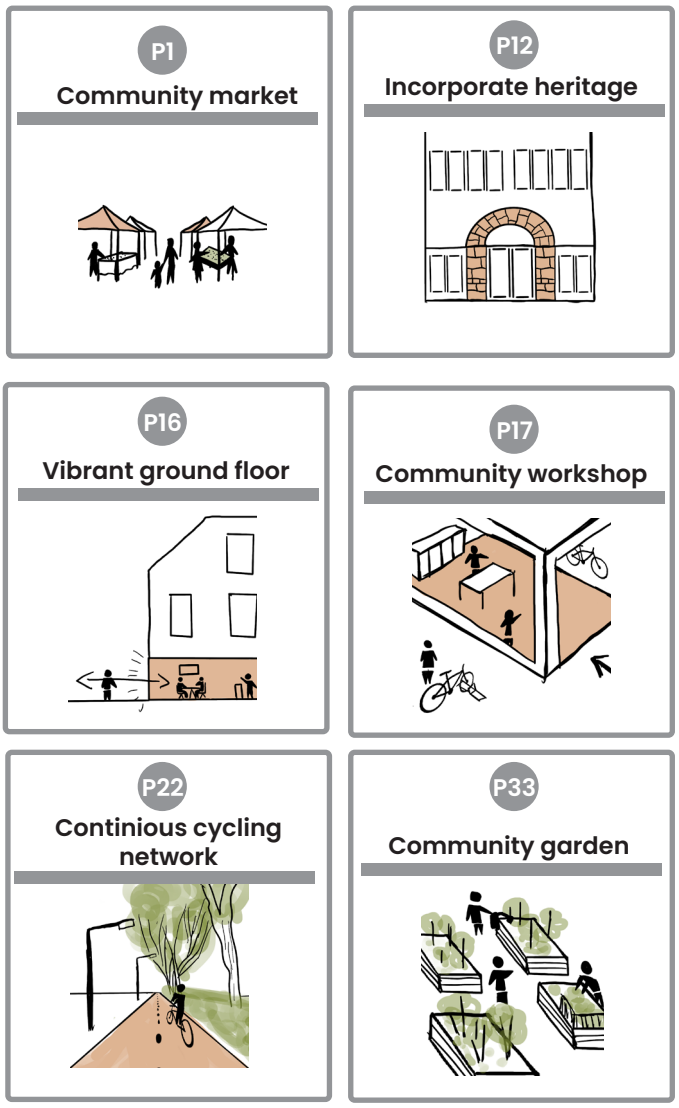


Figure 7.15: Example patterns supporting the Human-Culture maximisation



- Existing recreational areas
- Existing socio-cultural facilities
- Community garden
- Housing development opportunities
- Tramline
- Train
- Existing ferry route
- New ferry route
- Cultural-historic place-making
- Green heritage
- Protected townscapes
- Local economic centre
- (Inter)national economic centre
- New mobility hub
- Transformed mobility hub
- Multichange corridors
- Improved recreational corridor
- Improved historical corridor

Scale: 1:85.000

7.6 THE HUMAN CULTURE MAXIMISATION

NEIGHBOURHOOD SCALE

Figure 7.16: Molen de Otter 2024

The Frederik Hendrikbuurt can maximise its human-culture potential by exploiting the windmill as a historical site and place-making for the community. Molen de Otter is the last standing windmill along the Kostverlorenvaart. It is a sawmill and after years of being neglected a new group of volunteers is restoring it to its former glory. To strengthen their goal, there could be a museum, a community workspace and events like community markets. Through Roboat transportation the Kostverlorenvaart, which is a historical transportation canal, can be explored from the water. On the corners of the street, socio-economic functions can boost community interactions. The cycling network should be dominant, however, in this maximisation, there is no need to get rid of the car. Collective mobility hubs support sustainable modes of transport and make sure scooters and bikes are not all over the streets. The flat roofs can be used for activities or as private terraces.

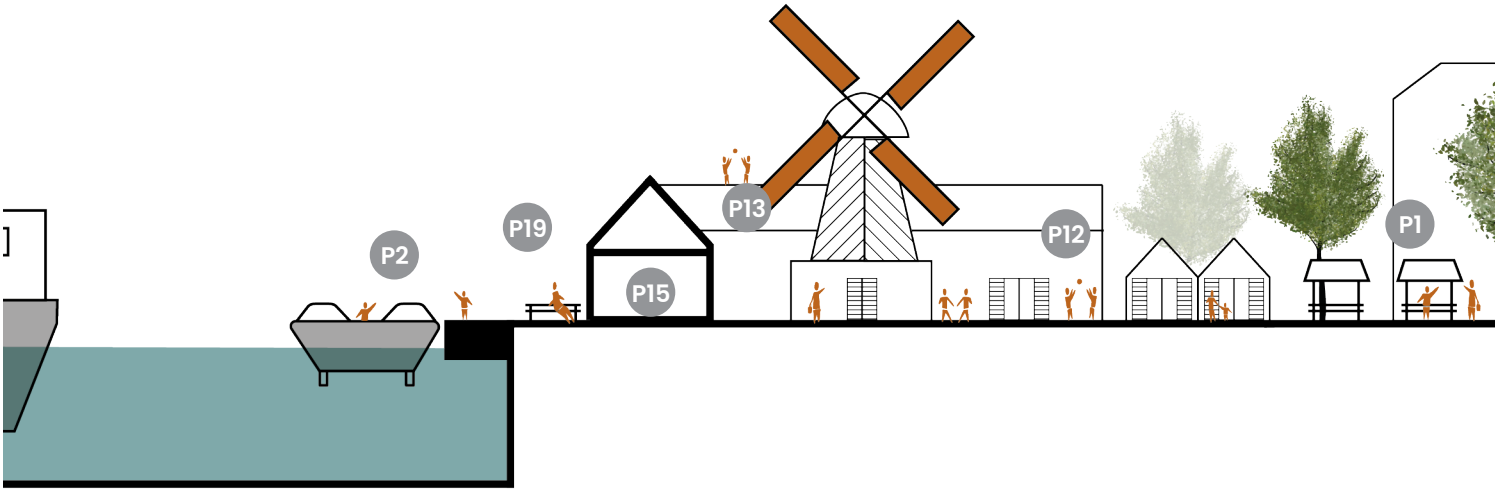
Figure 7.17: Recommissioning in 1996

Source: Stadsarchief Amsterdam / Van Gool (1996b)

Figure 7.18: Boats on the Kostverlorenvaart

Source: Stadsarchief Amsterdam / Smitch (1895)

Figure 7.19: Human-Culture neighbourhood scale section



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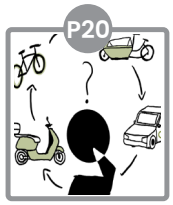
Scale: 1:500



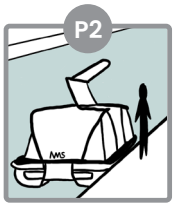
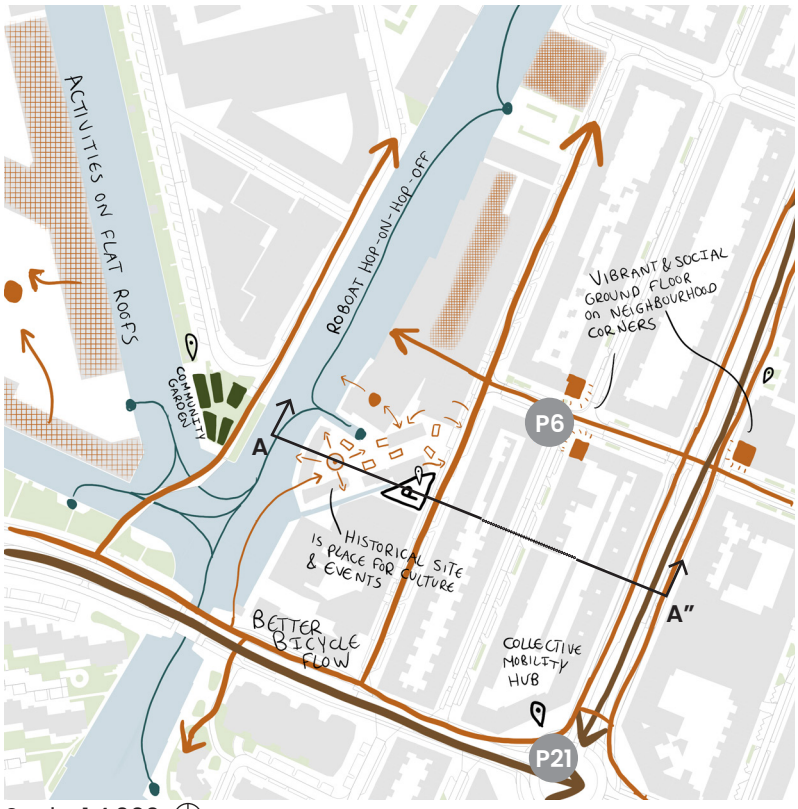


Figure 7.20: Human-Culture neighbourhood sketch design



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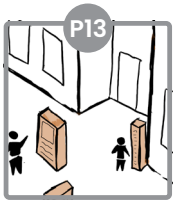
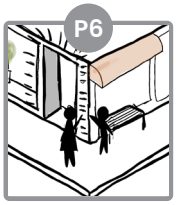
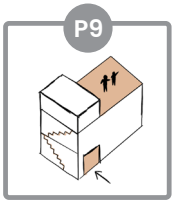
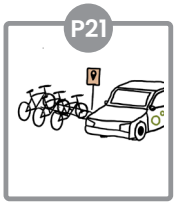
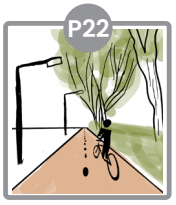
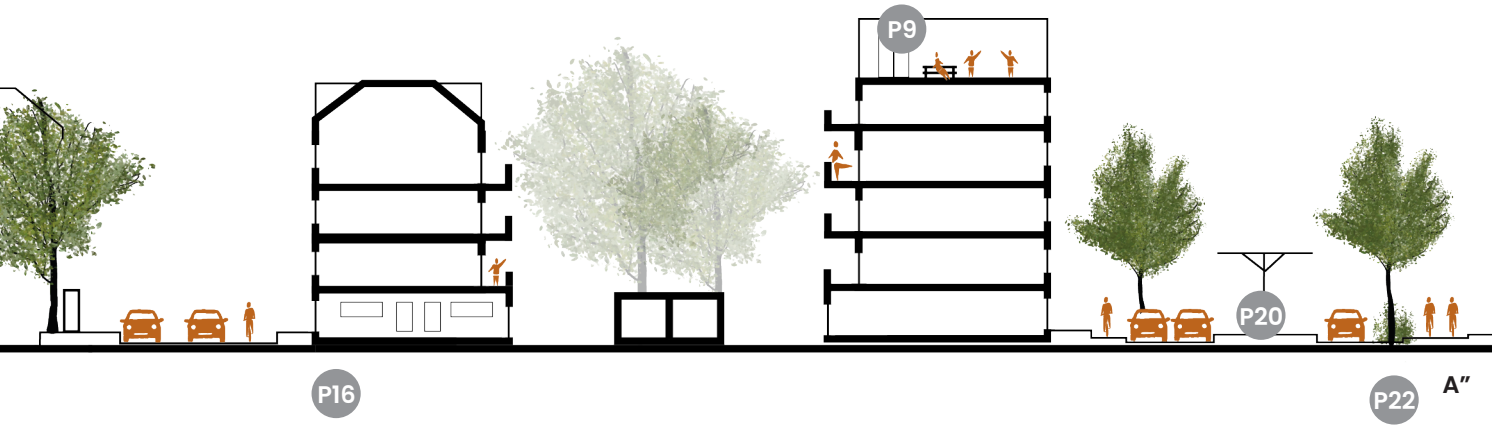










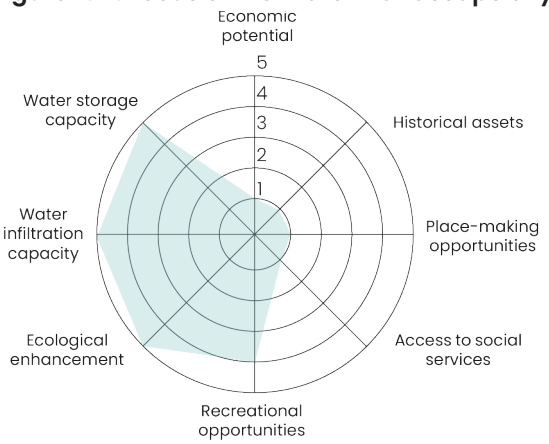


7.7 THE WATER LANDSCAPE MAXIMISATION

CITY SCALE

In the Water-Landscape maximisation the city of Amsterdam maximises its water infiltration and storage capacity, building resilience in the polder water system. In addition, it strengthens ecological enhancement and builds social waterscapes by increasing nature's recreation opportunities.

Figure 7.21: Focus of the Water-Landscape city



To relieve the boezem water system, more water should be stored in the polder water system. This is fresh and relatively clean water, which can be reused. Water naturally flows to the lowest alleviation, therefor the Algemeen Hoogte Bestand is used to determine the best places for water storage. In addition, the dike map and flood risk map (medium chance of flooding) determine which areas are most likely to flood first and therefore are most suitable for large-scale water storage or wet natural areas. This strategy is shown in Figure 7.22.

Maximising the water storage and infiltration capacity can be done by increasing the permeability of the urban environment. The existing permeable patches are important to consider, but extra permeability on roofs and streets is needed to maximise the water infiltration capacity. New permeable patches are based on building sites, industrial areas and semi-build areas (Figure 7.23)

Ecological enhancement can be understood by looking at the principles of landscape ecology. Landscape ecology uses the Patch-Matrix-Corridor approach to explain the different types of habitats. A corridor is a linear natural structure, which is used by animals as infrastructure. Patches are the smallest scale of green areas, a patch is a self-contained natural area, for example, city parks. The matrix is the surrounding landscape that separates patches (Norton et al., 2016). To maximise ecological enhancement, corridors should be consistent and connected, and the number of patches should be increased to allow for migration between patches (Figure 7.24).

Lastly, water and landscape are important recreational elements. In the maximisation, it is shown that recreational areas are important water storage areas and the ecological corridors are important recreational connections from the city to the rural areas.

Flood risk, elevations and controlled floodable polders

Figure 7.22: Maximise water storage capacity

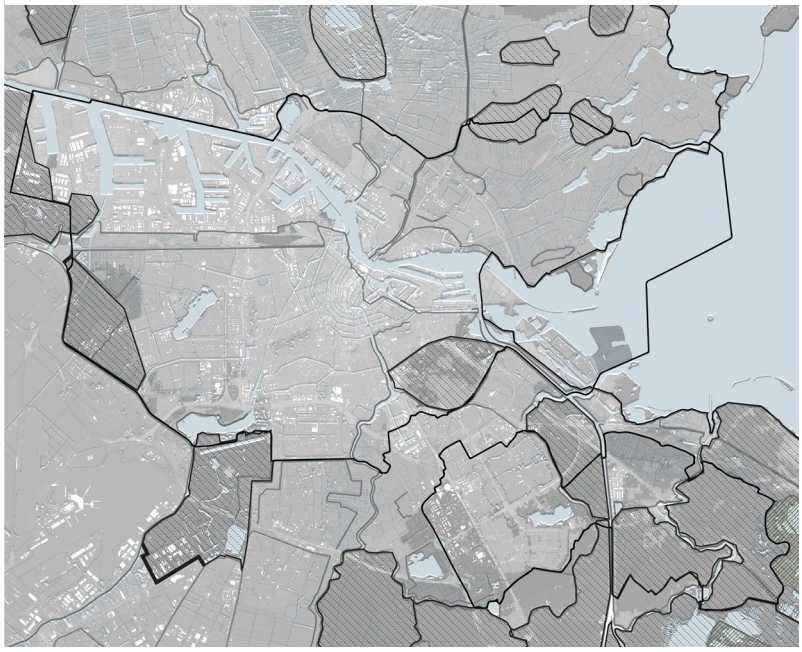


Figure 7.23: Maximise water infiltration capacity

Transformation areas for extra permeable patches and green roofs

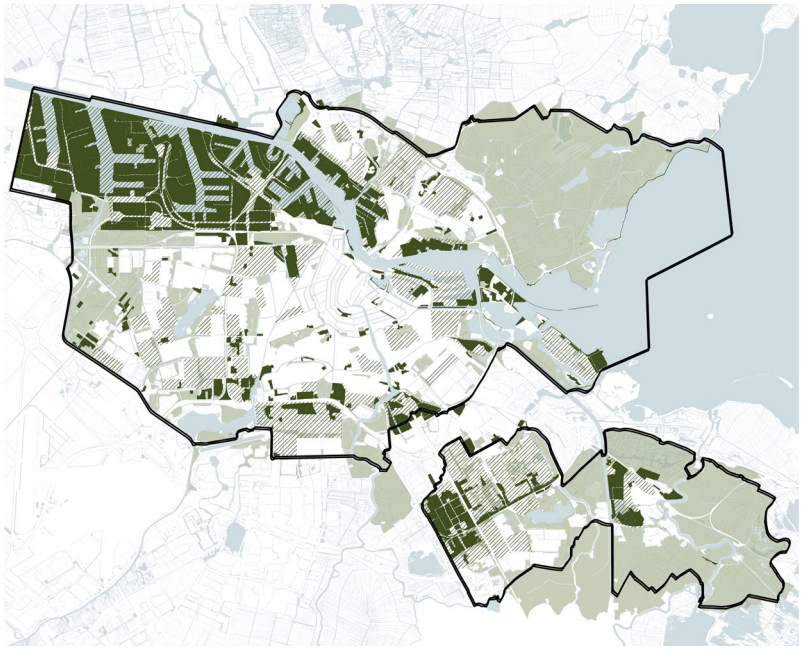


Figure 7.24: Maximise ecological enhancement

Ecological vision and missing links in the ecological structure

Scale: 1:250.000

Source: Data retrived from Klimaateffectatlas (2024b) and CBS (2017)

Figure 7.25: Water-Landscape maximisation on city scale

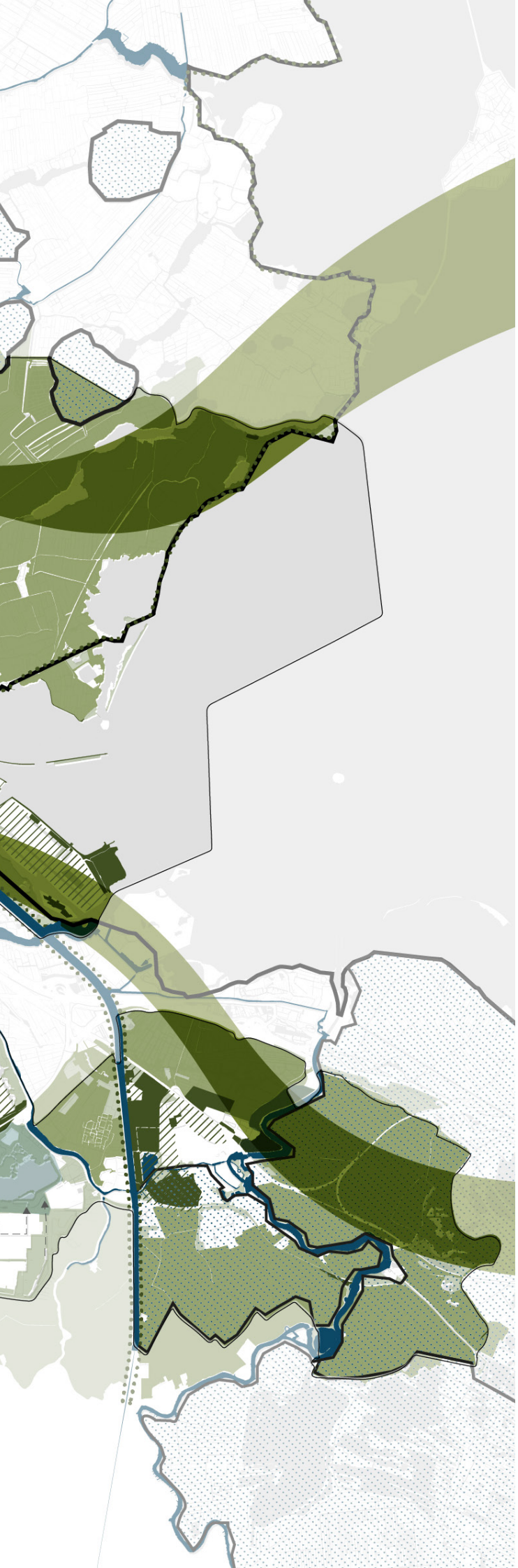
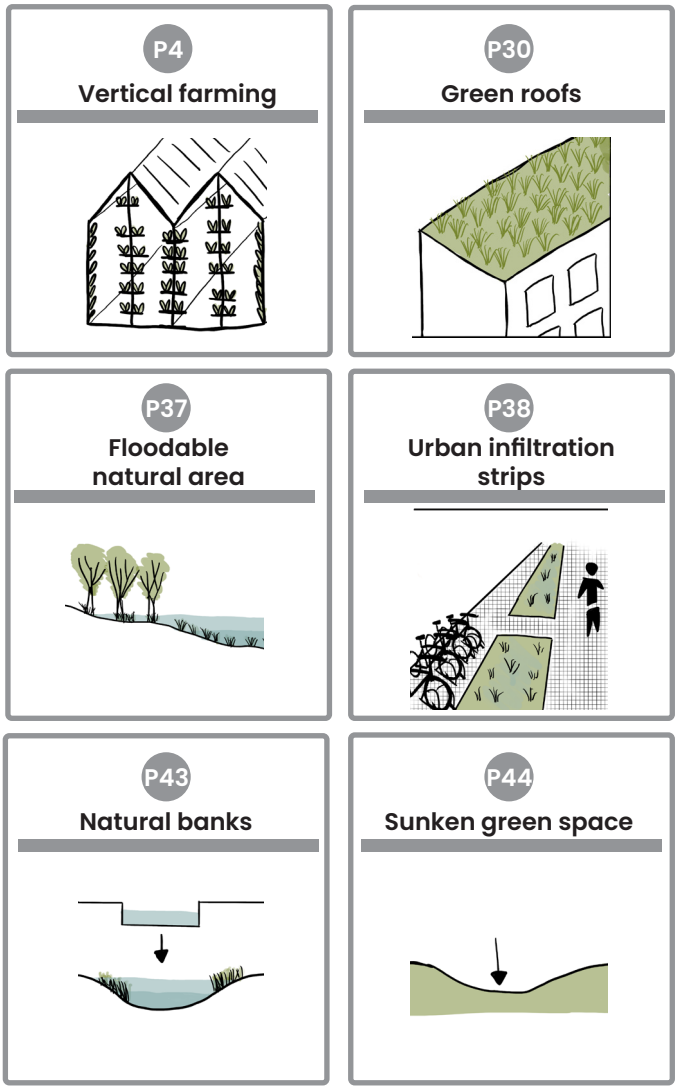


Figure 7.26: Example patterns supporting the Water-Landscape maximisation



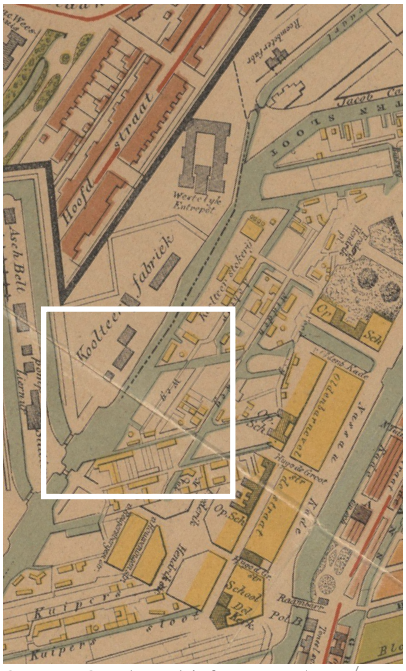
- Existing water
- Changed boezem environment
- Existing permeable patch
- New permeable patch
- Adaptive agricultural area
- Controlled floodable polder
- Controlled floodable recreation area
- Buffer zone polder
- Buffer zone boezem
- Green roof area
- Increased connectivity with scheg structure
- Natural banks
- Surface drainage
- Dike strengthening

Scale: 1:85.000

7.7 THE WATER LANDSCAPE MAXIMISATION

NEIGHBOURHOOD SCALE

Figure 7.27: Frederik Hendrikbuurt



Source: Stadsarchief Amsterdam / Van Der Stolk (1893)

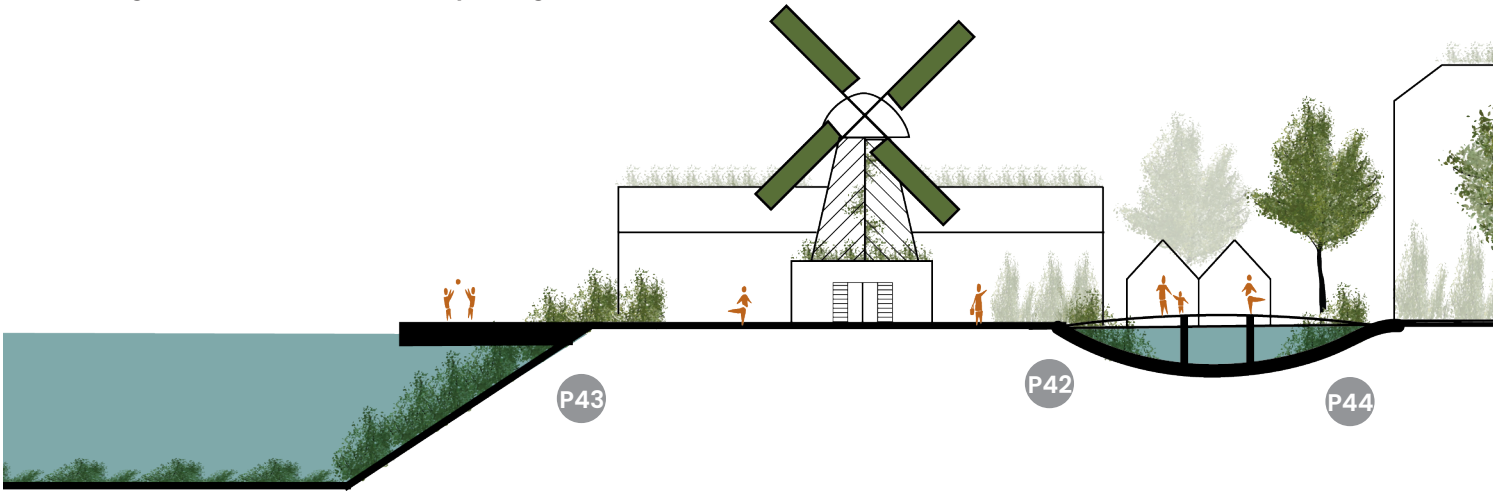
The Frederik Hendrikbuurt can maximise its water-landscape qualities by restoring historical water courses and increasing water bodies in small squares and open spaces (Figure 7.27). By moving out the car there will be much more space for infiltration strips, permeable pavement and ecological enhancement. In front of the windmill, there is a square and a small garden. This could be public space and extra water storage combined with an increased permeable area. By opening the windmill as a public space the urban waterfront will be publicly accessible. The quay could be changed to a natural bank. The streets are too small for any form of water body, but water infiltration boxes allow for the water to infiltrate into the subsoil so heavy rainfall won't cause a nuisance on the street. The flat roofs can be green. Facade gardens and green balconies allow for more ecology and biodiversity and in combination with rainwater harvesting this releases pressure from the water system because less water will enter the polder-boezem system.

Figure 7.28: Gillis van Ledenberchstraat

Figure 7.29: Achterweg, now Gillis van Ledenberchstraat

Source: Stadsarchief Amsterdam / Goedkoop (1890)

Figure 7.30: Water - Landscape neighbourhoodscale section



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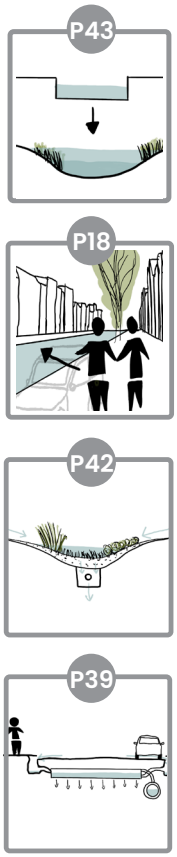
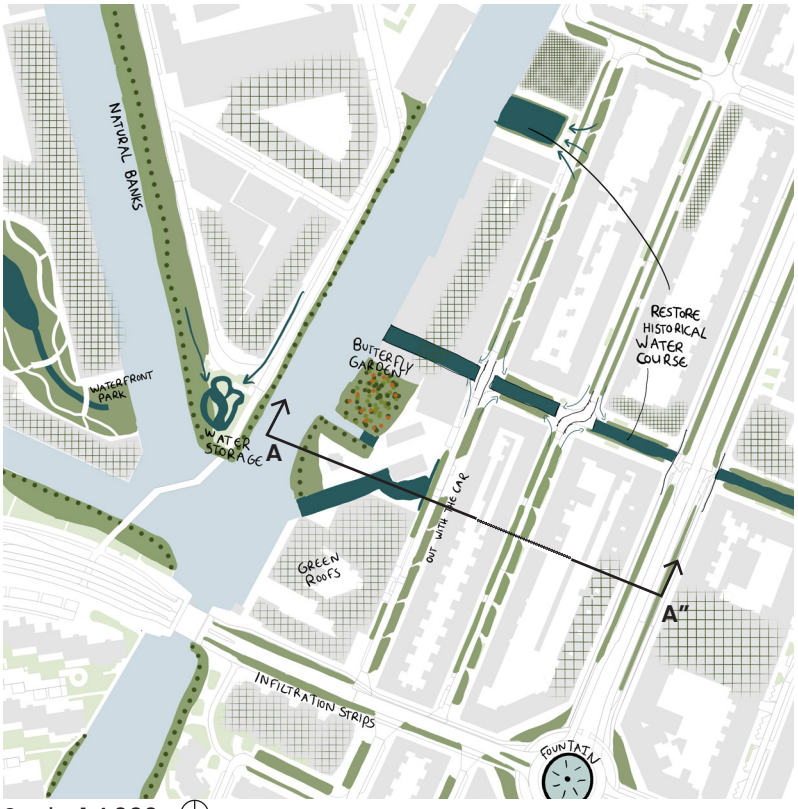


Figure 7.31: Water - Landscape neighbourhood sketch design



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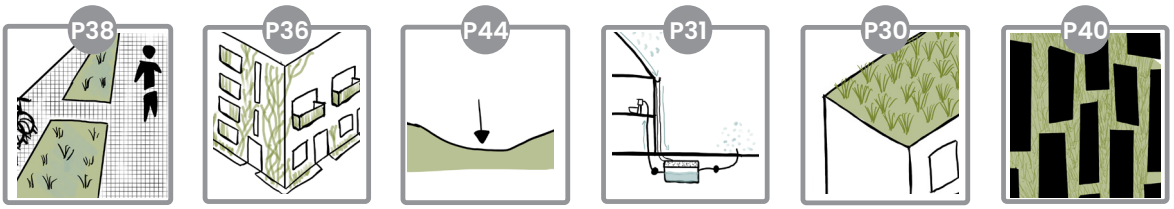


7.8 CONFLICTS AND SYNERGIES ON NEIGHBOURHOOD SCALE

By overlapping the sketch designs on a neighbourhood scale in Figure 7.32 it becomes clear that the maximisation scenarios often need the same space for implementation. The Frederik Hendrikbuut is used as a representative neighbourhood. This is an exploration for the maximisation and integration of the two scenarios and not a perfect context-specific design.

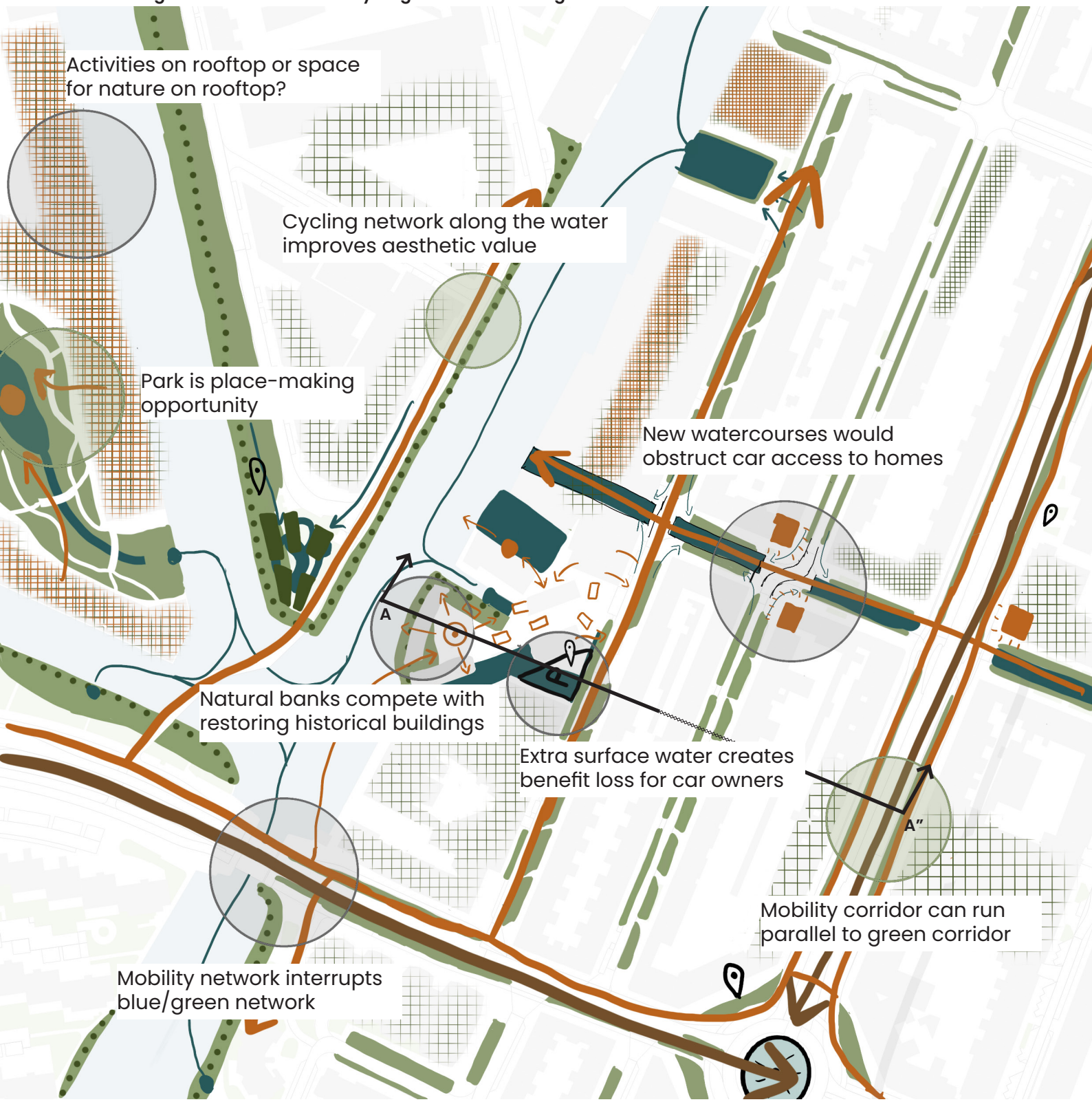
Public space is scarce in many neighbourhoods in Amsterdam. The streets are small and they need to accommodate cars, bikes and pedestrians. The increased need for permeable patches and water storage is conflicting with the strengthening of city-scale transportation corridors. On the other hand, focusing on sustainable modes of transport, eliminates the car from the street, allowing for more space for the water-landscape maximisation scenario. From Figure 7.32 it becomes clear that green corridors often go hand in hand with the improved mobility network, but at the same time, they also intersect interrupting one of the two networks. These are interesting points of conflict, which show that while corridors are desirable on a larger scale there are trade-offs to be made on a neighbourhood scale.

On the next page, in Figure 7.33, the conflicts and synergies are shown in the representative section of the Frederik Hendrikbuurt. It shows spatial conflicts and synergies, which focus on the physical allocation or land use. On the other hand, functional conflicts and synergies relate to the tensions between different purposes of space for the various stakeholders. The example of eliminating the car from the streets shows that a spatial conflict between the two scenarios can be solved, but this leads to functional conflicts because there would be benefit loss for a group of stakeholders, in this case, the delivery and transportation sector and private car owners. For this reason, it is important to consider the decision-making process before drawing the integrated implementation that supports the goals of this project.

7.9 VARIATIONS ON NEIGHBOURHOOD SCALE

For every street and every neighbourhood, the design solution can be different. Therefore the representative section is also shown with variation possibilities in the design in Figure 7.34. Some variations are part of the pattern set for this project. However, there are also variations that are not included as patterns. These variations are design solutions that do not specifically support one or multiple goals in this project and therefore are too context-specific to include in the pattern set. This example highlights the fact that a pattern language does not determine an urban design, it shows a variety of interconnected possibilities which support a specific goal, but in the complex urban design process there are always more options to consider and the patterns developed to integrate the goals of this project can be supported by other design solutions not included in the pattern language.

Figure 7.32: Conflicts and synergies of sketch design



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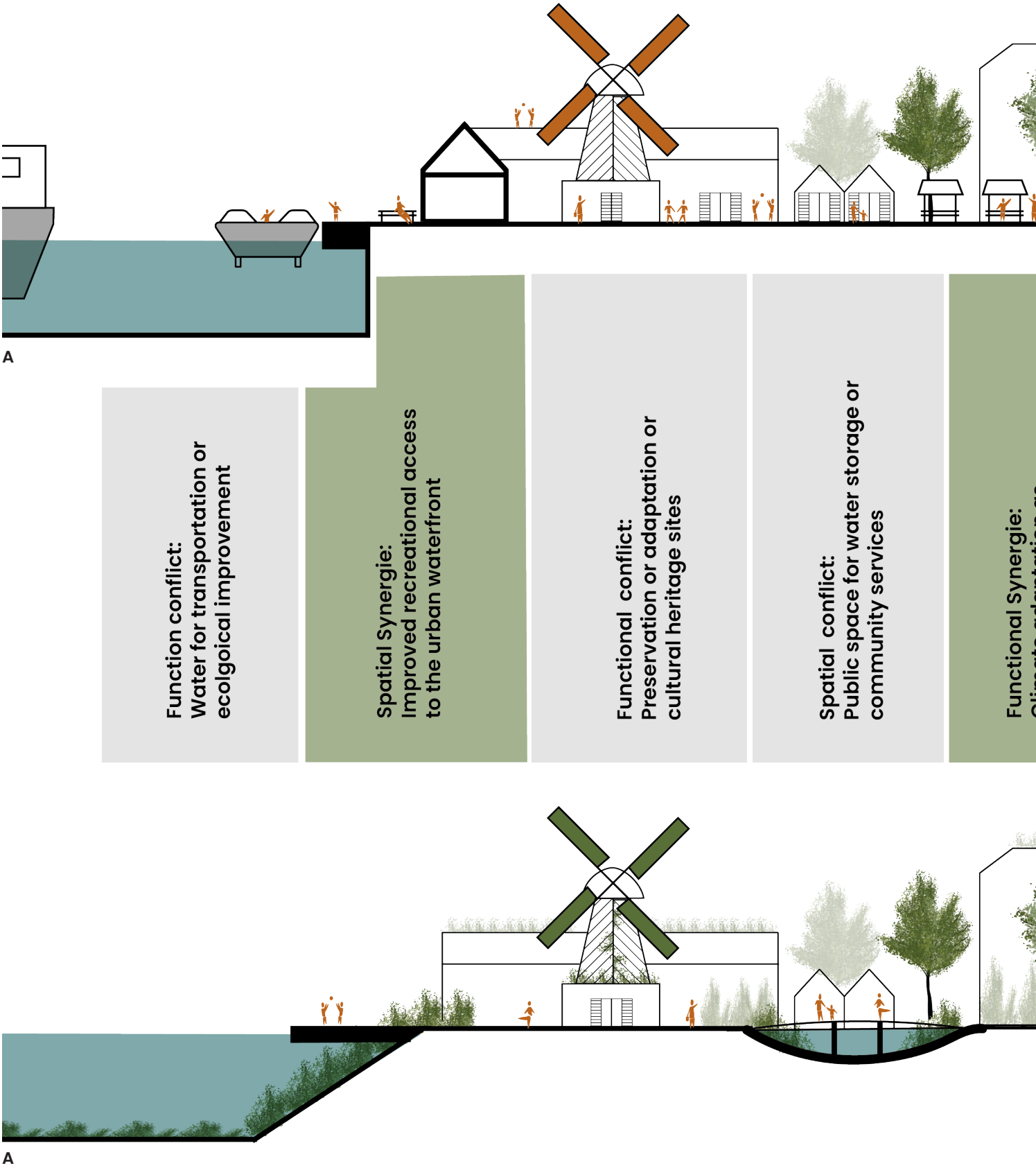


Figure 7.33: Conflicts and synergies in section on neighbourhood scale

Scale: 1:500

A”

Spatial Synergie:
Improved cycling network
and improved green corridor

Functional Conflict:
Green roofs or roof activities

Functional Conflict:
Vibrant ground floor or
housing on ground floor

Spatial Conflict :
Nature or mobility in living streets

Climate adaptation as
place-making

A”

7.9 VARIATIONS IN DESIGN ON NEIGHBOURHOOD SCALE

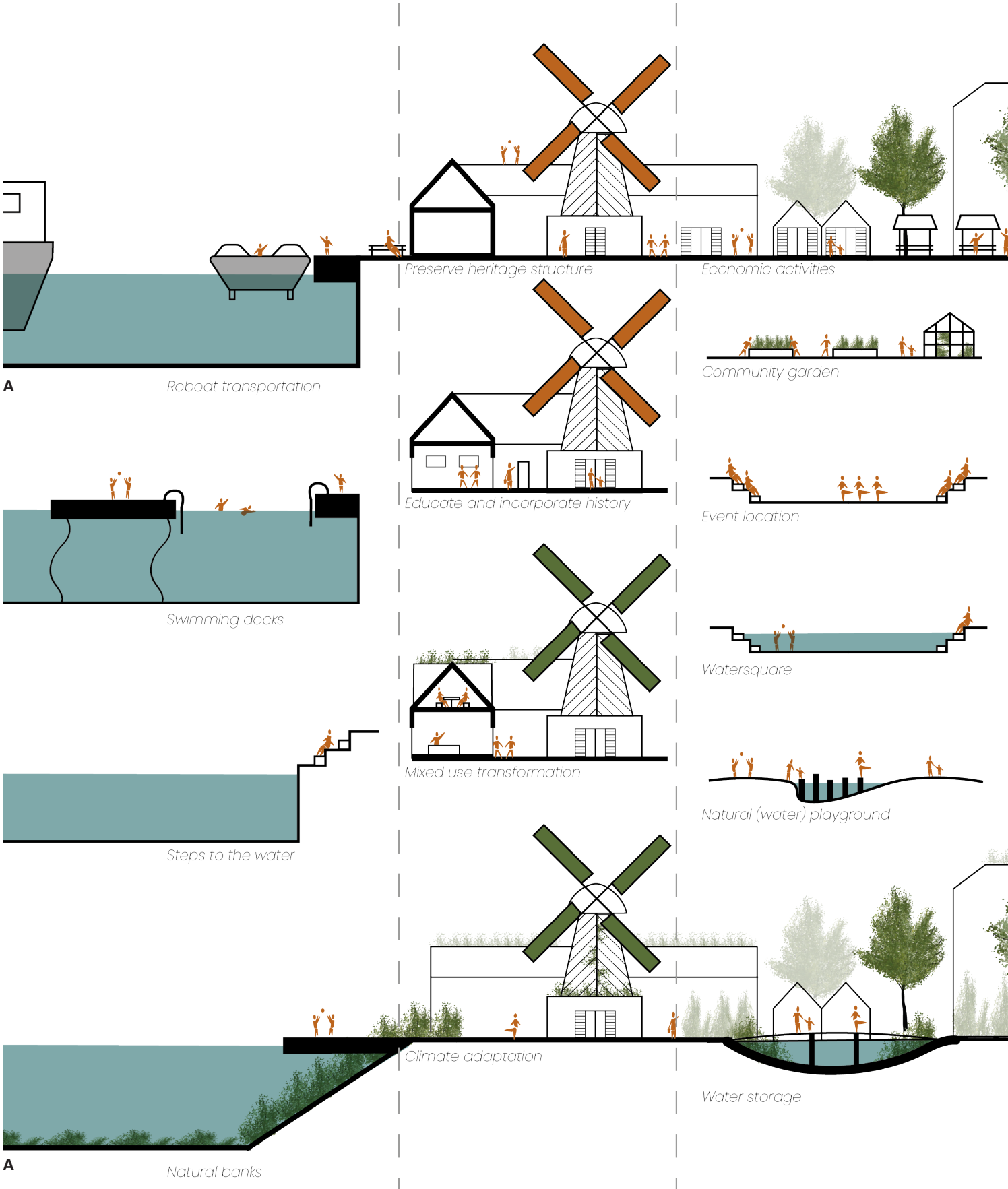
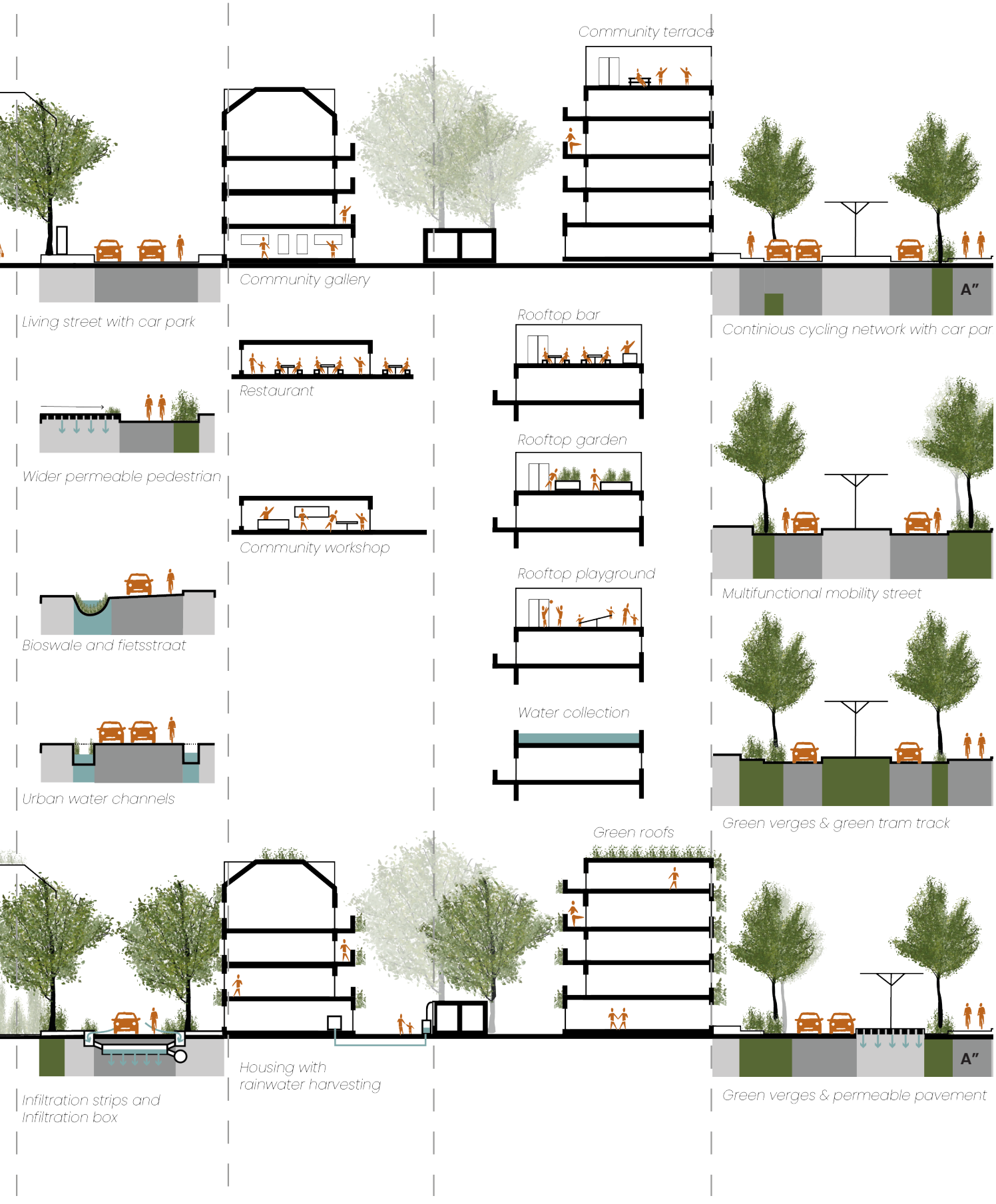


Figure 7.34: Variations in design on neighbourhood scale

Scale: 1:500


Community terrace
Community gallery
Living street with car park
A"
Continious cycling network with car par
Rooftop bar
Restaurant
Rooftop garden
Wider permeable pedestrian
Community workshop
Multifunctional mobility street
Rooftop playground
Bioswale and fietsstraat
Water collection
Urban water channels
Green verges & green tram track
Green roofs
Housing with
rainwater harvesting
A"
Infiltration strips and
Infiltration box
Green verges & permeable pavement

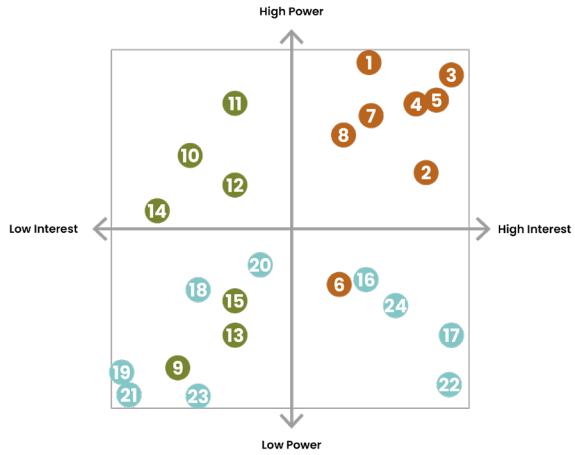
7.10 DECISION MAKING

CONSIDERATION OF STAKEHOLDERS

The maximisation experiments and pattern language explore a variety of possibilities for the integration of the needed resilience of the polder water system and the sustainable development of the water-related heritage. But this is not yet an urban design. To transform the maximisation experiments into an urban design there are different ways of reasoning. On a city scale, it is important to take into account all the stakeholders in the public, private and civil sectors. In the power-interest matrix for the two maximisations, it becomes clear in Figure 7.35 and 7.36 that more stakeholders have an interest in human-culture maximisation. This is because of the economic feasibility of this scenario which is interesting for most stakeholders in the private sector. However, the public sector often has more power and there are more bodies in the public sector interested in the water-landscape scenario. It becomes clear that the water-landscape scenario needs legislative policies and financial support from the government to be realised, while the human-culture scenario can be activated from local businesses and initiatives. At the same time, residents have an interest in both maximisation. Highlighting the importance of bottom-up decision-making in the integration process.

Figure 7.35: Stakeholder Power-Interest Matrix Human - Culture City

Figure 7.36: Stakeholder Power-Interest Matrix Water - Landscape City



PATTERN LANGUAGE AND STAKEHOLDER PARTICIPATION

The process of creating patterns based on theory simplifies the always-existing complexity of a project or site. In practice, this would be followed by stakeholder discussions on synergies and conflicts for the final decision-making. However, due to time constraints, this study lacked stakeholder workshops and relied on the researcher's design experience. Nevertheless, recognising the importance of stakeholder engagement in real projects, this section explains how the pattern language can be used in different stages of a project.

The pattern language is an excellent tool to use in both top-down and bottom-up design processes. This is shown in Figure 7.38 on the next page. The patterns created in this project are a systematic approach to meet the integration of the various design goals in this project. There are four main application stages for the pattern language (Croxford et al., 2020): Analysis, visioning, design and monitoring.

The pattern language is a clear communication tool that is understandable for designers, policymakers and other experts. Using the pattern language in the analysis stage generates a variety of ideas and allows for the use of patterns as the basis for discussion and prioritising issues from different fields of expertise.

In the visioning stage, the pattern language can be used in stakeholder participation processes to gain a better understanding of the needs and wishes of the community (Croxford et al., 2020). The patterns allow for the integration of different opinions and the possibility of adding new patterns to the pattern language. This can be done by co-creation where stakeholders help improve the quality of a project by sharing their knowledge and experiences. Therefore an empty, so-called wildcard, pattern is added to the pattern book. Secondly by involving stakeholders early in the project visions can be aligned, which helps to avoid conflicts in the long term.

In the design phase, like in the analysis phase, the patterns can help to improve the communication between different experts. They expose conflicts and synergies in the design and allow for discussion and prioritising among the experts. In the design phase, operational aspects can be added to the pattern language.

Lastly, the pattern language can be used to monitor the impact of the project development. Through monitoring it becomes clear how sites or neighbourhoods change and it identifies opportunities for new projects. It is important to have a multi-disciplinary stakeholder group to review what is monitored (Croxford et al., 2020). Based on the monitoring it can be concluded if the design did or did not improve the desired design qualities and envisioned integration.

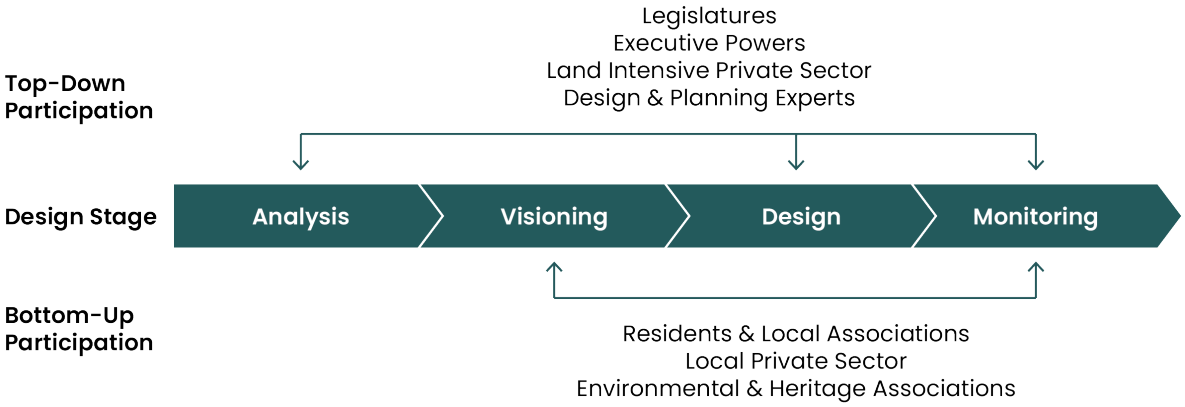
Figure 7.37: Stakeholder workshop

Source: Croxford (2020). Foundries of the Future (p. 225)

The designer of the pattern language is the most important facilitator in executing the participation process. However, a pattern language is a reusable tool and can be transferred to different projects. In this case, public authorities or even, businesses and local area manager can use a pattern language in their projects. To facilitate a participation process the following steps need to be taken into account (Hausleitner et al., 2019).

1. As the facilitator, you preselect cards which are considered relevant or most important for the site and communicate them to the participants.
2. Through discussion, pattern cards are set aside if not relevant, and new ones are selected which are more important. Exchange your knowledge on the subject while doing so.
3. Through consensus or a vote, refine the pattern field to the agreed and necessary solutions for the site.
4. Use the blank pattern card to introduce a new pattern if the group thinks an ingredient is missing from the stack.
5. With the help of the facilitator, organise the cards according to scale, user, type of solution, etc. Explore connections between patterns, and establish clusters and relations.
6. Discuss what the resulting pattern field means for the site. How can the solutions or clusters of solutions be put into action? Where? How? What are alternative scenarios? And what are the most desired solutions?

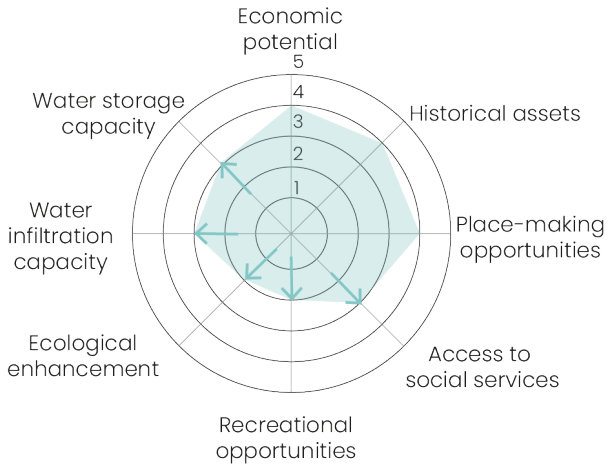
Figure 7.38: Top-Down and Bottom-Up participation with the pattern language



DECISION MAKING BASED ON VISIONING NEIGHBOURHOOD TYPES

A strategy without stakeholder participation to guide the decision-making process is based on the research and analysis done in this project. The constructed typology shows which design qualities are already present and which can be improved on a neighbourhood scale. This was formulated into a visioning design potential for every neighbourhood type. These design potentials can be used as a decision-making tool. This can be done with the pattern language because the patterns match the design qualities. However, it should not be forgotten that the design decisions on a neighbourhood scale should be complementary to the city-scale integration plan.

Figure 7.39: Type 1
Social waterscapes for urban living



Based on the typology Frederik Hendrikbuurt is a type 1 neighbourhood. These neighbourhoods have existing economic potential, place-making opportunities and historical assets. However, these neighbourhoods lack recreational opportunities and ecological enhancement. This would mean that it is more important to strengthen the water-landscape resilience in the Frederik Hendrikbuurt. Socio-ecological integration can be achieved with the climate adaptation and recreational possibilities of water-related heritage. By increasing the design qualities that are currently lacking there is a high integration possible of both scenarios, creating the most sustainable urban plan.

DECISION MAKING ON CITY SCALE

By considering the conflicts and synergies and the desired goals there is a high potential to reconcile both maximisations and integrate them into one integrated urban transformation plan. However, by prioritising the two main goals: resilient polder water system and sustainable heritage development there are trade-offs to be made. The main executive stakeholder and decision maker in this process is the municipality of Amsterdam.

Resilient polder water management asks for changes in the policies and zoning plans to accommodate more water storage and infiltration capacity. This will most likely result in benefit loss for the land-intensive private sector. To come to terms with these policies, financial compensation or economic alternatives are needed for them to change their practices. It is important to consider seasonal changes and adaptive strategies as alternative economic opportunities. By increasing stakeholder participation and inclusive decision making there will be more support for resilient water management.

To achieve sustainable heritage development an important measure is to create a variety of socio-cultural facilities throughout the whole city. Mixed-use development will lead to a higher viability because it increases diversity, general accessibility and functionality. This includes designing a variety of public spaces and effective public transportation. To successfully use heritage as a place-making asset, it is important to consider community participation with for example the pattern language and meet the local needs and wishes. This will ensure the transformation has long-term viability and can be a place to get together, supporting socio-ecological integration.

Figure 7.40: Generalised power - interest matrix

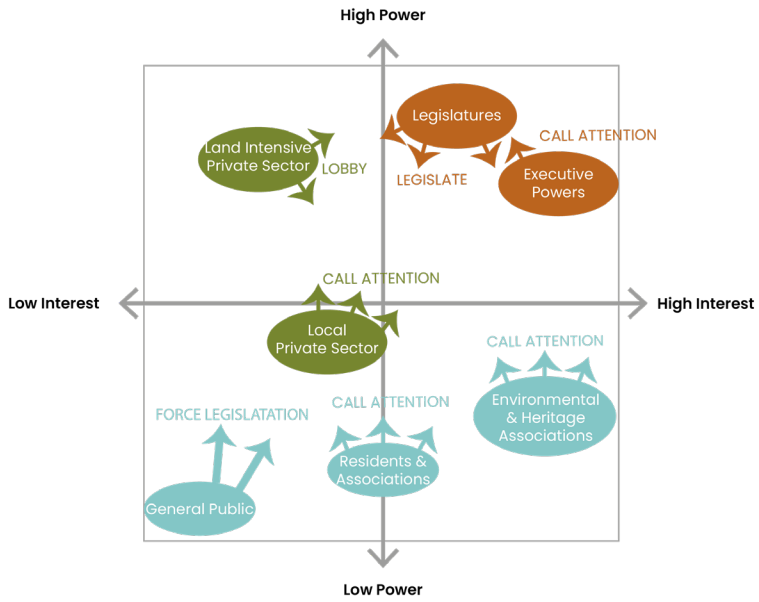
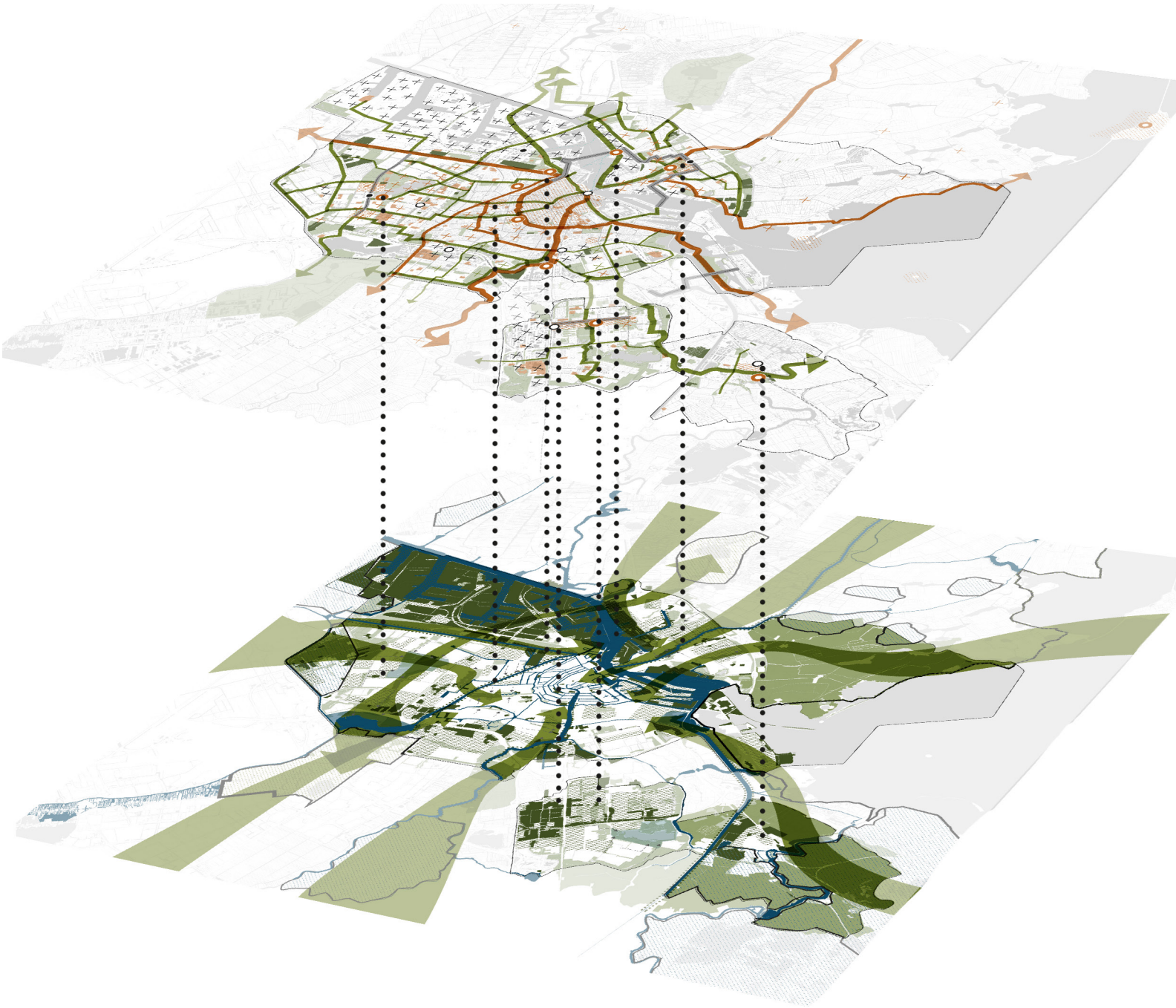


Figure 7.41: Comparision of the maximisation experiments on city scale



7.11 INTEGRATED URBAN TRANSFORMATION PLAN ON CITY SCALE

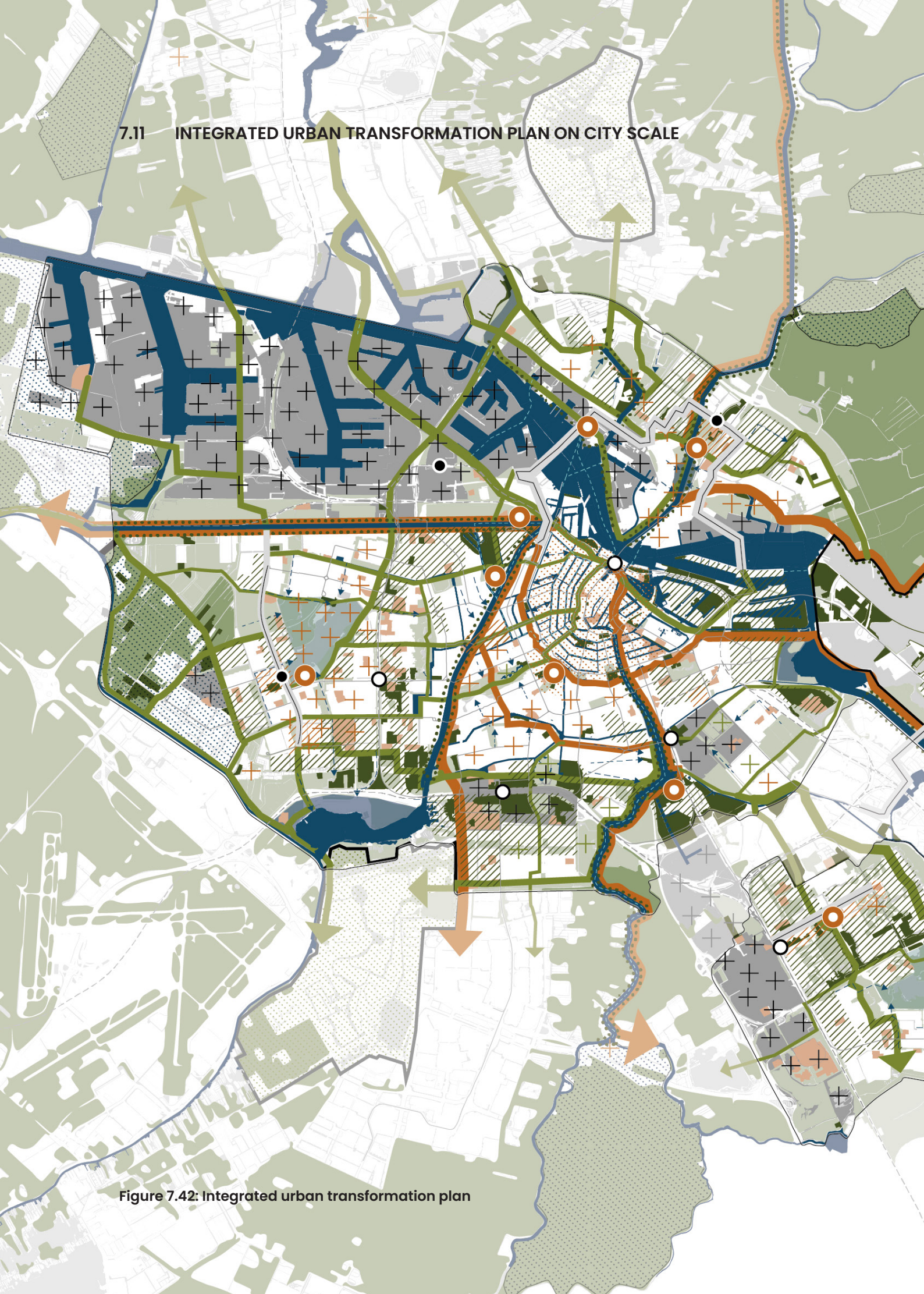
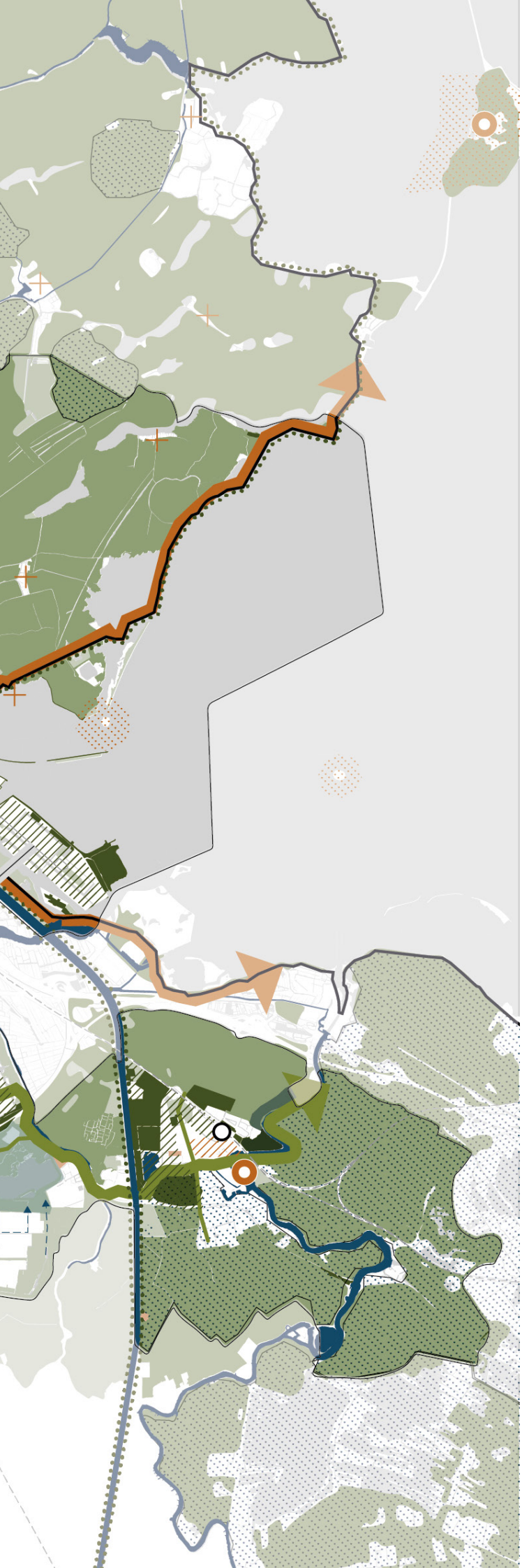


Figure 7.42: Integrated urban transformation plan



The integrated urban transformation plan shows the strategic plan to achieve a resilient water-heritage city. This map was constructed by considering the conflicts and synergies of the maximisation experiments and incorporates the visioning neighbourhood types and their role in the complex urban system by taking into account the positioning of neighbourhoods and their surroundings.

This design is not limited to the cities' boundaries but it is important to take the surrounding villages into account through corridors, densification potential, water storage buffers and public transportation. By doing this the broader resilience of the polder water system and sustainable heritage development is guaranteed.

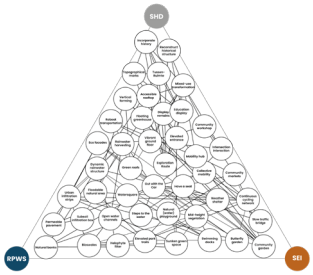
- Existing water
- Changed boezem environment
- Controlled floodable polder
- Controlled floodable recreational area
- Buffer zone polder
- Buffer zone boezem
- Roboat route
- Dike strengthening
- Improve surface drainage

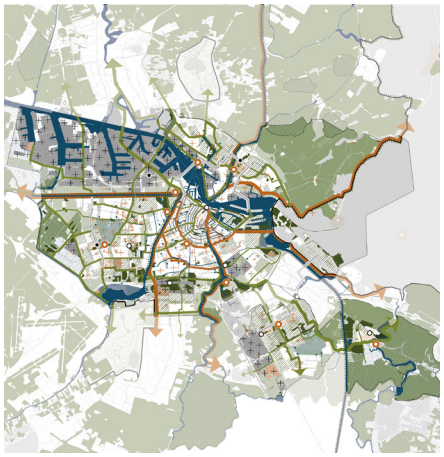
- Existing permeable patch
- New permeable patch
- Adaptive agricultural area
- Green roof area
- Green heritage
- Improved recreational corridor
- Natural banks

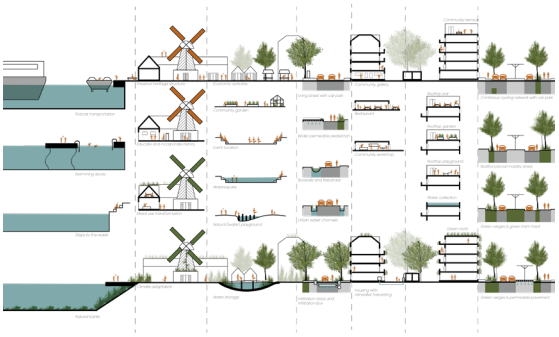
- Existing socio-cultural facility
- Cultural-historic place-making
- Protected townscapes
- (Inter)national tourist attraction
- Local economic centre
- Improved historical corridor

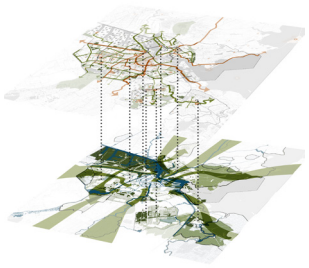
- Resilient densification neighbourhood
- Multichange corridors
- New mobility hub
- Transformed mobility hub
- Tramline
- Train

Scale: 1:85.000


SHD
RPWS
SD







CONCLUSION CHAPTER 7

Chapter 7 answered sub-questions 4 and 5. It showed how social-ecological solutions enable an increased capacity for water resilience by increasing the water infiltration capacity, water storage capacity, ecological enhancement and recreational opportunities of urban water. It also showed how sustainable development of water-related heritage can increase cultural resilience by using these cultural-historic sites as place-making and economic opportunities and increase the accessibility of social services and recreational activities. The pattern language explored design solutions that are compatible with these maximisation experiments. By comparing the two maximisation experiments conflicts and synergies were put forward and variations in the urban design are shown based on the design solutions developed in the pattern language. In the decision-making process, it is important to use stakeholder participation in both a top-down and bottom-up process to allow for inclusive decision-making with the pattern language. Chapter 7 concludes with the integration urban transformation plan on the city scale. This plan shows how the city of Amsterdam should be transformed to integrate resilient polder water management with sustainable heritage development.

NOORDZEEKANAAL
WESTHAVEN
SONTHAVEN
HORNHAVEN
MOEZELHAVEN
MAINHAVEN
BERINGHAVEN
Hempont
Rioolwaterzuiverings-
inrichting
Groote IJpolder
Westpoort
Beheer
Volkstuinenpark
De Bretten
Sportpark Spieringhor
WIM THOMASSEN
HEMWEG
HORNWEG
MALTAWEG
HARDINXWEG
RHOONWEG
NOORDZEEWEG
A5 WESTRANDWEG NOORD
(IN ONTWERP)
BASISWEG
THEEMSWEG
RHÔNEWEG
BRETTENPAD
HAARLEMMERWEG
HAARLEMMERVAART
SIERENBORCH
KOESEL
BERRIT
STAPEL
SEINEWEG
-15.50
-7.50
-9.50
-10.00
-15.50
-0.40
-13.00
-6.00
-13.50
-10.50
-14.50

CHAPTER

8

INTEGRATED DESIGN PROPOSAL

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Chapter 8 shows the integrated urban transformation plan on the city scale and the integrated implementation on the neighbourhood scale. Based on the city scale plan, the typology and results from the survey two representative locations were chosen as zoom-ins to develop a design proposal that shows how the climate adaptation of the water and cultural structures positively contribute to the living environment of the citisens, ultimately building resilience in the water identity of Amsterdam.

Figure 8.1: Blad 9 van de Kaart van Amsterdam

Source: Stadsarchief Amterdam / Dienst Openbare Werken (2009)
Black & White Adaptation

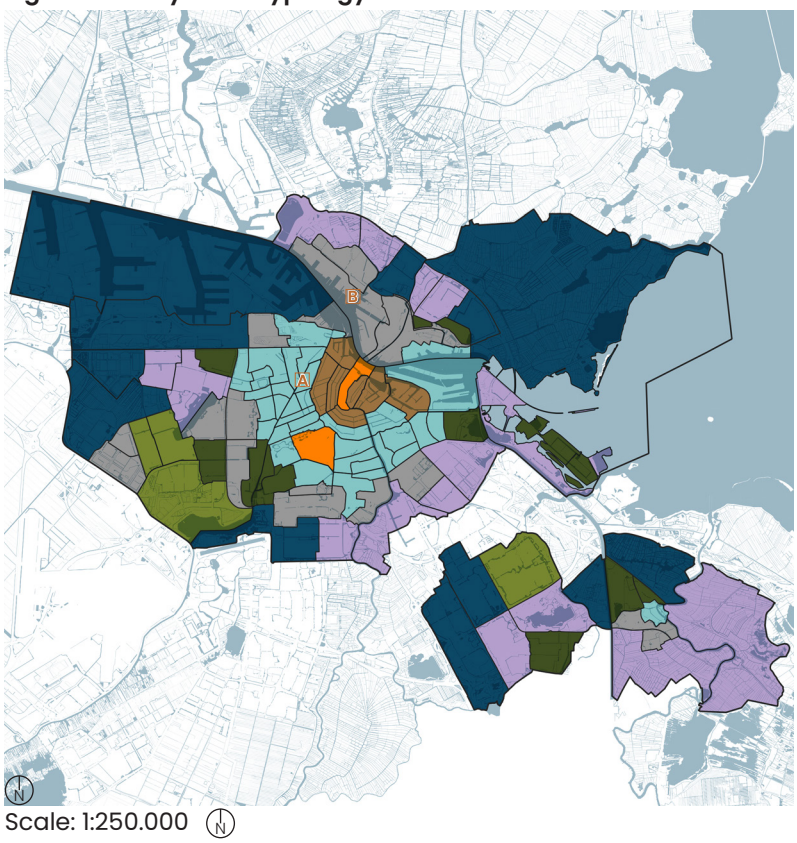
8.1 SELECTION OF LOCATIONS

Based on the typology and visioning neighbourhood types it became clear that different neighbourhoods have different implementations to achieve the desirable integration and maximise the local potential of the formulated design qualities. In combination with the integrated urban transformation plan, it was decided to focus on two different neighbourhood types to show the implemented integration in a design proposal. These pilot projects play a crucial role in showing the desired integration on a human scale. They serve as a practical demonstration of how resilient water management can coexist with sustainable heritage development and socio-ecological integration. This will improve the overall water identity in the city of Amsterdam.

The selected locations highlight their context-specific characteristics based on the site's history and their ability to maximise the local potential of the design qualities. The selected locations were mentioned by Amsterdam residents in the survey as places where the urban waterfront could be improved. Moreover, they show different environments in the integrated urban transformation plan.

Through these representative locations, the project shows how to contribute to the overall development of the city, while developing a context-specific design plan in different types of neighbourhoods. Together these design proposals contribute to securing the water identity for future generations.

Figure 8.2: City scale typology conclusion



Scale: 1:250.000

Figure 8.3: Improvement possibili urban waterfront based on surve

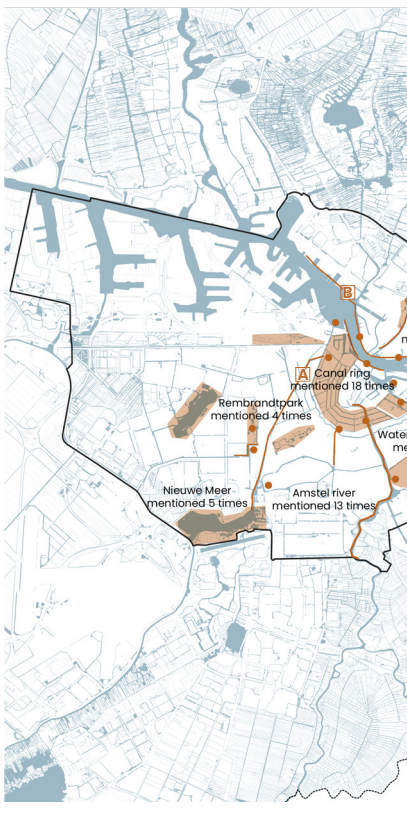
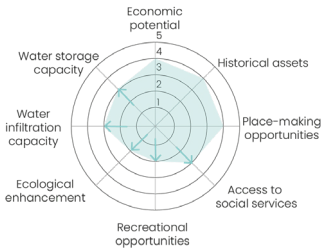


Figure 8.4: Visioning types of selected locations

A

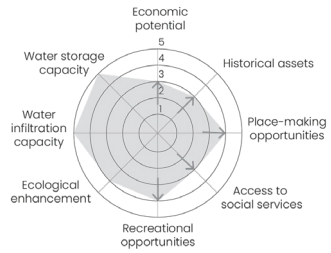


Type 1: Social waterscapes for urban living

Design plan Molen De Otter & Gillis van Ledenberchstraat:

Socio-ecological integration by exploiting the recreational possibilities and economic potential of water-related heritage, allowing for climate adaptation and better access to the urban waterfront

B



Type 5: Resilient densification

Design plan NSDM wharf:

Catalysing industrial heritage for mixed-use resilient densification and exploitation of the historic urban waterfront for recreational opportunities Assuring access to social services in new residential areas.

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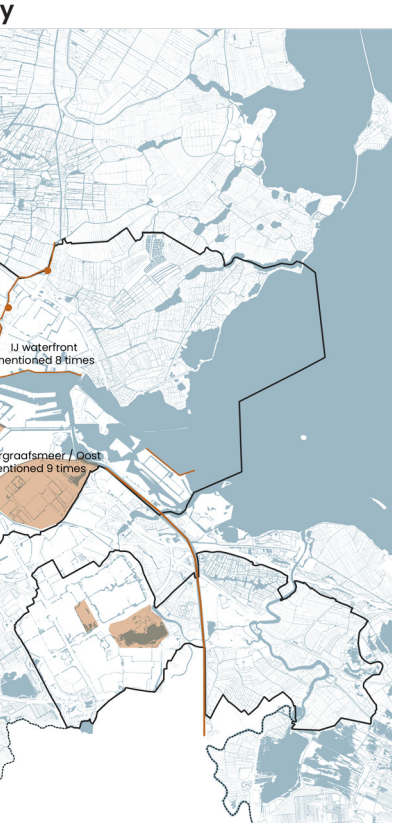
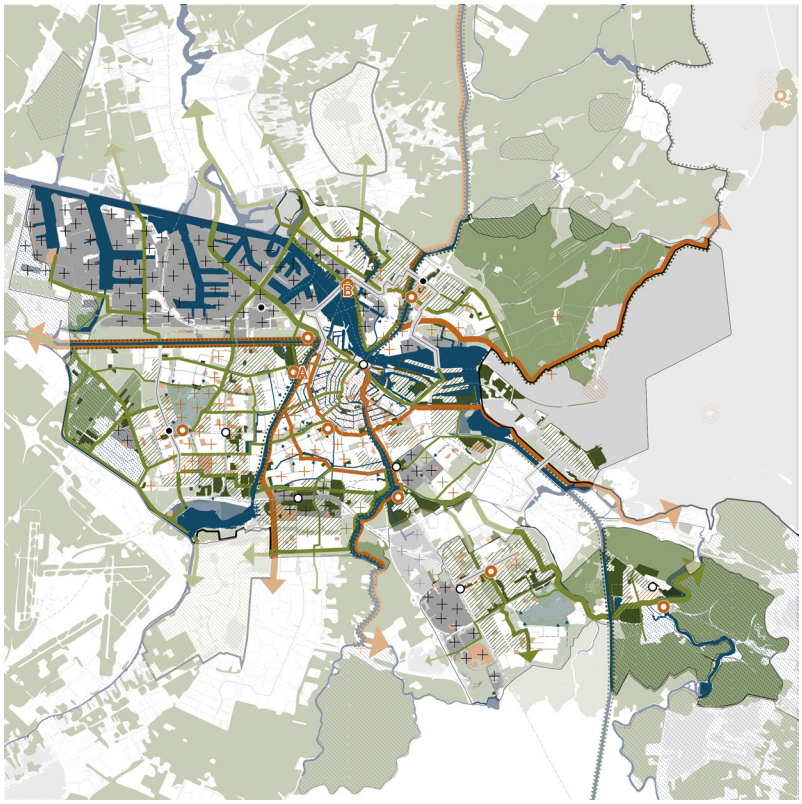


Figure 8.5: Integrated urban transformation plan



8.2 INTEGRATED IMPLEMENTATION SOCIAL WATERSCAPES FOR URBAN LIVING

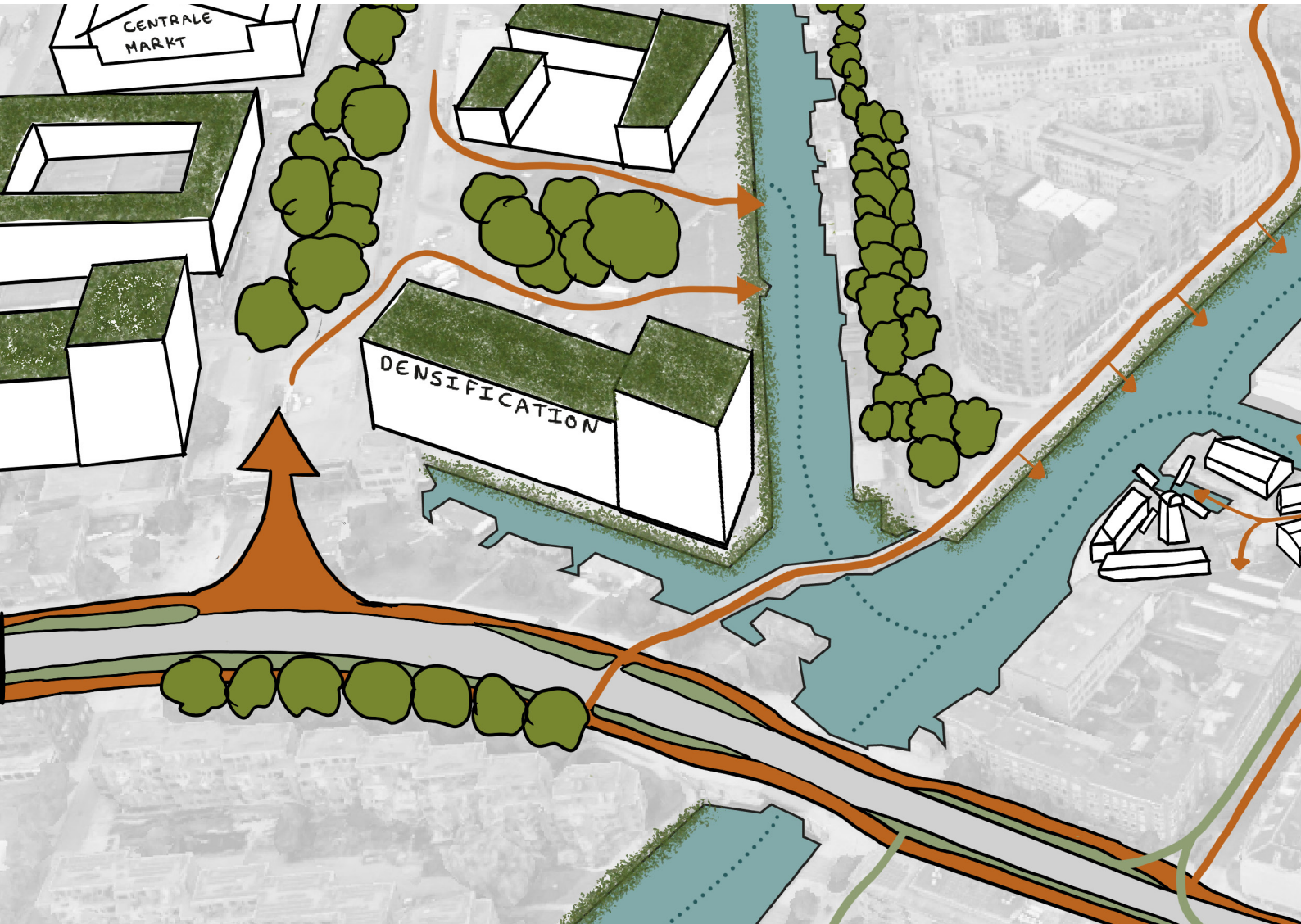
The Frederik Hendrikbuurt is a pre-war neighbourhood that was developed from 1870 to 1930. It is a representative neighbourhood of pre-war Amsterdam because of its closed-block residential function with strong historically valued characteristics. From the maximisation experiments, it became clear that the human-culture qualities are already strong in this neighbourhood, therefore the design should focus on improving the water-landscape qualities and integrate them with the historic character.
The Kostverlorenvaart is an important historic waterway, which is still used as a shipping route. The two historic sites (Centrale Markt and Molen de Otter) are used as a place-making opportunity, increasing access to the urban waterfront.

Figure 8.6: Achterweg, now Gillis van Ledenberchstraat

Source: Stadsarchief Amsterdam / Goedkoop (1890)

Figure 8.7: Gillis van Ledenberchstraat 2024

Figure 8.8: Birds eye view of neighbourhood design



On a neighbourhood scale, the design focuses on ecological enhancement by making greener corridors. This can be done by increasing the green patches in the smaller streets and the green verges and trees in the corridors. There where possible, parts of the quay can be changed to a natural bank. In the bigger mobility streets, it is important to allow for more infiltration capacity by transforming the tram track into permeable material.

The accessibility of the urban waterfront can be made better at the site of Molen de Otter, in the redevelopment around the Centrale Markt and along the natural bank. The Centrale Markt is a national monument, but the industry around the market has disappeared, this area can be transformed into a residential neighbourhood with the Centrale Markt at its core in the middle of the neighbourhood. At the same time, this new development has a high potential to also increase ecological enhancement, water infiltration and water storage capacity. In the places where there are no private buildings directly on the waterfront, public access to the waterfront should be improved. This can have a variety of different implementations. I will zoom into the Molen de Otter to show how this water-related heritage can be adapted and used as a place-making site for both cultural and water system resilience.

Figure 8.9: Local potential

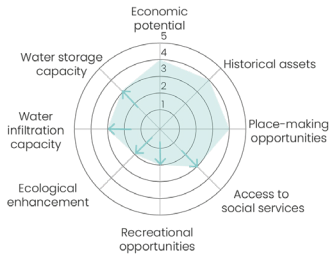
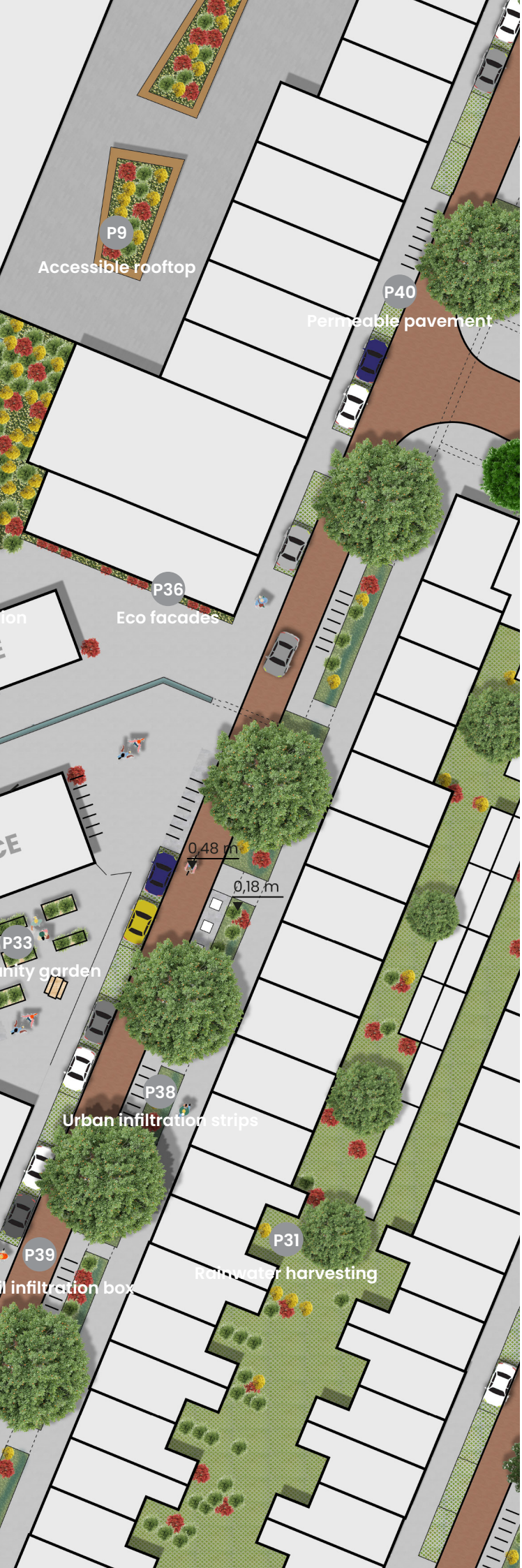


Figure 8.10: Design Plan Molen de Otter & Gillis van Ledenberchstraat

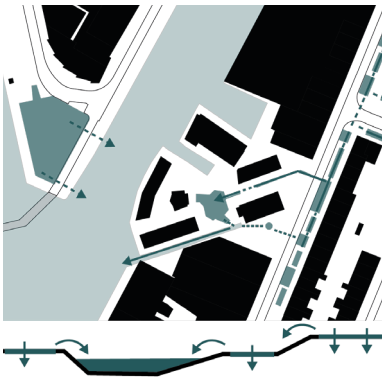


To achieve the desired integrated implementation the Gillis van Ledenberchstraat will be transformed to allow for a higher water infiltration and storage capacity. Half of the car parks will be transformed into green patches, but the amount of bike racks will increase. These green patches are slightly lowered and connected so the water can circulate. The leftover car parking spaces will be open brick pavement allowing for more infiltration capacity. In addition, a subsoil infiltration box is installed under the streets to prevent water nuisance in the streets. Supporting the transformation of private property with facade gardens and green balconies allows for more ecology and biodiversity and in combination with rainwater harvesting this releases pressure from the water system because less water will enter the polder-boezem system.

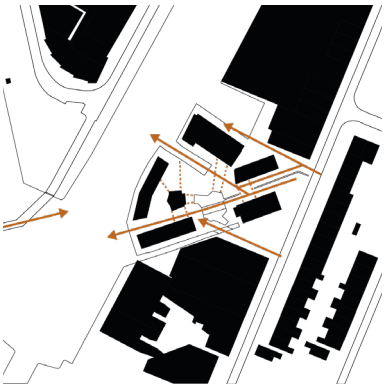
The last standing sawmill along the Kostverlorenvaart will be used as a cultural-historic place-making site with a small museum, café and space to access and relax along the urban waterfront. In addition, Roboat transportation allows people to access this site via the water and explore the Kostverlorenvaart from the water. For the Roboat harbour, an old barn needs to be demolished to bring back this historic water structure. In front of the windmill, there is a square and a small garden. This could be public space and extra water storage. Combined with an open water channel and steps to the water the water will be more present in this historic site. By opening the windmill as a public space the urban waterfront will be publicly accessible and people can learn about the historic activities along this waterway. The existing buildings on the site are offices of small companies and can still have this function as these companies increase the variety of activities at the site.

Scale: 1:500

Figure 8.11: Design diagrams
Delayed water run off



Opening sightlines to the saw mill and the waterfront



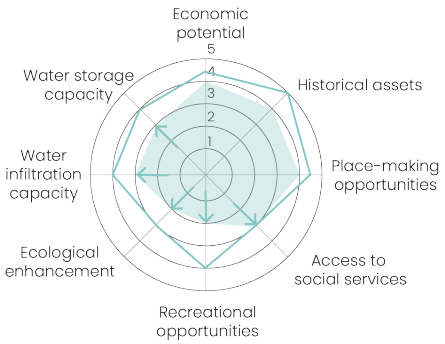
Stepping stones in mid-height vegetation

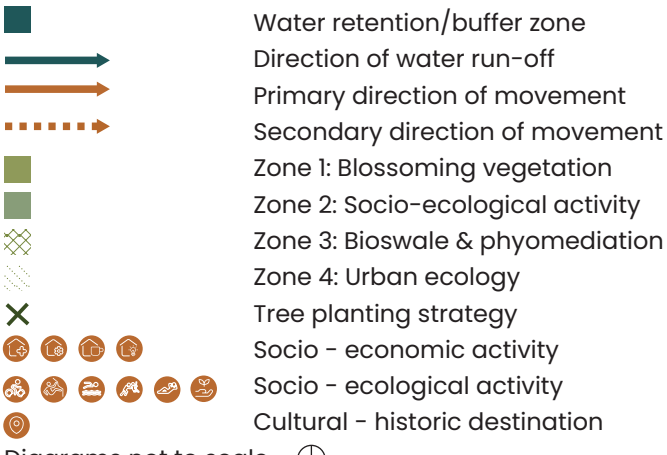
Socio-cultural and socio-eco-logical activities

The design of Molen de Otter focuses on slowing down the rainwater in the polder before entering the boezem by increasing the permeable patches, opening water channels and adding a water retention zone. The living streets increase their permeability and ecological enhancement with mid-size vegetation and new patches increase the possibility for species to migrate. Sightlines from the street towards the sawmill improve the accessibility to the waterfront and the sawmill is used as cultural-historic place-making opportunities with a museum and cafe.

Despite the limited space in this 1920s neighbourhood, this design proves that a variety of patterns from the constructed pattern language are applicable in this location. The design solutions demonstrate how to increase the water infiltration and storage capacity and at the same time use the public waterfront to sit and relax improving the aesthetic, historical and social values of the urban waterfront.

Figure 8.12: Improved qualities with design plan





Diagrams not to scale

Figure 8.13: Eye level design Gillis van Ledenberchstraat

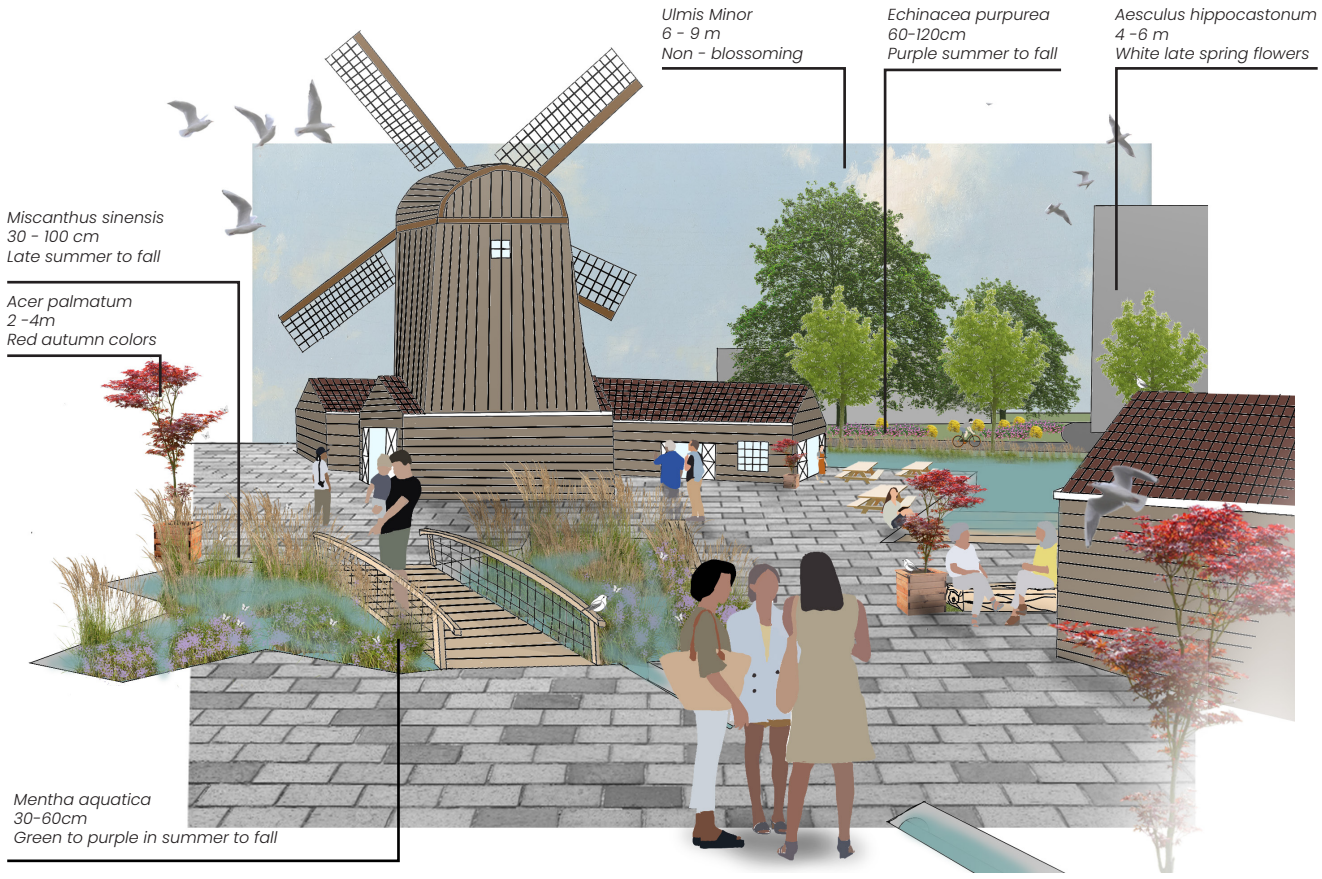


Figure 8.14: Eye level design waterfront Molen de Otter

8.3 INTEGRATED IMPLEMENTATION RESILIENT DENSIFICATION

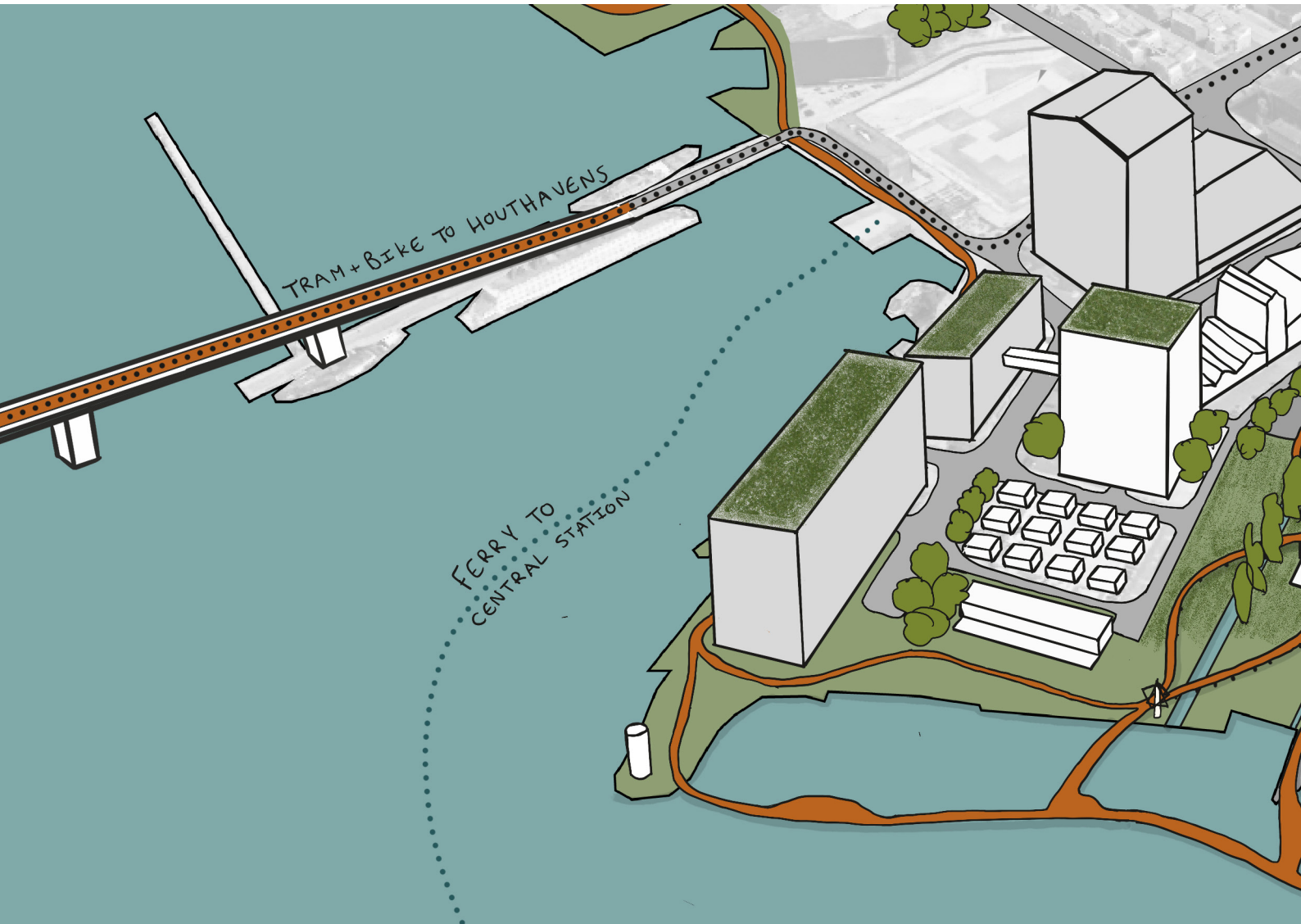
The NDSM is an old ship wharf on the north side of the IJ waterfront. The NDSM was considered a small city on the north bank with over 6000 employers, housing for immigrant workers, and social services like a school, library and a variety of workers' associations. In 1984 the company lost the competition from Asian competition and the ship warf was abandoned (Groeneboe, 2015). In the 1990s artists explored the NDSM and opened studios and workspaces for creative experiments. The cultural and creative sector has succeeded in reviving the NDSM wharf and it is a beloved space for events. At the same time, the surrounding areas are redeveloped into new residential neighbourhoods. However, the NDSM-Oost is still neglected due to the heavily polluted soil. The still-existing slopes of the ship wharf and the crane are considered national industrial heritage.

Figure 8.15: Shipwharf NDSM 1938

Source: Stadsarchief Amsterdam / Fototechnisch- en Cartografisch Bedrijf KLM (1938)

Figure 8.16: NDSM National Monuments

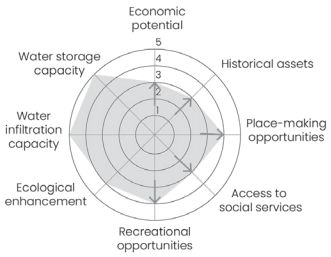
Figure 8.17: Birds eye view of neighbourhood design



To have a resilient densification project in the NDSM neighbourhood it is important that the accessibility to and from the neighbourhood is improved. First of all, there is the opportunity to build a new bridge for trams and bikes from the Houthavens to the NDSM, this would allow for the tram to go through the western harbour to the old parts of Amsterdam North and to the metro line in North. Historically the industrial sites were difficult to access, to allow for better accessibility of the urban waterfront and the new waterfront park a new bridge from Tuindorp Oostzaan needs to be constructed. Lastly, the recreational corridor from Overhoeks to Oostzaan needs to be improved for cyclists. The new blocks of housing should be built with an elevated (backup) entrance to be resilient to floods. Not only houses but also social services should be added to the neighbourhood because the neighbourhood is isolated from the urban network.

The industrial buildings should be incorporated into the new residential blocks. The culture hub and event space are kept to build upon the existing creative identity and creative industries in the NDSM. Moreover, the small buildings for start-ups and small companies should be kept or housed within the residential buildings to allow for this creative industrial identity to be preserved. Lastly, it would be interesting to allow for new innovative experiments like a vertical farm. This would be especially interesting in combination with the already existing restaurants in the neighbourhood. I will zoom into the waterfront park to show how this place can integrate the industrial heritage with ecological enhancement and new recreational opportunities.

Figure 8.18: Local potential



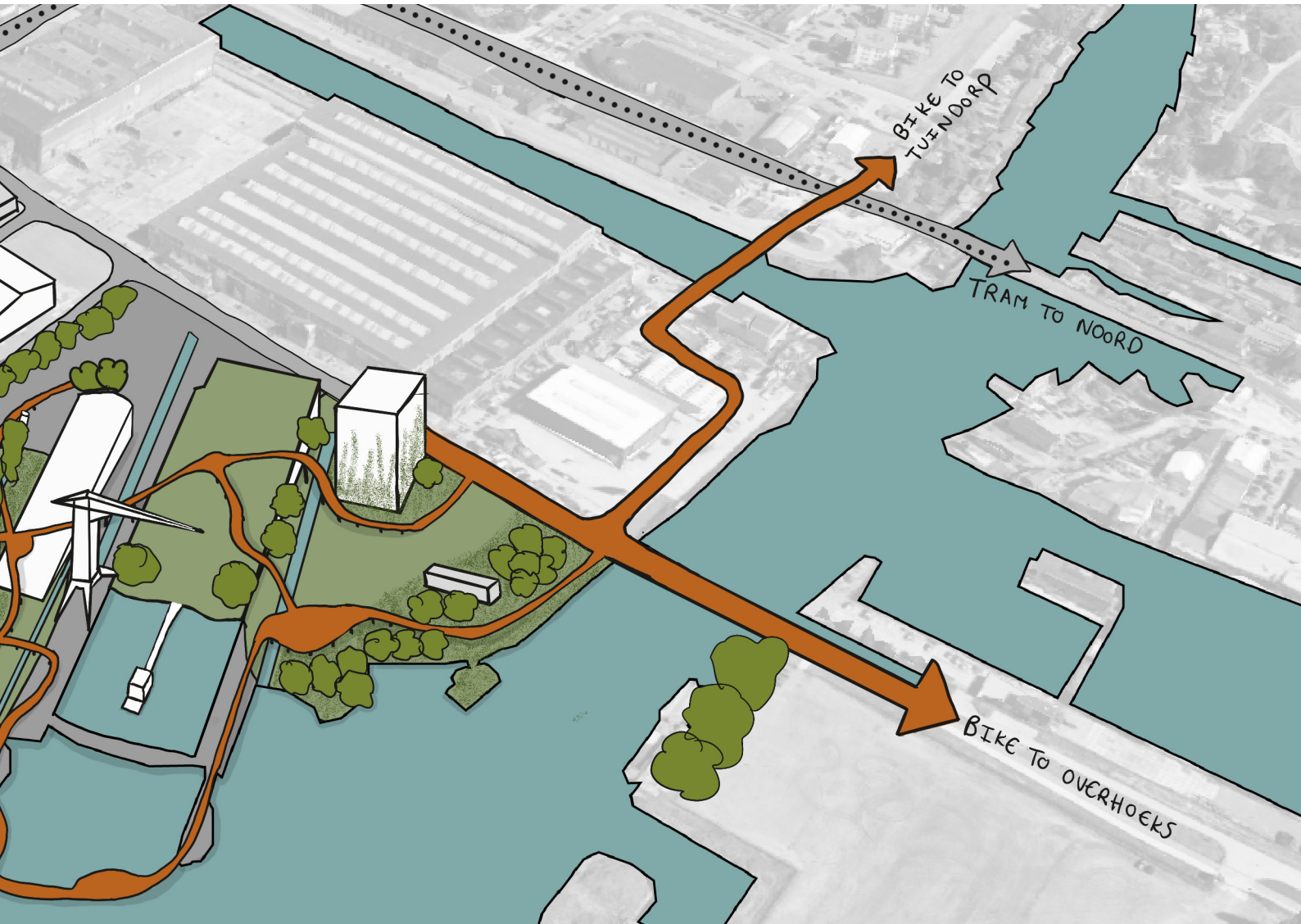
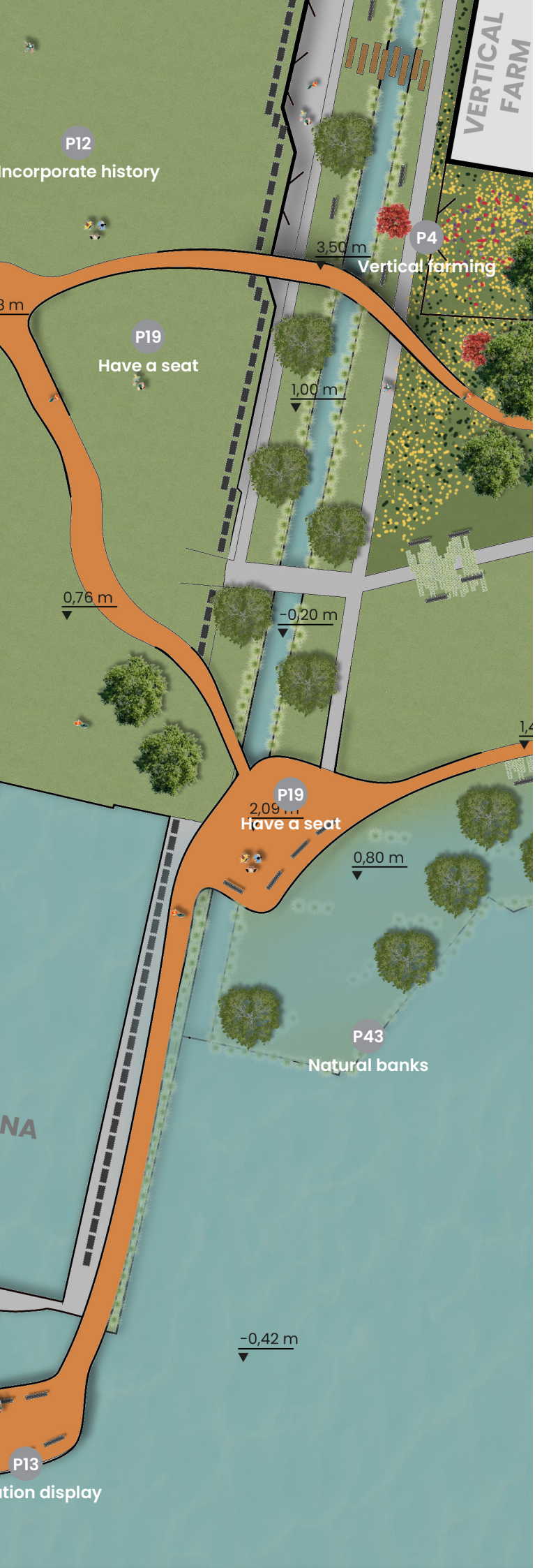


Figure 8.19: Design Plan NDSM wharf

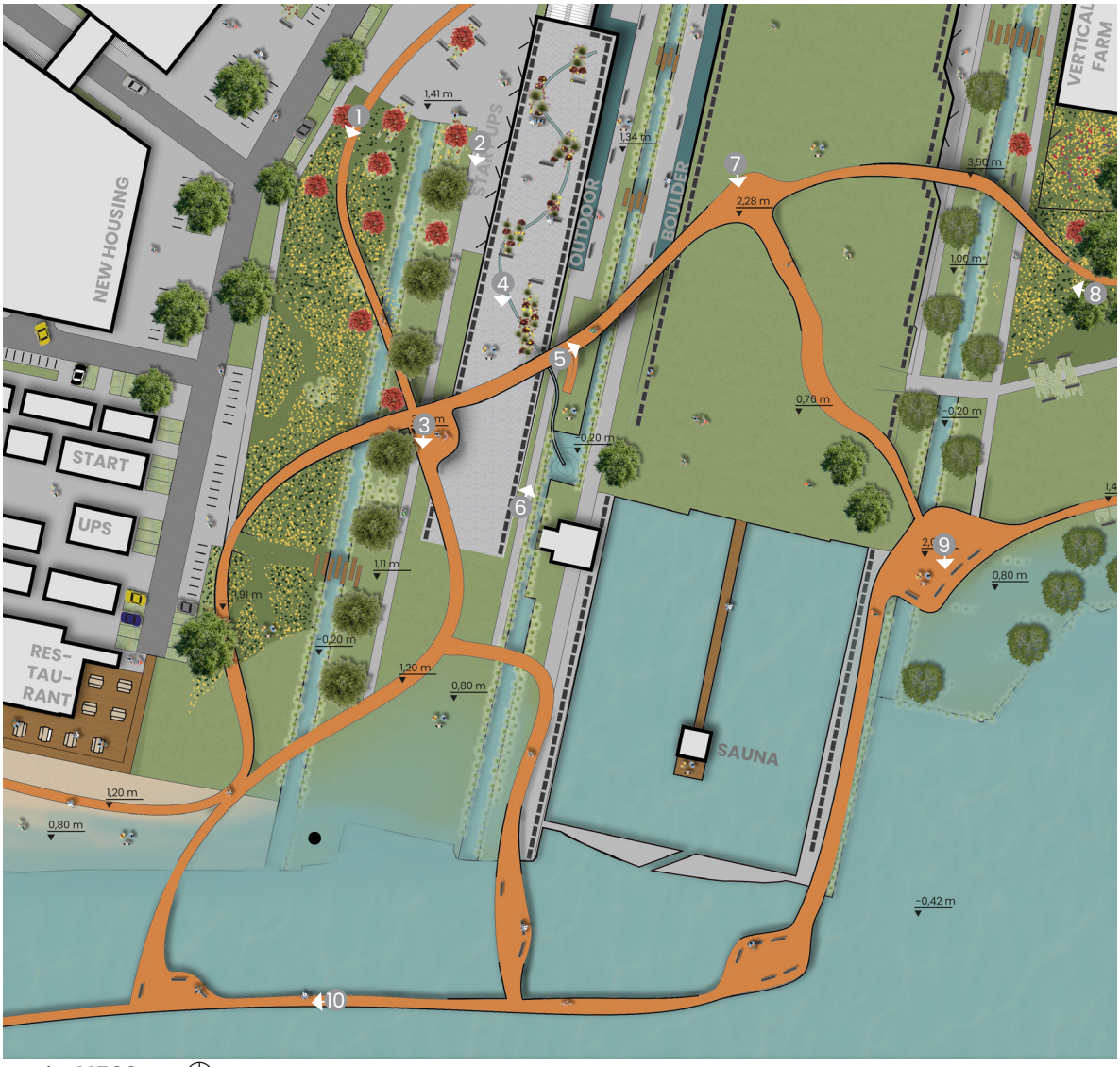


The soil around the NDSM wharf is heavily contaminated to allow for a healthy park environment phytoremediation will be used. Phytoremediation is a process where plants clean polluted soil by absorbing contaminants through their roots. For this process, bioswales are dug perpendicular to the urban waterfront. These bioswales are planted with five target species that use phytoremediation. These five plants are the willow and poplar tree, different grasses, indian mustard and sunflower.

Elevated park trails allow for these plants to thrive while the park is also accessible to the public. The two concrete slopes are incorporated into these elevated trails. The trails go over the slopes and are eye-catching connectors between the industrial heritage, straight ground-level park design and urban waterfront. Different platforms on the elevated trails and along the water allow for sitting and looking towards the city centre of Amsterdam. This elevated trail is completely wheelchair friendly and continuous outside of this park to be able to walk along the complete waterfront from east to west. Different landscape zones create different park environments, dense vegetation is alternated with water plants and open space.

To increase the recreational opportunities the biggest slope is turned into an artificial grass hill, where people can sit on a summer day. The sunny side of the IJ is a perfect place to swim. People already do this but the water is not closed of from boating activities. Therefore the walkway should close this off to make it safer for swimmers. This will create different swimming bays that can have different depths and target groups like kids or open-water swimmers. The space between the two concrete slopes will be transformed into an outdoor bouldering space in combination with some play elements like slides and swings.

Scale: 1:750



Scale: 1:1500

Figure 8.20: Landscape sketches of NDSM waterfront park

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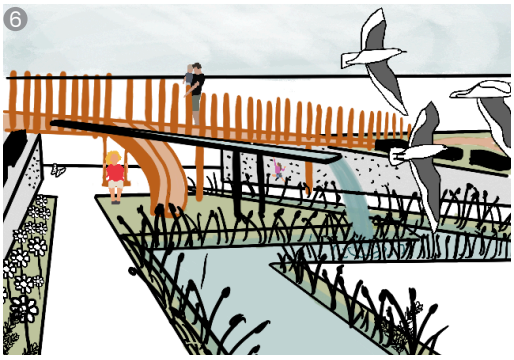
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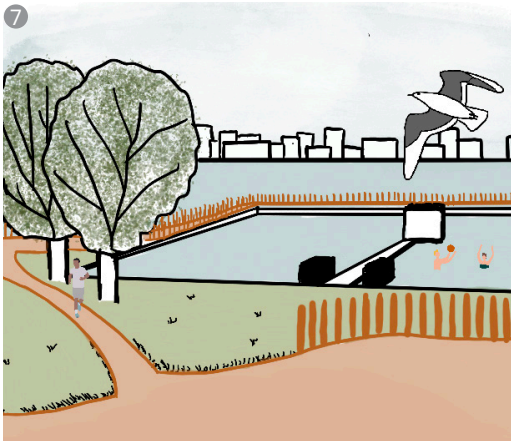
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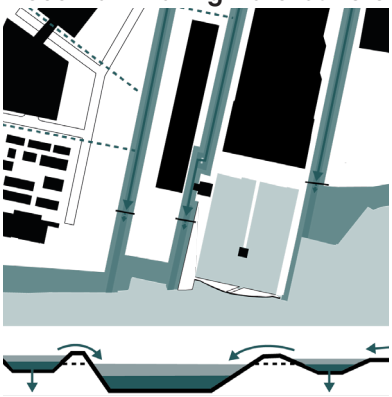
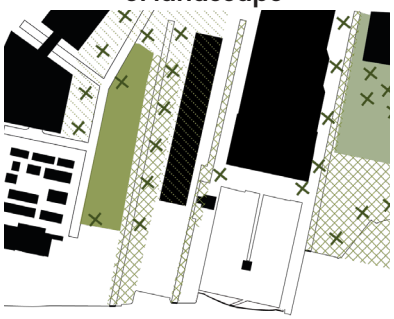
Figure 8.21: Design diagrams

Decontaminating waterbuffers



Accent on historical structure in contrast with 3D movement

Different zones of landscape

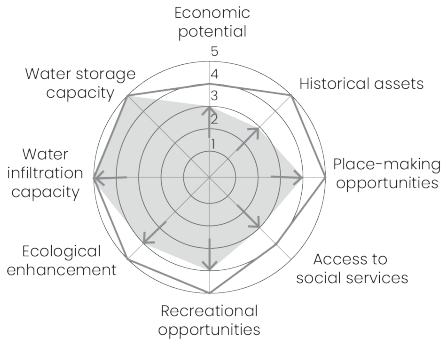


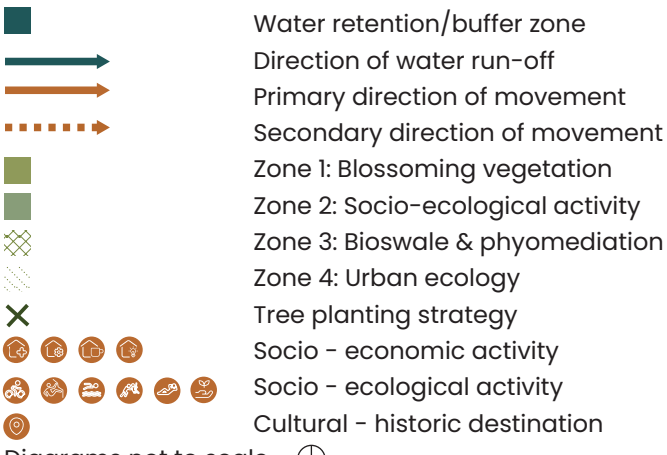
Socio-cultural and socio-ecological activities

The design of the NDSM wharf focuses on using the place as a cultural-historic destination where the creative identity is preserved. At the same time, the waterfront park increases the socio-ecological integration by combining a phytoremediation strategy with a variety of activities which attract both residents and visitors. The water infiltration capacity, ecological enhancement and recreational opportunities are strongly improved.

To create a resilient neighbourhood it is important to add social services and improve access to and from the neighbourhood by bike and tram from both the city centre and the older northern neighbourhoods. By doing so the NDSM has great potential for an advanced integration of sustainable heritage development and resilience in the polder water system. By doing this the cultural heritage values of the urban waterfront will be enhanced, ultimately strengthening the water identity of Amsterdam.

Figure 8.22: Improved qualities with design plan





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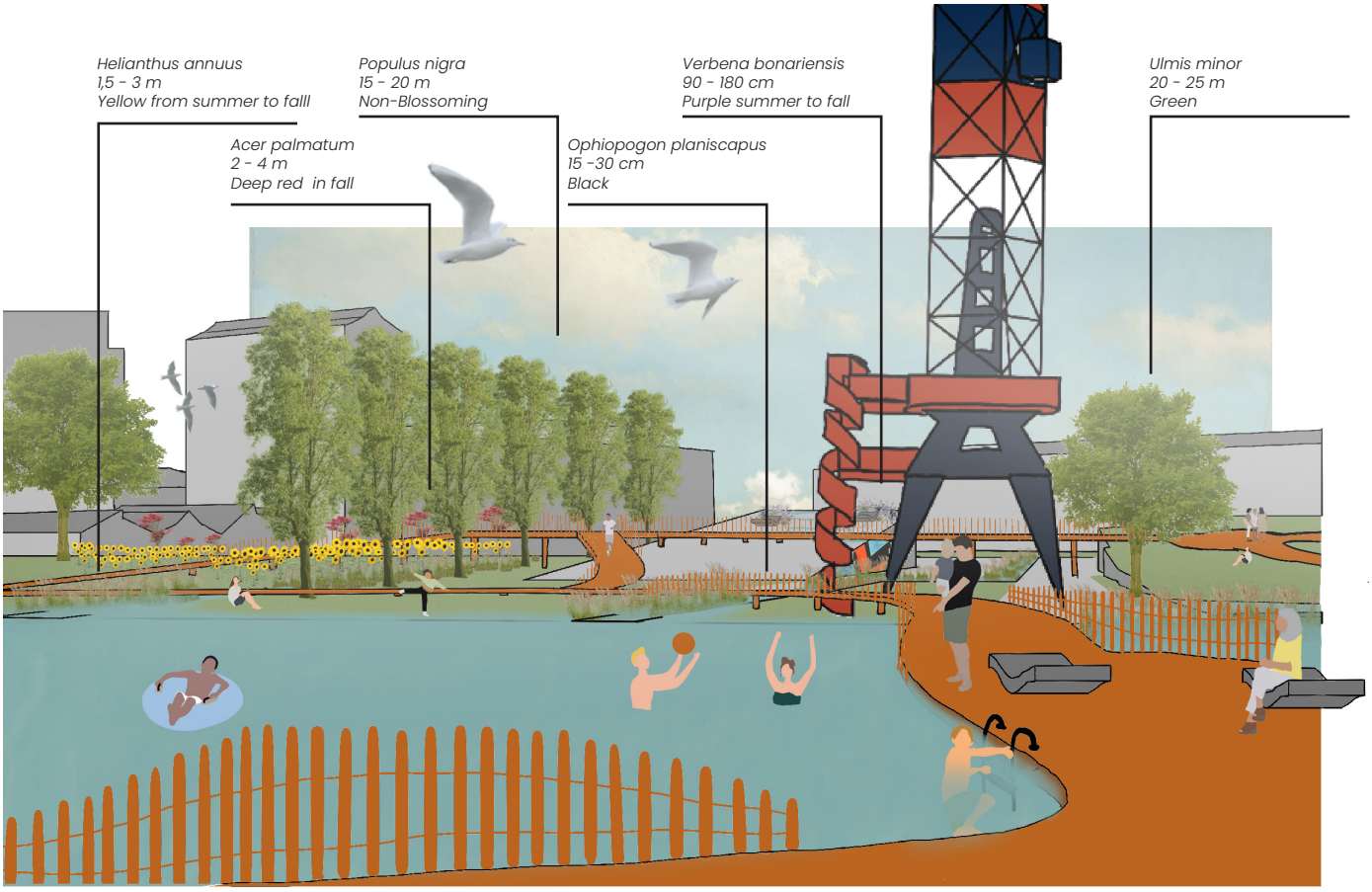


Figure 8.23: Eye level design waterfront NDSM wharf

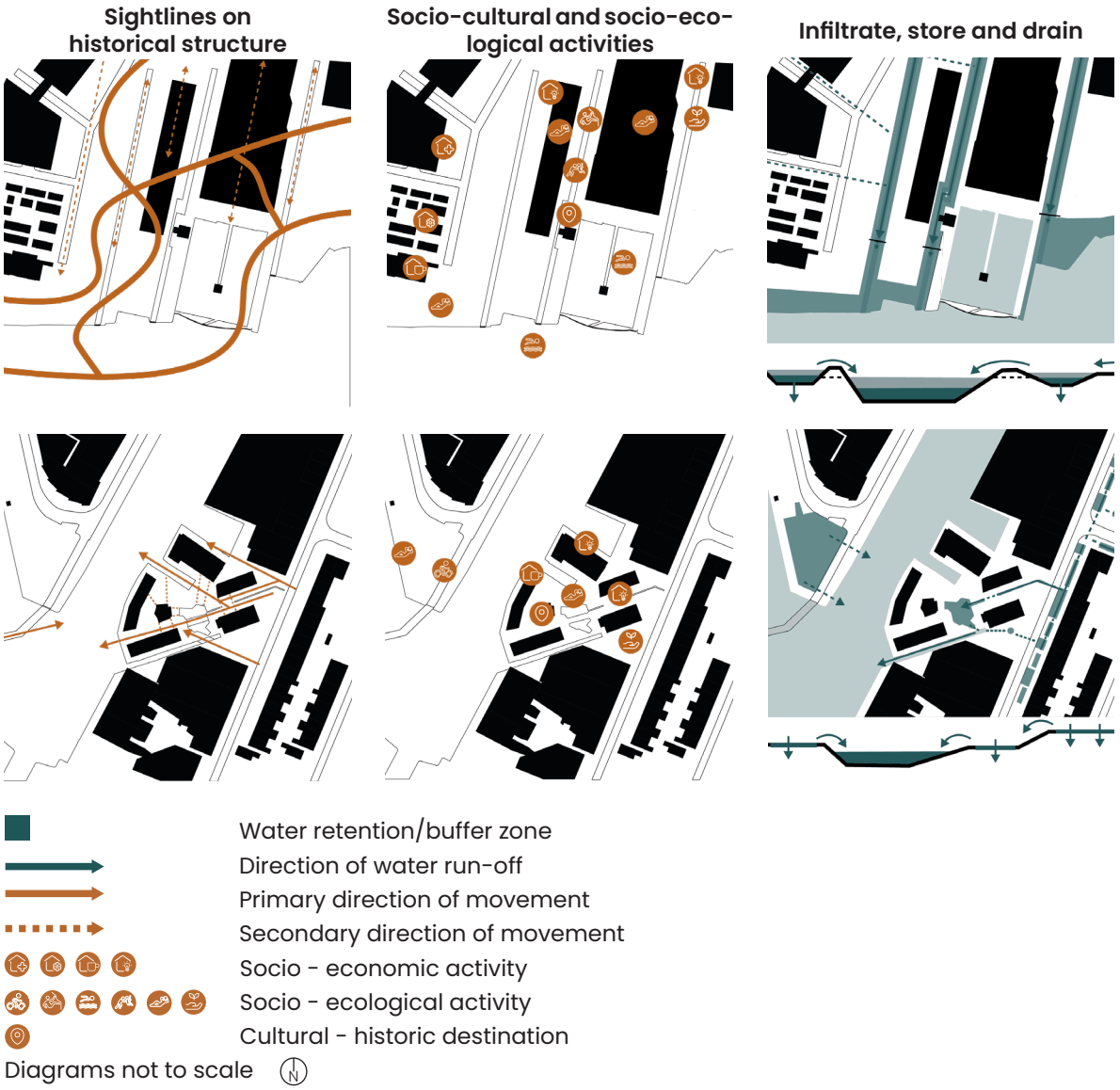
Figure 8.24: Eye level design sports & play zone NDSM wharf

8.4 SOCIO - ECOLOGICAL STRATEGY

To allow for the transferability of the project the socio-ecological strategy is based on general principles. First of all the activities are largely based on the developed patterns which are design solutions that support the socio-ecological integration by supporting one or multiple qualities that were formulated in this project. These activities are transferable to other locations. An important integrated strategy to increase socio-ecological enhancement and the cultural heritage values of the urban waterfront is to increase the accessibility to the urban waterfront. In both designs, this is done by sightlines that highlight the historical structure. Moreover, the waterfront park design in the NDSM serves as a place-making structure that allows for new socio-ecological integrated uses of the northern IJ oever.

To support a resilient polder water system it is important to infiltrate and store the water for as long as possible, before it is drained to the boezem system. By designing water infiltration and water retention zones. The design increases the presence and the aesthetic value of water, which increases the support for more water in the urban environment.

Figure 8.25: Comparison of design diagrams



Landscaping zones

For the planting strategy, it was decided to work with four zones that are transferable to different locations.

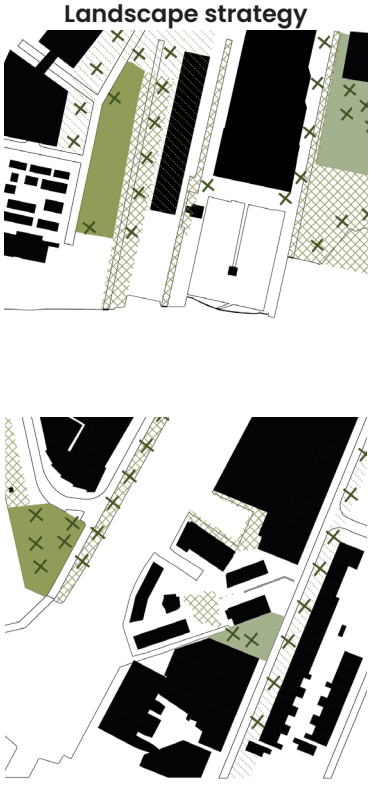
- Zone 1 are blossoming flower zones. This is the most vibrant ecological zone, were a variety of flowers is used to create a flower garden that blossoms from early spring to late fall to support the butterflies and bees. Moreover, these flowers vary in height, creating different park environments over the season and beautiful aesthetic values.
- Zone 2 focuses most on socio-ecological integration because the planting strategy is combined with green recreational activities. Zone 2 consists of plants that stimulate the senses. They have surprising smells or have eatable flowers and berries. Zone 2 plants can be combined with community gardens or community courtyards. In the NDSM, zone 2 is combined with a vertical farm.
- Zone 3 is the bioswale and phytoremediation zone. These are plants that grow well in watery environments and help decontaminate the polluted soil in the NDSM wharf. These plants can be used in retention zones, on natural banks and in bioswales in parks and streets.
- Zone 4 is called urban ecology, these are plants that can be grown in pots or small green patches in streets. It is tried to create a vegetation layer up to 1 m to make sure the streets are open and no unsafe corners are created. Zone 4 can often be combined with flowers from the zone 1 taxonomy.

Tree strategy

For the tree strategy, the starting point is to keep most existing trees. However new trees are added to support the phytoremediation process. Trees that support the phytoremediation process are the poplar and willow. Next to that these trees can grow in watery environments, which makes them a good choice to use in water buffer zones and along waterways. In addition, colourful trees are added to support the aesthetic qualities of the urban spaces. Lastly, if older trees fall over or die it is important to consider new trees. Two trees that are important to consider are the common oak because it strongly supports biodiversity. Secondly, the elm is considered a cultural-historic tree species in Amsterdam.

In streets and along waterways trees are planted in lanes, this supports the living environments of bats. In the blossoming vegetation zones, a combination of bigger and smaller trees supports the vibrant ecological environment, especially with trees that have vibrant autumn colours. In parks like the NDSM trees are also planted solitaire, as they will provide shade on summer days for summer activities in the park like sitting or relaxing after a swim. A detailed species taxonomy is added to the appendix.

Figure 8.26:
Landscape strategy



8.5 LANDSCAPE ECOLOGICAL STRUCTURE

The landscape strategy on a site or neighbourhood scale should be accompanied by a larger landscape ecology strategy to strengthen the city's ecological network by improving and creating new ecological corridors and adding green patches. A larger ecological structure is needed to enhance biodiversity. The green/blue network is a carrying structure for ecology but also enhances the possibility of implementing design solutions that support resilient polder water management and socio-ecological integration.

The water-landscape maximisation already showed the ecological corridors on a city scale and the possibility of connecting to the Scheg structures of Amsterdam. The Scheg structures of Amsterdam are like green-fingers that connect the city to natural areas around the city. These structures not only have high recreational value for inhabitants of the city but also have an important role in protecting and improving biodiversity and water management.

Figure 8.28 shows north-western Amsterdam, an in-between scale between the city and neighbourhood that highlights the characteristics and importance of the different ecological structures. It shows the broader connectivity of the waterfront park on the northern IJ-oever, which would be a new primary corridor in the city's ecological network. Moreover, it shows the importance of the Kostverlorenvaart, the Singelgracht and Amstel as water structures that can function as small-scale corridors in the pre-war city. The Kostverlorenvaart, where the design location Molen de Otter is situated is an important green/blue connector towards the Amsterdamsebos Scheg. Just like the Amstel which connects to the Amstelscheg and the Noord-Holandskanaal which connects to the Waterlandscheg.

Figure 8.27: Water-landscape maximisation

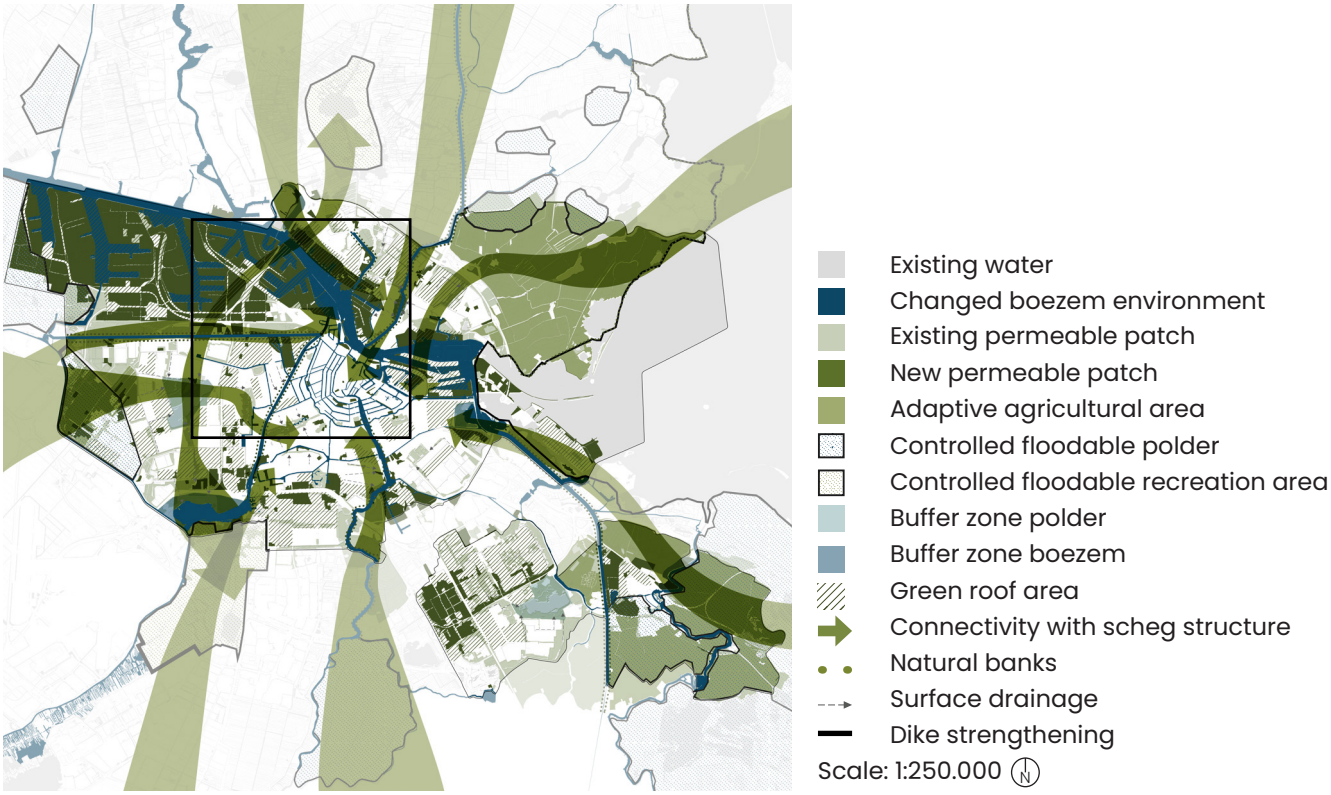


Figure 8.28: Landscape ecological strategy for north-western Amsterdam

- Improved primary corridor
- Primary ecological patch
- Secondary ecological patch
- Wet natural area
- Main water structure

Scale: 1:40.000

8.6 SOCIO - ECOLOGICAL CALENDER

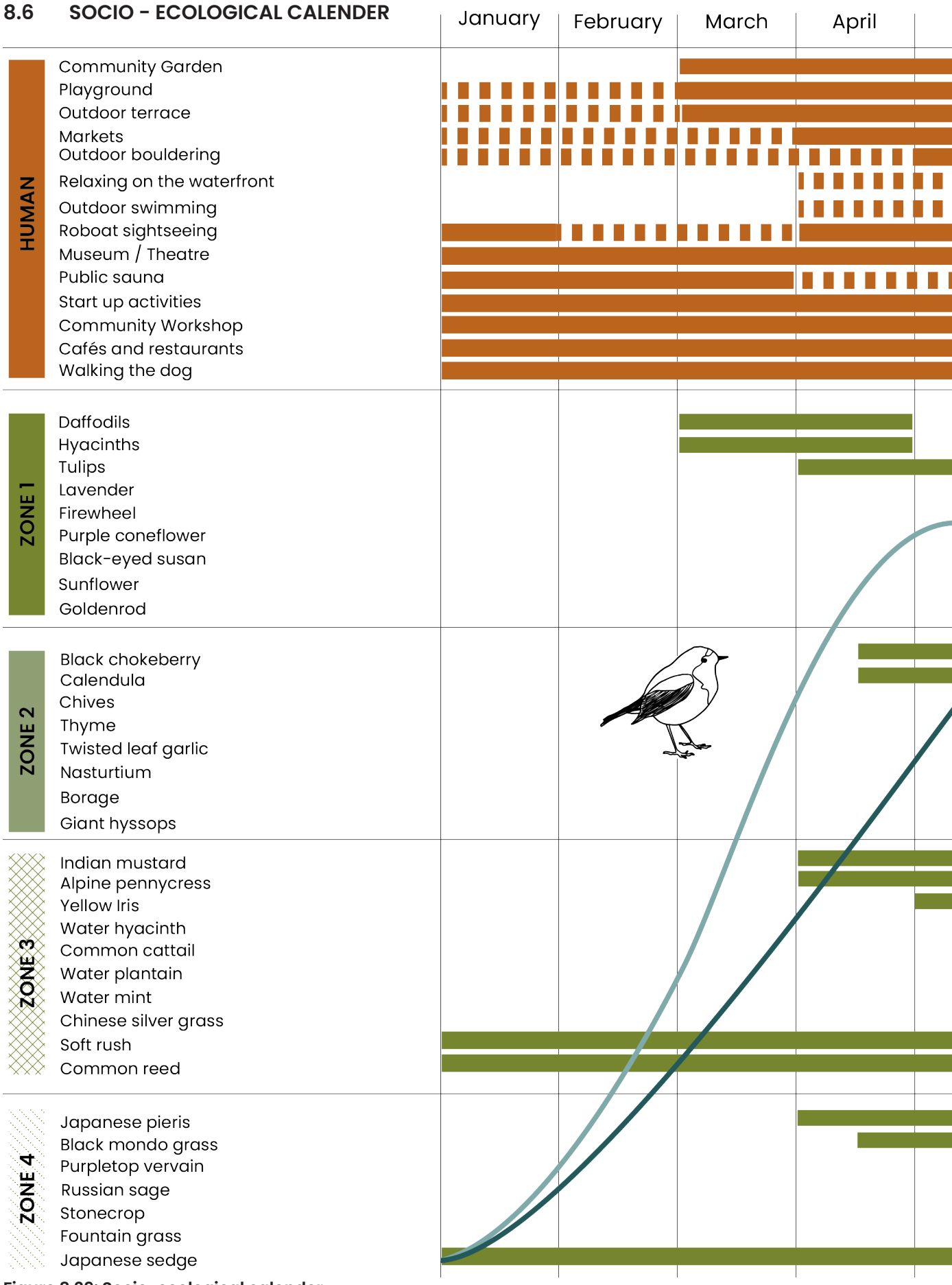
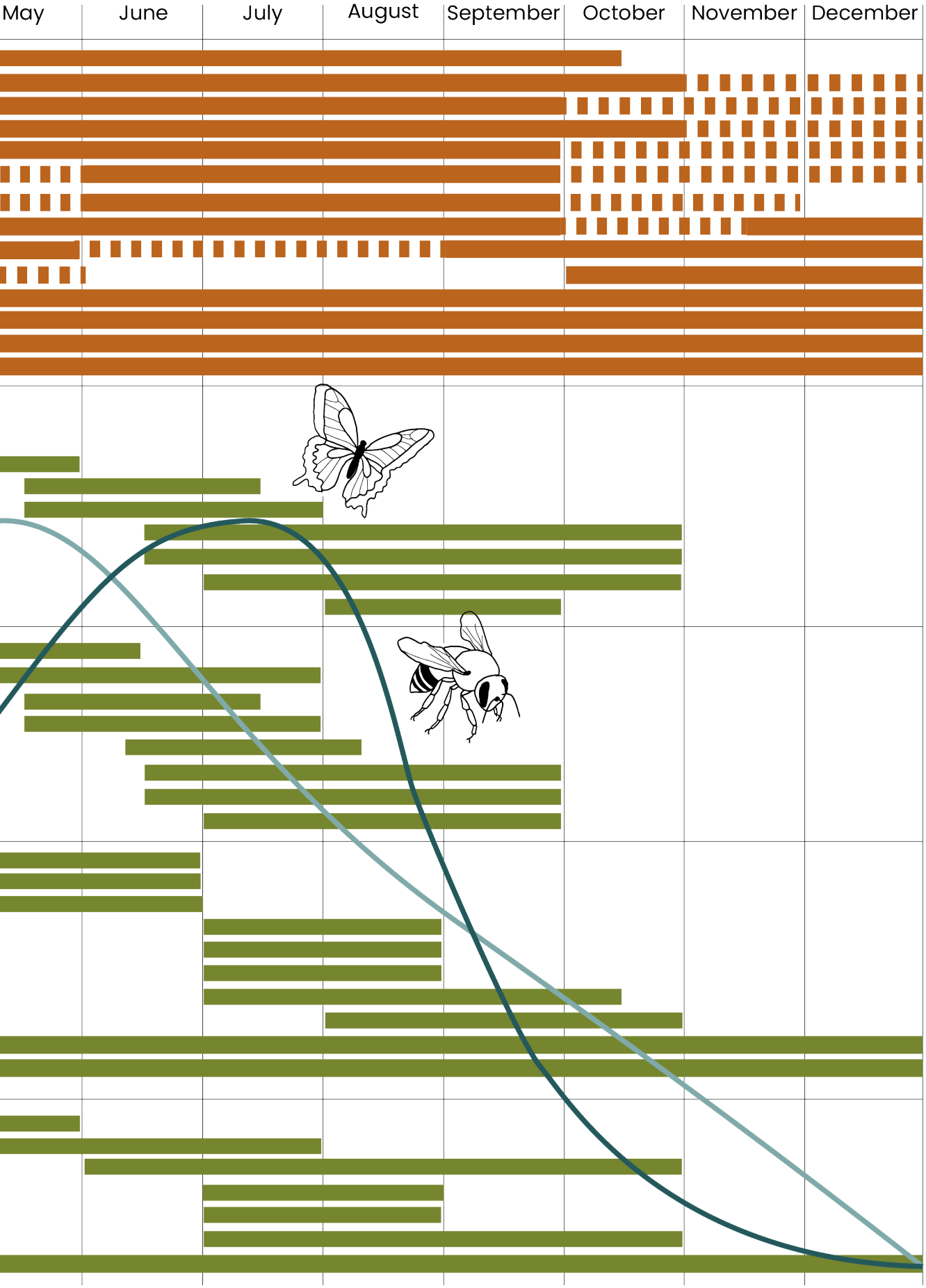


Figure 8.29: Socio-ecological calender

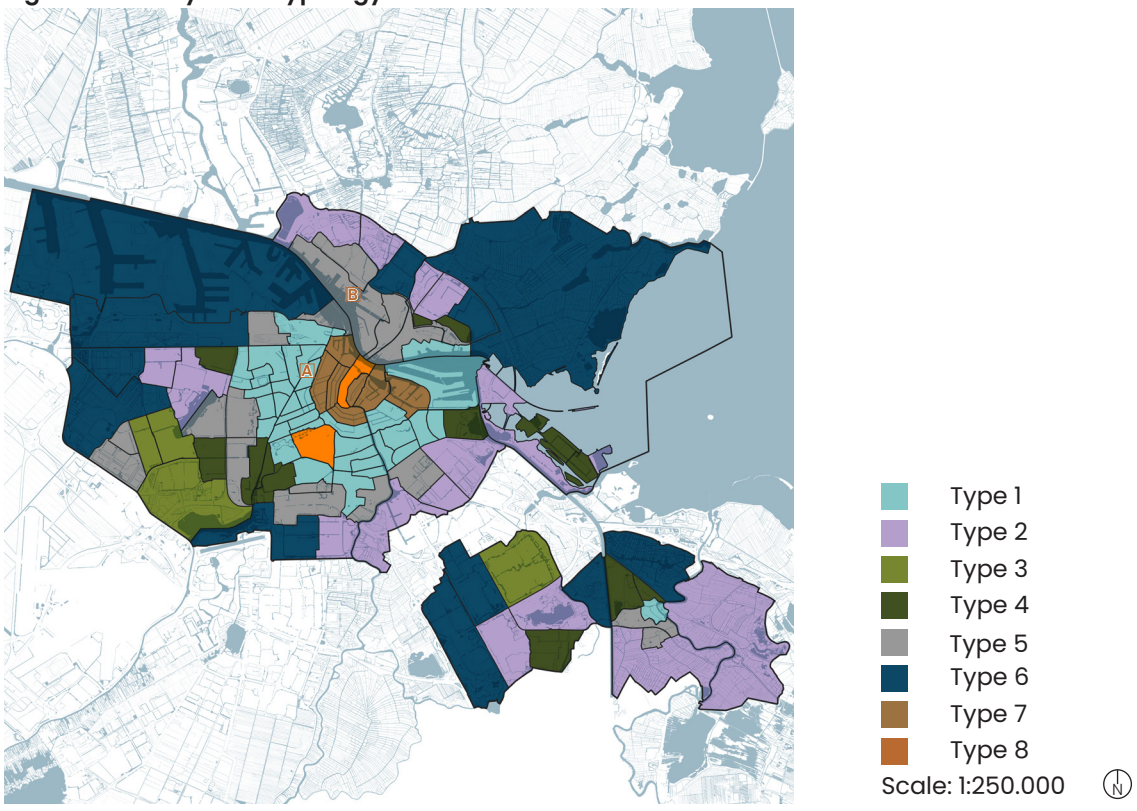

May
June
July
August
September
October
November
December

8.7 USE OF THE CITY SCALE TYPOLOGY IN THE DESIGN

The city scale typology that was constructed in this project was based on quantitative conditions. Therefore it can be considered a generalised representation of the real-life situation. The qualitative assessment proved that a type holds variations and exceptions and those should always be considered when designing on the neighbourhood scale. The assessment was based on the potential of a neighbourhood to increase the desired design qualities. The types form a sufficient start for a design project that wants to support sustainable heritage development, resilient water management and socio-ecological integration. In combination with the pattern language, this project provides the tools to translate the desired goals into an urban design.

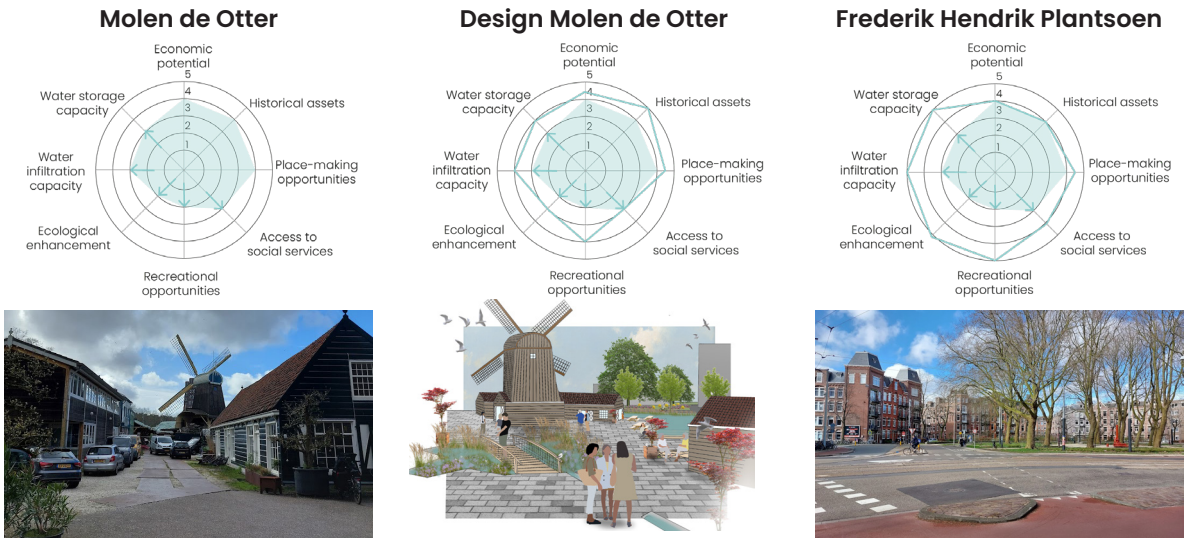
However, during the design process, it became clear that a design should always be context-specific. Even within neighbourhoods, there are variations in the assessment visible, because materialisation and density play an important role in the assessment. These variations often occur in the current conditions of a site, the potential for improvement of the design qualities stays the same, while the extent of the improvement is site and design-specific. The typology can be a starting point but never determines the design. A location-specific and qualitative assessment of the existing and potential design qualities should be done for every design.

Figure 8.30: City scale typology



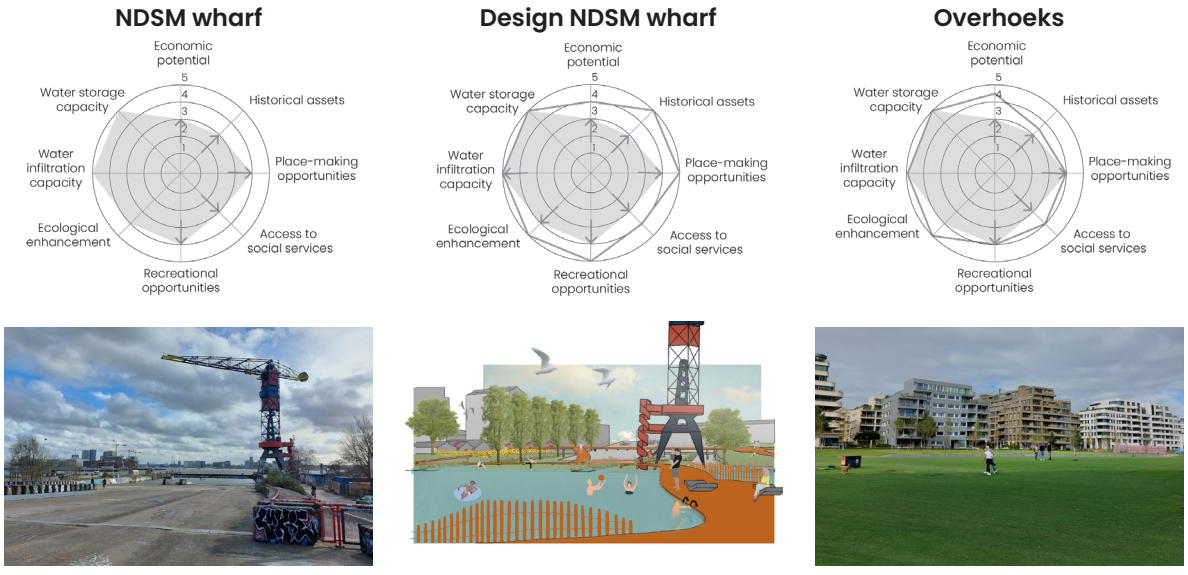
The Frederik Hendrikbuurt with Molen de Otter is an archetype type 1 neighbourhood. However, the neighbourhood has the windmill as an important historical asset and therefore it could be used as a place-making opportunity. Many neighbourhoods in type 1 are purely residential neighbourhoods. Their place-making potential may not be a historical site but a neighbourhood park or main square. Therefore a site like the Frederik Hendrik Plantsoen has a bigger extent of improvement for the landscape-related qualities but a smaller extent of improvement for the cultural qualities.

Figure 8.31: Type variations of the Frederik Hendrikbuurt



The Noordelijke IJ oever is a type 5 neighbourhood. Type 5 neighbourhoods are characterised by high transformation opportunities because of their low GSI and changeable land use. Because of their low GSI, they also have high water infiltration potential. This is strongly increased in the new urban design because, in the current situation, this was actually really low. The NDSM has the potential for advanced integration. In contrast, in a neighbourhood like Overhoeks, the extent of improvement for the place-making opportunities and historical assets is a lot smaller and therefore the integration is not as strong as in the NDSM.

Figure 8.32: Type variations in the Noordelije IJ-oevers-west



8.8 INTEGRATED STRATEGY ON THE METROPOLITAN SCALE

The integrated urban transformation initiatives undertaken in Amsterdam have implications beyond the city's borders, influencing the entire Amsterdam Metropolitan Area (AMA).

On the metropolitan scale, the priority is to develop a water management strategy that considers the interconnectivity of the polder water system. This connectivity reaches even beyond the metropolitan boundaries. This is needed to mitigate flood risk, deal with fluctuating water quantities and enhance water quality. In combination with the water management strategy, an ecological strategy has the goal to conserve biodiversity and increase the connectivity between animal habitats. This can be with the creation of more wet natural areas and stitching up fragmented ecological zones like forests and special provincial landscapes.

A collaborative strategy for heritage preservation and exploitation promotes the economic viability of tourism in the whole region. By creating synergies between Amsterdam's historic sites and other cultural attractions in the surrounding municipalities sustainable heritage development in the region will be assured. Lastly, to allow for the socio-ecological integration and the exploration of cultural sites throughout the whole region the regional public transportation should be improved and the main train station should be transformed to connect to the recreational corridors or cultural-historic destinations. In addition, sustainable modes of boat traffic, like the Roboat, allow for new ferry connections between Amsterdam, Almere and the cultural-historic places on the IJsselmeer.

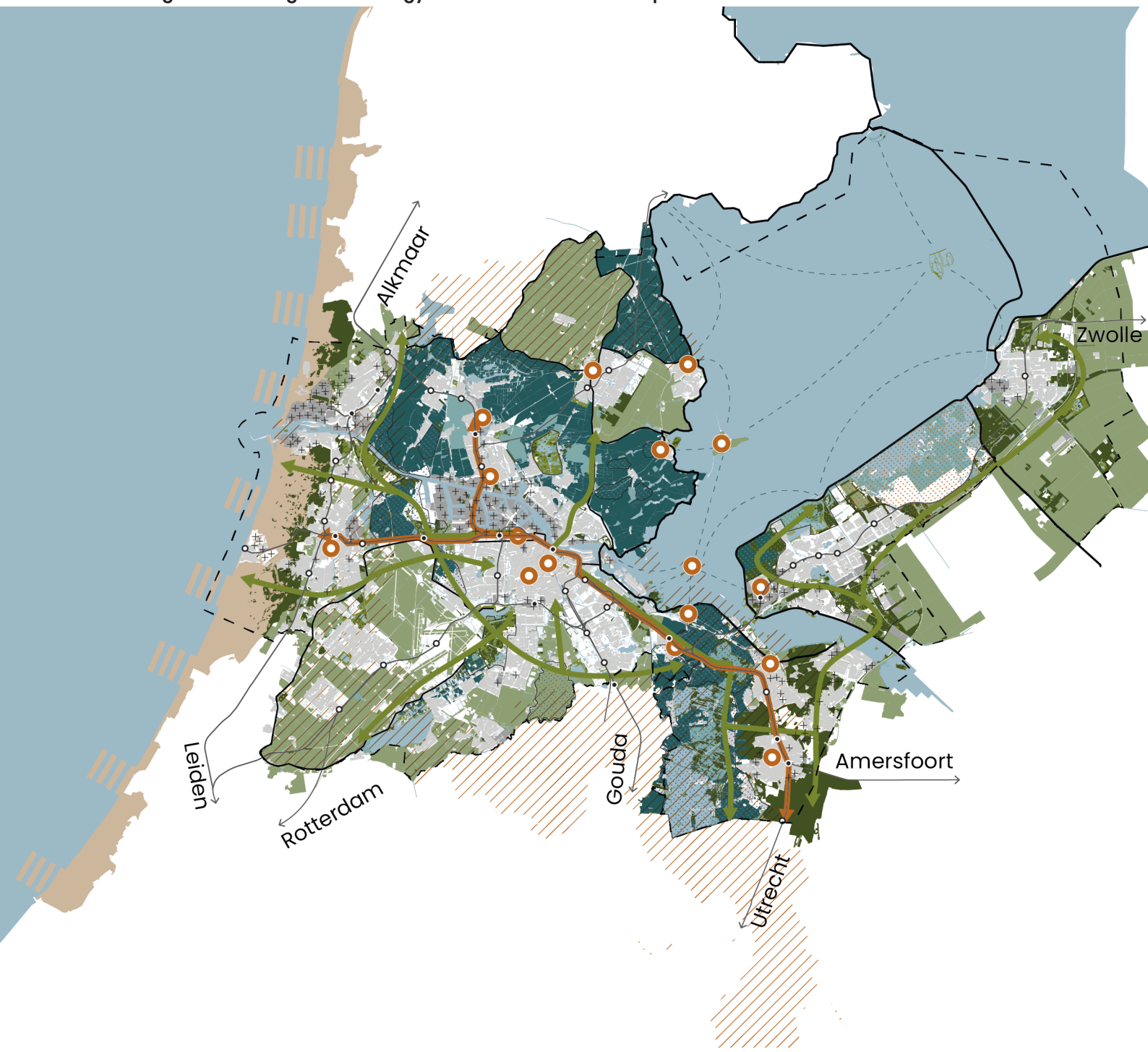
To effectively address these topics on a regional scale the decision-makers must prioritise the following actions. First of all, it is important to strengthen the AMA as a collaborative governance structure that facilitates coordination and cooperation among municipalities, stakeholders and even national governmental agencies. To effectively address regional challenges there should be a collective allocation of funding and resources to exploit opportunities that have collective benefits. This can be done through the provincial government.

The research for integrated urban transformation in Amsterdam can be an example for the region. To allow for the transferability of the project it is important to foster knowledge sharing and best practice exchange among municipalities and stakeholders to enhance expertise in resilience and sustainability. At the same time projects in other cities in the region can be beneficial to the case of Amsterdam allowing for complementary positive influences.

Lastly and maybe most important it is necessary to engage stakeholders in the regional planning process. Residents, local businesses and land-intensive economic sectors all operate throughout the region. On a small scale this can be done with the pattern language, but also on the regional scale inclusive and transparent decision-making should be ensured with participatory events.

By prioritising regional cooperation and collaboration, decision-makers in the Amsterdam Metropolitan Area can address common challenges, capitalise on shared opportunities, and create a more resilient and sustainable urban environment for all residents and stakeholders across the region.

Figure 8.33: Integrated Strategy for the Amsterdam Metropolitan Area



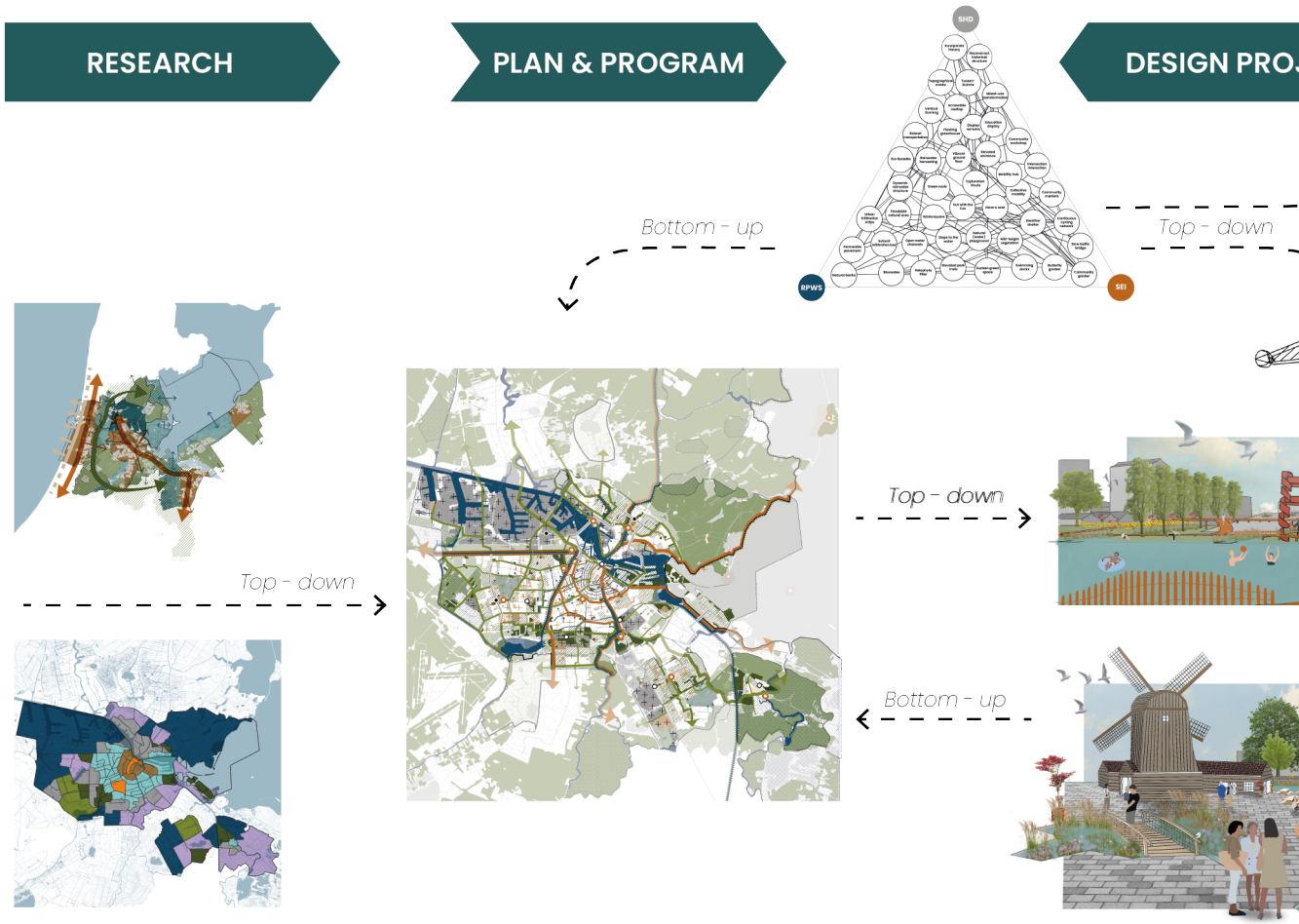
- Build area
- Resilient densification area
- Adaptive agricultural land (mostly dry)
- Adaptive agricultural land (partly wet)
- Wet natural area
- Recreational area
- Forest area
- Controlled floodable polder
- Controlled floodable recreational area
- Floodable nature reserve
- Nature based coastal reinforcement
- Dike reinforcement
- Improved Historical corridor
- Cultural-historic place-making
- UNESCO world heritage
- Improved Recreational corridor
- Roboat route
- Train
- Transformed mobility hub
- Improved mobility hub

Scale: 1:450.000

8.9 GOVERNANCE AND STRATEGIC PLANNING ASPECTS

The feasibility of the project largely depends on the commitment and coordination of the main executive stakeholder, the municipality of Amsterdam. This is based on the fact that the municipality has a cooperative and proactive attitude towards this project because it strengthens both its cultural identity and water management practices. Although this project proved to renew and add to the cultural value of Amsterdam, there is no guarantee that the municipality will be able to adapt the whole city plan. Therefore it is important to empower citisens, to allow for bottom-up, project-scale implementations that will add to the integrated urban transformation plan and also translate to the regional scale.

Figure 8.34: Strategic aspects of the integration on different scales



Local initiatives in combination with the pattern language can play a crucial role in empowering citisens. By providing a structured yet flexible framework for community-led projects, the pattern language enables residents to identify and implement design solutions that meet their specific needs and wishes. This fosters a sense of ownership and responsibility among citisens, encouraging active participation in urban transformation. Local initiatives, such as community gardens and heritage preservation groups, can leverage the pattern language to create context-specific plans. These initiatives not only enhance the immediate living environment but also contribute to broader city and regional goals.

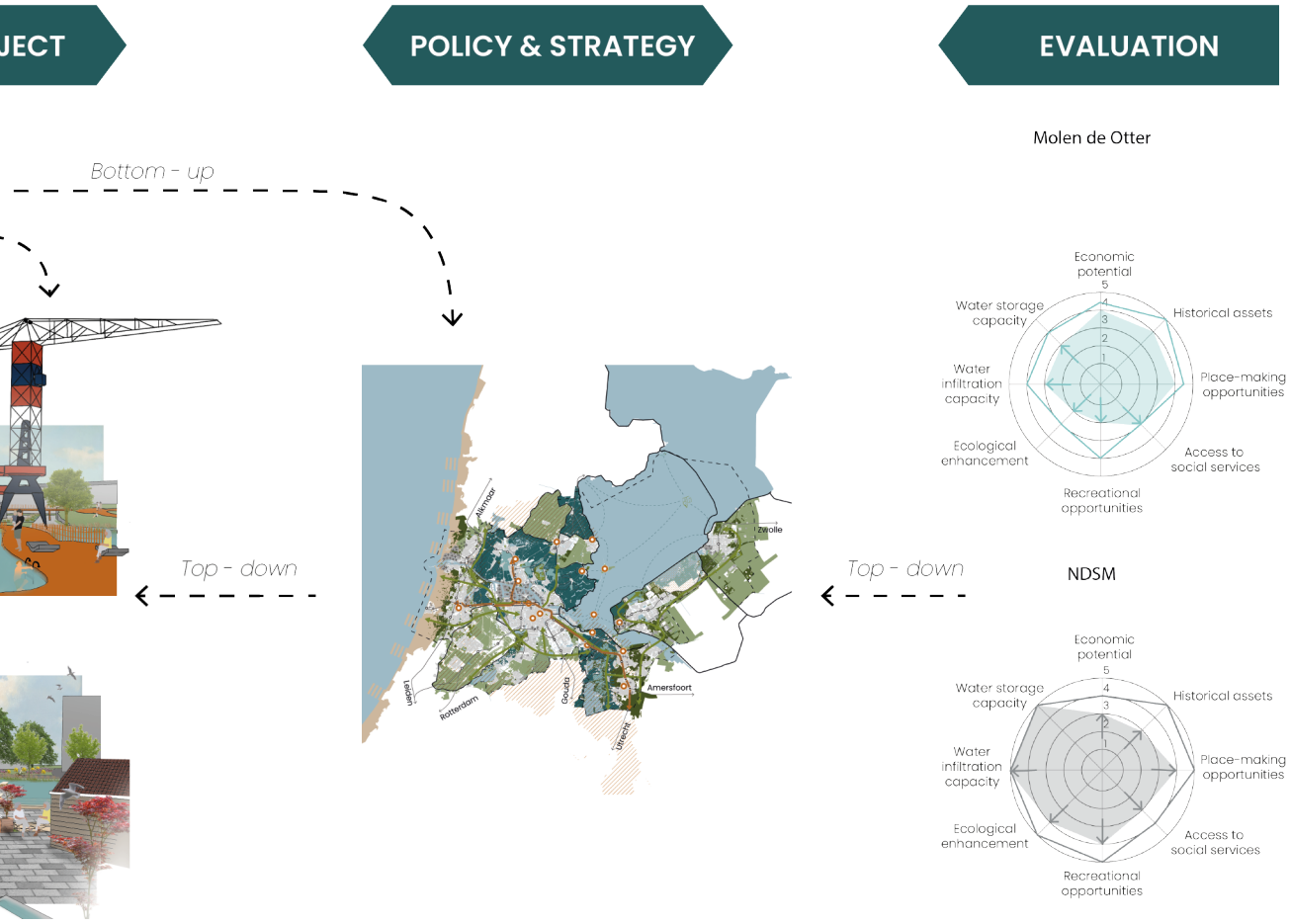
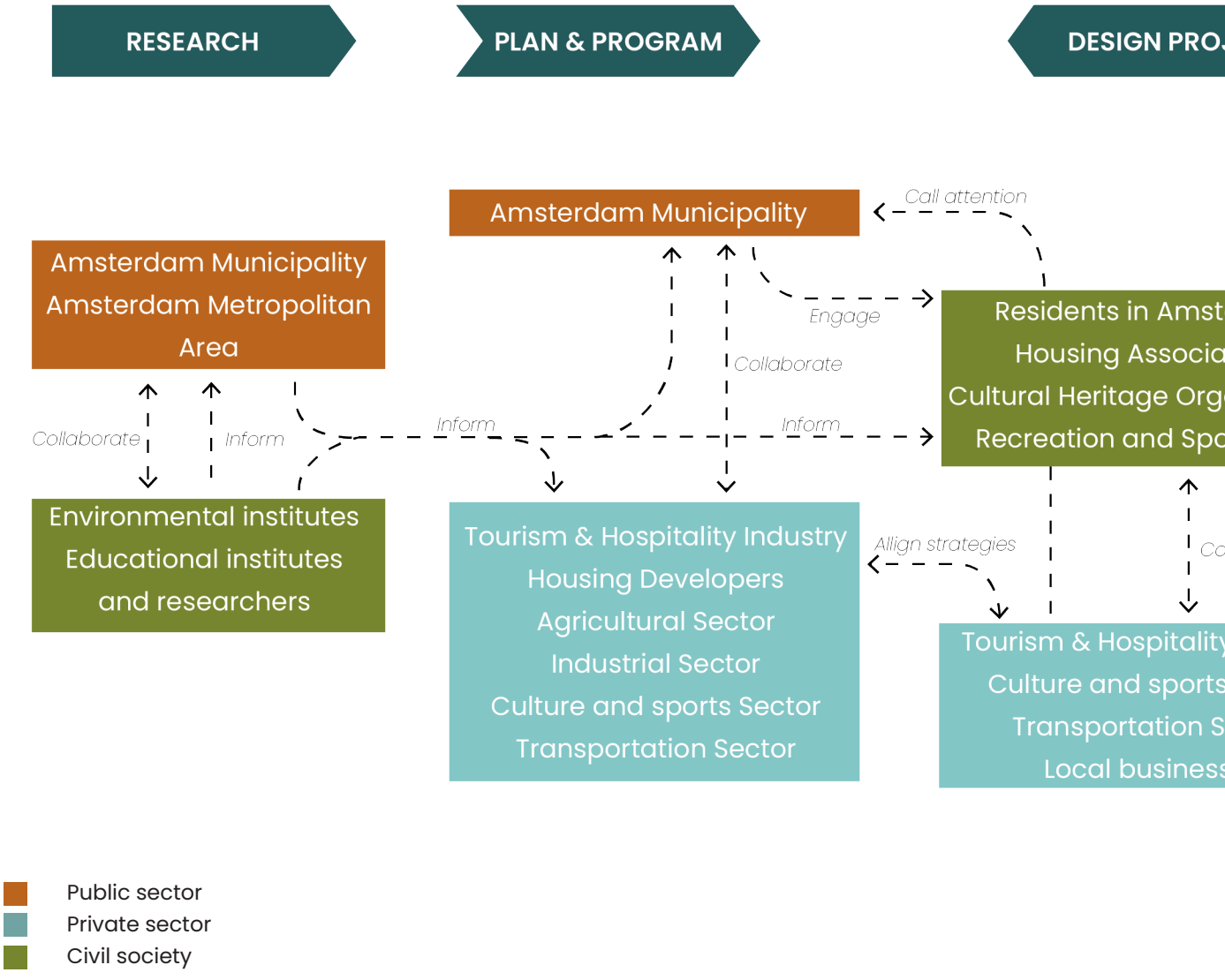
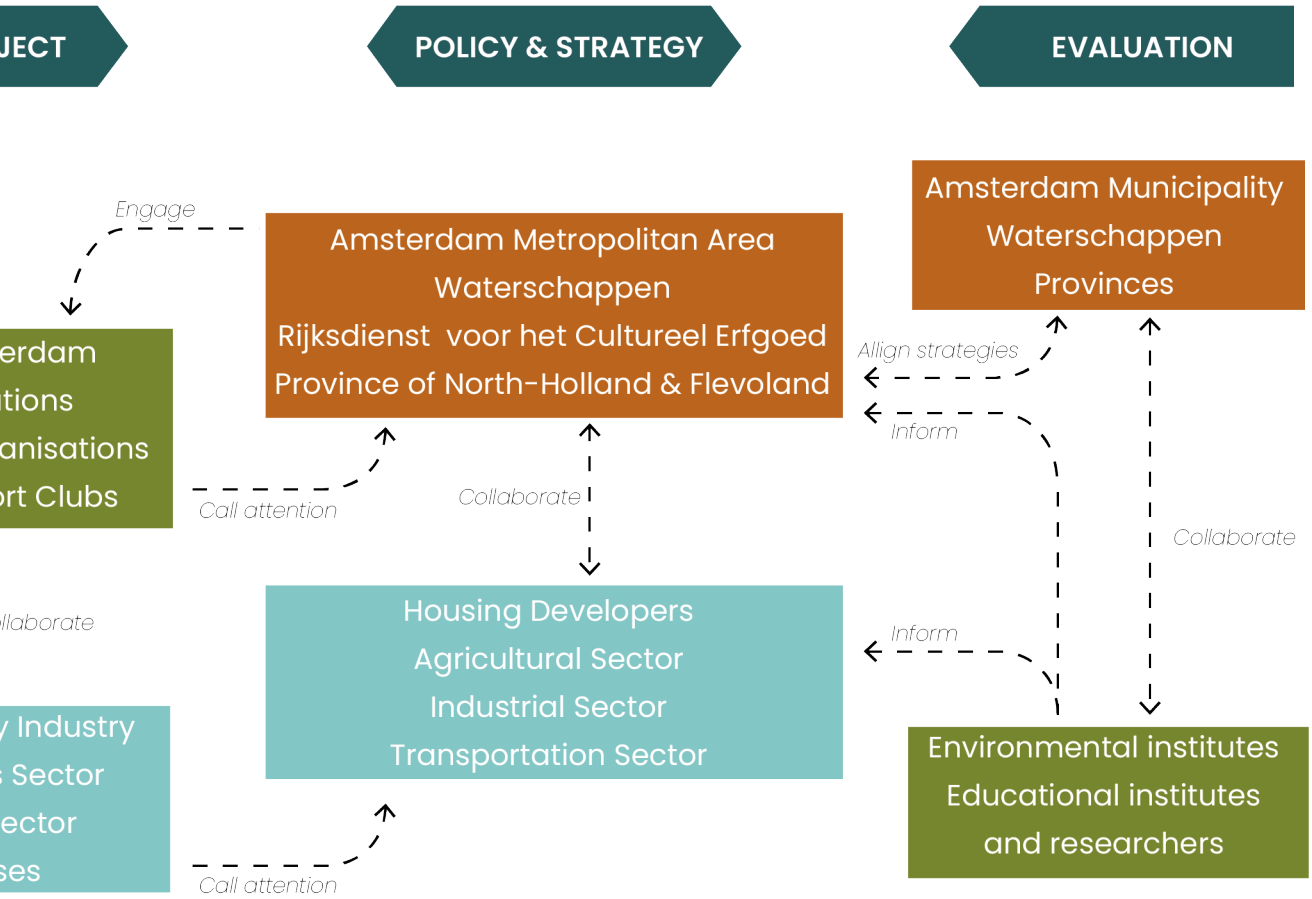


Figure 8.35 shows how the different stakeholders, on different scales, influence each other and how they could work together. For this project to succeed it is important to encourage public-private partnerships. These partnerships can combine innovative solutions and financial resources to drive the implementation from a bottom-up process. At the same this this project can not succeed without top-down regulations. Zoning plans might need to change to transform heritage sites into mixed-use areas or allow for the development of green infrastructure and floodable natural areas. Moreover, it is important to implement policies that provide financial incentives for developers and property owners to invest in sustainble developnet and adaptive water management solutions on both the local and regional scale.

Figure 8.35: Stategic aspects and stakeholder interrelation

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Waterschappen
Rijksdienst voor het Cultureel Erfgoed
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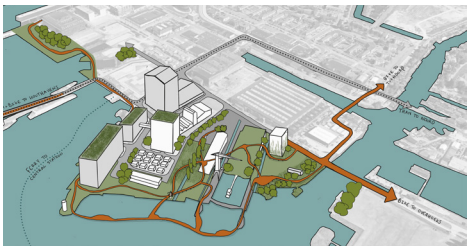
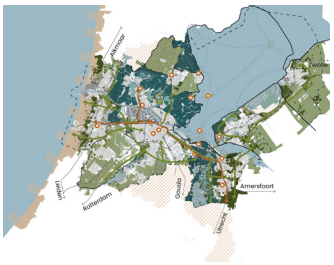
Collaborate
Housing Developers
Agricultural Sector
Industrial Sector
Transportation Sector
Call attention
Amsterdam Municipality
Waterschappen
Provinces
Allign strategies
Inform
Collaborate
Inform
Environmental institutes
Educational institutes
and researchers




Amersfoort

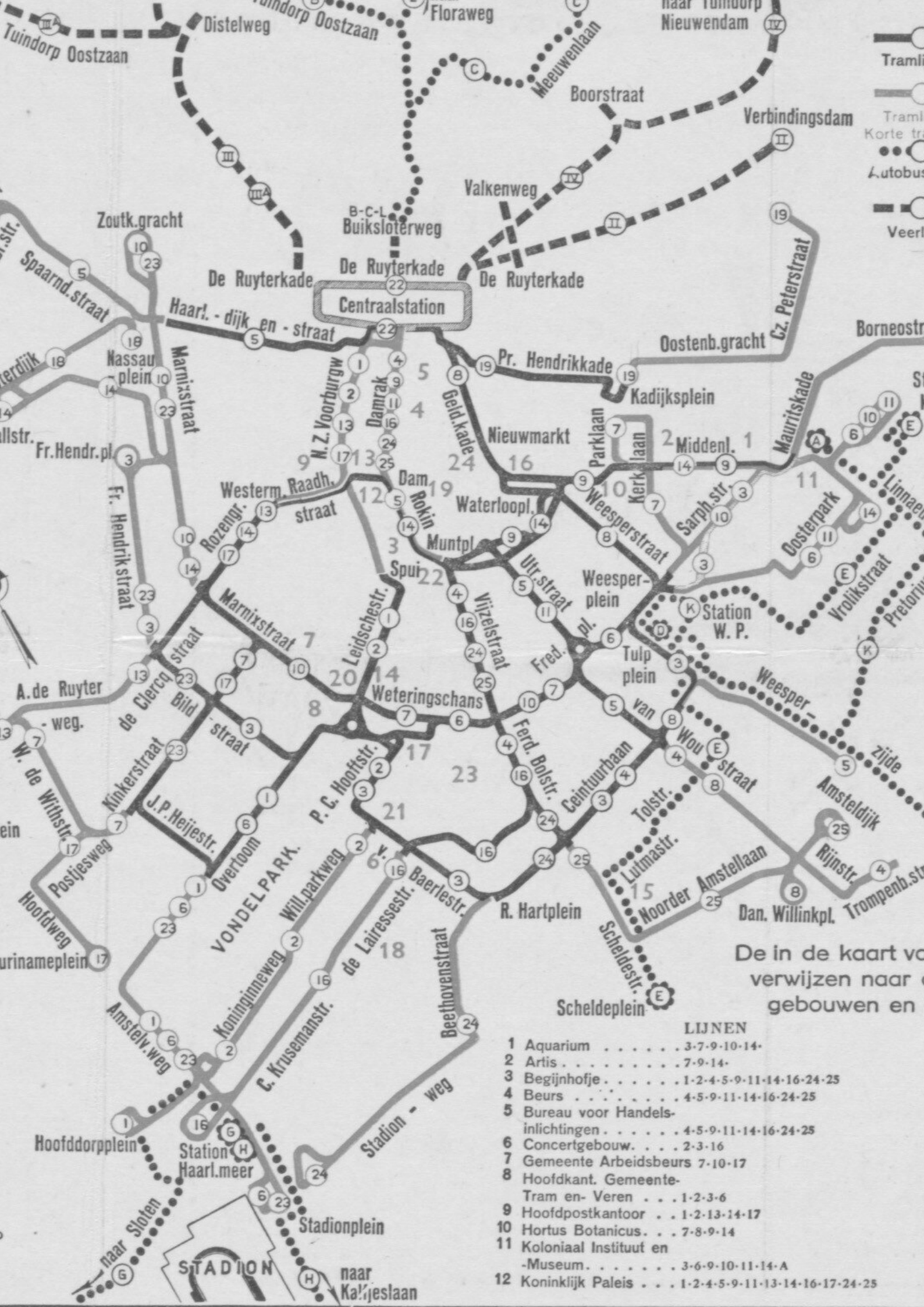
CONCLUSION CHAPTER 8

Chapter 8 showed the design proposal for Molen de Otter in the Frederik Hendrikbuurt and the NDSM wharf. Both designs show how the location is integrated into the neighbourhood and therefore the city scale plan. The design plan and additional diagrams show how the climate adaptation of the water-related heritage structures positively contributes to the living environment of the citisens, ultimately building resilience in the water identity of Amsterdam.

For Molen de Otter the main goals are to delay the stormwater as much as possible and to open the urban waterfront to the public for recreational and economic possibilities. The sawmill is used as a place-making opportunity for sustainable heritage development and socio-ecological integration.

On the NDSM the historical structures and industrial identity are preserved while an eye-catching walkway opens the urban waterfront for a variety of recreational activities and different vegetation zones, which provide ecological and aesthetic values while decontaminating the polluted soil in this industrial area.

To achieve the most resilient integration it is important to combine the city-scale design plan with a regional integrated strategy where collaborative governance can address common challenges and capitalise on shared opportunities.



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6 Concertgebouw. . . . 2-3-16
7 Gemeente Arbeidsbeurs 7-10-17
8 Hoofdkant. Gemeente-Tram en- Veren . . . 1-2-3-6
9 Hoofdpostkantoor . . 1-2-13-14-17
10 Hortus Botanicus. . . 7-8-9-14
11 Koloniaal Instituut en -Museum. 3-6-9-10-11-14-A
12 Koninklijk Paleis . . . 1-2-4-5-9-11-13-14-16-17-24-25

CHAPTER

9

CONCLUSION

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Chapter 9 summarises and concludes this report and thereby the graduation project. It shows how this project has given answers to the sub-questions and main research question: How can the needed resilience of the future polder water system be integrated with the sustainable development of water-related heritage, strengthening the water identity of Amsterdam? Lastly, the process and outcomes of the research and design are reflected in this chapter.

Figure 9.1: Gemeente tram

Source: Stadsdrukkerij (1940) via Stadsarchief Amsterdam
Black & White Adaptation

9.1 DISCUSSION

This project combines resilient polder water management and sustainable heritage development. It focuses on the integrated urban transformation of these two goals through socio-ecological integration in different urban environments. While these three concepts are all important to adapt the city for the future, they address different challenges and might conflict in certain situations or aspects. They highlight different aspects of urban life and therefore it is important to consider both quantitative and qualitative assessments on different scales, to avoid oversimplifying the complex urban system. By doing this it is hoped to provide solutions that integrate these aspects of urban life without neglecting other problems.

Theory and practice
Translating the theories of resilience and socio-ecological integration into physical implementations can be challenging due to their abstract and multifaceted nature. Resilience, in theory, emphasises the capacity of systems to adapt to disturbances. However, in practice, this requires complex solutions that can dynamically respond to changing conditions, which are difficult to predict and plan for. Similarly, socio-ecological integration seeks to harmonise the interactions between society and nature, promoting sustainability and coexistence. The intangible benefits of socio-ecological integration, such as enhanced social cohesion and ecological awareness, are often difficult to quantify and justify in traditional planning and development paradigms. Implementing these theories requires multidisciplinary approaches and extensive stakeholder collaboration. Therefore, while the theoretical underpinnings of resilience and socio-ecological integration provide a robust framework, their practical implementation is more complex and demands multi-disciplinary, context-specific strategies.

Time and scale
Working with scenarios in urban planning inherently means working with uncertainties. In this project the main uncertainty is the effects of climate change on the urban environment. In this project, the medium flood risk scenario was chosen for the water-landscape maximisation scenario. This is the 1 in 100 years scenario, in which it becomes clear what areas are most at risk. However, a small flood risk scenario, which would happen 1 in 1000 years, is not impossible considering the current climate change projections. This uncertainty poses a challenge for long-term planning and requires flexible, adaptive strategies that can evolve. Additionally, the absence of a quantified timeline in this project leaves room for ambiguity regarding the urgency and prioritisation of interventions. Not quantifying time was a well-considered choice because the neighbourhood scale scenarios allow for manageable and actionable plans and therefore have a short-term implementation. At the same time, they do not capture the full extent of future risks and opportunities and therefore larger-scale long-term strategies are needed for the integrated resilience this project is looking for. Considering extremes and more detailed long-term projections could provide a more comprehensive risk assessment but might also indicate scenarios where certain areas of Amsterdam become uninhabitable and the implemented design proposal is no longer relevant.

Typology transferability

The typology developed in this project, which identifies transformation opportunities in different urban environments, has potential applicability beyond Amsterdam. The typology clearly distinguishes differences in urban morphology between the types, some of them can be matched to specific periods of urban development. It could be argued that other polder cities in the Netherlands, like Rotterdam or Gouda, show the same correlation between urban morphology and integrated transformation potential. However, based on this research it is not possible to directly transfer the typology to another location. Nevertheless, the method can be easily transferred and the same type of spatial analysis can lead to the same quantitative construction of a typology. By doing this in different locations it would be possible to establish a holistic typology that shows transformation opportunities for the integration of resilient polder water management, sustainable heritage development and socio-ecological integration.

At the same time, each city has its unique set of challenges and opportunities, influenced by its specific urban fabric, heritage structures, and water management needs. Qualitative assessments or additional stakeholder participation in the local context would be needed to transfer the typology to other contexts and use the typology in urban design. Further research has to indicate if there is indeed a holistic typology possible to strengthen the water identity of polder cities or if the differences between the polder cities in the Netherlands are too big.

Limitations

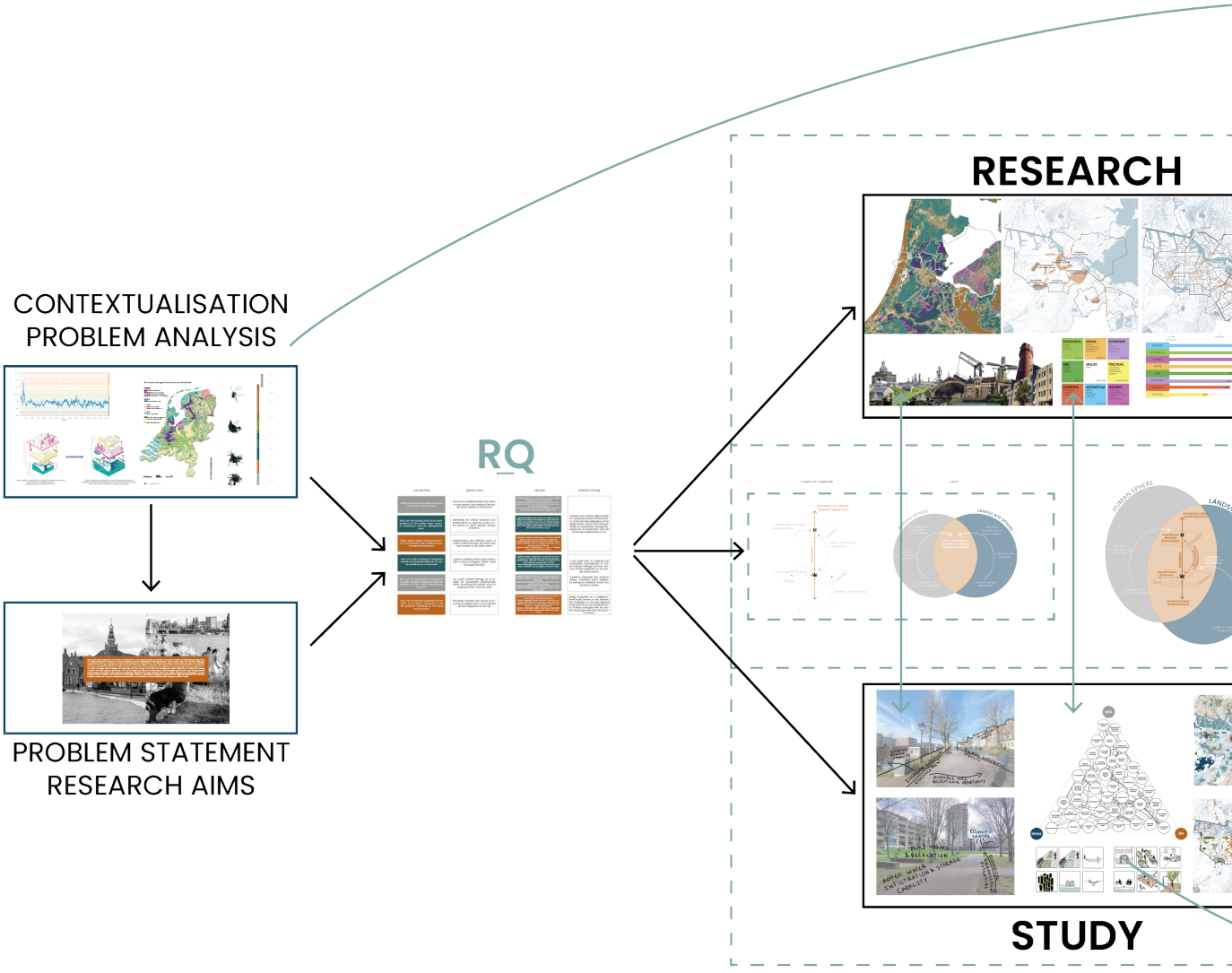
While the project provides a robust framework for integrating resilient polder water management with sustainable heritage development, there are some limitations. One significant limitation is the lack of co-creation and stakeholder participation in the design process. Engaging stakeholders early and throughout the project can provide valuable insights. Stakeholders, including residents, local businesses, environmental groups, and government agencies, bring diverse perspectives that can inform more inclusive designs. The pattern language can enrich stakeholder participation in further research and implementation. By involving stakeholders in the development and refinement of design solutions, the project can better address local needs and wishes. Furthermore, co-creation can help identify potential barriers to implementation and develop strategies to overcome them, ensuring more effective and sustainable outcomes. Incorporating stakeholder participation and co-creation into future research and projects can significantly enhance the value, feasibility, and resilience of urban transformation initiatives, ultimately leading to more sustainable and livable urban environments.

Another limitation is the fragmented landscape for urban development, water management, and heritage preservation. Different aspects of this project fall under the jurisdiction of various governmental agencies and departments, each with its regulations and priorities. For example, water management is governed by the Waterschappen, while heritage conservation is either a national or municipal concern. The lack of a unified regulatory approach can hinder the integration of resilient water management and sustainable heritage development. Because of this, securing funding and resources for integrated urban projects can be challenging due to competing priorities and budget constraints. Policy frameworks often allocate funds to specific sectors or projects based on historical priorities rather than innovative integrated approaches.

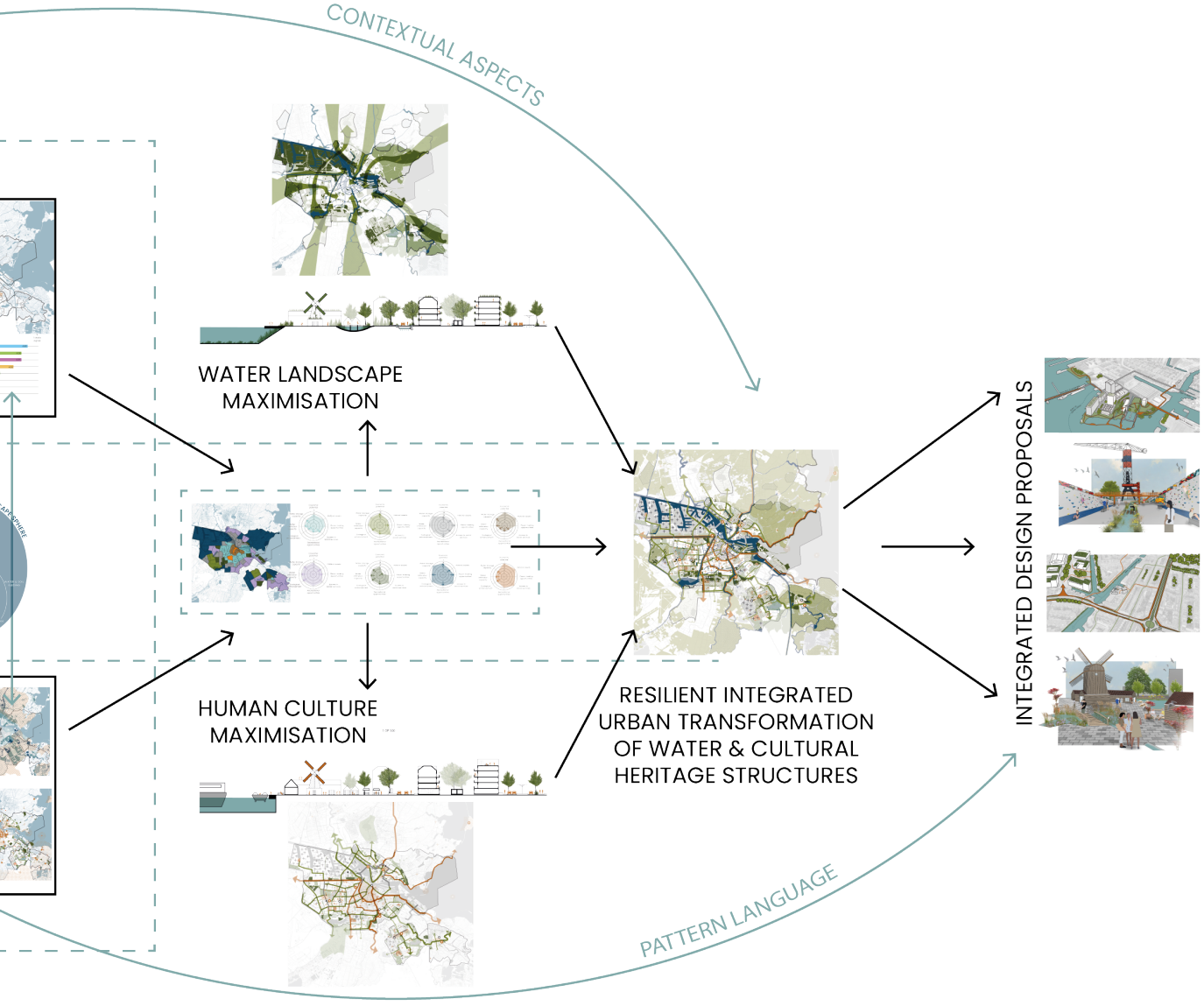
9.2 CONCLUSION

This research has explored the strategic and practical integration between resilient polder water management, sustainable heritage development and socio-ecological integration for the city of Amsterdam. Climate change presents multiple water-related challenges pressuring the polder city. Among these climate change challenges the heritage and cultural identity of Amsterdam, deeply rooted in its water system, are at risk. Cultural heritage has evolved to encompass not just tangible artefacts but also intangible and social values, emphasising the dynamic relationship between the past, present, and future. Therefore the main research question of this thesis was: **How can the needed resilience of the polder water system be integrated with the sustainable development of water-related heritage, strengthening the water identity of Amsterdam?**

Figure 9.2: Final outcomes in methodology framework



A few key theories were chosen to focus on in the theoretical and conceptual framework and they have formed the red threat of this research and design project. Their relationship is shown based on the three-layer approach in spatial planning which separates the landscape, network and occupation layer. The focus of this project is on the relation between the landscape and occupation layers. Water-related heritage serves as a crucial link between these layers. The theory of socio-ecological integration helps to understand how nature and people work together in cities. The theory behind sustainable heritage development explores how cultural assets in the occupation layer can lead to sustainable changes in cities. Resilience is a key goal of this project, focusing on how systems can adapt and transform.

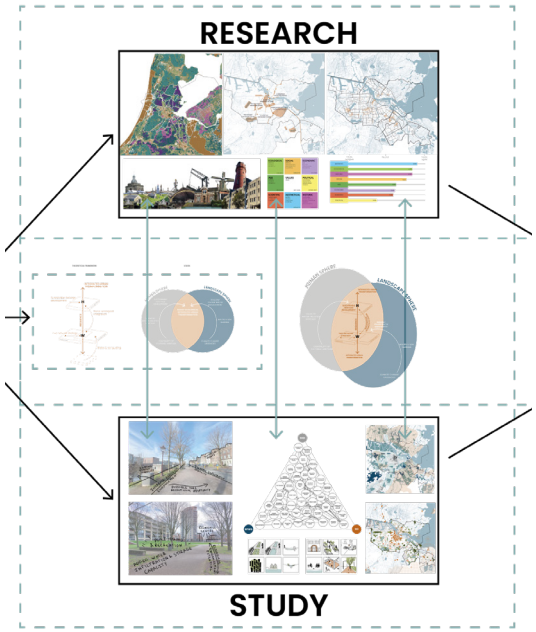


SQ1: What are the cultural values of the water identity of Amsterdam?
The cultural values of the water identity of Amsterdam were determined with a survey based on the cultural heritage value taxonomy. In this survey residents of Amsterdam were asked to rate to what extent they thought water in their living environment possessed a cultural heritage value. It became clear that water in the contemporary city holds important aesthetic, ecological and historical values. Moreover, water had high social values for the citisens. Respondents often mention that water provides openness and nature in the city, they confirm they value the historical narrative and they add that water has high recreational value. Insight into residents' activities related to the urban waterfront highlighted the opportunity to improve access to the urban waterfront improving its cultural heritage values.

SQ2: What are the existing and future water problems in the polder water system in Amsterdam and the metropolitan area?
The spatial analysis and literature review showed that there are five main problems in the future polder water system: Weak soil, increasingly wet circumstances, increasing periods of drought, salinisation and flood risk. These 5 problems are narrowed down to the fact that water needs to be held and stored for as long as possible to allow for sufficient water quantity and quality. On the city scale, there is a need for more water infiltration and water storage. Moreover, water needs to circulate in the polder water system before it is drained via the boezem system to the open water. On the metropolitan scale, there is a need for more wet natural areas and flood buffer capacity. Due to flood risk, the main areas suitable for large-scale urban development are the current urban environments. These areas are therefore subject to densification.

SQ3: Which water-related heritage structures in Amsterdam are suitable for sustainable heritage development?
Insight into the different types of water-related heritage and their location in the urban fabric has shown which heritage structures can be used for sustainable heritage development. On the metropolitan scale, this showed which historical landscapes should be connected to increase the historical and ecological value and which areas have the most built heritage which has economic potential. On a city scale, it was concluded which areas are most interesting as cultural-historic catalysts for urban development, which areas have high transformation potential and which areas can add to the city's cultural value because they already have high social or ecological values for the citisens. In addition, the urban morphology analysis determined which neighbourhoods are most interesting as local economic centres and thus have a higher place-making potential to cluster socio-cultural activities.

Figure 9.3: Section 1 of the methodology framework



Together these analyses resulted in a city-scale typology that showed the spatial opportunities for integrated urban transformation of the climate adaptation of the polder water system and the possibility for sustainable heritage development through socio-ecological integration in Amsterdam. Based on the literature review and analysis eight design qualities were formulated and the different neighbourhood types were qualitatively assessed to show to what extent the types possess the design qualities and where there is space for potential improvement. Based on these analyses a design potential was formulated for every type. Every type has another role in the integrated urban transformation plan. These design potentials were the start of the design project.

Zooming out, a regional cooperation strategy can amplify the city-scale integrated transformation plan. On a regional scale cooperation is needed for large-scale water storage, ecological enhancement, adaptive agriculture, densification and accessibility.

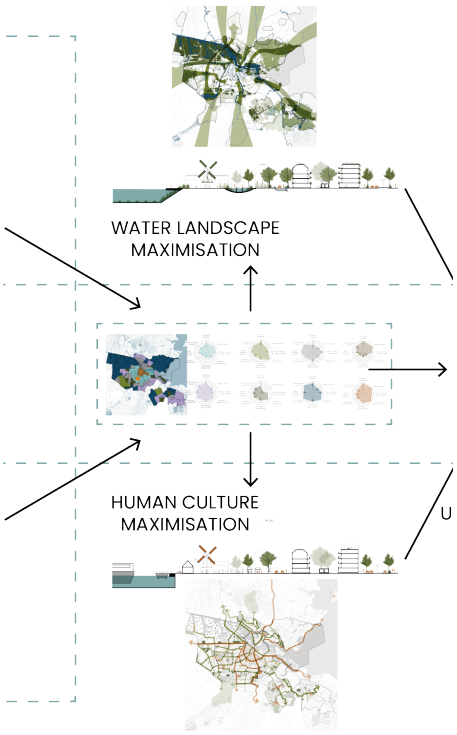
SQ4: How can socio-ecological integration enable increased capacity for water resilience on a city scale?

An increased water resilience on a city scale is achieved by increasing the water infiltration capacity, water storage capacity, ecological enhancement and recreational opportunities. By increasing the accessibility to the urban waterfront and giving recreational areas a function for water management and recreation it is tried to improve the socio-ecological integration, strengthening the cultural heritage value of the water and thus water identity of Amsterdam. The pattern language is used to explore design solutions that improve the desired design qualities: water storage capacity, water infiltration capacity, ecological enhancement and recreational opportunities. This results in design solutions like permeable patches, green roofs, community gardens, bioswales, floodable recreation areas and natural riverbanks.

SQ5: How can the sustainable development of water-related heritage increase the resilience of the cultural structure on a city scale?

The sustainable development of water-related heritage can increase cultural resilience by using these cultural-historic sites as place-making and economic opportunities. Therefore it is important to increase the accessibility of these sites, other social services and recreation activities. The pattern language is used to explore design solutions that improve the desired design qualities: Economic potential, historical assets, place-making opportunities, access to social services and recreation opportunities. This results in design solutions like mobility hubs, improved cycling networks, community markets, education and transformation of heritage assets and roboat transportation.

Figure 9.4: Section 2 of the methodology framework



For both resilience studies a maximisation experiment was used and based on these two experiments conflicts and synergies were put forward and variations in the urban design are shown based on the design solutions developed in the pattern language. In the decision-making process, it is important to use stakeholder participation in both a top-down and bottom-up process to allow for inclusive decision-making with the pattern language. The integration urban transformation plan on a city scale shows how the city of Amsterdam should be transformed into integrated resilient polder water management and sustainable heritage development.

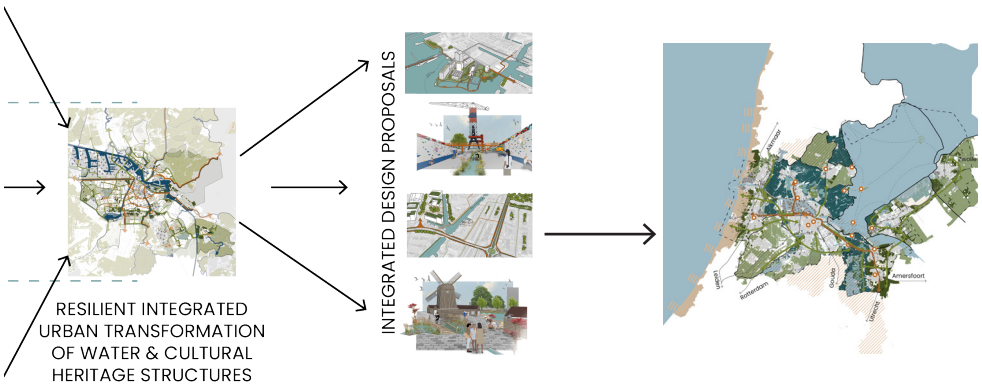
SQ6: How can the climate adaptation of water and heritage structures in the city positively contribute to the living environment?

To show how the desired integration can be achieved in an urban two locations were chosen to focus on. First the 1920s neighbourhood Frederik Hendrikbuurt, along a historical waterway, the Kostverlorenvaart. Molen de Otter is the last remaining windmill along this canal and is transformed into a socio-ecologic waterscape for residents and visitors of the neighbourhood. For Molen de Otter the main goals are to delay the stormwater as much as possible and to open the urban waterfront to the public for recreational and economic possibilities. The sawmill is used as a place-making opportunity for sustainable heritage development and socio-ecological integration.

Secondly, the NDSM wharf is an old industrial site on the northern side of the IJ. It has high transformation and development potential but is strongly disconnected from the urban network. First of all the accessibility to and from the neighbourhood needs to be improved. On the NDSM the historical structures and industrial identity are preserved while an eye-catching walkway opens the urban waterfront for a variety of recreational activities and different vegetation zones, which provide ecological and aesthetic values while decontaminating the polluted soil in this industrial area.

Both designs show how the location-specific design is integrated into the neighbourhood and adds to the city-scale integration urban transformation plan. The design plan and additional diagrams show how the climate adaptation of the water-related heritage structures positively contributes to the living environment of the citisens, ultimately building resilience in the water identity of Amsterdam. To achieve the most resilient integration it is important to combine the city-scale design plan with a regional integrated strategy where collaborative governance can address common challenges and capitalise on shared opportunities.

Figure 9.5: Section 3 of the methodology framework

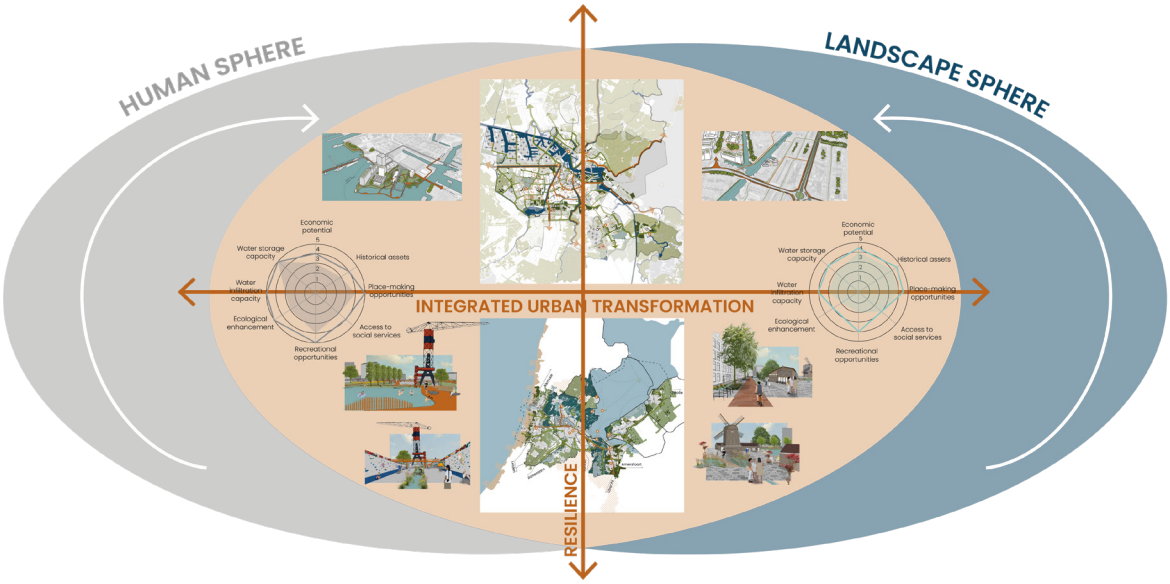


This leads to the main research question: How can the needed resilience of the polder water system be integrated with the sustainable development of water-related heritage, strengthening the water identity of Amsterdam?

To achieve the desired integration it is important to preserve water-related heritage structures that contribute to the cultural identity of Amsterdam. Moreover, it is important to make context-specific strategies to sustainably develop these heritage sites in combination with other socio-economic functions. They can be used for place-making initiatives, recreation activities and economic opportunities to enhance cultural resilience. On the other hand, there is a high urgency to address future water-related challenges. By incorporating socio-ecological integration into urban design. Not only the water management strategies will be improved, but also the cultural heritage values for the citisens in Amsterdam. To achieve the desired integration this project formulated three design goals with eight design qualities and 45 corresponding design solutions. By using the pattern language in the decision-making process design solutions that support one or multiple design goals can be combined and adapted for location-specific circumstances, assuring the applicability of this project in different locations in Amsterdam and other Dutch cities.

By integrating resilience-building measures with sustainable heritage development, Amsterdam can not only address current and future water challenges but also strengthen its historic cultural identity. This will ultimately bridge past and future and create resilient urban environments that positively contribute to the quality of life of Amsterdam's citisens.

Figure 9.6: The final outcomes in relation to the conceptual framework

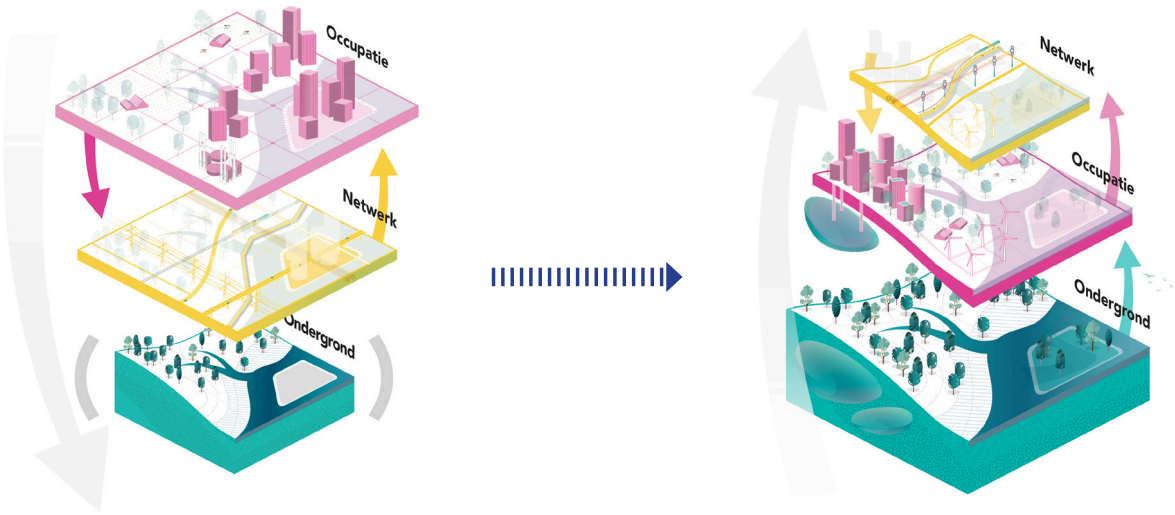


9.3 REFLECTION

The graduation topic in relation to the studio Design of the Urban Fabric, the master track Urbanism and the master programme Architecture, Urbanism and Building sciences

My graduation topic relates strongly to the theme of the Design of the Urban Fabric studio, which is embracing plurality, and growing porosity. The main foundation of my project was the new perspective on the Dutch layer approach in spatial planning (Figure 9.7). This approach centres around the importance of the landscape layer and its coexistence with the occupation and network layers. Ultimately this framework argues for an integrated approach of the layers, in the context of this project focusing on water & heritage structures. This is being done by looking at both the tangible and intangible values of these structures.

Figure 9.7: A new perspective on the layer approach



Source: H+N+S Landschapsarchitecten et al. (2021)

At the same time, there is a high urgency to rethink the way space is used in urban environments. Because of the scarcity of available space in the Netherlands and the need for climate adaptation in our cities, the plurality of space becomes more important. The project aimed to integrate the tangible structures in the city with the intangible cultural values that tell a historical narrative of living with water in a polder city. This relates to the Master Track Urbanism through the multi-scalar approach where both research and design are combined to understand cultural values and design physical changes on the regional, city and neighbourhood scale. The essence revolves around making Amsterdam's polder water system more resilient while strengthening its cultural value. Both the Master Track Urbanism and the Master Programme Architecture, Urbanism and Building Sciences emphasise sustainable urban development and resilience planning. My approach to using water-related heritage as a catalyst for sustainable development aligns with these programs' focus on contemporary and environmentally conscious practices.

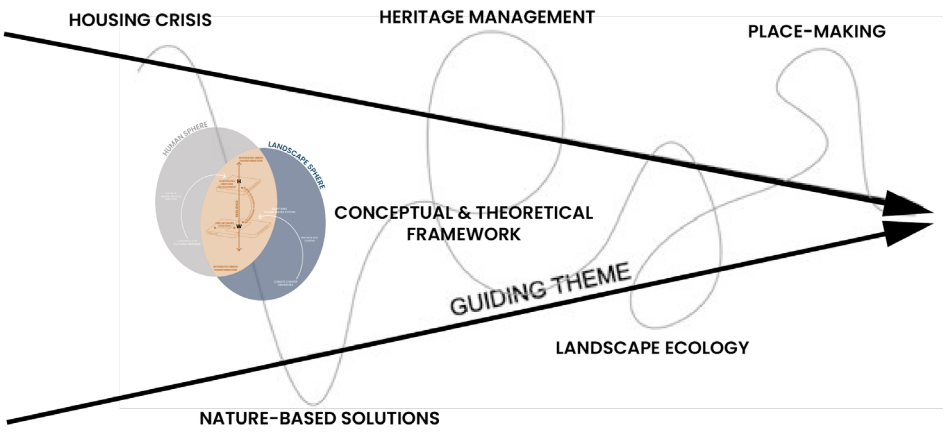
Creating and holding on to a process structure

From the start of the graduation process, I had the ambition to do an integrated multi-scalar project. However, the topic and methodology were still to be determined. The essential intensive of the Design of the Urban Fabric studio played a major role in shaping my graduation project. It allowed me to investigate the climate change urgencies in the Netherlands. Which gained academic substantiation for my focus on water problems. Next to that, it has shed light on the role of water in historical urban development in the Netherlands. This historical analysis has prominently shaped my graduation topic, with the decision to focus on water-related heritage as a driver for sustainable development. It framed water being both an asset and a threat to cultural identity.

From this point onwards the focus was on the interrelations of water and heritage, or in other words, landscape and human systems. This starting point is still visible in my conceptual framework. The first quarter of the graduation process was both exciting and challenging. Challenging because my ambition was high and so I was determined to construct a project that would keep me focused and challenge me for the whole year. On the other hand, I was excited because I could integrate my passions and personal goals into the process.

The complexity of the project asked for a very clear understanding of the research structure. I had a few clear starting points for my research, based on literature and theories I had found. At the same time, I struggled to not get lost in the research and theoretical framework. I often felt like I could not fully grasp the complexity of the topics, because there were so many theories to consider. Talking to other students and looking at graduation thesis examples made me realise that it is important to stick to my focus and use that as a guiding theme for my whole project, while contextual factors would not be excluded. Drafting my theoretical and conceptual framework helped me to make decisions about which theories would be my red threat. However there are also contextual theories that implicitly shaped the final outcomes. I have used the guiding theme framework by Van Dooren et al. (2013) to show the guiding theories and contextual theories (Figure 9.8).

Figure 9.8: The role of a guiding theme and additional theories



Source: Adaptation of van Dooren et al. (2013, p.9)

For example, I implicitly broadened my knowledge about heritage management and nature-based solutions. In the design process, I got interested in the theories behind place-making but decided not to keep on adding to the theoretical framework, while these theories are part of the project.

Although the theoretical and conceptual framework proved to be of important guidance, the learning process was a process of learning by doing and figuring out the reasoning and complementary products along the way. I am very thankful that Claudiu has given me the confidence to start on this project and assured me multiple times that I would figure everything out while I was doing my literature review and spatial analysis. Over the year I developed a healthy balance between structuring the tasks and letting go of to-do lists and trusting the process. However I have also observed that my motivation drops when there is a lack of clarity. Therefore, implementing strict deadlines has been an effective way of enhancing productivity.

Methodology and way of working

During the research phase, it was tried to keep a balance between using methods and analyses I was already familiar with and trying to expand my skill set. I was able to get better at software like QGIS and Procreate and got to know new software like Geoda. While I took a strong analytical approach to my research, Gerdy guided me with the important message of not forgetting the stories, feelings and emotions I am working with. Because cultural heritage is often strongly connected to certain emotions and the feeling of identity, which is not as easy to quantitatively analyse. Consequently, I tried to find a balance between quantitative analysis and qualitative methods like fieldwork and the survey I conducted. An important way to stimulate me to find new stories while not deviating from my project was to regularly check the 'monument of the week' (erfgoed van de week) stories on the website of the municipality of Amsterdam.

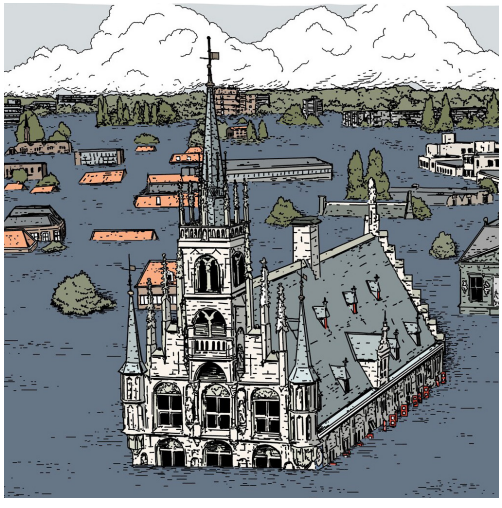
I am extraordinarily grateful that this multi-scalar integrated project has allowed me to divide this year into many different tasks, methods and ways of working. Although the complexity was the most challenging part of the project, the variety of methods kept me excited until my thesis defence. I had the chance to explore so many different topics, go on field trips to different locations and challenge myself to new ways of working and representing the outcomes.

Societal and academic values and ethical considerations

The research linked cultural values to the present-day identity and uses that as a driver for future transformation. The book 'Toekomst van het verleden' (Future of the Past) from Weststeijn has been a big inspiration for this project. According to Weststeijn (2023), there is an enormous amount of literature about the effect of climate change on nature and a lot less on the effect of climate change on the built environment and built heritage. It shows the difficulty in bridging the gap between landscape urgencies and their relation to human-cultural objects.

This research aims to integrate

Figure 9.9: Town hall of Gouda in flood event



Source: Keppel via Volkskrant (2023)

research, strategic planning and design for the polder city of Amsterdam. There are multiple research-by-design projects addressing the water problems in the Dutch river landscape. Het Programma Ruimte voor Rivieren resulted in national attention for the flood safety of rivers (Ministerie van Infrastructuur en Waterstaat, 2024). But, the problems that are or will be occurring in the polder city are fairly unknown among the general public. Amsterdam is a prime example of a polder city, consisting of a patchwork of polders. The multi-scalar approach addresses the complexity of spatial and temporal dimensions in the urban development of a polder city.

The integrated urban transformation builds resilience against climate change emergencies. This directly addresses the living environment and future of citizens in the Dutch Delta region. By exploring the cultural and historical significance of water in cities it is hoped to strengthen a sense of identity and pride. This can promote a stronger connection between citisens and water, opening up the way for socio-ecological urbanism, which can ultimately, build resilience against water quantity extremes, enhance the quality of life in urban areas and also contribute to sustainable heritage development. As cities embrace their water-related heritage, it can be used as a driver for urban transformation and meet the demand for inner-city development that counters the high pressure on urban space.

The survey was important to gain a valuable understanding of values and identity and engage stakeholders in my research. However, not all neighbourhoods were equally represented in the survey and therefore I partially had to rely on my knowledge for the design outcomes. To safeguard privacy and ethical issues a data management plan was constructed to describe how the data is collected, stored and shared within this research.

The project also aims to look into environmental ethics and strengthen ecological systems, by doing so the long-term nature of my research will have an impact on future generations. Because my project is a multi-scalar project with integrated topics, conflicts and synergies were mentioned. However, conflicts and synergies are often context-specific and I only was able to identify the conflicts and synergies for one representative location. When these projects are realised it is important to consider stakeholder participation in the decision-making process. This can be done with the guidelines explained in Chapter 7 of this report.

Transferability and pattern language

This project has provided innovative solutions for urban resilience, demonstrating the integration of landscape and human systems while preserving cultural values. It advances our understanding of socio-ecological urbanism principles and their application in the context of the Dutch Delta region, making a significant contribution to urban planning and climate adaptation research. The typology has potential applicability beyond Amsterdam, the case of Amsterdam can be an example for other cities to integrate a resilient water system with the sustainable development of water-related heritage. The design proposals are representative design proposals for different types of locations, but as mentioned cultural heritage management is an extremely context-specific issue. The pattern language plays an important role in bridging scales and contexts, however, the pattern language is not a final design.

Dovey (1990) argues that Christopher Alexander's "pattern language" method (1977) leans towards universal rationality and a single right way of designing, which stands in contrast to the relativistic nature of postmodernism. In my view, a valuable pattern for one aspect of urban design may not necessarily

hold the same value for another aspect. It's important to acknowledge that a pattern does not need to address multiple values – it serves to simplify the inherent complexity of urbanism. Dovey (1990) raises the question of whether meaning inheres in form or is brought to form by people, emphasising the need for a more inclusive approach in urban design that respects the plurality of values.

While I agree with Dovey about the plurality of values. I do think meaning is derived from both people and forms. That is where the pattern language can play an important role in bridging the gap between research, design and the users. That is why a plurality of values should be integrated into a pattern language, resulting in relativism in the possible design outcome. By doing so a pattern language will be a range of possible solutions that can be implemented into a design regarding the context or culturally specific values. The most important takeaway is that as a result of this idealogy, the pattern language is and always will be an open-ended product, that will never be a perfect fit. However, the relations, connections and conflicts established within the pattern language can create a highly suitable fit.

The relation between research and design

The Design of the Urban Fabric studio allowed for a great balance between research and design. The integration between imagination and evidence-based design strongly improved the final outcomes of this project.

The first important bridge between research and the design was the survey, The survey allowed for an important reflection moment because it was hoped it would confirm my hypothesis that the contemporary water structures had strong cultural heritage values. Because of the time needed to distribute and process the survey, the survey was distributed relatively early in the research. This had its pros and cons. It was convenient that the survey confirmed my hypothesis at an early stage and it added important extra values to consider in my research and design. However, as my research progressed new questions popped up for example about the perception of heritage structures as place-making sites and the accessibility to social services in different city districts. It would have added value to my design process if I had worked with community input during the maximisation and integration phase. In combination with the pattern language, this would have given great insights into the needs and values of the inhabitants. Due to time constraints, there was no opportunity to do this. The pattern language is the second important bridge between research and design. I have used the pattern language to generate design ideas that support the design qualities I retrieved from the literature. The patterns are based on literature, reference projects or on the survey. The whole pattern language combined all this input into a set of solutions for the integration of resilient water management, sustainable heritage development and socio-ecological integration.

My research gave me all the guidelines to make a coherent urban design. This included the input from the survey, the design qualities retrieved from literature, the neighbourhood types, the maximisation experiments and the pattern language. However, I had trouble letting go of the research and using my imagination for a beautiful urban design. I was stuck in an academic way of reasoning and forgot that I was the designer with enough knowledge to let my imagination speak. Schön (1983) refers to this as "knowing-in-action", addressing the phenomenon that implicit knowledge is only available by doing rather than thinking. At this moment in the graduation process, I had all the knowledge to make an urban design, but making the implicit knowledge explicit was only possible by starting drawing. Eventually, a switch clicked and the designer in me started working with experimental sketches. Experimenting is an important

action to make my implicit knowledge explicit. At the same time, it is a way to try ideas, make mistakes, put forward extremes and see what fits best in the design location (Van Dooren et al, 2013)

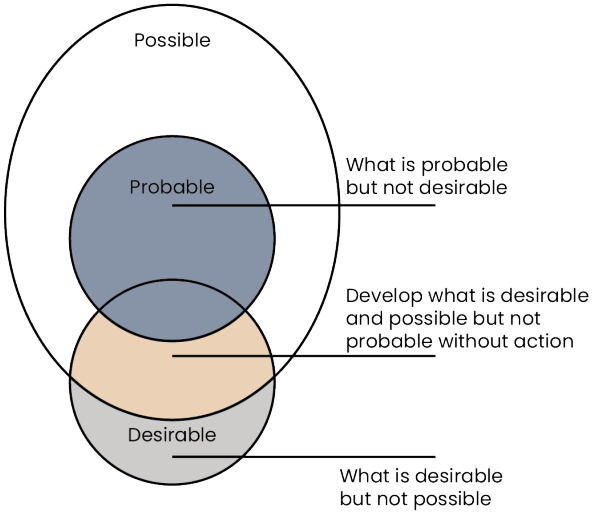
I see an interesting difference between the different design proposals that were constructed in this project. The design voor Molen de Otter, which was strongly based on the maximisation experiments and pattern language, resulted in a relatively modest design. Although constructed with experiments it was tried to find an integrated balance where solutions were fit together in the best way possible in a limited amount of space. On the other hand, the design of the NDSM wharf was started from my own imagination. I quickly had a visionary view on what that location needed to be, which resulted in a bigger and bolder statement design, that really envisions an alternative future for this location.

Growing as a designer

At the start of this graduation year, I wondered if I wanted to be an urban designer or a strategic planner. During my academic journey, I often leaned towards argumentation-based decision-making and pattern language-like solutions to explore infinite amounts of possibilities. As mentioned in the previous paragraph I did both in this project: A strongly argumentation-based design and an imaginary design with substantiating research. It became clear to me how important imaginary design is to generate desirable futures and desirable living environments, which is something that will stick with me for the rest of my professional career.

A big reason why I was not much into the imaginary design before, was the fact that I often struggled to find the right visualisation and representation skills for the final outcomes of a project. However, in climate-resilient design telling urgent stories with the right visualisation will be of big societal importance now and in the future. My graduation year confirmed to me that I wanted to be a designer but at the same time value evidence-based reasoning. Only as an urban designer, I will be able to shape the physical living environment into a more resilient and socio-ecological inclusive world (Figure 9.10). Consequently, I was determined to improve my visualisation and representation skills to be able to have the best communication tools for my project. Communication tools like diagrams, pattern language and different types of design visualisations all increase the feasibility of a project. I feel like the past year has proven the importance of both research and design as complementary disciplines to be a successful professional. I want to be the designer who can translate societal and spatial needs regarding climate adaptation and resilience planning into physical implacable changes, by bridging scales and bringing different stakeholders together.

Figure 9.10: The conceptual relations between possible, probable and desirable scenarios



Source: Adaptation of De Jong (1992, p.9)

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Chapter 9

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Figure 9.7: H+N+S Landschapsarchitecten, Rademacher / de Vries Architects, & NOHNIK architecture and landscapes. (2022). A new perspective on the layer approach. Toekomstverkenning NL2100. https://www.collegevanrijksadviseurs.nl/projecten/toekomstatelier-nl2100/toekomstverkenning-nl2100

Figure 9.8: Van Dooren, E., Boshuizen, H. P. A., Van Merriënboer, J., Asselbergs, T., & Van Dorst, M. (2013). Making explicit in design education: generic elements in the design process. International Journal of Technology and Design Education, 24(1), 53–71. https://doi.org/10.1007/s10798-013-9246-8

Figure 9.9: Keppel, M. (2023). Het stadhuis van Gouda. Volkskrant. https://www.volkskrant.nl/cultuur-media/klimaatverandering-bedreigt-ook-ons-erfgoed-hoogleraar-thijs-weststeijn-luidt-de-noodklok-het-was-ook-mijn-blinde-vlek~bd31e106/

Figure 9.10: De Jong, T. (1992). Kleine methodologie voor ontwerpend onderzoek. Boom uitgevers. https://www.taekemdejong.nl/Publications/1992/Jong%281992%29Kleine%20methodologie%20voor%20ontwerpend%20onderzoek%28Meppel%29Boom.pdf

Appendix

Front page: Doornick, M. W. (1665). Amsterdam met haar verscheyde vergrootingen, zo als het was, tot den Jare 1658. Stadsarchief Amsterdam. https://archief.amsterdam/beeldbank/detail/e4bda463-ba76-9f5a-5e94-468a9610a167/media/43d1fc3b-1d1f-8939-1fd3-c19d95faf6b3?mode=detail&view=horizontal&q=doornick&rows=1&page=3

APPENDIX

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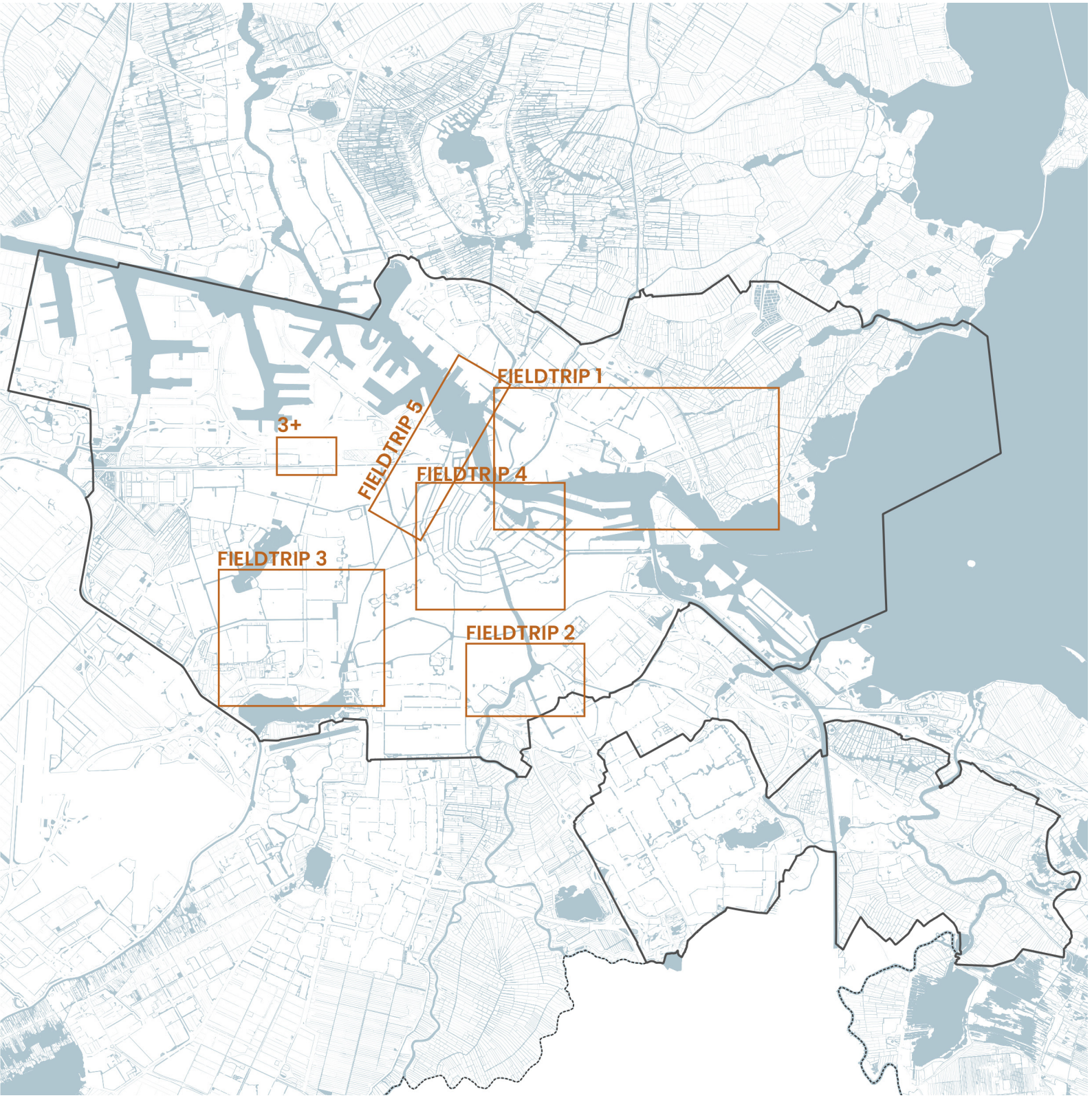
Amsterdam met haar verscheyde vergrootingen, zo als het was, tot den Jare 1658

Source: Stadsarchief Amsterdam / Marcus Willemz Doornick (1665)
Black & White Adaptation

APPENDIX A: FIELDTRIP OVERVIEW



Scale: 1:125.000

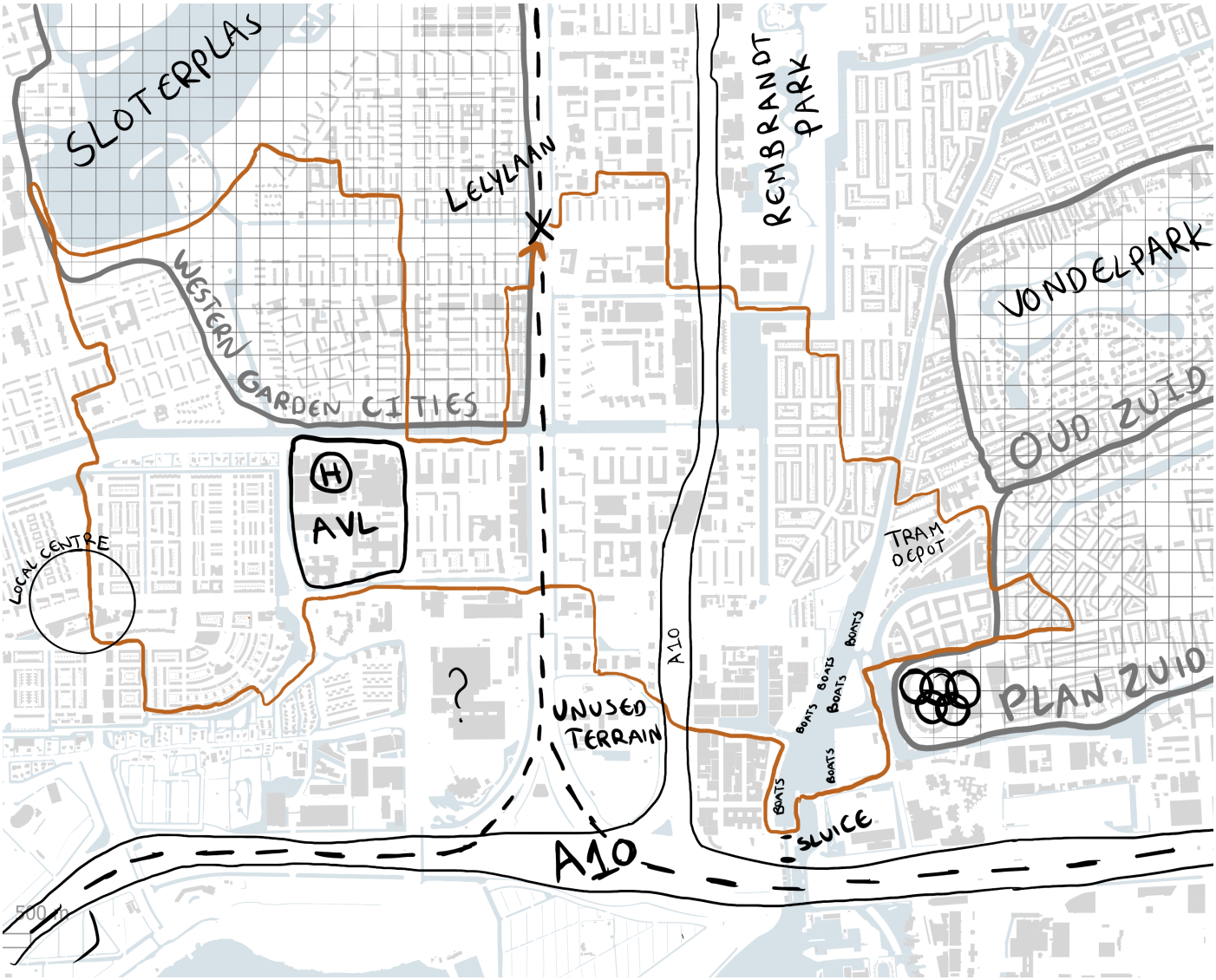
FIELDTRIP 1: AROUND THE EASTERN IJ

Fieldtrip 1
Monday 25 September 2023
Start time: 12:30u Amsterdam Central Station
End time: 15:45u Overhoeks / Amsterdam Central Station
Weather: Partly cloudy, partly sunny
Goal: Explore the structural / physical relation and use of the urban waterfront

FIELDTRIP 2: FROM OVERAMSTEL TO THE RIVIERENBUURT

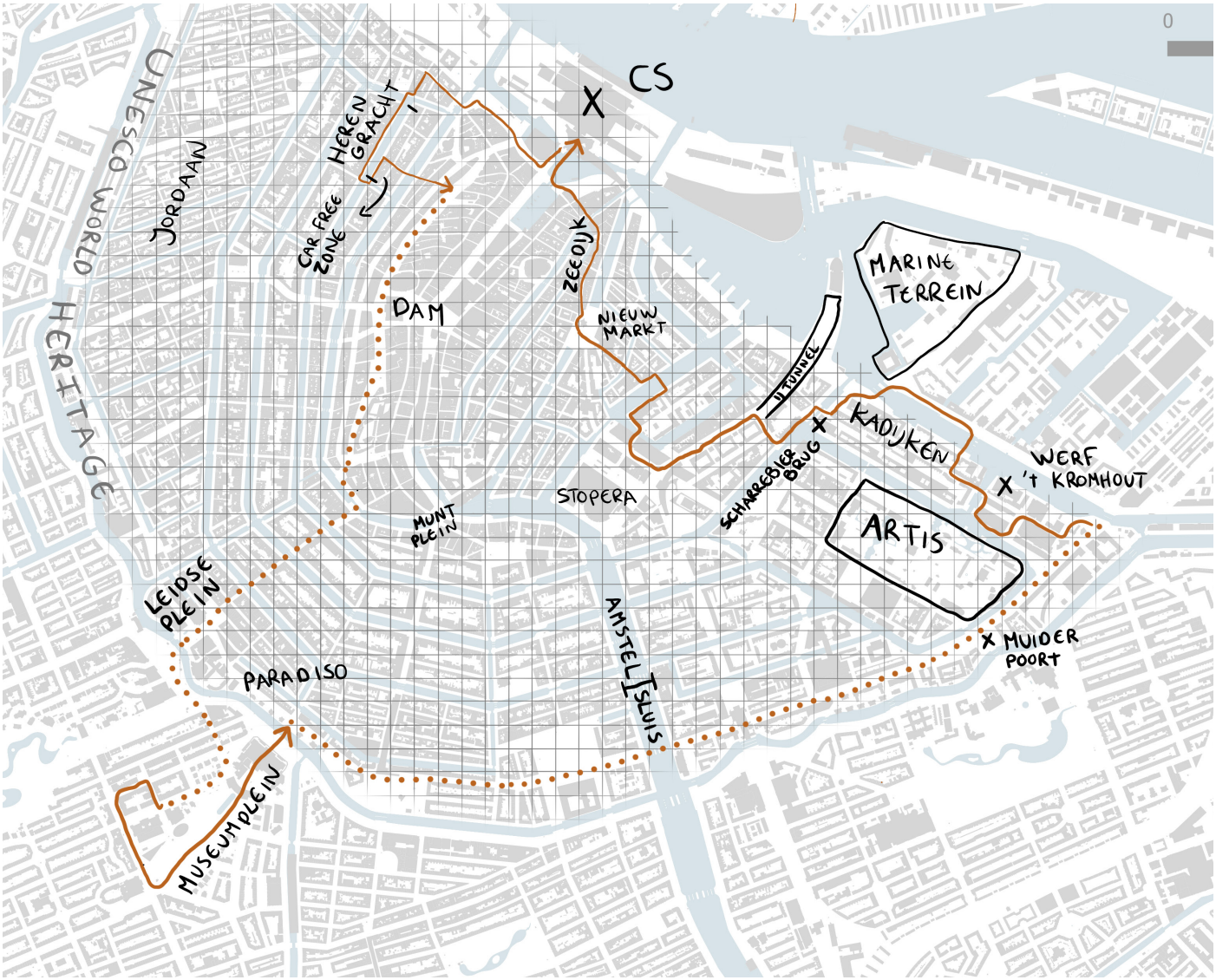
Fieldtrip 2
Friday 1 December 2023
Start time: 13:00u Metrostation Overamstel
End time: 15:15u Waalstraat, Rivierenbuurt
Weather: Bright blue sky & 0 °C
Goal: Getting to know new parts of the city around the Amstel River

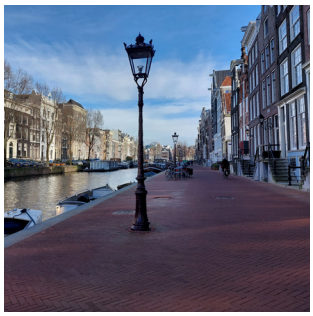
FIELDTRIP 3: SOUTH WESTERN ALGEMEEN UITBREIDINGSPLAN



Fieldtrip 3
Monday 12 February 2024
Start time: 10:45u Train station Lelylaan
End time: 13:005u Train station Lelylaan
Weather: Cloudy
Goal: Qualitative assessment of type 3, 4 & 6 neighbourhoods

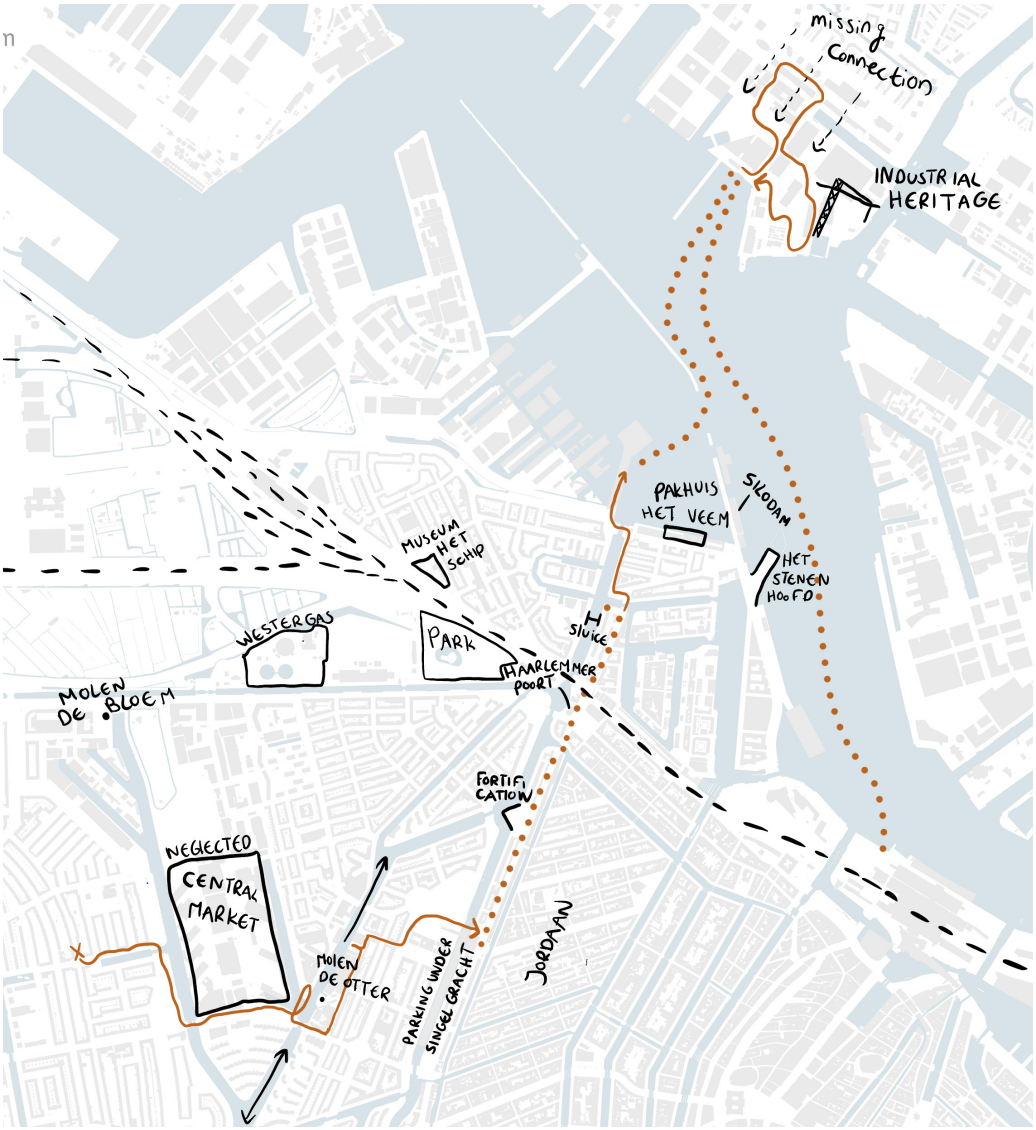
FIELDTRIP 4: UNESCO WORLD HERITAGE HISTORICAL CITY CENTRE





Fieldtrip 4
Tuesday 13 February 2024
Start time: 10:30u Amsterdam Central Station
End time: 12:30u Amsterdam Central Station
Weather: Partly sunny
Goal: Qualitative assessment of type 7 & 8 neighbourhoods

FIELDTRIP 5: FREDERIK HENDRIKBUURT & NDSM



Fieldtrip 5
Friday 15 March 2024
Start time: 14:00u Tramstop Rijpstraat (Landlust)
End time: 16:30u NDSM ferry stop (Noordelijk IJ-oever West)
Weather: Partly Sunny
Goal: Design research in design locations

APPENDIX B: DATA MANAGEMENT PLAN

Research Overview

The title of my graduation research is Bridging Past & Future: Utilising the Cultural Value of Water to create resilience in Amsterdam's polder water system. To gain an understanding of the qualities of the water identity in Amsterdam a subresearch question explores the values of the water structures in the city. This section explores the historical values the water had in urban development and the contemporary value the water has for its inhabitants. To obtain a better understanding of the contemporary values of the water structures in Amsterdam a survey is conducted. This survey targets inhabitants of the municipality of Amsterdam. To understand the contemporary values of water as the cultural values the heritage value taxonomy by Pereira Roders (2007) is used.

Privacy of the participants

At the start of the survey, the objective of this research is explained and a privacy statement describes why certain data is gathered. This privacy statement, visible to all participants, consists of the following statements:

- Your participation in this survey is voluntary and you have the right to stop the survey at any time.
- A small amount of demographic information is gathered. These are your age group, the district you live in and the district where you go daily for work/ school. You can choose to leave these questions blank if you do not want to share this information.
- The gathered data will only be analysed to inform my graduation project, after this analysis the data will be deleted.
- The survey is anonymous unless you choose to leave your email for possible follow-up research.
- By filling in this survey you agree with the gathering and analysis of your answers as stated in this privacy statement.
- For questions about the privacy statement you can contact L.A.vanLun@ student.tudelft.nl

Distribution

The survey is distributed via a personal network, increasing the scope of the survey by asking inhabitants of Amsterdam to distribute the survey among their roommates, family members and Whatsapp group chats in the neighbourhood. Three different starting points are taken into account. First of all, I send personal messages to friends who either live in Amsterdam or have grown up in Amsterdam. Secondly, a post on social media reaches out to all the people in my network who live in Amsterdam. Next to the fact that numerous people filled in the survey themselves resulted in six people texting me back if they could have a weblink to distribute in their personal network. Lastly, a post on LinkedIn with the specific question to share the survey through the readers' network resulted in six reposts and 25 interactions, having a reach of over 1000 people.

After the first round of distribution, the survey had enough participants but not every neighbourhood in Amsterdam was equally represented. Therefore the survey was shared in Facebook groups of the underrepresented neighbourhoods: Gein, Geuzenveld, Holendrecht, Slotervaart, Osdorp and Slotermeer.

Use of the gathered data

The program Qualtrics is used to set up, distribute and analyse the results of this survey. Different sections of the survey serve different purposes in the project.

- The assessment of the water in the city of Amsterdam with the cultural heritage value taxonomy will determine the cultural heritage values that are most associated with the water identity
- The location participants mention where more activities on the waterfront should be accommodated, will show the possibilities to expand the cultural heritage value of water in specific places in the city.
- The activities participants mention they prefer to do in or around the urban waterfront are input for the strategy and design of the urban waterfront. Together with the demographic information I can determine if the preferred use of the urban waterfront is different among different age groups or between different districts.
- Lastly, an open question gives the participants the possibility to mention other experiences related to urban water. If experiences are mentioned multiple times it is something I can take into account in my research conclusion and design process.

Storing data

The data will be stored in the Qualtrics database and back-upped on a personal external hard drive during the timespan of my graduation project. It is tried to analyse the gathered data in the Qualtrics database, however, other programs like Excel and eventually Illustrator may be needed to visualise the gathered data. Once my graduation project is finished the gathered data will be deleted from the personal external hard drive and the Qualtrics database.

Reflection

Because I started the distribution of this survey from my personal network the dominant age group of the participants was 18-30 years old. This is not a problem for this research, because the data gathered is not age-specific.

The language of this survey was Dutch, to make sure people from all age groups would have the needed understanding of the context of my project. However, in Amsterdam, there are many English-speaking inhabitants. I was asked several times if the survey was available in English because people would like to share it among their university friends or English-speaking roommates. However, I decided not to translate the survey because I already had many participants from the 18-30 age group and valued the older age groups being part of this survey over English-speaking participants.

APPENDIX C: CONTENT SURVEY

De waarde van water in Amsterdam

TU Delft Department of Urbanism
BK Bouwkunde

Introductie
Welkom bij deze enquête over de waarde van water in Amsterdam. Dit onderzoek is onderdeel van het afstudeerproject 'Van Verleden naar Toekomst: De integratie van veerkrachtig erfgoed en water in Amsterdam' dit onderzoek wordt uitgevoerd binnen de Master Stedenbouwkunde aan de Technische Universiteit Delft.

Het doel van dit onderzoek is om te analyseren hoe de bewoners van Amsterdam het water in hun woonomgeving waarderen en gebruiken.

De enquête duurt ongeveer 5 minuten.

Privacy informatie
Uw deelname aan dit onderzoek is vrijwillig en er wordt veel waarde gehecht aan uw privacy. Uw heeft het recht om op elk moment te stoppen met de enquête. Hieronder vindt u informatie over hoe ik om ga met de gegevens die u verstrekt.

- Ik zal een kleine hoeveelheid demografische informatie verzamelen ten behoeve van mijn onderzoek, mocht u hier niet aan willen deelnemen dan kunt u ervoor kiezen deze gegevens niet in te vullen.
- De verzamelde gegevens worden uitsluitend gebruikt voor het analyseren van de onderzoeksresultaten, na deze analyse worden de enquête en bijbehorende antwoorden verwijderd.
- De enquête is anoniem, tenzij u ervoor kiest om uw contactgegevens te delen voor eventueel vervolg onderzoek.
- Door de enquête in te vullen, stemt u in met het verzamelen en verwerken van uw gegevens zoals beschreven in deze privacyverklaring.

Voor vragen over deze privacyverklaring kunt u contact opnemen via L.A.vanLun@student.tudelft.nl

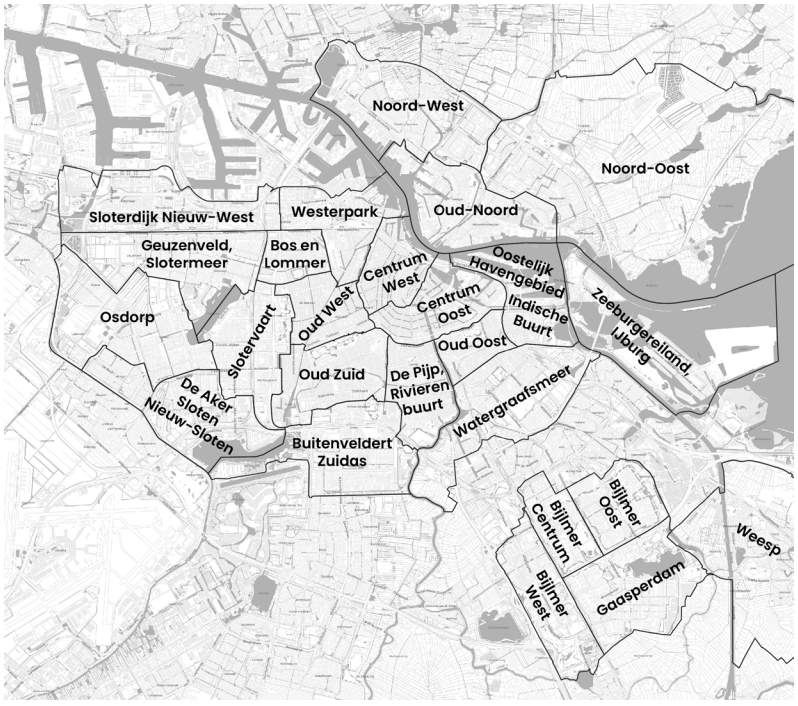
Deel 1 Persoonlijke informatie

Om een goed beeld te krijgen van de waardering en het gebruik van het water in de stad, zou ik graag een aantal persoonlijke gegevens van u willen weten.

In welke leeftijdsgroep valt u?

- Jonger dan 18 jaar
- 18 - 30 jaar
- 30 - 45 jaar
- 45 - 60 jaar
- 60 jaar en ouder

Gebiedsindeling Amsterdam



In welk gebied in Amsterdam woont u?

In welk gebied in Amsterdam komt u dagelijks voor werk, studie of school?

Deel 2 De culturele waarde van water

Veel water structuren in Nederland zijn cultureel erfgoed, cultureel erfgoed heeft culturele waardes.

In welke mate heeft het water in de stad voor u de volgende culturele waardes?

	Helemaal niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Helemaal mee eens
Het water in de stad heeft voor mij esthetische waarde	○	○	○	○	○
	Helemaal niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Helemaal mee eens
Het water in de stad heeft voor mij historische waarde	○	○	○	○	○
	Helemaal niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Helemaal mee eens
Het water in de stad heeft voor mij technologische of wetenschappelijke waarde	○	○	○	○	○
	Helemaal niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Helemaal mee eens
Het water in de stad heeft voor mij sociale waarde	○	○	○	○	○
	Helemaal niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Helemaal mee eens
Het water in de stad heeft voor mij economische waarde	○	○	○	○	○
	Helemaal niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Helemaal mee eens
Het water in de stad heeft voor mij ecologische waarde	○	○	○	○	○
	Helemaal niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Helemaal mee eens
Het water in de stad heeft voor mij politieke waarde	○	○	○	○	○
	Helemaal niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Helemaal mee eens
Het water in de stad heeft voor mij ouderdoms waarde	○	○	○	○	○

Leg uit waarom het water in de stad voor u wel/niet bepaalde waarde heeft

Deel 3 Functie van het stedelijk water

Voor welke activiteiten gebruikt u het water in uw woonomgeving? (Er zijn meerdere antwoorden mogelijk)

- [ ] Sporten langs het water: Hardlopen, vissen of andere sporten doen langs de waterkant
- [ ] Ontspannen langs het water: Lezen, rusten of wandelen
- [ ] Recreëren op het water: Kanöen, Suppen of varen
- [ ] Recreëren met het water: Zwemmen
- [ ] Dagelijkse bezigheden: De hond uitlaten, naar werk/school fietsen
- [ ] Sociale bijenkomsten: Barbecuën, picknicken of koffie drinken met vrienden/familie
- [ ] Gebruik van het water voor het irrigeren van (moes)tuinen
- [ ] Anders namelijk:

Voor welke activiteiten aan het water zou er meer aandacht moeten zijn in uw woonomgeving? (Er zijn meerdere antwoorden mogelijk)

- [ ] Betere fiets of wandelroutes langs het water
- [ ] Meer sportlocaties of speeltuinen aan het water
- [ ] Meer zwemlocaties
- [ ] Meer openbare plekken om samen te komen (picknick of barbecue plekken)
- [ ] Meer aanlegsteigers voor boten
- [ ] Meer plekken om te zitten en tot rust te komen
- [ ] Anders namelijk:

Deel 4: Belangrijkste locaties en overige informatie

Op welke plekken in de stad moet er meer ruimte komen voor activiteiten aan de waterkant?

Locatie 1

Locatie 2

Locatie 3

Zijn er nog andere ervaringen met het water in uw woonomgeving die uw graag kwijt wilt? Bijvoorbeeld: Wateroverlast, een prettige of juist onprettige openbare ruimte, slechte waterkwaliteit of locaties die een goed voorbeeld zijn voor de hele stad

Bedankt voor uw deelname aan deze enquete. Wilt u deelnemen aan een vervolg onderzoek over het stedelijk ontwerp van de waterkant op verschillende locaties in de stad? Laat dan hieronder uw emailadres achter.

APPENDIX D: TYPE ASSESSMENT

In these table it is shown how the spatial analysis has been translated into a design vision. To get an informed approach on the assessment per type, the outcomes of the Geoda have been used as an first assessment, on a scale of 1 to 5. Afterwards the combined average assessments of these values have been used to assess the design qualities. The combined average of of the design qualities is based on which analytical variables have influence on the design qualities, this is shown in the relation diagram. For example, to assess the economic potential the average of the assessment of local centres and heritage points has been used.

Outcome of Geoda Kmeans clustering & Assessment of these analytic variables

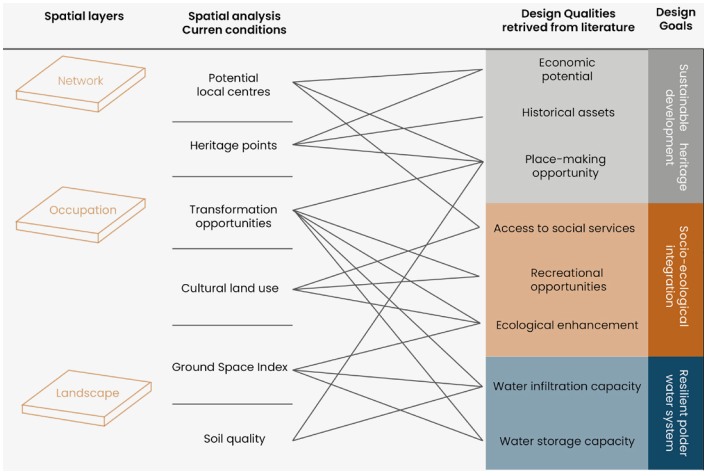
	Local centre	**LC** assessment	**Heritage points**	**H** assessment	**Porosity**	**P** assessment	**Cultural Land U**
T1	3367,76	3	2,31	4	1,21	2	
T2	3897,02	4	0,96	3	2,46	3	
T3	26189,6	5	0,71	3	1,85	2	
T4	4440,04	4	0,09	1	1,76	2	
T5	2541,64	2	0,61	3	3,27	4	
T6	3832,5	4	0,84	3	15,23	5	2
T7	3361	3	53,57	5	2	3	
T8	31244,4	5	17,3	5	1,33	2	

Calculation of the mean assessments of design qualities

	Economic potential	Historical Asset	Place making	Ecological enhancement	Recreational opport
T1	=(C2+E2)/2	=E2	=(C2+E2+G2+M2)/4	=(G2+I2+K2)/3	=(G2+I2)/2
T2	=(C3+E3)/2	=E3	=(C3+E3+G3+M3)/4	=(G3+I3+K3)/3	=(G3+I3)/2
T3	=(C4+E4)/2	=E4	=(C4+E4+G4+M4)/4	=(G4+I4+K4)/3	=(G4+I4)/2
T4	=(C5+E5)/2	=E5	=(C5+E5+G5+M5)/4	=(G5+I5+K5)/3	=(G5+I5)/2
T5	=(C6+E6)/2	=E6	=(C6+E6+G6+M6)/4	=(G6+I6+K6)/3	=(G6+I6)/2
T6	=(C7+E7)/2	=E7	=(C7+E7+G7+M7)/4	=(G7+I7+K7)/3	=(G7+I7)/2
T7	=(C8+E8)/2	=E8	=(C8+E8+G8+M8)/4	=(G8+I8+K8)/3	=(G8+I8)/2
T8	=(C9+E9)/2	=E9	=(C9+E9+G9+M9)/4	=(G9+I9+K9)/3	=(G9+I9)/2

Assessment of the design qualities

	Economic potential	Historical Asset	Place making	Ecological enhancement	Recreational opportunitie
T1	4	4	4	2	
T2	4	3	3	4	
T3	4	3	3	3	
T4	3	1	3	3	
T5	3	3	4	4	
T6	4	3	4	5	
T7	4	5	4	2	
T8	5	5	4	3	




```
Method:       KMeans
Number of clusters:  8
Initialization method:      KMeans++
Initialization re-runs:     150
Maximum iterations:  1000
Transformation:      Range Standardize
Distance function:   Euclidean

Cluster centers:
|  |Local cent|GSI_a   |Peat|Heritage c|Cultural l|Transforma|
|--|----------|--------|----|----------|----------|----------|
|C1|3367.76   |0.326324|0   |2.51351   |1.56757   |1.21622   |
|C2|3897.02   |0.101692|8000|0.961538  |6.73077   |2.46154   |
|C3|26189.6   |0.187762|8000|0.714286  |9.2381    |1.85714   |
|C4|4440.04   |0.241857|8000|0.0952381 |3.42857   |1.7619    |
|C5|2541.64   |0.128667|0   |0.611111  |3.83333   |3.27778   |
|C6|3832.5    |0.147923|8000|0.846154  |20.1538   |15.2308   |
|C7|3361      |0.447429|0   |53.5714   |0.571429  |2         |
|C8|31244.4   |0.376   |0   |17.3333   |5         |1.33333   |

The total sum of squares:  60.678
Within-cluster sum of squares:
|  |Within cluster S.S.|
|--|-------------------|
|C1|0.860468           |
|C2|1.14195            |
|C3|0.854568           |
|C4|0.656854           |
|C5|0.78023            |
|C6|1.68971            |
|C7|0.483191           |
|C8|0.258545           |

The total within-cluster sum of squares:  6.72552
The between-cluster sum of squares:       53.9525
The ratio of between to total sum of squares:   0.889161
```

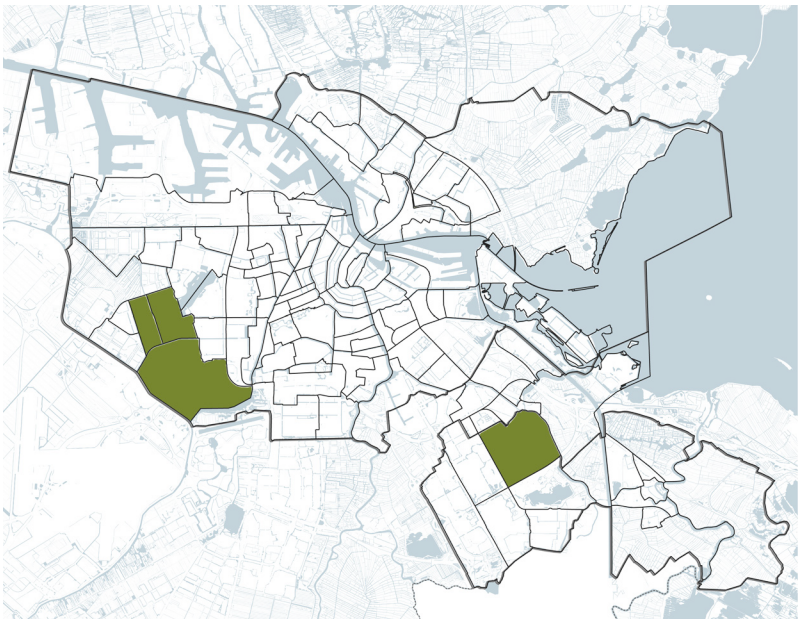
se	**CLU** assessment	**GSI**	**GSI** assessment	**Soil Quality**	**SQ** Assessment
1,56	2	0,3	3	0	5
6,73	4	0,1	5	8000	3
9,23	4	0,2	4	8000	3
3,42	3	0,2	4	8000	3
3,83	3	0,1	5	0	5
20,15	5	0,1	5	8000	3
0,57	1	0,4	2	0	5
5	4	0,4	3	0	5

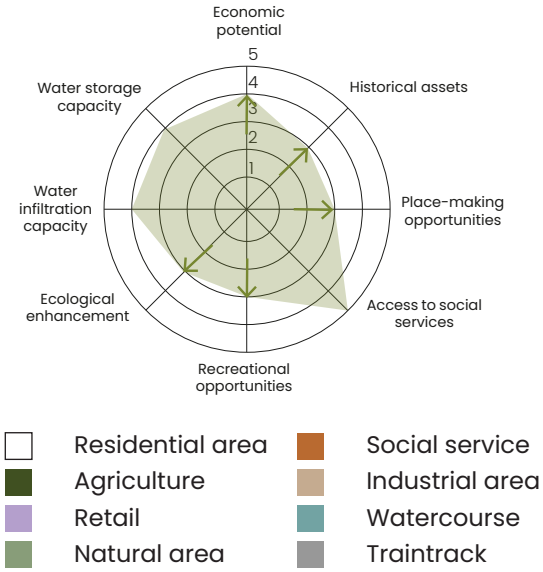
tunities	Social services	Water Infiltration Capacity	Water Storage Capacity
	=(C2+I2)/2	=(G2+K2+M2)/3	=(G2+K2)/2
	=(C3+I3)/2	=(G3+K3+M3)/3	=(G3+K3)/2
	=(C4+I4)/2	=(G4+K4+M4)/3	=(G4+K4)/2
	=(C5+I5)/2	=(G5+K5+M5)/3	=(G5+K5)/2
	=(C6+I6)/2	=(G6+K6+M6)/3	=(G6+K6)/2
	=(C7+I7)/2	=(G7+K7+M7)/3	=(G7+K7)/2
	=(C8+I8)/2	=(G8+K8+M8)/3	=(G8+K8)/2
	=(C9+I9)/2	=(G9+K9+M9)/3	=(G9+K9)/2

s	Social services	Water Infiltration Capacity	Water Storage Capacity
2	3	3	3
4	4	4	4
3	5	3	3
3	4	3	3
4	3	5	5
5	5	4	5
2	2	3	3
3	5	3	3

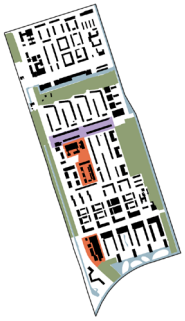
APPENDIX E: QUALITATIVE ASSESSMENT OF TYPE VARIATIONS

TYPE 3: 4 NEIGHBOURHOODS





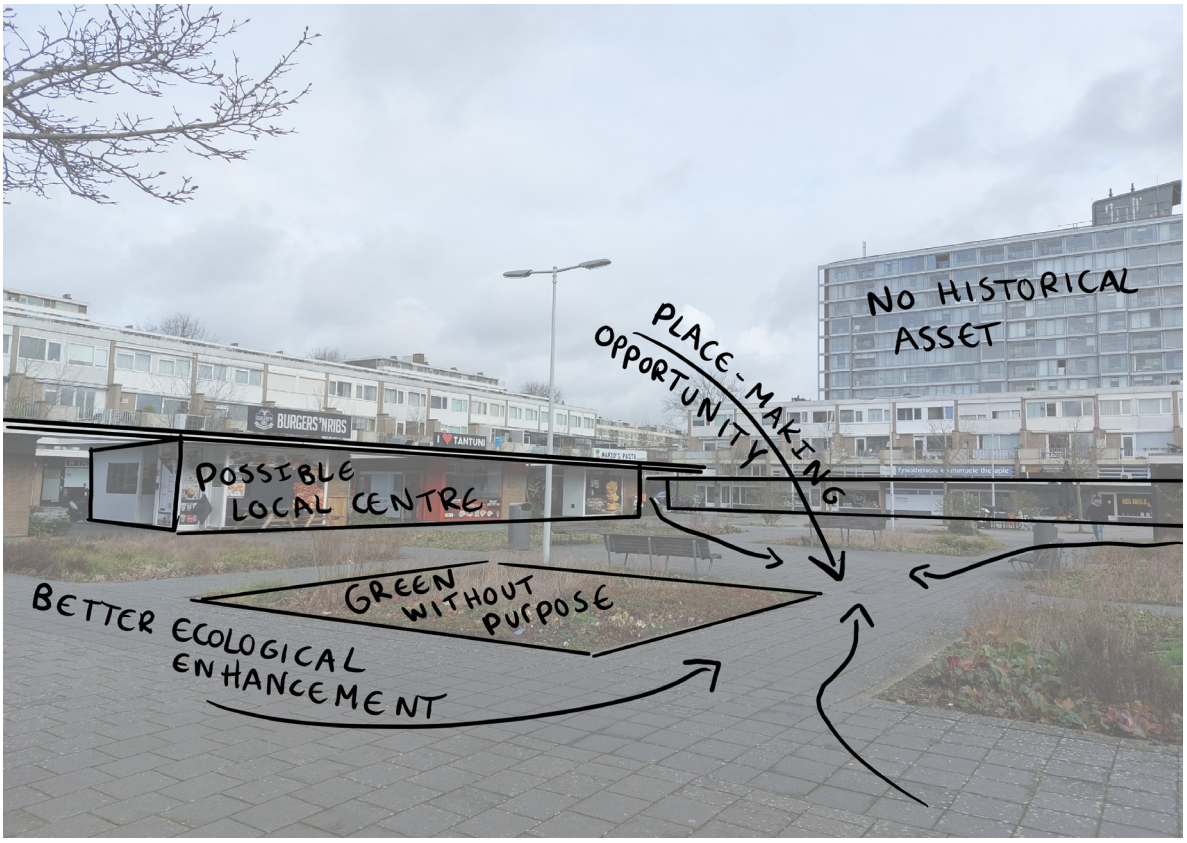
Type 3 consists of only four neighbourhoods. They are relatively similar and therefore their assessment is the same. The main variable that distinguishes these neighbourhood from the neighbourhoods in type 4, is the fact these neighbourhood have the highest potential to be local vital centres. Which results in the fact that these neighbourhood could accommodate important local destinations, like economic centres and socio-cultural facilties. This results in high place-making potential. Given the open space and natural areas, there is high potential for water infiltraten and storage capacity and the ecological enhancement in the neighbourhoods can be improved. The high accessibility also allows for the combination of economic activity with recreational activities. Concluding type 3 has very high potential to improve almost all the design qualities.



TYPE 3 ANALYSIS MAXIMISE LOCAL POTENTIAL

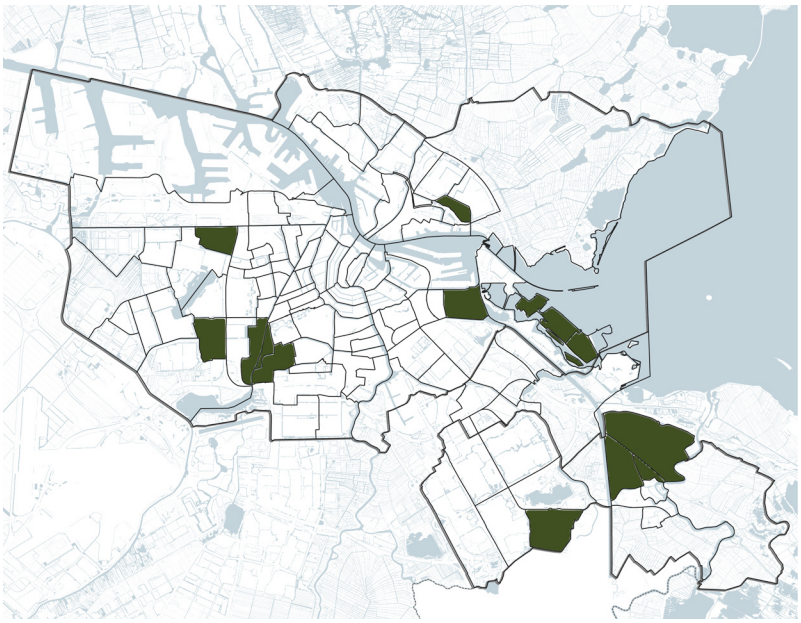
Sloten / Nieuwe-Sloten

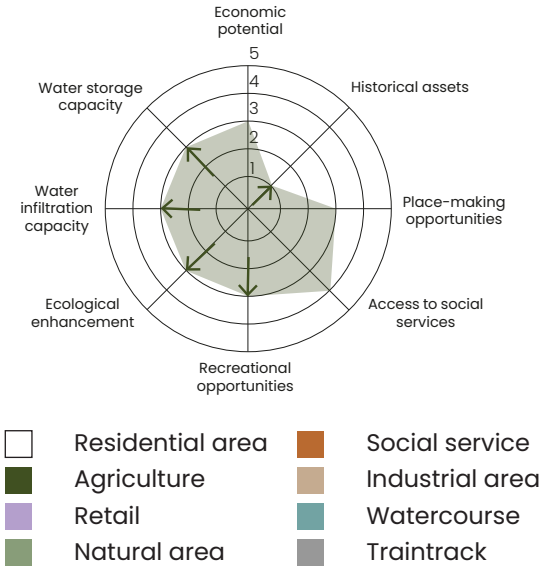
Osdorp Oost



QUALITATIVE ASSESSMENT OF TYPE VARIATIONS

TYPE 4: 13 NEIGHBOURHOODS





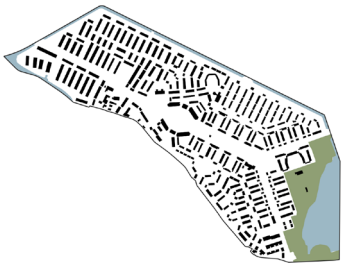
Neighbourhoods in type 4 are residential areas that lack socio-ecological values. It would be important to invest in neighbourhood specific social services and cultural values. However there are two types of type 4 neighbourhood to distinguish. First of all there are the single use residential areas, but there are also more mixed neighbourhoods that belong the historical valued areas. Why these are type 4 neighbourhoods became clear in fieldwork. These neighbourhoods are mostly highly valued residential areas, with strong historical character. However these neighbourhood have a high contrast because there is also a lot of low valued space. These include neglected industrial areas and wasted space next to the ringroad highway. In all of the type 4 neighbourhoods there is high potential for better water infiltration, water storage and ecological enhancement, because of the low density. Dynamic waterbodies combined with recreational opportunities could stimulate socio-ecological activities. Because of the variety of build environment climate adaptation can take many shapes and sizes. Place-making can be done with recreational opportunities or social services.

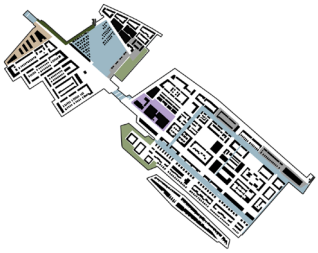
Exceptions

Bloemendaler polder

The Bloemendaler polder came out of the quantitative typology construction as type 4, however at first glance it looks more like a type 6 neighbourhood with high potential for urban transformation and water management. This is in fact the case, the Bloemendalerpolder is being transformed into a new low density residential neighbourhood, with 2/3 of the polder still be nature or recreational area (Atelier Dutch, 2010). However due to the large amount of open space and low GSI it was decided to move the Bloemendalerpolder to a type 6 neighbourhood.

Residential area with no natural area or socio-cultural facility



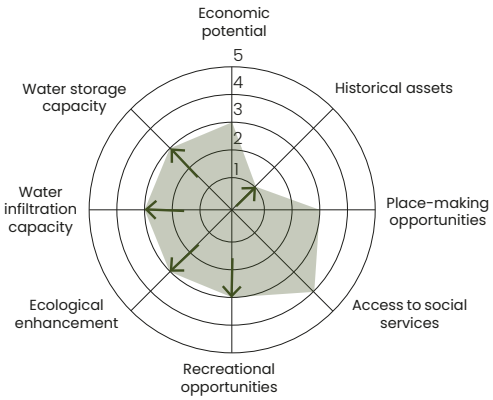


Residential area with historical and cultural character, but also currently low valued space

TYPE 4 MAXIMISING LOCAL POTENTIALS
ARCHETYPE AND EXCEPTION

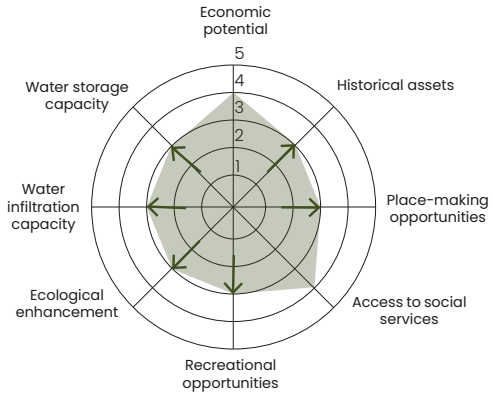
Tuindorp Nieuwendam

Tuindorp Nieuwendam is a clear type 4 neighbourhood that lack socio-ecological values. It is a single use residential area, with low valued green and lots of unused open space. While there is enough open space, there is little infiltration and water storage capacity and also little ecological enhancement. Tuindorp or Gardencities have historical assets, but these are strongly underused or not valued at the moment.

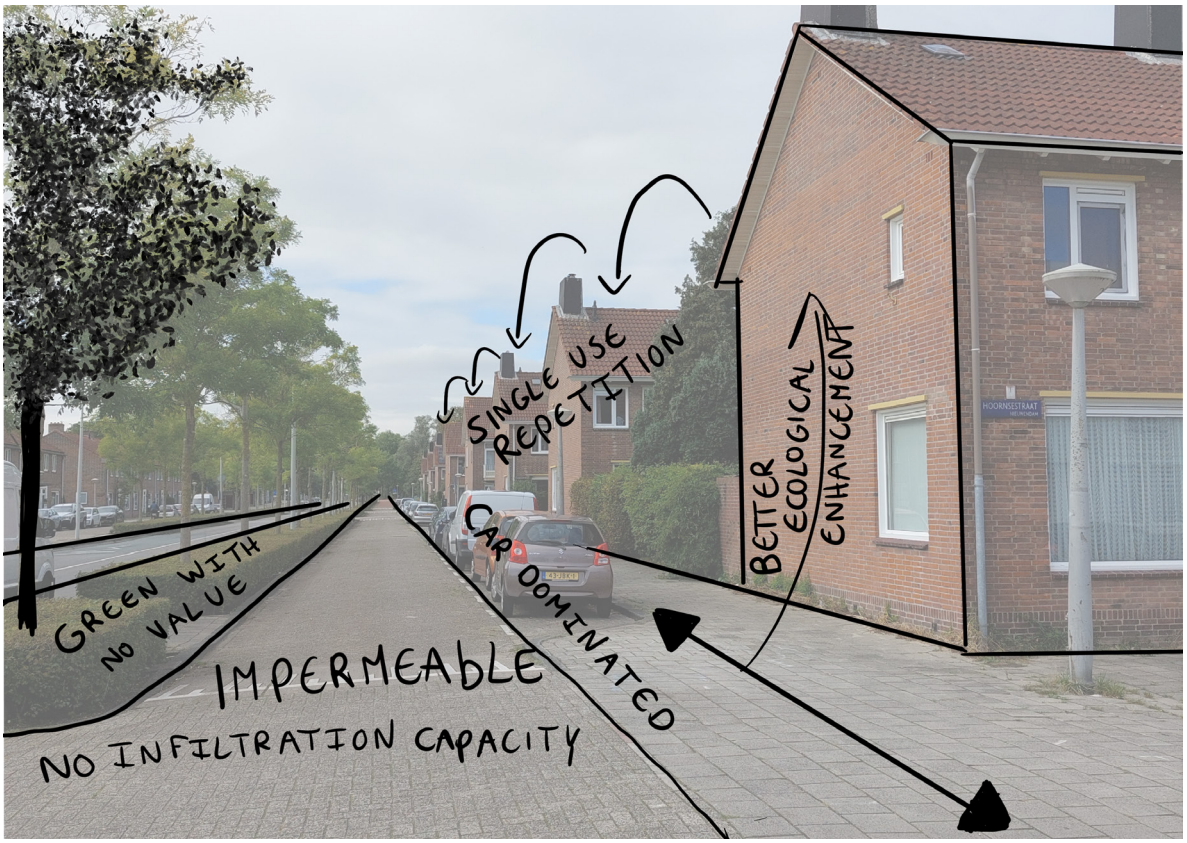


Stadionbuurt

The stadionbuurt at first glance looks more like a type 1 neighbourhood. It has closed block residential buildings, with economic activity on the ground floor and it is a highly valued historical area and part of the protected townscape Plan Zuid. But the neighbourhood is full of contrast and has a big amount of neglected industrial area and wasted space. It truly is a two faced neighbourhood. The assessment looks quite different from Tuindorp, because there are historical assets. place making opportunities and economic potential.



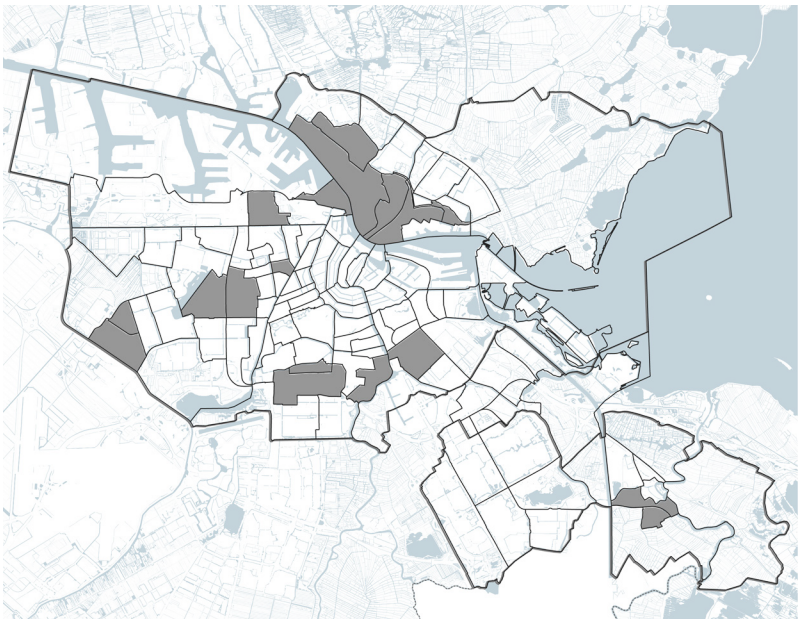
Showing both categories of type 4 it becomes clear that there are big differences, but both neighbourhood are characterised by the fact that there is a lot of room for improvement of the design qualities. It is important to consider a neighbourhood specific approach when working on type 4 neighbourhoods.

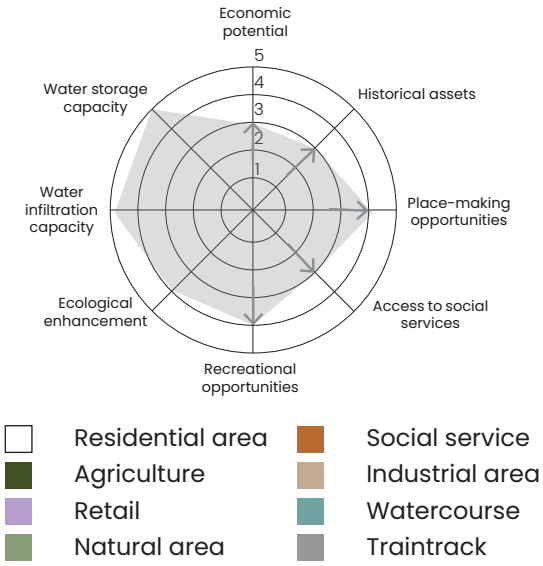

SINGLE USE
REPETITION
BETTER
ECOLOGICAL
ENHANCEMENT
GREEN WITH
NO VALUE
CAR DOMINATED
IMPERMEABLE
NO INFILTRATION CAPACITY

UNUSED
HISTORICAL ASSET
CONTRAST
ECONOMIC
ACTIVITY
PLACE MAKING
OPPORTUNITY
NEGLECTED
IMPERMEABLE
PAVEMENT

QUALITATIVE ASSESSMENT OF TYPE VARIATIONS

TYPE 5: 18 NEIGHBOURHOODS

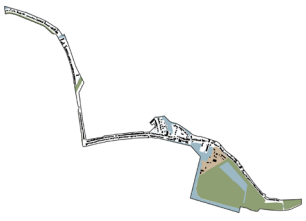




Type 5 shows the inner city porosity. There is not as much space as in the neighbourhoods in type 6. But these are still areas that hold potential for more or new activities. There is large water management potential, because many neighbourhoods possess large scale natural areas. These natural areas hold great potential for socio-ecological activities, place-making and recreation opportunities. Moreover multiple neighbourhood border important waterbodies, which allows for waterfront development, this would improve the historical asset. Because of the available space these areas hold potential for densification. Economic and social potential could be enhancement within the transformation and densification process.

Exceptions

Nieuwendammerdijk / Buiksloterdijk

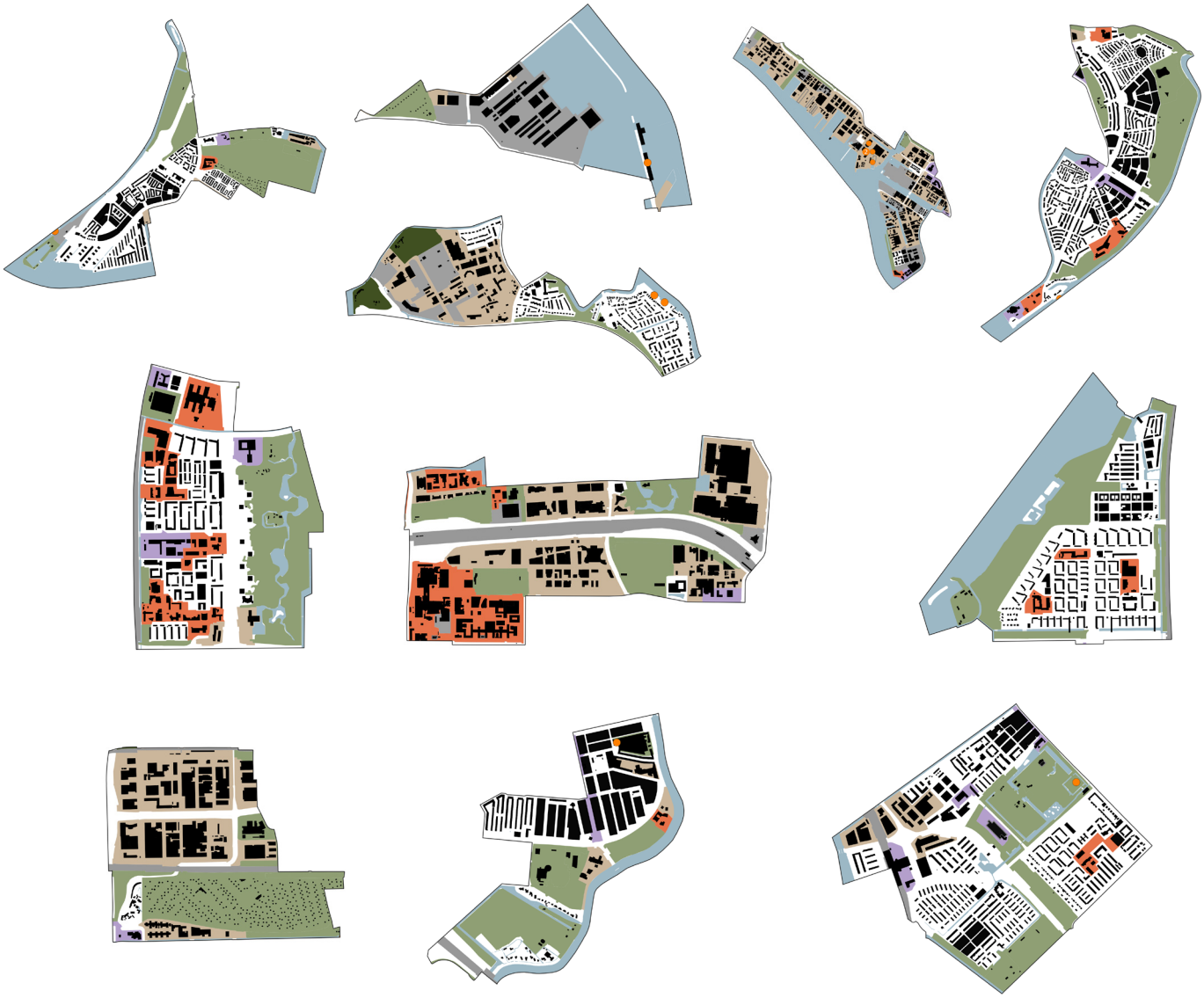


Nieuwendammerdijk / Buiksloterdijk is a low density residential area with transformable natural area. But because of the urban morpohology the actual transformation potential is very limited.

Geuzenbuurt

The Geuzenbuurt looks nothing like a type 5 neighbourhood. It is a closed block residential area, with no natural area or transformable space. There is no water infiltration or storage caapcity and no ecological enhancement or place-making potential. It has some economic activity and holds historical assets becomes of its time of construction. Therefore Geuzenbuurt belongs to type 1 instead of type 5.

Neighbourhood with porosity and high transformation potential

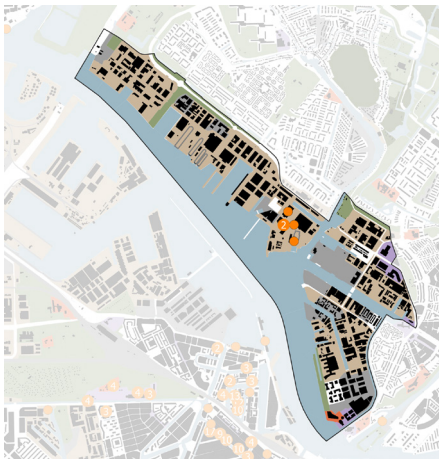


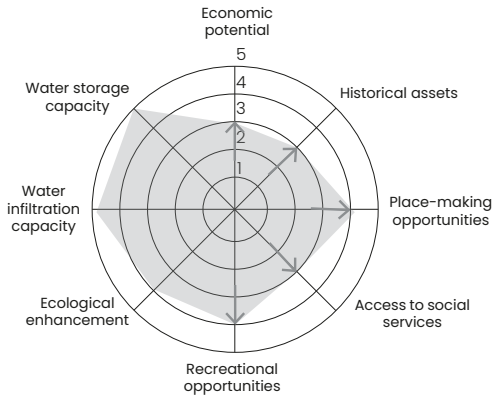
Low density residential area with transformable natural areas

TYPE 5 MAXIMISING LOCAL POTENTIALS
ARCHETYPE AND EXCEPTION

Noordelijk IJ Oevers West

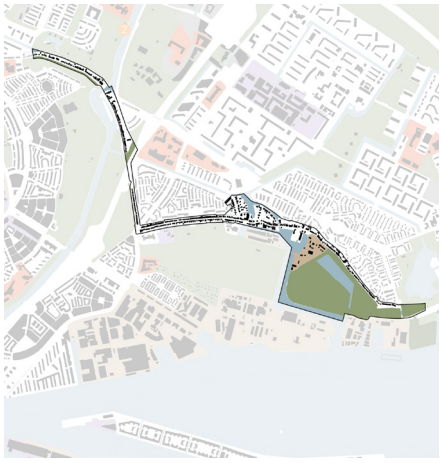
The Nooderlijke IJ Oevers are industrial areas that are slowly being redeveloped as most industrial activity is gone. It can be considered an archetype neighbourhood for type 5. This picture is from a new densification project Overhoeks, but you can see the industrial activity in the background. There is a lot of space for densification and new economic potential. However the access to social services is relatively low and the historical asset of the urban waterfront or specific industrial buildings can be increased.

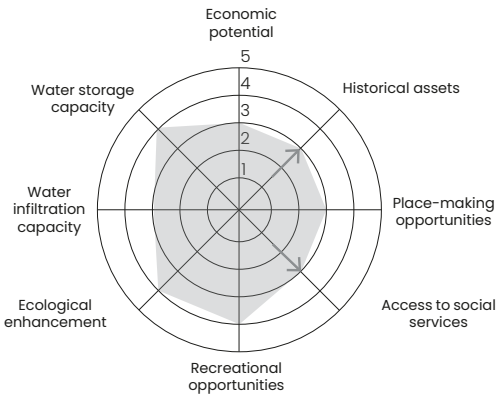




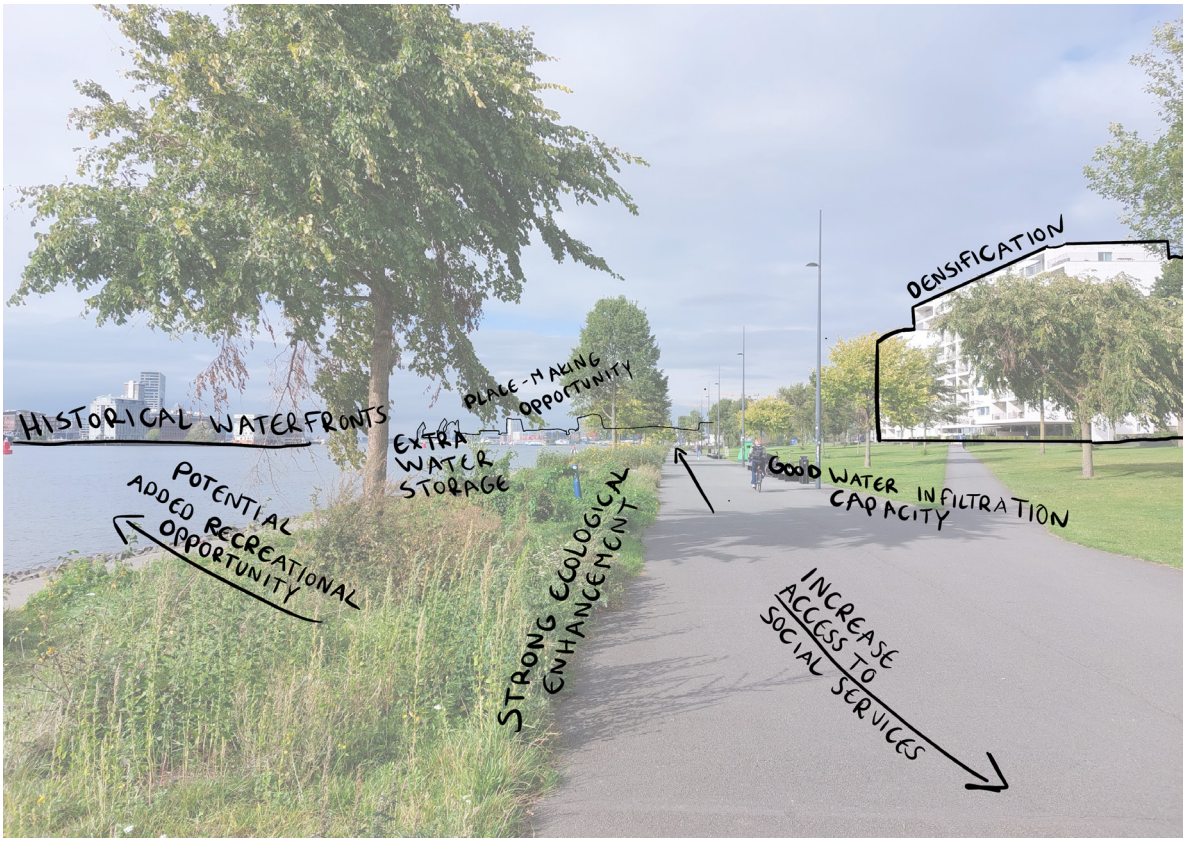
Nieuwendammerdijk / Buiksloterdijk

The Nieuwendammerdijk & Buiksloterdijk are exceptions of type 5 because there is very little space on these historical dike structures. However they do hold historical asset and ecological value. These areas can not be used for place-making or economic potential, because the limited amount of space. However there are small scale recreational opportunities and high potential for water management.





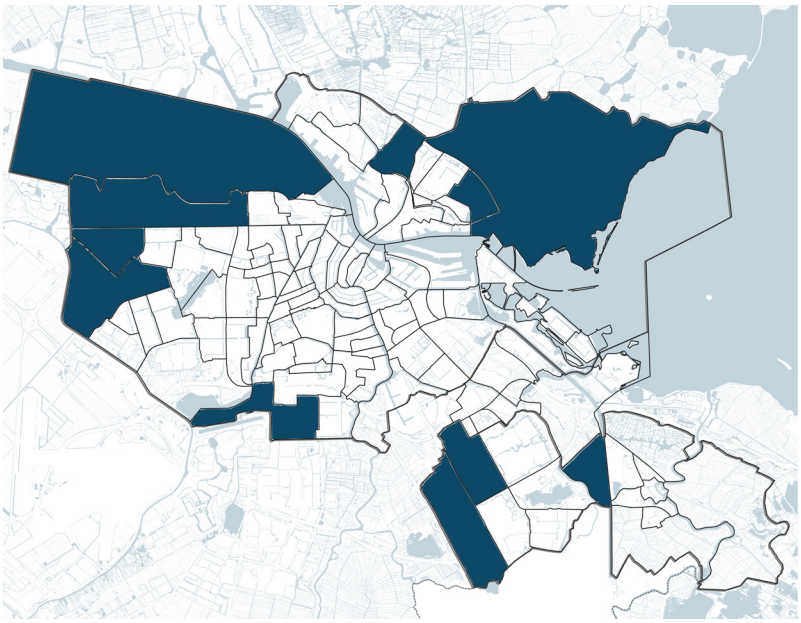
Although the Nieuwendammerdijk / Buiksloterdijk holds the same design qualities, it has not potential for large scale improvements or place-making like the archetype neighbourhoods. Concluding the Nieuwendammerdijk / Buiksloterdijk stills belongs to type 5, but this is not an area suitable for my design.

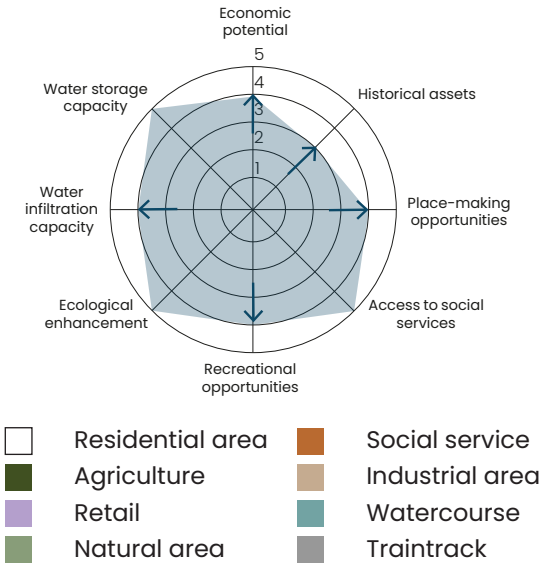

HISTORICAL WATERFRONTS
EXTRA WATER STORAGE
PLACE-MAKING OPPORTUNITY
DENSIFICATION
GOOD WATER INFILTRATION CAPACITY
POTENTIAL ADDED RECREATIONAL OPPORTUNITY
STRONG ECOLOGICAL ENHANCEMENT
INCREASE ACCESS TO SOCIAL SERVICES

SOCCER FIELD
OCCUPIED PUBLIC SPACE
SOCIAL SPACE
LITTLE TRANS-FOMATION POTENTIAL
HISTORICAL DIKE

QUALITATIVE ASSESSMENT OF TYPE VARIATIONS

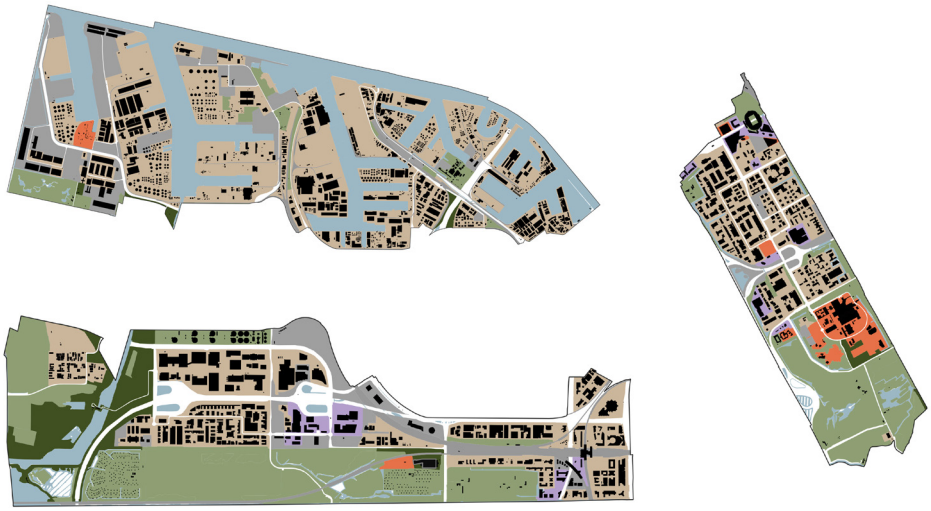
TYPE 6: 11 NEIGHBOURHOODS





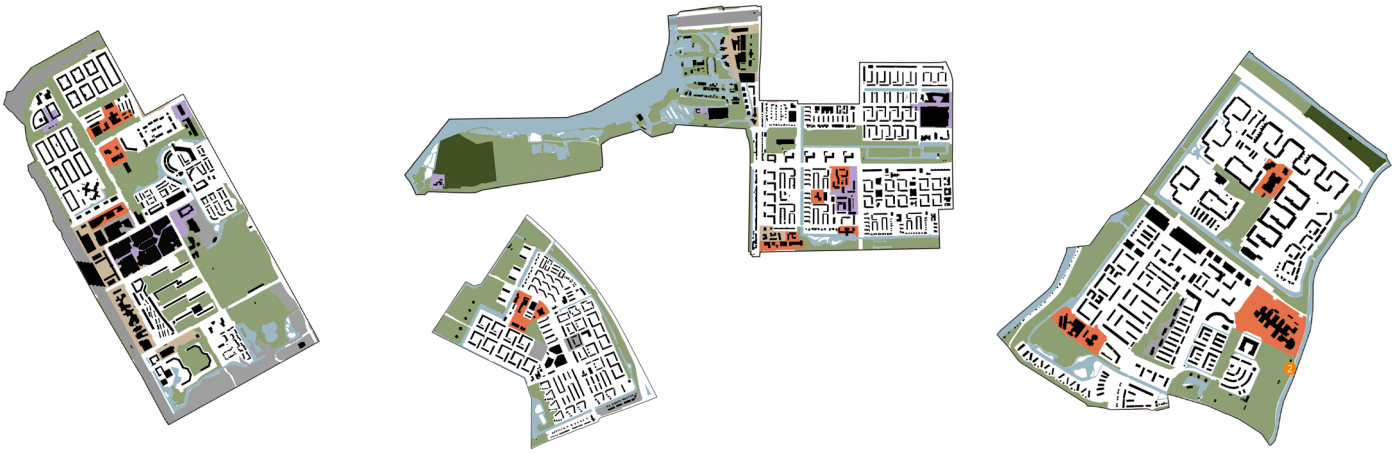
Type 6 is on the one hand the type with the largest transformation potential. Type 6 neighbourhood are on the edge of the city and already possess most of the qualities that are looked for in this design project. There are three variations to distinquish. The first variations are mixed residential neighbourhoods, they look a lot like the type 5 neighbourhoods, but have more space for transformation or water management. Moreover they already have social services and economic activity than type 5 neighbourhoods. The second variations are large scale industrial areas. These areas have high water management and economic potential. The place-making potential and historical assets could be increased in these neighbourhoods. Lastly there are large agricultural areas, that hold very high water management potential and ecological enhancement, but also can improve there historical assets and place making opportunities.

Large scale industrial areas open for future transformation



Large scale agircultural or natural areas open for future transformation

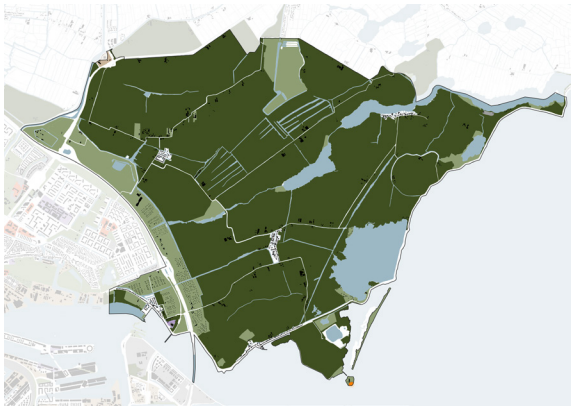
Mixed residential area and natural area with large space for transformation

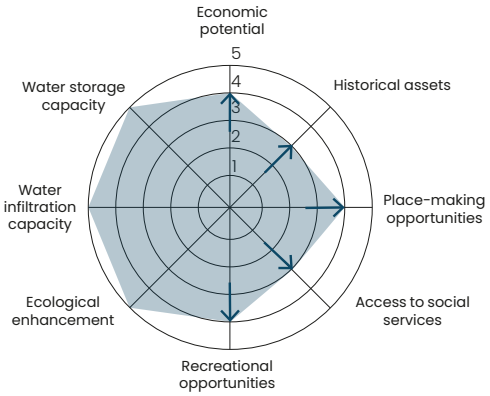


TYPE 6MAXIMISING LOCAL POTENTIALS

Waterland

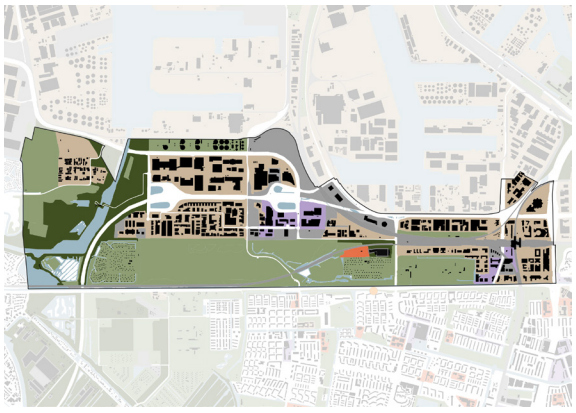
Waterland is large agricultural neighbourhood with small historic towns. It is a polder and therefore highly suitable for large scale seasonal water storage. The towns are protected townscapes and hold high historical value. The historical value of the landscape could be increased, by increasing the recreational opportunity in this neighbourhood

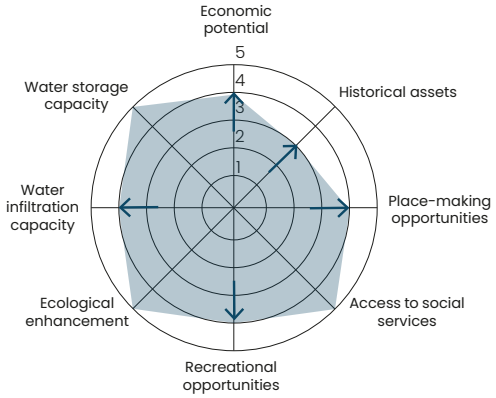




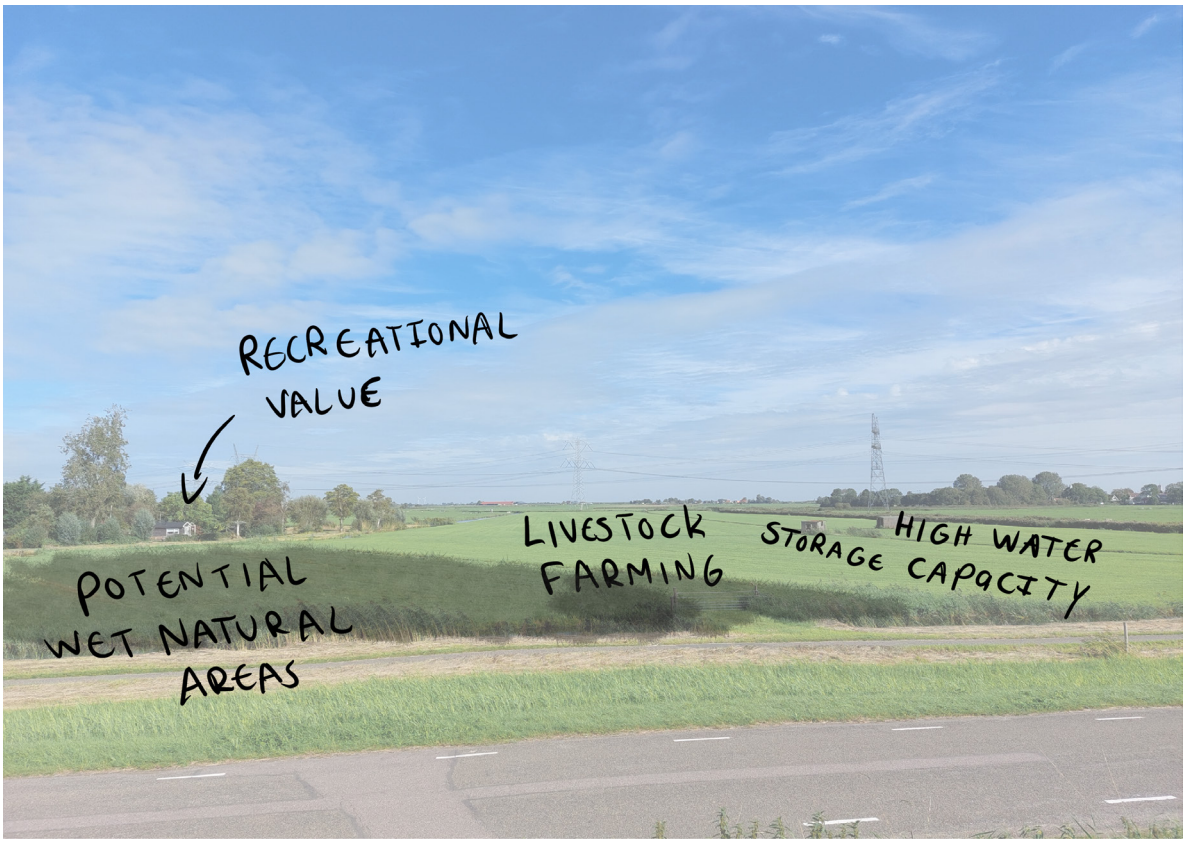
Sloterdijk / Nieuw-West

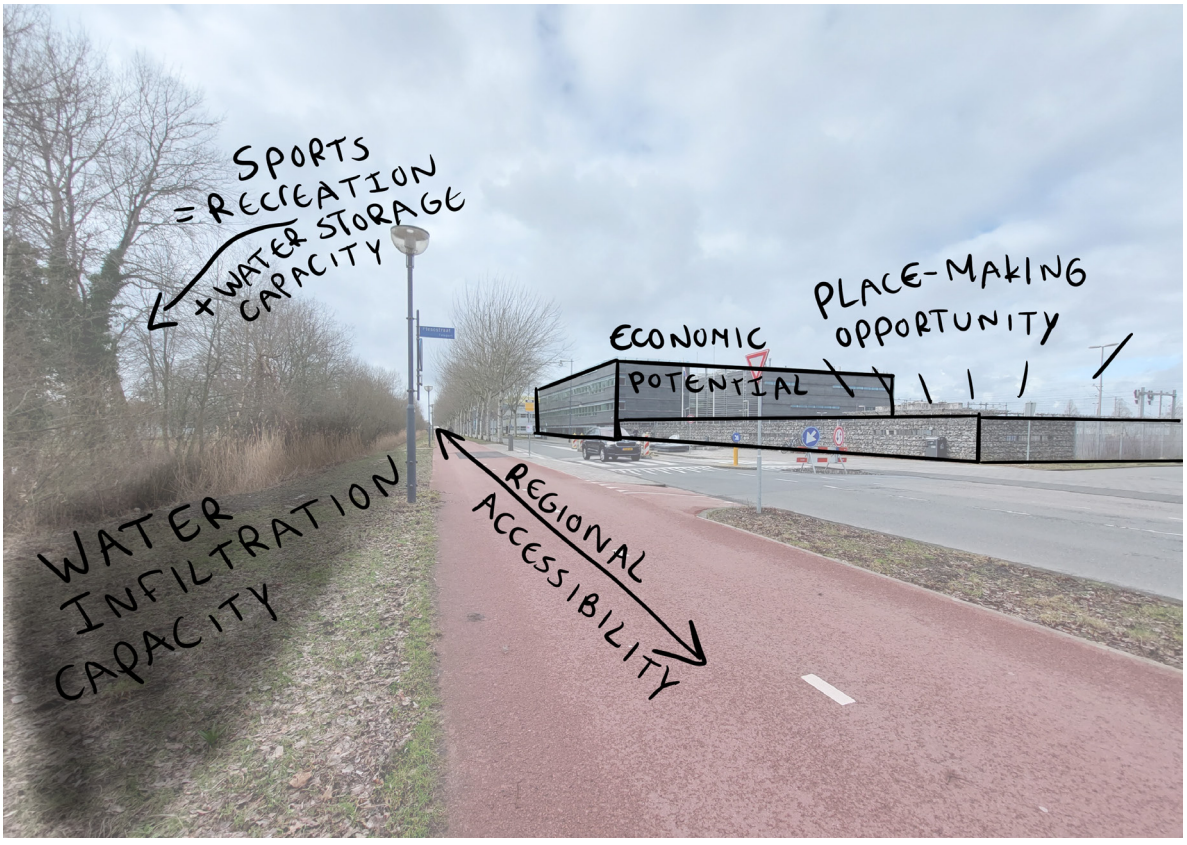
Sloterdijk / Nieuw-West is partly industrial area that is open for future transformation and it is partly recreational and natural space. It has creata access to social services and holds high economic potential. While the water storage and infiltration capacity is already high, this can be better designed. The historical assets are mainly industrial and it is yet to be determined how to use them for sustainable development.





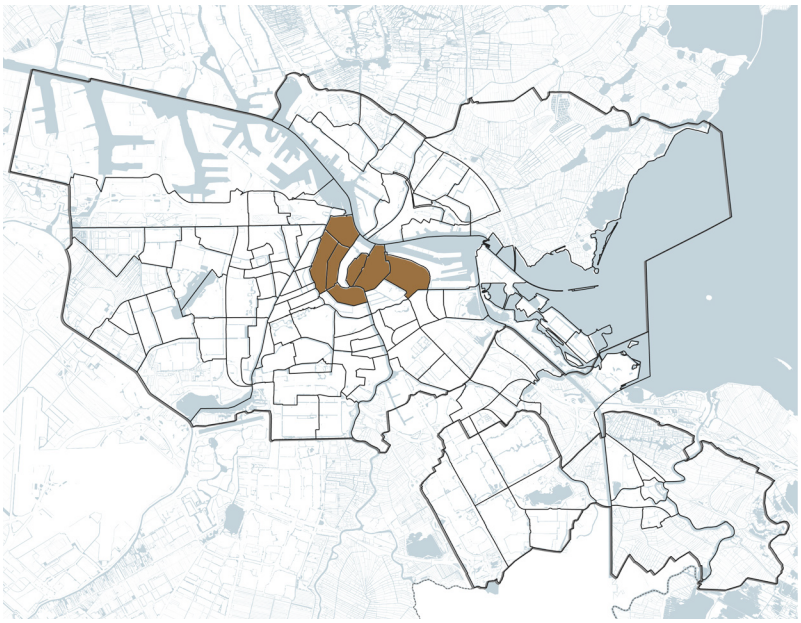
Type 6 are the edges of the city that hold great potential for large scale economic activity or could hold great potential as access to nature and the special provincial landscapes. However these activities are contrasting but economic potential can also come from recreational opportunities so there may be a possibility to unite these two qualities.

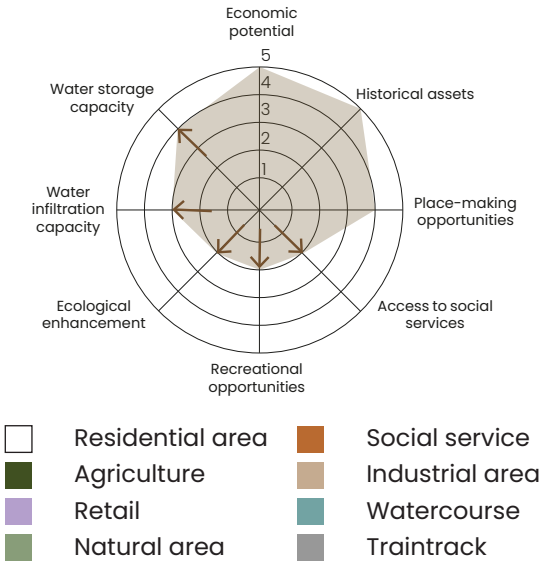

RECREATIONAL VALUE
POTENTIAL WET NATURAL AREAS
LIVESTOCK FARMING
HIGH WATER STORAGE CAPACITY


SPORTS = RECREATION + WATER STORAGE CAPACITY
ECONOMIC POTENTIAL
PLACE-MAKING OPPORTUNITY
WATER INFILTRATION CAPACITY
REGIONAL ACCESSIBILITY

QUALITATIVE ASSESSMENT OF TYPE VARIATIONS

TYPE 7: 7 NEIGHBOURHOODS





Type 7 is the historical inner city centre and canal ring. The neighbourhoods can be divided into two sub categories. The closed blocks of the canal ring, with little open space in between them and lots of economic and historical values. However as this is moslty privately owned, the access to social services is still low. The other sub-category consists of the neighbourhood bordering the IJ waterfront, they also have high economic and historical values. However they have more potential to add social and recreational value and ecological enhanced waterfronts. The water storage capacity is already quite high in these areas because of the many watercourses. However, because the area is highly human centered there is little ecological enhancement and this could be improved with small scale water infiltration and ecological improvements. From the survey it became clear that there is a need for more space to sit and relax along the canals.

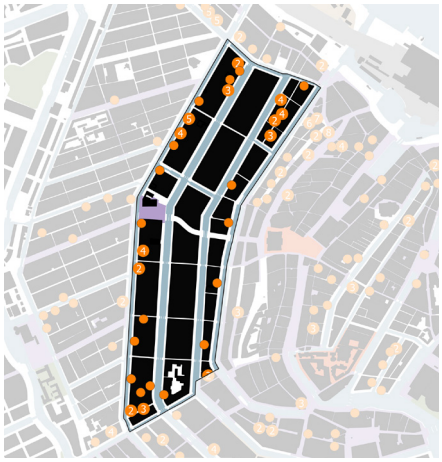
Closed block canal ring, UNESCO World Heritag Site

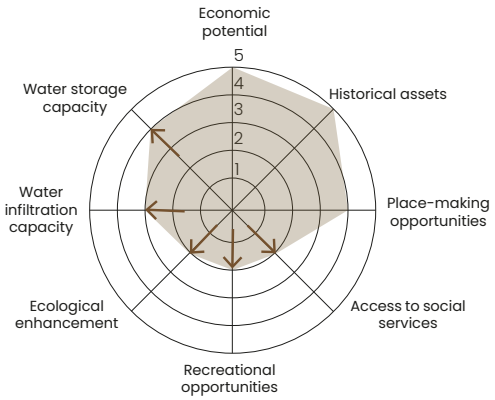
Historical urban waterfront

TYPE 7 MAXIMISING LOCAL POTENTIALS

Grachtengordel West

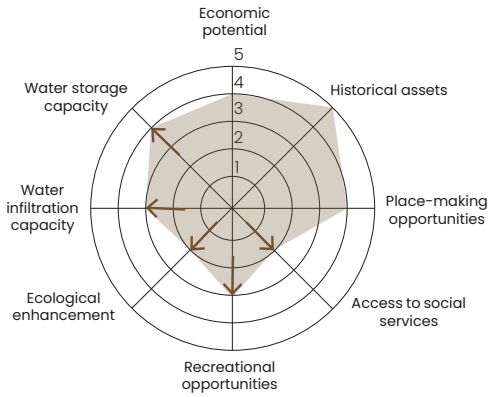
The grachtengordel are UNESCO protected sites and hold large historical asset and have great economic potential. However there is strong improvement possible on water infiltration capacity, recreational opportunity and ecological enhancement. Although the canals are relatively green, they are still car focused and access to sit along a canal is difficult.





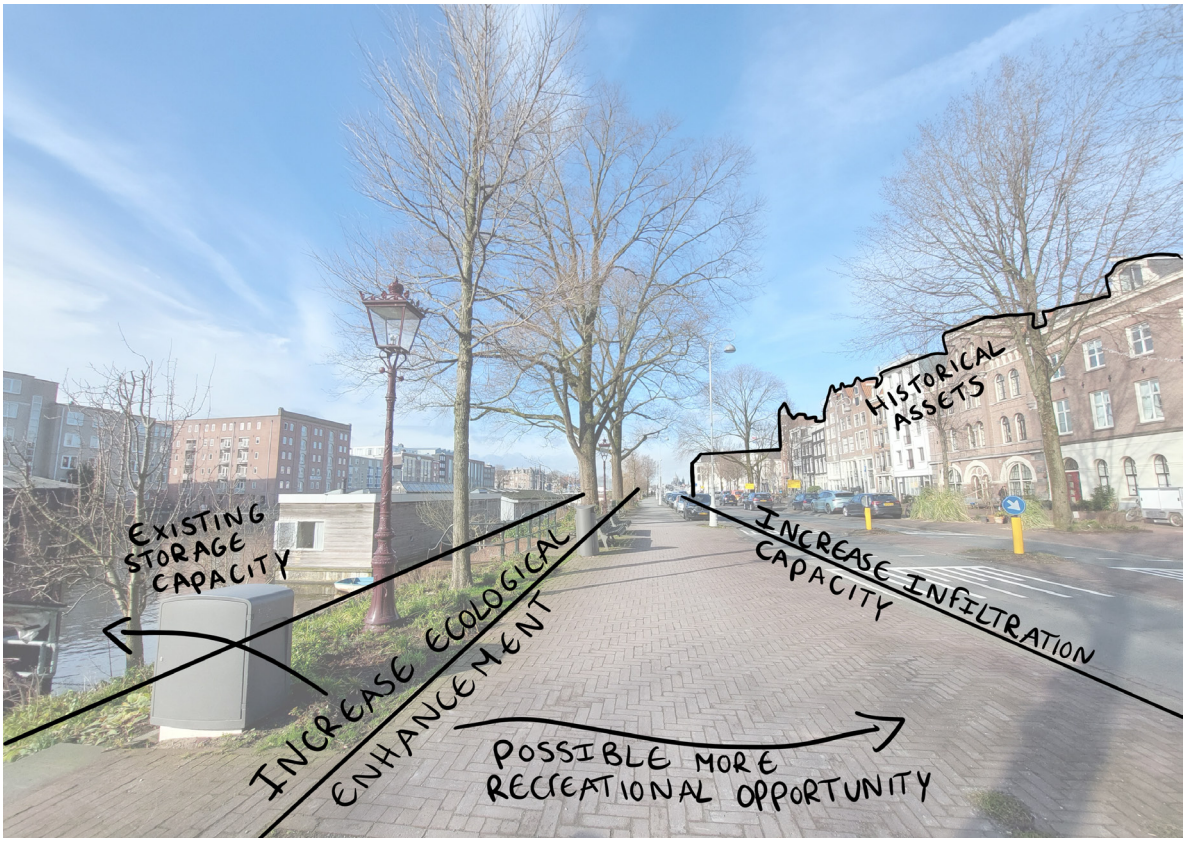
Oostelijke Eilanden / Kadijken

The Oostenlijk Eilanden / Kadijken are larger histircal areas, with a lower GSI. They have the same type of mix between residential buildings, offices and economic activity, but there is a lot more public space that is open for transformation. You can clearly see that there is a lot more space for water infiltration, water storage, ecological enhancement and recreational opportunities.



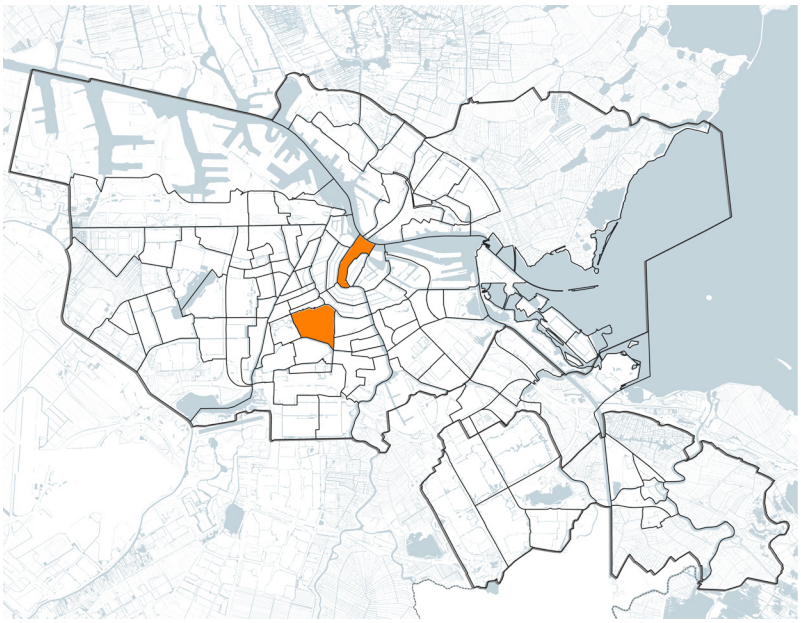
Concluding type 7 these neighbourhoods have great historical asset and economic potential to catalyse socio-ecological values. There is a lot of improvement possible in terms of climate adaptation. The waterfronts have more transformation potential than the canal ring. From the survey it became clear that there is a need for more possbilities to sit and relax along the historical waterfronts.

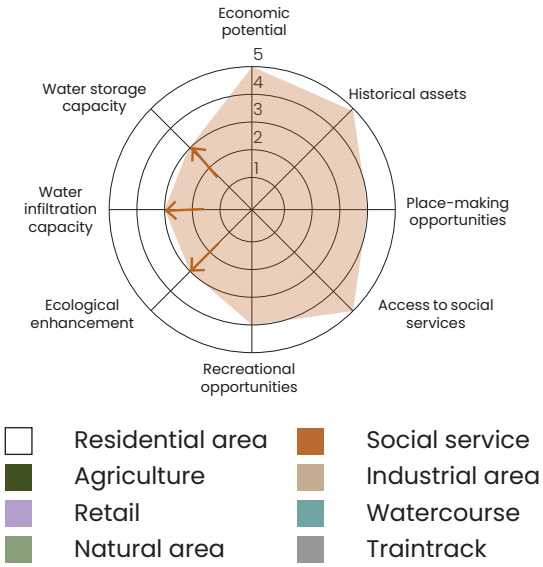
HISTORICAL ASSET
WATER SOMEWHERE HERE
POTENTIAL ADDED ECOLOGICAL VALUE
NO CANAL ACCESS
MOBILITY FOCUSSED
NO INFILTRATION CAPACITY


HISTORICAL ASSETS
EXISTING STORAGE CAPACITY
INCREASE ECOLOGICAL ENHANCEMENT
INCREASE INFILTRATION CAPACITY
POSSIBLE MORE RECREATIONAL OPPORTUNITY

QUALITATIVE ASSESSMENT OF TYPE VARIATIONS

TYPE 8: 2 NEIGHBOURHOODS

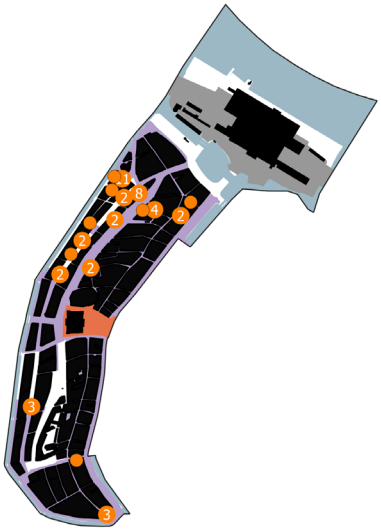




Type 8 are the two neighbourhoods that are the economic and touristique core of the city of Amsterdam. On the one hand you have the entrance to the city centre and historic heart of the city with the Dam and central station. On the other hand you have the cultural epicentre with the Rijksmuseum and Museumplein bordering the Vondelpark. Bot neighbourhood have the highest historical assets, economic potential and access to social services. However the ecological value and water management is strongly neglected. Because of the high place-making opportunity neighbourhood in type 8 can have advanced climate adaptation of cultural heritage sites, combined with small scale water storage in the urban environment, which can be used to promote climate adaptation among visitors from all over the world.

Museumkwartier

Burgwallen - Nieuwe Zijde



TYPE 8 ANALYSIS MAXIMISE LOCAL POTENTIAL

Museumkwartier

Burgwallen - Nieuwe Zijde

APPENDIX F: SPECIE TAXONOMY

Zone 1: Blossoming vegetation zone:
Patches with year-round blossoming flowers:

Lavender *(Lavandula angustifolia)*
- Blossoming: Late spring to early summer
- Height: 30 cm
- Colour: Purple to violet blue
- Attracts butterflies and bees

Multicolor coneflower *(Echinacea spp.)*
- Blossoming: Summer to early Fall
- Height: 60-120cm
- Colour: Purple, white, red and yellow
- Attracts butterflies and bees

Black-eyed Susan *(Rudbeckia fulgida)*
- Blossoming: Summer to Fall
- Height: 60-90cm
- Colour: Yellow
- Attracts butterflies and bees

Daffodils *(Narcissus spp.)*
- Blossoming: Spring
- Height: 20-40cm
- Colour: Yellow

Tulips *(Tulipa spp.)*
- Blossoming: Spring
- Height: 20-60cm
- Colour: Varies

Hyacinths *(Hyacinthus spp.)*
- Blossoming: Spring
- Height: 20-30cm
- Colour: Purple to blue

Goldenrod *(Solidago spp.)*
- Blossoming: Late Summer to Fall
- Height: 30-150cm
- Colour: Yellow

Sunflower *(Helianthus annuus)*
- Blossoming: Summer to Fall
- Height: 1.5-3m
- Colour: Yellow
- Attracts birds, bees, and butterflies

Firewheel (*Gaillardia pulchella*)
- Blossoming: Late spring to summer
- Height: 20 - 60 cm
- Colour: Red

Zone 2: Socio-ecological activities:
Species for supporting a community garden or urban farm:

Thyme *(Thymus vulgaris)*
- Blossoming: Late spring to summer
- Height: 15-30 cm
- Colour: Small, white to pale pink flowers
- Edibe herb

Chives *(Allium schoenoprasum)*
- Blossoming: Late spring to early summer
- Height: 30-50 cm
- Colour: Small, purple flowers
- Edible herb

Calendula *(Calendula officinalis)*
- Blossoming: Late spring to summer
- Height: 30-60 cm
- Colour: Bright yellow or orange flowers
- Attracts bees and butterflies
- Edible flower

Nasturtium *(Tropaeolum majus)*
- Blossoming: Summer to early fall
- Height: 20-40 cm
- Colour: Shades of orange, red, and yellow
- Attracts butterflies and bees
- Edibe flower

Borage *(Borago officinalis)*
- Blossoming: Summer to early fall
- Height: 60-100 cm
- Colour: Bright blue flowers
- Edible and used as a garnish or in a drink

Black chokeberry *(Aronia melanocarpa)*
- Blossoming: Late spring to early summer
- Height: 1 - 2 m
- Colour: White flowers and black berries
- Can be used to make jam, jellies and juice

Giant hyssops *(Agastache foeniculum)*
- Blossoming: Midsummer to early fall
- Height: 60 - 120 cm
- Colour: Purple to violet-blue
- Strong anise smell

Twisted leaf garlic (Allium obliquum)
- Blossoming: Summer
- Height: 80 - 100 cm
- Colour: Greenish yellow
- Eadible garlic flavoured plant

Zone 3: Bioswales and phytoremediation zone:
Plants that decontaminate the soil or water or grow well in watery environments

Common cattail *(Typha latifolia)*
- Blossoming: Summer
- Height: 1.5-3m
- Colour: Brown
- Helophyte filerting plant

Soft Rush *(Juncus effusus)*
- Non-blossoming
- Height: 30-60cm
- Colour: Green

Common reed *(Phragmites australis)*
- Non-blossoming
- Height: 1 - 2 m
- Colour: Green and brown
- Accumulates copper from the soil

Water plantain *(Alisma plantago-aquatica)*
- Blossoming: Summer
- Height: 30-60cm
- Colour: White
- Helophyte filtering plant

Yellow iris *(Iris pseudacorus)*
- Blossoming: Late spring to early summer
- Height: 90 - 150 cm
- Colour: Yellow
- Helophyte filtering plant

Indian mustard *(Brassica juncea)*
- Blossoming: Spring
- Height: 30 - 90 cm
- Colour: Yellow
- Accumulates lead from the soil

Chinese silver grass *(Miscanthus sinensis)*
- Blossoming: Late summer to fall
- Height: 30 - 100 cm
- Colour: Yellowish green

Water hyacinth (*Eichhornia crassipes*)
- Blossoming: Summer
- Height: 30 cm
- Colour: Green leaves and purple flowers

Alpine pennycress (*Thlaspi caerulescens*)
- Blossoming: Late spring to early summer
- Height: 20 - 60 cm
- Colour: White flowers
- Accumulates cadmium and zinc from the soil

Sunflower *(Helianthus annuus)*
- Blossoming: Summer to Fall
- Height: 1.5-3m
- Colour: Yellow
- Attracts birds, bees, and butterflies
- Accumulates arsenic and ceasium from the soil

Zone 4: Urban ecology zone:
Plants in pots and semi-permeable areas

Stonecrop *(Sedum spectabile)*
- Blossoming: Summer
- Height: 10-50cm
- Colour: Pink flowers
- Attracts butterflies and bees

Japanese sedge *(Carex morrowii)*
- Non-blossoming
- Height: 30-40cm
- Colour: Green

Fountain grass *(Pennisetum alopecuroides)*
- Blossoming: Summer to Fall
- Height: 90-120cm
- Colour: Orange-bronze in autumn

Russian sage *(Salvia yangii)*
- Blossoming: Late summer to early fall
- Height: 60 -90 cm
- Colour: Purple
- Attracts butterflies and bees

Japanese pieris *(Pieris japonica)*
- Blossoming: Spring
- Height: 1.5-2m
- Colour: Reddish - bronze

Lavender *(Lavandula angustifolia)*
- Blossoming: Late spring to early summer
- Height: 30 cm
- Colour: Purple to violet blue
- Attracts butterflies and bees

Purpletop vervain *(Verbena bonariensis)*
- Blossoming: Summer to fall
- Height: 90 - 180 cm
- Colour: Purple
- Attracts butterflies and other pollinators

Black Mondo Grass *(Ophiopogon planiscapus)*
- Blossoming: Late spring to summer
- Height: 15 - 30 cm
- Colour: Black

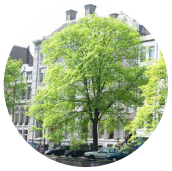
Trees that support biodiversity

Silver maple (*Acer saccharinum*)
- Blossoming: Flowers in March and autumn colors
- Height: 20 - 25 m
- Colour: Green to yellow
- Attracts birds, small mammals, bees and butterflies

Japanse Maple (*Acer palmatum*)
- Non blossoming
- Height: 2 - 4 m
-Colour: Deep red especially in fall
- Provides shelter for brids and small mammals

European horse-chestnut (*Aesculus hippocastonum*)
- Blossoming: Spring flowers
- Height: 10 -25 m
- Colour: Green to white
- Attracts butterflies and bees

Hawthorn (*Crataegus monogyna*)
- Blossoming: Late spring to summer
- Height: 5 - 10 m
- Colour: White flowers and red berries
- Attracts bees and provide food for birds



Elm *(Ulmis minor)*
- *Blossoming: March*
- *Height: 20 - 25 m*
- *Colour: Green*

Linden / lime tree (*Tilia spp)*
- Blossoming: June to july
- Height: 15 - 25 m
- Colour: Green to yellow in autumn

Target trees for phytoremediation

Black poplar (*Populus nigra*)
- Non blossoming
- Height: 15 -20 m
- Colour: Green
- Provide nesting for birds
- Accumulates lead from the soil

Silver poplar (*Populis alba*)
- Blossoming: Spring
- Height: 15 -20 m
- Colour: Green
- Provide nesting for birds
- Accumulates lead from the soil

Pollard willow (*Salix alba*)
- Blossoming: Catkins in spring
- Height: 5 m if pruned
- Colour: Yellowish green
- Provide nesting for birds and food source for bees
- Accumulates cadmium from the soil

Weeping willow (*Salix babylonica*)
- Blossoming: catkins in spring
- Height: 12 -15 m
- Colour: Green to white
- Provide nesting for birds and food source for bees
- Accumulates cadmium from the soil