



The solutions are under the soil.

Activating the UNESCO archaeological sites of the Lower Germanic Limes in Nijmegen by creating sustainable places for the cultural memory.

*P5 Report
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Abstract

Archaeological visibility, UNESCO development, Dutch Layer approach, Urban Palimpsest, Roman Heritage, Awareness of History

Around 19BC the Romans established their military camps on the hills of Nijmegen in their conquest of Germania. After a huge defeat the Roman Empire decided that the great Rhine river would be the permanent border of the empire. From that moment on the Lower Germanic Limes was fortified in stone to protect the border from the tribes north of the river. After 100 AD the Rhine tributary started flowing southwards, the Dutch constructed their dikes and urbanization sped up. Nowadays the historic knowledge of the Romans is protected in archaeological locations by UNESCO.

However above ground this archaeology isn't experienced in the urban fabric and additionally the cultural memory of this history induces a local identity, but the locations don't allow for place attachment or a representation of this identity. Therefore the challenge is how to translate this experience to the current locations as part of their heritage and the main question can be formulated as "How can urban design sustainably develop the UNESCO sites in Nijmegen-Oost to create awareness and create place attachment for the cultural memory of Roman Nijmegen?"

Nijmegen was chosen for this thesis, since it has the highest concentration of UNESCO sites within the Limes in the Netherlands, with 4 overlapping archaeological areas. These locations were analysed through the Dutch Layer Approach in Roman and current times, becoming a Diachronic Layer Approach that shows opportunities for transformation and Roman visualizations.

This research firstly aims to create an elaborate design for the Limes in Nijmegen by using methods to design with archaeology. Secondly it seeks to reflect on these methods by testing designs and using theory to develop a comprehensive method on designing with archaeological heritage, which is in its infancy at the moment. The report builds upon the Limes Atlas from 2005 and where Robert Broesi categorized 10 ways of doing this with references. Using these as design methods sparked creativity, but also showed that there are more elements to the process. The main findings were more ways of creating visibility, how interaction with senses and activities created awareness, but also that the site must have a sustainable impact to function in the community. Furthermore the incorporation of a questionnaire, in cooperation with the municipality of Nijmegen, determined what the inhabitants view as heritage and opportunities of the sites. This research shows that solutions to current challenges are truly under the soil and that the two fields of archaeology and urban design should interact more in future developments.

Preface

This P5 report was made for the Master track of Urbanism at the Delft University of Technology and dives into my personal interest of Roman archaeology and tries to incorporate this research into the field of Urban Design. The ancient civilizations that have gone before us are a place of wonder for me and many others. Moreover I feel personally connected to the area of Nijmegen that I chose to work on. I grew up hearing the stories of Romans in Nijmegen, visiting museums and even some excavations on building sites together with my parents. I hope this passion is conveyed through my research to design with these stories and bring them to life.

01. CHALLENGES

Introduction, history, urgency, research location

The first chapter will introduce the Lower Germanic Limes and its main characteristics, the developments that the border has undergone, the issues for protection and interaction with archaeological heritage. The end reveals the research location and concludes with the problem statement.

1.1 Introducing the Limes

In the year 9 AD the Roman Army lost greatly to the Germanic tribes in the Battle of the Teutoburg Forest. This moment was very vital to the development of Europe, since it meant that the Roman Empire quit their ambition of conquering Germania and settled behind the great Rhine river as the natural barrier of the empire (Polak et al., 2020).

The Lower Germanic Limes is a section of the Roman border that has different characteristics from other parts (image 1.1); it was protected by fortifications relating to water and soggy soil. It runs from the German province of Rhineland-Palatinate, through the Netherlands into North Sea. The Lower Germanic Limes became UNESCO World Heritage in 2021 after its archaeological monuments were brought forward for protection. UNESCO aims to protect all sections of the Roman frontier system in the future as one entity as it was before.

The importance of the Lower Germanic Limes lies in the quality of archaeological remains found in this area (Polak et al., 2020). Due to the high water level in this low lying region, much of the stone and timber has been preserved very well underground.

The border area was a host to a lot more activity than inland due to the large concentration of fortifications, infrastructure and architecture. This caused more locals to settle down around the forts and create a base for trade of goods from all around the empire over roads and waterways. Romans also brought their religion, military practices and politics with them and influenced the local population for centuries.

It introduced the Roman urban traditions further into Europe and many cities like Paris or London found their origin here. One can claim that it is the start of urban life for the Low Countries.



Image 1.1: Frontier of the Roman Empire with the Lower Germanic Limes around 117AD (based on Tataryn, 2012)

- = Battle of Teutoburg Forest
- = Frontier of the Roman Empire 100AD
- = The Lower German Limes
- = Roman Empire

1.2 Borderland

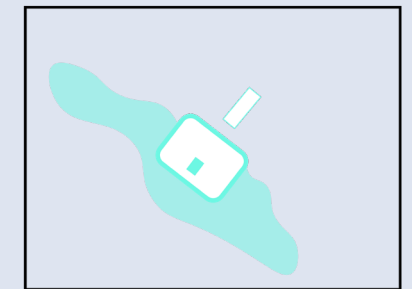
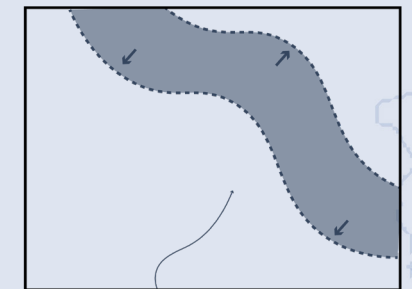
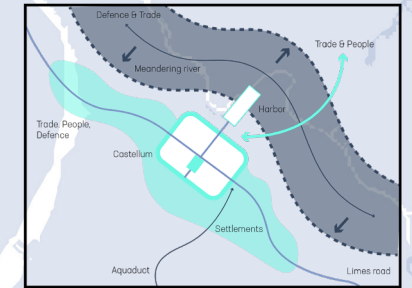
The Limes was a dynamic border bustling with live and trade. The need for defence made it a centre for activities in the Low countries. The Limes was lined with military instalations like forts, settlements and constructions like roads or aquaducts (Polak et al., 2020b). The river was also not a wall, nor was it a strong border. It was open and tribes were allowed to live within the empire even though they did not have Roman citizenship (image 1.3). Between the two cultures was a hybrid zone where the two mixed (Tuuk, 2017) The river was also not a stagnant border, it was still meandering and not held in place by dikes. Even though the whole idea of the border is a line with movements, it is protected only in these certain spots (Image 1.2).

Most castella (fortifications) were placed in the elbow of the rivers course so it wouldn't be flooded (Colenbrander, 2005). Many Roman coins have been found far up north, meaning that trade of goods happened between non-roman tribes in the north and the Roman empire in the south. Trade, supplying and mobilizing the army took place on the river and along it on the Limes road. These were the lifelines connecting all the castella of the Roman border. Around a castellum people created settlements called Vicus to cater to the needs of the army (Colenbrander, 2005). Local goods and services were sold creating an economic impulse for the region. The Limes border therefore exists of three elements, namely the water, the roads and the structures (image 1.3).

- = Upper Rhine in 100AD
- = Castellum
- = Roman Empire
- = UNESCO World Heritage Site
- = Limes Road
- = Nijmegen

Image 1.3: Movement along the river at a typical castellum and their elements (based on Colenbrander, 2005)

Image 1.2: Unesco locations in the Netherlands along the Limes road (based on Polak et al., 2020a)



1.3 Development of the line

The Rhine is synonymous with the Lower Germanic frontier and this was greatly solidified in the year 100AD with the construction of permanent stone fortifications.

During the Roman occupation of the Northern Tributary a change in the course of Rhine was already noticed. More water started flowing southwards and with that bringing the border in danger (image 1.4). If the Rhine became increasingly crossable and less navigable, it would become harder to defend. Near Herwen (at the German border today) where the Rhine splits the Romans installed a dike system to send more water flowing North. These are the first signs of water management in our country.

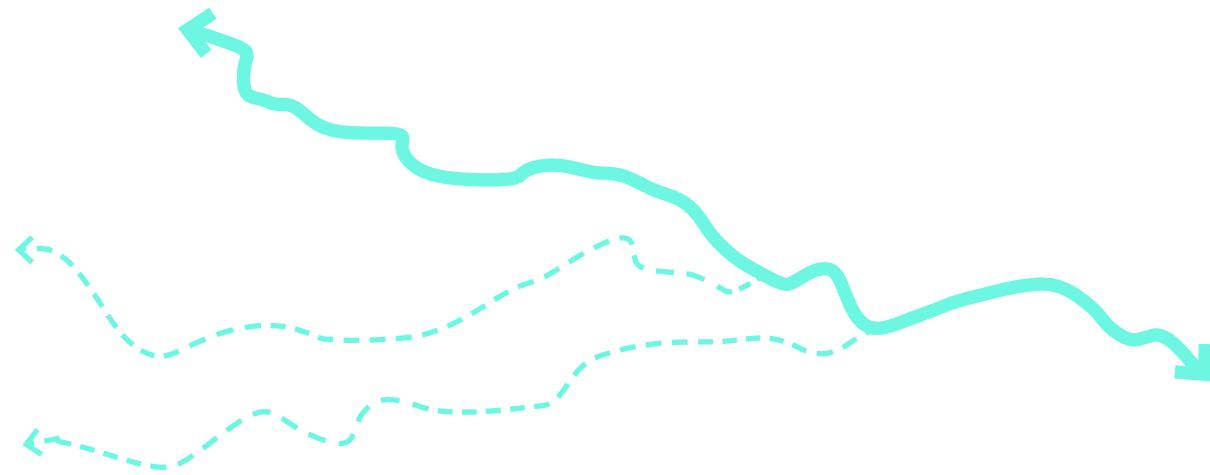
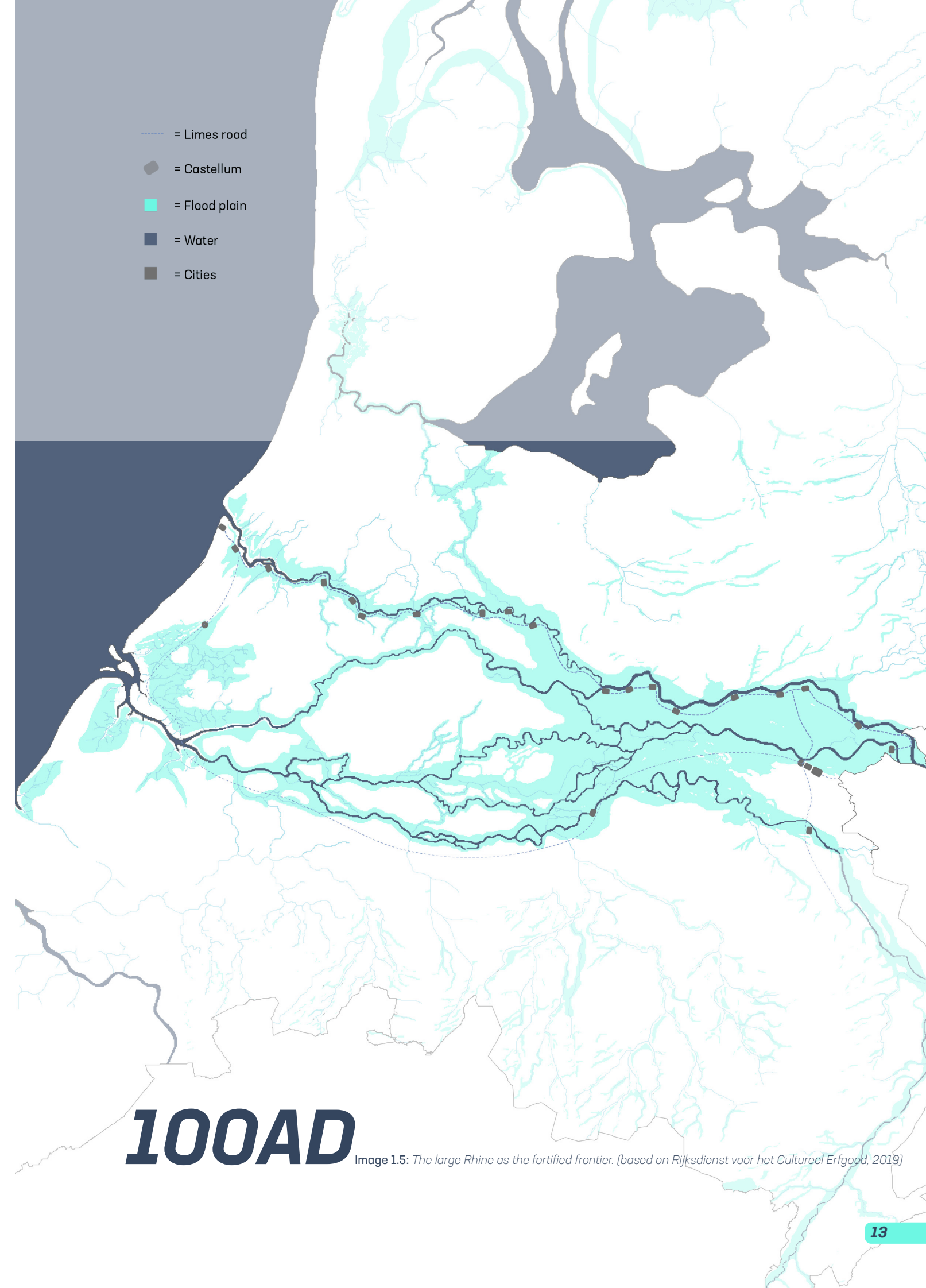


Image 1.4: The Rhine from 100AD flowing south.

Many years after the presence of Romans the river did start flowing south due to the northern tributary closing up (image 1.6). Around 1500 this had been greatly enhanced by the installation of dikes around the rivers (image 1.7). This locked their course in place and controlled their flow (Hooimeijer et al., 2005). What used to be the great Rhine was now partially cut off from the natural flow of water to prevent flooding. Keeping the rivers in place also meant that urbanisation could spread freely over the low lands and the rivers could be navigated easily to prosper in trade (image 1.8).



100AD

Image 1.5: The large Rhine as the fortified frontier. (based on Rijksdienst voor het Cultureel Erfgoed, 2019)

- = Limes road
- = Castellum
- = Flood plain
- = Water
- = Cities

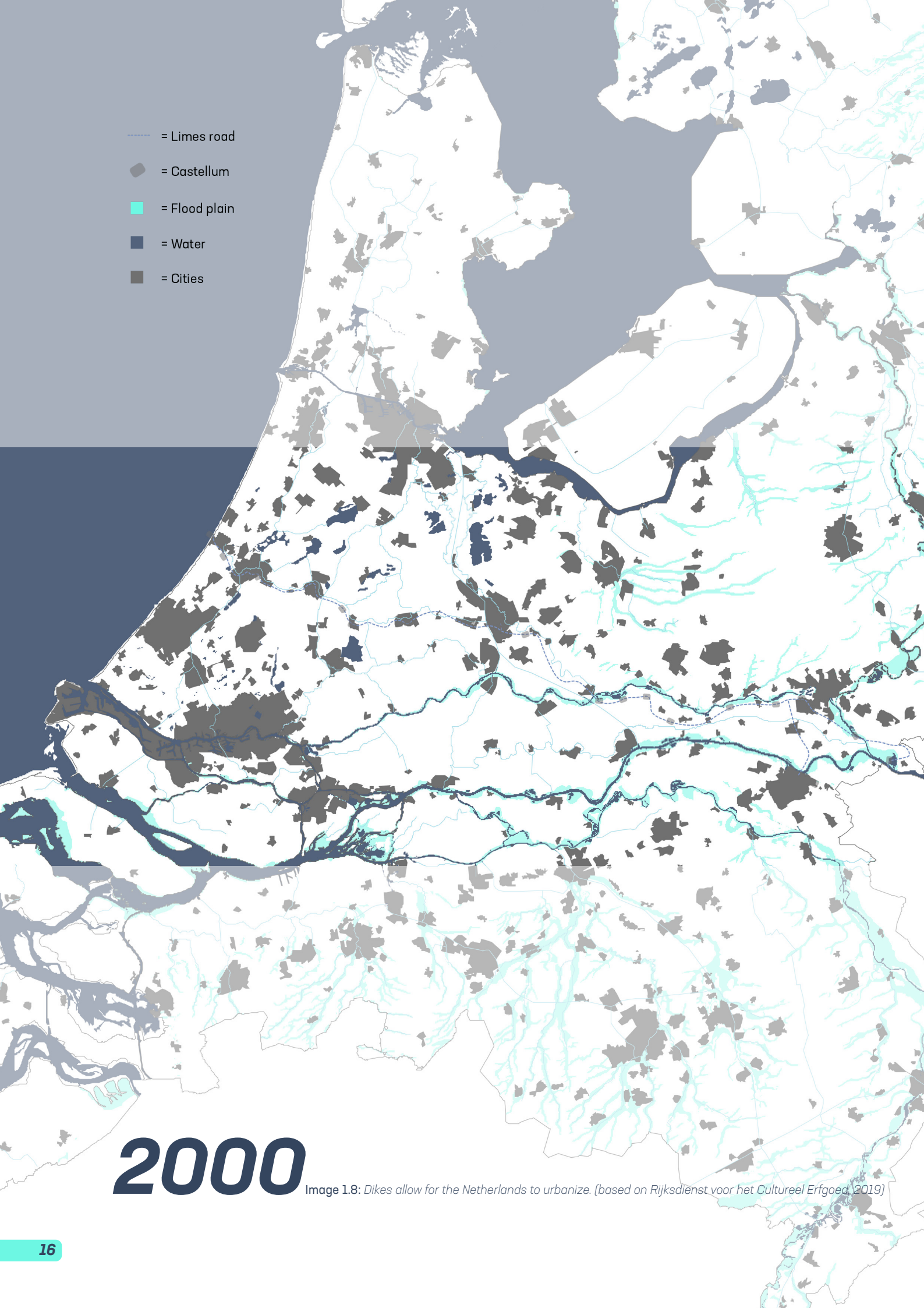
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Image 1.6: The Rhine flows south due to sedimentation. (based on Rijksdienst voor het Cultureel Erfgoed, 2019)

- = Limes road
- = Castellum
- = Flood plain
- = Water
- = Cities

1500

Image 1.7: The old Rhine is cut off with dikes to prevent flooding. (based on Rijksdienst voor het Cultureel Erfgoed, 2019)



2000

Image 1.8: Dikes allow for the Netherlands to urbanize. (based on Rijksdienst voor het Cultureel Erfgoed, 2019)

1.4 Surface and subsurface

The Romans stayed in the Netherlands for over four centuries and left a large impact on the landscape, but after many more centuries what remains of the Roman structures are buried underground. There are however some examples of how the frontier is shown today. Fortifications are protected and hidden under parks like in Hunnerpark, Nijmegen (image 1.9). Here a sign notifies people what is beneath them.

The last example is on the Hunnerberg in Nijmegen where the pavement in a housing area subtly reveals that an Amphitheater was once on that exact spot (image 1.11). A wide array of new landscapes developed on top on the Roman landscape and this is one of the difficulties of protecting and designing for the Lower Germanic Border. For every design it will be about the above ground and underground relations for any visualisation.

Another example is the Grote Kerk in Elst, which is a church build upon the remains of a temple. One place of worship continues into another (image 1.10).

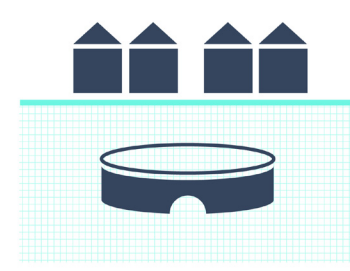
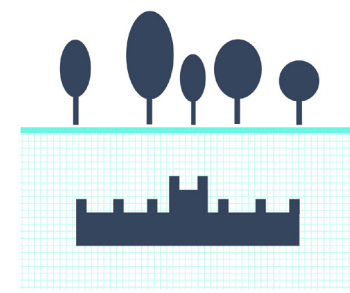


Image 1.9 A sign explains where the fort was for hickors (van Dinteren, 2017)



Image 1.10: Temple foundations underneath the Grote kerk in Elst (Tempel Kerk Museum Elst, 2018)



Image 1.11: Amphitheater in the pavement in Nijmegen (Joris, 2020)

1.5 Urgency for protection

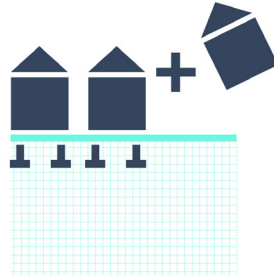
The sites are put under protection of UNESCO to secure them from harmful functions that could influence the archaeology. It is to control what happens on top of the sites and to retain the knowledge that is in the soil for future generations. All archaeology must be kept in situ and only ex situ (excavated) if preservation underground cannot be guaranteed (Bringmans, 2018). The remains are locked in its context and research will only be performed once with future techniques and paradigms. Harmful practices such as agriculture (ploughing), urbanisation (foundations) and placement of trees (roots) are limited. Current trends of climate adaptation (Ministerie van Algemene Zaken, 2021) and the housing shortage (Obbink, 2020) in the Netherlands also put pressure on space on and under the soil, which makes protection even more urgent.

A hold is put on the location, but at the same time potential is unlocked (Image 1.12). Tourism can become a great resource for the city, due to the brand of UNESCO putting the sites on the same list as Taj Mahal, The Great Wall of China and the Pyramids. Reuse of heritage is also a sustainable solution of coping with future needs of the city. Heritage needs to play an active role in the community its in instead of just being protected. This will protect the heritage sustainably for the long term and have financial incentives for the community. (Obad Šćitaroci & Bojanić Obad Šćitaroci, 2019). Protection can therefore also turn into an opportunity.

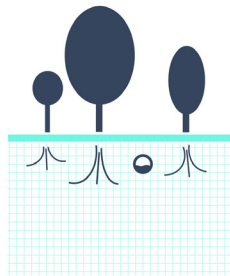
UNESCO PROTECTION OF ARCHAEOLOGY



HOUSING SHORTAGE



CLIMATE ADAPTATION



TOURISM POTENTIAL

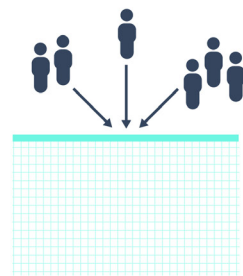


Image 1.12: Icons for the pressures on the new UNESCO heritage sites.

1.6 Research location

Nijmegen was selected for this case study, because it has the highest concentration of UNESCO protected sites of the Limes, namely five (Image 1.13 & 1.14). Nijmegen-East was specifically chosen for this in depth research for its high density with three of these sites overlapping in an Urban context. The first two carry fortifications with multiple iterations and developments during the Roman times. The third site is an aquaduct that was built to supply the army camps with a clean and steady flow of water from the hills outside the city. Nijmegen was subject to 400 years of Roman influence and the most important and oldest Roman settlement that is located in the Netherlands today (van der Heijden, 2008). The confluence of these places and the intensive history makes it a prime spot for my research and design. Nijmegen is also unique in the Limes since it is not directly at the border. Furthermore I grew up in this city and therefore share a personal connection to the city. I am one of the people that is proud of the great stories of Nijmegen as the oldest city in the country and heard these growing up without being able to see these grand structures anymore. This makes me very passionate to research this history and visualize it in designs as well.



Image 1.13: Location of Nijmegen within the Netherlands and the Limes UNESCO Sites (Polak et al., 2020b)

Image 1.14: UNESCO world heritage sites in Hunnerberg, Nijmegen (Polak et al., 2020b).



Problem statement

Around 1980 the Romans established their military camps along the great Rhine as the natural border. In the 2000 years following this the rivers started flowing differently, the Dutch built dikes and urbanization developed. Nowadays the historic knowledge is protected in archaeological locations by UNESCO. However above ground this archaeology often isn't experienced in the urban fabric. The line was also a dynamic river bustling with activity and movement, while UNESCO protects it in a few spots. Moreover the cultural memory of this history induced pride and a local identity, but the locations don't allow for place attachment or a representation of this identity. Therefore the problem is how to translate this Roman experience to the present in the location of Nijmegen-East.

02. METHODOLOGY

Theoretical framework, research question, methods, structure

The problem statement is supported by theory on heritage and is translated into a research question. The methods are laid out that will lead to the expected outcome of this research. This determines the structure of this report, which is introduced in form of a conceptual framework.

2.1 Theory

UNESCO world heritage development

UNESCO stands for the United Nations Educational, Scientific and Cultural Organization and its main goal is to encourage exchange of knowledge by ensuring the safeguarding of cultural and natural heritage (UNESCO, 2022). UNESCO does this by instating programmes that are in line with the Sustainable Development Goals for 2030 set at the UN General Assembly in 2015. The UNESCO brand of protection draws a great amount of attention to the protected sites and give them the opportunity to sustainably develop them as touristic sites. Local residents may also enjoy the improved quality of public space with the effects of redevelopment (Cao et al., 2021). Tourists seek destinations that have a great amount of authenticity and a feeling of otherness from another culture. At the same time there is the threat of 'Disneyfication' where everything becomes more similar to ensure quality and decreasing otherness. (Khirfan, 2017). Heritage therefore needs to serve as a unique commodity and a resource for the residents to profit off.

Cultural memory and identity

Meanwhile the memory of Nijmegen as the oldest city and founded by the Romans still exists separated from the sites. The city and inhabitants get their pride and identity from this cultural memory, which is formed by texts, monuments or rituals for example (Meckien, 2013). These build up the story of a community's past and creates a sense of belonging and connectiveness. But in this case there is the opportunity to connect these memories to the sites that receive UNESCO protection and create a unique place for them in their development (image 2.2).

The history of a place exists in the memory of the people and bringing them to the surface will represent the identity and culture of a location and experience it (Goussous & Al-Hammadi, 2018). Archaeological remains produce emotions and convey experiences that maintain the cultural memory and identity. (Ireland, 2016) Archaeological areas are testaments of the past and how a city developed socially and culturally. Local culture takes pride in this urban memory which fortifies the inhabitants identity (Cengiz, 2018). Activities around this past help people understand this identity and interact more with their tangible and intangible heritage.

Place attachment and interaction

Archaeological sites should therefore need to be protected from future development and should interact with the daily urban life by being visualized. They are the urban memory of the location and need to be experienced to give the city meaning (Obad Šćitaroci & Bojanić Obad Šćitaroci, 2019). Visibility & accessibility of heritage can make people more aware of the values. Memory can become ordered by the place and is experienced through the senses (Ireland, 2016) by interacting with the remains. More social interaction leads to emotional closeness and increases the place attachment between residents and also tourists (Woosnam et al., 2018). Local participation in heritage and tourism is also linked to economic, social and cultural benefits result in more place attachment (McCool & Martin, 1994). Place attachment is considered the yearning to maintain closeness to a location (Cao et al., 2021).

New connections

The solution can be summarized as to sustainably develop the sites with methods of visualizing archaeology (introduced by Broesi in the Limes Atlas (Colenbrander, 2005)), interacting with the design to engage the senses and creating awareness that binds their pride to the UNESCO sites. The end result will be spaces where inhabitants can experience their identity and create new memories.

2.2 Research Question

How can urban design sustainably develop the UNESCO sites in Nijmegen-Oost to create awareness and create place attachment for the cultural memory of Roman Nijmegen? is what this research concerns. Image 2.1 shows how the sub questions emerge from the main question. These are interconnected in order to answer the main question.

What are the Roman structures in the UNESCO Sites of Nijmegen-Oost? Is about encouering and realising what Roman Nijmegen is and what meaning it carries. It is then also important to know what is visible, then 'Where are people aware of Roman Nijmegen?' can be determined through researching the methods used. The goal is to increase the awareness and place attachment, but "How can urban design create place attachment and awareness with archaeology?" will elaborate on how and where to apply the methods.

"What is the cultural memory of Roman Nijmegen?" seeks to determine which memories can be used in the designs and what people know of the history.

How can Roman history contribute to a sustainable future? The visualisation of Roman history will land in an environment where it can make a sustainable impact. A Sustainable future can be judged by the four pillars of sustainability: Human/cultural, social, environmental and economical (RMIT University, 2017). The tourists and residents will be catered to in cultural needs, that is the main pillar of this research. It is importants however to also design the Roman history in a way that it encourages connections between people, the community profits financially and that climate change is combatted.

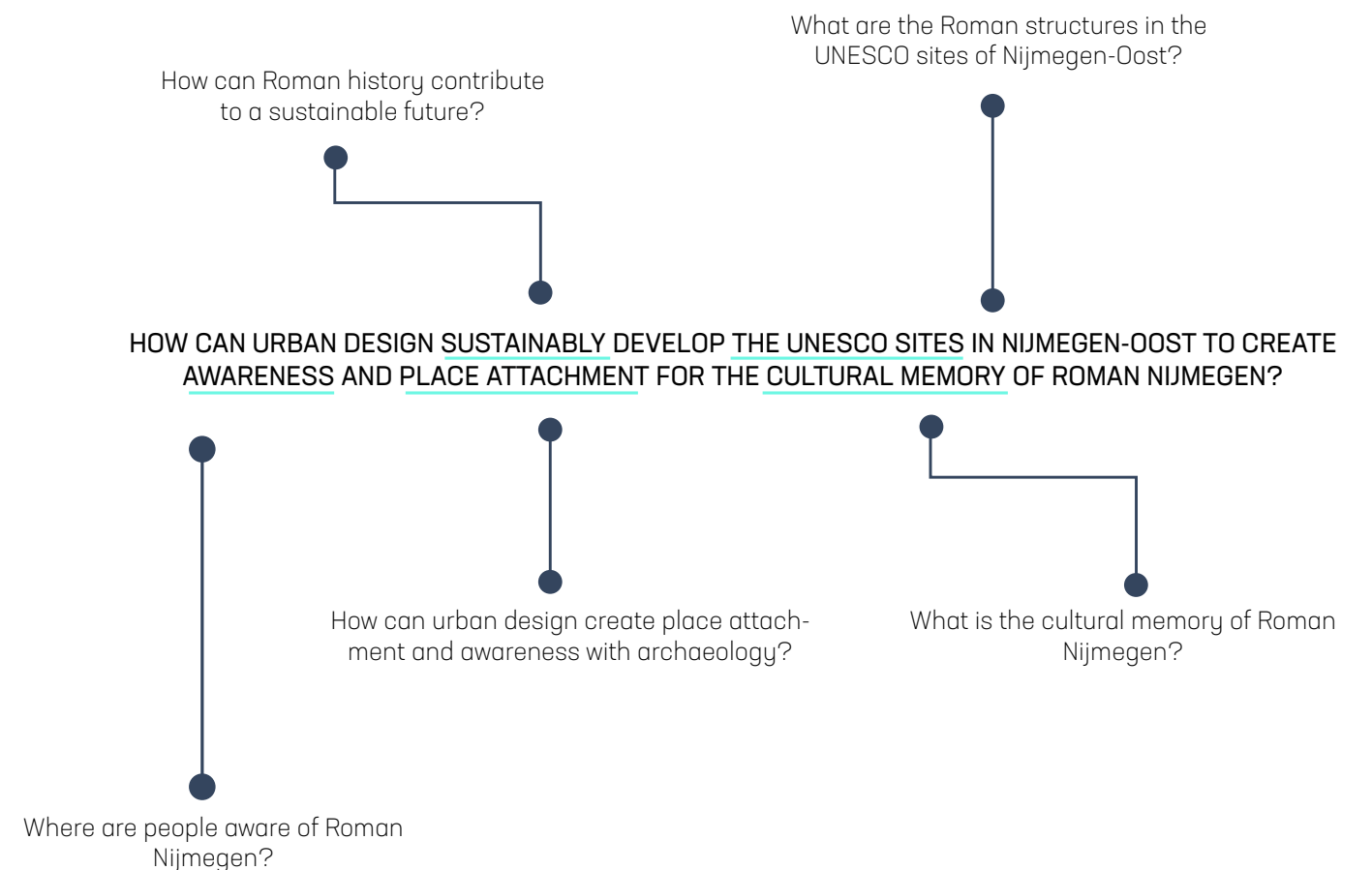


Image 2.1: The main question and subquestions

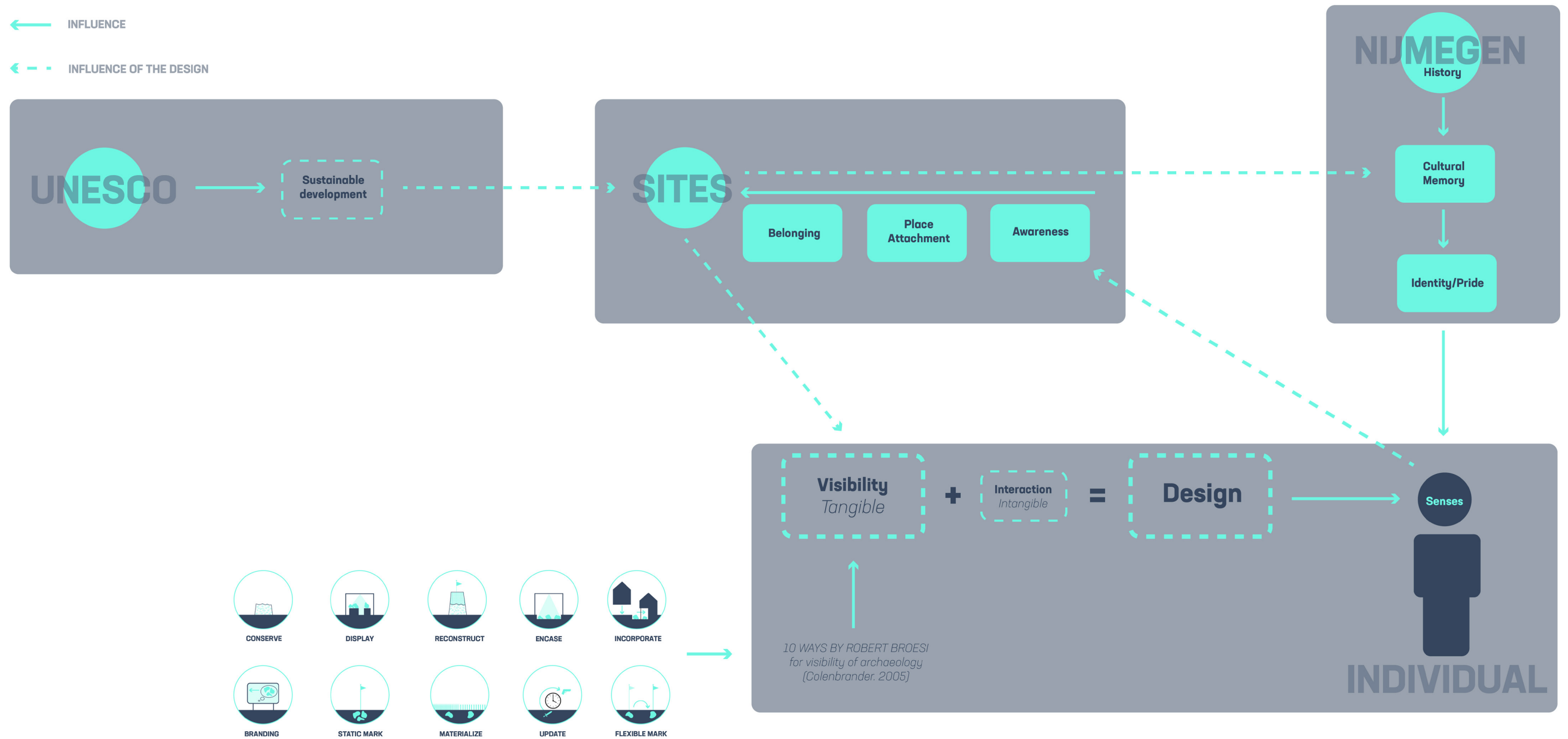
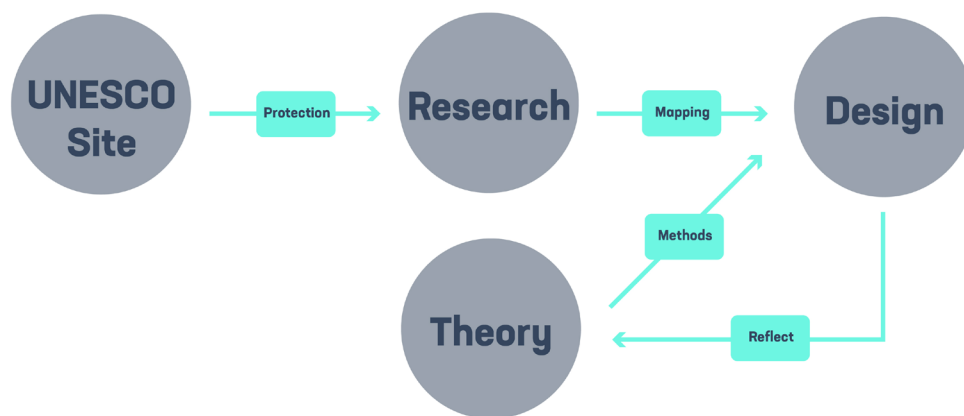


Image 2.2: The theoretical framework with new connections.

Goal 1:

Create a design for the UNESCO sites of Nijmegen.

**Goal 2:**

Use design methods from heritage theory and reflect on them through the design.

Image 2.3: The two goals of this research.

2.3 Methods

Goals

There are two main goals in this report (image 2.3). Firstly to create a design for the UNESCO sites of Nijmegen on the city scale, but also the effects on the small scale of streets and public spaces in Nijmegen-East. These will be places that the people can attach their collective memory of Roman Nijmegen to. The second goal is to test methods of designing with archaeology and reflect back to create a comprehensive approach for archaeological sites. Robert Broesi (co-writer of the Limes Atlas) categorized ten of these methods (Colebrander, 2005) and in these research these will be used as a starting point from which the approach is extended.

Diachronic layer approach

This research combines two methods of analysing the land to reach the final design, namely the Dutch layer approach and the Urban palimpsest to form a “diachronic layer approach” (image 2.4). The Dutch layer approach looks at the environment in the three layers of Occupation (Red and green), Network (Transport) and Substratum (Water management). These coincide with the main elements of the Limes being the Structures, Roads and Water respectively. These layers are separated since they change at different paces in time and often belong to different levels of government, causing them to create different networks with their own claims on the land (Van Schaick & Klaasen, 2011).

Since the goal is to see the potential of bringing Roman structures back to life, the palimpsest is brought in to compare historic layers to the current time of 2022. This research always seeks to look at the relations between the above ground and underground. A palimpsest is a type of script where monks wrote over the previous texts, but the erasure still left a trace (Kjerrgen, 2011). We can look at the urban landscape in the same way and see what impact the Romans had. The Diachronic layer approach explores each layer individually and through time before they can create coherence together. This will happen through (historic) mapping and (historic) literary reviewing. This combines the research field of Urban design, archaeology, hydrology and landscape design (Image 2.5). Archaeology is an exact science that can result in multiple interpretations of the past. The role of design here is to be inspired and translate that duality into the project. The areas of overlap will be highlighted in a vision of Nijmegen with the spaces of high potential for visualisations of the Roman archaeology to create coherence through urban planning (Van Schaick & Klaasen, 2011). This will give them a modern and sustainable meaning.

Engagement

The human element is added in the form of participation as seen as the catalyst for coherence and the final design. A questionnaire was made to involve the inhabitants of Nijmegen and research the place attachment of remains to the collective memory of the Romans.

The 10 methods of designing with archaeology were shared in 10 variants through a survey. The results of the questionnaire were discussed in a workshop to create further conversation about the subject and sites. Engagement is key in determining what the values of heritage are and the catalyst for change (Council of Europe, 2022). The Faro convention in 2005

determined that the object is not the heritage, but the meaning that it represents to people. A dialogue about the questionnaire will actively involve inhabitants into the development options and strengthen the community socially, culturally and economically.

Image 2.4: Research methods.

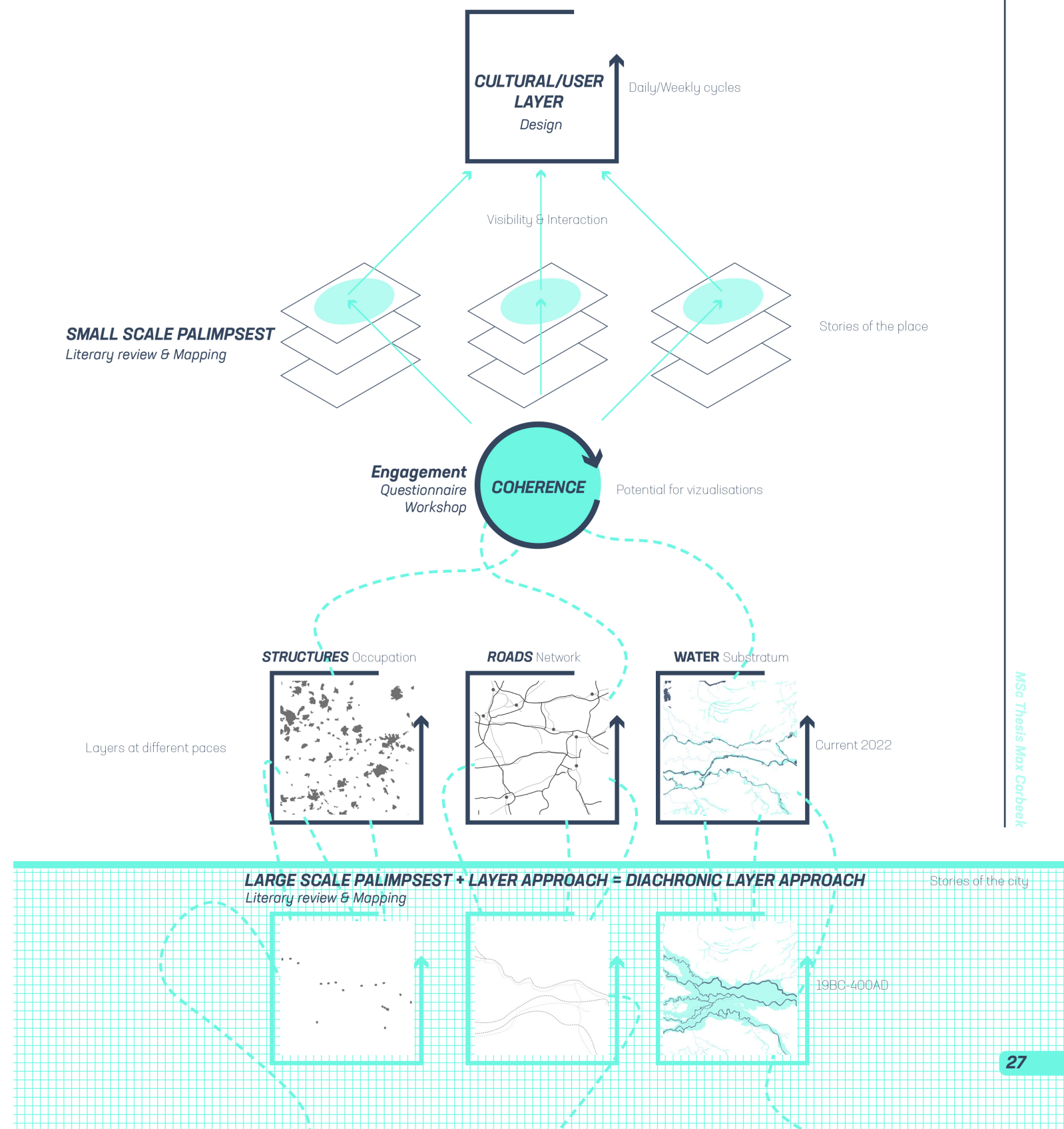




Image 2.5: Fields of research overlapping with Urbanism in this report.

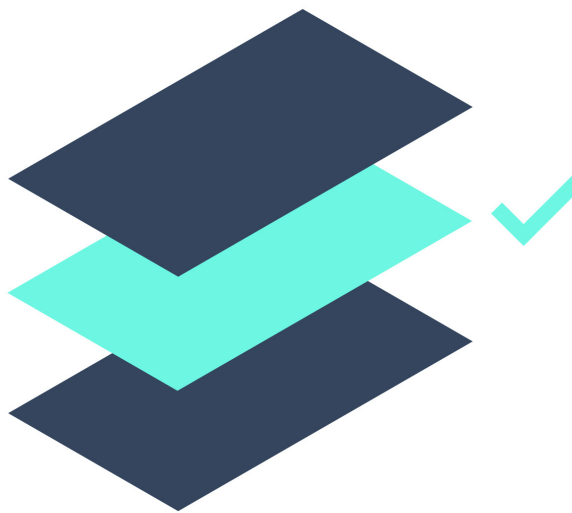


Image 2.6: Excluding layers is nearly impossible.

Cultural/User layer

Finally the spaces most suitable for visualisation are expanded upon on a smaller scale. Their palimpsest will be looked at to determine the genius loci (spirit of the place with cultural significance and also to not exclude other influential layers of history (Kjerrgen, 2011)) (image 2.6). This will inspire the final design. This is the final layer that involved the cultural and user perspectives that move with natural daily or weekly cycles, more than linear change through time (Van Schaick & Klaasen, 2011). The Roman design makes changes into every layer, but most of all creates new visibility, interactions and awareness with the users of the location it lands in and attaches their cultural memory to the place.

Structure

The methods laid out in this research also roughly follow the content of this report, creating the following layout for further reading:

Chapter 03 **Palimpsest:** Showing the history of Nijmegen.

Chapter 04 **Occupation:** Analysing the Roman and current structures.

Chapter 05 **Network:** Analysing the Roman and current roads and connections.

Chapter 06 **Substratum:** Analysing the Roman and current water elements.

Chapter 07 **Engagement:** Creating participation through a workshop and questionnaire.

Chapter 08 **Coherence:** Overlapping the opportunities.

Chapter 09 **Cultural layer:** Small scale palimpsest and the new (Roman) user layer.

Chapter 10 **Conclusion:** Results and answers to the main questions.

Chapter 11 **Reflection:** Further research and ethics.

03. PALIMPSEST

History of Nijmegen, Roman age, medieval, modern times, visibility, protection

This chapter explores the history of Nijmegen-East and Nijmegen in general from before the Romans until today. The Roman period is researched into great depth and split into multiple eras. At the end it is revealed what can still be seen from the Roman Empire after the developments the city went through since and which of these areas are protected.

3.1 Geological creation

The moraine that most of Nijmegen-East is a part of was created in the Saale Glaciation when glaciers of ice pushed the terrain upwards with its immense weight (Verhagen, 2021). The loam-clay soil underneath them allowed little water to enter causing the glaciers to glide southwards (image 3.1 & 3.2). In this period the Rhine was forced to flow below the edges of the ice and moraines, meeting the Meuse river earlier in the delta than nowadays (Abma, 2021).

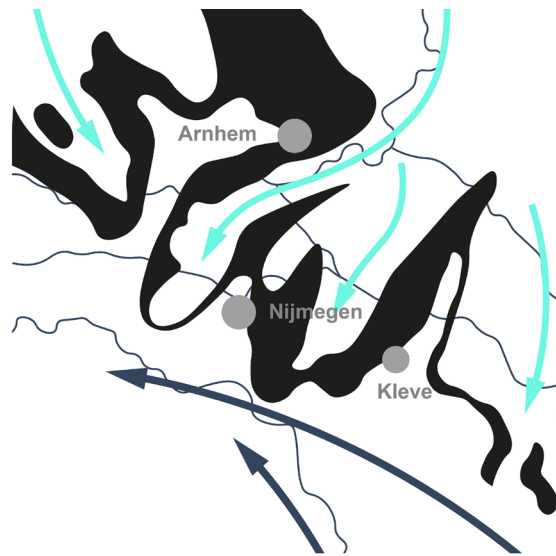


Image 3.1: Moraine creation in the Saale Glaciation (200.000-130.000 BC) (based on Verhagen, 2021a)

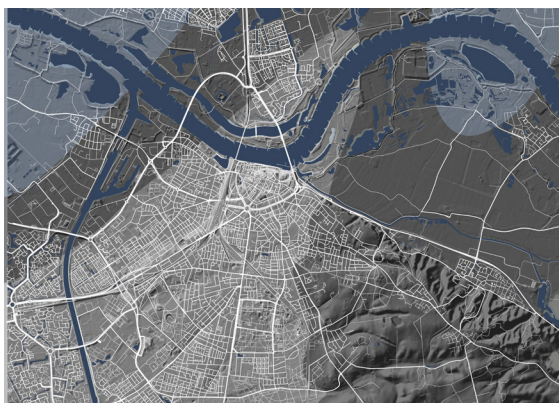


Image 3.2: Geology of Nijmegen in the Saale Period (200.000-130.000 BC) (based on Verhagen, 2021a)

In the Weichselian Glaciation the ice did not extend this far south and it was the melting runoff from these glaciers that started reshaping the moraines. Meltwater carried rubble downstream and sand without vegetation was moved by the wind towards the higher grounds (Verhagen, 2021). The Rhine eventually cut through the elevation and eroded its path (image 3.3). This changed the shape of the moraine into what the Romans encountered: A steep edge next to a low river valley (image 3.4 & 3.5).

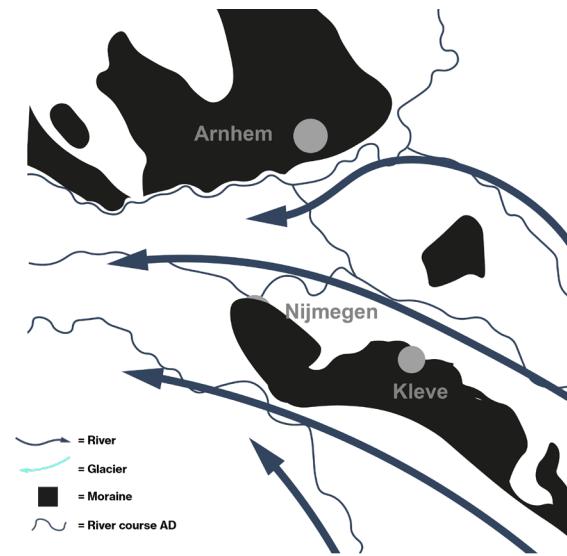


Image 3.3: Moraine erosion in the Weichselian glaciation (110.000-10.000 BC) (based on Verhagen, 2021a)

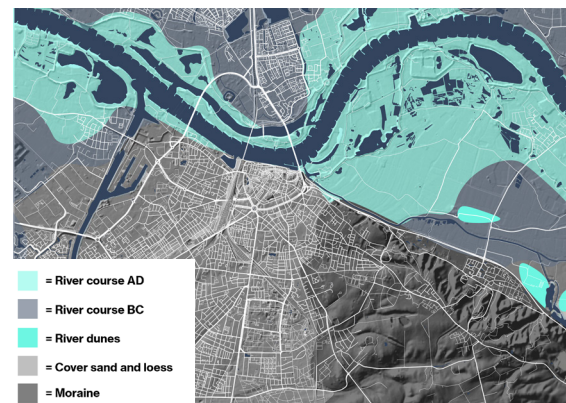
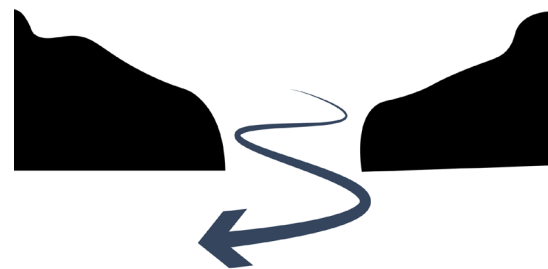


Image 3.4: Geology of Nijmegen in present time (2022) (based on Magnee-Nentjes & Gemeente Nijmegen, Bureau Archeologie en Monumenten, 2010)



3.2 Nijmegen 19BC-69AD

Around 19 BC the Romans set camp for about 15.000 soldiers on the Hunnerberg (in Nijmegen-East today). Initially the Roman emperor Drusus aimed to conquer the whole of Germania, but after a huge defeat in the Teutoburg forest, they were forced to abandon this conquest and retreat behind a natural border like the River Rhine (van der Heijden, 2008).

Nijmegen was chosen by the Roman army, because it is the last highland next to the river (image 3.7) (Abma, 2021). After massive deforestation the location gave a masterful overview of threat entering the empire. The army could swiftly move toward a threat on the border from this base further inland. Around 12BC the camp on the Hunnerberg was dismantled and a smaller commandpost was erected on the adjacent Kopse Hof with members of royal families staying in its luxurious villa at various times (Abma, 2021)

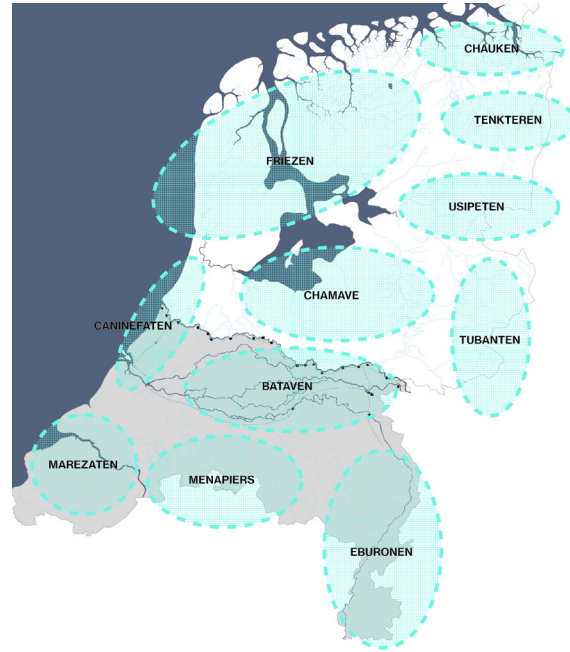


Image 3.6: Tribes in the Netherlands at the time of the Romans (based on van Renswoude, 2013)

Image 3.7: Map of Nijmegen between 15-70AD (based on Heijden, 2005)



The Romans army brought their respective cultures with them, as it can be contested how purely Roman these divisions from all around the empire actually were (image 3.8). As a show of cooperation between the local culture and Roman, the Batavi (Image 3.6) were given a city called Oppidum Batavorum (city of the Batavi) (van der Heijden, 2008). It is often thought that the Dutch descended from the Batavi, but they were a real part of the Roman empire and intermarried as well. Batavi were known for their cavalry skills and therefore used in various divisions and even as the emperor's lifeguards. As an ally of the Romans the Batavi also did not pay taxes (Tuuk, 2017).

Image 3.8: A Roman-Batavian village in c. 100 AD (Kriek, n.d.-a)

3.3 Nijmegen 70-260AD

The year 69 brought the revolt of the Batavi onto the Roman empire under the leadership of tribeleader Julius Civilis. The Batavi completely burned down the Oppidum Batavorum and the wooden commandpost on the Kopse Hof. After taming the uprising, the Roman emperor constructed a more permanent fortification out of masonry to replace the more temporary wooden camp and secure the border (image 3.10) (van der Heijden, 2008). The Lower Germanic Limes as we know it was from then set in stone. Traders also settled in the area (canabae legionis) surrounding the camp (image 3.9). A marketplace, hostel, stables and amphitheatre were constructed just outside to provide for all necessary entertainment. An 6km long aquaduct was also dug to supply the camp of about 10.000 people with clean water from a steady source of groundwater, estimated to be around 500.000 liters a day (Abma, 2021). The spring is still located in the forested hills just outside Nijmegen today.

The city was also rebuilt, but further west in the low riverplains and now named Ulpia Noviomagus Batavorum. The name means the New Batavian Market of Marcus Ulpius Traianus, after the Roman emperor who gave the city its' rights (van der Heijden, 2008). Here there were also a large array of public functions like temples and bathhouses. A ponton bridge connected the city to the northern border of the Roman Empire on the same location as the current railway bridge. A lot of effort was invested in Nijmegen, which says that the Romans were here to stay.

Image 3.9: Map of Nijmegen between 70-260AD (based on Heijden, 2005)

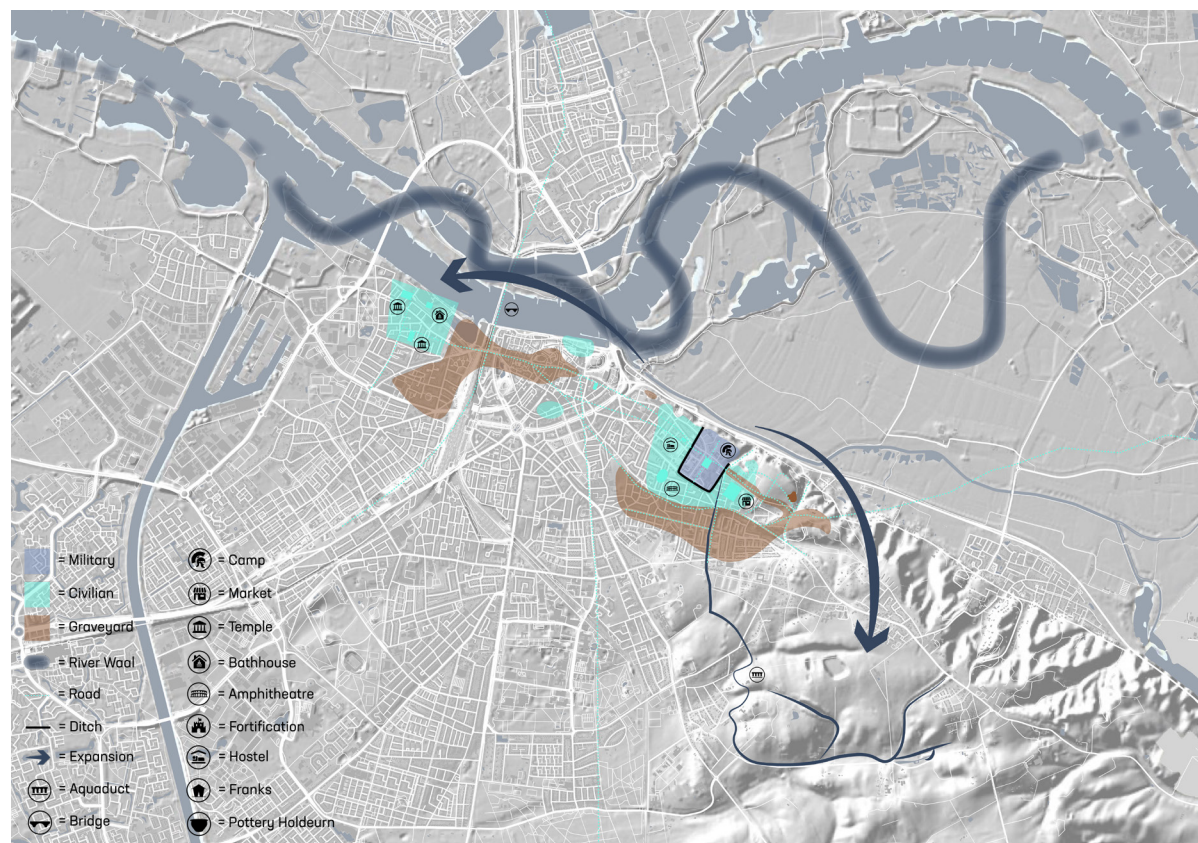


Image 3.10: The permanent fort built after the Batavian revolt of 69AD (Kriek, n.d.-b)

3.4 Nijmegen 260-400AD

Nijmegen would remain like this for almost two centuries, near the end of the Roman presence in the lower countries, the Roman army retreated to a new castellum on the Valkhof hill due to raids at the border (image 3.13) (Abma, 2021). On the same location where the Oppidum batavorum was located 200 years before (image 3.12). Around the fortification Frankish tribes also settled down and it is often thought that they invaded, but most were actually invited by the Roman Empire to defend the border so their forces could be used elsewhere (van der Heijden, 2008). The edge of the empire was not like we know borders today, tribes could move freely and inhabit the land, gaining citizenship was a lot harder though.

The Roman Empire started to collapse slowly near the end of the 4th century due to internal conflict between emperors, uprising and tribes seizing the opportunity to invade. The disappearance of the Roman fortifications, caused Nijmegen to lose its dynamic trade and bustling movement that a border city brought to the table (Abma, 2021). Less materials were needed for construction and trade was at an all time low.

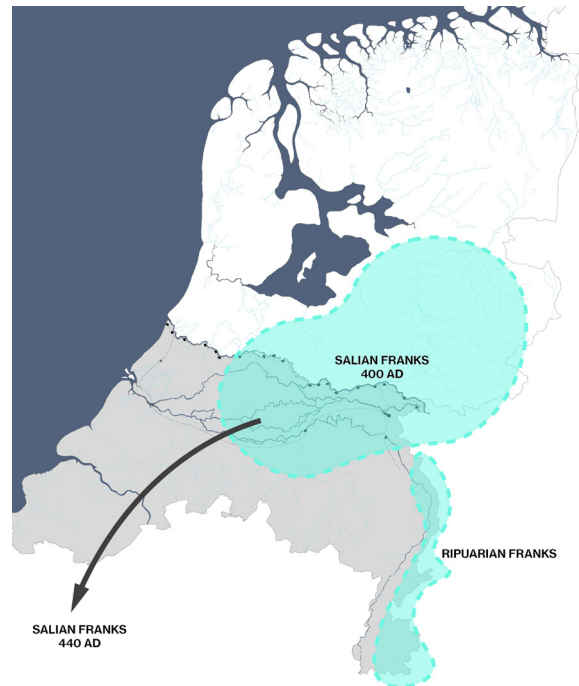


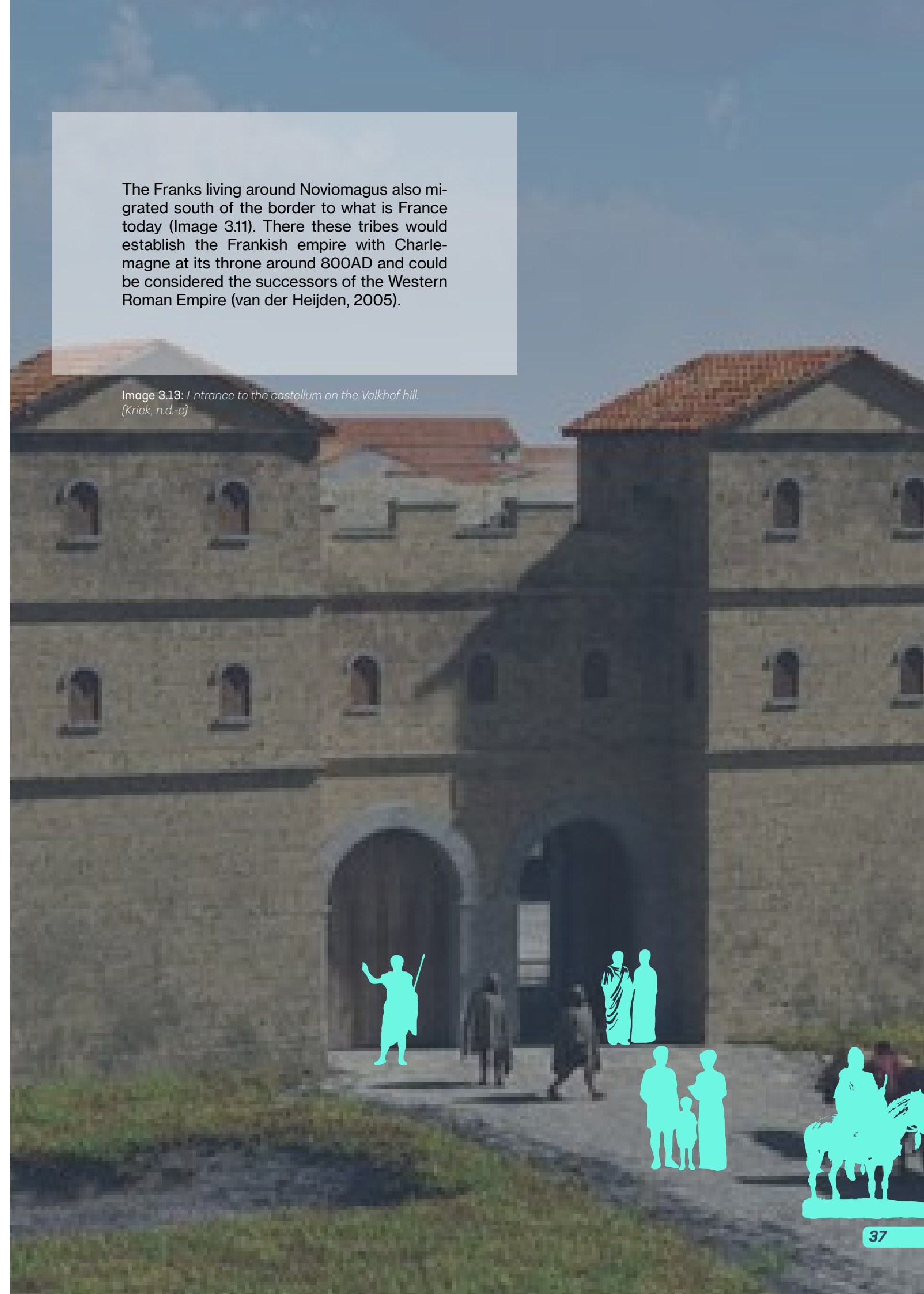
Image 3.11: Migration of tribes in the Netherlands at the end of the Roman period. (based on Erren, 2013)

Image 3.12: Map of Nijmegen between 260-400AD (based on Heijden, 2005)



The Franks living around Noviomagus also migrated south of the border to what is France today (Image 3.11). There these tribes would establish the Frankish empire with Charlemagne at its throne around 800AD and could be considered the successors of the Western Roman Empire (van der Heijden, 2005).

Image 3.13: Entrance to the castellum on the Valkhof hill. (Kriek, n.d.-o)



3.5 Fortifications 777-1870

The Franks inherited the castellum and transformed it into a palace fit for king Charlemagne around the year 777.

It had an inferior function in the empire and houses just a few hundred people. Stone from Ulpia Noviomagus was reused in 1155 to build the Valkhof castle where the dukes of Gelre would receive important guests. The defensive Valkhof would turn from the retreat to the source of Nijmegen (image 3.20).

After the Romans had left for centuries, the city of Nijmegen developed great economic prosperity due to its location on the river Waal and membership of the Haseatic League (Heijden, 2005). The city was back at 10.000 inhabitants and to protect their belongings a city wall was constructed (image 3.18) (Abma, 2021). This wealth came to a halt when the cities in Holland rose to prominence and Nijmegen was used as an important fortification once again, but this time on the eastern border with Prussia (Heirbaut & Gemeente Nijmegen, Bureau Archeologie & Monumenten, 2011).

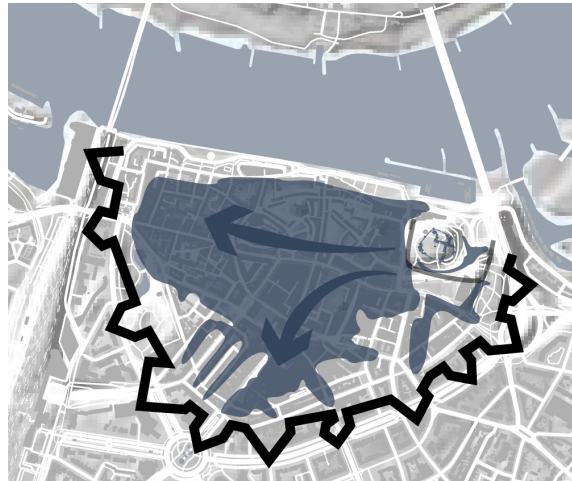
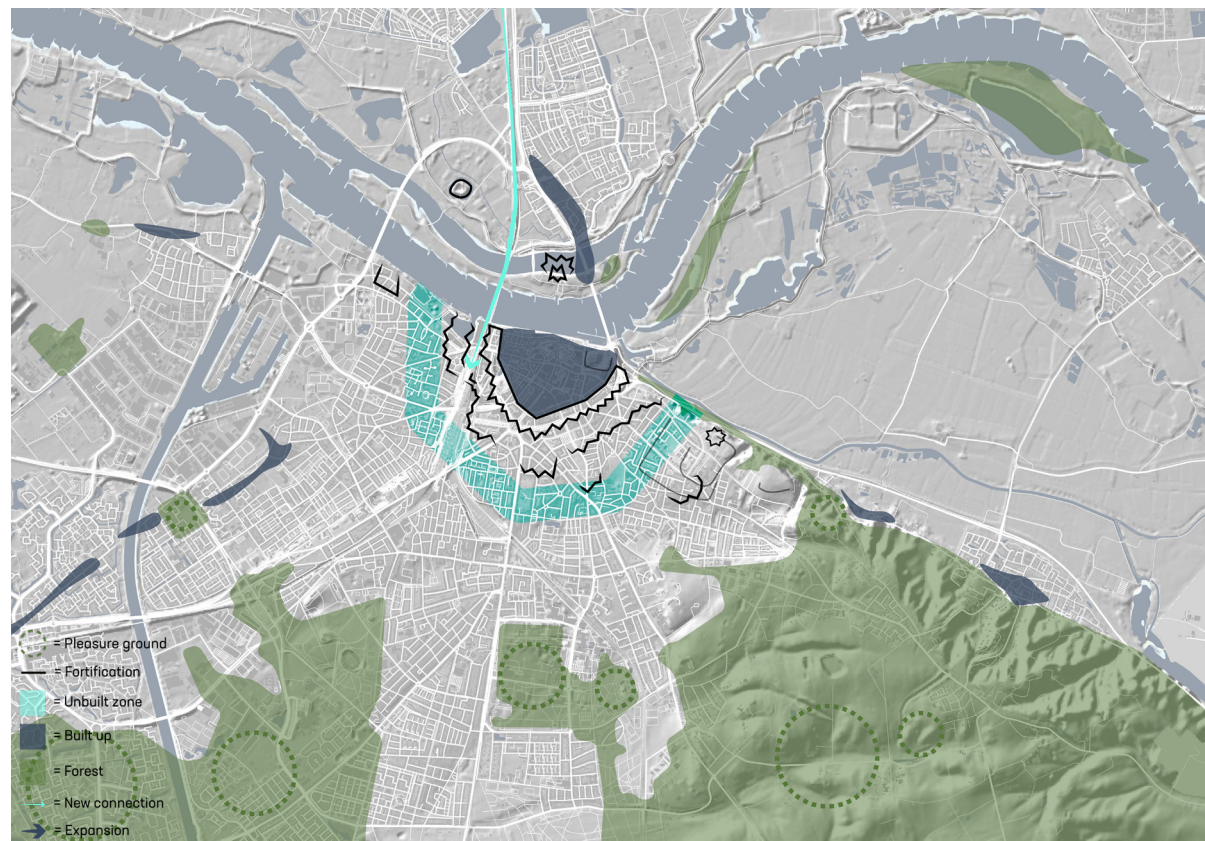


Image 3.18: Nijmegen in 1649 (based on [Blaeu, 1649])

Image 3.19: Nijmegen in 1875 (based on Kadaster, n.d.)



From 1732 Nijmegen was suffocated by a corset of dry ramparts in two rows (image 3.19). The Forts formed a tight ring around Nijmegen, with the zone inbetween being off limits for building activities due to defence purposes. In 1817, on the exact spot where the permanent Roman camp had been a new fort called De Sterreschans was placed for the same reason: overview (Abma, 2021).

The wealthy people of Nijmegen would flee cramped and smelly city to their large estates in the surrounding landscape (Abma, 2021). The city was locked in this state until the Vestingswet of 1874 allowed for dismantling (Heijden, 2005). At the same time cities with more than 50.000 inhabitants received the right to a train station, freeing Nijmegen and connecting it to the rest of the Netherlands.

Image 3.20: View of Nijmegen from the river Waal and the Valkhof castle (Cuyp & Dordrechts Museum, c. 1660)

3.6 Expansion east 1920

Nijmegen was finally able to expand outward and it soon did this eastward on the plateau where the new neighbourhoods were catered towards wealthy people returning from around Nijmegen and the Colonies in Indonesia (Heijden, 2005) (image 3.22). The old centre was viewed as too dirty due to being overcrowded for centuries, Nijmegen needed a new face.

Tourists were also attracted to Nijmegen for its natural beauty with going on spectacular walks being in fashion (Abma, 2021). Industrialisation was in progress and in 1889 a tramline was constructed to the hills with hotels as the final stop. Many Dutch landscape painters gathered there for the picturesque views.

Nijmegen East saw the rise of high end mansions and affordable worker's houses. As discussed in the last chapters, the Roman influence in Nijmegen lasted for more than 400 years and had many redevelopments. For centuries after the Roman Empire fell the stone remains were reused and up for grabs as an open quarry. At time of the expansion the remains were mostly buried underground.

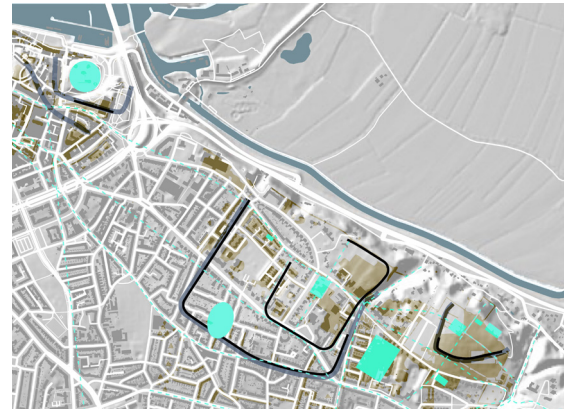
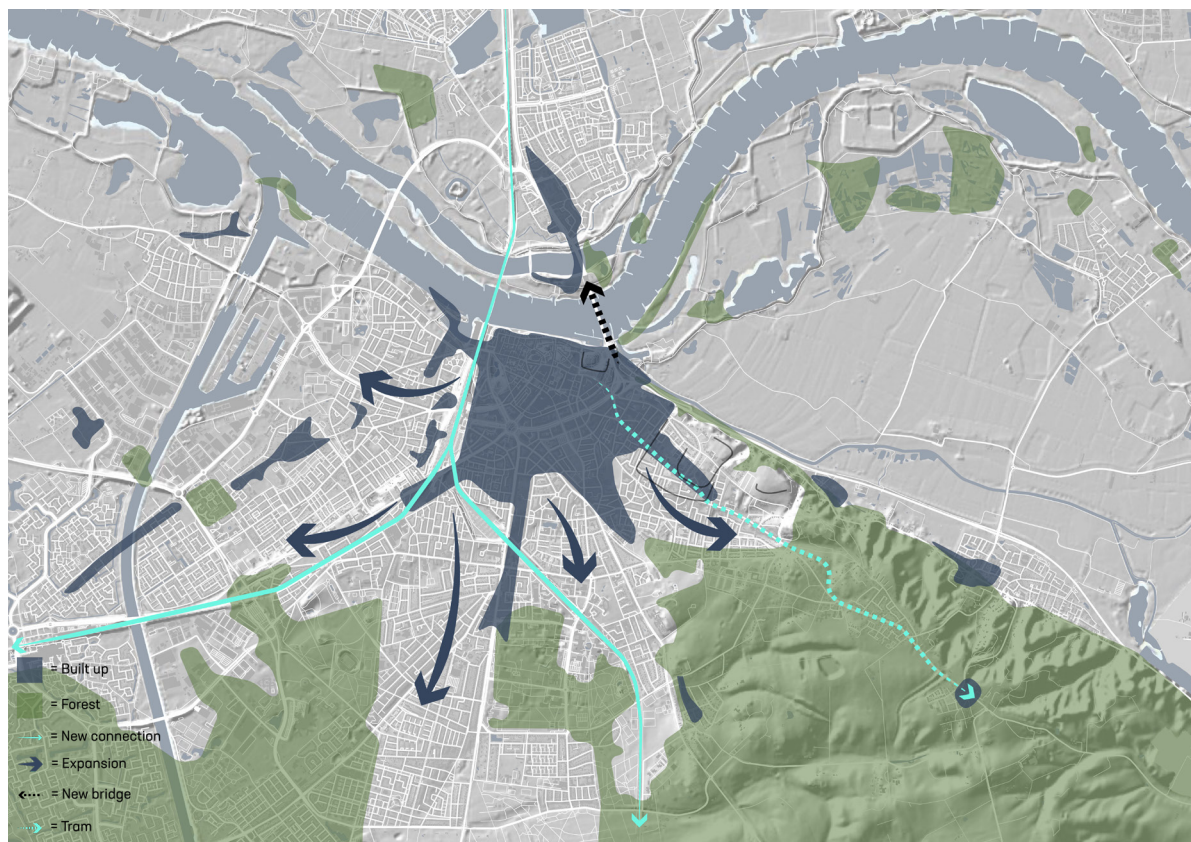


Image 3.21: Roman structures in Nijmegen and excavation sites (based on Kadaster, n.d. and Polak et al., 2020a)

- = Important Building
- - - = Roman Road
- = Ditch
- = Wall
- = Excavated area

Image 3.22: Nijmegen in 1920 (based on Kadaster, n.d.)



The interest in the past of Nijmegen lied in the hand of private exploiters. Businessman Gerard Marius Kam (1836-1922) was one of the people that funded excavation works and the creation of Museum Kam (predecessor to the Valkhof Museum) that would house his collection (Maenen & Regionaal Archief Nijmegen, 2010). The understanding of the great findings that lay underneath Nijmegen started to develop (image 3.21 & 3.23).

Image 3.23: Archaeologist W. C. Braat posing in the excavations of Pottery ovens in Holdeurn near Nijmegen (Rijksmuseum van Oudheden Leiden, 1941)

3.7 Reconstruction 1960-2022

Expansion was paused during the second world war, but would soon after continue as part of the reconstruction period. The centre of Nijmegen was greatly hit during the war by an American bomb (image 3.24). 800 people were killed and many more lost their home (Heijden, 2005). Nijmegen was also on the border of Operation Market Garden for months, causing more damage in the process of liberation.

The unbuilt parts of Nijmegen-East such as the Kopse Hof were used for temporary emergency housing (van Enckevort & Gemeente Nijmegen Bureau Archeologie en Monumenten, 2014). Eventually the empty and destroyed spaces were built up again.

With the eastern moraine and river polders being off limits to built (due to natural value) the city moved its focus to the southwest in the 1970s. Over the channel constructed just four decades earlier, the large Dukenburg estate was bought from its owner and built up. Currently Nijmegen combines the Room for the River program with expansion over the river Waal up North. This was the last suitable option and the large project is being filled up at the moment.

In the last decades Nijmegen-east has only experienced minor alterations in the urban fabric of merging or splitting building blocks and re-development. The city of Nijmegen is growing fast, due to its highly protected underground and above ground it is not considered as a location for densification, but as an area with cultural potential. (Gemeente Nijmegen, 2020)

Image 3.24: Nijmegen in 1960 (based on Kadaster, n.d.)

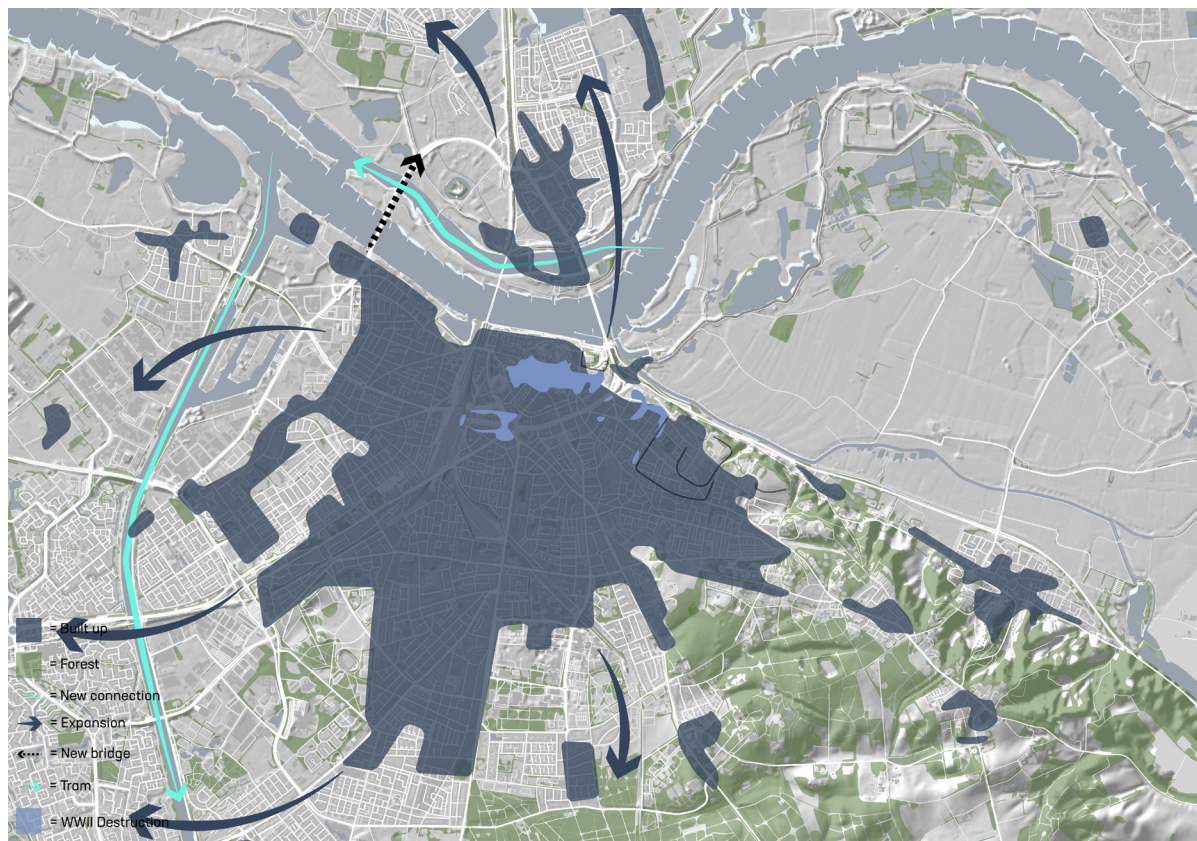


Image 3.25: View of the new expansion Van 't Santstraat in Nijmegen Oost (van Overveldt, n.d.).



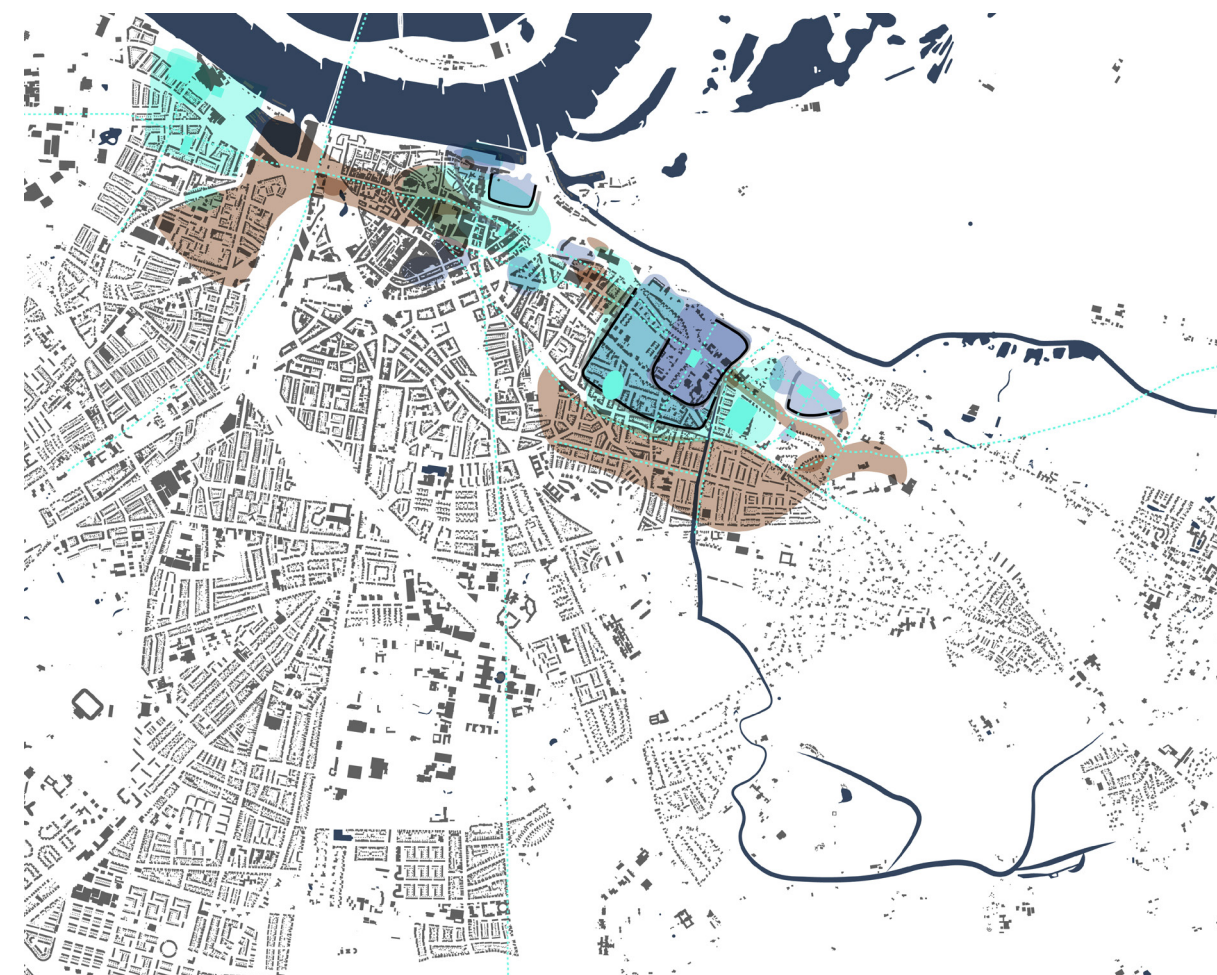
3.8 Roman age

The Roman history of Nijmegen spans over more than 400 years and therefore there is not one Roman layer of but it consists of multiple Roman layers in itself (Image 3.27).

It is difficult to arrange in one map, but image 3.26 shows all layers at once on top of the current situation. Some sites lie protected and dormant underground in parks or public spaces waiting for future developments. Here the spaces such as roads or voids in the grid are what remains. Many structures overlap however, such as the amphitheatre with a ditch from the former camp and forts where roads used to be. The site shows a degree of complexity when wanting to visualize Roman Nijmegen.

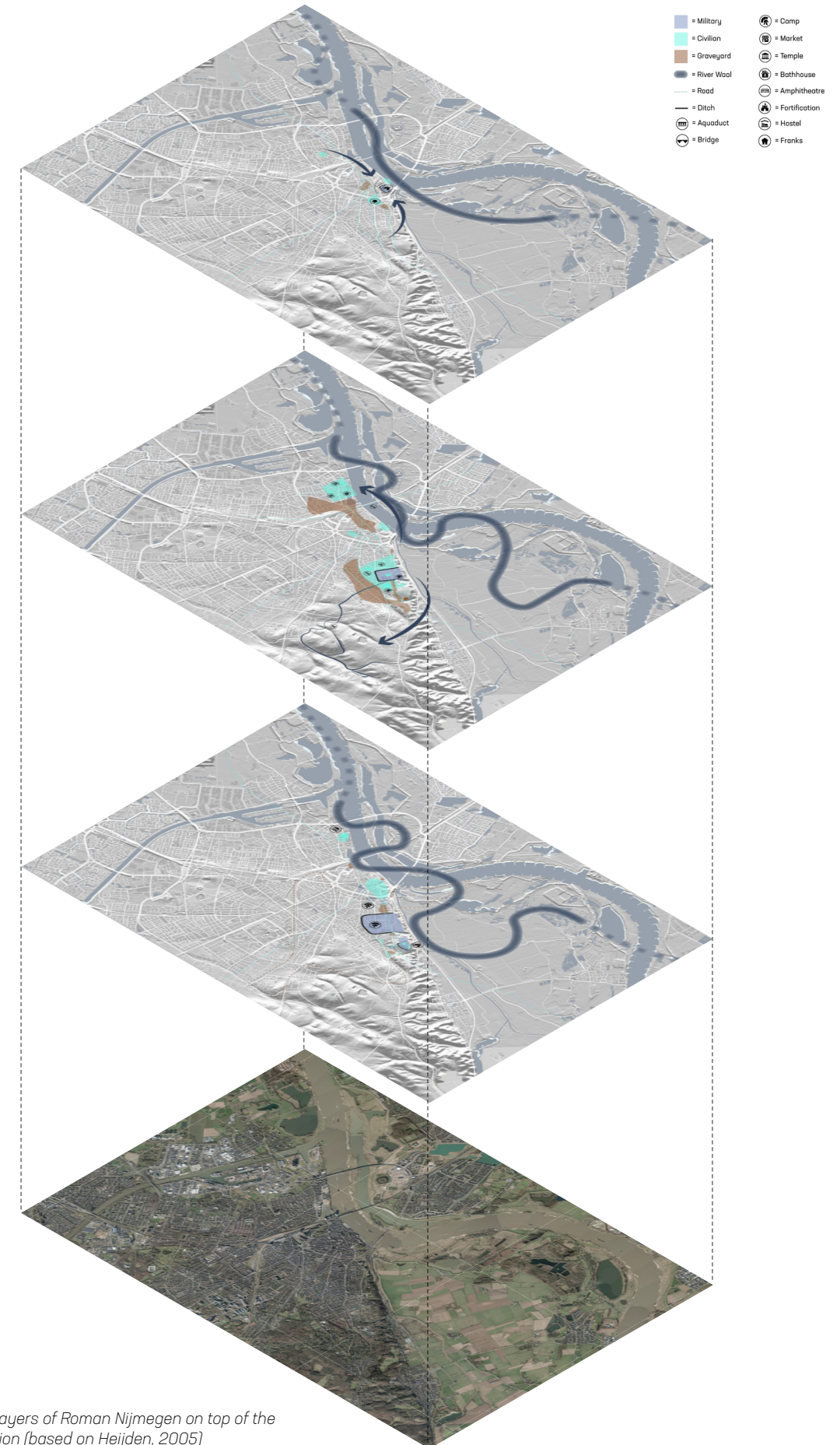
The map in 3.26 also gives a false image of the past when all layers are turned on. In reality visualizing the past could also give a similar image and therefore layers must be differentiated in design with respect to the present situation.

Image 3.26: All layers of Roman Nijmegen on top of the present situation (based on Polak et al., 2020a)



- = Military
- = Civilian
- = Graveyard
- = Important building
- = Road
- = Wall
- = Ditch
- = Aquaduct

Image 3.27: Layers of Roman Nijmegen on top of the present situation (based on Heijden, 2005)



- = Military
- = Civilian
- = Graveyard
- = Important building
- = Road
- = Wall
- = Ditch
- = Aquaduct
- = Camp
- = Market
- = Temple
- = Bathhouse
- = Amphitheatre
- = Fortification
- = Hostel
- = Franks

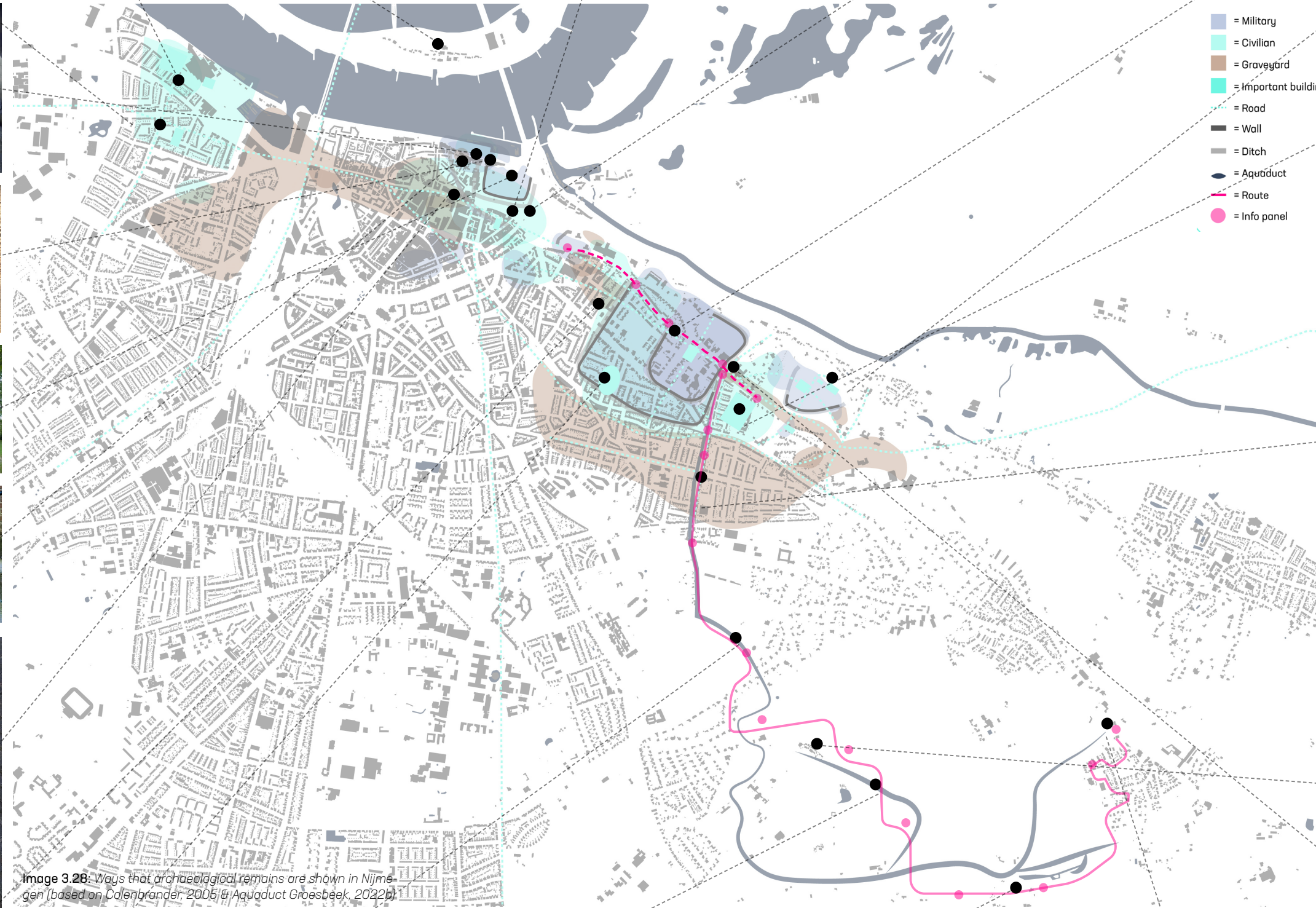
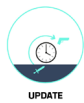




Image 3.29: Ways to show archaeological remains (Colenbrander, 2005)

3.9 Roman visibility

In the Limes Atlas, Robert Broesi categorized ten possible strategies of showing archaeological remains (3.29). These can be divided in two distinct groups. The first group is showcasing physical remains that can be seen directly or have been rebuilt close to the original. The second group are translations that show archaeology indirectly through design.

The Netherlands in general does not host many physical remains of the Roman period that are visible. Most of the Lower Germanic frontier translated into design (Image 3.30). Another big part can be seen in Museums behind a payment barrier and indoors, however they are the portal to conveying the past to the present day.

These methods can be projected on Roman remains and references in the region of Nijmegen (image 3.28). Nearly every icon can be seen in the area, with the exception of a reconstruction. The archaeology is translated

in with many 'Update' and 'Branding' in Nijmegen-East, but more west towards the centre of Nijmegen the physical remains are visible in Museums or incorporated into buildings. More can be seen of the Roman city than the fortifications in Nijmegen-East. There is also not a homogenous informative route connecting all Roman visualisations. Instead the route through the fortifications includes only informative panels and one visualisation of a gate.

Much of Nijmegen's Roman origin is still hidden under the soil, even though it is the archaeological epicentre of the Netherlands for Roman history (Tuuk, 2017). The visualisations are often aged and do not give the full impression of Roman Nijmegen (Mols, 2022). Nijmegen had many opportunities to show remains after excavations, but did not take these chances and left little trace (Dinther, 2021).

Image 3.30: Ways that archaeological remains are shown in the Limes (based on Visser et al., 2015)

3.10 Protected land

This Roman Heritage is nowadays protected by a range of laws, but it is also not always the physical objects that are protected, but regions of high value as a whole serve as monuments.

The Roman archaeological remains are protected by UNESCO and as national monuments (image 3.32). These areas differ however, creating areas that are protected by both or only one. The areas of value that were not excavated in the last decades are now national archaeological monuments. Moreover UNESCO differentiates Nominated properties with more strict rules than Buffer zones. The Nominated properties do not allow any disturbance of the soil unless vital to the city's functioning (such as sewage). UNESCO properties that are not national monuments do not receive the necessary protection at state level, meaning up to 1 meter depth is permitted to be disturbed.

Above ground the landscape is also highly layered with protections at multiple levels (Image 3.31). The edge of the moraine part of the National Landscape the Gelderse Poort that safeguards scenery that the entrance of the Rhine into the Netherlands brings. This protection influences what can be developed in this environment within the aesthetics. The same applies for the protected cityscape and monuments in the area.

The forested and steep edge of Nijmegen-East is part of the National Nature Network. Flora, Fauna and limited opportunities for densification need to be kept in mind when redeveloping. The stacked levels of protection dictate what will be possible on the site itself and what the heritage actually is by the label that has been put on it.

Image 3.31: Protected landscape & cityscape (based on (IPO, 2017), (IPO, 2018), (Ministerie van Onderwijs, Cultuur en Wetenschap, 2019) & (Gemeente Nijmegen, n.d.)).

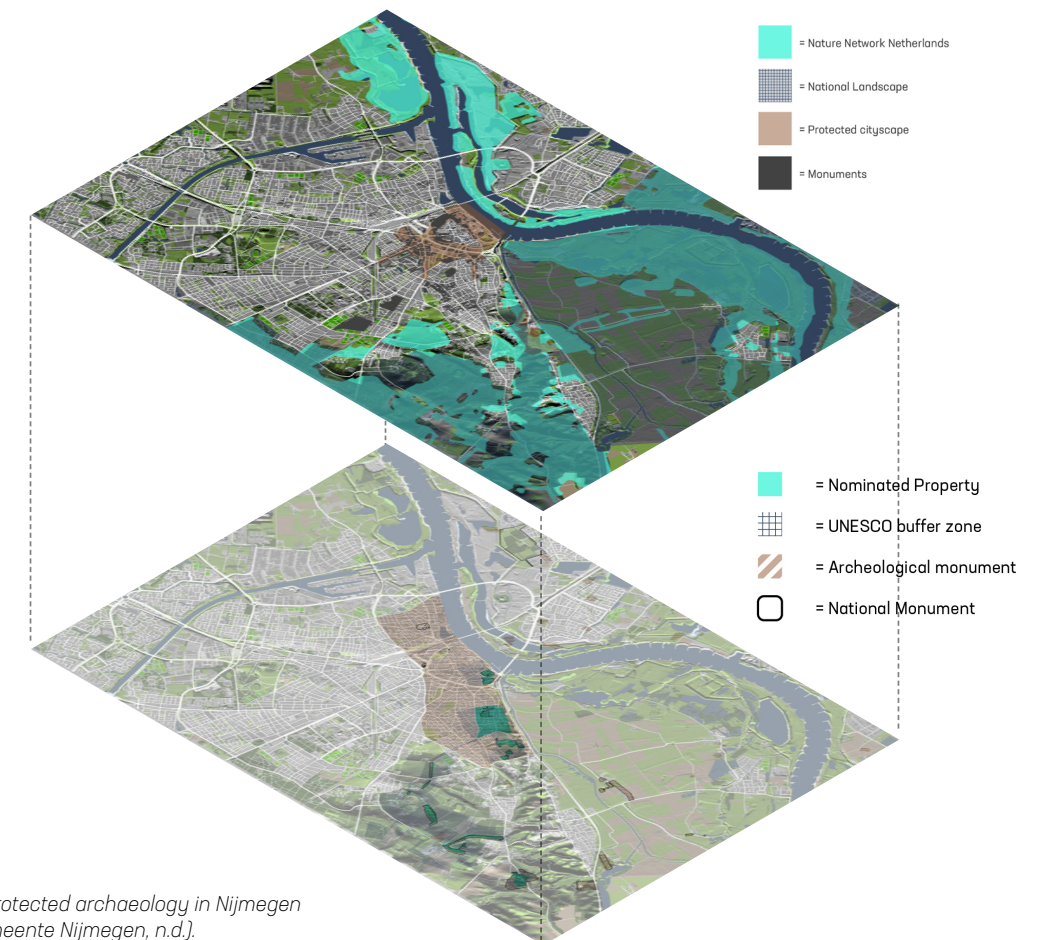


Image 3.32: Protected archaeology in Nijmegen (based on Gemeente Nijmegen, n.d.).

3.11 **CONCLUSION**

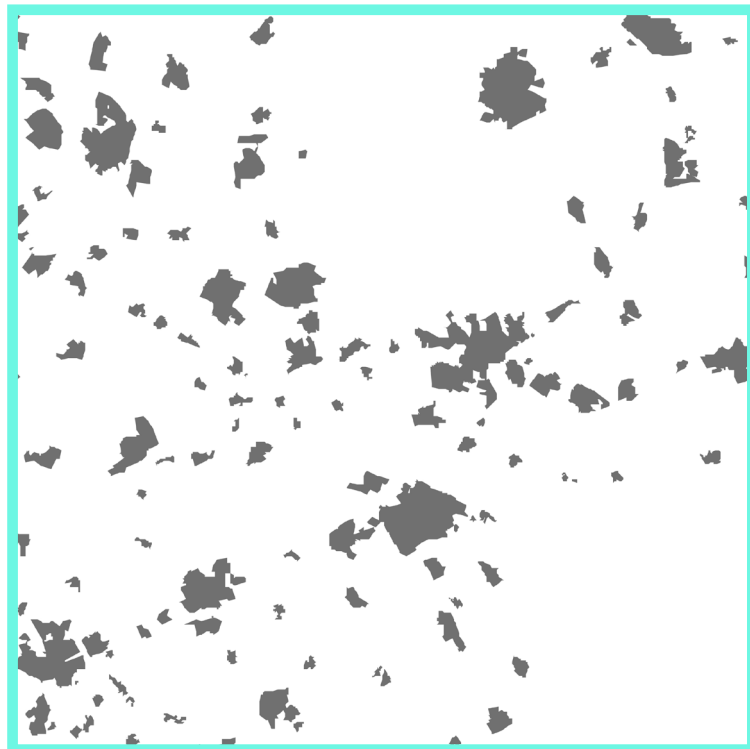
From day one Nijmegen's location was gifted by the glaciers in its geological formation. The Romans chose the hilly moraine as a military outpost of their empire and with that founded the city that is now known as Nijmegen. Soon the camps developed into a permanent and successful settlement bustling with live and trade. Nijmegen would remain in the empire for 400 years, showing different factettes. When designing these factettes, layers should be differentiated. Even after the Roman Empire fell, the story of Nijmegen continued to be one of military importance, destruction and rising from the ashes. Centuries of history and expansion cover what we know to be Roman. Few traces of grand quality remain in public space, but the hope lies in translating the large protected heritage areas.

04. **OCCUPATION LAYER**

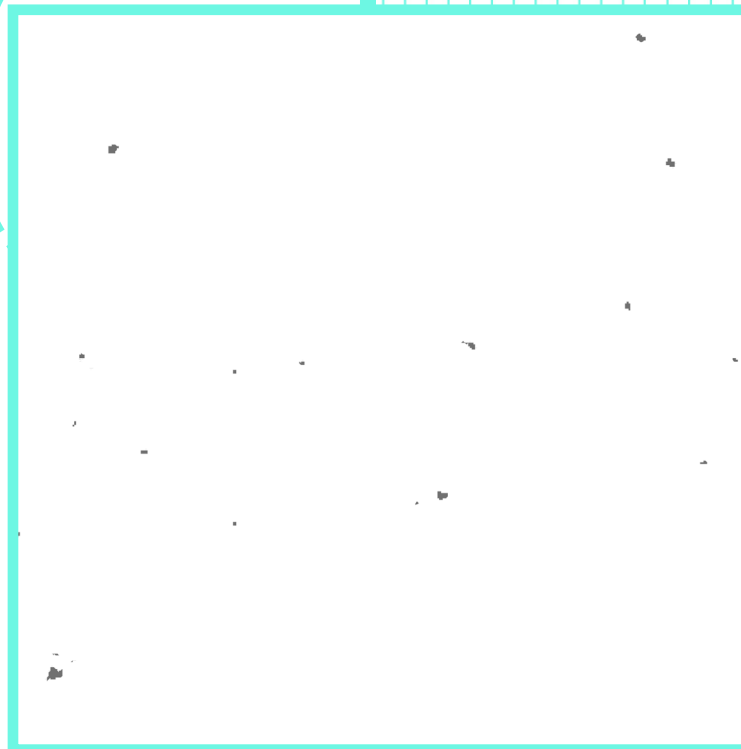
Castra, materials, green, public/private, functions

The Romans brought their own style of buildings, lifestyle and cuisine. The current city layout and its functions will be compared to the fortifications buried underneath. Moreover how their lifestyle impacted the landscape and findings will be discussed.

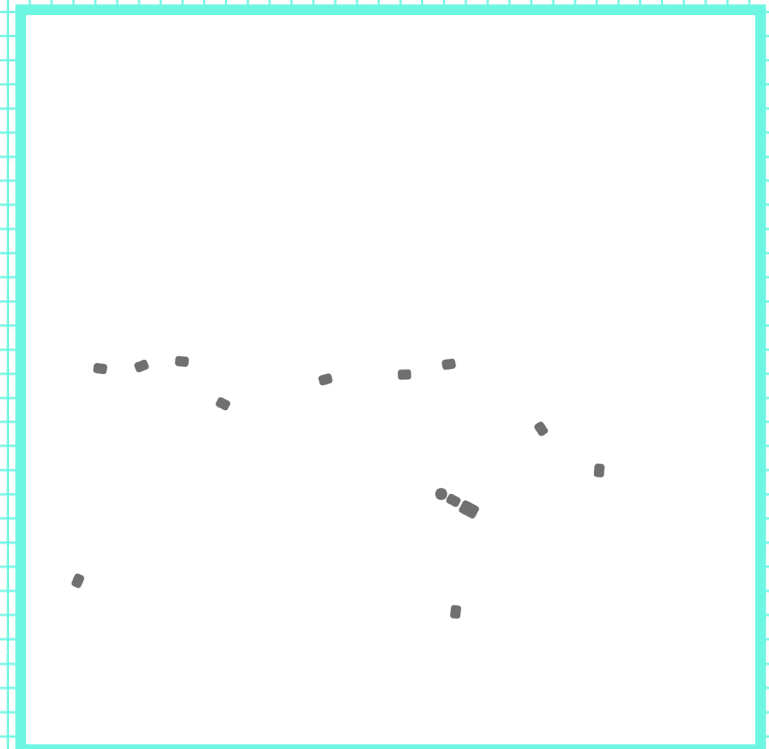
2000



1500



100



"If there is still anything left of the splendor of the Latin language, now that it has disappeared from Belgica and the Rhineland, it resides in you. As long as you are unharmed and able to speak, the Roman language will not falter, even if Roman law fails at the borders."

- Sidonius Apollinaris, 5th century AD
(Colenbrander, 2005)

4.1 Castra

Nijmegen east had three consecutive castra in Roman times between 19BC and about 270AD (image 4.2). These fortifications housed multiple army divisions to defend the Lower Germanic Limes. Today they are covered by 20th century expansions of Nijmegen, the city that was born from these camps.

4.1.1 Castrum Hunnerberg 19BC

The first fortification in Nijmegen may also be considered to be the cradle of the Lower German Limes. (Polak et al., 2020b). The camp was a temporary outpost for the conquest of Germania (Tuuk, 2017). It housed a minimal of two army divisions with at least 10.000 soldiers (van der Heijden, 2008). What surrounded them were wooden ramparts with towers every 24 meters and a 2 kilometers long dry moat (image 4.5). The fort was filled with wooden barracks, a praetorium (Commander's House) and principia (military headquarters). The northern edge ends at the moraine with kilometres of free sight. Due to its wooden construction underneath another castrum, less is known about the layout.

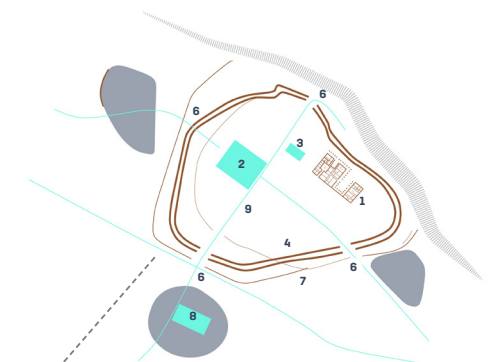
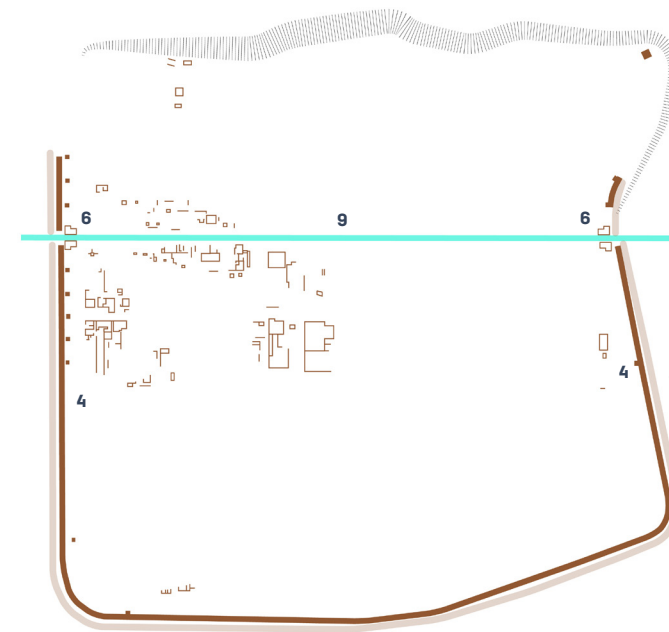
4.1.2 Castrum Kopse Hof 12AD

A smaller outpost with cavalry units replaced the large camp. Large wooden construction works in the area led to massive deforestation, which aided in the view (Tuuk, 2017). It is suspected that emperors Drusus, Tiberius and Germanicus prepared their campaigns against the northern Germania here in the Praetorium (image 4.3). The fort is appreciated for its irregular shape, luxurious praetorium and bountiful findings. The edge of the moraine was used as a trash dump, so a lot of the food culture was excavated (Polak et al., 2020b). The Horreum stored grain rations. (Colenbrander, 2005)

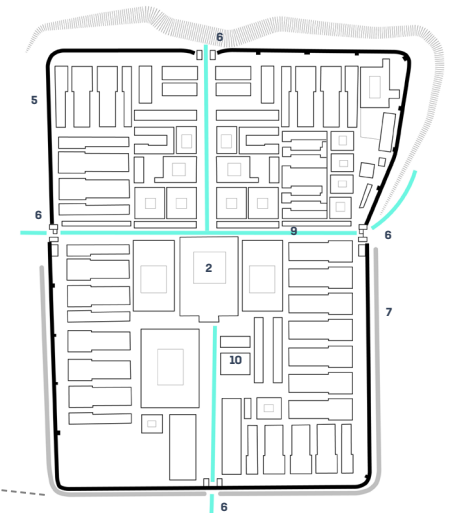
4.1.3 Castrum Hunnerberg 70AD

After the Batavian revolt incinerated Oppidum Batavorum, a fort was constructed in stone and ceramics to permanently calm the area. A civil settlement developed around the castrum with nurturing functions like an amphitheatre,

market and stables. The principia (image 4.4) was located on crossing paths in the centre, the physical and mental centre of the castrum (Colenbrander, 2005). Via principalis from west to east is the main road that connects to other settlements of the Limes (Colenbrander, 2005). The main organizing axis of the castrum. A checkerboard pattern was in fashion for organizing the fortifications.



■ = Wood
■ = Masonry



1. Praetorium
2. Principia
3. Horreum
4. Wooden rampart
5. Stone rampart
6. Porta
7. Dry ditch
8. Mensio
9. Via principalis
10. Castellum divisorium

Image 4.1: The three Roman castra of Nijmegen in chronological order (based on Polak et al., 2020b)



Image 4.2: Roman gate in Autun (Chabe01, 2017)

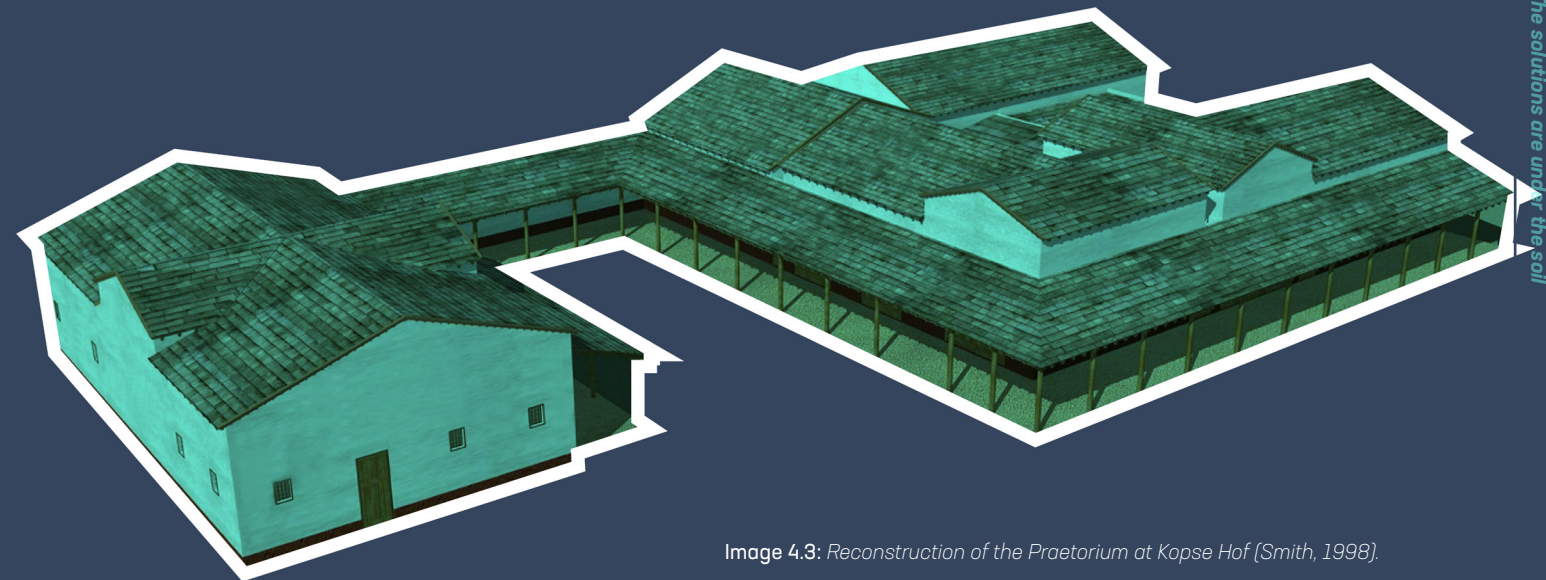


Image 4.3: Reconstruction of the Praetorium at Kopse Hof (Smith, 1998).

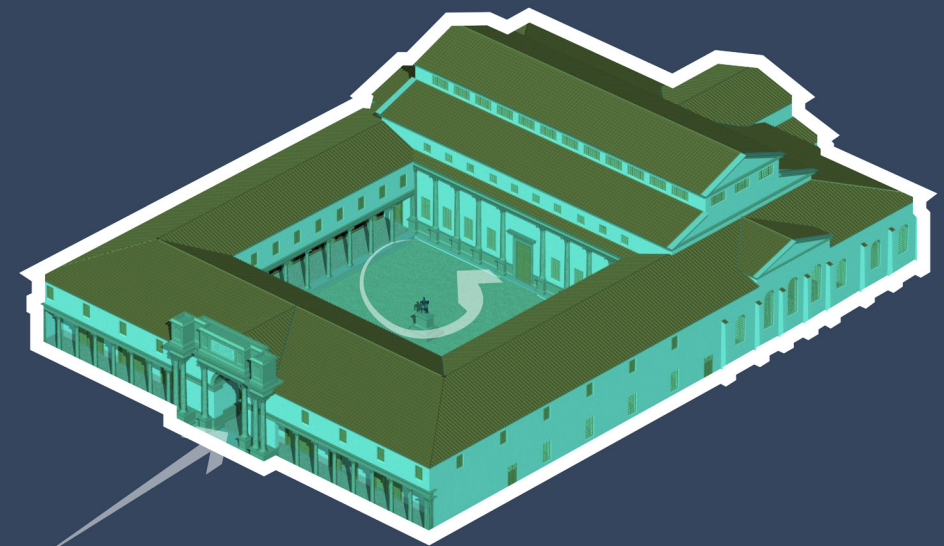


Image 4.4: Reconstruction of the Principia at Hunnerberg (Jonker, 2002).



Image 4.5: Reconstruction of the wooden ramparts in Haltern am See (Peterse, 2010).

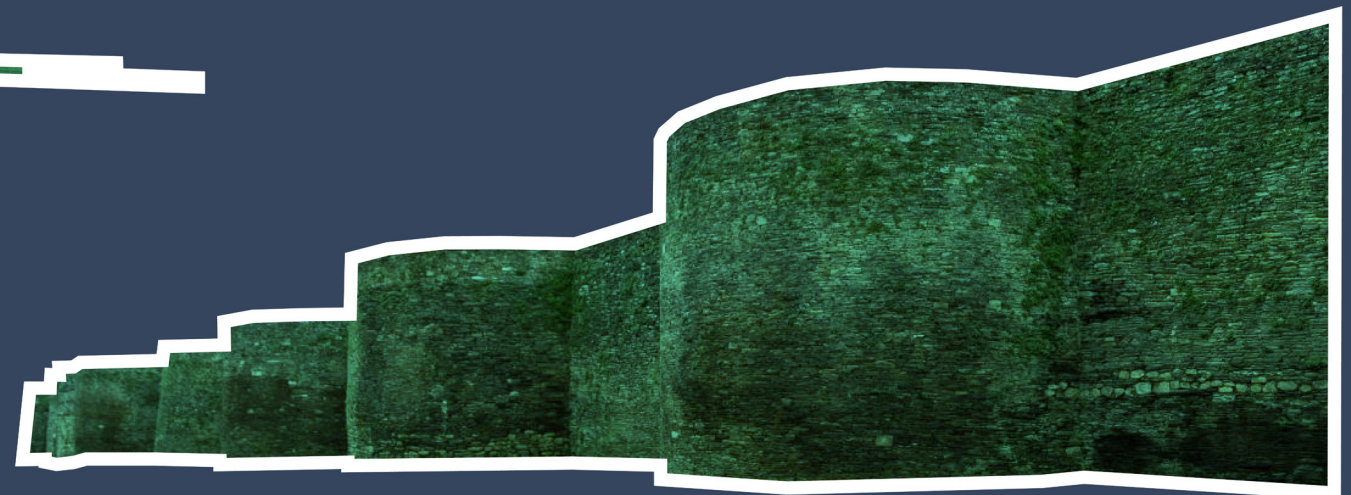


Image 4.6: Masonry Roman city walls of Lugo (Slotboom, 2018)

4.2 Buildings today

4.2.1 Residents

Currently most of what remains of the castra is underground and covered by the neighbourhood of Nijmegen-East (image 4.8). The majority is low rise, consisting of 41% of houses here (Gebiedsverschillen, 2022), mostly built before the year 2000 (AlleCijfers.nl, 2023). Nearly half of all houses are privately owned and on average more people have enjoyed a higher education than the rest of the Netherlands, with 58%. Inhabitants are very involved in their neighborhood to keep it safe, clean and green (Gebiedsverschillen, 2022). This is what characterizes the people of Nijmegen-East.

4.2.2 Functions

Towards the northwest is the centre of Nijmegen with many shops and restaurants (Image 4.7). It is also the point of gravity for museums and other cultural institutions. Considering that the neighbourhood is right next to the centre there seem to barely be any restaurants the more you move east and it does not have a centre of its own. The neighbourhood has a few schools and healthcare institutions just in proximity to the forts. There is very little that would attract visitors the neighbourhood could therefore not feel as lively. The whole area consists mainly of residential housing with some offices and shops scattered around.

4.2.3 Property

The archaeology of these forts are therefore also on private soil (image 4.9 & 4.10). The northeast corner of the Hunnerberg castra is undeveloped and public land, but is nearly fully surrounded by private land and the moraine. The rest of the castra is greatly fragmented, so opportunities lie in small scale visualizations in streets and squares. The largest opportunity lies in the Kopse Hof where the fort is almost fully accessible.

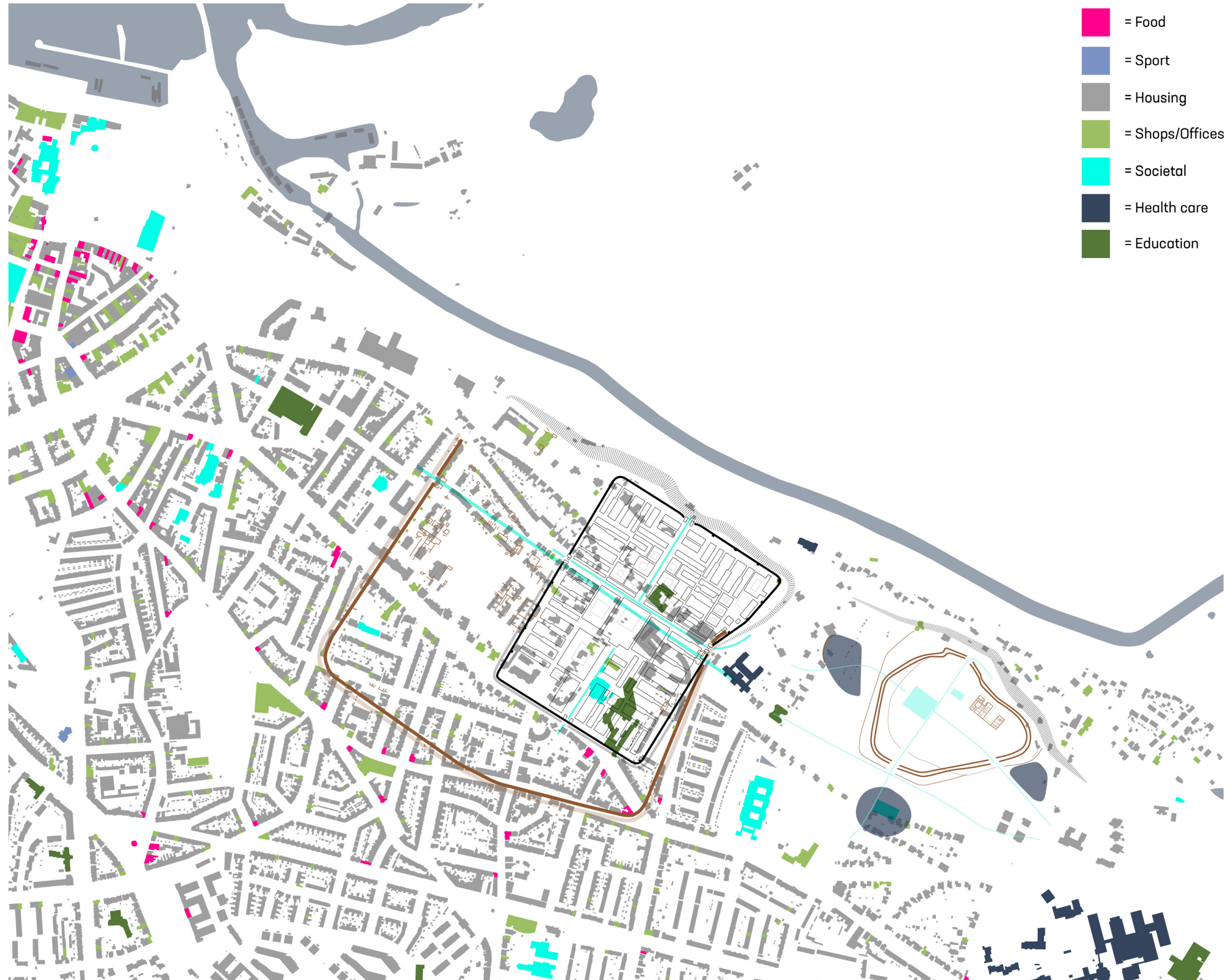


Image 4.7: Functions in Nijmegen East with the fortifications shown.



Image 4.8: Palette of buildings in Nijmegen-East





Image 4.9: Buildings in Nijmegen East on top of the fortifications.



Image 4.10: Public-Private in Nijmegen East on top of the fortifications. <https://kadastralekaart.com/>

4.3 Archaeophytes

The Romans adapted the landscape greatly and to build the wooden forts. The forests that are present on the moraine's edge today have regenerated from the barren land the Romans left behind and reach all the way into the city centre (Image 4.13).

With their building practices, tools and lifestyle the Romans also brought their own sources of food. This includes crops from the Mediterranean brought by Romans for agriculture or medicine and they still have an impact on the landscape today. These species are called 'archaeophytes' because they were introduced in ancient times before the Colombian exchange with America from 1492 rather than in modern times (BNNVARA, 2022). They are not invasive and even considered endemic, part of the ecosystem as it is defined and researched today (Coperus, 2019)

4.3.1 Economy

These species were brought to supply the Roman army with food from farms in proximity to the fort. At the same time they established trade with other regions of the empire (J.P. Pals et al., 1997). Olive oil, wine, chickpeas or dates were adored, but imported and traded for local grain. The Roman taught their methods of agriculture to the local tribes and intensified production for a long distance economy.

4.3.2 Herbs

Using herbs in cuisine was an unknown practice before the Romans arrived and various herbaceous species like fennel (*Foeniculum vulgare*), celery (*Apium graveolens*), coriander (*Coriandrum sativum*), dill (*Anethum graveolens*) and anise (*Pimpinella anisum*) were introduced as crops, but became wild. Romans also loved using scented flowers from ornamental plants like roses and violets as garnish (van Dingenen, 2013).

4.3.3 Fruits and vegetables

Nijmegen is surrounded by primitive medlars (*Mespilus germanica*) with thorns that bare a fruit (image 4.3) in the rose family (BNNVARA, 2022). Chestnut (*Castanea sativa*) was also grown for its fruit, but doesn't fruit in the first years, so planting these was a testament that the Romans were here to stay (Swart, 2022)

Marigold (*Calendula officinalis*) was grown for treatment of wounds and healing properties (Swart, 2022). Poppyseeds (*Papaver Somni-*

ferum) also has medicinal properties as opium, but were also used in cooking. Roots from Parsnip (*Pastinaca sativa*), beetroot (*Beta vulgaris*) and endive (*Cichorium pumilum*) were introduced as root vegetables (image 4.4).

4.3.4 Cultivars

Even though apples and garlic could be found in the low land, the Romans still brought their own cultivars that they were already accustomed to. (van Dingenen, 2013) It is unclear if the local *Alium* species such as chives were considered as food.

Not everything that was cultivated survived, because many crops required a lot of attention and effort to fruit, but a lot can still be found in and around Nijmegen, which in itself could be considered heritage



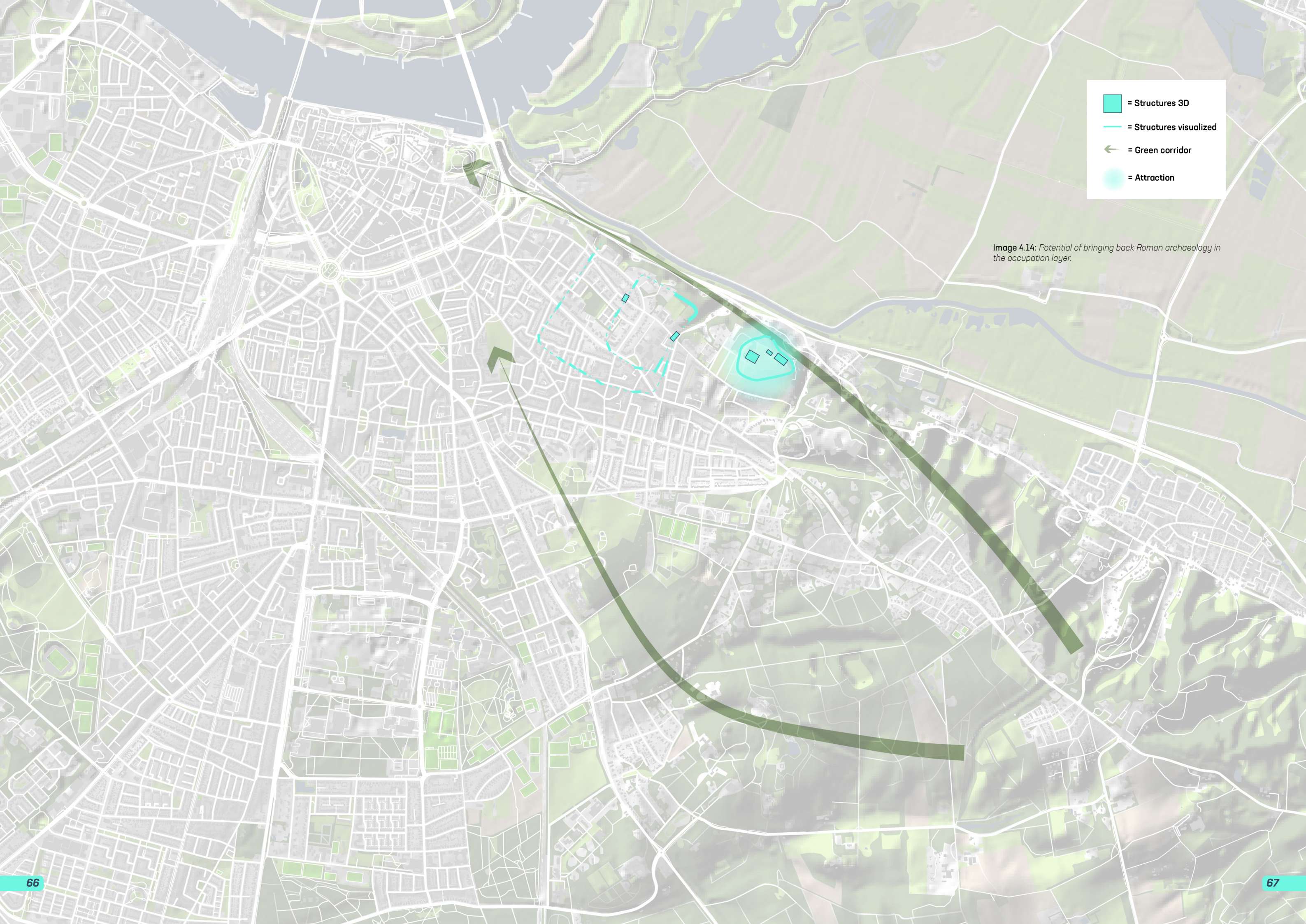
Image 4.11: Fruit from *Mespilus germanica* (Den Mulder Boomteelt, c. 2021)



Image 4.12: Endive (*Cichorium pumilum*) in bloom. (van Dorp, 2009)



Image 4.13: Green connections to the outskirts of Nijmegen.

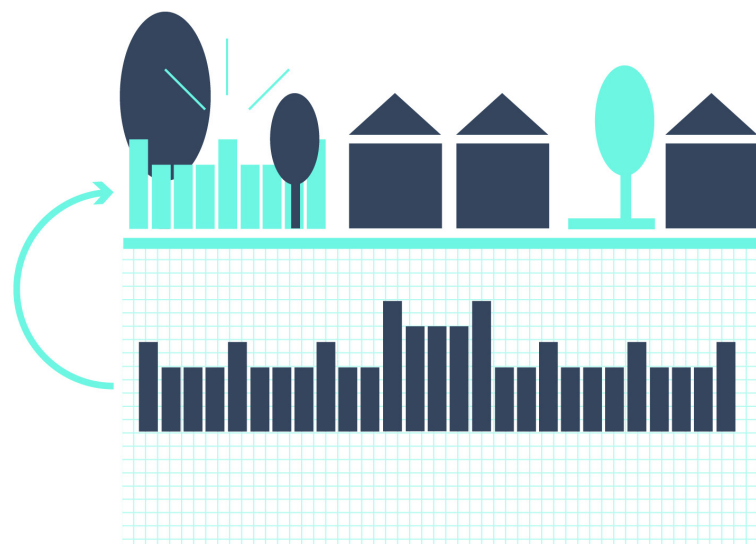


-  = Structures 3D
-  = Structures visualized
-  = Green corridor
-  = Attraction

Image 4.14: Potential of bringing back Roman archaeology in the occupation layer.

4.4 CONCLUSION

Nijmegen-East is a quiet neighborhood with not many functions other than housing. Much of what covers the fortifications is private and the potential then lies in the park covering Kopse hof and the roads above Hunnerberg (image 4.14). Moreover the material that was used determines what will be left behind. Not only finds remain, but some remains are still very much alive. Archaeophytes were introduced into the ecosystem by migration of the Roman lifestyle and could therefore be considered living ancient heritage and a Roman legacy. These species can be used to create new green corridors.



STRUCTURAL LAYER
Public space + Functions

05. NETWORK LAYER

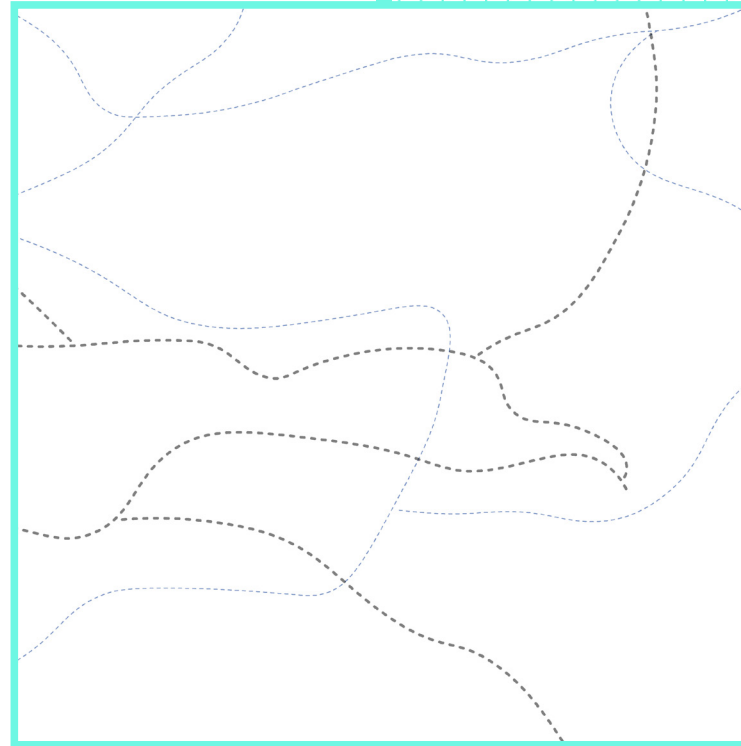
Roman roadsystem, routes, public space, public transport

The accessibility of Nijmegen-East and Nijmegen as a whole will be judged by analysing public transport. This chapter will also explore the relation between Roman roads and roads nowadays by traveling through the UNESCO sites in sections and photos.

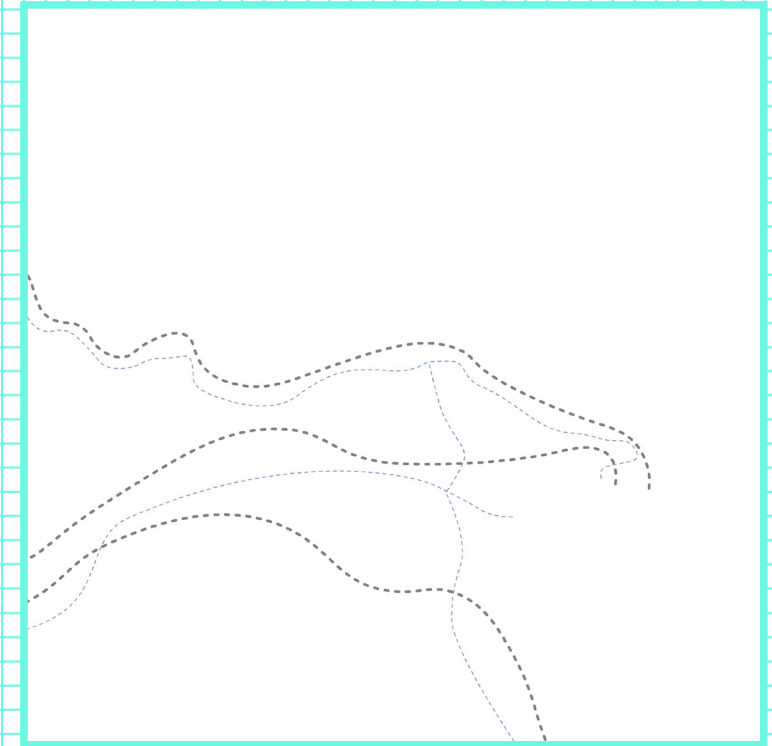
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1500



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"The terrain is desolate, the climate harsh, the life and landscape bleak. You only come here if it is your homeland."

- Tacitus, 98 AD (Colenbrander, 2005)

5.1 Roman roadsystem

Roman roads mainly connected the military and trade, and even trade served military purposes. Food and building materials were transported on horse drawn carriages (Colenbrander, 2005) (image 5.7). In cities like Pompeii, where the roads are still intact, you can still see the tracks that the carriages formed in the pavement with time (image 5.5). Roman roads in urban settings were built on a sturdy base and higher than the surrounding, so water couldn't flood them and they could be easily washed (image 5.3). Ditches along the edges drained the excess water off.

The roads linked the castella and castra like pearls on a necklace (image 5.1). In between the roads were mostly straight lines, with the landscape occasionally dictating a small deviation (Tuuk, 2017). These were the highways of that time and connected the Limes to the rest of the Roman empire.

5.1.1 Miliarium

Milestones (Milliarium) lined the edges at intervals of exactly one Roman mile (about 1480m) (image 5.2). They were very important in navigation, but often only had the name carved of the emperor that had the roadwork performed (Museon, n.d.) (image 5.8). One milestone found in Nijmegen commemorates Emperor Traianus (van der Heijden, 2008).

5.1.2 Turrus

Border patrol for preventing threats was organized through a row of wooden Turrus (watchtowers) that would sign to light or smoke in case of emergency (Tuuk, 2017). Visibility was key to their placement, so regular intervals of about 300 meters were used. Very little is found of these structures, considering their small surface area and wooden construction (image 5.6).

Image 5.1: Limes Road chains the castella and castra (based on Polak et al., 2020b)

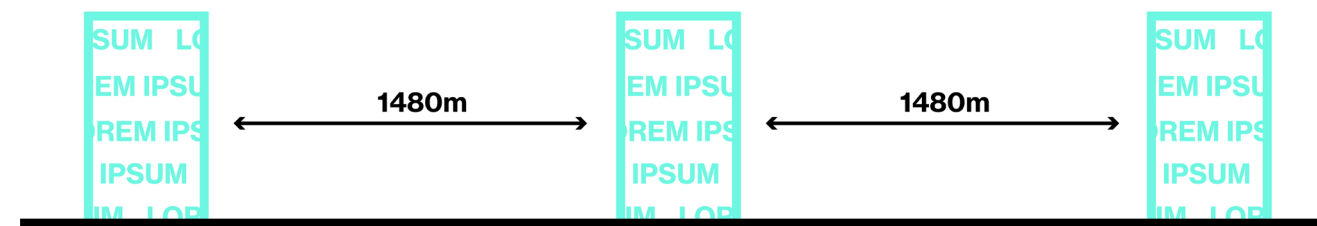


Image 5.2: Distances of Milestones

5.1.3 Location remains

Traveling through the development of Nijmegen shows that the Roman roads (image 5.4) were used continuously for centuries and were incorporated into the urban fabric (Abma, 2021). An example of this is the Ubbergseveldweg that runs above/through all three forts. When walking along this road, nothing remains, but also the feeling of the Roman space is not conveyed (image 5.9). There are few visualisations like the foundations of a porta and a route with informative panels. Here the heritage is the location and the space that has survived the test of time.

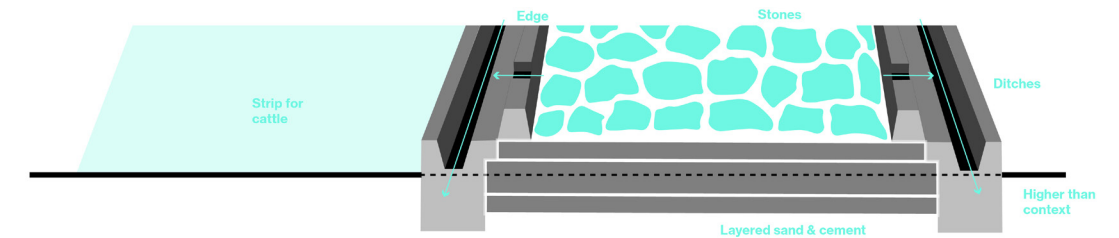
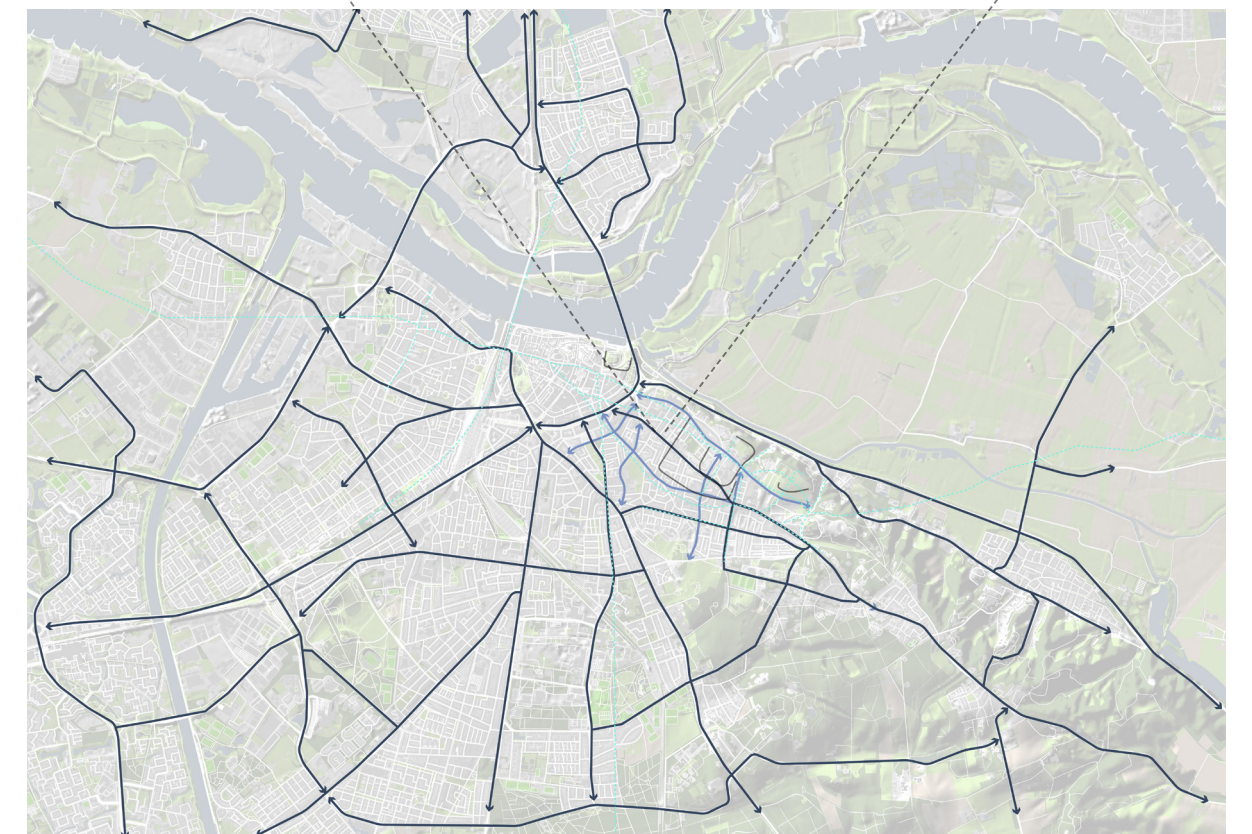


Image 5.3: Buildup of a Roman road in an urban settlement (Tuuk, 2017).

Image 5.4: Radial layout of Nijmegen with cross connections of Nijmegen-East compared to Roman roads (Gemeente Nijmegen, n.d.)



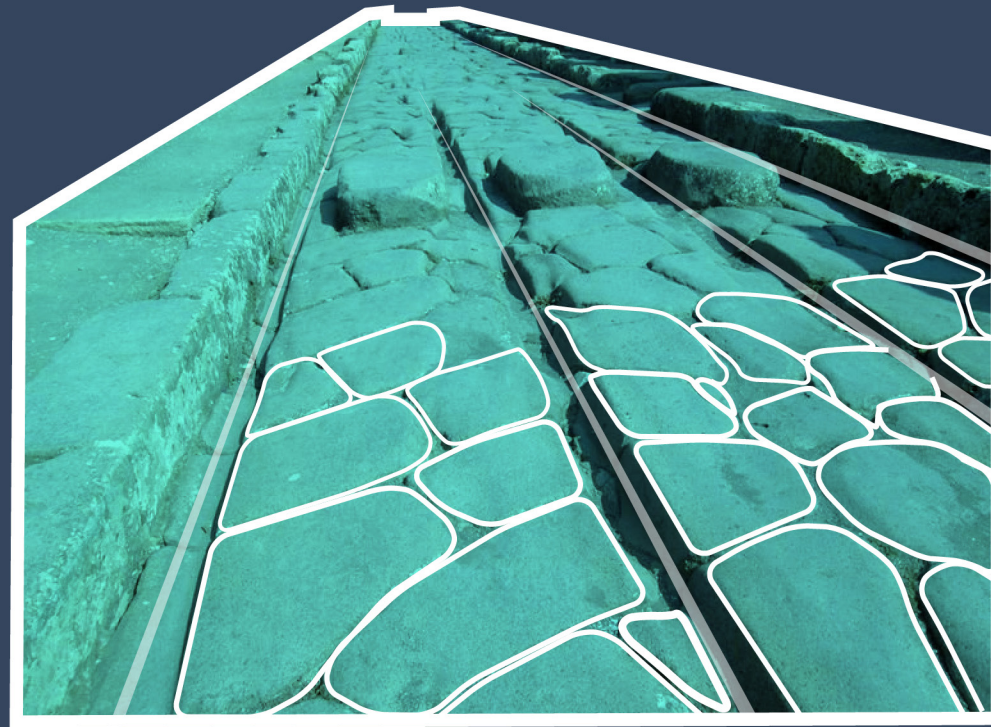


Image 5.5: Roman road in Pompeii (Poehler, 2019)



Image 5.6: Reconstruction of a watchtower in Vechten (Vermaat, 2005).



Image 5.7: Reconstruction of a Roman carriage (Cyron, 2006)



Image 5.8: Milestone in Braga (Reis, 2004)

Image 5.9: Sequence of walking on top a Roman road and through the UNESCO locations.



- = Nominated Property
- = UNESCO buffer zone
- = Nijmegen-East



Image 5.10: Location for the sections of UNESCO spaces along ancient roads.

- = Military
- = Civilian
- = Graveyard
- = Important building
- = Road
- = Wall
- = Ditch
- = Aqueduct

5.2 Roman spaces

What remains are the space that the Romans occupied (image 5.10 & 5.11). Sections of current roads in Nijmegen East (like number 7) show that the roads have only slightly shifted from the current layout and have sometimes been covered by housing. The soul of the space has therefore remained.

There is no visible difference between sections 1 and 6, while they are located inside the UNESCO zones of two different castra. Some roads cross temporally multi-layered spaces inside the two fortifications with their respective ramparts, Roman roads and aqueduct.

Sections 1, 3, 4 and 6 are fully within UNESCO nominated properties, meaning that any disturbance the soil needs to be grounded in purely civic needs or soil needs to be added. Sections 2, 5 and 8 are in between the core zones and the bufferzone. Only section 7 is fully inside the buffer zone.

These Roman spaces have the most potential for visualizations, since they receive the least regulations. Designing with other spaces is not impossible, but a bigger challenge at least. One that could be interesting at least.

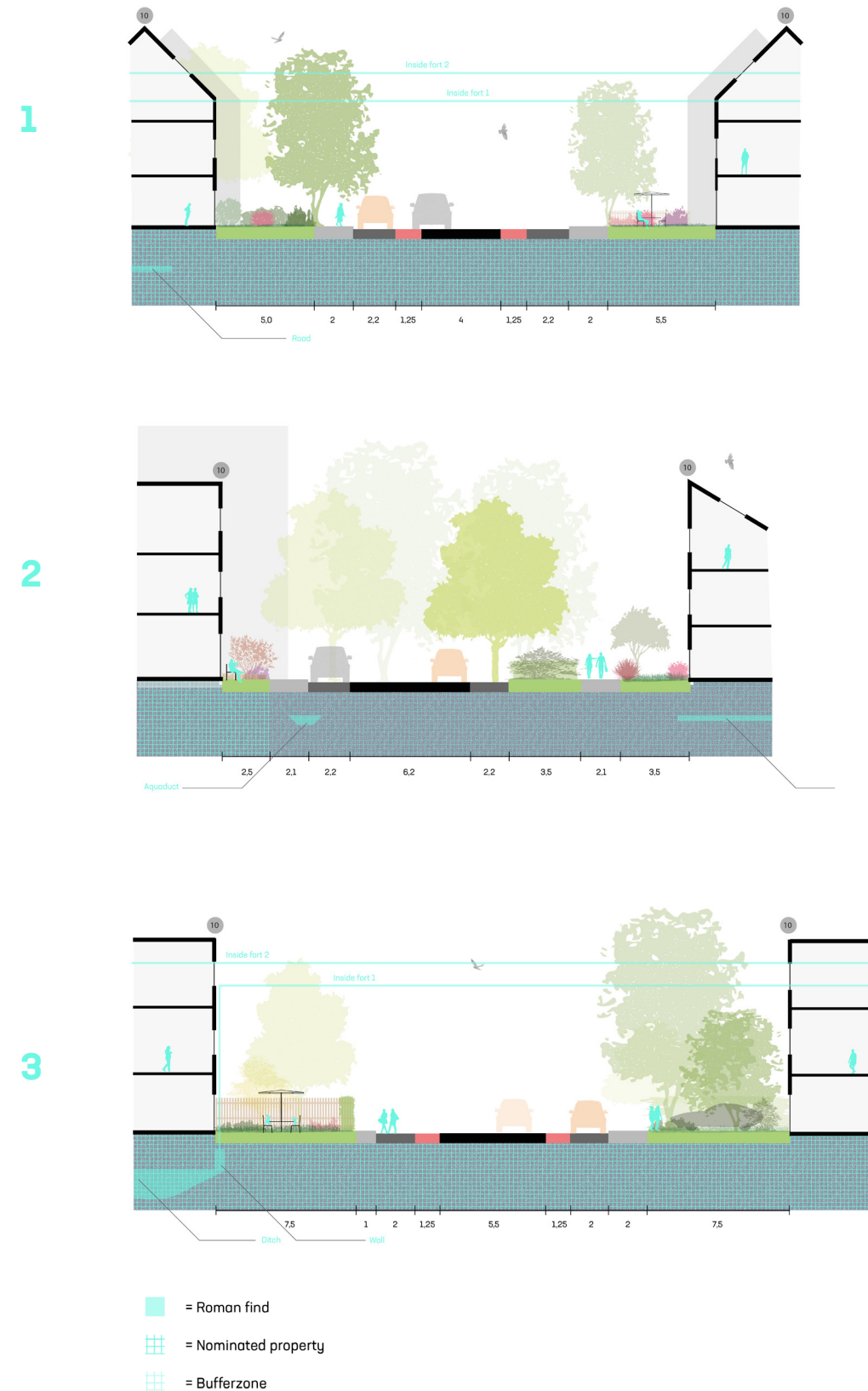
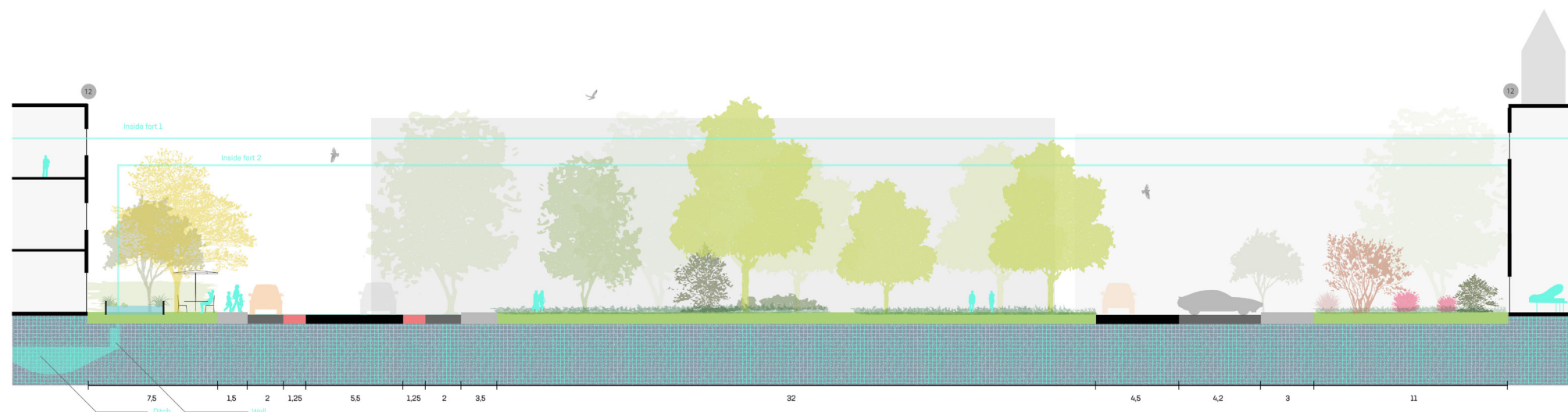
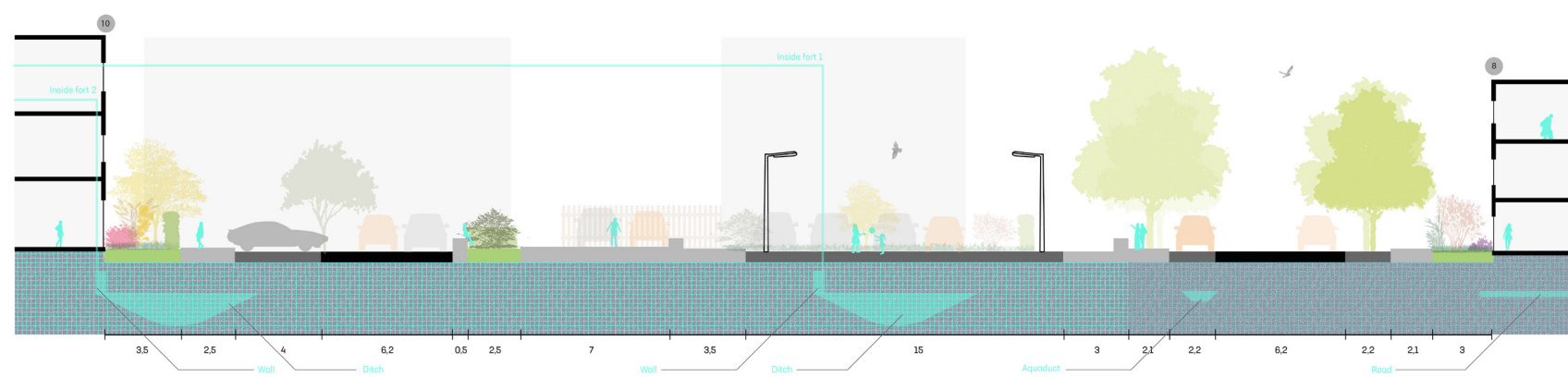


Image 5.11: Sections of UNESCO spaces along ancient roads with Roman elements shown (based on Vici, n.d. and Polak et al., 2020a)).

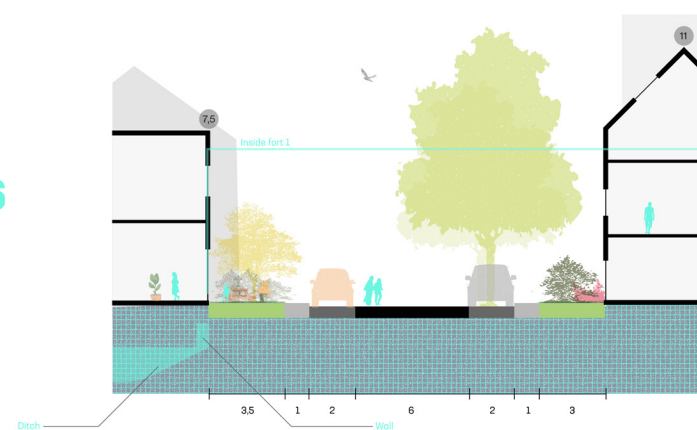
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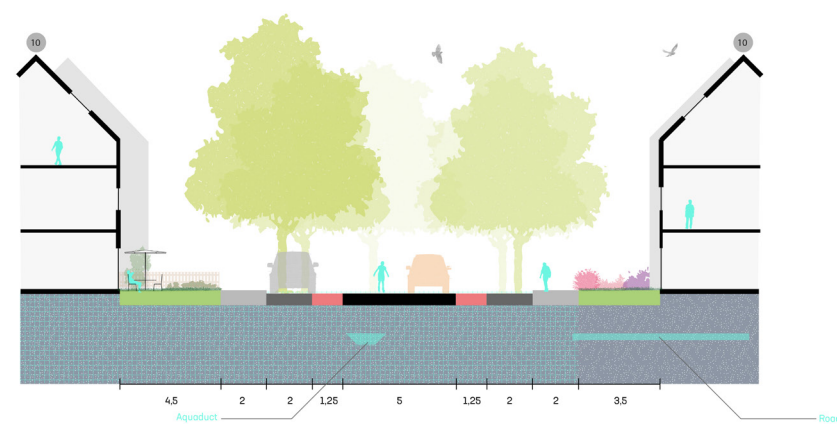


6

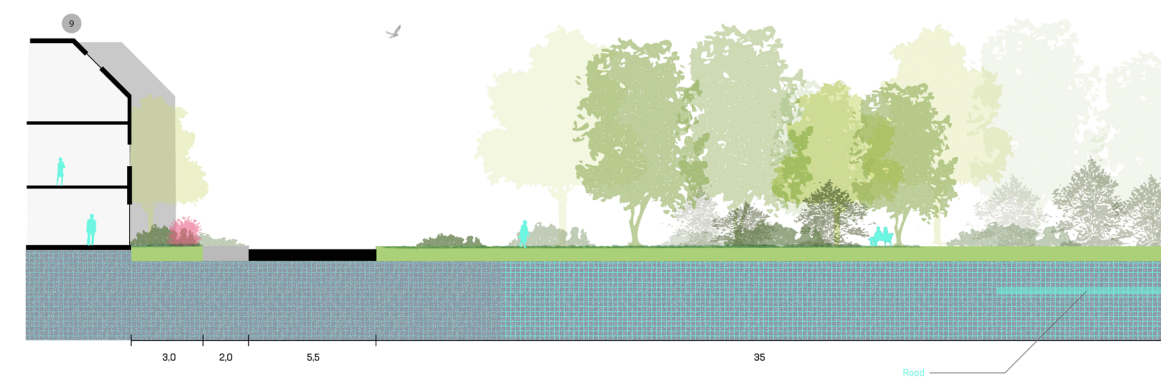


- = Roman find
- = Nominated property
- = Bufferzone

7



8

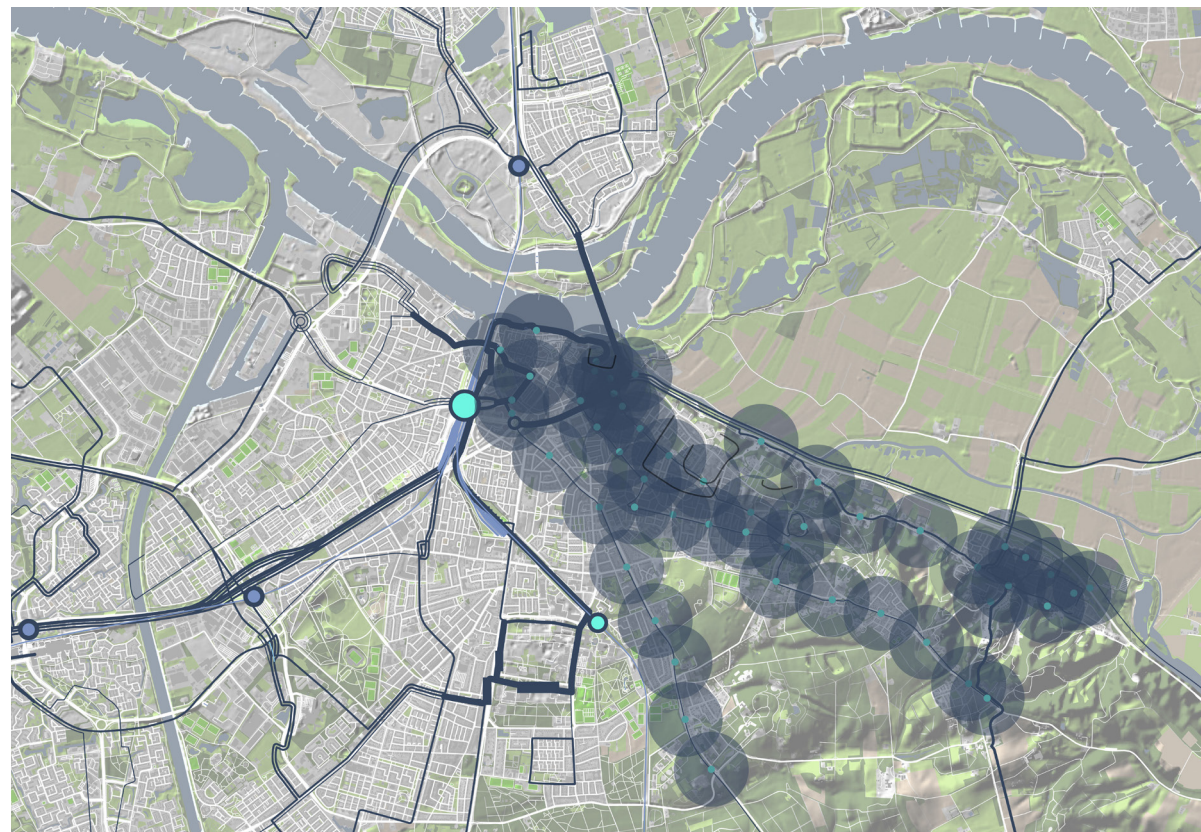


5.3 Current connections

Nijmegen is connected to the rest of the Netherlands by the railways network and various highways (image 5.13). From here large cities in the northwest like Arnhem or Utrecht, in the southwest like Den Bosch or Tilburg and in the south like Venlo or Roermond are very easily accessible.

Tourists who might enter Nijmegen via the central station have many options for reaching the city centre and its many museums like the Bastei or Valkhof. Nearly the whole neighborhood of Nijmegen-East is covered in busstops (image 5.12). Finding the UNESCO site of the Kopsse Hof is harder though, with two busstops being down the moraine, causing people to climb up to reach the sites. The best way is from the southern busstop through the park. A visual mark could capture the attention of the visitors. Therefore the infrastructure needs to serve the tourism and give more attention.

Image 5.12: Public transport in Nijmegen (Busses and train)
(Breng, c. 2022)

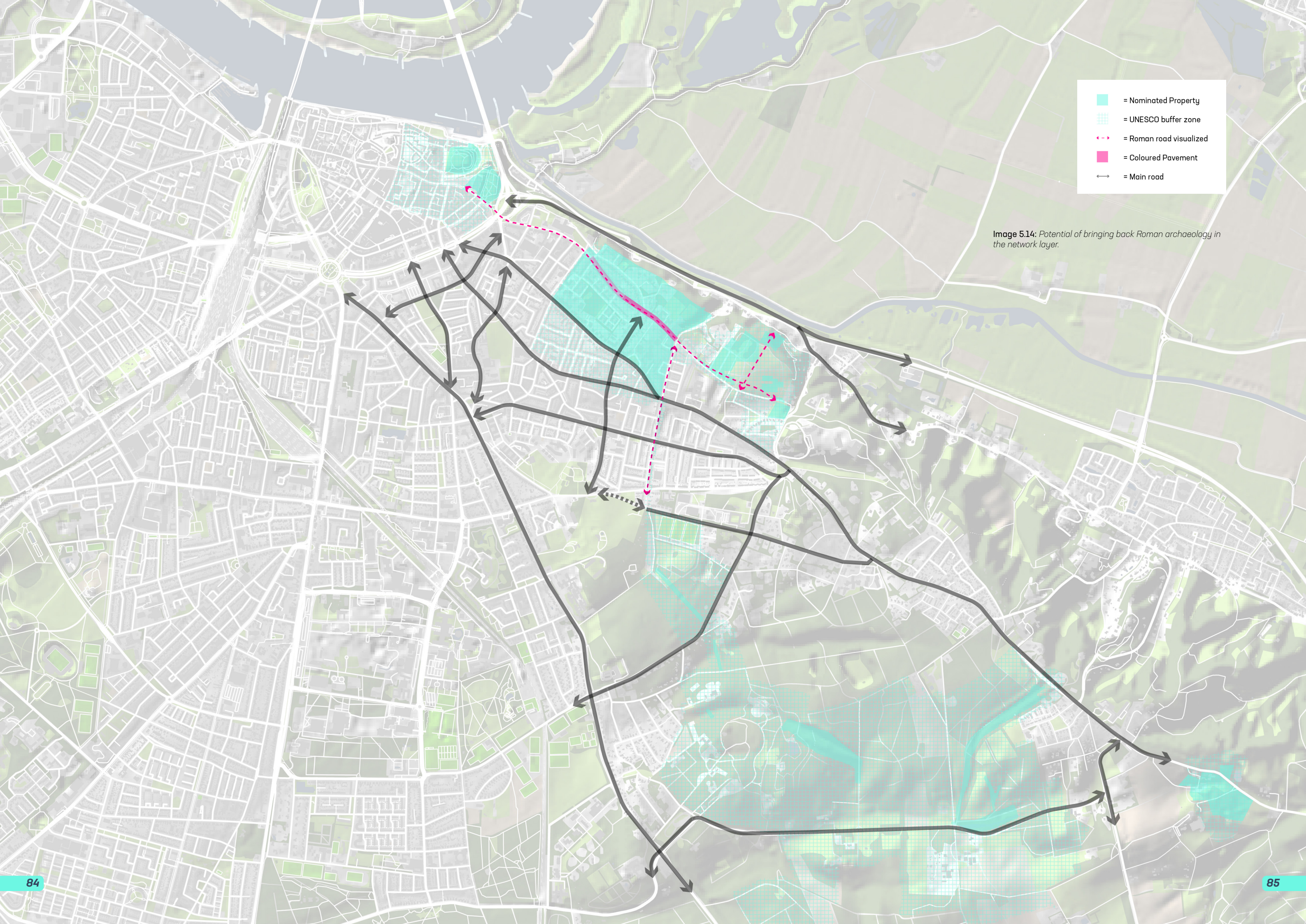


The aquaduct further into the landscape however is less reachable, no bus transports people there causing people to walk 20 minutes to the UNESCO sites. Here new lines could be the solution.

- = Busstops with 400 radius
- = Train/Bus station
- = Busline
- = Train
- - = Roman fortification
- = Roman road



Image 5.13: Roads and railway in the Netherlands (based on
NS & van der Loos, 2022).



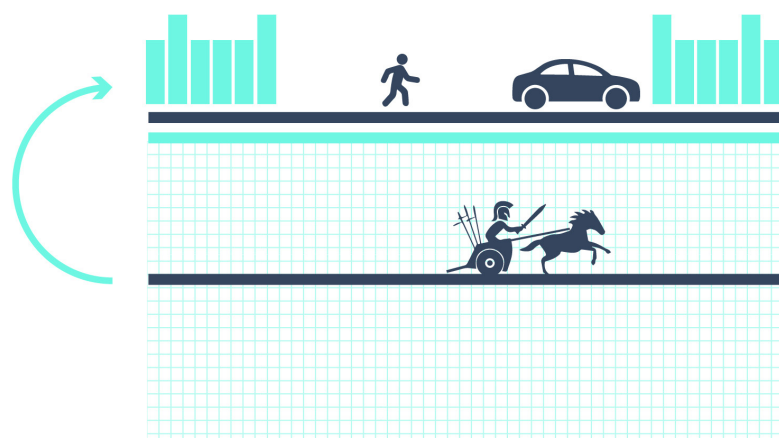
-  = Nominated Property
-  = UNESCO buffer zone
-  = Roman road visualized
-  = Coloured Pavement
-  = Main road

Image 5.14: Potential of bringing back Roman archaeology in the network layer.

5.4 *CONCLUSION*

Nijmegen is well connected to the rest of the Netherlands like in Roman times. Busses take people to the edges of the UNESCO sites, but are visually disconnected.

Roman roads do not remain physically, but are still used in the urban fabric. This is however not reflected in a visualisation. When following an informative route, the Roman road is not experienced throughout, but in informative panels. Many of these spaces are in UNESCO's nominated properties and within their regulations, but many are also partially in buffer zones, allowing more freedom in extravagant designs. The potential of the roads lie in connecting the UNESCO core zones through the bufferzones with their designs (image 5.14).



ROAD LAYER
Connecting through bufferzones

06. *SUBSTRATUM LAYER*

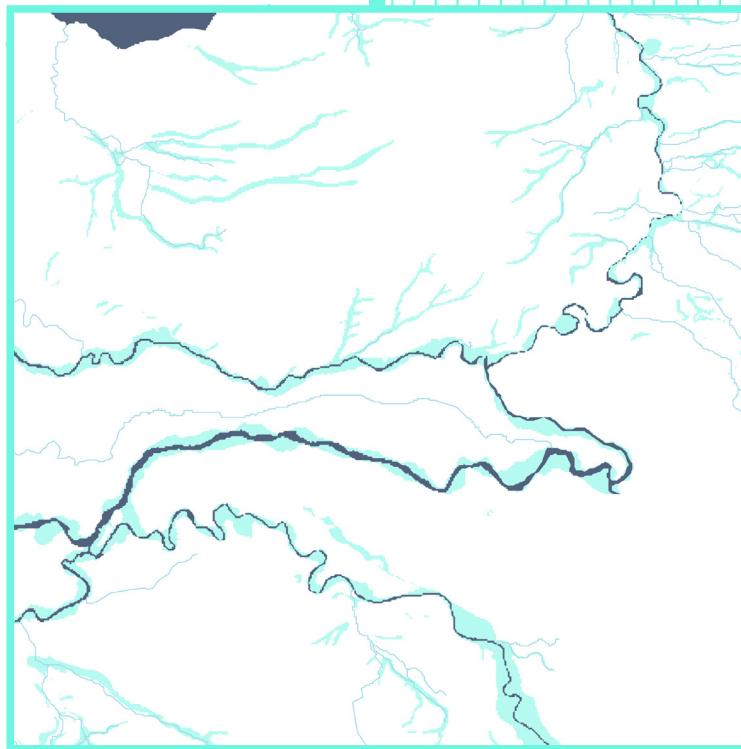
Aqueduct, river, waterways, rainfall, drought

The sixth chapter will discuss the water analysis of Nijmegen and surrounding areas. The Lower Germanic frontier is synonymous with the Rhine tributaries and therefore we start at the Roman water system and compare those to the current water system and water issues in mapping and images. The chapter will conclude with opportunities for improvement in the water management and catchment of Nijmegen in order to combat climate change.

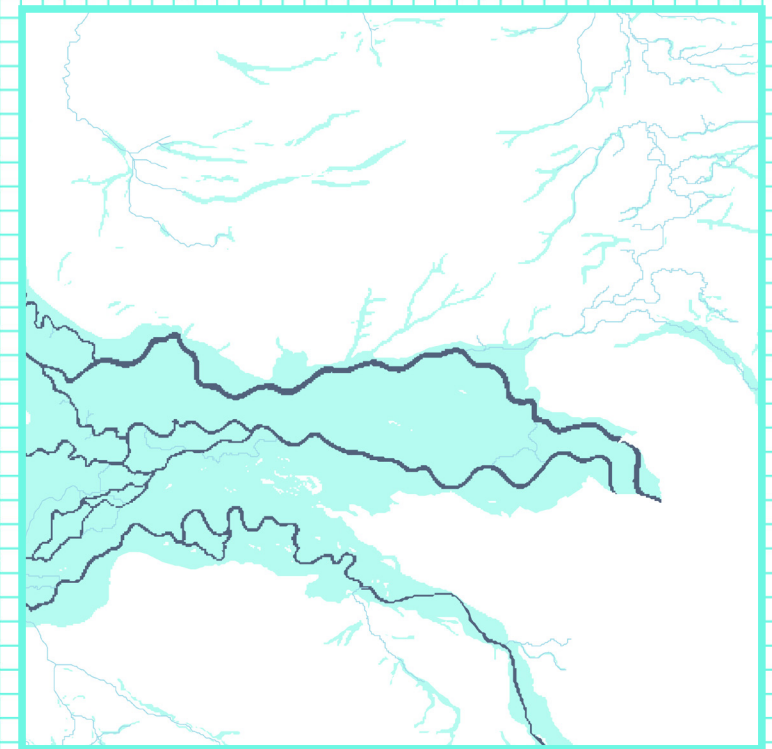
2000



1500



100



*"The skies are filled with rain rather than snow,
and even on clear days the fog lingers so long
that around noon the sun can be seen for three
or four hours at most."*

- Strabo, c. 20 BC (Colenbrander, 2005)

6.1 Roman water system

During Roman times the river was still flowing freely within its borders (Image 6.2). As could be seen from the different Roman periods, the River constantly changed courses until it was contained within the corset of dikes (Willemse, 2019, p. 303). Some waterways like Het Meertje have their origin in streams before the polders were constructed. It naturally delivered the water from high grounds to the River Waal. The dry valleys on the moraine had virtually the same geological features as nowadays. However the Romans did alter this natural system here by constructing an aquaduct. It functions perpendicular to the valleys and transports the water over them from a few sources for use in the fortifications. The alteration to the landscape can also still be seen in satellite images (Deurloo, 2020) and was necessary for a slow drop (Tuuk, 2017) (Image 6.1). In some locations the valleys were deepened or extended to new sources. Here the edging is raised where the soil was thrown. The aquaduct was also

not made out of stone or free flowing, but it was protected in a wooden trench, as can be seen in the reconstructions (Deurloo, 2020) (image 6.3 & 6.5). All that was found of these structures are discolorations in the soil where the wood has decayed (image 6.8). In Nijmegen the land formations are what is protected of the aquaduct.

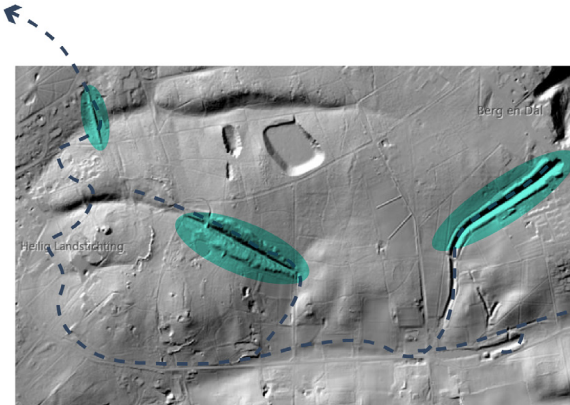


Image 6.1: Landformations created for the Roman aquaduct seen in satellite scanning.

Image 6.2: Watersystem of Nijmegen in Roman times 19-400 AD (based on PDOK, n.d. & Willemse, 2019, p. 303)

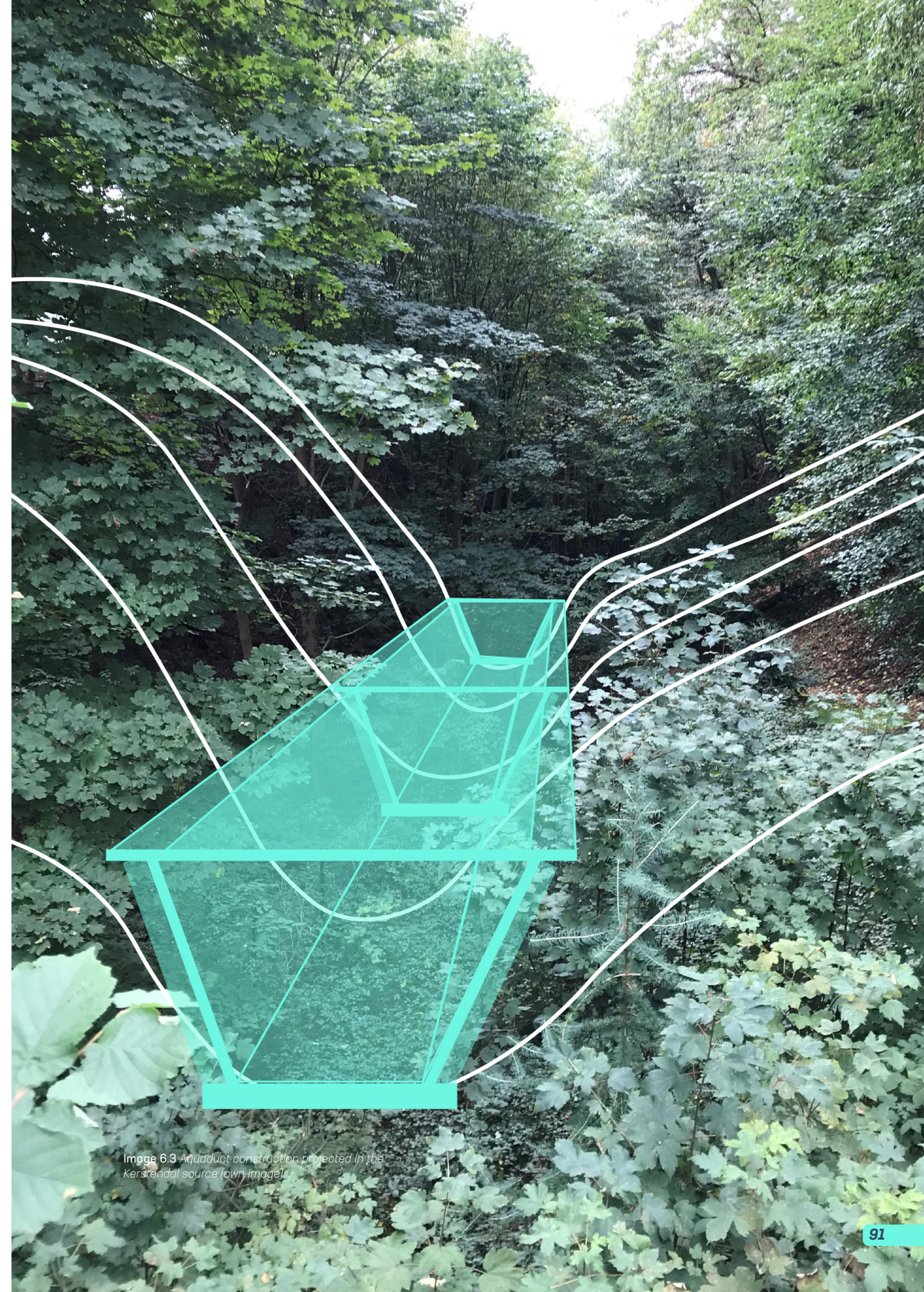
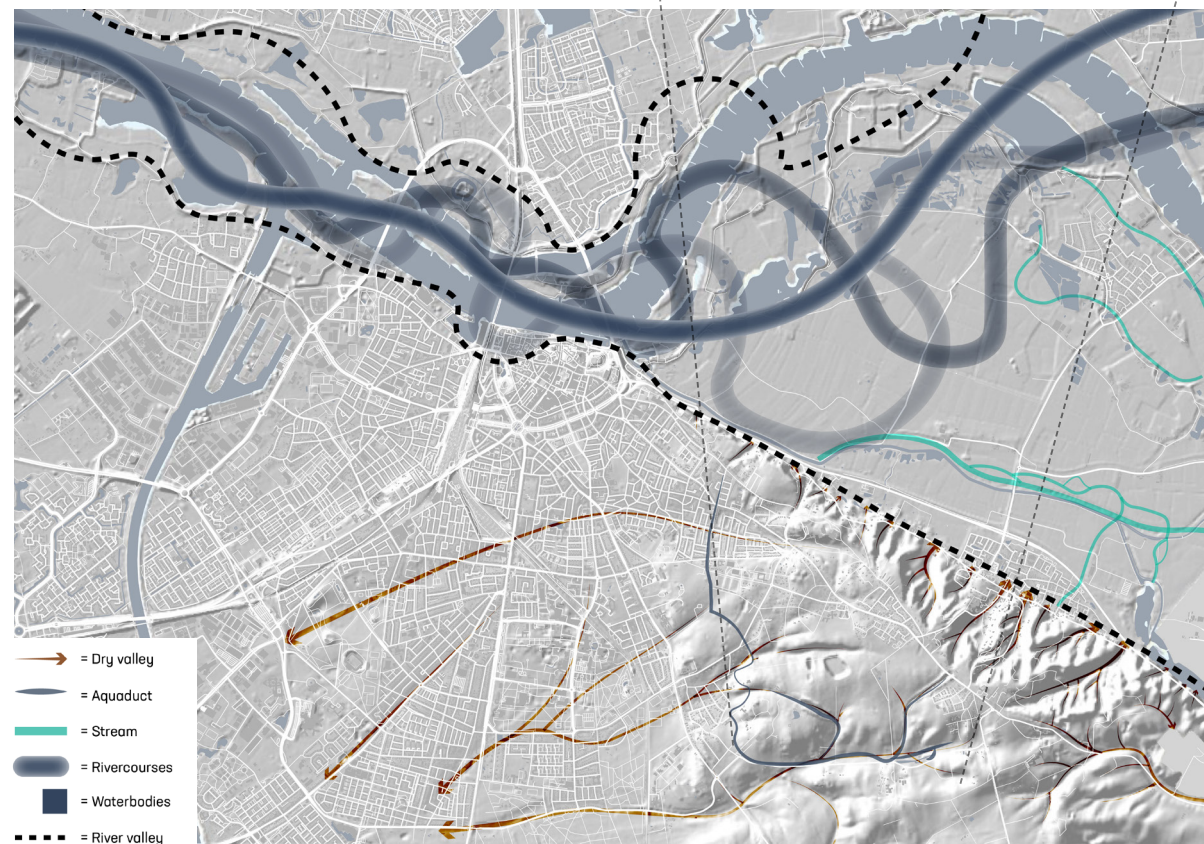


Image 6.3 Aquaduct construction protected in the Kerstendal source (own image).



Image 6.4 Aquaduct of Valens in Istanbul (Mondo79, 2019)

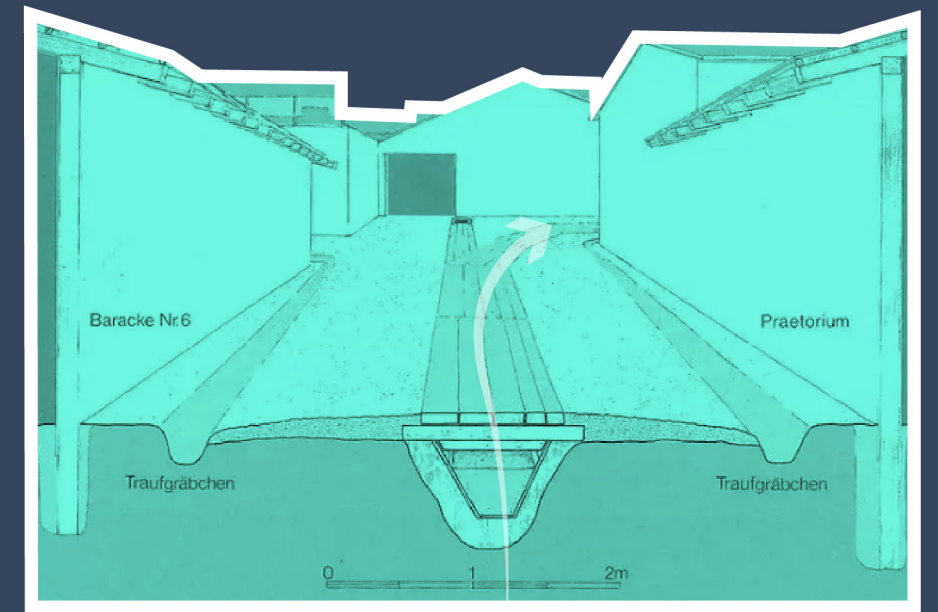


Image 6.5 Reconstruction of the Aquaduct in Xanten (Bureau Archeologie Nijmegen, 2020)

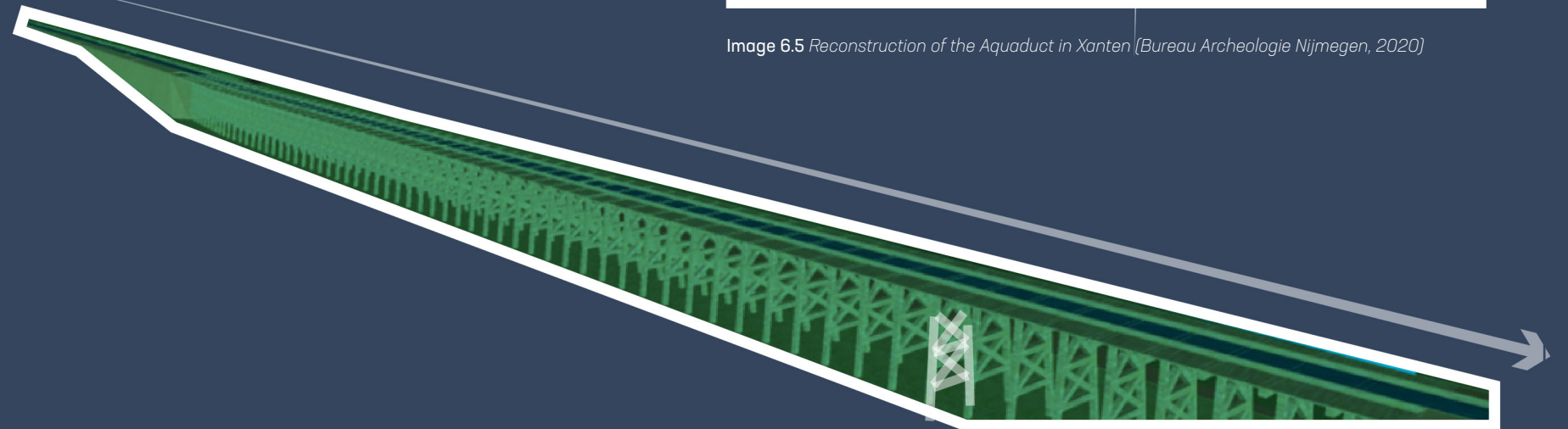


Image 6.6 Reconstruction of the Broerdijk in Nijmegen (Kuster, 2020)

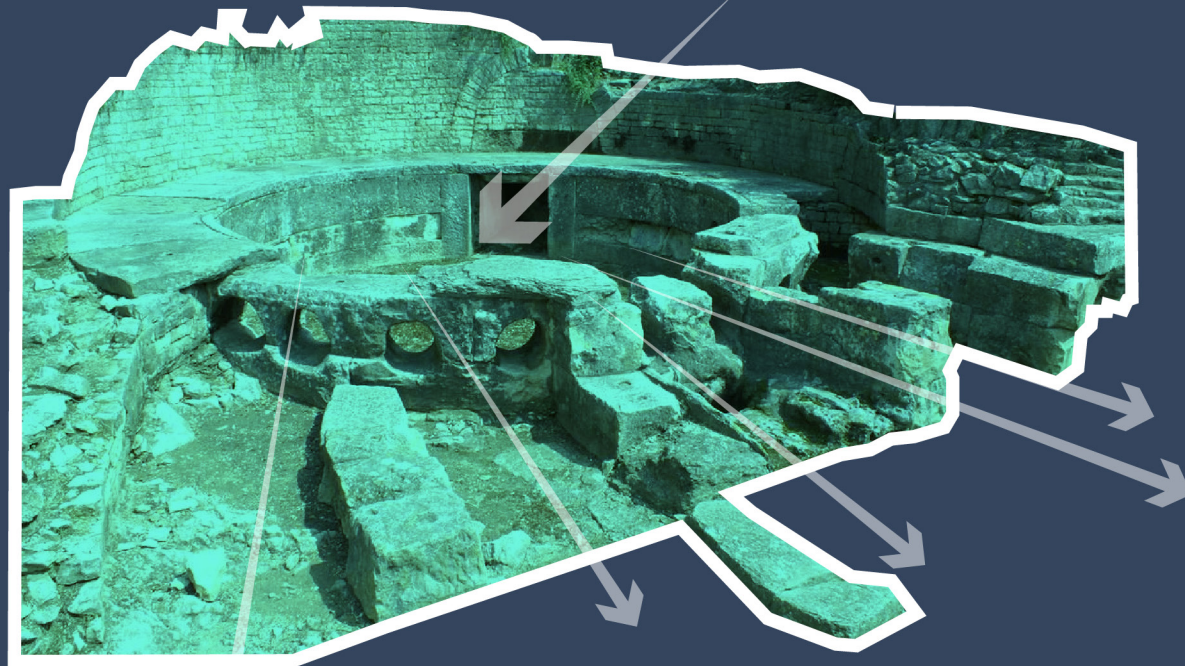


Image 6.7 Castellum divisorium in Nimes (Janberg, 2009)



Image 6.8 Excavated section of the Aquaduct in Nijmegen (Archeologie Nijmegen, 2020)

6.2 Aquaduct

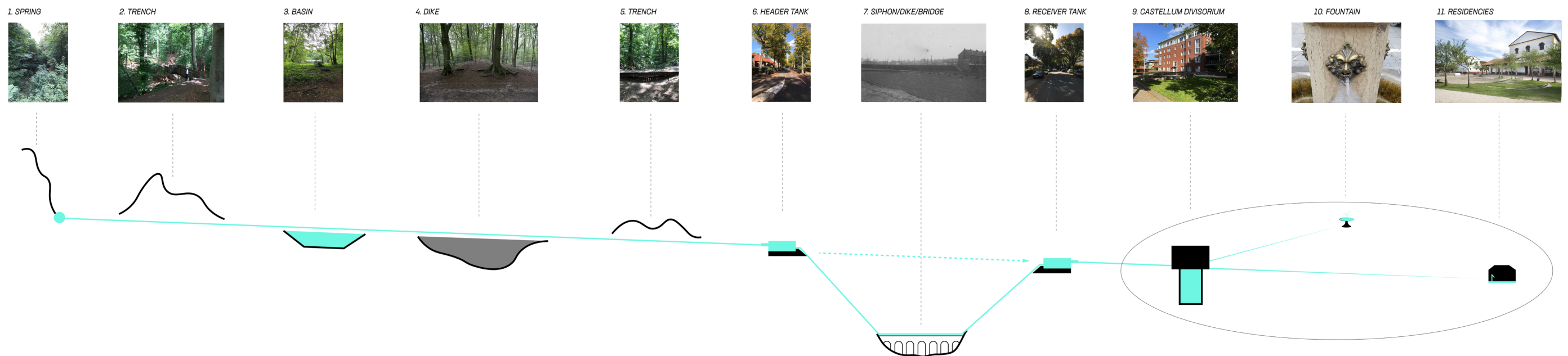
The Roman aquaduct started with the Kerstendal as the source (Image 6.9 & 6.10). The Romans deepened and extended this valley to reach a spring and tap into the groundwater (Aquaduct Groesbeek, 2022bb). The Louisedal further downstream was completely artificial and functioned as a second source. A waterbody remaining in Watermeerwijk at the end of the Kerstendal is thought to have been a basin to collect and control the water accessibility of the aquaduct. However the age of this basin still remains a mystery (Polak et al., 2020b). On further occasions a valley was bridged by raising the ground level with soil (a dike). It ensures that the aquaduct maintains a gradual decline of 0,05% to transport water. In general the aquaduct uses gravity to function.

The Broerdijk on the other hand is a peculiar incident where it is assumed that the dike was constructed with a wooden structure on top and therefore different from known stone aquaducts (image 6.4 & 6.6). Other theories predict that a siphon was used to bridge the valley (Aquaduct Groesbeek, 2022b). This functions based on flow mechanics where the decline must remain but a continuous pipeline is used at the bottom of the valley with two closed tanks on both sides (see image 6.4). The aquaduct ended in a castellum divisorium within the fortification, which essentially is a distribution station (image 6.7). From there water was sent to public fountains first and homes second.



Image 6.10: Map of the aquaduct in Nijmegen from source to the fort (based on Aquaduct Groesbeek, 2022b & Wijkcomité Oost, 2017).

Image 6.9: Diagram of the aquaduct in Nijmegen from source to use (Nr. 4: van As & Rijksdienst voor het Cultureel Erfgoed, 2010) (Nr.7: Aquaduct Groesbeek, 2022a) (Nr.10: De Haven, 2020) (Nr.11: Archeon, 2022b).



6.3 Current water system

The current water system for Nijmegen shows a divide between the high moraine and in the low lying riverpolders (image 6.11). Here a juxtaposition of a man made system and a natural system can be found. Lower lands are highly controlled through a system of small waterways and pumps. The waterways these polders were dug by people to transport the river and rain water to the main waterways and use the fertile river clay for agriculture.

From the higher grounds, the rainwater is carried down through dry valleys and mainly ends up in the sewage system. This water from the moraine is however very clean and effort has been put into retaining and supporting nature in the polders beneath it (Saris et al., 2004). To the east of the moraine 'Het Meertje' collects water from both systems and is emptied into the river Waal, which is nowadays the main tributary of the Rhine (image 6.12).

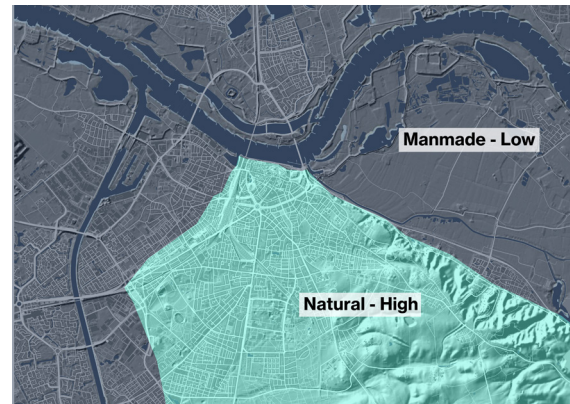
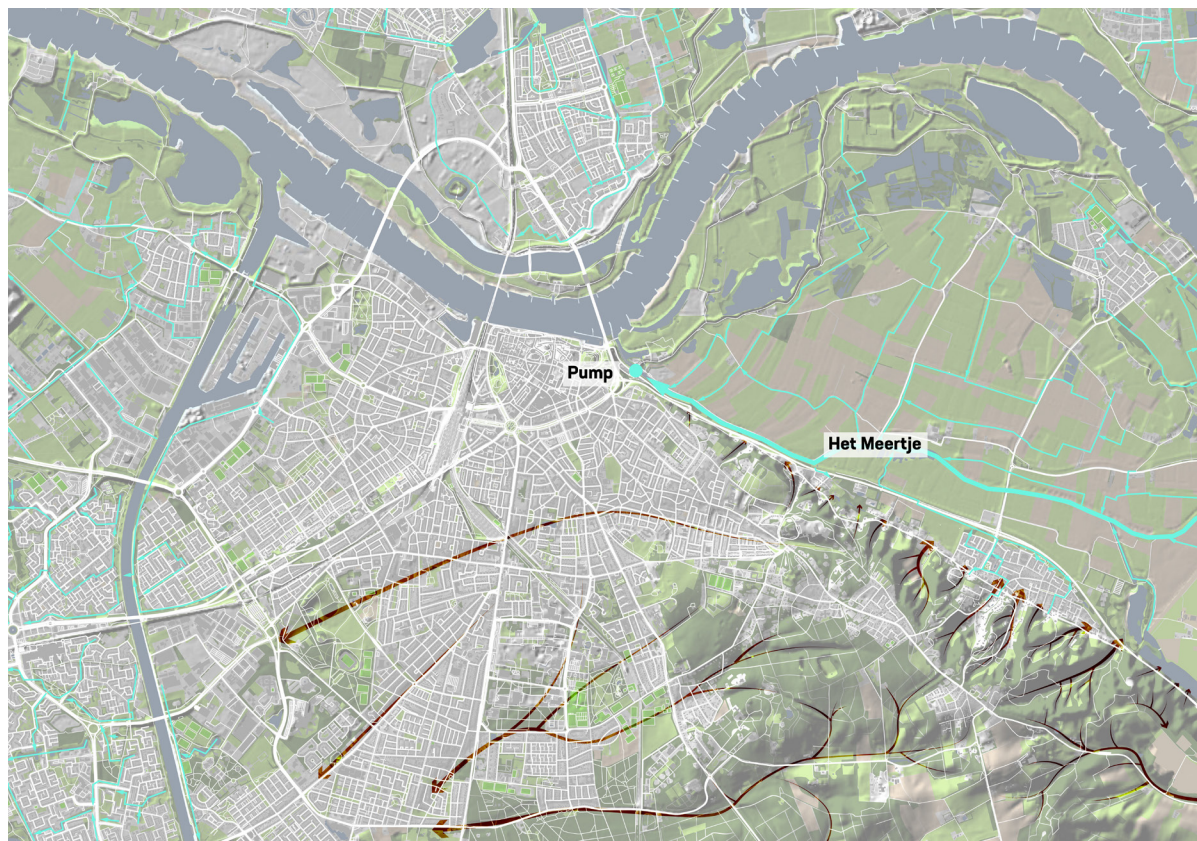


Image 6.11: The two watersystems in Nijmegen

-  = Dry valley
-  = Main waterways
-  = Primary flood defence
-  = Secondary flood defence
-  = Waterbodies

Image 6.12: Watersystem of Nijmegen (based on Waterschap rivierenland, 2020 and PDOK, n.d.)



6.4 Rainfall

The areas highlighted in image 6.14 are most prone to damage during heavy rainfall. During storm that occurs once per 100 years these places could be flooded with more than 30cm of water, causing terrible damage to housing areas (Smid, 2021). Interestingly enough these areas align perfectly with the dry valleys water system. It is logical that water would collect at the lowest point, but the water would run through a large built-up area of Nijmegen. Once every 100 years might not seem like a high chance, but it needs to be seen locally, as every year weather like this happens at least once somewhere in the Netherlands (KNMI, n.d.). In Nijmegen this results in a 1% change every year, but with less rainfall these areas are already prone to damage. Due to global warming extreme rainfall will occur twice as much as 50 years ago and will rise in the future (Image 6.13). Moreover the total amount of rainfall is also rising every year for each season (Image 6.15). Making preparations for these events will be necessary for these flood prone areas.

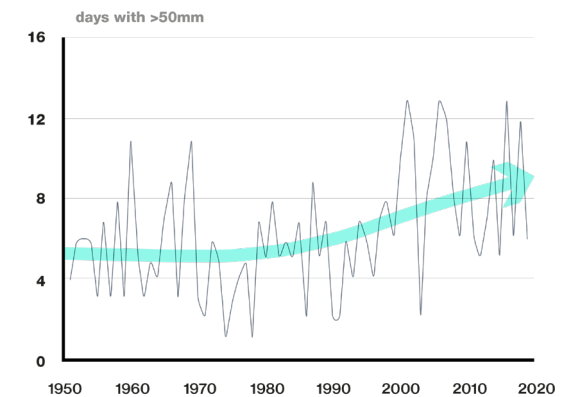


Image 6.13: Days with >50mm of rain per year in the Netherlands 1950-2020 (KNMI, n.d.)

Image 6.14: Extreme rainfall of 70mm/2 hours (Once per 100 years) in Nijmegen (based on Atlas Leefomgeving, 2018)





Image 6.15: Seasonal rainfall in the Netherlands 1900-2020 (KNMI, n.d.)

6.5 Drought

Global warming will increase the amount of water in Nijmegen, but will also increase the average temperature (Image 6.16) causing extreme drought. In 2020 the Netherlands was still recovering from severe drought and there was still a deficit in rainfall. This is set to increase in the future and cause more evaporation mainly in summer and resulting in very dry soil (KNMI, n.d.) (Image 6.17). The local flora is not prepared for these conditions and will suffer. After long periods of drought it is also harder for the soil to absorb rainfall, resulting in even more runoff. For example in 2022 after 10 days of no rain came heavy rainfall of 47mm (Image 6.18). The water needs to be captured and used properly.

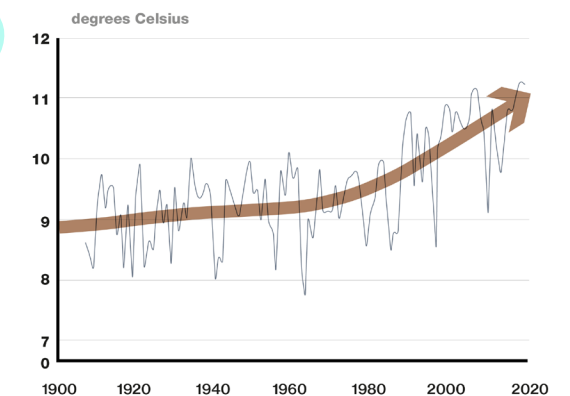


Image 6.16: Average annual temperature in the Netherlands 1900-2020 (KNMI, n.d.)

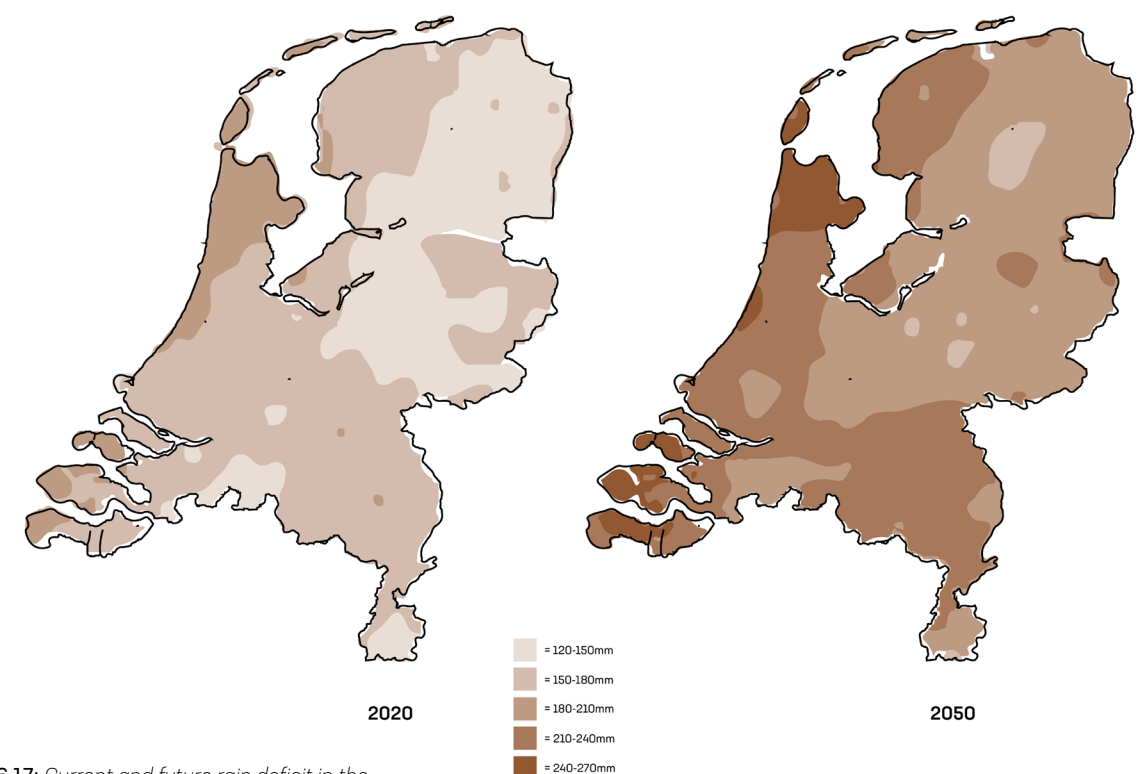


Image 6.17: Current and future rain deficit in the Netherlands (based on Atlas Leefomgeving, 2018)

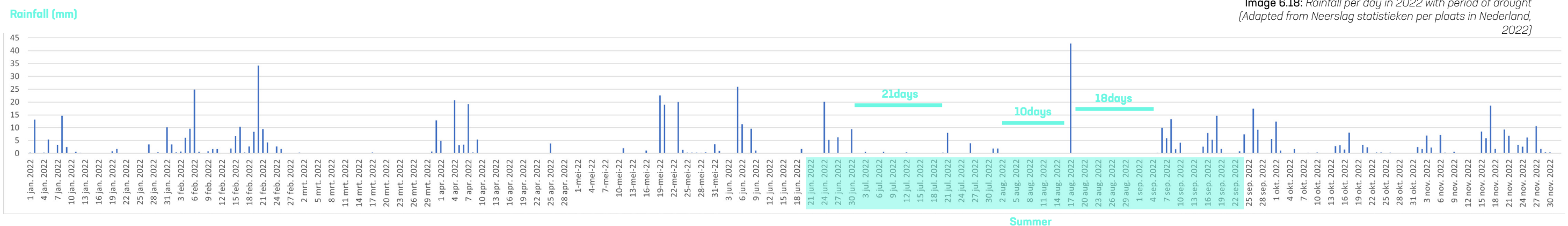


Image 6.18: Rainfall per day in 2022 with period of drought (Adapted from Neerslag statistieken per plaats in Nederland, 2022)

6.6 Increasing surface

To combat the extreme rainfall, flooding and drought a pattern of increasing water surface can be observed to the east of Nijmegen (image 6.19).

Around 1931 the river Waal had been fixed in its place by dikes and cribs. The Ooijpolder in the east was at its maximum extend with the only large water body being the Old Waal (a sedimented river arm). After the following decades the Polder was mined for clay by brick producing factories and for sand to make concrete to aid the Post-war reconstruction (Wandelen in de Ooijpolder, 2022). After these sites were excavated, the soil filled with water and were developed into natural parks. The industrial processes stopped in the nineties and most of these areas were returned to nature (Aarsbergen, 2018).

In recent years Global warming has become the main reason for more water surface area. Climate change causes the river to process increasingly more meltwater and rain from upstream causing flood in 1993 & 1995. To counter this the government made plans in 2000 to give the river Waal more space and capacity to hold water (Ministerie van Infrastructuur en Waterstaat, 2022). In Nijmegen this resulted in the creating of a new river arm that can be filled up in case of high water levels and reliefs the pressure on the city. History shows that the trend is to create more water areas and more storage capacity considering the water levels stay too high (Bingen, 2022).

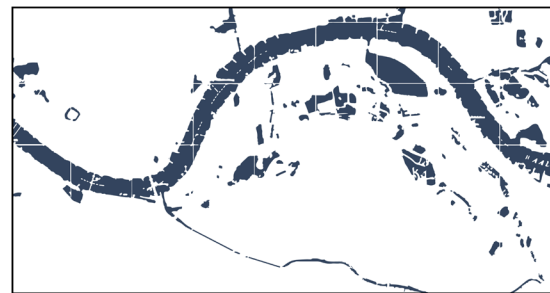
Image 6.19: Development of water surface east to the River Waal (based on Kadaster, n.d.)



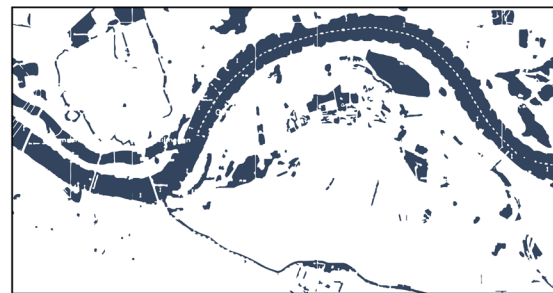
1931



1957



1972



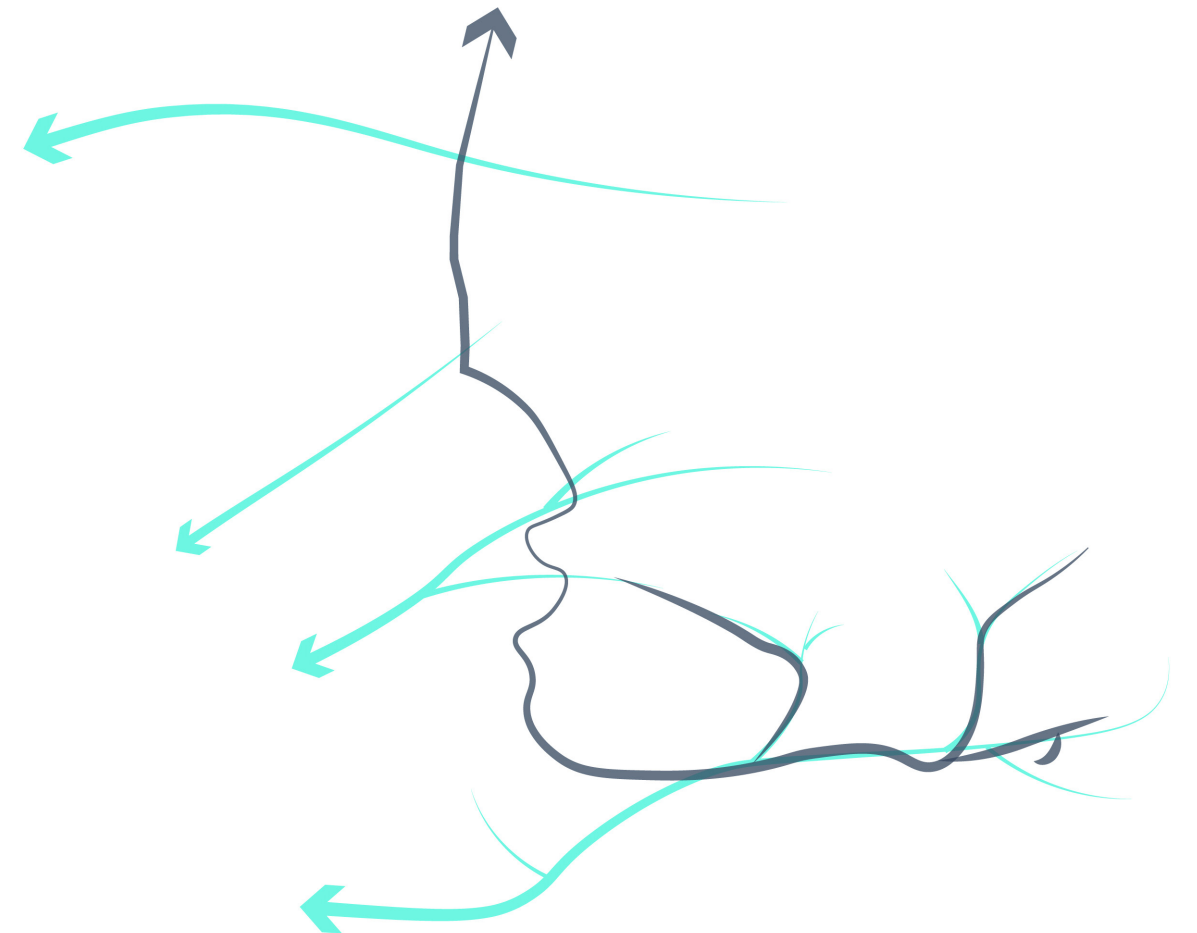
2021

6.7 Potential

The Lower Germanic Limes and water are intertwined, so when looking at the past and present of watersystem in Nijmegen some interesting opportunities arise on showing heritage and problem solving (Image 6.20).

The valleys carry water downstream through the neighborhood of Nijmegen, however here they increasingly create flooding issues due to global warming. As concluded from the Roman water system, the aquaduct ran against the grain of the valleys and gradually carried water further on the moraine. The opportunity here is to revive the aquaduct and use it as water retention on the moraine itself before it can cause damage in areas of lower elevation (Image 6.17). This water is of very high quality and can be maintained to host a specific kind of flora (Saris et al., 2004). The recent trend for increase in water surface area can be continued by retaining water also on the higher grounds prone to drought.

Image 6.20: How the aquaduct flows against the valleys.



6.8 Catchment

Bringing back the aquaduct with a water catchment function will create a new waterway in the area. The surface was divided in five simplified categories (Image 6.23 & 6.24) to calculate how much capacity the aquaduct could reach in case of a 70mm rainfall in 2 hours (see appendix 13.1). The area has a large surface of green that can absorb the water quickly. The second largest area however, is pavement, which together with roads and roofs of buildings create a large amount of runoff. There is barely any surface water at the moment that has the capacity to store water in case of heavy rainfall.

The aquaduct will occupy this function with its gradual angle of 0.05%. It could carry around 232.544 m³ of water along its 5.500 meters, but this however means the waterway needs to be very wide and deep (Image 6.21). A better solution is to focus on a smaller area and collection points in the dry valleys (Image 6.22).

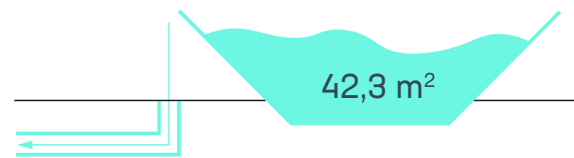


Image 6.21: Section of the aquaduct if all water is collected from the moiraine.



Image 6.22: Concept of collection points for the aquaduct.

Image 6.23: Concept of multiple collection points.

- = Watershed
- = Dry valleys
- = Potential collection points
- = Aquaduct
- = Water direction

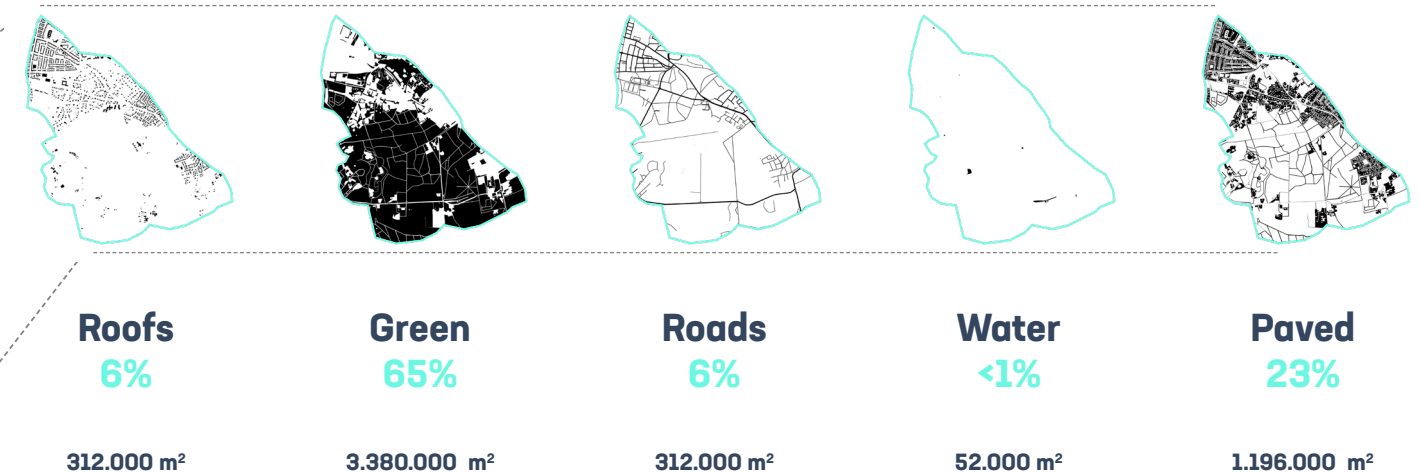


Image 6.24: Landuse for the calculation of rainfall runoff in total surface area

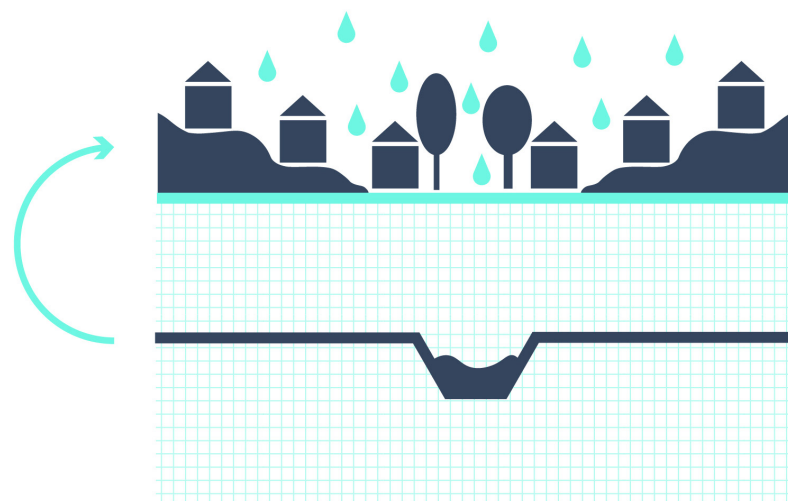


-  = Water collection
-  = Viewpoint
-  = Aquaduct flowing
-  = Aquaduct visualized
-  = Wet valleys

Image 6.25: Potential of bringing back Roman archaeology in the substratum layer.

6.9 **CONCLUSION**

The current watersystem controls the lower parts of Nijmegen in a network through the polders. On the moraine however, the water system is still natural with dry valleys that flood during heavy rain, potentially causing more problems in the neighbourhood located in these areas. The Romans did tame this system through altering the landscape to connect groundwater sources to the fortifications through the aquaduct. If the aquaduct is visualized it has the opportunity to sustainably catch a large amount of water and prevent flooding and drought. Since the potential is so large, the water storage is best solved in small areas for collection (image 6.25).



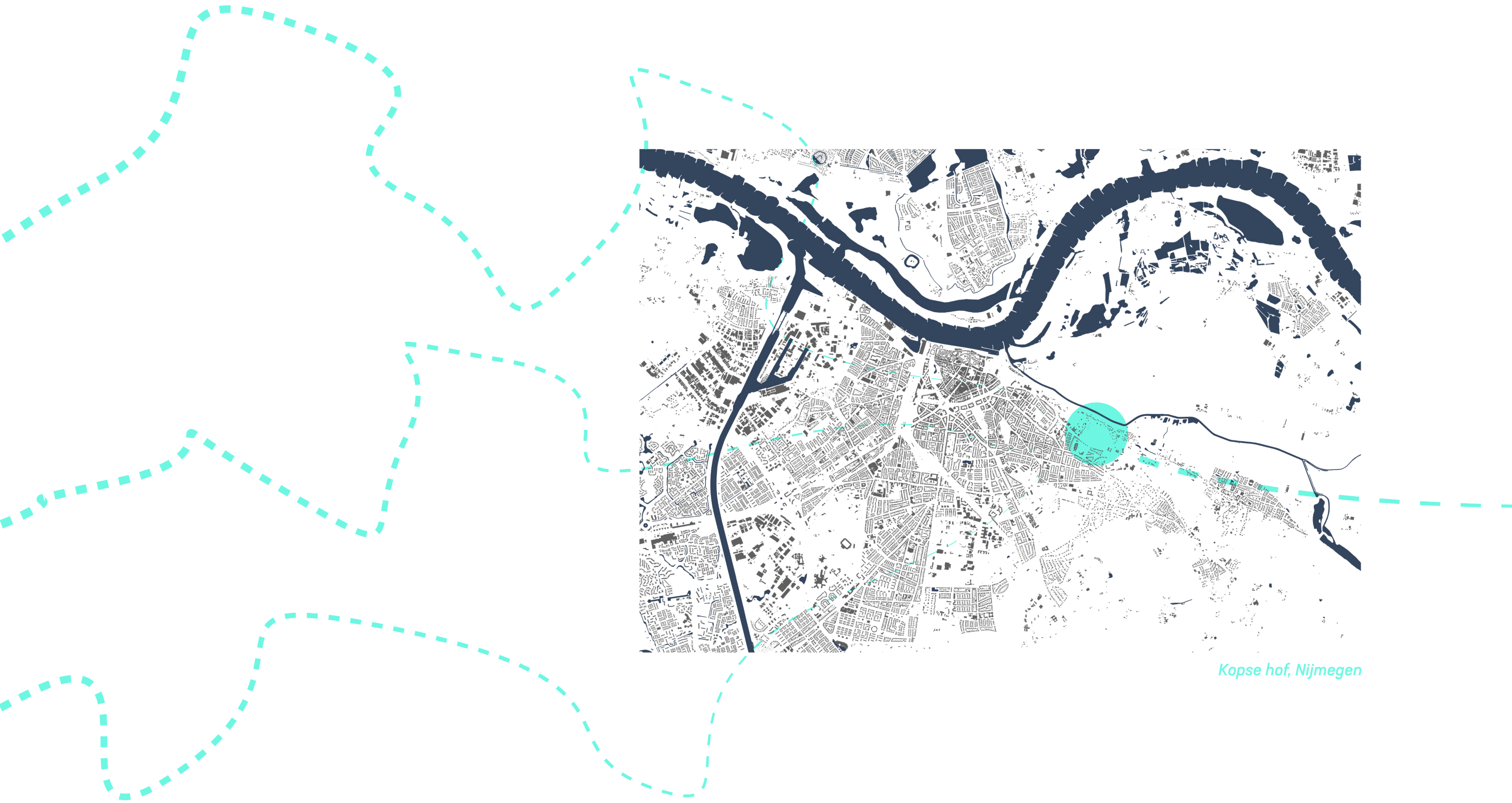
WATER LAYER

Catchment where valleys cross the aquaduct

07. **ENGAGEMENT**

Questionnaire, process, variants, workshop

Involvement is central to determining what heritage is and during this project that was achieved by distributing a survey and organizing meetings with the municipality of Nijmegen. This chapter will discuss the results from these methods.



Kopse hof, Nijmegen

7.1 Process

7.1.1 Site

The first step in creating participation was choosing a location for the questionnaire. The municipality of Nijmegen brought forth the Kopse Hof. Here a Roman fort is protected by UNESCO underneath a natural park (Image 7.1). The archaeology department of Nijmegen seeks to use this park to show Roman heritage, but no real projects have been developed. Using this location for the questionnaire can function as an exploration of possibilities for the municipality. The difficulty is however that the land is not only protected underground, but also above ground as nature. Adding to that a private foundation owns the land while the public uses it freely (image 7.2). The foundation has the last say in what can be developed on this soil within the rules of the municipality and who can enter it (they reserve the right to put a fence around it). In late 2022 a dialogue will be started with the landowners.

7.1.2 Goal

For me the task is to think freely about what is possible on the location and create a design for the municipality of Nijmegen. A design that the archaeology department can recommend to the landowners. Meanwhile I also aim to create designs that start the discussion about showing Roman archaeology in Nijmegen and can be used as a visual language in these discussions.

7.1.3 Methods

The 10 ways to approach archaeology from Broesi in the Limes atlas were used to create 10 different designs. In the process they of course overlapped and are not purely one category, but in essence they are inspired from one icon. The design results were then shared in a survey through Google forms.



Image 7.1: Current state of the Kopse Hof.

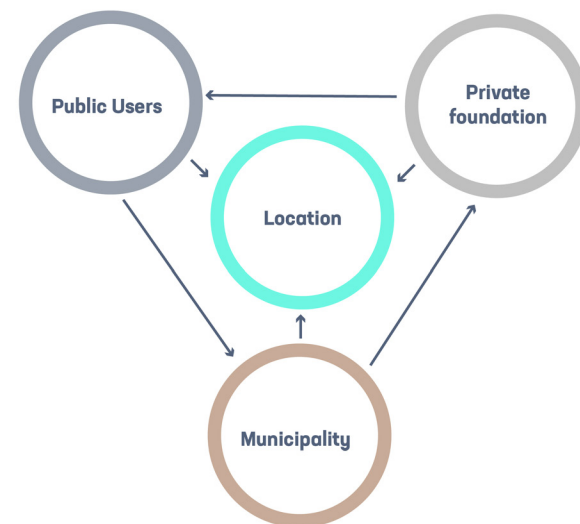


Image 7.2: Stakeholders on the location of Kopse Hof.



Image 7.3: Ten designs for the questionnaire based on Broesi.

7.2 Variants

The final designs took one of Broesi's categories of translating archaeology into design. Instead of a way to categorize designs, here the categories were used to design (Image 7.3).

1. Reconstrueren (Reconstruct) rebuilds the past structures like what happened in Xanten or the Archeon, but with a contemporary function such as a restaurant.

2. Inpassen (Incorporate) only builds where the archaeological value is low (like the areas that are not UNESCO or bufferzones). The municipality itself had expressed their interest in a visitors centre on this spot where people can be taught about the history of the place.

3. Statisch Markeren (Static Mark) is already what the location does by remaining unbuilt and protected. However in this variant this is emphasized by a permanent artwork of fish-bones found on the location. Kids can play in the pond and playfully learn about the Roman diet.

4. Branding (Branding) surrounds event of larping, markets and re-enactment shows. People gather and experience Romans intensely once a month, but there is barely any permanent structure needed to support this design.

5. Omhullen (Encase) builds a new museum around the in situ malta remains and protects them from weather conditions in a monitored setting.

6. Flexibel Markeren (Flexible mark) involves temporary functions to allow for designation of new protected areas. The Roman Mask of Nijmegen can temporarily be placed here to draw attention to the area. Moreover the site could lend itself to emergency housing (which the site had before just after WW2).

7. Conserveren (Conserve) unearths the remains so the public can view them and see what is left of the fortification inside the park. Furthermore small pockets with windows could give a peek into the soil with findings and layers of discolorations.

8. Etaleren (Display) is a museum design that showcases findings and history from this area ex situ malta.

9. Actualiseren (Update) visualizes the experience that Roman soldiers had inside the fort by imagining the Roman wall as a climbing wall that can be conquered. Moreover a walkway emphasizes that the location was chosen for its' view over the river valley. A playful way of learning is central to this variant.

10. Materialiseren (Materialize) uses lighting to show where the important structures were. Lasers give height and a futuristic look to this approach. Moreover lighting brings more safety for use of the park at night.

The designs were shown to the participants in the second part of the survey after some general questions about the people themselves and their knowledge of Roman Nijmegen.

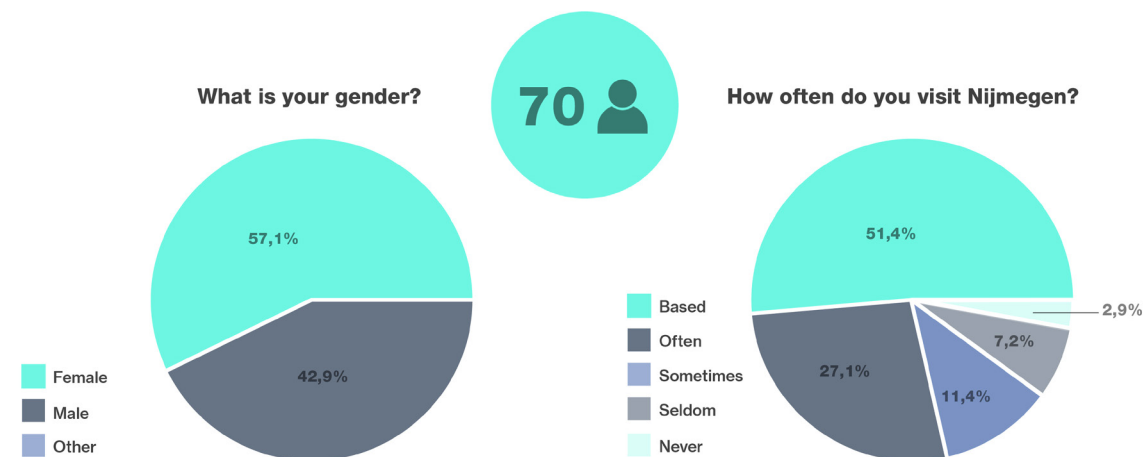


Image 7.4: General info of participants

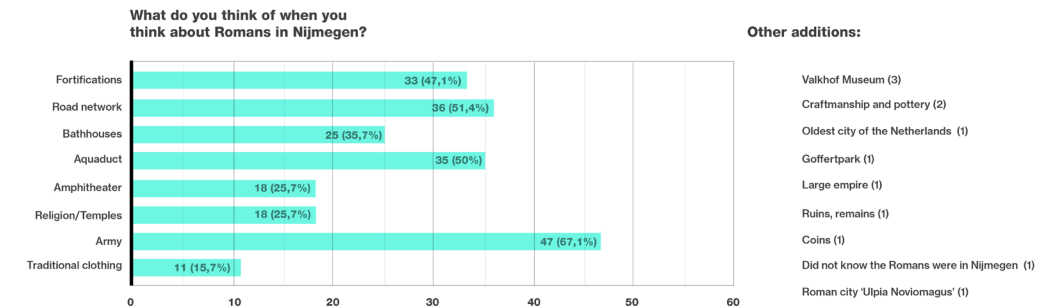


Image 7.5: Results for 'What do you think of when you think about Romans in Nijmegen?'

7.3 Questionnaire

The questionnaire starts by asking some personal facts, such as name, age, gender and visits to Nijmegen (Image 7.4). A total of 70 people participated in the questionnaire. The share of genders reached almost 50/50, with Female applicants being slightly more prevalent. More than 50% is based in Nijmegen, with 27,1% also visiting Nijmegen often with the remainder not visiting often.

7.3.1 Cultural Memory

People were asked what comes to mind when they think about Roman Nijmegen in order to determine what the cultural memory is made of. It was also possible to choose multiple answers and add other options. Most participants thought of the Roman Army, with 67,1% (Image 7.5). Around 50% associates Roman Nijmegen with fortifications and roads network and aqueduct. The Limes and this report also consists of these three main physical elements, but more can be done in design to incorporate the army. Or on the contrary the focus could be shifted to lesser known Roman attributes. The Roman city itself was also added, as well as craftmanship such as pottery and coins. These additions can be looked at in further research, since most participants chose the options that were given to them by the questionnaire.

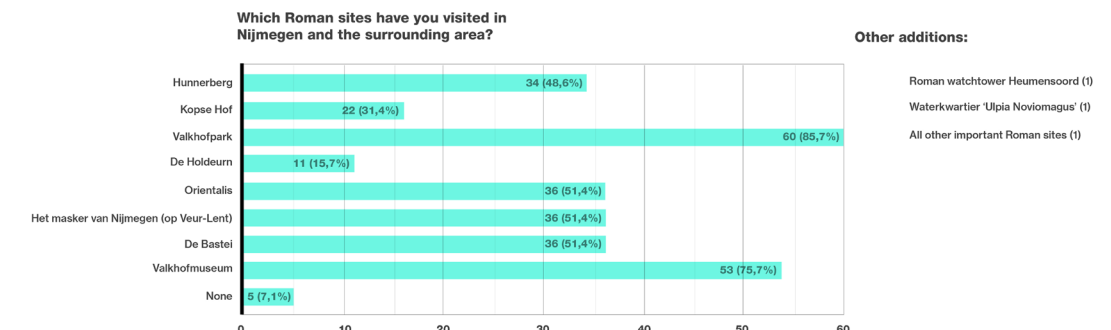


Image 7.6: Results for 'Which Roman sites have you visited in Nijmegen and the surrounding area?'

7.3.2 Roman places

The participants were then asked which sites they visited and an overwhelming 85,7% (6/7 people) have been to the Valkhofpark where there is some reused Roman masonry, meaning that only 10 people haven't visited yet (Image 7.6 & 7.7). 75,7% also visited the adjacent archaeological Valkhofmuseum. These are the locations people will have the memory most attached to.

Biblical history museum Orientalis, The artwork of the Roman Mask and De Bastei museum with Roman walls are tied for 51,4%. Close behind at 48,6% of participants have been to Hunnerberg, which generally is the neighbourhood in which the UNESCO sites are located. The potential here is to use the most visited locations as a platform to reach other sites. The site of Kopse Hof was visited by 22 people, and this was answered before it was stated that the designs in the questionnaire would be for that location specifically.

An important additions was the Waterkwartier where the Roman city of Nijmegen (Ulpia Noviomagus) was located. This was not included before due to the research aim being the UNESCO sites. However it would have been better to have a broader scope on all the Roman sites in Nijmegen.

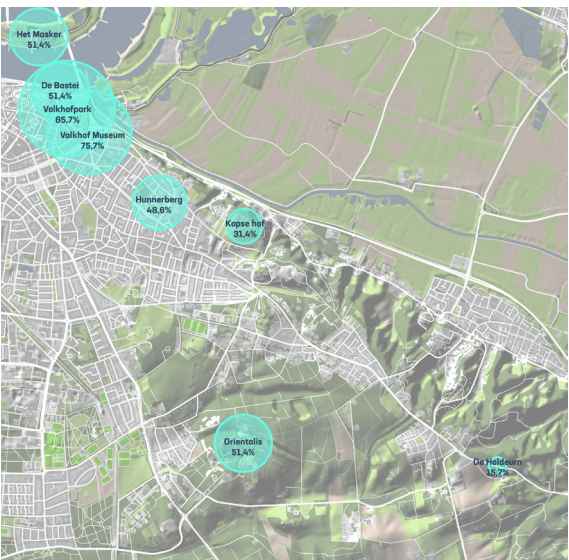


Image 7.7: Roman locations by visitors.

7.3.3 Design variants Kopse Hof

The second part of the questionnaire had the participants score the ten designs from 1 to 5 (Image 7.8). An average score was taken from the results, so they can be compared. The ranking of scores goes as follows:

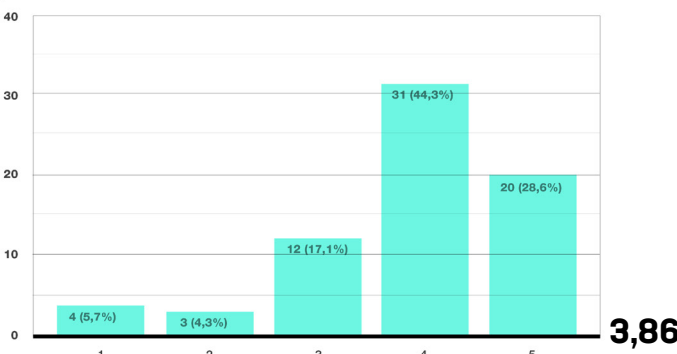
1. Reconstruct	3,86
2. Conserve	3,73
3. Materialize	3,36
4. Update	3,17
5. Display	3,16
6. Branding	3,06
7. Encase	3,01
8. Static Mark	3,00
9. Flexible Mark	2,97
10. Incorporate	2,69

Overall Reconstruct and Conserve scored higher than Materialize and Update. It can be concluded that the public prefers to see what physically remains or what used to be on this location. Cover however scored my lower than conserve, which is surprising considering the only difference is a construction over the in situ remains. People would rather enjoy the remains in open air. Incorporate scored the lowest, even though this variant has been proposed by the municipality itself. A new course of action is needed.

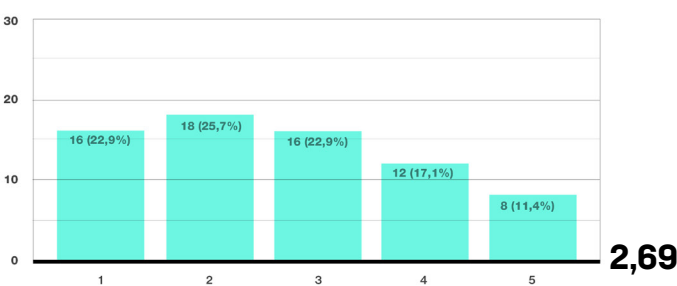
Other groups of people were separately looked at to conclude any significant differences from the general results (See 13.2 Appendix for scores).

People under the average age of 31 scored the playful artwork of Static mark much higher. Visitor of the location Kopse Hof itself scored all variants much lower, except for Flexible mark. Static mark also scored very low, even though conceptually it is highly similar to the Mask used in Flexible mark, namely an artwork of a finding. The only difference is the impermanence of the Mask and the fact that it has already become an icon. People who visited the mask or more than 5+ Roman locations therefore also score the Flexible mark variant higher. The higher scores can therefore not be completely attributed to the Impermanence of the artwork, but does show an appreciation of it.

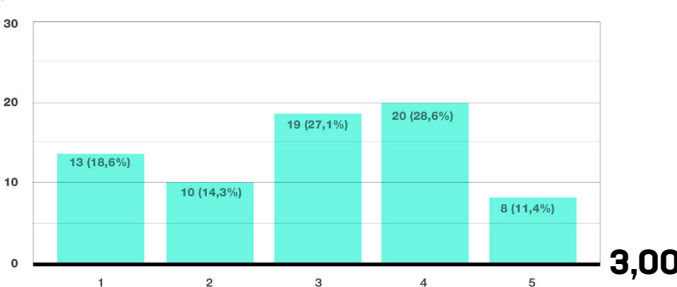
Concept 1: Reconstruct



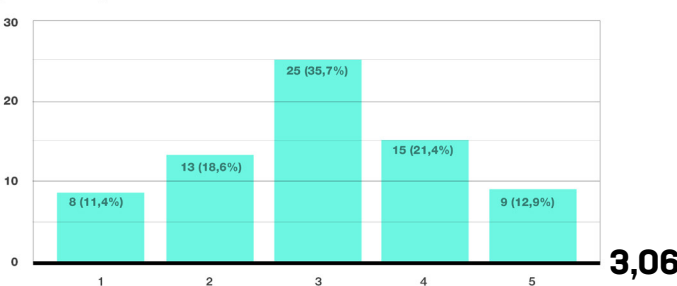
Concept 2: Incorporate



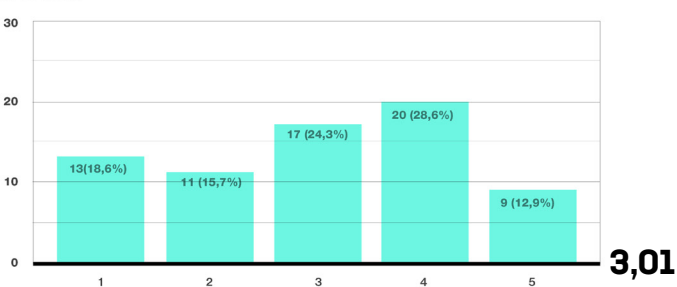
Concept 3: Static mark



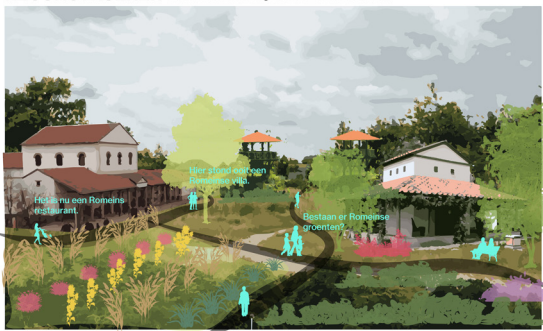
Concept 4: Branding



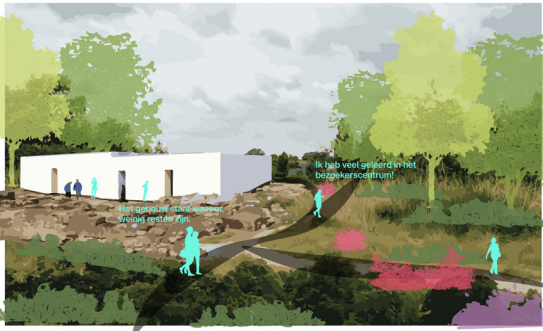
Concept 5: Cover



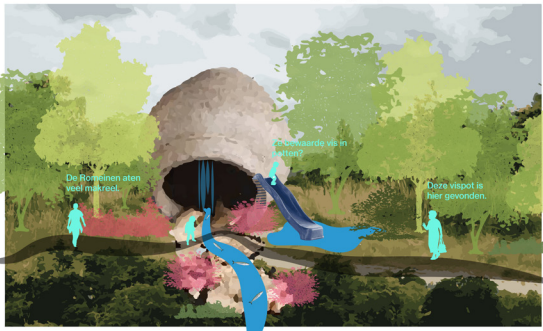
RECONSTRUEREN Herbouw de Romeinse gebouwen met nieuwe functies.



INPASSEN Bouw waar de archeologische waarde laag is.



STATISCH MARKEREN Kunstwerken van vondsten gedaan op deze plek.

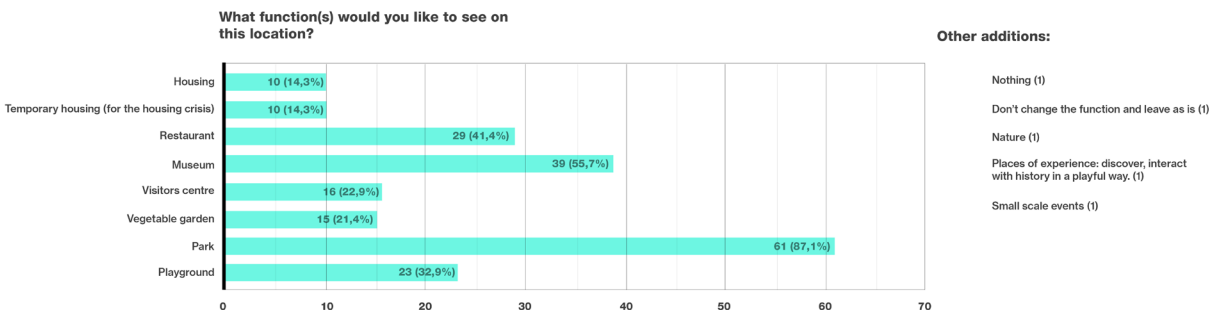
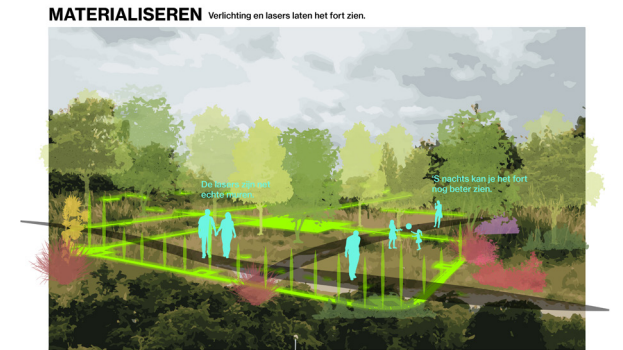
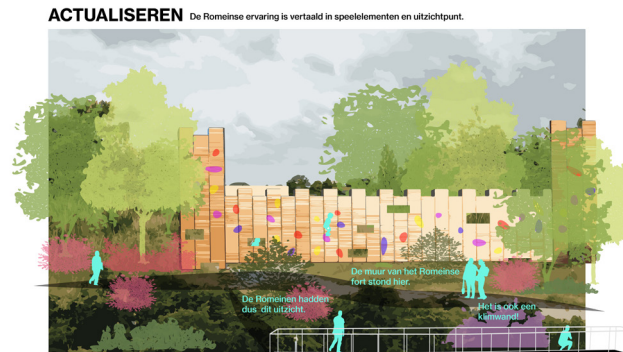
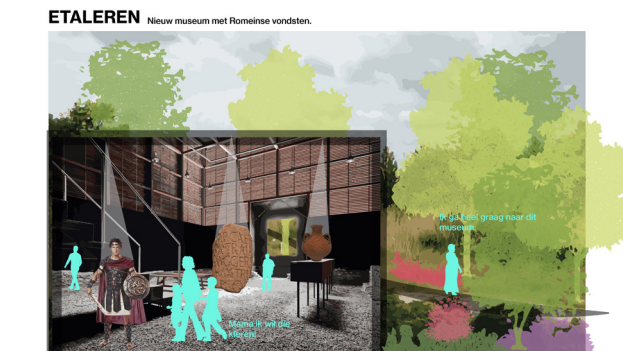
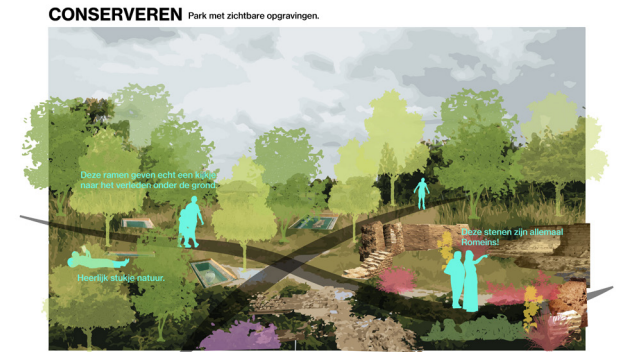
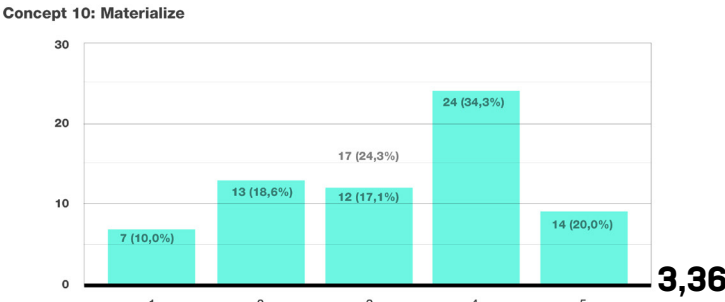
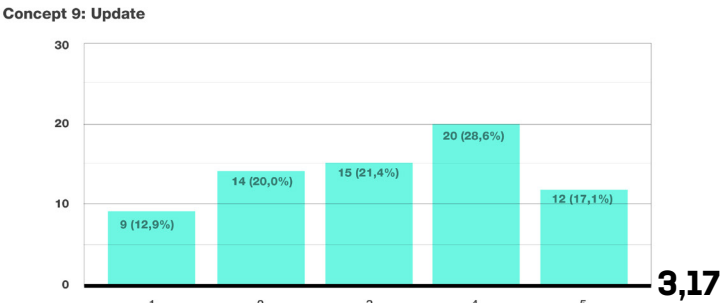
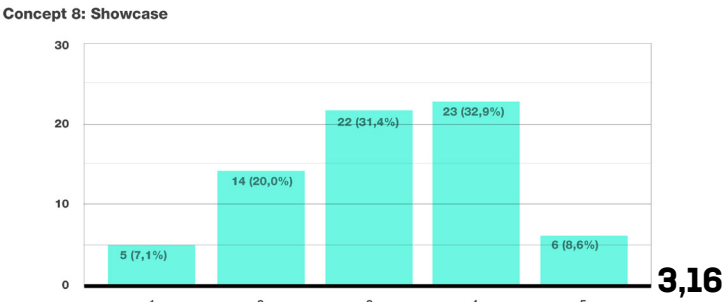
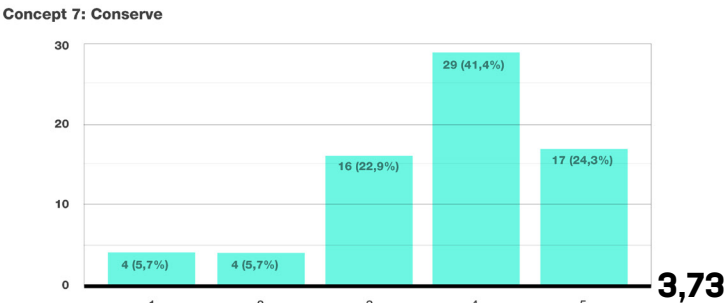
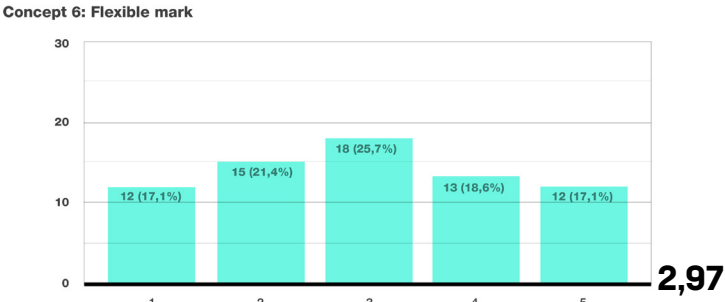


BRANDING Park met Romeinse festiviteiten eens per maand.



OMHULLEN Bedek de Romeinse resten in de grond met een constructie.





Do you have any tips or comments about the designs?

The images were too small and more text is needed. (2)

Show the old stuctures in housing with a glass floor. (1)

Maybe a combination of things? (1)

I think it would be nice to make here a meeting place for people from the neighborhood with the history from Roman times. (1)

I appreciate the design that reuse the Roman history in a contemporary way the most. (1)

Appreciate the natural value before you change anything. It is also a place of rest. (1)

There are mostly discolorations underground, so no ruins can be shown. Most of it has been excavated as well. (1)

A new museum wouldn't add much to the existing Bastei and Valkhof museums. (1)

Reference history in greenery, it was also a viewpoint. (1)

Give visitors the impression that they are going back in time in a stylish manner. Unfortunately in Nijmegen, they start energetically and in the end it just doesn't work out.. (1)

Image 7.9: Results for 'What functions would you like to see on this location?' and 'Do you have any tips or comments about the designs?'

Lastly people were given the opportunity to share their opinion on what functions they would like to see in the Kopse Hof and if they wanted to share any comments on the designs. 87,1% want the area to remain a park (some also added nature). More than half want to see a museum on site. 41,4% would like a restaurant and 32,9% wants to see a playground (Image 7.9). Similar scores can be seen in visitor of the Kopse Hof, with only a playground being less appreciated (Image 7.10). Moreover two people do not want anything to change on the location, which is a testament to the sensitive nature of the discussion on this location. The valuable tips for the locations showed the history should be used in a contemporary, playful, natural and social way where people can meet and gather to learn about Roman history.

Image 7.10: Results for 'What functions would you like to see on this location?' by people who visited the Kopse Hof.

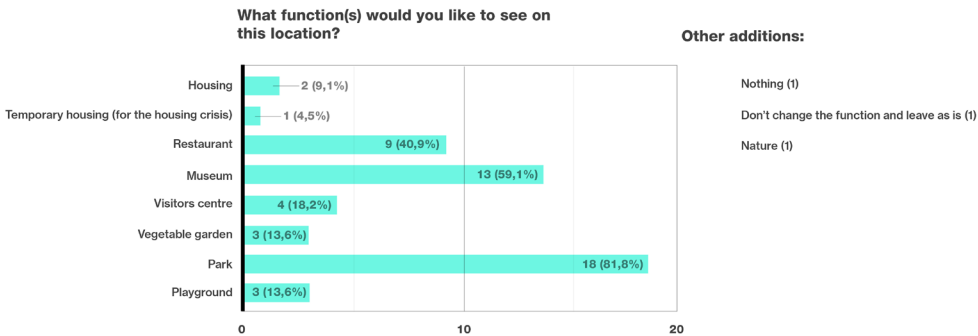


Image 7.8: Results for 'How appropriate do you think this design is?'

7.4 Workshop

The designs and results of the questionnaire were shared with the municipality of Nijmegen in a workshop where experts were invited to co-create and share their ideas for Roman heritage in Nijmegen through sketching and discussions (image 7.11). The people who joined had expertise ranging from history education at the Radboud University to archaeological policy and public space. The goal was to create more dialogue and gather opinions on a location that the archaeological department of Nijmegen sees potential in for showing Roman history. The questionnaire also aims to inspire new policies and approaches to heritage. The main recommendations for the Kopse Hof by the municipality are gathered below and showed that the location has conflicting perspectives.

7.4.1 General comments

It is not surprising that people think mostly about the Army, since there are barely any physical remains. From the results it also seems that people want something similar to Xanten in Nijmegen (which it does not have yet).

7.4.2 Values

Silence is the main value of the current state and how much of it will remain when tourists come? Is it possible to create one route for tourists and one for leisure and nature in this area? Some of the values for why the site is protected are:

- The irregular shape of the forts and annexes.
- Mystery of which important person lived in the villa.

- The great wealth and spectrum of findings like food and earthenware.

7.4.3 Fortification

Visitors should be able to experience the size of the fort, meaning that merely reconstructing the villa would leave out the perception of the whole story. The most important features to design are the walls, roads, villa and history of skilled equestrians in the stables. The Romans probably had a crane from the water at the foot of the hill to transport good from the harbor. This can inspire a new connection to the viewpoint via stairs and entice more visitors.

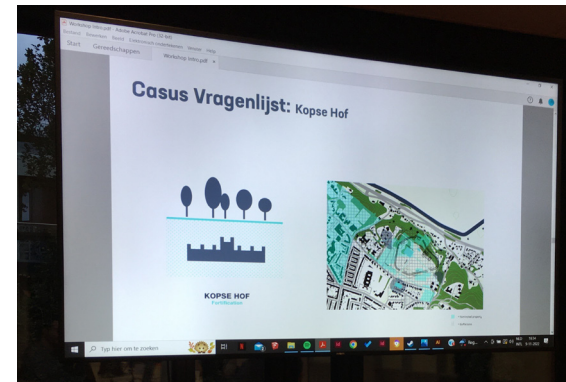


Image 7.11: Photos from the workshop with the Municipality of Nijmegen.

7.4.4 Planting

The current nature inhibits the wide perspective that the Romans used to have on the plateau. This can't and shouldn't be cleared due to the natural value, however a few sightlines could be considered, for example one ending in the viewpoint on the bridge.

Planting endemic species are still better for the visualizations, while Mediterranean species are however starting to perform better due to climate change.

The addition of extra soil is needed when visualizing or planting on the UNESCO core zones. The site also has buffer zones where these rules don't apply, for example where the villa and a big part of the walls lie.

7.4.5 Material

Wood is a preferred material considering it's sustainable character and the original fort being from wood, but it is hard in maintenance. Carving can show more of the story like has been done in Fort Vechten.

7.4.6 Conclusion

Cooperating with the municipality brought forth a very fruitful session and many expectations and inspiration for the location of the Kopse Hof (image 7.12). Next chapter will discuss the final layer and determine the future of showing heritage in Nijmegen and the Kopse Hof.

Image 7.12: Comments from the questionnaire and workshop.



7.5 **CONCLUSION**

The site showed to have a large potential in space, but many limitations in protection by the municipality and opinions from inhabitants. Many people visited the Valkhof area, but not the design location of Kopse Hof. People who did visit were also stricter in their scores and show a divide between preference of silence or development. The questionnaire showed that people prefer physical remains like reconstructions and conservations, followed by translations like materializations and updates. Preferred functions include a natural park restaurant, museum or playground. Involvement of interested people in the workshop will give more depth in concluding the designs to give advice to the municipality of Nijmegen.

08. **COHERENCE**

Vision, design locations, goals, toolbox

The final layer involves crossing the potential of all three layers and multiple timelines by bringing them back. With this the vision will be looking towards the future resilience of Nijmegen-East. This involves revising the toolbox for making archaeology visible.



8.1 Visibility

Nijmegen has a network of interconnected UNESCO heritage sites that have the potential to become a system of different translations for the Roman history. By adding the potential of all three layers together, it created the spaces that are most interesting to transform in Nijmegen to show the Roman History. The biggest potential for design are where the opportunities of the three Limes layers overlap (image 8.1) Nijmegen will have one route and one experience from the start at the popular Valkhofpark towards the natural landscape outside the city. One large open air museum of the whole system that it once was.

The Four locations chosen for more in depth designs show a variety of above ground situations and underground remains in the layers of Water, Roads and Structures. Therefore where space above the soil allows it, the archaeology is either a showcase or translation (image 8.3). Water is collected at various points throughout the aquaduct and used sustainably for greening the neighborhood. Locations like Broerdijk and Watermeerwijk (see chapter 9) reflect this. From the Valkhof Museum people are invited to start the route over the Roman road lined with visualizations of remains. Where space allows it, the structures from the fortifications are brought back to life in the third dimension like in Kopse hof (see chapter 9). In some locations all these three Limes layers from different periods of history interact all at once, creating interesting designs. The

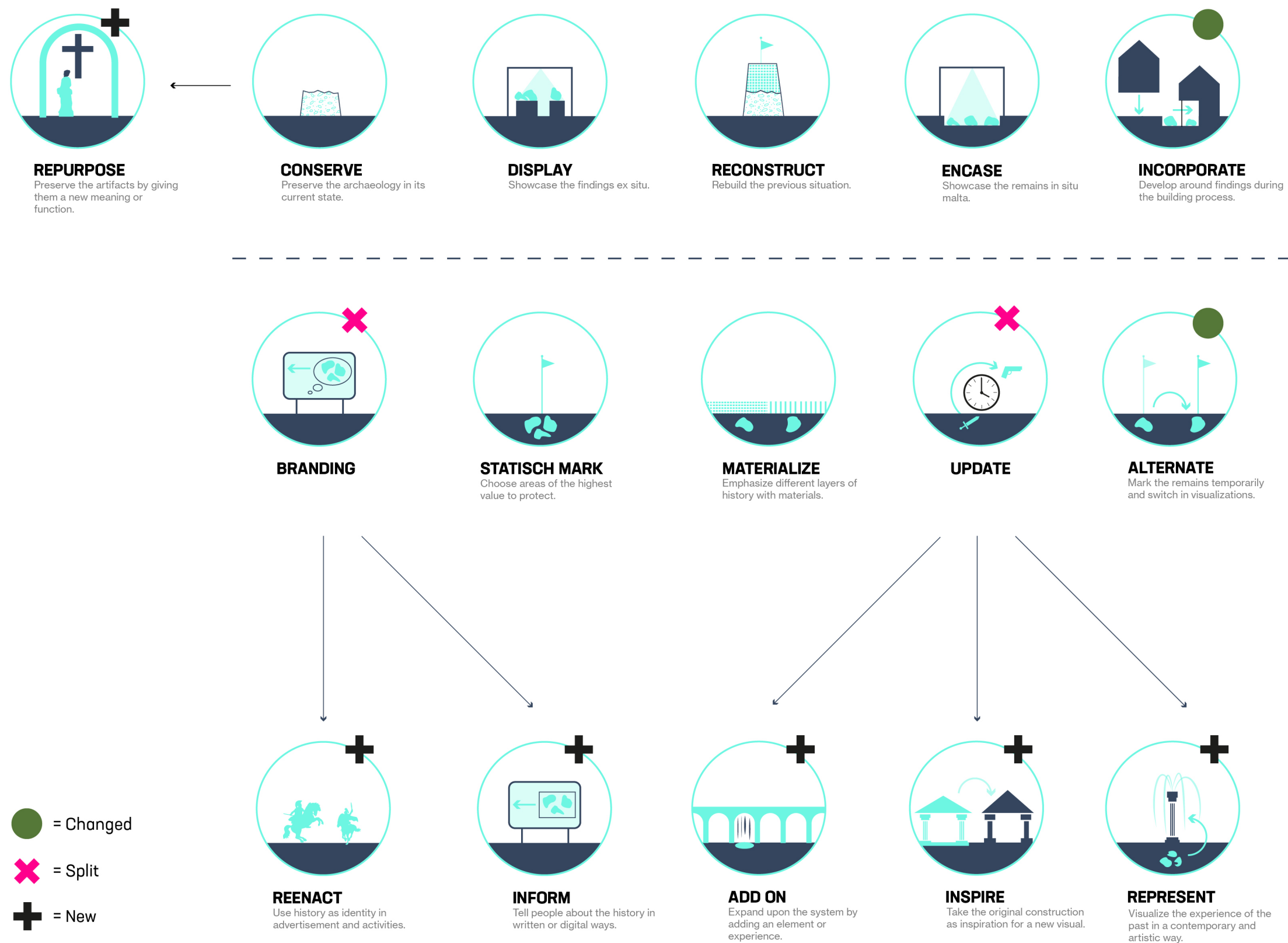
conclusions from the research resulted in a few statements about the transformations of Nijmegen-East (image 8.2)

New ways of visibility for archaeological heritage were found throughout this research, making a total of 14. This was done by reflecting on the design process of the questionnaire and by stating how visibility is created for archaeology (image 8.3). For example Incorporate and Flexible mark have been fused as they have nearly identical uses. Flexible mark has then been given a broader meaning and renamed as 'Alternate'. Branding and Update were split in new categories, since they were too broad and can be used more specifically in smaller tools. Repurpose was added as no category covered this, but it was birthed from conservation in a different manner than their current state.

These new methods all deserve a page of explanation with an exemplary reference like was done in the Limes Atlas (Colenbrander, 2005) which this report builds further upon. A variation of these tools were then applied in the final designs in the next chapter.

- Multiple Roman layers should be differentiated.
- Make one clear system, route, with similar materials.
- Connect the sites and draw attention for tourism.
- Spaces are the heritage, the potential is in bufferzones.
- Revive the aquaduct for small scale water collection.
- Take fluctuations in time like rainfall into account.
- Be aware of what you leave behind.

Image 8.2: Design statements following the analysis and questionnaire.



SHOWCASE

TRANSLATE

Image 8.3: New methods on how to design with archaeological remains (built upon Colenbrander, 2005)

8.2 Alternate

The definition of flexible mark was changed when using it as a design tool. The visualizations are temporary and leave no trace on the location.

Ongoing repair and excavation work such as at the Acropolis in Athens has a claim on space around the remains (image 8.4). The space needs to be able to host this together with visitors in unplanned compositions. Permanent elements like trees or buildings for example can damage the archaeological findings underneath.

The design of an active archaeological site will be based on impermanence and needs to handle multiple variants of configurations, since the research can move around and have new



impacts in the surface level such as preservation or removal (Dagli & Cengiz, 2018). Places like these are called 'Archeoparks'. Planting can only happen as a backdrop or on locations without remains underground. Temporarily planting with a low rooting depth such as flowers, grass or small bushes can also be used.

Image 8.4: Research on the Archeopark of the Acropolis (Ioannidis, 2019)

8.3 Repurpose

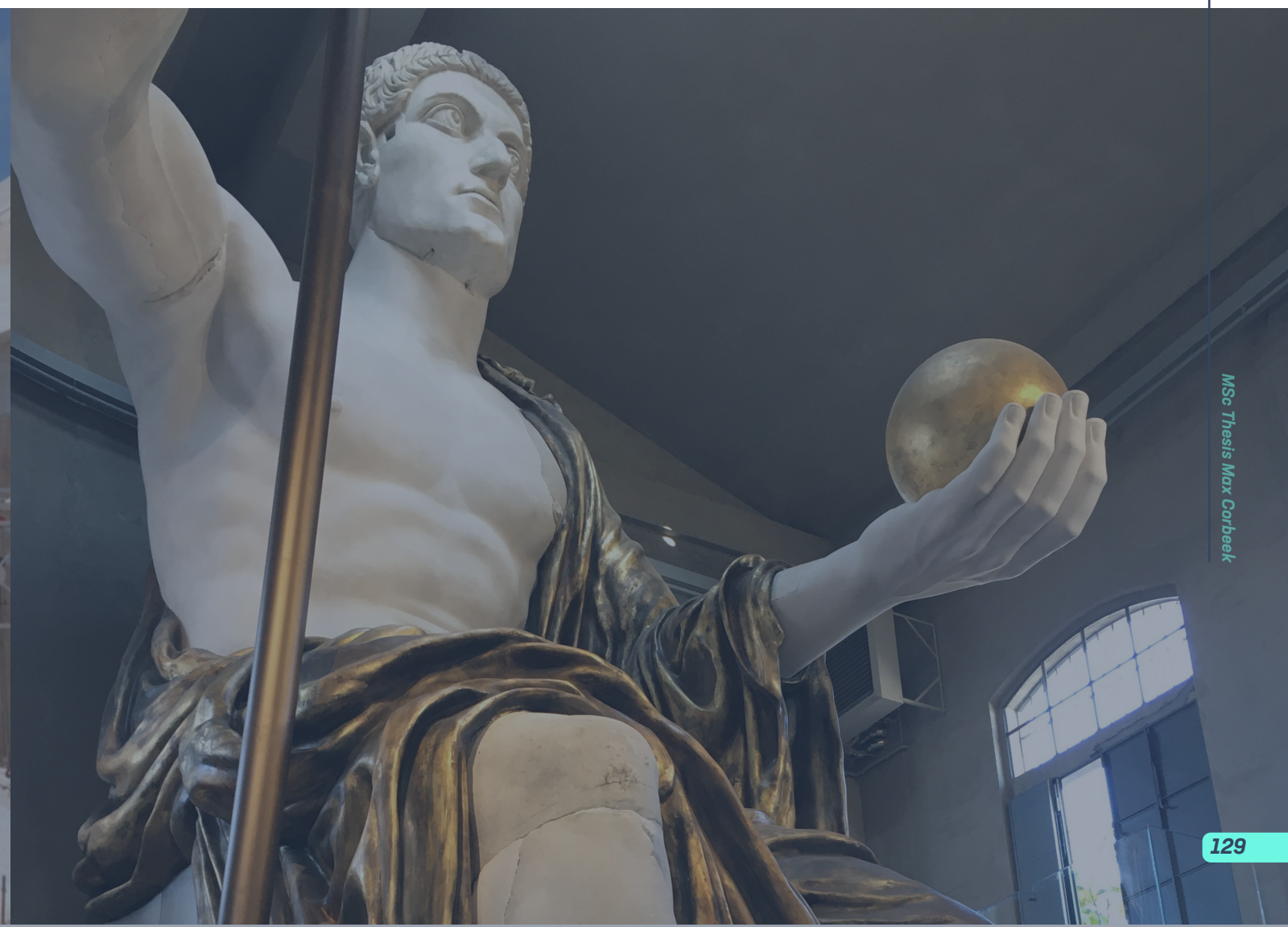
In 'Recycling Beauty' at Fondazione Prada the Roman past is exhibited through the eyes of cultures that inherited their artifacts. Through time their interpretation was changed, but the materials remain the same (Fondazione Prada, 2022). Statues of Roman gods were altered to fit evangelical stories and places in churches. Lavatories were used as thrones and marble was crushed for mosaics. The element of recycling was often more intangible through change of meaning than through reuse of the physical materials.

In the Museum, the colossal statue of Constantine (4th century AD) was rebuilt from its fragments that are normally displayed in the courtyard of the Palazzo dei Conservatori in Rome (image 8.5) (Conti, 2022).



Reuse of Roman remains is a design tool that was used hundreds of years ago and it can be controversial to let this happen today, but why can't it be considered as sustainable recycling of past beauty?

Image 8.5: Exhibition of inherited Roman artifacts that received new meaning through time (own image).



8.4 Re-enact

Archaeological areas are testaments of the past and how a city developed socially and culturally. Local culture takes pride in this urban memory which fortifies the inhabitants identity. Activities around this past help people understand this identity and interact more with tangible and intangible heritage (Dagli & Cengiz, 2018).

Archaeological sites need to be protected from future development and should interact with the daily urban life. They are the urban memory of the location and need to be experienced to give the city meaning.



One example is the Archeon Museum park in Alphen a/d Rijn, where reconstructions of Roman buildings from all around Europe are placed on the location of an old Roman fortification (Image 8.6). The museum has actors that give people the full experience of entering a different era.

A program of re-enactment activities allows people to relive the Roman history of and emerge in the identity for a moment (Archeon, 2022a).

Image 8.6: Reenactment activities at the Archeon (OmniTraveler, 2020)



8.5 Inspire

It is possible to rebuilt the past situation to great detail. Reconstruction is however on a spectrum and design could also loosely refer to the aesthetics of what the place used to look like.

Castellum Hoge Woerd, Utrecht resembles the form of the fort that is located underneath the soil, but a few liberties have been taken to ensure modern needs (image 8.7). The middle where the camp used to be is kept empty for re-enactment activities and protected from further development withing the museum (De Unie Architecten, 2020). The walls received an extra thickness to house the museum and an extra building was added to exhibit a Roman ship and host theatre shows.



Image 8.7: Aerial view of Museum De Hoge Woerd. (Museum Hoge Woerd, c. 2022)



8.6 Inform

When the remains of history are barely or not visible, visitors can be informed of the existence by informational panel. The remains are reference, shown in images, text and taught. The information can also be transferred digitally through QR codes. Together multiple signs can form a route like the aquaduct route within the Roman sites of Nijmegen and Berg en Dal (image 8.8).

The panels notify people of the land formations created by the Romans. A map shows where you are located and need to go for the next sign. The Limes is explained in various categories of lifestyle, defence or water (Aquaduct Groesbeek, 2022b).



Image 8.8: Information panel from the Limes route along the Roman aquaduct. (Werelderfgoed reiziger, 2021)

8.7 Represent

Not much reminds people of the Roman history in Nijmegen, but in their collective memory it is still remembered as the oldest city in the Netherlands.

An artwork was created to symbolise that the Roman aquaduct ran through this location. Inhabitants of this neighborhood ensured that enough money was collected for their initiative. Even the municipality supported the idea financially (Tokbay, 2022). More than 200 local residents were engaged and involved in the decision making.

The artwork spells 'AQUA CASTORUM NO-VIOMAGI' upside down, causing it to only be visible during rain when it reflects on the wet reflective tiles around it (image 8.9).

This projects not only represents what Roman history means to an involved community, but also refers to the aquaduct in by translating an experience in a contemporary way.

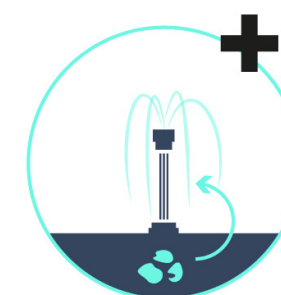


Image 8.9: The Neptunesring represents the Roman aquaduct. (own image)

8.8 Experiences

Applying these methods of visibility creates a multifaceted route. The full breath of Roman Nijmegen is felt through usage of a variety of visualizations. Diversity is increased to give visitors excitement throughout the route. Ways of showing archaeology are combined to create exciting new experiences in multiple core zones. These are grand new attractions for Nijmegen.

The two existing routes are upgraded with new informational panels and same QR codes that take the visitors along the new experiences. The first route is themed in the castra from the Valkhof to the Kopse Hof and takes visitors through their distinguishable features. The second route runs along the aquaduct from Hunnerberg to Berg & Dal. The two routes intersect and with the same visual language can be used as a continuation of each other, preventing overlap.

-  = New visualisation
-  = Current visualisation
-  = Castra Route
-  = Aquaduct Route
-  = Info panel
-  = Experience areas

Image 8.10: Upgraded routes and experience of Roman Nijmegen

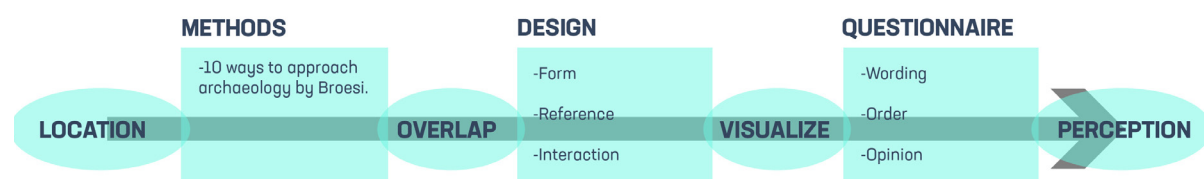


Image 8.11: Steps in making the questionnaire.

8.9 New design method

With the 10 ways of designing with archaeology as a starting point, choices were then made in form, reference and function fit to every design (image 8.11). Some of the variants were also more elaborate than others, showing that there was more inspiration for those designs. This is solely dependent on the creativity of the author and up to variables. Moreover during the process multiple overlapped. The designs were all visualized in a signature look and placed into the questionnaire in random order. All these choices in the process influence the eventual perception and opinion of the designs in the survey.

This design process concludes that the 10 ways are a great starting point to inspire elaborate designs, but cannot be considered an all-encompassing approach. After the results I reflected on which decisions I actually made during the process of making the questionnaire. When an archaeological structure is brought back, choices will be made in visibility (Broesi), but humans will interact with it by using the structure and the design will also impact the environment it lands in (image 8.12). Therefore the critique on using Broesi's categories as a method for archaeological sites is that it does not include interaction and impact further than simply visibility of the physical monument. The site is placed between the monument, its environment and the human dimensions (image 8.13) in order to create awareness of heritage.

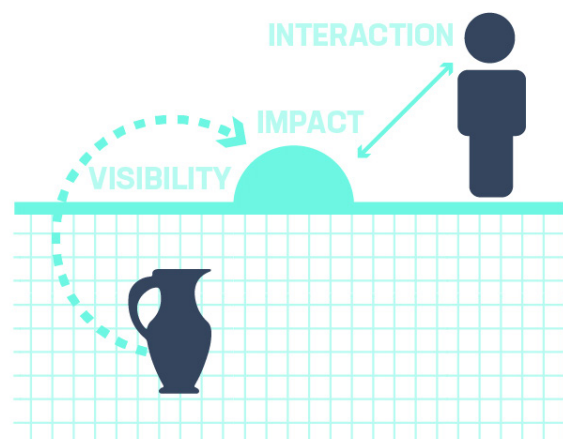


Image 8.12: The effects of bringing archaeology back.

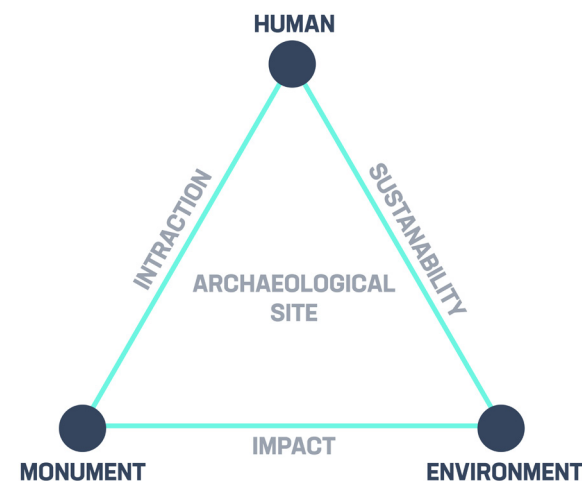


Image 8.13: Triad of designing an archaeological site

Interaction

In "Playful learning landscapes" children can develop knowledge and social skills that increase their mental development (Shwe Hadani et al., 2021). Therefore activities can serve as an approachable way to convey historic knowledge to the visitors by for example playing, sports, discussions or participating in re-enactments.

Urbanism has a visual bias and can look further but incorporating the other senses to help grab the attention of users (Niland, 2022). As a fountain makes noise or flowers give of a strong smell, messages can be conveyed beyond just the visibility of what used to reside on the archaeological sites. The designs have the opportunity to revolve more around non visual perception and sensory urbanism.

Impact

The impact that the design has on the environment must be sustainable and can within this theme take multiple routes. The categories are based on the four pillars of sustainability; human (cultural), economical, social and environmental (Goodland, 2002) (Image 8.14). Human (cultural) is about retaining knowledge for future generations, which inherently is the main goal of this research. Environmental has the main goal of reducing non-renewables and harm to the ecosystems.

This could happen through solutions in water, green, infrastructure, energy, materials etc. The subcategories are meant to inspire more detailed applications like water retention or water fountains for example. Socially people need to interact and meet to keep values like tolerance, trust and compassion. Lastly the design also needs to serve the community it lands in economically by creating a profit for the people that invest and live nearby.

Application

By using this method multiple ways can be chosen simultaneously and combined with interaction and sustainability to choose multiple ways (8.15). This way it is more mix and match, than a pure approach relying on visibility. The freedom also lies in the ways the categories are executed and their eventual form. It is a way to inspire for the location and the method should also keep evolving and is not finite. In the next chapter this method was applied to the chosen sites with high potential to create awareness.



Image 8.14: The pillars of sustainability



Image 8.15: Expanded method for designing archaeological sites and creating awareness.

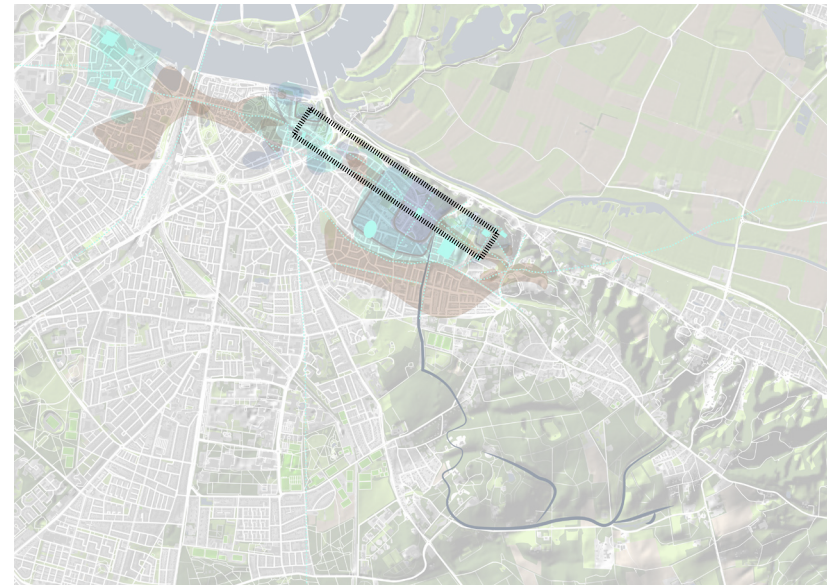
8.10 **CONCLUSION**

Opportunities for showing Roman History arise when all conclusions from the layer analysis and participation overlap. The result is a vision for a heritage route of various experiences. The research and design process allowed for reflection and revision on the 10 ways of visualizing archaeology. They are now 14 ways that have been applied to the continuous heritage route of Nijmegen. Furthermore a method was created for developing archaeological sites and creating awareness of the heritage that will eventually stimulate people's pride.

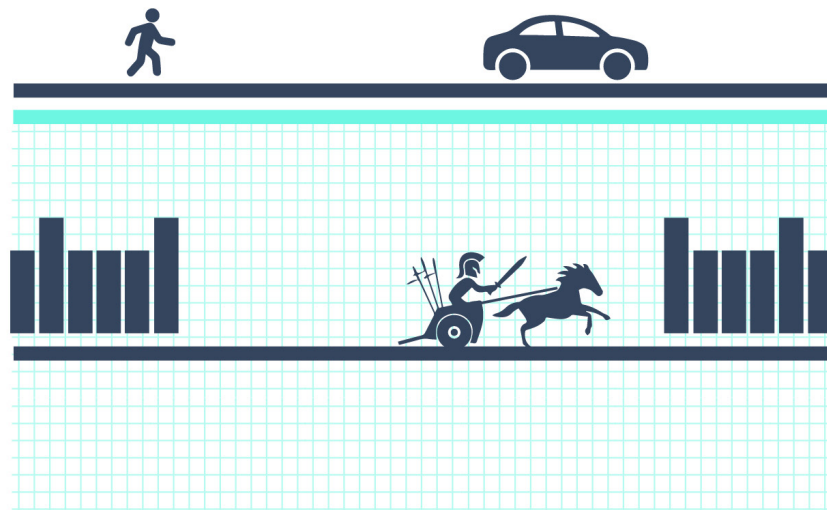
09. **CULTURAL LAYER**

Small scale palimpsest, final designs, assessment.

The Roman layer emerges from hiding and reveals itself in multiple urban design locations within the UNESCO world heritage experience of Nijmegen. The new design method is applied to transform these locations. The small scale palimpsest for these locations shows which other layers of history interacted with the roman layer to create multilayered visualizations. This is the final user layer where Roman heritage interferes with the daily lifecycles.



- Military
- Civilian
- Graveyard
- Important building
- Road
- Wall
- Ditch
- Aqueduct



UBBERGSEVELDWEG

Roman road

9.1 MUSEUM TRAIL

The Valkhof Museum is currently the most visited Roman UNESCO location in Nijmegen and could be the starting point for in situ exploration of the other UNESCO sites (image 9.1). The Valkhof is where people's cultural memory is most attached to at the moment. Large attention-grabbing artworks of finds line the roads like milestones in ancient times. The Roman layer emerges from the soil in extraterrestrial explosions of plants. Their QR code stories take the visitor through the layers of Nijmegen's Roman history.

People are invited to interact with the finds by climbing on a 'firestone', listening to a soundtrack of the stories, tapping water from pots, pulling carriages and generally learning by playing (image 9.2). The size of the statues and lines in the pavement are recognizable during the day and at night the animal-friendly red light emits from the artworks. The existing Castra route is upgraded with visualizations and a consistent look. Tracks on the road show the essence of the carriages that once drove here and pull the whole route together (image 9.3).

The artworks are small pockets of nature on elevated soil and surrounded by the now considered endemic Roman archaeophytes (chapter 4.3). When walking through the fort the porta's are marked by Roman Cypress trees and the pavement changes to give a visual cue that you have entered the fortification and walking on the important via principalis axis. The route takes visitors to the end with a parked carriage at Kopse Hof, another UNESCO location and project.



Image 9.1: Aerial photo of the route with location of the isometry and perspectives.

Image 9.2: Perspectives of the route and their interactions with archaeology.



1. QR tour



REPRESENT



INFORM



INSPIRE



WALK



SMELL



BIODIVERSITY



Decorated firelighter, Nijmegen-West - Valkhof Museum

2. Solar charge



ENERGY



USE

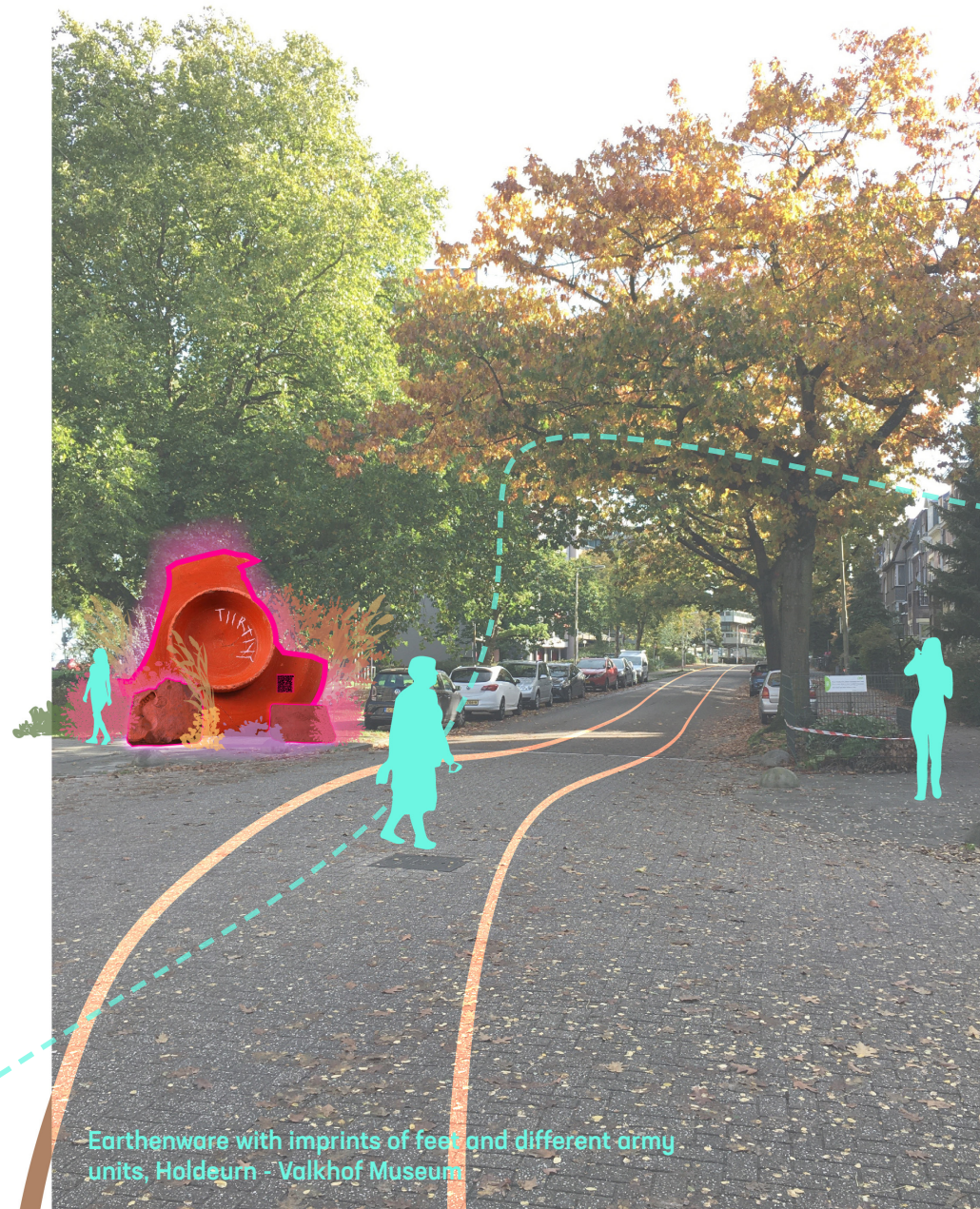


Amber sculpture of Amor symbolizes eternal sleep, Nijmegen-West - Valkhof Museum

3. Listen to the story



LEVEL



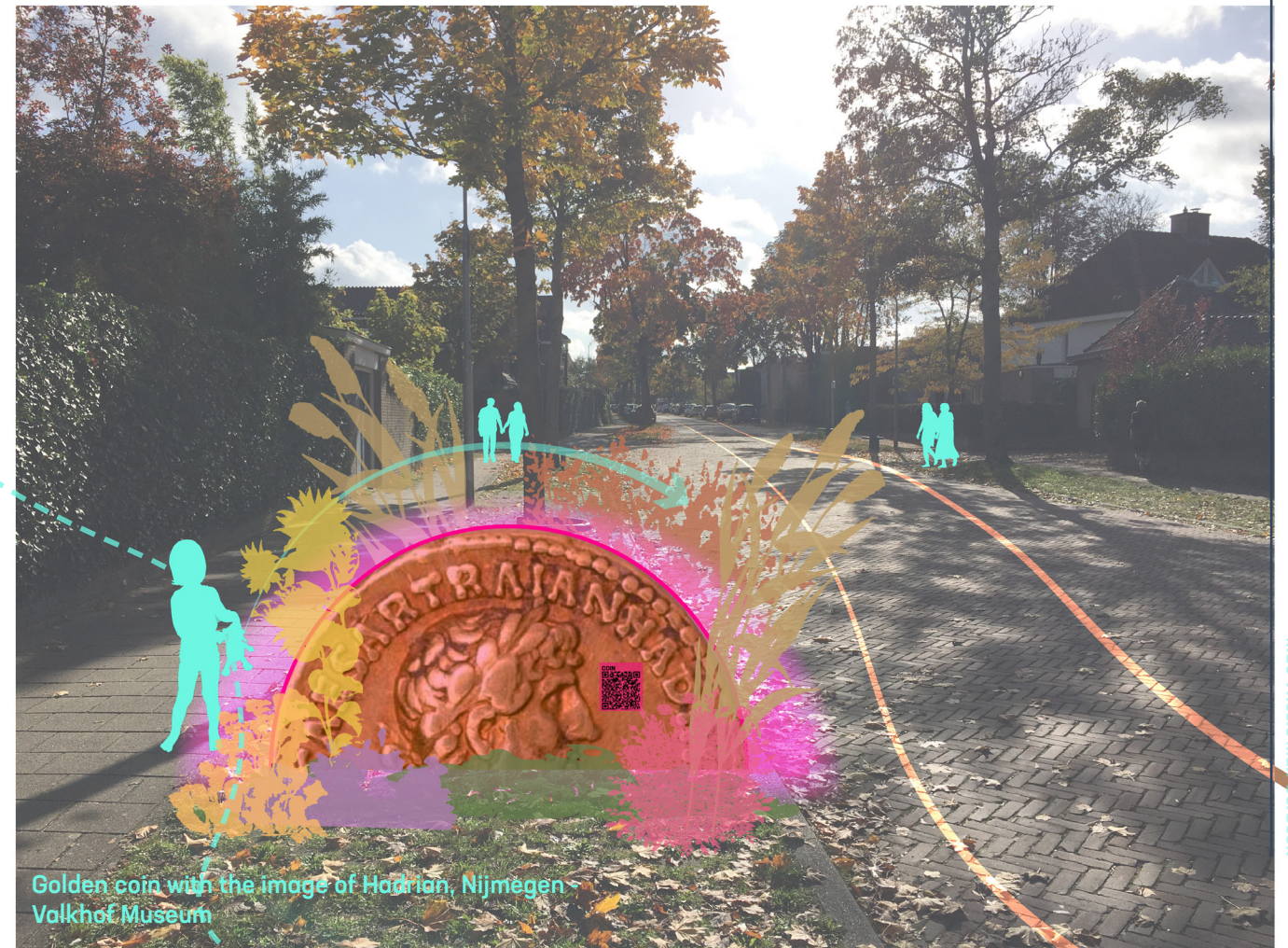
4. Compare imprints



TOUCH



DISCUSS



5. Twist the coin



TOUCH



PLAY

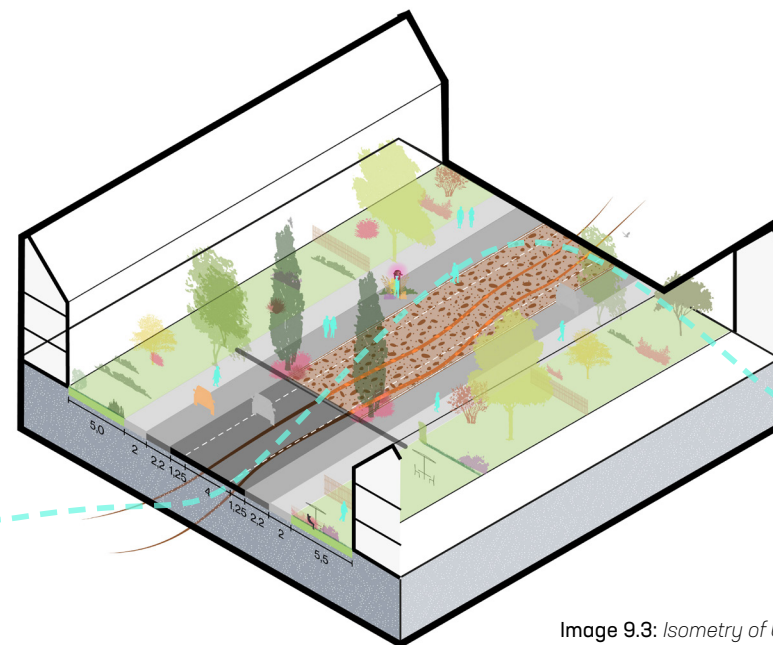
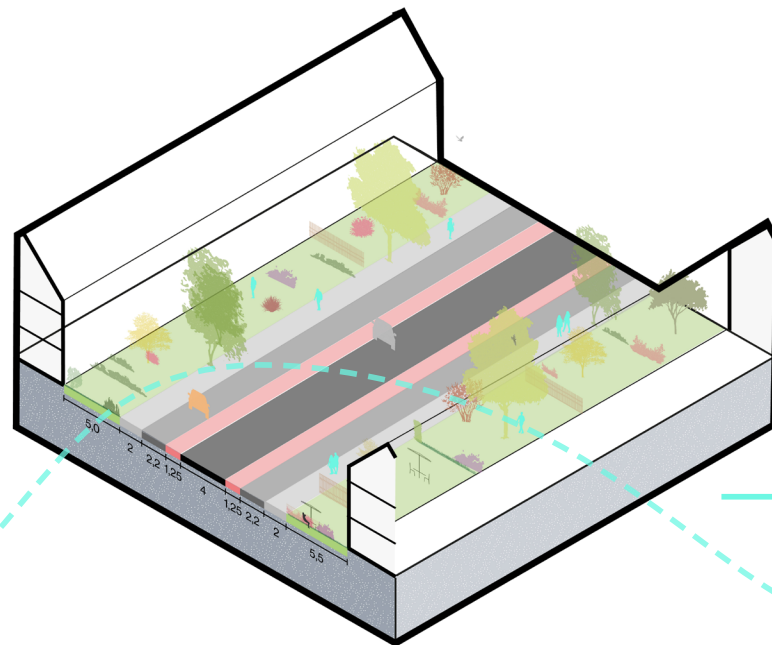


Image 9.3: Isometry of Ubbergseveldweg before and after transformation of the different pavements.

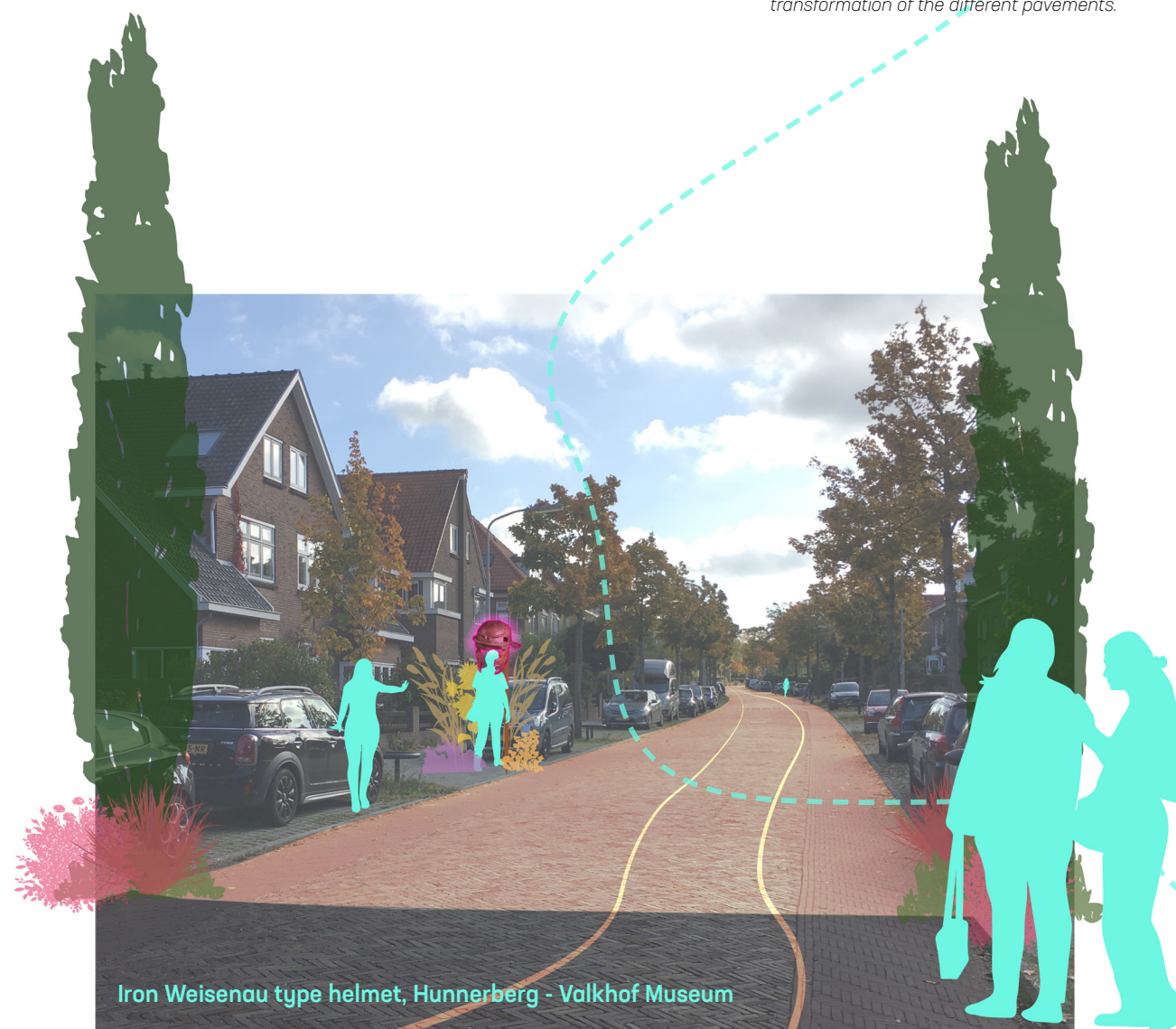


Marble head of the great founder and conquerer Gaius Julius Caesar (100-44BC) Hunneberg - Rijksmuseum van Oudheden

6. Conquer and climb



REST



Iron Weisenau type helmet, Hunneberg - Valkhof Museum

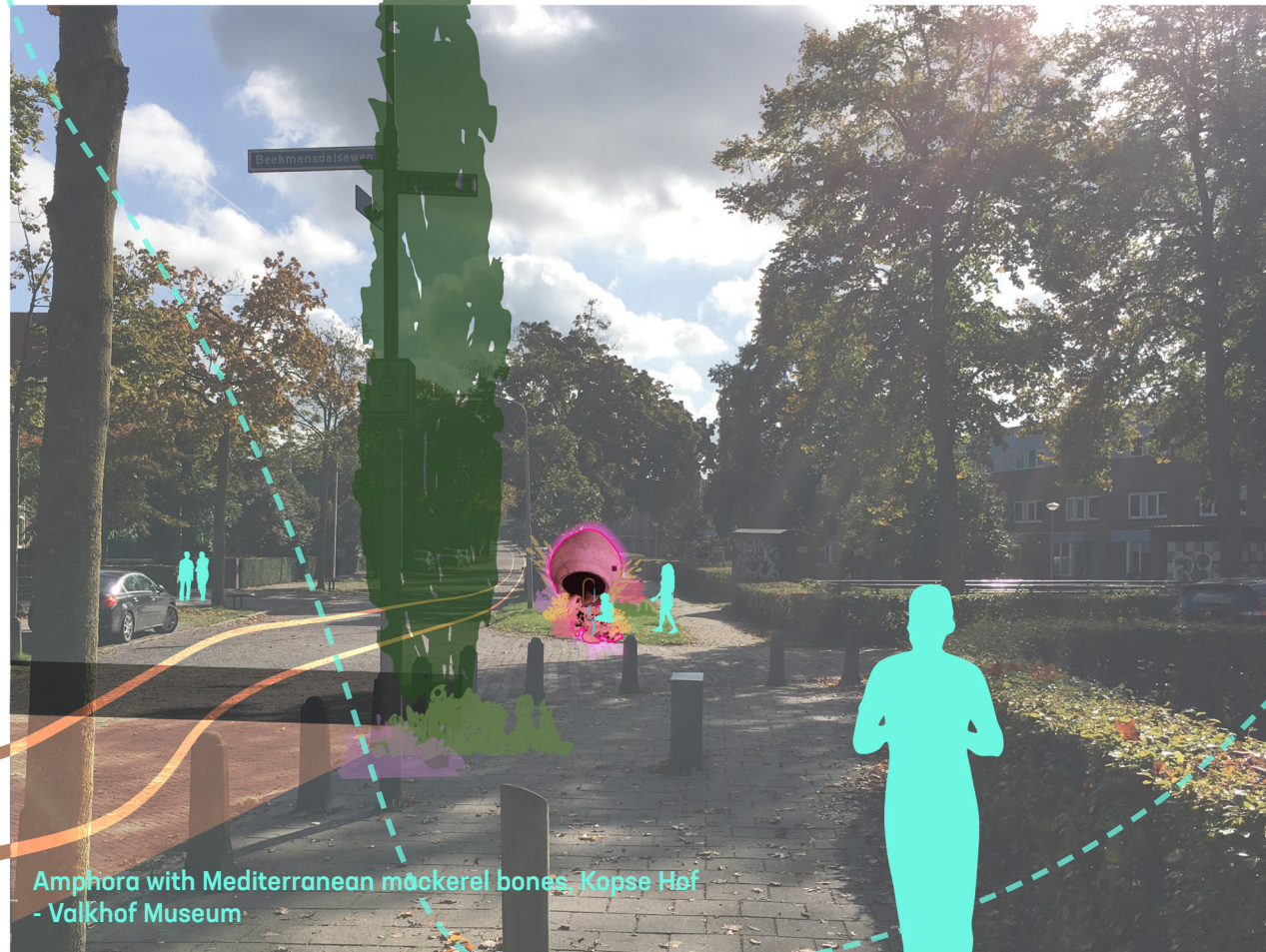
7. Photomoment



MATERIALIZE



PARTICIPATE



Amphora with Mediterranean mackerel bones, Kopse Hof - Valkhof Museum

8. Aquaduct watertap



USE



WATER



Reconstruction of a Roman carriage, Köln - Romano-Germanic Museum

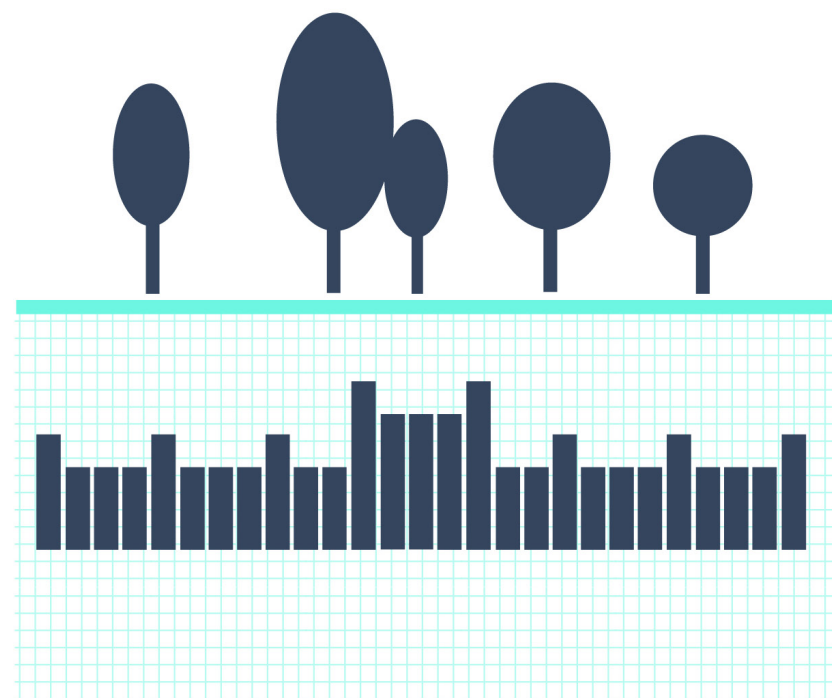
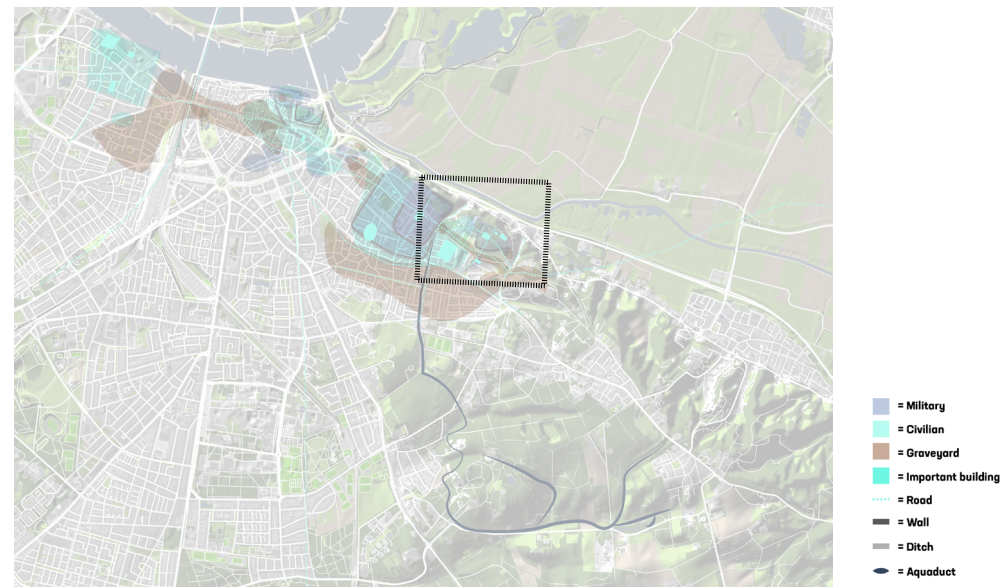
9. Try to pull



TOUCH



PLAY



KOPSE HOF

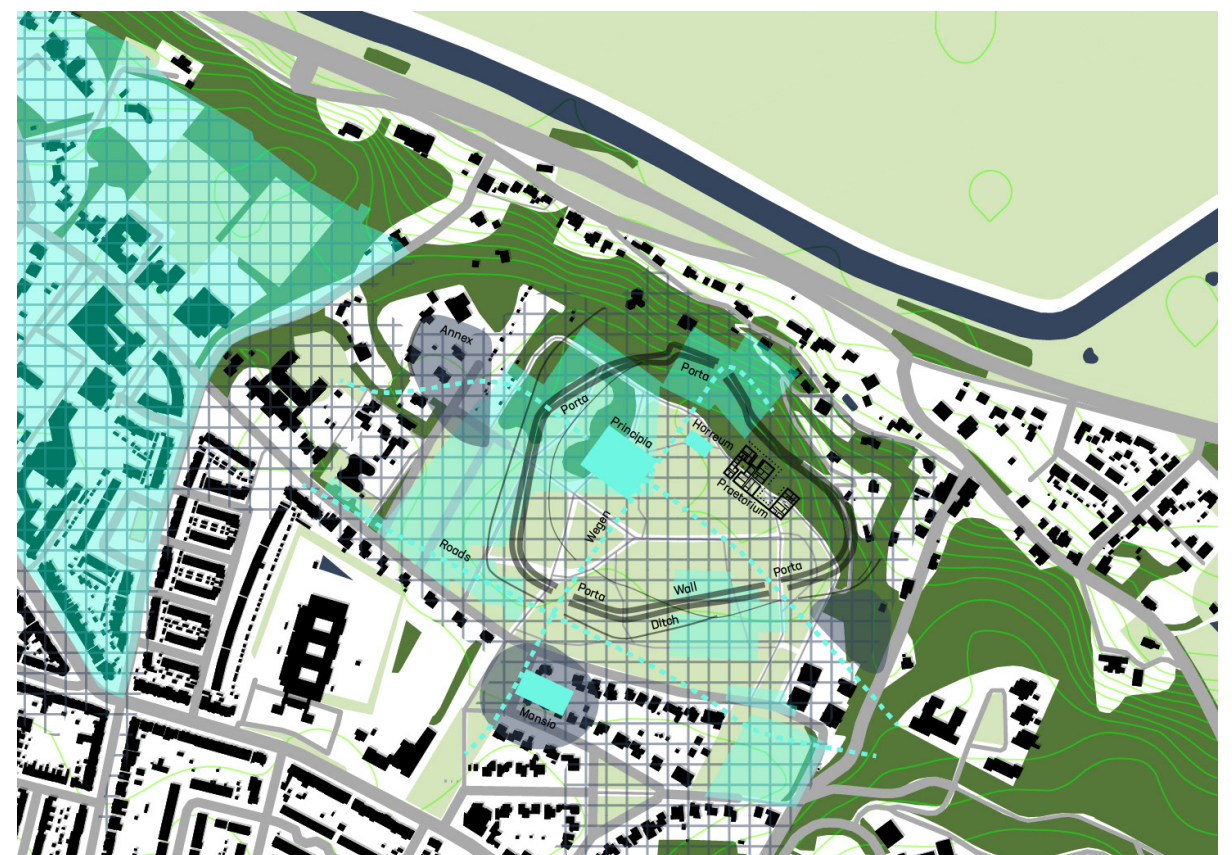
Fortification

9.2 HERITAGE PARK



Image 9.4: Aerial photo of Kopse hof.

Image 9.5: Map of Kopse hof with UNESCO sites.



- = Nominated property
- = Bufferzone



Image 9.6: Palimpsest for Kopse hof.

9.11.1 PALIMPSEST: Story of Impermanence

The story of Kopse Hof is one of impermanence (image 9.6). After the Romans left it was never fully covered again. The Romans also built their fort in wood, so little remains. Multiple plans were created for this area, including a villa neighborhood by the owners, but this was luckily prevented by the municipality of Nijmegen as the area came under strict protection (van Enckevort, 2014). Throughout history Kopse hof has had many functions in wars. From here the Spanish and the French sieged Nijmegen. All because of a plateau with an amazing overview. After WWII there were also some emergency houses placed, but after the reconstruction period most of the area was researched by Archaeologists, leaving it an unused wilderness today (image 9.4 & 9.5).

9.11.2 KOPSE HOF FINAL DESIGN

The design created two distinct routes through the wilderness that exists currently (image 9.7). The present is a special situation for a park in an Urban setting, so this silence is respected here.

Formal route

The first route is one that showcases the history with a reconstruction and displays. The luxurious villa is reconstructed and serves as an archaeological experience centre where people can see the exhibition on the wealth that was found here while meeting other residents interested in Roman history. Organization of events creates attention and enjoyment for visitors. A small kitchen organizes Roman cooking workshops to give people a taste of the Roman past. Interaction and sustainability lies therefore in discussions, educational tours and food for the community. With these workshops and particular opening hours, mass tourism can be prevented on the site. During a workshop/tour the site could attract a crowd, but it can also remain closed on Sunday or be rented to small groups (image 9.8). In this way it functions like a Roman community centre. A Roman road is reconstructed and cuts through the wilderness to create a sightline. The path joins the Museum trail and completes it in a walkway where you enter the marvelous view that the Romans had. A screen allows you to see the river like they once saw (image 9.9 &

9.10). The walkway lights up to just like the artworks and creates a safe environment in the darkness. Visitors of the centre will only need to use this one road and head straight to their destination.

Informal route

The second route is one that is translated with materializations and more desolate and quiet. It follows the former wall and guides you through the wilderness on narrow paths with the use of light. Lasers allow you to see how tall the construction was and can give projections of history. This route takes you along the edge of the former fort and allows you to experience the true size. Other constructions like the praetorium are simply created out of wooden frames that kids can climb and play on. Then all elements can be viewed in relation to each other. Everyone can pick a route depending on their mood.



Image 9.8: Kopse hof design vision with peoples opinions in mind.

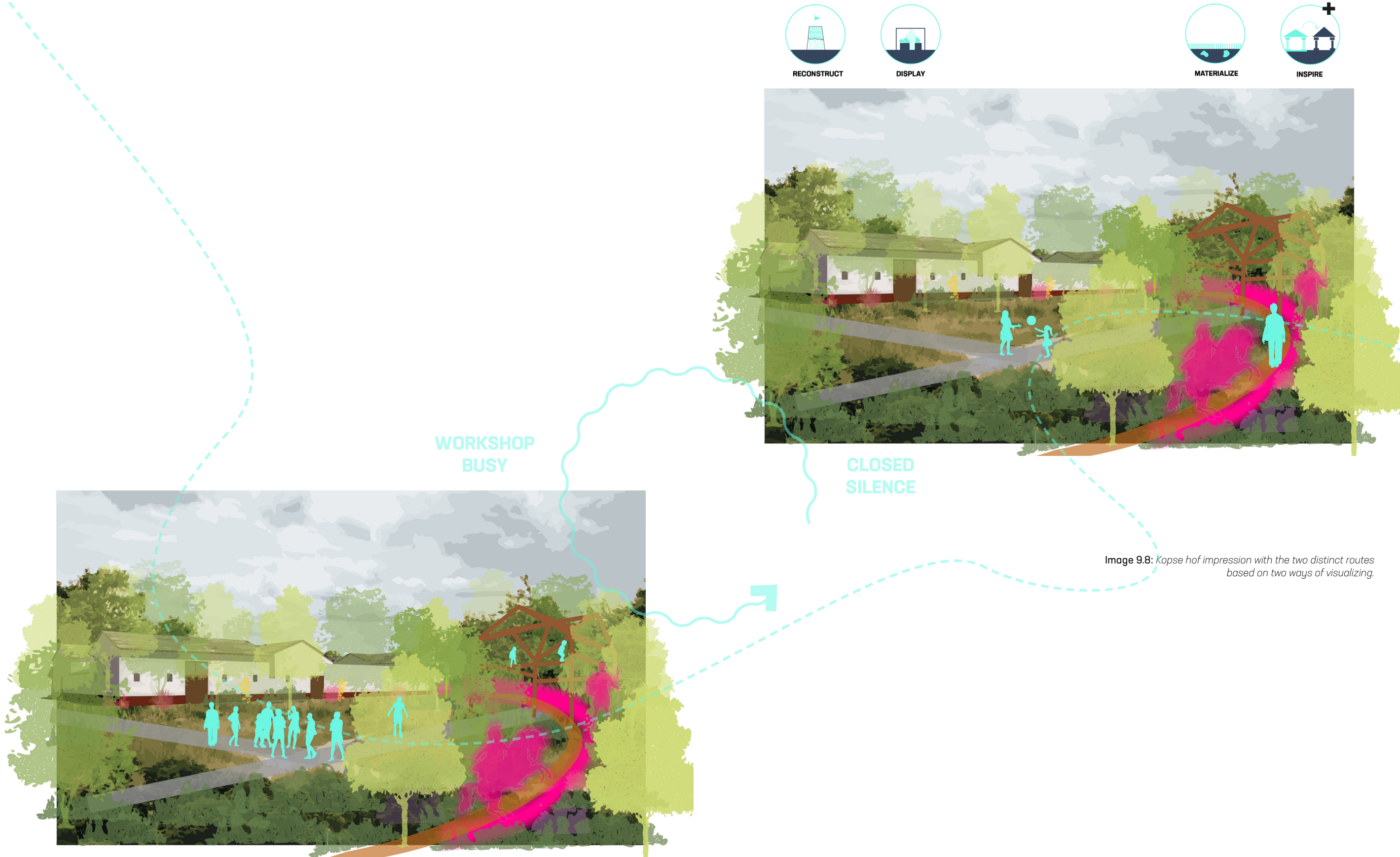
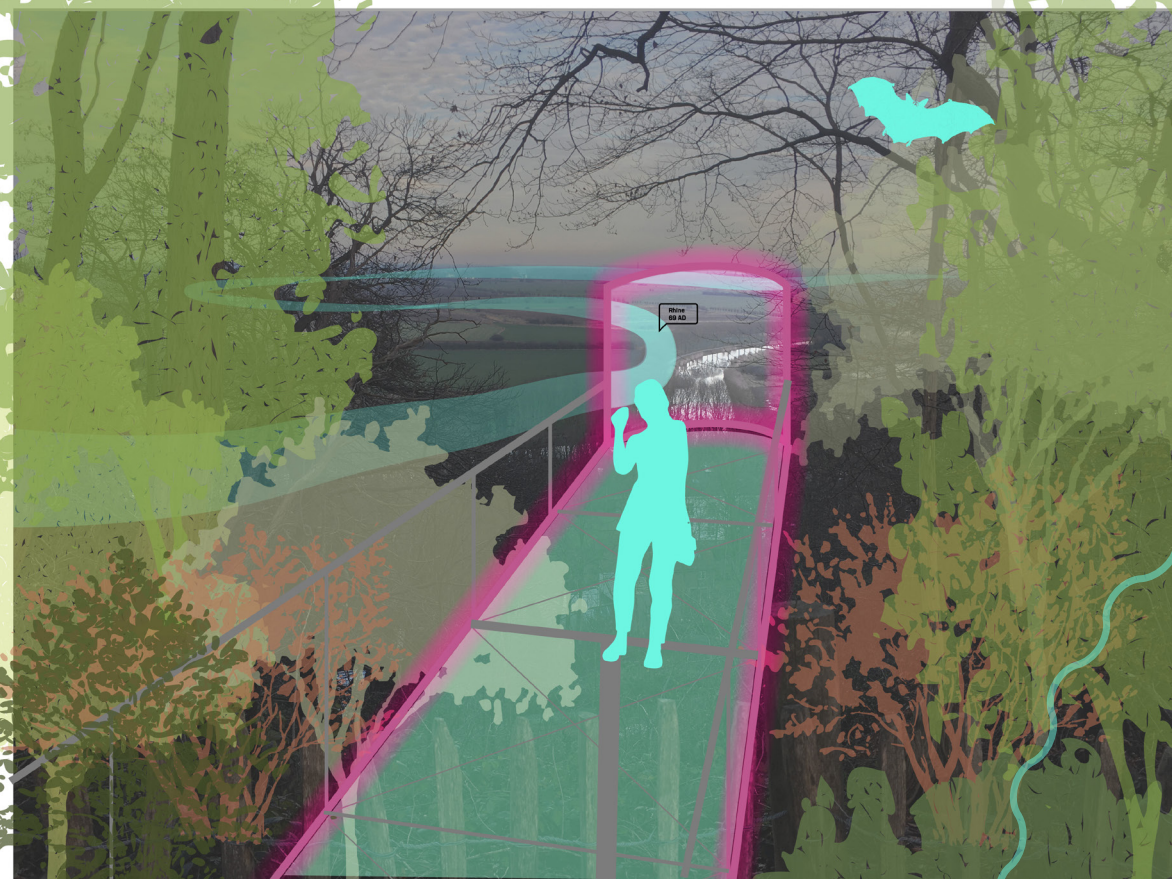


Image 9.8: Kopse hof impression with the two distinct routes based on two ways of visualizing.



NIGHT

Image 9.9: Kopse hof walkway at day and night.



EDUCATE



INFORM



ADD ON



REPRESENT

DAY

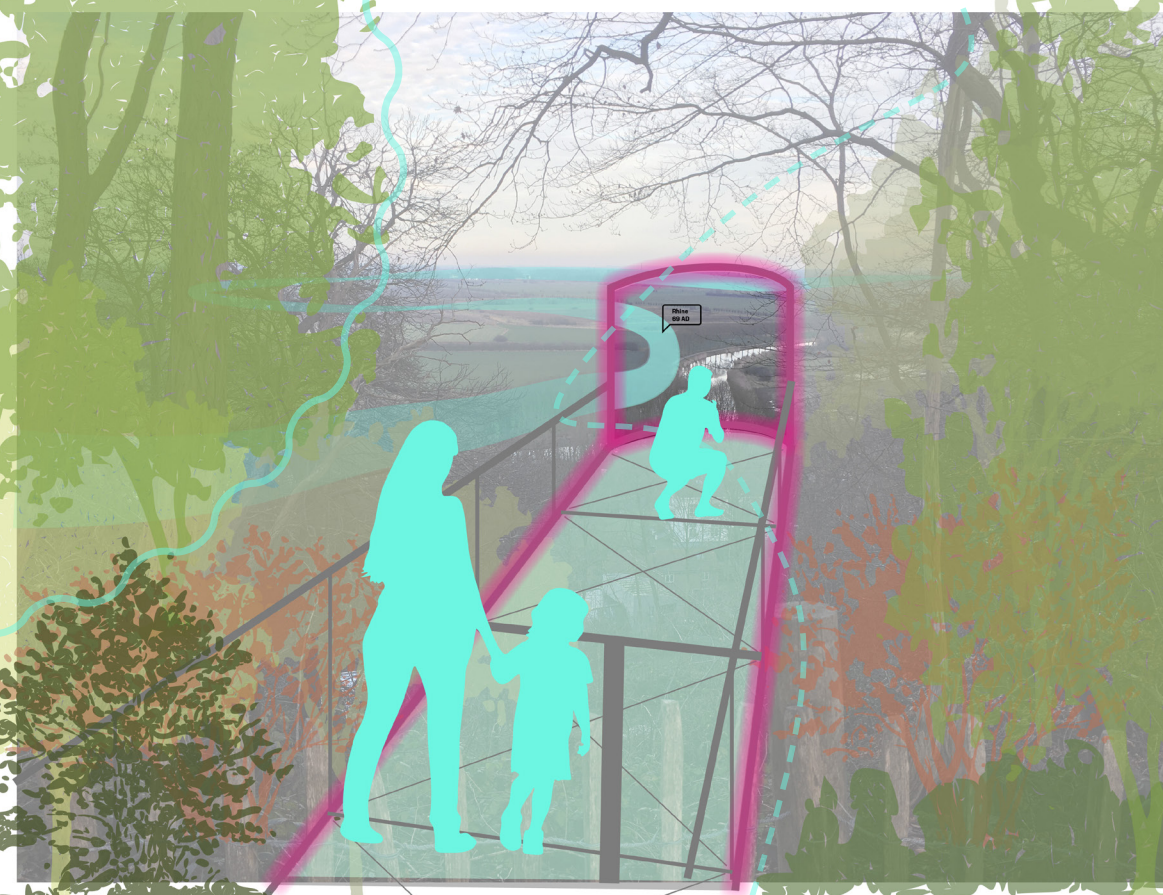


Image 9.10: Section of the walkway on the moraine.



▨ = Nominated property

▨ = Bufferzone

9.3 GREEN-BLUE AQUADUCT

9.3.1 PALIMPSEST: Longevity of the line

The Broerdijk is a mysterious linear element through the Hengstdal valley in Nijmegen. Romans created the dike to cross the valley and allow water to reach the castra (image 9.13). Today much of the dike has eroded and the dike is much lower (van der Heijden, 2015). The actual height therefore remains a mystery. Most theories claim that there was a wooden construction on top of the earthen mount to reach the full height of more than 9 meters to cross the valley. It is illogical to think this was fully constructed out of soil. Some theories also claim that a siphon was used, because two vague pipes were found on both ends of the valley (Aquaduct Groesbeek, 2022b). A siphon would flow as a pipe on the bottom of the valley and create a natural pump effect.

For decades the landscape element was a wonder for residents, why was it placed here?. Local legend claims the dike was constructed as a border between two feuding brothers (broers) (van der Heijden, 2015).

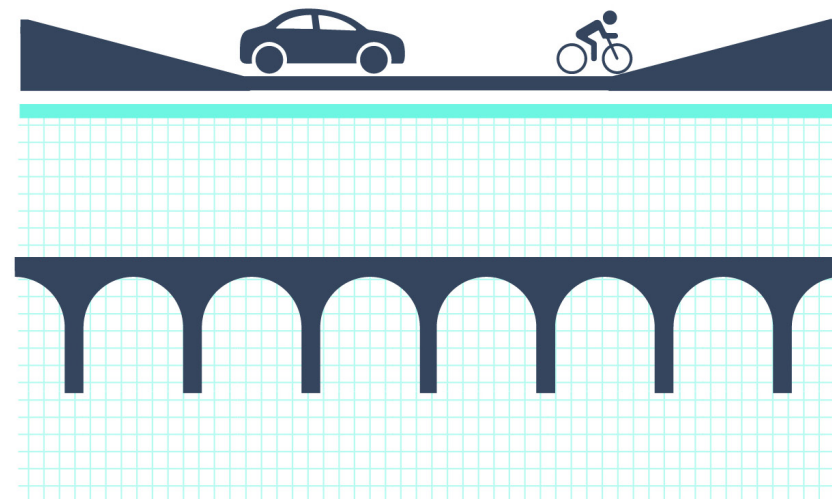
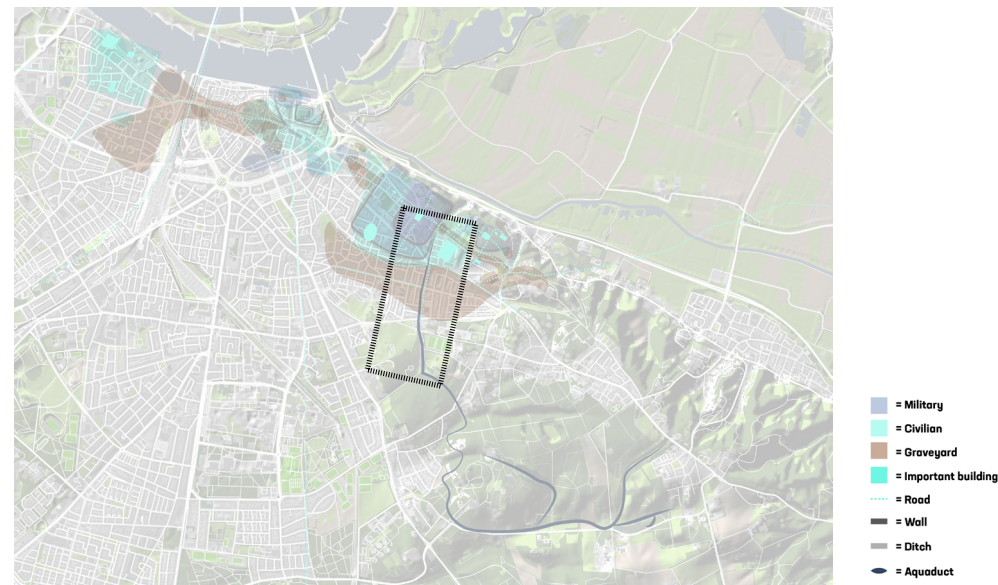
The dike came to be urbanized around the 1930 and was incorporated by constructed against the slopes. In the 2000s a part of the neighborhood was renewed and created a new square called the Esdoornplein next to the dike. Due to its shape as a dike it managed to survive fully as a line and is protected by UNESCO today (image 9.11 & 9.12).



Image 9.11: Aerial photo of Broerdijk with location of section.



Image 9.12: Map of Broerdijk with UNESCO sites.



BROERDIJK
Aquaduct

■ = Nominated property
■ = Bufferzone



Image 9.13: Palimpsest for Broerdijk.

- = Nominated property
- = Bufferzone

9.3.2 BROERDIJK FINAL DESIGN

On the location where the aquaduct crossed a valley (image 9.15 & 9.18), a bridge will once again be reconstructed, but with a modern twist.

Water is collected during heavy rain in an underground tank at the lowest point of the valley. The water is pumped into the glass pipes of the aquaduct and slowly irrigated into the plants underneath to give visitors a show (image 9.19). The aquaduct ends at the Esdoornplein where it interacts with the fortifications near the location of where the castellum divisorium once was. It will symbolically follow the same function of storing and distributing water flow into fountains or for local use in gardens. Esdoornplein would need a depth of 6,5 meters to collect all the water from the valley, this is not possible (image 9.14), so together with 0,5 meter depth here, more water is stored underneath the roundabout (just outside UNESCO property) and in the green zone underneath the arches (image 9.17). Together it is possible to store water from a rain shower of more than 5 mm. From here water will evaporate, slowly used to water residents' gardens and pumped back to water the green zone from the fountains above.

The aquaduct is a green-blue zone connecting the moraine's river edge (kopse hof) to the hilly interior (marienboom & watermeerwijk), promotes slow traffic and is lined with indigenous "Roman" species of plants and trees like Chestnut. It adds to the aquaduct system of by watering the green corridor with a trickling effect that calms visitors and gives them a sound interaction with the water. Residents and visitors are invited to sit underneath the arches on incorporated benches surrounded by greenery. Kids can meanwhile play in the water and green on swings or slides hanging from the aquaduct.

While it is a reconstruction in wood, it also has a modern look with a irregular pattern of arches. It is inspired by the fact that nobody fully knows how what the aquaduct looked like. Two minor neighborhood roads will be blocked and pedestrianized following the construction (see chapter 5). Nothing remains of the former wooden aquaduct, but the dike on which it was built. The bases of the wooden columns are purposely made out of stone to echo that the future archaeology will know something was here and do not need a foundation.

Image 9.14: Water catchment on the impenetrable surfaces of the valley crossing Broerdijk.

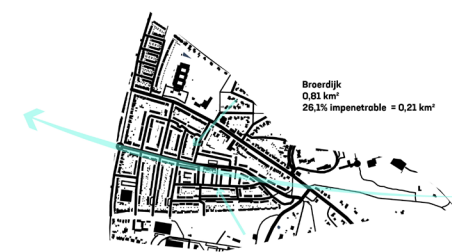


Image 9.15: Before section of Broerdijk.

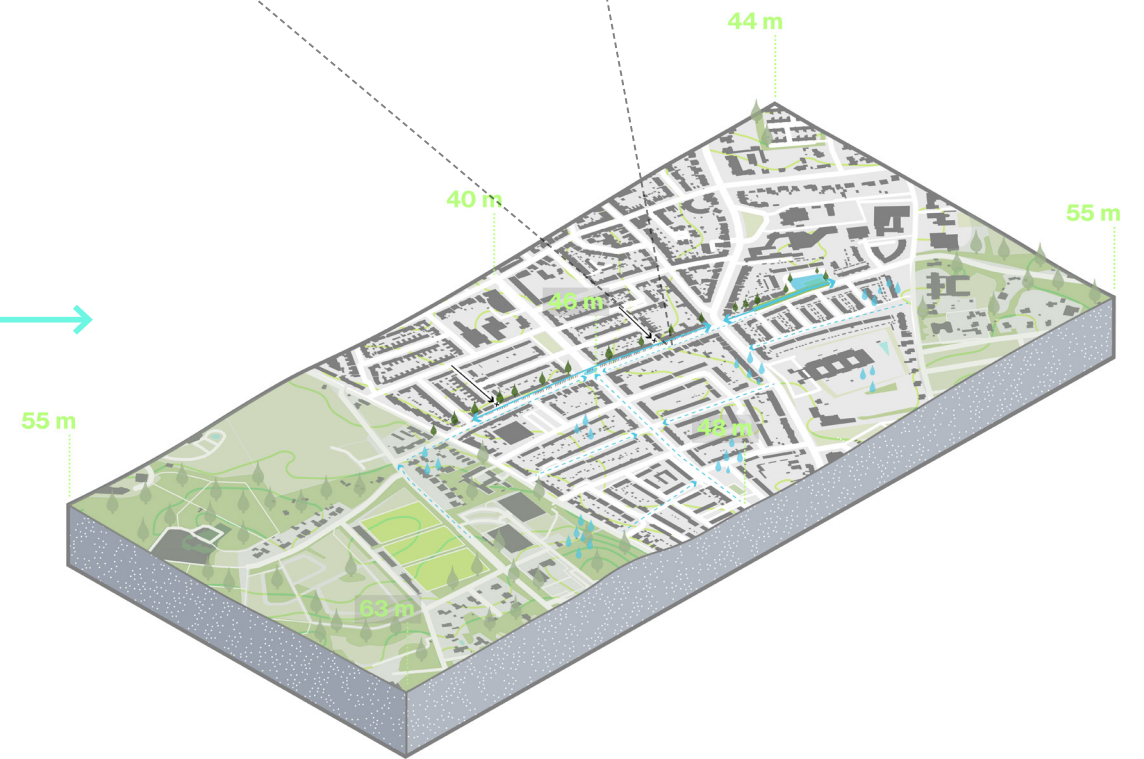
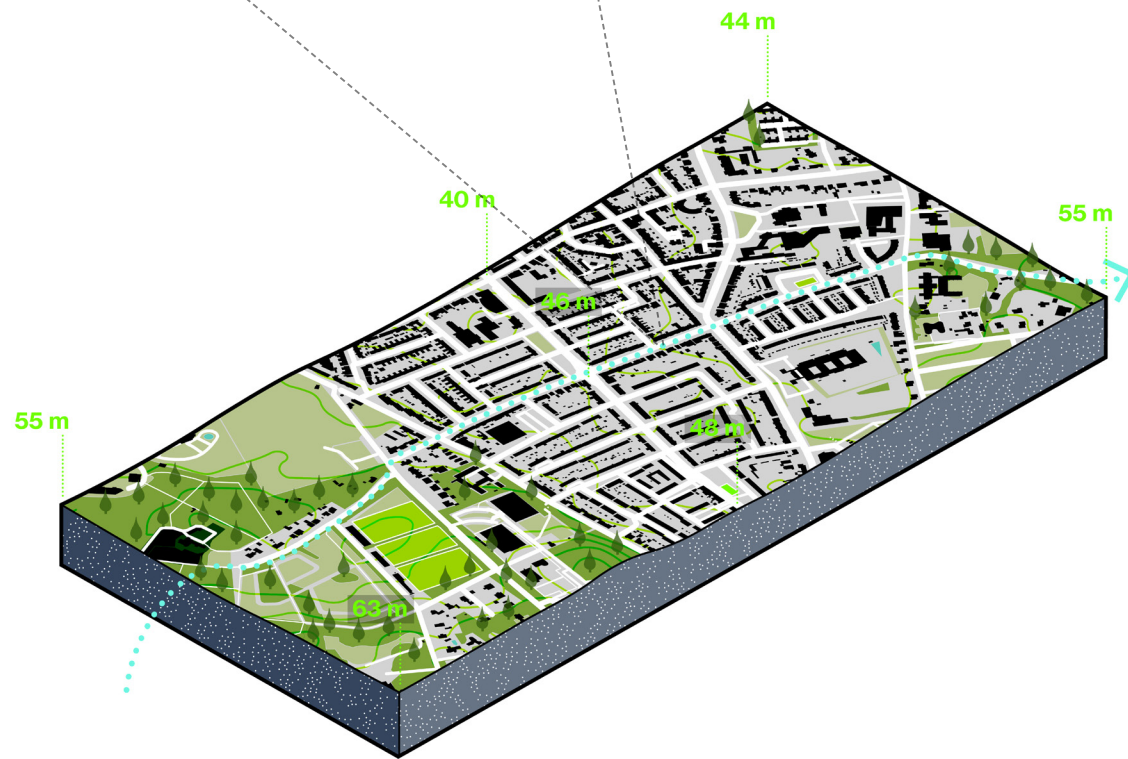
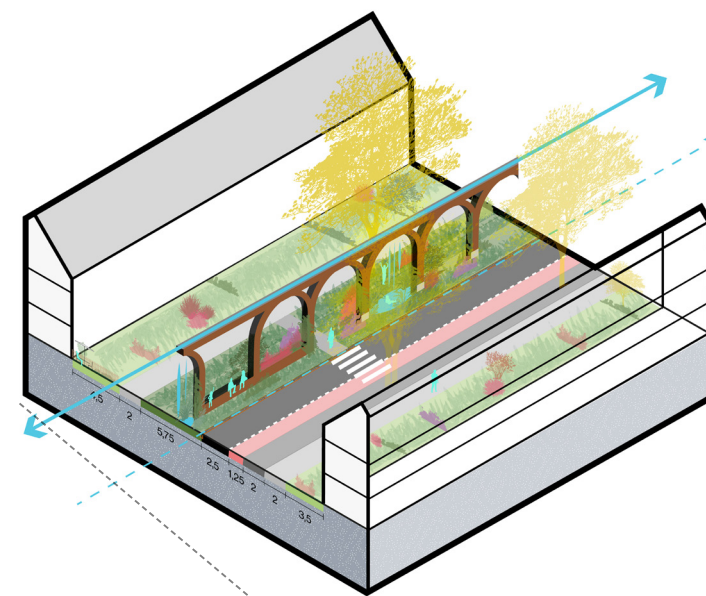
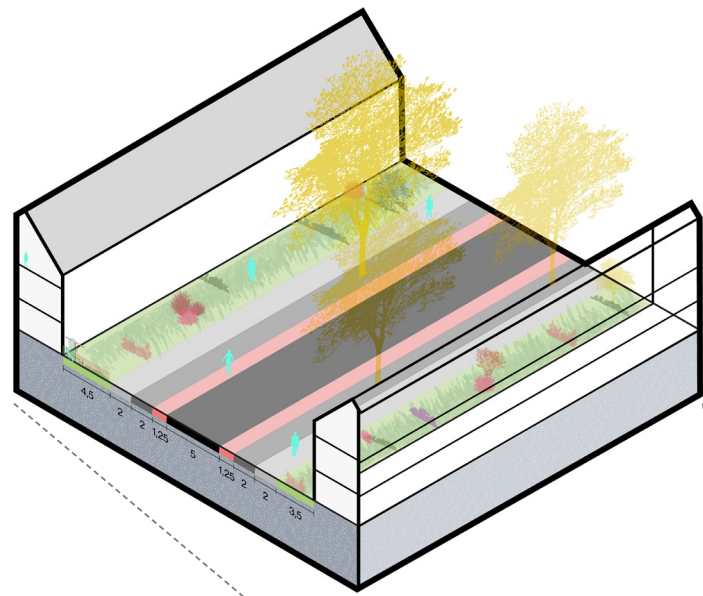


Image 9.16: Broerdijk topography before.

Image 9.17: Broerdijk design vision.

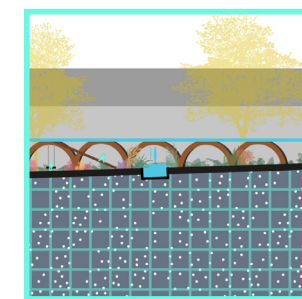
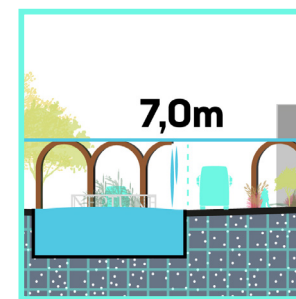
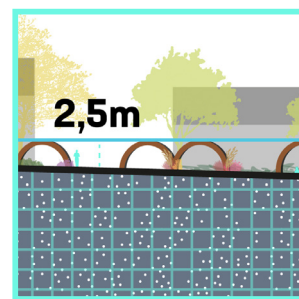


Image 9.18: Broerdijk design section.

■ = Nominated property
■ = Bufferzone

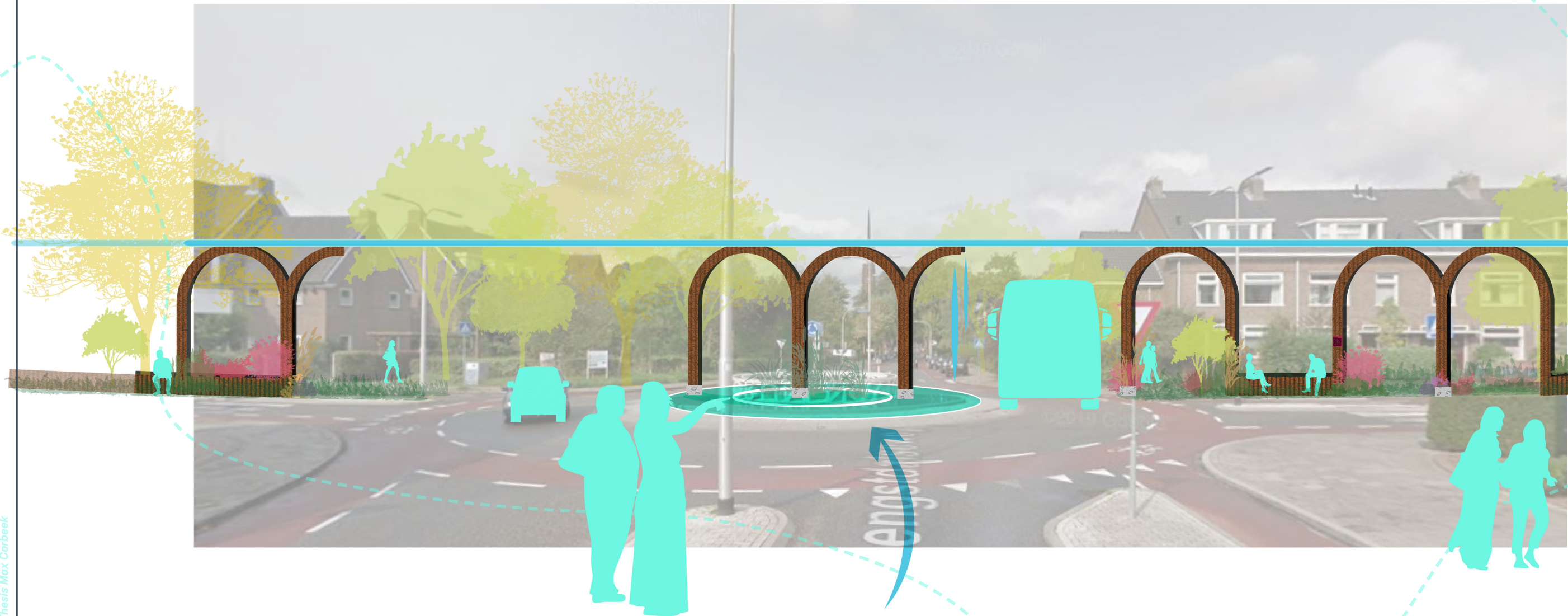
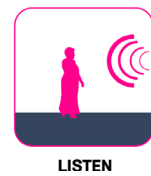
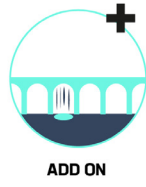


Image 9.19: Broerdijk design at the roundabout with water storage.

9.3.3 AQUADUCT ROUTE

The wooden material is continued in the aquaduct route to form a coherent unity different from the castra route. Green ditches in Marienboom used to harvest loam have the potential to become areas for water storage and wetland plants (image 9.20). The remaining original Roman valleys however cannot have this function due to the threat of erosion or accumulation of new soil. Instead the valleys are emphasized and stabilized with wood, referencing the original wooden aquaducts (image 9.21). Hickies get the opportunity to walk over, in and through the valleys on wooden paths that continue the material in multiple ways (image 9.22). The same QR codes are used here as in the castra route to create one continuous visitors' experience.

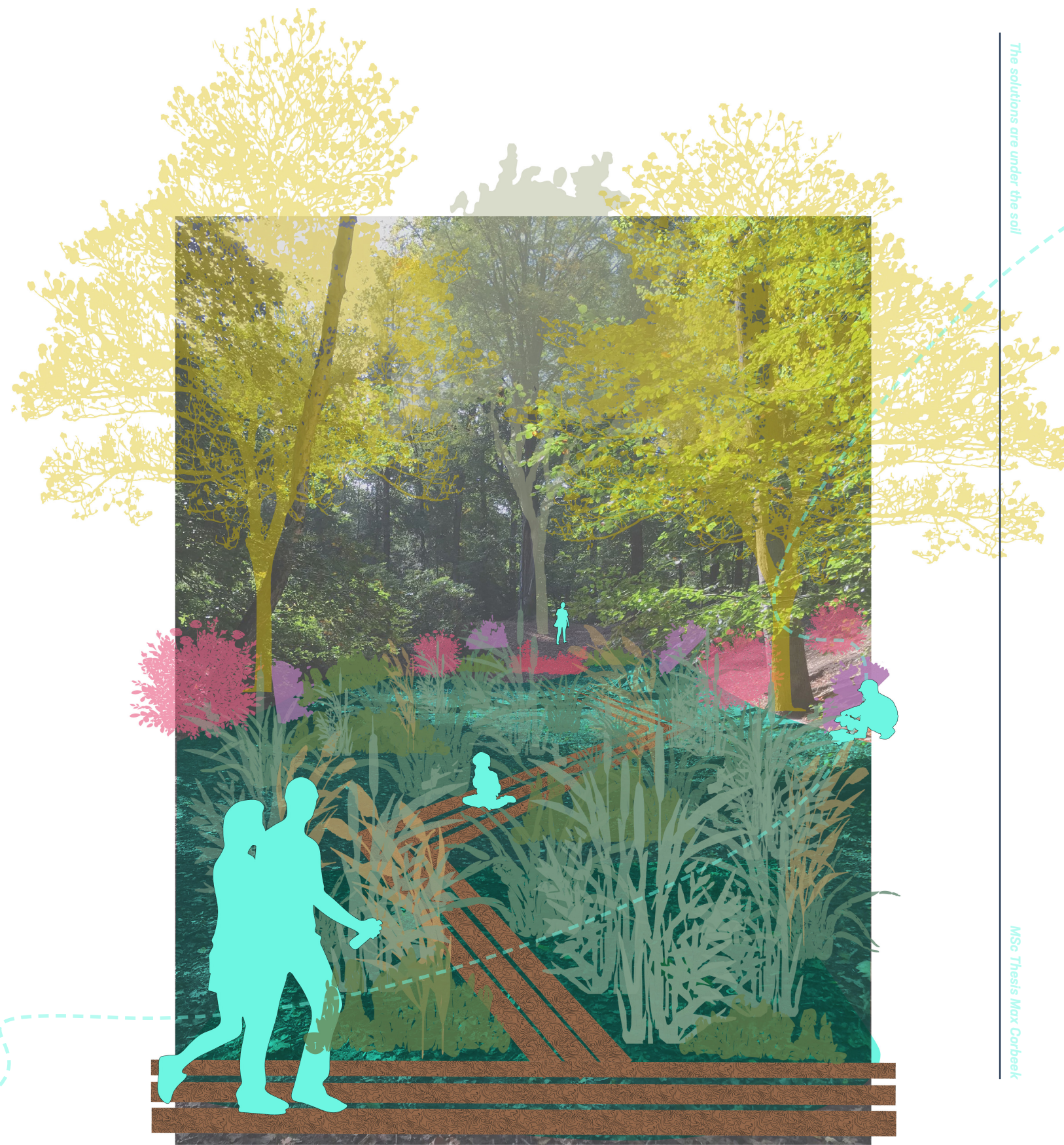
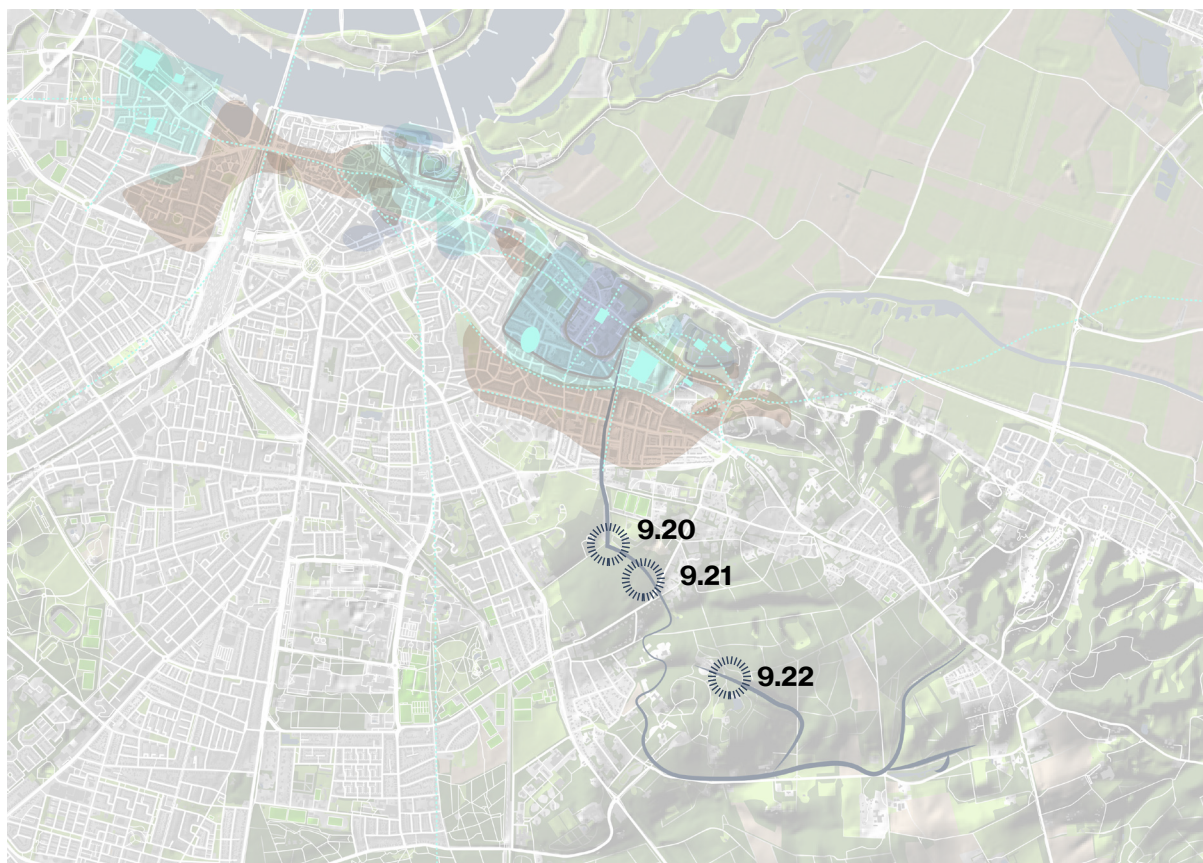


Image 9.20: Marienboom design with water storage.

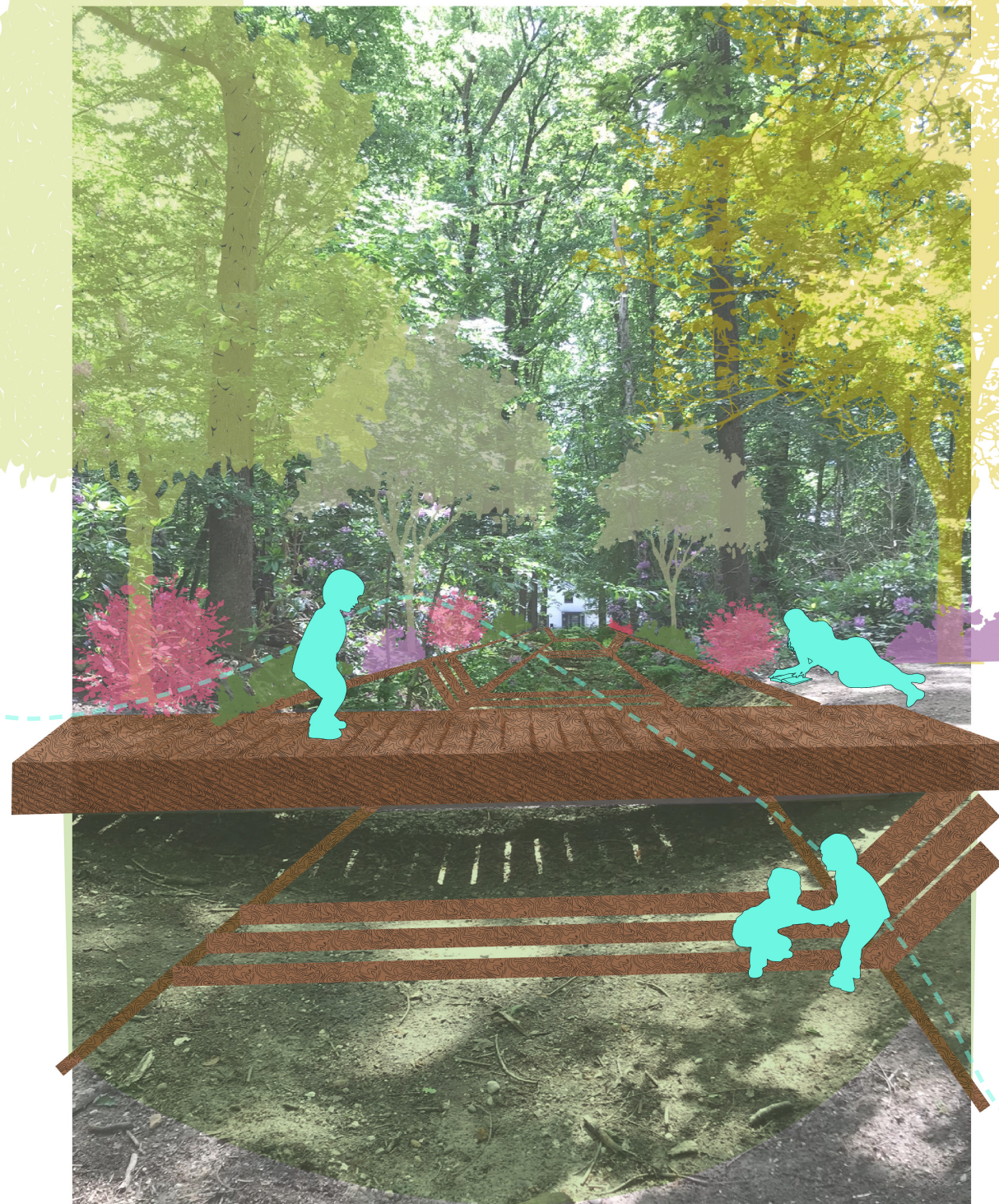
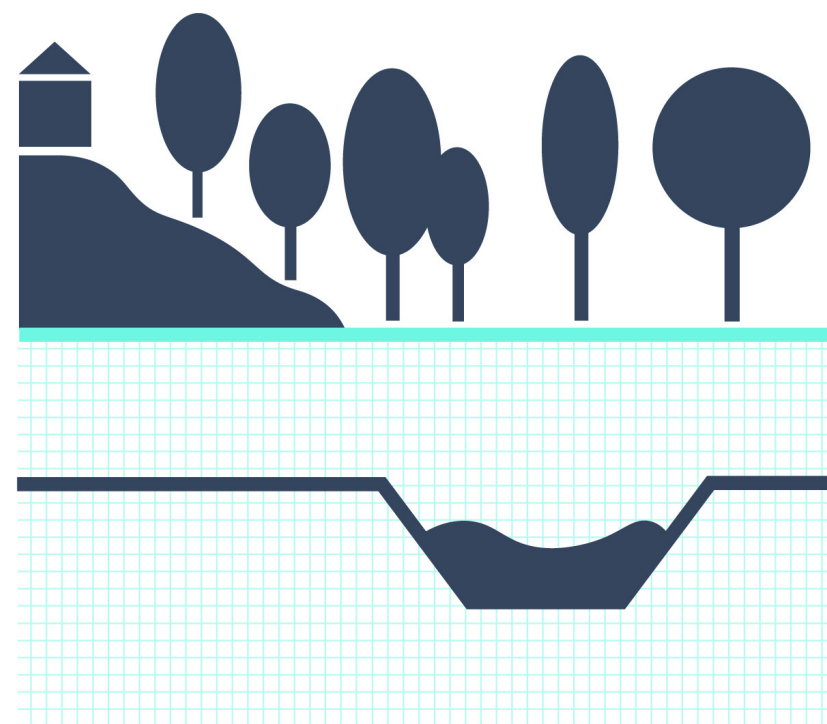
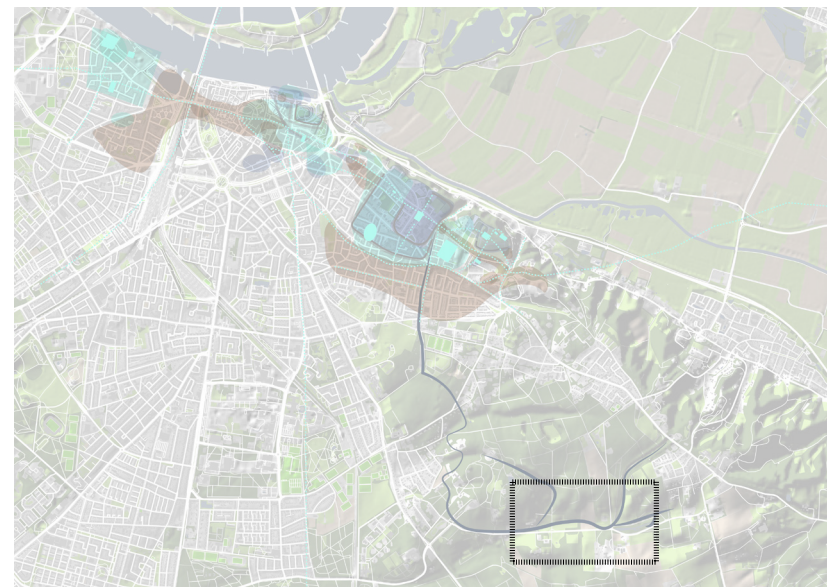


Image 9.21: Marienboom route design with aquaduct valley.



Image 9.22: Louisedal route through the aquaduct valley.



WATERMEERWIJK
Reservoir

9.4 ROMAN PLEASURE GROUND

9.4.1 PALIMPSEST: CONCEALED MYSTERY

The origin of the protected basin that remains in the Watermeerwijk estate has been a mystery throughout the years (image 9.24 & 9.25). It is thought to be dug by the Romans as a dam or separate source for the aquaduct. The basin was presumably then used as a moat for a small castle in the middle ages. The true age is tough to find out since the pond was used as a dump for WW2 ammunition, making it extremely dangerous to perform archaeology here (Aquaduct Groesbeek, 2022b).

Before the war it was included into a pleasure ground with star forest. Inhabitants of the overcrowded fortified Nijmegen came here to enjoy canoeing or walks in nature (Abma, 2021). The whole area used to be part of a larger collection of estates for agroforestry called De Vier perken (Klinkenberg, 2014). While in Roman times there was massive deforestation here for construction of the Limes. Today Watermeerwijk, including the basin are behind a fence, but the rest of De Vier Perken is a public protected forest.



Image 9.23: Aerial photo of Watermeerwijk with location of section.

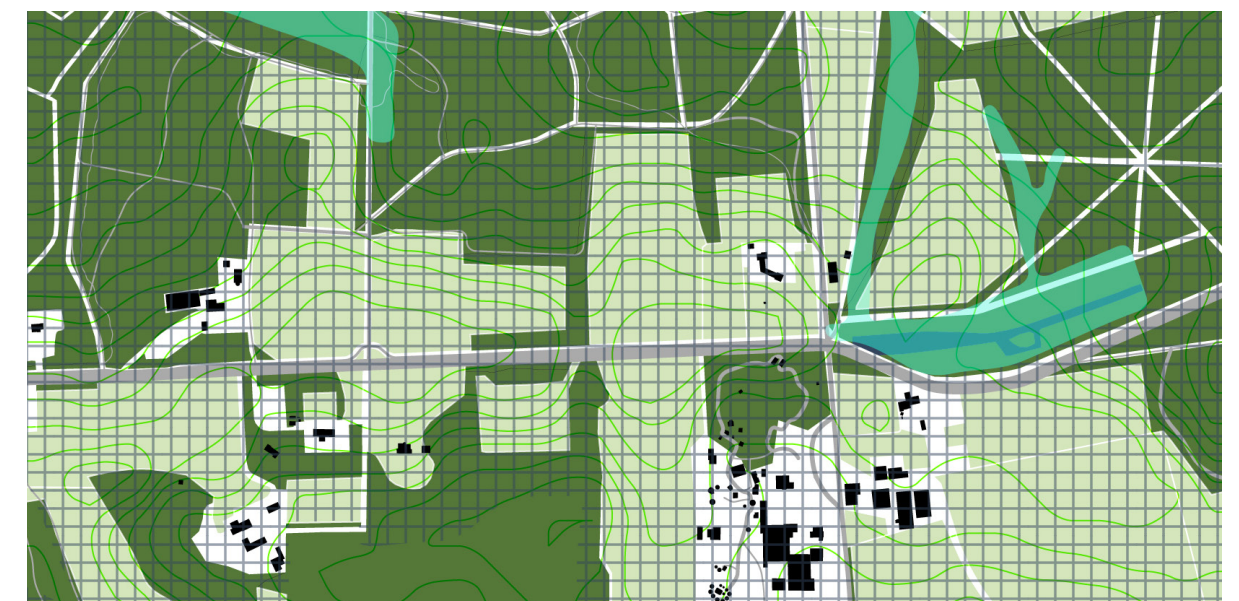


Image 9.24: Map of Watermeerwijk with UNESCO sites.

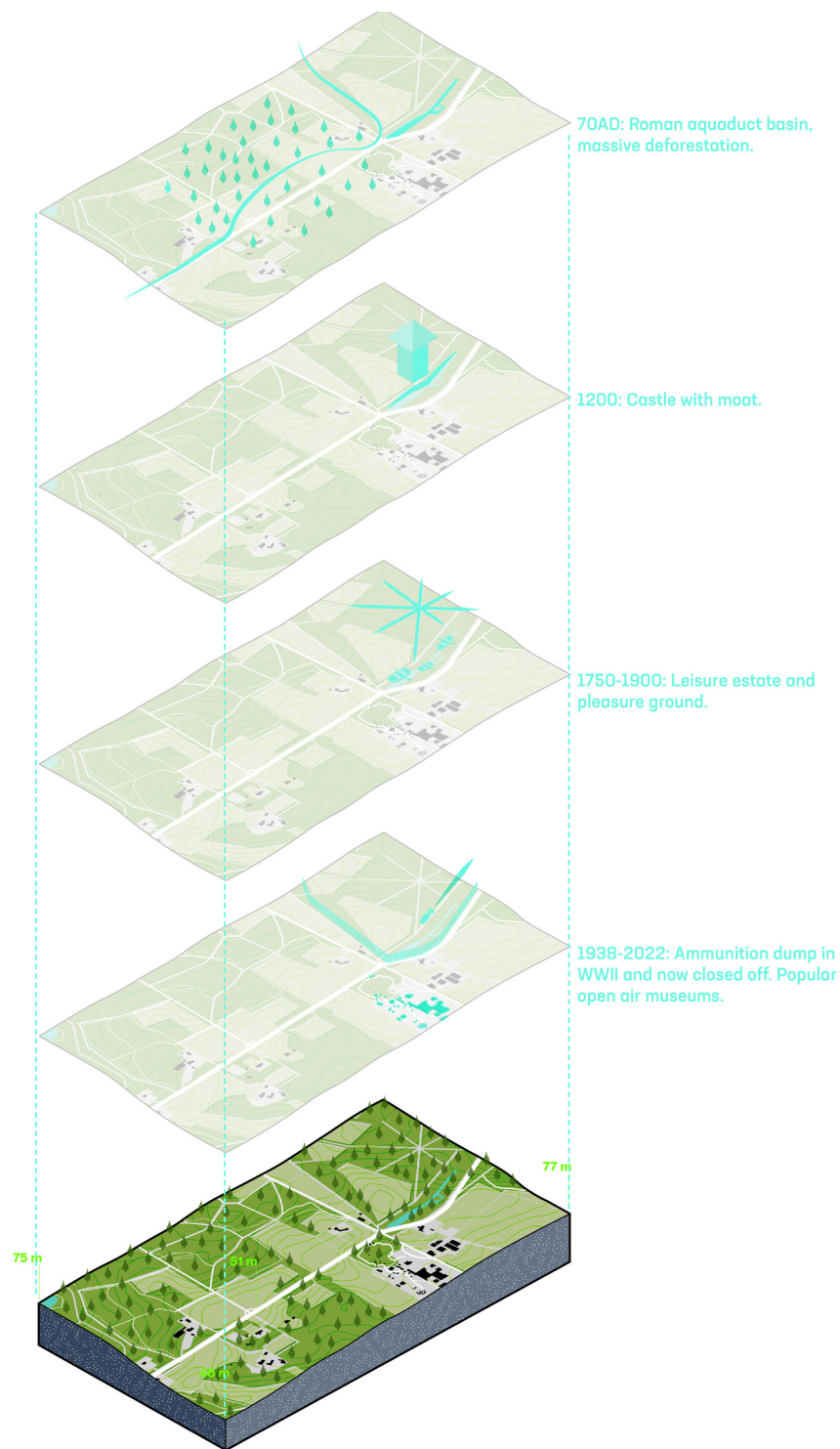


Image 9.25: Palimpsest for Watermeerwijk.

- = Nominated property
- = Bufferzone

9.4.2 WATERMEERWIJK FINAL DESIGN

The aquaduct system is expanded with a new water catchment pond in the adjacent natural park, following the topography to create the wetland (image 9.27 & 9.30). It will collect the runoff from the nearby village of Berg en Dal (image 9.29). A canal comes down from the village and invites people to rent canoes, play in the water, or cross on the stepping stones. The history of the area for pleasure ground and forestry is honoured in the application of a traditional technique to cultivate trees in estates with wet soil, called 'rabatbossen' (Majier, 2021). Parallel ridges are created by adding soil to the valley with fluctuation water levels in between. Trees fit for this are oaks or poplars for example. When dry the canals become playful pedestrian paths in the forest that give visitors a different perspective of the aquaduct. Cultivation of trees represents both the alternating cycles of deforestation

for construction during the Roman age and reforestation as an estate. The wood produce can participate in constructing the rest of the visualizations, creating a circular material (image 9.31).

The area had a potential of capturing rain in depth of 0,73m in extreme rainfall (Image 9.26), but by creating the ridges, the valley can fill up to the road with 1,3m. On the edge visitors on bikes or hikers can enjoy a rest from the Roman route. The aquaduct route ends here near the source and allows people to explore the areas museums the Afrikamuseum or Orientalis. (Image 9.26). Pleasure is once again the main function for the area and used to interact with the water.

Image 9.26: Water catchment on the impenetrable surfaces of the valley crossing Watermeerwijk.

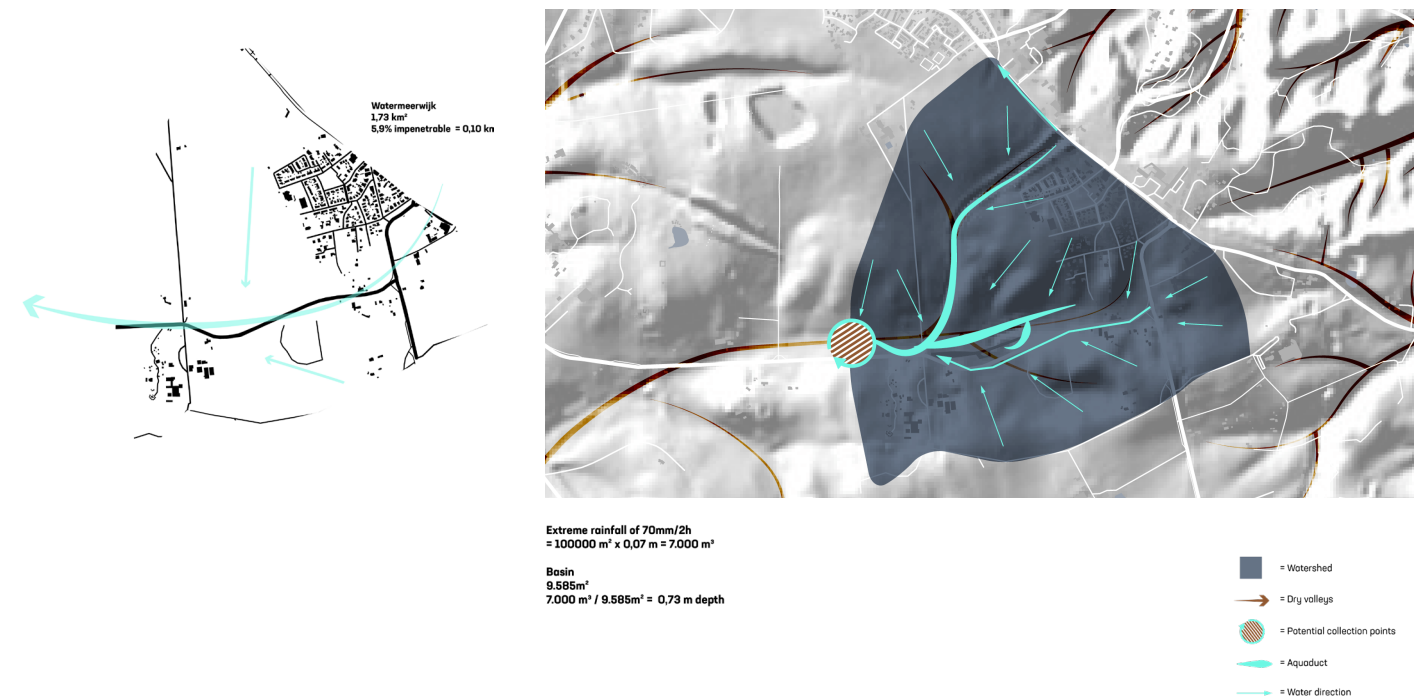


Image 9.27: Before section of Watermeerwijk.

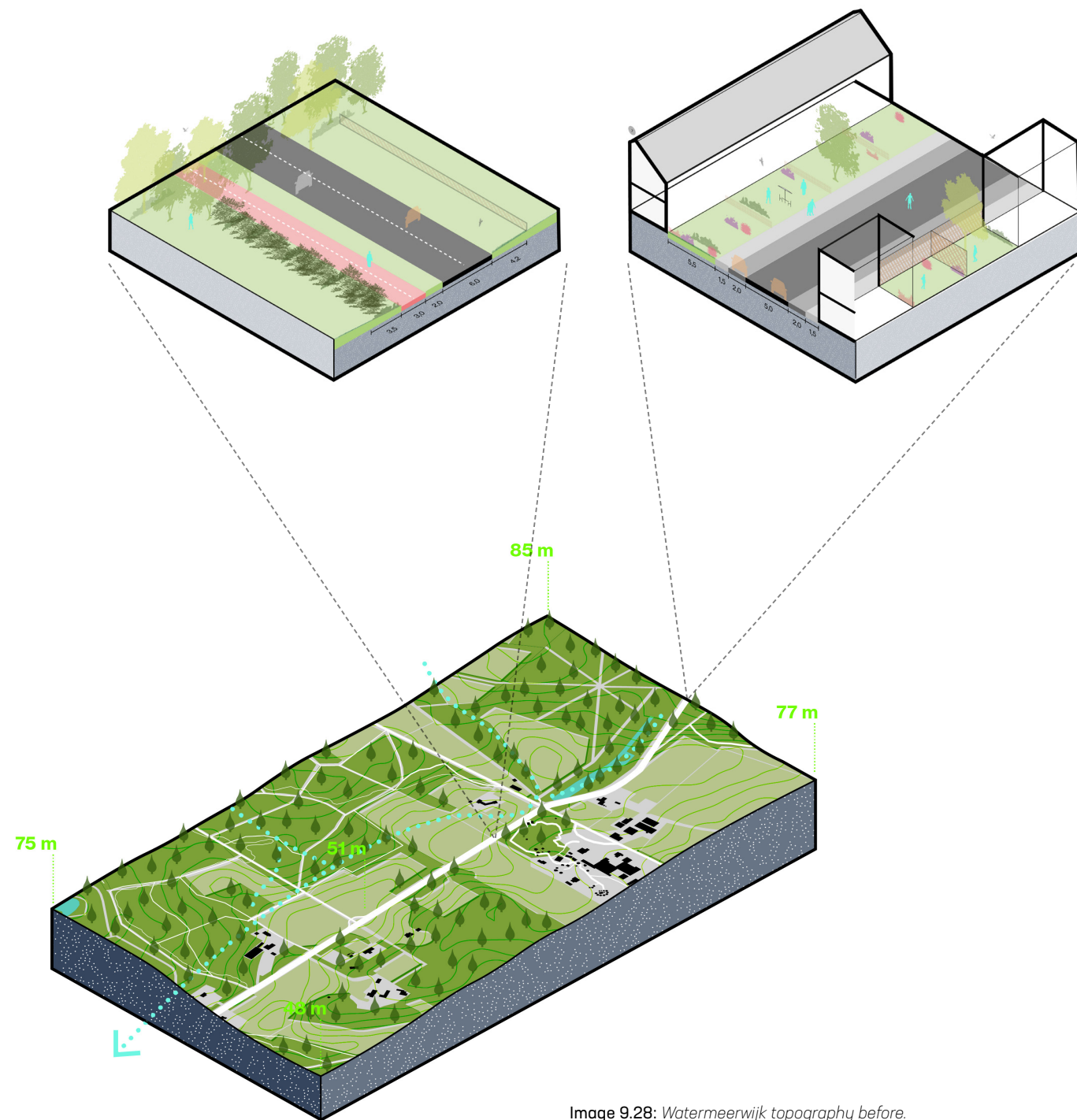


Image 9.28: Watermeerwijk topography before.

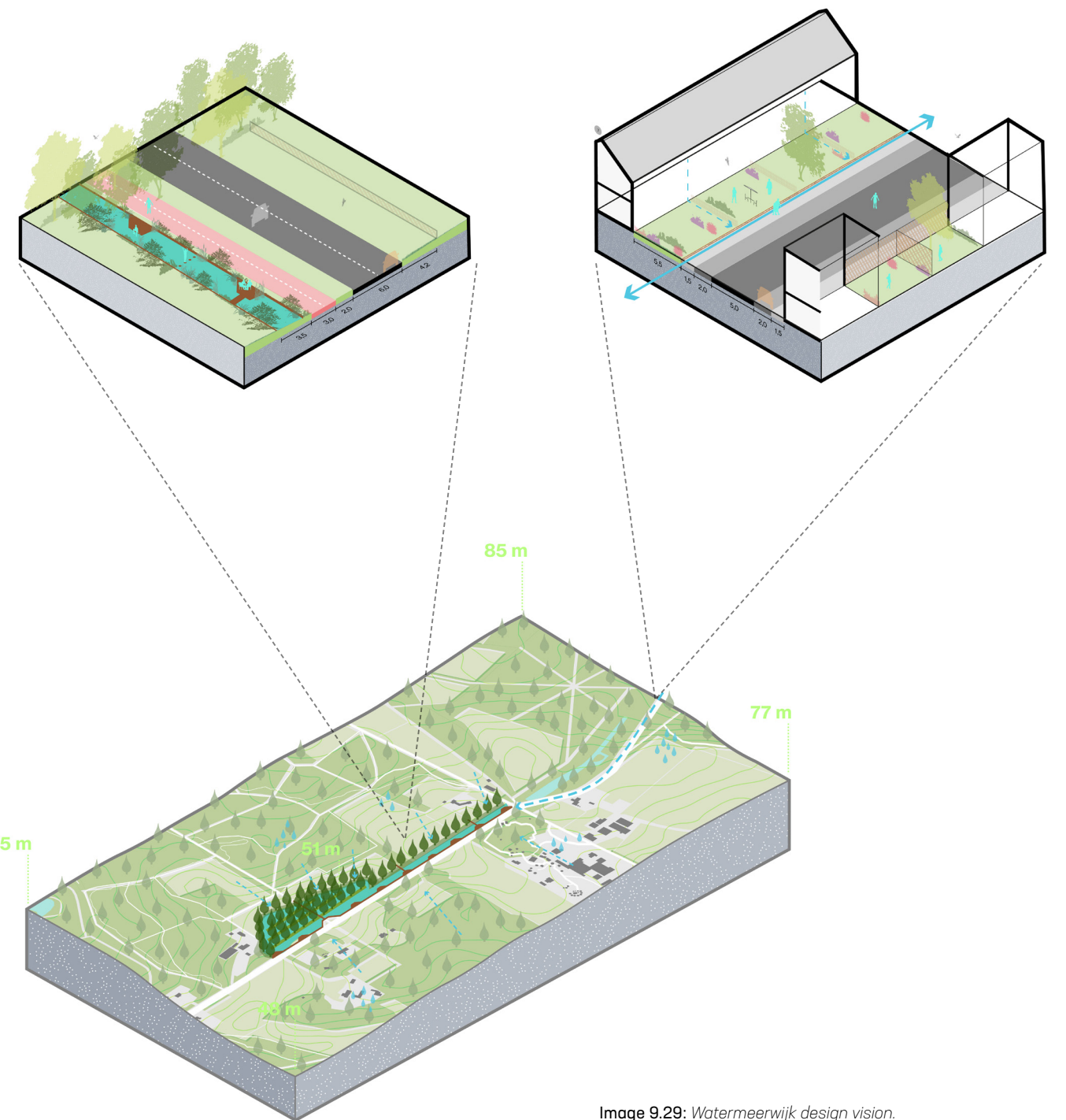
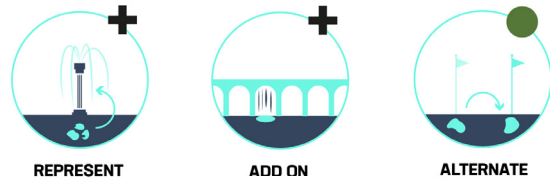


Image 9.29: Watermeerwijk design vision.

Image 9.30: Watermeerwijk design section.

- = Nominated property
- = Bufferzone



DRY CHOPPED



Image 9.31: Watermeerwijk design at two different moments in time.

10. CONCLUSION

Outcome, transferability, advice

The conclusion will conclude answers to the main questions of this report, the lessons taken from the report and zoom out in scale to show transferability.

10.1 Outcome

How can urban design sustainably develop the UNESCO sites in Nijmegen-Oost to create awareness and create place attachment for the cultural memory of Roman Nijmegen? The conclusions can be summarized in a timeline for how to develop archaeological heritage (Image 10.1).

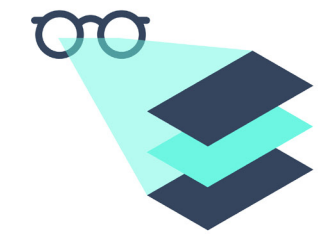
10.1.1 Diachronic Layer Approach

Through this report the Roman structures were discussed in depth with the layer approach. This is nothing new, but the general way of analysing the aspects of water, roads and structures through history and what remains is specifically Limes and could be transferred to other UNESCO sites within the border. Other layers of history unique to those locations can also be researched more thoroughly. The layers were looked at in different era's in order to see the changes and what remains. Moreover it brought to light very well what the issues are and the opportunities to solve them. Nijmegen in particular is a special case due to more than 400 years of Roman history, therefore a simplified method could fit other areas.

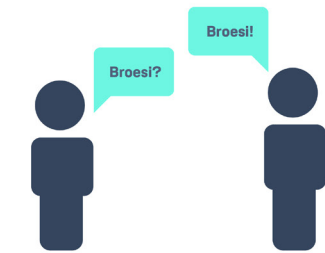
10.1.2 Design tool

People are aware of Roman heritage where it remains or is visualized. Broesi developed ten ways to translate archaeology into design as a classification tool. In this report these ways were used as a design tool to start off the creative process and researched for one location on what people prefer. Participants had a particular affinity with physical translations such as reconstructions and conservation on this site, however other locations will offer different ideas, possibilities, restrictions and therefore opinions on designs.

Applying the 10 methods in a survey brought forward a new approach that included the interaction with humans and the way it impacts the environment that it lands on in current times. Together they form the components to a functional design that creates awareness and place attachment. The approach is a new road for conventional heritage, considering it involves multiple ways of bringing back lost structures and goes further than reconstructions. The method is also a reduction of reality and therefore is not stagnant in the solutions, but seeks to inspire solutions.



Approach



Descriptive Language



Reduction of reality:
Design Tool



Expanding



User cycles interact with
Historic Timelines

Image 10.1: Lessons taken from this research in chronological order

10.1.3 Language for including Archaeologists

New ways were added to Broesi's system during the design process that could be included in further research. These tools can then become a standardized language that is used to compare ideas for archaeological policies and bridge the gap between the fields of archaeology and urbanism. Participation in the creation of these designs will promote the connection between people and place attachment surrounding Roman heritage, but also encourage the realization of the solutions knowledge of the past can bring. Archaeologists should therefore be included into the design process and from my experience have the largest drive to incorporate past ideas. For example my contact with the municipality of Nijmegen was

only with the department of Archaeology, since in the department of Urbanism there is not yet a project about Roman visibility. These are missed opportunities since the solutions to today's sustainability are truly under the soil (image 10.3).

10.1.4 Expanding

Nijmegen is rich in UNESCO sites that have the potential to be brought to live in one vision and heritage system. This system could be expanded to other sites in Nijmegen (like the Valkhof or Waterkwartier) and surrounding areas (like Holdeurn). The method of a system could be applied in other cities with high concentrations of Limes UNESCO sites as well (Image 9.2). These cities are already connected through Roads and train, but can now share in tourism

strategies. The design tools can also be used to spark inspiration for non-Roman archaeological sites on sites that are richer with a different kind of history such as Neolithic, Medieval or WW2 for example.

10.1.5 Sustainable Timelines

The last step is to acknowledge that by designing with the past the perception of timelines are converging. It is a trend to be interested in the Roman layer and important to learn from. The designs should play with the element of time in different waves of functions, water, people, lighting or materials that all change at different paces and cycles. The different wavelengths can be used to create a resilient circular design that respects the pillars of sustainability and solves modern needs by bringing back past identities.

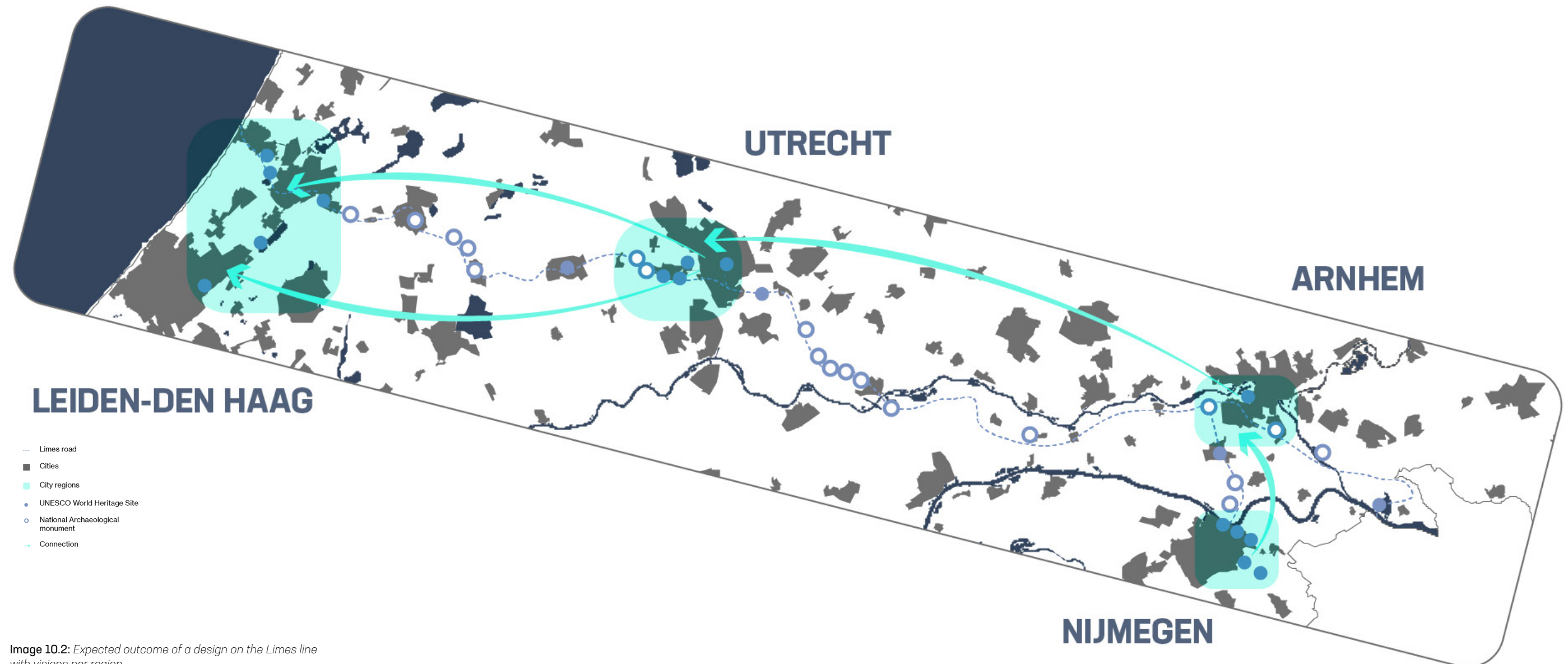


Image 10.2: Expected outcome of a design on the Limes line with visions per region.

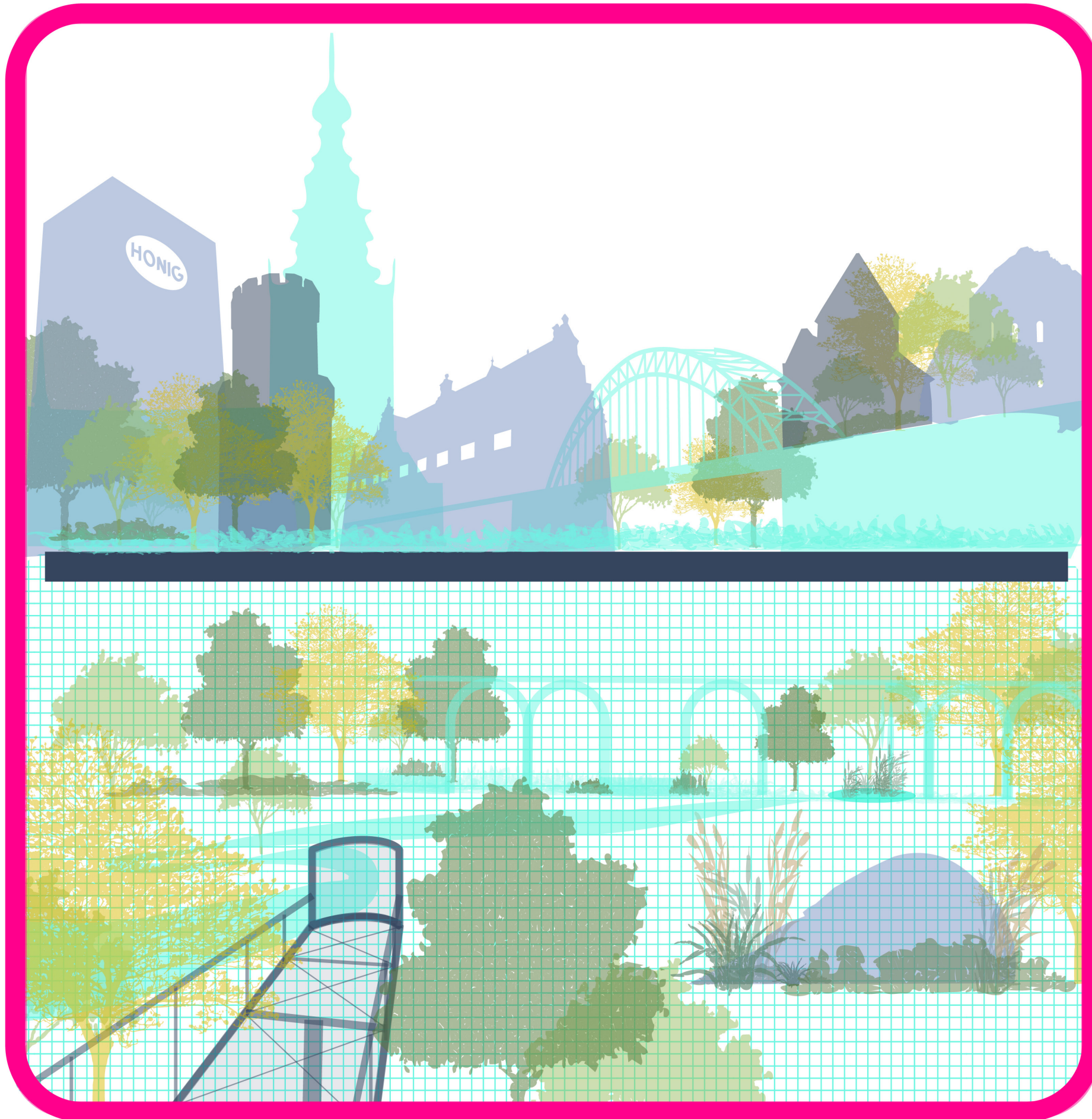


Image 10.3: *The opportunities for Nijmegen's sustainable future are under the soil.*

11.

REFLECTION

Methods, approach, ethics

The reflection will discuss the importance of this research, recommendations on further studies. The scientific methods, design approach and heritage ethics will also be critiqued.

11.1 Research methods

This combination of methods allowed this research and all had their own good and bad qualities, but also formed a synergy.

11.1.1 Layer approach

Splitting the Limes into layers of its three element of water, roads and structures concluded with what remains and different possibilities for each layer going into the design. By adding the potential of all three aspects together, it created the spaces that are most interesting to transform in Nijmegen to show the Roman History. Using the layer approach through time allowed to show new stories, limitations and opportunities (Image 11.1) (van Schaick & Klaasen, 2011).

11.1.2 Historic Literature

Literature and storytelling is highly important for archaeology and therefore this report. Often it seemed like this report was collecting different stories and perspectives on the past, but also writing a new narrative by adding urban layer analysis. What the heritage is, is determined by what we know of it and what stories are told.

It must be said that archaeology is often not an exact science, it is an interpretation of the past and results in telling of history. Similarly to how research and design go together, but are hard to measure. Archaeology also has multiple interpretations coexisting. Intuitive designing is the glue between the storytelling of archaeology and quantifiable research of the questionnaire and mapping (Image 11.1).

11.1.3 Questionnaire as a method

The questionnaire aim to mix research and design by quantifying what people think of design proposals. Successful references were used for the variants. Not only did it result in knowing what superior design is, but it also allowed peoples comments to be heard and added into the design. This is a good method to allow people to participate in heritage.

By using a questionnaire new perspectives on the site of the Kopse Hof emerged by involving the people who are interested in Roman Nijmegen. The questionnaire showed to be a great method for sharing possible directions for the design. Moreover it was a fast way to display what the location could be for inhabitants and the municipality. Creating an advice for policy as an advice. Experiences were shared in a discussion and workshop that showed peoples perspectives and interests in the location.

11.1.4 Questionnaire execution

As stated in chapter 8.9 the choices in the process influence the eventual perception and opinion of the designs.

For example some people said they would have filled in a different answer if they got more information on the designs. It was however important that the questionnaire was judged quickly as a first impressions, since not everyone is very interested in the subject of Roman history. The designs were judged on face value and what grabs someone's interest. Not everyone understood that the designs are not final and merely a way to explore what is

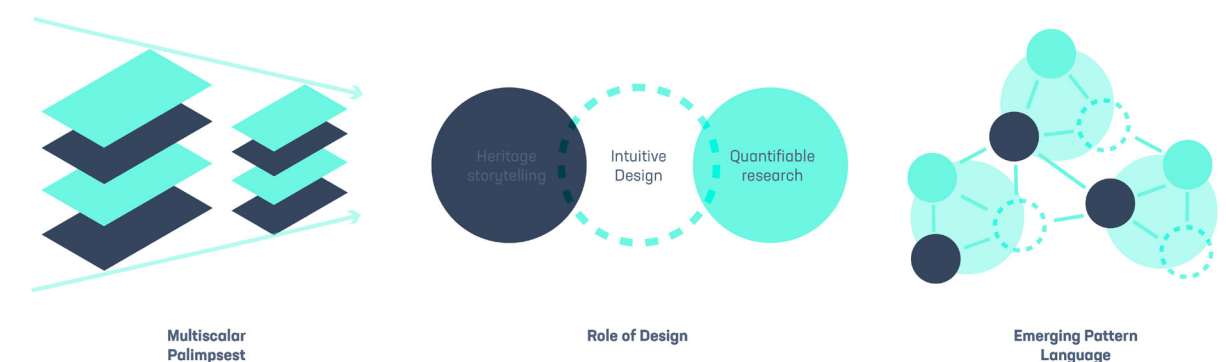


Image 11.1: Icons for reflections on methods.

possible. It was even stated that “Conserve’ is impossible, due to the absence of stone remains and the excavated areas being virtually devoid of findings at present time.

That does not make the research less valuable, since this location allows for many ideas to bring forth Roman history. It is a testing site and the designs could be applied on locations with other possibilities.

11.1.5 Recommendations

For further research the same methods could be used and could also be projected on another location within the Limes or another archaeological site. The questionnaire showed peoples opinion on the ways of translating archaeology, but further research on many other has the potential to generalize this more. This research very much revolves around designing for a location and reflecting on it and other sites could lead to new findings. The site was one of many opportunities space wise, but many limitations in protection and strong opinions. The combined result of further studies could then be a pattern language for people’s reactions to the new methods on visualisations and interactions with archaeology (Image 11.1) (Salingaros, 2002).

11.2 Design approach

Approach demands a masterplan

The new approach goes further than just the visibility of archaeology and also includes interaction with people and the environmental impact for sites. It can be argued that these are not the only factors that need to be considered in the development of heritage sites. Mubaideen en Al Kurdi (2017) propose that the following goals need to be kept in mind for integration of archaeological sites:

- preservation in situ: protect the soil from developments while showing history.
- integration: guidelines for development around the sites to keep integrity.
- accessibility: Connecting and improving reachability of the sites.
- enhancement: improving the surrounding infrastructure for locals and visitors.
- exploitation: An economic function on the site for the community to profit off.
- cohabitation: The surrounding commercial facilities relate to the presence of the site.
- presentation: The public urban space that is located in front of the site is redesigned to attract visitors.

The method do not include preservation or integration, since it can be seen as a prerequisite for UNESCO sites with their strict regulations making large disrupting developments impossible. A correct presentation of the public space around the archaeology can be considered the end goal of the approach since it is used for placemaking for visitors. Accessibility, enhancement, exploitation and cohabitation are subconsciously included in the environmental impact through the pillars of sustainability. Accessibility and enhancement have the potential to be more represented in the design method, but is assumed to be researched in the analysis phase as well through the diachronic palimpsest. The method therefore assumes that a masterplan must be made for the area surrounding the archaeological site, while the approach only deals within the sites border and does not stand on its own (image 11.2).

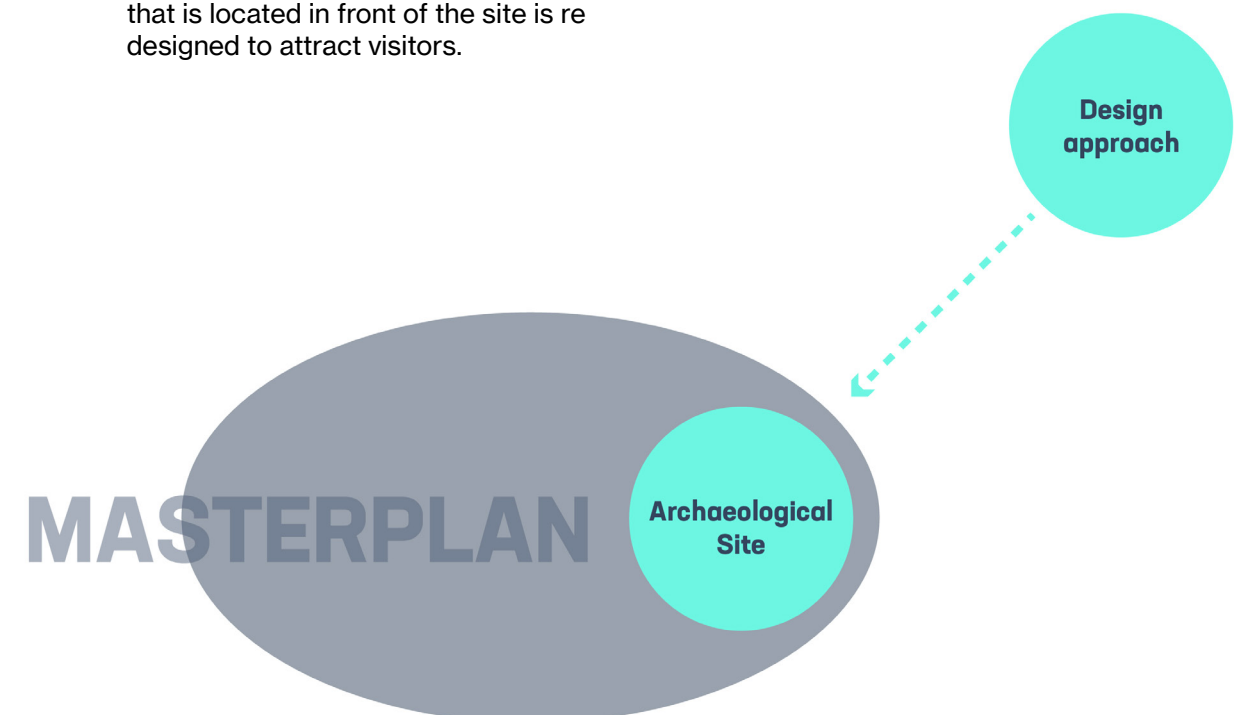


Image 11.2: The design approach is used within a Masterplan.

11.3 Ethics in Heritage

Throughout history there have been many contrasting opinions on how to approach heritage, but by viewing archaeology as a part of heritage, this discussion is brought back to life. Most methods on how to design with heritage originate from the 19th century (Rouhi, 2016). Valued structures constantly experience damage through aging by weather conditions or occupation. The majority of theories put the emphasis on the maintaining buildings in their current state with some allowing interventions to ensure the buildings survival or revive former glory (Yazdani Mehr, 2019). Several ways of approaching a heritage building developed through time. (Yazdani Mehr, 2019).

- **Conservation** is an umbrella term for allowing a building to keep its cultural significance and will include methods such as preservation, restoration, reconstruction and adaptation.
- **Adaptation** is bringing minor changes to its layout beyond maintenance for a new function to keep up with the changing time. This is the best method to save a building from being replaced and remain relevant in a community and for future generations.
- **Preservation** keeps the building in its current state and protection it from rapid decline, by slowing the process of aging. This can include maintaining damaged sections of the building.

- **Restoration** removes changes to a building and turns it to its previous state, without adding new materials as reconstructions. While stylistic restoration allows for bringing in new materials for small reconstructions.

Through time opinions changed on what is preferred. The most influential theorists are discussed here.

Eugène Emmanuel Viollet-le-Duc (1814–1879)

Viollet-le-Duc is one of the founders of the restoration movement. Viollet-le-Duc asserted that the perfect function should be found for a building to minimize the need for adaptations (Yazdani Mehr, 2019). However for his main idea revolves around maintaining the zeitgeist (spirit of time) by emerging oneself into the mind of the original architect (Rouhi, 2016). His goal was to reinstate a sense of completeness that may not have existed before, going further than just preservation. These 'interpretive stylistic restorations' are seemingly original but allow the building to be restored and house a new function (Rouhi, 2016). The threat is that these additions can be mistaken for the original and alter the intangible values and memories of the building.

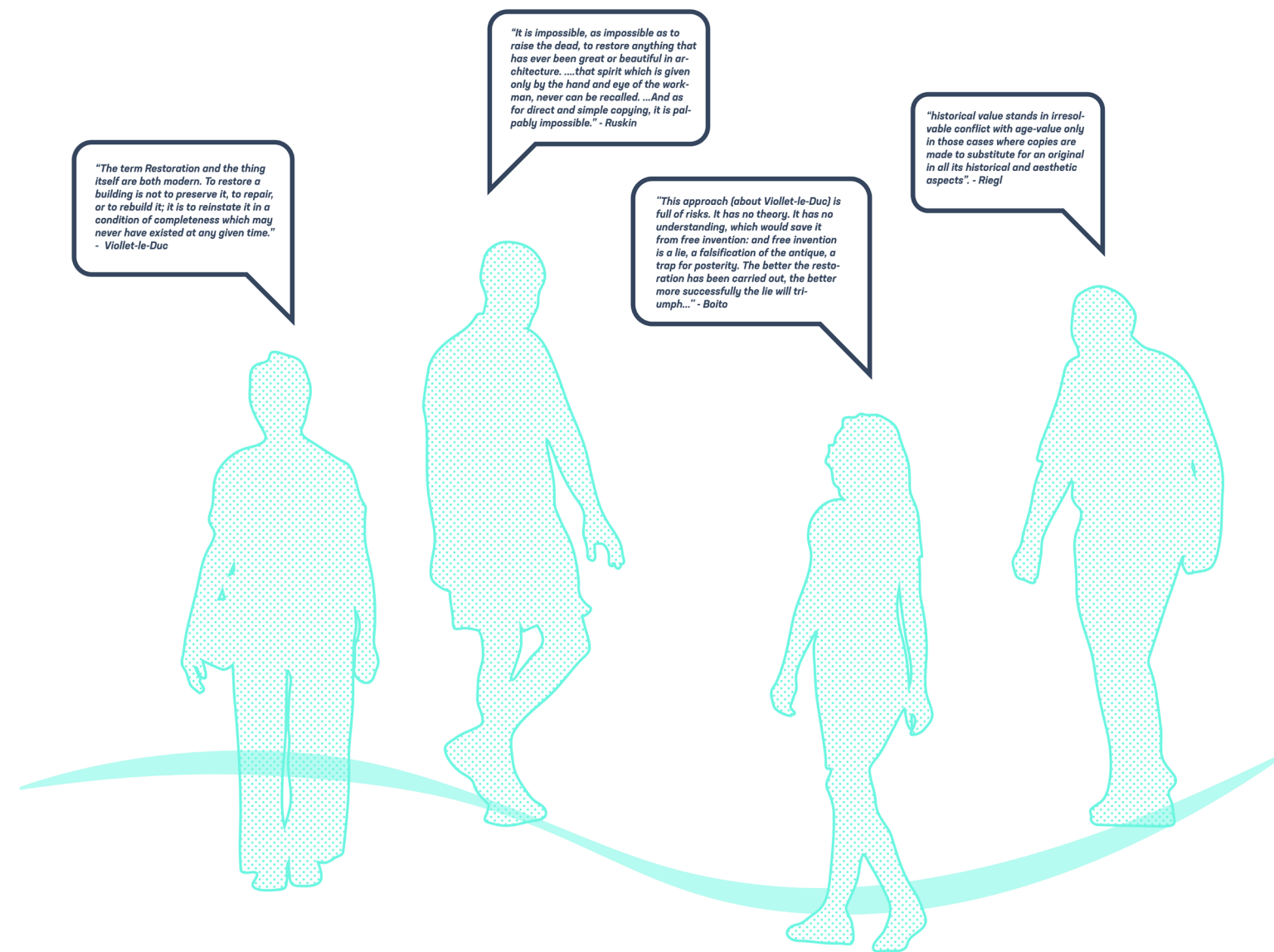


Image 11.4: Influential quotes from heritage theorists (Yazdani Mehr, 2019)

John Ruskin (1819–1900)

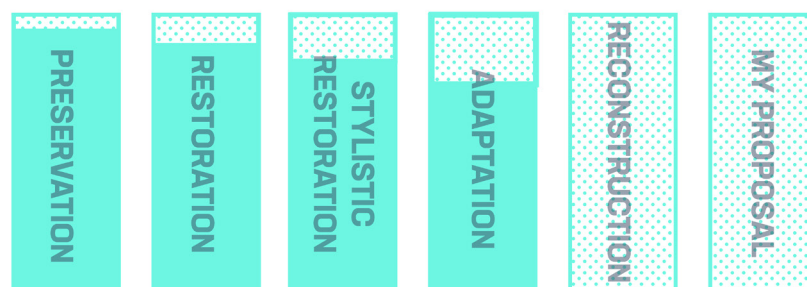
Ruskin was a leader of the Anti-restoration movement and highly critical of Viollet-le-Duc's stylistic restoration (Yazdani Mehr, 2019). His perspective put the emphasis on preserving the original design of a building withing the zeitgeist that it was constructed is, even going as far as comparing restoration to raising the dead. To him restoration was a complete falsification of history and only recommending proper maintenance (Rouhi, 2016). He views age as an value and restoration as destruction of historical authenticity.

Camillo Boito (1836–1914)

Boito followed and yet also critiqued both Viollet-le-Duc and Ruskin, stating that they risk falsification and deem the building to disrepair respectively (Yazdani Mehr, 2019). In his view, stylistic restoration was allowed, but only if the

reconstructions we distinguishable from the original to prevent misunderstandings (Rouhi, 2016). Boito composed eight means through which this can be achieved (Yazdani Mehr, 2019).

- Stylistic contrast between the original and additions.
- Contrast between old and new materials.
- Suppression of profiles or decorations.
- Display of removed pieces next to the reconstruction.
- Engraved date on the addition.
- Engraved text on the addition.
- Documentation of the restoration through photographs or a publication.
- Spread the knowledge that it is not an original.



 = New material
 = Original material

Image 11.3: Levels of new material in heritage methods compared to this research.

Alois Riegl (1858–1905)

Riegl distinguished different values for heritage buildings that should all be considered in conservation efforts and are also at odds with each other. These are: commemorative values, age-value, historical value, intentional commemorative value, present-day values, use-value, art-value, newness-value and relative art-value (Rouhi, 2016).

Riegl weighs historical value and age value against each other and therefore disapproved stylistic restoration but Riegl also stated that modern maintenance such as painting would result in a loss of historic value and small faithful reconstructions were acceptable (Yazdani Mehr, 2019).

Falsification?

To make many of the visibility interventions possible, a structure needs to be brought back or imagined and these different heritage theories become relevant once again and can be reflected upon to determine where my designs stand (image 11.4).

Viollet-le-Duc immersed himself in the original architect by creating 'reconstructions' in the spirit of the era. These structures are not original, but seem this way and are therefore deemed falsifications and fabrications of history by other theorists. This is not encouraged in any of my methods and also in none of my designs. For example the visibility method called 'Add on' is not a reconstruction in the zeitgeist, but one in the modern needs, issues and a yearning from the collective memory.

Even on the Kopse Hof where a pure reconstruction is preferred by the survey, it is highlighted as fake with exhibitions of findings within the methods of Boito. Moreover knowledge will be shared about the building, creating notoriety that it is not original. It can be argued that the reconstructions will never be close enough to the original and can hardly be mistaken for 2000 year old structures. In the future however this fact can get lost if it is not clearly stated. In these designs there is also no age value present and they all consist of purely new material just as reconstructions do, but they are still different in their newness value (image 11.3)

It is however important to still have reconstructions, even if they can be mistaken for original, since the knowledge of what has passed and by mimicking it can be underlined (Ireland, 2016). In the design for the aqueduct bridge I projected arches which probably did not exist in the wooden structure, but it is recognizable and with little remains the true appearance is still a mystery. Therefore design can also play with this fact and add elements like fountains to emphasize that it is a fake.

UNESCO themselves also seek to prevent outright falsification and promote restoration (Rouhi, 2016). At the same time they encourage design interventions with innovative technologies. Maybe a new name should be coined for bringing back old structures in aiding current goals; for example "Adaptive reconstruction"?

12.

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13.

APPENDIX

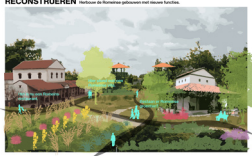
Other files

Files of further research behind what was shown in the report. For example the water balance and the other categories that were looked at during the questionnaire. These results of the survey are shown in this chapter in the form of rankings of scores.

Image 13.1: Simplified calculation of the runoff during heavy rainfall.

UNDER average age of 31

35

1		3,83
2		3,63
3		3,51
4		3,14
5		3,25
6		3,20
7		3,14
8		2,97
9		2,94
10		2,91

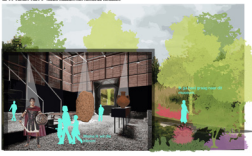
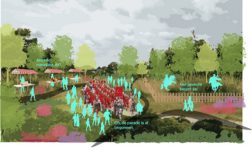
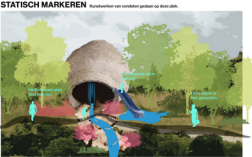
-0,2 higher

- 0,3 higher

Image 13.2: Scores for the questionnaire by category

ABOVE average age of 31

35

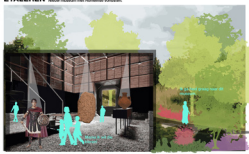
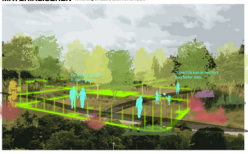
1		3,88
2		3,83
3		
4		3,20
5		3,11
6		3,05
7		3,00
8		2,97
9		2,74
10		2,46

0,3 lower

0,2 lower

VISITED THE MASK

36

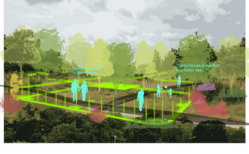
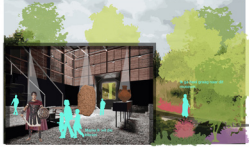
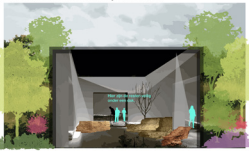
- 1  3,78
- 2  3,73
- 3  3,30
- 4   3,19
- 5
- 6  3,03
- 7  3,00
- 8  2,97
- 9  2,78
- 10  2,65

0,2 lower

-0,2 higher

VISITED 5+ ROMAN SITES

31

- 1  3,71
- 2  3,61 0,2 lower
- 3  3,26
- 4  3,13
- 5  2,97 0,2 lower
- 6  2,84
- 7
- 8   2,77 0,2 lower
- 9  2,68 0,3 lower
- 10  2,45 0,3 lower

LIVING IN NIJMEGEN

36

- 1

CONSERVEREN

Plaats met architectonische opmerkingen



3,75
- 2

RECONSTRUEREN

Verbreiden de bestaande gebouwen met kleine huizen



3,64
- 3

MATERIALISEREN

Verbreiden de bestaande gebouwen met kleine huizen



3,28
- 4

ACTUALISEREN

De bestaande omgeving veranderen in een woonwijk



3,28
- 5

BRANDING

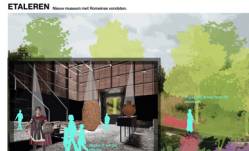
Plaats met architectonische opmerkingen



3,11
- 6

ETALEREN

Verbreiden de bestaande gebouwen met kleine huizen



3,05
- 7

STATISCH MARKEREN

Verbreiden de bestaande gebouwen met kleine huizen



2,92
- 8

FLEXIBEL MARKEREN

Verbreiden de bestaande gebouwen met kleine huizen



2,86
- 9

OMHULLEN

Verbreiden de bestaande gebouwen met kleine huizen



2,83
- 10

INPASSEN

Verbreiden de bestaande gebouwen met kleine huizen



2,69

0,2 lower

VISITORS KOPSE HOF

22

- 1

CONSERVEREN

Plaats met architectonische opmerkingen



3,45
- 2

RECONSTRUEREN

Verbreiden de bestaande gebouwen met kleine huizen



3,41
- 3

ACTUALISEREN

De bestaande omgeving veranderen in een woonwijk



3,05
- 4

MATERIALISEREN

Verbreiden de bestaande gebouwen met kleine huizen



2,91
- 5

FLEXIBEL MARKEREN

Verbreiden de bestaande gebouwen met kleine huizen



2,86
- 6

ETALEREN

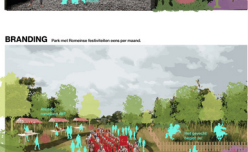
Verbreiden de bestaande gebouwen met kleine huizen



2,77
- 7

BRANDING

Plaats met architectonische opmerkingen



2,68
- 8

STATISCH MARKEREN

Verbreiden de bestaande gebouwen met kleine huizen



2,40
- 9

OMHULLEN

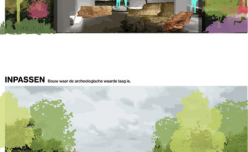
Verbreiden de bestaande gebouwen met kleine huizen



2,36
- 10

INPASSEN

Verbreiden de bestaande gebouwen met kleine huizen



2,27

0,4 lower

0,6 lower

0,6 lower



Acknowledgment

To conclude my report I would love to thank some people who supported me through this process and got me to where I am today. First and foremost I want to thank my mentor Gerdy Verschuure-Stuip for patiently pushing me into the design process when I was mentally struggling. And my second mentor Fransje Hooimeijer for patiently answering all my questions related to water and sustainability.

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