COLLEGE MAASLAND

TU Delft MSc Architecture
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COLOPHON

This document is a Master's Thesis for the completion of the Master of Architecture at the Delft University of Technology

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Title:	**College Maasland**
Research Title:	**Adaption through architecture** Architecture as a medium between a landscape and its community.

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Figure 1: *Cover image: Concept design perspective (Image by author)*

PREFACE

This book is the final product of my graduation project for the study architecture at Delft University of Technology. It describes the design and research process for developing a housing project for students in the landscape of Midden-Delfland as envisioned by architecture firm ZUS in the plan: *'National productive park Delfland'*. Starting in the fall of 2023 until the summer of 2024 I was working on the research and the design for this graduation project.

During previous work experience I worked mainly on housing projects. Designing space for people to live was my main motivation for continuing my studies into architecture. I found the studio question of '*How do we live together with water?'* to be an intriguing one. In the Netherlands water is always an issue, from storm floods to creating polders. Also looking at the future, with climate change, water will become even more of a threat in the Netherlands. However, the framing of the studio question made me think of a harmonious way of living with water and adapting to its changes. This thought led me to develop this plan called *'College Maasland'*.

I want to express my gratitude to Olv Klijn for his mentoring this past year. During mentoring sessions, Olv helped me gain different perspectives on design questions and motivated me to keep developing ideas even when I thought I was finished. I also want to thank Ruurd Kuijlenburg for is technical expertise and insight. Because of my background in engineering, I approached technical design in a practical way. Ruurd thaught me to create design principals for the technical design based on the architectural values of the project. Creating a more coherent and well-rounded design. Lastly, I want to thank Alejandro Campos Uribe for his advice during the research phase of my graduation.

I hope you enjoy your reading.

Cas Castenmiller,
Haarlem, 1st July 2024

CONTENTS

CONTENTS
(CONTINUED)

ADAPTION THROUGH ARCHITECTURE

ARCHITECTURE AS A MEDIUM BETWEEN A LANDSCAPE AND A COMMUNITY.

Figure 2: *Location model (Image by author)*

ABSTRACT

This thesis addresses the challenge of designing architecture which fosters student communities while integrating with a wetland landscape. It explores the environmental and social implications of transforming the peat polders of Midden-Delfland in the Netherlands, which are subsiding and emitting significant amounts of CO_2. The thesis builds on the masterplan by the architecture firm ZUS, which proposes converting these polders into a green buffer zone, combining productive landscapes with urban parks and wetlands to halt subsidence and CO_2 emissions.

The primary research question is: "*How can architecture create a place for student communities that connects to, and protects from, its surrounding wetland landscape?*" This is divided into two sub-questions: one focusing on the design of student community spaces and the other on integrating architecture with wetland environments.

Through literature review on student housing, different urban concepts and the preferences and needs of students in student housing are defined. With case study analysis of projects that have a close relationship with a wetland landscape, the thesis identifies design strategies that protect and connect architectural spaces to water landscapes.

Key findings suggest that there are two main urban concepts for student housing, college, and campus design. For students housing proximity to school complexes are important, as well as dwelling floorplans that are practical and mix private bedrooms with shared facilities and common spaces. Creating raised living planes and incorporating landscape features into design can effectively protect residents from and connect them to changing water landscapes.

This research contributes to the broader understanding of sustainable architectural practices in wetland areas, providing insights into how to design adaptive and resilient community spaces.

KEYWORDS

Architecture | Student housing | Wetland | Adaptability

INTRODUCTION

CAUSE

The peat polders of Midden-Delfland are subsiding and in doing so they emit a lot of CO_2 gas into the atmosphere (Fritz, 2014). A one-centimeter annual decline in elevation corresponds to an annual emission of roughly 22.6 tonnes of CO_2 per hectare (Verhagen et al., 2009). This means that per centimeter of subsidence the Commandeurspolder emits 744.331 tons of CO_2 per year. The area is also one of the lowest areas in the Netherlands with depths up to 6.5 m below sea level, and due to the subsidence these levels will sink even lower. In the Paris climate accords goals for the minimalization of greenhouse gas emissions are agreed. Due to the emittance of greenhouse gasses by these subsiding polders, stopping the subsidence helps reaching these goals.

The architecture firm of ZUS developed a new master-plan (figure 3) for the area of Midden-Delfland, as part of the research group for the Redesigning deltas Study. In this master-plan ZUS proposed to keep Midden-Delfland as a green buffer between the urban areas of Rotterdam and Delft. They proposed to create a productive landscape with forests for wood harvesting and food production, urban parks, and classic Dutch polders for agriculture. ZUS also wants to flood a large part of the landscape (light green areas) and create a wetland area, to divert stormwater and store fresh water for the urban centres lining the boundaries of Midden-Delfland. Although studies have shown that freshwater storage in peat polders does not work as well as the architects hoped (ZUS, 2022), reintroducing water into these areas will stop the

 Figure 3: *Masterplan ZUS*

subsidence of the land, and with that stop emitting CO_2. This couls also help in re-growing peat in the area, and will capture vast amounts of CO_2.

By changing the landscape, most of the farmers in this area will have to stop their business or relocate, because the current way of farming is unsustainable. However, by changing the type of farming from keeping cattle to a farming practice based on Paludiculture (wetland farming on peat lands), the farmers can stay and keep using the ground in a new way. Keeping the wetland area of the master-plan still a productive part of the landscape. This will however take a lot of knowledge about the new landscape, and education of farmers will be a key aspect to changing the farming landscape.

PROBLEM STATEMENT

The master-plan of ZUS is an ambitious plan that will sacrifice large amounts of (agricultural) land. With stopping the subsidence by creating a wetland, current villages in the area will become difficult to maintain and expand. Therefore, they will need to adapt to the new conditions without losing the community that has formed within these villages. In their plan, ZUS currently has no method of adapting these sites to the new landscape.

Not only current villages will need to change, but new developments also need to be designed to be adaptable to the new landscape. Because the wetland area will be used as a floodplain for the large rivers and excess water from the cities, the conditions of the site will change during the year. This means that the building should not only be designed for a wet landscape, but also for a flooded, or a completely dry one. It needs to be adaptable and function in all these different environments without becoming an island for its residents.

ZUS also has not proposed a plan to keep an agricultural presence in the new wetland area. In the west of the master-plan, right next to the village called Maasland, a trade school for agriculture is located. This school is currently located in a polder that is planned to become wetland area. By adding a Paludiculture track to the current curriculum, students can learn about cultivating crops in wetlands and practice it in a real landscape. To create a better connection to the landscape, students should be living in the landscape they study. This is a new development as described in the previous paragraph.

RESEARCH QUESTION

The question for the design of a new development in the wetland area, is not only a technical question about how to design a building that can withstand a flooded landscape, but also should embody a conceptual design ideas such as how do buildings interact with the changing water, and how student communities are enabled to share spaces and convene in these buildings. This research will provide a better foundation to design in or around wetland areas and floodplains.

Therefore, the main research question of this thesis is:

How can architecture create a place for student communities that connects to, and protects from, its surrounding wetland landscape?

To answer this question the main research question is divided into two seperate research sub-questions:

1. How can architecture create a place for student communities?

2. What are ways to connect architecture to and protect architecture from a wetland/water landscape?

THEORETHICAL FRAMEWORK AND METHODS

The first research question aims to find a design approach for spaces used by students that foster communities. To answer the first research question, different literature sources will be reviewed and compared. Relevant sources contain information about designing architecture for communities/groups of people (focusing on students), or sources that describe different spatial qualities of designs for students.

The second research question aims to find different frameworks for designing architecture in the context of wetland, floodplain, or water landscapes. To answer this research question different case studies will be analysed and compared on their connection and relation to the surrounding landscape and the connection with the water. Also meeting spaces for the residents (and their connection to the landscape) will be taken into account. Projects that qualify as case studies should have different approaches to designing in a wetland, floodplain, water landscape.

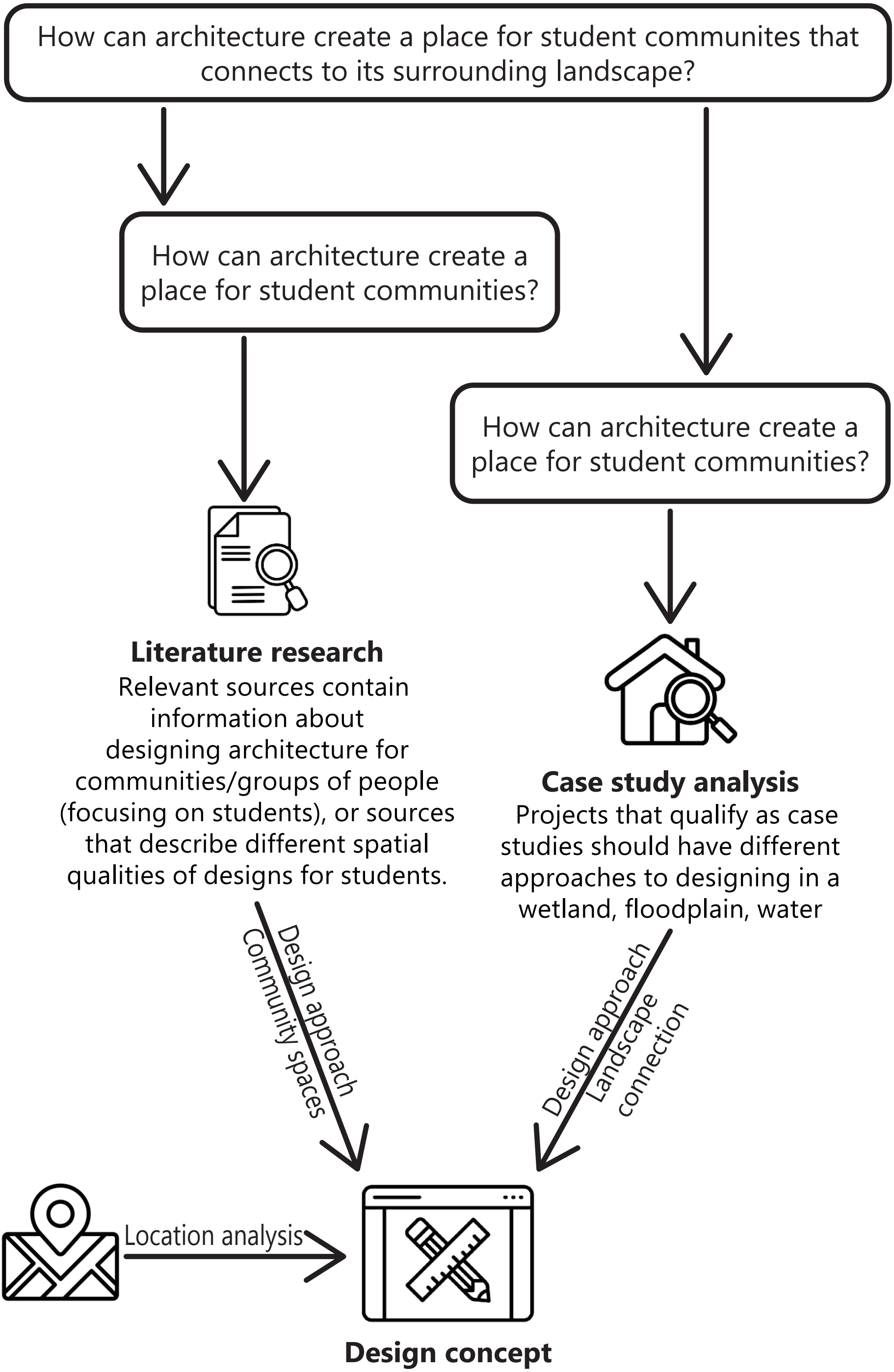


Figure 4: *Research diagram*

STUDENT HOUSING

URBAN DESIGN CONCEPTS

In the Dash article “College vs Campus” by Dick van Gameren (2018), the different concepts and implications of college and campus environments for higher education are explored. Van Gameren looks into the spatial, social and architectural distinctions between the concepts of the traditional college and the modern day campus. The author starts by explaining that nowadays the term of campus has become a generic term for any collection of university buildings regardless of typology. For clarity the term ‘campus’ in the context of this research will be referring to the typological campus of American style university complexes.

The traditional English colleges, like those in Cambridge and Oxford, have a close relation with their cities. Located in the city centre, the buildings merge with the urban fabric, shaping the city. Because of this close integration with the city, the college and the local community are closely connected and often interdependent. Because of the connection with the city, college complexes are located closely together and have a compact shape. This proximity encourages frequent interactions among students and faculty, creating a strong sense of community and belonging. In addition, most colleges have shared housing on site. This shared housing enforces the feeling of community and a home-like environment.

The historic nature of most European colleges is also visible in the architecture. Many colleges feature historical buildings with architectural styles reflecting their long heritage. The architecture often includes traditional elements such as courtyards, cloisters, and quads, contributing to a sense of continuity and tradition. To add to this close connection between the college and its community, many spaces within colleges are often multi-functional, serving various purposes such as academic, residential, and social activities. This versatility allows for more dynamic use of

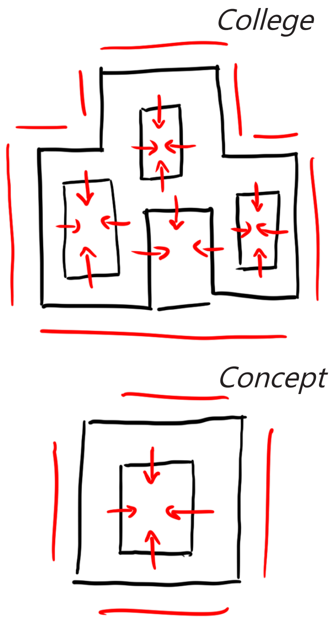


Figure 5: *Diagrammatic analysis college*

space and resources.

The cloister structure of colleges, with a mainly inward focus on the courtyards, further fosters this sense of community. The mix of residential and educational spaces around the multifunctional courtyards creates chance encounters and a personal level of connection between the faculty and its students. The multifunctionality of the courtyards also creates a dynamic use of space where communal experiences can flourish.

The university campus design is a more modern concept. A campus is typically located on the outskirts of a city, on a large plot of land. They are designed to be self-contained, providing all necessary facilities within the campus boundaries in an open and outward facing landscape. Zoning plays a large role in the campus design. Creating different zones for education, dwelling, recreation and administrative buildings. The layout is often carefully planned with a large and open green spaces and transportation network connecting the different zones. This zoning is also used for a community structure. Living on campus creates a residential community, and the shared living experience creates a home-like environment. In addition, campuses have different buildings for different activities, and often have large dinner and sporting facilities. This is used by all students and therefore creates areas for people to meet and connect.

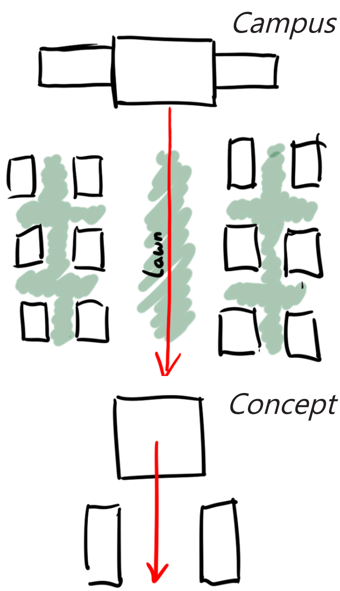


Figure 6: *Diagramatic analysis campus*

The preplanned nature in combination with the location of most campuses, contributes to the architectural expression of a campus. Buildings feature a mix of architectural styles, with a focus on modern and contemporary design. Because most campuses are located on the edges of a city, and designed to be self-contained, campuses are designed with ample space for specialised facilities, such as sports complexes, student centres and research labs.

Comparing the two different types of university housing, the first large difference between the two is scale. Colleges have a compact and diverse character, embedded in a city. Campuses on the other hand are expansive self-contained complexes with distinct zoning of functions, on the border of a city. This difference in scale is also visible in the approach towards community building. College design focuses on creating close-knit communities through proximity, multifunctional spaces and inward facing buildings, concentrating on the courtyards. Campuses provide different facilities and large open spaces, fostering a broader sense of community among students. The architecture also plays a role in this due to the history of colleges; the older buildings give a strong sense of identity to the students and staff. The more varied and modern design of campus buildings create a different atmosphere for students.

STUDENT PREFERENCES ON STUDENT HOUSING

Research done for the city of Trondheim Norway, surveyed the students in the city on their satisfaction with their student housing. From the results it identifies four main design elements of housing satisfaction among students. These are 1. Type of tenancy, 2. Location, 3. Housing characteristics and 4. Individual facilities. A research paper, published by the TU Eindhoven, about student housing preferences (Nijënstein et al., 2014) has found that students studying in the Netherlands view the same topics as most important with the addition of Social environment and Housing cost.

The Norwegian Research identifies two main types of tenancy; Institutional housing (by the university or large corporation) and privately owned. The results show that institutional housing is preferred by students. This is because institutional housing is perceived to be more secure and of a better quality than student housing on the private market. However, due to long wait times in the Netherlands there is some negative sentiment towards corporate housing providers (Nijënstein et al., 2014). The maintenance of student houses on the private marked also leaves something to be desired. This gives the private market a negative reputation amongst students (Adressa, 2012). A common critique of the institutional student housing is a lack of variation. This standardisation is not present on the private market.

Another significant impact on student satisfaction with their housing, is the proximity to the campus (school complex) and/or the city centre. Both studies show students report a higher tendency to choose a student house when it is close to the school complex or the city centre. In places that are both close to the city centre and close to the school complex, the number of student houses will increase. Inevetably this creates backlash from existing homeowners, when a large number of students come live in the area. Therefore, placement of student housing project should be well planned and controlled by the municipality.

Student satisfaction is also influenced by the characteristics of the house. Thomsen and Eikemo (2010) identify four main elements that are of significance influence. The most important is the size of the dwelling. Although no specific sizes where given, rooms should have an adequate size. More importantly students report that the floorplan should have a logical and practical layout. Secondly, the amount of daylight entering the dwelling has a considerable influence. Also, the ability for students to add their own style to the dwelling has a significant improves the satisfaction. A negative influence on the satisfaction is an institutional character. *"An example shows that a corridor solution in a residence is described as sterile, impersonal and with too many closed doors (Figure 7), which the students associate with an institutional nature"* (Thomsen & Eikemo, 2010). Lastly the modernity of the dwelling. The results of both studies show that newly built or recently renovated buildings have a significantly higher level of satisfaction amongst students. Student housing should not only deliver basic living needs, but also provide an environment for personal and academic growth.

Figure 7: *Bjølsen, student housing in Oslo, corridor (Thomsen & Eikemo, 2010)*

Thomsen's and Eikemo's (2010) research also looked at individual facilities, like a bathroom and kitchen, and found that there are no significant effects on student satisfaction. Another explanation for these results, according to the research, is that students would prefer a private bathroom and kitchen, but consider them less essential than other housing characteristics like a common entrance. The research done by Nijënstein et al. (2014) shows that students in the Netherlands prefer housing that offers private bedrooms within shared student houses or complexes. This setup provides a balance between personal privacy and opportunities for social interaction. The housing units typically include communal living spaces that facilitate a sense of community among students while ensuring they have their own personal space.

The design of the social environment has a significant impact on the success. Students highly value communal spaces that encourage interaction and socialization, such as shared kitchens, living areas, and study rooms (Nijënstein et al., 2014). These spaces are essential for fostering a sense of community and belonging among residents. The ability to engage with peers and build social networks is a key component of the overall student living experience, making the design and provision of communal areas a priority in student housing developments.

Housing cost is a significant factor in student housing preferences. Students seek affordable rent, which is a primary consideration when choosing housing. Balancing cost with the quality and location of housing is crucial, as students often have limited budgets but still desire convenient and well-maintained accommodations (Nijënstein et al., 2014).

Student housing organised and owned by a large organisation is preferred by students, so long as the housing is diverse and does not have an institutional character. Student houses are preferably located close to the school complex or the city centre. The dwellings should have a practical floorplan, get ample daylight, and creates space for the personal character and development of the residents. Students have a strong preference for well maintained and modern housing. Creating dwellings with private facilities such as a private kitchen and bathroom are not significantly better liked than dwellings with shared facilities. Creating private quarters (like a bedroom) in combination with communal areas fosters a sense of community among the students. The affordability of a house is one of the primary considerations for students. Balancing these elements is essential for creating fulfilling living environments that support student well-being and academic success.

CONCLUSION

This chapter answered the first research sub-question:

How can architecture create a place for student communities?

Multiple literature sources have been studied on the topics of urban planning of student housing and school design, and the needs of students in student housing.

For the urban planning two different concepts stood out: 1) The college design, focusing on close-knit student communities created by multifunctional spaces, as well as proximity to school and residential buildings incorporated in the cities urban fabric. And 2) Campus design, which uses a large plot of land on the border of a city for a self-contained and zoned urban plan. Each zone houses different facilities of one specific type.

Students report to have a strong preference for well-maintained housing close to the school complex and the city. Dwellings should have good daylight and a practical floorplan with space to develop and display the personal character of the residents without having an institutional character. Sharing facilities like kitchens and bathrooms is no issue, however, a private bedroom and study space is needed.

RE-PEAT *ANASTASIIA SOSHNIKOVA*

The Re-Peat project is a master project from the Technical University of Berlin, designed by Anastasiia Soshnikova. The project addresses degradation of the Dutch peatland (subsidence) and researches ways to stop this whilst using the land for future expansion plans by settlements. There is a close relation between the subject of the project and this thesis. However, the research of the master project mainly focusses on system changes to the landscape, not on the design approaches.

Figure 8: *Re-Peat Section (Soshnikova, 2023)*

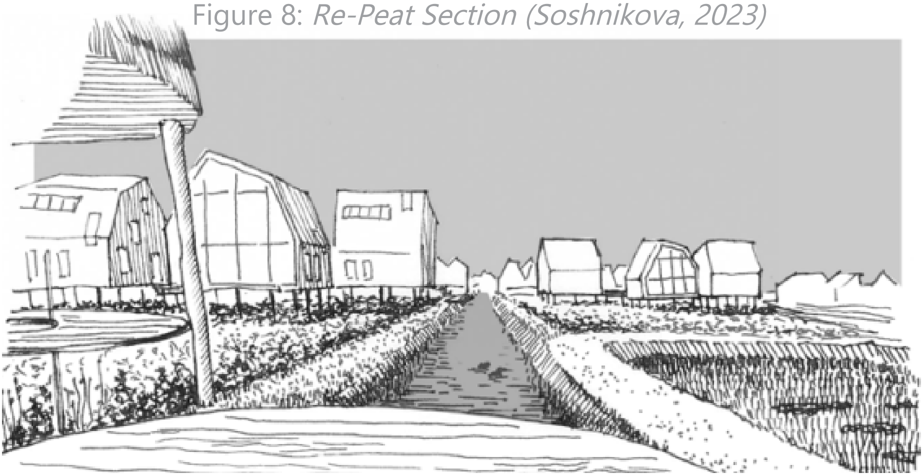


Figure 9: *Re-Peat Sketch (Soshnikova, 2023)*

Figure 10: *Re-Peat Sketch (Soshnikova, 2023)*

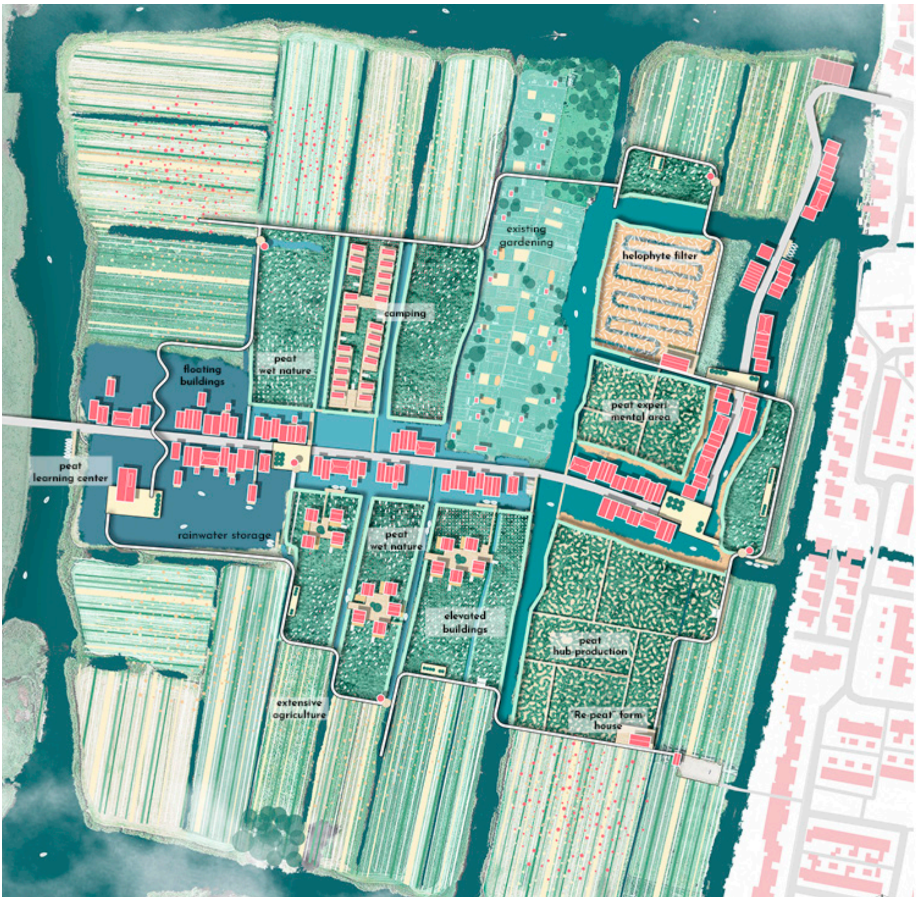


Figure 11: *Re-Peat Masterplan (Soshnikova, 2023)*

STRUCTURE

By studying different approaches of land use for revitalising the peat landscape, and combining these together in different configurations a balanced landscape is created with room for settlement. Each of the land-use concepts has its own type of housing attached. Such as; floating houses, raised houses, and bio based buildings. These dwellings are placed in clusters per type on the site. Each location has unique conditions that correspond to the land use approach for each housing type. In figure 12 the different land types are shown and their respective housing types.

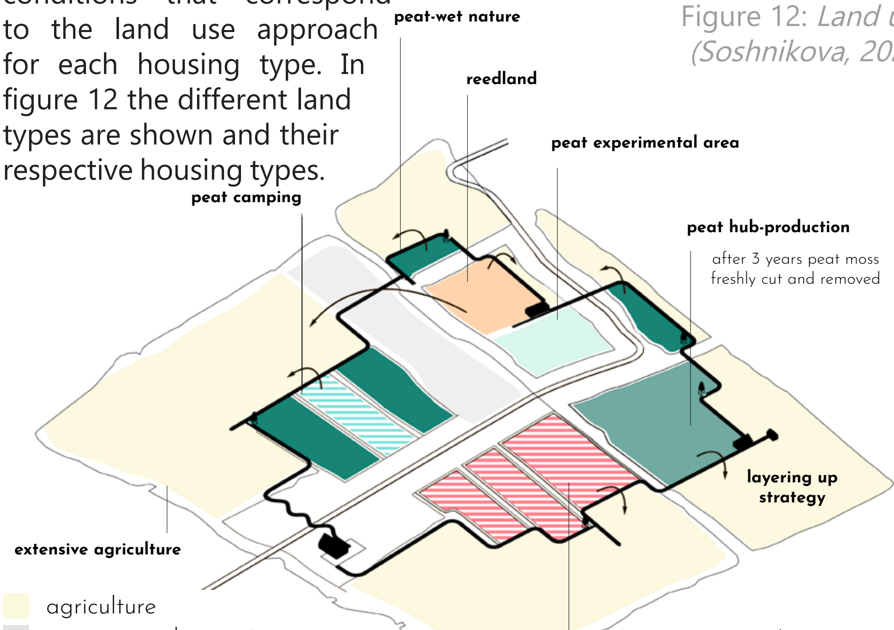


Figure 12: *Land use (Soshnikova, 2023)*

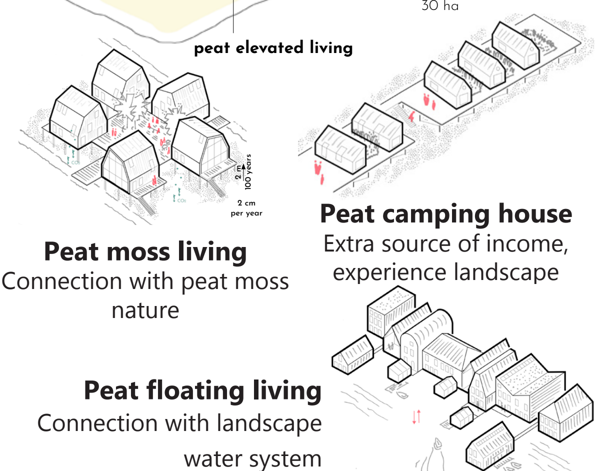


Figure 13: *Housing types (Soshnikova, 2023)*

CONNECTION WITH THE LANDSCAPE

The landscape strategies all call for a different housing type (figure 13). These building connect to their landscape in different ways. The houses that are built in the area that facilitates Paludiculture, bio-based houses are designed. They connect the dwelling to the landscape and give the residents a direct connection to the landscape. To strengthen the water system in the new landscape, more space for a 'boezem' is created. The housing typology for this strategy is a floating village, connecting the residents to the water landscape around the new polder landscape. Lastly an area for peat regrowth is created. Dwellings in this area are built on stilts, so that the peat can grow underneath the buildings. The buildings are lifted 2 meters above the ground. With a peat growth of 2 cm each year, the buildings are lifted above the ground for a century before the ground level surpasses them.

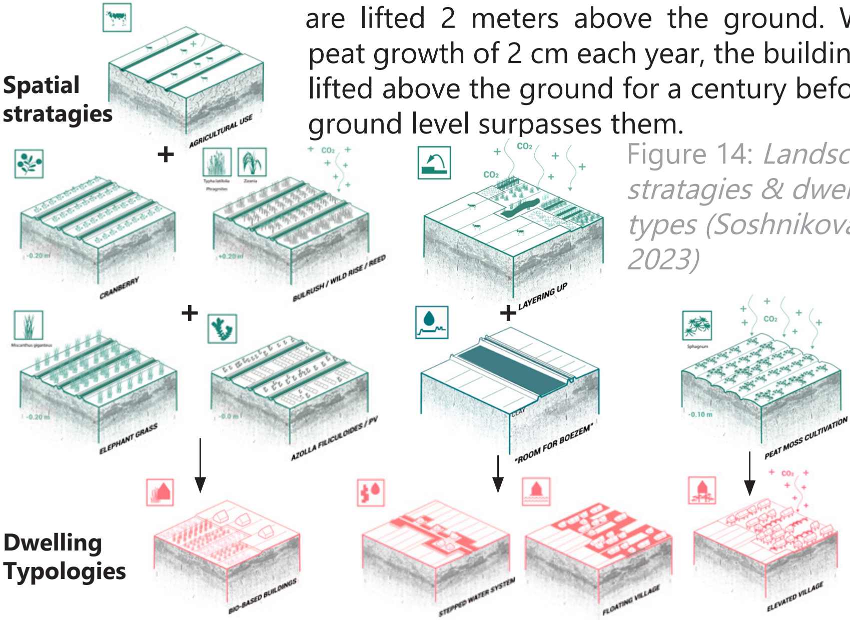


Figure 14: *Landscape stratagies & dwelling types (Soshnikova, 2023)*

PLACE FOR COMMUNITY

The project creates clusters of buildings, these clusters share similar building characteristics. Also it recreates the village street, and little squares to connect the residents of the project (figure 14).

ADAPTABILITY TO CHANGE

Because there are different strategies applied, they react differently to a changing landscape. However, they are all designed to combat the changing landscape, by floating, having a lightweight foundation or being lifted on stilts. Each building type is in its own area where it is capable to adapt to the change that is expected for that area.

SCHOONSCHIP *SPACE & MATTER*

Figure 15: *Schoonschip image (Space & Matter, 2008)*

Schoonschip is an urban plan by Space & Matter, in close collaboration with the residents of the project. The project was set out as a private collective commissioning by residents. The forty-six dwellings are self-built, and float on a side channel of the IJ lake in Amsterdam.

The collective had three main requirements for their project. It had to 1) house a diverse group of people, 2) be designed to be sustainable and environmentally friendly and 3) the project had to create a valuable place for its community.

Figure 16: *Schoonschip Jetty (Space & Matter, 2008)*

Figure 17: *Schoonschip perspective (Space & Matter, 2008)*

STRUCTURE

The project consists of five jetties in the shape of a 'T' extending the public space onto the water. The tops of the T's are connected to each other to create a street on the water. Each jetty connects six dwellings that are slightly rotated from the jetty to optimize the view over the water. To create a diverse community, different housing types were designed in the masterplan. from smaller volumes to large family dwellings.

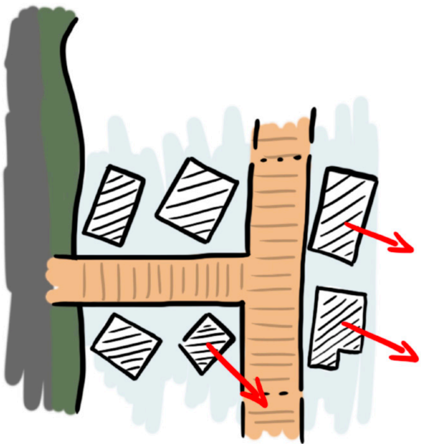


Figure 18: *Jetty structure*

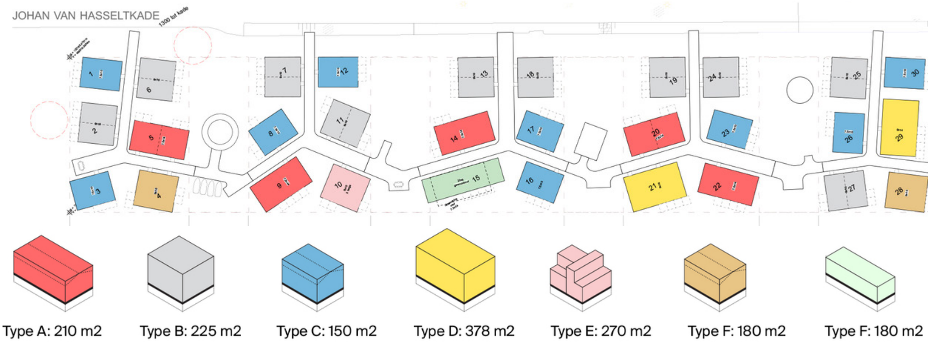


Figure 19: *(Space & Matter, 2008)*

CONNECTION WITH THE LANDSCAPE

Because the buildings are all boathouses, their only physical connection to the landscape are the mooring poles. These make sure the dwellings stay in their place.

However, the buildings also touch the water that they float in. Because of this nature, the buildings all have a hollow concrete box as a base. On top of this base the visible part of the building is built. The materials for the façades are wood cladding with large window openings to

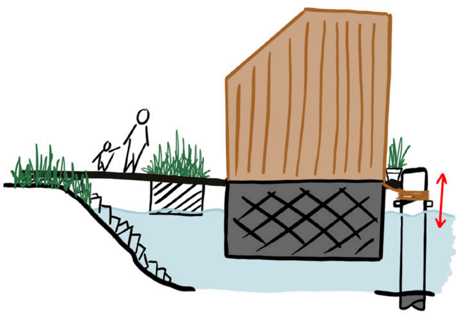


Figure 20: *Schoonschip section*

take in the view. Because of the self-built nature of the project multiple architects worked on the different dwellings.

Each project was commissioned by the resident. Between the buildings the wooden jetties are decorated with potted plants and also water plants on the outside of the jetty in the water. This creates the idea of a floating park between the houses. There are also jetties for boats to moor and to climb out of the water. This also furthers the connection between residents and the landscape.

PLACE FOR COMMUNITY

Due to the involvement of the residents in the development of the project, there was a common goal and aligned values for a community. One of the pilars of the urban plan by Space & Matter, was to design places for a community. therefore, the public space was designed to facilitate casual encounters between residents on the Jetties. By creating this space, the community can meet and connect with each other.

Figure 21: *(Space & Matter, 2008)*

ADAPTABILITY TO CHANGE

Because the dwellings are boathouses, they float and move with the water level. It might be a problem if the water level would drop so low that the bottom of the boat hits the ground, but with the water connected to a large lake, this case isn't likely to happen.

The neighborhood is also entirely self-sufficient. Creating its own power and dealing with waste water disposal. This creates a model for how to deal with larger scale issues connected to climate change

On a small scale, Schoonschip explores and applies innovative solutions to some of the most pressing challenges brought forth by climate change. (Schoonschip — Space&Matter, 2021)

XIXI WETLAND ESTATE *DAVID CHIPPERFIELD*

The Xi Xi wetland estate is a residential project located in the Xi Xi national park in China. Designed by the Berlin and Shanghai office of the British architecture firm.

 Figure 22: *(David Chipperfield architects, 2007)*

Figure 23: *Masterplan ((David Chipperfield architects, 2007)*

The project consists of twenty duplex apartments, placed in a grid pattern. The location on the edge of the national wetland park sets the tone for the project. The buildings are placed on a solid plinth, surrounded by a 'water garden' which refers to the park surrounding the estate.

"The omnipresent relationship between water, landscape, and architecture is key to the atmosphere in Xi Xi" (Xi Xi Wetland Estate, n.d.).

STRUCTURE

When looking at the floorplan the grid structure seems obvious. However, this grid only exists in one direction. The buildings are all aligned on the red gridlines. On the blue access, there is only a general sense of structure. Because of the alternation between odd and even horizontal rows, one can make out four columns, but the buildings do align with each other. This obscuring of sightlines creates a more intimate space.

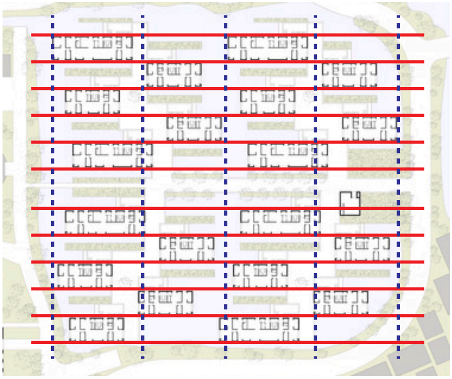


Figure 24: *Grid structure*

CONNECTION WITH THE LANDSCAPE

The rectangular buildings of dark stone are in stark contrast to the green wilderness of the water garden and the national part surrounding it. All buildings rise out of the water on a stone plinth. This plinth is continuous and houses the parking spaces for the vehicles of the residents. Above the water level the buildings are connected by the plinth which creates a pedestrian area. This is the basis for the village that the estate will create. By creating various levels and playing with sightlines through the placement of buildings, walls, and balustrades a sequence of exterior spaces is created.

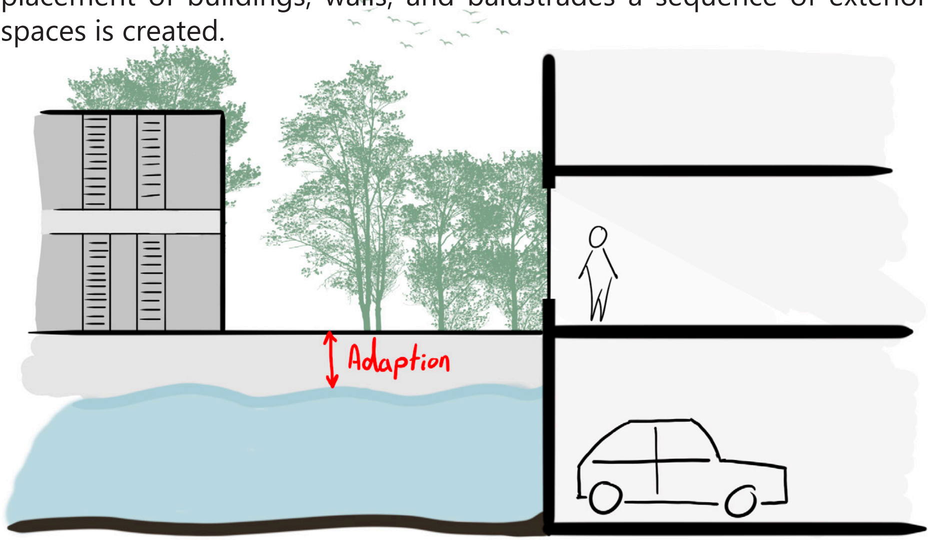


Figure 25: *Project section*

What is striking about this project is the contrast between the structure and the landscape surrounding it. The rectangular buildings, with minimalist detailing, stand to oppose the detail and fineness of the plants. They also rise out of the water as a solid mass.

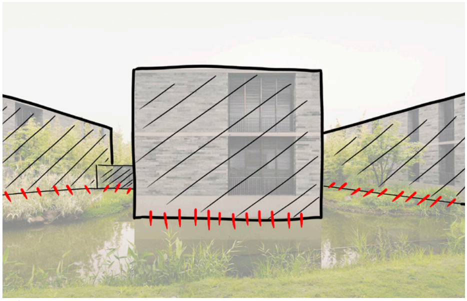


Figure 26: *Connection with landscape analysis (David Chipperfield architects, 2007)*

PLACE FOR COMMUNITY

The landscape surrounding and within the pedestrianised area creates a park like feeling, reflecting the surrounding national park. By playing with the grid structure, long sightlines are obscured, combining this with the use of different levels within the pedestrianised area and further obscuring elements like balustrades and low walls, enclosed outdoor spaces are created between the buildings. This creates different zones where residents can meet and connect.

Figure 27: *(David Chipperfield architects, 2007)*

ADAPTABILITY TO CHANGE

This project was designed to be a contrasting mass in the natural environment of the national park. With its monolithic masses and a connecting plinth it is very adept at keeping a clear distinction between nature and build environment whilst, also embracing the natural landscape by creating a close relationship with the water and wetland plants close to (or right next to) the buildings. This balance of distinction and embrace however, is a weakness when it comes to a change in the surrounding landscape. When water levels rise past the plinth of the buildings, the pedestrian area will be flooded. On the other hand, if the water level drops the close connection with the surrounding landscape will be weakened or lost entirely.

HAFENCITY *KCAP*

Havencity is a urban masterplan developed by KCAP architects. It is located in the old harbour harbour district of Hamburg Germany. KCAP developed a plan for the old dock areas which became floodprone due to rising sea levels. This masterplan has a size of 162 hectare and encorporates 2 km^2 of floorspace with a mix of functions (dwelling, office spaces, cultural hubs and public plaza's and promenades). The project started in the year 2000 and is still ongoing. For this casestudy one of the floodproof wharves is examined.

Figure 28: *Hafencity areal photo (KCAP, 2000)*

Figure 29: *Hafencity promenade (KCAP, 2000)*

Figure 30: *Hafencity flooded promenade (KCAP, 2000)*

Figure 31: *Hafencity masterplan KCAP (KCAP, 2000)*

STRUCTURE

The masterplan maintains the old harbour structure (figure 32), with buildings on eighter side of the wharf, and an acces road in the middle between the buildings. The old quaysides have been changed to a more public promenade whilst keeping the old harbour walls mostly intact. The plinth of the building has been made to be flood resistand (figure 33 & 34) by using shutters or creating window openings above the floodline.

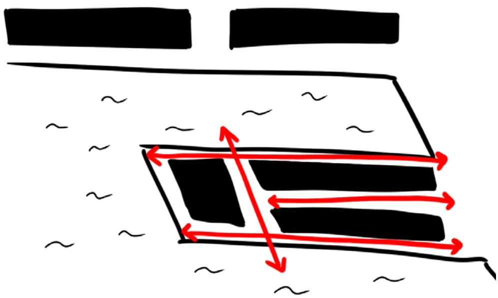


Figure 32: *Hafencity structure*

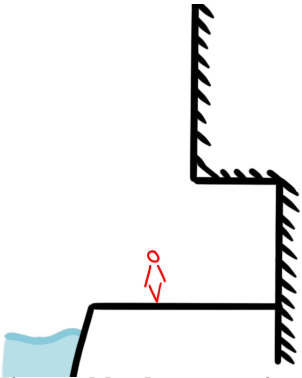


Figure 33: *Quay section*

Figure 34: *Hafencity Promenade (KCAP, 2020)*

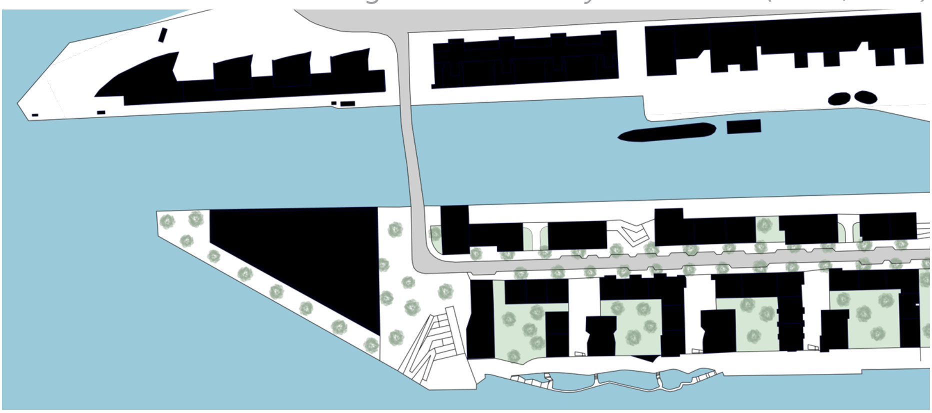


 Figure 35: *Hafencity wharf*

CONNECTION WITH THE LANDSCAPE

Hafencity is located in a very urban and industrialised area. Therefore the 'landscape' to connect with is different to the other casesudies. However, due to the danger of flooding, this project has a unique way of connecting to the water landscape it is surrouned by. Figure 36 shows a section of the different groundplains on the quay. By raising the middle acces road it is raised above the floodlevel. This keeps the buildings accesable, and operational in case of a flood. The lower pedestrianised promenades creates a closer connection to the water surrounding this harbour quay. This space is given up when a flood comes. The building plinth is made to be water tight, and openings are protected by shutters. or located above the floodline (figure 34 & 37).

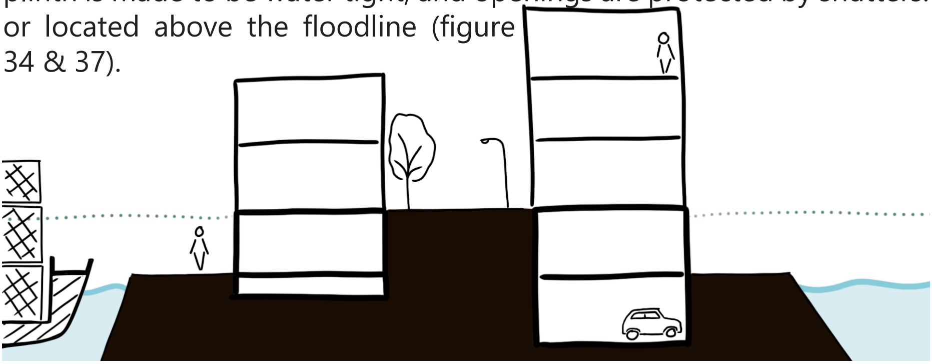


Figure 36: *Hafencity wharf section*

PLACE FOR COMMUNITY

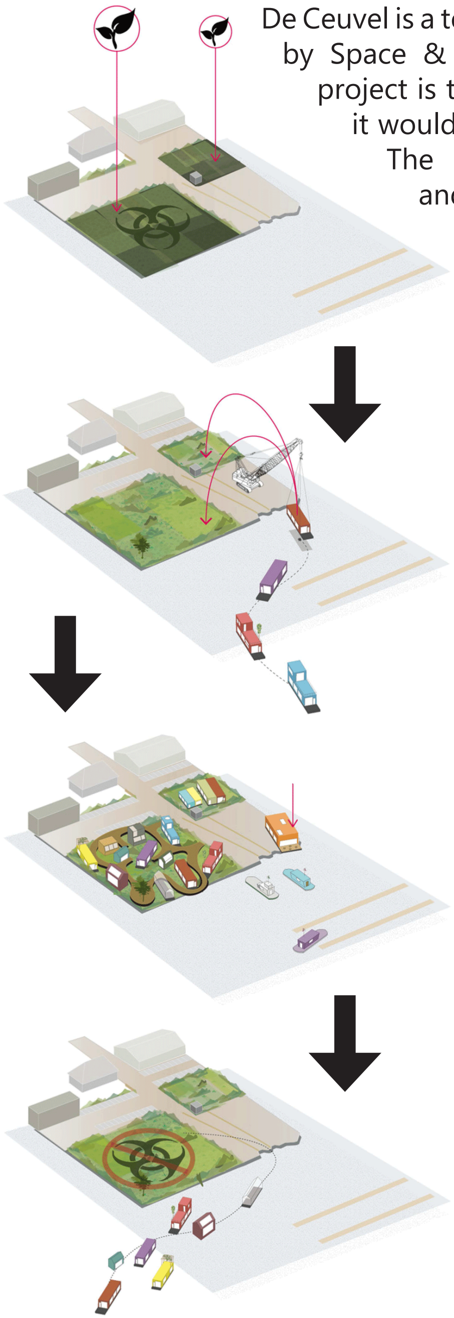
By creating pedestrianised promenades on eighter side of the wharf, a space for meeting is formed. Large openings between buildings as well as stepped plazas create a connection between the raised street level and the lower promenades. To make sure that the promenades and plazas became a place for strolling and meeting, restaurants with outside terasses are located as well as public benches. Due to the public connection, and large scale, these places are more a public than a common area in the masterplan.

ADAPTABILITY TO CHANGE

Because of promenades and plaza's that can flood and the floodproof building plinth the project can withstand the changing water landscape around it.

Figure 37: *Watertight shutters (KCAP, 2020)*

DE CEUVEL *SPACE & MATTER*



De Ceuvel is a temporary housing project developed by Space & Matter architects. The aim of the project is to keep the land in use even though it would be unusable due to contamination. The project consists of multiple boats and boat houses that are placed on a former shipyard. Because of the contaminated land, the ground is

Figure 38: *Project principals (Space&Matter, 2012)*

not to be disturbed. Therefore the boats are placed upon the soil, and connected with raised pathways separated from the ground level (Figure 39). This is a temporary project because next to the houses soil cleaning plants are planted, so that over time the topsoil will be contamination free and the plot can be used for other developments. De Ceuvel's polluted soil is purified with the use of phytoremediation techniques. A special set of plants are selected and used to break down and absorb pollutants in the ground. This process takes a decade to clean the entire plot. Research on the purification at De Ceuvel is conducted by the University of Ghent.

Figure 39: *(Space&Matter, 2012)*

STRUCTURE

The site is an L-shaped plot, surrounded by quays on 3 sides. The plot is an old shipyard with a concrete strip from the road to the quay. The narrow entrance of the site opens up to an open space and the quay side beyond. The rest of the site is contaminated soil with some trees.

The concrete area is used as an terrace for the restaurant/social hub. From this central area the raised footpath starts and winds in between the boathouses. The boathouses are placed in a circle with one boat in the middle. The path winds in between the houses, in the shape of a leaf.

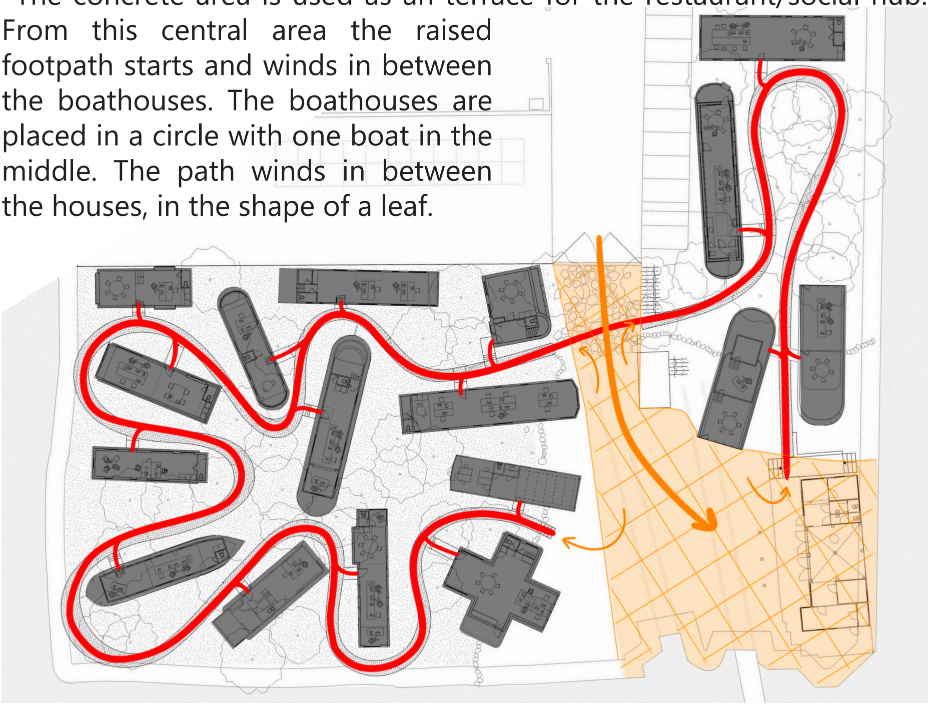


Figure 40: *Urban plan analysis*

Four boathouses are places on the other side of the entrance road. Where the pathway meets the road, it dips down to meet the concrete. Directly across, the pathway rises up and continues the winding line the path follows. This break creates two extra entrances to the pathway close to the entrance of the site.

Figure 41: *Site entrance (Googlemaps, 2018)*

CONNECTION WITH THE LANDSCAPE

Figure 42: *(Space&matter, 2012)*

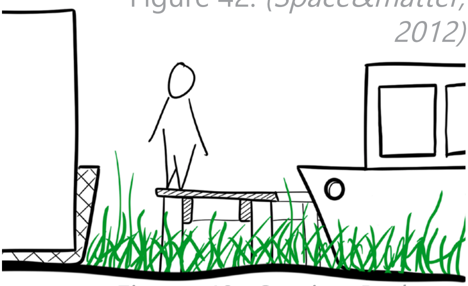


Figure 43: *Section Pathway*

This project has a controversial way of connecting with its landscape. On the one hand is the project designed to be temporary and therefore has minimal impact on the landscape. On the other hand, the project is designed to clean the landscape from toxins. This has a large impact on the landscape although, it is a less visible one.

The different boats are set on the ground and the purifying plants are growing around them. The only impact on the ground are the piles on which the raised footpath rests.

PLACE FOR COMMUNITY

The raised pathway connects all the dwellings. It is a continuous strip that links both parts of the project. The project also has a social hub with a restaurant and café on the site, although this is not specifically for the community, it is there for them to use.

Figure 44: *(Space&Matter, 2012)*

ADAPTABILITY TO CHANGE

The change in the landscape for this project is different from the other case studies. Here, the ground is being purified. The adaptability of this project is that it is temporary, after ten years the ground is purified and the project can be removed, and the ground can be repurposed.

On the other hand, if this project would be placed on a floodplain it would work quite well. Because the boathouses are meant to be craned back into the water after the project is finished, they are still watertight and can still float. The raised footpath creates a dry access route to the dwellings, that with marsh like ground or less than half a meter of water can still function.

CONCLUSION

The second chapter of the research answered to the second research sub-question:

What are ways to connect architecture to and protect architecture from a wetland/water landscape?

To answer this question, five different project have been analysed. Each project has its own water landscape and its own way of connecting to the landscape. All projects are analysed on four themes: 1) Structure (what is the organisational structure of the project?), 2) How does the project connect to its landscape?, 3) How does the project create a place for its community?, and 4) To what extent is the project adaptable to a changing landscape?

The Re-peat project's landscape most closely resembles that of the area described in the introduction. It approaches its design by creating clusters of dwellings, each adapted to its landscape type. Re-peat has floating houses in the boezem landscape, raised buildings in the area destined for regrowing peat, and bio based dwellings from local products in the Paludiculture landscape. All these different clusters are connected with pathways a little raised above the ground plane to keep them accessible.

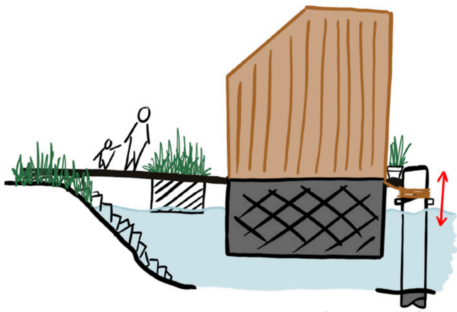


Figure 45: *Section Schoonschip*

Schoon-schip exists of only floating houses, therefore the 'landscape' needs to be flooded all the time (figure 45). If the water is not there, the boat houses will sustain damage from the lack of support. The project connects the dwellings to the shore and each other by jetties. These jetties create an 'in between' space between private and public. The space is owned and used by all neighbours. The project is sufficient by using smart and sustainable systems.

On the other end of the spectrum, is the XiXi wetland estate. Here grey stone blocks are placed in a wetland area. The entire project is placed on top of the ground however, because of the water surrounding the project the parking basement gives the impression of being underground (figure

46). The top of the parking structure creates a secondary (raised) ground plane for the apartment buildings to sit on, and for people to meet. Because the building access and meeting spaces are placed on the first floor instead of the ground floor, it is protected from flooding by the changing water level of the wetland.

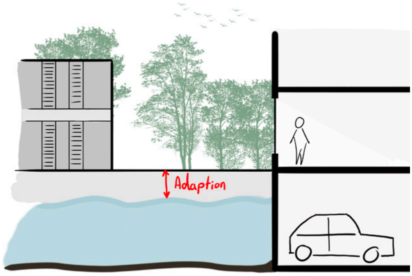
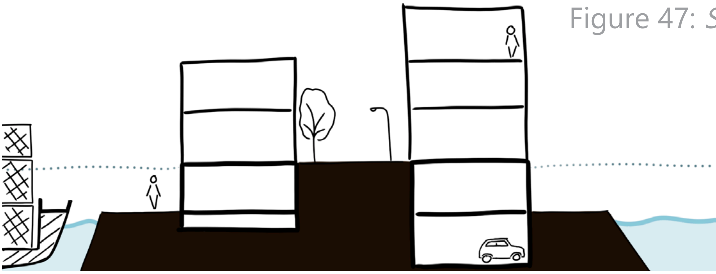


Figure 46: *Section XiXi*

HafenCity incorporates it's heritage into the new design. The old dock and quay structure is kept and used as promenades surrounding the buildings. The building plinth on the promenade is accessible and many shops and restaurants are housed here. Due to climate change the water level in the harbour rise, and sometimes supersede the elevation of the promenade. To project the building the central access road is raised to access the first floor, and the façade openings on the promenade can be closed off with waterproof shutters.

Figure 47: *Section Hafencity*



De Ceuvel uses waterproof structures and a raised access road not to project the residents from water, but from contaminated soil. Using boathouses the project has a minimal impact on the landscape, whilst plants decontaminate the soil. The raised road connecting all dwellings creates a space for residents to meet and at the local community centre to gather. The change the landscape undergoes is not so much a change in water state, but a cleaning. However, when water levels rise to such a degree that normal buildings flood, these dwellings will float and keep being functional houses, although the raised pathway might not be tall enough to function anymore.

Figure 48: *Section Pathway*

CONCLUSION

In answering the main research question "*How can architecture create a place for student communities that connects to, and protects from, its surrounding wetland landscape?*". To answer this main research question, literature on student housing was studied and five case study projects were analysed on the connection with their structure, connection with the landscape, place for community, and adaptability for change.

The first chapter of the research answered the sub-question: "*How can architecture create a place for student communities?*". This research resulted in an analysis of urban planning for and architectural design of student housing. For the urban planning, two primary concepts emerged: college design and campus design. College designs emphasize close-knit communities through multifunctional spaces and proximity to educational facilities and the city center, while campus typologies create self-contained, zoned areas on a large plot of land at the city's edge. The results for architectural design aspects of student housing showed essential features to be in close proximity to school complexes. As well as practical, light-filled floor plans that allow personal expression, private bedrooms and study spaces, and communal areas that foster social interaction without creating an institutional atmosphere. These insights highlight the need for student housing that supports both individual needs and community building.

The second chapter studied five case studies that shared a focus on water or wetland landscape. The focus of this chapter was to answer the second sub-question: "*What are ways to connect architecture to and protect architecture from a wetland/water landscape?*". Each project has its unique approach to creating protection and a connection to the landscape and creating space for its community. However, some overarching themes became evident. Most projects created a raised living plane to protect the residents of changing water levels. Projects like Schoonschip and Re-peat used floating structures to create an adaptable living plane. Projects like the XiXi wetland estate and HafenCity raised (parts of) the ground plane to keep the project accessible and functional during times of high tide. This raised plane in both approaches creates a space for resident communities to form and gather. The connection between the case studies and their landscape is varied. Projects like Schoonschip, De Ceuvel, and the boat houses of Re-peat, are moving with the landscape interacting with every change. Projects like the XiXi wetland estate and HafenCity are like a rock in water. They contrast the water landscape and stand firm. In the case of XiXi the wetland plants surrounding the project are also integrated into the design and are featured on the raised plane as well. HafenCity, on the other hand, maintains its industrial heritage to fit into its surroundings. Although these are two vastly different concepts, all case studies incorporate parts of the surrounding landscape in its design.

Architecture can create a place for student communities that protects them from and connects them to the wetland landscape by, creating college style student housing with close proximity to the school complex and city centre. The student housing should have practical floorplans, private bedrooms, shared facilities, and common spaces to enable social interaction. The design of the building has to leave room for personal expression and not create an institutional atmosphere. To project its residents from the wetland landscape, a raised living plane can be used. This also creates spaces for residents to meet and gather. By incorporating landscape features into the design, a stronger connection with the landscape can be created.

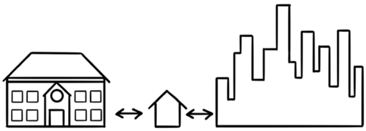
DISCUSSION

The research on student housing may have a slight bias due to the country where the referenced studies have been conducted. The research into student preferences are held with European students who are more used to the European college style of education (although many modern European universities have a more typology that more closely resembles a campus, and has the city expanded around the campus). For a more general analysis, studies about student preferences from American and Asian universities should also be taken into account. However, for this specific research, European students are the main target group and are therefore the only students referenced in this research.

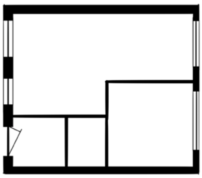
Although the projects for the case study were carefully chosen on the basis of the relationship with their landscape, the projects are just a couple of a vast amount of similar projects. For a more comprehensive analysis, more projects should be analysed. For this study just five case studies were chosen to limit the scope while maintaining a sufficiently large context to draw a meaningful conclusion.

DESIGN STRATAGIES

LITERATURE RESEARCH

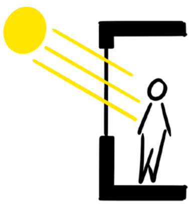


1. Close intergration with school and connected to the city/village

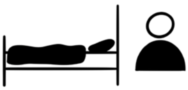


2. Not large, but functional floorplans

3. No institutional character



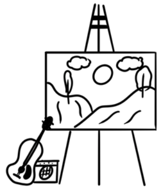
4. Well-lit rooms



5. Private bedrooms

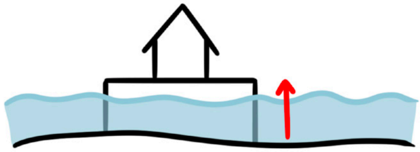
6. Shared facilities/common spaces

7. Leave room in architecture for personal expression

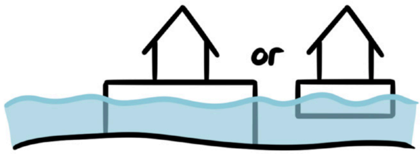


CASE STUDIES

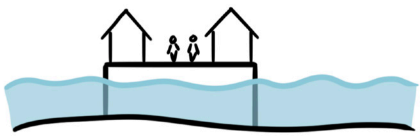
8. Create a raised ground plane



9. Housing on a floating structure or a 'rock' in water



10. Make the raised plane a communal meeting space



11. Include surrounding landscape in the design

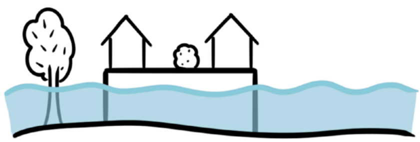


Figure 49: *Design stratagies from research*

LOCATION

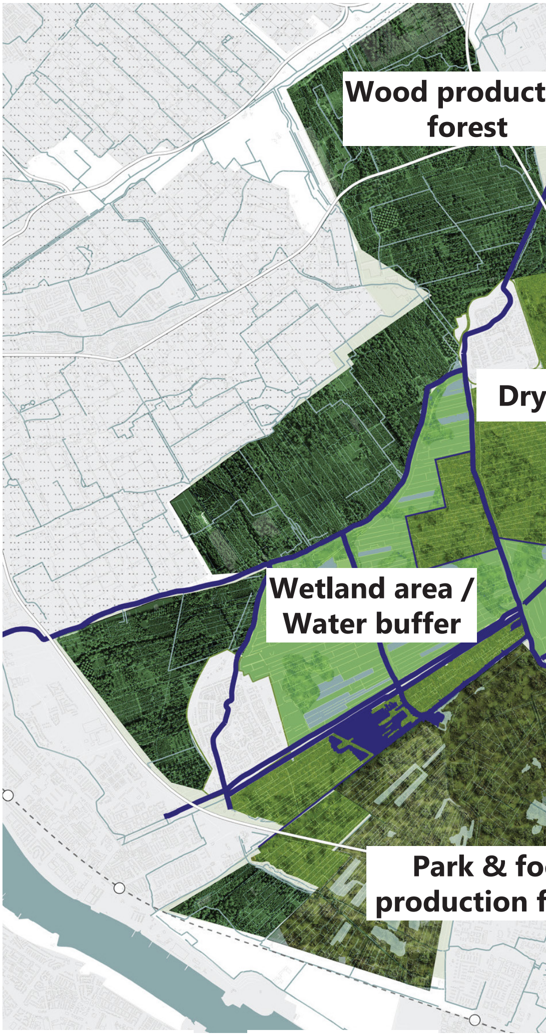
Figure 50: *Location model (Image by author)*

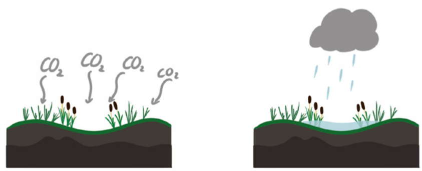
MASTERPLAN

Architecture firm ZUS created a master-plan for the area of Midden-Delfland, as a part of the Redesigning delta studies. This master-plan focused on what this area could be used for in the future. ZUS determined six different strategies to create a productive landscape (figure 52). Based on the soil types, historical records and current structures in the landscape, ZUS created a plan to redesign the polder landscape. By reintroducing water to most of the polders and creating a marshy peat landscape, the site can be adapted to be futureproof.

The site is separated in five different landscape types. 1. Border densification, 2. Dry peat polders, 3. Park & production forests, 4. Wood production forests, 5. Wetland areas.

Not all polders will be equally wet. The centre of the plan is designed to become a wetland and floodplain. The wetland will store water in the landscape and this continuously wet state will make it possible for peat to regrow. However, by flooding these polders vast amounts of farm area becomes unusable for the current way of farming. Some parts of the plan will create space for new types of farming, however there is no farming plan in place for the wetland are.





Zero CO_2 emissions
CO_2 absorbtion by regrowing Peat

Water storage
Store water overflow in the landscape (as water buffer)

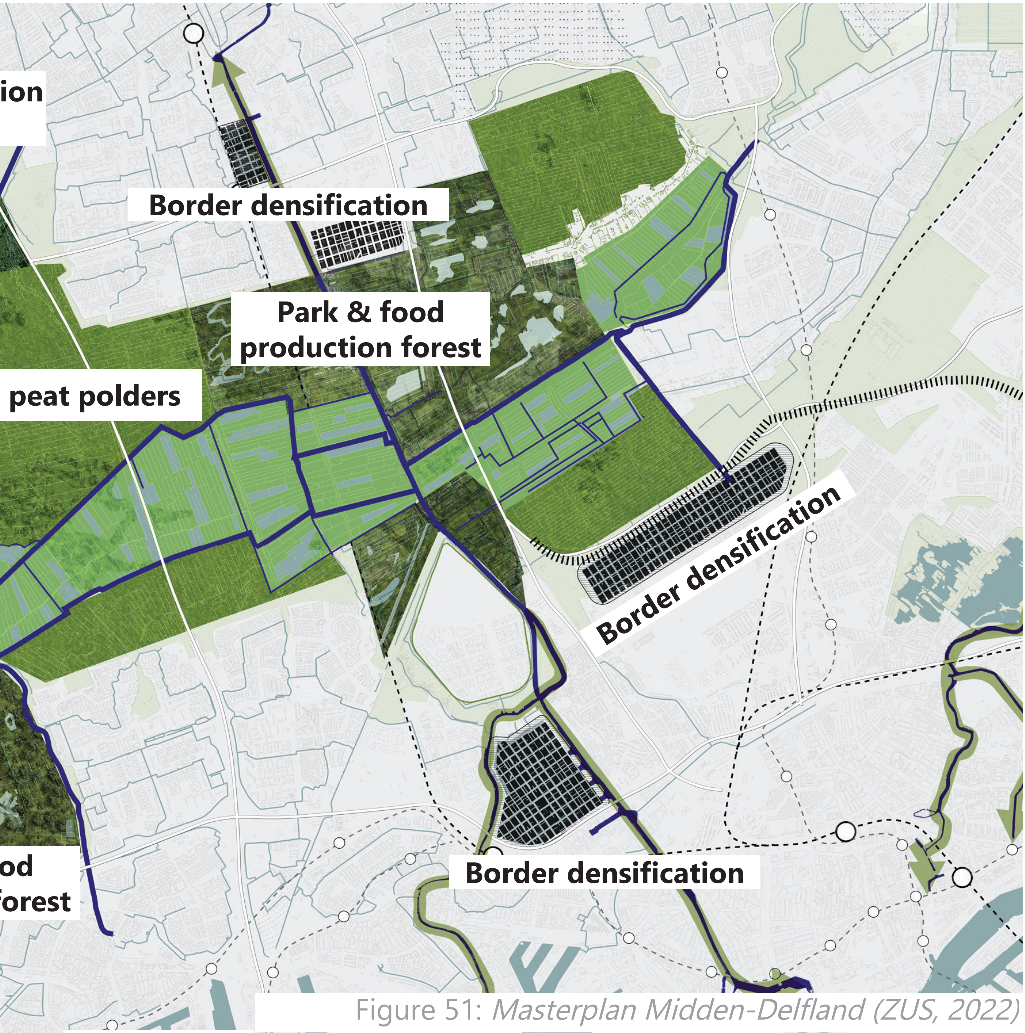
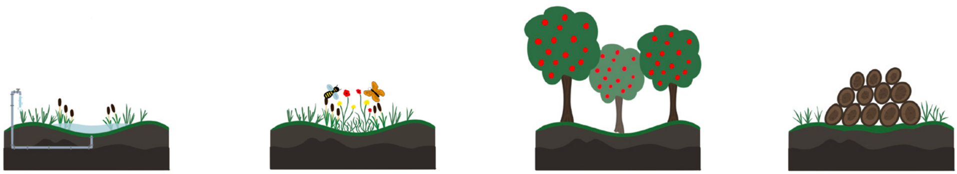


Figure 51: *Masterplan Midden-Delfland (ZUS, 2022)*



Water Purification
Purify water in the landscape to use for households

Nature inclusivity
Create a continuous nature inclusive & natural landscape

Food production
Produce food for the urban areas in the landscape

Wood production
Produce wood and building materials in the landscape

Figure 52: *Project principals masterplan Midden-Delfland*

SUSTAINABILITY THINKING

To answer the studio question of "How do we live together with water?", preliminary research approached this question from the sustainability thinking perspective. The most influential research it found was by the Wageningen University, into subsiding peat polders. This principle also formed the basis for the research of ZUS. The research showed that per hectare a subsiding peat polder (which are all Dutch peat polders) emits 22,6 metric tonnes of CO2 into the atmosphere annually (WUR et al., 2017). So therefore by creating a wetland the subsidence (and the emissions) would stop.

Subsidence of the polder landscape
and its influence on climate change

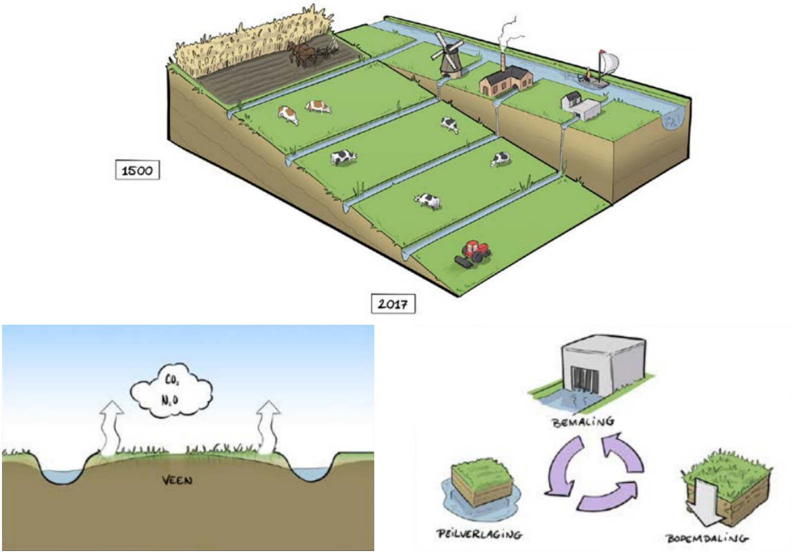


Figure 53: *(Wageningen University Research [WUR] et al., 2017)*

However, by introducing water into the landscape the farmland would become too wet to function for the current way of farming. Two solutions have been developed to keep this valuable land productive (like the rest of the productive landscape designed by ZUS). The first is moving the food production to urban areas. By using vacant urban project in combination with housing food can be produced right next to its customer. The second solution is split into two parts. The first part is adapting current farms to be able to farm in this wetland. By using paludiculture (a type of farming in wetlands with peat soil) farmers in the area can stay and create a productive wetland landscape. The problem with this solution is that current farmers have no knowledge of how to effectively do paludiculture. Therefore the second part of this solution is education. A new generation of farmers should be educated to start farming in paludiculture.

To execute this vision, two sites are selected. The first is in the Spaansepolder developing the idea of urban farming combined with housing in vacant buildings. The second location is in the Comandeurspolder, on the border of the village Maasland.

Figure 54: *Site choice withing masterplan of ZUS*

To further develop an answer to the studio question, 4 different strategies of living with water are developed. The first builds in a less wet area, whit a stable water level. The second uses the water management of an urban setting. The third builds on a mound in a wetland and floodplain. The fourth strategy explores an adaptable building type to protect from changing water levels.

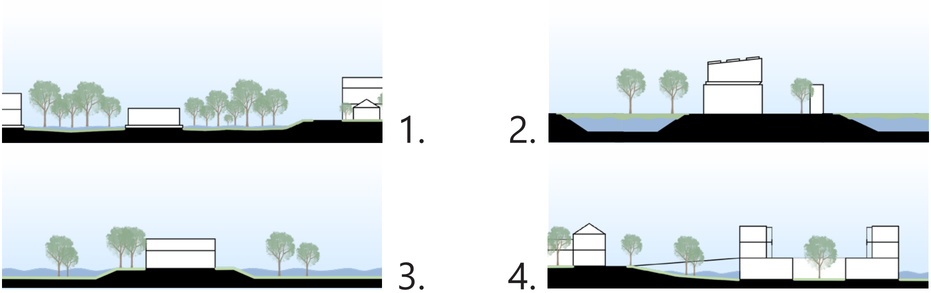


Figure 55: *Water stratagies*

THE SITE

 Figure 56: *Project location*

THE SITE

The site in the Commandeurspolder is located on the border of two different landscape types in the plan of ZUS. It consists of five different elements; 1. Polder dike - The chosen site is on the border of the Commandeurspolder. This is not only currently a clearly visible border in the landscape, but int the plan of ZUS it continues to be a border between the wetland area and the 'wood harvesting forest', and therefore will become an important artery in the new landscape both over land as via the water. 2. Wetland area - The Commandeurspolder is an area which is assigned to become a wetland area in the plan of ZUS. This means that the polder is not being actively drained, and it can be used as a floodplain for water storage. 3. Wood harvesting forest - This area is part of the productive forest, where trees will be harvested. The ground in this landscape will stay wet, however the water level will stay level. 4. Urban area - At the edge of the site there is a village called Maasland. It is a small town with 6500 inhabitants (2023), and can create the basis for future projects. 5. School - On the border of the town there is a highschool for practical teaching as well as a trade school with a focus on agriculture. By adding a paludiculture track in its curriculum the students can learn about the landscape they will cultivate whilst being surrounded by it. By adding student housing the farmer lifestyle will also be better enabled to live and work surrounded by the landscape you work with.

SITE | EXISTING STRUCTURES

Figure 57: *Green structures*

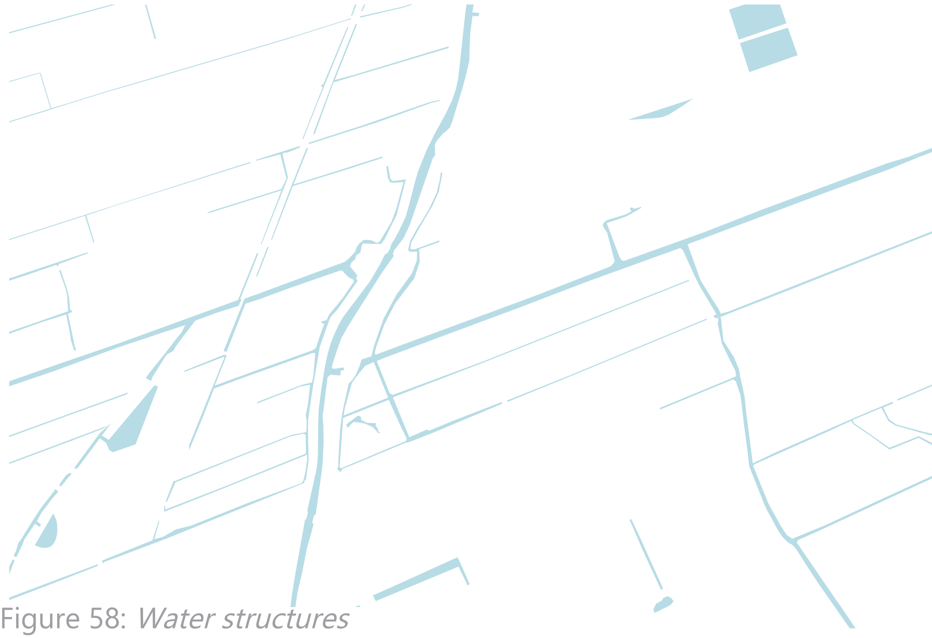


Figure 58: *Water structures*

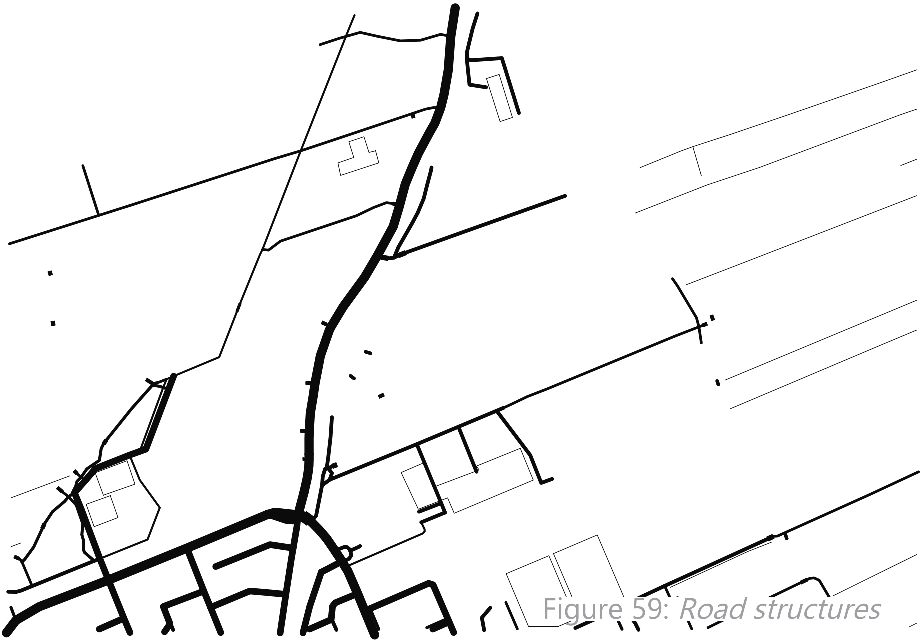


Figure 59: *Road structures*

Figure 60: *Buildings*

SITE | LOCATION IMAGES

Figure 61: *Image locations*

A

 Figure 62: *Lentiz school building*

Figure 63: *Traditional farm on site*

Figure 64: *Acces to landscape from village*

Figure 65: *Apartment buildings of village border*

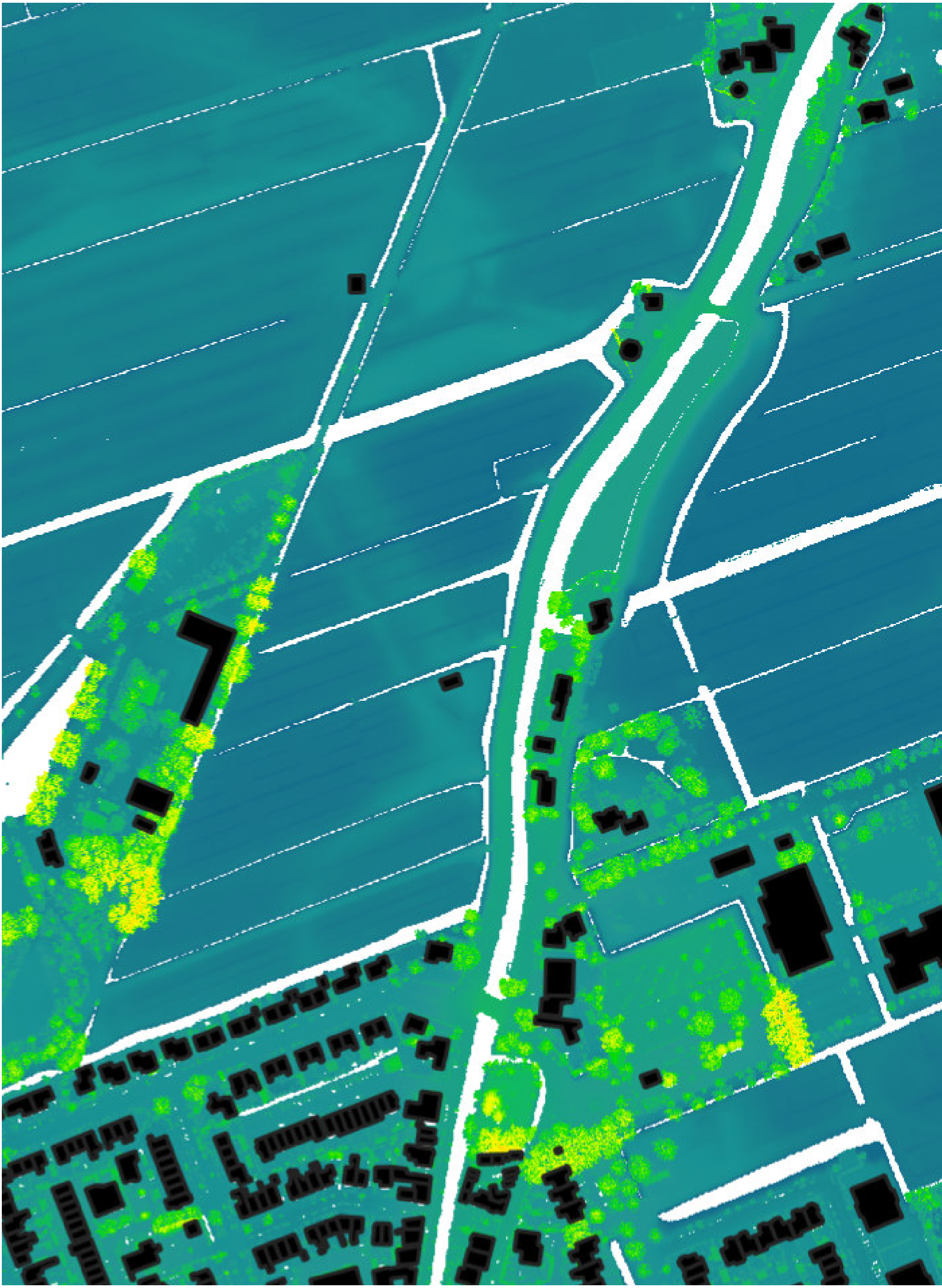
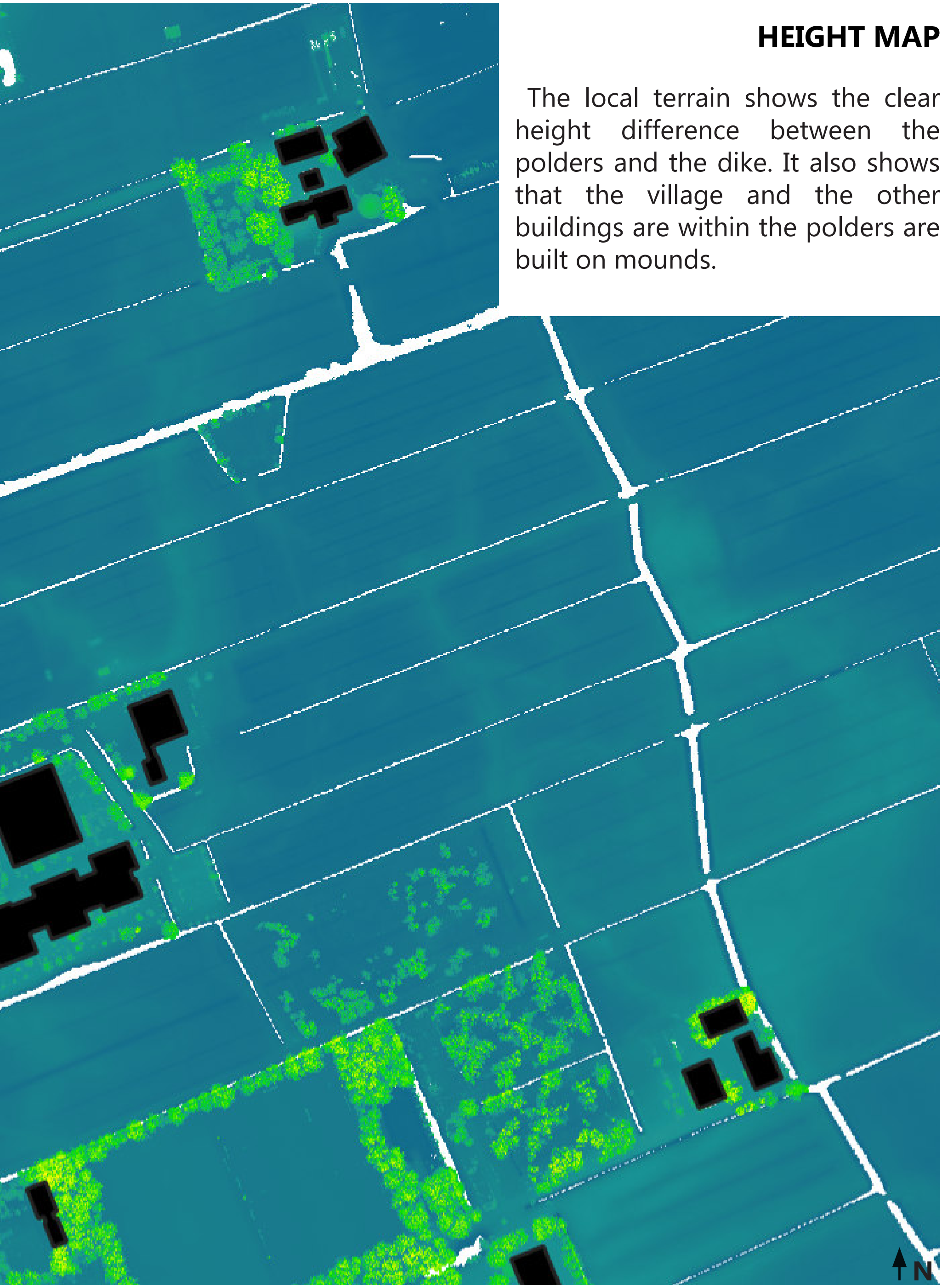


 Figure 66: *AHN - Height-map*

HEIGHT MAP

The local terrain shows the clear height difference between the polders and the dike. It also shows that the village and the other buildings are within the polders are built on mounds.



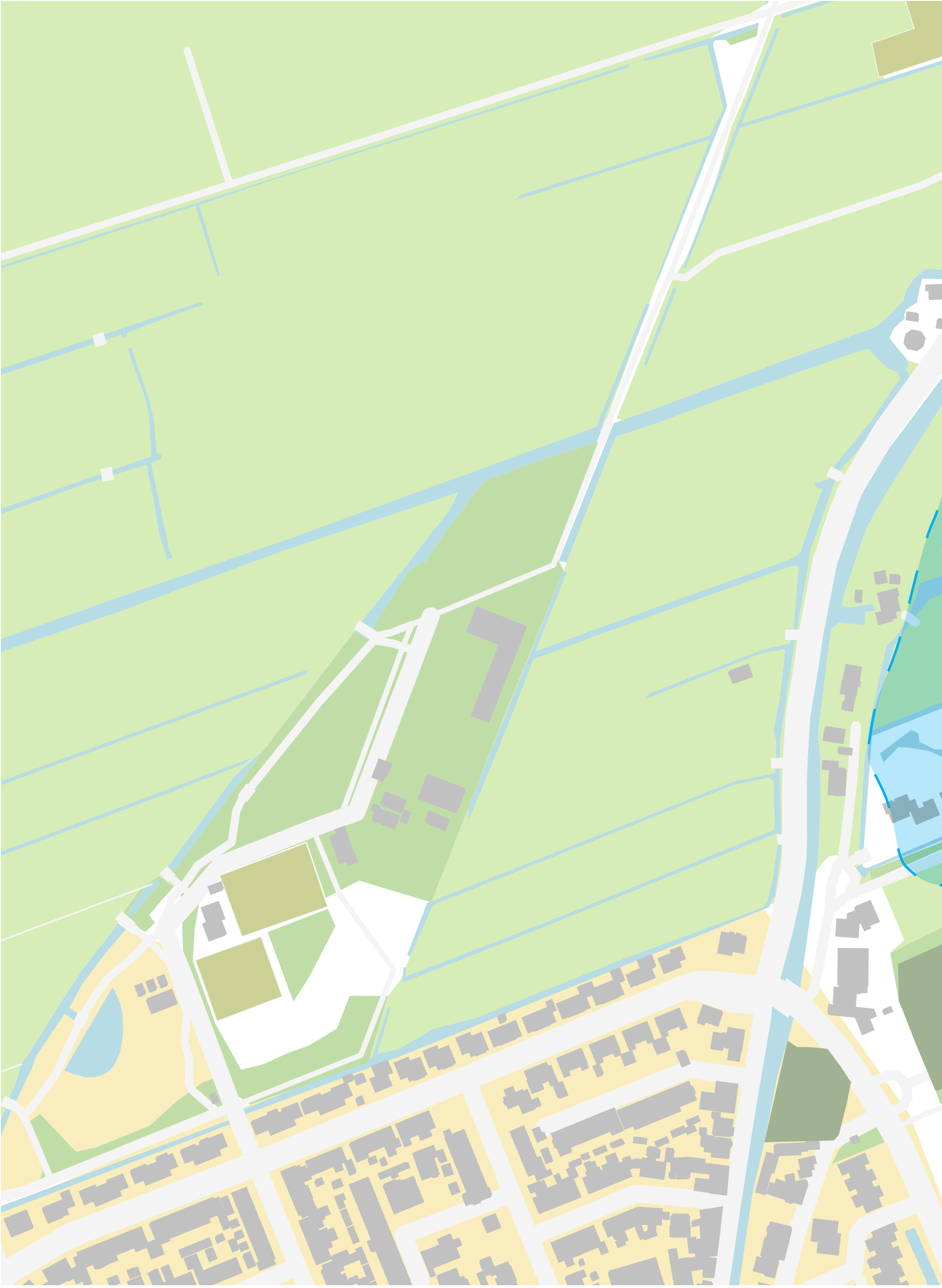


 Figure 67: *Floodline based on 1.5m water level*


N

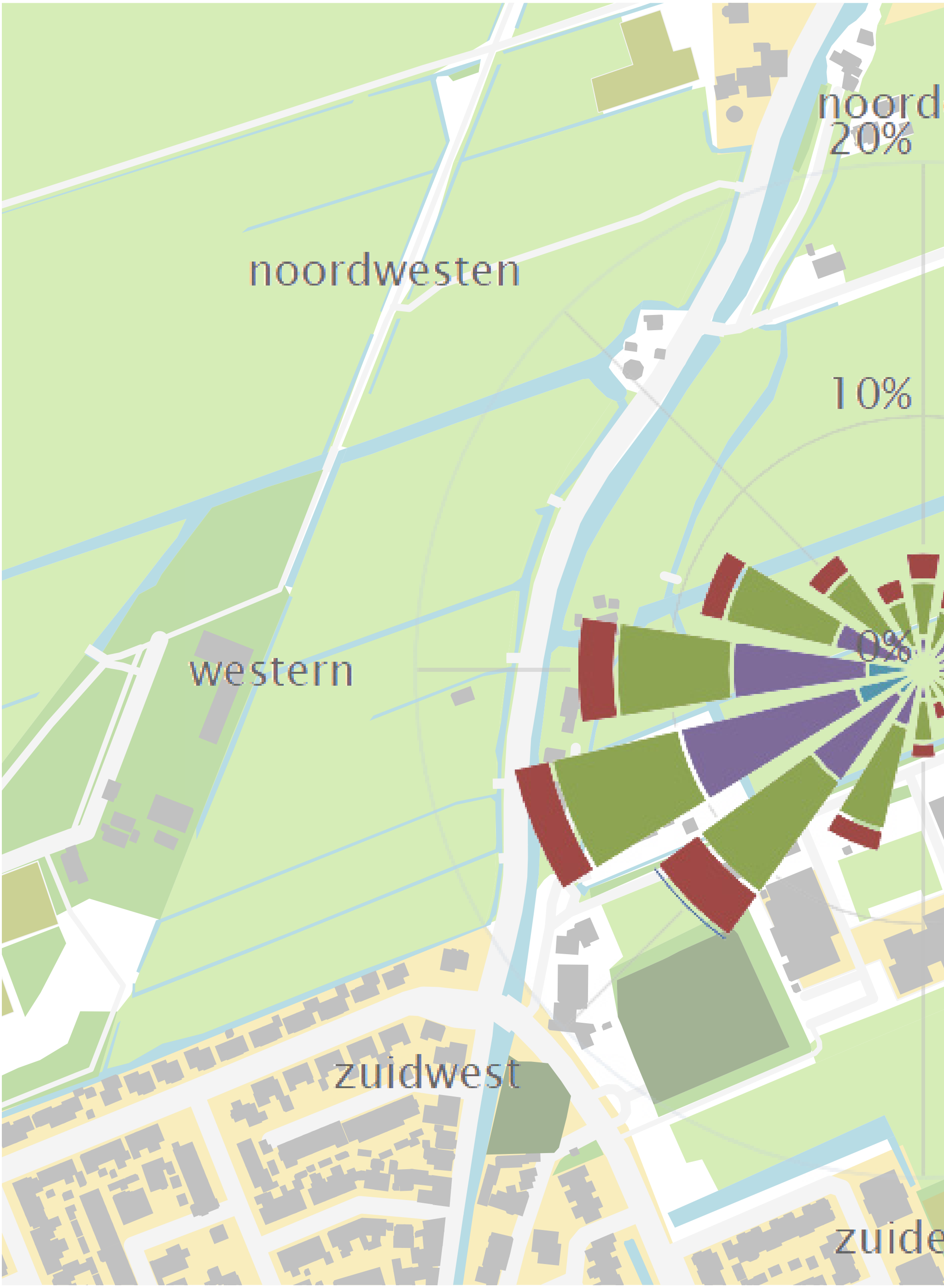


 Figure 68: *Wind analysis (Meteocast, 2023)*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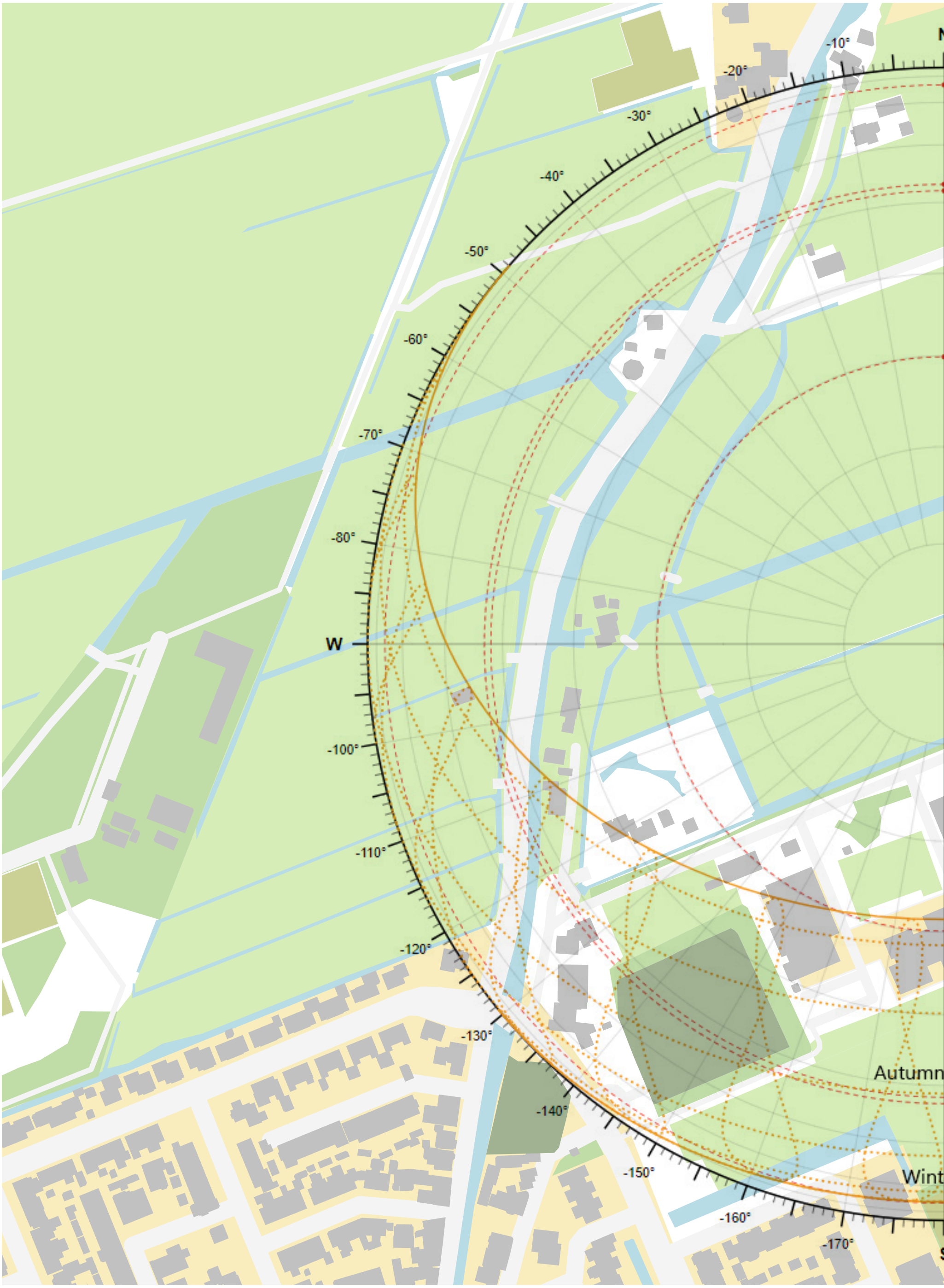
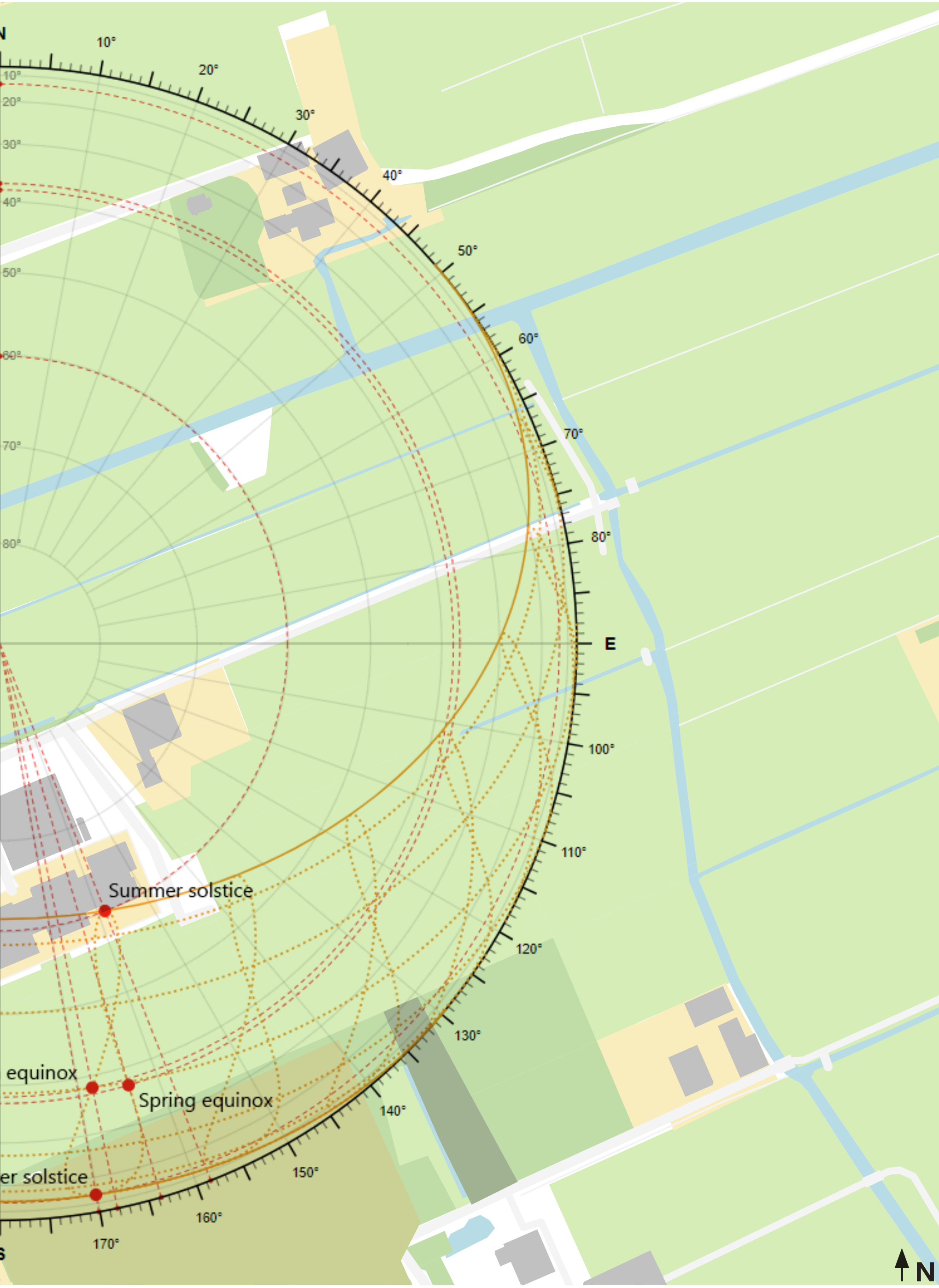


 Figure 69: *Solar study (andrewmarsh.com, 2023)*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CONCLUSION

The focus of the preliminary research was on sustainability thinking. This led to research done by WUR on subsidence in peat polder landscapes and the carbon emissions that it creates. Reintroducing water into the landscape was necessary to minimise (and reverse) these emissions. Therefore, the logical choice was a plot of land in the wetland area of the plan for Midden-Delfland. The chosen location is situated on the border of two different landscape types in the plan of ZUS. This ensures that the site will stay accessible and creates possibilities to develop projects in multiple landscape types. Looking at the existing structures, the polder dike (and border of the landscapes) becomes visible in all structures. Closer to the village, the density of roads and buildings increases. In the village the density of the green space and water structures decrease. Looking at the layout of the built area the village borders become clear (Red lines in figure 70). The research shows that students prefer a school with a close connection with the village. The school, on the other hand, requires to be situated in the landscape. Combining these requirements the best place for the project is at the location of the current school. In the heightmap, the village and polder dike are clearly elevated compared to the surrounding landscape. Therefore, the village will not flood during periods of water storage in the landscape. However, the site of the school is within the flooded area. The prevailing wind direction is from the southwest. The highest solar angle is 60° in summer and 15° in winter.

Figure 70: *Location conclusion*

DESIGN CONCEPT

Figure 71: *Location model (Image by author)*

DESIGN BRIEF

Project statement

Role of the project (urban master-plan)

Located at the site are a highschool and an agricultural focused trade school. Most students attending the highschool are kids from the local village. People from a wider area gather to attend the trade school. Within the masterplan of '*Productive landscape Delfland*' by ZUS both schools are located in the wetland area. Therefore it must move or adapt to the new landscape. Because of its social importance for the nearby village, adapting the school would be preferable. Not only schools but also farmers need to move or adapt their farms to be focused on Paludiculture. This requires knowledge of this new landscape type and how to farm it. This also underlines the importance of adapting the trade school. The students attending this new type of Paludicultural study, need a place to live whilst they are attending school. By incorporating housing with the new campus, student interested in wetland farming live next to that exact landscape and can learn there too.

Project agenda

This project aims to show adaptability in sustainable ways to a changing environment. Creating a visible contrast between different building structures in their materiality. The dual function of highschool (serving the local village) combined with the trade school mixes the functions. Because of this, residents will encounter not only other students and faculty on campus but also local people from the village.

Impact on scale

By keeping the value of the (to be) wetland area landscape, the entire plan of ZUS will meet less resistance and keeps the resource generating capability of the landscape intact. This also creates an opportunity for connecting urban areas and the larger landscape, creating a symbiosis by generating resources in the wetlands and processing them in urban areas.

Adapting these schools to the new landscape (architecturally and with their curriculum), knowledge on how to use the new landscape is shared, Local students can keep going to their highschool, and there will be new residents in the village (on campus) who make use of the villages facilities.

Declaration of Project Details

Description of dwellers

The residents of the project will be students at attending Lentiz MBO Maasland. As of 2024 Lentiz offers multiple agricultural study programs. However, to create a closer connection between the school and the natural landscape it will be part of, after the effects of the plan of ZUS, a new study program will be added to teach about Paludiculture and other forms of wetland farming. This type of study will attract students who want to connect with the landscape around the school, and therefore create another reason to create campus living in the Commandeurspolder.

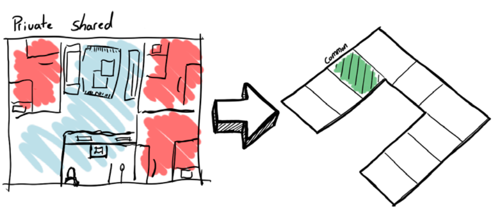
Sharing and living together is the key in student housing. It bonds and creates a community of people. With different scales of shared spaces in different places. A student has a small group of people they share a dwelling and it's shared services with. A wider social network can be met in common spaces on and around the campus. Interlaced with these common areas is a public infrastructure of places and routes that connect the campus area and the village nearby.

Type of housing tenure

Due to the temporary nature of student accommodation, all dwellings will be under tenancy and rented out on a room by room basis. Except the common spaces of the dwellings.

Programming of the collective space

The students will live in shared dwellings with communal areas like living, cooking and study spaces. Within the shared dwellings, private bedrooms will give student a private space on the campus to live, study and sleep. Shared between a couple of dwellings, common areas are spaced. This gives different 'households' a place to meet and connect.



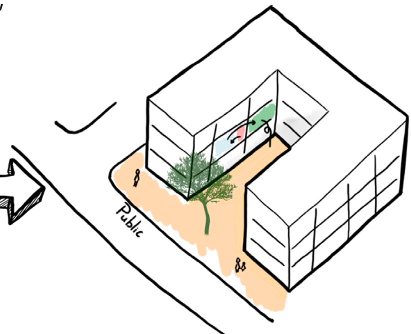


Figure 72: *Private > common > public spaces diagram*

SCALE REFERENCE

HYDE PARK HOOFDDORP

Hyde park is a student housing project in Hoofddorp, currently being developed By Vakwerk architecten and DUWO. When finished it will accommodate around 560 students.

It had different towers with each their own aesthetic to distinguish between the building volumes. These towers are on average 9 stories high.

Figure 77: *(Duwo, 2023)*

Figure 73: *Satalite photo of the building on location*

Figure 74: *The building footprint on site*

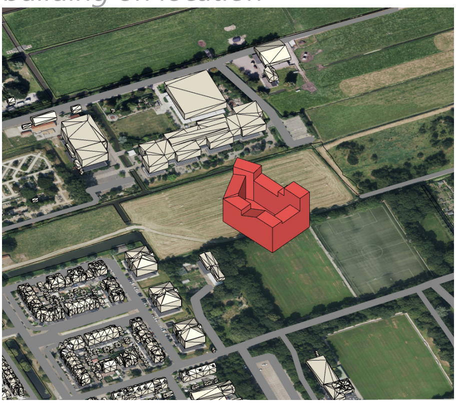


Figure 75: *3D isometric of the building on the site*

Figure 76: *Building footprint if it was 1 level*

ZEEBURGEREILAND AMSTERDAM

The student housing project next to 't IJ lake in Amsterdam houses 364 students near the city center of Amsterdam. Designed by Studio nine dots, in collaboration with DUWO housing corporation. The building has large roof terraces it gives space for students to enjoy the communal areas. The building has 7 stories. With a floor space of around 12.700 m2.

Figure 82: *(Studioninedots, 2023)*

Figure 78: *Satalite photo of the building on location*

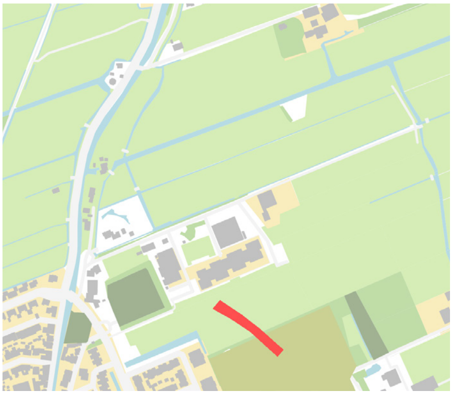


Figure 79: *The building footprint on site*

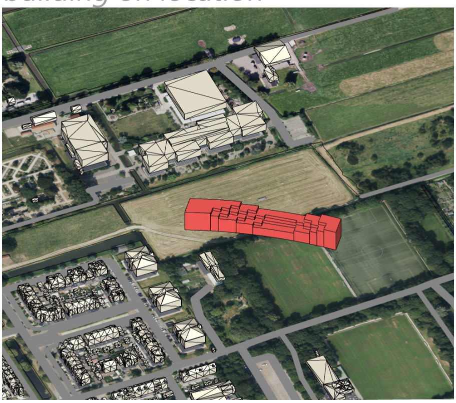
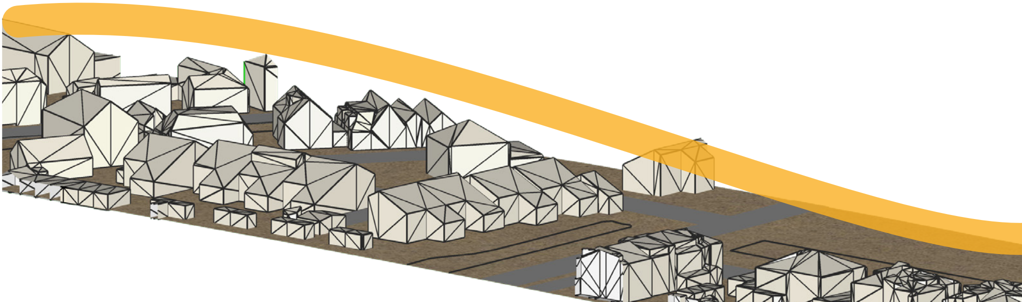


Figure 80: *3D isometric of the building on the site*

Figure 81: *Building footprint if it was 1 level*

HEIGHT STUDY



The village Maasland does not have many high buildings. The highest building is the church in the city centre with a height of around 15 meters. The other buildings in the village are two to three story buildings. With a height of 6 to 12 meters tall. Because the village is situated on top of a natural mound, the buildings height seems to increase towards the village centre. A notable aspect of the buildings on the border near the site, is that these are story higher than the buildings towards the centre.

These differences in ground plane level and building height give the village a waving effect, with a higher bump towards the landscape. This differing height level, as well as a higher border the project has to reflect.

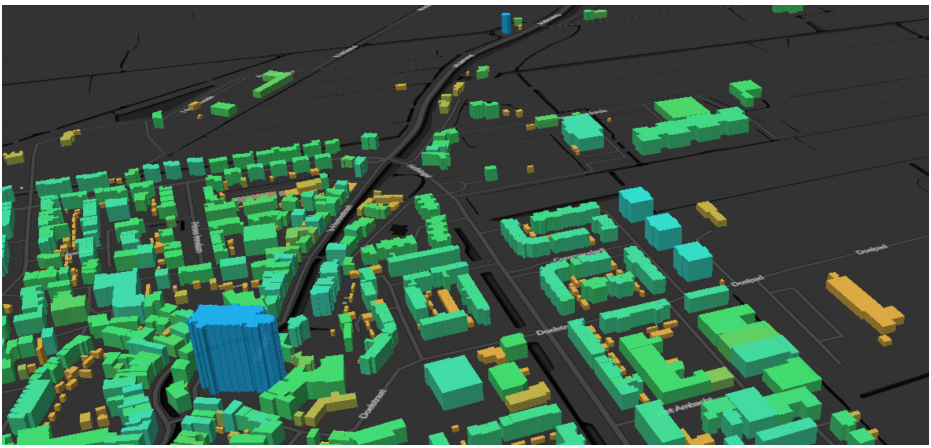


Figure 83: *Height study section (Webmapper, 2024)*

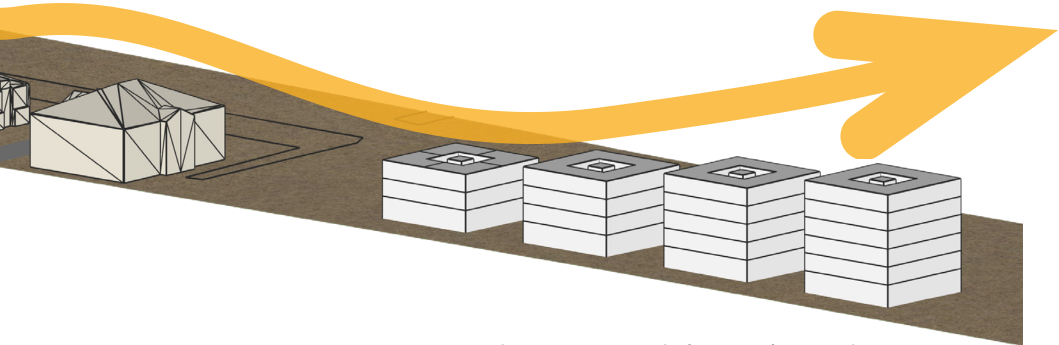


Figure 84: *Height study section*

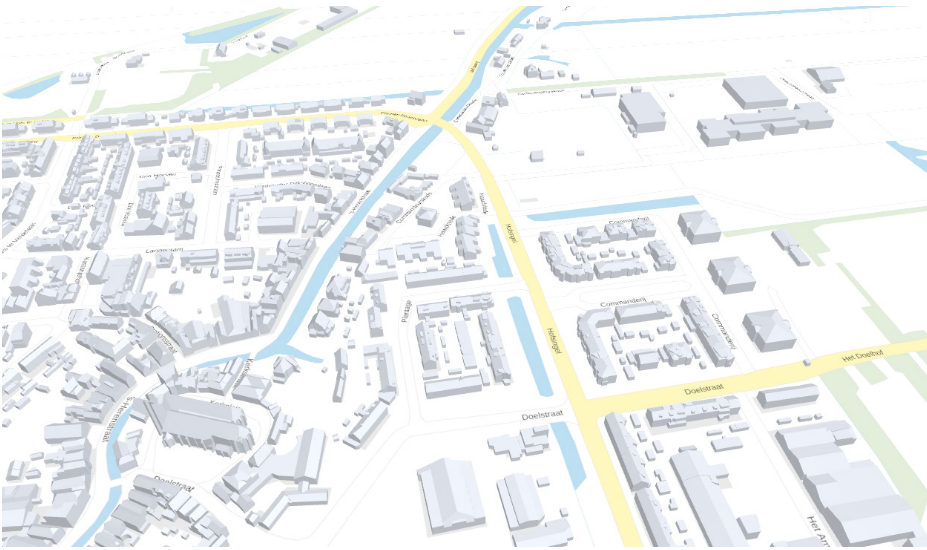


Figure 85: *(3dBAG, 2024)*

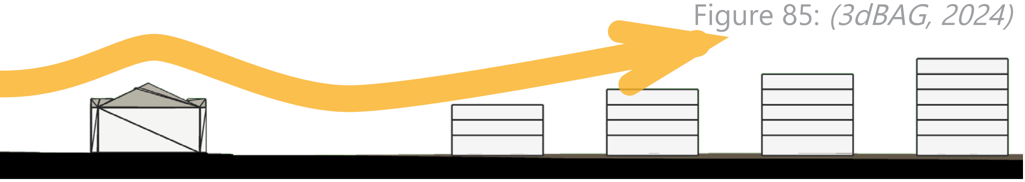
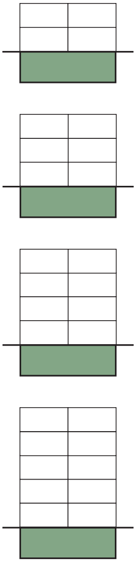


Figure 86: *Height study section*

DENSITY STUDY



Stories	Schematic	Dwellings	Student rooms	Number of buildings nessesary
2		*8*	*24*	**21**
3		*12*	*36*	**14**
4		*16*	*48*	**11**
5		*20*	*60*	**8**

Building layout

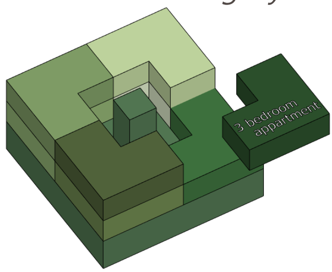


Figure 87: *Dwelling calculation*

Super imposed on site:

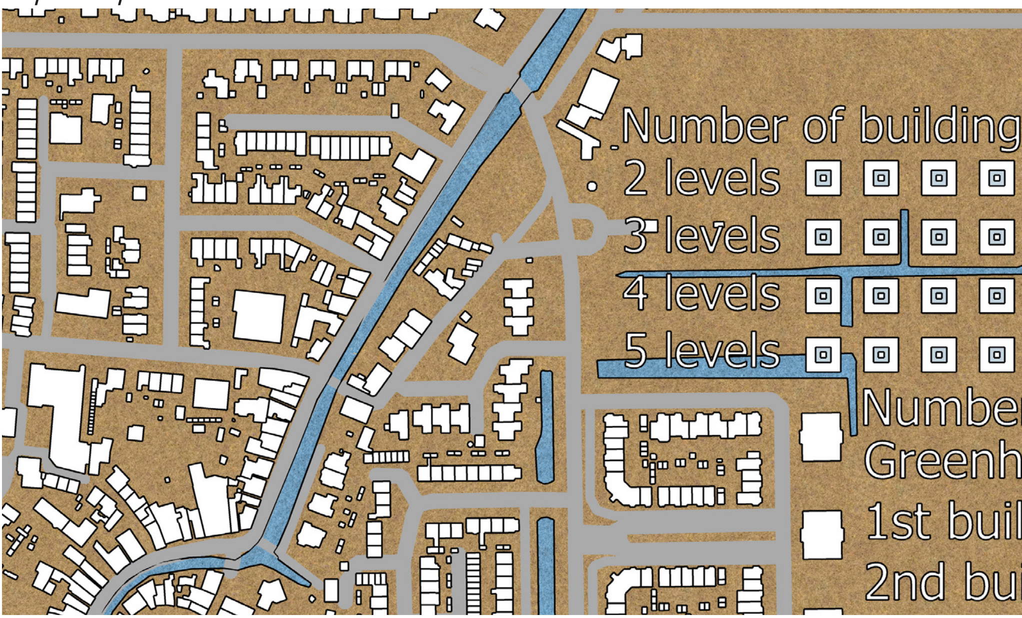
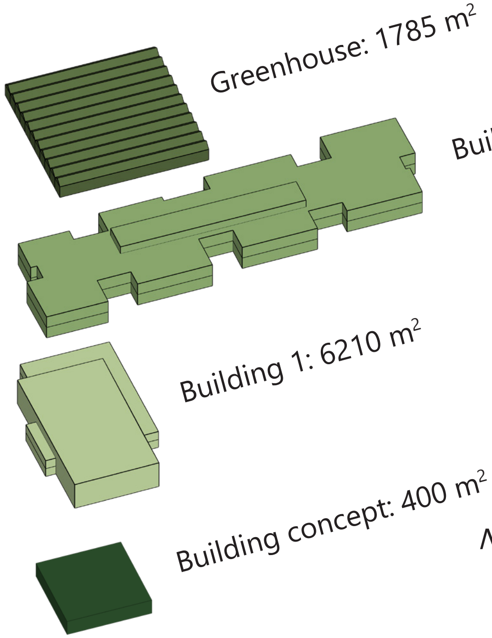


Figure 88: *GSI per levels on site*

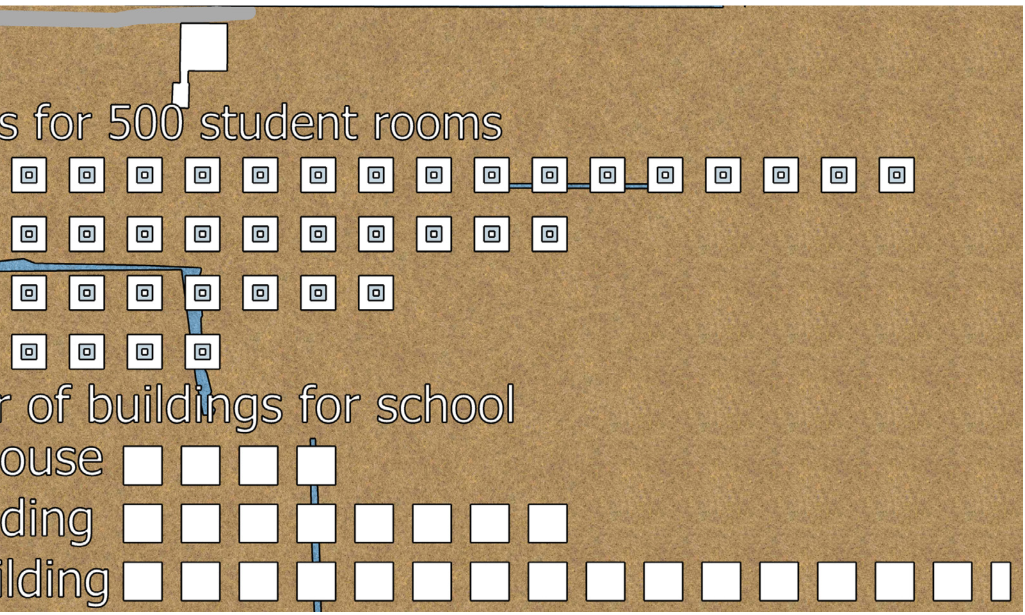
Total floor area school:



Number of buildings nessesary:

Greenhouse:	1785/400 ≈	**4,5**
Building 1:	6210/400 ≈	**15,5**
Building 2:	3120/400 ≈	**8**

Figure 89: *GSI school building*



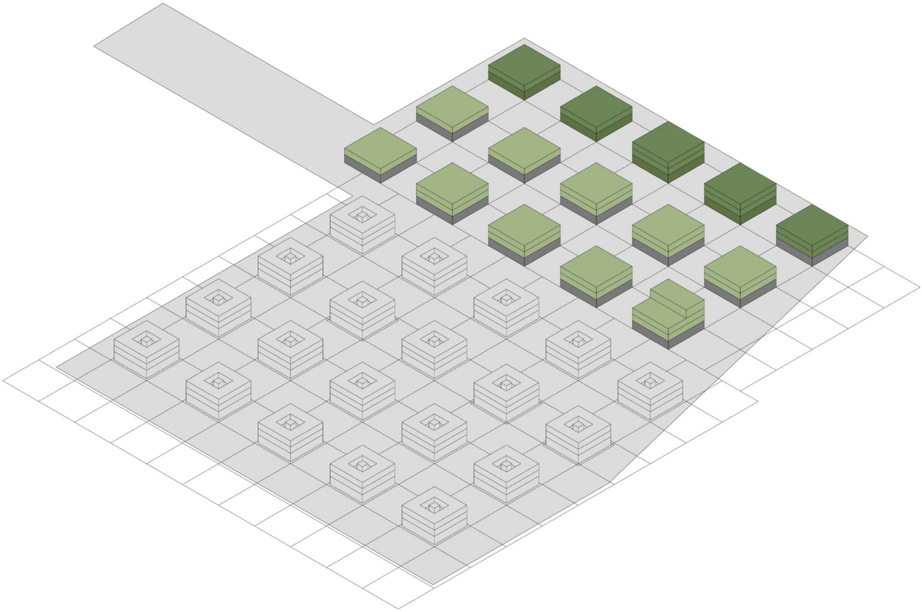


Figure 90: *2 Level dwellings (75& density)*

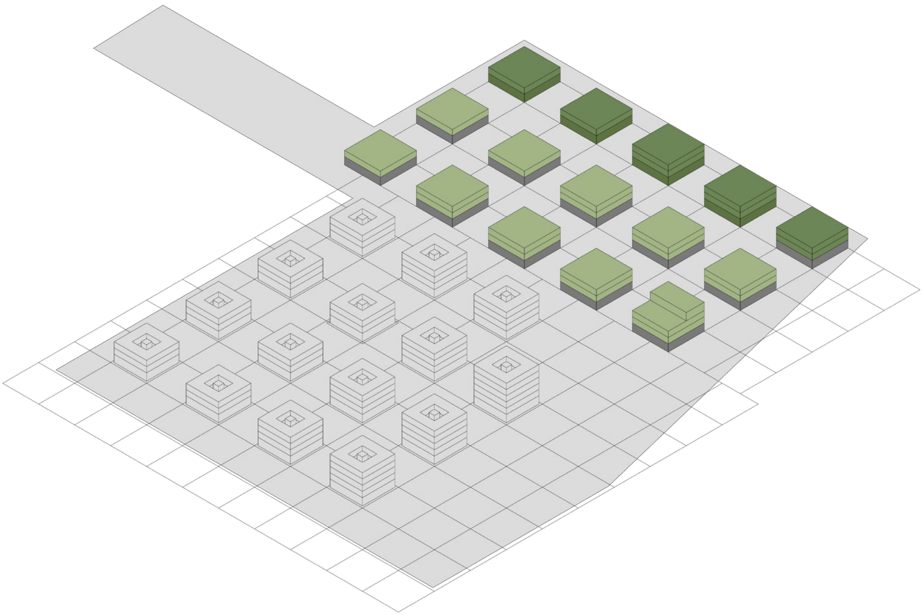


Figure 91: *Multilevel dwellings (<75& density)*

MIXING & CLUSTERING ON SITE

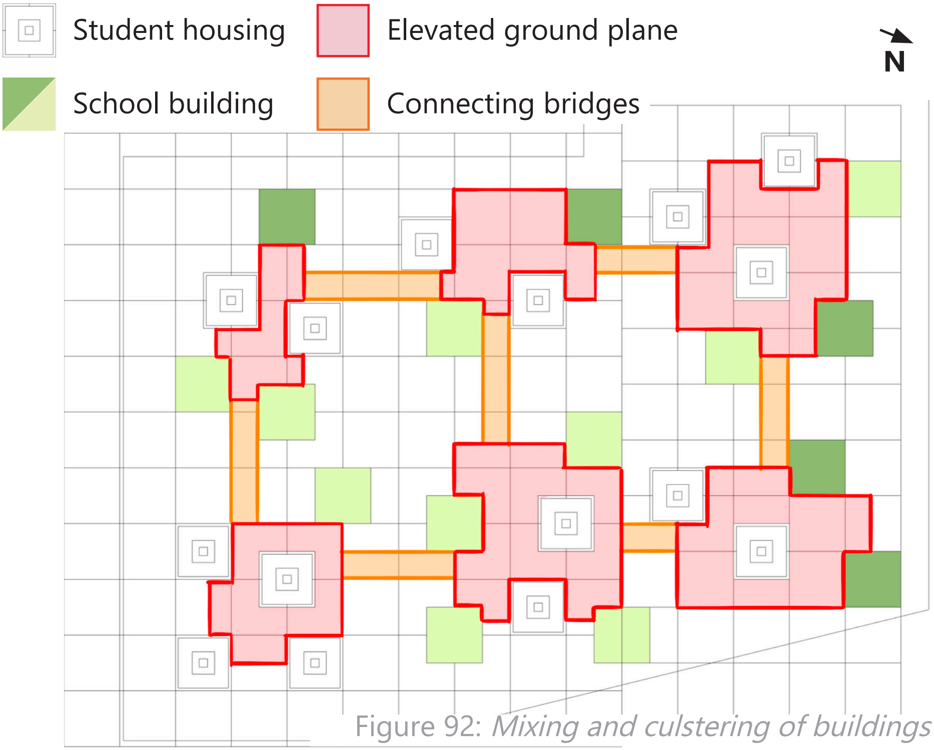


Figure 92: *Mixing and culstering of buildings*

AXONOMETRIC VIEW OF CLUSTERS

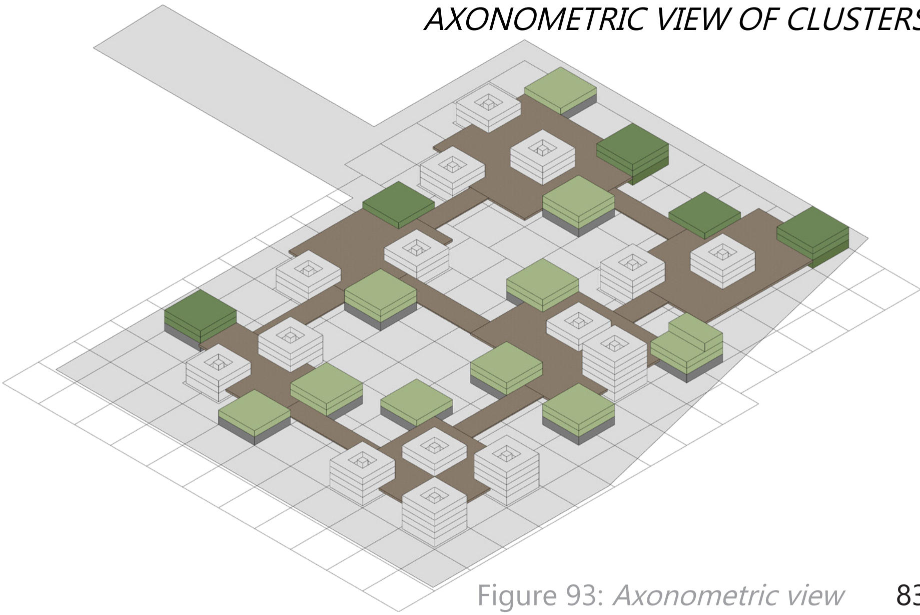


Figure 93: *Axonometric view*

MASTERPLAN V1

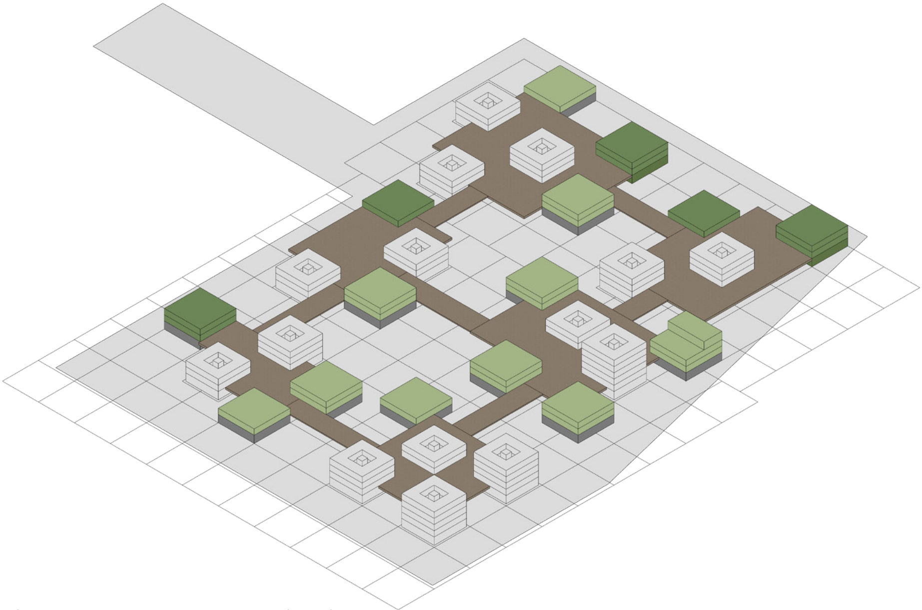


Figure 94: *Axonometric view*

Masterplan concept

The first masterplan consists of square buildings with varying building height. School buildings and student housing buildings are mixed to create a dynamic environment. The entrance of each building is on the first floor. A raised ground plane connected all entrances. Groups of buildings are clustered and connected with a platform. These platforms are in turn connected to each other via bridges. It will be possible for the landscape to continue underneath the platforms, connecting the two enclosed 'gardens' within the masterplan to the landscape surrounding it.

Building design

School buildings are divided into a high plinth to store equipment and activities that require more space. The upper levels are dedicated to classrooms and administrative facilities.

The dwellings are split into four or five shared apartments per dwelling. The apartments are shared dwellings with private bedrooms and common kitchens, living rooms, and bathrooms. All dwellings connect to a central staircase, which creates a central shared space for residents to meet.

Figure 95: *Mix of functions around plaza's in concept masterplan*

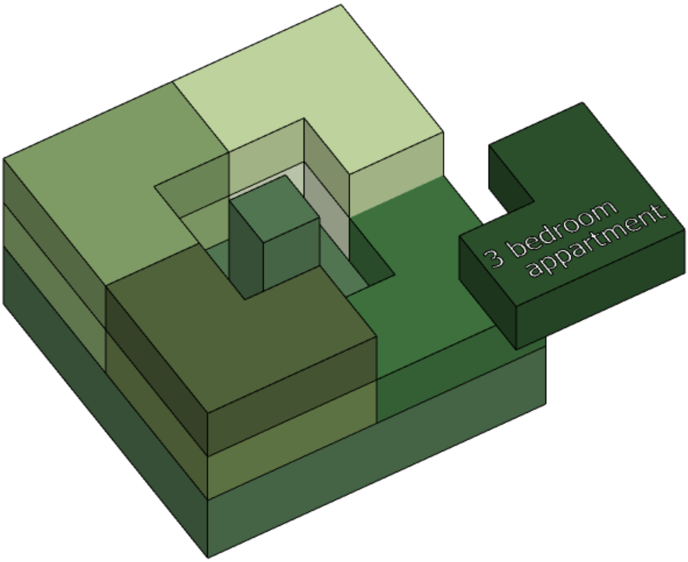
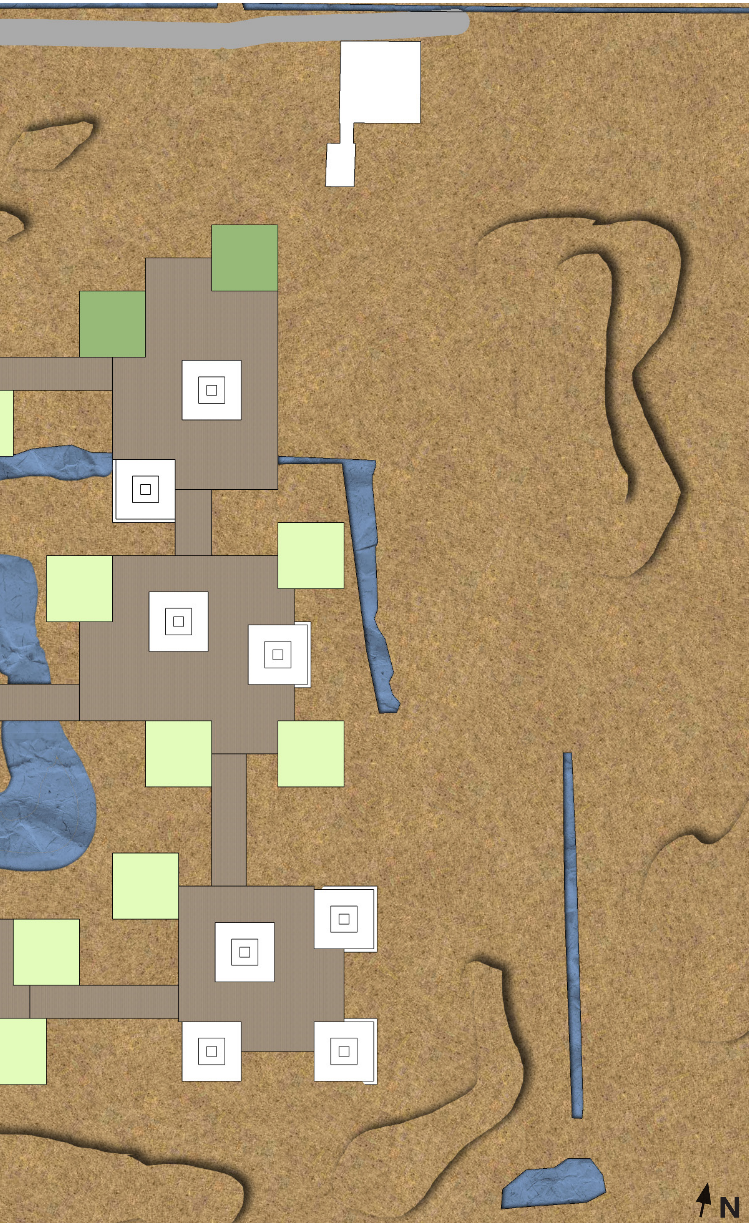


Figure 96: *Residential building layout*

Figure 97: *Masterplan proposal*

 Figure 98: *Masterplan proposal section*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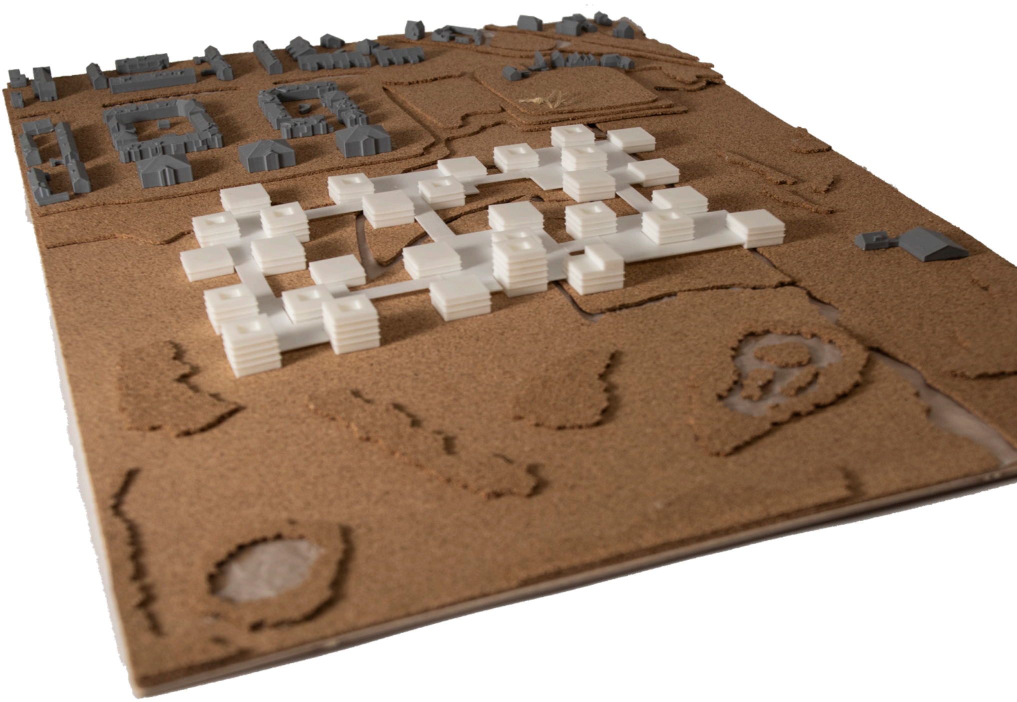


Figure 99: *Masterplan model*

Critique

There are some concerns with this layout. The design divides the program into separate buildings. This creates a lot of inefficiencies with access systems, installations and façade area. Also the raised ground plane shades large amounts of the ground and blocks daylight for the ground floor levels. Because of this, the use for these spaces is limited, making them effectively above ground basements.

In addition, because of the distance between buildings, students might have to travel far to get from one school building to the next. This coarse and widespread structure of the masterplan contrasts the village, where buildings are more densely packed but also have a smaller footprint, creating a finer structure.

Figure 100: *Masterplan proposal dry landscape*

The changing landscape

Figure 101: *Masterplan proposal wet landscape*

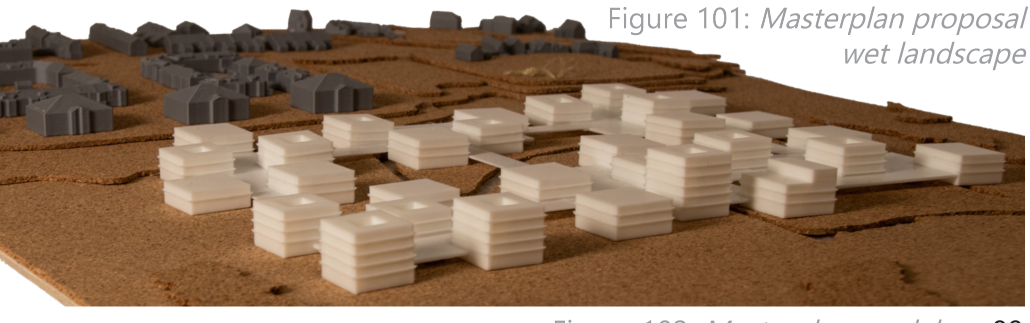


Figure 102: *Masterplan model*

MASTERPLAN CONCEPT

SCHOOL CONCEPT

Because the school teaches about a new way of farming the landscape, it should be all placed on the ground, in direct contact with its landscape. However, because the landscape can flood the plinth should be watertight up to 1,5 meters (higher than the estimated maximum flood level). Designing for this waterproof plinth, different strategies are used to ensure watertightness. To reduce complexity, most of the windows are placed above the flood level. However, windows this high do not create a welcoming and light interior. Therefore, larger window openings and doors can be closed off with protective (watertight) shutters. This is possible, because the floodplain is a controlled area, and floods are known in advance. These shutters are also a low tech, and therefore less complex way of sealing the building.

To make sure all parts of the plinth get enough daylight access. The building is configured in a way that interior spaces are not too deep for light to penetrate. However, in some places the program requires larger interior spaces. There a skylight is added, to let daylight enter the building. The building is also shaped so it fits in with the terrain, and surrounding buildings.

The research showed that outside spaces incorporated in a school design, become interactive and productive spaces. Therefore the reconfigurations incorporated three courtyards in its design. These spaces can be used for teaching as well as relaxing and studying. Because the courtyards are enclosed, they will stay dry during the periods when the surrounding landscape is flooded.

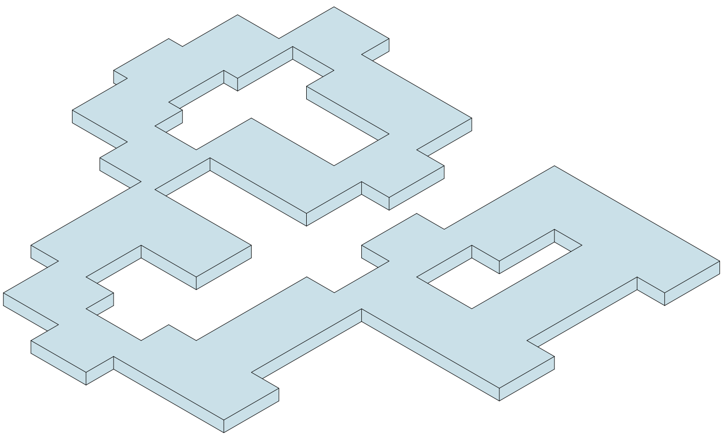


 Figure 103: *Reconfiguration School building*

DWELLING CONCEPT

In the first masterplan the residential and school buildings had the same footprint. Keeping the residential buildings closer in size to the density and footprint of the village, the old residential blocks are divided into four separate blocks per level. Each block consists of one apartment. By linking and stacking these blocks, smaller sized apartment buildings are created. To create efficient access systems, one or more access cores are placed within the building envelope and the apartments are linked to this core via a gallery system. Not all building blocks have the same roof height. Different parts of a building have different roof height. This creates a dynamic environment, and make residents not feel too enclosed walking between the residential buildings.

By placing the apartment buildings on top of the school building, the project becomes more compact and efficient. In addition, placing the apartments on top of the school, foregoes the need for a waterproof plinth underneath residential buildings. Because well-lit rooms was an important building requirement for students, residential buildings are placed to make sure that buildings do not cast shade on neighbouring buildings.

In between the residential building blocks a lot of space is left for creating an inclusive environment. This space, on the roof of the school building, is raised so that it will never be flooded. Therefore it can function as a public street, with bicycle and footpaths on this raised area. In between the buildings and pathways, green spaces are placed to incorporate nature and the surrounding landscape onto the raised ground plane.

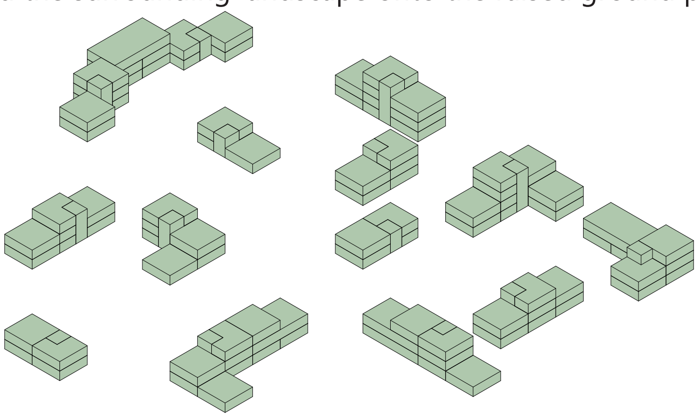


Figure 104: *Dwelling configuration*

BUILDING CONFIGURATION

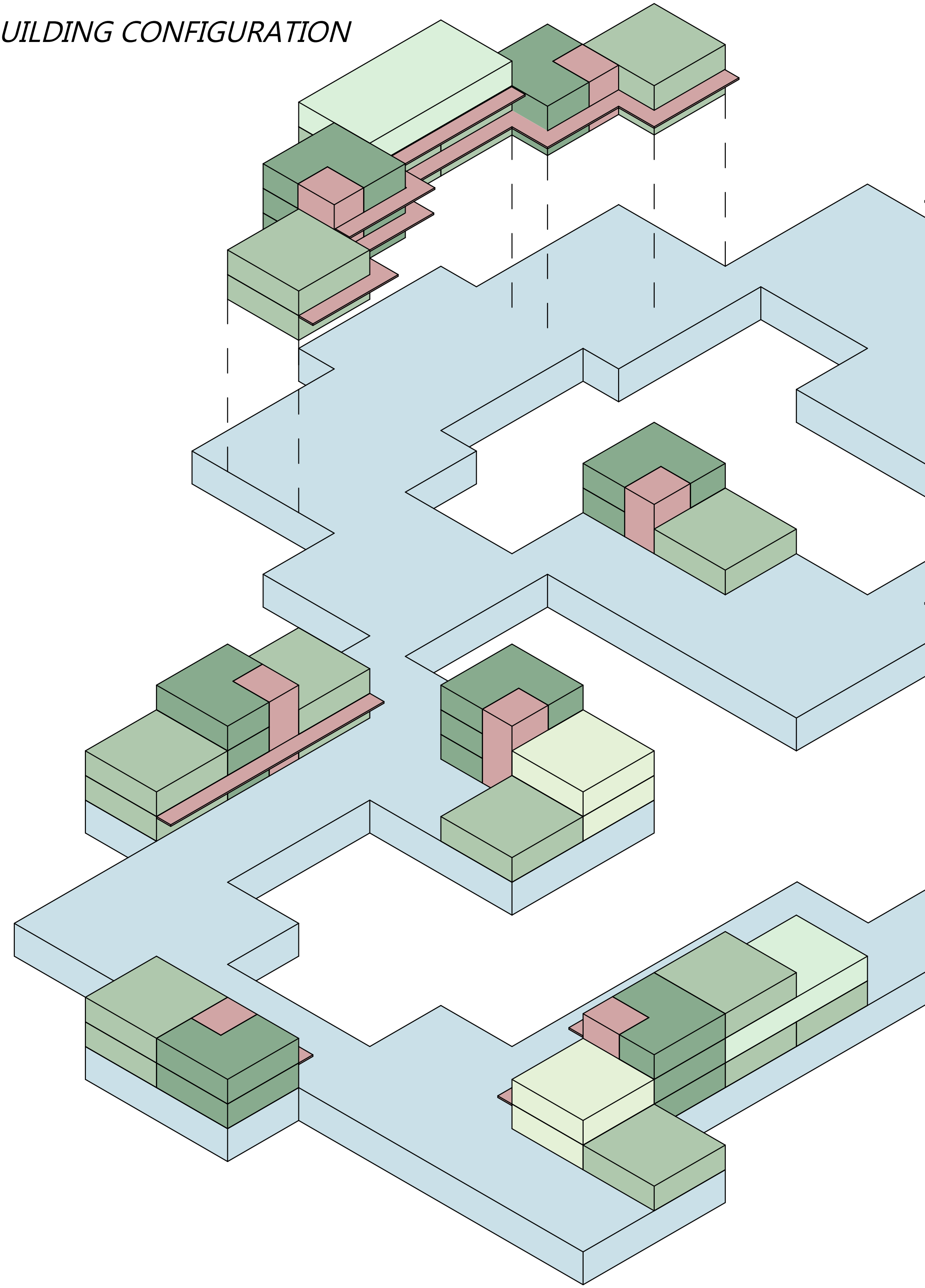
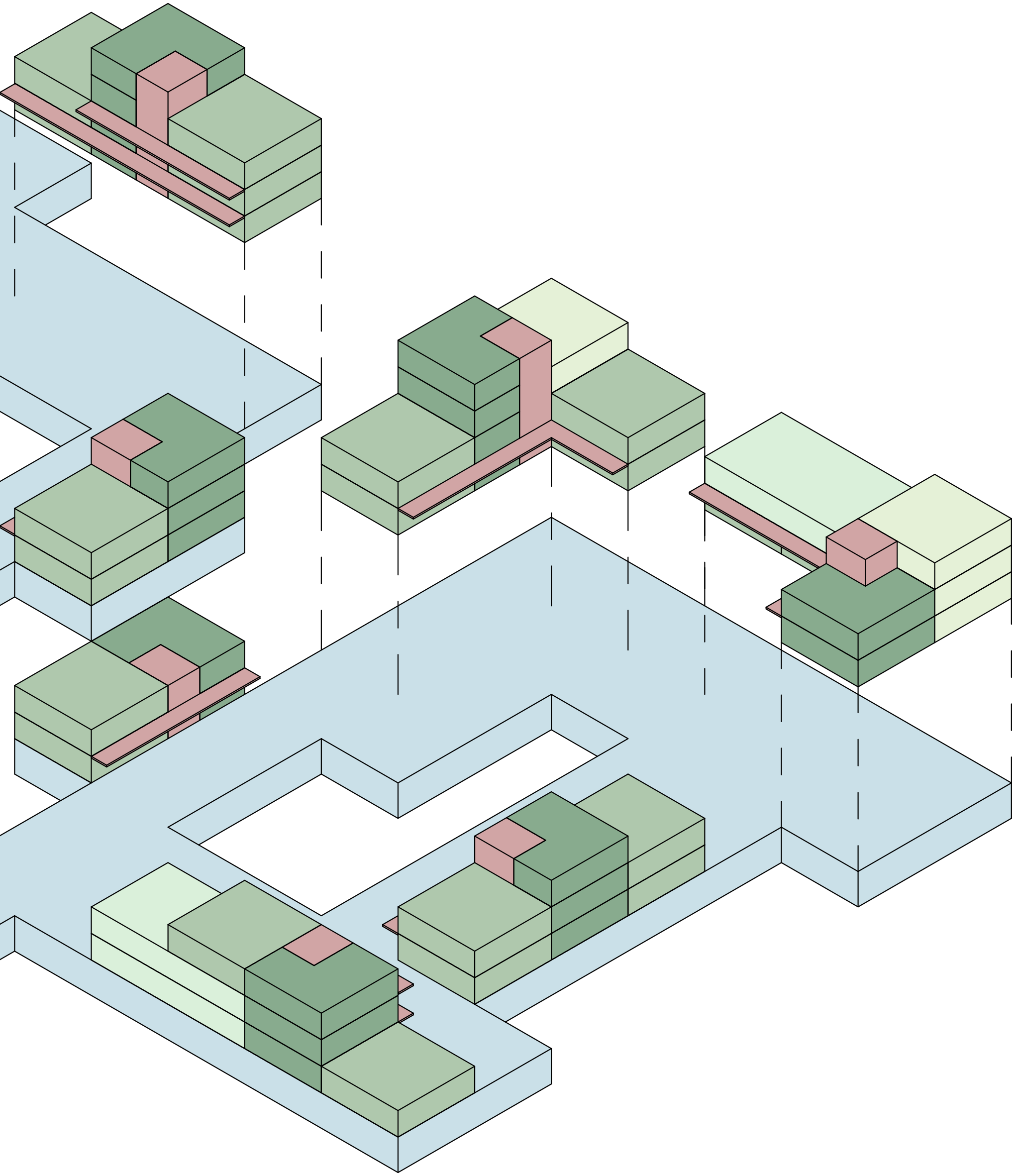


 Figure 105: *Building configuration*



SCALE OF THE MASTERPLAN

 Figure 106: *Nolly map*


N

RAISED GROUND PLANE

Because the dwellings are on top of the school building, a new ground plane emerges. The roof of the school building functions as a new street level. This area fulfils multiple goals, it functions as a new street level, and connects the student housing buildings. It also keeps the residences accessible during flooded periods. To make sure the project does not become an island when the landscape is flooded, the project is connected with an elevated access road to the village. Because of this, residents are always able to reach their home. In addition, the school can also keep operating. The main entrance will be closed, however via secondary entrances in the interior gardens, students can entre the school building.

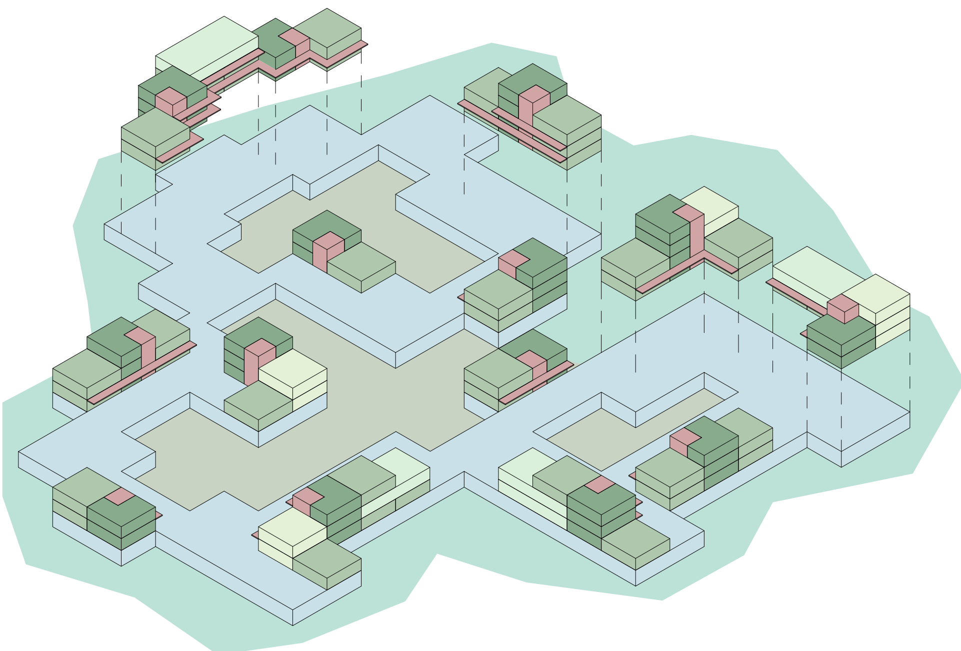


 Figure 107: *Masterplan conecpt with dry interior gardens (Axo)*

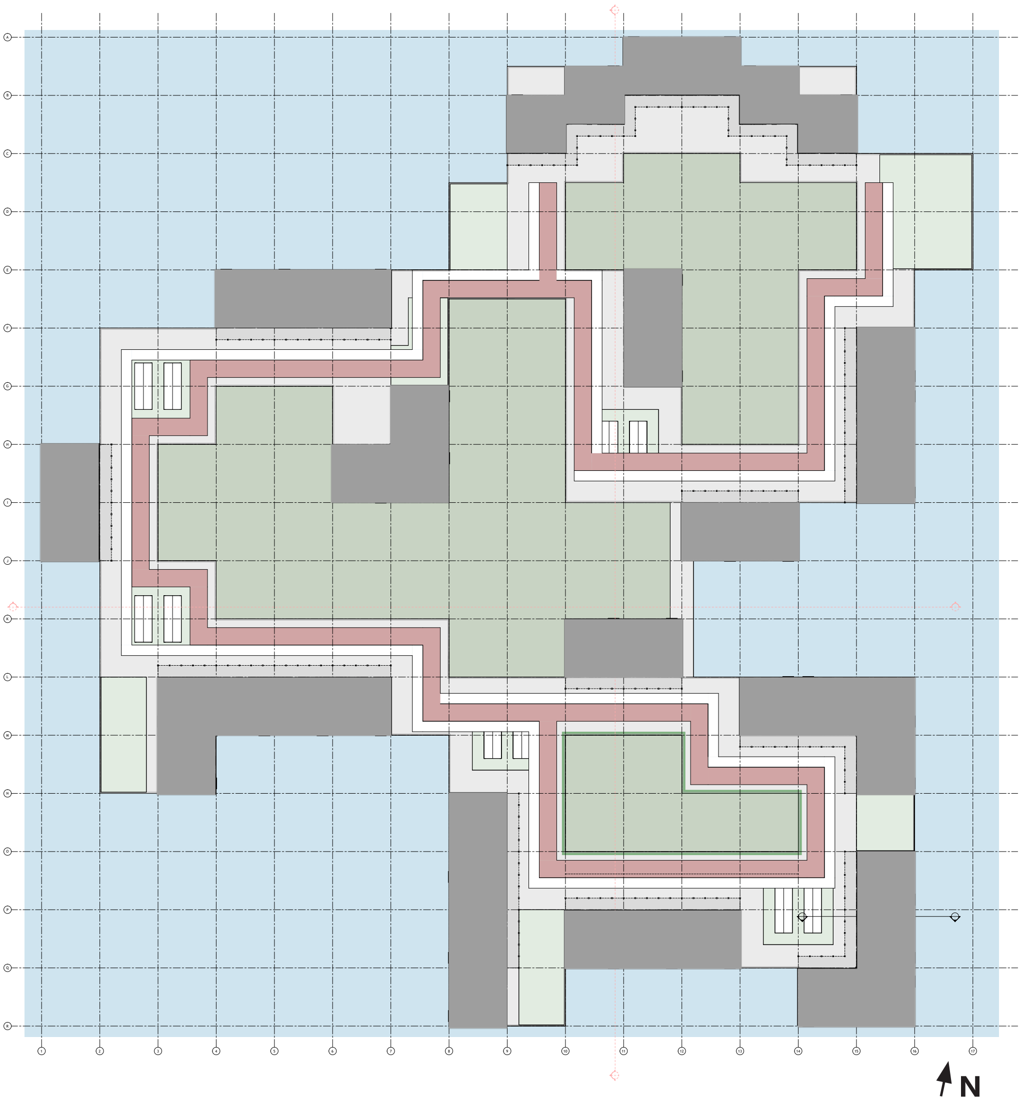


Figure 108: *Masterplan conecpt with dry interior gardens*

BUILDING DESIGN

Figure 109: *Project render (Image by author)*

MASTERPLAN

This project is one part of the urban masterplan for the village of Maasland. It is situated in a wetland area, that is also a floodplain. The aim for this project, within the urban masterplan, is to develop an adaptable building to a changing landscape. For the building to maintain functionality during times of both low and high water, the building plinth is made to be floodproof and the residential buildings are placed on top of this plinth.

During the development of the building design, different parts of the building concept are expanded upon. The main design challenge for this building is to connect the raised ground plane to the surrounding landscape and the interior gardens. Also the urbanity and the private, shared and public space are further refined. The materiality of the two separate building types is briefly discussed in the concept and is developed further in the final design.

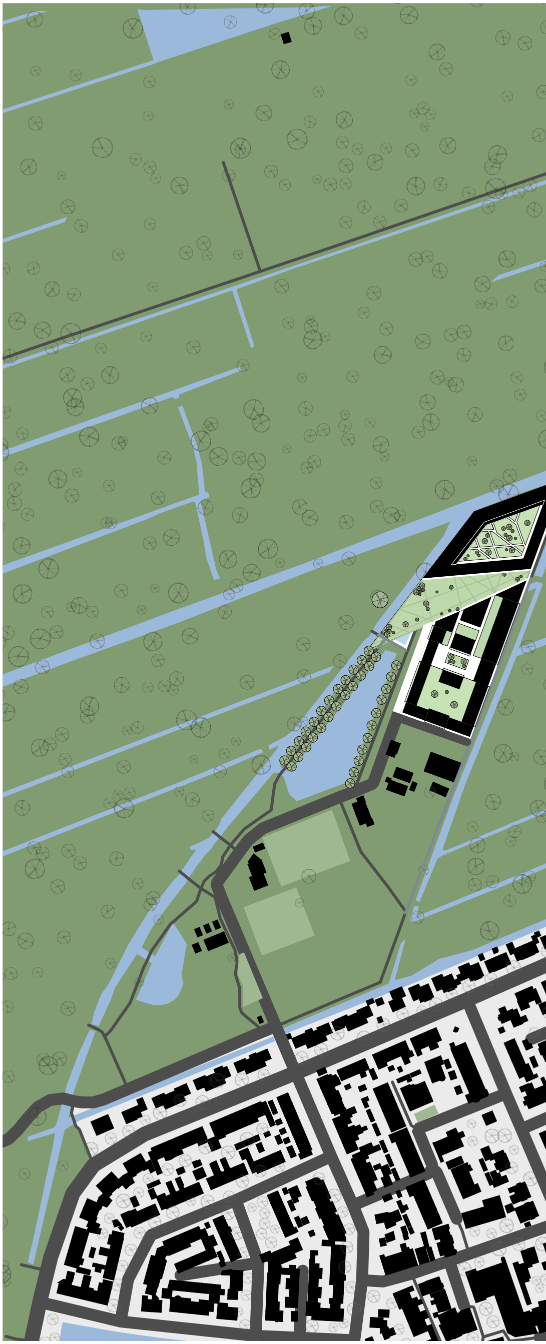
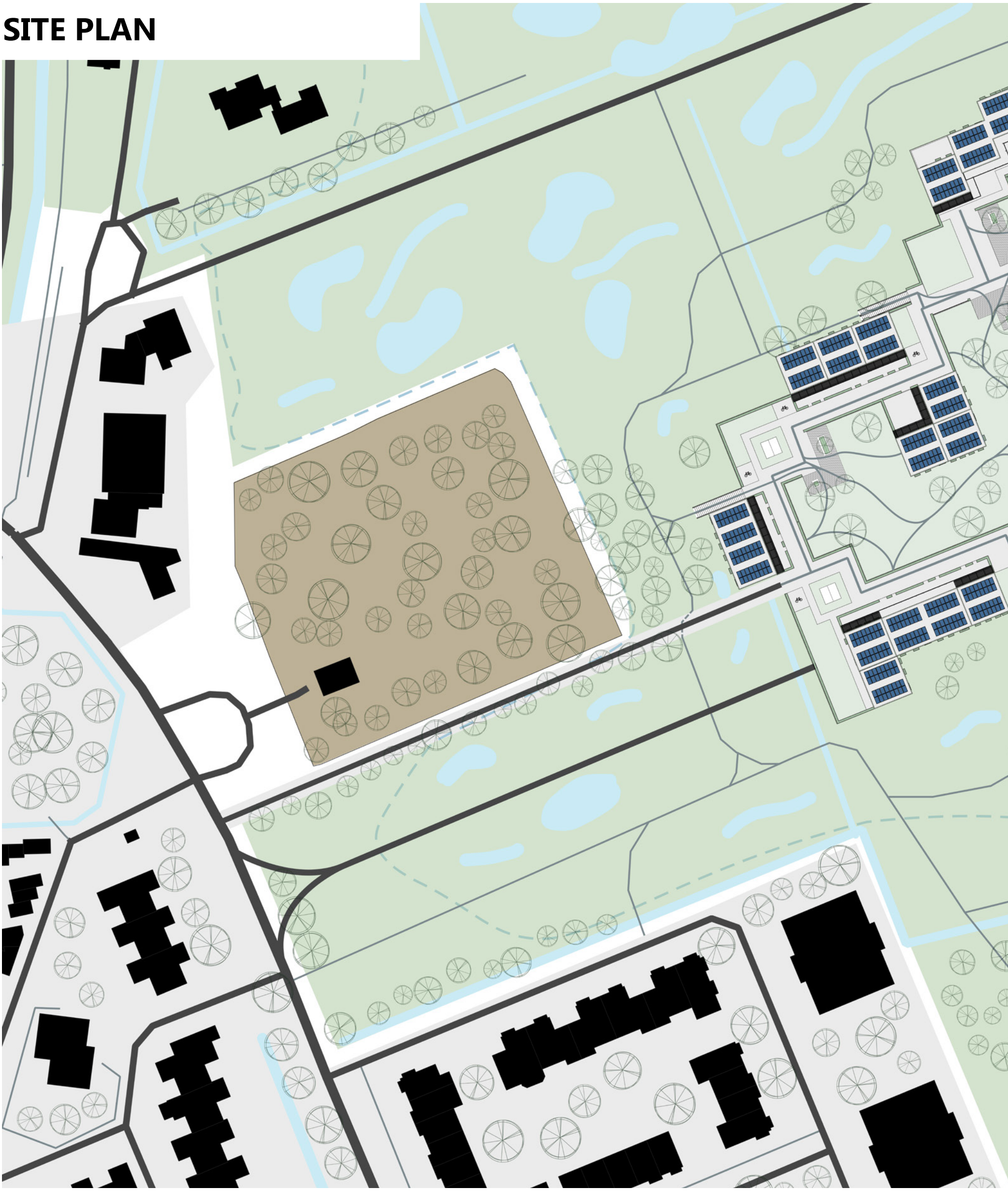


Figure 110: *Masterplan Commandeurspolder (Cas Castenmiller Max*

Meijer Shenaya Gocha-Dalger, 2024)

SITE PLAN



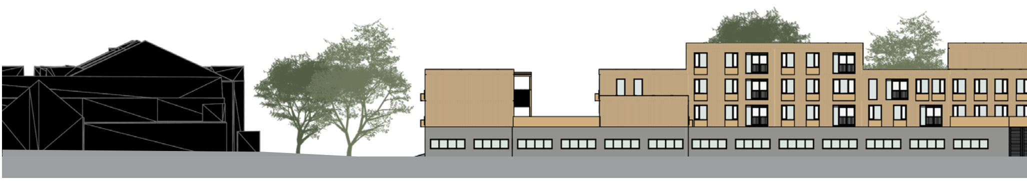
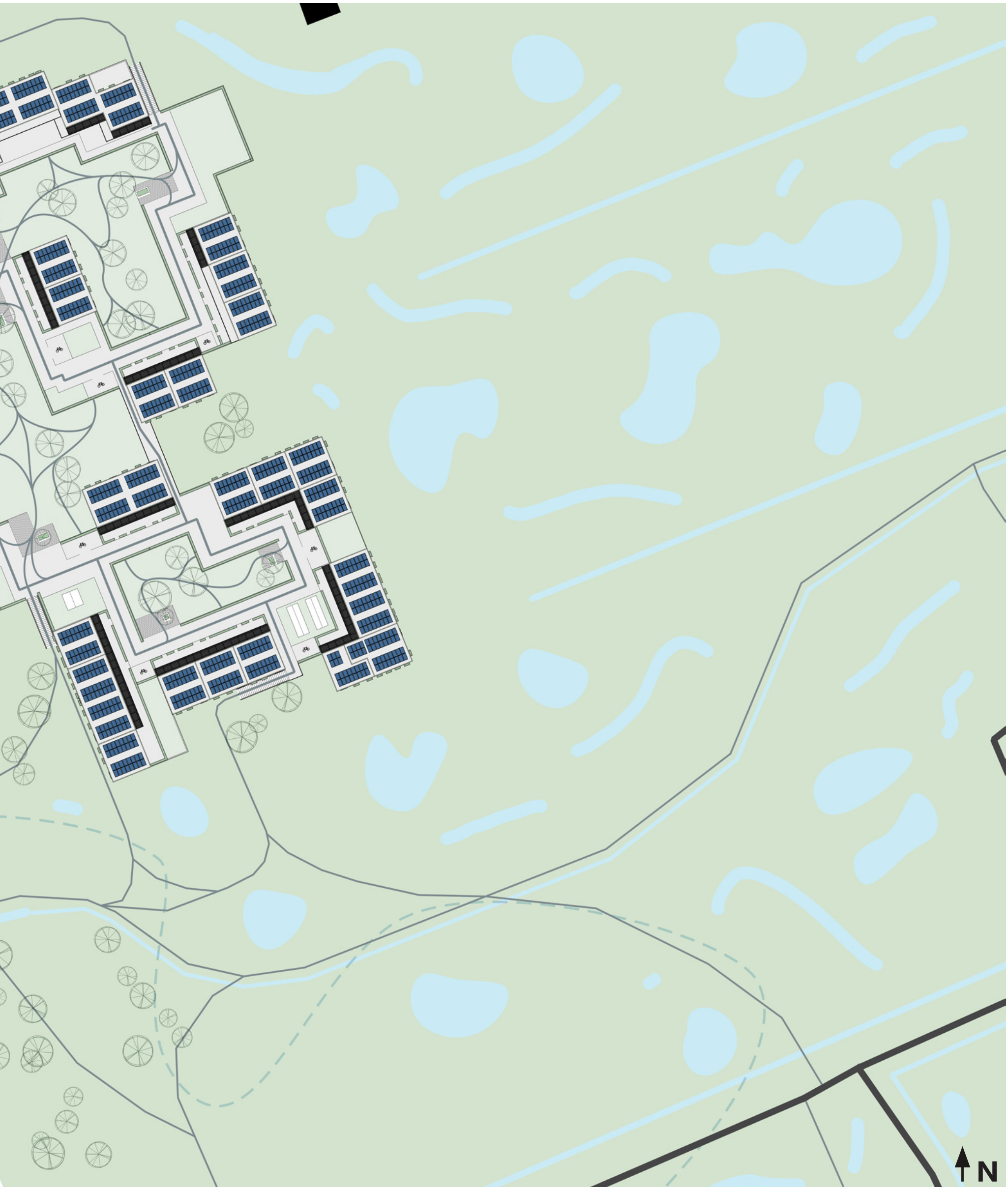


 Figure 111: *Site drawing (Urban intergration)*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RAISED GROUND PLANE

Figure 112: *Westelevation*

Figure 113: *First floor plan*

(raised ground plane)

Figure 114: *East elevation*

URBANITY

PUBLIC SPACE

The masterplan uses the roof of the school building as a plinth to protect the dwellings from the flooding landscape. This elevated position can create a distance and independence of the surrounding landscape. This however, was not the aim of the project. Both educational and residential buildings should have a close relationship with the landscape. The research showed that by incorporating (access to) greenery and features in the design of the raised ground plane, this area becomes closer connected to the surrounding landscape. Four main design features are contributing to this concept. *1) Access to greenery*. The layout of the school building created three interior gardens that will always stay dry. Large trees create a connection between the gardens and the raised ground plane. On this raised ground plane, multiple water retaining green spaces with grasses and low bushes are placed also the fencing is made with large planters containing grasses that appear in the peat landscape. Because of the different roof levels, most roofs are visible from other apartments. Therefore all roofs have an extensive green roof with sedum plants and grasses. *2) The use of pathways*. Surrounding the building and within the interior gardens many foot and bike paths cross the landscape (figure 111). This way residents can roam around in the landscape and through the interior gardens. *3) Connecting the two levels*. To connect the two different ground planes to each other two types of stairs are used. The first is a bike accessible staircase, connecting the bike paths outside the building to the raised ground plane. Making it easy for students to leave and explore and work in the surrounding landscape. The second type of stairs are large staircases with integrated benches and large planters for trees. These stairs connect the raised ground plane to the interior gardens. The benches in these staircases enable students to relax and stroll outside taking in the landscape. *4) Building materials*. The outside of the school building is made with concrete elements to reflect its structure and sturdiness against the landscape and floods. The buildings on top are made with natural materials from similar wood that is grown in the harvesting forests on the other side of the dike. Integrating local products into the architecture enforces the connection with the natural landscape surrounding the building. To create a closer connection between the school building and the residential buildings on top, the façades of the interior garden are made from the same materials as the residential façades.

Figure 115: *Impression: Raised ground plane*

Figure 116: *Impression: Stairs connecting internal gardens*

Figure 117: *Impression: Communal garden*

 Figure 118: *Impression: Galery acces*

BUILDING ACCES

In front of all residential buildings is a communal garden that is shared between all dwellings of that building block. This space has two purposes, the first is as shared outdoor space for the building. This is a space for meeting other residents and spending free time. The second purpose is to create some distance between the interior (private) space and the street. The garden functions as a transitional space between the public street and the private dwellings. Dwellings on the ground floor have their front door connected to the communal garden. Apartments on higher levels are accessed through the gallery in front of the façades. On the ground floor there is a main entrance for the building, behind this entrance is the circulation core. This core houses an elevator and stairs to get to the galleries. Some dwellings also have their front door directly connected to the circulation core. For larger apartment buildings, multiple circulation cores are placed. This prevents congestion and long distances between the buildings entrance and the front door of the dwelling.

Figure 119: *Impression: Communal garden*

CIRCULATION

FOOT/BIKE PATHS

Connecting the different parts of the building together was an important step for making the two functions of the project work together. Raising the ground plane creates a physical distance between the street and the landscape. The connection between the different public ground planes are more important because of this. To create this connection, large staircases are used to link the different levels of the project together. The staircases from the outside are accessible with a bicycle for better integration. Stairs that link the interior gardens focus more on wandering and enjoying the space by creating seating opportunities.

The raised ground plane has a main route around the project (figure 121 dark blue line). This route can also be used by cyclists as a quicker means of transportation. This area is a combined space for pedestrians and cyclists. In addition to this main route, there are also multiple footpaths through the interior gardens. The pathways in the interior gardens connect to the plinth to give access to the school building. They also create shortcuts within the project, to reach residential buildings or classrooms on the other side of the project faster.

Foot and bike paths that embed the building in the landscape are strategically linked to the building and the path structure. To link the path structures within the project and on the outside of the project together, the stair accesses are placed close to the stairs connecting the interior gardens with the raised ground plane. This creates a flow, from the outside over the raised ground plane along the paths, or into the interior gardens (figure 120).

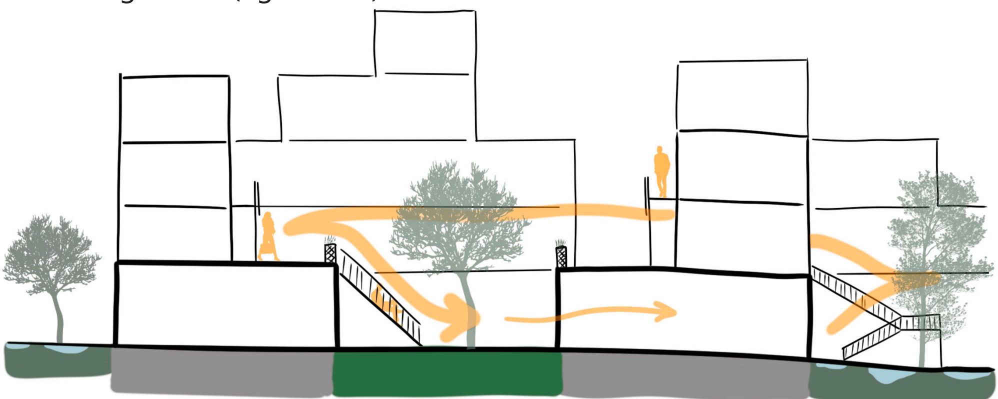


Figure 120: *Connection between the landscape/raised ground plane and interior garden*

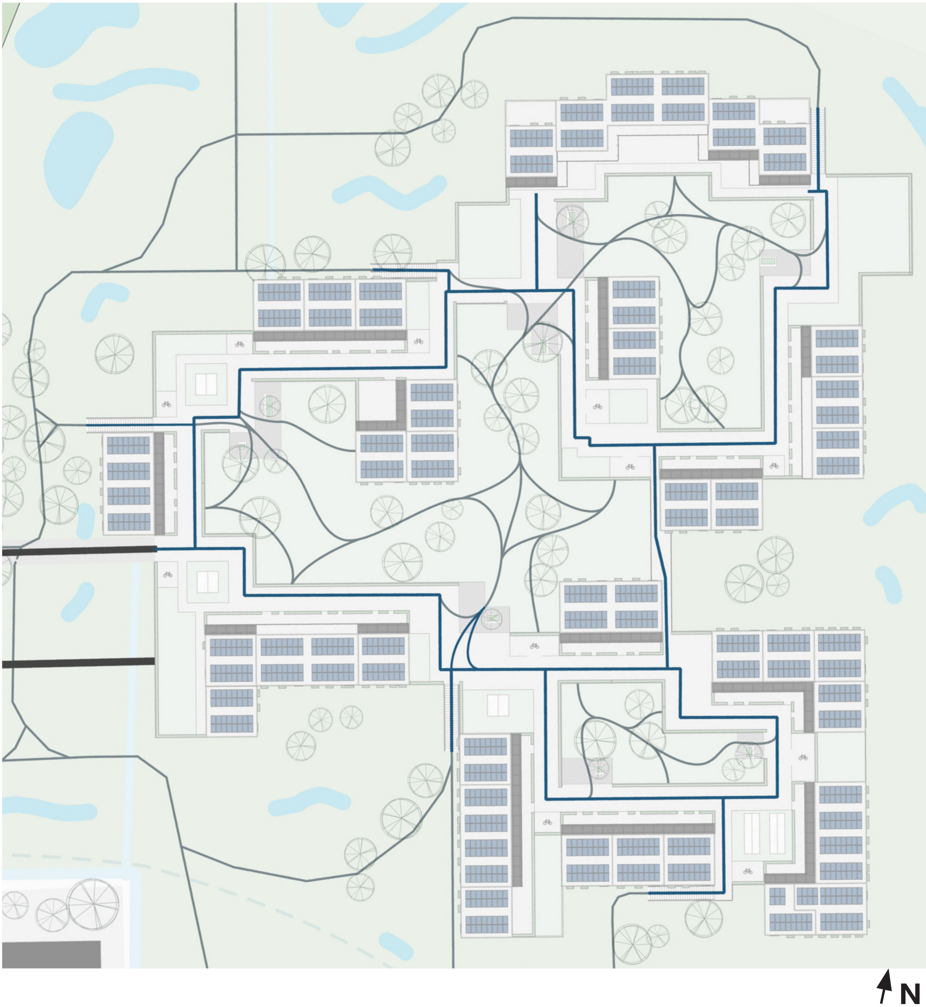


Figure 121: *Masterplan connecting bicycle and footpaths*

DWELLING CONFIGURATION

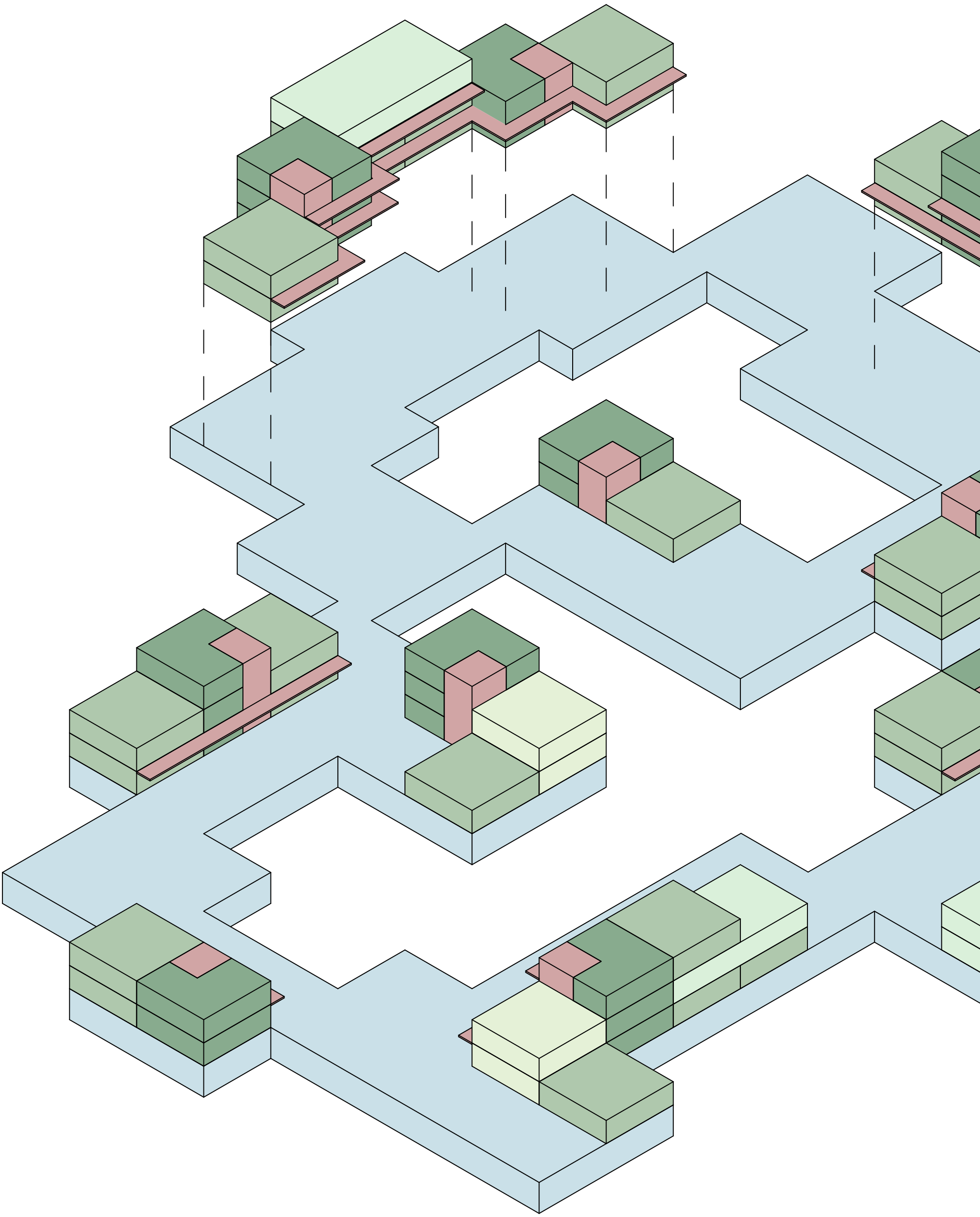
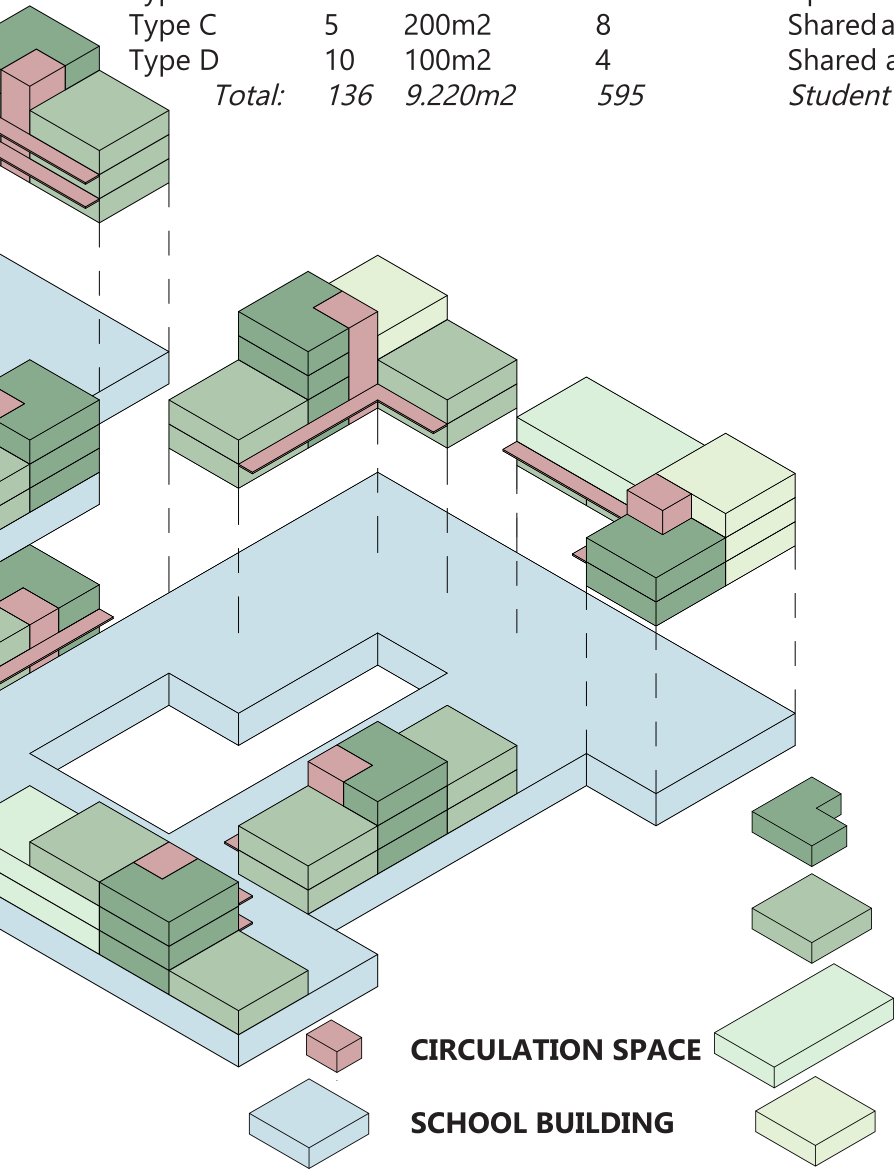


 Figure 122: *Dwelling configuration*

FACTS & FIGURES

Dwelling type	#	m2	Bedrooms	Living type
Type A	39	80m2	3	Shared apartment
Type B1	41	65m2	3	Shared apartment
Type B2	41	35m2	1 or 2	Apartment
Type C	5	200m2	8	Shared ammenties
Type D	10	100m2	4	Shared apartment
Total:	*136*	*9.220m2*	*595*	*Student houses*



DWELLING TYPES 1:20

TYPE A

Type A is a shared apartment with space for the vertical access core. This core houses the elevator and the stairs. The apartment itself has 3 bedrooms and has a shared living space and bathroom. The main aim for this dwelling type is for students to live together in smaller (family like) clusters. The main focus therefore is on the common living area, with private study space in each bedroom.

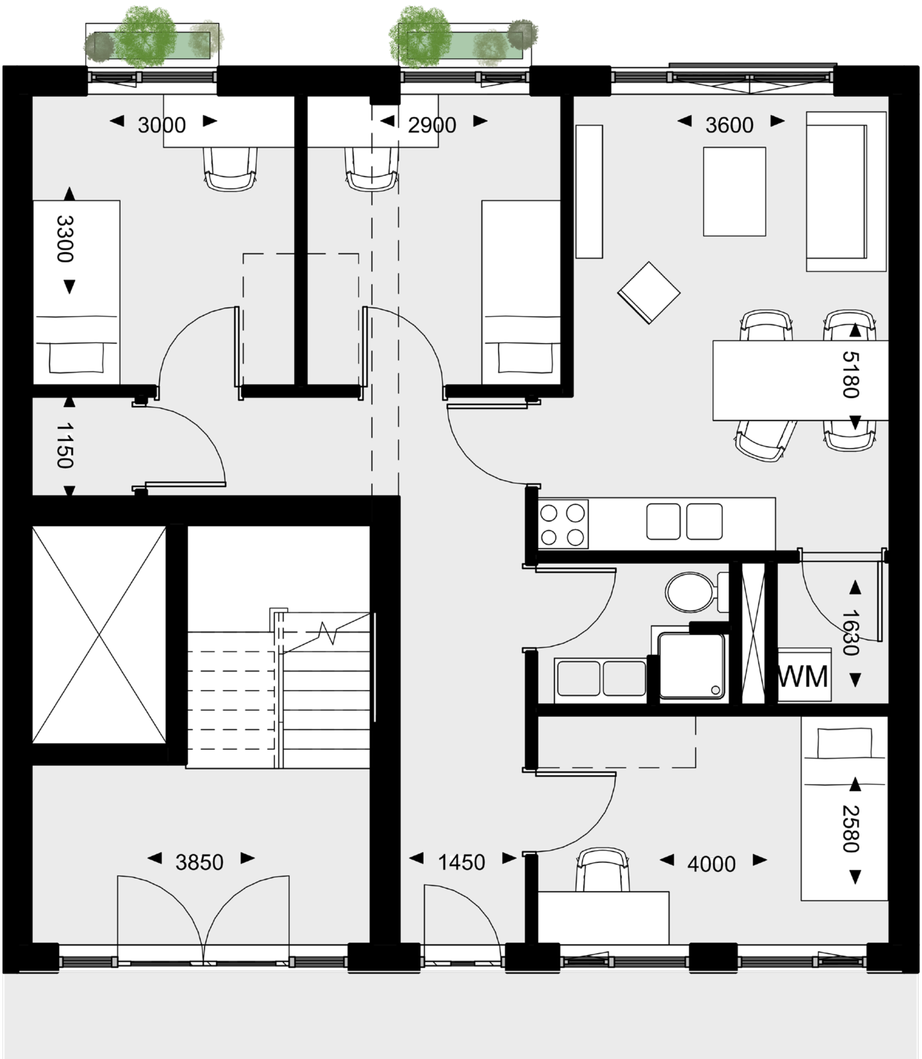


 Figure 123: *Dwelling floorplan Type A*

TYPE B

Type B is the 'standard' layout, consisting of two dwellings. The first dwelling type (B1) is a shared apartment with private bedrooms and a shared common space and bathroom. Similar to Type A the focus of this dwelling is on communal living, and having a private space for studying and sleeping. The second dwelling type (B2) is a private apartment for one to two people. It has one bedroom and a private livingroom/kitchen and also a private bathroom. This dwelling type is for students that want more space to themselves or want an apartment together with their significant other.

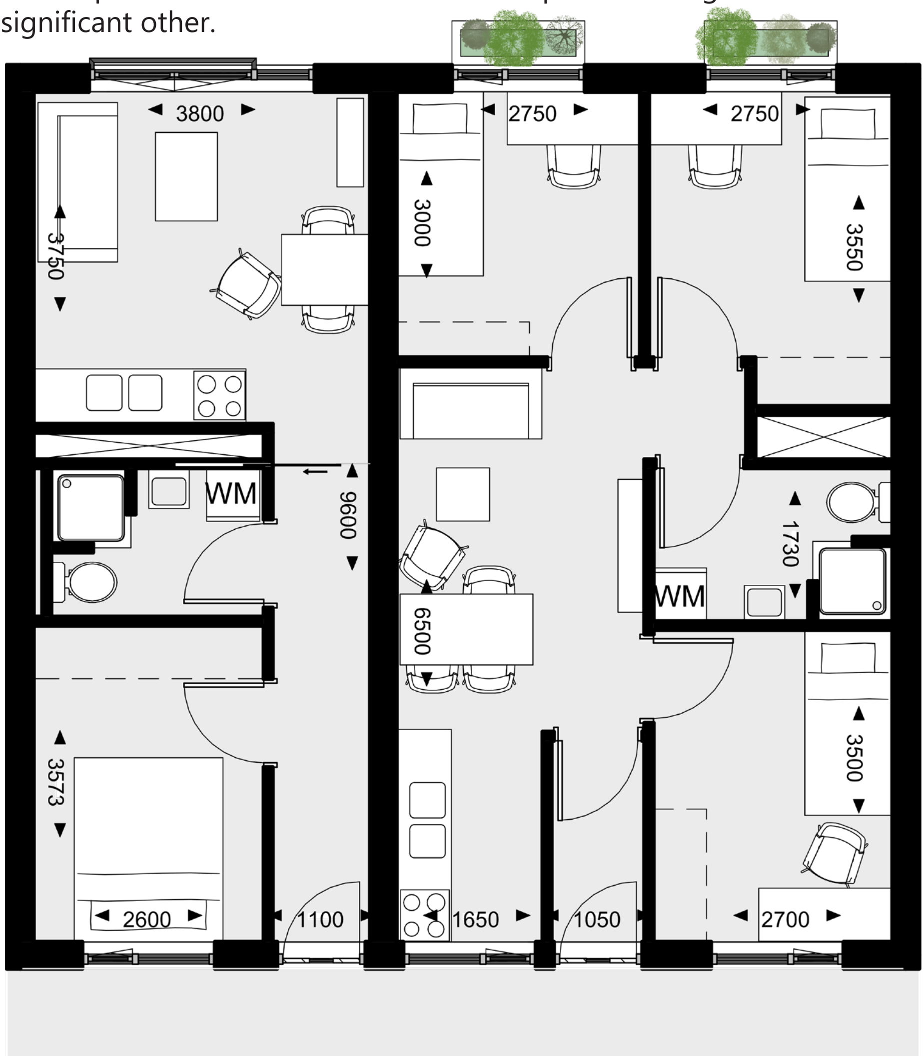


Figure 124: *Dwelling floorplan Type B*

TYPE C

Type C is the largest dwelling type. By connecting two blocks, a larger (single story) dwelling is created. Students living in this dwelling type want a more private room, but do not want a private dwelling like type B2. Most private bedrooms therefore are larger in size and also have space for a living room. Facilities like the kitchen and bathrooms are shared. And because it is a double sized dwelling, it also has two separate bathrooms.

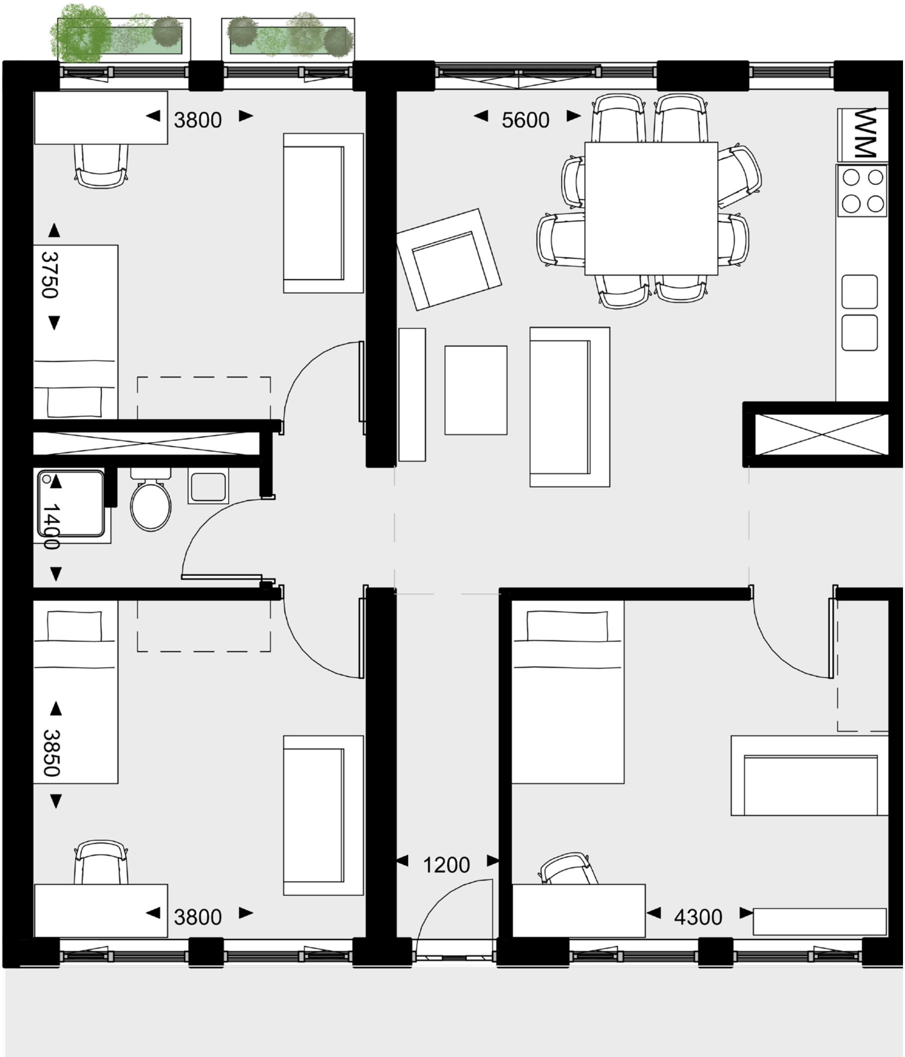
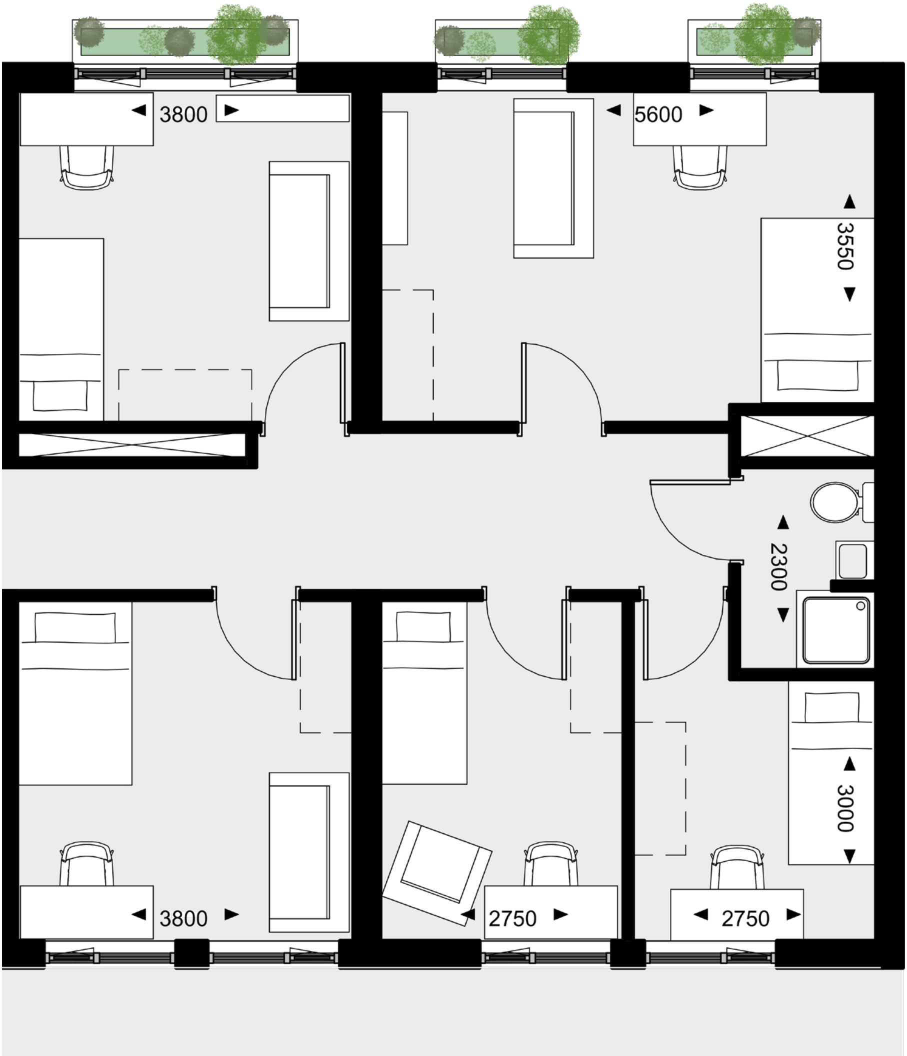


 Figure 125: *Dwelling floorplan Type C (connected)*

By coupling two blocks together, the same number of bedrooms can be created using the same space. However, this welling type saves space by only having one kitchen for two blocks and a smaller living room, creating the possibility for larger private rooms. With space for a seating area



TYPE D

Type D is also a shared dwelling with private bedrooms and shared facilities. Because of the configuration of the apartment buildings, some buildings had a corner in its plan. This created the need for a corner apartment. All previous dwelling types have two façade walls and two structural walls on opposite sides of one another. The corner apartments have two connecting façade walls and two connecting structural walls, creating the need for a special dwelling type. This dwelling type is divided in two parts. The left houses the common areas like the living room and kitchen and the bathroom. The other side of the dwelling has the four bedrooms equally sized private bedrooms with study area.

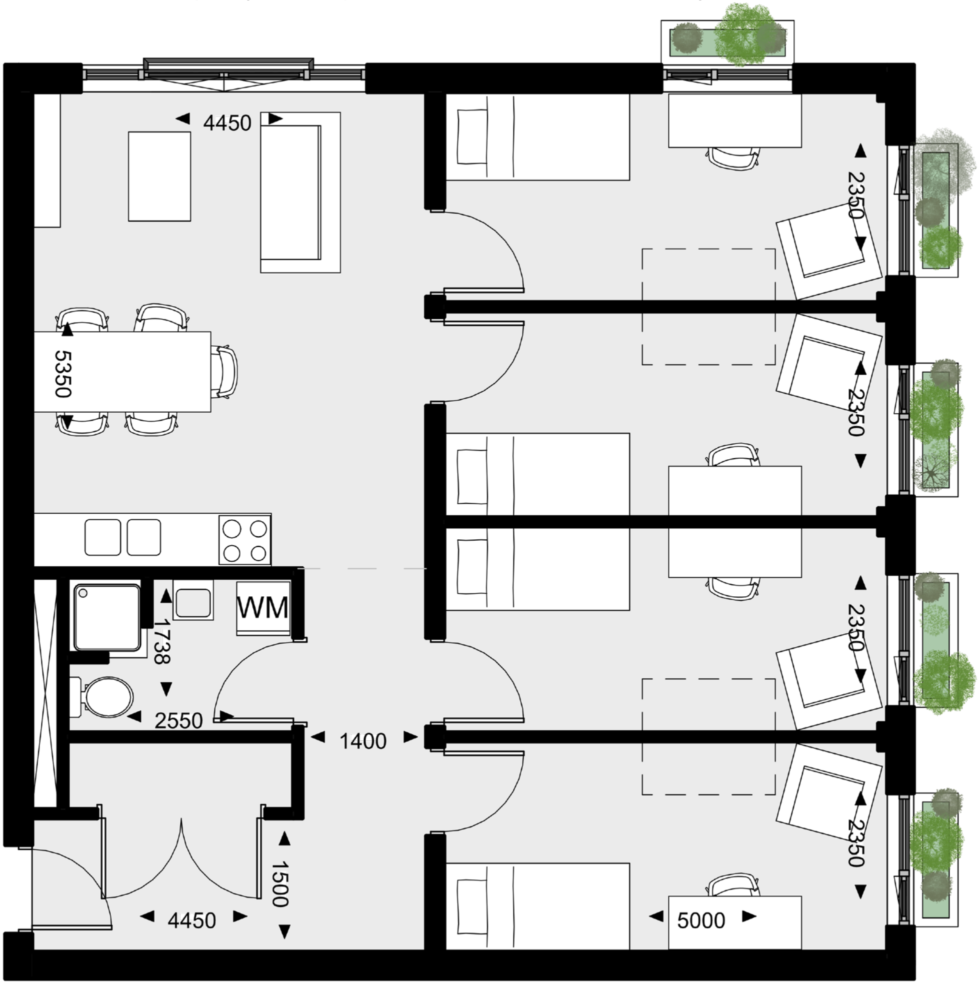


 Figure 126: *Dwelling floorplan Type D*

Figure 127: *Study space in private bedroom*

Figure 128: *Livingroom Type B2*

IMPRESSIONS

 Figure 129: *Impression: Masterplan in wetland landscape*

 Figure 130: *Impression: Masterplan in flooded landscape*

Figure 131: *Raised groundplain with interior garden*

Figure 132: *Shading strucutre on south facing façade*

Figure 133: *Galery acces system*

Figure 134: *Stairs connecting interior gardens and raised ground plane*

Figure 135: *Building in dry state*

Figure 136: *Building in flooded state*

Figure 137: *Galery acces system*

Figure 138: *Communal garden*

BUILDING TECHNOLOGY

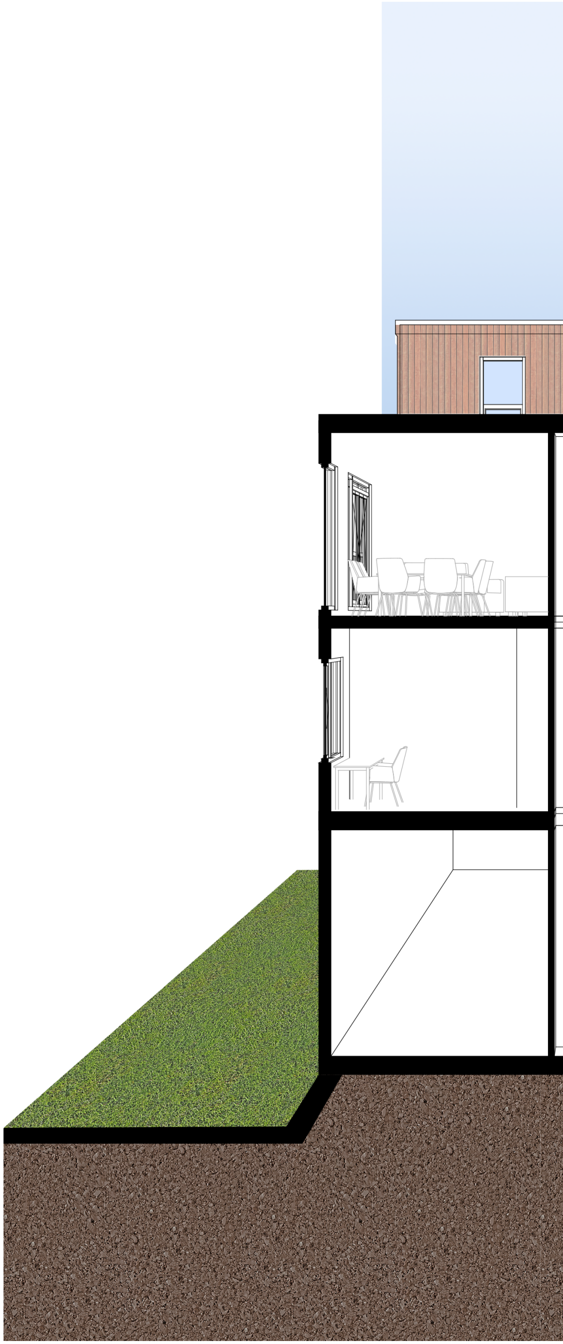


Figure 139: *Cover photo (Image by author)*

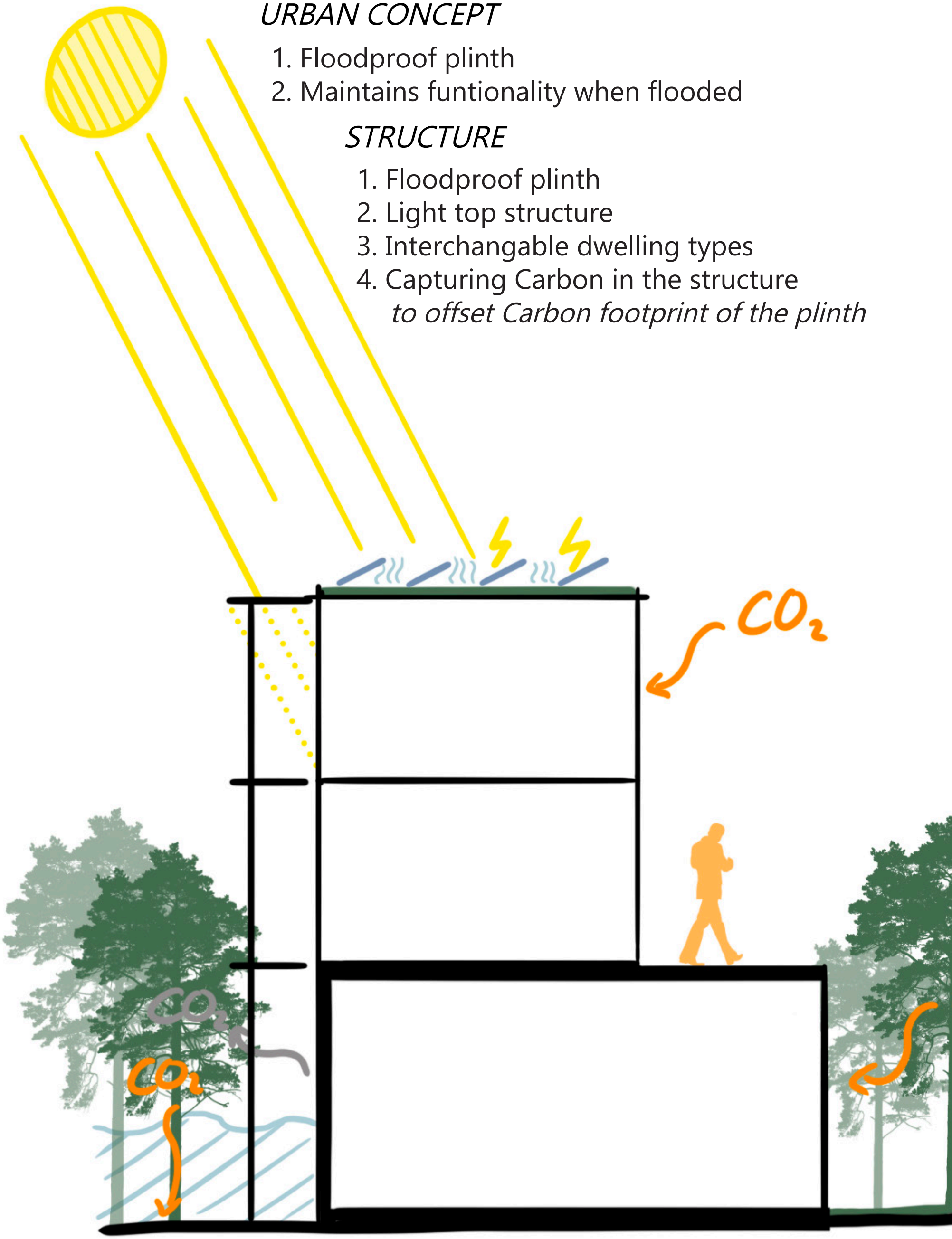
AMBITIONS

URBAN CONCEPT

1. Floodproof plinth
2. Maintains funtionality when flooded

STRUCTURE

1. Floodproof plinth
2. Light top structure
3. Interchangable dwelling types
4. Capturing Carbon in the structure
   to offset Carbon footprint of the plinth



CLIMATE

1. Energy efficient ventilation system
   Shared ventialtion system for each block
2. Renewable heating (and cooling)
3. Lowering heatload on the building
4. Renewable energy supply

FAÇADE & ROOFS

1. Capturing Carbon
   In façade cladding
   In the façade structure
   In Insulation
2. Reducing heatload
   Shade structures and others
3. Extensive green goofscape
   Low impact greenery on the roofs
4. Renewable energy supply

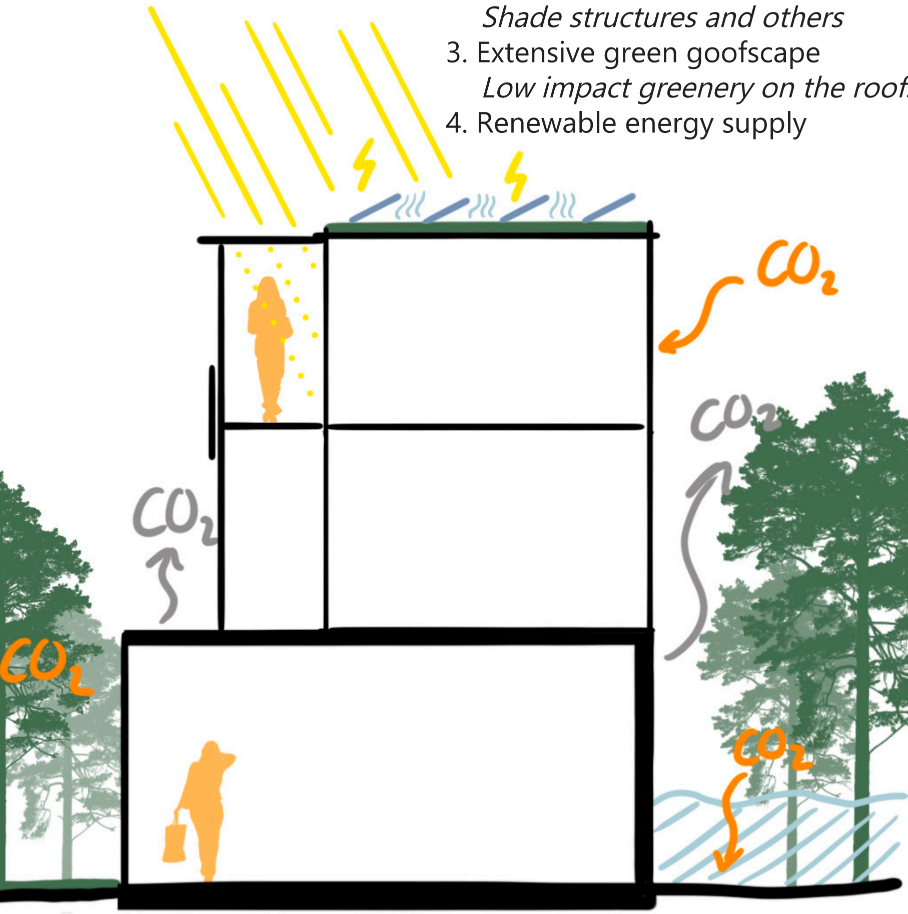


Figure 140: *BT ambitions diagram*

STRUCTURAL DESIGN

AMBITIONS

The projects ambitions highly influenced the material choice for the structure. Due to the ambition of a lightweight structure, the choice was between wood and steel structures. Because the structure needed to capture Carbon to offset, the emissions of the plinth, wooden structure types where left. A wood frame building was an option, however because it is a frame there is less Carbon captured, and CLT was chosen for the structure.

Due to the structural constraints of CLT, truly interchangeable dwelling types where not possible. However, during the design phase the dwelling types can be placed anywhere, with minimal impact on the structure.

STABILITY

The stability of the buildings in the project is achieved by a central core also used as a vertical transport hub. This element (combined with the corner in the building) achieves stability as is shown in figure 141. For longer buildings without a corner a second stability core is placed.

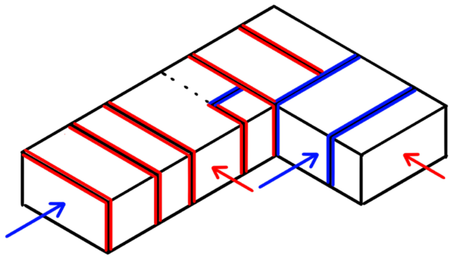


Figure 141: *Stability diagram*

SPANS & ELEMENT SIZES

For the design of the structural CLT elements three factors informed most of the dicisions. 1) Structural capability for free spans, 2) The dwelling floorplans, 3) Transport of the elements.

CLT elements are capable of spaning up to 6m (IMBO et al., 2021). so the elements had to be supported between the grid lines. To be able to place a structural wall, the dwelling floorplans had to be changed slightly, however most of the floorplans had a wall splitting the square block into two parts (around 5,5m and 4,5m). This wall became the extra structural support wall.

Wall elements are 3 by 10 meters to span the wall in one element. 3m is a standard size for CLT elements. The floor elements are also 3 meters wide and span in between two structural walls. These sizes are easily transportable on a truck.

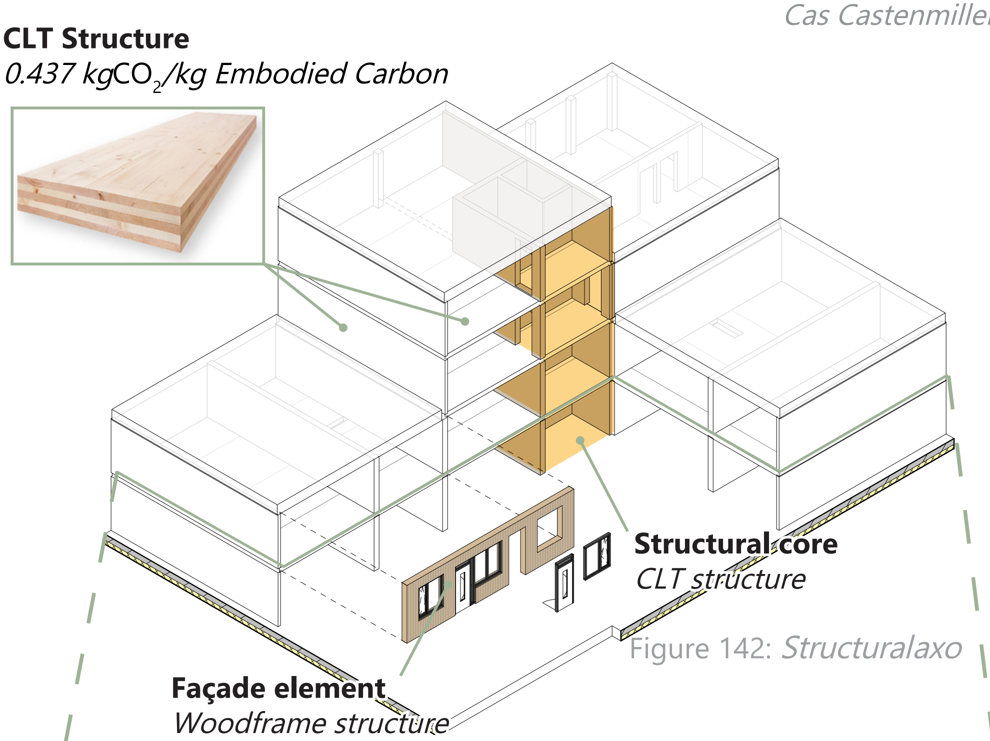


Figure 142: *Structuralaxo*

Figure 143: *Structural plan*

SUSTAINABILITY

CARBON EMISSIONS

Because the plinth op the building is made out of concrete, to ensure the flood proofness of the building, this produces vast amounts of CO_2. According to the Dutch ‘Nationale millieu database’ on site casted concrete of 200 mm has a measured Carbon footprint of 3,095 kg CO_2 / m^2. Similarly prefabricated concrete hollow core floors have a measured Carbon footprint of 3,875 kg CO_2 /m^2.

This measured Carbon footprint incorporates CO_2 emissions starting at the production proess, all the way through the life expectancy of the building. This also includes Carbons savings from (partial) reuse. Figure 144 shows the calculation for the CO_2 footprint of the building plinth.

Type	**kg CO_2 /m^2.**	**m^2**	**metric tons CO_2**
Walls	3,095	2.517	7,79
Floors	3,875	11.549,44	89,51
Totals:			**97,3**

Figure 144: *Carbon emissions of the plinth (Data source: (Stichting Nationale Milieudatabase, n.d.-a))*

Although wood is a material with a negative Carbon impact, transport and other production methods expel Carbon. According to the Dutch ‘Nationale millieu database’ this is a very small amount. Figure 145 shows the Carbon footprint of the wooden structures.

Type	**kg CO_2 /m^2.**	**m^2**	**metric tons CO_2**
CLT	0.011	7.914	91,04 Kg
Woodframe	0,299	5.805	1,74
Cladding	0,479	9.771	4,68
Totals:			**6,51**

Figure 145: *Carbon emissions by the wood structures (Data source: (Stichting Nationale Milieudatabase, n.d.-a))*

**Prefabricated façade panels where not in the database, therefore the calculation used a less optimal type of concrete.*

EMBODIED CARBON CLT

One of the ambitions for the project was to offset the Carbon emissions of the plinth by the lightweight top structure. To calculate the embodied Carbon of the wooden elements, the material needs to be multiplied with the Carbon factor of the material. For CLT this factor is 0,437 kg CO_2 / kg (Orr et al., 2020) In figure 146 the embodied Carbon for the wooden elements of the top structures is calculated.

Type	**Carbon factor** *kgCO$_2$ / kg*	**Density** *kg/m^3*			**m^3**	**kg**
CLT	0,437	480			1918,29	920,77 •10^3
Woodframe	0.263	456	*6,1%*	*89*	1741,65	155,10 •10^3
Plywood		550	*1%*			
Insulation		60	*92,9%*			

Type	**kg of CO_2**	**Metric tons of CO_2**
CLT	402.380,5	402,38
Woodframe	40.792,5	40,79
Totals:		**443,17**

Figure 146: *CO_2 captured by the wooden structure and façade elements*

The calculation shows that all CO_2 emissions by the plinth and top structures are more than compensated for in the CLT structure. Although the result of -339,36 metric tons of CO_2 emissions is achieving the ambition of compensating the Carbon footprint of the plinth, it is also a lot more compensation than is necessary. Therefore a different structural method could be used with less embodied carbon. Wood frame elements that are used in the façade can be also used for the structural elements. Because the wood frame elements are less dense the total captured carbon is 86 metric tons. This is not enough to offset the plinth, but a hybrid structure of CLT and wood frame elements can get the Carbon offset closer to the emissions.

CLIMATE DESIGN

The ambitions for the climate design mostly focused on renewable and efficient systems for heating, cooling, ventilation and energy supply. Because of the goal for all systems should run on renewable energy, the energy need should be as low as possible.

Energy

A low profile form of renewable energy supply are PV solar panels. However, the size of the roof(s) is not large enough to be able to accommodate the full energy need of the building. Also because of the different roof heights, there should be space left for an extensive green roofscape. Therefore, the amount of solar panels on the roofs is limited, but should be (close to) sufficient for the energy consumption of the climate systems.

Heating and cooling

For heating and cooling a efficient and renewable system is hot & cold storage in the ground. The drawback of this system is that it needs a large userbase for it to work properly, and be cost effective. However, for this project that is not an issue. All the apartment buildings combined with the size of the school, are more than enough to meet the consumption requirements of a hot & cold storage system.

Insulation

To minimize the energy need of the heating and cooling system, the building should be well-insulated. Also one of the ambitions was to capture as much carbon in the façade as possible. Therefore, the insulation of choice is the steico flex. This has a high R-value and is made from wood fiber, so it captures carbon. With standard size wood frame elements the R_c value is 5,55. For the roofs a more rigid variant of this insulation is used, with an additional sedum layer helping to insulate the roof even more. The roofs therefore have a an R_c value of 9,80.

Ventilation

For the ventilation system the choice was between an purely mechanical (type D) and a hybrid system (type C). The type D system has the ability to preheat the fresh air with an heat recovery system, however this would take up more space and also require more energy for the ventilation system. A type C system on the other hand, takes fresh air from outside (through vents above windows and doors), and is extracted via a duct. This system requires less energy, however it requires more from the heating system to heat up the fresh air. In a BENG calculation the difference and impact of each system can be analysed.

BENG CALCULATION

In figure 148 the BENG calculation for one of the residential buildings is calculated using the program of Uniec 3. All three BENG requirements are calculated, for 3 different design options. The first option is calculated with the setting seen in figure 147. Option 2 replaces the triple glazing for double glazing because this decreases material use and building costs. Option 3 changes the ventilation system to ventilation type D (mechanical supply and extraction) with a heat recovery unit, to use a more energy-efficient system.

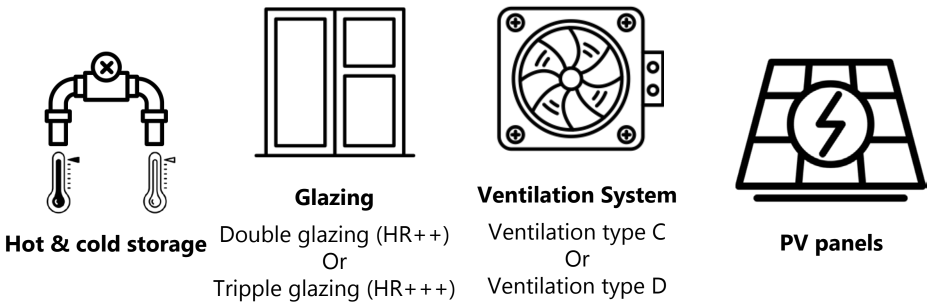


Figure 147: *Building settings for BENG calculation*

BENG 1:

The BENG 1 looks at the primary energy needs of the building. It does not take any climate installations into account. Option 1 and 3 have the lowest energy need according to BENG 1. Because both options are well insulated and have the least energy entering the building. The double glazing is less insulating. This requires more energy to heat the building in the winter

BENG 2:

BENG 2 looks into the fossil energy needs of a building. It takes the fossil energy per kWh of the Dutch energy production and uses it to calculate the amount of fossil energy needed. With increasing amounts of renewable energy on the Dutch grid, this result will only decrease. Because of the heat recovery system in the ventilation system, option 3 this is the most efficient.

BENG 3:

The last BENG requirement is the percentage of renewable energy. Similar to the BENG 2, the highest percentage for the BENG 3 is also option 3 because of the renewable systems in the ventilation.

CO_2:

The CO_2 emissions calculation is like the BENG 2 based on the fossil energy per kWh of the Dutch energy grid (Mijzen, 2023). Because option 3 has the most renewable energy and needs the least energy there is also the lowest CO_2 emissions.

TO_{juli}:

The TO_{juli} is a indicational number of the temperature exceedance in the month of July (Kuilder, 2024). Until the first of July 2024 all buildings with active cooling have a TO_{juli} of zero. Because this rule will change the TO_{juli} is also calculated without active cooling, these numbers are therefore not representative of the design, but they are indicative for a comparison between the different options. In addition, because of the use of hot/cold storage there is a need for active cooling in the summer to replenish the hot source, which will be used in the winter. Because of the well-insulated shell of the building, and the ability to directly get a fresh air supply (without transporting the air through the building via ducts), Option 1 has the lowest TO_{juli}.

Metered energy usage:

Because of the heat recovery in the ventilation system, less energy is needed for option 3 to heat the building. Option 2 does not have the heat recovery, and therefore only can use the heat exchanger from the hot/cold storage. Which uses more energy than the combined system.

Energy usage:

Heating:

Similar to the explanation for the metered energy use, Option 3 needs less energy to heat the building from the hot/cold storage. However, the energy need for the ventilation is significantly more.

	BENG 1		BENG 2		BENG 3		
variant	energiebehoefte [kWh/m²]		fossiel [kWh/m²]		hernieuwbaar [%]		CO_2-emissie
	eis	resultaat	eis	resultaat	eis	resultaat	[kg]
basisberekening	76,37	55,93 ✔	50,00	9,95 ✔	40,0	90,7 ✔	2.041
Double glazed windows	76,37	70,24 ✔	50,00	15,85 ✔	40,0	87,4 ✔	3.251
Type D ventilation	76,37	55,93 ✔	50,00	4,74 ✔	40,0	94,4 ✔	972

 Figure 148: *BENG calculation (Uniec3, 2024)*

Cooling:

The same explanation as for the TOjuli can be used here. Because there is a quicker way of getting fresh air into the building without passive preheating in ducts, the energy need for cooling is lower. However, due to the hot/cold storage cooling will be used nonetheless.

Ventilation:

As explained for the heating energy usage, the ventilation systems for options 1 and 2 are less complex, and therefore use significantly less energy.

By viewing all results, and adding up all the 'best' results, the option with ventilation type D (option 3) shows to be the most energy efficient and has the best scores for all three of the BENG requirements.

The results of this research have led to further investigation for solving the overheating problem in the summer. Further research into shading structures is needed to decrease the heat load on the building. Also due to the lightweight structure, there is not much thermal mass to regulate the heat load peaks during summer days. With the development of the façade, attention must be paid to increase the thermal mass with the insulation of the wood frame panels.

$TO_{juli;max}$		elektriciteit gebruik op meter [kWl Niet gebouwgeb. 27.000			energiegebruik [kWh]				
Without Cooling	With Cooling	gebouwge	opgewekte elek.	totaal	verw.	tapw.	koel	vent.	
2,85	0,00	30.095	24.091	33.004	13.538	13.835	815	1.907	4
2,95	0,00	33.654	24.091	36.563	16.883	13.835	1.029	1.907	1
4,13	0,00	26.951	24.091	29.860	7.949	13.835	928	4.238	6

SOLAR STUDY

SUMMER | *WINTER*

South & east

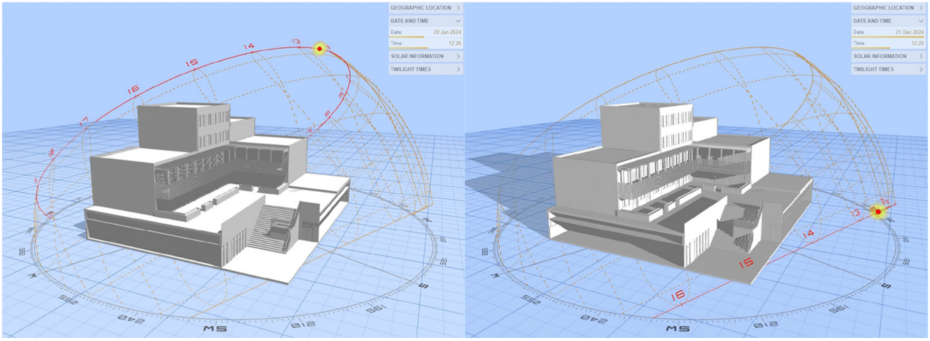


Figure 149: *Solar study south*

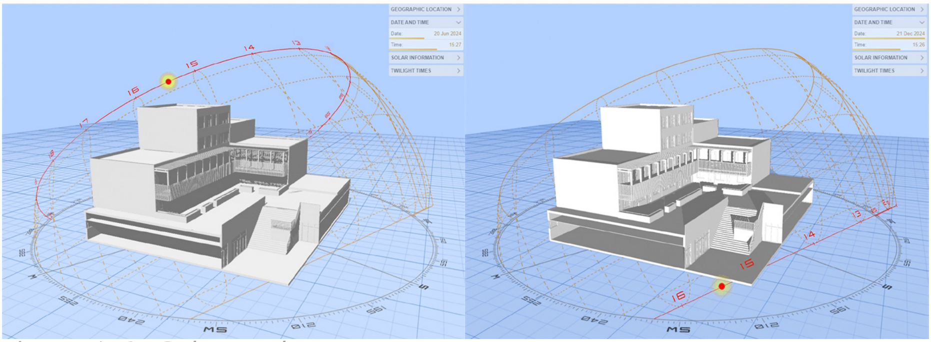


Figure 150: *Solar study east*

Brise soleil

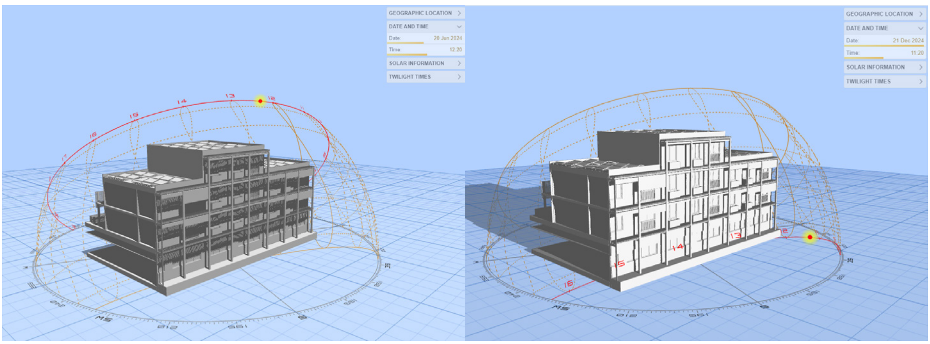


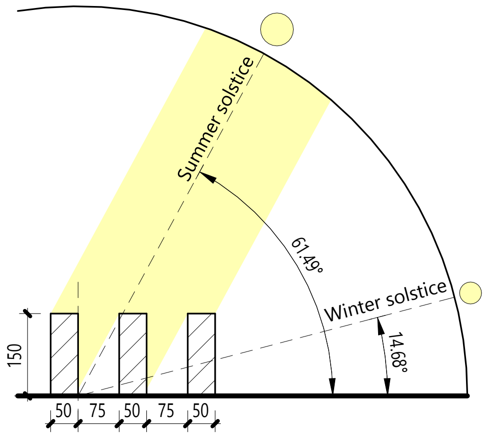
Figure 151: *Solar study south without galery*

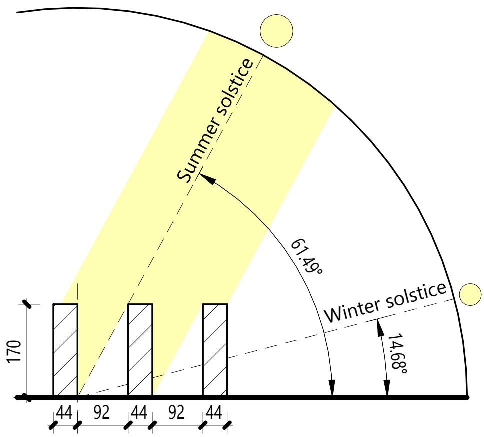
Shade structures

To decrease the heat load on the building, a shading structure needs to be placed on the façade. To determine which façade orientations need a shading structure and determine the size of the overhang, a 3d model is studied with accurate sun and shadow angles using the 3d solar tool of Dr. A.J.Marsh. This resulted in the conclusion that all south and east façades need a shading structure of approximately 2 meters overhang to create shadow on all glass surfaces during the summer months and have no influence on light entering the building during the winter.

Shade slats

The original shape of the slats are not based on any actual measures. To optimize the shading structure, actual wood sized are introduced and compared. Creating a wider gap, to optimize the amount of daylight reaching the façade without letting sunlight pass directly through the structure, the slats need to be taller. To stay in line with the proposed character of the design, proportions resembling the design more closely are used. This means that the distance between the slats is less, but the proportions of the slats are closer to the proposed design.





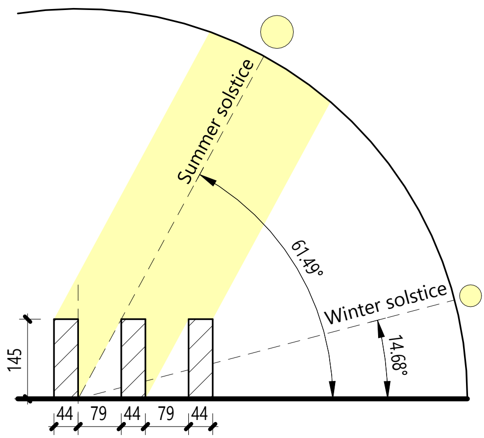


Figure 152: *Dimension slats*

SHADING STUDY

Shade structure design

On the next page the architectural look of the shading structure is studied. Not using any shading structure is not an option, because of BENG regulations. So therefore different options were designed. One hanging from the façade, the other with a support structure aligning with the gallery access system. This second option was preferred to create a reference to the access system. All façades get a similar structure, also the façades without a gallery.

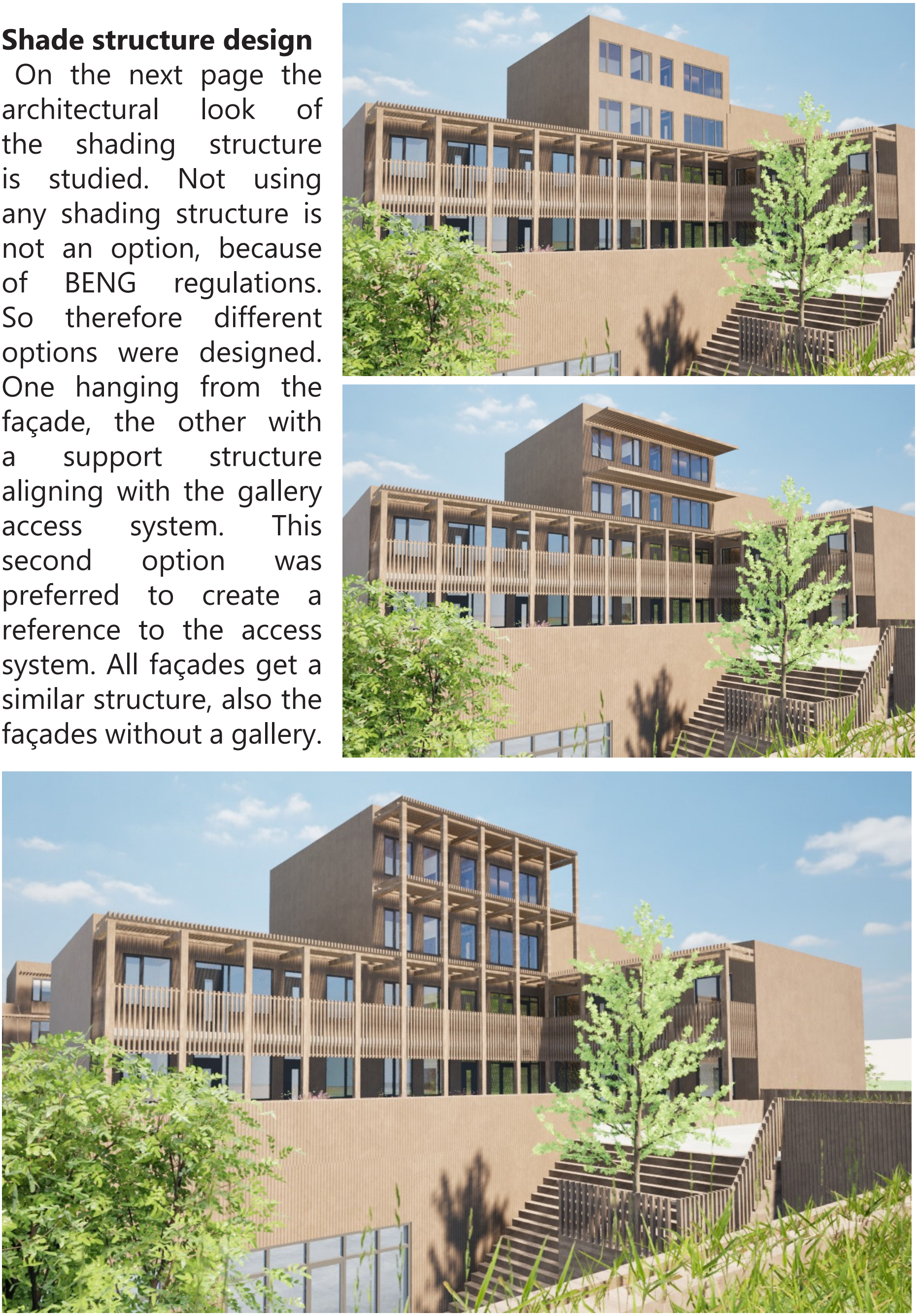


 Figure 153: *Design options galery shade structure*

Shading structures on these façades are less deep, and make use of screens to shade the façade. Partial permanent shade is created by the slats, for total shade, the screens can be lowered.

Figure 154: *Design options shade structure*

DAYLIGHT STUDY

Although the shade structure helps the building regulate temperatures during summer months, it also impacts the amount of daylight that enters the building. The Dutch building code has a minimum amount of daylight that needs to enter rooms that people stay in for longer periods of time (Bedroom, living room, etc).

To make sure the dwellings get enough daylight with the shading structures, all dwelling types are checked if they fulfil the requirements of NEN2057:2011.

Figure 155 explains the way to calculate daylight that hits the window according to the building code.

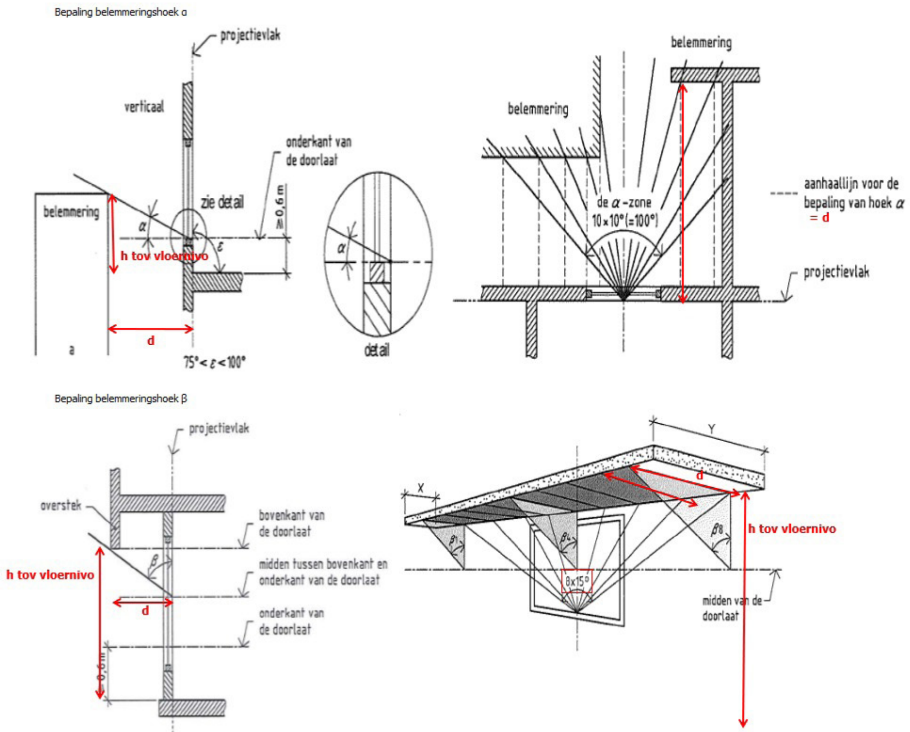
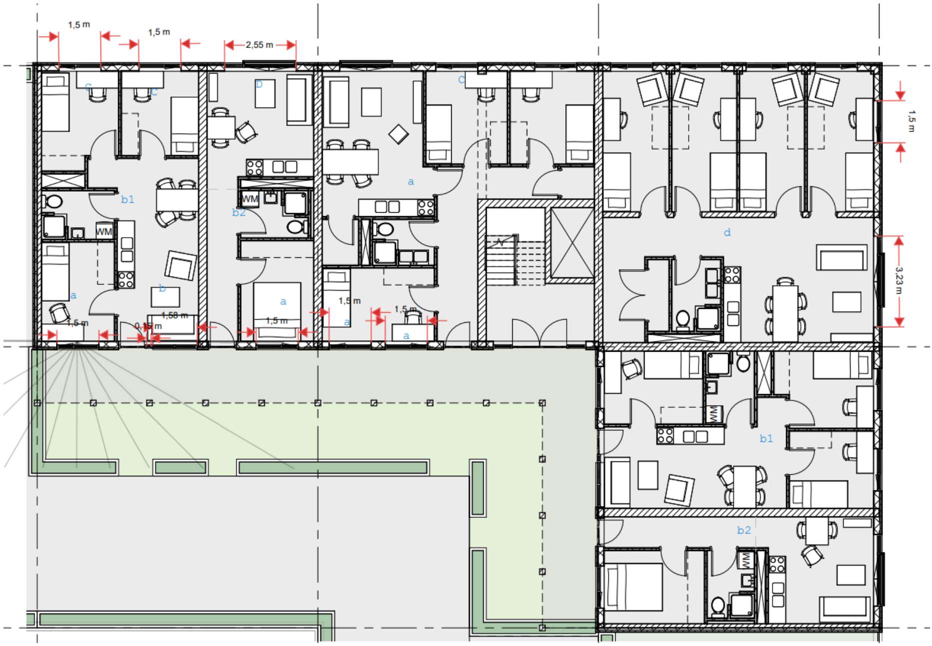


Figure 155: *Calculation method daylight study*

On the next pages the final calculation is shown. All dwellingtypes get plenty of daylight with the shade structures in place.



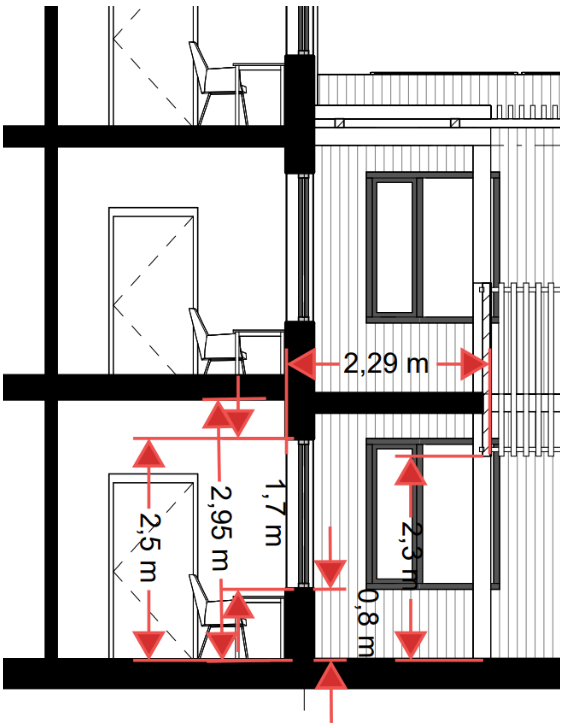


Figure 156: *measurements section daylight study*

DAYLIGHT CALCULATION

Daylight entry check [NEN2057:2011]			
GO: 263,0 m^2	VG: 191,0 m^2		
Rooms		Building code	
	Area m^2	VG m^2	VR m^2
Dwelling B1	46	4,6	
Bedroom south	9		0,5
Bedroom north 1	9		0,5
Bedroom north 2	8		0,5
Living room	20		0,5
Dwelling B2	24	2,4	
Bedroom	9		0,5
Living room	15		0,5
Dwelling A	49	4,9	
Bedroom south	10		0,5
Bedroom north 1	10		0,5
Bedroom north 2	10		0,5
Living room	19		0,5
Dwelling D	72	7,2	
Bedroom 1	12		0,5
Bedroom 2	12		0,5
Bedroom 3	12		0,5
Bedroom 4	12		0,5
Living room	24		0,5

 Figure 157: *Daylight calculation*

VG/GO: 73%							
Façade openings							Check
A_{glass} m^2	ε °	α °	β °	C_b	C_u	C_{LTA}	A_{Total} m^2
							6,86
2,55	90	20	69	0,32	1,00	1,00	0,82
2,55	90	20	0	0,80	1,00	1,00	2,04
2,55	90	20	0	0,80	1,00	1,00	2,04
2,55	90	20	46	0,66	1,00	1,00	1,77
0,29	90	20	45	0,66	1,00	1,00	0,19
							4,69
2,55	90	20	69	0,32	1,00	1,00	0,82
4,85	90	20	0	0,80	1,00	1,00	3,88
							9,59
5,1	90	20	69	0,32	1,00	1,00	1,63
2,55	90	20	0	0,80	1,00	1,00	2,04
2,55	90	20	0	0,80	1,00	1,00	2,04
4,85	90	20	0	0,80	1,00	1,00	3,88
							15,11
2,55	90	20	0	0,80	1,00	1,00	2,04
2,55	90	20	0	0,80	1,00	1,00	2,04
2,55	90	20	0	0,80	1,00	1,00	2,04
5,1	90	20	0	0,80	1,00	1,00	4,08
6,14	90	20	0	0,80	1,00	1,00	4,91

CLIMATE SECTION SUMMER

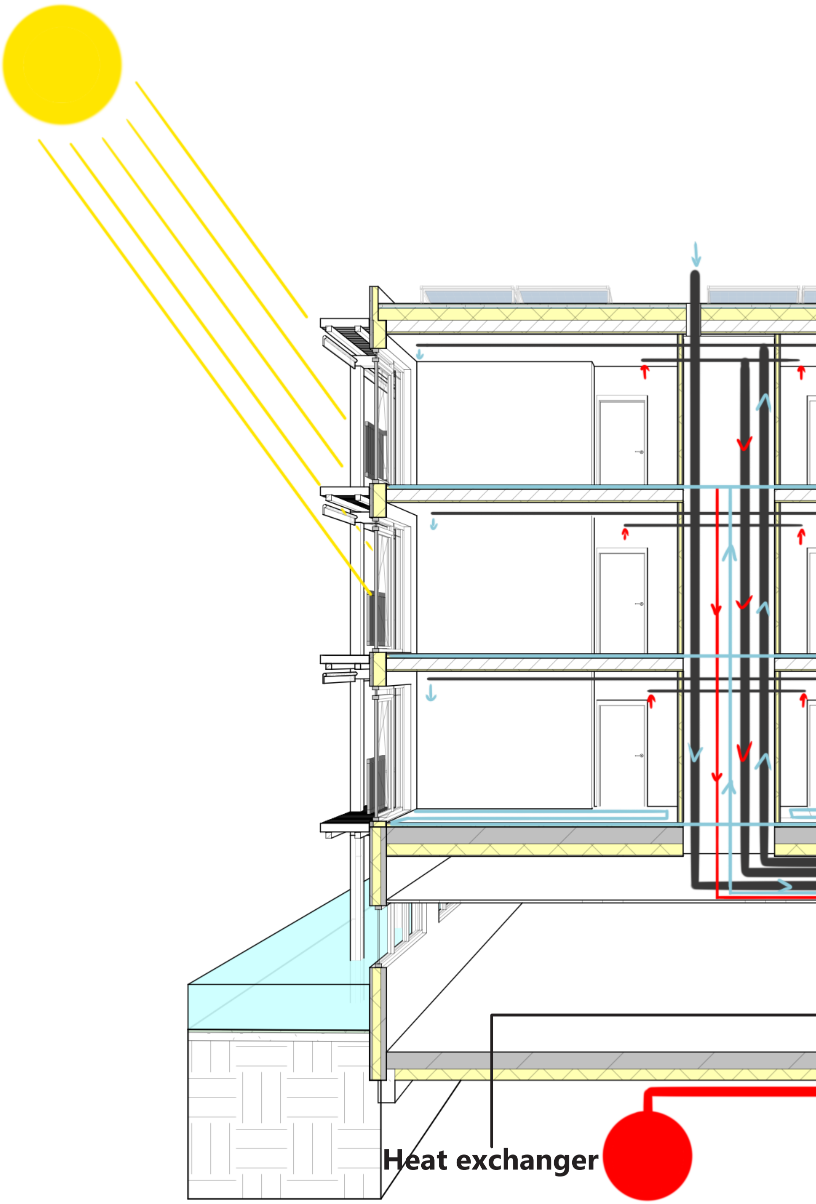
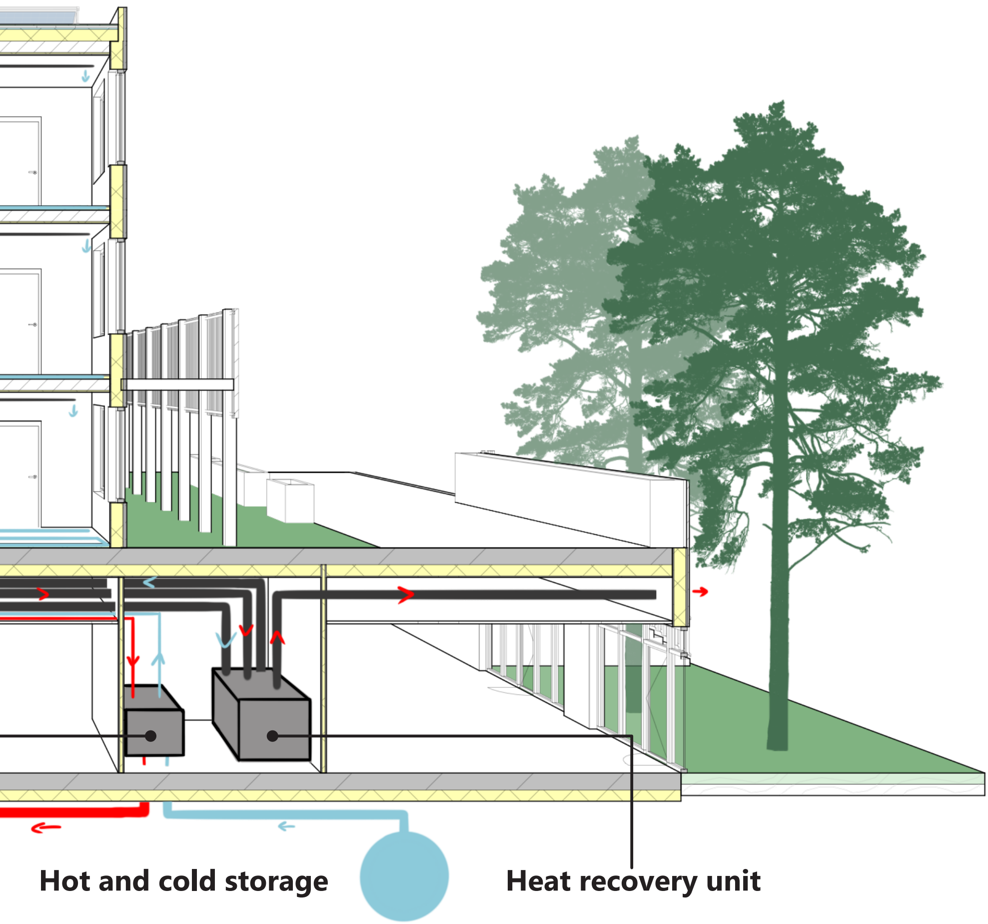


Figure 158: *Climate section Summer*

In summer the shading structures obscure most of the direct sunlight on the façades, in addition, screens can be lowered to fully shade the façade. To cool the building, cold water from the hot &cold storage is pumped up and as the building cools down, the water heats up, and is replenishing the hot side of the storage. To further cool the building, water in the water retention crates on the roof evaporates and passively cools the building. Also fresh air is taken into the building, and bypasses the heat recovery unit.



CLIMATE SECTION WINTER

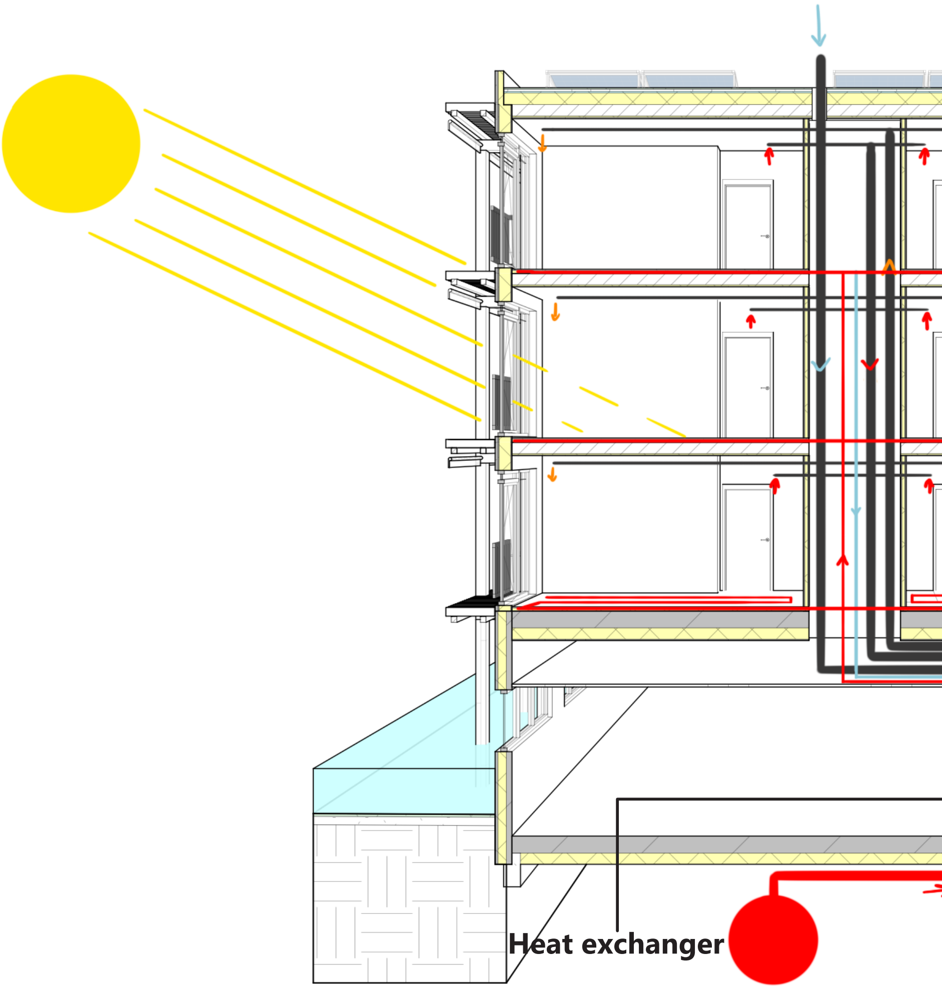
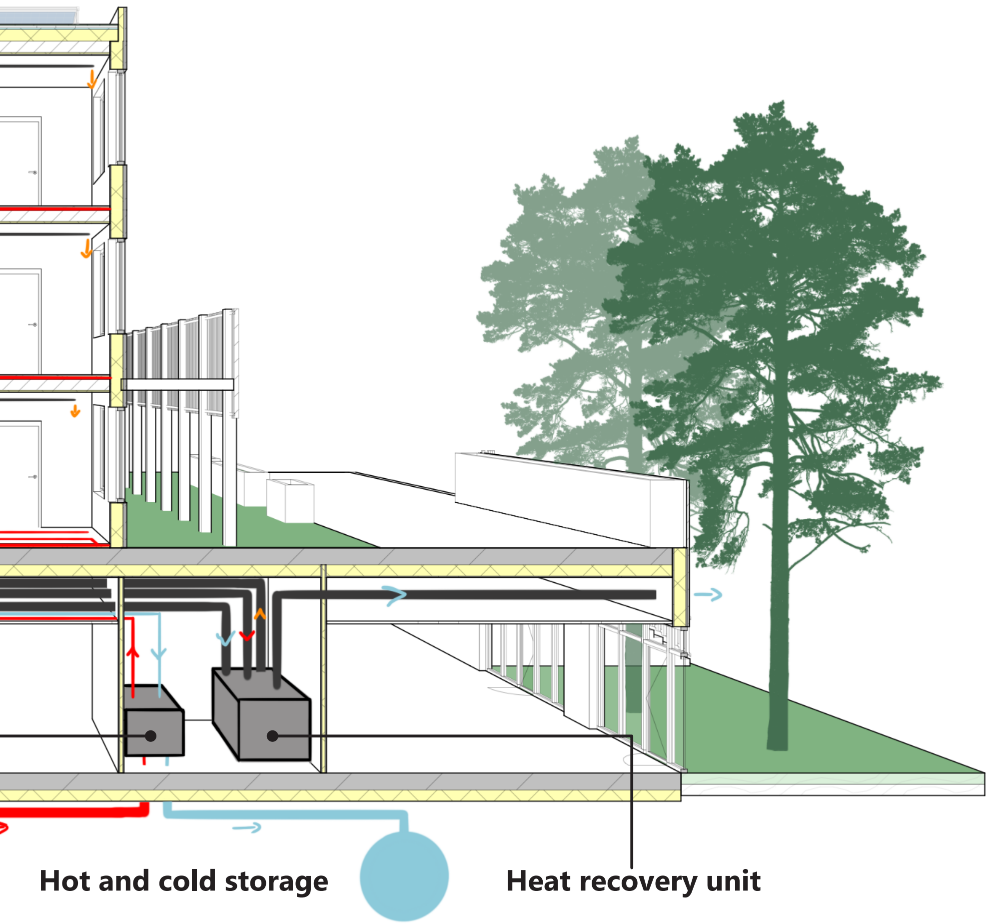


 Figure 159: *Climate section Winter*

In winter the sun is lower in the sky and passes unobstructed underneath the solar shades. The hot water is pumped out of the reservoir to heat the building. In doing so, the water cools down refilling the cool side of the hot & cold storage. Fresh air is taken into the building and preheated in the heat recovery unit. The warm air in the building is used for this process before being exhausted out of the building.



FAÇADE DESIGN

CARBON CAPTURE

Woodframe

The starting ambition for the façade was to capture carbon with the elements. The most efficient way of storing carbon, is with dense wooden elements (like CLT). However, to minimize the panel thickness, the façade elements will be made from woodframe elements, filled with Woodfiber insulation.

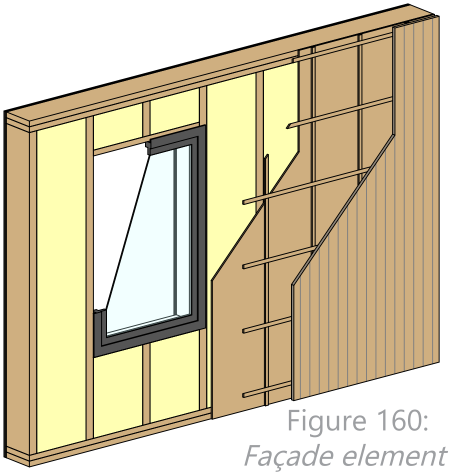


Figure 160: *Façade element*

Cladding

For the façade material, Western red cedar (WRC) has been chosen. The material has been proven to be resilient in the Dutch climate, even untreated, it can be exposed to the elements. After some time exposed to UV light, the wood discolours to a grey tone. Figure 161 shows the discaoloration after one year, compared to unexposed and treated wood.

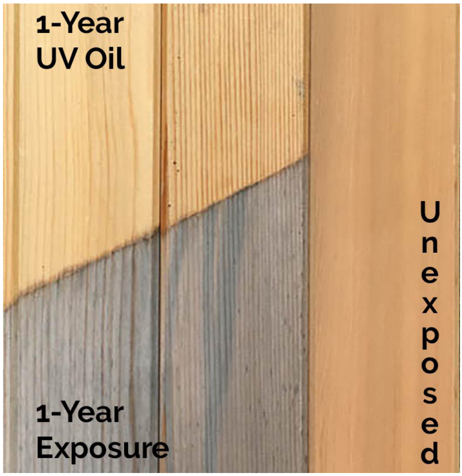


Figure 161: *UV treatment WRC*

Figure 162 shows two renders of the project with the unexposed and grey tinted façade. Because the colour influences the character of the project, all wood will be treated with an UV protective coating.

Figure 162: *Comparison render for treated or untreated WRC*

EXTENSIVE GREEN ROOFSCAPE

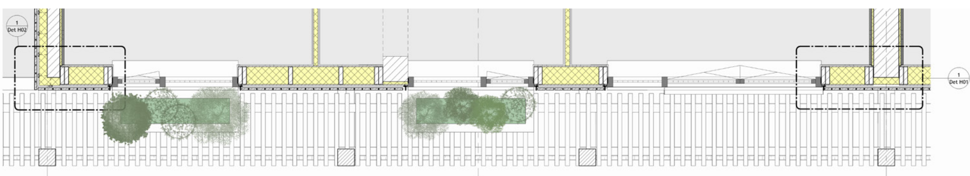
One of the ambitions for the roof, was to reduce the heat load on the building. Because the project has multiple roof levels, and most roofs can be viewed from other buildings, the ambition was to create a green roof. However, because the top structures were made to be lightweight, the structure was not sufficient for a 'green roof' with large plants and bushes. In addition, these plants would also cause shade on the solar panels. Therefore an extensive green roof has been determined to be the best alternative that applies to all ambitions. An extensive green roof with water retention aids in this reduction. Extensive roofs consist of a substrate on a drainage layer. The vegetation are sedums combined with wildflowers. The drainage layer in this case is combined with a water retention layer to water the plants in dry times, as well as passive cooling by evaporation.

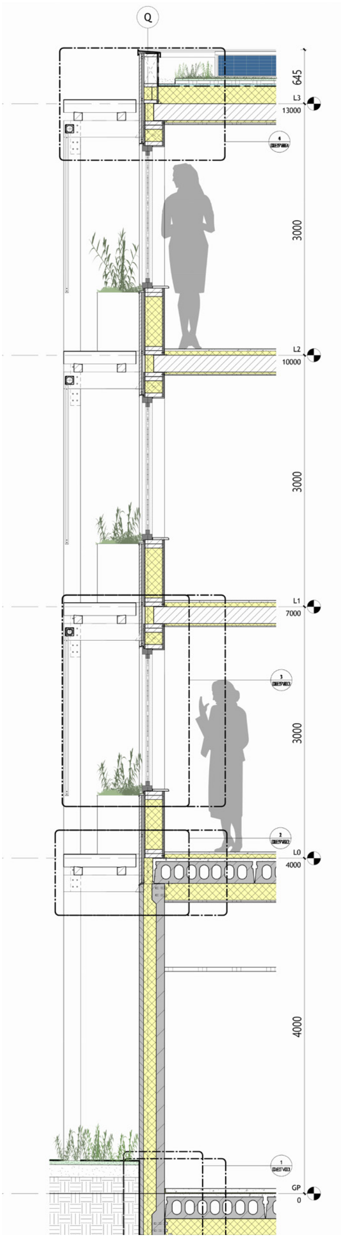
Figure 163: *Extensive green roof with solar panels*

RENEWABLE ENERGY SUPPLY

To generate renewable energy with the façade and roofs, PV solar panels on the roof are the best way of generating energy. The roof structure with its sedum plants and water retention also helps with the efficiency of the PV panels. The cooling effect from the evaporation cools not only the building, but also the panels. The colder the panels are, the more efficient they generate energy.

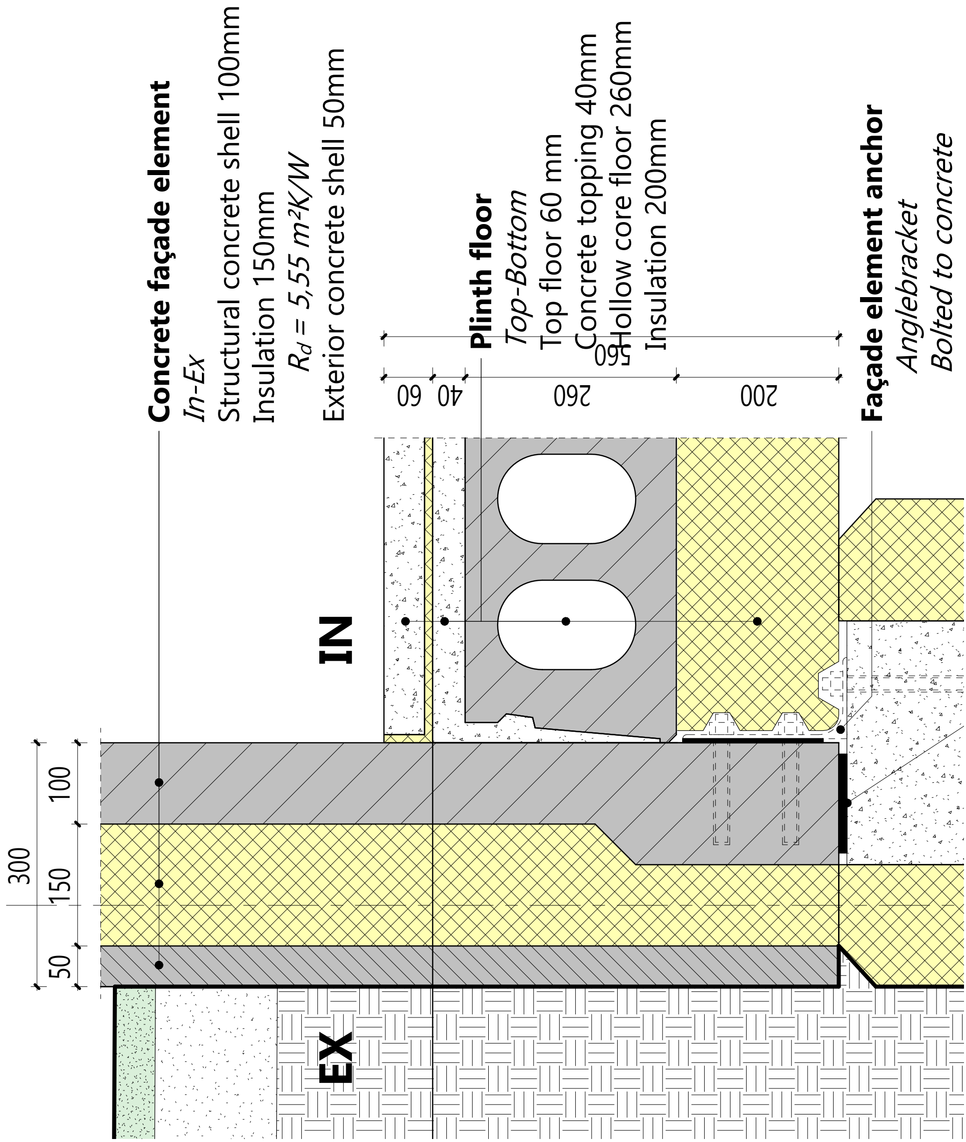

12
3562.5
2875
3562.5

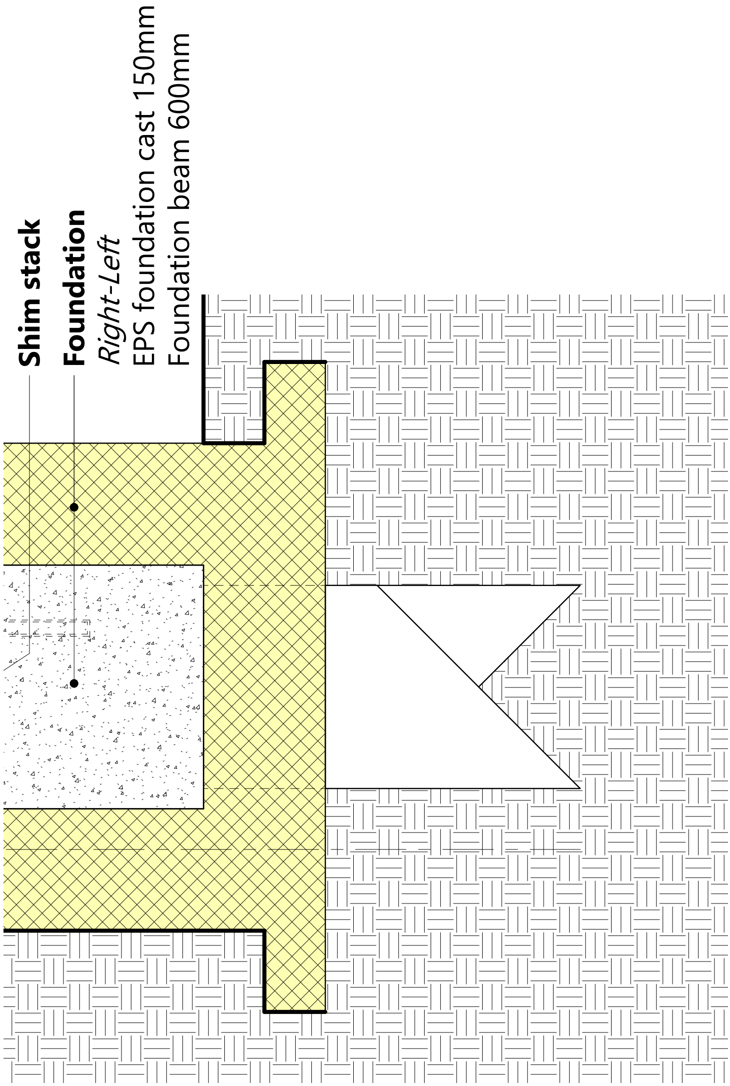

1
Det H02
1
Det H01


Q
645
L3
13000
3000
L2
10000
3000
L1
7000
3000
L0
4000
4000
GP
0

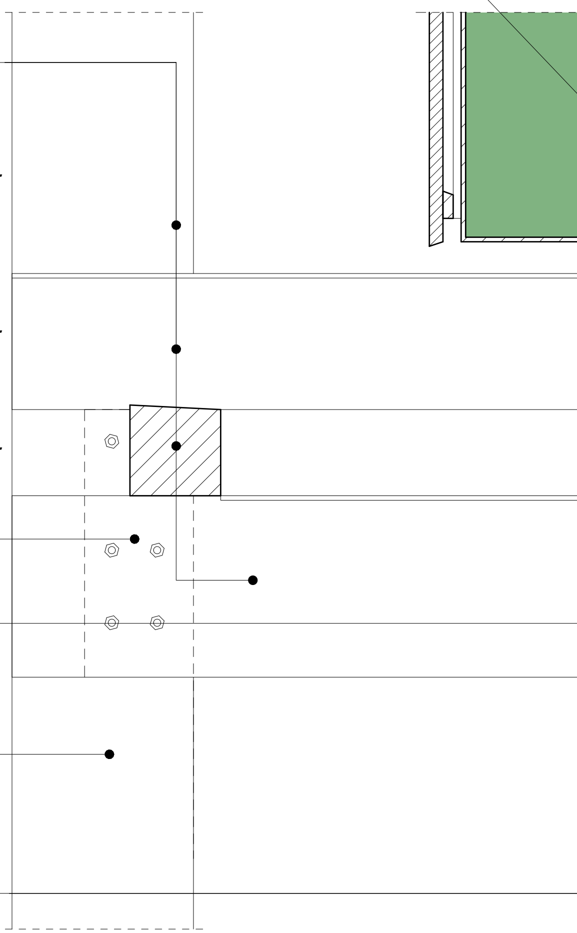
BUILDING DETAILS

DET - V01




Shim stack
Foundation
Right-Left
EPS foundation cast 150mm
Foundation beam 600mm

DET - V02



Steel bracket
for connecting shade structure

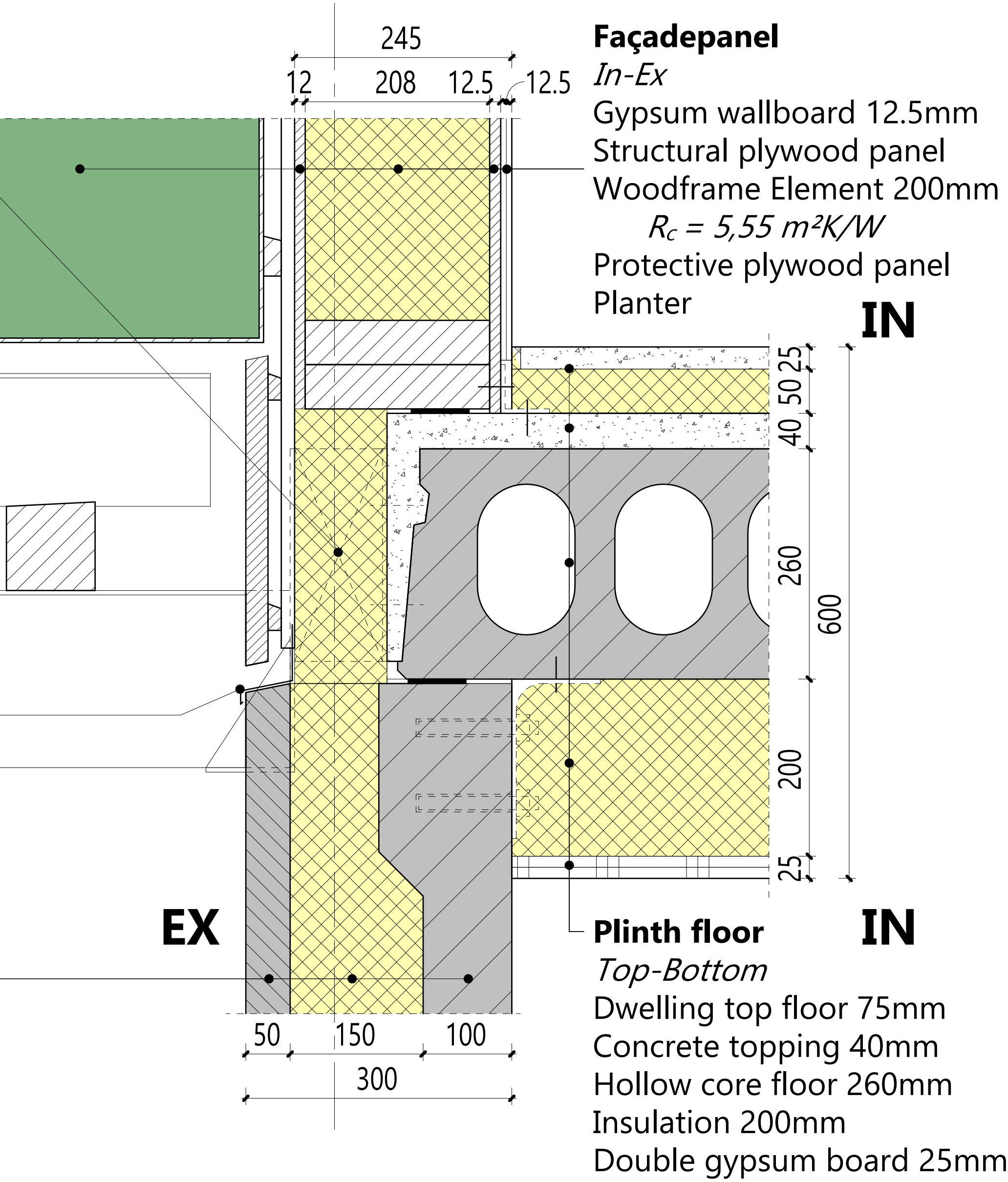
Shade structure
Top-Bottom
Wooden slats
WRC, UV resistand clearcoat
44x145x860mm (WxHxL)
Center distance 123mm
Substructure
WRC, UV resistand clearcoat
100x100mm (WxH)
Column & beam structure
WRC, UV resistand clearcoat
200x200mm (WxH)

Gusset plate
bolted

Steelwork
Water protection
Anthracite gray

Prefab concrete column
Concrete
200x200mm (WxH)

Concrete façade element
In-Ex
Structural concrete shell 100mm
Insulation 150mm
$R_d = 5,55\ m^2K/W$
Exterior concrete shell 50mm


245
12
208
12.5
12.5
Façadepanel
In-Ex
Gypsum wallboard 12.5mm
Structural plywood panel
Woodframe Element 200mm
$R_c = 5{,}55\ m^2K/W$
Protective plywood panel
Planter
IN
25
50
40
260
600
200
25
EX
Plinth floor
IN
Top-Bottom
Dwelling top floor 75mm
Concrete topping 40mm
Hollow core floor 260mm
Insulation 200mm
Double gypsum board 25mm
50
150
100
300

DET - V03

Shade structure
Top-Bottom
Wooden slats
WRC, UV resistand clearcoat
44x145x860mm (WxHxL)
Center distance 123mm
Substructure
WRC, UV resistand clearcoat
100x100mm (WxH)
Column & beam structure
WRC, UV resistand clearcoat
200x200mm (WxH)

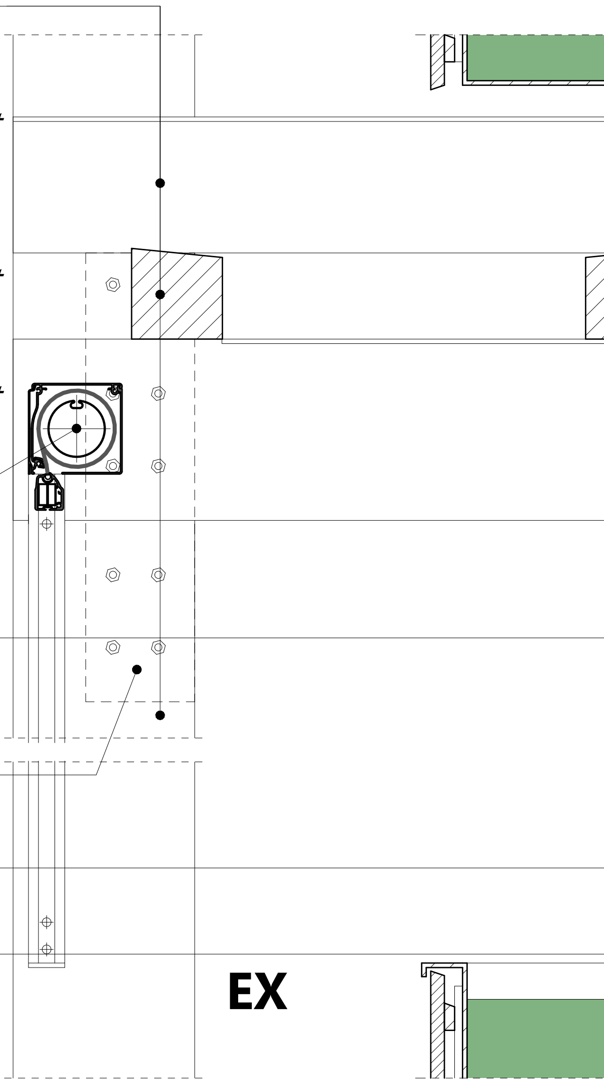
Shading screen
Merk
Colour

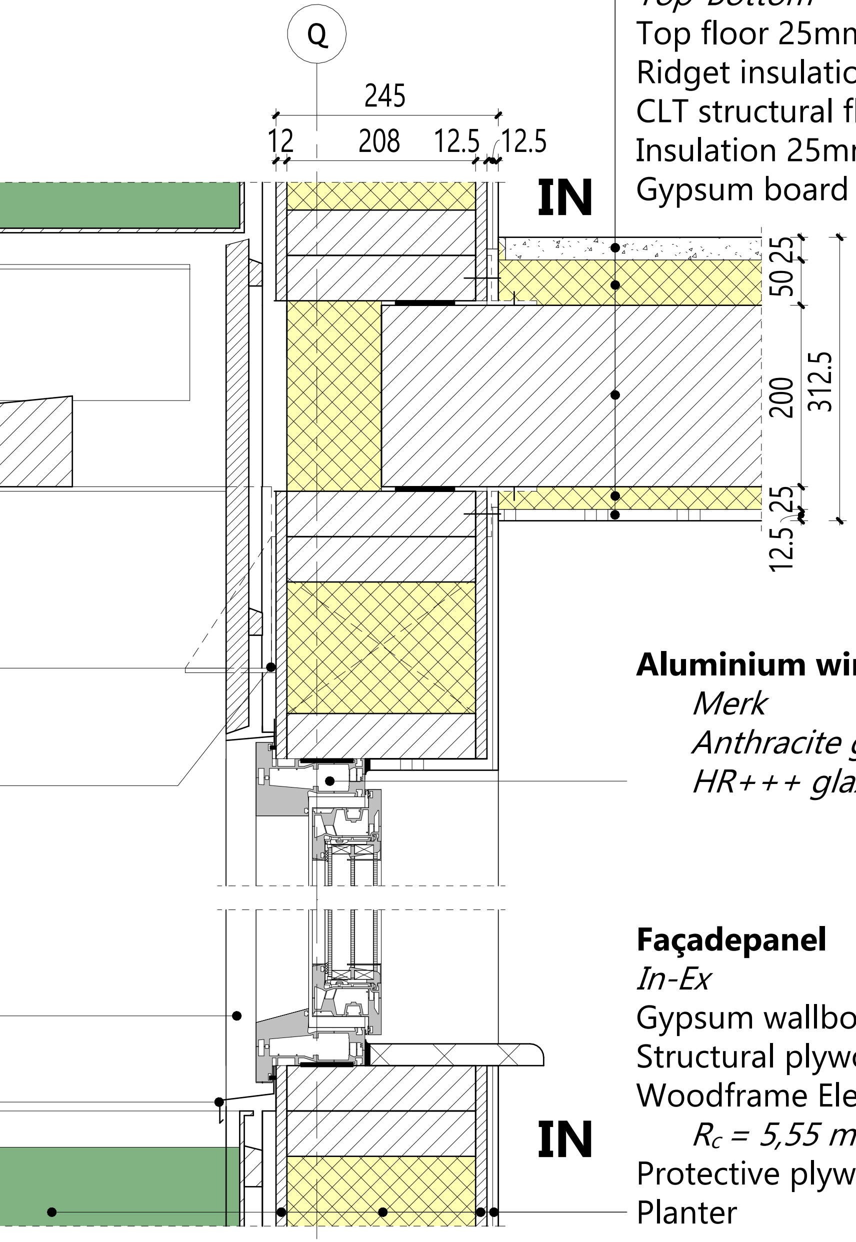
Steel bracket
for connecting shade structure

Gusset plate
bolted

Aluminum trim
Anthracite gray

Aluminum sil
Anthracite gray





CLT floor
Top-Bottom
Top floor 25mm
Ridget insulation 50mm
CLT structural floor 200mm
Insulation 25mm
Gypsum board 12,5mm

Aluminium windowframes
Merk
Anthracite gray
HR+++ glazing

Façadepanel
In-Ex
Gypsum wallboard 12,5mm
Structural plywood panel
Woodframe Element 200mm
R_c = 5,55 m²K/W
Protective plywood panel
Planter

DET - V04

Shade structure
Top-Bottom
Wooden slats
WRC, UV resistand clearcoat
50x150x860mm (WxHxL)
Substructure
WRC, UV resistand clearcoat
100x100mm (WxH)
Column & beam structure
WRC, UV resistand clearcoat
200x200mm (WxH)

Gusset plate
bolted

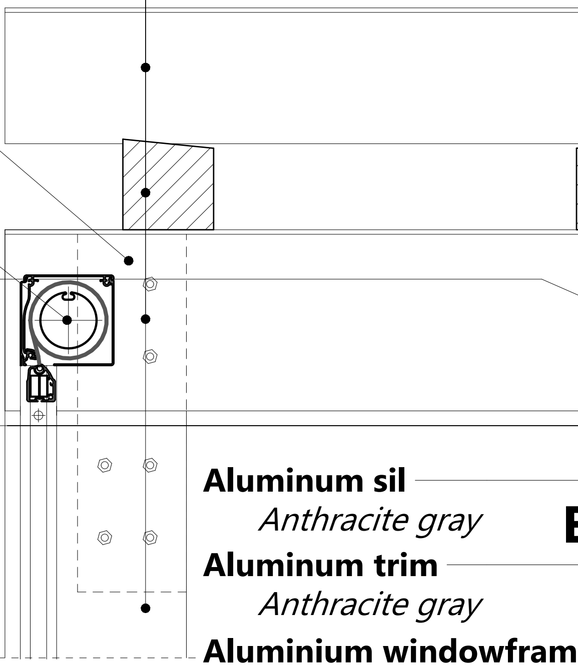
Shading screen
Merk
Colour

Steel bracket
for connecting shade structure

Façadepanel
In-Ex
Gypsum wallboard 12.5mm
Structural plywood panel 12mm
Woodframe Element 208mm
R_c = 5,55 m²K/W
Protective plywood panel 12mm
Facade substructure 30mm
Facade cladding 25mm
WRC, UV resistand clearcoat

Roof trim
Aluminium
Anthracite gray

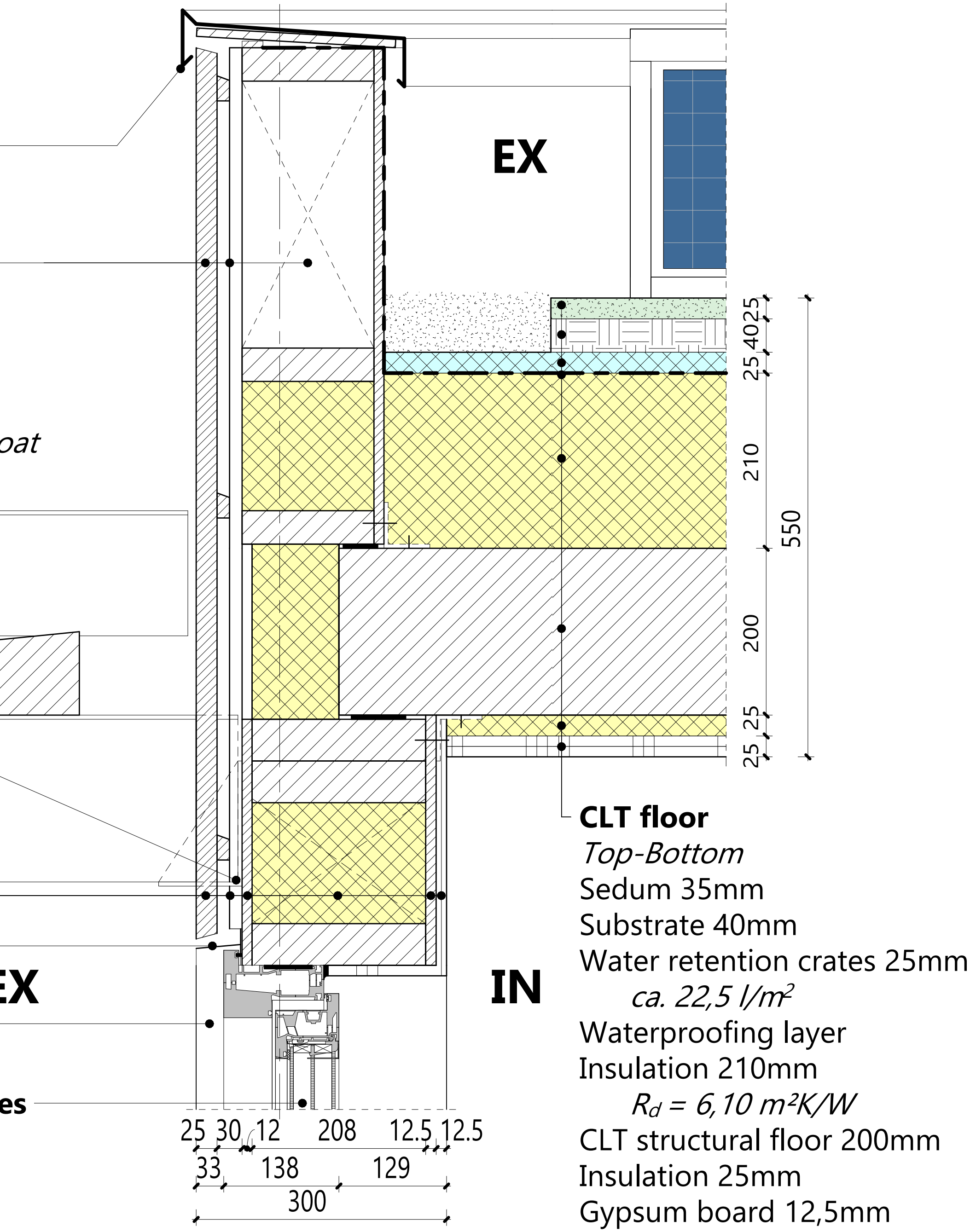
Parapet
Right-Left
Woodframe element 170mm
Facade substructure 30mm
Facade cladding 25mm
WRC, UV resistand clearc



Aluminum sil
Anthracite gray

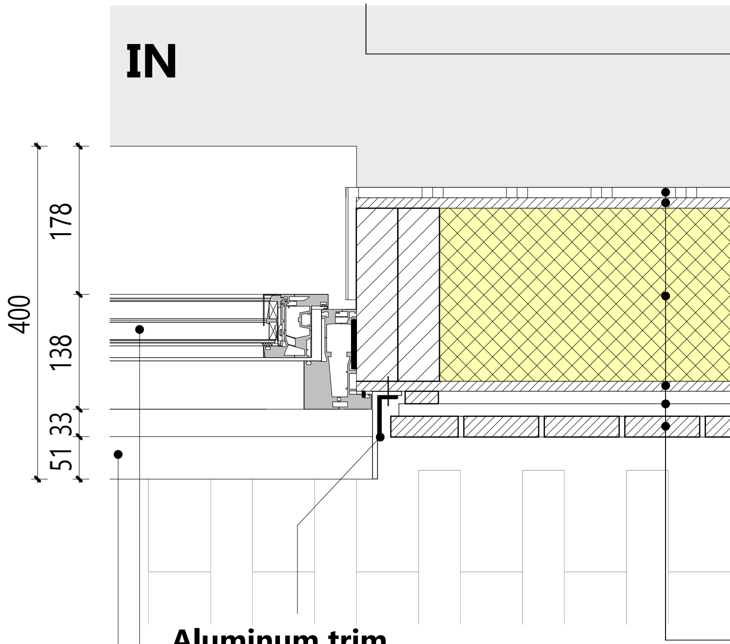
Aluminum trim
Anthracite gray

Aluminium windowfram
Merk
Anthracite gray
HR+++ glazing


EX
25
40
25
25
210
550
200
25
25
oat
EX
IN
es
25 30 12 208 12.5 12.5
33 138 129
300
CLT floor
Top-Bottom
Sedum 35mm
Substrate 40mm
Water retention crates 25mm
ca. 22,5 l/m²
Waterproofing layer
Insulation 210mm
Rd = 6,10 m²K/W
CLT structural floor 200mm
Insulation 25mm
Gypsum board 12,5mm

DET - H01

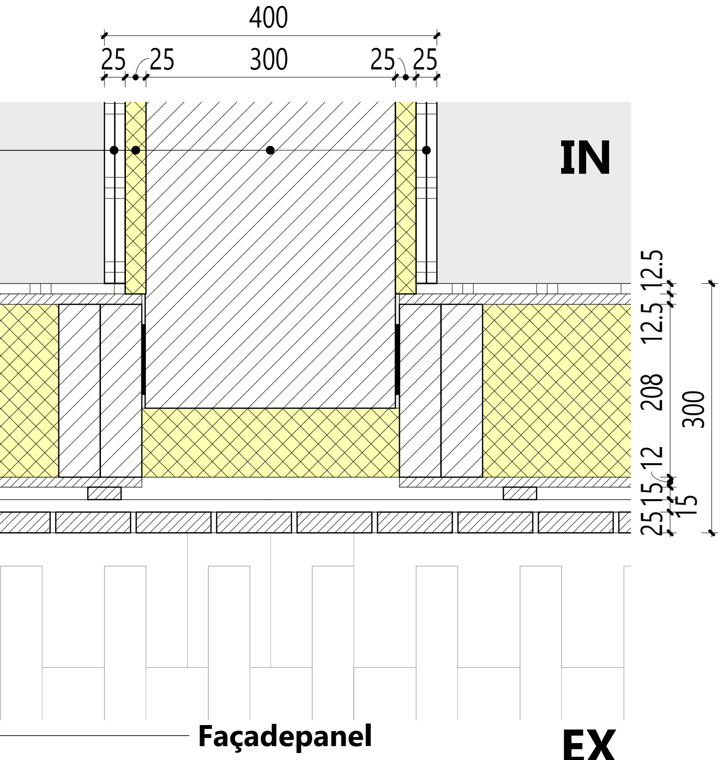
CLT wall
Double gypsum board 25mm
Insulation 25mm
CLT structural wall 300mm
Insulation 25mm
Double gypsum board 25mm



Aluminum trim
Anthracite gray

Aluminium windowframes
Merk
Anthracite gray
HR+++ glazing

Aluminum Railing
Anthracite gray



Façadepanel

In-Ex

Gypsum wallboard 12,5mm

Structural plywood panel 12mm

Woodframe Element 208mm

R_d = 5,55 m²K/W

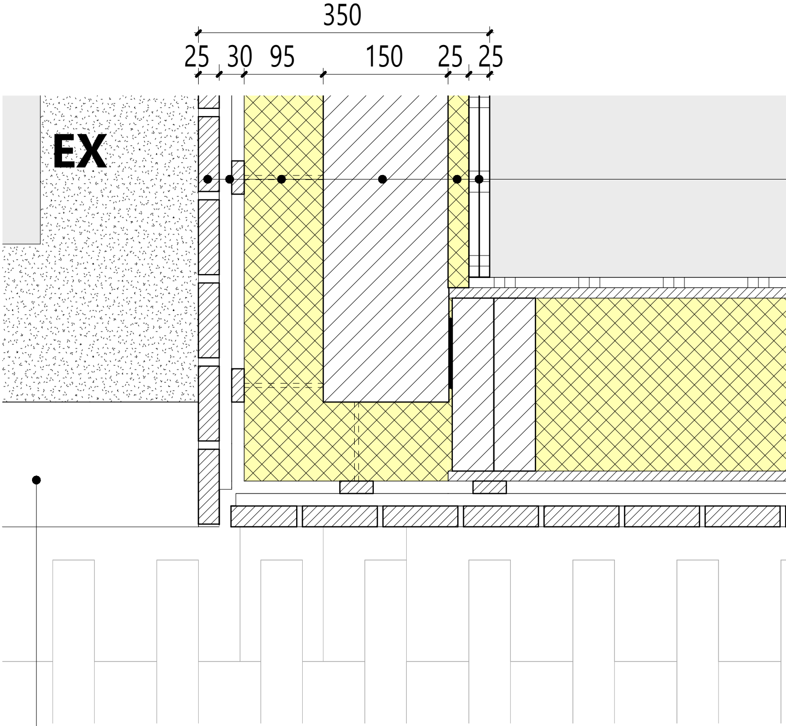
Protective plywood panel 12mm

Facade substructure 30mm

Facade cladding 25mm

WRC, UV resistand clearcoat

DET - H02

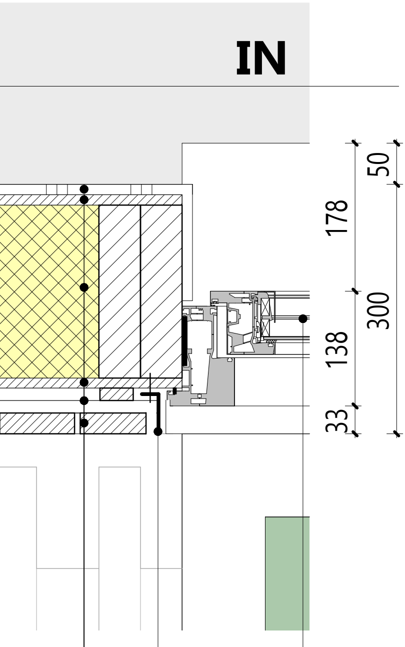


Roof trim

EX

Aluminium
Anthracite gray

Façadepanel
In-Ex
Gypsum wallboard 12.5mm
Structural plywood panel 12r
Woodframe Element 208mm
R_d = 5,55 m²K/W
Protective plywood panel 12
Facade substructure 30mm
Facade cladding 25mm
WRC, UV resistand clearc



CLT Façade
In-Ex
Double gypsum board 25mm
Insulation 25mm
CLT structural wall 300mm
Insulation 95mm
R_d = 3.10m²K/W
Facade substructure 30mm
Facade cladding 25mm
WRC, UV resistand clearcoat

Aluminium windowframes
Merk
Anthracite gray
HR+++ glazing

Aluminum trim
Anthracite gray

mm
n

mm

coat

FIGURES

COLOPHON

PREFACE

CONTENTS

ADAPTION THROUGH ARCHITECTURE

LOCATION

DESIGN CONCEPT

BUILDING DESIGN

BUILDING TECHNOLOGY

REFLECTION

FIGURES

REFERENCES

REFERENCES

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