MSC 3
Research

Compact starter dwellings & watermanagement, for Amsterdammers and the city.

Jamie Bakkes
4425685
January 2018
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INTRODUCTION

Dwellings for starters
For my graduation project I have chosen two topics: a topic that is close related to me and a topic that I follow with great interest.

The first topic is about starter dwellings in Amsterdam. In recent years Amsterdam has become increasingly popular and it is expected that the flow of people to the capital will continue in the coming years. The housing demand in Amsterdam has consequences for house prices. The average house price has risen enormously. Amsterdam has a relatively large number of social housing. However, many people are not eligible for this because of the long waiting lists. In addition, during the crisis not many new housing projects have been built. Also many investors see the opportunity to earn money with mostly small houses. The scarcity of property for sale pushes up the price and at the same time it also ensures high rents in the private sector.

These and also other factors results in starters have difficulty finding an affordable house in Amsterdam. It is expected that this trend will continue and will even grow worse. House prices are still rising. The position of the starters is becoming worse and that does not benefit diversity for a ‘socially healthy’ city. Densification of the city and more efficient living are the solution for a future liveable city.

This is a personal topic for me. I was born in Amstelveen, near Amsterdam. After graduating I want to live and work in Amsterdam. Because of the current housing market this is going to be difficult. However, I also see a possible solution that I would like to investigate further.

For example, Winny Maas of MVRDV has recently shown in his research that 75% of the m² in a house are often not used. Therefore, one must think about the efficiency of dwelling. With the high square meters price in Amsterdam, minimal-size dwellings are the solution to create affordable houses for starters.

The idea of Maas is a futuristic plan, but the essence of living more efficiently offers potential for the short term. Compact housing is becoming increasingly popular both nationally and internationally. In Amsterdam, there are many projects under development with compact apartments. It focuses on a target group with different wishes.

Watermanagement
In the relatively expensive area around the Singel canal, I want to introduce compact apartments for the starters target group that is struggling in these times. Moreover, I want to combine this with a different interest: water management in the city. This is an important issue for the city in the increasingly changing climate in which we live in.

The precipitation will have more peaks in the future. The city can not process these amounts of water with the existing sewer system only. To prevent damage of flooding, the city has to work more like a sponge in order to gradually transport the water to the sewer system, infiltrate in the soil and also to use the rainwater directly.

This research report concentrates on two main items. Compact apartments for starters and a building that helps solving rainwater problems. Nowadays both topics are important in Amsterdam. It serves to preserve a liveable Amsterdam in the future.

Assignment
The compact apartments will be placed on the Groenmarkt. An area that is located in a special strip between two different parts of the city. Waternet is responsible for all water management within Amsterdam. Together with the network of Rainproof Amsterdam they intensively try to achieve the new sewer system / water goals. Therefore, I have drawn up a fictitious assignment in which water management and compact apartments can be combined at this location:

Amsterdam wants to expand the planning of Waternet / Rainproof Amsterdam. The innovations by Waternet and Rainproof must be implemented in a real plan as an example for future projects and for the inhabitants of Amsterdam. The municipality will assign a building plot where this project has to be realized, with Waternet having an advisory role. The municipality demands that the realized dwellings are especially made for starters, a group that is struggling with the current housing market. The starter dwelling must be a small, efficient home that is really affordable for the starter.
INTRODUCTION

Research question
To gain insight into both subjects, the following main questions have been formulated. The main subject of this research is compact apartments. Therefore, the compact apartment program is leading in the design. The water management works as an extra layer that is integrated in the design. It is expected that this layer will also include architectural influences.

Main question 1:
What aspects do help to create a minimum-size dwelling complex for starters?

Sub questions:
1. Which aspects that help to create a minimum-size dwelling complex for starters are architectural?
2. Which strategies can be deployed to generate low-cost housing?

Main question 2:
What water management measures can be integrated in the design of a dwelling complex to assure a future rainproof Amsterdam?

Sub questions:
1. Which specific measures can be integrated in the design of a dwelling complex of the Groenmarkt?
2. Which measures contribute to the social improvement of the neighbourhood?

Method description
For the graduation project three research reports have been made. The first report focuses on the compact apartments. In this report four case studies are analyzed in addition to the literature research. It should eventually lead to an answer to what the elements are of compact housing. The neighbourhood / site is analyzed in the second report. Both reports were made in collaboration with my fellow student Quinten Boumann.

The third report is own work. This focuses on water management. In addition to the literature research, three case studies are also examined.

To answer the main questions only the first report (Compact apartments) and third report (Water management) are used. The second report is combined with the preliminary design for P2.
MSC 3
Research
Compact Apartments

Jamie Bakkes
Quinten Boumann
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In recent years Amsterdam has become increasingly popular. Due to a combination of a growing demand for housing and the hardly risen houses on offer during the crisis, housing prices have risen enormously as a result of the housing shortage. The strong economic position of Amsterdam will also ensure a huge increase in the number of residents in the coming years. The city is also appreciated for its diversity, vibrancy and its many amenities.

In the coming years it is expected that housing prices will rise. When this development continues, Amsterdam will only be inhabited by a select (rich) group. The diversity will decrease and that does not benefit the city. Amsterdam is aware of this development and has presented plans for a completely new district for 70,000 dwellings. Amsterdam North and the East of Amsterdam are also being developed further. In addition, densification of the existing urban landscape will be necessary.

These days ‘the starter’ especially has a hard time. Several newspapers have also paid attention to this problem. The small houses in this segment are also attractive for expats, investors and rich people. This further increases the price of the houses.

Moreover, for decades Dutch families have been getting smaller. In addition, the number of one and two-person households is expected to grow. The growth in the number of households in large cities is largely due to the growth of these small households. This group is quite diverse: students, starters (one or two persons), expats, singles, single parents and the elderly (one or two persons). Overall it can be said that the demand for small houses will increase further in the coming years.

The need for affordable housing in Amsterdam offers opportunities for innovative urban forms of housing that fit the lifestyle of a new generation, the new city dweller. All of this fits within the compact city while retaining its qualities. The price of the houses has to be lowered and with the high square meter prices, compact apartments can offer a solution. This goes beyond a normal studio dwelling. History has many examples of this on national and international level. For example, Japan has been very innovative in the field of ‘compact’ on many scales for years.

In summary:

- The demand for small houses will increase further in the coming years.
- Compact apartments offer a solution for affordable housing.
- History has shown many examples of compact living in different scales.
- The city of Amsterdam is aware of the housing shortage and has presented plans for a new district.
- The economic position of the city will ensure a continued population growth.
- The diversity of the city is important but at risk due to rising housing prices.

**References**

INTRODUCTION
Compact apartments

The growing group of one and two-person households belongs to the new city dweller. This target group attaches less value to private ownership and is willing to share more. After all, the more you share, the cheaper the living becomes.\(^5\) This group uses the city as an extension of their house, a kind of second living room. The car is no longer a general need, while urban facilities are important. They appreciate mobility and flexibility.\(^6\)

This research looks at various aspects of these compact apartments. For example, attention is paid to the possible target groups and the level of collectivity that is important. In addition, we look at the current context in which different trends are present. We look as well at the history in the field of small innovative housing that are the foundation for the new compact apartment idea.

According to the Architecture center of Amsterdam, the definition of a compact apartment / micro-dwelling is a small home, but the location is as close as possible to the city center and often with shared facilities. It is a pragmatic solution that contributes to keeping urban life affordable.\(^7\) By investigating these aspects and looking at current projects (case studies) inside and outside Amsterdam with a compact theme, we want to answer the question of what a compact apartment / micro-dwelling is and what architectural aspects are needed. Both for the dwelling itself and the entire complex. The term compact apartment is used in this document to limit the emphasis on a ‘small home’ and to see it more as an innovative solution.

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The idea of smart small apartments is in line with various social trends that are currently going on. Various developments in society ask for a new way of living or create a new way of living.

Pressure
For decades Amsterdam is known of a severe housing shortage. At the moment the housing shortage reached its peaks with several consequences. Globally, urbanization is a trend. In the Netherlands people move towards the bigger cities as well. The prognosis for Amsterdam by the municipal research group OIS (Onderzoek, Informatie, Statistiek) is that the population of Amsterdam will grow towards 980,000 citizens by 2040. Currently Amsterdam has 848,630 inhabitants. The urbanisation is partly caused by the fact that people identify themselves with the location and the type of dwelling where they life in. Due to this, more people want to live on the same location, the city of Amsterdam for this particular case. According to De Vries, the quality of the neighborhood, village or city became more important. As a result of the popularity of the city, housing prices are rising what makes it for a lot of people harder to stay or move towards the city.

Changing households
Next to the housing shortage, last couple of decades the composition of households is changing as well. Dutch families are getting smaller and the amount of single and two person households is growing. The growth of cities is mostly caused by the exponential growth of smaller households. A small household can be formed by students, starters, expats, single parents and elderly. For a long time, living alone was a taboo in the Netherlands. Living alone was seen as a temporary situation, for instance in between two relationships. The individualization of the society did change this point of view. The acceptance for dwellings especially for the single target group is growing.

Lifestyle
We also see a change in the urban lifestyle. Urban citizens use the city as their living room. Compared to the previous century, a big part of an urban life takes place in public spheres. This group is known as the ‘nomadische stedeling’ (nomadic townsman), according to Shift Architecture & Urbanism.

This specific group prefers a good location above a big apartment. They chose to lower their ecologic footprint, sustainability is becoming part of the lifestyle. The upcoming sharing economy is part of this lifestyle. In 2014 half a million people took part in the sharing economy in the Netherlands. ING expected that same year 1 million users for 2015. These numbers show the increasing interest in sharing, especially in the city. ‘Owning less, sharing more’ is an often heard statement recent years. More and more people question themselves whether they need to possess a product of that they can borrow or rent it from a friend, neighbor or company. Thanks to internet and smart phones it is easier to organize the sharing economy. The need of sharing implies also for amenities in peoples daily lives. It is getting more common to share amenities in building complexes, in order to save square meters in the apartments. Moreover, we need less space due to new technologies. We work at the dining table with our laptop, a desk is not necessary anymore. All our books are on a e-reader or tablet as well as music. This are just some examples. Hence the urban society becoming more flexible. Nowadays people work everywhere, at home, in the library or at the coffee shop on the corner.

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Prognosis population growth Amsterdam (data from statline.cbs.nl)

Prognosis single person households (data from statline.cbs.nl)
Although the idea of smart small apartments seems to be a development of recent years, the concept of compact living started in the beginning of previous century.

In the beginning of the 20th century functionalism was the start of the rational approach of the dwelling floor plan. The goal was to design comfortable houses for the society. Norms and regulations were made to achieve these goals. After the second world war the vision of functionalism played an important role in solving the housing shortage. Most new build houses were focused on the working class.\footnote{Synchroon, Shift Architecture & Urbanism. (2015) XS Deluxe: Het Micro-appartement.}

During the 1960’s the society individualized and the welfare grew. This resulted in a demand for variation in the way of living. Experiments with new ways of living like capsules or flexible furniture were popular. At the same time was the interest in hedonism growing. However, most of the experiments were realized on a small scale.

In the 90’s the government became less involved in housing. A housing market arises and housing becomes more relate to a certain lifestyle. The urban life develops and there is a growing interest in new ways of housing, like the smart small apartment.\footnote{Synchroon, Shift Architecture & Urbanism. (2015) XS Deluxe: Het Micro-appartement.}
**First patent Murphy-bed**  
*William L. Murphy*

A bed designed by William L. Murphy. The bed can fold up in order to save space in small apartments.

**Justus van Effencomplex, Rotterdam**  
*Miehcel Brinkman*

For that time this building block was striking. In the inner courtyard is a building where facilities like laundry, ironing and heating are centralized. This saved space in the dwellings.

**Het Nieuwe Huis, Amsterdam**  
*Barend van den Nieuwen Amstel*

This apartment complex was one of the first buildings especially for singles. The complex exists of more luxurious small and medium sized apartments. A concierge helped the inhabitants with daily chores like cleaning and shopping. On the ground floor are next to some shops a public library, a collective restaurant and a central kitchen.

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1929

Existenzminimum
CIAM/Walter Gropius

At the end of the 1920’s the modernists worked on Existenzminimum. Their goal was to develop an apartment with the basic needed facilities for mass production. By doing this, they searched for a solution for the high rent of the working middle class.

1928-1932

Narkomfin building, Moskou
Moisei Ginzburg & Ignaty Milinis

A building complex build on socialist ideals. A lot of facilities where organized in a collective way. Facilities like kitchens, kindergarten, laundry, roof terrace, library and gym where collective functions. Some apartments where more depending on the collective facilities than others.

1932-1934

Bergpolderflat, Rotterdam
W. van Tijen in collaboration with J. Brinkman & L. van de Vlugt.

The first flat with gallery access in the Netherlands. A revolutionary building because of the prefabricated design. Small apartments of 50 m² but because of a flexible setup and fold up beds still comfortable.
Unité d’habitation
Le Corbusier

Le Corbusier was inspired by the Narkomfin building in Moskou. There are four Unites d’habitation in Europe. This concept is also known because of its collective facilities. The collective functions are a kindergarten, daycare, gym, theater and a running track.

A Home is not a House
Reyner Baham & Francois Dallegret

An extreme concept by Ginzburg and Milinis to replace the traditional and permanent house by a minimal shelter with only the necessities for a modern life. This includes shelter, food, energy and television.

The Living Pod
David Greene

A Utopian plan developed by Greene with capsules for the ‘nomadic townsman’. The capsules can be connected to a bigger structure or function independent in an open field.
**1970-1972**

**Nakagin Capsule Tower**  
*Kisho Kurokawa*

This capsule tower is one of the most extreme examples of prefabricated apartment complexes. The tower was built for 140 single office workers. Prefabricated capsules of 10 m² are connected to a central core.

**1971**

**Total Furnishing Unit**  
*Joe Columbo*

Units with all the essential functions integrated that can be placed in an apartment.

**1972**

**Expandable Living Container**  
*Alberto Rosselli*

A lightweight house that can be expanded on four sides.
**Mobile and Flexible Environment Module**
*Ettore Sottsass Jr.*

A network of connectible modules with each an own function like stove, fridge, wardrobe, bathroom, jukebox and library. By using the modules it would be possible for everyone to create a personal living environment.

**Hotel Sphinx, New York**
*Elia & Zoe Zenghelis (OMA)*

A luxurious hotel as prototype for mass housing. Small apartments with luxurious balconies and high end collective functions.

**First Capsulehotel, Osaka**
*Kisho Kurokawa*

Designed by the same architect as the Nakagin Capsule Tower. Each ‘hotel room’ is designed as small as possible and has a bed, electricity and a television.
**HISTORY**

**Time line**

1990

**Kyosho Jutaku, Tokyo**

The Kyosho Jutaku (micro dwellings) became popular in Tokyo during the nineties. The demand for smart small apartments was caused by high rent and a recession. The small single family homes were mostly built on very small plots, even on parking spots.

2002

**Microflat, London**

*Piercy Conner*

Apartments of 32 m² with a prefabricated module that includes a kitchen and bathroom. Only a model apartment is realized.

2006

**24-in-1 apartment, Hong Kong**

*Gary Chang*

A Hong Kong-based architect designed a 32 m² apartment for himself that could transform to 24 different spaces by sliding walls.
**Sleepbox, Moskou**

*Arch Group*

A unit with to separate beds that can be rented. It is placed on an airport and can be rented from 30 minutes to a couple of hours.

**The Student Hotel, Rotterdam, Amsterdam, Den Haag**

A hotel for international student. Students can rent a luxurious furnished room in a complex with collective functions like a kitchen, study room, library, game-room, restaurant and a gym.

**Carmel Place, New York**

*nARCHITECTS*

A complex with prefabricated units. The goal was to keep living in New York affordable by producing small and cost efficient apartments. In exchange for small, single-occupancy units, residents could share amenities-like a restaurant-kitchen, dining area, lounge, and cleaning services.
Living in a smart small apartment is sustainable in several ways. First of all is a smart small apartment complex a good way to densify the built environment. Obviously, compact apartments in a high density save on space, material and energy compared to low density housing.

High density complexes do have a lot of potential in creating a more collective way of living, what contributes to sustainability. This collectivity creates possibilities on sharing facilities and installations. A distinction can be made between ‘need to have’ and ‘nice to have’ facilities. Especially ‘nice to have’ facilities are ideal to share with other inhabitants. But also facilities like washing machines and cars are great to share, especially because they are mostly not in use when owned by one or two persons.

Furthermore, a high urban density might reduce traffic because most facilities are within bike or walking distance. Smart small apartment complexes also contribute to social sustainability, since it stimulates diversity in the urban context.

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Heating less m² results in a more sustainable energy usage
SUSTAINABILITY
Sustainable densification

By stacking compact units space is used efficiently, it densifies the plot

Sustainable mobility because of close by facilities and public transport options

Sustainable lifestyle by sharing facilities and products
TARGET GROUP
Compact apartments

Introduction
Due to the shortage on the housing market, many studio apartments have been built over the years. These often offered less housing quality for their price and did not exceed the level of a student house. Compact apartments can offer a much broader solution for various target groups. Existing studies on compact apartments often focus on obvious target groups such as the millennial generation or single people. This group also includes students, starters, people without children, people who are divorced and expats. However, due to a changing lifestyle and zeitgeist, these dwellings can also become attractive for other target groups such as elderly, status holders, people with shared interests, but also small families. Therefore, compact apartments can be interesting for target groups in different stages of life. According to the Architecture Center of Amsterdam (ARCAM) this diversity is desirable.  

Wide target group
ARCAM developed a sociological model called the ‘Wekker-Duyvendak-diagram’. Instead of classifying in ‘traditional’ target groups such as starters, families and seniors, they thought about how an individual can relate to the collective, on multiple scales (apartment, building and neighbourhood).

This chart provides guidance to identify the needs of potential residents. The compact dweller is a person who is in the diagram on the side of physical proximity. However, there are differences in the social proximity that a person wants to experience. The ‘metropolitan inhabitant’ who thinks the proximity of facilities and entertainment of the city is the most important, wants to live as individually as possible and share as few facilities as possible. The ‘community seeker’, on the other hand, wants to be part of a community, also at building level, and is willing to share more facilities. The compact dweller is a broad group in which the degree of sharing makes the difference. For example, older people want to share more anonymously. This means that it is shared among a larger group of people. In their case social proximity with only a few neighbours is not desirable.

According to ARCAM, compact dwellers will have to share facilities. They argue that small living spaces need high-quality public space and personal services. There is also a demand for a non-privatized roof terrace. Creating an ‘address’ is also important. By ensuring a beautiful entrance, the entire building shares the luxury of the address, no matter how large or small the house is. With these measures a ‘leveled’ building is created where the happiness of the residents is maximal. As compensation on the lesser surface, the quality of life of the house could be improved by higher ceilings, extra light and beautiful views.

Sharing facilities also depends on the stage of life. Young people need the proximity of food service industry and flexible workplaces, while families place more emphasis on shared childcare, whereas elderly people need care. Sharing facilities can also be linked to a hobby or social life. A large kitchen to receive a group of friends or family is a need that many people do have, but can not always realize in their homes.

Facilities like a laundry, gym, restaurant are just seen as a distinctive quality, which a resident is willing to pay for. For shared facilities we can make a distinction between facilities that a resident really needs because of his stage of life or lifestyle (need to have) and facilities that make the dwelling more attractive (nice to have). Like freelancers who come into contact with each other in the same building. Broadly speaking, we distinguish the target groups for compact apartments from ‘the new city dweller’, (single) elderly people and specific target groups (because of their hobby and way of life).

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Target group wishes

Young adults: students, starters, singles and (starter) expats

The people in this target group have some similarities. They are mostly 1- or 2-person households, young and at the beginning of their careers. The young singles in particular provide a growth of the 1- and 2-person in the big cities. In terms of age, this group is very variable.

This difference of age also plays a role among the expats. The expat is looking for an independent accommodation in a central location. Not a (student) room, but an apartment with its own bathroom and kitchen. They see the city as an extension of the dwelling. Due to the lack of family and the social environment from their homeland, meeting places are important. The expat often chooses the bicycle and public transport over the use of a car.

Another group within the young adults are the students. Because of the difference in lifestyle, students are often not mixed with others within the target group of young adults. Nonetheless, they are often housed in the same building and use the same facilities. However, they live in different parts of the building. For student housing, the potential for compact apartments is linked to the cities where universities are located. After graduation, students can not continue to live in their student residence and have to look for a other living space.

Families

Families as a target group for living in the city is on the rise. The parents of these families are often highly educated. They both work and have an above average income. Many of the families who value diversity in their living environment are pushed out of the city as a result of rising house prices or too small living places. This target group also sees the city more and more as an extension of their home. In the city, living, working, children and social life logistics can be combined more easily.

Today’s 65-plus is in the midst of life and is enterprising. They are at the beginning of a new stage of life. They are looking for the comfort of smaller living near amenities and public transport. They want to move within the city or region to a place that meets these requirements.

The current trend is that older people have to stay at their own place longer and have to purchase care. By living close to each other and sharing facilities, care can be purchased in an efficient manner. Loneliness is also prevented because they can live with like-minded people.

The new city dweller

This research mainly focuses on the new city dweller. This target group:

- Prefer central living above a large land-based home.
- Want to live in proximity to amenities and work.
- Is less car-centric.
- Is willing to share facilities if this offers added value.
- Spends a lot of time outside the home.

Within the target group of the ‘new city dweller’ we can distinguish various subgroups each with their own needs. In this study single and couples get the attention. The compact apartments are also the most suitable for these smaller family compositions.

There are a few non-ground floor dwelling with these qualities in the city. A housing typology as described should keep more families in the city. According to the Architecture Center of Amsterdam it is possible for small families to live in a compact apartment. In this case children must have their own bedroom and the master bedroom can be integrated in the living room.

Elderly

This target group is also interesting for compact apartments. Due to maintenance they often no longer want to live in a large house. Materialism is often also less important. Moreover, their needs change in social life. It becomes more attractive to live closer to friends and family. They also often live together or alone.

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This target group has a good income. They are looking for a home that has similar qualities as a suburban dwelling. This does not have to be a house with a garden, but can also be a spacious outdoor area (15 m²) or a shared courtyard where children can play safely. Facilities such as childcare should also be nearby. The dwelling will possibly be smaller than a suburban family home.

TARGET GROUP
Needs

Overview target group compact apartment

<table>
<thead>
<tr>
<th>Starter</th>
<th>Bachelor</th>
<th>Couples</th>
</tr>
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<tbody>
<tr>
<td><strong>Budget</strong></td>
<td>● ●</td>
<td>● ● ●</td>
</tr>
<tr>
<td><strong>Need of luxury</strong></td>
<td>● ●</td>
<td>● ● ●</td>
</tr>
<tr>
<td><strong>Need social contact</strong></td>
<td>● ● ●</td>
<td>● ●</td>
</tr>
<tr>
<td><strong>Need of services</strong> (doorman, house keeping, etc.)</td>
<td>●</td>
<td>● ●</td>
</tr>
<tr>
<td><strong>spatial need</strong></td>
<td>20 - 30 m²</td>
<td>20 - 40 m²</td>
</tr>
<tr>
<td><strong>Programmatic need</strong></td>
<td>collective space, shared use, roof terrace, storage space</td>
<td>guest house, cooking studio, swimming pool / sauna, roof terrace, storage space</td>
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CASE STUDIES
For the research on smart small apartments 4 case studies are researched. The case studies exist of both built projects but also not (yet) realized projects. We were able to visit one of the projects, North Orleans in Amsterdam.

Each case study analysis begins with an overview of the project. A short description is given next to an info-graphic. The info-graphic shows the most important characteristics of the project in diagrams and numbers.

The complex is studied on the floor plan. The most useful information for us is the ratio of m$^2$, amenities and routing. Questions like “how much m$^2$ is needed to access a certain amount of units?”, “What kind of collective/public amenities are organized in the complex?” and “What is the routing through the building?” are answered. This is helpful information for the design of a smart small apartment complex.

The individual units are also mostly studied by the floor plan. Because of the small and efficient floor plans of compact apartments the ratio of m$^2$ in the units is interesting. Next to that, the way of access in relation to the routing in the complex is useful information. To give insight in the cost efficiency the ratio of construction wall - facade is also studied.

The collection of data is comparable and forms a valuable set of information for the development of a new compact/smart small apartment complex.
XS Deluxe is a concept for a new way of living, developed by Synchroon development and Shift Architecture & Urbanism. XS Deluxe is a concept for micro-apartments in the city. Due to high prices and a high demand cities like Amsterdam are becoming less accessible. Micro-apartments are comfortable to live in because of efficient use of space and shared amenities. Living smaller and sharing facilities fits in the sustainable and modern urban lifestyle.

This specific design is made for the Houthavens in Amsterdam. The Houthavens is an upcoming neighborhood with a lot of new developments.

Synchroon and Shift describe the target group for XS Deluxe as ‘the new urbanist’. According to the developers students, starters, bachelors, expats and empty nesters fit in this target group. The new urbanist uses the city as their living room and asks for flexibility in their way of living and working. In this way of living sharing is the new property.
CASE STUDIES
Info-graphic

Complex

Amenities

Square meters
- Dwellings: 11.024 m²
- Collective: 560 m²
- Public: 1.170 m²
- Circulation: 3.470 m²

Access

Dwellings
- Total: 235
- Types: 4

Unit types

Solutions
- Shared amenities
- Open floor plan
- Cluster services
- Narrow dwellings
The ground floor of XS Deluxe has a public plinth. Working and retail spaces are located on two sides of the ground floor. A bike shed and car parking are also situated on this floor.
The first floor has an inner courtyard with a raised garden for collective use. Most of the apartments on this floor are ground bound. Collective amenities like laundry facilities, collective living room and cooking studio are also located on this floor.
The access of the apartments on the upper floors is organized through corridors and galleries.
Next to the shared working spaces on the 5th floor is a collective terrace.
This single orientated unit is exceptional since it is relatively big and has a outdoor space. The bathroom and kitchen are not connected but located on both sided of the entrance. Because of its size, the percentage of facade is relatively high.

Dwelling information

- Height: 2.8 m
- Bathroom: 3.1 m$^2$
- Installations: 2.2 m$^2$
- Hallway: 2.9 m$^2$
- Living room: 34 m$^2$
- Kitchen: 1.4 m$^2$
- Bedroom: 3.3 m$^2$
- Storage: 1.4 m$^2$
- Outdoor: 4.5 m$^2$
- Total: 52.8 m$^2$
- Facade - wall %: 27 - 73

Separated services

- Outdoor: 9%
- Bathroom: 6%
- Storage: 3%
- Bedroom: 6%
- Kitchen: 3%
- Living room: 64%
- Installations: 4%
- Hallway: 5%
In this unit the services are located in the center of the apartment. Since this is inefficiently designed, it results in a lot of circulation square meters. 26% percent of the square meters is hallway.

Dwelling information

<table>
<thead>
<tr>
<th>Room</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2,8 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>3,5 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>- m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>11,4 m²</td>
</tr>
<tr>
<td>Living room</td>
<td>21,7 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1,5 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>3,3 m²</td>
</tr>
<tr>
<td>Storage</td>
<td>1,3 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>2,7 m²</td>
</tr>
<tr>
<td>Total</td>
<td>45,4 m²</td>
</tr>
<tr>
<td>Facade - wall %</td>
<td>20 - 80</td>
</tr>
</tbody>
</table>

CASE STUDIES

Unit 2

In this unit the services are located in the center of the apartment. Since this is inefficiently designed, it results in a lot of circulation square meters. 26% percent of the square meters is hallway.

Dwelling information

<table>
<thead>
<tr>
<th>Room</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2,8 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>3,5 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>- m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>11,4 m²</td>
</tr>
<tr>
<td>Living room</td>
<td>21,7 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1,5 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>3,3 m²</td>
</tr>
<tr>
<td>Storage</td>
<td>1,3 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>2,7 m²</td>
</tr>
<tr>
<td>Total</td>
<td>45,4 m²</td>
</tr>
<tr>
<td>Facade - wall %</td>
<td>20 - 80</td>
</tr>
</tbody>
</table>

CASE STUDIES

Unit 2

In this unit the services are located in the center of the apartment. Since this is inefficiently designed, it results in a lot of circulation square meters. 26% percent of the square meters is hallway.
Because there are no separate bedroom or kitchen, most of the square meters are dedicated to the living room. This results in a open and spacious floor plan on a small surface.

Dwelling information

<table>
<thead>
<tr>
<th>Room</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2.8 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>3.4 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>2.4 m²</td>
</tr>
<tr>
<td>Living room</td>
<td>19.9 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1.5 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>3.3 m²</td>
</tr>
<tr>
<td>Storage</td>
<td>1 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>m²</td>
</tr>
<tr>
<td>Total</td>
<td>31.5 m²</td>
</tr>
<tr>
<td>Facade - wall %</td>
<td>25 - 75</td>
</tr>
</tbody>
</table>
Unit 4 is the bigger option of unit 3. The wider apartment has more storage room and a bigger living area. Because it is wider and not deeper, the ratio of facade and construction wall because more inefficient.
A narrow unit with the services in the middle along the wall as a space divider. Together with the double orientation the apartment is suitable for couples.

Dwelling information

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2,8 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>3,5 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>1,8 m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>- m²</td>
</tr>
<tr>
<td>Living room</td>
<td>30,1 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1,4 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>4 m²</td>
</tr>
<tr>
<td>Storage</td>
<td>1,4 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m²</td>
</tr>
<tr>
<td>Total</td>
<td>41 m²</td>
</tr>
<tr>
<td>Facade - wall %</td>
<td>23 - 77</td>
</tr>
</tbody>
</table>

Services along wall

Single orientated

Living room 73%

Kitchen 5%

Bedroom 10%

Storage 4%

Bathroom 10%
Unit type 6 fits in each other like a puzzle. A narrow floor plan with the services located along the wall. The entrance is right in the living room, with no hallway.

Dwelling information

<table>
<thead>
<tr>
<th>Height</th>
<th>2.8 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathroom</td>
<td>3.2 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>- m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>- m²</td>
</tr>
<tr>
<td>Living room</td>
<td>31.5 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1.5 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>3.3 m²</td>
</tr>
<tr>
<td>Storage</td>
<td>1 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m²</td>
</tr>
<tr>
<td>Total</td>
<td>40.5 m²</td>
</tr>
<tr>
<td>Facade - wall %</td>
<td>24 - 76</td>
</tr>
</tbody>
</table>

Services along wall

Single orientated

CASE STUDIES

Unit 6
Unit 6 is the biggest apartment of XS Deluxe Houthavens. The apartment is separated in two living areas. Because of its length, the ratio facade - construction wall is highly efficient.

Dwelling information

<table>
<thead>
<tr>
<th>Height</th>
<th>2,8 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathroom</td>
<td>4 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>- m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>- m²</td>
</tr>
<tr>
<td>Living room</td>
<td>44 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1,5 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>4 m²</td>
</tr>
<tr>
<td>Storage</td>
<td>1,5 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m²</td>
</tr>
<tr>
<td>Total</td>
<td>55 m²</td>
</tr>
<tr>
<td>Facade - wall %</td>
<td>16 - 84</td>
</tr>
</tbody>
</table>

Separated services

Single orientated
North Orleans is a housing project in the north of Amsterdam. Originally the complex of 120 apartments was designed for students. Since there were no restrictions on the maximum rent, the developer raised the prices enormously. At the moment, 80% to 90% percent of the inhabitants is foreigner, mostly ex-pats. The apartments are similar to hotel rooms, all the services like room cleaning, bike usage, electricity, water and WiFi are included in the monthly fee. Every apartment is completely furnished, including a bed that folds away in the sofa.

Although the apartments are small, compared to the other case studies there are very little shared amenities. Besides a collective garden the lobby is the only collective space within the building. On the ground floor several public restaurants and cafés serve the complex and neighborhood.
CASE STUDIES

Info-graphic

Complex

Amenities

Square meters

Dwellings 3.940 m²
Collective 32 m²
Public 340 m²
Circulation 1.610 m²

Access

Dwellings

Unit types

Dwellings 120
Types 1
Standard width 3700 mm
All the public and collective functions are located on the ground floor. Four restaurants/bars are located on two sided of the design. Next to the entrance is a small lobby where inhabitants can relax. The bike shed is where the bikes are stored which are included in the monthly fee. In the collective garden the inhabitants can meet each other, for instance during a barbecue.
CASE STUDIES
Floor 1 - 6

All the upper floors are similar. The apartments are all accessed through galleries.
Because of the narrow design and its single orientation the facade - construction wall ratio is very cost efficient. The flexible bed design saves space in the living room.

**Dwelling information**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Height</strong></td>
<td>2.8 m</td>
</tr>
<tr>
<td><strong>Bathroom</strong></td>
<td>4.5 m²</td>
</tr>
<tr>
<td><strong>Installations</strong></td>
<td>- m²</td>
</tr>
<tr>
<td><strong>Hallway</strong></td>
<td>2.9 m²</td>
</tr>
<tr>
<td><strong>Living room</strong></td>
<td>17.5 m²</td>
</tr>
<tr>
<td><strong>Kitchen</strong></td>
<td>1.6 m²</td>
</tr>
<tr>
<td><strong>Bedroom</strong></td>
<td>- m²</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>1.1 m²</td>
</tr>
<tr>
<td><strong>Outdoor</strong></td>
<td>4.7 m²</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>32.8 m²</td>
</tr>
<tr>
<td><strong>Facade - wall %</strong></td>
<td>13 - 87</td>
</tr>
</tbody>
</table>

**Separated services**

**Single orientated**

**CASE STUDIES**

Unit
The Lofts is a new project in the Amstelkwartier, a new district in Amsterdam, directly on the Amstel. In addition to the affordable compact houses, special to the project is the community idea, in which facilities are shared. The Lofts therefore focuses on young people born between 1980 and 2000, the millennials who are also called young professionals. This target group buys a house at a later age, attaches less value to property and wants to share facilities.

The Lofts consists of 212 rental apartments divided over eight floors. These are compact studios and two-room apartments. Beside their own apartment, on the ground floor residents can use various communal areas, such as a living room, library, work spaces and a laundry. These areas offer an opportunity to meet each other. There is also a communal roof terrace with a view over the city. The other spaces at the plinth are arranged as a gym for yoga and CrossFit or other functions for relaxation. In addition, the complex also has a parking garage and a communal bicycle parking.

The project was designed by Inbo architects. Large windows give the apartments a light and spacious feel and are inspired by New York lofts.
CASE STUDIES

Info-graphic

Complex

Amenities

Access

Units

Dwellings

Unit types

Solutions

- Shared amenities
- Open floor plan
- Cluster services
- Folding bed system
- Storage walls
- High window openings
- Sliding doors

Public 5%

Dwellings 69%

Collective 5%

Routing 21%

Dwellings 7,317 m²

Collective 520 m²

Public 519 m²

Circulation 2,201 m²

Dwellings 212

Types 5

Standard widths 5700 mm

± 6000 mm
On this floor the common bicycle parking is located. This space has a double height but most of the basement actually consists of two floors. Therefore, the parking garage consists of two layers. Cars enter via a lift system.
There are a number of commercial spaces in the plinth of the building. Such as a hairdresser and a tanning salon. These areas are only accessible from the street. The Lofts has a spacious entrance that has a direct connection to the communal living room. The apartments on the ground floor have a small outdoor space. In addition, there is a small strip of greenery that can be used by all residents. The bicycle storage is accessible via a staircase.
Only apartments are located on these floors. They are made accessible through a corridor and gallery principle. Only on the first floor on the north side the apartments have an outdoor space.
On this floor the communal terrace of about 185 m² is located, with views over the city. The rest of the roof is reserved for PV cells.
This apartment has a separate bedroom, which can be closed with a large sliding wall. The open sliding wall provides light in this room because the bedroom itself has no window openings. Therefore, the living room has a large window surface that occur in all units. The living room and bedroom are separated by a storage element. The kitchen and the bathroom are connected to each other. Where most dwellings in this complex have the installation space in the common corridor, it is now located in the dwelling itself.

Dwelling information

<table>
<thead>
<tr>
<th>Category</th>
<th>Space (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2.75 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>2.9 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>0.2 m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>2.1 m²</td>
</tr>
<tr>
<td>Living room</td>
<td>17.0 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1.1 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>6.2 m²</td>
</tr>
<tr>
<td>Storage</td>
<td>1.5 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m²</td>
</tr>
<tr>
<td>Total</td>
<td>31.0 m²</td>
</tr>
</tbody>
</table>

Facade - wall % 24 - 76
This apartment has the same surface as unit 1. However, in this variant the bed is located in the living room. This bed folds into a closet element. This creates a relatively larger living room. Storage is located both in the living room and in the hallway. The kitchen and bathroom are separated from each other.

Dwelling information

Height 2,75 m  
Bathroom 2,9 m²  
Installations - m²  
Hallway 1,9 m²  
Living room 22,9 m²  
Kitchen 1,2 m²  
Bedroom - m²  
Storage 1,9 m²  
Outdoor - m²  
Total 30,8 m²  
Facade - wall % 24 - 76
This corner apartment has a separate bedroom, which can be connected to the living room with sliding doors. A closed bedroom does have its own window opening. However, to enter the bathroom with the toilet, one has to go via the bedroom. There are storage facilities in the hallway, living room and bedroom. The bathroom and kitchen are separated from each other.

Dwelling information

<table>
<thead>
<tr>
<th>Category</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2.75 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>2.9 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>- m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>3.5 m²</td>
</tr>
<tr>
<td>Living room</td>
<td>20.3 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1.1 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>7.7 m²</td>
</tr>
<tr>
<td>Storage</td>
<td>2.5 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m²</td>
</tr>
<tr>
<td>Total</td>
<td>38.0 m²</td>
</tr>
<tr>
<td>Facade - wall %</td>
<td>45 - 55</td>
</tr>
</tbody>
</table>

Separated services

Corner orientated

Case Studies

Unit 3
This corner apartment has a separate bedroom, living room and bathroom. In this case the bedroom also has its own window opening. In addition, the bathroom and the living room are separated by a closed hallway. Also the kitchen and bathroom are now separated from each other. Storage is only possible in the bedroom which can be entered through a sliding doors.

Dwelling information

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2,75 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>2,9 m$^2$</td>
</tr>
<tr>
<td>Installations</td>
<td>- m$^2$</td>
</tr>
<tr>
<td>Hallway</td>
<td>1,9 m$^2$</td>
</tr>
<tr>
<td>Living room</td>
<td>27,7 m$^2$</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1,6 m$^2$</td>
</tr>
<tr>
<td>Bedroom</td>
<td>7,1 m$^2$</td>
</tr>
<tr>
<td>Storage</td>
<td>1,3 m$^2$</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m$^2$</td>
</tr>
<tr>
<td>Total</td>
<td>42,5 m$^2$</td>
</tr>
<tr>
<td>Facade - wall%</td>
<td>39 - 61</td>
</tr>
</tbody>
</table>
This apartment has the same surface as unit 1 and 2. The apartment has a separate bedroom with its own window opening. However, to reach the bathroom with toilet, this must be via the bedroom. The bedroom can be closed with sliding doors. A storage element creates a hallway between the kitchen and the bathroom. Because of all this separated spaces, the dwelling has a relatively small living room.

**Dwelling information**

<table>
<thead>
<tr>
<th>Space</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2.75 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>2.9 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>0.3 m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>2.6 m²</td>
</tr>
<tr>
<td>Living room</td>
<td>13.7 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1.3 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>8.4 m²</td>
</tr>
<tr>
<td>Storage</td>
<td>1.5 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m²</td>
</tr>
<tr>
<td>Total</td>
<td>30.7 m²</td>
</tr>
<tr>
<td>Facade - wall%</td>
<td>24 - 76</td>
</tr>
</tbody>
</table>

**Separated services**

**Single orientated**

**CASE STUDIES**

Unit 5
Just like in Amsterdam, New York also has a shortage of affordable housing. nARCHITECTS came up with a smart solution to this problem; modular apartments intended for people who live with a relatively low income, live alone or with 2 people and do not need much space, but would like to live in the center. The aim was to provide a new social framework for small households that emphasizes nested scales of community rather than individual residents. Carmel Place is located in Manhattan in the Kips Bay district.

The complex consists of 55 residential containers stacked on top of each other with an area of around 30 m². These containers are first prefabricated and later on stacked on the building site. The complex has 9 floors with a floor height of about 3 meters. Each house has a Juliette balcony and concealed storage space near the ceiling. One of the reasons that this is a special project is that New York has a special rule. Apartments cannot be smaller than 37 square meters. But because of New York's interest in affordable housing, they deviated from this rule.

In exchange for small, single-occupancy units, residents could share amenities like a restaurant-kitchen, dining area, lounge, and cleaning services. The apartments are furnished, have a virtual doorman and have all access to an outdoor terrace, a fitness room, bicycle storage, game room, study room, and laundry.
CASE STUDIES

Info-graphic

Complex

Amenities

- Circulation
- Public
- Dwellings

Access

Units

Dwellings

- 55
- 7

Types

Standard widths

- 4940 mm
- 4575 mm
- 4630 mm
- 3470 mm
- 3395 mm
- 3420 mm

Solutions

- Shared amenities
- Open floor plan
- Cluster services
- Narrow dwellings
- Folding bed system
- High window openings
- Juliette balcony
- Folding bed system
- Storage walls
- Overhead storage
On this floor there several communal areas are located. In addition to the bicycle storage, there is also a room for study, a game room, storage and a laundry room.
The spacious entrance can be accessed on two sides. The entrance offers direct access to the sports room and the small communal living room. The entrance / lobby is also called the residential street. The restaurant is only accessible via the public street. The bicycle storage can be accessed via a staircase at one side of the building. On the ground floor there is also a small communal garden.
Only apartments are located on these floors. They are made accessible through a corridor principle. All apartments have a Juliette balcony.
The 7th floor has a common room / kitchen. Next to this room there is a communal roof terrace. The apartments on this floor also have their own balcony / terrace. On the 8th floor there are only apartments located.
Like all other units in the complex this apartment has a storage element against the ceiling. This is possible because of the relatively high space of almost 3 meters. The large window openings come back in all the other apartments. The apartment has a relatively large open hallway with access to the bathroom and overhead storage. The bed is located in the living room and can be folded into a closet element. The kitchen and the bathroom are connected to each other.

Dwelling information

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2.95 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>3.6 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>- m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>5.3 m²</td>
</tr>
<tr>
<td>Living room</td>
<td>14.9 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>2.6 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>- m²</td>
</tr>
<tr>
<td>Storage</td>
<td>0.6 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m²</td>
</tr>
<tr>
<td>Total</td>
<td>27.0 m²</td>
</tr>
<tr>
<td>Facade - wall %</td>
<td>14 - 86</td>
</tr>
</tbody>
</table>
This corner apartment is one of the largest in the complex. Due to the lack of the hallway and separate bedroom, the living room is relatively large. The bathroom is larger than usual and is connected to the kitchen. The apartment also has a large storage space in the corner.

Dwelling information

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2.95 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>7.9 m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>- m²</td>
</tr>
<tr>
<td>Living room</td>
<td>23.3 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>2.1 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>- m²</td>
</tr>
<tr>
<td>Storage</td>
<td>2.2 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m²</td>
</tr>
<tr>
<td>Total</td>
<td>35.5 m²</td>
</tr>
<tr>
<td>Facade - wall %</td>
<td>50 - 50</td>
</tr>
</tbody>
</table>
This apartment is very similar to unit 1. However, the entrance of the apartment is located in the middle of the dwelling. Therefore, the hall serves more as storage space and works as a buffer between the living room and bathroom. The bathroom and the kitchen are connected.

Dwelling information

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2.95 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>3.7 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>- m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>4.2 m²</td>
</tr>
<tr>
<td>Living room</td>
<td>17.5 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>2.7 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>- m²</td>
</tr>
<tr>
<td>Storage</td>
<td>1.6 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m²</td>
</tr>
<tr>
<td>Total</td>
<td>29.7 m²</td>
</tr>
<tr>
<td>Facade - wall %</td>
<td>13 - 87</td>
</tr>
</tbody>
</table>

- Single orientated
- Services in corner

CASE STUDIES
Unit 3
This large corner apartment has a large hallway. This is due to the connection with the kitchen. The hallway provides a separation between the kitchen and the bathroom. Despite the large space, the bed is still part of the living room.

Dwelling information

<table>
<thead>
<tr>
<th>Room</th>
<th>Area</th>
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</thead>
<tbody>
<tr>
<td>Height</td>
<td>2.95 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>4.2 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>5.3 m²</td>
</tr>
<tr>
<td>Living room</td>
<td>22.7 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>2.1 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>- m²</td>
</tr>
<tr>
<td>Storage</td>
<td>0.6 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m²</td>
</tr>
<tr>
<td>Total</td>
<td>34.9 m²</td>
</tr>
<tr>
<td>Facade - wall %</td>
<td>52 - 48</td>
</tr>
</tbody>
</table>

Separated services

Corner orientated

CASE STUDIES
Unit 4
This relatively wide apartment also looks like unit 1. A storage room provides for the separation of the kitchen and the bathroom. On the 7th floor this house also has a balcony.

Dwelling information

<table>
<thead>
<tr>
<th>Category</th>
<th>Size</th>
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</thead>
<tbody>
<tr>
<td>Height</td>
<td>2.95 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>4.1 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>3.4 m²</td>
</tr>
<tr>
<td>Living room</td>
<td>16.4 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>2.1 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>-</td>
</tr>
<tr>
<td>Storage</td>
<td>0.7 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>26.7 m²</td>
</tr>
<tr>
<td>Facade - wall</td>
<td>50 - 50</td>
</tr>
</tbody>
</table>
This is as well a apartment with a wide facade. Therefore, the dwelling is also less deep. Due to the lack of a hallway, the living room is larger. In addition, there is also large storage space. The kitchen and the bathroom are connected. On the 7th floor this apartment also has a balcony.

Dwelling information

<table>
<thead>
<tr>
<th>Space</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>2,95 m</td>
</tr>
<tr>
<td>Bathroom</td>
<td>4,7 m²</td>
</tr>
<tr>
<td>Installations</td>
<td>- m²</td>
</tr>
<tr>
<td>Hallway</td>
<td>- m²</td>
</tr>
<tr>
<td>Living room</td>
<td>18,7 m²</td>
</tr>
<tr>
<td>Kitchen</td>
<td>2,6 m²</td>
</tr>
<tr>
<td>Bedroom</td>
<td>- m²</td>
</tr>
<tr>
<td>Storage</td>
<td>1,2 m²</td>
</tr>
<tr>
<td>Outdoor</td>
<td>- m²</td>
</tr>
<tr>
<td>Total</td>
<td>27,2 m²</td>
</tr>
<tr>
<td>Facade - wall%</td>
<td>28 - 72</td>
</tr>
</tbody>
</table>
This is also an apartment with a wide facade. Due to the lack of a hall, the living room is larger. The kitchen and the bathroom are connected. On the 7th floor this house also has a separate balcony.

Dwelling information

- Height: 2.95 m
- Bathroom: 4.7 m²
- Installations: - m²
- Hallway: - m²
- Living room: 23.1 m²
- Kitchen: 2.6 m²
- Bedroom: - m²
- Storage: 0.8 m²
- Outdoor: - m²
- Total: 31.2 m²
- Facade - wall %: 47 - 53

CASE STUDIES
This conclusion summarizes which architectural aspects do help to create a compact dwelling for starters. It looks at both the dwelling and to the entire complex. Our results are combined and complemented by additional advises of the Architecture Center of Amsterdam (ARCAM). They developed a number of guidelines for compact apartments.

In history, luxury living concepts and socialist ideas were close together. The sharing of the various facilities such as laundry, kitchen, restaurant, lounge, kindergarten and gym can be found on both sides. In the more luxurious concepts there are more personal services. Most examples are focused on both small households and families. The saving of space is created by the ‘standard solution’ of folding bed systems. In addition, the integration of essential functions within the house is a common method. Less essential functions are kept outside the dwelling.

Despite the long history, the concept of small living is also a hot item of our time. In the coming years it is expected that amount of one- and two-person households will rise. These people belong to ‘the new city dwellers’. This group places less value on private ownership and is willing to share more. This target group primarily considers a good urban location important. Moreover, the compact dwellings are a good answer to the sustainability theme. The high densification has a positive influence on the use of land and energy consumption. This results in a small ‘footprint’ per person.

The complex

*Target group*

According to ARCAM in the compact dwelling concept diversity among the residents must be considered to prevent monotonous neighborhoods. For example, the classic system for target group selection on the basis of family composition, must therefore be different. Instead, one must look at the differences in need for social proximity with fellow residents. It is important to look for like-minded people for creating a community.

This is partly determined by the degree of sharing of certain facilities. A distinction is made between collective sharing and anonymous sharing. In collective sharing, facilities are shared by a small group of people. For example one floor. When sharing anonymously facilities are divided among a large group. For example the entire complex. With collective sharing, the focus is on more interaction between neighbors. One finds this more pleasant than the other. Therefore, programs of compact apartments complexes can differ.


*Amenities*

The appearance of the entire residential complex is an important aspect in the quality of the individual dwelling, whatever the size is small or large. Less square meters in an individual dwelling can be compensated by shared luxury. This can be accomplished by presence of high-quality collective facilities / amenities that are not present in a normal apartment.

*Entrance*

Following this shared luxury also the entrance is important. By creating a large entrance, luxury is again provided for the entire complex. Making a luxury ‘address’ benefits the individual (small) dwelling.

*Personal services*

With compact dwelling the ‘third party’ is also important. In addition to the management / maintenance by a separate party, personal service is also an important aspect in this residential concept. ‘Familiar faces’ have a positive effect on the social structure in the complex.

*Construction*

The building must have a flexible construction. A load-bearing facade and solid core ensures floors have a flexible layout. Therefore, the floor can accommodate a diversity of housing types and can be adapted to new trends and developments in housing.29

*Trends*

The compact dwellings must be adaptable to new trends. Today people need less space for parking and bookcases. This is due to technological advances such as iPad and e-readers that work in a space-saving way. In addition, they also state that people spend less time in the living room and that the role of the kitchen in an individual home will may change in the future. This all affects the layout of the house.30

*The Dwelling*

*Volume - M*³

Because the Residents in compact dwellings live on less square meters, other aspects in the home need to be improved in order to preserve the quality of life. People now should have more right to daylight and view. An important aspect is thinking in m³ instead of m². A higher ceiling not only provides more daylight, but also brings other benefits with it. Smart interior elements such as horizontal storage close to the ceiling (Carmel Place) and higher sleeping places on top of the storage spaces. Another solution can

29 Ibidem.
30 Ibidem.
31 Ibidem.
be sleep and storage in flexible floor elements.

**Single aspect dwelling**
In many examples the single aspect principle is used, where there is only one window opening on one side. In this case, the spaces with less daylight demand are located in the back (dark side) of the apartment. These are generally wet rooms, storage, but also the kitchen. Living room and bedroom are on the light side of the dwelling.

**Wet rooms**
In most cases, the toilet is located in the bathroom. The kitchen with its water applications water is often located close to the bathroom. Due to the clustering of bathroom and kitchen, the distance from ducts to shafts is reduced. Generally there is no room reserved for a washing machine and dryer. These are often part of the collective spaces.

**Bedroom**
In many compact apartments the bed is located in the living room. It can be folded in closet system. For privacy reasons, it is often tried to make a separate bedroom. However, due to the ‘single aspect’ principle, this room does not have its own window opening. In order to comply this space with the regulations of daylight this space is adjusted to the minimum depth of the bed and open connected to the living room. By using large sliding doors the room can be separated. Also in some cases you have to go via the bedroom to enter the bathroom (De Lofts).

**Privacy**
When families live in a compact apartment is advised to give the kids their own bedroom. A modern bedstead could be a solution. Parents can integrate their sleeping place in the living room.\(^{32}\)

### Case study statistics
Four case studies were discussed during this study. The number is too low to make exclusive statements about compact complexes. However, it gives a good impression what common elements compact complexes have and how they differ.

**Collective space**
When the complex gets smaller the amount of collective square meters also becomes smaller. However, in percentage this value rises. North Orleans is an exception here, because there is no collective space except for a small lobby. According to the calculations of the diagrams the average collective space is 5%.

The average amount of m\(^2\) per dwelling: XS Deluxe = 47 m\(^2\), De Lofts = 35 m\(^2\), North Orleans = 33 m\(^2\) and Carmel Place = 37 m\(^2\). All including outdoor space. The total average m\(^2\) per dwelling is: 38 m\(^2\).

The average amount of m\(^2\) of common space per dwelling: XS Deluxe = 2.4 m\(^2\), De Lofts = 2.5 m\(^2\), North Orleans = 0.3 m\(^2\) and Carmel Place = 5.8 m\(^2\). The total average m\(^2\) per dwelling is: 2.8 m\(^2\).

**Access**
Especially gallery and corridor principle are often used. Ground-based homes with a garden do occur with XS Deluxe. Portiek principle is not applied in any of the case studies.

**Outdoor space**
In most examples there is no private outdoor spaces. The outdoor spaces are often a collective solution. Beside to this collective space XS Deluxe has several dwellings with their own outdoor space. North Orleans compensates for the lack of collective space with a private balcony for each apartment.

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\(^{32}\) Ibidem.
Conclusion
Compact apartments

Structure width
In contrast to ARCAM’s advice, the case studies do not use the core in with a load-bearing facade combination. In general, narrow prefab channel constructions are used. Short floor spans that keep the price low. These narrow sizes vary between 3.4 and 3.7 meters. There are exceptions with larger structure width. For example, De Lofts uses a standard size of 5.7 and 6.0 meters. This value is also found in several cases in the design of XS Deluxe.

Heights
The advice is to think in volumes, but in the case studies it has hardly been applied. It is done to in limited way at Carmel Place. The high ceiling of 3 meters ensures high storage places. Nevertheless, in all cases large window openings have been used.

Dwelling services
The positioning of the services within the dwellings is very variable. Both between the complexes as in the complexes themselves. Two variants that are most common are: ‘Services in corner’ and ‘Separated services’.

The hallway
Inside the dwelling, the hallway plays an important role. This often works as a kind of buffer zone between the bathroom (with toilet) and the rest of the apartment. However, this area takes a lot of space. It varies between 4% and 26% of the total dwelling space. In many cases, the hallway is not included in the design.

Kitchen, storage and bathroom
These values are stable. With the kitchen around 4% and the storage around 4%. The bathroom is on average 11% of the total dwelling space.

Amenities
The amenities are part of the compact apartment concept and partly determine the people who will live there. On the basis of the four case studies, an overview has been made of the possible amenities and in which groups they can be accommodated.


Introduction

Newspaper attention (parool.nl)


Amsterdam housing market prices (daskapital.nl)


Context


Timeline & Sustainable densification


Target group

Wekker-Duyvendak-diagram (Ontwerplab min of meer: microwoningen)


Case studies

MSC 3 Research

Water Management

Jamie Bakkes
<table>
<thead>
<tr>
<th>TABLE OF CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
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<tr>
<td>Water drainage</td>
</tr>
<tr>
<td>Water plan</td>
</tr>
<tr>
<td>Water measures</td>
</tr>
<tr>
<td>Case studies</td>
</tr>
<tr>
<td>Conclusion</td>
</tr>
<tr>
<td>Sources</td>
</tr>
</tbody>
</table>
The Metropolitan Region of the city of Amsterdam is a safe and water resistant region. However, the climate change and further densification of the city asks for adjustment. The climate scenarios of the KNMI (2014) show a number of common features:

- The climate warming continues and results in less cold winters and warmer summers.
- The winters on average produce more rain and extreme precipitation rates are more common.
- The intensity of rain showers in summer increases, but the number of rainy days decreases, which increases the length of dry periods.

Therefore, in the design of urban areas, an increase in extremes in both excessive water and water shortages must be taken into consideration. Rainwater storage in the city must help to:

- Prevent water flooding.
- Supplement groundwater shortages.
- To cool and add more ‘green’ to the city.

Water management in Amsterdam is of all time. The canals are important in this management. They were made to get dry ground, for the discharge of rainwater, for sewage and water for extinguishing fires. The sewage function has caused inconvenience for many years. Once the dwellings were connected to the sewage system, the quality of water has improved.

Amsterdam
Waternet is the water company responsible for the water of the city of Amsterdam and a large part of the provinces of Utrecht and Noord-Holland. Waternet cleans wastewater, purifies it and supplies it to 1.3 million people living and working in this area. In addition to supplying drinking water, Waternet cleans and maintains the level of the surface water.

In Amsterdam, Waternet cooperates with Amsterdam Rainproof. They want to make the city ‘heavy rain proof’ by cooperating with residents, companies, knowledge institutions and governments.

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4 Waternet. (2016). Wat doet Rainproof?
INTRODUCTION

The City has the ambition to be able to handle a 60 mm rain shower per hour without damage to homes and vital infrastructure in 2020. In such a case, 20 mm is processed via the underwater system and 40 mm is temporarily stored in public and private spaces (roofs, gardens, etc.). In this way they want to be able to handle extreme rainfall and long drought periods.\(^5\)

The desired measures can only be carried out if an awareness process is initiated among city residents. This is possible if the design by urban designers and architects is involved in this process.

Future

60 mm of rain per hour is a large amount of rainwater. This is the equivalent to 60 liters of water per hour per m\(^2\). At the same time this also offers opportunities. In the recent years saving drinking water has gained more attention. However, the possibilities of re-use are hardly implemented. The current system which removes precipitation as quickly as possible, with the exception of the percentage taken in by the soil. In general, clean rainwater is still led directly to the sewer in the city. This is replaced by a new policy, a policy that aims at buffering, infiltration and delayed discharge of rainwater on site. In the future this rainwater will be used.\(^6\)

Content

This report first looks at the different types of sewer systems in Amsterdam where the advantages and disadvantages of the applied systems are discussed.

There is also attention for aspects that are important for a future water plan which supports the policy of buffering, infiltration and delayed discharge. Amsterdam including the Groenmarkt have specific soil types that are related to varying groundwater levels. Next, the various measures that Rainproof Amsterdam has proposed are being discussed. This involves both large-scale and small-scale interventions. Later on in this report three case studies are examined that focus on management in Amsterdam and Rotterdam. In this, the social aspects are brought forward as well.

In the conclusion an overview is made of the measures that can be taken at the Groenmarkt. At both building level and urban planning level, the aspects that need to be taken into account in the preliminary design are identified.

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The water cycle in Dutch cities has for years been focused on the rapid discharge of rainwater and domestic wastewater into sewage treatment or surface water. In the older neighbourhoods, this often happens with the ‘combined system’. In the new building areas, the ‘separate system’ and ‘improved separate system’ are used as a standard.

The combined sewer system aims to expel the water as quickly as possible. In this system, both the rainwater and the dirty water are lead to the purification. There, the water is purified and the (purified) effluent wastewater is discharged to the surface water. In case of heavy rainfall, peak discharges occur. The purification station may not be sufficient and the sewage will be discharged directly onto the surface water with the consequence of surface water contamination.

In addition, mixing of large amounts of rainwater and dirty water, dilutes the waste water. This is not beneficial for the purification process because some of the micro-organisms get insufficient nutrition and will die due to the dilution. These micro-organisms are essential for the purification process and need to be restored. That takes some time.7

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Therefore, during restructuring or sewage renewals the mixed system is replaced by the ‘separated system’ or ‘improved separated system’ if possible. If this cannot be done by lack of space, ‘disconnecting’ is a good alternative. Then, rainwater is no longer mixed with the waste water.

Due to the disadvantages of the mixed system, one has switched to the ‘separate system’. In this system the rainwater is discharged separately and discharged directly onto the surface water. The disadvantage of this system is that contaminated rainwater, caused for example by busy streets, may cause pollution of surface water.  

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Meanwhile, the ‘improved separate system’ is the standard. In this system, the first fraction of rainwater is directed through the sewage to the purification station. The remaining rainwater is discharged directly onto the surface water. However, this system also has limitations: heavy metals loosen slowly from paved surfaces and thus end up in surface water through the second fraction of runoff.\textsuperscript{9}

WATER PLAN

Introduction
The sewer system in Amsterdam is calculated on a rain shower that falls once every two years. As a result, the sewer system can process an average of 20 mm of rain per hour. In order to make the city more rainproof, a downpour with an intensity of 160 l / s / ha (about 60 mm / hour) should be calculated. Nowadays the systems are often calculated with 90-110 l / s / ha. 10

The chance that Amsterdam has to deal with 60 mm of rainfall per hour is small. The KNMI speaks of a cloudburst at 25 mm or more in an hour or at least 10 mm in five minutes. A random place in our country gets a cloudburst on average once every ten years. But the trend is that the amount of ‘extremes’ are rising more. 11 In Amsterdam on 28 July 2014, 40 mm fell in some places within an hour. In some locations even 12 mm in five minutes, which corresponds to an intensity of 135 mm per hour: that is very extreme rainfall. 12

According to the KNMI, global warming causes an increase in extreme showers. With one degree of temperature rise, the amount of precipitation per hour in the most extreme rain showers will increase by about fourteen percent.

Amsterdam is taking measures to prevent the damage from extreme showers in the future. Together with Rainproof Amsterdam they provide water plans at various locations. This varies from municipal projects to promotion and information for a lot of small-scale private project.

For creating a water plan a number of natural conditions are important. For example, the amount of precipitation and the available surface water are important values. Another point of attention is the height of the buildings in relation to the water. Lower areas are more difficult to discharge rainwater into the surface water. Moreover, the soil in Amsterdam is also an important aspect. One should think of the type of soil and the groundwater level. Therefore, this chapter looks at these aspects specifically for the Groenmarkt.

Height of water
In the city center of Amsterdam there is often mixed sewage system used. This means that rainwater and waste water run into the same duct. The contaminated water is then led to the purification. A portion of the rainwater falling on the street in the city center, runs off in the canals. This is possible because the streets and houses in the center are at least one meter above the water level of the canals.

Not all streets of Amsterdam are above the water level of the canals. There is a historical explanation for the difference in height. With the expansion of Amsterdam in the late 19th century, many agricultural land was used for building. Old ditches were filled up and made into streets. But in some places the ground was not heightened first, as it was in the center of Amsterdam, because these areas were already partly built on it. This applies for example to parts of Oud-West, de Baarsjes and Oud-Zuid.

In these areas the water can not go anywhere and stays on the street when it rains heavily. These are the places where most floodings take place. In addition, city parks such as the Vondelpark, the Sarphatipark and the Oosterpark are almost two meters below the water level. These low-lying areas are flooding more during heavy rain fall. 13

Soil type
The different composite soil types all have different characteristics with respect to permeability of water. In general, the larger the grain size, the more water can pass through the soil. Therefore, less water is retained. This means that clay allows a small amount of water to pass through the soil and also keeps water above the groundwater level, while gravel and sand let water pass through. This type of soil is dry above the groundwater level. Together with the groundwater level this has consequences for the possible water measures in the urban development plan.

The lower clay soils with a high groundwater level and low storage capacity are mainly found in the Western Netherlands. To the East are the higher sandy soils with a lower groundwater level and a high storage capacity. 14

11 KNMI. (n.d.). Uitleg over zware neerslag.
13 Naafs, S. (n.d.). Amsterdam Rainproof: Hoe rainproof is ons riool?
Amsterdam is also located in the area of the lower clay soils. Despite the fact that the soil type can vary in different locations in Amsterdam, the Geological Department of the Netherlands has drawn up general schematics of the soil types in Amsterdam. They are the central geoscientific information and research center of the Netherlands for sustainable management and use of the subsurface and underground natural resources.\footnote{De Gans, W. (2011). De bodem onder Amsterdam: een geologische stadswandeling. Utrecht: TNO}

It is noticeable here that the area next to the Singelgracht has a first layer of 'applied sand'. The soil under this layer of sand consists of 'Amstel-clay' and 'moor'.

**Groundwater level**

In addition to the type of soil, the groundwater level also has consequences for the possible water systems. The level of groundwater will rise during rainfall. The extent to which it rises depends on the storage coefficient of the soil type.\footnote{Pötz, H., Bleuzé, P. (2012). Groenblauwe netwerken: Handleiding voor veerkrachtige steden. Delft: coop for life.}

In Amsterdam and the surroundings area the groundwater is not deep underground. It is important that the level of the groundwater is steady and correct. When the groundwater is too high, basements can flood and gardens become swampy. If the groundwater level is too low, the wooden poles on which the houses are built can rot.\footnote{Waternet. (n.d.). Grondwater.}

Waternet monitors the groundwater with hundreds of ‘measurement tubes’ in and around Amsterdam. This happens about 6 times a year manually in about 2500 places. At the Groenmarktkaade there is also a tube located with recent measurements from 2017. Between the transformer station and the plot there is also a measurement tube. However, the last measurement dates from 2010. The values are in fact the same as the recent measurements used from the Groenmarktkaade.\footnote{Waternet. (2017). Grondwater levels.}

The street height for these measurements is 0.88 m + NAP (Normaal Amsterdam Peil). The average groundwater level is -0.35 + NAP. The difference between these numbers gives a value of 1.23 meters in which the groundwater is hardly present.


\footnote{17 Waternet. (n.d.). Grondwater.}

\footnote{18 Waternet. (2017). Grondwater levels.}
Water measures
In the wet clay situation, as is generally the case in Amsterdam, basically an above-ground drain, a buffering in ponds, in ditches and discharge on surface water or infiltration by means of a drainage system are the usual solutions. Buffering requires a storage surface.

On high, dry and sandy soils, rainwater is infiltrated into the soil or stored in open water. The groundwater is then replenished and drainage facilities are not required. In the case of wet soils, an above-ground storage room is created, so the water is discharged in a slow manner. Clay soils are very limited water permeability.

When making a water plan, it is important that measures are adjusted to one another. While some combinations of measures provide value, some may work against each other. For example, the combination of grass roofs and rainwater use does not work. Grass roofs retain rain water for a long time and the water can not be used. On the other hand, a water square provides a dual function.

The water to be drained can be divided into two groups. First, the rainwater from the roofs. This water is generally sufficiently clean. It can therefore be infiltrated or stored without a purifying process. The run-off water of roads can be polluted. This sometimes requires purifying provisions.

Basement attentions
The Groenmarkt area is under development. A new apartment complex is being created as well as a new residential block at the Marnixstraat. An underground parking garage will also be built in the area.

Therefore, in 2013 in the Urban Planning Program Requirements of the Groenmarkt a number of statements have already been made regarding to the soil. In 2009, the engineering firm Fugro composed an advice about the consequences of the parking garage on local water management. As a result of the construction of this parking basement, the infiltration of rainwater into the soil decreases. The descent of the groundwater level is expected to be negligible. Nor will there be an increase in the groundwater level.

At the project site no significant barrier effect is expected due to the construction of the parking with at a basement depth of -3 meters relative to the ground level. Due to a barrier effect the groundwater flow is locally hindered by underground constructions.

Waternet also recommends applying a layer of ‘water permeable sand’ of 30 - 50 cm under the basement floor.

20 Gemeente Amsterdam (2013). Stedenbouwkundig programma van eisen Groenmarkt
In Amsterdam, Rainproof Amsterdam is busy with the promotion and guidance of initiatives in the field of water management. It is a strong network of various organizations: government organizations, design firms, property owners, entrepreneurs, neighbourhood organizations, knowledge institutions and network organizations. The network supports each other in the rainproof design of the city, with which every organization contributes in its own way.

Their website contains measures that can be applied to increase the city’s sponge function and to stimulate the use of rainwater. Many options have already been applied to various projects in Amsterdam. In addition, there are also many initiatives planned or under construction. All these measures have different characteristics in terms of size and the degree of infiltration and buffering. Also in the book ‘GroenBlauwe netwerken’ a number of measures are compared in a diagram.²¹

In this chapter, different types of measures will be described and looks in many cases the impact they may have on water management.

**Infiltration crates**
Infiltration crates are underground soil filtration facilities. These plastic crates are covered with geotextile to avoid silting.

These crates do not use space above the ground and have a larger storage capacity than soil filtration facilities above the ground. More rainwater can be buffered and released to the groundwater in a gradual manner.

The crates can be used in gardens, under roads, sports fields and parking garages. This makes double use of land possible. Due to the extra infiltration less drought damage, soil subsidence and salinization occurs.²²

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**Facade garden**
By removing a row of tiles along the facade on the street side and creating a garden, the rainwater flowing from the facade can infiltrate into the ground. Facade gardens also contribute to a greener streets. By placing climbers plants the facade remains cool in the summer.

A facade garden can also be combined with a disconnected rain pipe. The condition is that there must be an overflow provision to the surface water or the street gutter.²³

It is also possible to store rainwater from the rain pipe under the facade garden with the installation of infiltration blocks. By connecting the rain pipe to these infiltration blocks, you collect part of the rainwater and it slowly infiltrates into the soil. The blocks slowly release the water to the ground or slowly to the sewer via an overflow pipe. In addition, these blocks also absorb excess groundwater. In contrast to ‘normal’ infiltration crates and gravel boxes, these Infiltration blocks can drain and irrigate.²⁴

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**Urban infiltration strips / fields**
Infiltration ditches or deepened fields next to paved surfaces can temporarily store rainwater. This allows easy infiltration of water of hardened surfaces such as roofs and cycle paths.

For infiltration, the amount of rainfall that needs to be buffered and the permeability of the soil is important. The required surface can be assumed from 10% to 20% of the connected paved surface. The depth and the surface determine the buffer capacity. In residential areas, a maximum depth of 30 cm is sufficient to ensure that is safe children.

Due to a limitation of space a possible system can be: a concrete-encased container without bottom, filled with gravel, soil, and plants, connected to the soil. The infiltration strips buffer and purify the rainwater and release it to the soil.²⁵

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²⁵ Amsterdam Rainproof. (n.d.). Infiltratiestroken met bovengrondse opslag.
**Water Square**
A water square is a deepened square where rainwater from the neighbourhood flows to and is held temporarily. In urban areas people often look for underground solutions. By giving the rainwater a visible place in the public space, a multifunctional square can be created.

A water square combines water storage with other urban functions in an attractive way. When it is dry, it can be used. When it rains, the square is filled with water and functions as a storage. The rainwater from the neighbourhood flows to the square via open drains or a rainwater sewer.

**Urban waterways**
Open urban waterways can drain and hold rainwater. This solution can be used in new urban areas, but as well in case of restructuring if there is enough space. In this application, the water is not released directly to the soil, but in a closed concrete element, like in the example.

The various aboveground drain options, such as open drains and ditches, can drain to an open urban waterway. A facility that temporarily holds rainwater must be designed to remain attractive at high and low water levels.

In the case of waterways with a natural appearance, this can be done by creating shallow banks. For more urban, stony, waterways this can be done through a stepped quay.26

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26 Amsterdam Rainproof. (n.d.) Waterpleinen.

27 Amsterdam Rainproof. (n.d.) Stedelijke waterlopen.

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*Schematic section open waterway (rainproof.nl)*

*Schematic section water square in a wet situation. (rainproof.nl)*
WATER MEASURES

Street elements

The excess of (closed) paved streets in the city cause inconvenience during extreme rain showers. Due to the intense use of the city these paved parts can barely be removed. However, we can make these elements ‘more permeable’.

Open gutter

An open gutter is a simple above-ground drain, which can be used in the garden, on the street, in parks and on squares. When used on the street, the street profile is identical to a conventional solution. Only the street profile has a slightly deepened gutter instead of a storm drain.

Then the water is led into the surface water, or by means of an infiltration installation released into the soil.28

Covered gutter

Following the open gutter, this gutter can be used in many current street profiles without many modifications. A simple example of an above-ground drain is a gutter covered with a grid. These gutters can be used in the garden as well as on streets and squares. The covered gutters can drain more water than open gutters due to their greater depth. Another advantage of covered gutters is that they do not obstruct the use of the road.29

Water passing pavement / Grass Concrete pavement

Paving bricks with an open joint can allow the rainwater to infiltrate into the ground. It does not have to be drained via the sewer and the groundwater is automatically replenished. Bricks with open joints have studs on the side to keep the right distance for an open joint. The bricks are suitable for a terrace, driveway, garden paths and for less intensively used roads and squares.

Less intensively used parking lots, roads, garage driveways and gardens can be hardened by using grass concrete blocks. Grass concrete blocks also provide more space for natural ‘micro soil life’ and this pavement also becomes less hot during the summer.

Gravel, and shells are also a form of semi-hardening. Rainwater can sink into the soil and replenish the groundwater. In case of heavy rain showers these materials help to prevent flooding.30

Speed bumps

In case of flooding caused by a heavy rain shower, strategically placed speed bumps can help to direct the water to a desired direction. The speed bumps may be positioned so that vulnerable lower-lying regions are not flooding. For example, the rainwater can be led to a green zone where it is temporarily stored. The water can also be temporarily stored on the street between two speed bumps and a sidewalk.31

Greenery between the tram tracks

The space between tram rails that is not used by other traffic can be let unpaved, so that it infiltrates rainwater. Grass is easy to maintain and protects the soil from erosion.32

28 Amsterdam Rainproof. (n.d.) Open goten.
29 Amsterdam Rainproof. (n.d.) Bedekte goten.
30 Amsterdam Rainproof. (n.d.) Waterpasserende verharding.
31 Amsterdam Rainproof. (n.d.) Drempels voor watersturing.
32 Amsterdam Rainproof. (n.d.) Groen tussen tramrails.
Building storage

Rain barrel
The rain barrel is the easiest way to use rainwater. Moreover, it is a rainwater buffer facility that is easy to install at homes. In most cases the rainwater will be used for watering plants on the balcony or in the garden. A rain barrel can store up to 200 liters.33

Rainwater use systems
A rainwater use system saves drinking water and collects rainwater. This rainwater is mainly used for the garden, toilet and washing machine. Rain water can be collected on the roof, terrace or in the garden. Because of the many different types and sizes of rainwater user installations, there is a suitable place for every home. For example in an indoor space, in the crawl space or in the garden.

A home installation for the use of rainwater consists of the following components: a reservoir, a pump, connection to points of use, an overflow and a supplementation (replenish reservoir).

Depending on the roof type (drain coefficient), roof surface and average rainfall, the collection of rainwater can be determined. As a rule of thumb for sizing rainwater reservoirs: 5 m³ reservoir for every 100 m² roof surface. Per person, an average of 35 liters per day is used for toilet flushing and 15 liters for laundry.34

Green facade
Green facades hold rainwater and evaporate it later. If the facade plants are soil-bound, rainwater can infiltrate into the soil. Plants keep the facade cool in the summer and non-deciduous species isolate in the winter. Green facades also provide space for flora and fauna.

There are various ways to install a green facade: with the help of climbing plants, a climbing construction, with bins on the facade or a substrate that is attached to the facade. Only if the plants are rooted into the ground, a green facade contributes to the urban water management because the water can infiltrate into the soil.35

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33 Amsterdam Rainproof. (n.d.) Regenton.
34 Amsterdam Rainproof. (n.d.) Regenwatergebruik bij woningen.
35 Amsterdam Rainproof. (n.d.) Groene gevel.
**Extensive green roofs**

A green roof contributes to the temporary retention of rainwater. Due to their low weight extensive sedum or herb roofs are suitable for almost all types of roofs. They are often applied to existing buildings, extensions and garden sheds. And with special constructions even possible on sloping roofs. The maintenance is minimal. However, the water-storing and retarding power is limited.

A sedum roof can easily be combined with solar panels. The greenery creates a less hot roof and that improves the efficiency of the solar panels. The water intake depends on the depth. With a depth of up to 15 cm these roofs can absorb 25 liters / m².  

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**Intensive green roofs**

An intensive natural roof is a sort of garden on the roof. Like all other green roofs, they help with water storage and temperature control. At the same time they increase biodiversity, ensure a longer lifetime of the roof covering, reduce noise and bind fine particles. Like a garden, an intensive natural roof needs maintenance. Think of watering, pruning and weeding.

In addition, they have a higher weight and are more expensive in the construction than a sedum roof, but these roofs can also hold much more rainwater. The water intake depends on the depth. With a depth of 25 cm, 80 liters / m² can be absorbed.  

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**Water roof**

A water roof is specially designed to temporarily store the rainwater on the roof. It is a retention roof, without a green vegetation layer. Therefore, the costs for construction and maintenance are considerably lower. By pinching the drain, rainwater is temporarily held on the roof. A leaf trap is necessary in order to avoid blockages. Another option is to use a Smart valve, such as used on a polder roof. Depending on the depth, water buffering can vary: 40-300 liters / m².  

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Retention roof / polder roof

A retention roof is a green roof with an extra layer under the substrate layer to store rainwater. Retention roofs increase the sponge function of the city.

During a rain shower rainwater is stored in the retention roof. Thanks to a ‘pinched’ drain, the water remains under the planted layer. The retention roof has a static drain and usually runs empty within 24 hours. This reduces the peak discharge of roof water towards the sewers. There is also an overflow present in case of heavy rain showers.

The polder roof is a retention roof that responds computerized to the weather forecast. It drains the rainwater just before a rainfall is forecast, so that the retention roof remains filled as long as possible. The polder roof has a dynamic control with the advantage that water can remain on the roof for longer and can be used for irrigation, infiltration and cooling. Due to the dynamic drain, the roof can also be emptied at predicted frost. The amount of water intake can vary. This depends on the depth. At a depth of 12 cm, approximately 25 l / m² can be buffered.39

39 Amsterdam Rainproof, (n.d.) Retentiedak/Polderdak.

Schematic section retention roof (rainproof.nl)
Other

**Water elements**
Water features such as fountains decorate the garden and public space. For a long part of the year they can be filled with rainwater from the area. This saves drinking water and relieves the sewer system.

There are many forms of water elements, such as ponds, water streams, fountains and waterfalls. Water elements in the form of fountains and waterfalls have a cooling effect on the immediate surroundings due to the greater evaporation.40

**Rainproof tree construction**
Like other plants, street trees have a positive rainproof effect. Both the trees themselves and the tree drip line partially keep rainwater. When a lot of rainwater flows to the tree drip line, additional draining measures are required, such as vertical infiltration crates with filter function. This keeps the roots dry. Tree roots may not be wet for longer than 48 hours.41

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40 Amsterdam Rainproof. (n.d.) Waterelementen.
41 Amsterdam Rainproof. (n.d.) Plein.
42 Amsterdam Rainproof. (n.d.) Regenwatervijvers.
Not only Amsterdam is working on getting the city waterproof. Also in Rotterdam people are busy trying to protect the city from the increasing rainfall peaks. In this chapter projects from both Amsterdam and Rotterdam are being examined. This concerns plans for existing buildings as well as projects that still have to be realized. For each project a number of measures are mentioned which stimulate de water management.
Buiksloterham is located on the Northern IJ-oever in the North of Amsterdam and between Overhoeks and the NDSM-werf. Once it was the area with one of the most polluting industries in Amsterdam, but it is now transformed into a sustainable area.

There will be room for creative entrepreneurs and people who want to build, live and work sustainably. The district is a testing ground for ‘circular area development’. This means recycling materials, generating energy from renewable sources, stimulating biodiversity, and supporting the health of people and animals. In addition, the neighbourhood will also focus on rainproof living.

Buiksloterham is a special and water rich area in Amsterdam-Noord with a lot of potential. It also has a nice central location in the city on the sunny side of the IJ. Approximately 1,500 homes are under development and in the next ten years more than 3,000 homes will be built. In 2030 the area development of Buiksloterham is expected to be completed.

‘Self-building’ people and ‘self-building groups’ are building on different plots. The first residents already live in their self-built houses. Self-built housing has become a serious part of the Amsterdam housing market. On the building plots, people get the chance to build their own house alone or with a group. Because people have the opportunity to shape their houses by their own wishes, surprising neighbourhoods are created.

Buiksloterham must become a rain-resistant district, where 73,000 m³ of drinking water per year can be saved and 9,000 kg of phosphate (fertilizer) from the waste water can be recovered.

Waternet wants to introduce new sanitation at various locations in Amsterdam. This is a new way to collect and process waste water. Dirty water from households is separated at the source. There are 2 streams: black and grey water. Black water is toilet water. Grey water comes from the sink, shower, washing machine and other taps. From black and grey water certain substances and energy are extracted.

Separate vacuum lines for vacuum toilets will be installed in the homes in Buiksloterham. A vacuum sewer is a good way to drain the thicker black water. The extra drain makes the construction costs higher than normal. But in the long term it is profitable. First because of the saving on drinking water. These toilets use only 1 liter of water during flushing instead of the normal 35 liters. In addition, the house can be heated with heat from grey water.

The vacuum sewer transports the black water to a tank (fermenter) in the district. This extracts harmful substances from the water and makes biogas. This gas can be converted into electricity. Cars can also drive on it. Furthermore, from the black water phosphate can be extracted. Phosphate is one of the most important fertilizers for making food.

The existing sewer collects grey water. Grey water is warm: on average more than 25 degrees. Normally in the existing sewer this heat will be lost. That costs about € 300 per household per year. This heat can be recovered. By linking a heat exchanger to a heat-cold storage per house or apartment block, the heat is collected from grey water and brought back to the houses.

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43 Gemeente Amsterdam. (n.d.) Buiksloterham.
44 Gemeente Amsterdam. (n.d.) De transformatie van Buiksloterham.
46 Waternet. (n.d.) Nieuwe Sanitatie.
One of the future projects in Buiksloterham is the Master plan DELVA LA and Studioninedots. They have worked on an innovative urban development, landscape and social development strategy on the sites of Nedcoat and Air Products in the Buiksloterham port area. The mono-functional industrial area will be transformed into a vibrant new part of town with room for experimentation on plots of 100 x 100 meters. Around 550 homes and a minimum of 4000 m2 of work units and food service industries will be realized in the area. The principle combines self-building with social housing, living with work and collective self-building groups with investors. Together with the Dienst Ruimtelijke Ordening Amsterdam, Waternet and future residents, this innovative form of urban planning is being developed.

Water plays a vital role in the perception of the area. The Tolhuiskanaal is an essential part of the neighbourhood. The quay is no longer a hard boundary between water and city, but is considered part of the public space. The access roads to the district gradually descend towards the waterfront with which the water is visually ‘pulled’ even further into the neighbourhood. A world of floating gardens, decks, greenhouses and boardwalks contributes to a unique identity of the area. For the first time the rainwater is no longer drained underground, but it forms a visible and practicable part of the plan. In the green courts, space is created in collective gardens, on roofs and at ground level for retaining and draining rainwater. Buiksloterham becomes a new part of the city that does not fight against the water, but makes it a tangible part of the whole.47

CASE STUDIES
City Plot

City streets
Rain is visibly drained through the street.

Boulevard
In an urban wadi, rainwater from the roofs is buffered and purified.

Green courts
The rainwater is visibly drained to a deepened water square.

Waterfront
Water and land will gradually merge..
The project is located in the old northern IJ ports. Olaf Gipser Architects is designing, in collaboration with SMARTLAND, a residential tower on the edge of the water along the Johan van Hasseltkanaal. The planned building volume consists of an urban wall along the Johan van Hasseltkade and the Ridderspoorweg and also has a tower volume of 45 meters high. The building focuses on the sustainable, green and rainwater processing aspects.

For the green concept of this building, the horizontal landscape of the area is put in a vertical way on to the façade. Greenery varieties for the hill country at the top and greenery varieties of the estuary on the ground floor.

The building contains green water-retaining roofs and a patchwork of green niches over the façades, always double-height. The niches accommodate layered greenery, consisting of a tree, some bushes, soil, hanging and climbing plants.

The basis for the vegetation in the façade is formed by sufficient substrate and a fully automated water supply. The discharge of the roof surfaces of the residential tower and the plinth are minimized. After a shower, the rainwater stays on the roof temporarily. Water stored in the substrate of the green on the roof disappears by evaporation through the vegetation. The plants on the roof use this rainwater.

The green and water are constantly interwoven in this project, both in the building and around the building. This makes the water less visible as in the City Plot concept. The planting in the niches provide a feeling of nature on every floor. In addition, it also offers cooling in the summer.48

48 SMARTLAND. (2017) Rainproof: Verticaal landschap
BSH20A.
In new neighbourhoods many alternative solutions are available to collect and draining rainwater. Sufficient surface water and infiltration solutions are now standard tools with which we keep the streets dry. But what about the older urban neighbourhoods? After all, such solutions require a lot of public space and that is not available in these areas. The Groenmarkt is such an old neighbourhood in Amsterdam. Except for the nearby surface water, the Singel canal, there are no further rainproof applications.

In Rotterdam, the team Built Water has investigated the possibilities for these older neighbourhoods. They asked themselves how to make these urban districts more rain proof and at the same time could it be an impulse for an overall quality improvement of the neighbourhood. Instead of increasing the existing sewerage and technical resources, how can the investments be used in a smarter approach to improve the neighbourhood?

At each location three architectural firms worked on the research. Each team consisted of an architectural firm with a great deal of knowledge of (private) housing and renovation projects, and a firm that has experience with urban renewal assignments, landscape design and resident participation projects, plus an architectural firm that has specific knowledge in the field of sustainability, healthcare or social real estate.

In addition, they worked together with general coalition partners, such as the municipality of Rotterdam, Housing Corporation Havensteder, which has a relatively large share of social housing in all three neighbourhoods and also the drinking water company Evides.

The aim of this design research by the team is to demonstrate that measures against flooding can be combined with improving the entire socio-spatial structure of the neighbourhood. It is important to find the right mix of solutions and to involve the residents in the plans.

The team investigated three neighbourhoods with a specific problem, so that for each district an individual approach and solution direction could be formulated. Applying for the three neighbourhoods: limiting flooding on both public and private grounds and all the measures are adjusted to one another.²⁹

This case study only looks at the Rubroek district. It mainly focuses on strategies which the team developed to relieve the sewage system and water retention in the district.

Rubroek is located north of the city center of Rotterdam. The most common function in the neighbourhood is housing. There are also shops, a care center and a number of schools. In the neighbourhood mostly post-war dwellings are located. The common construction method from the 1970s looks shabby in terms of choice of materials, spatial design and sustainability. Renovation has taken place, but did not result in the improvement of the impoverished impression of the area. Moreover, the district has relatively many paved outdoor spaces.

Within the district three different buildings have been examined. The following building is a winding block of three and four storeys high. With rainfall of 50 millimeters in an hour, this area must process 1.120 m³ of excess water.

The courtyard will be redecorated and the garden will be made accessible from the portieken. This gives all residents direct access to the courtyard.

There is a large terrace with a water pavilion, where communal activities can take place. The zone between the private gardens and the communal terrace is reduced and is made suitable for flooding during heavy rainfall. The terraces remain connected by stepping stones. An elevated sidewalk and cycle path ensures that the building block is always accessible.

Much of the pavement is replaced by semi-permeable paving. The parking spaces are filled with grass concrete blocks. The paved front gardens have been replaced by large beds of greenery and some of the windows that look out over this greenery have been replaced by doors. The residents use the gardens and take care of them. The district gardener supports the residents. Along the facade, decks are placed under which water can be buffered.

The large amount of rainwater drainage on the facade of the existing houses will be replaced by decorative elements that enrich the image of the street and transport the water from the roofs directly to the central greenery. These elements also provide lighting in the street.

The corners in the courtyard become green wetlands. Furthermore, additional balconies are added to the facade. This way of water storage creates a new kind of green facade.50

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CASE STUDIES
De Slinger

Water intervention
1. retain on the roof
2. retain in the skin
3. retain in the public space
4. buffering underground
5. retain in the plinth
6. retain and dispose to the singles
7. water absorption

Spatial translation
more greenery look
front balconies combined with stairs
canals, wadis and wetlands
crates provided with tapping points
urban furniture with buffer function
gutters and overflows
new building

Social opportunity
increase liveability
making physical connections
social security and programs for children
cover heat stress
stimulate social contact
making physical connections
towards a social mix

Neighbourhood canals, with decks
Water pavilion
Water with stepping stones
Sensory experience through sound and reflection

Connecting with ground level
Work together in gardens
Safe routes for children
Water storage balconies
Water furniture

all images (Eindrapport Gebouwd Water: Water als motor voor stedelijke vernieuwing.)
Amsterdam
Amsterdam has the ambition to be able to process approximately 60 mm of rain water by 2021. The first 20 mm will be discharged directly to the existing sewer. The other 40 mm must be temporarily stored in public and private areas in the city. This makes the city resistant to extreme rainfall and drought. The new policy of the city focuses on buffering, infiltration and delayed discharge of rainwater on site.

The probability of an extreme rain shower of 60 mm is minimal, but the KNMI predicts, partly due to the temperature rise of the earth, that the Netherlands will have to deal with more extreme rain showers and a higher frequency of rainfall in the future. That is why the city must take measures to prevent damage from flooding.

Groenmarkt is one of the older areas of Amsterdam. In this neighbourhood most houses use a combined sewer system. The new project must now be based on the future system of the city. A system in which ‘clean’ rainwater no longer disappears into the sewers and is preferably used.

The buildings around the Groenmarkt are located higher than the adjacent surface water, the Singel canal. This offers the possibility to discharge rainwater onto the surface water. The Groenmarkt is a heightened area and that offers opportunities. The diagrams show that the area next to the Singel canal (Groenmarkt) has a layer of almost 2.5 meters of applied sand. In addition, underground buffering systems are possible. The sand layer provides relatively good infiltration. However, several less permeable layers are located under this thin layer of sand.

Further soil research is necessary to get a precise underground overview. Normally, the soil in Amsterdam is humid and with the relatively high groundwater levels above-ground storage facilities are more advisable.

Measures
There will not be heavy traffic in the area. Mainly cyclists, pedestrians and cars of residents. As a result, water-permeable pavement can be used.

An underground parking garage will probably be constructed in the design. The construction of a parking garage has consequences for the water plan. The infiltration of the soil is negatively affected by the basement. Therefore, above-ground measures are taken for the area above the basement. It is important these areas remain beautiful in the time of drought.

A solution above-ground could be waterways with a closed bottom. The measures as implemented in the project in Rotterdam can also be a possible solutions: Neighbourhood canals with decks above it, low ponds, waterways where children can play and a special water pavilion where there is room for meeting. Sensory experiences through sound and reflection are retained, but direct infiltration does not apply.

In places where no basement is located in the ground, direct infiltration can take place. A water square can be a concrete measure. In addition, routes can be accentuated by the application of infiltration strips, low ponds and wadis according to the example of City Plot. In addition, infiltration blocks can be placed under different surfaces.

Building
The building also has a major role in the water plan. For example, the roofs are an important element. The polder roof and water roof are the best options. Because the Groenmarkt is a new construction project, during designing a stronger construction that is needed with this type of roof can be taken into account. The polder roof has the advantage that it can also be used as a (communal) outdoor space. Moreover, it has a positive effect on biodiversity.

In addition to the roof, the facade can also be used for the water plan. In addition to the regular green facades, special green boxes can also be installed on the facade as was done in Rotterdam. Furthermore, it is also desirable to construct facade gardens. This allows the water to infiltrate directly into the soil or be stored.

Moreover, the collected water can for example, be used for toilet flushing. The water is collected in a reservoir. This can be installed both outside (in the ground) and indoors. Space must be reserved for this. As a rule of thumb for sizing rainwater reservoirs: 5 m3 reservoir for every 100 m2 roof surface.

It is striking that green and water are often interwoven. With a new project of Groenmarkt, this will mainly be visible in the facade and roofs.
CONCLUSION

Social aspects
Many parts of the water plan take place in the public space. This means that the measures have the potential to have a social meaning. Therefore, a water square and water pavillion not only have a relationship with the building to be developed, but also with the rest of the environment. A neighbourhood square is missing in at the Groenmarkt. These solutions have the opportunity to create a place where the various building blocks are involved.

The water measures combine well with squares and boulevards such as this is done in Rotterdam and City Plot. The Groenmarkt has an extra quality with the adjacent Singel canal. By creating an active quay, the public space is extended in the water. The water and the neighbourhood have a stronger relationship. It can be an unique mooring place with floating streets, decks and greenhouses.

Decentralized
In the compact urban landscape of Amsterdam, buffering is often a difficult task. The solutions often take a lot of space above ground and in many cases there is no room for this. In many cases underground solutions are not possible due to the high groundwater levels. In addition, adapted constructions are often required for heavy retention roofs. The water buffering will mainly take place in the larger public places in the city and by a large amount of small private initiatives.

Water becomes more visible, rainwater is used, in the city paved surfaces will be removed where possible to stimulate infiltration. In the old city center the rainwater must be directed to the canals through varies manners. Moreover, many roofs in Amsterdam can be transformed to relatively light green roofs. In the end the Groenmarkt will become part of a decentralized water system.


What aspects do help to create a minimum-size dwelling complex for starters?

1. Which aspects that help to create a minimum-size dwelling complex for starters are architectural?

2. Which strategies can be deployed to generate low-cost housing?

Construction
The building must have a flexible construction. A load-bearing facade and solid core ensures floors have a flexible layout. Therefore, the floor can accommodate a diversity of housing types and can be adapted to new trends and developments in housing. If no load-bearing facade is used, the construction width must be taken into account.

Between two load-bearing walls, several dwellings must be placed next to each other. For example, 2 small homes can easily be made into 1 home in the future. In the examples, the construction width of the narrow houses varies between 3.4 and 3.7 meters. The wider homes between 5.7 and 6.0 meters.

Also in half of the examples, a basement was used. In this basement there are parking spaces for cars, bicycles storage and space for communal amenities.

Access
Especially the gallery and corridor principle are often used. Ground-based homes with a garden do occur with XS Deluxe. Portiek principle is not applied in any of the case studies.

In the corridor principle of De Lofts the distance dwelling-corridor-dwelling is 15 meters, with a corridor width of 2.4 meters. In XS Deluxe, the distance of the dwelling- corridor-dwelling is 16 meters, with a corridor width of 1.8 meters.

Single aspect dwelling
In many examples the single aspect principle is used, where there is only a window opening on one side. In this case, the spaces with less daylight demand are located in the back (dark side) of the apartment. These are generally wet rooms, storage, but also the kitchen. Living room and bedroom are on the light side of the dwelling. The depth of this dwelling type varies. It has a minimum depth of 6 meters and a maximum of 9.5 meters.

In the case of single aspect dwellings, the house usually has one large window opening for maximum daylight entry.

Volumes
The residents in compact apartments live on less square meters. Other aspects need to be improved to keep the quality of life well. People now should have more right to daylight and view. An important aspect is thinking in m³ instead of m². A higher ceiling not only provides more daylight, but also brings other benefits, with it. Smart interior elements such as horizontal storage close to the ceiling (Carmel Place) and higher sleeping places on top of the storage spaces. Another solution can be sleep and storage in flexible floor elements. However, the Dutch case studies did not have this higher ceilings.

The housing size
The compact apartment is for one or two person households and a larger version could also be suitable for families. Of the homes analyzed, the average size is 38 m². There were no family variants here. Private outdoor spaces are not available in most cases. Special collective terraces are being built for this. Often on the roof.

Floorplan lay-out
Because of the single aspect principle, the spaces that require less daylight are placed in the back of the house. When the dwellings are wider, it is often tried to place a bedroom that can be closed off. A separate bedroom has daylight rules and therefore this space must be designed creatively. Often with sliding doors, this room is connected with the living room. The kitchen block takes about 4% of the house, storage 4% and the bathroom 11%. Installations are mostly located in the corridor, not in the dwelling itself.

The positioning of the services within the dwellings is very variable. Both between the complexes as in the complexes themselves. Two variants that are most common are: ‘Services in corner’ and ‘Separated services’.

Furthermore, in many cases the hallway is not included, but the residents step directly into the living room. A hallway can have a maximum of 26% share in the home.

Shared luxury
Communal amenities distinguish compact apartments with normal studio apartments. Sharing high-quality facilities / amenities compensates for living smaller. It is the collective part that determines the target group in these complexes. Different facilities and the degree of sharing should lead to a new selection of residents. ‘Self-employed’ could form a cluster, with flexible workspaces as a common facility. By sharing a large workplace together, there is no need to have a large workplace in the dwelling itself. Various applications are possible: shared laundry room, shared living area for friends, a common dining room with large kitchen and common play area. Also more expensive facilities such as a gym, swimming pool or special personal services can give the dwelling extra quality and keep it relatively affordable.

Costs for luxury can be shared. The small dwellings can be upgraded in status by giving the complex a luxe entrance.
OVERALL CONCLUSION

Collective part
In the case studies, a distinction was made between four different spaces during the analysis: collective space, public space, private space and circulation space. On average, a 5% percent devoted to public space in the building. The collective contribution for each dwelling is 2.8 m².

Dwelling
In order to keep the houses affordable, often small exterior facade surface is used. The exterior facade is relatively expensive. Therefore, the dwellings are narrow and/or single aspect. The clustering of water services makes the dwellings cheaper.

What water management measures can be integrated in the design of a dwelling complex to assure a future rainproof Amsterdam?

1. Which specific measures can be integrated in the design of a dwelling complex of the Groenmarkt?
2. Which measures contribute to the social improvement of the neighbourhood?

Above/underground measures
The Groenmarkt is a relatively favorable location in terms of water management. Unlike many areas in Amsterdam, the Groenmarkt has a layer of applied sand. Water infiltration in this type of soil is possible. However, below this layer a clay and moor soil is located. These types of soil do not easily infiltrate rainwater. In addition, the area has to deal with a high groundwater level. That is why underground measures are less suitable. Furthermore, a basement will have a negative effect on the infiltration. Above ground options seem to be the best solution above the basement area.

Possible measures are: waterways with a closed bottom, neighbourhood canals with decks above it, low ponds, waterways where children can play and a special water pavilion.

In the places where there is no basement located, some underground measures can be placed. Although further soil research is still necessary. In addition to the permeable pavement in the area, buffering facilities can installed under the roads. These facilities can also ensure that the groundwater level remains constant. Infiltration strips and wadis can also be a solution.

Roof and facade
An important part of the water plan is the roof. A polder-roof provides the best sponge effect in the city. This roof can quickly release the water. Therefore, the rainwater can be used quickly in the building. For example toilet flush water. At the same time, the polder roof can be used as a common roof terrace. Inside the building, the water will not have much influence on the program. The program of the compact apartment concept is leading for the design. However, space has to be reserved for rainwater storage. Depending on the depth of the roof, the capacity can be calculated.

The water will have a strong relationship with green, just like on the polder roof. Therefore, a green facade is also used. It is important that there is soil available for infiltration. This is also possible with special green balcony boxes.

Social
Water squares and special water pavilions have a social function in the district. Social contact and water management are combined. Moreover, the Singel canal offers opportunities. By creating an active quay, with floating elements in the Singel, public space and water will engage a stronger relationship. A decentralized system will be needed for the good total sponge working of the city, mainly made by many small private initiatives.
**Design brief**

The research into compact apartments and watermanagement has led to a design brief for the new design of the Groenmarkt. Waternet has an advisory role in the fictitious assignment. Water management techniques will be implemented in and around the building. The awareness of this subject will be strengthened with this project. Therefore a space in which the applied techniques can be exhibited will also be reserved in the program.

The compact apartment complexes are known for their shared amenities / facilities. Various amenities were discussed during the research. These amenities are present in this building: Communal roof garden, collective living room, shared kitchen / bar, bike storage, laundry facilities, luxurious entrance.

In addition, compact apartment complexes distinguish themselves by special facilities. In this case, these will be flex workplaces for the residents and for public use. The two buildings on the Marnixstraat will be renovated. In this existing plan, residential / work houses are located on the ground floor for creative professions. Flexible workplaces complete the ‘work’ character of the square next to the building.

The public space needs to be improved. The program has a crucial role in this. A restaurant / bar should attract people to the water. Moreover the total plinth should have a public character.

The new building will become a place for starters, especially for professions within the creative field. The dwellings focus on one-person households and two-person households. The apartment surface will probably vary between 30 - 40 m².

The scale of this project is approximately between case studies Carmel Place and North Orleans. This first project includes 55 dwellings. The second project has 120 dwellings. The number of houses for the Groenmarkt will be somewhere in between these two. The apartments will be single-aspect.