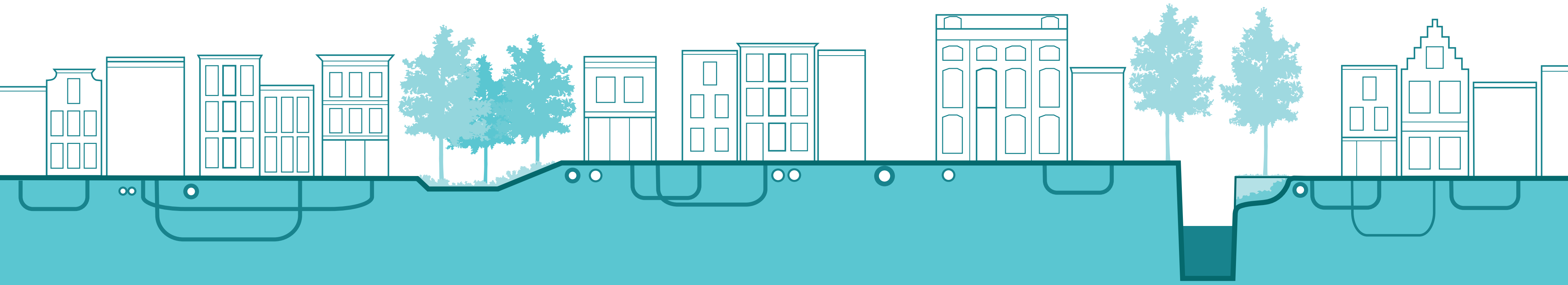
Waterproof Gouda: Addendum

The creation of new spatial pathways to connect climate sustainability with monumental preservation



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Introduction

This booklet covers all the addendum materials for the project ‘Waterproof Gouda: the creation of new spatial pathways to connect climate sustainability with monumental preservation’.

Included are all those materials, workshop products and calculations that would distract from the main message of the project. These materials were created to test the ongoing research project, using various methods and techniques to gather a more complete image of both the problems and the solutions the main thesis project has to deal with. The addititíon of these steps result in a more integrated and varied project, but it generated a lot of data.

This addendum starts with the close-up versions of the technical sections presented in the main project. The main body is filled up by the the complete portfolio of design interventions developed for the two workshops that were held throughout this project. This includes the creation and explanation of these interventions as well as the version that was handed out to the participants, including maps with extra information as well as the resulting filled in documents, which show the opinions and preferences of the stakeholders.

One other major step in this project was the testing of the efficacy of the research interventions through a series of calculations. All this data, including measurements, assumptions and final calculations can be found here.

Last, this addendum includes the Theory Paper written for one of the graduation courses, which formed the basis for the methodology that was used throughout this project, as well as the the reference list.

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A. TECHNICAL PROFILE

A.1. Technical profile

The technical profile is discussed in chapter 8.4.3 of the main thesis.

It shows a complete section of the ground and water levels, canals, sewers, soil, pavement types and green elements throughout the entire city.

This booklet shows this technical profile on a larger scale, allowing for closer examination.

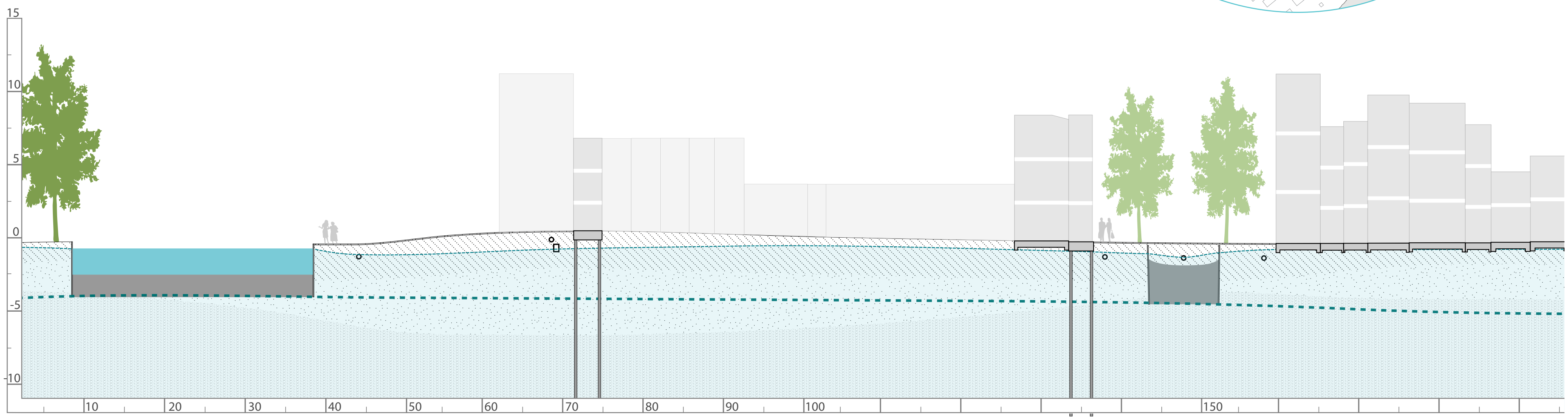
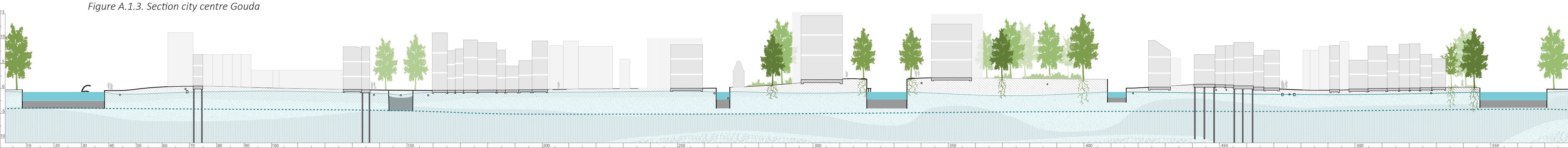
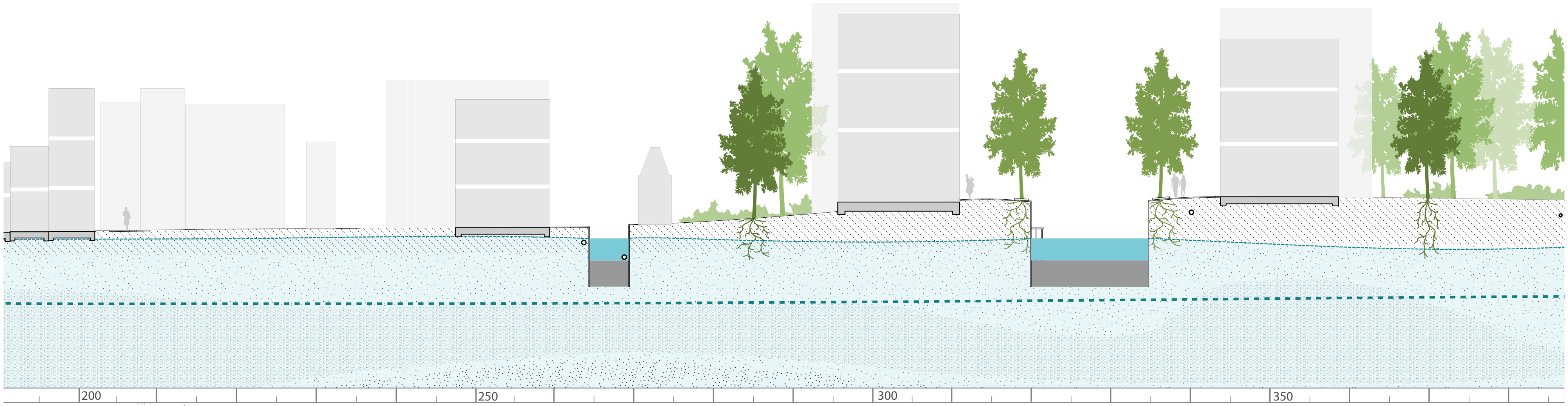


Figure A.1.1. Map and sections
Figure A.1.2. Section Turfsingel - Raam
Figure A.1.3. Section city centre Gouda





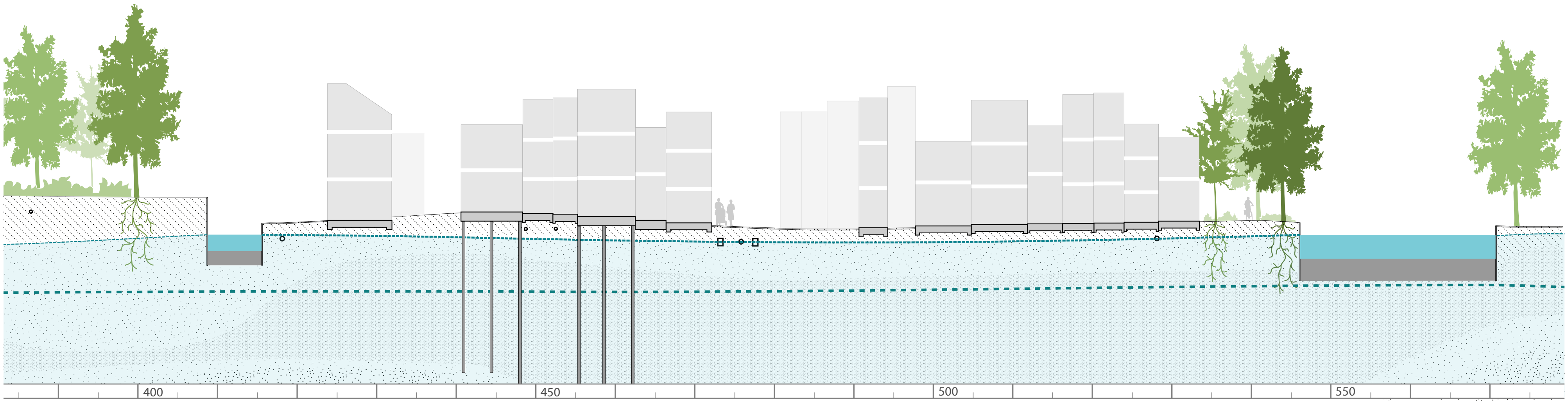


Figure A.1.4. Section Peperstraat - Westhaven - Oosthaven
Figure A.1.5. Section Spieringstraat - Fluwelensingel

B. RESEARCH INTERVENTIONS

B. Research interventions

This chapter is an addendum to chapter 9 of the thesis.

B.1. Introduction

One important step used in the methodology to structure this project is the organisation of potential interventions (actions) according to preference. This inclination should be determined both by stakeholders and decisionmakers, according to their personal knowledge and experience of the city (Haasnoot et al., 2013).

In order to meet these stakeholders and gather their opinions, two workshops were developed, the results of which are detailed in the main thesis. As material for this workshop, a series of products were developed. This included two extreme scenarios, each of which had a portfolio of typologies and options from which the stakeholders could select their preferred solutions. This series of interventions is drawn and described in detail in this booklet.

B.2. Scenarios

B.2.1. Blue Scenario

The blue scenario was created by doubling the available water surface in the area. The outer ring of houses in the inner city has been demolished and replaced with water. Precipitation that falls elsewhere in the city centre is quickly caught and discharged into the canals. In place of the now demolished buildings, new floating and water adaptive housing is constructed.

B.2.2. Green Scenario

The green scenario is less drastic, because it does not adapt or demolish any of the building stock, but it does bring major changes to the streets. All public areas, streets, markets, parks, will now be green, planted with new vegetation and capable of more water storage. This will change the way transport throughout the city takes place. In order to change the character and image of all the streets, but still keep the essence of Gouda, several typology options for greenery in the streets were developed.

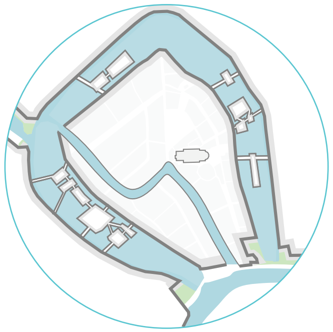
Figure B.2.1. Scenario blue
Figure B.2.2. Scenario green

B.3 Typologies

B.3.1. Blue Scenario

There is a marked difference in typology and appearance between the newer areas of the city centre, compared to the older ones.

The blue scenario doubles the water surface by transforming this newer part of the city centre into a large waterfront and so helps promote the city as a climate adaptive, future-proof water city. Additions to this new water surface must combine innovations with the spatial character of Gouda. To find out where this balance lies, several typologies for the waterproof housing were developed, based on existing structures in the city centre.



B.3.1.1. Canal/Gracht

The first, named Canal/Gracht, is based on the historic centre of the city, the river the Gouwe. The street that frames this river has a wide and stately character, with formal houses facing each other, following the curve of the canal. This monumental typology has been mimicked here. A wide stretch of the river remains open for any type of water traffic.

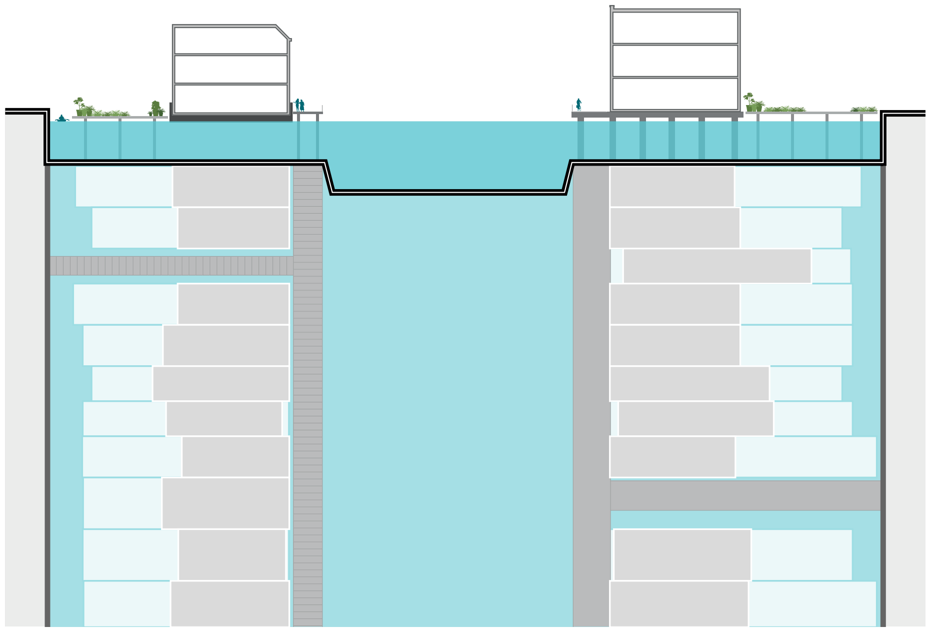


Figure B.3.1 Typology canal

B.3.1.2. Singel structure

This is very similar to the canal structure but scaled down to fit the housing scale of Gouda. These houses open onto a central road built in the middle of the river, or onto the quay. Open water surface is more limited than in the original situation, and the only waterway large enough for ships to pass through is between the backyards of the houses.

B.3.1.3. Side streets

The city centre of Gouda is known for its monumental streets, but also for its dense building structure and small side alleys which link onto these larger avenues. This typology has been adapted to fit on the new water surface. As a disadvantage, this structure does not allow for any water traffic through the outer canals.

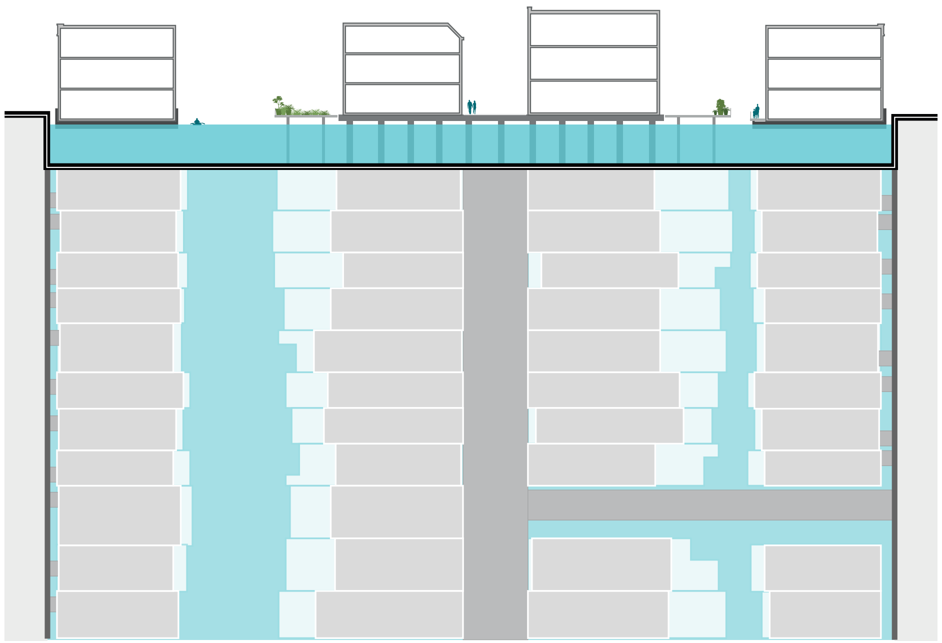


Figure B.3.2. Typology Singel structure

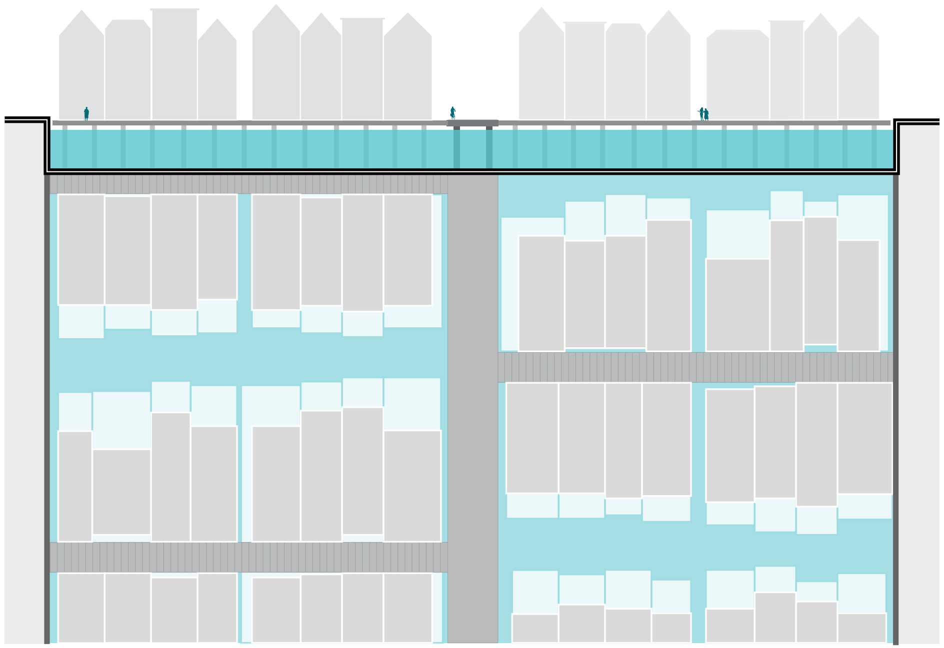


Figure B.3.3. Typology Side streets

B.3.1.4. Houseboats

There are already multiple houseboats anchored onto the quays on both sides of the canal. This typology can be maintained, though updated with new architecturally developed floating houses.

As all houses are anchored to either side of the canal, the increased water surface will create a lot of new open water surface that can be used for recreation and traffic through the city.

B.3.2. Typologies green

There are many varying and unique street profiles throughout the city, created through different ratios of pavement, roads and canals, but also through green elements. The existing green structures range from formal and symmetrical tree lines across the city, to small 'front yards', created by the inhabitants.

To find out what type of green space fits best within the city structure, several typologies have been created along this formal-informal axis.

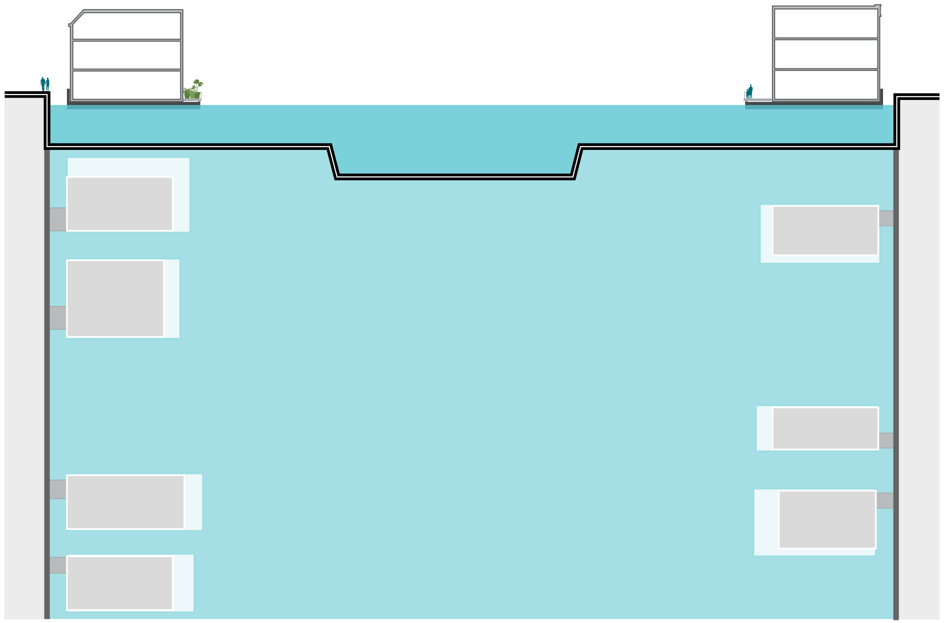


Figure B.3.4. Typology Houseboats

B.3.2.1. Single tree row

A simple intervention, with a single tree in the profile of each street. While the traditional and monumental streets in Gouda commonly use a double row, this typology is more suited to many of the narrower streets and will still allow traffic to pass while at the same timing adding many of the positive elements created by more green space in the streets, such as increased biodiversity and lower temperatures.

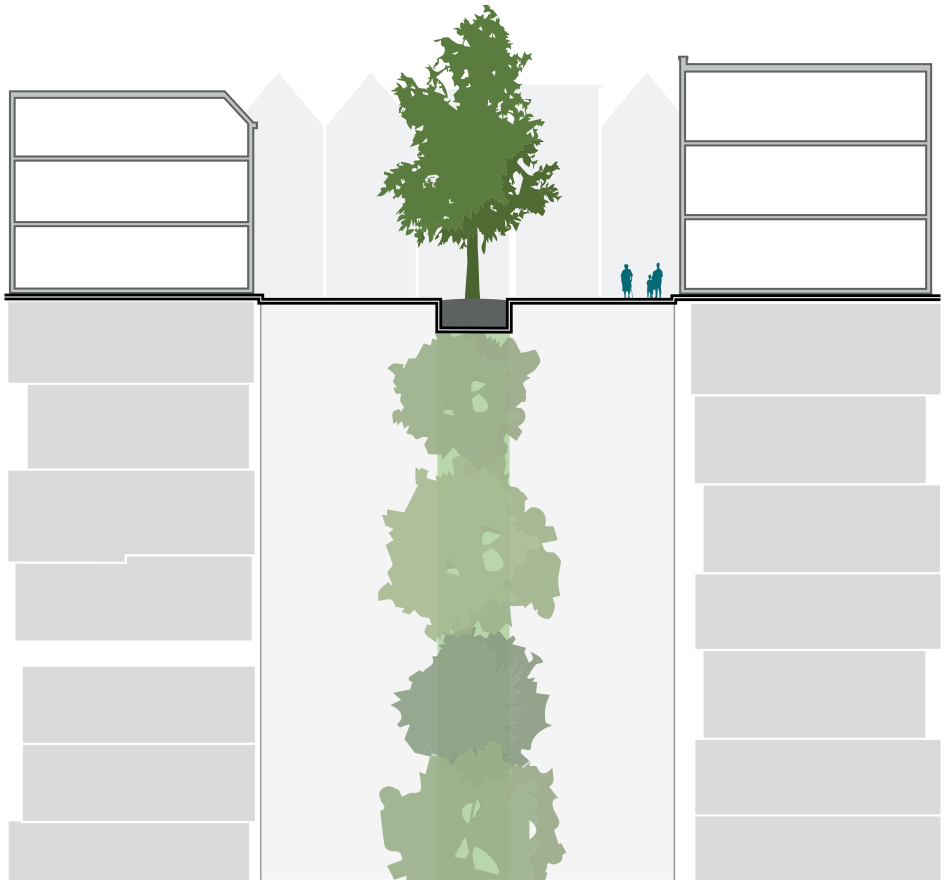


Figure B.3.5 Single tree row

B.3.2.2. Double tree row

This is the traditional typology of the most important streets in Gouda, and weaves throughout the entire city. The addition of this symmetrical green element will add a level of formality and dimension to the new streets, and connect it to these monumental streets.

Figure B.3.6. Double tree row

B.3.2.3. Green centre

The green structures of the current city centre are mostly limited to various configurations of trees. Smaller green elements, such as shrubs or even grass, are mostly found in the backyards of the houses, or in green parks dotted throughout the city.

In many of the smaller streets, high, enclosing elements could block the light and feel constrictive. This typology studies the applicability of shrubs and grasses within the city streets, providing the benefits of green without blocking the view.

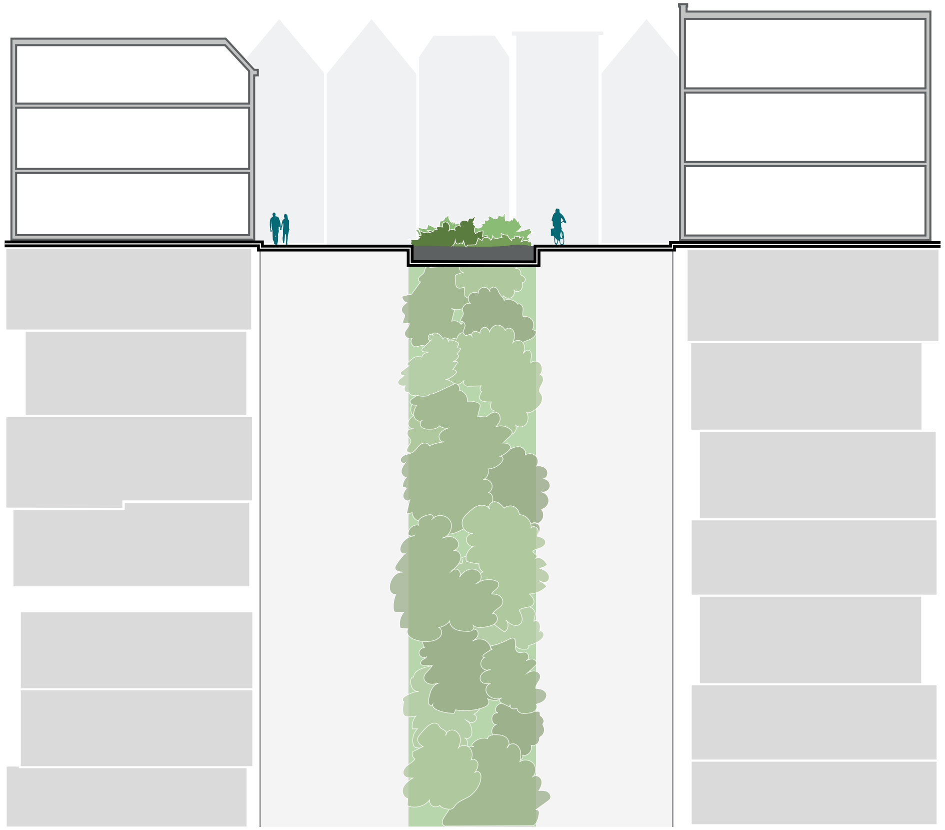


Figure B.3.7 Green centre

B.3.2.4. Front yards

A characteristic element of the city centre is that there are no houses with front yards, thus there are no semi-private zones between the housing facades and the streets. In several streets throughout the city centre, citizens have created such zones for themselves. By placing benches and greenery outside, small semi-private social spaces have been created.

This typology tests if an extension of this idea can be successful.

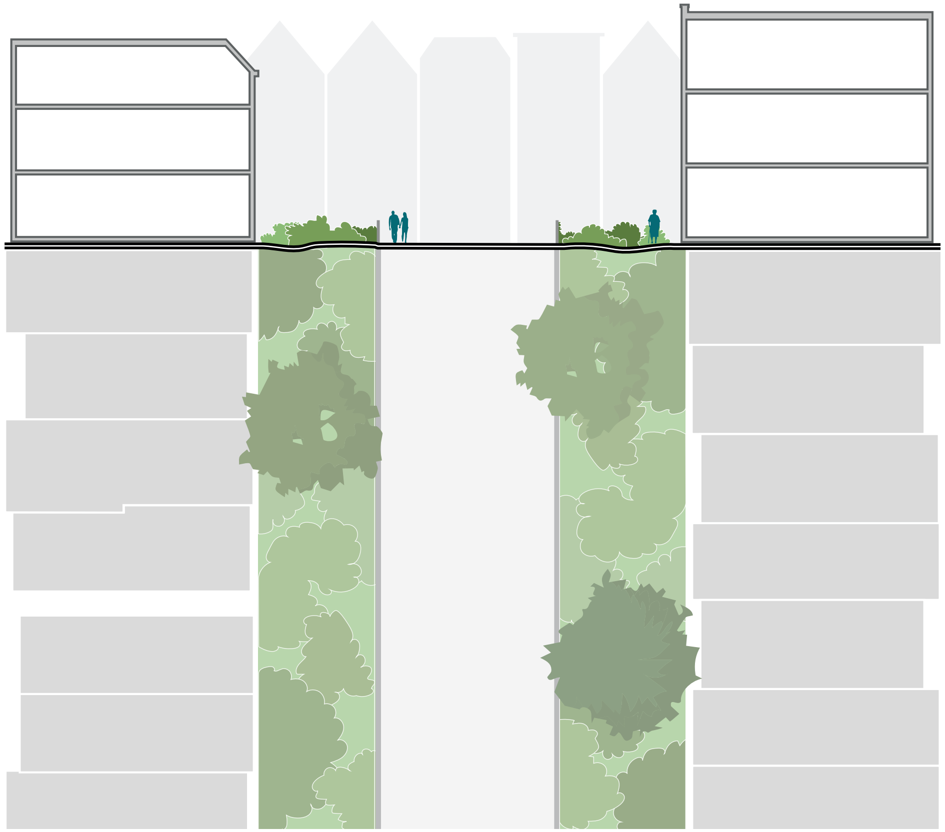


Figure B.3.8. Front yards

B.2.3.5. Wilderness

While the other typologies test various additions to the street profile, this particular design does away with the entire street. Instead, a green park-like structure is constructed that weaves through the entire city across the former streets, adding a high variety of green spaces, biodiversity, cooling and locations for social gatherings.

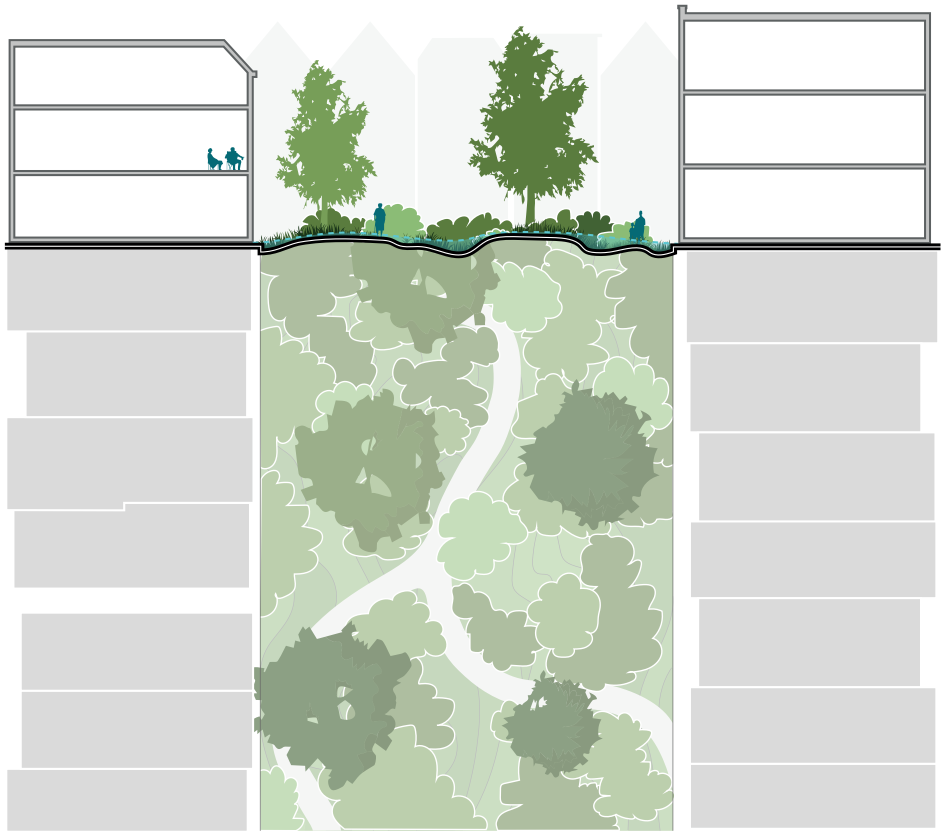


Figure B.3.9. Wilderness

B.4. Interventions

The scenarios described in B.2. are extreme, unrealistic, and limited in their scope, but information gained from studying them will form the basis from which new decisions can be made. The goal of each of these interventions is to add water storage and climate adaptivity to the city, but each will have a unique approach. They can be divided into four categories:

1. Adaptation to the housing: gutters (1), green ditches (2), barriers (3), raised houses (4), floating houses (5), amphibious housing (6). These interventions fit under the housing category as their main goal is to prevent precipitation-caused flooding from reaching the buildings. They concern the creation of barriers between houses and the water, whether this is a physical barrier on the house, at some distance, or if this involves moving the house up or even away.

2. Adaptation to the street: permeable streets (7), infiltration boxes (8) and raised streets (9). These interventions involve the creation of extra storage within or below the surface of the streets.

3. Water interventions: varied street heights (10) or canals (11) were only presented to the workshop group that focused on the water scenario. The goal of these interventions is to create new surface water, whether this addition is temporary or permanent, modern or monumental, connected to the groundwater or not.

4. Green interventions: rows of trees (12) or wilderness (13) are interventions based on the green scenario, these involve any new additions of green to the city streets.

Within these groups, there are both normal and 'extreme' scenarios. The division of interventions into these groups is dependent on to what extent they change the physical (and useable) space of the city. In this study, financial concerns are not taken into account. Each of these interventions, in addition to water storage, will bring some new character to the city.

B.4.1. Buildings: Gutters (intervention 1)

As one of the smallest and most non-invasive interventions, gutters create a barrier before the front doors of houses to protect them from flooding. As the gutters are quite deep, they are covered with a roster for practicality, further decreasing the space they take up within the street. The addition of this element to the street creates the possibility to define a small semi-private space between the gutter and front door that could be utilized as a garden space, for socializing and greenery, but which has no official status. Other than that, this intervention does not promote any new social activities.

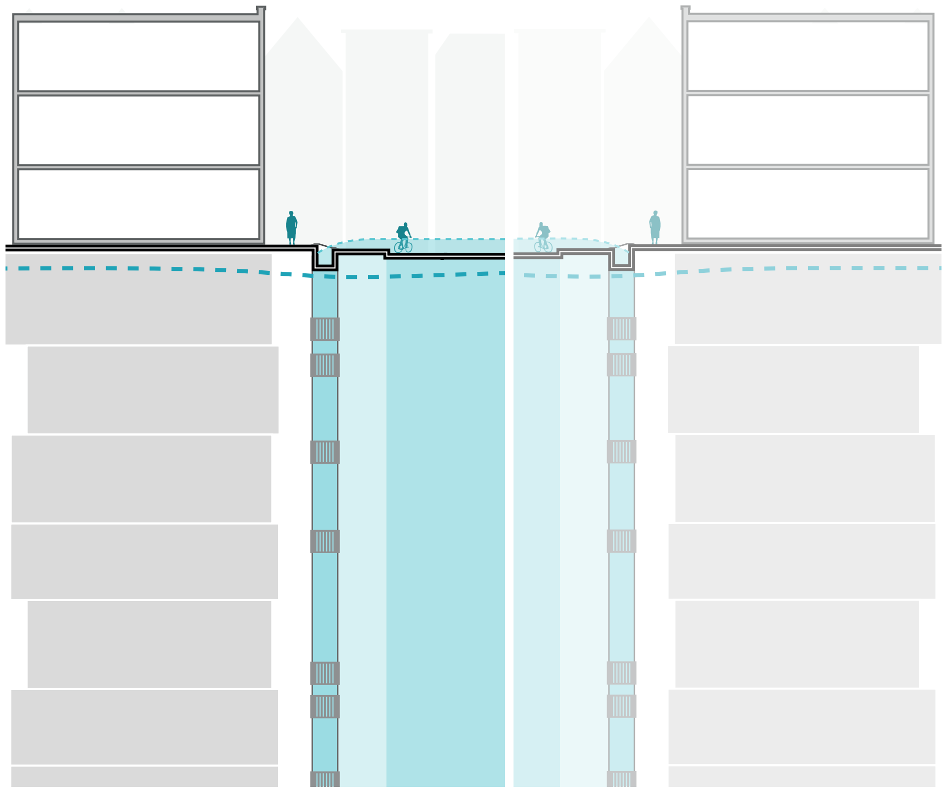


Figure B.4.1. Gutters

B.4.2. Buildings: Green ditches (Intervention 2)

A variant on the gutters, the green ditches also create a barrier between houses and water. Instead of a simple vehicle for water transport, this variant has green elements and a more natural slope. While such an intervention will take up more space, there are some advantages. Green ditches have more water storage capacity, adding interception storage and infiltration storage. Besides this advantage, green ditches will also add biodiversity and lower temperatures. As a disadvantage, they will remove several parking spaces and will require more maintenance.

B.4.3. Buildings: Barriers (intervention 3)

Spatially, this is one of the least invasive interventions, which can be an advantage in the dense city centre. At the same time, this adaptation will visually change the monumental buildings. This is done by putting up a water proof barrier between the foundations and the groundwater, as well as a barrier that covers the lower 500 mm of the building. This is reminiscent of the barriers some inhabitants already use throughout the city. It will not take up a lot of space, and the street at eye level will remain the same, but the permanent barrier will alter the facades of the houses.

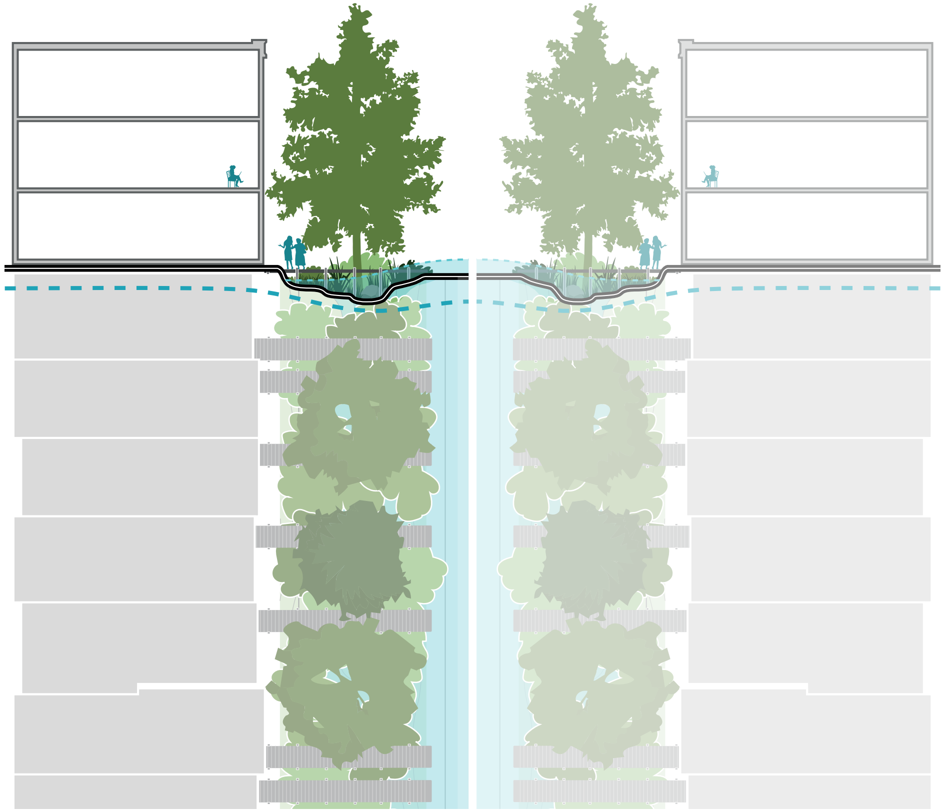


Figure B.4.2 Green ditches

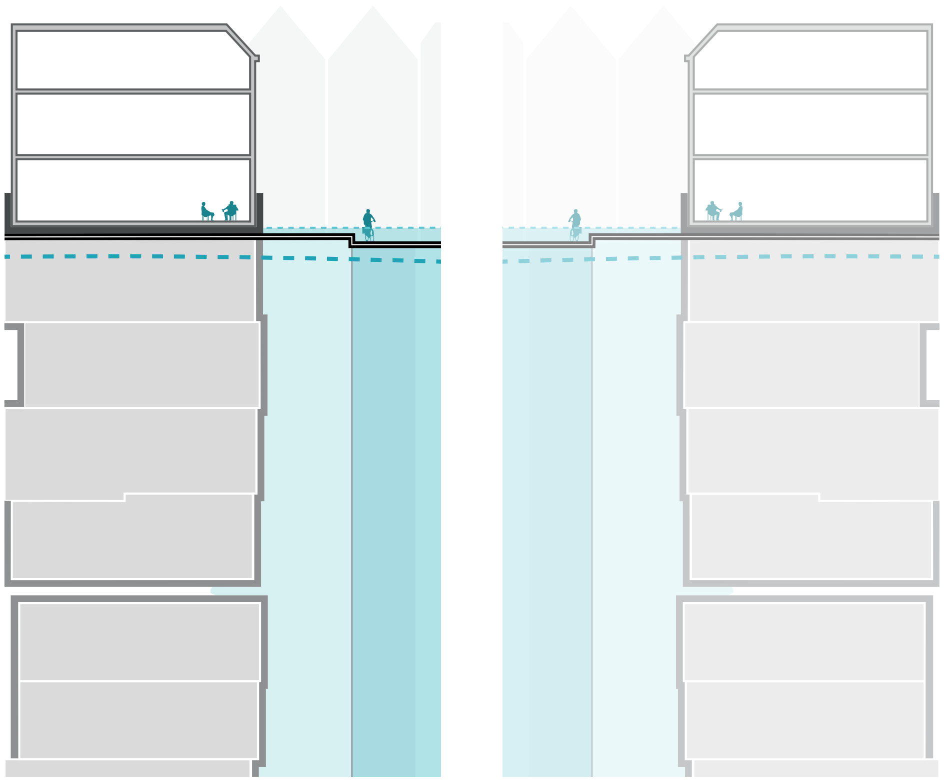


Figure B.4.3. Barriers

B.4.4. Buildings: Raised houses (intervention 4)

This intervention is reminiscent of an old building typology in Gouda: the warehouse. These buildings used the ground floor as storage, or currently as a garage, while the living space starts on the first floor (J. van Leuken, H. Suijs et al., personal communication, november 21, 2017). The water scenario postulates that several blocks of houses were torn down, leaving the area free for sustainable new building designs, such as the raised housing. This will create water storage on the lower floor during extreme weather events, and useable space at other times. This can either be a private addition of the house or extend the (semi-)public space.

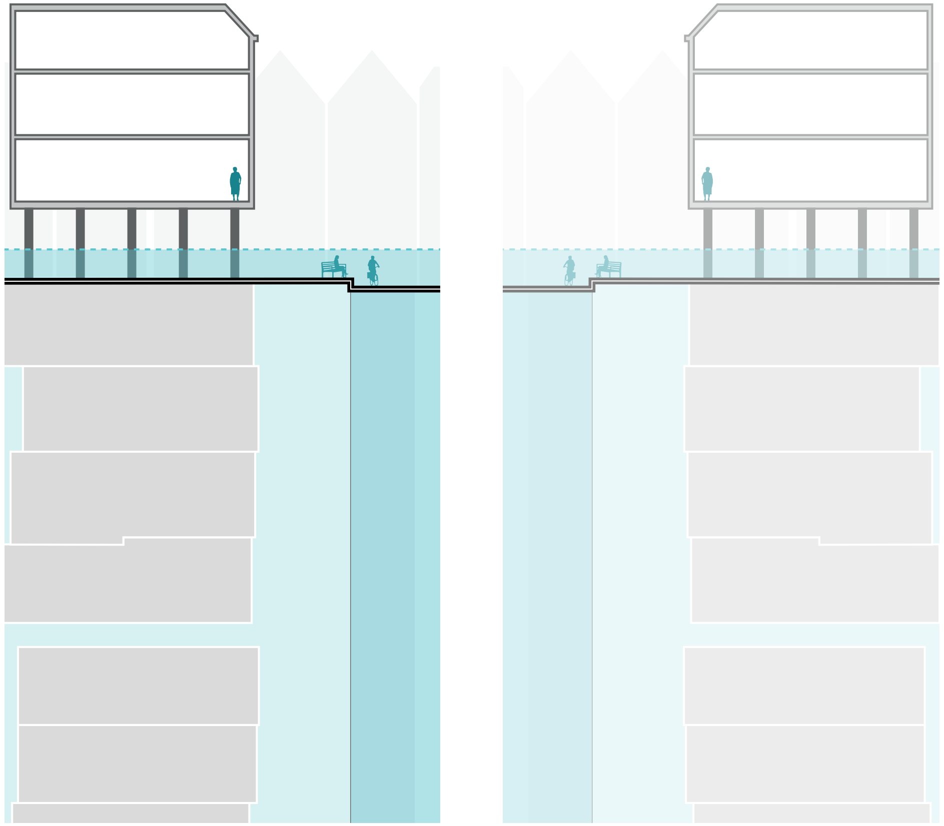


Figure B.4.4. Raised houses

B.4.5. Buildings: Floating houses (intervention 5)

The water scenario accounts for a demolishing of a percentage of the building stock, which will be replaced with new, water-adaptable variants of housing. This variation will create new adaptable houses with a lot of high-value public space around them.

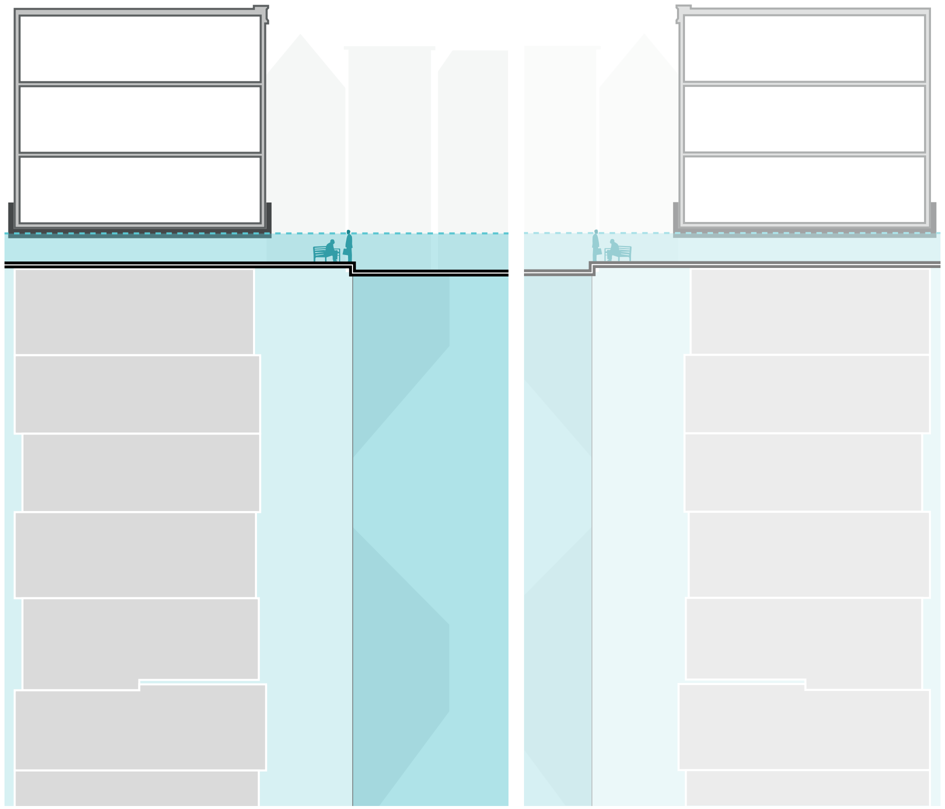


Figure B.4.5. Floating houses

B.4.6. Buildings: Amphibious houses (intervention 6)

A variation on the floating house. These buildings are not constructed on open water. Instead, they are designed to be built in floodable areas (baca architects, n.d.). When water levels rise, these dynamic buildings will change along with the water situation.

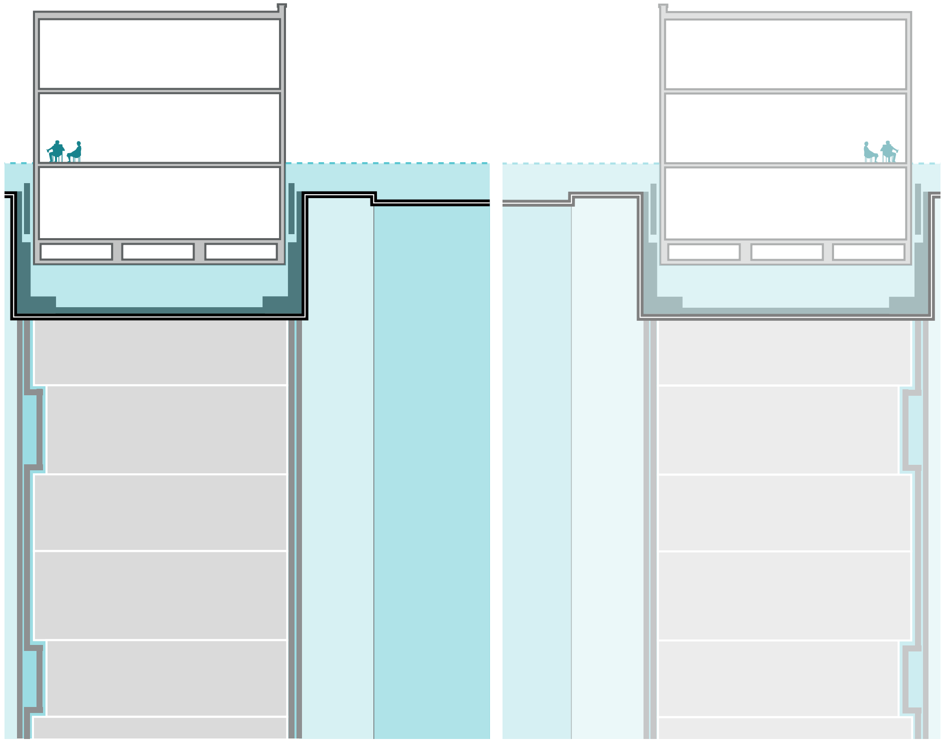


Figure B.4.6. Floating houses (baca architects, n.d.)

B.4.7 Streets: Permeable streets (intervention 7)

One of the easiest ways to create more water storage is to open up the pavement to let the water drain away into the ground. The actual effectiveness of this intervention is highly dependent on the surface level. As the groundwater is kept at a set height (-0.7 m) (Tamboer, 2007), lower-lying areas will have less dry soil into which water can be infiltrated.

Other than materialization, the street profile does not change. However, the effectiveness of this intervention is highly dependent on the permeability of the pavement. The higher this percentage, the weaker the loadbearing capacity of the road. This limits the use of heavy vehicles on these roads, which will change traffic patterns throughout the city. However, lowering the number of cars will create more open space for other public locations.

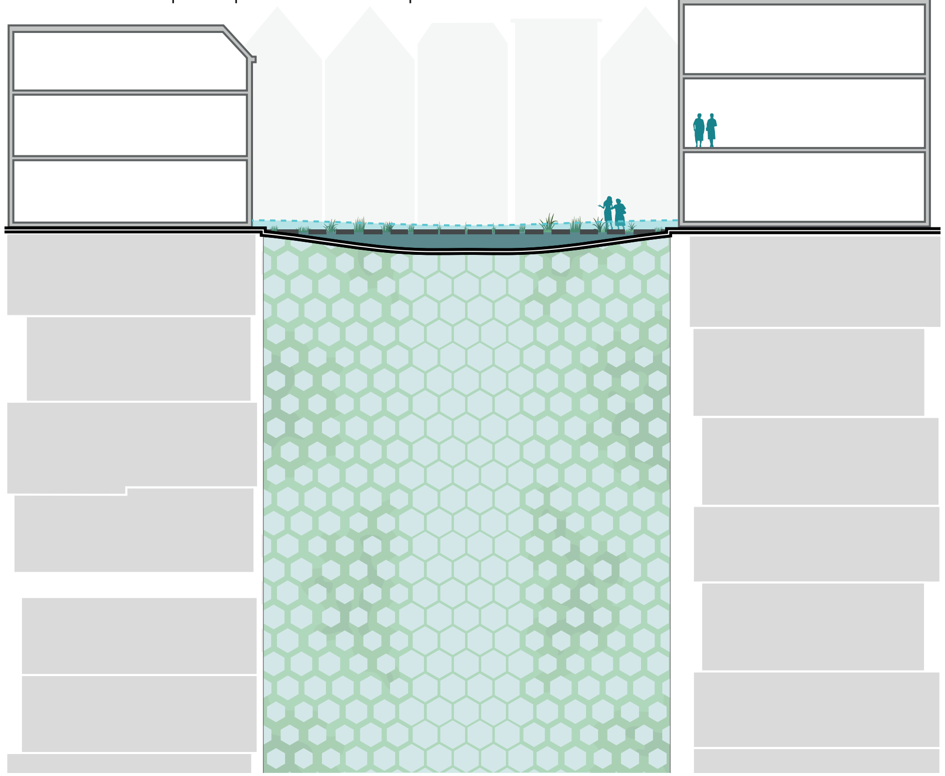


Figure B.4.7. Permeable streets

B.4.8. Streets: Infiltration boxes (intervention 8)

This intervention has the same goal as the permeable streets: to add more water storage into the ground. But where the permeable streets use the infiltration capacity of the soil, this intervention adds open water boxes beneath the street, capable of retaining precipitation.

Nevertheless, the same weight limitations apply, as these boxes are hollow, and are not capable of carrying the same amount of weight a compressed layer of sand could. Light traffic and emergency vehicles will still be possible in both intervention scenarios.

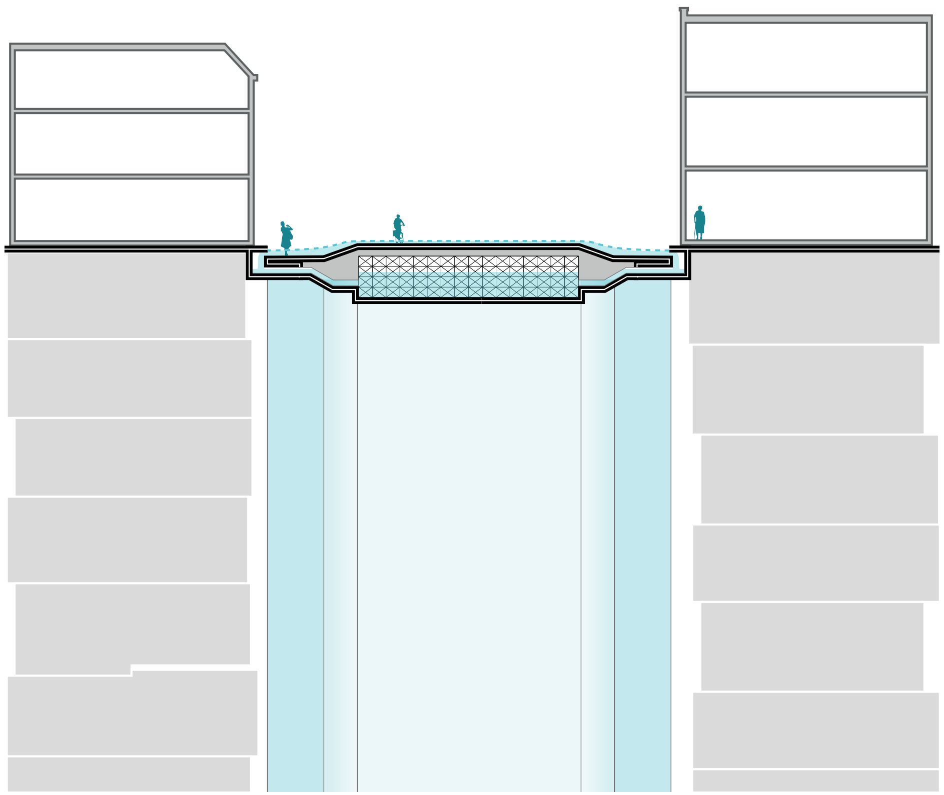


Figure B.4.8 Infiltration boxes

B.4.9. Streets: Raised streets (Intervention 9)

This intervention functions slightly differently from the previous two. While they focused on the creation of water storage capacity in the ground, this intervention follows the same structure as the raised/floating/amphibious houses. By raising the streets and walkways to a higher level, they are always protected from flooding, and safe evacuation routes are maintained throughout the city. This intervention also doubles the available public space and at the same time creates a dynamic multileveled environment.

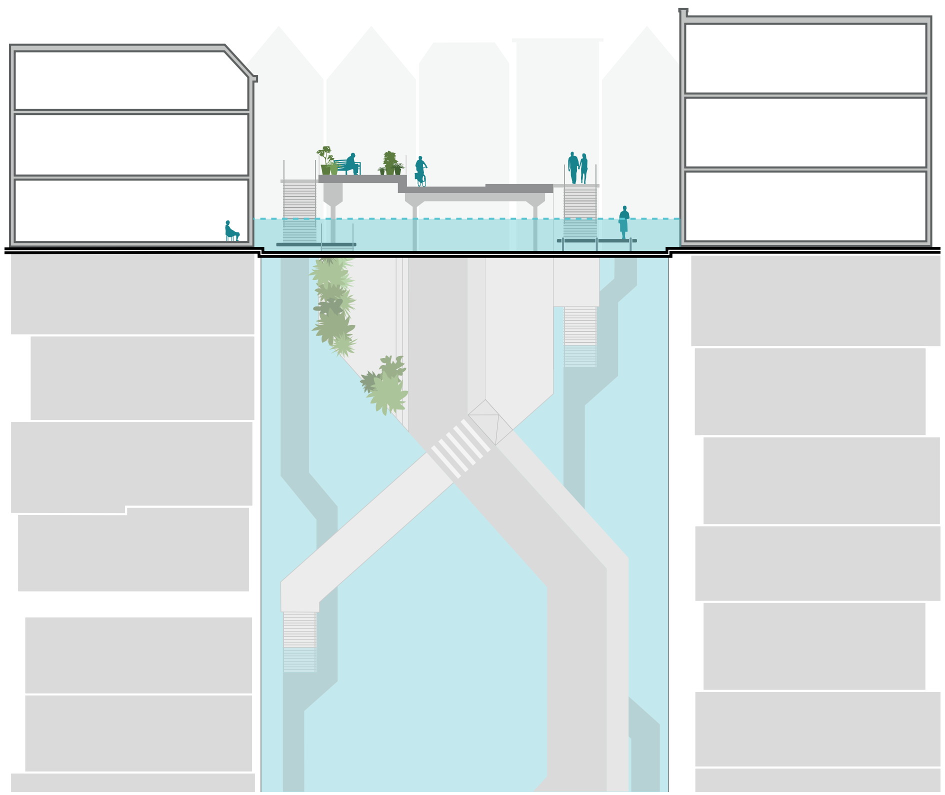


Figure B.4.9. Raised streets

B.4.10. Varied street heights (intervention 10)

In this chapter, a varied set of interventions have already been proposed, which have focused on everything, from discharging the water quickly, to creating storage and the use of barriers to keep the water safely on the street. In this design, they were all combined. Inspired by the concept of water squares, and with the goal to keep large parts of the street functional even during heavy precipitation, this intervention works by dividing parts of the street into different heights. By creating lower gutters that fill up quickly, most of the road will remain useable. During heavy precipitation, water will flow into the lowest part of the street, keeping the rest dry. During dry periods, the various heights will divide the different traffic paths and add to the safety of the street.

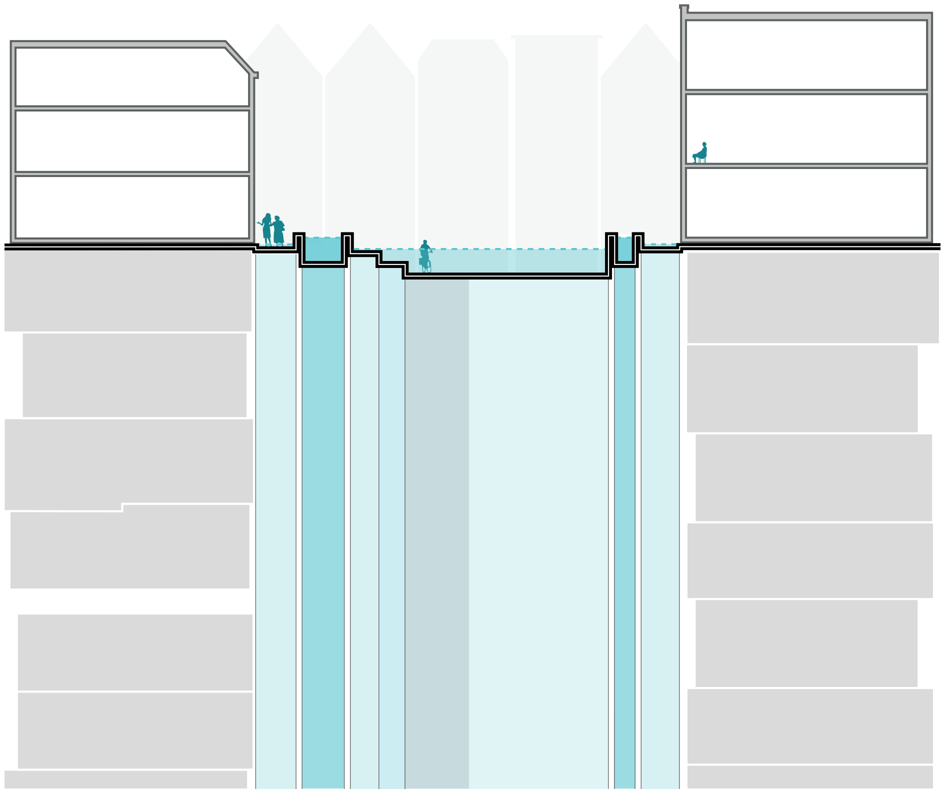


Figure B.4.10. Varied street heights

B.4.11. Canals (intervention 11)

Gouda is a water city and has borne this label proudly for nearly 700 years (van Winsen et al., 2015). The city centre is shaped by the canals, present or past. During the last century, developing technologies made it possible to disconnect the spatial and water requirements of the city from the construction of the city (Hooimeijer, 2014). Combined with the increase in cars, many of the canals in Gouda were drained, filled in and disappeared from the landscape (Raap, 2017). Re-opening these canals reconnects the city centre to this part of its history, while at the same time adding a lot of water storage into which all the precipitation can easily drain.

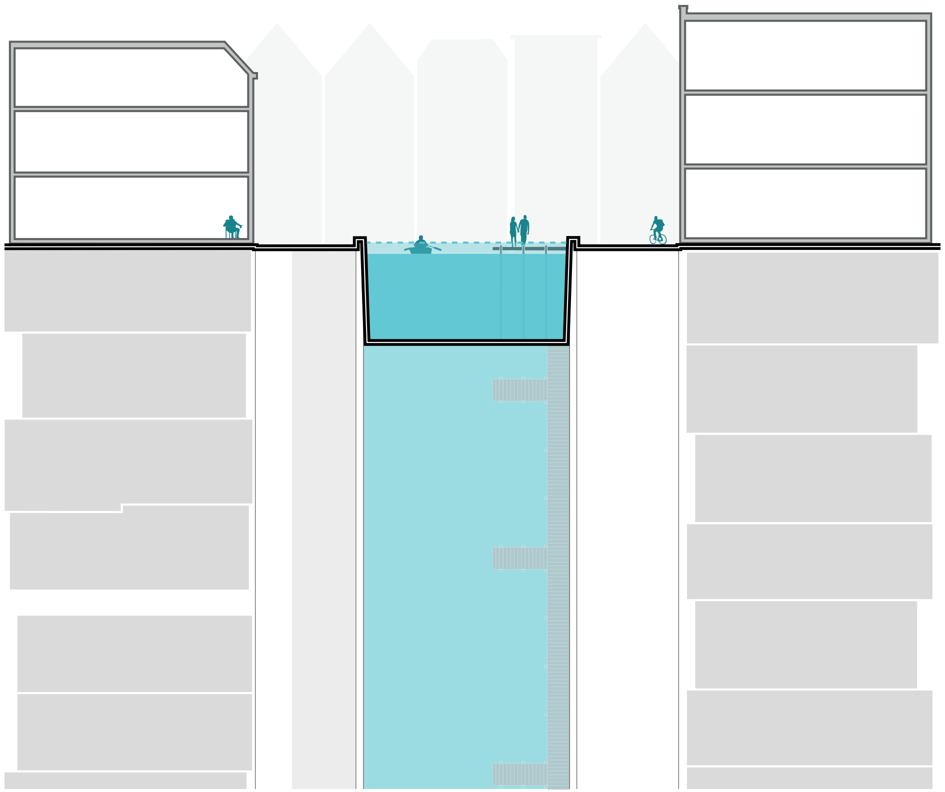


Figure B.4.11. Canals

B.4.12. Row of trees (intervention 12)

A double row of trees is a characteristic element in many monumental streets, and indeed this typology can be found in the centre of Gouda, outlining one of the oldest historic networks in the city. Using this image, variant typologies of these rows of trees can be created for the smaller streets in Gouda, generating new visual centre points, providing shade and adding to the biodiversity.

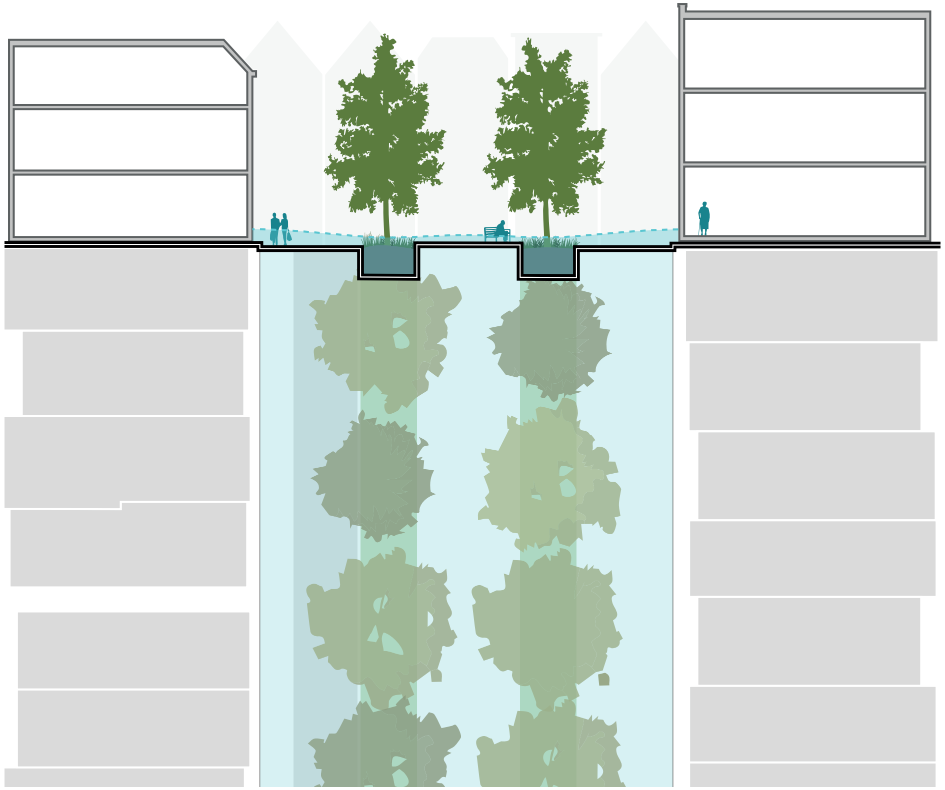


Figure B.4.12. Row of trees

B.4.13. Wilderness (intervention 13)

While trees and other small foliage is common in the city centre, more intense forms of greenery have commonly been limited to the parks around the outer canal ring, especially the Houtmansplantsoen, in the southeast corner of the historic centre. This intervention creates a web of interconnected parks throughout the city centre.

The adaptations brought by this design mean that only emergency traffic is allowed and all other movement throughout the city will happen by foot or bike, across walkways that meander through these new green areas. This combination of double interception storage, infiltration, biodiversity, lower temperatures and attractive public places will create climate adaptive and social spaces.

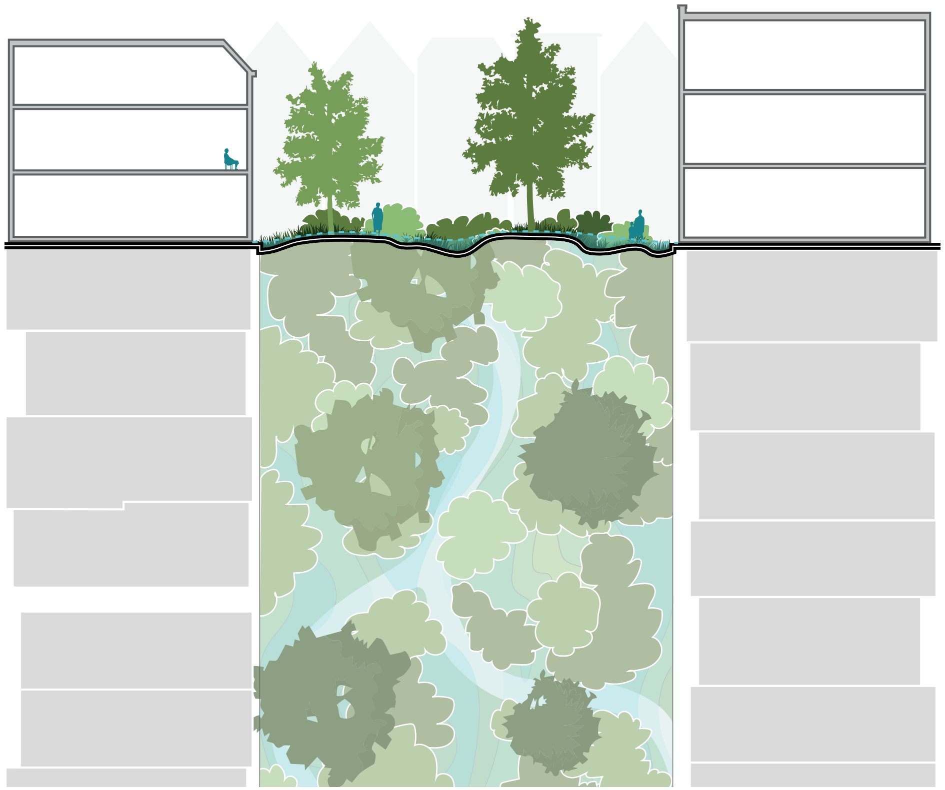


Figure B.4.13. Wilderness

C. CALCULATIONS

C. Efficacy interventions

This chapter covers all the data and and calculations used in chapter 11 of the thesis to determine the efficacy of the research interventions.

C.1. General assumptions and formulas

In order to test the efficacy of all the designed interventions, specific formulas have been drawn up to manually calculate the water storage capacity. While the original plan was to use the watermodel (Suijs, 2016), created by Hans Suijs, early tests showed a mismatch of scales between the data the model produced and the data needed to test the efficacy for this thesis. As an alternative, each of the following sections describes the calculation done for two streets, Hoogstraat and Kleiweg, (which lie in extension of each other to form one long road, see figure C.1.). Not all of the interventions presented in chapter 9 are calculated. Those which involve the creation of new houses are assumed to succeed automatically.

These calculations focus on the designs that involve adaptation of the existing street. They represent a very rough indication of the effectiveness of the various interventions. In order to carry out these calculations, several assumptions have been made. As these numbers are estimates, they have been rounded up to whole numbers in order to avoid the assumption of high accuracy. Blue cells indicate a surplus of water storage, while orange cells show a shortage. In this second case, the precipitation will cause flooding.

C.1.1. Data: values

There are several standard measurements that show up in every intervention. These have been measured, using an autoCAD map provided by the Municipality of Gouda.
Length street (Hoogstraat + Kleiweg) = 326 m
Average width = 10.2 m
This chapter also includes other standardized data that will be used in every intervention.
Average surface level = -0.3 m (Actueel Hoogtebestand Nederland, n.d.)
Average distance between trees = 10 m
Average (large) tree crown = 6 m
Ground water level =-0.70 m (Gemeente Gouda, 2018)

C.1.2. Data: precipitation

The rainfall scenarios described in chapter 8.2 of the thesis are used. With these numbers, the water situation for two areas has been calculated. The first (directly on street) only contains the precipitation that falls '*directly onto the street*' surface, with the assumption that rain water on nearby houses is discharged through the sewers.
The second approach assumes that all water must be drained through the public streets. As a result, this '*larger area*' adds the rain that falls on nearby houses to the former number (table C.1).

Table C.1. Precipitation volumes on the Hoofdweg & Kleiweg

		10 mm/hour	25 mm/hour	50 mm/hour	100 mm/2 hours
Precipitation volume in m^3	Directly on street	36	90	181	361
	Larger area	126	314	629	1257

C.1.3. Saturation depth

The maximum amount of water storage in the soil depends on the saturation depth. The effective porosity for coarse sand is between 0.26 and 0.43 (Geotechdata.info, 2013). As a worst-case approach, since it is possible that there is fine sand present in the area, the lowest value is taken. The worst situation, a precipitation of 100 mm will saturate the first 100/0.26 = 385 mm of the ground.

The controlled ground water level is set at -0.70. These calculations are set in the summer, so the assumption is made that the ground will be relatively dry in between precipitations. Because of this, the capillary function of the water is not taken into account.

The difference between the ground water level and the average surface level is 0.70 - 0.3 = 0.4 m, which is larger than 0.385 mm. Therefore, saturation is not a limiting factor, and consequently is not taken into account in the rest of the calculations.

C.1.4. Soil infiltration
This is the amount of rain that can infiltrate through the soil within an hour.
For medium coarse sand the infiltration is 1-10 m/24 hours (De Jong, 2008) with an average of 5 m/24 hours this leads to 5/12 = 0.42 m/2 hours.

For fine sand the numbers are: 0.2- 1 m/24 hours. With an average of 0.6 m/24 hours which results in 0.6/12 = 0.05 m/2 hour. (De Jong, 2008)

Research shows that a mix of medium coarse sand and fine sand is common in the city centre (Van Dasselaar, 2013). In order to represent the worst-case situation, the infiltration factor for fine stand will be used. This makes the average infiltration 0.05 m = 50 mm. In situations where the ground infiltration is higher than 50 mm, this value will be used as a limiting factor.

C.1.5. Interception factor
One of the ways trees store water during moments of precipitation is through interception.

The interception factor of trees is between 5-20% for deciduous trees (Gerrits, 2008). This percentage can of course not be scaled up to extreme precipitations, but can be assumed as a valid factor for a less extreme rainfall of about 10 mm. This is the amount of precipitation that the KNMI uses to define a rainy day (KNMI, n.d.), and a quick look through some precipitation statistics show that this amount of rain, without including the duration of the precipitation is very common. (KNMI, 2014)

Interception % = 20% (Gerrits, 2008) (5-20% for deciduous trees)
Average rainfall = 10 mm (KNMI, n.d.)

Interception factor = interception % x average rainfall = 0.20 x 10 = 2 mm
The 'interception factor' that will be used throughout these calculations is 2 mm, which represents a realistic amount of interception (F. van de Ven, personal communication, may 16th, 2018).

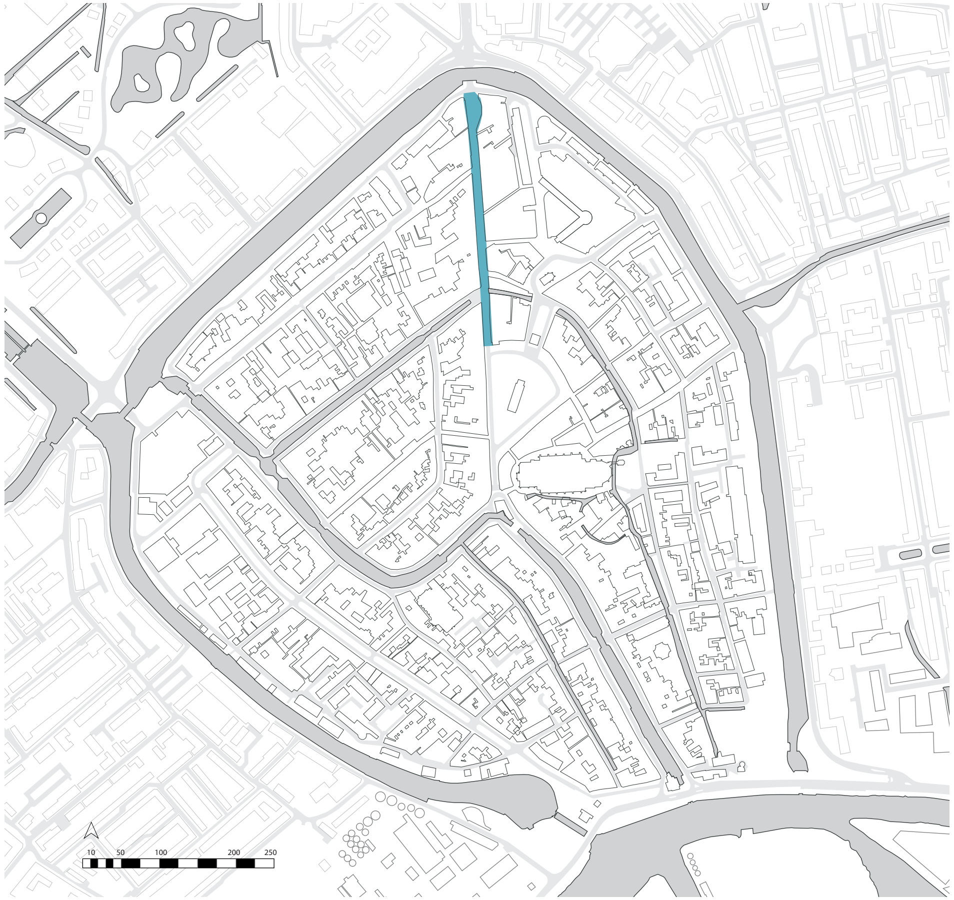
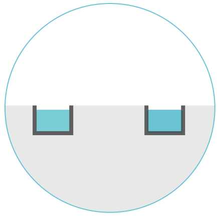


Figure C.1. Hoogstraat and Kleiweg

C.2. Gutters (intervention 1)

C.2.1. Formula



discharge capacity *local storage*

Storage = (cross-sectional area) x (k/n x $Rh^{2/3}$ x $S^{1/2}$) x duration + filled in gutter

Part 1: Discharge capacity (Gauckler-Manning-Strickler formula)

Part 1 = (cross-sectional area) x (k/n x $Rh^{2/3}$ x $S^{1/2}$) x duration
Width gutter = 0.2 m (used for this calculation)
Depth gutter = 0.2 m (used for this calculation). As the gutter starts out empty, and ends up full, an average of 0.1 m will be used for the calculations
Length street = 326 m (measured)

Cross-sectional area gutter = 0.2 x 0.1= 0.02 m^3
V = cross-sectional average velocity (m/s)
n = the Gauckler-Manning coefficient ($s/m^{1/3}$)
n = 0.011 (neat cement) (Chow, 1959)
Rh = hydraulic radius (L) = A/P = 0.02/0.4 = 0.05

With:
A = the cross-sectional area of flow (L^2) = 0.02 m^2
P = wetted perimeter = 0.1 + 0.2 + 0.1 = 0.4 m

S = the slope of the hydraulic grade line or the channel bed slope (L/L) (consistent water depth is assumed) = height difference/length

According to Pötz & Bleuzé (2012), there is a minimum gradient for gutters which allows for sufficient water flow.
S = 0.005/1 = 0.005 (minimum gradient gutter) (Pötz & Bleuzé, 2012)

In the streets used in the calculation there are height differences which form a natural slope. From the city centre outwards, this slope is approximately 0.00143. This is considerably less than the minimally required slope. For this reason, the gutter slope will follow the minimum requirements with a gradient of 0.5 cm per meter.

k = conversion factor between the standard unit system and English units. Because standard units are used throughout the calculation, k = 1
V = k/n x $Rh^{2/3}$ x $S^{1/2}$ = 1/0.011 x $0.05^{2/3}$ x $0.005^{1/2}$) = 0.87 m/s
Duration of precipitation = 2 hours = 60 x 60 x 2 = 7200 s
Part 2 = 0.02 x 0.87 x 7200 = 126 m^3

Part 2: Local storage

Part 2 = width x height x length
Width gutter = 0.2 m
Height gutter = 0.2 m
Length street = 326 m
Part 3 = 0.2 x 0.2 x 326 = 13 m^3

C.2.2. Efficacy intervention

By recombining these two parts, the calculation reads:

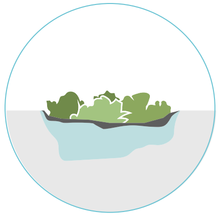
Storage = 126 + 13 = 139 m^3
In case of a 1-hour precipitation = 76 m^3
The remaining capacity is calculated for the two areas described in C.1.2.

Table C.2. Remaining capacity

		10 mm/hour	25 mm/hour	50 mm/hour	100 mm/2 hours
Remaining capacity in m^3	Directly on street	40	-14	-105	-222
	Larger area	-50	-238	-553	-1118

C.3. Green ditches (intervention 2)

C.3.1. Formula



infiltration storage

Storage = infiltration depth x width ditch x length street

interception storage

\+ width ditch x length ditch x shrub density x shrub surface x interception factor

local storage + *discharge capacity*

\+ (capacity ditch x ((water velocity x duration rainfall) + storage capacity ditch)

Part 1: Infiltration storage

Part 1 = infiltration depth x width ditch x length street

Width ditch = 1 m (used for this calculation)
Length street = 326 m (measured)
Infiltration depth = 0.05 m (see C.1.4.)
Infiltration storage = 0.05 x 326 x 1 = 16 m^3

Part 2: Interception storage

Part 2 = width ditch x length ditch x shrub density x shrub surface x interception factor

Width ditch = 1 m (used for this calculation)
Length ditch = 326 m (measured)
Shrub radius = 0.5 m (in this calculation, the average diameter of the shrubs is set at 1 m)
Shrub surface = $\pi \times r^2 = \pi \times 0.5^2 = 0.8$ m^2
Shrub density = 0.5 shrub/m^2
Interception factor = 2 mm = 0.002 m (calculated in C.1.5)

Part 2 = (1 x 326 x 0.5) x 0.8 x 0.002 = 0.3 m^3. This storage is so small that it is negligible and rounded down to 0.

Part 3: Local and discharge capacity

Part 3 = cross sectional area x water velocity x duration rainfall

This ditch is assumed to be triangle-shaped, 0.3 m deep, and 1 m wide. The wetted perimeter of this ditch is 1.05 m, as on average, the ditch will be half-filled with water.
The effective cross-sectional area = 0.5 x 0.5 x 0.3 x 1 = 0.075 m^2

Water velocity = V = (k/n x $Rh^{2/3}$ x $S^{1/2}$)
k = 1 (standard units)
n = 0.06 (light brush and trees in summer) (Chow, 1959)
Wetted perimeter = 1.05/2 = 0.525 m
Rh = A/P = 0.075/0.525 = 0.143 (calculated based on ditch capacity)
S = 0.005 (minimum slope)
V = (k/n x $Rh^{2/3}$ x $S^{1/2}$) = (1/0.06) x $0.143^{2/3}$ x $0.005^{1/2}$ = 0.322 m/s
Duration rainfall = 2 hours = 7200 s
Length street = 326 m (measured)
A completely full ditch can hold = 0.5 x 0.3 x 1 x 326 = 49 m^2

Part 3 = 0.15 x 0.322 x 7200 + 49 = 397 m^3

C.3.2. Efficacy Intervention

Storage = 16 + 0 + 397 = 413 m^3
1-hour variant: 8 + 0 + 223 = 231 m^3

Table C.3. Remaining capacity

		10 mm/hour	25 mm/hour	50 mm/hour	100 mm/2 hours
Remaining capacity in m^3	Directly on street	196	141	50	52
	Larger area	105	-83	-398	-844

C.4. Barrier (intervention 3)

C.4.1. Formula

local storage

Storage = (height barrier x width street) x length street

Height barrier = 0.25 m
Width street = 10.2 m (measured)
Length street = 326 m (measured)

C.4.2. Efficacy Intervention

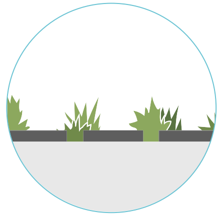
Storage = 0.25 x 10.2 x 326 = 831 m^3

Table C.4. Remaining capacity

		10 mm/hour	25 mm/hour	50 mm/hour	100 mm/2 hours
Remaining capacity in m^3	Directly on street	795	741	650	470
	Larger area	705	517	203	-426

C.5. Permeable streets (intervention 7)

C.5.1. Formula



infiltration storage

Storage = width street x length street x infiltration factor pavement x infiltration factor ground

Width street = 10.2 m (measured)
Length street = 326 m (measured)
Infiltration pavement = 23 mm/hour for ‘klinkers’ (2018 Boomtechniek)
This means the infiltration during a two-hour rainfall = 23 x 2 = 46 mm = 0.046 m
Infiltration factor ground = 1 (calculated in C.1.4., as this is less than 50 mm)

C.5.2. Efficacy intervention

Storage = 10.2 x 326 x 0.046 x 1 = 153 m^3
The 1-hour rainfall variant is 77 m^3

With a pavement infiltration factor of 23 mm/hour, this is also the maximum amount of precipitation that can be stored. Less precipitation will infiltrate completely.

The limiting factor in this calculation is the permeability of the pavement. The chosen type, while somewhat permeable, is not completely open. Other more open types (such as a type of half-open pavement often used for parking places, called a 'graskei', in Dutch, or grass pavement in English), would have a higher permeability, with 10.2 x 326 x (2 x 0.07) x 1 = 466 m^3 per two hours of precipitation. This type of pavement will be more permeable, but less suitable for heavy city traffic.

Table C.5. Remaining capacity (clinker bricks)

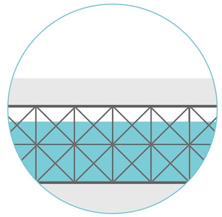
		10 mm/hour	25 mm/hour	50 mm/hour	100 mm/2 hours
Remaining capacity in m^3	Directly on street	41	-13	-104	-208
	Larger area	-49	-237	-552	-1104

Table C.6. Remaining capacity (grass pavement)

		10 mm/hour	25 mm/hour	50 mm/hour	100 mm/2 hours
Remaining capacity in m^3	Directly on street	197	143	52	105
	Larger area	107	-81	-396	-791

C.6. Infiltration boxes (intervention 8)

C.6.1. Formula



local storage

Storage = ((surface level – groundwater level) x width street) x length street

surface level =- 0.3 m (measured)
Groundwater level =- 0.70 m (GIS Gouda)
Width street = 10.2 m (measured)
Length street = 326 m (measured)

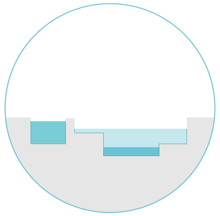
C.6.2. Efficacy intervention
Storage = (-0.3--0.70) x 10.2 x 326 = 1370 m^3

Table C.7. Remaining capacity

		10 mm/hour	25 mm/hour	50 mm/hour	100 mm/2 hours
Remaining capacity in m^3	Directly on street	1361	1307	1216	1036
	Larger area	1271	1083	769	140

C.7. Various street levels (intervention 10)

C.7.1. Formula



local storage

Storage = (width gutter x depth gutter x length street)

discharge capacity

+ cross-sectional area x (k/n x $Rh^{2/3}$ x $S^{1/2}$) x duration

Part 1: local storage

Storage = (width gutter x depth gutter x length street)
Width gutter = 7.5 m (assumed for this calculation)
Depth gutter = 0.3 meters (assumed for this calculation)
Length street = 326 m (measured)
Storage = 7.5 x 0.3 x 326 = 733 m^3

Part 2: discharge capacity

The same gutter as in C.2.1. is used:
Storage = cross-sectional area x (k/n x $Rh^{2/3}$ x $S^{1/2}$) x duration + storage gutter

Storage = 0.02 x 0.87 x 7200 = 126 m^3
1-hour variant = 76 m^3

C.7.2. Efficacy Intervention

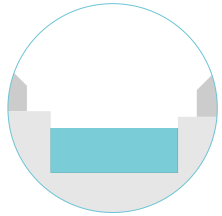
This intervention is capable of storing:
Storage = 733 + 126 = 859 m^3
For a 1-hour rainfall: 733 + 76 = 809 m^3

Table C.8. Remaining capacity

		10 mm/hour	25 mm/hour	50 mm/hour	100 mm/2 hours
Remaining capacity in m^3	Directly on street	773	719	628	498
	Larger area	683	495	181	-398

C.8. Canals (intervention 11)

C.8.1. Formula



local storage

Storage = (surface level – ground water level) x width canal x length street

surface level = - 0.3 m (measured)
Ground water level = - 0.70 m (GIS Gouda)
Width canal = 4 m (used for this calculation)
Length street = 326 m (measured)

C.8.2. Efficacy Intervention

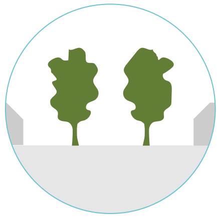
Storage = (surface level – ground water level) x width canal x length street
Storage = (-0.3--0.7) x 4 x 326 = 521 m^3

Table C.9. Remaining capacity

		10 mm/hour	25 mm/hour	50 mm/hour	100 mm/2 hours
Remaining capacity in m^3	Directly on street	485	431	340	160
	Larger area	395	207	-108	-736

C.9 Row of trees (intervention 12)

C.9.1. Formula



infiltration storage

Storage = (width open soil x length open soil x infiltration depth x (length street/distance trees)

interception storage

+ ((π x r^2 x (interception factor) x (length street/distance trees)

Part 1: Infiltration storage

Part 1 = width open soil x length open soil x infiltration depth x (length street/ distance trees)

Width open soil = 1 m
Length open soil = 1 m
Infiltration depth = 0.05 m (calculated in C.1.4)
Length street = 326 (measured)
Distance trees = 10 m (measured on average)

Part 1 = 0.05 x 1 x 1 x (326/10) = 1.6 m^3

Part 2: Interception storage

Part 2 = ((π x r^2 x (interception factor) x (length street/distance trees)
Tree radius r = 3 m (the average tree crown is measured at 6 m)
Tree crown surface = π x r^2 = 28.27 m^2
Interception factor = 2 mm (see C.1.5)
Length street = 326 m (measured)
Distance trees = 10 m (measured average)

Part 2 = 28.27 x 0.002 x (326/10) = 1.8 m^3

C.9.2. Efficacy Intervention

Storage = 1.6 + 1.8 = 3 m^3
The storage for this intervention is very small, which means this intervention is insufficient during any precipitation.

Table C.10. Remaining capacity

		10 mm/hour	25 mm/hour	50 mm/hour	100 mm/2 hours
Remaining capacity in m^3	Directly on street	-33	-87	-178	-358
	Larger area	-123	-311	-626	-1254

C.10. Wilderness

C.10.1. Formulas

infiltration storage
Storage = width street x length street x 0.8 x
(surface level – groundwater level) x infiltration depth +
interception storage 1
width street x length street x 0.8 x shrub density x
(π x r^2 x interception factor) +
interception storage 2
((width street x length street x 0.8) x tree density x ((Π x r^2 x interception factor)

Part 1: Infiltration storage
Part 1 = ((width street x length street x 0.8) x infiltration depth
Width street = 10.2 m (measured)
Length street = 326 m (measured)
It is assumed that 80% of the street is green, 20% is roads. This results in an extra factor of 0.8
surface level = - 0.3 m (measured)
Groundwater level = - 0.70 m (measured)
Infiltration depth = 0.05 m(calculated in C.1.4)
Part 1 = (10.2 x 326 x 0.8) x 0.05 = 133 m^3

Part 2: Interception storage 1 (foliage)
Part 2 = ((width street x length street x 0.8 x shrub density) x (Π x r^2 x interception factor)
Width street = 10.2 m (measured)
Length street = 326 m (measured)
As described previously, 80% of the street is green, 20% is roads, so there is a factor of 0.8 that is used.
Shrub density = 0.5 shrub/m^2 (used for this calculation)
Shrub radius r = 0.5 m (used for this calculation is a foliage surface area of 1 m^2)
Shrub surface = π x r^2 = π x 0.5^2 = 0.785 m^2
Interception factor = 2 mm = 0.002 m
Part 2 = (10.2 x 326 x 0.8)/2) x 0.4 x 0.002 = 2 m^2

Part 3: Interception storage 2 (trees)
Part 3 = ((width street x length street x 0.8) x tree density x ((π x r^2 x interception factor x average rainfall)
Width street = 10.2 m (measured)
Length street = 326 m (measured)
80% of the street is green, 20% is roads, which leads to an extra factor of 0.8
Tree density = 0.02 (there is one tree on every 50 m^2)
Tree radius r = 3 m (surface area tree crown has been measured at 6 m)
Tree surface = π x r^2 = π x 3^2 = 28.27
Interception factor = 2 mm = 0.002 m
Part 3 = 10.2 x 326 x 0.8 x 0.02 x 28.27 x 0.002 = 3 m^3

C.10.2. Efficacy Intervention
Storage = 133 + 2 + 3 = 138 m^3
The interception factor is so small that, while it is included, it is not really relevant in this calculation. No special calculations have been done to account for the water that drains from the nearby rooftops into the street.

Table C.11. Remaining capacity

		10 mm/hour	25 mm/hour	50 mm/hour	100 mm/2 hours
Remaining capacity in m^3	Directly on street	102	48	-43	-223
	Larger area	12	-176	-491	-1119

C.11. Conclusions

Earlier calculations showed an incredibly high efficacy rate for the interception storage and unfortunately, due to a unit conversion error, a re-calculation quickly showed that this was untrue.

Instead, the interception storage ends up being so small that it is negligible in nearly all calculations. In the end, the most effective interventions turned out to be those which were capable of storing a good amount of water in or on the surface of the street, such as the green ditches, the barriers, the infiltration boxes and the varied street heights.

The canals did quite well, but all canals in the inner city are connected. Higher than normal water levels in one canal means flooding elsewhere in the city. This is something that must be considered. Overall, water storage with a one-sided connection to the water system was most successful.

D. LITERATURE STUDY AND REFERENCES

D.1. Literature study (Theory of Urbanism)

A review of the reaction to the Dynamic Adaptive Policy Pathways method, and its supportive potential for planners in urban environments

The field of urbanism and urban planning is currently trying to adjust their project progresses to the consequences of climate change, which are being felt in cities throughout the world. Various methods have been published specifically to support planners in this complex task. One of these methods, Dynamic Adaptive Policy Pathways seems potentially suited to support planners with two of the main issues in this field, 1. general uncertainty and 2. The interconnectivity of different social, physical, short and long-term streams in urban water environments, which can complicate the issues and make the final end goal unclear.
This paper studies whether this theoretical suitability is reflected in practical applications. A literature study has been carried out across 50 papers which discuss this method in depth. This investigation discusses the advantages of a step-wise approach without setting final goals. It also summarizes the inherent weaknesses of a method which requires a model in complex environments, and the improvements that have been published to shore up this weakness. Last it analyses the attractiveness of this method for long-term, large-scale fields, similar to delta urbanism, and what steps have been taken to take DAPP beyond this niche toward application for other (urban) environments.

1. Introduction
Over the past decade, the need to adapt for climate change has come to the forefront of many planning fields, including those in urban areas (Chu, Anguelovski & Roberts, 2017). This has become especially prevalent now the consequences of climate change are making themselves known, damaging cities and causing economic problems (Rosenzweig & Solecki, 2014). Unfortunately, awareness does not translate into adaptive capacity (Moser & Ekstrom, 2010).
In response, several methods have been developed to encompass this added difficulty. Each of these strategies supports planners in various ways, suited to different situations and applications (Hallegatte, 2012).

This paper analyses one such method: Dynamic Adaptive Policy Pathways (Haasnoot, Kwakkel, Walker & ter Maat, 2013). The first part of this paper analyses the method for potential application to general urban environments. The issue of uncertainty, which has been mentioned before, is especially prevalent in these locations. These, due to their interconnected systems, processes and flows (Birkmann, Garschagen, Kraas & Quang, 2010) often deal with more difficulty in determining the knowledge needed for both the means and ends types of uncertainty (lack of knowledge of both the means by which to complete the project, and the lack of a final goal to strive for (Christensen, 1985)). To this is added the common issue of a high persistence level (Birkmann et al., 2010), high costs and a lack of useable space.

The second half of the paper analyses whether or not this theoretical conclusion about the potential applicability is repeated in other literature studies, and if this shows up in practical case studies using this method.

2. What is the Dynamic Adaptive Policy Pathways method?
All of the currently available planning methods are still evolving and improving to supply urbanists with the best structure and coverage for adaptive design. Dynamic Adaptive Policy Pathways, or DAPP, is one of these methods, and was developed by Haasnoot et al. (2013), as a combination of an earlier method by the same authors, concerning adaptation pathways strengthened by the addition of another method, adaptive policymaking.

The first, adaptation pathways, is a method capable of dissecting a wide variety of scenarios on which intervention sequences are based, which are all connected in a web-like structure. Each single link in the chain is assigned a tipping point, acting as a signal to the planner that the existing strategy no longer fulfils the minimal requirements for success. After a tipping point the project switches to another pathway (Haasnoot et al., 2013)

The second approach, adaptive policymaking, is a very structured, stepwise approach. It leads the planners through the phases of creating analyses, plans, and prompts the placement of monitors in vulnerable places. Attached to these triggers are pre-determined actions to shore up the project (Haasnoot et al., 2013).

The strengths of these methods are combined in DAPP. It uses a framework that is capable of analysing the many various permutations of the future, using model-based scenarios. This makes it useful in projects that deal with considerable uncertainty. The framework also prompts planners to define vulnerable places where monitoring is needed and creates moments in which these places can be strengthened. On the other hand, it also provides support when a change of direction is necessary because certain thresholds were breached (Haasnoot et al., 2013).

Haasnoot et al. (2013) assert that they see a lot of potential for further development of this method as well, and Deltares (2014) has started early testing in several projects. However, it still remains to be seen if this potential is reflected in other writings and practical application of this method.

3. Strengths

In theory, DAPP seems to be a strategy that could be very useful to the problems that are stalling progress in adaptive planning in spatial planning fields (Kato & Ahern, 2008). Kato & Ahern's paper focuses on landscape planning, but other spatial fields such as urban and water planning deal with very similar issues. One of the main issues raised by these researchers is the lack of monitoring to provide information, timely prompts and structure for projects, both of which are provided by Dynamic Adaptive Policy Pathways.

3.1. Uncertainty

Stafford Smith, Horrocks, Harvey & Hamilton (2011) state that one of the difficulties of working with uncertainty is that it is complex for human nature to comprehend, and reactions to it will not always be made from a position of logic. New adaptation options are often at least partially based on historical successes, as people prefer to base future decisions on past events (Dessai, Lu & Risbey, 2005). However, increasing likeliness of more extreme climate change diverges possible futures so much historical data is no longer accurate for the future (Stafford Smith et al, 2011).

Uncertainty is often a major issue in every planning project, being defined by Abbot (2005) as 'anything that is either unknown or cannot be known'. More specifically, Christensen (1985) states uncertainty is present when either the means (technology) or the ends (goal) are unknown. Both are present in climate change adaptation.

Figure 1 . Dynamic adaptive policy pathway (Haasnoot, et al, 2013.)

Traditionally planners often used simplified or historically based scenarios which assumed certain factors and often ignored uncertainty. While planners from as early as 1971 (Mack, cited by Abbott, 2005) to as recent as Stafford Smith et al. (2011) have been warning that this might cause inadvertent sabotage in a later stage, the shift from this practice is relatively recent (Haasnoot et al., 2013). From this a general understanding that these scenarios are no longer sufficient has grown. Climate change does not follow a logical progression of events, and unpredictable events can easily exacerbate the situation, and cause interventions to fail (Haasnoot et al., 2013).

Unfortunately, making the step to fully incorporate all types of uncertainty is difficult and requires a lot of special attention within a project (Stafford Smith et al, 2011), in addition to the already existing complexity of the projects. This is specifically the case in projects where many different (eco)systems and other processes interconnect (Birkmann et al., 2010). Past practice involved limiting this inherent variability through engineered interventions, but this ignored the innate instability and uncertainty of urban equilibriums (Folke, 2006).

There is still no unanimous scientific agreement on how uncertainty should be integrated (van der Pol, van Ierland, Gabbert, 2017), which only adds complexity to the chaos of the varied ways cities collect and use vital data (Birkmann et al, 2010). A systematic and structured framework to support planners is a necessity (Stafford Smith et al., 2010)). According to Haasnoot et al., (2013), DAPP is such a framework. It allows planners to lay out a project in logical, ordered steps, including which factors should be considered at certain points. It prompts planners to set danger thresholds and add contingency plans. Lastly, it helps to create an overview for monitoring the various unsure elements. Theoretically, this should solve many of the uncertainty issues.

3.2. Urban environments

Uncertainty is relevant to many fields, yet, as Kato & Ahern (2008) note, spatial planning fields specifically fall behind the curve. These fields deal with added a difficulty that generally does not apply elsewhere: their location. Urban centres and environments have a very high persistence level (Birkmann et al., 2010). At the same time, they are more vulnerable to disasters now than they have ever been before (White, 2010; Rosenzweig & Solecki, 2014).

An occasional strategy in urban centres is to use interventions that are capable of partially covering a wide range of potential problems, rather than specific, focused solutions (McInerney, Lempert & Keller, 2012). In order to achieve this, over-dimensioned or robust interventions are preferred (Hallegatte, 2009; Dessai & Hulme, 2007). When strategies require further adaptation, this is often done on short notice. These impromptu changes are an expected element of certain methods of urban planning (McInerney et al., 2012), as it is argued that urban centres have always changed in reaction to a damaging interaction with the environment (Smit & Wandel, 2006). But changes caused by uncertainty are often ruinously expensive (Yzer, Walker, Marcau & Kwakkel, 2014), and can make further adaptations more complicated.

DAPP's adaptive pathways can help with longer term future planning and testing of scenarios to check how cities will react. It builds on the standard practice of scenarios, yet instead of accepting these as an accurate assessment, they are used to set limits to the effectiveness of various interventions. These interventions can then be linked into pathways, so changes can be both swift, pre-planned and prepared. These pathways allow plans to build on each other, allowing planners to add efficacy to finished projects, without stumbling over lock-ins (Haasnoot et al., 2013).

This adds a lot of flexibility, without including late term chaos, as large parts of the data have been progressed and ranked in interventions at an early stage of the project, thus combining long and short-term interventions into a complete project.

4. Weaknesses

While DAPP seems to bring many advantages to the table, no method is universally applicable. Planners have to look at the demands and data of their project, to find which method would be most suitable (Hallegatte et al, 2012).

4.1. Model requirements

The Dynamic Adaptive Policy Pathways method is part of a shift from the use of historic data to using modelled changes (Lawrence, Quade & Becker, 2014). Adaptation pathways is a strategy to test a large number of future scenarios to check the efficacy of future interventions. However, this generally requires a model in which these scenarios can be run. This model must be detailed enough to incorporate most of the factors and uncertainties yet be simple enough that many different scenarios can be checked (Haasnoot et al., 2013). Thus, the complete underlying complexity of values, knowledge and institutions and their interactions is often simplified (Wise et al., 2014). Therefore, planners have to understand the model, and critically consider the simplifications and limitations during the project (Zeff, Herman, Reed & Characklis, 2016; Jurgilevich, Räsänen, Groundstroem & Juhola, 2017).

There might not be enough time or knowledge available to create such a model within the thresholds of the project. Even with a model present, the planner is still responsible for setting acceptable tipping point threshold levels with the available information (Gersonius, Ashley, Jeuken, Pathinara & Zevenbergen, 2015). While the framework prompts planners to complete these actions, planners are not supported in any other way.

The research paper that introduces DAPP does not actually use a current model. Instead, it uses earlier studies and expert knowledge to simulate these scenarios (Haasnoot et al., 2013). So, there are some alternatives to detailed models, but a certain level of expert knowledge must be available. These experts are the most important source to guide planners in setting correct threshold levels. This makes it very important to attract and retain active, interested and critical stakeholders (Gersonius et al., 2015). Therefore, DAPP would not be suitable in situations with unknowledgeable or unavailable stakeholders.

5. Research method

The literature analysis database comprises of 102 papers, collected through Scopus (2017), published before September 2017 which reference the original paper by Haasnoot et al. (2013). Out of this number, 50 of these references are relevant to this analysis. The other 52 papers are not used in this study.
The papers were sorted into support papers (written to add improvements and extra applicability to the DAPP method). Categorization papers (mainly focused on sorting and placing the method into the larger paradigm of uncertainty frameworks), and in application papers (mostly containing case studies).

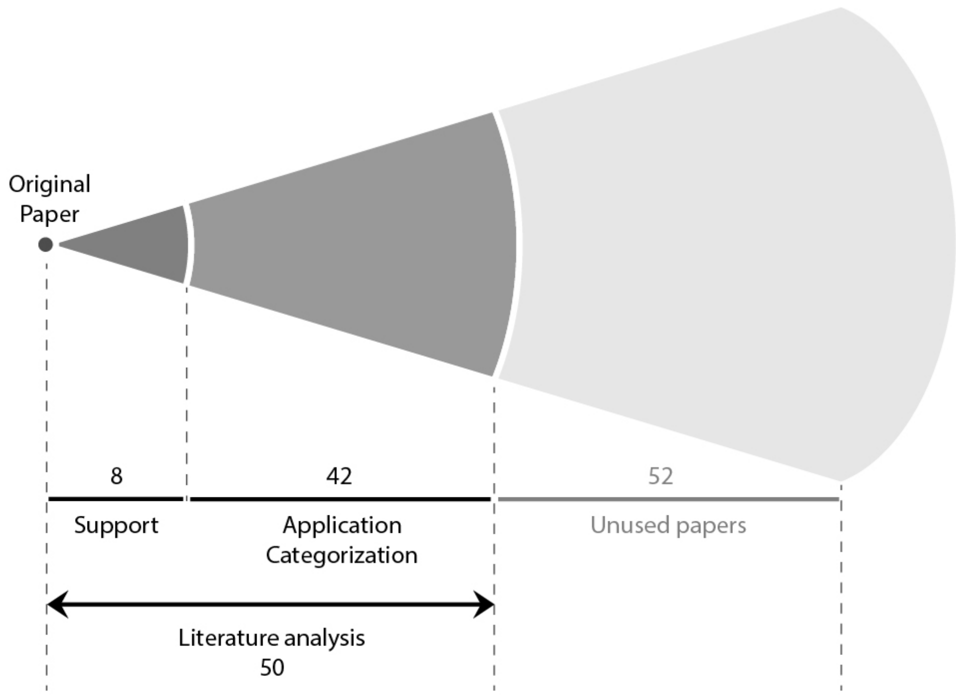


Figure 2 . An overview of the literature categories used in the analysis

5.1. Critical

By far the largest category of papers were those that focused on placing DAPP in the larger academic debate. This was usually done through comparison with other approaches, analysing, criticising and categorizing the various elements of the method.

5.1.1. Framework and results

Comparative studies were a common way to assess this planning approach (Eisenhauwer, 2016; Van der Voorn, Quist, Pahl-Wostl & Haasnoot, 2017). These studies have brought several results; the method, Dynamic Adaptive Policy Pathways falls under what researchers call the pathway approach. This approach focuses on setting up sequential decision points with iterative elements to create progress, rather than the definition of a final goal. (Maru, Stafford Smith, Sparrow, Pinho & Dube, 2014; Zeff, Herman, Reed & Characklis, 2016; Watkiss, Hunt, Blyth & Dyszinsky, 2015).

The many transient scenarios created through adaptation pathways are independent from the probabilities of different futures (Gersonius et al., 2015). This modelling uses critical points of the spatial system as start-up opportunities, which planners can develop into a series of possible interventions (Van Veelen, Stone & Jeuken, 2015). This is advantageous to users, because the decision point thresholds do not have to change in accordance with future projections. Only the timeline of the pathways will change in accordance to how these new predictions compare to the thresholds (Klijn, Kreibich, de Moel & Penning-Rowsell, 2013. This makes DAPP a good method for governing a slowly changing situation, as well as unexpected events, while integrating strategic future interventions into a planning process (Merrie et al., 2014).

5.1.2. Uncertainty

One of the big issues in dealing with climate change is the large role of uncertainty. Since once of the advantages of DAPP is to help planners in dealing with this, it is important to analyse how the way Haasnoot et al. (2013) define uncertainty has influenced the construction of the method.

In one review Woodruff (2016) points out that, DAPP is part of a newer type of method that attempts to change the common assumption that by using one future scenario, an adaptive plan can be created. Haasnoot et al. (2013) have created a plan to work under deep uncertainty. The addition of this future uncertainty can greatly increase the understanding of a project (Huskova, Harou, Kasprzyk & Lambert, 2016). Vulnerability is defined as a threshold (Jurgilevich, Räsänen, Groundstroem & Juhola, 2017), where the monitoring of these maximum limits is one of the main elements (Culley et al., 2016). The entire DAPP strategy is framed round the point of where interventions fail, and how projects progress from that point (Walker, Loucks & Carr, 2015; Groves et al, 2015; Yzer, Walker, Marchau & Kwakkel, 2014).

5.1.3. Weaknesses

Another categorization article, which compares this method to Back-casting (Van Vliet & Kok, 2015), noted several issues with the method. Back-casting promotes the participation of stakeholders, while DAPP is stronger with the modelling aspects. However, setting the correct threshold and placing the tipping points in the right spot is vital for using the DAPP method successfully. To do that, you need stakeholders which are capable and knowledgeable enough to set a limit. Furthermore, these stakeholders need to define acceptable risk threshold levels (Gersonius et al., 2015). This makes active and interested stakeholders an important amenity in adaptive design (Rosenzweig & Solecki, 2014).

5.2. Changes to model

While there are clear criticisms to be made about this method, the writers have proven to have good self-reflection and have published papers on a regular basis that can improve or add supporting tools to the DAPP method.

Several researchers noted the weakness of the method at the modelling phase, but new models and toolkits have been developed, which can be used to analyse plausible futures with less effort than before (Haasnoot et al., 2014; Kwakkel, 2017; Kwakkel, Haasnoot & Walker, 2015). Another criticism of the method, is that there is very little support regarding when, how and why planners have to make decisions when they create an adaptation pathway. A supporting strategy for that has been developed (Hermans, Haasnoot, ter Maat & Kwakkel, 2017), which also assists in the monitoring of these pathways.

Some researchers publish strategies that build on the adaptive sequential pathways method that DAPP has introduced (Zeff et al., 2016). While the original method stresses the avoidance of lock-ins that cause excessive costs when switching to another pathway, modifications add strategies to avoid this issue (Lahtinen, Guillaume & Hämäläinen, 2017). Other papers refine DAPP further and add a practical element to the originally theoretical strategy, such as methods to avoid illogical pathways, and a proposed minimal gain level from switching pathways in order to avoid waste. (Manocha & Babovic, 2017) or warnings for future conditions that might cause a project to fail (Groves et al., 2015).

However, practical application has shown that an exact model is not always necessary. In one case study, an older model, created by, Middelkoop, Offermans, van Beek & van Deursen (2012) was used and adapted to the situation. While not exact, this representation of decisions and consequences motivated planners and politicians to move forward with DAPP in various areas and layers of government (Lawrence & Haasnoot, 2017).

A further problem is fragmentation (Walker et al., 2013). In accordance with this, a final addition to the DAPP method is a strategy to attract new people and promote the advantages, to catalyse progress in the world of adaptive planning (Lawrence & Haasnoot, 2017).

A second type of dissolution occurs when planners adopt partial elements of this strategy. And unlike the first type, this one is advantageous. Using elements of the method which are applicable to the project, e.g. delta management researchers are now able to build improved strategies based on (parts of) the new DAPP method (Sánchez-Arcilla et al., 2016) (Groves et al., 2015), and apply it.

5.3. Case studies

Elements of the DAPP method (e.g. Adaptation Tipping Points and Adaptation pathways) were tested at several projects worldwide, from river management strategies (Van Slobbe, Werners, Riquelme-Solar, Bölscher & van Vliet, 2016), to storm water management, each with a different focus or scale (Manocha & Babovic, 2017).

Besides the interest in the use of adaptive pathways, the creation of transient scenarios and sequenced interventions is also a popular aspect (Beh, Maier & Dandy, 2015). An advantage of this strategy is that it works in cases that involve a lot of chaotic, fast-changing elements, for example wastewater management in Amsterdam. Due to the fast-paced external changes, combined with a large amount of resources as well as an overabundance of recovery methods, the problem there is finding a method with the capacity to cover and review all potential options. Using the first six steps of the DAPP method, the researchers have been able to successfully organize most of the data into several plausible strategies (Van der Hoek, de Fooij & Struker, 2016).

Since this method was first published in the literature, it has been carried out in several case studies. Many of these were large or national scale projects e.g. the Rhine delta (Haasnoot et al., 2013). On the other hand, there have also been projects on a very small scale (Van der Hoek et al., 2016). The similarity here is that both scales have information, resources and clear mandates to carry out their projects. It is the scales in between where studies become scarcer, for both DAPP and various other methods (Woodruff, 2016). However, one case study showed that a program involving an awareness program and a simplified model, adapted from Haasnoot et al. (2012) led to experimentation and application of DAPP, even in other areas and layers of government (Lawrence & Haasnoot, 2017).

5.4. Applicability

While DAPP was originally developed for delta management, there are several other fields where stakeholders desire to advance their progress in uncertain sustainable adaptation. Several have shown interest in using Dynamic Adaptive Policy Pathways, or elements thereof in pursuit of this goal, in fields that vary from organised dialogue social change in rural Transylvania (Câmpeanu & Fazey, 2014) to forest management (Petr, Boerhoom, Ray & van der Veen, 2015).

This last example used the DAPP strategy to move beyond simple risk studies and add uncertainty in a long-term plan that could connect change with spatial elements. Using the first five steps of the DAPP method, they set up an action expiration chart, including other potential uses later on (Petr et al., 2015).

Other interested parties could be found in urban heat risk management. This deals with similar levels of infrastructure persistence as delta management, where the creation of a timeline and a portfolio of possibilities using adaptation pathways is an enormous advantage. These options can be used to compensate for the vulnerabilities and static nature of singular actions (Kingsborough, Jenkins & Hall, 2017).

In the similar case of decarbonization, with its slow and expensive infrastructure, DAPP would be very useful in the analysis of adjustment capabilities when comparing energy transition scenarios. Having the capability to transition between pathways without incurring excessive costs would be a great advantage in this field. Continuous monitoring would also help usher in new energy scenarios more quickly and streamline the moment of transition. (Mathy, Criqui, Knoop, Fischedick & Samadi, 2016).

6. Conclusion

In order to research the applicability of DAPP for spatial design and planning in urban water environments, a literature analysis has been done, consisting of 50 articles.

Within this analysis, three main subject matters can be named. First, categorization papers focused on comparing the DAPP method to other strategies, to see when it could be applicable. One of the strengths of DAPP is in the fact that it lacks a final goal, instead using sequential decision points (Maru et al., 2014). This allows planners to keep using it during periods of rapid development (Merrie et al., 2014). This neutralizes one of the main two types of uncertainty (unknown goals), as defined by Christensen, (1985). Thus, projects can be set into motion earlier, even with long-term uncertainty (Klijn et al., 2013). However, while modelled transient scenarios allow for more and faster calculation of various futures (Haasnoot et al., 2013), this strategy cannot be carried out without active human supervision to set limits and react to upcoming vulnerabilities (Gersonius et al., 2015)

The second category involved an improvement approach. Various strategies to increase accessibility to the model and to add stakeholder support have been proposed.

The last group consisted of a wide variety of case studies. Through analysis, it has become clear that this method is very applicable to a specific type of project. A large percentage of the case studies that have tested this method in practice all involve long-term projects, which either run on large or national scales, or on very small, focused subjects. These projects often already have models, and have clear boundaries, which do not conflict or interact with a great number of other fields e.g. decarbonization transitioning (Mathy et al., 2016).

The requirement of a model excludes middle scale and urban environment projects, as resources are scarcer, and goals are more unclear, with the lack of technical capacity as an important barrier (Woodruff, 2016). The model is yet another bottleneck that has stopped expansion of this method out of delta management and similar fields. However, Lawrence & Haasnoot (2017) just finished a four-year case study that showed that neither of these bottlenecks are definite limits to the use of DAPP in all sorts of scales and areas.

These conclusions show potential for expansion of the DAPP method with new steps added before the rest of the method, to create a base of knowledge from which adaptable design can be made. Another analysis that follows the progression of these new developments over a longer period of time could show if these early results are representative of the full potential of this method.

D.2. References thesis

D.2.1. Reference list: thesis

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E. Workshop documents
(in Dutch)

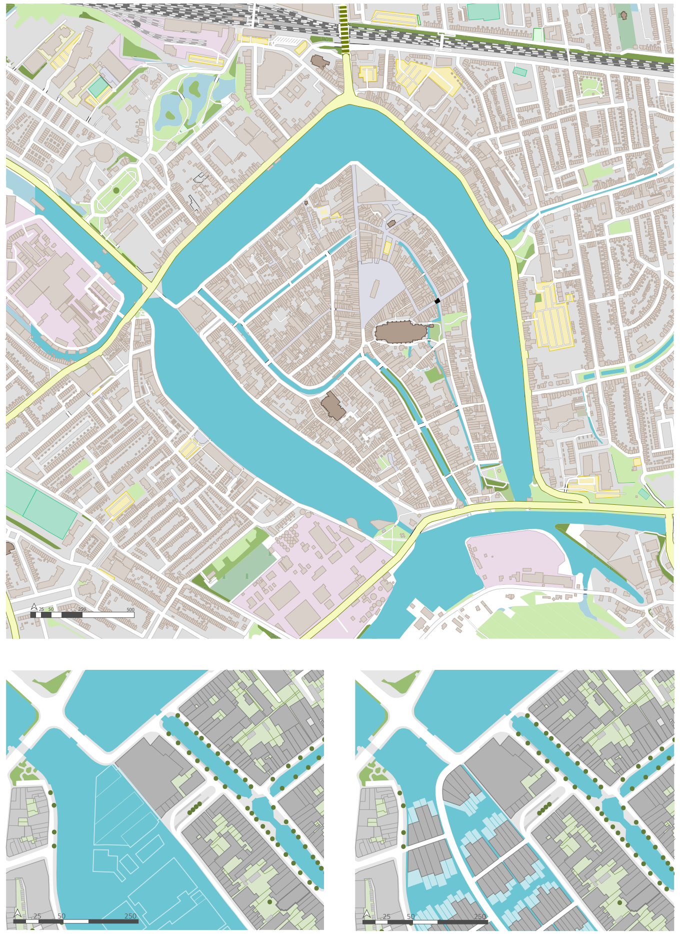
E. Workshop handouts

E.1. Stap 1: Scenario's

E.1.1. Algemene kaarten

E.1. Stap 1: Scenario's

E.1.2. Water

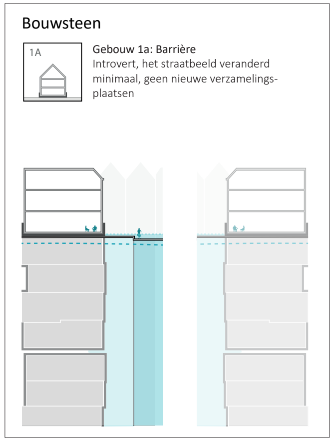


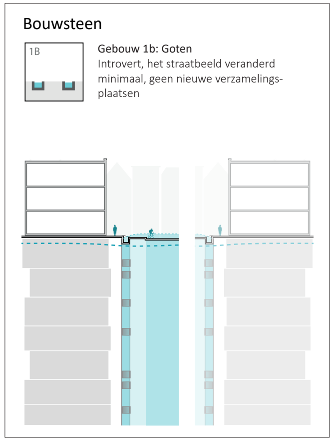
E.1. Stap 1: Scenario's

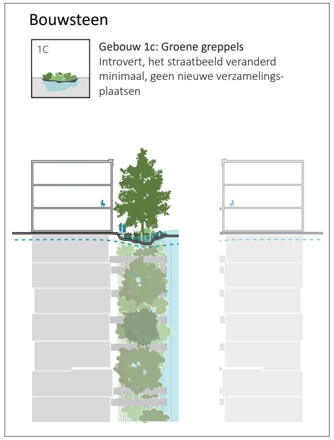
E.1.3. Water

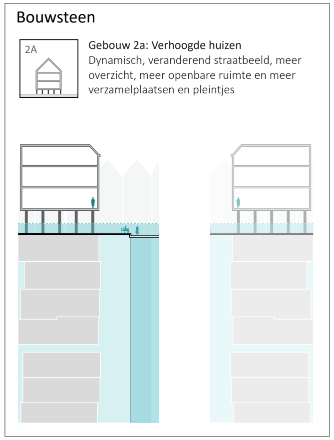
E.2. Stap 2: Bouwstenen

E.2.1. Gebouwen



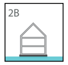




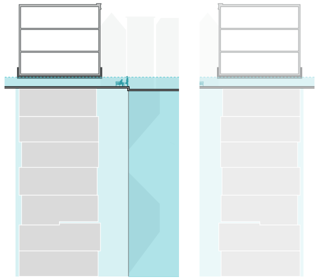


E.2. Stap 2: Bouwstenen
E.2.1. Gebouwen

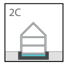
Bouwsteen



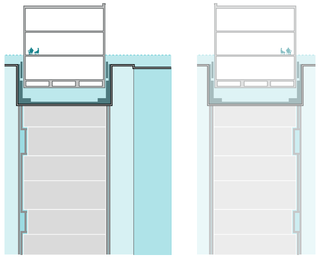
Gebouw 2b: Drijvende huizen
Dynamisch, veranderend straatbeeld, meer overzicht, meer openbare ruimte en meer verzamelplaatsen en pleintjes



Bouwsteen

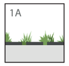


Gebouw 2c: Amfibische huizen
Dynamisch, veranderend straatbeeld, meer overzicht, meer openbare ruimte en meer verzamelplaatsen en pleintjes

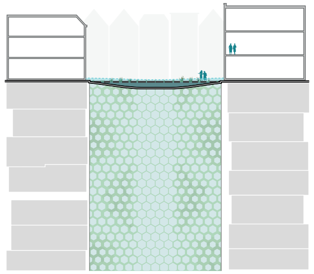


E.2. Stap 2: Bouwstenen
E.2.2. Straten

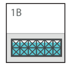
Bouwsteen



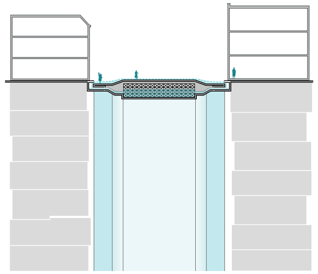
Straat 1a: Doorlaatbare straten
Natuurlijk, veel gedeelde ruimtes, veel verzamelplaatsen, auto's zijn te gast



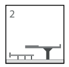
Bouwsteen



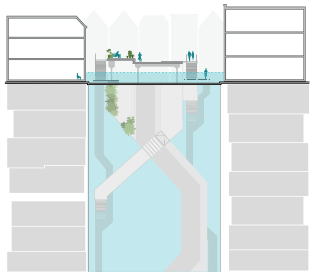
Straat 1b: Waterkratten
Veel gedeelde ruimtes, veel verzamelplaatsen, auto's zijn te gast



Bouwsteen



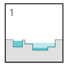
Straat 2: Verhoogde wegen
Alles is verhoogd, geen auto's, fietsers slechts op uitzonderlijke plekken, veel verzamelplaatsen



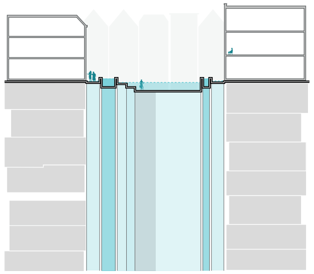
E.2. Stap 2: Bouwstenen

E.2.3. Water en Groen

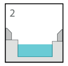
Bouwsteen: Water



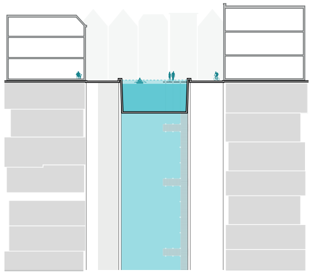
Water 1: Afwisselende straathoogtes
Alle ruimte is nog gebruikbaar, verschillende functies op verschillende hoogtes, veilige scheiding ruimtes



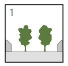
Bouwsteen: Water



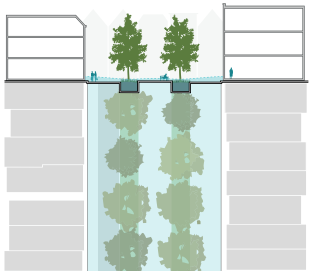
Water 2: Gracht
Formeel, ruimte is opgedeeld in rechte lijnen, veel kijkruimte, weinig gebruiksruimtes



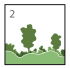
Bouwsteen: Groen



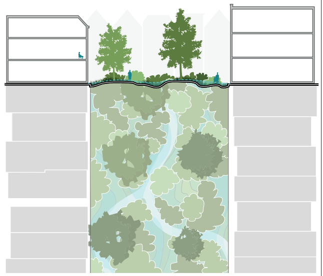
Groen 1: Bomenrij
Formeel, weinig verzamelplaatsen, bomen als gordijn om ruimtes te scheiden



Bouwsteen: Groen



Groen 2: Wildernis
Wild, alles is openbare ruimte, groene speelplaatsen geen rechte paden, af en toe een verzamelplaats



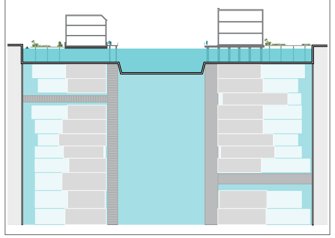
E.3. Stap 3: Typologie

E.3.1. Water

Bouwsteen: Water

Typologie

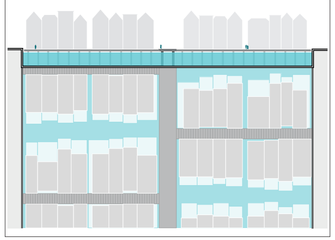
Watertypologie: Gracht
Nieuwe huizen zijn opgesteld aan de hand van de grachtenpanden in de Oost en Westhaven, grote huizen en een grote gracht met ruimte voor grotere schepen



Bouwsteen: Water

Typologie

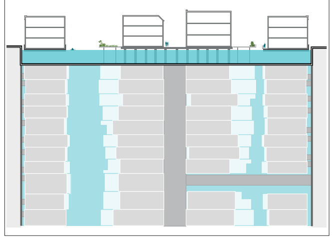
Watertypologie: Zijstraten
Grotere dichtheid, straten volgen de oude ontginningsstructuur, smallerere straten, geen doorgang voor schepen, slechts watersteegjes voor kleine bootjes



Bouwsteen: Water

Typologie

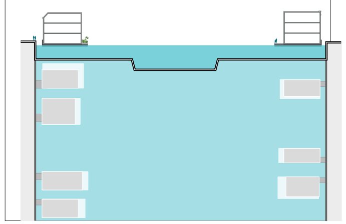
Watertypologie: Singelstructuur
Wegen volgen de vorm van het water, grotere dichtheid, ruimte voor gemiddeld grote schepen aan een kant



Bouwsteen: Water

Typologie

Watertypologie: Woonboten
Nieuwe huizen zijn opgesteld aan de hand van de huidige woonboten die nu aan de singel liggen, laagste dichtheid, veel ruimte voor schepen, veel open water



E.3. Stap 3: Typologie

E.3.2. Groen

Bouwsteen: Groen
Straatbeeld

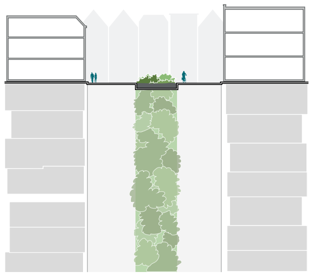
Straatbeeld Groen: Bomenrij
Formeel, weinig verzamelplaatsen, bomen als gordijn om ruimtes te scheiden, monotoon beeld

Bouwsteen: Groen
Straatbeeld

Straatbeeld Groen: Dubbele bomenrij
Formeel, weinig verzamelplaatsen, bomen als gordijn om ruimtes te scheiden, monotoon beeld

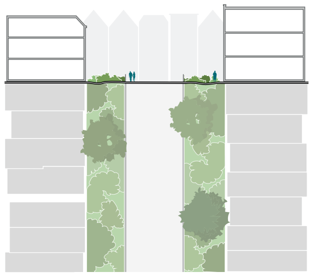
Bouwsteen: Groen
Straatbeeld

Straatbeeld Groen: Groen centrum
Formeel, weinig verzamelplaatsen, lage scheiding van huizen, monotoon beeld



Bouwsteen: Groen
Straatbeeld

Straatbeeld Groen: Voortuinen
Grotere kavels, meer variatie in groen en stijl, nieuwe semi-private verzamelplaatsen

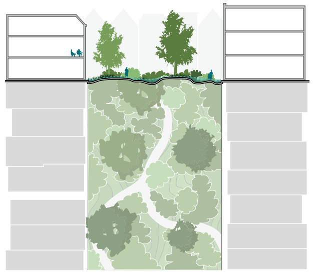


E.3. Stap 3: Typologie

E.3.2. Groen

Bouwsteen: Groen
Straatbeeld

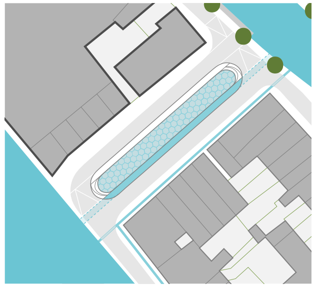
Straatbeeld groen: Wildernis
Wild, alles is openbare ruimte, groene speel plaatsen, geen rechte paden, af en toe een verzamelplaats



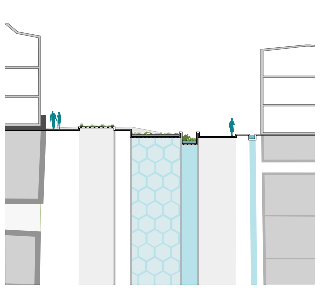
E.4. Stap 4: Ensembles

E.4.1. Water

Ensemble: Blauw
Nonnenwater - normaal
G1 - S1 - Wa1

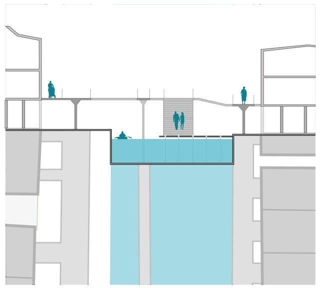


Ensemble: Blauw
Nonnenwater - normaal
G1 - S1 - Wa1



Ensemble: Blauw
Nonnenwater - extreem
G2 - S2 - Wa2

Ensemble: Blauw
Nonnenwater - extreem
G2 - S2 - Wa2

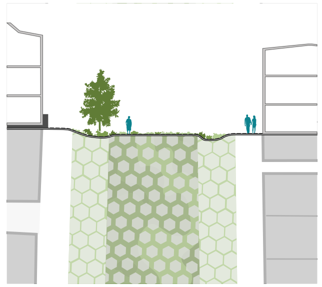


E.3. Stap 3: Typologie

E.4.2. Groen

Ensemble: Groen
Nonnenwater - normaal
G1 - S1 - Gr1

Ensemble: Groen
Nonnenwater - normaal
G1 - S1 - Gr1



Ensemble: Groen
Nonnenwater - extreem
G2 - S2 - Gr2

Ensemble: Groen
Nonnenwater - extreem
G2 - S2 - Gr2

E.5. Resultaat workshop 1

E.5.1. Workshop 1, water groep 1

Stap 1: Blauw

Sterkte-Zwakte analyse

Sterkte

- in één klap een groot wateroppervlak
- Het deel wat water wordt heeft het minst historische waarde van de hele binnenstad.

Zwakte

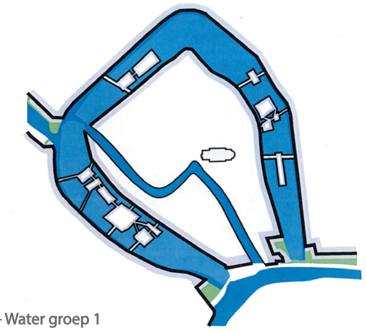
- aantasten historische binnenstad
- Houdt geen rekening met bestaande hoogteverschillen
- onderbouwing van de keuze van de afscheiding lijkt willekeurig

Kansen

- watersport
- recreatie & horeca
- Toerisme

Bedreigingen

- Maatschappelijke weerstand



Workshop 1 - Water groep 1

Naam	Functie
Participant Water-1	Bewoner
Participant Water-2	Bewoner/bedrijf
Participant Water-3	Bewoner
Participant Water-4	Bewoner

Sterkte
Intern, positief

Zwakte
Intern, negatief

Kansen
extern, positief

Bedreigingen
extern, negatief

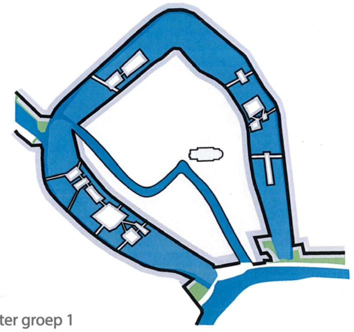
Stap 1: Bespreek het scenario en de consequenties hiervan voor Gouda, en vul aan de hand daarvan in wat de sterktes, zwaktes, kansen en bedreidingen van dit scenario kunnen zijn.

Stap 2: Bekijk de bouwstenen die bij het scenario horen, en organiseer deze bouwstenen van beste naar slechtste aan de hand van welke het beste zullen werken en het beste bij Gouda passen. Vul in waarom dit zo is (en geef ook de negatieve kanten aan als deze er zijn). Als geen van de bouwstenen passen of er een betere mogelijkheid is, teken deze of beschrijf het.

Stap 3: Bekijk de voorbeeldensembles die opgebouwd zijn met de bouwstenen, en geef de positieve en negatieve kanten hiervan aan. Als u een betere optie weet, of een idee heeft over een andere combinatie van bouwstenen, teken deze of beschrijf het.

Stap 2: Blauw

Bouwstenen



Workshop 1 - Water groep 1

Gebouw

1 1a Goten + want lijkt ons het makkelijkst realiseerbaar
- geeft het genoeg ruimte om al het water weg te krijgen

2 1c Groene greppels + groen, leefbaar, mooi, warmte, CO_2
- minder verkeers- & parkeersruimte

3 2b ← 1b
+ veel vrijheid

4 2c

5 2a - Estetisch?

6

Straat

1 2 verhoogde wegen ① leukste inrichting

2 (misschien omdat we die andere 2 opties niet helemaal begrijpen)

3

Water

1 2 Gracht leuk, historisch gezien

2 1 straathoogte modernere oplossing

Stap 2: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.

Stap 2: Blauw

Bouwstenen typologie

(woonboten & paalwoningen)

Water

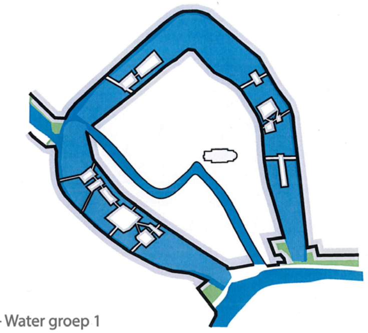
- Leuk - maar gemengde type woningen

1 zijstraten - Maar met behoud van een bevaarbare singelstructuur aan de buitenkant.

2 ↳ met mix van woonboten - huis op palen.

3

4



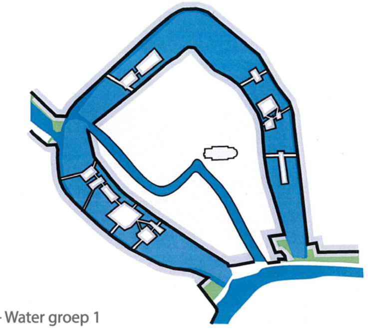
Workshop 1 - Water groep 1

Stap 2: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.

Een van de bouwstenen is als voorbeeld in de locatie getekend bij de scenario-kaarten van water.

Stap 3: Blauw

Ensembles Nonnenwater



Workshop 1 - Water groep 1

Ensembles

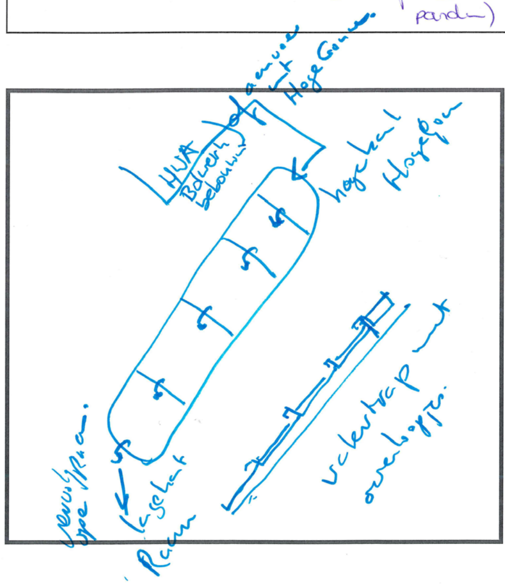
1 ° Nonnenwater geheel gracht ✓ zoals vroeger.

° waterberging – watertrap – zie ontwerp – ©

2 – G1 – S1 Wa 1

G2 S2 Wa2 – Te veel gracht – Te futuristisch ontwerp voor het nonnenwater (historisch pand)

Stap 3: Bekijk de voorbeeldensembles die opgebouwd zijn met de bouwstenen, en geef de positieve en negatieve kanten hiervan aan, van problemen met de vormgeving tot problemen met de waterhuishouding (denk ook aan infrastructuur, aanpasbaarheid, openbare ruimte). Geef hier ook aan wat voor u echt belangrijk is om te behouden bij het nonnenwater, en mogelijk andere gebieden van Gouda. Als u een betere optie weet, of een idee heeft over een andere combinatie van bouwstenen, teken deze of beschrijf het in de onderstaande kaders.



Stap 1: Blauw

Sterkte-Zwakte analyse

Sterkte

Meer waterberging.
Aantrekkelijker voor jongemensen
minder wateroverlast /klimaatoverlast
Probleemgebied verkleind.

Zwakte

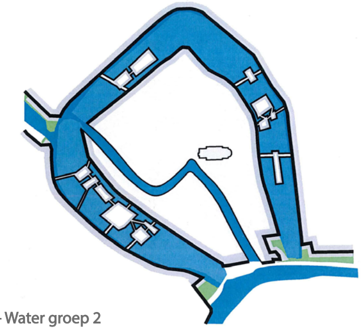
Verlies woonoppervlakte.
Verlies historisch karakter.
Meer golfslag / waterstuwing / kadeafkalving.

Kansen

Meer waterrecreatie
autoluw
vogelrijk / verhoogde biodiversiteit
Alternatieve parkeeroplossingen.
Aantrekkelijkheid vergroten : waterstad

Bedreidingen

Verlies monumenten
Zakkende bodem overgebleven binnenstad
Aantrekkelijkheid verkleind : verlies historische waarde.



Workshop 1 - Water groep 2

Naam	Functie
Participant Water-5	Bewoner Nonnenwater
Participant Water-6	Bewoner Nonnenwater
Participant Water-7	Senior Planner (afd POR Gouda)
Participant Water-8	Watergilde

Sterkte
Intern, positief

Zwakte
Intern, negatief

Kansen
extern, positief

Bedreigingen
extern, negatief

Stap 1: Bespreek het scenario en de consequenties hiervan voor Gouda, en vul aan de hand daarvan in wat de sterktes, zwaktes, kansen en bedreidingen van dit scenario kunnen zijn.

Stap 2: Bekijk de bouwstenen die bij het scenario horen, en organiseer deze bouwstenen van beste naar slechtste aan de hand van welke het beste zullen werken en het beste bij Gouda passen. Vul in waarom dit zo is (en geef ook de negatieve kanten aan als deze er zijn). Als geen van de bouwstenen passen of er een betere mogelijkheid is, teken deze of beschrijf het.

Stap 3: Bekijk de voorbeeldensembles die opgebouwd zijn met de bouwstenen, en geef de positieve en negatieve kanten hiervan aan. Als u een betere optie weet, of een idee heeft over een andere combinatie van bouwstenen, teken deze of beschrijf het.

Stap 2: Blauw

Bouwstenen

Gebouw

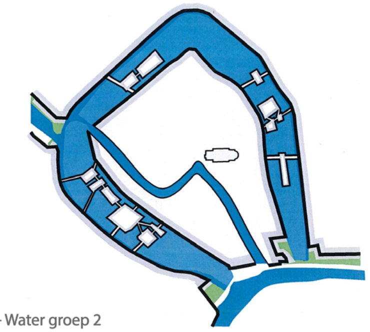
1 Verhoogde huizen (2a): Behoud historisch aangezicht.
Stabilisatie historische panden.
2 Groene Greppels (1c): Voegt waarde toe. ~~Wat~~ Natuurlijke
waterhuishouding, vergroening, leefbaarder.
3 Drijvende huizen (2b): Flexibel, biedt mogelijkheden (meedraaien zon,
mee met waterstijging/-daling), portable, makkelijk onderhoud (huis en omgeving)
4 Amfibie (2c): complex, duur, gaat mee met de waterspiegel,
kan uit 'oevers' treden, behoud historisch straatbeeld.
5 Goten (1a.) goedkoop, gelijk aangezicht, voegt weinig
visueels toe, veiligheid issue
6 Blokkade (1b) : goedkoop, lelijk, doet af aan het
straatbeeld.

Straat

1 (2) klimaatbestendig, speels, autoluw (hulp-
diensten?), veel waterberging.
2 (1a) groen, monotoon/eenzijdig, infiltratie, auto is er nog
3 Waterkratten (1b) saai, gelijk versteend straatbeeld.
goede waterbuffer, goedkoop.

Water

1 (tijdelijk) 1 : goede overgang naar nr.1 (Gracht) geeft
tijd stabilisatie panden, goede waterberging.
~~2~~ 1 Gracht (2) : " ", historische
waarde verhogend, toerisme.



Workshop 1 - Water groep 2

Stap 2: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.

Stap 2: Blauw

Bouwstenen typologie

Water

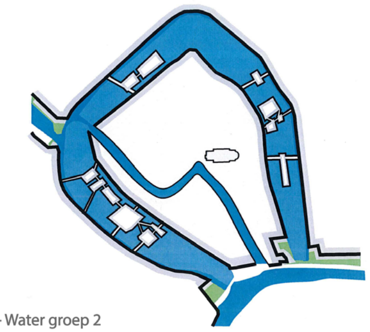
1 Zystraten: Intiem, behoud karakter stad, steegjescultuur tussen hoofdgrachten, stabiel (onderheid), kleinschalig.

2 Singelstructuur: combi groot vs. klein, historisch stabiel, nieuw verstoord ond niet.

3 Gracht: doorvaart blijft behouden.

4 Woonboten: te monotoom /groots/veel water, niet hun karakter wat bij Gouda hoort

aandachtspunt algemeen: hulpdiensten



Workshop 1 - Water groep 2

Stap 2: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.

Een van de bouwstenen is als voorbeeld in de locatie getekend bij de scenario-kaarten van water.

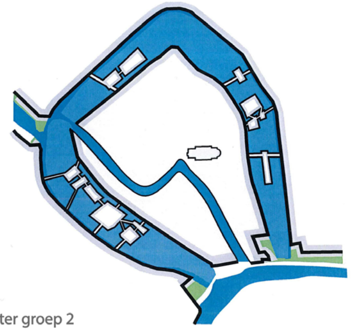
Stap 3: Blauw

Ensembles Nonnenwater

Ensembles

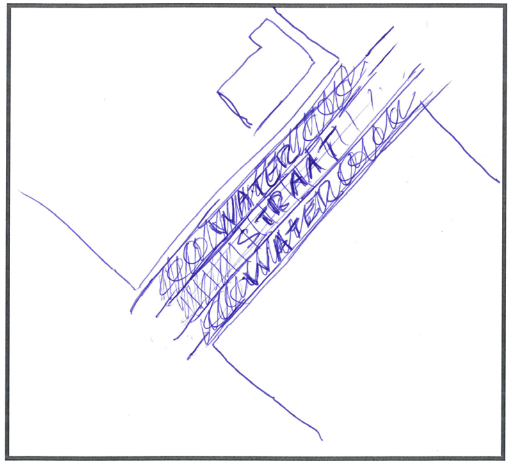
1 niet doorvaarbaar (-) eentonig
realistisch, past in het nu, snel realiseerbaar
groener, mag meer.
~~weinig~~ minder weerstand.

2 Doorvaarbaar (+) speels
veel weerstand.
toekomstbestendig
te hoge verhoging (gezellig in de woonkamer)



Workshop 1 - Water groep 2

Stap 3: Bekijk de voorbeeldensembles die opgebouwd zijn met de bouwstenen, en geef de positieve en negatieve kanten hiervan aan, van problemen met de vormgeving tot problemen met de waterhuishouding (denk ook aan infrastructuur, aanpasbaarheid, openbare ruimte). Geef hier ook aan wat voor u echt belangrijk is om te behouden bij het nonnenwater, en mogelijk andere gebieden van Gouda. Als u een betere optie weet, of een idee heeft over een andere combinatie van bouwstenen, teken deze of beschrijf het in de onderstaande kaders.



Stap 1: Groen
Sterkte-Zwakte analyse

Sterkte	Zwakte
Zuurstof	Parkeerprobleem
leefbaarheid	Slechte waterafvoer
rust ervaring	Onderhoud
gezonde leefomgeving	Verkeers probleem
temperatuur neemt af.	
vergrote capaciteit voor water vast te houden	
Flora en Fauna	

Kansen	Bedreidingen
Samenhang	
buitenverblijf	
Toerisme	

Workshop 1 - Groen groep 1

Naam	Functie
Participant Groen-1	Bewoner
Participant Groen-2	Bewoner
Participant Groen-3	Watergilde
Participant Groen-4	Watergilde
Participant Groen-5	Bewoner/Initiatiefgroep Raambuurt
Participant Groen-6	Bewoner

Sterkte *Intern, positief*

Zwakte *Intern, negatief*

Kansen *extern, positief*

Bedreigingen *extern, negatief*

Stap 1: Bespreek het scenario en de consequenties hiervan voor Gouda, en vul aan de hand daarvan in wat de sterktes, zwaktes, kansen en bedreidingen van dit scenario kunnen zijn.

Stap 2: Bekijk de bouwstenen die bij het scenario horen, en organiseer deze bouwstenen van beste naar slechtste aan de hand van welke het beste zullen werken en het beste bij Gouda passen. Vul in waarom dit zo is (en geef ook de negatieve kanten aan als deze er zijn). Als geen van de bouwstenen passen of er een betere mogelijkheid is, teken deze of beschrijf het.

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Stap 2: Groen

Bouwstenen

- Graag een meer natuurlijkere uitstraling ~~creëeren~~ creëren

Workshop 1 - Groen groep 1

Stap 2: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.

Gebouw

1 1C - goede waterberging met groen voorziening

2 1a barrière - tijdelijke oplossing

3 1a goten - bijna nergens toepasbaar

4 2a - combineren met de verhoging van de huizen die al omhoog moeten

5 2b zie 2C

6 2C - destructief, kapitaal vernietiging, geen draagvlak.

Straat

1 - Wildernis - Nonnenwater, Koningshof, Verloren Kost en Pottersspoort.

2 - Bomenrij voor de doorgaande straten

3 - Verhoogde wegen - Aan de Turfmarkt Venetië laten ontstaan

Groen ~~Water~~

1 Doorlaatbare straten - Positief - Groener
Negatief - bij ~~het~~ clusterbuien slechte afvoer

2 Waterkrallen - positief - snelle wateropslag
- negatief - versteend.

Maatwerk voor binnenstad
niet alle straten hebben een waterprobleem.

braakliggend terrein zou 2b en 2C toegepast kunnen worden.

Stap 3: Groen

Ensembles Nonnenwater

Ensembles

1 extreem, omdat je daarin het meest kan experimenteren

2

Workshop 1 - Groen groep 1

Stap 3: Bekijk de voorbeeldensembles die opgebouwd zijn met de bouwstenen, en geef de positieve en negatieve kanten hiervan aan, van problemen met de vormgeving tot problemen met de waterhuishouding (denk ook aan infrastructuur, aanpasbaarheid, openbare ruimte). Geef hier ook aan wat voor u echt belangrijk is om te behouden bij het nonnenwater, en mogelijk andere gebieden van Gouda. Als u een betere optie weet, of een idee heeft over een andere combinatie van bouwstenen, teken deze of beschrijf het in de onderstaande kaders.

Stap 2: Groen

Bouwstenen straatbeeld

Groen

1 In het algemeen moet Gouda groener en de situatie per plek aanpassen. ~~Zet~~

2 Zie stap 2 - straat

3

4

5

Workshop 1 - Groen groep 1

Stap 2: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.

E.5.4. Workshop 1, groen groep 2

Stap 1: Groen

Sterkte-Zwakte analyse

Sterkte

- Alles kan blijven staan
- Behoud van historie, cultuur, karakter
- Stijging van waarde/attractiviteit
- Tegen hitte
- Schonere lucht, enz./gezondheid
- Ruimte om te leven

Zwakte

- Bomen veroorzaken funderingsschade
- Enorm veel onderhoud aan groen
- Niet meer hoeveelheid water als andere
- Muggen

Kansen

- Unieke selling point
  - voorbeeld
  - toerisme, horeca
  - wonen
  - internationaal
- Biodiversiteit ~~biod~~
- Groen kan hoeveelheid water worden

Bedreidingen

- Politieke haalbaarheid.
- Identiteit verschuift van water naar groen.

Workshop 1 - Groen groep 2

Naam	Functie
Participant Groen-7	Bewoner/Bestuur Stichting Gouda Sterk aan de IJssel
Participant Groen-8	Watergilde
Participant Groen-9	Gemeente Gouda
Participant Groen-10	WB de Ruimte
Participant Groen-11	Nonnenwater

Sterkte *Intern, positief*

Zwakte *Intern, negatief*

Kansen *extern, positief*

Bedreigingen *extern, negatief*

Stap 1: Bespreek het scenario en de consequenties hiervan voor Gouda, en vul aan de hand daarvan in wat de sterktes, zwaktes, kansen en bedreidingen van dit scenario kunnen zijn.

Stap 2: Bekijk de bouwstenen die bij het scenario horen, en organiseer deze bouwstenen van beste naar slechtste aan de hand van welke het beste zullen werken en het beste bij Gouda passen. Vul in waarom dit zo is (en geef ook de negatieve kanten aan als deze er zijn). Als geen van de bouwstenen passen of er een betere mogelijkheid is, teken deze of beschrijf het.

Stap 3: Bekijk de voorbeeldensembles die opgebouwd zijn met de bouwstenen, en geef de positieve en negatieve kanten hiervan aan. Als u een betere optie weet, of een idee heeft over een andere combinatie van bouwstenen, teken deze of beschrijf het.

Stap 2: Groen

Bouwstenen

Gebouw

1 a (bak) slechts tijdelijke oplossing; duur; eenzijdig
b – just beter
2 c mogen beginne / prettig verblijfsgebied (Winter, bodem verzadigd, geen vochtopname)
3
2a slecht leefbaar; lelijk; hele stadsbeeld verdwijnt
4
2b + 2c niet realistisch
5

6

Straat

1 a rommelig als alleen halfverharde straten/groen.
b er kan geen groen op harde groeien
2 c niet de duur

3

~~Water~~ Groen

2 ~~1~~ afhankelijk v/d plaats (plein of straat).
~~b~~ ~~realistisch~~
1 ~~2~~ realistisch.

Workshop 1 - Groen groep 2

Stap 2: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.

Stap 2: Groen

Bouwstenen straatbeeld

Groen

1 Voortuin worden ~~[illegible]~~ weer bestraat.

2

3

4

5

Workshop 1 - Groen groep 2

Stap 2: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.

Stap 3: Groen

Ensembles Nonnen~~water~~tuin

Ensembles

1 Niet fraai, hinken op twee gedachte, (niet meer dan plaatselijke oplossing voor bijv. parkeren binnen 2).

2 Visionair, de gehele oplossing (zie sterktes + kansen)

Workshop 1 - Groen groep 2

Stap 3: Bekijk de voorbeeldensembles die opgebouwd zijn met de bouwstenen, en geef de positieve en negatieve kanten hiervan aan, van problemen met de vormgeving tot problemen met de waterhuishouding (denk ook aan infrastructuur, aanpasbaarheid, openbare ruimte). Geef hier ook aan wat voor u echt belangrijk is om te behouden bij het nonnenwater, en mogelijk andere gebieden van Gouda. Als u een betere optie weet, of een idee heeft over een andere combinatie van bouwstenen, teken deze of beschrijf het in de onderstaande kaders.

E.6. Resultaat workshop 2

E.6.1. Workshop 2, water groep

150 m³/m. → mm/a

Stap 1: Blauw

Sterkte-Zwakte analyse

Sterkte

- kans hoogwaardige nieuwe bebouwing (tijdelijke sterkte?)
- kans wordt beter geutiliseerd door buitenring onder water te zetten met de binnenstad
- waterrecreatie krijgt ruimte

Zwakte

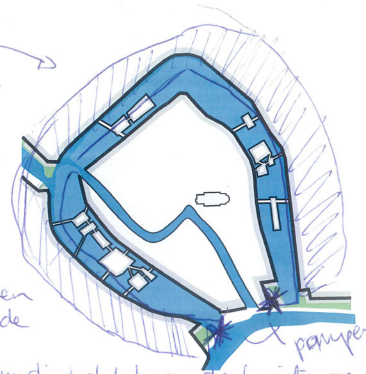
- verlies van bebouwing (monumentaal)
- het blijft een beperkte berging omdat het een kleine droogleggin heeft (maar 5 cm opleggin)
- je zet mes in levend systeem dus dat maakt kapot.

Kansen

- voortbouwen op de traditie van water kan innovatie veroorzaken waarmee gouda zich kan profileren
- meer toerisme
- auto eruit

Bedreidingen

- deel van bevolking niet terug komt
- binnenstad onbewoonbaar door te veel toerisme
- auto eruit



Workshop 2 - Water groep 1

Naam	Functie
Participant Water-9	Universitair docent TU Delft
Participant Water-10	Gemeente Gouda
Participant Water-11	Hoogheemraadschap Rijnland

Sterkte *Intern, positief*	Zwakte *Intern, negatief*
Kansen *extern, positief*	**Bedreigingen** *extern, negatief*

Stap 1: Bespreek het scenario en de consequenties hiervan voor Gouda, en vul aan de hand daarvan in wat de sterktes, zwaktes, kansen en bedreidingen van dit scenario kunnen zijn.

Stap 2: Bekijk de bouwstenen die bij het scenario horen, en organiseer deze bouwstenen van beste naar slechtste aan de hand van welke het beste zullen werken en het beste bij Gouda passen. Vul in waarom dit zo is (en geef ook de negatieve kanten aan als deze er zijn). Als geen van de bouwstenen passen of er een betere mogelijkheid is, teken deze of beschrijf het.

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Stap 2: Blauw

Bouwstenen

Gebouw

1 waterschap: 1C dan 1B dan 1A
monumenten: 1A, en anders 1A + eerst 1B dan 1C
2 om de structuur van de stad te behouden
pleh geven oude structuur > auto's eruit
3 beleving over water.
waterschap: 1C is ook belangrijk voor temperatuur
4 reductie + vergroten bio diversiteit
2C levert minder waterberging op
5 2a kansen voor meervoudig ruimte gebruik +
licht en lucht in het water.
6

Straat

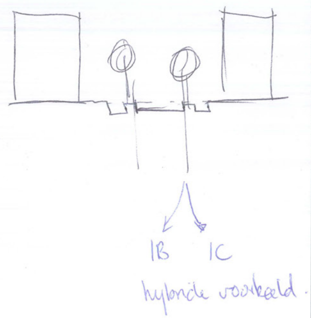
1 2) maakt echt weinig verschil in aansluiting op de
grote ingreep
2 dan 1a en dan 1b.
3

Water

1 1) is beter omdat omdat het effect heeft op waterberging
2) is toch weer heel weinig rendement.
2 1) beter omdat er al veel water is en dit
multifunctioneel grondgebruik stimuleert.

Workshop 2 - Water groep 1

Stap 2: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.



Stap 3: Blauw

Typologie

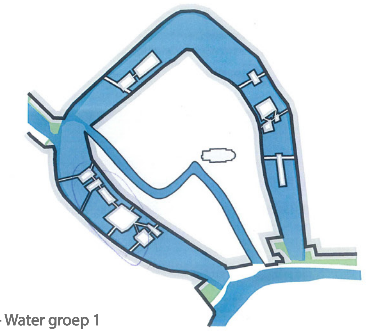
Water

1 woonboten niet want te lage bebouwsdichtheid

2

3 past het beste bij water naar buiten aanleggen en oude rijweg als primaire ontsluiting => down sized

4

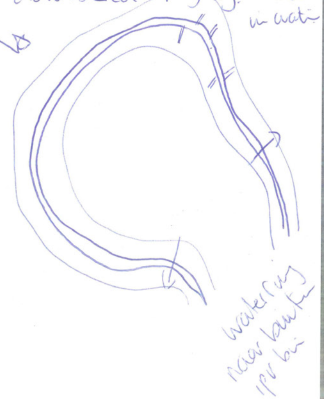


Workshop 2 - Water groep 1

Stap 3: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.

Een van de bouwstenen is als voorbeeld in de locatie getekend bij de scenario-kaarten van water.

Zijstraten liever aan downsized rijweg. midden in water



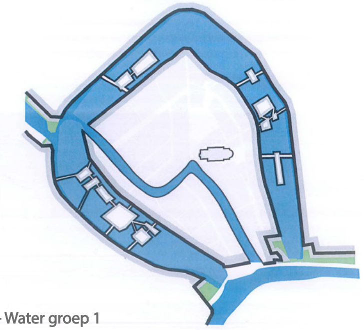
Stap 4: Blauw

Ensembles Nonnenwater

Ensembles

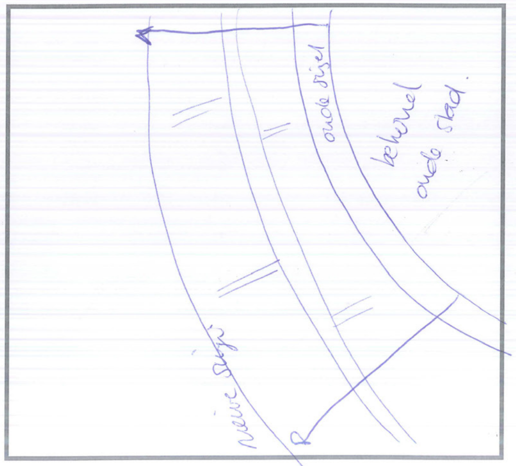
1 nonnenwater extream.

2



Workshop 2 - Water groep 1

Stap 4: Bekijk de voorbeeldensembles die opgebouwd zijn met de bouwstenen, en geef de positieve en negatieve kanten hiervan aan, van problemen met de vormgeving tot problemen met de waterhuishouding (denk ook aan infrastructuur, aanpasbaarheid, openbare ruimte). Geef hier ook aan wat voor u echt belangrijk is om te behouden en bij het nonnenwater, en mogelijk andere gebieden van Gouda. Als u een betere optie weet, of een idee heeft over een andere combinatie van bouwstenen, teken deze of beschrijf het in de onderstaande kaders.



* wat je ook maakt het draagt bepaalt bij aan je klimaat doelstelling
* groen werkt indrukwekkend goed.
* nadeel waterconcept is dus dat er vanzelfsprekend groen mee komt.

nu keuze maken voor de komende decennia > een strategie ontwikkelen die relatie tussen publiek en privaat in beeld brengt. bv opkopen van huizen die niet te beschermen zijn of het investeren in monumentale panden al nu.

E.6.2. Workshop 2, groen groep

Stap 1: Groen

Sterkte-Zwakte analyse

Sterkte

- autoluwe binnenstad, voor toerisme aantrekkelijk
- verkoeling hete zomer
- toename diversiteit
- creëert uniciteit

Zwakte

- autoluwe binnenstad, voor misschien parkeerprobleem en bereikbaarheid woning.
- bereikbaarheid hulpdiensten
- cultuurhistorische identiteit neemt misschien af.

Kansen

- buurtmoestuinen
- te koppelen met energietransitie?

Bedreigingen

- vormt waterbehoefte van bomen in zomer bedreiging voor grondwaterstand?
- idem wortelgroei en K+L of funderingen

Workshop 2 - Groen groep 1

Naam	Functie
Participant Groen-12	Gemeente Gouda
Participant Groen-13	Deltares
Participant Groen-14	Hoogheemraadschap Rijnland
Participant Groen-15	Hoogheemraadschap Rijnland

Sterkte *Intern, positief*	Zwakte *Intern, negatief*
Kansen *extern, positief*	Bedreigingen *extern, negatief*

Stap 1: Bespreek het scenario en de consequenties hiervan voor Gouda, en vul aan de hand daarvan in wat de sterktes, zwaktes, kansen en bedreidingen van dit scenario kunnen zijn.

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Stap 2: Groen

Bouwstenen

Gebouw

1 a voorkeur 3

1 b wegen in Gouda vaak te smal voor dit profiel.
voorkeur 2

1 c voorkeur 1

2 a
2 b ruimtelijke inpassing moeilijk binnen oude stad met monumenten.
2 c

extreem, moeilijk per woning toe te passen

Straat

1 a. standaard kiezen voor waterpasserende bestrating: no regret maatregel

1 b. levert meer winst, maar kratten aan huizenzijde en overstroomde zone in midden.

2 doet afbreuk aan historisch beeld, slecht te beheren, vervuiling bij droogstand.

Groen

1 voor doorgaande routes te gebruiken

2 voor situaties waar auto's te gast kunnen zijn of doodlopende of vergelijkbare straten

Workshop 2 - Groen groep 1

Stap 2: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.

Stap 3: Groen

Straatbeeld

Groen

1 groen centrum } 1ste voorkeur; zelfde principe, andere uitwerking
2 groen bomenrij }
3 dubbele bomenrij: eigen aan binnenstad in breder profiel
4 wildernis: bijzondere locaties
5 voortuinen: past niet in binnenstad

Workshop 2 - Groen groep 1

Stap 3: Bekijk de bouwstenen voor het scenario, en sorteer ze per onderdeel van beste naar slechtste. Geef aan waarom ze goed (ze passen goed in het scenario, ze zorgen voor veel water opslag, ze passen goed binnen de essentie van Gouda), of slecht zijn. Als een bouwsteen zowel positieve als negatieve aspecten heeft, schrijf dit alstublieft op. Als er een belangrijke bouwsteen of ander element ontbreekt, beschrijf deze of teken hem in de onderstaande kaders.

Stap 4: Groen

Ensembles Nonnenwater

Ensembles

basis : variant normaal, combinatie met groen uit extreem zonder verhoogde loop - en fietsroutes.
aanpassing naar 1 rijbaan met mogelijk 1- richting verkeer.
in het groen verlaagde delen voor extreme water opvang.

Workshop 2 - Groen groep 1

Stap 4: Bekijk de voorbeeldensembles die opgebouwd zijn met de bouwstenen, en geef de positieve en negatieve kanten hiervan aan, van problemen met de vormgeving tot problemen met de waterhuishouding (denk ook aan infrastructuur, aanpasbaarheid, openbare ruimte). Geef hier ook aan wat voor u echt belangrijk is om te behouden bij het nonnenwater, en mogelijk andere gebieden van Gouda. Als u een betere optie weet, of een idee heeft over een andere combinatie van bouwstenen, teken deze of beschrijf het in de onderstaande kaders.