

# KEEP YOUR HAGUE COOL

Mitigating heat stress and the urban heat island effect through urban design

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TU Delft



Den Haag

Source: (ANP, 2019)

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The problem



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Design



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# HEAT STRESS PROBLEM

## **The Guardian**

**Extreme temperatures kill 5 million people a year with heat-related deaths rising, study finds**

## **stadszaken**

Nadelige effecten hittestress veelal niet direct zichtbaar

**Hittestress is een sluipmoordenaar**

## **Forbes**

**1 Billion People At Risk From Potentially Lethal Heat If Global Warming Passes 2C, Scientists Warn**

## **SCIENTIFIC AMERICAN®**

**Risk of Dangerous Heat Exposure Is Growing Quickly in Cities**

Population growth, climate change and the urban heat island effect are combining to put more people at risk



# HOUSING PROBLEM



**Antoinette (19) is de wanhoop nabij: ze kan geen eigen woonruimte vinden in Eindhoven, en is niet de enige**



## **de Volkskrant**

**Huurprijzen in vrije sector  
verder gestegen, minder  
mensen slagen erin een  
huurhuis te vinden**



## **RTLnieuws**

**VEH: 'Betaalbare woningen' voor veel  
mensen niet betaalbaar**

## **De Telegraaf**

**'Woningmarkt gaat nu écht verkeerde kant op'**



**How to densify in The Hague in order to mitigate and prevent heat stress and the urban heat island effect to improve the livability of the city and the health of its inhabitants?**

# ANALYSIS



1. Densification locations.



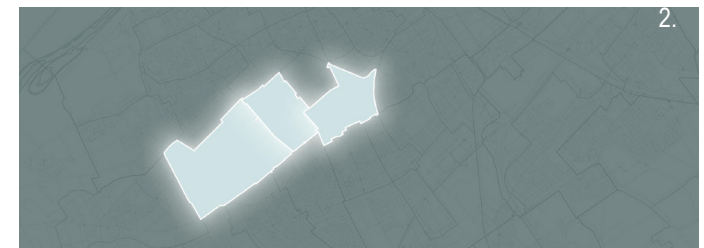
2. Locations with a high density of elderly people.



3. Locations with an insufficient liveability index.



4. Locations with the least green spaces.

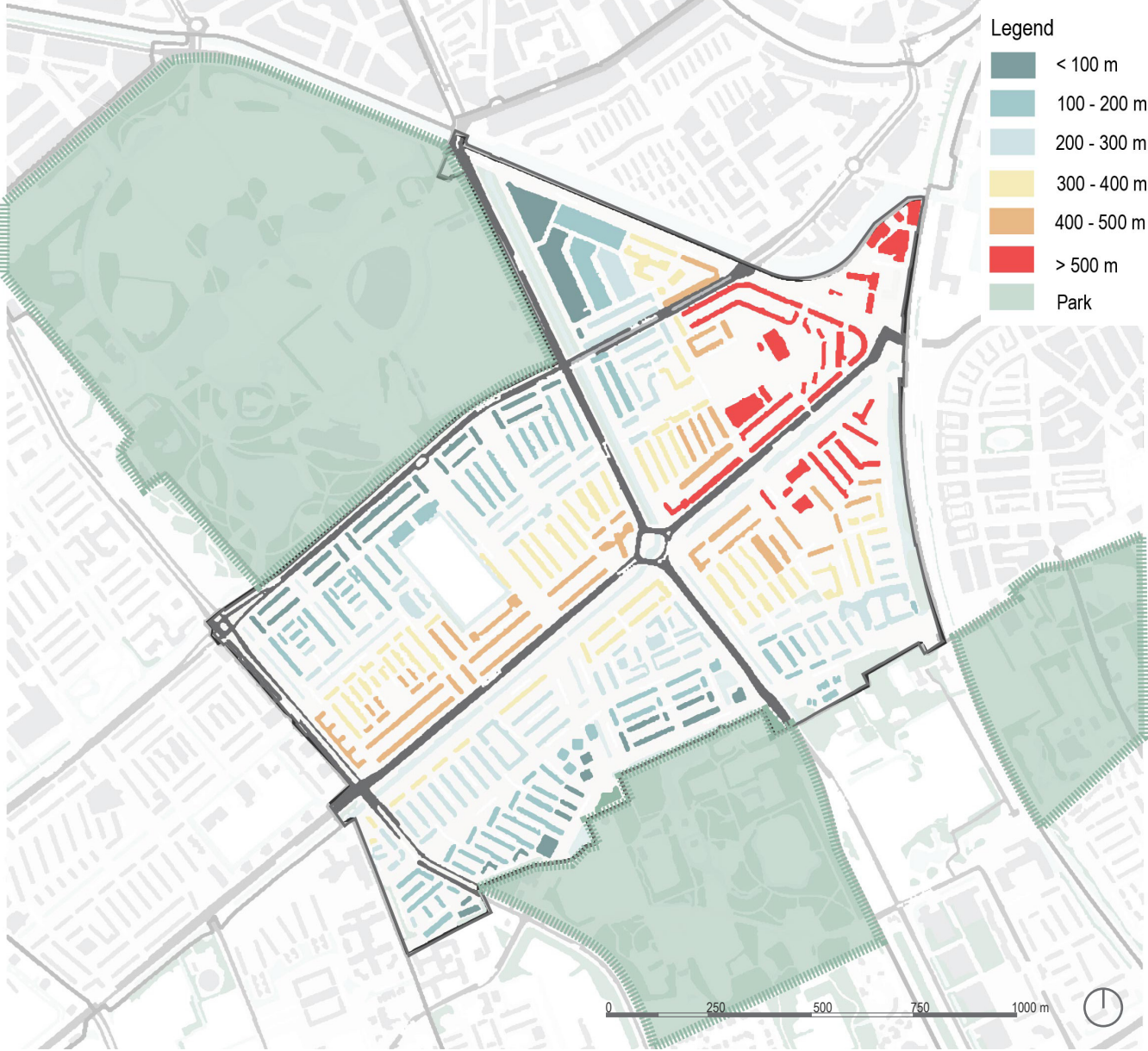


# ANALYSIS



Source: Generated by author using GIS software, based on buildings, streets, water and green, and edited by author (Google, 2021)

# POSITIVE ASPECTS

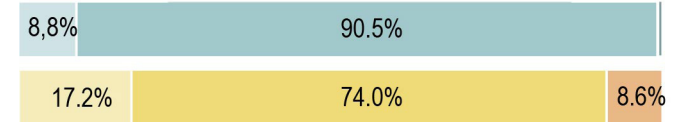




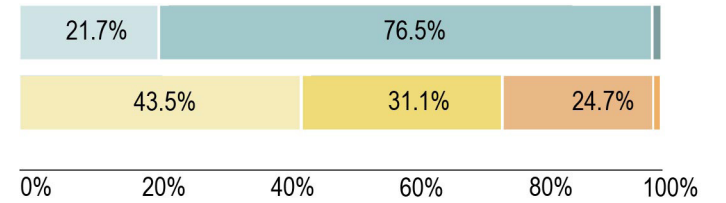
# NEGATIVE ASPECTS



MOERWIJK



THE HAGUE



Legend

- Privately owned
- Social rent
- Private rent
- Ownership not yet determined

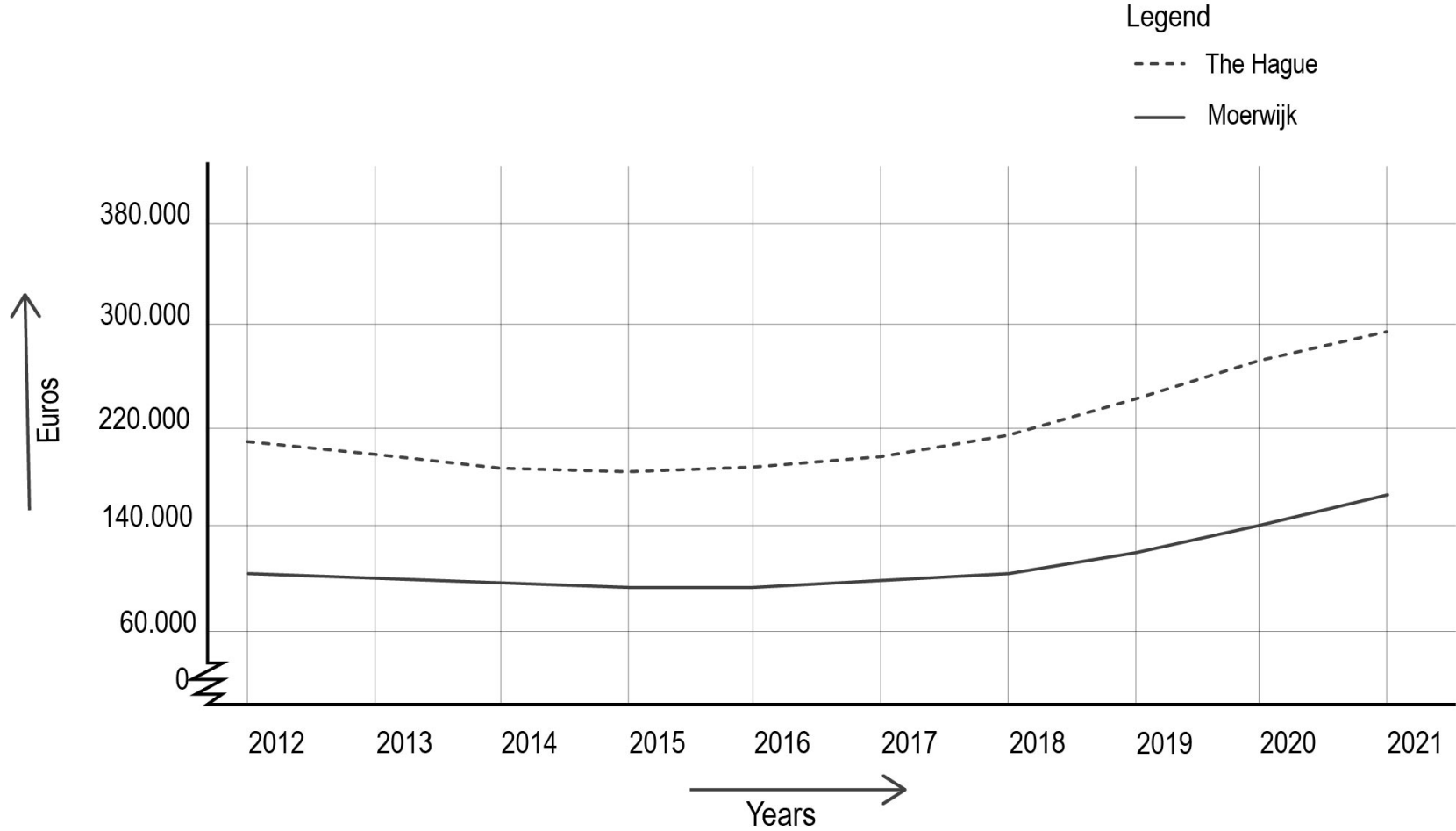
Legend

- Single-family house
- Apartment
- Other house

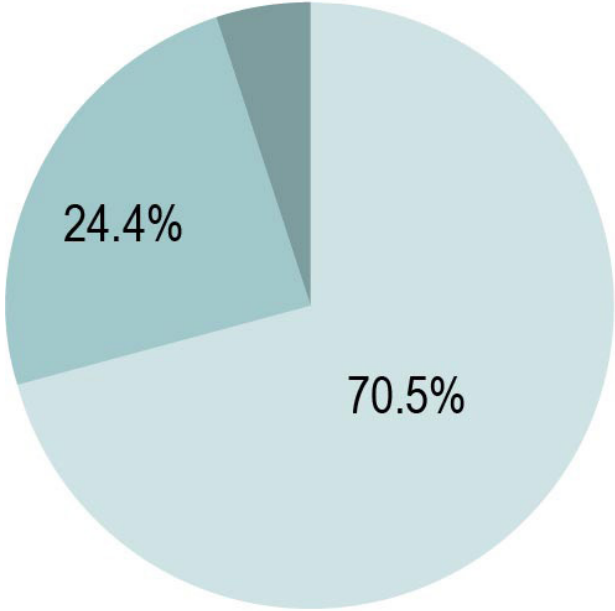
# NEGATIVE ASPECTS



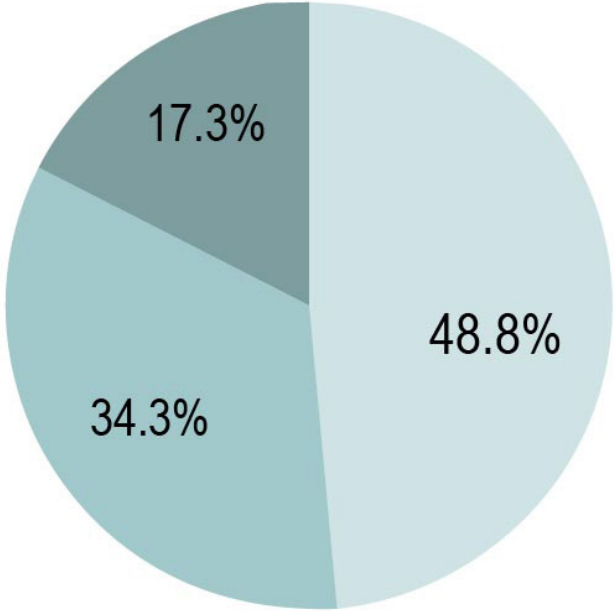
# NEGATIVE ASPECTS



# NEGATIVE ASPECTS

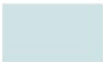


MOERWIJK



THE HAGUE

### Legend



Low income



Medium income

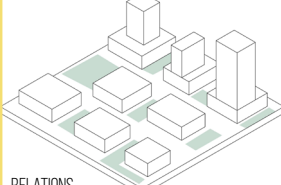


High income

# PATTERN LANGUAGES

**H. 1 CREATING GREEN AREAS**

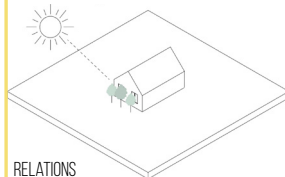
**HYPOTHESIS**  
Increasing the percentage green spaces in the city by creating and improving small green areas in locations where there is currently unnecessary paving.



**RELATIONS**  
H.6, H.7, H.8, H.9, H.16

**H. 2 SUN PROTECTION THROUGH GREENERY**

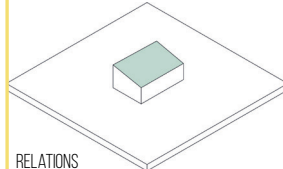
**HYPOTHESIS**  
Strategically placed vegetation that functions as sun protection.



**RELATIONS**  
H.3, H.4

**H. 3 HEAT REDUCING ROOFS**

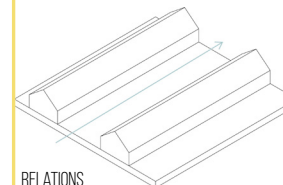
**HYPOTHESIS**  
Intensive use of roofs to cool the indoor and outdoor climate.



**RELATIONS**  
H.2, H.4, H.5

**H. 10 VENTILATION CORRIDOR**

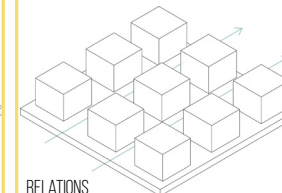
**HYPOTHESIS**  
Large open spaces in the city can be cooled by the air flows of the wind.



**RELATIONS**  
H.11, H.15

**H. 11 AIRFLOW CIRCULATION**

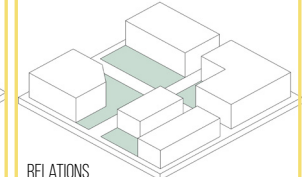
**HYPOTHESIS**  
Small blocks provide a circulation path for wind to pass through for ventilation on a pedestrian level.



**RELATIONS**  
H.10, H.12, H.15, H.16

**H. 12 OPEN SPACES**

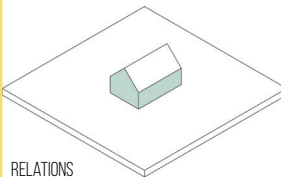
**HYPOTHESIS**  
A maximum of 65% of the block can be built on, leaving open spaces. These open spaces must be placed so that airflow between the buildings is possible.



**RELATIONS**  
H.11, H.15, H.16

**H. 4 GREEN FACADES**

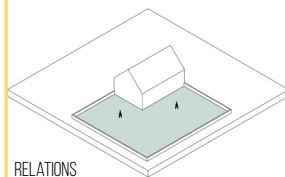
**HYPOTHESIS**  
Intensive use of facades to cool the indoor and outdoor climate.



**RELATIONS**  
H.2, H.3, H.5

**H. 5 PRIVATE GREEN GARDENS**

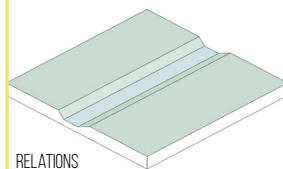
**HYPOTHESIS**  
Private gardens with no more than 20% paving for a cool outdoor environment.



**RELATIONS**  
H.3, H.4, H.8

**H. 6 GREEN BANKS**

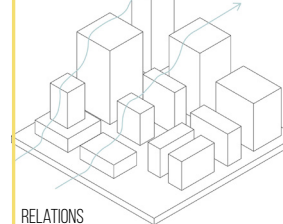
**HYPOTHESIS**  
Nature-friendly banks that form a gradual transition from land to water and have a cooling effect on the surroundings.



**RELATIONS**  
H.1

**H. 13 LADDER TYPE BUILDINGS**

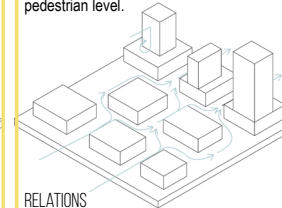
**HYPOTHESIS**  
Raising the buildings step by step with the direction of the summer wind.



**RELATIONS**  
H.14, H.17, D.1

**H. 14 STAGGERED ARRANGEMENT OF BUILDINGS**

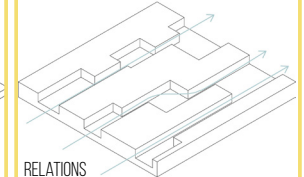
**HYPOTHESIS**  
With staggered arrangement of buildings and podiums, air flow can ventilate and provide a comfortable environment at pedestrian level.



**RELATIONS**  
H.13

**H. 15 VENTILATION GRID**

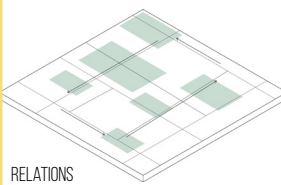
**HYPOTHESIS**  
The orientation of buildings and open spaces allows the wind to ventilate at pedestrian level.



**RELATIONS**  
H.7, H.10, H.11, H.12

**H. 7 GREEN GRID**

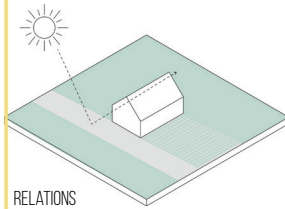
**HYPOTHESIS**  
A grid of parks and small green areas that form pleasant cooling zones for surrounding residents.



**RELATIONS**  
H.1, H.16

**H. 8 COOL PAVING MATERIALS**

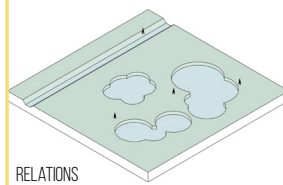
**HYPOTHESIS**  
Use of cooling hardening materials to reduce the ambient temperature.



**RELATIONS**  
H.1, H.5

**H. 9 COOLING WITH WATER**

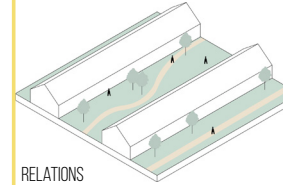
**HYPOTHESIS**  
Evaporation of water that has a cooling effect on the immediate surroundings.



**RELATIONS**  
H.1

**H. 16 CAR FREE ZONES**

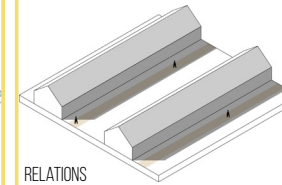
**HYPOTHESIS**  
Use superblocks by increasing the size of the block to make streets accessible only to slow traffic, and create possibilities to combine it with other patterns



**RELATIONS**  
H.1, H.11, H.12

**H. 17 SHADOW**

**HYPOTHESIS**  
Shade to reduce surface area and wind chill during hot periods.



**RELATIONS**  
H.2, H.13, D.1

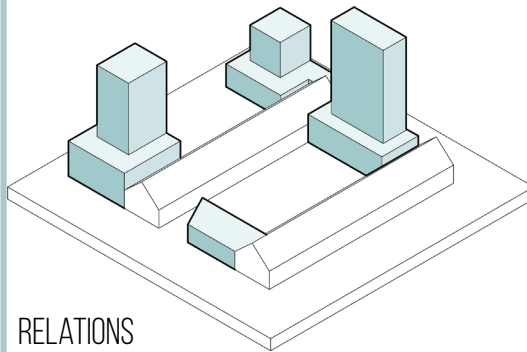


# PATTERN LANGUAGES



## D. 1 CREATING MORE HOUSES

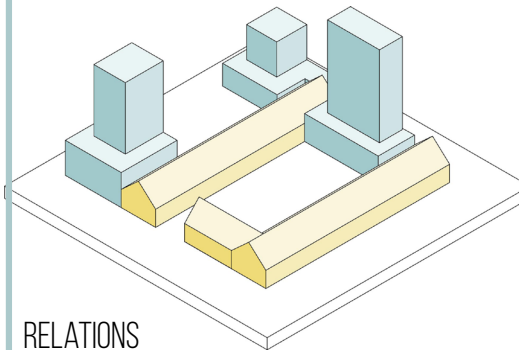
**HYPOTHESIS**  
Realising more homes by densifying vertically on the same land area to increase the housingsupply.



**RELATIONS**  
H.13, H.17, D.2, D.3

## D. 2 VARIETY IN HOUSING SUPPLY

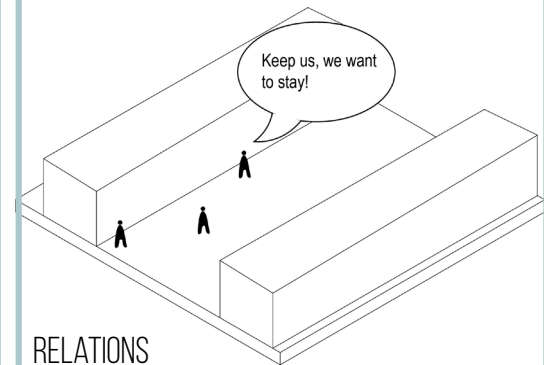
**HYPOTHESIS**  
Create different types of housing to attract different types of residents.



**RELATIONS**  
D.2, D.3

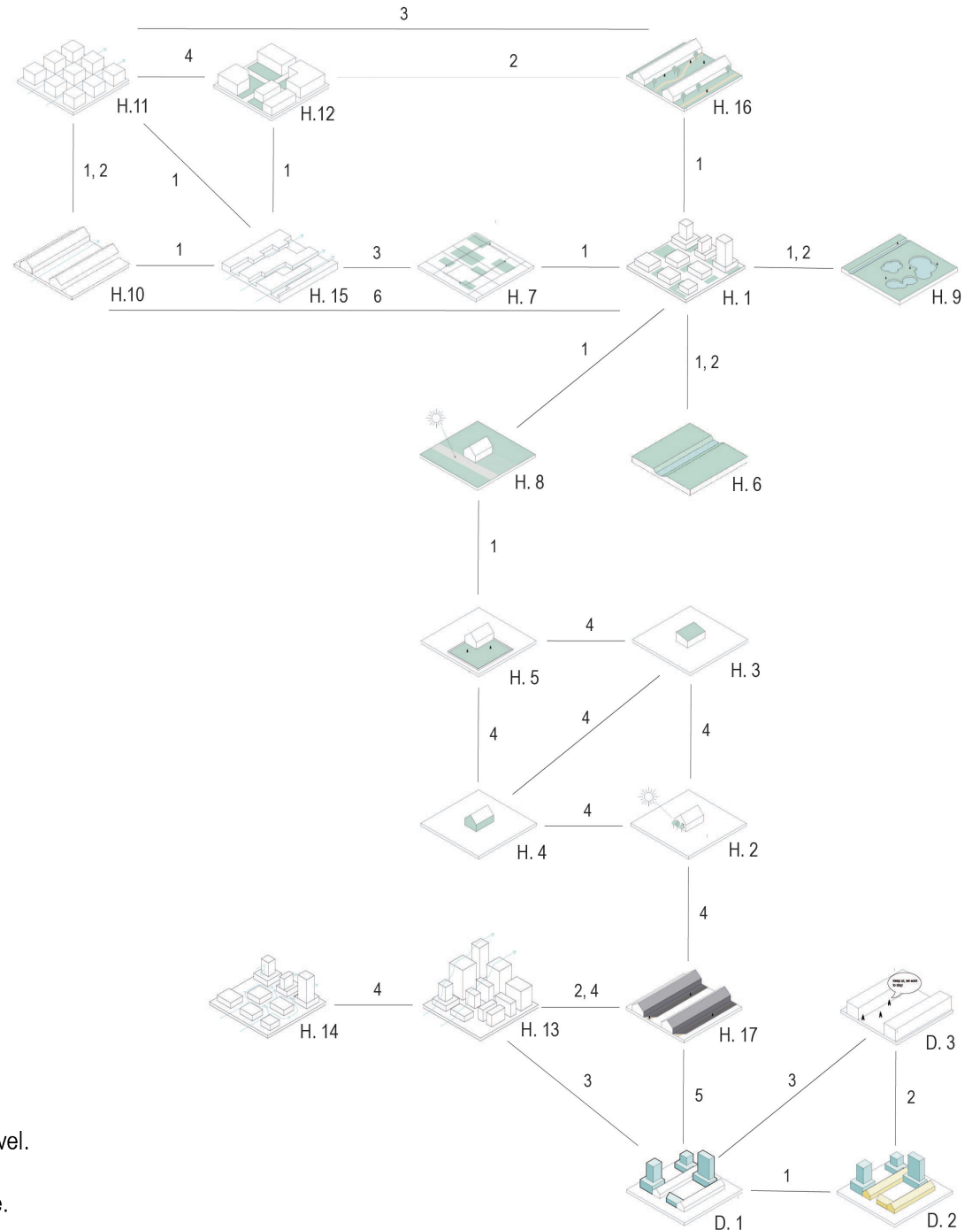
## D. 3 RETAINING CURRENT RESIDENTS

**HYPOTHESIS**  
The new interventions for densification and heat stress must not drive current residents away from the neighbourhood.



**RELATIONS**  
D.1, D.2

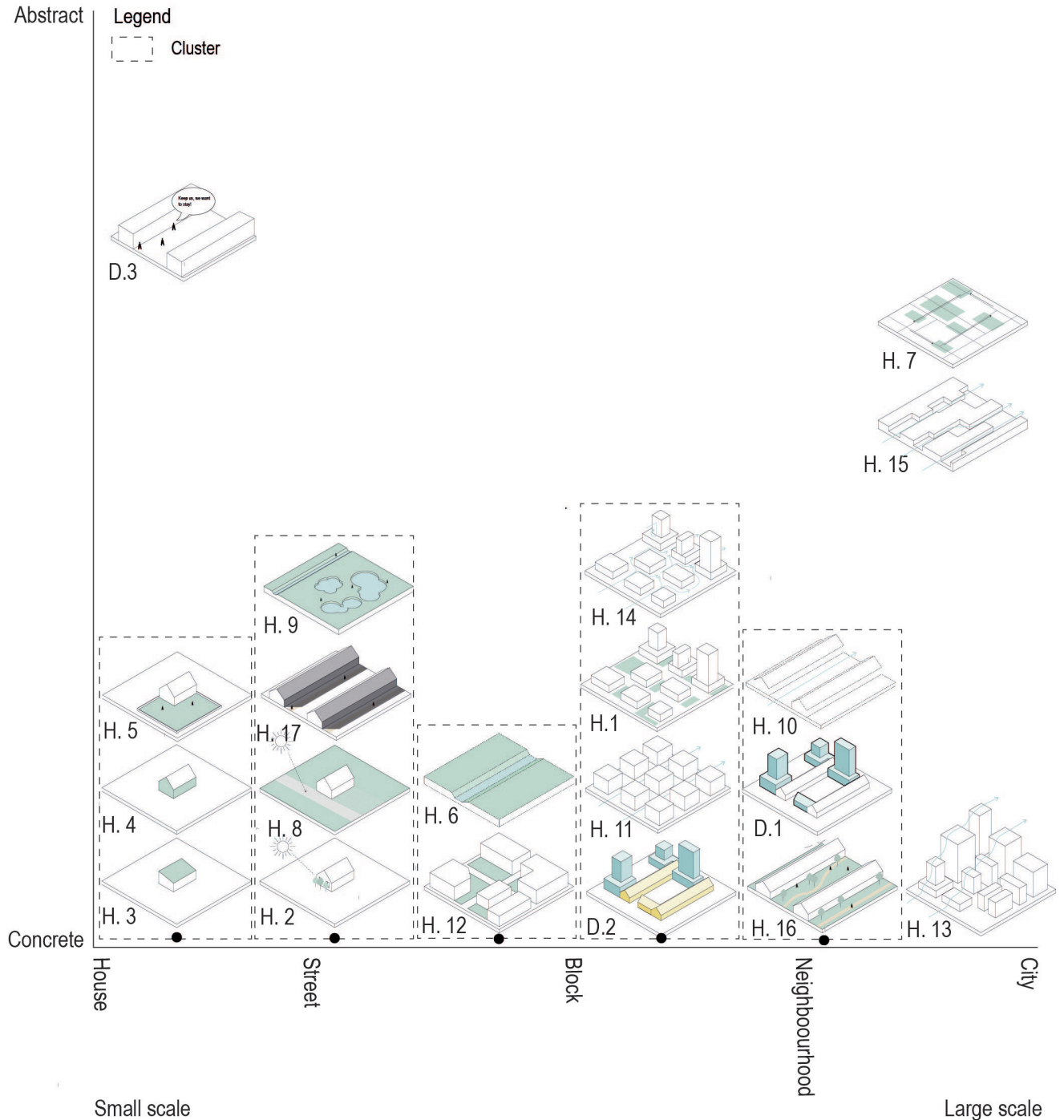
# PATTERN LANGUAGES



## Legend

1. One pattern contains or generalises another pattern.
2. Two patterns need each other for completeness.
3. Two patterns solve different problems that overlap and co-exist at the same level.
4. Two patterns solve the same problem in an alternative, equally valid way.
5. Distinct patterns share a similar structure, implying a higher level of coherence.
6. Two patterns colliding on the same level.

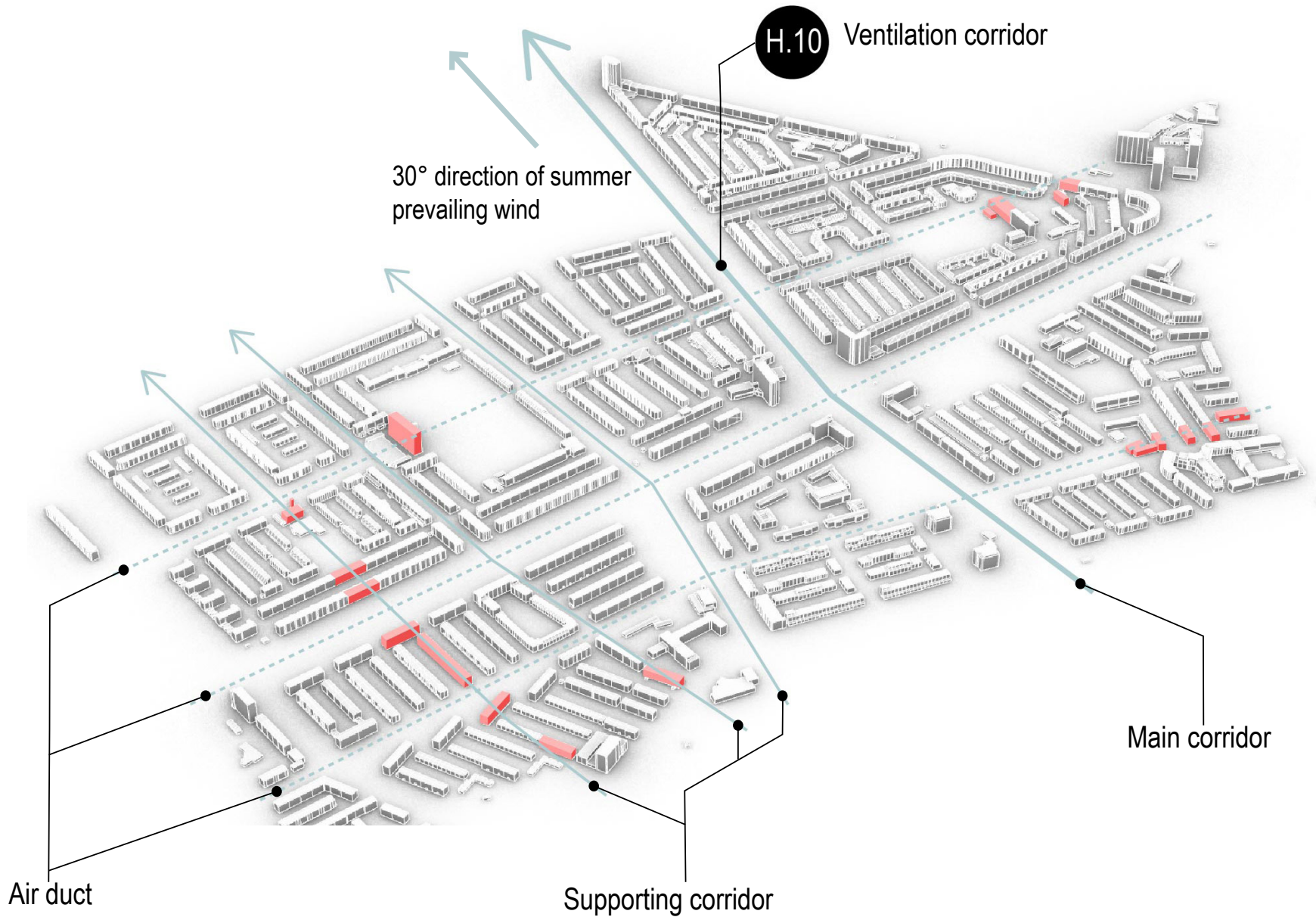
# PATTERN LANGUAGES





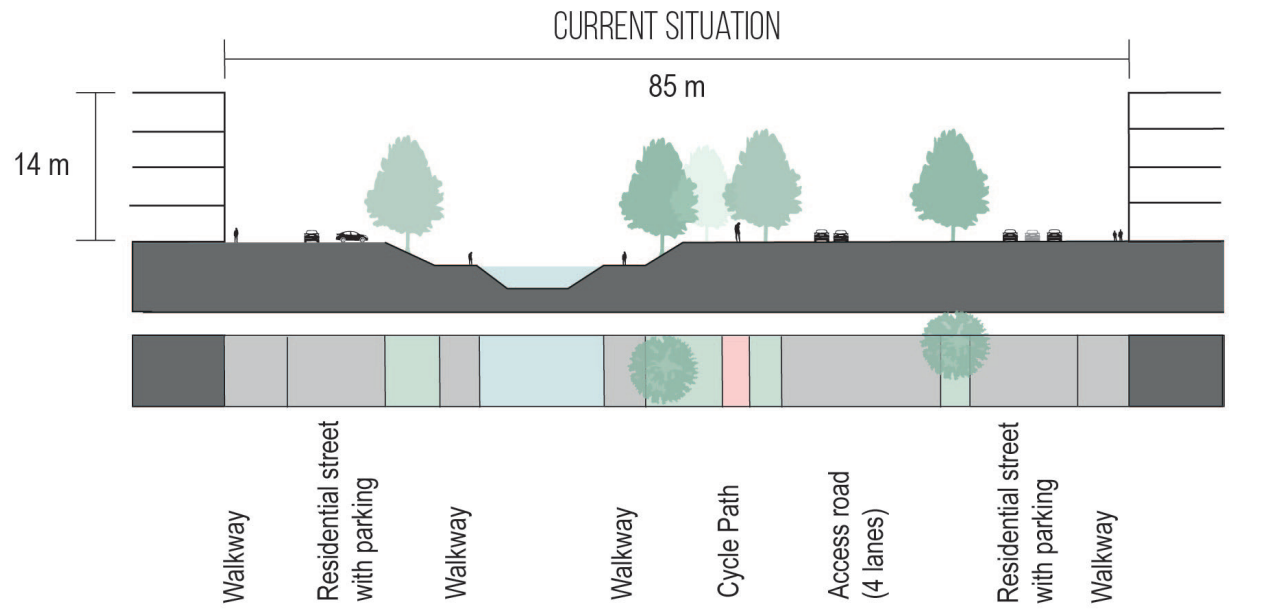
# IMPLEMENTATIONS

## H.15 VENTILATION GRID

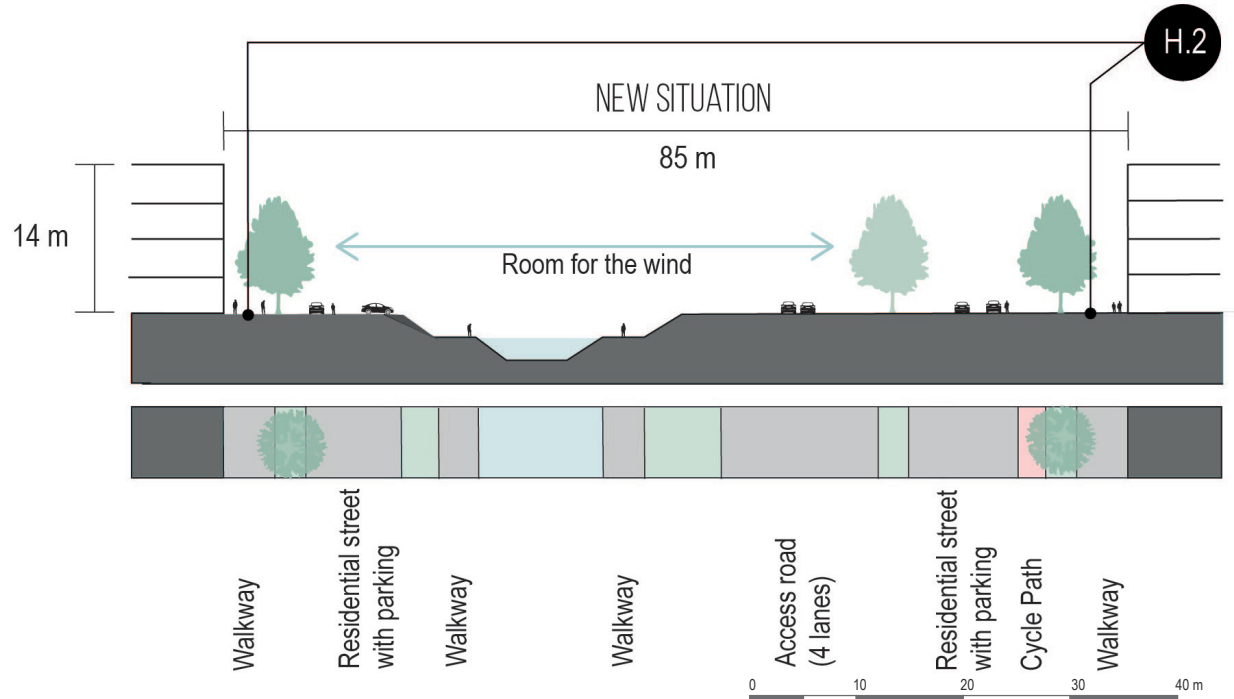


# IMPLEMENTATIONS

## H.10 VENTILATION CORRIDOR



Sun protection



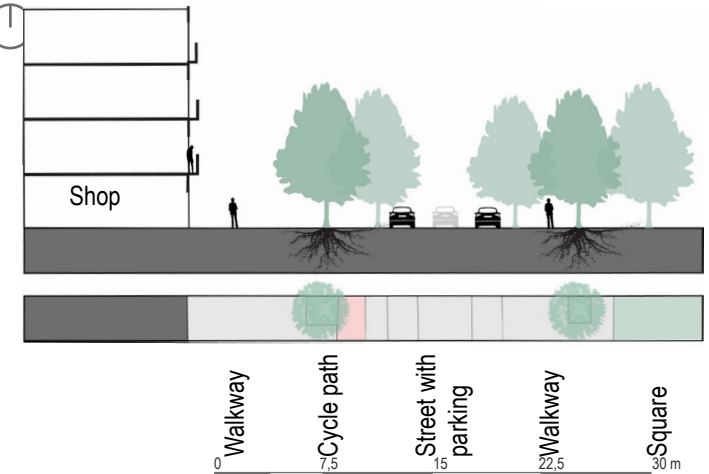
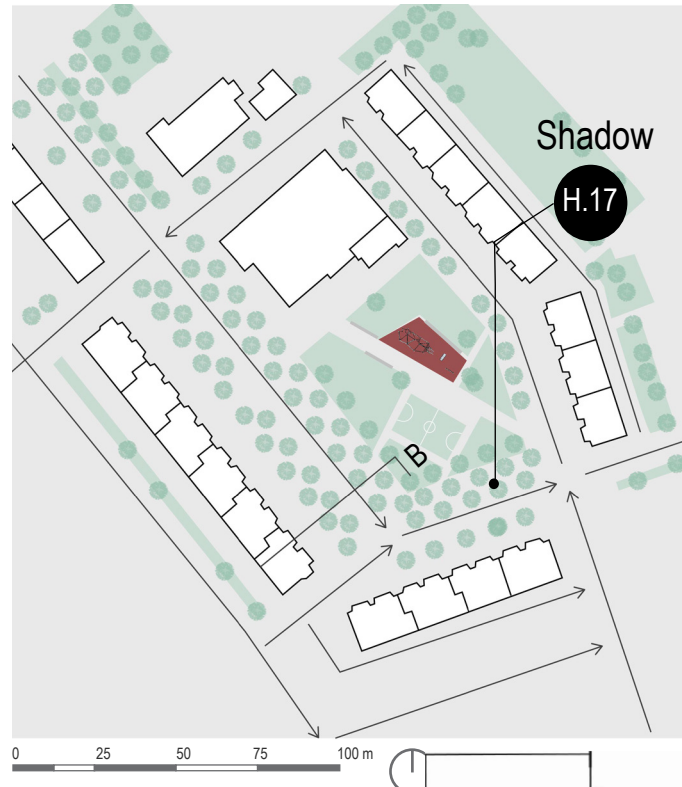
# IMPLEMENTATIONS

## H.7 GREEN GRID



# IMPLEMENTATIONS

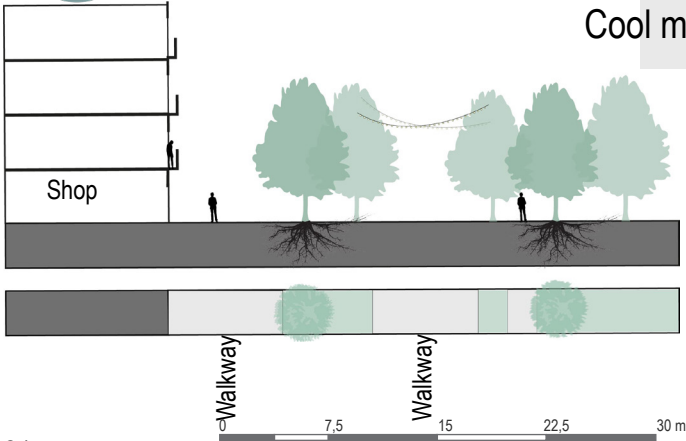
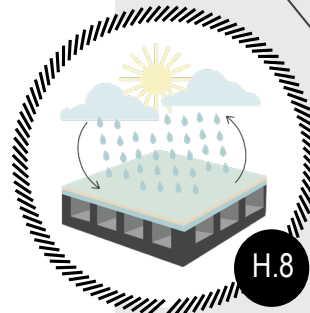
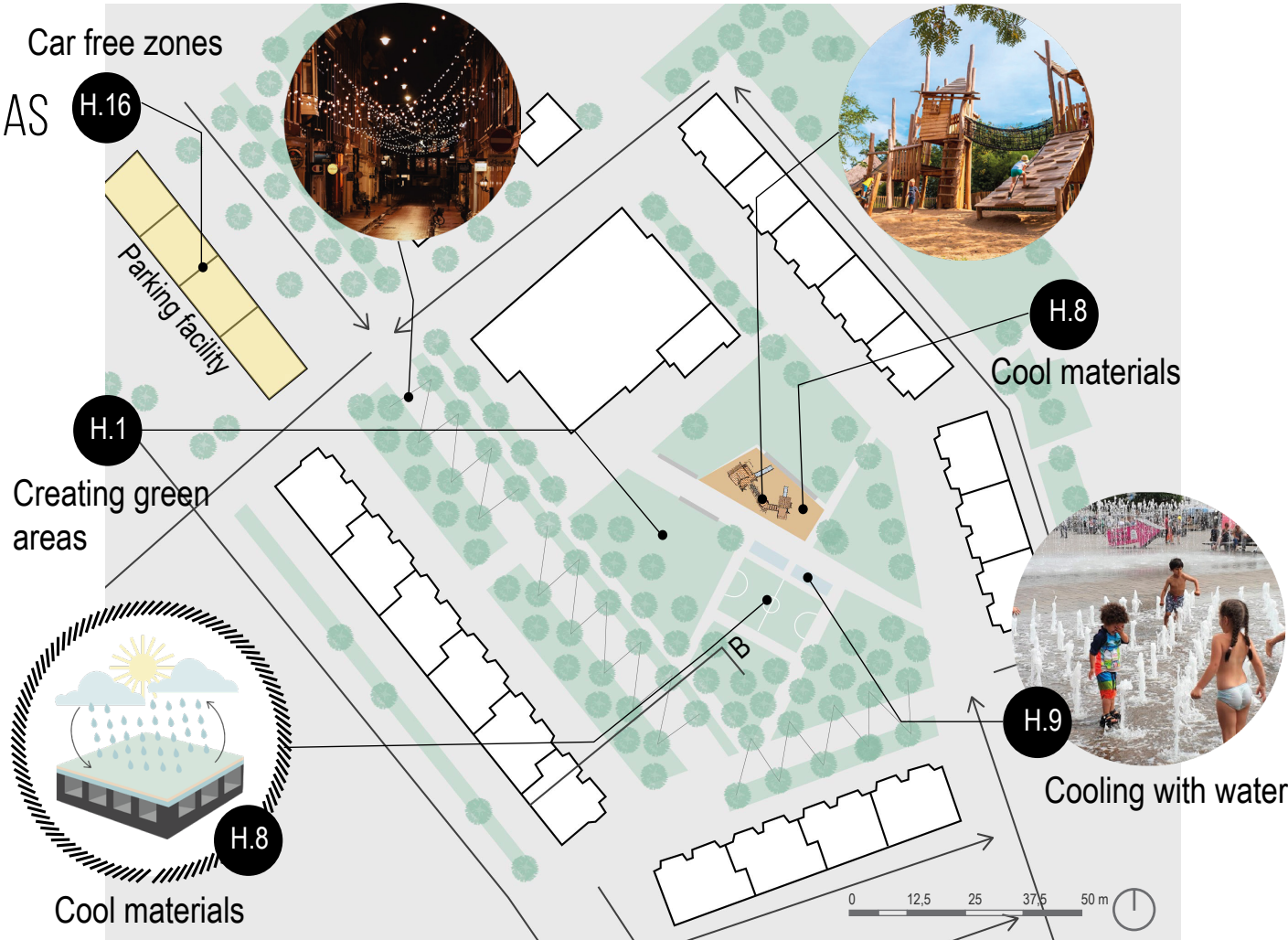
## H.1 CREATING GREEN AREAS



Source: Produced by author.

# IMPLEMENTATIONS

## H.1 CREATING GREEN AREAS



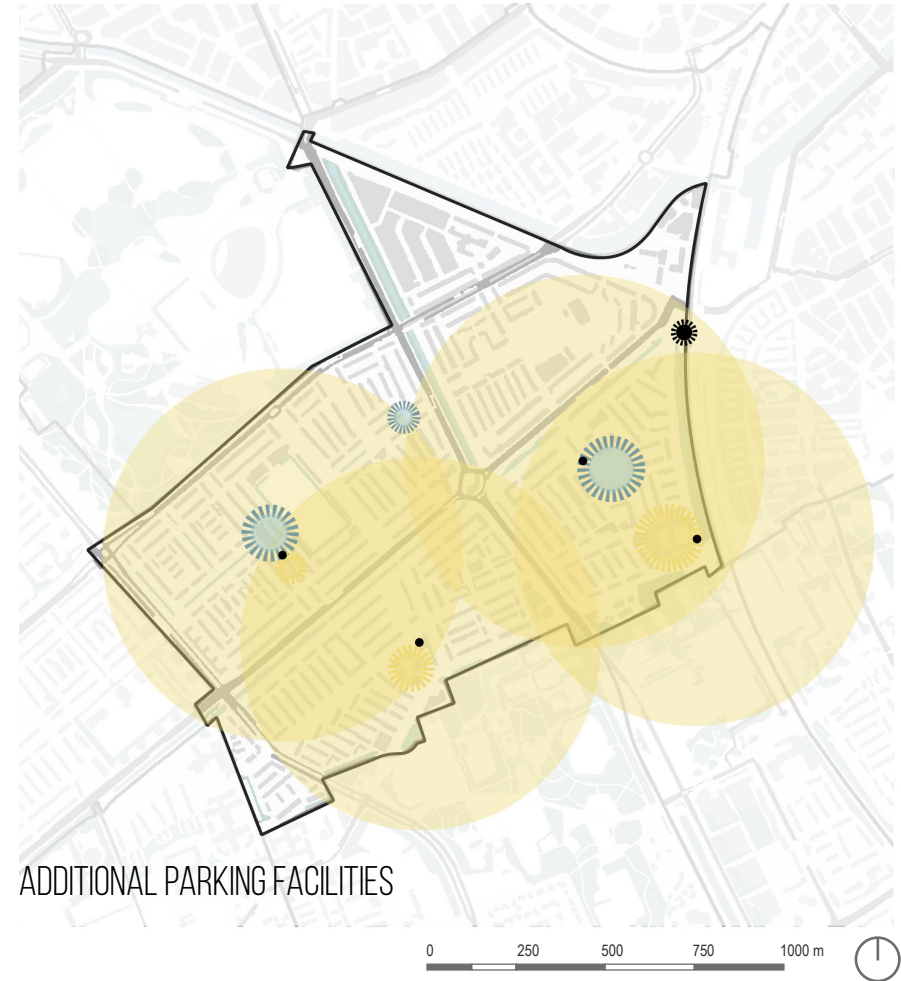
# IMPLEMENTATIONS

## H.16 CAR FREE ZONES



### Legend

- Shopping centre
- Elderly centre
- Walking distance to parking facility
- Parking facility
- Train station
- Super block



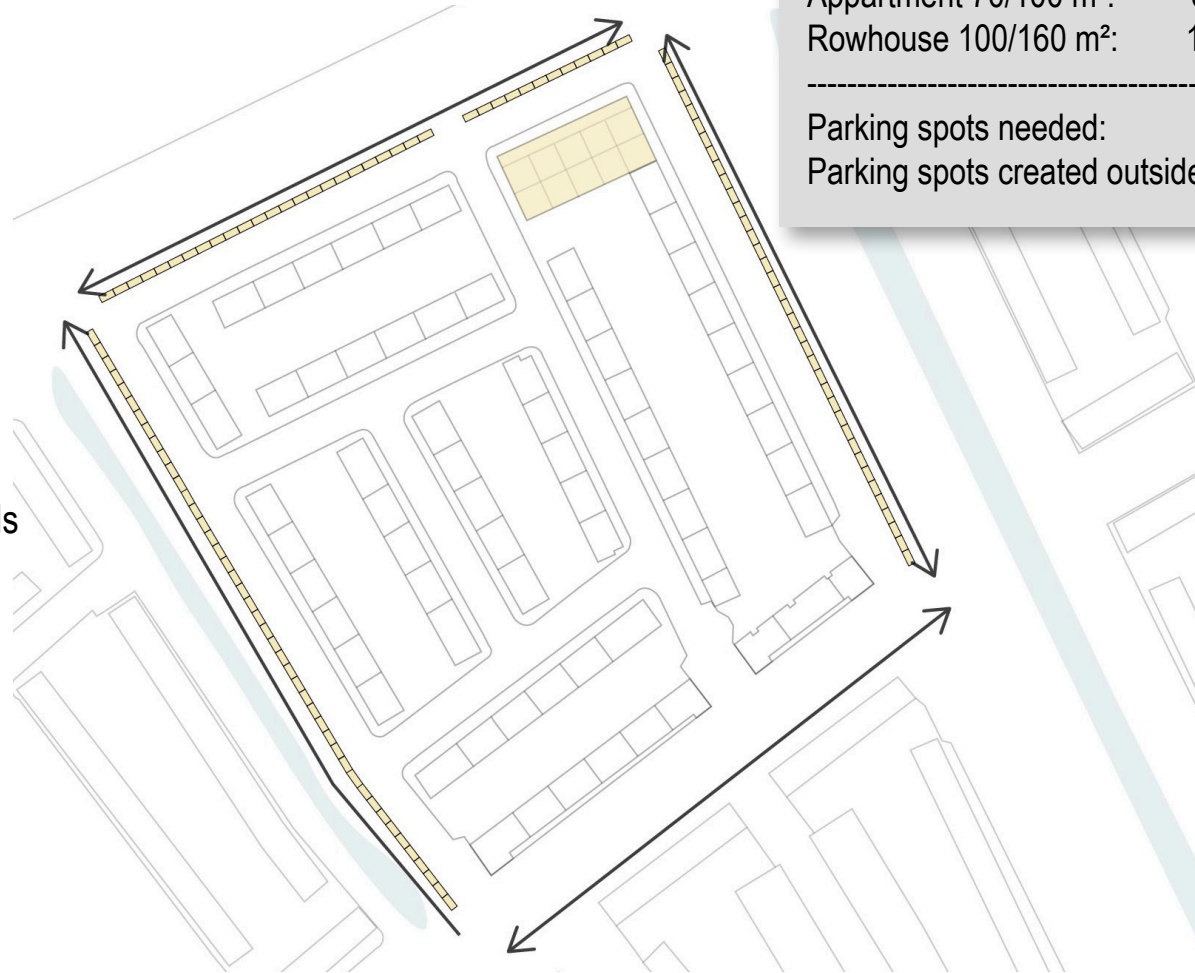
# IMPLEMENTATIONS

## H.16 CAR FREE ZONES



H.8

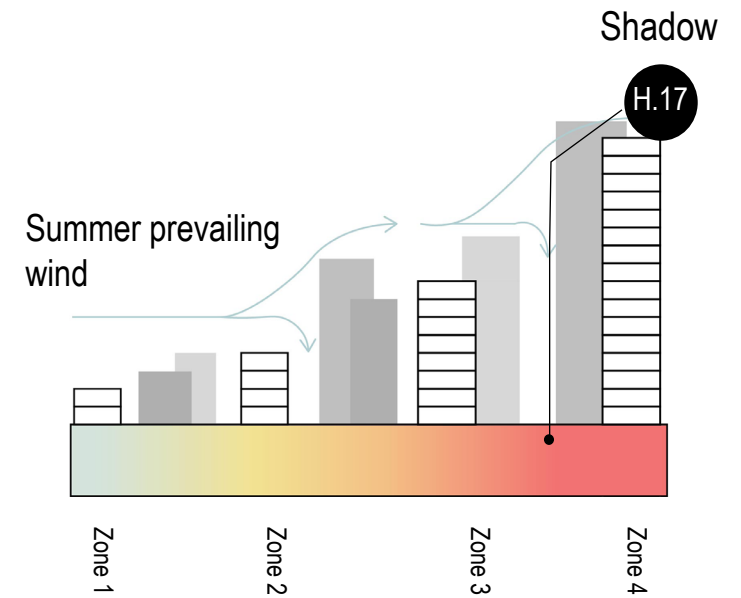
Cool materials



	Rental	Sale
Apartment 70/100 m <sup>2</sup> :	0,66	0,8
Rowhouse 100/160 m <sup>2</sup> :	1	1,5
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Parking spots needed:		233
Parking spots created outside:		229

# IMPLEMENTATIONS

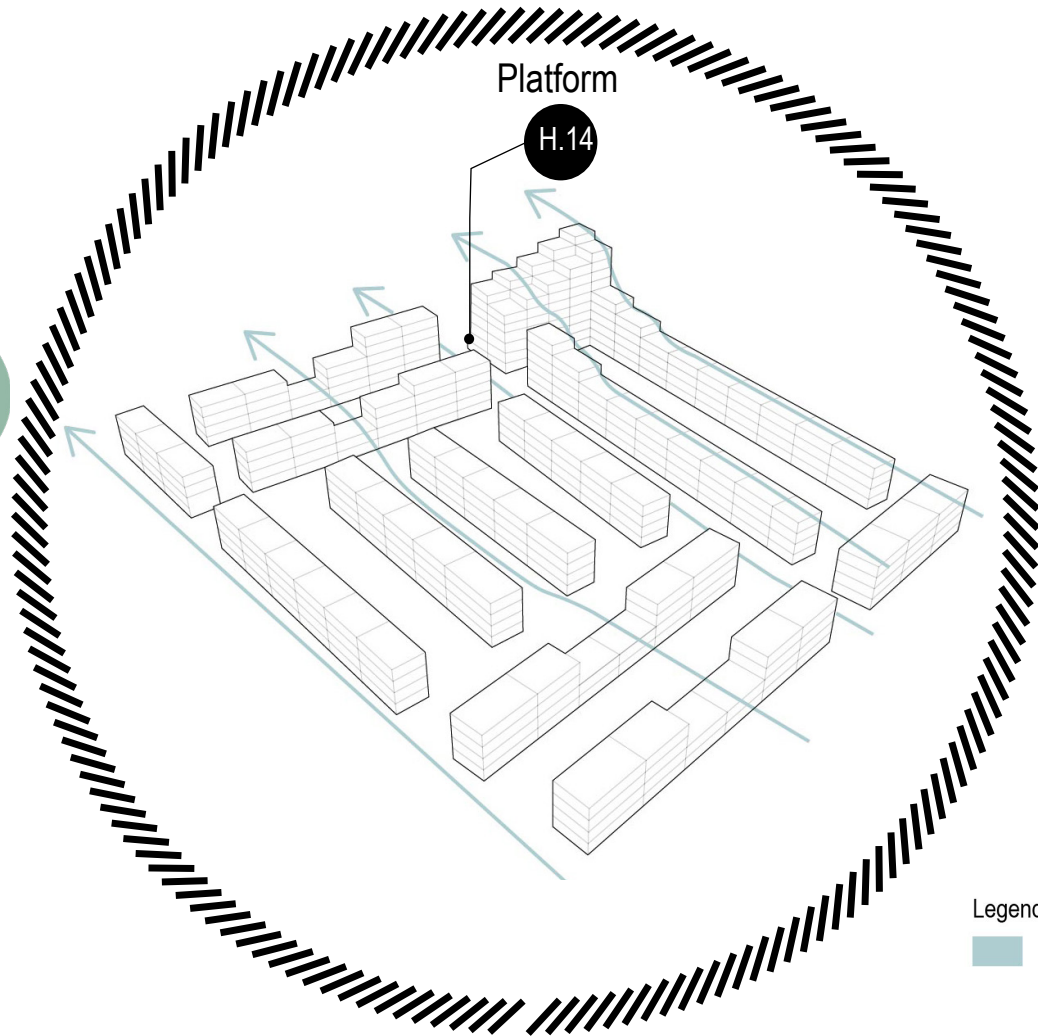
## H.13 LADDER TYPE BUILDINGS



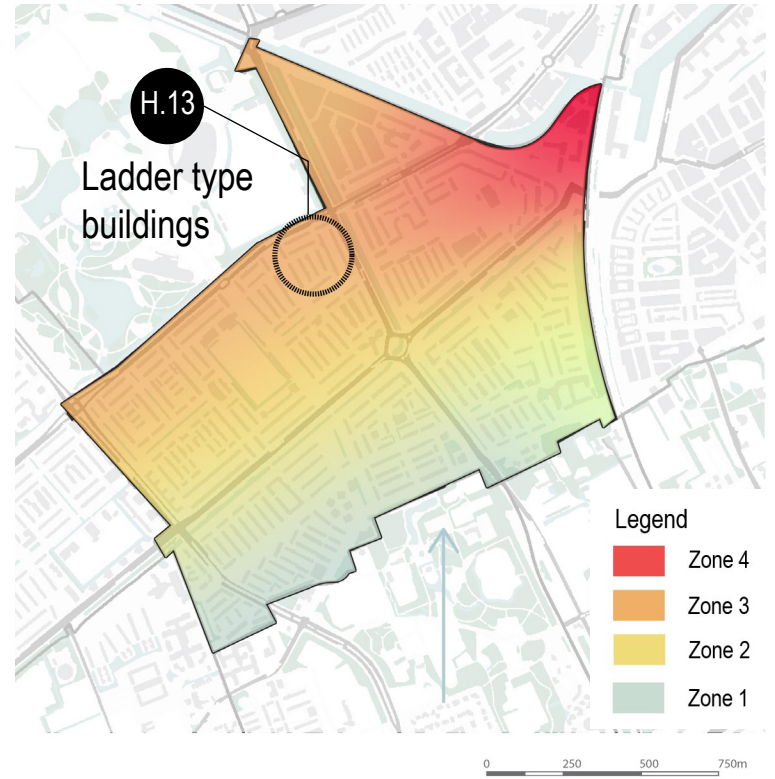


# IMPLEMENTATIONS

## H.11 AIRFLOW CIRCULATION



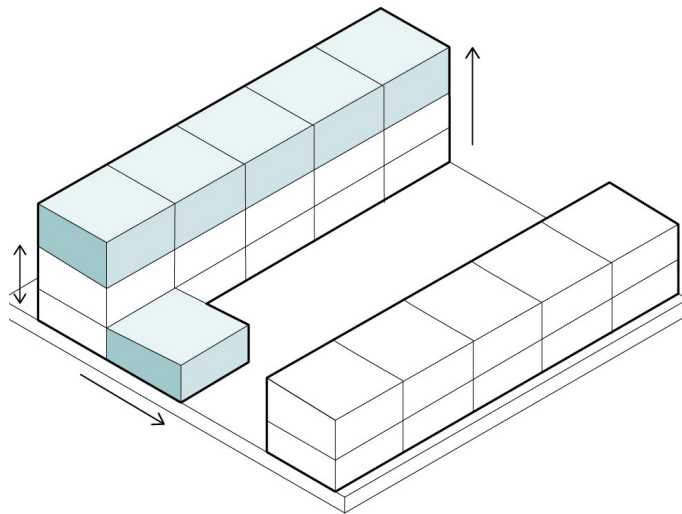
Legend  
Windflow



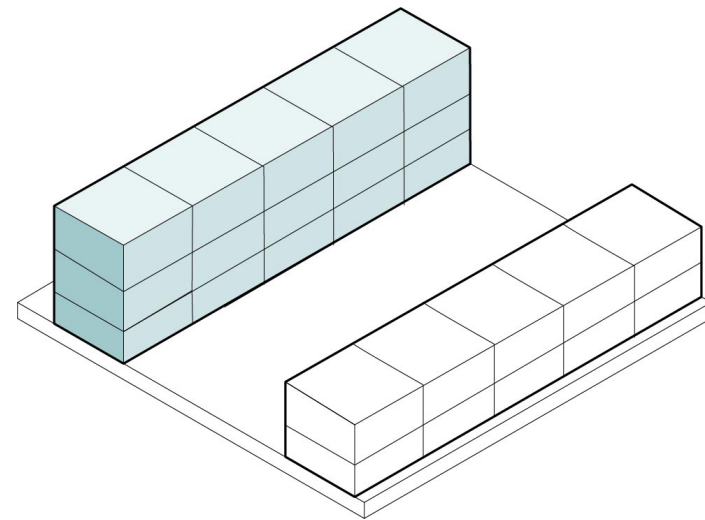
# IMPLEMENTATIONS

## D.1 CREATING MORE HOUSES

Densification for Moerwijk: +1800 dwellings  
Densification for each block: +75 dwellings  
Current number of dwellings: 210 dwellings



INTERVENE



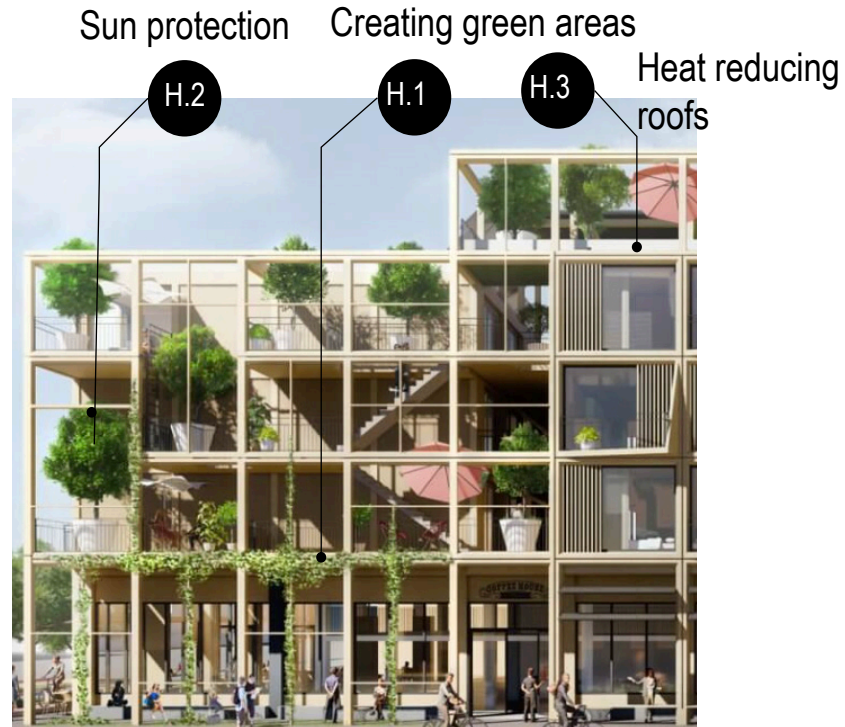
RESTRUCTURING

# IMPLEMENTATIONS

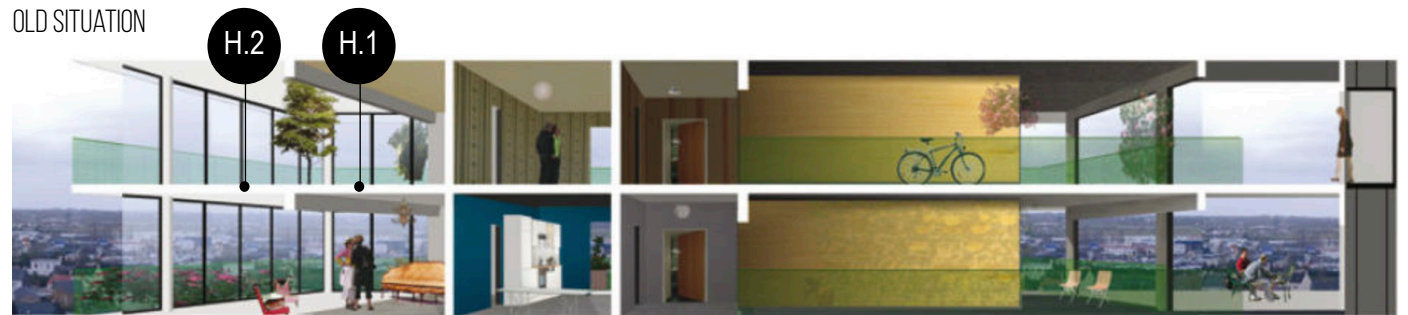
## D.1 RESTRUCTURING



POPPIES  
BUIKSLOTERHAM,  
AMSTERDAM



OLD SITUATION



NEW SITUATION

PLUS - LES GRANDS  
ENSEMBLES DE LOGEMENTS,  
FRANCE

# IMPLEMENTATIONS

## D.1 INTERVENE



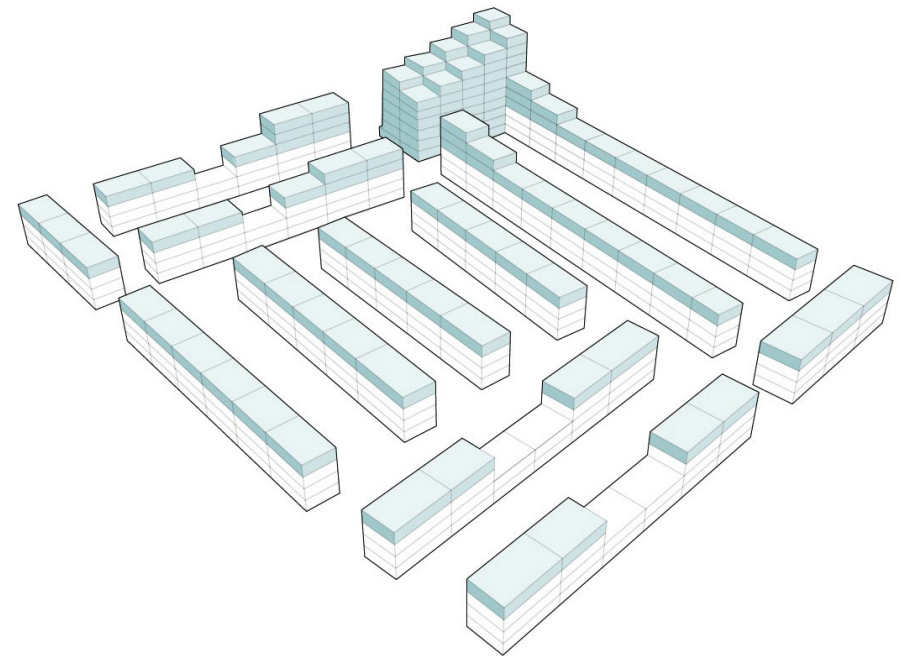
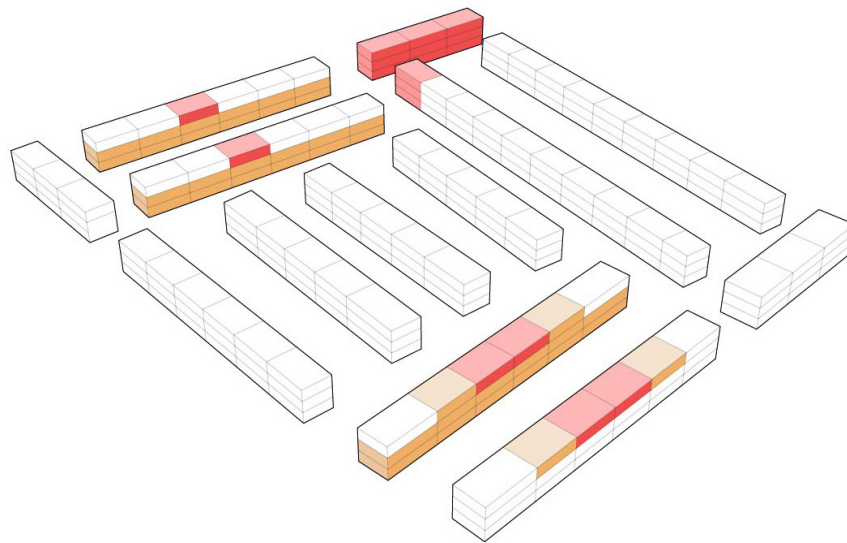
KLARENSTRAAT,  
AMSTERDAM



PANELAK,  
SLOVAKIA

# IMPLEMENTATIONS

## D.1 CREATING MORE HOUSES



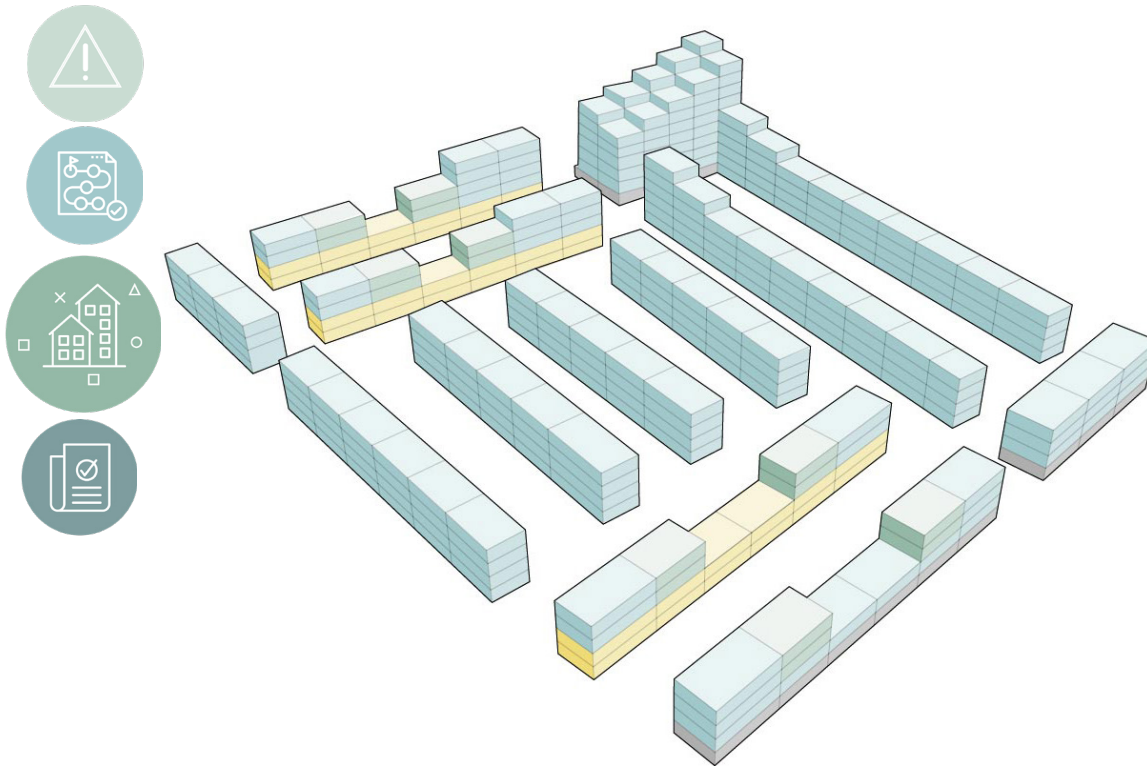
Current number of dwellings:	210 dwellings
Realised number of dwellings:	316 dwellings
-----	
Densification:	106 dwellings
Dwellings to be demolished:	-18 dwellings
Dwellings to be transformed:	+ 44 dwellings
Dwellings to be renovated:	148 dwellings

### Legend

- Dwellings that will be added
- Dwellings to be demolished
- Dwellings to be transformed

# IMPLEMENTATIONS

## D.1 CREATING MORE HOUSES



### Legend

- Apartment:
- Maisonette
- Row house
- Other buildi

Apartments:  
Current social rent: 148 dwellings  
Replacing demolished/transformed: +62 dwellings  
Newly built apartments: +80 dwellings

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230 dwellings for social rent  
20 dwellings for private rent  
40 dwellings for sale

Rowhouses/massionettes:  
Transformed row houses: +18 dwellings  
Newly built massionettes: +8 dwellings

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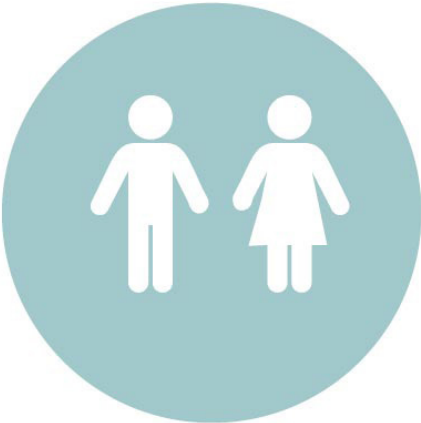
12 row houses for sale  
6 row houses for private rent  
8 massionettes for sale

# OUTDOOR SPACE IN THE BLOCK

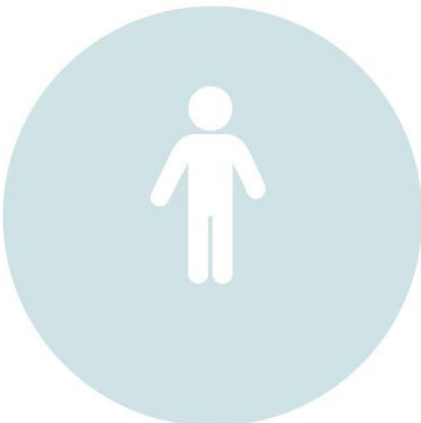
## TARGET GROUPS



FAMILIES



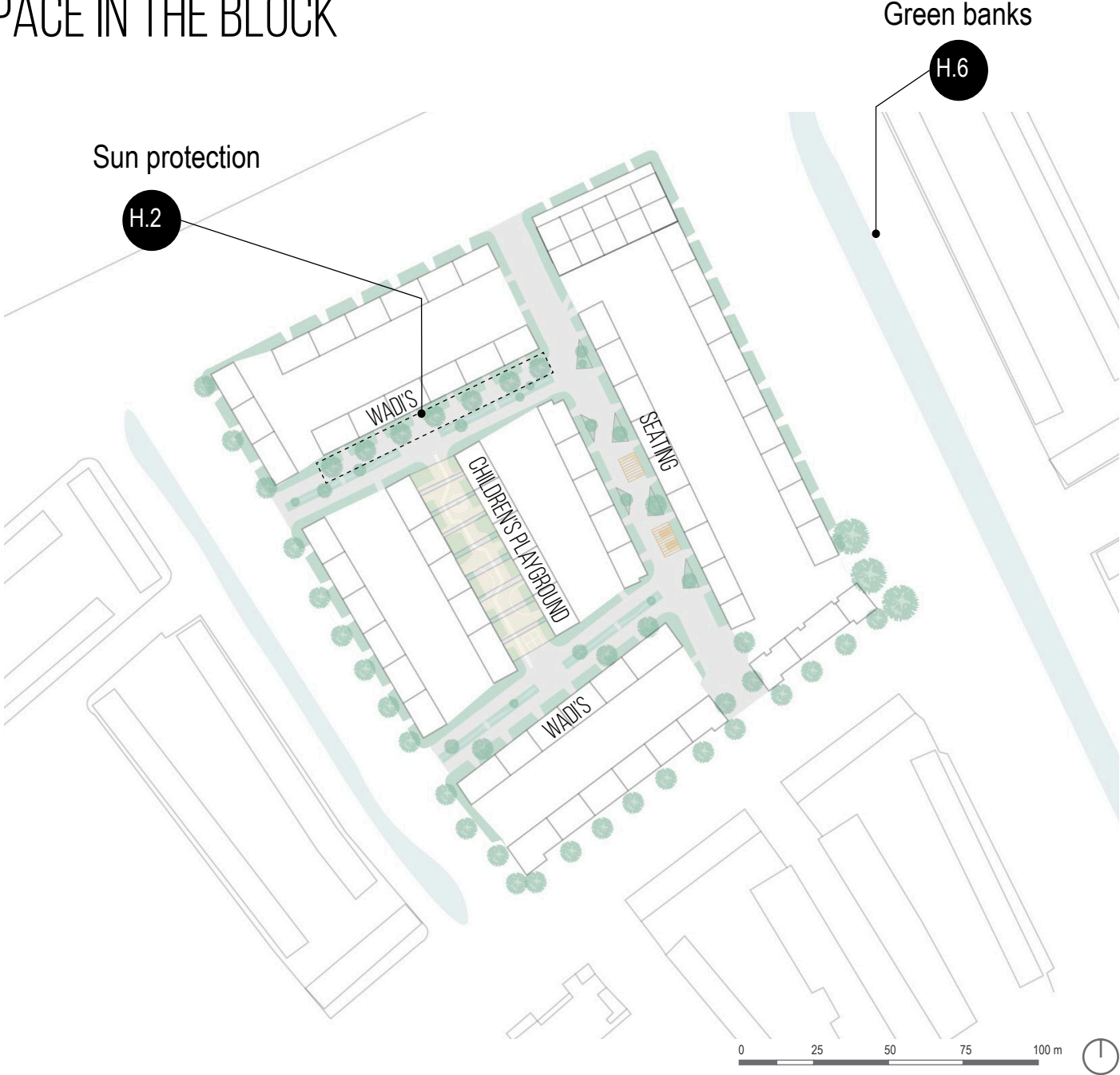
COUPLES



SINGLES

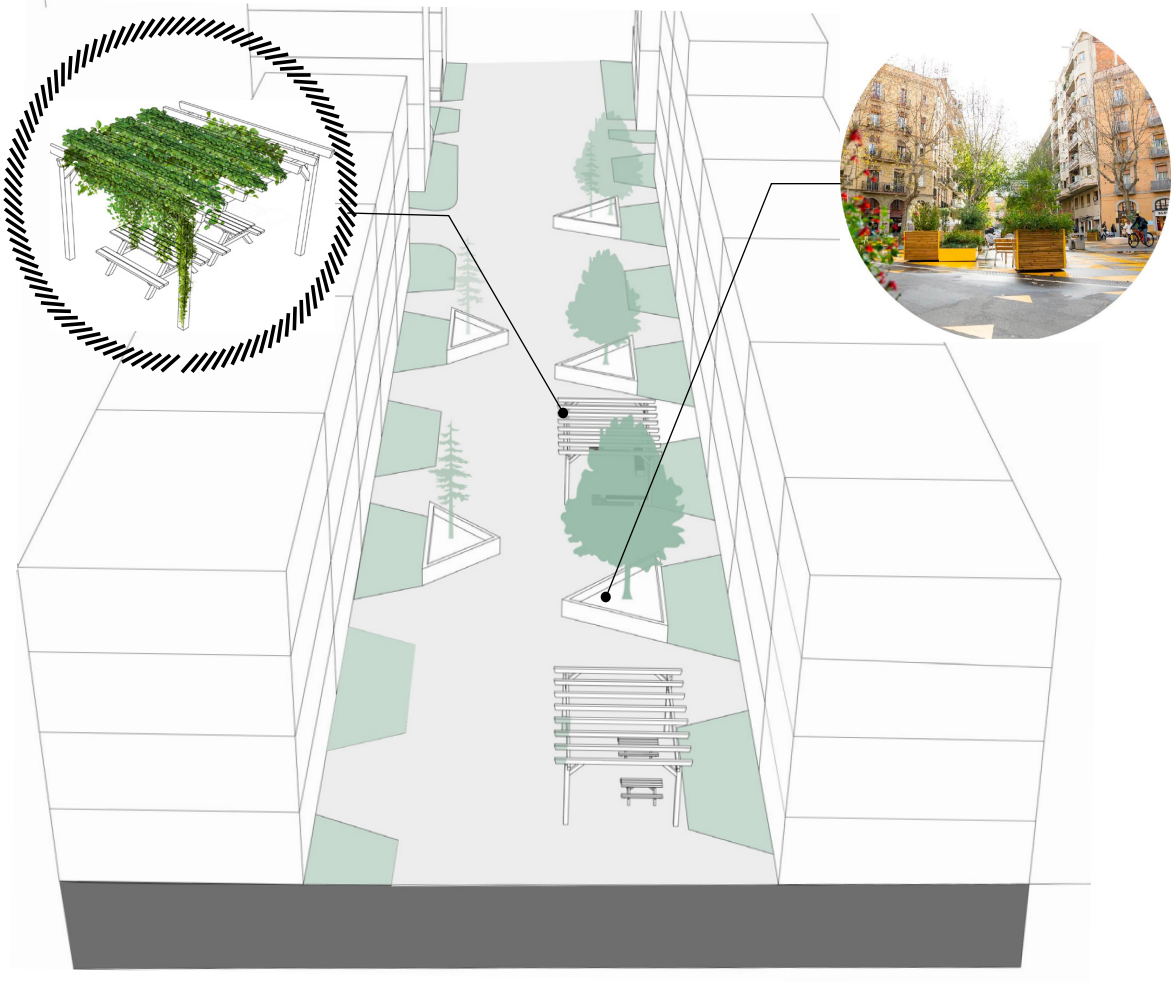
# OUTDOOR SPACE IN THE BLOCK

## PUBLIC SPACE





# PUBLIC SPACE SEATING



# PUBLIC SPACE SEATING



Shadow      Creating green areas



# PUBLIC SPACE

## CHILDREN'S PLAYGROUND



# PUBLIC SPACE

## CHILDREN'S PLAYGROUND



Creating green areas

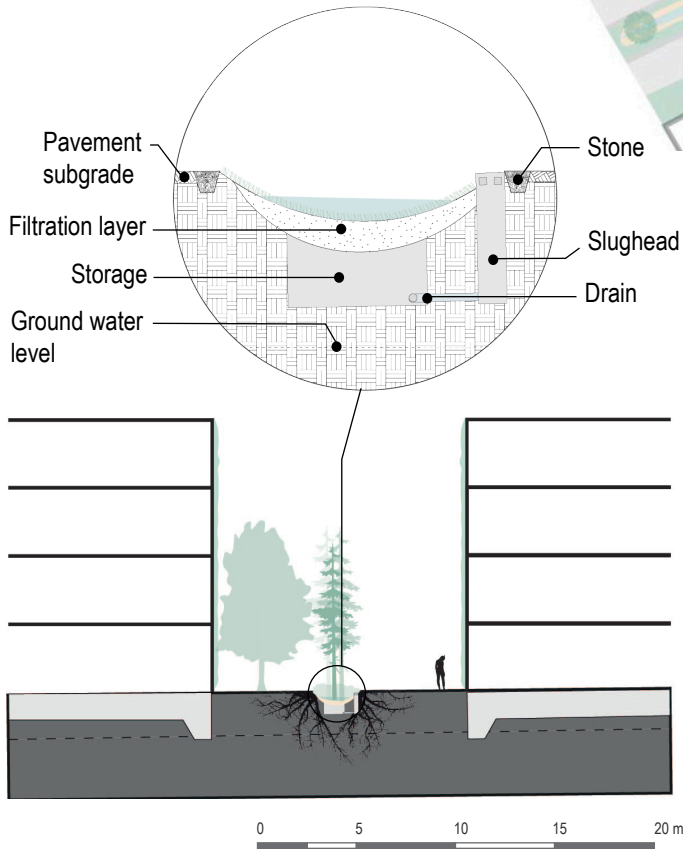
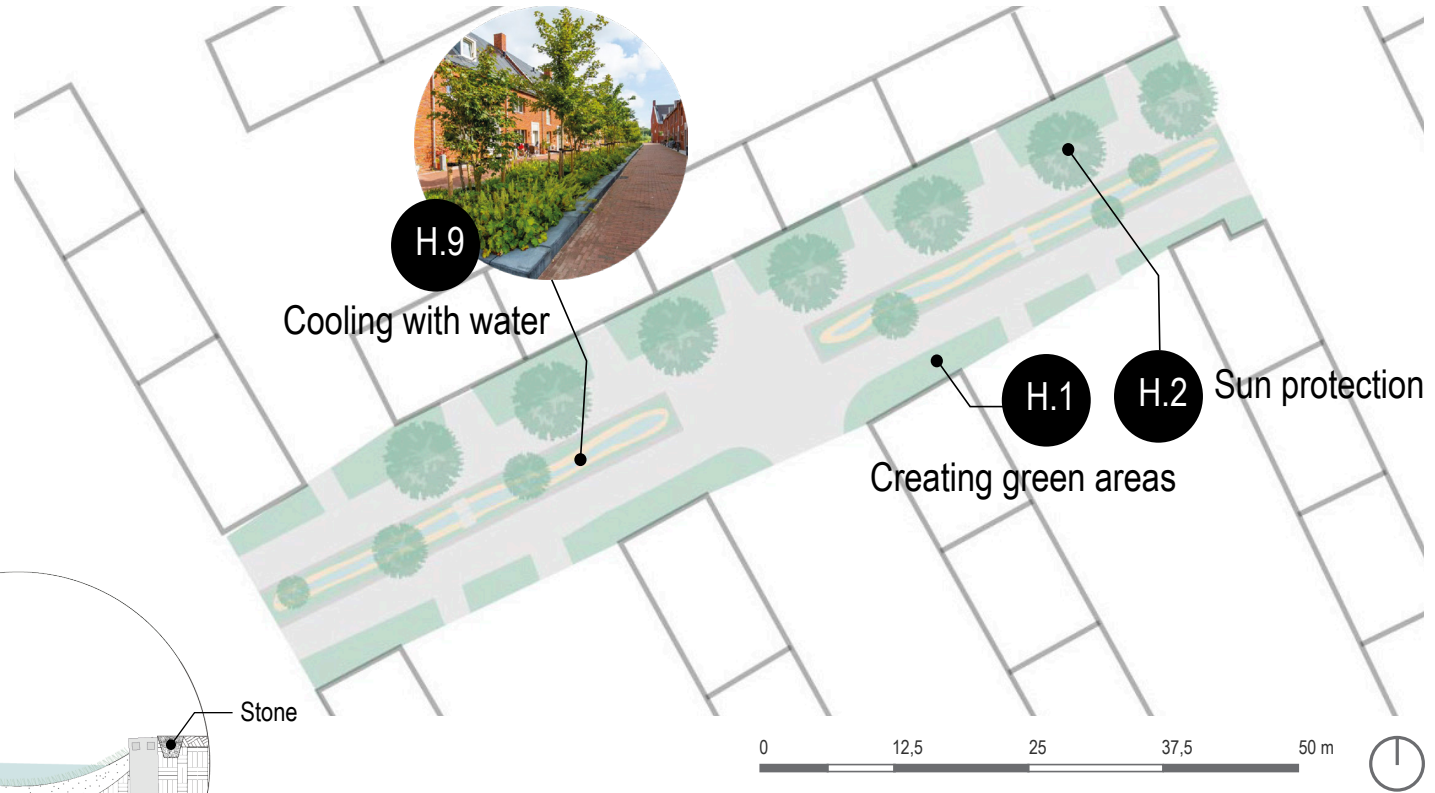
H.1

Shadow

H.17



# PUBLIC SPACE WADI'S



# PUBLIC SPACE WADI'S



Sun protection

H.2

Creating green areas

Cooling with water

H.1

Green facade

H.9

H.4

# FROM PUBLIC SPACE TO PRIVATE GARDEN



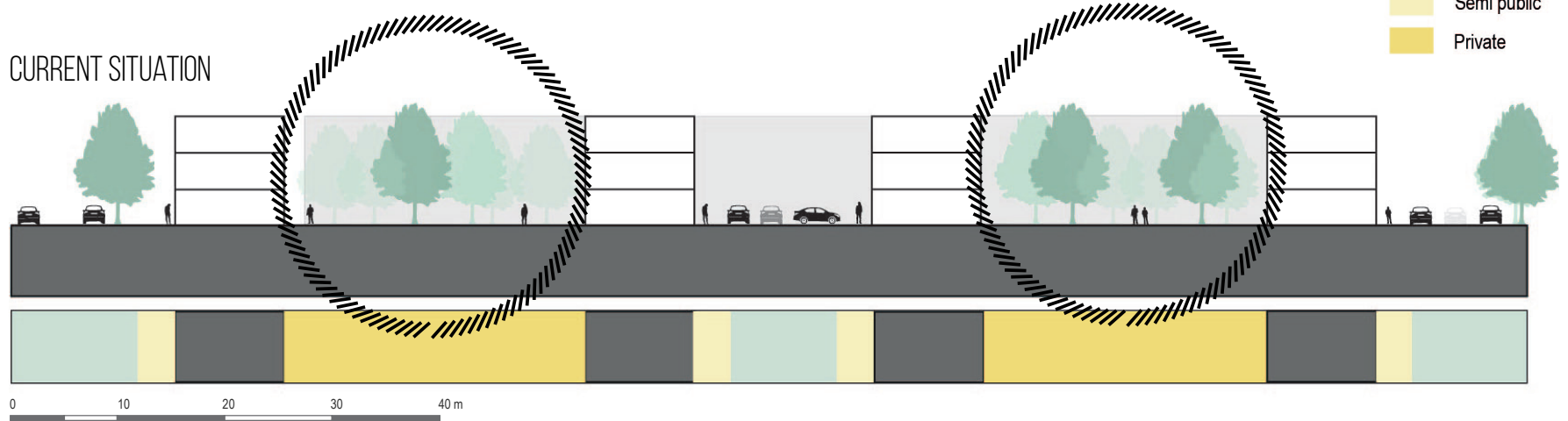
FENCING



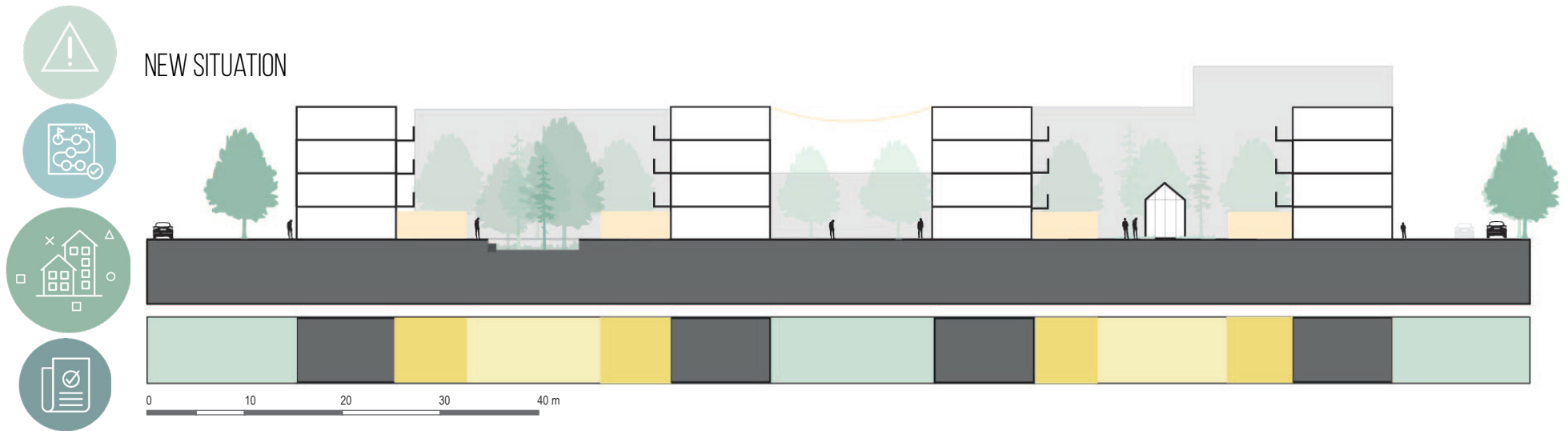
SIGNS



CURRENT SITUATION



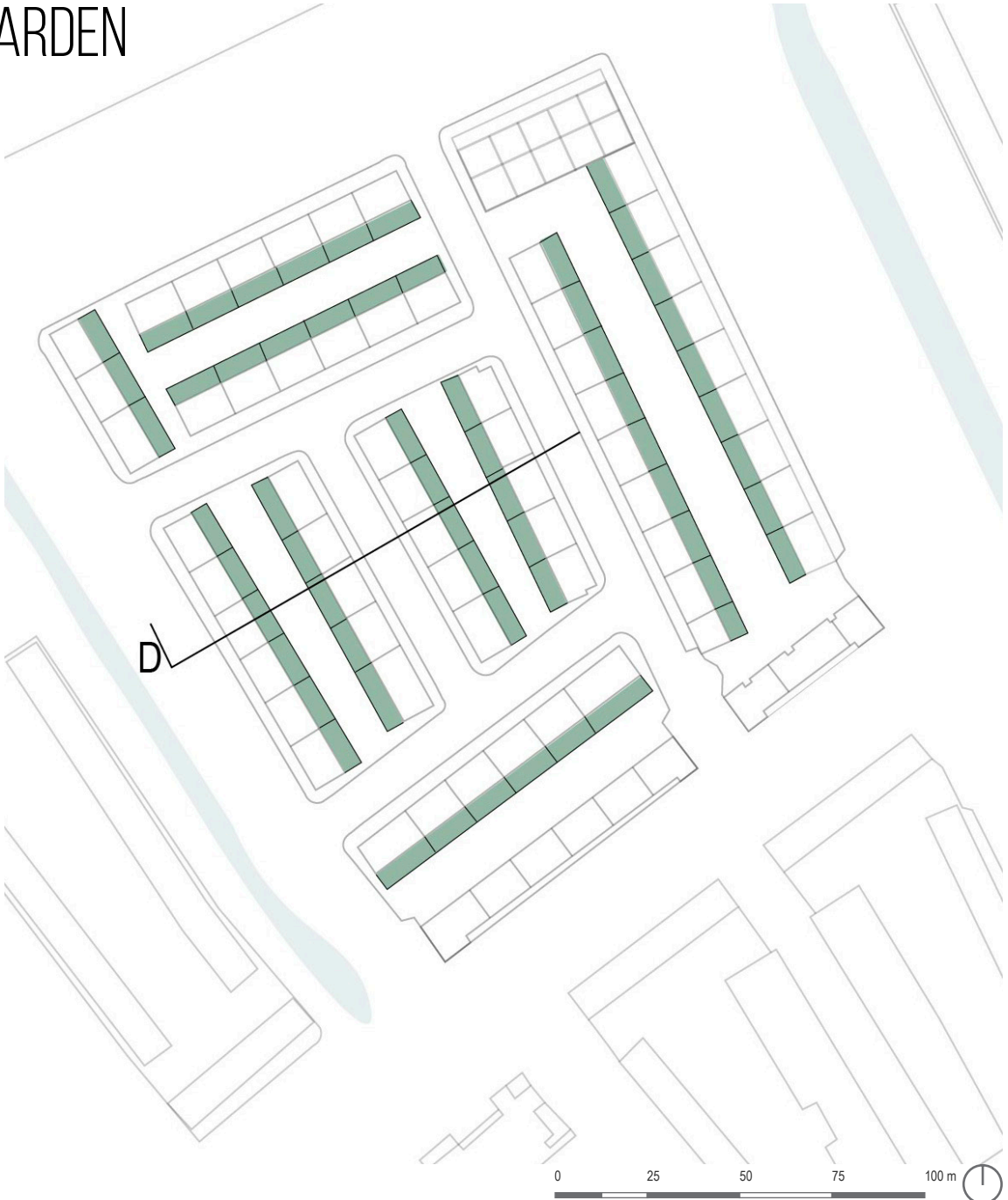
# FROM PUBLIC SPACE TO PRIVATE GARDEN





# FROM PUBLIC SPACE TO PRIVATE GARDEN

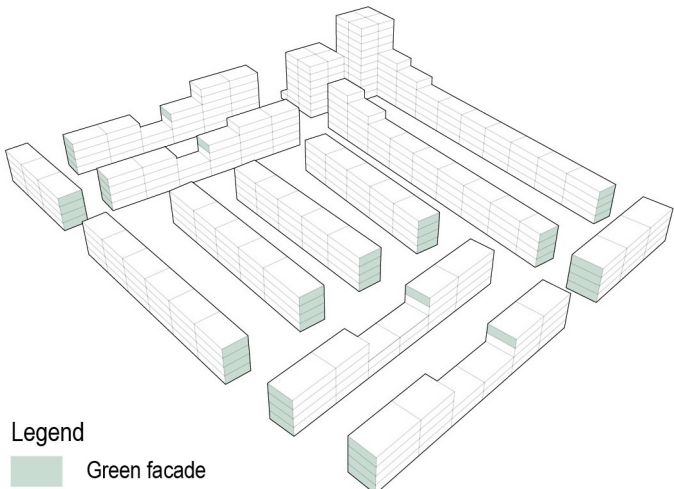
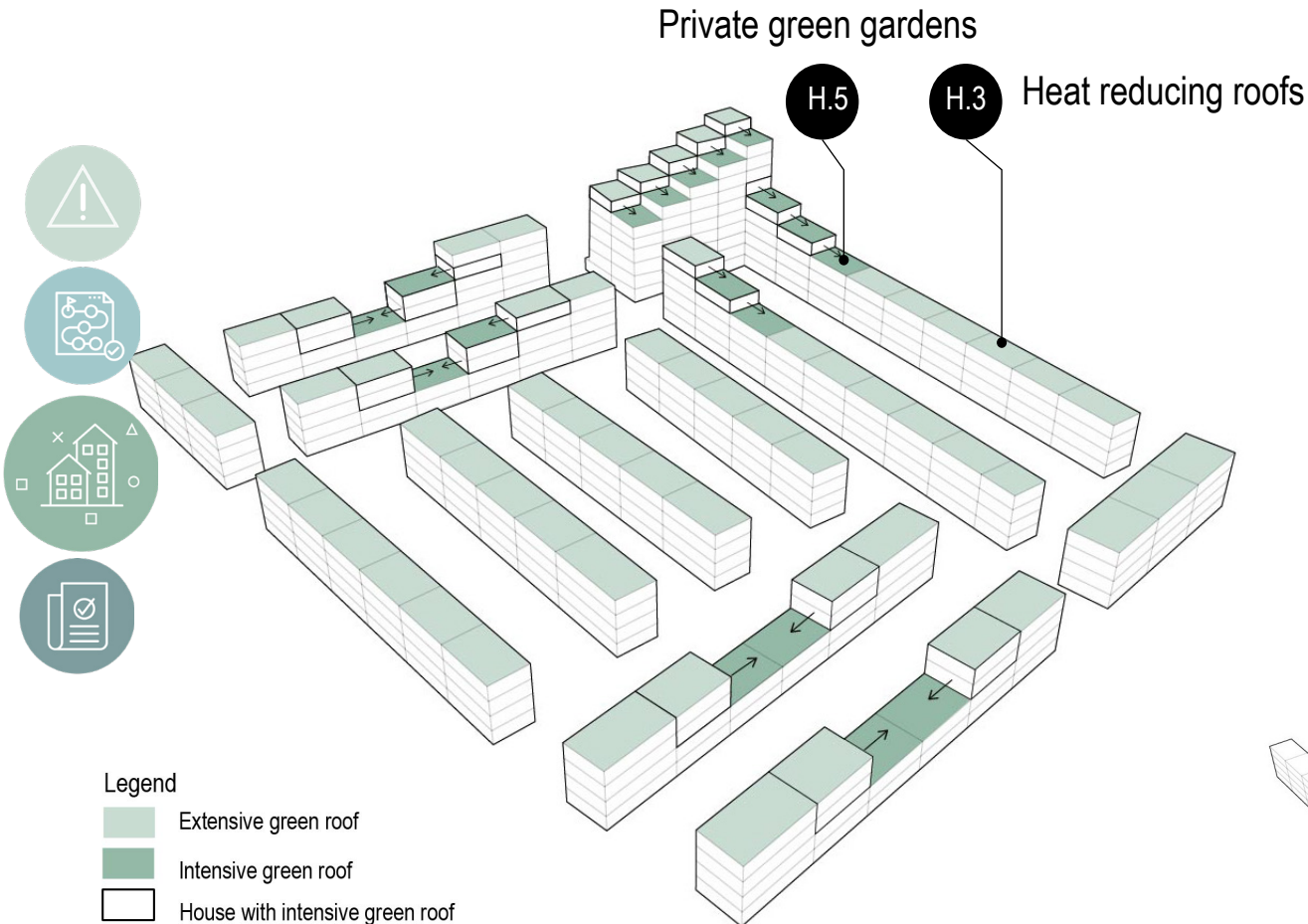
## H.5 PRIVATE GREEN GARDENS



# FROM PUBLIC SPACE TO PRIVATE GARDEN

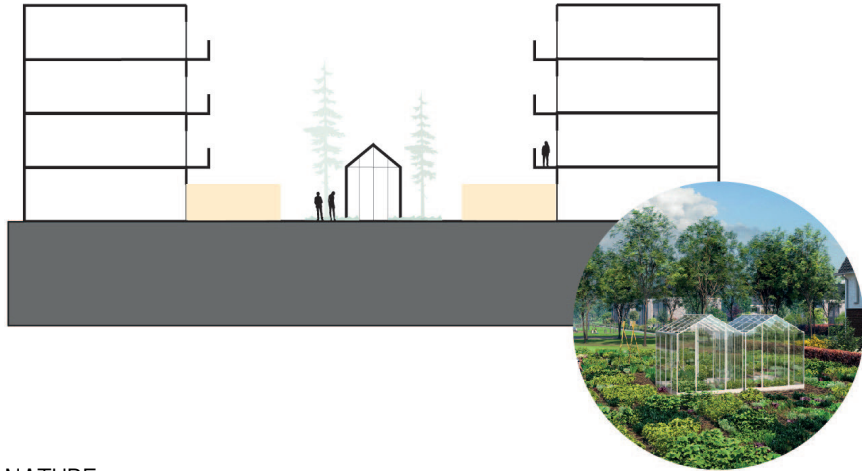
H.3 HEAT REDUCING ROOFS

H.4 GREEN FACADES

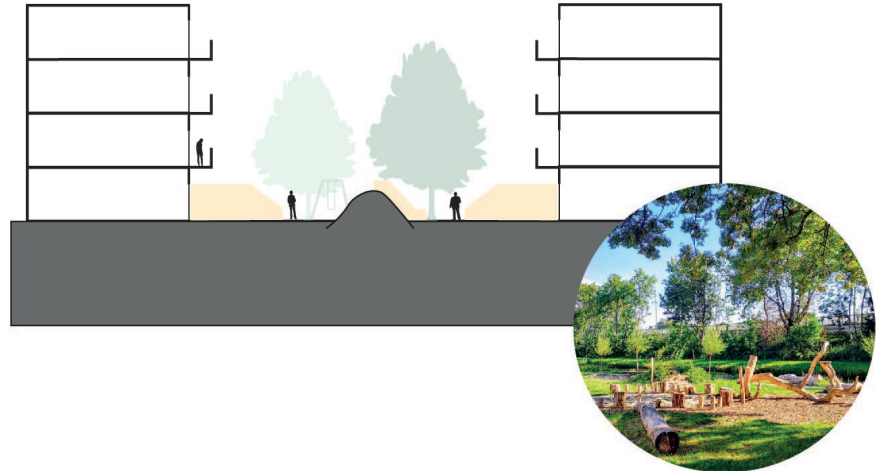


# SEMI-PUBLIC SPACE POSSIBILITIES

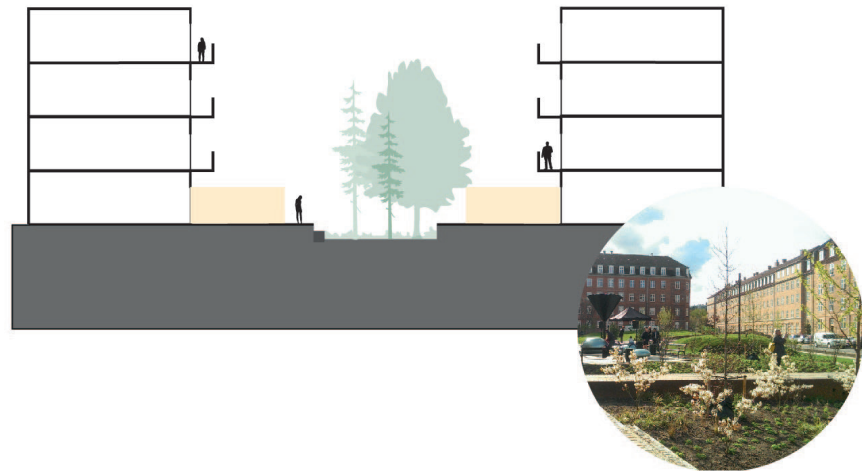
VEGETABLE GARDEN



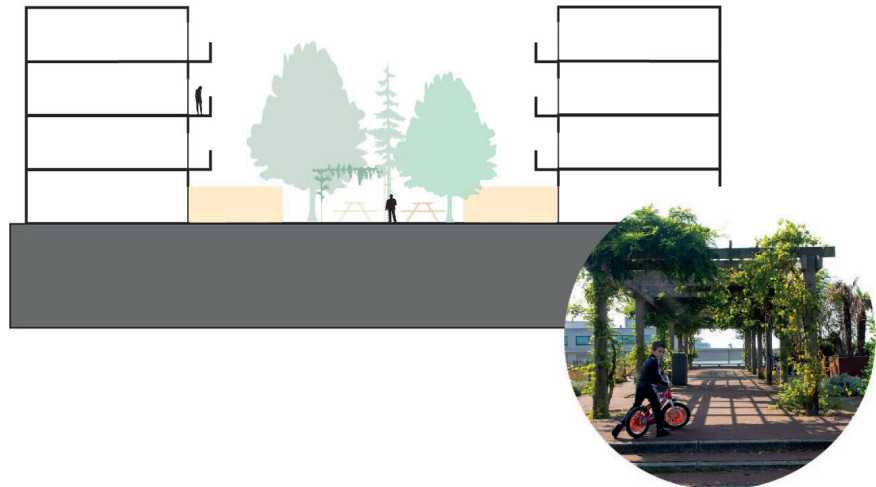
CHILDREN'S PLAYGROUND



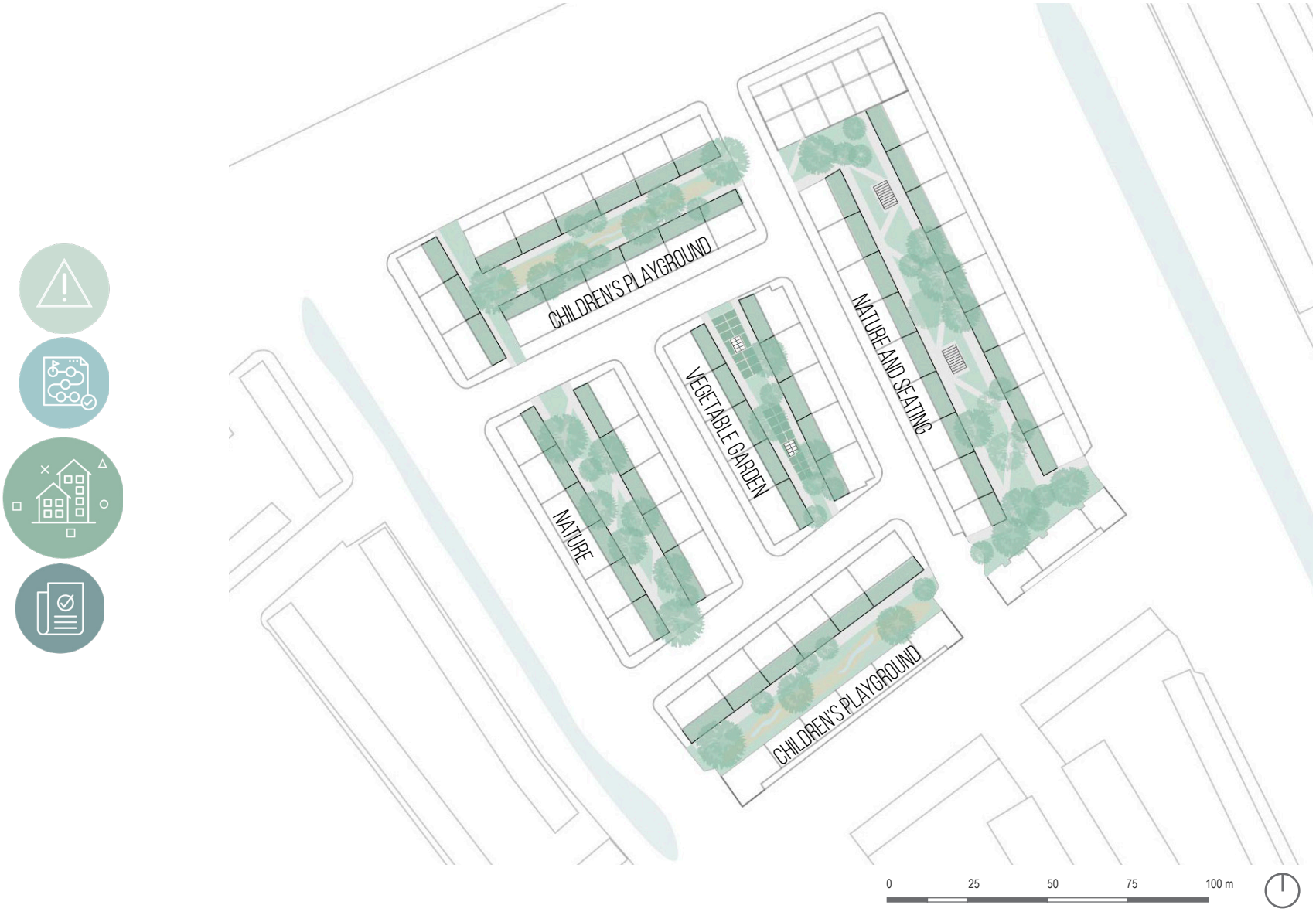
NATURE



SEATING



# SEMI-PUBLIC SPACE



# SEMI-PUBLIC SPACE CHILDREN'S PLAYGROUND



# SEMI-PUBLIC SPACE CHILDREN'S PLAYGROUND

Shadow

Cool materials

Creating green areas

H.17

H.8

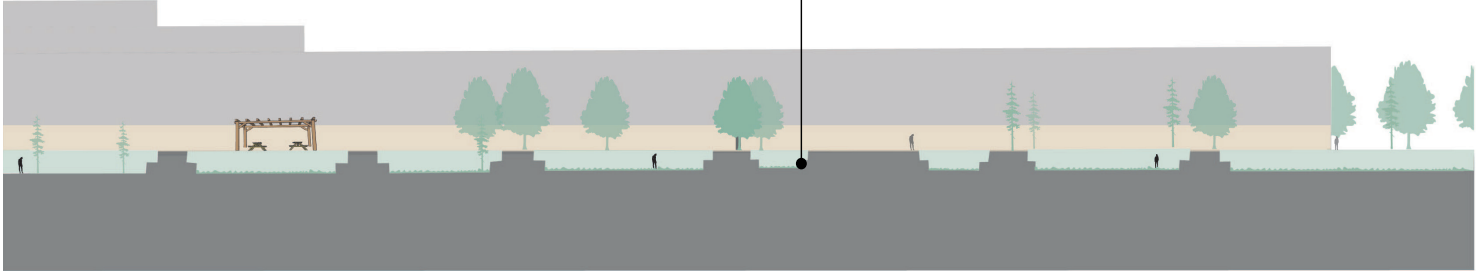
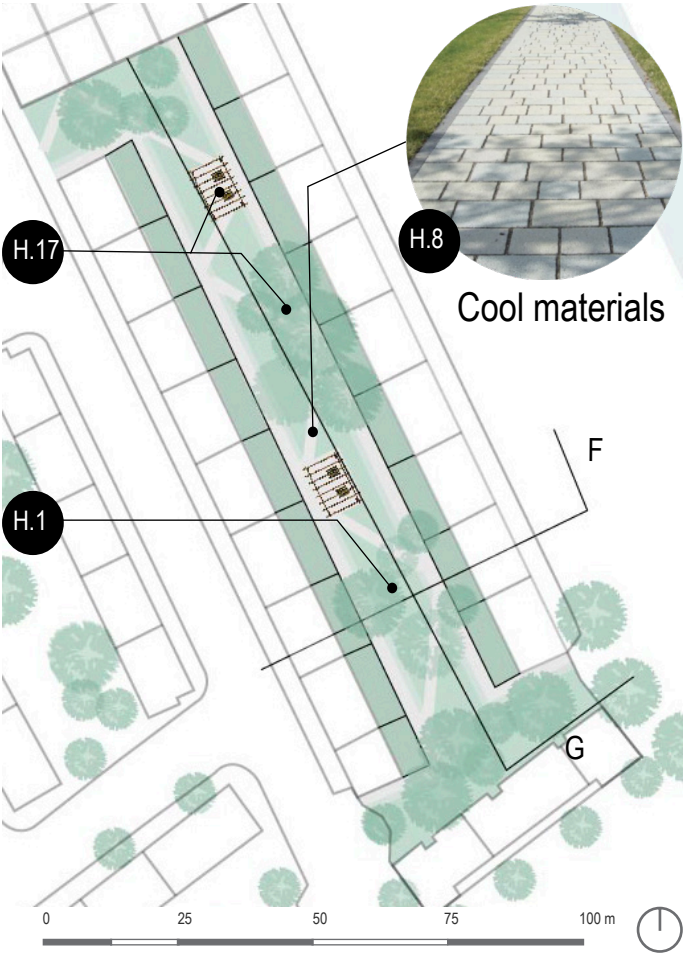
H.1



# SEMI-PUBLIC SPACE NATURE



Shadow  
H.17  
Cool materials  
H.8  
Creating green areas  
H.1



# SEMI-PUBLIC SPACE NATURE

Cool materials

H.8

Shadow

H.17

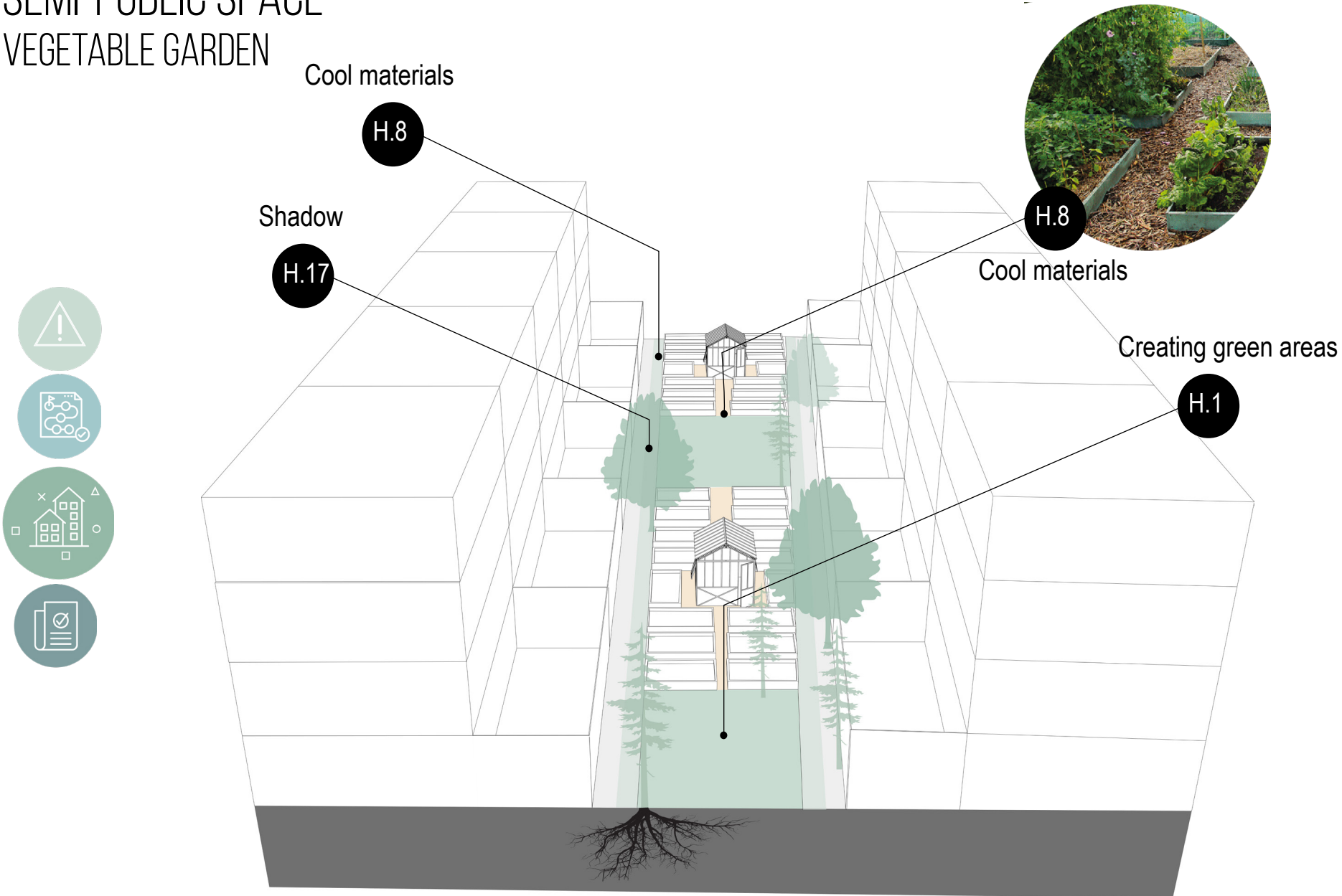
Creating green areas

H.1





# SEMI-PUBLIC SPACE VEGETABLE GARDEN



# SEMI-PUBLIC SPACE VEGETABLE GARDEN



# OUTDOOR SPACE VEGETATION

Native trees with dense tree canopies and high drought tolerance are (Green Cities, 2019):



- Field maple or Spanish oak (*Acer campestre* 'Elsrijk')



- Small-leaved lime tree (*Tilia cordata* 'Greenspire' or 'Rancho')



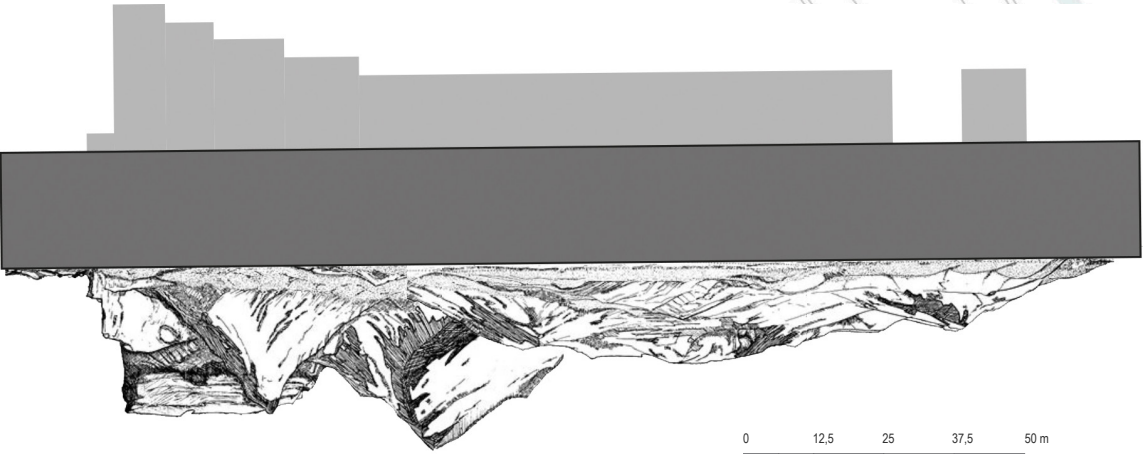
- Japanese caucasian alder (*Alnus spaethii*)



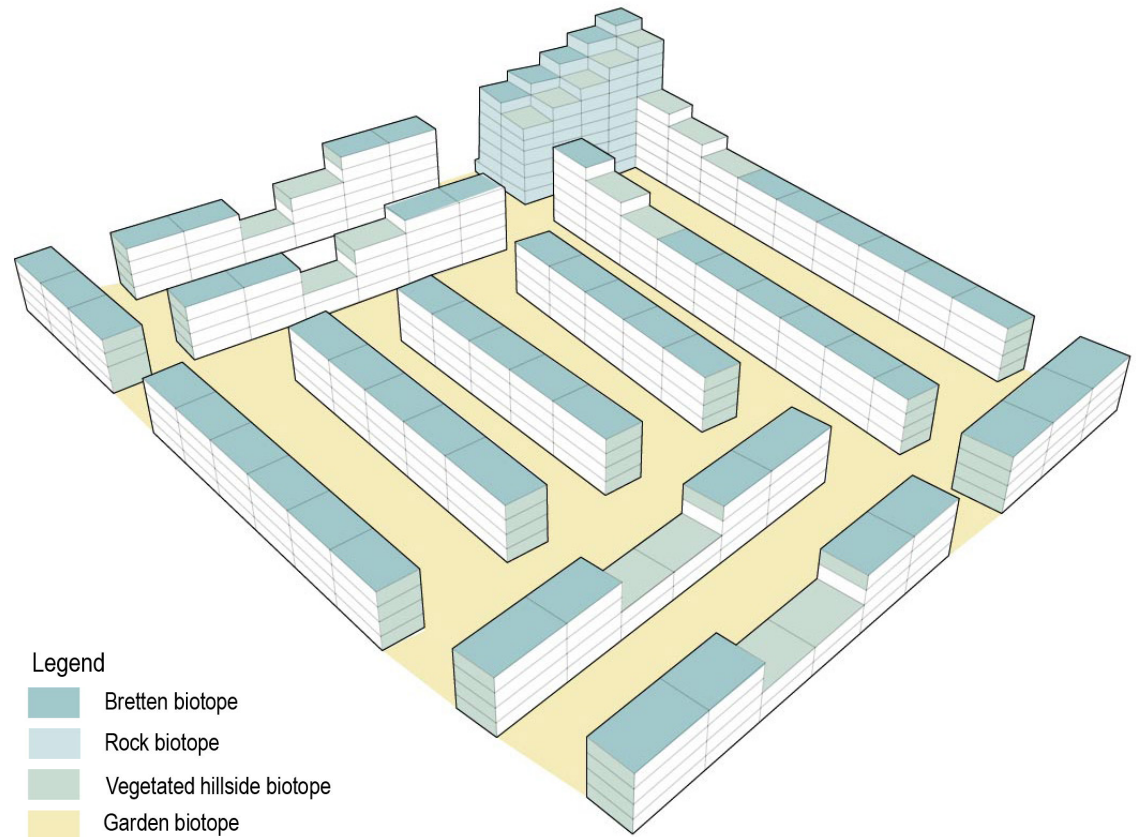
- European nettle tree (*Celtis australis*)



# OUTDOOR SPACE EXPERIENCE



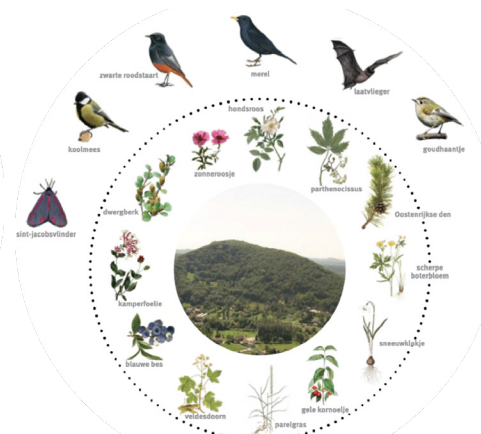
# OUTDOOR SPACE BIOTOPES



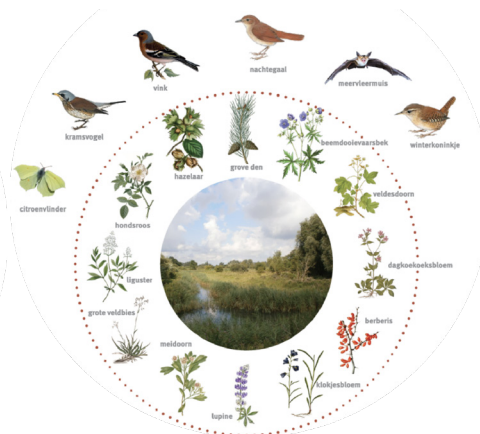
- Legend**
- Breten biotope
  - Rock biotope
  - Vegetated hillside biotope
  - Garden biotope



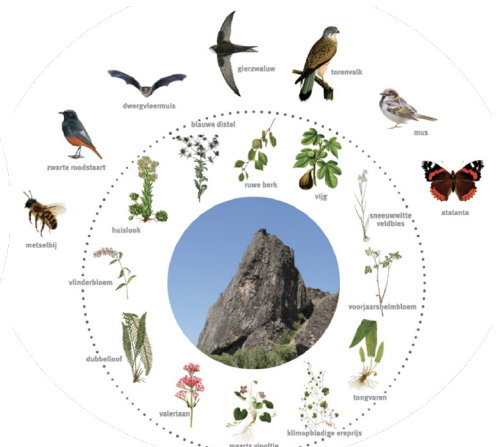
GARDEN BIOTOPE



VEGETATED HILLSIDE BIOTOPE



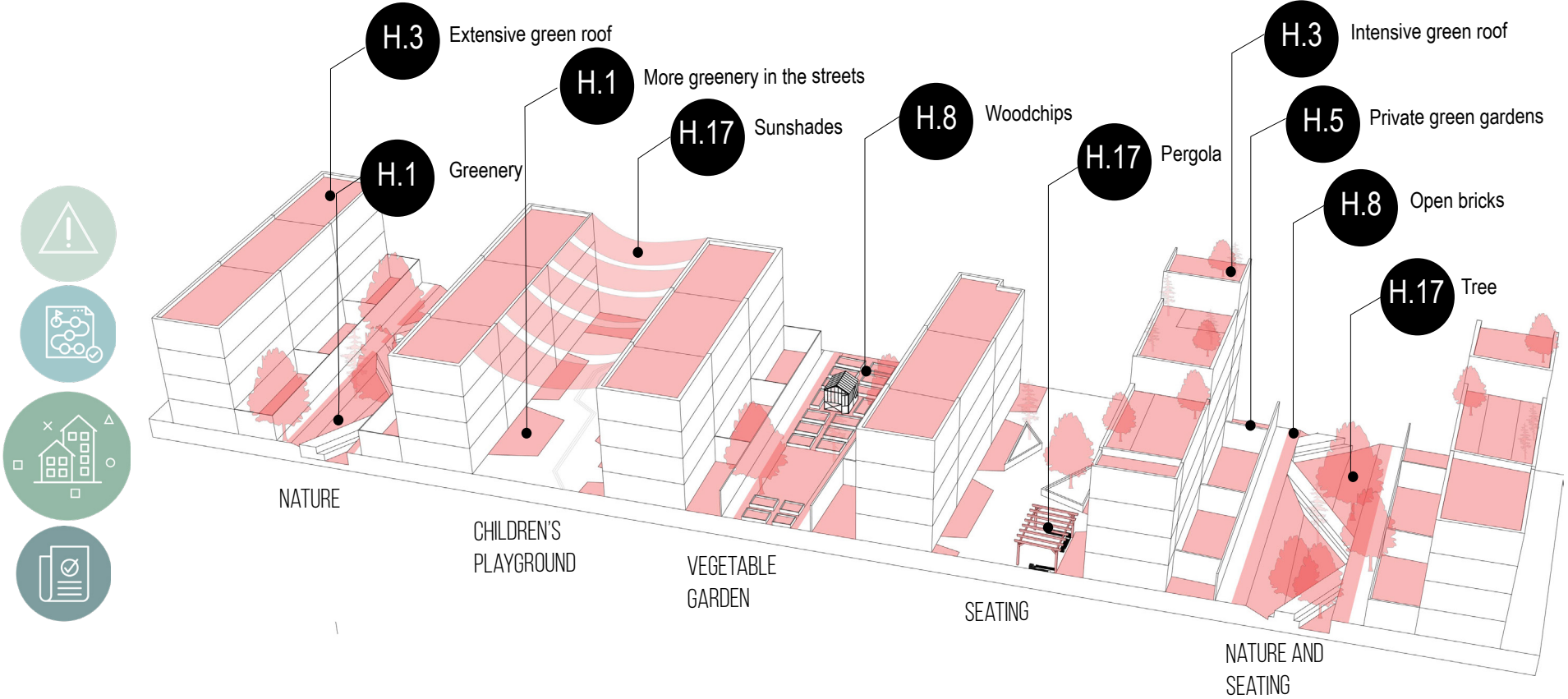
BRETEN BIOTOPE



ROCK BIOTOPE

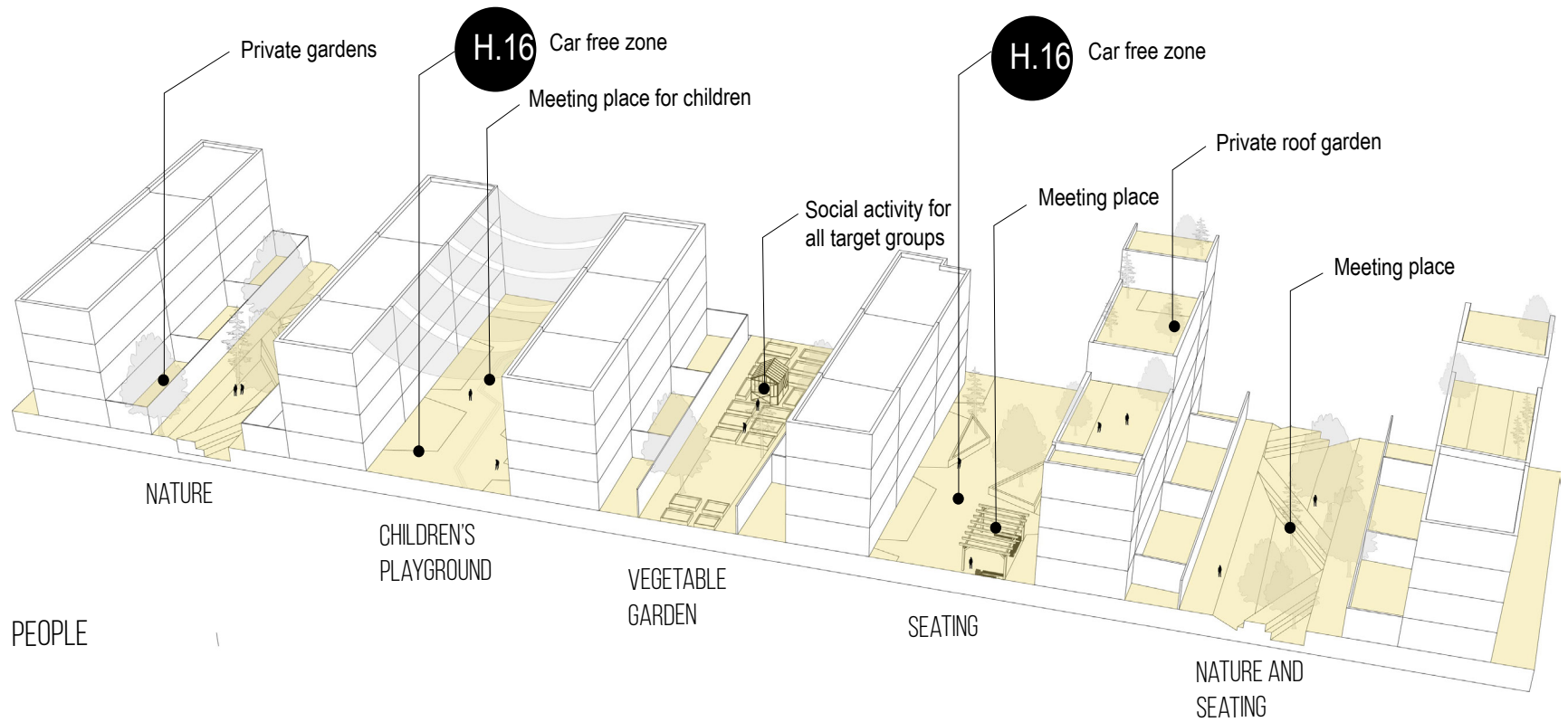
# CONCLUSION DESIGN

## HEAT STRESS



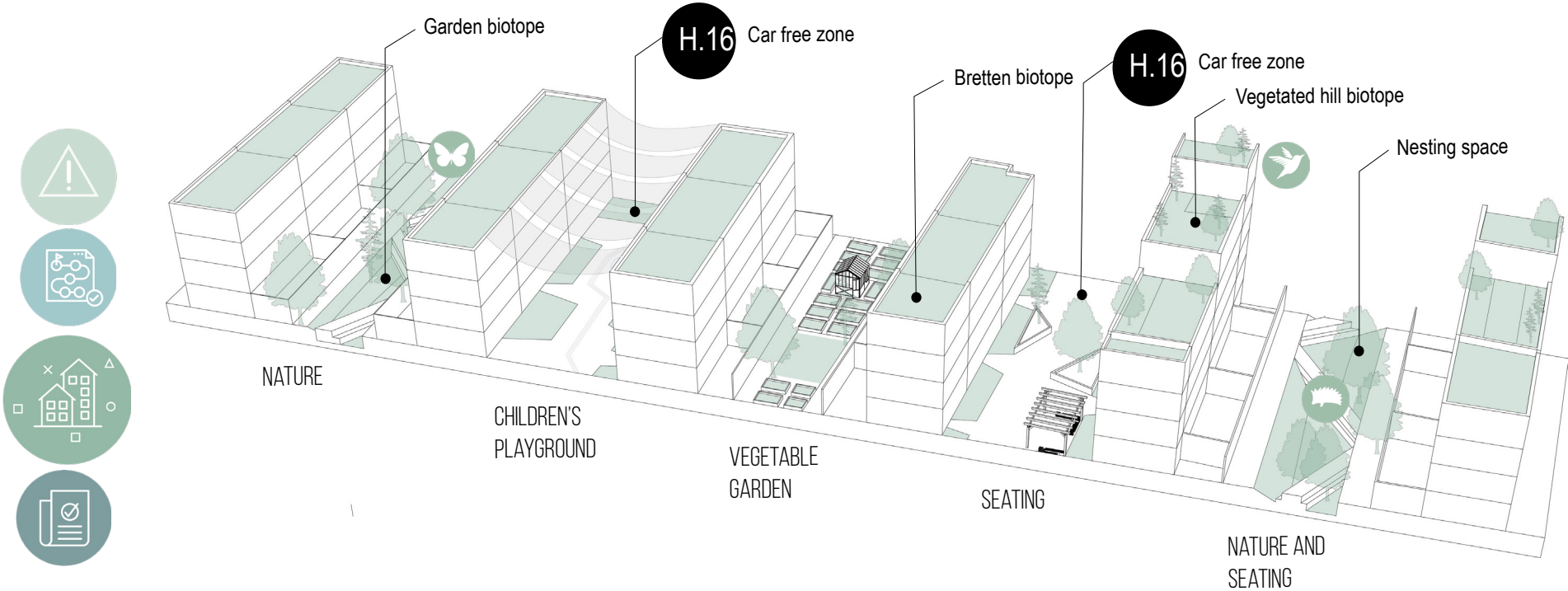
# CONCLUSION DESIGN

## PEOPLE



# CONCLUSION DESIGN

## ECOLOGY





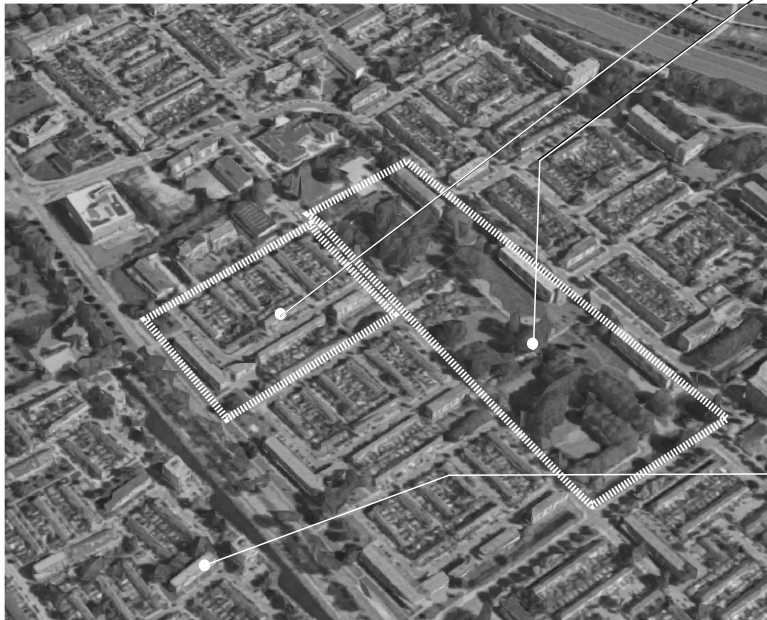
# CONCLUSION

## TRANSFERABILITY

### THE EARLY POST-WAR NEIGHBOURHOOD



#### Presikhaaf, Arnhem



Open building blocks, stamped  
Large collective green

Post-war entoned  
housing construction  
Semi-public space  
Domination  
of the car

#### Agreements:

- + Monotone residential buildings
- + Stamping building blocks
- + Collective green areas
- + Separation between living, working and recreation
- + The public space filled with cars
- + High percentage social rent
- + High percentage of low income residents

#### Differences:

- Stakeholder composition

# CONCLUSION

## TRANSFERABILITY

### 1970S AND 1980S NEIGHBOURHOOD



#### Agreements:

- + Architecture of the buildings
- + Collective green areas
- + The public space filled with cars
- + High percentage social rent
- + High percentage of low income residents
- +Density

#### Differences:

- Structure of the neighbourhood
- Morphology of the buildings

### Venserpolder, Amsterdam



Closed building blocks, stamped

Collective green

Monotome housing construction

Street oriented to the car



# CONCLUSION

## MAIN QUESTION



**How to densify in The Hague in order to mitigate and prevent heat stress and the urban heat island effect to improve the livability of the city and the health of its inhabitants?**

# CONCLUSION

## REFLECTION



**Relation between research and design**

**Methodology**

**Outcome**



Source: Photo taken by author.

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