Unraveling Heatscape

Heat, Inequality, and Microclimates:
Rethinking Architecture for Thermal Security



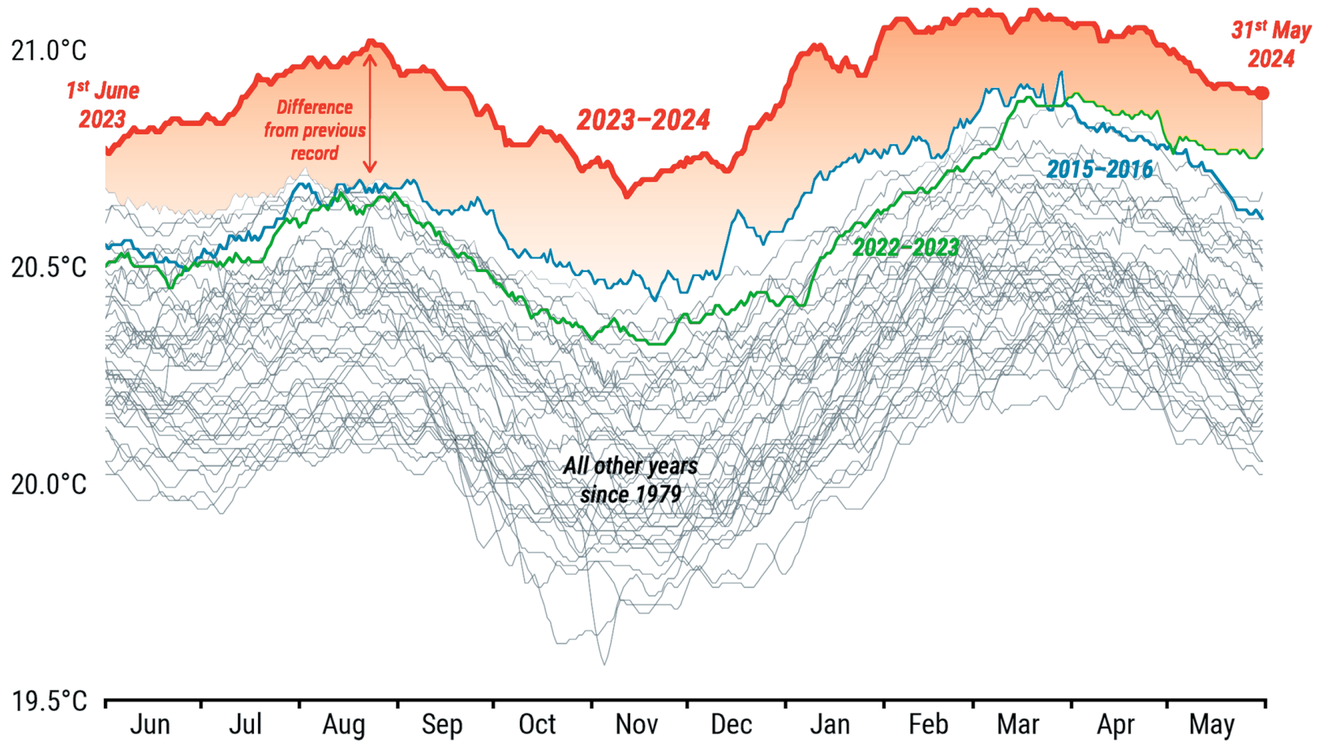
Man struggling to cope with heat at the Piazza del Popolo in Rome. Reuters (Jul 19, 2023) Financial Review

Is heat a luxury, or a threat?


Delft
My Location
10°
Sunny
H:11° L:0°
Taipei
26°
Cloudy
H:27° L:20°
Madrid
2:24 pm
10°
Rain
H:11° L:7°

Daily sea surface temprerature for 60°S-60°N

Data: ERA5 1979-2024 Credit: C3S/ECMWF



the impact of heatwaves is not borne equally within cities



Paul White/AP (2023,EuroNews Green)

Madrid

People cool off at a fountain in Madrid Rio Park during the first heatwave of the year in Madrid, June, 2022. (Reuters)

in Madrid

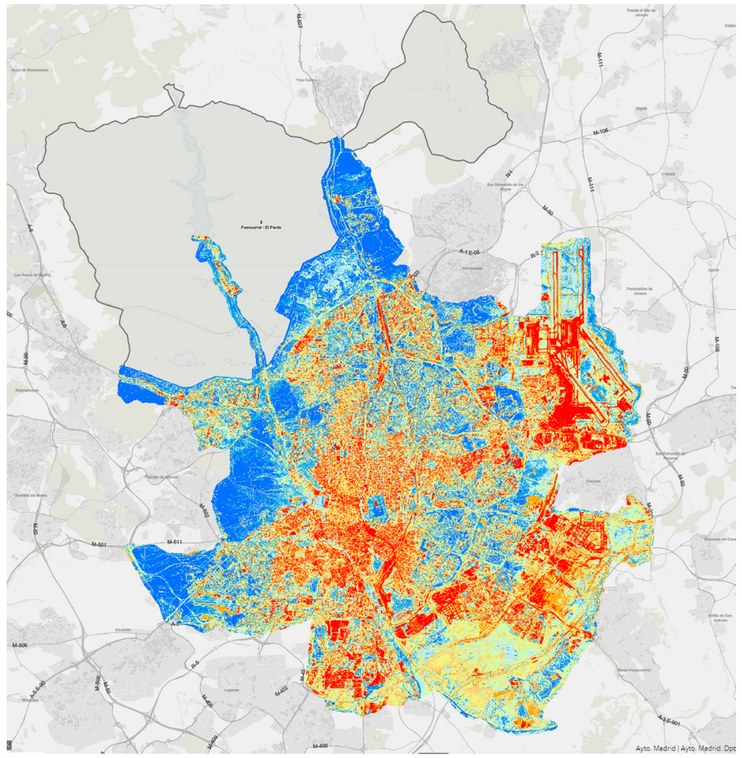
- 4th city in the world with the highest deaths due to heatwaves
- 1,243 heatstroke deaths were recorded in 2022
- 12% premature mortality rate
- Spain experiences warmest autumn in 2023 with record temperatures reaching 32°C

MADRID NO FRILLS

CLIMATE CRISIS

MADRID'S CLIMATE INEQUALITY: TEMPERATURE READINGS REVEAL 15-DEGREE DIFFERENCE BETWEEN RICH AND POOR BARRIOS

10 July 2023



Government of Madrid. (2022). Mapa de Isla de Calor Urbano. Año 2022

Heat, Inequality, Microclimate

Health Risk

the elderly, pregnant women, children, and people with neurodegenerative diseases



Mexico, photo by Felix Marquez / AP (June 21, 2024, NBC News)

Energy Poverty

high energy prices + low household income + poor energy efficiency in homes



old lady sitting at her door in La Ventilla

Green Gentrification

new green infrastrcuture leads to unintended displacement



new residential buildings in Tetuan. retrieved from https://www.eefjevoogd.nl/nl/projecten/skylinemadrid/

Aggravating Inequality

.
.
.
urban heat island
pre-existing health conditions
less greenary in the neighbourhood
outdoor labour
high energy price
low household income
poor energy efficiency in homes
living alone
lack of access to cooling infrastructure
overworked healthcare systems
limited awareness and education
displacement from green gentrification
overcrowded living conditions
language and cultural barriers
landlord constraints on tenants
.
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.
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Thermal Comfort

~~Aggravating Inequality~~

urban heat island
pre-existing health co ns
less greenary in the ne urhood
outdoor l
high ener rice
low house' income
poor energy e ency in homes
liv lone
lack t oling infrastructure
overw lthcare systems
limited aw ducation
displacemen m grec tion
overcro d living conditi
langu nd cultural barriers
lan constraints on tenants

Current Methodology
(Numerical-Based)

Meteorological Data
Infrared Satellite Imaging
Patterns on Large-scale Maps
Census Tract and Demographic Groups
Proxies of Vulnerability

+

alternative perspectives
(lived experience)

ethnography
interviews
photography
questionnaires
microclimate observation

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Heat, Inequality, **Microclimate**

Heat Reality in Madrid



To maintain a core temperature of 37°C, the human body relies initially on natural thermal regulation processes like thermogenesis and thermolysis. When these mechanisms are insufficient in extreme temperatures, additional methods become necessary to offset external climatic conditions. For instance, in the metro, passengers employ personal fans to generate a localised airflow, boosting evaporative cooling from sweat. Wearing lightweight, breathable clothing enhances air circulation around the skin, supporting the body's thermoregulatory efforts.



The human body constantly exchanges heat with its surroundings through radiation, convection, evaporation, and conduction, creating a microclimate around itself. In an outdoor market, a woman shields herself with an umbrella-shaped hat, blocking direct sunlight and reducing heat absorption. Others around her wear lightweight clothing suited to the season, enhancing air circulation. The shaded areas provide additional relief. This scene illustrates adaptations such as clothing choices and shade-seeking to help individuals manage the heat.



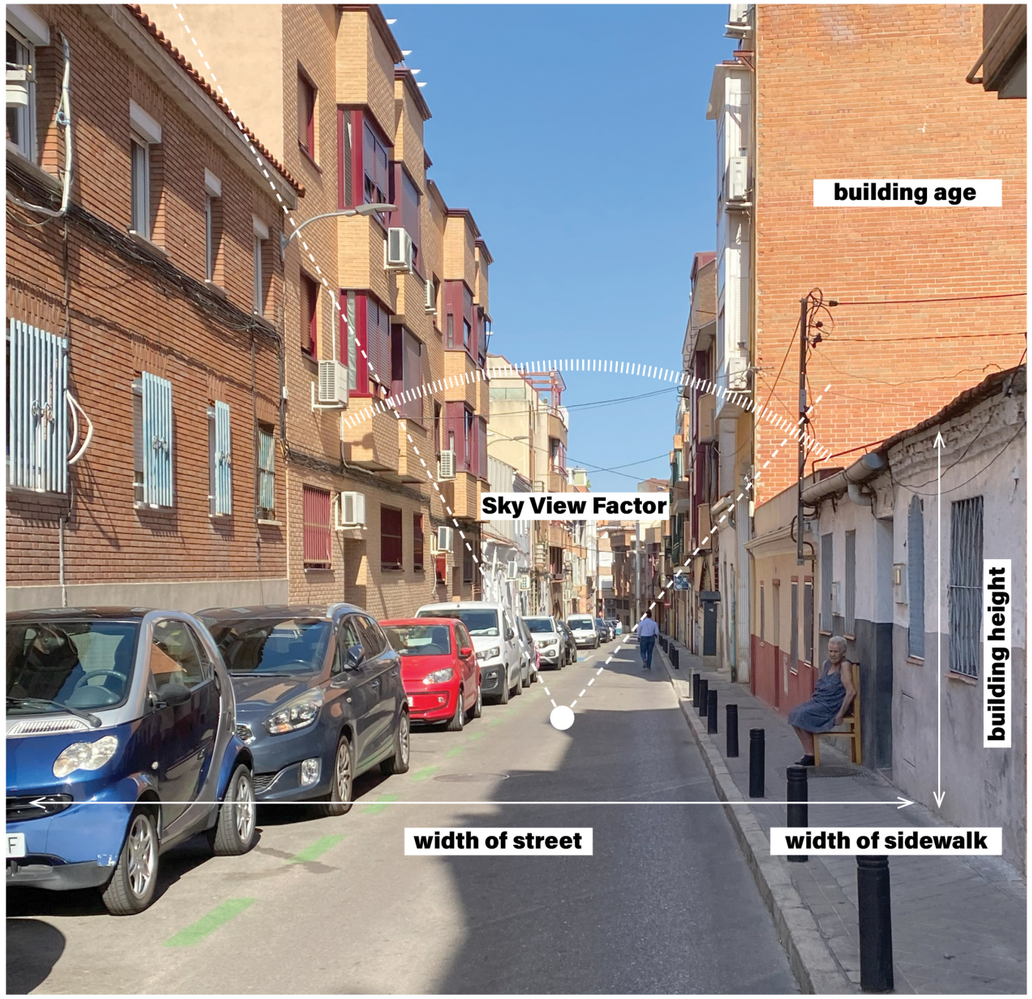
This patchwork façade showcases the individual strategies residents employ to contend with the sun's relentless heat. Designed initially with open balconies to provide horizontal shading, many have enclosed these spaces, unintentionally trapping heat. Now, a layering of apparatus—curtains, windows, shutters, awnings, and louvres—allows residents to adjust height and angle, ensuring just the right amount of sunlight enters without overheating their homes. Each adaptation reflects a family's ongoing negotiation with the heat, one window at a time.



Despite being a community centre, the dark façade feels unwelcoming, its low albedo material absorbing significant solar radiation and radiating heat back into the surrounding environment. The minimal openings reduce indoor heat gain but intensify the oppressive heat outdoors, making the space less inviting. The solid, windowless ground floor—likely shaped by Madrid's uneven terrain—adds to this sense of separation, creating both a thermal and psychological barrier for those it aims to serve.



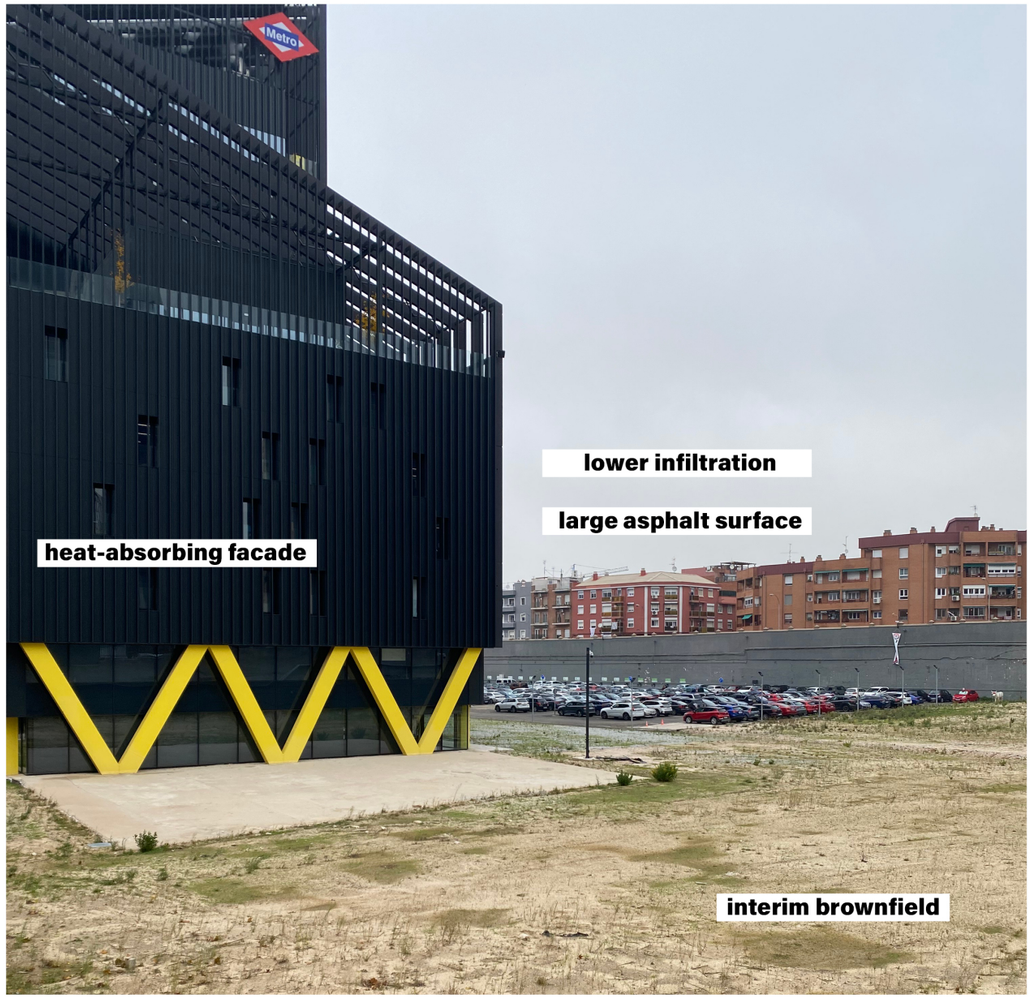
Under the protective canopy of trees, the street feels like a sanctuary. Beyond offering shade, the trees release moisture through transpiration, further cooling the air and enhancing comfort. This tranquil oasis highlights the profound role greenery plays in mitigating heat, a privilege often more evident in some neighbourhoods than others. The shade not only reduces thermal gain to surrounding buildings but also cools the streetscape, inviting moments of pause, connection, and relief from the urban heat.



The narrow street lacks space for trees, depriving pedestrians of cooling greenery. While the low sky view factor allows buildings to provide shade, it also traps heat, with surfaces reflecting warmth between them, making midday walks an ordeal. At her doorway, an old woman sits on a stool, escaping the stifling heat of her home—a building older than the rest, likely constructed before modern regulations for thermal efficiency. With limited ventilation and thermal insulation, the building struggles to shield its occupants from the unrelenting heat.



The mirrored glass façade reflects distorted images of the four towers in the CBD onto the opposite side of the boulevard, creating a surreal and almost confrontational experience. While the low emissivity system reduces heat entering the offices, its high reflectivity intensifies glare and radiates heat back into the surrounding streetscape. Pedestrians squint and adjust their paths to escape the searing reflections, while office workers behind the glass retreat into air-conditioned bubbles, further disconnected from the baking street below.



This barren expanse, an interim brownfield, lies idle as part of a planned development that has yet to materialise. Without vegetation, the dry, exposed soil and sprawling asphalt parking lots absorb and radiate heat, amplifying the urban heat island effect and adding to air pollution in the area. While the proposed design envisions this site as a green, welcoming public area that could enhance the neighbourhood, its current state serves as an environmental burden, intensifying thermal stress and reducing the overall comfort for nearby residents.



The sloping terrain of Madrid presents a challenge for those navigating the city. The incline demands physical effort, turning what might be a simple walk into an exhausting ordeal under the relentless sun. The lack of shaded pathways or cooling resources along these streets compounds the struggle, leaving pedestrians exposed to both the heat and the effort of climbing. For many, the combination of uneven topography and high temperatures transforms everyday mobility into an uncomfortable and draining experience.



This loggia, originally designed as a shaded, semi-open space to respond to the local climate, reflects architectural efforts to provide cooling and comfort. However, its potential as a communal space has been compromised by the addition of gates, likely installed to deter use by the homeless. The uneven terrain and height difference in this area further limit accessibility, making what was intended as a cooling, inviting space inaccessible and leaving its original purpose unfulfilled.


La Ventilla



Significant Terrain Variation



Highly Reflective Facades



Heat-Absorbing Surfaces



Improvised Balcony Extensions
Lack Horizontal Shading











Passive Cooling to enhance thermal comfort and energy independence

fostering **Community Agency** and **Psychological Comfort**

preserving **Affordability** while enhancing functionality

Passive Cooling to enhance thermal comfort and energy independence



fostering Community Agency and Psychological Comfort



This community garden,granted temporary use by the municipality, is proposed to become a formal park as part of the green infrastructure.

preserving **Affordability** while

enhancing functionality



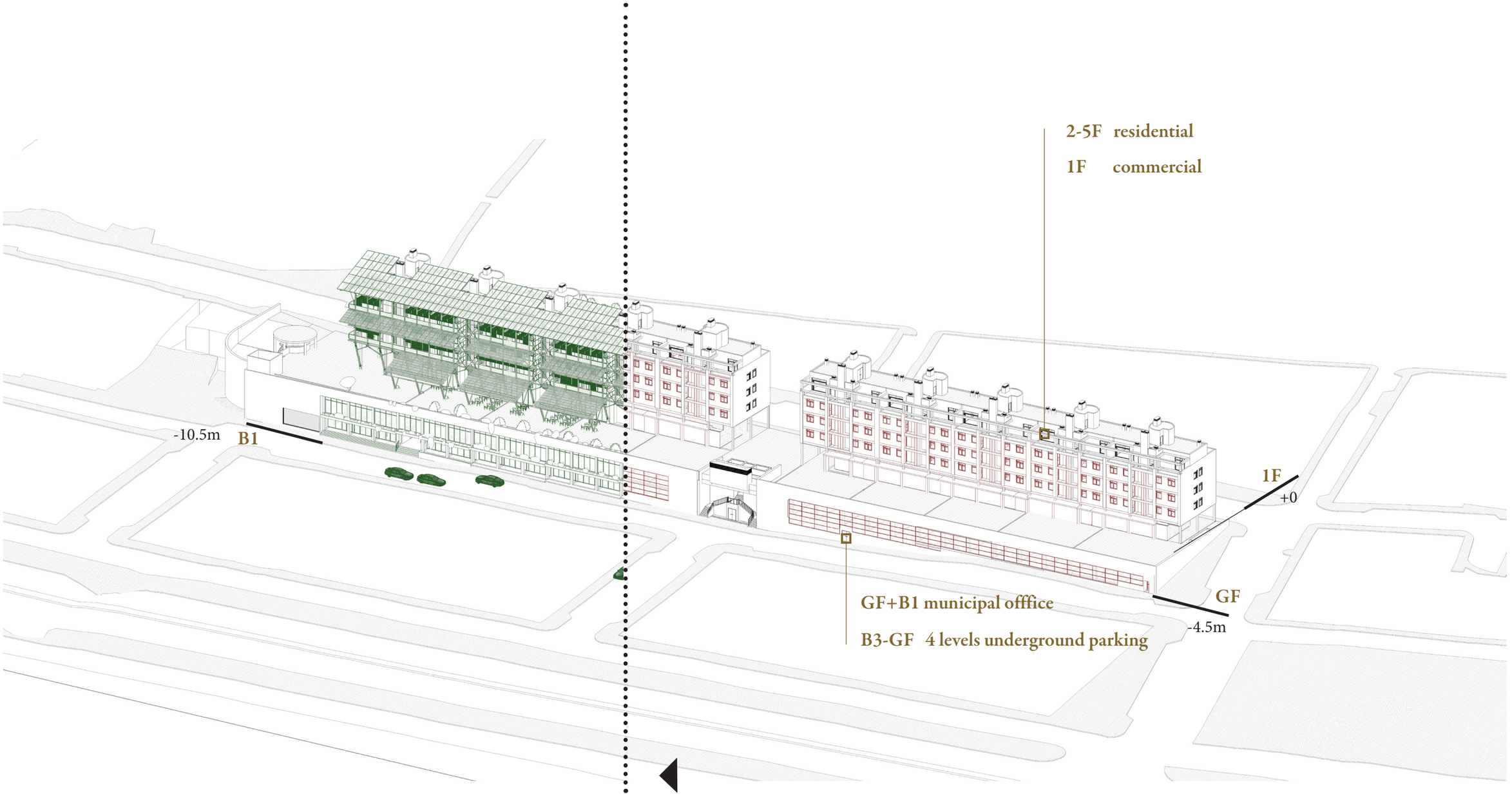
The ground floor hosts businesses like online and delivery services, drawn by lower costs compared to the city center, but this displaces local businesses that foster community connections.



Passive Cooling to enhance thermal comfort and energy independence

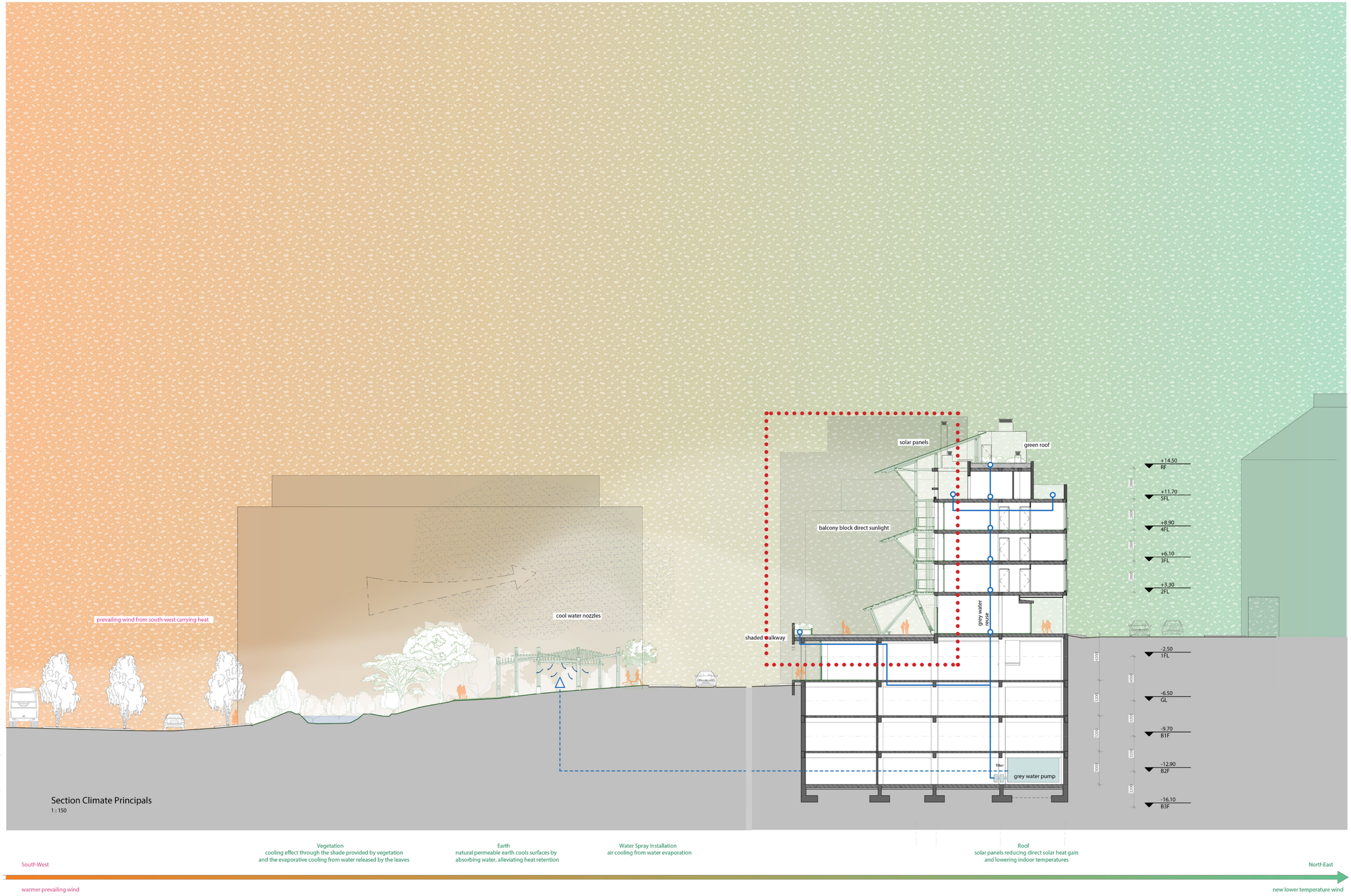
fostering **Community Agency** and **Psychological Comfort**

preserving **Affordability** while enhancing functionality

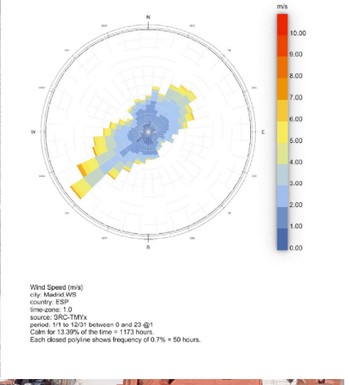


potentials of the site?


big terrace
N
SW



solar panels
green roof
balcony block direct sunlight
prevailing wind from south-west carrying heat
cool water nozzles
shaded walkway
grey water reuse
filter
grey water pump
+14.50 RF
+11.70 5FL
+8.90 4FL
+6.10 3FL
+3.30 2FL
-2.50 1FL
-6.50 GL
-9.70 B1F
-12.90 B2F
-16.10 B3F
Section Climate Principals
1 : 150
Vegetation
cooling effect through the shade provided by vegetation
and the evaporative cooling from water released by the leaves
Earth
natural permeable earth cools surfaces by
absorbing water, alleviating heat retention
Water Spray Installation
air cooling from water evaporation
Roof
solar panels reducing direct solar heat gain
and lowering indoor temperatures
South-West
North-East
warmer prevailing wind
new lower temperature wind



Wind Speed (m/s)
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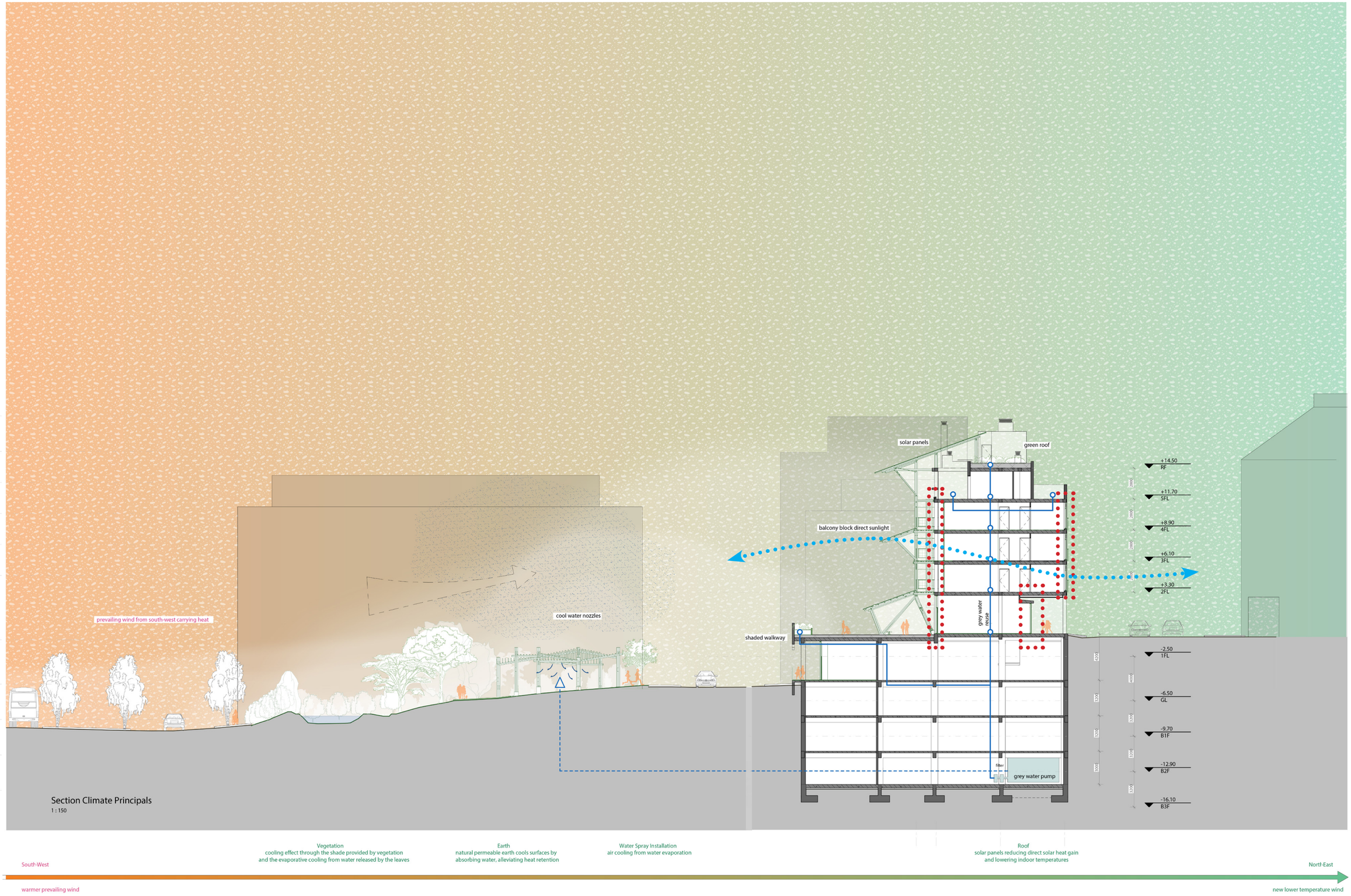
country: ESP
time-zone: 1.0
source: SRC-TMYx
period: 1/1 to 12/31 between 0 and 23 @1
Calm for 13.39% of the time = 1173 hours.
Each closed polyline shows frequency of 0.7% = 50 hours.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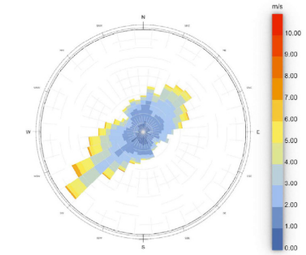
vacant public land
N
SW



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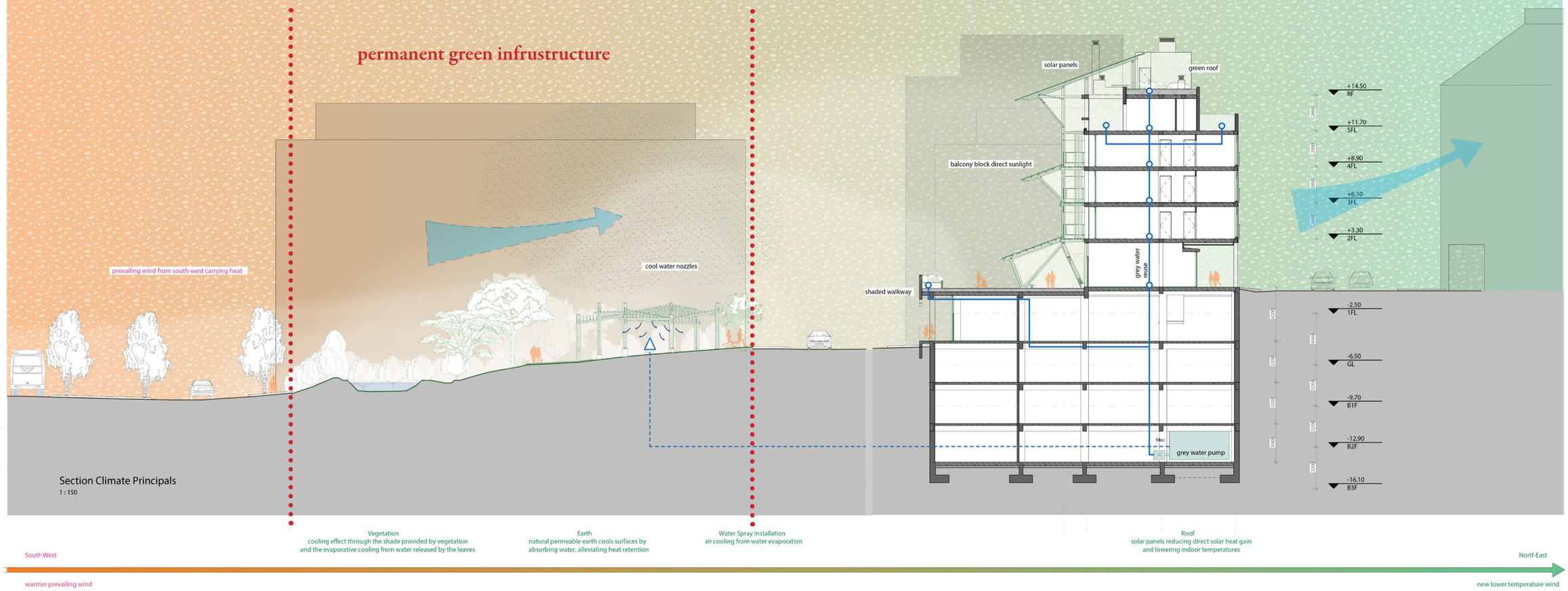
permanent green infrustructure



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air cooling from water evaporation

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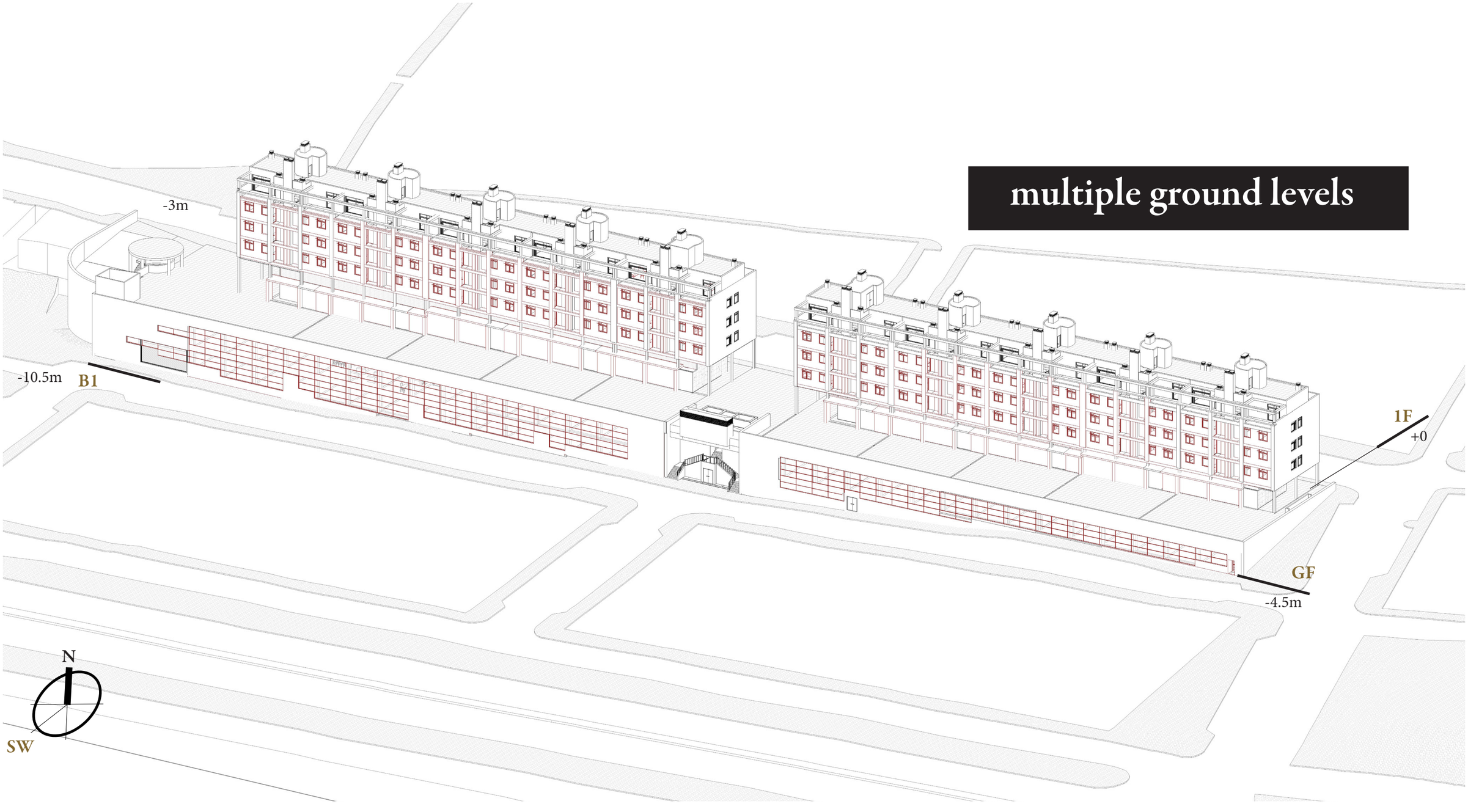
South-West

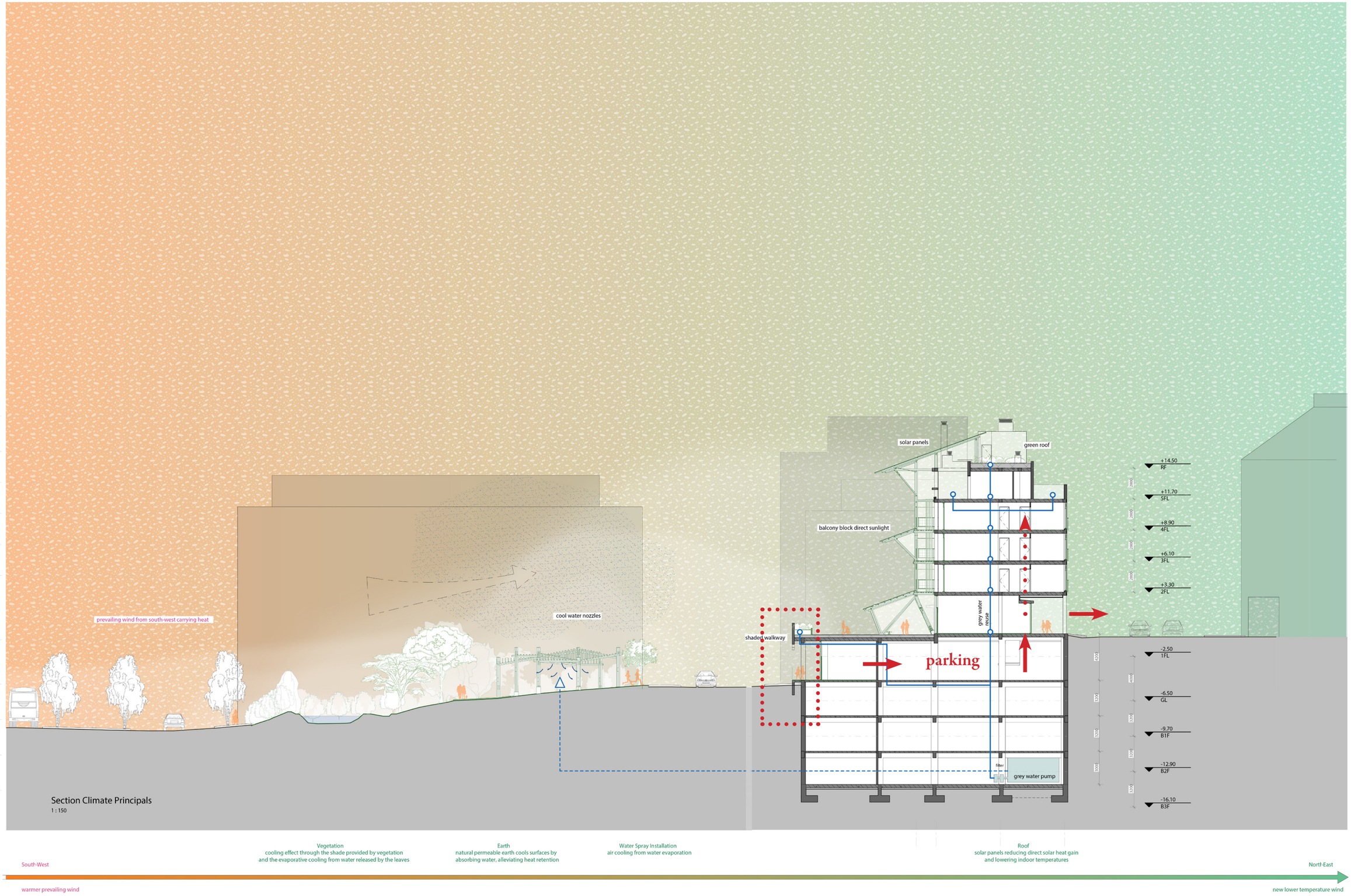
warmer prevailing wind

North-East

new lower temperature wind

multiple ground levels

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AGENCIA DE VIVIENDA SOCIAL
social housing department


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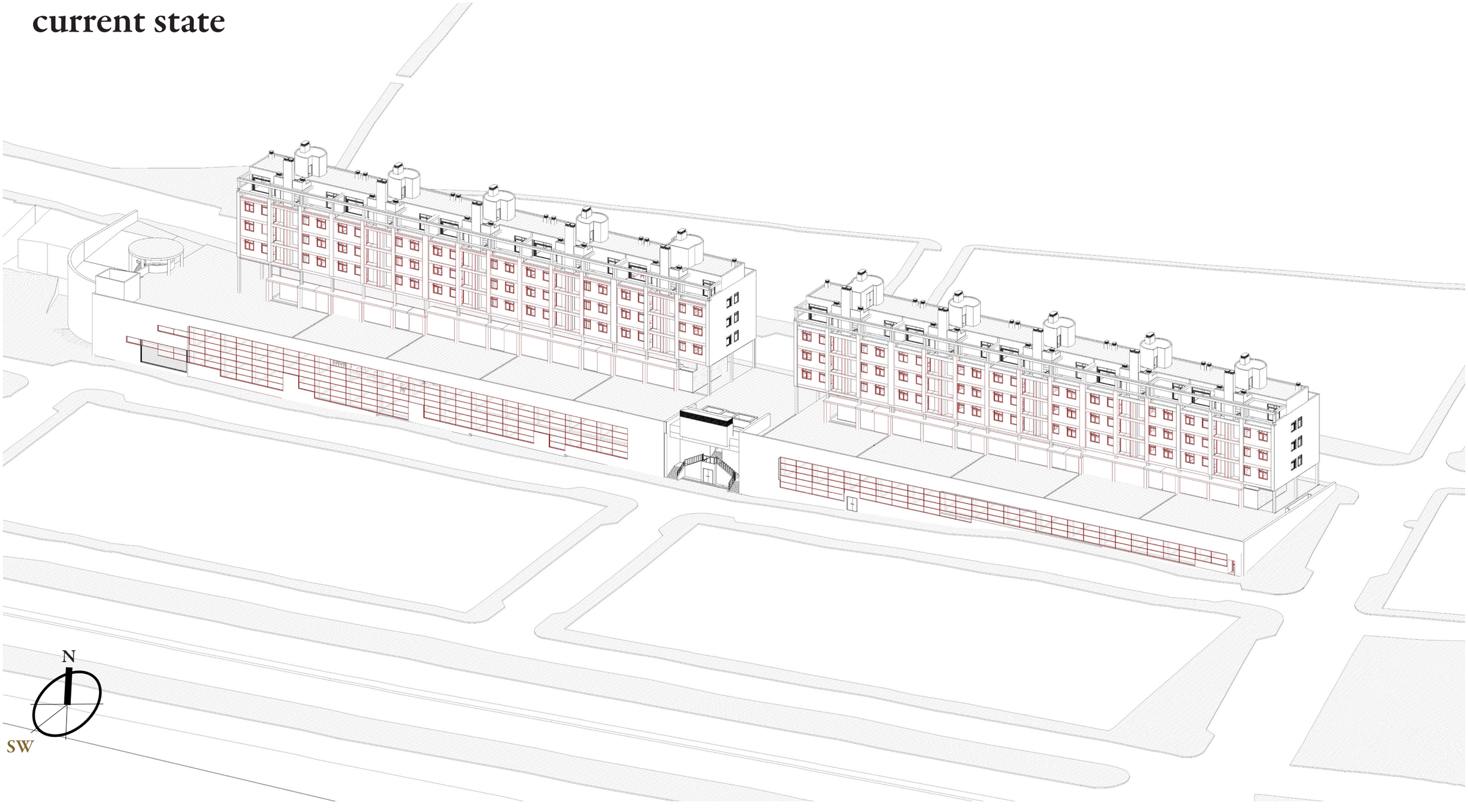
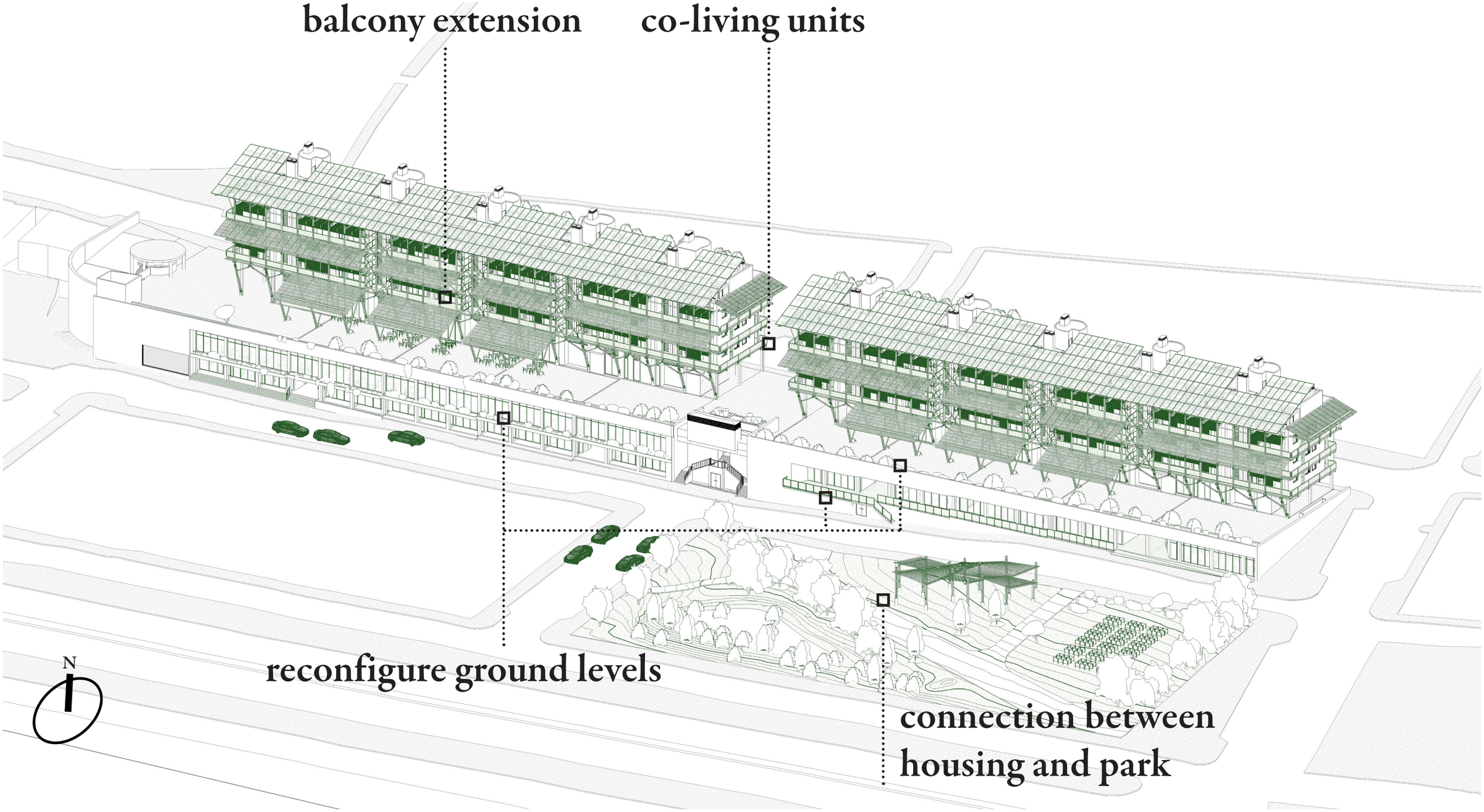
social housing department

current state

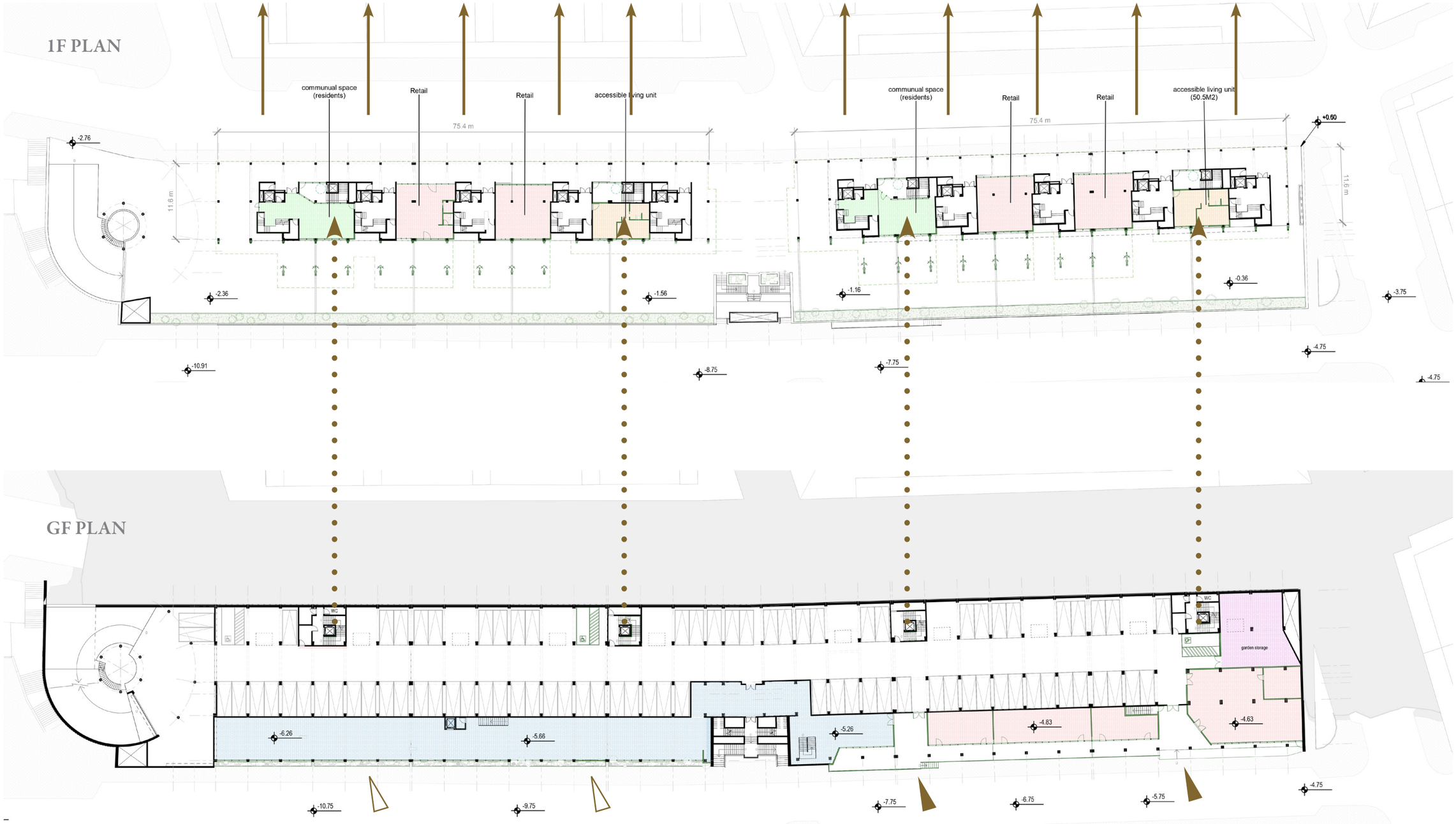



balcony extension
co-living units
reconfigure ground levels
connection between
housing and park
N


9877 FTX



1F PLAN



access to the elevators from B1

ground floor access to the elevators

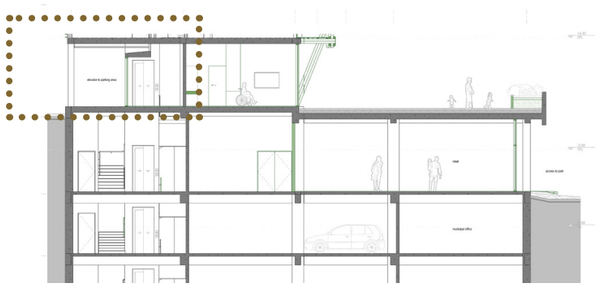
467 parking spaces

70 residential units

unraveling heatscape

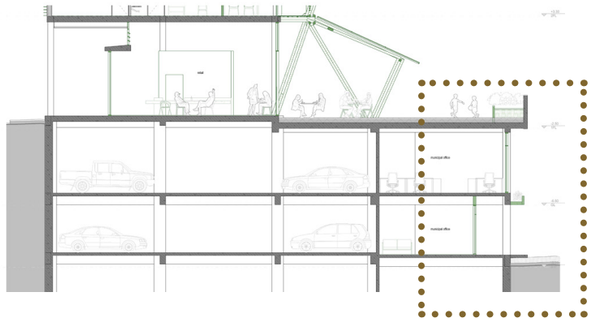





elevator to parking area
roof
access to park
municipal office

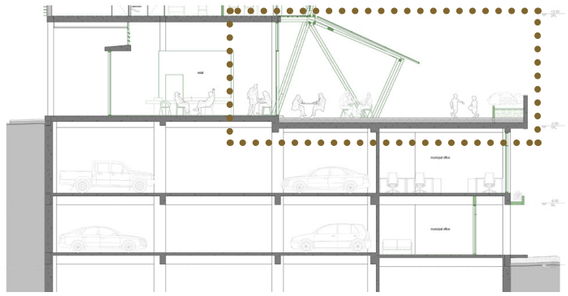

Mahou





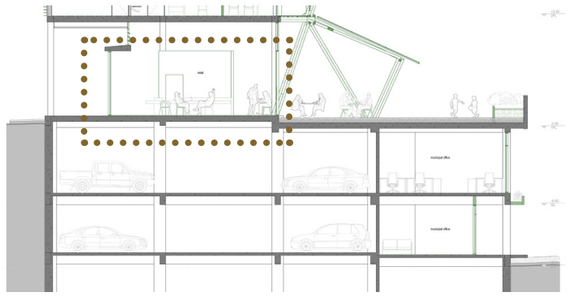








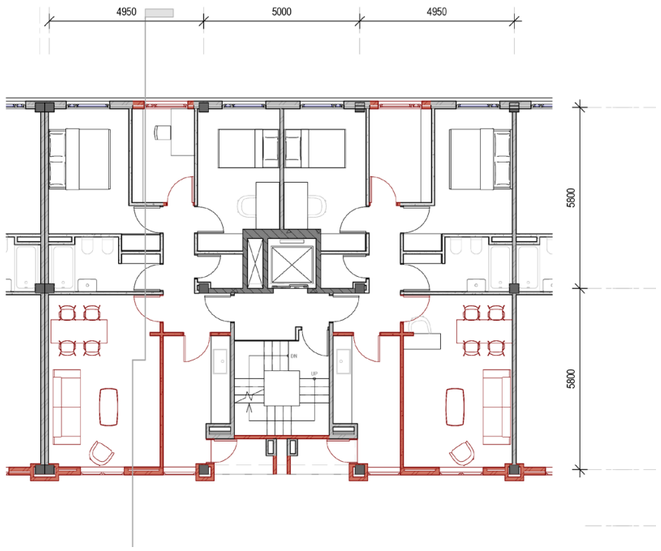








Housing 3F_Standard Unit (Existing)
1 : 100



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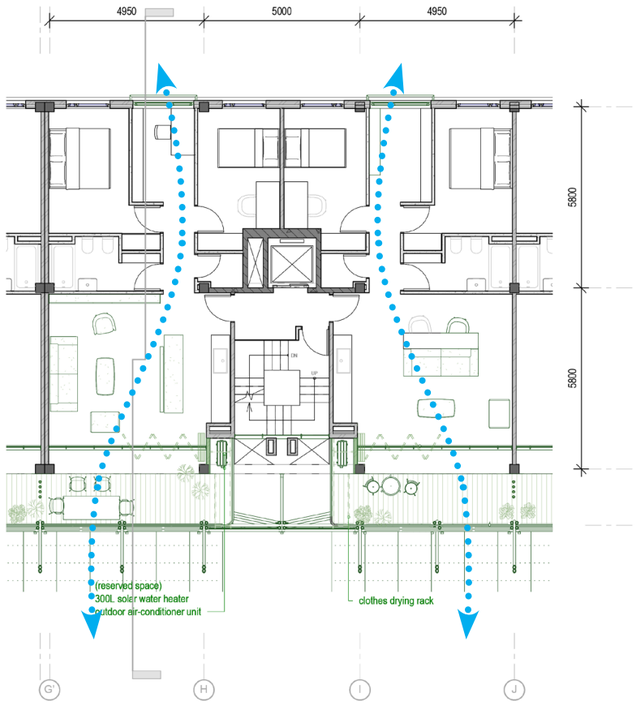
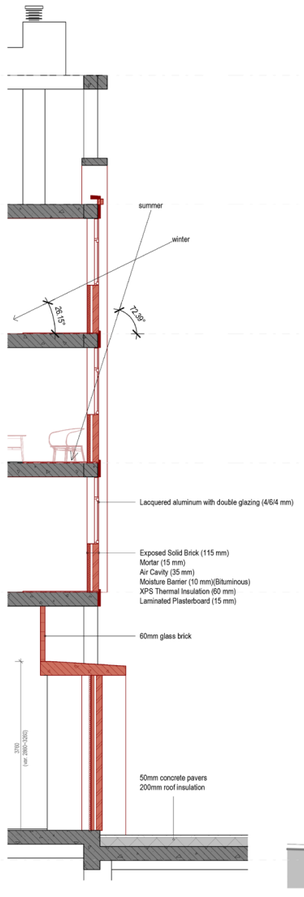
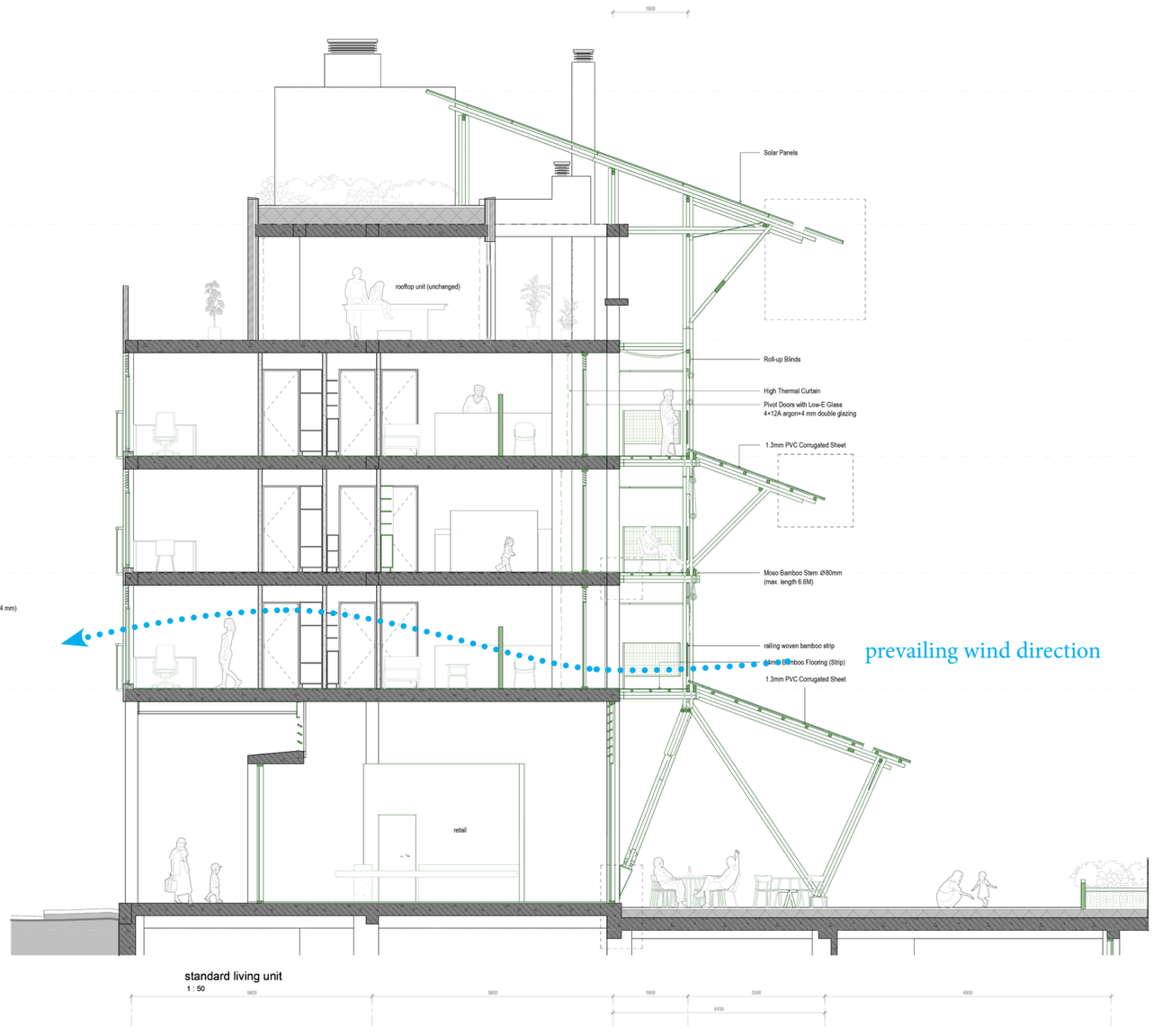




Section Standard Unit (Existing)
1 : 50



standard living unit
1 : 50

Housing 3F_Standard Unit (Existing)
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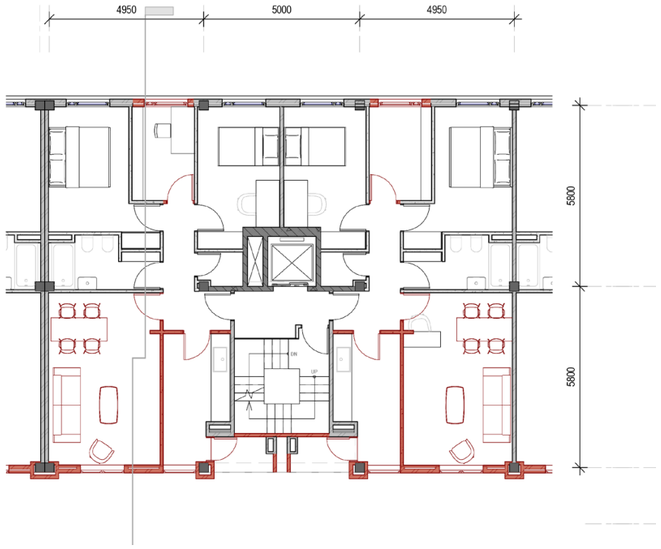

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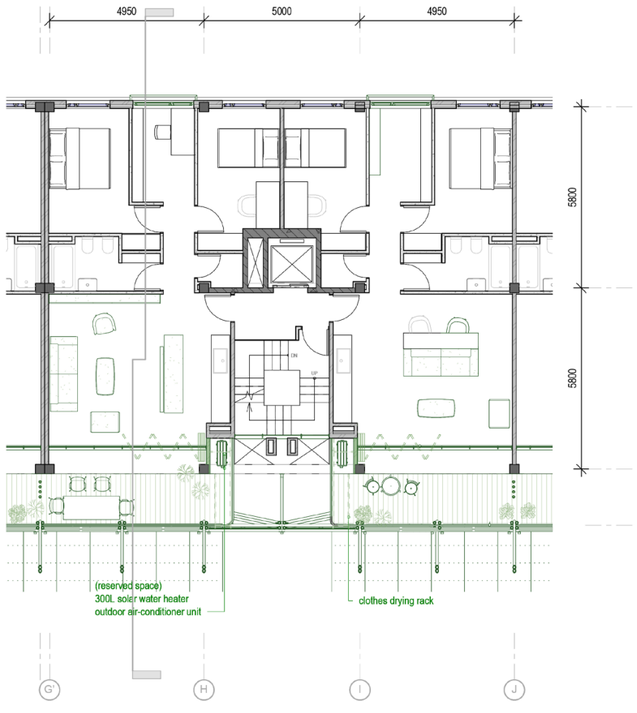

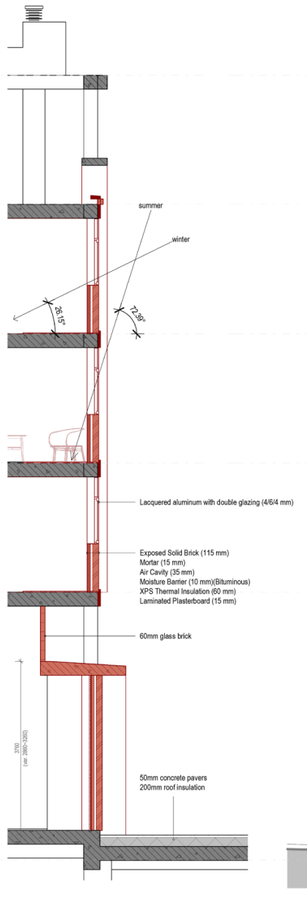

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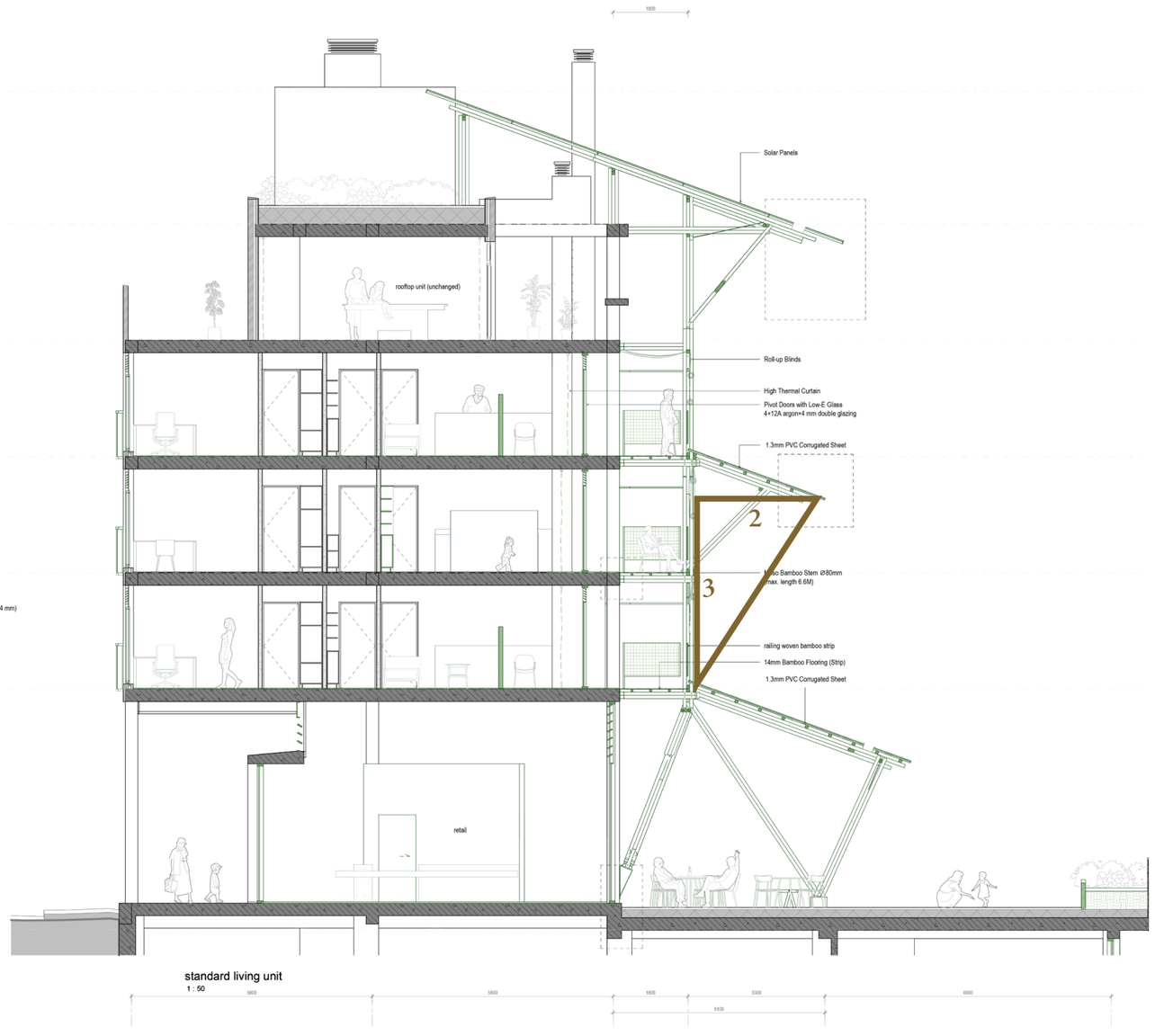

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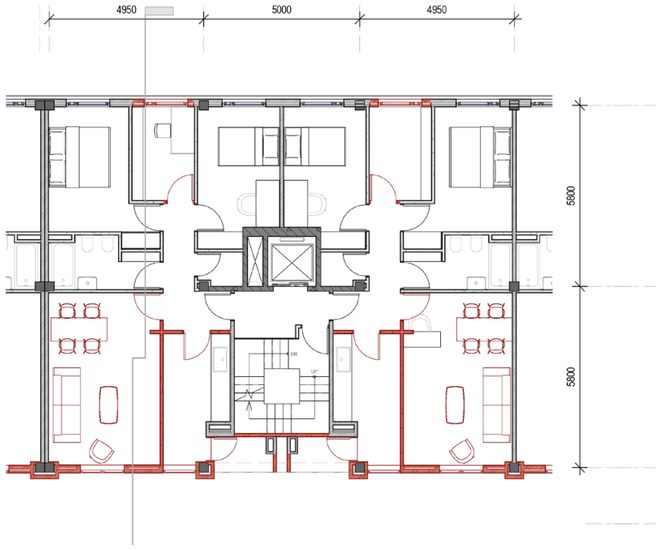

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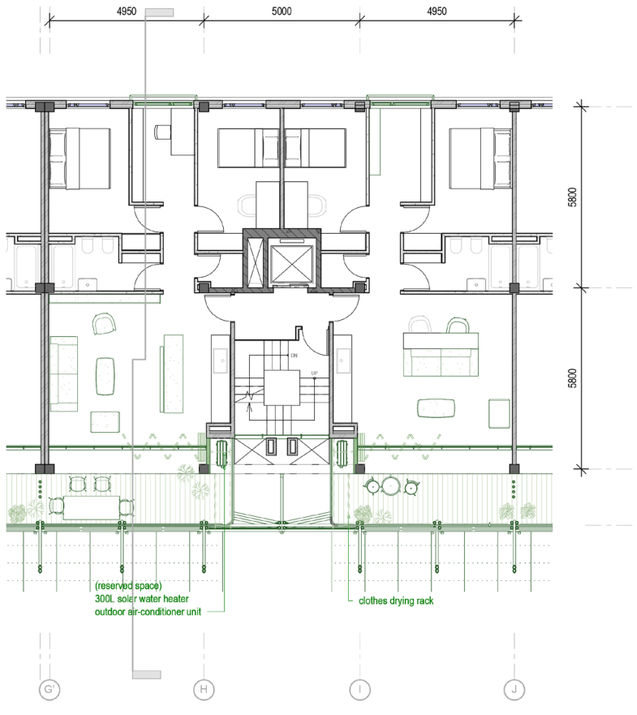

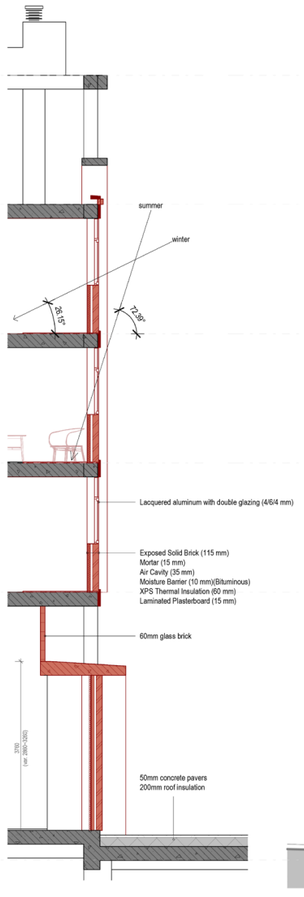

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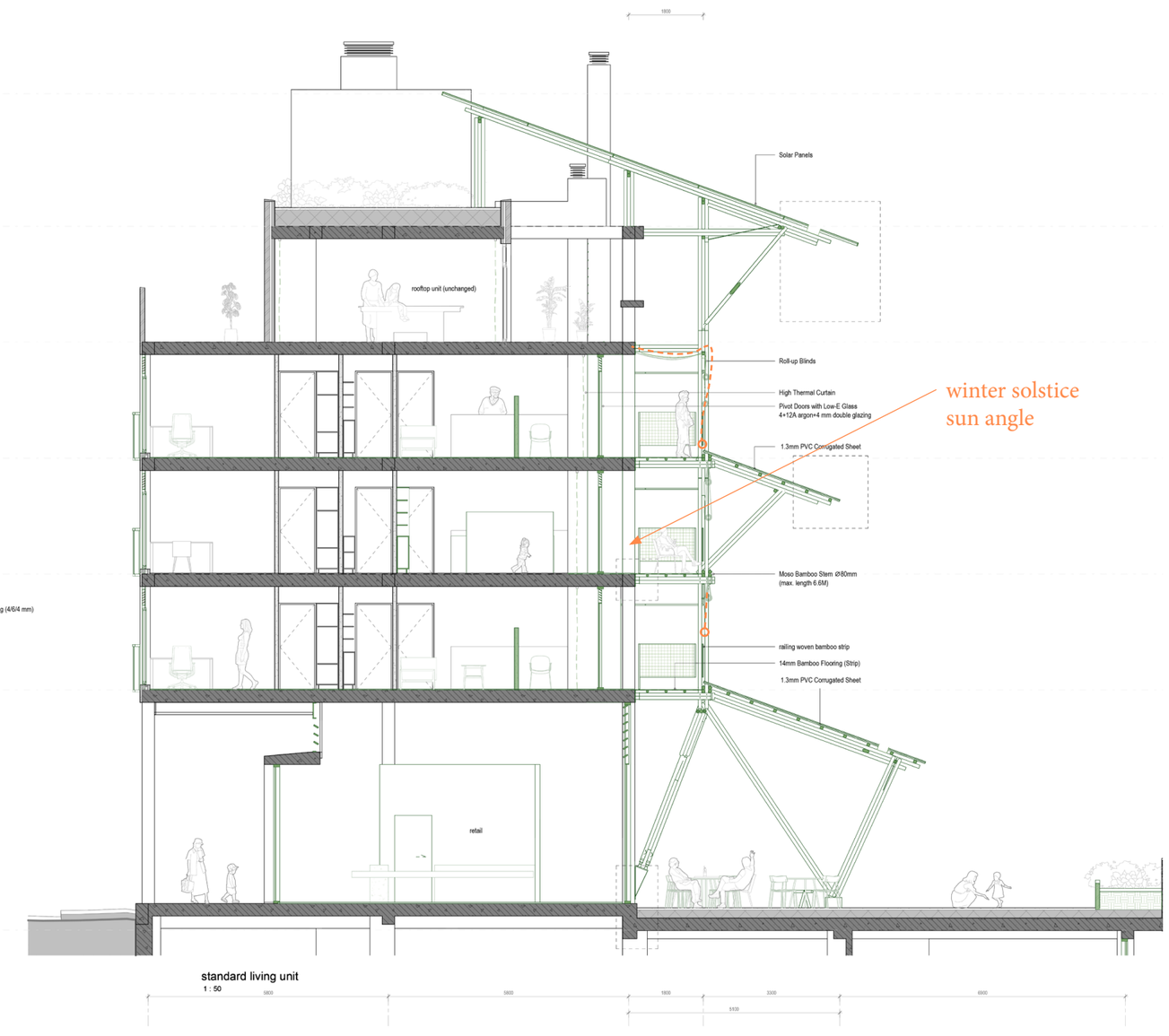
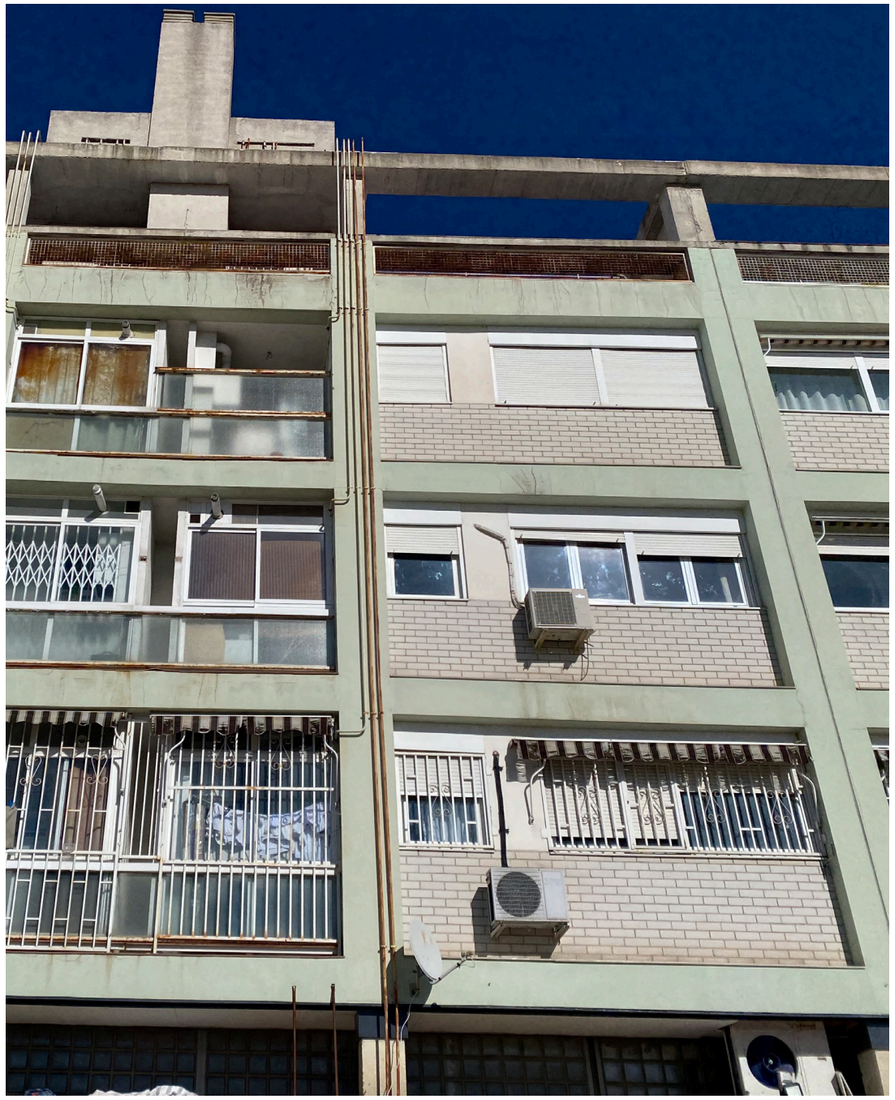
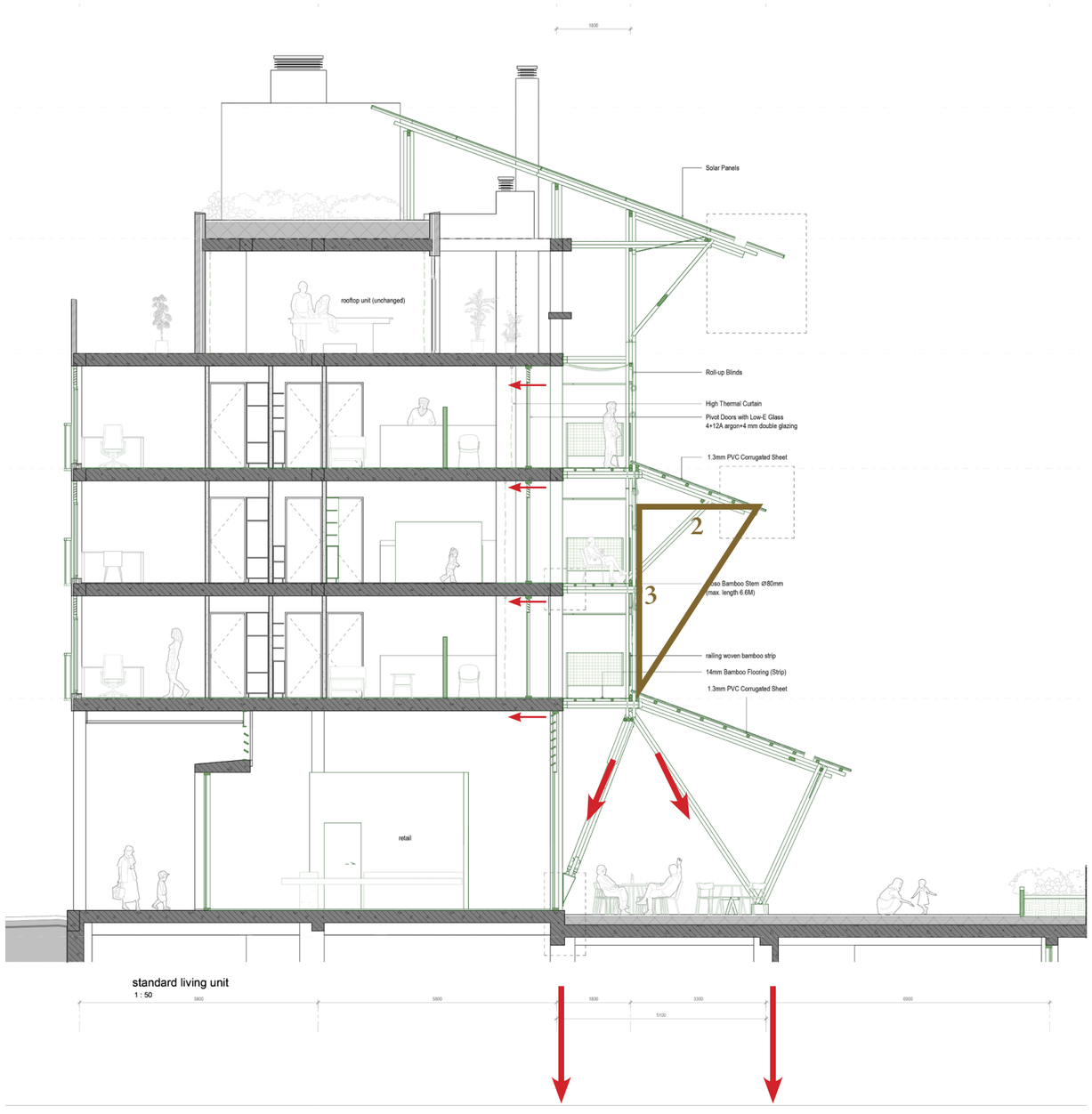


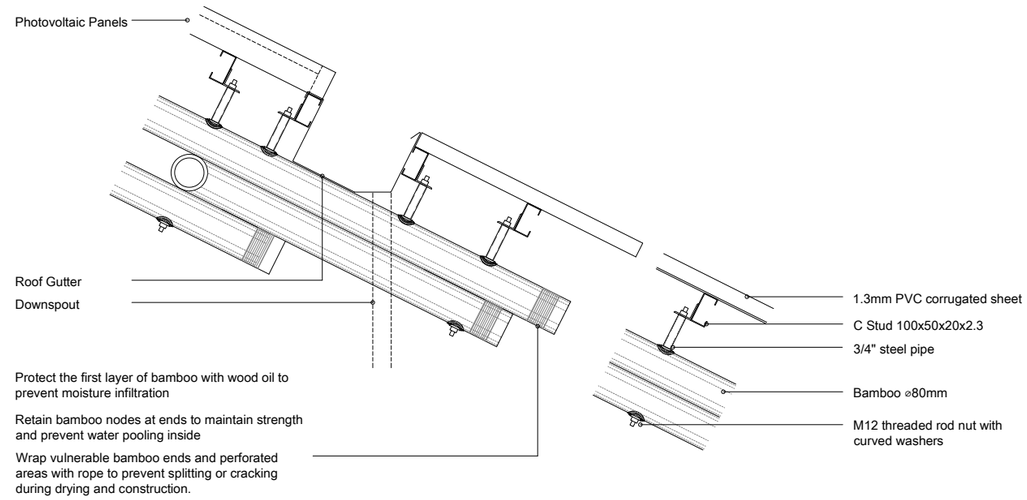
standard living unit
1 : 50



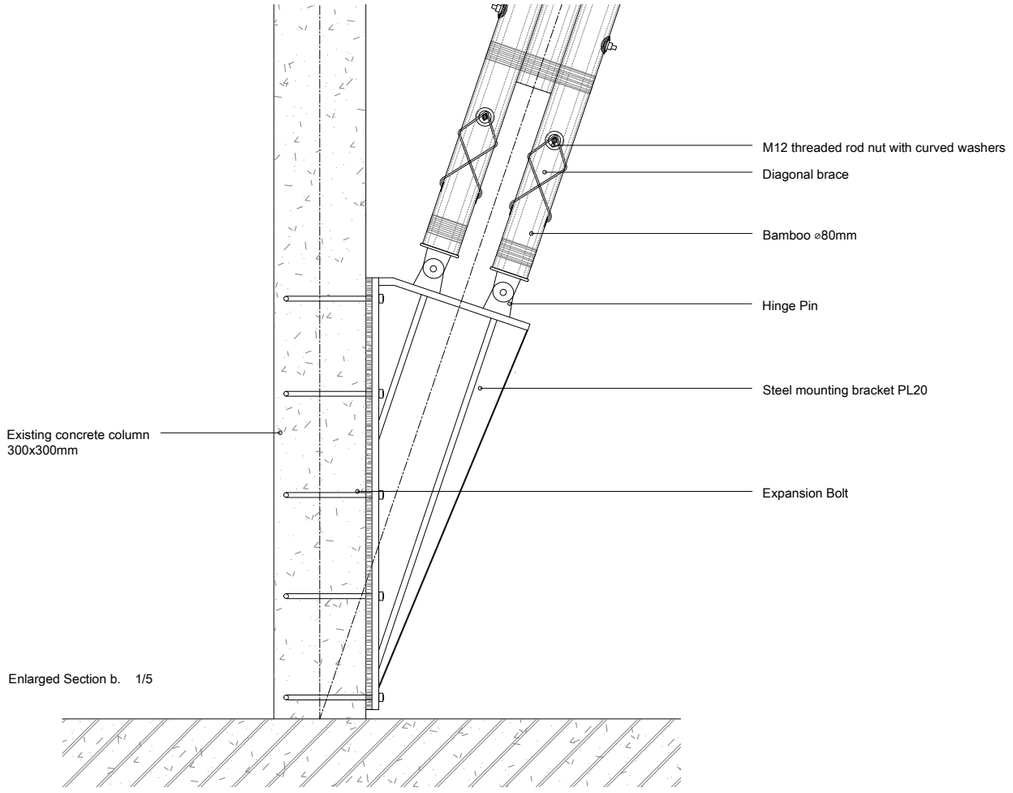



1600
Solar Panels
rooftop unit (unchanged)
Roll-up Blinds
High Thermal Curtain
Pivot Doors with Low-E Glass
4+12A argon+4 mm double glazing
1.3mm PVC Corrugated Sheet
2
3
railing woven bamboo strip
14mm Bamboo Flooring (Strip)
1.3mm PVC Corrugated Sheet
retail
standard living unit
1 : 50
5800
5800
1800
3300
6900
5100

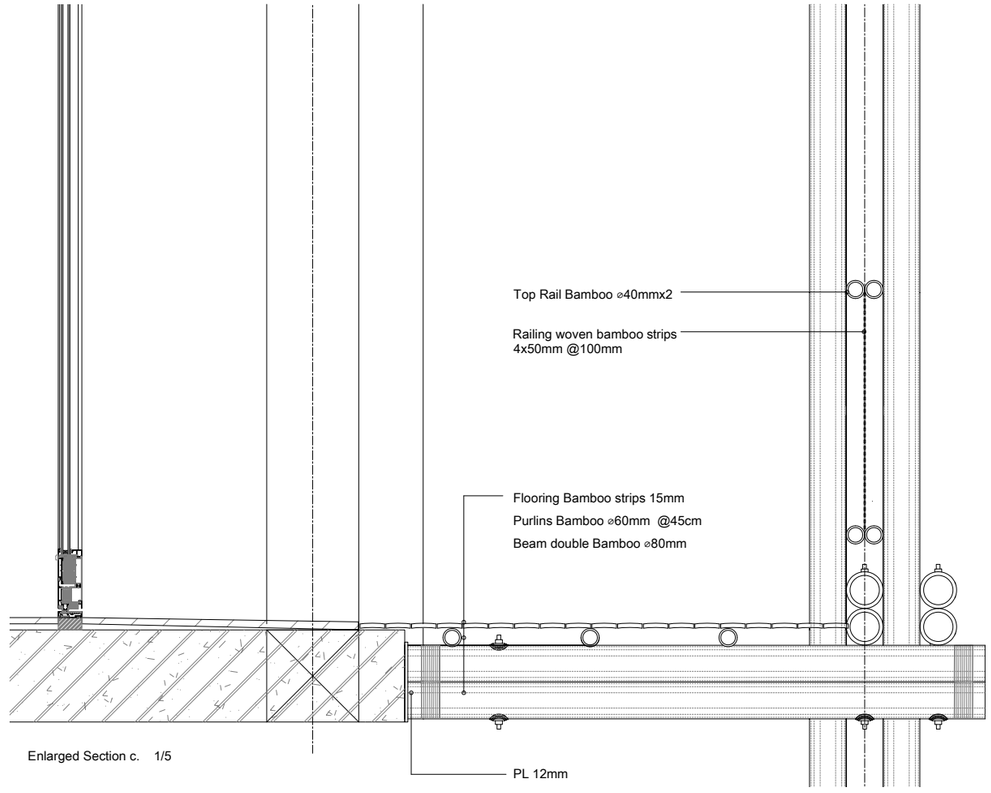




Enlarged Section a. 1/5



Enlarged Section b. 1/5



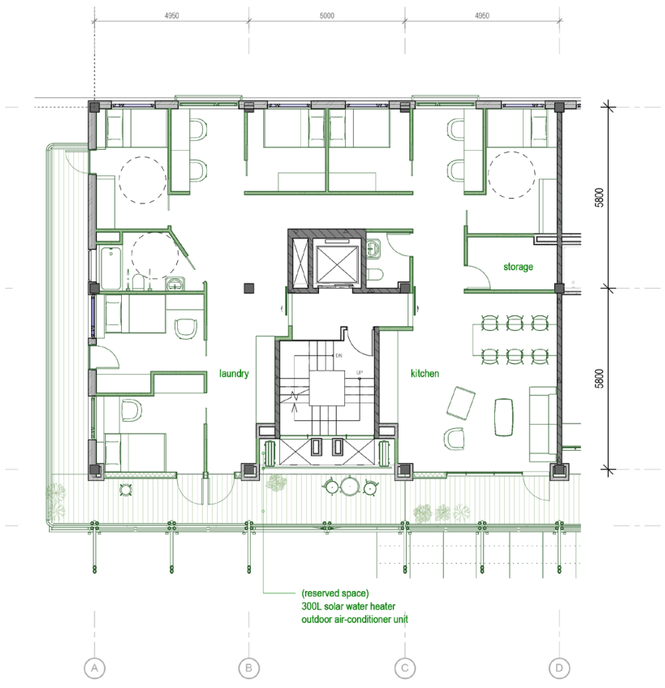
Enlarged Section c. 1/5



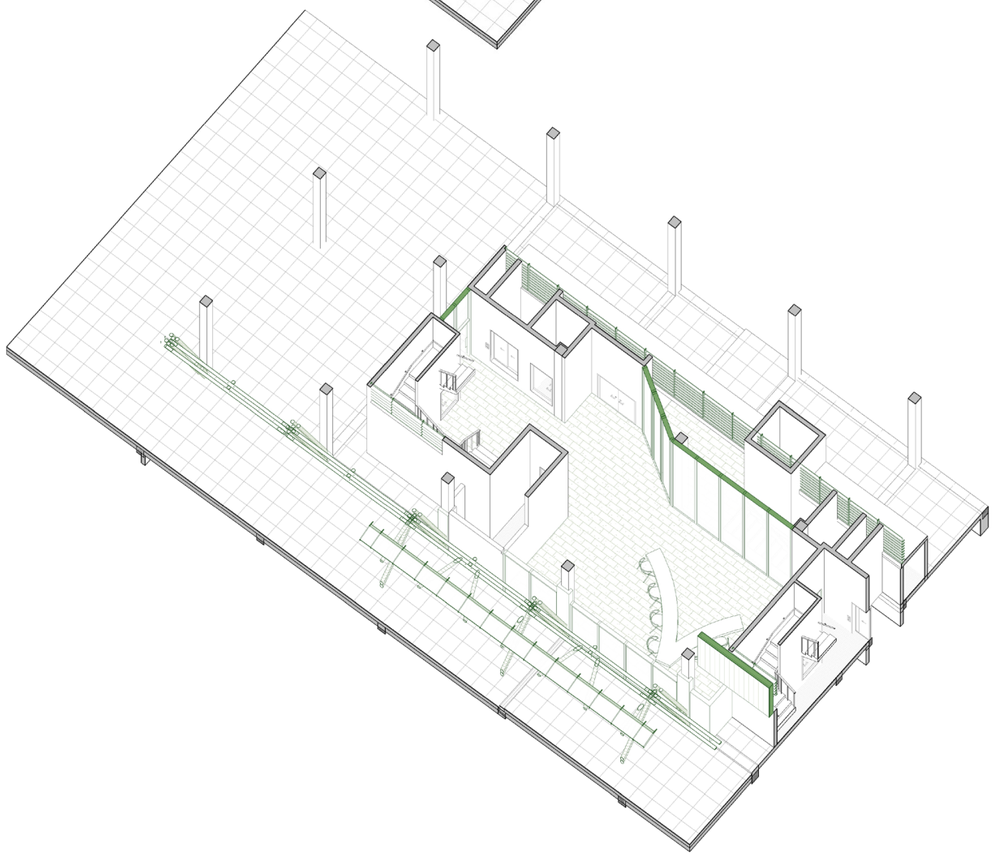


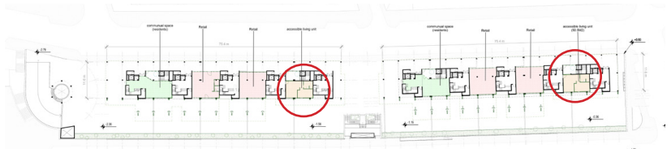
Housing 3F_Senior Co-living Unit

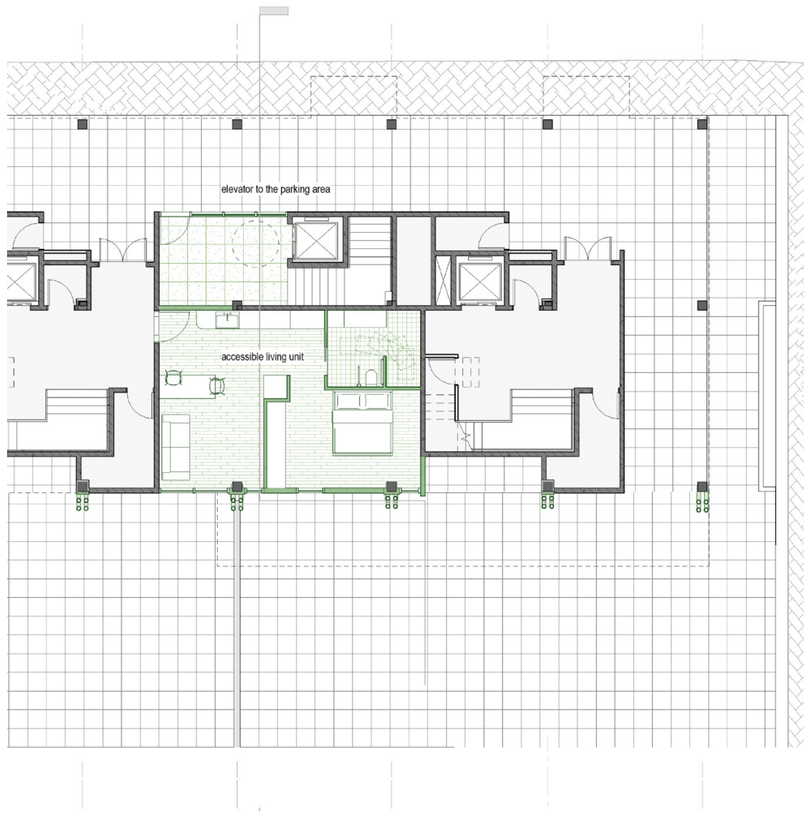
1 : 100

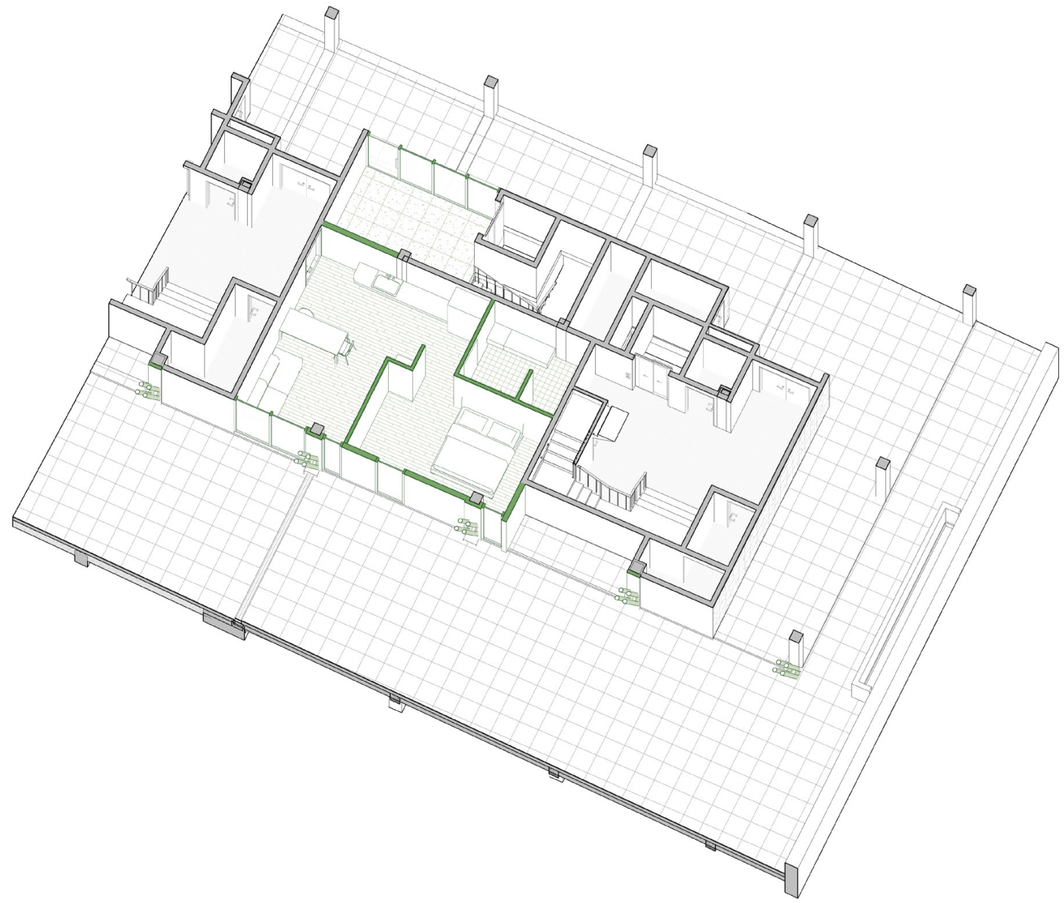







communal space
Retail
Retail
accessible living unit
communal space
Retail
Retail
accessible living unit


elevator to the parking area
accessible living unit

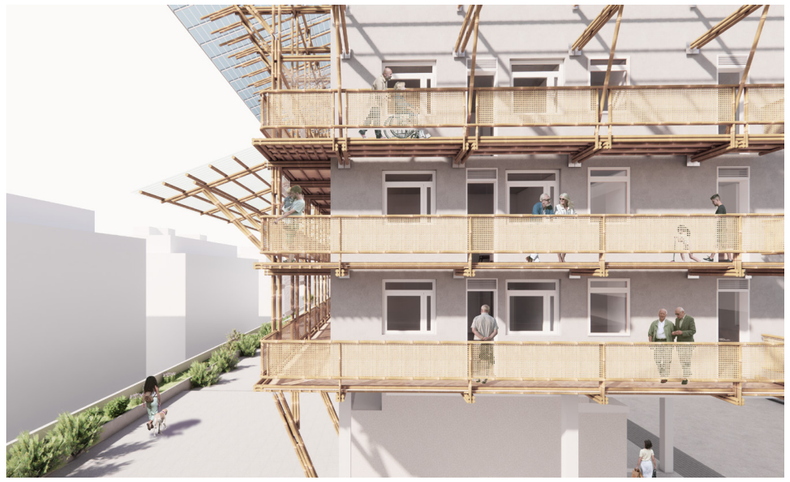




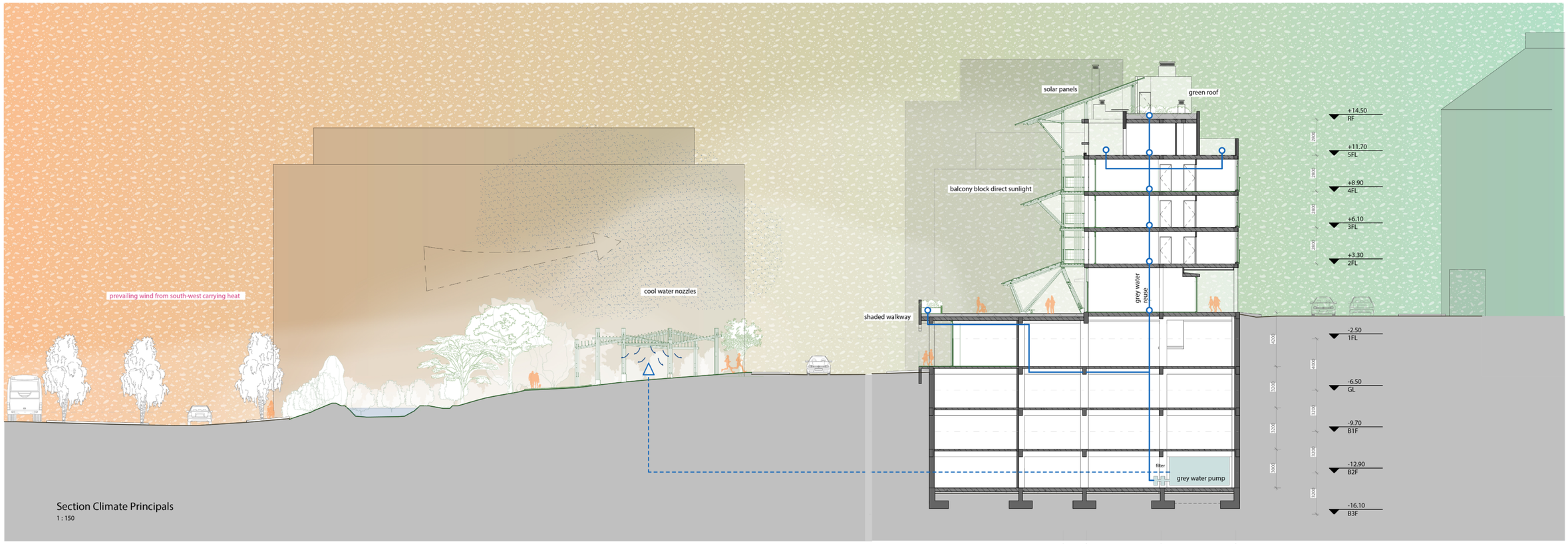
activate underused parking



appealing terrace for better business



shared living free up more units



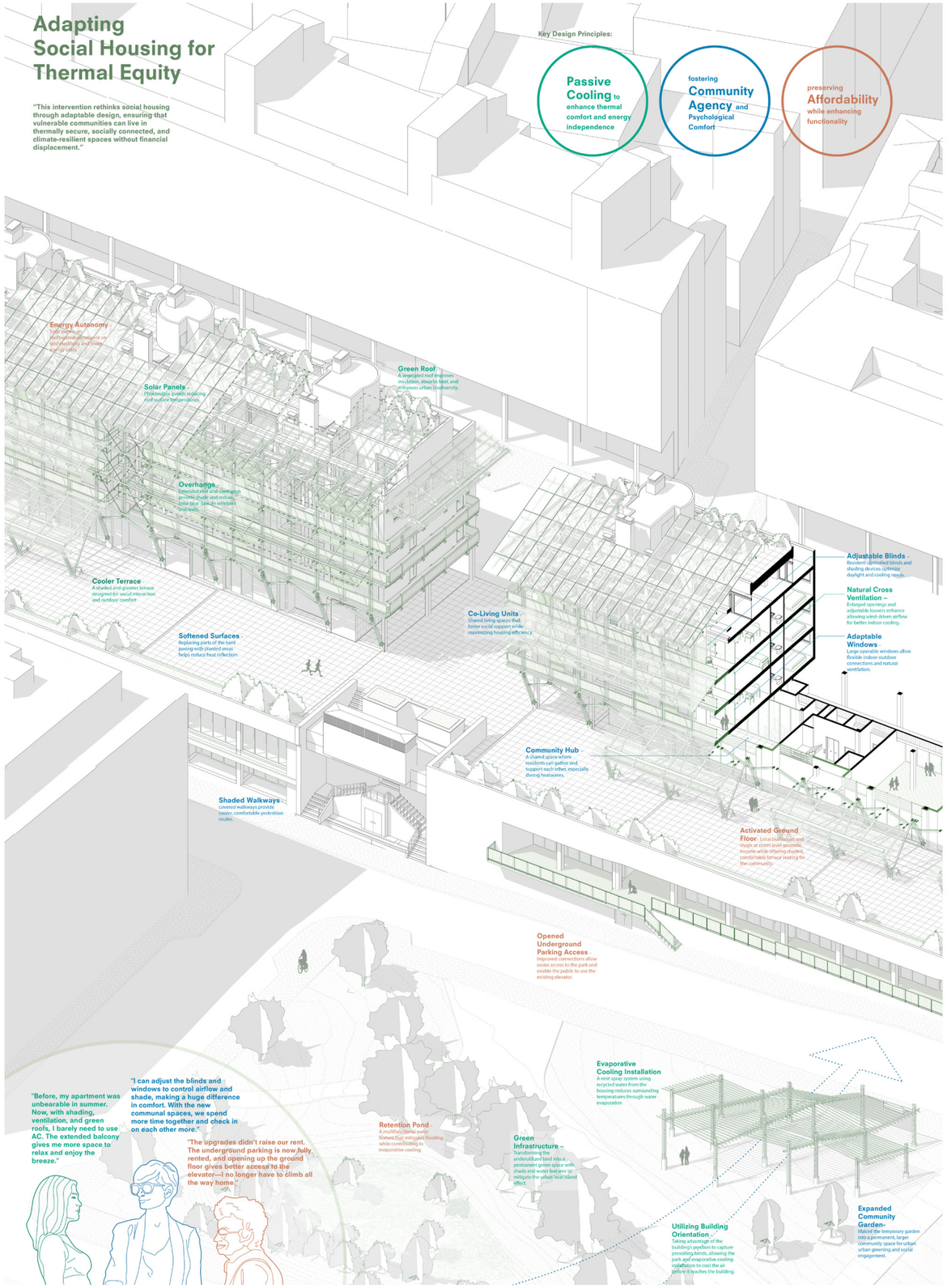




Resource Efficiency
Energy Reduction
Community Inclusion







Adapting Social Housing for Thermal Equity
"This intervention rethinks social housing through adaptable design, ensuring that vulnerable communities can live in thermally secure, socially connected, and climate-resilient spaces without financial displacement."
Key Design Principles:
Passive Cooling to enhance thermal comfort and energy independence
fostering Community Agency and Psychological Comfort
preserving Affordability while enhancing functionality
Energy Autonomy - Solar panels on rooftop reduce reliance on grid electricity and lower energy costs.
Solar Panels - Photovoltaic panels reducing roof surface temperatures.
Green Roof - A vegetated roof improves insulation, absorbs heat, and enhances urban biodiversity.
Overhangs - Extended roof and overhangs provide shade and reduce solar heat gain on windows and walls.
Cooler Terrace - A shaded and greener terrace designed for social interaction and outdoor comfort
Softened Surfaces - Replacing parts of the hard paving with planted areas helps reduce heat reflection.
Co-Living Units - Shared living spaces that foster social support while maximizing housing efficiency.
Adjustable Blinds - Resident-controlled blinds and shading devices optimize daylight and cooling needs.
Natural Cross Ventilation – Enlarged openings and adjustable louvers enhance allowing wind-driven airflow for better indoor cooling.
Adaptable Windows - Large operable windows allow flexible indoor-outdoor connections and natural ventilation.
Community Hub - A shared space where residents can gather and support each other, especially during heatwaves.
Shaded Walkways - covered walkways provide cooler, comfortable pedestrian routes.
Activated Ground Floor - Local businesses and shops at street level generate income while offering shaded, comfortable terrace seating for the community.
Opened Underground Parking Access - Improved connections allow easier access to the park and enable the public to use the existing elevator.
"Before, my apartment was unbearable in summer. Now, with shading, ventilation, and green roofs, I barely need to use AC. The extended balcony gives me more space to relax and enjoy the breeze."
"I can adjust the blinds and windows to control airflow and shade, making a huge difference in comfort. With the new communal spaces, we spend more time together and check in on each other more."
"The upgrades didn't raise our rent. The underground parking is now fully rented, and opening up the ground floor gives better access to the elevator—I no longer have to climb all the way home."
Retention Pond - A multifunctional water feature that mitigates flooding while contributing to evaporative cooling.
Green Infrastructure – Transforming the underutilized land into a permanent green space with shade and water features to mitigate the urban heat island effect.
Evaporative Cooling Installation A mist spray system using recycled water from the housing reduces surrounding temperatures through water evaporation
Utilizing Building Orientation - Taking advantage of the building's position to capture prevailing winds, allowing the park and evaporative cooling installation to cool the air before it reaches the building.
Expanded Community Garden- Makes the temporary garden into a permanent, larger community space for urban urban greening and social engagement.

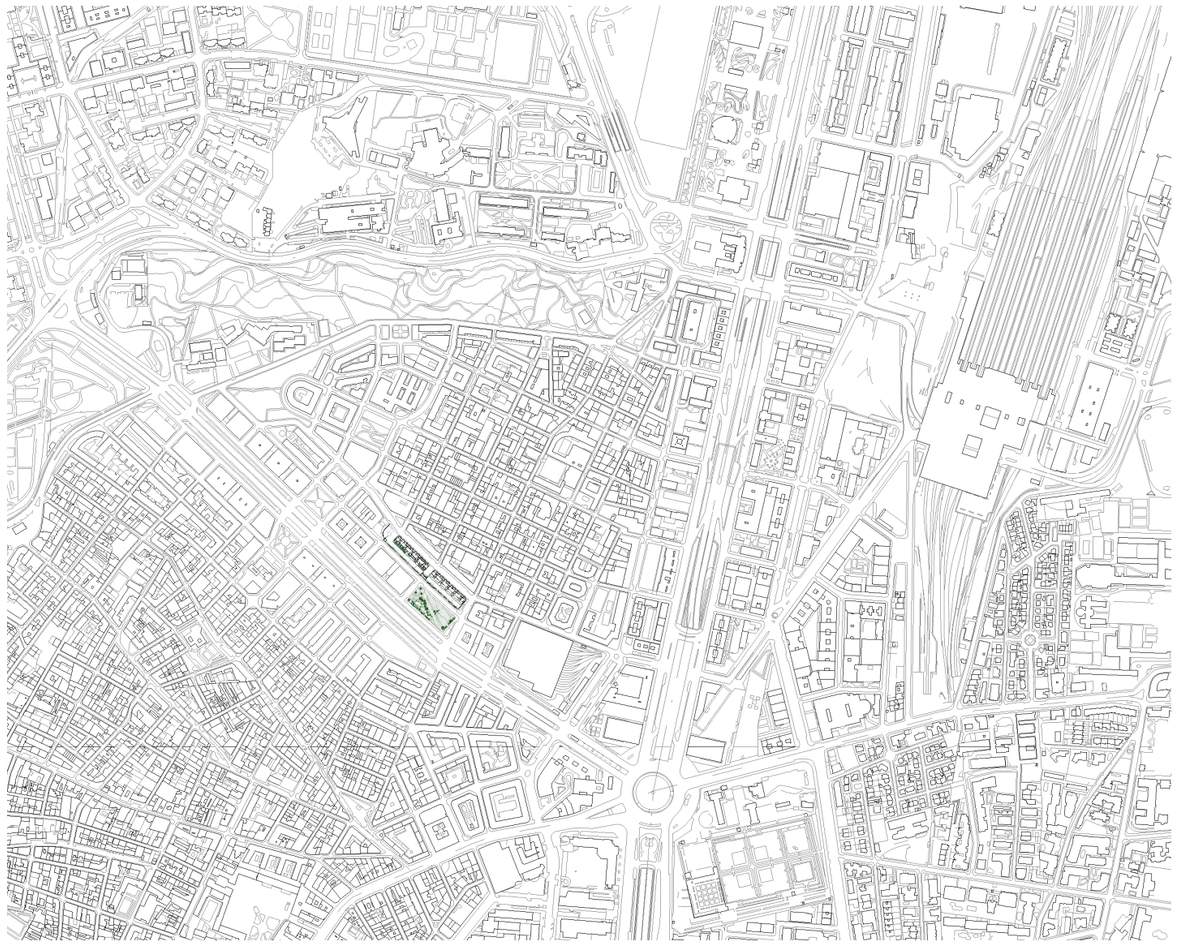
Unraveling Heatscape

Heat, Inequality, and Microclimates: Rethinking Architecture for Thermal Security



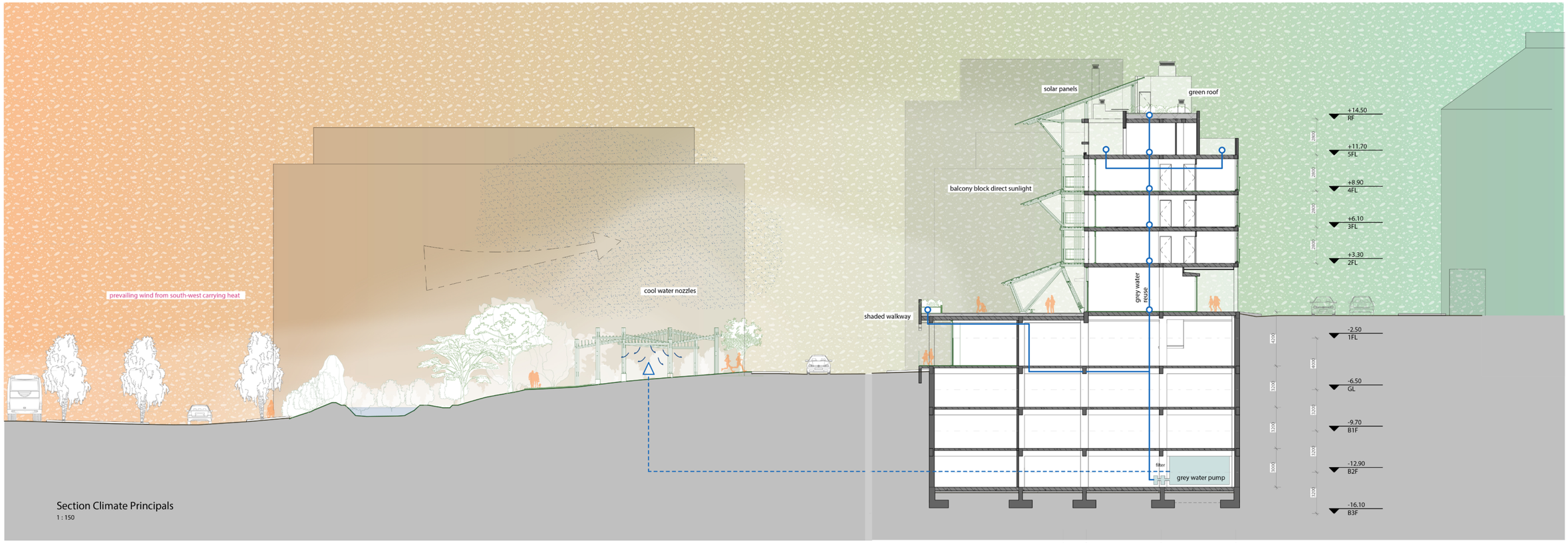
drawing sets





site

unraveling heatscape



Section Climate Principals
1 : 150

Vegetation
cooling effect through the shade provided by vegetation
and the evaporative cooling from water released by the leaves

Earth
natural permeable earth cools surfaces by
absorbing water, alleviating heat retention

Water Spray Installation
air cooling from water evaporation

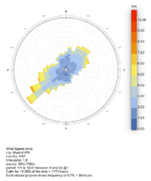
Roof
solar panels reducing direct solar heat gain
and lowering indoor temperatures

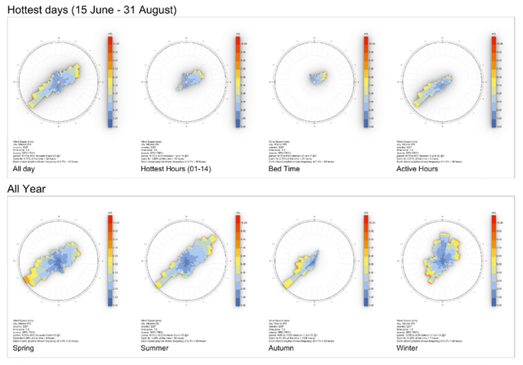
South-West
warmer prevailing wind

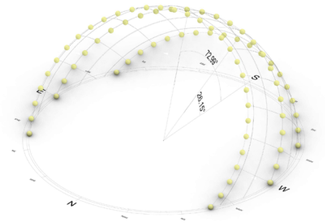
North-East
new lower temperature wind

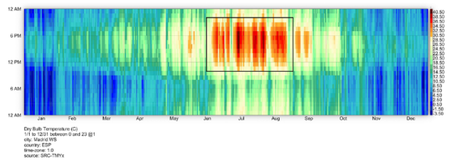


Site Plan
1 : 5000

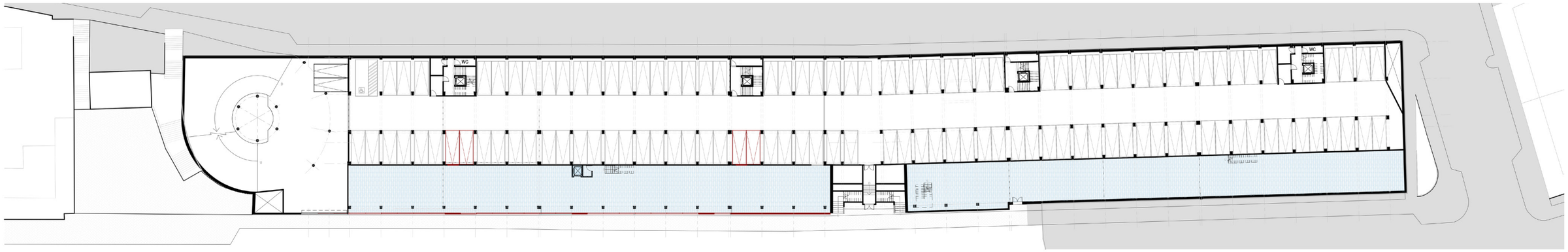




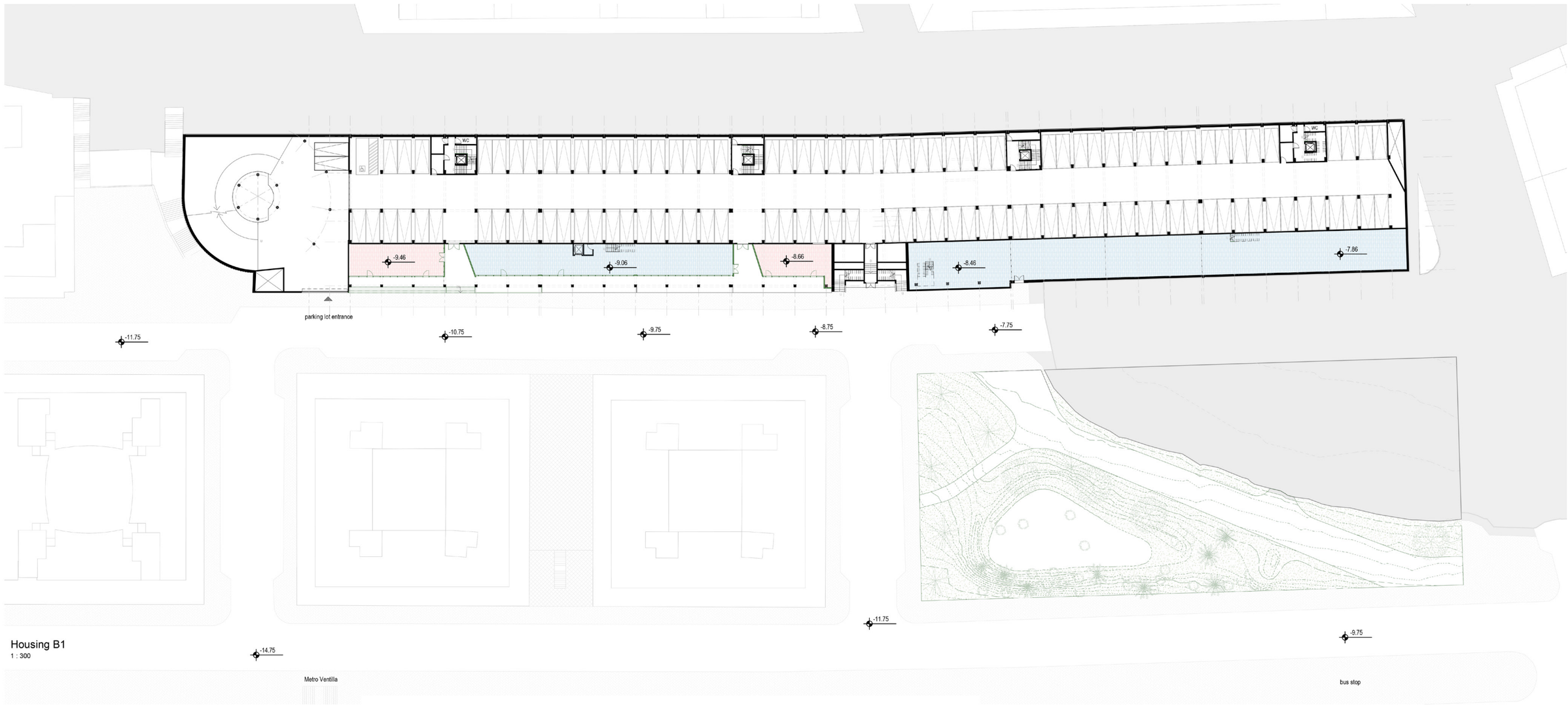




site



Housing B1 (Existing)
1 : 300

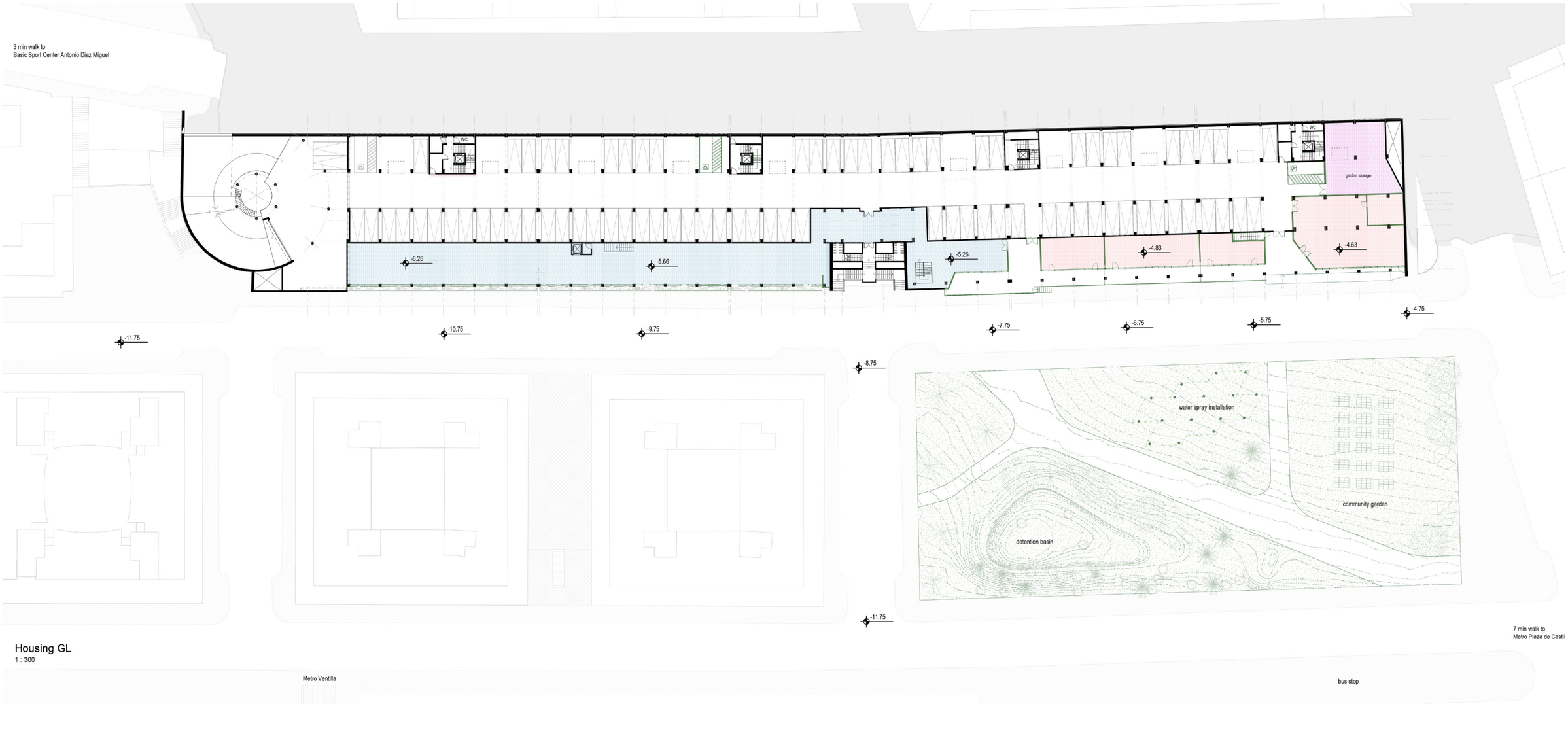


Housing B1
1 : 300

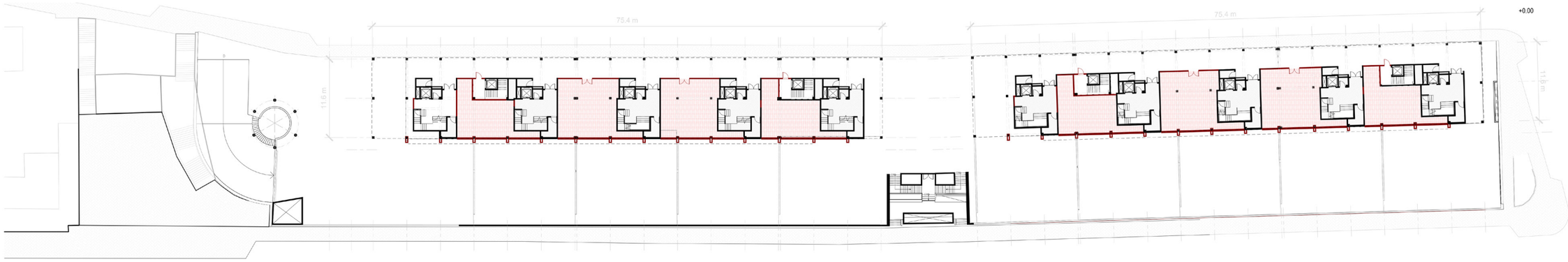


Housing GL (Existing)
1 : 300

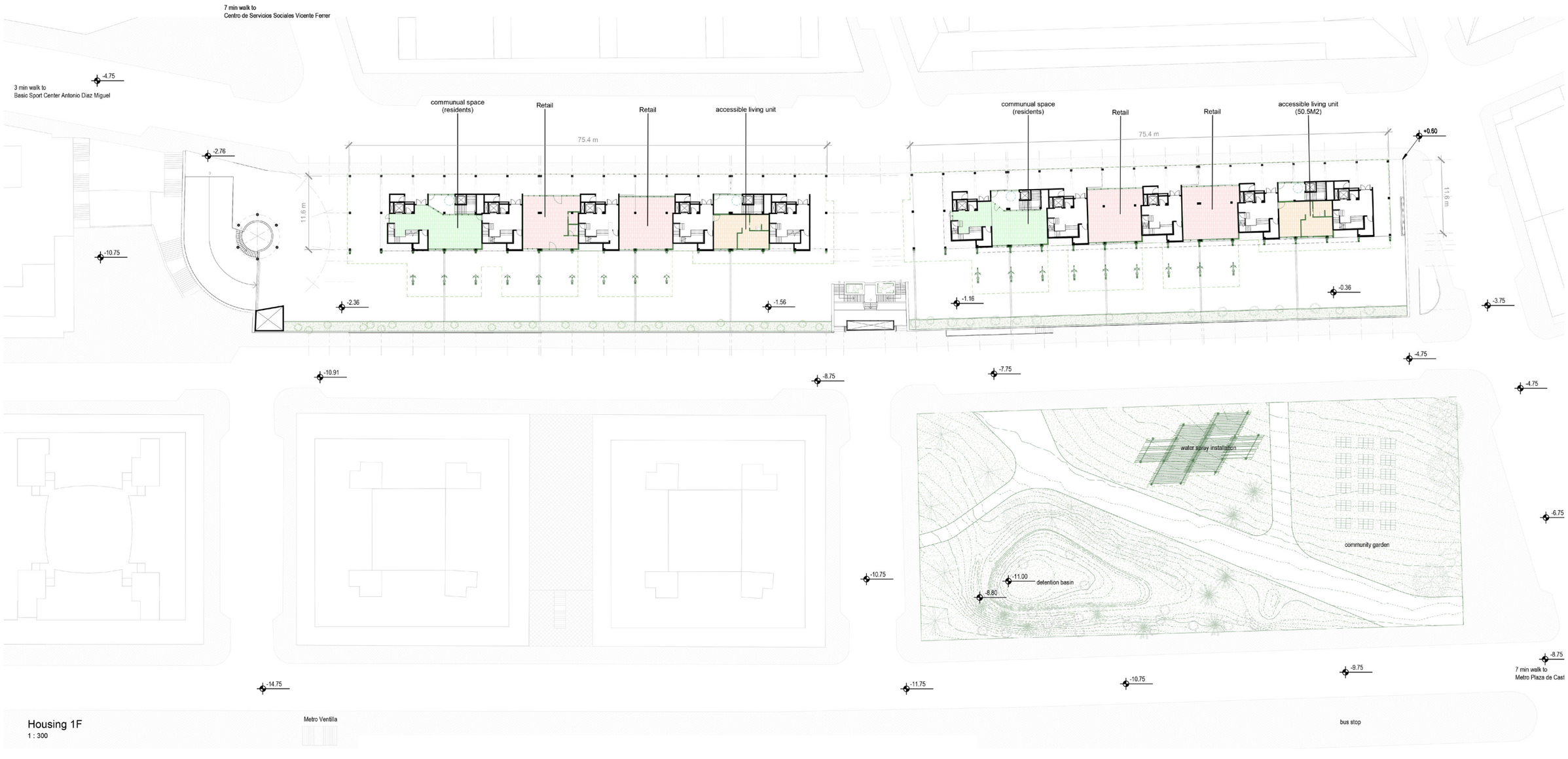
3 min walk to
Basic Sport Center Antonio Diaz Miguel



Housing GL
1 : 300



Housing 1F_L (Existing)
1 : 300



Housing 1F
1 : 300



Housing 3F_standard level 2-4F (Existing)
1 : 300



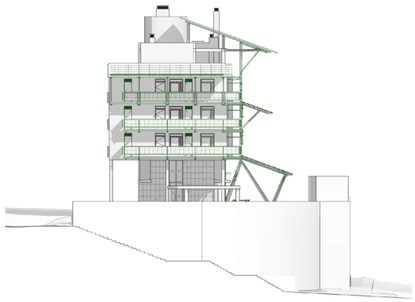
Housing 3F _standard level 2-4F
1 : 300



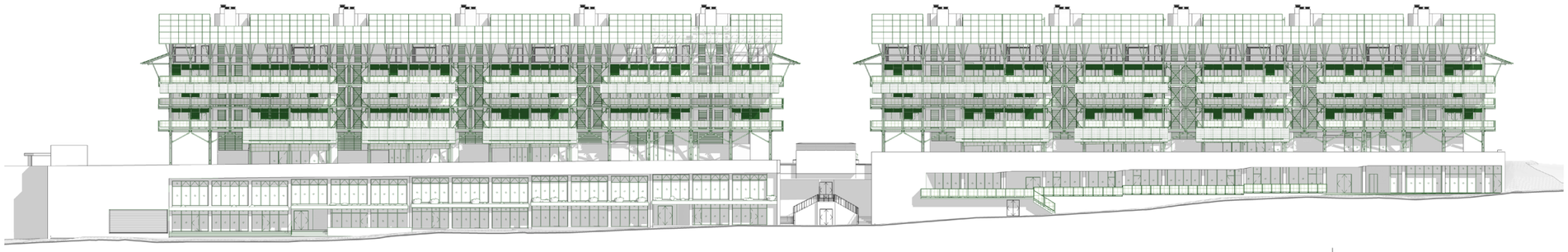
Housing 5F _rooftop unit (existing)
1 : 300



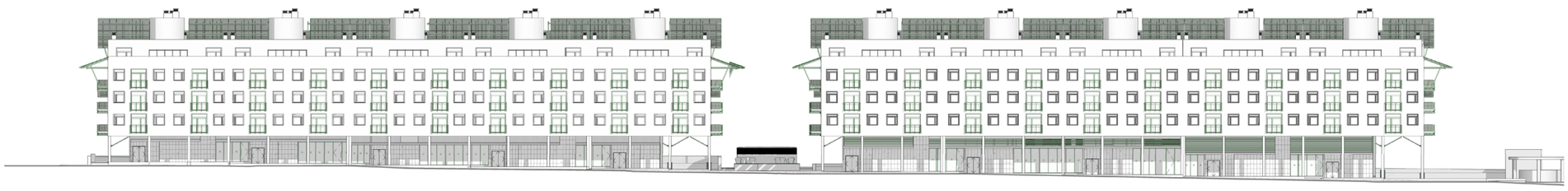
Housing 5F _rooftop unit
1 : 300



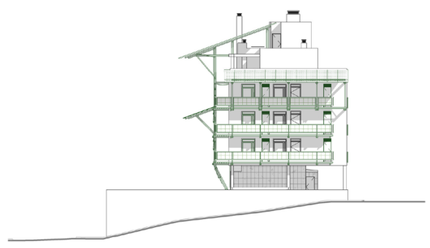
Elevation West
1 : 300



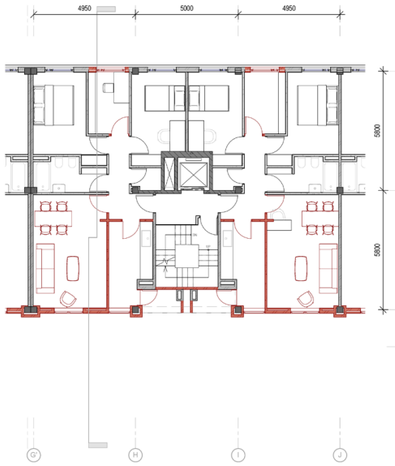
Elevation South
1 : 300

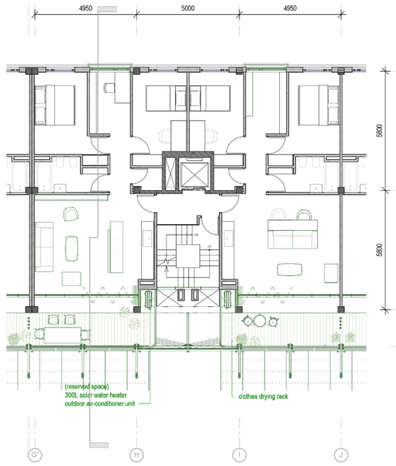


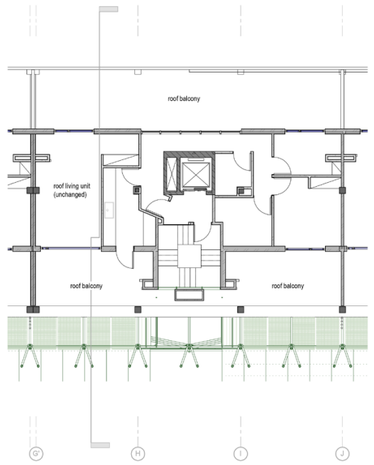
Elevation North
1 : 300

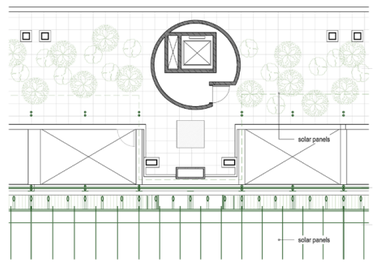


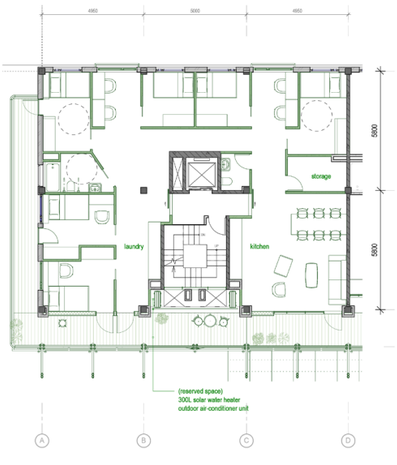
Elevation East
1 : 300

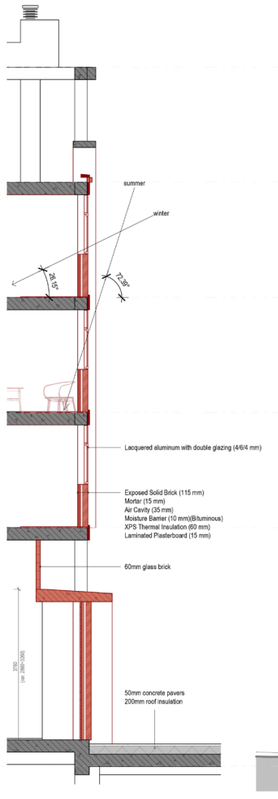




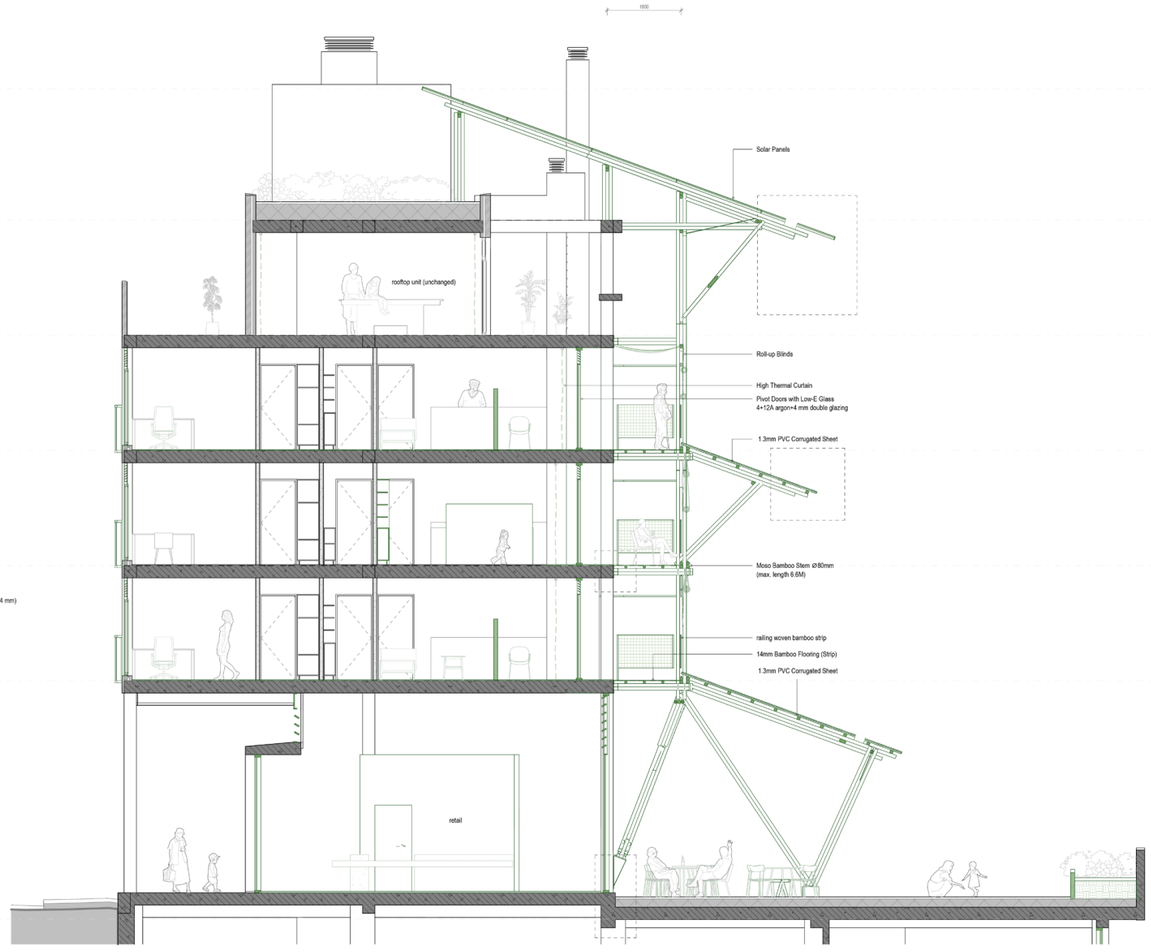




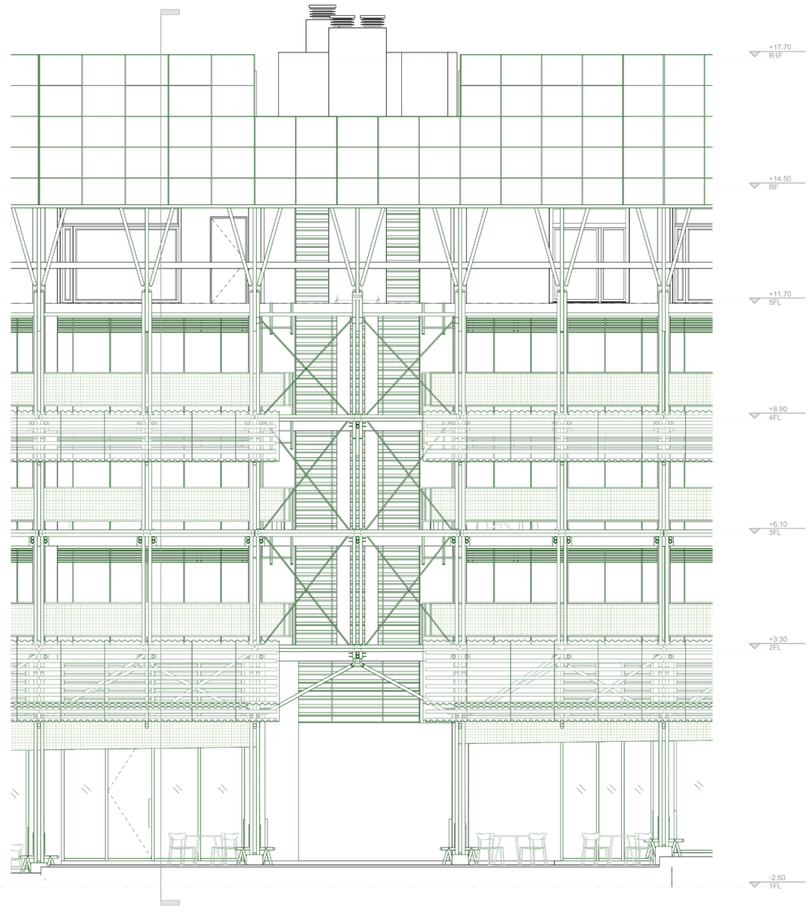




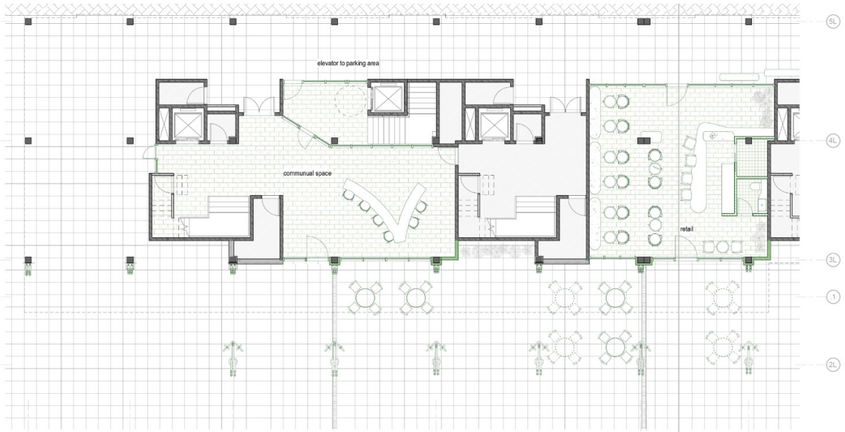
Section Standard Unit (Existing)
1 : 50



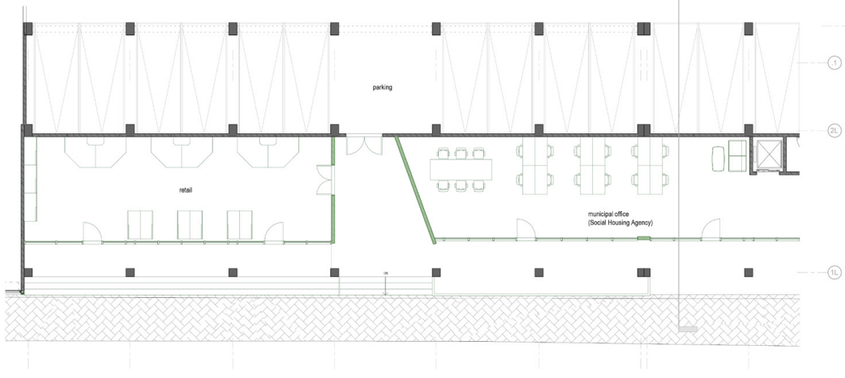
standard living unit
1 : 50

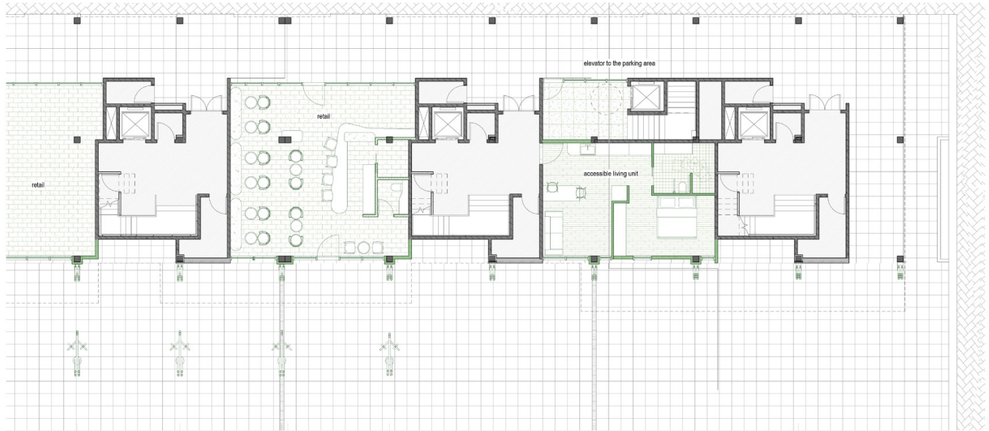


Elevation New Facade
1 : 50

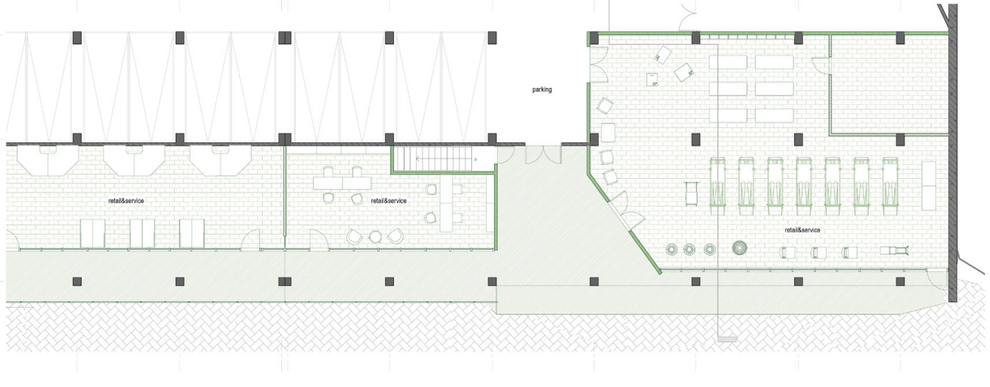


1F Plan_Community Space +Commercial
1 : 100

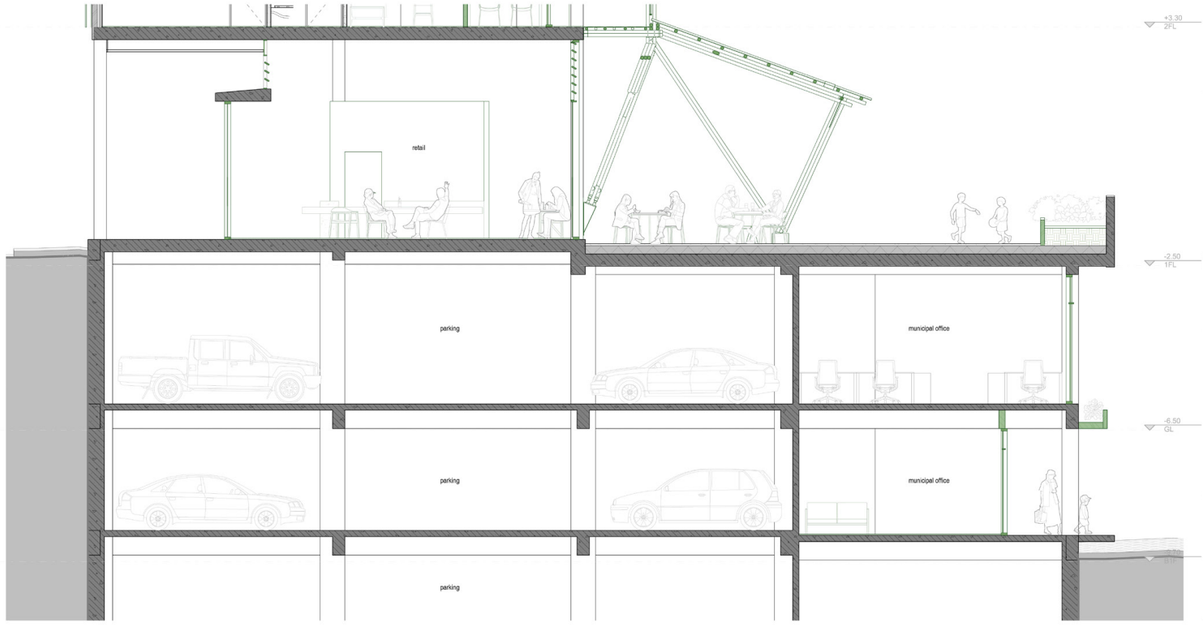




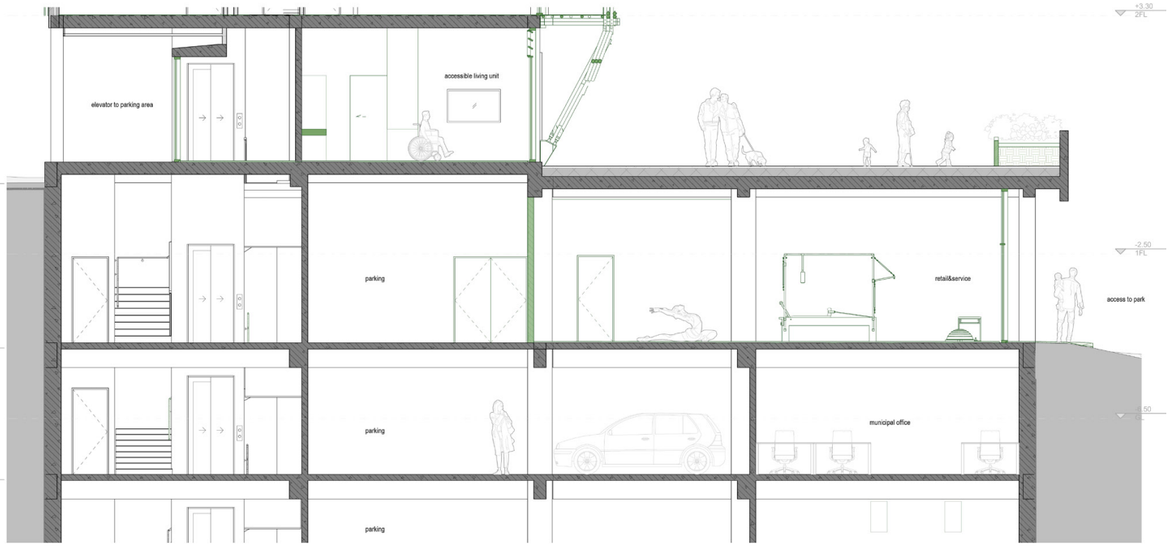
1F_Community Hub + Accesible Living Unit
1 : 100



B1 Plan Commercial/Office - West
1 : 100



GL Plan Commercial - East
1 : 100



dapting ocial Housing for hermal Equity

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preserving **Affordability** while enhancing functionality

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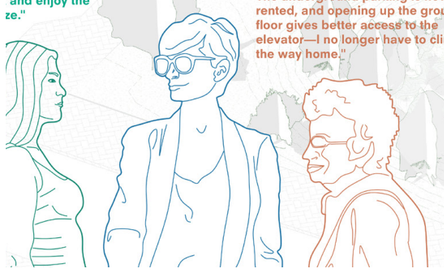

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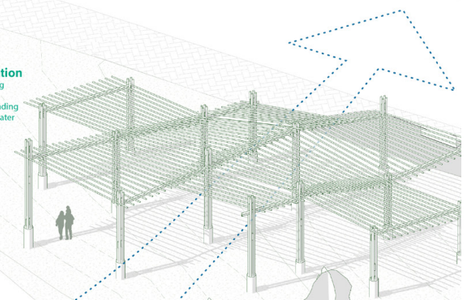
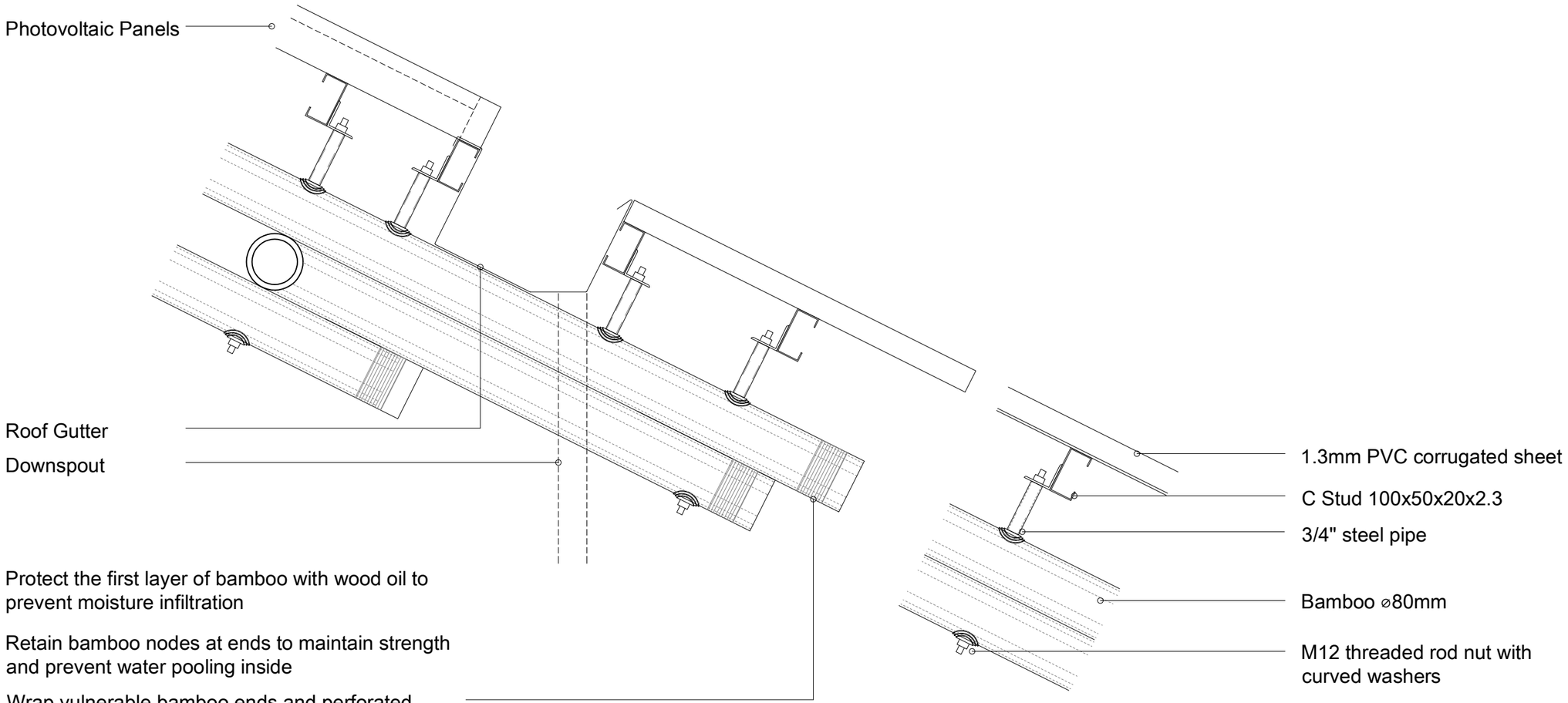
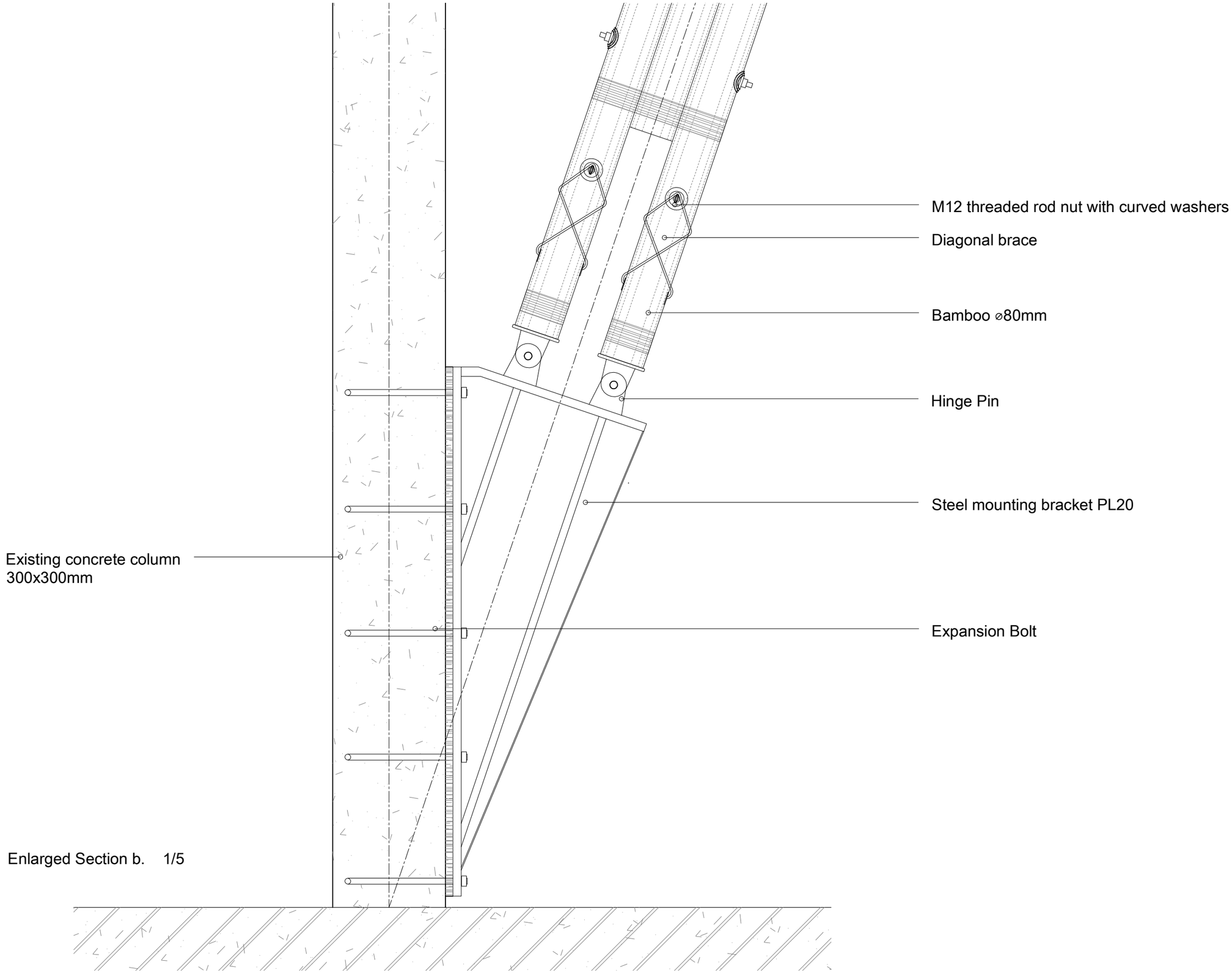


Utilizing Building Orientation – Taking advantage of the building's position to capture prevailing winds, allowing the park and evaporative cooling installation to cool the air before it reaches the building.

Expanded Community Garden- Making the temporary into a permanent, large community space for u urban greening and so engagement.



Enlarged Section a. 1/5



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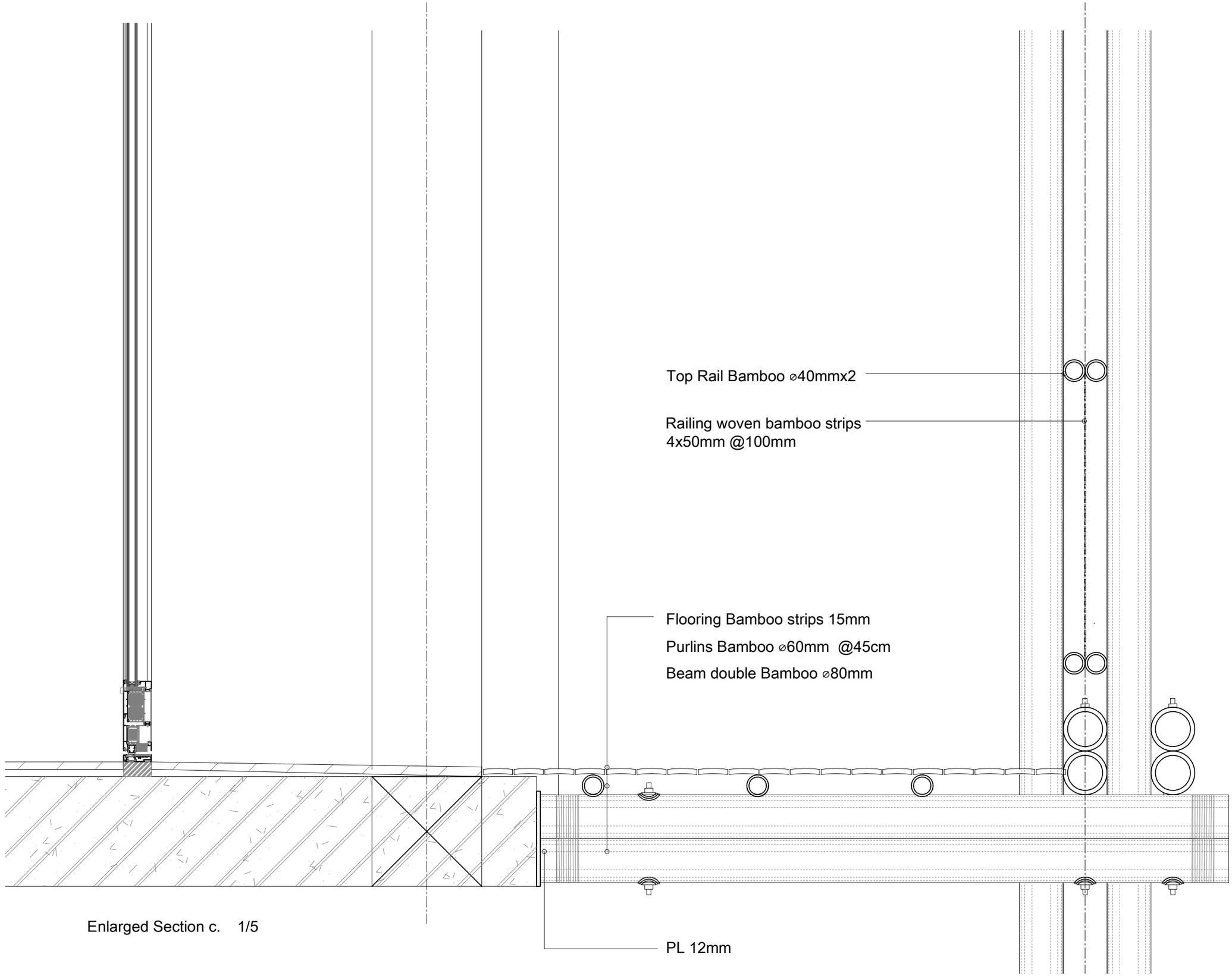
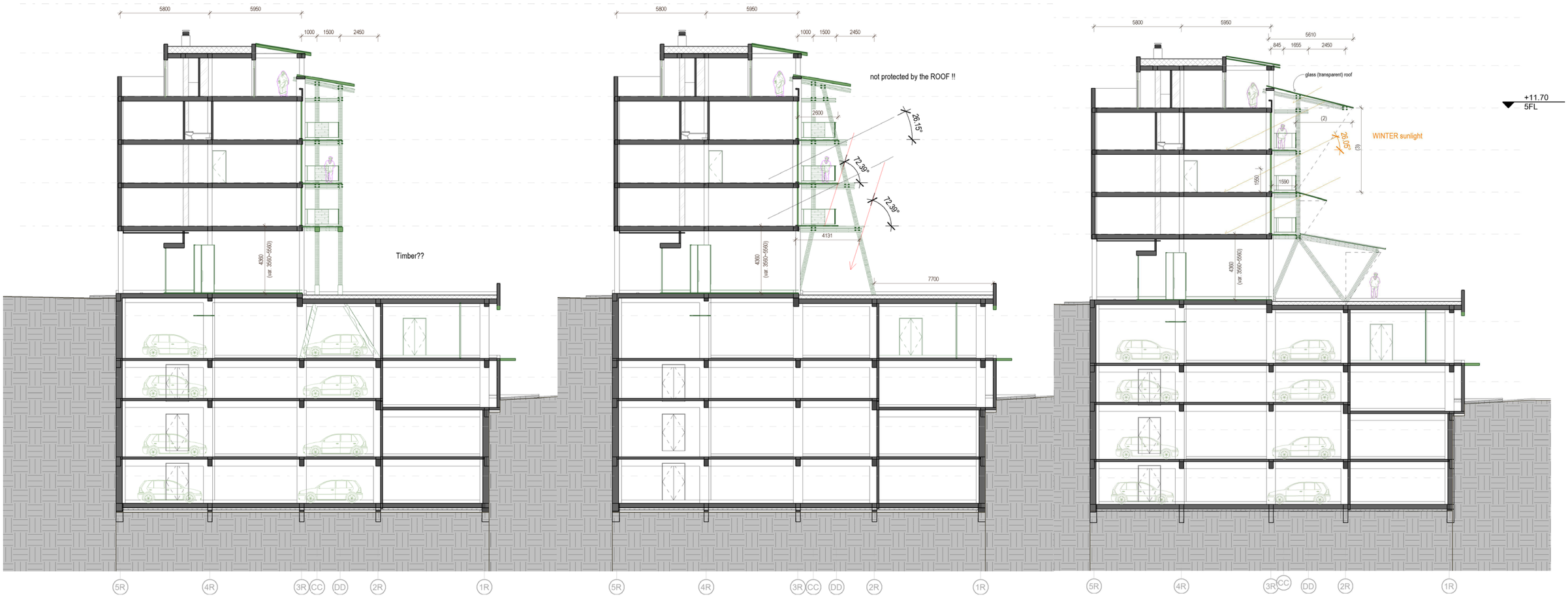


Enlarged Section c. 1/5

design development











minor architecture

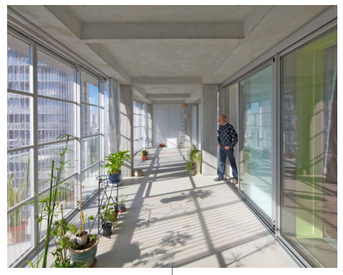
architects' position	prefer not to	looking for	(tactics)	actions
mediator	departing from Major practices	tatics instead of strategies	self-made	sharing + care + co-activities
act from the middle together with all actors		urban dissidence	appropriation	sharing responsibility
openness	departing from Top-Down Planning	tension?	temporary intervention	commoning
	resisting Boundaries	porous	event-based participation	democratise
	refusing oversimplify "people" as "users"	potential variations	working inside-out	working inside-out
	rejecting standardisation?	an escape from organising system		
		uncertainty / instability		
		insignificance that makes a difference		

(Querrien, Petcou, and Petrescu 2013, p.269)

constantly support and stabilize systemetic and dominant way of doing things. static

the material social practices through which hegemony is secured in everday life

is not dependent on the abandonment of professional roles, but rather on the departure from fixed or hegemonic ideas about how to do things, as well as a profound acceptance of the interdependence of all actors in a process.

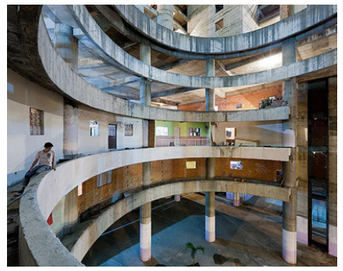
















minimal intervention
renovation
add-on
appropriation
taken-apart
evolutionary
inclusivity
co-creative
re-purpose
Humorous / playful
diversity

surrounding buildings

Site

Northern part of de la Castellana around year 2018



José María Ezquiaga Domínguez (2018).The Historical Development of Madrid's Paseo de la Castellana, Arquitectura: Revista del Colegio Oficial de Arquitectos de Madrid (COAM), ISSN 0004-2706, Nº. 376, 2018 (Ejemplar dedicado a: Atolón), págs. 38-51

Heat reality in Madrid







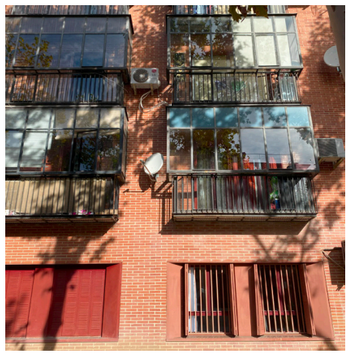


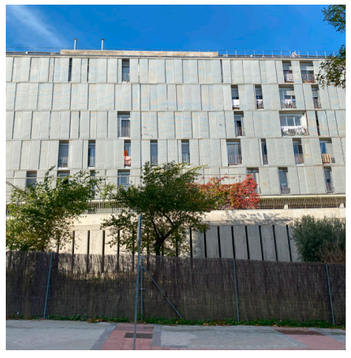
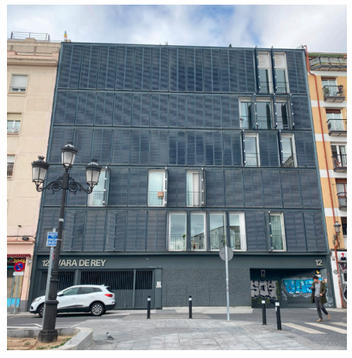


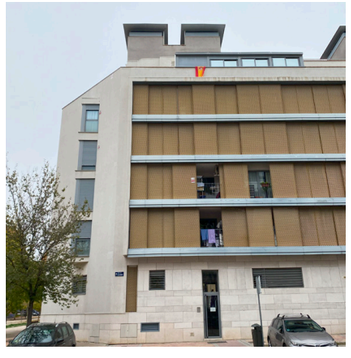


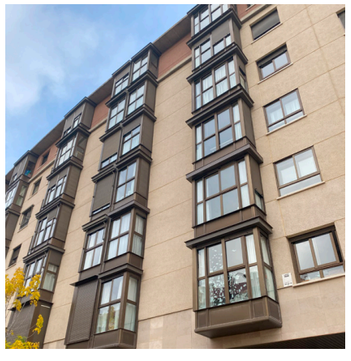


Heat reality in Madrid





Madrid Nuevo Norte



La Ventilla



Madrid
Nuevo Norte

Central
Park

Chamartin
Station

Climate Action
Demonstration Area

Madrid Nuevo Norte





Top: https://rshp.com/projects/masterplanning/madrid-nuevo-norte-mnn/
Bottom: https://www.adif.es/en/proyecto-chamartin

Madrid Nuevo Norte



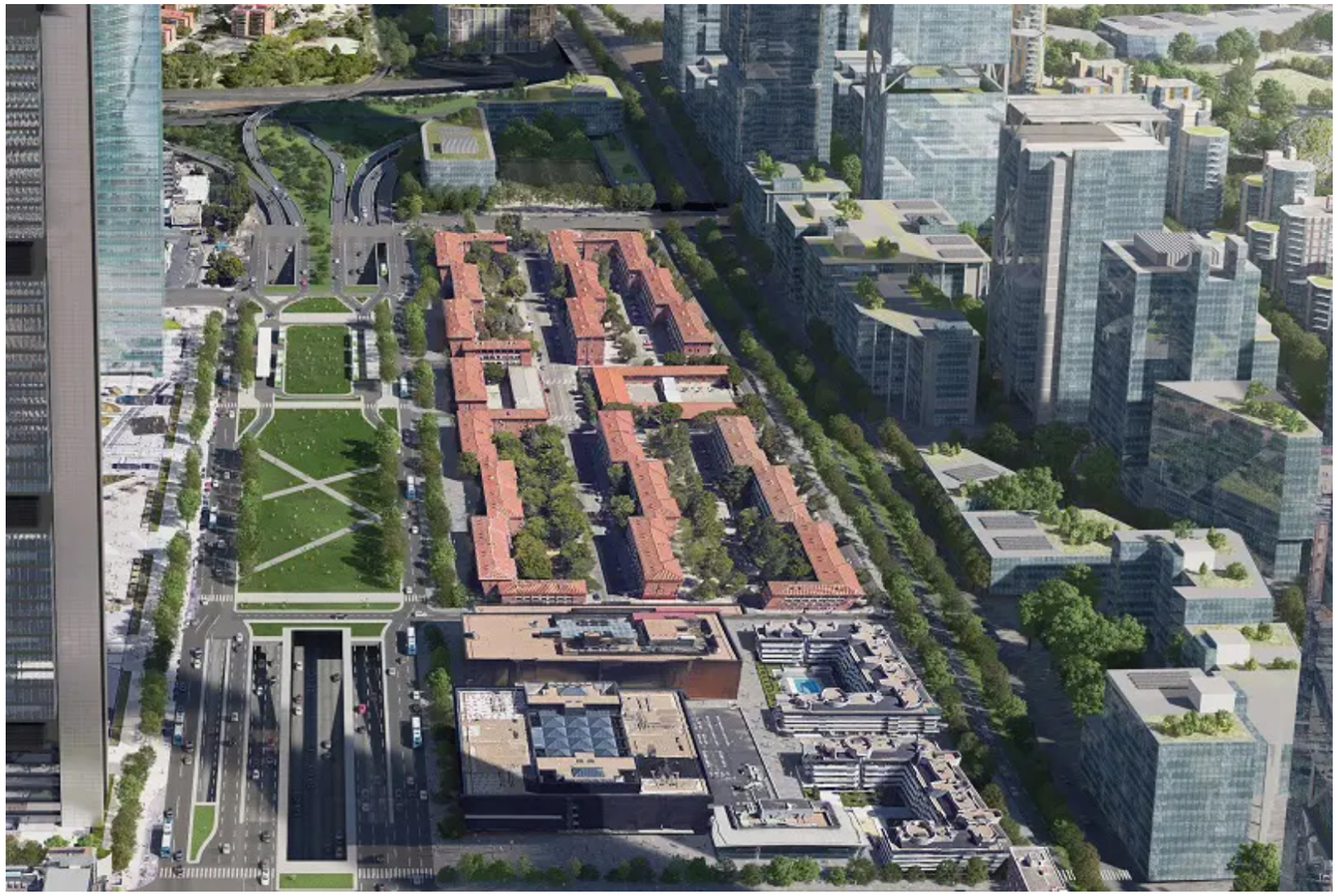
Central Park

Chamartin Station

Climate Action Demonstration Area

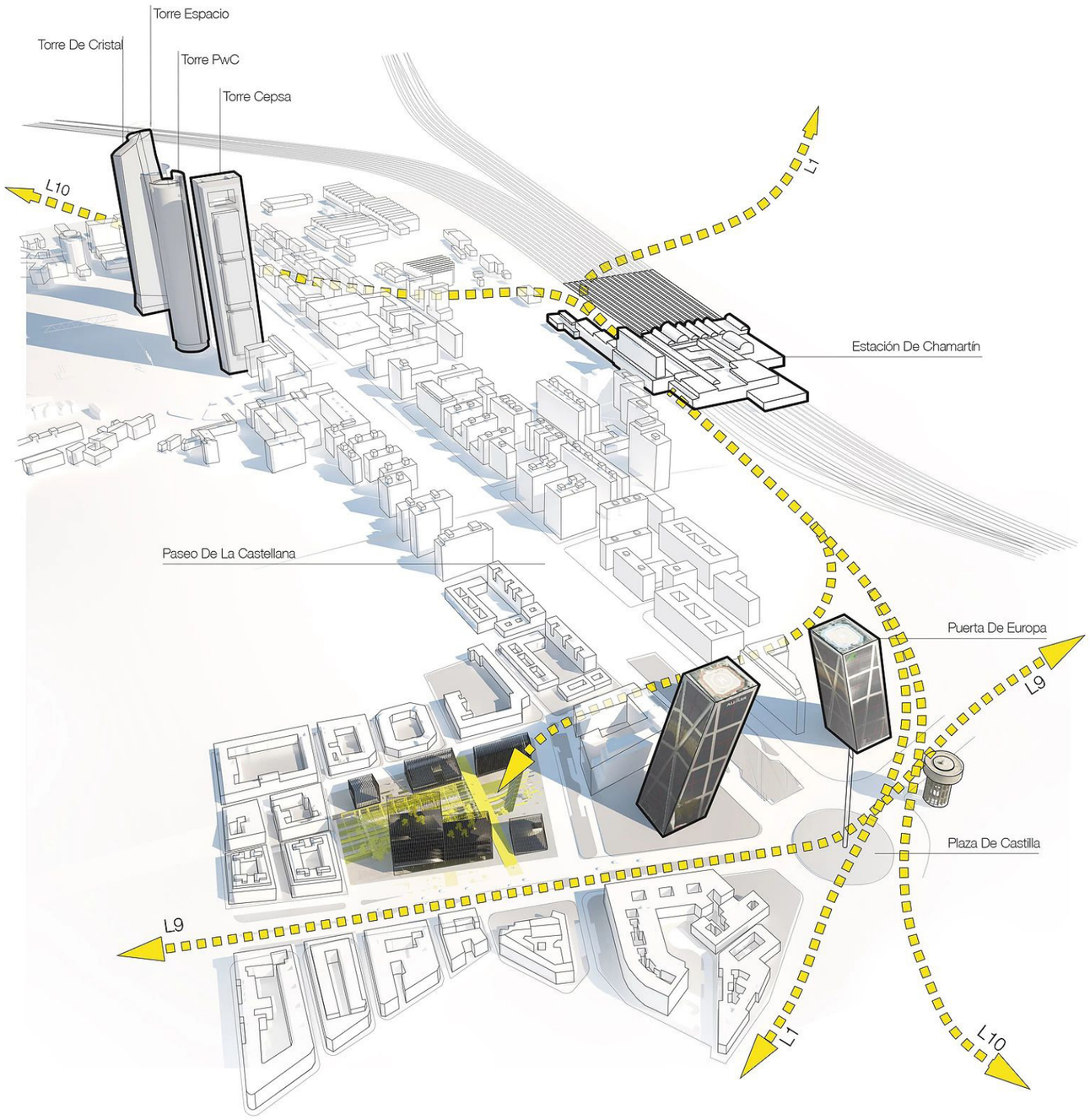
Colonia San Cristóbal

inaugurated in March 1954





Metro Headquater



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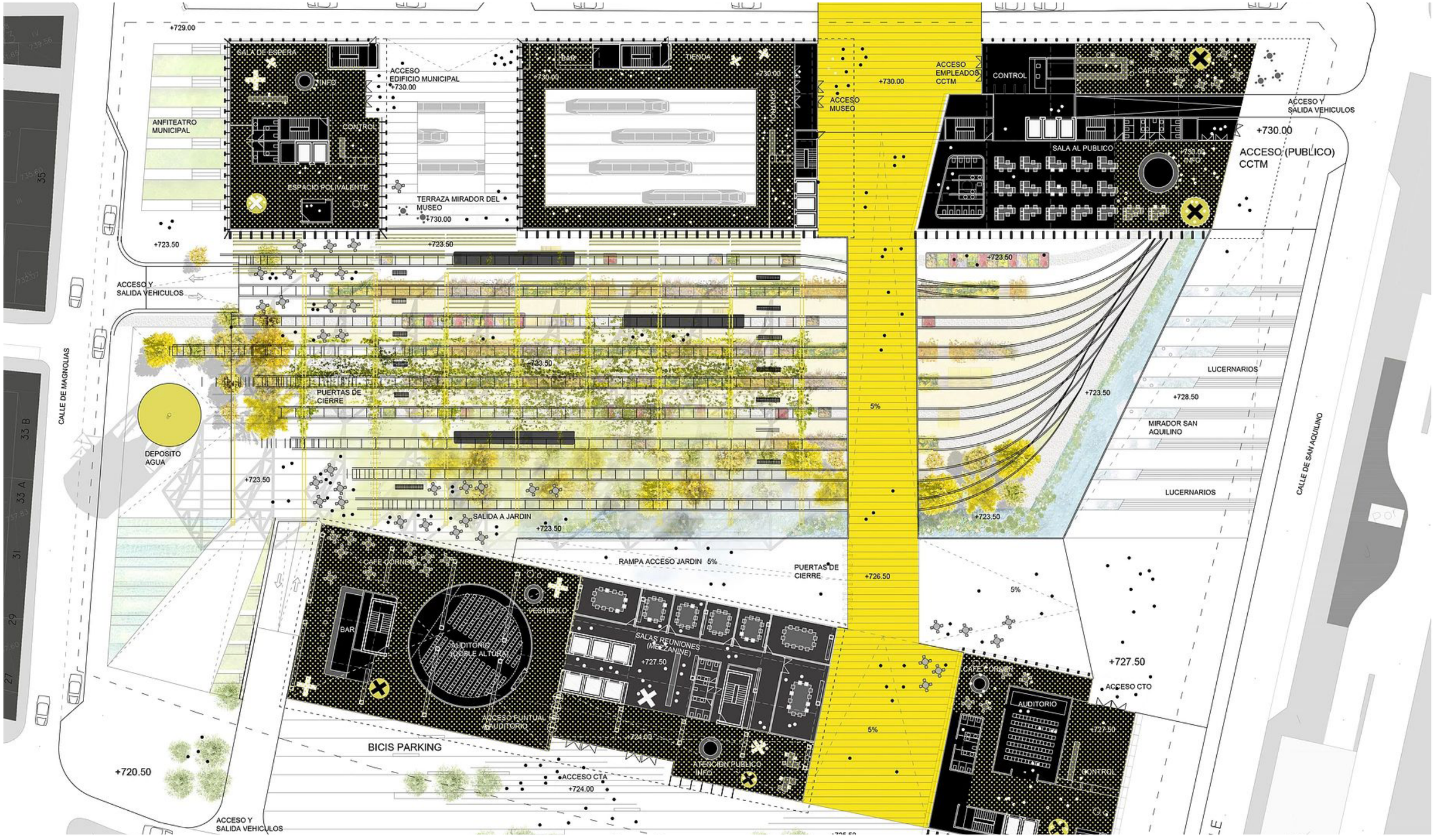
Metro Headquater



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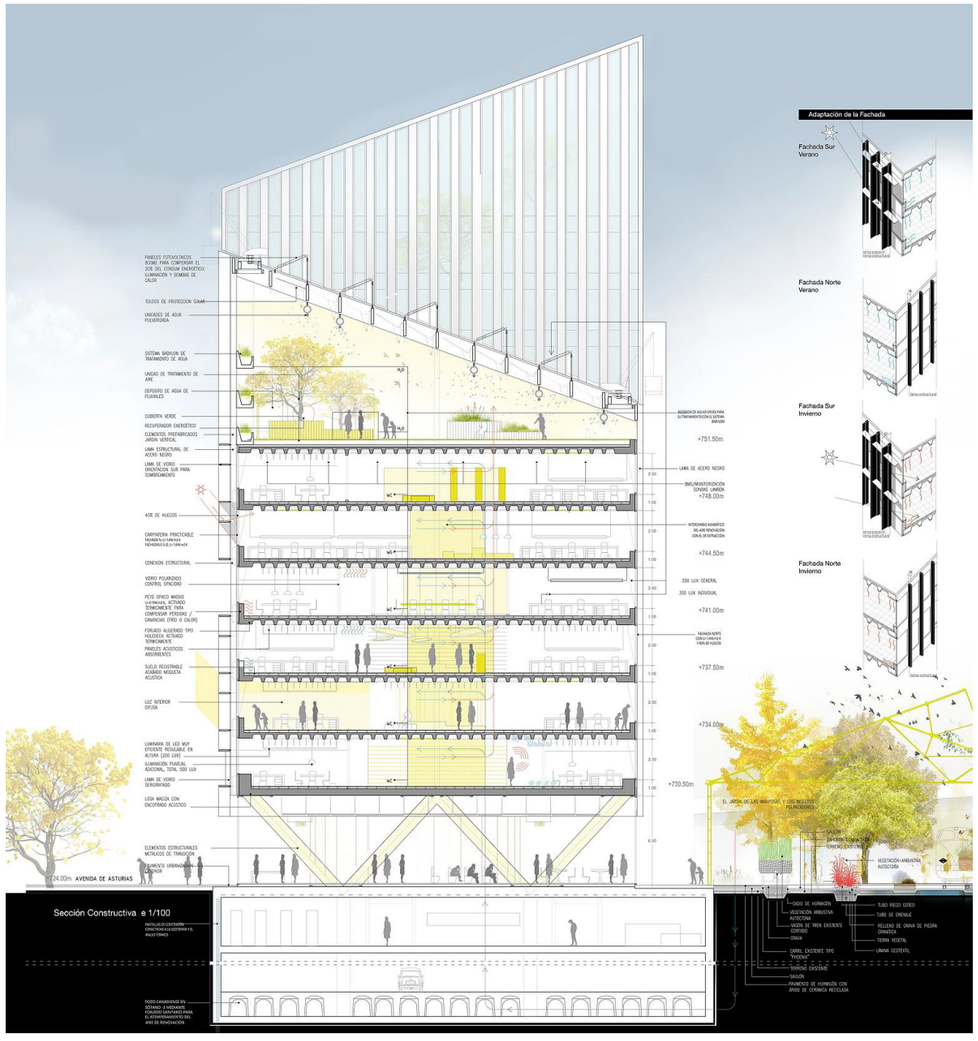
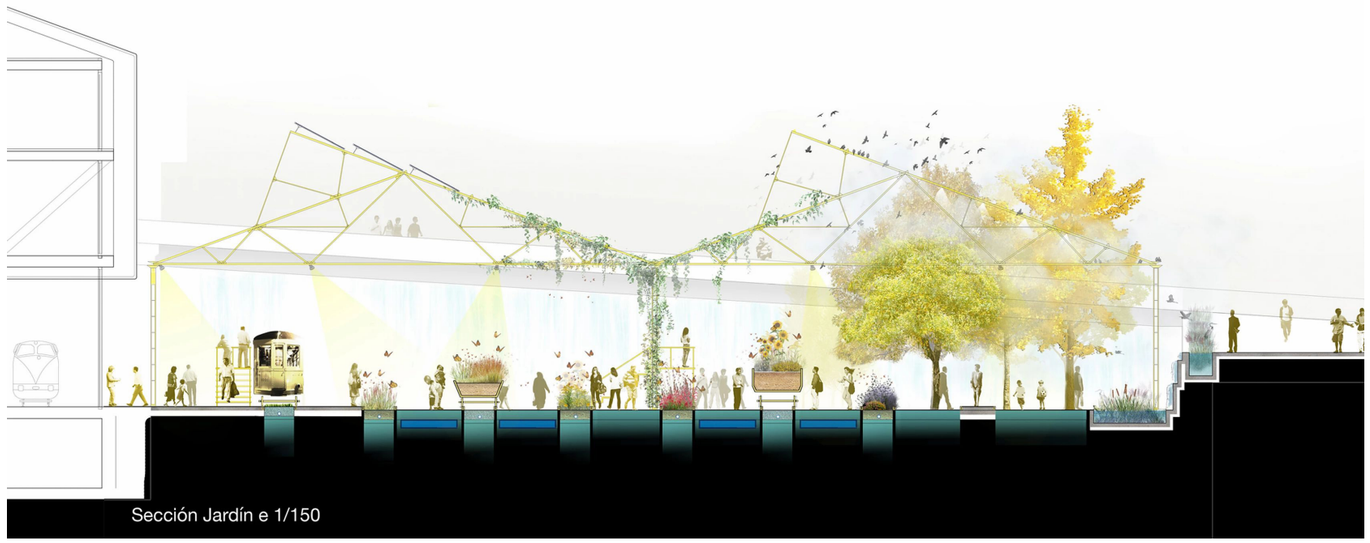
Metro Headquater





https://madriddealers.es/arquitectura/otros-edificios/sede-de-metro-de-madrid-y-centro-integral-de-transporte/

Caleido Tower （Cuatro Torres Business Area)

