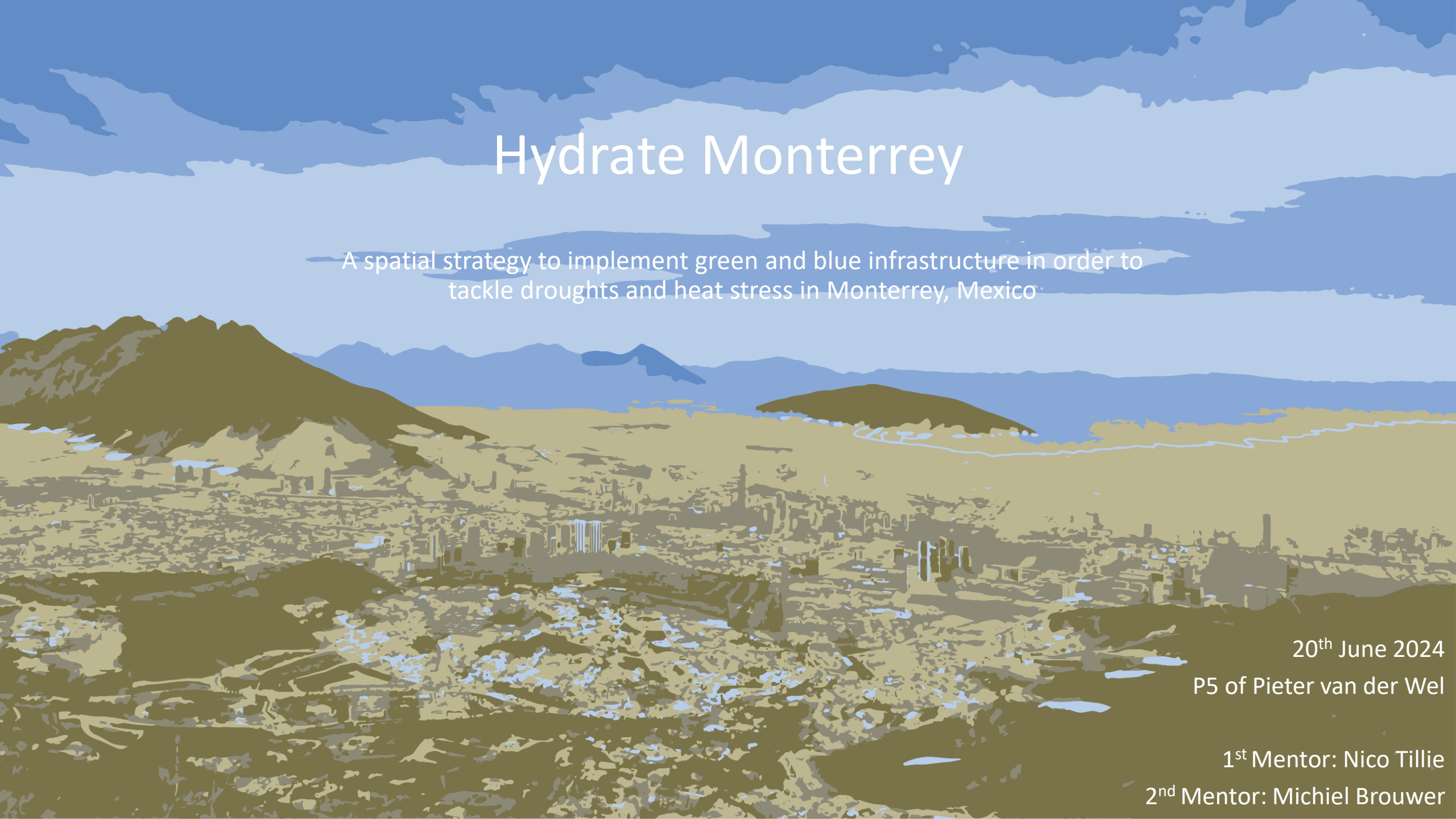
Hydrate Monterrey

A spatial strategy to implement green and blue infrastructure in order to tackle droughts and heat stress in Monterrey, Mexico



20th June 2024

P5 of Pieter van der Wel

1st Mentor: Nico Tillie

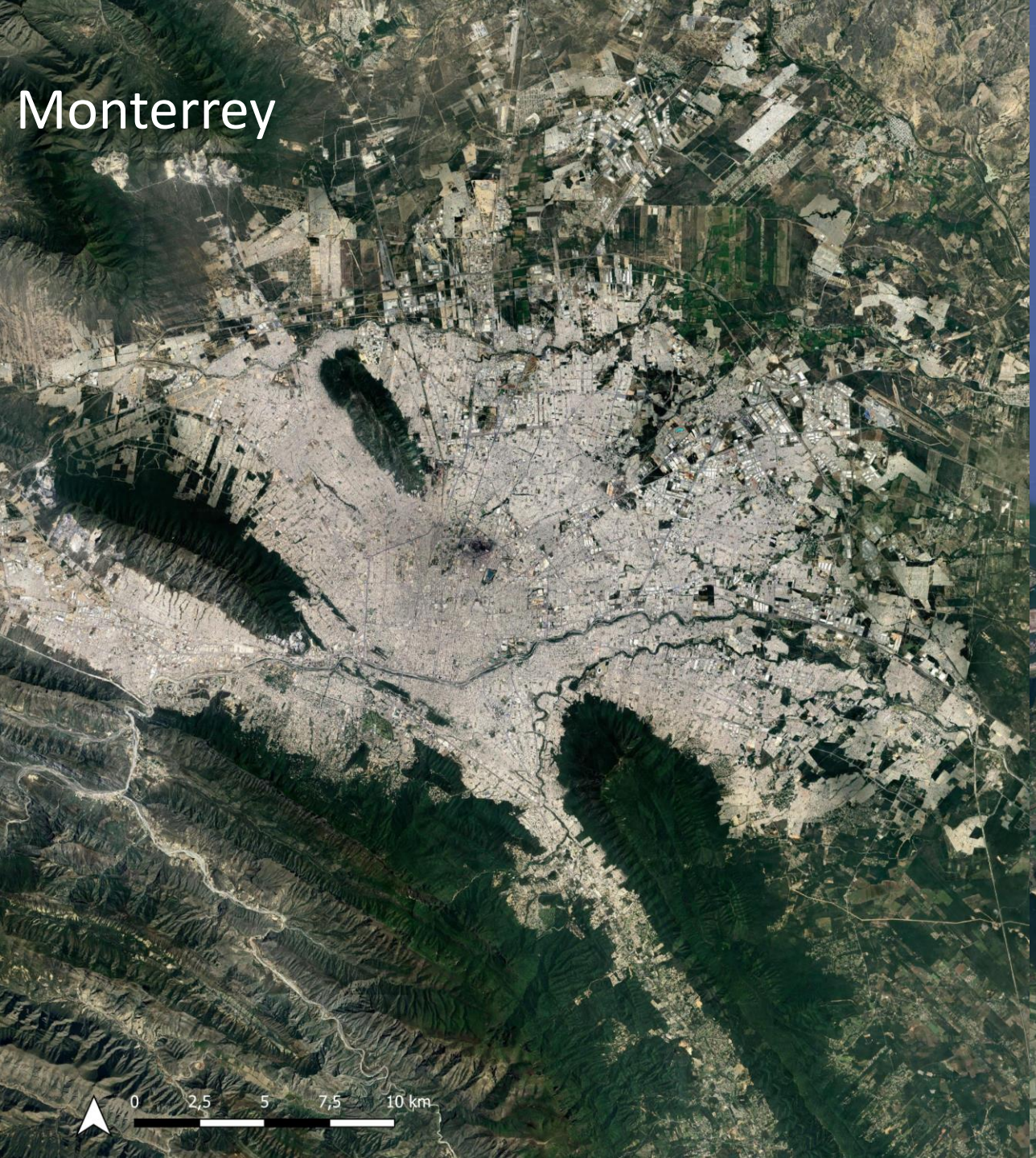
2nd Mentor: Michiel Brouwer

Hydrate Monterrey

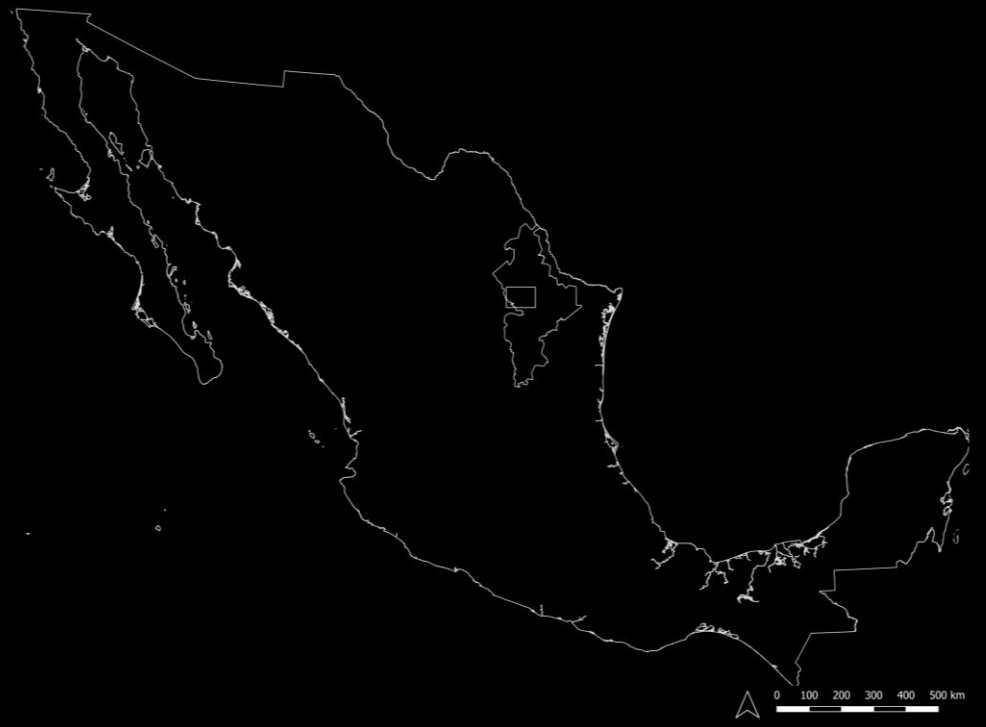
A spatial strategy to implement green and blue infrastructure in order to tackle droughts and heat stress in Monterrey, Mexico

Content

- Introduction
- Problem
- Methods
- Analysis & Design principles
    1. Landscape and Ecology
    2. Heat stress
    3. Hydrological cycle
- Metropolitan vision
- Spatial designs
- Conclusions


Monterrey
0
2,5
5
7,5
10 km


South Holland
0
2,5
5
7,5
10 km

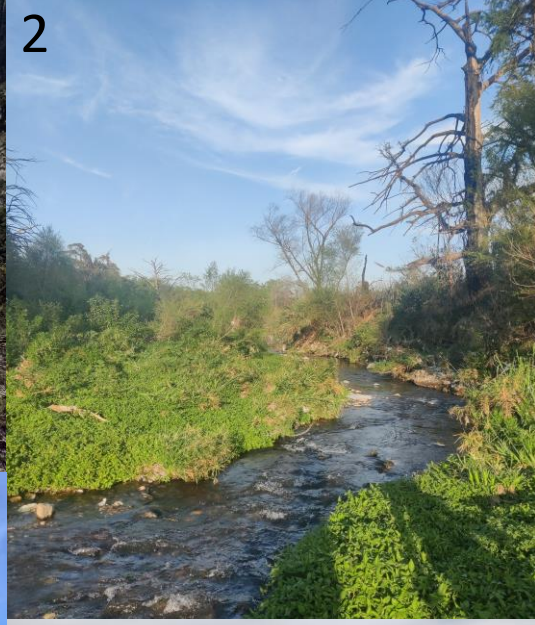


- Semi-Arid Environment
- 2nd biggest Metropolis
- Population: 5,341,177 (2020)

(economiagov. 2023)


1
2
3
4
5
6
0
2,5
5
7,5
10 km


1


2


3
CHIPINQUE


4


5


6

Problem: Monterrey at risk in the future by climate change

Climate change results into more extreme weather events (Meteoblue, n.d.), which leads into intensification of the following problems:

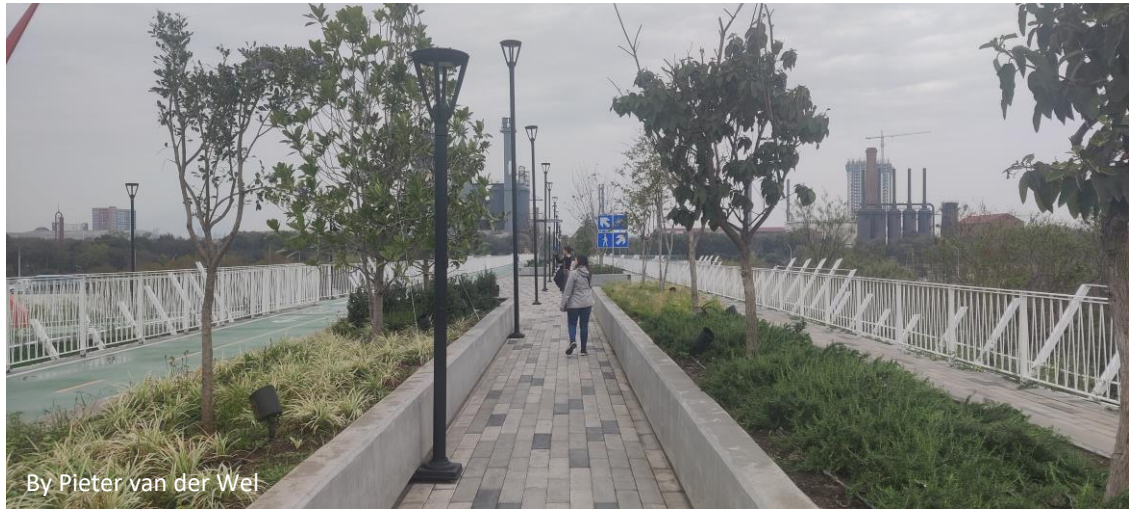
Droughts

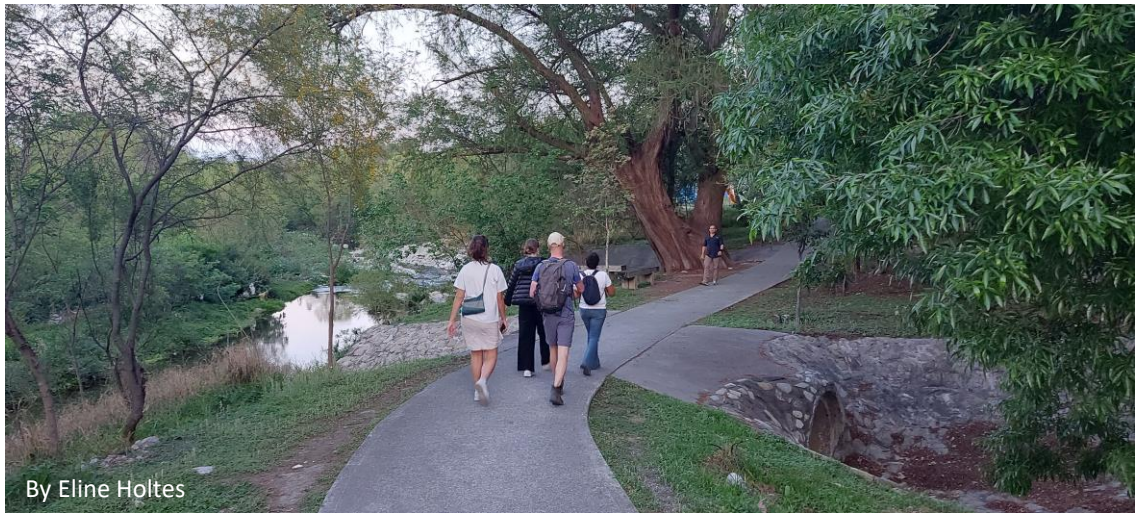
Heat stress

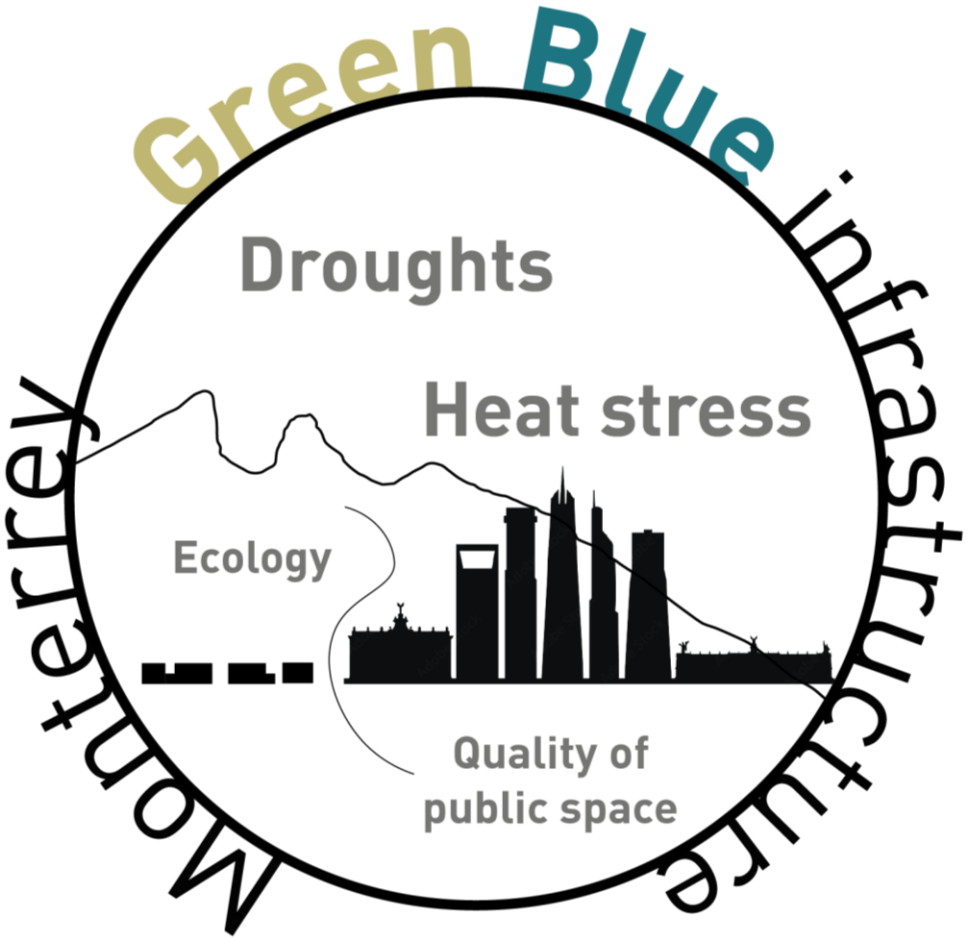
Water scarcity

Floods

Methods: Goal

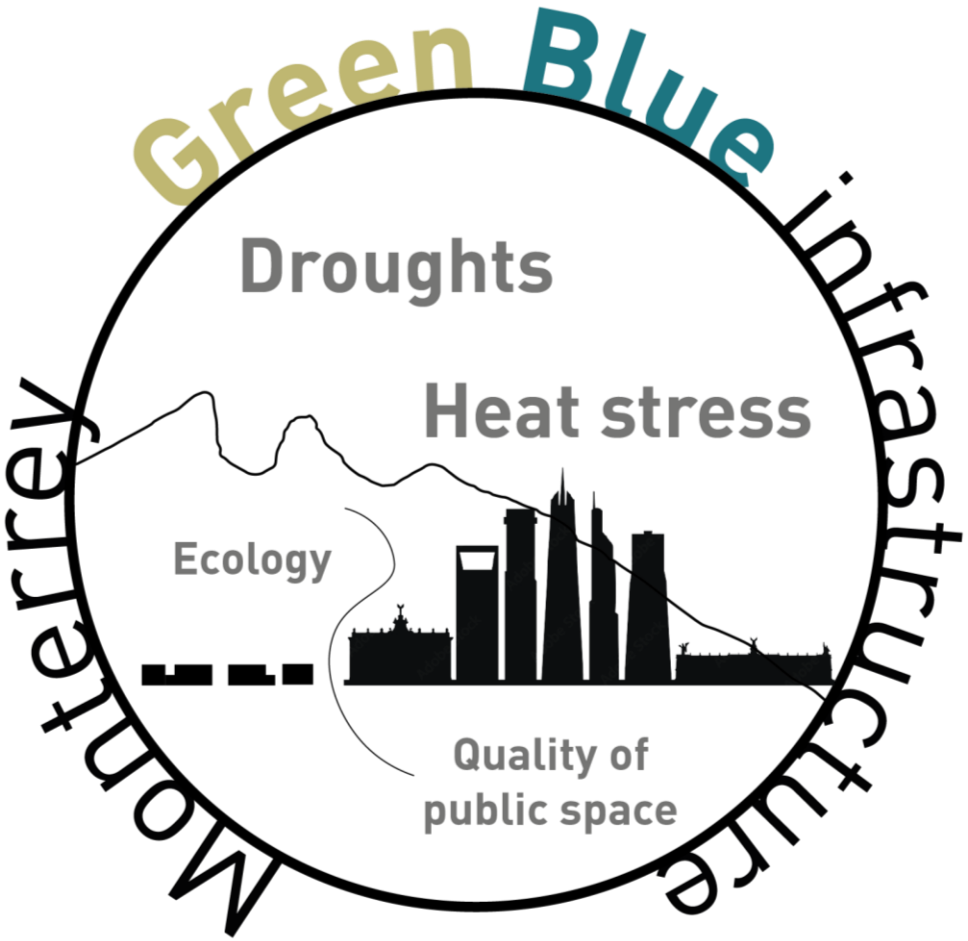






Methods: Research question

"What spatial strategy can be used to implement green and blue infrastructure in order to tackle droughts and heat stress in the metropolitan area of Monterrey?“



Methods: Subquestions

"What spatial strategy can be used to implement green and blue infrastructure in order to tackle droughts and heat stress in the metropolitan area of Monterrey?“

1. What are the (natural) systems of the landscape in and around the Metropolitan area?

2. What are the design principles translated from the analysis?

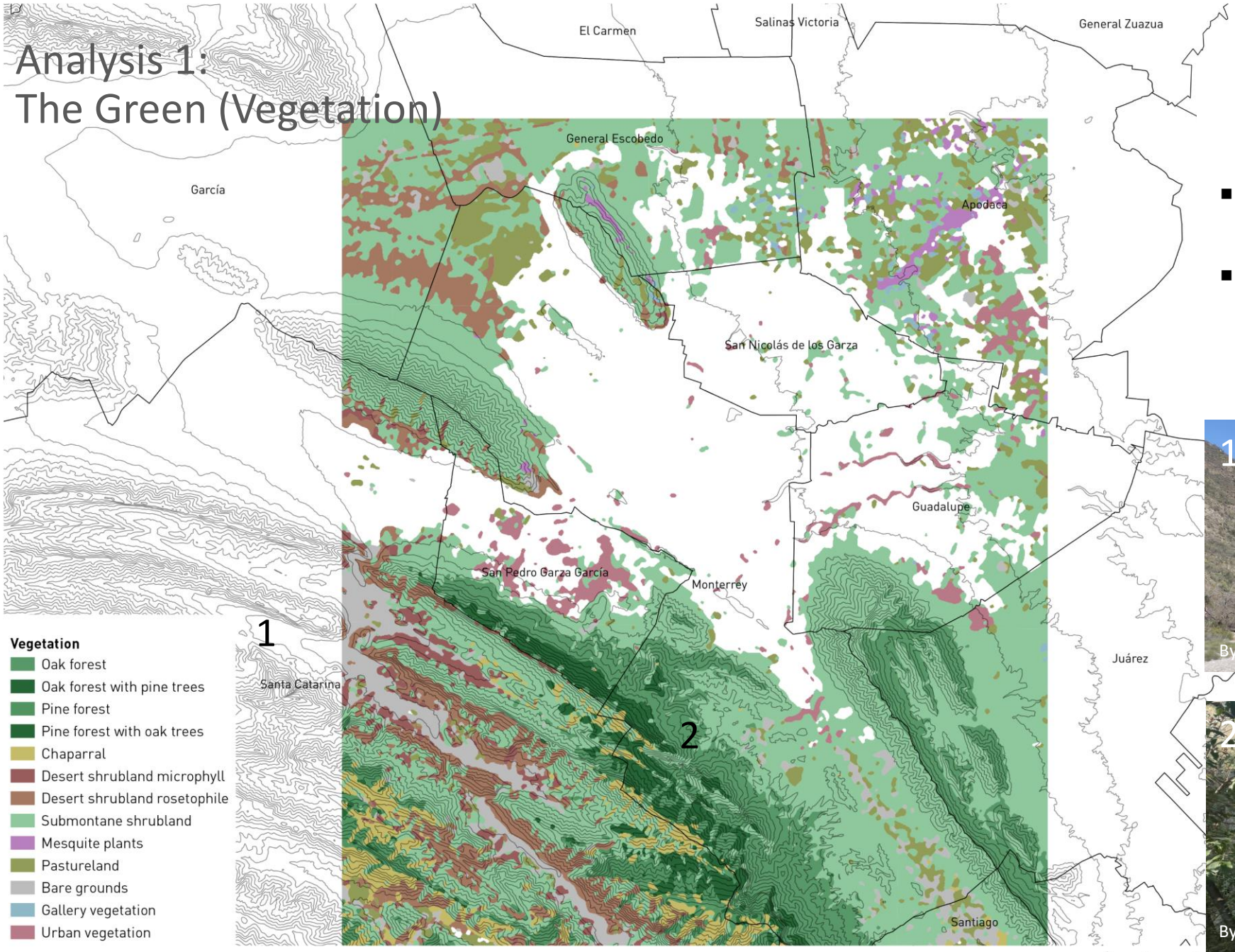
3. How are the design principles implemented in the metropolitan area?

4. What strategy is used for designating the design location?

5. What strategies are used to implement green and blue infrastructure into a spatial design?

Analysis & Design principles 1:
Landscape and Ecology

Analysis 1:
The Green (Vegetation)

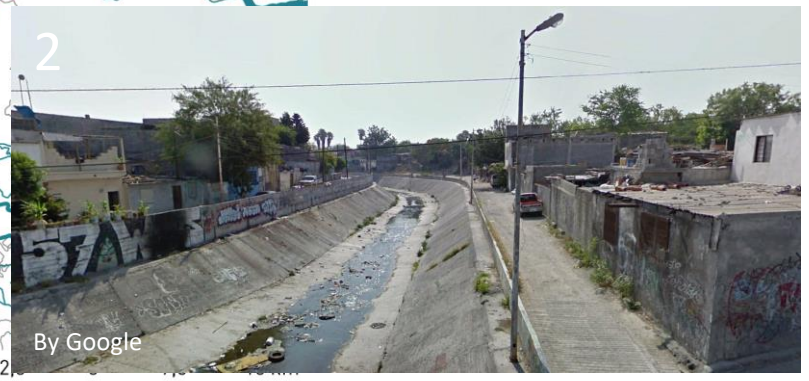


- The soil types and climate sets the conditions for plant species.
- Urbanisation caused loss of vegetation cover.

Sources: INEGI, OSM, Municipality Monterrey (n.d.)

Analysis 1: The Blue (waterstructure)

- Most of the rivers and streams are (almost) dry
- Several of concrete cased waterways (stormdrains)
- Risks of floods and landslides because of urbanization



Landslide zone
Inundation zone

Waterstructure
Rivers
Streams
Channel
Drain
Dam
Ditches
Little streams
Wastewater treatment plant
Water storage tank

Presa Rompe Picos

1
2

0 2

Sources: INEGI, OSM, Municipality Monterrey (n.d.)

Design principles 1: Landscape & Ecology

Cerro del Topo Chico

Sierra las Mitras

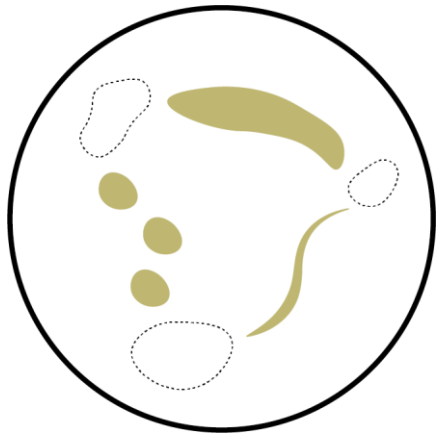
Cerro de la Silla

Cumbres de Monterrey

Parks & Plazas
Nature reserve
Waterstructure
Rivers
Streams
Little streams

0 2,5 5 7,5 10 km

Creating patches of natural areas



Creating connection

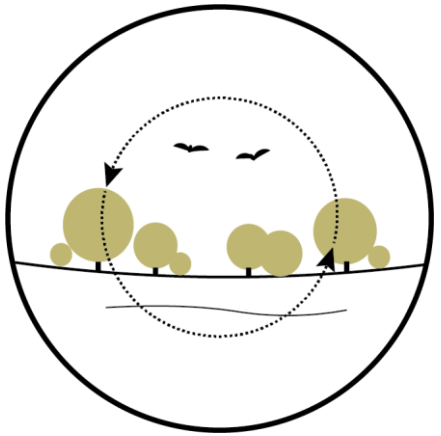
- To encourage biodiversity and therefore quality iof life

(R. Forman. 2008)
(Wageningen University & Res
n.d.)

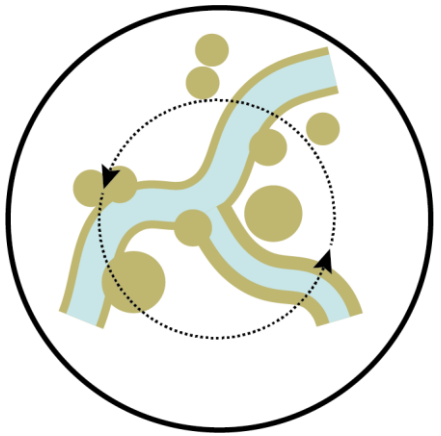
Design principles 1: Landscape & Ecology

Parks & Plazas
Nature reserve
Waterstructure
Rivers
Streams
Little streams

0 2,5 5 7,5 10 km



Restore the ecology

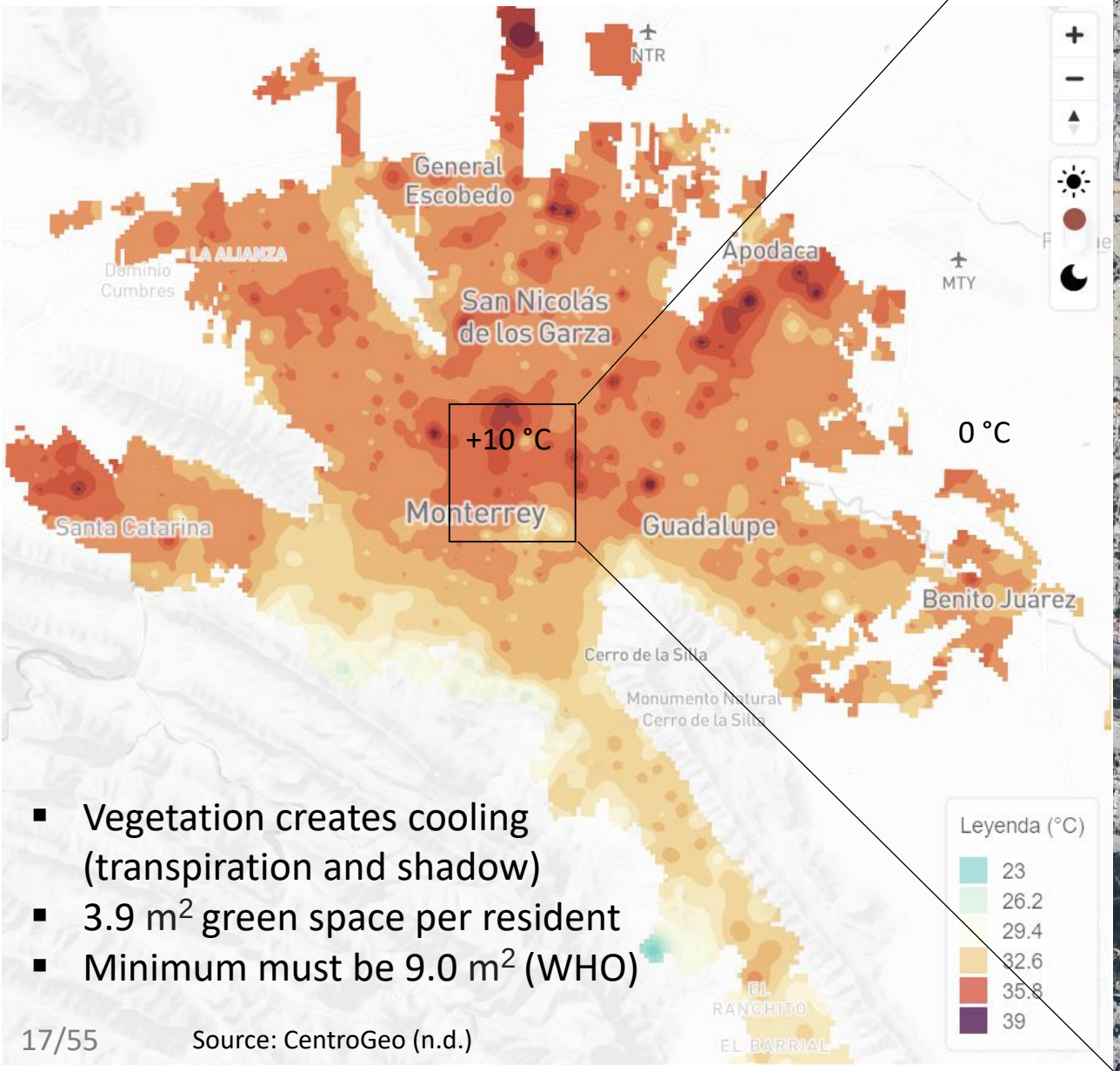


Restore the waterstructure

- Making an ecological and recreational grid

Analysis & Design principles 2:
Heat stress

Analysis 2: Heat stress



- Vegetation creates cooling (transpiration and shadow)
- 3.9 m^2 green space per resident
- Minimum must be 9.0 m^2 (WHO)

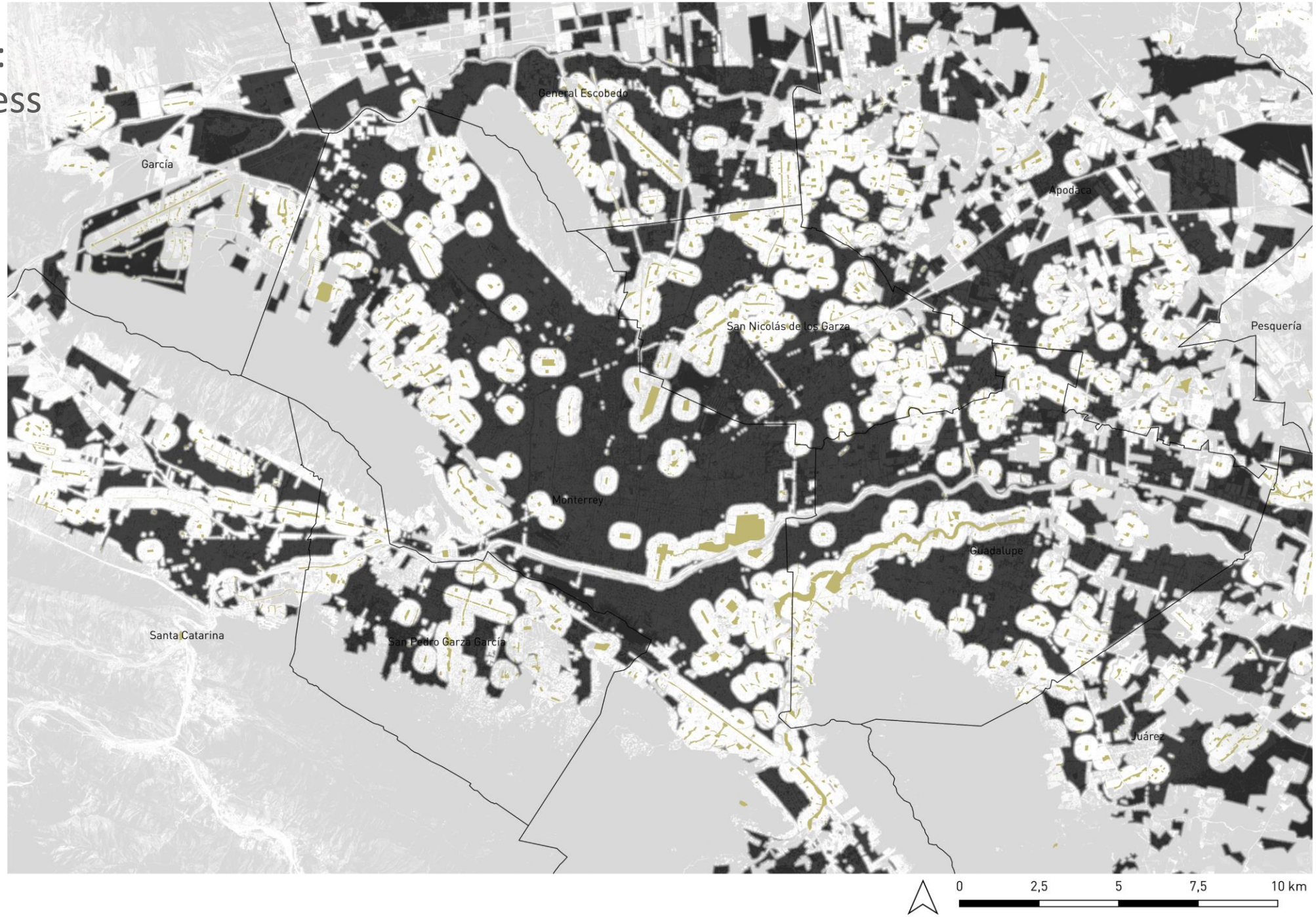
Source: CentroGeo (n.d.)

Source: Google Earth (n.d.)

Design principles 2: Mitigating heat stress

300m from current green spaces > 1 ha

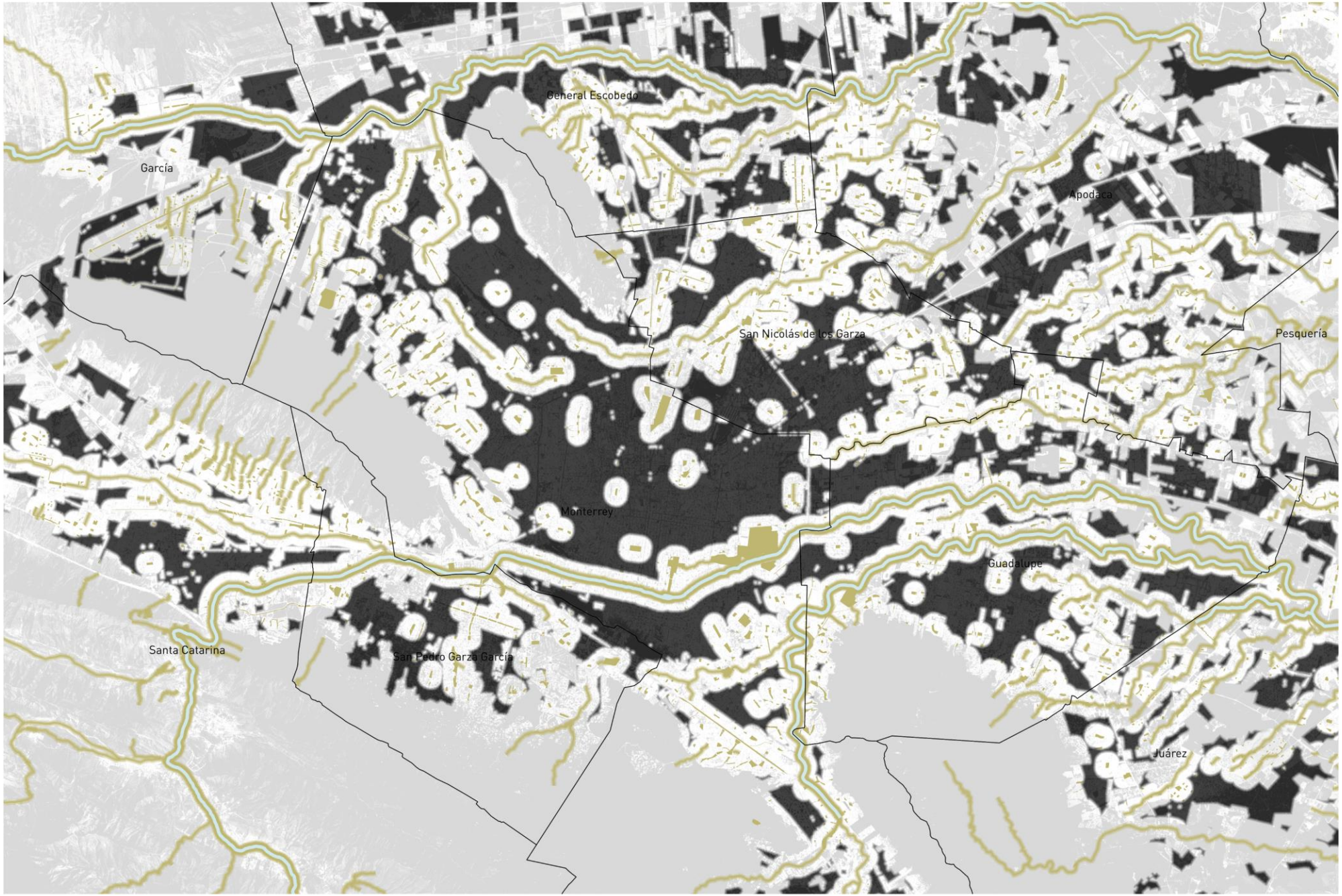
(C.Konijnendijk, 2021)

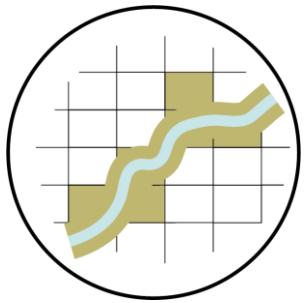


300 meter rule

New Parks along

- Rivers
- Streams

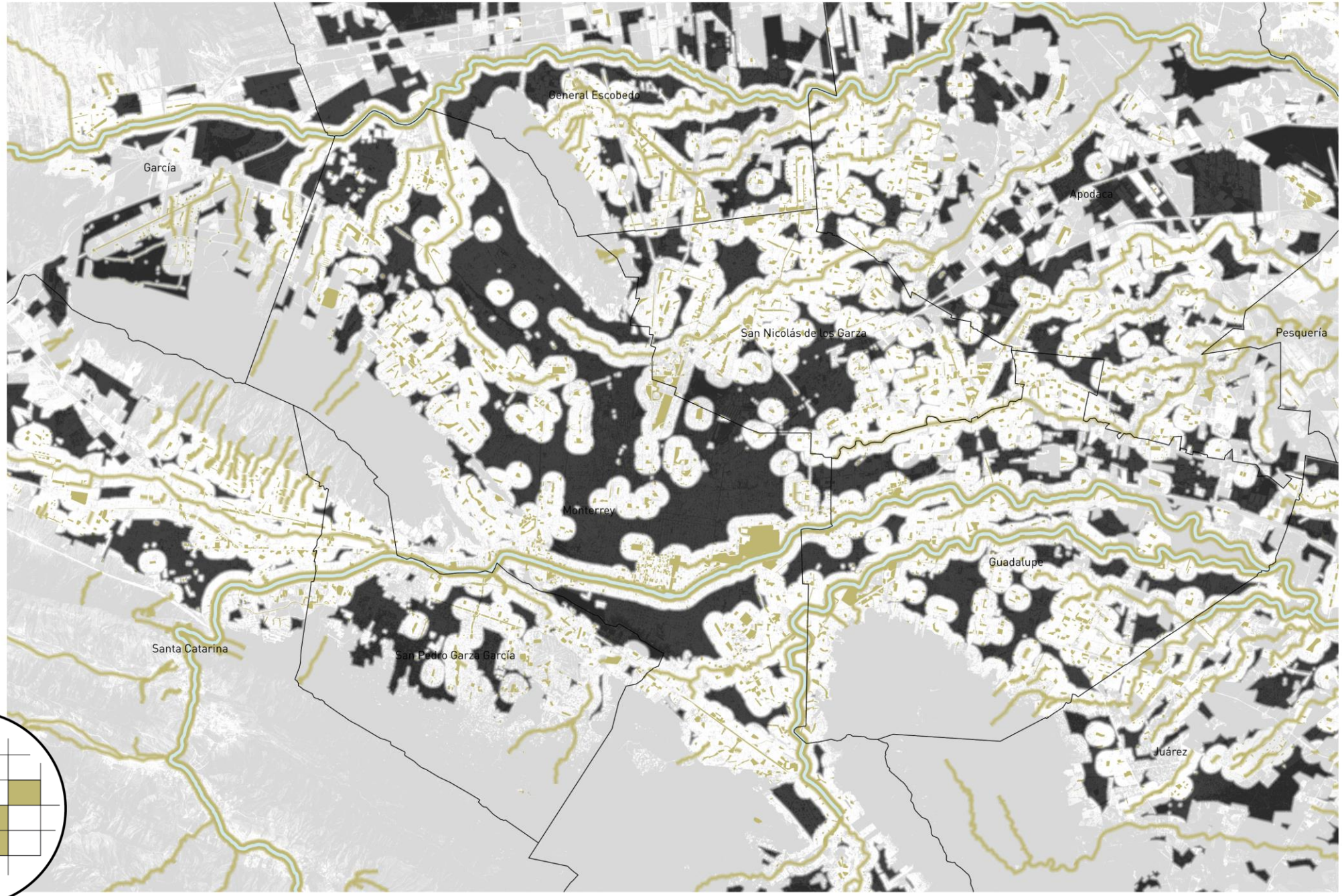


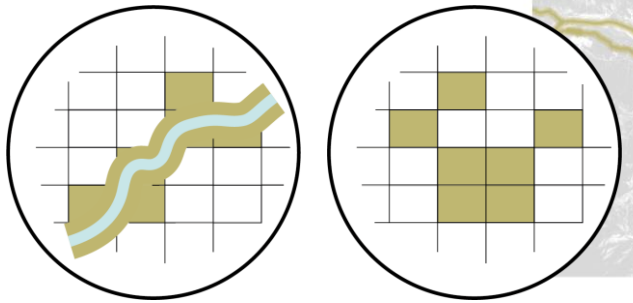


300 meter rule

New parks

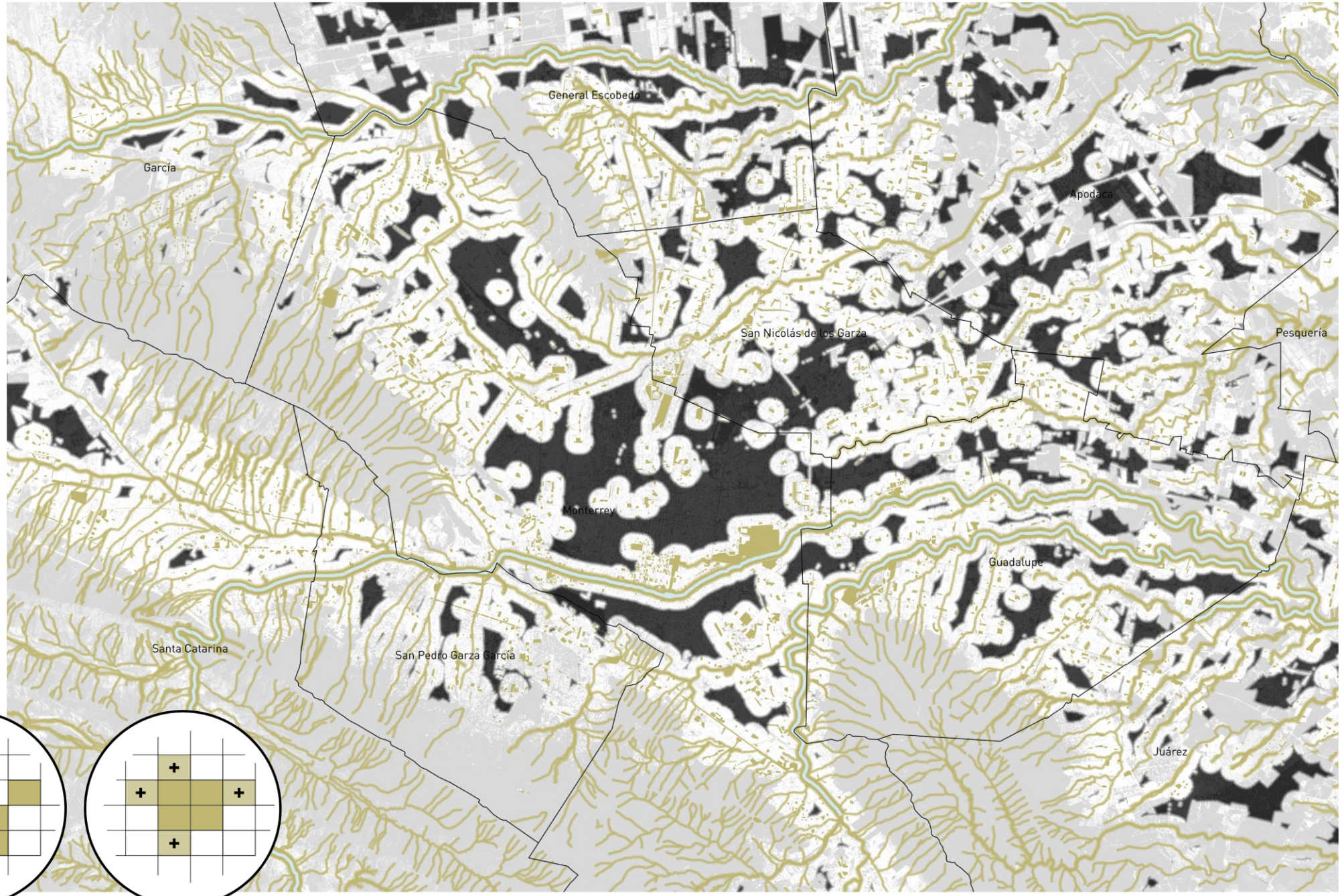
- Parkinglots
- Empty lots

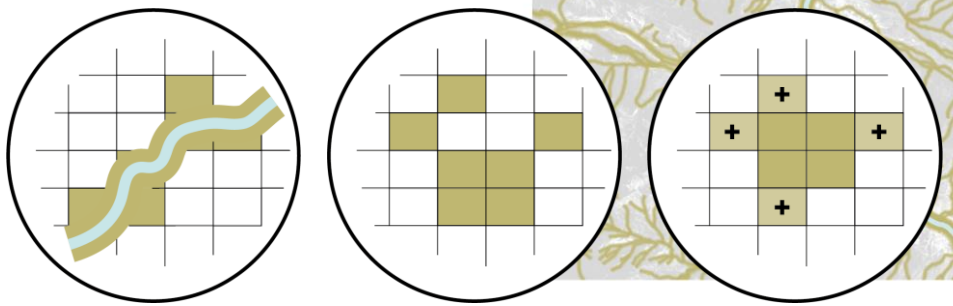




300 meter rule

Expand
existing Parks

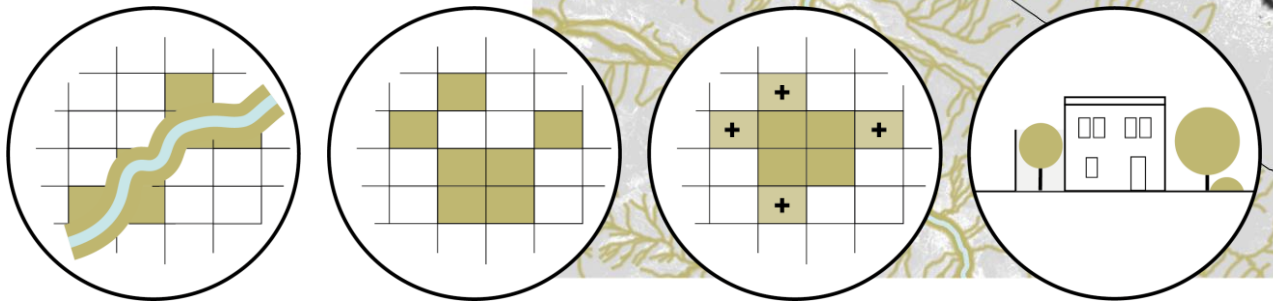




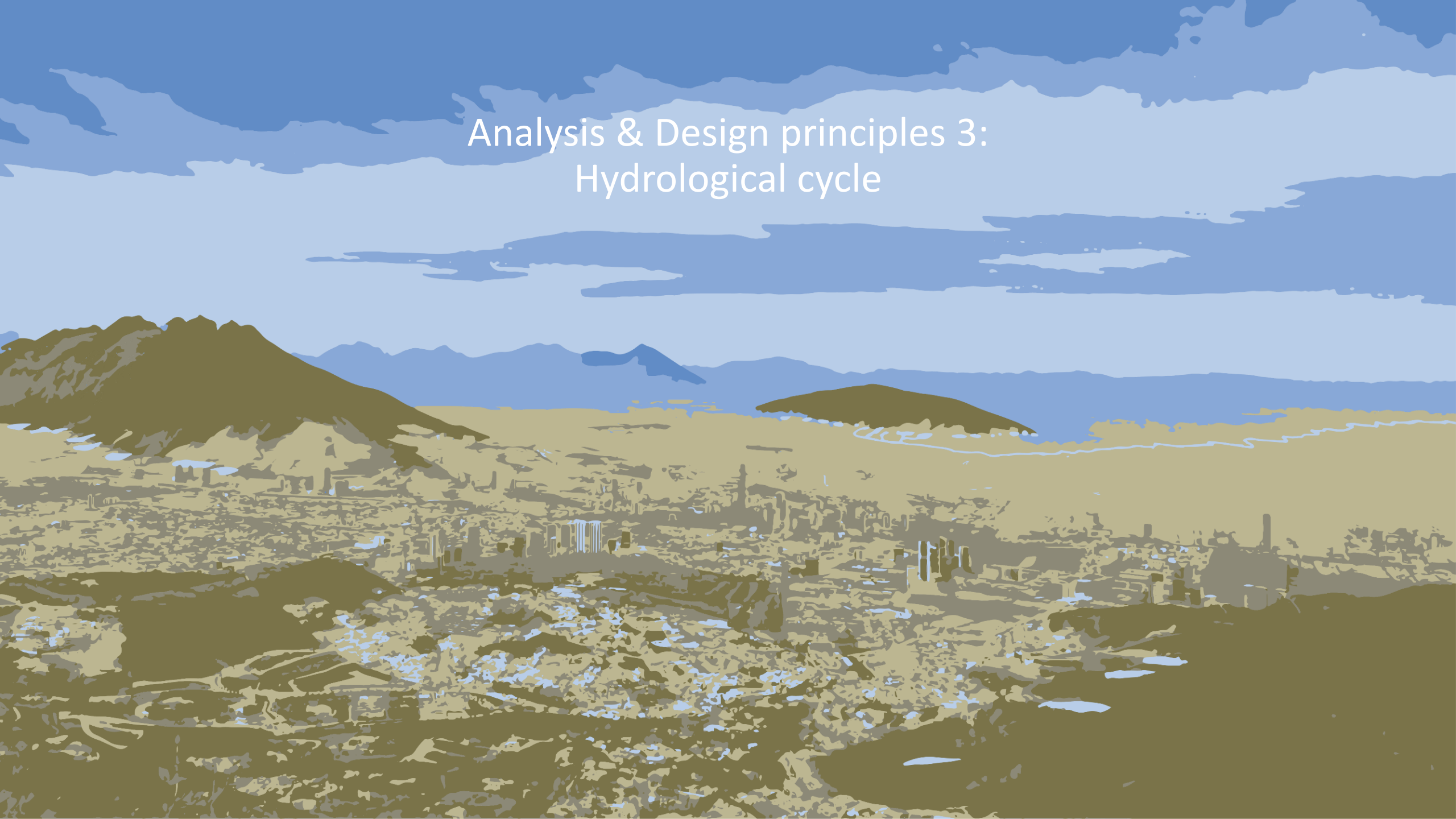
300 meter rule

Connect with

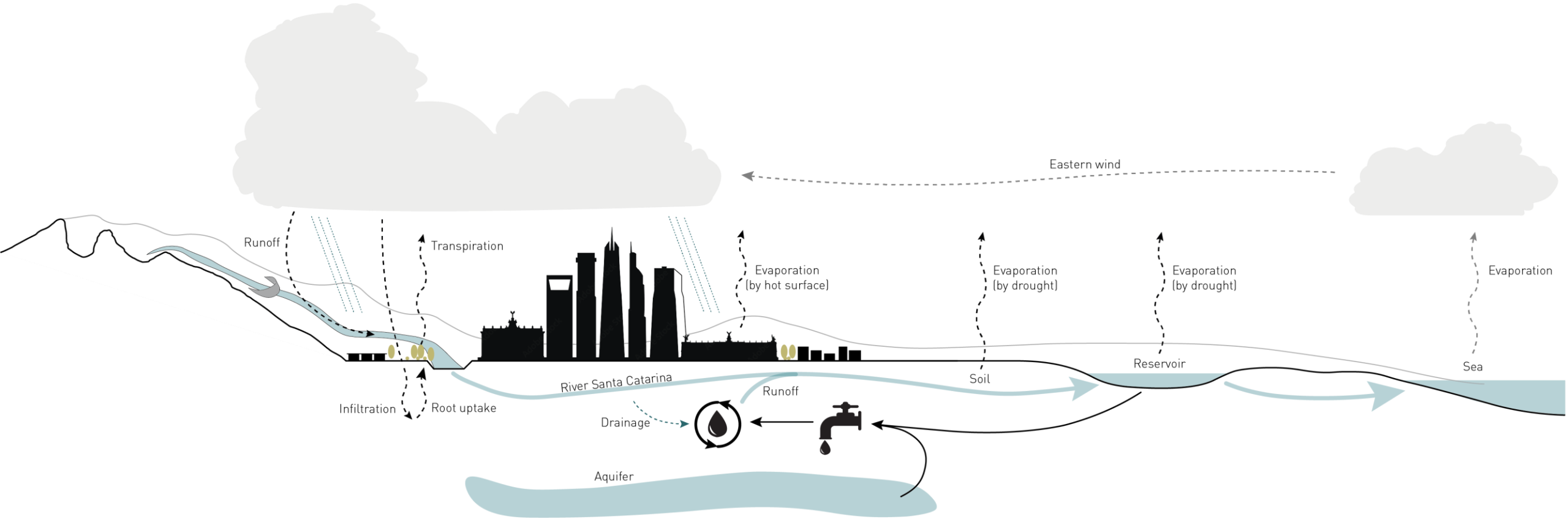
- Treelines
- Little streams



Analysis & Design principles 3: Hydrological cycle



Analysis 3:
Hydrological Cycle

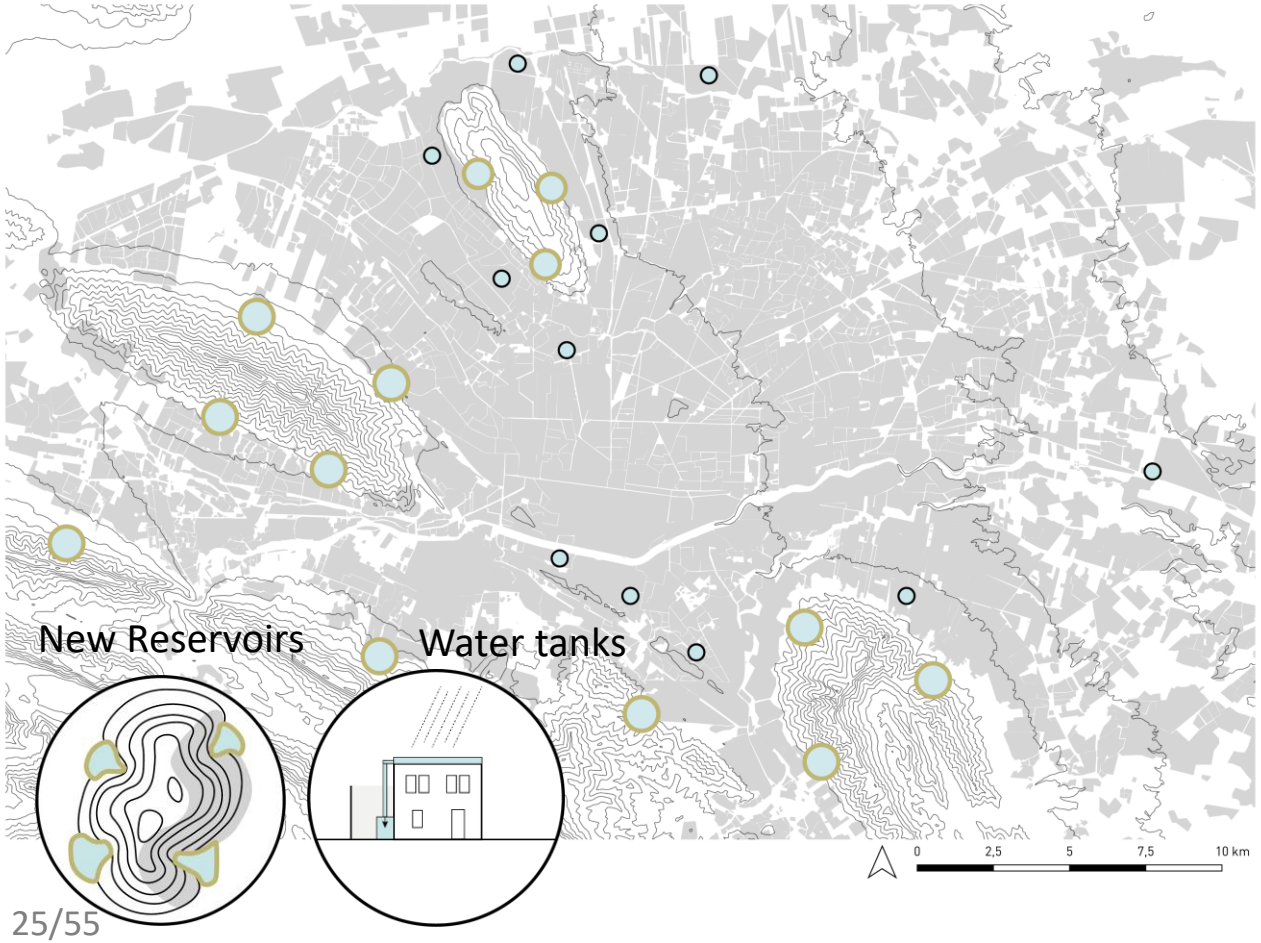


Sources: SADM, CEDES, TEC University (n.d.)

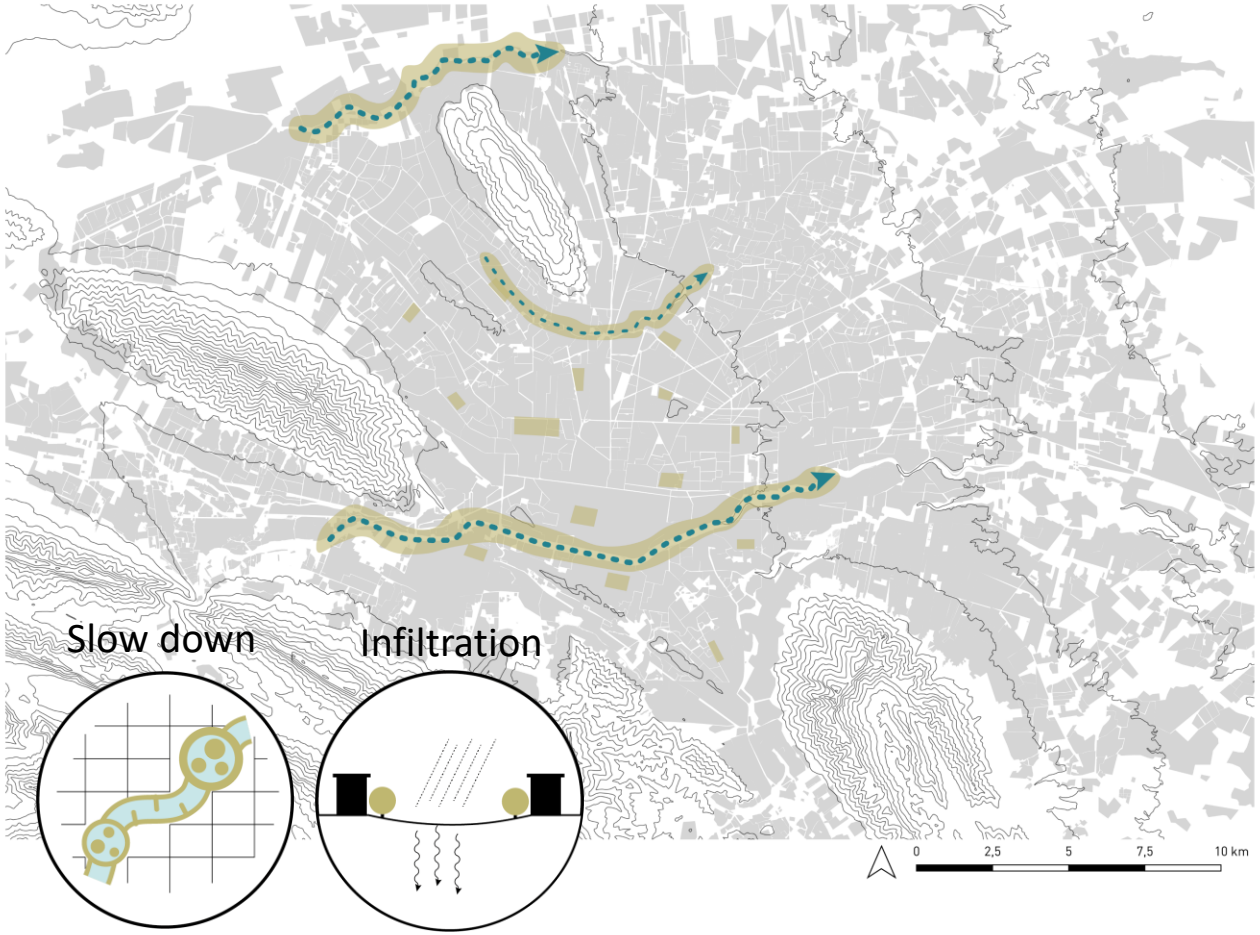
Analysis 3: Mitigating drought

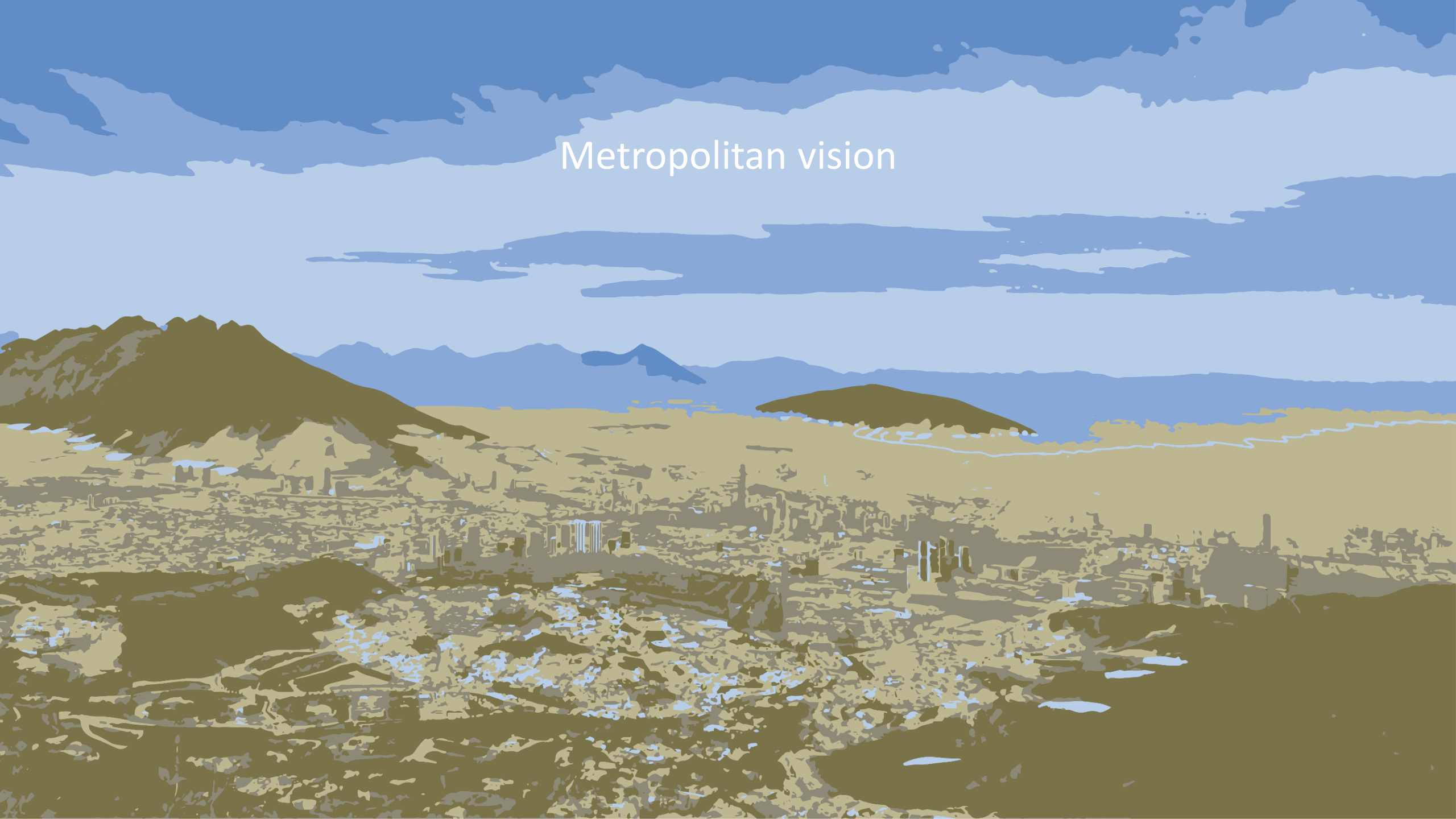
Creating a sustainable watermanagement with equal distribution and restoring the ecological environment

1. Store water upstream
   - Quality water (Environmental Protection Agency, n.d.)
   - less evaporation
   - Water available for the urban ecology

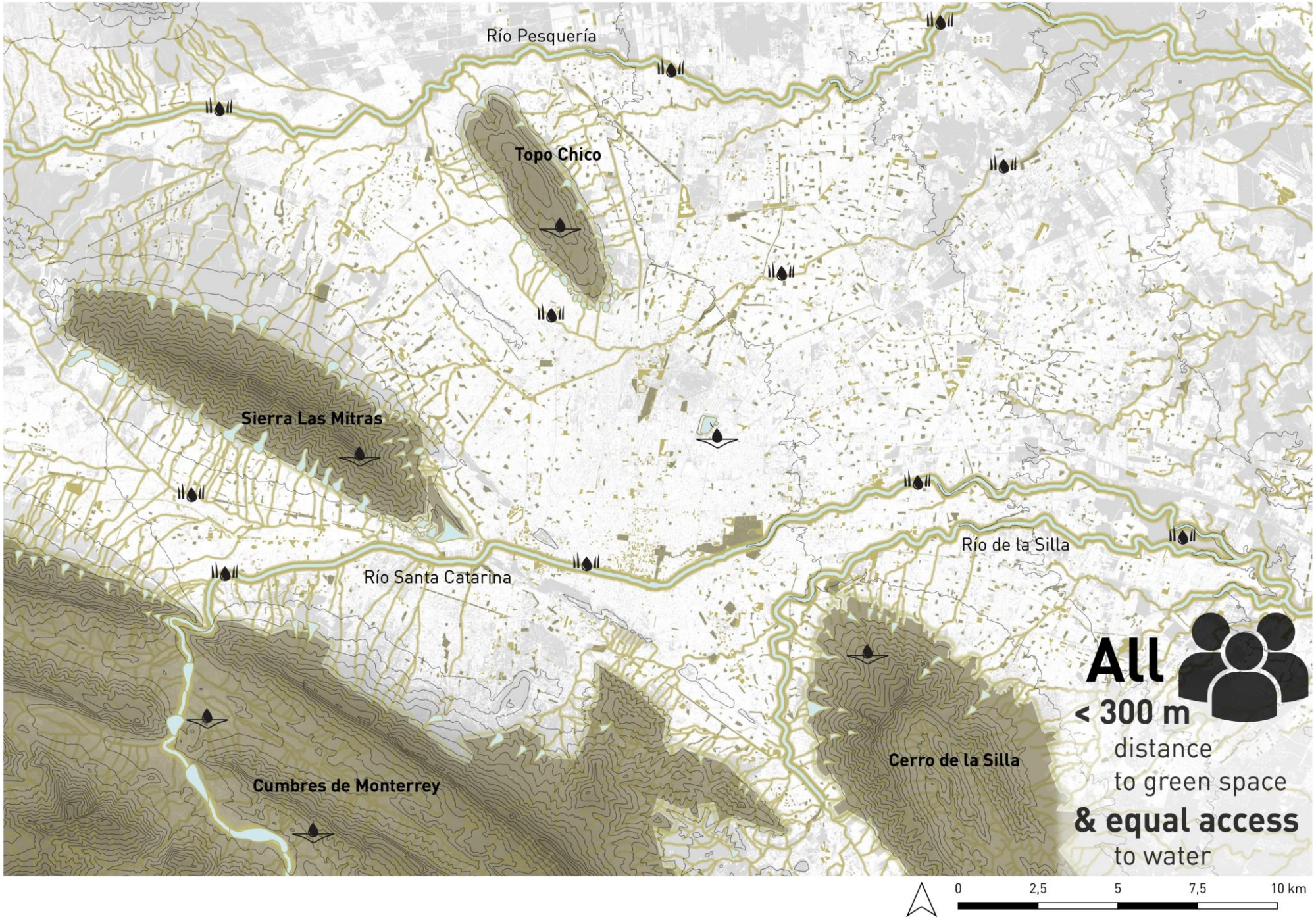


2. Retain water downstream
   - Cooler areas (Climate Adapt, n.d.)
   - More root intake from plants
   - Less contaminated water




Metropolitan vision

Metropolitan vision

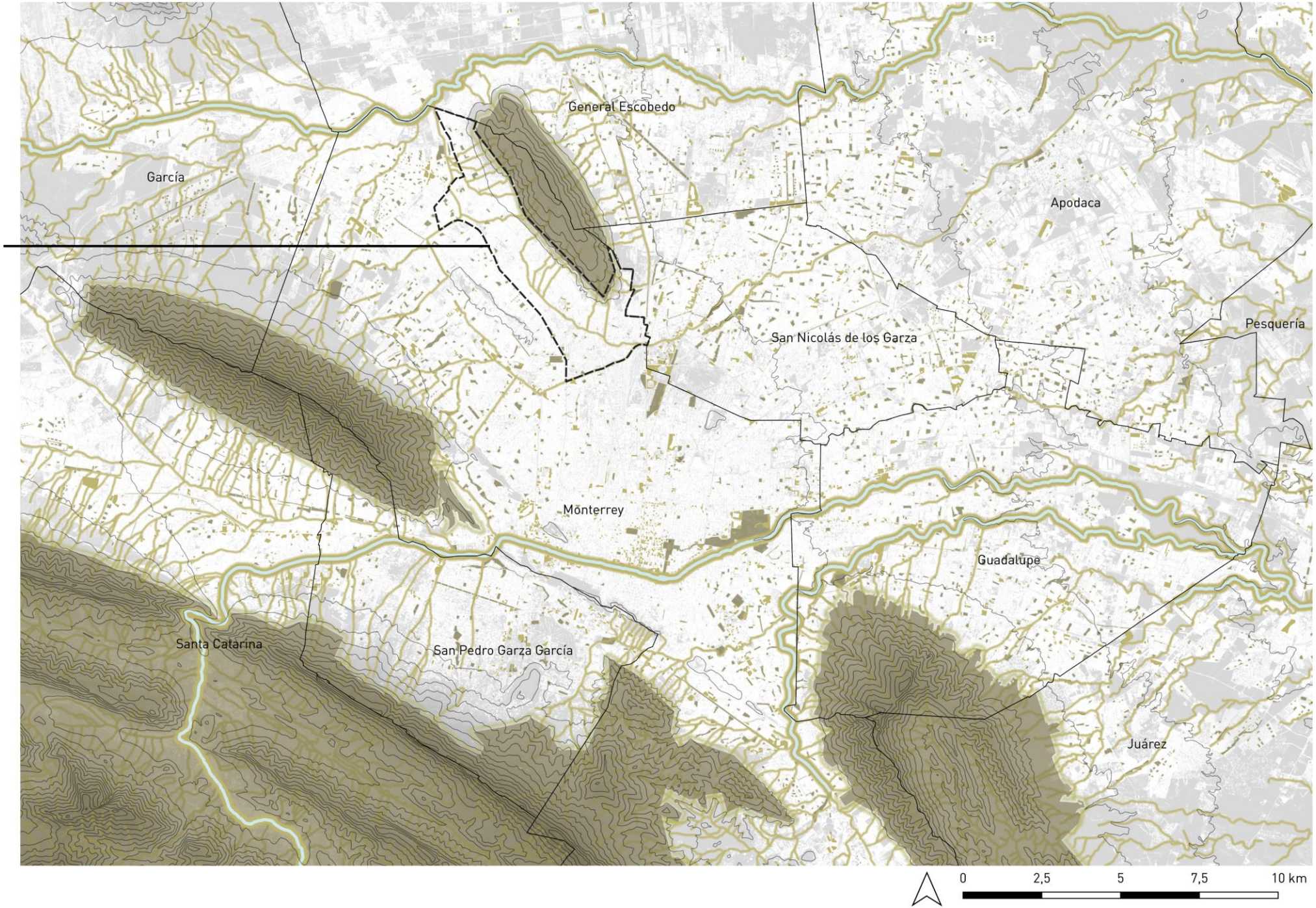


Metropolitan Strategy

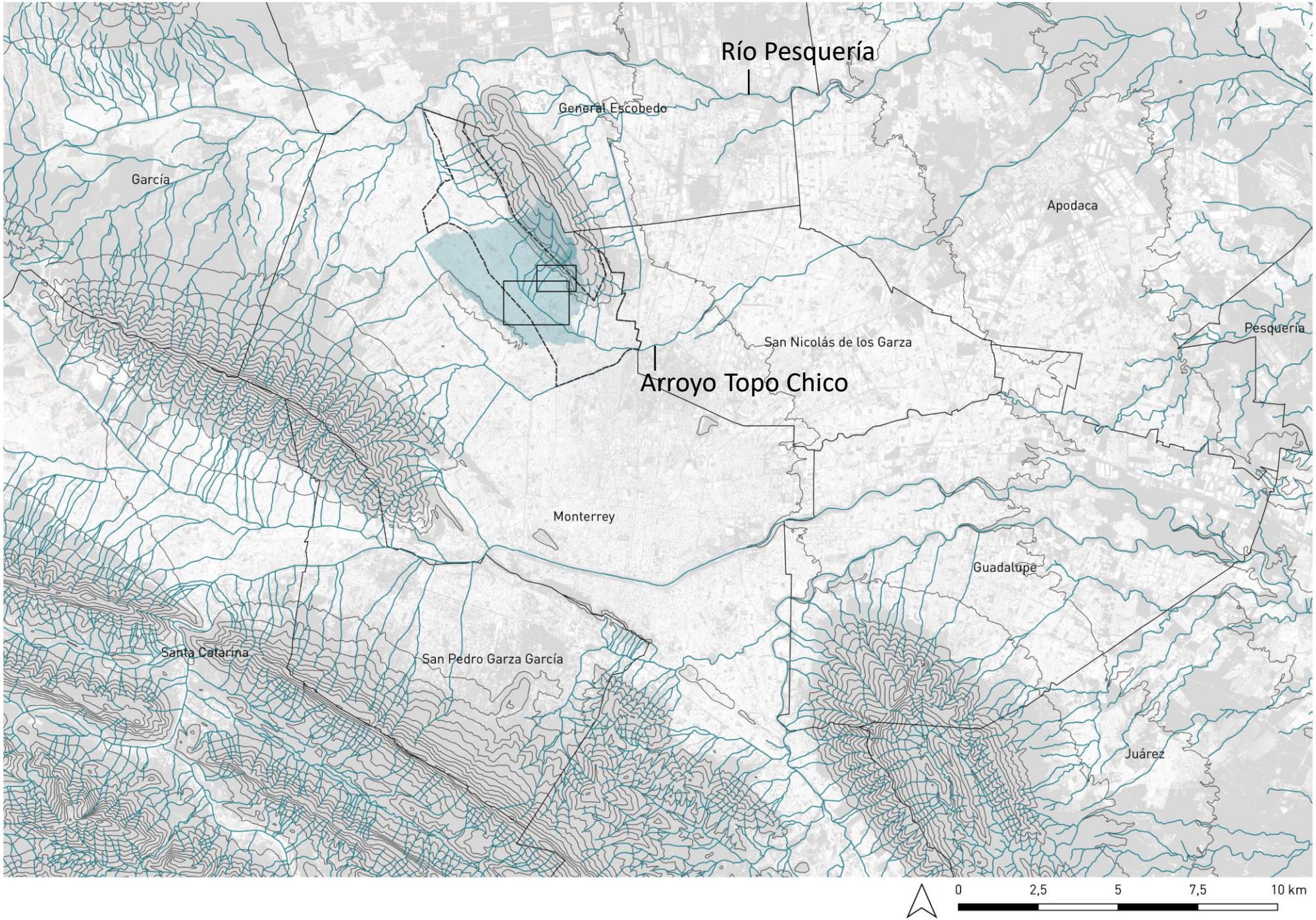
Starting with

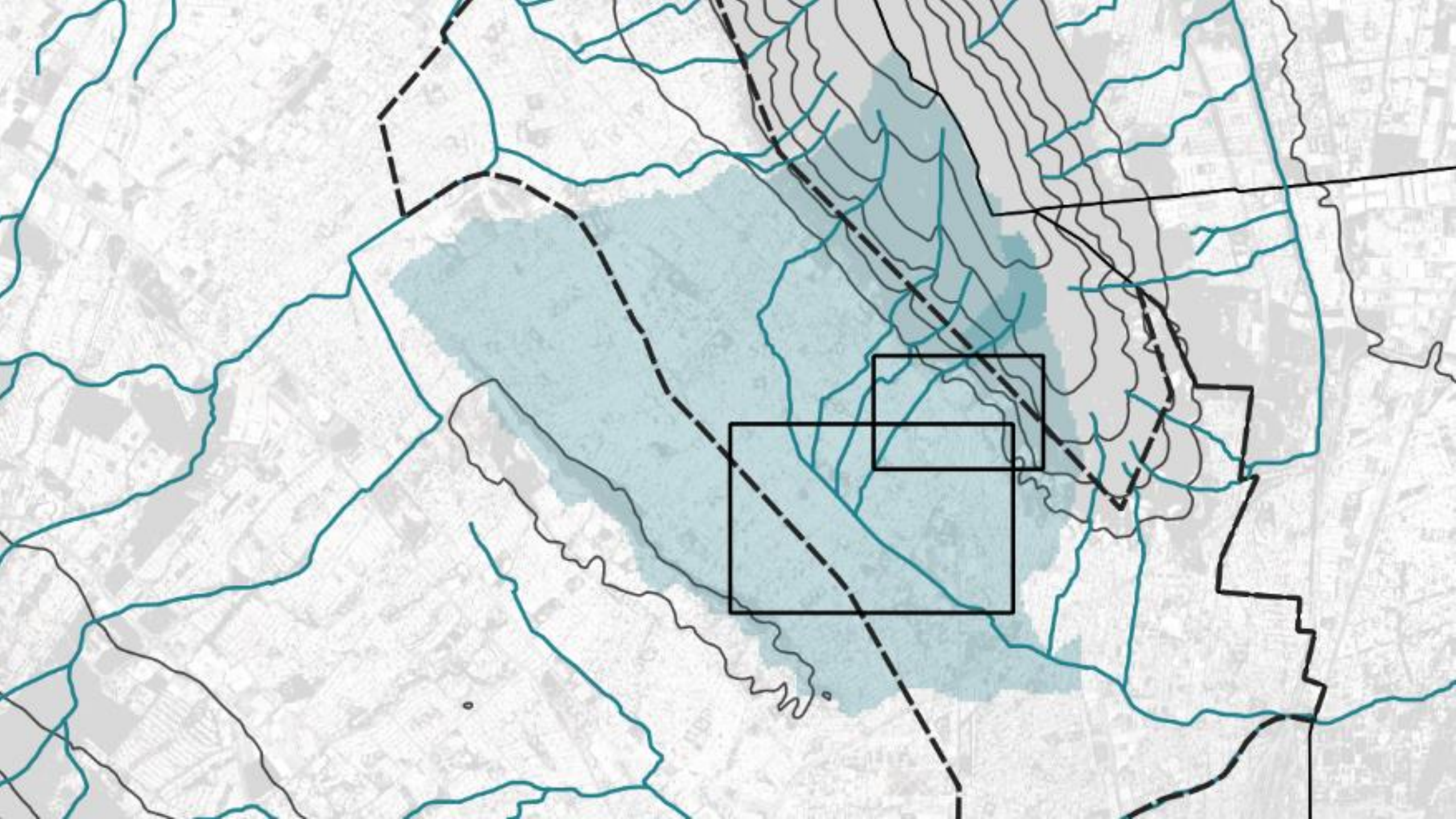
San Bernabé
District

- **Poverty**
- **Heat stress**
- **Lack of green**
- **Landslides**
- **Inundation**

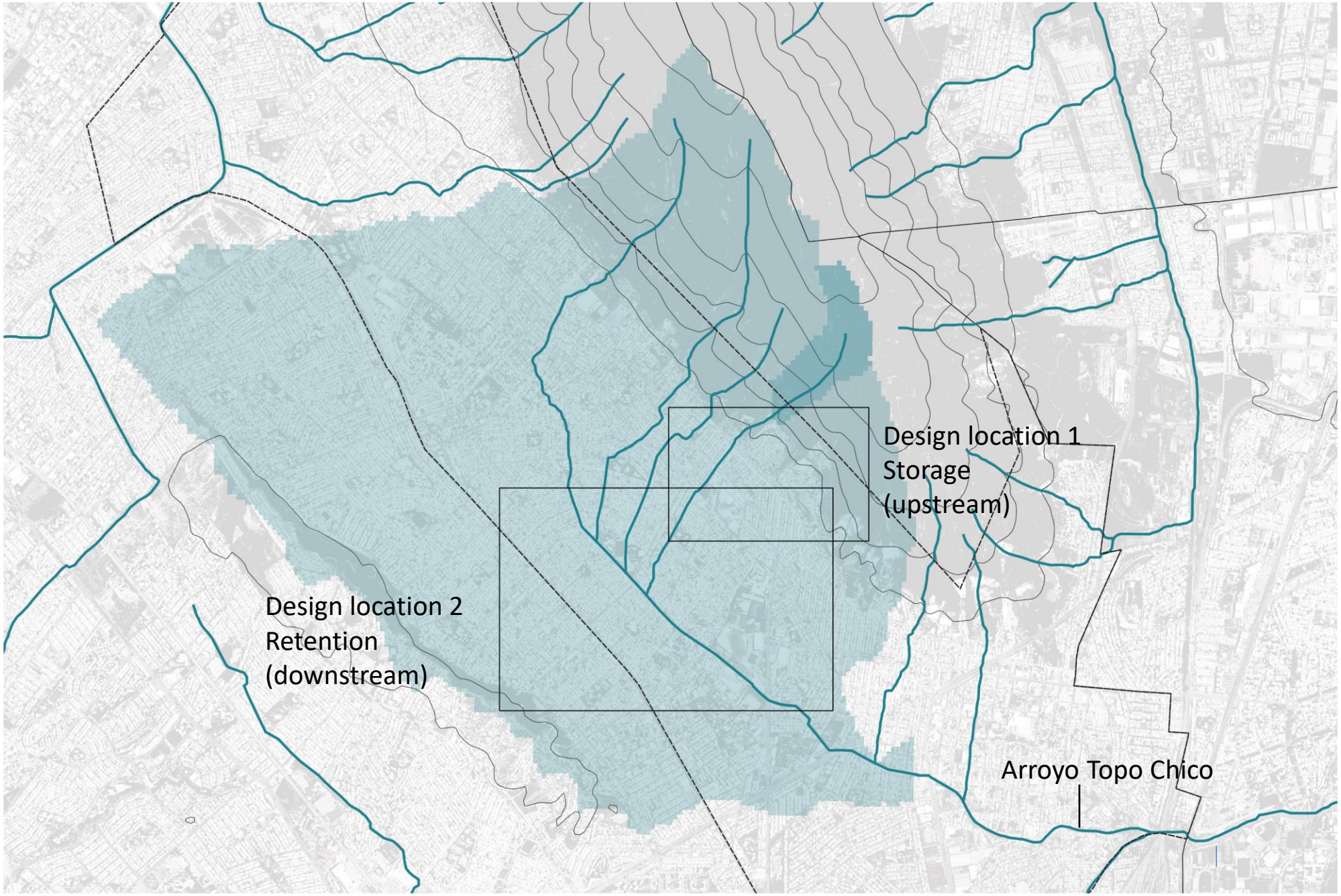


Watershed Strategy

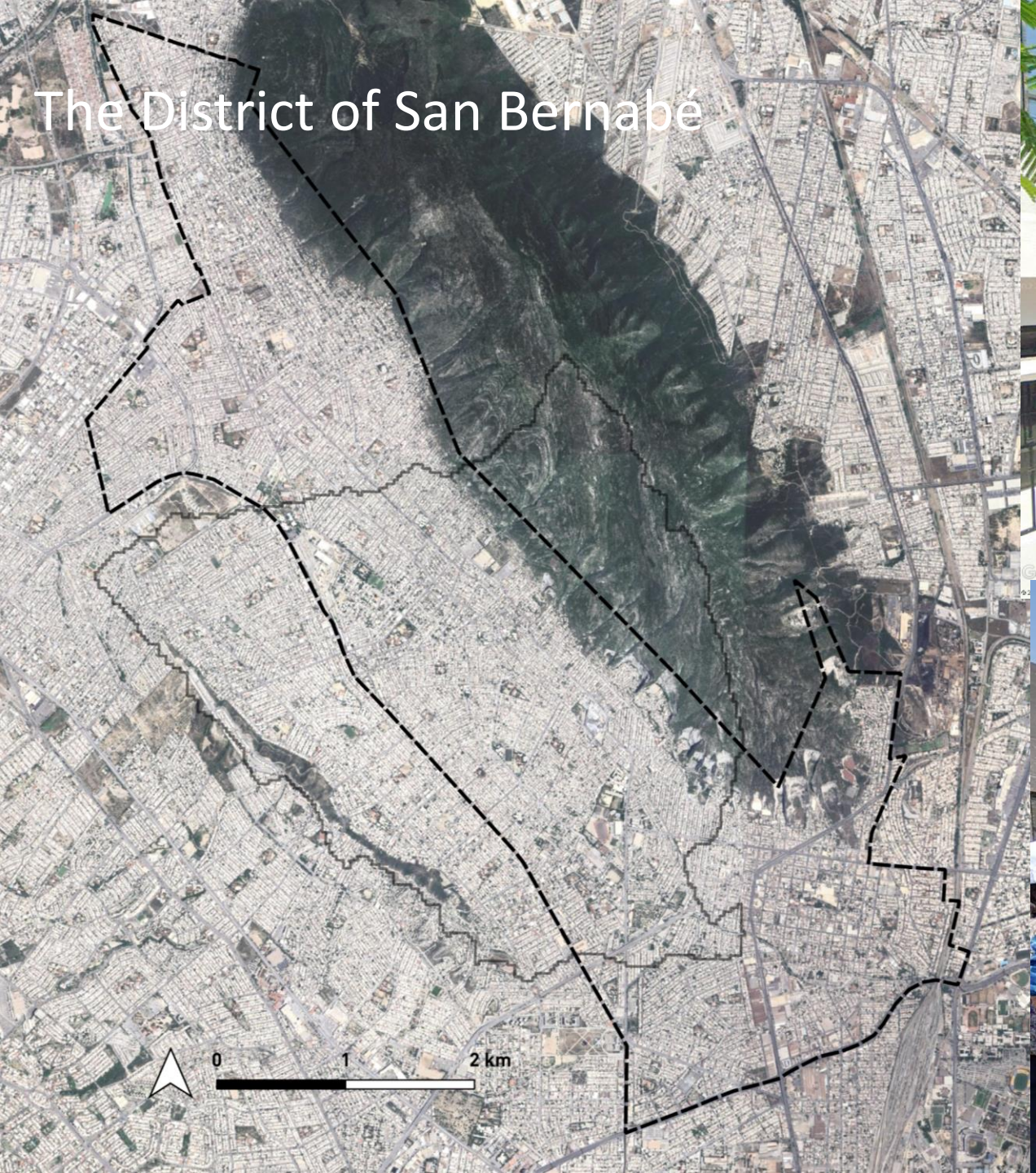




Upstream Arroyo Topo Chico Watershed



The District of San Bernabé

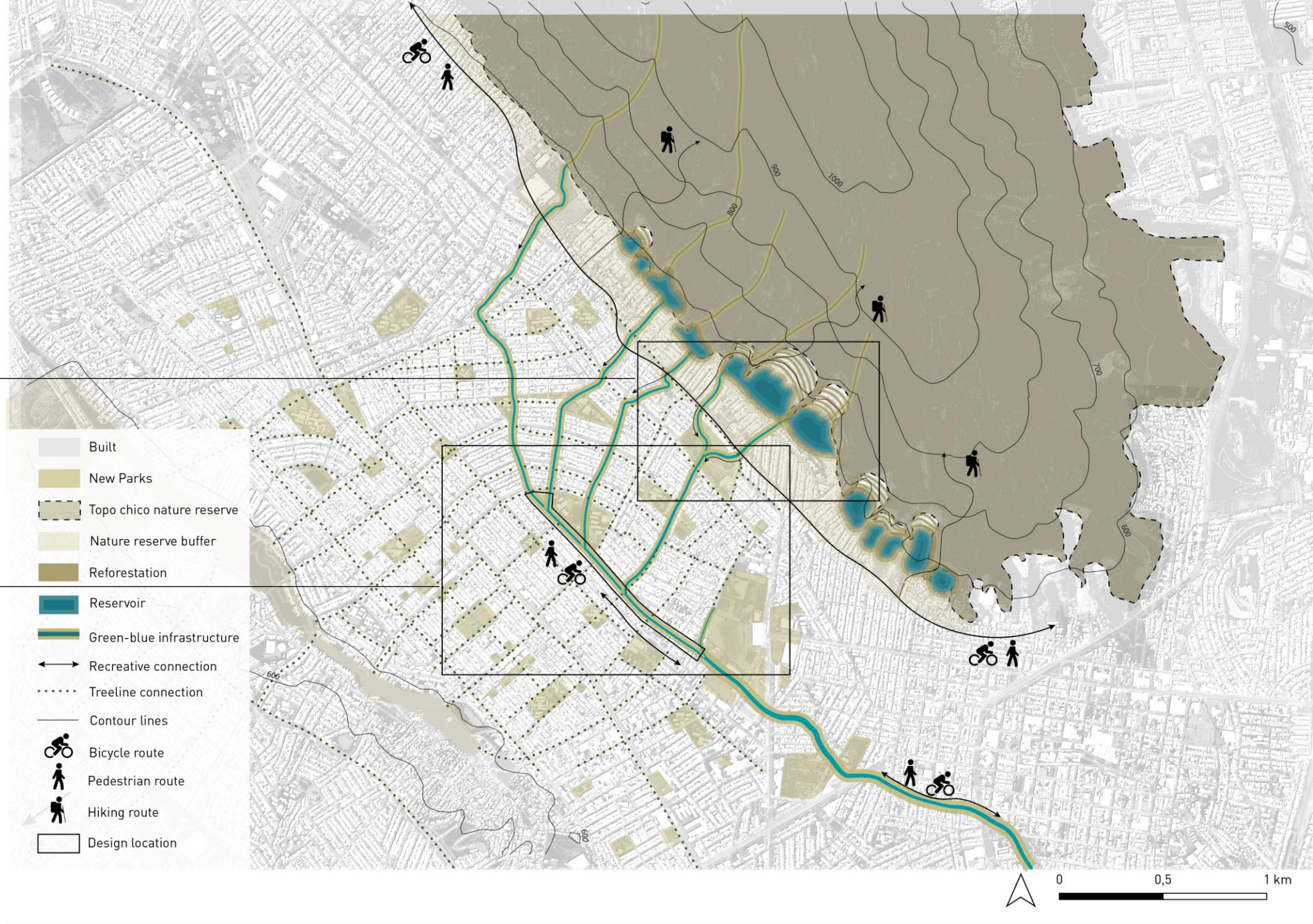


Current flow Arroyo Topo Chico

Urban Watershed Design

Design location 1:
Quarry restoration
(upstream)

Design location 2:
Linear park
(downstream)

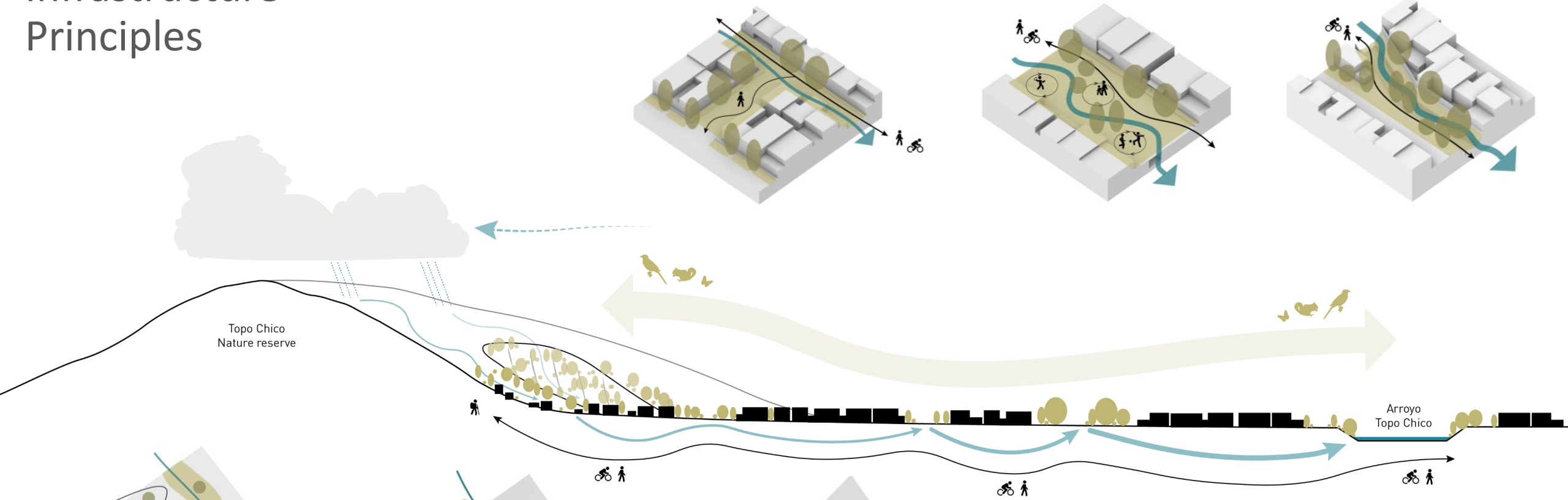


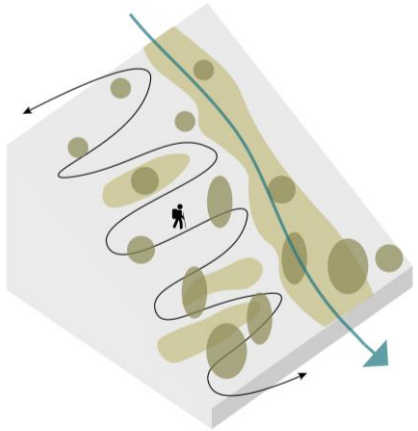
Green & Blue Infrastructure Principles

Green street

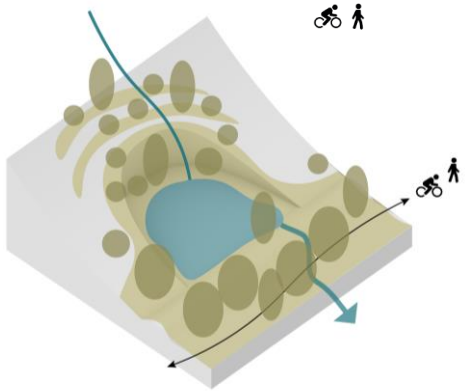
Linear park

"Daylighting" Stormdrain

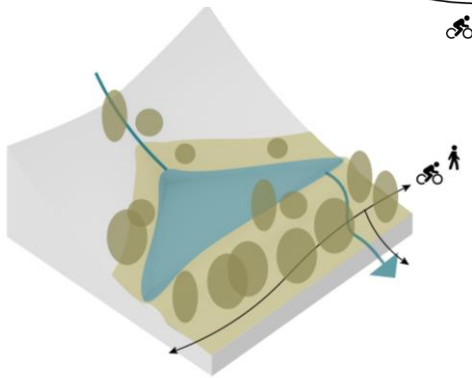




Preserving the slope



Quarry reservoir

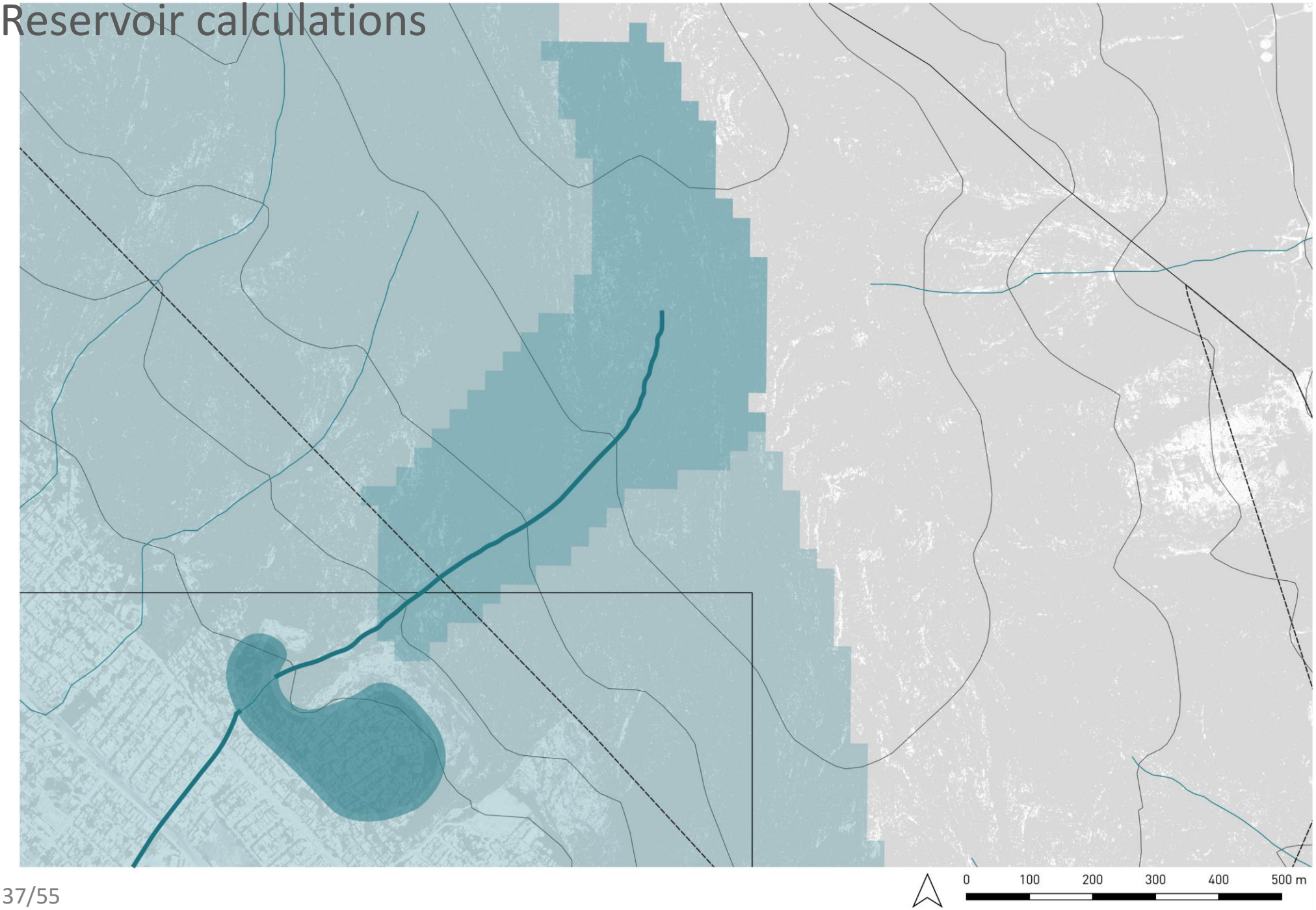


Foothill reservoir


Spatial design
location 1:
Upstream, Quarry Restoration

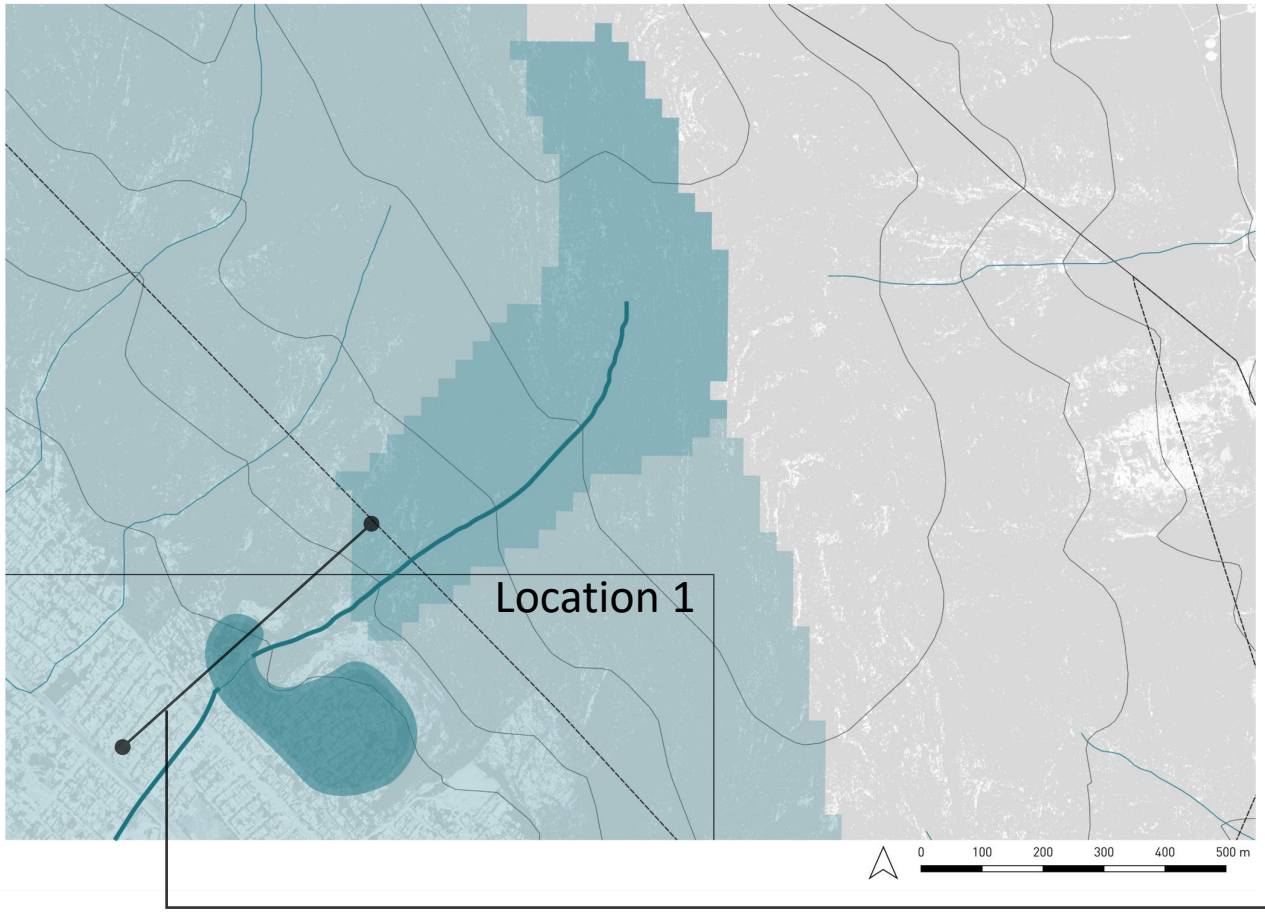
Quarry restoration Context

Reservoir calculations



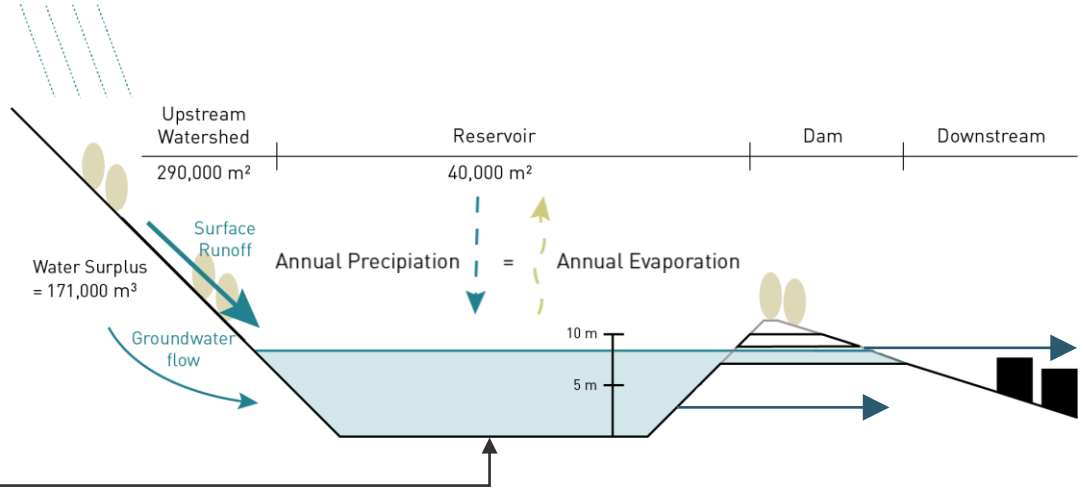
Reservoir calculations

Uphill Watershed



Reservoir Section

- Annual precipiation = Annual Evaporation (INEGI, n.d.)
- Uphill Watershed is the surplus of water.
- Sluice controls the discharge of water
- Extraction of Tapwater
- This reservoir takes **two years** to fill (no infiltration loss).

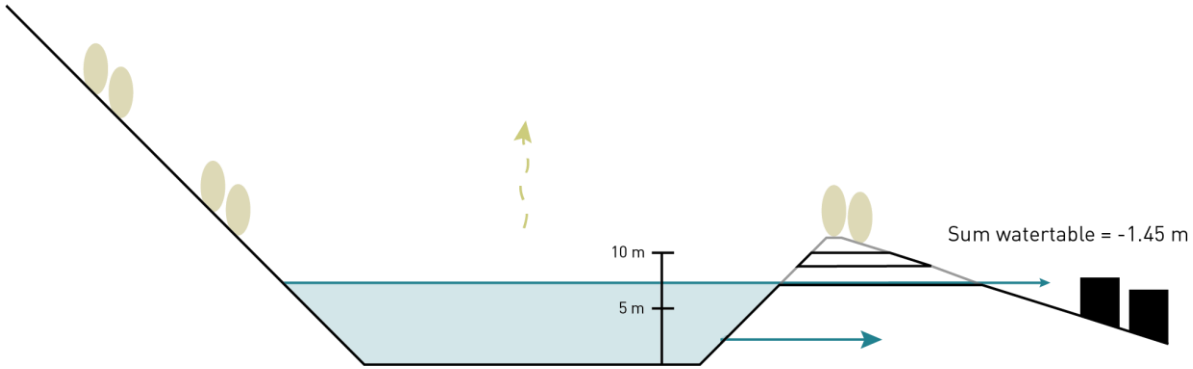


Sources: INEGI (n.d.), CEDES (n.d.), ClimatestoTravel (n.d.), Wetzel (2001)

Reservoir calculations

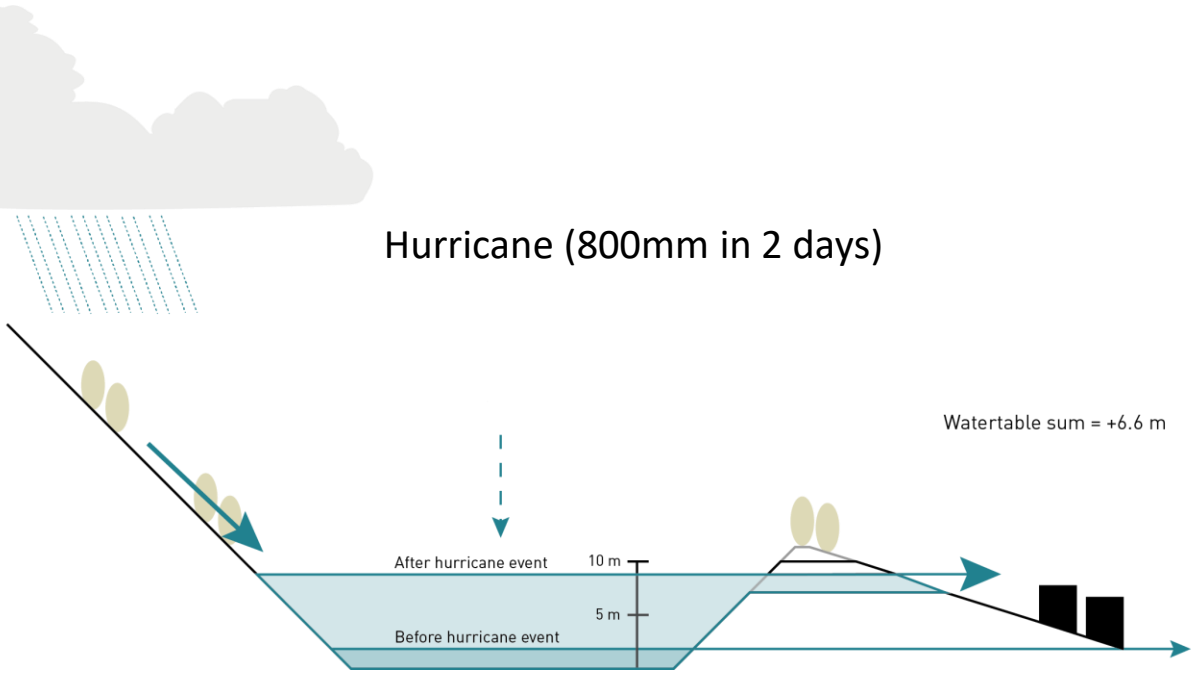
- Extreme events necessary to calculate for managing the water availability.
- Every period a drinkwater extraction for approximately 1000 residents.

Drought (90 days without rain)



- But after a drought, less discharge in September and October.

Hurricane (800mm in 2 days)



- Watertable fall before hurricane starts
- The surplus of water from a hurricane can be stored in other storage tanks.

Quarry restoration Design

(Inhabitat, 2024)
(Archiru, 2024)


Spatial design
location 2:
Downstream, Linear Park

Linear Park Context

Álvarez street
- 20-25 meters wide asphalt
- Flooding zone

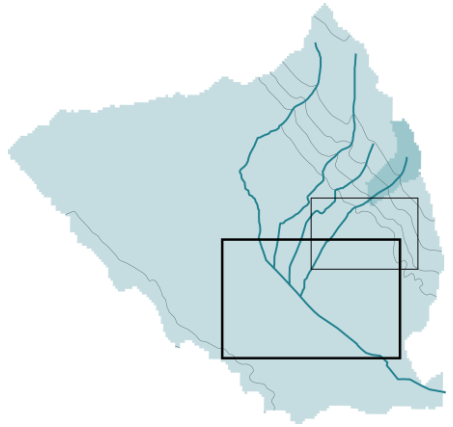
Zoom-in location

1

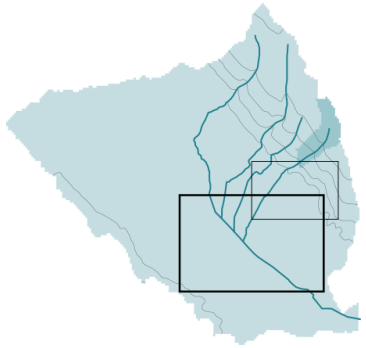
2

Stream
Buildings
Parkinglots
Main street
Transport route
Sports
Parks & Plazas
Landslide zone
Inundation zone
Zoom 1:500

0 100 200 300 400 500 m



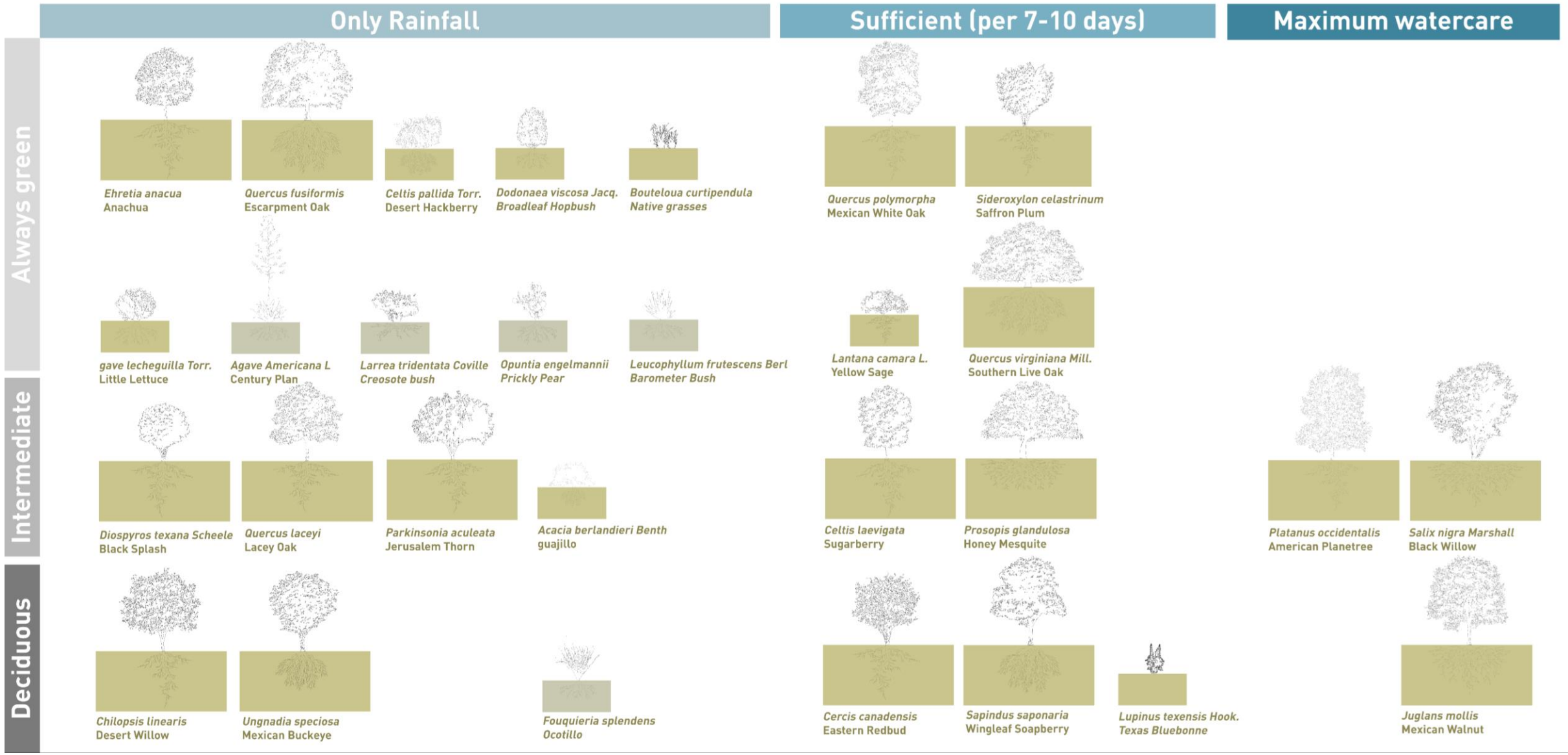
Linear Park Design



Ecological and recreational grid with:

- Daylighting the streams
- Green streets
- Pedestrian zones
- Connected facilities

Plant Catalogue



Sources: Native plants in Monterrey (2009), Texas A&M Forest Service (n.d.)


Zoom-in
location

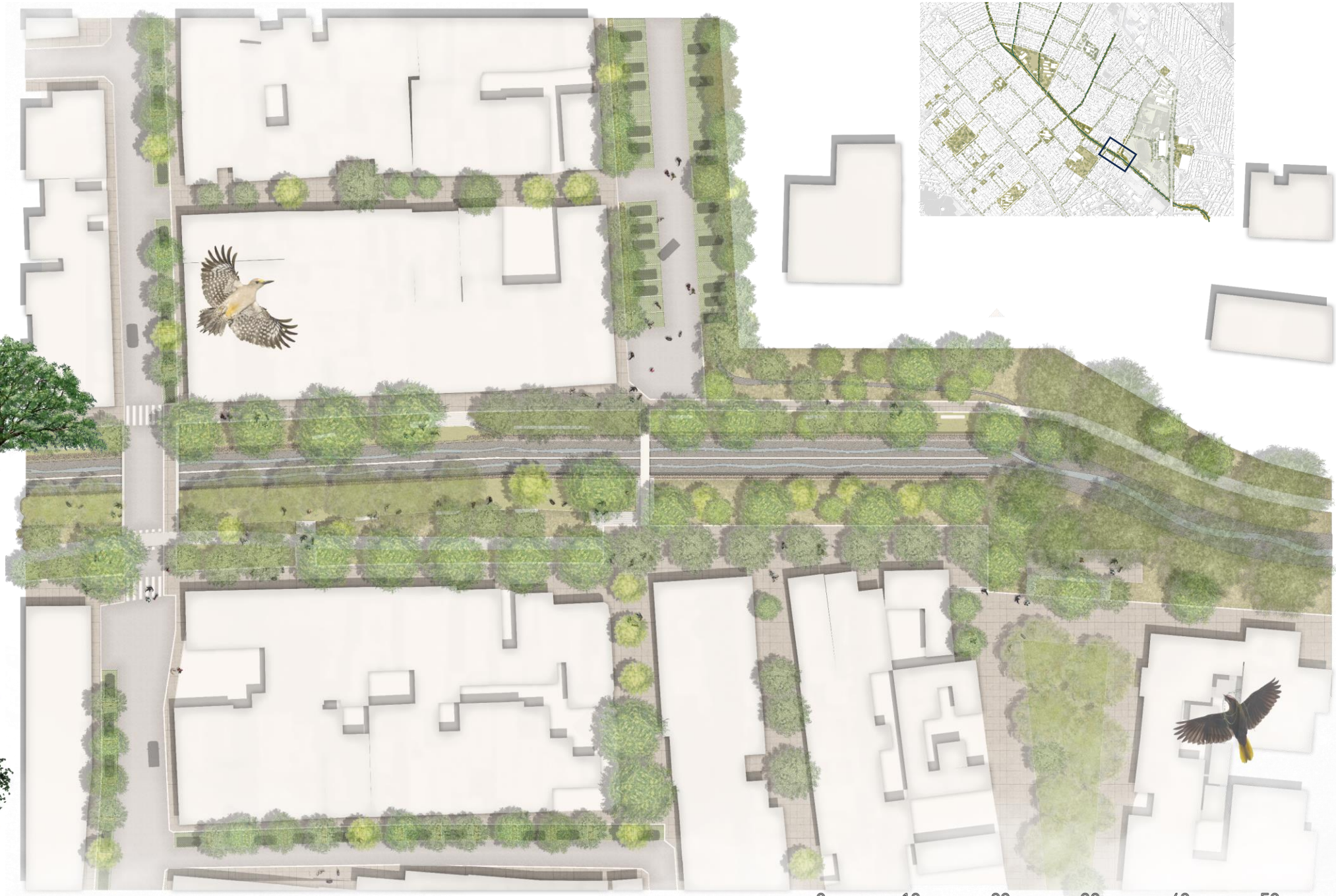
Linear Park Detailed Design

Sugarberry

Mesquite

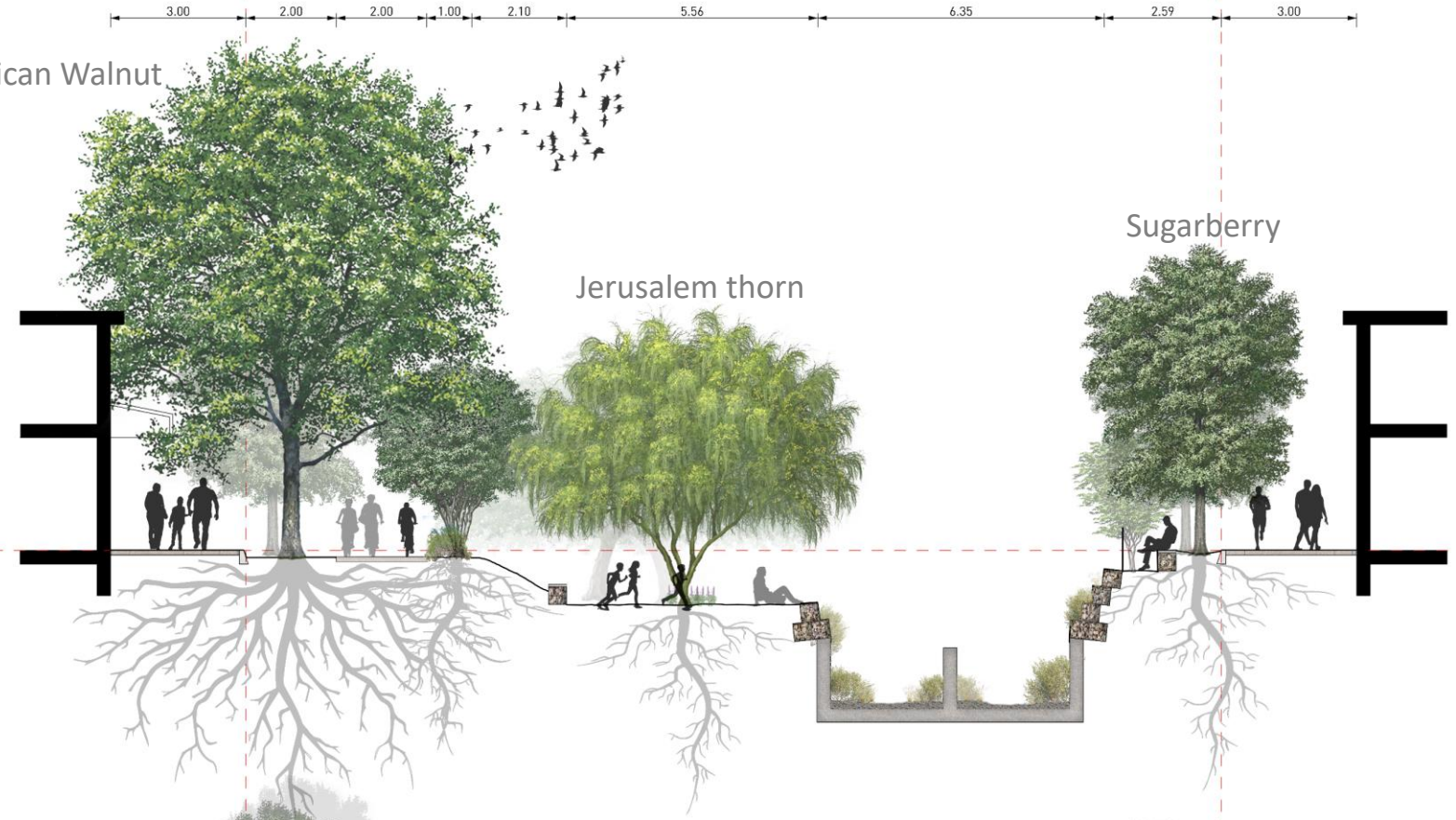
Black Willow

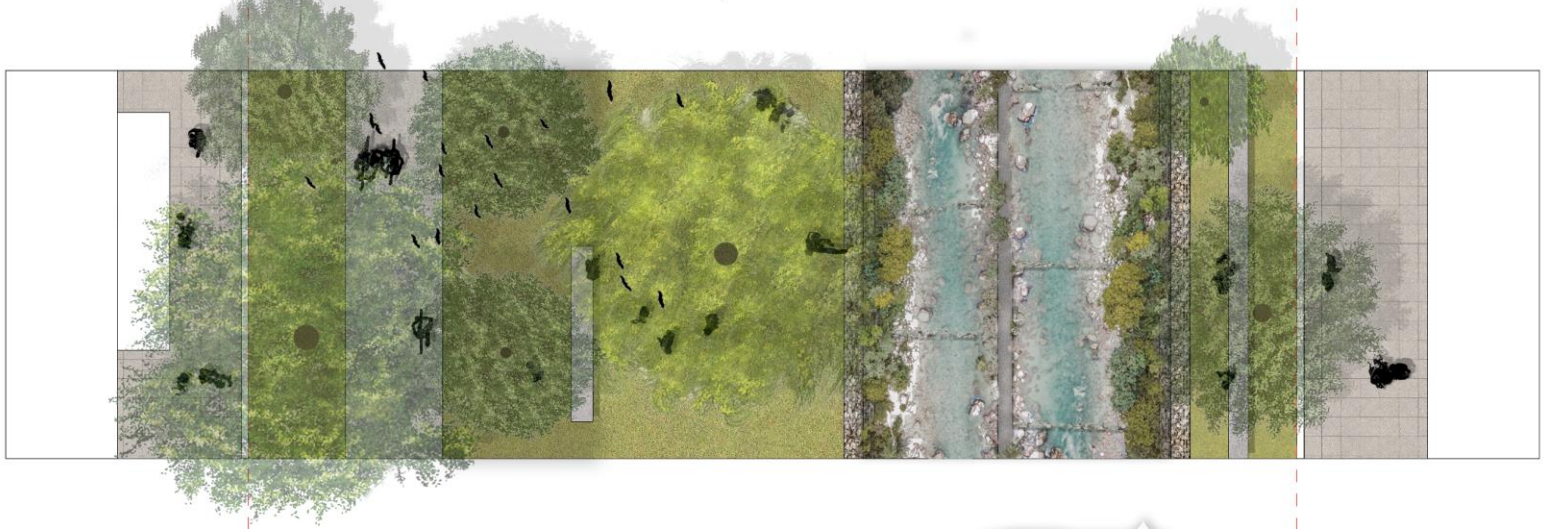
American Planetree



Linear Park Section Design

- Using the old stormdrain
- Still resistant against big discharges





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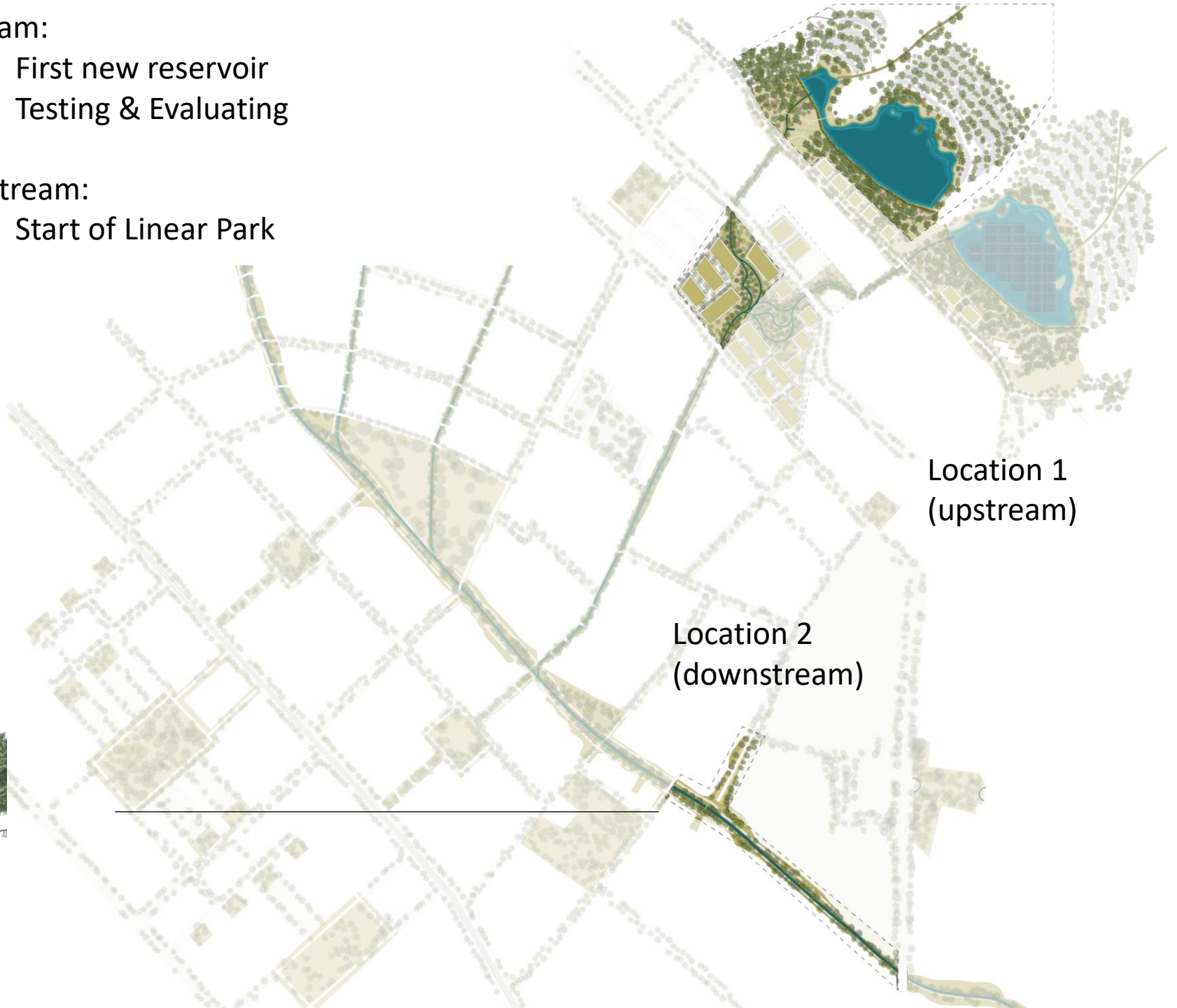
Phase 1
in 10 years

Upstream:

- First new reservoir
- Testing & Evaluating

Downstream:

- Start of Linear Park



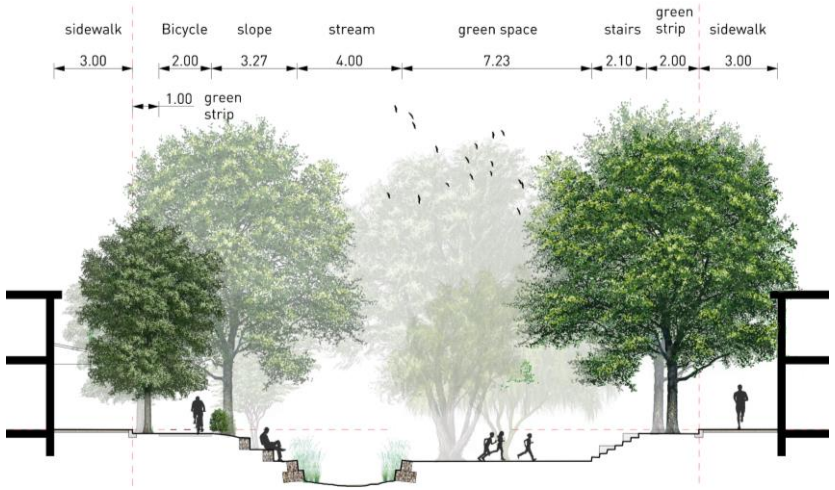
Phase 2
in 25 years

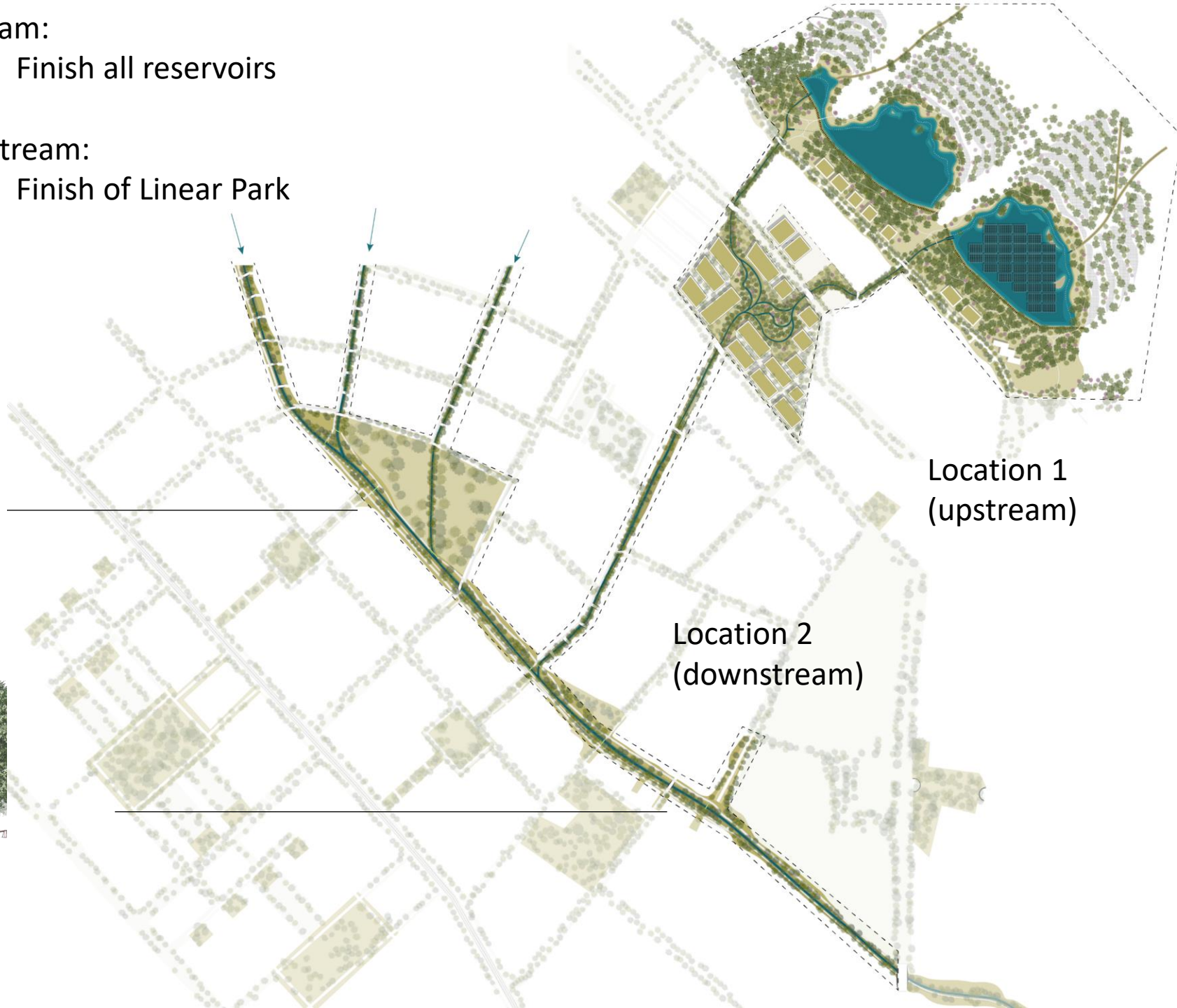
Upstream:

- Finish all reservoirs

Downstream:

- Finish of Linear Park

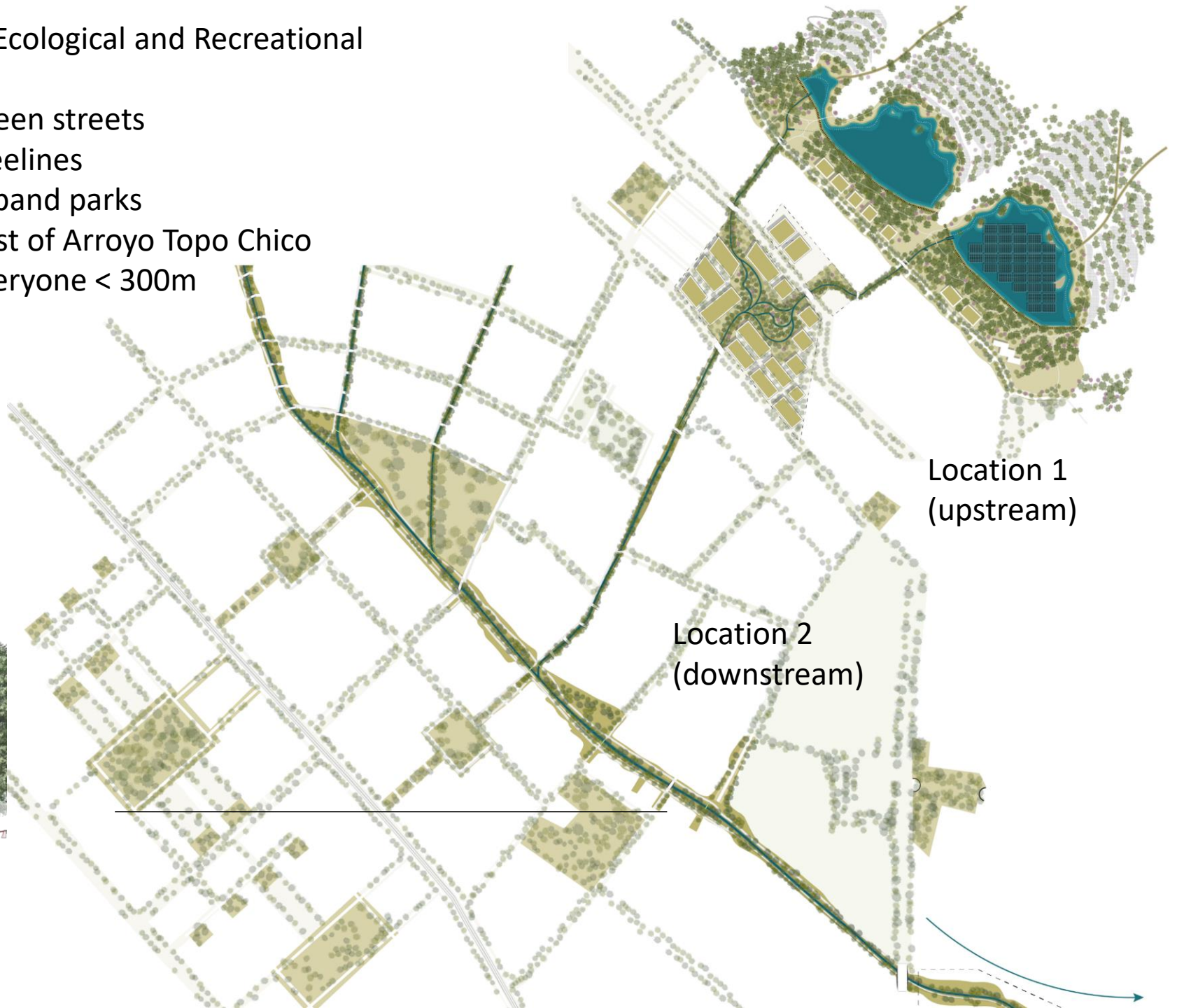




Phase 3
in 50 years

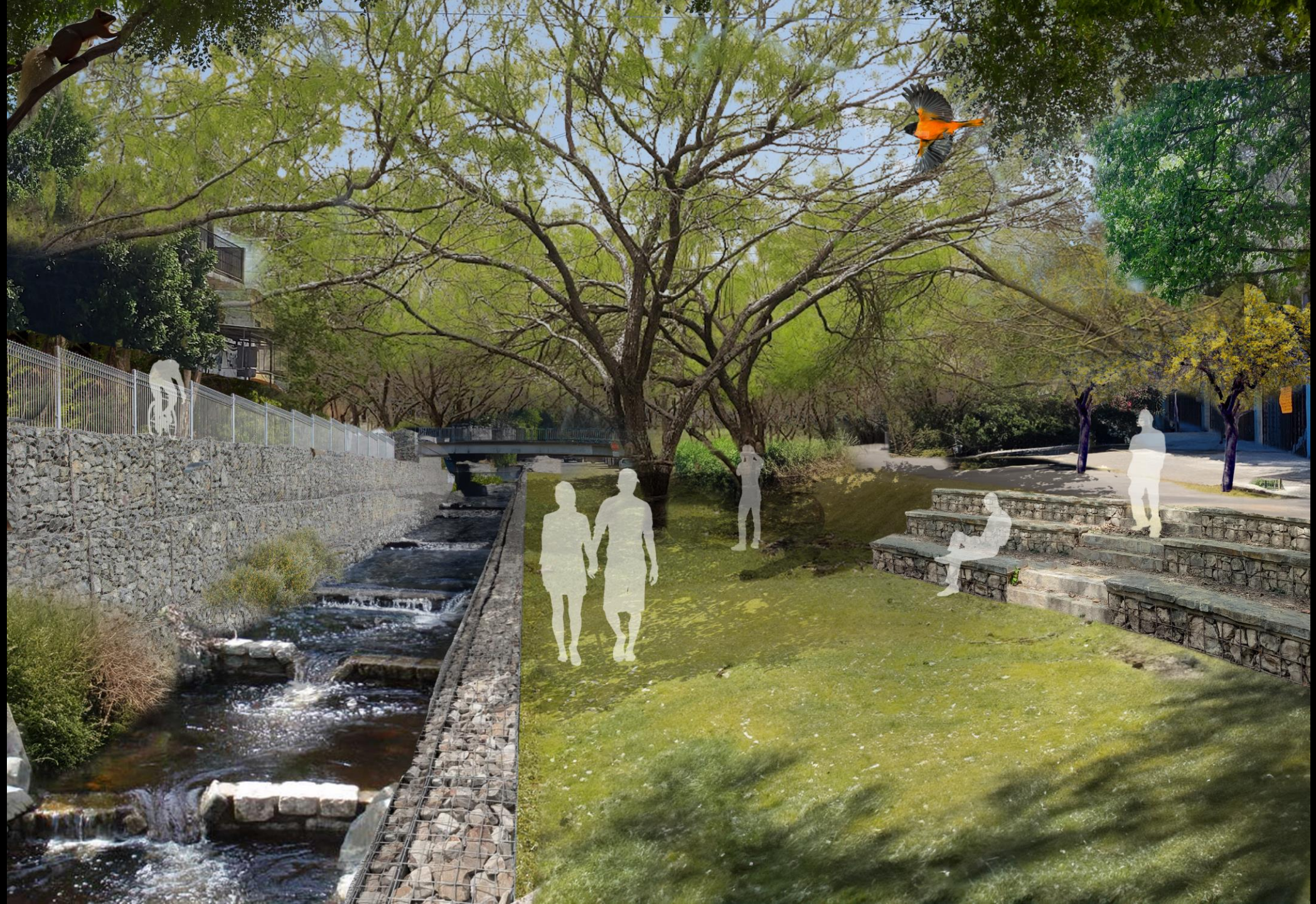
Finish the Ecological and Recreational Grid:

- Green streets
- Treelines
- Expand parks
- Rest of Arroyo Topo Chico
- Everyone < 300m



Birdeye


Birdeye



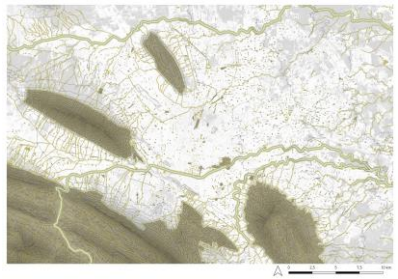

TAA CHICOS

Conclusions

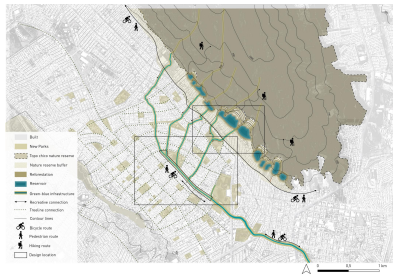
"What spatial strategy can be used to implement green and blue infrastructure in order to tackle droughts and heat stress in the metropolitan area of Monterrey?“

Through the scales

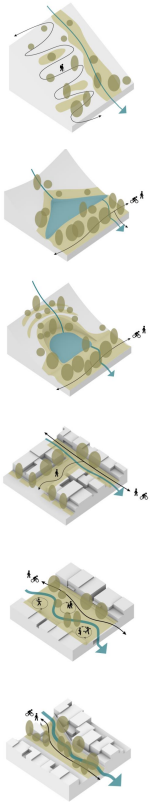
1. Metropolitan vision



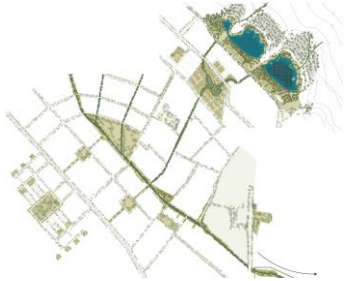
2. Urban Watershed design



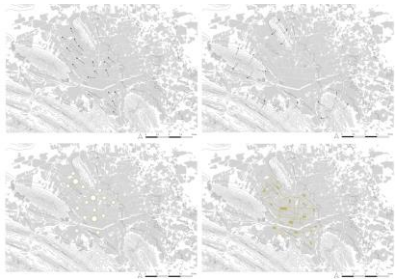
3. G & B Infrastructure principles



4. Spatial Design Storage upstream Retention downstream

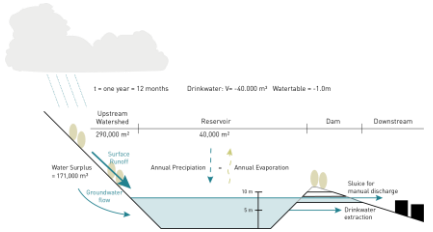


5. Detailed Design

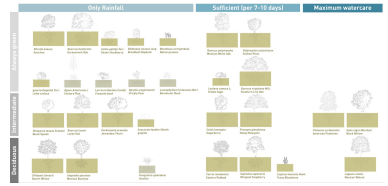


System analysis and Design Principles

Hydrological foundation



Calculations



Plant Catalogue

Conclusions: Future scenarios

Green and blue infrastructure:

- Makes a climate resilient city (droughts and heat stress)
- Restores the ecology
- Creates quality public spaces
- Building the first steppingstones for other semi arid and mountainous urban environments: Mexico City, Los Angelos (USA), Santiago (Chile)

Hydrate Monterrey

Thank you!