RIVER AND DELTA URBAN RESEARCH PLATFORM

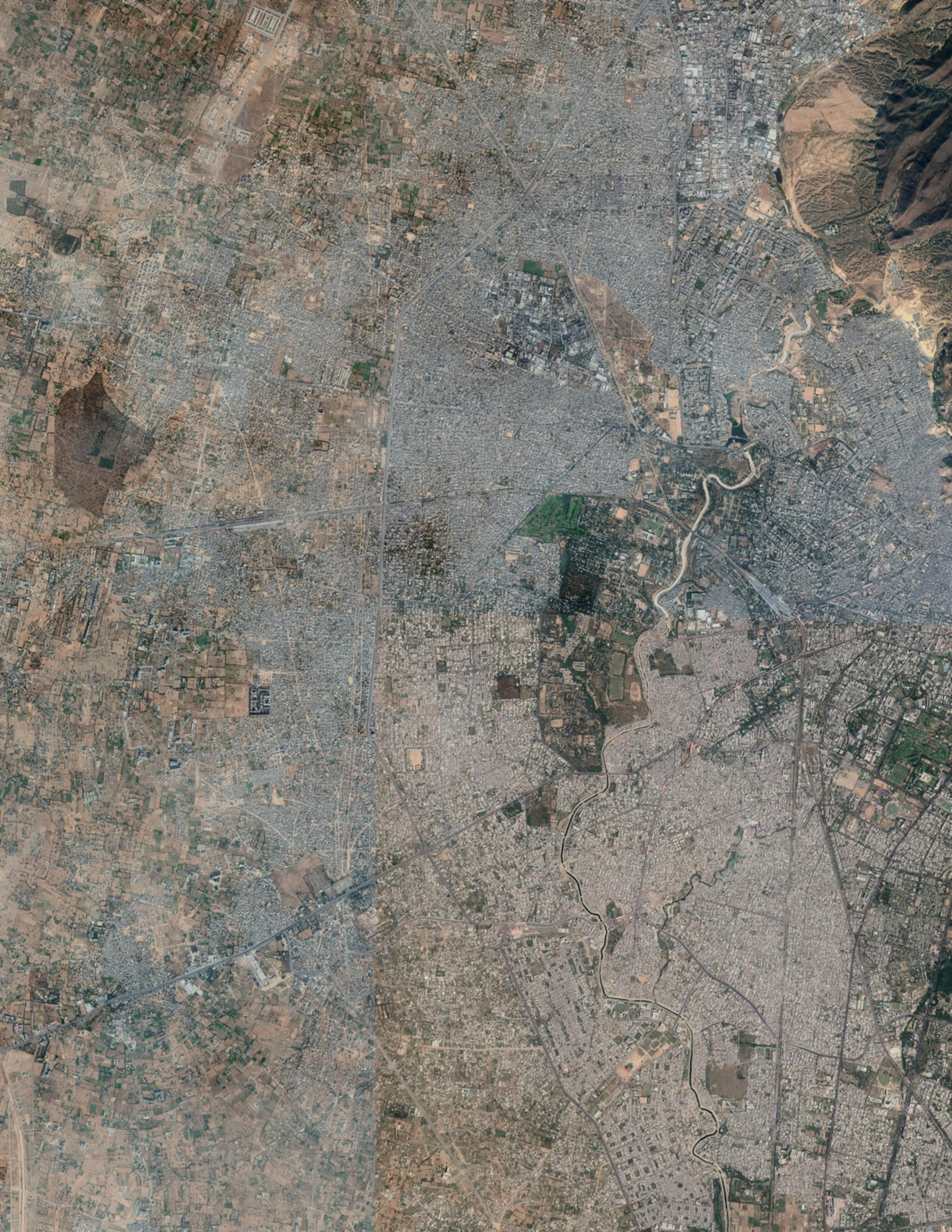
RAJASTHAN CITIES PROJECT //JAIPUR

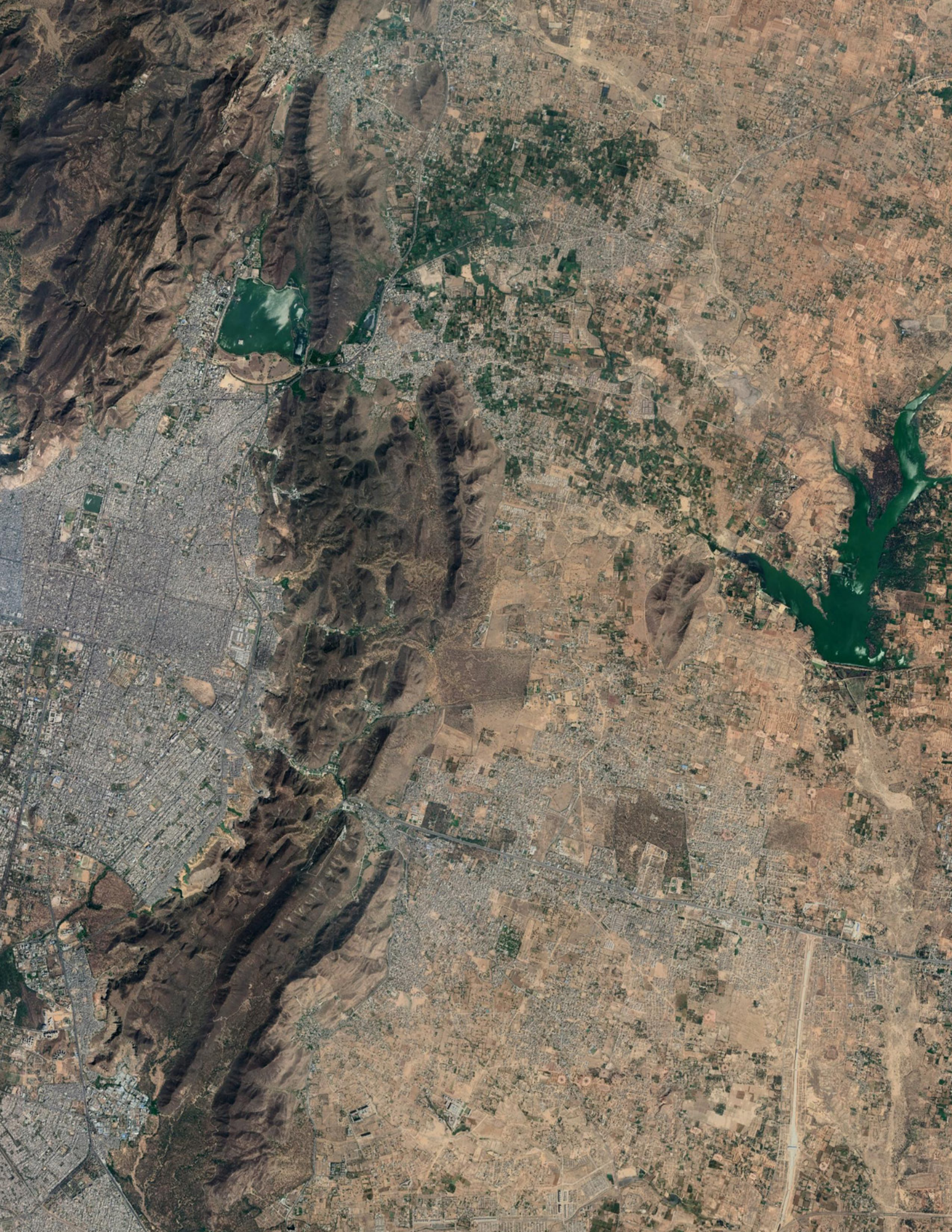
TULANE SCHOOL OF ARCHITECTURE

Saul A. Mintz Global Research Studio

YRP
Yamuna River Project

RAJASTHAN CITIES PROJECT //JAIPUR





THE RAJASTHAN CITIES // **JAIPUR** // YAMUNA RIVER PROJECT

RESEARCH STUDIO // FALL 2019
TULANE SCHOOL OF ARCHITECTURE

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1. EXECUTIVE SUMMARY AND POLICY RECOMMENDATIONS

The research project 'Rajasthan Cities // Jaipur' offers an innovative approach to address the main challenges of the city, with a long term and multidisciplinary approach that only top world research universities can offer. Jaipur, founded in 1727, is the capital city of Rajasthan, India's largest state. Designed by the architect Vidyadhar Bhattacharya, the extraordinary heritage makes it a magnet for tourism. Behind the pink sandstone facades of the medieval city, Jaipur confronts an urgent crisis: the rapidly diminishing supply of drinking water. A growing city with a population of 3.65 million inhabitants, Jaipur is expected to reach 5 million in 2030 (UN World Urbanization Prospects). The loss of ecological territory – to unplanned growth, and the increasing encroachment on the fragile environment of this desert city, has undermined the already scarce water sources. In the summer of 2019, Jaipur – now dependent on the supply of piped water from the distant Bisalpur dam, was 10 days away from Day Zero – the point where there would be no fresh water available to the city!

The recommended interventions are based in urban wide systems and specific areas. Systems focus on Water safety, Energy safety and Solid Waste Management infrastructures. Areas of focus are the Protected Mountain Reserve and the creation of a buffer zone, the Agricultural Edge and the main activity axis of the Jaipur Route. The project proposes the following urban and architectural strategies that might enable Jaipur to be sustained environmentally (including fresh water safety), socially and economically.

1. Rain water harvesting and re-use:
Infrastructures for water catchment, storage and distribution
See page 28, 32, 36

2. Restoration of water bodies:
Interception of sewage, addition of ecologies and public space
See page 36,38

3. Decentralized Sewage treatment plants:
Hybridization with public programs, green filters and re-use
See page 36, 38

4. Public sanitation network:
Toilets and small neighborhood public programs
See page 28, 32, 34, 36, 38

5. Solid waste management network:
Neighborhood communal bins with sanitation, laundry and community space
See page 28, 32, 34, 36

6. Public mobility improvement:
Hybrid urban space for pedestrian, bicycles and buses
See page 28, 40

7. Distributed Solar Plants network
Reduction of fossil fuel dependency and carbon emissions in a resilient urban infrastructure
See page 32

8. Neighborhood public facilities network:
Associated with other infrastructures providing community spaces and safe rooms for women and children
See page 28, 32, 34, 36, 38

9. Reforestation of city edges:
Definition of the urban footprint limiting sprawl and encroachment of parks and agricultural lands
See page 36

10. Improvement of informal settlements
Adding basic public amenities and ecological public space
See page 36

11. Reinforcement of cultural and tourist infrastructure
See page 40

12. Revitalization of markets and commerce
See page 28, 32, 38, 40

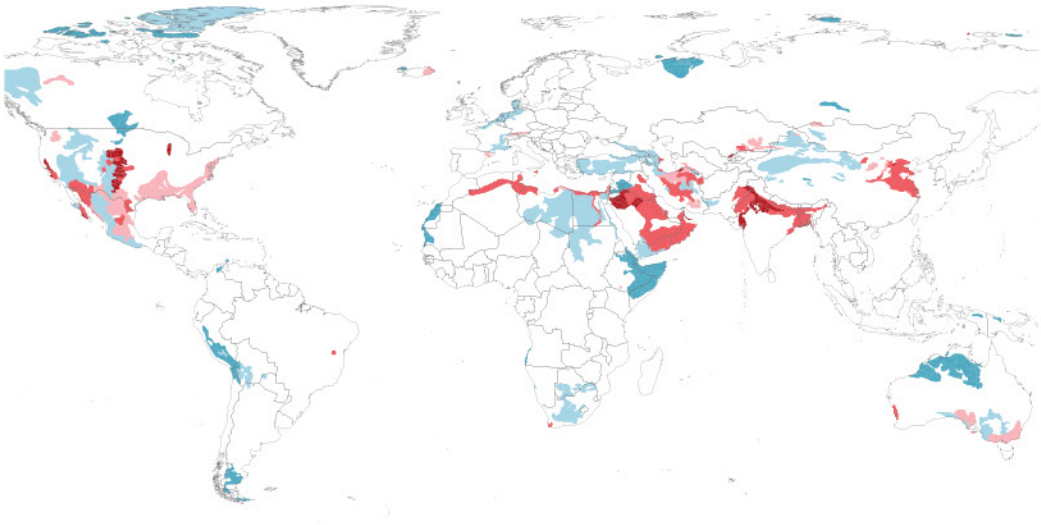
Jaipur lies in a semi-arid region, dependent completely on rainfall for all it's water. Although water is a limited resource, the condition of water bodies is dismal with unchecked pollution and sewage finding it's way into the water, while the population of 3.6 million people is growing at an unprecedented rate.

2. WATER STRESS

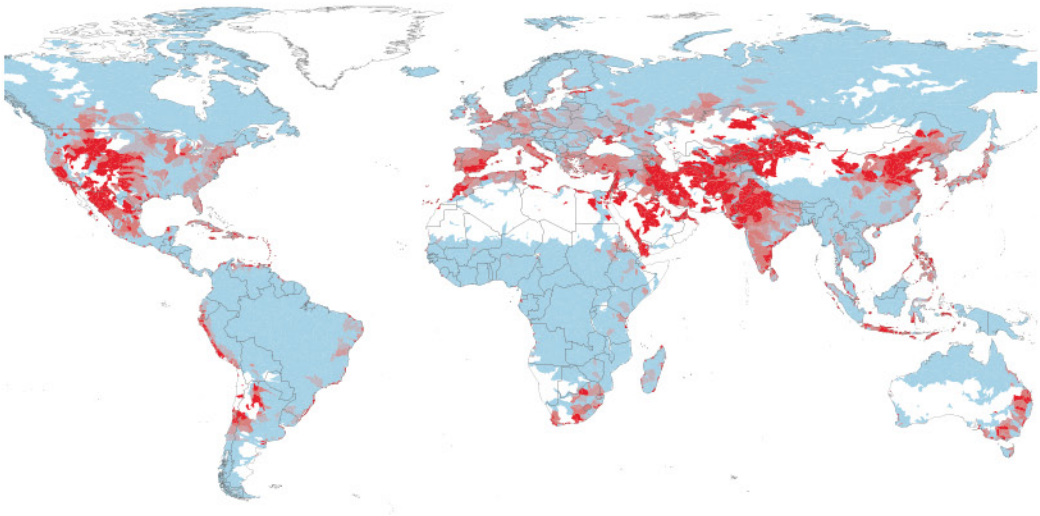
Over 2 billion people live in countries experiencing high water stress. (UN, 2018). Groundwater depletion is caused by sustained groundwater use at a rate faster than it is replenished by long term natural processes. Groundwater comes from the natural percolation of precipitation and other surface waters down through Earth's soil and rock, accumulating in aquifers - cavities and layers of porous rock, gravel, sand, or clay. In some subterranean reservoirs, the water may be thousands to millions of years old; in others, water levels decline and rise again naturally each year. Groundwater levels do not respond to changes in weather as rapidly as lakes, streams, and rivers do. So when groundwater is pumped for irrigation or other uses, recharge to the original levels can take months or years.

North India is experiencing a high rate of groundwater table decline. Some estimates show that the groundwater in this region has been receding by as much as one foot per year over the past decade (Matt Rodell, Goddard Space Flight Center, NASA, 2014). After examining many environmental and climate factors, it was concluded that the loss is almost entirely due to human consumption.

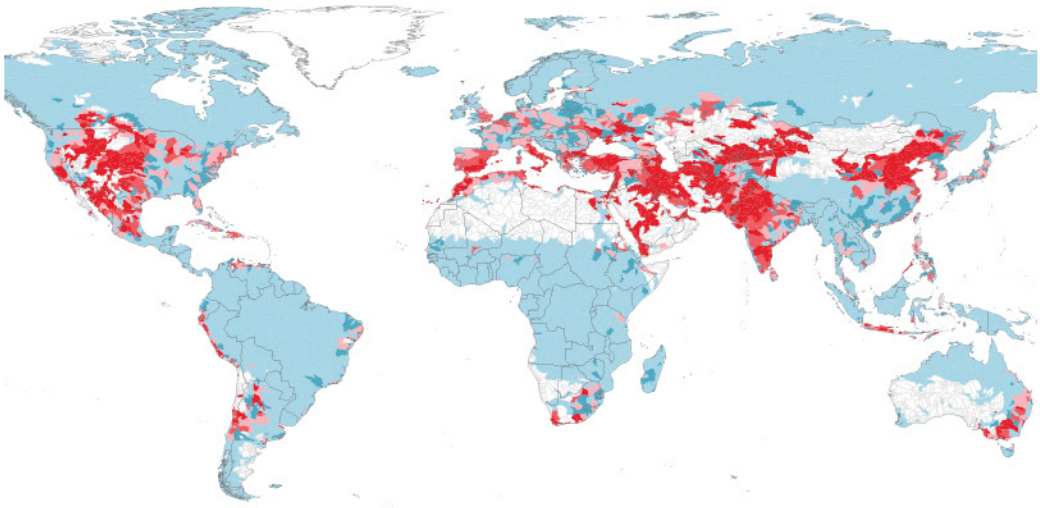
The Niti Aayog (the urban think tank of the Indian government) states that 21 major Indian cities will reach zero ground water level by 2020, including the capital, New Delhi. The same report says that 40% of India's population would have no access to drinking water in 2030.



GLOBAL GROUND WATER TABLE DECLINE



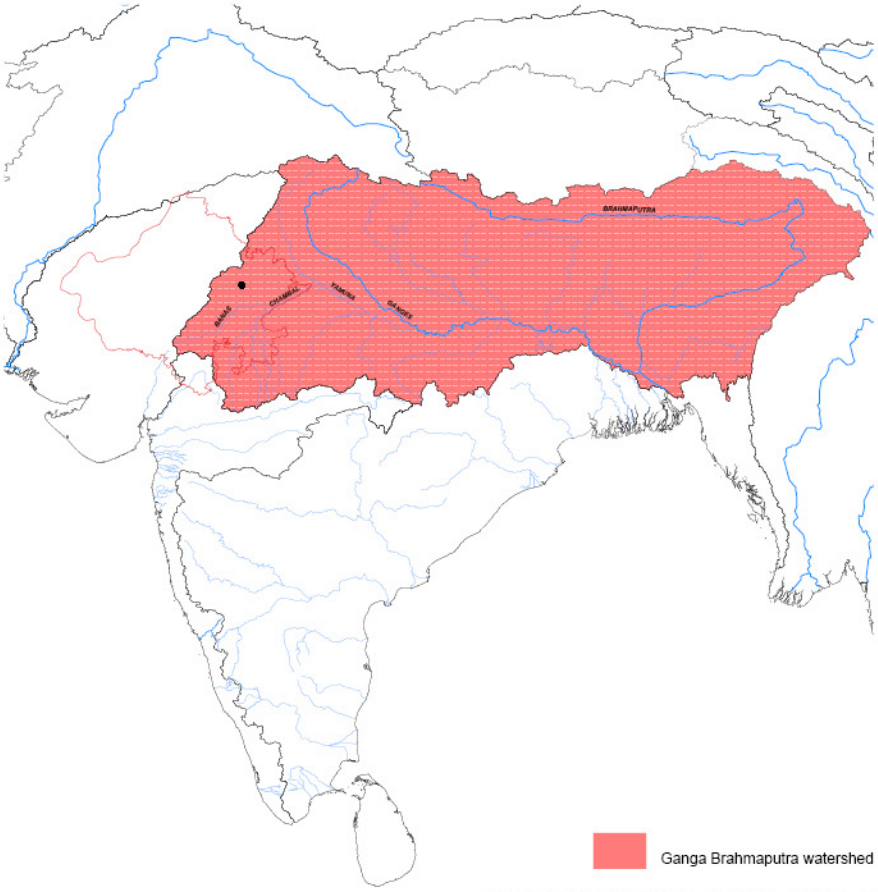
BASELINE WATER STRESS, 2010



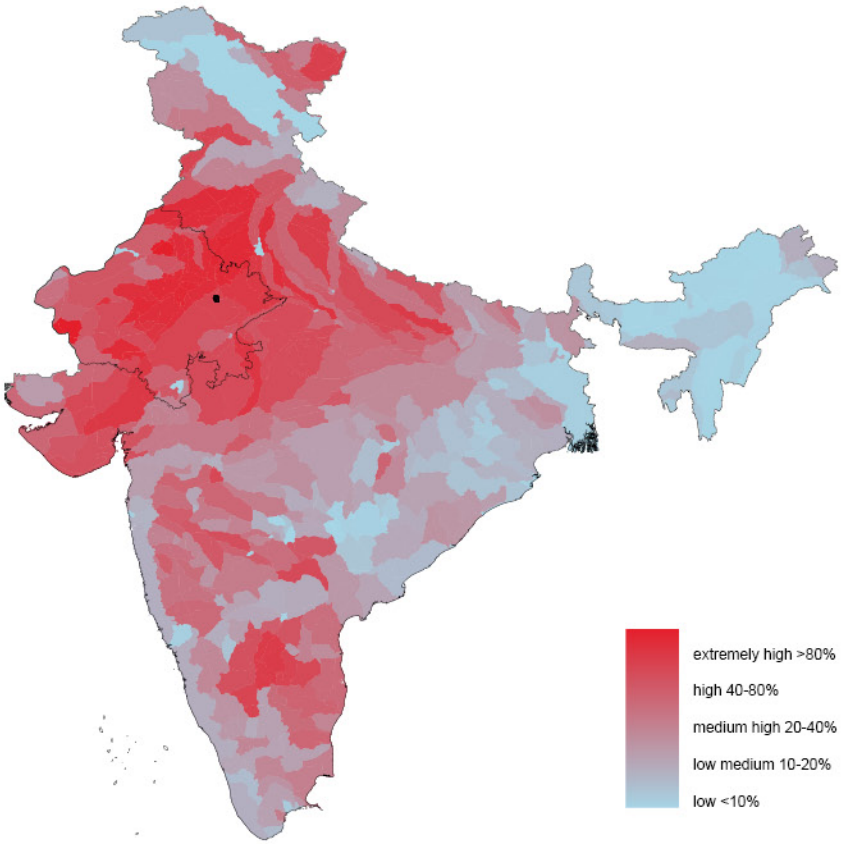
PROJECTED WATER STRESS, 2024

Figure 1

Jaipur lies in the upper part of the Ganges watershed in a semi-arid region, it depends primarily on rainfall (650mm/ year during June to September) and non perennial streams for its rapidly growing population of 3.5 million inhabitants

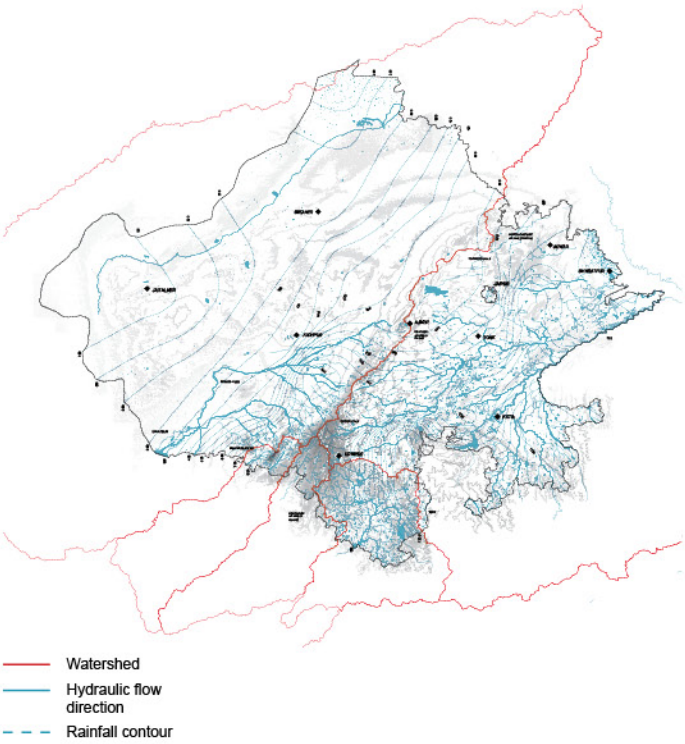


GANGA BRAHMAPUTRA WATERSHED



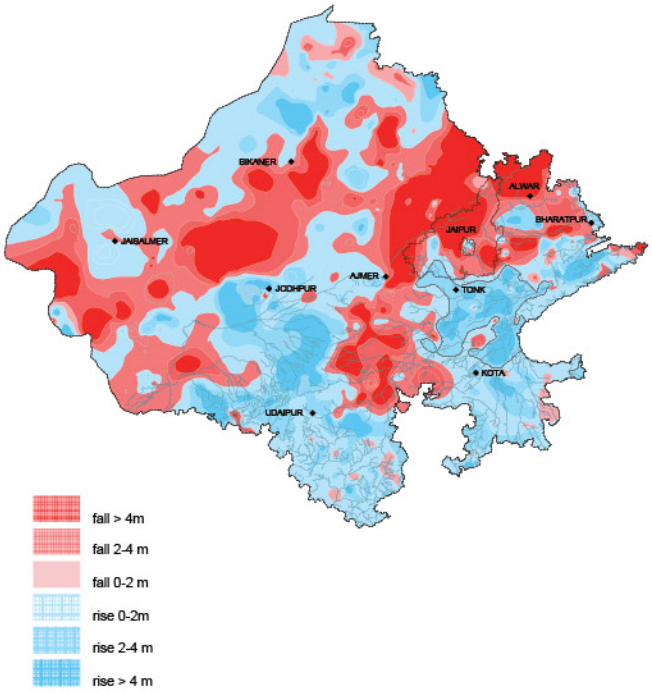
INDIA WATER STRESS, 2010

Figure 2



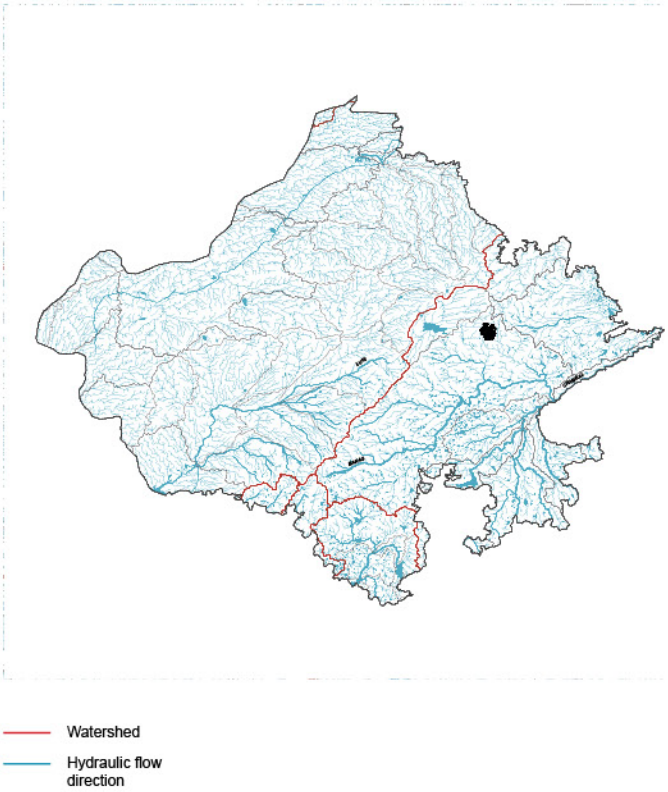
RAJASTHAN, TOPOGRAPHY AND WATERSHEDS

Figure 3



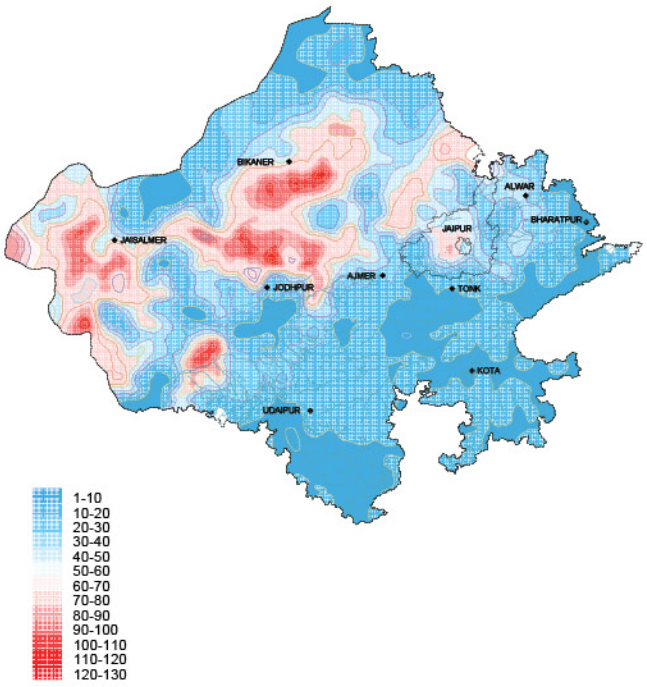
RAJASTHAN DECADAL GROUND WATER FLUCTUATION

Figure 4



RAJASTHAN, HYDRAULIC FLOW MAPPING

Figure 5



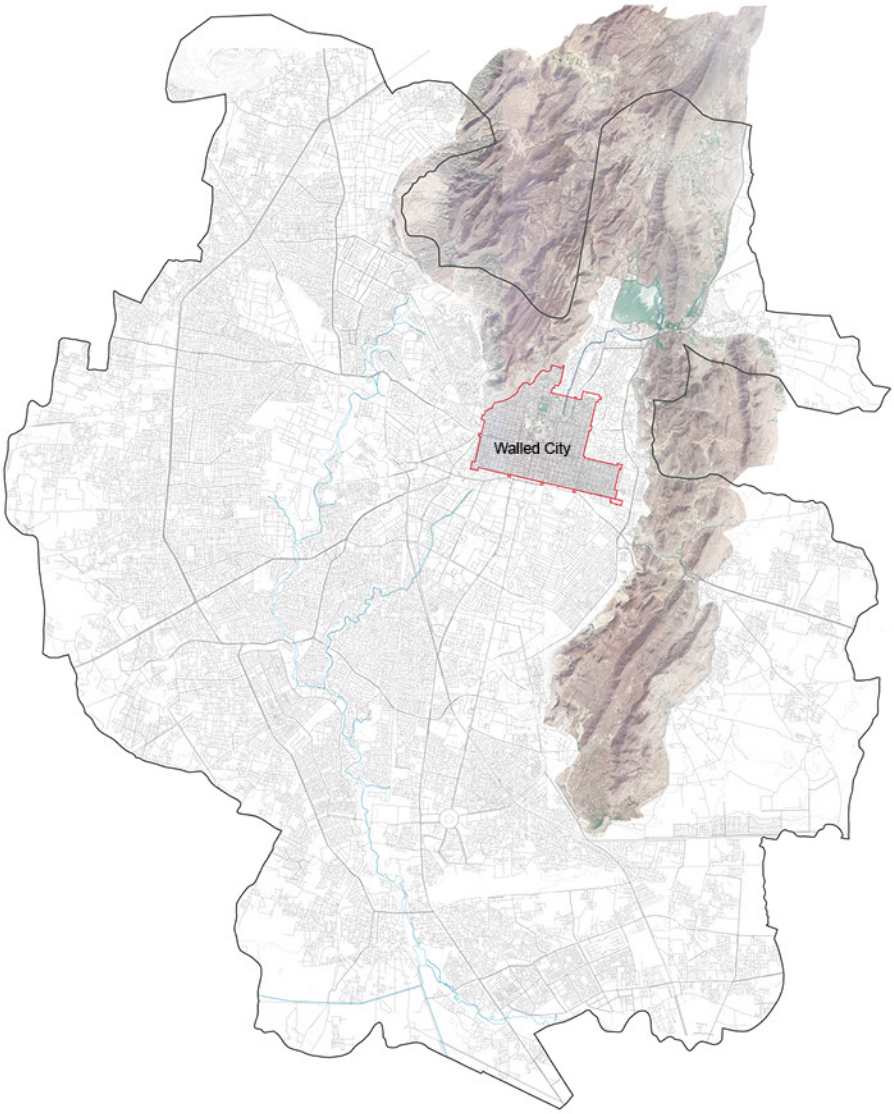
RAJASTHAN DEPTH TO WATER LEVEL

Figure 6

INDIA

RAJASTHAN

JAIPUR DISTRICT



JAIPUR CITY

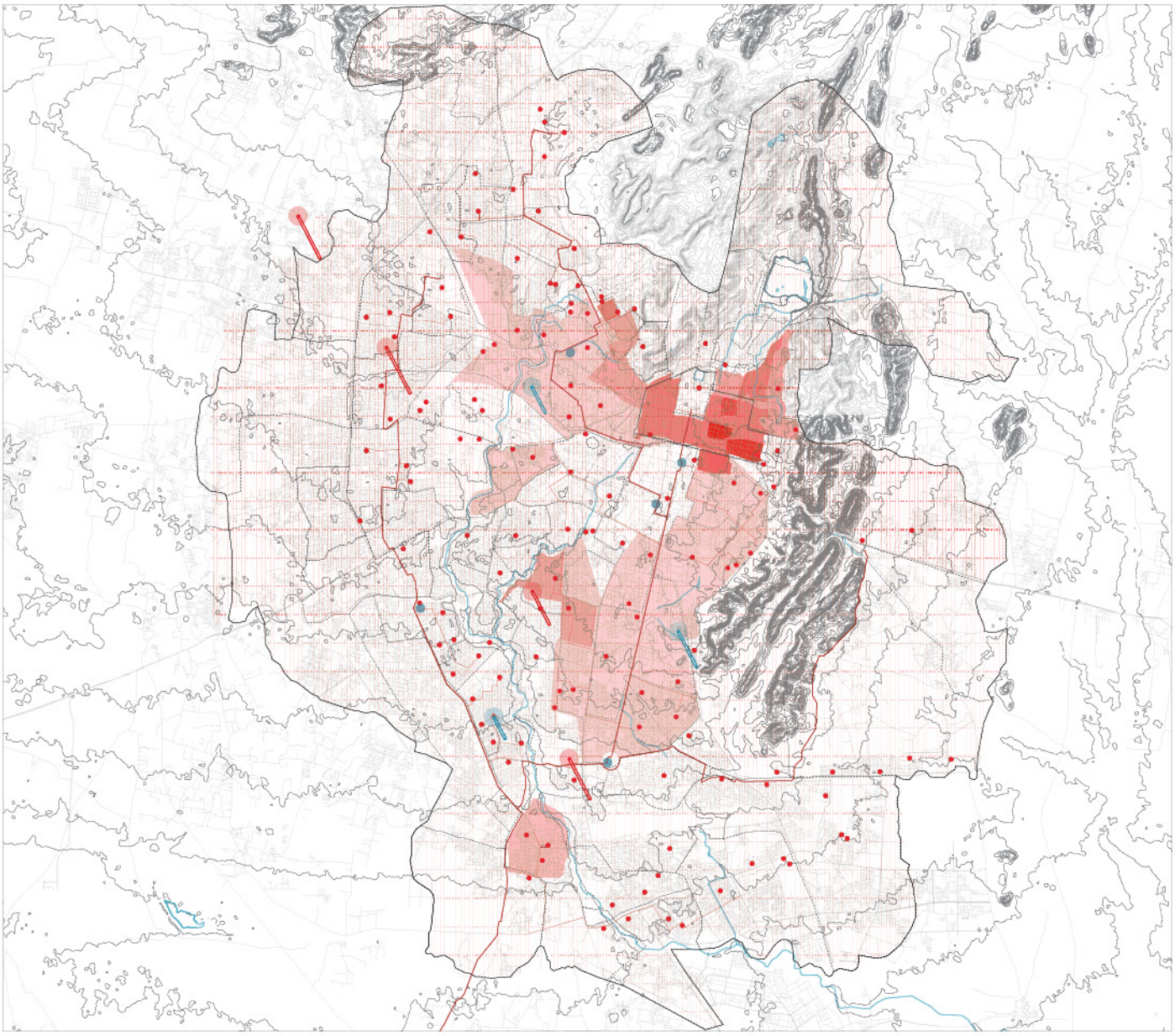
The Aravalli range cuts across the state of Rajasthan from north to south, dividing the state into two major watersheds. The western half drains south towards the Arabian Sea while the eastern half drains northwards to join the Ganges watershed.

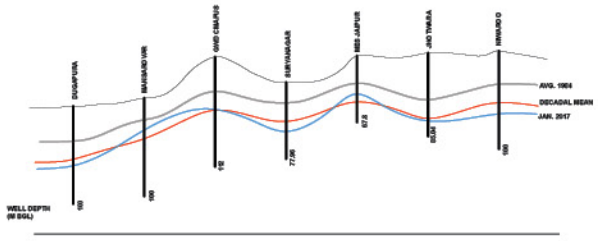
The Banas river is a tributary of the Chambal river, itself a tributary of the Yamuna which in turn merges into the Ganga. Banas originates in the Veron ka Math situated in Khamnor Hills of the Aravalli Range. It is a seasonal river that dries up during the summer.

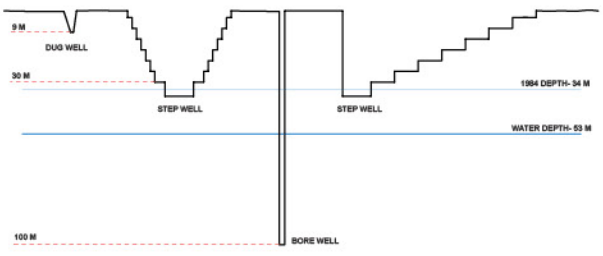
The Bisalpur-Jaipur project (a dam across the Banas at Deoli, about 40 km from Tonk) was completed by the Government of Rajasthan in 2009 and provides drinking water from the Banas to Jaipur city, Ajmer and Tonk.

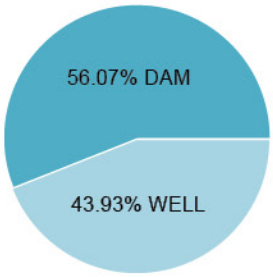
Engagements with the Deputy Chief Minister of Rajasthan - Mr. Sachin Pilot, Chief Town planner of Rajasthan - Mr. Rajendra Kumar Vijayvargia, local communities, grassroots and non-profit organizations as well as scholars and professionals in the related fields proved extremely critical in the design process.

3. JAIPUR CITY SYSTEMS







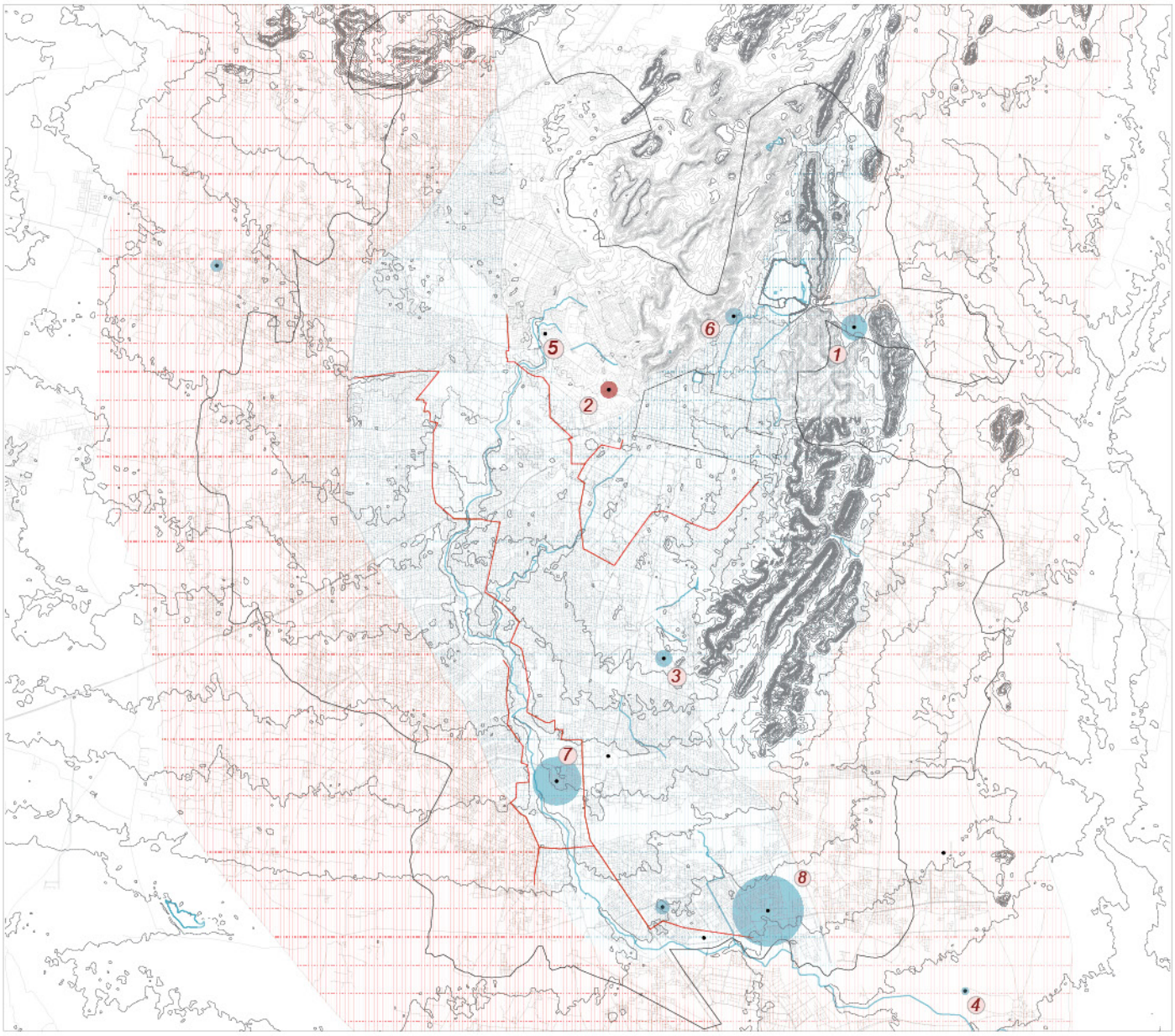


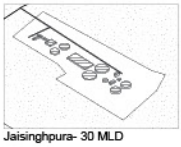
WATER SUPPLIED BY DAM VS GROUND WATER (RUIDP 2017-18)

WATER SUPPLY

- ***Pipes from Bisalpur Dam***
- ***Overhead water tanks***
- ***Water Pump Houses***
- ***Monitor Test Wells***

DECLINING GROUND WATER LEVELS, JAIPUR CITY

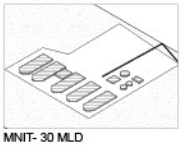



Jaisinghpura- 30 MLD

1


North Zone- 50 MLD

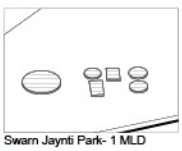
2


MNIT- 30 MLD

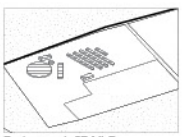
3


Ralawata- 30 mld

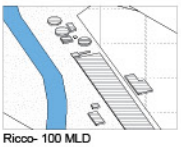
4


Swarn Jaynti Park- 1 MLD

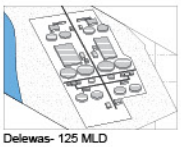
5


Brahmapuri- 27 MLD

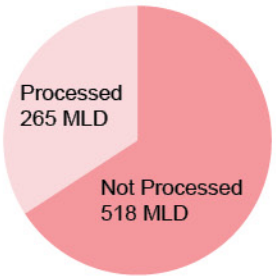
6


Ricco- 100 MLD

7


Delewas- 125 MLD

8



SEWAGE GENERATED VS STP CAPACITY FOR 2025

SEWAGE

Sewage Treatment Plant

Cachement 1

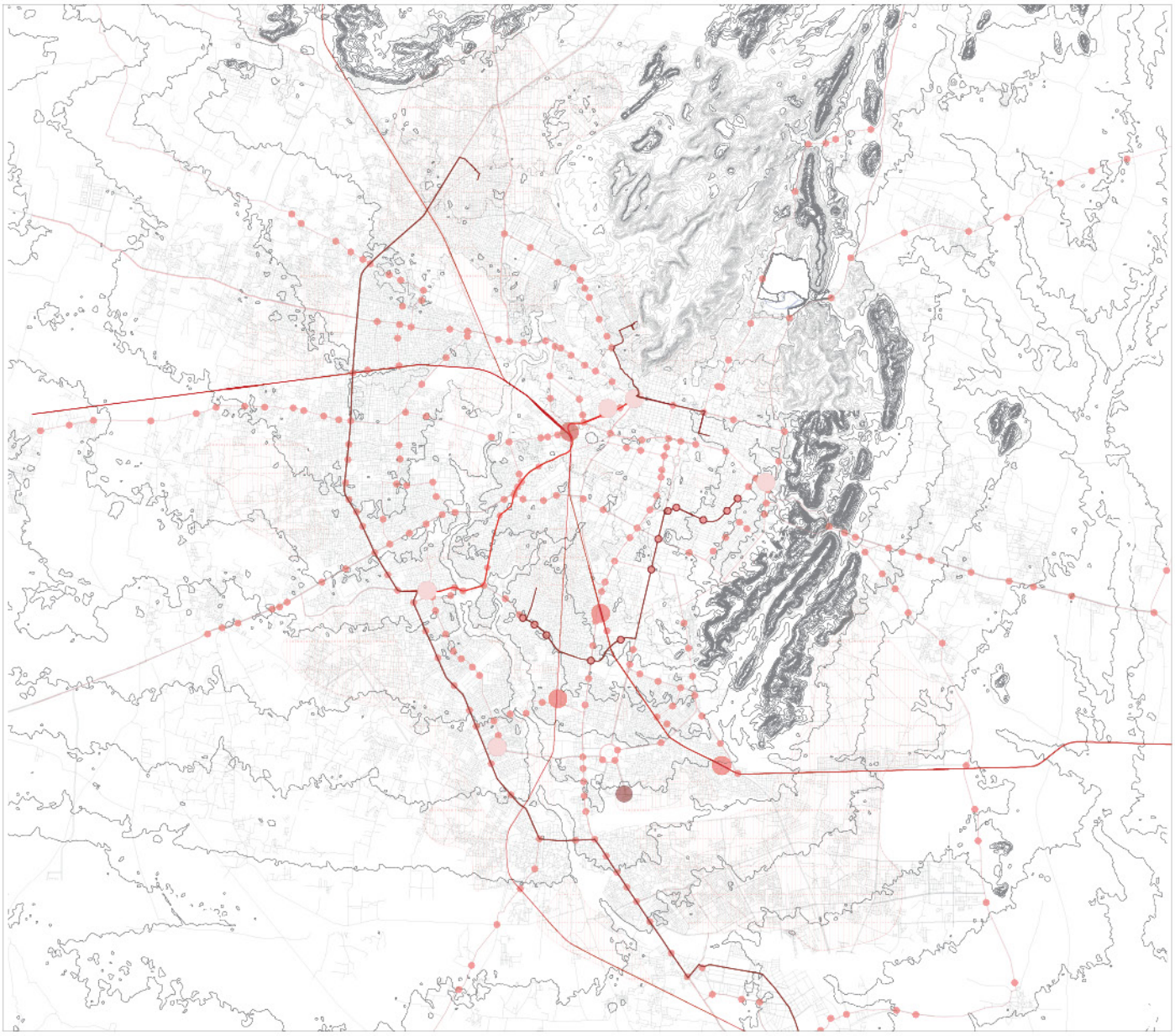
Cachement 3

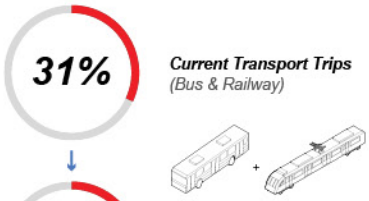
Cachement 2 & 4 (proposed)

Cachement 5, 6 & 7 (proposed)

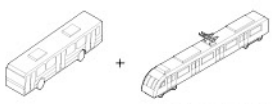
RUIDP Sewage Lines

Open Air Subdrains



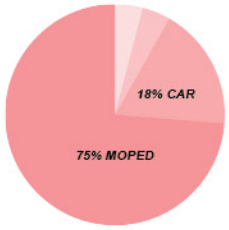


Transportation Goal

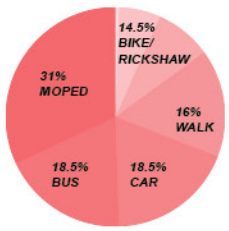


8,245,890: 2015-16
7,222,871: 2016-17
6,164,850: 2017-18

Bus/ Railway Usage



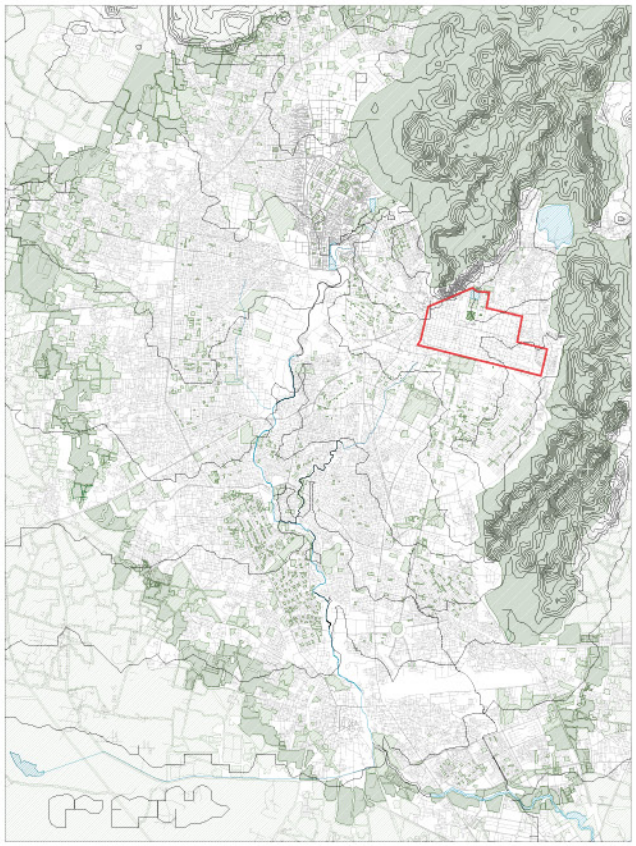
Vehicle Registration 2018



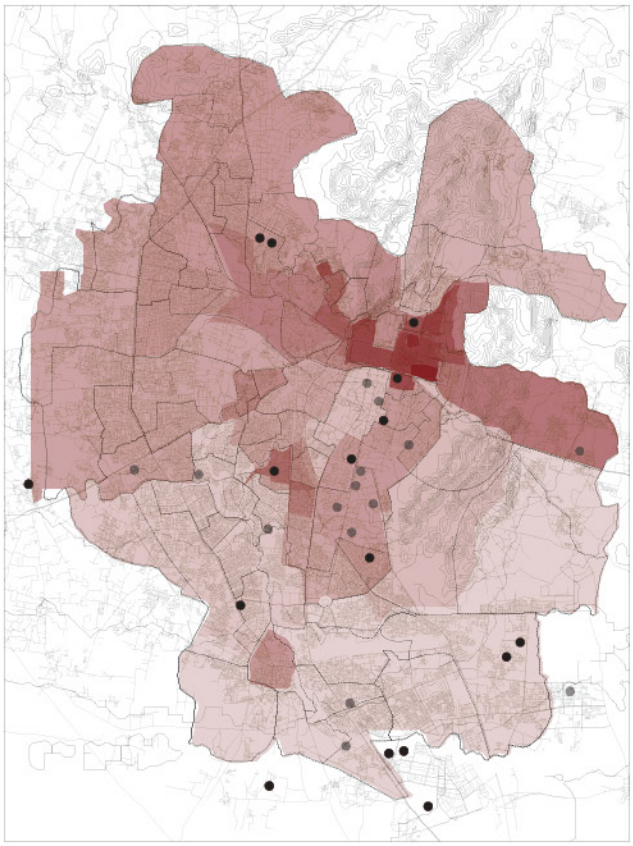
Daily Commute

MOBILITY

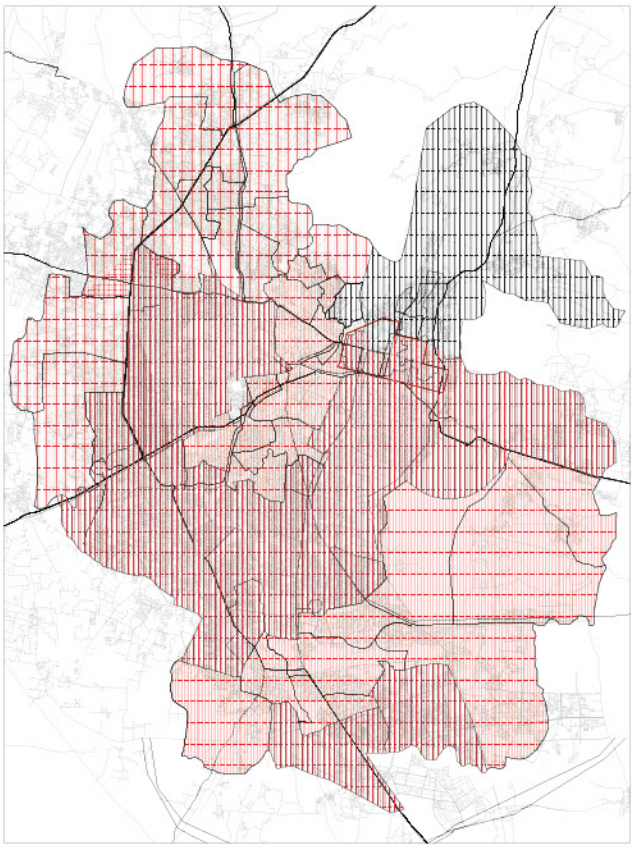
- **Bus stops**
- **Bus routes**
- **Metro stops**
- **Metro routes**
- **Railway stops**
- **Railway routes**
- **Public Transit Dead Zones (US Standard)**
- **Public Transit Dead Zones (India Standard)**
- **1 Hr Commute Paths (Mixed Transportation Methods)**



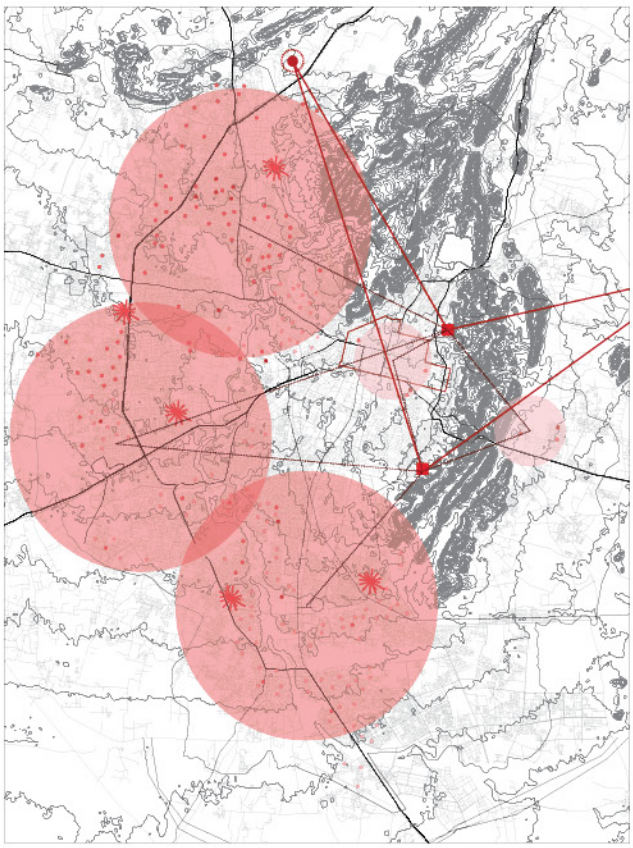
GREEN AND OPEN SPACES NETWORK



POPULATION DENSITY VS SCHOOLS



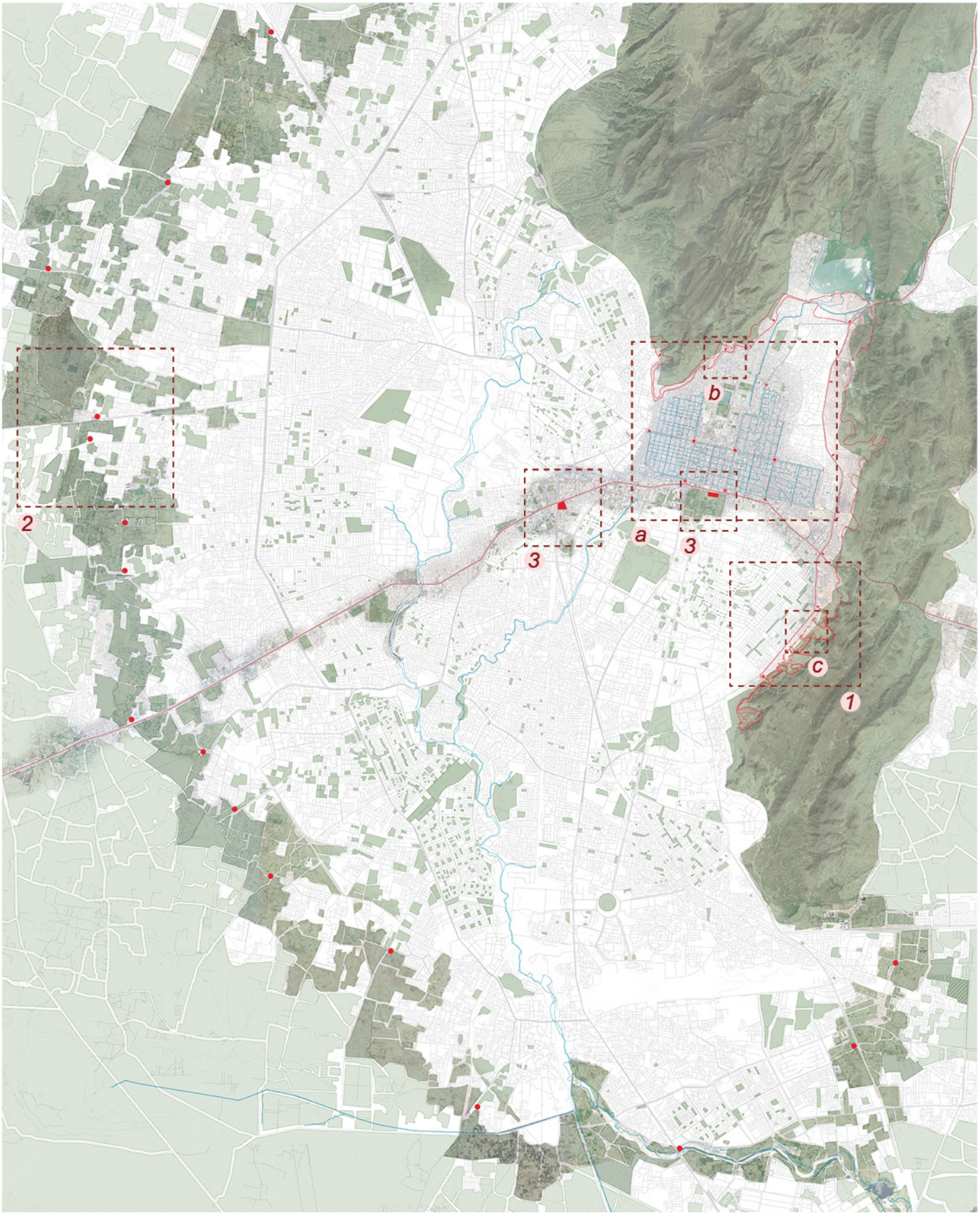
WASTE GENERATION PER CAPITA - JAIPUR



WASTE MANAGEMENT NETWORK

The Research & Design Team did field research in Jaipur city and New Delhi. Engagement with the communities provided an understanding of the needs and aspirations of local people. Few recognized that the lack of water is/ could be a potential threat to their well being.

4. JAIPUR CITY STRATEGIC VISION



3 critical SYSTEMS

- *a* Water Safety : Water harvesting
- *b* Energy Safety : Distributed Solar Network
- *c* Solid Waste Management : Communal Bin

3 intervention AREAS

- *1* The Green Belt : Mountain Edge
- *2* The Green Belt - Agricultural Edge
- *3* The Jaipur Route - Culture, Economy and Mobility

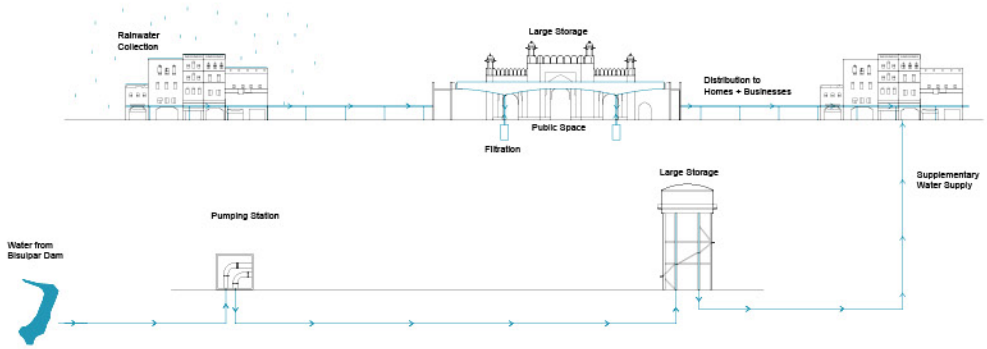
ACTIONS

ACTIONS	*a*	*b*	*c*	*1*	*2*	*3*
Rain water harvesting and re-use: Infrastructures for water catchment, storage and distribution	●	●		●		
Restoration of water bodies: Interception of sewage, addition of ecologies and public space				●	●	
Decentralized Sewage treatment plants: Hybridization with public programs, green filters and re-use				●	●	
Public sanitation network: Toilets and small neighborhood public programs	●	●	●	●	●	
Solid waste management network: Neighborhood communal bins with sanitation, laundry and community space	●	●	●	●		
Public mobility improvement: Hybrid urban space for pedestrian, bicycles and buses	●					●
Distributed Solar Plants network Reduction of fossil fuel dependency and carbon emissions in a resilient urban infrastructure		●				
Neighborhood public facilities network: Associated with other infrastructures providing community spaces and safe rooms for women and children	●	●	●	●	●	
Reforestation of city edges: Definition of the urban footprint limiting sprawl and encroachment of parks and agricultural lands				●		
Improvement of informal settlements Adding basic public amenities and ecological public space				●		
Reinforcement of cultural and tourist infrastructure						●
Revitalization of markets and commerce	●	●			●	●

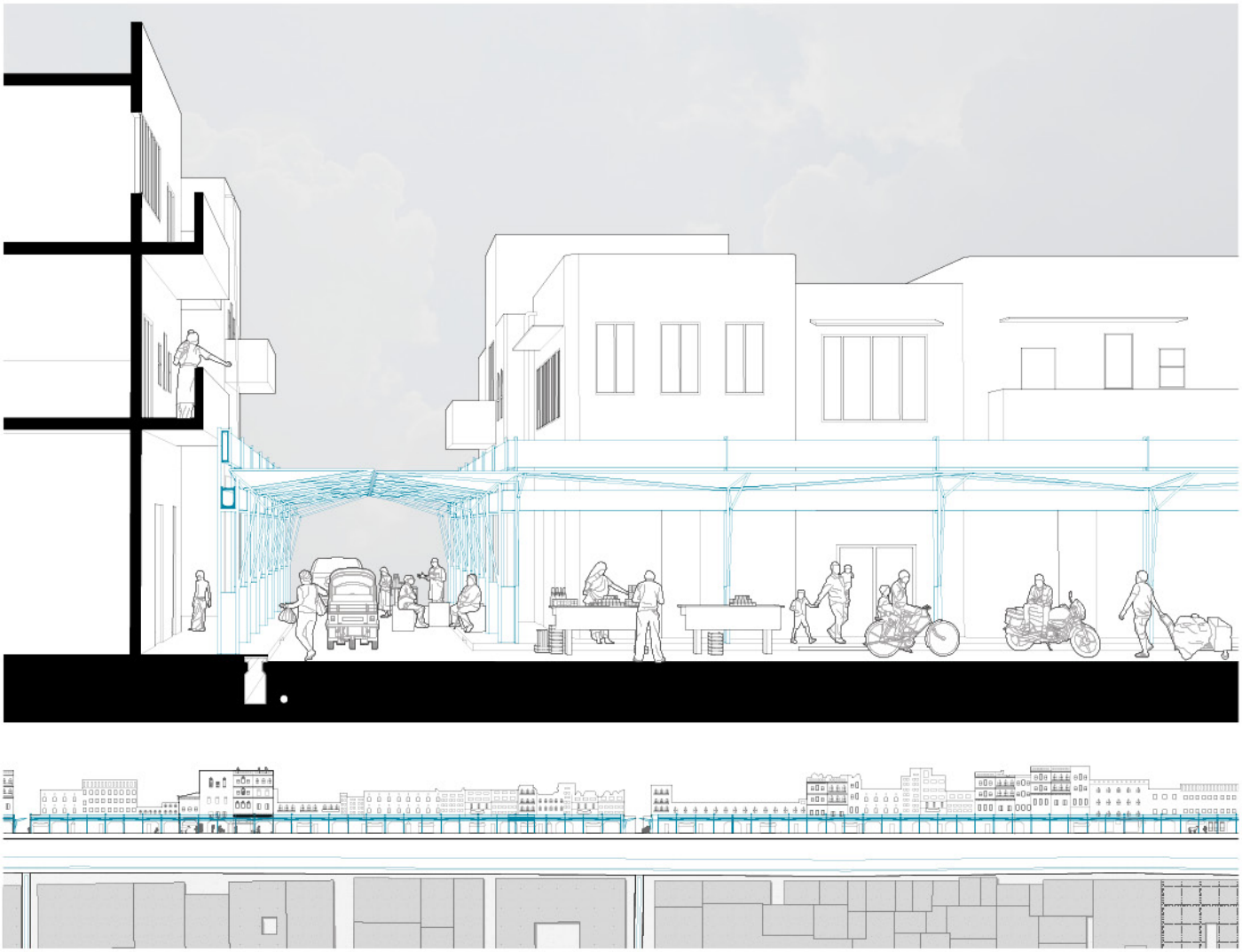
The Team engaged in various group and individual exercises - mapping the existing urban systems of Jaipur and identifying the strengths, weaknesses and opportunities to create a Strategic Vision for the sustainable and cohesive future growth of Jaipur and eventually proposing pilot projects that test this vision

a WATER SAFETY : WATER HARVESTING

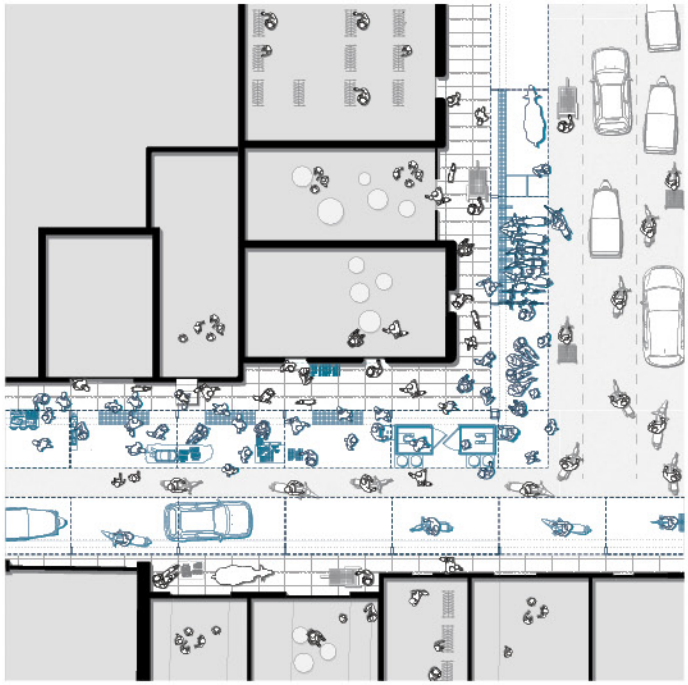
The project proposes to create a new rainwater collection system in the Walled City of Jaipur. Water from roofs, collected by tapping into existing pipe networks is directed along the street and brought to a series of water tanks. Hybridized light weight structures provide public space and amenities for citizens of Jaipur along with introducing a new infrastructural spine.

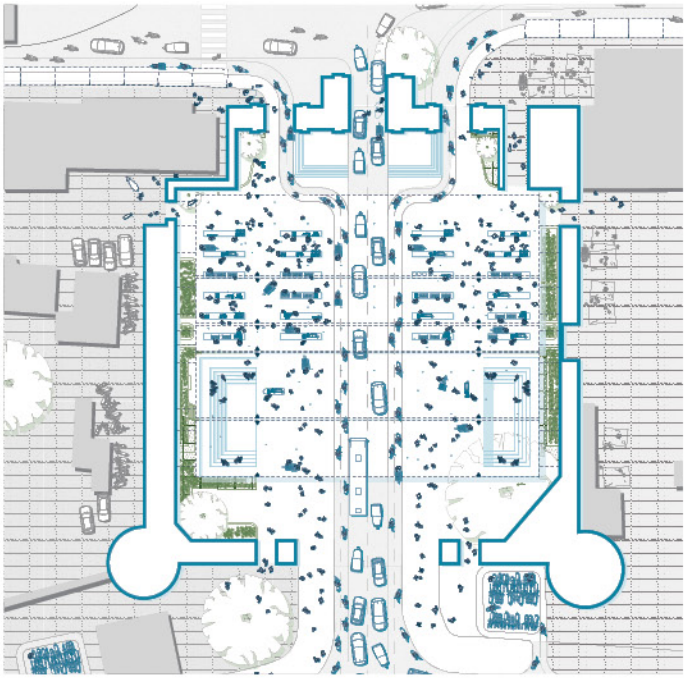


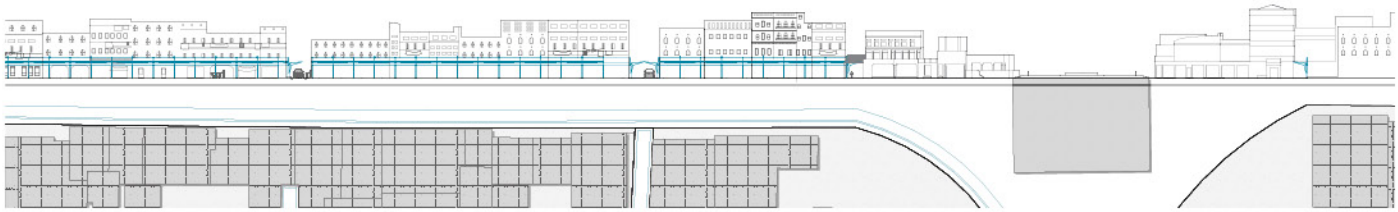
PROPOSED WATER DISTRIBUTION SYSTEM



WATER COLLECTION INFRASTRUCTURE ALONG WALLED CITY STREETS

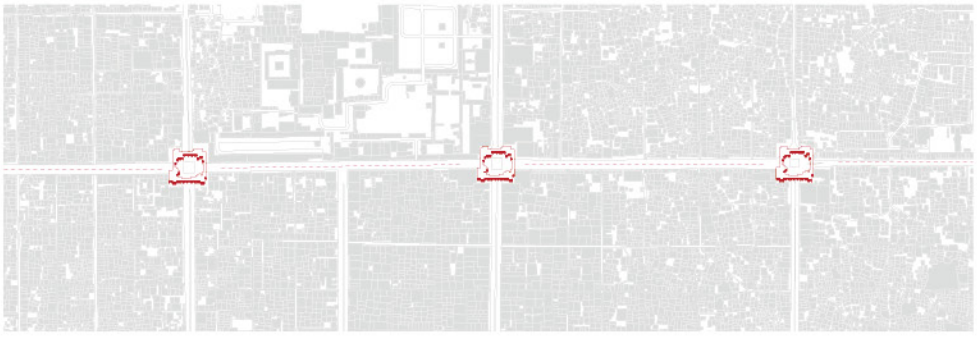


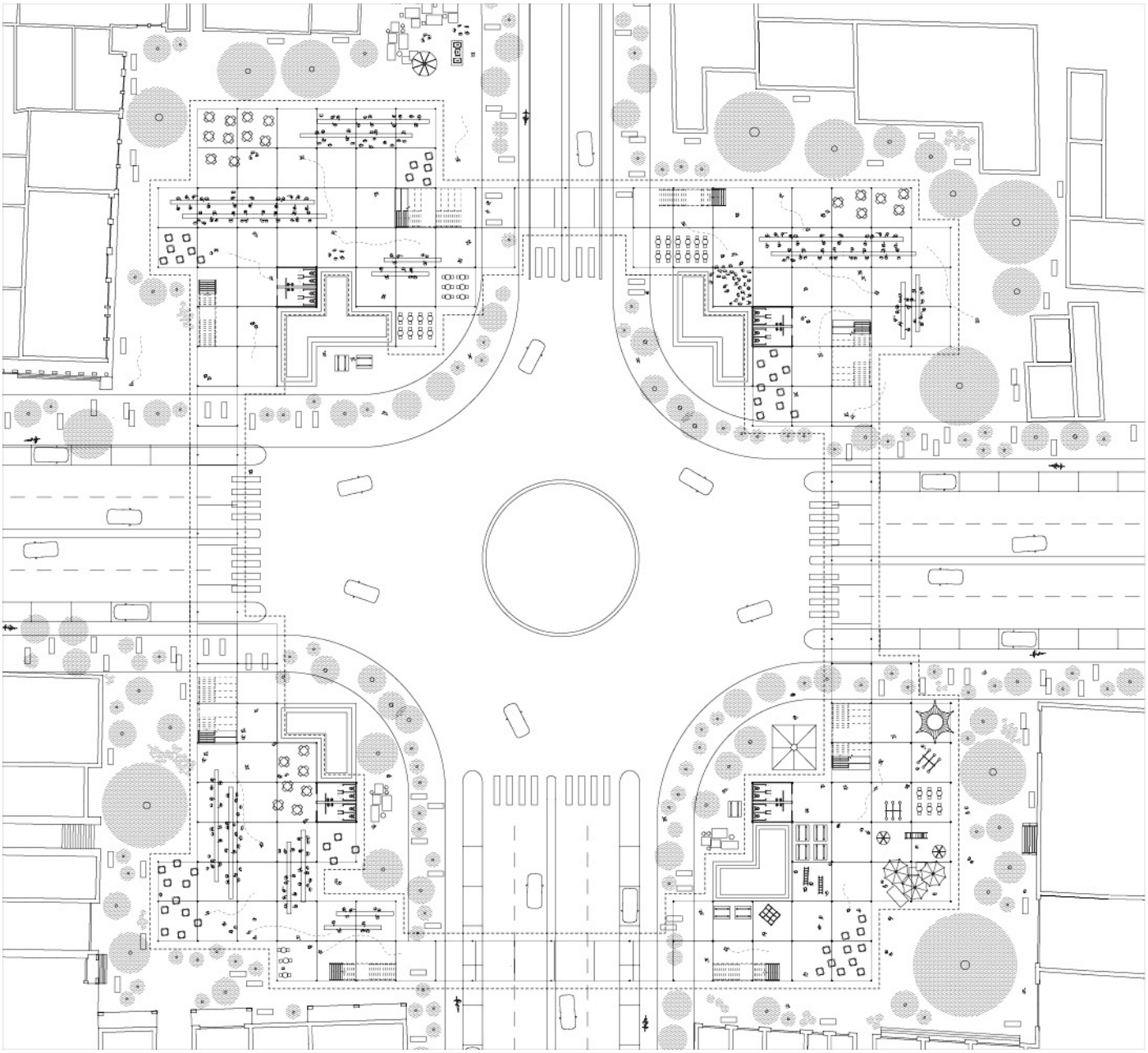


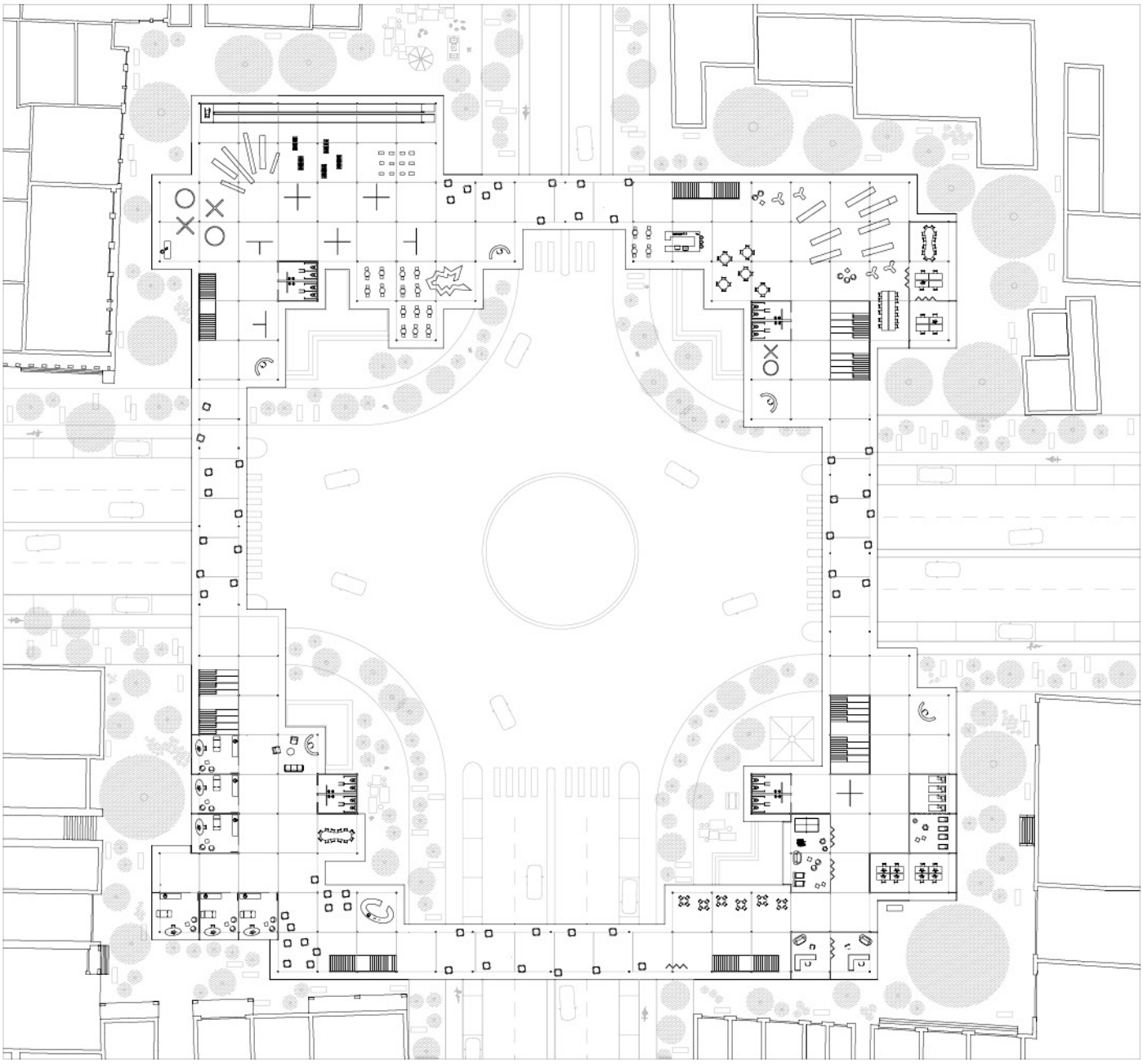


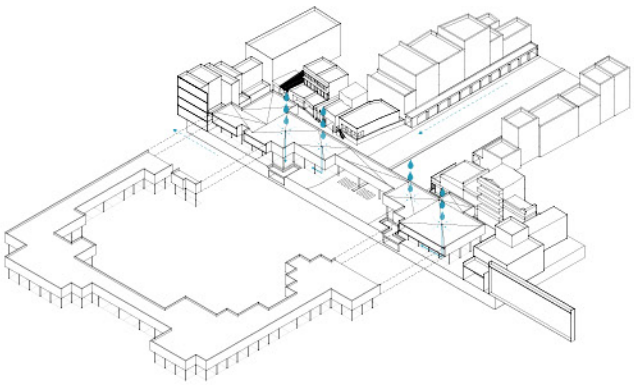
a WATER SAFETY : WATER HARVESTING

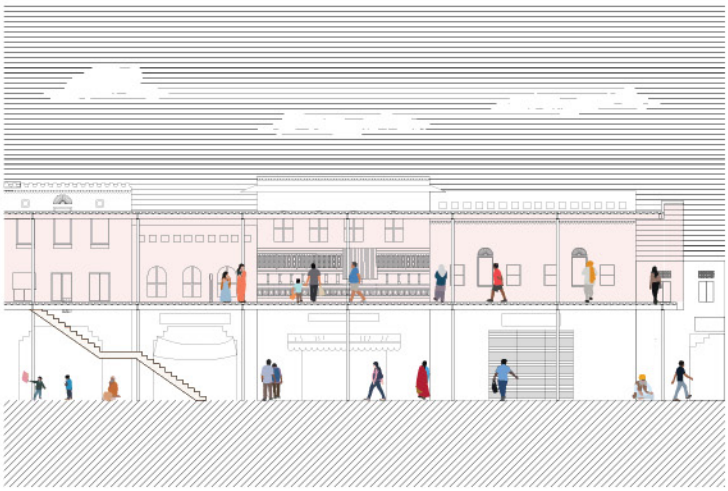
The project seeks to organize the walled city squares by creating a structure that harvests rainwater and restores responsibility and ownership to the commons. The structure provides public space for tourists, clinics for women and children, libraries, markets and galleries as well as organizes the mobility on the street.





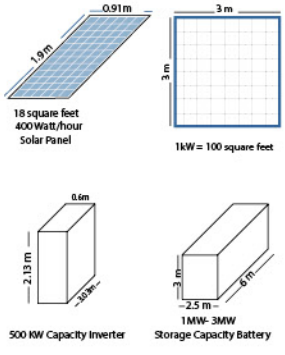


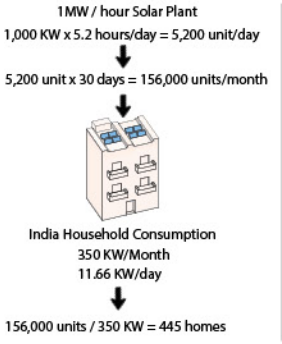


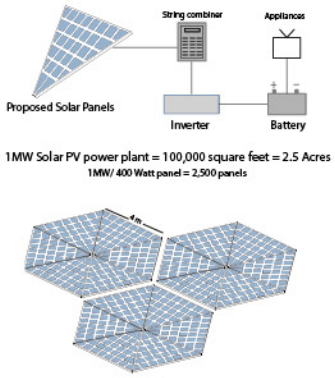


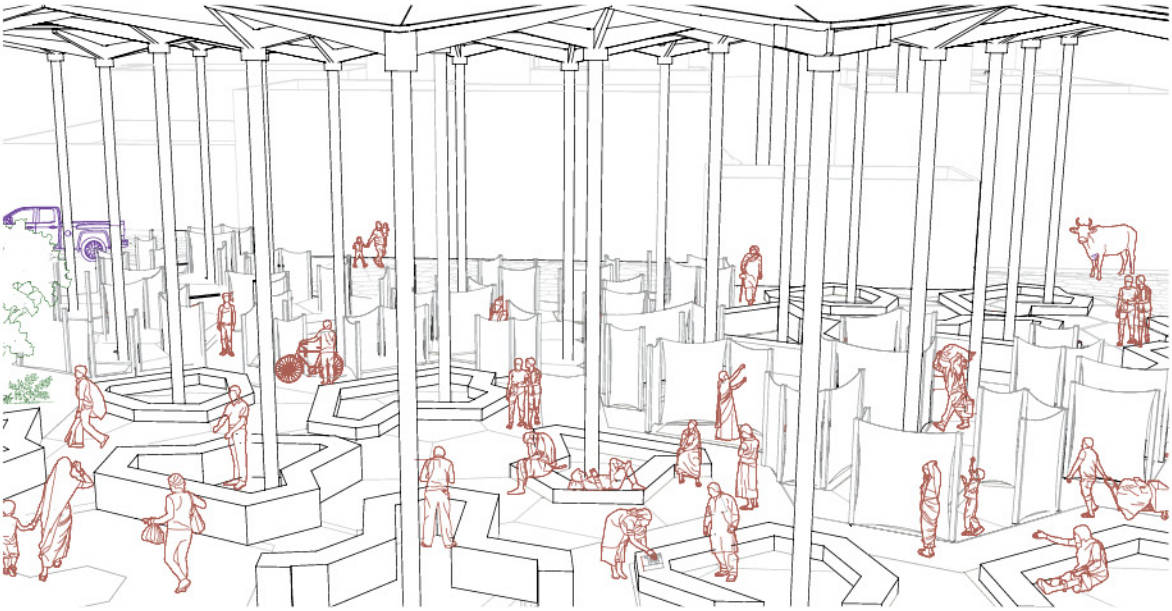
b ENERGY SAFETY : DISTRIBUTED SOLAR NETWORK

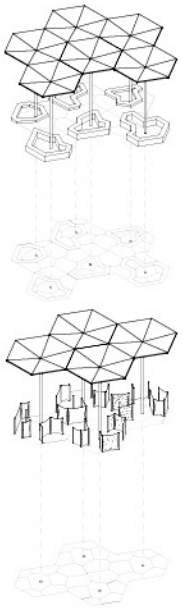
The project proposes to create a distributed hybrid power network in Jaipur at the neighborhood scale. By creating a new typology of public space with a solar roof system to reduce the carbon emission and dependability on non renewable sources of energy. The system imagines an alternative to the existing centralized energy network.

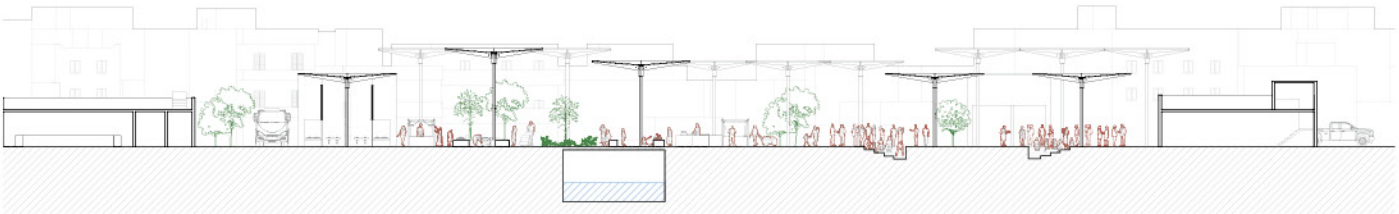


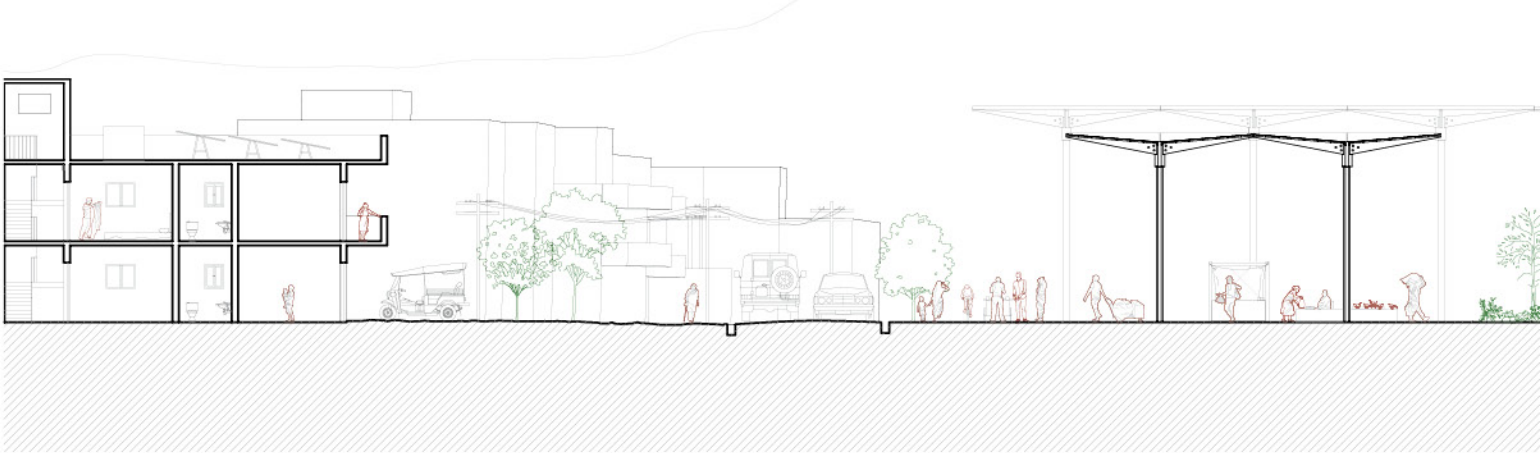


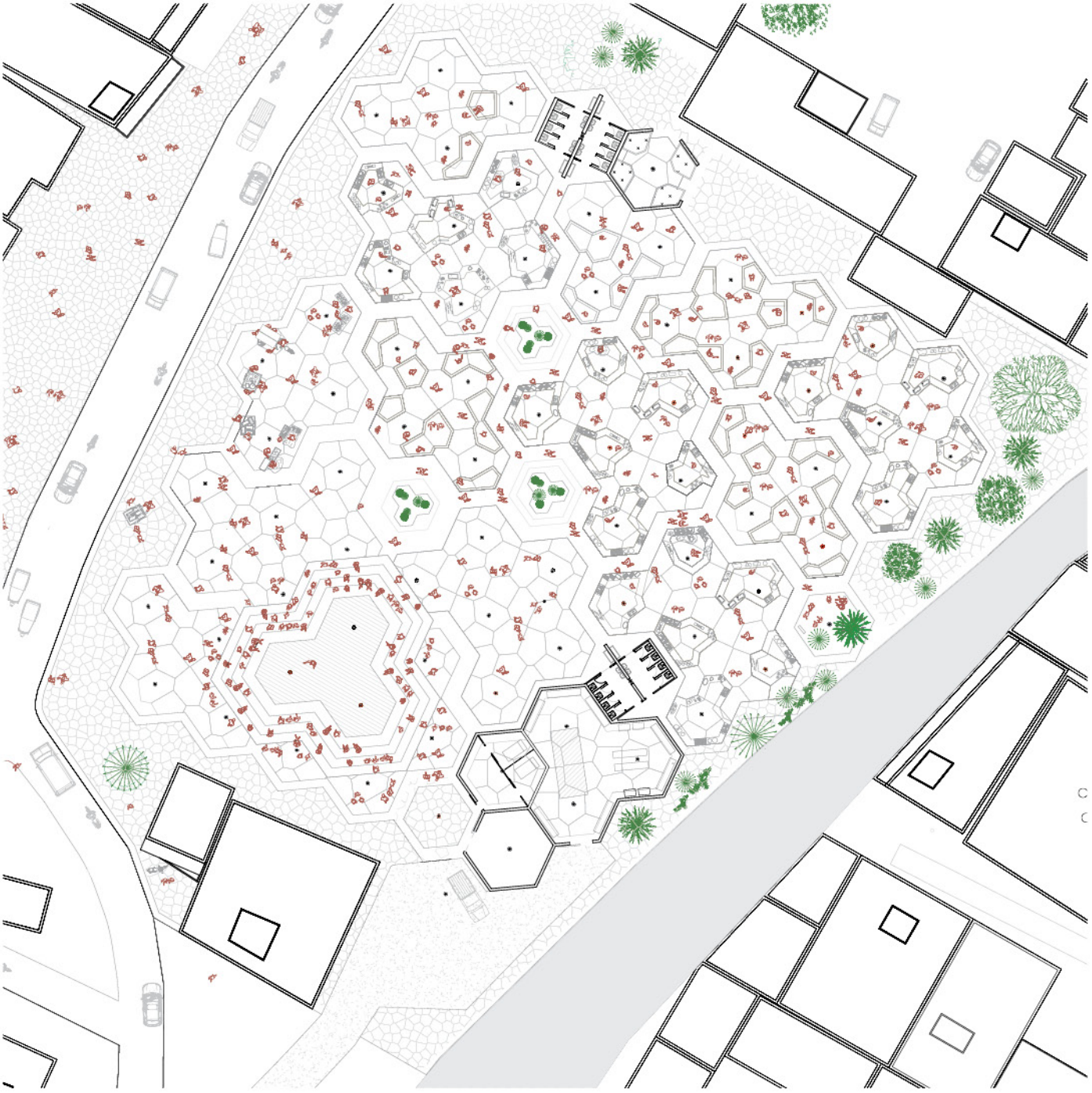


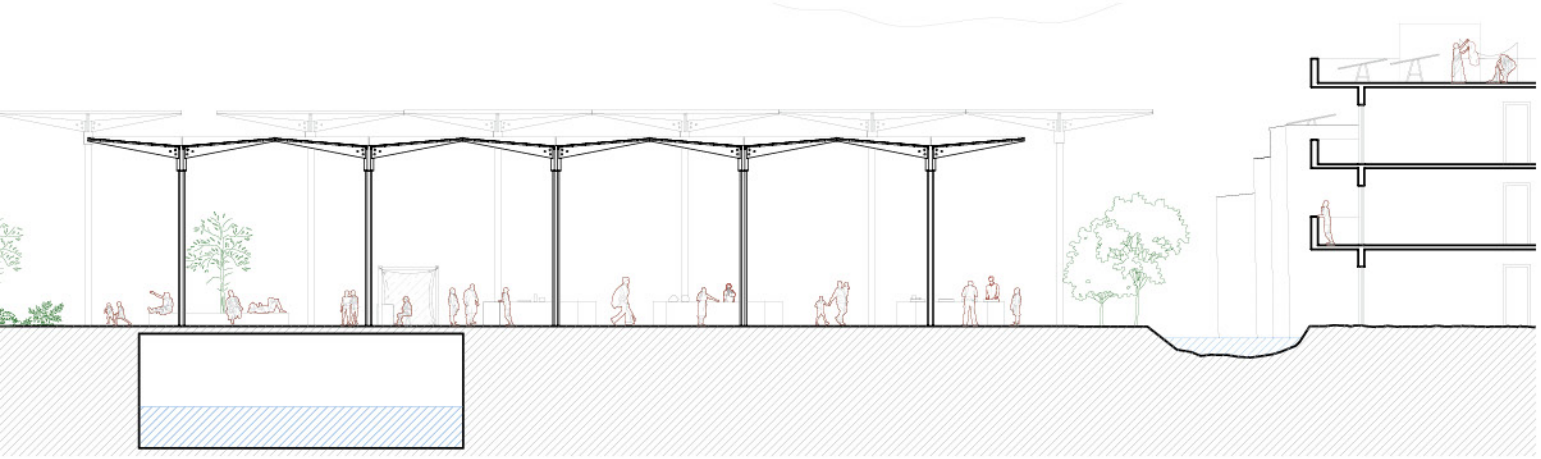






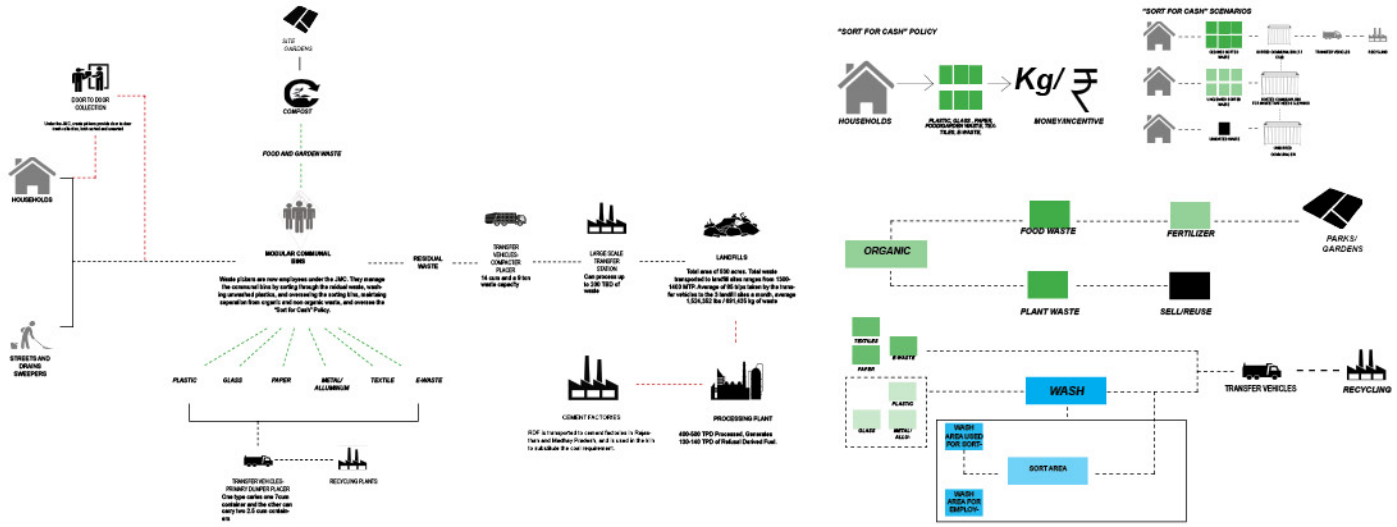




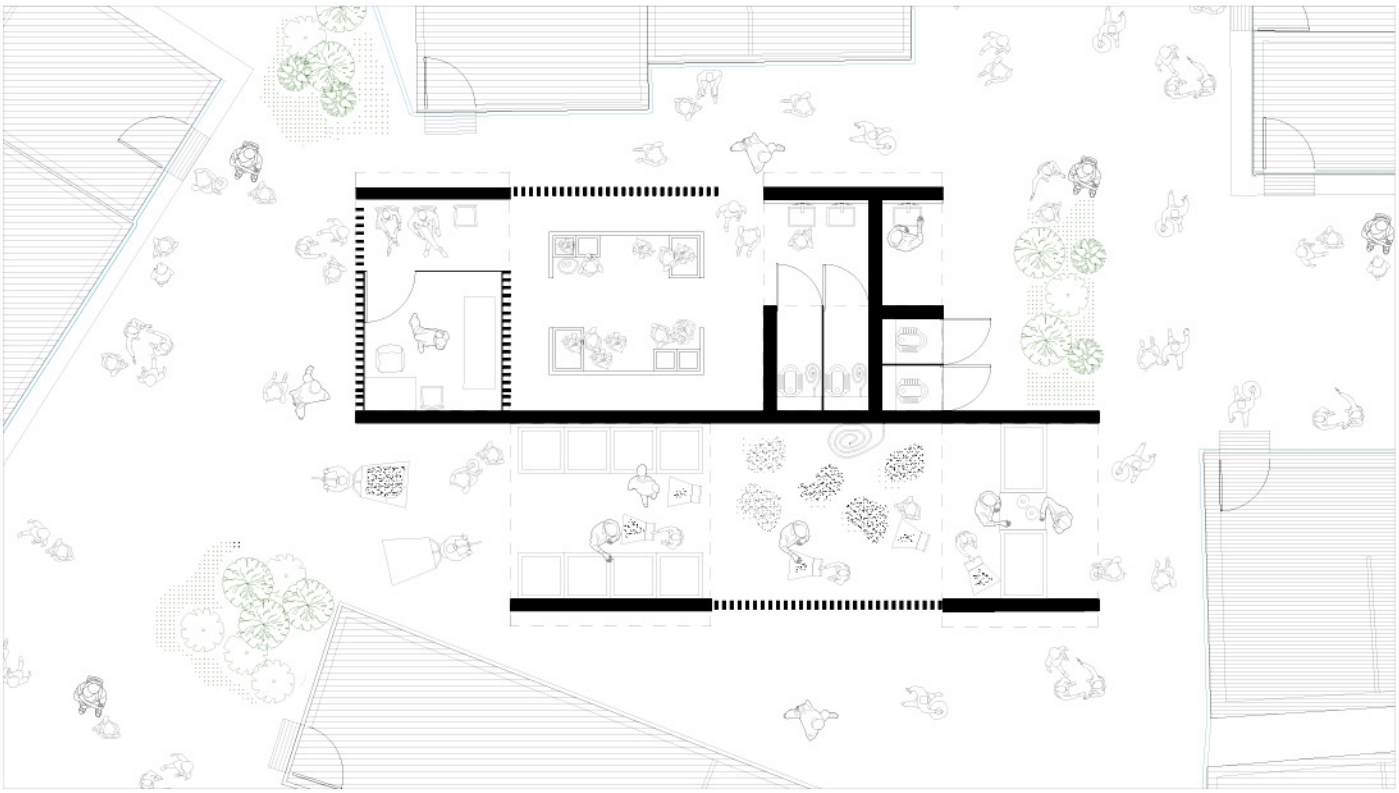


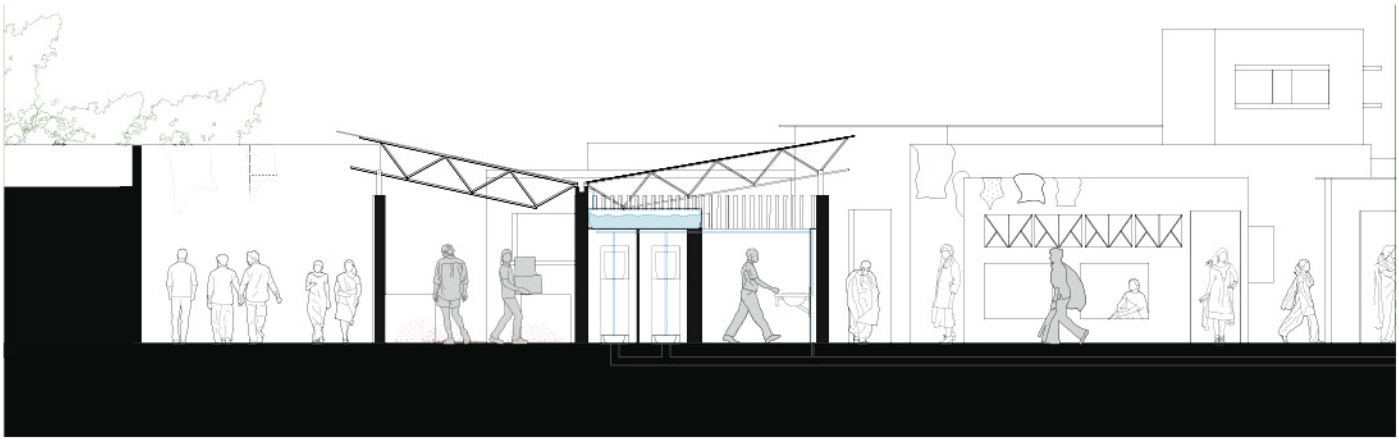
C SOLID WASTE MANAGEMENT : COMMUNAL BIN

The project proposes a modular communal bin system that deals with waste segregation while providing public spaces & amenities such as bathrooms, community room, laundry, clinics for women and children etc. at the neighborhood level. A system of public incentives are introduced to organize the waste collection network of the city.



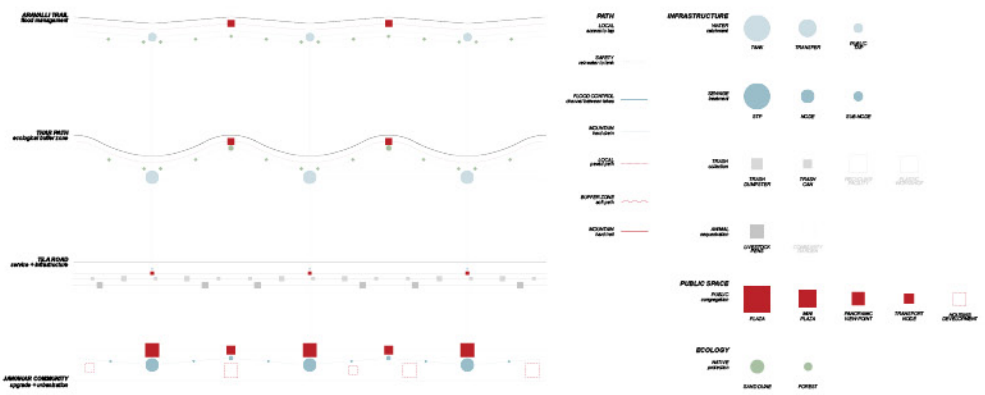
EXISTING VS PROPOSED TRASH COLLECTION SYSTEM

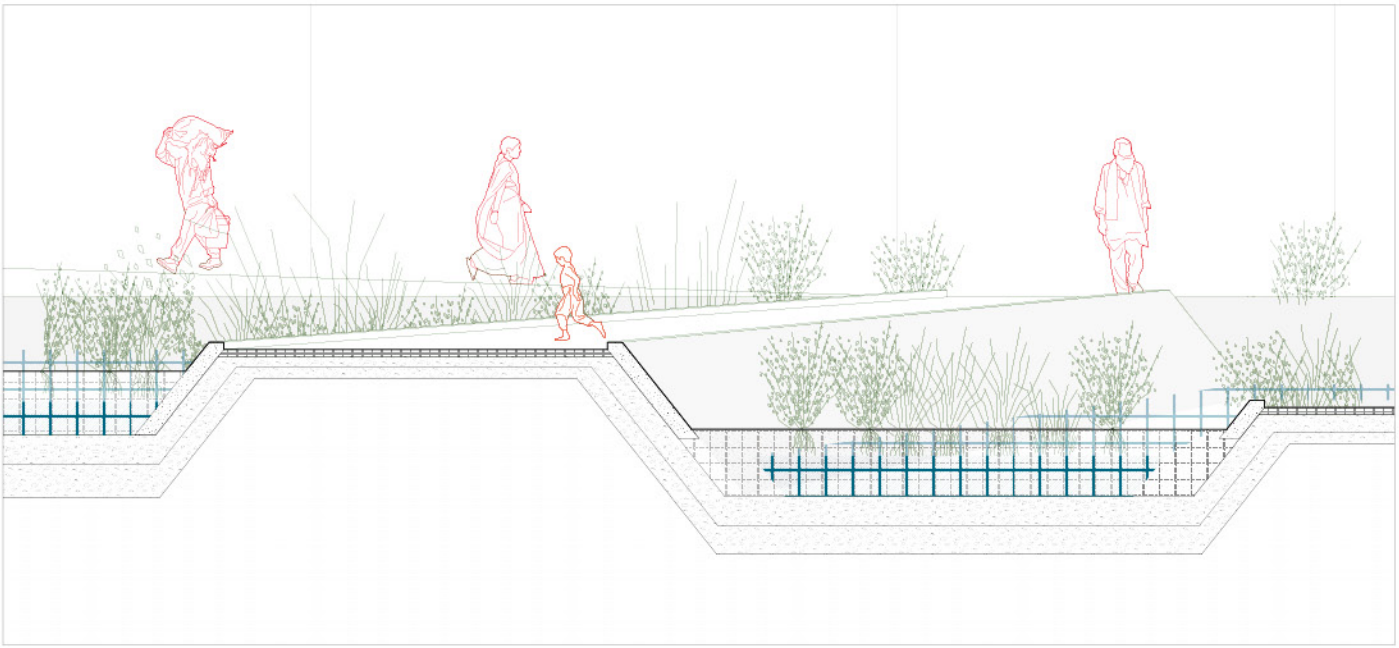


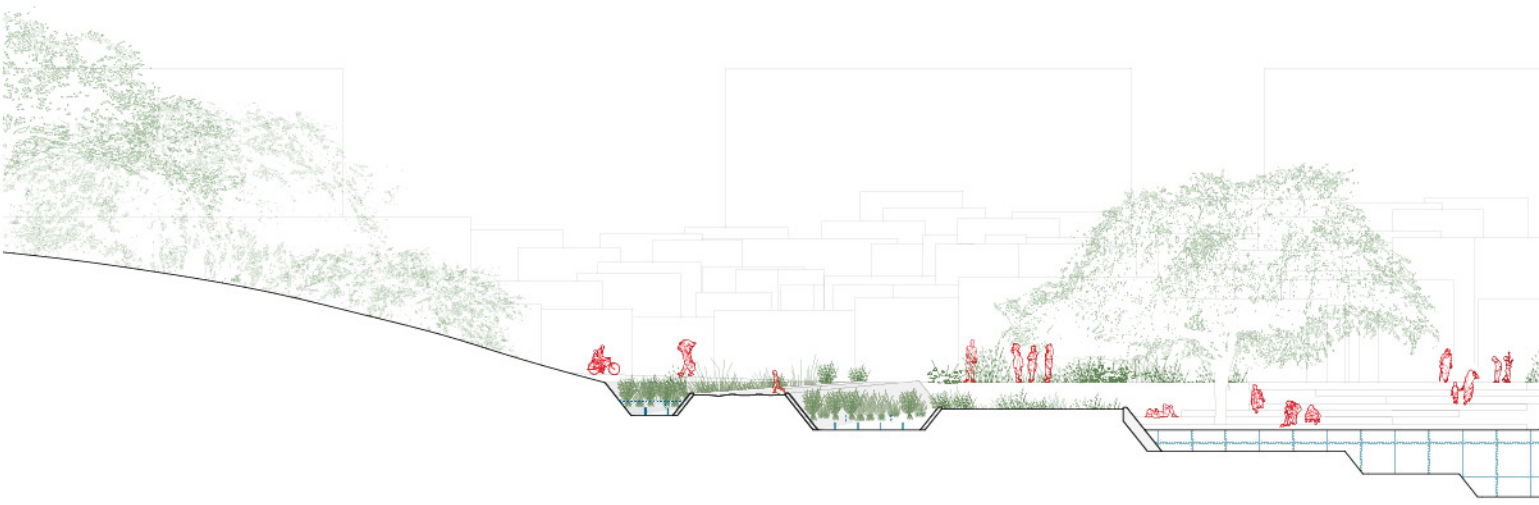


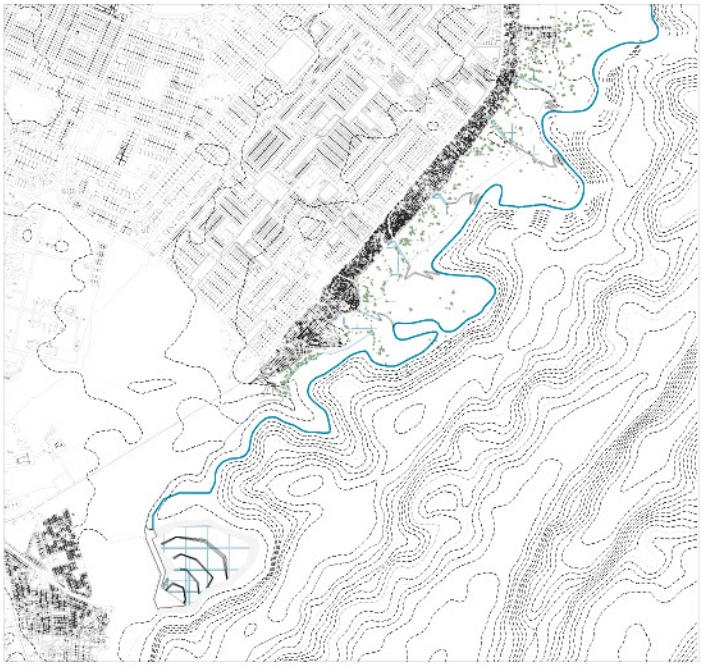
1 THE GREEN BELT : MOUNTAIN EDGE

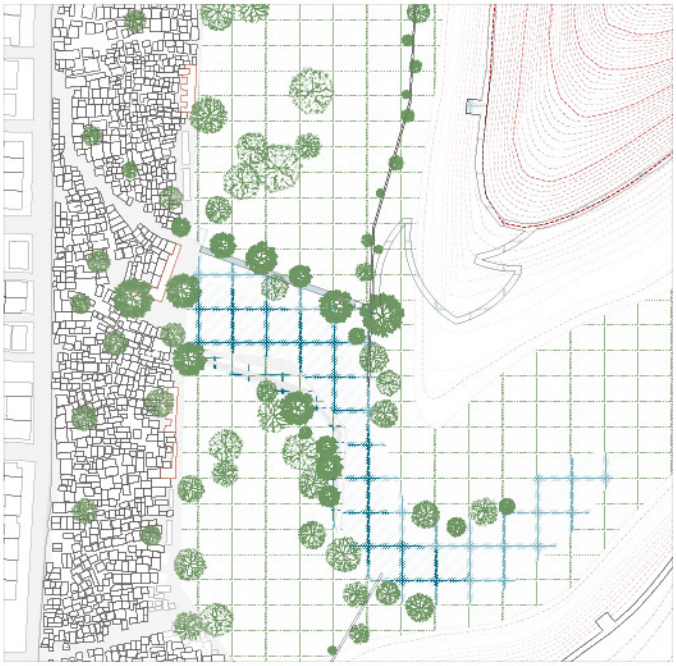
The project aims to limit the continued urban sprawl in the ecological mountain reserve of Jaipur. It proposes to create a resilient hillside flood prevention system that provides the framework for further fortification of adjacent neighborhoods and curates an ecological buffer that becomes an urban asset.

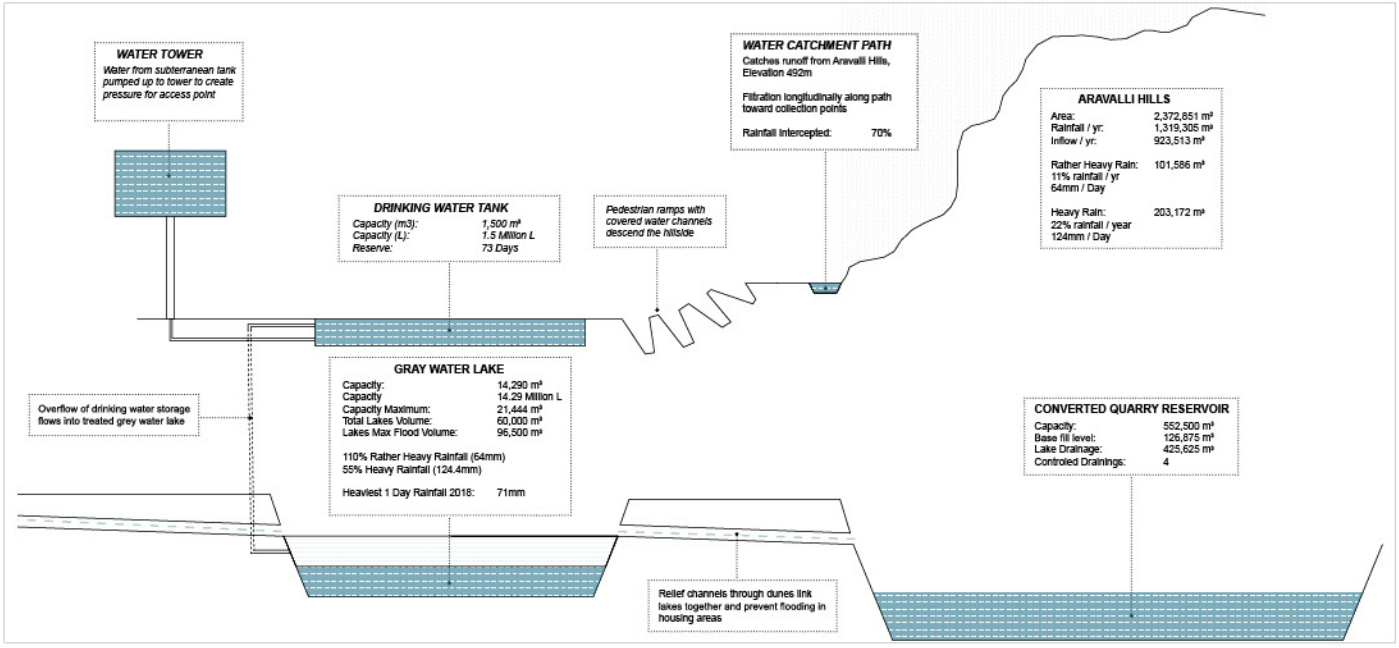


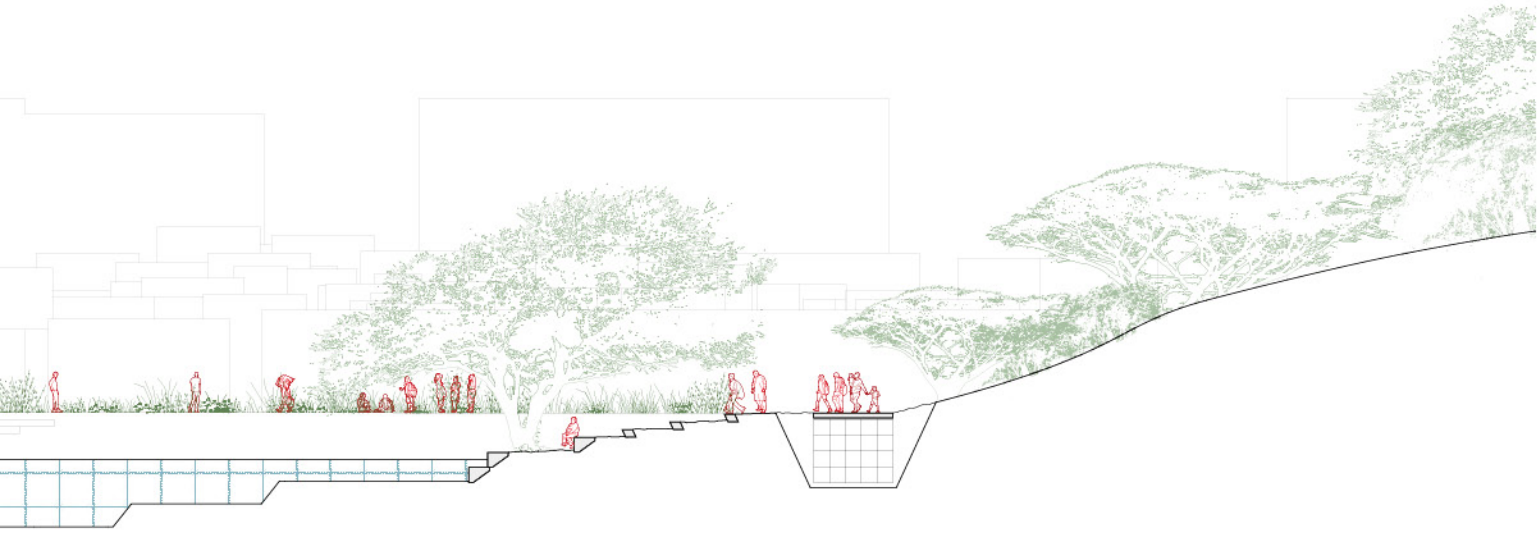






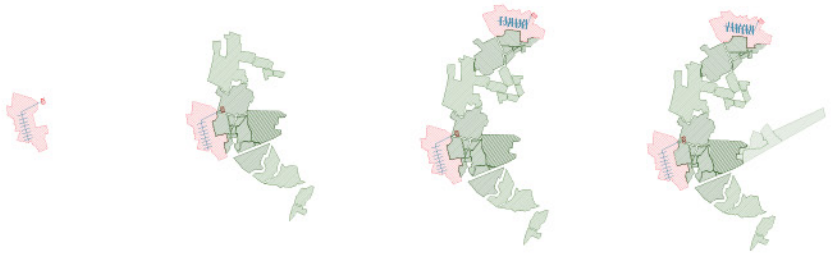



WATER TOWER
Water from subterranean tank pumped up to tower to create pressure for access point
WATER CATCHMENT PATH
Catches runoff from Aravalli Hills, Elevation 492m
Filtration longitudinally along path toward collection points
Rainfall intercepted: 70%
ARAVALLI HILLS
Area: 2,372,851 m²
Rainfall / yr: 1,319,305 m³
Inflow / yr: 923,513 m³
Rather Heavy Rain: 101,586 m³
11% rainfall / yr
64mm / Day
Heavy Rain: 203,172 m³
22% rainfall / year
124mm / Day
DRINKING WATER TANK
Capacity (m3): 1,500 m³
Capacity (L): 1.5 Million L
Reserve: 73 Days
Pedestrian ramps with covered water channels descend the hillside
GRAY WATER LAKE
Capacity: 14,290 m³
Capacity 14.29 Million L
Capacity Maximum: 21,444 m³
Total Lakes Volume: 60,000 m³
Lakes Max Flood Volume: 96,500 m³
110% Rather Heavy Rainfall (64mm)
55% Heavy Rainfall (124.4mm)
Heaviest 1 Day Rainfall 2016: 71mm
Overflow of drinking water storage flows into treated grey water lake
CONVERTED QUARRY RESERVOIR
Capacity: 552,500 m³
Base fill level: 126,875 m³
Lake Drainage: 425,625 m³
Controled Drainings: 4
Relief channels through dunes link lakes together and prevent flooding in housing areas

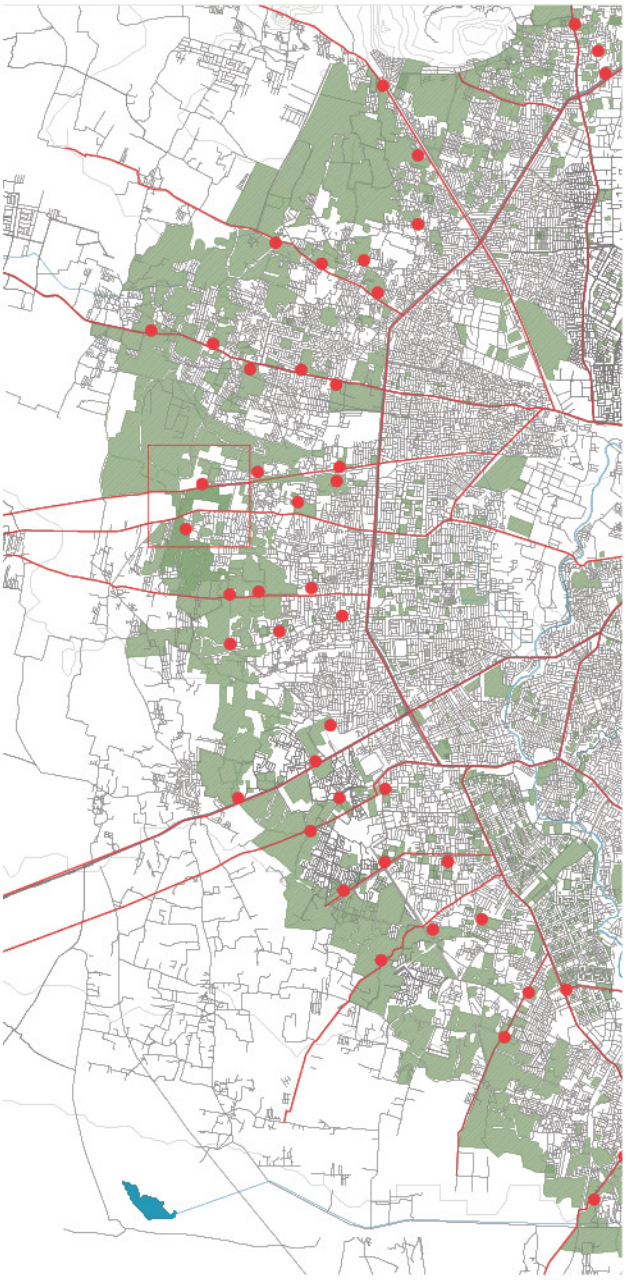


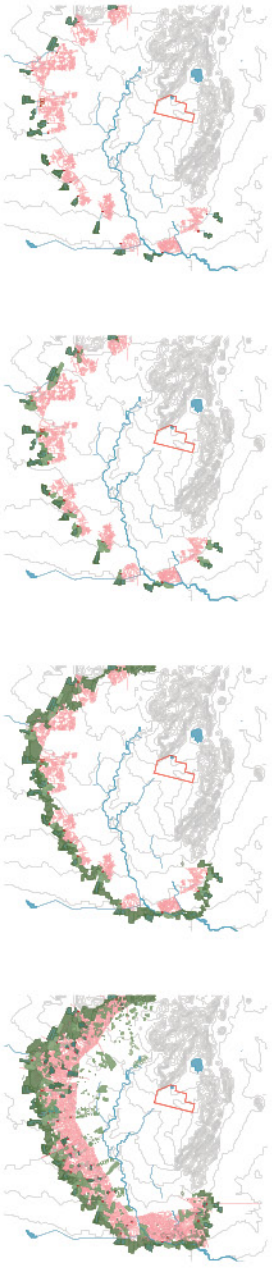
2 THE GREEN BELT : AGRICULTURAL EDGE

The project proposes a comprehensive green belt system with multiple steps to address the problems of urban sprawl, unconnected sewage networks and lack of green space in Jaipur city.

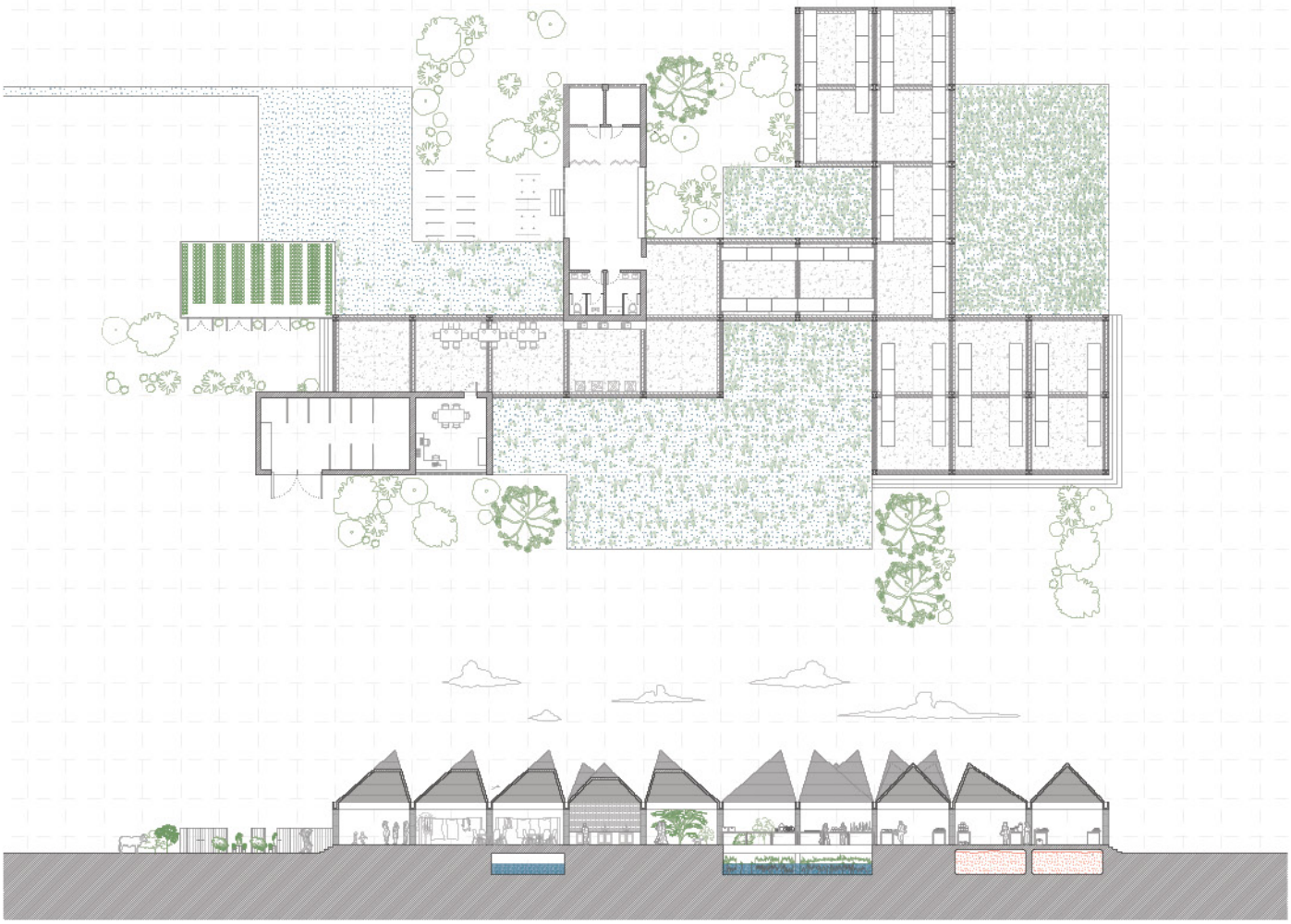


EVOLUTION OF GREEN BELT: ORCHARDS + TREE COVER + FINGERS

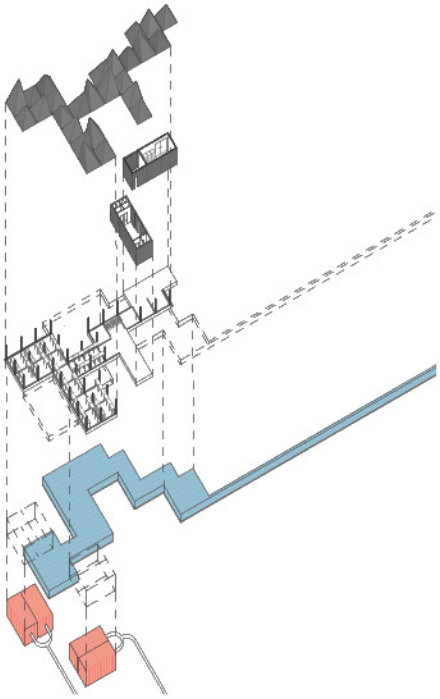


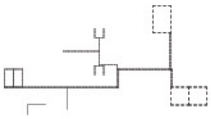


GREEN BELT PHASES OF GROWTH

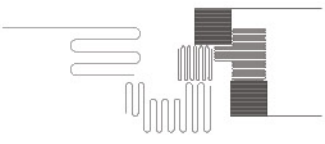


PROPOSED DECENTRALIZED SEWAGE TREATMENT PLANTS HYBRIDIZED WITH COMMUNITY SPACES

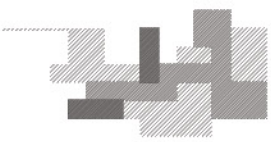




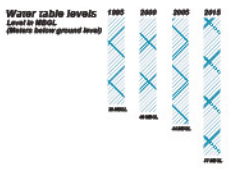
CIRCULATION



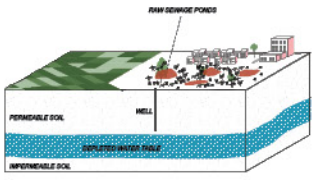
WATER MOVEMENT



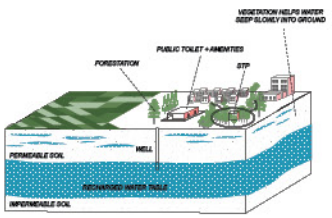
ENCLOSURE



BEFORE

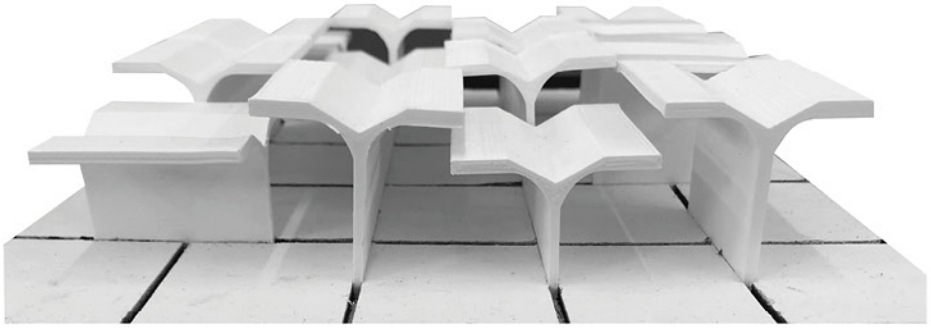


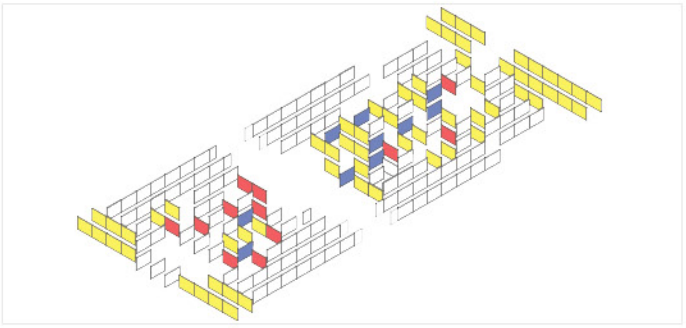
AFTER

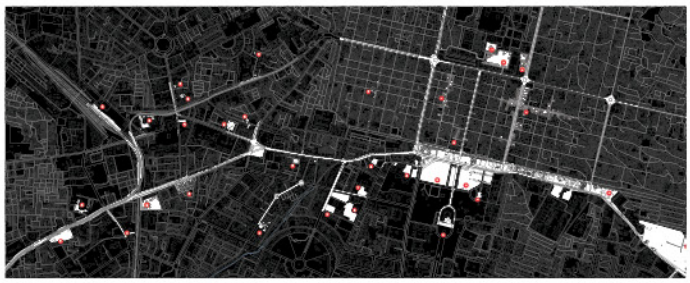


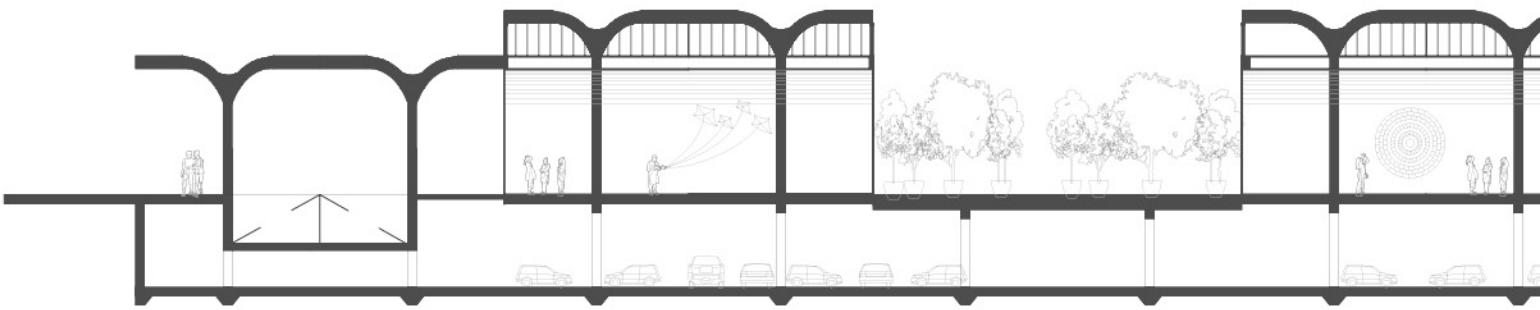
3 THE JAIPUR ROUTE - CULTURE, ECONOMY AND MOBILITY

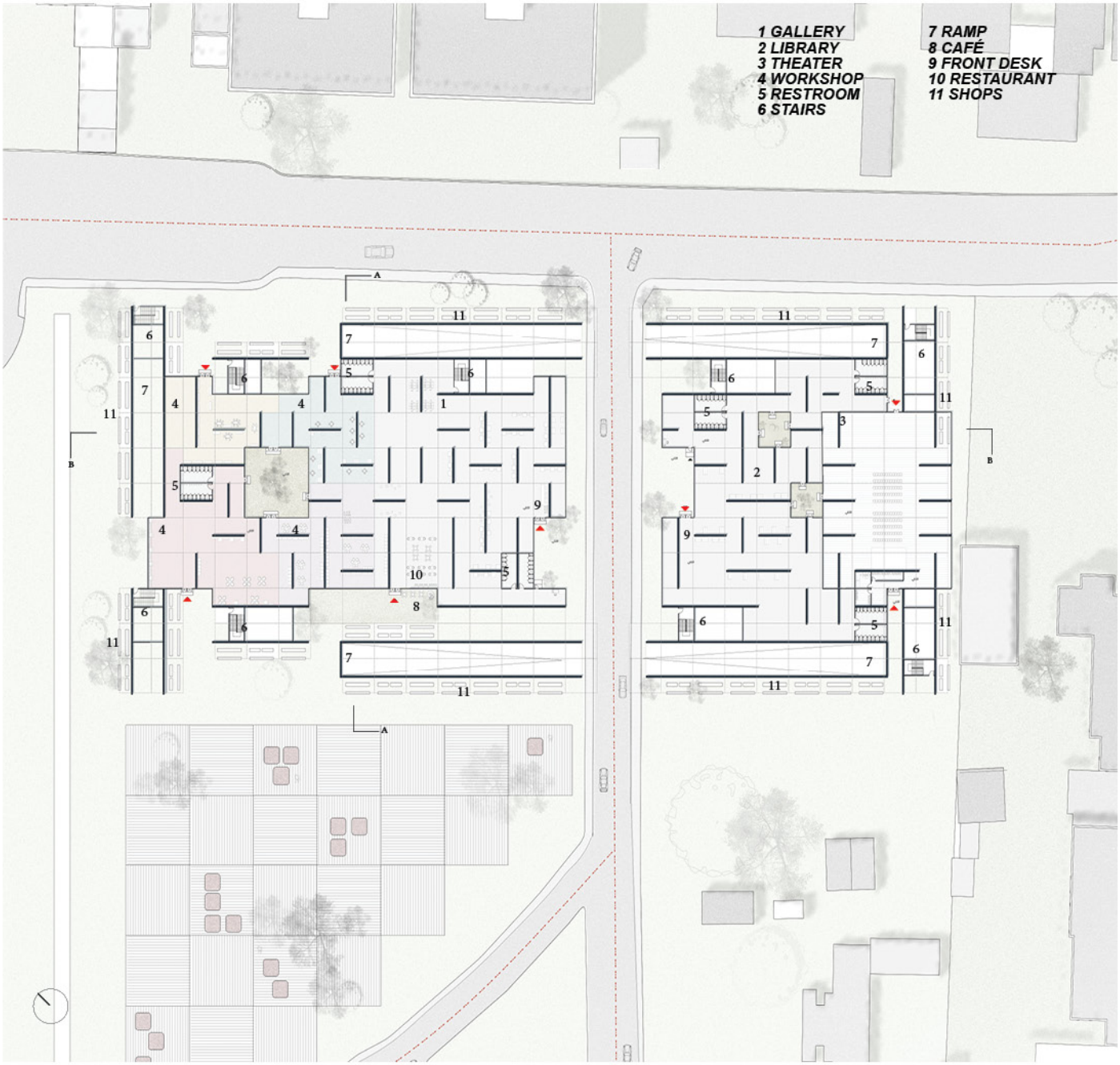
The project aims to leverage the rich history of local craft in Jaipur to create a cultural infrastructure that seeks to promote tourism.

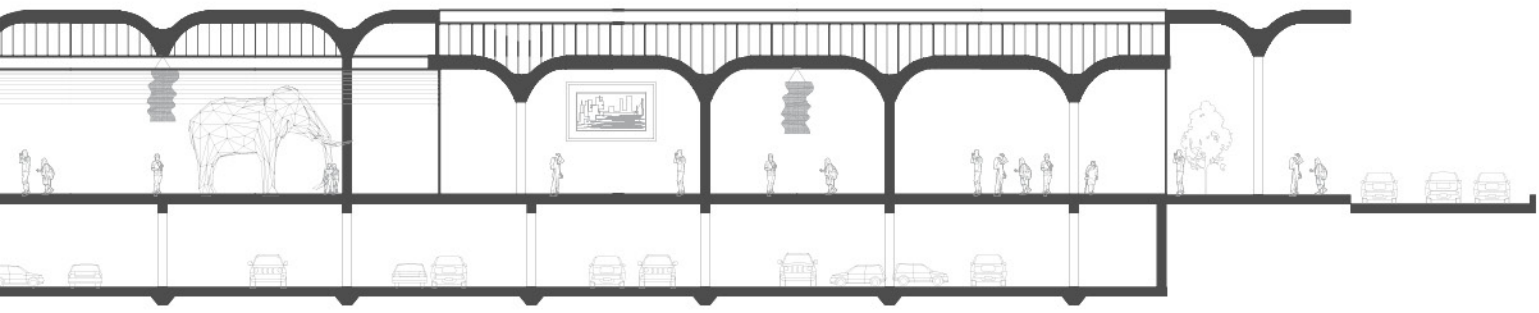






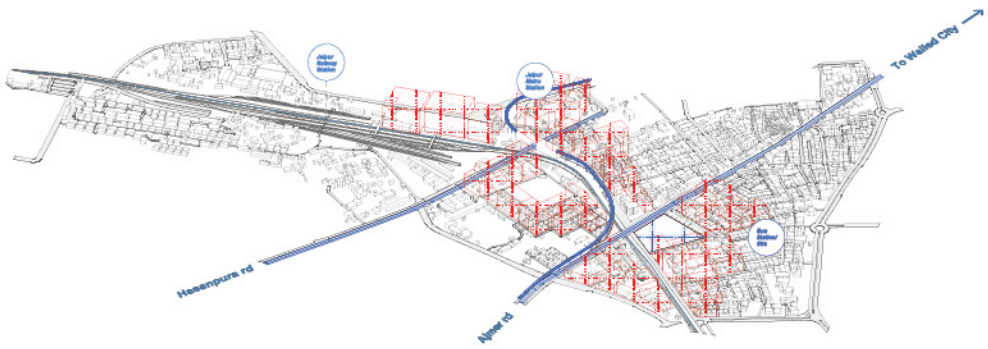


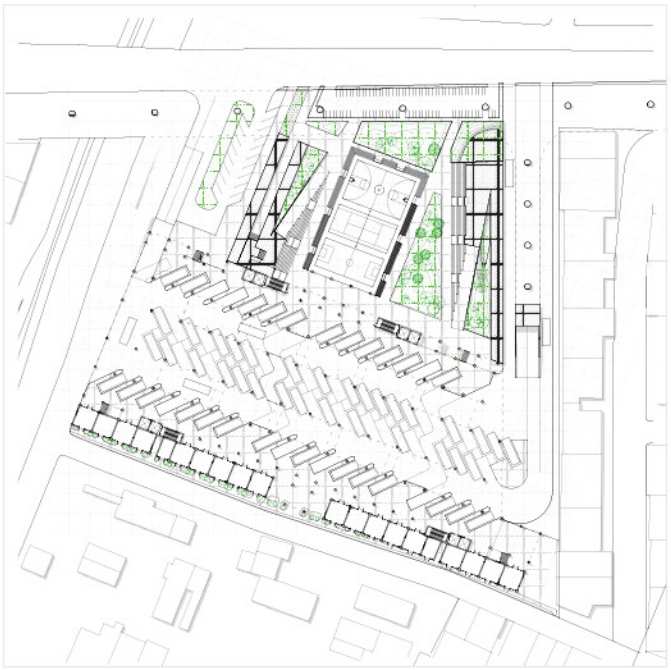

1 GALLERY
2 LIBRARY
3 THEATER
4 WORKSHOP
5 RESTROOM
6 STAIRS
7 RAMP
8 CAFÉ
9 FRONT DESK
10 RESTAURANT
11 SHOPS
A
B

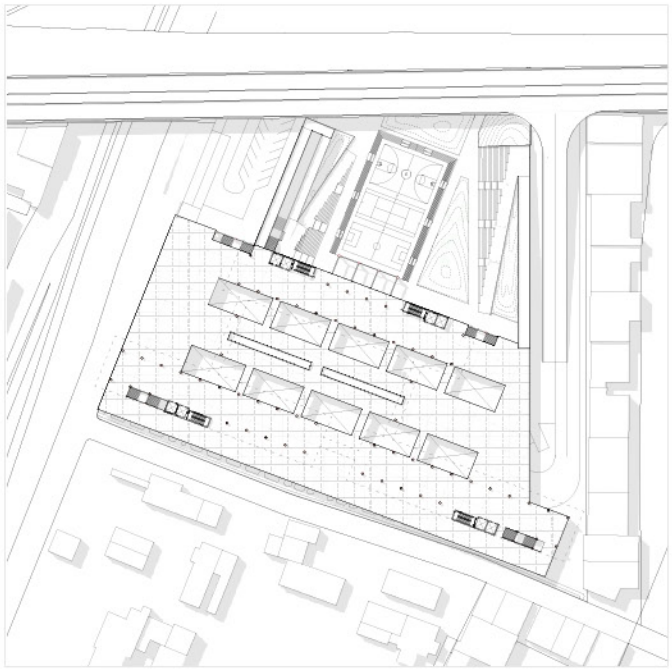


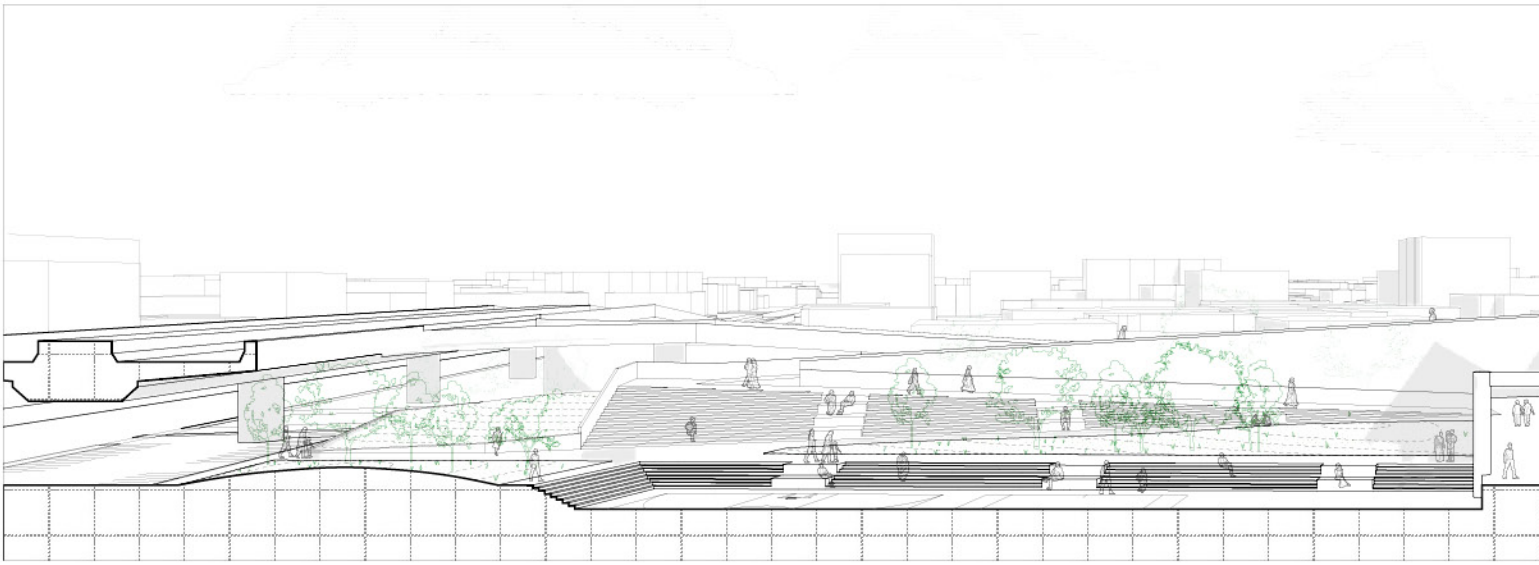
3 THE JAIPUR ROUTE - CULTURE, ECONOMY AND MOBILITY

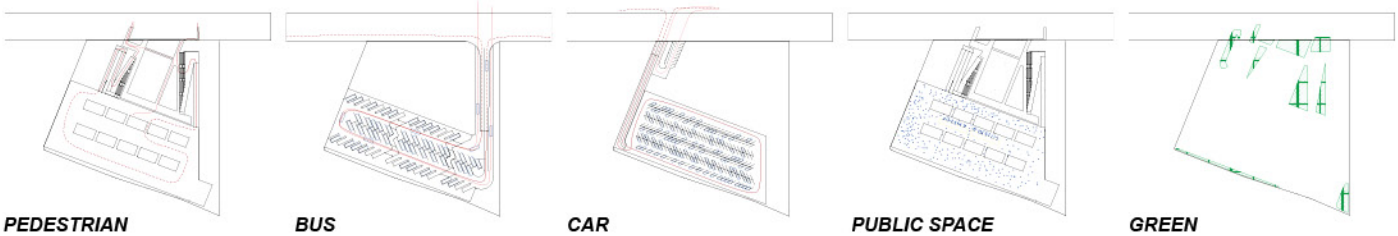
The project proposes a series of interventions to improve the city's mobility. Specifically, re-purposing the current Jaipur bus station into a bus depot, public market, recreation space, and hostel. This plan envisions a new central section of the city through accessible public transportation and public engagement leading to economic growth in the surrounding area.



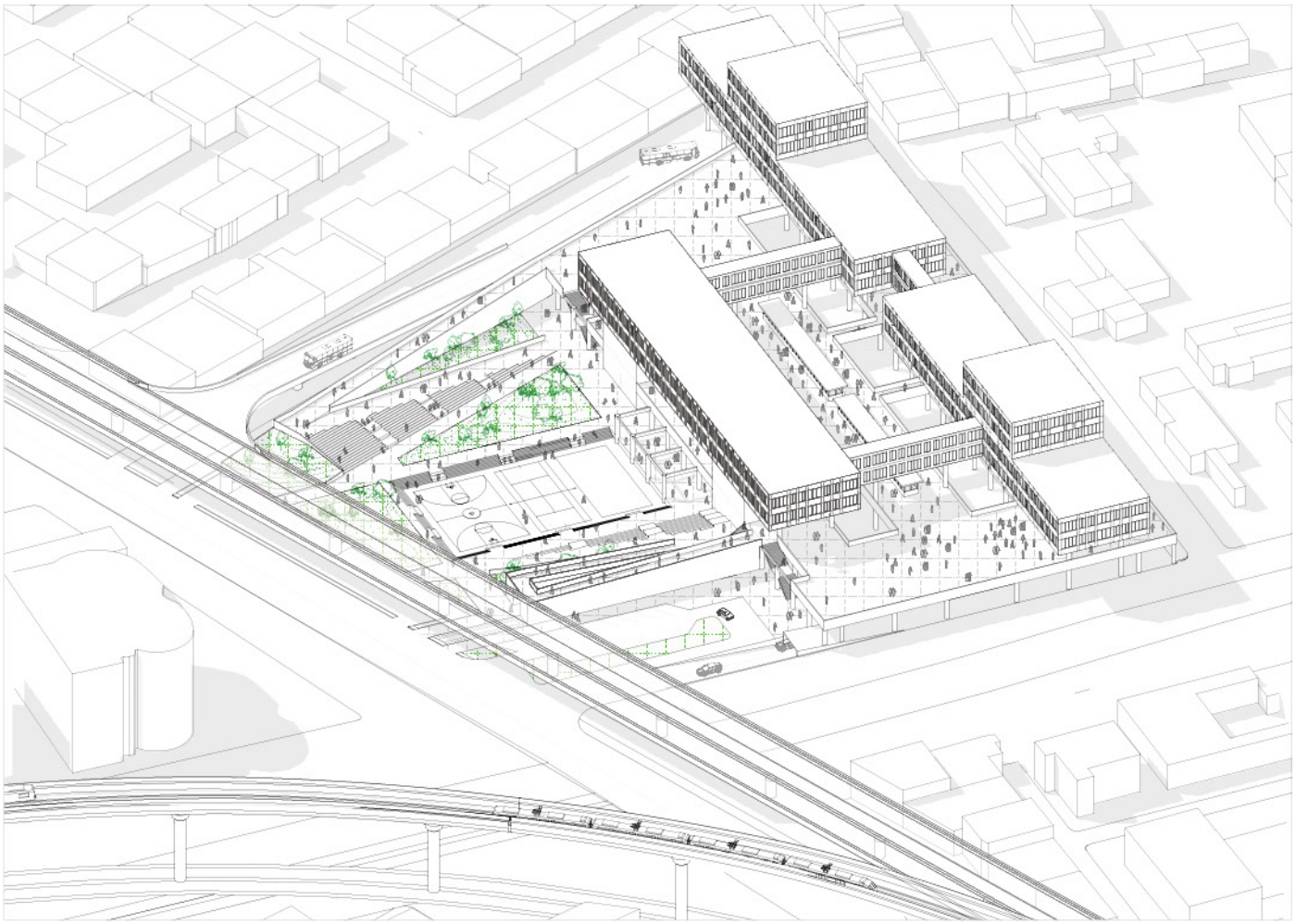








PEDESTRIAN ***BUS*** ***CAR*** ***PUBLIC SPACE*** ***GREEN***



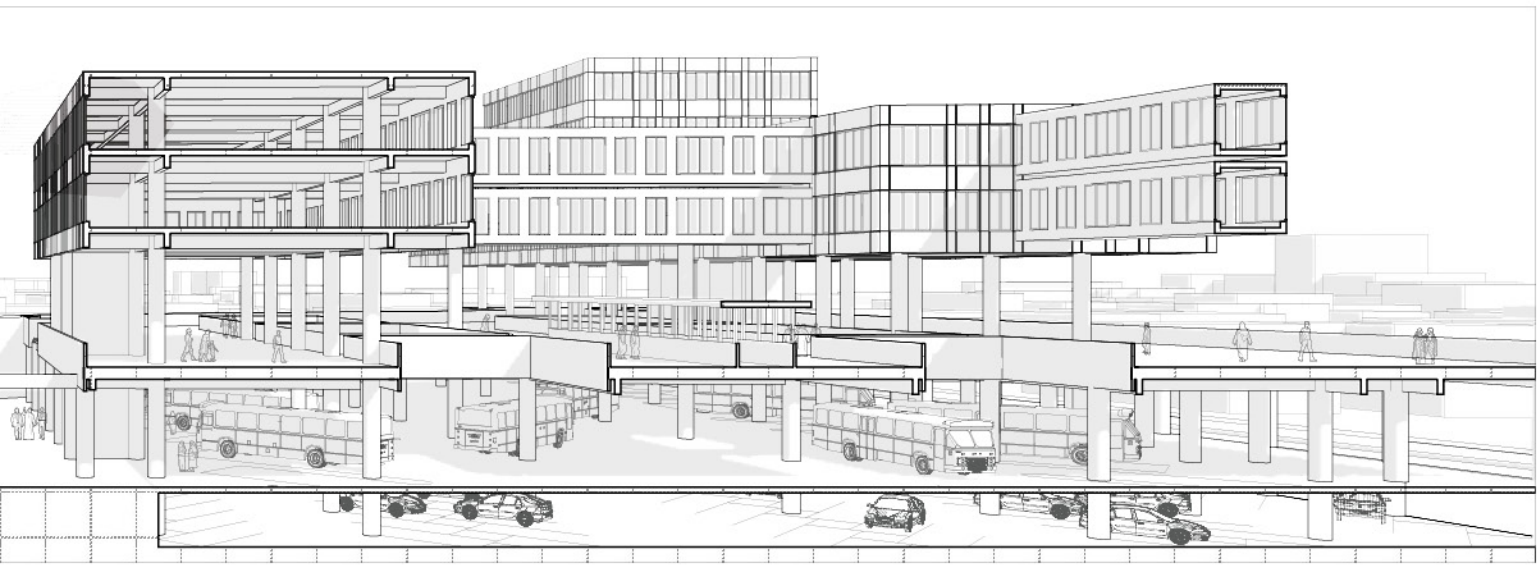


IMAGE CREDITS

Figure 1,2: Created using World Resources Institute Aqueduct Water Stress Projections Data

Figure 3,4,6: Created using Ground Water Yearbook 2016-17, Rajasthan State

Figure 5: Created using Lehner, B., Verdin, K., Jarvis, A. (2008): New global hydrography derived from spaceborne elevation data. Eos, Transactions, AGU, 89(10): 93-94

Fieldwork images on Pages 10-11, 16-17, 22-23, 26-27: Research Team

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Page 30-31: Adrian Evans
Page 32-33: Walid Shahin
Page 34-35: Austin Hogans
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