Return of the Lake:
Repairing Mexico City's Relationship to Water

by

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CONTENTS

ABSTRACT

Mexico City originated as an island city founded in a vast lake system. Today, the lakes have been desiccated and the city is unable to alleviate the thirst of 21 million people. Water infrastructure is failing; the efficient movement of water has become the goal without thought to social forces, traditions or the specificities of place. Both the city and its citizens are disconnected from the natural water cycle.

This thesis considers the reintroduction of a lake into the drained lake bed as a way to promote hydrological recovery and reconnect water, people and the city to its origins. The design argues that the strategic design of water infrastructure, public space, landscape and social programmatic elements can engage inhabitants with the lake. This new water infrastructure adds resiliency to the existing system while also harnessing the atmospheric qualities of water, giving visibility to water treatment and distribution.

ACKNOWLEDGEMENTS

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Finally, thank you Ben for your endless love and support.

CHAPTER 1: INTRODUCTION

> Water has been the deepest of concern to man as long as he has existed. The control he has exercised over it, the forms he has caused it to take and the meaning of those forms could lead to a cultural history of man.[1]

This is the first urban century in human history. For the first time, more people live in cities than in rural areas. Water scarcity is a growing concern in cities across the world, especially considering future implications of climate change. The United Nations identifies water as "at the heart of adaptation to climate change, serving as the crucial link between society and the environment."[2] In many places, lack of access to water and overconsumption can be seen side by side and highlight socioeconomic disparities that exist in society. Many cities and their citizens are disconnected from the natural water cycle. This suggests that a new approach to water management is needed in cities that have abused their relationship to water and that water infrastructure itself might be re-imagined.

In *City of Flows,* Maria Kaika argues that in the past, people's experience of the water supply was more visceral, social, and public.[3] Charles Moore similarly writes, "water has become increasingly domesticated and decreasingly appreciated…designs involving water and architecture must remind people of this dual impact that water has on our lives." This duality is our physical need for water and its place culturally and spiritually as a source of recreation, wonder, and beauty. Moore continues, "its [water's] use in architecture should reflect the attitude about the natural world

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1 Charles Moore, "Water and Architecture" (PhD diss., Princeton University, 1957), 2.

2 United Nations, "Water and sustainable development International Decade for Action 'Water for Life' 2005-2015." 2018. http://www.un.org/waterforlifedecade.

3 Maria Kaika, *City of Flows: Modernity, Nature, and the City* (Hoboken: Taylor and Francis, 2012), 59.

held by the people who design, construct, and inhabit the building."[4]

Mexico City is a prime test site for an exploration into new possibilities for water infrastructure, as a dense urban landscape and the most populous city in North America. The city is facing water scarcity exacerbated by crumbling infrastructure, excessively paved urban spaces, over-pumping of aquifers, and immense energy inputs to transport remote sources of freshwater to the city. Lack of water security has significant social implications: many must carry and store water daily, some rely on water trucks, and many must deal with issues of contaminated water. In light of these issues, this thesis questions: in Mexico City, can additional meaning be embedded in

Collage considering the imaginative qualities of water.

4 Moore, "Water and Architecture," 198.

water as a shared public resource, and can the water management system achieve additional resiliency, through a new architectural interface between water infrastructure and public life?

Many other cities globally have also abused their water resources leading to a disconnection between people, the built environment, and the natural water cycle. In Mexico City, this disconnect is specific. The drainage of Mexico City's lakes has led to a broken relationship with water in the city. However, the city is unique in that there is potential to work with the existing environment toward hydrological recovery.

The drainage of Lake Texcoco is emblematic of the city's relationship with water. This drained lake bed is now a vast barren area that the city has grown around. This thesis builds on the work of many who have questioned the drainage paradigm of Mexico City and imagined the possibility of lake reintroduction (including early work in the 1960s by engineers Nabor Carrillo and Gerardo Cruickshank and later work by architects Teodoro González de León and Alberto Kalach). Kalach's team investigated the broader environmental and social implications of lake reintroduction. They also developed a controversial design for a new international airport on an island in the lake. This work moves further to imagine how combining architecture and water infrastructures (water treatment processes) can address the return of water to the lake. This work looks at the edge condition of the recreated lake and the relationship between the urban environment and people at several scales of investigation: from the territorial scale to a specific study of water in the city of Neza, to a focused community site. The design explores how architecture can engage people with water through buildings and landscapes that connect the city to the lake.

The project also argues that water infrastructure can contribute

to hydrological recovery in the city while also harnessing the experiential, atmospheric, and imaginative qualities of water. In the design, people engage with water through programmatic elements and are exposed to water through sensory experiences (with shifting views and physical positions to water to capture haptic, auditory and visual experiences) as they sit, circulate and experience the site. They also experience water through the tectonics of the design; materials and architectural details that signal to people the flows and presence of water.

The thesis proposes the recreation of the lake's edge, that couples water treatment facilities with public programs informed by the specific needs of each community. In the city of Neza, a community garden space, a market, and a public library are paired with the water infrastructure system creating visibility and connectivity to the traditionally hidden system of water treatment and distribution. The conceptual design of a water treatment facility that serves as a public building argues for architecture based on experience, and the less tangible traces of memory of the city's lacustrine past. The site acts as a connector, linking the community, socially and environmentally, to their water and history. Thus, architecture can enable a new relationship to water in the city; increasing knowledge, awareness, and a sense of agency over water resources and reintegrating water into community life.

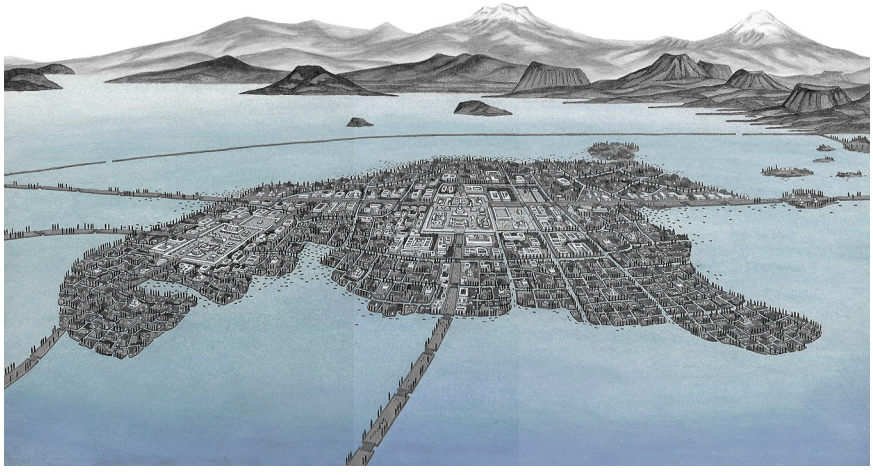
CHAPTER 2: HISTORY + CONTEXT

History of Lake Drainage: Water and the City of Tenochtitlán

Mexico City now occupies what was once a network of lakes. The valley contained five lakes that swelled in size during the rainy reason and became linked. To the South, Lake Chalco and Xochimilco were at a higher elevation. These freshwater lakes, filled by springs and rivers, drained into the lower lake of Texcoco, which contained brackish water due to mineral deposits.

In 1325 the Aztecs (or Mexicas as they called themselves) established the city of Tenochtitlan on an island in the middle of Texcoco Lake. The city grew as atolls were formed and then filled in over generations to make a larger island. The city had a sophisticated water management system that included canals, causeways, aqueducts, and gardens (see diagram on page 6).[5]

The garden islands created in the lake, *chinampas*, were used for intensive agriculture. These parcels of land were made from piling



The urban layout of ancient Tenochtitlán. Base image by Luis Covarrubias, *View of the Valley of Mexico*, ca. 1964, from Collection of Museo Nacional de Antropologia, Mexico City.

5 Barbara E Mundy, *The Death of Aztec Tenochtitlan, the Life of Mexico City* (Austin: University of Texas Press, 2015), 35-39.

Map of lake network and Mexica settlements including Tenochtitlán c. 1500s. Base map from: Deborah Nichols, Hector Neff, and George L. Cowgill. “Cerro Portezuelo: states and hinterlands in the pre-hispanic Basin of Mexico.” *Ancient Mesoamerica* 24, no. 1 (2013): 47-71.

dredged soil into a structure created by a border of sunken posts secured with trees at the corners. The dredged areas became canals used for transportation by boat. The *chinampas* were seen as a microcosm of the city itself – artificially created land surrounded by water.[6] In the Xochimilco region, to the south of the city, *chinampas* are still used for agriculture today, and the area is recognized as a UNESCO world heritage site.

In the 1420s the Mexica built a raised causeway that served as a dike spanning a natural bottleneck. The dike was a complex system with the island city at its center. Networks of east-west canal routes were dug through the city that included removable barriers for water flow and the passage of canoes. Waterworks continued, and in the 15th century, a freshwater zone was created in the west part of Lake Texcoco (Laguna de Mexico). This area was at a slightly higher elevation from the rest of the lake. It was fed by rivers and springs – which made the water sweeter over time. This area essentially became a reservoir separated from the more brackish water of

Detail of mural depicting the city of Tenochtitlán. Diego Rivera, *La Gran Tenochtitlan*, 1954.

6 Ibid., 35.

Xochimilco, 1950; photograph by Huan Rulfo.

Frida Kahlo at Xochimilco, Mexico, 1937; photograph by Fritz Henle.

Xochimilco in 20th Century, 1910; photograph.

the rest of the lake by the dike.[7] In the rainy season, it contained openings to allow the overflow of water to drain to prevent flooding in the city.

In The Death of the Aztec Tenochtitlán, the Life of Mexico City, Barbara Mundy analyses historical illustrations of the city and landscape. She writes, “Representations of space like the Map of Santa Cruz reflected the lived spaces of the city, like those great water-works and networks of roads and canals that we see on the map, and the artists’ attentiveness to the dikes and understanding of the separations of water indicate how widespread knowledge and appreciation of this infrastructure were…we have also seen how daily experience and practice taught the Mexica that they lived in an environment of lightning, thunder, drops of rain, and flows of streams.”[8] The Mexica combined sophisticated water management structures with a knowledge and appreciation of the natural environment.

Mundy argues that waterworks, their construction and control, were linked to rulers. Many scholars have discussed theories of the development of power through the control of water, such as sociologist Wittfogel’s theory of universal “hydraulic societies.”[9] In Mexico, the struggle to control water, and thus people, became even more pronounced with the arrival of Cortez. Mundy argues that there was an intricate relation between the conquest state and the hydrological state. After the Spanish conquest, lakes, rivers, and canals were drained, and the surrounding area was deforested to create a more typically European settlement.

While drainage started during Spanish colonial times, efforts to drain Mexico Valley continue to today. The drainage system is colloquially

7 Ibid., 37.

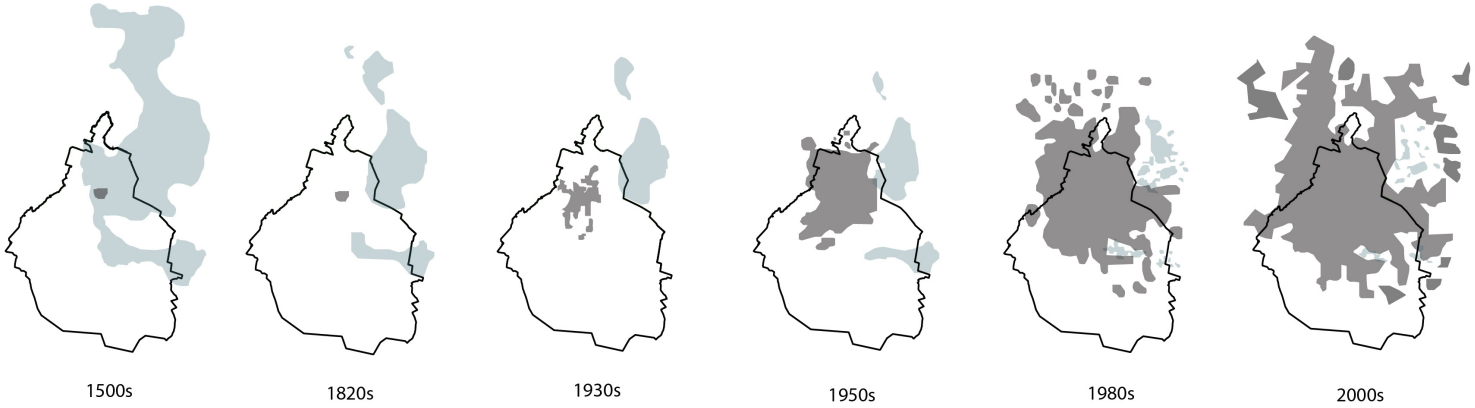
8 Ibid., 42.

9 Ibid., 27.

Detail of the Santa Cruz map showing Mexica interaction with water (transport, fishing, swimming, etc). The more turbulent water beyond the dike is green while the canal water of the city behind the dike is more blue. *The valley and city of Mexico in 1550*, 1948, from The Ethnographical Museum of Sweden, Stockholm.

known as the *Drenaje Profundo* (an underground system of tunnels, emitters, and pipes that carry wastewater and rainwater out of the city). Architect V. Mitch McEwen wrote about this process, “Drenaje Profundo reshaped Texcoco Lake in service of a certain idea of ground. It aimed to prepare the city for its complete territorialization by automobiles and tall buildings—both idealized as existing on foundations of firm, dry land.”[10] As the lake disappeared, the city grew.

10 V. Mitch McEwen, “Profound Modernity,” *E-flux architecture journal* (Oct. 5, 2017). https://www.e-flux.com/architecture/positions/156858/profound-modernity/.



The disappearance of Mexico's Lakes mapped against the growth of Mexico City. Data from: Edvardo Marin Salinas, *Towards a Water-Sensitive Mexico City*.

The Current Crisis

Today, Mexico City simultaneously has issues of too much water, causing flooding, and water scarcity, which creates an unreliable water supply. Areas of the city receive between 600 to 1,500 millimeters of rainfall annually.[11] Despite these rainfall amounts, the city relies heavily on its aquifers which are being drawn down at a faster rate than they are being replenished (aquifer extraction rate of 60 m^3/s vs. a recharge rate of 32 m^3/s).[12] Currently, the city gets over 60% of its water from overdrawing its aquifers.[13] The draining of the aquifer is causing dramatic land subsidence as the clay beds collapse as water is drawn out.

The wealthier areas of the city use more water and have a more reliable supply. Over 20% of citizens do not get reliable water and need to use *pipas* (water trucks) to fill cisterns.[14] Lack of water security has significant social implications: many must carry and store water daily, some rely on water trucks and many deal with contaminated water. The burden of procuring water disproportionately affects women who are often the ones required to collect water. Many women must wait for water truck deliveries (affecting their ability to work), haul water or wait for intermittent access at the tap.[15]

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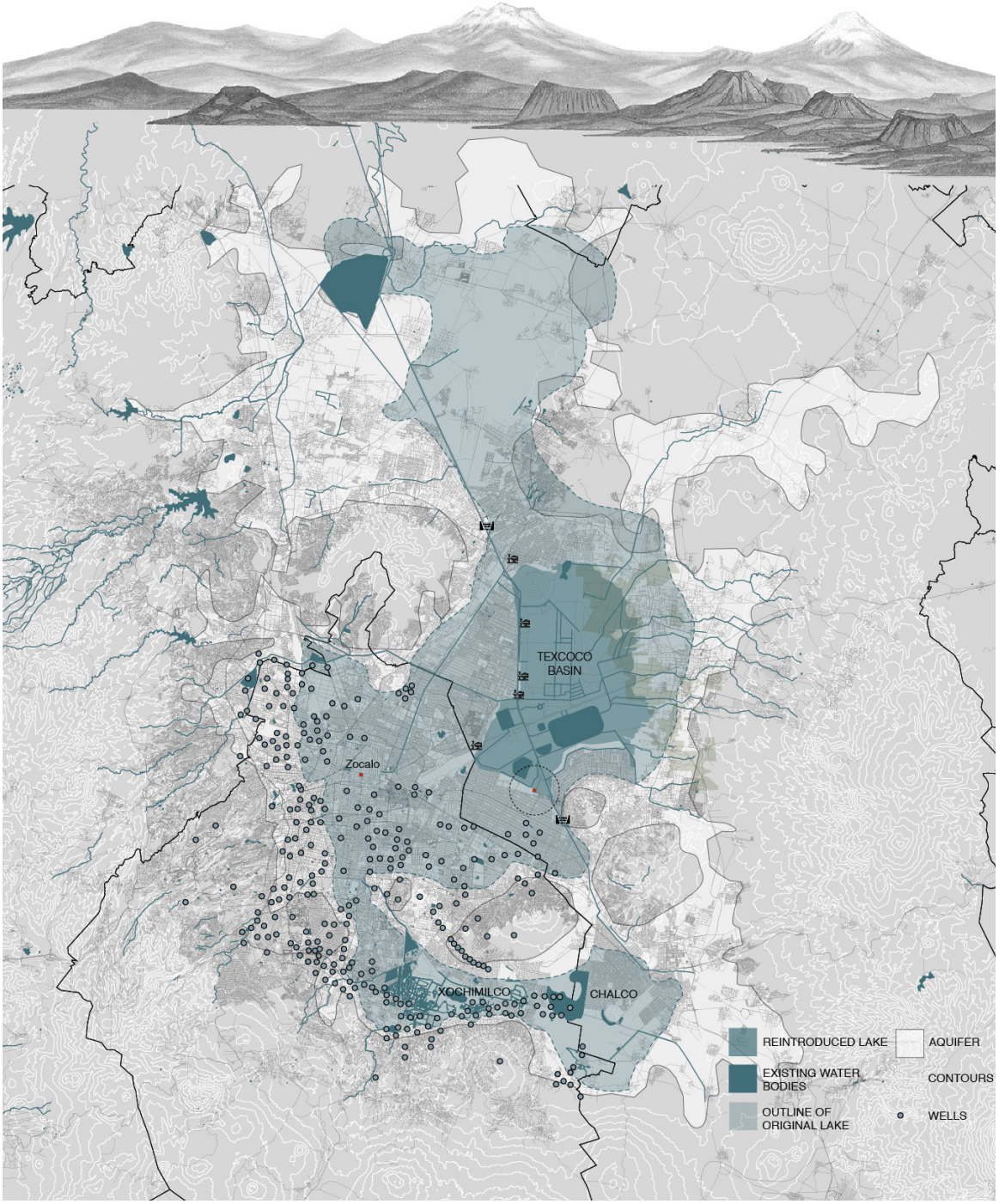
11 Edvardo Marin Salinas, *Towards a Water Sensitive Mexico City*. (Rotterdam: De Urbanisten, 2016), 50. https://www.deltares.nl/app/uploads/2018/01/20160629_WS-CDMX_final-version-report-smsize.pdf.

12 Marin Salinas, *Toward a Water Sensitive Mexico City*, 82.

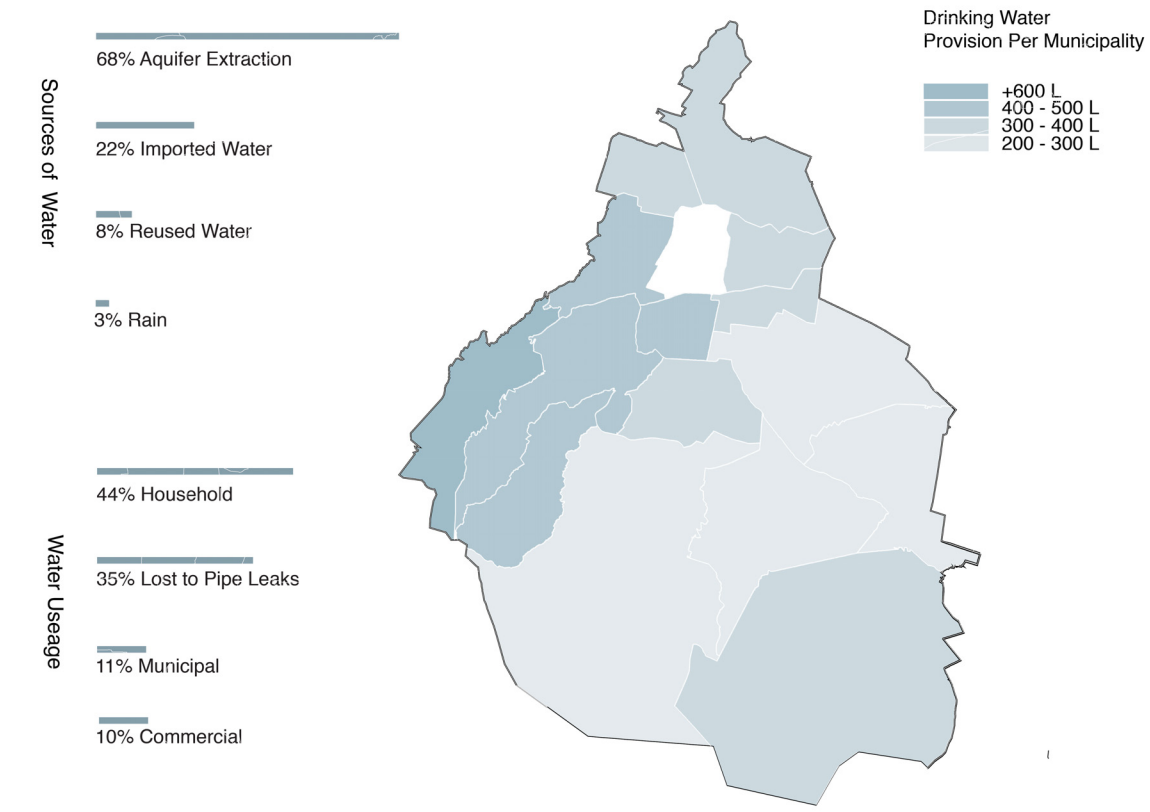
13 Ibid., 70.

14 Michael Kimmelman, “Mexico City, Parched and Sinking, Faces a Water Crisis,” *The New York Times*, Feb. 17, 2017. https://www.nytimes.com/interactive/2017/02/17/world/americas/mexico-city-sinking.html.

15 Jonathan Watts, “Mexico City’s water crisis – from source to sewer,” *The Guardian*, 2015. https://www.theguardian.com/cities/2015/nov/12/mexico-city-water-crisis-source-sewer.



Map showing outline of ancient lake network and potential site for lake reintroduction. Data from: Edvardo Marin Salinas, *Towards a Water Sensitive Mexico City*, INEGI National Institute of Statistics and Geography of Mexico.



Current sources and uses of potable water in Mexico City and drinking water provision by municipality. Data from: Edvardo Marin Salinas, *Towards A Water Sensitive Mexico City*. Base map from: INEGI National Institute of Statistics and Geography of Mexico.

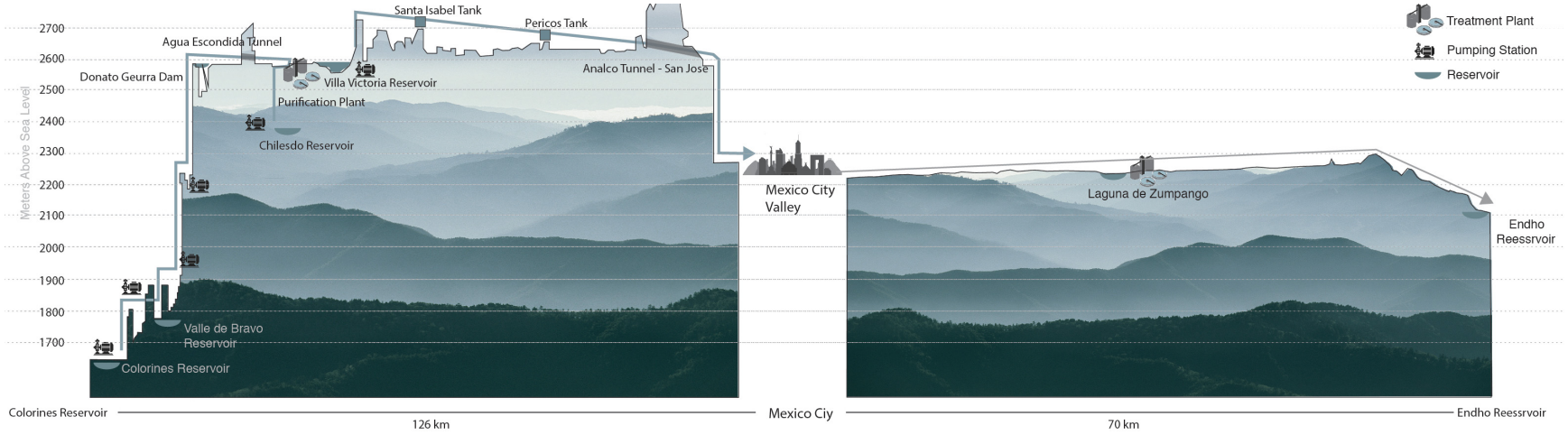
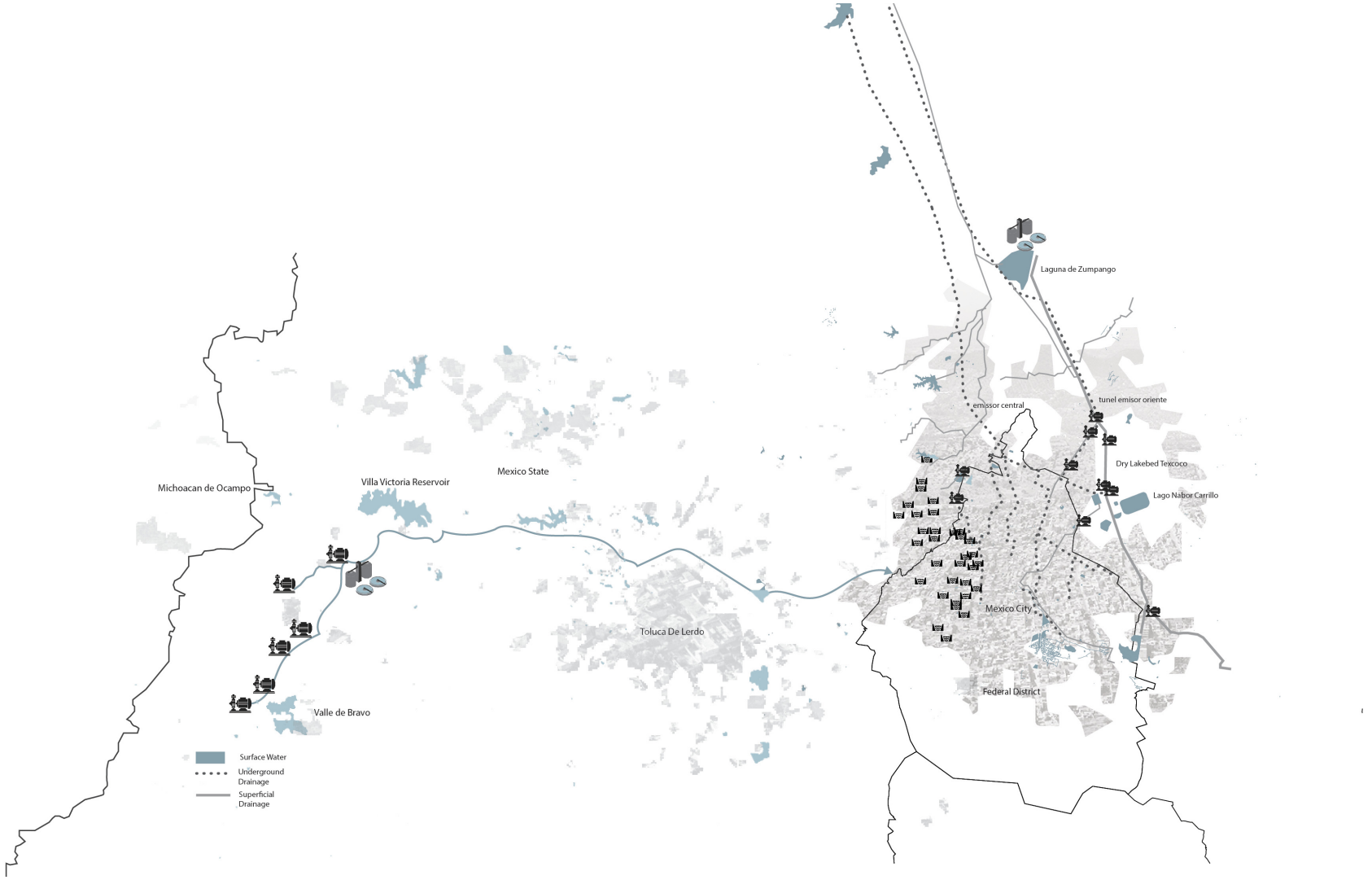
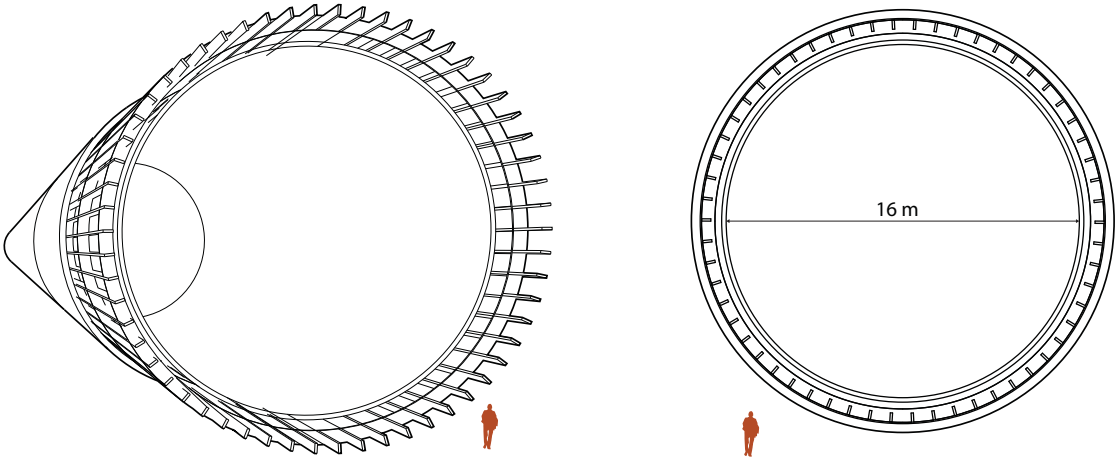


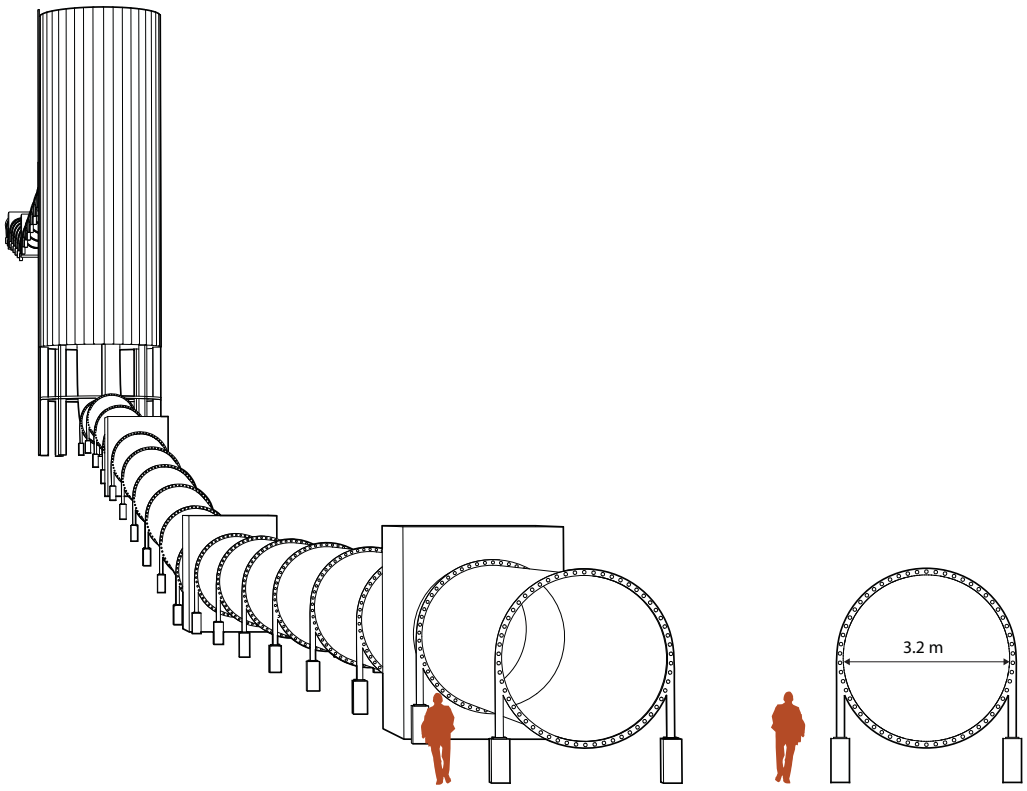
Diagram showing elevation profile for water pumped into and out of Mexico City. Data from: Cecilia Tortajada, “Water Management in Mexico City Metropolitan Area.” *Water Resources Development,* 2006.



Map showing the source location for water pumped into Mexico City as well as where waste water is pumped out of the city. Data from: Cecilia Tortajada, “Water Management in Mexico City Metropolitan Area.” *Water Resources Development*, 2006.



Emisor Oriente drainage tunnel - moves water out of city



Culzamala tunnel - moves water to the city

Diagram of Culzamala system and Emisor Oriente system. Based on diagrams from: Felipe Correa and Carlos Garciavelez Alfaro, *Between Geometry and Geography*, Applied Research & Design, 2014, 264.

Mexico City has no large-scale operation for recycling wastewater or collecting rainwater – they expel 200 billion gallons a year of both. Paradoxically the city must pump 40% of its water from remote sources, 40% of which is lost to leaks and pilfering.[16] Pumping this water (up to a mile in elevation) is incredibly energy-intensive, using as much energy as could power a city of 3 million.[17] The city is also woefully unprepared for a drought - heightening social tensions within the city. Some areas such as Iztapalapa and Xochimilco have further issues of contaminated water.

The former environmental minister Ms. Sheinbavia has said of the water issues that plague the city, “We have the resources but lack the political will.”[18] The city under-funds critical infrastructure projects while it is also in the midst of constructing lavish new public projects including, a new airport by Norman Foster. The city has been called “an intense mixture of seductive cosmopolitanism and the failures of urban modernism.”[19]

Regional Water Concerns

Various regions of the city have been identified as having unique water-related issues with different solutions and approaches. These six zones were identified and described in the report, “Towards a Water Sensitive Mexico City.” Each area of the city is identified with its corresponding water-related issues, main water-related goals, and possible interventions (see diagram on page 20).

16 Kimmelman, “Mexico City Parched and Sinking.”

17 Shumi Bose, “Meet the architect who wants to return Mexico City to its ancient lakes,” *The Guardian*, November 13, 2017, https://www.theguardian.com/cities/2015/nov/13/alberto-kalach-return-mexico-city-ancient-lakes.

18 McEwen, “Profound Modernity.”

19 Ibid.

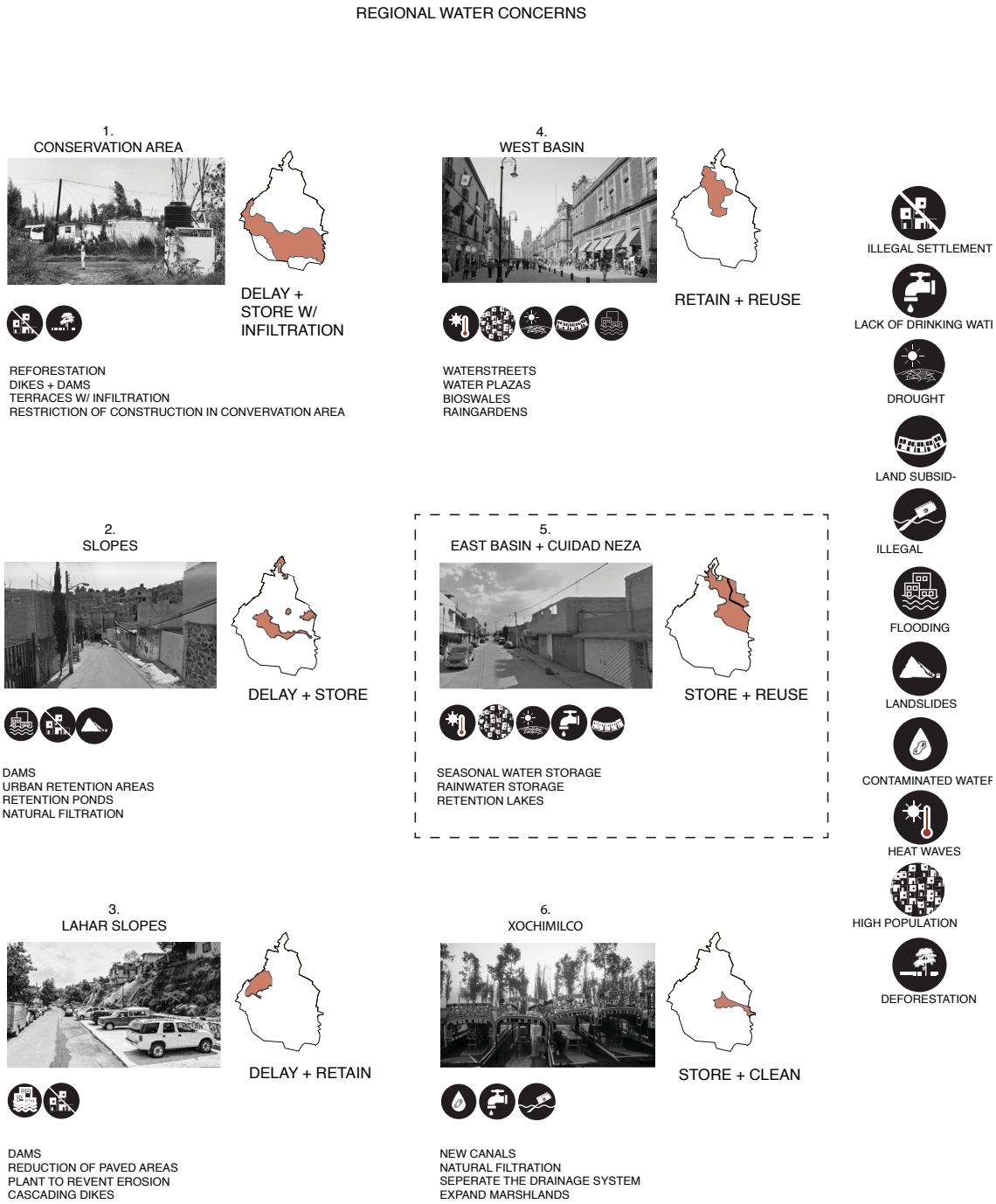


Diagram of water-related issues, goals and possible interventions. Data from: Edvardo Marin Salinas, *Towards a Water Sensitive Mexico City*.

CHAPTER 3: CITIES + WATER

Where is ground level after all, where is terra firma? Hard to tell. Instead there is a strange sensation of hovering in a zone of water and sky as the earth drifts somewhere in the mix. [20]

Not all cities have sought to eliminate water from the urban environment to the same extent as Mexico City. Most cities do seek to control the environment, including water, in order to facilitate settlement, development, and public health. The origins of the urban structures of many cities are linked to early methods of controlling water. Water flowed in canals, was ditched and drained, or covered over and in-filled. Copenhagen and Venice are examples of cities organized around water with architecture and urban design that responds to its presence. Venice, like Mexico City, is built within a lagoon/lake and Copenhagen is a port city on a river. In both these cities, water has a historical resonance that has impacted the aesthetics and development of the built environment. It has also influenced how people engage with water in their daily lives.

Historically, Mexico City too was on water with a direct relationship to a vast lake network. The drainage of Mexico's City's lakes is a result of the city's specific colonial past, relating to a Spanish ideal of land settlement and agriculture. However, it is interesting to consider other paths the city may have taken if not for the drainage paradigm that was instituted.

In 2015, the Mexican Pavilion at the Venice Biennale, *Possessing Nature*, by artists Tania Candiani and Luis Felipe Ortega contemplated the link between Venice and Mexico City – the "City of Canals and City of Drains." From the curator of the exhibit, "The curatorial concept juxtaposes Mexico and Venice as "amphibious cities." While one embraces the sea, the other is dried out and its

20 Michael Cadwell, *Strange Details* (Cambridge, MA: The MIT Press, 2007), 33.

lakes are exhausted under the imprint of colonial sovereignty... the result is a trace that refers to the history of architecture and infrastructure, as well as its relation to political, economic, religious and military powers that have supported the Western Empire from its origins."[21] While Mexico City, Venice and Copenhaggen all were cities on water, the imposed drainage paradigm of Mexico City means that the city developed a very different relationship to water.

Venice is a city that's built environment is inextricable from water. The city is made up of series of islands within a boggy lagoon and contains 118 islands separated by canals and connected by over 400 bridges. Huge investments in infrastructural systems were needed in order to create the city and canal system within the lagoon. Transport in the city is by water (even public transit) or on foot. Venice proposes a differing urban example from typical car-centric cities; its waterways and urban form make it the largest car-free urban area in Europe. The integration of water into cities may open up new possibilities for how we structure cities including transport, circulation, and public space.

The waterways of Venice and its lagoon were integral in developing the city's public spaces. Many of the buildings bordering the canals were constructed pragmatically to be in dialogue with the water's visual and spatial properties. Carlo Scarpa, at the Fondazione Querini Stampalia, played with the interaction of building and water by inviting water to enter the building from the Venetian canal beyond through metal portal gates. He also used two addresses: one for boats (that responds to different water levels and seasonal flooding) as well as one from the street (via a pedestrian bridge). Scarpa's integration and elaboration of details and materials in

21 Karlo Jasso, "Tania Candiani and Lousie Felipe Ortega Will Represent Mexico in Venice 2015," *Biennial Foundation,* last modified Dec. 2, 2014, http://www.biennialfoundation.org/2014/12tania-candiani-and-luis-felipe-ortega-will-represent-mexico-in-venice-2015/.

the building emphasize the city's infrastructure and shows the adaptability to a changing environment.

In Venice, buildings (as well as paths, roadways, and plazas) are built on pile structures. Wooden piles reach through the water, then a layer of sand and mud, finally reaching a hard layer of compressed clay. The wood used for the piles decays slowly in water, and many

Pedestrian bridge to the Plazzo Querini Stampalia, 2016; photograph.

Water entering into the entrance of the Plazzo Querini Stampalia, 2016; photograph.

piles have been in place for hundreds of years. Limestone rests on top of the closely spaced piles, and buildings (most in brick or stone) are built on this foundation. Venice is an example of a city that's built environment works with its water environment - resilient to the changing water levels and designed to work with the silty soil of the lagoon.

Copenhagen is similarly a city in dialogue with water. The city is surrounded by water, split in half by a harbour and intersected by canals. The physical relationship to the Baltic Sea has shaped the city's built environment, social activities, and public spaces. Bridges span the canals of the city, connecting the many islands of developed land. The canals are multiuse, used for boat traffic as well as floating offices and residences.

The city has actively sought to integrate water into the daily lives of its citizens. The contaminated water of its harbour (in the past it ejected raw sewage into the water body) has been remediated. The harbour is now safe enough for both food production (the harvesting of local oysters) and recreation. The city has four harbour baths, which have made the habour a destination for recreational

Harbour bath in Copenhagen. Copenhagen Harbor bath, 2014; photograph by Linda Kastrup.

swimming (the first Islands Brygge, opened in 2002). Islands Brygge brought public interaction with water to a central, downtown location and was designed by JDS Architects and Bjarke Ingels Group. In Copenhagen, this layered interaction of water in the city, for transport, food production, and recreation, relates to a more traditional relationship between cities and water.

Venice and Copenhagen can provide insights into how cities (people and the built environment) can relate to water. The proposed return of the lake in Mexico City allows for imagining a new relationship between the current built environment and water while also contemplating the historical resonance of water in the city.

The Changing Relationship of Water to the Built Environment

As modern states developed, water became a significant area of interest due to its impact on public health, agriculture, power generation, and flood control. The control and distribution of water became crucial for the growth and development of cities. In *The Fabric of Space*, Mathew Gandy argues that water, connected with infrastructure, is the organizational element that underpins the functional dynamics of urban space.[22]

Historically water infrastructure was central to urban centres as an essential part of daily life. In ancient Rome, public fountains supplied water to the masses, and public baths became social centres. In India, stepwells were both spiritually laden and social areas for washing and gathering water. These spaces engaged socially and symbolically, through ritual, and architecturally, though topography and the control of water flow. They also emphasize experiential qualities of water through the senses (i.e., fountains

22 Mathew Gandy, *The Fabric of Space* (Cambridge: MIT Press, 2014), 2.

create white noise or step wells stimulating the haptic senses through washing and bathing). The architecture of historic water infrastructure expressed the importance of water in the city. In pre-colonial Mexico, water was weaved into the fabric and structure of the city, public life, and religion. Later, in colonial times, public fountains and aqueducts became tied with ideas of colonial power and public spectacle.

The rise of industrialization brought many challenges, from over-crowding to sanitation issues. The result was a public health crisis that necessitated the modernization of the water supply in the mid 19th century. Elisabeth Heidenreich, in her work *Fluids* argues that the development of water infrastructure networks corresponded with a shift toward the individualized experience of modernity.[23]

As cities expanded indoor plumbing, private and public realms were regularized and separated. Maria Kaika writes that in developed countries water has disappeared from the public realm corresponding with the modernist concept of hidden urban infrastructure and the "self-sufficient domicile."[24] Georges Vigarello similarly argues that modern cities were established on this very concept of hidden infrastructure.[25] In most developed countries, water infrastructure remains unseen until there is a failure (broken pipes, flooding, etc.).

With this shift of water's dwelling place from public space to domestic space, social aspects of water collection and usage have been removed from public life. Kaika writes that modernity produced nature (water) as a commodity and made it part of modern life, while simultaneously conceptually constructed nature as externalized

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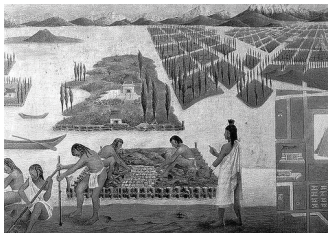
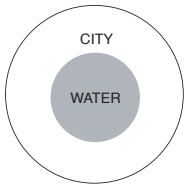
23 Elizabeth Heidenreich, *Fluids: The Networking of Nature, Space and Society Since the 19th Century* (Berlin: Campus Verlag, 2004), 13.

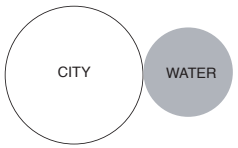
24 Kaika, *City of Flows*, 59.

25 Gandy, *The Fabric of Space*, 14.

Pre-Colonial	Colonial	Industrialization	Modern Movement	Contemporary
RELIGION + SUBSISTENCE	POWER + SPECTACLE	INDUSTRY + PUBLIC HEALTH	CONVENIENCE + SELF-SUFFICIENCY	COMMODIFICATION + CAPITALISM







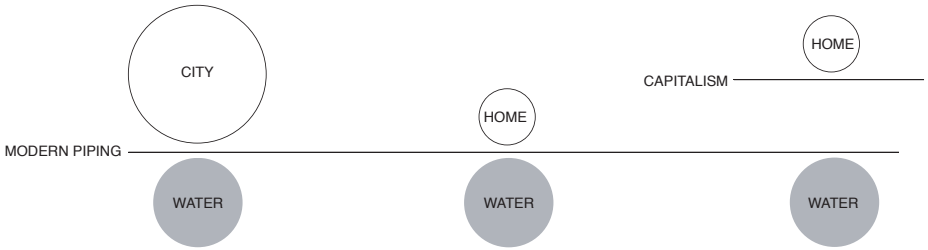


Diagram of the evolving relationship between water + built environment.

"other."[26] Thus, in many places, water was seen as a threat, to be wholly removed from cities. This is true in Mexico City, where much of the water that enters the city as rain is immediately ejected.

Today, water is increasingly identified as a commodity tied to a monetary value. In some cases, water is becoming a geopolitical tool (hydro-politics) similar to hydrocarbons. This can conflict with democratic ideals about access to safe drinking water. In 2010, the UN formally acknowledged water as a human right: "The human right to water is indispensable for leading a life in human dignity. It is a prerequisite for the realization of other human rights."[27] This tension between water as a public resource and commodity erupted in early the 2000s with the Cochabamba Water War in Bolivia. The public protested the privatization of their water supply (and subsequent water fee increases) leading to clashes with the government. In *The Fabric of Space*, Mathew Gandy goes further to suggests that in the future efforts to discover "unconventional water" will be similar to extraction efforts of unconventional hydrocarbons.[28]

If the design of water infrastructure over time reflects societies shifting ideas about water, then how can design affect society's value of water? This thesis argues that the architecture of waterworks should reinforce that water is a public amenity and convey ideas of stewardship, care, and universal access through education and public engagement.

Infrastructure + Drosscape

The development of modern water infrastructure, while improving sanitation and public health, has also had unforeseen impacts on the fabric and structure of cities. Allen Berger uses the term

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26 Kaika, *City of Flows*, 57.

27 United Nations, *Water and Sustainable Development.*

28 Gandy, *The Fabric of Space,* 12.

drosscape to describe wastelands created by sprawl or industrial or infrastructure processes.[29] Drosscape shows that infrastructure often fails to effectively mediate the boundary between industrial spaces, natural spaces, and human habitation. Frequently infrastructure produces unused or "leftover" space in the city due to its mono-functionality and its separation from the "lived" aspects of the city. Joan Busquets refers to this separation as "the fatal duality of architecture and infrastructure."[30] Drosscape, terrain vague, and liminal spaces are all ways to describe these interstitial areas of the urban metropolis. In the past, these areas have been seen as problematic yet they have potential to restructure and re-imagine the city.

Water infrastructure, as stated above, has become hidden (in the case of the vast plumbing and drainage networks), unacknowledged (in the case of reservoirs) or inaccessible (in the case of large fenced off water treatment facilities). The efficient movement of water has been the primary goal of city planners without thought to the relationship water once had with the cultural and social traditions of a place. In their essay *Generica*, Kwinter and Fabricius write about the purely functional development of urban infrastructures, "What emerges more and more is a developmental ethos that does not hesitate to declare itself a kind of new mathematical sublime: this landscape, with its engineered berms, boxes, piles, glacis, and equipment parks, offers itself as the pure, one-dimensional result of numbers, algorithms, and protocols crunched…elsewhere."[31] Thus, infrastructure becomes disconnected from the place, context, and people it is meant to serve.

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29 Alan Berger, *Drosscape: Wasting Land in Urban America* (New York: Princeton Architectural Press, 2006), 12.

30 Joan Busquets, "New Urban Phenomena and a New Type of Urbanistic Project," in *Present and Futures. Architecture in Cities* (Barcelona: Centre de Cultura Contemporània, 1996), 286.

31 Rem Koolhaas et al., *Mutations* (Barcelona: Bordeaux, France: ACTAR Arc En Rêve Centre d'architecture, 2000), 13.

Joan Busquets has written about internal voids in the city and suggests that rehabilitation of terrain vague can lead to new opportunities for amenities, parks, and infrastructure. He argues the city can rebuild itself from these “abandoned” spaces and that integration of diverse programs and functions in infrastructure can lead to new types of public spaces. He further suggests that these spaces that evolve from terrain vague should embed collective value and culture.[32] This suggests that in Mexico City, the drosscape created through the drainage of the lake network has the potential to be rehabilitated into a new public space that can have cultural significance.

Landscape + Water Infrastructure

In Mexico City, the entire built environment is constructed on land created through the human act of drainage. The Spanish began the erasure of the lake through processes of infilling and draining that replaced the connected islands that made up Tenochtitlán with a gridded city. Causeways and canals were infilled to create land for cattle and roads, and attempt to (unsuccessfully) mitigate flooding. Over time, the multipurpose canals of Tenochtitlán turned into underground sewers with roadways above. The further mechanization of the water system increased the rate of lake drainage and created a vast drosscape that is the subject of this thesis work.

In some areas of the world, such a the Netherlands, the drainage and creation of land have led to, arguably, productive land. The word landscape comes from the Dutch *landschap* meaning a “unit of human occupation”; connected to the drainage and regularization of land.[33] In the case of Mexico City, much of the drained land

32 Busquets, *Present and Futures: Architecture in Cities*, 286.

33 Gandy, *The Fabric of Space,* 3.

was too expensive to remediate, was not productive and became drosscape. A resource, the freshwater of the lake and its related flora and fauna, was destroyed. However, there may be potential to use landscape as a means of restoring this resource.

There is a growing interest in what Gandy refers to as “re-wilding” of cities through landscape creation and restoration.[34] Some of these landscapes combine ecology with water infrastructure and are used to control flooding, encourage infiltration, and create water reservoirs. Infrastructures, with a compliment of public space and architectures can be a means for people to engage with and understand these new human-formed landscapes (such as constructed wetlands for treating wastewater or stormwater).

In this thesis, the reintroduced lake will form a network of landscapes along its 80 km coastline. These new environments transition from an urban condition on the east side of the lake to a rural one on the western edge. Architecture can shape the experience of these landscapes and sensitize people to water in different ways.

A New Identity for Water Infrastructure

A new way of thinking about water infrastructure is needed in cities that have a broken relationship with water. In *The Fabric of Space*, Mathew Gandy writes that we should, “rethink the flow of water through urban space at different spatial scales, ranging from individual households to more complex communities negotiations.”[35] Thus, a layered approach that considers how decentralized mechanisms can add to the overall resiliency of systems should be employed. The specificity of the city (its ecology, culture, built environment) would then tailor the system of interventions.

34 Ibid., 17.

35 Ibid., 16.

This idea of layering can also apply to an overall way of thinking about water as a system. This system can incorporate traditionally conflicting ideas: bridging scientific and traditional knowledge, infrastructure and ecology, community space, and resource delivery. Water Infrastructure can encompass both buildings (such as water treatment facilities) and landscapes (constructed wetlands, source water) that are more than singularly functional and but are programmed, visible, and accessible.

In the dense urban setting of Mexico City, these buildings and spaces can become centers (either recreational, educational, or cultural) that alleviate the infrastructural needs and benefit the surrounding communities. Following this layered approach, interventions in the city should relate to the specific needs and opportunities of each area.

CHAPTER 4: LAKE REINTRODUCTION + SITE

The Lakes Project

This thesis considers the reintroduction of a historic lake as a means of moving closer to hydrological recovery in the valley of Mexico City. The contemporary origin of the project to recover the lakes of Mexico City was a report written by engineer Nabor Carrillo in the 1960s. He suggested that the continual drainage of the lakes to avoid flooding was costly and ineffective. Instead, he envisioned the reconstruction of the city's lakes aggressively drained since the Spanish Conquest. Carrillo proposed the reconstruction of part of the original Texcoco Lake as a large water retention pond. This would allow the city to control flooding and contain treated wastewater.[36] The government enacted a portion of this proposal with the construction of a 2,500-acre basin on the drained basin of Texcoco lake – known as Laguna Nabor Carrillo. Later, two architects Gonzales de Leon and Alberto Kalach found Carrillo's

Nabor Carrillo Lake; photograph by Esther Rivas.

36 Amanda Reeser and Ashley Schafer, "México City : Projects from the Megacity." *Praxis: Journal of Writing Building* 1, no. 2 (2001): 14.

old report. A group assembled including activists, architects, engineers, soil mechanics experts, hydrologists, and geologists. In 1998 building on the original work of Carrillo they published *La Ciudad y Sus Lagos* a feasibility study on the lakes project. An understanding of the natural hydrology and current water usage in the city is needed to understand the potential impact of the lake in promoting hydrological recovery in the valley.

Hydrological Recovery

Currently, water usage in Mexico City follows a linear process. Water is pumped into the valley from a remote source, and wastewater and rainwater are pumped out of the valley to a different location to the north. Only about 15% of wastewater is treated[37]. Pumping water creates environmental issues in the water extraction areas as well as the areas that are receiving contaminated wastewater (used for irrigation of crops).[38] This highly mechanized process is very different from the natural flows of water in the valley.

Mexico City Valley is a naturally occurring endorheic basin, it does not drain into a subsequent watershed, and instead, water collects in lakes and equilibrates through evaporation. If the water source for Mexico City was located close to end-users in the valley, filled by natural rainfall (currently drained out of the valley), and treated wastewater, the water system could achieve additional resiliency and operate closer to a traditional endorheic basin.

The lake basin would act to both retain water and allow the infiltration of water to replenish groundwater sources. Using source water from the lake would also lessen the need for wells.

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37 Latin American Water Funds Partnership, *Water Fund Situation Analysis: Mexico City, (Mexico City: Anteagroup, 2017),* https://s3.amazonaws.com/tnc-craft/library/Water-Fund-Situation-Analysis-Mexico-City-21-August-2017-FINAL.pdf?mtime=20180107031306.

38 Watts, “Mexico City’s water crisis – from source to sewer.”

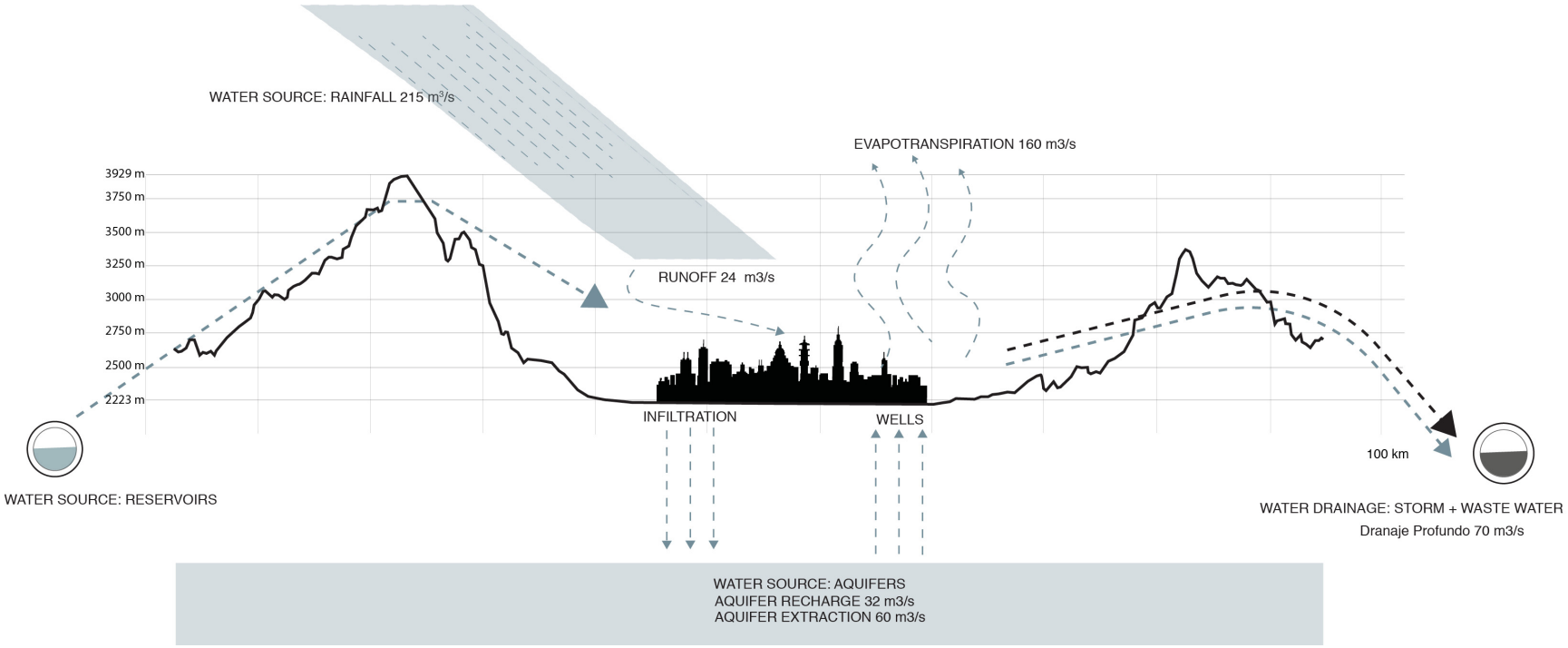


Diagram showing the water balance in Mexico City, characterized by intensive aquifer extraction. Data from: Edvardo Marin Salinas, *Towards a Water-Sensitive Mexico City*.

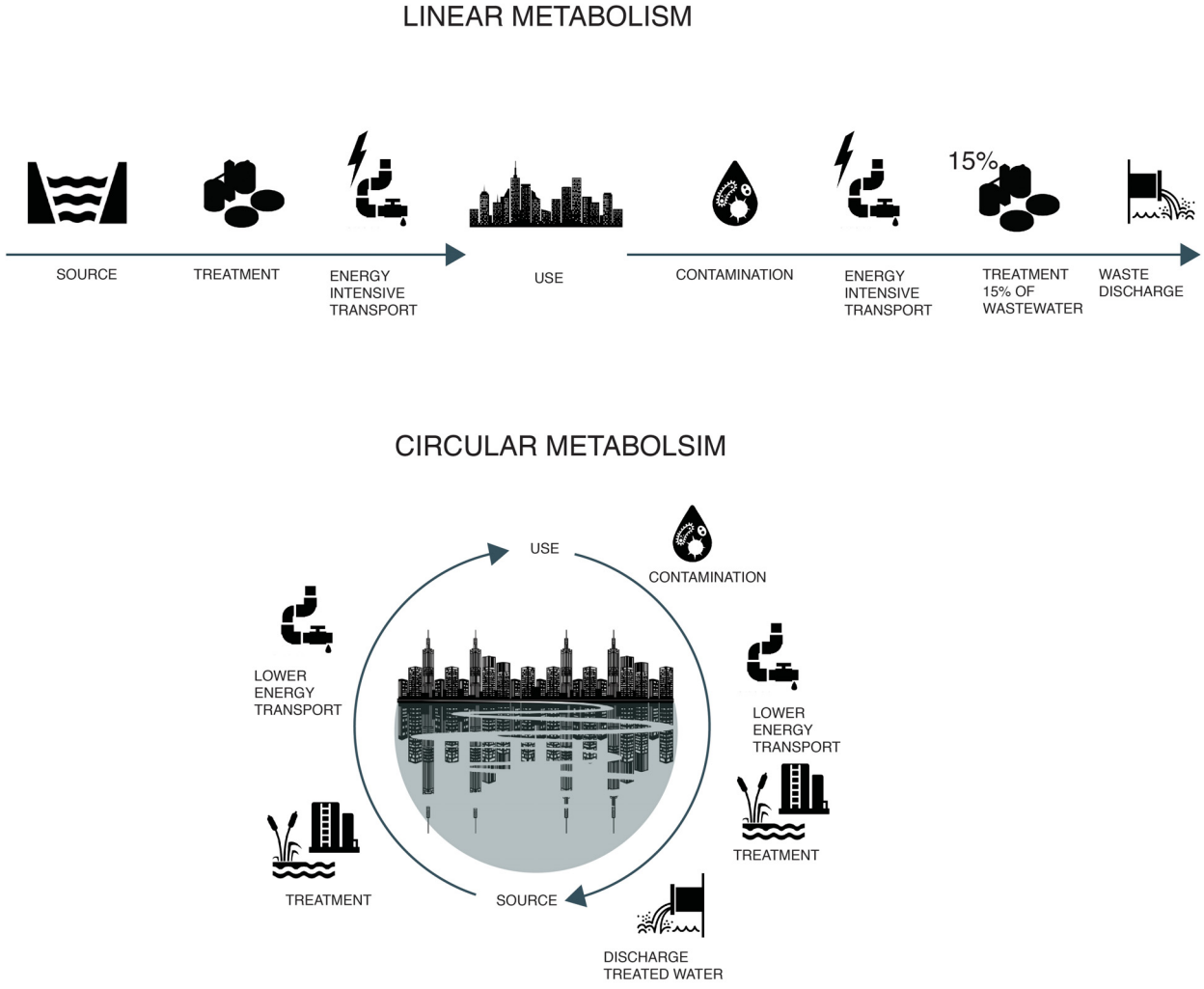


Diagram showing the current linear metabolism of water and the potential for a more sustainable circular metabolism.

As outlined in the report, *Mexico: Ciudad Futura*, additional environmental benefits of lake introduction would be: recovery of regional flora and fauna, a natural barrier to uncontrolled growth in the valley, climatic benefits of evaporative cooling and increased cloud coverage and the rehydration of subsoil (to prevent the clays from drying out and cracking, leading to land subsidence and dust storms). There are also several social benefits to lake reintroduction: the improvement of infrastructure and amenities in some of the most marginalized areas of the city, recreational space to interact with water, increased green space and vegetation, and restoring a lost cultural connection to the lake.[39]

The Texcoco Basin is selected for this study due to its proximity to the city, the scale of the drosscape that exists (and the resulting harmful atmospheric conditions created from dust storms) and the need for green space and public buildings in the communities that surround the Texcoco Basin.

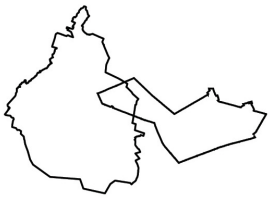
39 Alberto Kalach, *Mexico Ciudad Futura* (Mexico City: Diado, 2010), 89.

Restoring historical connection w/ lakes

Recovery of regional flora + fauna

Improvement of infrastructure + amenities in marginalized area

Natural barrier to uncontrolled growth



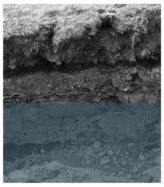
Common project across municipalities, + social groups

Start of hydrological recovery

Recreational space to interact with water

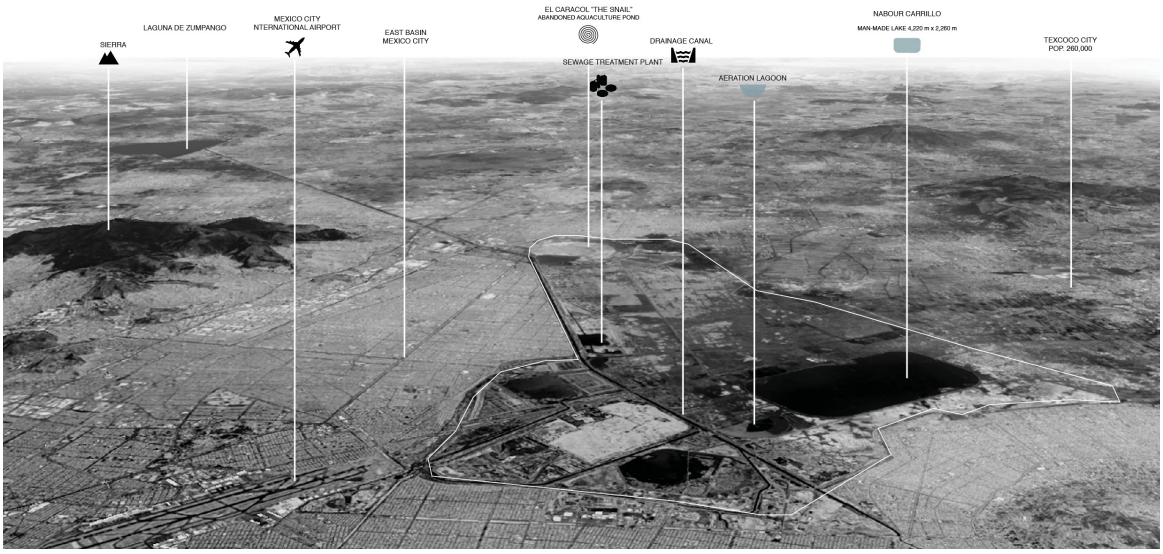
Evaporative cooling + cloud coverage

Increase in green area + vegitation



Rehydration of subsoil prevent susidence

Diagram of the social and environmental benefits of lake reintroduction.



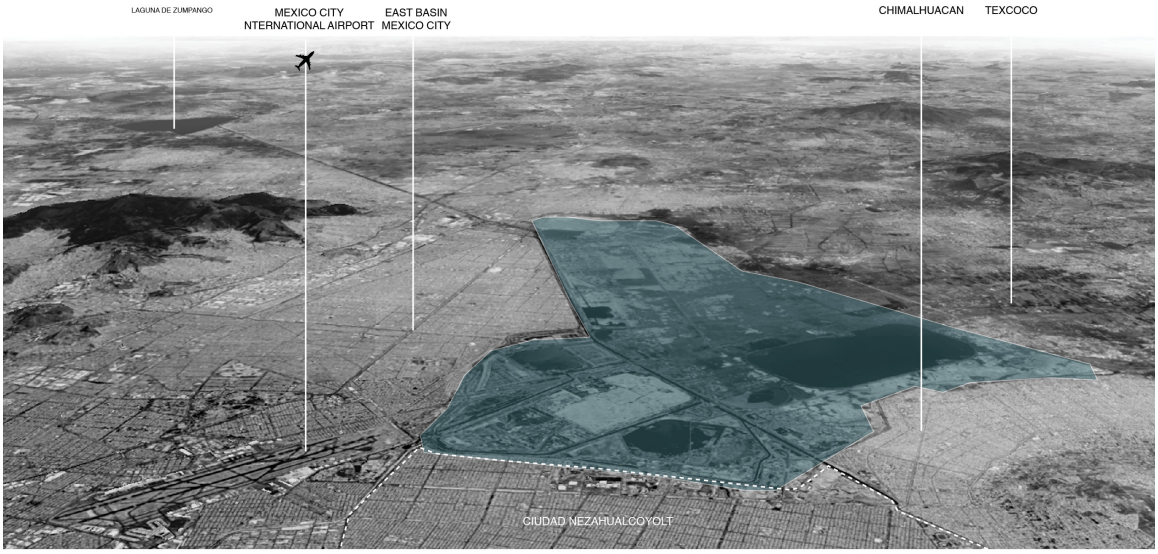


Diagram showing the extent of the reintroduced Lake Texcoco. Base image from: Google Earth.

Texcoco Basin

The proposed site for lake reintroduction is the basin of the original lake Texcoco. Today the lake bed is owned by the federal government and has not been built on due to the poor soil quality and flooding concerns. It is a vast, barren zone that the city has begun to grow around. It is described as “a windswept landscape of red earth and scrub, bisected by two interstate highways and marked by a decommissioned salt harvesting operation. At the eastern edges, unregistered farm plots encroach on marshland. In urban areas to the west, the city comes to an abrupt halt as it reaches the edge of what is essentially, a wasteland.”[40]

Adjacent to the site, are several neighbourhoods that are part of the geographic area that was the east basin of original Lake Texcoco. This part of the city has a high population density and a large concentration of vulnerable individuals. Much of the urban landscape here is paved. The area suffers from heat waves, droughts, and a lack of drinking water. Texcoco basin also suffers from land subsidence due to excessive pumping of underground aquifers.[41] The soil in this area is primarily sediment and clays. As the water is extracted from the ground, the soil dries up becomes brittle and collapses.

The main water strategies in this area of the city are to retain, reuse, and recycle water to alleviate seasonal drought and the lack of drinking water provisions. Aside from lake reintroduction (which would provide a large water retention area) other suggested water interventions from the report “Toward a Water Sensitive Mexico City” include: seasonal water storage, increased street vegetation, rainwater collection, and urban farming.

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40 Daniel Brooks, “History of the Present: Mexico City.” *Places Journal.* (Feb. 2017). https://placesjournal.org/article/history-of-the-present-mexico-city/.

41 Edvardo Marin Salinas, *Toward a Water Sensitive Mexico City*, 84.

Texcoco Basin; photographs by Esther Rivas.

Aerial view of Texcoco Basin, 2013; photograph by Haakon S. Krohn from *Wikimedia Commons.*

Some water-related issues in the East Basin have a historical resonance and are linked to persistent issues of environmental injustice faced by the poor in Mexico.

History of Drainage and Settlement in the Texcoco Basin

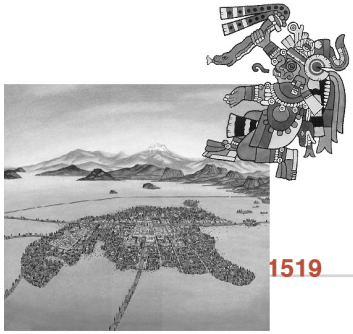
In order to formulate architectural responses in the Texcoco Basin, it is important to understand the historical and social context of this region. Texcoco was the largest and lowest lake in the valley. It was silted with eroded soil and salts from volcanic rocks making the water brackish. Communities along the edge of the lake relied on the lake for their livelihood – salt extraction, hunting waterfowl, fishing, and subsistence agriculture.

Mexican President Diaz implemented massive drainage works between 1876 and 1911 in an effort to address flooding in the city. The Gran Canal, a massive drainage structure, was completed in 1900. At the time the canal was praised for combating the persistent flooding issues that had plagued the city. However, the drainage was more effective than anticipated, and a larger than expected area of Texcoco Lake was drained.[42] The desiccated land was barren, and dust storms tormented the city – the dust was particularly harsh due to the salt content from the previously salt marsh area.

After the Mexican Revolution (1910 – 1920) there was a significant interest in fertilization schemes in the lake bed as part of a populist development agenda. The aim was to turn the barren lake bed into a fertile hinterland of Mexico City. Historian Mathew Vitz writes, “Elites promoted “modern” agriculture, shunned lake oriented subsistence and small scale trade, and considered the local economy as part of a primitive, indigenous past.”[43] Thus, a productive, ordered, “modern” economy would replace the existing one. The fertilization

42 Mathew Vitz, “The Lands with Which We Shall Struggle,” *Hispanic American Historical Review* 92, no. 1 (2012): 43.

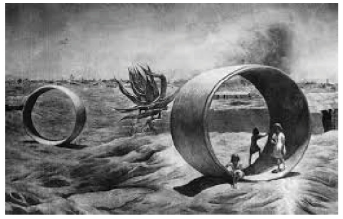
43 Ibid., 44.



1519 -1521 Spanish Conquest of Tenochtitlan

1929 Airport Texcoco Basin

1948 Presidential visit and inauguration of the Sosa Texcoco Factory.



1949 Guillermo Meza, La Tolvanera (The Dust Storm)

GRAN CANAL CONSTRUCTED 1880's

To carry wastewater + lake flood water out of city

CARRANZA DEGREE 1917

All areas formally part of the lake belong to government. Agriculture to replace "primitive" lake-based economy

DUST STORMS FROM LAKEBED 1930's

DRAINAGE + SEDIMENTATION OF LAKE TEXCOCO 1910's

ESTABLISHMENT OF PRI

1519 1880 1890 1900 1910 1920 1930

MEXICAN REVOLUTION 1910 - 1920

Fertilization schemes on lakebed

GALINDO + DE LA CERDA 1930's

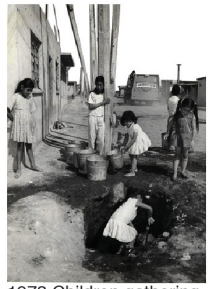
Propose introduction of lake made of recycled water to prevent desertification of the valley

PUBLIC DEBATES ON LAKE 1920's - 1930's

Activists argue for afforestation and lake regeneration. Arguing conservation of resources not agricultural experimentation will curtail dust storms, and promote public health.

1897 Dam gates of the Grand Canal and drain.

1970's Boy with dog, Neza



1973 Children gathering water in Neza

Timeline of Lake Drainage 1940 - 2018.

1958 Moya Rodrigo. Dust storm.

1968 Flooded strees in Nezahualcoyotl.

1947 Carlos Tejeda, La cuidad de Mexico alla por 1970.

LAKEBED STARTS TO BECOME SETTLED 1950's

Lakebed is encroached by urban settlement of poor migrants to the City

NABOUR CARRILLO LAKE CREATED 1985

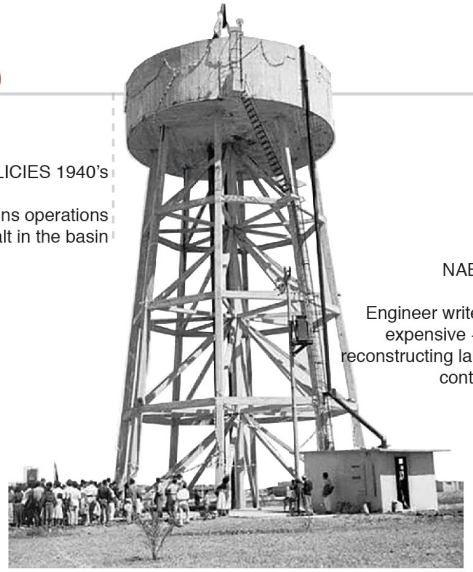
Government constructs 2,500 acre basin in keeping with ideas of Nabor Carrillo

Greater Mexico City reaches 21 million

1940 1950 1960 1970 1980 1990 2018

INDUSTRIAL POLICIES 1940's

Sosa Texcoco begins operations producing salt in the basin



1960's Water tank that was in the roundabout of Pantitlan.

TAX PUBLISHES PLAN TEXCOCO 1998

Alberto Kalach with multidisciplinary team publishes "La Cuidad Y Sus Lagos" a feasibility study on lakes project

NABOR CARRILLO REPORT 1960's

Engineer writes report stating draining lakes is expensive + ineffective. Explains benefits of reconstructing lakes as natural retention ponds to control flooding and treat waste water

2018 Marco Urgarte. Residents march against the construction of new airport.

Timeline of Lake Drainage 1940 - 2018.

project included experiments in salt washing and fertilization for plant growth on the marginal lake bed soil. However, the dust storms, *tolvaneras*, continued to grow in intensity during the dry season. [44]

From the 1920s to the 1930s some began to argue for water conservation, afforestation, the renewal of the lake system and an overturn the fertilization/drainage paradigm of the government. Architects, engineers, urban planners, and scientists documented environmental changes within the urbanizing basin of Mexico City.

In the 1940s there was a shift towards pro-business industrial policies and companies like Sosa Texcoco began to operate on the lake bed. By the 1950s Mexico City started to see increased migration of the rural poor into the city. During this time, there was a shift away from thinking about *compesino* (small scale farming) production due to the high cost of remediating the land. Vitz writes that "Instead of an ordered system of fertile and forested plots, the lake bed quickly became the center of poor urban settlement."[45]

During the 1950s discussion of conservation became linked with fears of population overgrowth. Some began arguing that human habitation and biological processes were interrelated, "The different issues that constitute the problem of the [basin] of Mexico are interconnected in such a way that one cannot refer to one of them without alluding to the rest. Water and subsidence, for example, are intimately united…deforestation, erosion, and dust storms are other threads of the same warp."[46]

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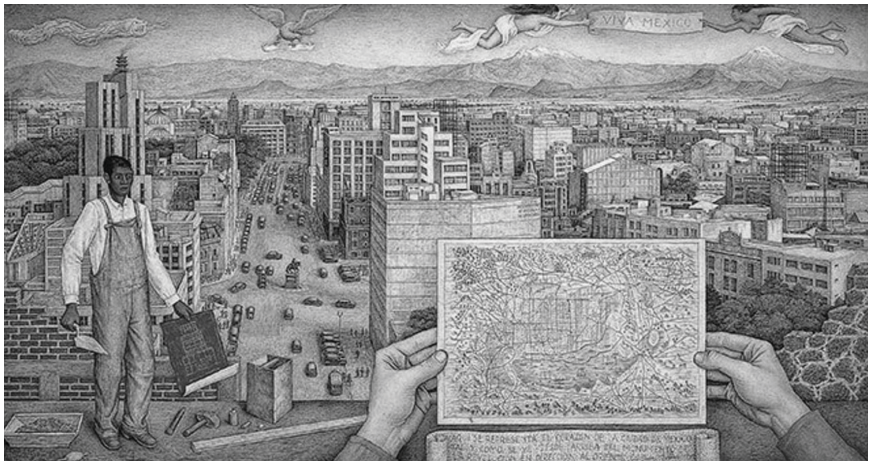
44 Ibid., 50.

45 Ibid., 69.

46 Mathew Vitz, "An Unlikely Environmentalism: Mexico City's Urban Ecological Thought in the Age of Development," last modified September 11, 2018. https://globalurbanhistory.com/2018/09/11/an-unlikely-environmentalism-mexico-citys-urban-ecological-thought-in-the-age-of-development/.

The discourse surrounding fears of environmental degraded was exemplified in the Excelsior artistic competition in 1949, “Mexico City as Interpreted by its Painters.” The winner was Juan O’Gorman’s “Paisaje de la Ciudad de Mexico.” In it, O’Gorman criticizes PRI (Institutional Revolutionary Party) rule, showing the erosion of the national culture and the abandonment of the working class. In the foreground of the painting is an old colonial map of the once lacustrine city, representing the lost indigenous civilization contrasted with the desolate lands beyond (where Texcoco Lake once was). An Indigenous man (a Mexican craftsman), forgotten amid the concrete, glass, and steel of the new International architectural style.

The second prize went to Guillermo Meza “La Tolvanera” (The Dust



Juan O’Gorman, *Paisaje de la Cuided de Mexico*, 1949, from Vitz, *A City on a Lake.*

A dystopian painting of drained Texcoco Basin. Guillermo Meza, *La Tolvanera*, 1949, from Vitz, *A City on a Lake.*

Storm) which contemplates environmental catastrophe and depicts the barren lands of the Texcoco lake bed. In the painting, harmful briny soil swirls as children stand in a drainage pipe fragment – an allusion to the infrastructure that desiccated the lake.[47] These painters were attempting to demonstrate that ecology, the built environment, culture, and infrastructure were all intimately linked.

"Environmentalist technocracy" became laced with disdain for the migrant poor. Poor migrant settlements were called "tumors" and "parasites" and blamed for the city's environmental issues.[48] Vitz writes, "A geography that once sustained a diverse, if poor, lake-based economy now contained the shacks of millions of poor."[49]

By the 1970s half of the lake bed was covered. The largest settlement was Ciudad Nezahualcóyotl, which quickly grew into a vast slum.

Site Selection Ciudad Nezahualcóyotl

In this thesis, Ciudad Nezahualcóyotl (Neza) is the location for the development of an architectural response that incorporates public architecture with water infrastructure – in an attempt to address the environmental injustice and ecological damage that was primarily felt by the migrant poor.

The city developed from a slum built on the drained lake bed. Corrupt land dealers sold plots and did not build the infrastructure or public services that had been stipulated in tender contracts. Residents banded together, and in 1963 the area incorporated as a city to help facilitate the development of necessary infrastructures such as electricity and water. However, many buildings still do not

47 Mathew Vitz, *A City On A Lake. Urban Political Ecology and the Growth of Mexico City* (London: Duke University Press, 2018), 2.

48 Vitz, "An Unlikely Environmentalism."

49 Vitz, "The Lands With Which We Shall Struggle," 69.

have a water connection.

The degradation of the local environment, and lack of amenities and infrastructure, has contributed to social issues in the city. Due to its history as a slum and historically marginalized area, there are a high number of socially vulnerable people in Neza. The city deals with issues of poverty and youth gang violence. Tourists and residents of wealthier areas of Mexico City are discouraged from visiting the area, which makes successful commerce in the area difficult. Improvements to environmental conditions, public space and amenities, and basic infrastructures (safe and accessible drinking water) could help to improve social conditions and combat long-held stigmas about the city.

In selecting the site of the water treatment building, it was important that the building have access to the lake for the intake of source water. The selected site is to the north of the original settlement area, along the proposed new lake edge. This area of the city is close to some existing water retention areas, water drainage ditches and the Gran Canal (which carries primarily stormwater and some untreated wastewater).

The site is also suitable for public programs and amenities as it is situated along a strip of land that has been developed with public facilities including a large sports facility, hospital buildings, a police school, and a courthouse. The area also contains several university buildings, high schools, and a shopping area. The site would be adjacent to various public buildings and able to connect with diverse groups of people in the community.

Map of urban layout of the city of Neza. Characterized by densely populated blocks with limited green space. Base map from: Google Maps.

CHAPTER 5: DESIGN

Design Framework

In Mexico City, the denial of its hydrological and ecological essence as a lake network, and the resulting urban structures of the city has led to the water issues facing the megacity. Previous chapters discussed how water issues have impacted the city at the territorial scale, the scale of communities like Neza, and individuals who face the lived realities of water scarcity and environmental degradation. Thus, the project must also operate at multiple scales: that of the region of Mexico City Valley, the communities that surround the lake, and the individual. This project aims to design spaces that promote hydrological recovery and allow people to experience water in multiple capacities. This means design considerations relating to:

- The territorial/watershed scale
- The urban lake and city interface
- The site scale; which has typologies that connect water, ecology, and social/cultural engagement
- The building scale, a water treatment facility integrated with other public spaces and programs.
- The individual scale, details and moments in the building that allow people to have a sensory experience of water

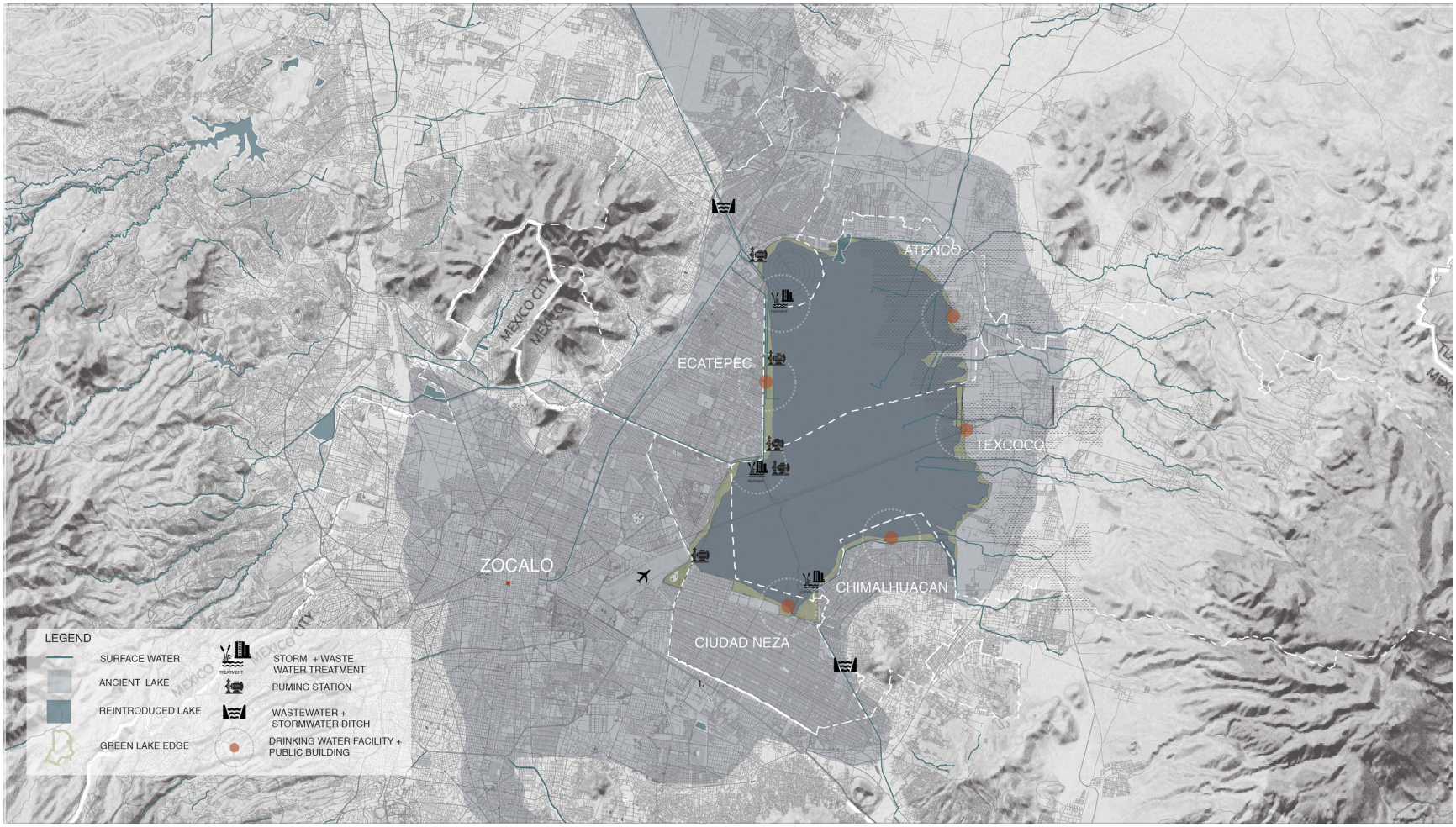
The overall framework for the design is translatable to other compatible sites in other cities that have a broken relationship with water. However, the main critique of contemporary water infrastructure is that it often does not address the specificities of place, history, or environment. In this thesis, the context of Mexico City and its pre-colonial and contemporary histories are significant in developing an architectural and infrastructural response to water such that the public space and programs are calibrated to the needs and daily lives of the community. The overall design goals/ principles are to:

- Improve water management in Texcoco Basin through lake reintroduction
- Create new landscapes (green space + waterscapes) for recreation
- Create a public space that increases the visibility of water infrastructure
- Populate new lake edge with public buildings that respond to community needs
- Design a public building that allows people to have a visceral experience of water

Territorial Scale: A Reintroduced Water's Edge

With the reintroduction of the lake, a new edge condition, and also a new landscape, will exist where the urban and rural areas of the Texcoco Basin meet the water's edge. Different edge conditions will exist along the 80 km coastline that respond to the specificities of each place. Functional requirements will play a role in determining edge conditions. For example, in some areas, wastewater and stormwater treatment will be required and will be accomplished through constructed wetlands. These areas will be navigated by paths and boardwalks across the wetland area. A public edge that surrounds the urban lake acts in a number of ways:

- It is a continuous public space ensuring that there is public access to the lake
- It is a space for various forms of active transport, through walking and bike paths and docking areas for boat traffic.
- It encourages the infiltration of rainwater through soft-scaping and will contain wetland areas that filter storm or wastewater before it enters the lake.
- It contains programmatic elements (social and educational amenities) that serve adjacent communities.
- The lake intersects with five municipalities, and each could include a water treatment facility that provides potable water for the adjacent community. In this way, less water is lost to leaks in the vast distribution network, less energy is used, and less groundwater pumping is required.



Map showing proposed site for lake reintroduction, continuous public edge, and sites of water treatment + public program. Data from: INEGI National Institute of Statistics and Geography of Mexico. Google Maps.

The water treatment sites respond to the specificities of each community – offering a variety of cross-programing opportunities (social, cultural, or recreational centres). The specificities of the programs are dependent on the needs of the community but could include recreational, educational, or cultural buildings.

Mexico City's Chapultepec Park is an example of an approach that combines public space and recreational green areas with cultural

Photo of the Anthropology Museum, Mexico City 2018.

Photo of the recreational lake in Chapultepec Park, Mexico City 2018.

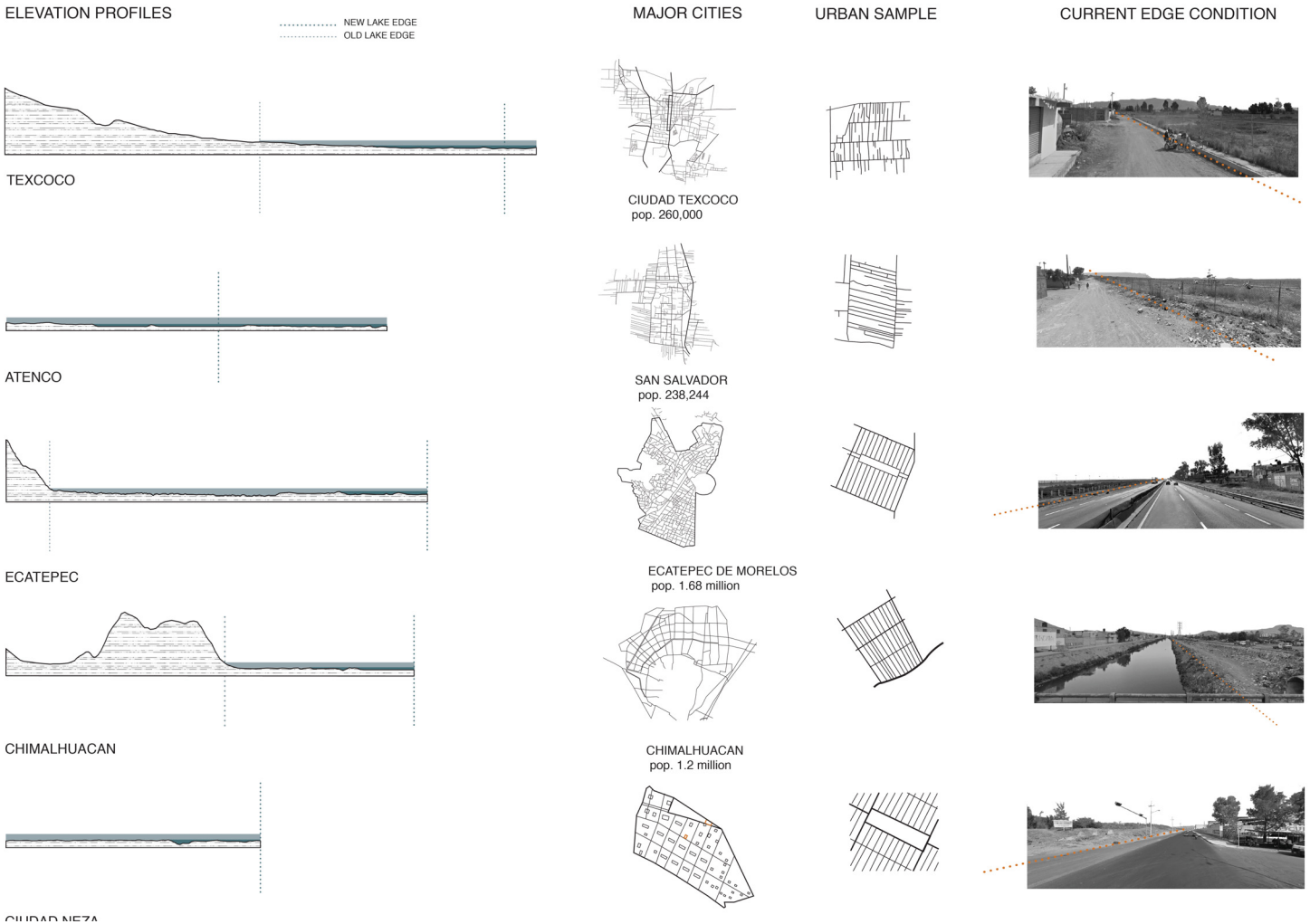
buildings. The park contains nine museums, including the historic Chapultepec Castle, a zoo, the Museum of Anthropology, and several modern and contemporary art museums. It also contains sculpture gardens, small recreational lakes, and street food areas. Chapultepec Park is a good case study for a site that combines green areas with educational, cultural, recreational, and commercial (food vendors) areas. However, the park is removed from the poorest and most marginalized areas of the city, such as Cuidad Neza, that have a lack of public amenities, green space, and suffer from a heat island effect. The lake and the proposed continuous edge would provide an opportunity for a similar kind of space for these marginalized communities.

City Scale: A Water Flow Strategy in Neza

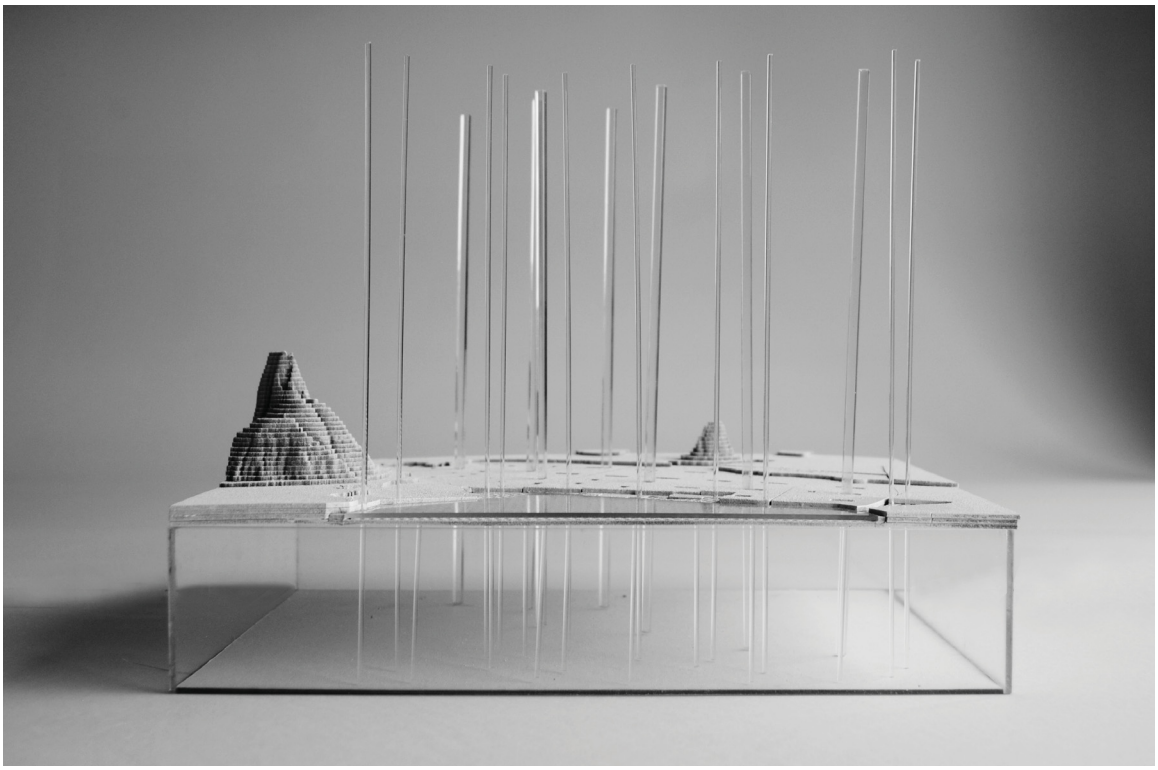
Of the five municipalities, including Texcoco, Atenco, Ecatepec, and Chimalhuacán, that would meet the edge of the lake, Neza was selected to develop further (see illustration on page 57). It is historically a marginalized area, settled by poor migrants because the land was undesirable. The city is plagued by floods, lack of infrastructure, dust storms, and poor soil quality. It is interesting to consider how the empty wasteland of the lake bed could be transformed by the reintroduced lake to benefit this community.

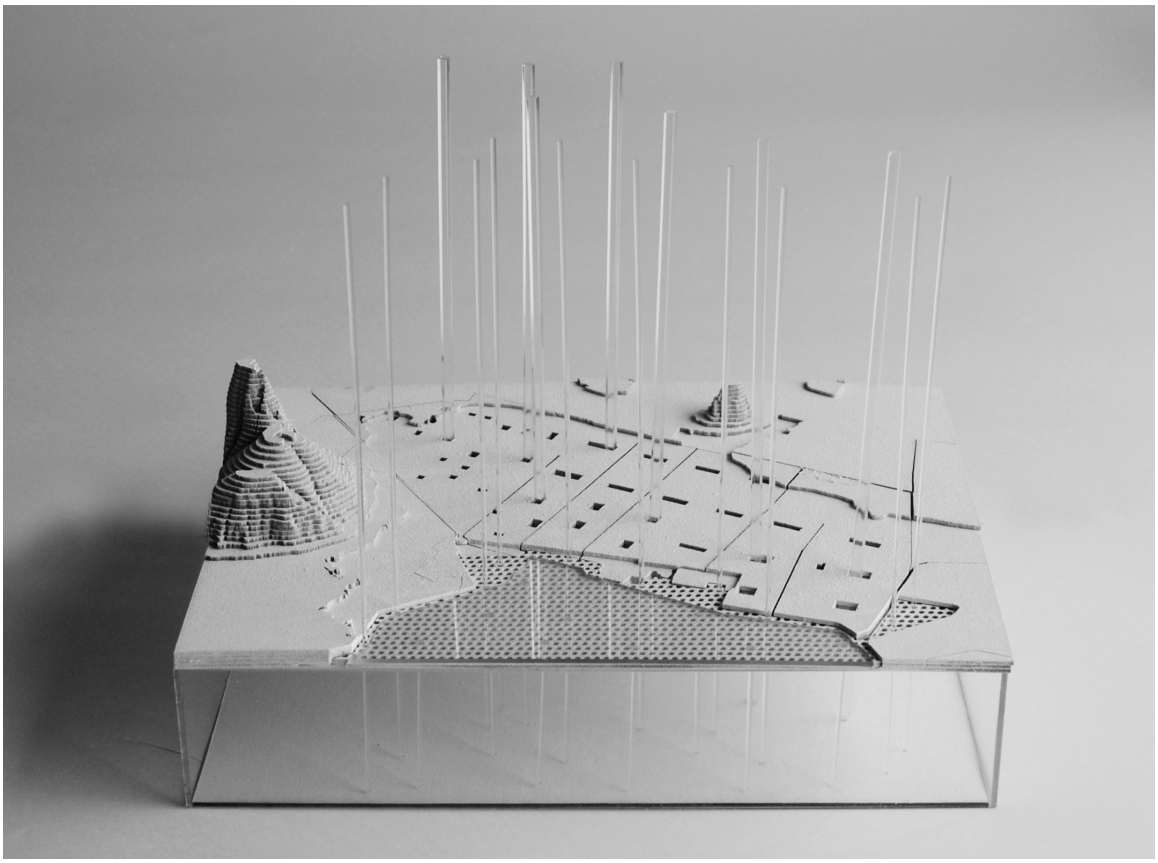
In considering how the lake will interact with the city of Neza, a strategy for the flow of water to and from the lake is needed. Water needs to be directed to the lake and encouraged to infiltrate recharging the aquifer and alleviating some issues of flooding in the city (as the area is relatively flat being part of the original lake bed).

In the proposed design, rainwater is encouraged to infiltrate through porous ground treatments in public squares (many of which are paved with impermeable materials like concrete). Stormwater is transported by bioswales (which also help to treat water through



Five municipalities surrounding proposed lake + current edges of Texcoco basin. Data from: Google Maps, Google Street View.





Conceptual model for water flow strategy for the city of Neza (showing lake, permeable spaces and aquifer recharge)

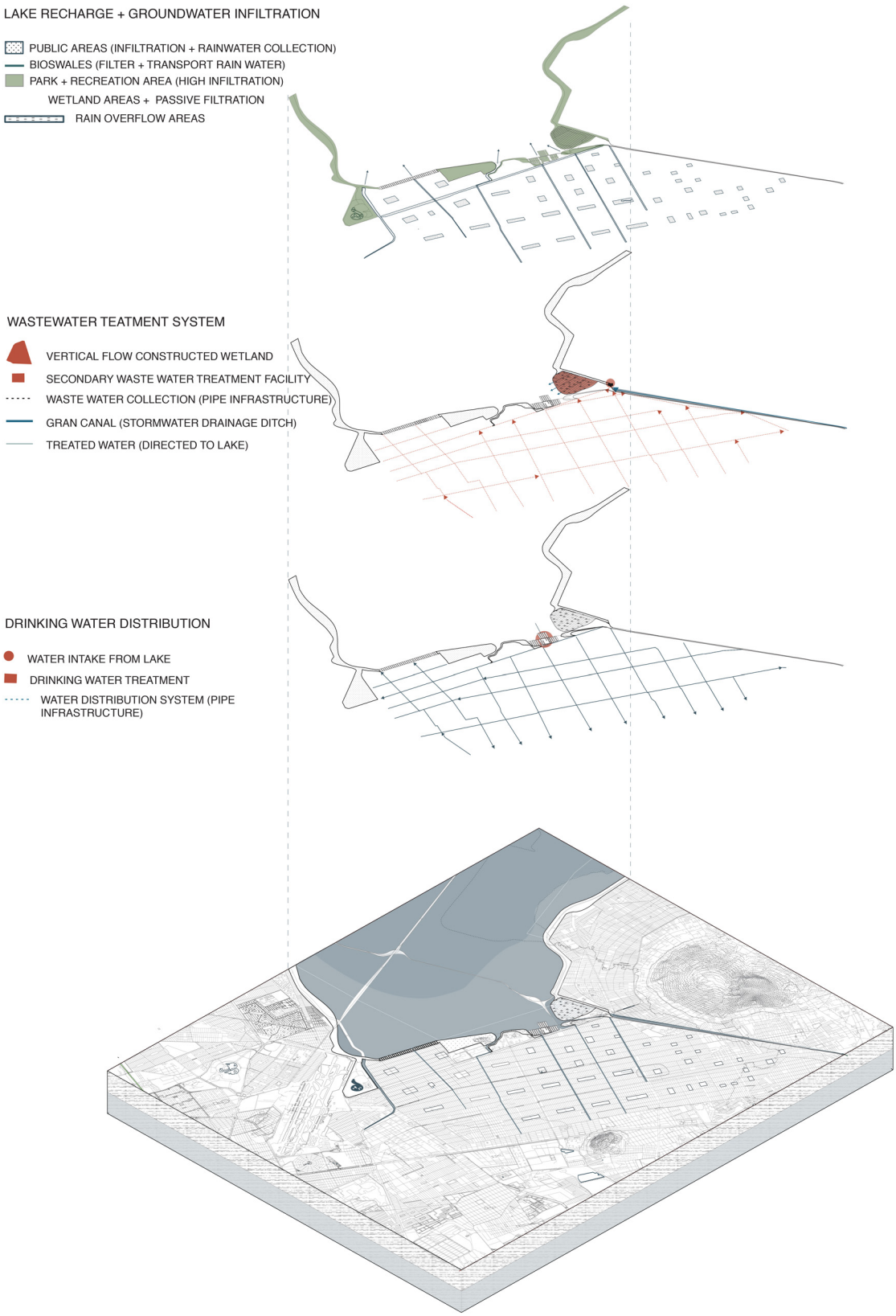


Diagram of water strategy for Neza. Data from: INEGI National Institute of Statistics and Geography of Mexico.

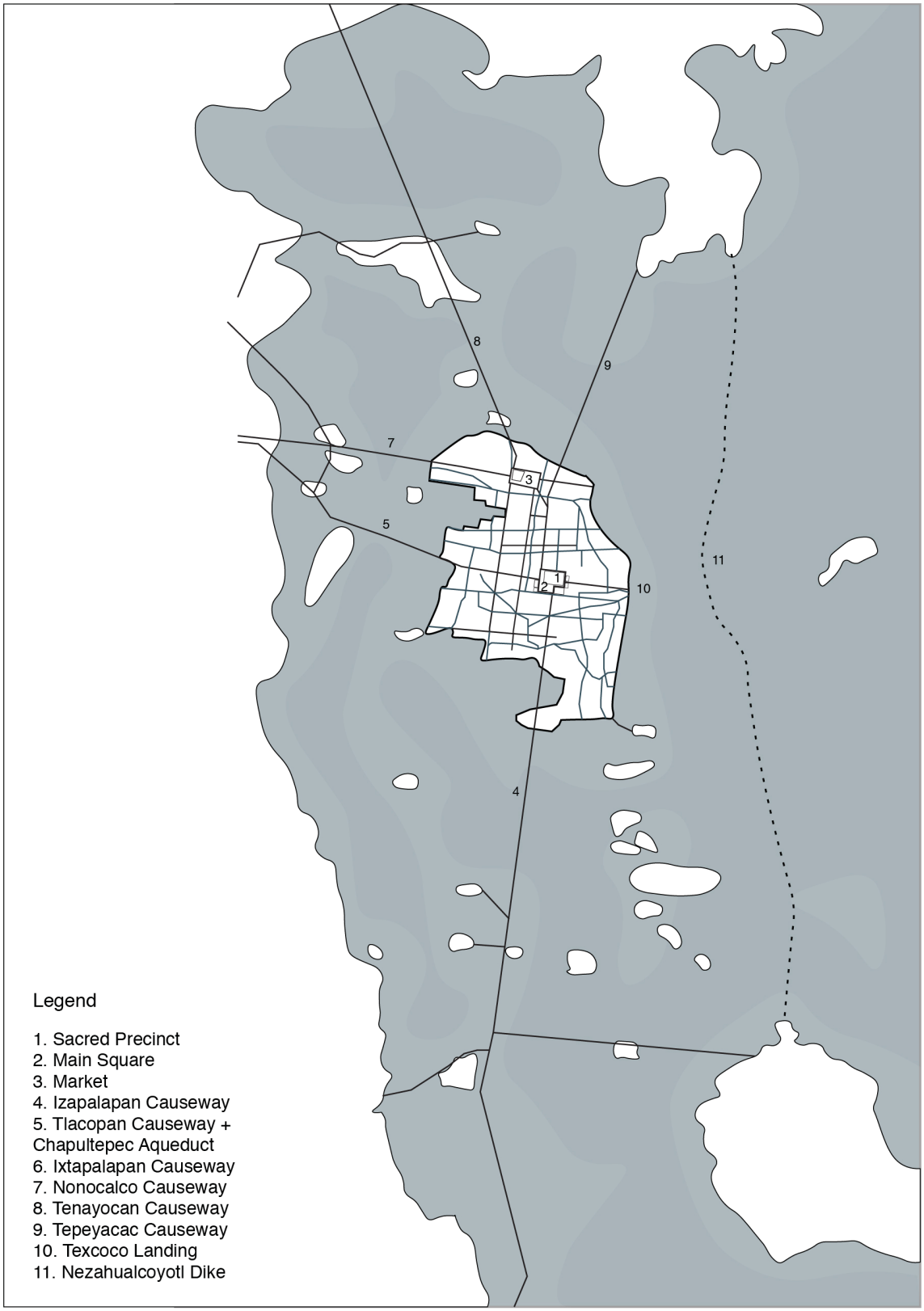
vegetation that filters water) to wetland areas at the lake edge before entering the lake itself. Wastewater and stormwater from the existing Gran Canal receive secondary treatment (which removes solids) then enters a constructed vertical flow wetland (which further purifies the water) before finally entering the lake. Potable water for the city of Neza will be produced by taking water from the reintroduced lake, treating it on site and distributing it to the city. Thus, water flows in the city of Neza (usage, treatment, and transport) all are designed to flow to/from the lake and slowly recharge the aquifer below the city (see diagram on page 57).

Site Scale: A Method for a Lake-City Interface

This thesis argues that contemporary water infrastructure does not address the specificities of place, history, or environment. In developing a design method for the architectural response to the lake/city interface (and water infrastructure in the city) an understanding of Mexico City's pre-colonial and contemporary histories are essential. The design considers how traces of the city's past as a lake city might be referenced in the context of contemporary Neza. Traditional land formation methods and ways of building on the lake are paired with the modern urban morphology of Neza to create a new system. Below the traditional ways of building on the lake (dating back to the time of Tenochtitlan), and the contemporary morphology of Ciudad Neza are discussed.

Traditional Building Methods

The design builds from the strategies developed by the Mexica in ancient Tenochtitlán. The Mexica developed ways of building on and in the lake that worked with the existing ecology. They implemented a complex water infrastructure network of dikes, agricultural islands, causeways, and canals (see diagram on page 59).



Map showing roads, causeways and canals in Tenochtitlán c. 1500's. Based on map from: Felipe Correa and Carlos Garciavelez Alfaro, *Mexico City Between Geometry and Geography*, 43.

The city of Tenochtitlán was created from a series of islands and was surrounded by a series of smaller agricultural islands called chinampas. Chinampas are a method of land creation developed over 3,000 years ago, and productive chinampas are still operating in the Xochimilco region to the south of the city.

Chinampas are an agro-hydraulic system of raised fields in shallow lake areas that allow for the irrigation of crops independent of rainfall. The word chinampa is derived from a Nahuatl word that means 'weaving fence of canes' – referring to their method of construction.[50] Walls of wooden poles are used to create a border (usually rectilinear in shape) that is then filled in with layers of soil and organic material (see diagram on page 61).

Chinampas are delineated by channels of water that connect in a network. More than just an agricultural system, the chinampas, and their waterways historically acted as a landscape infrastructure system used for communication, transport of goods, recreation, the supply of water and irrigation. The layering of program and infrastructure corresponds to some of the contemporary lessons from the earlier case study of the city of Copenhagen (which uses its waterways for transport, housing, food production, and recreation).

This design incorporates chinampas and their corresponding canal network into the design of the site both for practical considerations (for community gardens areas) and for also reintroducing culturally significant ways of building that disappeared from the Texcoco basin with the drainage of the lake.

Aside from the chinampa network, in Tenochtitlán there was also

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50 Government of Mexico, *Chinampa Agricultural System of Mexico City, Mexico. A Proposal for Designation as Globally Important Agricultural Heritage Systems*, last modified 2017, http://www.fao.org/3/I9159EN/i9159en.pdf.

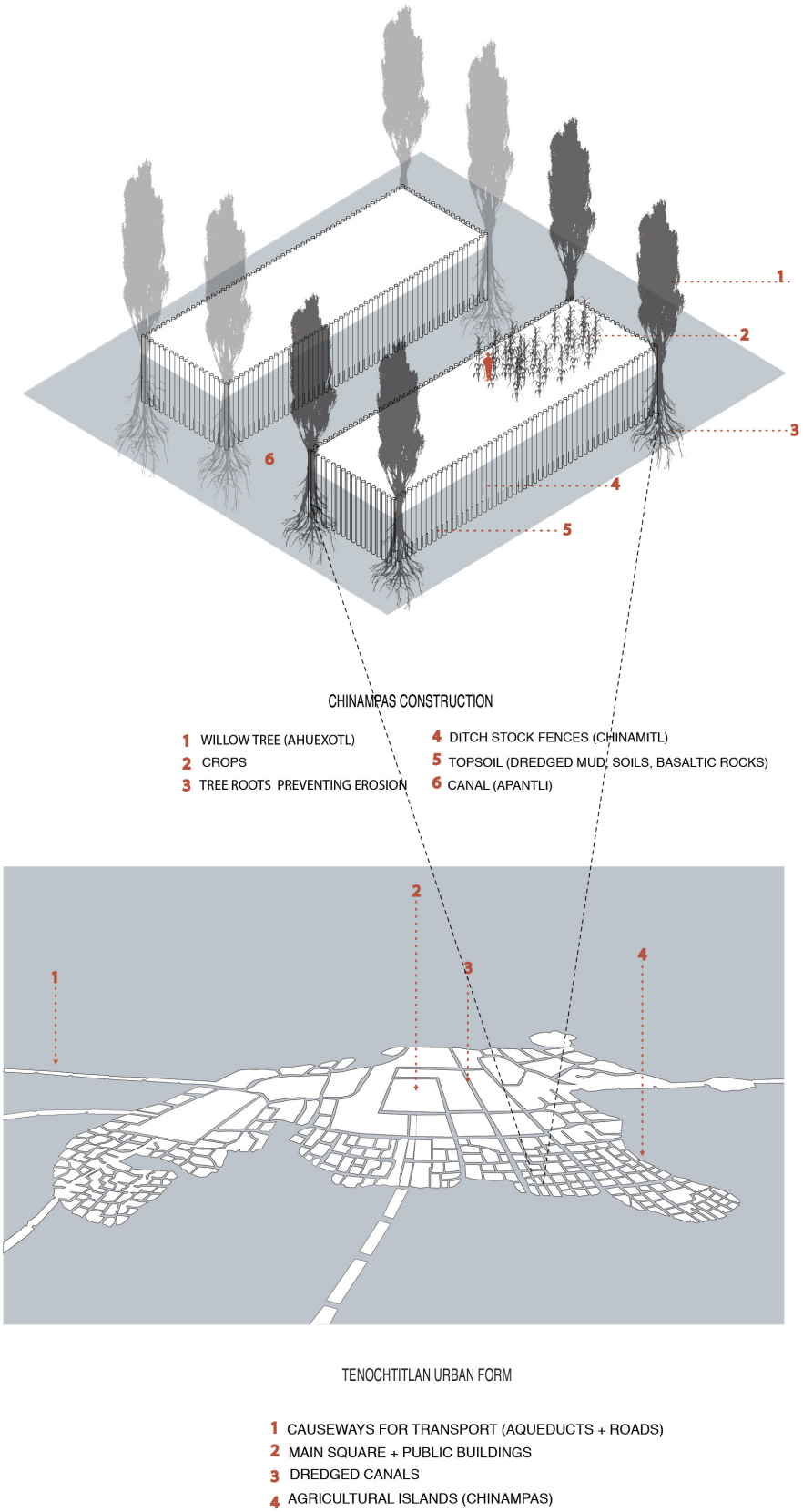


Diagram showing the construction of the chinampa islands that surrounded Tenochtitlan.

a legacy of stone and adobe buildings. Heavier structures were constructed on thousands of fence-post-sized supporting piles within the porous marshy terrain to stabilize the building. Today, much of the city is sinking due to over-pumping of groundwater - the degradation of the natural environment is leading to the degradation of the built environment.

This principle of working with the local environment and ecology relates to the earlier case study of Venice, which makes use of similar structural systems in an also marshy environment. In this design, a pile system is proposed to deal with the unstable, marshy terrain of the area. The reintroduced lake would also replenish the aquifer, rehydrating and re-stabilizing the soil.

Contemporary Morphology

While the design incorporates traditional building methods, it also acknowledges the contemporary city. Unlike other places that originated as slums, Neza's settlement process created a distinct, regular urban pattern due to the sale of plots by illegal land dealers. The city has a population of about 1.2 million people and is divided into a series of "mega blocks" each contains 90 residential blocks. Buildings are tightly packed, and public space and green space is very limited in the city. Each mega block has a central block with public amenities to service the surrounding residents (schools, medical buildings, libraries, and cultural centres). Blocks contain recurring elements: enclosing walls (that wraps the entire block and often continues through to further divide spaces), entry gates (used to control access), courtyards, playing fields and public buildings.

The enclosing wall and entry gate effectively means that access to public space is always controlled; even most park spaces have a gated entry. Without openly accessible places to gather, or really any city center, much of public life happens in along the streets of

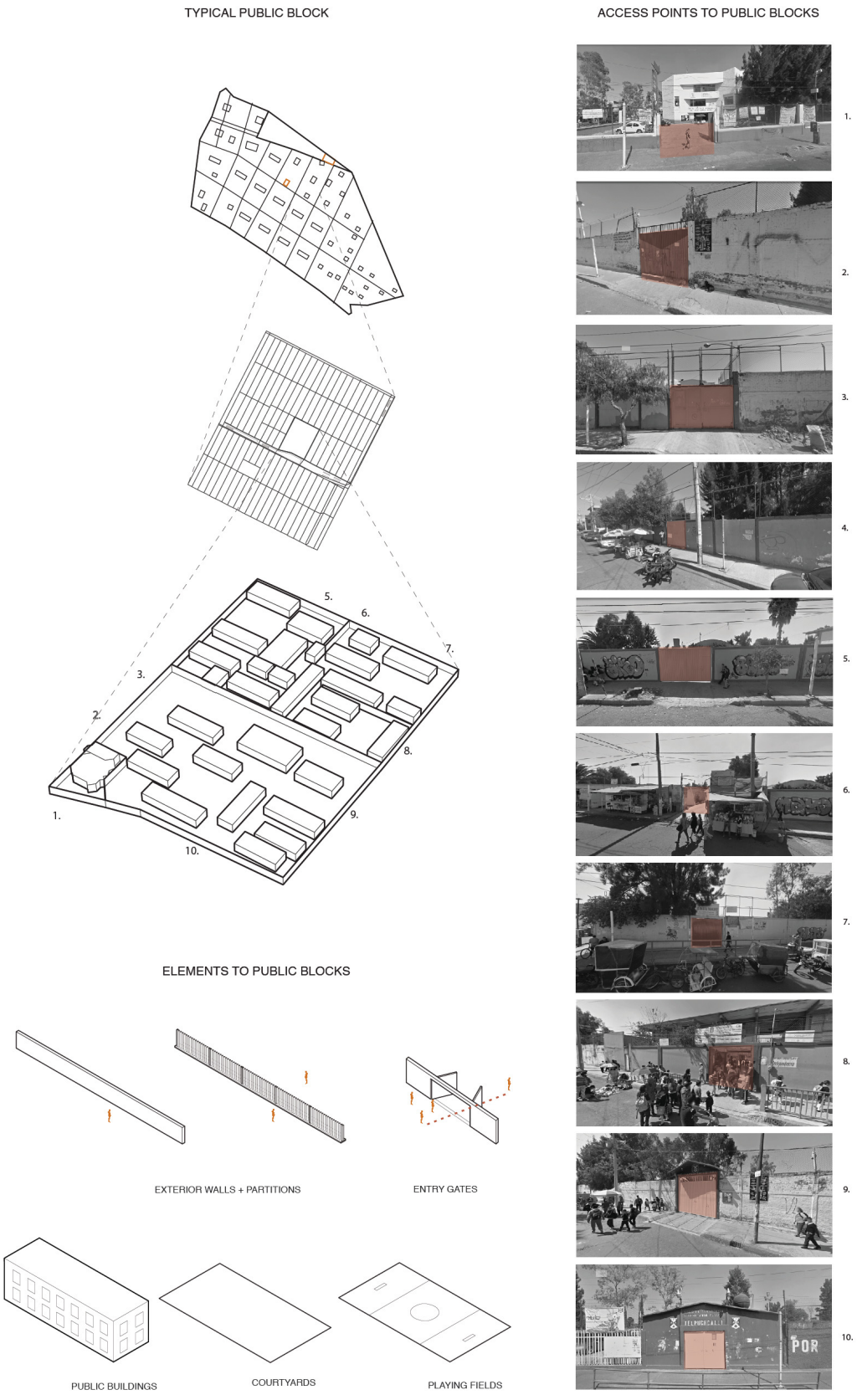


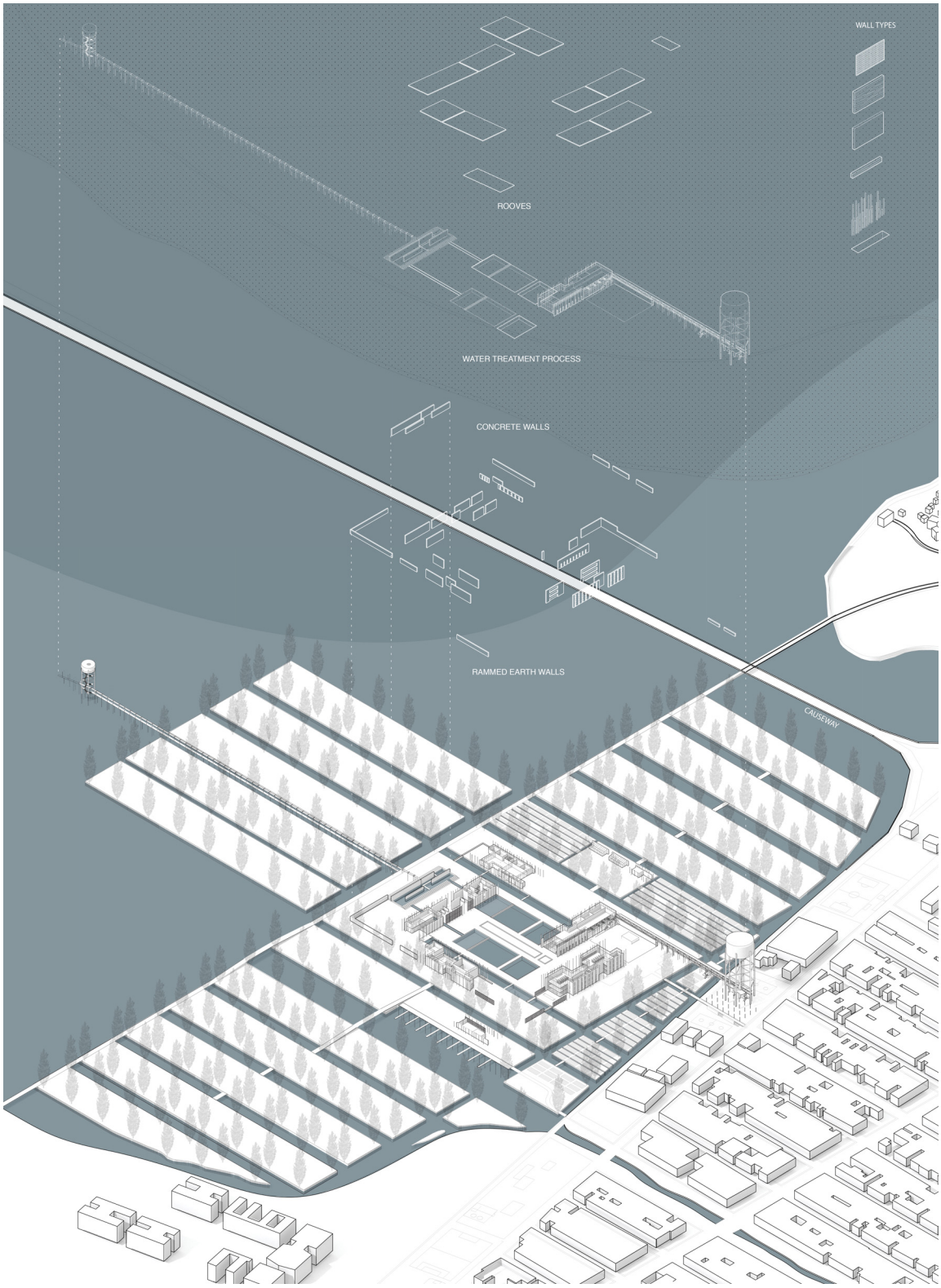
Diagram showing urban morphology of Neza. Images from: Google Street View, Google Maps.

the city. The introduction of the lake opens up new possibilities for public space in the city and an opportunity to critique the current urban structure.

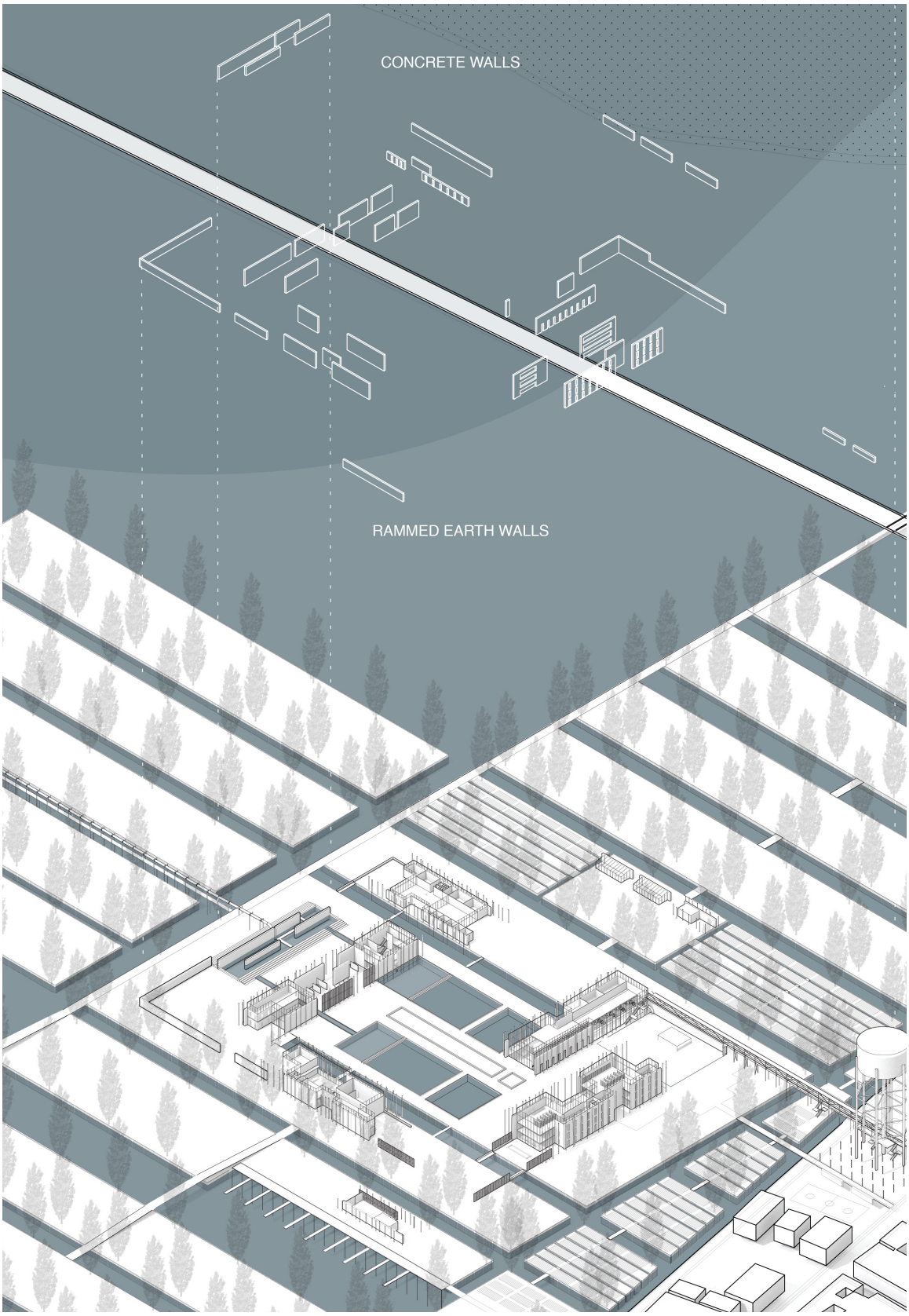
Combining Contemporary Morphology + Traditional Building Methods

The proposed design of the site references traditional ways of building on the lake and also the patterns of the contemporary city. The urban grid continues into the lake, but the resulting space is reconsidered. Instead of dense blocks of concrete-block houses, public spaces in the form of chinampa islands are created. These islands are openly accessible park areas, community cultivation spaces, and active transit paths. Instead of busy streets, a canal network supports transport by boat and areas for water-based recreation. In this way, the contemporary urban grid imposed long ago by land dealers is subverted with the traditional building methods that were erased from the region with the desiccation of the lake.

The site, like other “mega blocks” in the city, also has a central block. The gated public blocks of the current city are subverted as this central block is an island that contains openly accessible public programs and the water treatment facility. Access to water and access to public space are both salient in the history of Neza. Currently, much of the source water and treatment facilities for Neza’s drinking supply are located outside the control of the community. The lake will increase proximity to the water supply and water treatment buildings, giving more access and control to the community.



Axo showing the site, the rammed earth and concrete walls, and water treatment process.



Detail of the axo showing the central island that references the central blocks typical in Neza.

Project Phasing

In imagining the development of the project, it becomes evident that the water would be introduced in a number of phases over several years. Each area of the lake would be phased to accommodate it's particular topography and the size of any existing areas with water (drainage ditches, canals, water retention areas). Below is an example of a possible phasing of the Neza site.

Phase I

Bioswales would be introduced to the city (where existing roads are wide enough to accomodate them). The bioswale water would be directed to connect with current areas used to retain water. These water retention areas would be expanded to accommodate more water over time.

A constructed wetland would be introduced to treat water from the existing gran canal (building a secondary treatment plant to remove solids prior to flow into the wetland).The chinampa islands would begin construction (prior to the water being introduced into the area for ease of construction).

Phase II

The areas containing water would continue to increase. The chinampa islands could begin to act as community gardens and the market and vendor areas would be introduced. Supporting programs like the boat launch and green houses could also be built. Construction could begin on the main island for the water treatment facility.

Phase III

The lake would be fully introduced and the water treatment system could start to operate. The educational and cultural buildings could also be introduced as funding allows.

Diagram of existing conditions

Diagram of phase I of the site.

Diagram of phase III of the site.

Water Treatment Process

The site challenges the current invisibility of water infrastructure in the city of Neza. On site, potable water is treated, producing approximately 250L per person per day for the city of Neza. The water treatment process begins with an intake in the lake and ends on shore held in the water tower. The water treatment process happens sequentially across the site.

- Water is taken from an intake pipe in the lake. The intake is situated far enough from the shore to avoid disturbance of the water column due to onshore activities. The Location is chosen carefully to optimize raw water quality for the treatment process.
- Water is then carried and transferred to the aeration process. Here water is pumped up and cascades down four vertical walls, this creates turbulence, increasing the dissolved oxygen in the water. This oxidizes dissolved metals to insoluble particles that are removed during clarification and filtration.
- The water then passes through two channels to the clarification pools. Particles and microbes, destabilized with the aid of a coagulant, settle out of the water column during this step.
- Water flows from these to filtration pools and then into the water treatment building. Here a UV light wall (here it is glass structure; however, usually it is contained in a concrete channel) treats the water. Filtered water is disinfected with ultraviolet light. This does not provide protection against microbial contamination through the distribution network. For that, chlorine is added as a secondary disinfectant
- Water then stays in the clear well before being pumped

up into the water tower. The water tower adds additional capacity to the system and ensures water supply in the event of power outages or other serious events. Water is distributed throughout the city via a network of buried infrastructure and storage tanks.

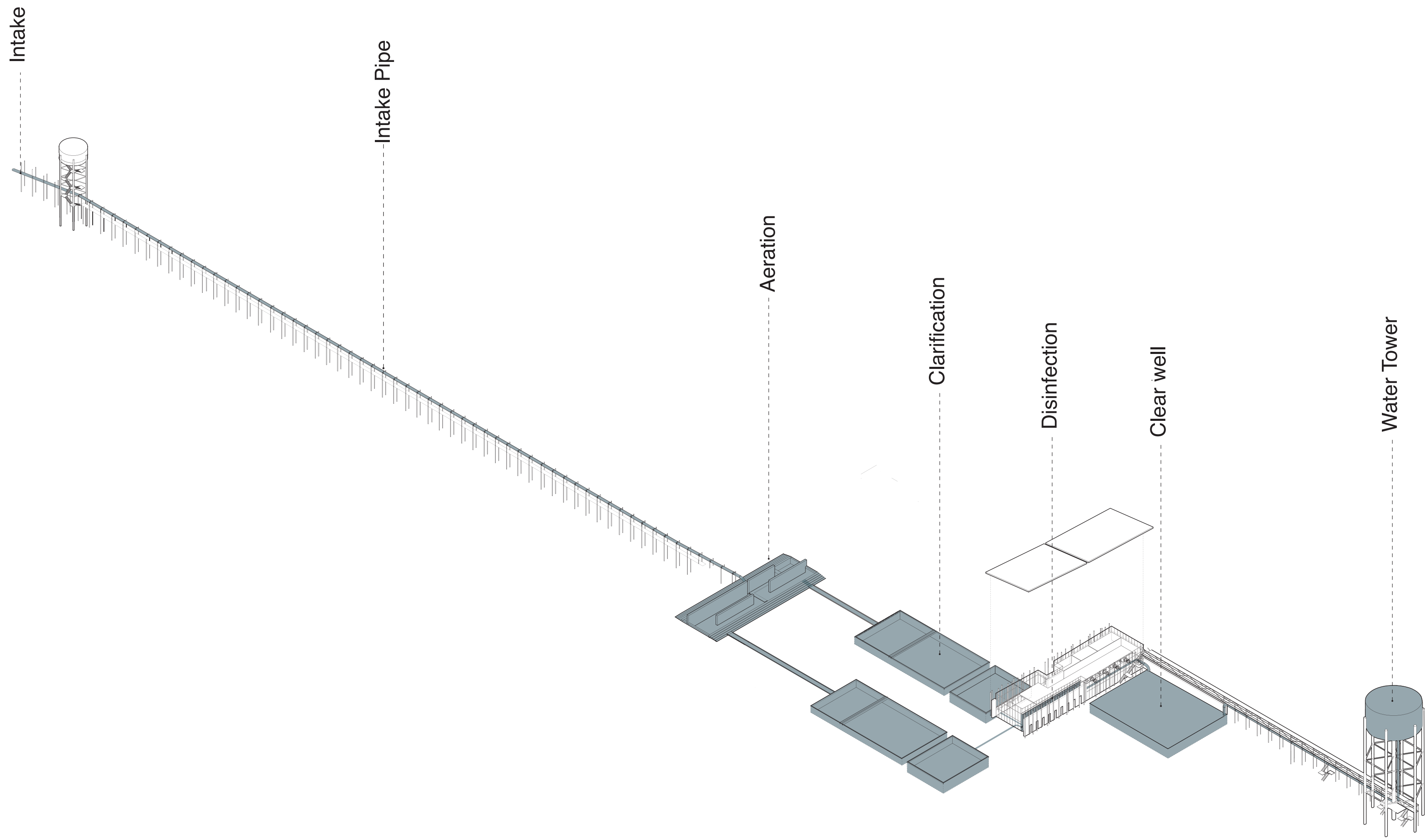


Diagram isolating the water treatment process (highlighted in blue)

Building Scale: Tectonics + Materiality

On the site, instead of the enclosing walls typical of Neza's public blocks, the walls are elements that operate in different ways: they carry water and store water; are benches or are screens to frame courtyard areas; they support greenhouses and storage areas for the community cultivation areas, and provide access to water and electricity in the market space. On the central island, the perimeter wall is pulled apart or pushed in, to allow for the circulation of people and lake water across the site. Portions of this outer wall become parallel earth walls that enclose portions of the program. The chinampa islands themselves are also effectively created from a series of "walls" that hold in the earth through an aggregation of small, round wood members (refer to the diagram on page 75).

Rammed earth is used extensively on site. Like the chinampas, the material is taken from the surrounding environment and layered. Also, like chinampas, rammed earth walls respond to the environment – regulating moisture and also temperature through its material properties and thermal mass.

The buildings use a pile system, much like the buildings of Tenochtitlán, to better stabilize the structures in the porous marshy soil. These piles continue up to become columns that support the roofs of the buildings. In some areas, the columns also connect into the walls of the chinampa islands below. The two types of building methods are in contrast: piles, columns and chinampa islands work through an aggregate of members and allow flows through (water, people, light), while the thick rammed earth or concrete walls act as a solid mass to contain (water, books, people).

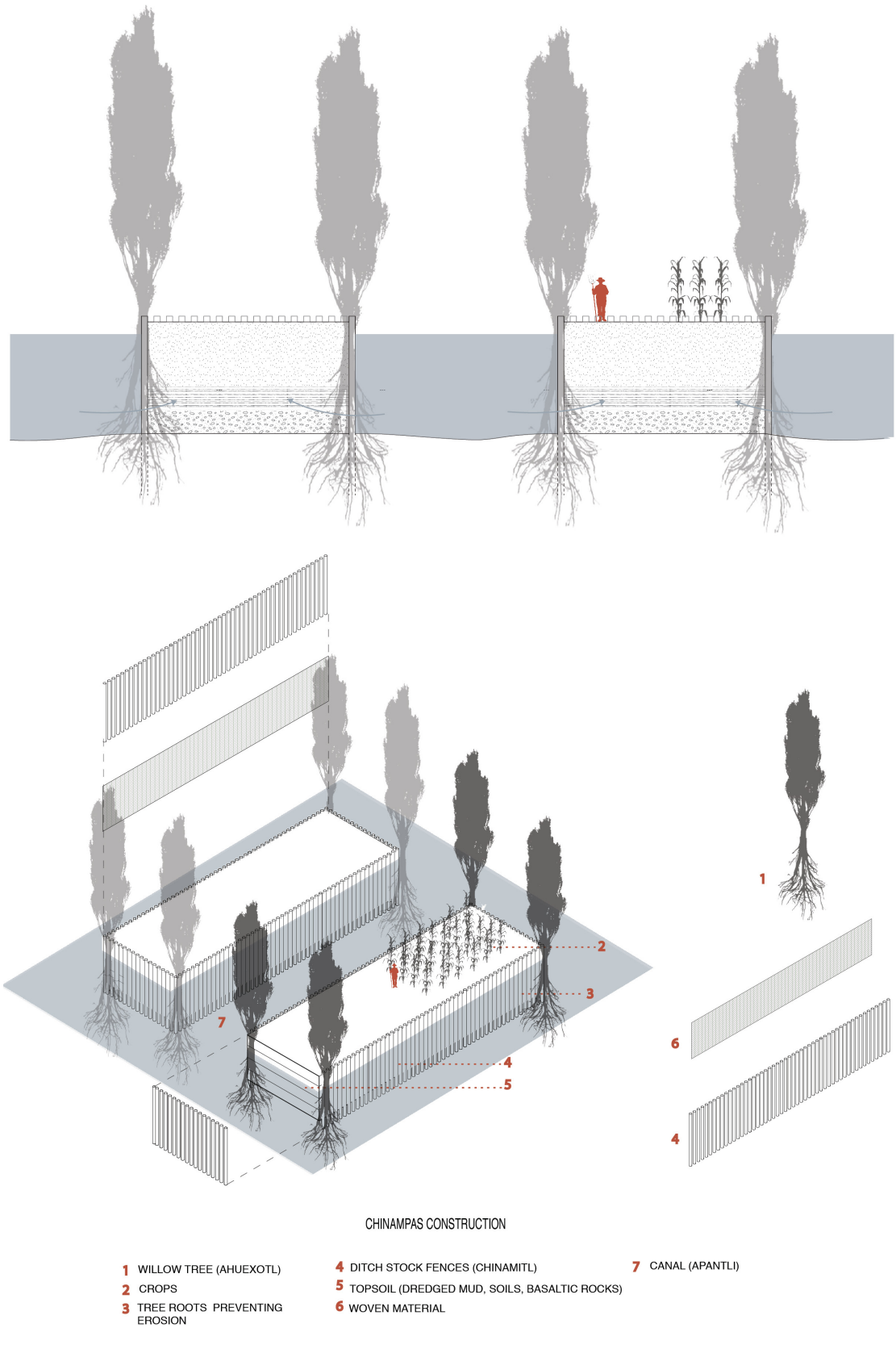
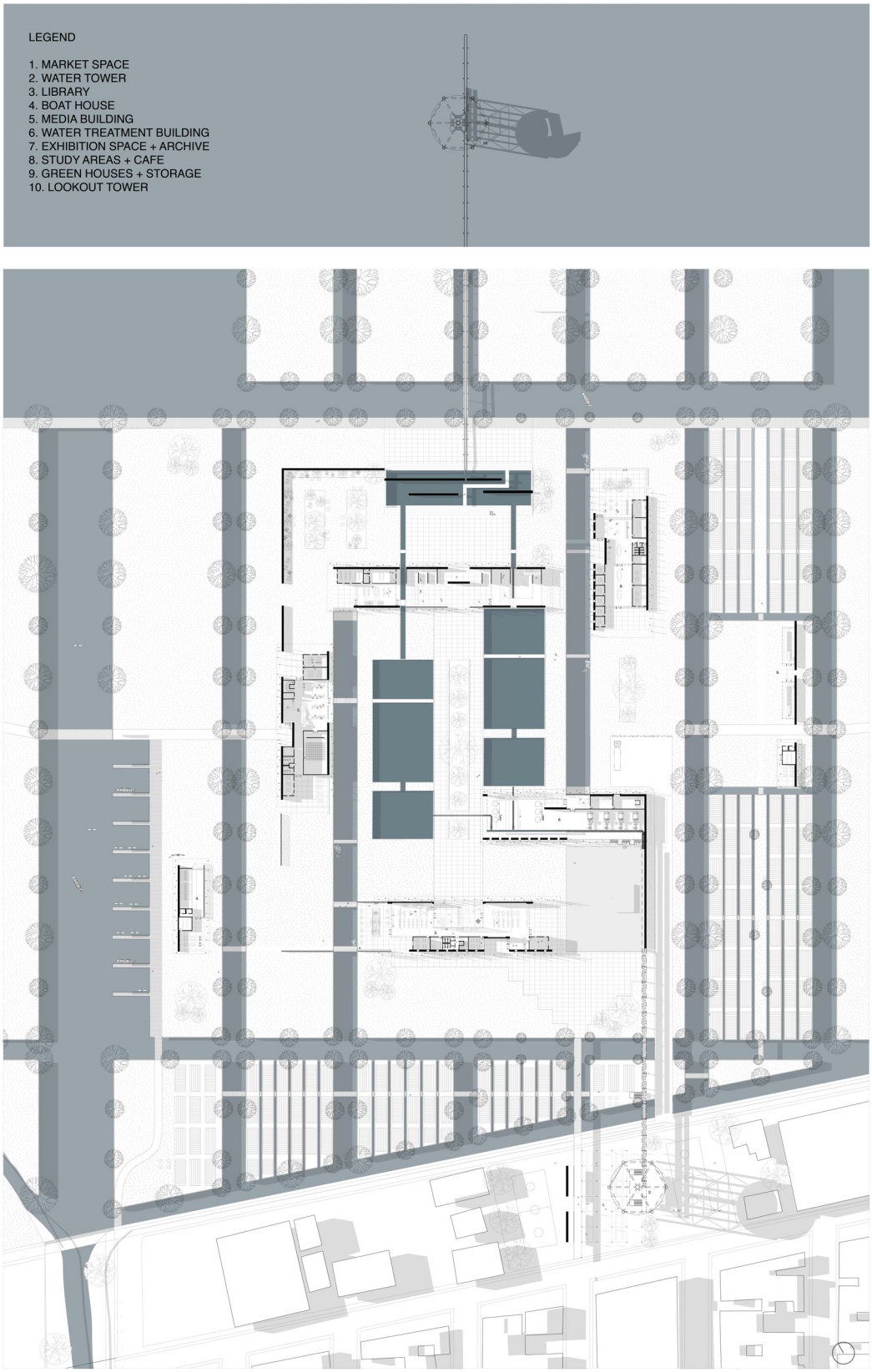
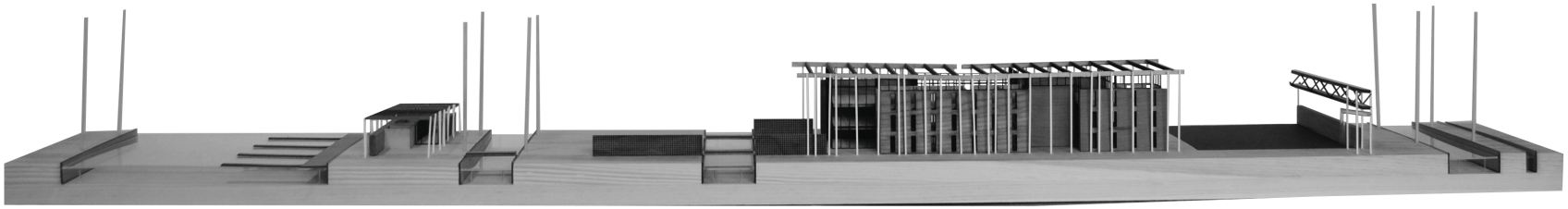


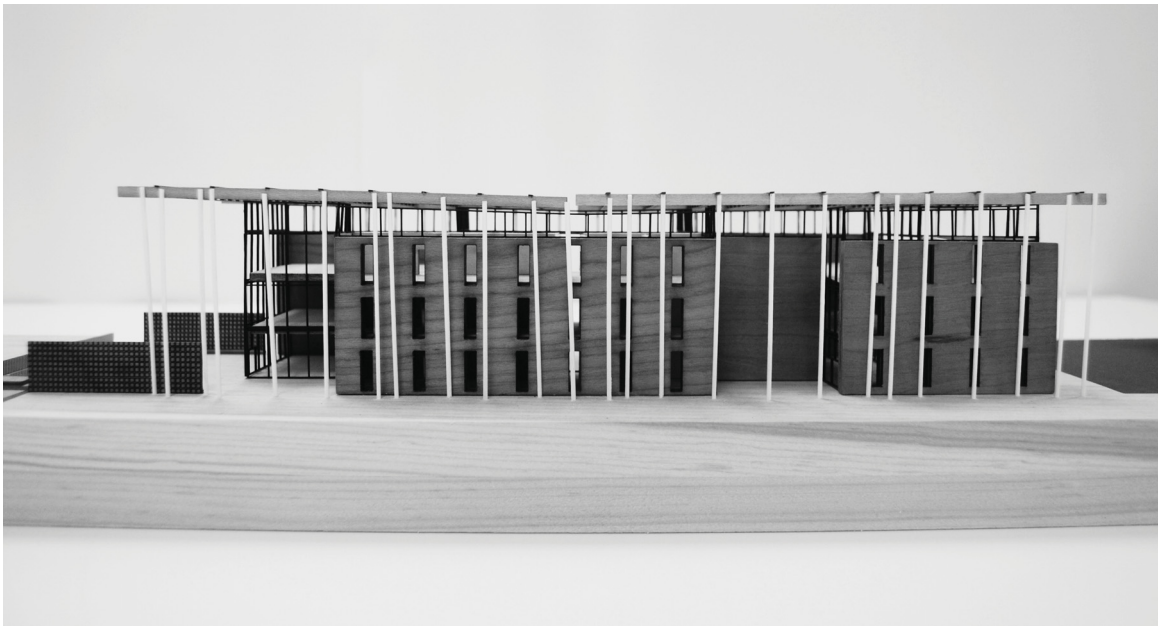
Diagram showing chinampa construction.

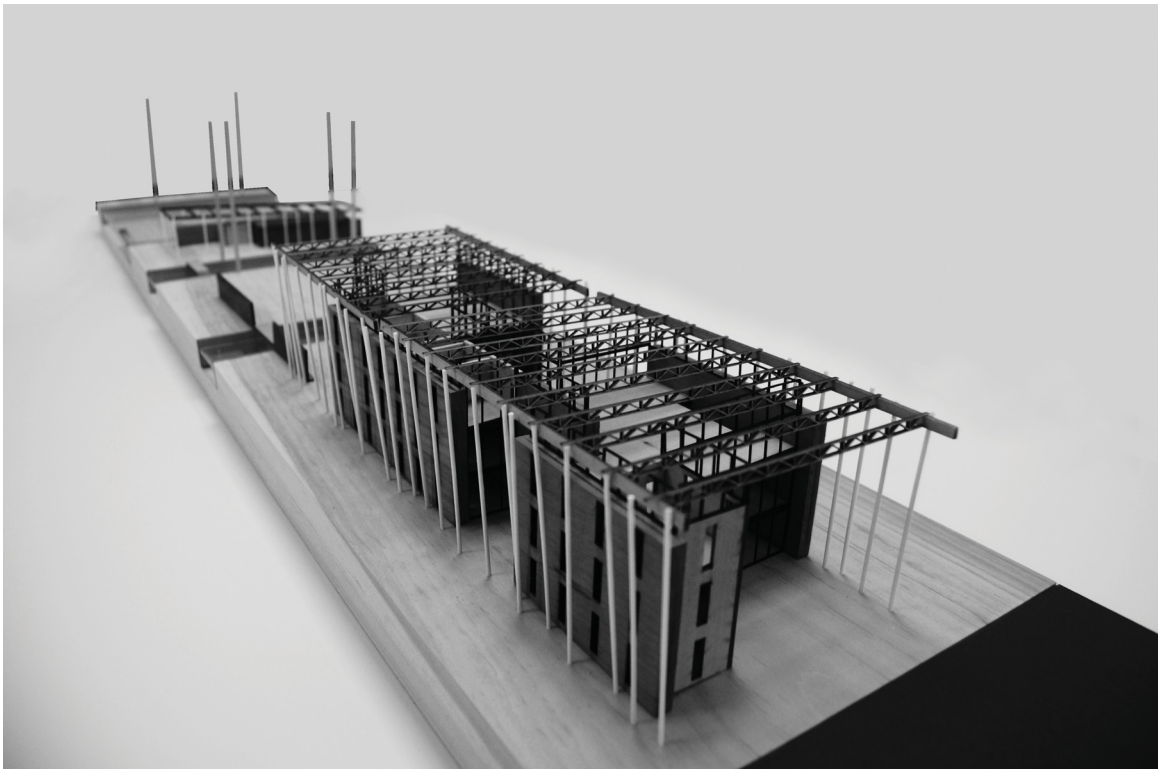


Site plan and first floor plans of educational/cultural buildings + water treatment process.



Photograph of the model (original scale 1:200) showing a section through the site (including: clear well, pedway, library building, water cannels, and boat house).





Photographs of the model (original scale 1:200) showing a section through the site (including: clear well, pedway, library building, water cannels, and boat house).

Social, Educational + Cultural Programs

Social and educational amenities appropriate to the community were selected to pair with the water treatment facility to create a public space that connects inhabitants to the lake, educates people about where their water comes from and encourages local culture and education. Alberto Kallach, considers education central to the social transformation required for the return of the lake: “Large cities have great social problems. In order to solve them we need education, without which it is impossible to be aware of the importance of water in life and of the importance of the return of the city to it”.[51] In selecting programs to couple with water treatment, the following criteria were considered:

1. Since the lake is meant to be a space for all inhabitants, the program should reinforce the idea of accessibility and be a space open to everyone
2. The program should be useful to local people.
3. The program should be appropriate for the site (the site will likely be determined by the needs of the water treatment facility)
4. The program should support education and cultural activities
5. The program should benefit from its proximity to water (engaging with the lake, rainwater, and treated water on site)

In Neza, several programs were chosen based on the above criteria: a library, work/reading spaces, a local history archive, exhibition spaces, and a media centre (see plan on page 76). The larger site also includes: community cultivation areas and gardens that feature local endemic species (many of which are endangered due to the dissection of the lake), green areas for recreation, and a docking area for small boats including canoes, kayaks, and trajineras (traditional gondola-style boats still in use in Xochimilco).

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51 We Are Water Mexico Foundation, *Lakeside City: the Return of Water is Possible,* last modified Oct. 5, 2016, https://www.wearewater.org/en/mexico-lakeside-city-the-return-of-water-is-possible_275561.

In Mexico City, libraries are important community anchors. In 1922, the government started a national public library program to increase literacy, support education, and promote Mexican culture. The government also has created a National Reading Program to "recognize the ethnic, linguistic and cultural diversity of Mexico." The program sees "access to information and knowledge of Mexicans as an essential measure for social and human development." The program further argues that "democratizing access to reading and books promotes equity and reduces inequalities."[52]

During the summer months, over a million children and youth participate in activities at their local libraries. Many of these activities increase the scope of what libraries have traditionally offered, including research, games, storytelling, theater, painting, movies, and exhibitions. With proximity to the lake that the site provides, activities for children will also be able to include interaction with the ecology of the lake, learning about the water cycle and experiencing local flora and fauna.

Libraries are changing in response to the shifting way that people are accessing information and media. In contemporary Mexico, like most places, access to electronic media and the internet is necessary for access to knowledge. A media centre was selected for the site to offer more than just conventional book borrowing. Internet access in Neza is not ubiquitous and so, many people, particularly youth, will be interested in coming to the site to use computers and the internet. The media centre will also contain classrooms and workshop spaces. In Neza, several libraries currently offer skills training and learning workshops (language skills, computer skills).

The government also has a national program to foster a connection

52 Elsa Margarita Ramírez Leyva, *Mexico Reads: national program for the promotion of reading and the book*, (Puerto Rico: International Federation of Library Associations and Institutions (IFLA), 2011), https://www.ifla.org/past-wlic/2011/114-ramirez-en.pdf.

between libraries and cultural activities. Libraries are encouraged to extend programming to public places (parks, plazas, esplanades) to showcase different artistic and cultural endeavours. These cultural activities include exhibitions, public readings, film screenings, musical performances, and lectures. The site includes performance and exhibition spaces.

The exhibition space and local archive (along with the library space), is also a space for memory and stories. Some libraries in the city currently promote storytelling workshops that encourage the older generation to pass on stories to young people. This type of activity could be particularly salient in Neza, which started as an informal settlement, only becoming an official city in 1963.

The goal of coupling water treatment with a library (and related programs) is an important signifier – that knowledge of water is placed on equal footing with other kinds of knowledge and that water has a connection to the social and cultural life of a city.

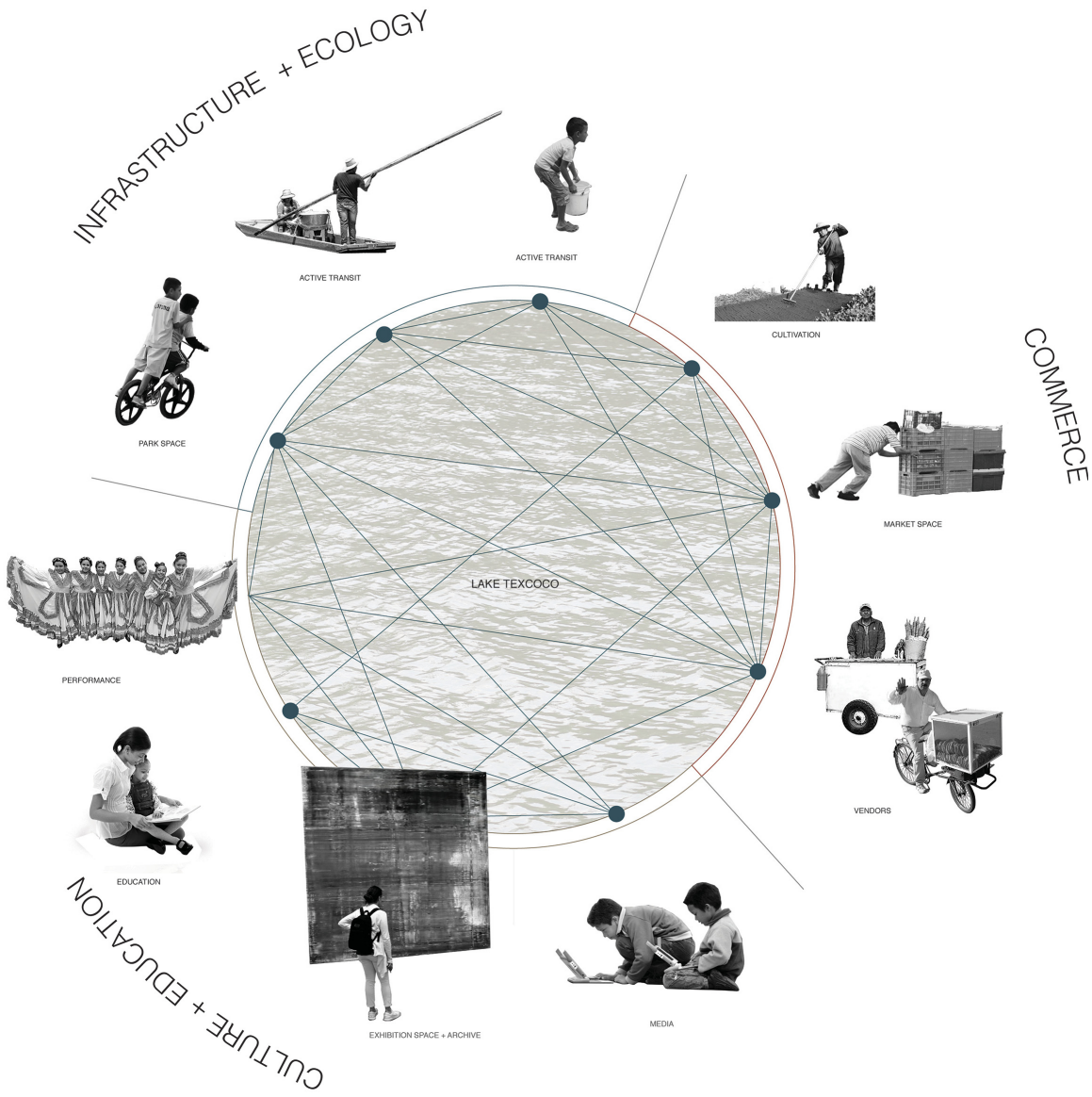


Diagram showing program connections between commerce, education, infrastructure and ecology.

Individual Scale: Experiencing Water Through Design

This thesis investigated how traces of the city's past as a lacustrine city might be referenced in contemporary Ciudad Neza in light of the Drenaje Profundo (the drainage of the city's historic lakes) and the lake's proposed reintroduction. For this, an understanding of water in the built environment historically was drawn from. However, more than just a collective history of place as an island city is relevant to Mexico City. The individualized moments of experiencing water are important in building a relationship between people, their city, and water.

Along with added resiliency, the design of water infrastructure should shape the human experience of water in the city. Charles Moore wrote in his dissertation Water and Architecture, "water is not often used in architectural composition in our time, and even when it is used, it is usually unconvincing…" He goes on to say, "water offers constant change and movement coupled with a suggestion of the infinity of time and space. It offers qualities of splash and play and delight, and other qualities of calm, profundity and invitation to meditation."53 This pronouncement suggests many possibilities for water as a design element, both in terms of cultural meaning and sensory experience.

Moore suggests that through design, it is possible to connect the human need for water, for health and hygiene, with recreation and wonder. Below are four projects that connect architecture with an experience of water including: Therme Vals (a public bath), Trevi Fountain (a public fountain/aqueduct), Las Arboledas (a courtyard with a water trough), and BLUR (a water exhibit). These projects allow people to engage with water on a visceral level creating atmospheric experiences that engage the senses. The projects

53 Charles Moore and Jane Lidz, *Water and Architecture* (New York: H.N. Abrams, 1994), 198.

(discussed and analysed further in the Appendix) relate to water in different ways and demonstrate a series of principles used in designing interactions with water on the site.

BLUR building approach towards the cloud. *Blur Building on Lake Neuchatel*; photograph by Beat Widmer, 2019.

Atmosphere in the Therme Vals. Peter Zumthor Thermal Vals, 2004; photograph by Fernando Guerra

Trevi Fountain; photograph by Hernán Piñera 2009.

Water Trough at Las Arboledas. Plaza & Fountain of the Trough, Luis Barragan 1959.

From these projects, a set of design principles was created:

- Using water's inherent properties (ability to flow, reflectiveness/ translucency) to engage different senses: haptic, auditory, visual, and olfactory.

- Using waters in various states: as liquid or mist/cloud.

- Using "bracketing" or the denial or dampening of other senses in order to amplify others to enhance the sensory experiences.

- Using water's relationship to the materiality of the project either as a contrast (as in the Trevi Fountain or Therme Vals contrasting stone and water) or water as a primary material (as in the BLUR building).

- Using the sensory experience to evoke a set of emotions or as a symbolic element (at the Trevi Foutnatin, it is awe and delight, and in Barragán's work, it is a feeling of serenity.

Water Treatment + Social Program Integration

Therefore are Moore suggests, sensory experience is used here in this thesis as a way to integrate the water treatment process and social programs. While initially there might seem to be a contradiction between the programs of the library and water treatment facility, further investigation shows that they can be complementary. The possibilities for the imaginative and atmospheric qualities of water were considered for both the water treatment and library programs. Water treatment produces specific auditory, visual, or even physical opportunities to interact with water – which are mapped for each process. The library programs that could benefit from these experiences are also mapped (see diagram page 88). For example, study areas could benefit from the white noise of falling water produced by the aeration process.

In further developing a method for program integration, the social/educational programs were arranged in a continuum from "hydrophobic" to "hydrophilic" elements. The hydrophobic elements

require a higher level of environmental control – for example, the main book collection. Other programs like the café or reading/reflection areas do not require the same level of environmental control and are considered more hydrophilic. The water treatment process similarly is arranged on a continuum from “anthrophobic” processes to “anthrophilic” processes – relating to the level of allowable exposure to human contact and the exterior atmosphere. As the water treatment process purifies the water, the level of allowable contact lessens. For example, at the source (the lake itself) people can enjoy recreational activities in the lake, making it anthrophilic. However, once disinfection takes place, there should not be any human contact with the water, making it anthrophobic. This method informed program adjacencies and building placement.

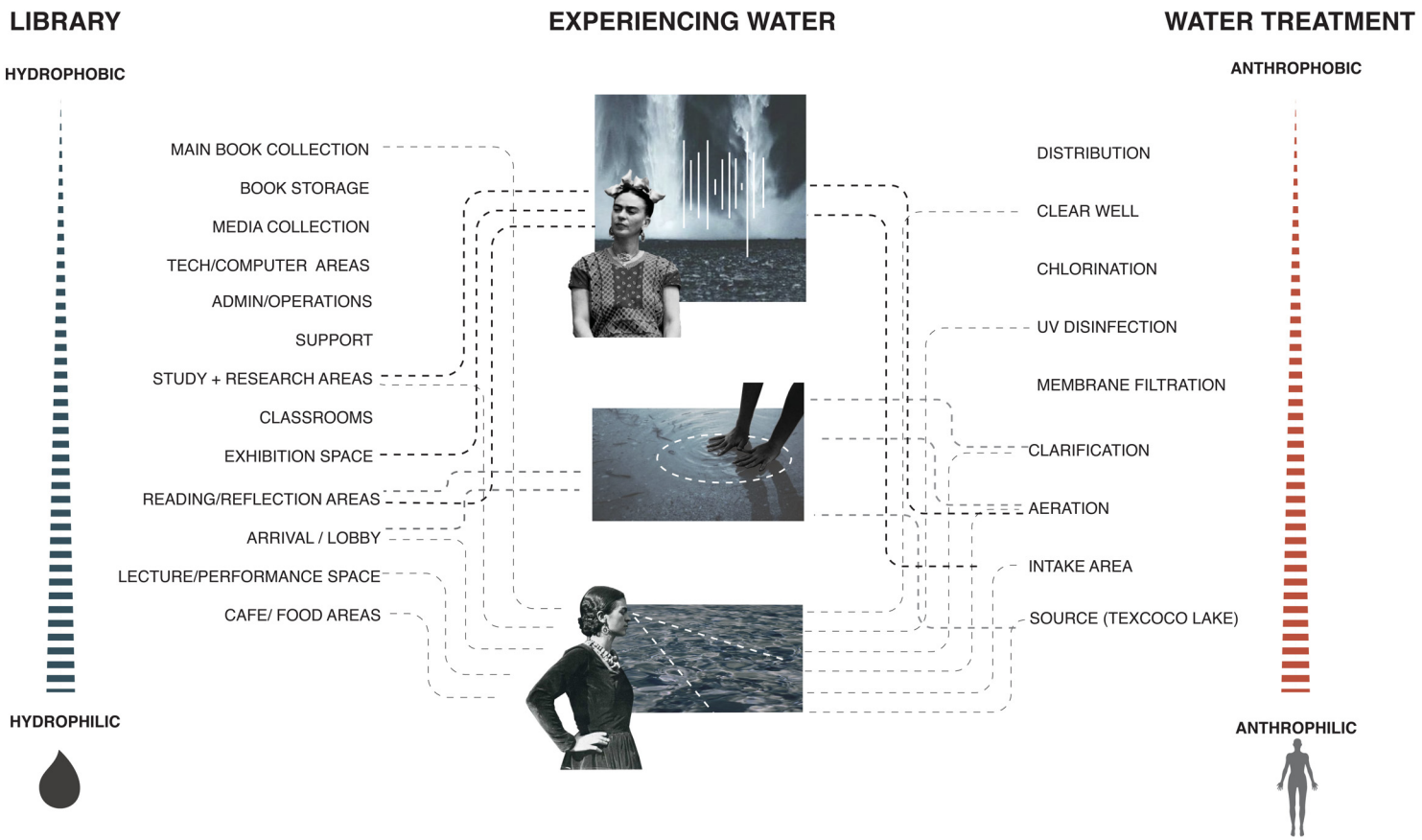


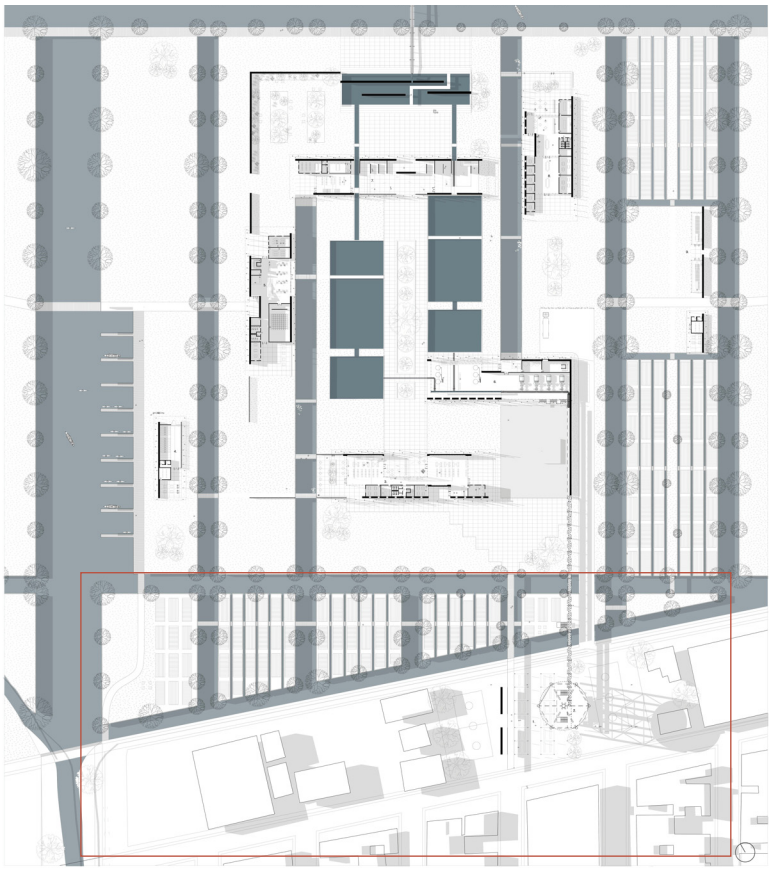
Diagram showing program integration method.

Experiencing Water

The architecture of the site deploys design principles from the case studies and the program integration method, as a means to integrate program, architecture, people and water (the water treatment process, the lake, and rainwater). Below is a sequential look at how an individual would experience the site as they move from the city to the intake point.

Water Tower, Market + Cultivation Areas

A person approaching the site in the new reestablished lake would see the site linked to the city with a market space and beyond that a series of islands that are public cultivation areas. The community gardens use traditional chinampa construction to form the land and to irrigate crops and are



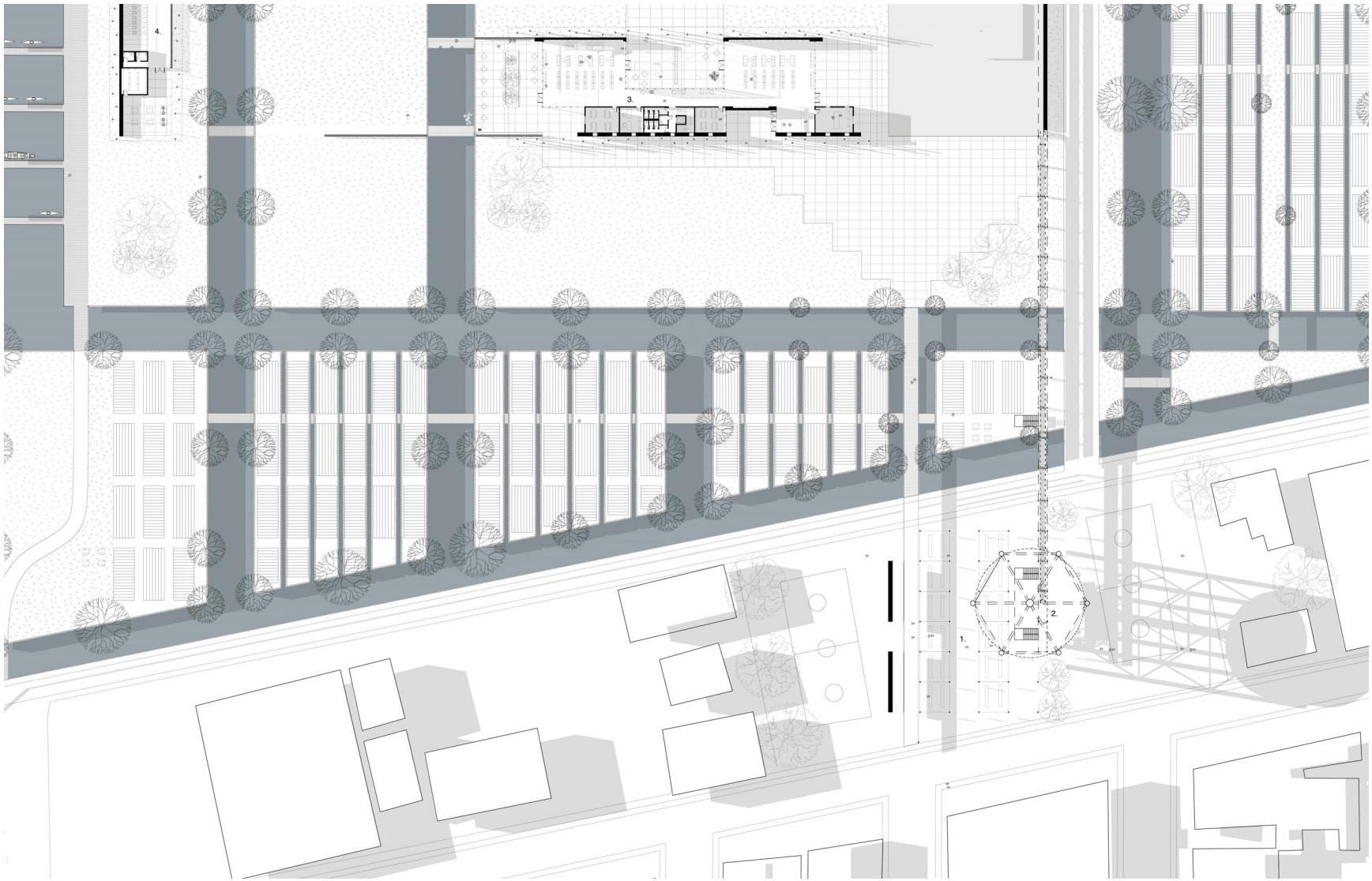
Key plan of the water tower, market and cultivation spaces

connect by wooden bridges.

In the market, walls and vertical columns are used to create a flexible system (canvas coverings can be attached as shade and rain protection). A wall framing the market space incorporates as a series of public water taps, placing water as an accessible public resource forefront in the design.

Within the market space, a water tower adds capacity and water pressure to the existing system. The water tower references the form of an original water tower that was once a symbol of the city, and when decommissioned was replaced by the red coyote statue that now represents Neza. The water tower once again becomes a symbol of the community and is a wayfinding device for the site.

Stairs lead partway up this water tower to a pedway that connects to the main island. Below the pedway a distribution pipe is suspended - both water and people cross above an existing busy road.



Detail of the plan showing the market space, water tower, community garden areas and pedway.

Section through market space and water tower.

Detail of the section showing the public water tap, market space and pedway.

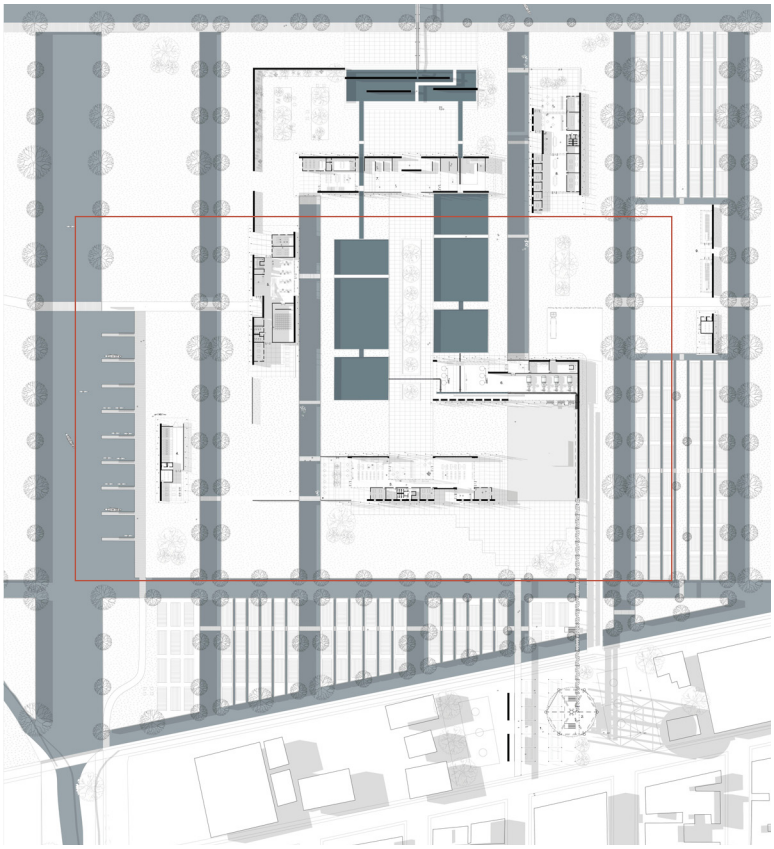
Exterior view of community cultivation gardens, library buildings and water tower and pedway beyond.

Water Treatment Building, Clear Well + UV Light Wall

A person would then descend from the pedway to the main island. Here they can see into the water treatment building at the series of pumps and equipment, workers in the labs and the UV light wall.

The UV light wall is a glass channel that emits a bluish light through the series of openings in a rammed earth wall in front of it. People can pass through this rammed earth wall to see water as it moves through the channel and is treated by the light. In this way, the wall acts as a bracketing device - once between the rammed earth and the UV wall it is an immersive experience of light and water.

The clear well (which stores water in a large underground tank), is identified by a shift in the ground material and

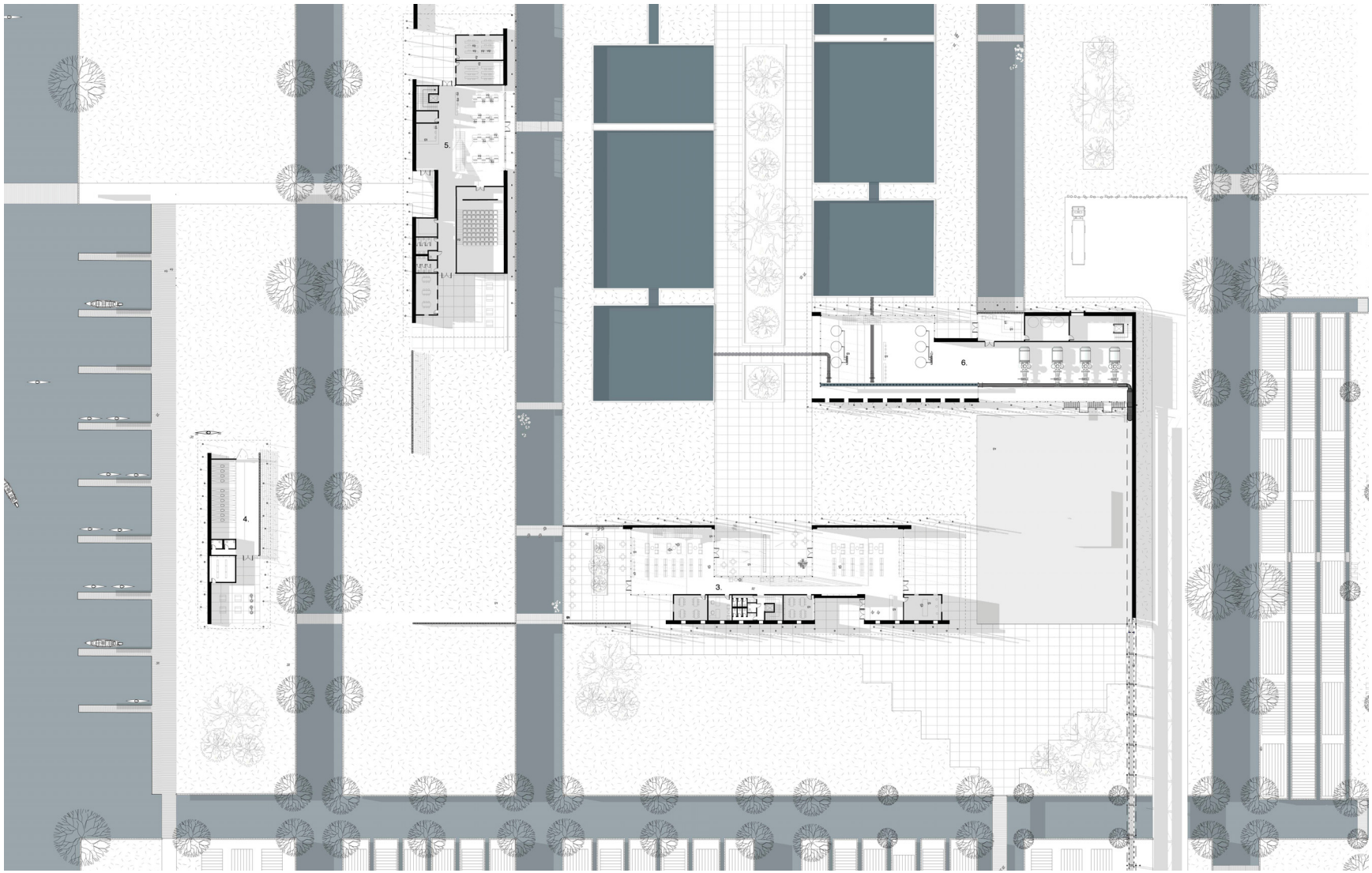


Key plan of the water treatment building, clear well and UV light wall.

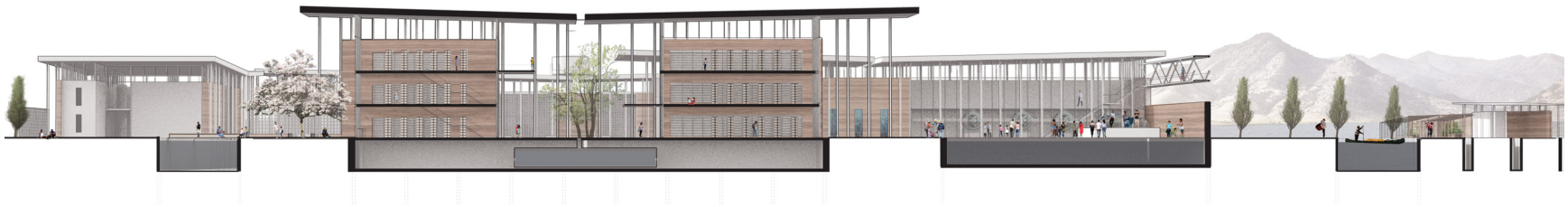
creates an open space for events.

The library building is situated adjacent to the clear well. The thick rammed earth walls of the building house the book collection. An opening between the walls creates a partially covered exterior atrium/courtyard area.

When it rains the library roof channels water to fall into the atrium below where it flows through a grate into a cistern in the basement for reuse, the falling rainwater engages multiple senses: in the library, the falling water creates white noise and visual interest, and in the courtyard, the falling water creates sensations of splash and mist as it hits grade.



Detail of the plan showing the water treatment building, light well, and library building.



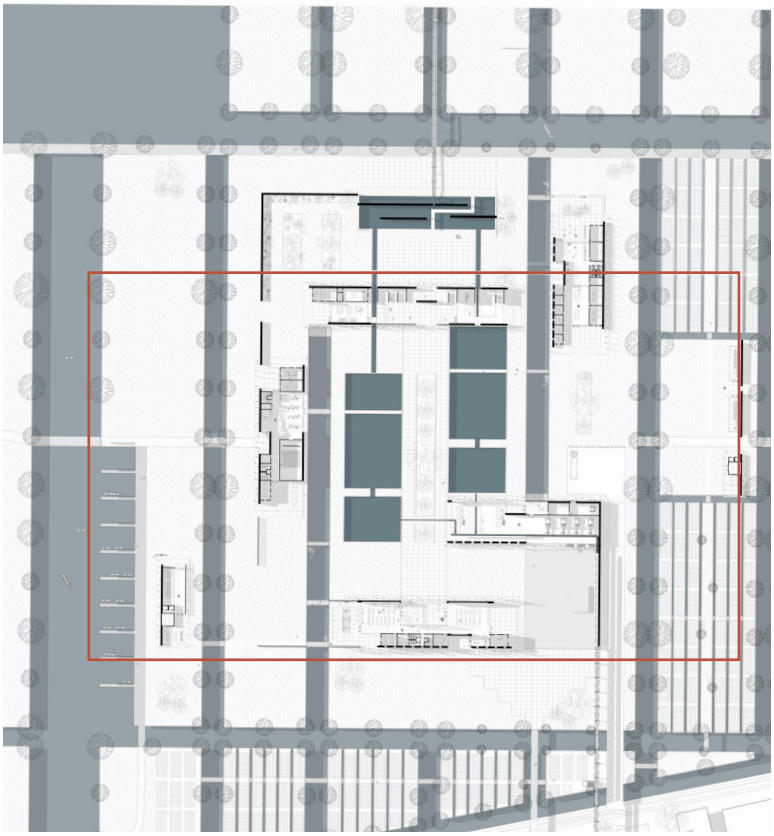
Section through library building, clear well and pedway.

Detail of section through clear well and pedway with water treatment building behind.

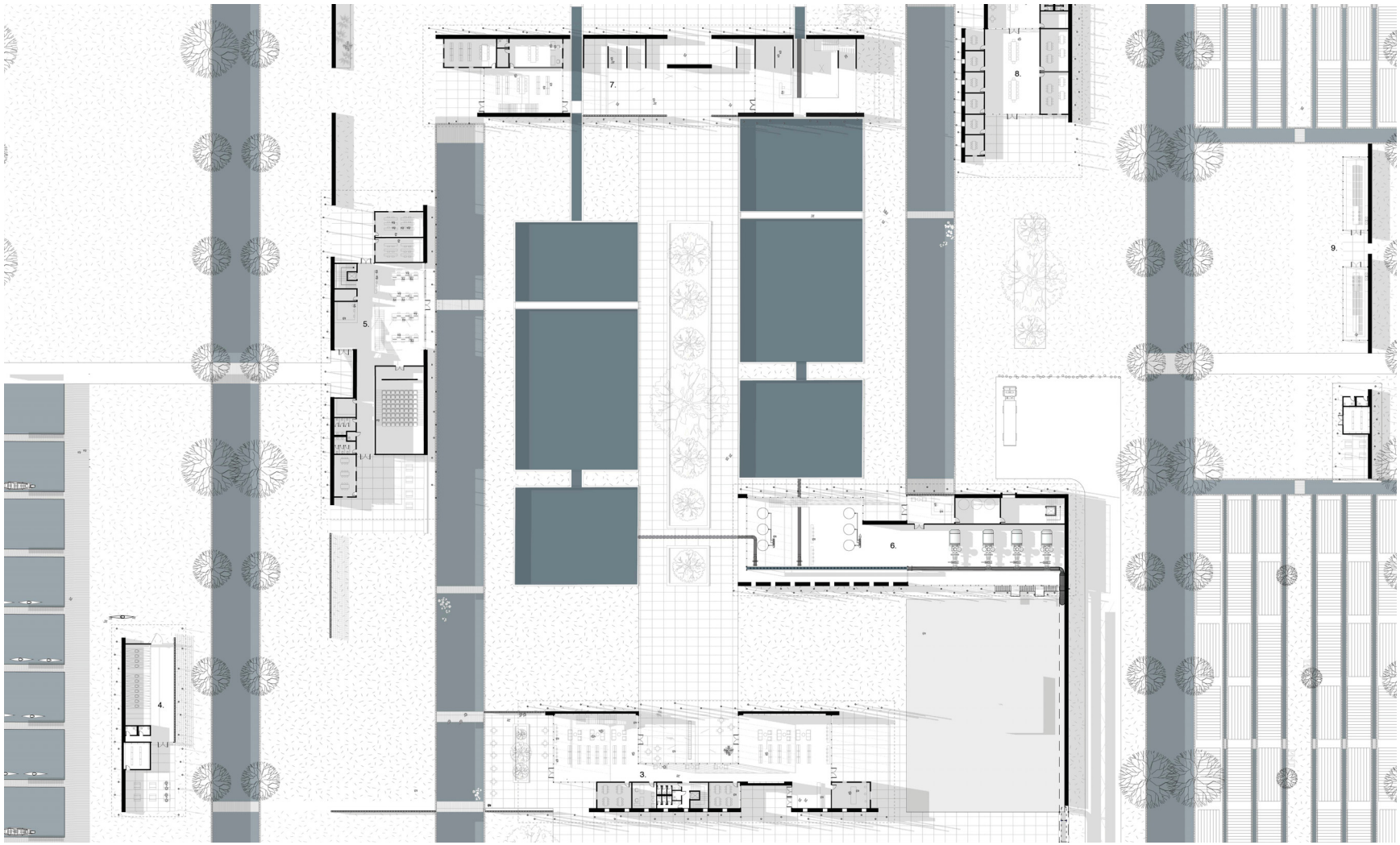
View of the UV light wall.

Clarification + Courtyards

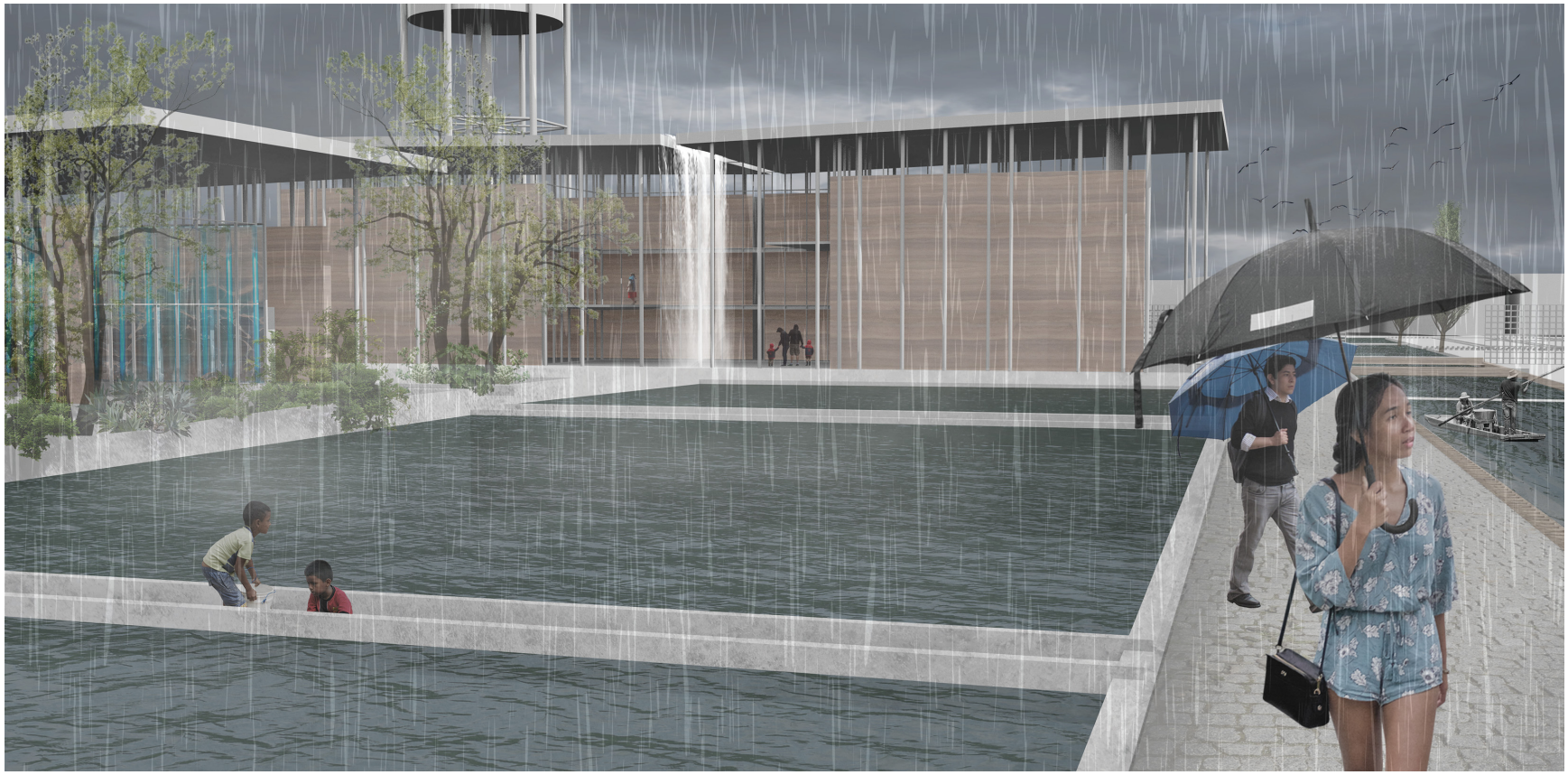
Like the library building, other buildings (including the media building and exhibition and archive building) frame a central courtyard that houses the clarification and filtration processes; essentially four large open water tanks at the center of the site. These water tanks become reflecting pools that people can cross over on pathways (these pools also help to cool the immediate area) or sit on the edge of.



Key plan of the media building, archive building and clarification process;



Detail of the plan showing the water treatment building, clarification process, media building, and archive and exhibition building.

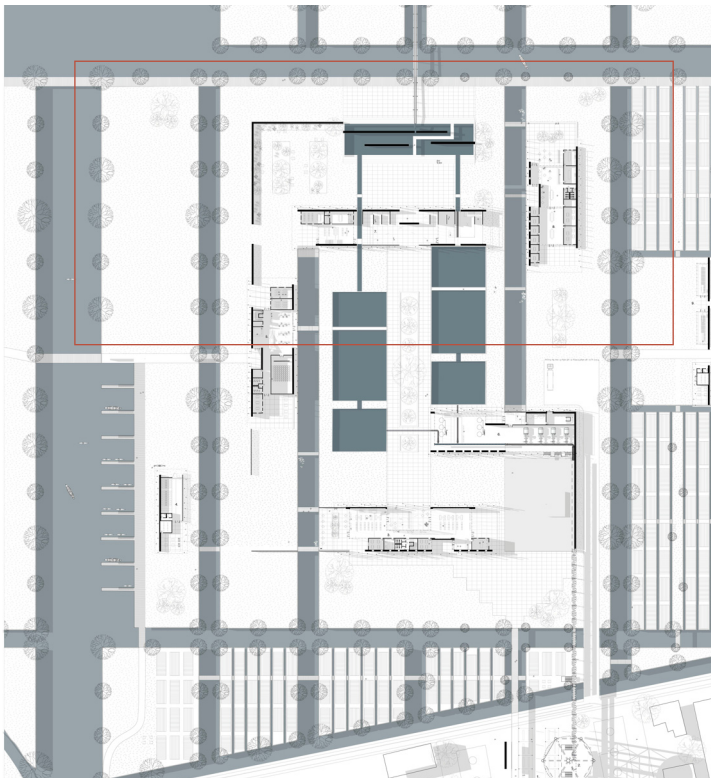


View of clarification process, UV light wall and library building.

Aeration Process

As people move through the central courtyard, they can enter the exhibition space. The central portion of the building is open-air with enclosed portions of the building on either end: on one side is the archive and the other is another exhibition space. A channel of flowing water passes through the space (in the enclosed exhibition space an exposed pipe also carries water). A person would be able to hear but not yet see falling water beyond.

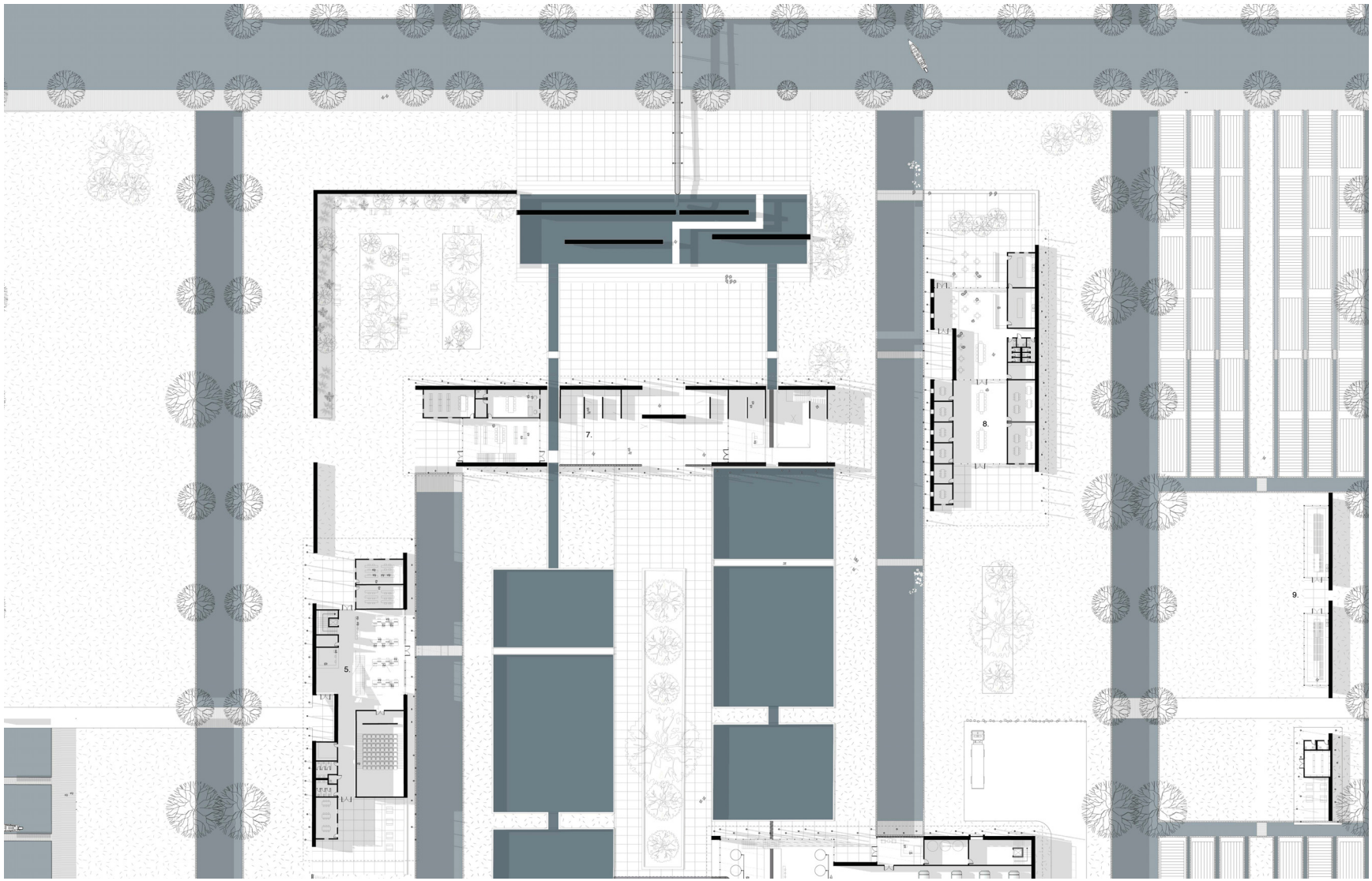
Past the exhibition space, a courtyard is framed by a series of concrete walls (in a pool of water) that make up the aeration process on one side and the exhibition building on the other. Water cascades down the aeration walls to create turbulence. The parallel walls amplify the sound of falling water in the courtyard. People can



Key plan of the aeration process.

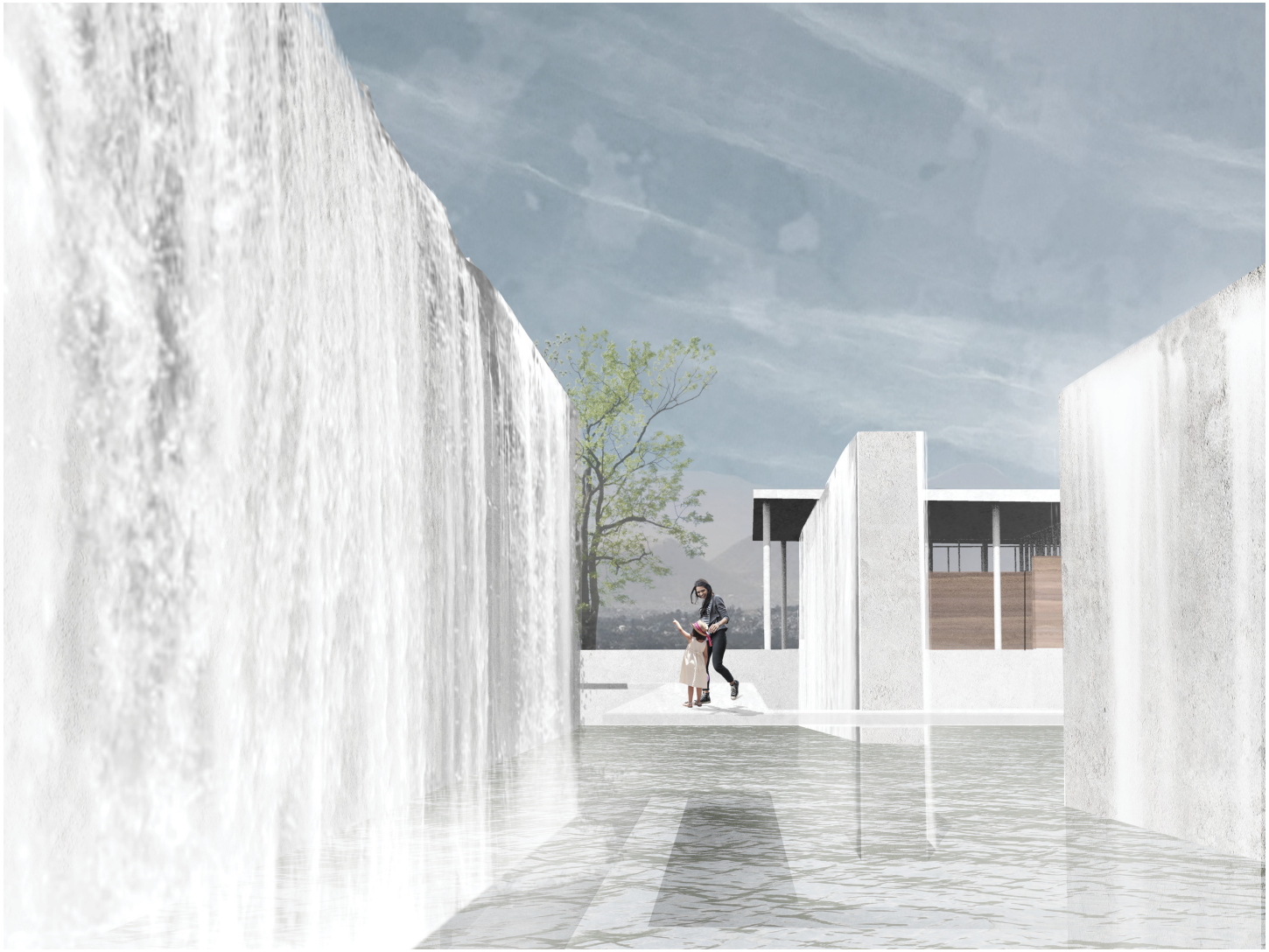
sit on a series of steps or walk along a path that passes in between the walls of falling water.

In between the walls, people are engulfed in an atmosphere of splashing water and mist to create an immersive auditory, haptic, and visual experience of water.



Detail of the plan showing the exhibition building, aeration process and study building.

Section through clarification pool, exhibition space and aeration process

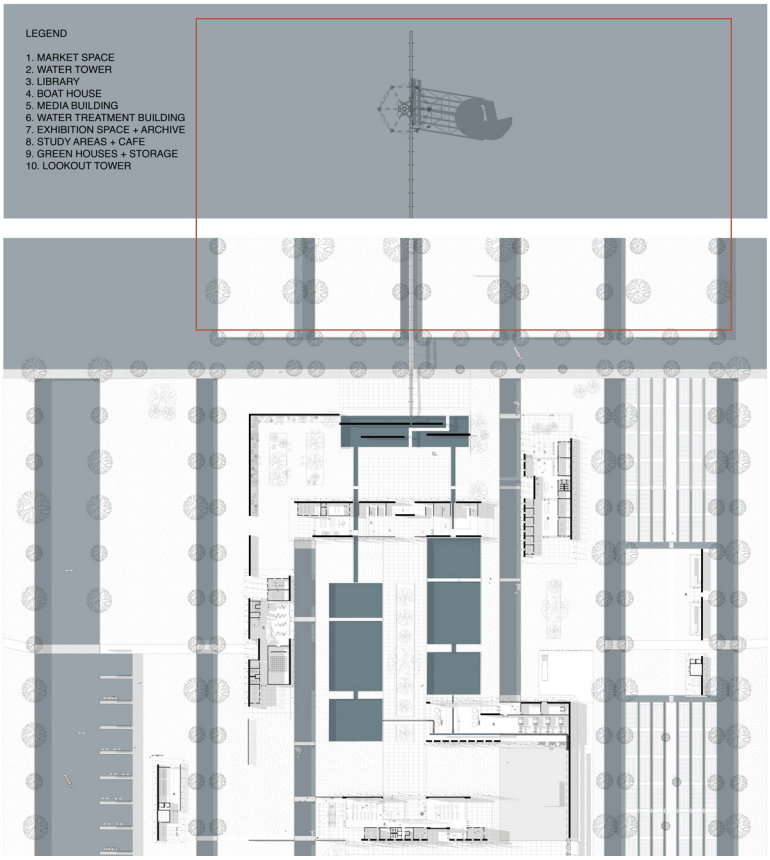


View of pathway through the aeration process.

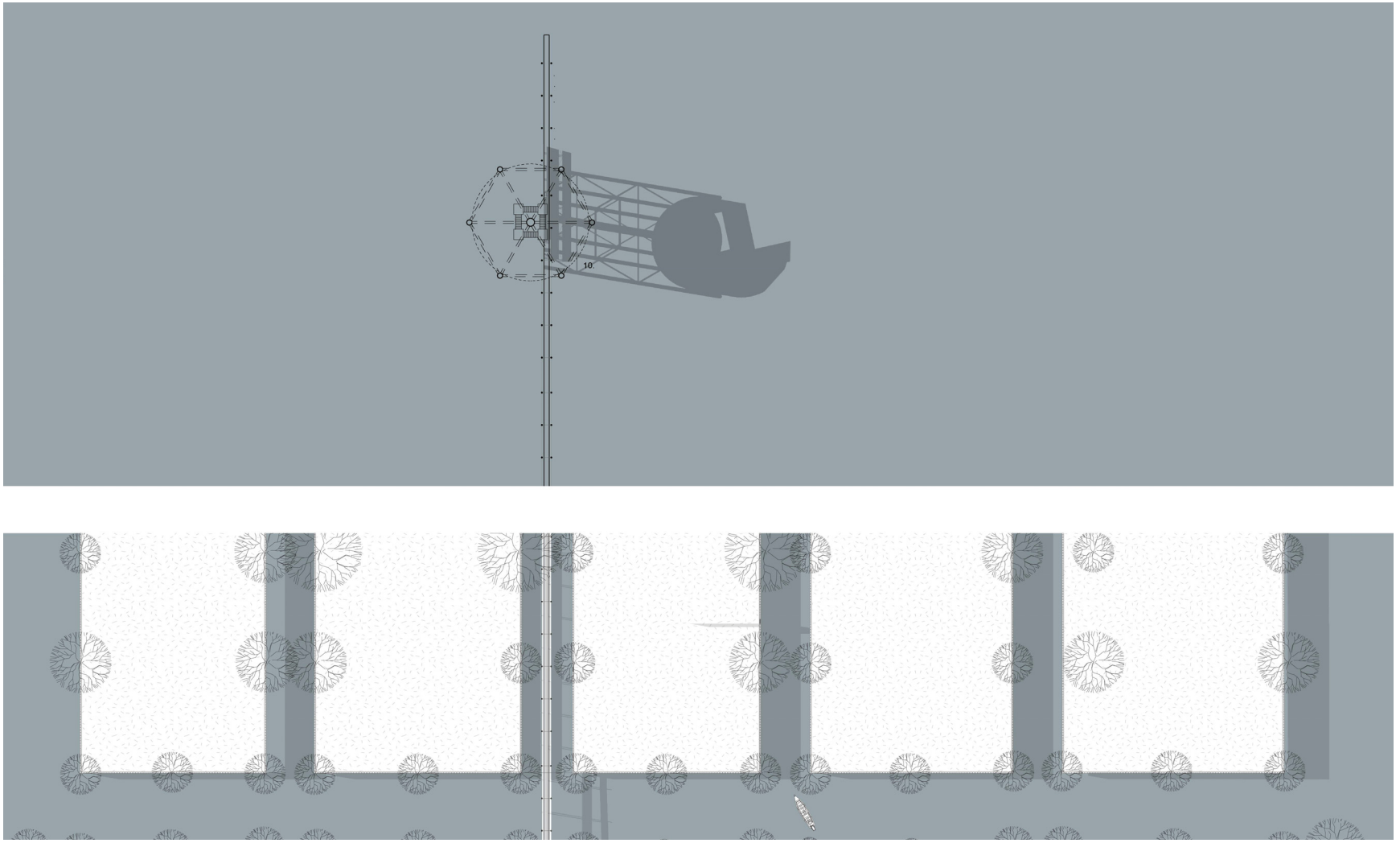
Lake, Intake Pipe + Lookout Tower

A person could then follow a pier, past chinampa islands into the lake, with the intake pipe suspended above. Finally, the pipe descends into the lake where it collects water and the visitors can either sit by the lake or ascend upwards to a lookout tower similar in form to the water tower. The tank of this tower is made of perforated metal, which light can shine through making it a beacon at night.

This final vantage point from above, allows them to see and experience the lake in a different way. They can see the city of Neza, the bioswales entering into the lake, the chinampa islands and look back at the entire water treatment process.



Key plan of the intake and look out tower.



Plan detail of intake and lookout tower.

View of site from the lake including the intake pipe and lookout tower.

CHAPTER 6: CONCLUSION

Projections indicate that the globe will continue to become increasingly urban, and with the growth of cities, resources like water will become increasingly strained. Each city will face unique challenges (flooding, water scarcity, contamination) in addressing their relationship with water. This thesis began as a way to study and ultimately question how cities approach water infrastructure design.

Mexico City posed a unique condition for this exploration, as it has large amounts of freshwater resources yet the imposition of a drainage paradigm (began by the Spanish and continued until today) perpetuates a condition of simultaneous water scarcity and flooding. The drainage paradigm also denied citizens of the valley much of their connection to the historic lake system - affecting traditions, agriculture, and the built environment.

This project aimed to question the existing monofunctional water infrastructure system that is largely invisible in the city, and instead design water infrastructure as a layered approach that considers the local environment and hydrology, the built environment, and the local people. The project is about dualities - traditional ways of land formation and the modern city, water technology and ecology, social programs and infrastructure.

The historic lake system became a focus of the work, and imagining its return leads to many interesting

questions. A few of these questions were addressed within the thesis project. Broadly, the work questioned how public access to the lake would be maintained and how public space along the lake edge could look. Specifically, the thesis investigated how water infrastructure could interact with the lake, the public, and the existing built environment.

This project was built on the work individuals from contemporary times stretching back to the 1930s that have considered the reintroduction of a lake to Mexico City Valley. Through analysis of how people in the Mexico City Valley built in the lake in the past, and through a critical reading of the contemporary morphology of the city of Neza, a new interface between the reintroduced lake and the city was created. The project uses traditional ways of building within the lake and the connections these traditional landforms and water infrastructures had with and public space, markets, and agricultural lands.

The project was also built through an understanding of the connection of the waters that interact on-site and in the city: rainwater, stormwater, lake, treated water, and the aquifer below. The design process demonstrates that water infrastructure can serve many functions and can be made visible in our cities.

The large scope and scale of the project mean that there are opportunities to develop a number of aspects of the project further. If realized, the project would have a large cross-disciplinary team of hydrologists, engineers, water quality experts, architects, government and community stakeholders, and a wide range of other professionals. If continuing to develop the project, some areas to develop

further would be the design of the bioswales within the city fabric, the constructed wetlands, and the primary waste treatment sites. It would also be instructive to look at the other municipalities along the lake edge and see how the contemporary morphology of that city would impact the site design in different ways.

While the results of the design process are specific to the city of Neza, and Mexico City more broadly, the process could apply to other cities and communities.

APPENDIX: CASE STUDIES

Several projects were used to developed a series of design principles for creating a sensory experience of water.

BLUR (Diller + Scofidio)

The BLUR building created a total experience of water. The structure has been described as an architecture of "pure atmosphere." The building material was water itself, harvested from the lake, filtered and sprayed by thousands of misting nozzles. The fine mist created a cloud in the center of the lake. The structure was reached by a gangplank that hovered above the lake and "disappeared" into the cloud. Once in the thick humidity of the cloud, visual and auditory cues were muffled, creating a sensory experience that erased everything but the sensation of mist. From the architect, "Throughout the fog mass, visitors will be drawn to explore this suspenseful, disorienting and unfamiliar setting."[1]

This project is at the intersection of technology (climatic information was tracked to adjust the water system in real-time) and a very individualized experience of water. The project used "bracketing" or the denial or dampening of other senses in order to amplify others and enhance the sensory experiences. In BLUR, water is both used both as the bracketing mechanism and the experiential aspect itself. It also used the inherent properties of water (such as its ability to flow and to exist in multiple states) to transform liquid water from the lake into humidity and mist to create the cloud.

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1 Elizabeth Diller and Ricardo Scofidio, *Blur: The Making of Nothing* (New York, N.Y.: Harry N. Abrams, 2002), 323.

Therme Vals (Peter Zumthor)

Zumthor was interested in connecting architecture with the bodily experience of bathing as a personal, sensual practice. In the Thermal Vals atmospheric qualities are generated through the use of light and its interplay with stone and water. Throughout the project, the heaviness of local stone is used in contrast with the ephemeral qualities of water. Zumthor plays with dark and light, reflections on water, the haziness of steam against the solid walls of slate. He also uses stone's unique qualities to enhance other senses - acoustic properties enrich sounds of bubbling water; warm stone is used to create sensation against bare skin. The project harnesses physical sensations of water: submersion and buoyancy, water as humidity, and even feelings of thirst (incorporating a drinking stone).[2]

Trevi Fountain (Architect Nicola Salvi)

The Trevi fountain celebrates Giovanni Poleni's contributions to water theory and the aqueduct's entrance to the city. The fountain is primarily a visual and auditory experience of water in motion. Pedestrians are funneled through narrow side streets as they near the piazza, "from the Via di S. Vincenzo, an old Roman Street, a distant echo of moving water floats over the crowded buildings and reverberates through the narrow urban canyon…As one enters the piazza, the sound of gushing water steadily mounts to a gentle rumble, then suddenly the street bursts into the sunlight, and a crash of water engulfs the senses"[3] Water gushes everywhere over carved statues and stone in the Baroque fountain. People gather daily around the fountain for its dramatic atmosphere.

2 Phillip James Tabb, *Elemental Architecture: Temperaments of Sustainability* (New York: Routledge, 2019), 20.

3 Moore, *Water and Architecture*, 22.

This project uses water in motion to create visual and auditory stimuli. The surrounding buildings are used as a bracketing device to first dampen the sound and deny views of the fountain and then to amplify it (once one is in the plaza).

Las Arboledas (Luis Barragán)

At Las Arboledas, Mexican architect, Luis Barragán uses water to create an atmosphere of serenity. A processional avenue places water symbolically at its center. A long water trough emphasizes the avenue's axis, and one can hear the murmur of water as they move inward.

In this project, Barragán's stucco walls are used as bracketing devices to remove distractions such as noise and views from beyond. In his interior spaces, water's reflective properties are used to reflect the sky. "The raised, brimful trough, the hidden water outlets, and the narrow drip gutter —a device…for obtaining a solid reflecting image without surface ripples or edge interruptions."[4] The placement of the trough is a symbol of the importance of water.

4 Emilio Ambasz, *The Architecture of Luis Barragán* (New York: Boston Museum of Modern Art, 1976), 63.

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