Revenge of the Lake

An Exploration of Water, Sacrifice, and Regeneration in Mexico City

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Abstract

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Mexico City is sinking quickly, in parts up to nine inches a year and in total thirty feet since its foundation in 1325. Mexico City was built on the lake bed of Lake Texcoco. The original inhabitants of the city, the Méxica, worked with the water and worshiped the water god, Tlaloc, often through sacrifice. The city then fell to the Spaniards who in ignorance attempted to control the water and drained the lake, allowing for further expansion of the city. Mexico City continued to grow and drill wells that are overdrawing potable water from the aquifer; this is one of the main reasons the city is sinking. The city experiences seasonal flooding, which residents of Mexico City call, the "revenge of the lake." There are no measures in place to capture the rain or try and use it to help any of the city's problems with water. In order to end the cyclical nature of revenge, the city must sacrifice drawing water from their aquifer and look to alternative solutions for potable water. This design explores natural treatment of rain and waste water, recycling water, and storing treated water. Through a number of explorations, the design provides a precedent for how the city should re-examine its relationship with water: water as a source of value, not only as a resource.[1]

ACKNOWLEDGMENTS

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To my cohort - Thank you for making graduate school a great, collaborative, and interesting experience.

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Figure 1. Axolotl in murky water.

PREFACE

Revenge of the Lake is a saying that comes from a colloquial saying in Mexico City, one that is used to describe the annual rain storms that flood the city. Residents of Mexico City refer to these rains and floods as the "revenge of the lake" because during these storms there can be a perception that the lake may come back and flood the urban landscape. With the title *Revenge of the Lake*, the drama within the title lead to reviewing stage plays and how they relate to architecture, which then brought on the discovery of Sebastiano Serlio's architectural play sets of the Tragic Scene, the Comic Scene, and the Satiric/Satyric Scene. Looking at Eisenstein's theory of montage, piecing together clips of film to make a movie in *¡Que viva México!;* this movie focuses on Mexico City and its imagery captures each of the three scenes in various parts of the film, as seen in Figure 1. The Tragic, Comic, and Satiric/Satyric Scenes informed the decision to digest and convey Mexico City's rich, complex history, with a focus on its relationship to water, by breaking it into three acts, the tragic, comic, and satiric/satyric.

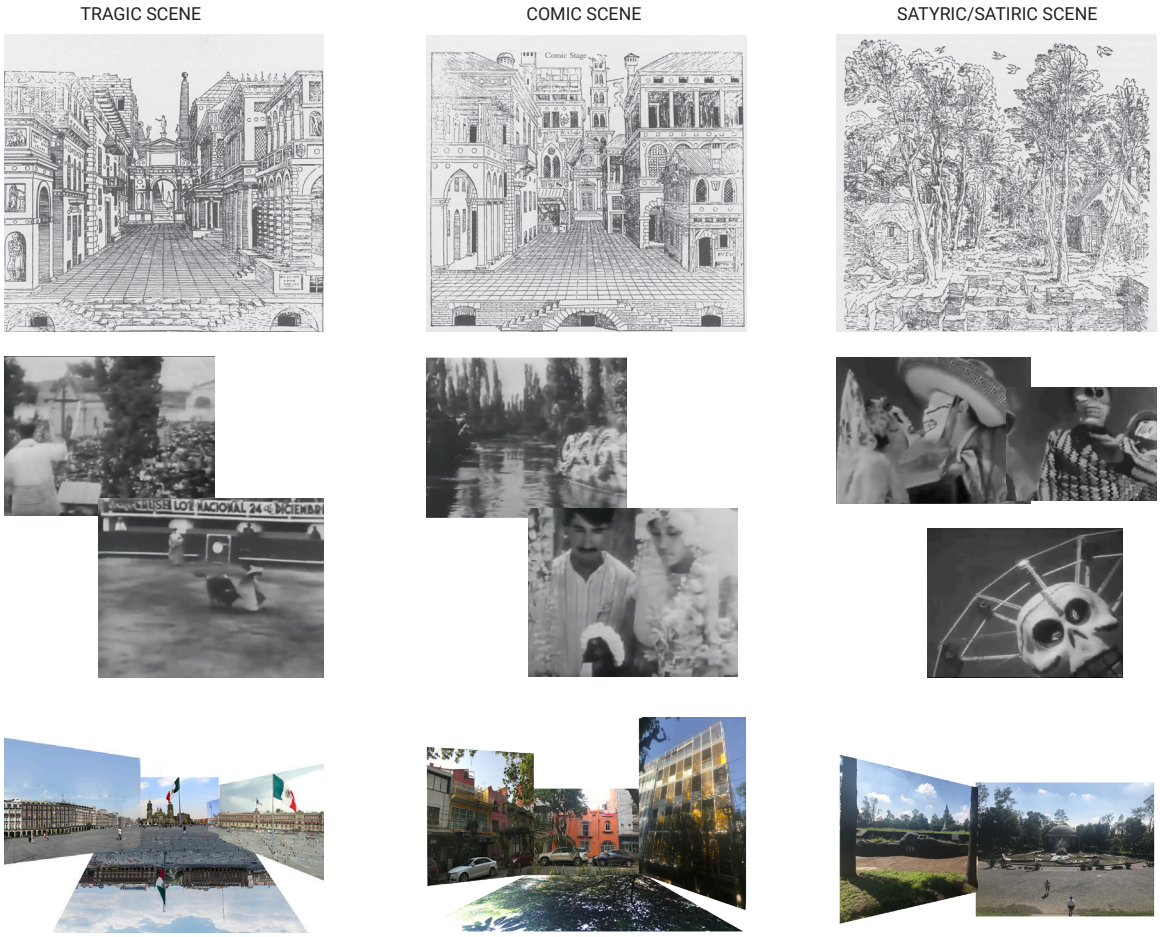

Figure 2. Tragic, Comic and Satyric/Satiric Scenes .

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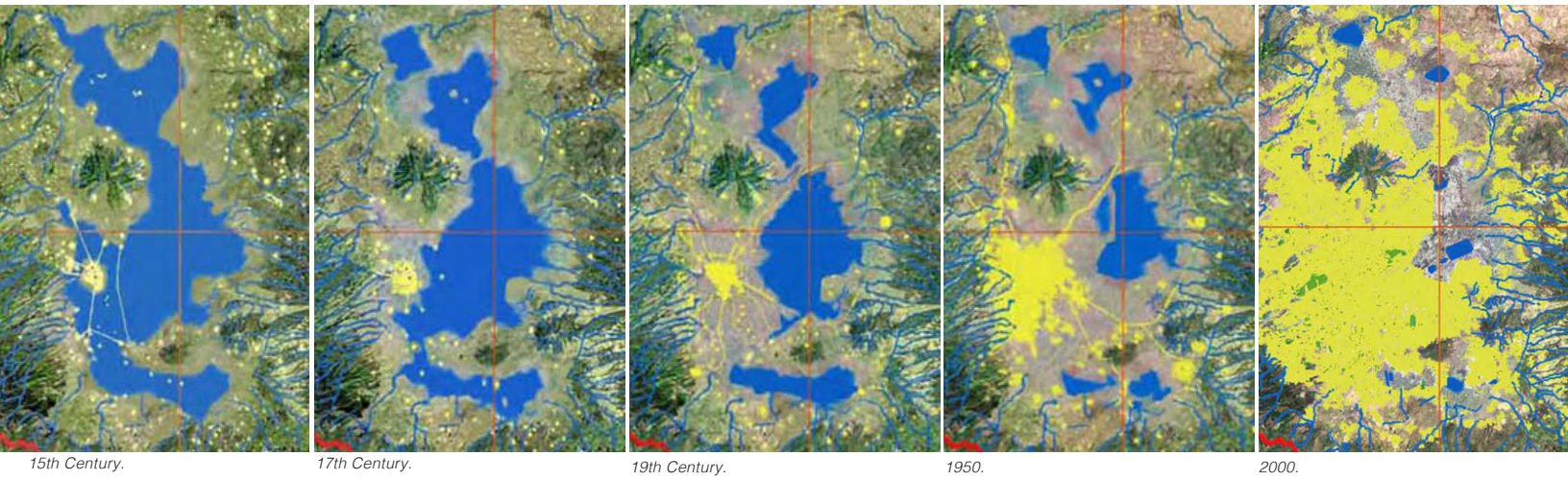
PROLOGUE

Mexico City is sinking quickly, in parts up to nine inches a year and in total thirty feet since its foundation in 1325. This city was built on the lake bed of Lake Texcoco. The original inhabitants of the city, the México worked with the water and worshiped the water god, Tlaloc, and the lake their island city lived on through sacrifice. The city then tragically fell to the Spaniards who in ignorance attempted to control the water and drained the lake, allowing for further expansion. From the time of colonial through global Mexico City, the Lake has not forgotten its mistreatment and is building its revenge; seasonally the Lake ensures the city has problems with water, either through drought or flooding. The Lake is encroaching on the metropolis slowly breaking down the established perception that water is at the mercy of the human population. The city has reached a tipping point of surviving and it has realized: the Lake has risen and the time for penance is here.

Figure 3. Mexico City's Development; yellow: development, blue: waterways, red: outline of Mexico City.



15th Century. *17th Century.* *19th Century.* *1950.* *2000.*

Figure 4. Growth of Mexico City, 1325, and disappearance of the lake; blue: water, pink: city growth, black: outline of Mexico City, grey: state of Mexico.

ACT I. AZTECA | TRAGIC SCENE

I, the Lake, exist peacefully. I am made up of water bodies of cobalt blue (potable) and dark teal waters (saline). Mountains surround my borders, and humans settled at my shoreline, at least, until the god, Huitzilopochtli, directed them to colonize an island that existed within me. The humans developed systems that worked with my unique characteristics, however new, foreign humans do not seem to have the same sense of reverence for me. This chapter tells the story of how my existence began its permanent alteration.

Figure 5. Tragic Scene. Serlio's tragic scene, Eisenstein's religious ceremony and bullfight scenes, and the Zocalo, Mexico City.

SCENE I. FOUNDATION OF MEXICO CITY

Pre-civilization, the Valley of Mexico was formed from water flowing from the surrounding mountain peaks. The Valley, in the central part of the Trans-Mexican Volcanic Belt, is about 9,000km^2 (3,475m^2) in size, with an altitude of 2,200m above sea level. The Valley of Mexico is surrounded by mountains with peaks around 5,000m or more above sea level. Five lakes made up a body of water located in the Valley of Mexico, also known as the Basin of Mexico. These five lakes were named Zumpanco, Xaltocan, Texcoco, Xochimilco, and Chalco. The lakes were formed, fed water from the mountains.

The Azteca civilization originally lived in the Aztlán cave located in the northwest desert. The Azteca were a religious people who worshiped numerous gods including Huitzilopochtli, the god of sun and war often represented in the form of a hummingbird. He led the Azteca people to think of themselves as the Méxica, or “people of the sun," and guided them to migrate to the water source of Lake Texcoco. While Huitzilopochtli led the Méxica to Lake Texcoco, the location of the island where they settled was decided by the heart of Malinalxochitl’s (Huitzilopochtli’s sister) son, Copil; Copil started a rebellion on the migration route, and Huitzilopochtli killed Copil and threw his heart into Lake Texcoco. The Méxica founded their city on the island (location of Copil’s heart), the genesis of the city was “marked by an eagle sitting on a prickly-pear cactus (nopal) and devouring a snake."[2] The name of the city, Tenochtitlán, comes from the city’s foundation, “tetl meaning rock, nochtli, the prickly-pear cactus, and tlan, the locative suffix."[3] In addition to leading the Méxica to their city, the Méxica also believed Huitzilopochtli needed to be fed every day with the nourishment of human hearts and blood. Since the Méxica were the, "people of the sun," they sacrificed human lives in order to satisfy their god.

The development of the city on an island within a lake began and ended with the Méxica; Tenochtitlán was 12,000m^2–14,000m^2. There were five causeways that connected Tenochtitlán to the mainland and vassal towns: Tepeycac Causeway, Tenayocan Causeway, Nonoalco Causeway, Tlacopan Causeway (runs alongside the Chapultepec Aqueduct), and Ixtapalapan Causeway.[4] The causeways connecting Tenochtitlán to the mainland were planned and constructed in the cardinal directions of north, south, east, and west, important

Figure 6. Map of the Mexico City overlaid with image of Lake Texcoco. The darkest ares of red show where the city is sinking most rapidly. Pink line overlay indicates design site.

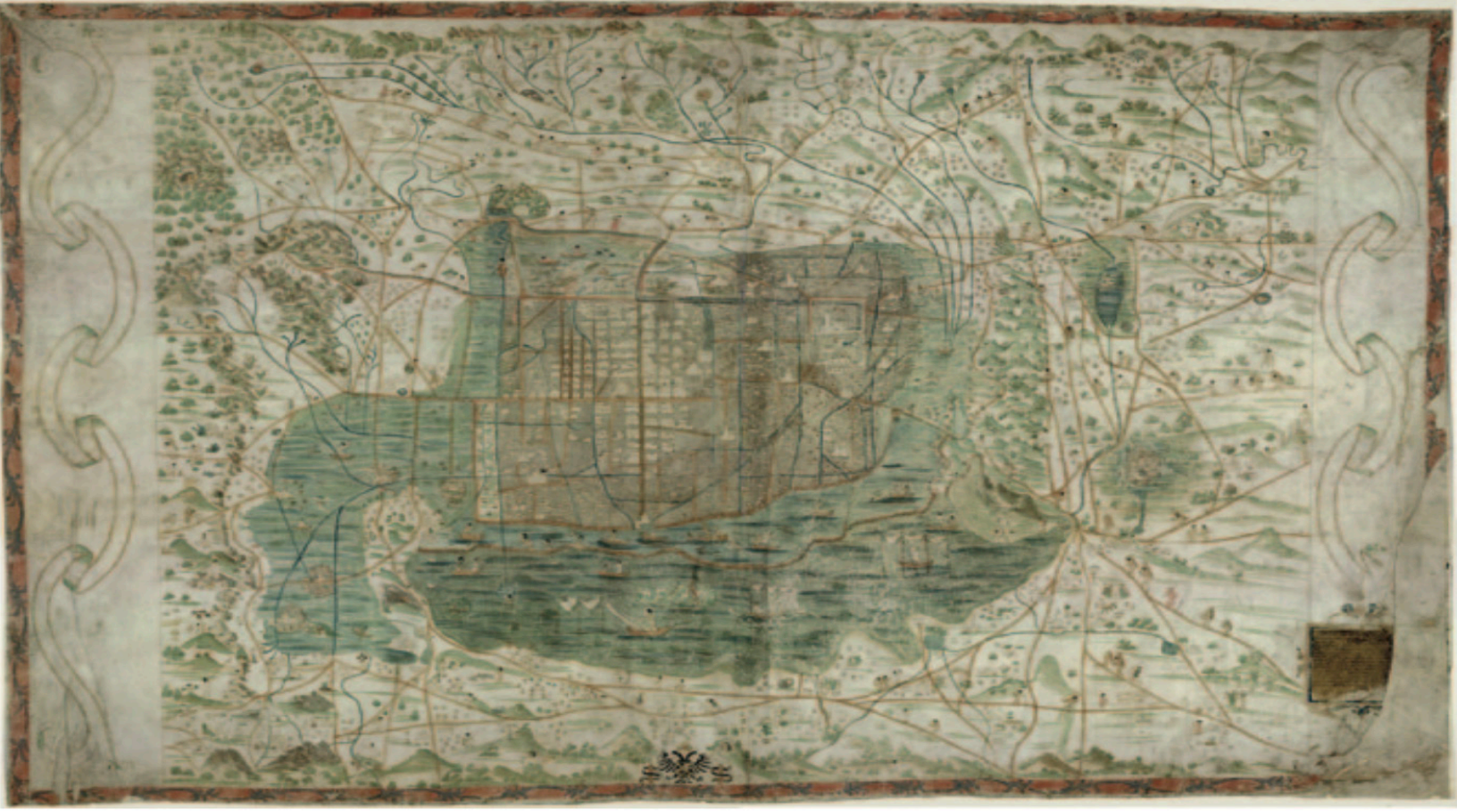


Figure 7. "Nuremberg Map of Tenochtitlán, attributed to Hernan Cortes, 1524."

to the Mexicás because it related to their gods and calendar. “Aztecs associated the 20 signs attributed to the days of their calendar with east, north, west and south (in this order). Each cardinal direction had 5-day signs attributed to it. Some Aztec divinatory books show the following groupings alongside a specific deity."[5] The México were led to develop their city by their gods, but they had to develop workarounds in order to make this city a viable place to live, particularly related to water.

The México valued the water they settled by; the water and the area’s mild climate (average 15^0C/ 60^0F), allowed for larger scale agriculture; México spiritual beliefs aligned with living where food and water were plentiful, but never taken for granted.[6] "The México identified the sacred quality of the natural world as teotl, a word that expresses, as Richard Townsend put it, 'the notion of a sacred quality, but with the idea that it could be physically manifested in some specific presence—a rain- storm, a lake, or a majestic mountain.'"[7] The México worshiped numerous gods, each with their own force of nature. Gods were represented through natural forces such as "rain, wind, thunder, and sun" and "mountains, rivers, lakes, trees, and rocks were sacred and had spirits."[8] Water was believed to be controlled by Tlaloc, the god of rain and other primary god of the México. In addition to making sacrifices

Figure 8. "Bird's Eye View of Tenochtitlán in 1519" (Hirst).

to Huitzilopochtli, the México also sacrificed people to avoid drought and famine. They lived by an eighteen-month ritual in which five months of the year were dedicated to sacrificing to different deities; on the first month of the ritual year, they sacrificed children to Tlaloc. During the sixth month, Etzalqualiztli, the rain priests ceremonially bathed in the lake; they imitated the cries of waterfowl and used magic “fog rattles” (ayauhchicauaztli) to obtain rain."[9]

Figure 9. Huitzilopitchli (Huitzilopitchli, Aztec God).

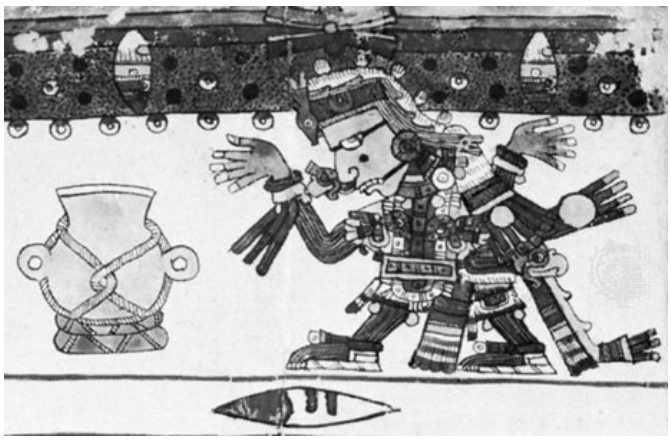


Figure 10. Tlaloc.

Figure 11. Axolotl (Dalton).

The México were not the only ones to sacrifice in order to maintain balance, their gods did as well. The story is that the gods gathered to sit around the fire and had to sacrifice themselves to the fire to give life a new element. "But the god Xolotl, Quetzalcoatl's twin brother, refused to sacrifice himself, which angered his brother, who ordered him to be pursued and sacrificed."[10] In order to escape this order, Xolotl shaped-shifted into several forms to hide until he found the hiding place of Xochimilco; at Xochimilco Xolotl transformed into an axolotl and found a permanent home. Since Xolotl found a home out of view, the story ends with Quetzalcoatl letting Xolotl live, however Xolotl was required to remain under water "to live in darkness forever."[11]

Water was vital to the México for religious reasons, defense, and agricultural economy. While water was vital, its relationship with the México culture was complex. Water seemed

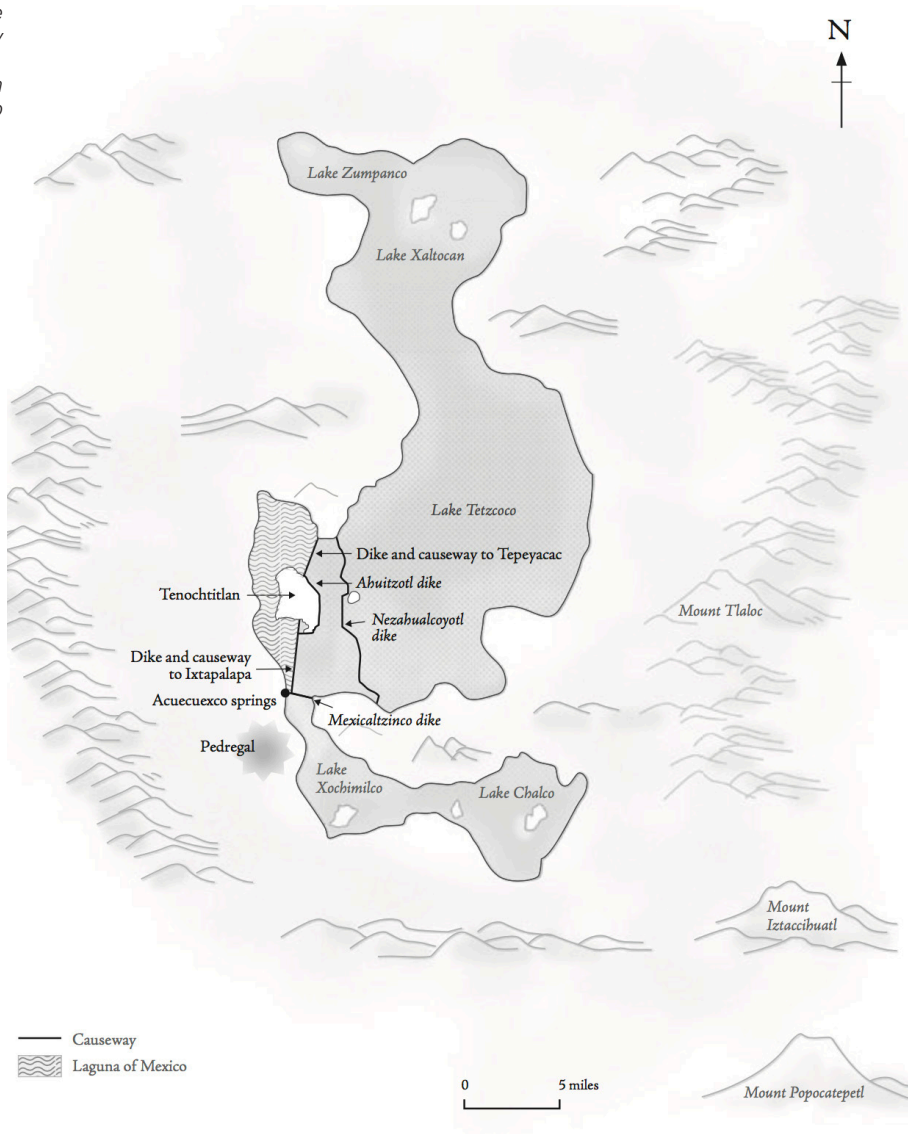


Figure 12: "Map of the major dikes of the Valley of Mexico, ca. 1500, by Olga Vanegas, with information from Gerardo Gutierrez."

available to the city, however the northern part of the system of lakes was saline, "salty," while the southern lakes were potable, "sweet." These lakes had these two different compositions because the southern lakes were at a slightly higher altitude, so when water would drain, it went from south to north. Another reason the two lakes remained separate compositions, saline versus potable water, was due to the narrowing of the water bodies between hills and Pedregal, as seen in ***Figure 12***. In the 15th century, the Méxica built a dike that "separated fresh, upland water from brackish Lake Texcoco."[12] The Méxica also developed a system of aqueducts through which water traveled down from the higher elevations in the southern portion of the Basin of Mexico.[13] These aqueducts were essential for bringing clean water down to the Méxica, because the lake they lived on was a saline lake and therefore offered no

potable water. The principle stone aqueduct brought water to the city from Chapultepec Hill (Cartwright). Montezuma ruled over the Méxica, enforcing the cultural climate of reverence for the gods, development of both city and agricultural infrastructure while working within the natural environment, and sacrifice when conflict arose. As another strategy of working with Lake Texcoco, the Méxica watered their crops via chinampas, “agricultural land fill irrigated with canals."[14] Chinampas are also known as, “‘floating gardens,’ (mud rafts secured with willow trees)."[15] Through the system of chinampas, the Méxica gradually expanded their city.[16]

While the Méxica worked with the water, the relationship was never perfect. From the beginning of their colonization of the island, the lake was never meant to be lived on given its salinity. The Méxica developed their city of Tenochtitlán in a form typical of urban development today. The most important civil infrastructure buildings were focused towards the center of the city and included the Royal Temple Precinct, where the Templo Mayor stood, the Zocalo (city’s

Figure 13: Chinampas.

principle square), and Montezuma's home. The other important feature for the city was the Tlatelolco Temple and Market; while not located with other significant structures, this temple and market were surrounded by city quarters, giving those who resided too far away from the Royal Temple Precinct a place of worship. Within Templo Mayor, there was a "60m high pyramid platform, reached by two flights of steps;" each flight of stairs led to a temple of the México gods, Tlaloc on the north side, and Huitzilopochtli, on the south side. Tlaloc's temple was on the north side, representative of the "summer solstice (symbolic of the wet season) whilst Huitzilopochtli's marked the winter solstice (symbolic of the dry season and a time for warfare)."[17] The rainy season represented a time where the México's crops were bountiful and therefore food and water were in good supply; the dearth of food and water in the dry season lead to unrest amongst the people, and therefore conflict ensued. Color was also significant in the México culture; blues and whites were used to represent Tlaloc and reds and golds were used to represent Huitzilopochtli. The temples also stood as markers

Figure 14: Mexico City 1521.

of time, as the temples grew in size and height with each leader. In addition to being places of worship and respect, the temples were also symbolic of fear because they were where people were sacrificed to the gods. The center of the city grew outwards with homes of middle and lower class as well as chinampas. The city developed with a grid layout; some of the grid was defined by streets and other parts were defined with canals.

Instead of trying to subdue nature, the México worked with their natural environment to develop a successful city and culture; they saw the advantage of working with the water as a source of life and connection with their gods, a form of defense, and a valuable resource for their agriculture.

SCENE II. ARRIVAL OF THE SPANISH

1521 marked a point of tragic transformation for Tenochtitlán; the city's urban form along with its economic, political, and social systems shifted completely with the arrival of the Spanish. 1519 was the year Hernan Cortés arrived from Spain and overthrew Tenochtitlán. Historians originally thought that the Aztecs peacefully relented to the Spaniards. The timing of Cortés' arrival corresponded with the prophesied return of the Aztec god, Quetzalcoatl; Quetzalcoatl was the god "whom the México credited with the creation of humans among other notable feats."[18] Due to this coincidence, Montezuma believed that Cortés could possibly be Quetzalcoatl, and therefore Montezuma welcomed the Spaniards to his city. With this welcoming entrance to the city, Cortés took over and placed Montezuma under house arrest to use him as a bargaining tool with the México. It was thought that due to Montezuma's beliefs and his welcome of the Spaniards, he lost the respect of his citizens and died while under custody. Montezuma's nephew, Cuauhtémoc, became the new leader and led the México army to push the Spaniards out of Tenochtitlán. While Cortés had lost that battle, he was not defeated; he rebuilt his army with local rivals of the México in addition to his Spanish army. The fall of the México occurred on August 13, 1521 at the Plaza of Trés Culturas, a plaza adjacent to Tlatelolco's main pyramid; With this location being of such a significance to the México, the Spanish wanted to claim this site as the foundation for establishing their culture; they built the catholic church, Templo de Santiago at this site in 1609.[19]

Figure 15: Detail from "Conquest of Mexico."

Another institution put into place at this time was a university for the city. The university was founded in 1551 and named Universidad Real y Pontificia de México. The university started "its classes on the 25th of January 1553 by the viceroy of New Spain, Don Luis de Velasco, on the street of San Idelfonso, located in downtown Mexico City, and was closed by liberals in the mid-XIX century.[20] Starting a university was another way the Spanish altered the city culture.[21]

The Spaniards did not revere nature and its systems as the México had established with their city structure and relationship with water. With the city conquered, the Spaniards developed it as they saw fit; they brought their own culture and religion to the city and began to build more

religious institutions. The Royal Temple Precinct and Zocolo were replaced with a cathedral, and a main square (still entitled the Zocolo). In addition to developing over significant building infrastructure, Cortés also imposed a Cartesian grid to the road and neighborhood layout. “The overlay of the Pre-Colonial axes with the inscription of the Spanish grid gave way to a complex transformative process in which a lacustrine-agricultural infrastructure was gradually transformed into a grid and block structure predominantly made up of ecclesiastical buildings for the Catholic church."[22] In addition to constructing building infrastructure, the Spanish built out the city itself. Cortés commanded expansion and development in the form of typical Renaissance city structure. With the expansion of the city and new construction, the water systems in place were ignored and the established dikes were in parts destroyed and in other negated, removing any of their original purpose of separating potable versus non-potable water. The stage was set as the lake disappeared under infrastructure or was drained to quench the needs of its citizens. As the Méxica reluctantly relinquished their city and culture to the Spanish, nature also fell; the seeds for revenge were sown.

ACT II. COLONIZATION + INDUSTRIALIZATION OF MEXICO CITY I
COMIC SCENE

A foreign group of humans arrived on my waters, bringing their ideals and customs. These humans are changing my body, filling it with soil, draining my water away because they do not want to exist within my waters. They think they can remove me, control me...they will find out that is not possible. They believe human infrastructure and engineering will solve their problems with water, where they could have built a system that worked with my waters. This is comedic, their "solutions" are making their situation worse. I will not be forgotten.

Figure 16. Comic Scene. Serlio's comic scene, Eisenstein's canal boat ride and wedding ceremony scenes, and a Mexico City street with residential apartments.

Figure 17. Main Square of Mexico City, Jose Maria Fernandez.

SCENE I. COLONIZATION

The 16th century marked the arrival of Cortés and the Spaniards which led to the end of Tenochtitlán and the development of Mexico City. During the 16th and 17th centuries, Mexico City experienced the re-establishment of the colonial capital; the city underwent an incredible number of changes ranging in a shift of everyday life from the transition of a whole culture's religion to a whole new government and social establishment. Within all the changes, water and its access remained a key component to every facet of life in Mexico City. Spanish residents did not follow the Méxica way of life in utilizing potable water for drinking and saline water for other purposes; they "instead used valuable drinking water from Chapultepec for irrigation and for other low purposes."[23] The other purposes referenced included cleaning clothing, bathing, and providing water for animals. The misuse of potable water, that the Méxica worked on storing, was just the beginning of how the Spanish fought the city's environment.

One of the major forces of change occurred due to fear of the valley flooding. Infrastructure intervention began in 1555 with Luis de Vlasco, the second viceroy of New Spain. “The city’s first great flood crisis hit in the wake of the 1555 rainy season, when the city experienced flooding so severe that the Spanish cabildo[24] complained in October that the city was almost underwater."[25] The large effort to control the water situation of the city was to rebuild the Ahuitzotl dike; this dike, like the others, was ruined and ignored since the conquest of the city over twenty years prior. The viceroy struggled to obtain funding for the rebuild of this dike and while he eventually maintained funding, the damage had been done. The dikes were not sufficient to fix the flooding problem; in 1607, the next viceroy, Marqués de Montesclaros, and cosmographer, Enrico Martínez, began to work on a tunnel that would go through the mountains; this became known as the Nochistongo Gash. The aim of the Nochistongo Gash was to drain waters that flooded the valley. While these systems seemed feasible, King Philip III of Spain was not convinced this measure would be successful and instead ordered the evacuation of Mexico City in 1616. This order was not heeded and instead another viceroy, Marqués de los Gelves, directed that the city experiment with allowing water to return to its natural levels within the city. This order ended up flooding the city and was exacerbated by a storm; as a result, the city experienced a great flood in 1629 that submerged the city for five years. In 1637, King Philip focused on a large drainage project for the city instead of trying to relocate it. King Philip employed a drainage ditch to divert water of the three small rivers (east of Mexico City) away from the city. This ditch worked in diverting water, but was not cared for and eventually became obsolete.[26]

1750 marked the rise of the House of Bourbon, bringing a series of changes, called the Bourbon Reforms, that benefited the wealthy and did nothing for the majority of people; this led to unrest amongst the people. In 1778, the city declined even more, as the Nochinstongo Gash was completed and the lake shrank even faster. The drainage of the lake allowed for faster colonization with more direct roads as well as a spread of western agriculture; these changes made the chinampas move southwards. In terms of water infrastructure, the development of the city extended the Chapultepec aqueduct to the “hills of Cuaujmalpa and supplemented by Behlehem Arcade, a southern spur."[27] Through colonization, the Spaniards worked to expand the city, ignoring its natural setting and building over the lake. Water in Mexico City in the 19th century was brought in on the aqueducts until the 1850s. The discovery of ground water as a source of potable drinking water around 1850 was seen as progress, moving away from the ancient systems of aqueducts and reliance on mountain spring water; ground water was the new, innovative discovery and was used to serve

Figure 18: Growth of Mexico City, 1900, and disappearance of the lake; blue: water, pink: city growth, black: outline of Mexico City, grey: state of Mexico.

the new population of Mexico City. "Over the next century, a combination of increasing ground water extraction and artificial diversions to drain the valley resulted in the draining of many natural springs, shrinking of lakes, and a loss of pressure and subsequent consolidation of the lacustrian clay formation on which the city is built.[28] This drilling into the aquifer that exists below the city began the process of Mexico City's state as a sinking city. Mexico City was developing a cycle of expansion of infrastructure, leading to an increase in population, the beginning of social tensions, and further interest in industrial infrastructure and advancement.

SCENE II. INDUSTRIALIZATION

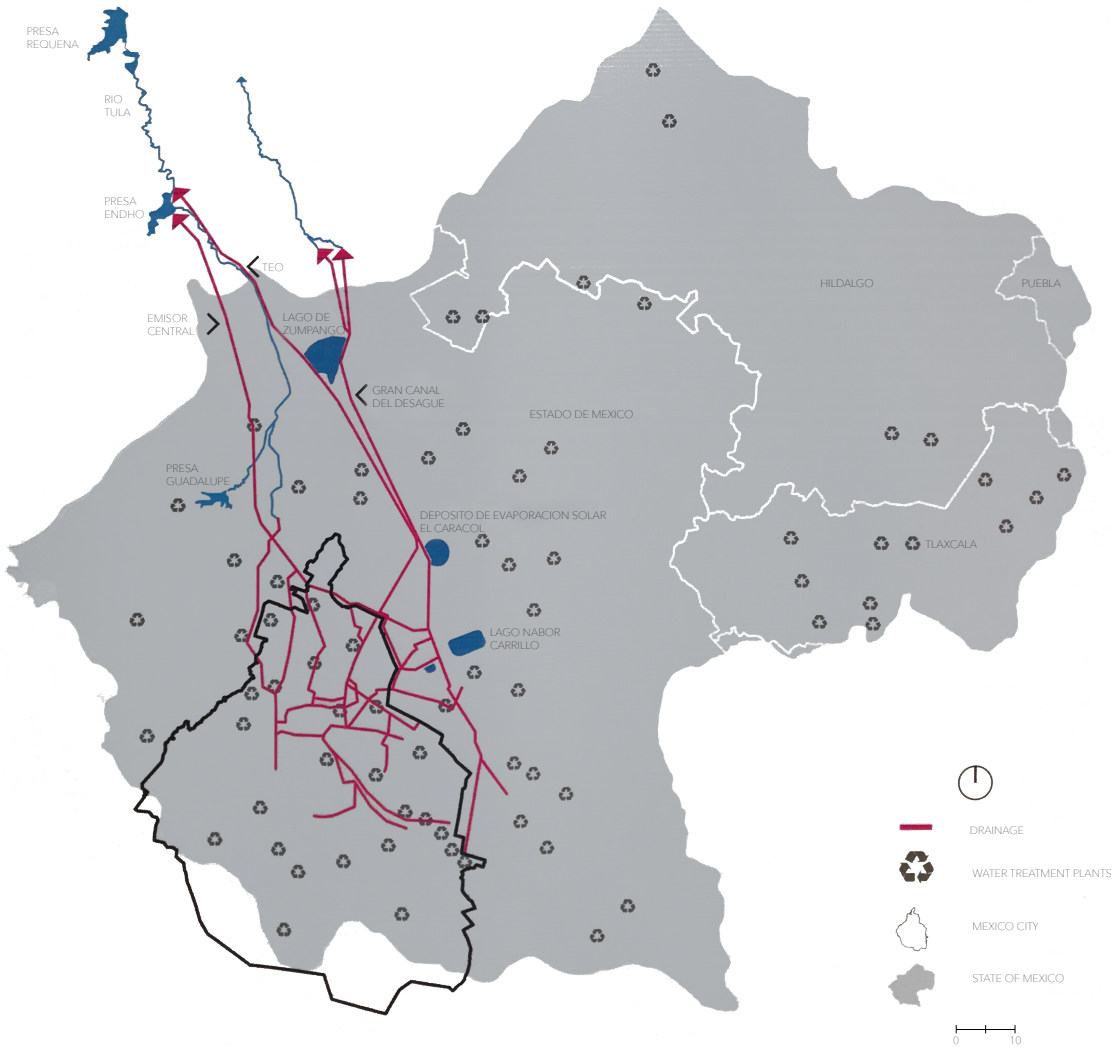
As Mexico City moved into an industrial age and an era of production, the 19th century marked another period of change. A major facet within the era of Industrialization was the peoples' interest in engineering and solving issues through technology and construction. In 1872, as Porifirio Diaz became president, there was a lot of civil unrest due to the lack of equality between social and economic classes. The lake had been drained further and the city expanded beyond the original limits of Tenochtitlán; church properties were taken over and often turned into plantations and other developments. "Canal de la Viga, the city's primary inlet for produce, was dredged, lined by an esplanade, and extended to Xochimilco, creating a commercial corridor. Older canals were decked over with streets.[29] There was also an interest in increasing facilities for leisure programs; the leisure programs include the addition of two Bull Fighting Rings as well as the Hippodrome, a horse racing track. An increase in leisure programs was an effective move made by Diaz to distract and entertain the majority without addressing social issues. Bull fighting as well as horse racing sacrificed the health of animals in order to appease unrest; sacrifice was necessary in order for the people to focus on sport and remain complacent. Another amenity added to Mexico

City at this time was public mass transit; the horse-drawn omnibus allowed for travel to Tacubaya which led to increased connection between towns and interest in suburban development.

1886 marked a significant year for water infrastructure intervention, with the Gran Desagüe, also known as the Grand Canal, project.

> " The project proposed to create a system of dikes and holding tanks for excess water, to construct barriers for overflow, and to provide for general drainage. The momentous undertaking included a thirty-mile canal with four aqueducts and bridges, a six-mile tunnel coated with brick and Portland cement, and a mile and a half cut through the mountainous terrain."[30]

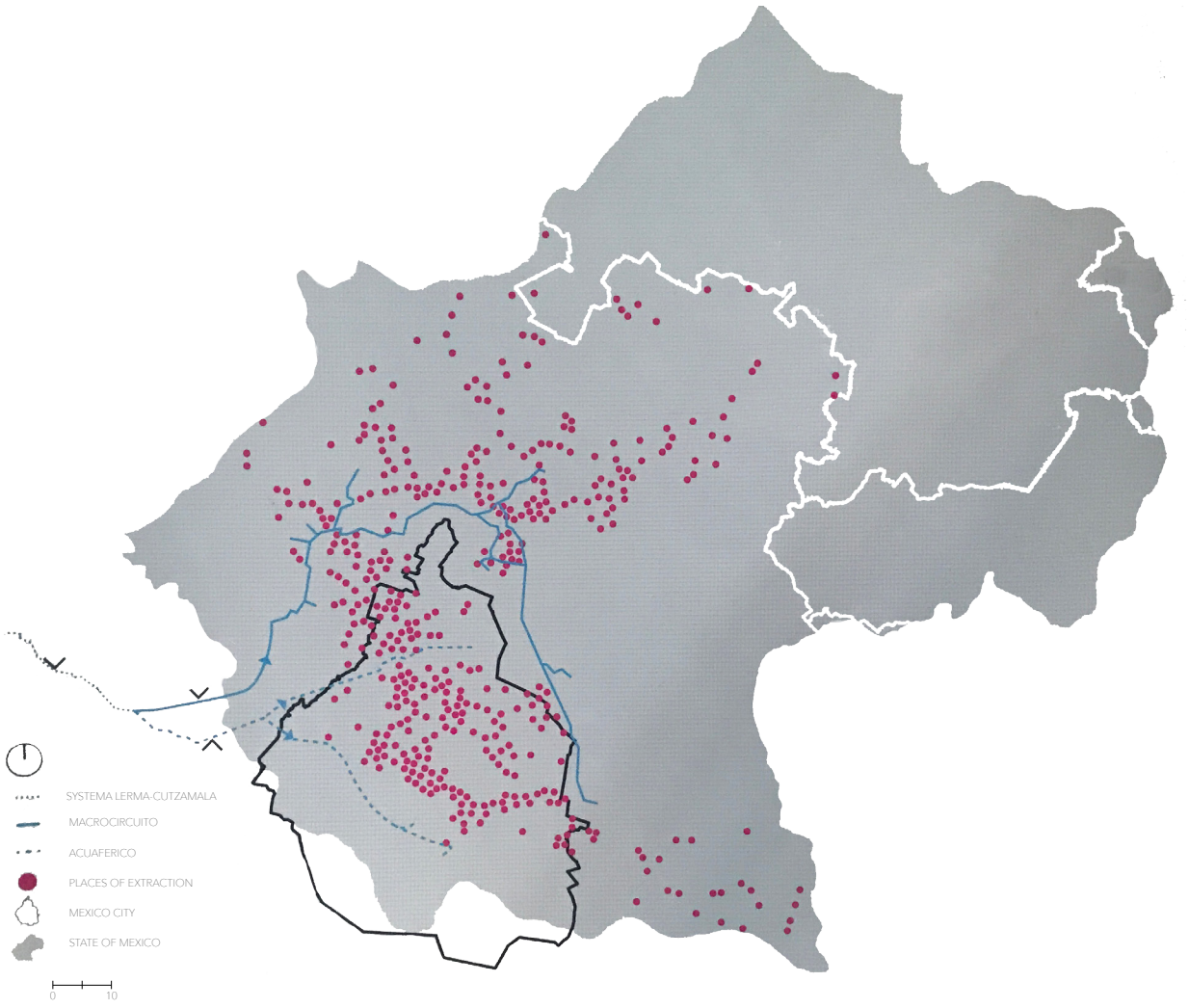
Figure 19: Mexico City's Drainage System.



The Gran Desagüe was constructed under President Porfirio Díaz; the large scope not only included the physical materials and construction, but also work to keep potable and infectious waters separate.

Towards the end of the 19th century, Mexico City was also developing its transportation infrastructure with a railway line, tramway line, and an increase in number of roadways. By this time, Mexico City's population had increased to 3,050,442 inhabitants, an increase of over 2.5 million people from 1800. Mexico City was dealing with its social, political, and water issues by not truly addressing them, but by distracting from them. 1902 marked the year of Mexico City War for Independence and thus President Porfirio Diaz commissioned the Angel of Independence; the

Figure 20: Water Distribution System.



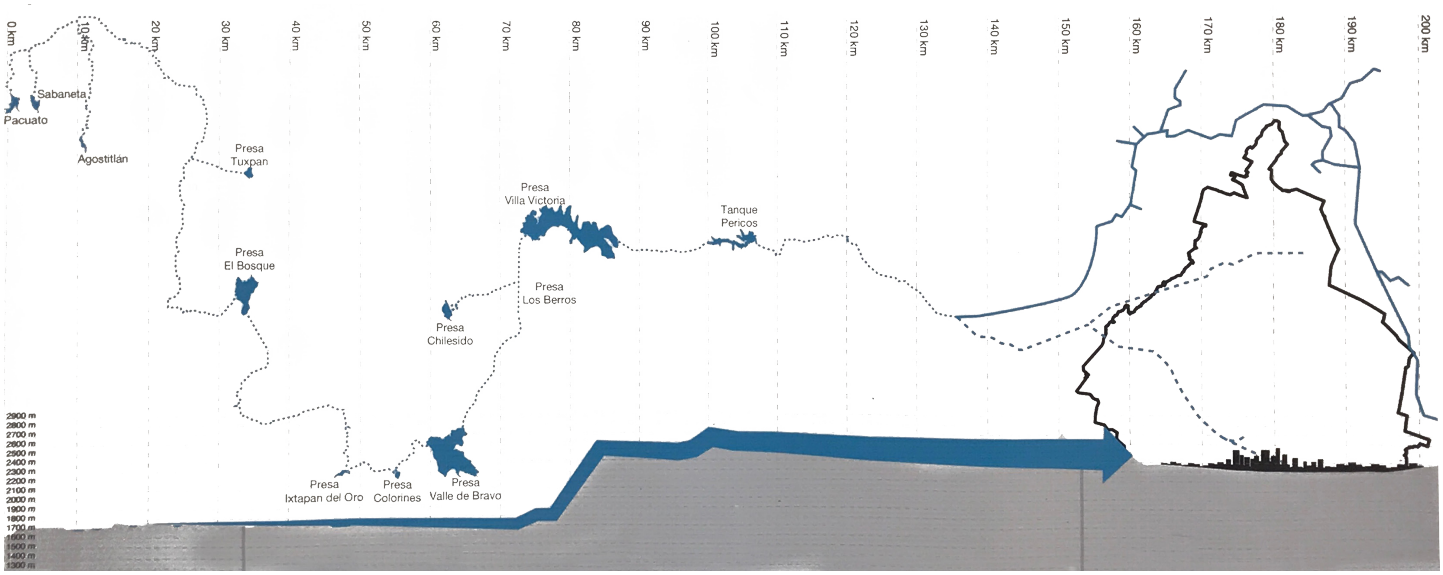


Figure 21: Lerma-Cutzamala System.

Angel was a symbol of independence, strength, and hope within the city and remained a figure that grew in significance but also in parts changed in meaning.[31]

> " Porfirians spared no expense attempting to alter the environment, convinced that the careful application of scientific principles would solve their problems. By 1911, most of the country remained rural, and the parks and gardens would soon be trampled by revolutionaries refuting the cold-hearted calculus of scientific modernization. Porfirians ordered nature just as they ordered society, and in the end, both rebelled"."[32]

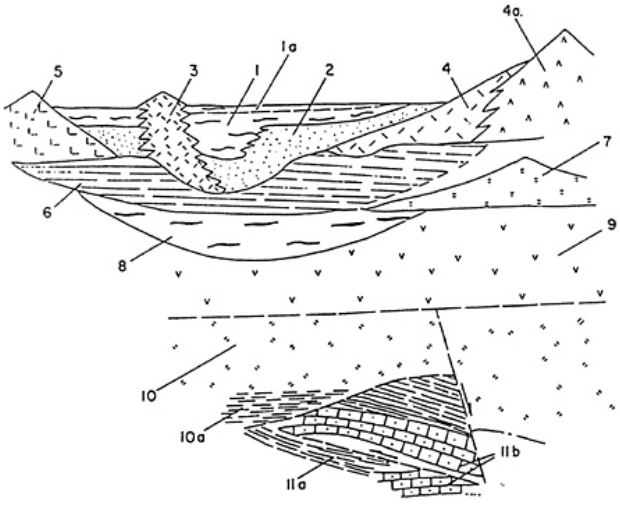
Water in the city was becoming more noticeably disappearing; around 1930, it became evident that the natural springs were drying up and as a result there was increased exploitation of the city's

Figure 22. Mexico City's Angel of Independence in 1910 and Angel of Independence in 2017.

Figure 23: Tlaloc Water Sculpture Fountain.

Figure 24: Tlaloc Water Sculpture Fountain and Museum.

aquifers with deeper wells (100-200m depths).[33] Not only were aquifers beginning to be exploited, but the city was looking to bring potable water into Mexico City through a pipeline system. 1942 marked the engineering and construction of the Cutzamala-Lerma System, built to bring water from the Lerma Basin and the Cutzamala River west of Mexico City. These water systems traveled "a distance of 127 kilometers and a net rise in elevation of 1,200 meters."[34] Along this route, there are several water treatment facilities to ensure the cleanliness of the water. The completion of this water importation system was a huge feat of engineering and was celebrated with a large fountain sculpture by Diego Rivera and adjacent to this sculpture is, Cárcamo de Dolores, within which there was a large mural, Water, the Origin of Life. "In the city there is a singular space that demonstrates the opposite because it pays tribute to the conjunction between nature and the disciplines that allow us to understand it better : Cárcamo de Dolores."[35] The mural inside Cárcamo de Dolores and the Tlaloc sculpture show the complexities of the water system and what it meant socially and spiritually, in addition to the obvious increase in potable water. The mural bleeds inside to out with its alignment with the sculpture; when one looks from inside Cárcamo de Dolores out to the fountain, one can see the head of the sculpture aligns with the mural, the hands delivering water to



"Interpretation of the historic ground water flow system in the Basin of Mexico. Infiltration of precipitation and snow melt in the surrounding mountains forms a deep water table (A) with downward gradients, some of which exits at shallow water tables (Bi) in the lower foothills or piedmont regions, and the majority flows under the valley floor and upward through the clays as diffuse discharge (Bii) and as thermal springs (Biv) through fractures in the deep aquifer. All discharge from the closed basin is by evapotranspiration (C). Source: Durazo and Farvolden, 1989."

Figure 25: Interpretation of Historic Ground Water Flow System in the Basin of Mexico.

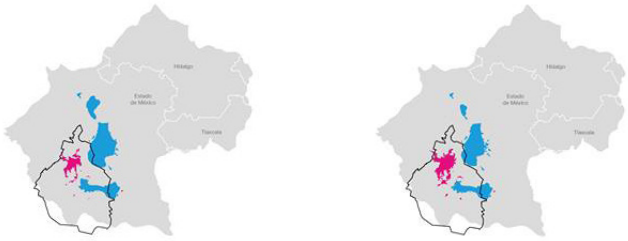


Figure 26 and 27. Growth of Mexico City, 1930 - left and 1940 - right, and disappearance of the lake; blue: water, pink: city growth, black: outline of Mexico City, grey: state of Mexico.

the people of Mexico City are connected to Tlaloc, as seen in ***Figure 28***. In addition to the mural, a system of chimes is incorporated into the system of water ebbing and flowing from the fountain, making a constantly varying, almost eerie, sound; the sound transports focus to the water and how it moves and makes sound all on its own and cannot truly be controlled by human intervention, while being linked to a human-made instrument. The water creates the sounds solely through its presence. Rivera designed a sculpture of Tlaloc with his body facing towards the sky in an effort to have the sculpture to be viewed by the gods, acknowledging their role with water in Mexican culture. The hill across from the museum and water fountain sculpture is the highest point in the park; even from this vantage point, it cannot be appreciated it as much as a viewpoint of a deity in the sky.

The museum and sculpture are within Chapultepec Park which has always had strong ties to the water culture of Mexico City. In addition to the more celebratory art for the systems' completion, water storage tanks were built to hold water brought in from the Cutzamala-Lerma System. In 1942, the first water storage infrastructure was constructed and was called Carcamo de Dolores. Carcamo de Dolores and the Lerma system (water harvesting irrigation system) "have the capacity to store 0.3 cubic hectometer of water, equivalent to the volume capacity of a small lake that belongs to the Cutzamala system."[36] At the beginning of the twentieth century, another series of water storage infrastructure was constructed within Mexico City called Molino del Rey. This system was also built in Chapultepec Park and each tank stores about twelve and a half million gallons of water. Rivera created snake sculptures around the storage tanks that formed a small capture area to hold any water overflow from the storage tanks. The snakes are depicted because once again Rivera showed deference for Tlaloc; snakes are a symbol of the water god and incorporating them into the storage tank system Rivera acknowledged while the Cutzamala-Lerma System is a major feat of engineering, it is important to acknowledge the water god to whom the Méxica once sacrificed human lives to appease.

Figure 28: Rivera's mural showing the importance of water and its connection to all parts of life.

The Cutzamala-Lerma System began the same year Mexico City was undergoing a beautification initiative; “the then president of Mexico, Manuel Ávila Camacho, through the regent of the Federal District, Javier Rojo Gómez, began a program of beautification of the city that included the creation of several monumental fountains in roundabouts or representative corners."[37] They created an illusion of a natural environment with planting native plant species on boulevards and side streets. Another “natural” feature added to the city’s environ was water, added through man-made, sculptural fountains. Often these fountains are found in the middle of traffic rotundas, and while they are attractive, the monuments are rendered unreachable and defeating the purpose of water typically used in a city to drown out street noise. The sculpture of Fuente de la Diane Cazadora was built at the time of beautification in Mexico City.

Colonization and development were seen as great moves to improve and advance the city in this industrial age; as the time approaches the year 1950, reality begins to creep into this facade of the city image. The people in the city were distracted by growth but as each day passed, it became more apparent that their water sources, lakes, river, springs, were disappearing. Cracks started chipping away at the illusion of "modern" industrial Mexico City.

Figure 29. Growth of Mexico City, 1970, and disappearance of the lake; blue: water, pink: city growth, black: outline of Mexico City, grey: state of Mexico.

ACT III. POST-INDUSTRIALIZATION OF MEXICO CITY I
SATYRIC SCENE

Most of my water is gone. Humans have devised a system to bring water into the city; this system will never be as effective as pulling water from the source, the aquifer, below ground. They have designed systems to "fix" their problems with water, I have not made it that easy. Even with new systems in place they are beginning to see I will not go away, water comes and goes, floods and dries up. They have realized their error with building factories in the middle of their city, polluting their own air, and moved them to the outskirts of the city. While humans have worked on ameliorating some of their errors in hurting the earth, they still pull the only non-polluted water from the ground for their own greed; their own government cannot figure out a more sustainable way to obtain water. They are sinking their own buildings, their own city; I am here to watch it happen.

Figure 30. Satyric Scene. Serlio's satiric/satyric scene, Eisenstein's Day of the Dead scene, and Tlaloc fountain and sculptures in Chapultepec Park, Mexico City.

Figure 31. Plaza de Tres Culturas 2017.

SCENE I: POST-INDUSTRIALIZATION

Around 1950, Mexico City began a shift away from industrial manufacturing due to several factors, including three national/ global moves as well as three environmental events. One national and global factor that influenced Mexico City was the shift away from industry within the city; the textile industry became a strong economy in the northern part of the country in the 1970s. This shift in industry from the city as well as Mexico's recession and inactive economy in the 1980s and 1990s had a strong impact on Mexico City and was the second factor in the city's move away from industry. The third national and global occurrence that caused the shift was the move of automotive and food industries out of the city and towards the northern and central parts of the country.

Major cultural events heavily impacted Mexico City in the year 1968, with the 1968 Massacre and the 1968 Summer Olympics. The 1968 Massacre happened at the aforementioned Plaza de Tres Culturas, bringing yet another significant era event, an occurrence of tragedy and death to this location; this is the third of the three cultural events that are referenced within the title of the plaza. The movement that turned massacre occurred on October 2nd; students and other interested individuals wanted a Mexican Revolution and moved to a peaceful protest in the plaza.[38] The police did not tolerate this movement and open fired into the crowd of unarmed people. Casualty numbers range since the government disguised the massacre mislead its people on the truth of the situation. This massacre was also hidden and further disguised by the summer Olympics that started only ten days later. Mexico City had gone to great lengths to prepare for the Olympics, building infrastructure including a large rowing pool adjacent to the historic Xochimilco canals. The Olympic games were bittersweet; many

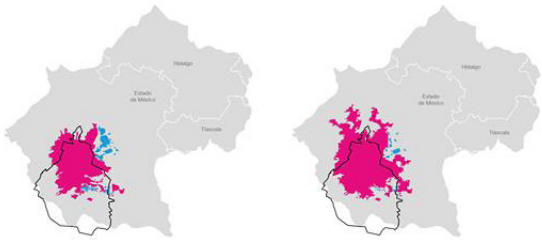


Figure 32 and Figure 33. Growth of Mexico City, 1980 - left and 2000 - right, and disappearance of the lake; blue: water, pink: city growth, black: outline of Mexico City, grey: state of Mexico.

people were unaware of the massacre that happened and therefore enjoyed their city being represented, while people who lost loved ones in the massacre were left dismayed and confused. Plaza de Tres Culturas has a complicated history, leaving those who visit a heavy understanding of all that place has seen.

Mexico City's post-industrial era was also influenced by environmental shifts. In 1984, there was an explosion at the Pemex gas plant in San Juan Ixhuatepec, Tlalnepantla, State of Mexico. This gas plant explosion killed approximately 600 people and injured over 2,000 people. The explosion also had a major impact on surrounding industries, informal housing areas as well as the environment; the explosion caused a lot of pollution, which in turn created a great deal of social pressure. Pollution itself was another factor in closing industries within the city. "Pollution levels, in conjunction with it geomorphological condition as a closed basin, brought about thermal inversion processes that caused critically high atmospheric pollution events."[39] With these environmental conditions, the President followed with a decree in 1991 to close Pemex's Azcapozalco Refinery and other factory closings soon followed. "The earthquake in September 1985, whose sweeping destruction unleashed emigrations toward the center and north of the country, including industries. Said destruction in terms of life, infrastructure and services, produced social, political, and inhabitation costs in the city, highlighting its vulnerability."[40]

Along with all the chaos and destruction occurring in Mexico City, there was a positive historical and environmental effort in 1987, making the Historic Center of Mexico City and Xochimilco World Heritage Sites. Xochimilco was designated a World Heritage Site due to it being one of the last remaining areas close to the original water and agricultural environments of the city of Tenochtitlán. A criterion listed on UNESCO World Heritage Site website is, "Having

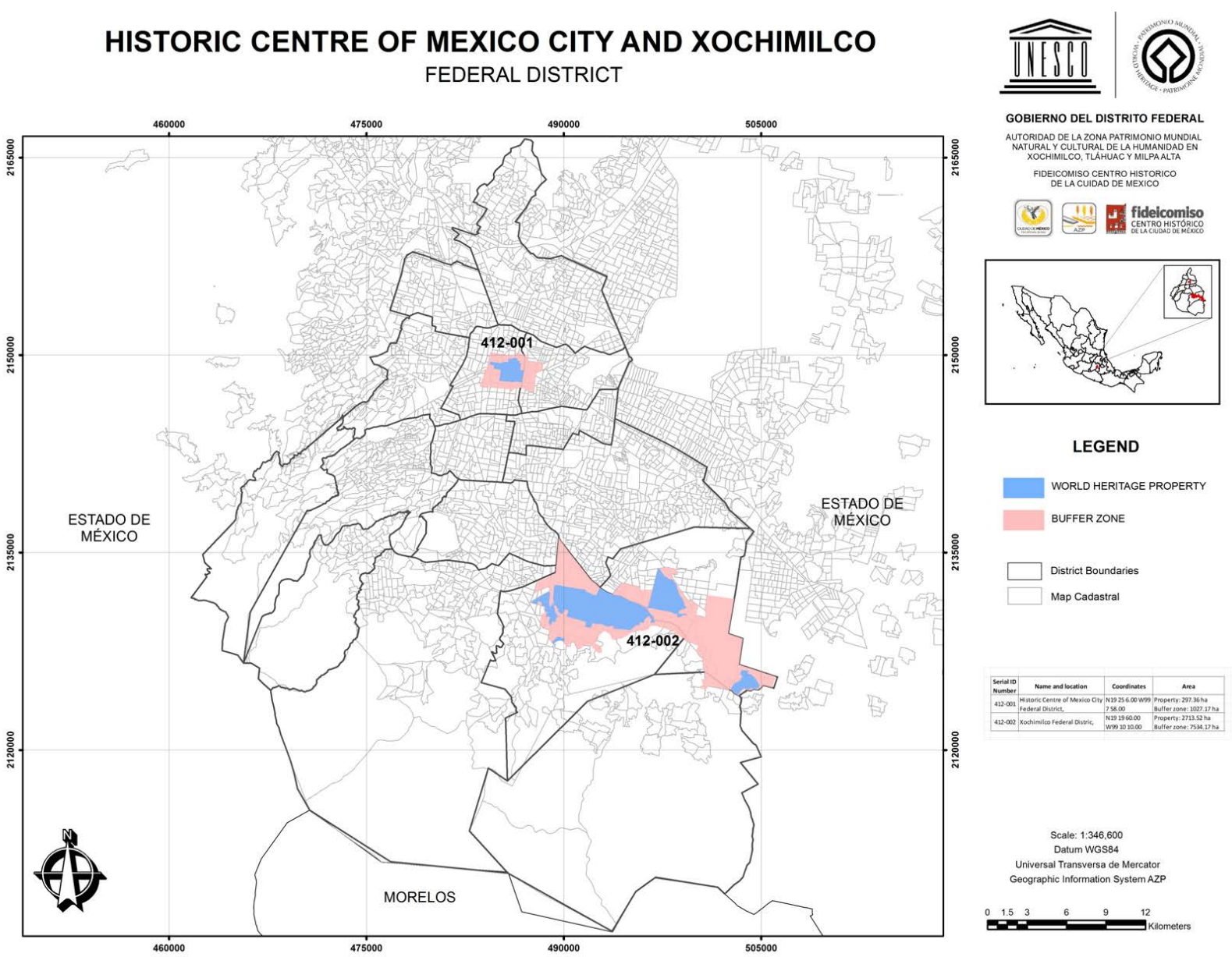


Figure 34. World Heritage Sites and buffer zones in Mexico City.

become vulnerable under the impact of environmental changes, the lacustrine landscape of Xochimilco constitutes the only reminder of traditional ground occupation in the lagoons of the Mexico City basin before the Spanish conquest." The original designation document describes the designation as such, "In the midst of a network of small canals, on the edge of

Figure 35. Photographs of Xochimilco World Heritage Site, 2017.

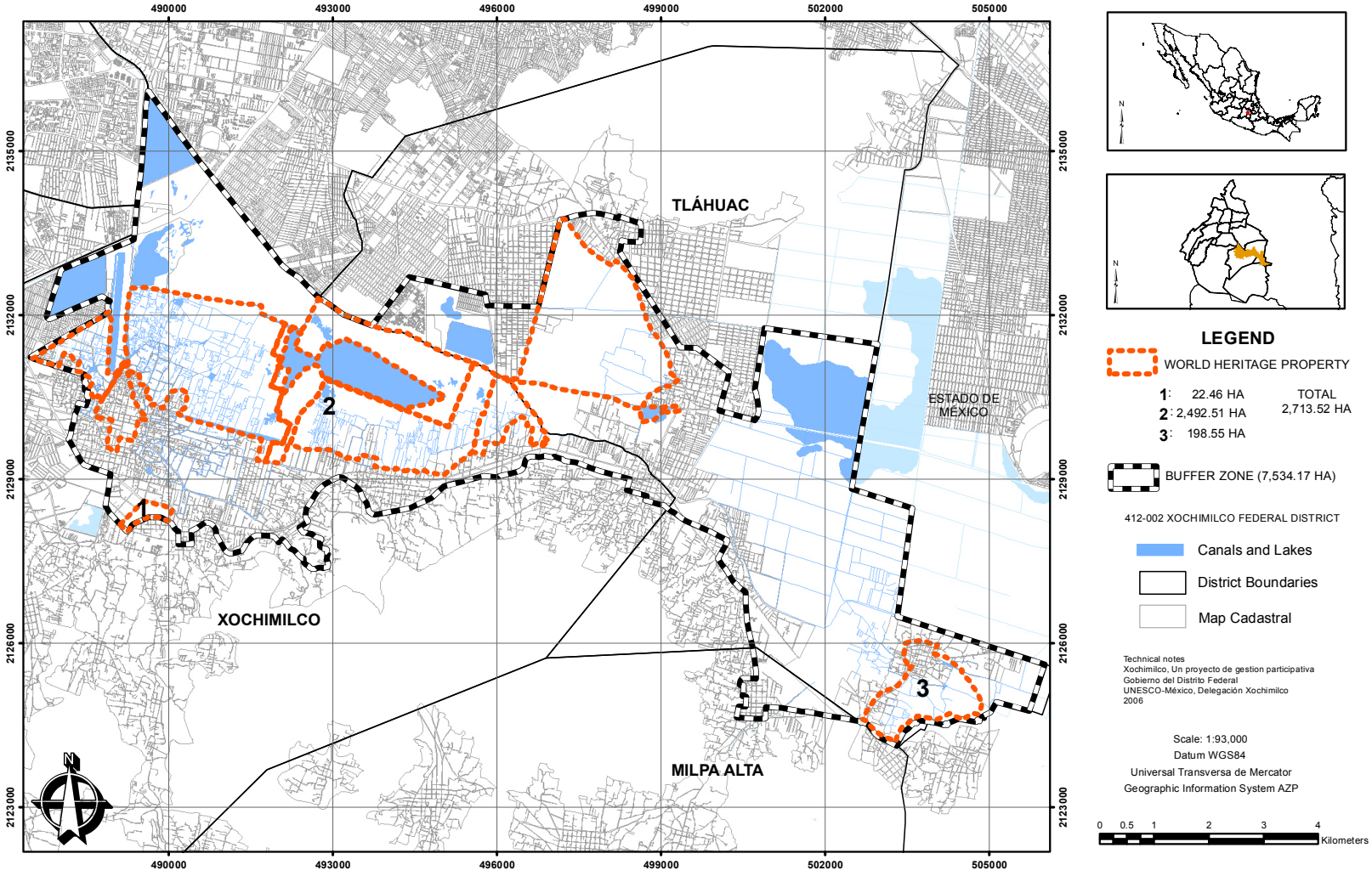


Figure 36. Xochimilco World Heritage Site and buffer zone.

the residual lake of Xochimilco (the southern arm of the great drained lake of Texcoco), some chinampas or 'floating' gardens can still be found. Parts of this half-natural, half-artificial landscape are now an 'ecological reserve.'"[41]

With the designation of the canal system as a World Heritage Site, the next land in question is that which borders it. To the western side of the canal system is the Olympic training pool, to the south is the developed town of Xochimilco, to the east is the district of Iztapalapa[42] and to the north was unclaimed land that was turned into the Xochimilco Ecological Park in 1993. The Xochimilco Ecological Park's master plan was designed by Mario Schjetnan, an architect and landscape architect who studied at National Autonomous University of Mexico

Figure 37. Diagram of site in Xochimilco. Pink dashed line shows Xochimilco World Heritage site outline. Black dashed line is the Xochimilco World Heritage site buffer zone. Small photographs call out what the area looks like.

Figure 38. Sustainability Tour of the Xochimilco Canals, 1980.

Figure 39. Xochimilco Canals, 2017.

(UNAM,)University of California at Berkeley, and Harvard University. His philosophy is about integrating architecture, design, and the natural landscape; he also views the natural integration of landscape into a designed environment as a natural process and not as one to be fought. In order to fund the park, the Xochimilco Ecological Park Foundation developed four mechanisms to receive funding; 1. fees paid by visitors, 2. concession vendors giving part of their income to the park, 3. tax deductions, 4. "The continuous implementation of new financial means that fulfill two conditions: they must be a public service and generate funds[43]."[44] The new continuous public services and engagement were idyllic methods of garnering funding for the park and was not an effective way of maintaining the park as of 2017, as seen in comparative images (***Figure 41***).

Figure 40. Photograph of Parque Ecologico de Xochimilco at its foundation.

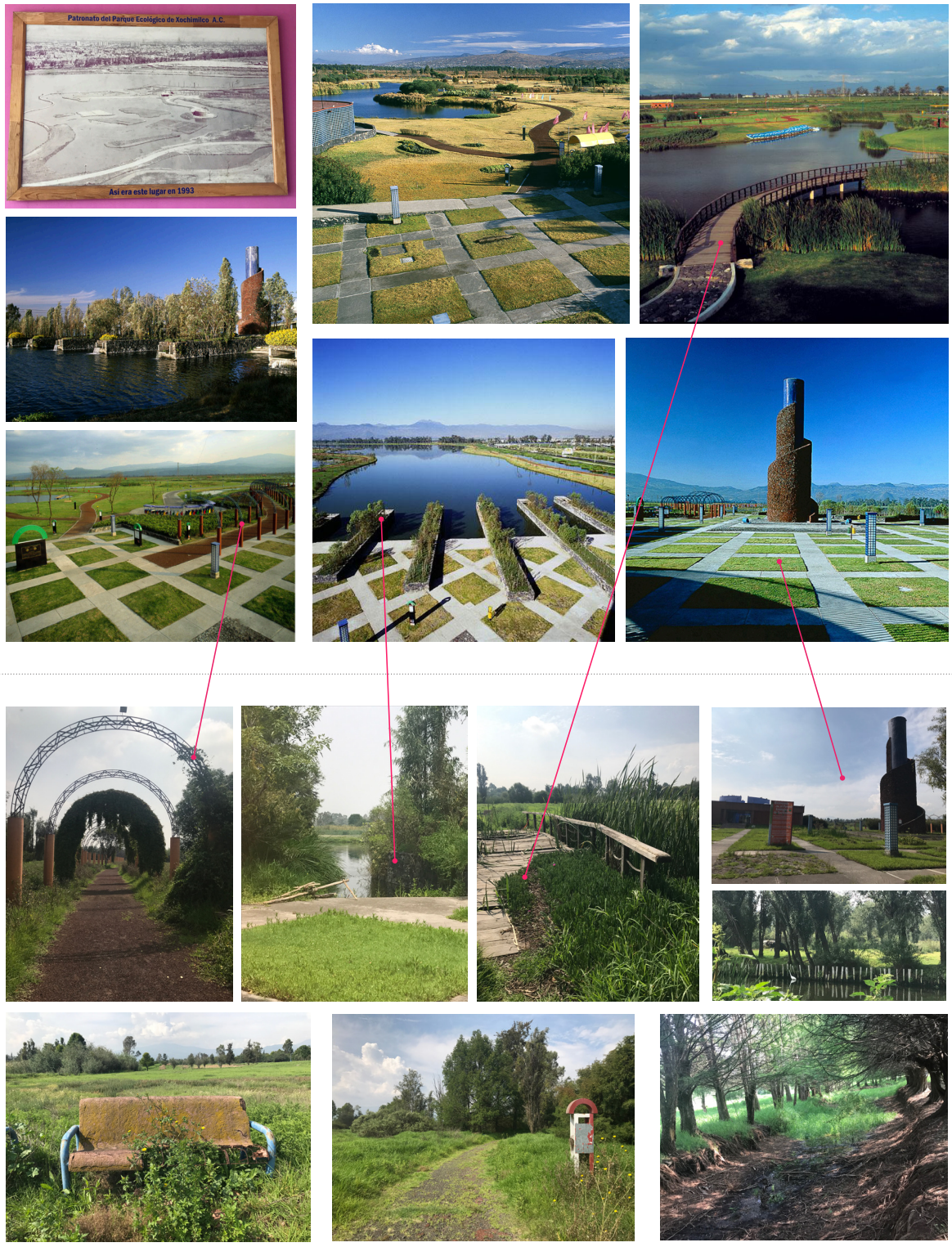


Figure 41: Assembly of Xochimilco Ecológico Park photographs from 1993, above dotted line, and Xochimilco Ecológico Park from July 2017, below dotted line. Photographs include the aging of parks of the park including infrastructure, seating, signage, vegetation, and the water draining away from existing canals within the park.

Figure 42. Growth of Mexico City, 2010, and disappearance of the lake; blue: water, pink: city growth, black: outline of Mexico City, grey: state of Mexico.

In this period of post-industrialization, the city was beginning to focus on the environmental condition of their city, including their water infrastructure. The city trapped surface water left in the western part of Mexico City to ensure enough potable water and they also began to build the Miguel Alemán viaduct. Since 1983, Mexico City began to more closely monitor its water levels; "the average annual declines in ground water levels range from 0.1 to 1.5 meters per year in the different zones of the MCMA Water level measurements during the period from 1986 to 1992 show a net lowering of 6 to 10 meters in the heavily pumped zones of this region."[45]

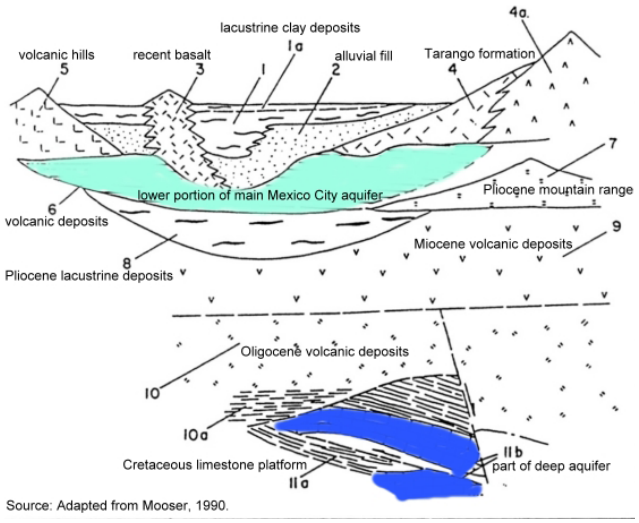
Figure 43. Street in Mexico City demonstrating uneven settlement due to overdrawn aquifer.

Figure 44. A local on his boat in Xochimilco at dawn.

SCENE II: GLOBAL MEXICO CITY

Mexico City as of 2000, had a population increase to 18 million people; with the augmentation in population, public city transit infrastructure expanded and became more regulated and the urban development of the city developed rapidly.

In 1944, architect, Mario Pani, proposed a city plan that dealt with housing and roadways; this plan was controversial and remained a theoretical concept. Pani joined forces with José Luis Cuevas and together they started an organization, Taller de Urbanismo, to deal with urban growth. "Taller de Ubanismo (City Planning Workshop), was one of the offices with the greatest impact on urban development in Mexico over the 20th Century."[46] Pani worked to make great strides in Mexico City through housing proposals and projects, urban projects, territorial planning, and overall new methods of urban renewal. 1954 - 1958, Pani worked on



"The National Water Commission (CNA) and Mexico City Water System (SACM) are undertaking a 3-year, 23-million-dollar feasibility study to assess the potential of an aquifer that lies more than 2000 meters below Mexico City. Initial exploratory wells have shown that the deep aquifer's water quality is superior to that currently derived from the overexploited shallower wells that extend to depths of around 800m."[66]

Figure 45. Diagram showing aquifer depth Mexico City currently draws water from and the aquifer the city is investigating pulling water from.

Ciudad Satélite, which was a new development in the northeast of Mexico City similar to an American suburb, but with super-blocks and a great deal of urban planning integrated into the design.

Water infrastructure of Mexico City, as in any city, is integral to a functioning urban environment. Mexico City is struggling to provide all citizens with consistent water supply, particularly potable water. While Mexico City developed this elaborate system of pipes to bring in water, the city still only maintains about thirty percent of its water from this system; the rest of their water comes from wells accessing the aquifer. Drilling into their aquifer has forever altered the city in multiple ways: it is affecting infrastructure because buildings are sinking and leaning due to unstable ground as well as causing any areas with surface water to decrease in water levels (refer to ***Figure 45***).

"'Water is not just remarkable, it's miraculous,' he says. 'It has a memory, an intelligence, it's extremely strong. And it will always return. No matter whether it takes five, 50 or 500 years. It will come back.'"[47] Marco Alfredo, president of the Mexican Association of Hydro-engineers, also advocates a return to the city's lacustrine origins. "Mexico City's situation is chaotic and absurd. We could have natural pure water, but for hundreds of years we have been draining it away so we have created an artificial scarcity," he says "This is not an engineering problem: we have the expertise and the experience. It is also not a problem of economics: we have the financial resources to do what needs to be done. It's a problem of governance."[48] Alfredo's opinion was to work with the water as the original settlers of their city did, when it

Figure 46. Xochimilco chinampa post and netting support system.

was simply an island surrounded by water (of variable qualities). With contemporary weather patterns, one can find the validity in this statement. Mexico City experiences shifts in weather seasonally; in the winter, the city experiences extreme drought and in the summer rains so intense that city streets flood. The city is not built to handle the storm-water created by the storms; the water overflows the drainage system in place because trash in the streets has clogged the gutters, leaving them ineffective. Since storm-water not only has issues draining, but the drainage system itself, the Grand Canal, combines storm-water and waste. Only about ten percent of the wastewater in Mexico City is treated and the rest goes into the Grand Canal.

The whole city only has thirteen water treatment plants, many of which are old and require updating; water can quickly become subject to contamination, particularly that which travels the distance through the Cutzamala-Lerma System. This water gets treated at the source of extraction, again while its traveling, and a third time once it reaches the city. While this water is treated, the systems are old and often just involve adding chlorine to the water. This water is questionably potable, however it is present. Due to the deficit of accessible water in the outskirts of the city and the farmlands bordering the city limits, farmers often pull water from the uncovered Grand Canal to water their crops; the water is "used to irrigate 80,000 hectares

of farmland in the Valley of Mezquital in the State of Hidalgo to the north. Irrigation return flow drains into tributaries of the Panuco River, which empties into the Gulf of Mexico."[49]

SCENE III. GLOBAL MEXICO CITY 2017

Weather patterns in Mexico City have developed in strength in 2017 alone; 2017 has been a year of natural calamities, a fissure, flooding, and two earthquakes. Xochimilco is known for its canal system; what once was an area of agriculture and markets, the canals have now turned to a primarily tourist use. The boats, as seen in the back of ***Figure 48***, are called trjinera and are used to give people tours of the canal system while they party and drink, often littering their bottles and garbage into the water. The water in the canals is vital to the livelihood of the people that still use the chinampas to grow crops. Since water is so important to the livelihoods of many as well as to the canal system itself, to maintain World Heritage Site status, the levels in the canals are being monitored. "Since 2010, the water level in Xochimilco canals has dropped two meters, half of which was lost during the last twelve months."[50] The fissure appeared one day in late January 2017 at the Xochimilco canals. "After the three-meter fissure was identified, workers with the city's water department created

Figure 47. Fixing the fissure hole.

Figure 48. Fissure at the Xochimilco Canals.

a makeshift dam using sandbags, temporarily controlling the flow of water."[51] Another issue happening in the landscape of the Xochimilco canals is the development of shanty structures on the chinampas as well as the alternative, which is the flattening of the land to turn it into sports fields. The financial gain of renting out sports fields is a more lucrative business than growing most crops on the chinampas; there is the looming potential of development of the chinampas, which would cause the site to lose its World Heritage status and thus alter the landscape forever.

The original use and intention of the canals is not the only factor that has changed; the number of wells, drilling into the aquifer, present has also changed, it has increased and the drilling sites moved closer to Xochimilco. The government realized its error in pulling so much water from their aquifer system near the center of the city, and this can be seen in the sinking and tilting infrastructure in that area. Since the decision to decrease the amount of water being pulled from the center of the city, the city moved drilling locations closer to Xochimilco. The pressure in the earth caused by a continuing depletion of the aquifer resulted in a fissure, which caused the water in the canal to get pulled down to the aquifer; problems like this are unlikely to end unless there is an effort made to adjust aquifer drilling practices. “This is a

Figure 49. White with black eyes axolotl.

Figure 50. Brown molted axolotl (typical)

warning," said Sergio Raúl Rodríguez Elizarrarás, a geologist at the National Autonomous University of Mexico. "We are driving the canals towards their extinction." Another perspective on this situation comes from a local boatman, Juan Velazquez, who's income was severely affected by the fissure (went from $15 a day not including tips to $2.50 a day within the last two weekends), "'Nature is making us pay for what we have done,' he said."[52]

Fissures are not Xochimilco's only problem; other problems include the collapsing canal infrastructure as well as the rapidly disappearing axolotl population. Canal infrastructure of posts with nets to help support chinampas have to be maintained and are supposed to be maintained every few years. Maintenance of this post system requires funding which is supposed to come from the government, however it is not always provided. The disappearance of the axolotl salamander is another result of the change in the canals (litter, pollution, water decrease, and collapsing chinampas). Xochimilco is the only natural habitat of the axolotl salamanders; these salamanders exist in zoos and aquariums, however due to the decline in their natural environment, the species is now critically endangered. Axolotls are unique because after they are born they stay in a relatively similar form of maturation. The state of holding onto its larval traits into adult maturation is called "neotony" which means: "it keeps its tadpole-like dorsal fin, which runs almost the length of its body, and its feathery external gills, which protrude from the back of its wide head."[53] These feathery gills are important for the axolotl's breathing; for while this salamander has fully developed lungs, it breaths

Figure 51. Axolotl Skeleton.

through, the "feathery filaments which increase the surface area for gas exchange."[54] Axolotl's have the special skill of regenerating limbs and organs countless times, and each time they regenerate the new part is exactly as good as the part before it. In addition to regenerative properties, the axolotl is "over 1,000 times more resistant to cancer than mammals."[55] In 1998, UNAM worked with the Biology Institute of the Autonomous Metropolitan University of Xochimilco to take a census of the number of axolotls. Reporting on the matter, Horacio Mena, Veterinarian at UNAM, stated, "the final amount in the first census was 6,000 axolotls in a square kilometer. In 2014 there were only 35 axolotls in a square kilometer."[56] Efforts are being made in the canals to not take boats in the areas where axolotls have been seen, but these efforts are preliminary and in order for more to be done on the matter, including cleaning up the water, additional funding will need to be provided. Dionisio Eslava, Umbral Axochiatl, "This is our territory, where we live, grow, and coexist with other forms of life - in this case with the axolotl which is part of our culture, our roots, and our identity."[57]

2017 was also a very bad year for flooding in Mexico City. Rain storms may have come later

Figure 52. Axolotl, in this photo you can see one of its gills regenerating.

Figure 53. Axolotl eating a fish.

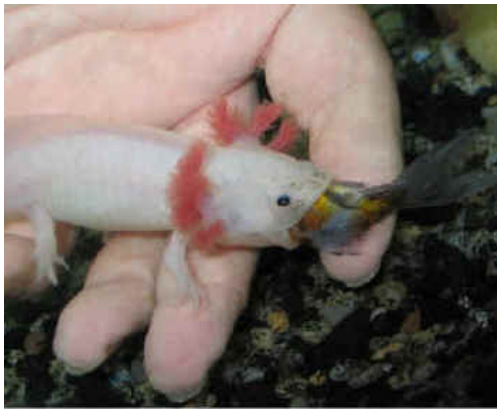


Figure 54. 2017 flooding of street in Mexico City, near the Polanco neighborhood.

than they typically do in the summer in Mexico City, but they did not lose strength; in fact the rains have been particularly bad, so much so they've flooded whole neighborhoods, leaving people and cars stranded. ***Figure 54***, shows policemen trying to help citizens out of their cars on the highway. People in Mexico City are aware that when it rains, it pours and everything about one's situation becomes unpredictable once it begins to rain.

Two other natural disasters occurred in 2017; an earthquake with a magnitude of 8.2 happened and was "felt by tens of millions of people in Mexico and in Guatemala," as well as an earthquake with a magnitude of 7.2 right, the epicenter of which was just outside the city.[58] This earthquake had an impact on the residents of the city because many still remember the 1985 earthquake that killed over 10,000 people. While none of Mexico City's infrastructure collapsed from these tremors, many of its buildings collapsed and streets cracked from the earthquake of 7.2 that this infrastructure has the potential to collapse in the future. Due to the overdrawn aquifers the land is not stable for older structures, only the newer infrastructure has been outfitted with structure for seismic events. The unstable ground caused by depleted aquifers combines with the city's unique tectonic plate situation, the Cocos Plate sliding beneath the North American Plate on which the city is founded. " The unique geology of Mexico City’s lake basin can amplify earthquake waves to be a hundred times stronger than they would be otherwise, a phenomenon that Dr. Cruz-Atienza said is not matched anywhere else in the world."[59]

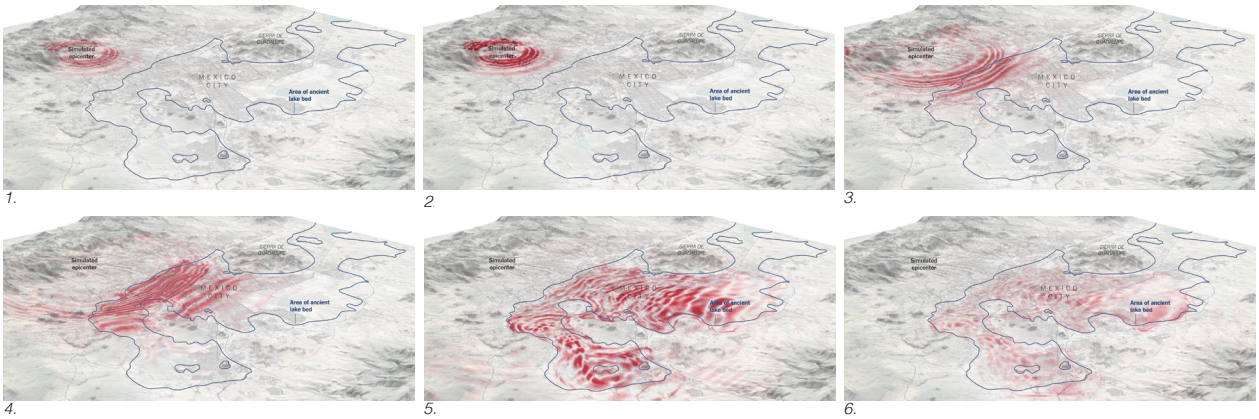


Figure 55. Map of shock waves from an earthquake simulation demonstrating that lake bed's contribution to the severity of the earthquake.

Mexico City felt the full effects of natural disaster potential in the year of 2017; the question for the city now is about the future of the city. Nature clearly cannot be controlled and has shown there is no barrier between the natural world and the human world, both exist in the same universe, in the same time. Mexico City is realizing their problems with water are more complex than ever. Looking back over history, they can see the error of their ways from the very beginning of development on the 'heart' of the lake. 2017 marked a year of disasters, none with large body counts; what disasters to come remains unclear. The Lake is encroaching on the metropolis and is slowly breaking down the established perception that water is at the mercy of the human population; it is the humans who are at the mercy of the lake. The city has reached a tipping point of survival and it has realized: the Lake has risen and the time for penance is here.

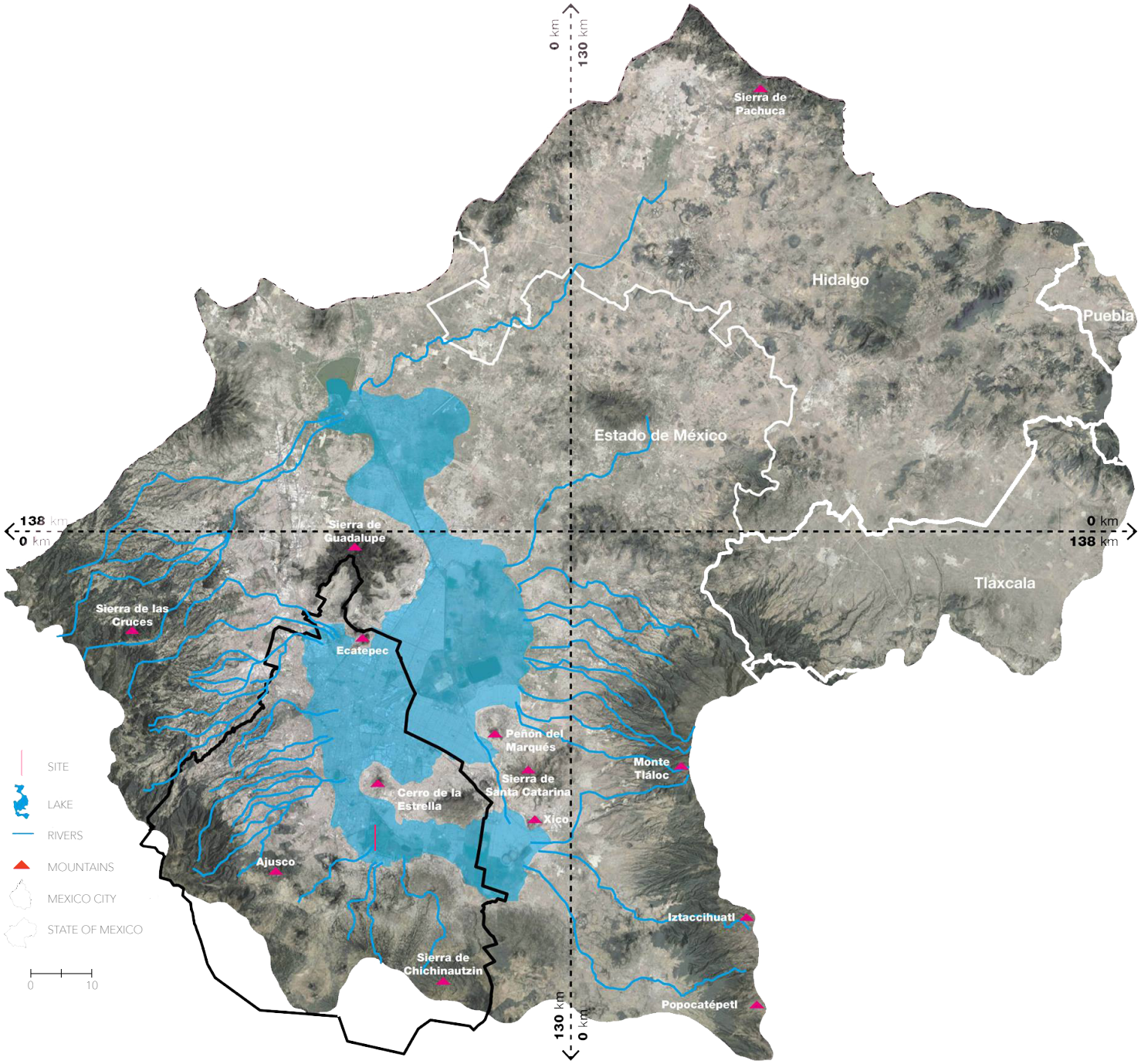


Figure 56. Map of lake and natural water bodies overlaid with Mexico City as of 2017.

Figure 57. Lake Texcoco overlaid with Mexico City.

ACT IV. THE REVENGE OF THE LAKE

I have reached my tipping point. My cobalt blue and dark teal waters are mixed together to a formidable ink, reflecting my emotional state. Humans have pushed my waters to points of near extinction, even in Xochimilco, a developed recreation area they left alone for so long that it has fallen into decay. They pull their drinking water from the aquifer below me, draining the water table. In response I have made fissures, allowing water to drain down; if the humans cannot take care of the water above ground I will take it away. They have destroyed the environment of the axolotl; axolotls are my water spirits and water monsters, they have always existed in my waters. Sacrifices must be made in order to appease me.

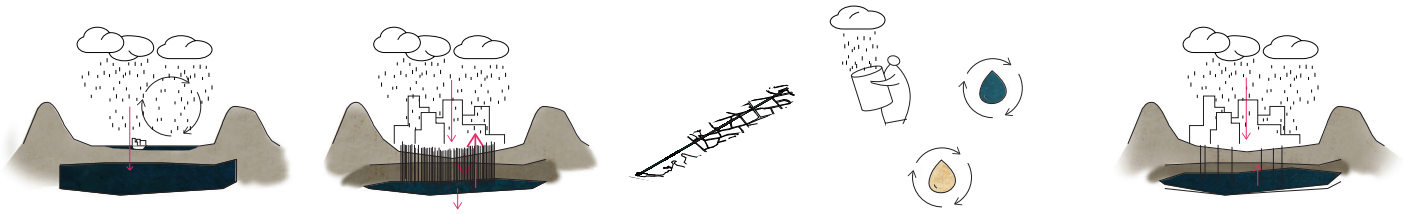


Figure 58. Diagrams demonstrating how through sacrificing drawing water from the aquifer and exploring alternatives to attain potable water could help Mexico City's aquifer to replenish and possibly slow the city's sinking.

Mexico City needs to sacrifice in order to end the cycle of revenge; the sacrifice the city must make is ending the overuse and drawing of water from its aquifer. With this action in mind, the city needs to find other methods to attain and recycle potable water. This design project locates its site in one of the last remaining areas of the lake, the area of Xochimilco. The design explores the idea of regeneration to its fullest, treating and recycling rain and waste water (found in the Xochimilco canals). Looking at alternatives to drawing water from the aquifer, this design does not propose to solve all of Mexico City's water use problems, because as history has demonstrated, Mexico City has more than just one problem with water; this design explores the natural treatment of rain and waste water and the storage of treated water. Through a number of explorations, the design provides a precedent for how the city should re-examine its relationship with water: water as a source of value, not only as a resource.[60] The number of natural disasters in 2017 sets up what can be interpreted as a "tragic scene;" however, this design goes the route of the satiric/ satyric scene, the joking tragedy, similar to how the Day of the Dead commemorates the dead with celebration and colorful flowers and skeleton imagery. This design employs the idea of the satyric to explore potential new relationships with water and water treatment.

SCENE I: SITE AND DESIGN

Site selection for this design became quite clear upon reflecting on Mexico City's history; the decision on a site to commemorate sacrifice goes back to the very site where sacrifice was evaded by the god, Xolotl in Lake Xochimilco. Lake Xochimilco, one of the original five lakes that comprised Lake Texcoco, still exists as a canal system and as a World Heritage Site and buffer

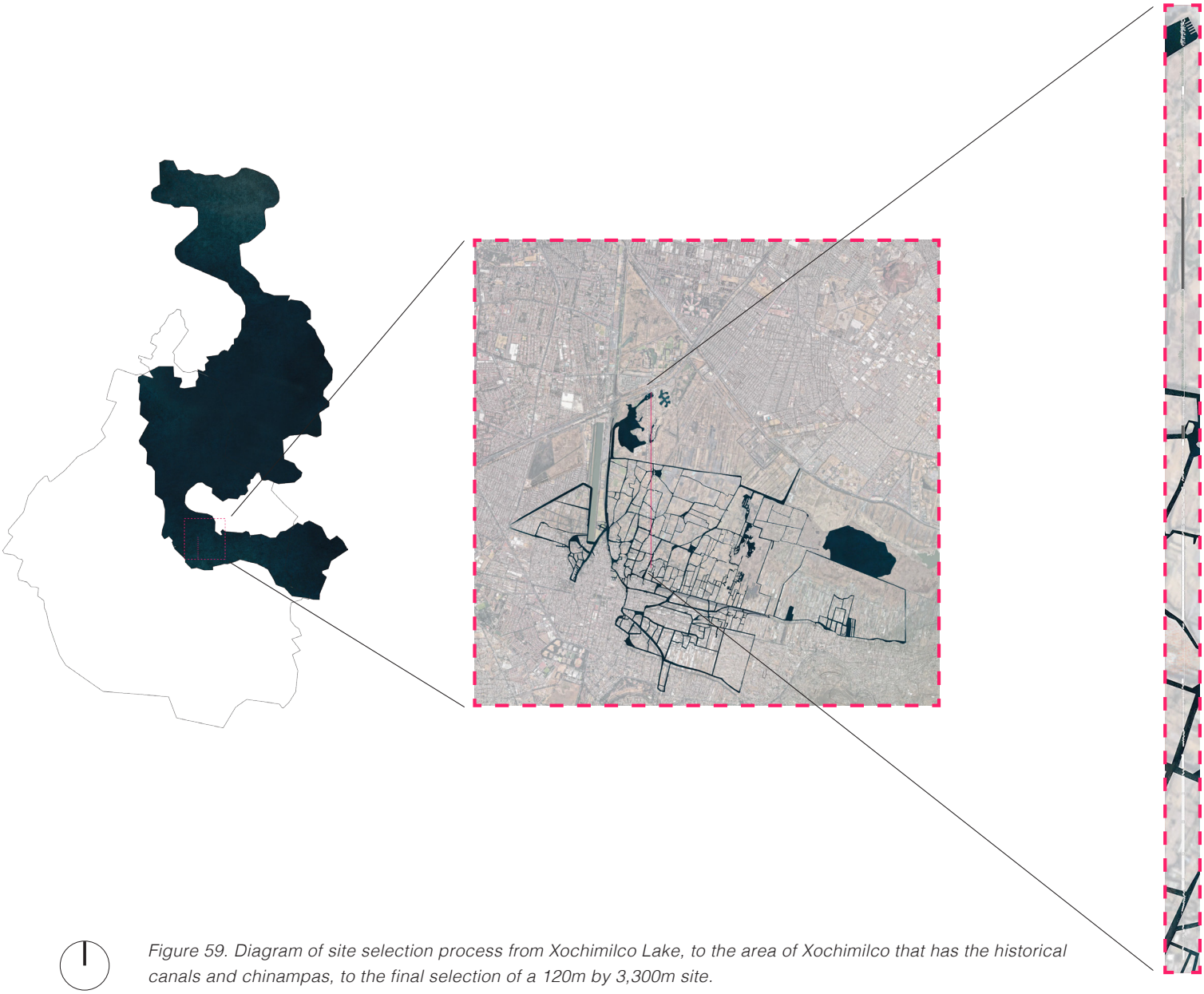


Figure 59. Diagram of site selection process from Xochimilco Lake, to the area of Xochimilco that has the historical canals and chinampas, to the final selection of a 120m by 3,300m site.

zone of the Xochimilco Ecológico Park. In addition to relating to the past, this site also relates to the city's present and future with respect to its relationship with water. January 2017 marked the sighting of the first fissure in the canal system itself. Since the fissure was caused by wells over-drawing water from the aquifer,there are more likely to occur without significant changes in water management and implementation of a new system to attain potable water. Within the broader area of Xochimilco, the selected site is focused on a long rectangular section, 120m by 3,300m, that stretches over both the Xochimilco Ecológico Park and the canal and chinampa area of the World Heritage site. This site was also chosen for its diversity of ground conditions which include: lakes, canals, dried up canals, marsh, park program (paths, benches, and trellis archways), and chinampas with agriculture, cows, flowers, and informal structures. These ground conditions play

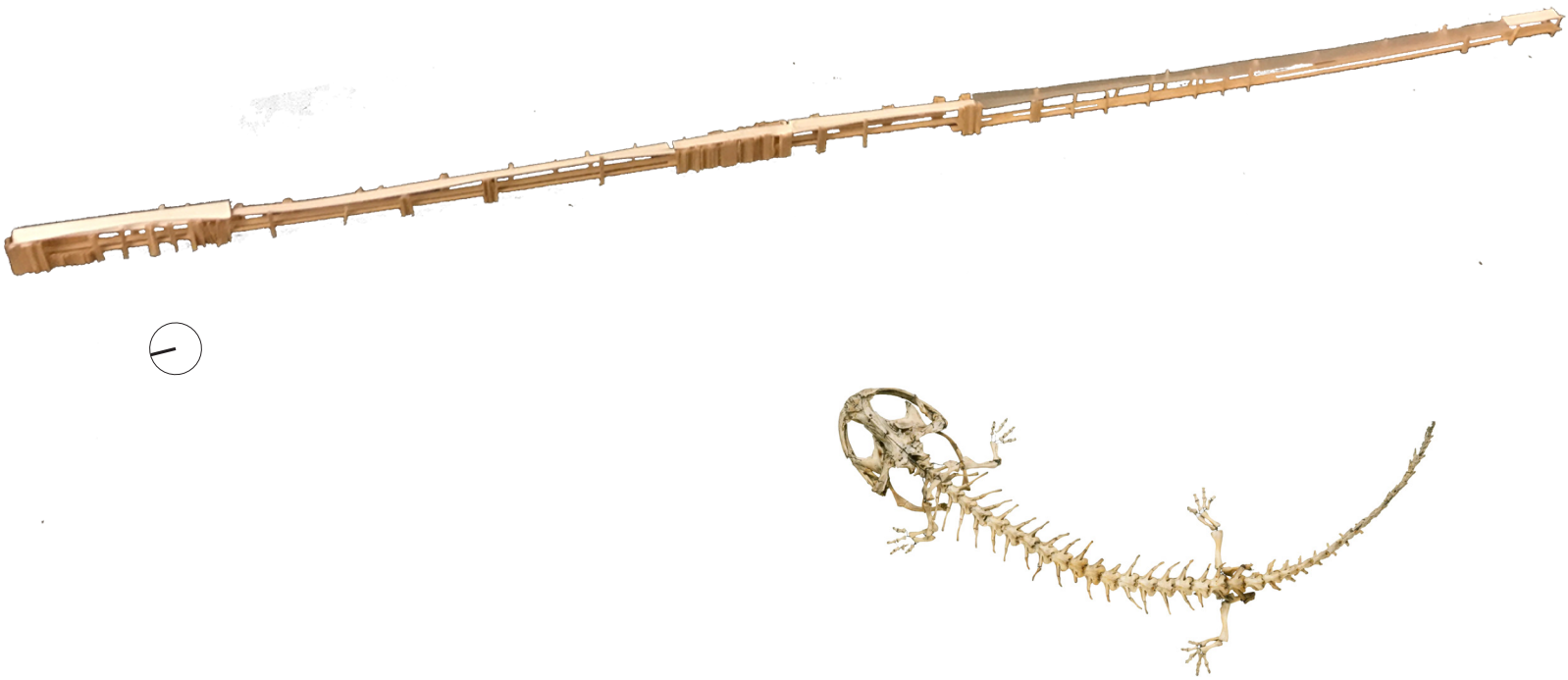


Figure 60. Concept model inspired by axolotl skeleton.

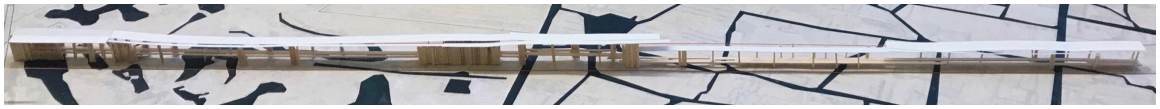


Figure 61. Concept model relative to map.

an important role in how the design decides its program and program location.

In conceptualizing the design, it was important to be bold and suggest a strong move in regards to not only design but the idea behind shifting Mexico City's understanding of how to regenerate the water using the historical canals and how to attain potable water from another source than the canals. The first part of the design process was making the conceptual model (***Figure 60***). The sticks in the model were used to represent a marching structure that depending on program could infill or not be placed. The different materials and slants of the roofs also related to ideas of program, such as solid white roofs directing water to storage tanks or having the interior space be darker, whereas the trace, translucent roof could house an agricultural growing system. The break in the wood floor represented the idea that water would always return to the earth, and that the design would incorporate regeneration and not create more hard-scape (as the city stands as a model for how hard-scape prevents water returning to the aquifer). This model would serve as inspiration for the design as it progressed.

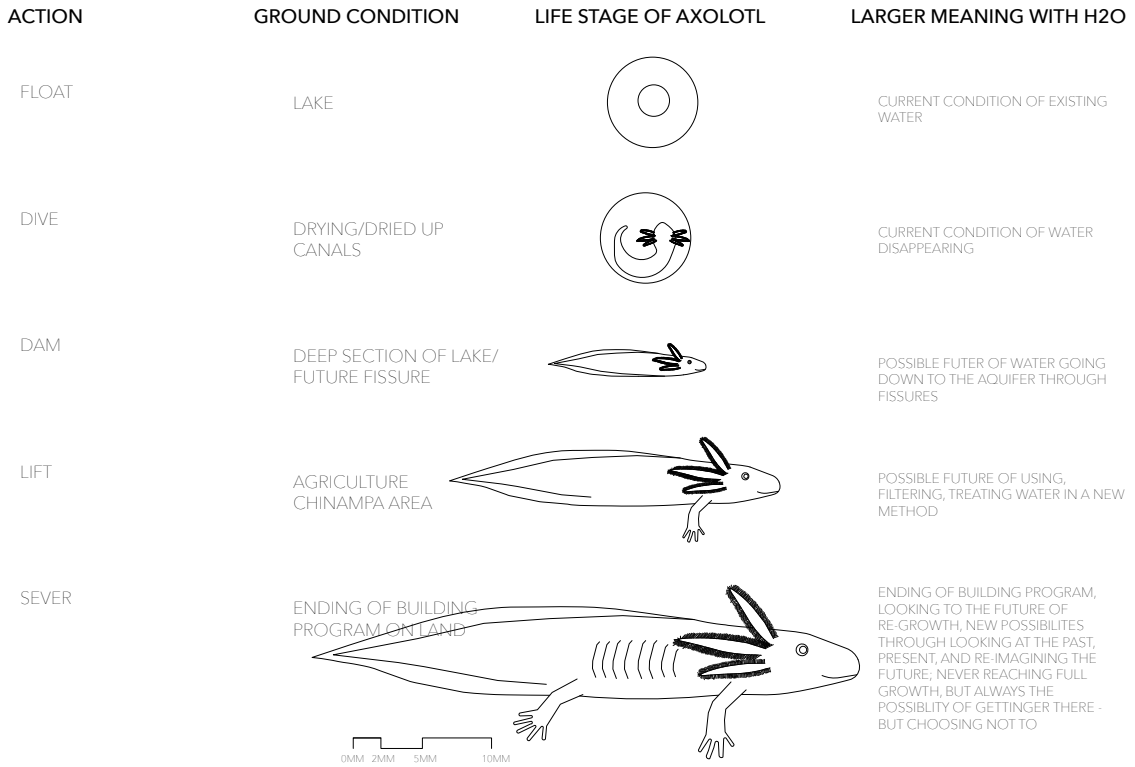


Figure 62. Diagram of design verb to ground condition to axolotl life stage to the larger context of the condition of water in Mexico City.

The project is placed directly north/south, connecting to the importance the México placed on use of the cardinal directions in buildings over history. The overall goal of the design project is to exemplify the idea of regeneration, naturally treating the canal water and returning it to the canal system, while also capturing and naturally treating rain water[61]; both treated waters have the potential to filter through other programs in the building. Another important factor in this design is the fact that this building does not hold any conditioned space. To determine the program in the site, there were several factors that needed to be studied including ground condition and the impact that would have on the program of the building. ***Figure 62*** outlines the preliminary investigations into site ground conditions and the action the building could perform at that condition. Ground condition and building action were also tied to the life stages of the axolotl, since it is a large point of inspiration for the design, being a strong symbol of regeneration in Mexico City. The "larger meaning with water" column of the ***Figure 62*** chart connects the building action, ground condition, and life phase of the axolotl to the cycle of water's significance in Mexico City.

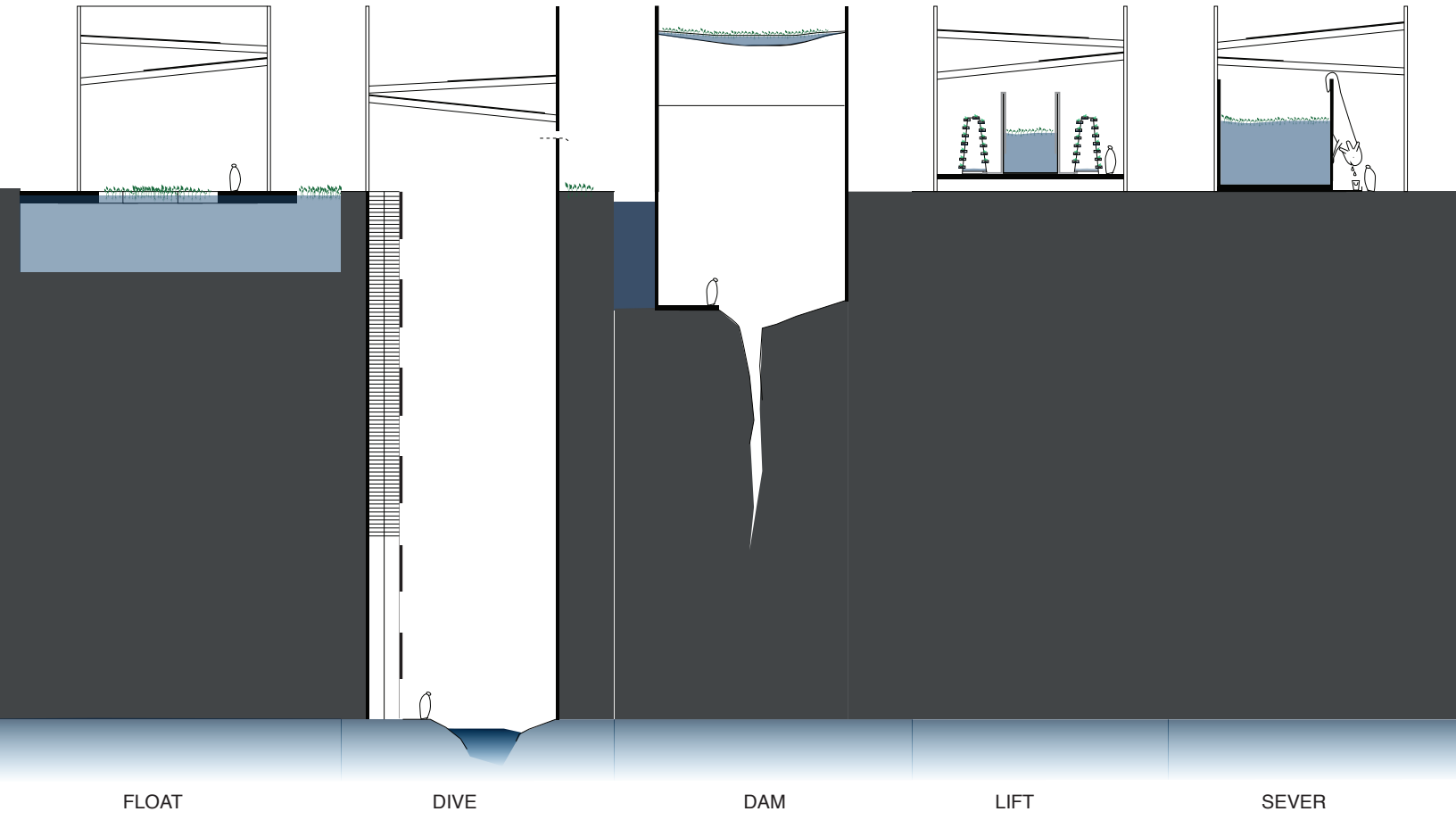


Figure 63. Diagram of building actions relative to ground condition.

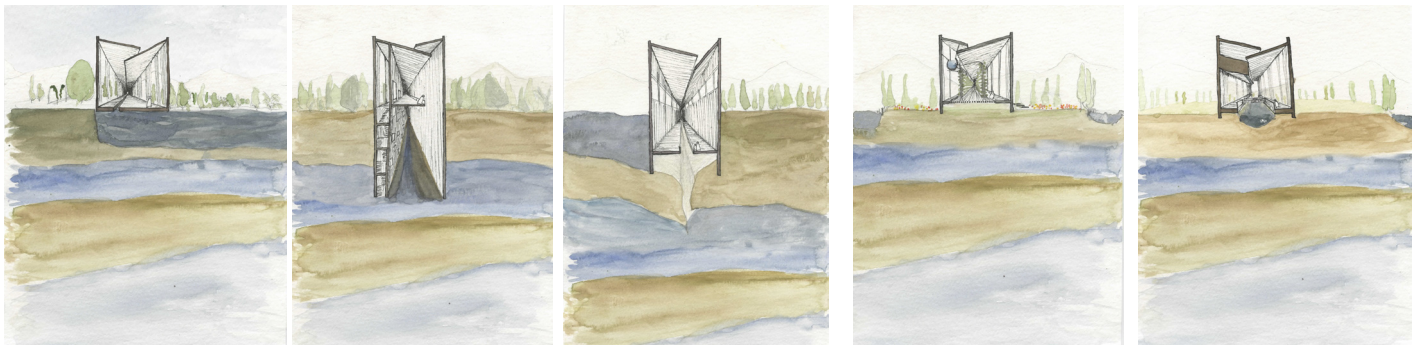


Figure 64. Concept section perspective water colors.

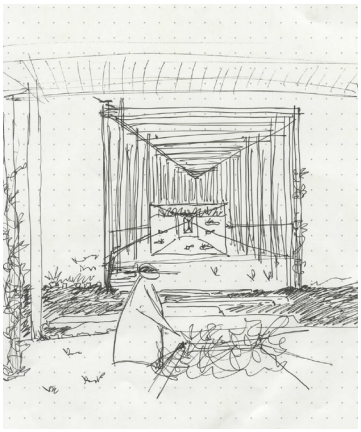


Figure 65. Concept sketch of gardener maintaining garden bed water treatment system, with views from one chinampa to the next.

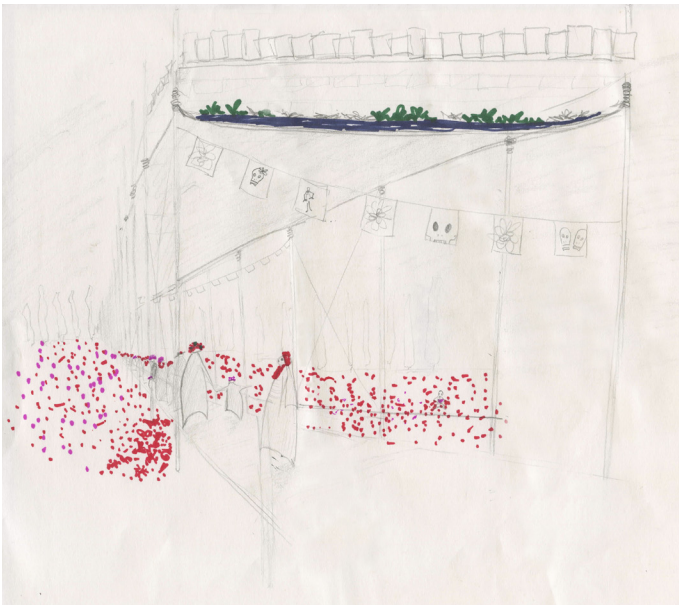


Figure 66. Concept section of Day of the Dead celebration through chinampa of flowers.

Strong action verbs were a starting point for the design process in terms of choosing program that would be placed in the building. The verb "float" represents the design starting in a lake connected to the rest of the canals and is within a body of water that exists in 2017. "Float" represents the idea that the design that has a primary focus on water, begins in water. "Dive" explores how the building delivers water back to the aquifer; the water going to the aquifer would be treated through a first flush diverter; the first flush diverter would direct the polluted water out to a bioswale along a portion of the building. "Dam" represents the action that would take place when fissures open up, and water drains way; this portion of the building would explore how when water disappears though fissures, building infrastructure can stop fissures from draining water out of the canal system. "Lift" represents moving the program above the ground plane to explore the idea of the program no longer being reliant on the ground plane and could occur on more than just on the surface level. "Sever" represents the building ending suddenly and dramatically that also makes sense in a culmination of the themes of water, regeneration, and sacrifice. The action verbs remain an important part in the design process.

Determining how to treat water was one of the first moves in the design process. In the site area that was in the Xochimilco Ecológico Park, water would be treated naturally either through water plants (in the lake) or through a bioswale. Using water hyacinths to clean the water was a large part of the design. Water hyacinths are aquatic plants that have the ability to remove heavy metals from water, making them an option to be applied to polluted and even waste water to clean the water.

Xochimilco Ecológico Park

Xochimilco World Heritage

Figure 67: Diagram of site in Xochimilco. Pink dashed line shows Xochimilco World Heritage site outline. Black dashed line is the Xochimilco World Heritage site buffer zone, Park is within buffer zone. Photographs show what the areas look like.

> “Gamage and Yapa[126] used hyacinth in textile effluent and found reductions in volatile solids (72.6%), mean suspended solids (46.6%), phosphate (52.9%), sodium (40.2%), potassium (64.4%), dissolved solids (61.07%), total solids (59.4%), total nitrogen (83.5%) and chloride reduction (36.0%). An increase in nitrate ion concentration was observed, suggesting nitrification of organic nitrogen in the medium during the long HRT of 30 days. pH varied from 12.8 to 7.0 at inlet and after treatment it was in between 8.52 to 6.50, whereas John[141] observed pH levels were increased by water hyacinth irrespective of different effluents with HRT’s."[62]

In this study water hyacinths were tested to see what percentage of pollutants the water hyacinths removed in a 30-day time period. The study also discussed that with a steady planting and removal system, water hyacinths can remove >99% of orthophosphate, nitrate, and ammonia. The only exception to the purely natural water treatment system in the Xochimilco Ecológico Park happens where the building "dives" down to the aquifer; the system in place here is a first flush diverter that redirects the most polluted water in a rainstorm away from the direct flow to the aquifer and sends it outside the structure to ground vegetation that will treat the water.

Once the structure moves from the area of Xochimilco Ecológico Park to the area of Xochimilco World Heritage Site, the water treatment systems move from natural treatment on the ground to natural systems that work in the roof/ceiling structure or in the water storage. One of the systems acts like an"elevated bioswale," using a polyester base fabric and wire rope and cable system in order to have a more flexible system. Other systems in place include a hygroscopic roof that works with light and directing rainfall and roofs that slope to direct rain into a storage container that is then treated with water hyacinths or an aquaculture system. Structure and material selection are all important in the design process and chosen in order to work with the various systems, while not focusing on permanence; they can either age and fall back into the landscape or are able to have a “second life” and be used for another purpose once the original structure serves its purpose.

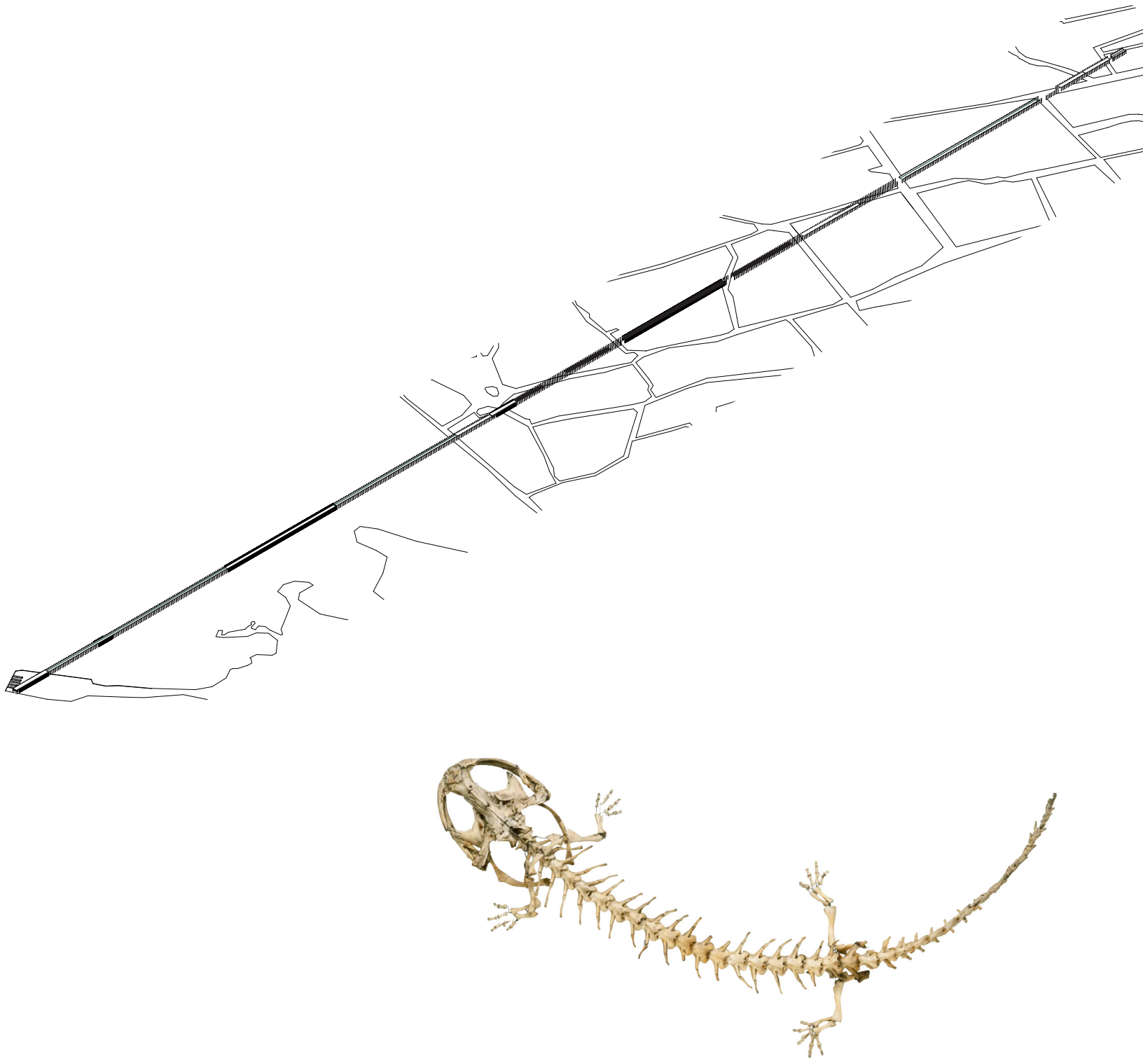


Figure 68. Axonometric diagram of the building relative to an axolotl skeleton.

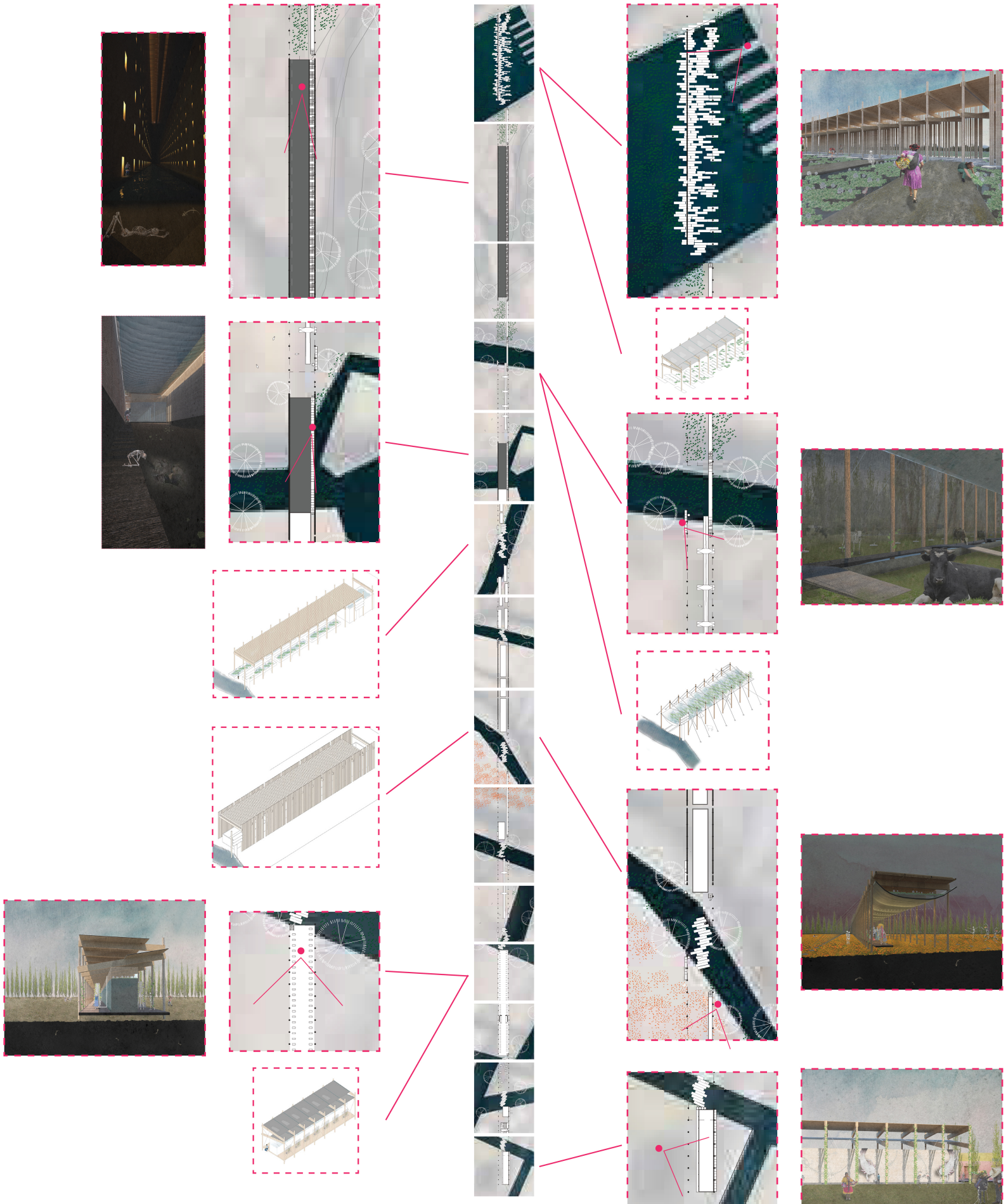


Figure 69. Plan map of diagrams and images of the design.

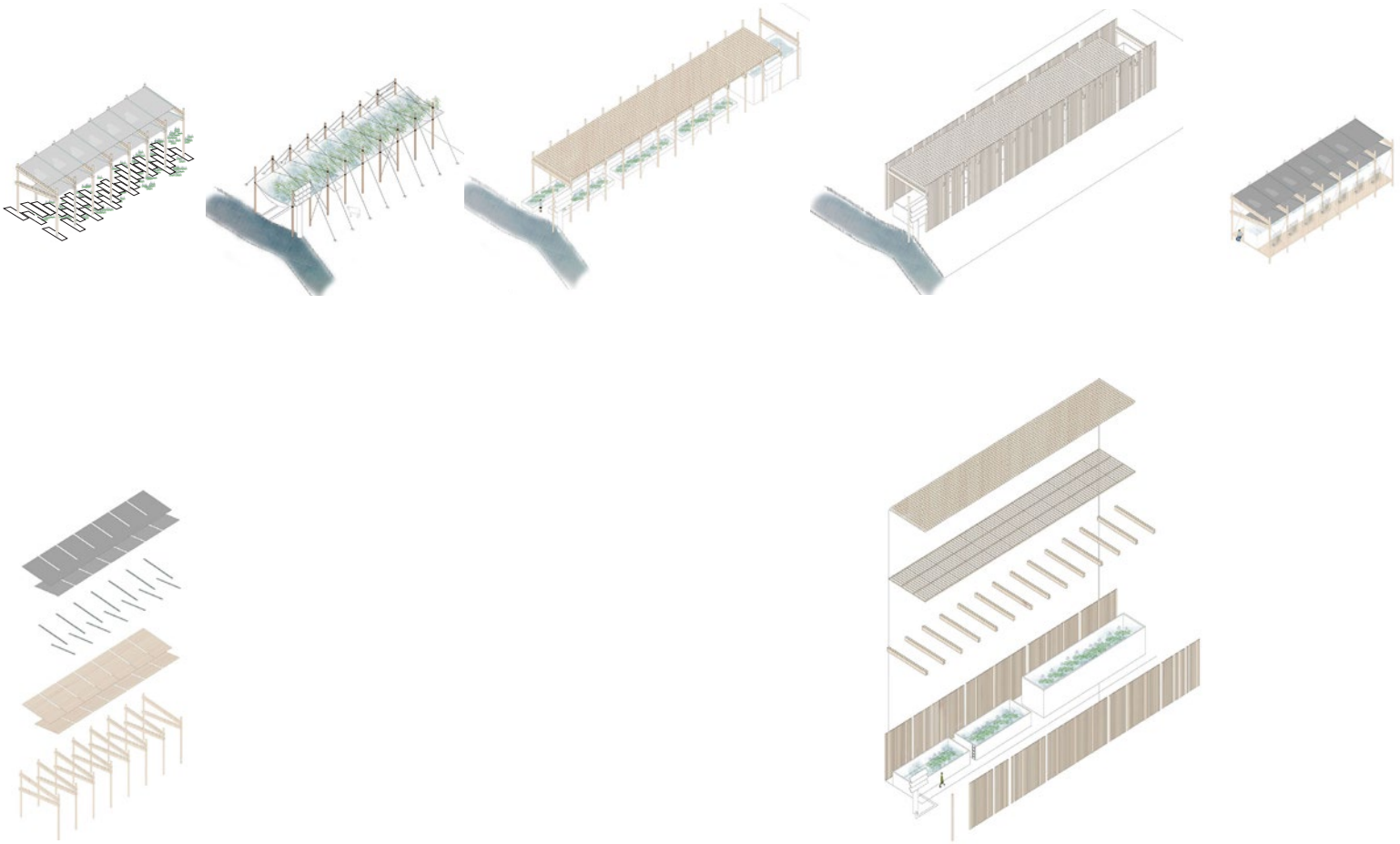


Figure 70. Axonometric diagrams of building systems and structure.

SCENE II: SYSTEMS

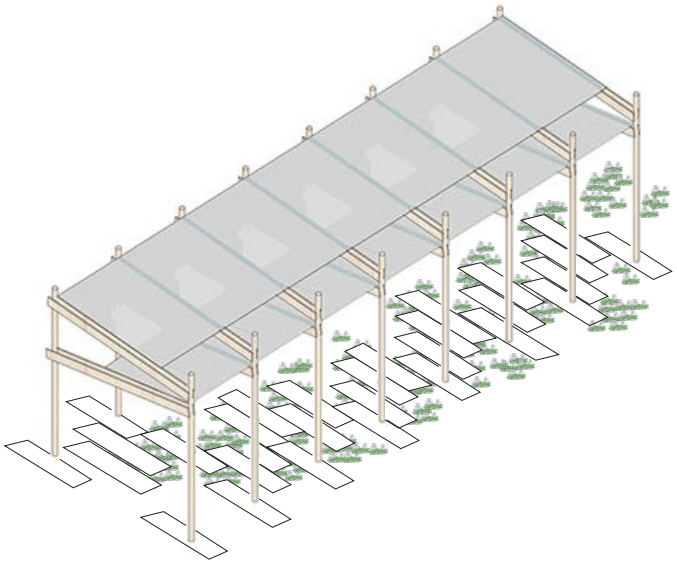


Figure 71. Axonometric diagram of natural ground system. This diagram shows the structure at the beginning of the building where it starts in the water, here the poles float on pontoons and the water hyacinths clean the water.

BIOSWALE WATER TREATMENT

The Xochimilco Ecológico Park area of the building implements a bioswale along the building in order to catch and treat the rain water. "Bioswales achieve the same goals as rain gardens by slowing and filtering storm-water, but are designed to manage a specified amount of runoff from a large impervious area. Like rain gardens, they are vegetated with plants that can withstand both heavy watering and drought."[63] All the available permeable land in this area offers the opportunity to select a bioswale as the water treatment system. Additionally, a bioswale plays on the satire/satyr quality of the site, a once human-focused designed park, that within thirty years has fallen apart and is being taken over nature; a natural bioswale system demonstrates further how nature plays a strong role in this site. At the entrance of the building program, water hyacinths do their part to clean the water. Poles are on pontoons which act as a path for people, permitting a view of nature at work without human disruption. A meter-and-a-half elevated path allows people to move through the building without focusing the space itself on people. The roofs slope in both directions to guide water to the lake or bioswale while also shielding people from getting soaked in a rainstorm.

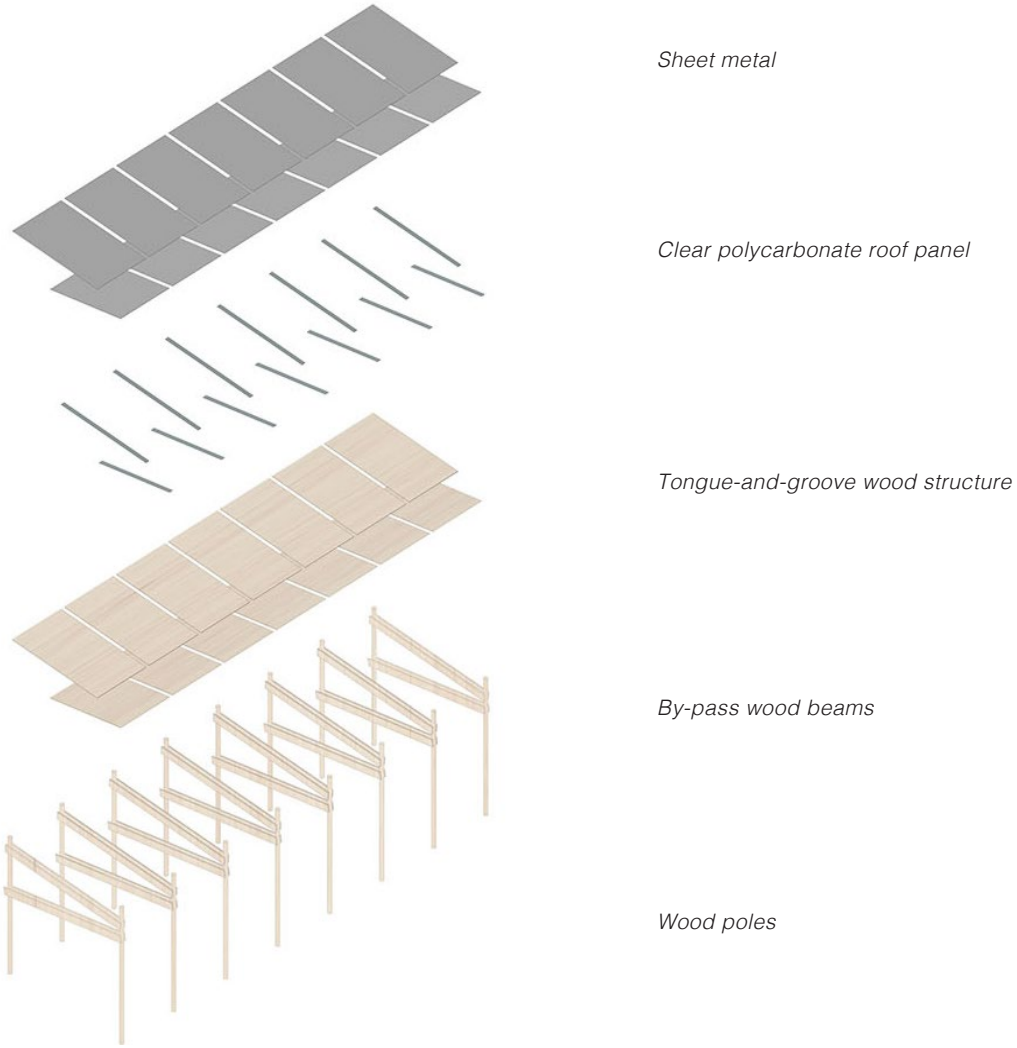


Figure 72. Exploded axonometric diagram.

STRUCTURAL COMPOSITION

The structure of the building together consists of wood poles, by-pass wood beams, tongue-and-groove wood structure, clear polycarbonate roof panels, and sheet metal; this structural system also implements steel cables as cross-braces every few bays or more as needed by interior program. Wood poles are inspired by the wood posts currently used in the Xochimilco canal system to support the chinampas. The wood poles are set into the ground, a method seen in the precedent of pole barn architecture. These wood poles are 0.3m in diameter and placed every 4.8m on center, an interval that works with standard sheet metal sizing and structural allowances. The by-pass wood beams allow for straightforward structural assembly that could be done with a simple steel connection. The bypass wood beams then support a tongue-and-groove wood assembly above the beams, but does not run over the space between the beams, as seen in ***Figure 72***. The clear polycarbonate roof panels fit into the sheet metal assembly and allow for light to pass between the beams and to the program below.

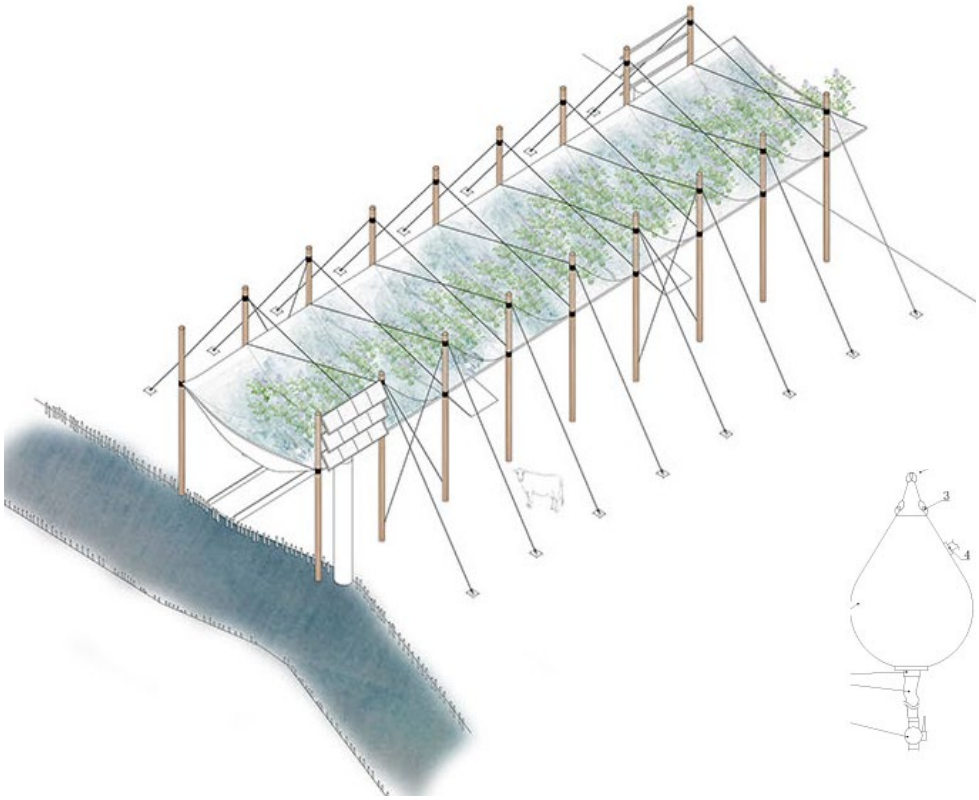


Figure 73. Axonometric diagram of "elevated bioswale" system.

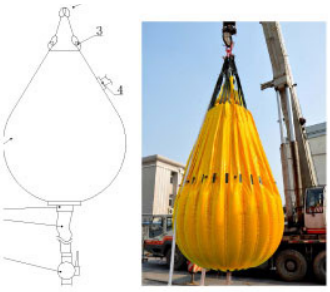


Figure 74. Polyester based fabric used at MoMA PS1 2013, Party Wall.

ELEVATED BIOSWALE

Certain sections of the building employ the system of an "elevated bioswale," an idea explored due to Mexico City's unstable ground condition. This idea explores a flexible system that could adjust in time due to sinking, in order to have a slope that worked with slowly filtering water, and be flexible in different weather conditions. In determining a material that could hold a volume of water and also flex to accommodate large rainfalls, the polyester base fabric used at MoMA PS1's 2013 winner, Party Wall, was identified. This material could be applied to an "elevated bioswale;" the elevated bioswale works with a low slope (~2%) and water hyacinths to treat rainwater and channel it towards a water catchment/storage tank. This material and its flexible structural system, of wire rope and steel cable ties to concrete blocks on the ground, works to accommodate the water volumes during different seasons. During the rainy season, this material can flex and channel water through the plant matter, while during the dry season, the steel cables can be adjusted and the system can become more perpendicular to store water to support plant life that lives within the system. This system also connects to a solar water pump that pumps water up to the filtration system, this water is then pumped down to a trough for cows, which is slightly sloped and channels the water back to the canal. This material also has the potential to be re-used in a variety of ways once it serves its purpose as an elevated bioswale; the nature of fabric is that it is malleable for a number of circumstances.

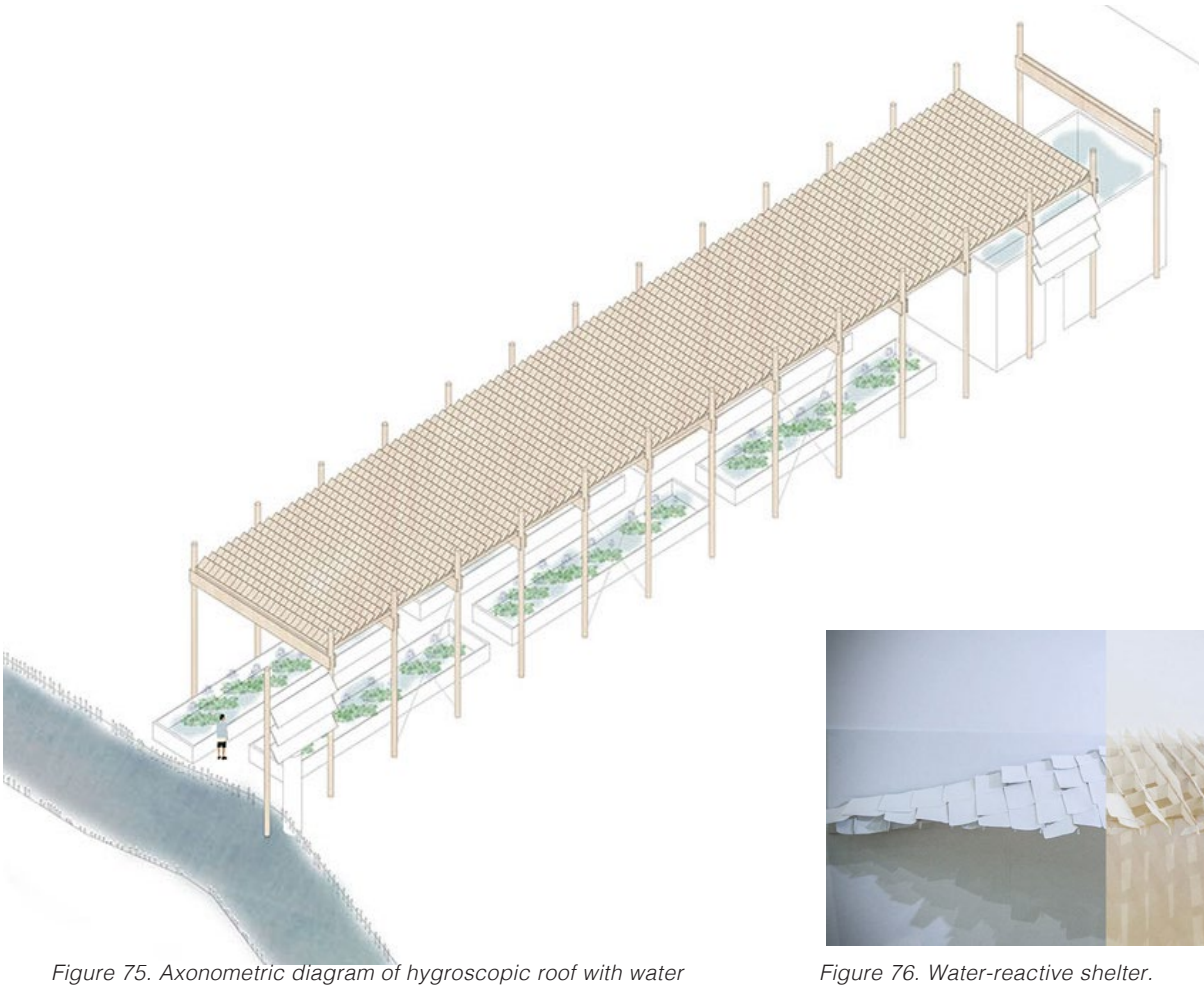


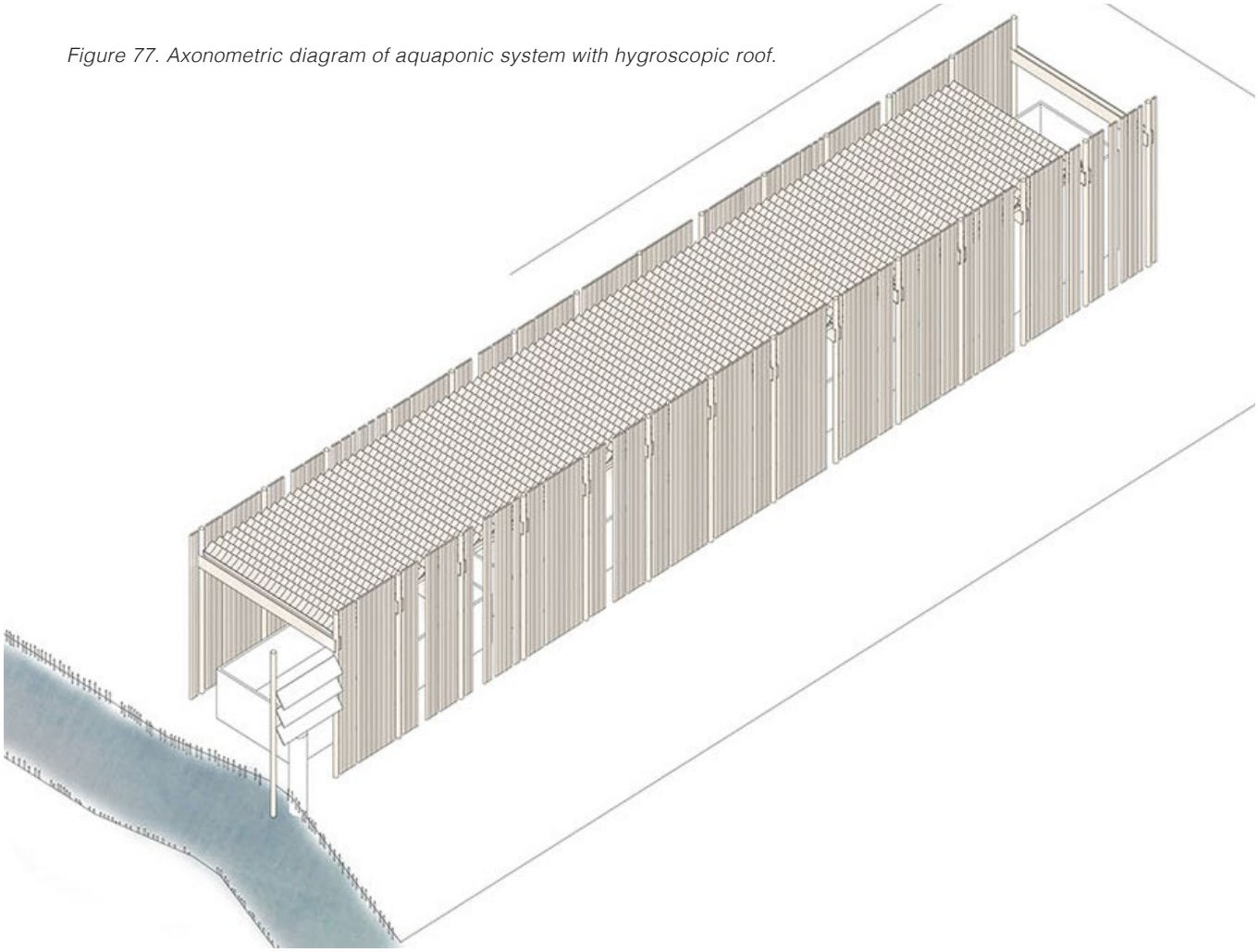
Figure 75. Axonometric diagram of hygroscopic roof with water filtering beds and a water catchment tank.

Figure 76. Water-reactive shelter.

HYGROSCOPIC ROOF SYSTEM

The hygroscopic roof system is a new roof concept that works with water as a reactive material, giving the building an ever-changing quality. This material curls upwards, opening up the form when the material is dry, then when it is wet, the material curves down, forming an almost planar surface. The ability to use this material either in its primary form of veneer or 3-D printing the material depends on the resources of those purchasing the material. The applications for this material have not been fully explored, but this thesis proposes it could be used as a roofing material, particularly for program that needs to let light in most of the time, but direct rain away from the interior to a focused catchment area. An application of the hygroscopic roof can be seen in ***Figure 75***; here there is vegetation below (which requires sunlight) and also a water catchment tank which can capture and hold rainwater from the roof to be used for irrigation as needed.

Figure 77. Axonometric diagram of aquaponic system with hygroscopic roof.



AQUAPONIC SYSTEM WITH HYGROSCOPIC ROOF

The aquaponic system in the building is one that employs the hygroscopic roof overhead. The building at this section of water treatment program involves: solar water pumps, an aquaponic system, infill poles, structural poles, a hygroscopic roof system, a water catchment tank, and a path for people. This system employs a solar water pump to move waste water in the canals to a system of treatment tanks, the first involving plants to treat the most polluted water, then the water progresses through a series of tanks that involve plants, native fish, and axolotl. Introducing fish and axolotls not only helps to clean the water, it also sets up a system that could begin to reintroduce native fish and axolotls to the canal system. There are infill poles (0.15m in diameter) between structural poles in order to create a dark environment for the aquatic life. The infill poles break where there is a break between tanks ,the equivalent of six infill poles, approximately a meter wide, in order to allow for emergency exits. The hygroscopic roof lets in light for the plants and then acts as a planar surface to direct rainwater to the catchment tank to be cleaned and returned to the canal system. The volume of the catchment tanks through the building are sized in order to catch all the rain water from the roof (related to each tank) based on Mexico City's annual rainfall.

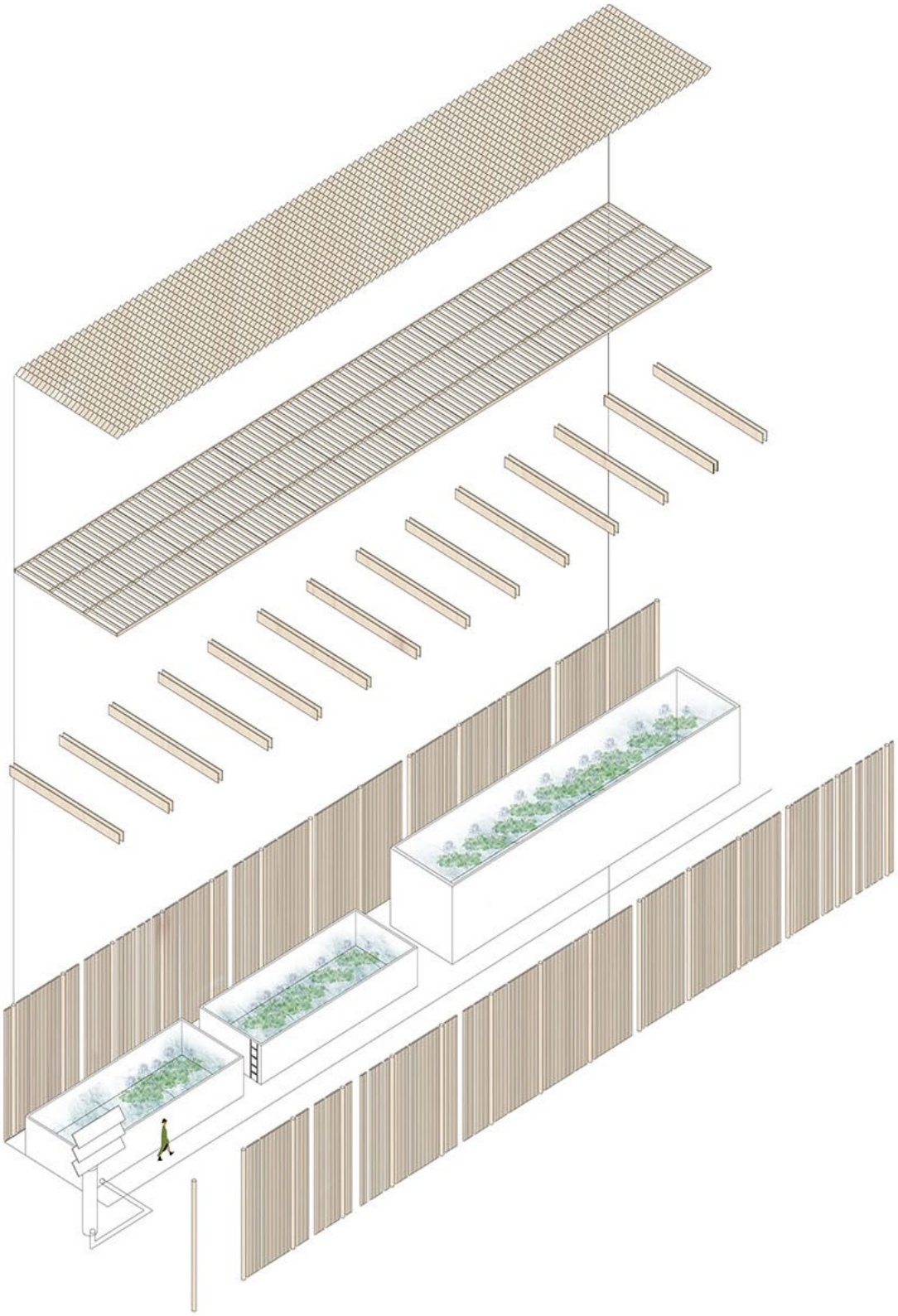


Figure 78. Exploded axonometric diagram of aquaponic system with hygroscopic roof.

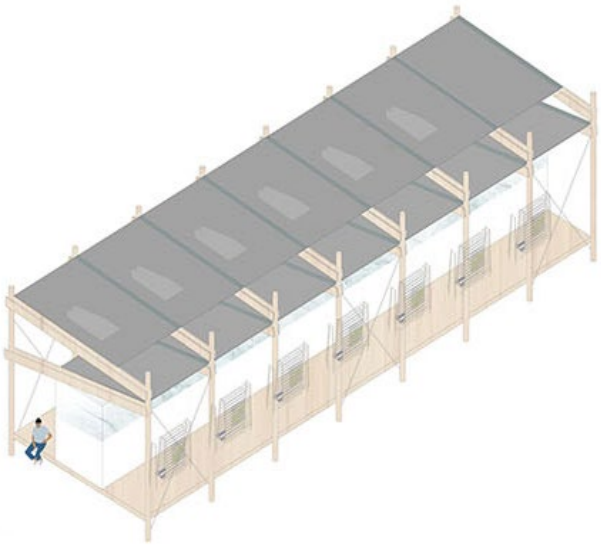


Figure 79. Axonometric diagram of hydroponic system.

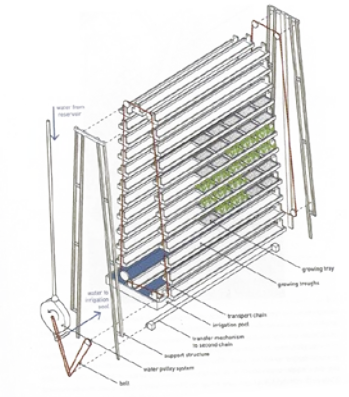


Figure 80. Vertical hydroponic system.

VERTICAL HYDROPONIC SYSTEM

The vertical hydroponic system is a section of the building that treats water in a central catchment tank with water hyacinths and then this water is pumped through vertical hydroponic growing systems with a solar pump. Due to the polluted nature of the canal water and chinampa soil, people have not been able to use the chinampas for their original purpose, agriculture. Introducing a vertical hydroponic growing system would bring agriculture back to the chinampas and offer a possible source of income for people who used to rely on agriculture as a source of income. Water hyacinths and any plants that die in the hydroponic system can be composted and used for fertilizer for the ground, regenerating the soil condition of the chinampas. The building has multiple water treatment systems in place with the concept they will help wastewater in the canal system regenerate and rid it of most pollutants. Treating the canal water will improve soil quality and the lives of any living species in the canal system. This building employs a variety of water treatment systems as a way of demonstrating the potential for each system, and these systems contribute to making the building a dynamic system.

Figure 81. Elevation of building shortly after it was constructed.

SCENE III: SACRIFICE AND RENEWAL

Entering the canal system is done primarily on the canal that separates the designated World Heritage Site and Xochimilco Ecológico Park. ***Figure 81*** shows a man moving through the canal on his trjinera with water hyacinths floating in the canal and the building moving through the land and water in the background.

Given the design's scale, the design is conveyed through a series of images of its spaces. These views all have a quality of being a little dirty which is intentional in order to convey the quality infrastructure gets when its aged and nature begins to influence its appearance. ***Figure 69*** provides a reference map to understand where the images were captured along the building design. The viewpoints were chosen to try and show different ground conditions and water treatment systems. These images work to capture the satiric/satyric quality of the design process and resulting design. There is also a sense of time to the images, moving through them vines grow up and around wood poles, an increased number of axolotls can be seen in the water, and the final render, ***Figure 97***, represents the structure having lived its "life" cleaning the water and its materials being taken away to be re-purposed.

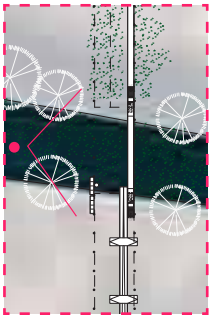


Figure 82. View map.

Figure 83. Entrance on water.

FLOAT

Figure 83 shows how one can enter the building on a concrete pier, water and water hyacinths surrounding it and leads one to the building, with the building itself floating on water. One of the existing concrete pieces in the lake acts as a bridge from land to the building on pontoons. The pontoons are sized to support the weight of the structure and have it float on the lake. Water hyacinths are being placed into the water in this image and there are axolotls being introduced to the water as well. Between the structural poles, infill poles are placed to act as a guard against falling into the lake; the primary path on pontoons is towards the west side of the building. Roofs slope so rain water drains down to the lake and water hyacinths. This water treatment system is exploring the use of water hyacinths to treat waste water.

Figure 84. View map.

Figure 85. Dive down to the aquifer.

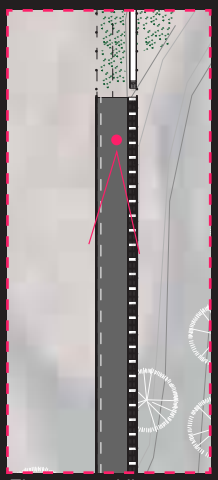


Figure 86. View map.

Figure 87. Clean water, pump to cows then canal.

DIVE

The portion of the building that dives down to the aquifer as a series of stairs and access points to the water is meant to act like a step well and allow water to rise and fall while always being able to reach it. The roofs slope and direct rain water down to the aquifer. The rain water falls down this earthen wall, leaving it wet during the rainy season. The light from the stairwells and doors reflect on the wet, earthen wall opposite it (***Figure 85***). At this depth there is some water from the aquifer exposed and reflecting light.

CROSS

Figure 87 shows clean water being pumped down to the cow trough, providing potable water for the animals. To allow cows to cross the trough, ramps were put in place.

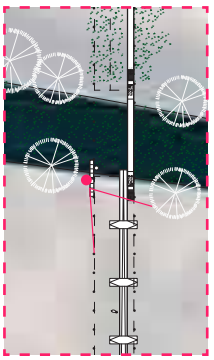


Figure 88. View map.

Figure 89. Dam the water from draining through the fissure.

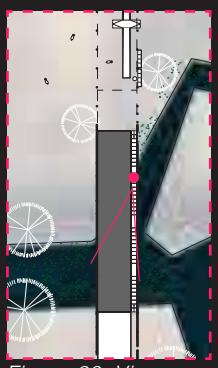


Figure 90. View map.

Figure 91. Moving through chinampa of Cempazuchitl (marigolds). Flowers are the primary crop grown to generate income on the chinampas in 2017. Cempazuchitl (marigolds) are the flowers most commonly used to celebrate the Day of the Dead.

DAM

Figure 89 shows the potion of the building that emphasizes the absence and disappearance of water that is a possible future for Mexico City if no sacrifice is made. The skeleton emphasizes the absence and loss represented in this image.

LIFT

Figure 91 is a section perspective captured on the Day of the Dead celebration. This image shows the building at dusk and the potential to host celebrations, in addition to treating water. The water treatment system in place is an elevated bioswale with a hygroscopic roof. This image shows life and death and the inseparable relationship they have; people alive and dead dance through the building and axolotl skeletons live in the earth, reinforcing the importance of their imagery and symbol for regeneration.

Figure 92. View map.

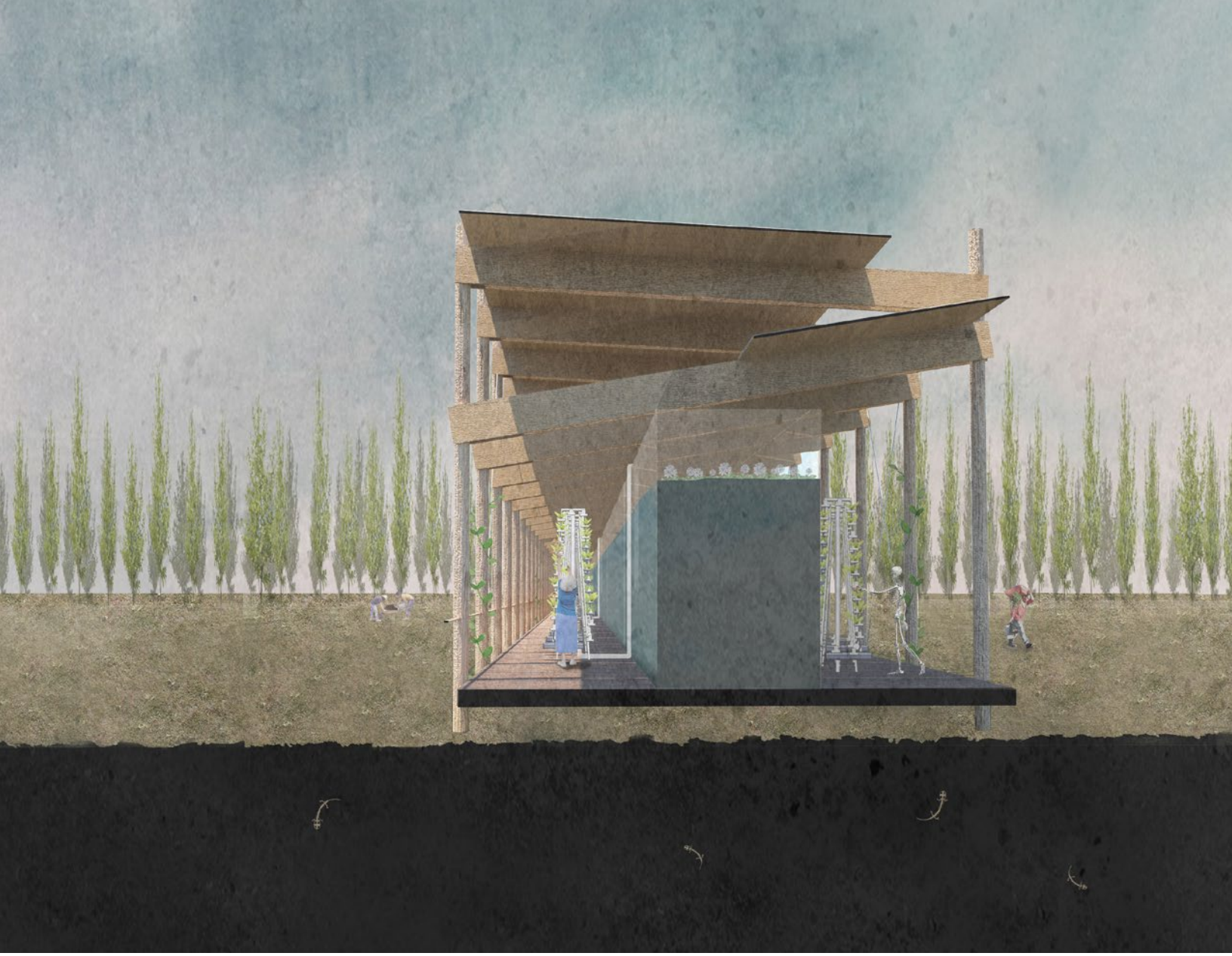


Figure 93. Maintaining the hydroponic system.

LIFT

Figure 93 is a section perspective through the hydroponic system section of the building. This system employed the roof assembly of by-pass beams, tongue-and-groove structural ceiling, sheet metal, and clear polycarbonate roof panels. These roof planes angle to direct rainwater into a catchment basin that runs the length of the program; this basin was sized based on how much water it could collect from the roofs. This image shows a woman maintaining the hydroponic system by removing plants that have died; to the right of the image, there is a skeleton helping her and also removing the dead plants. People out in the chinampa landscape are using composted plant fertilizer to reinvigorate the soil of the chinampa.

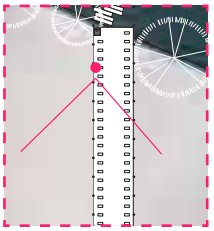


Figure 94. View map.

Figure 95. Building severs as it reaches the urban area of Xochimilco.

SEVER

Figure 95 shows the end program of the building, that of a public water fountain; here people access treated, potable water. The fountain spouts are two axolotl mouths, playing on the idea the axolotl is giving people potable water, even though humans destroyed their natural environment. This fountain is not meant as a stable resource for potable water, it demonstrates how rain water could be captured and treated naturally, but also reinforces the idea of water as a source of value, not only a resource.

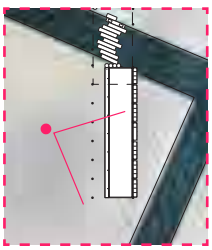


Figure 96. View map.

Figure 97. Future collapse and re-purpose of materials.

FINAL ACT | EPILOGUE

"I think the ideal space must contain elements of magic, serenity, sorcery, and mystery."[64]

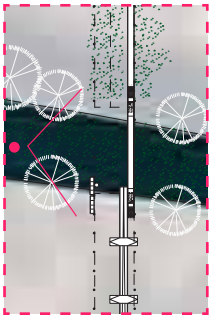
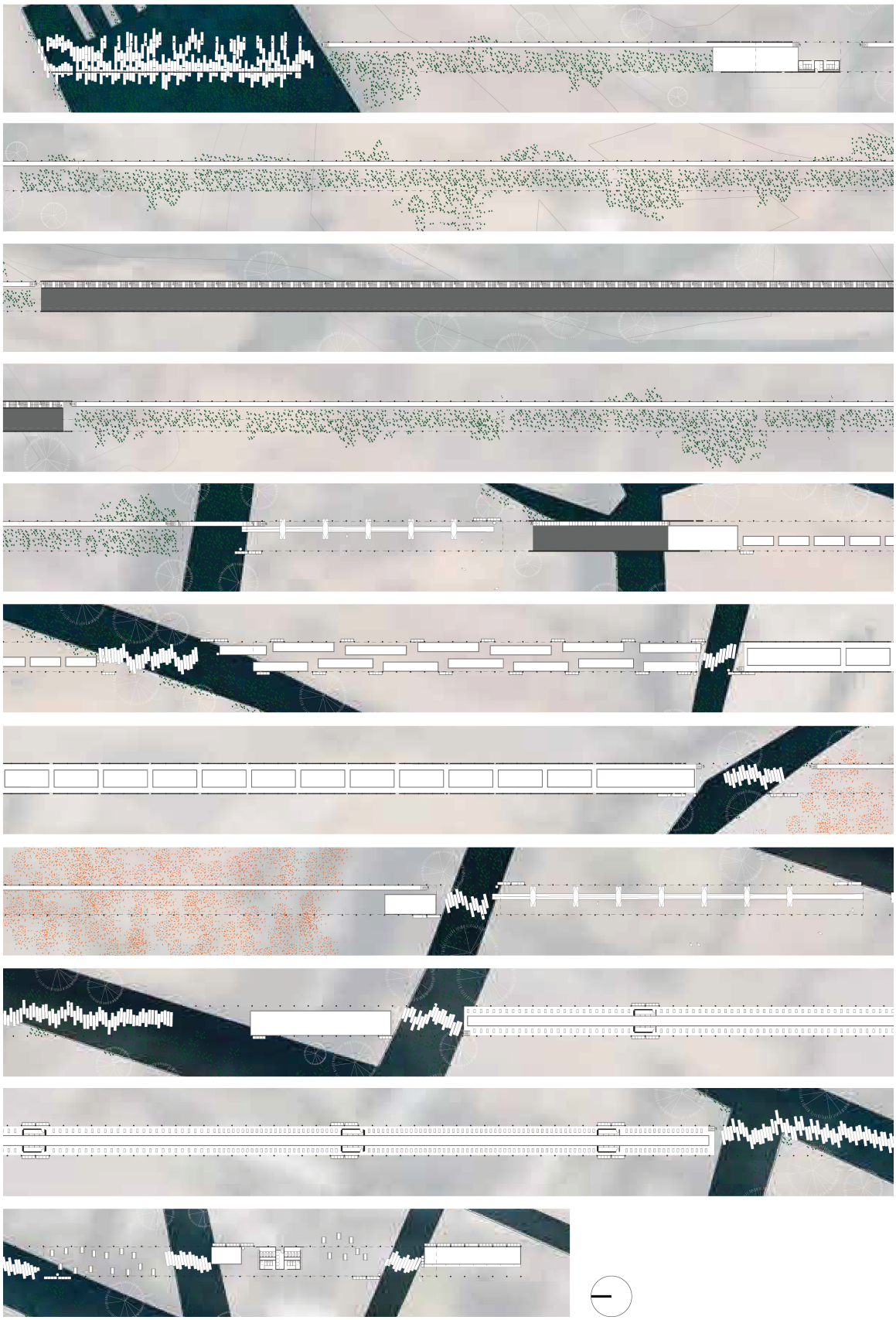


Figure 98. View map.

Mexico City has a rich, complex history layered with realism and magical realism, tragedy, comedy, and satire. This thesis began with examining Mexico City's history and breaking it into sections that correlate with the narrative, *Revenge of the Lake*. Mexico City has always had a tumultuous relationship with water, from its foundation on an island, draining and infilling the lake, engineering complicated water systems for potable water and waste water, drilling thousands of wells into the city's aquifer, and floods and droughts. Mexico City 2017 is feeling the full force of the "revenge of the lake" with a deficit of potable water and numerous natural disasters, worsened by the fact the city is built on a lake bed. The city is the real-life version of Serlio's Satyric scene where nature is breaking down the wall between it and civilization, collapsing the perception that nature can be kept at bay. Focusing on the area of Xochimilco, where the traditional canal and chinampa system still exist, this site provides the perfect setting to explore Mexico City's relationship with water and create a design to shift that relationship. The mostly open area provides space to design a large program related to water and water treatment.

This thesis proposes a design that emphasizes the importance of water through a strong form that moves through the landscape and involves ideas of temporality and regeneration. The design's program emphasizes the continuous concept of water both in the presence and absence of water, while exploring different natural systems that can be in place to treat rain and waste water. The design works to clean water but it doesn't suggest a permanence; its materials are meant to age and fall to the landscape or have a “second life” and be used for another purpose once the original structure had served its purpose. The design works to be like the axolotl, a symbol of regeneration. The design regenerates the water, the soil, the life of the area, and then its materials can be re-purposed for other uses. The goal of the design would not only be to have this regenerative spirit, but also to inform people how there are other solutions to attaining potable water than just drilling into the aquifer. Mexico City's government issued a release that they were planning on investigating its deep aquifer as a potential resource for drinking water; this project will be very costly and just injects another engineering "solution," - the comic scene - that does nothing to solve the problem at hand. This thesis dramatizes many alternatives to attain potable water, all of which use natural treatment methods and fairly simple materials, as part of a satyric scene. The design is meant to be bold in form and idea, to experiment with different water treatment systems, and embrace "elements of magic, serenity, sorcery, and mystery."[65]

Figure 99. Right, the entire plan whole. Below, the entire plan broken into eleven segments and flipped 90º in order to be able to read plan program.



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21 The official original building was constructed 1584. In 1867 professional schools were added to the school's cirriculum: medicine, engineering, architecture, and law. The original building "was demolished in 1910, and the university was moved to a new campus (constructed 1949–52) at Pedregal de San Angel in the southern part of Mexico City, opening In 1954; the campus was designated a UNESCO World Heritage site in 2007" (Editors of the Encyclopedia Britannica).

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24 Cabildo means the city's governing council. While members of the Méxica government were called to council the Spanish, the primary governmental power was the cabildo.
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31 The Angel of Independence stands today not only as a symbol of independence, but also a symbol of Mexico City's sinking. When the Angel of Independence was first inaugurated there were four steps leading up to its column; as the Angel of Independence stands in 2017, there are fourteen steps leading up to the column. The increase in steps is due to the fact the Angel's solid base has remained in the same place while the city has sunk around it.
32 ibid. Pg. 123.
33 *Mexico City's Water Supply*. Op. Cit. Pg. 12.
34 *Mexico City's Water Supply*. Op. Cit. Pg. 23.
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39 Correa, Alfaro. Op. Cit. Pg. 150.
40 ibid.
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42 Iztapala one of the districts in Mexico City with the largest water access deficit. The lack of access to water has increased tensions amongst the people that live there, from having the women in the household start waiting at midnight at the water delivery location to ensure their family gets water (an amount still unequal to those in western, wealthier districts); to a report of holding a water delivery man at gunpoint to get water from him.

ENDNOTES CONT.

43 "Among these financial means are the educational services of the park such as guided tours, summer courses and workshops. The co-production of a number of events and the rent of locations for special events such as the shooting of films for TV or the cinema should be mentioned. The Laboratory of Soil and Water Analysis is still another service. Originally created for the park only, today its capacity surpasses the park's needs. The Runner's Club, the three food stands, the craftsmanship shop, and the chinampa's production represent a small income. There will soon be restaurant, a camping zone, and a movie theater, among other facilities."

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