TOWARDS
A REPARATIONS ECOLOGY:

Ecosystem design narratives for rewilding and regenerating desecrated lacustrine landscapes in Tláhuac-Xico, Mexico City

by
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Author's declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis including any required final revisions as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

For centuries, built environments have been instrumental in imposing an anthropocentric system that has separated nature from human civilization. In retrospect, this dualist structuring of man and nature stems from land practices that were homogenized across the world through colonialism. Colonial practices have appropriated land, culture and ecology for extraction and accumulation. Until only a couple of centuries ago, more than eighty percent of the entire world was colonized by European imperial powers. Although most of these regions have gained autonomy since then, colonial power structures are still dominant in impeding possibilities for a viable and ecologically sustainable future for all.

The region of Tláhuac-Xico (Chalco) in Mexico City presents a complex set of socio-ecological issues whose origins can be traced back to colonial land practices. Before colonization, the region existed as a lacustrine ecology centered around Lake Chalco and sustained prehispanic civilizations through centuries. These civilizations thrived by forging symbiotic relationships with land, water, and nature through engineered hydraulic systems. They had no intention of defiling the natural environment for survival. Instead, they were agents in upholding a socio-ecological landscape that was rooted in conserving, enriching, and beautifying the lacustrine ecology they inhabited. In contrast, Spanish colonists who arrived in the early 16th century unleashed a system that led to the desiccation of the lakes. In its place emerged a 'modern' metropolis that continues to extract and appropriate from lands usurped from indigenous communities. Colonial land practices led to the devastation of indigenous communities whose lives and livelihoods were woven into the lacustrine ecology[1]. The repercussions of colonial practices continue to manifest as social and ecological disasters even today.

In 1988, Lake Chalco re-emerged as Lake Tláhuac-Xico due to land subsidence and seismic activity. The return of the lake presents a hopeful possibility for indigenous communities who have throughout centuries resisted the cultural and ecological appropriation of the ex-lacustrine region. The term 'reparations ecology' hypothesizes a new model for making amends to grave errors of the past by rethinking relationships between human society and natural ecology as mutually constituting each other[2]. Through an elaborate ecosystem design narrative, the thesis explores a potential 'reparations ecology' in Tláhuac-Xico (Chalco) that is rooted in rewilding and regenerating desecrated lacustrine landscapes that once thrived in the region. The result envisions methods of design that present architectural capacities through the lens of decolonization.

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2 Patel, Raj, and Jason W Moore. 2017. A History Of The World In Seven Cheap Things : A Guide To Capitalism, Nature, And The Future Of The Planet. Oakland, California: University of California Press.

Acknowledgments

This thesis deals with an incredibly complex and layered crisis that affects Mexico City. Being an outsider, I must acknowledge that it is impossible for me to fully comprehend the true extent of these complexities. I am deeply grateful to everyone who has contributed to the existing discourse and scholarship around this topic. I hope that I will be able to visit my site in the near future and reflect on the work presented within this thesis.

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To my brother, Vivek. You sought to change the world with your ideas and inspired others to do the same. I can only hope to carry your light forward.

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- https://www.dw.com/en/mexicans-turn-to-ancient-aztec-floating-gardens-to-revive-mangrove-forests/a-48939312
- https://www.garrofarms.com/post/aztecs-and-aquaponics-a-surprising-history

107 **figure 3.15** : ownership & control typologies diagram
diagram recreated by author (2020)
original diagram from: France RL. Restorative Redevelopment of Devastated Ecocultural Landscapes. Boca Raton: CRC Press; 2011.

109 **figure 3.16** : relationship diagram - interactions for ecosystem integrity
diagram recreated by author (2020)
original diagram from: https://www.researchgate.net/figure/Interaction-between-built-social-human-and-natural-capital-required-to-produce-human_fig1_271658752

112 **figure 3.17** : images depict various initiatives undertaken by the museum. this includes alves's historic model of colonization in the region, re-creation of a prehispani-era chinampas, and organizing community meetings for social engagement.
retrieved from: http://www.mariatherezaalves.org/works/the-return-of-a-lake?c=17

112 **figure 3.18** : poster for an event organized by the Xico Community Museum that lobbies for proposals to revive the former lacustrine ecology.
retrieved from: http://www.mariatherezaalves.org/works/the-return-of-a-lake?c=17

113 **figure 3.19** : scope of design
map by author (2020).

115 **figure 3.20** : ecological succession diagram
diagram by author (2020).

119 **figure 4.1** : isometric view, contemporary chalco.
image by author (2020).

121 **figure 4.2** : isometric view contemporary chalco - site boundary
image by author (2020).

123 **figure 4.3** : isometric view contemporary chalco - key areas
image by author (2020).

125 **figure 4.4** : isometric view key areas - before terraformation
image by author (2020).

127 **figure 4.5** : isometric view - key area #1 - before terraformation
image by author (2020).

129 **figure 4.6** : terraforming sequence - key area #1
image by author (2020).

131 **figure 4.7** : isometric view - key area #1 post terraformation
image by author (2020).

133 **figure 4.8** : isometric view - key area #2 - before terraformation
image by author (2020).

135 **figure 4.9** : terraforming sequence - key area #2
image by author (2020).

137 **figure 4.10** : isometric view - key area #2 post terraformation
image by author (2020).

139 **figure 4.11** : isometric view - key area #3 - before terraformation
image by author (2020).

141 **figure 4.12** : terraforming sequence - key area #3
image by author (2020).

143 **figure 4.13** : isometric view - key area #3 post terraformation
image by author (2020).

145 **figure 4.14** : isometric view - key area #4 - before terraformation
image by author (2020).

147 **figure 4.15** : terraforming sequence - key area #4
image by author (2020).

149 **figure 4.16 :** isometric view - key area #4 post terraformation
image by author (2020).

151 **figure 4.17 :** isometric view key areas - post terraformation
image by author (2020).

153 **figure 4.18 :** vignette - key area #1
image by author (2020).

154 **figure 4.19 :** vignette - key area #2
image by author (2020).

155 **figure 4.20 :** vignette - key area #3
image by author (2020).

156 **figure 4.21 :** vignette - key area #4
image by author (2020).

157 **figure 4.22 :** isometric view ecosystem design narrative- key areas
image by author (2020).

159 **figure 4.23 :** isometric view ecosystem design narrative- site boundary
image by author (2020).

161 **figure 4.24 :** isometric view ecosystem design narrative
image by author (2020).

163 **figure 4.25 :** ecosystem design narrative - proposed masterplan
image by author (2020).

165 **figure 4.26 :** isometric view - water
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167 **figure 4.27 :** vignette #1
image by author (2020).

169 **figure 4.28 :** isometric view - wetlands
image by author (2020).

171 **figure 4.29 :** vignette #2
image by author (2020).

173 **figure 4.30 :** isometric view - chinampas
image by author (2020).

175 **figure 4.31 :** vignette #3
image by author (2020).

177 **figure 4.32 :** isometric view - infrastructure
image by author (2020).

179 **figure 4.33 :** vignette #4
image by author (2020).

181 **figure 4.34 :** isometric views: towards a reparations ecology
image by author (2020).

185 **figure 4.35** : in the midst of the covid-19 pandemic, smaller farmers in xochimilco increased production and rehabilitated abandoned chinampas to fulfil demands for fresh, organic and local produce.
retrieved from: https://upload.wikimedia.org/wikipedia/commons/8/88/Sembrad%C3%ADo_en_chinampa.JPG

Introduction

The Mexico Valley Basin was once home to five great lakes that sustained a complex socio-ecological landscape where humans and nature lived in symbiotic harmony. After Spanish colonists seized the valley in the early 1500s, they began the process of draining the lakes to build a Euro-centric 'modern' metropolis in its place.[1] Six centuries later, the city that replaced the lakes faces an environmental catastrophe that threatens lives and livelihoods for millions of its residents. The crisis in Mexico City is the making of an epic multi-generational mismanagement of the valley's resources.[2] The city now faces various existential threats that have actualized in the form of an ecological crisis characterized by severe water scarcity, floods, and earthquakes.[3] The bowl-like depressions where the lakes once stood are consumed by an unceasing urban sprawl that continues to usurp, extract, and appropriate from the former lacustrine ecology.

The region of Tláhuac-Xico (Chalco), which was once home to the desiccated Lake Chalco, is entangled in an intricate web of complex socio-ecological issues that have risen as a direct consequence of colonial land practices. Colonial practices have led to the region developing a perverse relationship with its natural environment.[4] Following the desiccation of Lake Chalco, the city had to rely on underground aquifers to sustain its freshwater requirements. Overexploitation of groundwater resources led to land subsidence, which was followed by pluvial water collecting to form large puddles in newly created depressions.[5] Eventually, the puddles merged to become a new lake that is now named Lake Tláhuac-Xico[6] (figure 0.1).

The re-emerging lake presents an ecological conundrum for the region. The lake is contained by urban and agricultural zones that are now threatened by incessant flooding and significant damage to property and infrastructure.[7] Based on empirical projections, the lake would eventually consume large swaths of land, thus displacing thousands of people and destroying livelihoods that depend on agriculture and ranching. On the other hand, indigenous

1 Candiani, Vera S. 2014. Dreaming Of Dry Land. Stanford: Stanford University Press.

2 Vitz, Matthew. 2018. A City on a Lake: Urban Political Ecology And The Growth Of Mexico City. Duke University Press.

3 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

4 Vitz, Matthew. 2018. A City on a Lake: Urban Political Ecology And The Growth Of Mexico City. Duke University Press.

5 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

6 Lake Tláhuac-Xico is unofficially named after the two communities that make up the area where the lake is expanding. The new lake is also often referred to as the returning Lake Chalco.

7 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

communities who have fought for centuries against colonial power structures regard the returning lake as a latent substrate to rewild and regenerate former lacustrine ecologies that once thrived in the region. This paradoxical challenge is the crux for design synthesis in this thesis.

Throughout this thesis, research and analysis are directed towards exploring alternative decolonial possibilities by instituting a 'reparations ecology' in Chalco. The resulting design outcomes are presented through an elaborate ecosystem design narrative. The ecosystem design narrative is informed, aided, and constrained by an array of parameters derived from historical and theoretical research, case-studies, and a comprehensive spatial data analysis. The final results will challenge existing spatial norms in Chalco and seek to inform methodologies for ecological design that present architectural capacities through the lens of decolonization.

This thesis is structured into four chapters. The first three chapters will build a compelling narrative that seeks to establish parameters that influence the final ecosystem design narrative presented in the final chapter. The chapters are further summarized as follows:

PI (Retracing Lago de Chalco): This chapter of the thesis will seek to reiterate current states of knowledge pertinent to indigenous heritage, Hispanic colonization, and contemporary resistance movements in Chalco. Historical and theoretical references will be analyzed to illustrate a chronology of events relevant to colonial practices and its subsequent repercussions.

PII (Unfolding post-colonial Chalco): In this chapter of the thesis, a series of layered maps will be assessed to determine various site conditions that would influence design synthesis. The data represented within this section will be used to establish parameters based on current social, economic, and environmental conditions relevant to the site. These site conditions will directly inform key design interventions that are necessary to institute a reparations ecology in Chalco.

PIII (Systems for Designing Ecologies): In this chapter of the thesis, design objectives will be established through a series of coordinated diagrams and case studies. The intent is to establish a clear design framework of systems and strategies that would shape the proposed ecosystem design narrative.

PIV (Synthesis: Ecosystem Design Narratives): In this chapter of the thesis, a vision for a reparations ecology in Chalco is presented through a sequential ecosystem design narrative that will include a series of isometric drawings and vignettes. The intent is to illustrate how existing underlying conditions and spatial norms can be transformed to create and accommodate self-organizing systems that invoke a reparations ecology in Chalco.

figure 0.1 [spread]:
satellite image timeline -
return of lake tláhuac-xico

1985

1995

2020

2010

2005

2000

P I

“ six centuries of colonial land practices has led to the permanent desecration of lacustrine ecologies that one thrived on the former lake chalco.

a part of the lake has now re-emerged but the continued persistence of colonial power structures in the region impedes the possibility for a viable and sustainable future for the people of chalco. ”

retracing
lago de chalco

Mexico Valley
c. 1519
Brackish Water
Fresh Water
Marshes
Chinampas
Causeway
Lake Zumpango
Lake Xaltocan
Teotihuacan
0
10 miles
0
10 km
Texcoco
Azcapotzalco
Lake
Texcoco
Tlacopan
Tenochtitlan
Culhuacan
Lake Xochimilco
Lake Chalco
Xochimilco
Chalco

There once was a lake

The year is 1894. Íñigo Noriega Laso, a Spanish immigrant from Colombres, Asturias has just bought the Island of Xico on Lake Chalco. The lake was once part of an intricate lacustrine ecology in the Mexico Valley Basin that comprised of five great lakes. By the late 19th century, almost all the lakes in the valley had been desiccated by colonial land practices. In its place, an urban metropolis named Ciudad de México (CDMX) emerged - irrepressibly expanding, desecrating the delicate lacustrine ecology that had once flourished for centuries prior to colonization. Lake Chalco was one of the last lakes to survive this systematic desiccation. Indigenous communities who lived there had relentlessly fought colonial attempts to eliminate the lakes from the valley[1]. This was until Íñigo Noriega Laso arrived.

The Island of Xico was home to the Chalcas, one of the twenty-four indigenous communities that lived on or around the lake in closely-knit hydro-agrarian settlements. Lake Chalco constituted the "primary element of life" for these communities. Their lives and livelihoods were woven into the lake's ecology. Following Noriega's acquisition of the island, he began experimenting on drying up the lake. The lake covered about 10,000 hectares (100 square kilometers). Desiccating the lake would enable Noriega to expand his estate and appropriate the lush lake-bed for commercial ventures. Once granted concession by Porfirio Díaz, the then President of México, Noriega systematically begins to drain the lake and usurp the desiccated lands to build an agriculture and cattle enterprise. He also forcibly expelled the Chalcas from the Island of Xico to a low-lying flood-prone area about four kilometers away. Those who resisted Noriega were assassinated or had their property, homes and possessions burnt. Others fled in fear. Noriega's actions dispossessed and marginalized indigenous communities with an ecological heritage that thrived for centuries around the lake. By 1908, Lake Chalco would cease to exist. In the following years, Noriega would become the second wealthiest man in Mexico. He would also own the fourth largest estate in the country, a large portion of which was illegitimately appropriated from Lake Chalco[2].

For most of history, Lake Chalco was part of an elaborate network of interconnected rain-water lakes that fostered the growth of the Aztec Civilization. The Aztecs built complex hydrological systems to control water flow and co-actively utilized lacustrine resources for sustenance[3]. The Chalcas, who had arrived in the valley even before the Aztecs, were the first to create centralized control over the valley's lacustrine ecology. They inhabited the

figure 1.1 [left]:
mexico valley basin (c. 1519)
prior to colonization, the mexico valley basin existed as a lacustrine ecology centred around six great lakes, lake chalco is on the south.

1 Vitz, Matthew. 2018. A City on a Lake: Urban Political Ecology And The Growth Of Mexico City. Duke University Press.

2 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

3 Morehart, Christopher and Charles Frederick. "The Chronology and Collapse of Pre-Aztec Raised Field (Chinampa) Agriculture in the Northern Basin of Mexico." Antiquity 88, no. 340 (2014): 531-548.

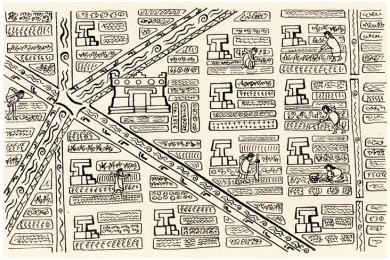


figure 1.2 [above]:
artist's impression of various canal networks linking chinampas in the mexico valley basin.

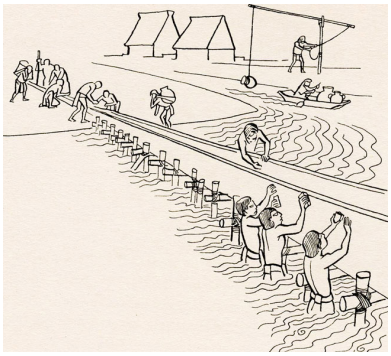


figure 1.3 [above]:
artist's impression of the building a causeway on the lakes within the mexico valley basin.

figure 1.4 [above]:
models replicating chinampa agricultural practices during the pre-hispanic era.

Island of Xico on Lake Chalco and turned it into a major hub for distribution and regulation of water across the valley. They built an intricate network of hydrological systems that included dykes, levees, and canals (Figure 1.2), which allowed them to control flooding during the rainy season and assure adequate fresh-water resources during the dry season[4]. The Chalcas also engineered Chinampas - islands for farming that produced intense and high yielding agriculture. Often characterized as an aquaponic system that dates back to 1400 B.C., Chinampa agriculture had evolved into being one of the most productive agricultural systems in the world[5]. The success of Chinampa agriculture led to a large number of indigenous communities and small towns to be founded on island settlements located on water and in between Chinampas. These communities would gradually make up the framework for an interwoven socio-ecological landscape. Socio-ecological landscapes can be broadly defined as nested sets of co-evolving social and ecological systems that are linked through symbiotic interactions that occur on spatial and temporal scales[6]. In the context of regions in and around Lake Chalco, social systems – hydro-agrarian indigenous settlements were woven into the natural lacustrine ecology. Chinampas relied on using lacustrine resources to artificially create an organic substrate for cultivation. It comprised of raised beds held together by reeds and fabricated by alternating layers of decomposing aquatic plants with highly fertile lake sediment (Figure 1.7). The ensuing soil substrate is soft and permeable, thus allowing natural drainage and irrigation. Through effective crop-rotation systems, Chinampa agriculture allowed for the cultivation of a variety of crops that fed over 170,000 people annually[7]. Its implementation depended on exploiting lacustrine water-cycles as a stable and controllable hydrological resource. For the communities that lived here, sustenance was directly reliant on maintaining a delicate ecological equilibrium between the lake and their lands. They had no intention of defiling the natural environment for survival. Instead, they engaged in conserving, enriching, and beautifying the socio-ecological landscapes that they inhabited[8]. They acted as agents, forging symbiotic relationships with land, water and nature through complex hydrological systems. These relationships molded the core fabric of intricate socio-ecological landscapes that enabled the Aztec Civilization to flourish for centuries[9].

4 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

5 Morehart, Christopher and Charles Frederick. "The Chronology and Collapse of Pre-Aztec Raised Field (Chinampa) Agriculture in the Northern Basin of Mexico." Antiquity 88, no. 340 (2014): 531-548.

6 Fischer, Alexandra Paige. "Forest Landscapes As Social-Ecological Systems And Implications For Management". Landscape And Urban Planning 177 (2018): 138-147.

7 Morehart, Christopher and Charles Frederick. "The Chronology and Collapse of Pre-Aztec Raised Field (Chinampa) Agriculture in the Northern Basin of Mexico." Antiquity 88, no. 340 (2014): 531-548.

8 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

9 Vitz, Matthew. 2018. A City on a Lake: Urban Political Ecology And The Growth Of Mexico City. Duke University Press.

figure 1.5 [below]:
isometric view
prehispanic chalco

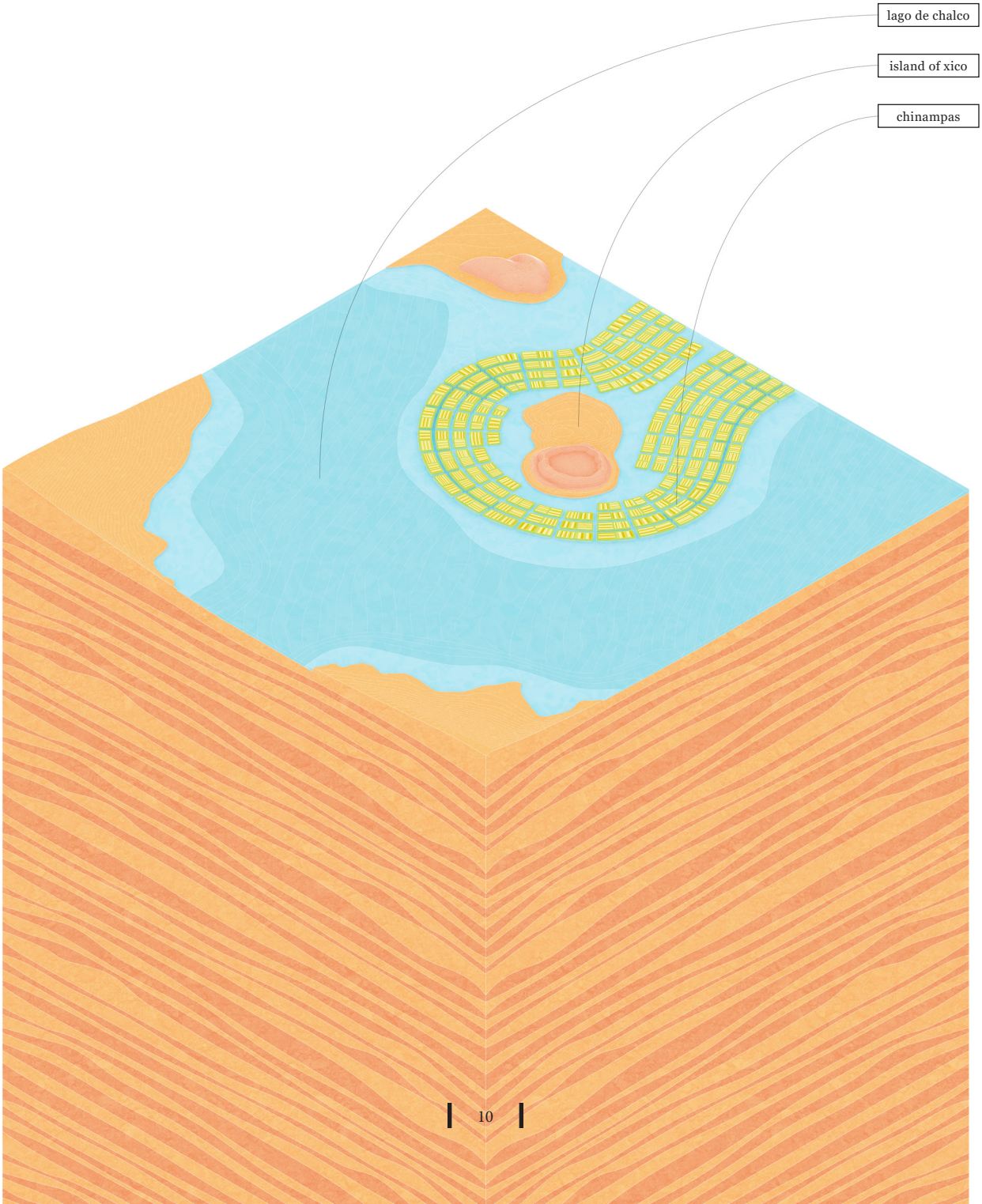


figure 1.6 [above]:
diego rivera's mural fantastically delineates the aztec civilization embedded within the lacustrine ecology.

figure 1.7 [right]:
models replicating chinampa agricultural practices during the pre-hispanic era.

Colonial power structures

With the arrival of Spanish colonists in the 16th century, a scheme to deliberately desecrate the same hydrological systems was deployed. Unacquainted with the region's ecological fragility, they sought to build a Euro-centric metropolis on the lakes. The colonists demolished elaborate hydrological systems that maintained ecological equilibrium and replaced them with tunnels. Driven by a manic necessity of draining the lakes, the tunnels would get larger and longer over centuries. Constructing tunnels were not an effective system, and yet they persisted in building their urban metropolis on land appropriated from draining the lakes. As a result, the metropolis which was officially christened as Ciudad de México (Mexico City) in 1585 was imperiled by persistent flooding[10]. The colonists prioritized flood prevention in Mexico City and the Spaniards in it above everything else. They directed excess water flow towards areas on the city's peripheral regions, which were mostly inhabited by indigenous communities. The rising water levels would flood their settlements, harvests and livelihoods, and subsequently desecrate the delicate equilibrium that sustained socio-ecological landscapes in valley[11].

Following the Mexican War of Independence, the Spanish colonists relinquished political control of Mexico in 1836. However, the impact of colonialism is still prevalent in the region through colonial power structures. Colonial power structures, which are emblematic of a racist structuring of power geared towards economic extraction and capitalist accumulation is a direct consequence of colonialism[12]. The political control of a territory by an external group, in this case – the Spanish colonists, has had long lasting consequences that actualize as catastrophic socio-ecological disasters. Íñigo Noriega's actions, that led to the permanent desecration of Lake Chalco in 1908, was enabled by the prevalence of colonial power structures rooted in appropriating and exploiting indigenous heritage lands. Desiccating the lake inevitably led to the economic, social and cultural decline of indigenous communities. The communities that resisted were silenced, expropriated, and massacred. They were inherently removed from the socio-ecological landscape that nurtured their sustenance for centuries. Needless to assert, desiccating the lake also had regressive consequences on nonhuman lifeforms that thrived within Lake Chalco. The lacustrine ecology had sustained over 110 species of birds, which included five million migratory birds that visited annually. Furthermore, dozens of aquatic plant species, about ten species of fish, and the Axolotl - an amphibious mole salamander indigenous to the region, are all critically endangered. Even today, active remnants of regressive colonial power structures continue to threaten the lives of communities that

10 Vitz, Matthew. 2018. A City on a Lake: Urban Political Ecology And The Growth Of Mexico City. Duke University Press.

11 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

12 Quijano, Aníbal. "Coloniality of Power and Eurocentrism in Latin America." International Sociology 15, no. 2 (June 2000): 215–32.

now occupy the ex-lacustrine region. They grapple with systemic adversities that impact their social mobility and prolonged sustenance. Their lands and livelihoods are affected by floods, contaminated water, and an extreme scarcity of drinking water. Moreover, large portions of the Chalco region is impacted by land subsidence that has destroyed over hundreds of houses and has ruptured public infrastructure such as roads and sewage pipes[13].

The biggest paradox that has risen as a direct consequence of past colonial actions is the looming water crisis in Mexico City. Desiccating the lakes has led to a severe shortage of potable water availability in the city. In response, pumps were installed on usurped lands to extract water from underground aquifers. During the 1980s, underground aquifers in the Chalco region were appropriated to supply water to meet the city's water needs. Fourteen pumps were installed but almost twice the volume of water is extracted than is recharged naturally through infiltration[14]. This results in land subsidence which continues to damage homes and infrastructure and increase flood risks. However, in 1988, the formation of depressions due to land subsidence caused by overexploitation of the aquifer in Chalco let to the collection of pluvial waters to form giant puddles. Eventually, the puddles merged to form a lake[15]. This has led to the re-emergence of Lake Chalco as Lake Tláhuac-Xico[16]. The return of the lake presents a paradoxical challenge to those that inhabit the region. The majority of the ancient lake-bed is now urbanized. Large plots of land that have not succumbed to urban sprawl are appropriated for contemporary agricultural practices in the form of ejidos[17]. Due to continued land subsidence, the returning lake is over a meter and a half above the adjacent urban zone. The lake continues to expand and is now about 1300 acres (5 km^2) in area and holds 9 million cubic meters of water. Any quantity above this would result in flooding of adjacent urban zones. Despite this, aquifers in Chalco are still being exploited causing further land subsidence that only exasperates the problem. Additionally, the state continues to make proposals to build even more tunnels to remove water as a response to the threat of flooding[18].

figure 1.8 [above]:
"conquista de méxico por cortés". unknown artist
spanish conquistadors fight against soldiers of the aztec empire to take their capital.

figure 1.9 [above]:
archival image of the island of xico prior to lake chalco being desiccated.

13 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

14 Watts, Jonathan. "Mexico City's Water Crisis – from Source to Sewer." The Guardian, November 12, 2015, sec. Cities. https://www.theguardian.com/cities/2015/nov/12/mexico-city-water-crisis-source-sewer.

15 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

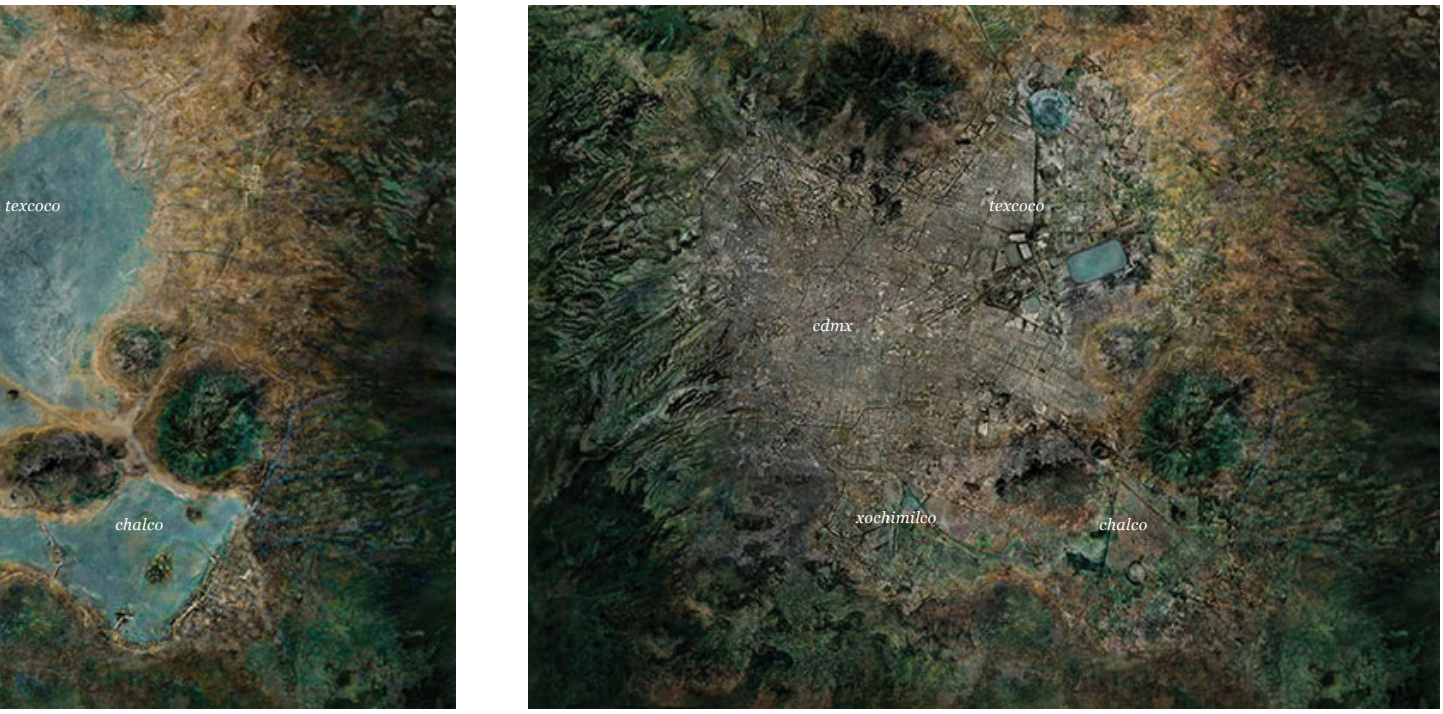
16 Named after the two communities (Tláhuac and Xico) that border the re-emerging lake.

17 Ejidos are areas of community land used for agricultural purposes wherein the local community members have usufruct rights rather than ownership rights to land. In this case, ownership rights are held by the state of Mexico.

18 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

1500

18

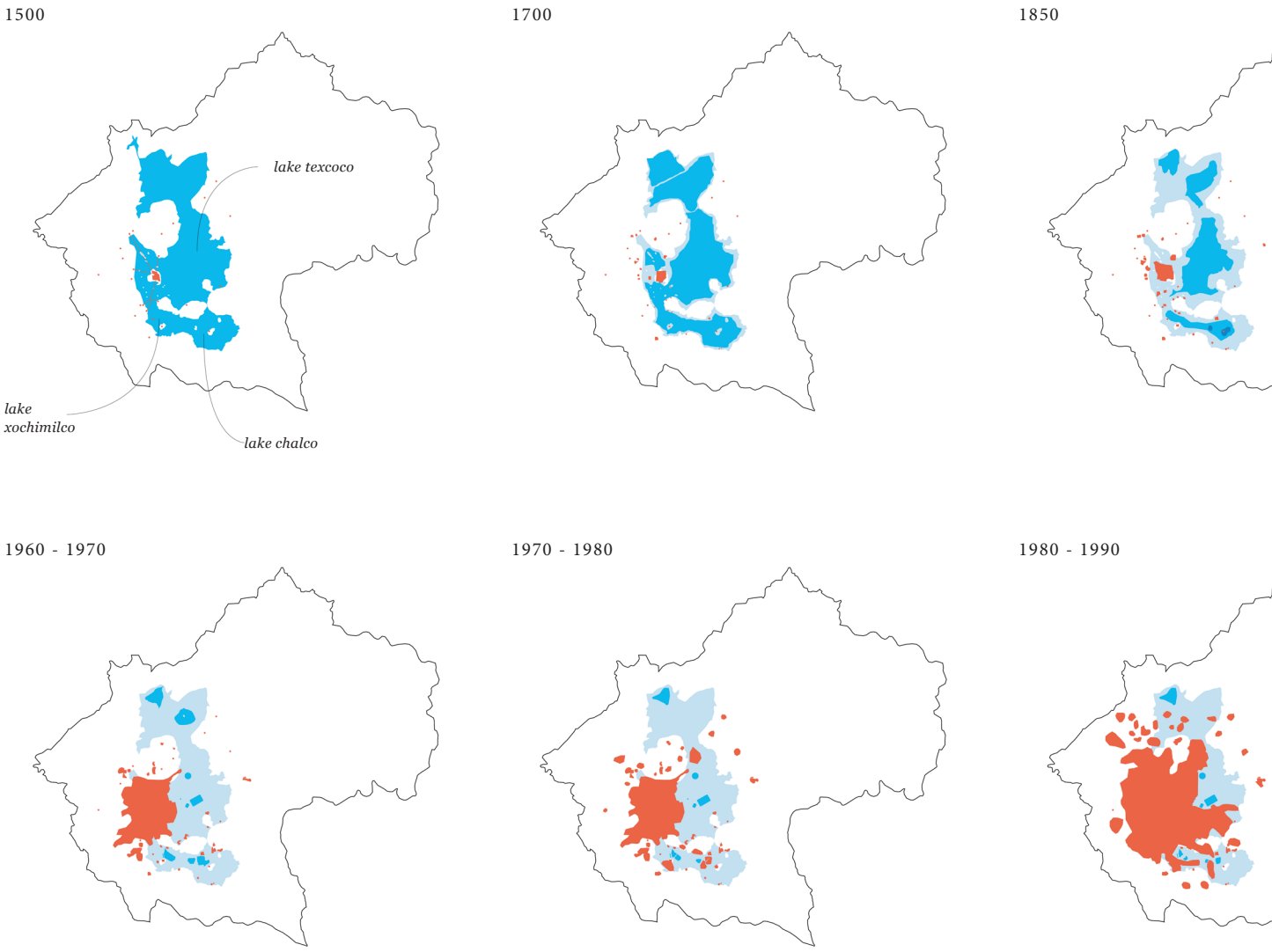


50

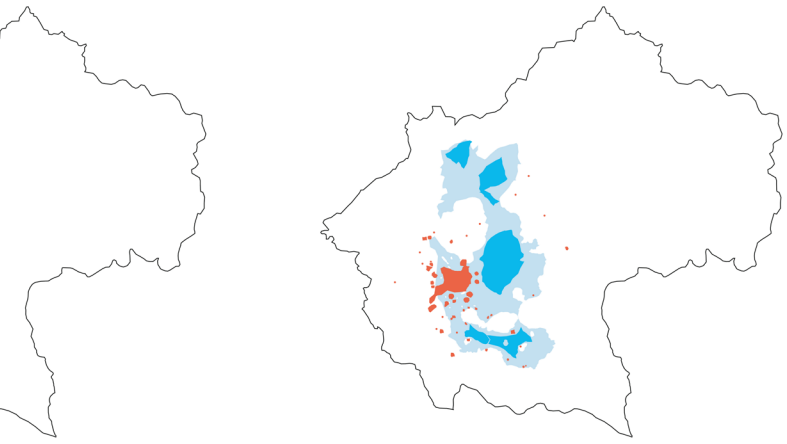
2000

figure 1.10 [spread]:
artist's rendering of the lakes around mexico city over time: 1600 (left), 1850 (centre) and 2000 (right). [image courtesy: tomás filsinger].

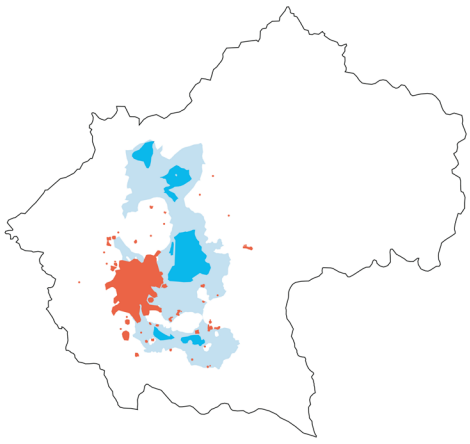
figure 1.11 [spread]:
time-line - colonial terraformation of
the mexico valley basin.



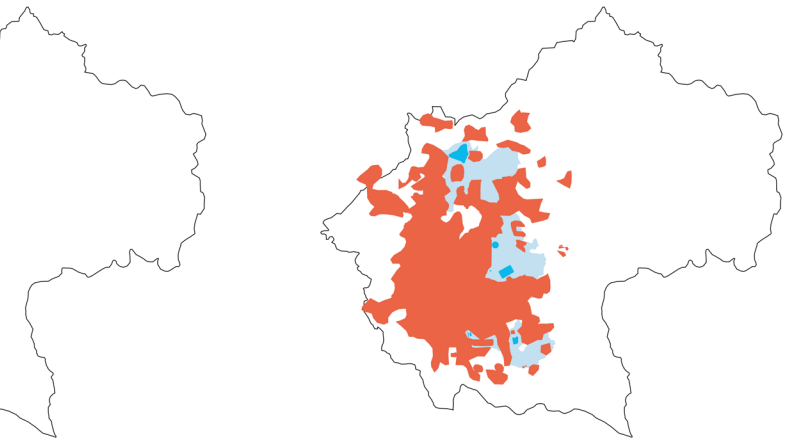
1900 - 1950



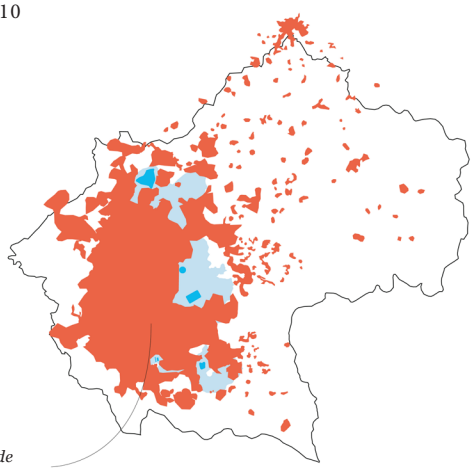
1950 - 1960



1990 - 2000



2010



lakes
former lake bed
urban sprawl
mexico valley basin

Seeds of resistance

figure 1.12 [above]:
íñigo noriega laso was depicted as a caricature burning in flames by the artist maria thereza alves at the xico community museum to highlight the atrocities he had committed against the chalcas. [image courtesy: maria thereza alves]

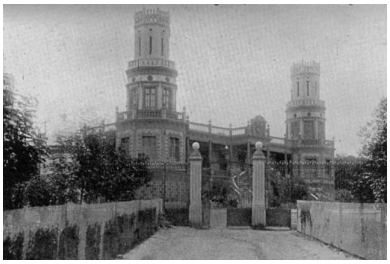


figure 1.13 [above]:
noriega's estate and mansion was built on land that was illegitimately appropriated from lake chalco.

It is apparent that various crises that threaten sustenance for communities that live in Chalco are rooted in the continued dominance of colonial power structures. For indigenous communities in Chalco, the repercussions of past colonial actions have manifested in the form a contemporary socio-ecological crisis. The multi-generational mismanagement of the region's land and water resources has had dire consequences and continue to impede the possibility of a viable and sustainable future. However, these communities have tenaciously resisted colonial practices for centuries, and continue to do so even today.

Hannah Arendt theorizes the idea of 'Space of Appearance' as a space "where I appear to others as others appear to me, where men exist not merely like other living or inanimate things, but to make their appearance explicitly"[19]. Such a space can always be manifested wherever individuals gather together politically that is, "wherever men are together in the manner of speech and action." Arendt further asserts that a potential 'Space of Appearance' can either actualize abruptly like in the case of insurgencies, or alternatively it may organically manifest out of an assemblage of shared efforts that seek to transform something specific[20]. The infamous Zapatista movement that heralded the Mexican Revolution was rooted in an actualization of 'Spaces of Appearance'. Emiliano Zapata, who founded the movement was an employee of Íñigo Noriega at his mines in Tlalchichilpa in the Mexican state of Guerrero. As a response to unfair working conditions and prejudicial colonial land practices, he decided to initiate a revolution. Zapata acquired Noriega's mansion and transformed it into the official headquarters of the Zapatista movement in the region. Today, the same mansion houses the Museo Comunitario del Valle de Xico (Xico Community Museum)[21].

The Island of Xico, which was once home to the indigenous Chalca community is now one of the thirteen municipal areas that make up the region of Chalco. The re-emerging Lake Chalco lies adjacent to the municipal area of Xico and serves as the only remaining bridge to the prehispanic socio-ecological heritage of the Chalcas. Preserving and protecting the lake has therefore become a matter of utmost priority for indigenous communities in Xico. Ever since the lake has re-emerged, the state government has strategically positioned itself through reforms and actions to prolong extraction and accumulation practices. These have manifested in the form of policies that favor the interest of real estate developments, continued extraction of groundwater, and other forms of land exploitation[22].

19 Arendt, Hannah. 2019. The Human Condition: Second Edition. University of Chicago Press.

20 Arendt, Hannah. 2019. The Human Condition: Second Edition. University of Chicago Press.

21 Llano, Pedro de. 2017. Maria Thereza Alves. The Long Road To Xico / El Largo Camino A Xico, 1991-2015. Berlin: Sternberg Press.

22 Lafuente, Pablo, and Michelle Sommer. "'History is made by the people': Fragments on the Museo Comunitario del Valle de Xico." Afterall: A Journal of Art, Context and Enquiry 43, no. 1 (2017): 58-63.

The State's political and economic interests in the returning lake and its adjacent territories aligns with the systemic exploitative nature of colonial power structures. As a direct response to this, indigenous communities of Xico have developed a substantial network of grassroots initiatives led by local communities, NGOs, academics, artists, and autonomous political organizations. These initiatives are mobilized through the Xico Community Museum. Following the Mexican Revolution, the Xico Community Museum has actively sought to protect, preserve and restore indigenous heritage through grassroots initiatives backed by a socially cohesive local community (Figure 1.14). Over the years, the Community Museum has acted as a spatial medium to generate counter-stories and autonomous identity narratives that preserve indigenous cultural patrimony. Examples of such initiatives include saving and preserving almost five thousand indigenous artifacts from being destroyed, as well as generating awareness and discussion among community members through the publication of material that reiterates indigenous history[23]. With the return of the lake, an ecologically motivated form of resistance has spawned among local community members. For indigenous communities in Chalco, the return of the lake offers a hopeful possibility to 'write back' six centuries of damage imposed by colonial power structures. The Community Museum is driven by a sustainable agenda that lobbies for concrete proposals to realize political self-determination, the recovery of the lacustrine systems, and sovereignty over natural resources[24]. Despite persistent threats from the State, the Community Museum, and by extension – the returning lake, now exist as a latent 'Space of Appearance' through which decolonization could be mobilized as a real-world possibility.

It is apparent that the colonial belief of 'nature separated from humans' has shaped an anthropocentric system that enables individuals like Íñigo Noriega to accumulate and extract from lands usurped from others. This anthropocentric system is rooted in a dualist structuring of heritage and nature, and seeks to uphold and reinforce colonial power structures. In contrast, Juanita Sundberg has reiterated the term 'posthumanism' to present a diverse method of practice that refuses to treat humans as "disembodied and autonomous, that is - separate from the world of nature and animality". Sundberg asserts that in order for decolonization movements to thrive, it is pivotal to reconsider human relationships to land and nature, as well as how human societies interact with those cast as nonhuman[25].

figure 1.14 [above]:
xico community museum was founded to preserve indigenous heritage and resist colonial practices through grassroots initiatives and community engagement. [image courtesy: museo comunitario del valle de xico]

figure 1.15 [above]:
xico community museum is now housed in noriega's former mansion.

23 Emmelhainz, Irmgard. 2017. "Chronicle Of A Visit To The Museo Comunitario Del Valle De Xico, Or: Cultural Solidarity In The Globalised Neoliberal Age". Afterall: A Journal Of Art, Context And Enquiry 43: 46-57. doi:10.1086/692553.

24 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

25 Sundberg, Juanita. "Decolonizing Posthumanist Geographies." Cultural Geographies 21, no. 1 (January 2014): 33–47.

figure 1.16 [above]:
aerial view of the returning lake tláhuac-xico.

figure 1.17 [above]:
the returning lake is bordered by the municipal region of valle de chalco on the east.

The term 'reparations ecology' hypothesizes a new model for making amends to grave errors of the past by rethinking relationships between human society and natural ecology as mutually constituting each other[26]. A 'reparations ecology' within the context of Chalco would invoke a decolonial possibility that is rooted in restoring and regenerating indigenous socio-ecological landscapes that once thrived in the region. It would also challenge prevailing colonial power structures that still persists on extracting, appropriating and desecrating the ex-lacustrine region. A reparations model could also advocate for local communities who were both culturally and ecologically dispossessed by colonization, to have sovereign control over the returning lake and its ecology.

To a great extent, the Xico Community Museum has been able to mobilize reparations that seek to decolonize the returning lake and its ecology. The Museum's various initiatives have invoked a new way of living that relies on social and environmental engagement to push for a 'reparation ecology'. The return of the lake offers a new medium to invoke decolonial possibilities. It is worth stating that various regions across Mexico with a similar socio-ecological heritage have irreversibly succumbed to colonial power structures. Their landscapes have been permanently altered to suit colonial processes of extraction and accumulation[27]. Although the region of Chalco is still subject to regressive colonial practices, the Community Museum has been able to engage the local community in resisting the same within the contemporary context[28].

Without the Community Museum, the returning lake would cease to exist. In its place, a number of real estate projects would be developed to capitalize on rising land value[29]. With political tides now shifting towards pro-environment movements, the viable realization of a 'reparations ecology' in Chalco offers a chance to actualize solutions to the various crises that threaten human sustenance. Above all, a 'reparations ecology' would re-institute indigenous cultural and ecological patrimony and liberate nature from enclosures imposed by colonial power structures. As a sustainable alternative to colonial models that rely on extraction and appropriation, it would invoke for the return to a cyclical utilization of the region's natural resources through symbiotic interactions between humans and natural ecologies.

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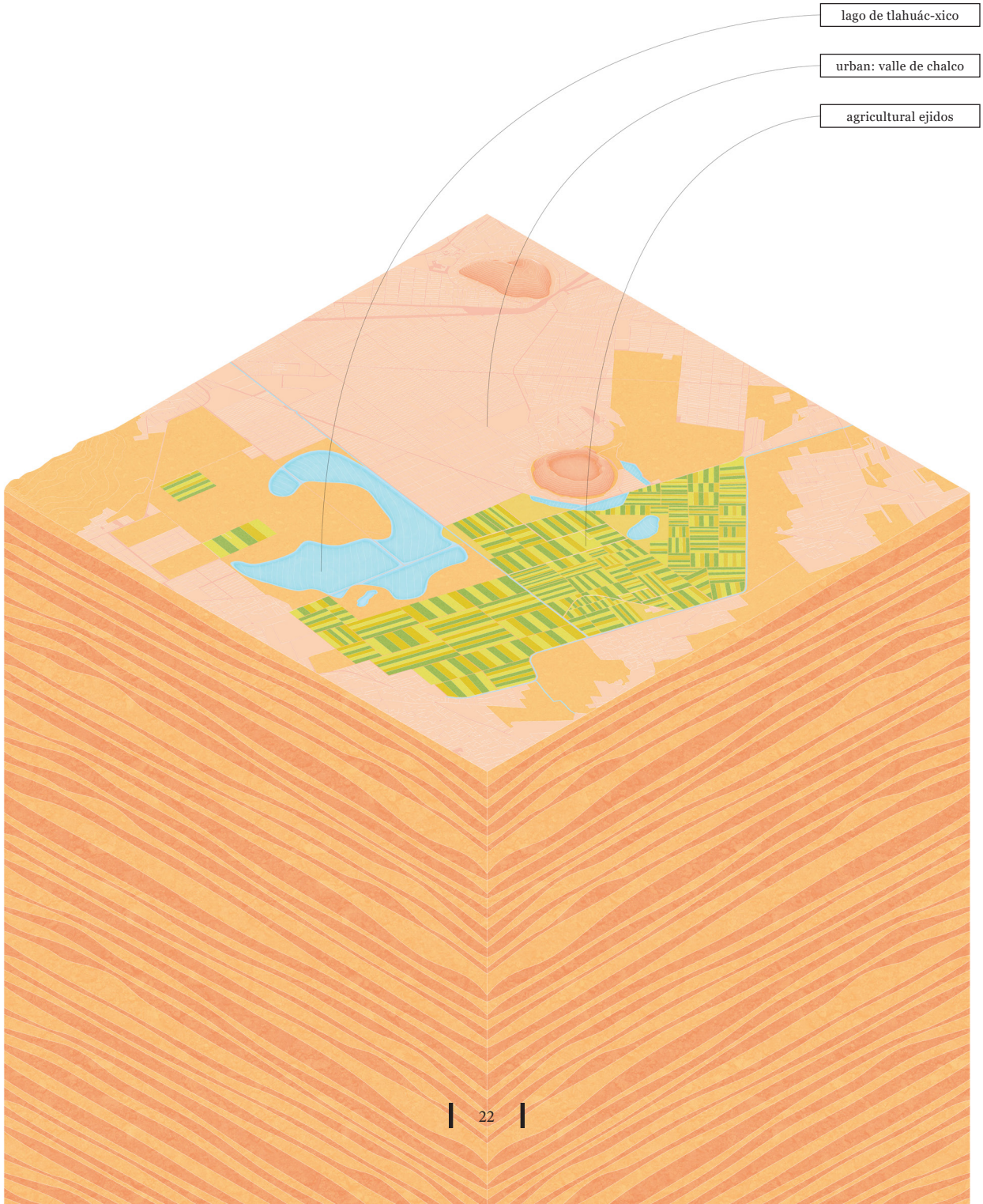
26 Patel, Raj, and Jason W Moore. 2017. A History Of The World In Seven Cheap Things : A Guide To Capitalism, Nature, And The Future Of The Planet. Oakland, California: University of California Press.

27 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

28 Emmelhainz, Irmgard. 2017. "Chronicle Of A Visit To The Museo Comunitario Del Valle De Xico, Or: Cultural Solidarity In The Globalised Neoliberal Age". Afterall: A Journal Of Art, Context And Enquiry 43: 46-57. doi:10.1086/692553.

29 Emmelhainz, Irmgard. 2017. "Chronicle Of A Visit To The Museo Comunitario Del Valle De Xico, Or: Cultural Solidarity In The Globalised Neoliberal Age". Afterall: A Journal Of Art, Context And Enquiry 43: 46-57. doi:10.1086/692553.

figure 1.18 [below]:
isometric view
contemporary chalco



P II

“ the implications of colonial land practices are deeply rooted in the social, political, and environmental fabric of tláhuac-xico. as the re-emerging lake continues to expand, it presents a paradox that can either be characterized as a hopeful possibility for regeneration or an existential threat to sustenance. ”

unfolding
(post-) colonial chalco

Defining boundaries

More than a century has passed since Íñigo Noriega Laso desiccated Lake Chalco causing irreversible socio-ecological devastation. While Noriega's actions have been detrimental to the region's ecosystem integrity, it has also set in motion a sequence of complex urban and environmental transformations that continue to unfold over time[1]. Today, the region is caught in a web of complex social, political and environmental entanglements that can be traced back to the colonial era. As a result, contemporary conditions such as political conflicts, urban sprawl, mono-crop agriculture, groundwater extraction, and the subsequent return of the lake have manifested as existential threats for the people of Chalco[2]. The desiccation of Lake Chalco followed by the ecological degradation of the region is a testament to the complex relationship between colonial dispossession and environmental desecration[3]. The re-emergence of Lake Chalco as Lake Tláhuac-Xico presents a rare opportunity to invoke reparations or 'write back' grave errors of the past through an ecologically motivated program.

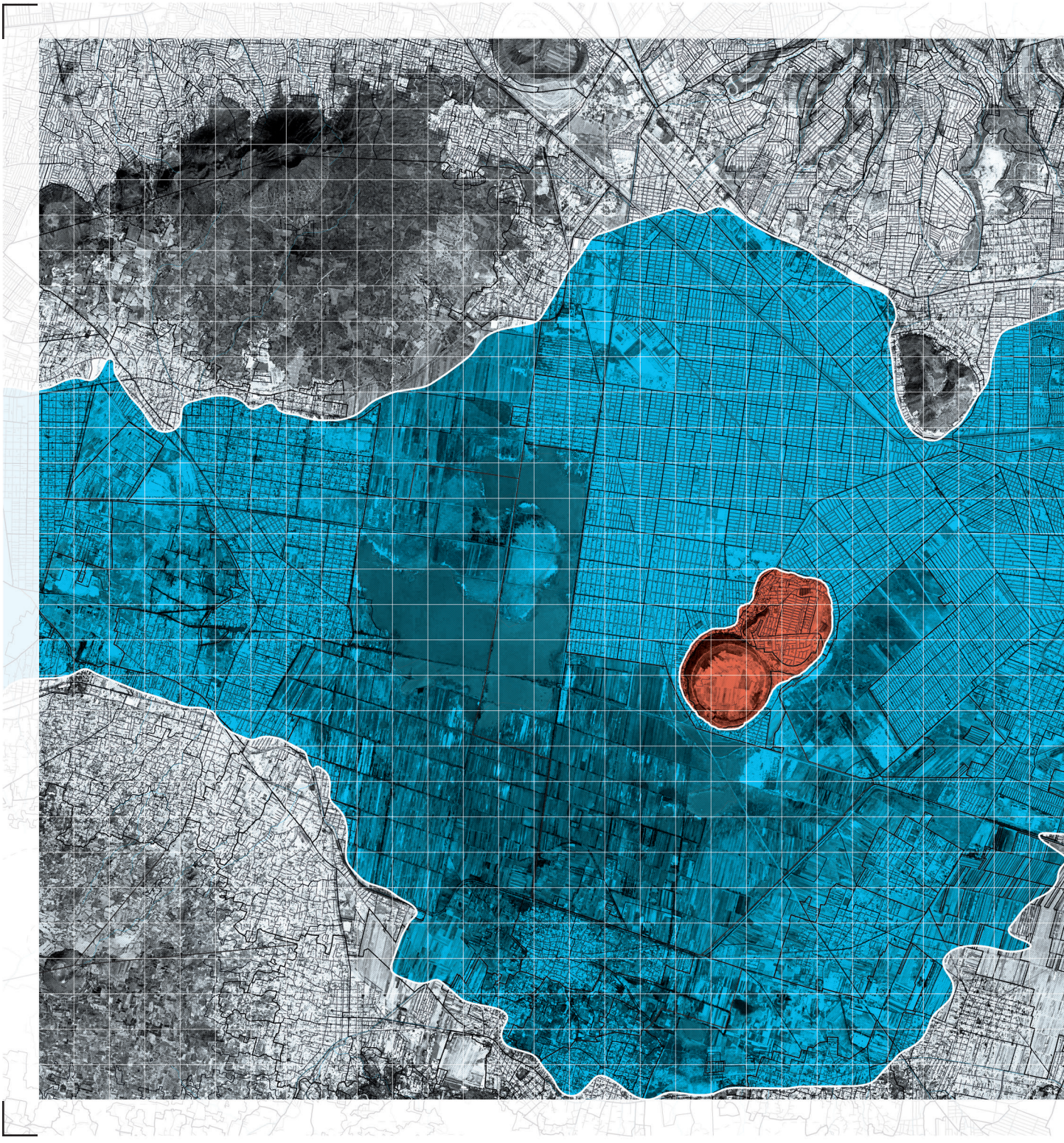
As this thesis is directed towards developing an ecosystem design narrative that is rooted in rewilding and regenerating devastated socio-ecological landscapes around the returning lake in Chalco, it is imperative to unpack various entanglements that threaten sustenance for the region. Therefore, in this chapter of the thesis, a series of layered maps will be assessed to unpack various environmental, social, urban, and ecological underlying conditions that make up the site around the returning lake. These maps will be informed by a comprehensive spatial data analysis of the site from GIS libraries sourced from Instituto Nacional de Estadística y Geografía (INEGI) and Universidad Nacional Autónoma de México (UNAM). Additional data sources include empirical evidence derived from satellite imagery from Google Earth. Inferences and outcomes from this comprehensive mapping study will establish key site condition parameters, and subsequently inform the process of design synthesis to realize a reparations ecology in Chalco.

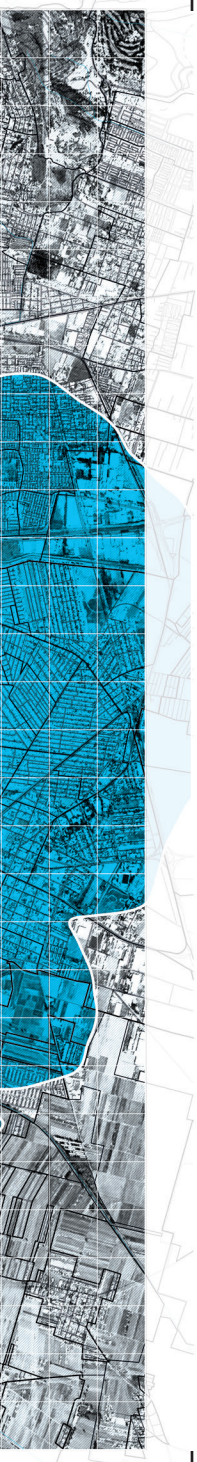
1 Llano, Pedro de. 2017. Maria Thereza Alves. The Long Road To Xico / El Largo Camino A Xico, 1991-2015. Berlin: Sternberg Press.

2 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

3 Emmelhainz, Irmgard. 2017. "Chronicle Of A Visit To The Museo Comunitario Del Valle De Xico, Or: Cultural Solidarity In The Globalised Neoliberal Age". Afterall: A Journal Of Art, Context And Enquiry 43: 46-57. doi:10.1086/692553.

figure 2.1 [left]: aerial view of post-colonial chalco. the returning lake is visible in the background. [image courtesy: santiago arau]





lake chalco

for most of history, lake chalco was part of an elaborate network of interconnected lakes that fostered the growth of the aztec civilization.

island of xico

the chalcas, who had arrived in the valley even before the aztecs, were the first to create centralized control over the valley's lacustrine ecology. they inhabited the island of xico on lake chalco and turned it into a major hub for distribution and regulation of water across the valley.

0
500 m 1 km 2 km

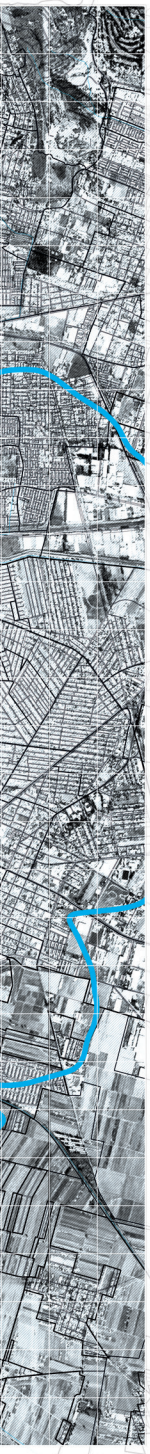
figure 2.2 [left]:
lake chalco - prehispanic era.

The illustrated map on figure 2.2 delineates the extent of Lake Chalco prior to its desiccation. During prehispanic era, indigenous Chalcas inhabited the island of Xico and were able to strike an ecological balance between the lakes and their lands through engineered hydrological systems that complimented the region's diverse fauna and flora. Before the region was colonized, Lake Chalco covered an area of about 10,000 hectares (100 km^2) and encompassed the island of Xico[4]. All the lakes of the Mexico Valley Basin including Lake Chalco were interconnected and functioned as a complex lacustrine ecology that sustained indigenous communities for centuries[5].

4 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

5 Vitz, Matthew. 2018. A City on a Lake: Urban Political Ecology And The Growth Of Mexico City. Duke University Press.

valle de chalco
tláhuac
lago de tlahuác-xico
xico
lagunas de xico



groundwater well

lago de tlahuác-xico
the lake is now returning due to land subsidence and the ensuing lowering of the lakebed due to excessive pumping of the underground aquifer

former island of xico

former lake boundary

0
500 m 1 km 2 km

figure 2.3 [left]:
contemporary chalco

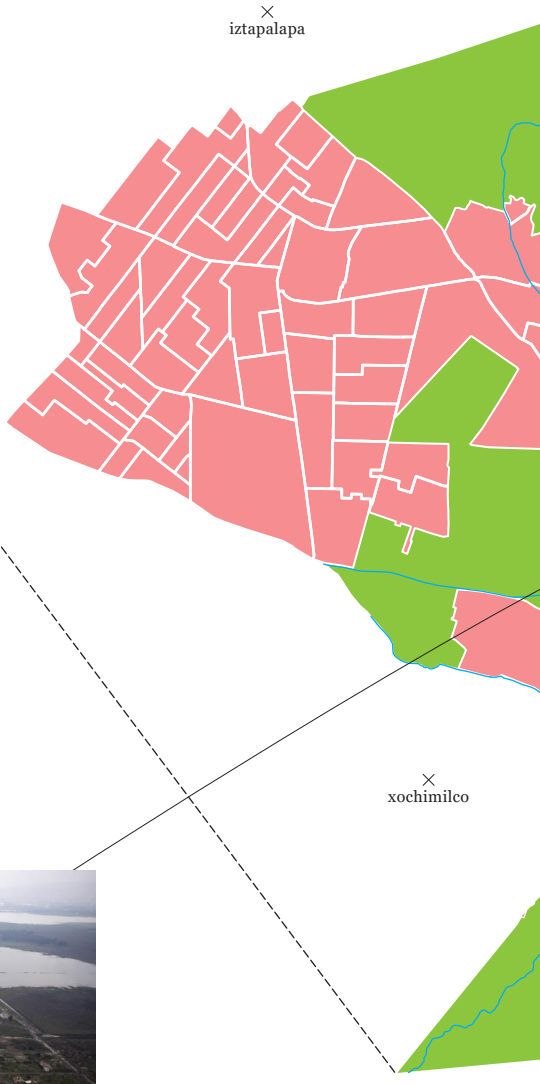
Xico, which was once an island on Lake Chalco is now one of the thirteen municipal seats that make up the municipality of Valle de Chalco[6]. In the 80s, due to severe water shortages in Mexico City, fourteen pumps were installed in the region to extract groundwater. This enabled excessive groundwater pumping that led to the sinking of land to form depressions. Eventually, pluvial waters collected within these depressions and merged to form a new lake on the former lake-bed of Chalco. The new lake is also referred to as the returning lake and is named Lake Tláhuac-Xico after the two communities on its western and eastern borders respectively[7]. Due to persistent groundwater pumping and subsequent land subsidence, the returning lake continues to expand over time. It currently covers an area of 1300 acres (5 km^2)[8]. Additionally, new pluvial water bodies such as the Xico Lagoons have begun to emerge in the region (Figure 2.3). The returning lake serves as one of the few remaining bridges to the prehispanic ecological heritage of the Chalcas.

Figures 2.4 and 2.5 provides a graphical overview of the returning lake and its immediate urban context. It also geographically positions the site within the wider context of Mexico City and the State of Mexico. As illustrated, the majority of the ancient lake-bed of Lake Chalco is now urbanized. Most of the land that has not succumbed to urban sprawl is dedicated to agriculture.

6 Emmelhainz, Irmgard. 2017. "Chronicle Of A Visit To The Museo Comunitario Del Valle De Xico, Or: Cultural Solidarity In The Globalised Neoliberal Age". Afterall: A Journal Of Art, Context And Enquiry 43: 46-57. doi:10.1086/692553.

7 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

8 Watts, Jonathan. "Mexico City's Water Crisis – from Source to Sewer." The Guardian, November 12, 2015, sec. Cities. https://www.theguardian.com/cities/2015/nov/12/mexico-city-water-crisis-source-sewer.



state boundary
water channels

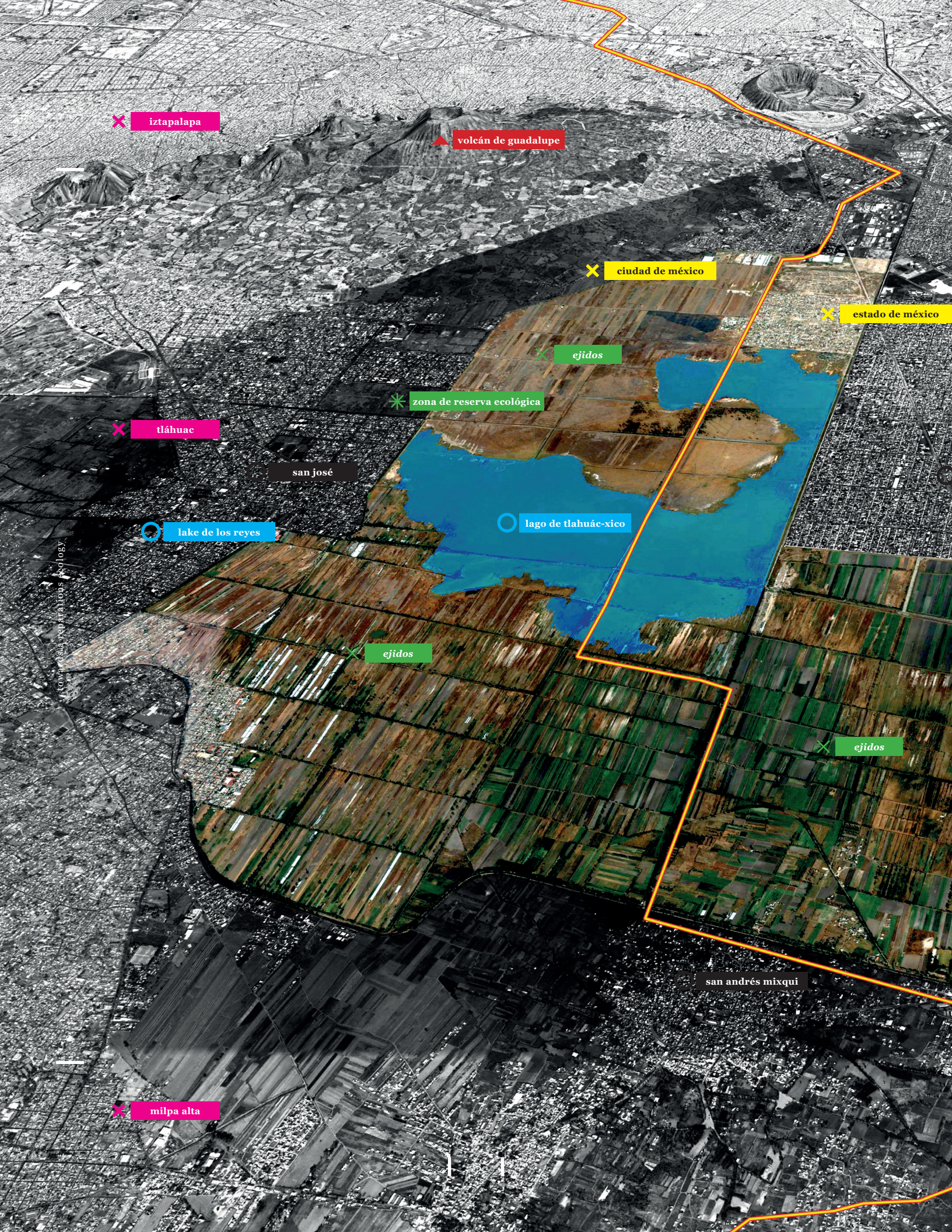
water bodies

urban - valle de chalco
urban - tlahuác
rural // agricultural

0
500 m
1 km
2 km

figure 2.4 [spread]:
chalco (tláhuac - xico) : at a glance

ixtapaluca
valle de chalco
tlahuác
xico
lago de tlahuác-xico
parque
xicotencatl
lagunas de xico
chalco de díaz
milpa alta



© toward a reparations ecology

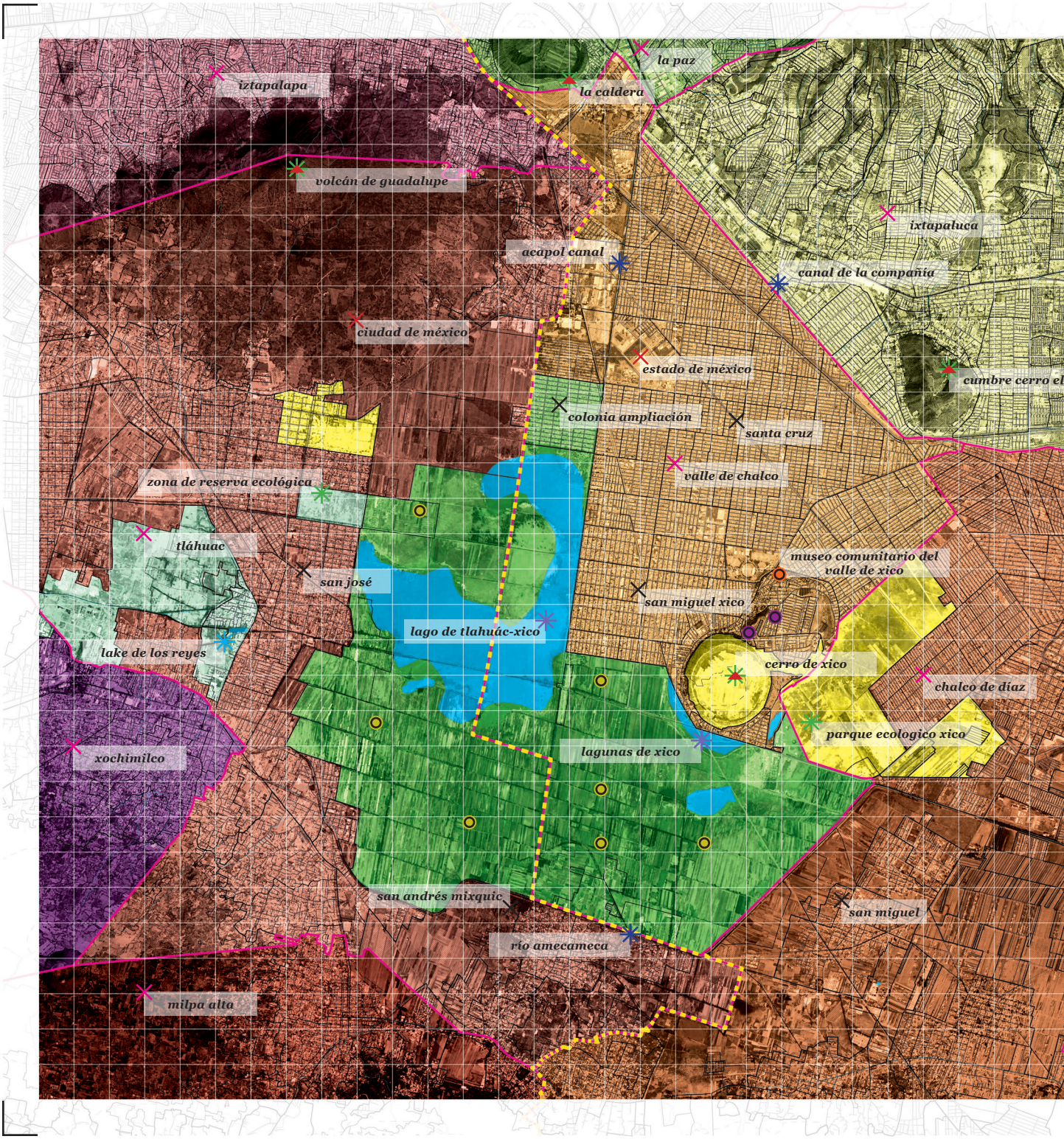
figure 2.5 [spread]: satellite image illustrating the returning lake tláhuac-xico and its surrounding urbanscape.

iztapalapa
la paz
ixtapaluca
ciudad de méxico
estado de méxico
valle de chalco
tláhuac
san miguel xico
chalco de díaz
xochimilco
milpa alta

figure 2.6 [left]:
political boundaries

The former lake-bed of Chalco is now occupied by 8 different municipalities as illustrated in Figure 2.6. The state border dissects the returning lake into two, such that half of it lies within Mexico City (CDMX), and the other half lies in the State of Mexico. The returning lake is contained by the municipality of Valle de Chalco (Xico) on the East, and Tláhuac on the West. The prevailing political boundaries in the region has led to the emergence of various political conflicts over resources. The returning lake is situated at a juxtaposition of competing demands for water and land between local communities and the State (CDMX and the State of Mexico)[9].

9 Llano, Pedro de. 2017. Maria Thereza Alves. The Long Road To Xico / El Largo Camino A Xico, 1991-2015. Berlin: Sternberg Press.


iztapalapa
la paz
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volcán de guadalupe
ixtapaluca
acapol canal
canal de la compañía
ciudad de méxico
estado de méxico
cumbre cerro el
colonia ampliación
santa cruz
valle de chalco
zona de reserva ecológica
tláhuac
museo comunitario del valle de xico
san josé
san miguel xico
lago de tlahuác-xico
lake de los reyes
cerro de xico
chalco de díaz
parque ecologico xico
xochimilco
lagunas de xico
san andrés mixquic
san miguel
río amecameca
milpa alta

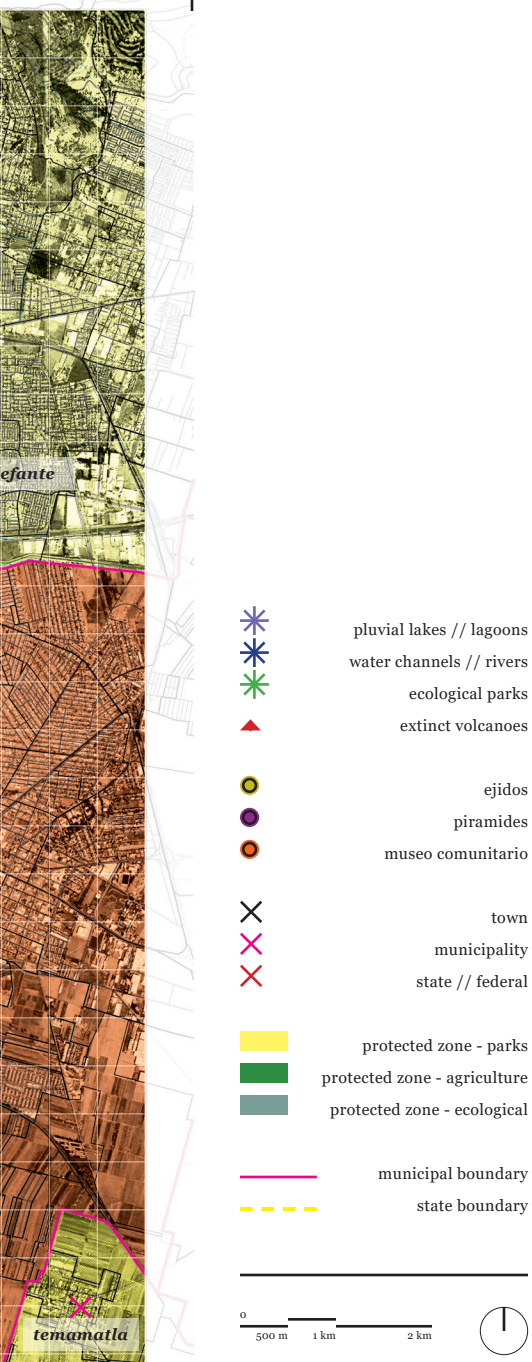

figure 2.7 [left]:
points of interest

The municipality of Valle de Chalco (VDC), which borders the returning lake on the east was founded in 1994. Its urban fabric contains traces of both Mexico's prehispanic and colonial eras. For the majority of the 20th century, most of the land across the region was dedicated for agricultural practices. However, over the last 30 years, the region has witnessed a significant growth in the rate of urbanization. As of 2010, VDC has over 406,521 inhabitants, most of whom have migrated from rural areas in search of better opportunities in Mexico City[10]. The majority of urbanized areas within VDC lacks sufficient services and infrastructure with regard to water, education, jobs, and healthcare[11]. As illustrated in Figure 2.7, the returning lake is emerging within a federally protected agricultural zone. It is surrounded by ejidos, which are areas of community land used for agricultural purposes wherein the local community members have usufruct rights rather than ownership rights to land. In this case, ownership rights are held by the State of Mexico. Additionally, the State has also granted protected status to other ecologically sensitive areas in the vicinity. This includes national parks such as Cerro de Xico and Parque Ecologico Xico.

10 Chelleri, L., T. Schuetze, and L. Salvati. 2015. "Integrating Resilience With Urban Sustainability In Neglected Neighborhoods: Challenges And Opportunities Of Transitioning To Decentralized Water Management In Mexico City". Habitat International 48: 122-130. doi:10.1016/j.habitatint.2015.03.016.

11 Emmelhainz, Irmgard. 2017. "Chronicle Of A Visit To The Museo Comunitario Del Valle De Xico, Or: Cultural Solidarity In The Globalised Neoliberal Age". Afterall: A Journal Of Art, Context And Enquiry 43: 46-57. doi:10.1086/692553.

iztapalapa
la paz
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ciudad de méxico
estado de méxico
valle de chalco
tláhuac
chalco de díaz
xochimilco
milpa alta

figure 2.8 [left]:
designated zoning

Until only a few decades ago, the majority of land in the region was dedicated for farming after it had been appropriated from desiccating Lake Chalco. From the early 70s, large influxes of migrants from rural areas across Mexico began to settle here on stolen, purchased, on appropriated land. This pattern of migration persists even today and has led to an incommensurable urban sprawl. As a result, agricultural farmland has been declining in the region and is quickly replaced by urban settlements. Today, Valle de Chalco is one of the fastest growing urban areas in Mexico. The availability of relatively cheap real estate in such proximity to Mexico City attracts more and more migrants every year. However, most new migrants work in perilous conditions in the informal service industry of the city. They have limited social mobility and have little to no access to basic services and infrastructure[12].

12 Emmelhainz, Irmgard. 2017. "Chronicle Of A Visit To The Museo Comunitario Del Valle De Xico, Or: Cultural Solidarity In The Globalised Neoliberal Age". Afterall: A Journal Of Art, Context And Enquiry 43: 46-57. doi:10.1086/692553.

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estado de méxico
valle de chalco
tláhuac
chalco de díaz
xochimilco
milpa alta

figure 2.9 [left]:
human settlements

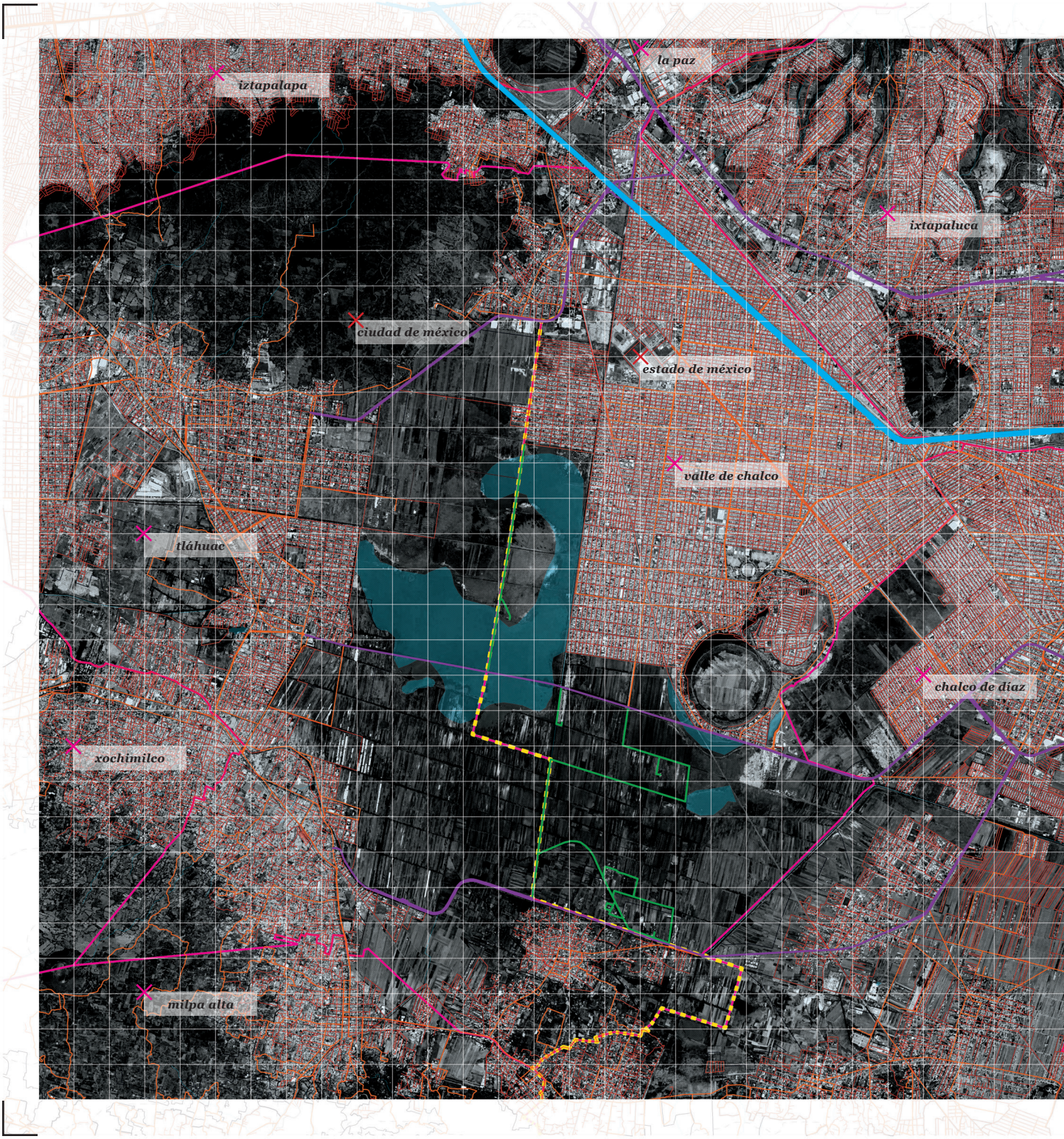
Ever since the late 20th century, the State has politically positioned itself in Valle de Chalco (VDC) to extract and appropriate land from the former lake-bed. This is exemplified through various policies and reforms that have preferred the interests of real-estate developers and corporate interests[13].

The State's policies have been mostly directed towards various forms of social and territorial exploitation that include excessive pumping of groundwater, dismantling rural economies and small-scale farming enterprises, and enabling rapid urbanization on appropriated land. This has led to declining agriculture and degradation of land. Subsequently, farmland is rezoned and sold to real-estate developers[14]. As illustrated in Figure 2.9, a significant number of settlements have begun to emerge and encroach within protected areas near the returning lake. These settlements consist mostly of poorly built housing with deficient sewage and water infrastructure. This results in raw and untreated waste contaminating the returning lake and its surrounding ecology[15].

13 Emmelhainz, Irmgard. 2017. "Chronicle Of A Visit To The Museo Comunitario Del Valle De Xico, Or: Cultural Solidarity In The Globalised Neoliberal Age". Afterall: A Journal Of Art, Context And Enquiry 43: 46-57. doi:10.1086/692553.

14 Llano, Pedro de. 2017. Maria Thereza Alves. The Long Road To Xico / El Largo Camino A Xico, 1991-2015. Berlin: Sternberg Press.

15 Chelleri, L., T. Schuetze, and L. Salvati. 2015. "Integrating Resilience With Urban Sustainability In Neglected Neighborhoods: Challenges And Opportunities Of Transitioning To Decentralized Water Management In Mexico City". Habitat International 48: 122-130. doi:10.1016/j.habitatint.2015.03.016.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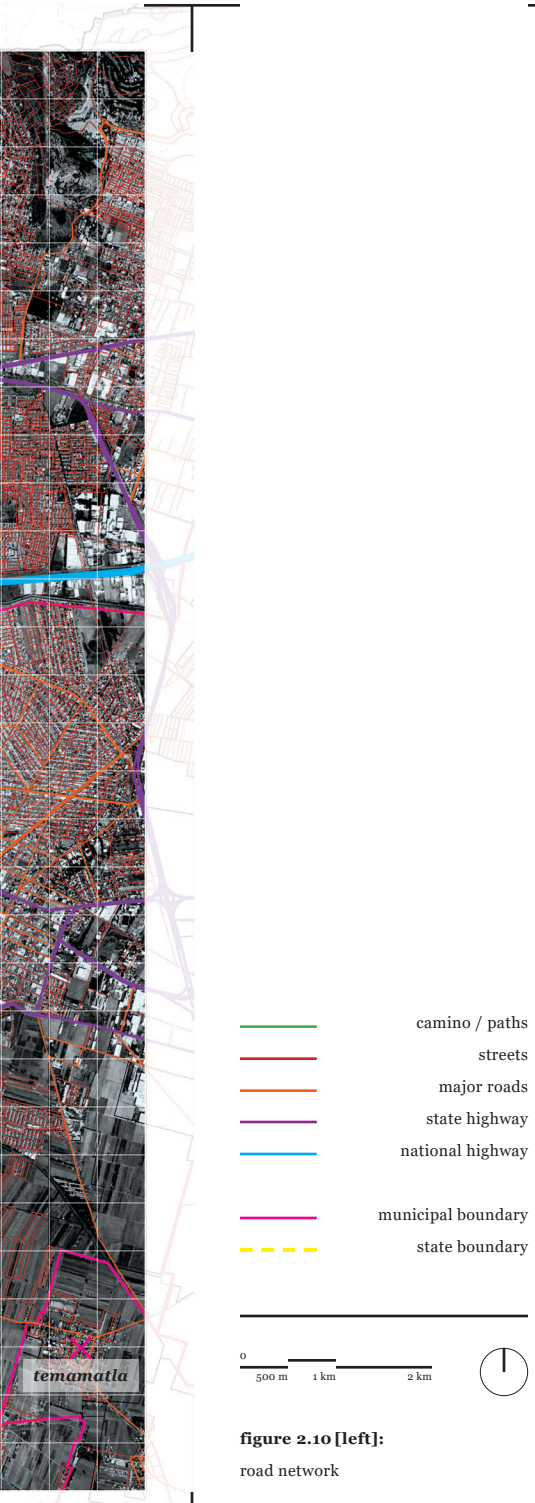

figure 2.10 [left]:
road network

As the majority of region is now urbanized, it is well-connected with regard to its road infrastructure. Figure 2.10 illustrates major roads and streets that connect the returning lake to the wider urban core. A national highway runs along the northern fringes of Valle de Chalco and provides access to CDMX. Also, a state highway dissects the returning lake near its southern edge connecting Valle de Chalco to Tláhuac. During the rainy season, this highway is often flooded and rendered unusable due to rising water levels[16].

16 Municipio de Valle de Chalco Solidaridad, Estado de Mexico. 2011. "Atlas De Riesgo Municipio De Valle De Chalco Solidaridad". Dirección Municipal de Protección Civil y H. Cuerpo de Bomberos. http://www.normateca.sedesol.gob.mx/work/models/SEDESOL/Resource/2612/Atlas_Estados/15122_VALLE_CHALCO/0_Atlas_Valle_de_Chalco_2011.pdf.

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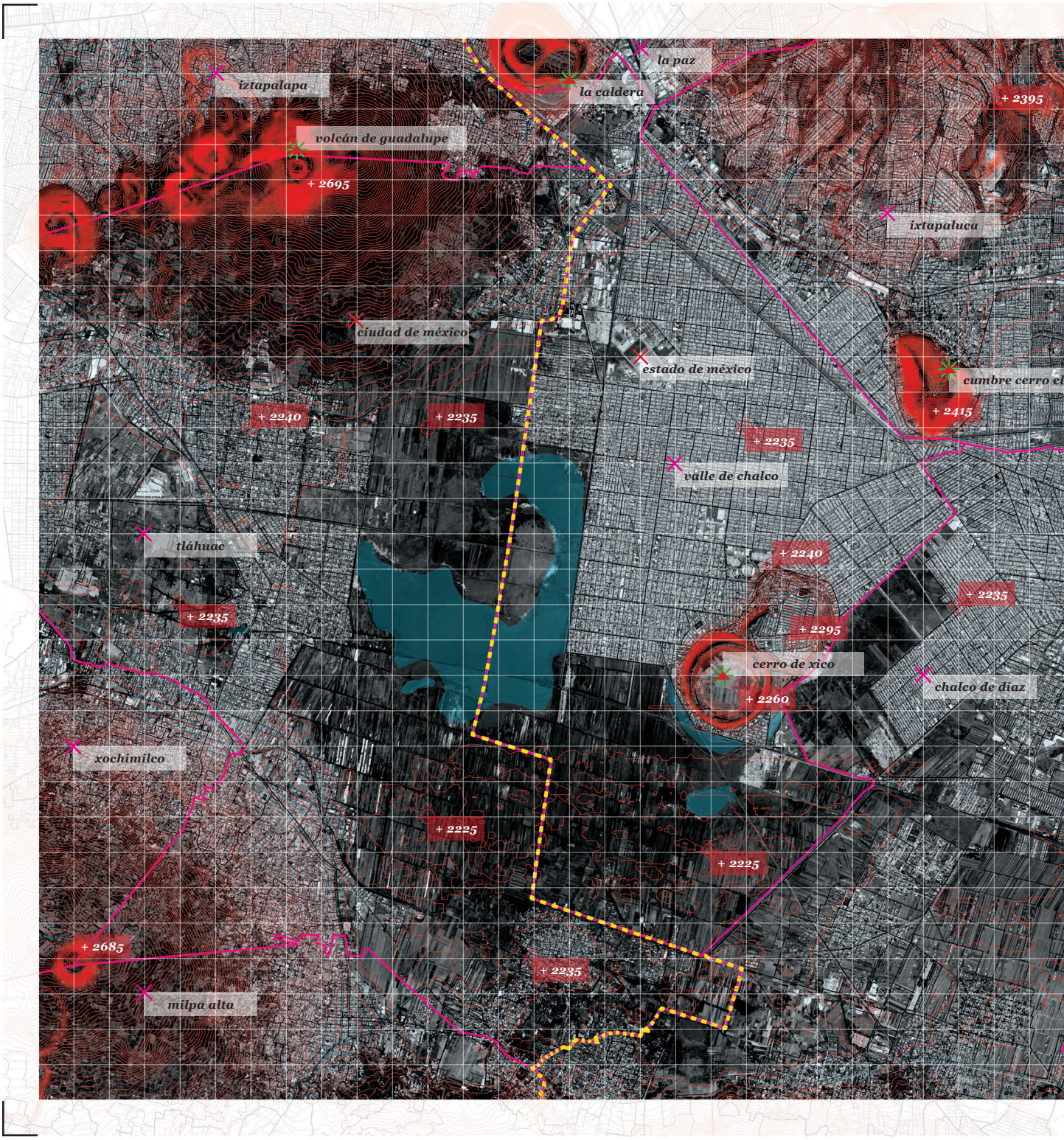
estado de méxico
cumbre cerro el
valle de chalco
tláhuac
cerro de xico
chalco de díaz
xochimilco
milpa alta

figure 2.11 [left]:
geology

Being a former lake-bed, the majority of the site around the returning lake is composed of lacustrine plains, and is encompassed by low-lying hills, ridges, and extinct volcanic craters (Figure 2.11). The lacustrine plains are made of thick layers of clayey soil with high water content. It is also highly compressible, thus making it particularly vulnerable to subsidence and cracking from excessive groundwater pumping[17].

17 Municipio de Valle de Chalco Solidaridad, Estado de Mexico. 2011. "Atlas De Riesgo Municipio De Valle De Chalco Solidaridad". Dirección Municipal de Protección Civil y H. Cuerpo de Bomberos. http://www.normateca.sedesol.gob.mx/work/models/SEDESOL/Resource/2612/Atlas_Estados/15122_VALLE_CHALCO/0_Atlas_Valle_de_Chalco_2011.pdf.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+ 2395
volcán de guadalupe
+ 2695
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ciudad de méxico
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cumbre cerro el
+ 2415
+ 2240
+ 2235
+ 2235
valle de chalco
tláhuac
+ 2240
+ 2235
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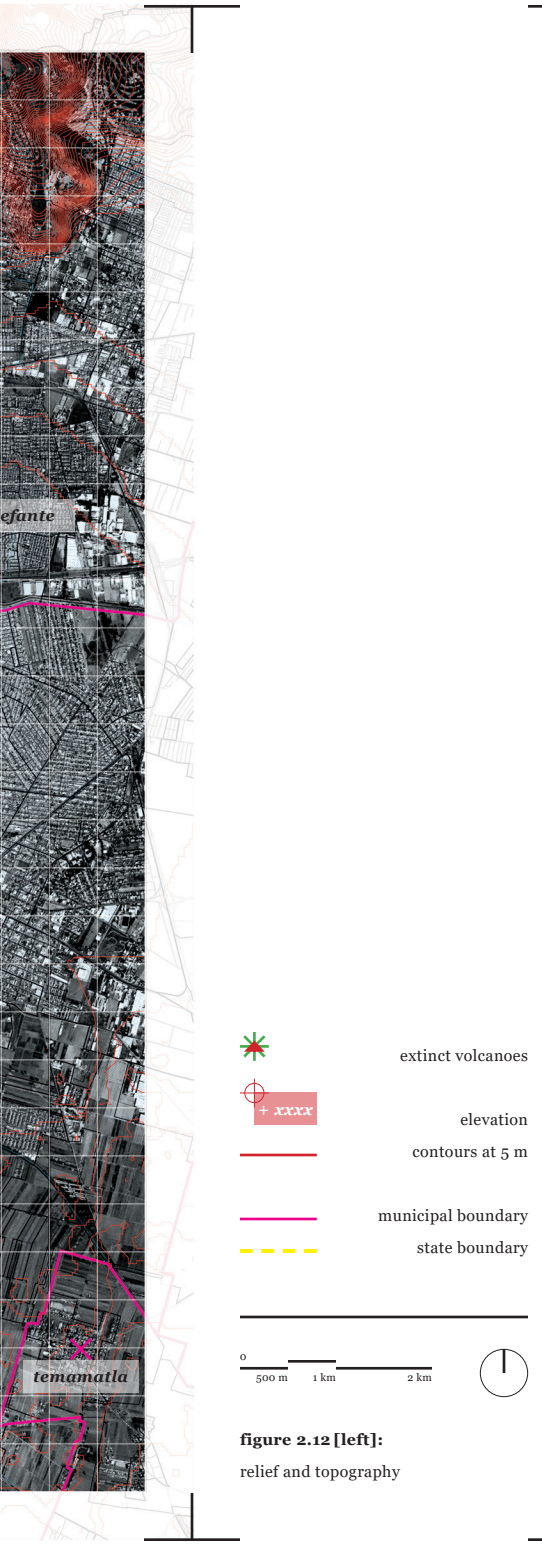
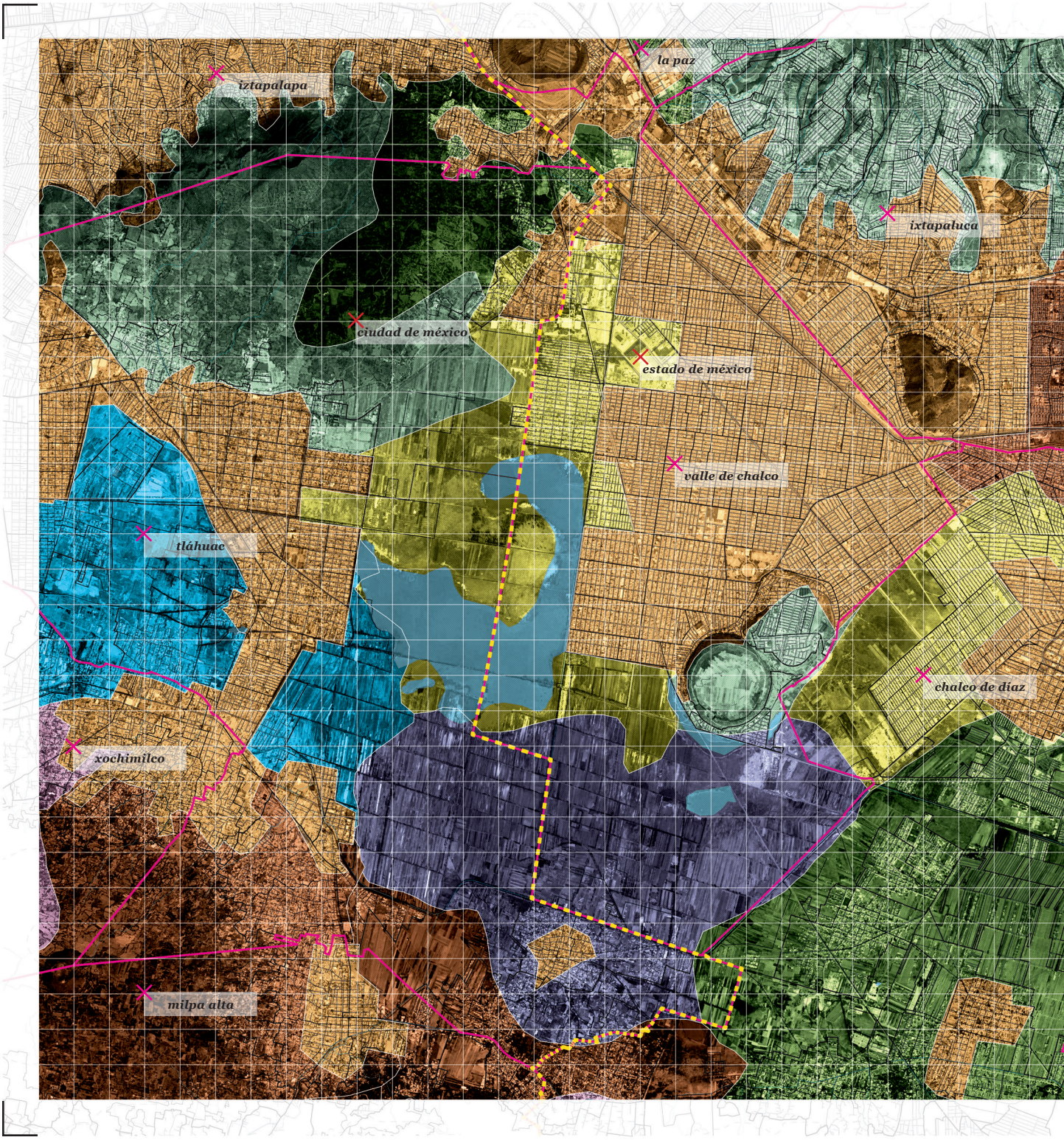


figure 2.12 [left]:
relief and topography

As illustrated in the relief and topography map, the region of Chalco can be distinguished as a lacustrine basin contained by a number of hills and ridges[18]. Since the majority of the region was artificially fabricated from desiccating Lake Chalco, the site around the returning lake is relatively flat with elevation differentials within the range of 1-3 meters (Figure 2.12). However, due to continued land subsidence, low-lying areas have emerged to create permanent depressions. The returning lake and other nearby water bodies are a result of pluvial waters accumulating in these newly formed depressions[19].

18 Municipio de Valle de Chalco Solidaridad, Estado de Mexico. 2011. "Atlas De Riesgo Municipio De Valle De Chalco Solidaridad". Dirección Municipal de Protección Civil y H. Cuerpo de Bomberos. http://www.normateca.sedesol.gob.mx/work/models/SEDESOL/Resource/2612/Atlas_Estados/15122_VALLE_CHALCO/0_Atlas_Valle_de_Chalco_2011.pdf.

19 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.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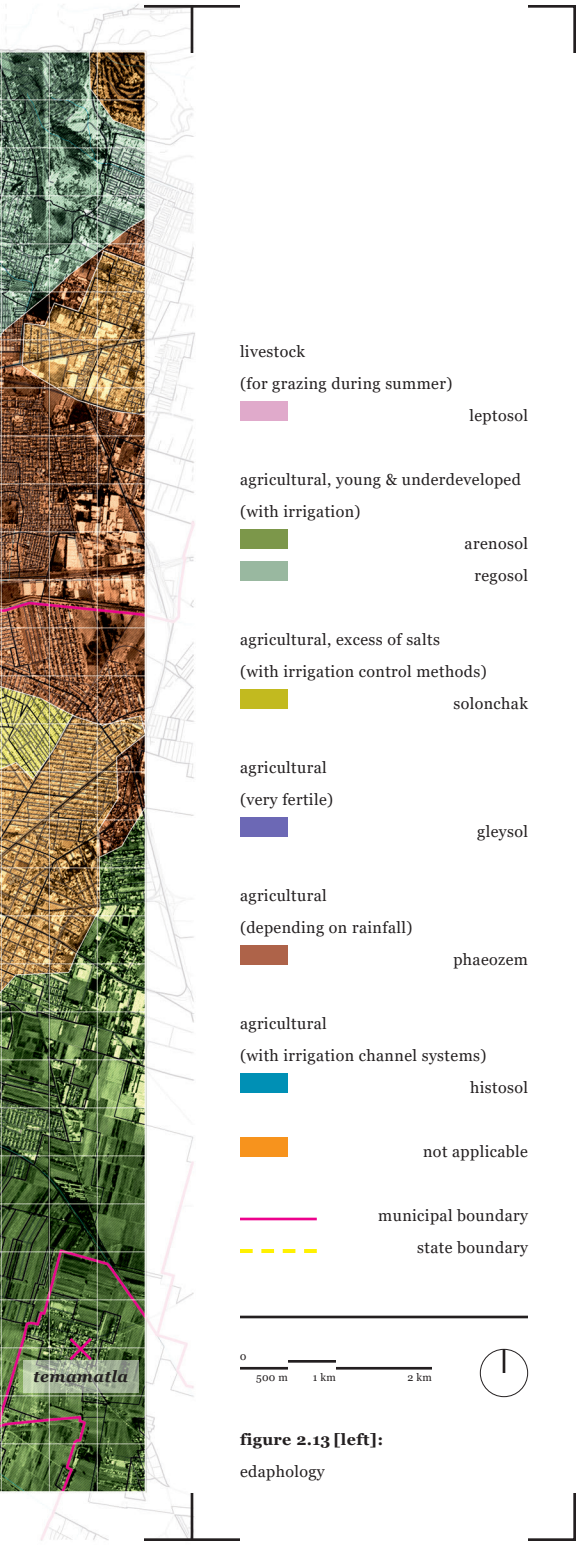
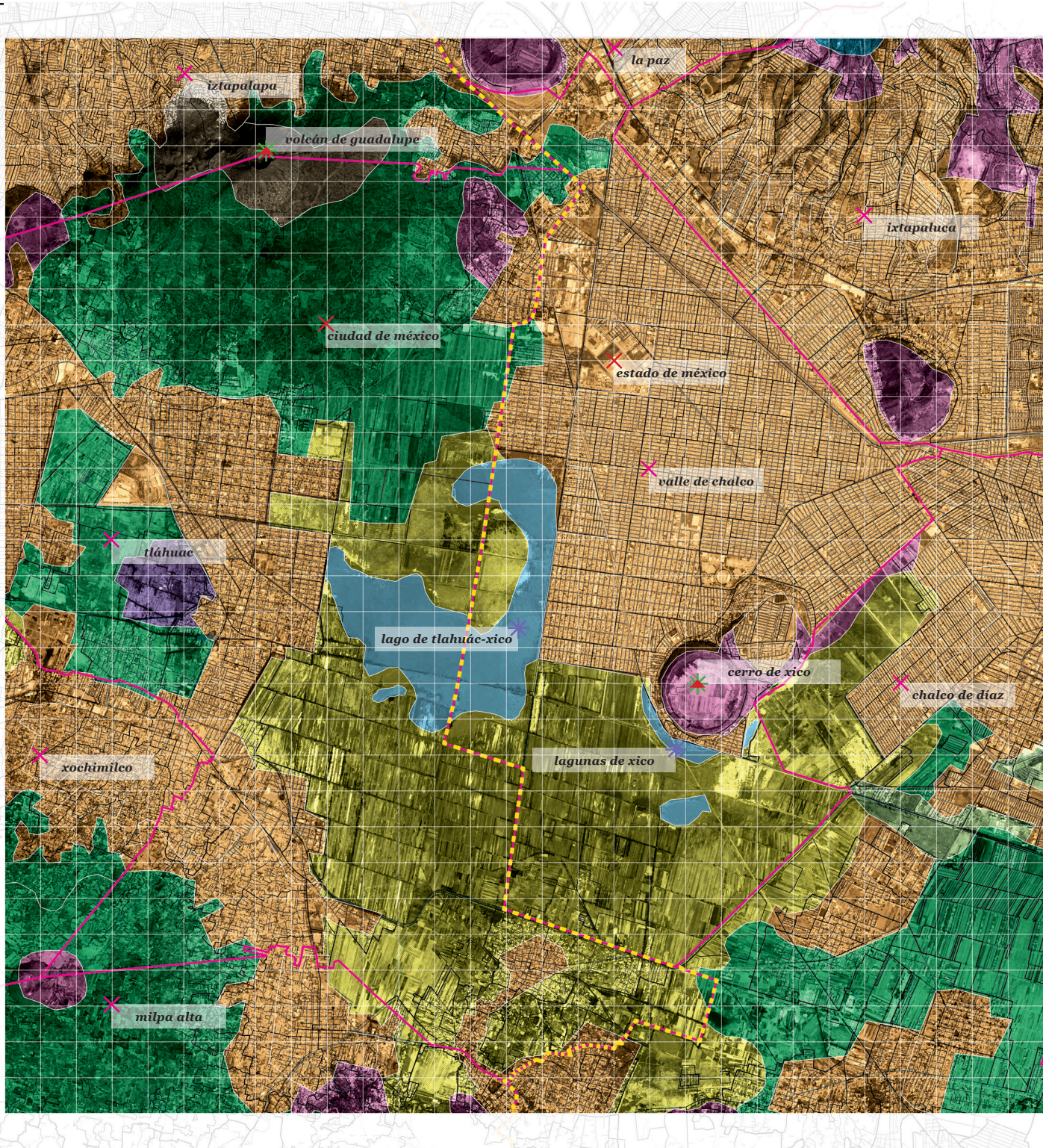


figure 2.13 [left]:
edaphology

The dominant soil present in undeveloped land around the returning lake is gleysol, which is highly fertile and thus suitable for industrial-scale agriculture (Figure 2.13). However, crops require mechanical irrigation to sustain high yields. The persistence of industrial-scale mono-crop agriculture in the region has led to the degradation of land. Large swaths of previously fertile lands have turned brownfield due to an excess amount of salts and contaminants from chemical fertilizers and pesticides seeping into the soil[20].

20 Municipio de Valle de Chalco Solidaridad, Estado de Mexico. 2011. "Atlas De Riesgo Municipio De Valle De Chalco Solidaridad". Dirección Municipal de Protección Civil y H. Cuerpo de Bomberos. http://www.normateca.sedesol.gob.mx/work/models/SEDESOL/Resource/2612/Atlas_Estados/15122_VALLE_CHALCO/0_Atlas_Valle_de_Chalco_2011.pdf.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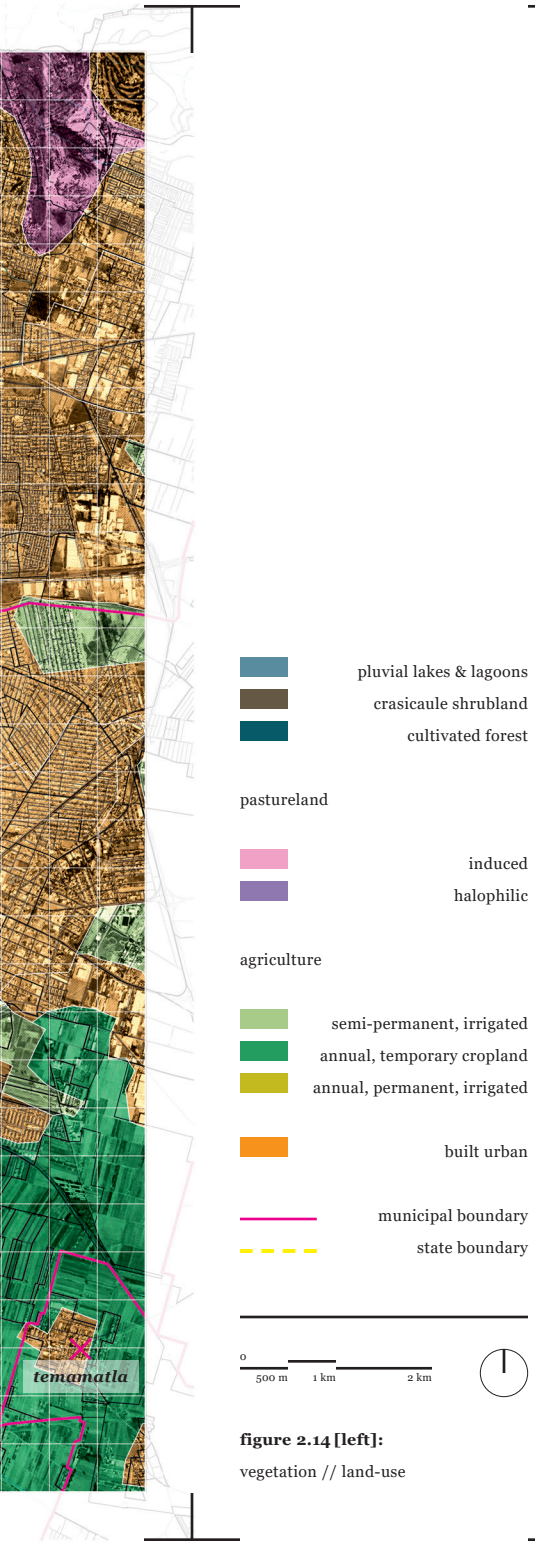

figure 2.14 [left]:
vegetation // land-use

As illustrated in Figure 2.14, predominant vegetation mostly comprises of irrigated permanent and semi-permanent agricultural crops, with induced pasture grasslands scattered across the wider terrain. However, the returning lake has filled large swaths of territory previously dedicated to agriculture. As it continues to expand, it poses a significant flood risk to existing farmlands in the region[21].

21 Municipio de Valle de Chalco Solidaridad, Estado de Mexico. 2011. "Atlas De Riesgo Municipio De Valle De Chalco Solidaridad". Dirección Municipal de Protección Civil y H. Cuerpo de Bomberos. http://www.normateca.sedesol.gob.mx/work/models/SEDESOL/Resource/2612/Atlas_Estados/15122_VALLE_CHALCO/0_Atlas_Valle_de_Chalco_2011.pdf.

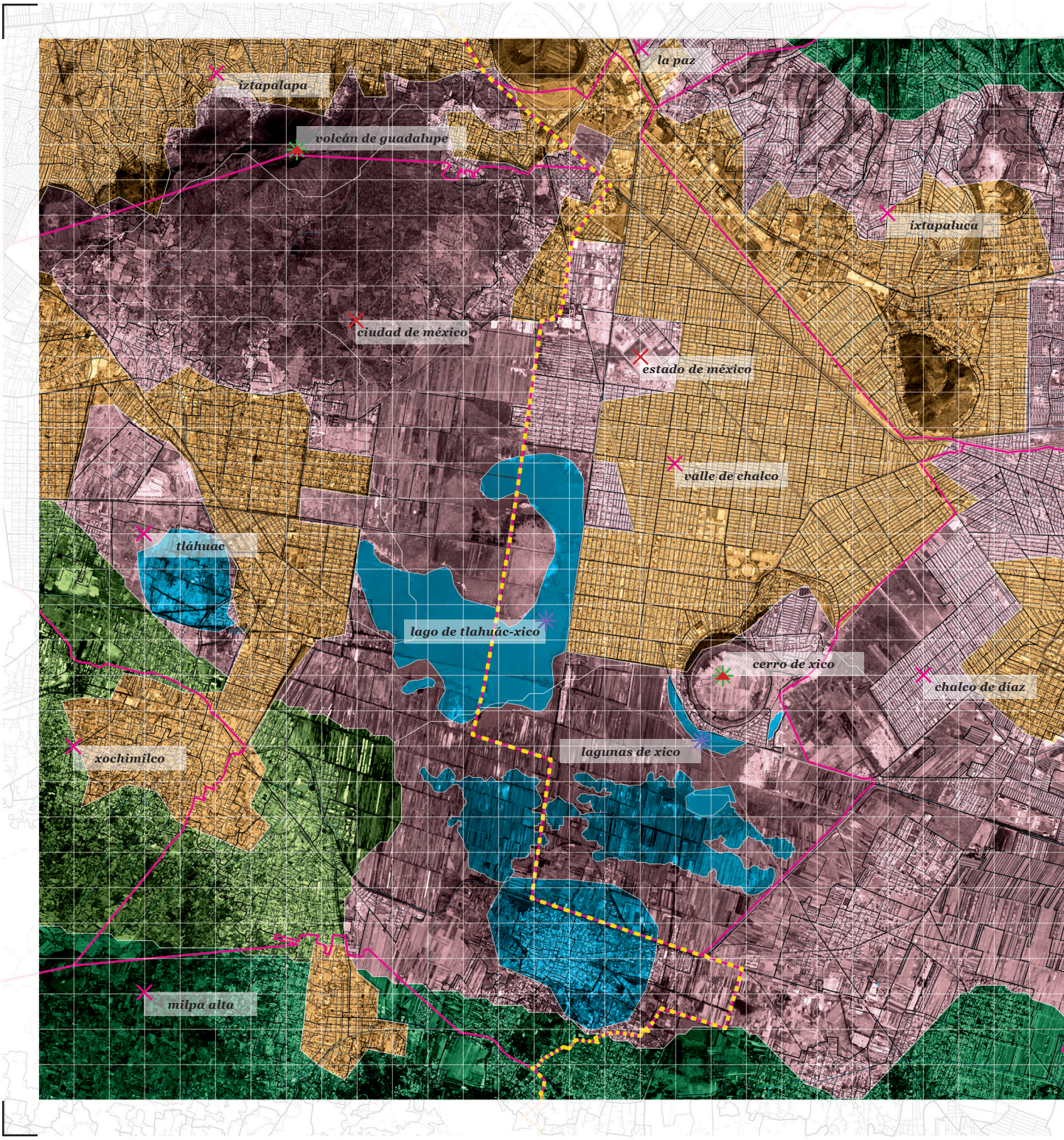
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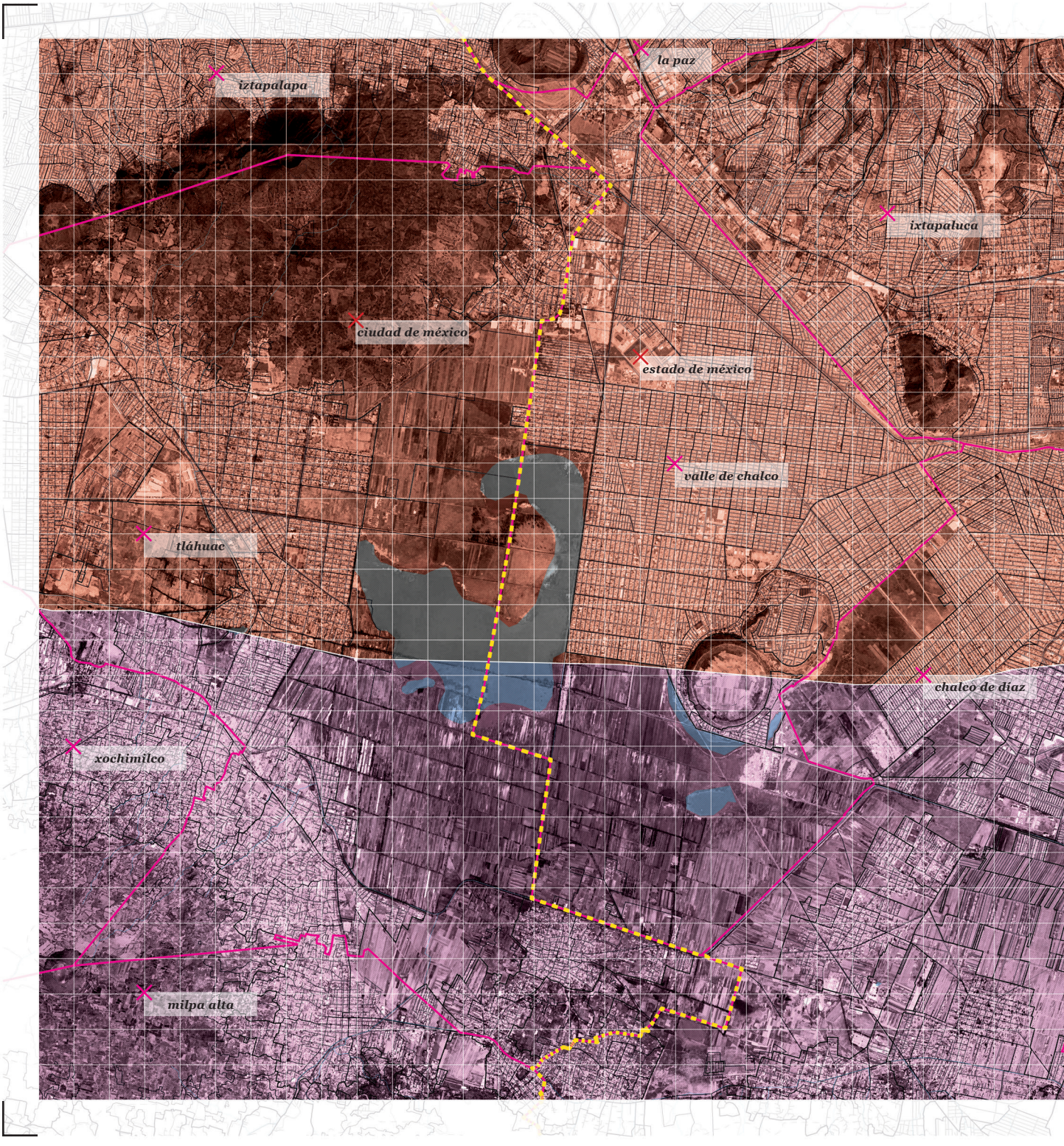
figure 2.15 [left]:
potential vegetation // land-use

Figure 2.15 projects potential vegetation in the region based on the exploitative nature of contemporary land practices. In its current form, the nature of agricultural practices in the region is unsustainable as it causes severe depletion of land. Subsequently, land would degrade to a point where it would ecologically succeed into brownfield or grasslands[22]. This would make it unfeasible for agriculture to continue, and based on existing land-use patterns, these areas would be rezoned for urban settlements. Additionally, low-lying areas would continue to accumulate water leading to its eventual ecological succession to swampy wetlands.

22 Alexander, Rani T., Janine Gasco, and Judith Francis Zeitlin. "Agrarian Ecology and Historical Contingency in Landscape Change." Colonial and Postcolonial Change in Mesoamerica: Archaeology as Historical Anthropology (2018): 53.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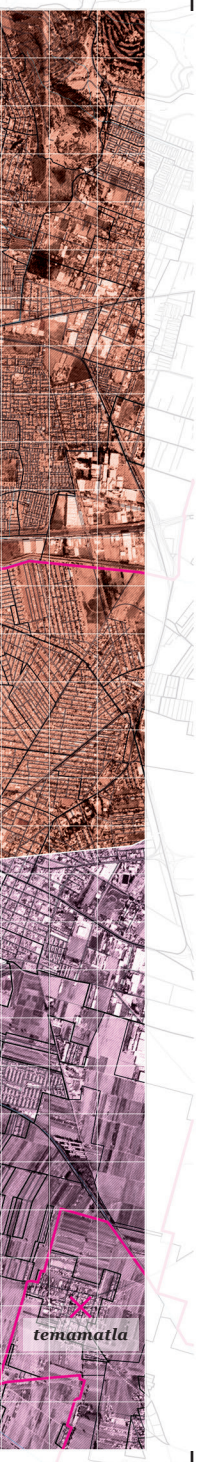


climate
wet temperate sub-humid with
summer rains and drought, and winter
rains less than 5% of annual total.
annual average temperature: 12-18 °C

humidity index (P/T ratio)

< 43.2
55.0 - 43.2

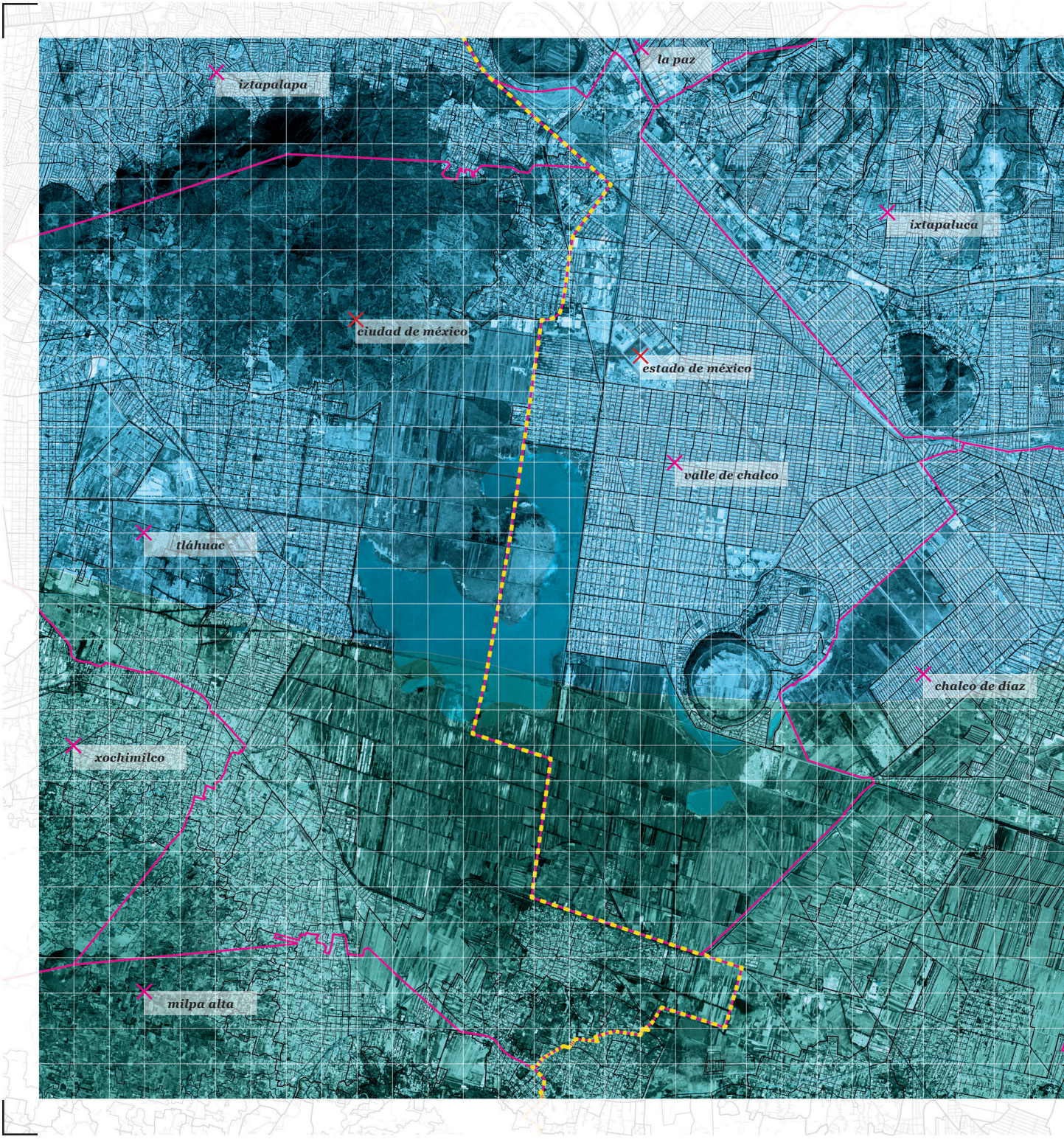
municipal boundary
state boundary

0
500 m
1 km
2 km

figure 2.16 [left]:
climate

As illustrated in Figure 2.16, Chalco has predominantly temperate sub humid climate, with annual temperatures ranging between 12° C to 18° C[23]. Its climate makes it appropriate for a variety of agricultural crops that include corn, vegetables and various flowers.

23 Municipio de Valle de Chalco Solidaridad, Estado de Mexico. 2011. "Atlas De Riesgo Municipio De Valle De Chalco Solidaridad". Dirección Municipal de Protección Civil y H. Cuerpo de Bomberos. http://www.normateca.sedesol.gob.mx/work/models/SEDESOL/Resource/2612/Atlas_Estados/15122_VALLE_CHALCO/0_Atlas_Valle_de_Chalco_2011.pdf.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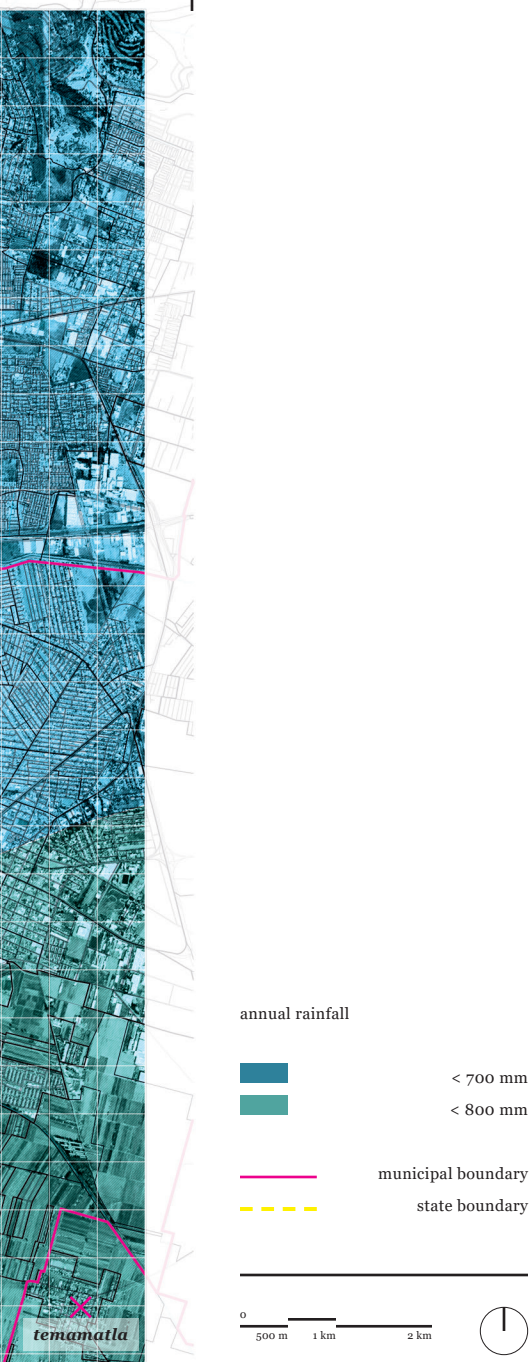


figure 2.17 [left]:
precipitation

As illustrated in Figure 2.17, average annual precipitation in Chalco ranges between 700 mm to 800 mm of rainfall[24]. Although the region receives a generous amount of rainfall, the majority of its inhabitants face severe water shortages. Within the wider context, it is fairly common for the region to experience both flooding and drought cycles within the same year. It is projected that climate change will make this hostile cycle even more punishing. As temperatures continue to rise, both dry and rainy seasons are set to become more extreme. However, several studies have conclusively shown that Chalco receives more than enough rainfall to be self-sufficient with respect to its water needs[25].

24 Municipio de Valle de Chalco Solidaridad, Estado de Mexico. 2011. "Atlas De Riesgo Municipio De Valle De Chalco Solidaridad". Dirección Municipal de Protección Civil y H. Cuerpo de Bomberos. http://www.normateca.sedesol.gob.mx/work/models/SEDESOL/Resource/2612/Atlas_Estados/15122_VALLE_CHALCO/0_Atlas_Valle_de_Chalco_2011.pdf.

25 Chelleri, L., T. Schuetze, and L. Salvati. 2015. "Integrating Resilience With Urban Sustainability In Neglected Neighborhoods: Challenges And Opportunities Of Transitioning To Decentralized Water Management In Mexico City". Habitat International 48: 122-130. doi:10.1016/j.habitatint.2015.03.016.

Return of the lake

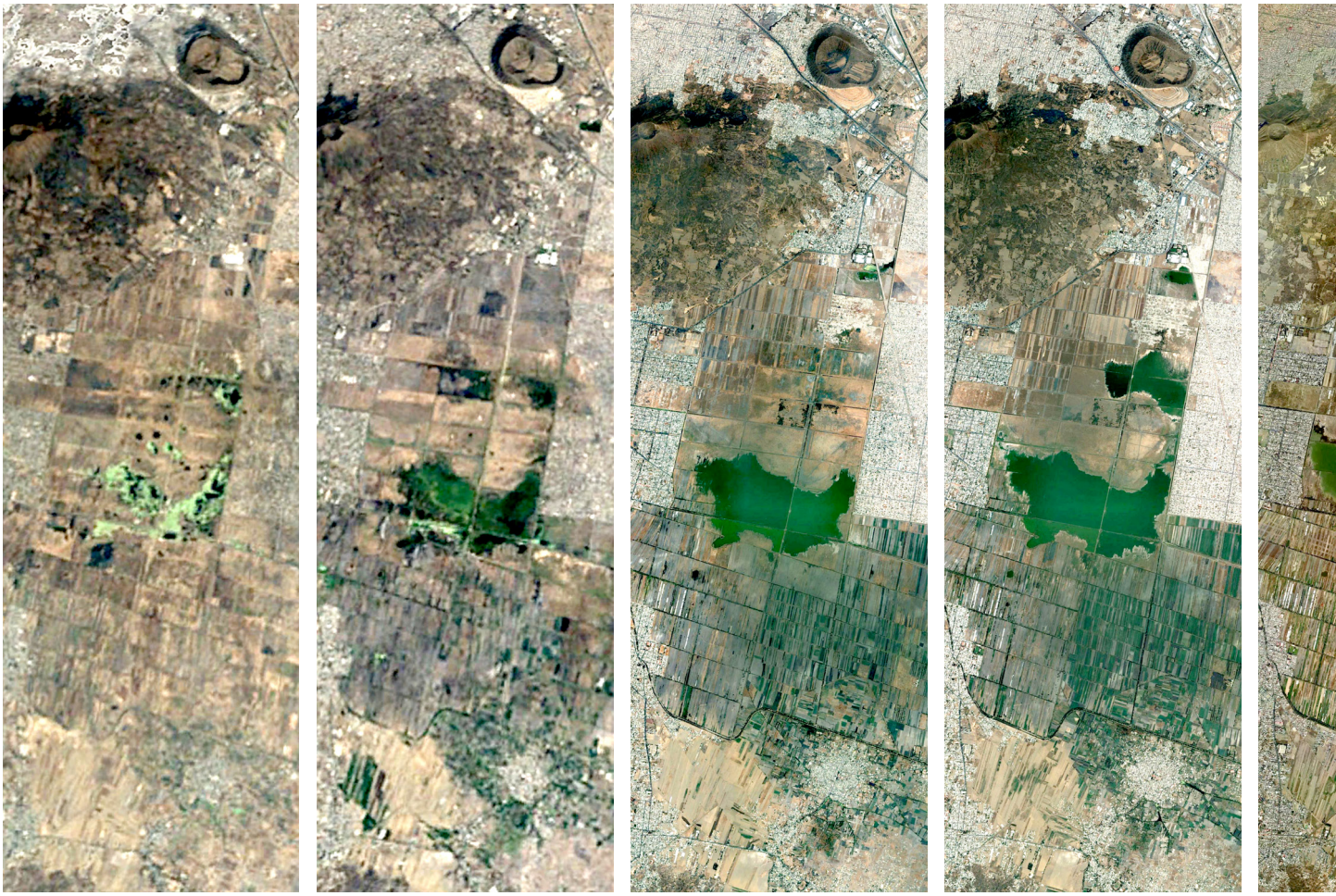


figure 2.18 [spread]:
satellite image timeline -
return of lake tláhuac-xico.

2010

2020

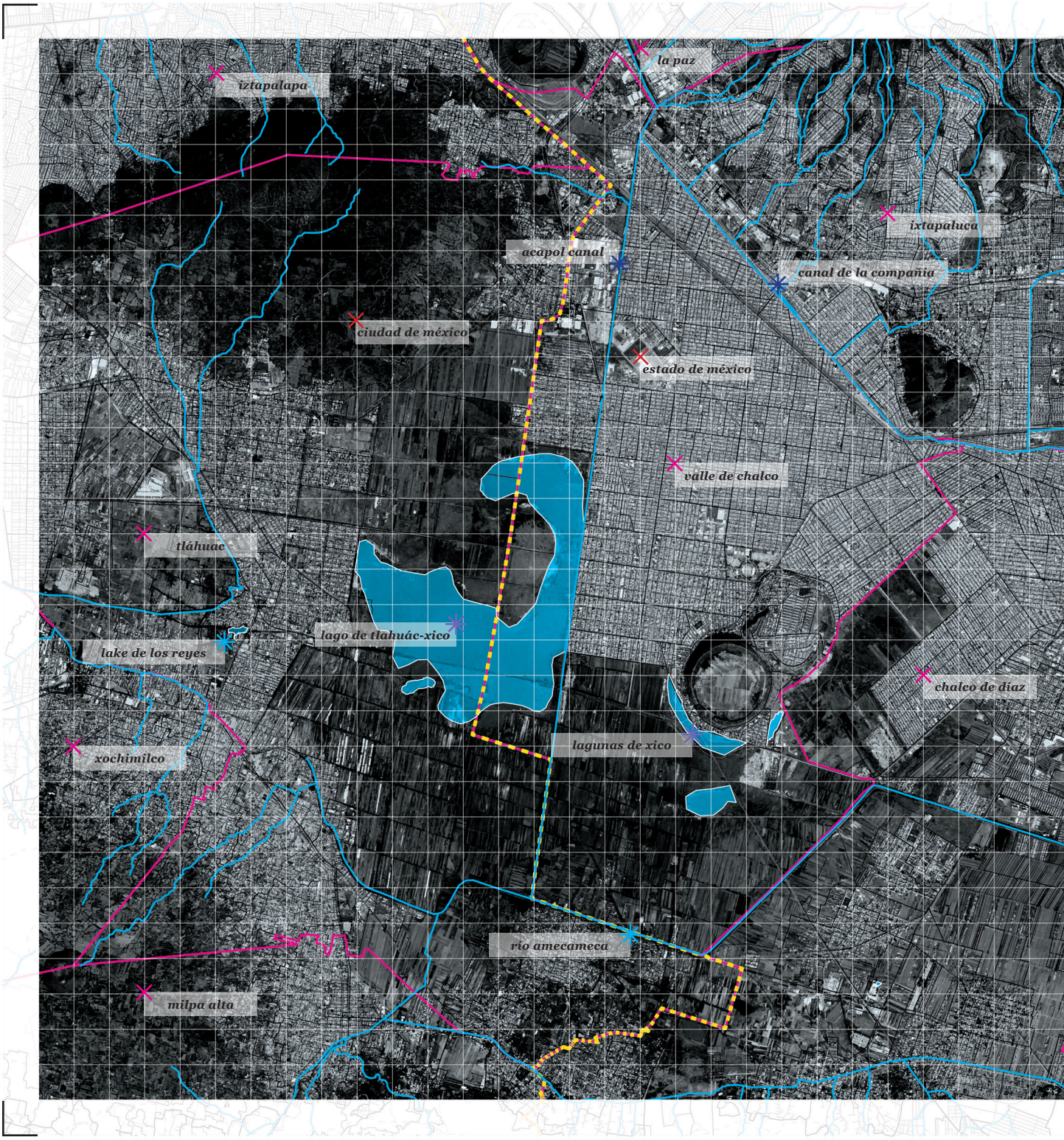
As illustrated in Figure 2.18, the returning lake has been growing in size since 1985, filling large areas of former agricultural and urban land. The lake stretches across more than 1300 acres (5 km^2) and continues to expand in size due to the persistence of subsidence caused by groundwater pumping in the region[26]. Over the past decade, the re-emergence of water in the region as has trigged new forms of political, social, and environmental conflicts. Not only does the returning lake embody traces of prehispanic ecological heritage, it also carries latent potential to address the various crises that affect the region of Chalco. According to Elena Burns, the co-founder of the Watershed Commission in Mexico City, a majority of water-related issues that threaten local populations could be resolved by deepening the lake. This includes the over-exploitation of aquifers, ground subsidence, black-water flooding and improper sewage discharge, and the lack of access to good quality potable water. Harvesting and expanding the returning lake as a reservoir for rainwater catchment offers a sustainable alternative to current water management practices[27]. Additionally, a public campaign under banner "Water of the Basin for the Basin" has advocated for the shutting down of groundwater pumping stations in the region. Rather than extracting from aquifers, the campaign calls for a return to the prehispanic concept of cyclical utilization of water by harvesting the returning lake. It is also worth noting that a large number of aquatic and migratory birds have returned to the region since the lake has re-emerged.

The returning lake also poses an existential threat to the local population. As the lake continues to expand, it will flood adjacent urban and agricultural areas. This would result in the destruction of property and infrastructure. It would also displace thousands of people from their homes and destroy livelihoods that depend on agriculture and ranching. Moreover, ground subsidence in the area has resulted in the formation of cracks on the lake-bed floor, thus exposing the aquifer. Due to the degrading state of water infrastructure in the region, sewage and other waste often overflows into the lake. This could irredeemably contaminate the aquifer[28]. Through sustainable measures, the returning lake could offer solutions to various water-related crises that plague the region. However, without intervention, the continued expansion of the lake only aggravates the existing crisis causing irreparable devastation.

26 Chelleri, L., T. Schuetze, and L. Salvati. 2015. "Integrating Resilience With Urban Sustainability In Neglected Neighborhoods: Challenges And Opportunities Of Transitioning To Decentralized Water Management In Mexico City". Habitat International 48: 122-130. doi:10.1016/j.habitatint.2015.03.016.

27 Watts, Jonathan. "Mexico City's Water Crisis – from Source to Sewer." The Guardian, November 12, 2015, sec. Cities. https://www.theguardian.com/cities/2015/nov/12/mexico-city-water-crisis-source-sewer.

28 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.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tláhuac
lago de tlahuác-xico
lake de los reyes
chalco de díaz
xochimilco
lagunas de xico
río amecameca
milpa alta

figure 2.19 [left]:
hydrology // watershed

Valle de Chalco is the deepest part of the Mexico City watershed. It's drainage comprises of colonial era open-air canals that carry untreated sewage and industrial waste. As illustrated in Figure 2.19, Canal de la Compañía which runs along the northern perimeter of Valle de Chalco, and Acapol Canal which runs adjacent to the returning lake, carry untreated waste from more than 5 million inhabitants of Mexico City[29]. During the rainy season, the canals would rupture at various points, flooding nearby settlements, as well as contaminating the returning lake[30]. Additionally, due to poor water-management and failing water infrastructure, most of the rainfall received gets mixed with sewage black-water. Less than 10% of wastewater in Mexico City is treated[31], and most of it is discharged into reservoirs on the outskirts of the city via open air sewage canals. As the majority of the region is densely urbanized, there is limited scope for water retention.

29 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

30 Chelleri, L., T. Schuetze, and L. Salvati. 2015. "Integrating Resilience With Urban Sustainability In Neglected Neighborhoods: Challenges And Opportunities Of Transitioning To Decentralized Water Management In Mexico City". Habitat International 48: 122-130. doi:10.1016/j.habitatint.2015.03.016.

31 BBC News. 2016. "Quenching Mexico City's Thirst", , 2016. http://news.bbc.co.uk/2/hi/americas/4812352.stm.

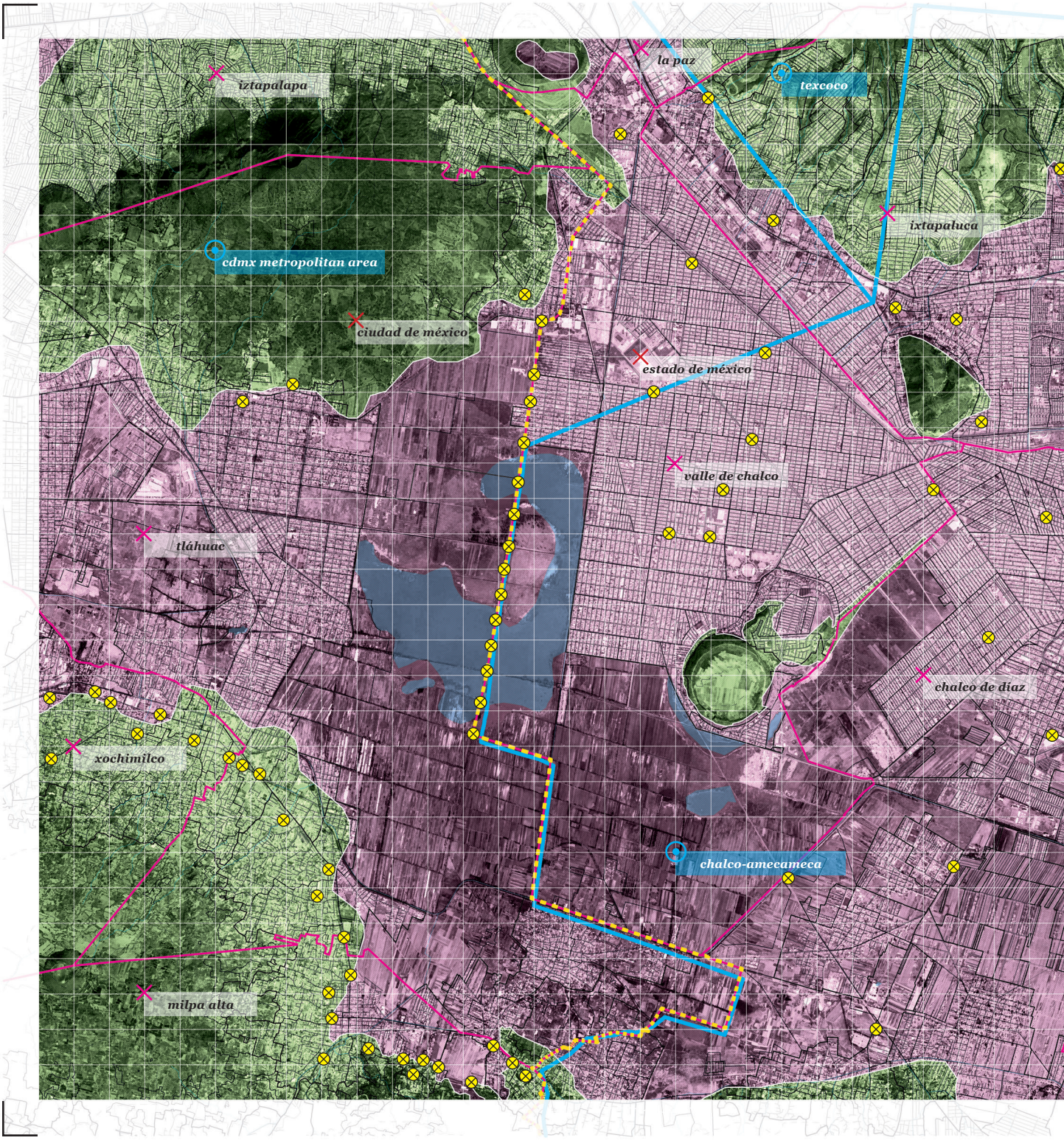
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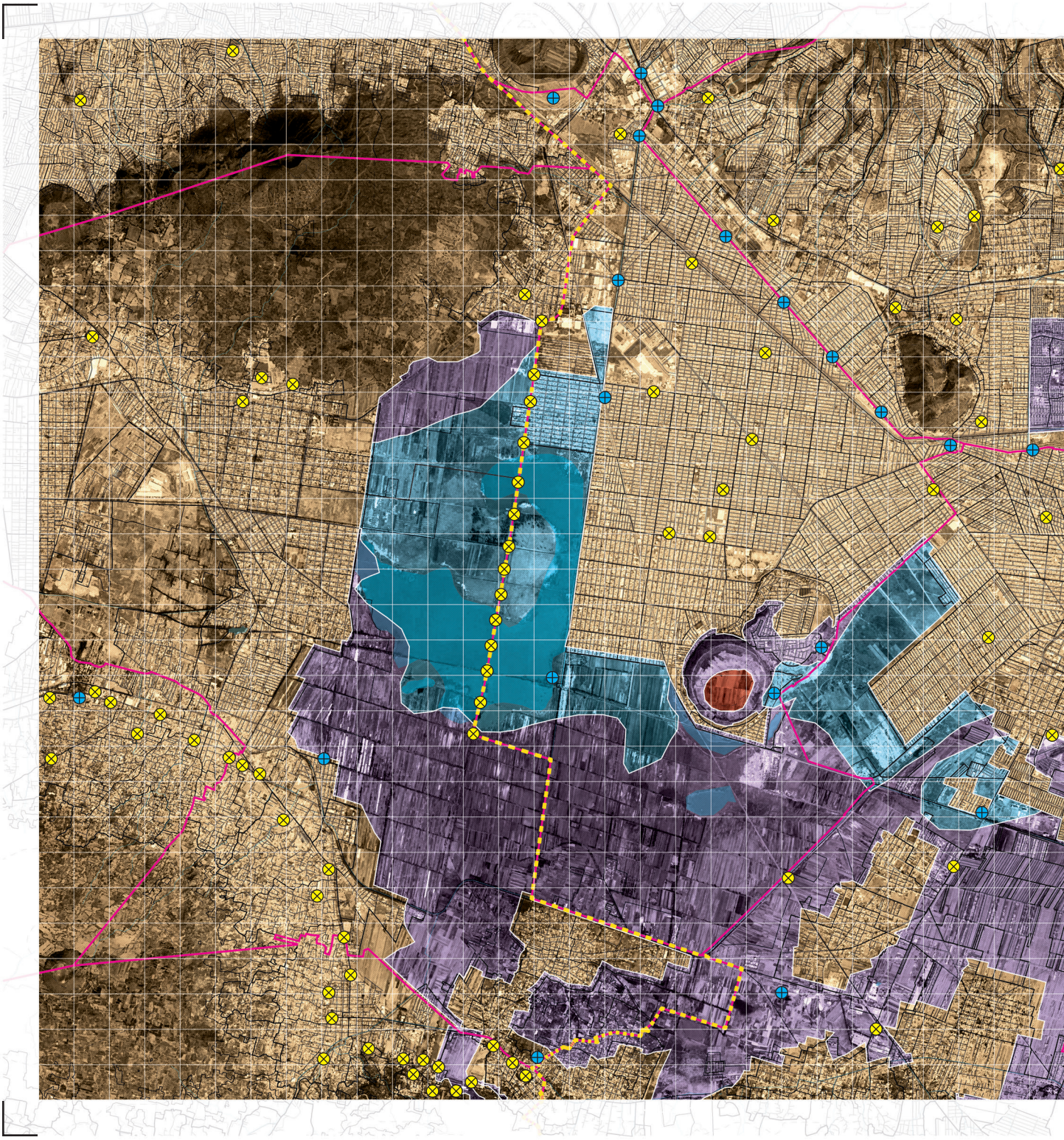
figure 2.20 [left]:
hydrogeology (i of ii)

As illustrated in Figure 2.20, Chalco is primarily divided into three major aquifer zones. The map also illustrates groundwater extractions areas as well as recharge areas. Due to the over exploitation of aquifers in the region, a significantly disproportionate amount of water is extracted as compared to natural recharge through groundwater infiltration[32]. As the water crisis in the region continues to aggravate, deeper pumping is required to extract potable water. This practice is unsustainable as the aquifers are on the brink of running dry. It also makes the region increasingly susceptible to seismic activity in addition to various other ecological disasters[33].

32 Chelleri, L., T. Schuetze, and L. Salvati. 2015. "Integrating Resilience With Urban Sustainability In Neglected Neighborhoods: Challenges And Opportunities Of Transitioning To Decentralized Water Management In Mexico City". Habitat International 48: 122-130. doi:10.1016/j.habitatint.2015.03.016.

33 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.



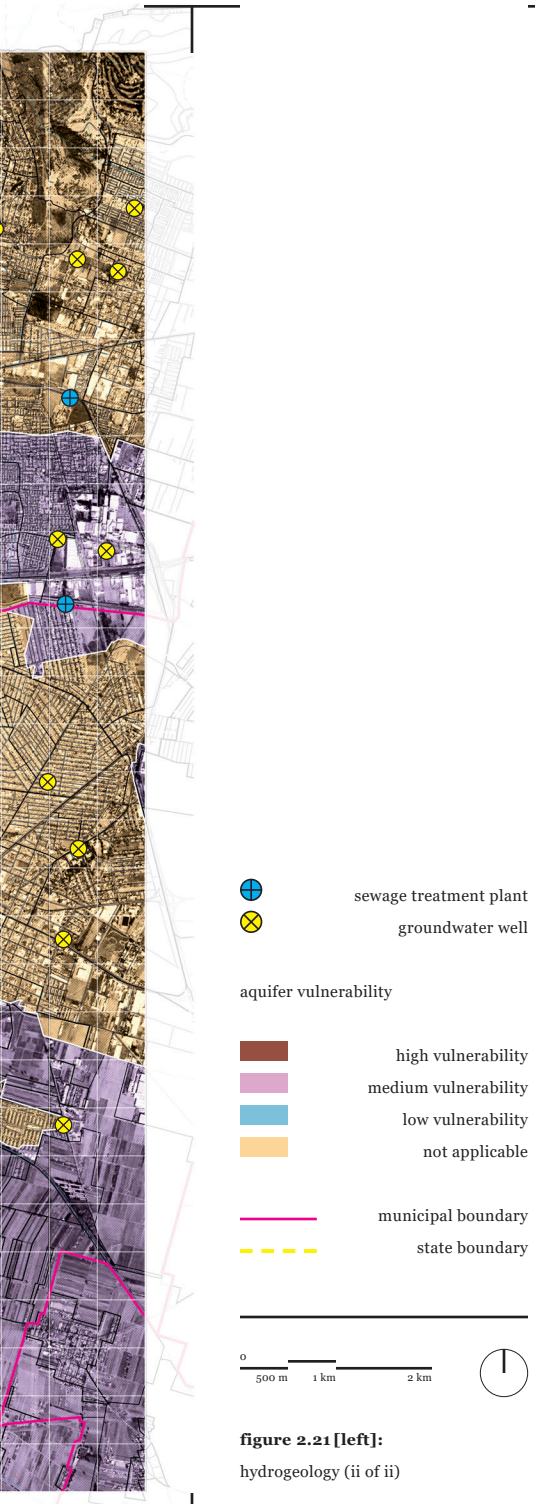


figure 2.21 [left]:
hydrogeology (ii of ii)

As illustrated in Figure 2.21, aquifers are vulnerable to contaminants from the rupturing and subsequent flooding of untreated waste from open-air sewage canals in the area. Also, current agricultural practices rely on a range of chemical fertilizers for higher crop-yields. These chemicals and various other contaminants could seep through the soil and potentially contaminate the aquifer[34].

34 Municipio de Valle de Chalco Solidaridad, Estado de Mexico. 2011. "Atlas De Riesgo Municipio De Valle De Chalco Solidaridad". Dirección Municipal de Protección Civil y H. Cuerpo de Bomberos. http://www.normateca.sedesol.gob.mx/work/models/SEDESOL/Resource/2612/Atlas_Estados/15122_VALLE_CHALCO/0_Atlas_Valle_de_Chalco_2011.pdf.

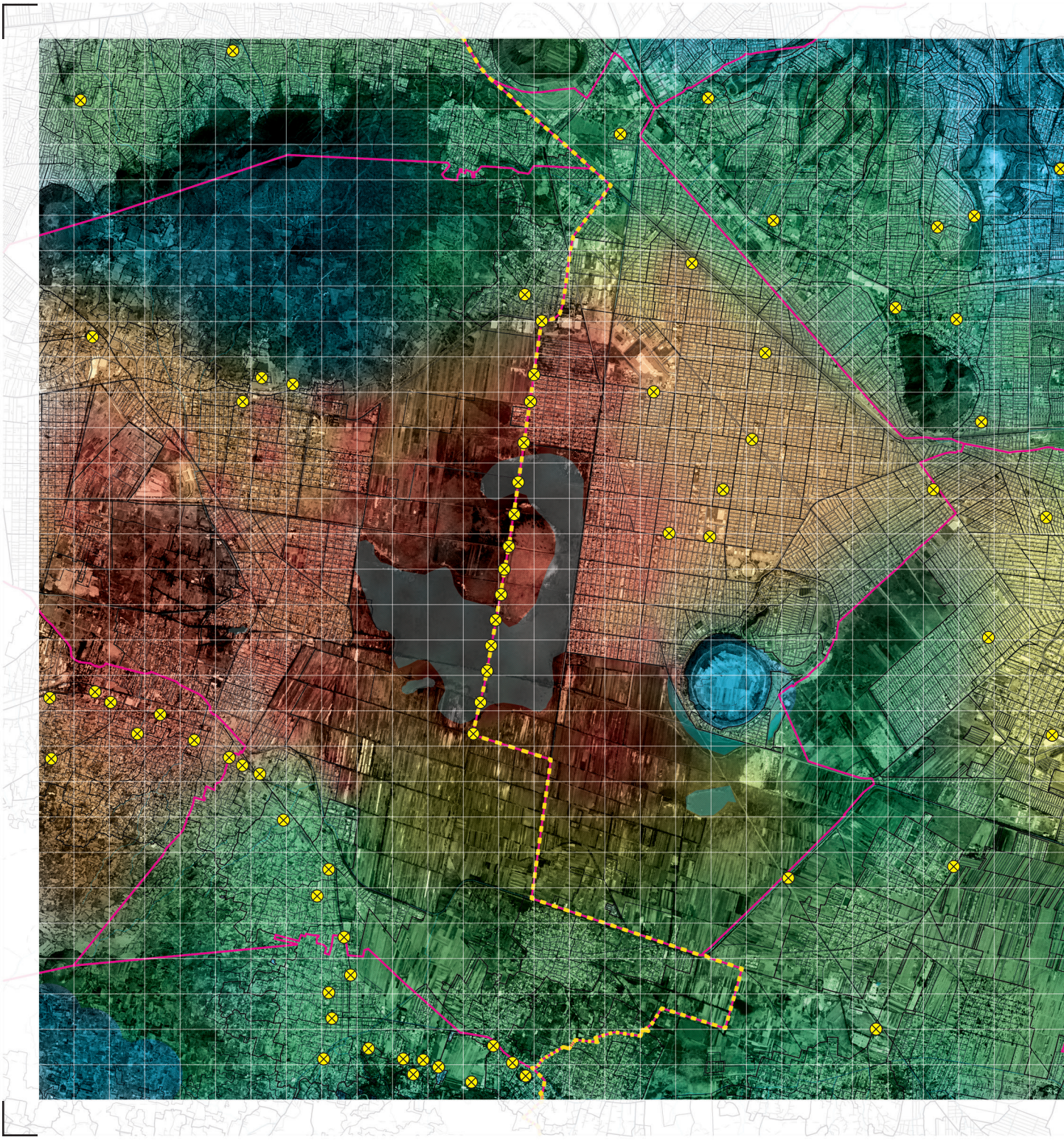
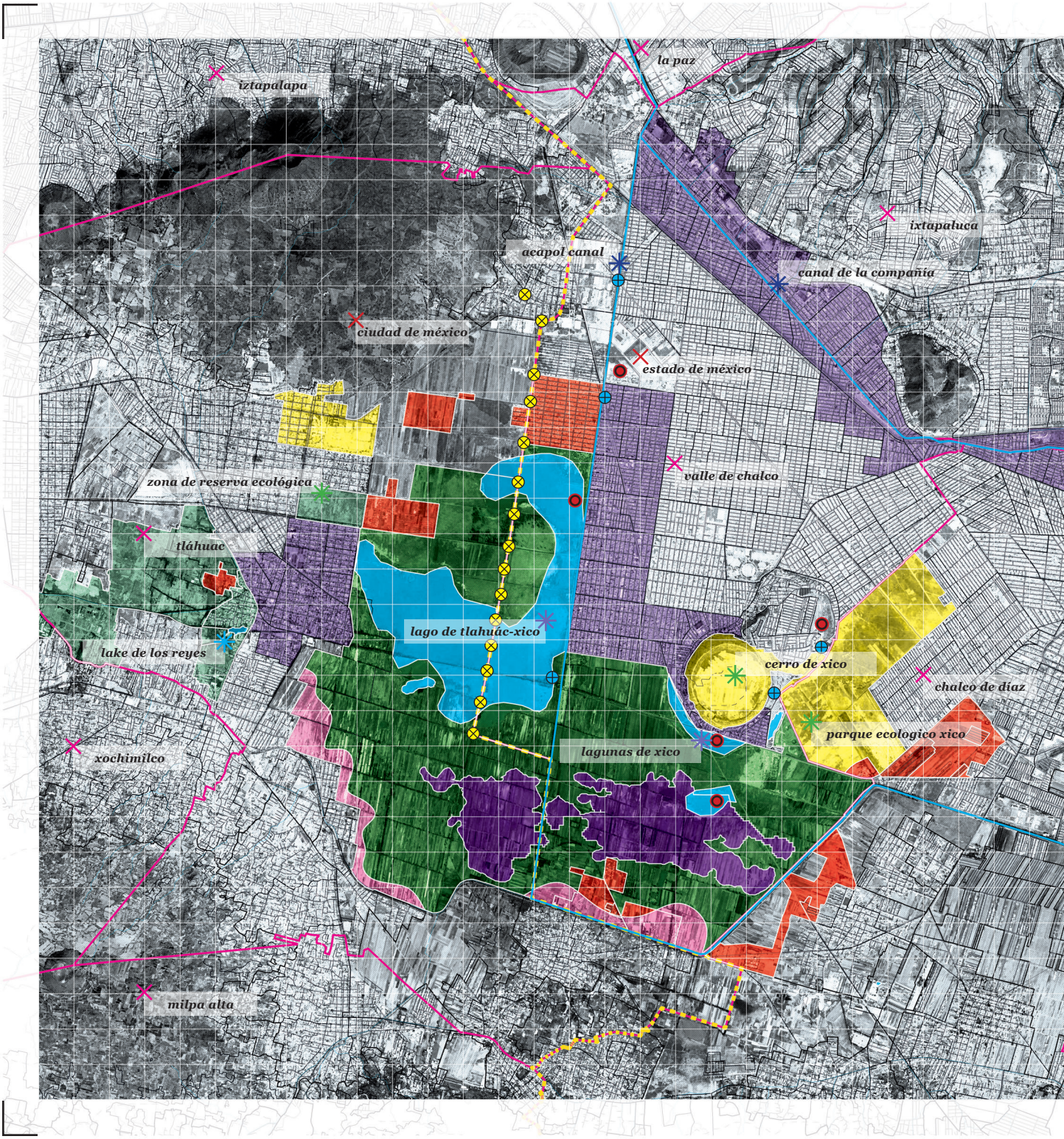


figure 2.22 [left]:
subsidence

Ground subsidence due to over-exploitation of aquifers remains a critical issue that worsens over time. As illustrated in Figure 2.22, land is sinking at dangerous rates of up to -2.50 cm per month in areas with a high concentration of groundwater wells. As water shortages continue to plague the city, more water has to be extracted from previously depleted aquifers. The ground is sinking at different rates, making Chalco particularly vulnerable to earthquakes and seismic activity. The formation of cracks, sinkholes, and subsequent property damage are quite prevalent in the region.[35]

35 Municipio de Valle de Chalco Solidaridad, Estado de Mexico. 2011. "Atlas De Riesgo Municipio De Valle De Chalco Solidaridad". Dirección Municipal de Protección Civil y H. Cuerpo de Bomberos. http://www.normateca.sedesol.gob.mx/work/models/SEDESOL/Resource/2612/Atlas_Estados/15122_VALLE_CHALCO/0_Atlas_Valle_de_Chalco_2011.pdf.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estado de méxico
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tláhuac
lago de tlahuác-xico
lake de los reyes
cerro de xico
chalco de díaz
parque ecologico xico
lagunas de xico
xochimilco
milpa alta

dump sites for sewage, industrial and construction waste

open air sewage canals carry untreated waste, and rupture at various points causing flooding.

flooded neighbourhoods lack of proper hydraulic infrastructure leads to flooding of urban areas.

irregular settlements improper sanitation facilities result in raw sewage filling environments and potentially contaminating the aquifer.

urban sprawl encroaching into protected zones.

low-lying agricultural areas at risk from flooding

treatment plants water treatment plants have very low efficiencies, dumping raw sewage into the xico lagoons and the lake.

groundwater wells cause land subsidence due to excessive pumping of the underground aquifer.

protected zone - parks

protected zone - agriculture

protected zone - ecological

municipal boundary

state boundary

0 500 m 1 km 2 km

figure 2.23 [left]:
environmental threats

Figure 2.23 summarizes various environmental threats that plague the region around the re-emerging lake. This includes a variety of issues that range from land subsidence due to overexploitation of aquifers to flooding caused by insufficient water infrastructure. The lake is re-emerging within a federally protected agricultural zone and continues to expand and consume large swaths of agricultural land. Moreover, the development of irregular settlements with improper sanitation facilities has resulted in raw sewage filling natural environments. This is worsened by the large influx of migrants arriving in the region every year, as it triggers urban sprawl to encroach upon ecologically sensitive protected areas.

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cerro de xico
chalco de díaz
xochimilco
lagunas de xico
milpa alta

pluvial lakes // lagoons
extinct volcanoes
municipality
state // federal

municipal boundary
state boundary

proposed site boundary

0
500 m
1 km
2 km

figure 2.24 [left]:
proposed site boundary

Based on various underlying conditions highlighted in this chapter of the thesis, a site boundary is drawn to demarcate key areas of concern and identify the extents of a potential site for design intervention (Figure 2.24). The proposed site boundary will encompass the returning lake and federally protected agricultural areas in its vicinity. It will border the urban areas of Valle de Chalco and Tláhuac on its eastern and western fringes respectively. The site also includes low-lying areas wherein the lake could potentially expand, as well as the recently formed Xico Lagoons which have emerged due to land subsidence. The proposed site will also reiterate boundaries around ecologically sensitive land, thus restricting urban sprawl from further encroaching upon protected areas.

P III

" for indigenous communities in chalco who have resisted the cultural and ecological appropriation of the ex-lacustrine region through centuries, the returning lake presents an opportunity to invoke a decolonial possibility that is rooted in rewilding and regenerating devastated socio-ecological landscapes "

systems
for designing ecologies

The lake as an ecosystem

Ecosystems can be defined as complex systems wherein nonliving and living actors are linked to each other through symbiotic interactions. The structure and functionality of every ecosystem is determined by the interactions between its components. While ecosystems are capable of self-organization to achieve ecological equilibrium and ecosystem integrity, the loss of a system component could potentially lead to a catastrophic loss of ecosystem integrity[1].

For most of history, the Mexico Valley Basin was home to five great lakes. The early inhabitants of the valley, which included the Chalcas who settled on Xico Island on Lake Chalco, engineered complex hydraulic and hydro-agrarian systems that enabled them to symbiotically interact with the lacustrine ecology[2]. For these indigenous communities, their livelihoods were woven into the lake's ecosystem such that maintaining ecosystem with non-human actors had become essential for their sustenance. These symbiotic interactions molded the core fabric of intricate socio-ecological landscapes that enabled the Aztec Civilization to flourish for centuries.[3] The colonists, who were unacquainted with the region's ecological fragility, were driven by a manic necessity of draining the lakes. As a result, lacustrine ecosystems that had thrived for centuries were catastrophically desecrated to make way for an urban metropolis. The persistence of colonial power structures in the region subsequently led to the permanent desiccation of the lakes, and had regressive consequences on indigenous livelihoods, as well as non-human agents that were part of the lacustrine ecology[4]. A stable attractor refers to the state of equilibrium into which an ecosystem settles until disturbed by a change in its ecology. The system would then settle into a new state of equilibrium[5]. The desiccation of the lakes led to shifts in the ecosystem and the catastrophic loss of ecosystem integrity. However, following decades of groundwater pumping and subsequent land subsidence, Lake Chalco, which was permanently desiccated in 1908 has now re-emerged as Lake Tláhuac-Xico. The return of the lake shows a tendency for the formerly desecrated lacustrine ecosystems to shift towards a new stable attractor. The emerging lake stretches over 1300

1 Woodley, Steven, and James Kay. Ecological Integrity and the Management of Ecosystems. CRC Press, 1993.

2 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

3 Vitz, Matthew. 2018. A City on a Lake: Urban Political Ecology And The Growth Of Mexico City. Duke University Press.

4 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

5 Walker, Brian, C. S. Holling, Stephen R. Carpenter, and Ann Kinzig. "Resilience, Adaptability and Transformability in Social–Ecological Systems." Ecology and Society 9, no. 2 (2004). https://www.jstor.org/stable/26267673.

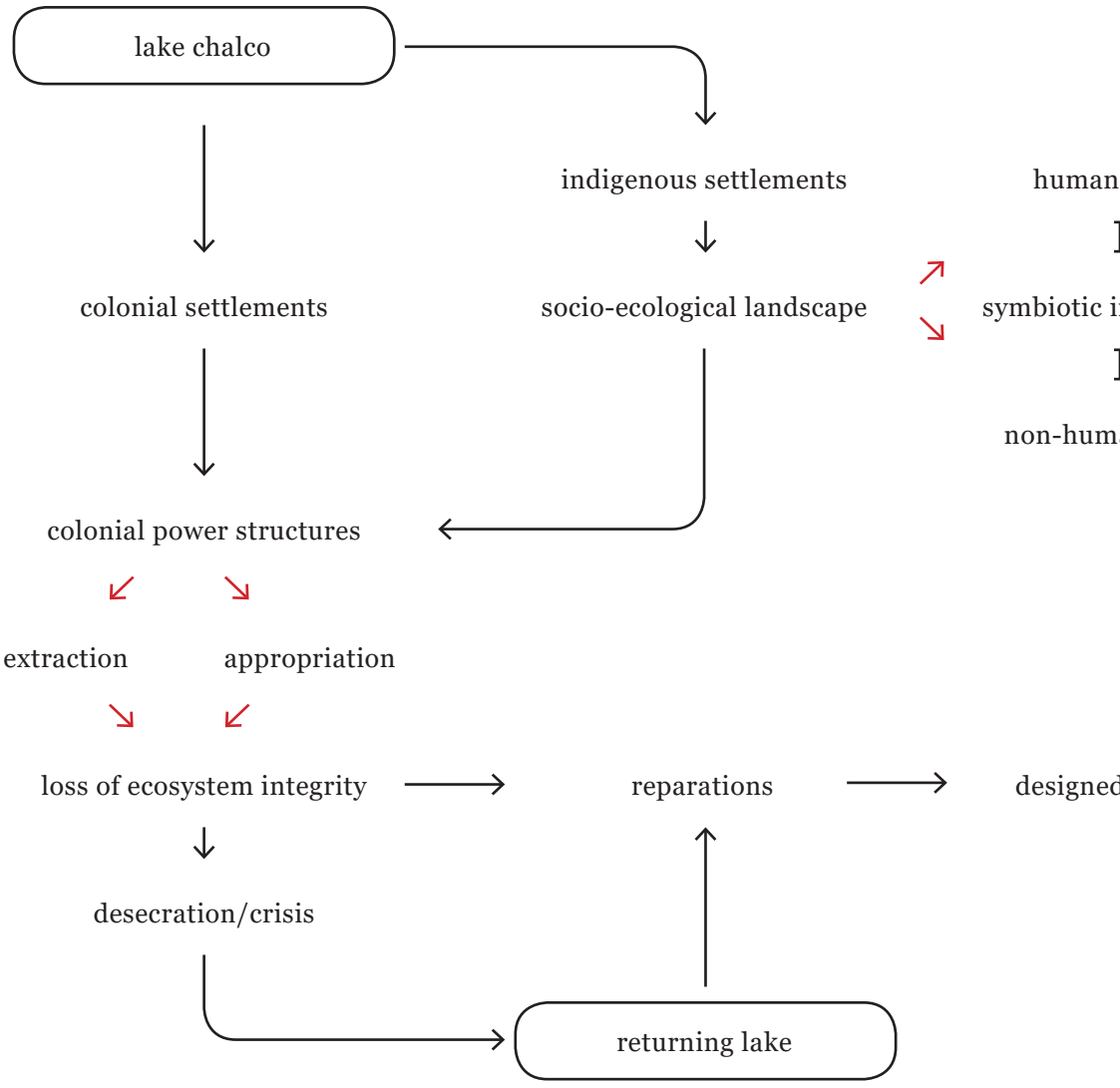
acres of subsiding land and holds over nine million cubic meters of water[6]. Due to the persistence of groundwater pumping and land subsidence in the region, the lake continues to expand, and many species of flora and fauna have returned to the region[7]. However, for current inhabitants of Chalco who are now dissociated from the lacustrine ecology, the return of former lacustrine ecology poses a significant existential threat to their livelihoods.

Figure 3.1 diagrammatically illustrates the evolution of Lake Chalco as a complex ecosystem. While indigenous models created a socio-ecological landscape which relied on symbiotic interactions between human and non-human agents to achieve ecosystem integrity, the colonial model appropriated, and then extracted from the lake leading to a socio ecological crisis. The returning lake is an outcome of this crisis. A 'reparations ecology' hypothesizes a new model for making amends to grave errors of the past by rethinking relationships between human society and natural ecology as mutually constituting each other[8]. A 'reparations ecology' within the context of Chalco would invoke a decolonial possibility that is rooted in restoring and regenerating indigenous socio-ecological landscapes that once thrived in the region. It would employ regenerative design methodologies to act as reparative mediums between the local community and natural ecology. Despite having underwent centuries of colonial desecration, the ex-lacustrine region has paradoxically regenerated through the re-emergence of the lake as Lake Tláhuac-Xico. While systems put in place by colonial power structures threaten the lake's renewed existence, a 'reparations ecology' model rooted in regenerative design and re-instituting indigenous patrimony could restore the heritage socio-ecological landscape that once flourished in the region. A 'reparations ecology' also carries the potential to offer resilient solutions to contemporary environmental crises that threaten human sustenance. Rewilding and regenerating the returning lake would liberate natural ecologies from enclosures imposed by colonial power structures that impede an ecologically sustainable future for all. Through an elaborate ecosystem design narrative, this section of the thesis will present systems and strategies for invoking a reparations ecology in Chalco to rewild and regenerate the former lacustrine ecology and achieve ecosystem integrity.

6 Chelleri, L., T. Schuetze, and L. Salvati. 2015. "Integrating Resilience With Urban Sustainability In Neglected Neighborhoods: Challenges And Opportunities Of Transitioning To Decentralized Water Management In Mexico City". Habitat International 48: 122-130. doi:10.1016/j.habitatint.2015.03.016.

7 Watts, Jonathan. "Mexico City's Water Crisis – from Source to Sewer." The Guardian, November 12, 2015, sec. Cities. https://www.theguardian.com/cities/2015/nov/12/mexico-city-water-crisis-source-sewer.

8 Patel, Raj, and Jason W Moore. 2017. A History Of The World In Seven Cheap Things : A Guide To Capitalism, Nature, And The Future Of The Planet. Oakland, California: University of California Press.


lake chalco
indigenous settlements
human
colonial settlements
socio-ecological landscape
symbiotic i
non-huma
colonial power structures
extraction
appropriation
loss of ecosystem integrity
reparations
designed
desecration/crisis
returning lake

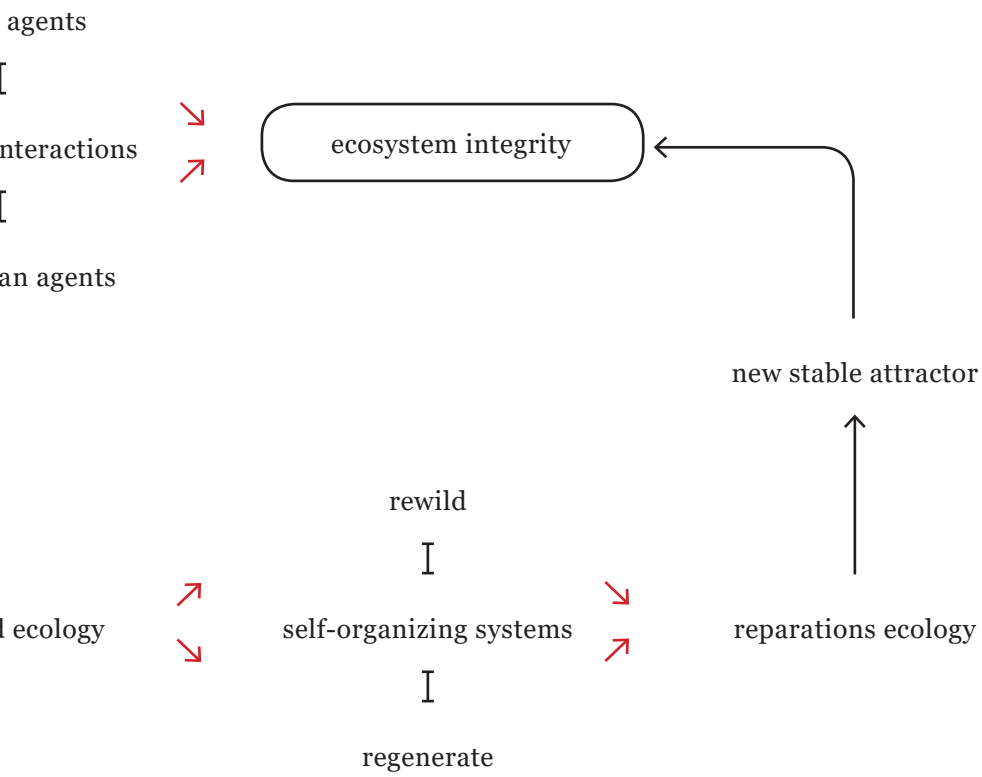


figure 3.1 [spread]:
diagram - the lake as an ecosystem

Part I of this thesis documents historical scholarship that is pertinent to indigenous heritage ecologies in Chalco. Indigenous settlements that were woven into the lacustrine ecology were uprooted and dispossessed from socio-ecological landscapes that had thrived for centuries prior to colonization. Part II of this thesis illustrates the negative implications of colonial land practices, which has manifested as a socio-ecological crisis in contemporary Chalco. This chapter of the thesis will focus on designed systems and strategies through which a potential reparations ecology could actualize in Chalco.

In contemporary architectural discourse, a new paradigm for landscape remediation through regenerative design has emerged. As an alternative to temporarily fixing 'broken bits and pieces' of nature to address the environmental crises that we face today, this new paradigm advocates for a complete restoration and revitalization of desecrated landscapes to effectively reinstate natural processes and functions[9].

Within the context of Chalco, the region has been suffering from severe ecological degradation ever since Lake Chalco was desiccated by colonial land practices. With the lake now re-emerging, an opportunity to rewild and regenerate the former lacustrine ecology through a designed reparations ecology has risen. Designing a reparations ecology in Chalco will include functional and dynamic interventions that will repair and restore the desecrated lacustrine landscapes. Based on theoretical research presented by Zhifang and Yuan in "Perspectives of Designed Ecologies", these design interventions can be defined key across three levels[10]. These are listed as follows:

- **Ecological functionality**: the design is able to create and maintain a self-organizing ecosystem that provides key ecosystem services. The goal is to create resilient systems that offer socio-ecological solutions to various crises that threaten ecosystem integrity.

- **Succession efficiency**: the effect of the designed ecological succession surpasses the results of 'succession without intervention' and the design helps promote natural regeneration.

- **Landscape experience**: the design promotes aesthetic, cultural and heritage values that represent and benefit the local community[11].

9 France RL. Restorative Redevelopment of Devastated Ecocultural Landscapes. Boca Raton: CRC Press; 2011.

10 Wang, Zhifang, and Zhenyu Yuan. "PERSPECTIVES OF DESIGNED ECOLOGIES." Landscape Architecture Frontiers 7, no. 1 (2019): 8. https://doi.org/10.15302/J-LAF-20190102.

11 Wang, Zhifang, and Zhenyu Yuan. "PERSPECTIVES OF DESIGNED ECOLOGIES." Landscape Architecture Frontiers 7, no. 1 (2019): 8. https://doi.org/10.15302/J-LAF-20190102.

A reparations ecology in Chalco would act as a substrate for self-organizing ecosystems to deploy a wide range of functions and processes that promote the natural regeneration of the returning lake. In contrast to colonial models of development that rely on untenable extraction and land appropriation, these systems could potentially offer an alternative model that rely on symbiotic interactions between humans and nature in a manner that is viable, sustainable, and ecologically resilient. In response to the region's underlying social and environmental conditions, these systems could provide efficient ecological solutions to various crises related to water utilization, land appropriation, agriculture and food security, as well as provide political agency for local communities.

A design framework for self-organizing systems that would instill a reparations ecology in Chalco can be defined based on its proposed objectives and functions. These are categorically listed as follows:

1. **Improving water resilience**: As a response to Chalco's aggravating water crisis, systems that integrate green, blue and gray infrastructure could improve water resilience and enable a cyclical utilization of the region's resources.

2. **Rewilding lacustrine ecosystems**: Desecrated wetland ecologies could be rewilded through the reintroduction of native flora and fauna to promote natural regeneration.

3. **Regenerative agriculture:** As an alternative to industrial mono-crop agricultural practices that have caused substantial ecological degradation in the region, heritage hydro-agrarian systems such as chinampas could be reintroduced to ensure agricultural sustenance.

4. **Social infrastructure:** Ecosystems are characterized by symbiotic interactions between human and nonhuman actors. The designed ecology should therefore include spatial mediums that promote interactions that build social capital. These mediums will also allow for the maintenance and preservation of the regenerated landscape.

The following pages of the thesis will elaborate on the aforementioned design objectives through a series of images, sequential diagrams and case studies. The intent is to establish a clear design framework of systems and strategies that would shape the proposed ecosystem design narrative to invoke a reparations ecology in Chalco.

integrated green, blue and gray infrastructure to improve water resilience and enable a cyclical utilization of the region's resources.

water resilience

designing a repa

lacustrine ecosystems

rewilding wetland ecologies and reintroduction of native species to improve natural regeneration.

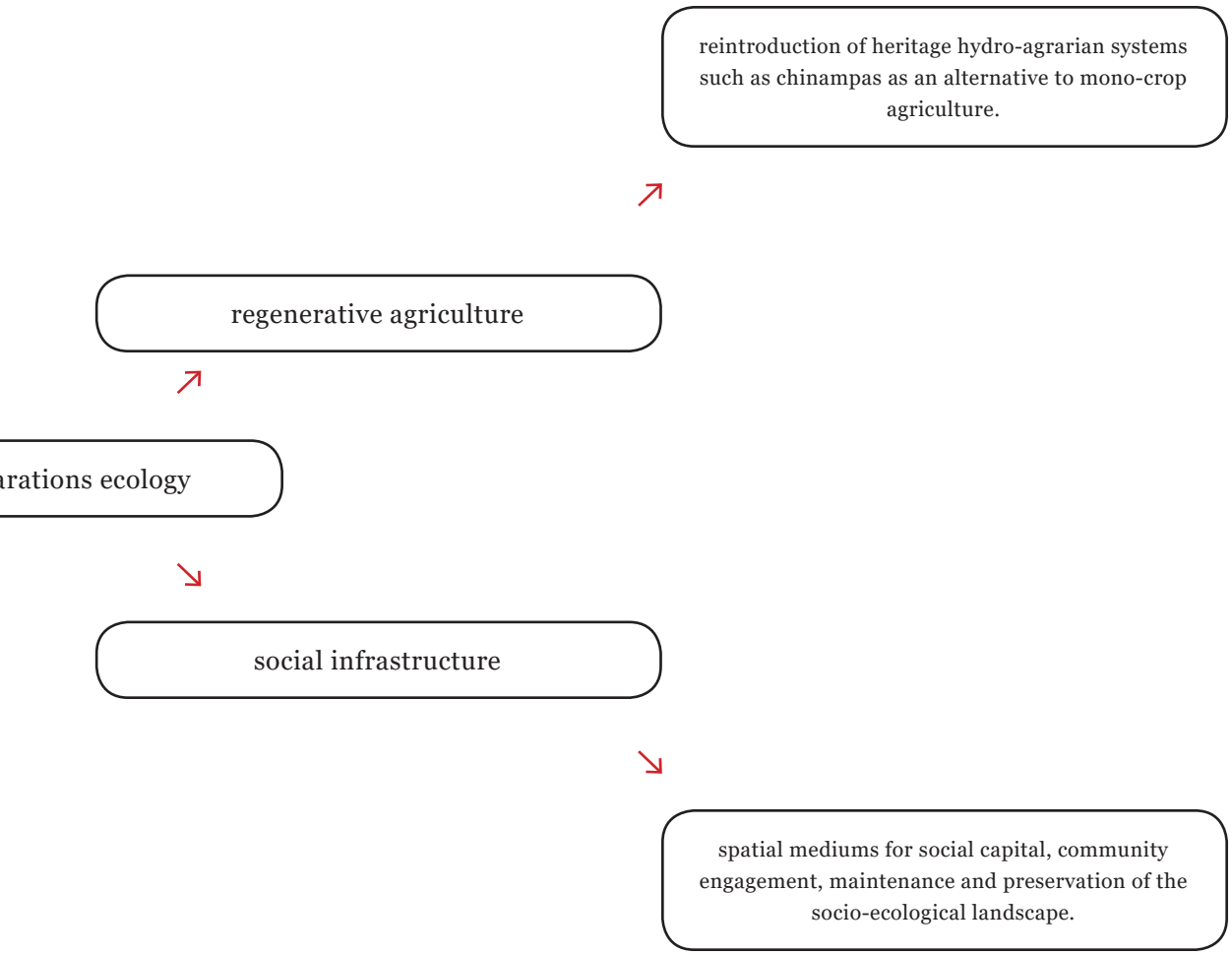


figure 3.2 [spread]:
proposed design framework

Chalco is in the midst of a water crisis. The crisis matrix in Figure 3.4 highlights key underlying conditions that continue to aggravate the water crisis. As illustrated, excessive groundwater pumping has led to the over-exploitation of aquifers to a degree where land is subsiding by over -2.50 cm every month[12]. This has resulted in the creation of depressions filled by rainwater. The returning lake is a direct outcome of land subsidence. Existing water infrastructure in the region has been unable to cope with the amount of storm-water accumulating in the area, thus leading to the expansion of the lake. As the lake continues to expand, it fills surrounding areas, and large swaths of agricultural and urban land are consumed or threatened by floods, causing an urban equity slump. Flooding and land subsidence have also caused significant property and infrastructure damage in the area. In spite of excessive groundwater pumping, the region faces severe water scarcity issues as the aquifers are on the verge of being depleted, and there is limited scope for water retention in the area. Most of the rainfall received in Chalco is mixed with sewage and improperly discharged – potentially contaminating aquifers and causing soil degradation[13].

Through a series of sectional diagrams, Figure 3.5 illustrates various best practices for improving water resilience in Chalco through integrated solutions for better utilization and management of resources. This would include creating rainwater catchment areas for water retention and regenerating the returning lake to act as a reservoir for supply and groundwater recharge. The urban edge would be re-profiled to create a levee to regulate flooding. As opposed to improper sewage discharge into water bodies, wetland ecosystems would naturally re-mediate contaminated water. There could be an emphasis to adopt systems that efficiently integrate green, blue and gray infrastructure to provide key ecosystem services. Moreover, hydro-agrarian systems like chinampas could alleviate the loss of farmland from flooding.

12 Municipio de Valle de Chalco Solidaridad, Estado de Mexico. 2011. "Atlas De Riesgo Municipio De Valle De Chalco Solidaridad". Dirección Municipal de Protección Civil y H. Cuerpo de Bomberos. http://www.normateca.sedesol.gob.mx/work/models/SEDESOL/Resource/2612/Atlas_Estados/15122_VALLE_CHALCO/0_Atlas_Valle_de_Chalco_2011.pdf.

13 Chelleri, L., T. Schuetze, and L. Salvati. 2015. "Integrating Resilience With Urban Sustainability In Neglected Neighborhoods: Challenges And Opportunities Of Transitioning To Decentralized Water Management In Mexico City". Habitat International 48: 122-130. doi:10.1016/j.habitatint.2015.03.016.

figure 3.3 [left]:
less than 10% of wastewater in mexico city is treated,
and most of it is discharged into reservoirs on the
outskirts of the city via open air sewage canals.

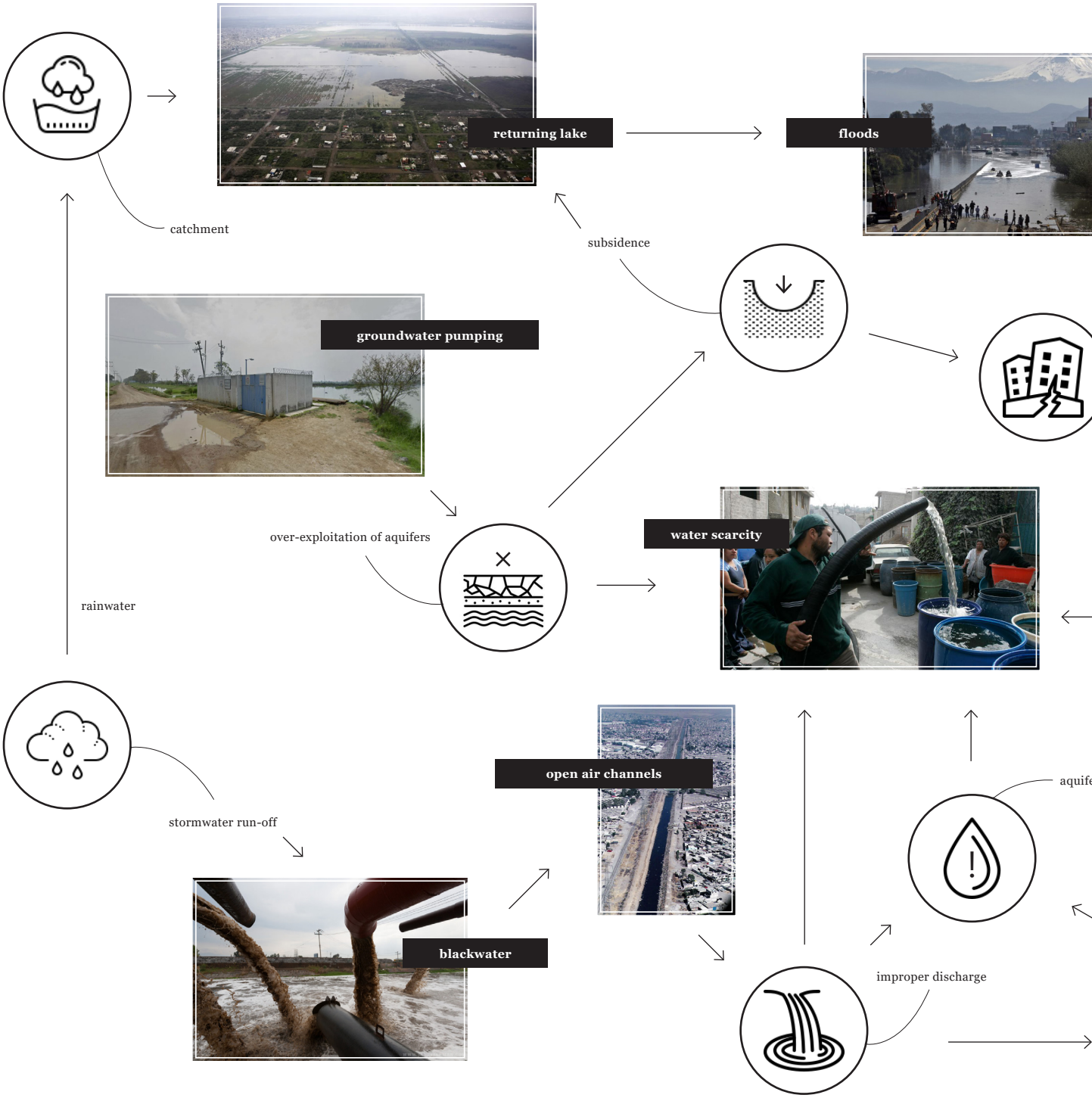


figure 3.4 [spread]:
crises matrix -
the case for water resilience

lake expansion

land lost to flooding

property damage

cracks

urban equity slump

loss of farm land

degrading water infrastructure

socio-economic decline

er contamination

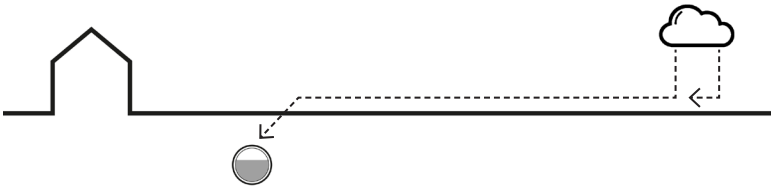
catastrophe

soil deterioration

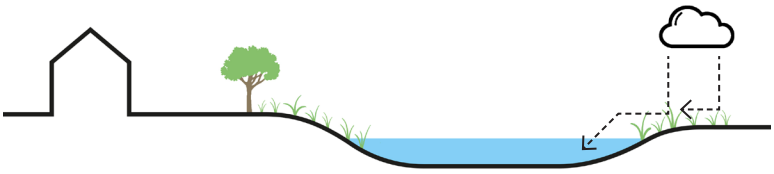
loss of farm land

deficits in crop yield

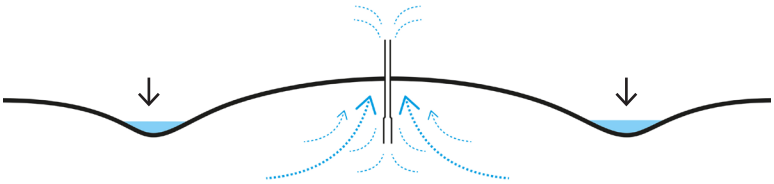
stormwater run-off
mixed with sewage



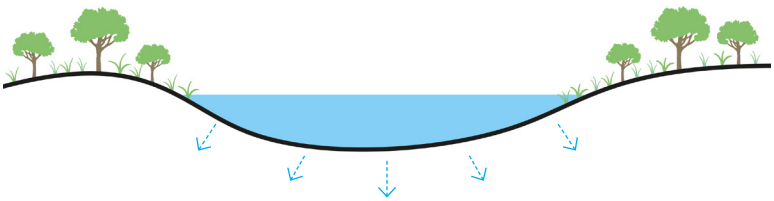
rain water catchment
and retention



groundwater extraction
and subsidence



returning lake could be a
reservoir for supply and
groundwater recharge



flood vulnerability and open air
sewage canal overflow

re-profiling the urban edge
- levee to regulate flooding

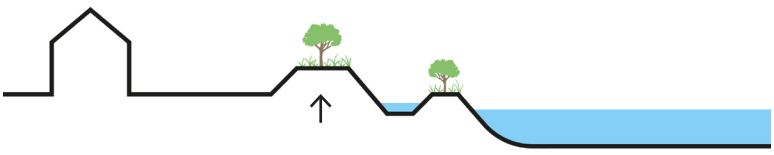
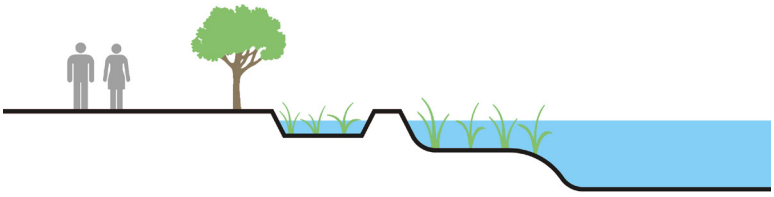
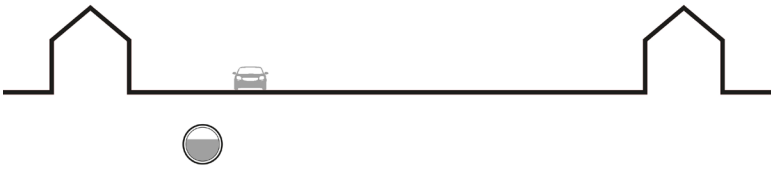


figure 3.5 [spread]:
best practices for water resilience

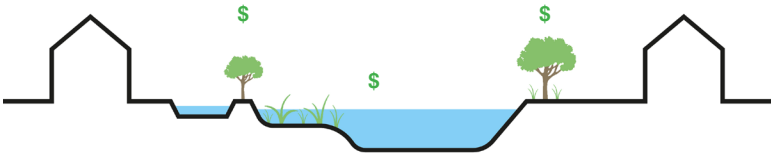
untreated sewage discharge



wetland ecosystems naturally remediate contaminated water



grey infrastructure



green infrastructure to provide ecosystem services

low-lying farmland vulnerable to flooding

hydro-agrarian systems - chinampas

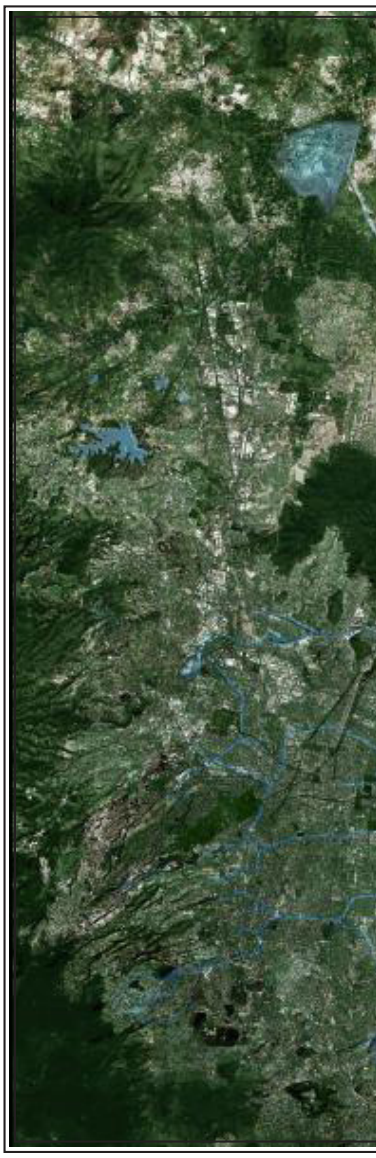


figure 3.6 [spread]:
kalach's proposal propositioned ideas to restore all of mexico city's lakes to create an interconnected hydrological system that is reminiscent of the prehispanic era.

Developed by architects - Alberto Kalach and Teodoro González de León, the Lakeside City ("La Ciudad Lacustre") project proposed a comprehensive regeneration masterplan that sought to recover the desiccated Lake Texcoco as a response to the looming water crisis in Mexico City[14]. The masterplan proposed strategies to collect rainwater, as well as efficiently discharge treated sewage to restore and regenerate the former lake. The restored lake would eventually span over 17,000 acres, and could potentially spur urban regeneration in the City's impoverished districts. The proposal also propositioned ideas to create an interconnected hydrological system to recover all of Mexico Valley's lakes including Lake Chalco and Lake Xochimilco[15] as highlighted in Figure 3.6. This would enable a cyclical utilization of the region's water resources in a manner that is reminiscent of the prehispanic era. The Lakeside City project failed to actualize in any meaningful manner due to the lack of political backing. However, the ideas and strategies presented in this project highlights latent scope for regenerating lacustrine ecologies to combat the existing water crisis. As a region that receives yearly rainfalls that far exceed its potable water demand, Chalco is presented with a unique opportunity to harvest the returning lake and its surrounding areas to create a self-sufficient model for the cyclical utilization of local water resources[16]. In addition to potentially improving the local population's living conditions, it could also alleviate the stresses imposed on aquifers by excessive groundwater pumping. Many of the water related issues faced by the region such as land subsidence, black-water flooding, and water scarcity could be resolved by expanding the returning lake. Rewilding Lake Chalco will help create resilient self-organizing systems that adapt to changing underlying conditions, thus enabling a viable and ecologically sustainable future for all.

14 Ballenger, Stephanie. Review of Dreaming of Dry Land: Environmental transformation in colonial Mexico City, by Vera Candiani. Journal of Colonialism and Colonial History 18, no. 1 (2017) doi:10.1353/cch.2017.0006.

15 Bose, Shumi. 'Meet the Architect Who Wants to Return Mexico City to Its Ancient Lakes'. the Guardian, 13 November 2015. http://www.theguardian.com/cities/2015/nov/13/alberto-kalach-return-mexico-city-ancient-lakes.

16 Chelleri, L., T. Schuetze, and L. Salvati. 2015. "Integrating Resilience With Urban Sustainability In Neglected Neighborhoods: Challenges And Opportunities Of Transitioning To Decentralized Water Management In Mexico City". Habitat International 48: 122-130. doi:10.1016/j.habitatint.2015.03.016.

figure 3.7 [left]:
returning species: over 60 species of migratory aquatic and land birds have returned to the region since the lake has re-emerged.

The term ecosystem services refer to the wide range of both direct and indirect benefits provided by natural ecologies to humans. These services cover a wide spectrum of benefits that include provisioning services, regulating services, habitat services and cultural services[17]. Prior to the desiccation of Lake Chalco, wetland ecologies that encompassed the lake provided a wide range of ecosystem services that was crucial for maintaining ecosystem integrity in the region. As part of a complex lacustrine ecology, wetlands acted as sponges for excess water, and served as a natural regenerative buffer between people and water. The lacustrine ecology also included a diverse range of endemic flora and fauna that thrived by forging symbiotic relationships with the lake. The desiccation of Lake Chalco unleashed a cycle of regressive ecological degradation that has led to most of the endemic species being critically endangered. The bowl-like depressions where the lake once stood have been artificially fabricated as plains to make way for commercial agriculture and urban settlements[18]. The restoration of Lake Chalco to improve water resilience has to be accompanied by rewilding former wetland ecosystems in order to achieve ecosystem integrity in the region.

As illustrated in Figure 3.8, wetland ecologies provide critical ecosystem services that would address the various crises that the region faces today. This includes its capacity to act as sponges that passively absorb, filter and retain water. Wetlands are also critical for sediment regulation, nutrient cycling, and rebuilding organic matter in the soil. This will promote natural regeneration and also provide habitats for a wide range of species, thus improving biodiversity. Other ecosystem services provided by wetlands include water treatment through natural remediation, allowing groundwater infiltration, and serving as a buffer that would protect urban areas from floods and storms. By providing efficient outlets for peak storm-water discharges, wetland ecologies could potentially reduce economic loss from flooding by 39 to 46%[19]. Wetland flora serves a critical role in climate change mitigation by sequestering carbon, and also carries eco-tourism potential for its aesthetic, recreational and cultural value. The schematic section in Figure 3.9 illustrates the diversity of species that make up a typical coastal wetland ecosystem. Regenerating wetland ecosystems would promote the recovery of the lake by creating landscapes that are flexible to changing water levels.

17 Robertson, Morgan M. "The Nature That Capital Can See: Science, State, and Market in the Commodification of Ecosystem Services." Environment and Planning D: Society and Space 24, no. 3 (June 2006): 367–87. https://doi.org/10.1068/d3304.

18 Ballenger, Stephanie. Review of Dreaming of Dry Land: Environmental transformation in colonial Mexico City, by Vera Candiani. Journal of Colonialism and Colonial History 18, no. 1 (2017) doi:10.1353/cch.2017.0006.

19 O'Neill, Sara Jane, and Stephanie Cairns. 2016. "New Solutions For Sustainable Stormwater Management In Canada". Sustainable Property. https://institute.smartprosperity.ca/sites/default/files/stormwaterreport.pdf.

sustainable water cycles

stormwater catchment

SPONGE CITY

freshwat

soil & sediment
regulation

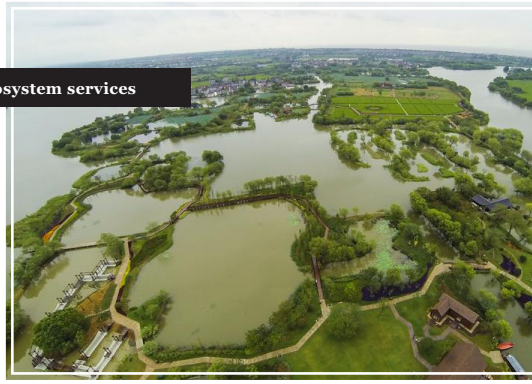
lake expansion

nutrient cycling

aquifer recharge

passive absorption &
water treatment

provisioning ecosystem services



rebuilding soil
organic matter

NATURAL REGENERATION

figure 3.8 [spread]:
functions matrix -
the case for rewilding wetland ecologies

climate change mitigation

cultural & heritage value

recreational value

aesthetic value

er reservoir

carbon sequestration

flood & storm protection

conservation &
preservation

ecotourism potential

WETLAND / LACUSTRINE
ECOLOGIES

aquaponics &
aquaculture

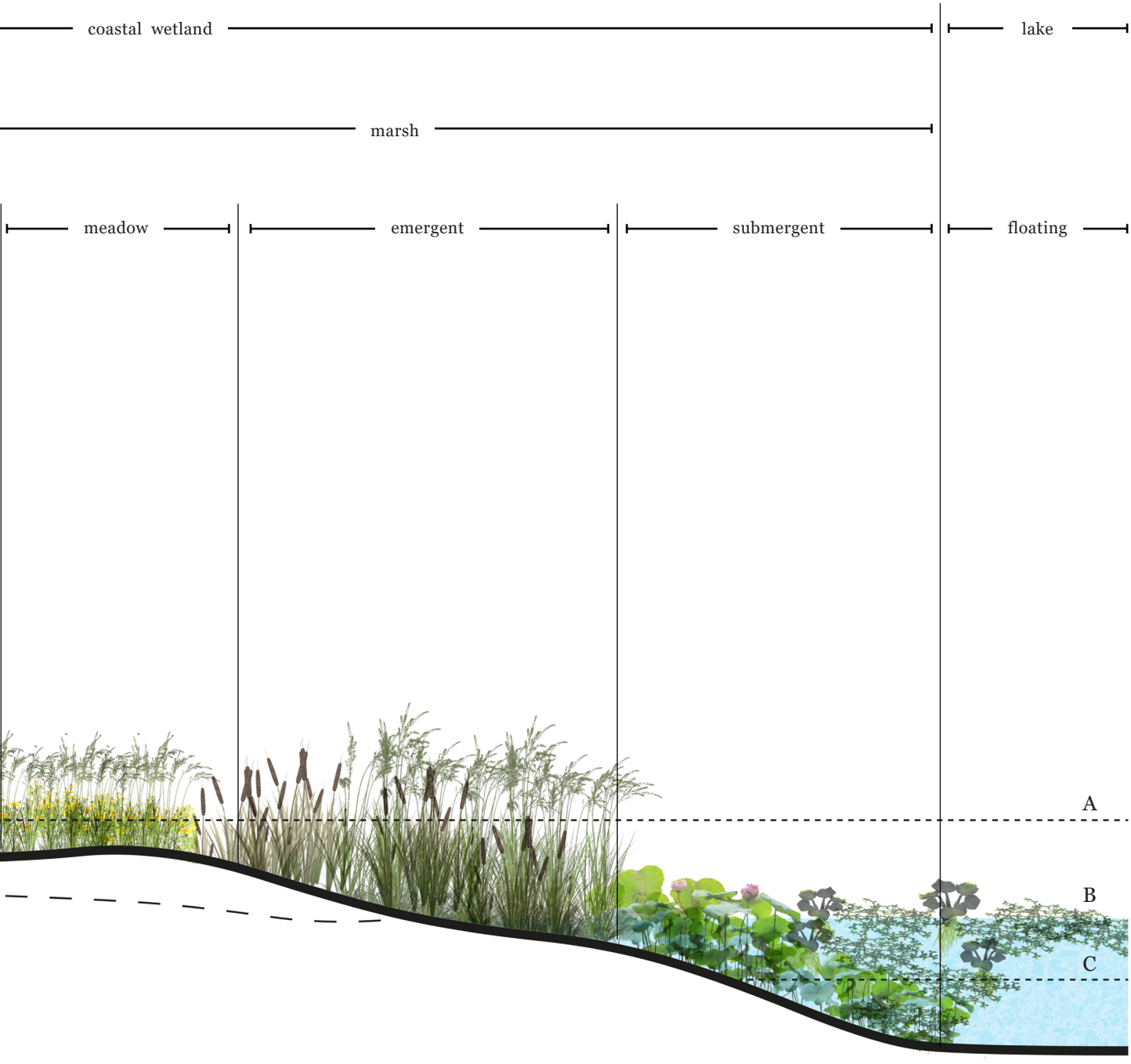
ecological parks

reintroduction of
native species

AXOLOTL

improved habitat & biodiversity

figure 3.9 [spread]:
schematic section -
wetland vegetation hierarchy


coastal wetland
lake
marsh
meadow
emergent
submergent
floating
A
B
C

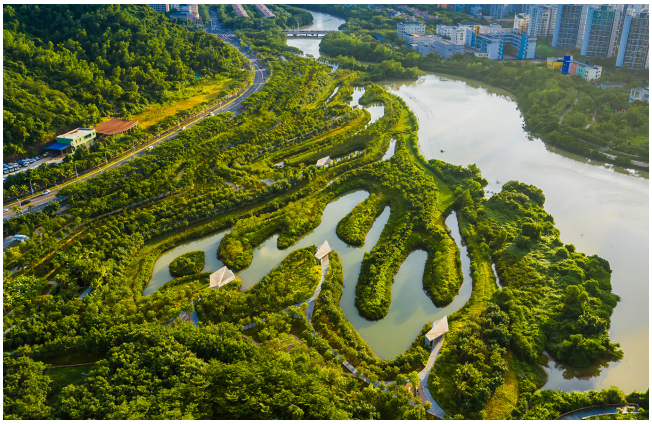


figure 3.10 [spread]:
examples of sponge cities designed by kongjian yu (turenscape) in major cities across china.

In an article published by the Guardian, Amy Fleming makes a case for embracing nature-based indigenous systems to address the crises we face today. She argues that contemporary built environments reinforce an unhealthy disconnect between humans and nature. As a result, urban landscapes of today are increasingly vulnerable to adverse weather conditions, storms and floods, as well as pollution and carbon overloads. In contrast, indigenous systems relied on symbiotic interactions between humans and nature to creating resilient socio-ecological landscapes[20]. Over the past couple of decades, Kognjian Yu of Turenscape China has designed a network of Sponge Cities across China that reintroduces wetland ecologies to the city. Sponge Cities rely on integrated systems of green, blue and gray infrastructure to improve ecological resilience and provide key ecosystem services. In addition to passively absorbing and retaining rainwater, these urban wetlands also alleviate environmental stresses caused by floods and droughts. The wetlands can also clean wastewater through natural remediation processes and provide soft permeable mediums for aquifer recharge. It also improves biodiversity in urban environments by bringing plants, birds, and fishes back to the city[21]. The return of the lake in Chalco offers a chance to reintroduce wetland ecologies to the urban fabric. As opposed to colonial era water infrastructure which relies on appropriation of natural environments for extraction, wetlands could provide viable ecological solutions to drainage, wastewater treatment, flood resilience, and food security.

20 Fleming, Amy. 2020. "The Case For ... Making Low-Tech 'Dumb' Cities Instead Of 'Smart' Ones". The Guardian. https://www.theguardian.com/cities/2020/jan/15/the-case-for-making-low-tech-dumb-cities-instead-of-smart-ones.

21 Saunders, William S, and Kongjian Yu. 2012. Designed Ecologies. The Landscape Architecture Of Kongjian Yu. Basel: Birkhäuser Verlag.

figure 3.11 [above]:
chinampa agriculture in xochimilco, mexico city

Regenerative agriculture refers to a system of sustainable farming techniques that puts emphasis on rehabilitating and improving ecosystems. It relies on principles that promotes land regeneration by focusing on soil health, efficient water management, micro-climates, and cyclical utilization of organic matter[22]. Chinampa agriculture is one of the oldest regenerative agricultural systems in the world. Prior to colonization, Lake Chalco was covered by chinampas - which relied on lacustrine resources to create one of the most productive agricultural systems in the world[23]. Following the desiccation of the lake, the chinampas were destroyed and the former lake-bed was artificially fabricated to enable large-scale commercial agriculture. However, not all chinampas in the Mexico Valley Basin were destroyed by colonists. There is history of uninterrupted chinampa agriculture in the region of Xochimilco, which lies a few miles to the west of Chalco. Figure 3.12 compares and contrasts contemporary mono-crop agriculture in Chalco to chinampa agriculture in Xochimilco. Prevalent agricultural practices in Chalco exploits groundwater for irrigation and relies on chemical fertilizers for nutrients. They are susceptible to droughts and other calamities, and the persistent use of chemicals to improve yields causes severe soil degradation. This leads to the eventual ecological succession of agricultural land to brownfield grasslands[24]. In contrast, chinampa agriculture is regenerative in nature. As illustrated in Figure 3.13, chinampas are composed of raised beds fabricated by alternating layers of decomposing aquatic plants with highly fertile lake sediment. The ensuing soil substrate is soft and permeable, thus allowing natural drainage and irrigation. Trees planted on the edge of chinampa beds anchor the soil sediment, thus strengthening the chinampa's foundation and preventing soil erosion. They also regulate micro-climates by raising humidity and creating channels of warmer air underneath its canopy. The canals in a chinampa system are able to retain water from rainfall and is rich with nutrients, thus reducing dependence on mechanical irrigation from groundwater. In addition to providing habitats for aquatic species, detritus and sediment from the canal bed is used as fertilizer for agriculture. Up to 7 crops can be harvested every year on a single bed through effective crop rotation. This includes maize, flowers, vegetable and a variety of grains[25].

22 Rhodes, Christopher J. "The imperative for regenerative agriculture." Science Progress 100, no. 1 (2017): 80-129.

23 Morehart, Christopher and Charles Frederick. "The Chronology and Collapse of Pre-Aztec Raised Field (Chinampa) Agriculture in the Northern Basin of Mexico." Antiquity 88, no. 340 (2014): 531-548.

24 Alexander, Rani T., Janine Gasco, and Judith Francis Zeitlin. "Agrarian Ecology and Historical Contingency in Landscape Change." Colonial and Postcolonial Change in Mesoamerica: Archaeology as Historical Anthropology (2018): 53.

25 Merlín-Uribe, Yair, Carlos E. González-Esquivel, Armando Contreras-Hernández, Luis Zambrano, Patricia Moreno-Casasola, and Marta Astier. "Environmental and socio-economic sustainability of chinampas (raised beds) in Xochimilco, Mexico City." International Journal of Agricultural Sustainability 11, no. 3 (2013): 216-233.

chinampa agriculture

v/s

supports aquaponics

relies on organic biomass

ecologically regenerative

canals enable nutrient cycling

farming on low-lying flood prone areas

climate change resilient

water retention & reuse

facilitates groundwater recharge

habitats for other species

facilitates expansion of lake chalco

wetland ecosystems regeneration

community engagement

ecotourism potential

perennial farming

sustains crop rotation

heritage & cultural value

monocrop agriculture

threatened by
the expansion
of the lake

seasonal agriculture

high water consumption
and waste

relies on
chemicals for
nutrients

groundwater
exploitation for
irrigation

contamination of
aquifers and natural
hydrology

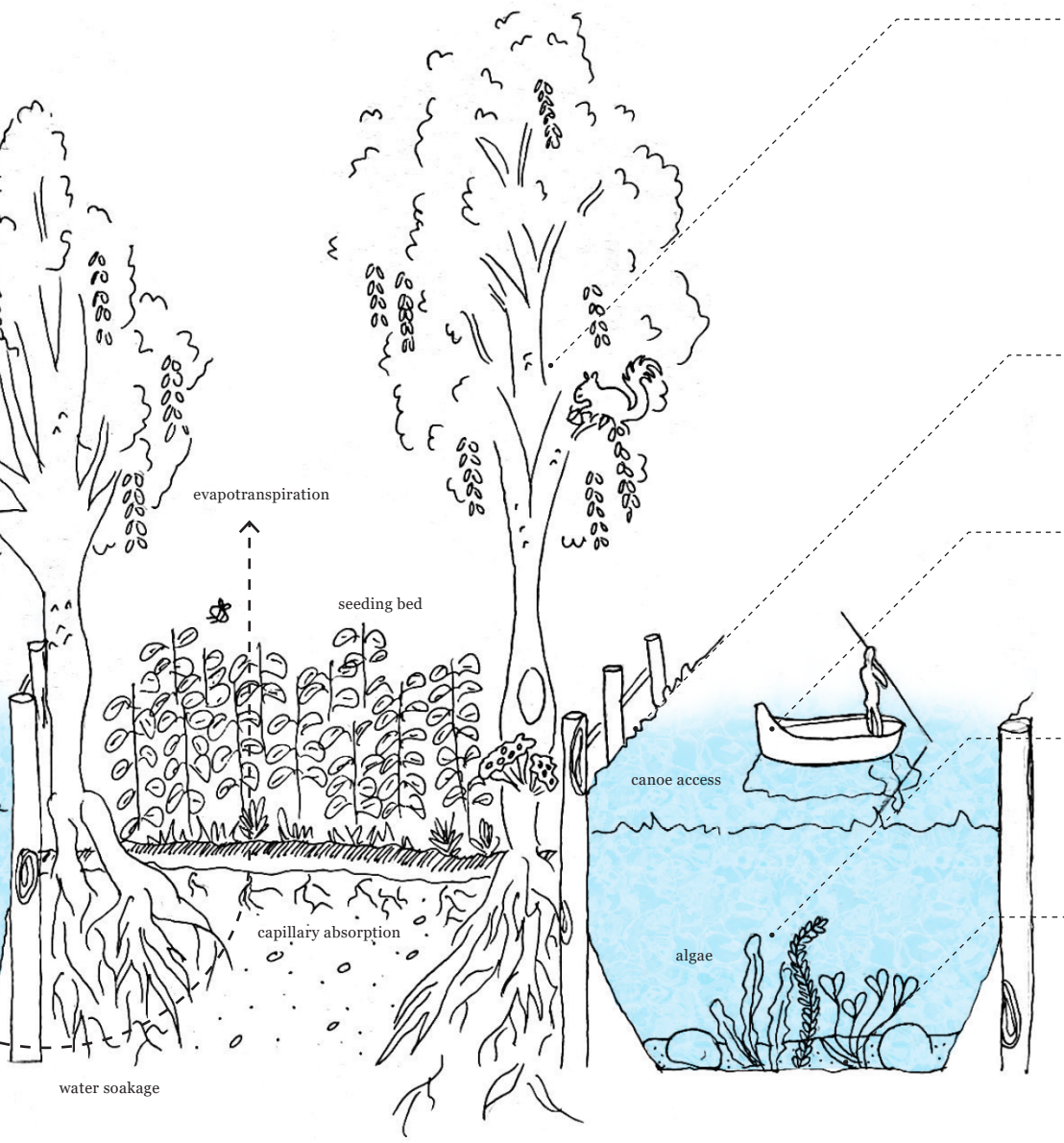
extremely susceptible to
droughts and other calamity

soil degradation and
contamination

potential ecological
succession to grasslands

figure 3.12 [spread]:
diagram -
the case for chinampa agriculture

figure 3.13 [spread]:
section sketch
chinampa agriculture



trees regulate micro-climates by raising humidity and creating channels of warmer air underneath its canopy. this enables all year-round farming without the use of expensive row covers or greenhouses.

mounded edges with useful weeds and crops preventing erosion and regulating biological control.

the canals are able to retain water from rainfall, and is rich with nutrients, thus reducing dependence on mechanical irrigation from groundwater.

habitat for aquatic species like algae and fish that could sustain an aquaculture program.

fertile detritus and sediment from the canal bed is used as fertilizer for agriculture.

Case study: Xochimilco, Mexico City

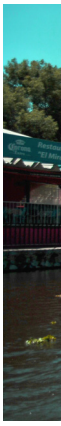


figure 3.14 [spread]:
images of chinampa islands, canals, wetlands and ecotourism initiatives in xochimilco, mexico city.

The region of Xochimilco is a unique socio-ecological landscape in contrast to dense urban environments of Mexico City. Its fabric consists of acres of chinampa beds interspersed between deep canals and wetlands. For centuries, indigenous communities in Xochimilco have tenaciously resisted colonial appropriation and the elimination of water from their lands. Their persistence played a big part in the preservation and eventual revival of lacustrine ecologies in contemporary Xochimilco. Today, the region is officially recognized as a UNESCO Heritage site. Xochimilco also provides 20% of potable water for Mexico City in addition to economic benefits from community agriculture and eco-tourism programs[26]. In the 80s, Xochimilco underwent a decade of restoration work and was finally opened to the public in 1993. The rehabilitated ecological park in Xochimilco includes over 6000 acres of wetlands and chinampas and over 100 miles of canals. Agriculture in Xochimilco is reminiscent of prehispanic era farming, wherein local communities grow a variety of crops on chinampa islands using regenerative techniques and the efficient use of water resources. Chinampa agriculture in Xochimilco is not scalable at industrial production levels. Instead, it is driven by a Community Supported Agriculture (CSA) program that focuses on long-term sustenance. CSAs in Xochimilco rely on a small-scale production model that regularly supplies organic and locally sourced produce to a variety of restaurants and local consumers in the city. Xochimilco also generates significant revenue from an extensive eco-tourism program that is supported by small-businesses and a cohesive local community[27].

26 France RL. Restorative Redevelopment of Devastated Ecocultural Landscapes. Boca Raton: CRC Press; 2011.

27 Dieleman, Hans. "Urban agriculture in Mexico City; balancing between ecological, economic, social and symbolic value." Journal of Cleaner Production 163 (2017): S156-S163.

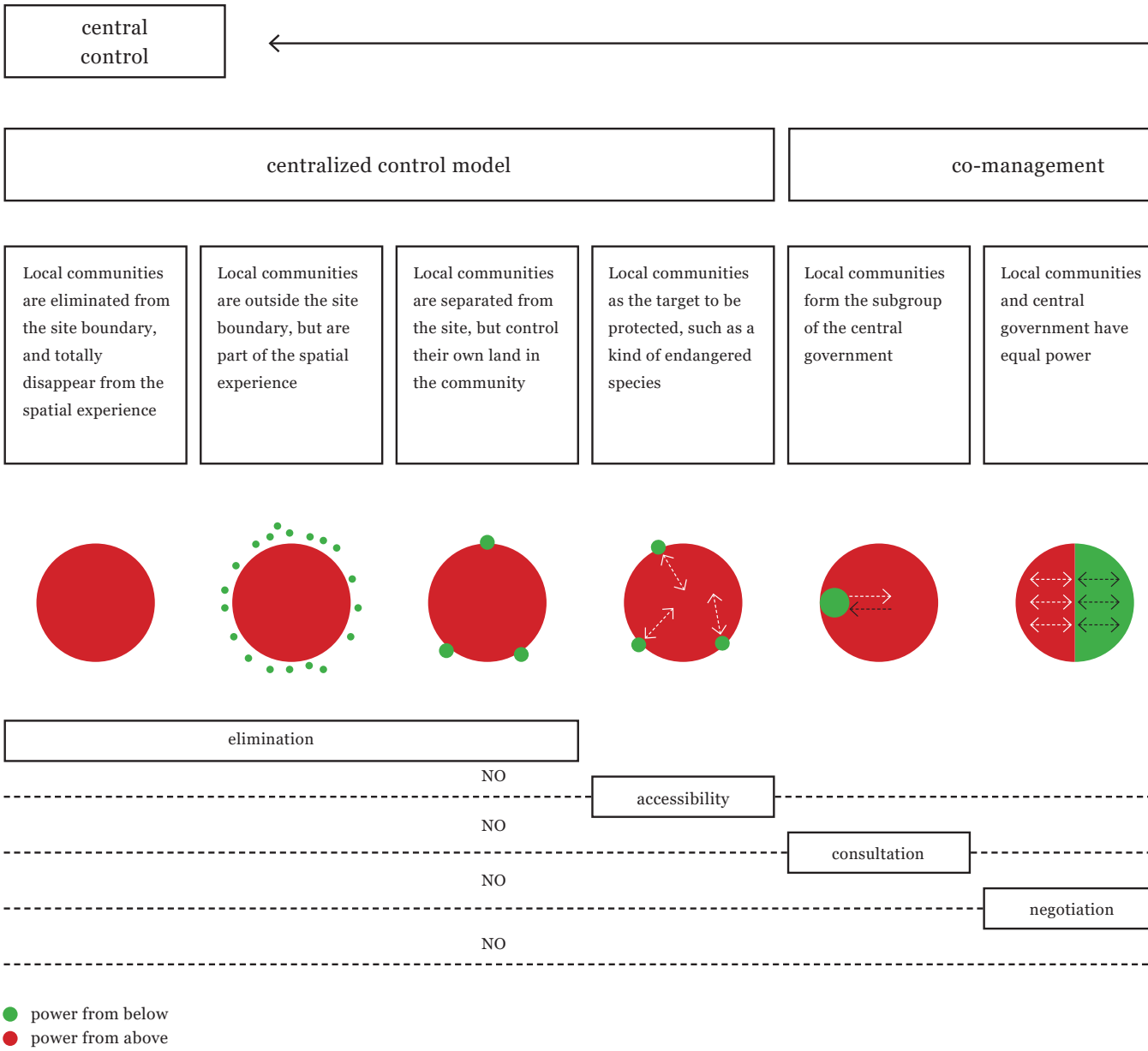
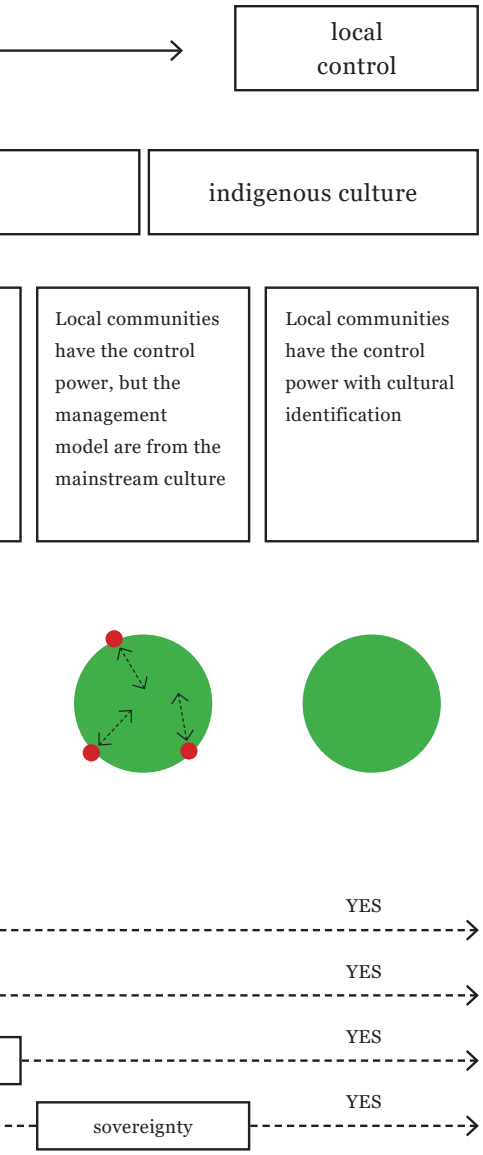


figure 3.15 [spread]:
ownership & control typologies diagram



In spite of its rapid urban transformation over the past few decades, the region of Chalco has significant potential for a transition to ecologically sustainable model of development. Chalco's potential lies in its relatively unique underlying social conditions. This includes the availability of large open space both within and outside urban zones, the prevalence of small-scale community-based enterprises, and high rates of individual property ownership. Almost 90% of households in Chalco hold tenure to their property. In addition, local communities in Chalco have also shown strong levels of social cohesion, which is a critical aspect for the success of ecological building capacities at an urban scale[28].

Currently, protected areas in Chalco follow a centralized control model (Figure 3.15), which applies to national parks, ecological zones, and agricultural areas[29]. Centralized control models have little to no involvement from local communities and is entirely controlled by the central government (in this case, the State of Mexico). This is evident in the system of agricultural ejidos in Chalco, wherein the local community members have usufruct rights rather than ownership rights to land. Land practices in the area are also influenced by corruption amongst government official. This has led to the imposition of strict constraints on community driven initiatives that seek to enhance ecological and social well-being[30]. With the presence of an active and cohesive local community in Chalco, a case could be made to implement a system of co-management wherein local communities and the state have shared access to the site. This would prevent existing protected areas from being urbanized due to pressure from the real-estate developers. Social capital refers to efficient networks and organizations among people who live and work within the local community[31]. As illustrated in Figure 3.16, the effective functioning of a socio-ecological program relies on symbiotic interactions between humans, nature, and built environments. The success of socio-ecological interventions will require an efficient network of natural and spatial mediums that build social capital. These mediums could manifest as ecological parks, chinampas, infrastructure, community hubs, and ports for logistics and access. It will also allow for the formation of community supported agriculture and eco-tourism programs (similar to Xochimilco) that could sustain ecological regeneration and spur economic growth.

28 Chelleri, L., T. Schuetze, and L. Salvati. 2015. "Integrating Resilience With Urban Sustainability In Neglected Neighborhoods: Challenges And Opportunities Of Transitioning To Decentralized Water Management In Mexico City". Habitat International 48: 122-130. doi:10.1016/j.habitatint.2015.03.016.

29 France RL. Restorative Redevelopment of Devastated Ecocultural Landscapes. Boca Raton: CRC Press; 2011.

30 Llano, Pedro de. 2017. Maria Thereza Alves. The Long Road To Xico / El Largo Camino A Xico, 1991-2015. Berlin: Sternberg Press.

31 Dinda, Soumyananda. "Social capital in the creation of human capital and economic growth: A productive consumption approach." The Journal of Socio-Economics 37, no. 5 (2008): 2020-2033.

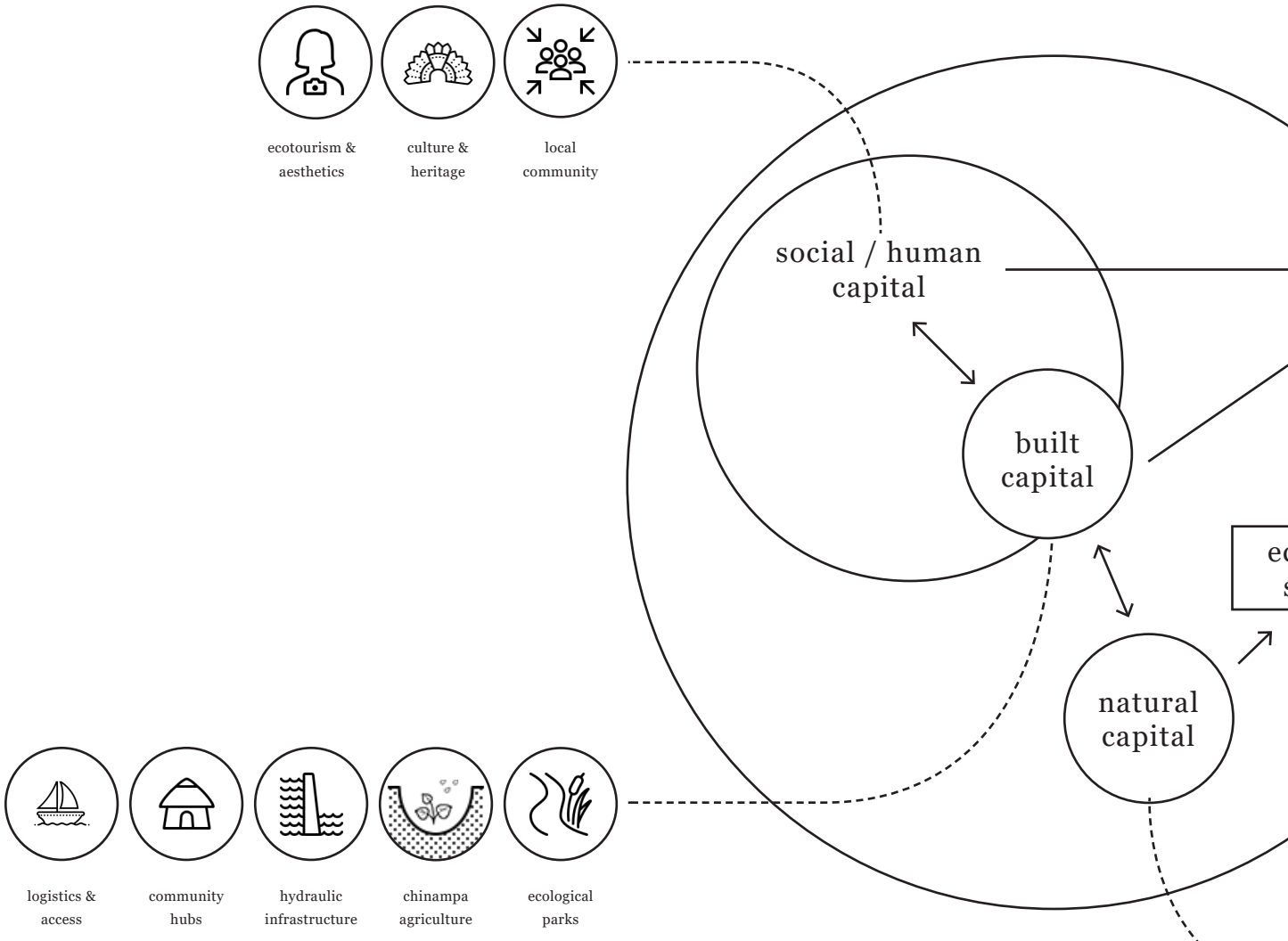
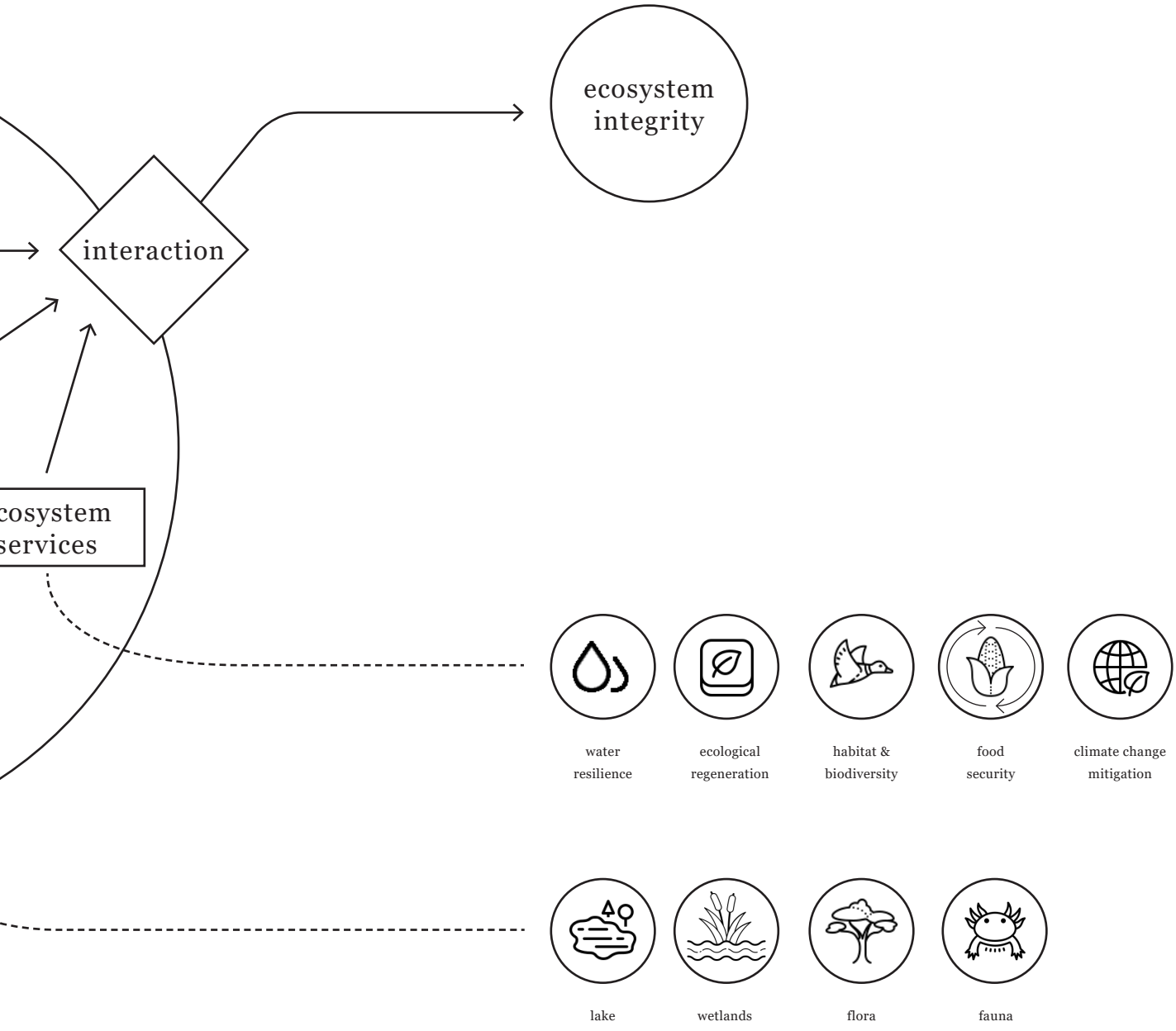


figure 3.16 [spread]:
relationship diagram -
interactions for ecosystem integrity


ecosystem integrity
interaction
cosystem services
water resilience
ecological regeneration
habitat & biodiversity
food security
climate change mitigation
lake
wetlands
flora
fauna

Case study: Xico Community Museum, Valle de Chalco

figure 3.17 [above]: images depict various initiatives undertaken by the museum. this includes alves's historic model of colonization in the region (top), re-creation of a prehispani-era chinampas (middle), and organizing community meetings for social engagement (bottom).

figure 3.18 [left]: poster for an event organized by the Xico Community Museum that lobbies for proposals to revive the former lacustrine ecology.

Over the years, indigenous communities of Xico have developed a substantial network of grassroots initiatives led by local communities, NGOs, academics, artists, and autonomous political organizations. These initiatives are mobilized through the Xico Community Museum. With the return of the lake, an ecologically motivated form of resistance has spawned among local community members. For indigenous communities in Chalco, the return of the lake offers a hopeful possibility to 'write back' six centuries of damage imposed by colonial power structures. The Community Museum is therefore driven by a sustainable agenda that lobbies for concrete proposals to realize political self-determination, the recovery of the lacustrine systems, and sovereignty over natural resources[32]. The Museum's sustainability agenda has manifested in various forms that challenge the exploitative nature of colonial power structures. Various real-estate proposals in the area have been met with strong resistance and are subsequently called off because of the Museum's community outreach. They have also launched public campaigns such as "Water of the Basin for the Basin" that demands for the decommissioning of groundwater extraction stations on the returning lake. They have formed committees that are engaged in clearing human waste from the lake and beautifying its surroundings. This has enabled a large number of species of flora and fauna to return to the site[33]. In the year 2009, the Museum collaborated with Brazilian artist Maria Thereza Alves to publish, install and exhibit a series of works that focused on highlighting indigenous heritage in the region, and challenge colonial counter-narratives. One element of their work involved the re-creation of the prehispanic chinampa. The chinampa is symbolic of a forgotten socio-ecological landscape that was desecrated by dominant colonial practices. According to Alves, recreating the Chinampa is akin to "unearthing different voices" which constitute indigenous heritage. Through the act of re-creation, the Museum is able to lay out an ethnography for the continued existence of indigenous heritage through community engagement, social research, and colonial resistance. In addition to the re-creation of the Chinampa, Alves also designed an elaborate installation of models that delineate the impact of colonial practices in the region. Her work has been exhibited across the world through lectures, exhibitions, and academic publications[34]. The Xico Community Museum is a testament to the importance of social capital in mobilizing actions that seek to decolonize the returning lake. The Museum's various initiatives have invoked a new way of living that relies on social and environmental engagement to advocate for a reparation ecology in Chalco.

32 Emmelhainz, Irmgard. 2017. "Chronicle Of A Visit To The Museo Comunitario Del Valle De Xico, Or: Cultural Solidarity In The Globalised Neoliberal Age". Afterall: A Journal Of Art, Context And Enquiry 43: 46-57. doi:10.1086/692553.

33 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

34 Llano, Pedro de. 2017. Maria Thereza Alves. The Long Road To Xico / El Largo Camino A Xico, 1991-2015. Berlin: Sternberg Press.

iztapalapa
la paz
ixtapaluca
ciudad de méxico
estado de méxico
cumbre cerro el
valle de chalco
tláhuac
1
lago de tlahuác-xico
4
cerro de xico
chalco de díaz
2
xochimilco
lagunas de xico
3
milpa alta

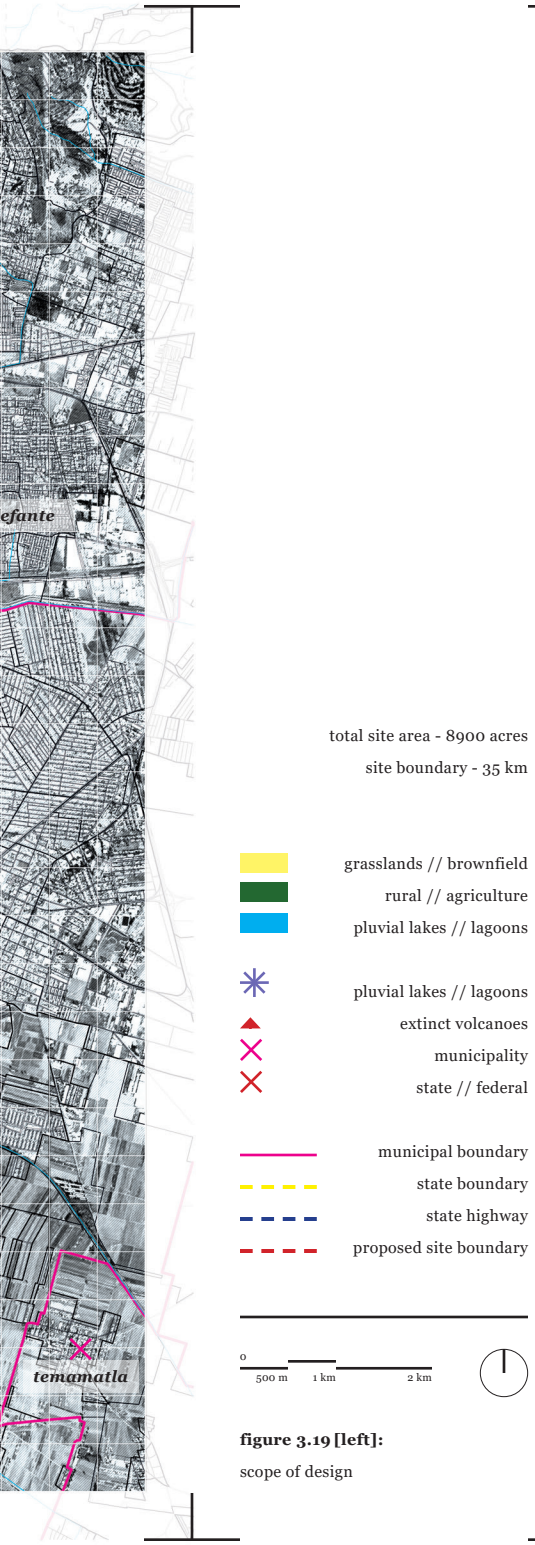


figure 3.19 [left]:
scope of design

Scope of design

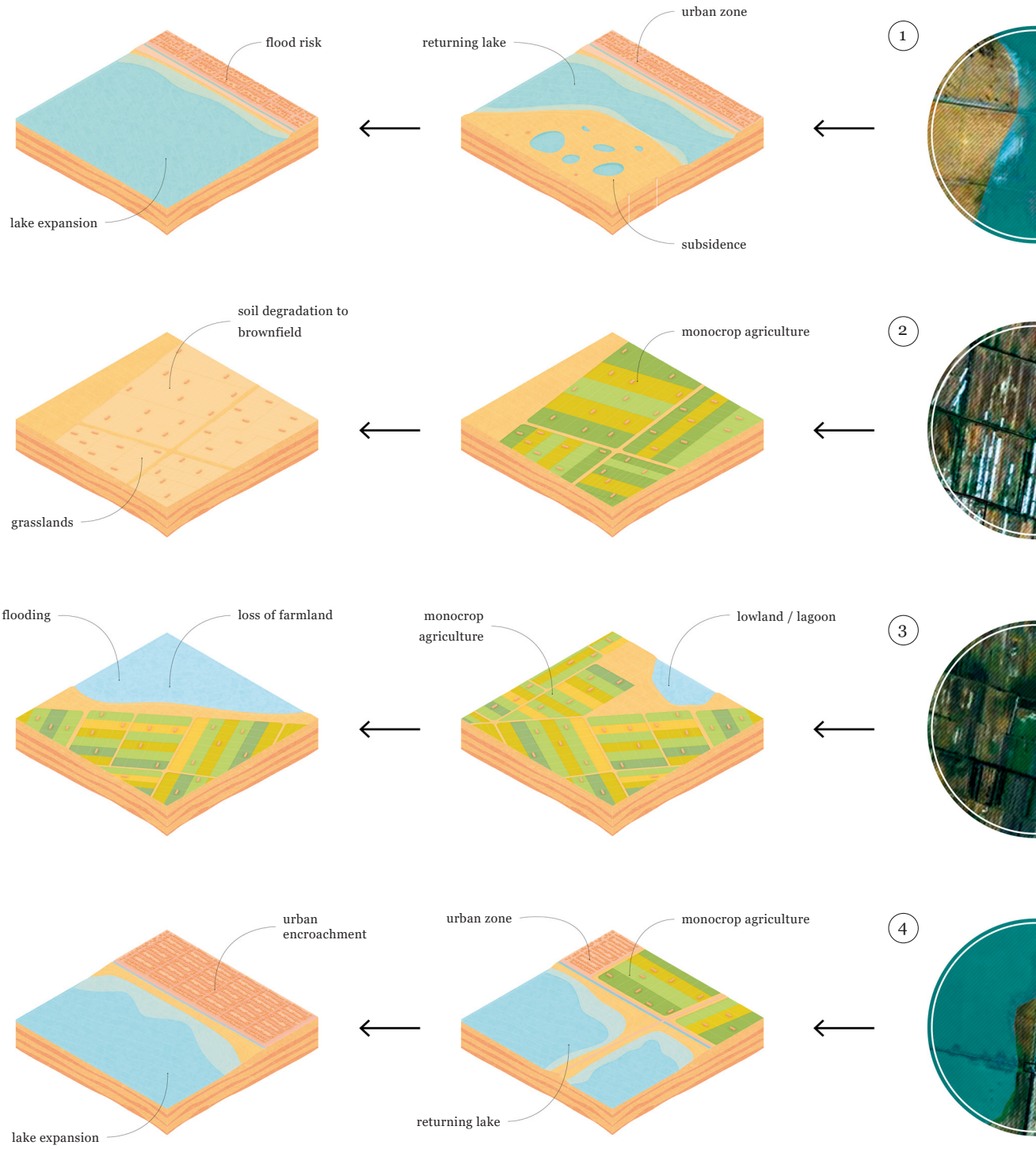
The site will cover a total area of 8900 acres. This includes the returning lake which covers an area of 1300 acres (5 km^2), as well as the Xico Lagoons which fills an area of 120 acres (0.5 km^2). The remainder of the site is occupied by agricultural ejidos and brownfield or grassland areas. The site perimeter extends over 35 km and shares a border with the municipal region of Valle de Chalco on the east and Tláhuac on the west. The state border between Mexico City and the State of Mexico dissects the returning lake, and by extension the site, into two. Also, a state highway divides the returning lake near its southern edge. The extents of the site includes low-lying areas wherein the lake could potentially expand, and also reiterates boundaries around federally protected land. As illustrated in Figure 3.19, four key areas have been identified to represent various underlying conditions that impede the possibility for a viable and ecologically sustainable future in Chalco. The projected ecological succession for these key areas, and by extension the entire site, highlight a wide range of ecological threats that continue to worsen over time. These are listed as follows:

1. In key area 1, returning lake would continue to expand aggravating flood risks for the urban core.
2. In key area 2, persistence of mono-crop agriculture would lead to severe soil degradation, thus rendering the land unusable.
3. In key area 3, accumulation of pluvial waters in low lying areas would lead to the loss of farmland.
4. In key area 4, existing infrastructure on site would be flooded by the expansion of the lake. Also protected agricultural areas would be encroached by urban sprawl.

A designed reparations ecology in Chalco will propose a range of social, environmental, and infrastructural systems to rewild and regenerate the former lacustrine ecology. These systems include functional interventions for regenerating the lake, rewilding wetland ecologies, reintroducing hydro-agrarian systems, and creating social infrastructure to build social capital. As highlighted in Figure 3.21, the effects of a designed ecological succession could potentially alleviate the stresses imposed by the persistent ecological degradation of the site. The following chapter of this thesis will elaborate on these designed succession models in greater detail.

projected succession

current site condition



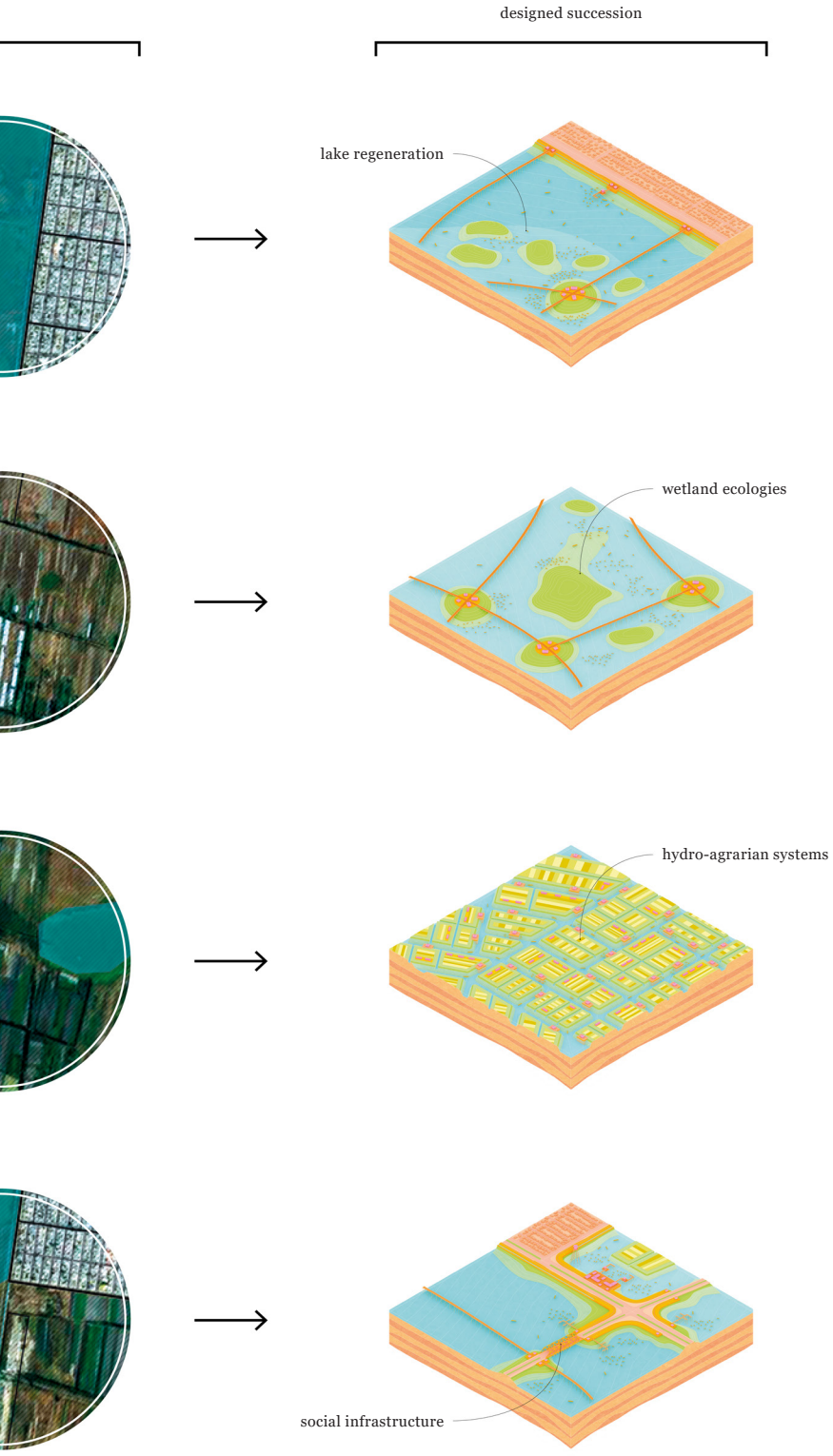


figure 3.20 [spread]:
ecological succession diagram

P IV

“ a reparations ecology carries the potential to offer resilient solutions to various environmental crises that threaten chalco. rewilding and regenerating the returning lake would liberate natural ecologies from enclosures imposed by colonial power structures that impede an ecologically sustainable future for all ”

synthesis:
ecosystem design narratives

Ecosystem design narrative

In this chapter of the thesis, a vision for a reparations ecology in Chalco is presented through a sequential ecosystem design narrative that will include a series of isometric drawings and vignettes. The drawings will highlight designed succession models across the site through various terraforming sequences. The intent is to illustrate how existing underlying conditions and spatial norms can be transformed to create and accommodate self-organizing systems that invoke ecological reparations.

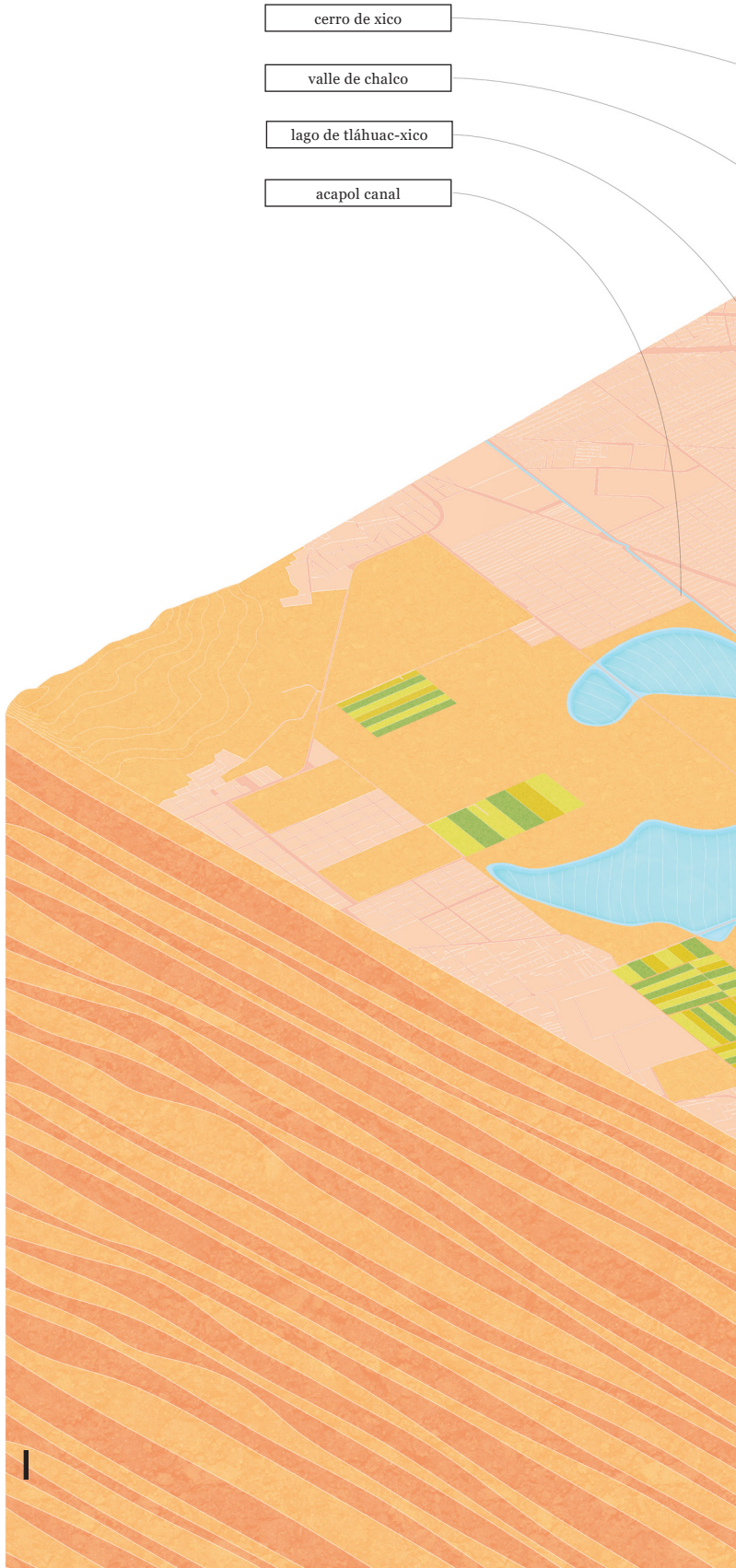
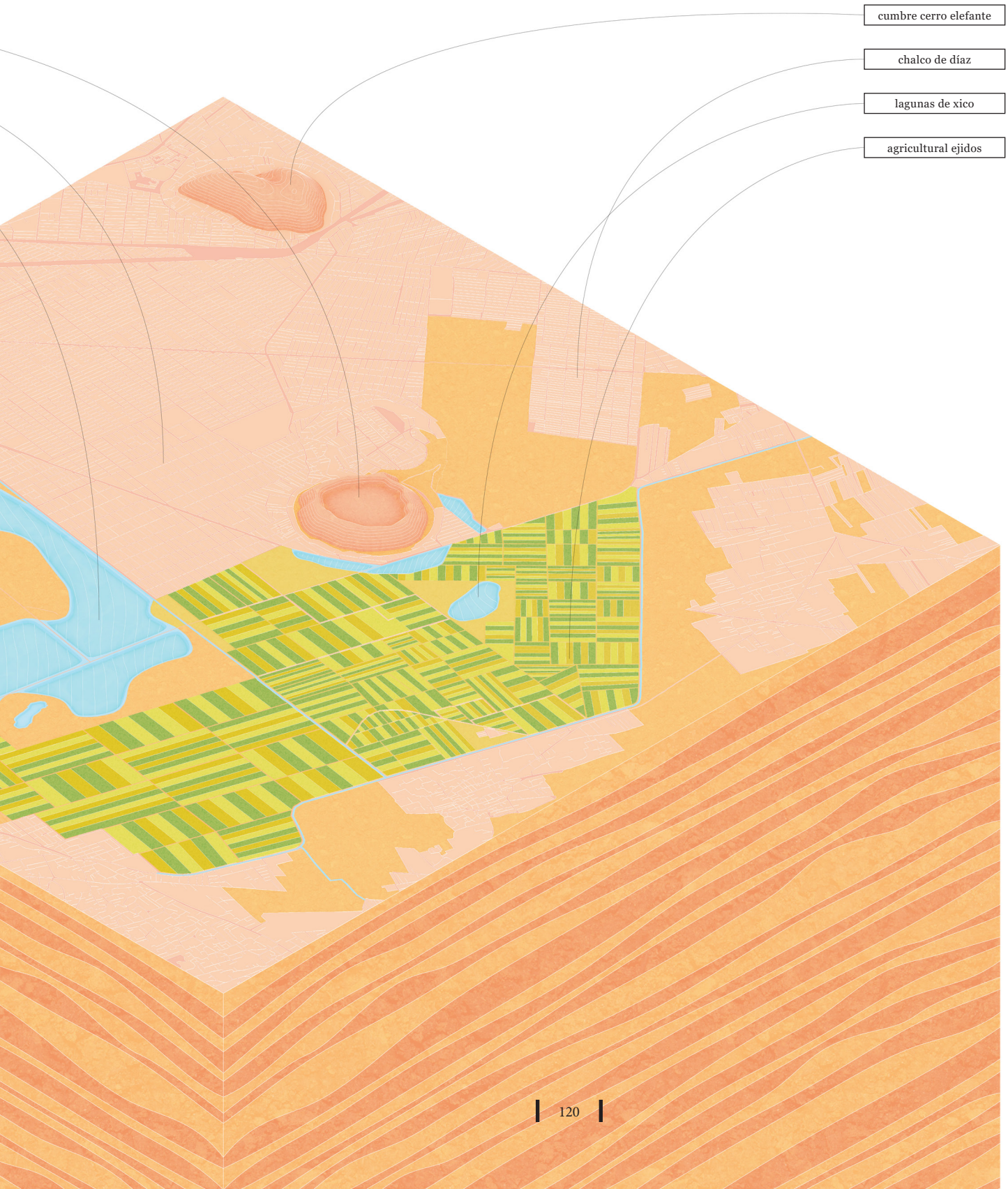


figure 4.1 [spread]:
isometric view
contemporary chalco


cumbre cerro elefante
chalco de díaz
lagunas de xico
agricultural ejidos

The isometric drawings illustrated in Figures 4.1-4.3 represents the region of Chalco across an urban scale of 10 x 10 km. The site boundary covers a total area of 8900 acres (36 km^2) that includes water bodies such as Lake Tláhuac-Xico, Xico Lagoons, and Acapol Canal. The majority of the site is occupied by protected agricultural land. The site is contained by densely populated urban areas and also encompasses large expanses of grasslands or brownfield areas.

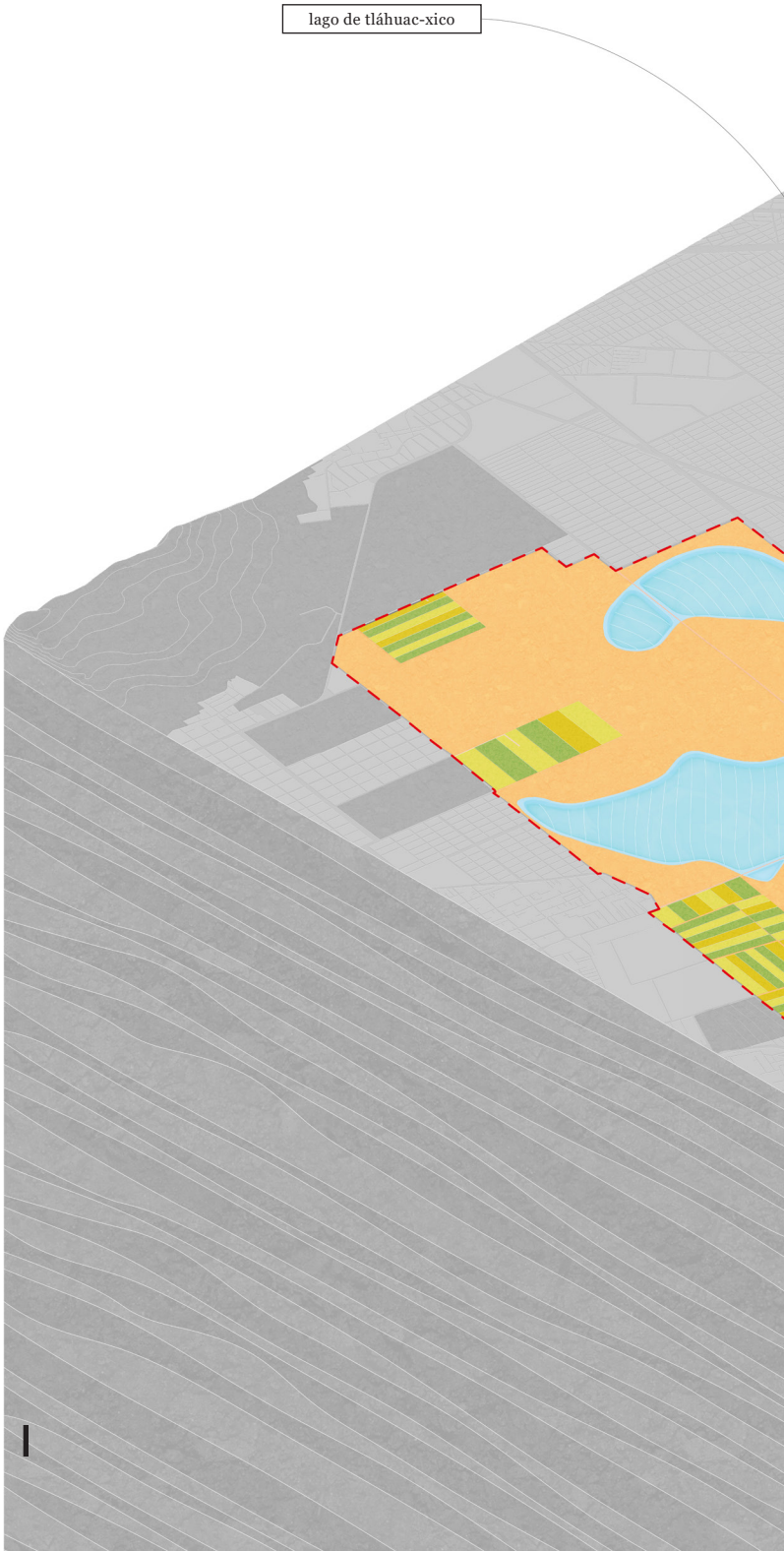
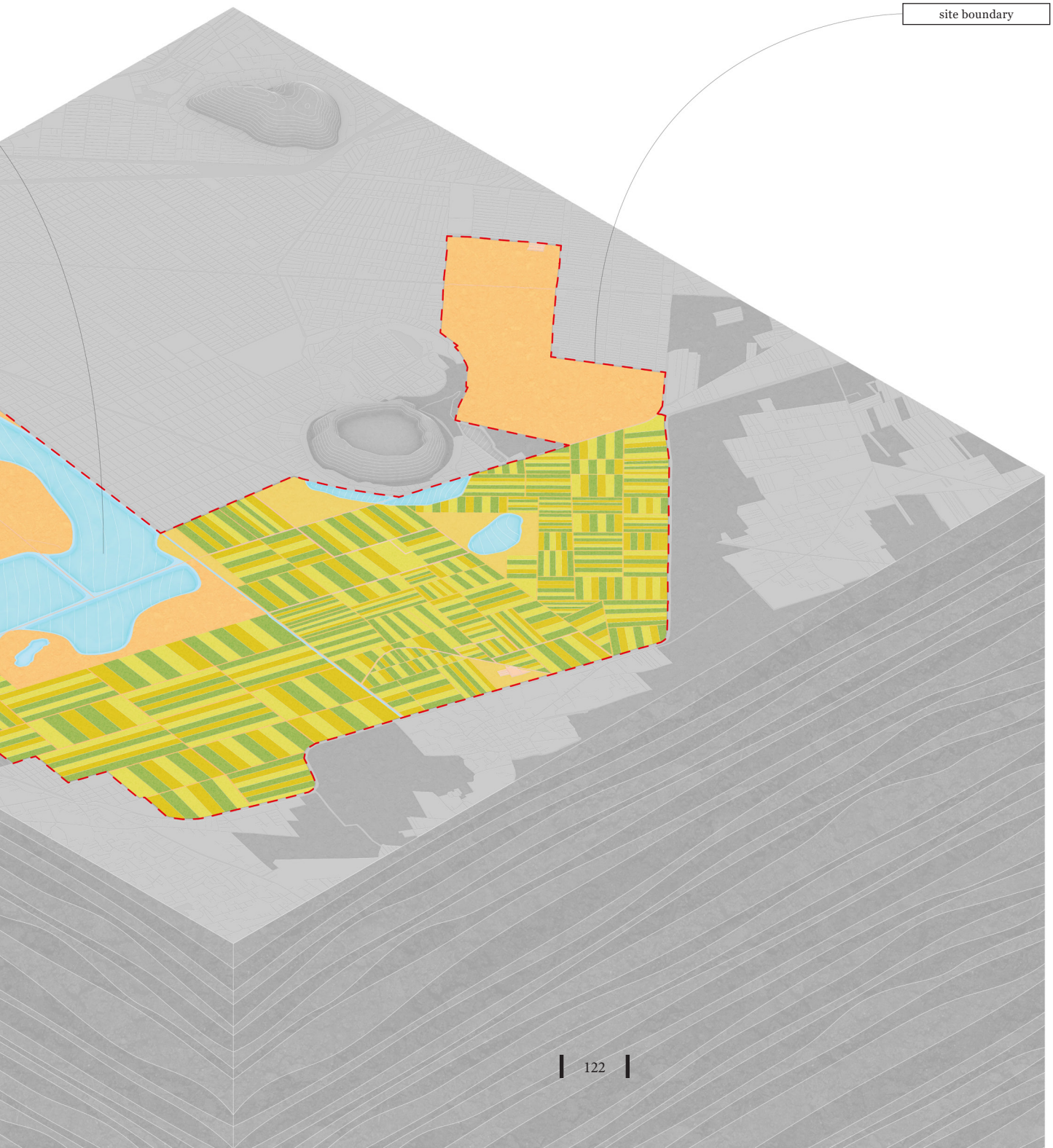


figure 4.2 [spread]:
isometric view
contemporary chalco - site boundary


site boundary

Due to the size and scale of the site, 4 key areas have been identified to isolate specific site conditions that require design intervention. Each of these covers an area of 1 km² (1 x 1 km). The underlying conditions represented within these areas are prevalent across the full extent of the site. The following pages will demonstrate various interventions required to ecologically terraform these areas.

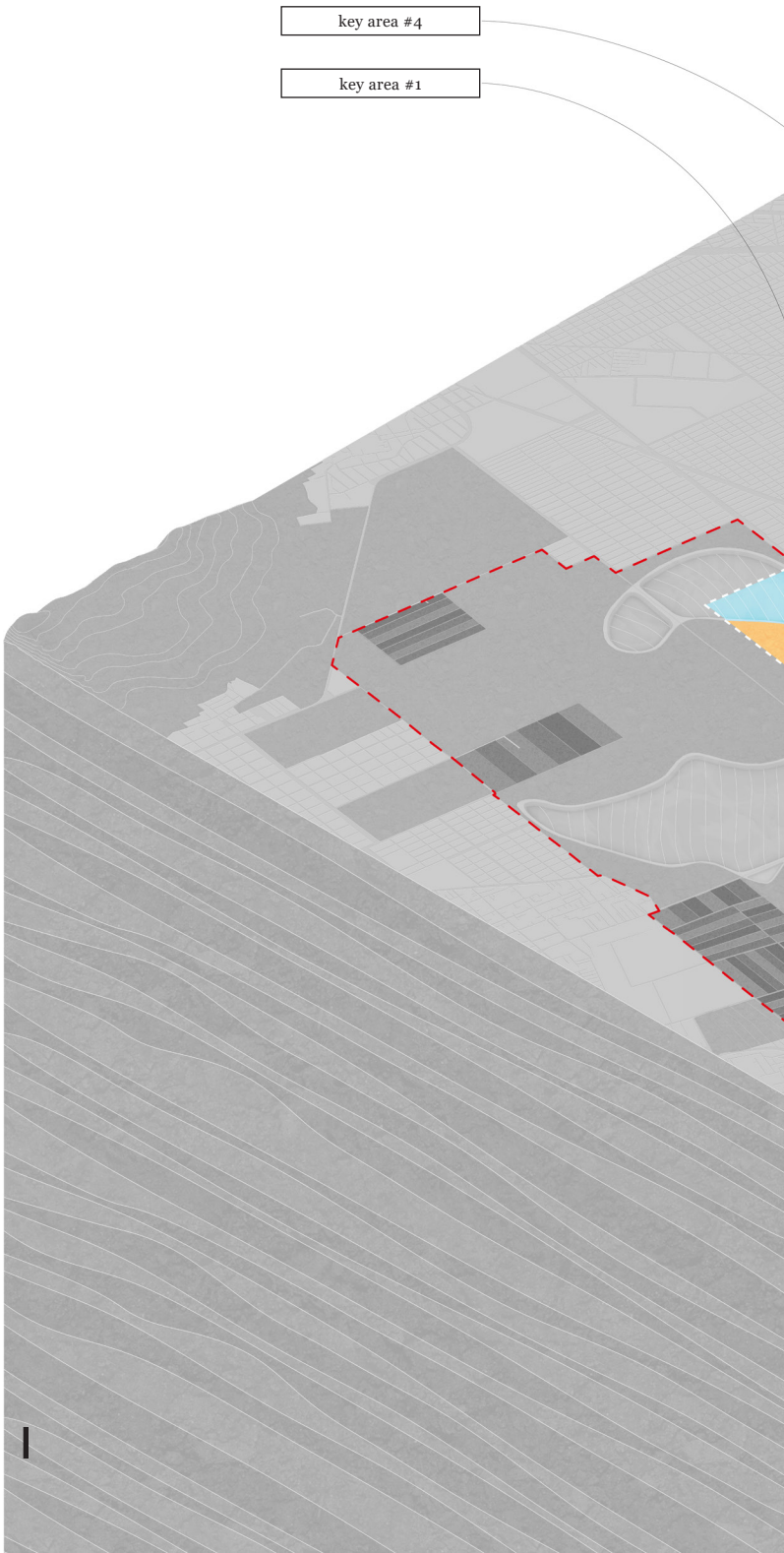


figure 4.3 [spread]:
isometric view
contemporary chalco - key areas

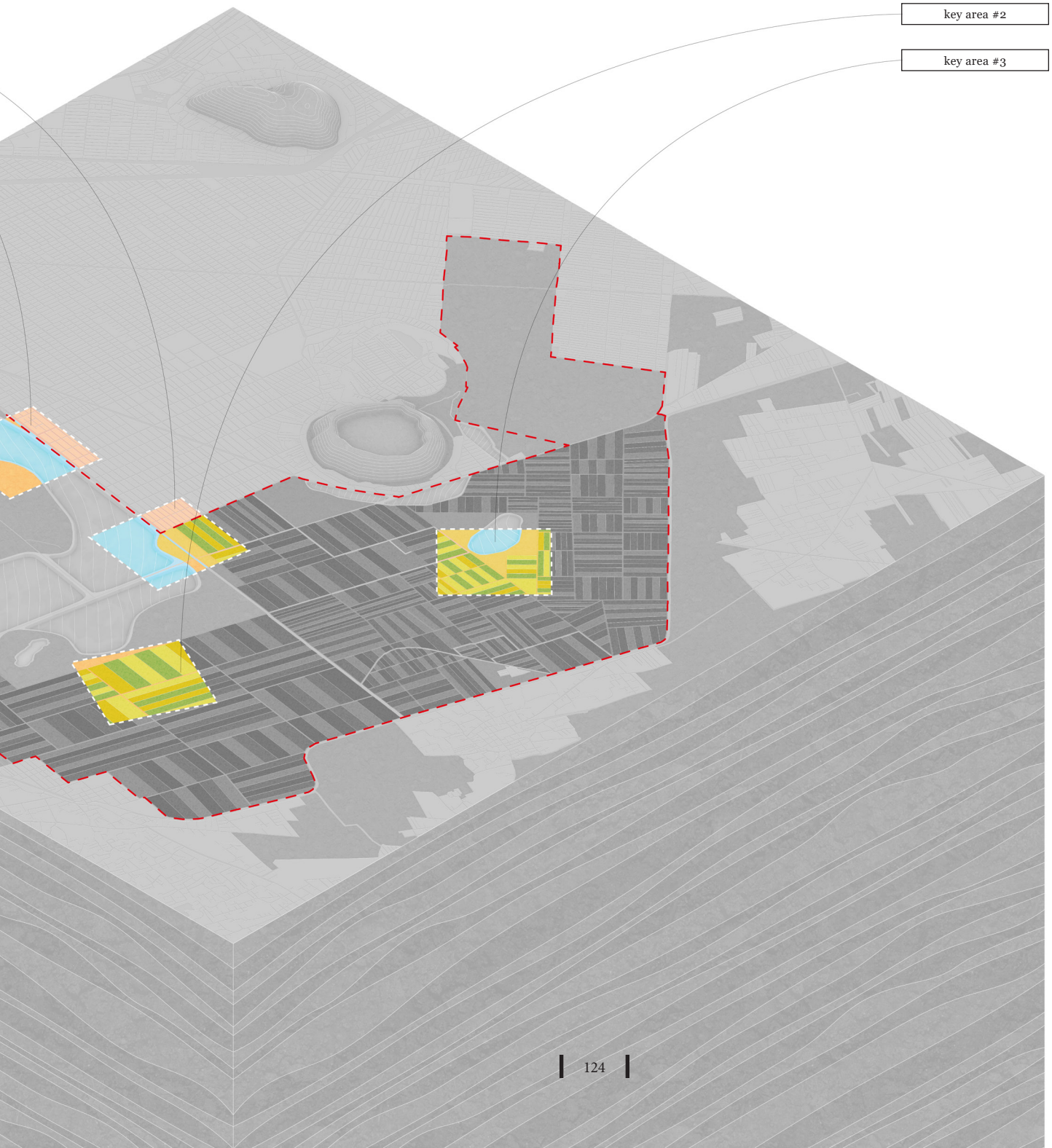
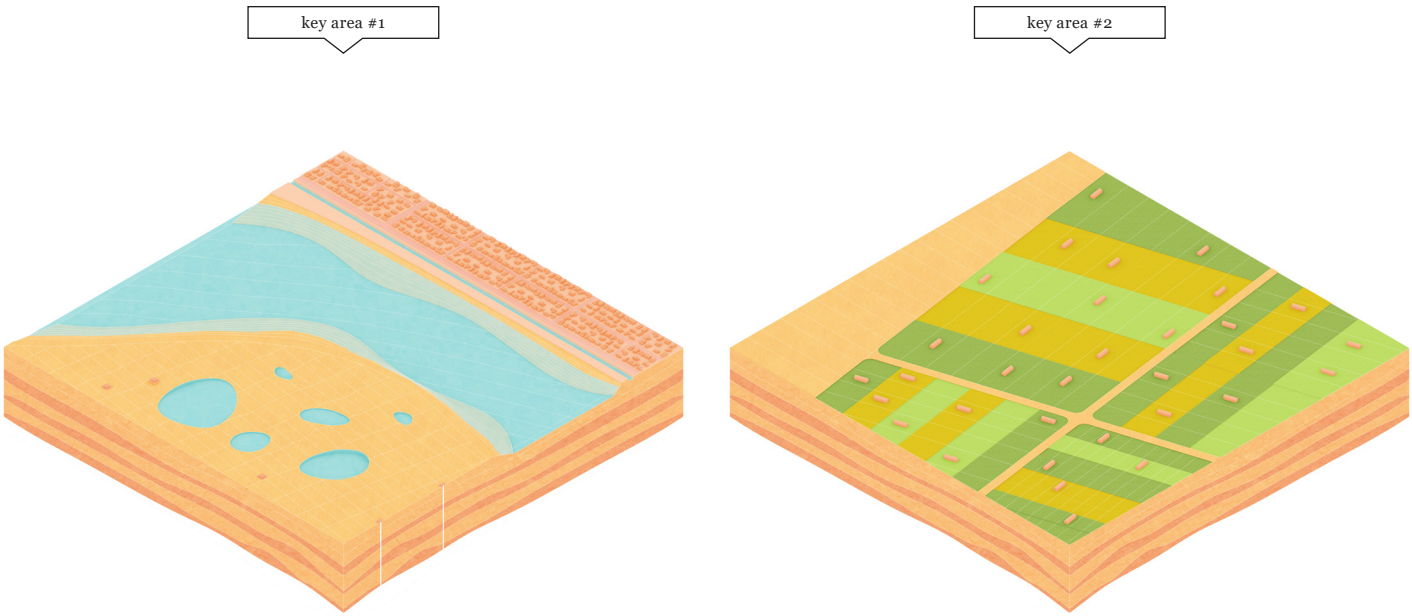
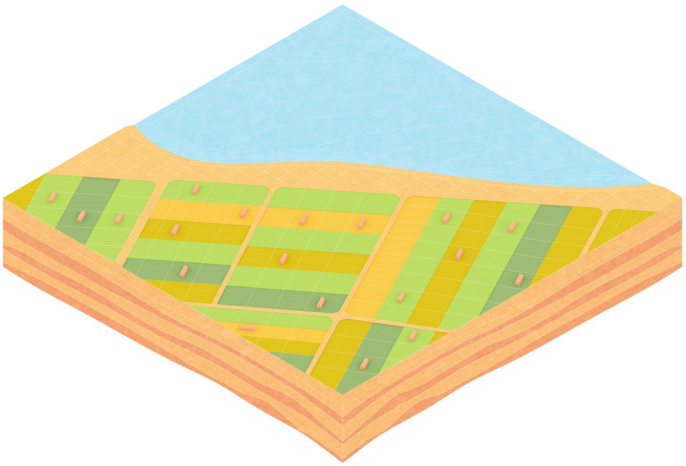

key area #2
key area #3

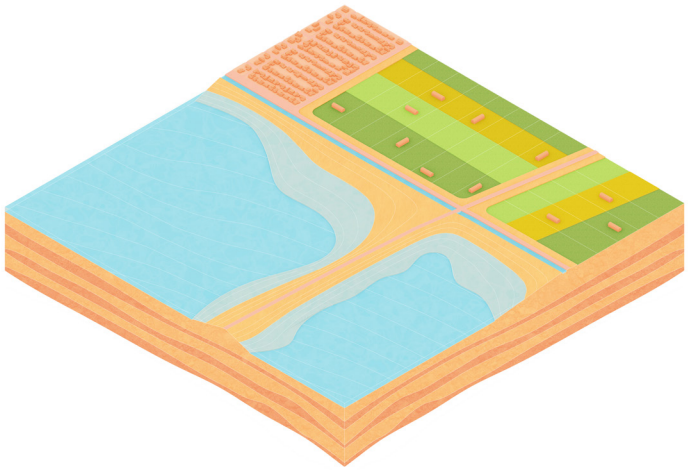
figure 4.4 [spread]:
isometric view
key areas - before terraformation



key area #3



key area #4



Key Area #1 - underlying conditions include the returning Lake Tláhuac-Xico, which expands and consumes agricultural and urban land, and poses a significant flood risk for the local community. Acapol canal, which is an inefficient open-air sewage canal is prone to regular flooding, potentially contaminating the returning lake and surrounding urban areas. The site also contains groundwater pumping stations that deplete the aquifer causing depressions to form due to land subsidence. Brownfield areas on site include agricultural land lost to subsidence, soil degradation or flooding.

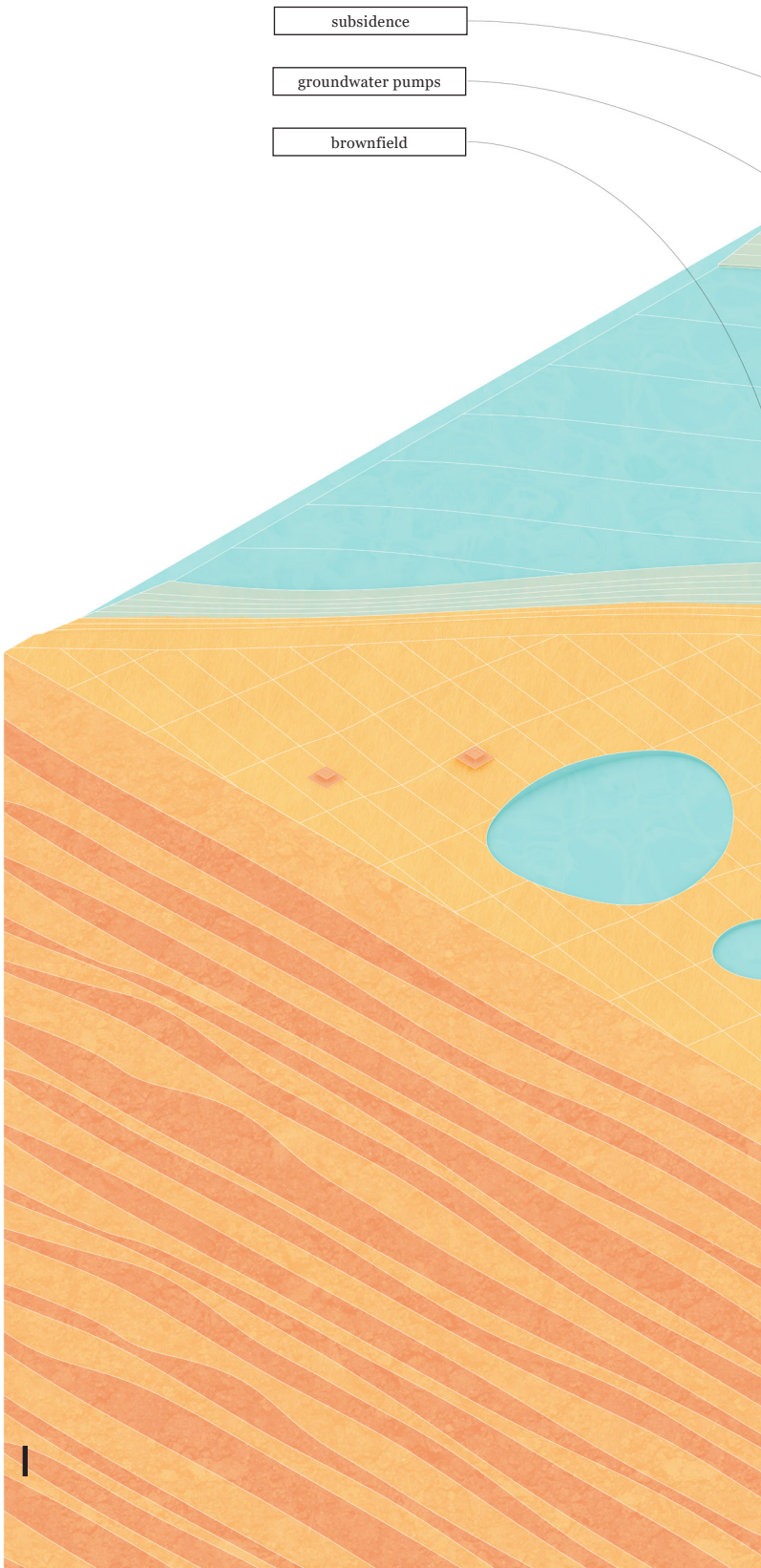
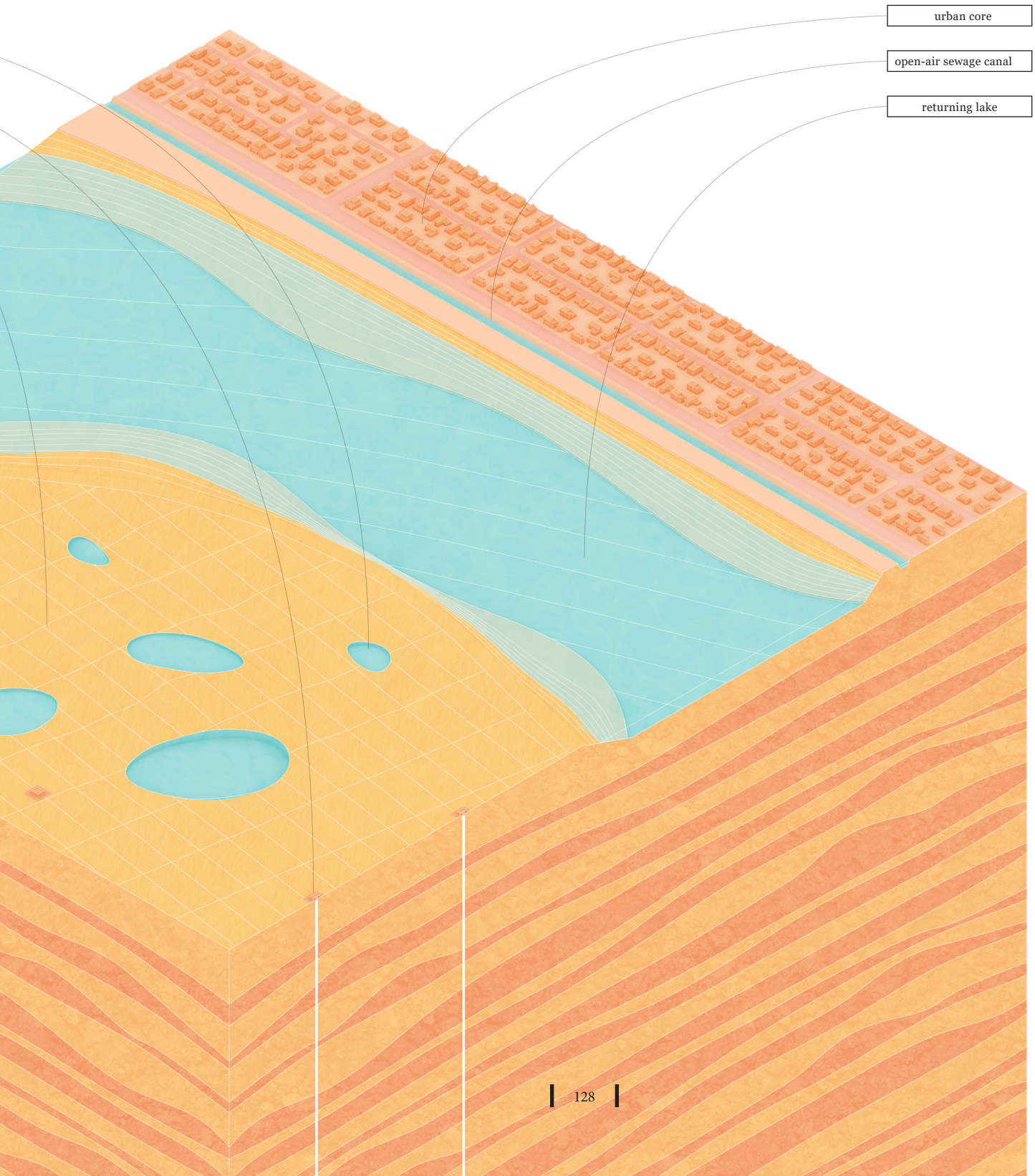
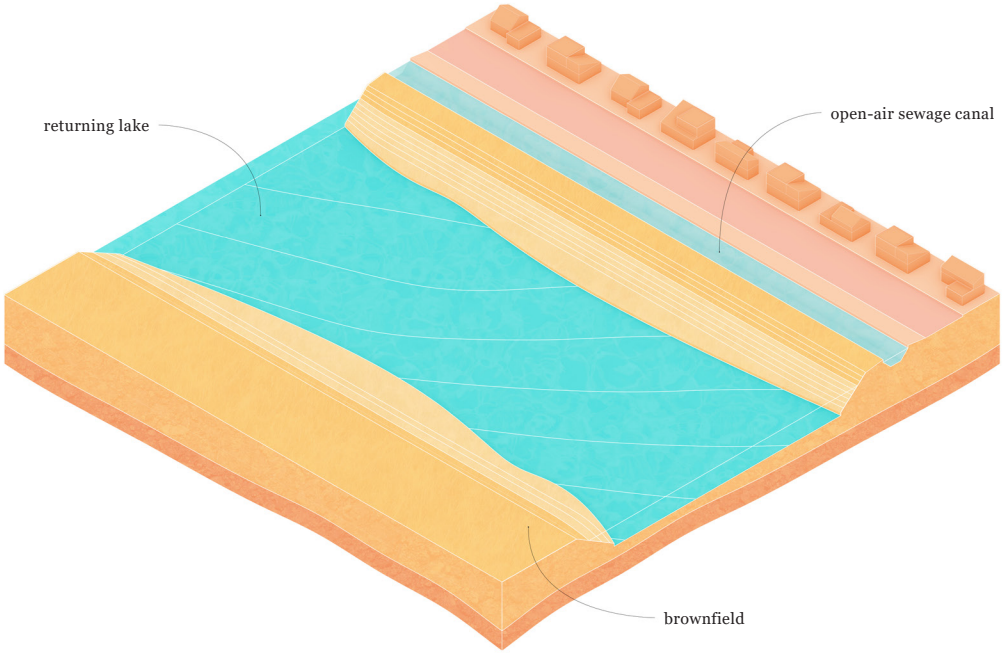
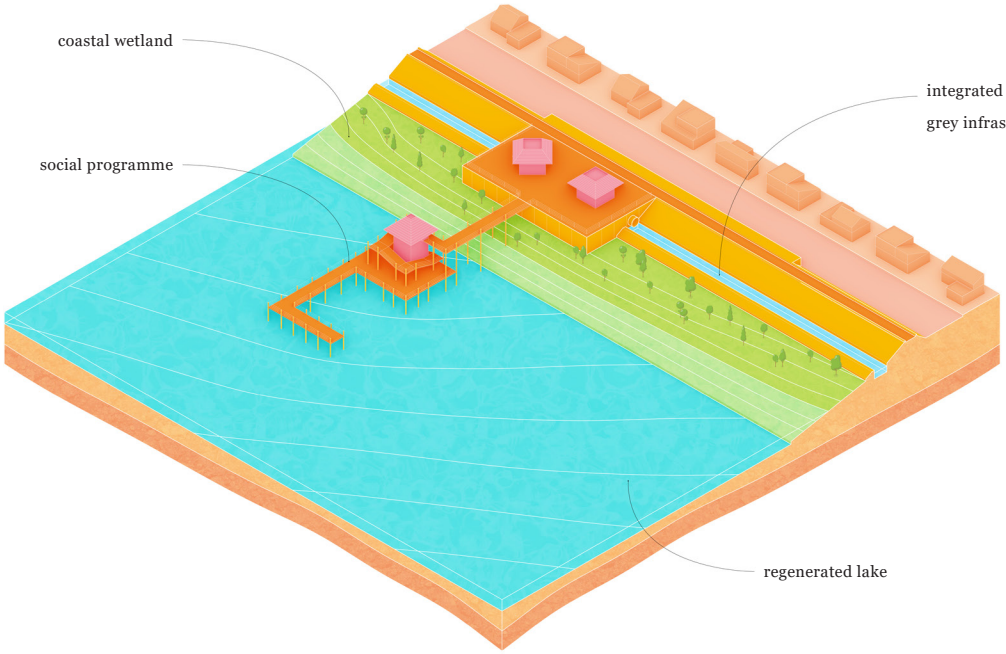


figure 4.5 [spread]:
isometric view - key area #1
before terraformation


urban core
open-air sewage canal
returning lake

1


returning lake
open-air sewage canal
brownfield


coastal wetland
social programme
integrated green, blue and
grey infrastructure
regenerated lake

5

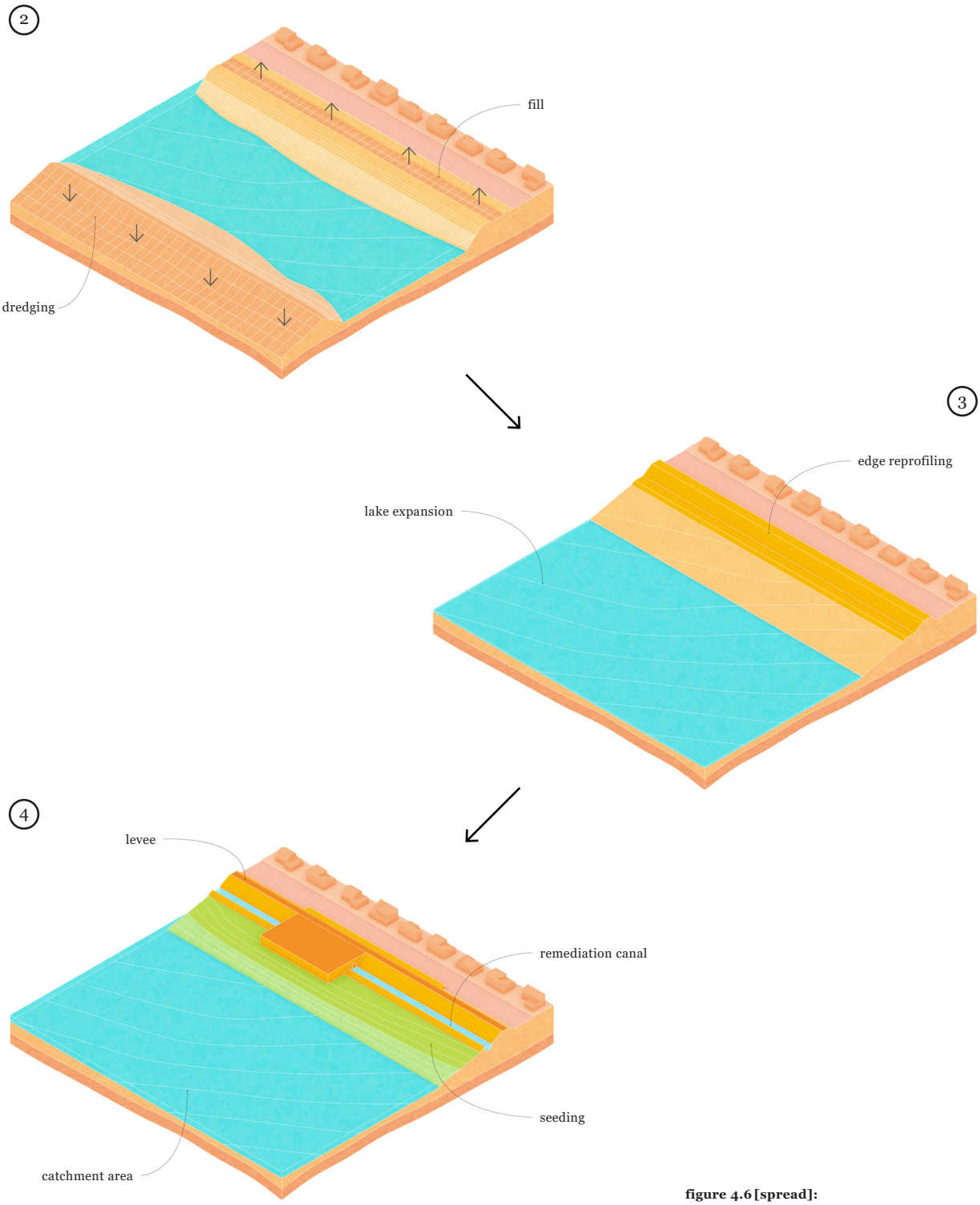


figure 4.6 [spread]:
terraforming sequence - key area #1

As illustrated in Figures 4.6-4.7, site terraformation will include re-profiling the urban edge to create a raised levee to protect urban areas from flooding. Adjacent brownfield areas will have to be dredged to increase catchment area and allow the returning lake to expand. Seeding the edge condition with native marshland species will create a coastal wetland ecology along the levee. The open-air sewage canal will be replaced by a remediation canal that will accommodate storm-water and treated sewage discharges from urban areas. Social hubs and docks will be interspersed along the urban edge. These will provide access to the site either via boats or nature trails. The renewed urban edge condition will integrate green and blue infrastructure to create systems for improved water resilience.

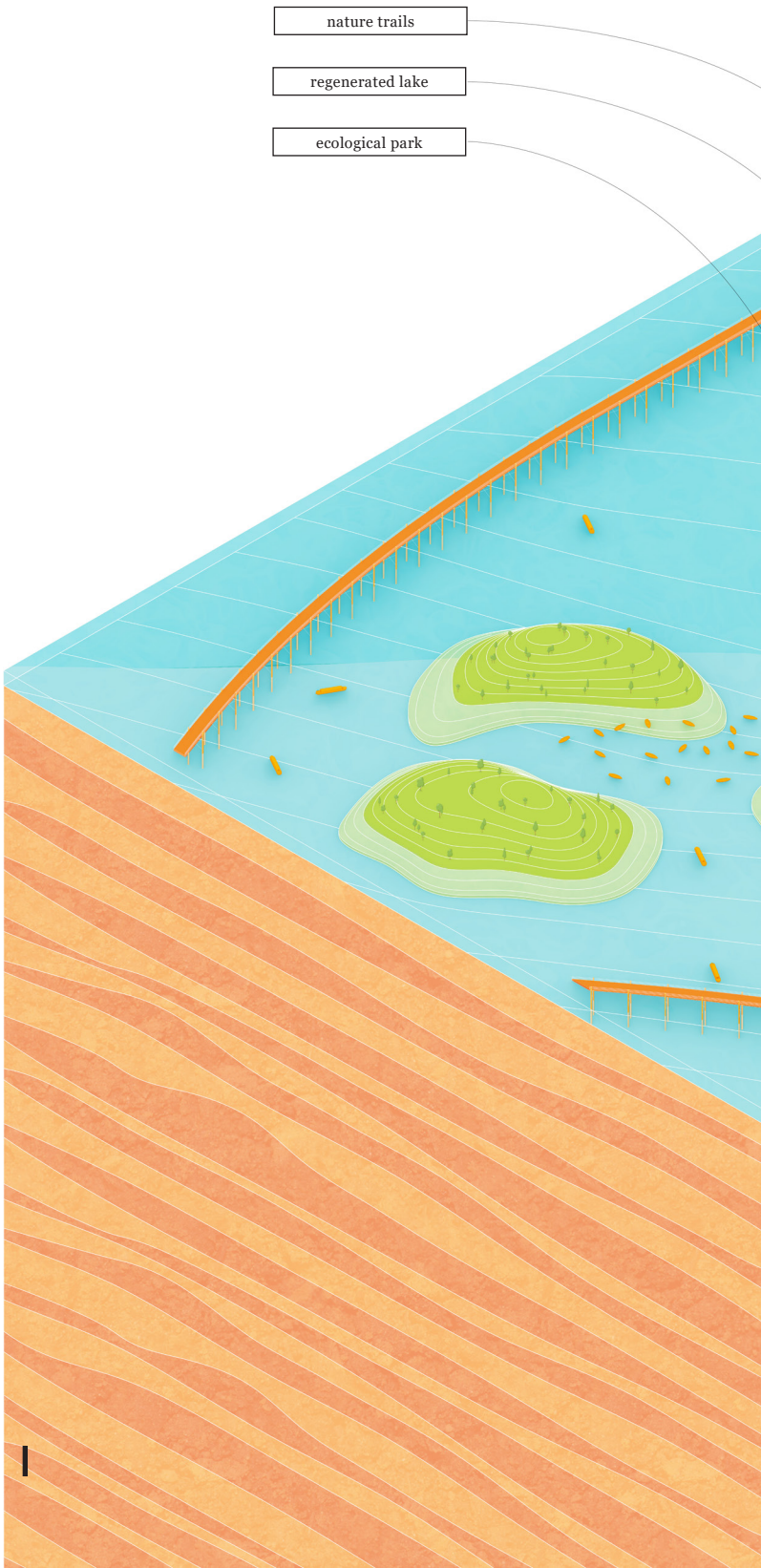
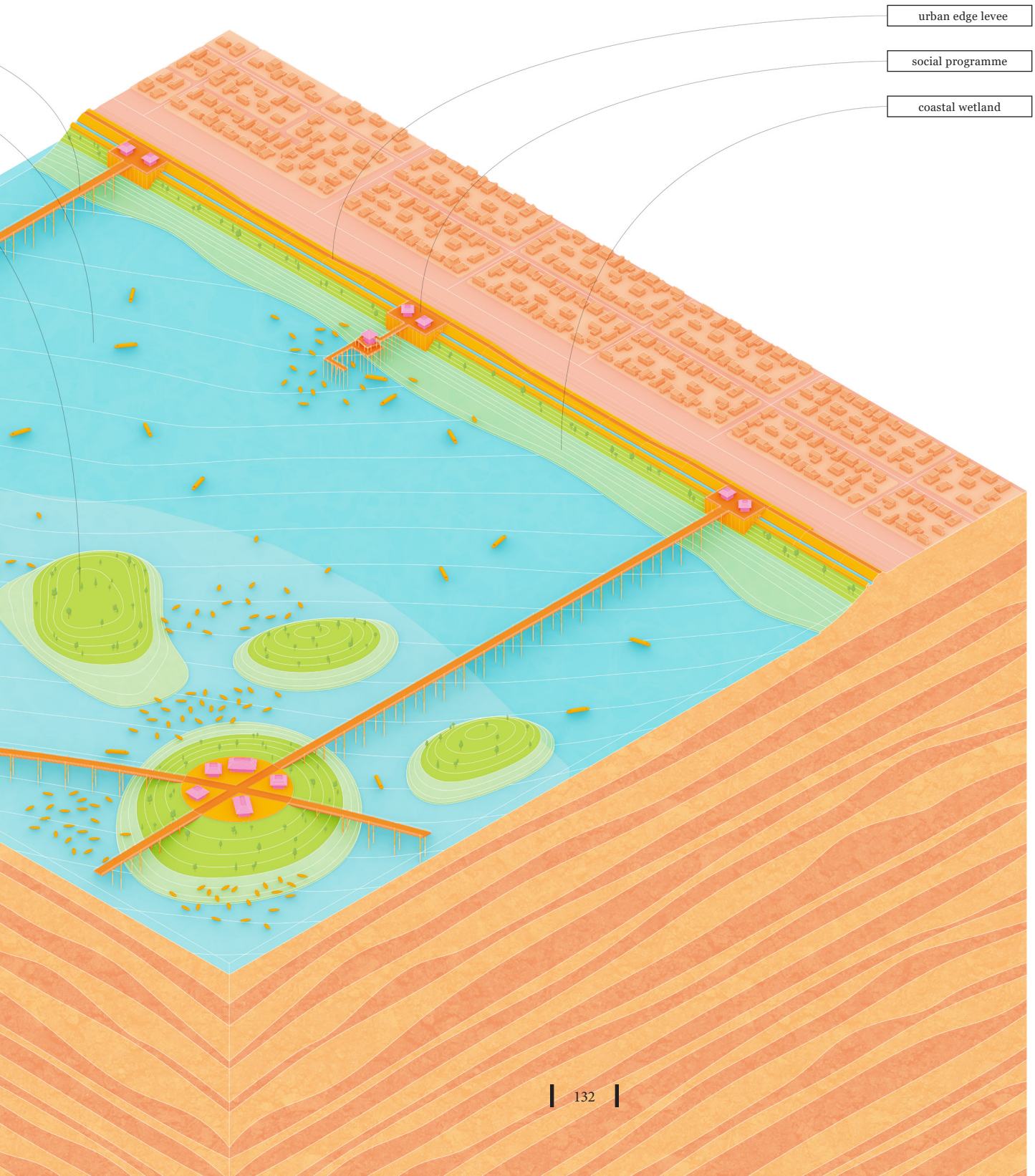


figure 4.7 [spread]:
isometric view - key area #1
post terraformation


urban edge levee
social programme
coastal wetland

Key Area #2 - underlying conditions include large expanses of protected ejidos dedicated for mono-crop agriculture. Agriculture in the region has high water consumption rates, most of which is extracted from depleted aquifers. These lands are susceptible to severe soil degradation leading to its eventual ecological succession to grasslands. Based on existing trends, these lands will eventually succumb to urban sprawl.

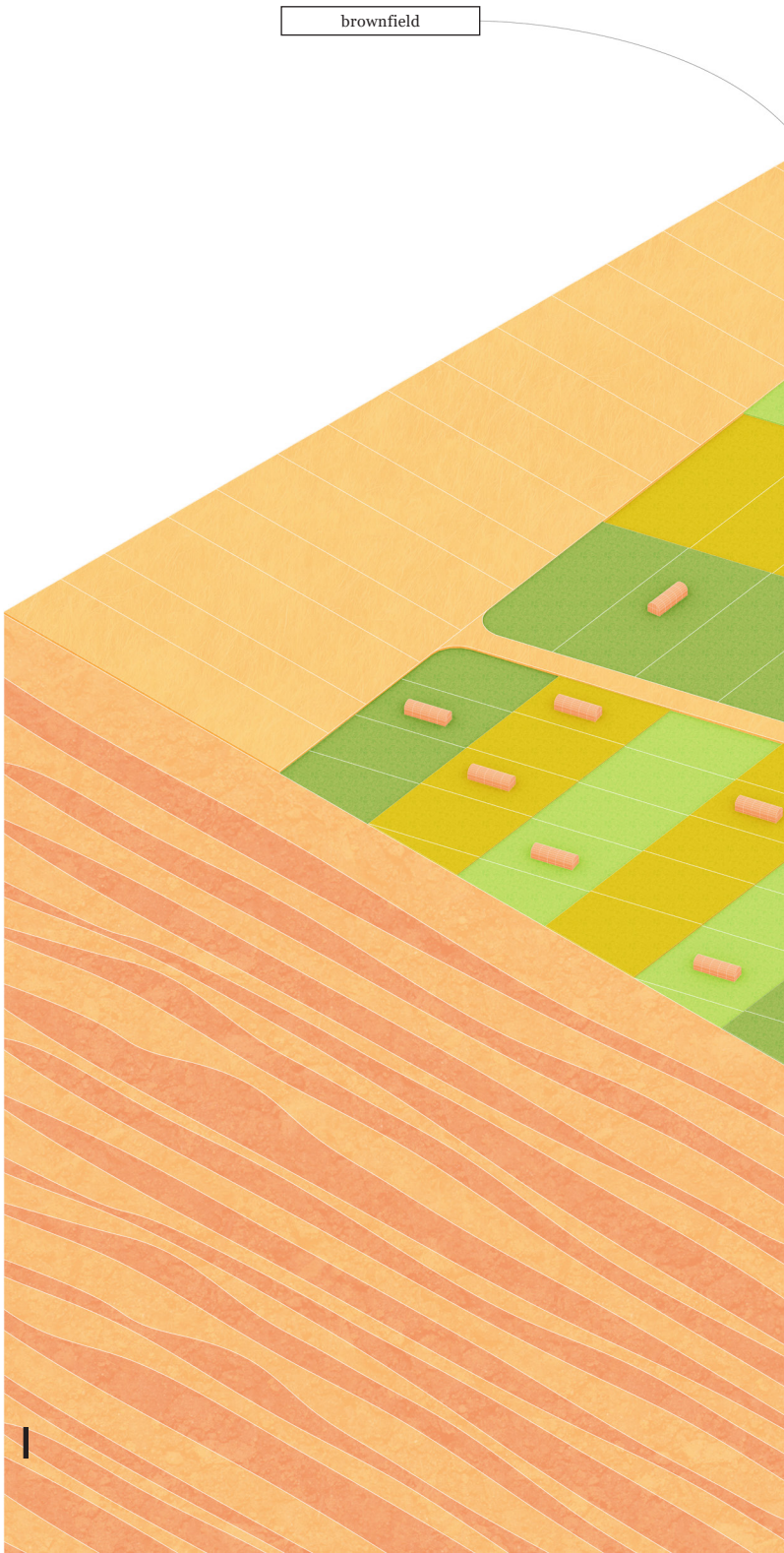
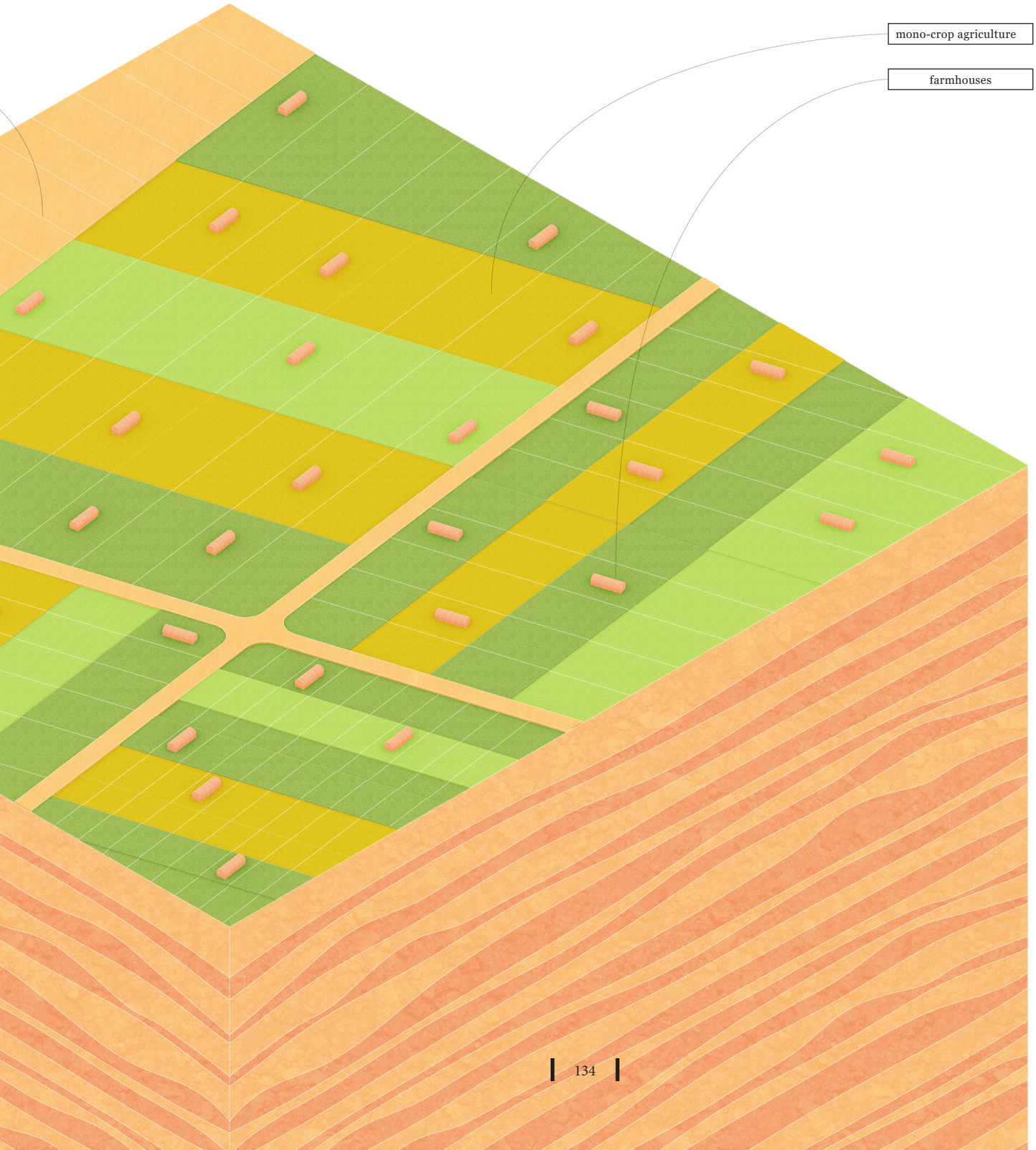
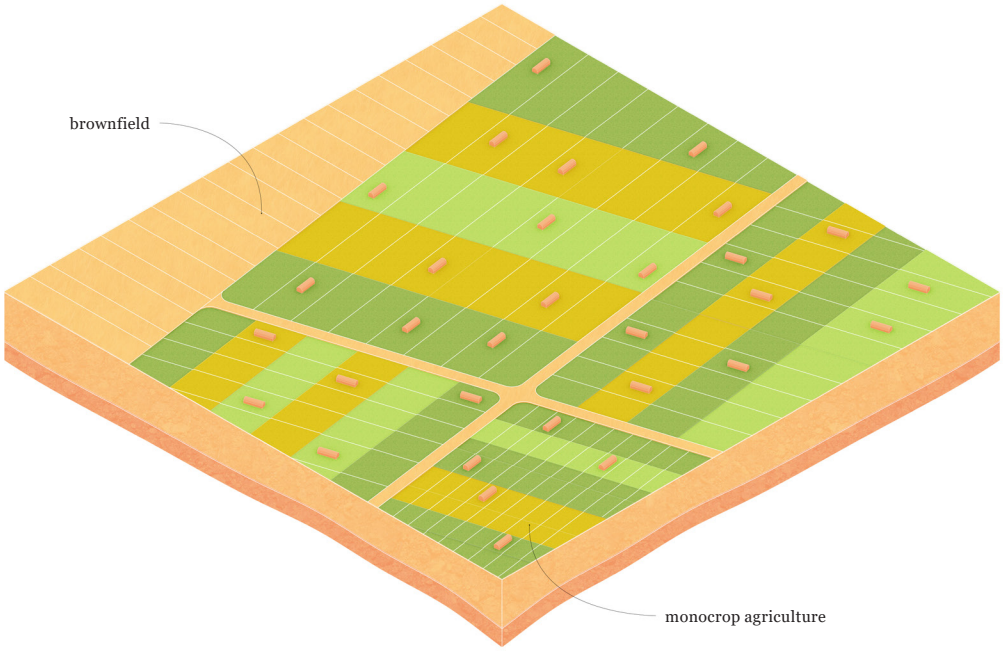
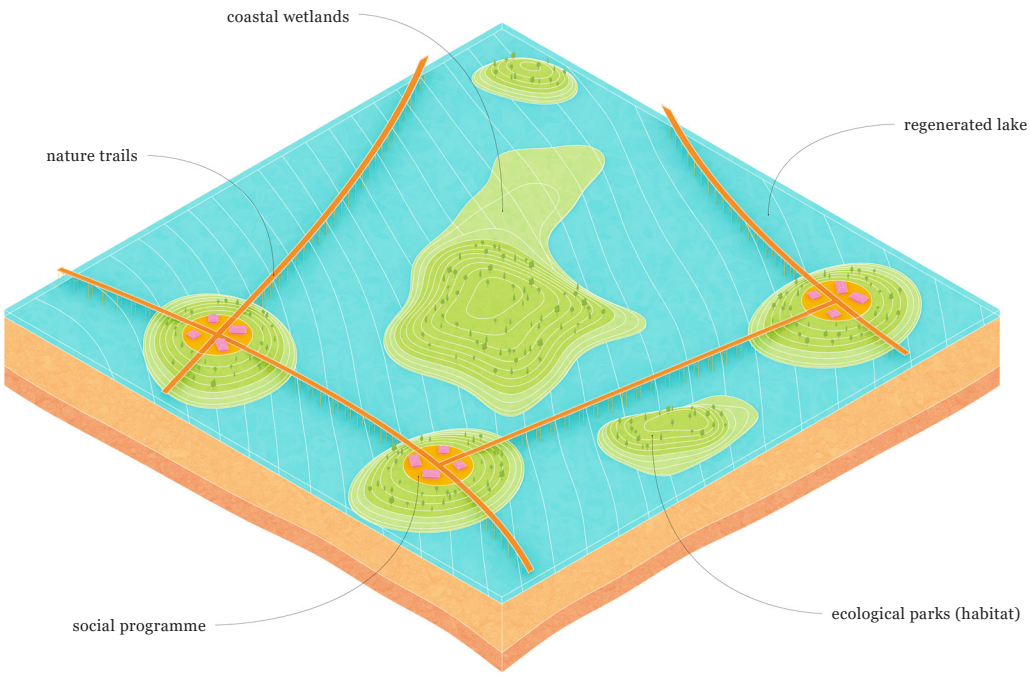


figure 4.8 [spread]:
isometric view - key area #2
before terraformation


mono-crop agriculture
farmhouses

1


brownfield
monocrop agriculture


coastal wetlands
nature trails
regenerated lake
social programme
ecological parks (habitat)

5

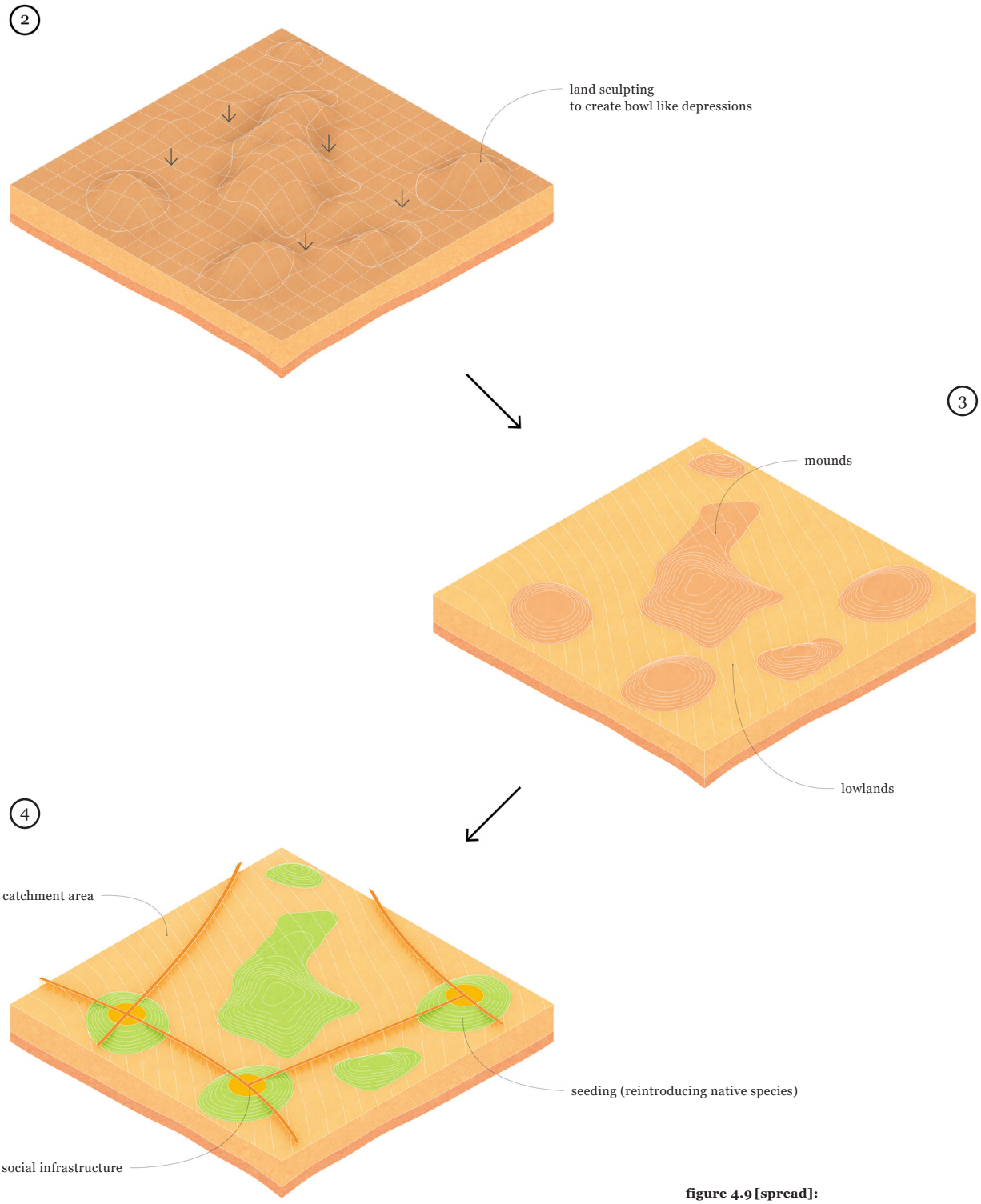


figure 4.9 [spread]:
terraforming sequence - key area #2

As illustrated in Figures 4.9-4.10, site terraformation will include clearing and sculpting the land to create a system of bowl-like depressions and mounds. The lowlands will act as a catchment area that collects rainwater and storm-water discharges, thus allowing the returning lake to regenerate. The mounds will be seeded with endemic flora to create a series of protected ecological parks and coastal wetlands. These parks are connected via nature trails and community hubs to accommodate an eco-tourism program. The system as a whole will improve biodiversity and promote natural regeneration by rewilding lacustrine ecologies.

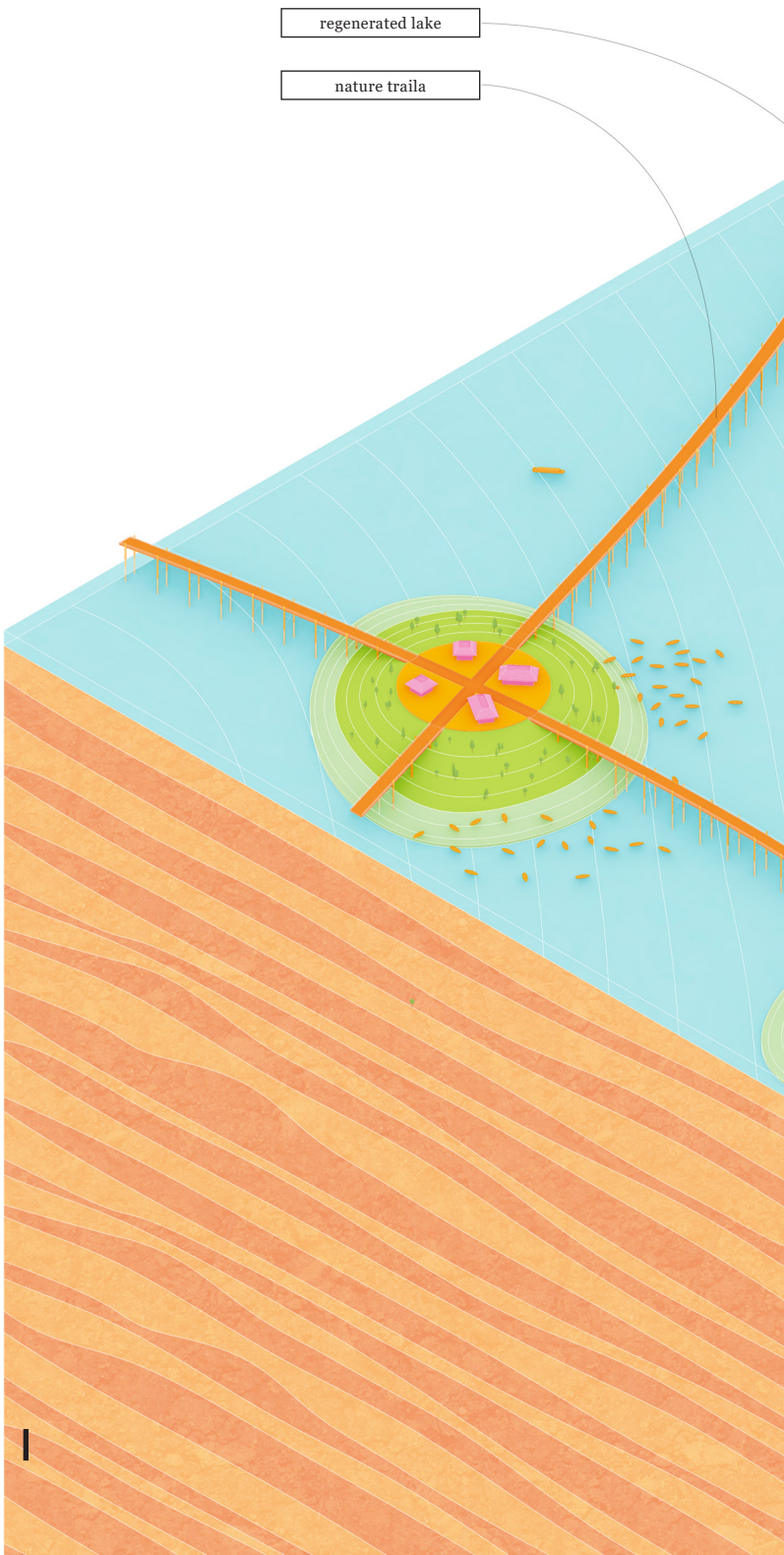
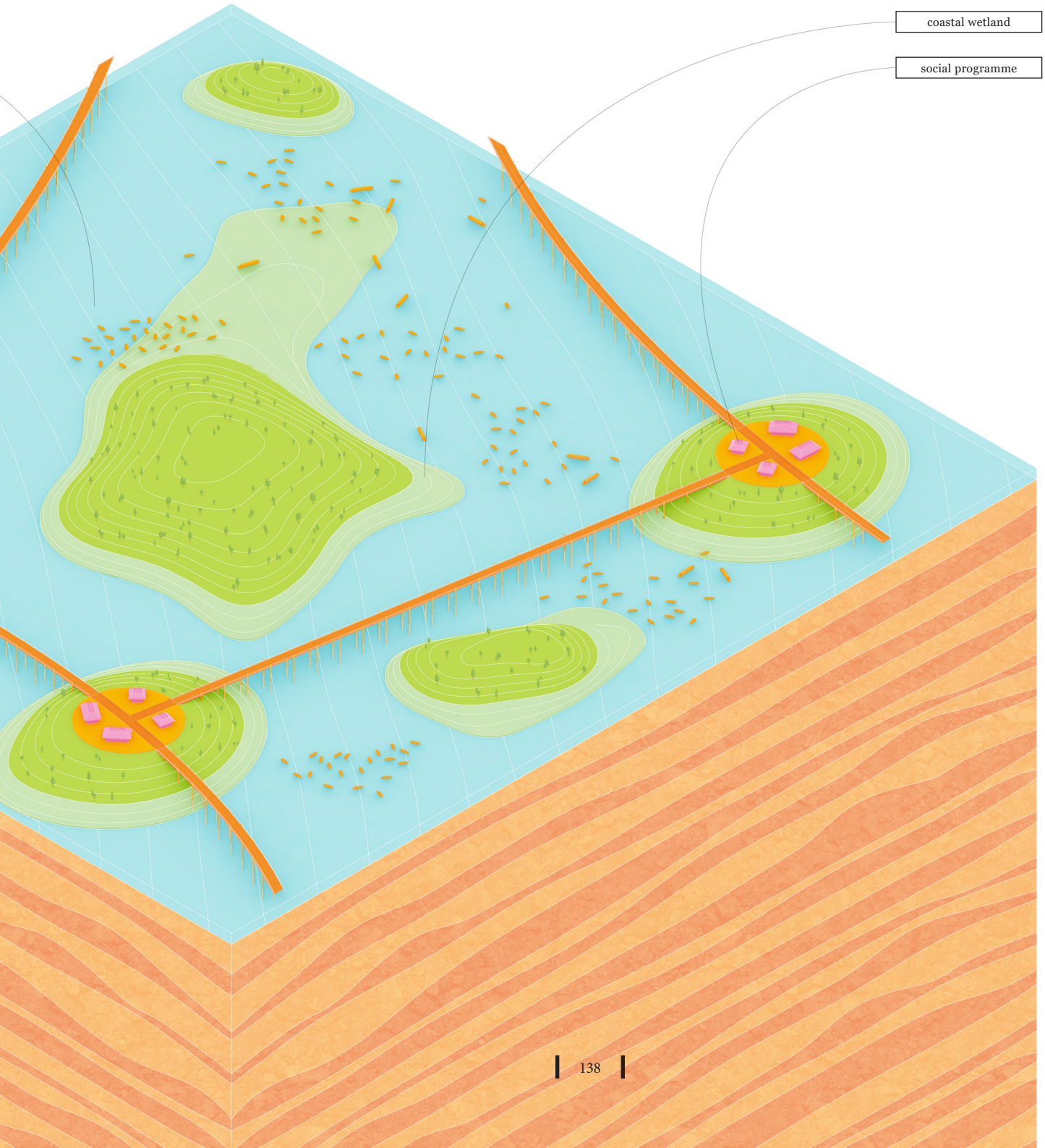


figure 4.10 [spread]:
isometric view - key area #2
post terraformation


coastal wetland
social programme

Key Area #3 - underlying conditions include the Xico Lagoons, which are formed due to the accumulation of pluvial waters on depressing land. Low-lying areas dedicated to agriculture are increasingly susceptible to floods as water continue to accumulate and expand over time. Current agricultural practices in the region are unsustainable as it causes severe soil degradation over time.

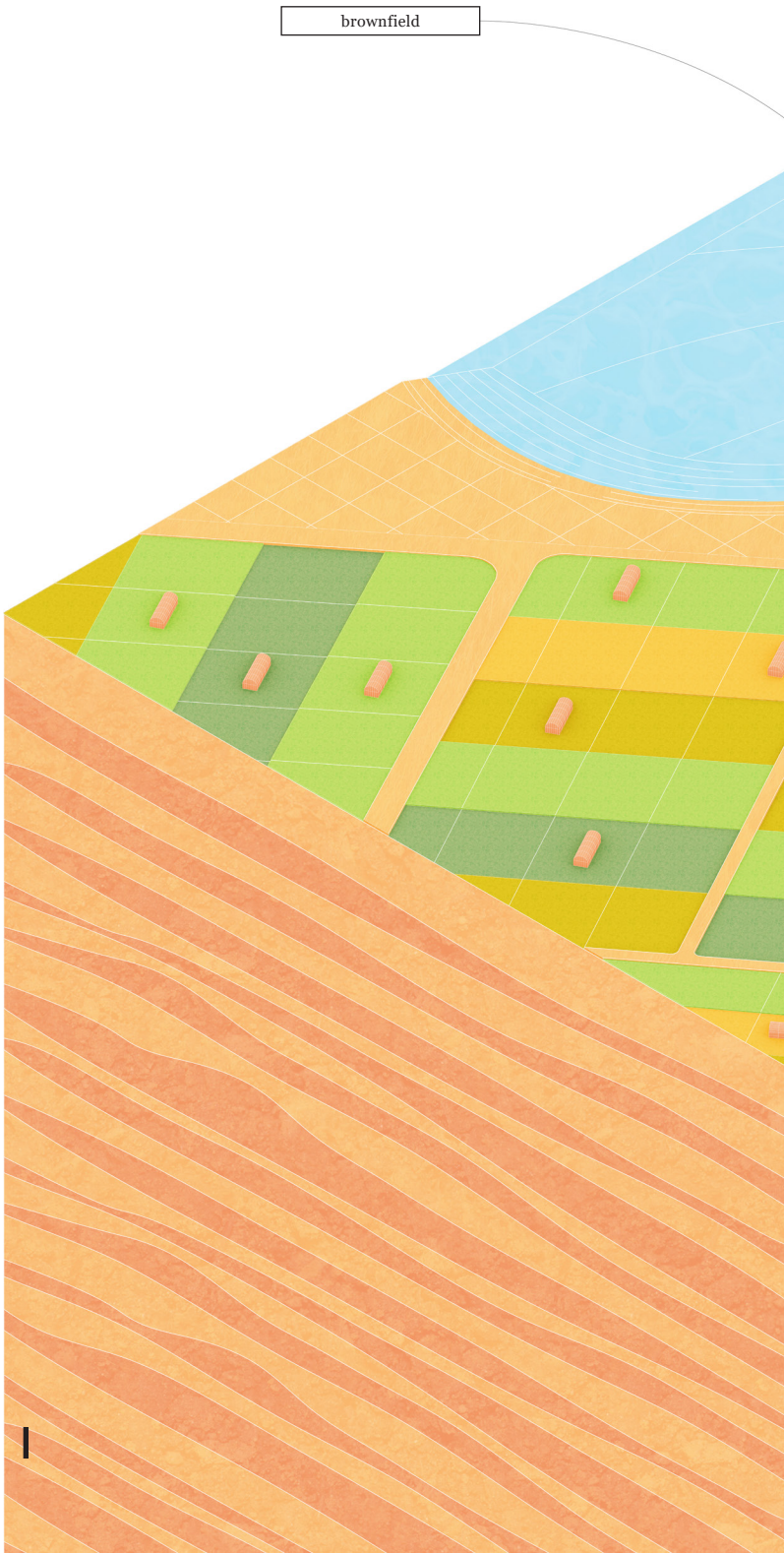
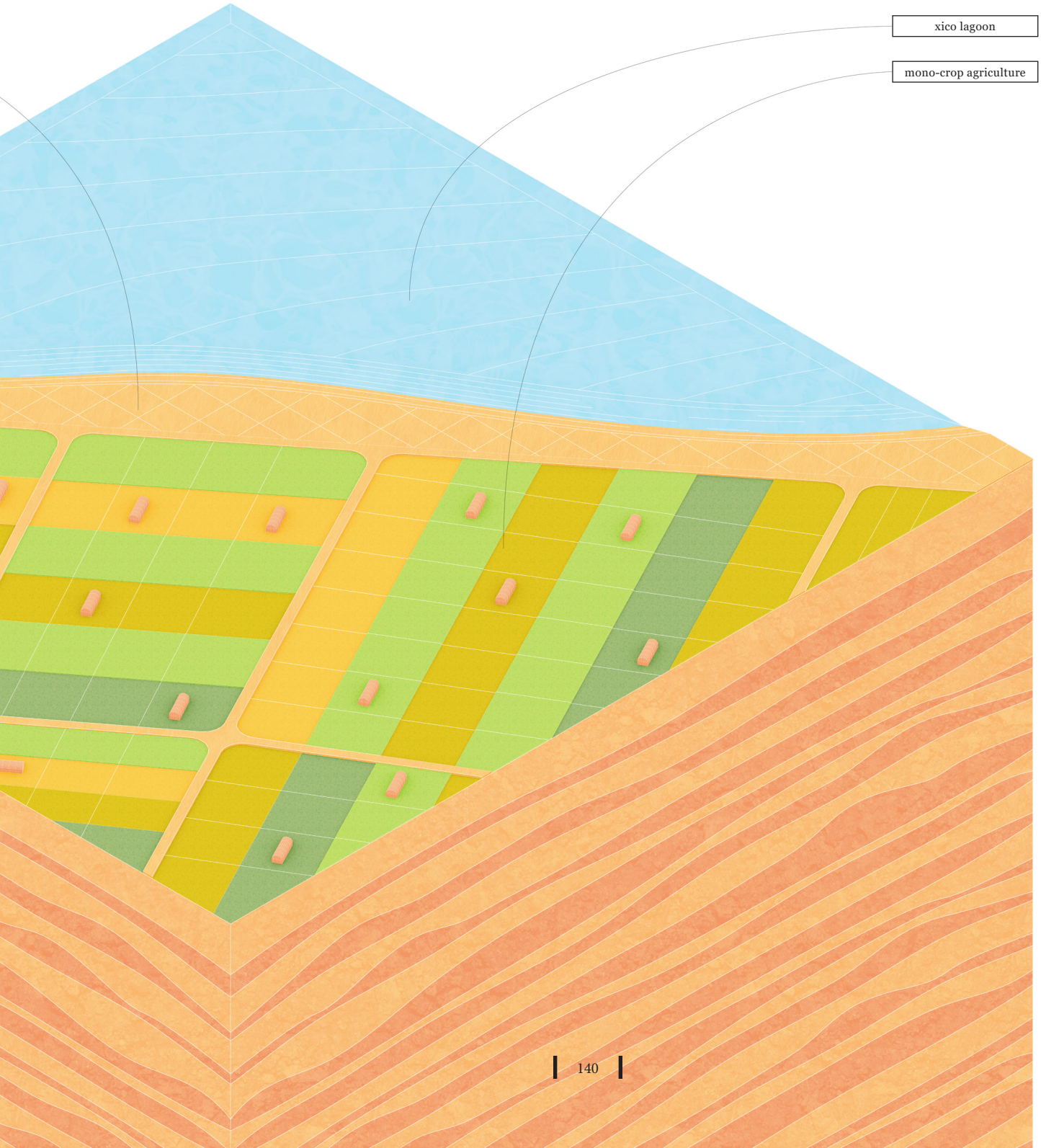
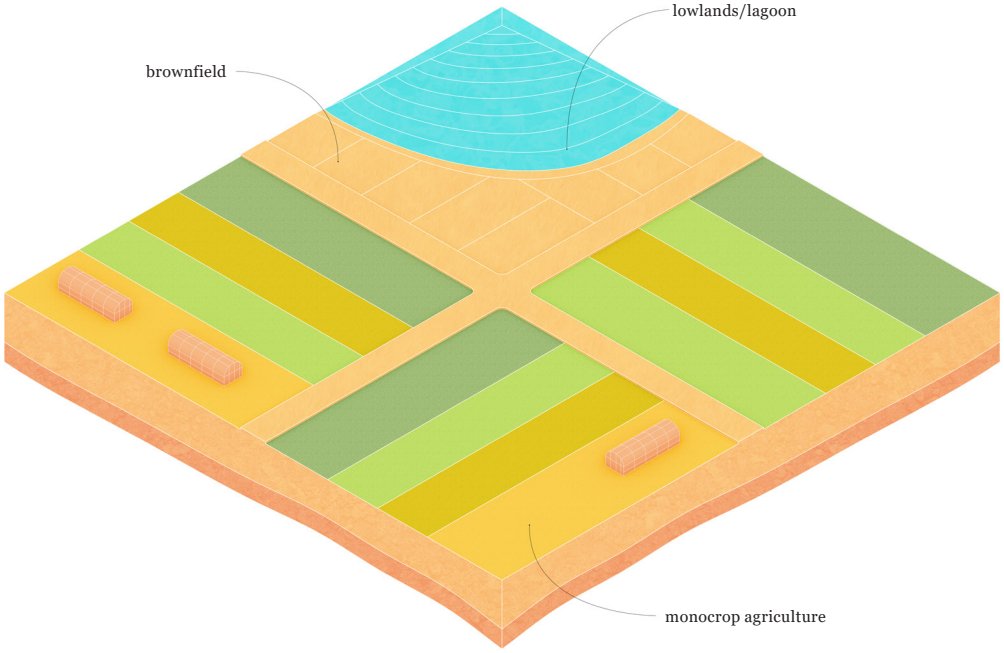
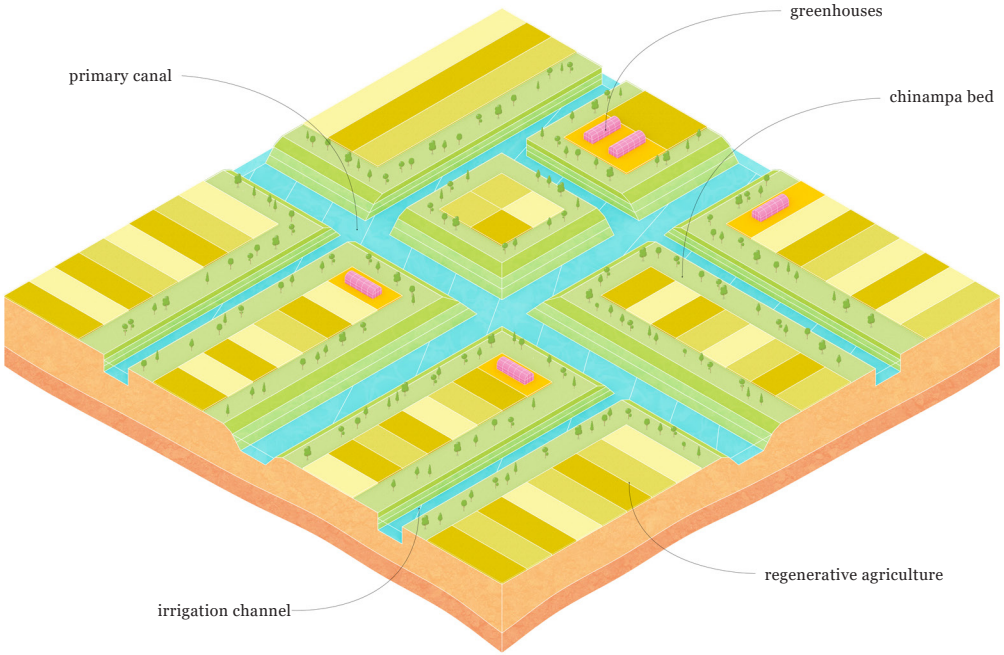


figure 4.11 [spread]:
isometric view - key area #3
before terraformation


xico lagoon
mono-crop agriculture

1


lowlands/lagoon
brownfield
monocrop agriculture


greenhouses
primary canal
chinampa bed
regenerative agriculture
irrigation channel

5

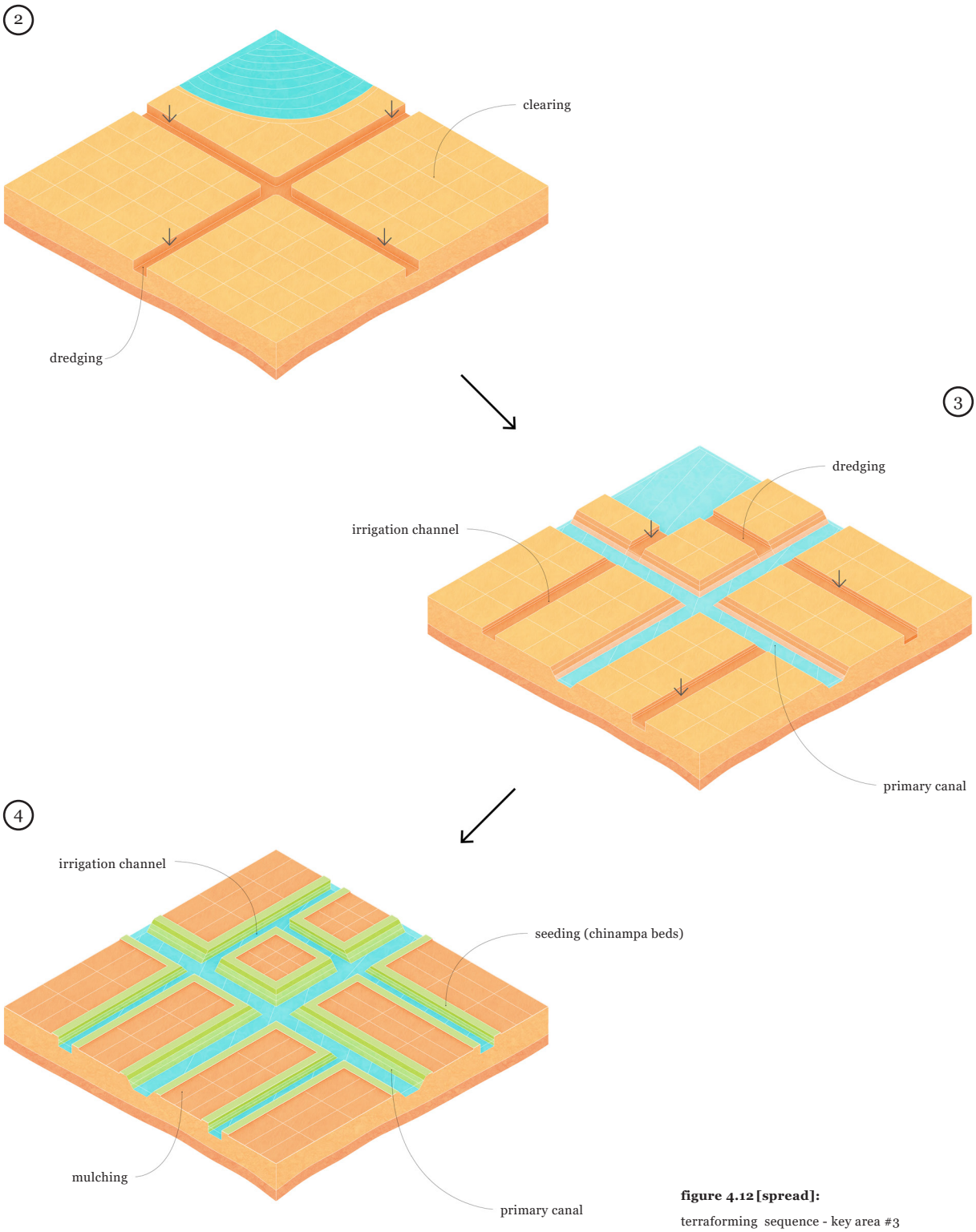


figure 4.12 [spread]:
terraforming sequence - key area #3

As illustrated in Figures 4.12-4.13, site terraformation will include clearing and dredging land to create a network of canals and chinampa beds. Each chinampa is composed of raised beds, which are fabricated by adding additional soil layers of biomass and highly fertile sediment from the canal bed. Canals and irrigation channels allow natural drainage and nutrient cycling as nutrient rich water soaks into the soil keeping it permanently moist. Chinampa agriculture is regenerative and resilient to changing underlying conditions. These systems will also provide a wide range of ecosystem services.

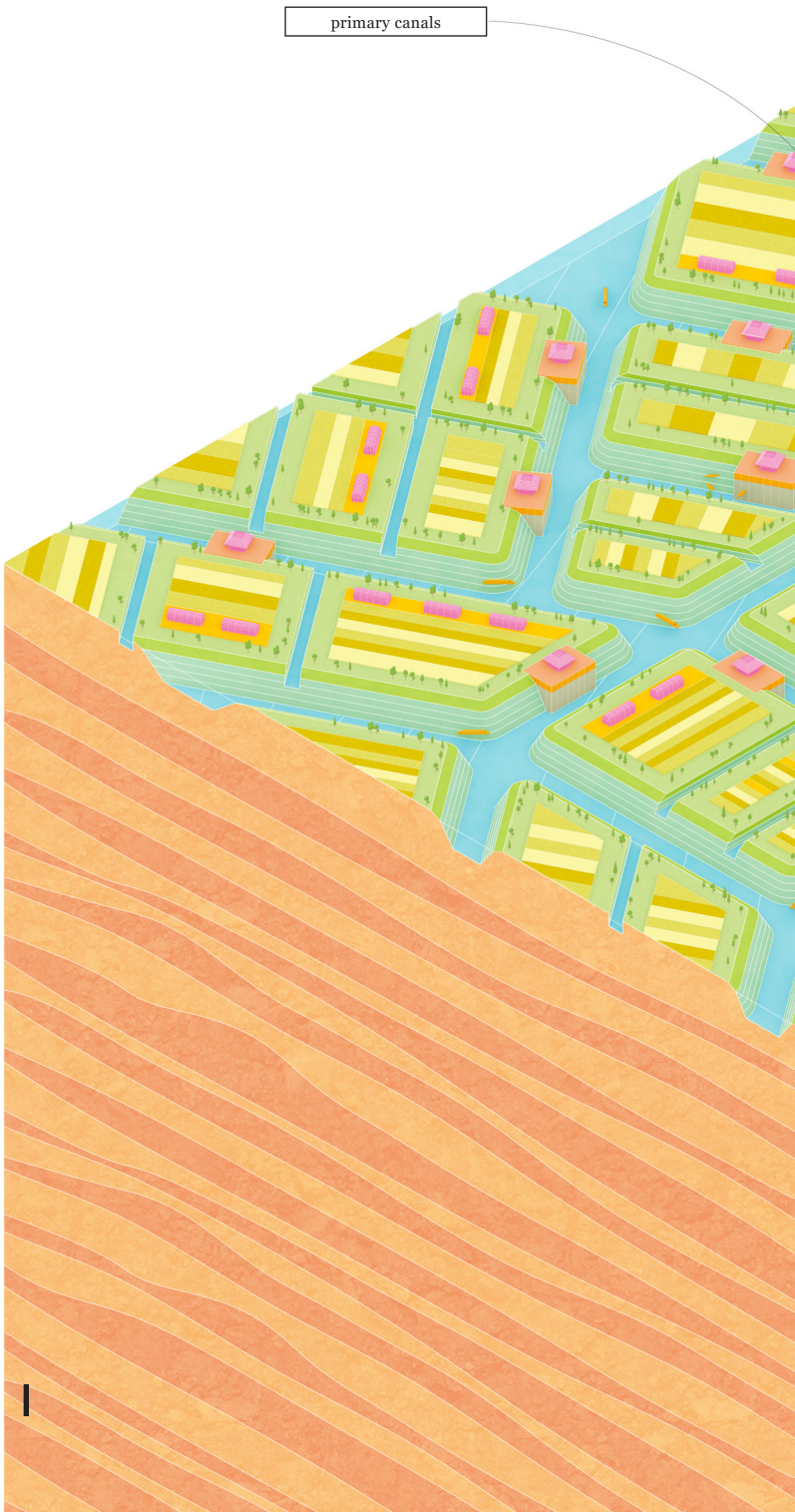
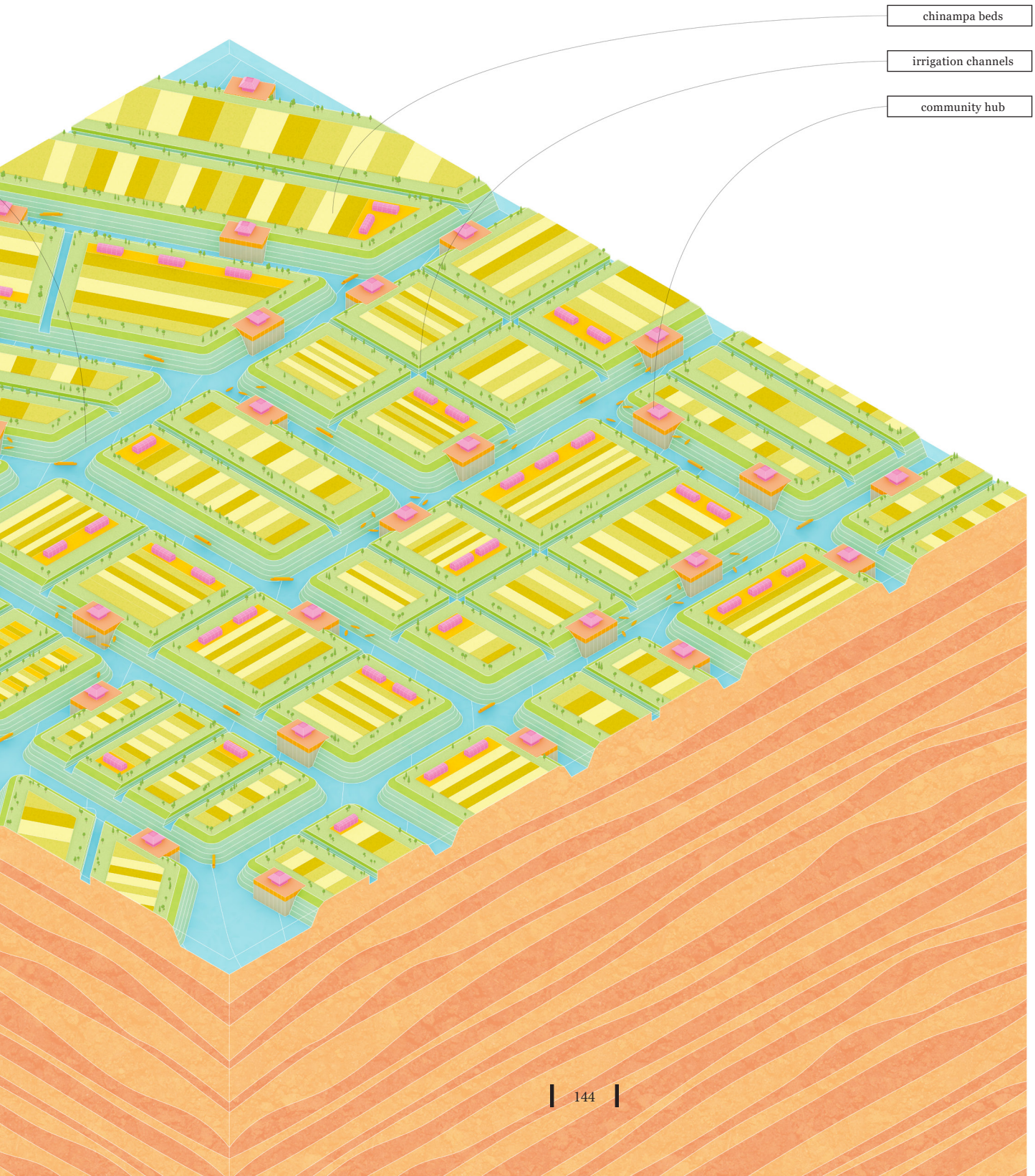


figure 4.13 [spread]:
isometric view - key area #3
post terraformation


chinampa beds
irrigation channels
community hub

Key Area #4 - underlying conditions include existing road infrastructure which are increasingly vulnerable to flooding, and often rendered inaccessible. Lake Tláhuac-Xico, which expands and consumes agricultural and urban land poses a significant flood risk for the local community. Acapol canal, which is an inefficient open-air sewage canal regularly floods and contaminates the returning lake and surrounding urban areas. Agricultural lands are susceptible to severe soil degradation leading to its eventual ecological succession to grasslands. Without intervention, these lands will eventually succumb to urban sprawl.

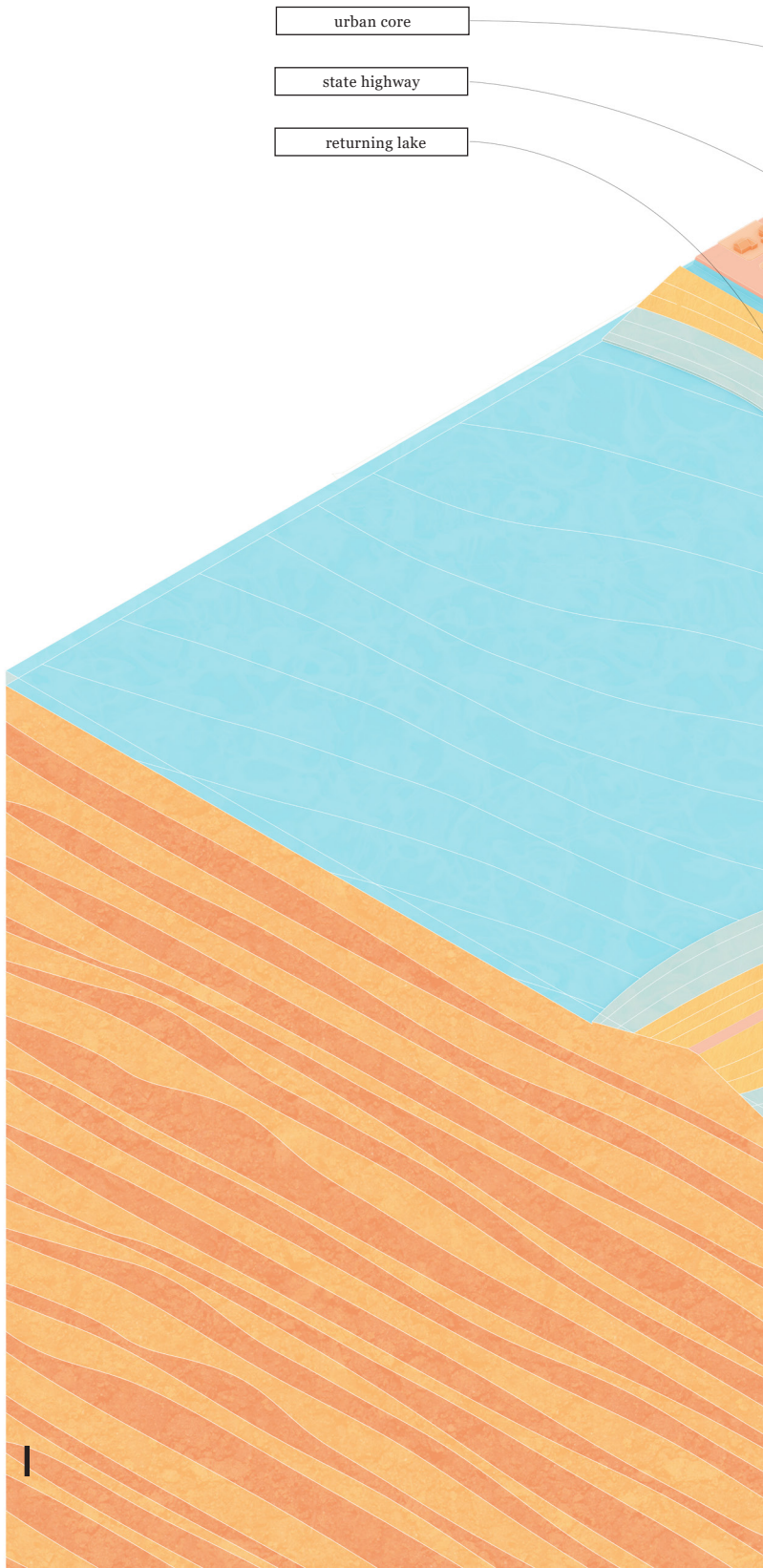
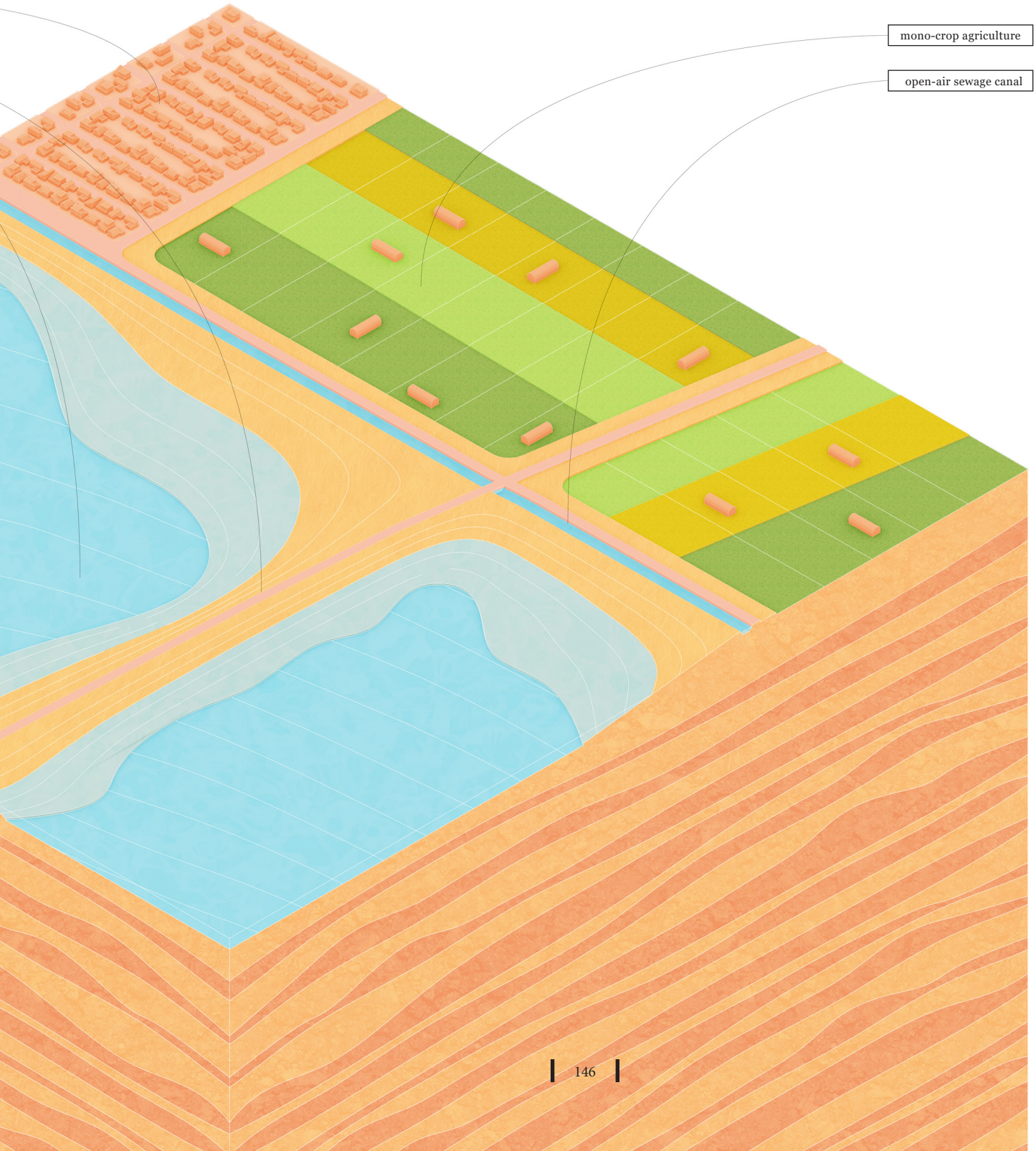
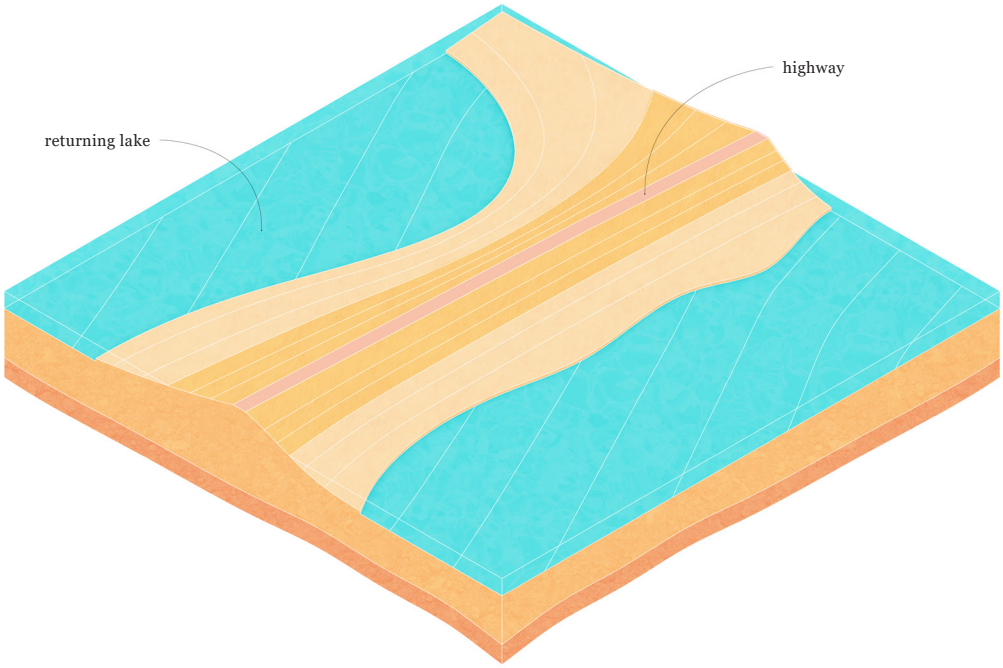
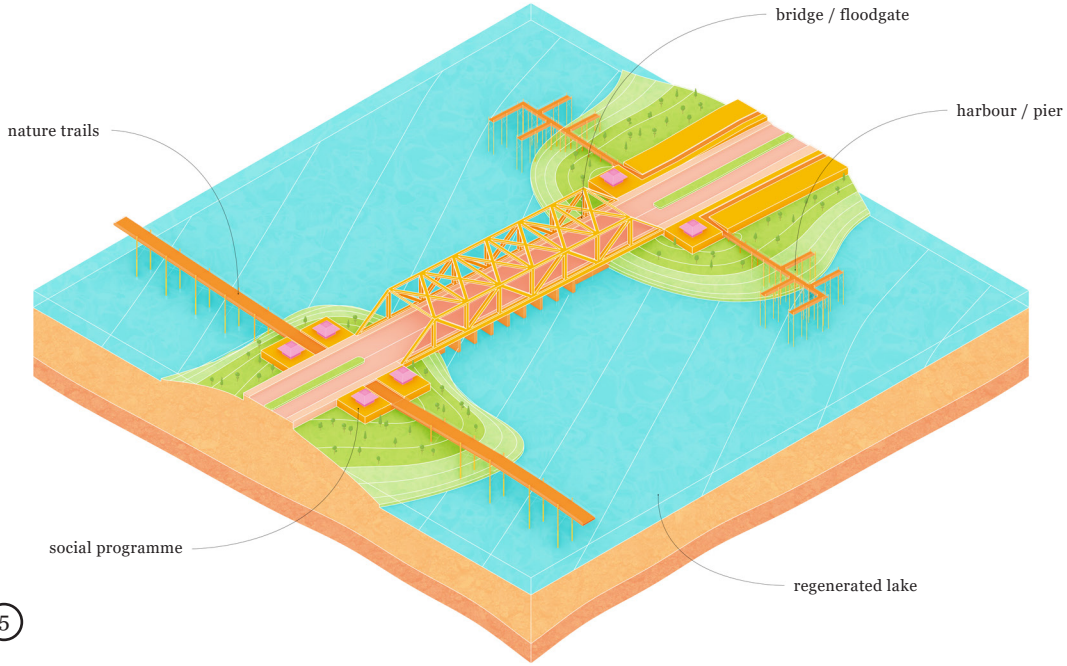


figure 4.14 [spread]:
isometric view - key area #4
before terraformation


mono-crop agriculture
open-air sewage canal

1


highway
returning lake


bridge / floodgate
harbour / pier
nature trails
social programme
regenerated lake

5

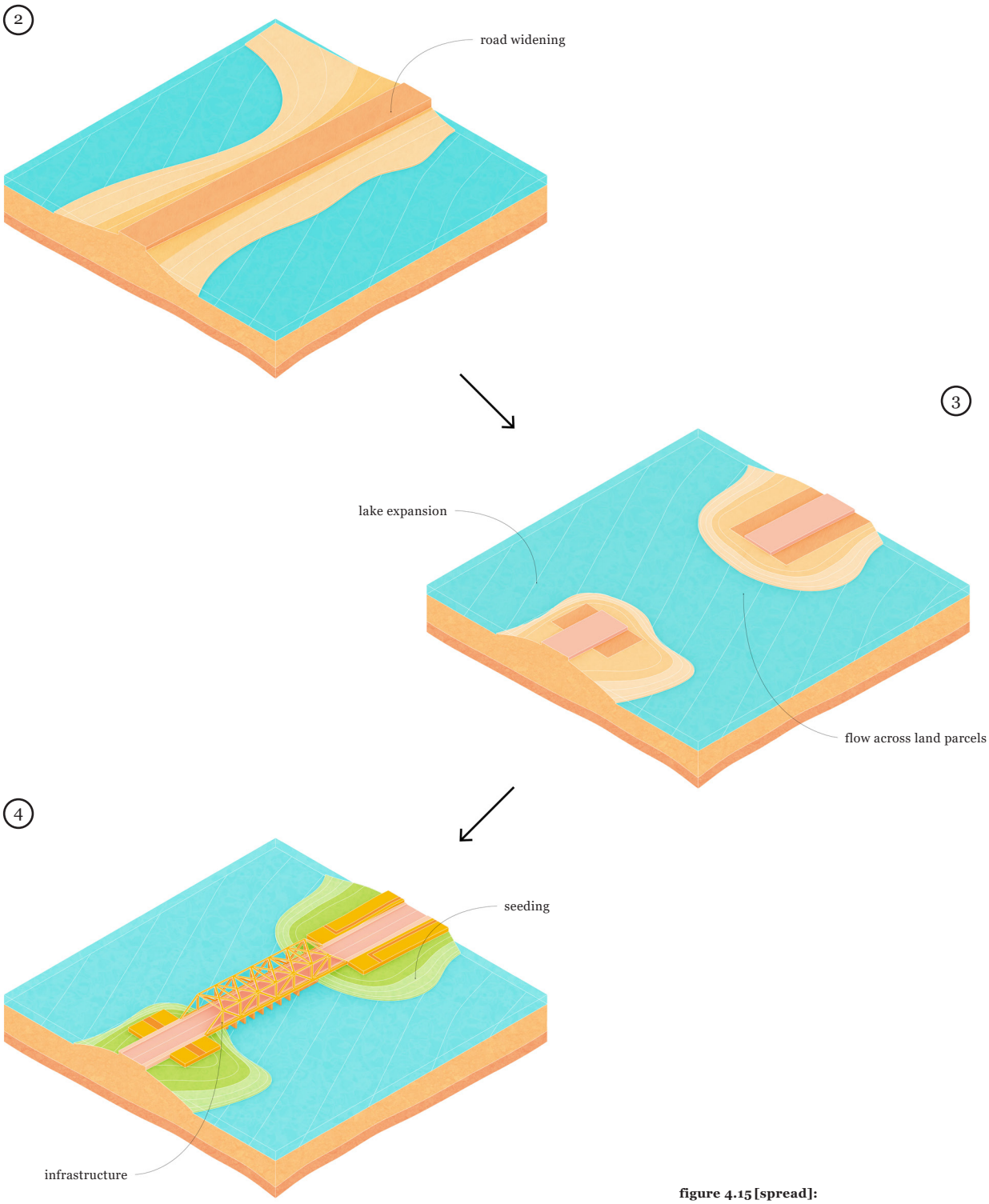


figure 4.15 [spread]:
terraforming sequence - key area #4

As illustrated in Figures 4.15-4.16, terraformation will include raising and widening the existing highway to allow access into the site. The new highway will be dissected by a bridge and floodgate to enable flow of water between land parcels. Additional social infrastructure are strategically scattered across the site to enable access and engagement with natural environments through community supported agriculture and eco-tourism initiatives.

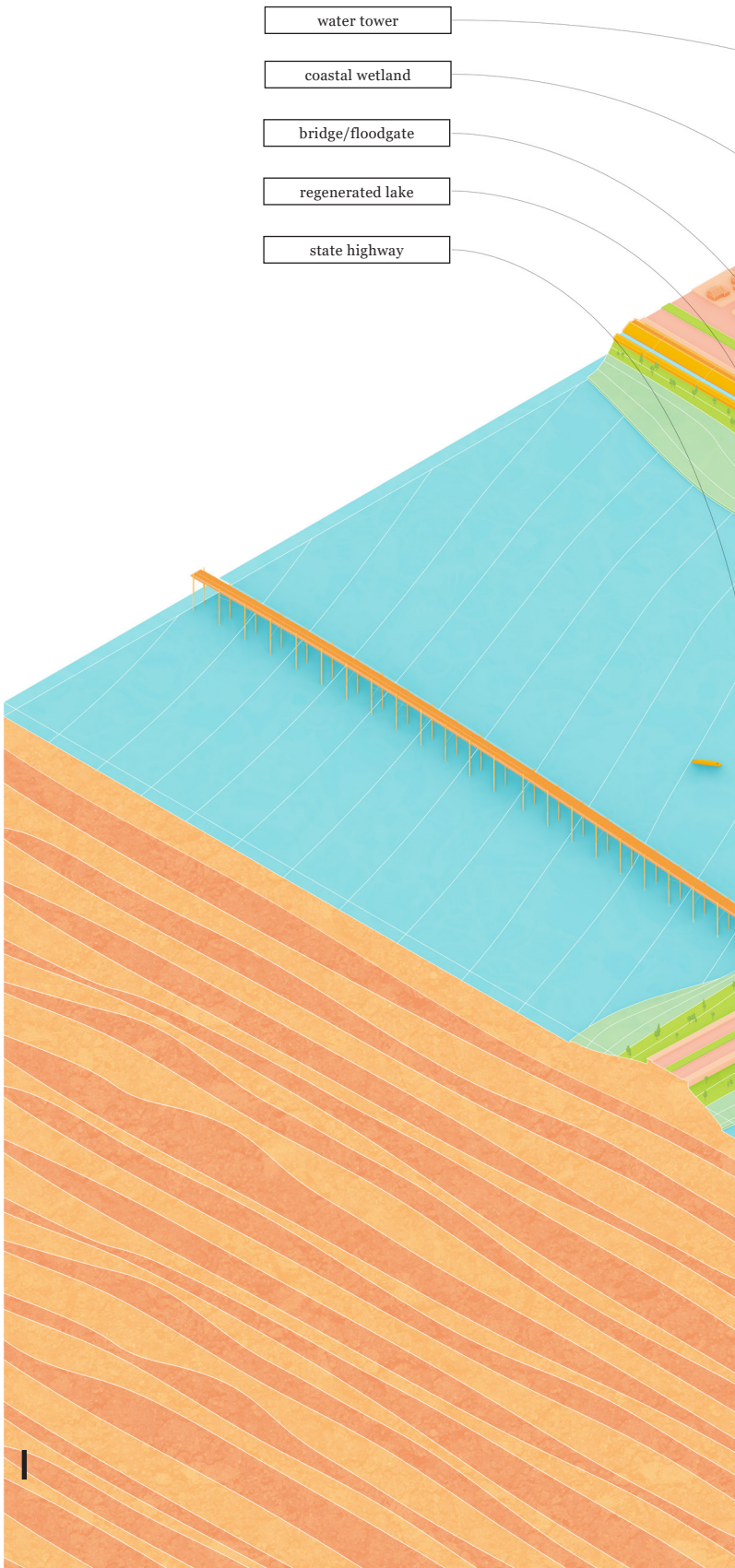


figure 4.16 [spread]:
isometric view - key area #4
post terraformation

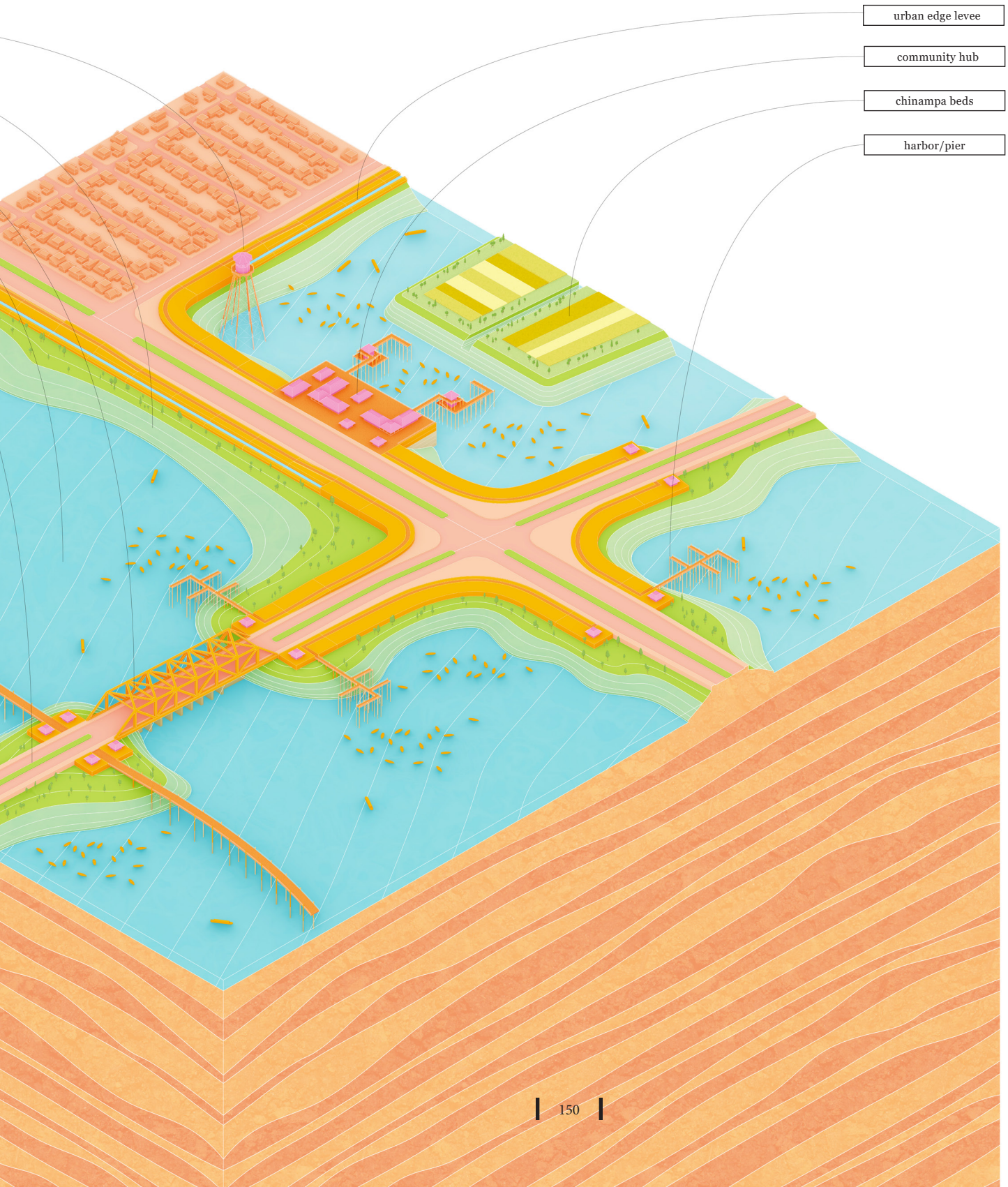
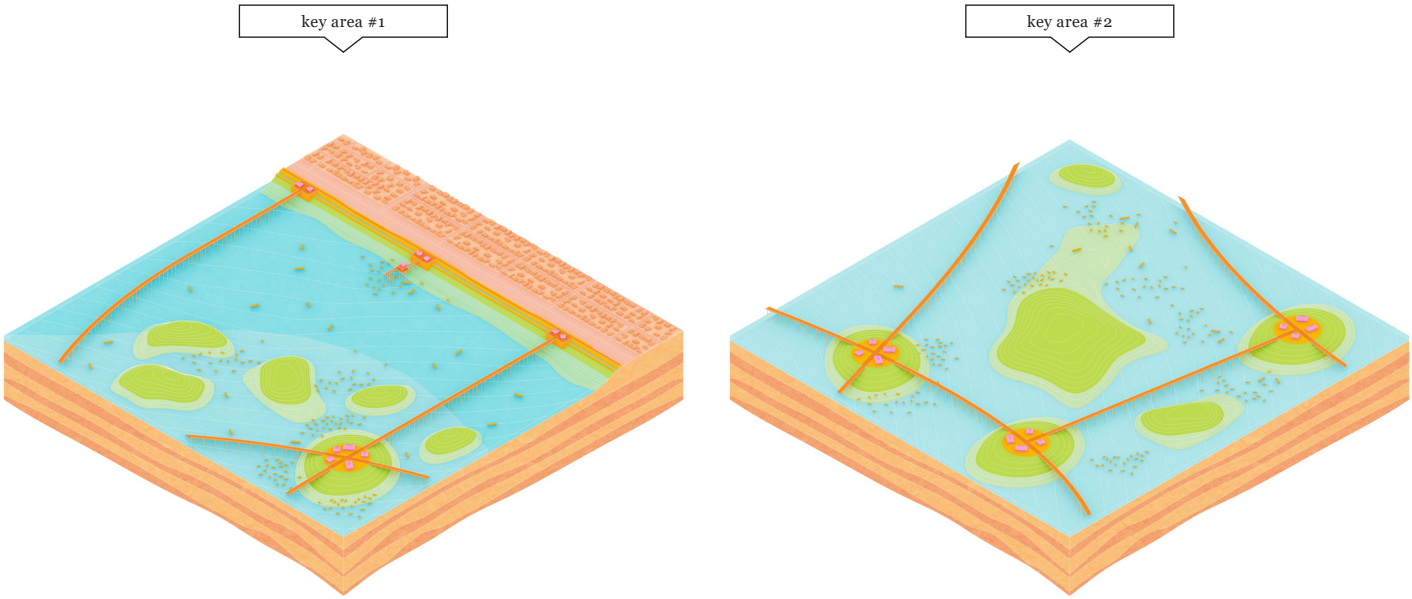
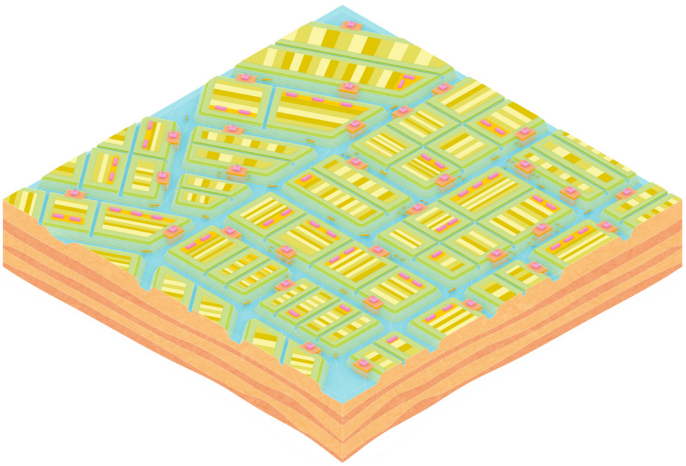

urban edge levee
community hub
chinampa beds
harbor/pier

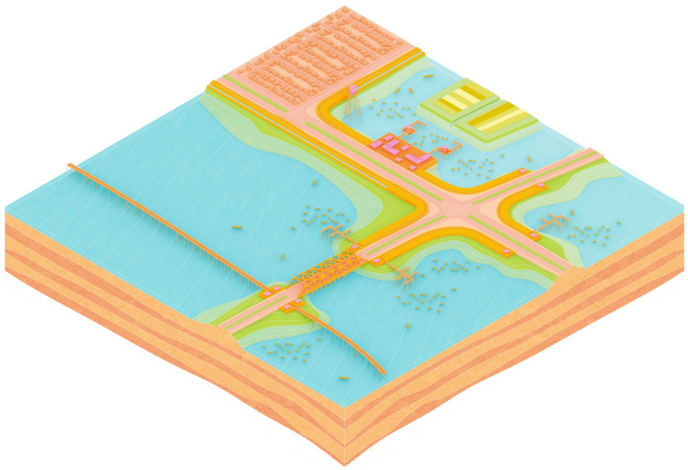
figure 4.17 [spread]:
isometric view
key areas - post terraformation

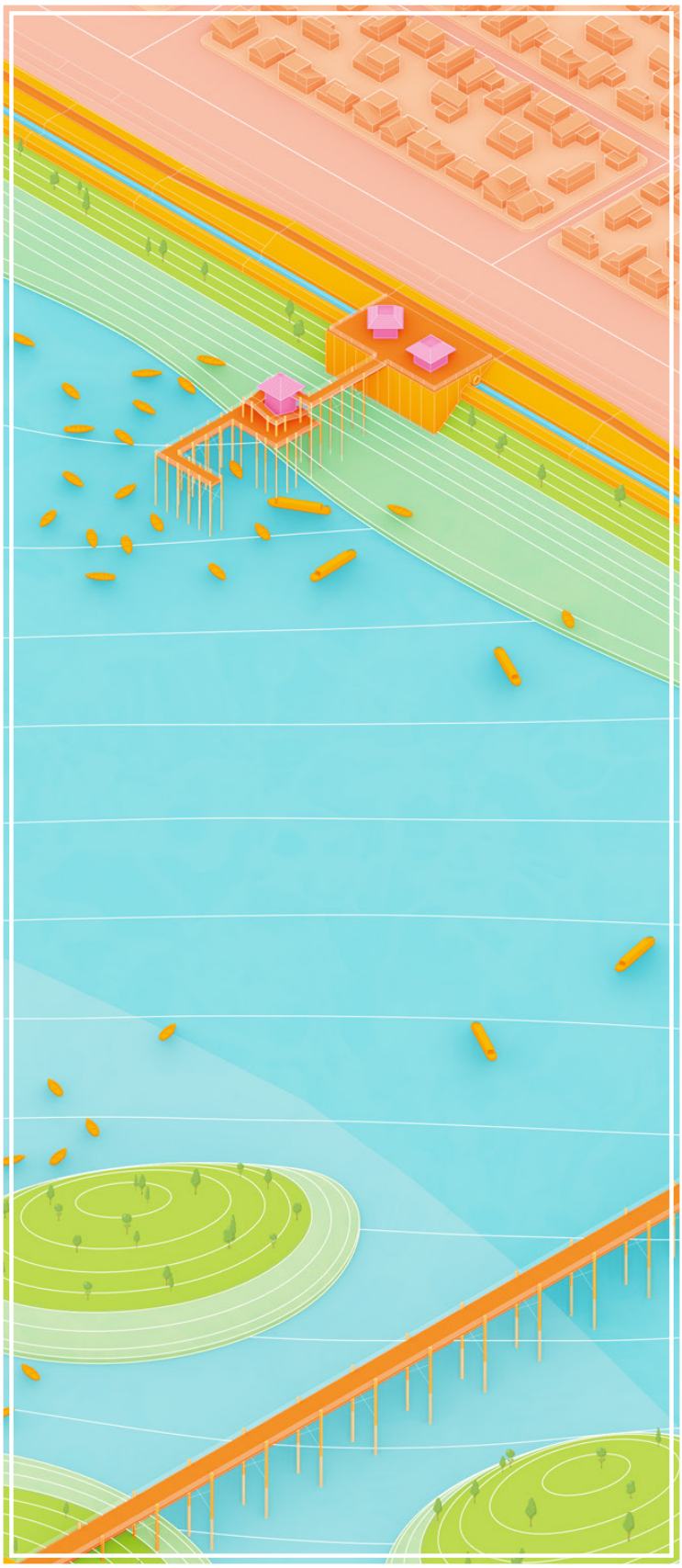


key area #3



key area #4





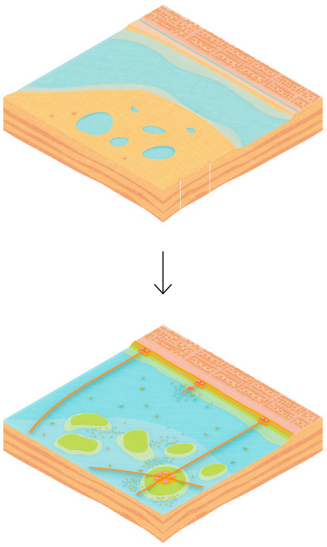
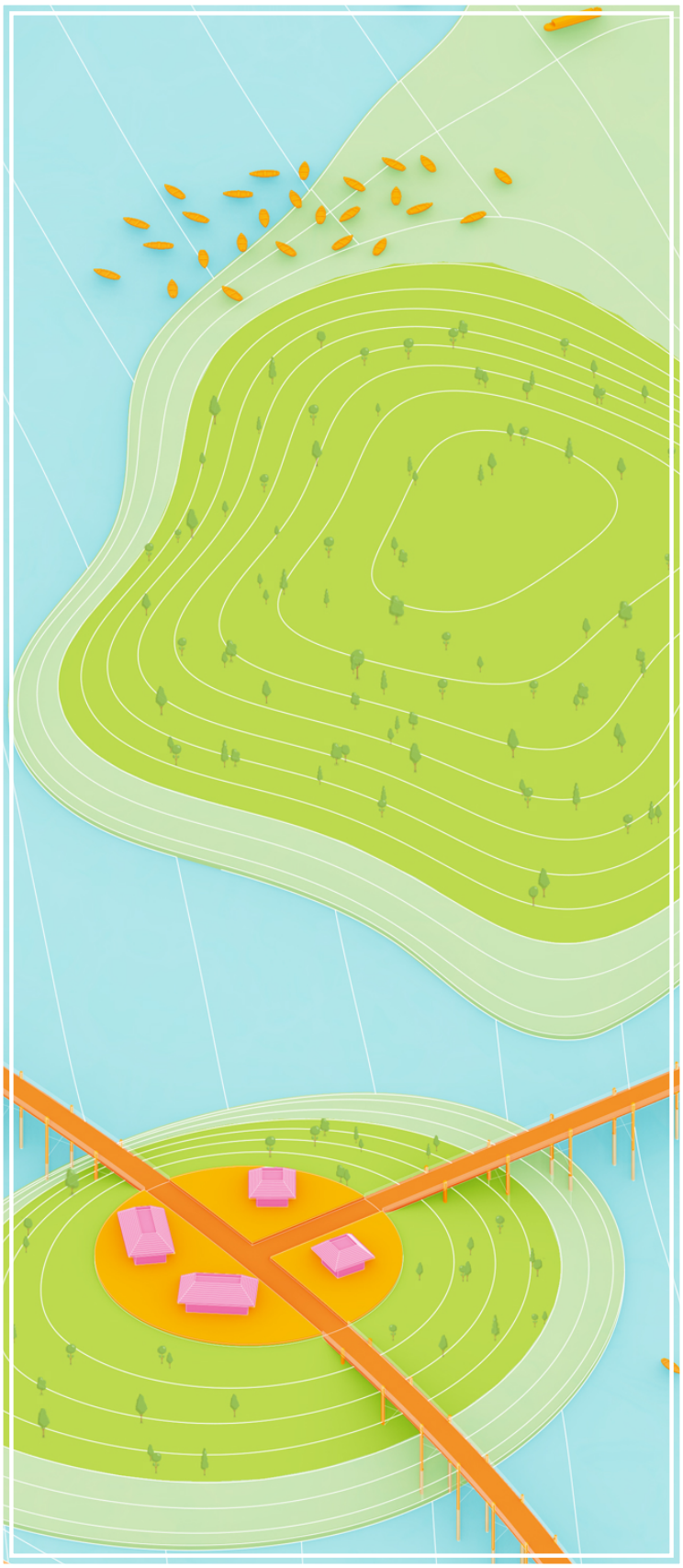


figure 4.18 [left]:
vignette - key area #1



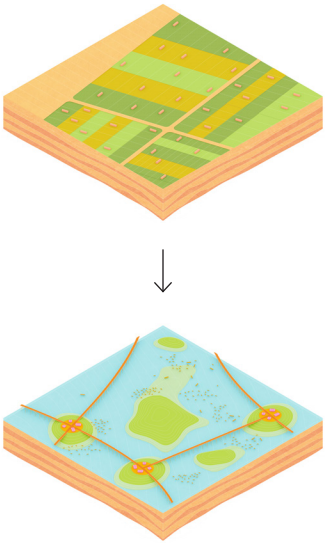
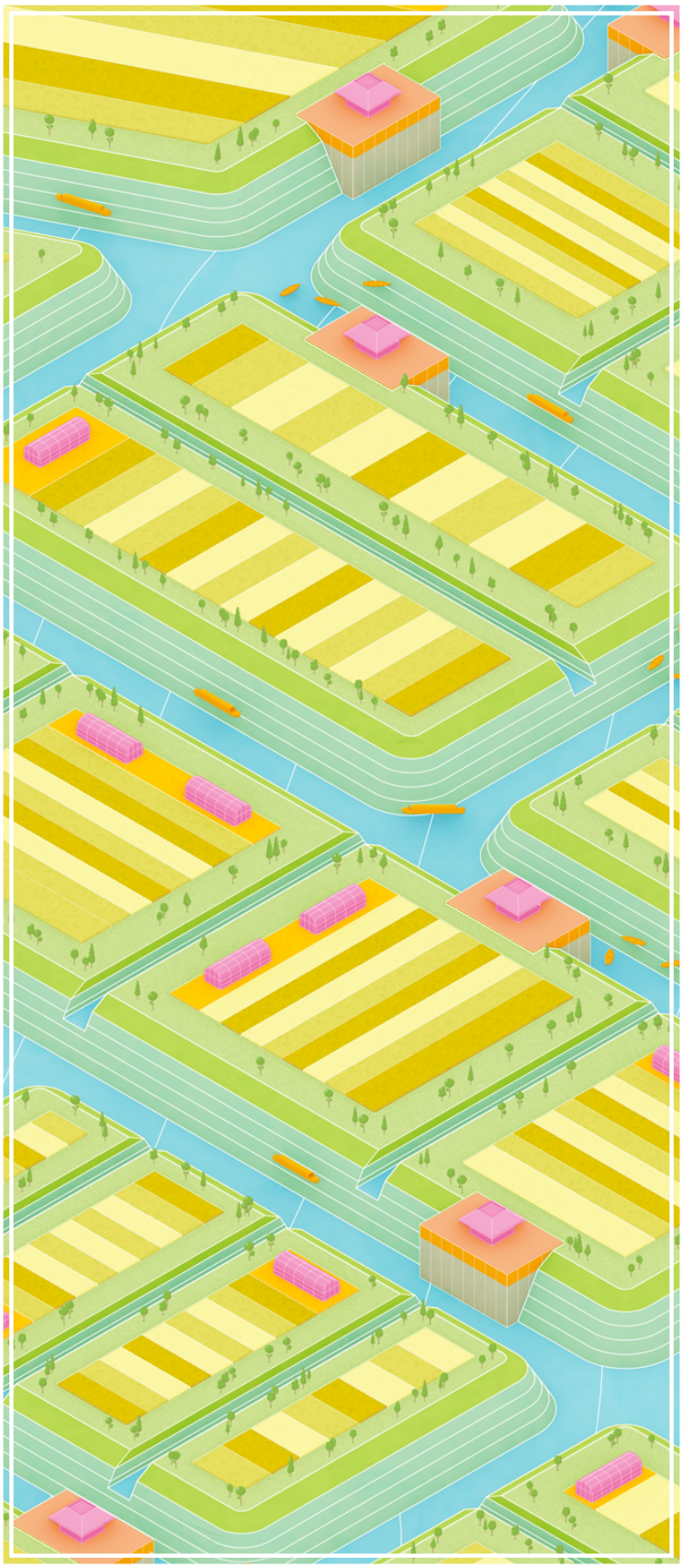


figure 4.19 [left]:
vignette - key area #2



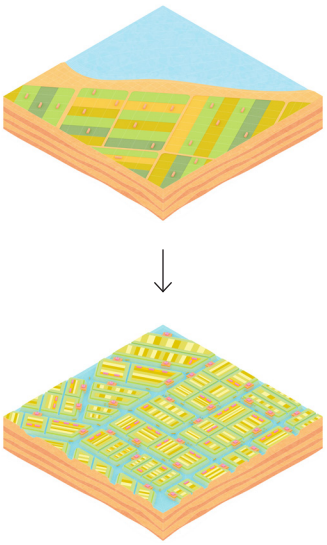


figure 4.20 [left]:
vignette - key area #3

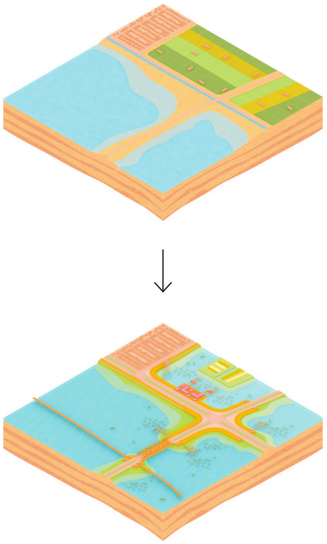


figure 4.21 [left]:
vignette - key area #4

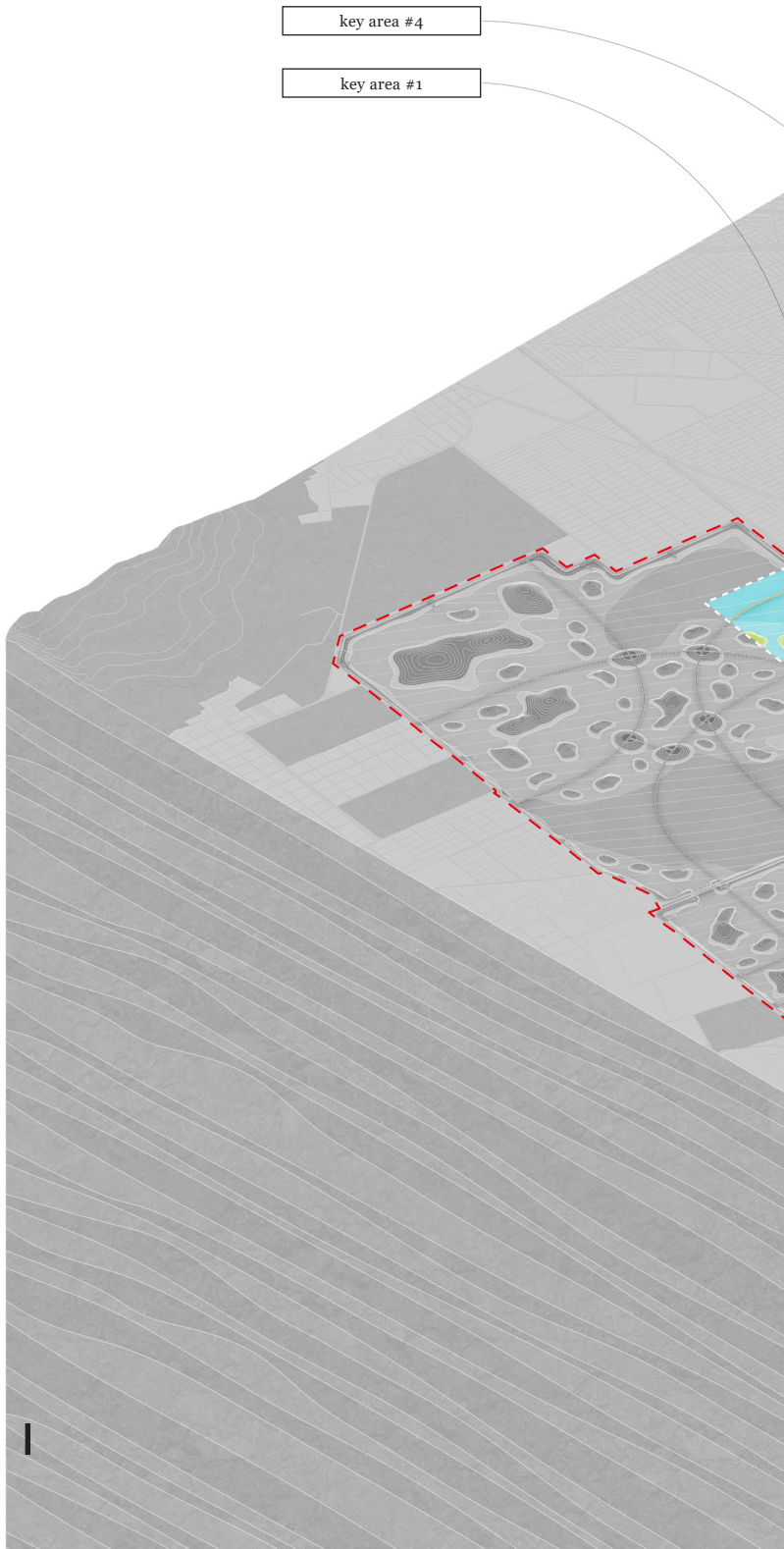
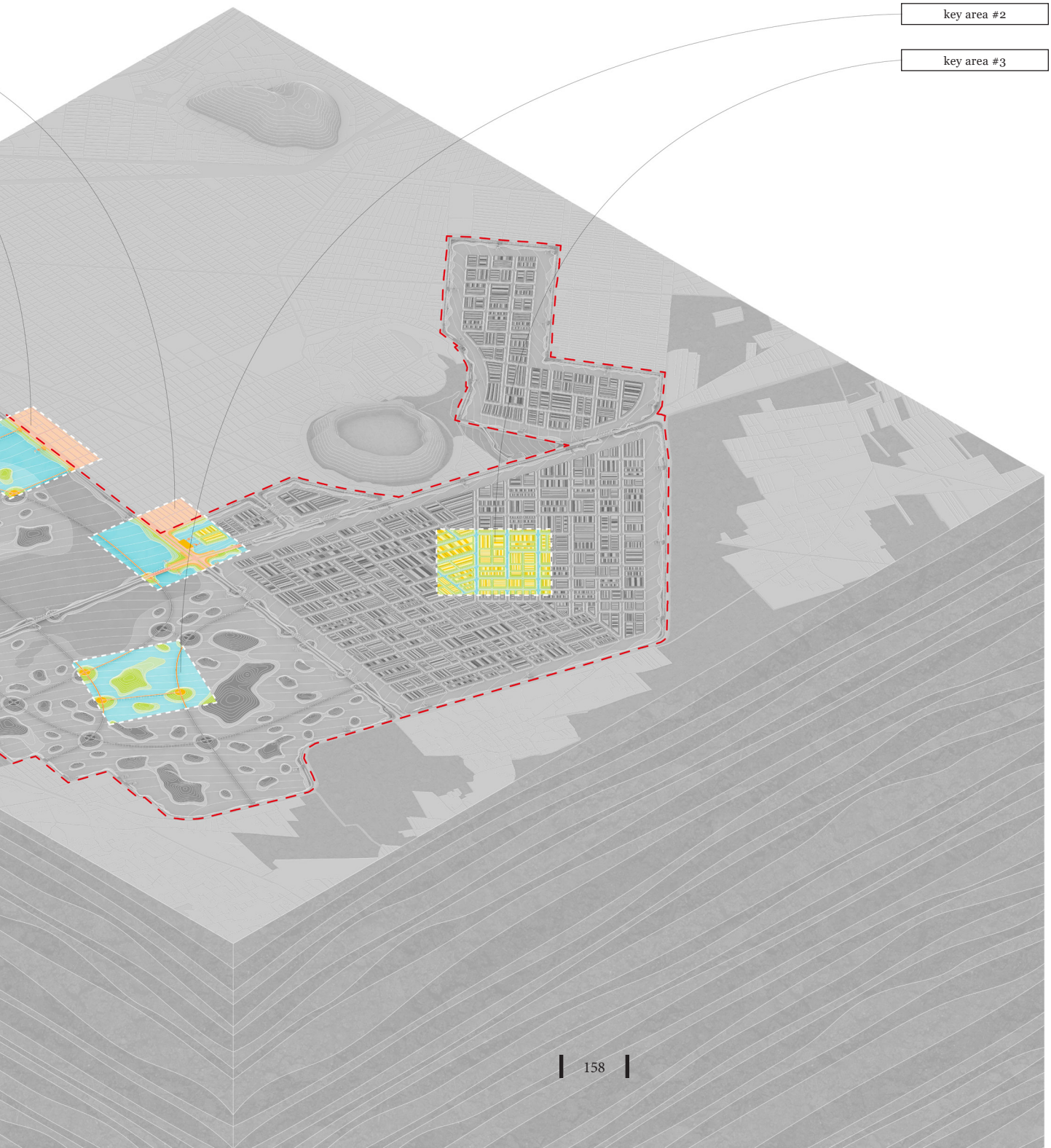


figure 4.22 [spread]:
isometric view
ecosystem design narrative- key areas


key area #2
key area #3

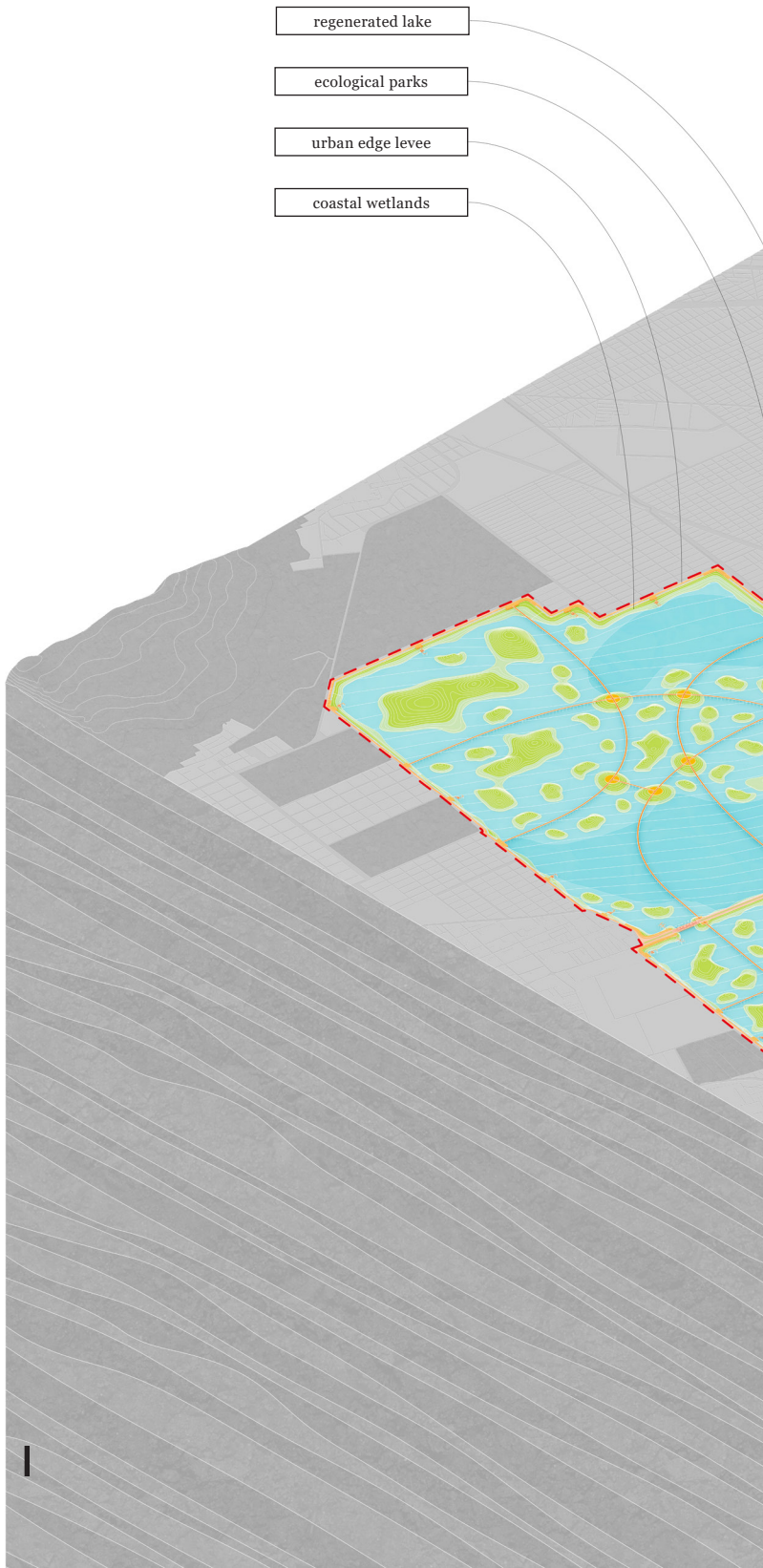
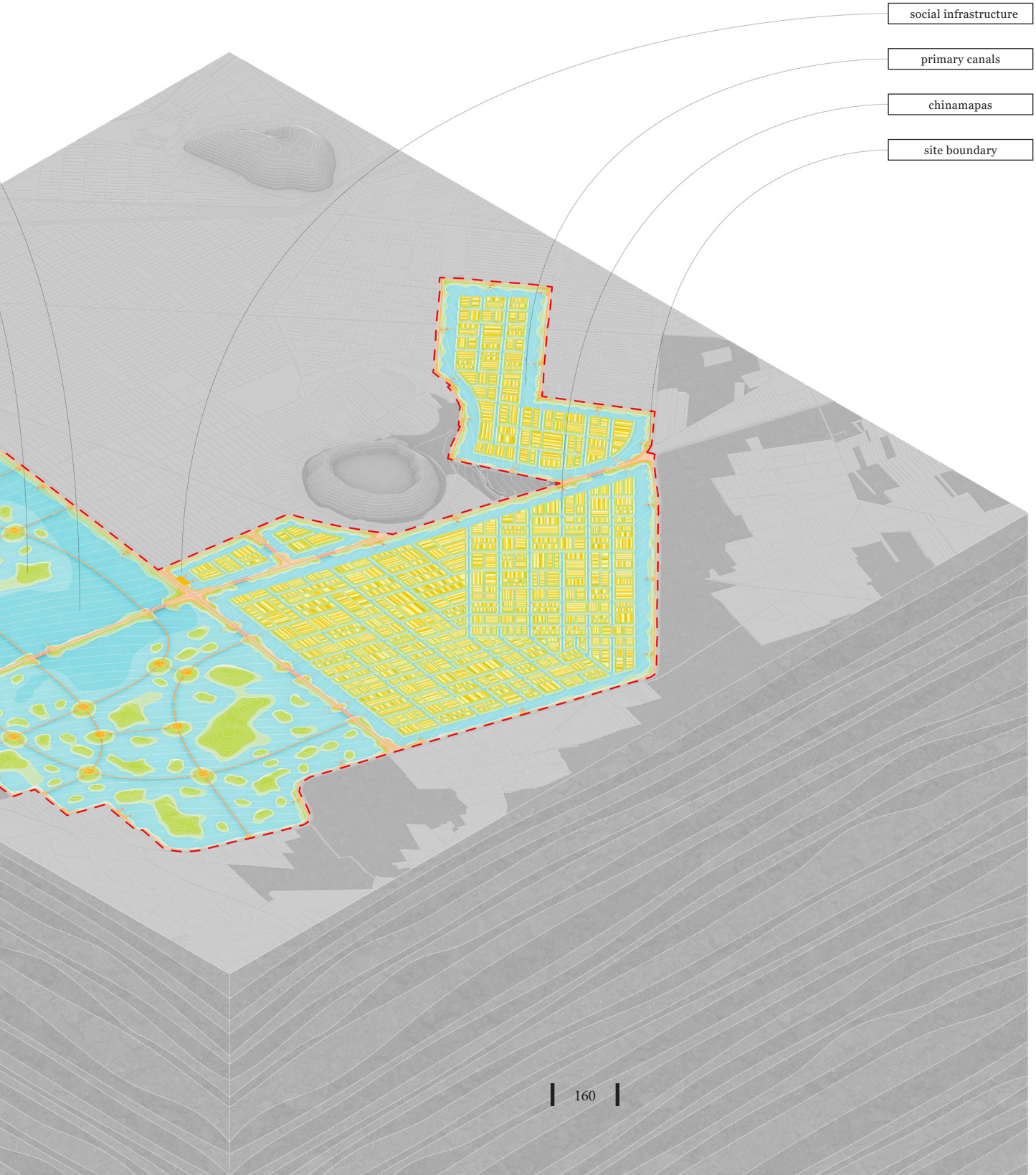


figure 4.23 [spread]:
isometric view
ecosystem design narrative - site boundary


social infrastructure
primary canals
chinamapas
site boundary

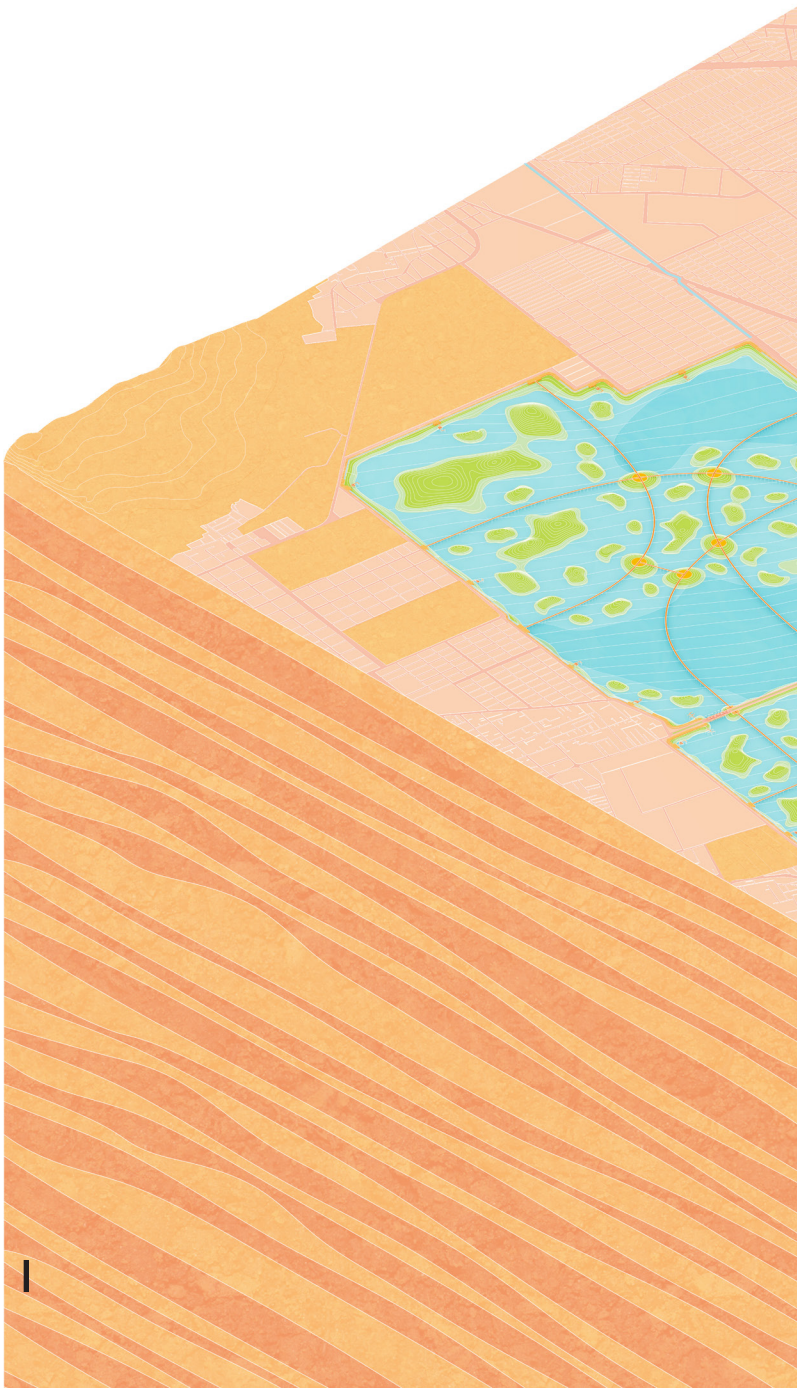
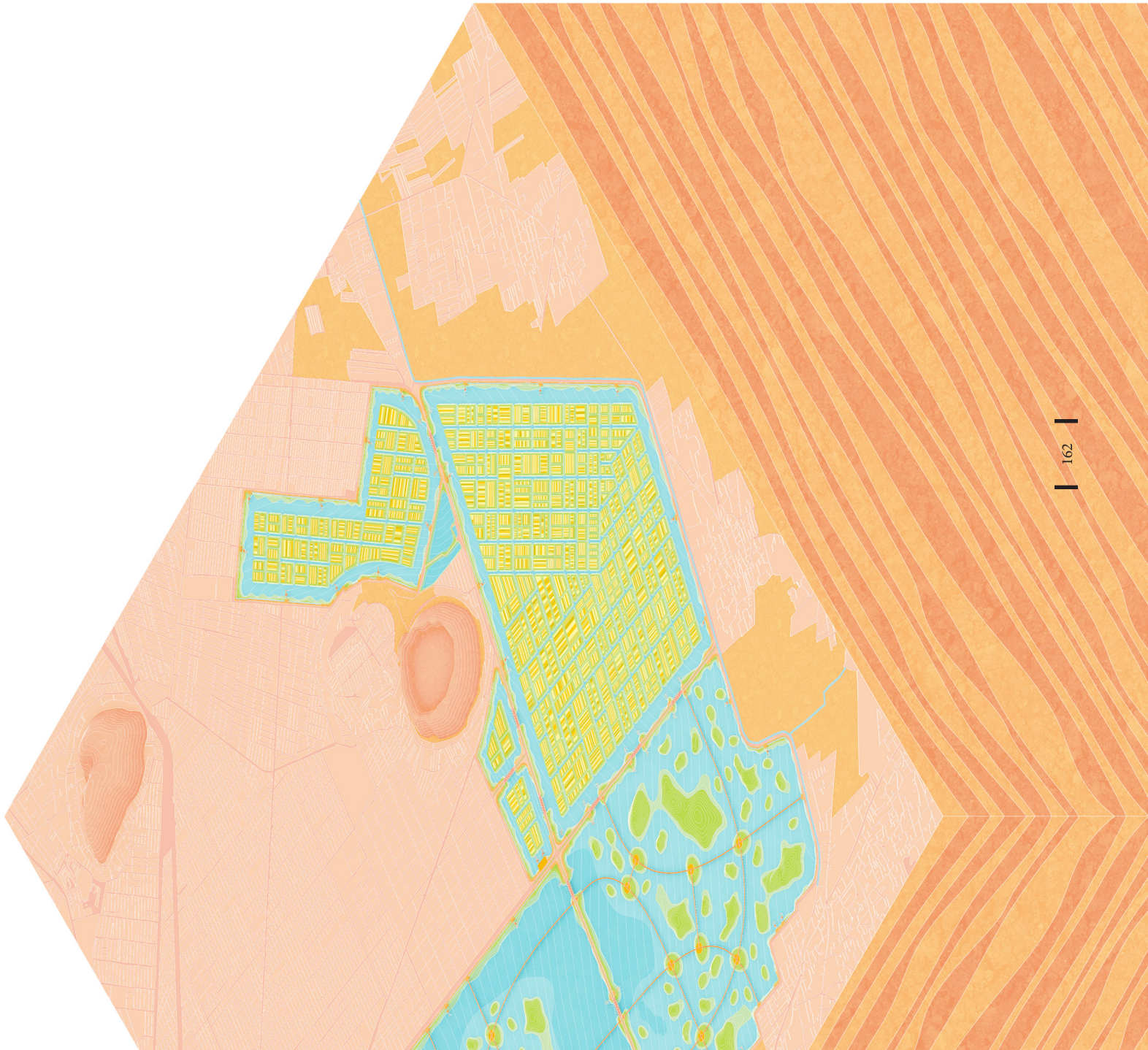
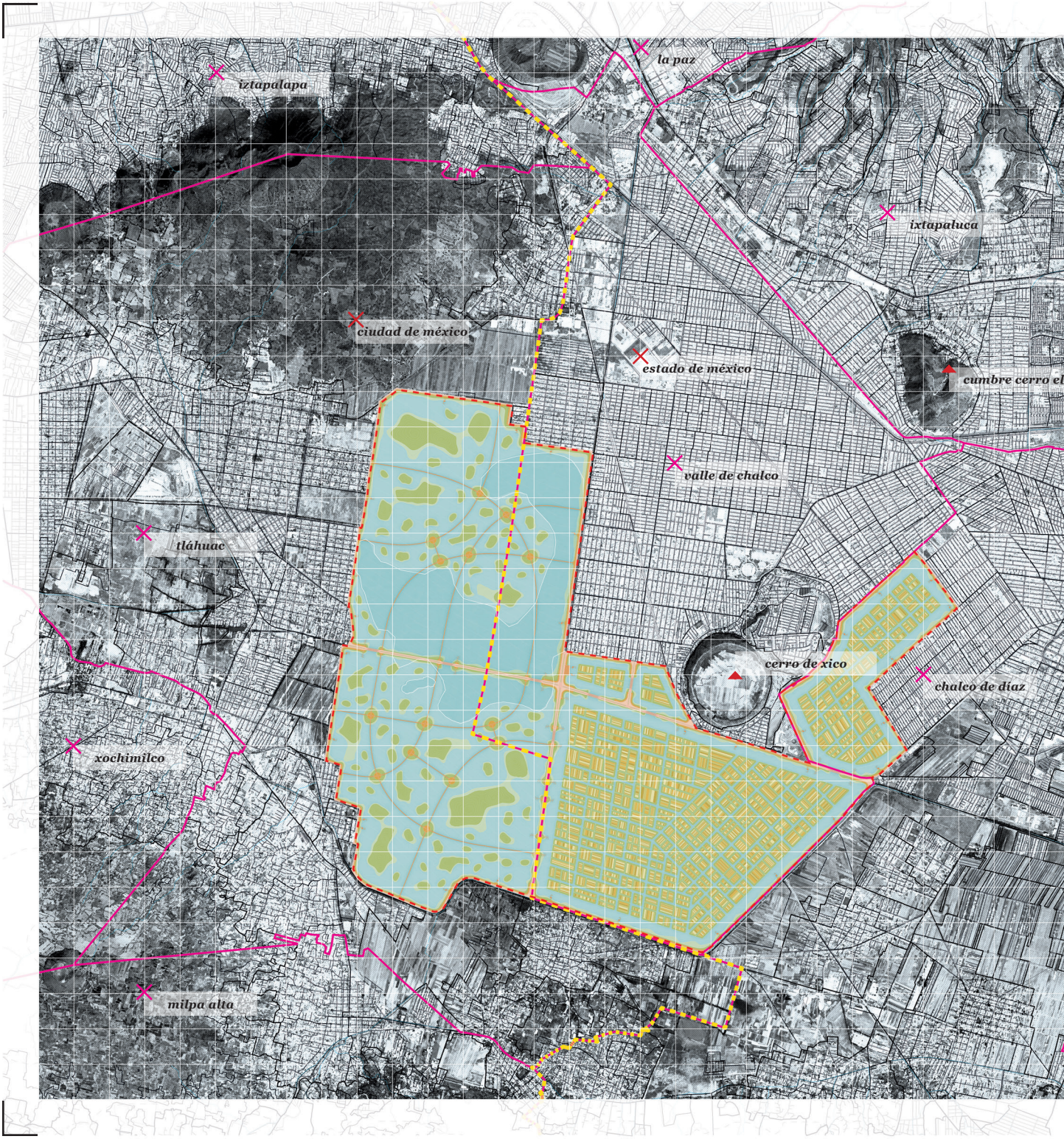


figure 4.24 [spread]:
isometric view
proposed ecosystem design narrative




iztapalapa
la paz
ixtapaluca
ciudad de méxico
estado de méxico
cumbre cerro el
valle de chalco
tláhuac
cerro de xico
chalco de díaz
xochimilco
milpa alta

extinct volcanoes
municipality
state // federal

municipal boundary
state boundary

proposed site boundary

0
500 m
1 km
2 km

figure 4.25 [left]:
ecosystem design narrative
proposed masterplan

Proposed masterplan

A viable realization of a reparations ecology in Chalco will entail the incremental application of various systems, strategies, and processes described in the previous sections of this thesis. As illustrated in the proposed masterplan (Figure 4.25), expanding and regenerating the returning lake will alleviate the flood risk imposed on adjacent urban areas as well as provide avenues for better water management in the region. The western portion of the site will accommodate the regenerated lake on an undulating terrain interspersed with ecological parks and contained by coastal wetlands. The urban edge condition and existing roads are reinvigorated to create integrated infrastructure systems that adapt and compliment natural regeneration. The eastern portion of the site, which was previously dedicated to unsustainable mono-crop agriculture, is transformed to create a network of chinampas and canals that promote regenerative farming. The masterplan also includes various social infrastructure in the form of community hubs, docks, piers, and nature trails that acts as mediums for access, engagement, maintenance and preservation of the ensuing socio-ecological landscape.

Design outcomes

Water Resilience: As a region that receives yearly rainfalls that far exceed its freshwater demand, Chalco is presented with a unique opportunity to harvest the returning lake and its surrounding areas to create a decentralized self-sufficient model for the cyclical utilization of local water resources. In the proposed ecosystem design narrative, water will cover about 65% of the total site area i.e. 5800 acres. The returning lake would expand by 6.7 times in surface area. In addition to collecting rainwater, treated sewage water could be used to regenerate the returning lake.

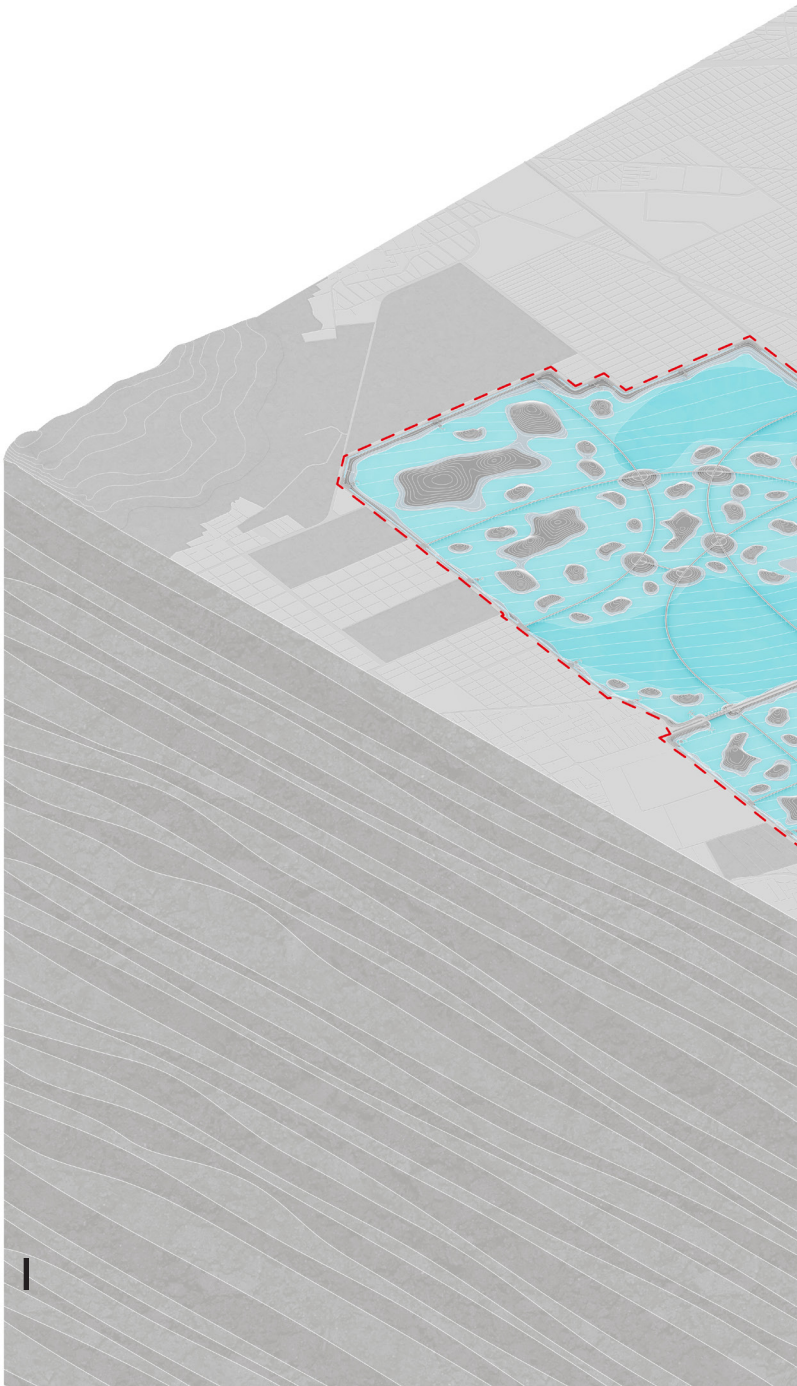
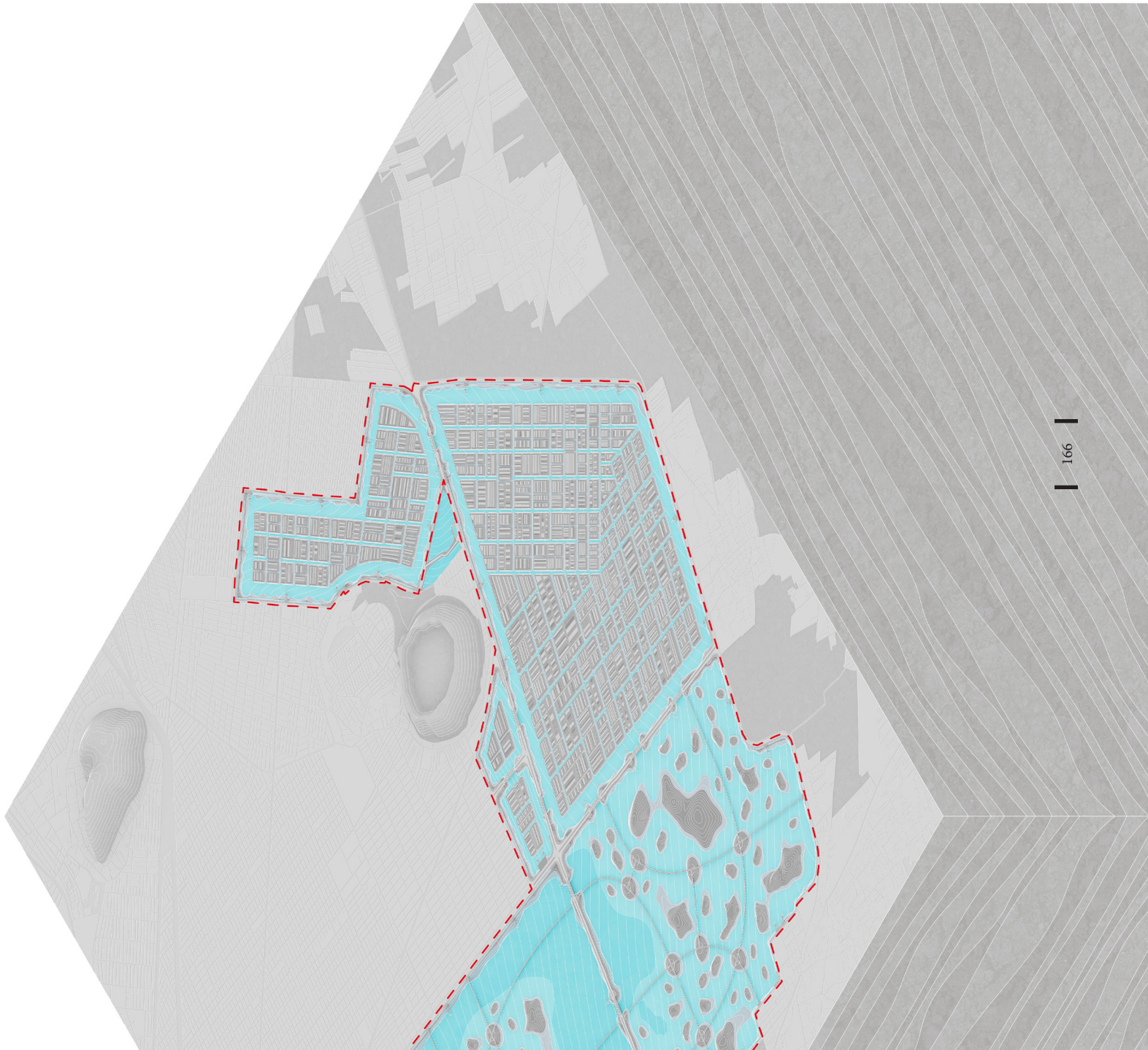
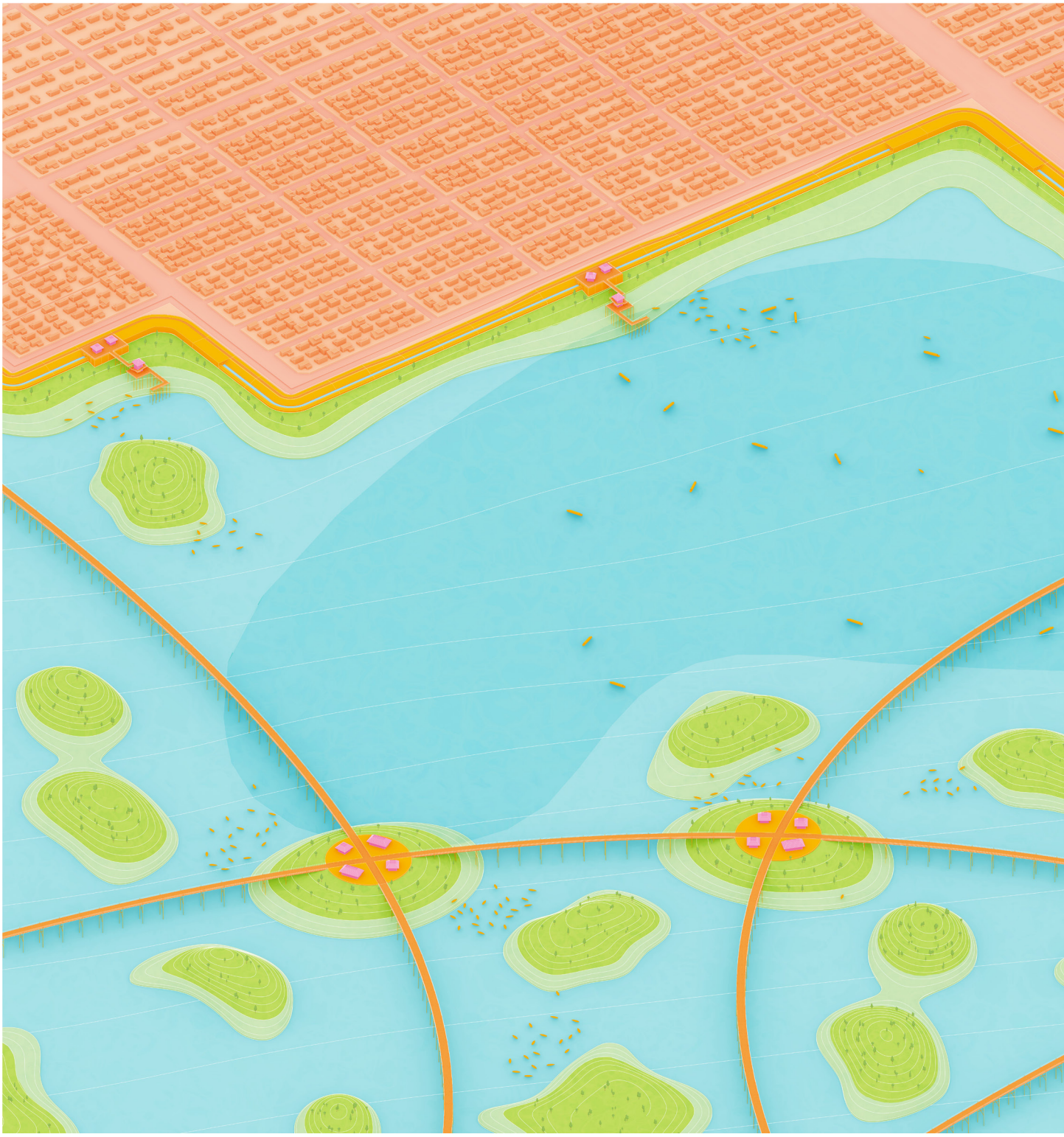
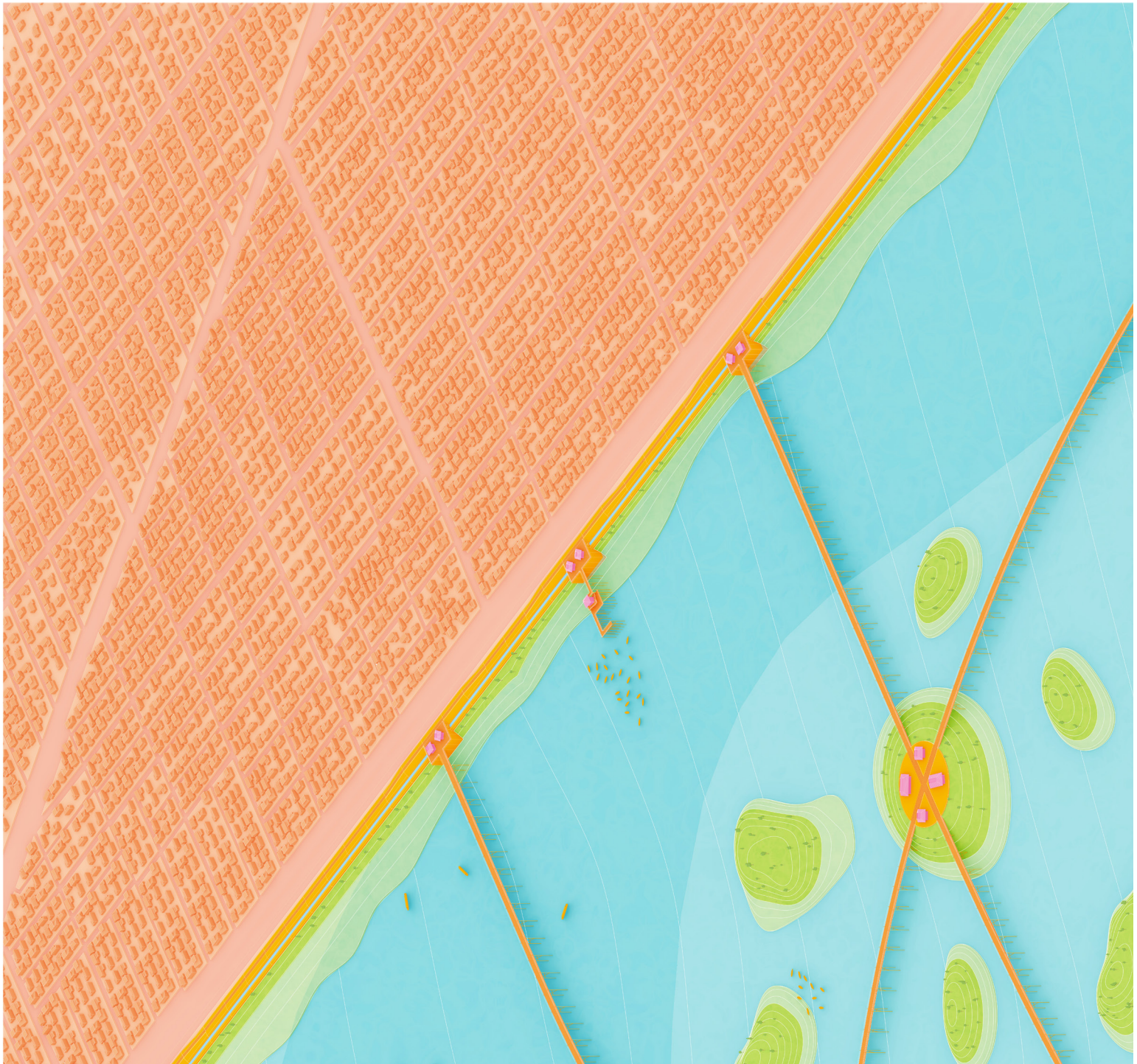


figure 4.26 [spread]: isometric view - water

figure 4.27 [next spread]: vignette #1







Lacustrine Ecosystems: The coastal wetlands along the urban edge and ecological parks would act as sponges that passively absorb, filter and retain water. In addition to providing habitats and improving biodiversity, wetlands will serve as a buffer between water and people, and enable an eco-tourism program. Wetlands will cover more than 1000 acres, which accounts for around 11.2% of the total site area.

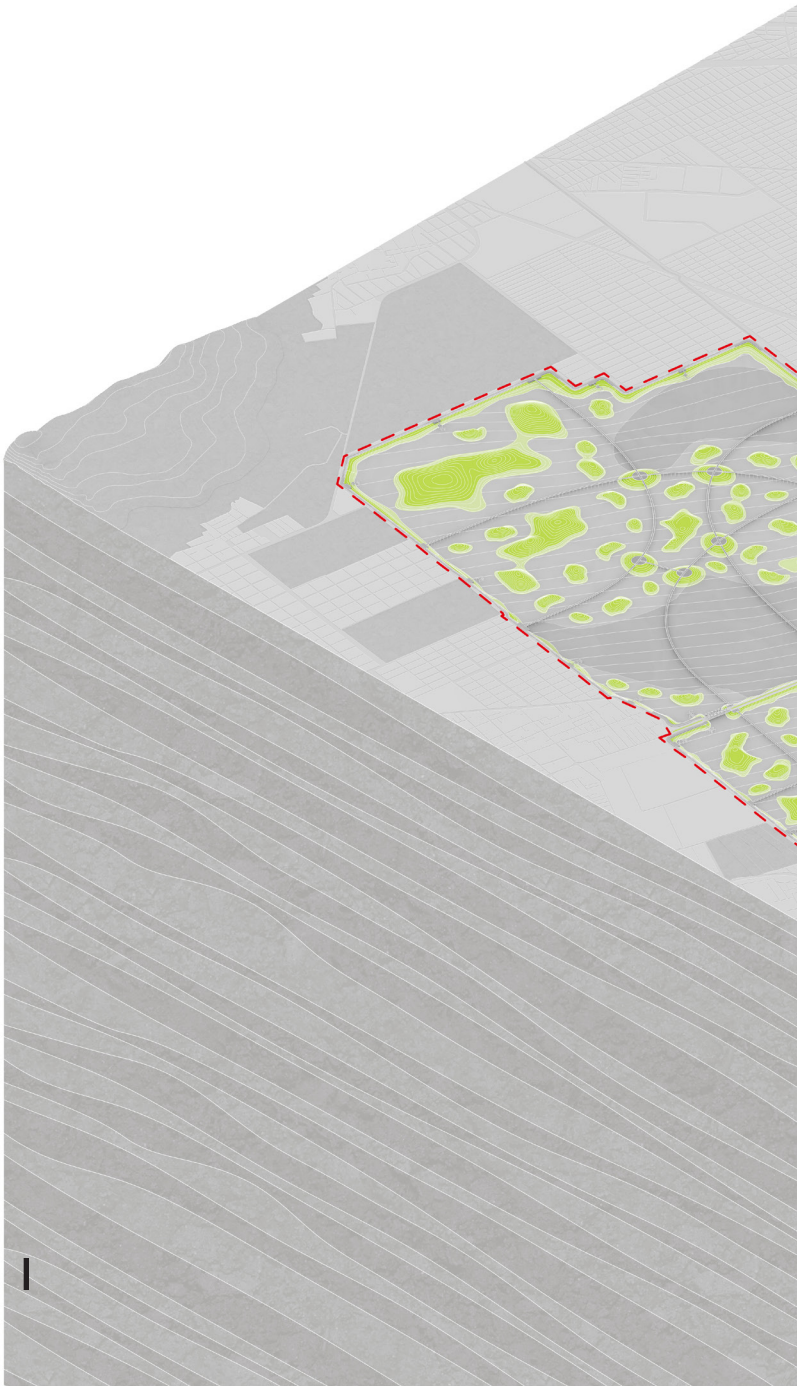
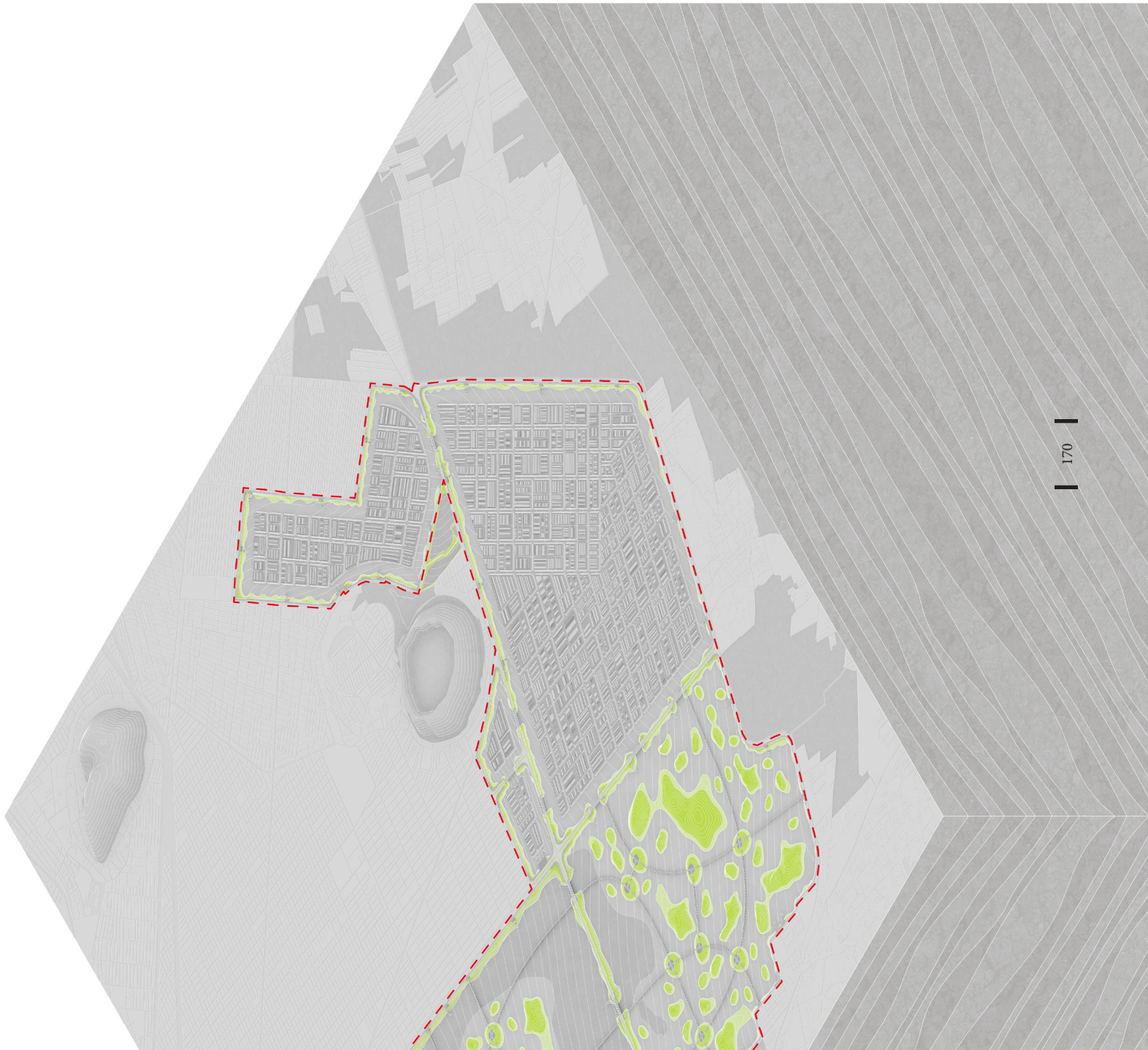
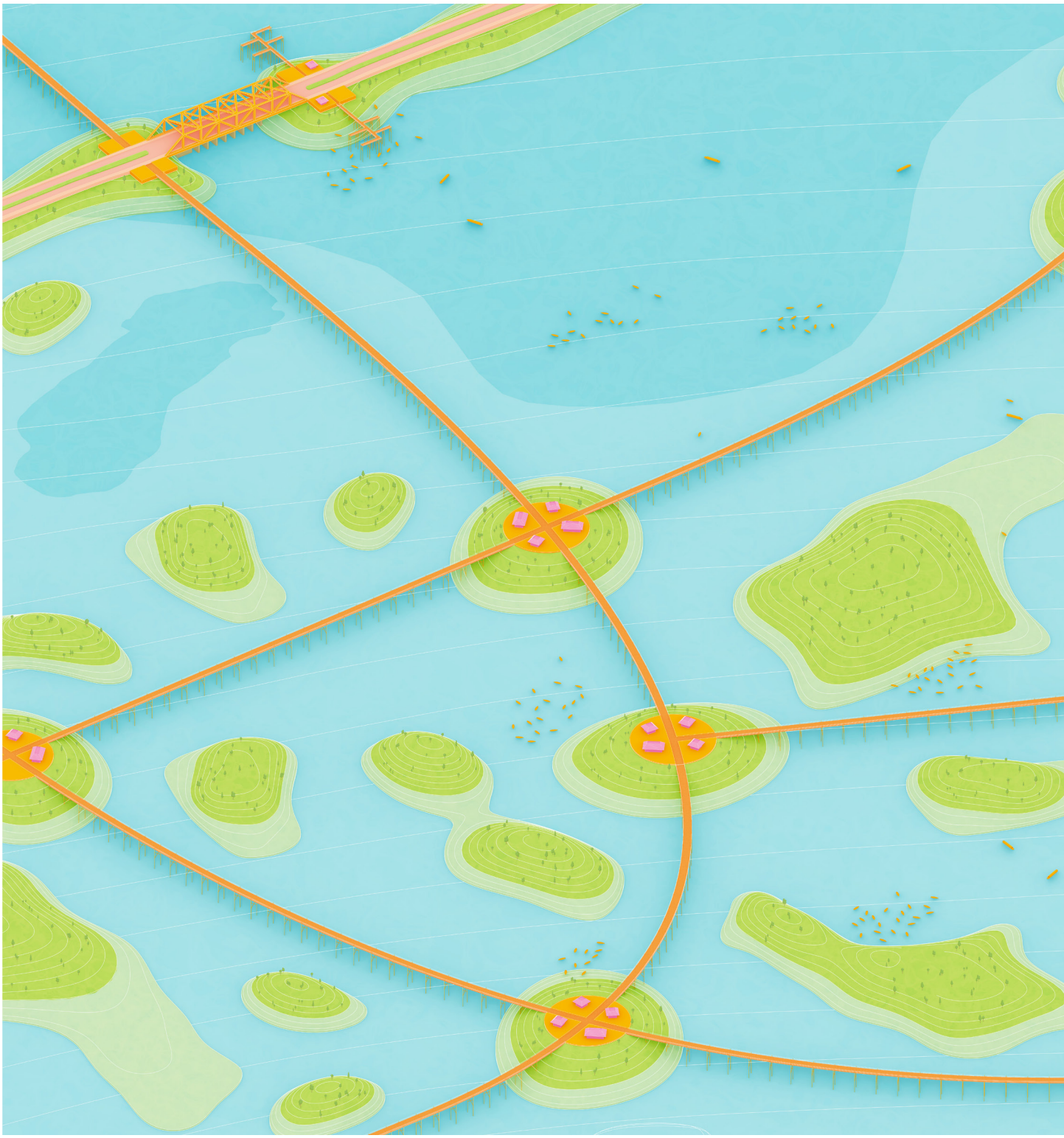
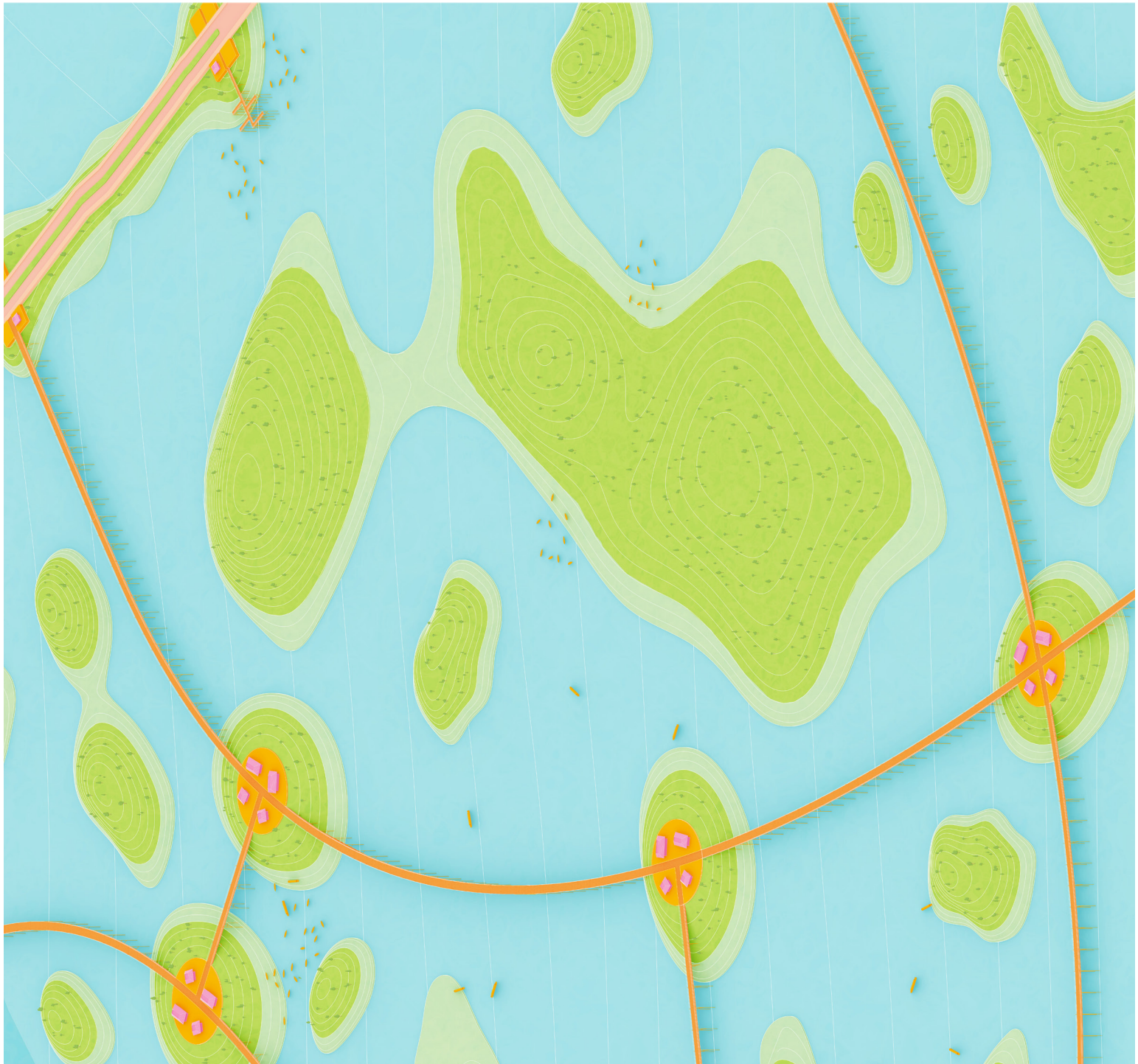


figure 4.28 [spread]: isometric view - wetlands.

figure 4.29 [next spread]: vignette #2







Regenerative Agriculture: Chinamapas will cover around 2100 acres of land, which accounts for 23.7% of the total site area. Chinampas are climate change resilient and would alleviate the stresses imposed on water resources for agriculture. Although chinampa agriculture is not scalable to meet industrial agricultural demands, they provide a wide range of ecosystem services that promotes natural regeneration. It will also allow for the formation of community supported agriculture programs that provide locally sourced organic produce to restaurants and consumers in the city.

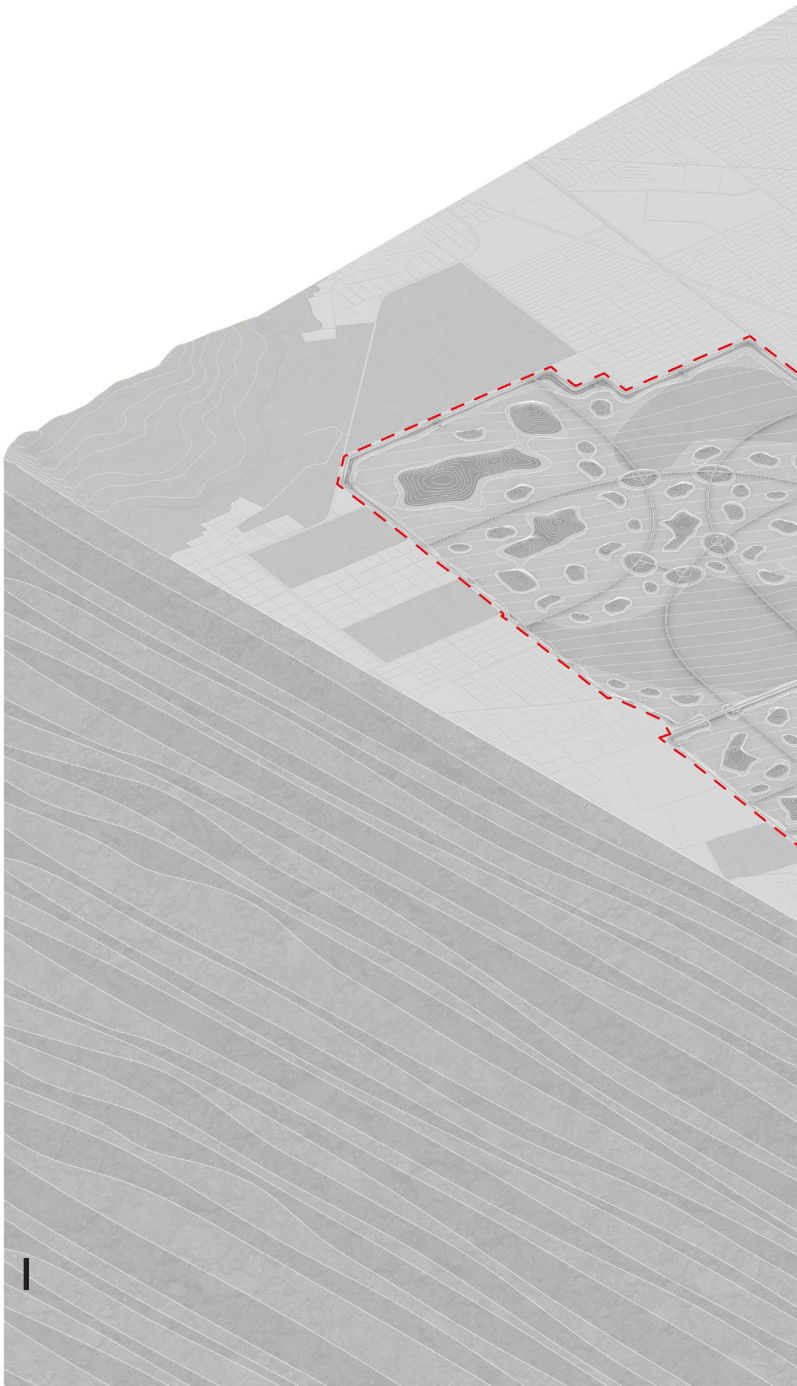
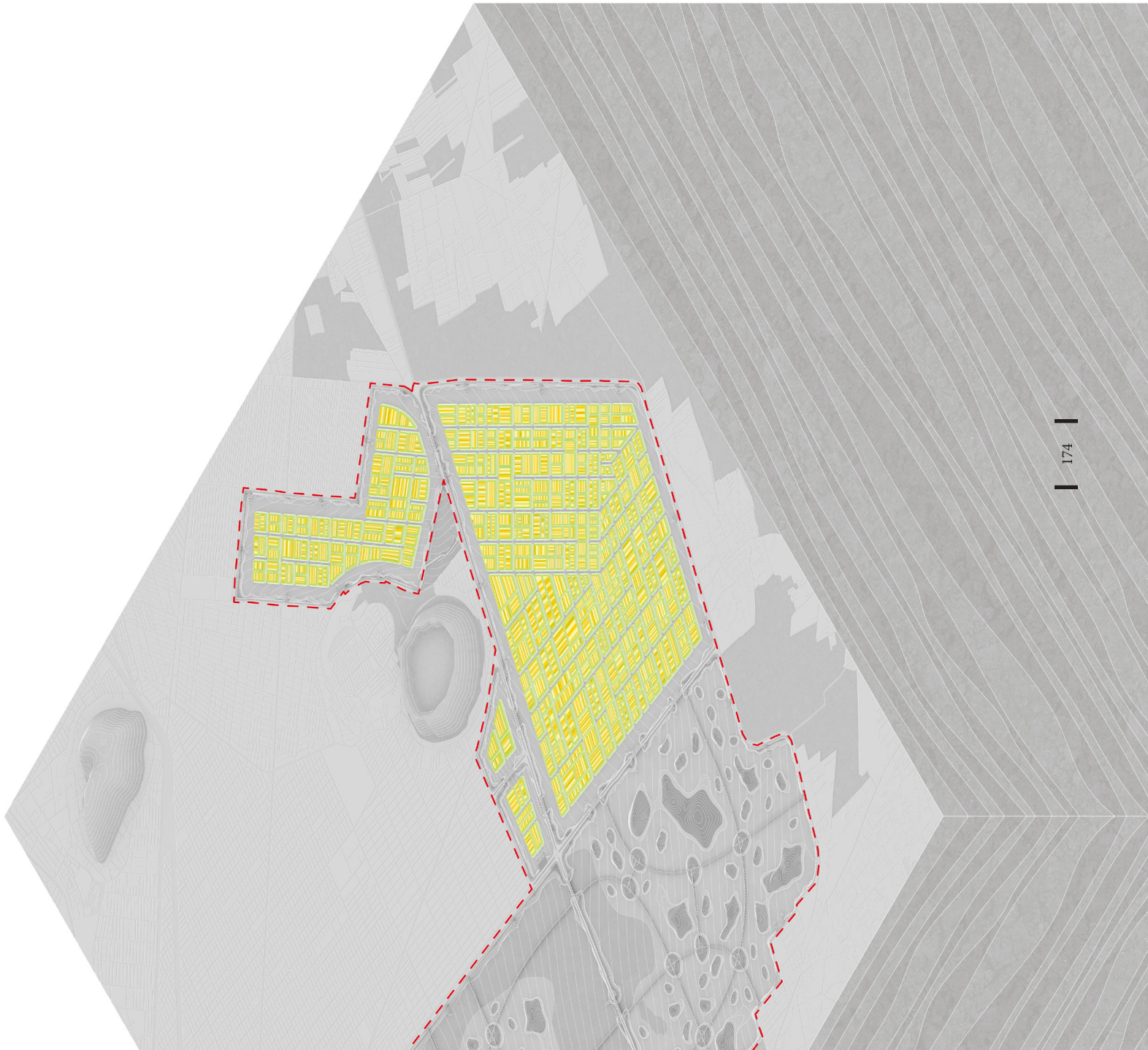
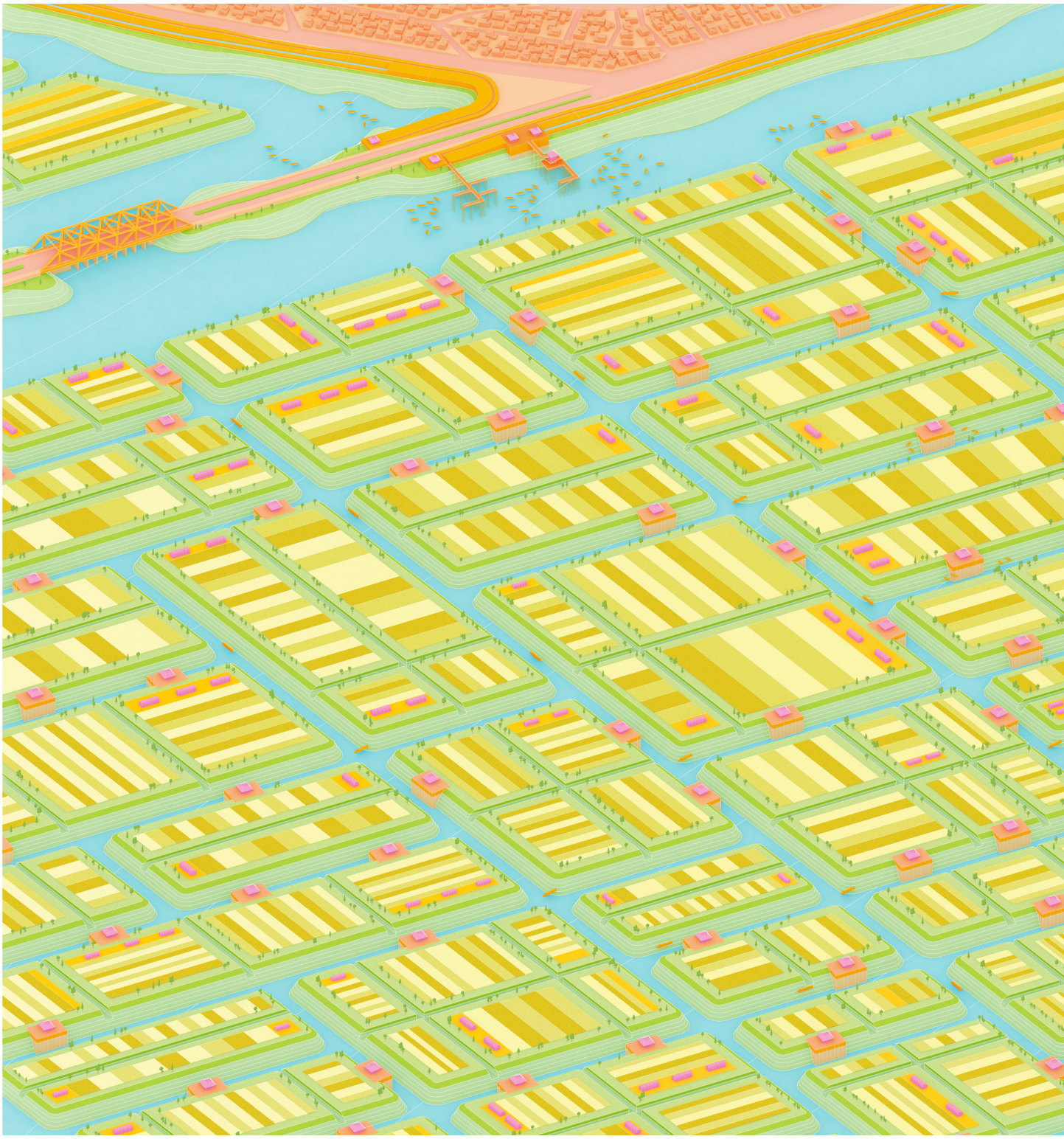
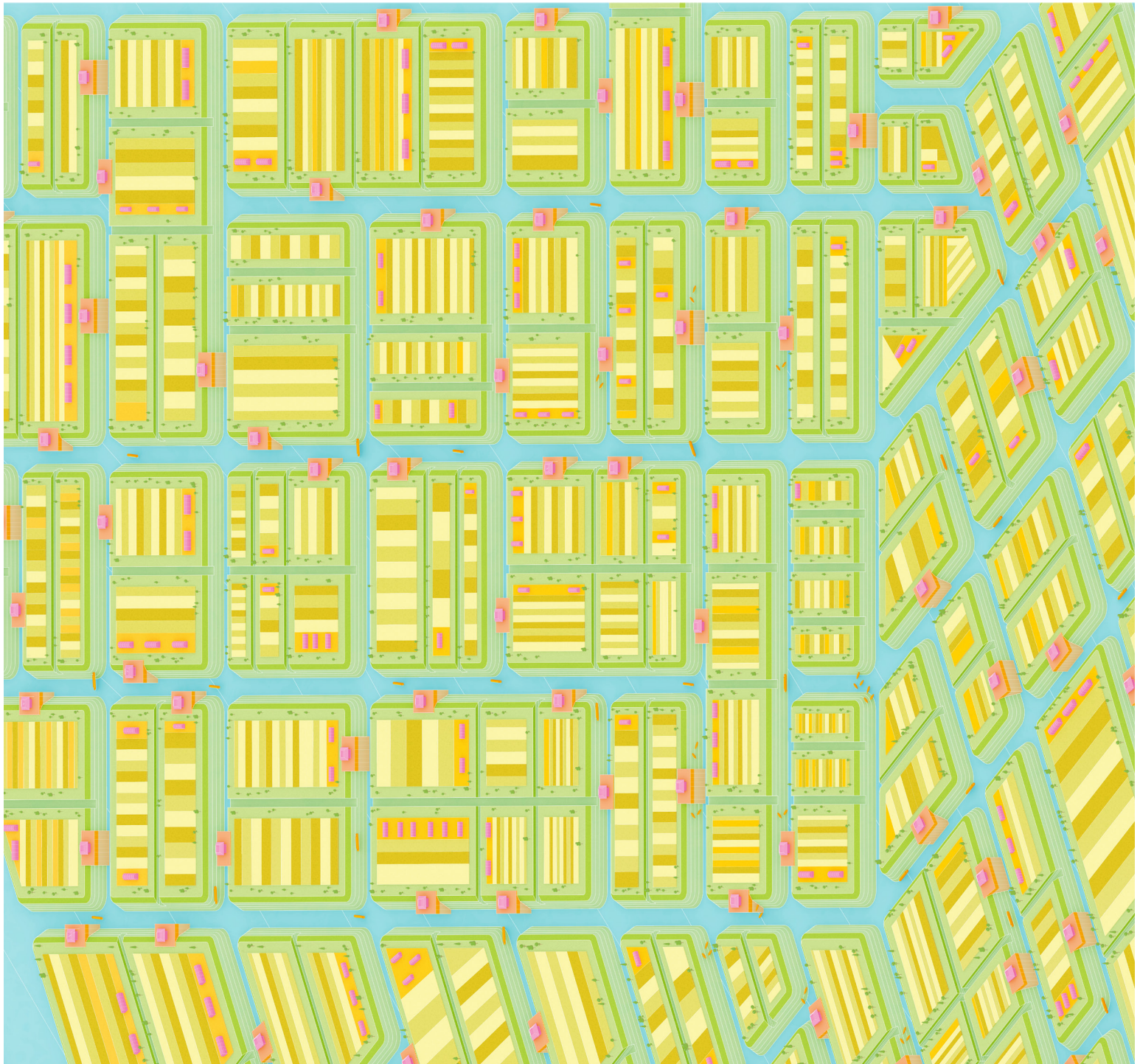


figure 4.30 [spread]: isometric view - chinampas

figure 4.31 [next spread]: vignette #3







Social Infrastructure: This would include community hubs, harbors and piers, nature trails, flood-gates, and other built infrastructure that are embedded across the site. They will offer spatial mediums for building social capital, promoting community engagement, and enabling the maintenance and preservation of the socio-ecological landscape.

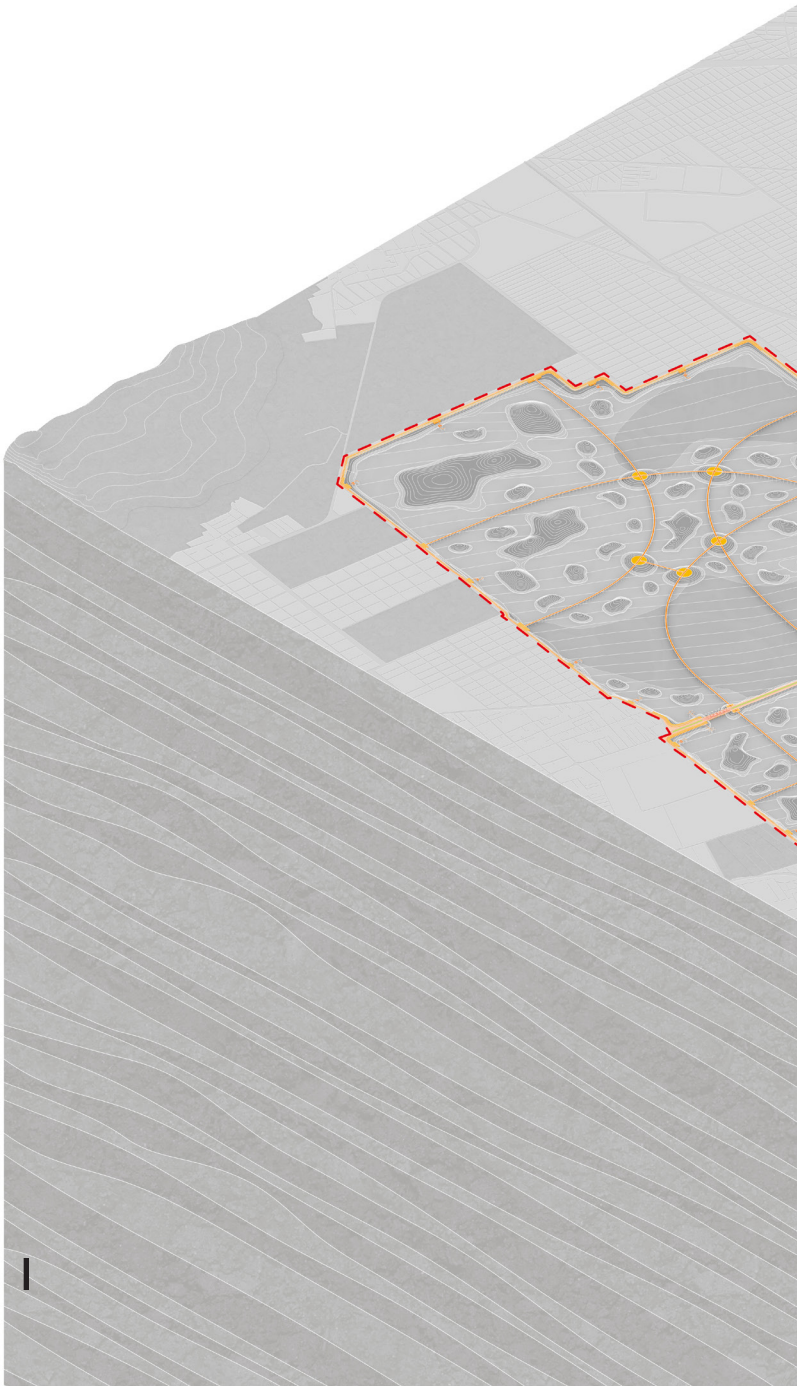
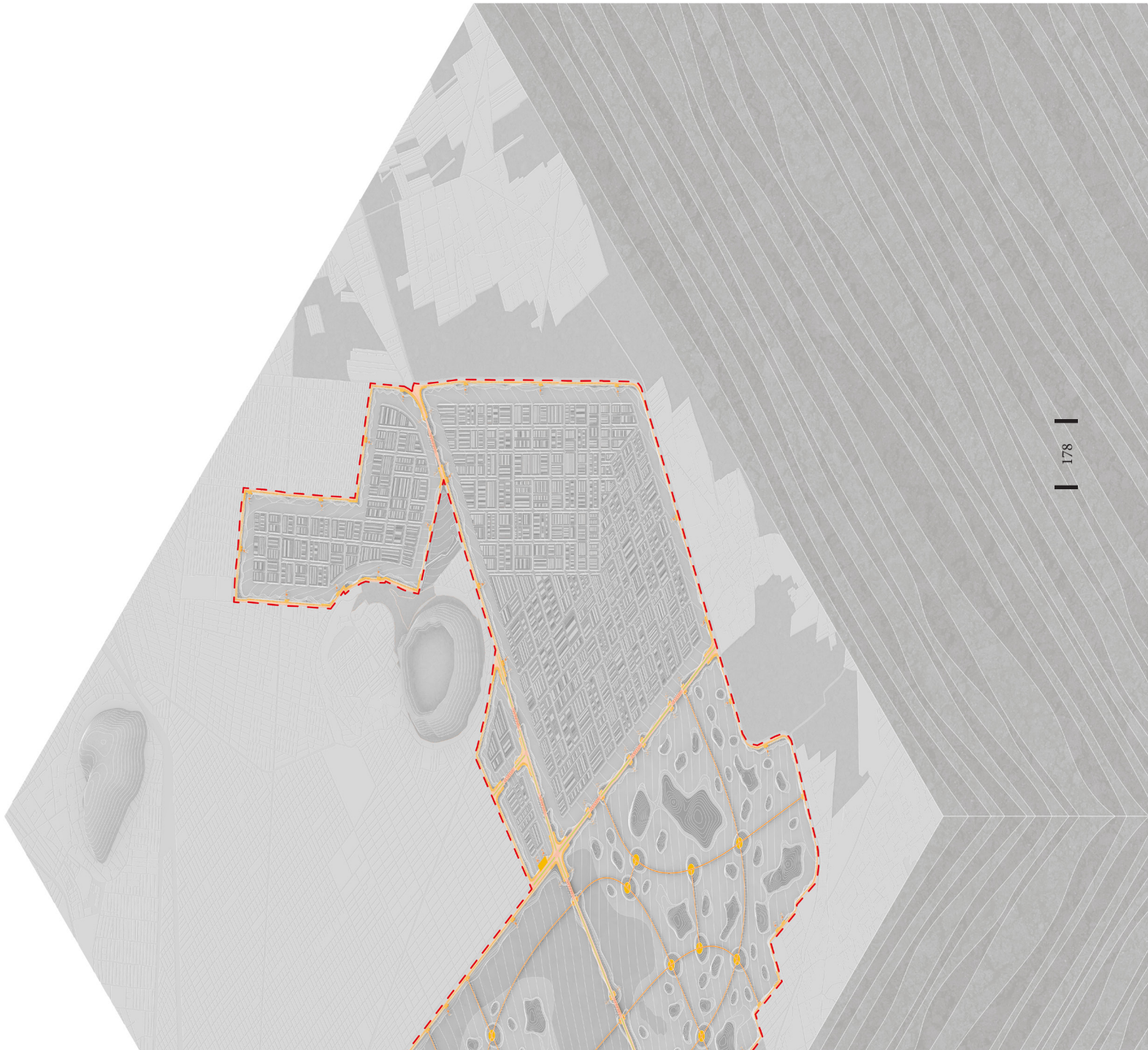
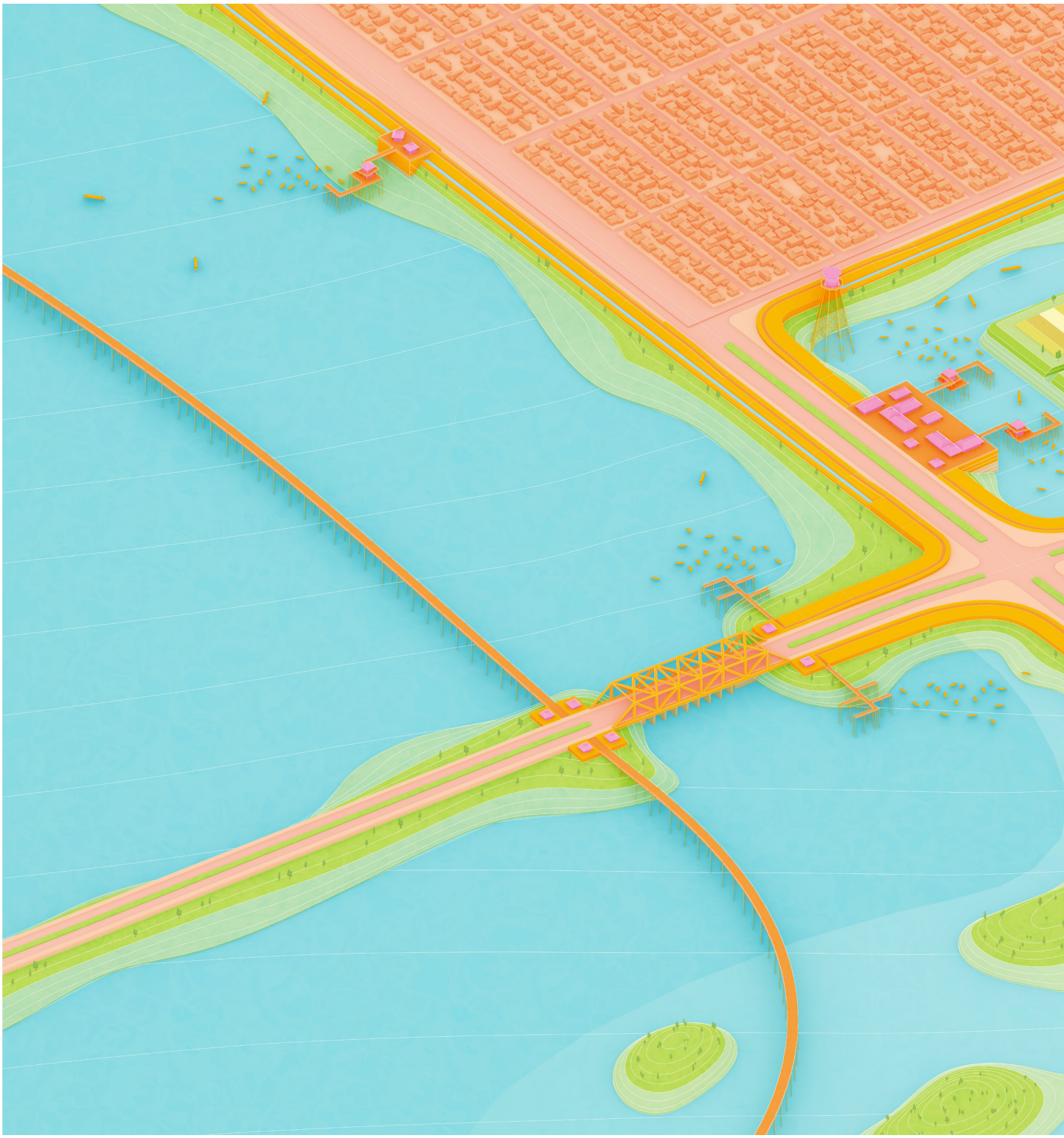


figure 4.32 [spread]: isometric view - infrastructure

figure 4.33 [next spread]: vignette #4





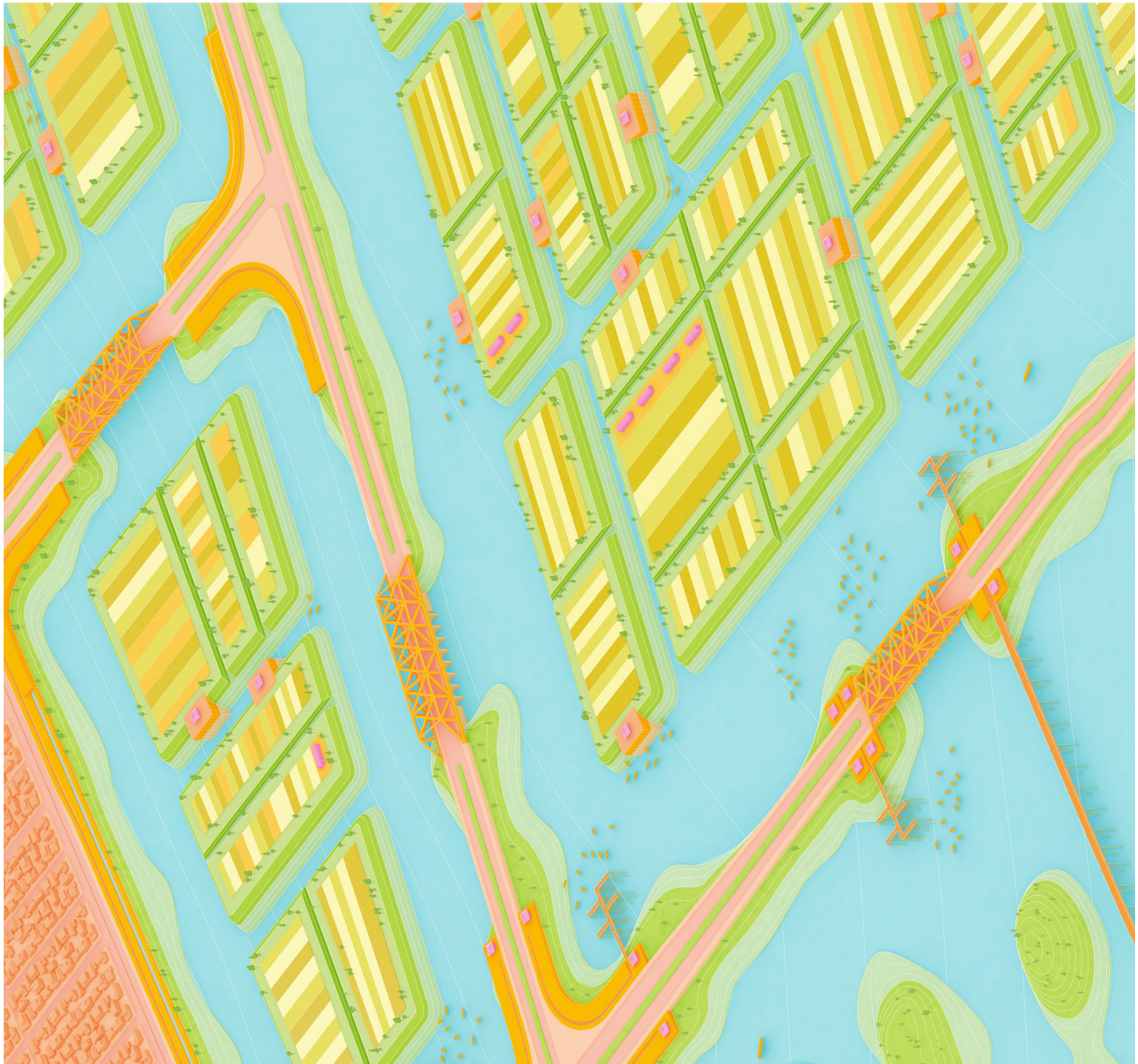
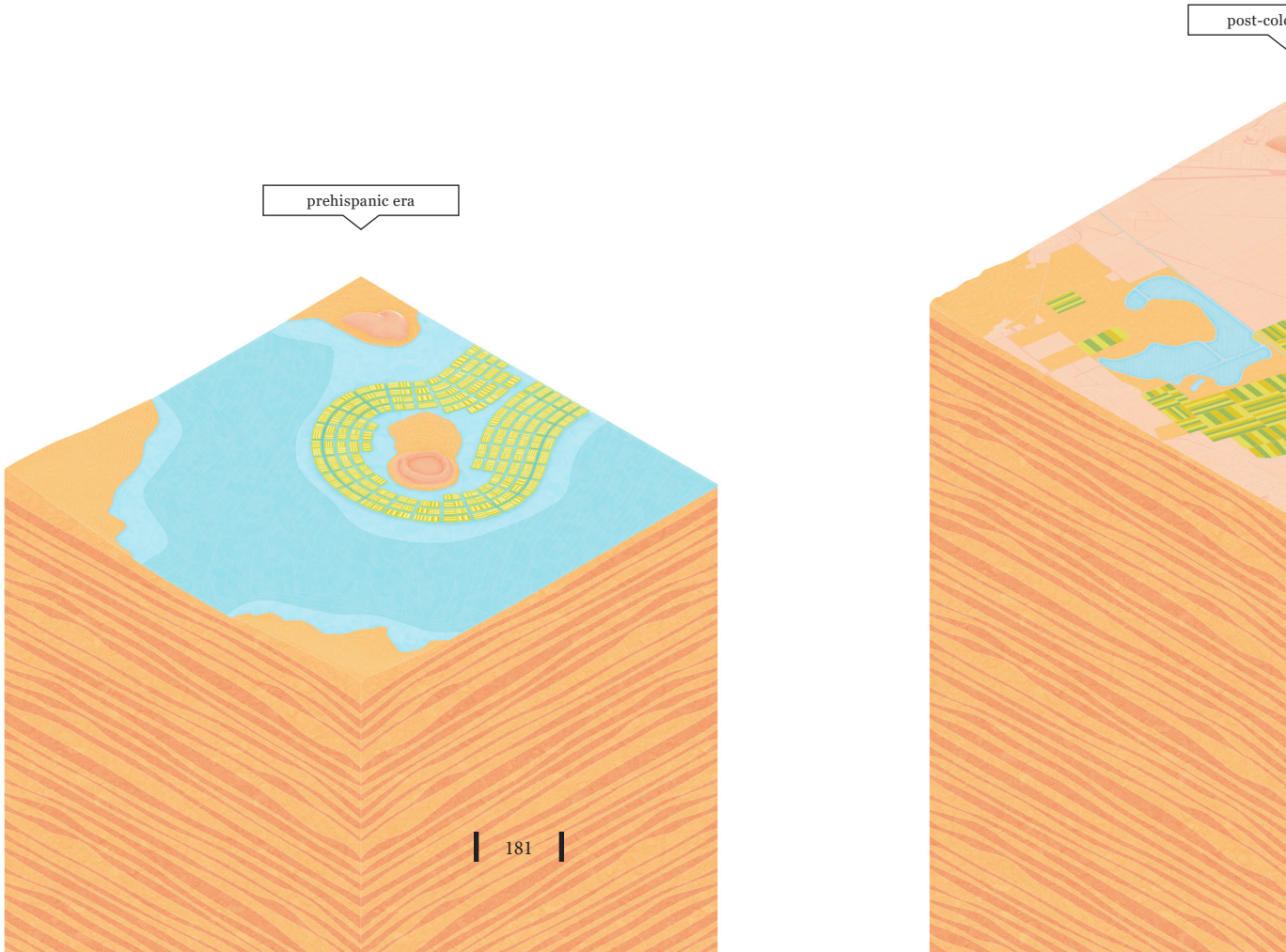
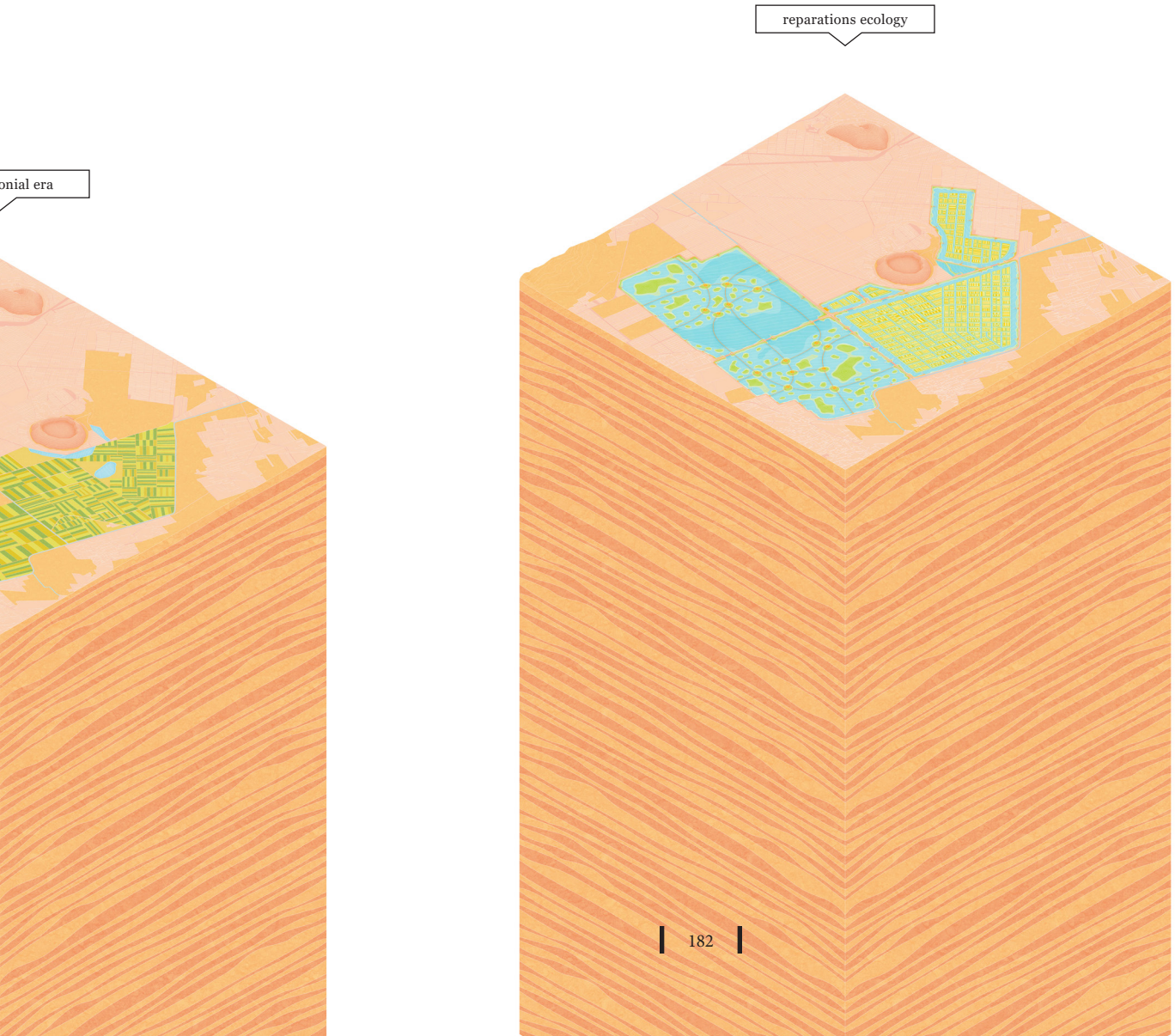


figure 4.34 [spread]:
isometric views:
towards a reparations ecology




onial era
reparations ecology

Conclusion

Over the past few centuries, Mexico Valley Basin has undergone several environmental transformations. For most of history, the region existed as a system of interconnected lakes that supported a diverse and self-sustaining lacustrine ecology. Earlier civilizations who inhabited the valley created a network of settlements that were woven into the natural lacustrine ecology. They had no intention of defiling the natural environment for sustenance. Instead, they engaged in conserving, enriching, and beautifying the socio-ecological landscapes that they inhabited. Following Spanish colonization, a system of incessant extraction and accumulation was unleashed upon the valley. Lacustrine ecologies were systematically desecrated and replaced with an urban metropolis[1]. In the last 50 years, the population of this metropolis - Mexico City (CDMX) has grown from 3 million residents to 9 million. Across the wider Mexico Valley Basin, Greater Mexico City has reached a population of about 20 million making it one of the largest, and most densely populated metropolitan regions in the world. Current estimates project that the population will grow to over 24 million residents by the year 2030[2]. The city continues to grow, eluding the fact that this is probably the worst place on earth to build a metropolis of this scale. Rising populations represent just one amongst many of the critical issues that pose an existential threat to contemporary Mexico Valley Basin.

The elimination of lakes from the region has given rise to a water crisis of existential proportions. Water issues are exasperated as the population continues to grow. Several studies have shown that the city receives more than enough water to be self-sufficient. The crisis is not a created by scarcity or lack of resources. Instead, it is a direct result of mismanagement of resources. Despite receiving generous amounts of rainfall every year, the city is ill-equipped to collect rainwater or recycle wastewater. Instead, the city fulfills its needs from importing water from remote sources and excessive groundwater pumping. Due to inefficient infrastructure and the region's undulating terrain, large amounts of energy and water are squandered away in this process. Moreover, excessive groundwater pumping has depleted aquifers to the verge of being overdrawn. It also leads to severe land subsidence causing infrastructure to crumble, thus making the region increasingly susceptible to earthquakes. The region is parched and sinking and being pushed towards a breaking point[3].

1 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

2 Patel, Ramesh, and Dan Cloer. 2018. "How Not To Build A City: Will The Infrastructures Of Our Cities Be Able To Keep Up With Increasing Urban Populations?". Vision. https://www.vision.org/increasing-populations-challenge-city-infrastructure-8601.

3 Schlanger, Zoë. 2018. "Solving Mexico City's Cataclysmic Cycle Of Drowning, Drying, And Sinking". Quartz. https://qz.com/1281506/solving-mexico-citys-cataclysmic-cycle-of-drowning-drying-and-sinking/.

This thesis is about hope and possibilities in the wake of an existential crisis. The returning lake in Chalco, albeit a direct outcome of excessive groundwater pumping in the region, offers a unique opportunity to 'write back' grave errors of the past. Centuries' worth of social and ecological desecration have manifested in the form of severe environmental repercussions that impede a viable and ecologically sustainable future for the people of Chalco. It is time to make amends through ecological reparations.

The thesis makes a case for rewilding and regenerating former lacustrine ecologies to invoke a reparations ecology in Chalco. It presents an elaborate ecosystem design narrative that is backed by historical findings, systems and design strategies to instill reparative measures in Chalco. The design interventions presented in this thesis explores how existing spatial norms in the region can be challenged to address the various crises that threaten the region. However, this thesis is limited in its scope. The design scenario described in this thesis exists within a realm of speculation. It is highly unlikely that a proposal of this nature would ever manifest in Chalco. This is because Chalco is tied to a range of social, political, and environmental complexities that are rooted in colonial power structures[4].

The majority of urban planning schemes in the city follows a Euro-centric model that is unsuitable for the region's complex geography. This is a direct consequence of left-over colonial-era inertia that stresses on dissociating from natural environments. Rather than embracing sustainable solutions that create mediums for symbiotic interactions with nature, funds are spent on expensive projects like long tunnels and deep groundwater wells that work against the region's natural ecology. Also, there is the problem of insufficient political capital. The inner city is highly densified and major investments are directed towards wealthier neighborhoods in the city. On the contrary, peri-urban zones – where the majority of open-spaces and water bodies lie, lack sufficient political capital to attract investments[5]. Chalco is a peri-urban zone on the eastern fringes of Mexico City. The returning lake and its adjacent undeveloped lands carry immense amounts of potential to instill reparative measures that could alleviate the crisis. Unfortunately, the current state of socio-economic conditions makes it unlikely for such schemes to ever manifest in Chalco. Instead, the region is entangled in various conflicts that further aggravates the stresses imposed by the crisis. These conflicts include high rates of urban migration, competing demands for water resources, corruption

4 Alves, Maria Thereza. 2013. Maria Thereza Alves. El Regreso De Un Lago / The Return of A Lake... Köln: Buchhandlung Walther König.

5 Bose, Shumi. 'Meet the Architect Who Wants to Return Mexico City to Its Ancient Lakes'. the Guardian, 13 November 2015. http://www.theguardian.com/cities/2015/nov/13/alberto-kalach-return-mexico-city-ancient-lakes.

figure 4.35 [above]:
in the midst of the covid-19 pandemic, smaller farmers in xochimilco increased production and rehabilitated abandoned chinampas to fulfil demands for fresh, organic and local produce.

amongst government officials, and ecologically strategic lands being sold for urban development[6]. However, not all hope is lost. In the advent of a crisis, the political climate in Mexico City is shifting. In 2008, Claudia Sheinbaum was elected mayor of Mexico City. She is a Nobel prize winning environmental scientist who ran a successful campaign that focused on pragmatic measures to alleviate the water crisis in Mexico City[7]. This included strategies for reforestation, increasing catchment areas for rainwater collection, and treating and recycling wastewater to fulfill agriculture's massive demands. Her election reflects the people's mandate for a regenerative program in the region. The success of chinampa agriculture in Xochimilco also offers hope for similar programs to be emulated in other areas. In the midst of the COVID-19 pandemic, industrial food supply in Mexico City was disrupted in major ways. However, the prevalence of Community Supported Agriculture (CSAs) programs in Xochimilco allowed smaller farmers to increase production and rehabilitate abandoned chinampas to fulfill demands for fresh, organic and local produce[8]. It is apparent that the strength behind socio-ecological and regenerative systems lies in its resilience and ability to adapt to changing underlying conditions.

Rewilding and regenerating socio-ecological landscapes to invoke a reparations ecology around the returning lake in Chalco would liberate natural ecologies from enclosures imposed by colonial power structures. It would be reminiscent of indigenous models of living that relied on symbiotic interactions between human and non-human agents to achieve ecosystem integrity. As illustrated in this thesis, various ancient indigenous systems can be revived to deal with the crises we face today. These systems offer ecological solutions to drainage, treatment of wastewater, flood resilience, agricultural production and pollution. They have allowed indigenous communities to thrive for thousands of years before colonization. In an era coaxed by climate change and ecological disasters, the time has come to decolonize and 'write back' the socio-ecological damages imposed by colonial land practices. A reparations ecology in Chalco offers a sustainable alternative to colonial models that rely on extraction and appropriation. It advocates for the return to a cyclical utilization of natural resources through ecological interactions between humans and natural processes. It would enable a viable and ecologically sustainable future for all. The possibilities are endless, and its actualization lies latent in a post-colonial epoch besieged by repercussions of past errors.

6 Llano, Pedro de. 2017. Maria Thereza Alves. The Long Road To Xico / El Largo Camino A Xico, 1991-2015. Berlin: Sternberg Press.

7 Pskowski, Martha. 2018. "The Long Road To Mexico City'S First Elected Woman Mayor". Bloomberg. https://www.bloomberg.com/news/articles/2018-08-06/claudia-sheinbaum-and-women-s-rise-in-mexican-politics.

8 Gokee, Amanda. 2020. "The Coronavirus Is Bringing Back Aztec-Era "Floating Gardens"". Mother Jones. https://www.motherjones.com/environment/2020/07/the-coronavirus-is-bringing-back-aztec-era-floating-gardens/.

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