OFFICE

South Florida and Sea Level: The Case of Miami Beach

OFFICE FOR URBANIZATION

RESEARCH REPORT

South Florida and Sea Level:
The Case of Miami Beach

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2017

Harvard University
Graduate School of Design

SOUTH FLORIDA AND SEA LEVEL

The Case of Miami Beach

South Florida and Sea Level: The Case of Miami Beach

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Harvard University Graduate School of Design
Office for Urbanization

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The Harvard University Graduate School of Design is dedicated to the education and development of design professionals in architecture, landscape architecture, urban planning, and urban design. With a commitment to design excellence that demands the skillful manipulation of form and technology and draws inspiration from a broad range of social, environmental, and cultural issues, the Harvard GSD provides leadership for shaping the built environment of the twenty-first century.

The Harvard GSD Office for Urbanization draws upon the School's history of design innovation to address societal and cultural conditions associated with contemporary urbanization. It develops speculative and projective urban scenarios through design research projects. The Office imagines alternative and better urban futures through applied design research. The Office aspires to reduce the distance between design innovation and societal impact.

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SOUTH FLORIDA AND SEA LEVEL

The Case of Miami Beach

“The infrastructure we have is built for a world that doesn’t exist anymore.”[1]

Nicole Hernandez Hammer, 2015
Environmental Studies Researcher, Union of Concerned Scientists

Fig. 1. Aerial view of South Beach looking south.

Contents

Acknowledgments

This report documents the work of an investigation conducted at the Harvard University Graduate School of Design's Office for Urbanization from 2015 to 2017. The research and this report would not have been possible without the generous contributions of many people and institutions.

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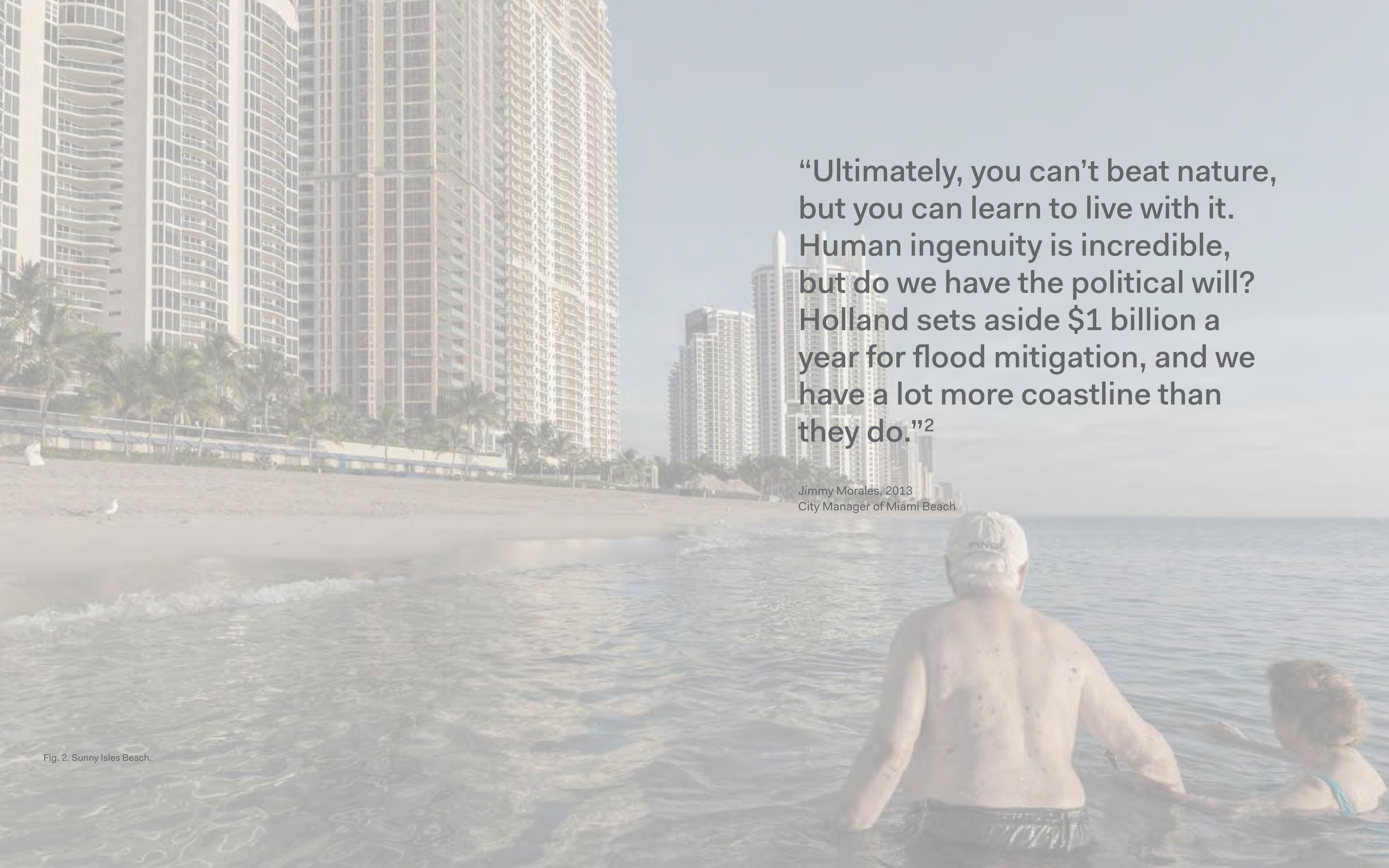


"Ultimately, you can't beat nature, but you can learn to live with it. Human ingenuity is incredible, but do we have the political will? Holland sets aside $1 billion a year for flood mitigation, and we have a lot more coastline than they do."[2]

Jimmy Morales, 2013
City Manager of Miami Beach

Fig. 2. Sunny Isles Beach.

Introduction

Project on South Florida and Sea Level

The Harvard University Graduate School of Design's Office for Urbanization draws upon the School's history of design innovation to address societal and cultural conditions associated with contemporary urbanization. It develops speculative and projective urban scenarios through sponsored design research projects. The Office imagines alternative and better urban futures through applied design research. The Office aspires to reduce the distance between design innovation and societal impact.

The challenges of contemporary urbanization rarely correspond to discrete professional or disciplinary boundaries. The Office is committed to enabling and accelerating societal impact through collaborative, multidisciplinary design projects. This work aspires to construct alternatives to present conditions and predictable outcomes with a relevant array of future options. These scenarios are selected in order to insulate individuals and their communities from the most adverse social and ecological impacts associated with ongoing processes of urbanization. They are also identified for their potential to contribute to urban life and culture as well as our knowledge of urban sites and subjects. The work of the Office centers on design as an activity of collective imagination.

The work of the Office can be described under the general rubric of design research. The Graduate School of Design has a longstanding tradition of pursuing research through a diverse array of methods and media. Faculty members pursue research agendas closely associated with the humanities on the one hand, or with the natural, social, or political sciences on the other. In addition to those forms of research, faculty at the School pursue design research as its own unique form of knowing in and about the world.

Over the past two years since July of 2015, the Graduate School of Design and the City of Miami Beach have partnered on *South Florida and Sea Level*, a study of the impacts of and potential responses to sea level rise for coastal communities in South Florida. This research project examines the implications of rising sea levels and increased storm events on the economy, ecology, infrastructure, and identity of Miami Beach in relation to its metropolitan and regional contexts. This report synthesizes and presents strategies to anticipate future events and to mitigate present threats. As Miami's coastal barrier islands form one of the most recognizable and singularly valuable cultural landscapes in the world, the study of Miami Beach reveals the potential for ecological and infrastructural strategies as alternatives to large, single-purpose engineering solutions.

The emergent topic of urban adaptation to the effects of climate change is among the more pressing areas of research for those engaged in the built environment. While it was not entirely clear how the mitigation of climate change implicated the disciplines of architecture, urban design, or planning; the recent focus on adaptation to ongoing human impact on the environment and climate change puts those fields at the center of the conversation.

Over the past several years, the North American discourse on the subject has sensibly focused on the significant case studies of New Orleans post Katrina and New York post Sandy. Both of these cases have engendered a range of public discourse, planning proposals, and design strategies for living with the ongoing reality of increased storm events, rising sea levels, and a host of secondary and tertiary effects associated with this new reality. In each of these cases, the design disciplines have been central to projecting alternative futures for these vulnerable major metropolitan centers.

While these cases have provided unique contexts for advancing disciplinary knowledge, professional practices, and societal engagement with the subject of urban adaptation to sea level rise, they have also reinforced the defense of relatively densely concentrated urban agglomerations through the deployment of large hydrological engineering systems. By contrast, much of the North American coastline, and its associated urbanization, resist such approaches due to their geography, hydrology, and patterns of urbanization. Among the more extreme cases in this regard is the present status and uncertain future of South Florida's coastal communities.

Using Miami Beach as a case in point, the GSD and its partners have examined the implications of sea level rise and increased storm events on the sprawling urbanism of metropolitan Miami and its numerous municipalities and communities. Among those communities, Miami Beach presently experiences multiple occurrences of so-called "sunny day" flooding (i.e., flooding in the absence of a storm event).[3] From 2014 to 2015, the City of Miami Beach convened a Blue Ribbon Panel on Flood Mitigation[4] to advise the Mayor's Office on this issue. The City is also in the midst of a multi-million dollar upgrade to its drainage infrastructure, which is designed to mitigate the most immediate impacts of seasonal flooding. Ultimately, this work can do little to apprehend the larger impacts of sea level rise. The low-lying coastal conditions and singular cultural heritage of Miami Beach resist the types of massive civil engineering projects that have recently been proposed for London, Venice, or other major international cities. Given that South Florida's economy and identity rely upon the specific landscape conditions of Miami Beach, this research project uses the frameworks of green infrastructure, landscape ecology, and cultural heritage as potential responses to looming threats associated with sea level rise.

This research project is led by Principal Investigator Charles Waldheim, John E. Irving Professor of Landscape Architecture, who is joined by Assistant Professor of Landscape Architecture Rosetta Elkin as well as research associates, graduate research assistants, and students from across the GSD. The project launched in July of 2015 and has since gathered expertise from across the GSD and the University through research seminars, design workshops, design studios, and scholarly meetings. In addition, the studios and their related site visits, colloquium and studio reports convened leading experts from various disciplines and professions in South Florida with participants for dialogue. This report synthesizes the best practices and compelling cases and proposes strategies and solutions for mitigating the impacts of sea level rise in the context of Miami Beach. Divided into two time scales, short-term (approximately 10 years out) and medium-term (50 years out), recommendations presented here should be understood not as design projects but as principles conveyed through design scenarios.

The report was made possible with the support the City of Miami Beach. It is informed by the collaboration of committed public servants and citizens from Miami Beach who have been appointed by their Mayor to represent the city on the Blue Ribbon Panel on Flood Mitigation, including Special Advisor to the Mayor and Chairman Scott Robins, retired engineer Dr. Dwight Kraai, and Professor Emeritus from the University of Miami Dr. Michael Phang, with help and guidance from Mayor Philip Levine and his City Manager Jimmy Morales. Additional contributions were provided by thought leaders at Florida International University, Florida Atlantic University, the University of Miami as well as local non-governmental and professional offices.

RECOMMENDATIONS

Summary
Prospects
Scenarios

"In the face of climate change and sea level rise, Miami Beach will need to make a decision about what type of city and what type of community it wants to have. It goes back to the question of identity at the end of the day."[5]

Greg Guannel, 2016
Director of Urban Programs, The Nature Conservancy

Fig. 3. Aerial view of Venetian Islands and Venetian Causeway in the Biscayne Bay.

Summary

Miami Beach

1

The City of Miami Beach should mainstream climate adaptation in all infrastructural, environmental, economic, and social undertakings because climate issues have now become common to each sector. The city should continue to initiate experimental research, reports, and projects as well as engage with all relevant stakeholders and agencies to coordinate ongoing and future adaptation efforts. Additionally, the city should continue to engage with local civic and research institutions and professionals to solicit imaginative adaptation strategies. Through prototypes of projects and policies, the city has the opportunity to develop the appropriate pathways through trial and error.

2

The City of Miami Beach should continue to engage national, state, regional, and local actors through the Southeast Florida Regional Climate Change Compact in order to translate scientific consensus into support tools, guidelines, and design standards for managing infrastructure systems and the built environment. A uniform application of standards based on a range of direct and indirect climate change impacts can help local municipalities serve as leaders that other jurisdictions can learn from.

3

The City of Miami Beach should create a comprehensive and flexible medium-term plan for urban adaptation. This plan should project a shared, future cultural identity. This aspiration should draw upon the history of Miami Beach's natural endowment and synthetic construction to inform a future imaginary that simultaneously respects and transcends nostalgia and heritage. This medium-term plan should be comprised of short-term, multi-scalar efforts that multiple stakeholders can cumulatively and sequentially complete. Within these short-term projects, the challenge is to respond to shifting environmental and economic conditions that preserve the economic and cultural value of prior investments.

4

The City of Miami Beach should expand flood mitigation projects from single-purpose engineering solutions to multi-functional green infrastructure. The city should commission a study that examines, among others, strategies to replace hard seawalls with living seawalls, increase permeable surfaces, maximize on-site stormwater capacity, and leverage different water types (e.g., saltwater, freshwater, greywater) according to their utility. In the medium term, the city should design urban environments around current and future hydrological performance. As jurisdictional oversight and permitting inertia pose the primary challenges, the city should seek joint cooperative agreements with cross-sectorial and cross-jurisdictional partners.

5

The City of Miami Beach should incorporate landscape ecology into the evaluation and design of all infrastructural projects. The city should commission a study of the resilience metrics for local species and ecologies to inform ongoing and future flood mitigation projects. Beyond studying the hydrological and ecological advantages of native mangroves and rhizomatic grasses, the city should promote their public perception and work with the private sector to mandate their deployment, particularly along jurisdictionally discontinuous coastlines. Finally, the city should differentiate between plants used for ecological versus aesthetic purposes and deploy them accordingly to environmental, public, and educational ends.

6

The City of Miami Beach should reconceive elevated streets and avenues to maximize infrastructural and public co-benefits and to contribute to multi-adaptive infrastructure. The city should commission a study or conduct a pilot program on using elevated roads for the conveyance, absorption, and storage of stormwater as well as for public benefits (e.g., recreation amenities). Furthermore, the city should commission a study on the use of interstitial block alleys for hydrological, environmental, and public functions. In the medium term, the city should develop sectional strategies for the gradual one-story elevation of streets and avenues and integrate them with ingress/egress requirements, sidewalks, storefronts, and other public right-of-ways.

7

The City of Miami Beach should reconceive the historic district as a stormwater sink. The city should commission a study on specific typological and morphological strategies to elevate the historic district over time without sacrificing cultural identity. This study should develop codes and massing strategies to rewrite existing regulations, maximize permeable ground, increase on-site stormwater retention, and incentivize development interest. In the medium term, the city should consider prioritizing typological preservation over strict architectural or material preservation.

8

The City of Miami Beach should commission studies that transform its main public right-of-ways into green infrastructure and exemplify innovative urban adaptation. One of the studies should reconceive Collins Canal as stormwater infrastructure that also provides new waterside development, a public promenade, and coastal vegetation. Another study should reconceive the Biscayne Bay coastline as a living seawall that also connects a system of elevated street-end plazas over pump stations with a continuous public bay walk. A third study should reconceive Flamingo Park as a hydrological and ecological resource that also maintains its public landscape.

9

The City of Miami Beach should include the public realm as a metric of evaluation in all adaptation efforts. The city should commission a study on strategies to incorporate public space and programming into all hydrological, ecological, and infrastructural landscapes by integrating promenades, open spaces, public amenities, and educational opportunities. This study should also examine maintaining and increasing public access around large luxury developments along the waterfront. In the medium term, the city should continue to enhance public transit options along major corridors (e.g., Alton Road, Washington Avenue) by prioritizing buses, pedestrians, and bicycles over vehicles.

10

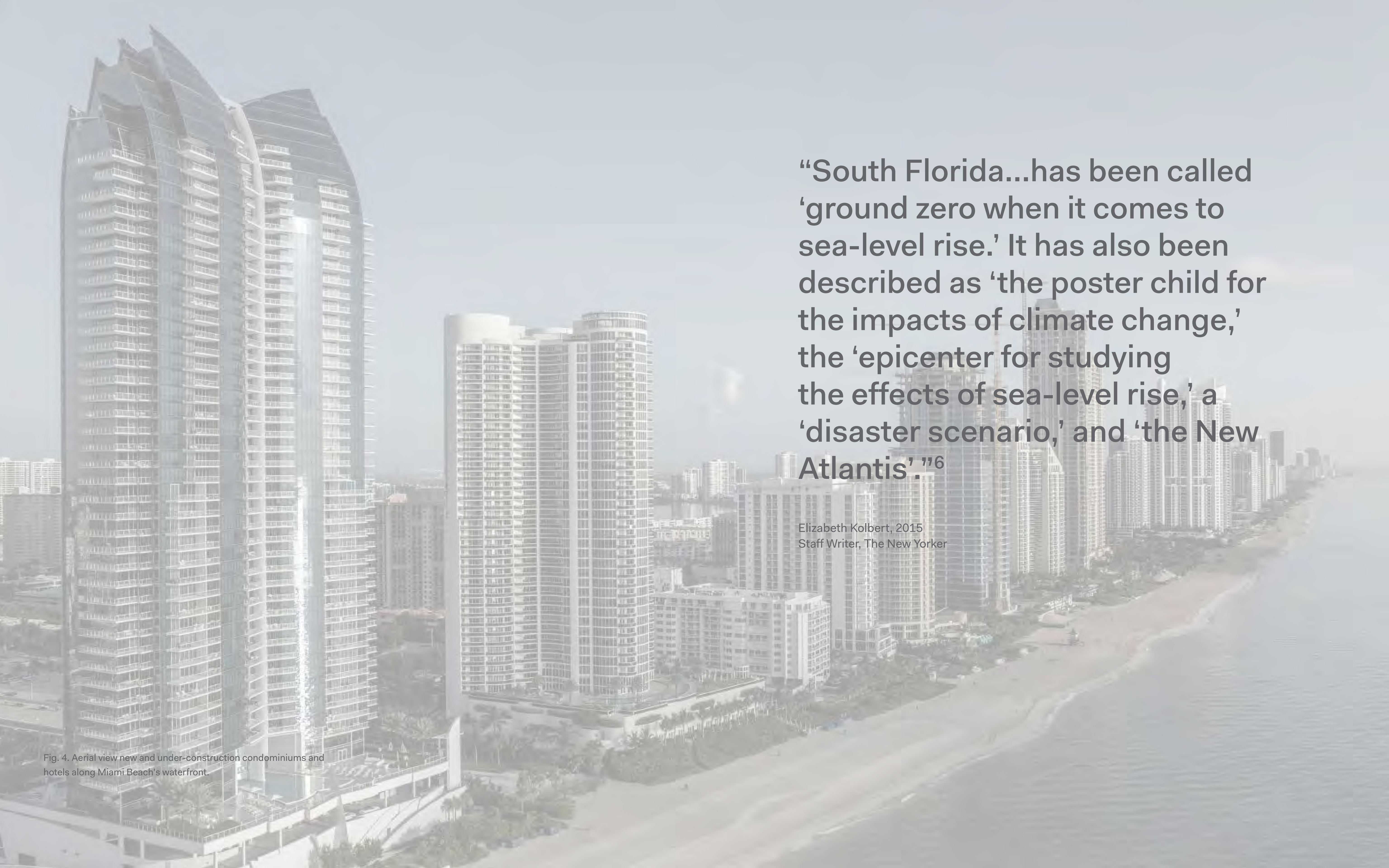
The City of Miami Beach should commission a transportation study on fortifying connections with mainland Miami in terms of mass transit and transportation resilience. This study should explore designs that expand transit options on existing causeways by widening and/or decking in order to accommodate bike paths, light rails, and rapid bus lanes. The city should coordinate with the Miami-Dade Transportation Planning Organization (TPO) and Miami-Dade Transit (MDT) to streamline intercity and multi-modal commuting.

11

The City of Miami Beach should incentivize, guide, and coordinate future adaptation efforts. The city should revise its zoning regulations and land use practices to reflect regional and local policy initiatives. The city should create a finer-grained regulatory system, beyond the catch-all Adaptation Action Areas designation, for areas vulnerable to flooding and prioritize or restrict funding accordingly. Finally, the city should: 1) standardize Base Flood Elevations by location, use, and program; 2) negotiate Flood Insurance Rate Maps that incorporate current probabilities for sea level rise and frequency of storm events; and 3) explore strategies that qualify for credits under the pending FEMA rule for Public Assistance Deductibles.

12

The City of Miami Beach should channel its real estate market toward uses and co-benefits that inure to public and private realms. The city should commission an economic study on maximizing development contributions without diminishing the inherent values in retail, commercial, and housing sub-markets. This study should examine policies that incentivize or require new developments to not only incorporate engineered resilience but also contribute to the resilience of the contextual public realm. Additionally, the city should require transparency in real estate transactions by requiring brokers to disclose current and projected risks to properties based on current data from the Southeast Florida Regional Climate Change Compact.



"South Florida…has been called 'ground zero when it comes to sea-level rise.' It has also been described as 'the poster child for the impacts of climate change,' the 'epicenter for studying the effects of sea-level rise,' a 'disaster scenario,' and 'the New Atlantis'."[6]

Elizabeth Kolbert, 2015
Staff Writer, The New Yorker

Fig. 4. Aerial view new and under-construction condominiums and hotels along Miami Beach's waterfront.

Prospects

Hydrologies

Ecologies

Infrastructures

Identities

Spaces

Publics

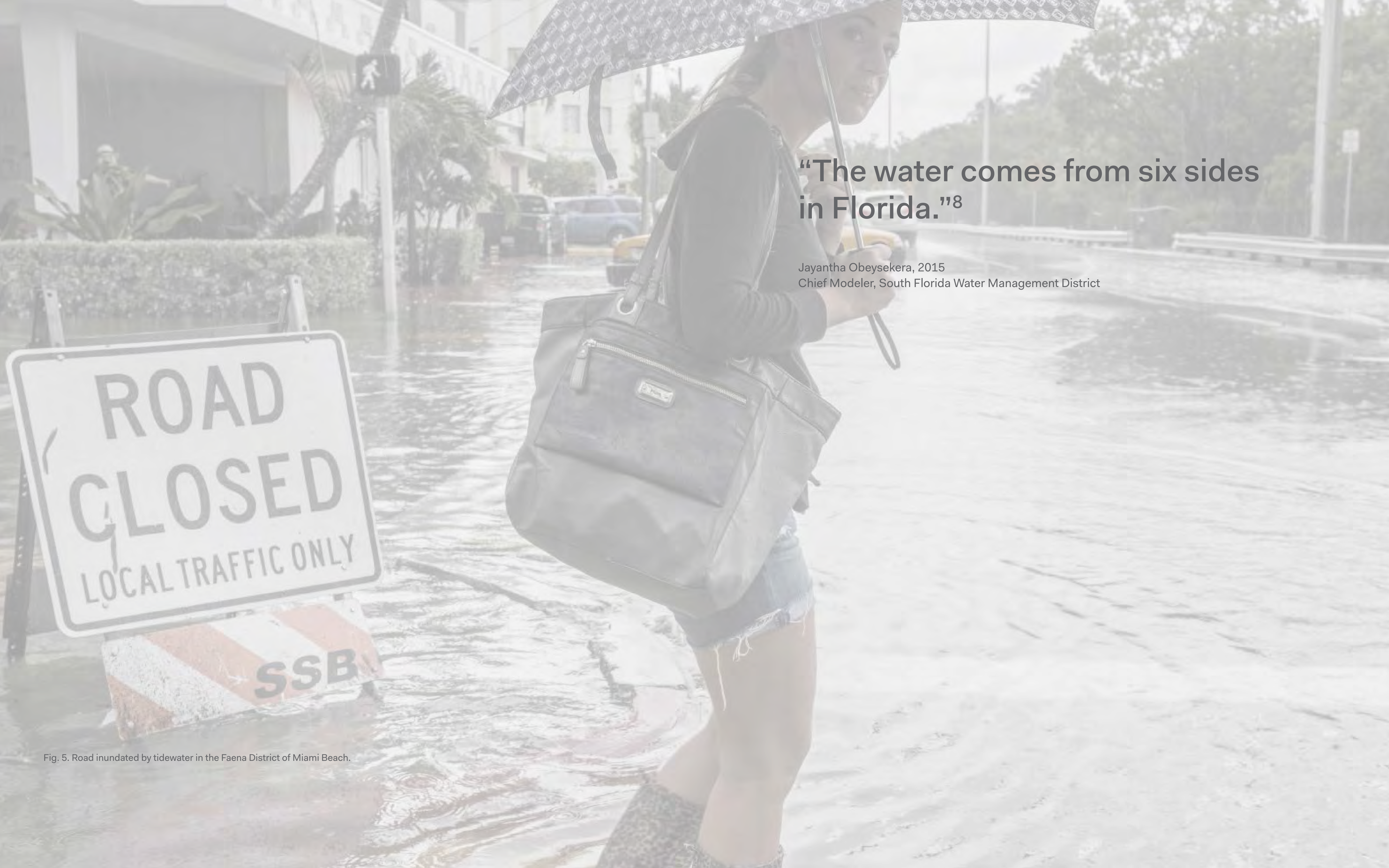
Policies

Developments

As sea levels rise and storm events intensify, the City of Miami Beach must confront the challenge of urban adaptation, an existential problem that directly implicates the practices and ethics of the design fields. However, current efforts to stem the rising tides employ single-purpose, engineered infrastructure that offers a temporary fix in order to buy time and delay an inevitable future. This infrastructure—manifesting as flood pumps, raised seawalls, elevated roads, and the like—represents a disparate set of defense mechanisms that promises minimal change in planning operations or associated design standards. Furthermore, betting on a miraculous technological fix to save the city[7] is not only dangerous but willfully ignores the capacities of the design disciplines to address the challenge across a range of sectors, assets, and programs. As every adaptation effort carries environmental, social, and cultural roles and responsibilities, Miami Beach must turn toward alternative strategies that embrace green infrastructure, landscape ecology, livability standards, and a future cultural imaginary worth adapting and aspiring toward.

Absent state and federal leadership, the City must act to develop a comprehensive and simultaneously flexible plan for future adaptation within the context of a municipal government. As a barrier island, Miami Beach enjoys a certain level of autonomy in terms of geological and morphological scale as well as political and legislative agency. This degree of independence gives the City leeway to act beyond regional coordination when appropriate and necessary. At the same time, while ongoing efforts at a regional scale (i.e., the Southeast Florida Climate Change Compact) are laudable for their spatial coordination, the City must also plan ahead for multi-decade temporal coordination, recognizing that stakeholders have different time cycles: 1-year municipal budgets, 5-year capital plans, 4-year mayoral terms, 10-year real estate developments, 20-year mortgages, and 50-year building cycles. This outlook therefore requires a robust and coherent long-term plan that is comprised of short-term projects and micro-efforts that can be cumulatively completed by public administrations, private developers, and local citizens.

The following recommendations are loosely grouped around eight disciplinary categories: hydrology, ecology, infrastructure, identity (i.e., preservation and cultural image), urban form, public realm, policy, and development. Within each category, recommendations are further grouped into two timescales: short-term (approximately 10 years) and medium-term (approximately 10-50 years out). While most recommendations are synthesized from two and a half years of academic research, others require additional study. Finally, all recommendations draw upon the history of Miami Beach’s natural endowment and synthetic construction to inform the city’s urban adaptation and future imaginary.



“The water comes from six sides in Florida.”[8]

Jayantha Obeysekera, 2015
Chief Modeler, South Florida Water Management District

Fig. 5. Road inundated by tidewater in the Faena District of Miami Beach.

Hydrologies

Given its unique geology and geography, Miami Beach faces threats of water from all sides: heavier precipitation due to increased storm events; higher flood levels due to rising sea levels and storm surges; groundwater intrusion due to rising water tables and a porous limestone foundation; and stronger and more frequent nuisance flooding and king tides.[9] This ongoing reality necessitates a reevaluation of the city's relationship to incoming waters beyond mere engineered defenses. Rather, the narrative of water as a threat must instead be reconceived as an opportunity that signals change, collectivity, and environmental stewardship. Because the city's hydrology is the basis for subsequent urban transformations, we recommend the following:

Short-Term

> Expand from single-purpose grey infrastructure to include multi-purpose green infrastructure. Ongoing efforts to install water pumps and raise streets only stave off water for the immediate future. These strategies cost the city several hundred million dollars and are potentially detrimental to the public realm. Introducing green infrastructure, such as living seawalls and permeable surfaces, provides alternative, sustainable strategies that augment existing engineering efforts.

> Introduce subtle landscape conditions to manage local stormwater drainage and retention to reduce the burden on surrounding pipes and pumps. Introducing

basins and permeable surface areas (e.g., through porous ground cover, elevated decking) increases on-site holding and absorptive capacities. Additionally, the City should encourage new developments to maximize on-site permeable surfaces by reducing building footprints and elevating onto higher planes. (See Scenario 09)

> Use Flamingo Park as both a hydrologic and an ecological resource while maintaining its existing public and vegetated condition. Maximize its ability to hold and filter runoff during storm and tidal events. Because subtropical Florida usually suffers an excess or a deficit of water, Flamingo Park can help balance freshwater availability through seasonal fluctuations by using rainwater collection and distribution strategies. This can be accomplished while at the same time engaging vector borne control and providing additional amenities that are central to Flamingo Park's function for the community. (See Scenario 06)

> Differentiate saltwater (e.g., seawater) from sweetwater (e.g., freshwater, rainwater, groundwater) from greywater (e.g., used water) and consider how each can be retained, reused, or rejected. Rainwater and greywater, for instance, can be stored and reused for local irrigation while saltwater can be retained to stage coastal biodiversity. In particular, use Alton Road as the conceptual and physical divider between these water types so that landscapes and basins on the Flamingo Park side retain and recycle sweetwater while floodable spaces and canals on the Biscayne Bay side host salt-tolerant species. (See Scenario 02)

> Enhance strategies to clean and treat runoff water (e.g., stormwater, groundwater, or otherwise) before it is pumped into the bay. In addition to elevating from water, proper stewardship also needs to improve the water quality of the discharge. Stormwater for instance often picks up pollutants from asphalt before it is drained or pumped into the bay. Maximize biological stormwater filtration systems (e.g., bioswales, planted acequias) as the first layer of treatment before polluted stormwater is treated mechanically within the stormwater system.

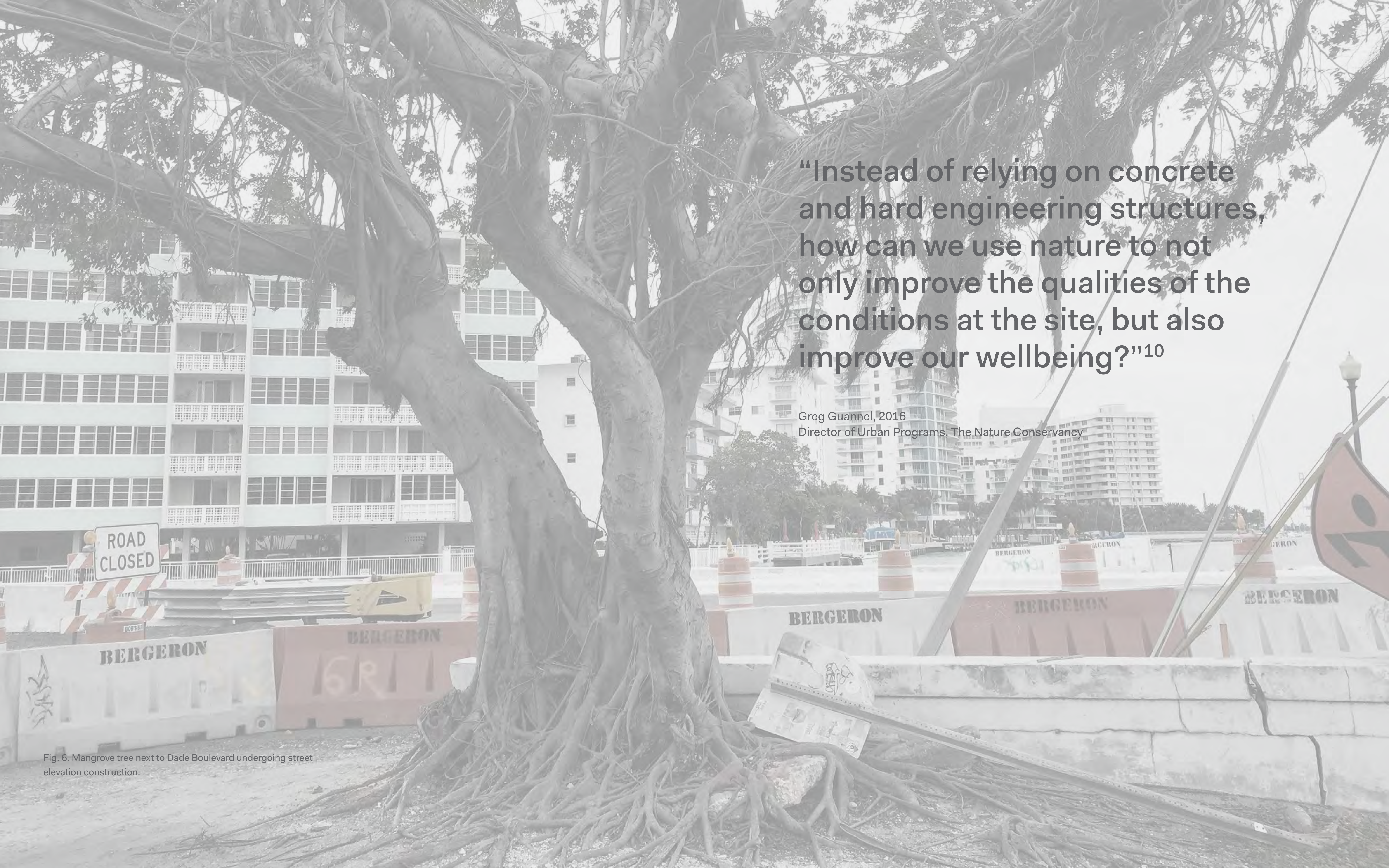
> Reconceive Collins Canal as stormwater storage infrastructure. Originally built as a transportation route for agricultural shipments, Collins Canal today can instead accommodate flood control functions. For instance, a cut-and-fill strategy can expand its capacity to hold water and simultaneously elevate adjacent lands above rising flood projections. Furthermore, new developments and public spaces should be introduced along its banks where the former is channeled to maximize public benefits. (See Scenario 07)

Medium-Term

> Create a networked canalization strategy throughout Miami Beach using different scales of canals for the conveyance and storage of stormwater: local bioswales, linear acequias, and larger channels. Pair with city-wide efforts to reduce cars by gradually trading street medians, edges, and on-street parking lanes for such canals. (See Scenario 04)

> Transform the Biscayne Bay coastal edge from the existing hard seawall into a variegated living seawall using topographic landscapes that mediate hydrological forces. In particular, building out into the bay with choreographed landforms elevates dry land, absorbs tidal impacts, retains seawater and stormwater, and stages ecological habitats. (See Scenario 05)

> Synthesize these hydrological strategies to create a comprehensive, cut-and-fill plan along the principal, public right-of-ways (e.g., Collins Canal, Biscayne Bay, and Flamingo Park) where each offers robust flood mitigation and control capacity. This strategy minimizes dredge that would otherwise disrupt the ecology of the Biscayne Bay.



“Instead of relying on concrete and hard engineering structures, how can we use nature to not only improve the qualities of the conditions at the site, but also improve our wellbeing?”[10]

Greg Guannel, 2016
Director of Urban Programs, The Nature Conservancy

Fig. 6. Mangrove tree next to Dade Boulevard undergoing street elevation construction.

Ecologies

Before Miami Beach was drained, defoliated, and developed, the barrier island was a mangrove swamp in a region whose subtropical climate endowed it with almost gratuitous vegetation and irrigation. As such, Miami Beach has the opportunity to learn from its environmental history and transform its future urban organization with green infrastructure that supports, or altogether replaces, ongoing engineering solutions. The mangrove tree is, in fact, more native than the city's iconic palm tree and has the potential to be a protagonist in the city's hydrological, infrastructural, and cultural adaptation solutions.

While the City has employed the mangrove species to a certain extent, the issue here is one of scale: a mangrove simply does not perform hydrologically or ecologically as a horticultural insert or a decoration around paths and buildings. Rather, for mangroves to comprise meaningful green infrastructure, they must be deployed *en masse* as a thick and deep system such as along the entire length of the bay or creek coastline. To deploy mangroves at this scale, this city must promote the tree's public perception and mandate planting them along privately-owned coastlines.

Short-Term

> Develop and integrate appropriate coastal plant communities using native species that reduce tidal forces, soil erosion, and runoff pollutants. Salt-tolerant and rhizomatic, these species provide a natural and resilient defense system that enhances existing protection.

> Deploy the native and resilient mangrove hammock as a natural coastal infrastructure. Red and black mangroves' rhizomatic roots retain soils, provide nursery habitats, produce rich nutrients, and form pollution sinks. Their tidal positions also create natural breakwater structures and reduce storm surges. White mangroves provide similar advantages on higher intertidal grounds during storm events as well as added aesthetic qualities. (See Scenario 04)

> Deploy salt-tolerant grass species as additional phytohydraulics—plants that absorb, hold, and move water. Like Everglades' sawgrass, certain coastal grasses (e.g., the paspalum) form thick, networked roots that withstand inundation during wet seasons and incidental fires during dry seasons. Inland, they can comprise the primary species in bioswales and daylit acequias, thereby acting as the first layer of the city's stormwater treatment system. (See Scenario 03)

> Differentiate between plants used for ecological and absorptive functions (e.g., saltwater) versus those used for cultural and aesthetic purposes (e.g., sweetwater) and deploy them to appropriate ends. In addition to the aforementioned capacities, native species also reduce the urban heat island effect, freshwater demand, and pollution buildup. On the other hand, aesthetic species, such as the iconic palm, afford a cultural value, such as improving the collective sense of place for local residents.

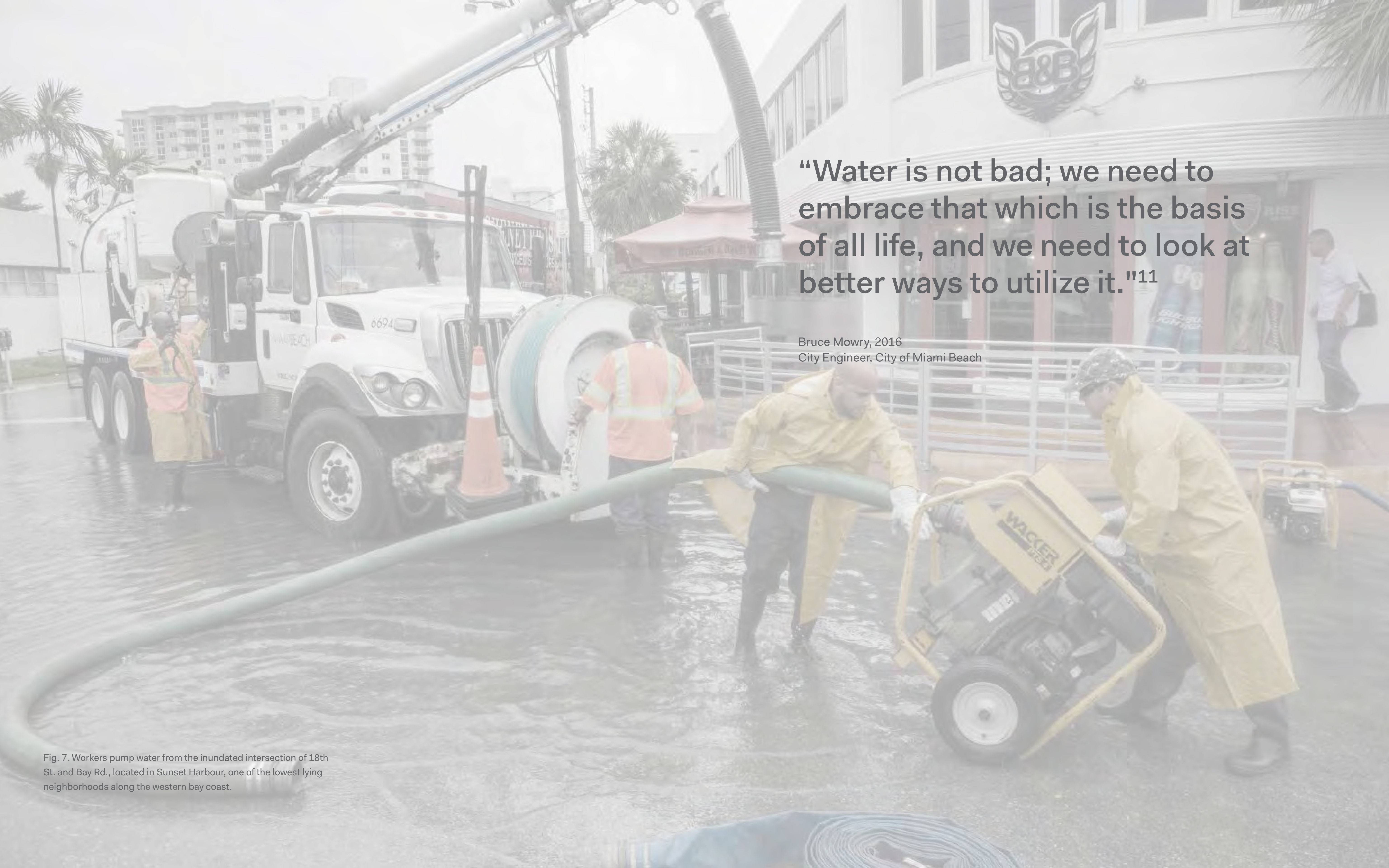
> Encourage programs that promote environmental education, restoration, and stewardship. Performative vegetation (e.g., rhizomatic grasses, salt-tolerant species) can be a didactic tool to teach lessons about natural sustainability and resiliency. For instance, introduce recreational and community-based programs centered on wildlife protection and awareness both on floodable land and in the bay.

Medium-Term

> Deploy *en masse* mangroves and salt-tolerant grasses as significant defense buffers, particularly along the entire length of the bay and creek coastlines. Promote the public perception and reception of these species so they gradually become just as integrated with the identity of the city as the iconic palm.

> Transition from planting non-native trees to native, salt-tolerant trees, particularly in urban areas covered primarily by asphalt and hardscape. As the city elevates both roads and buildings, the city should develop strategies to incorporate salt-tolerant vegetation to ensure their future growth and resilience.

> Build out into coastal waters and stimulate diverse flora and fauna species using topography to perform hydrologically, ecologically, and aesthetically. These species can add to the cultural image of the city and index its hydrological health and management. Biscayne Bay, for instance, can host a mosaic of heterogeneous species that provide an aesthetic and experiential counterpoint to the typical homogeneity of the eastern beaches. (See Scenario 01)



“Water is not bad; we need to embrace that which is the basis of all life, and we need to look at better ways to utilize it."[11]

Bruce Mowry, 2016
City Engineer, City of Miami Beach

Fig. 7. Workers pump water from the inundated intersection of 18th St. and Bay Rd., located in Sunset Harbour, one of the lowest lying neighborhoods along the western bay coast.

Infrastructures

The immanent and ongoing threats of climate change strain Miami Beach's increasingly vulnerable municipal infrastructure. Pumps and pipes have been installed where gravity-based systems no longer suffice. Yet the recent incapacity to manage sunny day or flash floods highlights the limits of single-purpose engineering solutions and their inability to handle larger storm events.[12] Beyond flood pumps, raised roads, and sacrificial floors, incorporating landscape conditions and hybridized systems offers an opportunity to augment existing flood-resistant infrastructure.

Short-Term

> Use elevated streets and avenues to convey, absorb, and store stormwater. Elevated streets can use limestone-like fill to augment its sponge capacity. Pauses along its cross section can host deeper urban soils for added permeability, storage, and vegetation. Coordinate between jurisdictions to elevate roads in a comprehensive manner, such as for state roads, county roads, and municipal roads. (See Scenarios 08)

> Use rooftop cisterns for water collection and storage in and around Flamingo Park in addition to rain gardens and bioswales. Collected rainwater can help mediate fluctuating irrigation demand in the park. Additionally, underutilized areas in the park can host large rainwater collection tanks that double as public art. Lastly, the city should transform existing hardscapes into permeable surfaces for additional recreation grounds. (See Scenario 06)

> Reconceive block alleys as opportunities to add pervious surfaces and retention basins. Existing alleys adjacent to primary commercial avenues (e.g., Oceans Court, Collins Court) can stage additional public and semi-public spaces as extensions from the public realm. City works can pair these efforts with cut-and-fill strategies to further elevate low-lying lands and structures. (See Scenario 09)

> Coordinate with city-wide efforts to limit on-street parking in order to "trade cars for water" by expanding public transit options. These expansions include extending bike lanes, increasing bus capacity, promoting car-sharing programs, upgrading garage sensors, and ultimately adding mass transit capacity along Alton Road and Collins Avenue as well as rapid bus service to the mainland.

> Use road elevation schemes as opportunities to simultaneously elevate municipal utility infrastructure and avert salt water damage and corrosion. In the private realm, establish new building codes and base flood elevations (BFEs) to elevate critical machinery, utilities, and equipment beyond ASCE 7 and 24 standards to account for relative sea level rise within the useful life of these critical systems.

> Advocate to update the Florida Building Code to account for sea level rise projections. The Southeast Florida Climate Change Compact has standardized the sea level rise projections for the region, however, the next step is to incorporate these into the Florida Building Code. Where different elevation measurement systems (NAVD or NGVD) apply or exist, a consensus standard should use the best available science for protecting the life, safety, and property of citizens. These standards should be updated periodically as scientific certainty dictates.

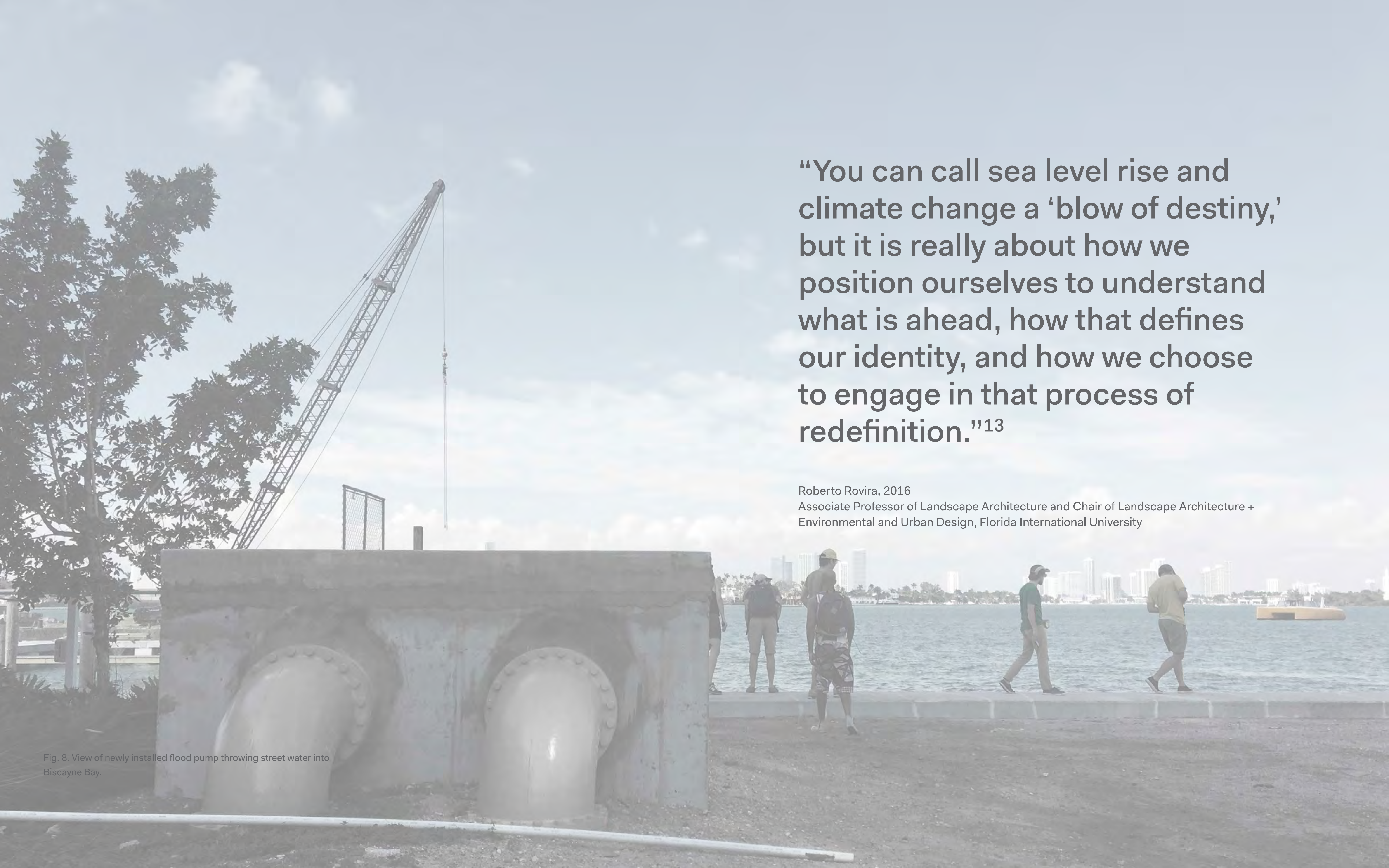
Medium-Term

> Introduce living sea walls in conjunction with grey infrastructure that can accommodate quick elevational change and host living organisms. To ensure continuity and coordination, require private developments to similarly construct their respective seawalls. Coordinate with engineers to incorporate design solutions that multiply infrastructural capacities. (See Scenario 10)

> Introduce mass transit infrastructure (e.g., light rail) on Alton Road and upzone adjacent blocks for increased density while maintaining historic preservation and affordability. Added density supports transit viability, equitable housing, and much needed tax revenue. Integrate this public transit masterplan with the rest of Miami Beach as well as the City of Miami and Miami-Dade County. (See Scenario 03)

> Create intentional, multi-layered infrastructural redundancies as an added form of defense and resilience. In particular, incentivize decentralized renewable energy production and consumption habits, such as photovoltaic and rainwater capture, and introduce educational programs on resource reuse and waste mitigation. Encourage civil society, private citizens, and other grassroots organizations to invest in more localized solar production and water collection systems to augment post-disaster relief.

> Expand transit options on existing causeways by widening and/or decking in order to accommodate light rails, pedestrian, and bike paths as well as emergency bus lanes. Just as the original Collins Bridge catalyzed Miami Beach's development, fortifying these causeways with resilient infrastructure underpins the future adaptation and viability of the city.



> “You can call sea level rise and climate change a ‘blow of destiny,’ but it is really about how we position ourselves to understand what is ahead, how that defines our identity, and how we choose to engage in that process of redefinition.”[13]

Roberto Rovira, 2016
Associate Professor of Landscape Architecture and Chair of Landscape Architecture + Environmental and Urban Design, Florida International University

Fig. 8. View of newly installed flood pump throwing street water into Biscayne Bay.

Identities

Integral to the identity of Miami Beach, Art Deco and MiMo architectures broadcast the city's imaginary of fantasy and escape. Yet, these historic buildings comprise preservation districts that currently sit at low elevations.[14] Pressed between rigid preservation laws and rising sea levels, the future of these districts will rely on aligning the principles of preservation with those of sustainability—and what has successfully sustained Miami Beach (and Miami at large) more than anything else is its economy of images. From postcards of perfect beaches, to billboards of real estate rewards, to television dramas of dystopic seduction, and finally to today's full-resolution renderings of waterfront getaways; Miami's deliberate cultivation of desire through visual media has reciprocally formed and reformed its built environment, not the least of which, its architectures. Therefore, central to its future identity, Miami Beach must ask what aspirational image the city should pursue in order to adapt to climate change and, more importantly, renew its imaginary landscape altogether.

As the public sector cannot single-handedly maintain the city's historic urban fabrics, whose many buildings are in fact of questionable architectural value, the irony in Miami Beach is that preservation depends largely on development. Nevertheless, the good news is that adopting this perspective liberates the city from the price of rigid nostalgia and instead affords it the opportunity of imagination to reshape its built identities in order to propel itself into the future.

Short-Term

> Develop specific typological and morphological strategies for the elevation of historic districts over time while maintaining their cultural identity. Phase this district-wide elevation by prioritizing the most vulnerable, low-lying areas first. Introduce regulations that require constructing higher ground floor ceiling heights so that as sea level rises, this floor can likewise elevate and adapt over time to new Base Floor Elevations (BFEs).

> Pair the elevation of historic districts with incentives for on-site stormwater retention and over-flooding. The necessity to raise these districts affords reconceiving their historic status beyond a one-dimensional label. For instance, elevating also means increased porous groundcover and vegetated gardens. Incentives such as FAR bonuses or transfer of air rights can catalyze adaptation that begins with—instead of ends with—the historic district.

> Prioritize select architectural landmarks for strict preservation or relocation rather than whole neighborhoods. In general, prioritize typological preservation over material and architectonic preservation, recognizing that urban consistency and coherence are more important than specific—and outdated—tectonics and motifs. (See Scenario 03)

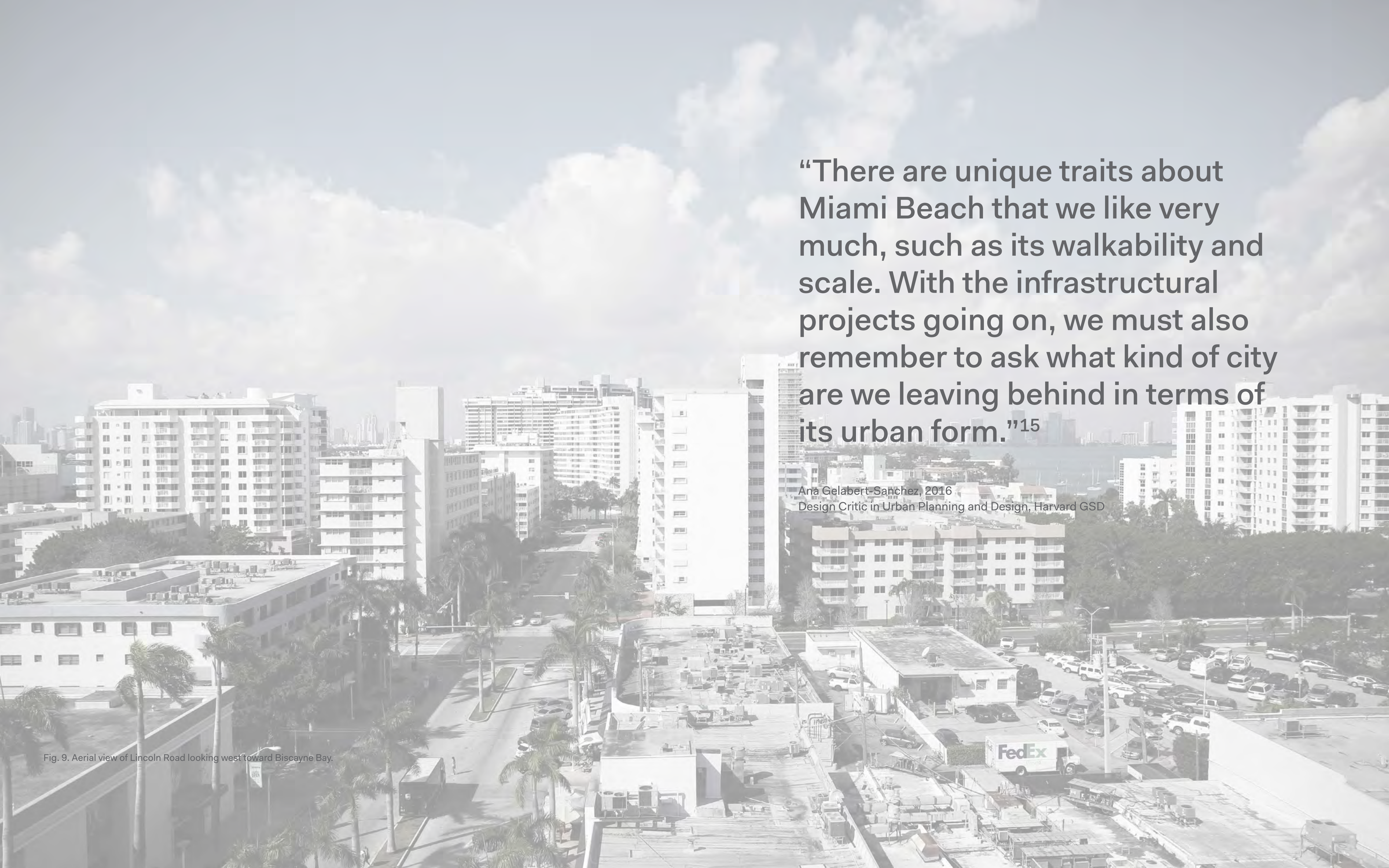
> Coordinate with the Historic Preservation Board and the Planning Office to revise preservation restriction codes. Among others, these include: broadening what may be considered “contributing,” such that the term also includes more significant and/or new construction that is contextually sensitive; encouraging new construction that complies with standardized sea level projections within upzoned or upgraded existing land-use categories (e.g., RM-1 to RM-2); issuing appropriateness for demolition and subsequently allowing for increased FAR; allowing the sale of air rights to promote development feasibility for select landmarked buildings and sites; and expanding the historic tax credit to make historic building adaptation and redevelopment efforts more financially viable.

Medium-Term

> Foreground the future imaginary of Miami Beach on its adaptability to climate change and sea level rise by reshaping the city’s urban identity (i.e., urban form, morphology, and typology) according to hydrological and ecological performance. Just as Miami’s climate has yielded a composition of unique typologies (e.g., destination resorts, garden apartments, pleasure gardens), it follows that the imminent and drastic change in climate prompts a corresponding change in built form. (See Scenario 02)

> Reimagine the historic district as a stormwater sink. Begin by developing codes and massing strategies to accommodate “sponge pads” below the sacrificial floors of the historic district. Sponge pads can also hold overflow from rooftop cisterns or gardens. As the city elevates, gradually fill in these sacrificial floors with similar sponge-like (i.e., limestone-like) composites.

> Reconceive the single-family residential district around Flamingo Park (currently RS-4) as a floodable, transitional, upzoned district that channels development toward public ends (e.g., added public space, affordable housing, payment’s earmarked for municipal resiliency efforts). This district should transition from the larger developments by Alton Road to the smaller-scale urban fabric around Flamingo Park. (See Scenario 03)



"There are unique traits about Miami Beach that we like very much, such as its walkability and scale. With the infrastructural projects going on, we must also remember to ask what kind of city are we leaving behind in terms of its urban form."[15]

Ana Gelabert-Sanchez, 2016
Design Critic in Urban Planning and Design, Harvard GSD

Fig. 9. Aerial view of Lincoln Road looking west toward Biscayne Bay.

Spaces

Miami Beach's existing urban form is largely determined by a street grid laid out near the beginning of the 20th century. In general, from the city's coasts inward, block types transition from irregular to homogenous, from porous and permeable to compact and impermeable, and from high-rise towers and plinths to low-rise bars and courtyards. Adapting to sea level rise means recognizing the economic and political realities of city-making in the 21st century and, by extension, orchestrating these forces to guide urban form. As such, any significant comprehensive plan requires concerted efforts from both the public and private sectors.

Short-Term

> Begin to trade existing height and lot limitations for open space, particularly in the city's interior blocks (e.g., blocks between Alton Road and Washington Avenue). Concentrate density in taller typologies (e.g., mid-rise slabs and towers) in order to create more open, public space for holding water in addition to other hydrological and ecological functions. Where these blocks intersect commercial corridors, eliminate any setbacks.

> Direct the construction and adaptive improvements of private property on the block, rather than parcel, level in order to streamline building elevation, code enforcement, and existing capital improvement efforts. In general, use codes, particularly municipal zoning codes over State-determined building codes, to lead a more proactive transformation of these blocks. Furthermore, allow for the

amalgamation of adjacent properties (e.g., up to 3 continuous lots) to promote higher density developments.

> Distribute density along major avenues and thoroughfares where such corridors can accommodate increased urban scale and traffic. Where these blocks intersect historic districts, establish regulations (e.g., BFE compliance) and incentives (e.g., FAR bonuses) that allow for the elevation of these districts typologically instead of materially. For instance, a historically designated two-story single-loaded residential bar can be completely rebuilt as an elevated three- to four-story bar that occupies a smaller footprint. (See Scenario 03)

> Pair the increase of density with owners' ability to transfer development rights across select districts (e.g., through an overlay zoning district). This transfer right further enables redevelopment feasibility and potentially provides a mechanism to punctuate urban fabric.

Medium-Term

> Develop street cross section types for the gradual one-story (e.g., 3-4 meters) elevation of streets and avenues. Integrate these street sections with sidewalks and building fronts using specific landscape conditions that incorporate on-site drainage, planters, seating surfaces, and other amenities. Formulate programmatic scenarios for the use of floodable ground-floors, such as parking, lobbies, storage, loading docks, and other back-of-house logistics.
(See Scenario 08)

> Pair the construction of the bayfront's living seawall with the extension of the public right-of-way to increase public accessibility. Existing blocks at the waterfront span multiple blocks and effectively deny visual and public access to the bay. Additionally, these streets can be designed to prioritize people and water over cars. (See Scenario 10)

> Introduce solar performance as a guiding parameter to shape collective urban form. Zoning envelopes can be calculated to privilege either solar equity (i.e., minimizing shadow on the public right-of-way) or solar energy (i.e., maximizing solar gain on building surfaces). While the former approach ensures optimal daylight on the public realm, the latter approach permits maximal on-site energy exposure and production. (See Scenario 04)

> Research the feasibility of further urbanizing extant islands (e.g., Star Island, Venetian Island, or new islands altogether) through densification and simultaneous decentralization of existing residential nodes on Miami Beach. This reduces the risk of concentrated populations on the city and requires fortifying existing infrastructure that links such islands. (See Scenario 05)

“How can open public space become an adaptation strategy?”[16]

Ana Gelabert-Sanchez, 2016
Design Critic in Urban Planning and Design, Harvard GSD

Fig. 10. Flamingo Park, looking southwest.

Publics

Racing to keep dry, the city is quickly becoming overwhelmed by pumps, seawalls, elevated roads, artificial dunes, and sacrificial floors that increasingly intrude and disrupt the public realm.[17] Building resilience, however, must incorporate metrics of success beyond stemming rising tides; it must also respond to and accommodate new public parameters. Additionally, existing public spaces must also take on additional resilience-oriented responsibilities as well as provide post-disaster shelter, food, and other relief. The following recommendations represent short- and medium-term plans for a more comprehensive open space plan that integrates urban adaptation, cultural identity, and public space.

Short-Term

> Increase public access in certain areas (e.g., via paths, easements, public right-of-ways), particularly along the waterfronts. Current and future luxury developments that line the city's waterfront are significantly larger in scale and often encompass multiple city blocks. These developments de facto privatize the waterfront. As such, ensure public access by preserving public corridors, maximizing sunlight, and enhancing wayfinding.

> Develop a catalog of cross section types that mediate between the changing elevations of roads, sidewalks, and buildings. Study how these urban thresholds shape and augment pedestrian access and experience and build on opportunities to expand the public realm. Additionally, use these sectional changes to incorporate storm and flood water drainage and holding capacities. (See Scenario 08)

> Develop street end plazas over pump stations on the bayside and connect these public spaces with the existing bay walk. Decking over existing pump stations masks their visual and aural noise and recovers much-needed bayfront public space. Additionally, integrate coastal plant communities to increase both hydrological and aesthetic benefits.

> Enhance public transit options along major corridors (e.g., Alton Road, Washington Avenue), prioritizing pedestrians and bicycles over vehicles. Maximize permeable surfaces at medians and sidewalks to host deep soils for vegetation and stormwater storage. As urban density increases, implement mass transit to accommodate transportation demand and intercity connectivity.

> Use public space as a didactic tool to educate residents on the issues of sea level rise and the public infrastructure necessary for future adaptation. Develop strategies to visually express and index the city's infrastructure to the public as a marker of both efficacy and accountability. For instance, the health of performative vegetation in parks, bioswales, and/or acequias is directly linked to the strength of its stormwater management system.

> Create a public ombudsperson who would advocate on behalf of residents, citizens, and tourists. This public voice would review and provide input to measures, interventions, and strategies that are undertaken in the name of resilience and adaptation. In particular, the public ombudsperson should seek to understand the multi-scalar and unintended consequences of action that may lead to undue burdens or may otherwise be regarded as maladaptive. In particular, the public ombudsperson may seek to mitigate the effects of "climate gentrification,"[18] which arise when resilience investments or undue financial burdens lead to localized displacement.

Medium-Term

> Connect aforementioned bayfront street-end plazas with a continuous bay walk to develop a coherent public realm in relation to the city fabric, pump stations, and hydrological infrastructure. Establish zoning codes along the Biscayne Bay shoreline to incentivize new developments to construct their portion of the public bay walk promenade. Where politically necessary, circumvent uncooperative bayfront developments by building out into the bay, making sure to minimize ecological disruption and damage. (See Scenario 10)

> Establish incentives and requirements on new developments to provide and/or maintain additional public spaces and services (e.g., privately-owned public spaces). These requirements can be paired with other flood-mitigating codes as part of a more comprehensive zoning plan. For instance, require new inland developments to provide permeable pocket parks and those along the bay to construct their respective portion of the bayfront living seawall.

> Incorporate public space and programming into all hydrological and ecological landscapes by integrating promenades, open space, public amenities, and educational opportunities. Any investment made in such open spaces should be designed to also accommodate public access and programming. For instance, waterfront landforms can stage public piers, infrastructural canals can host linear parks, and stormwater collection tanks can double as public art. (See Scenario 07)

"Choosing [the municipal] scale of government to solve the problem could mean not necessarily dealing with only local codes but actually dealing with creating coalitions around the state, nation, or world."[19]

Jerold Kayden, 2016
Frank Backus Williams Professor of Urban Planning and Design, Harvard GSD

Fig. 11. View of Museum Park across Biscayne Bay with One Thousand Museum tower by Zaha Hadid Architects under construction.

Policies

In the absence of state and federal leadership, the onus falls on the municipality of Miami Beach to formulate a comprehensive and flexible adaptation plan. While the viability of adaptation largely hinges on the health of the private sector (e.g., sustaining tax revenues, building investor trust, minimizing actuarial risks), the city must nevertheless take preemptive action toward both incentivizing and guiding adaptation measures. A failure to do so will yield momentum and decision-making to public bond markets which are less disciplined in evaluating the opportunities associated with adaptation plans and strategies. For instance, as a baseline, maintaining dry streets hedges against the potential, if not inevitable, retreat of insurance and mortgage industries long before rising sea levels actually sink the city. Furthermore, while the imminent threats of climate change prompt urgent new policies, the city should remember that it must act with appropriate sensitivity such that the interests of different stakeholders, particularly the most vulnerable, are not overridden in the name of adaptation.

Short-Term

> Establish codes and regulations to incentivize and/or require developments to be constructed or rebuilt with resilience principles and with material and programmatic adaptive capacity. For instance, require developments to meet Base Floor Elevations (BFEs) and encourage them to hold a certain amount of stormwater on-site. Assess fees on new developments to support city-wide green infrastructure through different zoning tools. Additionally, establish new incentives (e.g., density bonuses) that are geared toward adaptation. Currently, federal and state incentives, while helpful, are not specifically related to promoting adaptation

to climate change (e.g., LIHTC, Historic Tax Credit, HOME grants, New Market Tax Credits). The City should provide leadership by aligning its public policy goals with programs such as the New Market Tax Credit in order to advance the resilience of vulnerable populations.

> Create a finer-grained regulatory system, beyond a broad catch-all AAA designation (Adaptation Action Areas), for areas particularly vulnerable to flooding, such as the island's western half. For instance, New York City denotes gradated vulnerability parallel to its Special Flood Hazard Area (SFHA) maps and prioritizes funding accordingly for areas most susceptible to the effects of climate change.[20] In Miami Beach, this more nuanced map can be achieved through a zoning overlay that attracts primary attention and requires stricter building standards.

> Clarify outstanding and future questions around public and private flood insurance costs and availability. First, establish a collective, municipal co-insurance pool to subsidize uninsured risks based on geographic exposure and household vulnerabilities. By one measure, this could be linked to standardized Base Flood Elevation (BFE) metrics and resiliently designed for retrofitted buildings. Additionally, gradate premiums based on elevations above BFEs to encourage elevating higher than projected flood levels. Second, clarify insurance costs and availability for private owners facing elevated streets. In particular, determine whether properties adjacent to elevated streets are entitled to flood insurance and at what grade;[21] whether property owners are entitled to compensation if they are obliged to raise their businesses to the level of the street to maintain commercial viability; and whether property owners with historic homes are entitled to compensation for a taking if the historic board does not allow them to raise said homes.

> Strategize with appropriate committees to continue investigating federal, state, regional, and local funding assistance and grants; prioritizing such funding for green infrastructure; and coordinating capital improvement projects with other resiliency masterplan efforts. The City should develop a restoration and response plan that anticipates future events and develops Community Development Block Grant-Disaster Recovery Action Plans that maximize Public Assistance funds for resilience and adaptation projects.

> Coordinate with the State of Florida and Miami Dade County Division of Environmental Resources Management to make green infrastructure easier to permit. This effort should include an alignment with recent permitting regimes advanced by the US Army Corps of Engineers. Currently, coordinating across jurisdictional lines presents the biggest challenge. This joint agreement, for instance, can be modeled on current road pumping efforts that cross state, county, and municipal lines.

Medium-Term

> Build standardized sea level and nuisance flood projections into all public works decision making related to investment, design, construction, maintenance, and operations.

> Coordinate with county and state actors to plan and develop synergistic mitigation and resilience interventions using the joint-effort on street raising as a potential template. The City should continue to coordinate with the region to build upon the plans of the Southeast Florida Regional Climate Compact and mainstream the scientific consensus data into capital investment decision-making. Additionally, coordinate with the State of Florida to implement expenditures and taxes earmarked for funding stormwater management infrastructure so that Miami Beach is not solely dependent on municipal property tax.

> Research the feasibility of a “hybrid retreat” scenario wherein permanent residences are gradually replaced (via buyouts or otherwise) by tourism-oriented programs (e.g., hotels and condos) and permeable open space (e.g., parks and basins). This medium-term scenario reduces risk for homeowners located on an increasingly vulnerable barrier island, preserves Miami Beach's economic and cultural sustainability, and propels its imaginary as America's definitive subtropical paradise. Nevertheless, this scenario must be choreographed in a manner that supports mixed-income, high-density housing to avoid the worst effects of "climate gentrification."

> "Resilience may lead to maladaptation, the paradox being that investment made to protect vulnerable citizens may ultimately drive them away."[22]

Jesse M. Keenan, 2016
Lecturer in Architecture, Harvard GSD

Fig. 12. Aerial view of residential subdivision under construction at the western edge of the metropolis bordering the Everglades.

Developments

From its inception, Miami Beach has been a product of private and ambitious speculation. Catalyzed by John Collins's wooden footbridge across Biscayne Bay and Carl Fisher's feverish promotion of the barrier island as a real estate gold mine, Miami Beach sustained a building boom that almost weathered the Great Depression. Today, not surprisingly, Miami Beach's adaptive future continues to be tethered to the prospects of its real estate market. While many real estate transactions (e.g., buying, renting, investing) occur with little to no reference to climate change or sea level rise, certain development and investment firms are already accounting for such futures through added line items of risk, shorter hold-periods, sacrificial floors, and elevated mechanical equipment.[23] In its effort to encourage building for resiliency, the city must balance promoting—and harnessing—real estate development with implementing exactions that risk suffocating such investments.

Short-Term

> Clarify and standardize Base Flood Elevations (BFEs) based on sea level rise and other scientific projects from the Southeast Florida Regional Climate Change Compact into flood insurance maps and require developments to construct to or above referenced elevations. Where appropriate (e.g., storefront retail, lobbies), the city should incentivize such developments to construct higher ground floors and ceiling heights so that these floors can adapt to higher BFEs over time. This also includes alternative ingress and egress models as the grade changes. Lastly, site

grading requirements should be decoupled from the requirements associated with street elevations.

> Negotiate with FEMA for revised Flood Insurance Rate Maps (FIRMs) that are inclusive of projections consistent with the Southeast Florida Regional Climate Change Compact. The City should also develop a plan to communicate the advantages of such a negotiated settlement with FEMA.

> Create zoning incentives for new developments to encourage projects designed with flood mitigation and resilience principles. As such, the city should put in place policies that require and/or reward adaptation efforts, including building beach buffers and dunes, ecological habitats, vegetated bioswales, additional on-site flood mitigation measures, and higher density infill developments on less vulnerable grounds. Where developments do not meet such requirements, the city should impose a resilience impact fee that is earmarked for resilience projects.

> Restrict foreign investments to curb empty residences that drive up local housing costs by introducing taxation on unoccupied units. The tax revenue should go into an affordable housing trust fund to retrofit those units and buildings that are currently and will continue to serve cost-burdened households.

> Create brokerage requirements that necessitate real estate brokers to disclose any prior flooding events or flood insurance claims as well as provide the prospective purchaser with a map of the unmitigated inundation projected to happen over 25 years and 75 years. Prior to fully engaging the broker for brokerage services, prospective purchasers must sign an affidavit stating that they have been reviewed these materials with the broker.

Medium-Term

> Require new developments to contribute funding toward major infrastructural improvements whether on-site or off-site, such as living seawalls at the Biscayne Bay coastline. These financial contributions may operate from a range of models such as impact fees, equity contributions, or public-private infrastructure ventures. Additionally, explore public-private partnership opportunities to support major public amenities, such as public parks and waterfront spaces. Lastly, the city should consider selling city parcels to fund risk mitigation projects and simultaneously seed new developments. The city should mandate that new developments on these parcels meet strict flood mitigation standards through a rigorous RFP process.

> Prepare measures to protect against the potential deleterious effects of “climate gentrification,”[24] a scenario whereby the investments put into protecting and adapting communities vulnerable to sea level rise ultimately price them out of their neighborhoods due to increased appeal, amenities, safety, and/or taxation. For instance, the city should require new luxury condominium developments to support inclusionary housing and new luxury hotel developments to pay a fee earmarked toward affordable housing for its service employees.

Scenarios

Developed across two studios and one seminar, the following projects represent select scenarios that illustrate particular design principles for Miami Beach's urban adaptation to sea level rise. These scenarios address adaptation in a range of spatial and temporal scales: from small-scale street section interventions to new urban imaginaries for Miami Beach's twenty-second century. Rooted in hydrological performance, each scenario presents adaptation measures that simultaneously address a number of urban parameters, such as infrastructural coordination, public realm improvement, and ecological cultivation, among others. Furthermore, while some scenarios work within disciplinary boundaries and municipal limits, others imagine complete urban environments whose realization is dependent on much broader political agency and coordination. Finally, all scenarios draw upon Miami Beach's history of natural endowment and synthetic construction to inform strategies that anticipate future challenges and opportunities as well as mitigate present threats.

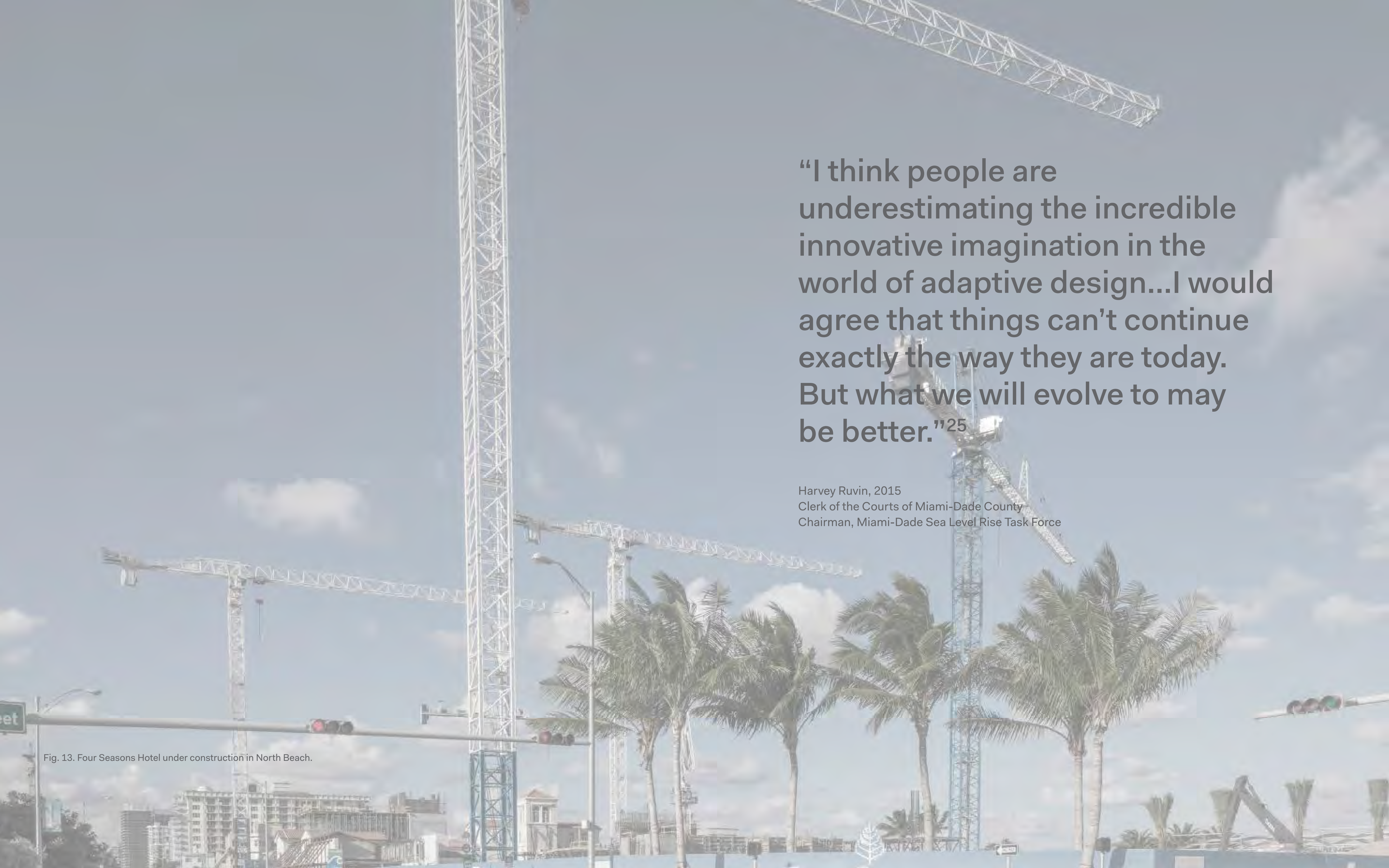


Fig. 13. Four Seasons Hotel under construction in North Beach.

“I think people are underestimating the incredible innovative imagination in the world of adaptive design...I would agree that things can’t continue exactly the way they are today. But what we will evolve to may be better.”[25]

Harvey Ruvin, 2015
Clerk of the Courts of Miami-Dade County
Chairman, Miami-Dade Sea Level Rise Task Force

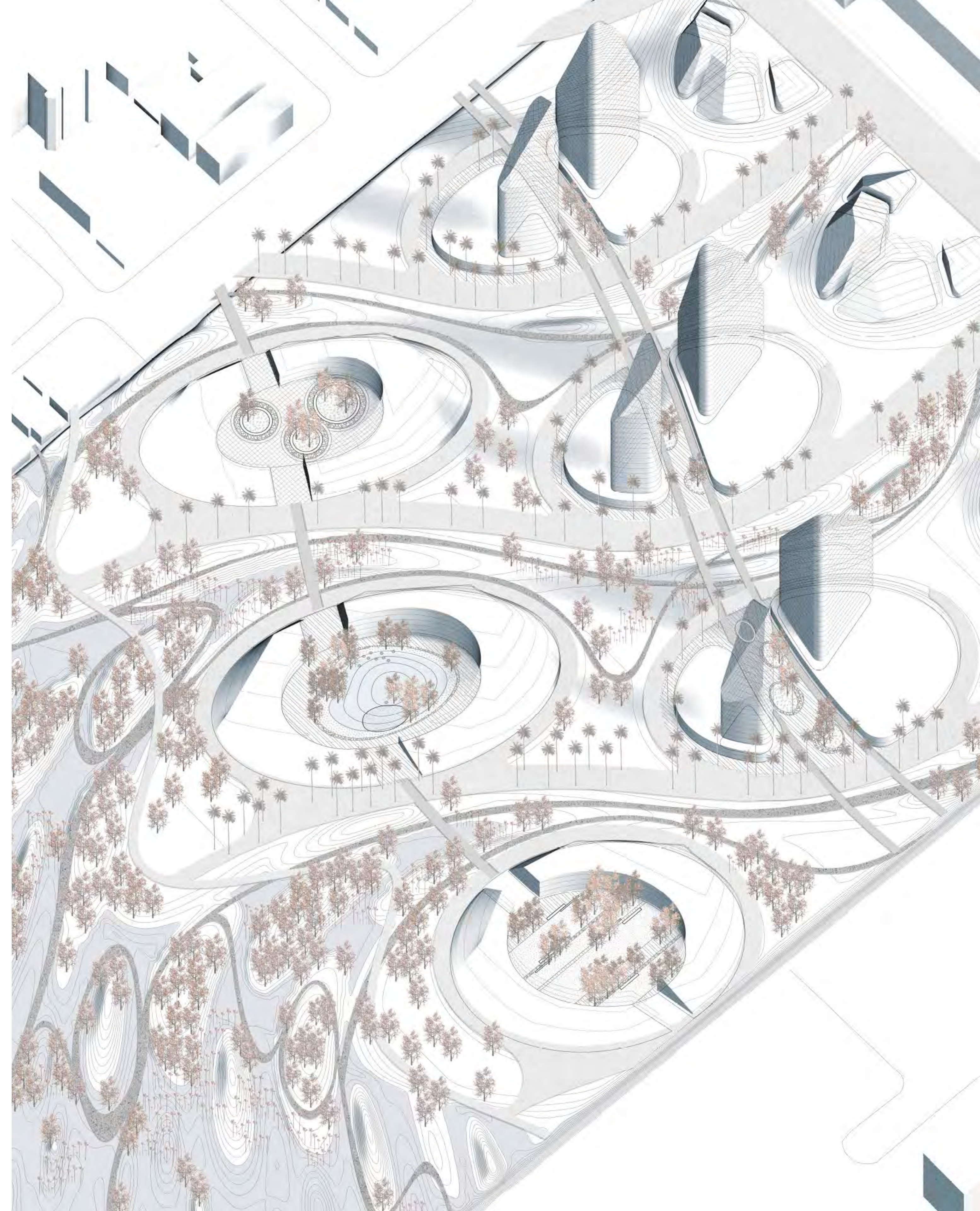
Scenario 01

Types in the Park

Boxia Wang
Advised by Charles Waldheim

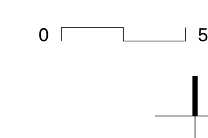
Drawing from Miami Beach's history as a mangrove swamp, this project reintroduces this species, and its associated hydrological habitats, as the basis for a new urban adaptation model to sea level rise. The mangrove's four typical habitat conditions inform a gradated, sloped living seawall on the Biscayne Bay coastline which in turn shapes its block structure and urban form. A meandering elevated path weaves the landscape into a public promenade and park.

> Fig. 14. Axonometric view of project proposal showing the integration of novel urban form with hydrologically performative landforms.



Scenario 01: **Types in the Park**

Fig. 15. Site plan from the Biscayne Bay at left to urban blocks adjacent to Alton Road at right.



Scenario 01: **Types in the Park**

Hydrologies

The proposed variegated landforms in the bay are informed by the communities of different mangrove species, each of which has a preference for elevation, inundation, water salinity, and moisture level. Freshwater and saltwater systems are separated by a living seawall where these mangroves are curated and concentrated. A riverine system further inland connects to existing outfalls and provides an added layer of stormwater filtration before such water is discharged into the bay.

Ecologies

The geometry of the landforms in the bay are intimately tied to the way they host different communities of mangroves. Each species provides different ecological benefits. From the bay inward, the over-washed mangrove islands host a large, thick system of mangroves that protects against storm surges and soil erosion; the basin zone provides shelter for aquatic wildlife and retains seawater; the fringe mangrove zone stages red mangroves to protect the shoreline; and the highland riverine zone channels water during high tides and storm events.

Infrastructures

This project embraces the ecological and absorptive capacities of the mangrove and functions as a deep, resilient green infrastructure system. While most of the proposed bayfront landscape is floodable, the independent urban blocks are elevated approximately 3-4 meters above the existing ground level. Primary east-west arterial roads align to existing streets and circumvent each block to provide both programmatic and logistical access. Secondary cross-grain roads connect these blocks along a north-south axis.

Identities

Potentially integral to Miami Beach's urban adaptation, this project reconceives the native mangrove as the new icon in the city's future imaginary. In contrast to its found state, the mangroves are deployed systematically and architectonically. As such, they exist not as found nature but as constructed artifice. Lastly, while not shown, the project also proposes the elevation and reorganization of the adjacent historic districts such that they also cede floodable ground to different inland mangrove communities.

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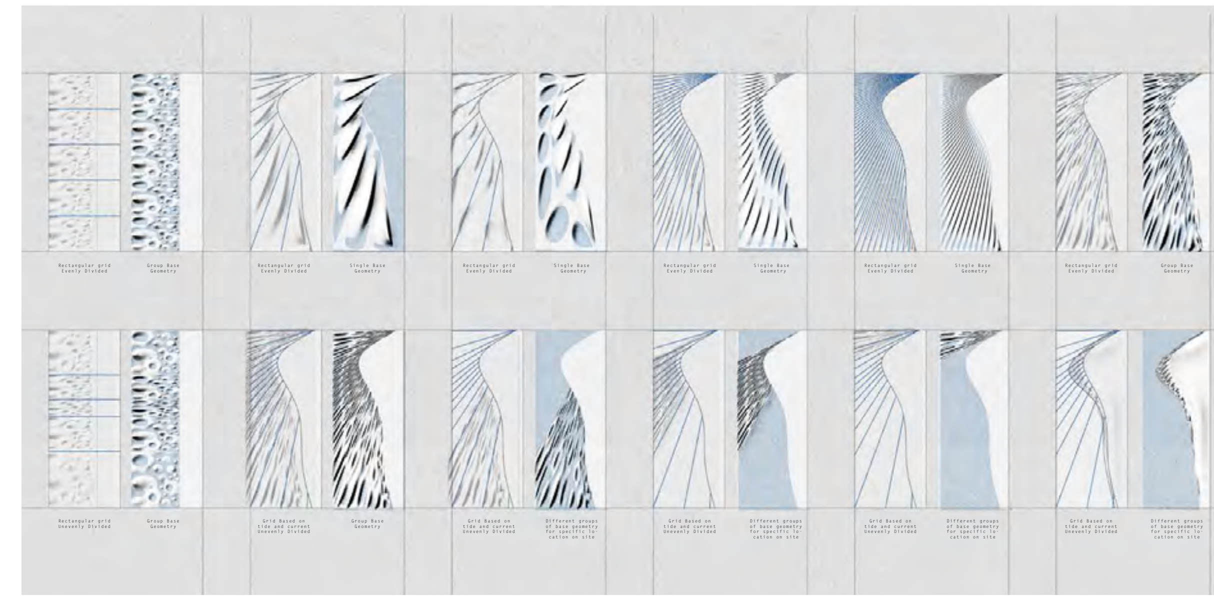

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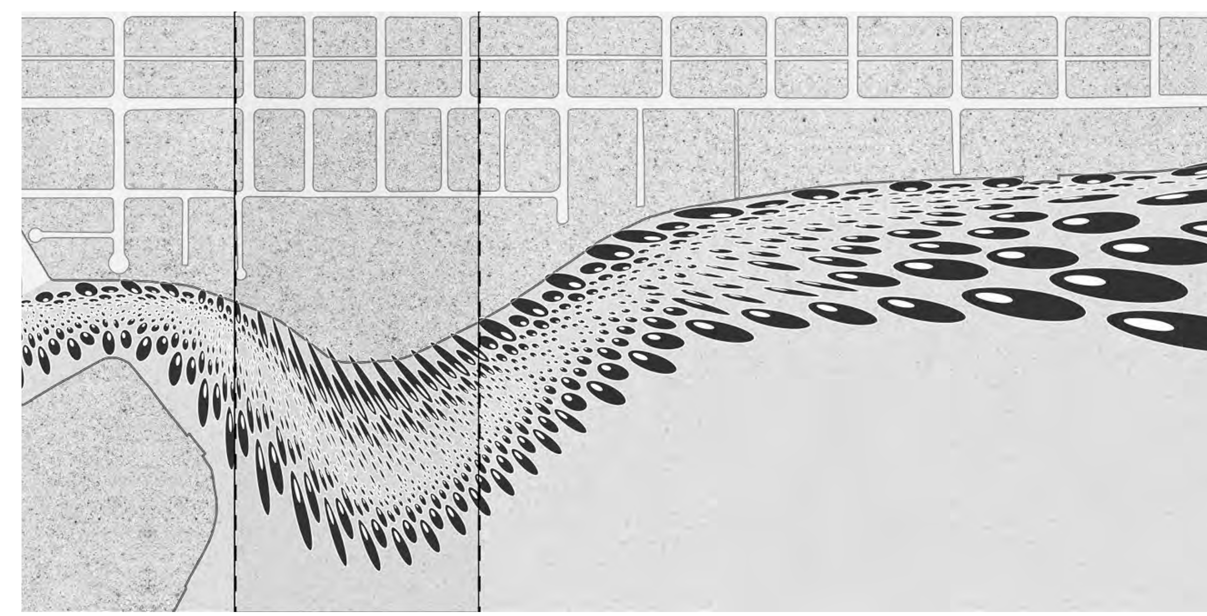

Fig. 16. Matrix of topographic operations at the scale of the Biscayne Bay coastline.

Fig. 17. Site plan showing landform composition and its relationship to the existing coastline and urban fabric. Project fragment is marked in dashed lines.

Scenario 01: **Types in the Park**

Spaces

The elevated urban blocks host several hybridized typologies, all of which stem from the garden courtyard type found throughout Miami Beach. From the bay inward, a set of mid-rise, C-shaped bars host recreational programs such as sports facilities; a series of towers-on-plinths contain luxury hotels atop shopping centers; and adjacent to Alton Road, a row of low-rise linear buildings with local residential communities. Their vertical profiles are shaped to maximize light onto the public park.

Publics

A hierarchy of public roads and paths meander through the entire site. While a trio of arterial roads connect the project back to the city's grid, a lighter and elevated public deck in the form of a "ribbon" ties all components of the project together and offers a new public realm. Visitors have the opportunity to stroll from Alton Road to the over-washed mangrove islands in Biscayne Bay. Lastly, the urban blocks' courtyards provide semi-public spaces for residents and visitors.

Policies

Because the project is predicated on the continuity of its living seawall, the City of Miami Beach must coordinate with adjacent jurisdictions, in particular the County and State, to facilitate permitting and construction. As prime sites for development, the City should promote them through a rigorous RFP process that channels benefits toward public functions and holistic municipal resiliency. Lastly, policies should be put in place to ensure the waterfront promenade and park remain public.

Developments

The project seeks to leverage its attractive waterfront blocks as development opportunities to fund extensive parts of the proposed green infrastructure. For instance, the middle row of urban blocks containing high-rise luxury towers command open views of both the Biscayne Bay and the Atlantic Ocean, and as such, these sites should contribute both impact fees and/or maintenance fees toward the park.

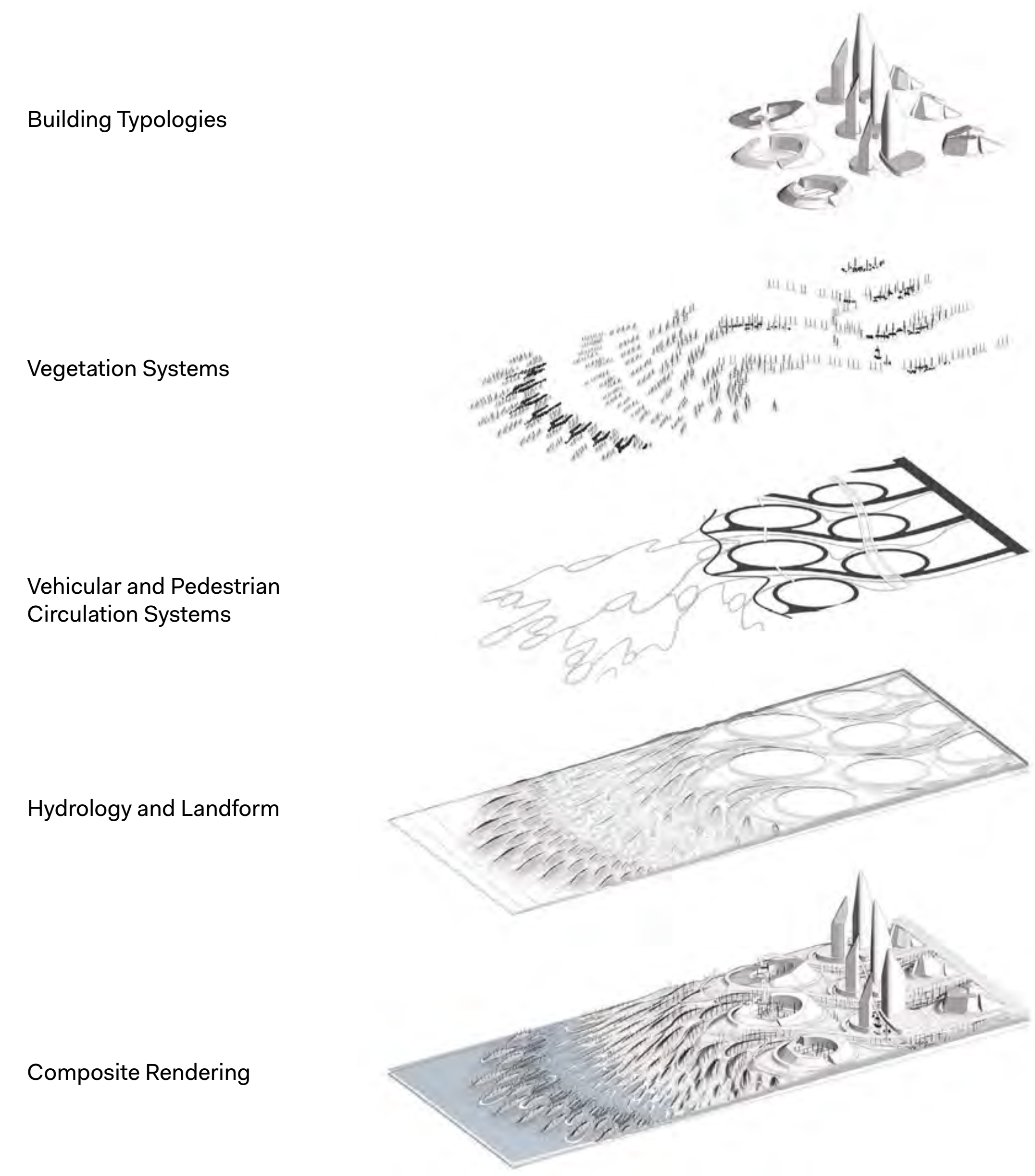

Fig. 18. Exploded Axonometric showing project components.

Scenario 01: **Types in the Park**

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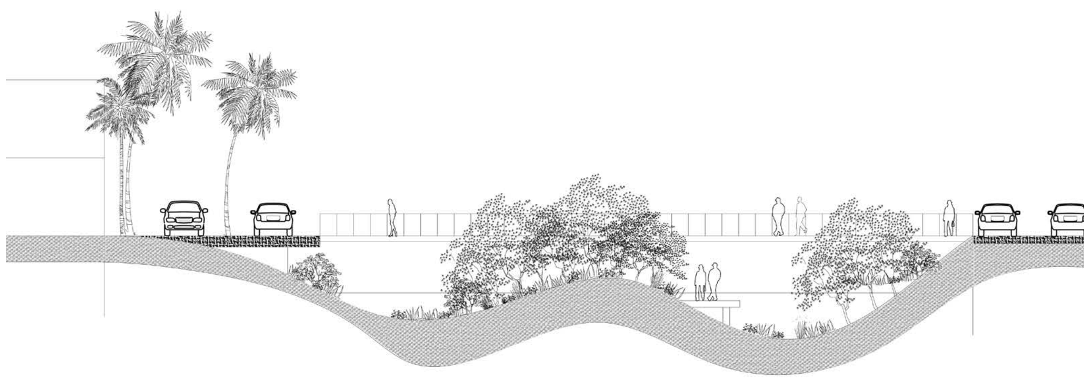

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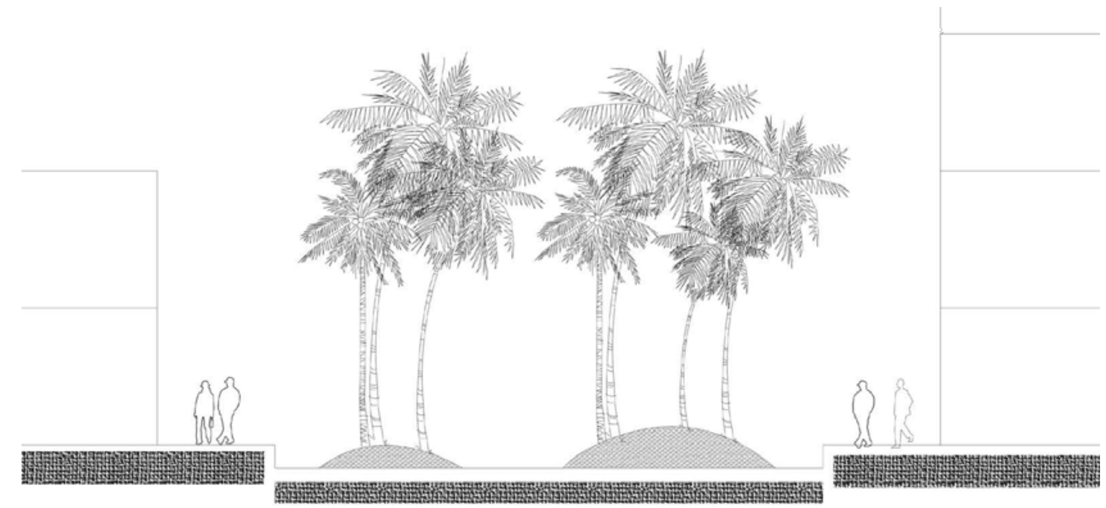

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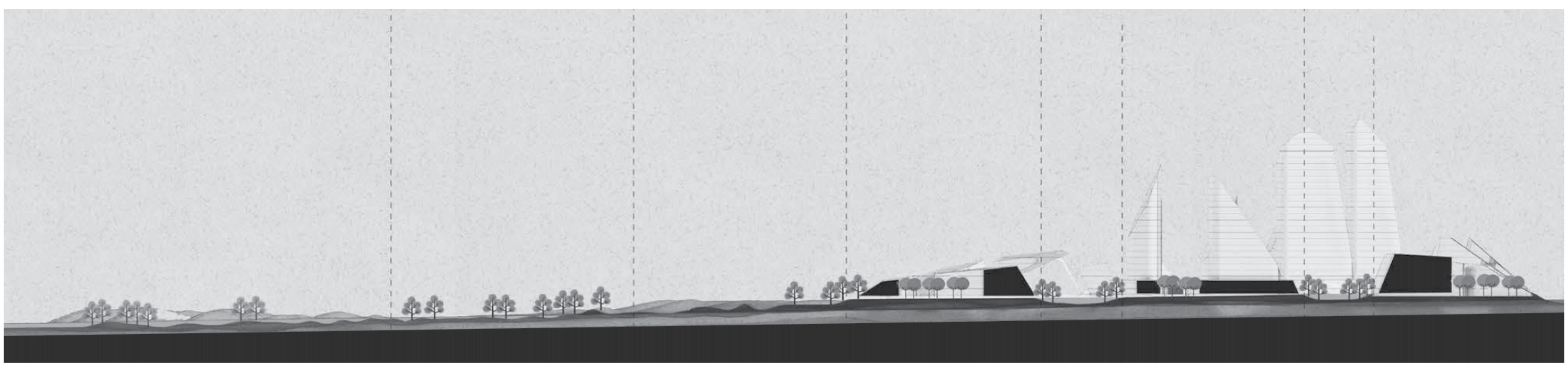


Fig. 19. Street section showing vegetated canal between new blocks.

Fig. 20. Section from Biscayne Bay at left to Alton Road at right.

Fig. 21. Section of courtyard highlighting elevational change.

Fig. 22. Aerial view toward Biscayne Bay showing landforms, public paths, and vegetation.

Scenario 02

Hydrological Urbanization

Andrew Madl
Advised by Charles Waldheim

Rising ocean levels, increasing magnitude of storm events, and the implementation of new stormwater infrastructure necessitate a re-tooling of the current urban paradigm. As such, factors associated with the deconstruction of oceanic systems and ecosystems; such as pH levels, salinity levels/gradients, plant community patterns, and landform typologies should be leveraged to imagine new integrated urban and ecological systems.

> Fig. 23. Aerial perspective showing adaptive urbanization driven by hydrological factors and functions.

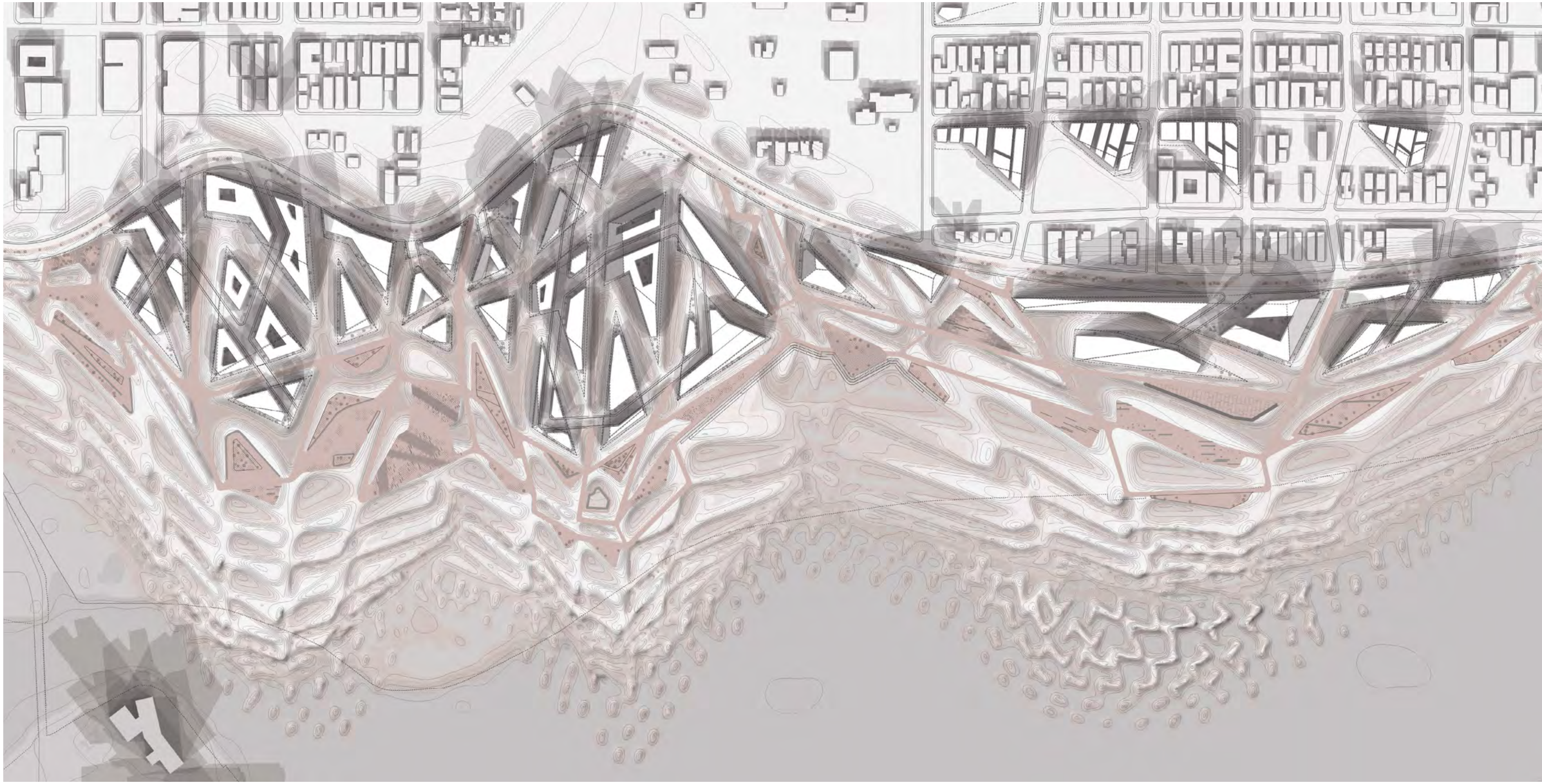


Fig. 24. Site Plan showing landform and urban strategy with planting communities and public space.

0 100m

Scenario 02: **Hydrological Urbanization**

Hydrologies

Various visible and invisible hydrological forces can be exposed and leveraged to underpin a new littoral urbanism for Miami Beach that both maintains existing spatial qualities and projects a future adaptive city. Informed by computational fluid dynamics, intertidal flow rates, salinity levels, among other hydrological parameters, landforms protect the city from future storm surges and stage new urban islands for development.

Infrastructures

Instead of relying on engineered defense against the rising tides, this scenario leverages landform operations as a natural hydrological infrastructure. Alton Road is imagined as the seam and stitch between a new adaptive expansion to the west and an urban transformation to the east. It is also the divide between saltwater in the bay and sweetwater in the park. A network of roads extend from Alton Road and create a sequence on the island to provide both visitor and logistical access.

Identities

This scenario represents a position on sea level rise adaptation where development and policy are not based purely upon economic drivers but rather on the spatialization of various simulated, data-driven natures that also govern the barrier island. Just as Miami Beach's unique built environment has always been intimately tethered to its natural environment, this scenario projects a form of the city in direct dialogue with increasingly intense climatic pressures and environmental drivers.

Spaces

The proposed urban morphology of Miami Beach is driven by the relative calibration of different hydrological forces (e.g., flow dynamics, tidal levels, and salinity). These factors collectively produce a new urban framework that allows for ecological, social, and urban occupation that both respects vernacular architecture and offers a novel urban form. For instance, a combination of hybrid bars, courtyards, and towers prioritize an association with performative landforms over programmatic needs.

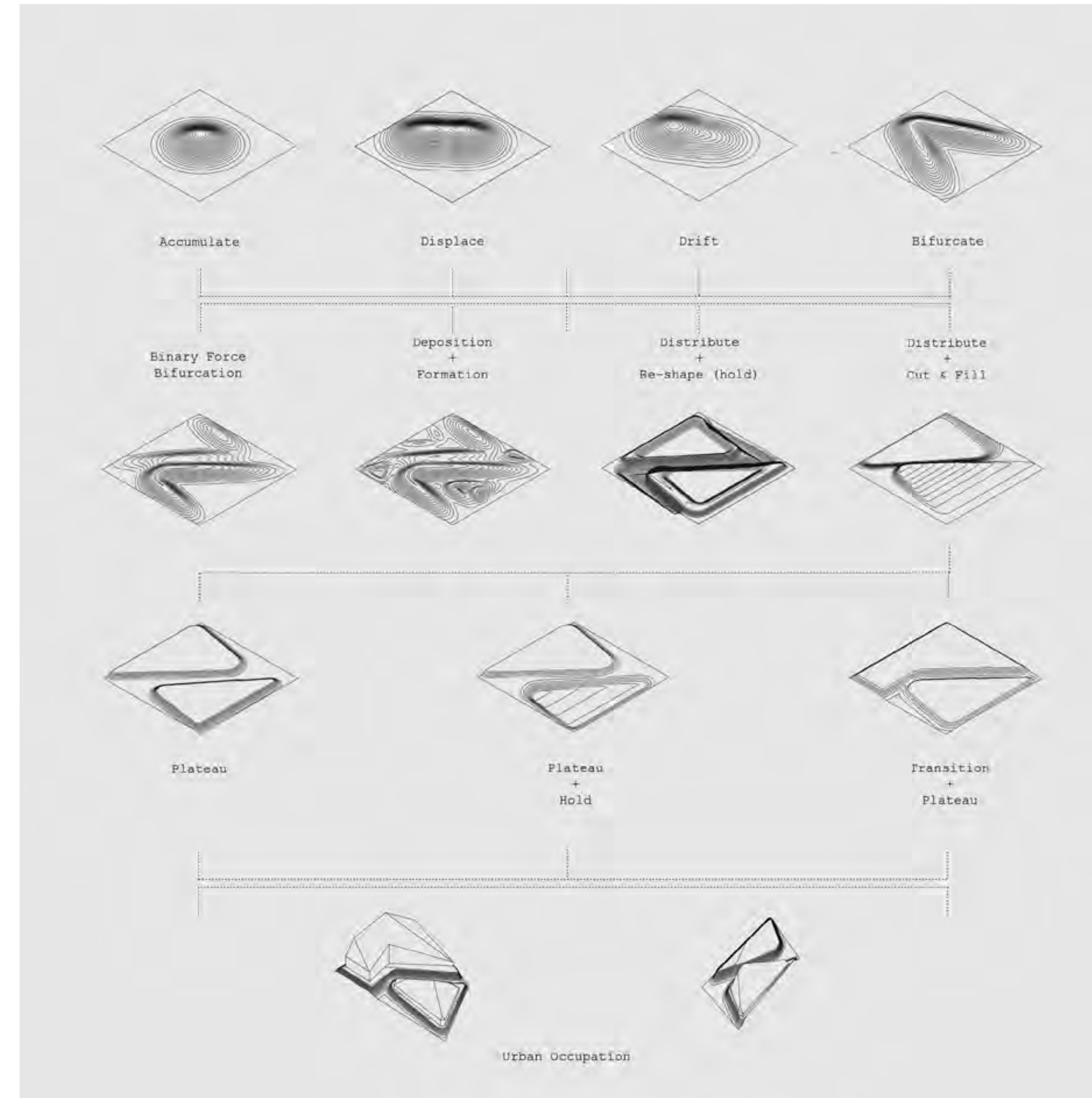
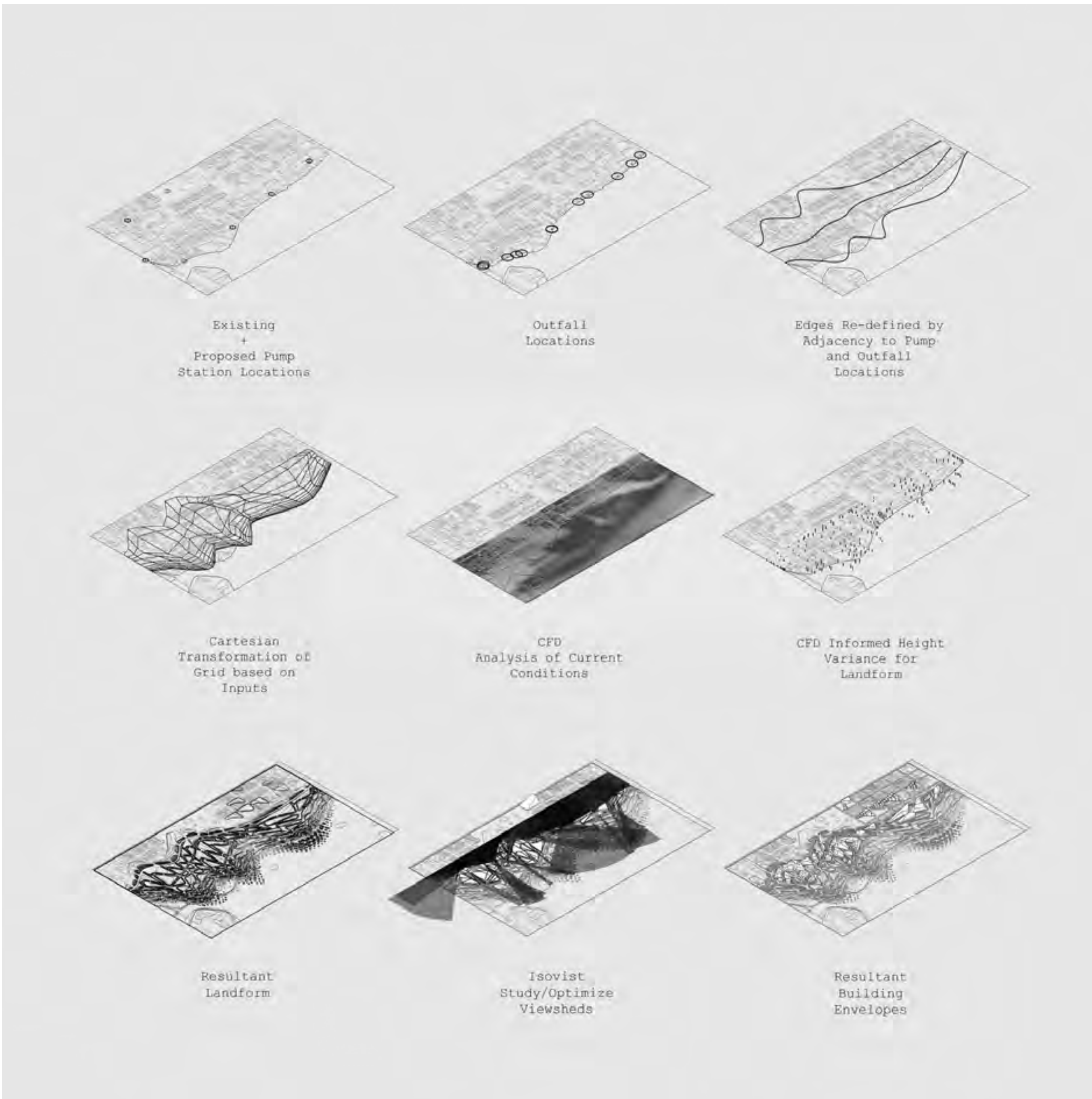


Fig. 25. Landform assemblies based on sand dune geometries.



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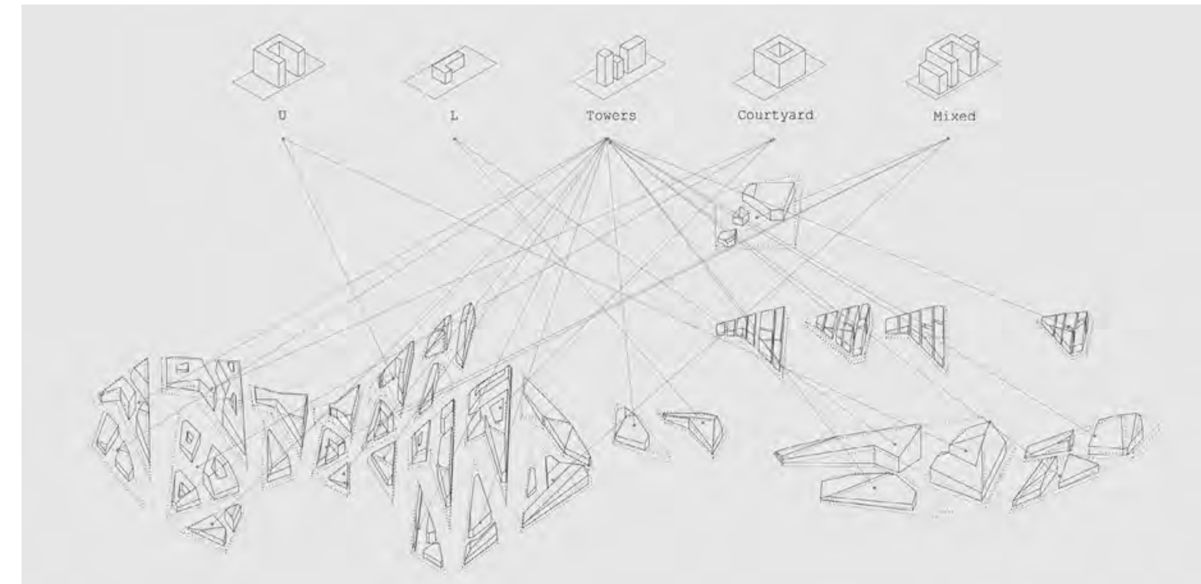

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Fig. 26. Site analysis and operation sequence.

Fig. 27. Genealogical tree and assemblies diagram.

Fig. 28. Possible programming expressions based on elevation, CFD, view sheds, and salinity/pH levels.

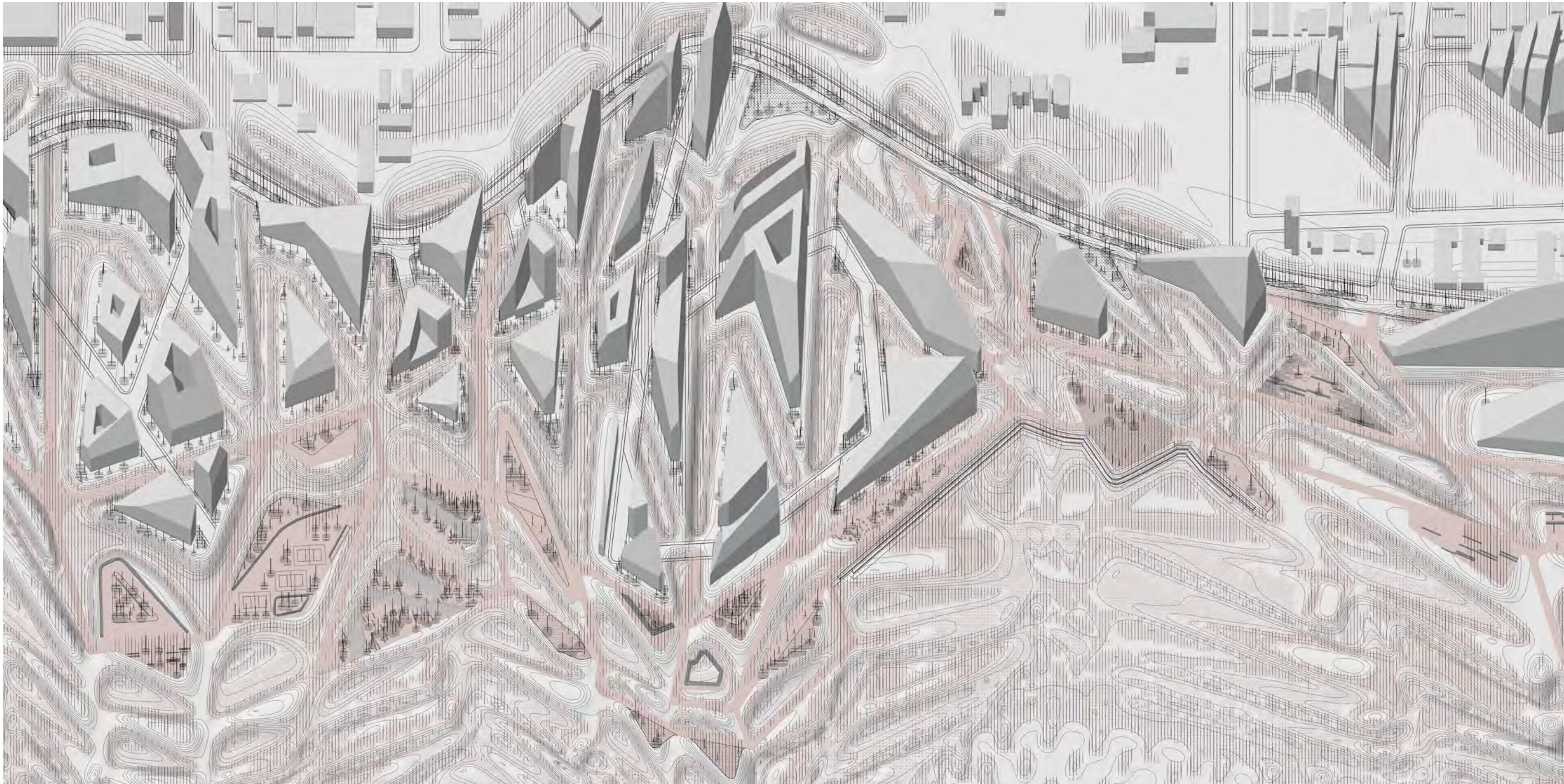


Fig. 29. Oblique plan showing integration of landform, urban form, and vegetation.

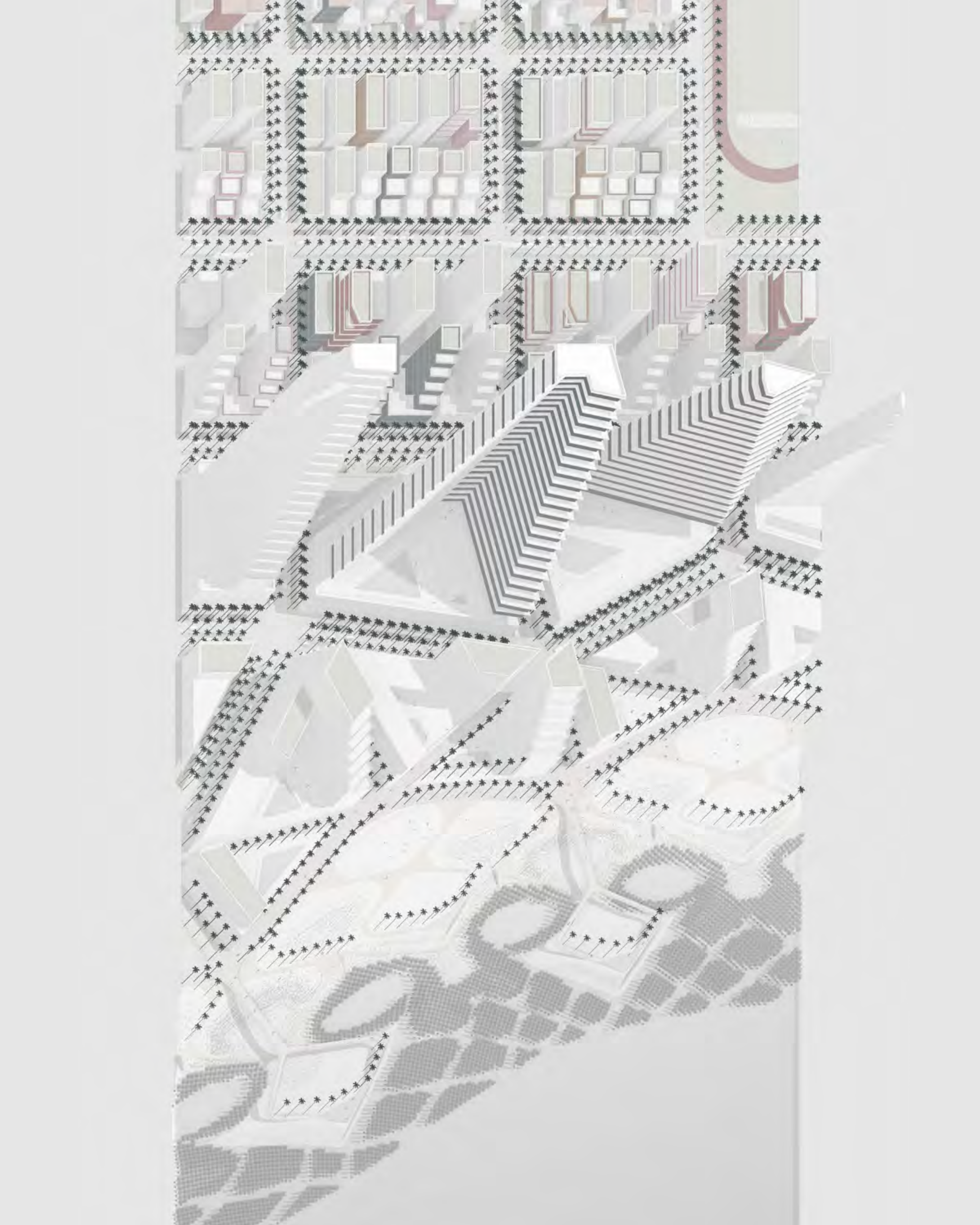
Scenario 03

Paradise in Process

Jessy Yang
Advised by Charles Waldheim

This project perceives imminent sea level rise and the ongoing real estate boom in Miami Beach as opportunities to reshape the future collective image of the city. The proposal deploys a new grid framework along the city's Biscayne Bay coastline. This opens up access to the waterfront through existing superblocks, crenellates a resilient living seawall to protect from future storm events, and stages the future developments of the city through a consistent formal language that is informed by sea level rise adaptation and solar performance.

> Fig. 30. Oblique plan showing proposed urban form, waterfront park, and mangrove buffer.



Scenario 03: **Paradise in Process**

Hydrologies

In addition to elevating all streets and buildings, the project proposes a crenellated living seawall that averts new land from rising waters, retains stormwater, and absorbs the impacts from future storm surges and waves. Elevated buildings allow for floodable ground floors and elevated streets contain new pipes that channel stormwater to the bay or the park. Additionally, roof gardens hold stormwater and reduce freshwater consumption for irrigation purposes.

Ecologies

A thick buffer of mangroves along the Biscayne Bay coastline protects against future storm surges and soil erosion. Closer to the coast, a sequence of retention basins provides habitat for salt-tolerant rhizomatic grasses which contribute to stormwater retention and filtration. Further inland, elevated buildings cede additional ground for both native and aesthetic species.

Infrastructures

As a base line, this scenario plans for the one-story elevation of all streets and buildings in the city. These elevated streets accommodate vegetation that provides hydrological and ecological benefits. Additionally, to accommodate increased density and mobility, an added light rail along Alton Road reduces private vehicles and parking spaces and trades “cars for water.” Lastly, elevated streets contain new pipes and utilities to avert future stormwater intrusion and damage.

Identities

The project reimagines its historical district by privileging typological preservation over strictly material or architectural preservation. This strategy retains the urban qualities of the city (e.g., its block dimensions, urban types, and architectural exuberance) and simultaneously allows for its future growth. At the bayfront, a curated set of landscapes based on hydrological and ecological performance creates a different kind of waterfront experience relative to that of the city’s well-known eastern beaches.

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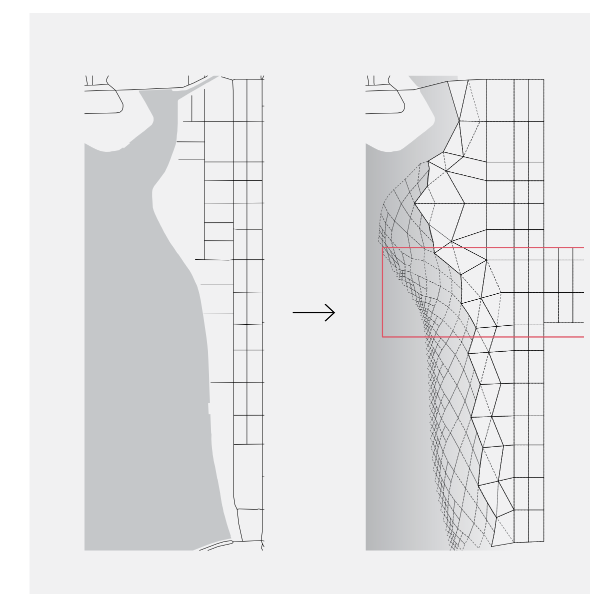

Fig. 31. Everglades' sawgrass fields.

Fig. 32. Detail of sawgrass.

Fig 33. Western half of Miami Beach showing privatized superblocks at bayfront.

Fig. 34. Proposed transformation of bayfront in terms of street network and living seawall framework. Area of study captured in red.

Scenario 03: **Paradise in Process**

Spaces

Recognizing that buildings have an approximately 50-year cycle, this scenario projects a new urban structure and fabric across Miami Beach. At the center of the island, buildings elevate onto columns and trade their footprints for added porous ground cover. Along West Avenue, an underlying grid framework stages a set of high-rise developments whose reduced block dimensions promote public accessibility and walkability. At the waterfront, a new band of mid-rise buildings front a new promenade and park.

Publics

The project deploys an underlying grid framework that is based on the dimensions of the city's typical blocks. This grid subdivides the existing waterfront's superblocks and crenellates the coastline to maximize bay views and inform the geometries of the proposed living seawall. It also manifests in the design of the park's public paths, retention basins, piers, and landforms.

Policies

As the project reimagines a continuous resilient seawall, its success hinges on the abilities of all jurisdictions involved to coordinate planning and construction. This will therefore involve the City of Miami Beach, Miami-Dade County, and the State of Florida. Further inland, existing zoning codes around preservation are revised to allow for both the one-story elevation of the historic district as well as typological preservation (i.e. through new developments) over strict architectural preservation.

Developments

This scheme seeks to harness the strength of the current market to maximize public benefits. Buildings in preservation districts are given FAR bonuses in compensation for elevating and adopting resilience principles. New high-rise developments along Biscayne Bay contribute funding to the construction of the waterfront's green infrastructure. Increased density implicates affordable housing that helps to hedge against the worse effects of climate gentrification.

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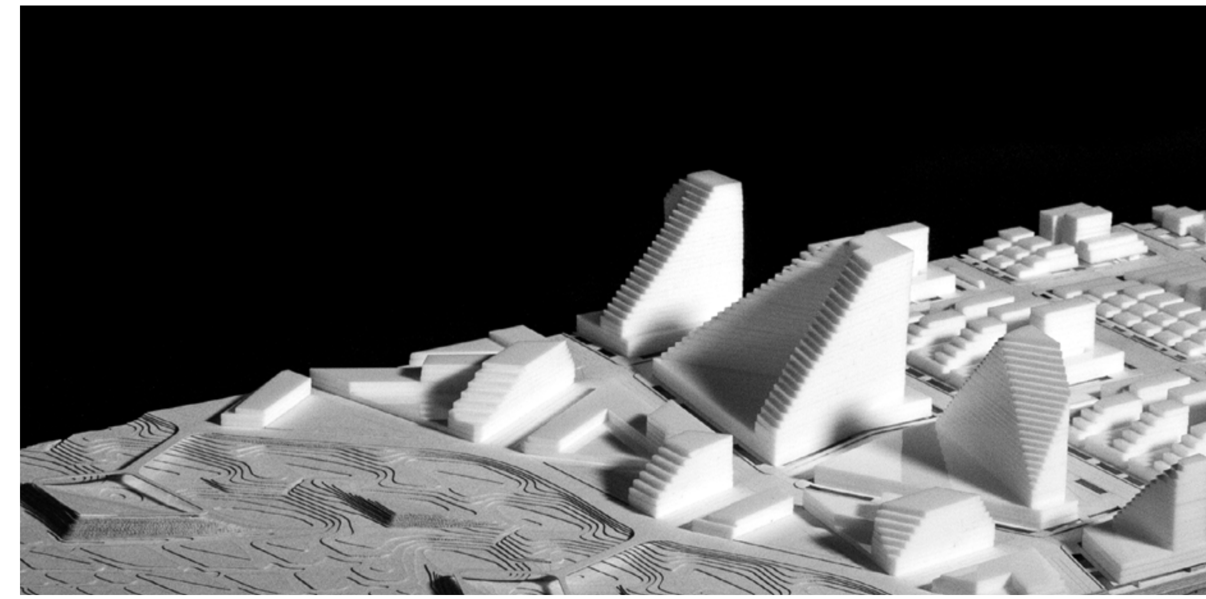

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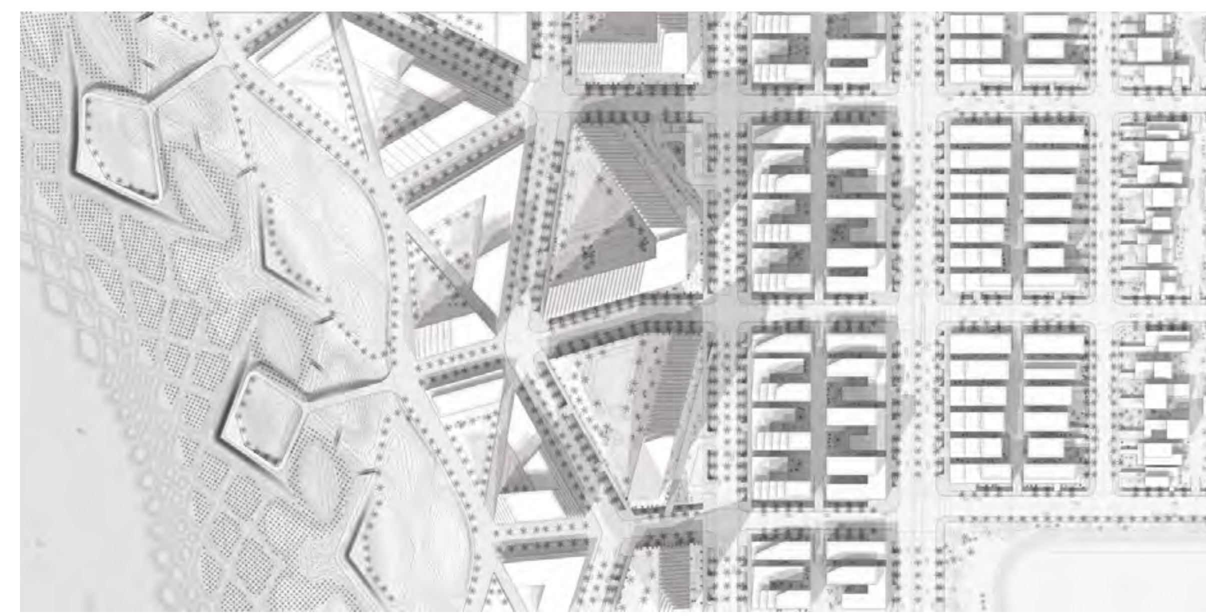

Fig. 35. Proposed urban form and bayside hydrological landform.

Fig. 36. Fragment plan from Biscayne Bay to Flamingo Park showing mangroves at bay and urban form shadows at 3 times during the day on the winter solstice.

Scenario 03: **Paradise in Process**

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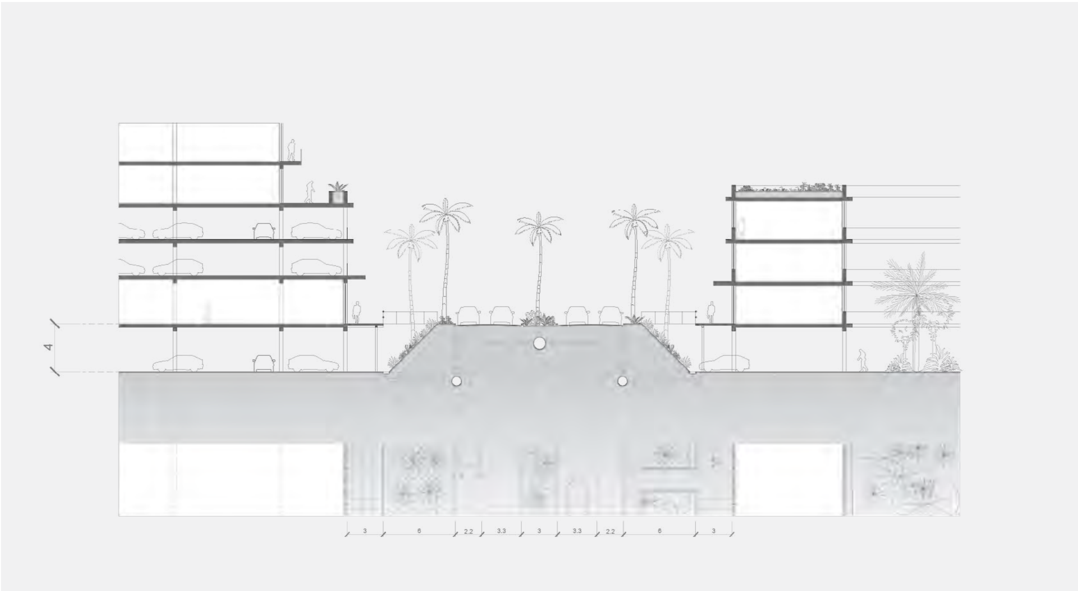

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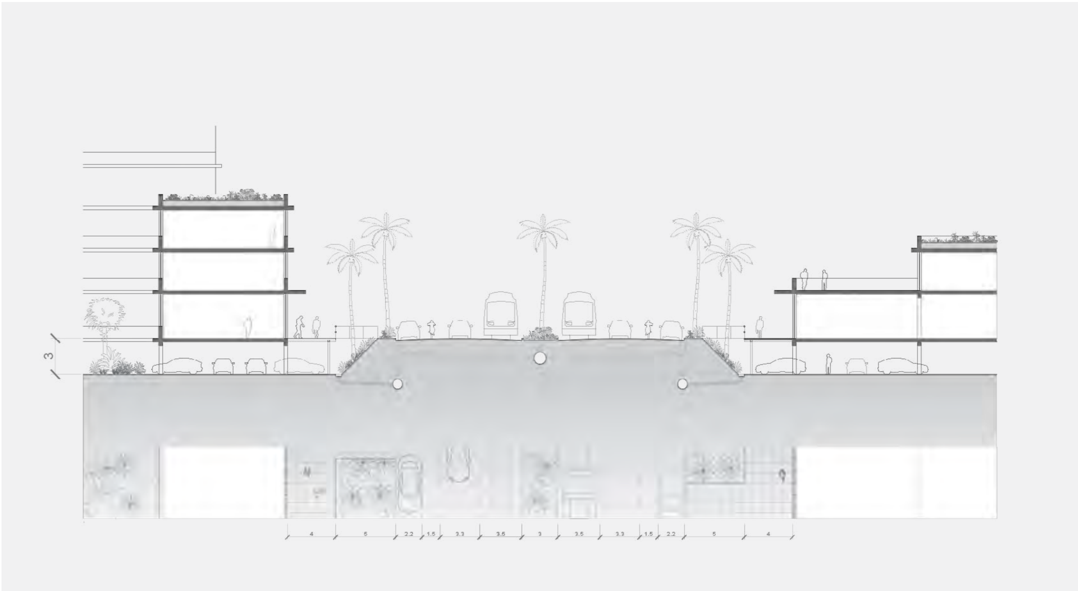

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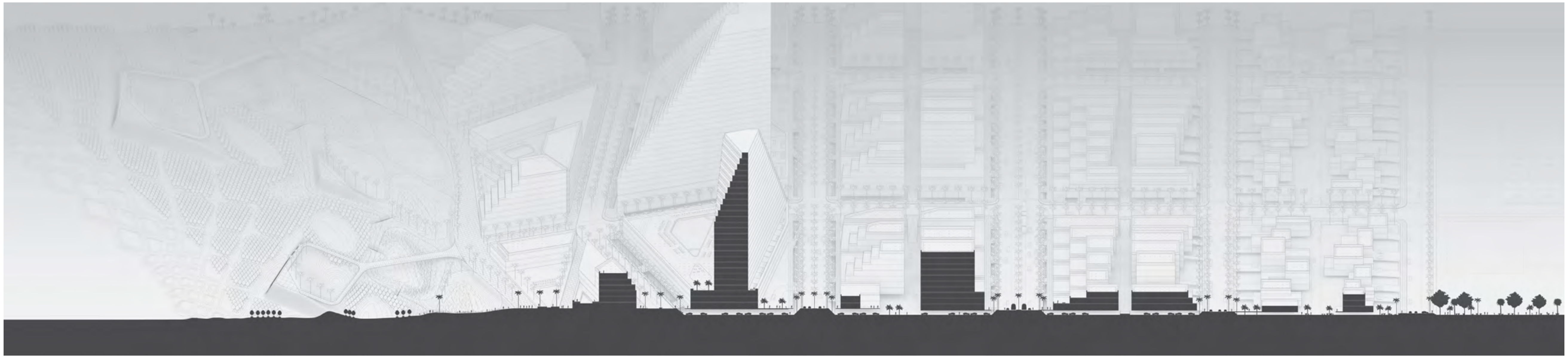


Fig. 37. Proposed street section at West Ave where dashed line represents existing grade.

Fig. 38. Site section from Biscayne Bay at left to Flamingo Park at right.

Fig. 39. Proposed street section at Alton Rd. where dashed line represents existing grade.

Fig. 40. View west toward Biscayne Bay from 13th St. and Alton Rd. showing elevated buildings in foreground, light rail transit in midground, and bayfront developments in background.

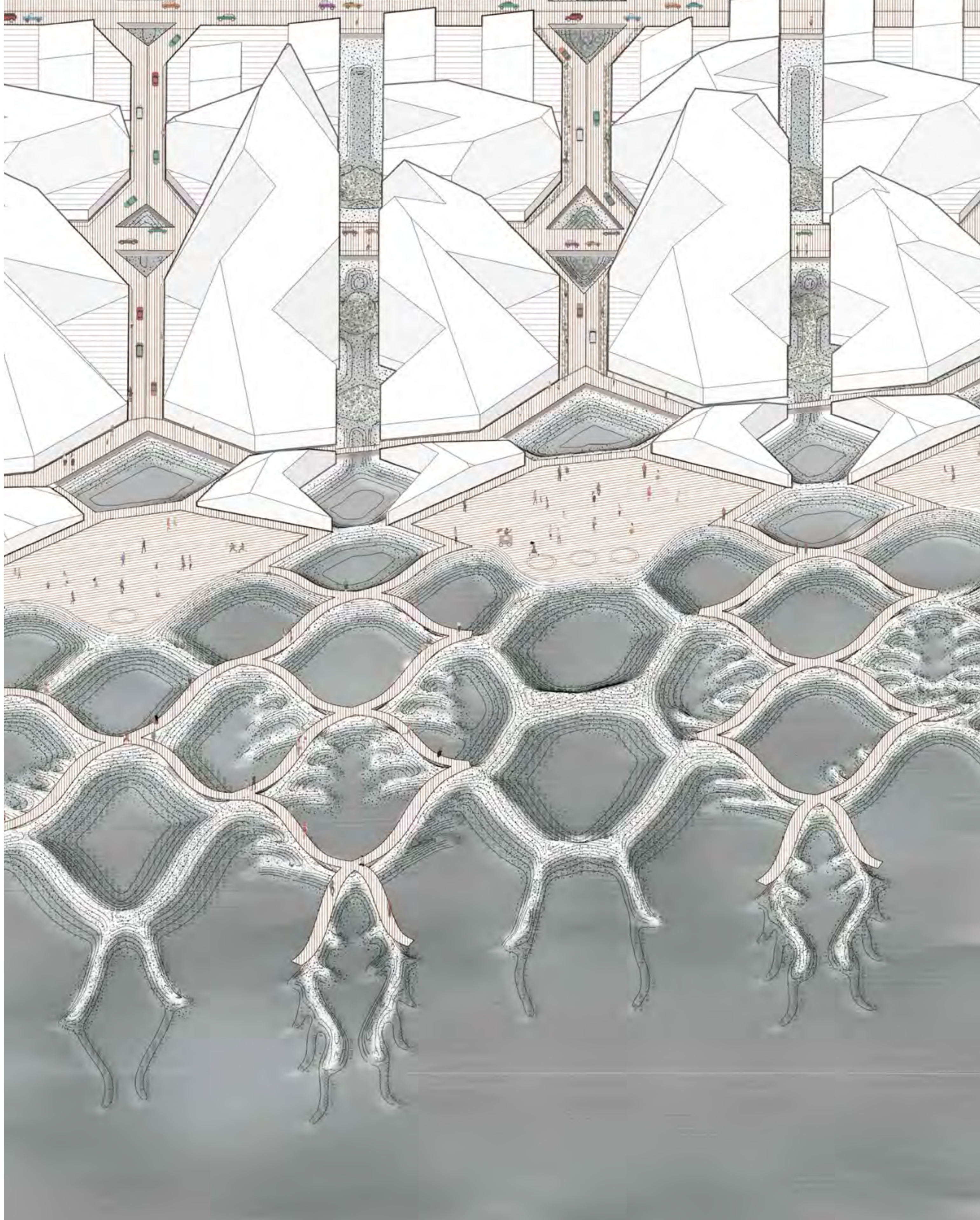
Scenario 04

Living Landforms

Ziwei Zhang
Advised by Charles Waldheim

As sea levels rise, Miami must adopt new urban models that embrace the incoming waters. In the coming decades, new construction of seawalls, breakwaters, and other coastal defense systems must be coupled with green infrastructure to maximize resilience and local ecological assets. This project integrates landform as a new kind of infrastructure that simultaneously informs the city's future urban block structure.

> Fig. 41. Aerial view of waterfront showing proposed landforms staging ecological habitats. Zoning envelopes based on solar performance are rendered in white.



Scenario 04: **Living Landforms**

Hydrologies

New landforms shaped by flow dynamics and habitat formation provide a landscape structure to avert seawater, absorb tidal water, and hold stormwater. Further inland, a combination of sunken inner courtyards, elevated roads, and elevated buildings create a new drainage system that augments existing engineered solutions and streamlines public to private thresholds. This scenario represents only a snapshot moment where roads are elevated roughly half a floor (e.g., 2 meters) while buildings are elevated a full floor (e.g., 3-4 meters).

Ecologies

The deployed species perform a suite of different hydrological and ecological functions. Mangrove communities along the coastal areas of Biscayne Bay stabilize ground sediment and protect shorelines from erosion and storm surge. Rhizomatic, salt-tolerant grasses bind sediment and provide local nutrients for marine life. These two vegetal species occupy different coastal conditions. The landform geometry, developed by repeating and mirroring an S-shape, creates diverse habitats with varying wetness for red, black, and white mangroves as well as grasses.

Spaces

Landform geometry and solar performance shape this scenario's proposed urban form. The block envelope responds to a combination of solar access, equity, and views. For instance, at the bayside, urban form privileges views while within the urban context, it privileges the public realm by casting less shadows, specifically on Alton Road and its adjacent low-rise neighborhoods. Within each block, the southern parts of the building gradually lower to allow more direct sunlight into interior courtyards.

Publics

Currently, the accessibility to the bay front is relatively limited due to a series of privatized superblocks. This scenario creates new public connections and spaces so the new waterfront coheres with the existing city grid. Inner courtyards within each block enhance visual connections to the bay and the regularity of the proposed grid allows for optimal street integration with the rest of the city. Lastly, the ends of the new streets accommodate elevated plazas atop pump stations.

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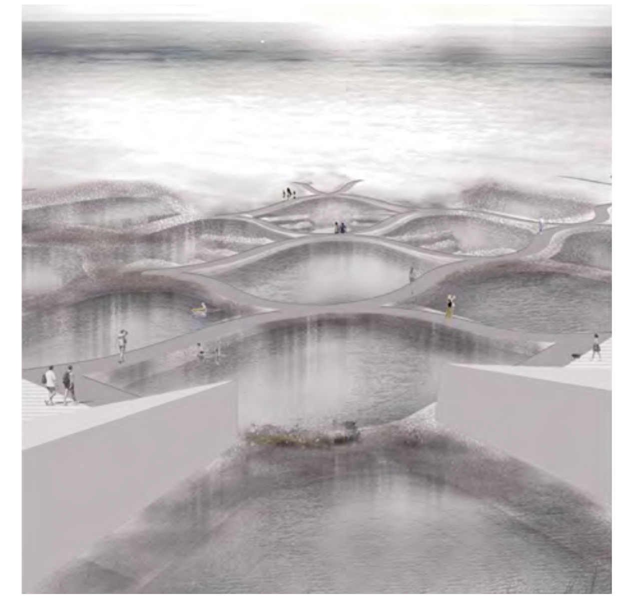

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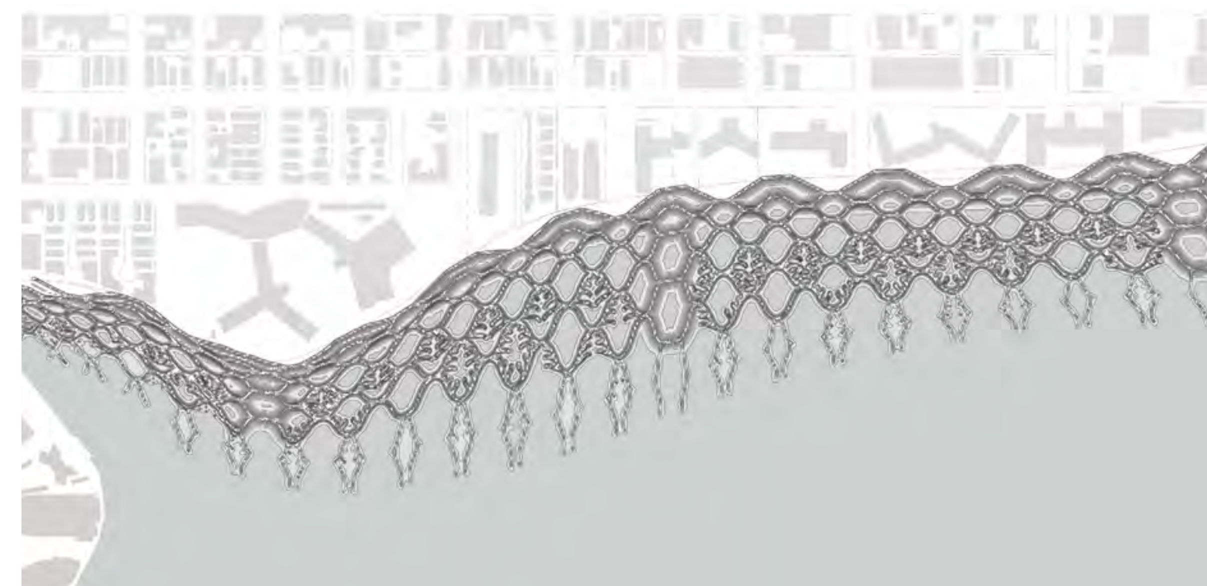

Fig. 42. View west from proposed bayfront across Biscayne Bay.

Fig. 43. View east from the proposed bayfront to Miami Beach.

Fig. 44. Site plan of Biscayne Bay coastline showing proposed networked landforms.

Scenario 04: **Living Landforms**

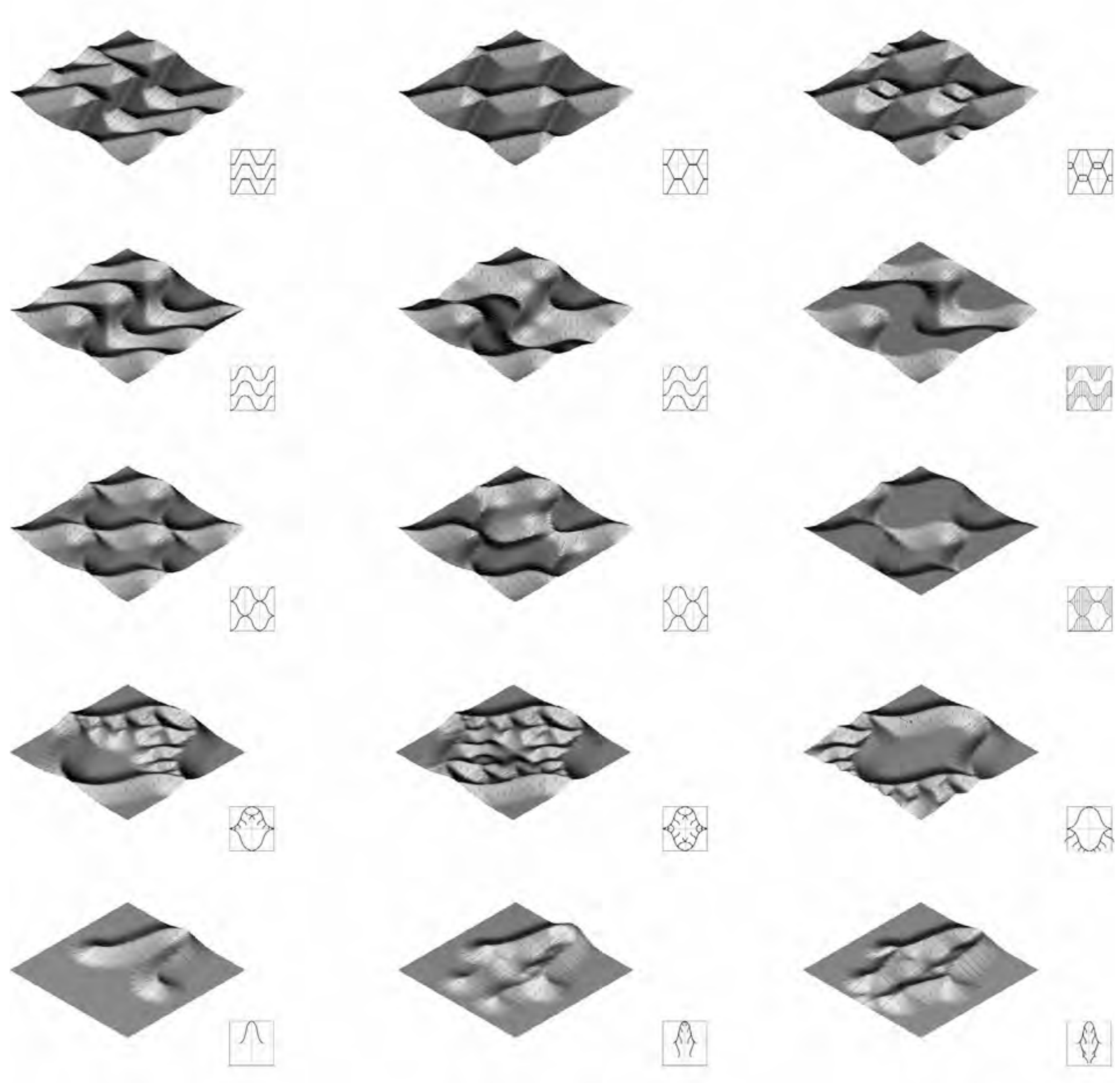

Fig. 45. Matrix of topographic operations and stormwater drainage flows.

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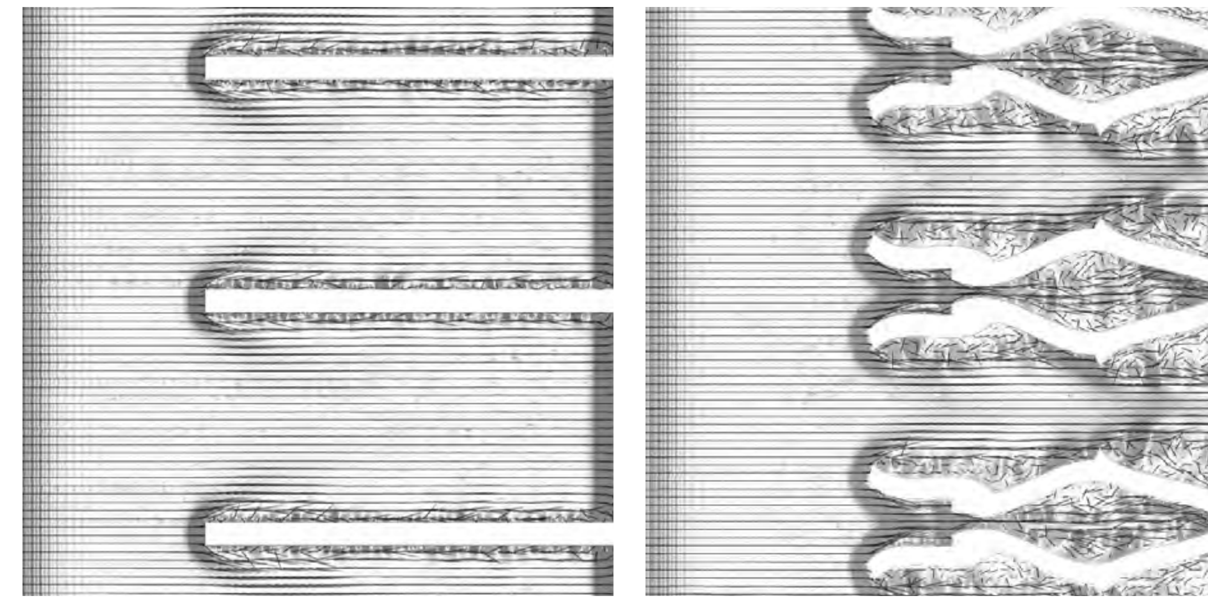

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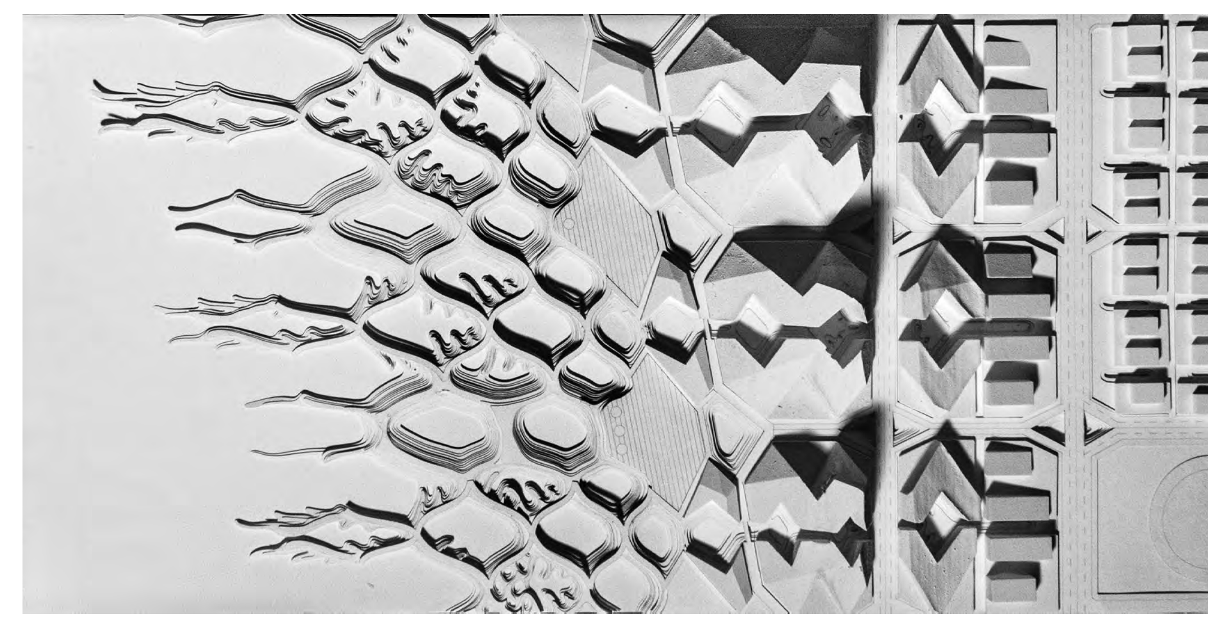

Fig. 46. Computational Flow Dynamic (CFD) simulation of proposed landforms testing for wave dissipation and defense.

Fig. 47. Plan view of site model showing transition from landforms, building form, and existing built form.

Scenario 04: **Living Landforms**

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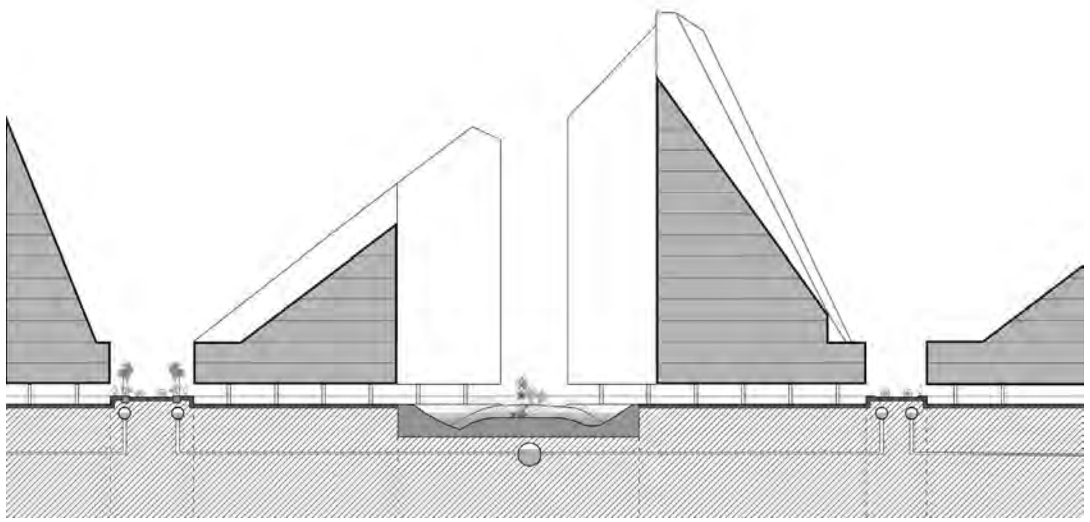

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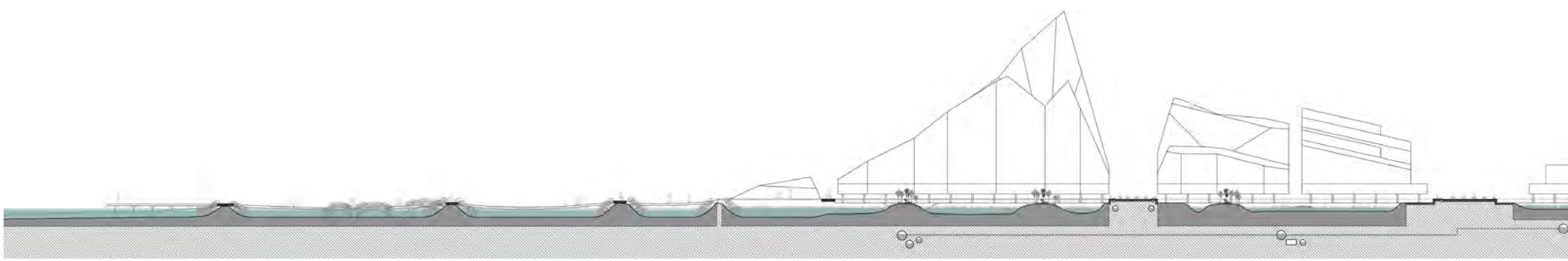

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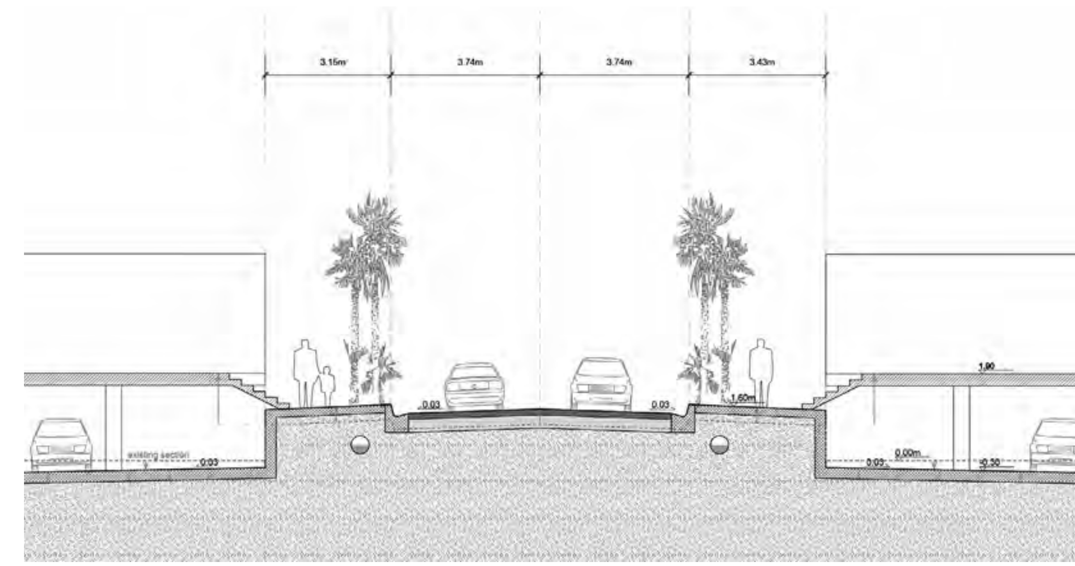

Fig. 48. Urban section showing relationship between elevated buildings, streets, pipes, and courtyards.

Fig. 49. Site section from Biscayne Bay at left to Flamingo Park at right.

Fig. 50. Street section showing proposed urban threshold between a 2 meter road elevation and a 3-4 meter building elevation. Existing section dashed.

Scenario 05

Biscayne Barnacles

Sonny Xu
Advised by Charles Waldheim

The project aims to build a more resilient and ecologically performative Biscayne Beach shoreline while simultaneously creating a new urban and cultural identity for the city. Through analyzing the form, function, and the aggregation of barnacles; a species commonly found in the bay, the project deploys a comprehensive urban design that holds water, provides habitats, and stages a new littoral urbanism.

> Fig. 51. Axonometric view showing proposed landform and urban form expansions into Biscayne Bay.

Scenario 05: **Biscayne Barnacles**

Hydrologies

The topology of the barnacle species is a donut-like form with a central void or pocket. This geometry serves as the hydrological basis for the projection of landforms, building forms, and public spaces. Landforms aggregate as connected, multi-scaled retention ponds to store water and provide water-based habitats. Building forms elevate above projected sea levels and provide semi-public and semi-private courtyards. The courtyard's public spaces host recreational islands and swimming pools.

Ecologies

While the scenario is based on the geometry and topology of the barnacle, it provides habitats for other species. Seawater ponds, stepped pools, rainwater basins, and other holding wells offer habitats for a variety of marine life: mangroves, salt-tolerant grasses, palms, flamingos, shellfish, oysters, barnacles, corals, etc. Where the Biscayne Bay's ecology is continually stressed, this scenario embraces the native flora and fauna of the bay as an integral component of the future adaptation of the city.

Spaces

Courtyards create a series of multi-scaled typologies for a variety of programs. Smaller courtyards offer a modest residential scale, much like garden apartments often found throughout Miami Beach, whereas larger courtyard bars provide dense multi-family housing that supports additional mass transit on ground and/or water. Lastly, a series of courtyard-shaped zoning envelopes deployed over existing urban blocks aims to guide future adaptive developments for the rest of the city.

Identities

The project revives the history of Miami Beach's land formation and transformation as a future adaptive strategy to sea level rise. West of Alton Road, a new littoral urbanism projects an imaginary that is based on living with and learning from the city's native marine life. As such, the scenario posits that any future adaptation to environmental parameters necessitates a renewed and mutualistic relationship with its contextual ecologies.

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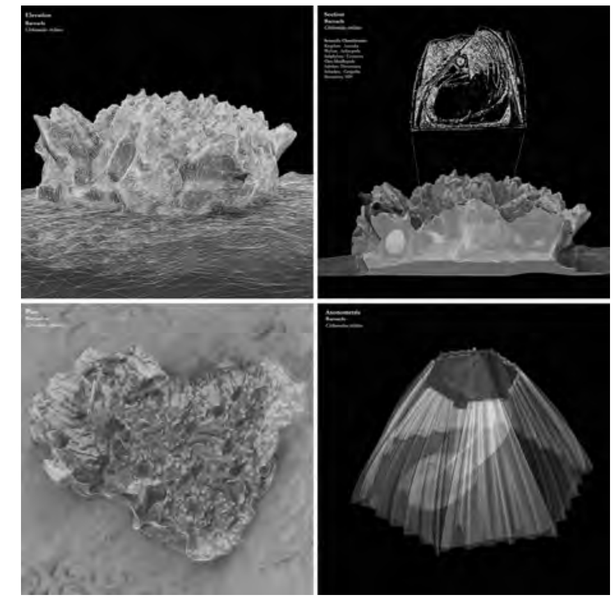

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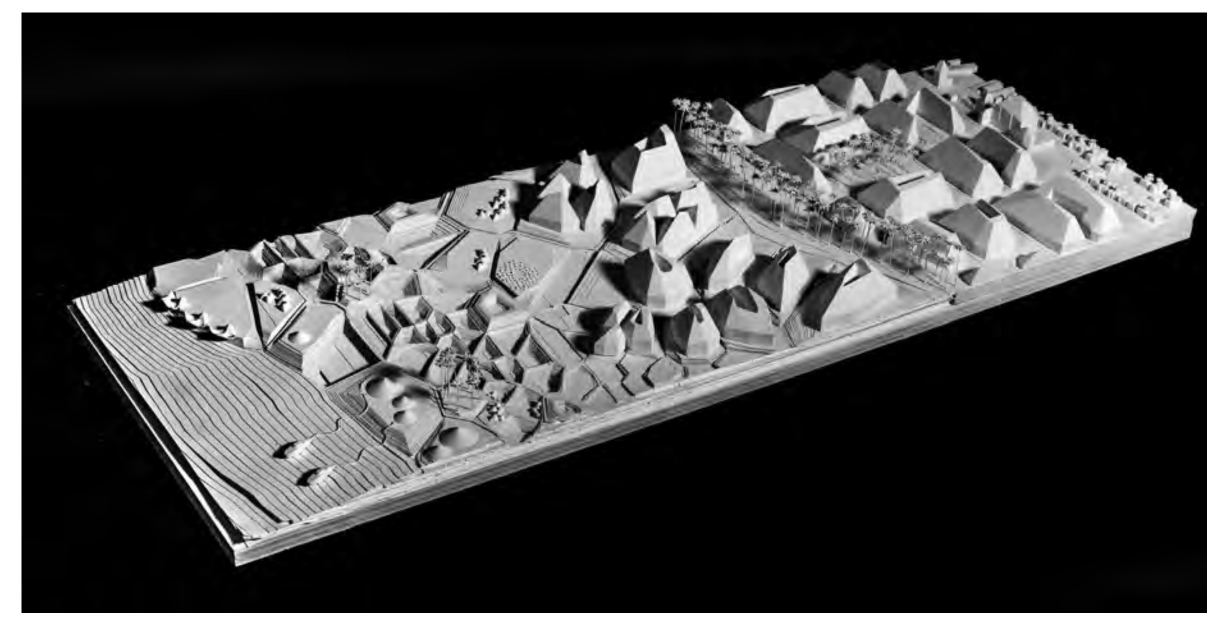

Fig. 52. Study of the Barnacle geometry and topology.

Fig. 53. Plan view of site model showing proposed building typologies based on the barnacle geometry.

Fig. 54. Aerial view of model showing transition from Biscayne Bay at left, to proposed littoral urbanization, and to existing urban fabric transformations.

Scenario 05: **Biscayne Barnacles**

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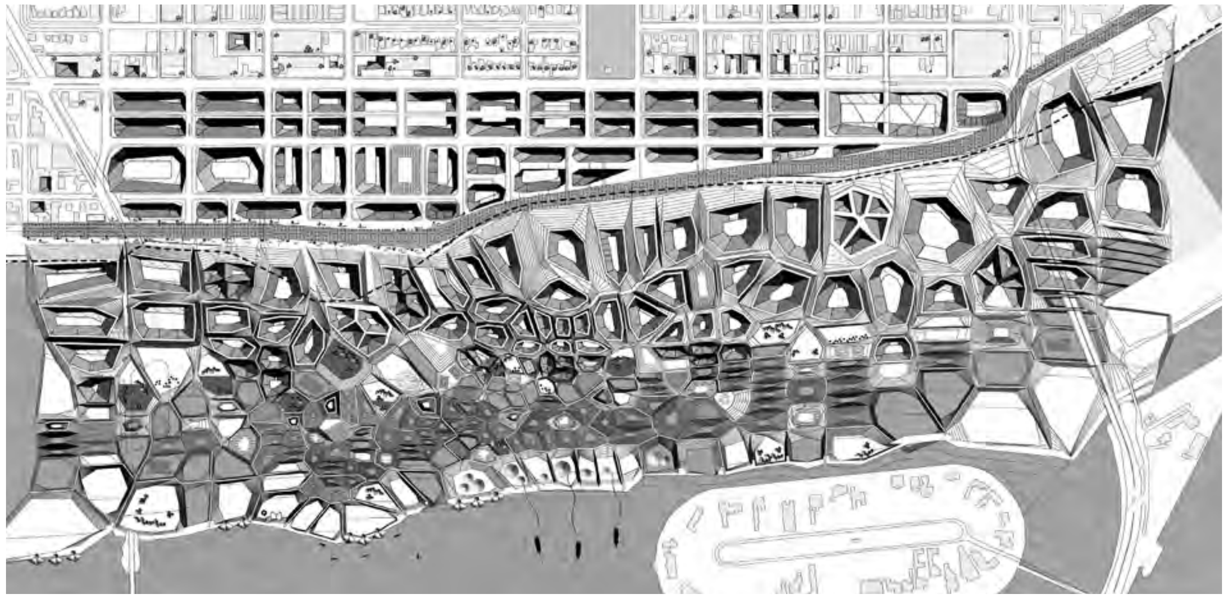

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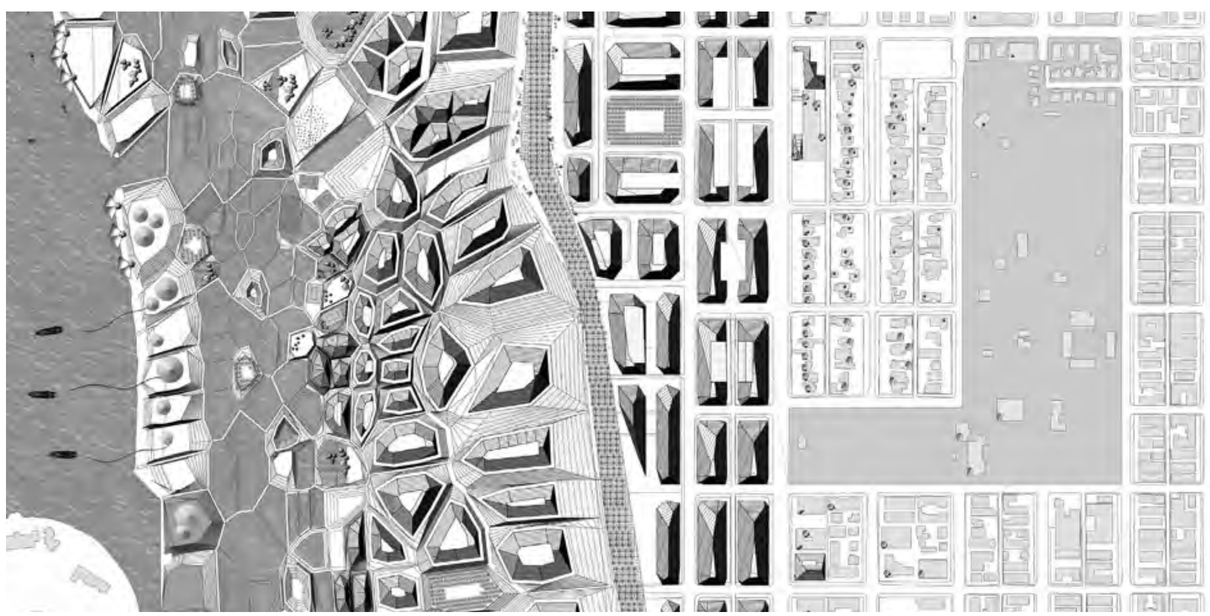


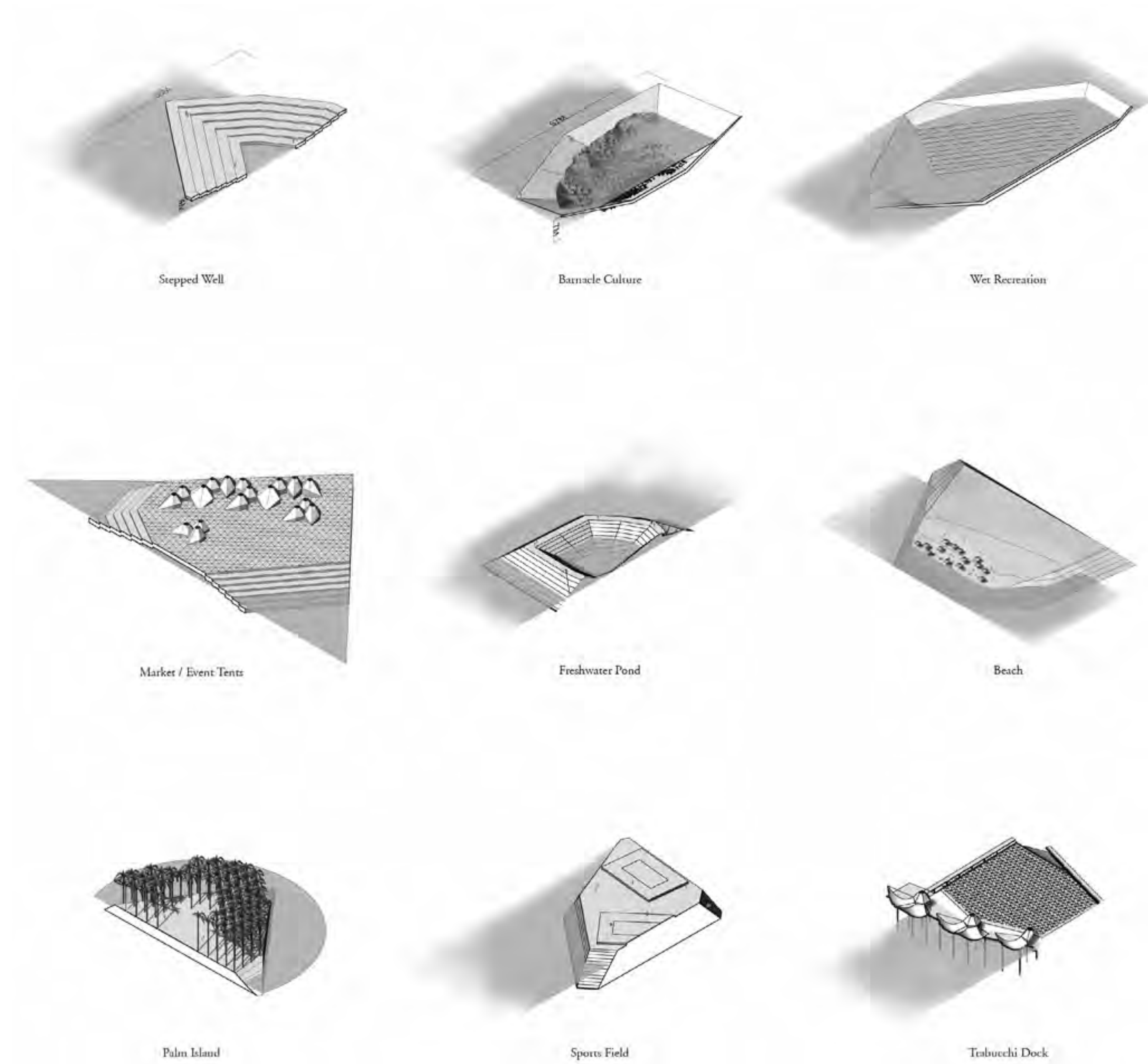


Fig. 55. Site plan of entire Biscayne Bay coastline showing proposed landform and urban form.

Fig. 56. Detail of site plan from Biscayne Bay at left to Flamingo Park at right.

Fig. 57. Matrix of section vignettes showing various built form to hydrology relationships based on the barnacle geometry and topology.

Scenario 06

Flamingo Waterpark

Izgi Uygur
Advised by Rosetta Elkin

Sub-tropical Florida usually suffers an excess or a deficit of water due to highly stochastic weather patterns unique to this region in the United States. By defining the varying merits of increased salination, this project balances freshwater availability through seasonal fluctuations using a series of stormwater retention tanks. In this way, Flamingo Park can become a model for water collection and distribution without drastically modifying its existing character as a critical open and vegetated landscape.

> Fig. 58. View of a proposed water tower on raised ground by the Flamingo Park track field.

Scenario 06: **Flamingo Waterpark**

Hydrologies

As the only large, open landscape in Miami Beach, Flamingo Park offers the opportunity to address two hydrological issues: the fluctuation of freshwater availability and the threat of sea level rise. This scenario proposes a set of stormwater retention tanks to reduce the burden of municipal drainage and to offer consistent freshwater irrigation for the park's native and aesthetic vegetation. A sequence of undulating landforms elevates these tanks above projected flood lines and also offers dry ground for post-storm relief.

Infrastructures

Short of elevating the entire Flamingo Park, this project imagines strategic interventions that think of the park as added municipal infrastructure without completely altering its public landscape. Here, the insertion of stormwater retention tanks coupled with select landform maneuvers provide hydrological management capacities and renewed public landscapes. In particular, elevated cisterns irrigate the park through a sub-grade network of interconnected pipes that reinforce each other in case of failure.

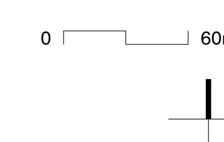
Ecologies

Endemic to the area's character is the history of its many botanical gardens (e.g., Vizcaya Museum and Gardens, Miami Beach Botanical Garden). In a similar vein, this project offers the City greater control over freshwater availability to stage a new palette of native and/or aesthetic vegetation species with increased ecological and aesthetic public benefits. While not shown, the project implies that localized water retention capacities (e.g., stormwater cistern at ground level sacrificial floors) across the city on a per lot basis can contribute to individual irrigation and vegetation control.

Identities

In addition to its role as added infrastructure and public space, the proposed series of elevated cisterns offer a new identity for Flamingo Park beyond mere recreation grounds. The iconicity of the tanks coupled with their new botanical landscapes suggest a new imaginary for the park that fuses the city's history of vegetal exuberance and extravagance with its future of sea level rise adaptation.

Fig. 59. Oblique site plan and section showing proposed topographic intervention and water tower composition.



Scenario 06: **Flamingo Waterpark**

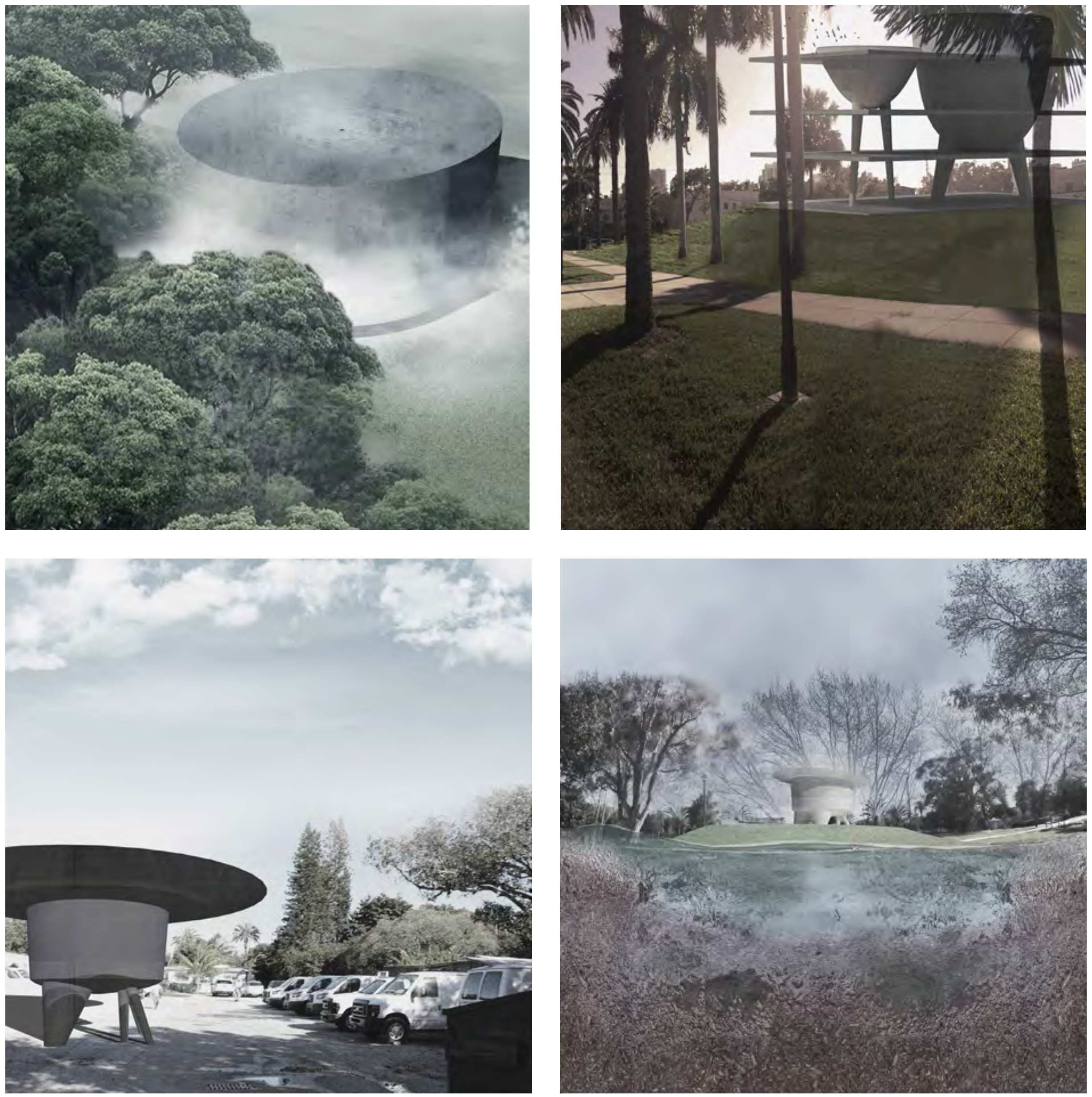


Fig. 60. Views of proposed water towers throughout Flamingo Park, conceived as simultaneously infrastructure and public art.

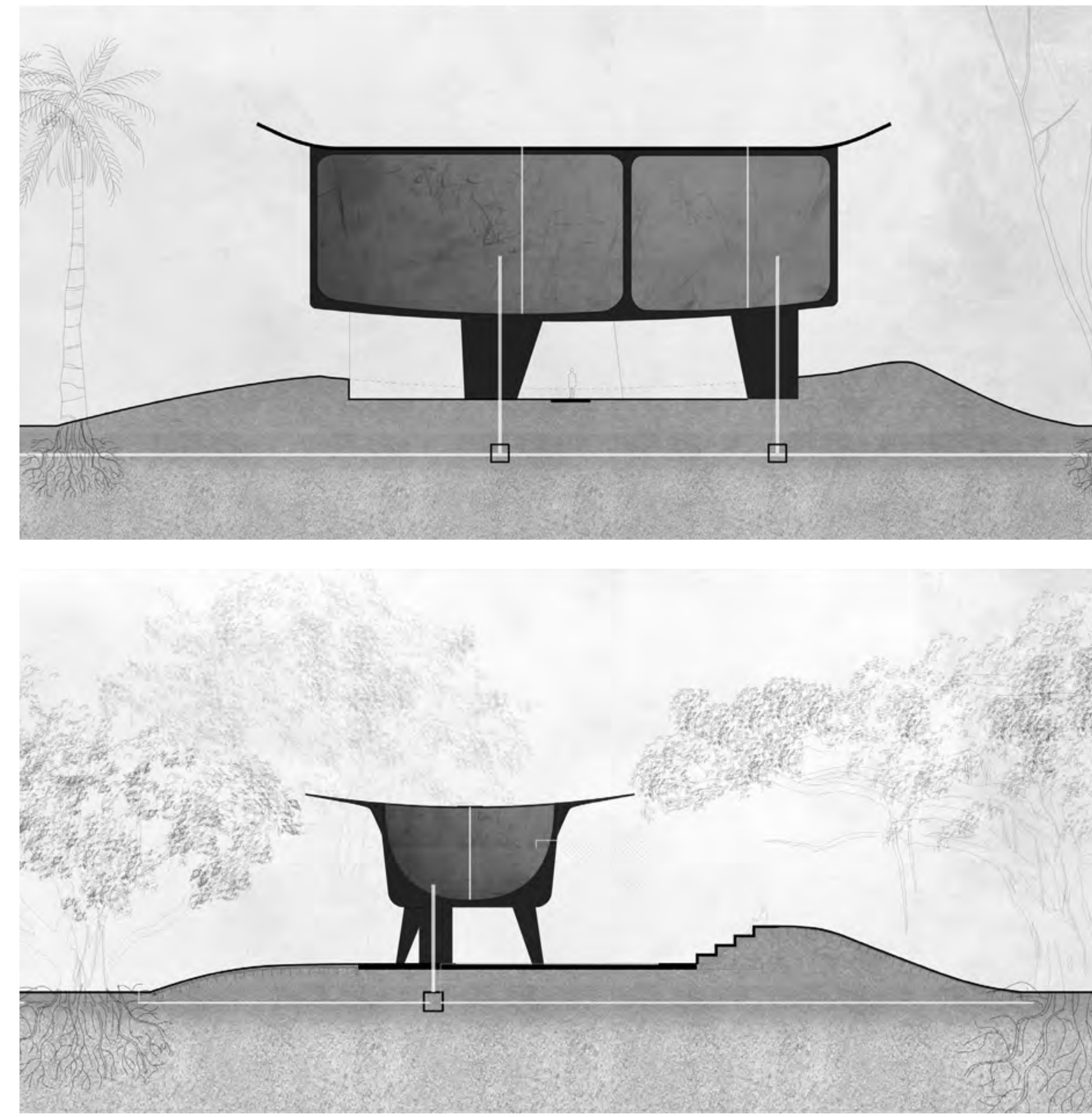


Fig. 61. Sections thru proposed water towers showing how they interface with adjacent topography, vegetation, and public spaces.

Scenario 07

Collins Reservoir

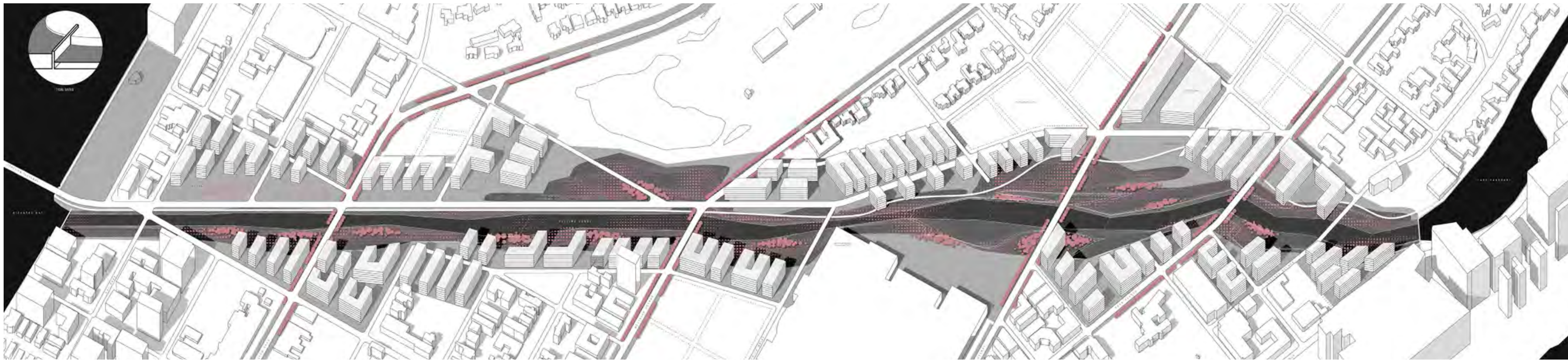
Kent Hipp
Advised by Rosetta Elkin

First cut in 1912 to move produce across the island, Collins Canal is an artifact from the city's past which has received little design attention since its construction. Today, the canal lies adjacent to many publicly owned parcels and a major roadway/evacuation route; and it remains sparsely developed. This project suggests that the canal should be considered as a test site for a novel, adaptive infrastructure.

Fig. 62. Analytical site plan of Collins Canal showing extent of water shed and proposed pump stations adjacent canal.

Scenario 07: **Collins Reservoir**

63



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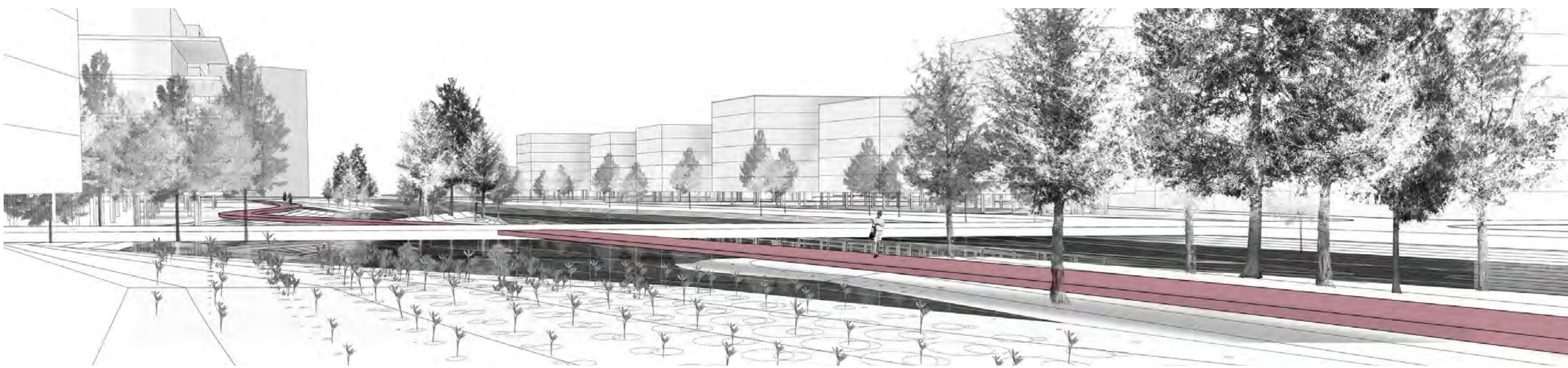


Fig. 63. Axonometric showing proposed hydrological, infrastructural, and typological interventions along Collins Canal. Floodgates are installed at the ends to maximize holding potentials.

Fig. 64. View down proposed Collins Canal highlighting the new riverfront promenade.

Scenario 07: **Collins Reservoir**

Hydrologies

The existing hard edge of the Collins Canal is transformed into a soft, living seawall through a sequence of excavation operations. A pair of gates are placed at either end of the canal basin to regulate tidal flow, thereby creating a reservoir. During low tide, these gates are closed to create a two foot differential as the tide rises. This creates a void space to store water during heavy rain events. Because the basin would receive sea water and large quantities of stormwater, its salinity would vary greatly.

Ecologies

This scenario proposes a planting regime of three specific species. First, a mangrove swamp is established along the water's edge. As a rapidly growing species, it would quickly cover all areas that inundate and can be subsequently trimmed by the city as needed. Second, a number of islands, or cypress heads, would be established to stabilize the fluctuation of the mangrove. Finally, new lines of street trees mark key bridge crossings and stitch the project with its context.

Infrastructures

The main infrastructural operation is the transformation of the canal into a reservoir. The process of excavation produces land mass that is used to elevate adjacent blocks. Additionally, this project shifts a few critical major roadways to streamline city traffic, provide more room for water storage, and articulate new areas of development that link back to the canal. Furthermore, the road network is softened with vegetation and set back from the edge of the canal to create space for public access to the waterfront.

Identities

Once integral to the identity of the city, Miami Beach today generally turns it back on the Collins Canal. This scenario reactivates its urban imaginary from an outdated, transportation artifact to a novel adaptive landscape bordered by vegetated parks and promenades. As such, this transformation posits that the future of Miami Beach needs not tether itself to outdated models of engineering, but instead should draw from its history of imaginative, synthetic landscapes to adapt to rising sea levels.

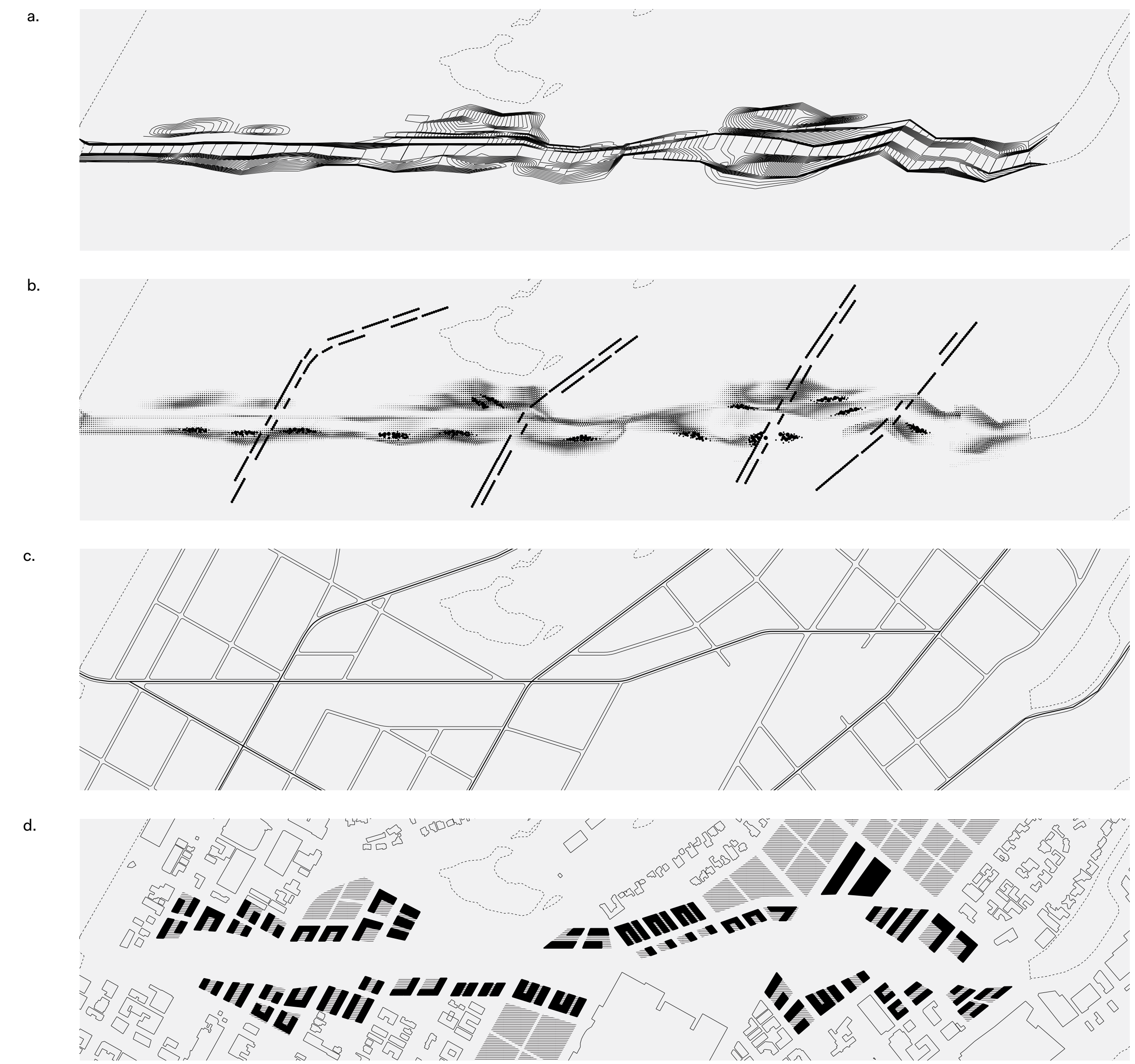


Fig. 65. Sequential concept operations.

a. Topographic subtraction and formation.
b. Planting axis and hierarchy.
c. Grid adjustment and alignment.
d. Typological envelopes and block divisions.

Scenario 07: **Collins Reservoir**

Spaces

The urban form along the two banks of the canal is significantly upzoned and densified in order to fund the new water infrastructure. Using a 40' residential envelope, the project proposes a number of new block and building typologies at the canal edge. Using a consistent grain perpendicular to the water, the urban configuration maximizes visual access between the adjacent neighborhoods and the canal.

Publics

This scenario reclaims the currently underused canal as part of a larger comprehensive strategy to activate this transect into multi-functional public landscape. Because most parcels adjacent this canal are publically owned, the City of Miami Beach should leverage this opportunity to increase development and affordable housing. Lastly, the artificially controlled tidal fluctuations of the reservoir create a sequence of littoral conditions that provides different sectional programming.

Policies

Beyond the level of organizational coordination necessary to carry out this major urban transformation, the City should also implement codes on new adjacent urban blocks to guide their adaptive redevelopment. For instance, zoning regulations and incentives should be established to elevate new edge front developments along the banks. Where these districts intersect historic fabric, priority should be given to typological elevation as opposed to architectural preservation.

Developments

Significant upzoning at the blocks adjacent to the canal provides opportunities for a suite of public benefits: funding infrastructure, providing privately-owned public spaces, elevating resilient-oriented urban fabric, and supplying affordable housing. Because multiple parcels adjacent to the canal are publically-owned, the City should consider redeveloping these through a rigorous RFP process to maximize their adaptive redevelopment. Lastly, the City should hedge against the effects of climate gentrification via inclusionary housing and residential rehabilitation programs.

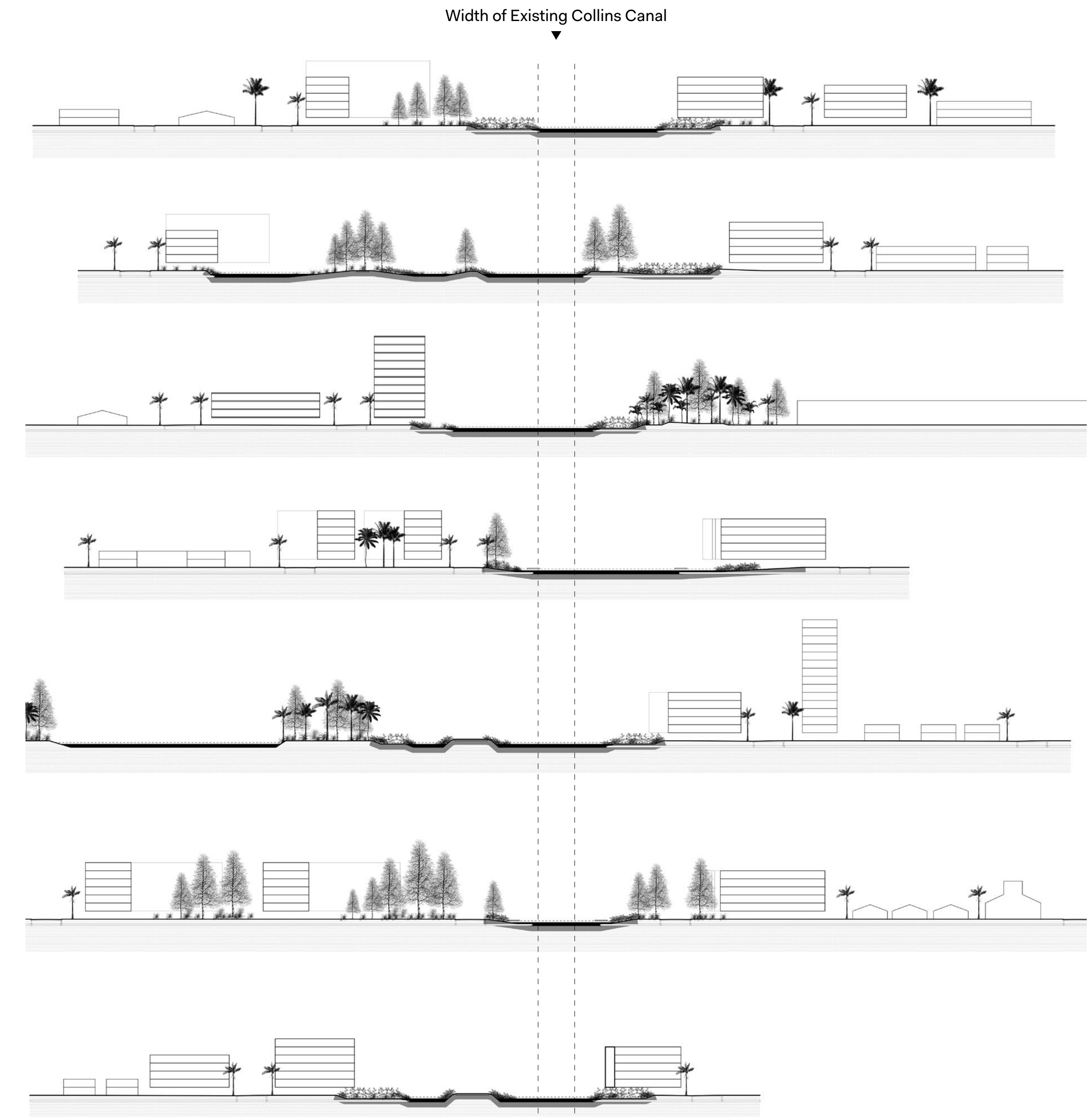


Fig. 66. Cross sections showing the existing canal's relationship (dashed at center) to that of the proposed canal, promenade, and urban form.

Scenario 08

Higher Lanes and Public Planes

Myrna Ayoub
Advised by Rosetta Elkin

The proposed new flood level floors and raised roadways are a deliberate re-articulation of the ground-plane that creates a new urban threshold. By reworking these modifications, water can be absorbed, moved, or retained as opposed to shed, concealed, or pumped. The fluctuation of urban boundaries, manifest in the section in particular, reveals an exploration of levels that augment civic context.

a.
b.
c.
d.

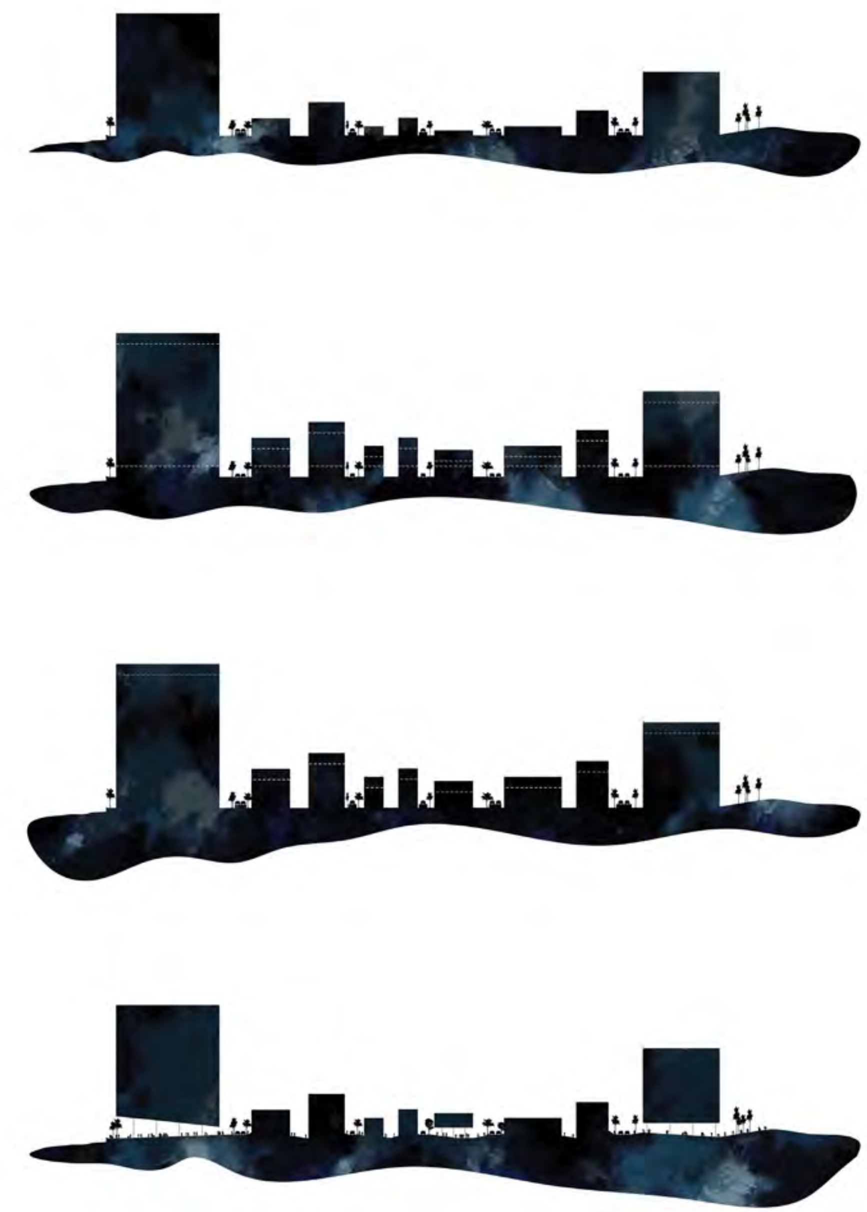


Fig. 67. Street and building elevation scenario.

a. Sea level rise prompts elevating roads, disrupting public realm thresholds.
b. Elevated buildings are economically feasible through floor bonuses.
c. Elevated roads and buildings pose a pedestrian continuity challenge and opportunity.
d. Landscape connections and architectural gestures choreograph a more urban, porous, and continuous "ground plane" experience.

Scenario 08: **Higher Lanes and Public Planes**

Hydrologies

This project explores section operations to maximize municipal stormwater management capacities. In the public realm, streets elevate with limestone-like fill to increase storage. New pervious groundcover materials slow runoff from overburdening existing drainage systems. In the private realm, new ground floors sit atop limestone filled "sponge pads" and elevated buildings cede ground to maximize sheet flow. In both realms, additional vegetation and their deep urban soils add stormwater infrastructure.

Infrastructures

This scenario views ongoing engineered infrastructures as a multi-layered system that provides pubic benefits and a new urban landscape. In addition to elevating the street roughly 5' above current grade, mass transit is also introduced along 5th Street where it connects directly to the MacArthur Causeway. Pedestrian walkways and bikeways take precedence over vehicular traffic which is reduced in capacity and speed. Lastly, certain parts of the new ground plane are reimagined as extensions of public space.

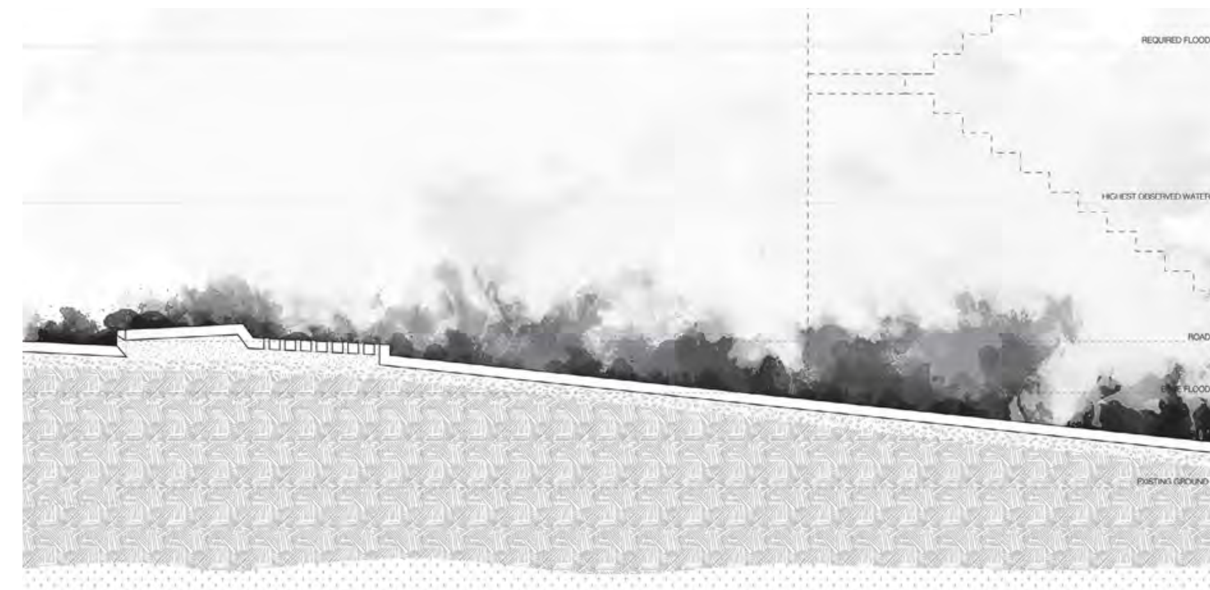
Spaces

The interior of the site is set aside for ecological performance. Low-maintenance native ecosystems are fostered to regenerate potential habitats and reduce open-space maintenance fees. Concentration of tree planting at the northern and southern tips suggest public parks and possible habitats that could spur from the alluvial channel. Topographical modifications foster the succession of native species. East-west corridors enable street tree planting schemes that organize and orient the block structure.

Policies

Coordination between the public and private realms is paramount to creating seamless urban thresholds and transitions. A finer-grained zoning overlay map would be necessary to integrate suggested common flood elevations and regulate private properties to match such elevations. Where roads cross multiple jurisdictions, additional cooperation is necessary to ensure the successful design, construction, and maintenance of proposed section scenarios. Lastly, FAR incentives on key corner properties would help initiate and accelerate their adaptive redevelopment.

68



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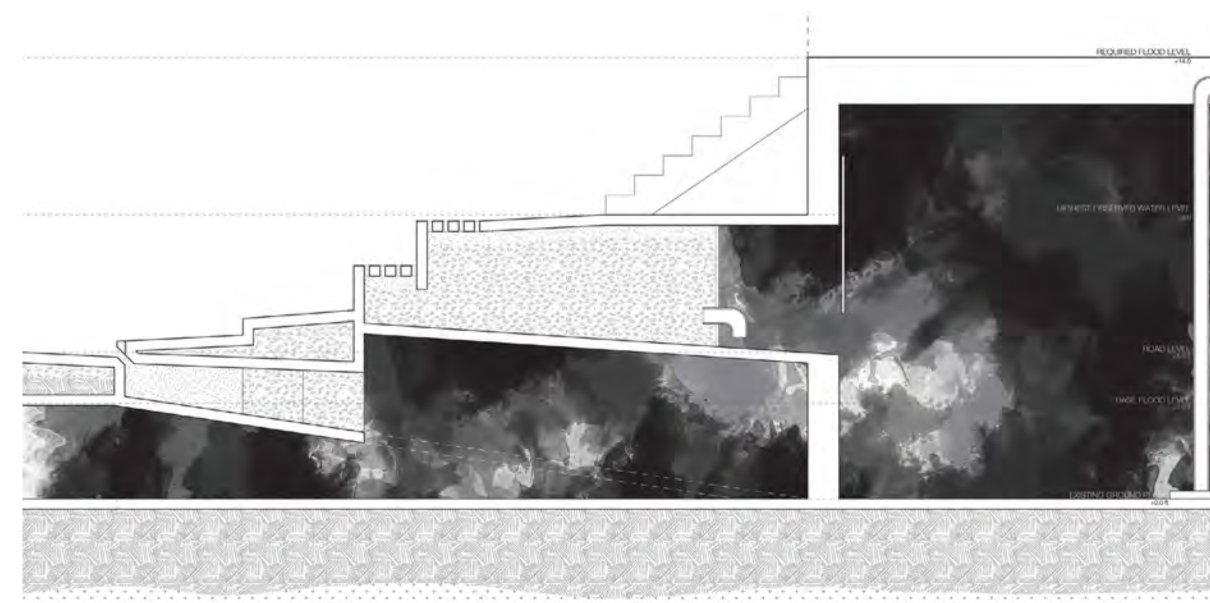
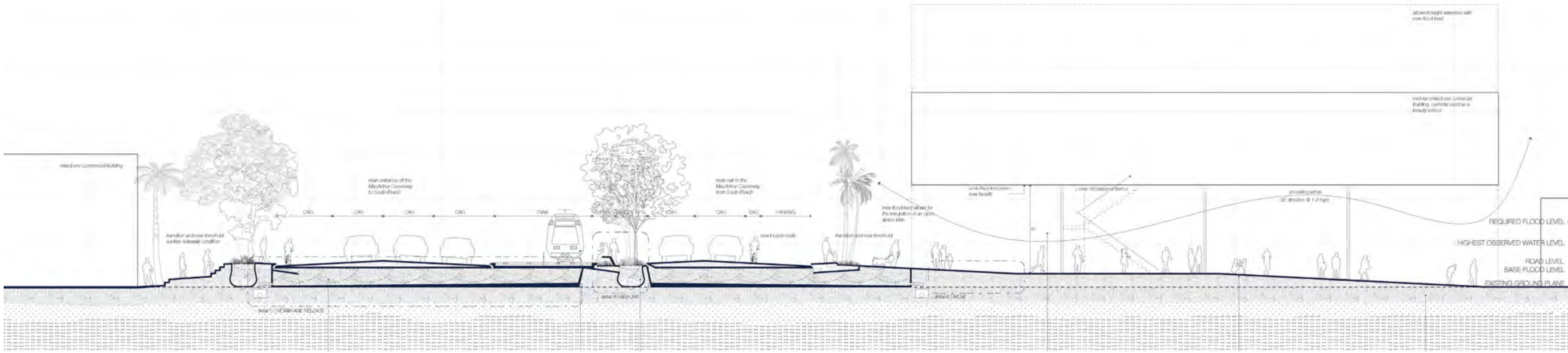


Fig. 68. Section Concept: Move and Flow. Here, elevated streets provide a means to choreograph the flow and filter of water through slopes and absorptive vegetation.

Fig. 69. Section Concept: Retain and Release. Here, shifting street to building thresholds offer water retention capacities through limestone-like fill.

Scenario 08: **Higher Lanes and Public Planes**

70



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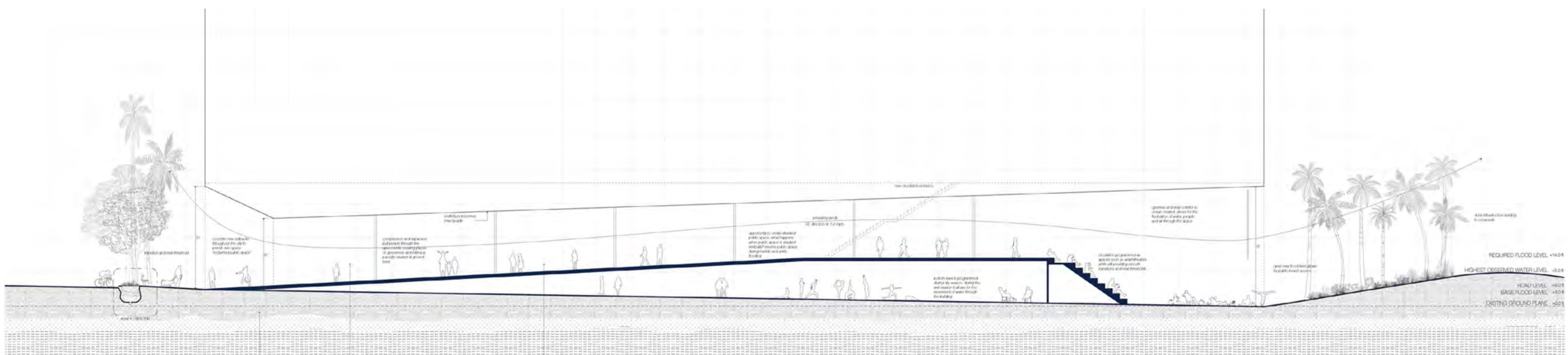


Fig. 70. Section at Alton Road and adjacent mixed-use building.

Fig. 71. Section at the terminus of 5th St and adjacent residential building base.

0 20ft

Scenario 09

Ocean Courtyards

Daniel Widis
Advised by Rosetta Elkin

In a city lacking accessible public space, Ocean Courtyard reclaims and reimagines the interstitial areas behind the iconic Ocean Drive. This project rejects adaptation as a purely functional endeavor and instead argues for the benefits inherent to elevating as a means of reconceiving civic space. By carving new physical and visual connections within adjacent alleys, novel forms of engagement are proposed to a city in need of truly public landscapes.

> Fig. 72. View of Ocean Court transformed from a hardscaped block alley into a public deck over porous ground.

Scenario 09: **Ocean Courtyards**

Hydrologies

The interstitial alleys behind existing streets and avenues present opportunities for added stormwater management. This project reconceives Ocean Court, currently an underused backstreet, as a landscape of elevated public decks which increases porous ground, soil capacity for new vegetation, and semi-public spaces. Because this part of Miami Beach is located on higher elevation, retaining stormwater here critically reduces runoff and over-flooding on lower grounds, particularly toward the city's more vulnerable western half.

Publics

In a city lacking public space, this scenario activates the underused block alleys as potential extensions of adjacent sidewalks and promenades, like the often frequented Ocean Drive. This added public realm will prove critical as the city's existing roads are subject to ongoing infrastructural renovations whose engineered designs often intrude into the public right-of-ways. Furthermore, public and semi-public courtyards offer novel spaces that reconfigure existing perceptions of the city's strict divide between public and private realms.

Spaces

The introduction of occupiable spaces into existing block alleys implies their reorganization. Existing building footprints step back and shrink to cede ground to added semi-public spaces and transitional porches, arcades, porticos, open lobbies, and courtyards. The combination of these elements would likely result in a welcomed cacophony of novel indoor-outdoor experiences. Additionally, buildings would likely become taller to compensate for reduced floor areas.

Developments

The success of the project depends as much on private initiatives and investments as on public incentives and regulations. The City should encourage these hydrological and publicly-oriented spaces through block-scaled (as opposed to lot-scaled), form-based zoning codes and FAR bonuses. It is important to balance these zoning concessions such that the addition of building mass does not overshadow these interstitial spaces and undermine their open atmosphere and potential occupation.

73

Fig. 73. Site plan showing proposed layout for Ocean Court block alley between 13th and 14th St.

0 15m

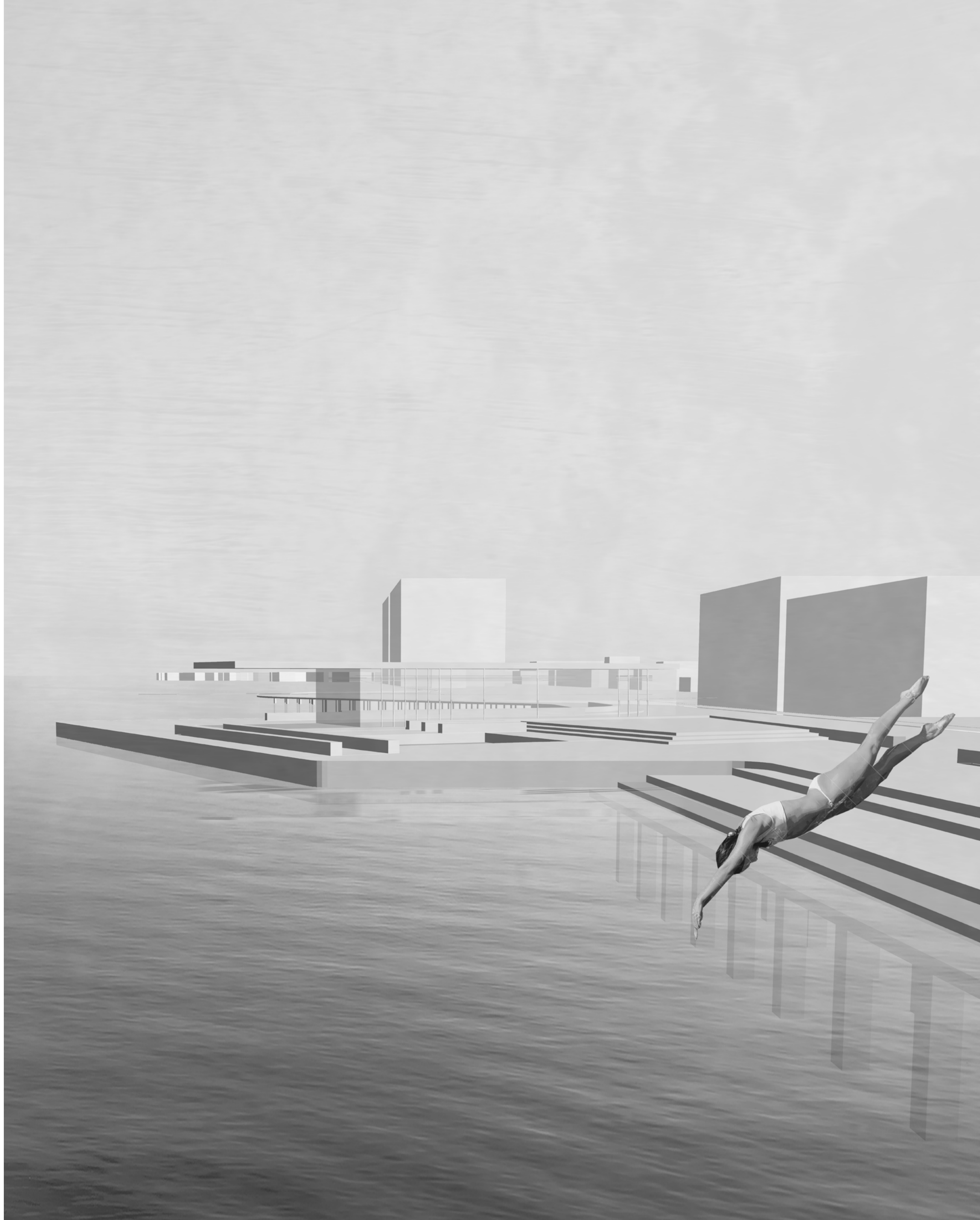
Scenario 10

Biscayne Baywalk

Chris Merritt
Advised by Rosetta Elkin

The bayside coastline holds the potential to become infrastructure for storm surge while functioning as an augmented public promenade. Recently, the City of Miami Beach has installed pumps along the Bay to handle the pressures of large volumes of stormwater runoff. The proposed *Biscayne Baywalk* is designed to alleviate stormwater quality issues and enhance the quality of the civic realm, serving as a continuous, connected, and visible system that returns the bayside as a destination.

> Fig. 74. View of a new pubic promenade at the bayfront.



Scenario 10: **Biscayne Baywalk**

Hydrologies

As the bayside of Miami Beach sits at the lowest elevation of the island, this scenario imagines a continuous elevated walkway that protects against storm surges, conceals existing and future water pumps, and integrates with adjacent raised streets and sacrificial floors. To negotiate the elevation difference between the water level and the new promenade, different section scenarios offer a variety of resilient seawall conditions for the absorbing, conveying, and shedding of runoff. Lastly, a system of ground covers augment overall hydrological performance and inform programmatic occupation.

Infrastructures

This scheme works with the ongoing municipal installation of pumps and pipes and incorporates this system into a more comprehensive infrastructural plan that also provides long-term adaptation and novel public spaces. The elevated walkway, for instance, extends raised streets and lifted lobbies, both of which cede their ground levels as sacrificial floors for floodable programs, such as parking and storage. The varying walkway sections toward the bay act as models for different resilient seawall conditions (e.g., living shorelines, dunes, dike, levees).

Ecologies

The new Baywalk provides a framework to host a planting regime of different native and aesthetic species, each of which is deployed according to its elevational preference and efficacy along the varying sections of the Baywalk. For instance, mangroves are positioned on deep soils closer to the sea level, grasses are planted at an intermediate level, and aesthetic species such as salt-tolerant palms are deployed closer to the street-end plazas. This curation of plantings therefore becomes the ecological and cultural index of their adjacent spaces.

Identities

This scheme not only transforms the identity and public perception of the Biscayne coastline, but also provides a new model of sea level adaptation that transcends engineered elevation and protection. Here, the Biscayne Baywalk represents a design principle where resilient grey infrastructure can be intermeshed meaningfully with green infrastructure to mutually augment their capacities and accommodate hydrological and public parameters.

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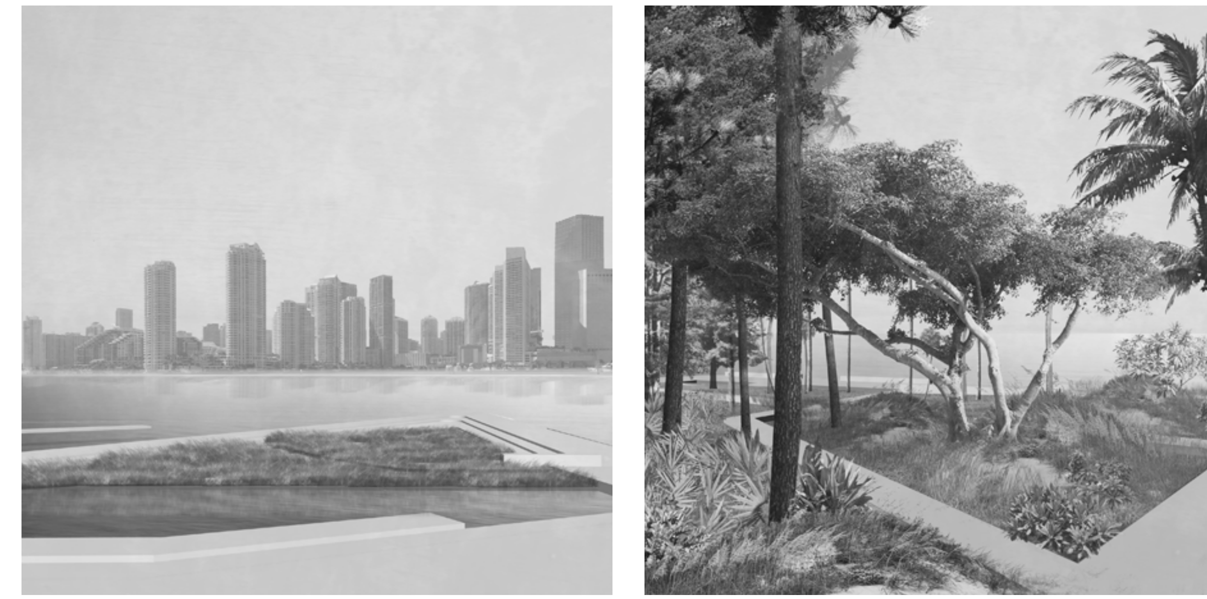

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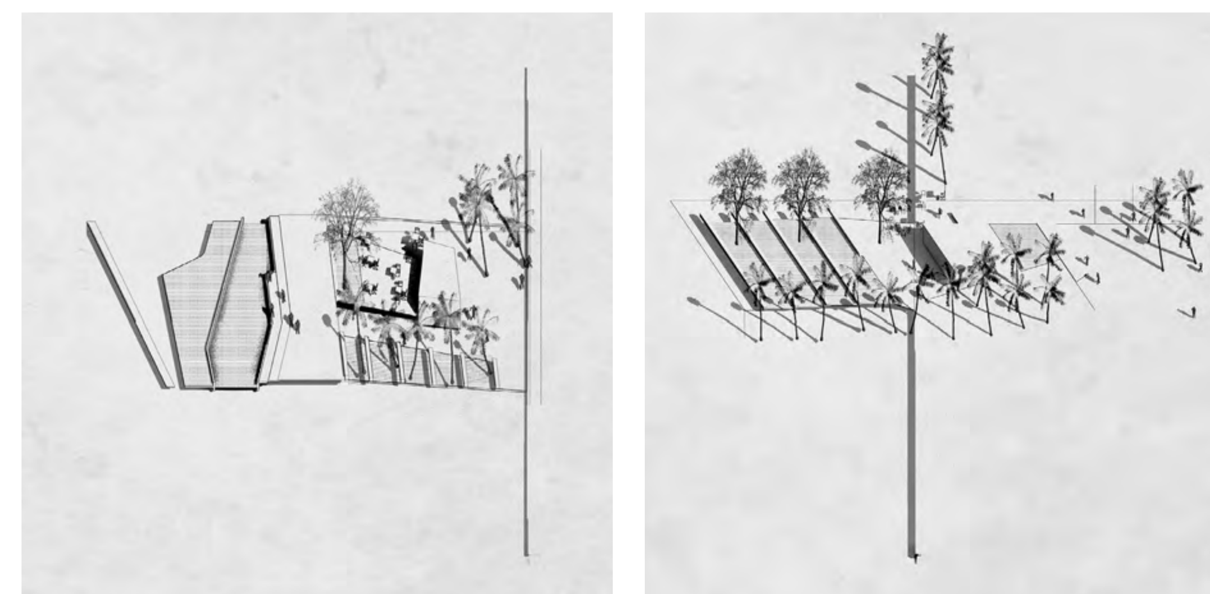


Fig. 75. Views of various bayfront conditions showing the deployment of vegetation and public paths.

Fig. 76. Isometric views of various bayfront conditions showing the integration of the existing pump, landscaped promenade, and vegetation.

Fig. 77. Site plan showing proposed continuous baywalk and its connections to the city fabric.

0 80m

Scenario 10: **Biscayne Baywalk**

Spaces

As the city elevates its public and private realms, it must contend with a constantly shifting set of public thresholds: road to bikeway, bikeway to sidewalk, and sidewalk to storefront. The Biscayne Baywalk projects this scenario forward and preemptively elevates existing structures, ground lobbies, and public promenades to the second level (i.e., 3-4 meters above existing ground level). It offers a suite of sectional conditions to meet the bay water—through stepped seawalls, terraced amphitheaters, sloped parks, and floating decks.

Policies

Currently, the bayfront coastline is divided under multiple property owners. Only the street-ends are under municipal control. Therefore, to ensure continuity, the Baywalk depends on zoning regulations that require each waterfront property to construct their piece of the promenade. Furthermore, to alleviate municipal maintenance burdens, these spaces can be modeled after privately-owned public spaces. Where certain property owners are uncooperative, the Baywalk can circumvent these private coastlines and become floating decks, thereby ensuring its continuity and feasibility as a public space.

Publics

Currently a fragmented set of mostly privatized coastlines, the Baywalk reclaims this western edge as a new public space for the city. Public plazas positioned above existing street-end pump stations become civic nodes in a larger network of connected streets and promenades. Additionally, street trees planted along key east-west axes (e.g., Lincoln Road, 15th St, 13th St) tie the project back to the city. The visitors are encouraged to fish, picnic, swim, nap, bike, paddleboard, skateboard, kayak, and dog walk, among other recreational activities.

Developments

The Baywalk integrates with the raised ground levels and elevated lobbies of adjacent properties, thereby ensuring a mutually beneficial relationship. The sections here demonstrate a coordinated transition from an elevated drop-off at the entrance, to a public or semi-public deck over floodable parking, to a plaza over existing or future flood pumps, and lastly to a variety of section conditions that ultimately meet the bay water. This scenario would also examine other funding mechanisms from the private sector, such as impact fees, equity contributions, or public-private infrastructure ventures.

a.

b.

c.

d.

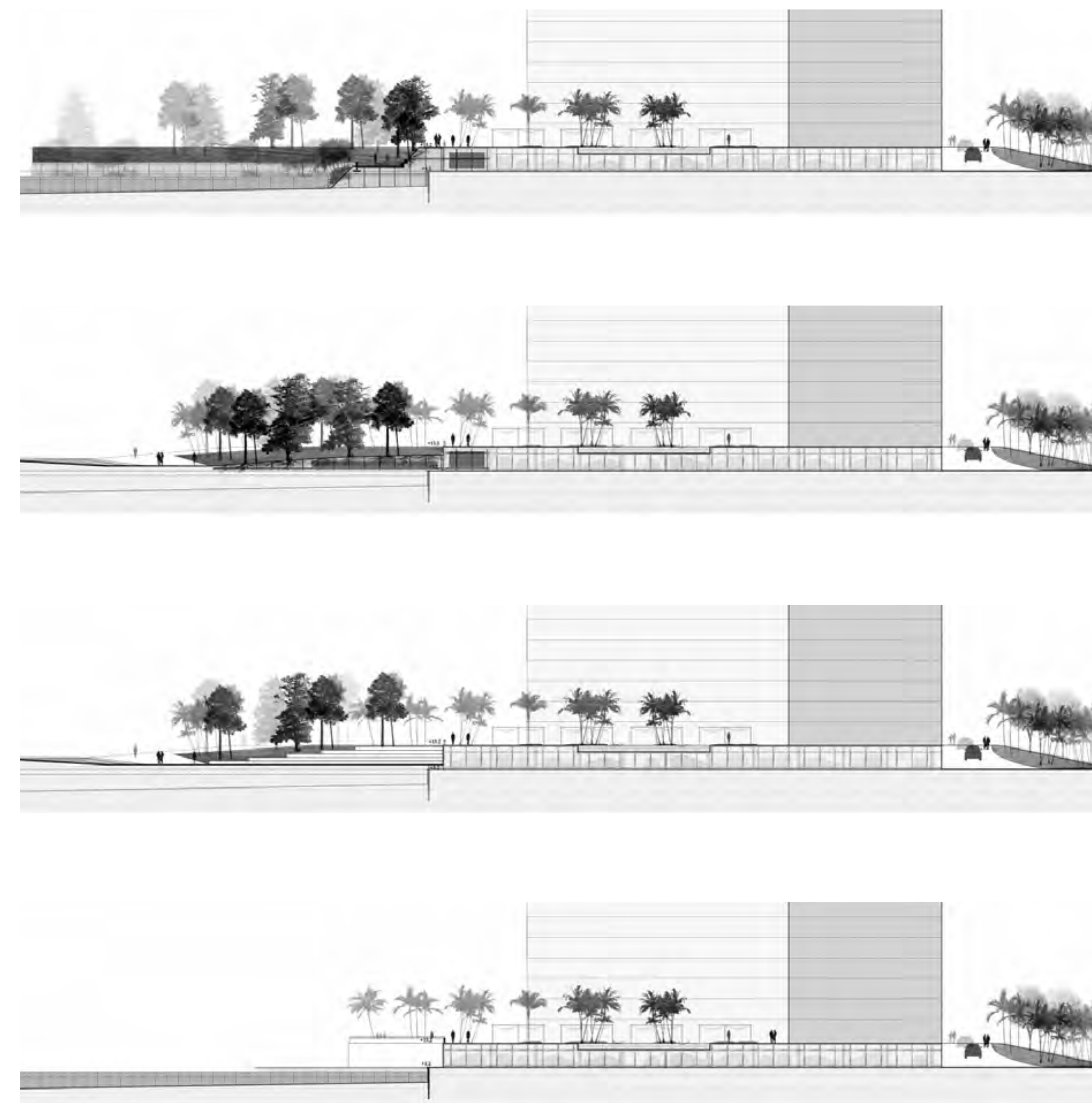


Fig. 78. Section scenarios at the bayfront showing how an elevated plaza deck integrates infrastructure, parking, and public space.

a. Stepped Seawall.
b. Sloped Park.
c. Terraced Plaza.
d. Deck and Seawall.

Fig. 79. View of elevated plaza at the bayfront. In this scenario, the pump station is contained within a glass pavilion.

PROCESS

Contexts
Fieldwork

"Resiliency and adaptation are processes, not outcomes. It is a periodical cycle."[26]

Jesse M. Keenan, 2016
Lecturer in Architecture, Harvard GSD

Fig. 80. Passengers exiting a bus during a "sunny day" flood in Miami Beach.

Contexts: **Overview**

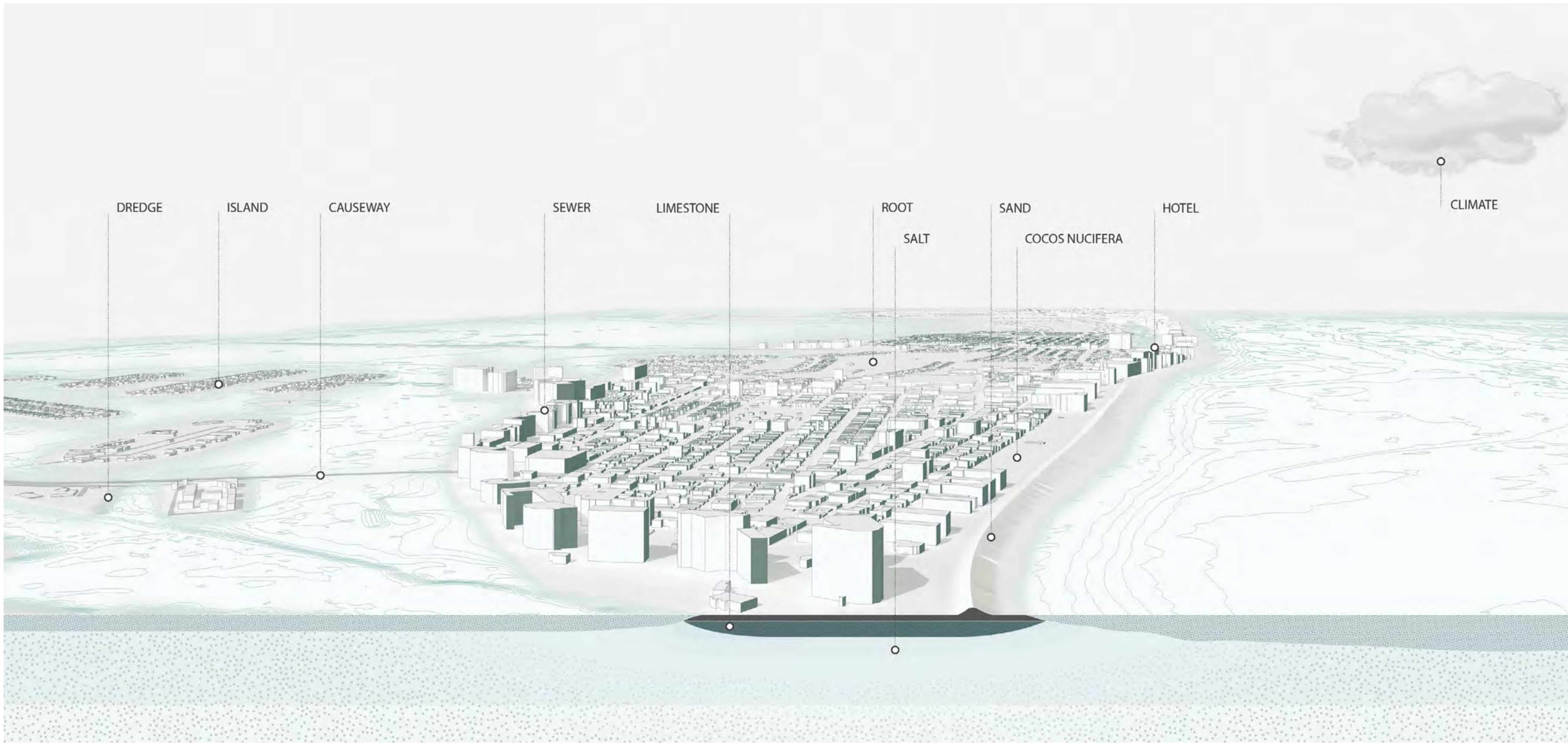


Fig. 81. Section perspective of Miami Beach highlighting different components of research.

Contexts: **Geology and Geography**

Fig. 82. Geological map of Southeast Florida showing bedrock composition. Miami Limestone is the dominant bedrock and the only rock to surface in Miami Beach.

- Miami Limestone
- Key Largo Limestone
- Holocene Sediments
- Shelly Sediments

0 10km

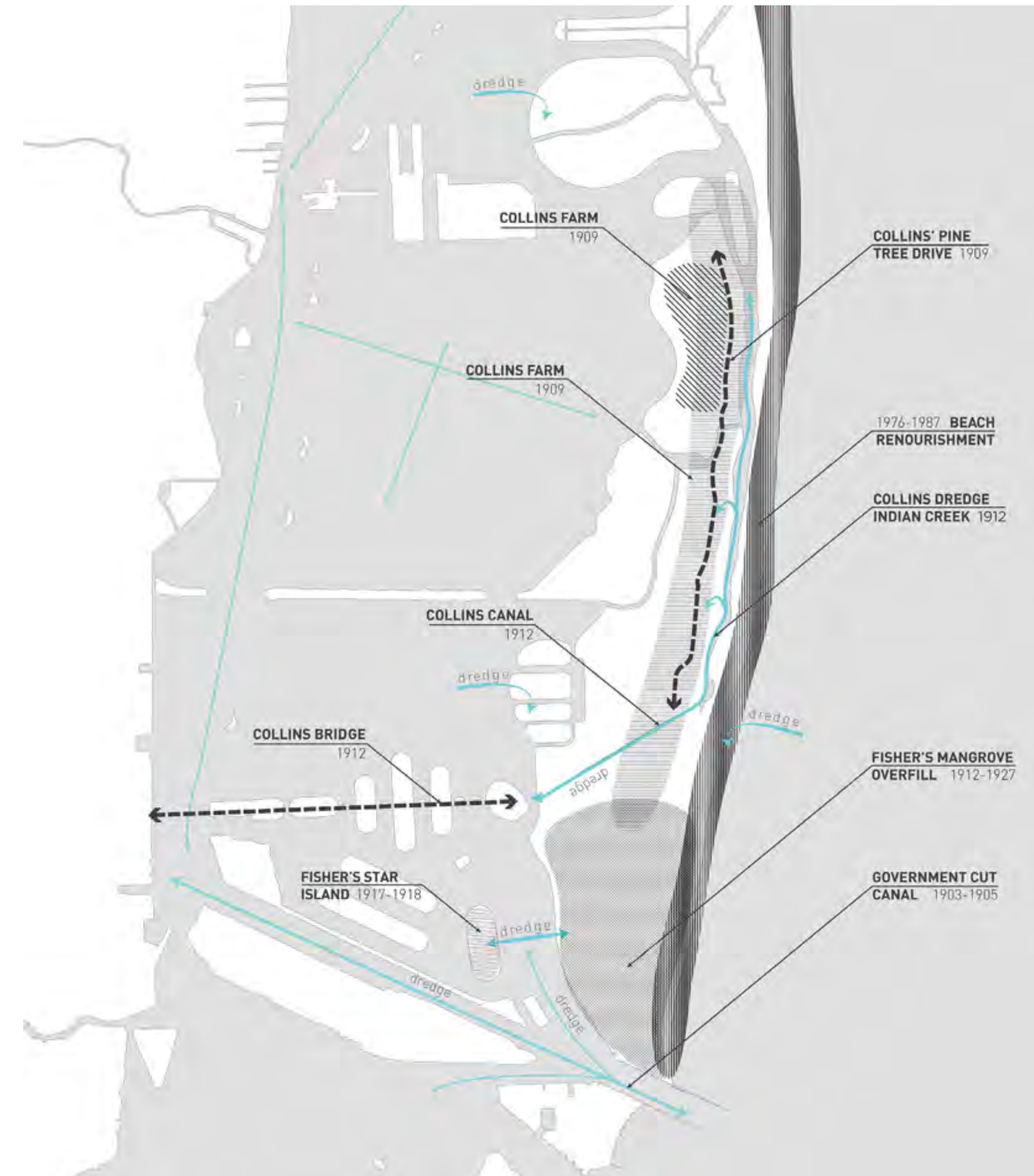


Fig. 83. Dredge Map of Miami Beach showing the historic and synthetic formation of its geography.

0 1000m

Contexts: **Hydrology**

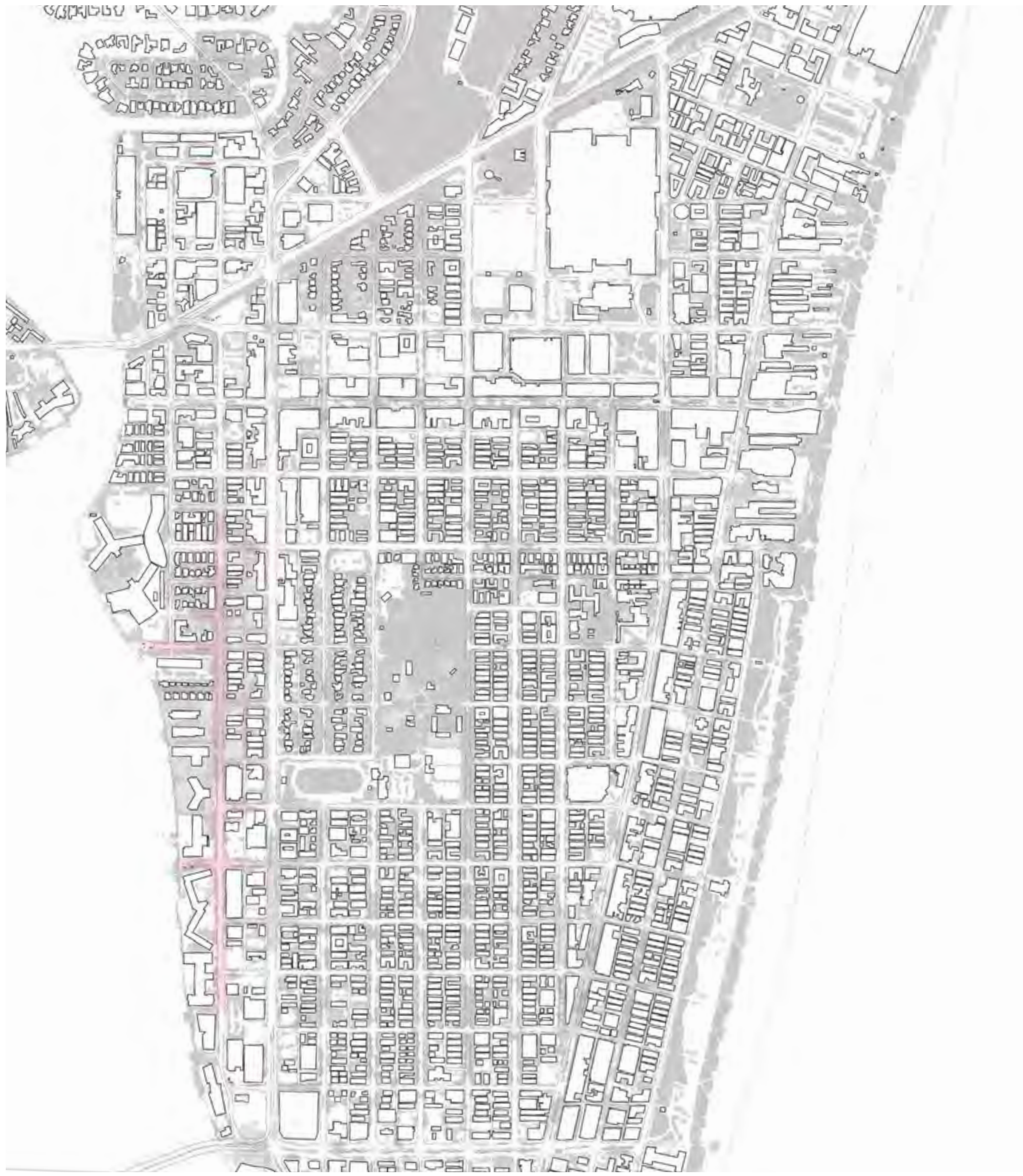


Fig. 84. Hydrological site plan of Miami Beach highlighting pump stations, pipes, and road elevation areas.

0 300m

Fig. 85. Detail of hydrological site plan showing western half of Miami Beach from Biscayne Bay to Flamingo Park.

0 100m

Contexts: **Zoning Envelope and Existing Urban Form**

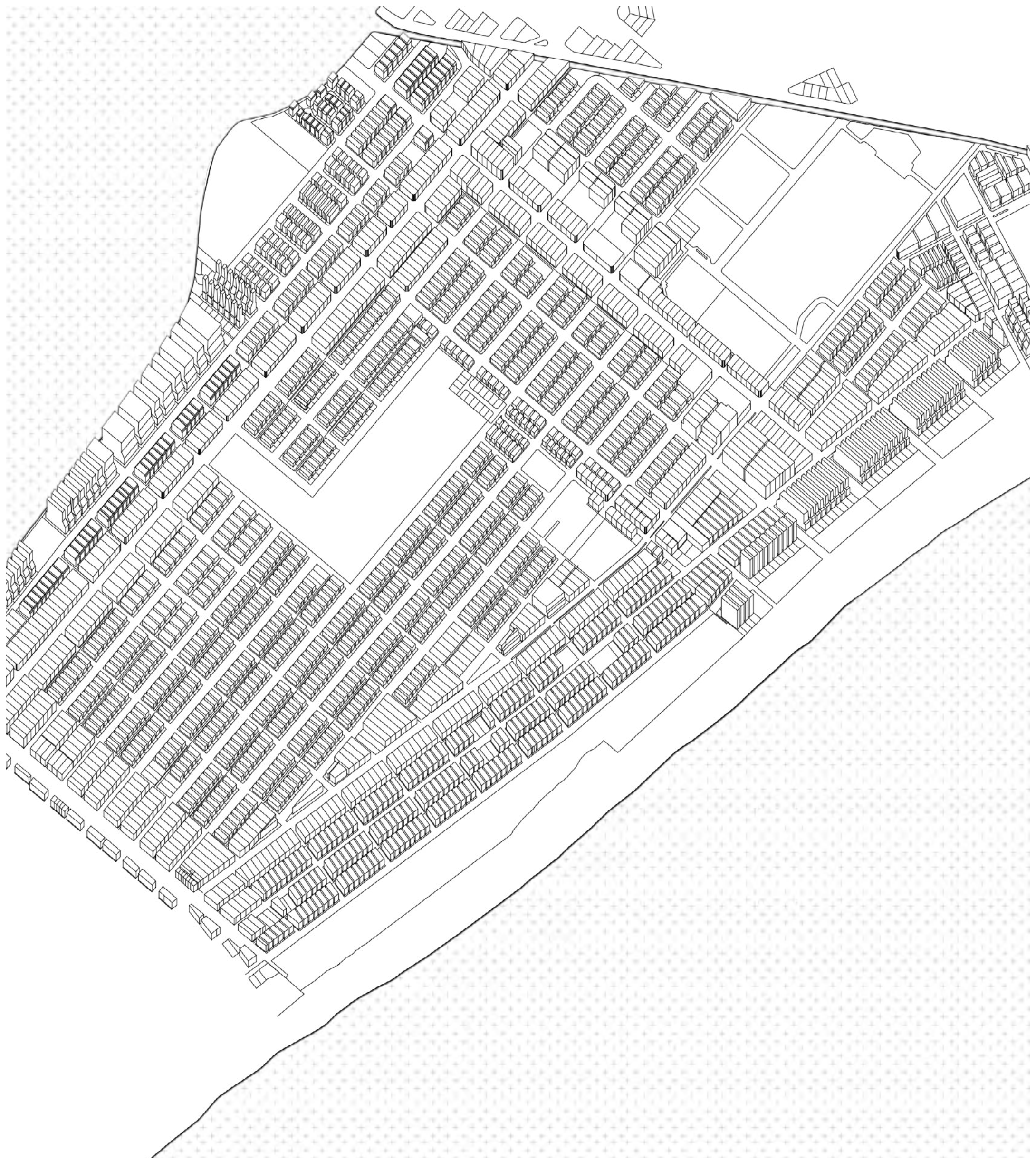


Fig. 86. Axonometric showing the maximum built-out zoning envelopes of Miami Beach between Collins Canal and 5th St.

Fig. 87. Axonometric showing the existing built form of Miami Beach between Collins Canal and 5th St.

Contexts: **Urban Typology**

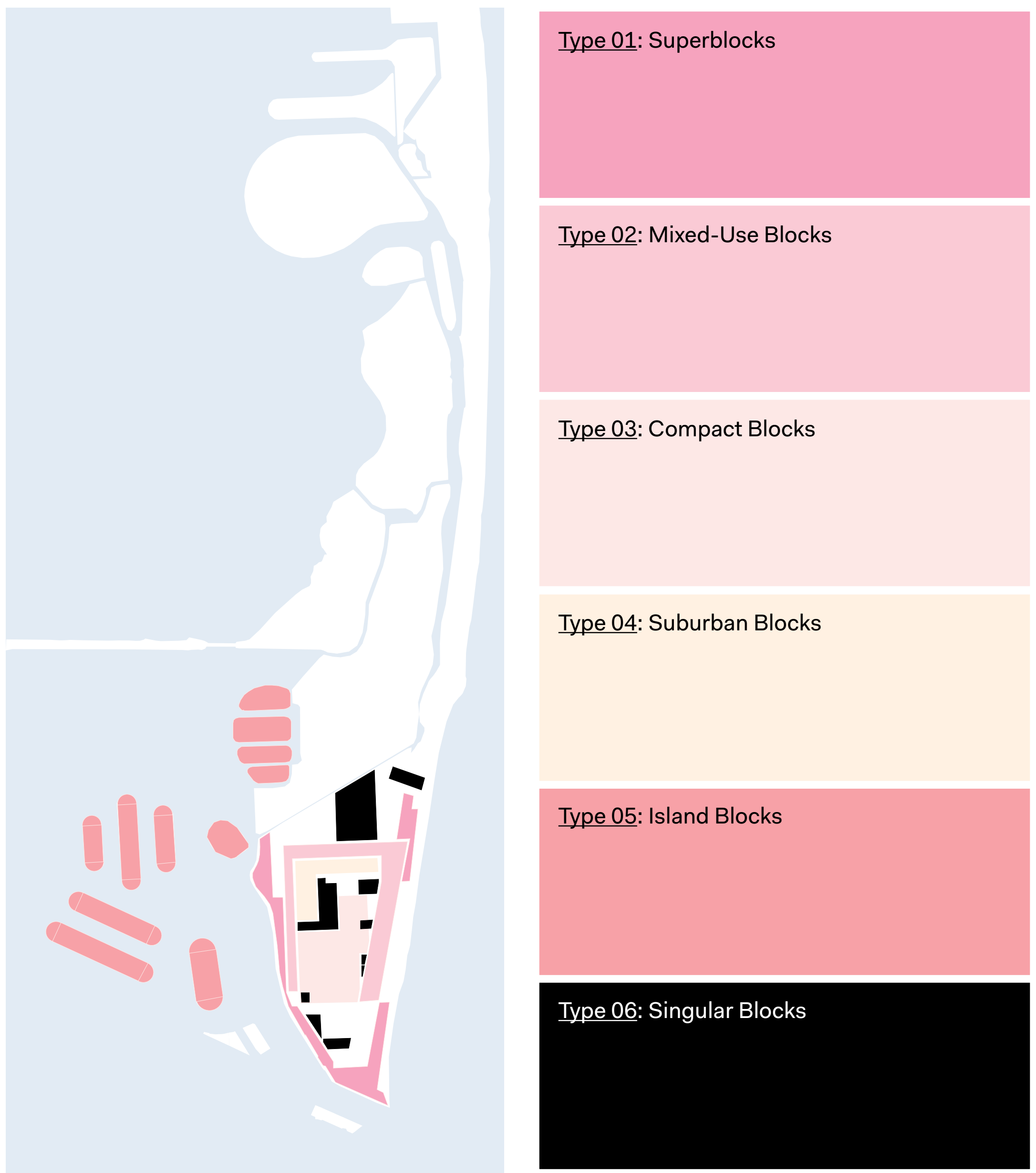


Fig. 88. Map and key showing Miami Beach's 6 dominant urban typologies.

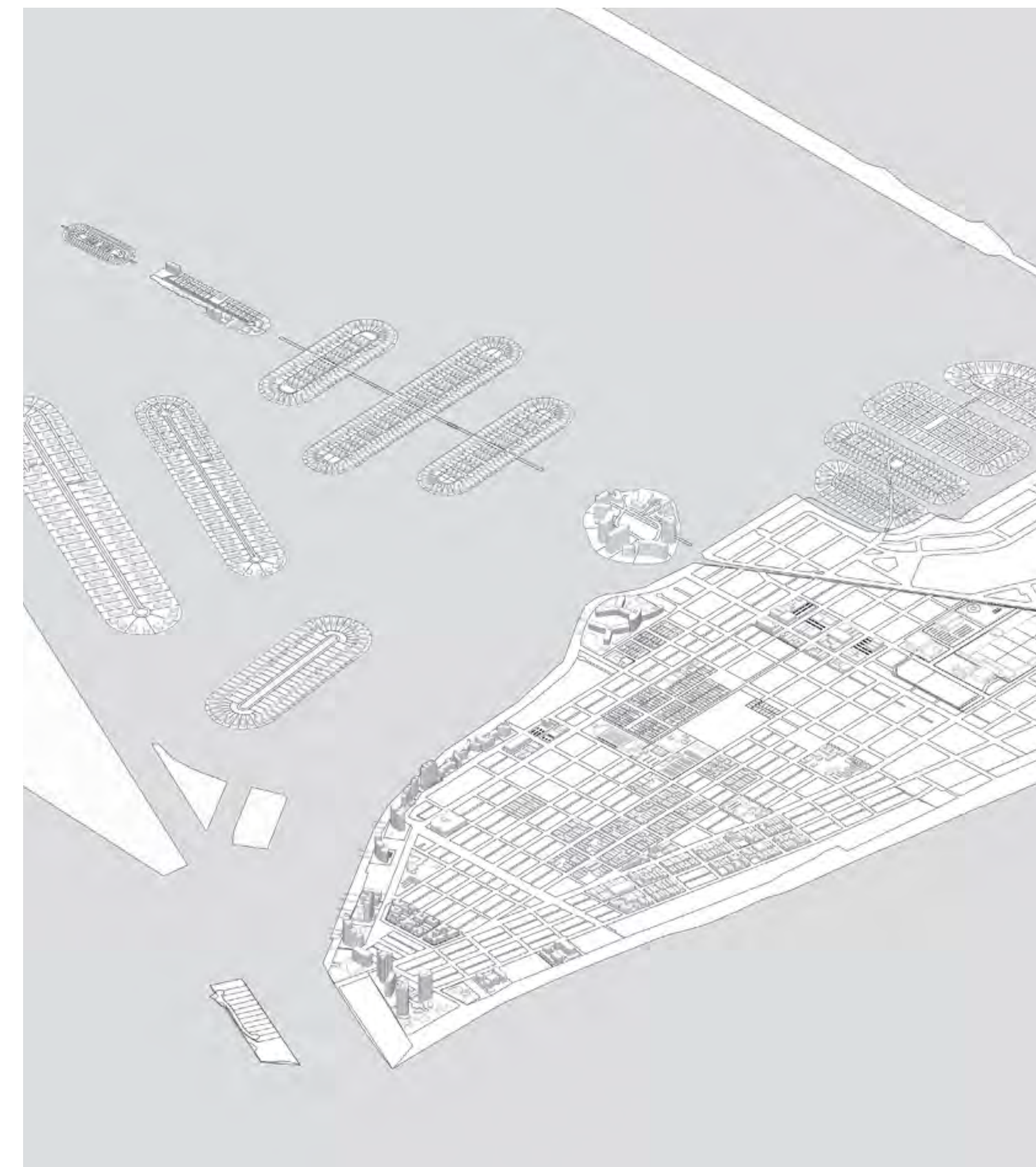


Fig. 89. Isometric view of showing select representative urban types.

Contexts: **Urban Typology**

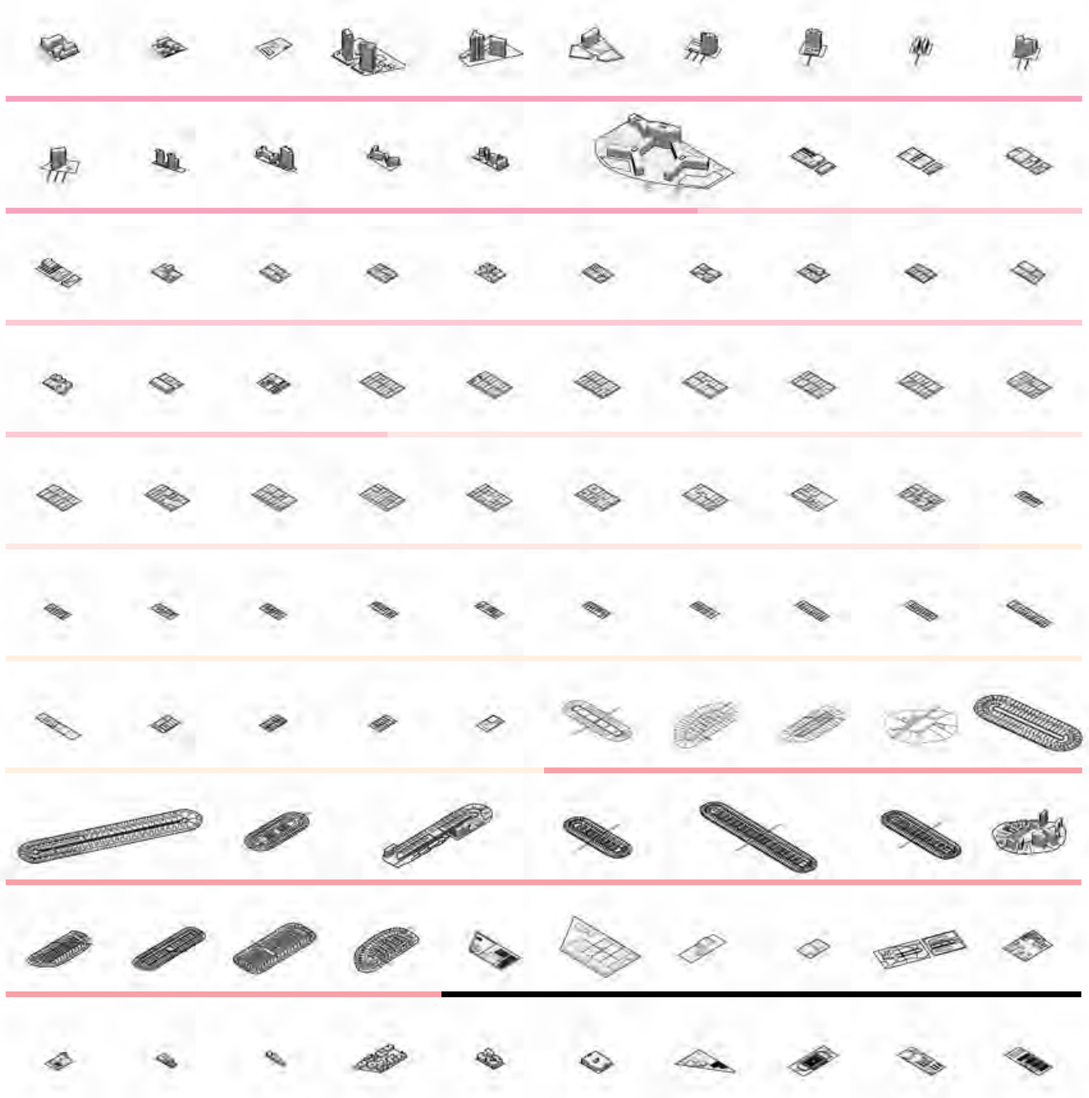


Fig. 90. Typological inventory as axonometric vignettes.

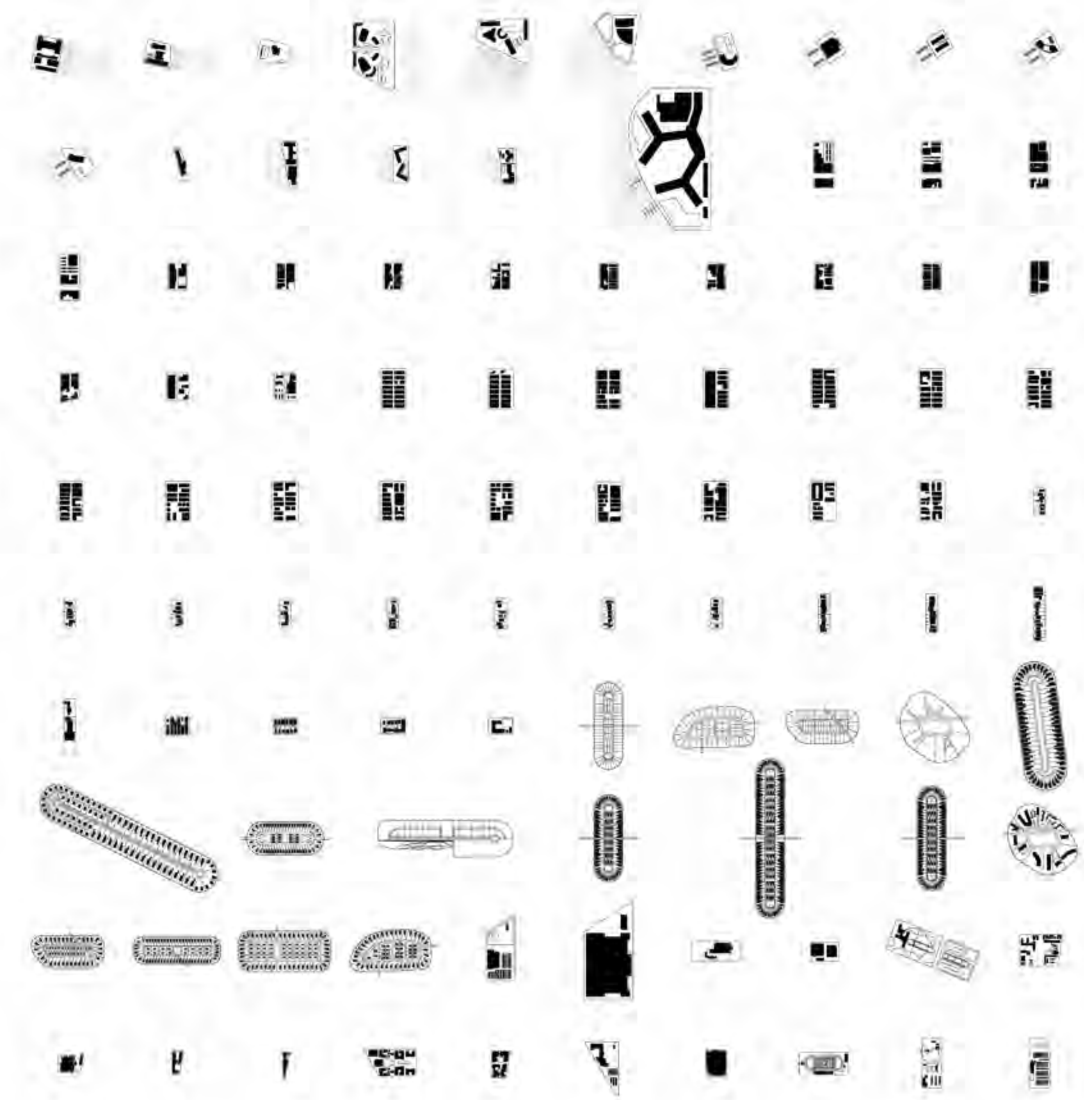


Fig. 91. Typological inventory as figure-ground plans.

Contexts: **Urban Typology**

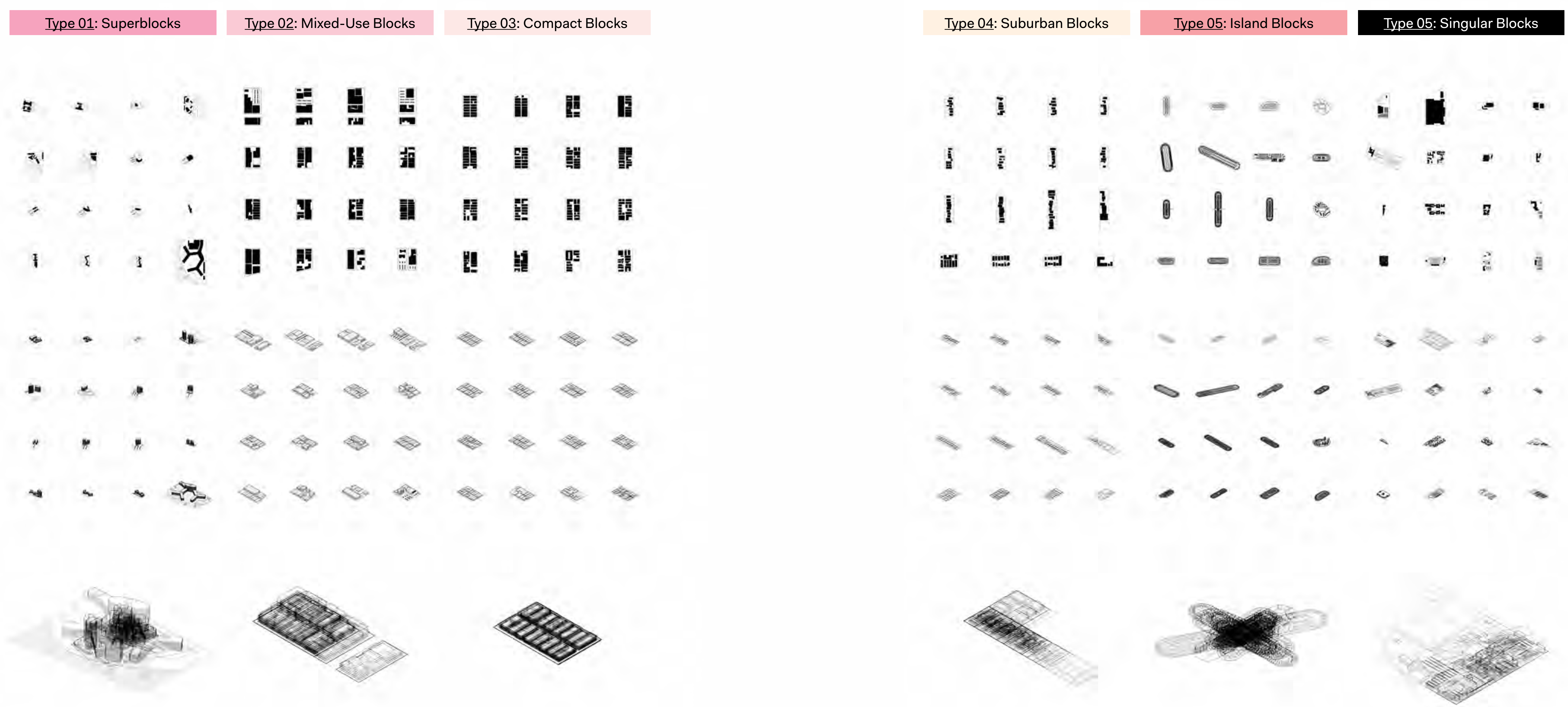


Fig. 92. Comparative catalogue of all 6 types showing, from top row to bottom row, figure-ground plans, axonometric vignettes, and composite models.

Fig. 93. View of newly raised sea wall along the Collins Canal.

"As Miami's coastal barrier islands form one of the most recognizable and singularly valuable cultural landscapes in the world, the conditions in Miami Beach reveal the potential for ecological and infrastructural strategies to act as alternatives to large single purpose engineering solutions."[27]

Rosetta Elkin, 2016
Assistant Professor of Landscape Architecture, Harvard GSD

Fieldwork: **South Florida and Sea Level Colloquium**

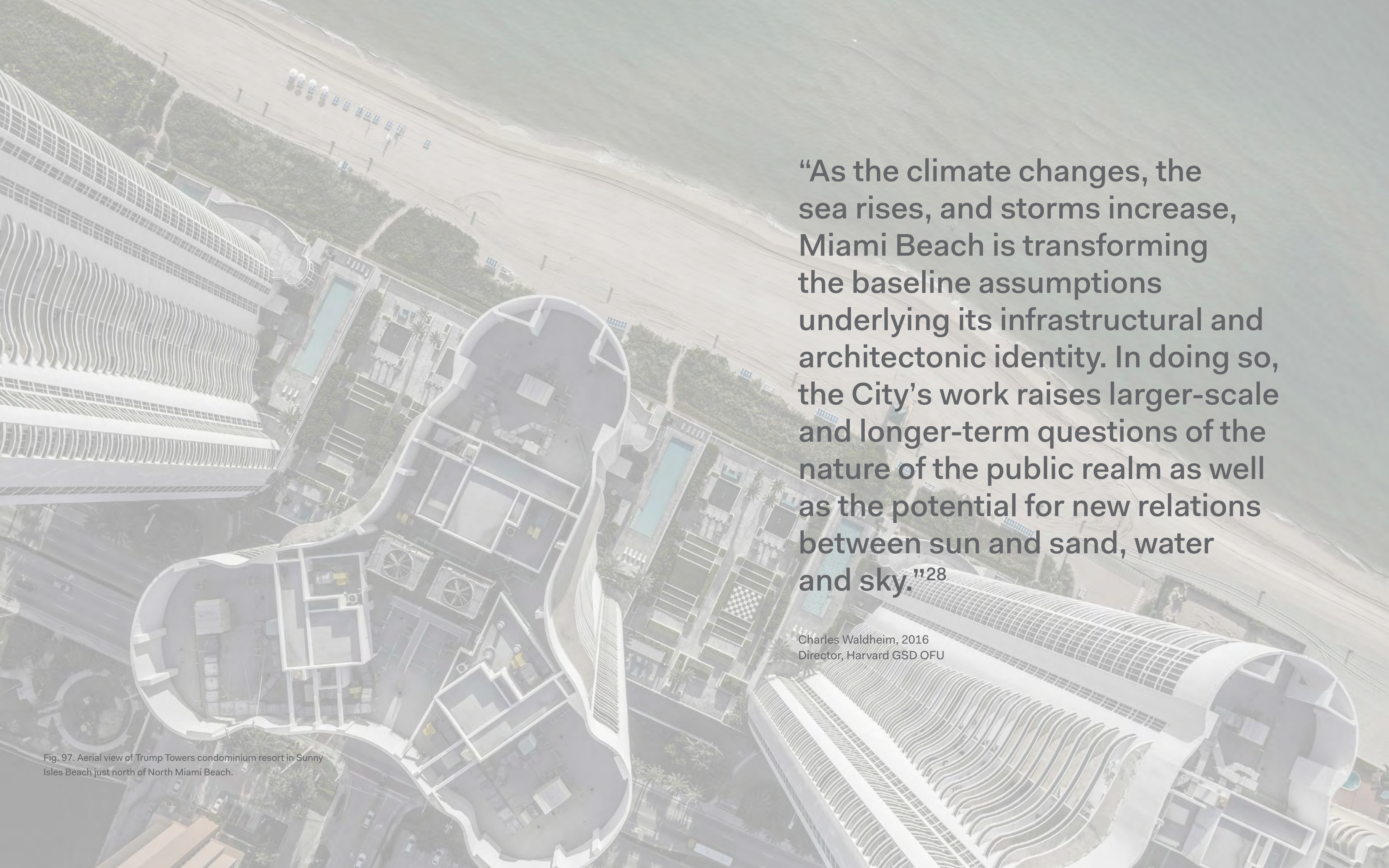
Fig. 94. *South Florida and Sea Level* Colloquium at the Wolfsonian-FIU in Miami Beach. Presenters and speakers include Marta Canaves, Florida International University; Rodolphe el-Khoury, University of Miami; Rosetta Sarah Elkin, Harvard GSD; Jeremy Gauger, ArquitectonicaGEO; Ana Gelabert-Sanchez, Harvard GSD; Alastair Gordon, Miami Herald; Greg Guannel, The Nature Conservancy; Jerold Kayden, Harvard GSD; Jesse M. Keenan, Harvard GSD; Benjamin Kirtman, University of Miami; Bruce Mowry, City of Miami Beach; Maria Nardi, Miami-Dade Parks Department; Eric Rodenbeck, Stamen; Eric Rothstein, eDesign Dynamics; Roberto Rovira, FIU; Rachel Silverstein, Biscayne Bay Waterkeeper; Susanne Torriente, City of Miami Beach; Marcia Tobin, AECOM; Charles Waldheim, Harvard GSD; Harold Wanless, University of Miami; Elizabeth Wheaton, City of Miami Beach; and JJ Wood, Urban Robot.

Fieldwork: **Design Reviews**

Fig. 95. Studio final reviews at the Harvard GSD. Critics include Jeremy Gauger, Arquitectonica; Anita Berrizbeitia, Harvard GSD; Dr. Alan Blumberg, Oceanographer; Neil Brenner, Harvard GSD; Scott Cohen, Harvard GSD Diane Davis, Harvard GSD; Mitesh Dixit, Syracuse University; Rosetta Elkin, Harvard GSD; Martin Felsen, Illinois Institute of Technology; Gerald E. Frug, Harvard Law School; Jesse M. Keenan, Harvard GSD; Mouzayan al Khalil, HMWhite; Amy Knowles, City of Miami Beach; Paul Lewis, LTL Architects; Joanna Lombard, University of Miami; Richard Peiser, Harvard GSD; Eric Rothstein, E-Design Dynamics; Laurinda Spear, Arquitectonica; Ashley Schafer, Ohio State University; Daniel P. Schrag, Harvard Center for the Environment; Marcia Tobin, AECOM; Susy Torriente, City of Miami Beach; Charles Waldheim, Harvard GSD; Elizabeth Wheaton, City of Miami Beach; and Mason White, University of Toronto.

Fieldwork: **Site Visits**

Fig. 96. Student site visit and documentation. Site tours led by Jesse M. Keenan, Harvard GSD; Bruce Mowry, City of Miami Beach; Chad Oppenheim, Oppenheim Architecture; Eric Rothstein, E-Design Dynamics; and Rachel Silverstein, Biscayne Bay Waterkeeper.



"As the climate changes, the sea rises, and storms increase, Miami Beach is transforming the baseline assumptions underlying its infrastructural and architectonic identity. In doing so, the City's work raises larger-scale and longer-term questions of the nature of the public realm as well as the potential for new relations between sun and sand, water and sky."[28]

Charles Waldheim, 2016
Director, Harvard GSD OFU

Fig. 97. Aerial view of Trump Towers condominium resort in Sunny Isles Beach just north of North Miami Beach.

Notes

1. Nicole Hernandez Hammer, as cited in Elizabeth Kolbert, "The Siege of Miami," *The New Yorker*, December 28, 2015.
2. Nick Madigan, "South Florida Faces Ominous Prospects from Rising Waters," *The New York Times*, November 10, 2013.
3. Jonathan Corum, "A Sharp Increase In 'Sunny Day' Flooding," *The New York Times*, September 3, 2016, https://www.nytimes.com/interactive/2016/09/04/science/global-warming-increases-nuisance-flooding.html.
4. City of Miami Beach, "Mayor's Blue Ribbon Panel on Flood Mitigation," Last modified October 10, 2016, http://www.miamibeachfl.gov/cityclerk/default.aspx?id=78270.
5. Greg Guannel, Untitled presentation given at the *South Florida and Sea Level* colloquium conducted at The Wolfsonian-FIU, Miami Beach, FL., February 23, 2016.
6. Elizabeth Kolbert, "The Siege of Miami," *The New Yorker*, December 28, 2015.
7. David Kamp, "Waterworld," *Vanity Fair*, December 2015.
8. Jayantha Obeysekera, as cited in Elizabeth Kolbert, "The Siege of Miami," *The New Yorker*, December 28, 2015.
9. Jeff Goodell, "Miami: How rising sea levels endanger South Florida," *Rollingstone*, June 20, 2013, http://www.rollingstone.com/politics/news/why-the-city-of-miami-is-doomed-to-drown-20130620.
10. Guannel, Untitled presentation.
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Credits

Fig. 1; Global Aerials.
Fig. 2-5; George Steinmetz Photography.
Fig. 6; Sonny Xu.
Fig. 7; George Steinmetz Photography.
Fig. 8; Rosetta Elkin.
Fig. 9-11; Sonny Xu.
Fig. 12-13; George Steinmetz Photography.
Fig. 14-22; Boxia Wang.
Fig. 23-29; Andrew Madl.
Fig. 30-40; Jessy Yang.
Fig. 41-50; Ziwei Zhang.
Fig. 51-57; Sonny Xu.
Fig. 58-61; Izgi Uygur.
Fig. 62-66; Kent Hipp.
Fig. 67-71; Myrna Ayoub.
Fig. 72-73; Daniel Widis.
Fig. 74-79; Chris Merritt.
Fig. 80; George Steinmetz Photography.
Fig. 81; Harvard GSD Office for Urbanization.
Fig. 82; Justin Henceroth.
Fig. 83; Tyler Mohr.
Fig. 84-92; Harvard GSD Office for Urbanization.
Fig. 93; Sonny Xu.
Fig. 94; Sonny Xu and Harvard GSD Office for Urbanization.
Fig. 95; Justin Knight Photography.
Fig. 96; Rosetta Elkin and studio members.
Fig. 97; George Steinmetz Photography.

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