Northeastern University
College of Arts, Media and Design

July 2, 2025.

Executive Committee
College of Fellows
The American Institute of Architects
1735 New York Avenue, NW
Washington, DC 20006

Dear COF Executive Committee,
We are delighted to share with you this final report on our work for the 2022-2024 Latrobe Prize *Common Senses: Standards for Enacting Sensor Networks for an Equitable Society*.

Completed work in the last year:

Thanks to the No-Cost Extension approved last year, we completed our Latrobe work plan and more, including:

- a year of data collection after the June 2024 completion of construction at 22 Willow site
- completed analysis of that data
- two courses—an architecture design studio and a Participatory Modeling course—focused on this work in Chelsea
- engagement with city planners, city councilors, design professionals, and the community (through our community partner at La Colaborativa), to do green infrastructure modeling and design for West Chelsea
- dissemination of findings and outputs for multiple audiences (listed below)

Note: data collection continues at 22 Willow as the new building is still vacant. Our goal is to understand the impacts of the design and green infrastructure once tenants occupy the site to assess the effect of new traffic patterns. Based on the data contract the sensors supported by the Latrobe Prize will remain in Chelsea collecting data until at least November 2025.

Ongoing and future directions of the work:

Thanks in part to the pilot data and collaborations supported by the Latrobe Prize, the team achieved additional support to expand on this work beyond the original plan, and we continue to explore future collaborations with stakeholders, including:

- Internal funding at Northeastern (iSUPER project) to expand the sensor network in Chelsea, which dovetailed with the sensor data in the Latrobe site (ongoing)
- External funding - a $2.5M grant from the National Science Foundation program for Smart & Connected Communities (S&CC) for an expansion of the Common Senses project to an entire urban corridor in the Blue Hill Avenue area of Boston, which started in September 2022 and will be running until September 2025 (ongoing)
- EPA grant application for a mini-grant program for community-led green infrastructure projects (submitted, program recently canceled by Federal Government)
- Proposals with Sloan and Robert Wood Johnson Foundation with the City of Chelsea, La Colaborativa, Utile Design and Planning, to build on the work from the Latrobe Prize

towards the *Pa'lante* Comprehensive Plan (unsuccessful due to unprecedented volume of applications after federal funding cuts)

Outputs:

The following deliverables were the direct result of the Latrobe Prize research activities, and are linked or attached in full as appendices to this letter:

Output to AIA practitioner audience:

- **Appendix A**: The final contract milestone was the presentation at the **2025 AIA Conference in Boston**, led by a panel from the research team and the city of Chelsea.
    - ***This presentation is available to be given at other conferences if solicited, for example regional AIA conferences.***

Output to Chelsea community audience:

- **Appendix B**: A **design studio report** showing the resulting community-led plan for the **West Chelsea Transit Oriented Development**, focused on high-density balancing affordable housing and green infrastructure for equitable climate adaptation – submitted to the City of Chelsea, community partners of this research, and the practitioners involved in the studio: Utile and Studio Luz.
- **Appendix C**: A **video** of the community co-design process and outputs, shared with the City of Chelsea Planning Department, City Council, as well as distributed through community partners from La Colaborativa
- **Appendix D**: A **series of proposals for community engagement** for Chelsea's Comprehensive Planning process, ***Pa'lante*** (Spanish for Onward!), with science-based and equity-focus tools and methods, submitted to Utile (the lead firm for *Pa'lante*), the City of Chelsea planners and City Councilors, La Colaborativa (community partner of Pa'lante) and Studio Luz (an architecture firm acting as consultant to the city in the West Chelsea Transit Oriented Development)
- **Appendix E: Poster** of the course outputs above presented at the **Chelsea Research Festival** in May 2025, attended by high school students, community members, and other researchers in involved in Chelsea. (See Appendix E)
- **Appendix F:** Invited presentation at **Urban Land Institute Regenerative Design Workshop** focused on the Mystic River Lower Watershed (April 8th 2025) by Michelle Laboy.

Outputs for Academic Audiences:

- **Appendix G:** Peer-reviewed conference proceedings paper for the Association of Collegiate Schools of Architecture (ACSA), based on the participatory modeling workshop with planners at the City of Chelsea, focused on the 22 Willow site
- **Appendix H**: Presentation of the paper above at ACSA conference in March 2024, the top conference in the US for architecture educators
- **Appendix I:** Peer-reviewed **journal article** in *Environment and Planning B*, a top journal in the field of planning, focused on the process of facilitation and the tools used in

two workshops with city planners in Chelsea and with scientists, for green infrastructure design and flood modeling of the 22 Willow site.
- **Appendix J:** Presentations and workshops at conferences on participatory modeling in Chelsea

Output for broadly defined audience:

- **Common SENSES Playbook:** This publication presents a summary of our process and our results, as lessons learned and a guidebook on how this can be applied in other communities**. (See Appendix K)**
    - ***This playbook may be of interest to the AIA as a practitioner-focused publication, and we are open to your thoughts on how this can be most effectively disseminated, through the AIA COF, AIA resources, and/or AIA Continuing Ed publications. As our Common SENSES work continues with the City of Boston in the Blue Hill Avenue Corridor, we will expand this into a broader publication, most likely to be shared online in the Common SENSES website, with more applications and methods of this work.***

Conclusion

We are proud of the achievements and impacts of the Common SENSES project. We are deeply grateful for the support of the AIA COF. We welcome your advice and partnership in finding the best method of further disseminating our playbook with your community of practitioners. We look forward to building on this work with the City of Chelsea, the City of Boston, and others. As always, if you have any questions or suggestions, we can be reached by phone 617-373-5320, of via email at m.laboy@northeastern.edu

Sincerely,

Michelle Laboy (contact PI)
Associate Professor, Architecture
Affiliate Faculty, Civil & Environmental Engineering, School of Public Policy & Urban Affairs

Amy Mueller
Associate Professor, Civil & Environmental Engineering, Marine & Environmental Sciences

Dan O'Brien
Professor, Public Policy and Urban Affairs
Director of Boston Area Research Initiative (BARI)

Moira Zellner
Professor, Public Policy and Urban Affairs
Director of Participatory Modeling and Data Science & Co-Director of NULab for Digital Humanities and Computational Social Science

Appendix A:

Presentation slides for the 2025 AIA Conference in Boston
June 7th 2025
10:30am-11:45am
Panel: Michelle Laboy (Northeastern, moderator), Karl Allen (City of Chelsea), Amy Mueller (Northeastern), Dan O'Brien (Northeastern / BARI), Moira Zellner (Northeastern)

Session Title: Common SENSES: building equity through sensor networks and participatory modeling

Session description:
This panel will present processes and lessons from the research project funded by the 2022 Latrobe Prize awarded by the AIA College of Fellows. The panel of researchers, city planners, and practitioners will discuss a science-based and equity-focused approach to designing green infrastructure in architecture projects to improve microclimates and mitigate environmental hazards. Understanding whether projects can exacerbate or mitigate local inequities, e.g. higher exposure to hazards like extreme heat, pollution, or flooding—requires exploring complex and dynamic interactions of buildings within and beyond site boundaries. This collaborative project between Northeastern University and the city of Chelsea, Massachusetts, integrates (1) sensor network design and data measuring local variation in hazards at relevant spatial scales and (2) inclusive participatory tools for modeling the impacts of interventions with local stakeholders. Recognizing that green infrastructure can play an important part in mitigating climate hazards, but that competing demands on public space and infrastructure can limit its scale, this project highlights the need for a decentralized network of green infrastructure in private sites to support targeted mitigation and incremental implementation. The session will share important lessons on how architecture can build capacity, connectivity, co-benefits, and shared responsibility for advancing broader environmental justice goals.

Learning Objectives:
By the end of this presentation, participants will be able to:

1. Explain the causes of microspatial inequities in exposure to environmental hazards and how building projects can exacerbate these inequities.
2. Apply rules-of-thumb for the design of sensor networks and interpret data to characterize the variation in environmental hazards in and around their own project sites.
3. Develop an inclusive, science-based approach to design that engages diverse communities of stakeholders in deliberating trade-offs and co-benefits to find a pathway to implementation of equitable solution.
4. integrate science-based green infrastructure solutions into their projects that mitigate environmental hazards and support climate resilience and sustainability in their communities.

AIA25

Common SENSES:

Building Equity Through Sensor Data & Participatory Modeling

SA212

Saturday, June 7th 10:30 – 11:45am

1.25 HSW Learning Units

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Questions related to specific products and services may be addressed at the conclusion of this presentation.

Acknowledgement

This research was funded by the 2022 Latrobe Prize, awarded by the AIA College of Fellows.

Special thanks to the Jury:

Billie Faircloth, FAIA, Chair

Roger Schluntz, FAIA, 2022 Chancellor

Ronald Blitch, FAIA, Bursar

Dr. Malo Hutson

Alison Kwok, FAIA

Vivian Lee, FAIA

Dr. Upali Nanda, Assoc. AIA

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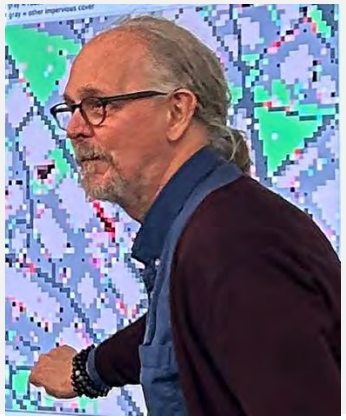
Speakers | Research team

Moderator

Michelle Laboy

Architecture

Panelists



Karl Allen

City of Chelsea

Amy Mueller

Environmental Engineering

Dan O'Brien

Urban Informatics

Moira Zellner

Participatory Modeling

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Course / Learning Objectives

- Explore the causes of **microspatial inequities** in exposure to environmental hazards in urban areas and how building projects can exacerbate or mitigate these inequities.
- Learn how to apply rules of thumb in designing **sensor networks** and approaches to interpreting data to characterize the variation in environmental hazards in and around your project sites.
- Examine an **inclusive, science-based approach** to design that engages diverse communities of stakeholders in evaluating trade-offs and co-benefits of various design scenarios
- Discover how to integrate science-based **green infrastructure solutions** into your projects to mitigate environmental hazards and support climate resilience and sustainability in your community

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Research Theme

Buildings ∩ Planetary Health and Human Health

Intent of the 2022 Latrobe Prize Theme

- **Establish that architecture** goes beyond the design of buildings to the creation of positive outcomes for people and communities – a direct connection to the theme of the 2019 Latrobe Prize
- **Prioritize the creation of knowledge** that supports the transformation of practice and an architect's ability to "achieve a zero-carbon, equitable, resilient, and healthy built environment" – a direct connection to the *AIA Climate Action Plan, The Climate Imperative*
- **Affirm research projects** that help Architect Practitioners and their Clients make wonderful architectural solutions that contribute to healthy and equitable communities
- **Affirm research projects** that help Architect Practitioners and their Clients realize solutions for climate action
- **Demonstrate research methods** that are valid, defensible, appropriate, and repeatable
- **Elevate research findings** for any building type that are usable and applicable to Architect Practitioners in design decision-making
- **Elevate research that Clients** will view as truly "value-added" as opposed to Architect's marketing speak
- **Align with the AIA** Research Agenda through a new, emerging field of interdisciplinary research
- **Demonstrate models** for interdisciplinary collaboration between Architect Practitioners, Clients, and individuals in fields such as environmental science, urban ecology, public health, and planetary health

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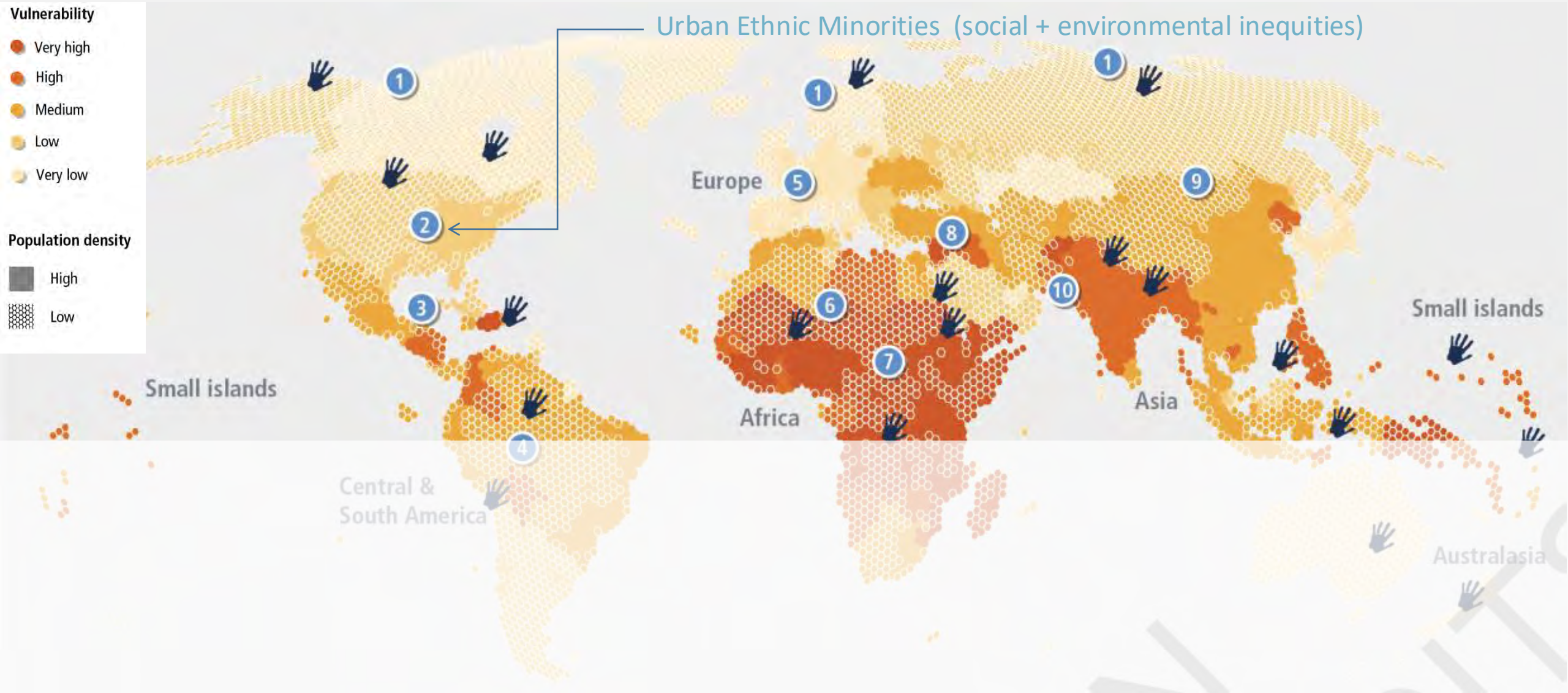
Global Inequities

Source: Working Group II. *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2022. https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_FinalDraft_TechnicalSummary.pdf.



Chelsea, MA

Intersection of Planetary & Human Health

Planetary Health

Human Health

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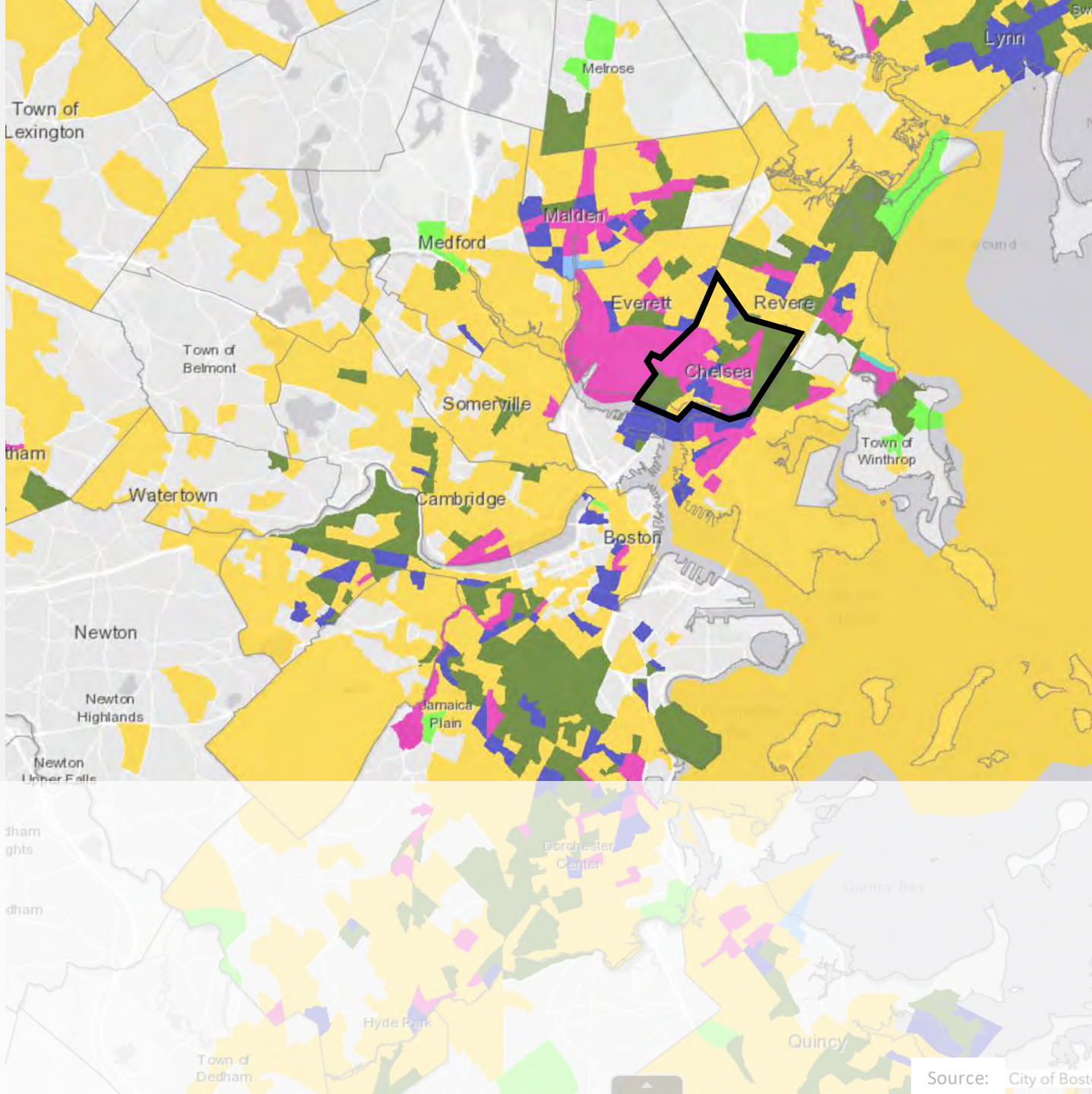
Regional Inequities

Boston Metropolitan Area



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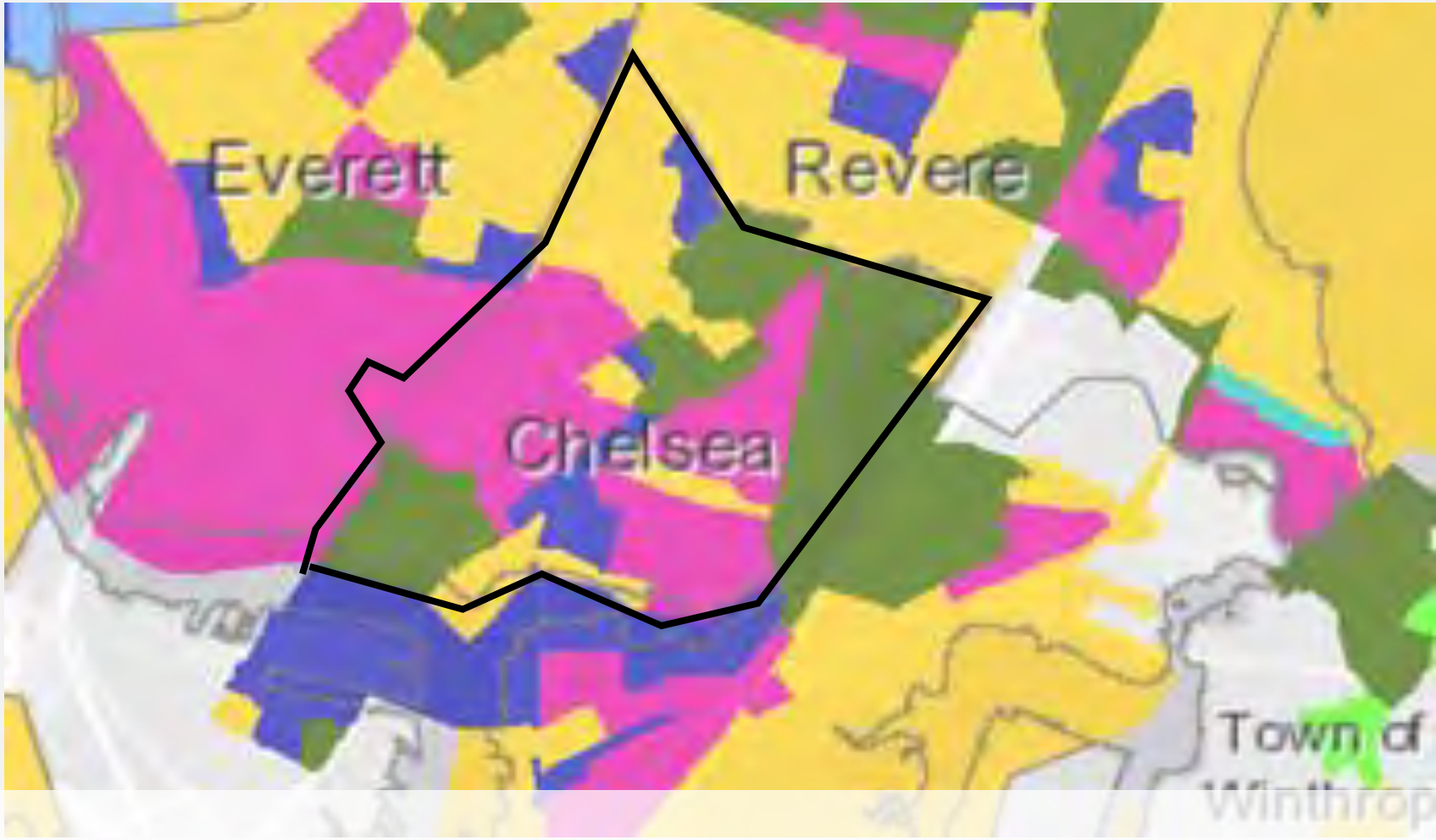
Local Inequities

Chelsea

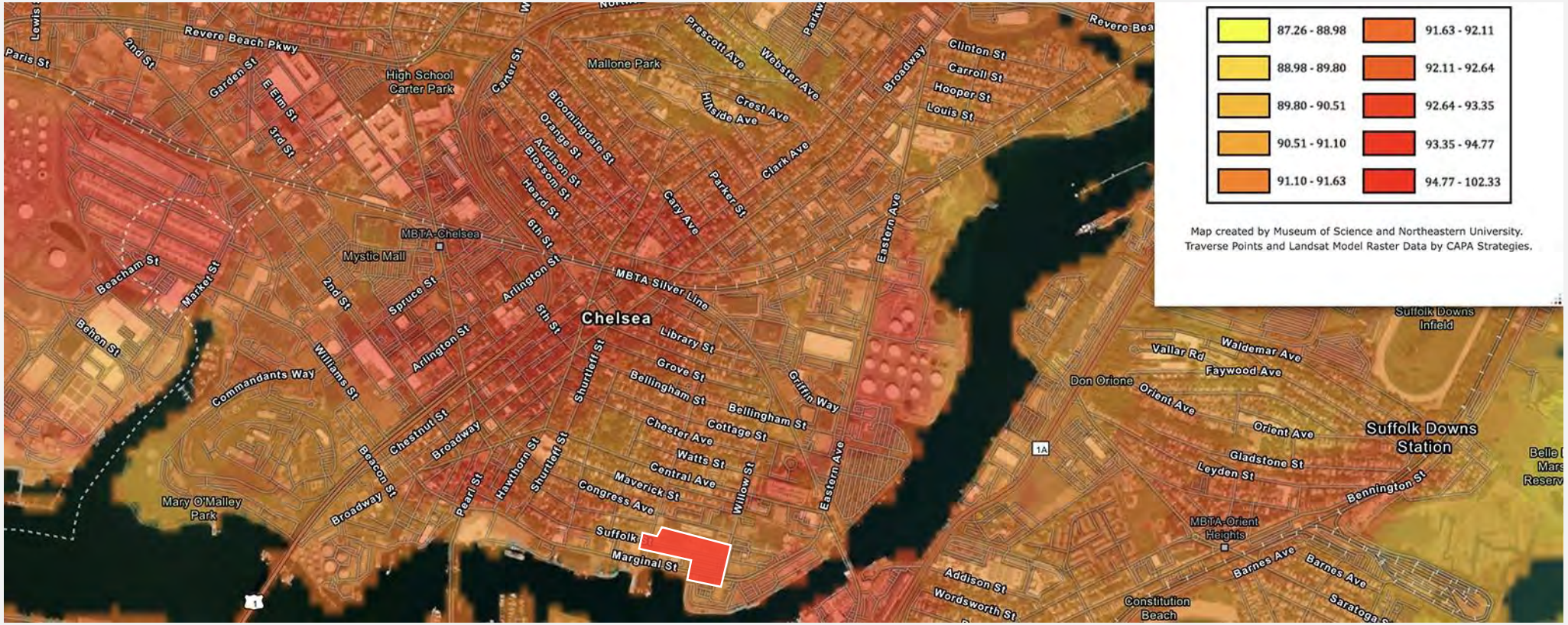


Microspatial inequities Air quality

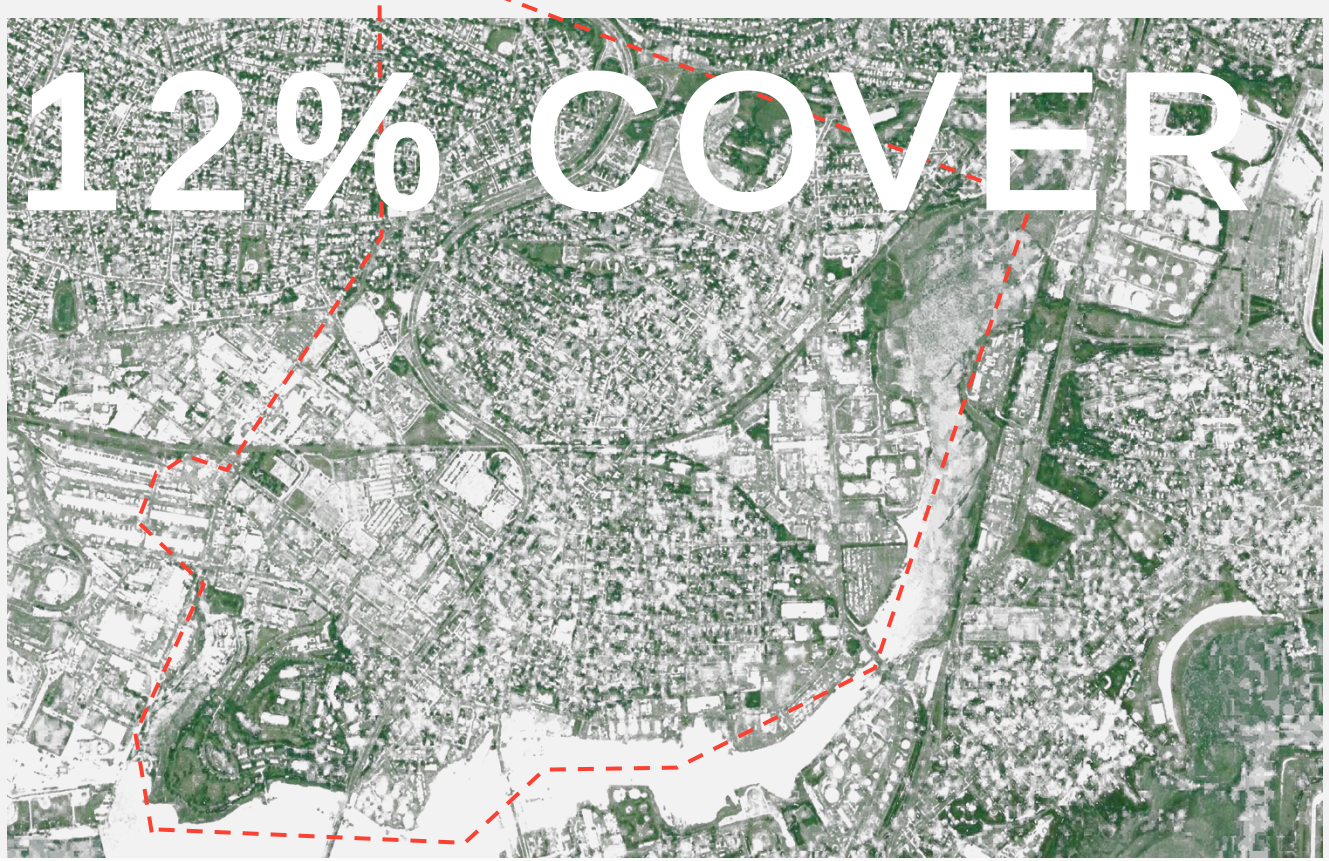

Flood Depths
0 - 2 Feet
2 - 4 Feet
> 4 Feet
Map Development:
Chris Watson,Ellen Douglas - UMass Boston
Paul Kirshen - Battelle
Chelsea

Microspatial inequities

Heat



Green-Blue infrastructure



- Mitigate heat, flood, and air pollution*
- **Public domain** – limited space
- **Dense environments** require **distributed networks** of development sites… without shifting **the cost or burden** to communities already disproportionately affected.

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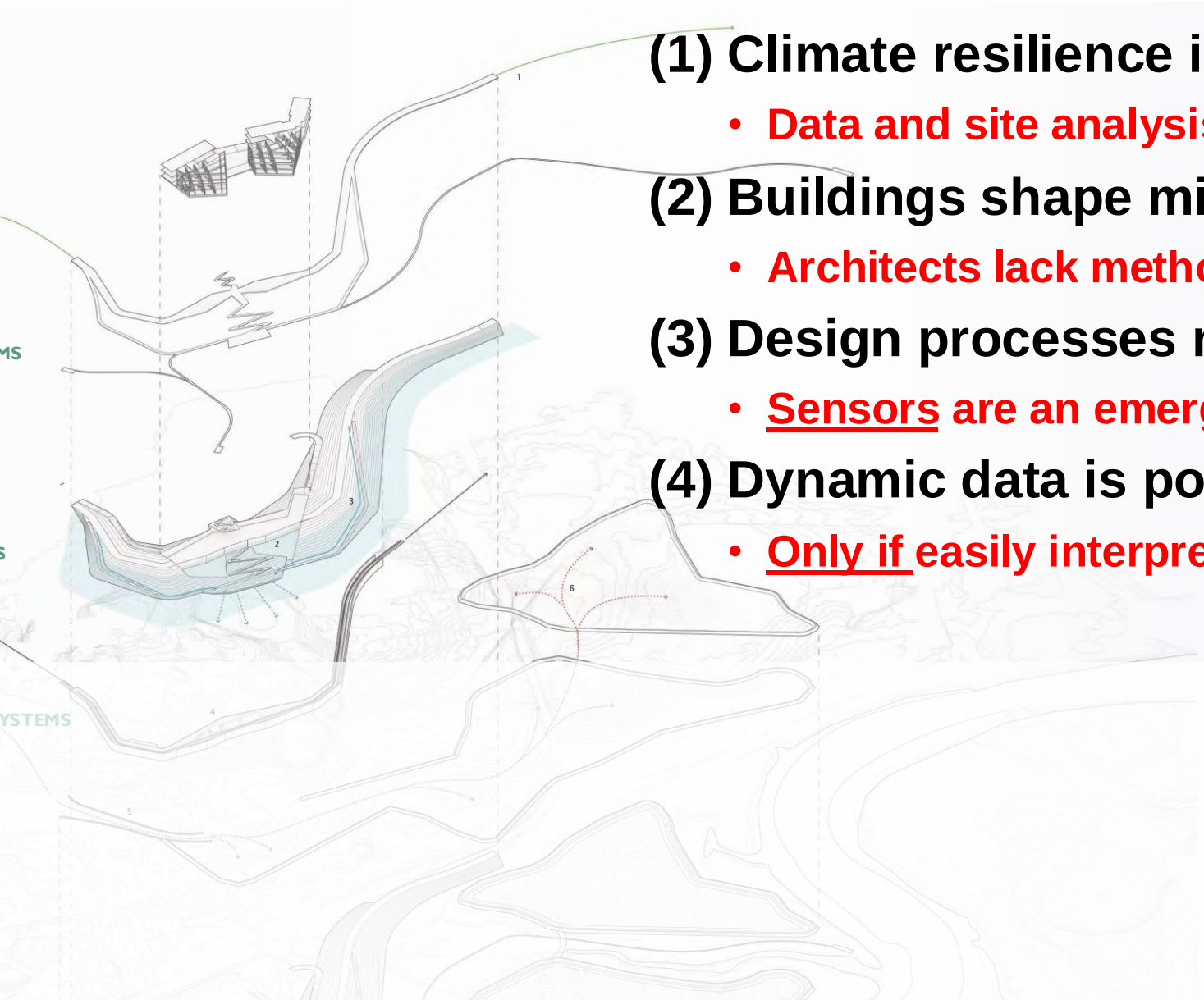
Challenges for Architects



(1) Climate resilience is both global and local

- **Data and site analysis does not yet reflect this.**

(2) Buildings shape microspatial inequities

- **Architects lack methods to measure and mitigate impacts.**

(3) Design processes need to be conscious of inequities

- **Sensors are an emergent but underutilized solution in design**

(4) Dynamic data is powerful

- **Only if easily interpreted to guide better community decisions.**

Part I

Research Problem

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Green Infrastructure development in Chelsea

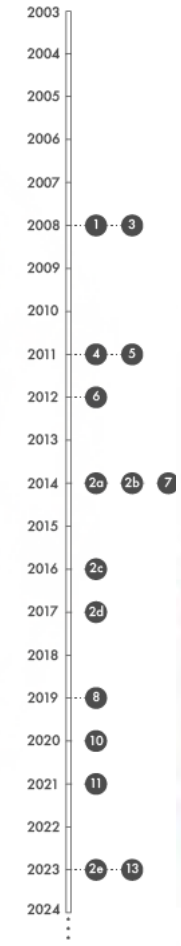
2003:

Open space: **331 acres** (23%)

Vegetated cover: **176 acres** (12%)

In 20 years (2023):

GBI added / restored: 27.5 acres (2%)



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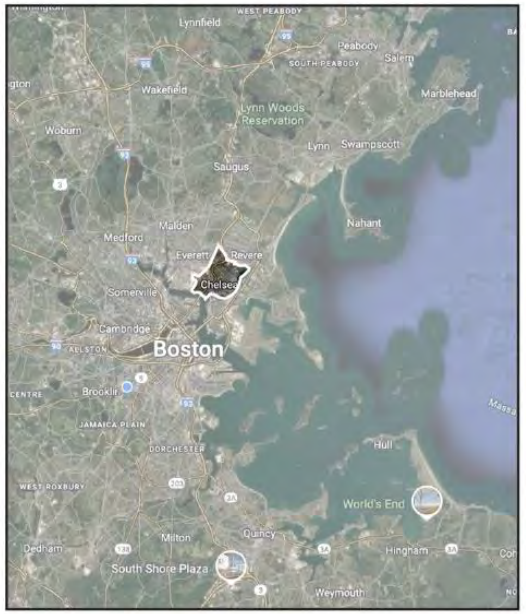
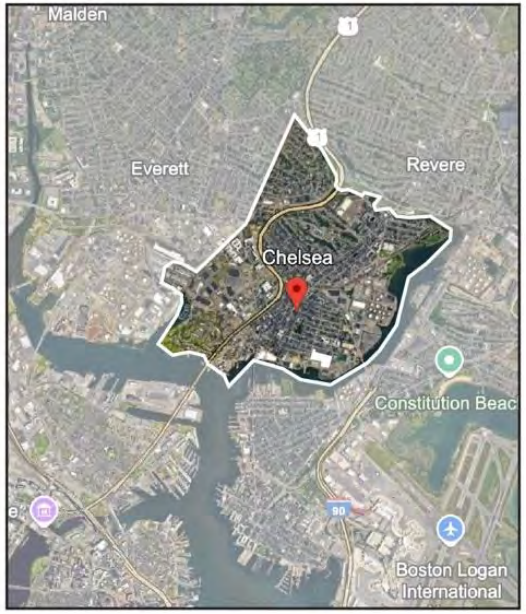
Aerial Photography + GIS

source: Google Earth, DHS, and other (varied resolution)



GREATER BOSTON REGION



CHELSEA

22 WILLOW ST

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Satellite images: Landsat 8

source: NASA

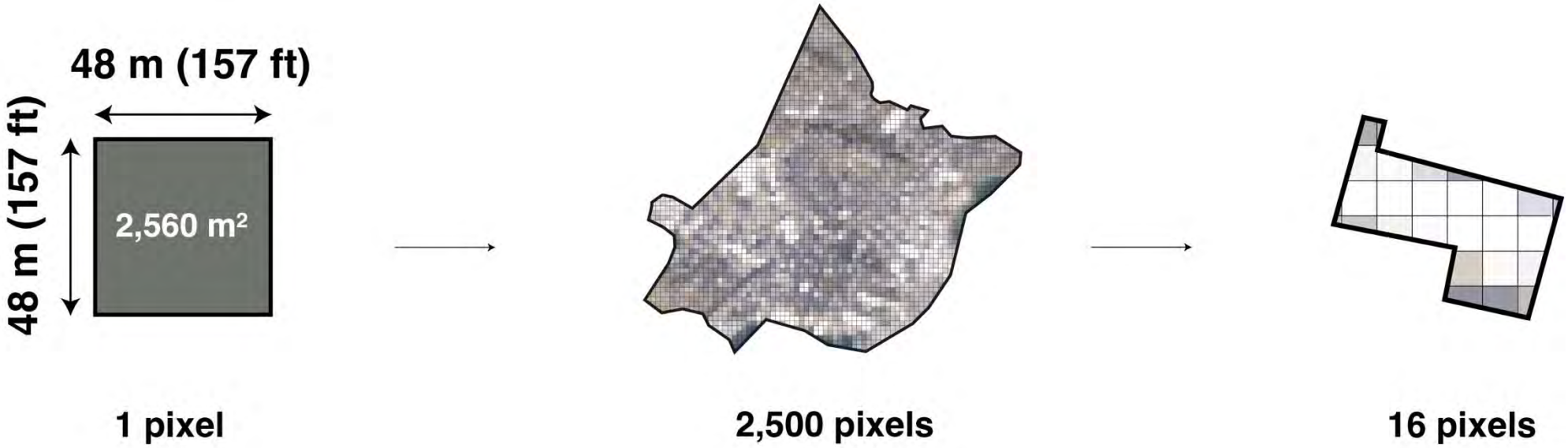
GREATER BOSTON REGION

CHELSEA

22 WILLOW ST

Satellite images: Landsat 8

source: NASA



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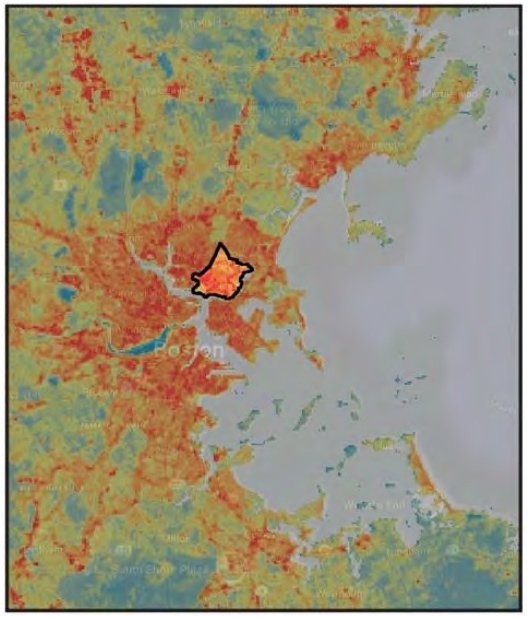
Proxies for Land Surface Temperature

source: LandSat (Boston region), Google Earth Engine (global)



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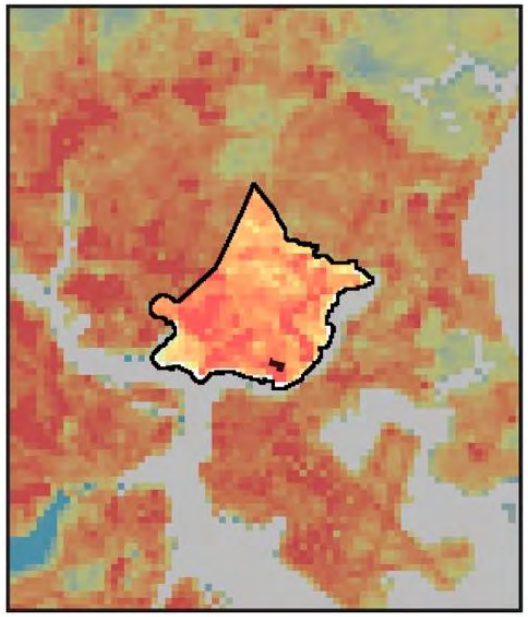

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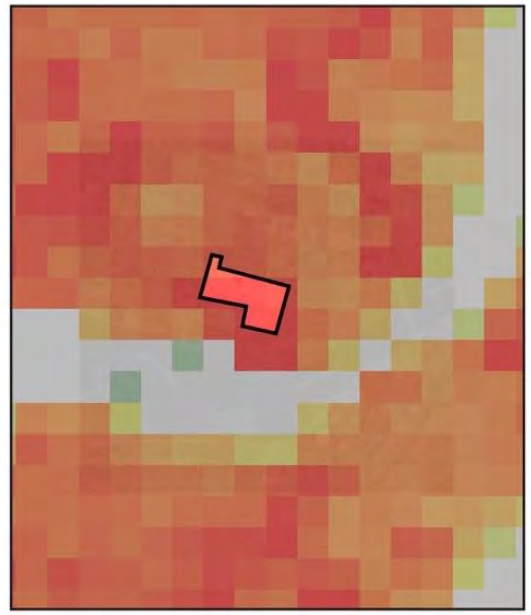

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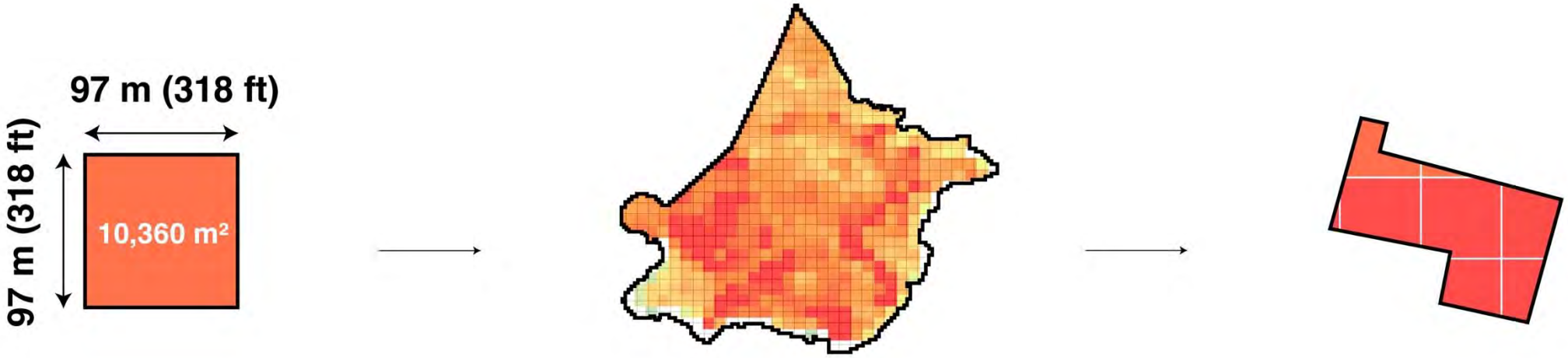
Proxies for Land Surface Temperature

source: LandSat (Boston region), Google Earth Engine (global)



1 pixel

615 pixels

3.5 pixels

871,525 pixels in Greater Boston

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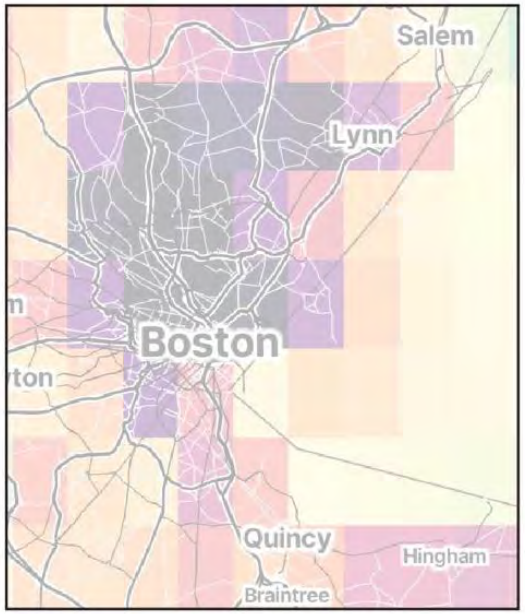
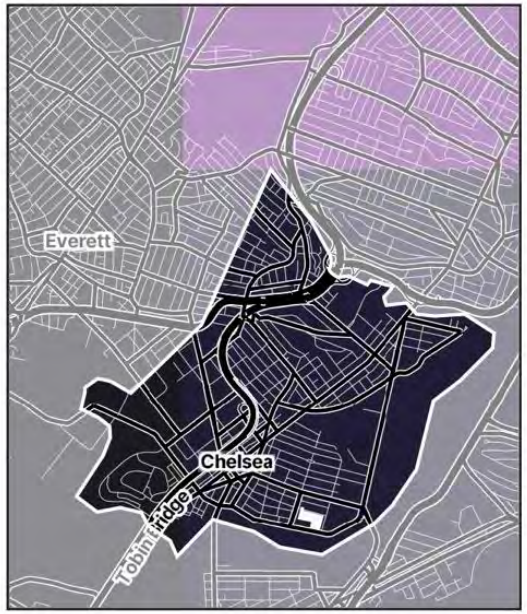
Air Quality

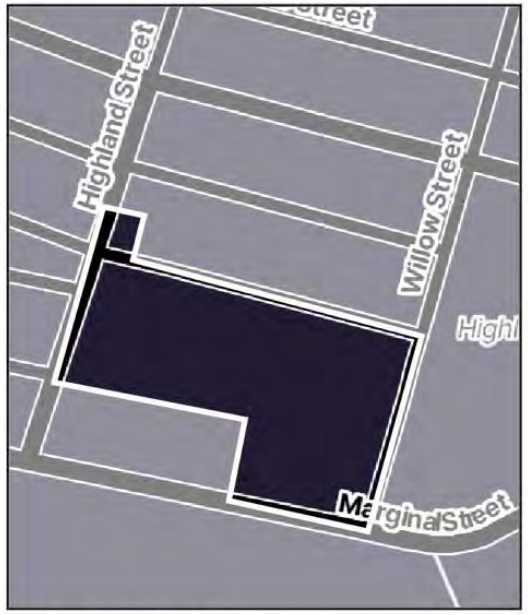
source: tempo.si.edu



GREATER BOSTON REGION



CHELSEA



22 WILLOW ST

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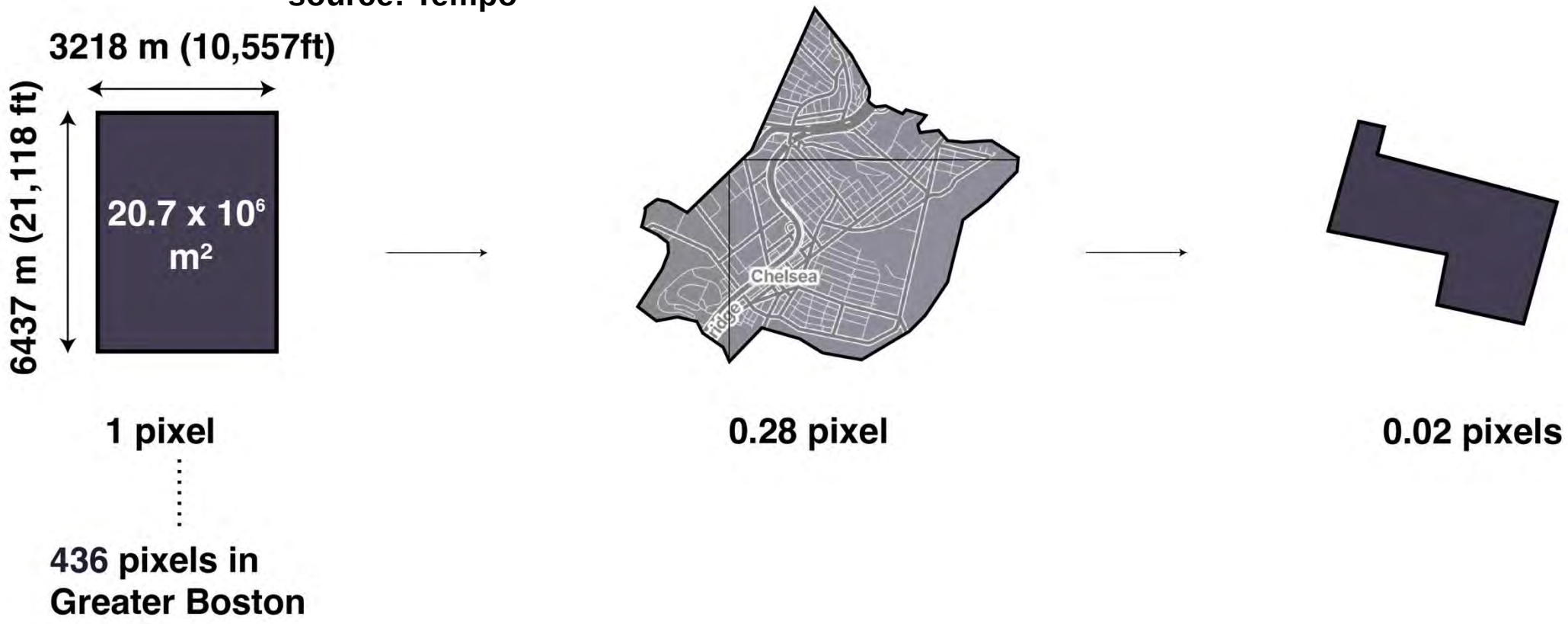
Air Quality (NO2)

source: Tempo



Limitations

- Remote-sensed measures are based on proxies.
- Coarse spatial measurement in some cases (e.g., air pollution).
- No access to daily, weekly, or seasonal rhythms.

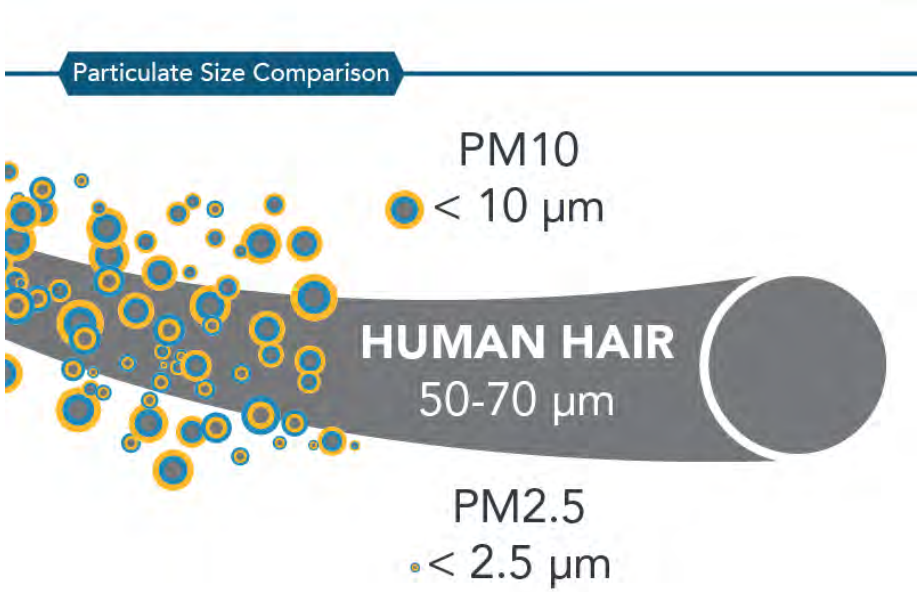
What questions might we want to ask?

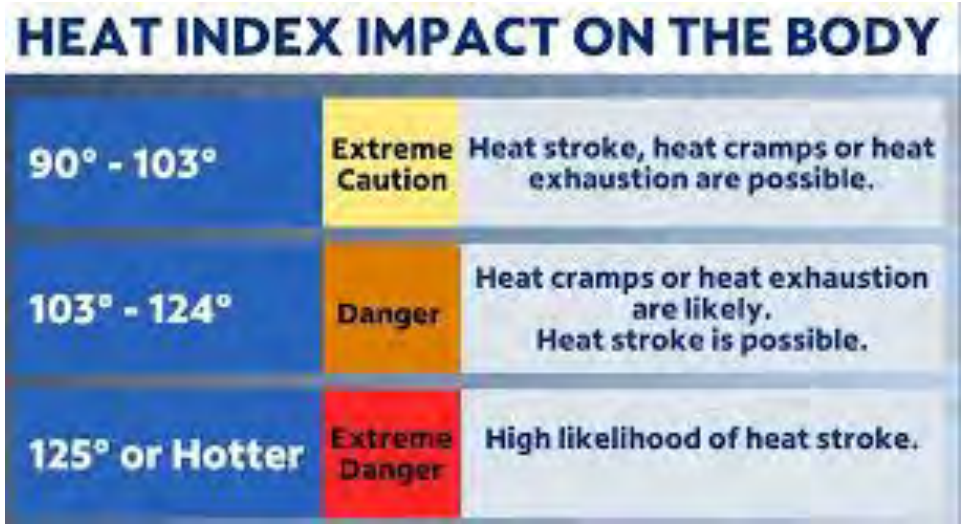
- Does post-construction look different than before? (“Before/after”)
- Are certain areas more affected? (“Spatial differences”)
- Are effects more pronounced at certain times? (“Seasonality”)

Opportunities & Limitations

- Highly local measurements – site specific!
- Affordable options for air quality, heat – but not noise, flooding, or all things we might care about
- Installation locations are critical for ensuring data are relevant to posed questions

In this study: particulate matter (PM) and heat index





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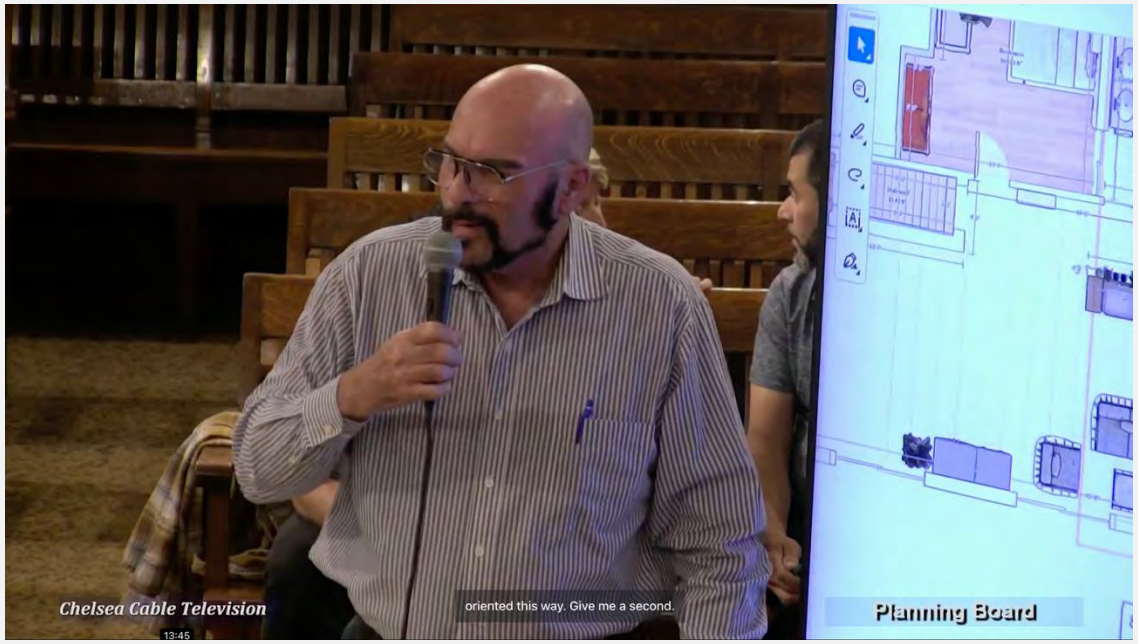
Making decisions for complex problems



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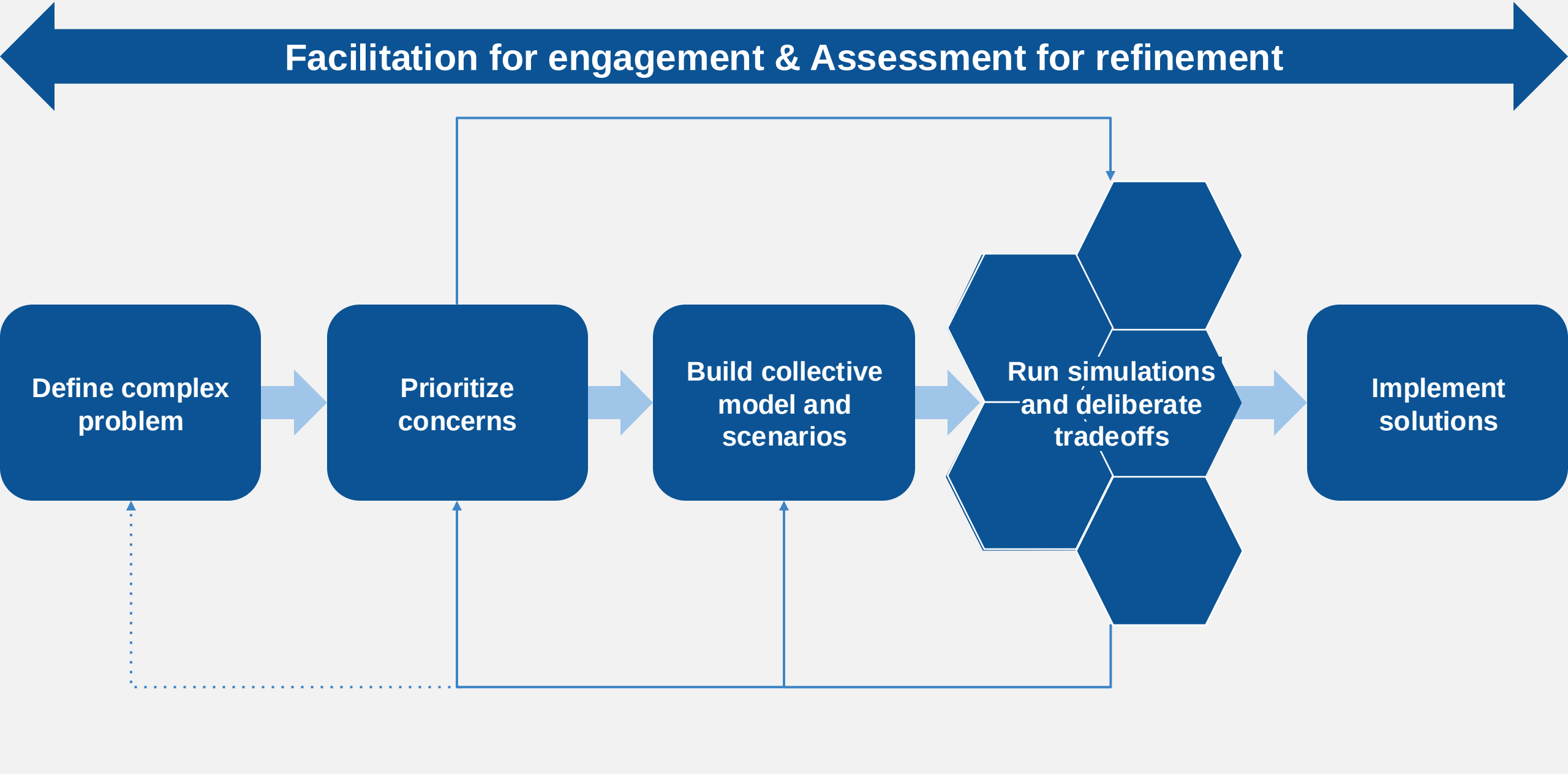
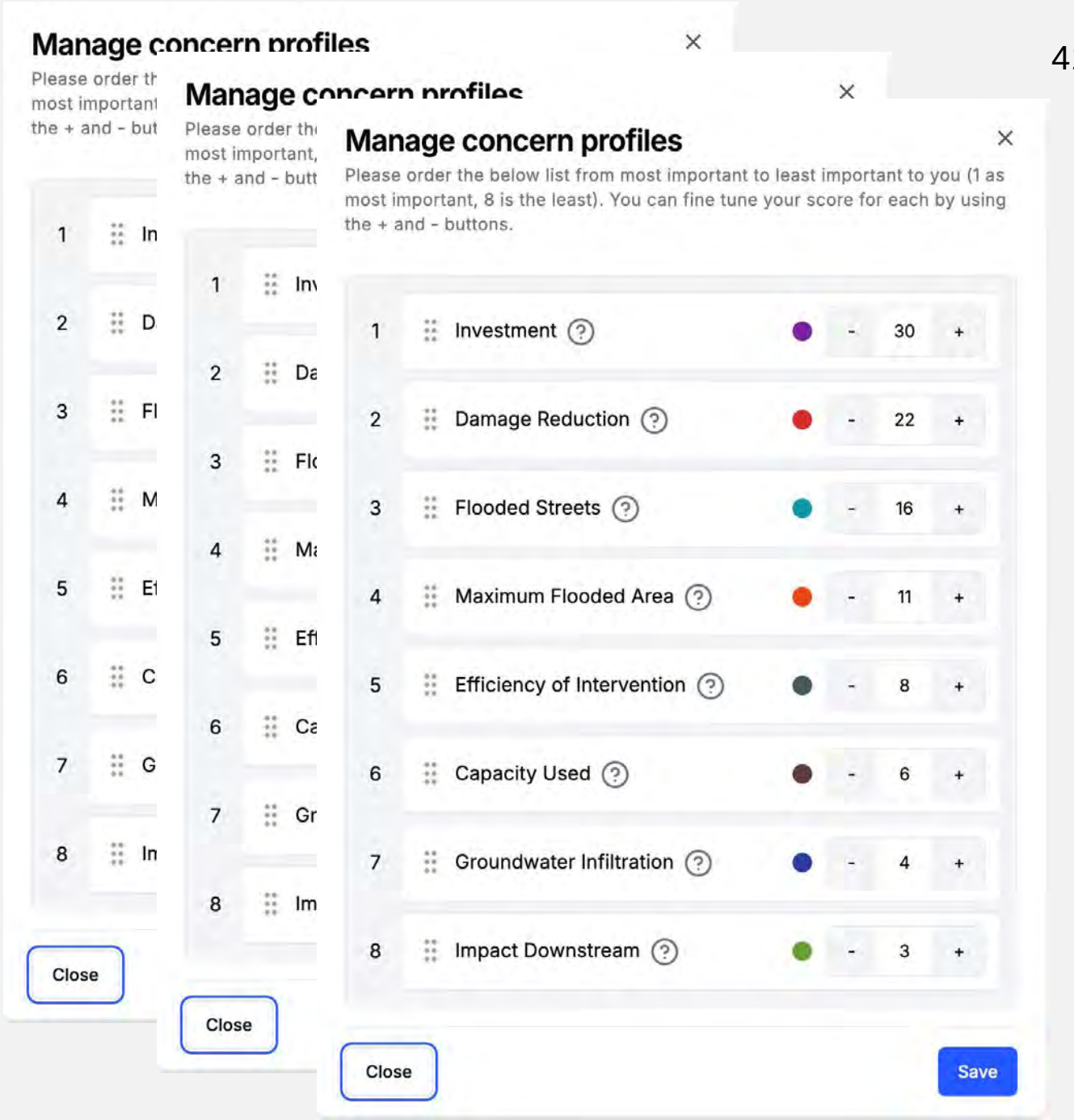
Participatory Modeling

“A purposeful learning process for decision-making that engages the implicit and explicit knowledge of stakeholders to co-create formalized and shared representation(s).”

Gray et al. (2018); Jordan et al. (2019); Sterling et al. (2019)

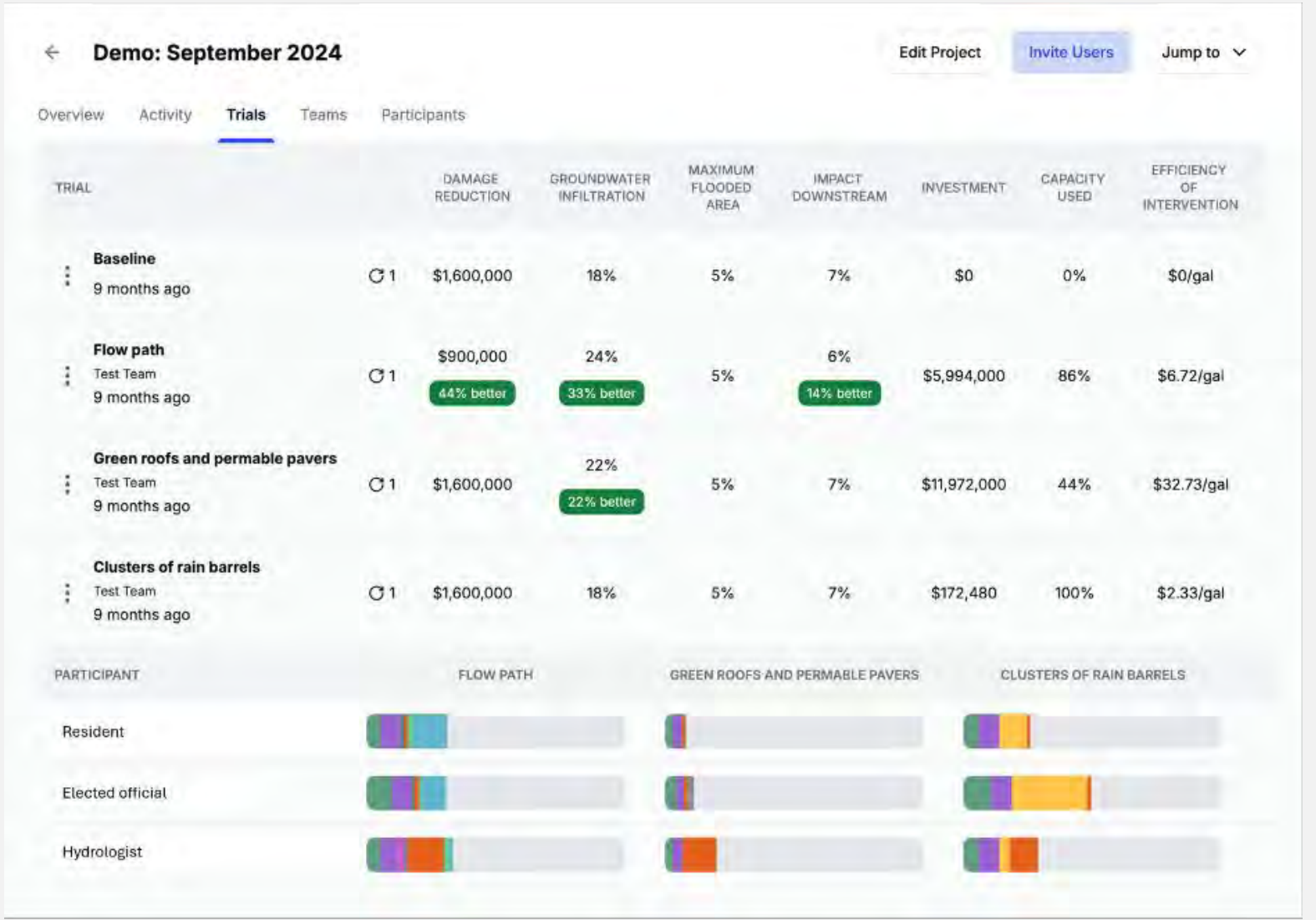

Facilitation for engagement & Assessment for refinement
Define complex problem
Prioritize concerns
Build collective model and scenarios
Run simulations and deliberate tradeoffs
Implement solutions

Fora.ai: Prioritize



Fora.ai: Build and simulate

Fora.ai: Assess, deliberate, and iterate!



Part II

Pilot Site

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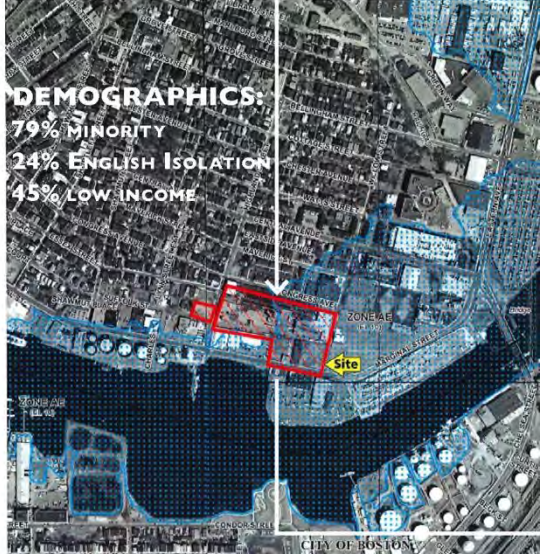
Pilot Site



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Before


(a) Before redevelopment


(b) Before redevelopment

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After


(c) Courtesy of RODE Architects


(d) Courtesy of RODE Architects

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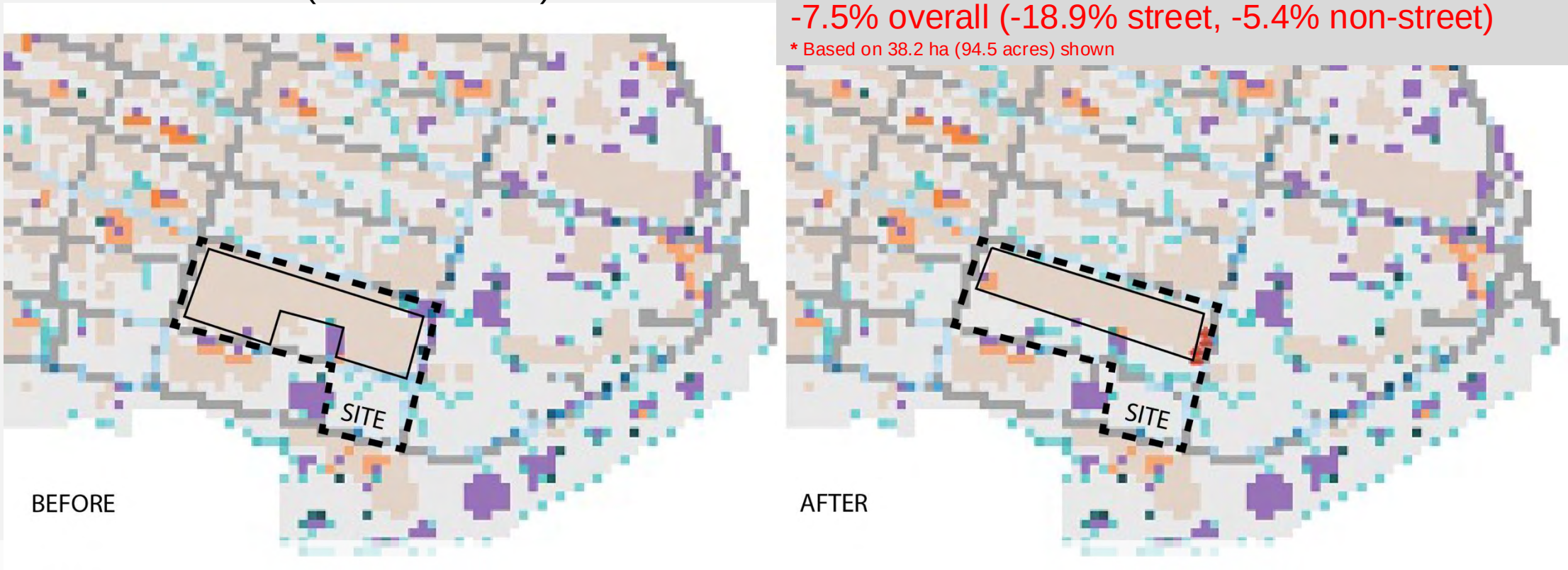
Flood modeling in L-GrID

Pixels: 10m x 10m (32.8 ft x 32.8 ft)

Reduction in flooded area* post-redevelopment:
-7.5% overall (-18.9% street, -5.4% non-street)
* Based on 38.2 ha (94.5 acres) shown



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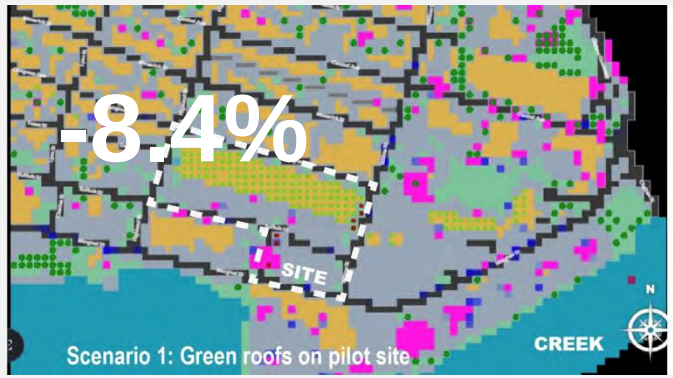
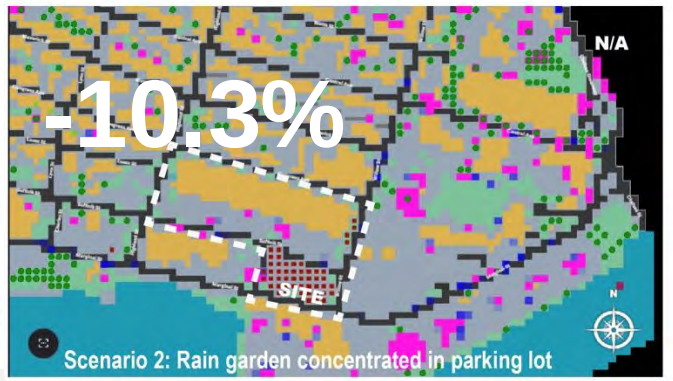
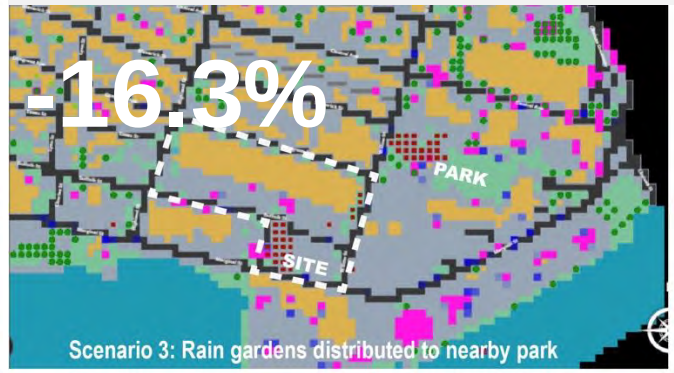
GROUP 1







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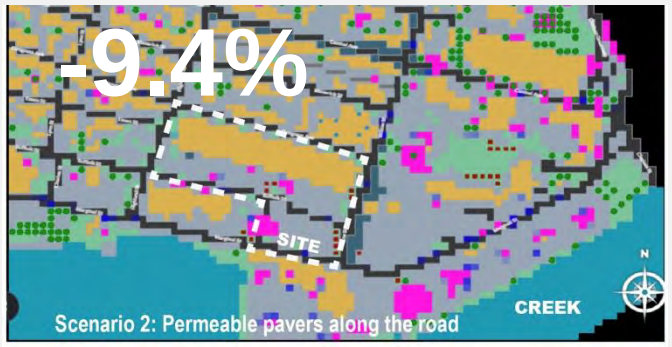

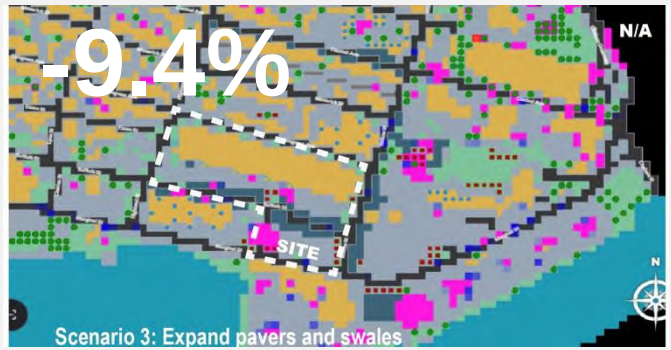

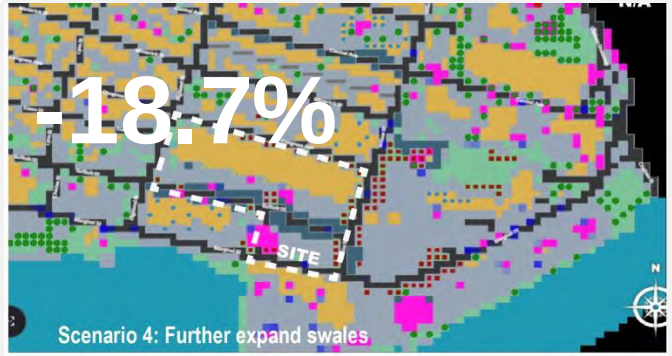

- Half of improvements by on-site G
- Half by GI in surrounding fabric

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Iterations lead to decentralization

- Consistently started with concentration **“on site”**
- Followed by concentration in **“trouble spots”** (sponge)
- Moved towards decentralization, **“patches” or “stitching”**

Emergence of ‘Signaling’

- Centralization’s aesthetic: signaling investments doing more
- Decentralization reframed as **cooperation,** recruiting even the smallest sites or interventions regardless of impact

Temp|RH sensors locations

Key questions:
1. What is radius of effect of the site?
2. How variable is heat index across the neighborhood?

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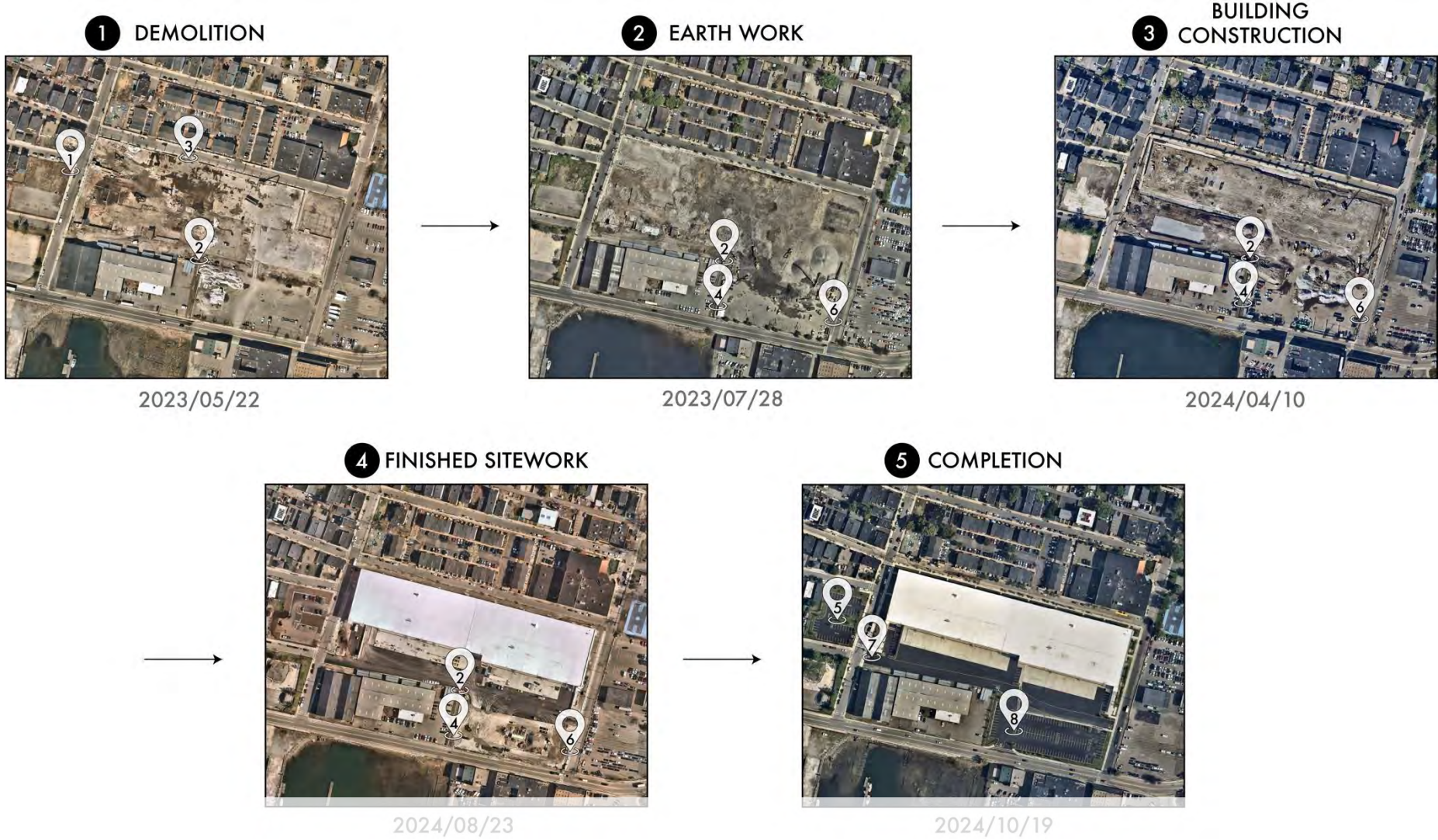
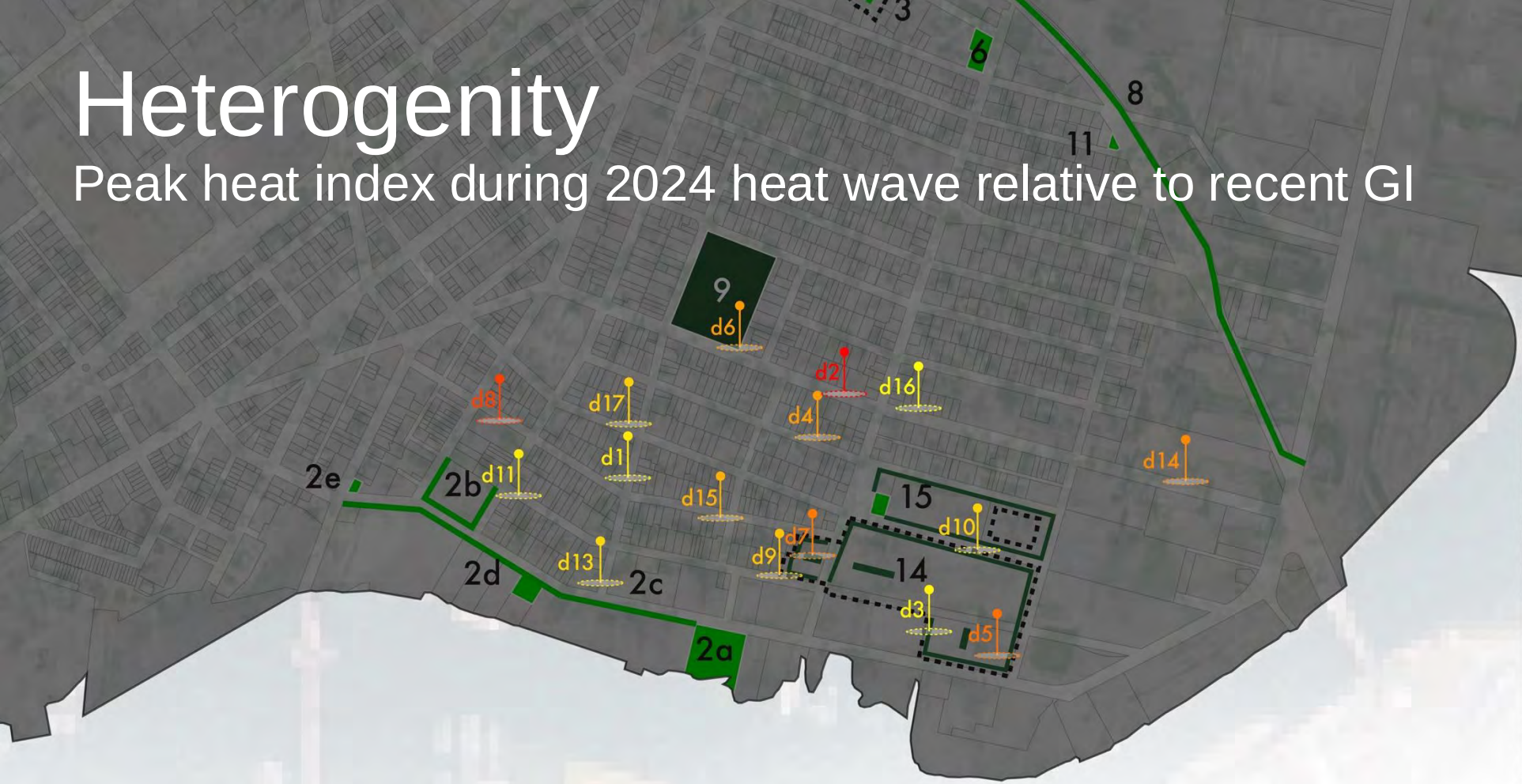
AQ sensor locations

Key questions:
* Before & after
* Effects of green elements and traffic after



Heterogenity

Peak heat index during 2024 heat wave relative to recent GI



Sensor	Peak Average Heat Index
d16	101.1
d3	101.6
d1	101.9
d11	101.9
d13	102.8
d10	102.9
d17	103.3
d9	103.8
d15	104.2
d4	104.5
d6	104.5
d14	104.8
d7	105.0
d5	105.2
d8	105.9
d2	106.9

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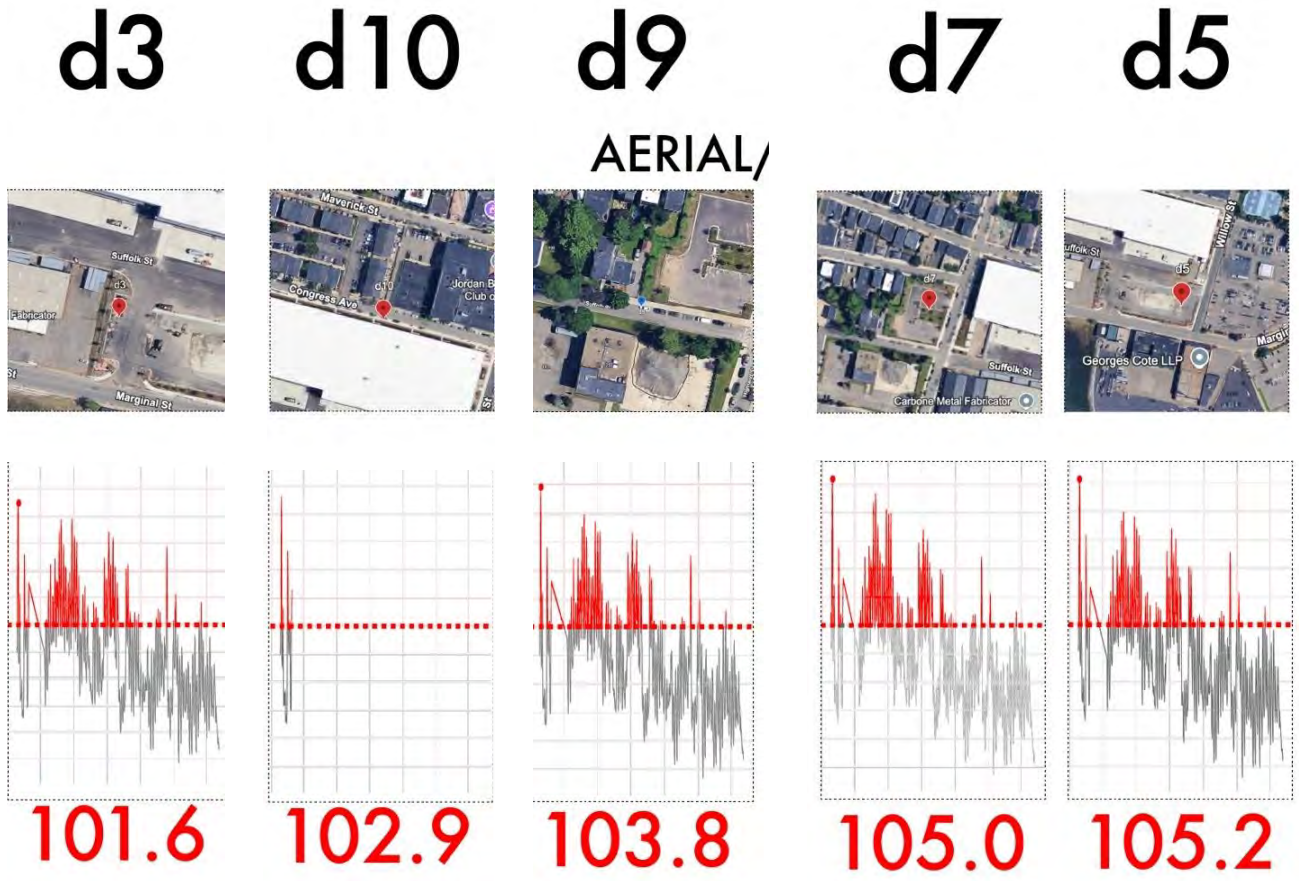
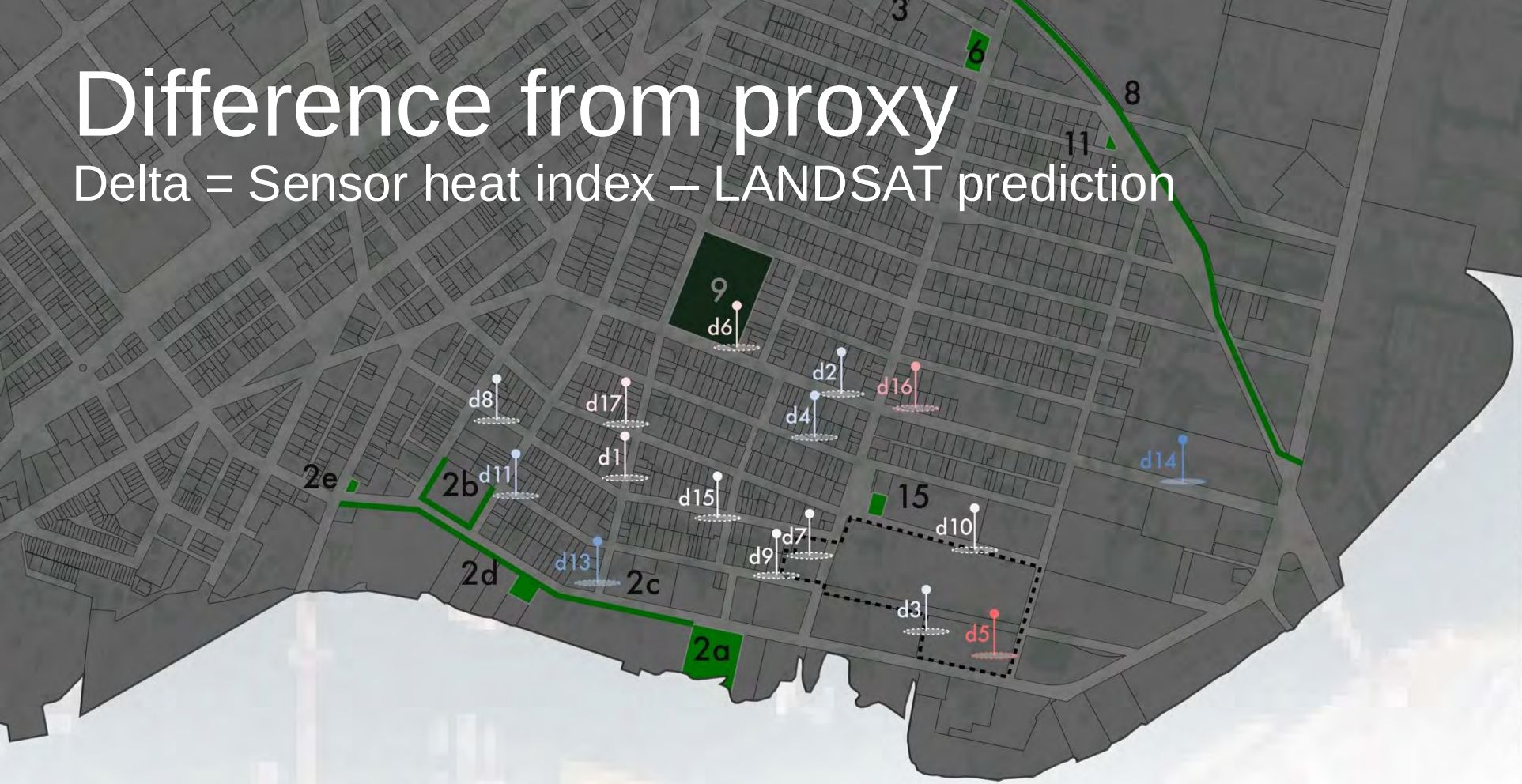
Heat: variability at 22 Willow



Difference from proxy

Delta = Sensor heat index – LANDSAT prediction



Sensor	Smallest to Largest Delta
d14	21.0
d13	22.5
d11	25.5
d4	25.9
d2	26.1
d3	26.9
d8	27.3
d15	27.4
d9	27.8
d7	28.0
d10	28.0
d1	28.3
d17	28.6
d6	28.6
d16	29.3
d5	34.6

Below-average difference

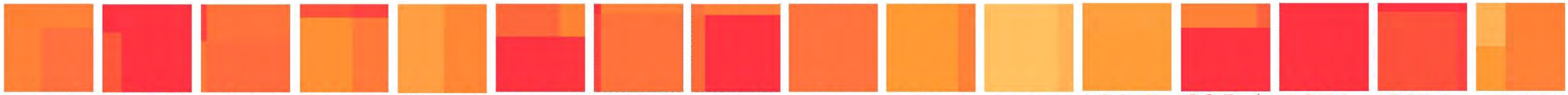
Average difference →

Above-average difference

d16	d3	d1	d11	d13	d10	d17	d9	d15	d4	d6	d14	d7	d5	d8	d2

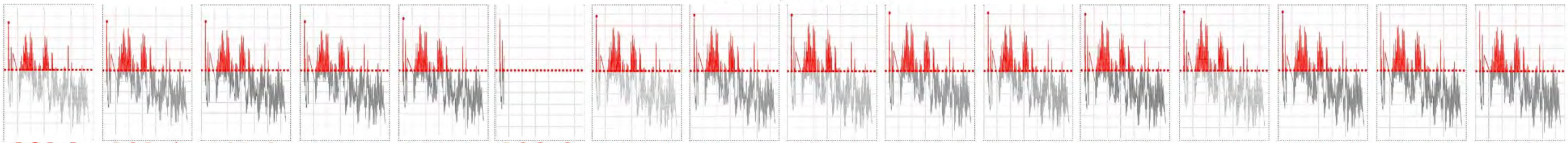
AERIAL/CONTEXT

SATELLITE/LAND SURFACE TEMP



106.0	105.4	106.1	102.8	100.4	114.6	105.9	105.9	104.6	105.6	100.7	98.8	105.4	107.1	107.1	104.7

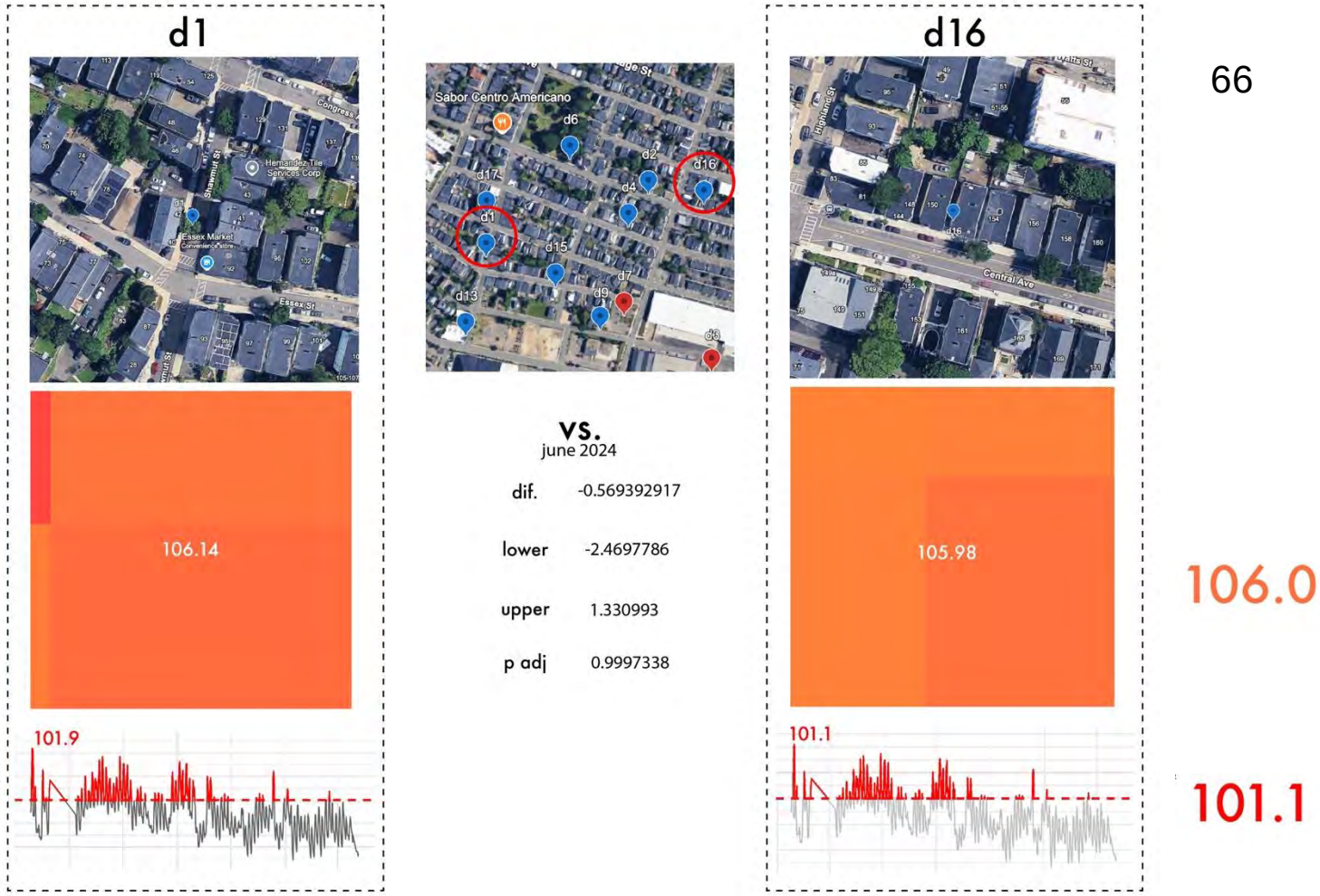
SENSOR/HEAT INDEX



101.1	101.6	101.9	101.9	102.8	102.9	103.3	103.8	104.2	104.5	104.5	104.8	105.0	105.2	105.9	106.9

PEAK HEAT INDEX
2024

Expected similarities



Landsat 106.1 — 106.0

Sensor Peak 101.9 — 101.1

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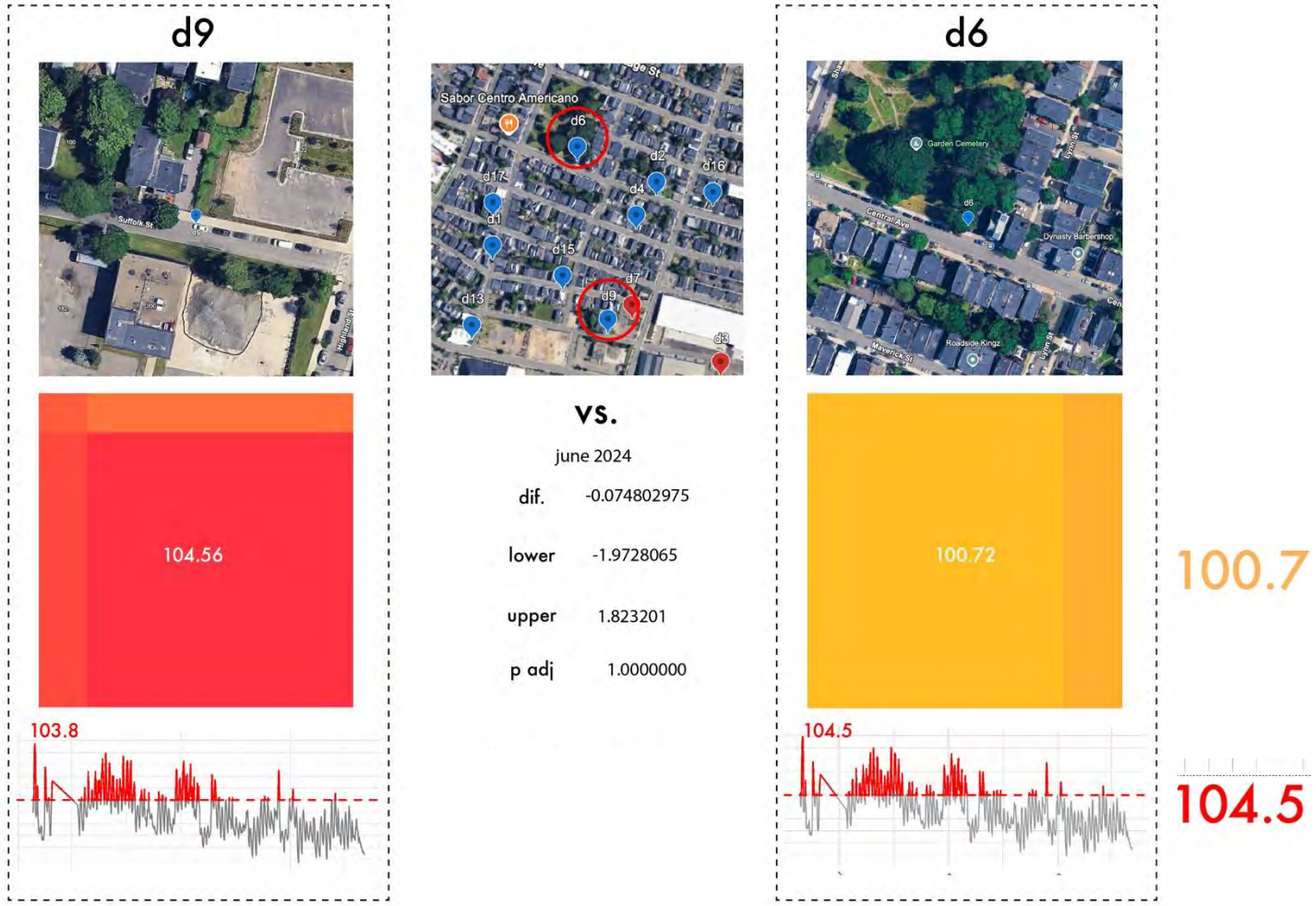
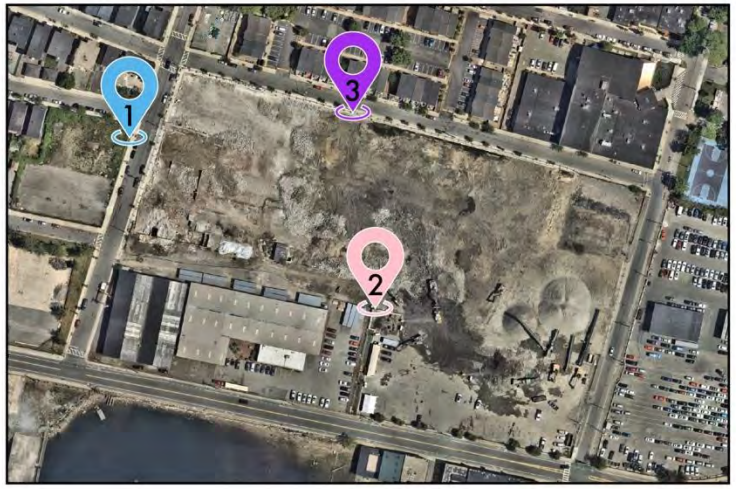
Unexpected similarities

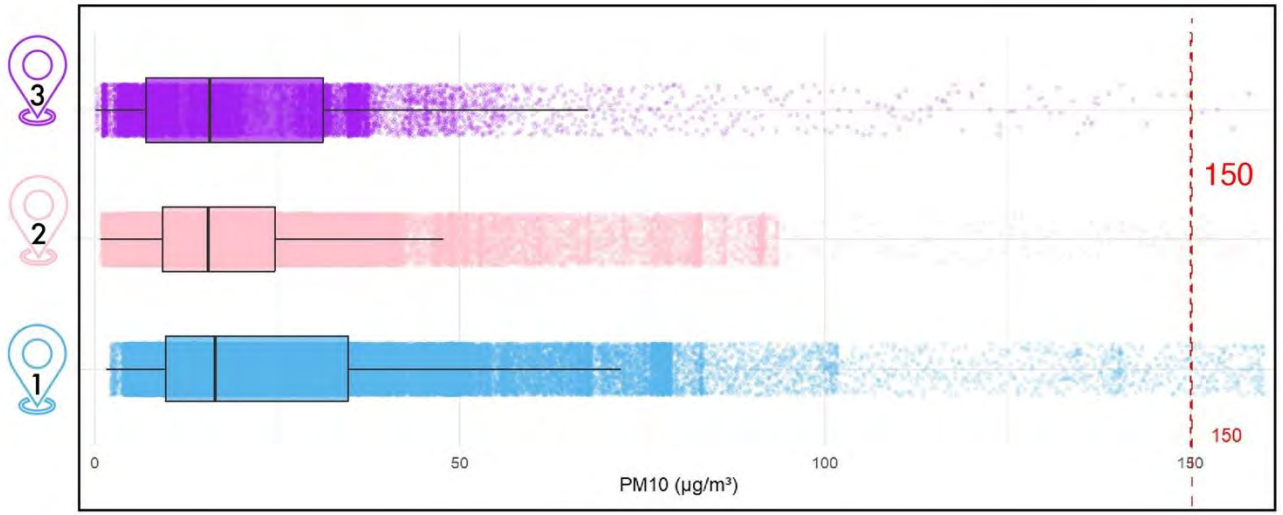


PM10

2 DURING BUILDING CONSTRUCTION

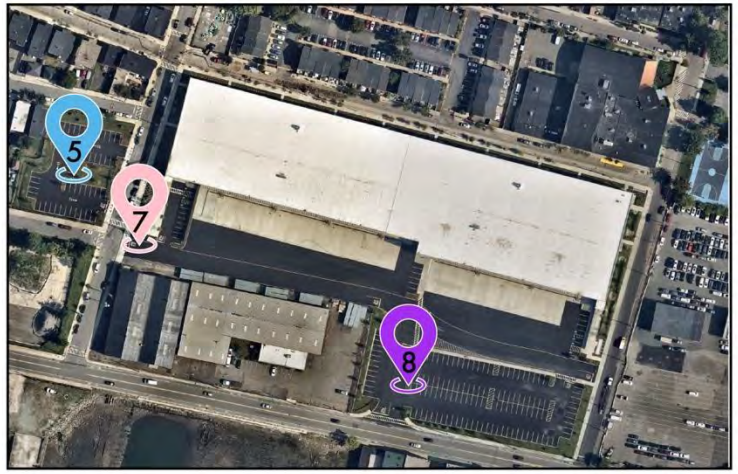
2023/07/28

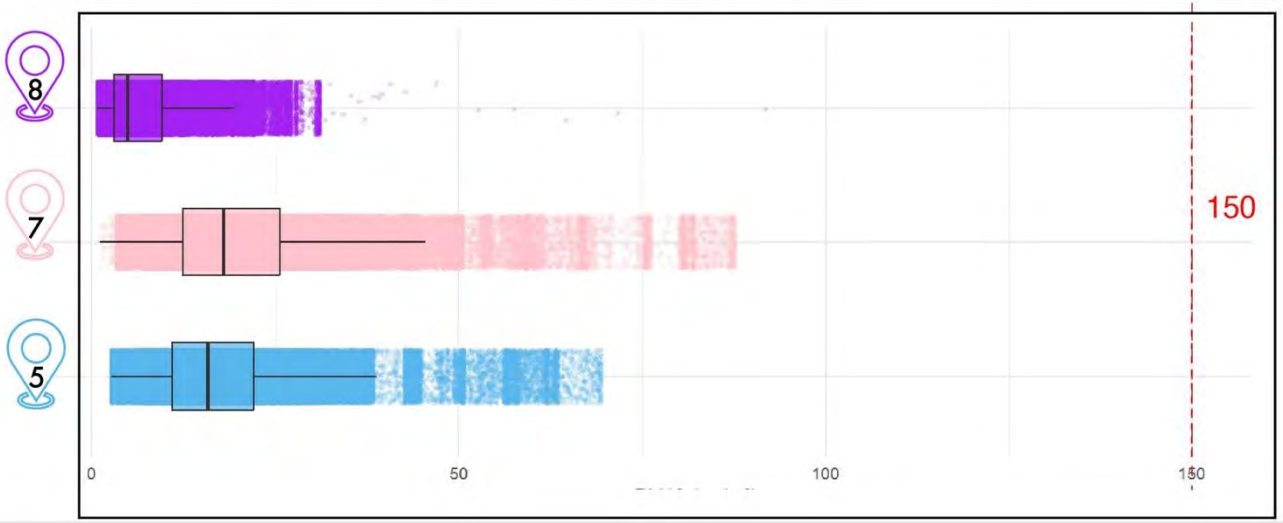




5 AFTER COMPLETION

2024/10/19





PM 10 LEVELS

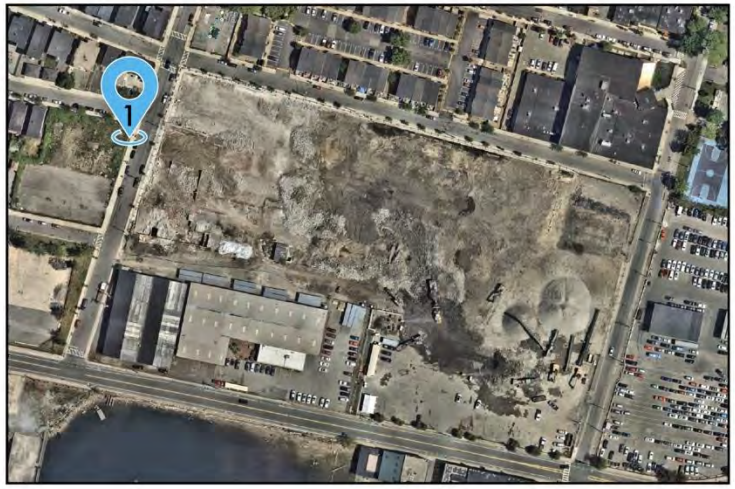
PM10

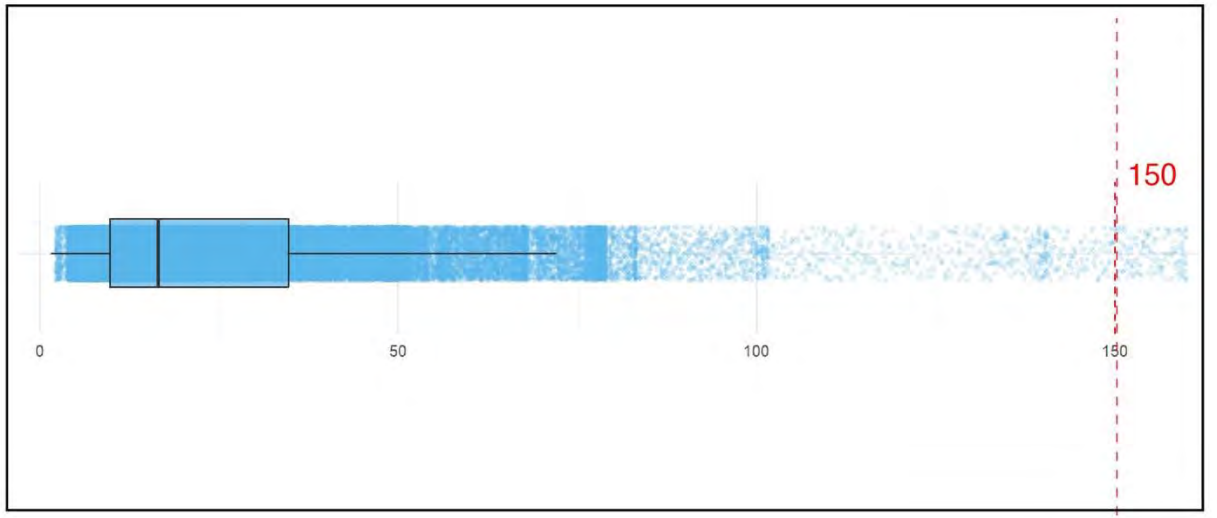
2

SENSOR 1

DURING BUILDING CONSTRUCTION

2023/07/28



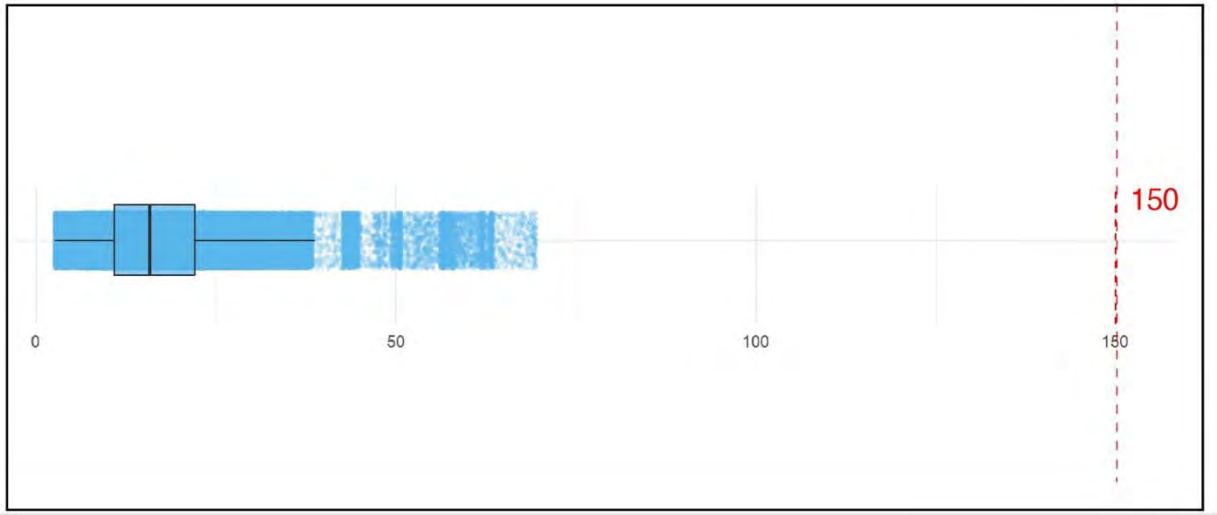


5

SENSOR 5

AFTER COMPLETION

2024/10/19



PM 10 LEVELS

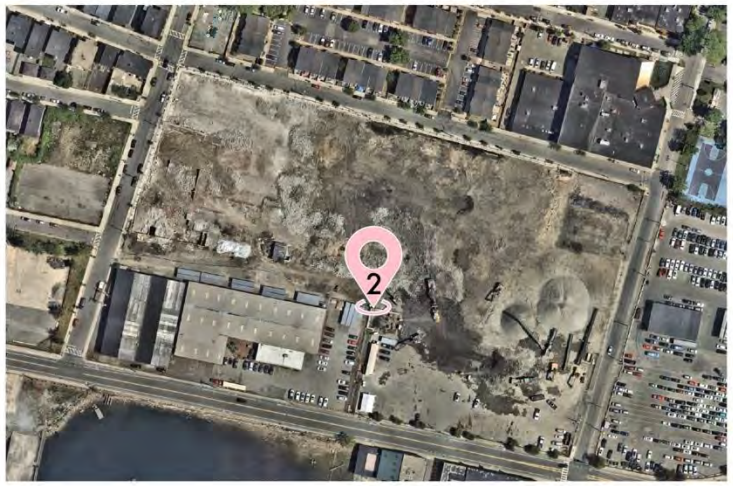
PM10

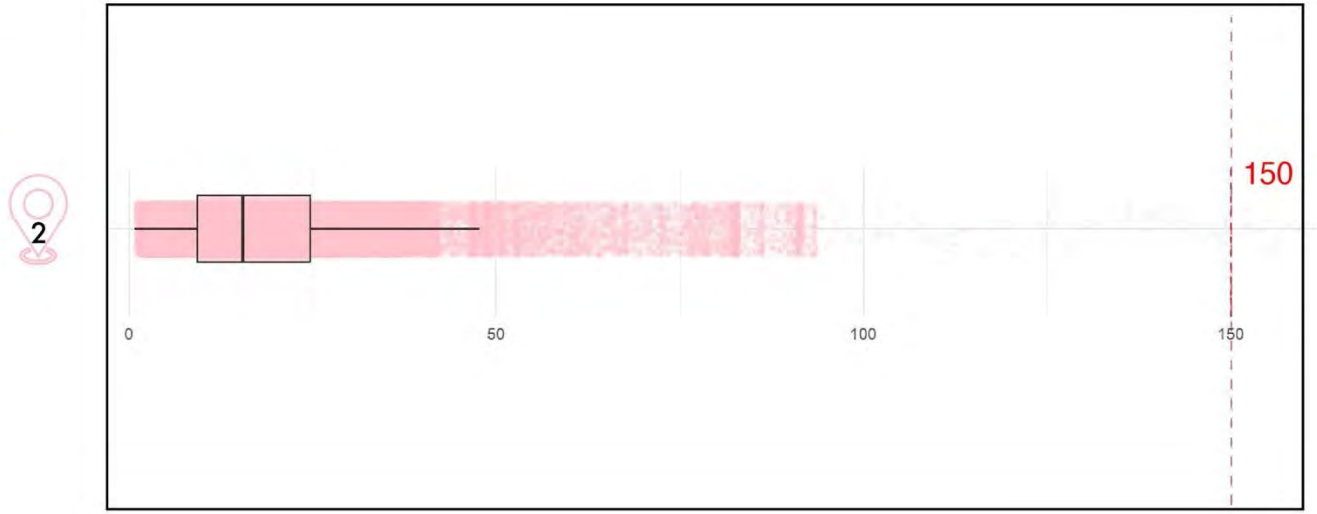
2

SENSOR 2

DURING BUILDING CONSTRUCTION

2023/07/28



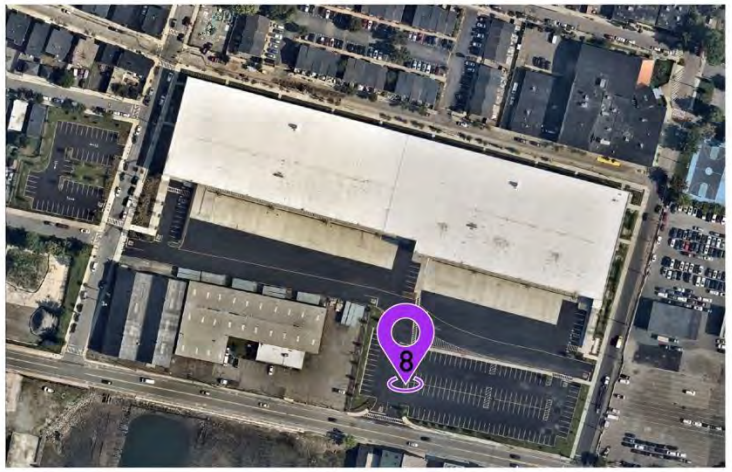


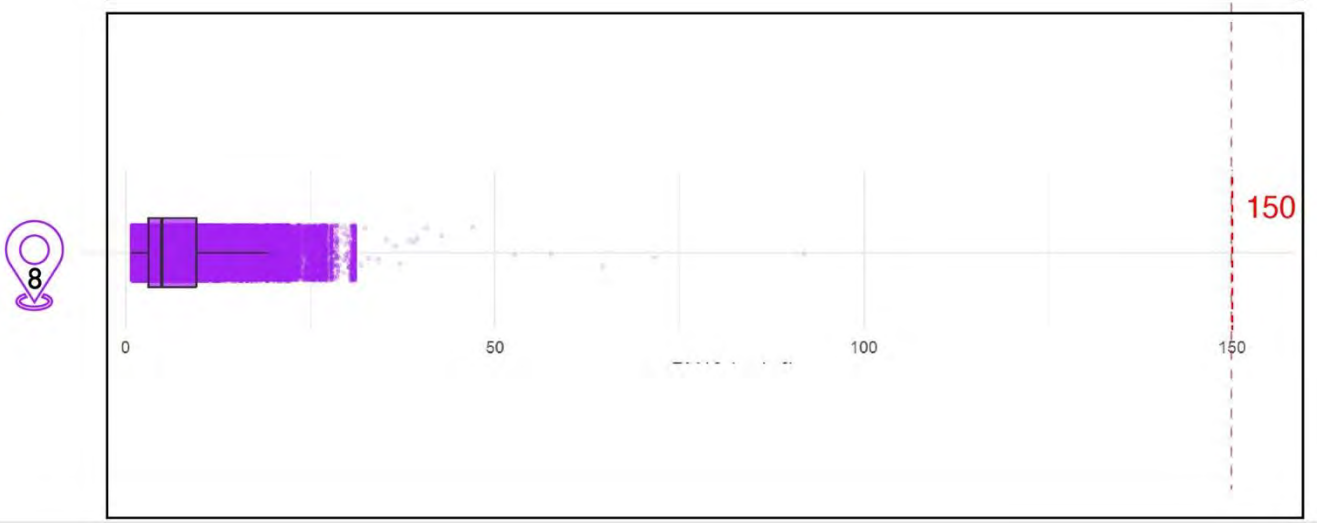
5

SENSOR 8

AFTER COMPLETION

2024/10/19





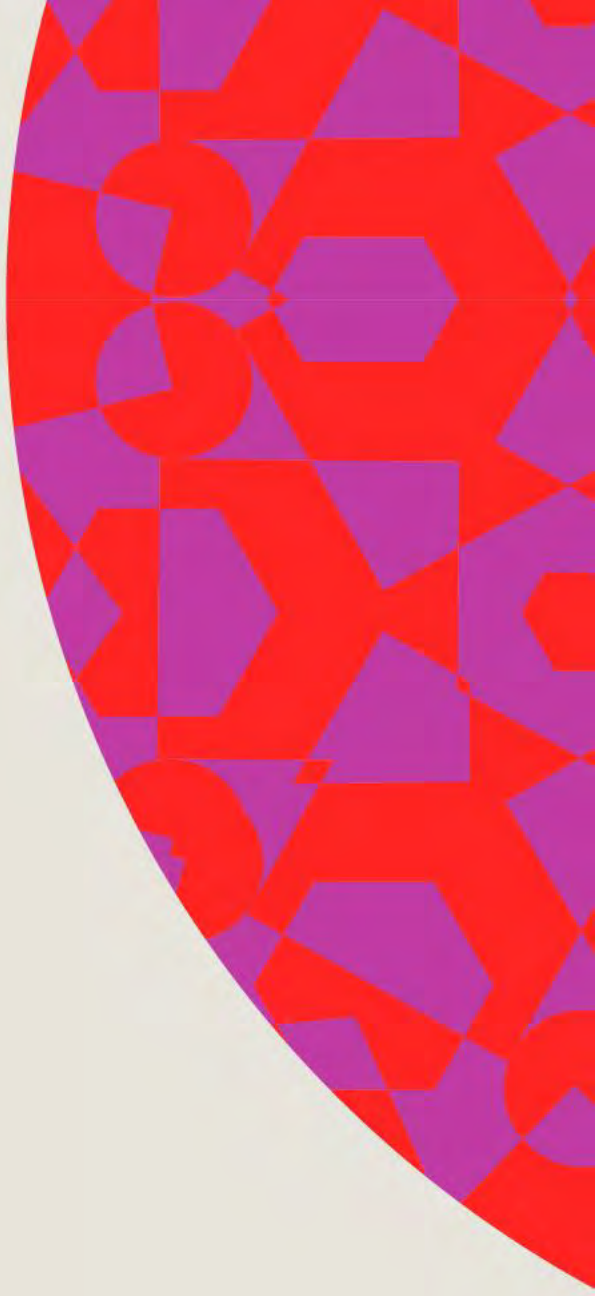
PM 10 LEVELS

Conclusions

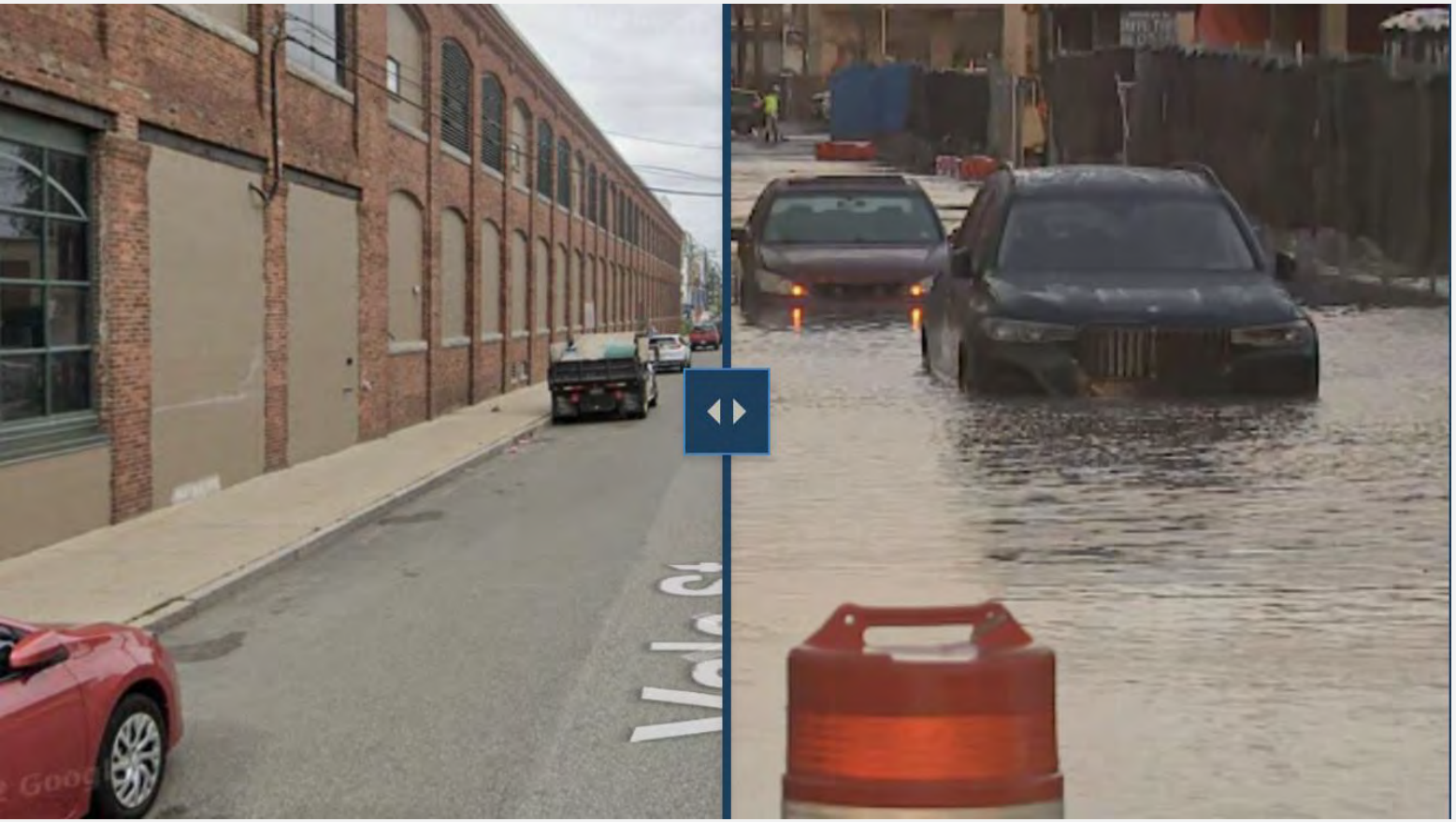
- Microspatial heterogeneity is apparent for both air pollution and heat.
- Air pollution is much worse during construction.
- Sensors provide superior information to remote sensing, especially for air pollution.

Part III

Envisioning West Chelsea



West Chelsea Transit Oriented Development



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Community-based Design Studio + Participatory Modeling Course

COMMUNITY WALK

CITY PLANERS AND COUNCILORS

UNDERSTANDING NEEDS

SURVIVAL CENTER

MODELING WORKSHOP

WITH FORA.AI

DESIGN REVIEWS

LA COLABORATIVA

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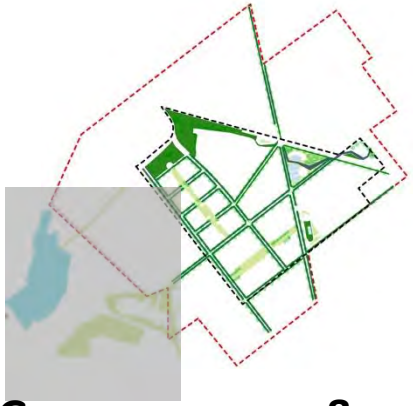
Planning with community priorities

PRESERVE INDUSTRIAL USE
& CREATE WALKABLE STREETS

ELEVATION CHANGES
PATHS FOR WATER
FOR CONTROLLED FLOODING

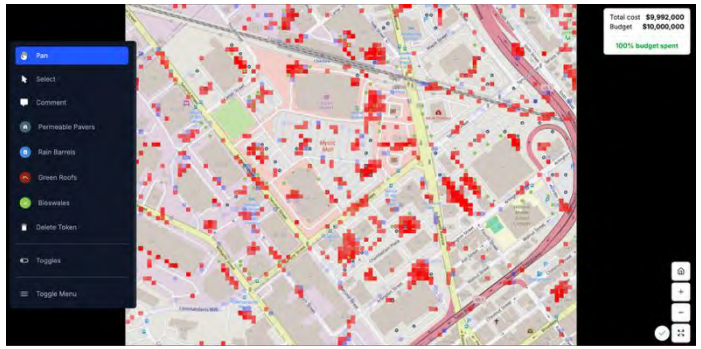


GREEN CORRIDORS &
WATERFRONT ACCESS
6% GI STREETS|PARKS
24% GI POPS

HOUSING: 1200 UNITS
20% AFFORDABLE

COMMUNITY AMENITIES
ECONOMIC & CULTURAL OPPORTUNITY

Participatory modeling



MODELING GREEN INFRASTRUCTURE (GI) IN FORA.AI

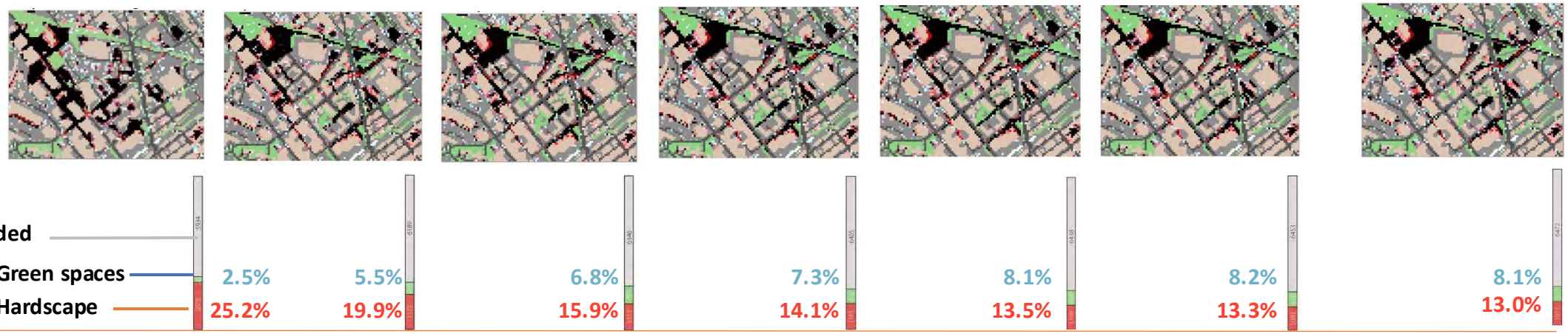
TRIAL		DAMAGE REDUCTION	GROUNDWATER INFILTRATION	MAXIMUM FLOODED AREA	IMPACT DOWNSTREAM	INVESTMENT	CAPACITY USED	EFFICIENCY OF INTERVENTION	FLOODED STREETS
Baseline a month ago	1	$6,700,000	15%	8%	3%	$0	0%	$0/gal	8%
Trial 5: Bioswales + Pavers Otters 16 days ago	2	$5,700,000 15% better	19% 27% better	7% 13% better	2% 33% better	$9,992,000	67%	$10.13/gal	7% 13% better
Trial 4: Bioswales + Green Roofs Otters 16 days ago	2	$6,200,000 7% better	17% 13% better	7% 13% better	3%	$9,974,000	75%	$12.47/gal	7% 13% better
Trial 3: Pavers Otters 16 days ago	1	$6,200,000 7% better	19% 27% better	7% 13% better	2% 33% better	$9,971,000	68%	$14.14/gal	8%
Trial 1: Bioswales Otters 21 days ago	2	$6,000,000 10% better	19% 27% better	7% 13% better	3%	$9,916,000	61%	$9.41/gal	7% 13% better

PERFORMANCE OF GI DESIGN ITERATIONS

RESULTS ON INDIVIDUAL STAKEHOLDERS' CONCERN PROFILES

Design Studio: Systematic Modeling with L-Grid

100-yr | 24-hr storm (Flooded Area > 3.5 inches)



EXISTING CONDITIONS	+ ELEVATION CHANGES	+ 6% GREEN-BLUE INFRASTRUCTURE IN PUBLIC LAND	+ 10% GBI PRIVATE PARCELS	+ 20% GBI PRIVATE PARCELS	+ 30% GBI PRIVATE PARCELS	= FINAL PLAN 60% GBR
	24% BETTER	36.8% BETTER	44.1% BETTER	46.6% BETTER	47.3% BETTER	49.6% BETTER

Visualization: stakeholders inspire /refine ideas for resilient spaces in public & private land

FOOD DISTRIBUTION SPACE

GROUND FLOOR ACTIVATION

GREEN PERMEABLE PARKING

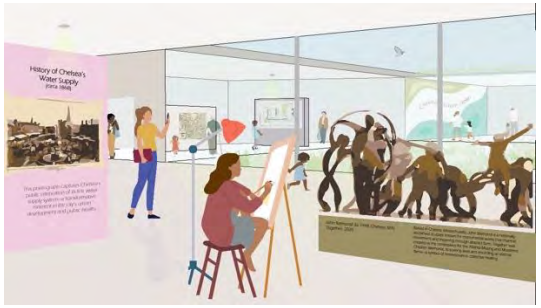
COMMUNITY CENTER

PUBLIC GREEN COURTYARDS

CHILD CARE NEAR HOUSING

GREEN MALL

HEALING GARDENS



INDOOR|OUTDOOR CULTURAL CENTER

PLAZA, PARK, & URBAN FARM

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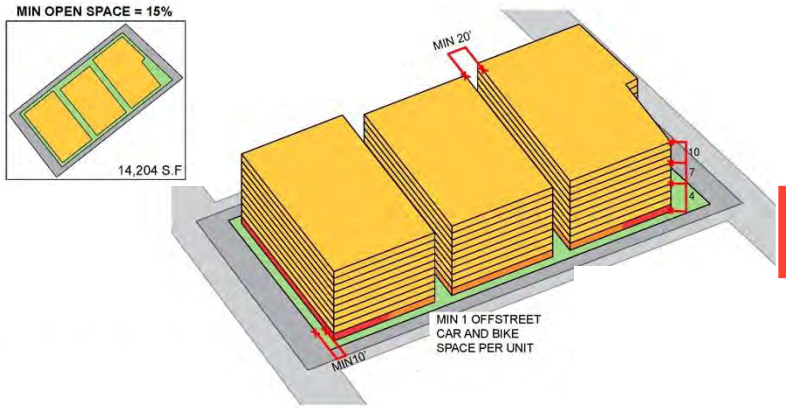
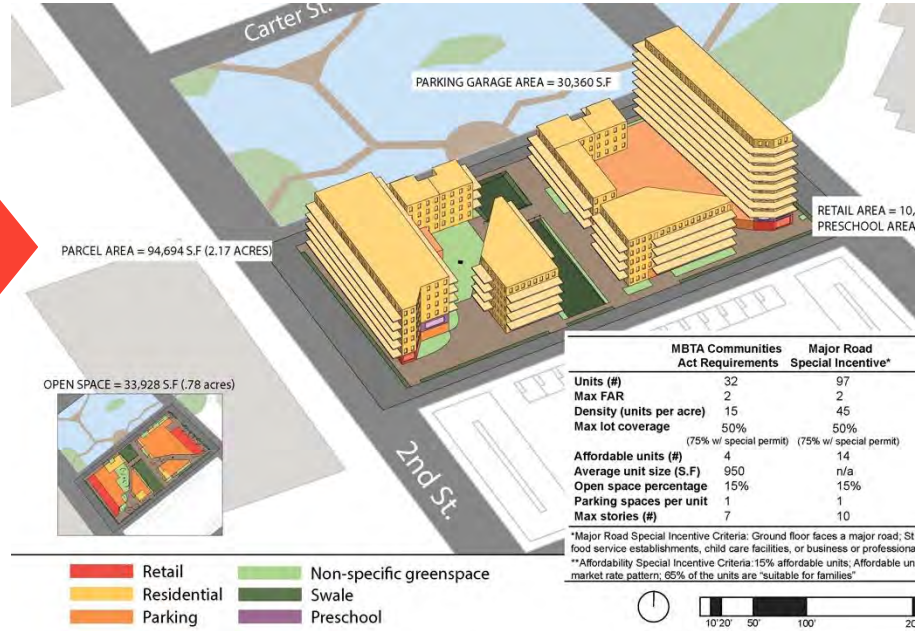
Concepts + metrics to inform development





Conclusion

What's next in Chelsea?

?

Takeaways: Sensor Playbook Rules-of-thumb

1. **Carefully define the question to answer, use that to guide sensor placement**

   Before and after? Green infrastructure vs. unaltered area? Other?

2. **Consistency in installations is critical**

   Height, attachment location (poles better than trees). Solar shields critical for T.

3. **How many sensors needed?**

   See #1!

Takeaways: Data Playbook

- A simplified "cookbook" of analyses for testing spatial heterogeneity, seasonality, and impacts of building.
- Interactive data portal for accessing and interpreting data and implications.

Takeaways: PM playbook

- Collaborative design, reasoning and deliberation
  - versus realism and solutionism
- Scaling up
  - Platform
    - New version, public launch
    - Facilitation structures, debriefing
  - Models
    - L-GrID extensions for heat, coastal flooding
    - Different models (wildfire, delta and agricultural water management) and impact metrics
  - Sensors
  - Communities

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Contact Information

General inquiries | future collaborations:

Common SENSES info@commonsensesproject.org

Specific topical areas:

Architecture / GI: Michelle Laboy m.laboy@northeastern.edu

City of Chelsea: Karl Allen kallen@chelseama.gov

Sensors: Amy Mueller a.mueller@northeastern.edu

Data | BARI: Dan O'Brien d.obrien@northeastern.edu

Participatory Modeling / fora.ai: m.zellner@northeastern.edu

THANK YOU!

Appendix B:

Report from ARCH 5115 Common SENSES Studio: West Chelsea
Professor Michelle Laboy
Northeastern University School of Architecture

Course Description:
The studio will build on the research project called Common SENSES, funded by the 2022 Latrobe Prize of the AIA College of Fellows. Students will explore the design of green infrastructure to retrofit and repair the ***Commons* – the shared natural and cultural resources stitching public and private spaces**—to (1) build community, (2) mitigate climate hazards and (3) improve human wellbeing in sensitive urban areas. The pedagogy explores three ideas through the following three frames: ***a polemic, the context, and collaborations***.

Polemic: Given space constraints in cities, the *Commons* is not limited to public land, or traditional definitions of the public realm. Increasingly cities expand the public realm within private sites, using creative design and policy mechanisms such as POPS (Privately-owned public spaces) to leverage new building developments to expand the capacity and benefits of urban green space for the benefit of everyone. Yet more housing developments are opting to restrict access to their zoning-required open space for residents only, instead offering "community benefits" in the form of payments or intangibles "elsewhere," severing the act of building from the act of community building. This studio will examine literature and case studies that address the question: **how does a building or development become part of a community, and how can design support the regeneration of the Commons?**

Context: This is timely question since the passing of the MBTA Communities Act, which affects 130 cities and towns in Massachusetts, requiring them to rezone a "district of reasonable size" that allows much needed multi-family housing near transit stations. Some cities want to support this increased density, but are concerned about mitigating environmental and social impacts, especially in already vulnerable populations. In this studio, we will work with one of those communities—the City of Chelsea—in the district that they have designated for this purpose, a low-lying area in West Chelsea near important commuter line, with high social and environmental vulnerabilities.

The city is interested in comparing the performance of different urban forms to support more robust green infrastructure and a thriving public realm while avoiding gentrification. This studio will help the city explore the question: **what could dense urban developments do to mitigate the environmental impacts of increased density (flood hazard, urban heat island, air pollution) and strengthen existing communities?** We will collaborate with city planners in

Chelsea to explore spatial parameters for architecture that supports high-performing green infrastructure, stitching individual buildings into a sustainable and socially-just urban fabric.

Collaborations: This studio will connect students to an interdisciplinary team of experts from allied fields. We will examine sensor data on climate-related health hazards in this district, collected by our Environmental Engineering collaborators, and work with them to interpret the data. We will also learn to use participatory modeling tools built by colleagues in Urban Planning who do ecological-systems modeling, to get science-based feedback on the flooding outcomes for students' design strategies. Finally, working in close collaboration with a Participatory modeling course in the School of Public Policy and Urban Affairs, students will have an opportunity to learn about how their approaches to community engagement can support a more inclusive design process to achieve more equitable outcomes. These collaborations will give students the opportunity to examine the question: **how can the design process be more science-driven and equity-focused, and what kind of urban form and public spaces emerge from it?**

Students will have an opportunity for real impact, by leveraging ongoing relationships with developers and city planners in the City of Chelsea, and in the region. This studio is open to upper-level architecture, SUEN, and landscape students to collaborate with city planners in envisioning more equitable and sustainable developments in parts of Chelsea most impacted by environmental hazards.

COMMON SENSES

REDESIGNING THE COMMONS FOR EQUITABLE CLIMATE ADAPTATION IN CHELSEA, MA

Community Contributors

City of Chelsea: Karl Allen

City Council: Norieliz De Jesus, Giovanni Recupero

Utile: Jose Cotto

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COMMON SENSES

REDESIGNING THE COMMONS FOR EQUITABLE CLIMATE ADAPTATION IN CHELSEA, MA

A love letter to Chelsea...

Chelsea is not where we designed—
it's where we listened,
where we learned what it means
to show up for one another.

Chelsea is a boat with a hole in the hull—
and still, it keeps moving.
Not by luck, but by people who refuse to let it sink.
Chelsea is a tree that's burned down twice
and still bears fruit.

We came with drawings.
But Chelsea gave us direction—
wetlands to catch the storm,
plants that know this soil by name,
gathering spaces rooted in pride,
an urban farm growing more than food—
growing future.

Creating here meant creating with.

Somewhere in the process,
Chelsea stopped being a site.
It became something we carry.
What we designed is one thing.

But what we found—
in its loyalty and love—
that's what stays with us.

Chelsea will always be part of us,
because it let us become part of it.

Table of Contents

Introduction

This studio began not with a design proposal, but with a question: how can the process of development build the Commons—those shared natural, cultural, and social spaces that bind communities together? Working closely with the City of Chelsea and community-based organization La Colaborativa, we set out to understand West Chelsea not as a site for intervention, but as a place of resilience, care, and community.

Our work unfolded alongside Chelsea youth advocates, community activists, city councilors, city planners, and residents, whose lived experiences revealed spatial and infrastructural needs and systemic inequities. We also learned of the ways in which the community is already working to strengthen their community. This proposal emerged from that collaborative process, rooted in the belief that climate adaptation must be ecologically effective and equitable. Through master planning and parcel-scale interventions, we explored how high-performing green infrastructure, transit-oriented development, and cultural programming can together strengthen the social fabric and climate resilience of Chelsea.

Context

The MBTA Communities Act requires municipalities across Massachusetts to designate transit-oriented districts that accommodate multifamily housing, creating both an opportunity and a challenge for cities like Chelsea. West Chelsea, already burdened by environmental and public health hazards, now faces the dual pressure of increased density and the risk of displacement. The district sits in a low-lying floodplain, with projections showing that by 2030 a 10-year storm could inundate significant portions of the area. Climate models also indicate that more severe flooding from 100-year storms may become regular occurrences by mid-century.

Simultaneously, residents contend with severe Urban Heat Island effects and some of the highest levels of air pollution in the region—factors that compound health risks, particularly for low-income and immigrant communities. Rising real estate speculation further threatens cultural continuity and access to affordable housing, increasing the urgency for thoughtful, community-driven planning and design interventions.

To respond, our process integrated site visits with city officials and La Colaborativa, spatial analysis and mapping, participatory modeling with stakeholders, and community feedback. We walked the area , witnessing families in line waiting for food, and heard students express a need for safe indoor spaces to gather. Community aspirations—including walkable routes to school, access to fresh food, flood-protected housing, and places for cultural expression—became the foundation of the plan. This booklet presents the technical proposals and the community priorities that shaped them.

Chapter 1
Case Studies

The first part of this work was to define how much space should West Chelsea dedicate to public green infrastructure, and what could new developments contribute to that fabric. We set out to understand how cities around the world are balancing high density with effective green infrastructure. We explored a range of case studies that highlight the ambitious implementation of **green-blue infrastructure (GBI)**. GBI is a planning and design approach that integrates nature-based and engineered systems to mitigate and adapt to the effects of climate change while also enhancing urban ecology and livability.

Green infrastructure refers to vegetated solutions like parks, green roofs, bioswales, and tree canopies that provide environmental and social benefits, including management of stormwater quantity andquality, shade and evapotranspiration for heat reduction, and filtering air pollution. ***Blue infrastructure,*** on the other hand, focuses specifically on water elements such as water bodies, canals, ponds, blue roofs and hardscape basins to make space for temporary water storage, to slow and manage water flow, and move water intentionally to produtive paths.

Another goal of these case studies was to develop ***metrics*** to understand the balance of urban density with the need for open space and climate resilience. These projects identified types of GBI, their capabilities, and their spatial qualities.

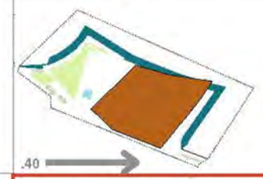
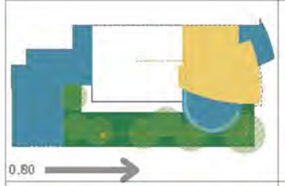
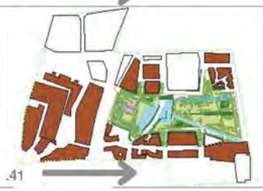
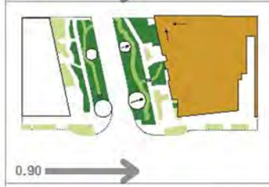
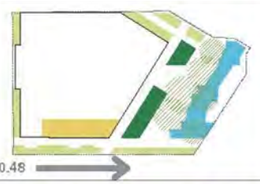
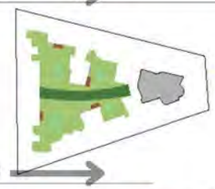
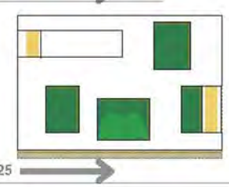
The innovative examples show how high-density urban areas expanding GBI within limited space that housing, transportation, and economic needs, which pertain to Chelsea directly.

The matrix that follows organizes the case studies by site area and available open space, showing where Chelsea and its development areas sit in comparison. Each site diagram shows what GBI approaches were used and provides a metrics of GBR (the ratio of GBI to site area), FAR (floor to area ratio), and percentages of architectural versus landscape-based GBI approaches.

As can be seen, Chelsea has very low GBR, but the West Chelsea TOD and individual parcels can achieve substantially higher levels of GBR, which can increase Chelsea's overall GBR by over 20%.

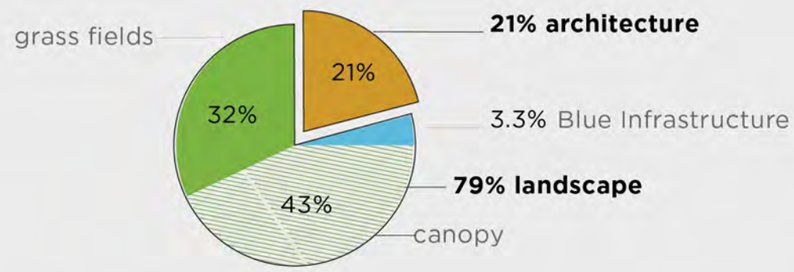
SITE AREA

OPEN SPACE (%)

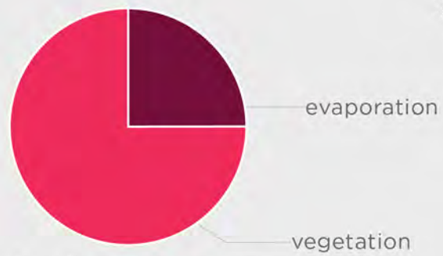
	<0.5 acres	0.5 - 1.5 acres	1.5 - 3 acres	3 - 6 acres	6-25 acres	25-80 acres	80 - 126 acres	126 - 175 acres	>175 acres
100%					 .45				 .13
85%					 .30	 .42			
75%			 .56		 .40	 .70	 .50	 .47	
55%	 0.80			 .38	East Green Corridor  .70	 .32		 .41	
40%	 0.90	 0.48	 .21	Commercial Parcel  .42	 Community Center Parcel .40	 .60			
30%	 .41	 .55	 .21		 West Green Corridor .73	**Chelsea Proposal Affected Area**			
10%		 .60	 .25		 .25				

100' 200' 400' 600' 1000'

Chelsea - Affected Area



% of Total Stormwater Management Areas



*% of Water Usage**

*qualitive estimate

SITE AREA = 76 acres (30.7 hectares)

O.S. = 52 %

GBR= .6

Superblocks and Parcels

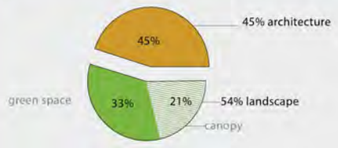
The following outlines the proposed development parcels in Chelsea, strategically organized to align with the broader vision of sustainable urban planning. These parcels are primarily concentrated along both the eastern and western segments of two green corridors, forming larger superblocks that serve as key nodes within the city's evolving ecological framework. These blocks are designed not only for development density but also to act as integrated systems that support green-blue infrastructure goals.

Additional individual parcels are distributed throughout Chelsea, which are purposefully designed to support and extend the environmental strategies established.

Each parcel and superblock has been evaluated within a comprehensive green-blue infrastructure matrix. Together, the coordinated arrangement of these parcels demonstrates a holistic approach to urban development that creates a healthier, connected, and sustainable Chelsea.

50' 100' 200' 300' 500'

Chelsea - West Green Corridor



% of Total Stormwater Management Areas

*% of Water Usage**

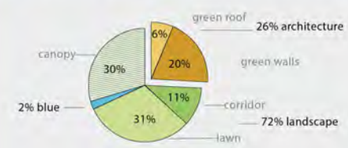
SITE AREA = 10.7 acres (4.33 hectares)

O.S. = 51 %

GBR= .73

50' 100' 200' 300' 500'

Chelsea - East Green Corridor



% of Total Stormwater Management Areas

*% of Water Usage**

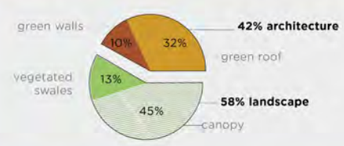
SITE AREA = 12.9 acres (5.2 hectares)

O.S. = 63 %

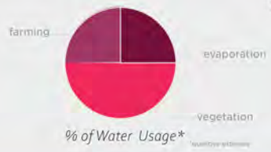
GBR= .7

50’ 100’ 200’ 300’ 500’

Chelsea - Market Basket Parcel



% of Total Stormwater Management Areas



*% of Water Usage**

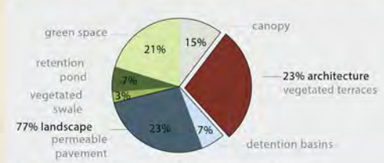
SITE AREA = 8.9 acres (3.6 hectares)

O.S. = 47.6 %

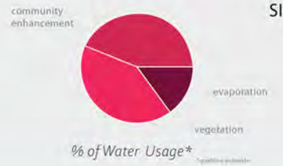
GBR= .4

50’ 100’ 200’ 300’ 500’

Chelsea - Park Parcel



% of Total Stormwater Management Areas



*% of Water Usage**

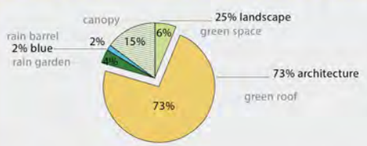
SITE AREA = 6.6 acres (2.7 hectares)

O.S. = 100 %

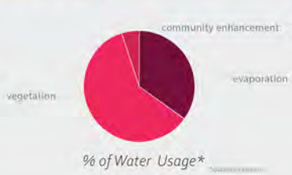
GBR= .6

50’ 100’ 200’ 300’ 500’

Chelsea - Commercial Parcel



% of Total Stormwater Management Areas



*% of Water Usage**

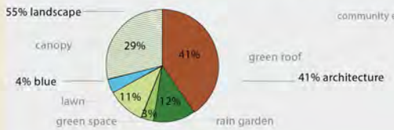
SITE AREA = 4.75 acres (1.9 hectares)

O.S. = 40 %

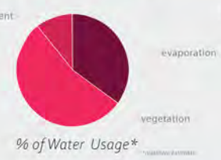
GBR= .42

50’ 100’ 200’ 300’ 500’

Chelsea - Community Center Parcel



% of Total Stormwater Management Areas



*% of Water Usage**

SITE AREA = 11.5 acres (4.6 hectares)

O.S. = 53 %

GBR= .4

Chapter 2
Proposed West Chelsea Plan

Our Urban Design Studio has five principles for imagining the district's master plan:

1. Preparing for climate hazards
2. Maintaining the industrial economic center
3. Increasing affordable housing
4. Improving connectivity to open spaces and the waterfront
5. Building spaces for the community and their needs

We aim to do that by visualizing the balance between a feasible density and a resilient public realm in the overlay district. We seek not to prescribe solutions but to begin conversations with stakeholders about how to meaningfully build community while designing for rising sea levels, increasing temperatures, and housing costs.

Our goals took shape through close observation during our site visit, conversations with community members, and a deep understanding of the overlay district's vision.

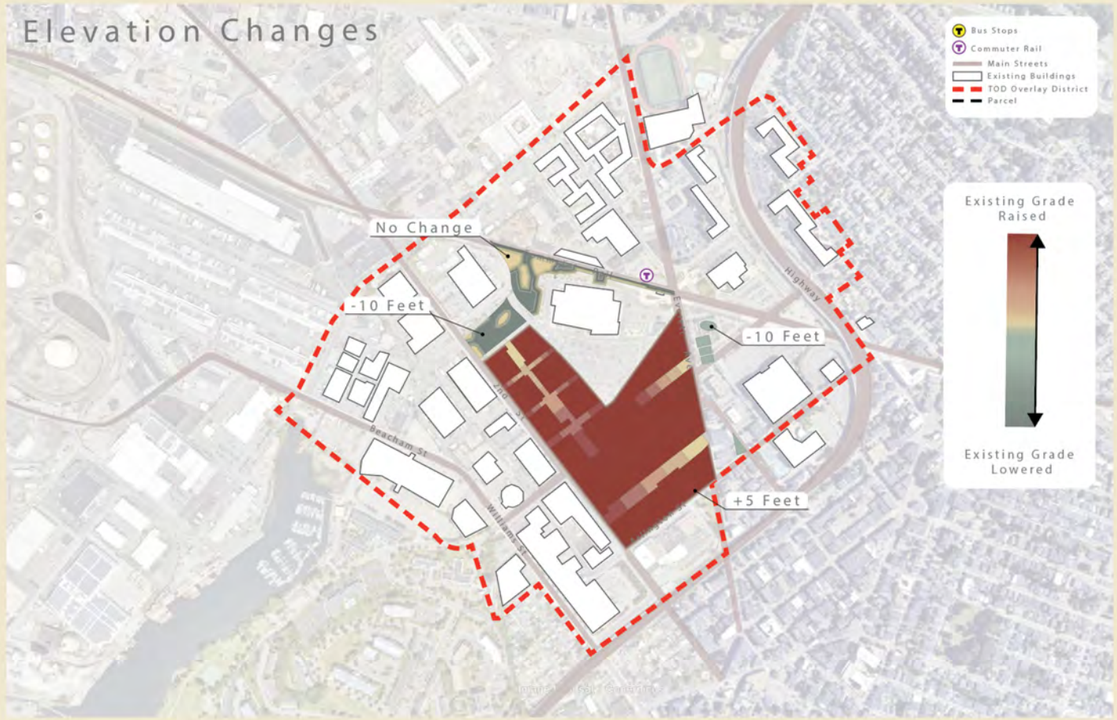
We saw La Colaborativa's vital role in providing food security by creatively using the space under the highway, where long lines of families highlighted the need for open areas that offer both comfort and joy. Elderly and pregnant women can go into the warehouse of La Colaborativa to receive their provisions. But many families stand outside in the cold with young children. Can this space provide

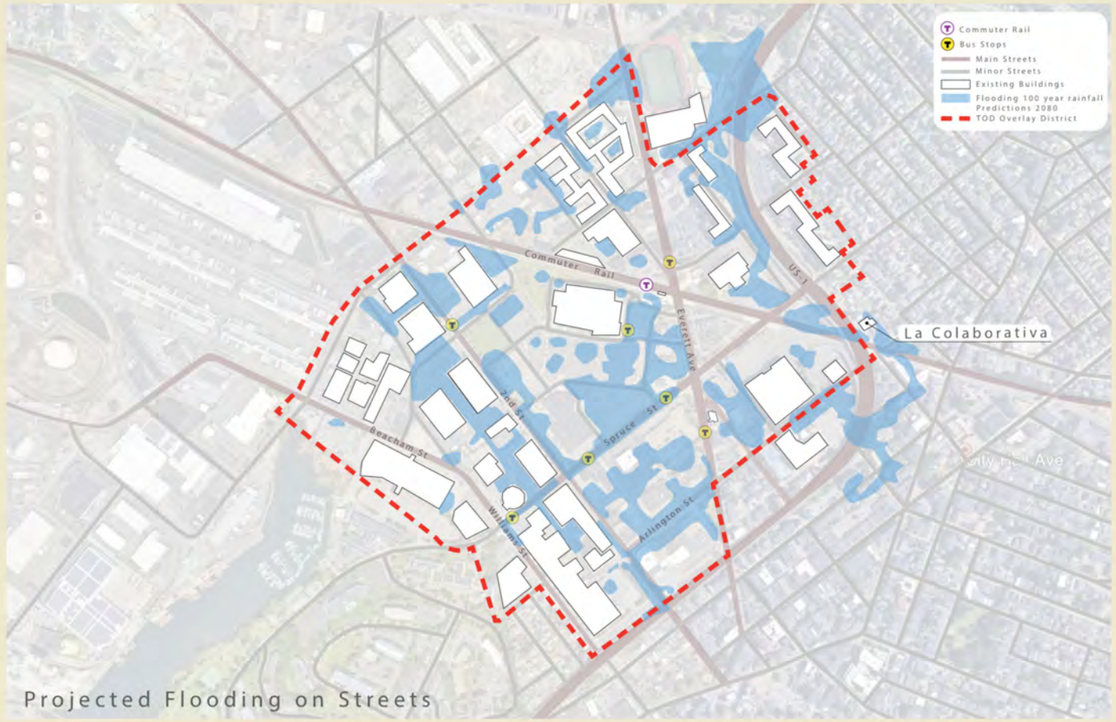
Youth also expressed a lack of safe indoor spaces beyond La Colaborativa, underscoring the spatial needs created by Chelsea's overcrowded housing, and the need to create welcoming public environments to study, relax, and connect.

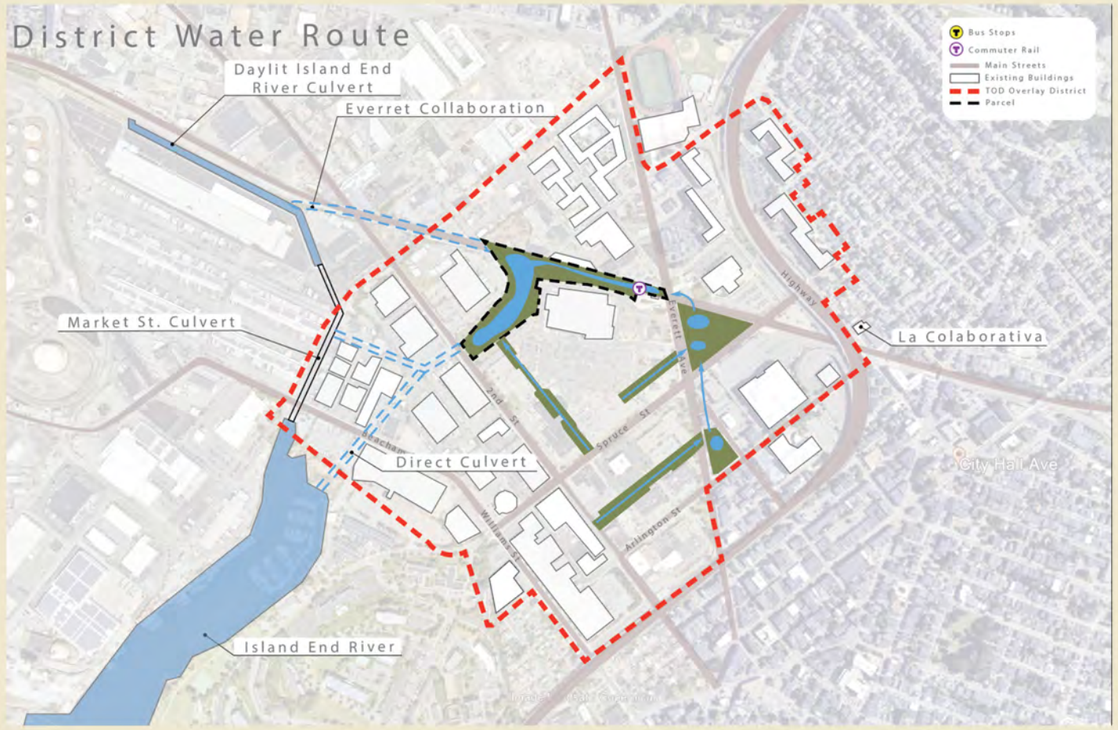
Planning West Chelsea is a once in a generation opportunity to build community infrastructure that green infrastructure is traditionally associated with water-management elements like rain barrels and gardens, but it can also be connected with community opportunities for rooftop gardens and familiar, culturally rooted learning spaces.

1. Preparing for Climate Hazards

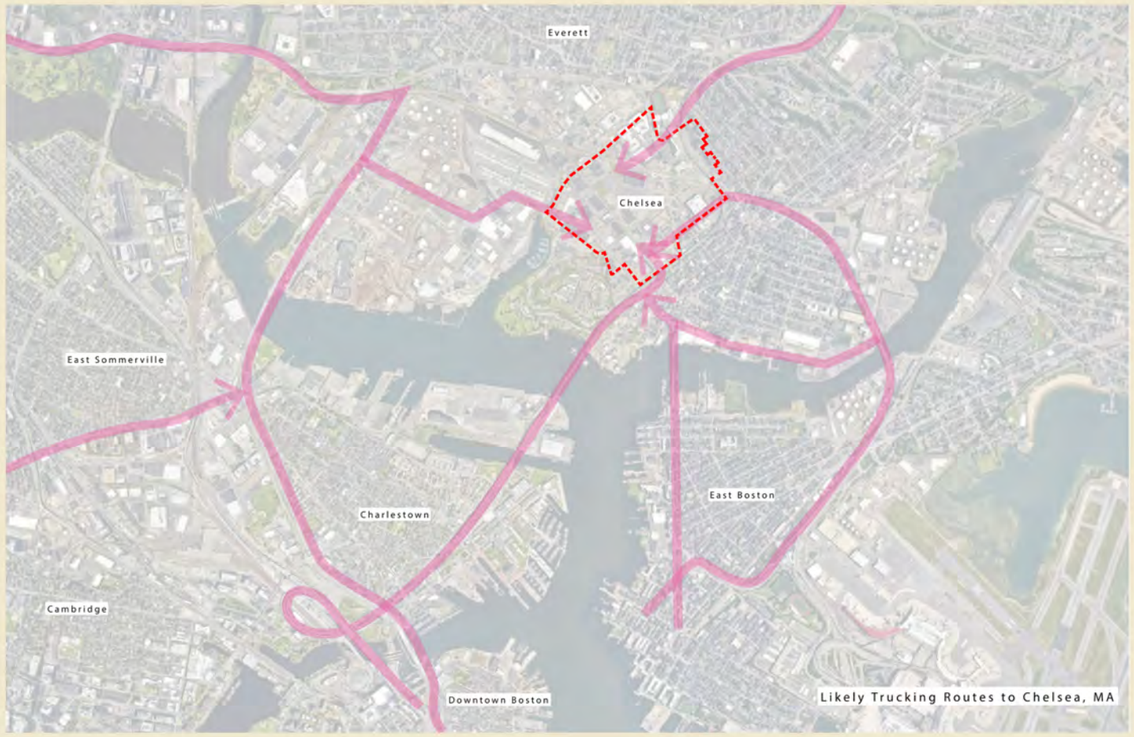
Highlighting the urgent need for resilient infrastructure and green-blue interventions, our first and most crucial step was to elevate specific areas—including Spruce Street, Second Street, and the eastern parcels between the industrial buildings and Market Basket. Additionally, we introduced a swale south of the commuter rail to retain stormwater and gradually release it to the sea.



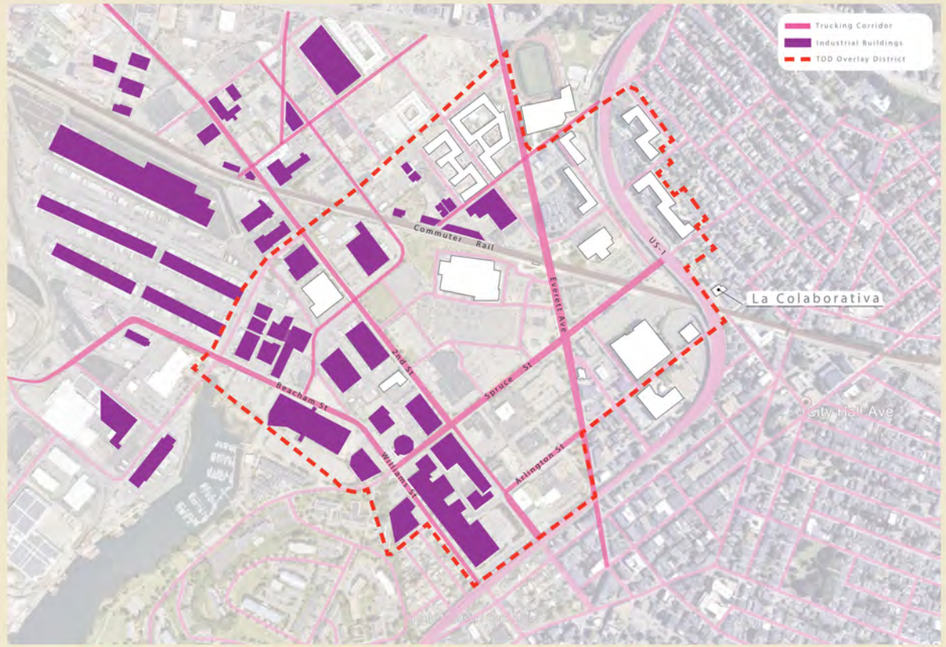




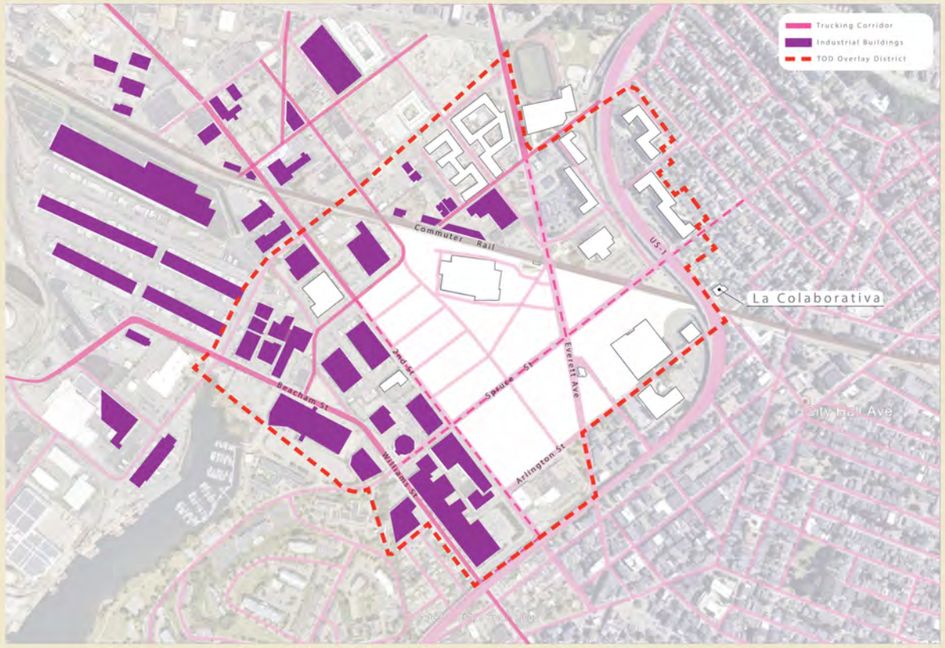
2. Maintaining the Industrial Economic Center



Preserving the industrial economic center was key to our master plan. Chelsea's waterfront has long served as a vital industrial hub, generating jobs and supporting the city's economy, so eliminating it was never our goal. Instead, we decided to embrace the industrial buildings and design around them, integrating them into a more connected, accessible neighborhood. Looking at where trucking routes come from outside of Chelsea helped us locate which streets within our site boundary were important to keep accessible for large shipments of various products. To improve safety and air quality, we present the option of rerouting existing truck corridors, reducing the impact of freight traffic on residential streets.



West Chelsea's Existing Industry & Trucking Corridor



Trucking Corridor Potential Changes

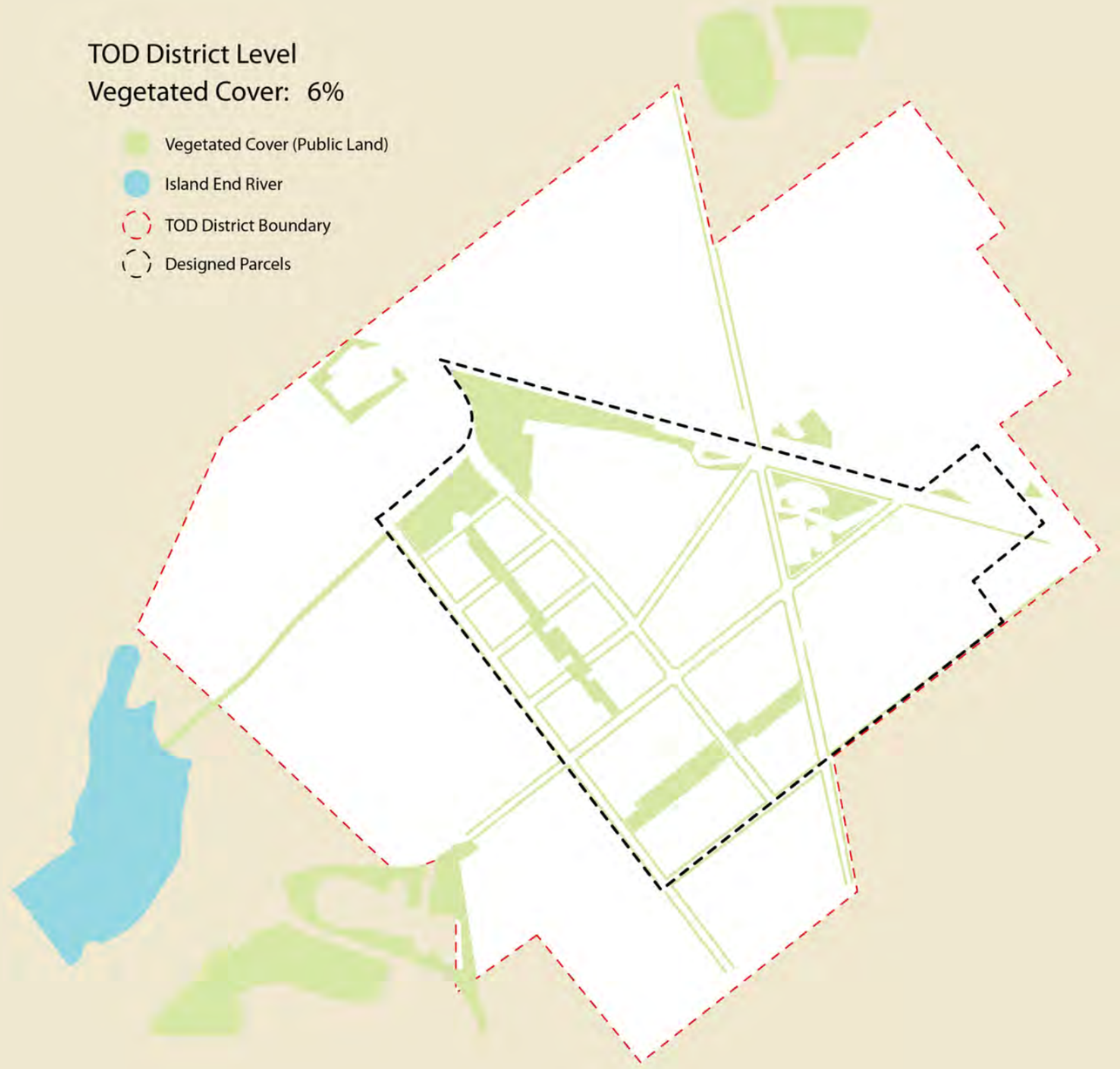
3. Increasing Affordable Housing

Unit Type	*# of units*	*% of total*
1 bedroom	*276*	*23%*
2 bedroom	*452*	*38%*
3 bedroom	*363*	*31%*
4 bedroom	*51*	*4%*
5 bedroom	*52*	*4%*
Unit total	*1194*	*-*
Total Affordable	*243*	*20%*

Increasing affordable housing was a direct response to the community's expressed need for more inclusive living options—specifically mixed-size units with 3–5 bedrooms to support larger families.

4. Improving Connectivity to Open Spaces and the Waterfront

Improving connectivity to open spaces and the waterfront was shaped by the community's desire for greater access to Chelsea's coastline—an amenity that, despite the city's location, remains largely out of reach. Our proposal introduces more green spaces and weaves them into the existing urban fabric, creating continuous, walkable connections that bring residents closer to nature and the water.



5. Building Spaces for the Community

Our proposed amenities respond directly to the community's call for more public resources and safe, welcoming spaces, especially for youth. Currently, amenities in West Chelsea are scattered, making access inconvenient.

By centralizing them, introducing new parks, education centers, libraries, fitness facilities, and gathering spots throughout the district, we aimed to support multi-generational use and foster a more vibrant, livable neighborhood. These interventions build on the work already being done by organizations like La Colaborativa and help ensure West Chelsea meets the needs of its current and future residents.

Chapter 3:
Design Concepts

Over the course of the semester, each student in the Urban Design Studio was assigned a parcel within the same urban context and challenged to respond to the neighborhood's complexities—its zoning constraints, changing demographics, environmental vulnerabilities, and cultural vibrancy.

Our process began with a deep dive into site analysis, historical context, and community needs. With those foundations, we each developed distinct proposals that tested how architecture and urban design can shape more inclusive, resilient, and livable neighborhoods. Though working independently, our designs collectively explore a wide range of programs—residential, commercial, civic, and recreational—reflecting the multifaceted character of West Chelsea and the diverse needs of its residents.

Across all proposals, we prioritized public access, climate adaptation, and community-centered design. In particular, many of us were drawn to the need for flexible, indoor spaces where people can gather beyond the scale of the private unit—spaces for storytelling, performance, entrepreneurship, and connection.

Proposed District Plan

1 Open Spaces

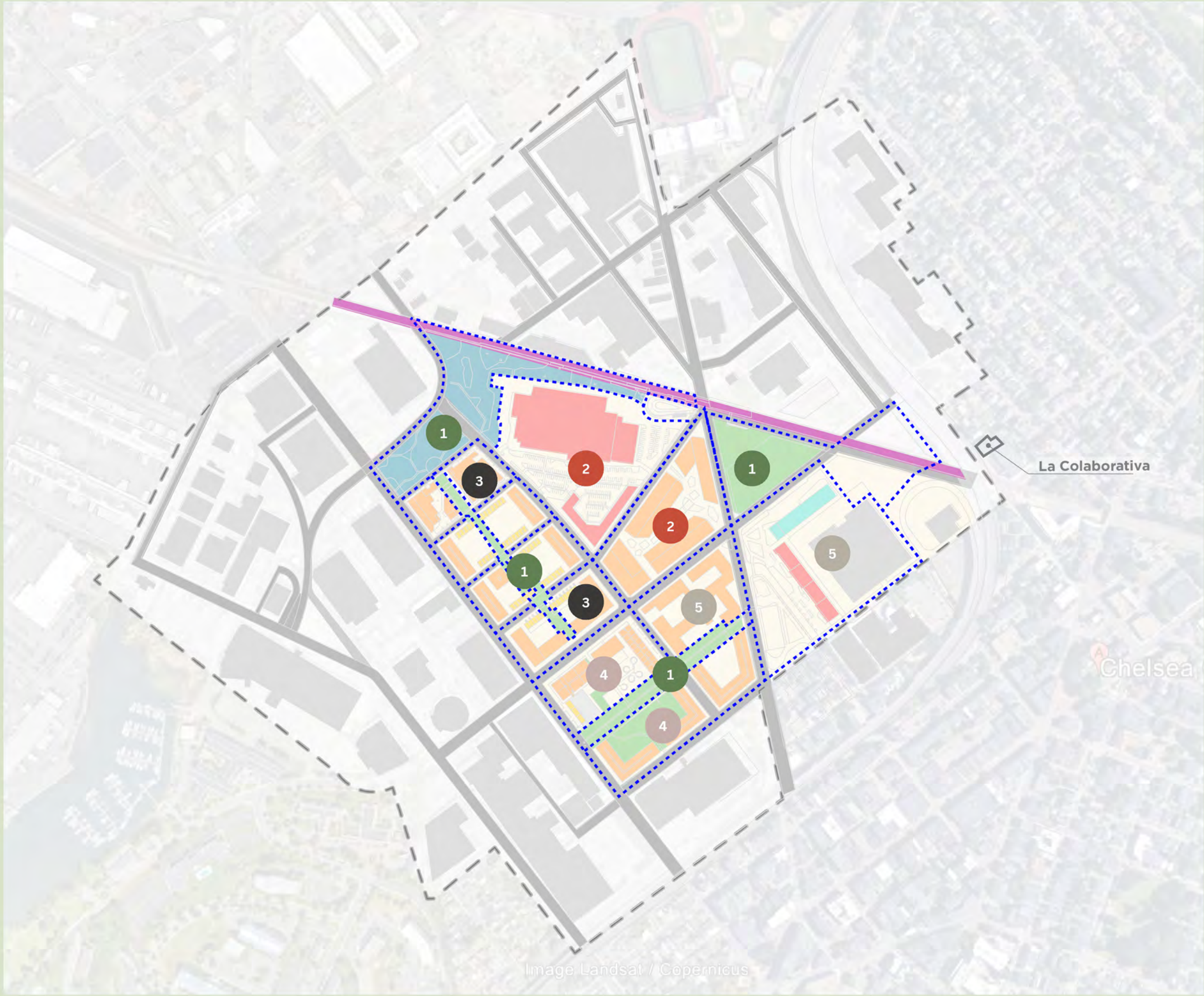
2 Mixed Use and Commercial Core

3 West Green Mixed Use Corridor

4 Healing Garden and Arboretum Mixed Use Corridor

5 Cultural District

Streets and Parcel Divisions

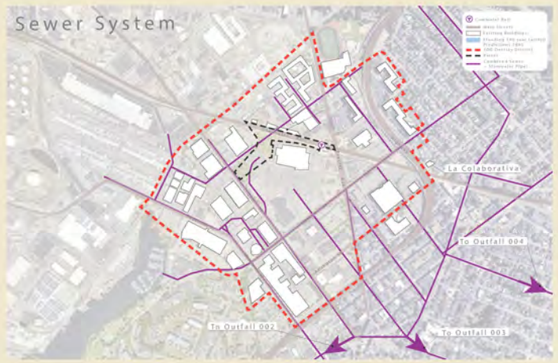


Wetlands Parcel

South of the Commuter Rail

Chelsea's landscape was once a dynamic tidal marsh, stewarded by the Massachusett Tribe and shaped by natural rhythms of tides and storms. Over centuries, industrialization paved over this critical floodplain, replacing it with a combined sewer system that now struggles under climate change. Today, heavier rains overwhelm these pipes, spilling sewage into the Mystic River and flooding neighborhoods—especially along the MBTA commuter rail corridor, the district's lowest-lying land. This critical transit artery unintentionally channels floodwater, threatening both rail operations and nearby homes.

Historical Map



Combined Sewer System

Our design reimagines this corridor as a climate solution. A constructed wetland, inspired by the Netherlands' "Room for the River" program—which integrates railways with adjacent floodplains to safely manage storm surges—would absorb and filter stormwater, reducing pressure on Chelsea's combined sewer system. This approach, proven in Dutch regions like the IJssel Valley, prioritizes "living with water" by pairing infrastructure with ecology. Here, it revives the land's ancestral hydrology while reconnecting the community to the waterfront, a cultural touchstone for Caribbean-rooted residents whose island homelands face similar climate threats.

Existing Conditions

Parcel Location

View of Large Wetland Where Current Parking Lot is

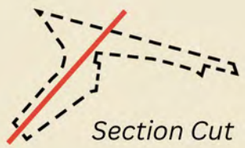
View from MBTA Station Connecting to Boardwalk

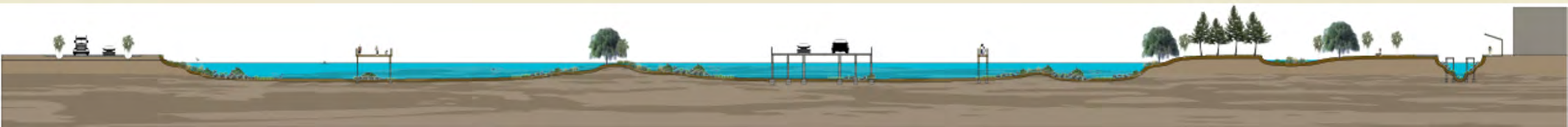
View of MBTA Station

Collaboration with the MBTA is essential. By elevating tracks where needed and integrating wetlands alongside the rail corridor, Chelsea can transform a liability into a lifeline. Let's work with MBTA, MDOT, and community voices to build a resilient future where green infrastructure protects both people and place.

District-Level Plan

Site-Level Plan





West Chelsea's Public Park

Parcels Between La Colaborativa and the Train Station

We're transforming the parcels next to La Colaborativa into a vibrant public park that reconnects neighborhoods, buffers highway noise, and supports urban farming through *'La Finca'* atop a new parking structure. Designed for community use, the park includes recreation space, stormwater basins, and a plaza that reimagines the current food distribution area as a welcoming place to gather, wait, and play.

Existing Conditions

Program Relocation

Proposed Park Perspective

View from Splash Pads to the Community Center and Urban Farm

View from 'La Plaza' to the Highway

View from Amphitheater: Hosting a Concert

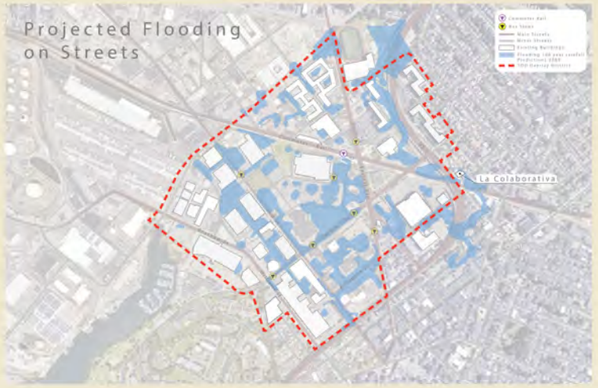
View from Amphitheater: Flooded Condition

View from Amphitheater: Hosting a Soccer Watch Party

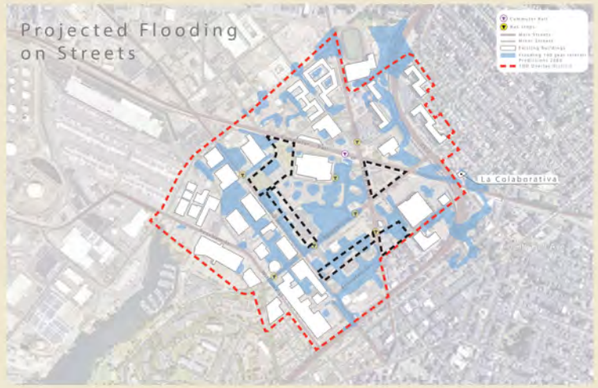
Section Cut

West Chelsea's Streets

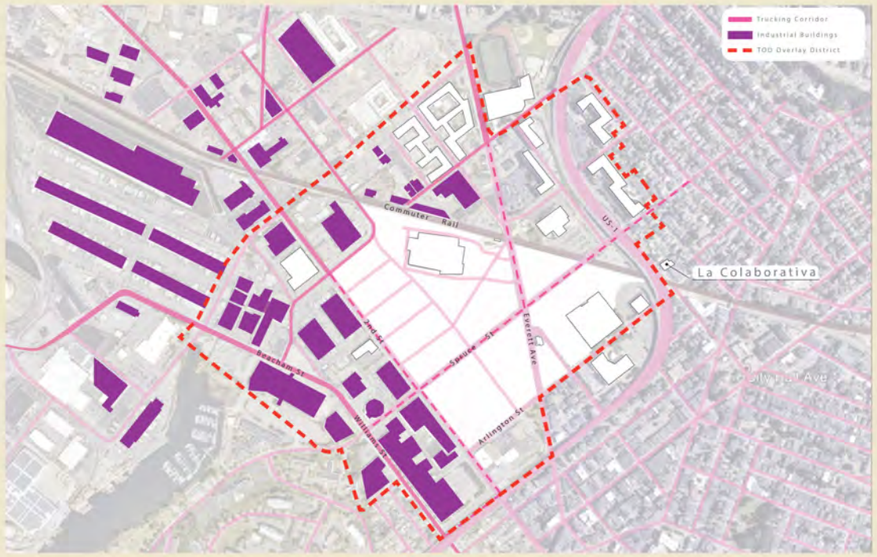
In the streets, we observed significant flooding, especially along 2nd, Spruce, and Arlington, which led us to raise the elevation of the streets to help reduce the overall impact. At the same time, we strategically lowered the elevation in designated areas to intentionally direct and collect excess water, minimizing risk to key infrastructure.



Projected Flooding on Streets



Areas Proposed to be Lowered in Elevation



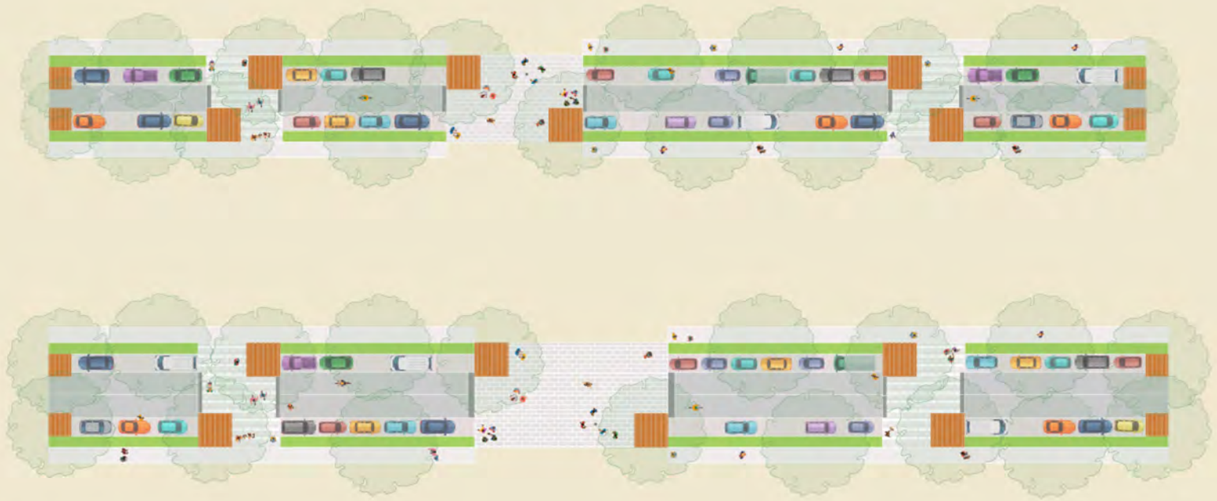
Further proposed road changes consolidates the current truck traffic to the north and west perimeter of the district, to serve industrial buildings and reduce truck-source pollution on streets serving residential and commercial areas. This realignment could allow for upgrades to West Chelsea's streets, transforming them into slower, safer spaces for residents while organizing resident and commercial street parking, raising them above floodplain, and providing green space to enhance livability and environmental resilience.

Streets like Spruce Street, that will serve mixed-use and community-oriented developments, can be reorganized to follow a pattern of: sidewalk, swale, street parking, bike lane, and a travel lane that accommodates for the bus and cars, creating a safer, greener, and more accessible environment for all users.

Section at Spruce Street

Key Plan

Streets between the new parcels are designed to slow car traffic and prioritize pedestrian travel and play. These potential options for one-way and two-way streets give additional parking for the parcels, but they are also meant to slow cars down and bring back play into streets.



Example Plans of In-Between Streets

Streets Made for Play

Images from "Open Streets" A NYC DOT Initiative

Market Basket Parcel

Between Large Swale, New Residential District, and Commercial Center

To maintain the important role of the existing Market Basket site and to bridge the new surrounding urban density, we could reimagine parking as a vibrant oasis lined with bioswales and trees that mitigate flooding and urban heat island effect. A parking garage with street-facing retail could handle seasonal overflow, daytime commercial parking and overnight residential parking, while its rooftop could house an urban farm for the ground floor restaurants and the farm to table rooftop restaurant, providing fresh food and jobs.

Pre-Covid (2017-2018)

Peak Season - Spring 2017
75% used (1518 spaces)

Approximate occupancy range of in 2017-2018
65-75% (1316-1518 spaces)

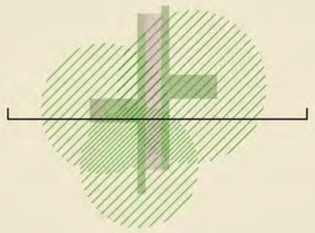
Post-Covid (2023-2024)

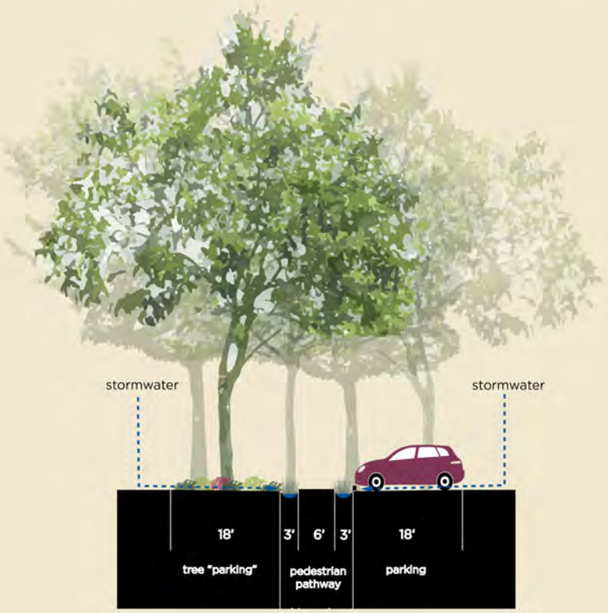
Peak Season - Fall 2024
70% used (1416 spaces)

Approximate occupancy range of in 2023-2024
55-70% (1113-1416 spaces)

actual capacity range | Market Basket | approximated 100% parking capacity

Parking Analysis of Pre and Post-Covid Conditions of Existing Parking to assess how much parking is needed for proposed site.





Typical Pedestrian and Bioswale Pathway Section Cut

1 *View from across adjacent southeast parcel*

2 *Ground Floor Restaurant and Retail Space*

3 *Rooftop Farm to Table Restaurant and Rooftop garden*

4 *Parking Lot Pedestrian and Bioswale Pathways*

Commercial Parcel

Within Existing Market Basket Parcel; Parallel to Everett Street and Spruce Street

This commercial parcel between the Market Basket and the proposed park and community center could create a mixed-use hub for housing and retail with open plaza spaces. This parcel demonstrates the City of Chelsea's aspirations for transit-oriented development with increased density that can support a higher mix of affordable housing with an inclusive and vibrant public realm that supports economic activity and accessible public space. The large atrium building serves as a safe indoor area where teens can feel free to gather and relax after school, while providing air-conditioned public space that can offer cooling during heat waves.

1 *View From Proposed Street*

Ground Floor

Typical Upper Floor

Total Affordable Units	*41*
Average Unit Size	*1000 SF*
Retail Spaces	*48*
Retail SF	*107,583 SF*

Total 1 beds	*40*
Total 2 beds	*117*
Total 3 beds	*119*
Total Units	*276*

2 *Interior Atrium View*

3 *Courtyard View*

Mixed Use Block at Spruce and 2nd Street

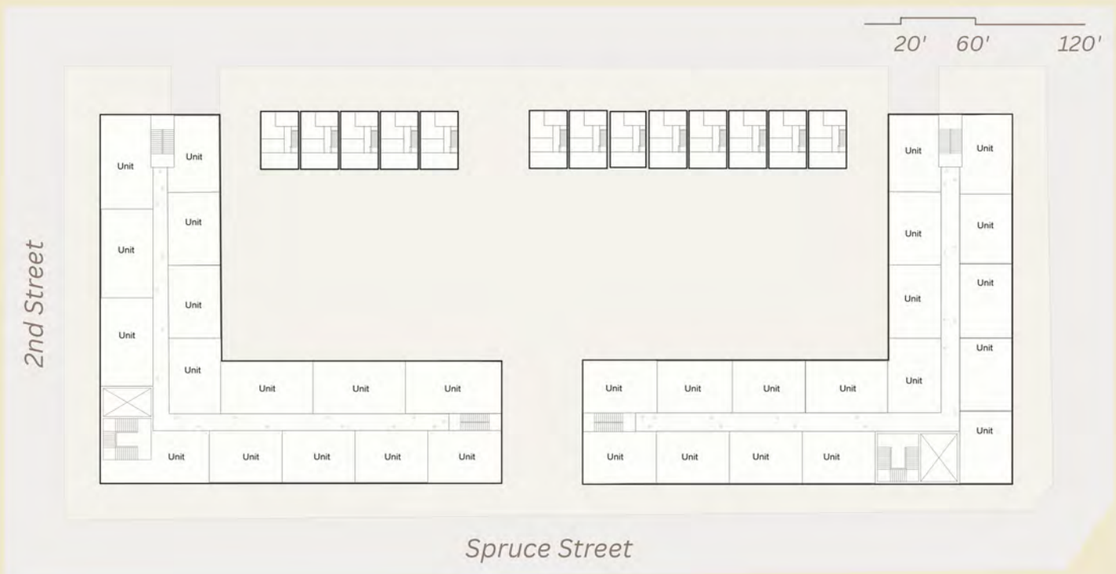
West Green Mixed Use Corridor

At the intersection of Spruce and 2nd Street, a series of parcels bridges Chelsea's commercial and industrial zones. The plan introduces 201 market—rate and affordable housing units across rowhouses and mixed-use buildings designed for larger families. A central pedestrian corridor anchors the site with green infrastructure like rain gardens and bioswales, promoting climate resilience and community. Facing the street, flexible retail spaces support local entrepreneurship. One example is Tobin Table—a shared food hall with communal seating that welcomes small food vendors and offers Chelsea residents a place to gather and enjoy local eateries.

1 *View of Tobin Table Food Hall*

View of Central Green Corridor 2

3 *Spruce Street*



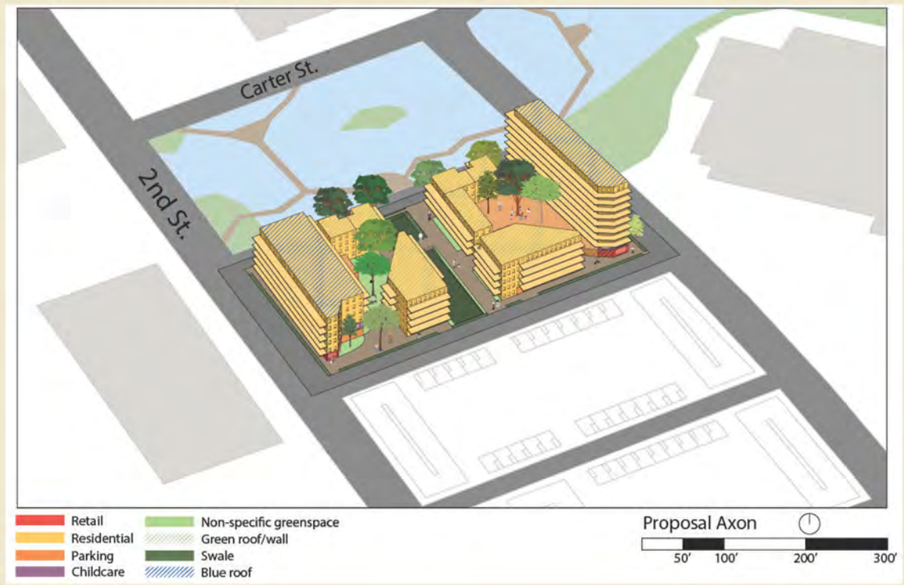
Total 1 beds	*17*
Total 2 beds	*79*
Total 3 beds	*92*
Total 5 beds	*13*
Total Units	*201*

Total Affordable Units	*31*
Rowhouse Size	*2100 SF*
Average Unit Size	*990 SF*
Retail Spaces	*5*
Retail SF	*20553 SF*

Mixed Use Between 2nd St. and Proposed Wetlands

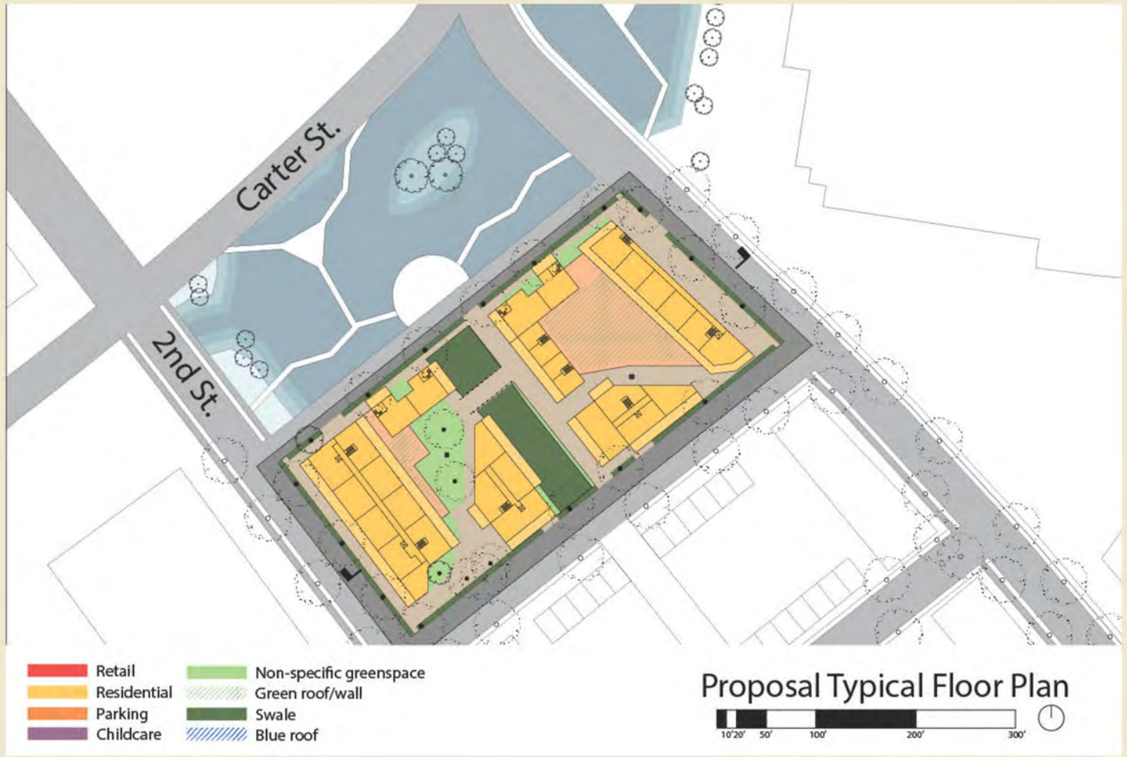
West Green Mixed Use Corridor

This block could act as a threshold for people and water to the constructed wetlands that would manage stormwater for the district. The primary goal is to balance a need for high unit density to achieve housing affordability goals allowed by zoning, with the needs for accessible open space, ground-floor retail, and community amenities. This manifests as a 140-unit development, that accomodates ground floor retail along the major roads; the creation of 2 spaces for universal preschool classrooms which open to semi-private green roofs; 3 pedestrian only streets that invite mendering through the site and towards the new wetlands; and a large biosswale to alleviate flooding for this site and its neighbors to the south east. This block prioritizes providing a variety of housing typolgies, large unit options, and a parking space for each unit. The varity allows some units to have great view of the Boston skyline while others get walk up access from the pedestrian-only road, letting families have further agency in how they want to live.



View of the Swale from the Interior Pedestrian Street

View in the Southwest Pedestrian Street



Total 1 beds	*13*	*9%*
Total 2 beds	*20*	*14%*
Total 3 beds	*82*	*58.6%*
Total 4 beds	*25*	*17.8%*
Total 5 beds	*14*	*10%*
Total Units	*140*	

Average Unit Size	*1100 SF*
Total Afforable Units	*21*

Retail SF	*10,623 SF*
Childcare SF	*5,331*

Arboretum, Green Corridor, and Recreational Parcel

Between Arlington and Spruce St

This proposal creates a space where public places interconnect through nature. The arboretum, adjacent to the healing gardens and extending along the green corridor, provides space for play, education, and relaxation. Patients at the health center and residents in halfway living can find peaceful refuge amongst the reflection pools and natural spaces. The sports courts located in the courtyard of the second building provide space for the public and users of the community center in the building to play games while also doubling as strategic stormwater infrastructure. The large corridor invites the public into this otherwise enclosed block, providing a pleasurable pathway to commute through.

The shape of the buildings creates an enclosed space that shields pedestrians from the noise, air pollution, and overall intensity of the nearby raised highway. The bottom floor hosts space for retail and a community center with two stories of parking above. This height and layout also ensure that the residents' dwelling units all stay above the highway for a better and more equitable living experience.

Existing Conditions

Program Relocation

The corridor is inspired by the University of Pennsylvania's Locust Walk, which features trees from all over the world and creates a culturally and naturally rich public space.

Perspectives Guide

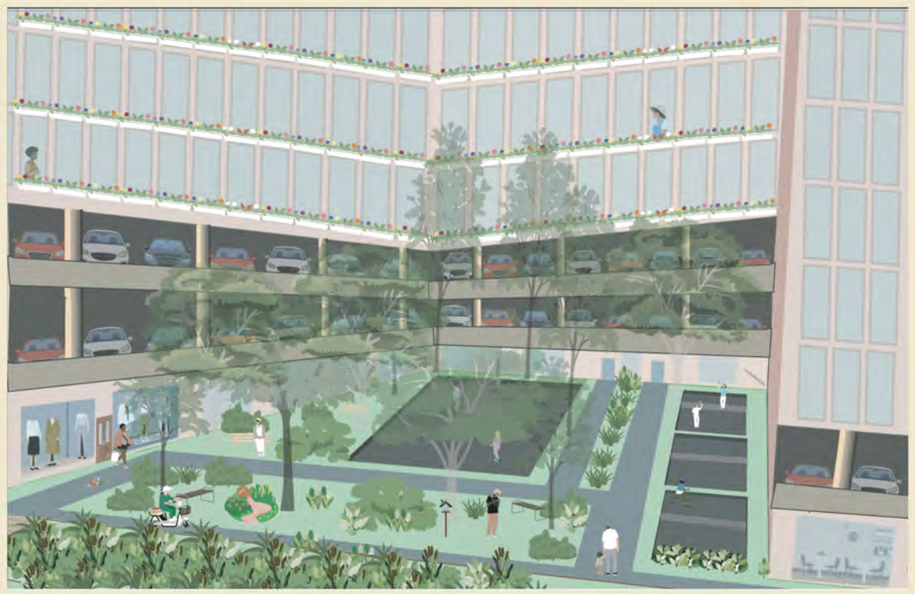
1

Perspective of water feature plaza with pollinator gardens

3

Perspective of arboretum and large swale to the east

Sections show water flow from slanted roofs to inner courtyards and eventually to the swale. The arboretum courtyard is slightly sloped to guide the water to the appropriate place. The basketball and pickleball courts hold excess water during a storm and eventually drain to the swale, slowing the movement of water and flooding.



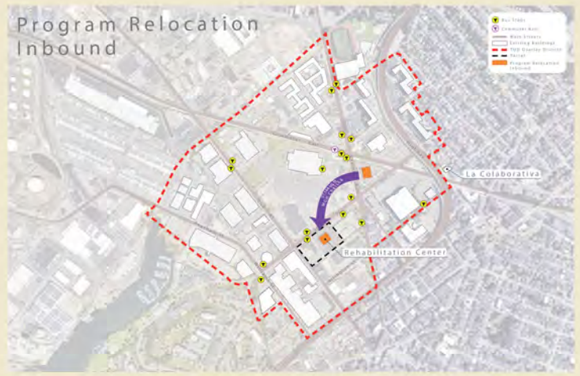
2

Perspective of recreational sports courtyard and ground floor retail

Health Campus & Healing Garden

Between New Residential District and Arboretum

Program Relocation: Outbound

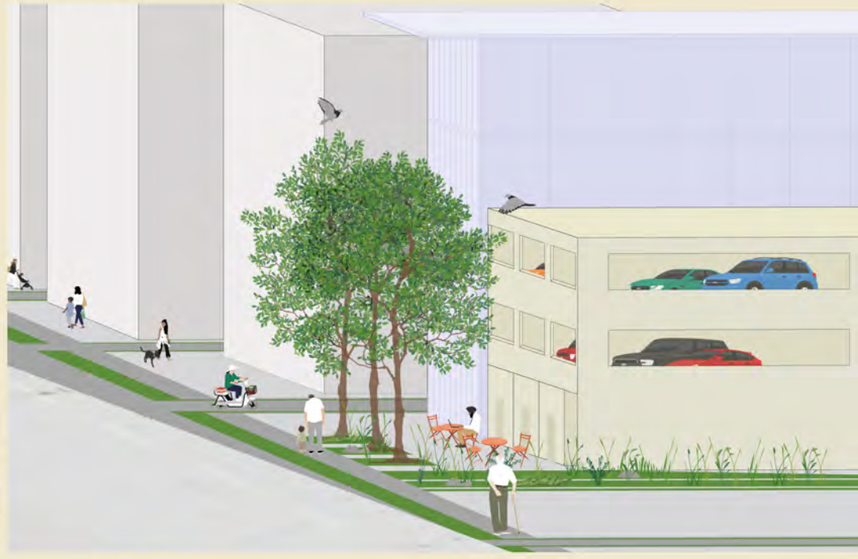


Program Relocation: Inbound

West of the cultural center this block could be transformed into a wellness campus, reimagining healthcare access to Chelsea residents. An upgraded clinical building is located at the highest elevation with a fitness community center like a YMCA, and halfway housing supports people in addiction recovery. Nestled in between is a healing garden that provides a calm retreat and an opportunity for a more holistic approach to community health and wellbeing.

View of the medical center lobby

View of the healing garden and parking garage



View from existing industrial to the commercial spaces

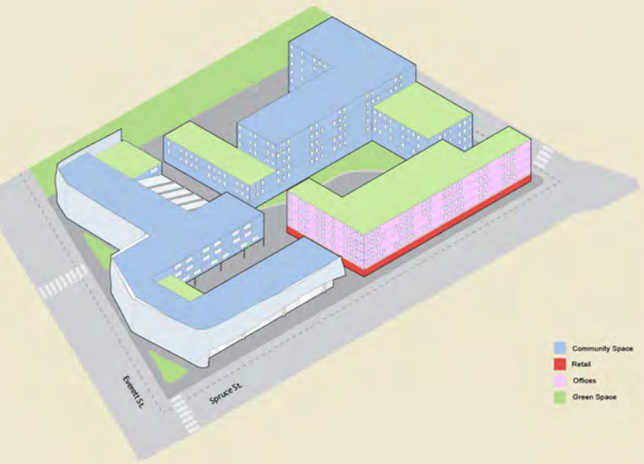
A Civic Hub

Between Spruce and Everett Ave

This proposal reimagines a central parcel as a civic anchor that bridges Chelsea's past and future—linking the historic fire station, one of the few remaining heritage structures in West Chelsea, with a new cultural center. This center would serve as a hub for storytelling, gathering, and celebration, highlighting the city's immigrant histories, labor movements, environmental justice struggles, and collective resilience through events like historic fires and the pandemic. Potential stakeholders and advocates include La Colaborativa, Bunker Hill Community College, local consulates, the City of Chelsea, and the small business incubator across the street—each bringing programming, partnership, and community presence. Together, this block aspires to become a vibrant, inclusive space that embodies Chelsea's civic identity and cultural pride.

Parcel Location

Existing Conditions



1

Interior View of Cultural Center

1

View From SouthEast Parcel

2

View of Revived Historic Path


Spruce St.
Everett St.
Retail
Retail
Retail
Retail
Retail
Retail
Retail
Retail
Consulate of Honduras
Daycare
Retail
Event Space
Cafe
Gallery
Admin.
Admin.
Admin.
Admin.
Cafeteria
Workspace
Sculpture Garden
Gallery
Admin.
Admin.
Admin.
Admin.
Green Corridor
Arboretum
A


Spruce St.
Everett St.
Office
Office
Office
Office
Office
Office
Office
Gallery
Gallery
Gallery
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Classroom
Sculpture Garden
Artist Housing
A


20´
60´
120´
20´
60´
120´
Cheslea's Culture Center
Everett Street
Water used to irrigate plants
Water diverts to basins and swale

Civic & Commerce Core

Between Arlington Street and Spruce Street

This block anchors the West Chelsea master plan as a vibrant hub for community life and local entrepreneurship. A new plaza fronts the Entrepreneurship Building, developed with La Colaborativa to support small businesses through shared office space, mentorship programs, and retail opportunities.

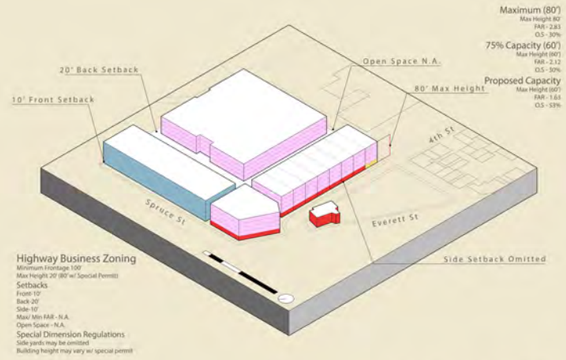
Responding to the city's RFP for a community center, the site offers a resilience-focused space with childcare, mixed-age working lounges, public greenhouses, and flexible gathering areas. It directly connects to La Finca, a large urban farm, reinforcing ties to food sovereignty and community care.

The plaza doubles as green infrastructure — a detention basin collects stormwater overflow from adjacent lots to the southwest, making climate resilience visible and functional.

Parcel Location | Flood Analysis

Existing Conditions | Land Owners

Second Floor Plan



Zoning Limit

Proposed Axonometric | Program Diagram

**Scale Bars are 300'*

Site Plan

1 *View of West Chelsea Community Center*

2 *View of Plaza Detention Basin*

3

View of Children's Garden

4 *View of Plaza Central Courtyard*

Chapter 4: Modeling

L-GrID, also known as the Landscape Green Infrastructure Design model, is a process-based modeling tool that allows for the design development of green infrastructure. The software tests different landscapes under storm conditions to test how to mitigate urban flooding. The model begins with a current map of the area. This information includes elevation that is topped with the land cover, including buildings, streets, permeable, and impermeable surfaces. The green infrastructure can be aggregated across the site area, which includes bioswales/rain gardens, permeable pavers, green roofs, and rain barrels.

We heard from the people of Chelsea that flooding in the area was catastrophic, so we began to research how we could mitigate the amount of flooding in the district. Through our masterplan proposal of West Chelsea, we dug a bioswale that spanned across the site. With the additional soil we treated and strategically placed it in areas with low elevation and higher risk of flooding. Using the elevation change tool, we decided where to raise certain areas and by how many inches. The next step was adjusting the land cover for the new streets and buildings in our proposal. The land cover change tool was made available and we were then allowed to model roads, buildings, permeable, and impermeable surfaces in new locations.

Based on the flooding changes with elevation and land cover redesign, we determined which GI and in which location is most effective. Each GI's rigor can be edited by adjusting the water-holding capacity or by placing multiple adjacent to one another. As a class, we modeled trees using rain barrels with a capacity of 200 liters, which is typical for a fully matured deciduous tree. To model underground cisterns, we placed multiple rain barrels on the roof of a building.

Our project aimed to not get rid of flooding, but to intentionally direct the water in areas that can withstand heavy flooding and direct it into nearby water bodies. As we ran multiple storm tests, we aimed to see less flooding on impermeable surfaces and more flooding on impermeable surfaces.

Existing Conditions

Data gathered from L-Grid

We composed different studies using L-Grid to research the best way to manipulate the site's topography and GBI. Initially, we began by running queries over the existing site to see which areas were most susceptible to flooding (Fig.1). We found that the most amount of flooding happened along 2nd Street, Spruce Street, and 4th Street. The dark black pixels indicate flooding. Once we pinpointed the most vulnerable areas, we researched how the site could change to minimize the amount of flooding in the area. Most of the flooding happens in smaller depressions around the site, but a big variable for flooding is correlated to the surface type; generally, permeable surfaces experienced less flooding than impermeable surfaces. That is why our proposed masterplan included more permeable blocks, with vegetated spaces, and promote the use of GBI to prevent flooding.

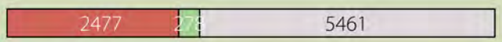
Fig. 1

100-year-storm: existing conditions

Greatest Depth over 1"

Percent of flooded area in permeable land: **3.38%**

Percent of flooded area in impermeable land: **30.15%**



Greatest Depth over 3.5"

Percent of flooded area in permeable land: **2.52%**

Percent of flooded area in impermeable land: **25.26%**

In the existing plan of West Chelsea, we found that during a 100-year-storm 33% of the site experienced flooding (over 1"). When we compared it to the proposed master plan we found equal amounts of flooding (without GBI or topography changes). We then changed the topography in the proposed site and saw major changes from existing plan.

Changing the topography of the proposed site allowed us to add green corridors to "guide" water to areas of the site meant to hold water and guide it to the larger constructed wetland. The data for a 100-year-storm (Fig.2) showed a 24% improvement to the site's flood amount. The amount of flooding (greatest depth over 1") decreased from 33% to 29%, but more than ¾ of the flooding is now in detention basins and green swales.

Total Pixels : 8216

#of flooded pixels in imperable land

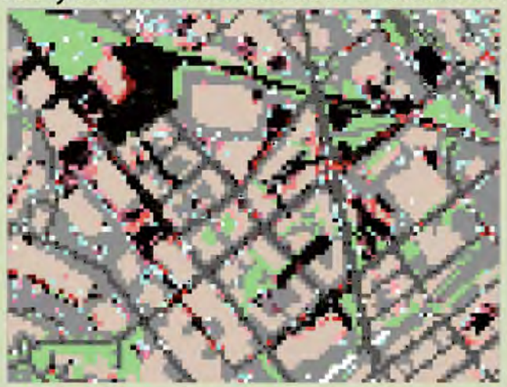
#of flooded pixels in permeable land

#of pixels NOT flooded

After changing the elevation, we added GBI to public areas (Streets, Wetlands and Green Spaces). When we ran the query we found that adding GBI to the public areas further increased the water management in West Chelsea; the 100-year-storm (Fig.3) shows the results of the site with edited elevation and added GBI, and shows an improvement by 14% less flooding compared to the elevation study. The data shows that elevation and GBI changes decrease flooding (over 1") by 30% compared to the existing plan. The most effective change to the site is manipulating the terrain to guide the water through the site, bring the building footprints higher than the flood line.

Fig. 2

100-year-storm: elevation + landcover

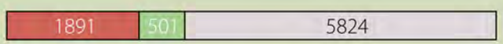


Greatest Depth over 1"

Percent of flooded area in permeable land: **6.10%**

24% Improvement from Existing Conditions

Percent of flooded area in impermeable land: **23.02%**



Greatest Depth over 3.5"

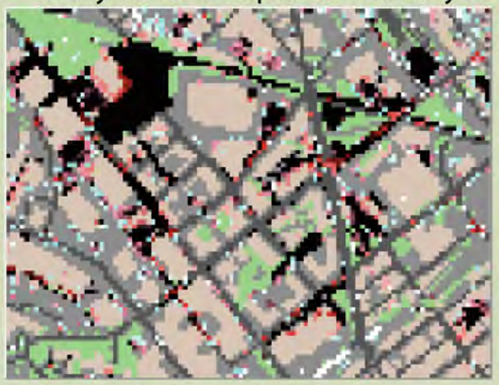
Percent of flooded area in permeable land: **5.48%**

24% Improvement from Existing Conditions

Percent of flooded area in impermeable land: **19.19%**

Fig. 3

100-year-storm: public GBI only



Greatest Depth over 1"

Percent of flooded area in permeable land: **7.55%**

14% Improvement from Elevation+Land Cover

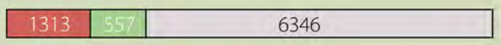
Percent of flooded area in impermeable land: **19.83%**

Greatest Depth over 3.5"

Percent of flooded area in permeable land: **6.78%**

17% Improvement from Elevation+Land Cover

Percent of flooded area in impermeable land: **15.98%**



Proposed Conditions

Data gathered from L-Grid

After researching the existing site, we wanted to study the most effective amount of GBI to add to the site. We ran tests with the maximum amount of GBI we could add to each parcel and the results from 10%, 20%, and 30% GBI. We found that with maximum GBI (Fig.4) in the site we could reduce flooding (over 1") by 44% compared to the existing conditions; but, maximizing GBI is very expensive and unrealistic. We studied how the site flooded in 10% intervals of GBI. Starting with a 10% landcover of GBI, we found that the flooding (over 1") improved by 10% from the public GBI study (Fig.5). The 20% GBI study (Fig.6) showed a minor 4% improvement from the 10% study (Fig.5). Lastly, the 30% GBI study (Fig.7) showed that there was a 1% improvement from the 20% study (Fig.6).

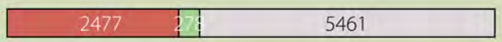
Fig. 1

100-year-storm: existing conditions

Greatest Depth over 1″

Percent of flooded area in permeable land: **3.38%**

Percent of flooded area in impermeable land: **30.15%**



Greatest Depth over 3.5″

Percent of flooded area in permeable land: **2.52%**

Percent of flooded area in impermeable land: **25.26%**

Total Pixels : 8216

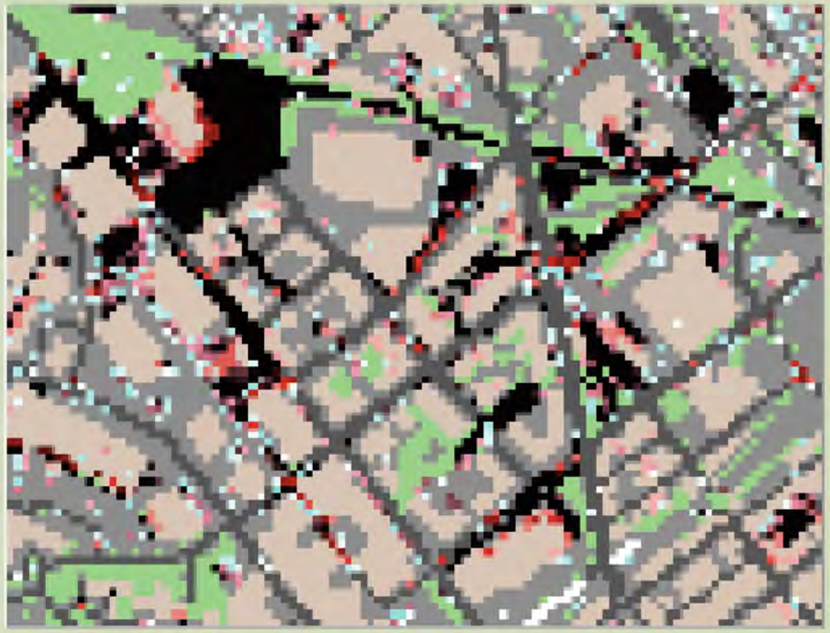
#of flooded pixels in imperable land

#of flooded pixels in permeable land

#of pixels NOT flooded

Fig. 4

100-year-storm: max GBI

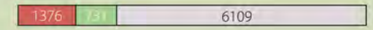


Greatest Depth over 1″

Percent of flooded area in permeable land: **8.90%**

Percent of flooded area in impermeable land: **16.75%**

44% Improvement from Existing Conditions



Greatest Depth over 3.5″

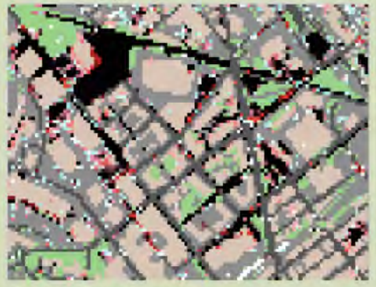
Percent of flooded area in permeable land: **8.17%**

Percent of flooded area in impermeable land: **13.06%**

48% Improvement from Existing Conditions

Fig. 5

100-year-storm: 10% GBI

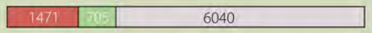


Greatest Depth over 1″

Percent of flooded area in permeable land: **8.58%**

Percent of flooded area in impermeable land: **17.90%**

10% Improvement from Public GBI Only



Greatest Depth over 3.5″

Percent of flooded area in permeable land: **7.91%**

Percent of flooded area in impermeable land: **14.13%**

12% Improvement from Public GBI Only

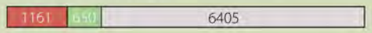
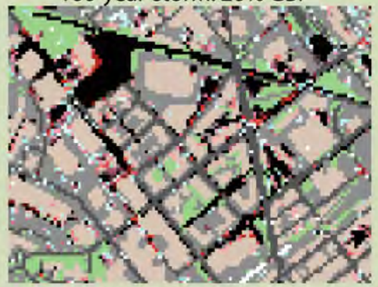


Fig. 6

100-year-storm: 20% GBI

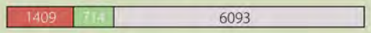


Greatest Depth over 1″

Percent of flooded area in permeable land: **8.69%**

Percent of flooded area in impermeable land: **17.15%**

4% Improvement from 10% Public GBI



Greatest Depth over 3.5″

Percent of flooded area in permeable land: **8.14%**

Percent of flooded area in impermeable land: **13.50%**

4% Improvement from 10% Public GBI

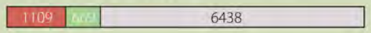
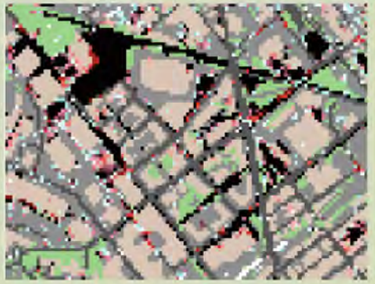


Fig. 7

100-year-storm: 30% GBI

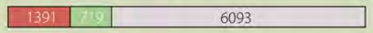


Greatest Depth over 1″

Percent of flooded area in permeable land: **8.75%**

Percent of flooded area in impermeable land: **16.93%**

1% Improvement from 20% Public GBI

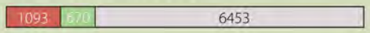


Greatest Depth over 3.5″

Percent of flooded area in permeable land: **8.15%**

Percent of flooded area in impermeable land: **13.30%**

1% Improvement from 20% Public GBI



Below is a summary of our efforts to quantify and visualize open space, vegetated areas, and Green-Blue Infrastructure (GBI) within West Chelsea. The following set of diagrams, created with the data provided by LGrid, highlights these spatial elements at both the district and parcel scale.

Figure 8: Percentage of open space in TOD district level

TOD District Level
Open Space: 69%

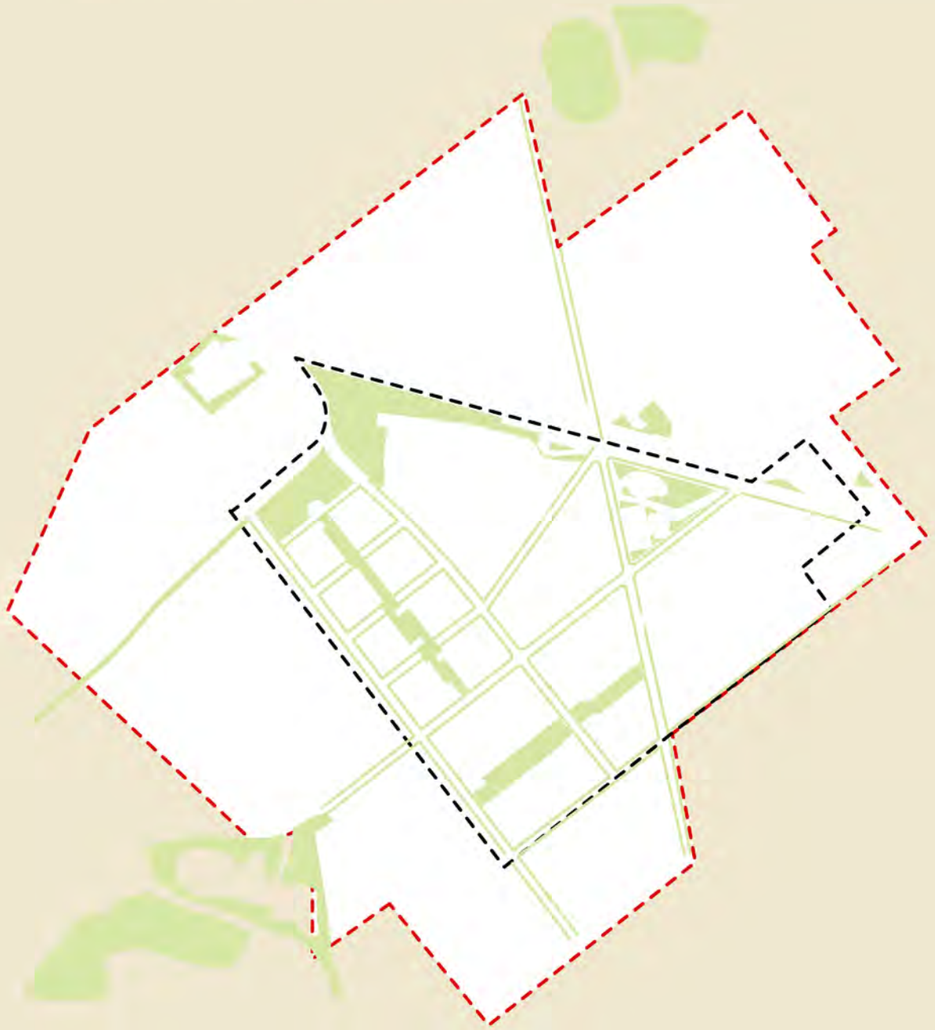
- West Chelsea
- Buildings
- TOD District Boundary
- Designed Parcels

Figure 9: Percentage of open space in designed parcels only

Designed Parcels Only
Open Space: 25%

- West Chelsea
- Buildings
- TOD District Boundary
- Designed Parcels

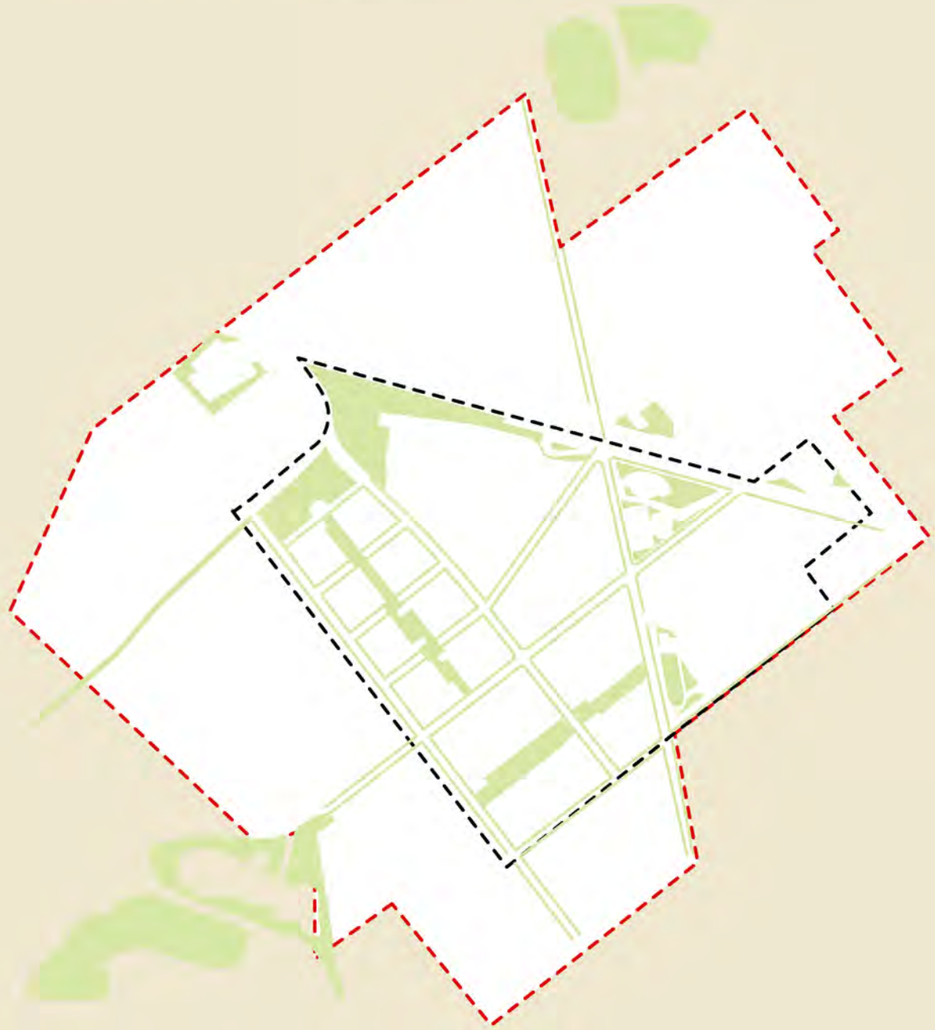
Figure 10: Percentage of open space in TOD district level



TOD District Level
Vegetated Cover: 6%

- Vegetated Cover (Public Land)
- TOD District Boundary
- Designed Parcels

Figure 11: Percentage of open space in designed parcels only



Designed Parcels Only
Vegetated Cover: 17%

- Vegetated Cover (Public Land)
- TOD District Boundary
- Designed Parcels

Figure 12: GBR (green blue infrastructure ratio) within public areas only in the TOD district level

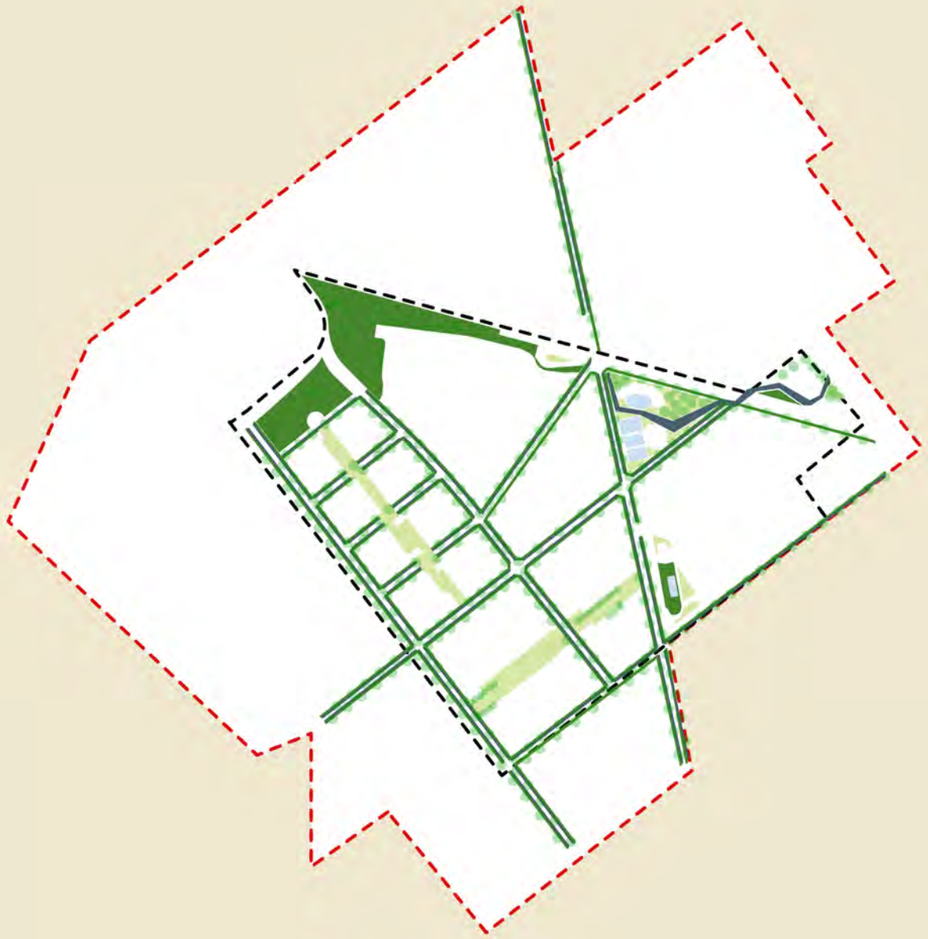
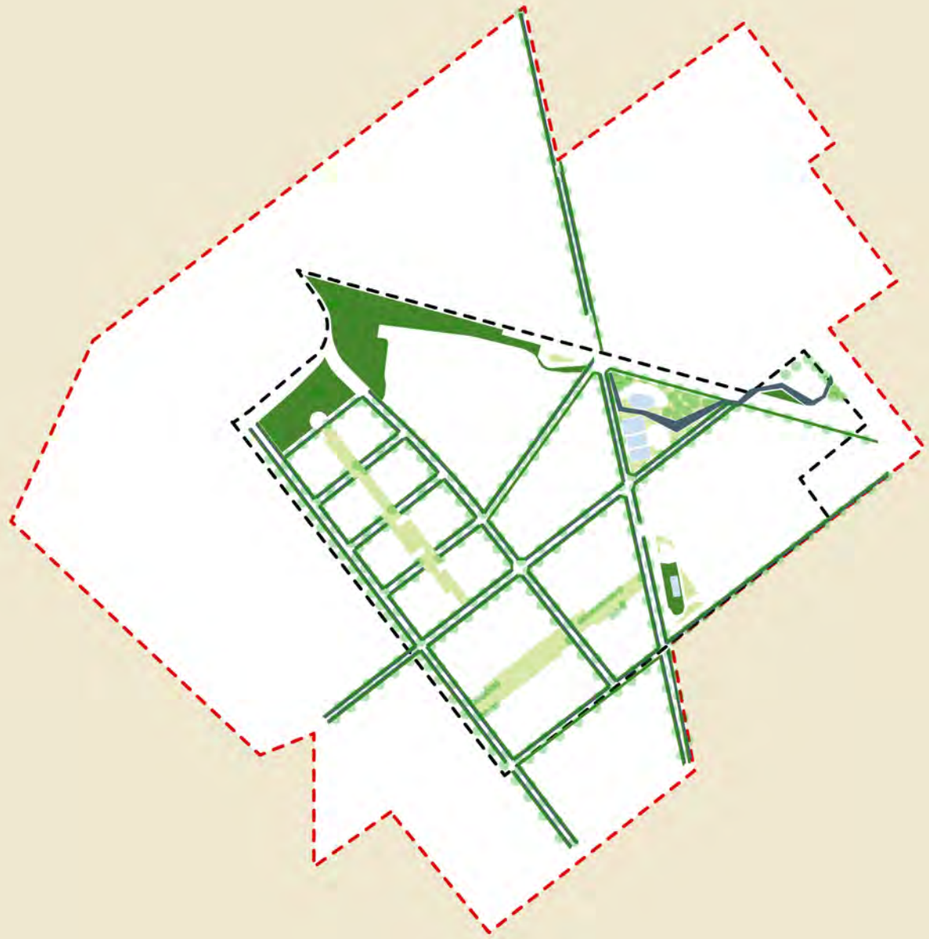


Figure 13: GBR (green blue infrastructure ratio) within public areas only, only accounting for the designed area



Conclusion

Our proposals intentionally foreground what is possible when community benefits are prioritized in planning. The parcels are designed as thoughtful responses to the community needs identified by La Colaborativa in our initial conversations, while taking into consideration the long-term environmental effects.

The proposals are meant to serve as flexible starting points, shaped by what we understand to be the city and community priorities. They are intended to spark meaningful conversations between stakeholders and designers, combining valuable knowledge from all parties to create the best possible outcome. For the best chance of success, Chelsea residents must be involved in every step of the process in order to give the community a voice to their future.

Thank You

We want to thank our partners at the City of Chelsea, La Colaborativa, City Council, Utile, Studio Luz, and Northeastern for their invaluable contributions to the creation and realization of this project, and for trusting us with this work. As architecture students, we deeply value opportunities to collaborate with communities and design with real people in mind. This experience reminded us of the impact thoughtful urban design can have when rooted in local voices.

We're also incredibly grateful to Professor Michelle Laboy, whose guidance made this semester's project very inspiring. It was a joy to learn and design under her mentorship!

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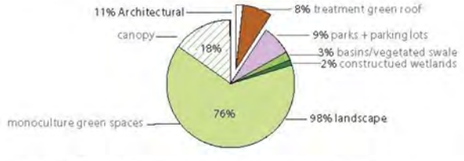
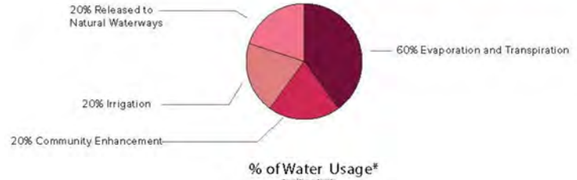
Appendix - Case studies

Scharnhauser Park

Ostfildern, Germany - 2004



% of Total Stormwater Management Areas



% of Water Usage*

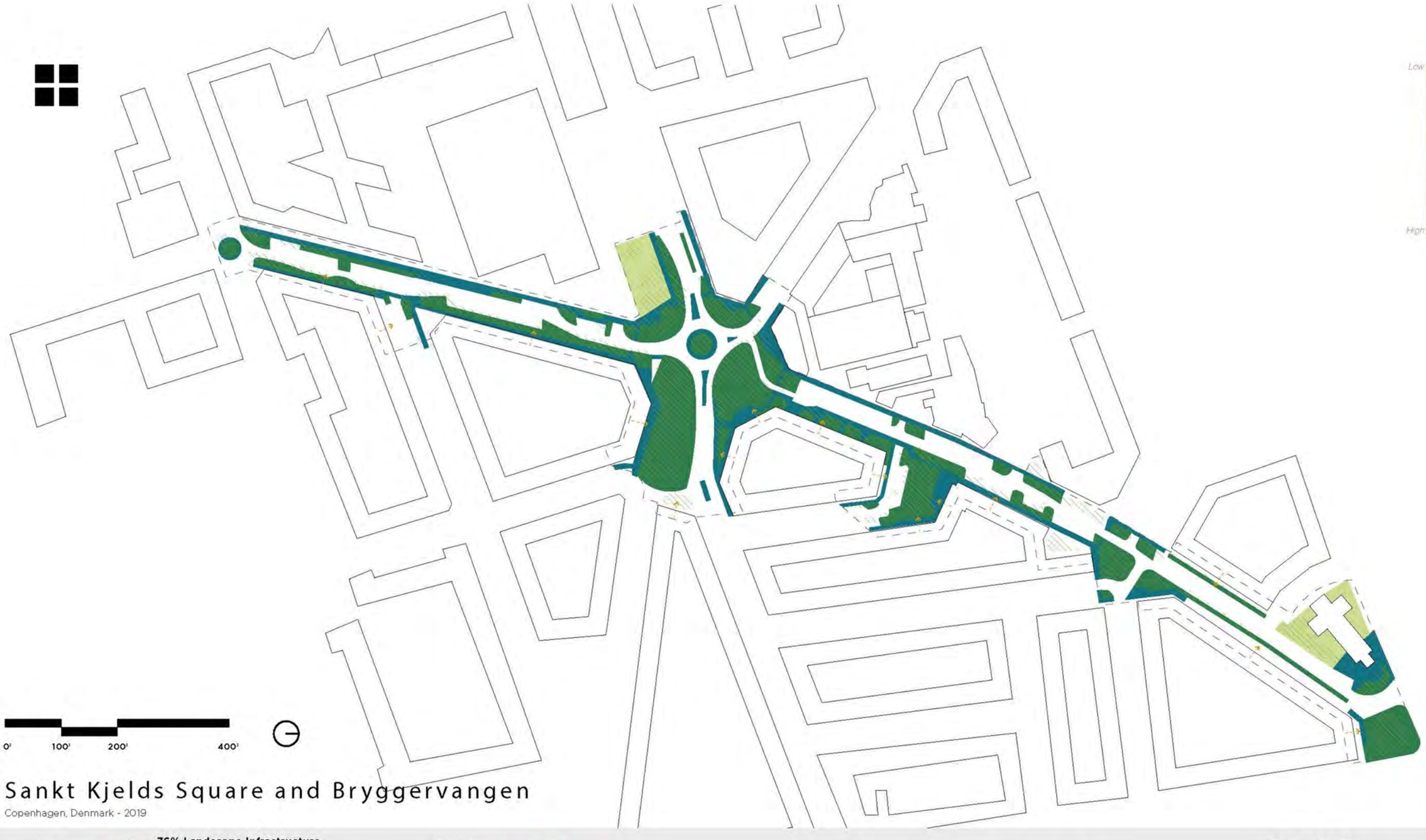
*qualitative estimate

O.S. = 98 %

SITE AREA = 373 acres (148 hectares)

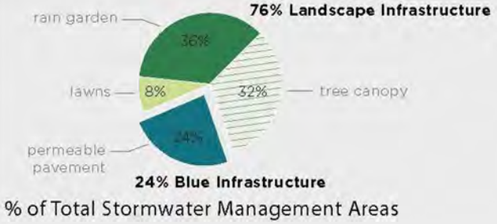
GBR= 0.13

F.A.R. = 0.04

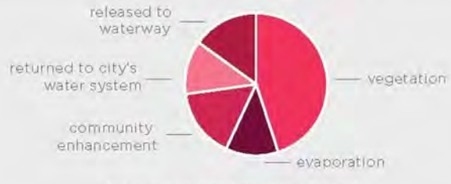


Sankt Kjelds Square and Bryggervangen

Copenhagen, Denmark - 2019



% of Total Stormwater Management Areas



Programmatic Reuse of Water

SITE AREA = 7.8 acres (373,955 ft^2)

Roof water flow

O.S. = 85 %

G.B.R. = .45

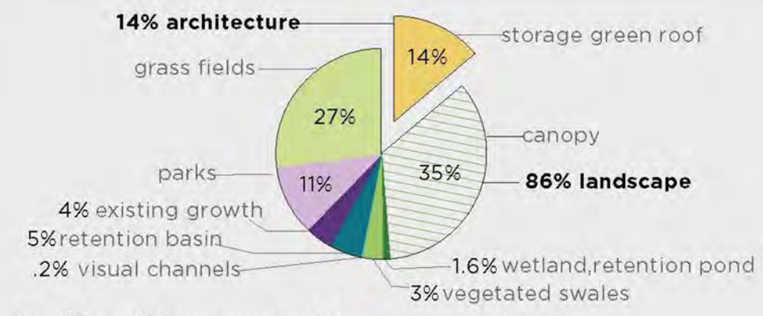
F.A.R. = 2.2

meters - scale = 1:3000

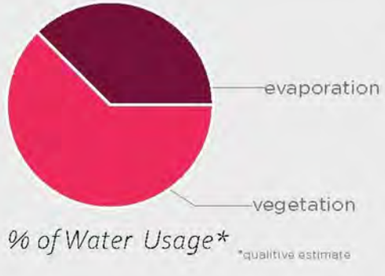
50 100 200

Augustenborg

Malmo, Sweden - 1998



% of Total Stormwater Management Areas



*% of Water Usage**

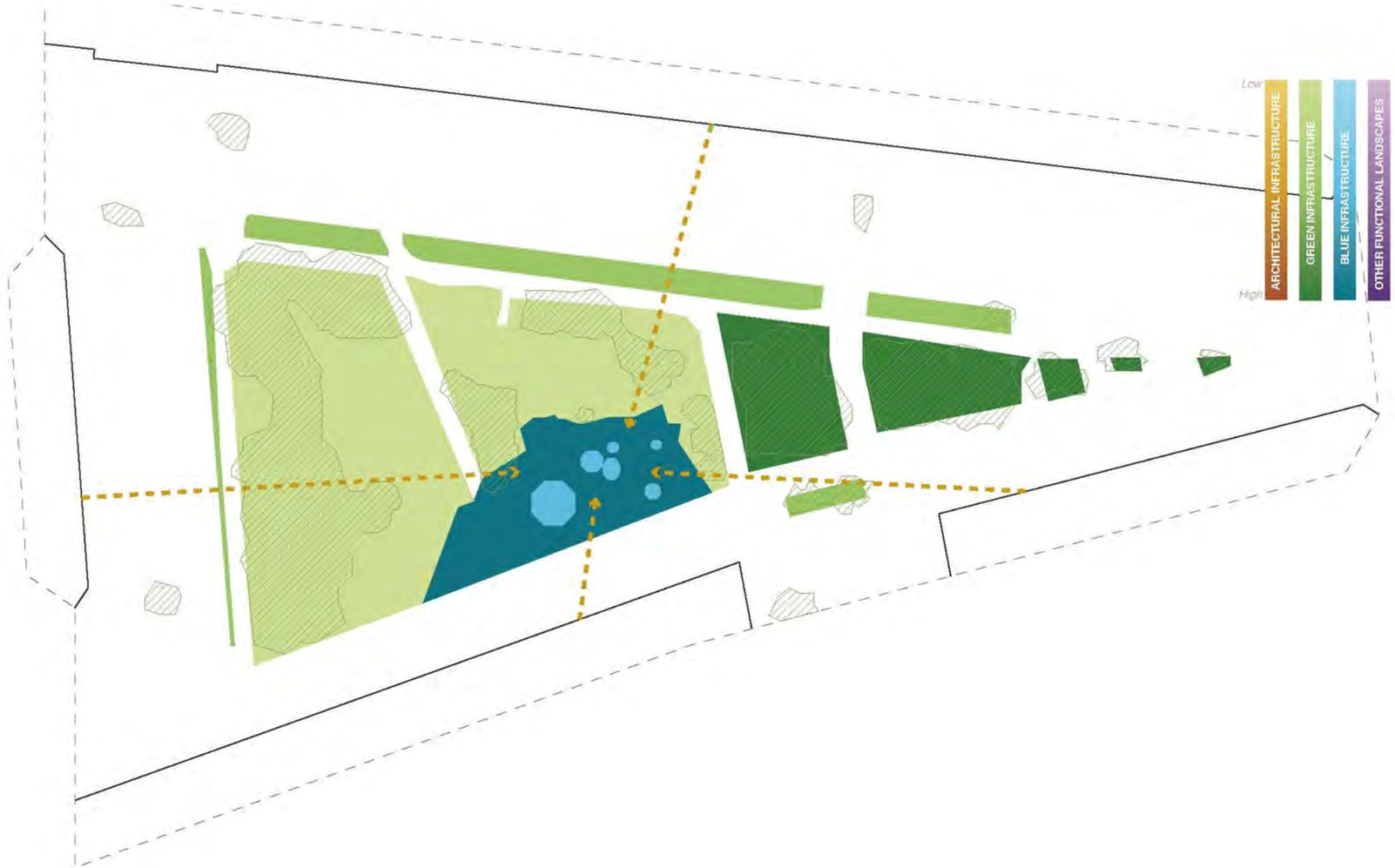
*qualitive estimate

SITE AREA = 75.1 acres (30.4 hectares)

O.S. = 76 %

GBR= .42

F.A.R. = .77



Tasinge Plads

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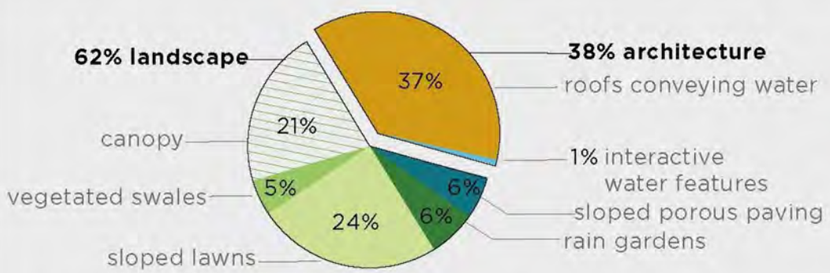
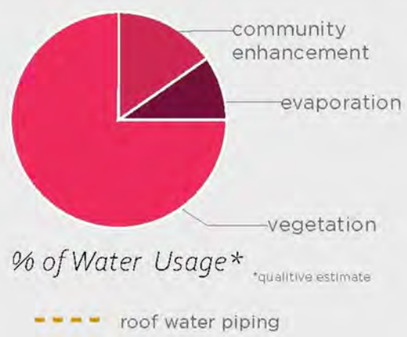


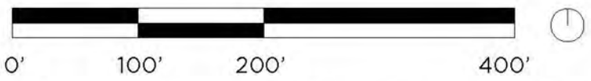


SITE AREA = 2.11 acres (.85 hectares)

O.S. = 79 %

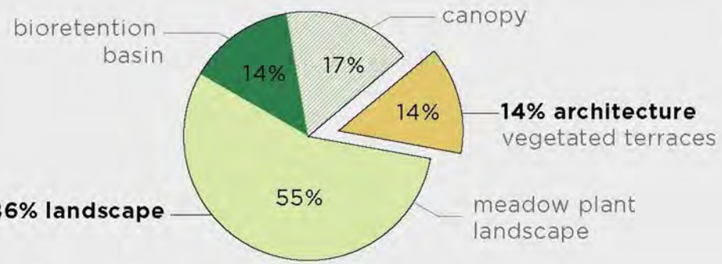
GBR. = .56

F.A.R. = 1.05

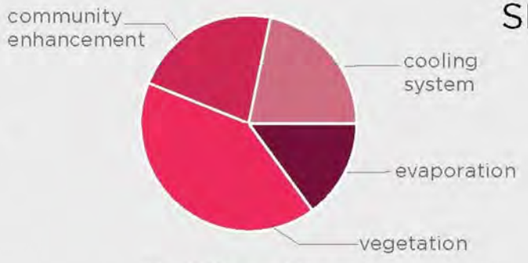


Harvard Science & Engineering Complex

Boston, Massachussetts - 2021



% of Total Stormwater Management Areas



*% of Water Usage** *qualitive estimate

SITE AREA = 16.2 acres (6.6 hectares)

10,030 ft^3 cistern

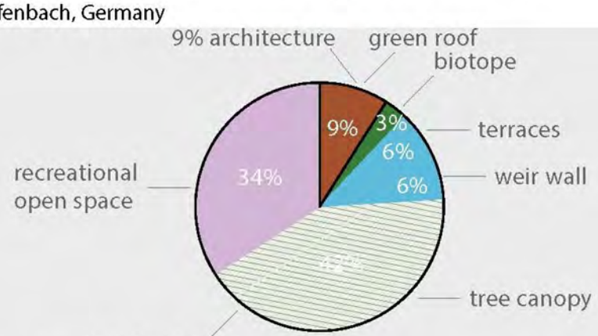
O.S. = 77 %

GBR. = 0.3

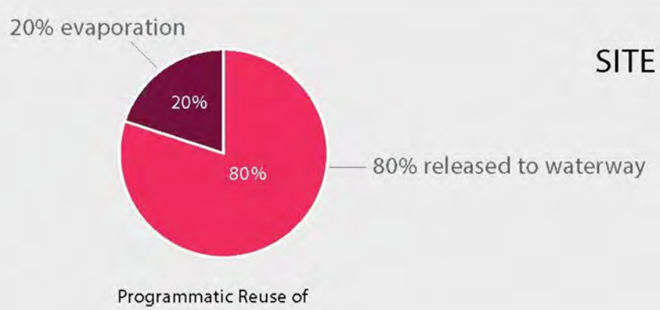
F.A.R. = 1.7

Offenbach Harbour

Offenbach, Germany



% of Total Stormwater Management Areas



Programmatic Reuse of

SITE AREA = 61.6 acres (29 hectares)

O.S. = 77.8 %

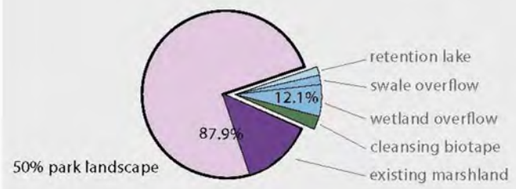
GBR. = 0.7

F.A.R. = 1.6

meters - scale= 1:7500

Nansen Park

Oslo, Norway (2008 - Present)



% of Total Green Blue Infrastructure

development area (under construction)

road

catchment area/ site boundary

SITE AREA = 126 acres (51 hectares)

O.S. = 75%

GBR = 0.5

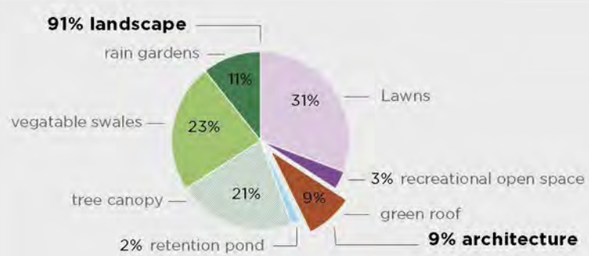
F.A.R. = 0.2

Low
High
ARCHITECTURAL INFRASTRUCTURE
GREEN INFRASTRUCTURE
BLUE INFRASTRUCTURE
OTHER FUNCTIONAL LANDSCAPES

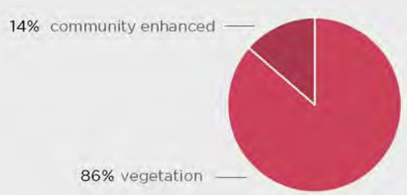
meters - scale = 1:12000
50 100 200

Hanover-Kronsberg

Kronsberg, Germany - 1998



% of Green Blue Infrastructure



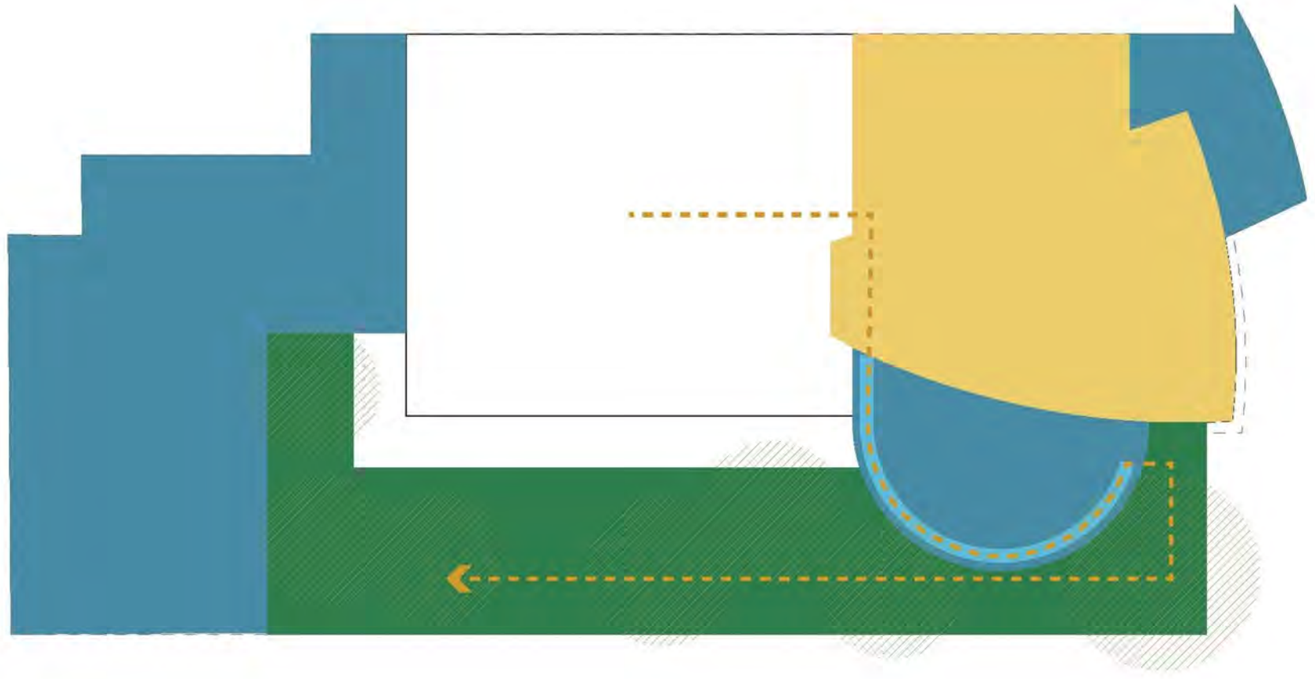
% of Water Usage

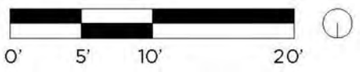
SITE AREA = 164.7 acres (66.3 hectares)

O.S. = 84 %

GBR= .47

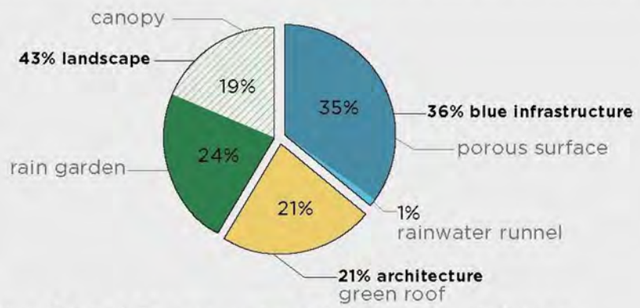
F.A.R. = .89



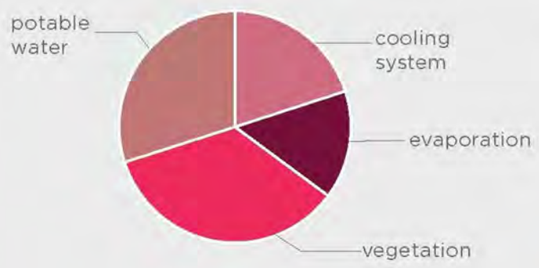


Bertschi School Living Building

Seattle, Washington - 2011



% of Total Stormwater Management Areas



SITE AREA = 0.1 acres (0.04 hectares)

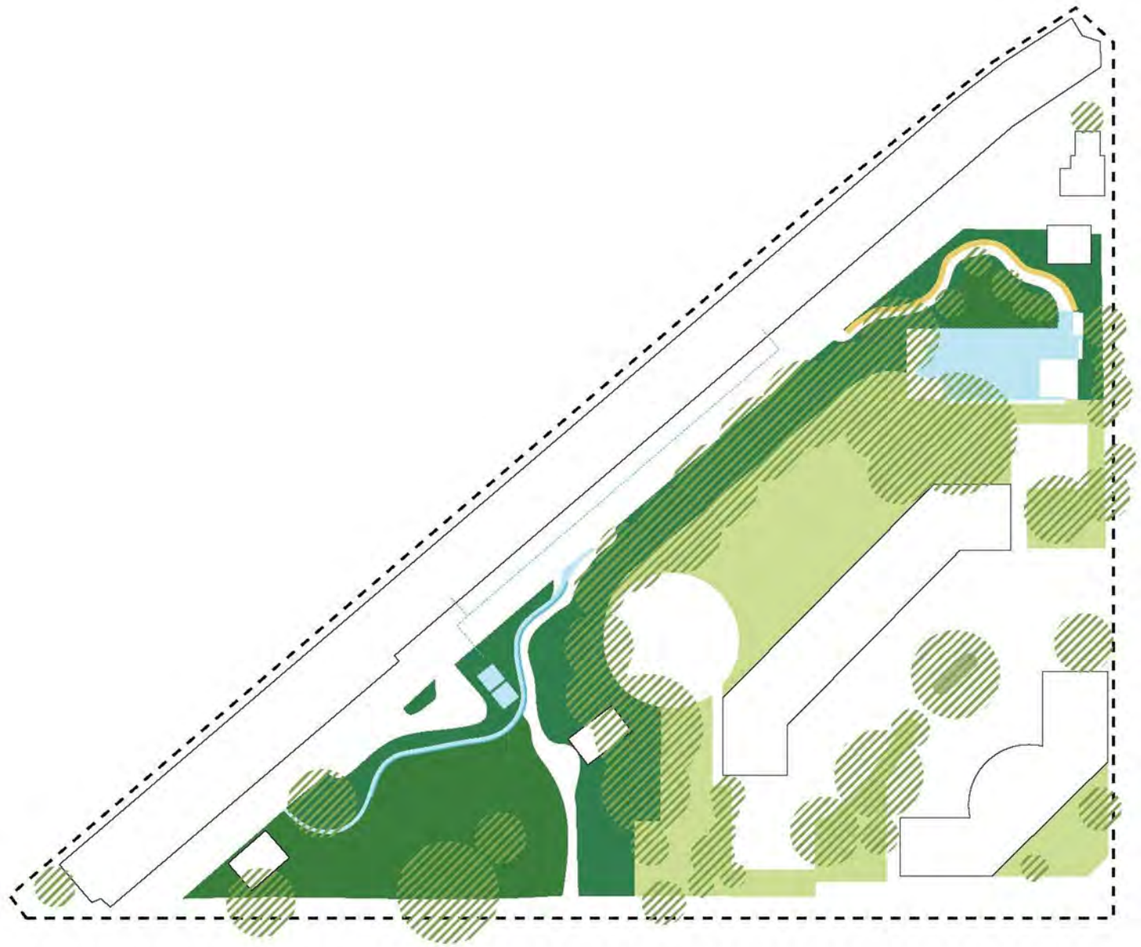
17.8 m^3 cistern

water trajectory

O.S. = 60 %

GBR. = 0.8

F.A.R. = 0.4

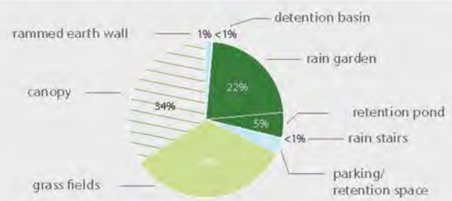


Low
ARCHITECTURAL INFRASTRUCTURE
GREEN INFRASTRUCTURE
BLUE INFRASTRUCTURE
OTHER FUNCTIONAL LANDSCAPES
High

50 100 200 300 feet - scale = 1:1000

Tomsgardsvej Open Courtyard

Copenhagen, Denmark - 2022



% of Total Stormwater Management Areas

95% landscape

5% blue strategies

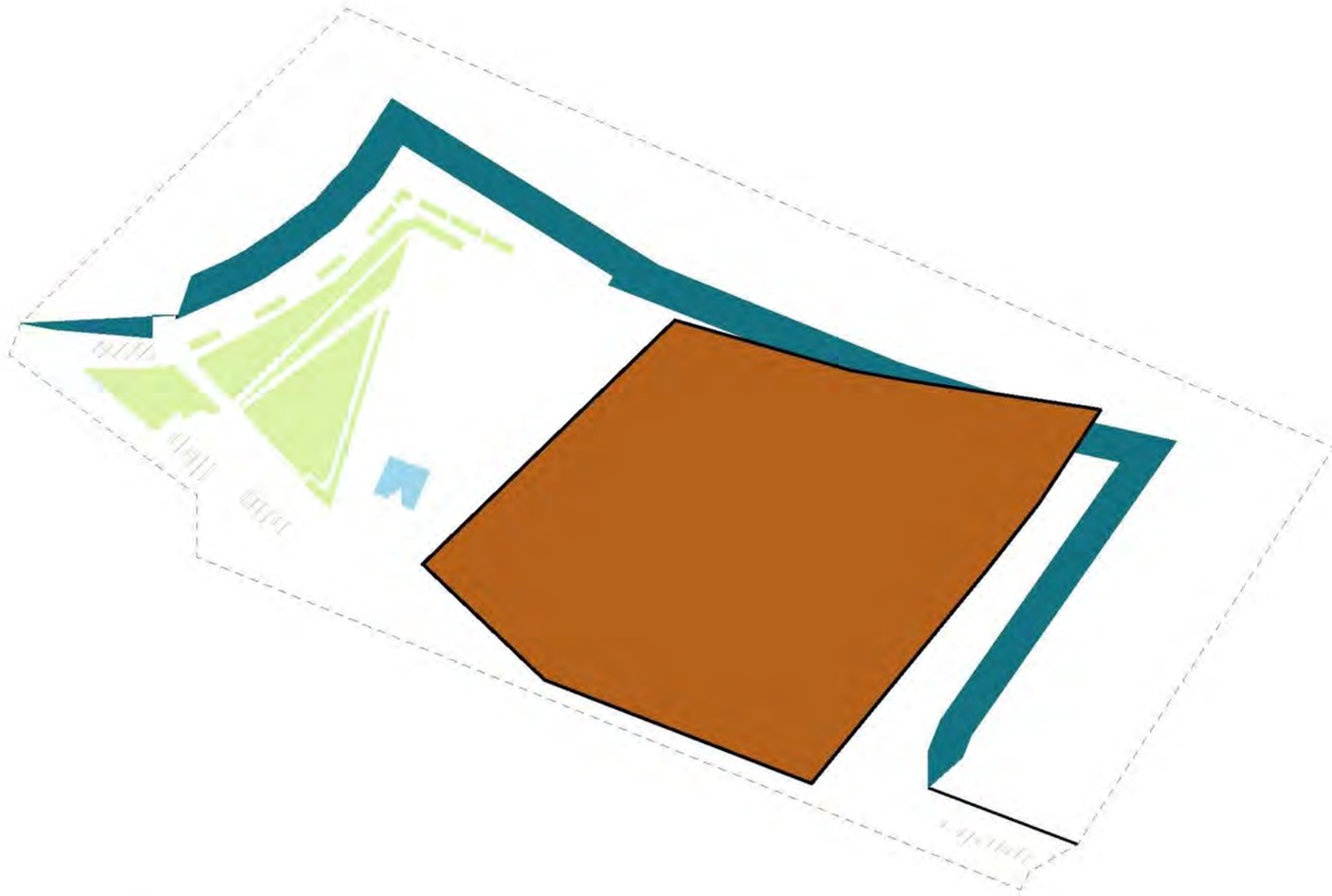
SITE AREA = 4.7 acres (1.9 hectares)

O.S. = 74%

Canopy = 20%

GBIR = .38

S.A.R. = .16

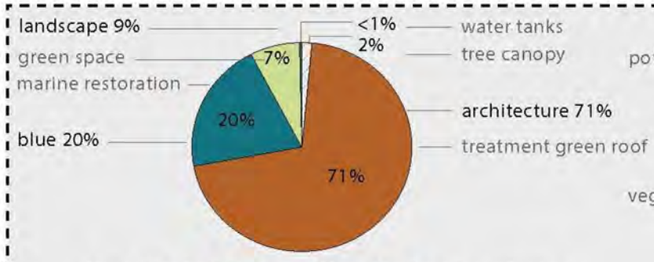


Low
High
ARCHITECTURAL INFRASTRUCTURE
GREEN INFRASTRUCTURE
BLUE INFRASTRUCTURE
OTHER FUNCTIONAL LANDSCAPES

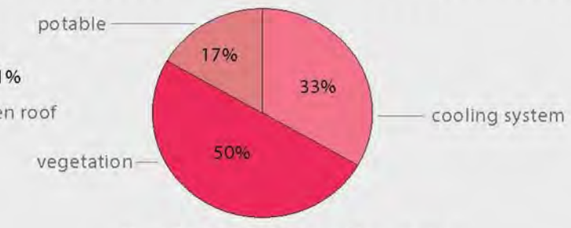
meters - scale = 1: 5000
5 10 20 30

Vancouver Convention Centre

Vancouver, Canada - 2009



% of Total Green Blue Infrastructures



% of Total Water Reusage

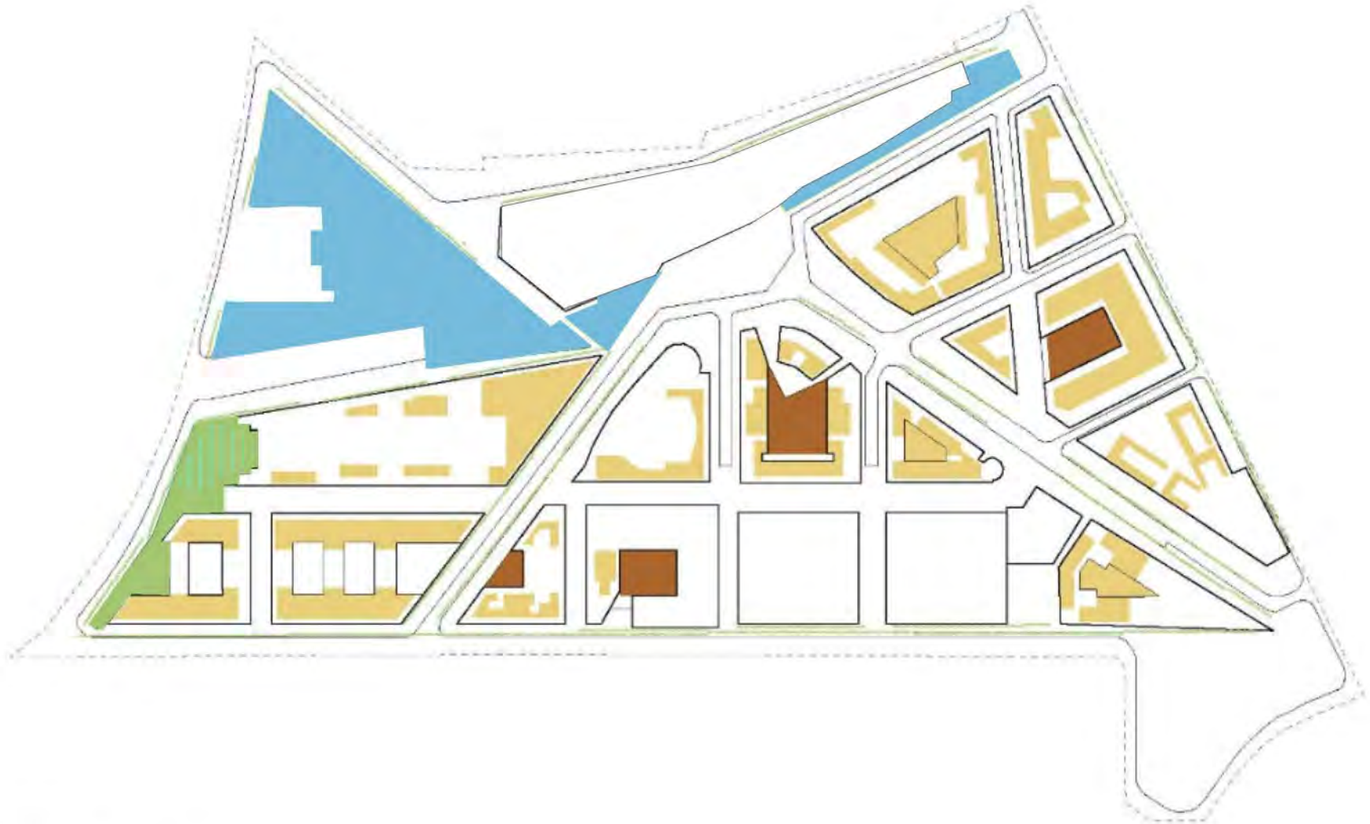
SITE AREA = 22 acres (8.9 hectares)

cistern

O.S. = 72 %

G.B.R. = .40

F.A.R. = 1.04

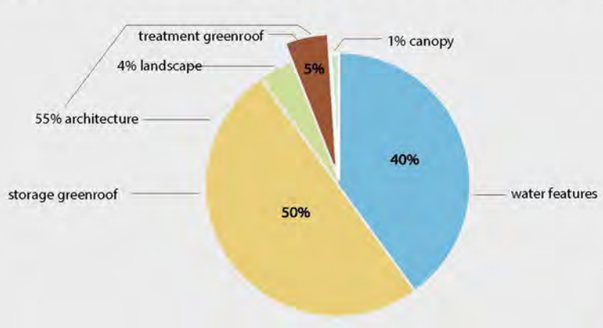


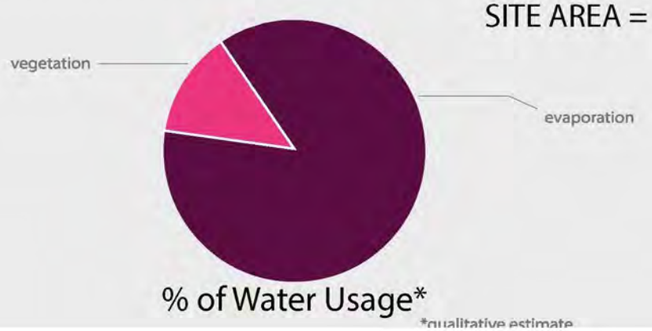
Low
High
ARCHITECTURAL INFRASTRUCTURE
GREEN INFRASTRUCTURE
BLUE INFRASTRUCTURE
OTHER FUNCTIONAL LANDSCAPES

meters - scale = 1:6000
25 50 100

Postdamer Platz

Berlin, Germany





% of Water Usage*

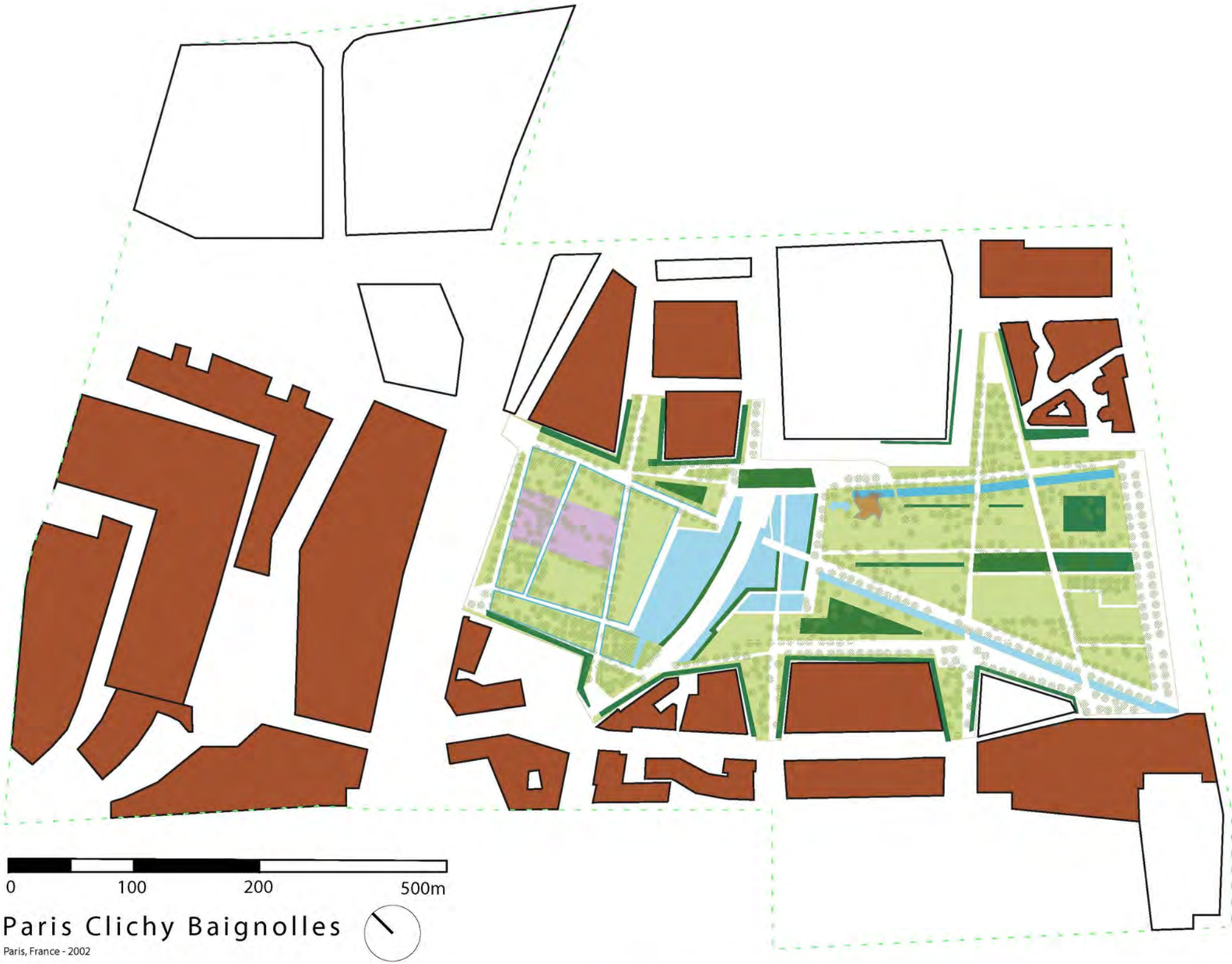
*qualitative estimate

SITE AREA = 27.5 acres (11.13 hectares)

O.S: 58%

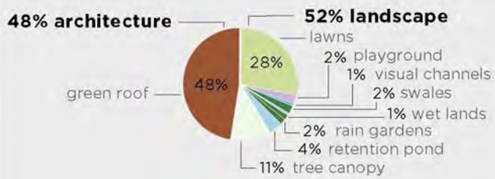
GBR: 31.9%

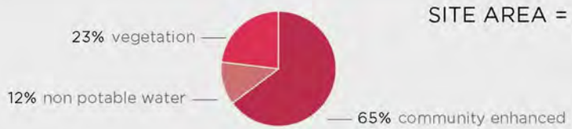
F.A.R: .20



Paris Clichy Baignolles

Paris, France - 2002

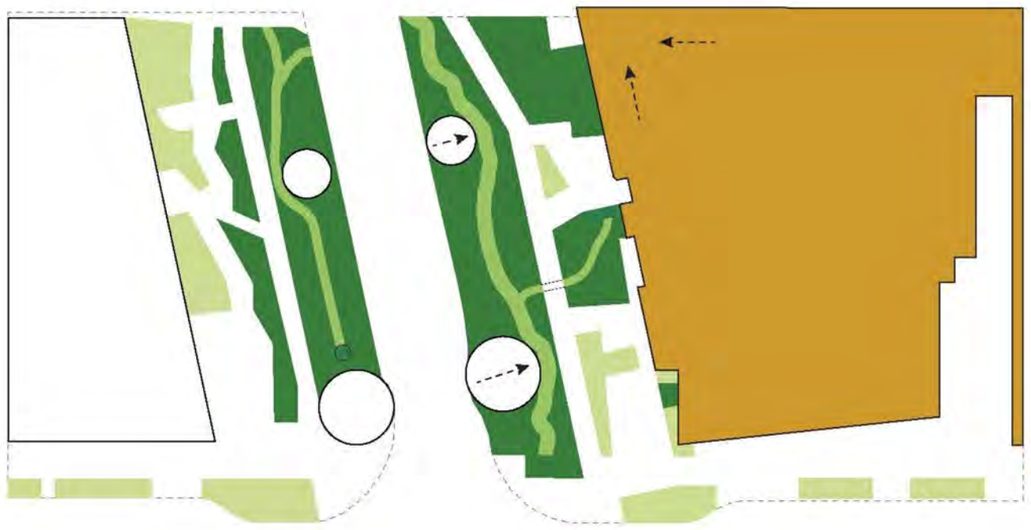


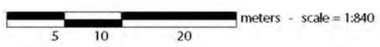


SITE AREA = 140.5 acres (56.8 hectares)

O.S. = 56 %

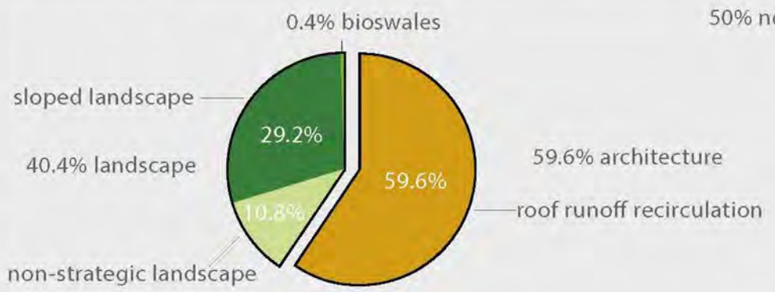
GBR= .41



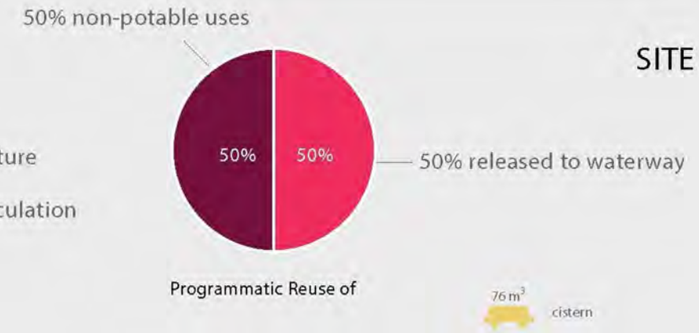


Watershed Building

Seattle, Washington



% of Total Stormwater Management Areas

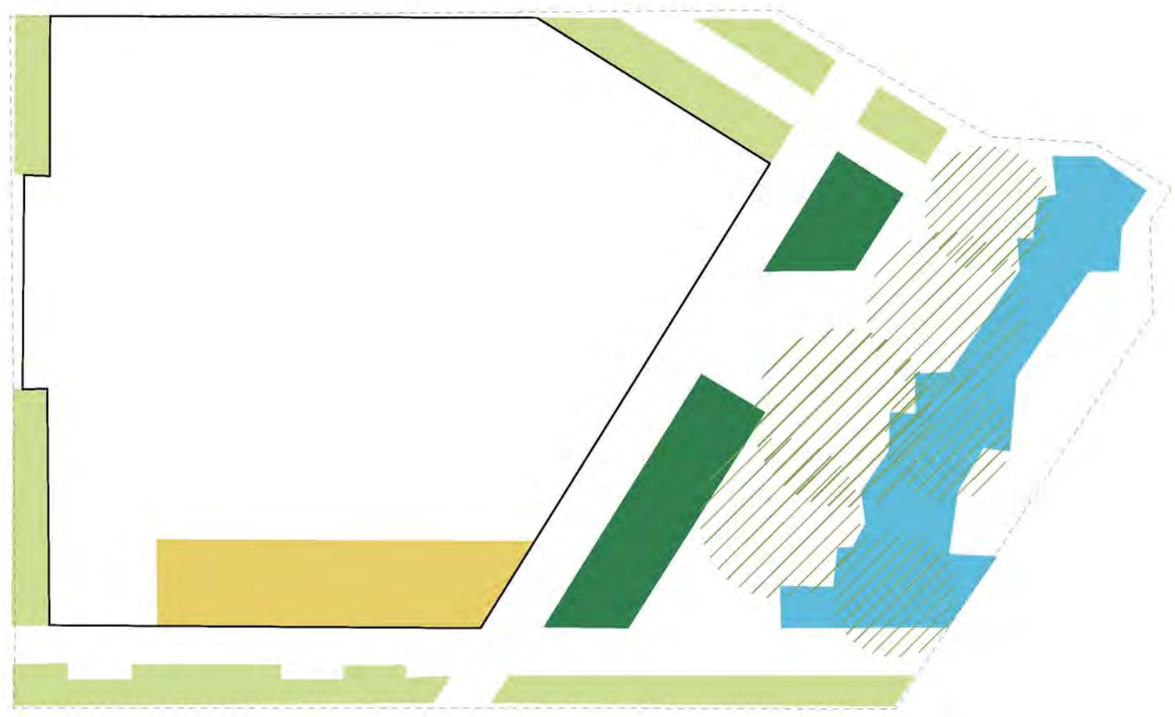


SITE AREA = 0.5 acres (0.2 hectares)

O.S. = 47 %

GBR. = 0.9

F.A.R. = 3.7

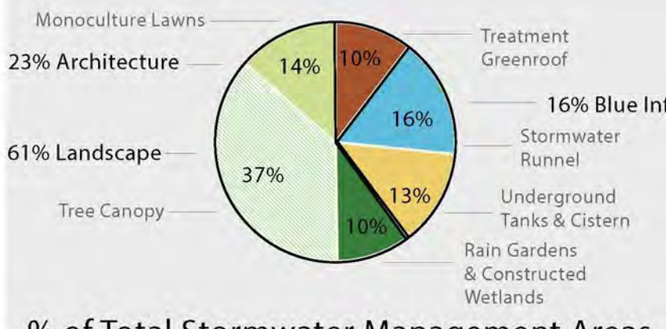


Low
ARCHITECTURAL INFRASTRUCTURE
GREEN INFRASTRUCTURE
BLUE INFRASTRUCTURE
OTHER FUNCTIONAL LANDSCAPES
High

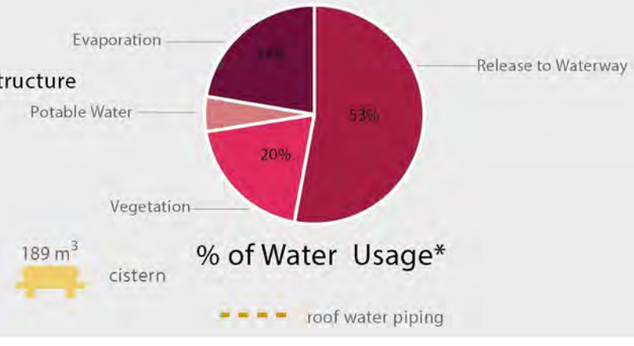
meters - scale = 1:840
5 10 20

Bullitt Center

Seattle, Washington -2013



% of Total Stormwater Management Areas



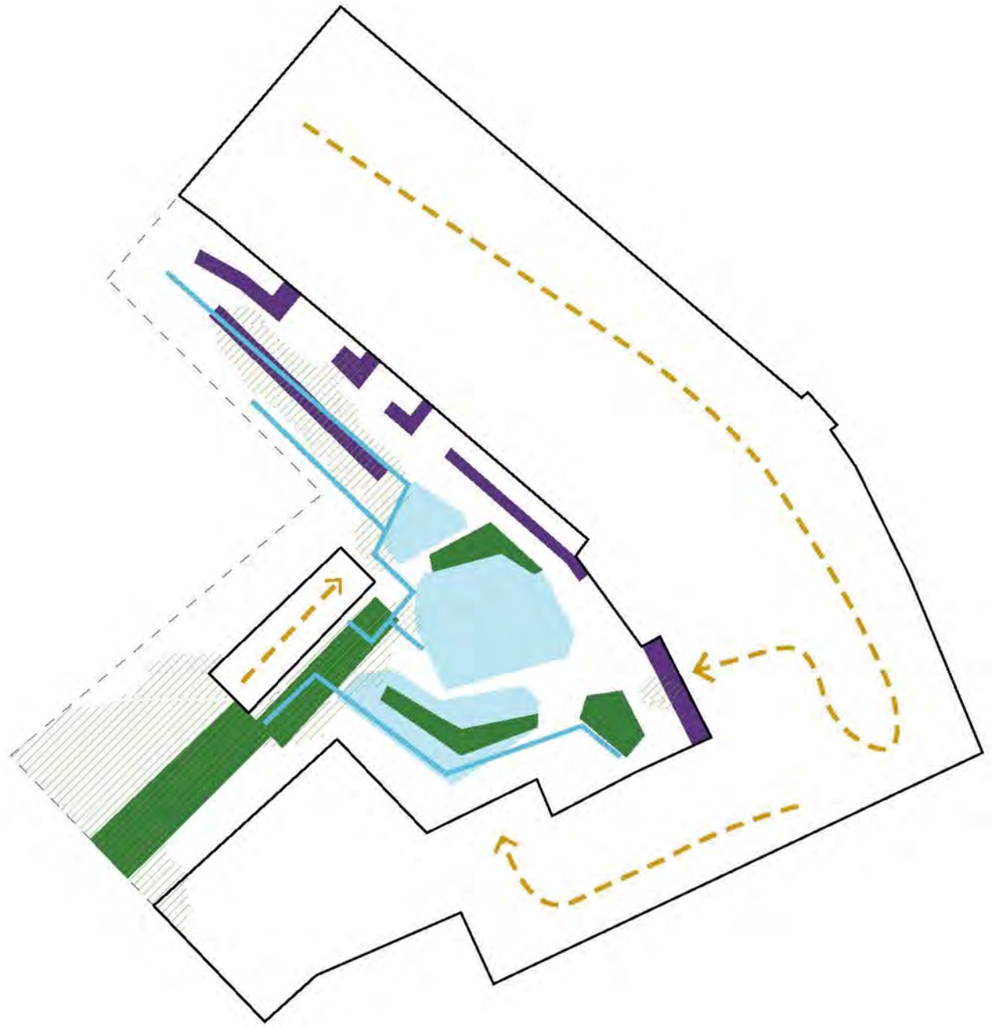
% of Water Usage*

SITE AREA = .6 acres

O.S. = 50 %

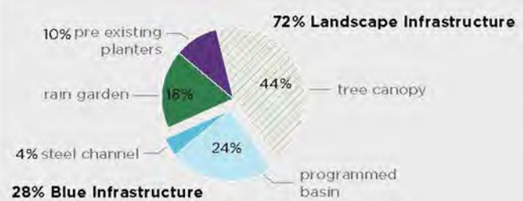
GBR. = .48

F.A.R. = 2.5

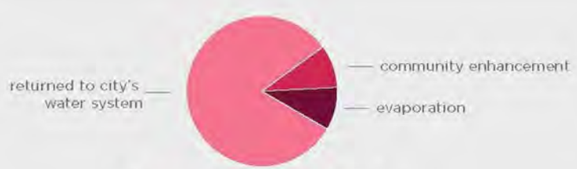


Water Square

Rotterdam, Netherlands - 2013



% of Total Stormwater Management Areas



Programmatic Reuse of Water

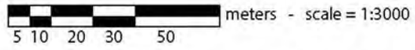
SITE AREA = 6.3 acres (275,319 ft^2)

Roof water flow

O.S. = 37 %

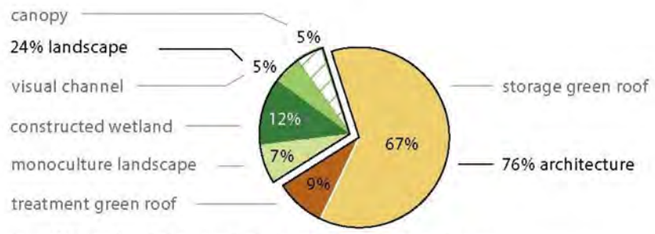
G.B.R. = .21

F.A.R. = 2.39

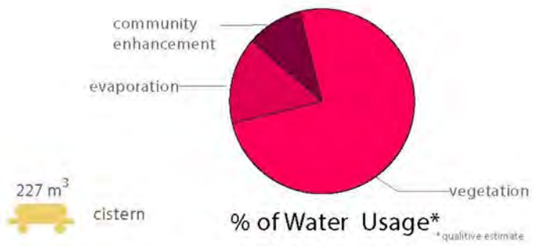


Hassalo on Eighth

Portland, Oregon - 2009



% of Total Stormwater Management Areas



% of Water Usage*

* qualitive estimate

SITE AREA = 6.6 acres (2.7 hectares)

O.S. = 46 %

GBR. = .25

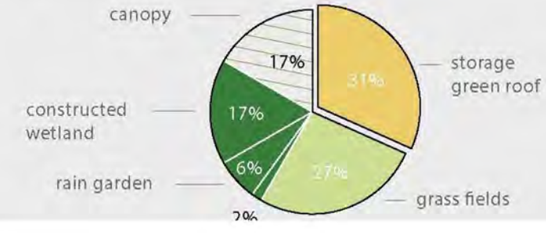
F.A.R. = 3.05

Low
High
ARCHITECTURAL INFRASTRUCTURE
GREEN INFRASTRUCTURE
BLUE INFRASTRUCTURE
OTHER FUNCTIONAL LANDSCAPES

5 10 20 30 meters - scale = 1:1200

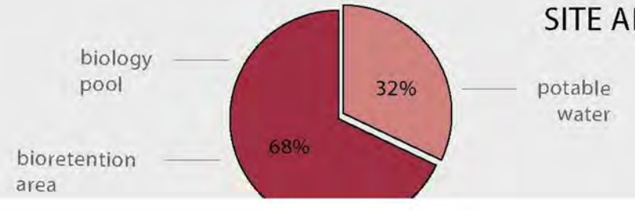
Sidwell Friends School

Washington, DC - 2007



69% landscape

31% blue strategies

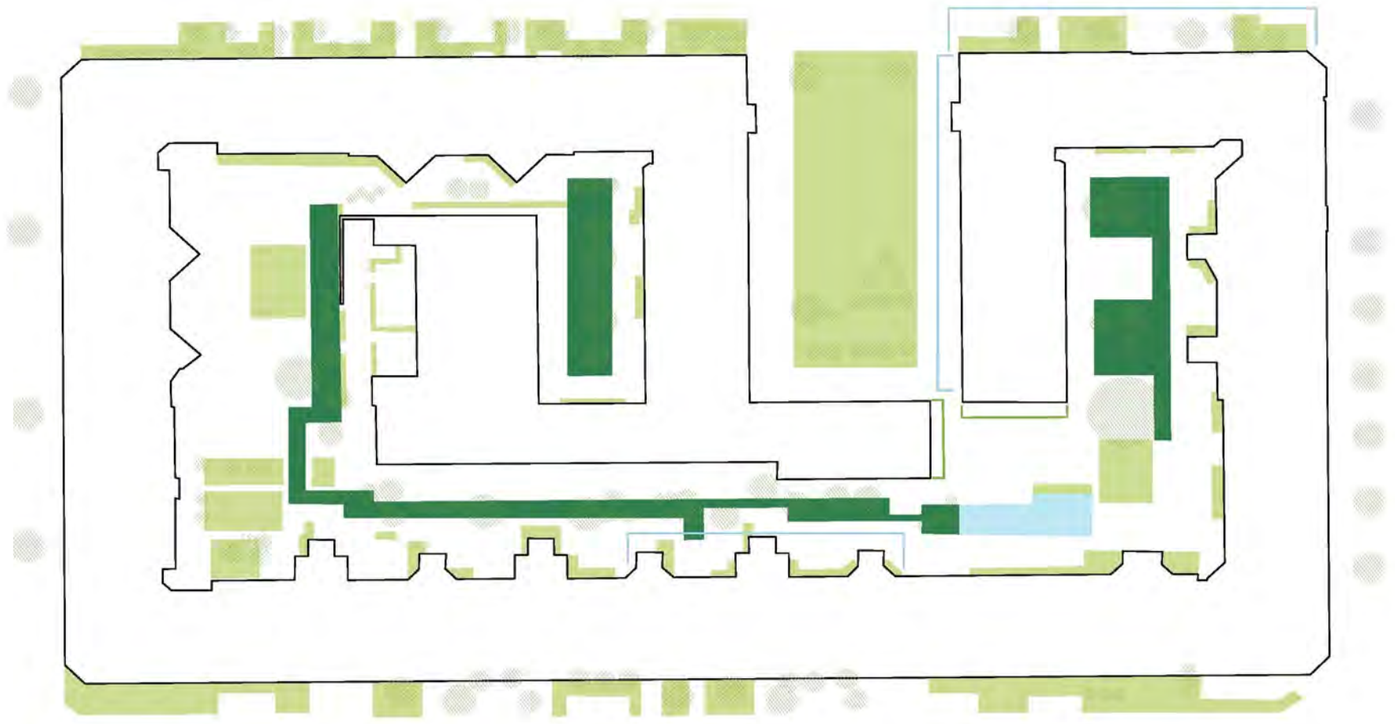


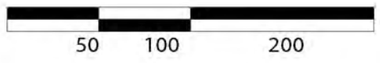
SITE AREA = 1.1 acres (.4 hectares)

O.S. = 38%

Canopy = 9.6%

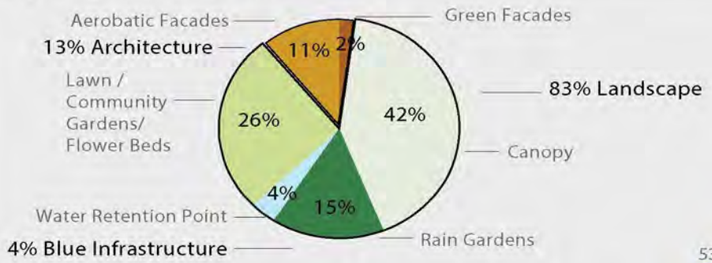
GBIR = .41



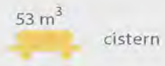


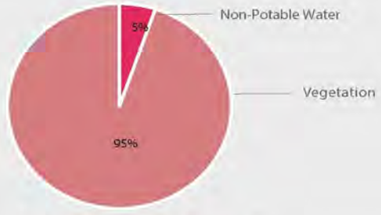
Climate Resilient Block

Copenhagen, Denmark - 2024



% of Total Stormwater Management Areas





% of Water Usage*

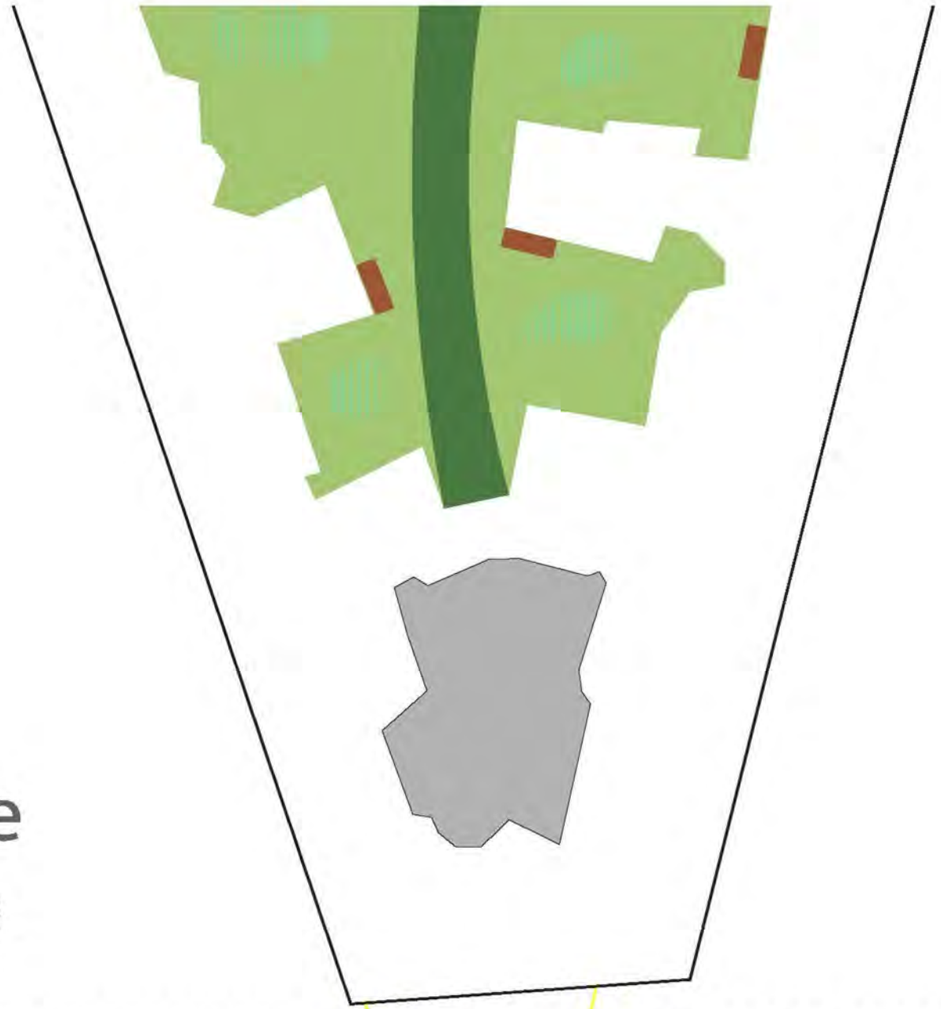
roof water piping

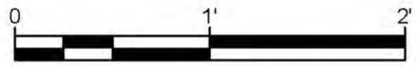
SITE AREA = 2.65 acres

O.S. = 27 %

GBR. = .55

F.A.R. = 2.65



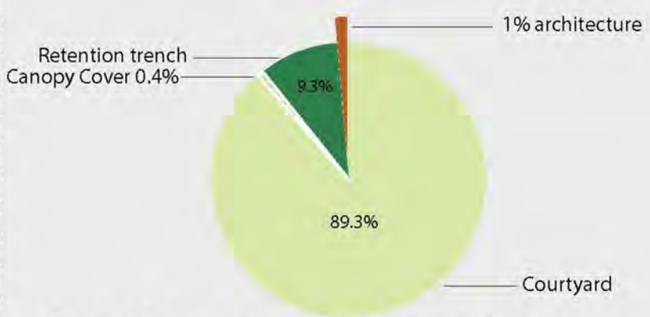


Scale 1:100

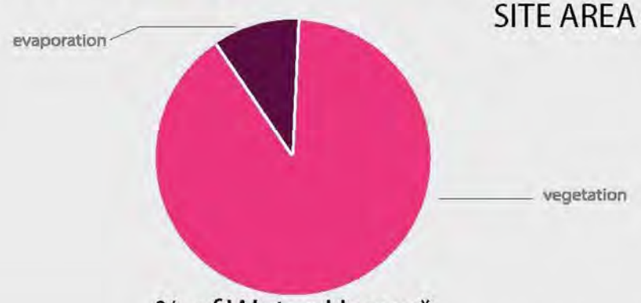
The Courtyard of the Future on Askøgade

Copenhagen, Denmark

SITE AREA = 2.3 acres (0.930777 hectares)

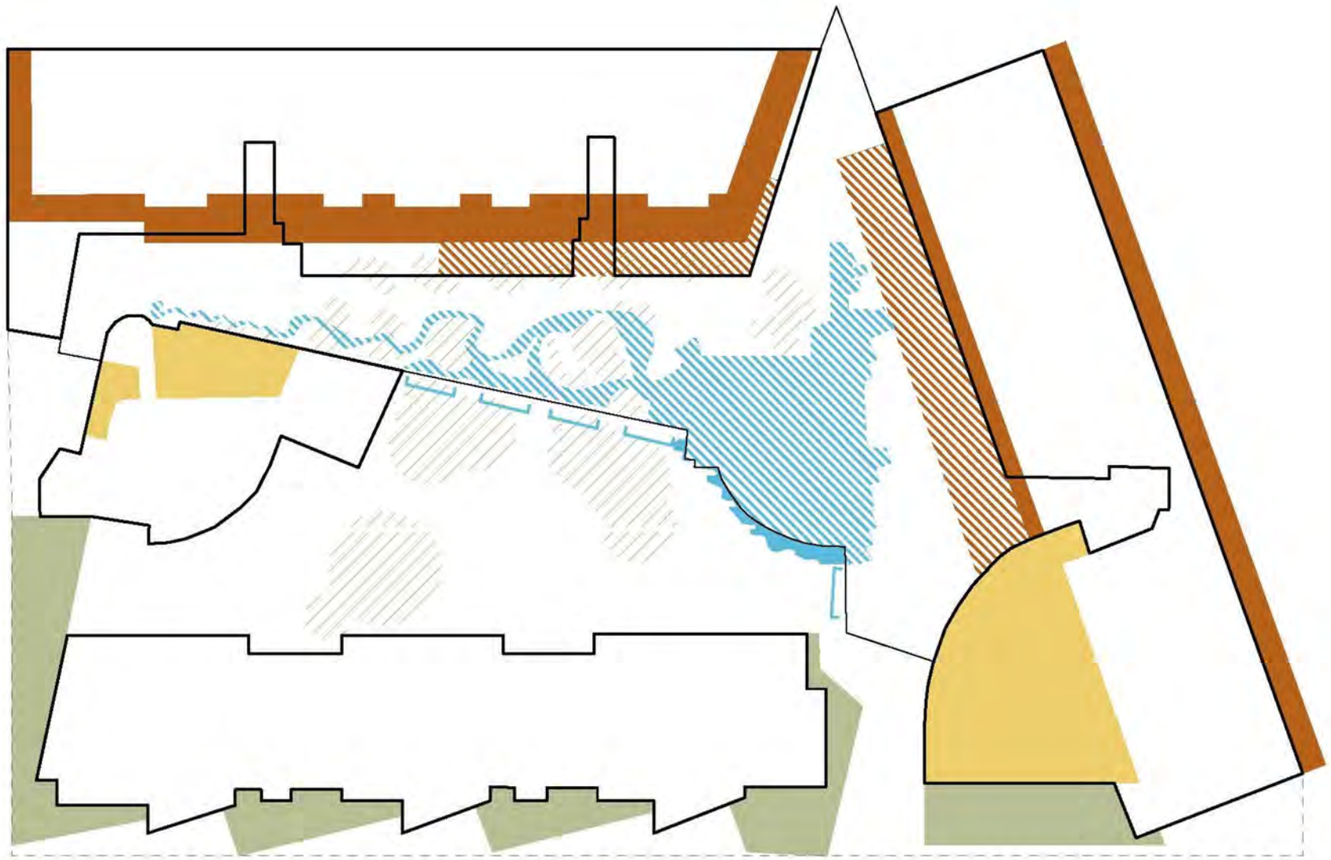


% of Total Stormwater Management Areas



% of Water Usage*

*qualitative estimate

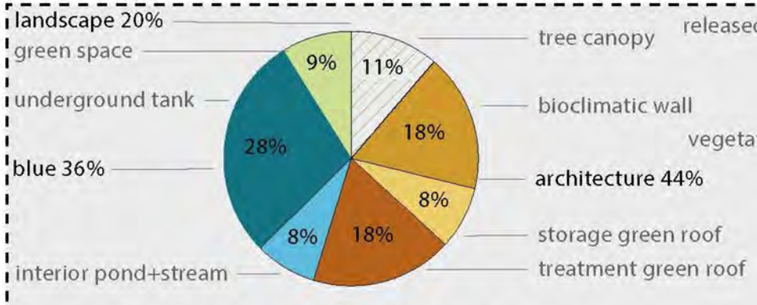


Low
High
ARCHITECTURAL INFRASTRUCTURE
GREEN INFRASTRUCTURE
BLUE INFRASTRUCTURE
OTHER FUNCTIONAL LANDSCAPES

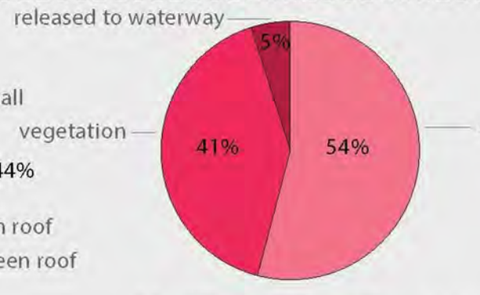
meters - scale = 1:1200
5 10 20 30

Prisma Nuremberg

Nuremberg, Germany - 1997



% of Total Green Blue Infrastructures



% of Total Water Reusage

SITE AREA = 1.3 acres (.5 hectares)

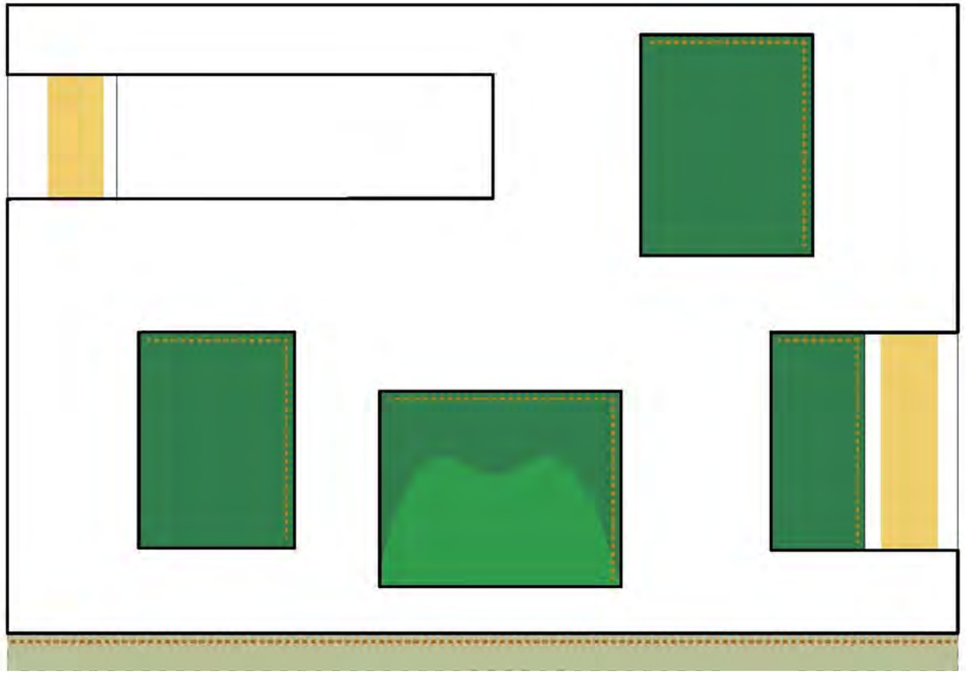
greenhouse atrium

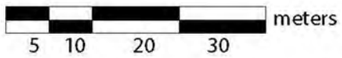
300 m^3 cistern

O.S. = 14 %

G.B.R. = .6

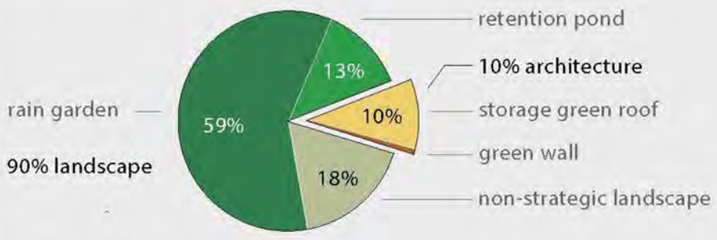
F.A.R. = 3





Institute of Physics

Berlin, Germany - 2003



% of Total Stormwater Management Areas

green wall

unknown

cistern

SITE AREA = 2.1 acres (.8 hectares)

O.S. = 13 %

S.A.R. = .25

Appendix C:

Video from ARCH 5115 Common SENSES Studio: West Chelsea
Professor Michelle Laboy
Northeastern University School of Architecture

Link

Appendix D:

Proposals for Community Engagement from course **PPUA 5246 Participatory Modeling for Collaborative Decision-Making**
Common SENSES: West Chelsea
Professor Moira Zellner

These story maps linked below were prepared for the City of Chelsea and its consulting firm Utile, as starting points fo the upcoming ***Pa'lante*** **Comprehensive Planning**. The various proposals described plans and activities for community engagement in Chelsea around climate resilience and related issues like housing and food security. Community partners and city councilors have expressed interest in some of these methods and are continuing to collaborate with our team in these initiatives and in funding proposals to support the engagement activities.

- Flood resilience
- Urban Heat Island
- Climate resilience
- Flooding vulnerability and resilience

Appendix E:

Poster for West Chelsea Research Festival
Presenting outputs from the joint **Common SENSES: West Chelsea** courses in architecture and planning
ARCH 5115 Common SENSES Design Studio and PPUA 5246 Participatory Modeling Course
Professors Michelle Laboy and Moira Zellner

Description:
The Chelsea Research Festival highlights Chelsea residents' contributions to science and bridges the gap between community and research. Chelsea Research Festival is a research poster session that showcases research that is either ABOUT Chelsea, or conducted BY Chelsea community members---or both!

Thirty poster presentations featured research from all sorts of fields, from history to medicine, being presented by researchers from universities, hospitals, longtime Chelsea community members, and Chelsea high and middle school students!

SESSION 1: 1:30pm-3:00pm (CHS 6th period)
SESSION 2: 5:30pm-7:30pm

Location:
Chelsea High School
Red gymnasium
299 Everett Ave
Chelsea MA 02150

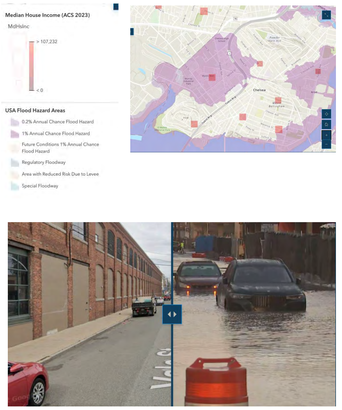
Community-led design for equitable climate adaptation in West Chelsea

Northeastern University Faculty: M.Laboy, D.Massey, and M.Zellner | **City of Chelsea**: K.Allen
School of Architecture Students: G. Keller, C. Zuleta, A.Evans, J.Ijeh, K.Klacko, E.Baptista, S. Hellmund, M.Logan, A.Tejada Simeon, S. Wong, S. Ahern
Participatory Modeling Students: B.Anderson, D.Healey, J. Hughes

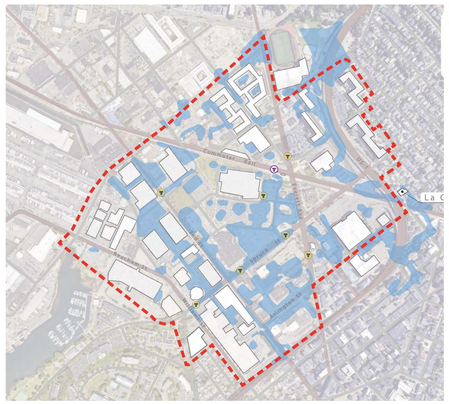
RESULTS

Background: The enactment of MBTA Communities Act required that Chelsea define a zoning overlay district for "Transit-Oriented Development" (TOD) in West Chelsea to allow construction of more housing near public transit. TOD zoning allows higher density (taller buildings with more units) in exchange for more affordability.

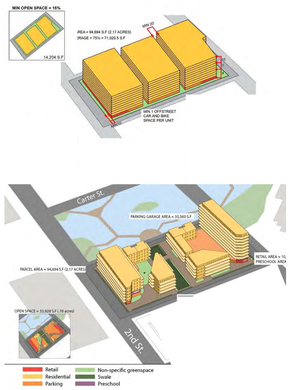
Building housing on a floodplain requires mitigation of climate hazards. The proximity to schools and low income neighborhoods creates potential for community benefits. But can the community ensure equitable outcomes?



CHELSEA FLOODING MAP | PHOTOS



WEST CHELSEA T.O.D. FLOOD PROJECTIONS



DENSITY ALLOWED & MODIFIED

Problem: Green infrastructure (trees, rain gardens, and other green space) can mitigate climate hazards (flood, urban heat island, air pollution), but it requires space and funding, and can be connected to gentrification and displacement if not done with an equitable approach.

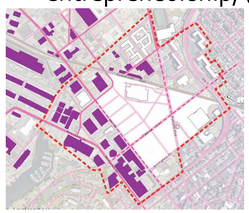
Research questions

- *How can the city engage community in guiding equitable regeneration of ecological and cultural space?*
- *What Green Infrastructure design strategies maximize density while minimizing environmental and social impacts of climate hazards on existing communities?*
- *What solutions emerge from engaging the community in an inclusive design process that is science-driven and equity-focused?*

Method: Community-led design and modeling engages community stakeholders in:

(A) Site visits & workshops: stakeholders (La Colaborativa , City planners, youth) defined Community Priorities:

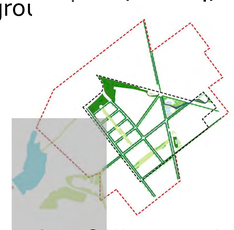
(1) Affordable housing for multi-generational families, (2) active streets with small retail, (3) more shading / less flooding in walking paths to school, (3) safe and active open space with opportunities for fun, cultural representation, and local entrepreneurship, (4) safe public indoor s[illegible] age grou[illegible] socialization, and work



PRESERVE INDUSTRIAL USE & CREATE WALKABLE STREETS

ELEVATION CHANGES FOR CONTROLLED FLOODING

HOUSING: 1200 UNITS 20% AFFORDABLE



GREEN SPACE & WATERFRONT ACCESS 6% GI STREETS|PARKS, 24% GI POPS

COMMUNITY AMENITIES ECONOMIC & CULTURAL OPPORTUNITY

(B) Participatory modeling: stakeholders develop concern profiles, design criteria, scenarios, and compare results

PARTICIPATORY MODELING OF GI IN FORA.AI

OVERALL RESULTS OF GI SCENARIO ITERATIONS

RESULTS ON INDIVIDUAL STAKEHOLDERS' CONCERN PROFILES

(C) Visualization: participants inspire y refine ideas for resilient public spaces in public and private parcels.

FOOD DISTRIBUTION SPACE

GROUND FLOOR ACTIVATION

GREEN PERMEABLE PARKING

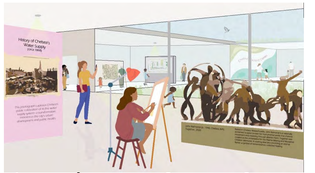
COMMUNITY CENTER

PUBLIC GREEN COURTYARDS

CHILD CARE NEAR HOUSING

GREEN MALL

HEALING GARDENS

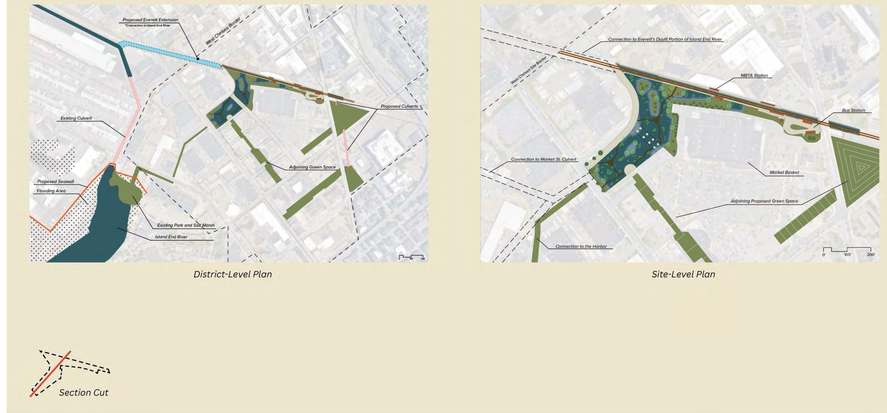


INDOOR|OUTDOOR CULTURAL CENTER

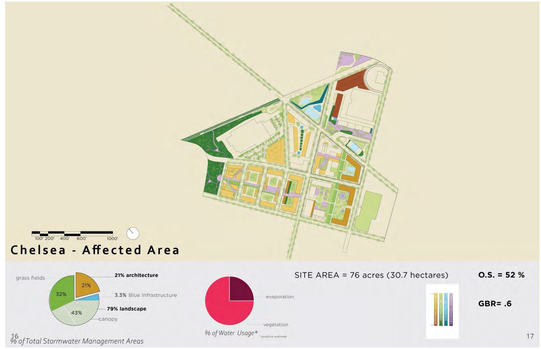
PLAZA, PARK, & URBAN FARM

Results: Green Infrastructure Types and Distribution by Parcel

PRIVATE PARCELS

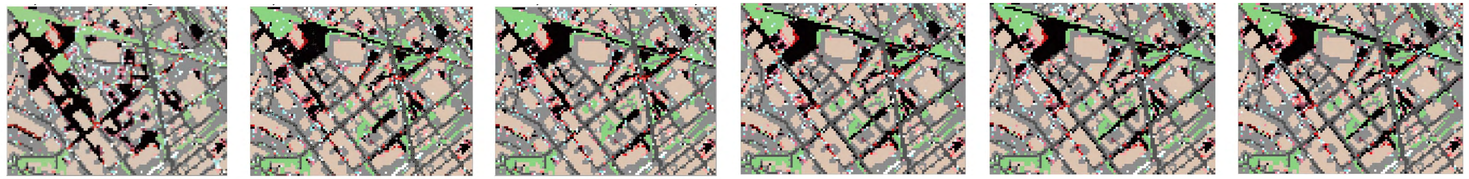


DISTRICT-WIDE



Results: Flood Modeling of 100-yr | 24-hr storm using L-Grid tool (Flooded Area > 3.5 inches)

Incremental Improvements by Design Strategy



5934

Percent of flooded area in permeable land: **2.52%**

Percent of flooded area in impermeable land: **25.26%**

NO CHANGE

6189

Percent of flooded area in permeable land: **5.48%**

Percent of flooded area in impermeable land: **19.19%**

24% Improvement from Existing Conditions

ELEVATION CHANGES

6046

Percent of flooded area in permeable land: **6.78%**

Percent of flooded area in impermeable land: **15.98%**

17% Improvement from Elevation+Land Cover

ADDING GREEN-BLUE INFRASTRUCTURE (GBI) IN PUBLIC LAND ONLY (6% AREA)

6405

Percent of flooded area in permeable land: **7.91%**

Percent of flooded area in impermeable land: **14.13%**

12% Improvement fr Public GBI Only

ADDING 10% GBI IN PRIVATE PARCELS

6438

Percent of flooded area in permeable land: **8.14%**

Percent of flooded area in impermeable land: **13.50%**

4% Improvement f 10% Public GBI

INCREASING TO 20% GBI IN PRIVATE PARCELS

6453

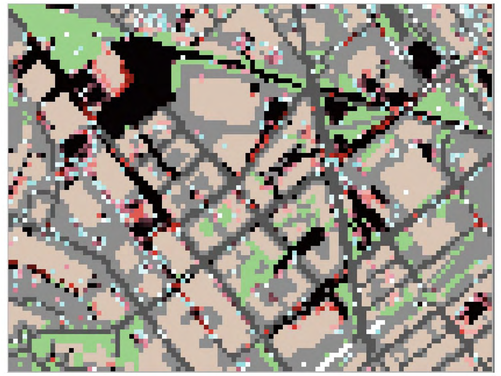
Percent of flooded area in permeable land: **8.15%**

Percent of flooded area in impermeable land: **13.30%**

1% Improvement from 20% Public GBI

INCREASING TO 30% GBI IN PRIVATE PARCELS

Overall Results



6472

Percent of flooded area in permeable land: **8.17%**

Percent of flooded area in impermeable land: **13.06%**

48% Improvement from Existing Conditions

DISRUPTIVE FLOODING REDUCED BY MORE THAN HALF
SHIFTED FLOODING TO INTENTIONAL GBI WATER PATHS (SWALE CORRIDORS)

Diseñando con comunidad para la adaptación climática equitativa en West Chelsea

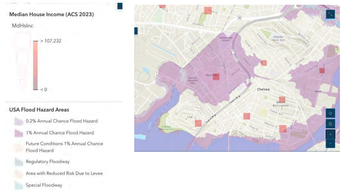
Facultad de Northeastern University: M.Laboy, D.Massey, and M.Zellner | **Ciudad de Chelsea**: K.Allen
Estudiantes de la Escuela de Arquitectura: G. Keller, C. Zuleta, A.Evans, J.Ijeh, K.Klacko, E.Baptista, S. Hellmund, M.Logan, A.Tejada Simeon, S. Wong, S. Ahern
Estudiantes de Participatory Modeling: B.Anderson, D.Healey, J. Hughes

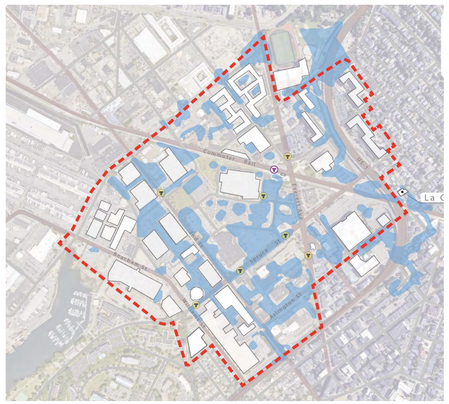
RESULTADOS

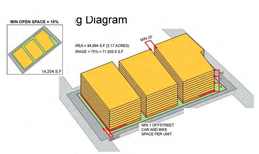
Contexto:

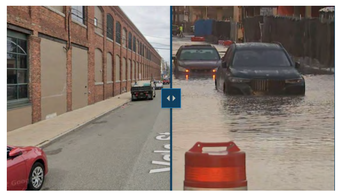
La Ley de Comunidades de la MBTA exigió que Chelsea definiera un distrito de superposición de zonificación para el "Desarrollo Orientado al Transporte" (DOT) en West Chelsea, con el fin de permitir la construcción de más viviendas cerca del transporte público. La zonificación DOT permite una mayor densidad (edificios más altos con más unidades) a cambio de una mayor asequibilidad.

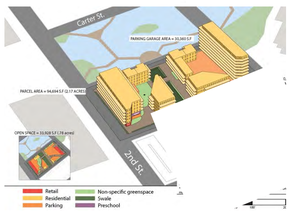
Construir viviendas en una llanura aluvial requiere mitigar los riesgos climáticos. La proximidad a escuelas y barrios de bajos recursos genera beneficios potenciales para la comunidad. Pero ¿puede la comunidad garantizar resultados equitativos?











MAP | FOTOS DE INUNDACIONES

INUNDACIÓN PROYECTADA, WEST CHELSEA D.O.T.

DENSIDAD PERMITIDA Y MODIFICADA

Problema:

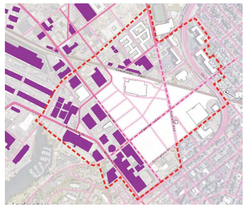
La infraestructura verde (árboles, jardines, y otros espacios verdes) puede mitigar los riesgos climáticos (inundaciones, efecto invernadero urbano, contaminación del aire), pero requiere espacio y financiación, y puede estar relacionada con la gentrificación y el desplazamiento si no se realiza con un enfoque equitativo.

Preguntas de investigación

- *¿Cómo puede la ciudad involucrar a la comunidad en la orientación de la regeneración equitativa del espacio ecológico y cultural?*
- *¿Qué estrategias de diseño de infraestructura verde maximizan la densidad y minimizan los impactos ambientales y sociales de los riesgos climáticos en las comunidades existentes?*
- *¿Qué soluciones surgen al involucrar a la comunidad en un proceso de diseño inclusivo impulsado por la ciencia y centrado en la equidad?*

Método: El diseño y modelado con la comunidad les involucran en:

(A) Visitas al barrio y talleres: participantes (La Colaborativa, urbanistas, jóvenes) definen prioridades comunitarias: (1) Viviendas asequibles para familias multigeneracionales, (2) calles activas con pequeños comercios, (3) más sombra/menos inundaciones de camino a la escuela, (3) espacios abiertos seguros y activos, incluyendo diversión, representación cultural y emprendimiento local, (4) espacios interiores públicos, seguros, refrescantes para recreación



PRESERVAR USO INDUSTRIAL & CREAR CALLES CAMINABLES

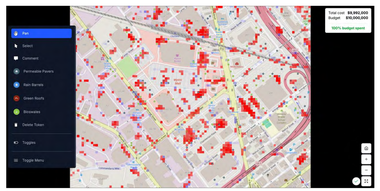
CAMBIOS DE ELEVACIÓN INUNDACION CONTROLADA

VIVIENDA: 1200 UNIDADES 20% ASEQUIBLE

ESPACIO VERDE & ACCESSO A LA COSTA 6% GI STREETS|PARKS, 24% GI POPS

COMODIDADES PARA LA COMUNIDAD ECONOMIC & CULTURAL OPPORTUNITY

(B) Modelado participativo: participantes crean perfiles de prioridades, criterios de diseño, y escenarios de prueba.



MODELACION DE INFRA. VERDE EN FORA.AI

RESULTADOS-ESCENARIOS DE INFRAESTRUCTURA VERDE

COMPARANDO RESULTADOS EN LOS PERFILES DE PRIORIDAD DE PARTICIPANTES

(C) Visualización: participantes inspiran y refinan ideas para espacios públicos resilientes en parcelas públicas y privadas.

DISTRIBUCION ALIMENTATIA

ACTIVACIÓN DE PLANTA BAJA

PARQUEO VERDE, PERMEABLE

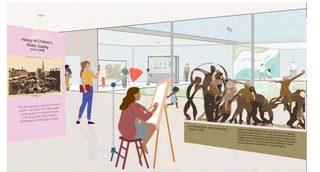
CENTRO COMUNAL

PATIOS PÚBLICOS VERDES

CUIDO DE NIÑOS CERCA DE CASA

MALL VERDE

JARDINES CURATIVOS



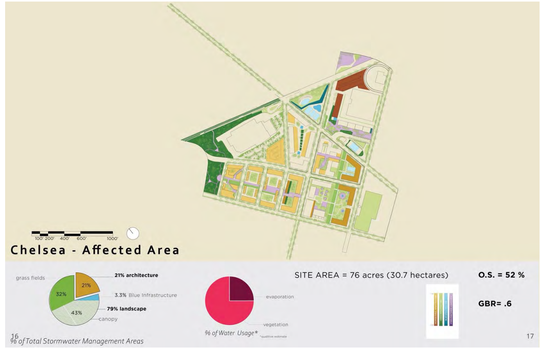
CENTRO CULTURAL INTERIOR/EXTERIOR

PLAZA, PARQUE & FINCA URBANA

Resultados: Tipos de Infraestructura Verde-Azul y su Distribución

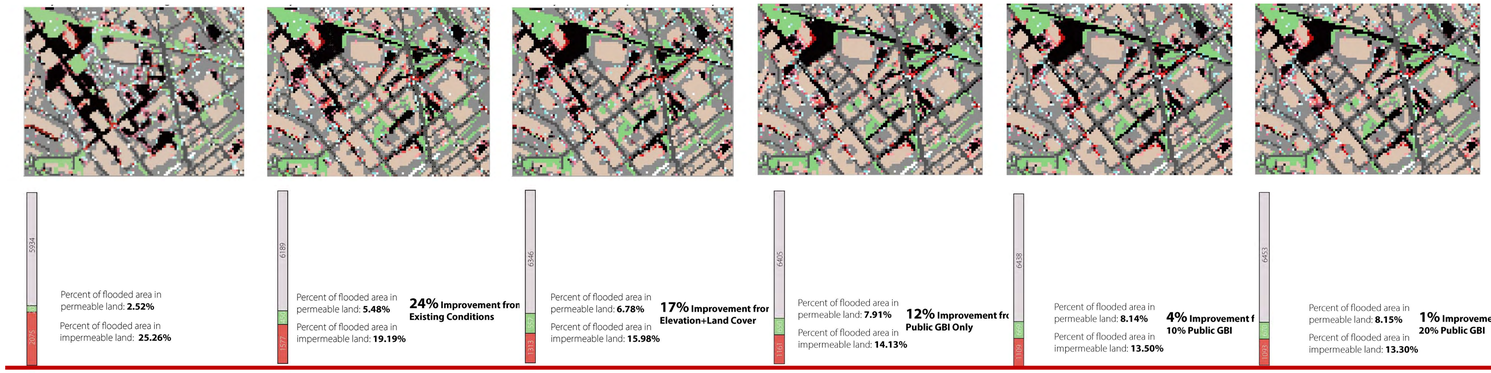
Parcelas Privadas

Distrito



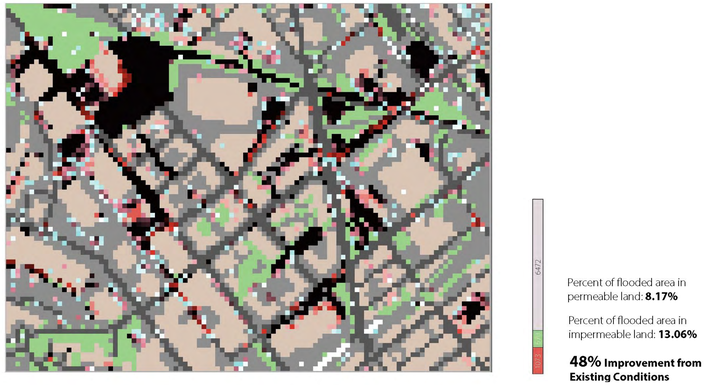
Resultados: Modelación de Inundaciones, tormentas de 100-años | 24-horas, con software L-Grid (Areas con Inundación > 3.5 pulgadas)

Mejoras incrementales, para cada estrategia de diseño



Ningun Cambio | **Cambios de Elevacion** | **Añadiendo Infraestructura Verde-Azul (GBI) Solo tierra Pública (6% Area)** | **Anadiendo 10% GBI Parcelas Privadas** | **Aumentando a 20% GBI Parcelas Privadas** | **Aumentando a 30% GBI Parcelas Privadas**

Resultado Total



Inundaciones Proboematicas se redujeron por mas de mitad
Inundaciones de movierson a senderos de GBI (corredores verdes)

Appendix F:

Slides of presentation at the Regenerative Design Workshop hosted by the **Urban Land Institute Boston | New England**, focused on the Lower Mystic River Watershed and Chelsea's neighboring city of Everett. Michelle Laboy was invited to speak based on the work with the City of Chelsea supported. by the Latrobe Prize.

Unconstrained: Regenerative Architecture
By Michelle Laboy, invited speaker
April 8, 2025
Location: Offices of CBT Architects, Charlestown, MA

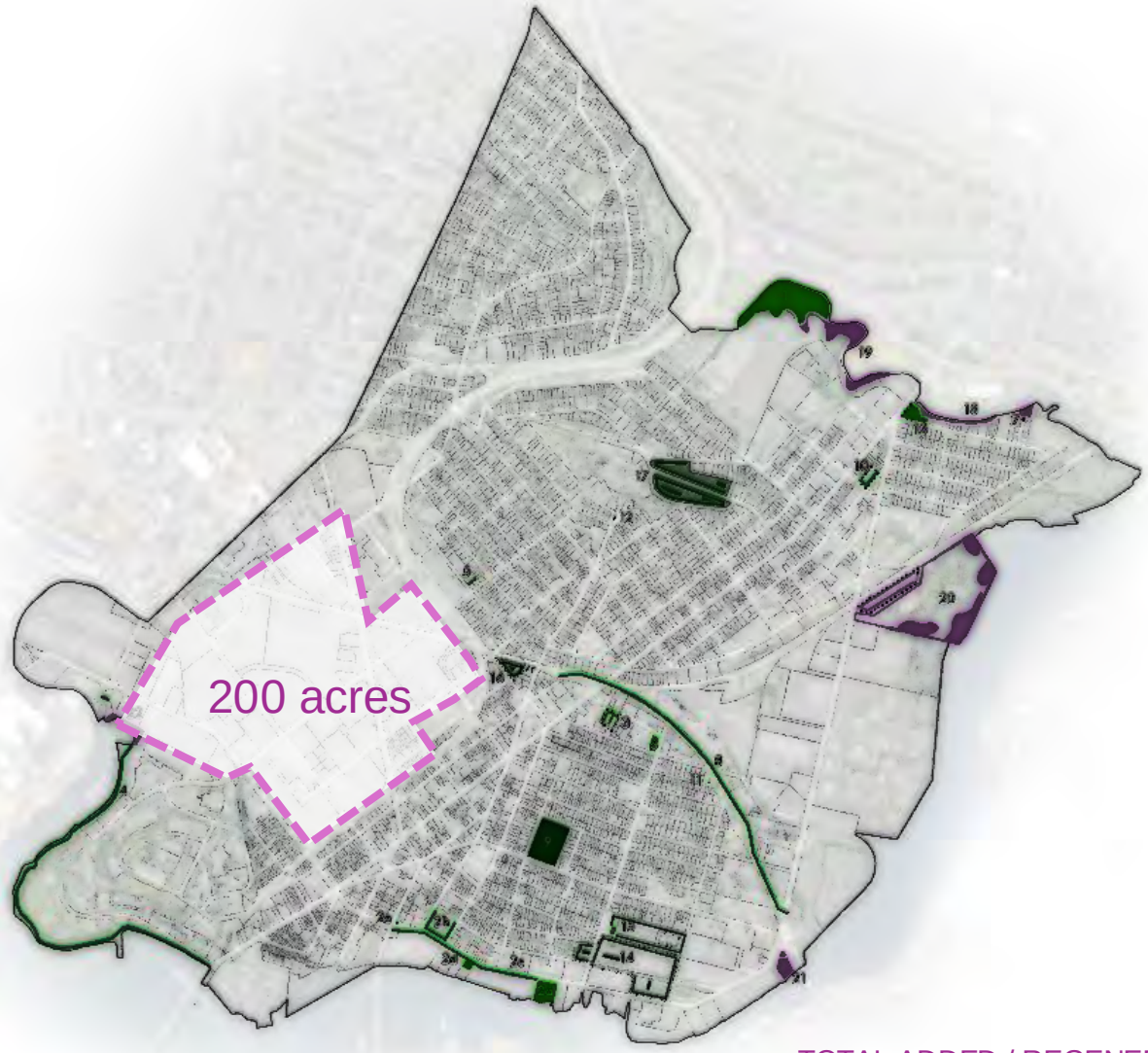
un-CONSTRAINED: regenerative architecture

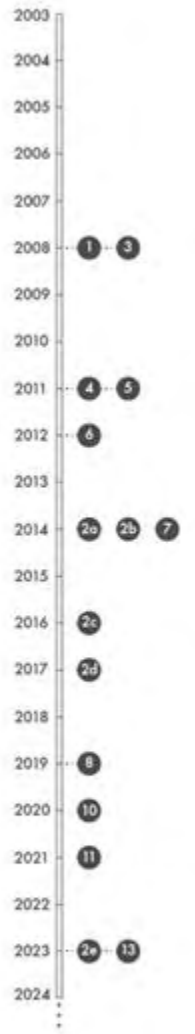
Michelle Laboy PE, LEED AP BD+C AIA Assoc.
Northeastern University | FieLDworkshop

2025 - future

Total open space: 330 acres (134 ha): 23.34%
Total vegetated land cover: 176 acres (71 ha): 12.41%

1. Mill Creek Salt Marsh Restoration Project
2. Marginal Street Community Industry Corridor
   a. P.O.R.T. Park
   b. Tree planting
   c. Tree planting
   d. Pocket park and tree planting
   e. Pearl Plaza & Bus Shelter
3. Janus Highlands
4. Island End Park
5. Anita's Garden
6. Box District Park
7. Mace Apartments Rain Garden
8. Chelsea Greenway
9. Chelsea Garden Cemetery
10. Acadia
11. Marlborough Street Community Garden
12. Forsyth Open Space
13. 1005 Broadway
14. 22 Willow
15. Cooling Block
16. 25 Sixth Street
17. Chelsea Soldier's Home
18. Mill Creek Flood Mitigation and Restoration
19. Mill Creek Parcel Park and Coastal Remediation
20. Chelsea Creek Nature Trail
21. Chelsea Street Bridge Park
22. Island End River Flood Resilience Project



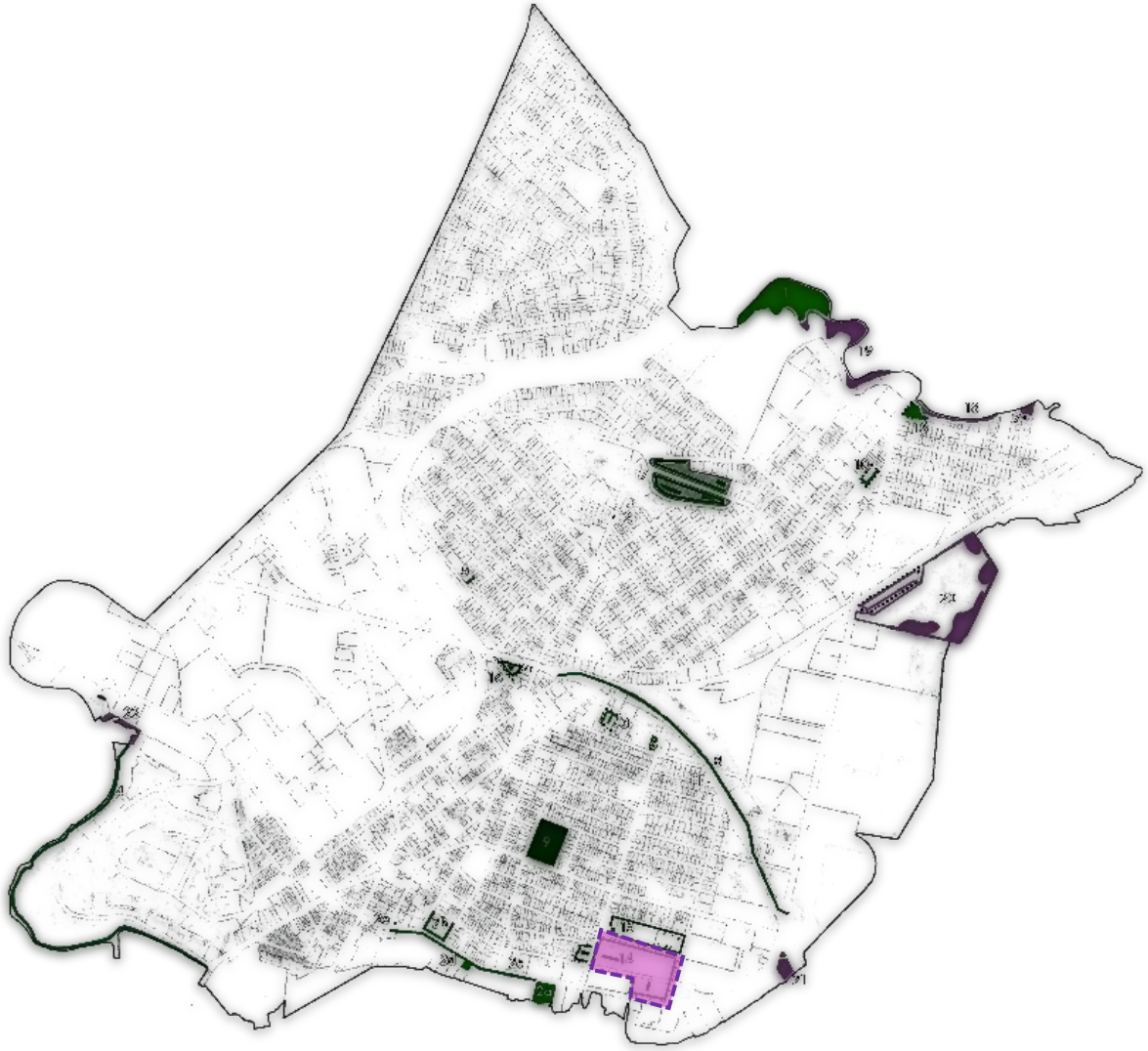


Green infrastructure in Chelsea

TOTAL ADDED / REGENERATED GI: 27.5 acres (11.1 ha)
15% increase in 20 years:

completed projects ongoing projects upcoming projects

Pilot Site: 22 Willow Local Impacts of Green Infrastructure



Before-after


(a) Before redevelopment

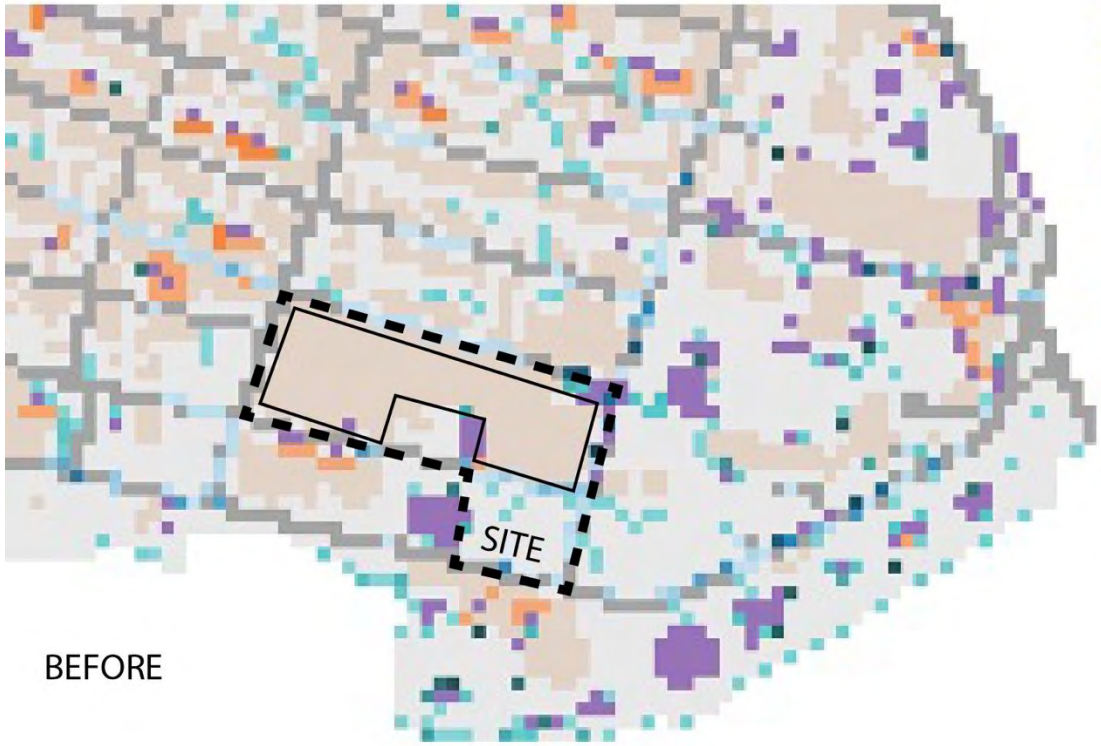

(b) Before redevelopment

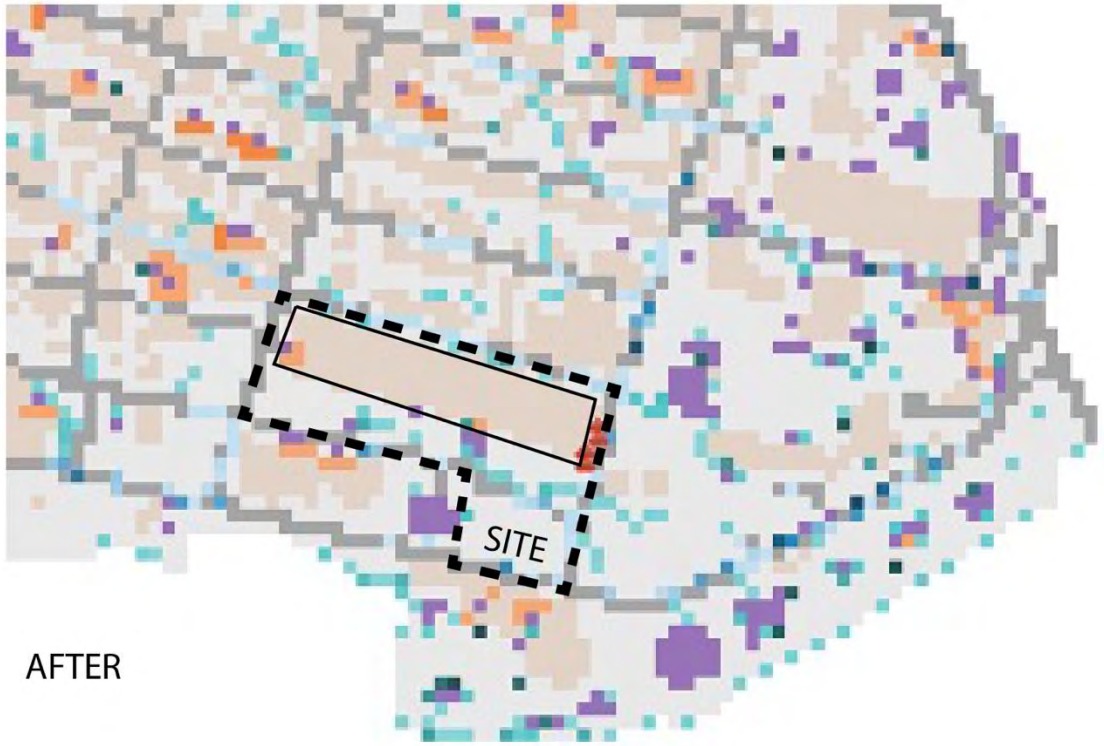

(c) Rendering courtesy of RODE Architects


(d) Rendering courtesy of RODE Architects

Flood modeling

L-grid pixels: 10m x 10m (32.8 ft x 32.8 ft)





Reduction in flooded area* post-redevelopment:
-7.5% overall (-18.9% street, -5.4% non-street)

***** Based on 38.2 ha (94.5 acres) shown

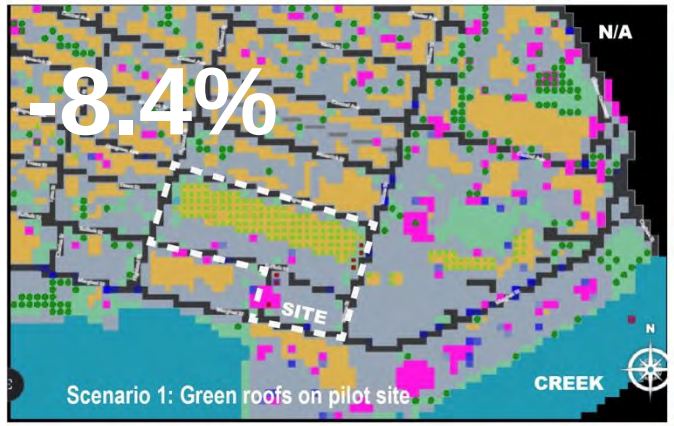
Participatory modeling

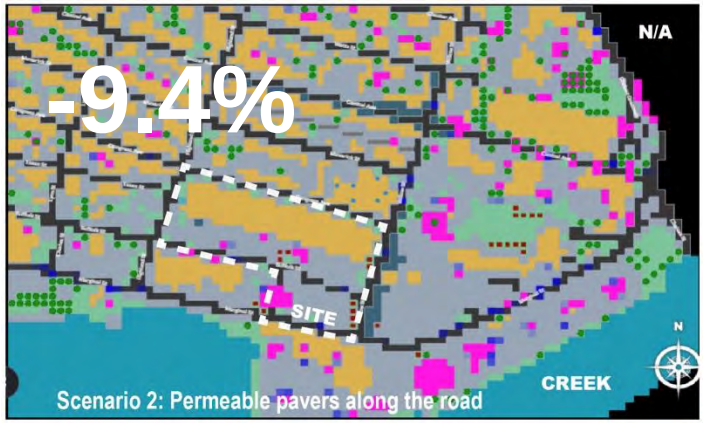
Iterating towards decentralization:

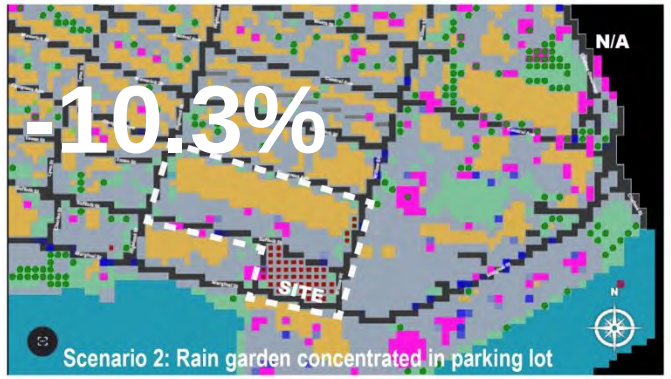
- Consistently started with concentration **“on site”**
- Followed by concentration in **“trouble spots”** (sponge)
- Landed on decentralization, in **“patches” or “stitching”**

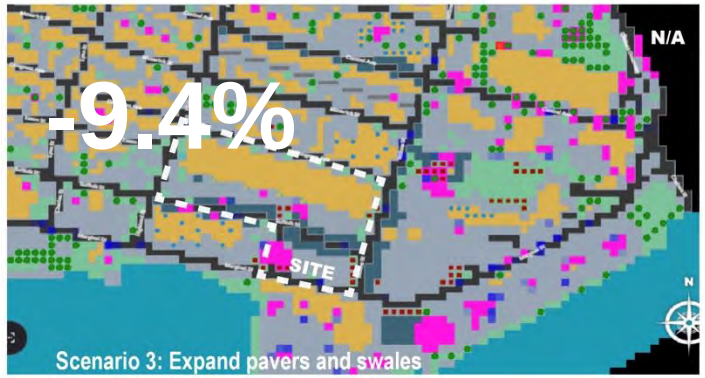
Emergence and shift of ‘Signaling’

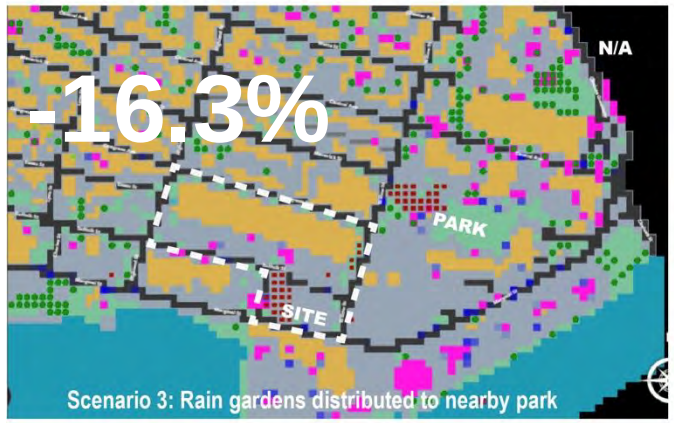
- Impulse towards centralization is aesthetic and social: investments doing more
- Distribution reframed as **cooperation,** desire to recruit even the smallest sites regardless of impact

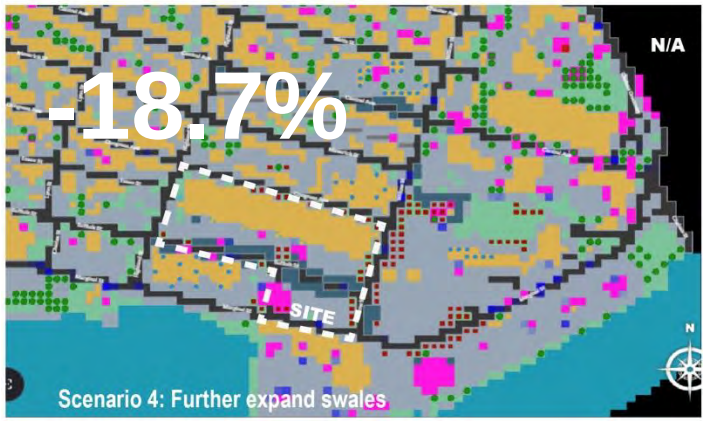












GROUP 1

GROUP 2

% REDUCTION FLOOD AREA

Land Cover:
- Buildings
- Roads
- Impermeable Ground
- Permeable Ground

Green Infrastructure:
- Green roof
- Swale
- Pavers
- Existing Trees

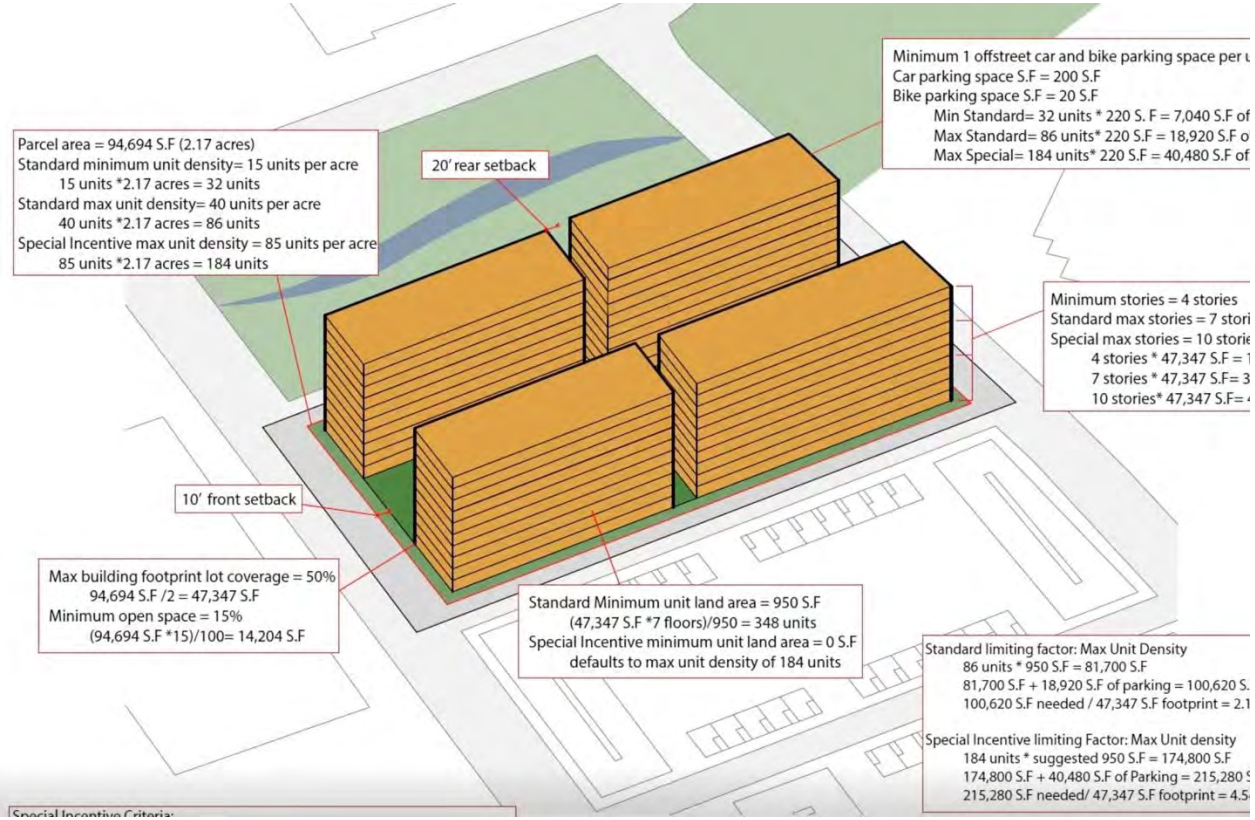
Impacts:
- Deeper flood
- Shallow ponded water

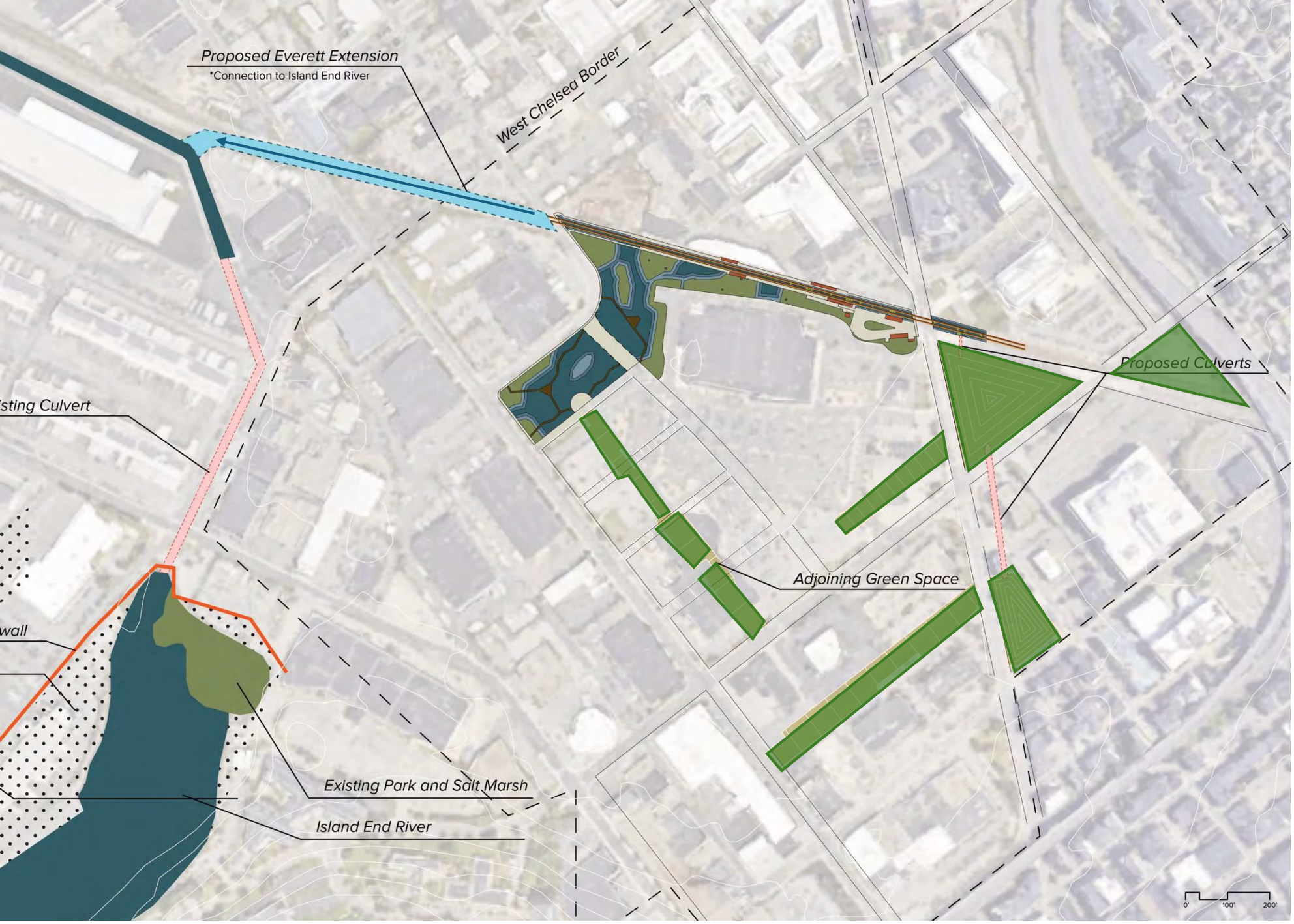
Laboy, M., Zellner, M. et.al. 2024. “Decentralizing Infrastructure: Expanding Architectural Practice towards Equity and Health.” In *ACSA 112th Annual Meeting: Disrupters on the Edge*, 325–33. ACSA Press. https://www.acsa-arch.org/chapter/decentralizing-infrastructure-expanding-architecturalpractice-towards-equity-and-health/.


Common SENSES - Chelsea, MA
Design Studio course (Laboy)
+ Participatory Modeling course (Zellner)
City of Chelsea
MBTA / TOD Zoning

Polemic: building the Commons

Optimize density





Flow Paths

Public GBI:

- public ROW
- existing open space
- new parks
- added pedestrian streets

Achieved:

0.1 GBI

15% less flooded area

Maintain industrial uses

Private GBI:

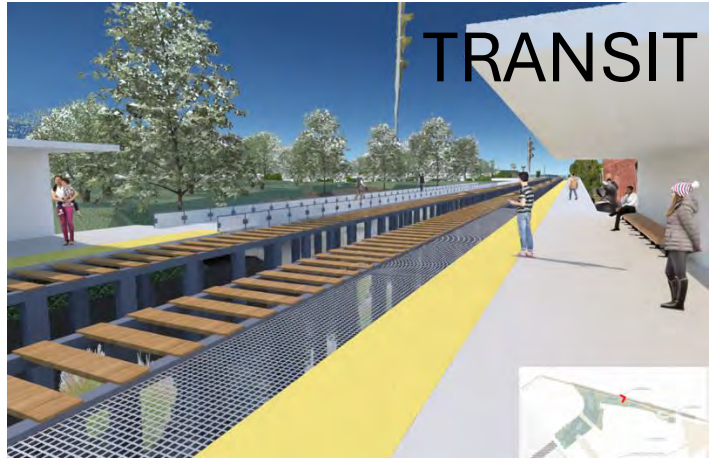
- POPS
- Green roofs
- Tree canopy

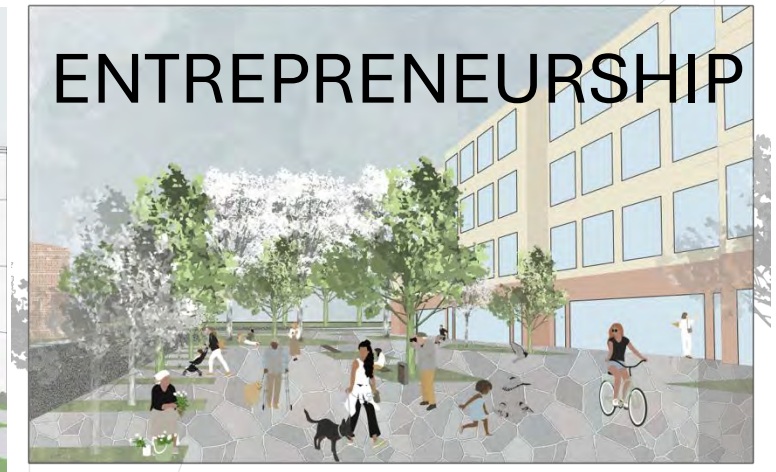
Achieved

0.19 GBI

36 % less flooding

community priorities in development





Appendix G:

Peer-reviewed conference proceedings paper based on the participatory modeling workshop with planners at the City of Chelsea, focused on the 22 Willow site

Laboy, Michelle, Moira Zellner, Amy Mueller, Dan O'Brien, and Dean Massey. "Decentralizing Infrastructure: Expanding Architectural Practice towards Equity and Health." In *ACSA 112th Annual Meeting: Disrupters on the Edge*, 325–33. ACSA Press, 2024. https://www.acsa-arch.org/chapter/decentralizing-infrastructure-expanding-architecturalpractice-towards-equity-and-health/

Appendix H:

Presentation at ACSA conference based on the participatory modeling workshop with planners at the City of Chelsea, focused on the 22 Willow site.

Michelle Laboy
Title" "Decentralizing Infrastructure: Expanding Architectural Practice towards Equity and Health."
Conference: ACSA 112th Annual Meeting: Disrupters on the Edge
Date: March 2024
Location: Vancouver, British Columbia.

Decentralizing infrastructure

expanding architectural practice towards equity and health

Michelle Laboy

ACSA 112th meeting

March 2024

Authors | Research Team

Michelle Laboy

Architecture

Moira Zellner

Participatory Modeling & Data Science

Amy Mueller

Sensors Networks& Environmenal Engineering

Dan O'Brien

Urban Informatics

Dean Massey

Complex Systems Modeler

Northeastern University

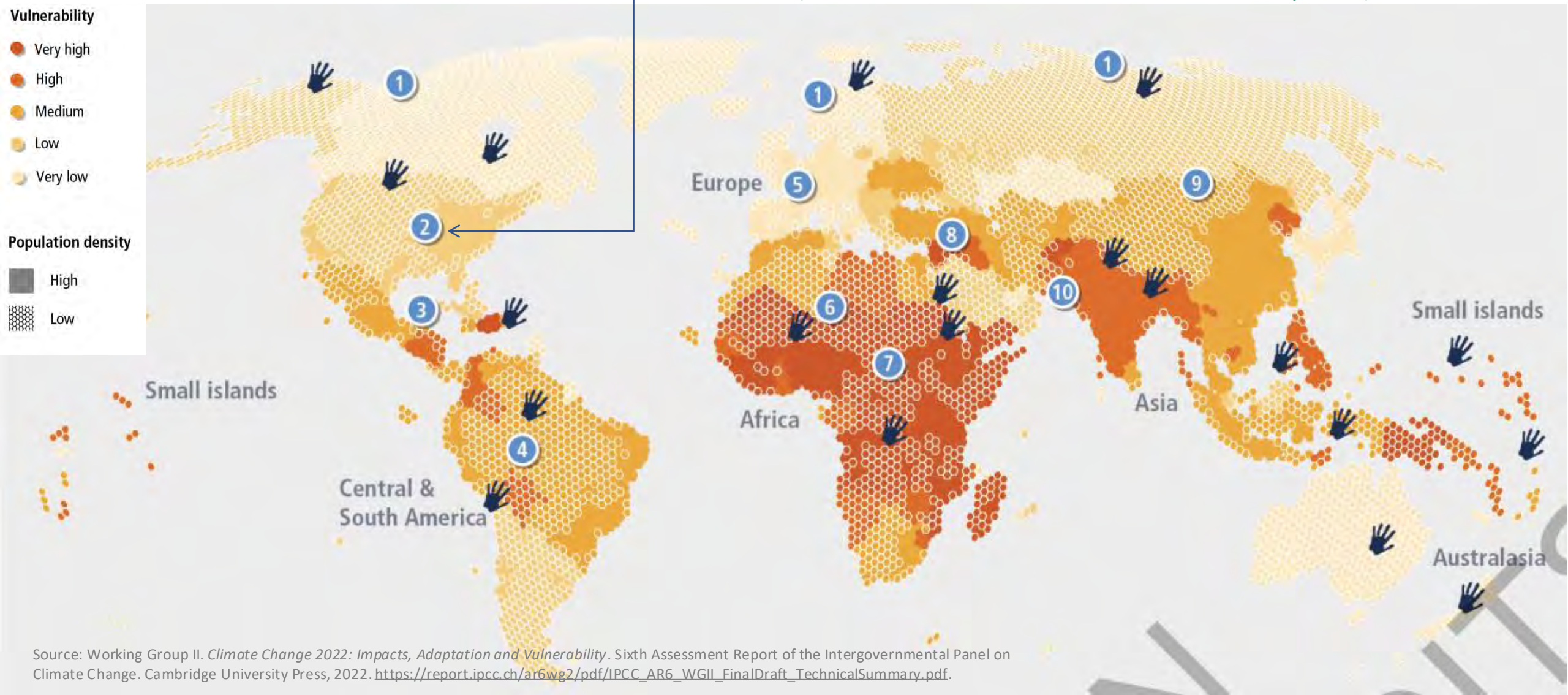
Acknowledgments:

Funding: AIA College of Fellows: Latrobe Prize 2022

Community Partner: City of Chelsea, MA

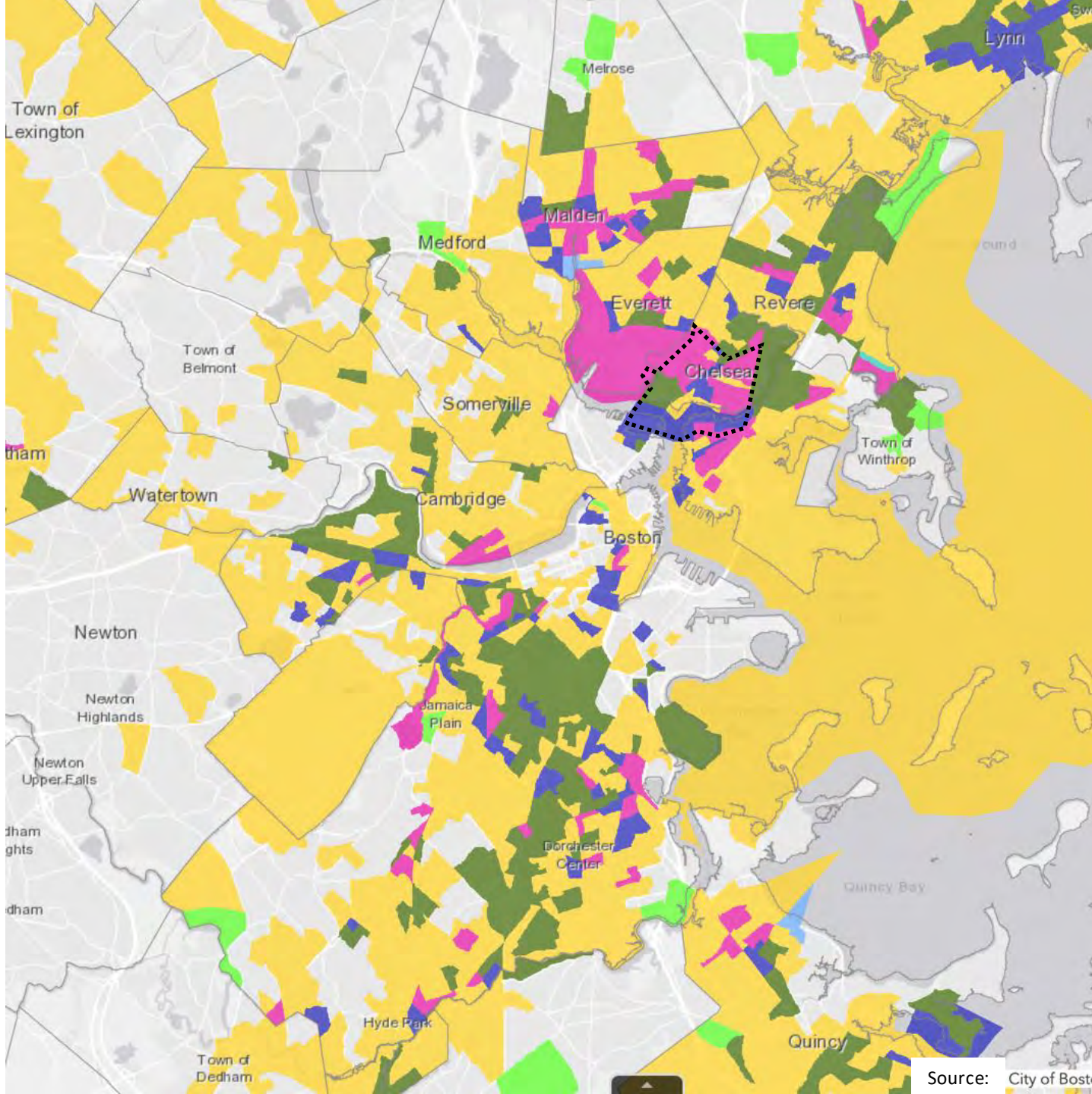
Global inequities

Urban Ethnic Minorities
(historical economic + environmental inequities)



Source: Working Group II. *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2022. https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_FinalDraft_TechnicalSummary.pdf.

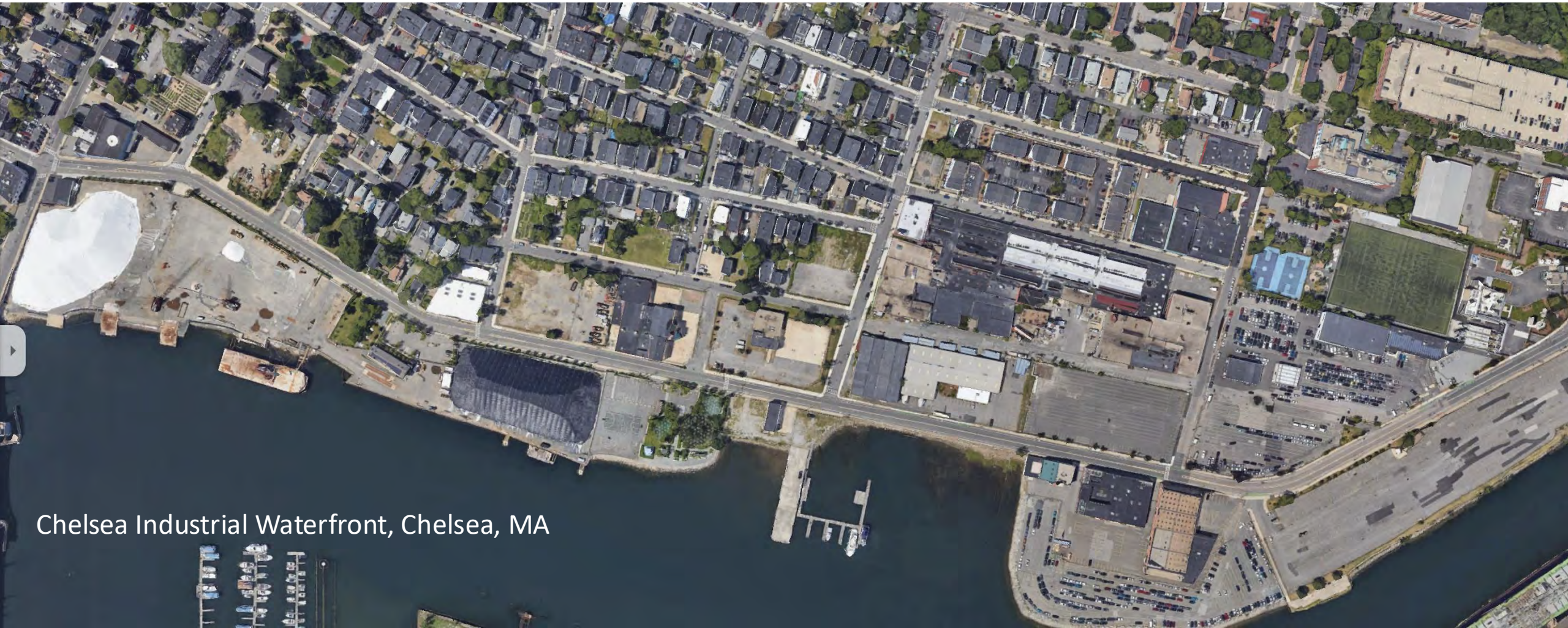
Regional Inequities



Boston metropolitan area
Massachusetts, USA

Microspatial inequities

- Scale: Block-to-block, site-to-site, etc.
- Drivers: surfaces, traffic patterns, permeability, tree canopy, etc.



Chelsea Industrial Waterfront, Chelsea, MA

Policy problem: Building capacity for GI

GI: nature-based solution, ecosystem services. Traditionally larger scale (planning, landscape, civil engineering) in the public domain, but increasingly needing a shift in scale…

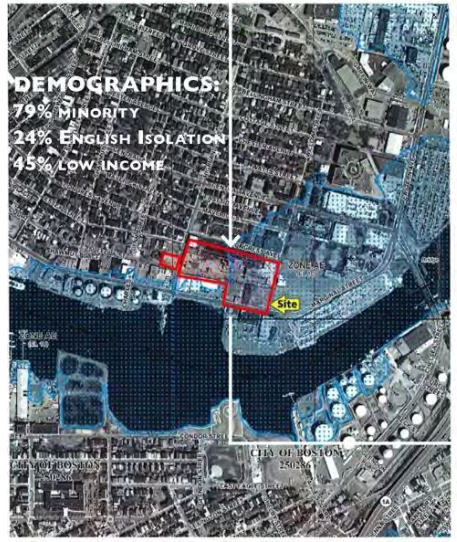
*"… in dense environments may require **targeted**, locally specific solutions and a **distributed network** of development sites, including private sites, **without shifting the cost or burden** to communities that are already disproportionately affected."*

+

"One-size fits all policies often target economic interests more than environmental justice." (Razzhagi 2023)

=

Solution: Decentralization + Equity



Chelsea, MA

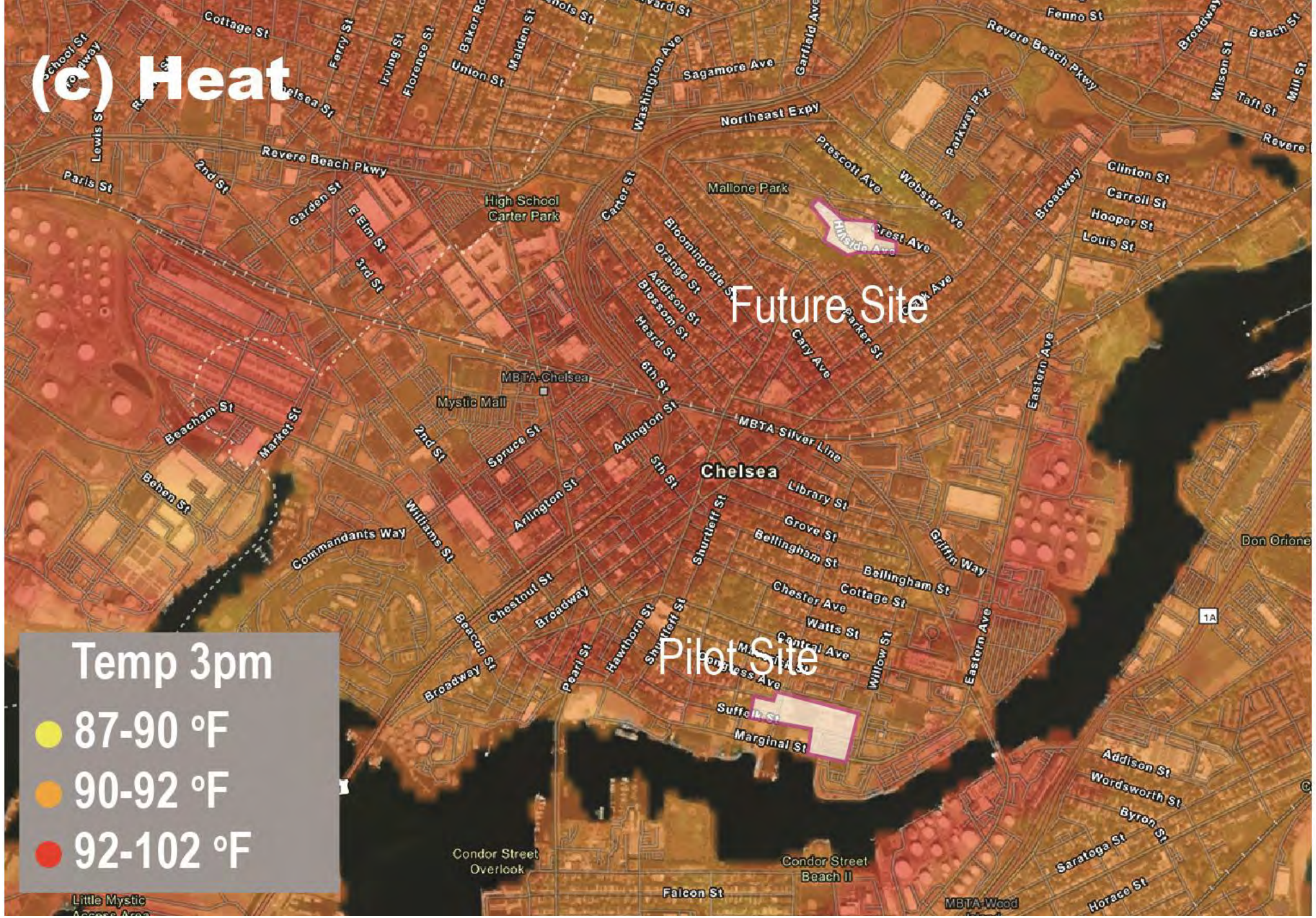
Intersection of Planetary & Human Health

Planetary Health

Human Health


(a) Air Pollution
DIESEL-COMMUTER RAIL
Future Site
HIGHWAYS
DIESEL BUS
DIESEL GRID
BACKUP STATION
Pilot Site
AIRPORT
FREIGHT (TRUCKS AND SHIPS)


(b) Flooding
Future Site
Chelsea
Pilot Site
Flood depth
0-2 ft (0.6m)
2-4 ft (1.2m)
4-6 ft (1.8m)


(c) Heat
Future Site
Pilot Site
Temp 3pm
87-90 °F
90-92 °F
92-102 °F
Chelsea
Mystic Mall
MBTA-Chelsea
MBTA Silver Line
High School Carter Park
Mallone Park
Revere Beach Pkwy
Northeast Expy
Sagamore Ave
Broadway
Eastern Ave
Arlington St
Spruce St
Commandants Way
Williams St
Beacham St
Market St
Behen St
Chestnut St
Pearl St
Hawthorn St
Shurtleff St
Willow St
Griffin Way
Bellingham St
Grove St
Library St
Chester Ave
Watts St
Cottage St
Marginal St
Suffolk St
Condor Street Overlook
Condor Street Beach II
Falcon St
Little Mystic
MBTA-Wood
Addison St
Wordsworth St
Byron St
Saratoga St
Horace St
Don Orione
Clinton St
Carroll St
Hooper St
Louis St
Webster Ave
Prescott Ave
Parkway Plz
Fenno St
Revere Beach Pkwy
Wilson St
Taft St
Mill St
Beach St
Cottage St
Ferry St
Irving St
Florence St
Union St
Malden St
Washington Ave
Garfield Ave
Lewis St
Paris St
2nd St
Garden St
E Elm St
3rd St
Carter St
Bloomingdale St
Orange St
Addison St
Blossom St
Heard St
6th St
Cary Ave
Parker St
5th St
Arlington St
2nd St
Shurtleff St
Beacon St
Broadway
Chestnut St
Broadway
Hillside Ave
Crest Ave
1A

Need: downscaled data + solutions

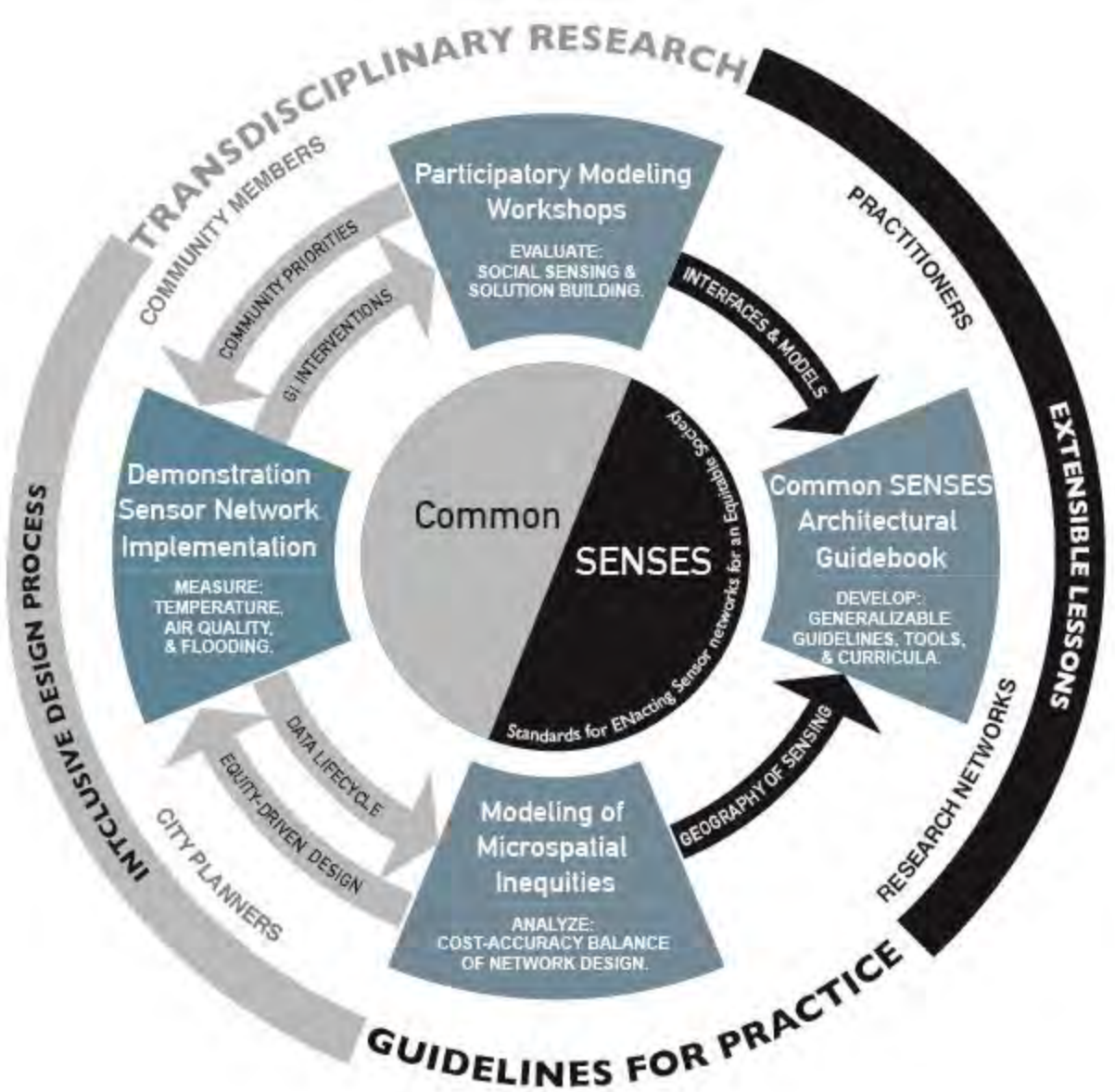
- Data for Design: some exacerbating mechanisms are well understood (e.g. UHI)
  - *"few models are available to predict these significant local variations at a **high-enough resolution for architects to respond**"*
  - *"**additional work is needed**"…to translate how climate change present locally* (City of Cambridge 2015)
- Models to understand spatial implications of Green Infrastructure (GI) on Health + Equity: building capacity and distributing co-benefits
  - *"and doing so **equitably** to improve resilience of and reduce burden on the most affected communities."*
- Methods of participation: community engagement often "approval-focused", instead of…
  - *"to build **consensus** around equitable solutions"*

Goals and Methods

a. Sensor Networks: Leveraging data to identify *microspatial inequities*

b. Green Infrastructure (GI): Gaining insights on socio-ecological impacts of designing GI in the context of *architecture projects*

c. Participatory modeling: Implementing new tool (**fora.ai**) that empowers community to *grasp and deliberate*



Expanding architectural practice

Better data on hazards.

Better models to evaluate impacts of design.

Co-learning and co-designing with the community.

Why architecture matters

- Scale: Building forms, surfaces affect microclimates, impacts most immediately felt by human bodies
- Distribution: Buildings occupy most urban land, emit 39% of GhG, yet we need more buildings where hazards may be highest.
- Funding: Buildings are large investments, and public process negotiates community benefits

Research Question:

"How can architectural sites define better GI goals that maximize capacity and co-benefits in the most vulnerable areas?"

Research goal:

Equity-focused approach to co-design GI in architecture (decentralization) and to measure cumulative impacts

Precedents on architecture as reparative (green) infrastructure

Literature review on Decentralization

- Decentralized: *"small scale dispersed facilities that are located near or at the point of use."* (Stang 2021)
  - Distributed: *"focused on the benefits and advantages, rather than what it is not…" suggesting "the possibility of being integrated or networked"* (Johnson 2014)
  - Different from scarcity-driven "independence" paradigm: *maximizes "the implementation of technology in each individual site without considering the optimal scale of performance of each system."* (Laboy 2016)
- Resilient: *"building redundancy and capacity through a network of smaller system nodes that better distribute co-benefits and are less prone to cascading failures."*
- Equitable: *"contribute to mitigating microspatial health impacts for varying distances with decreasing benefit away from their location…".e.g. heat* (Kirschner 2023) *pollution,* (Tiwari 2019) *and flooding* (Sorensen 2019)

Pilot Site


(a) Before redevelopment

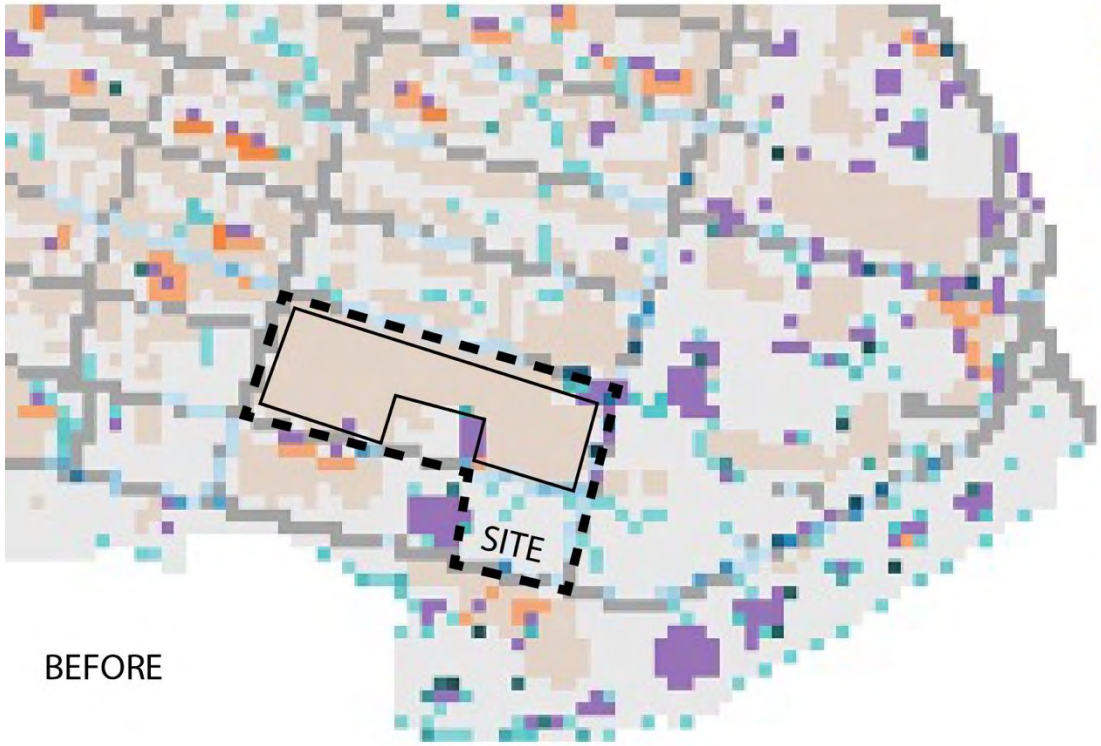

(b) Before redevelopment

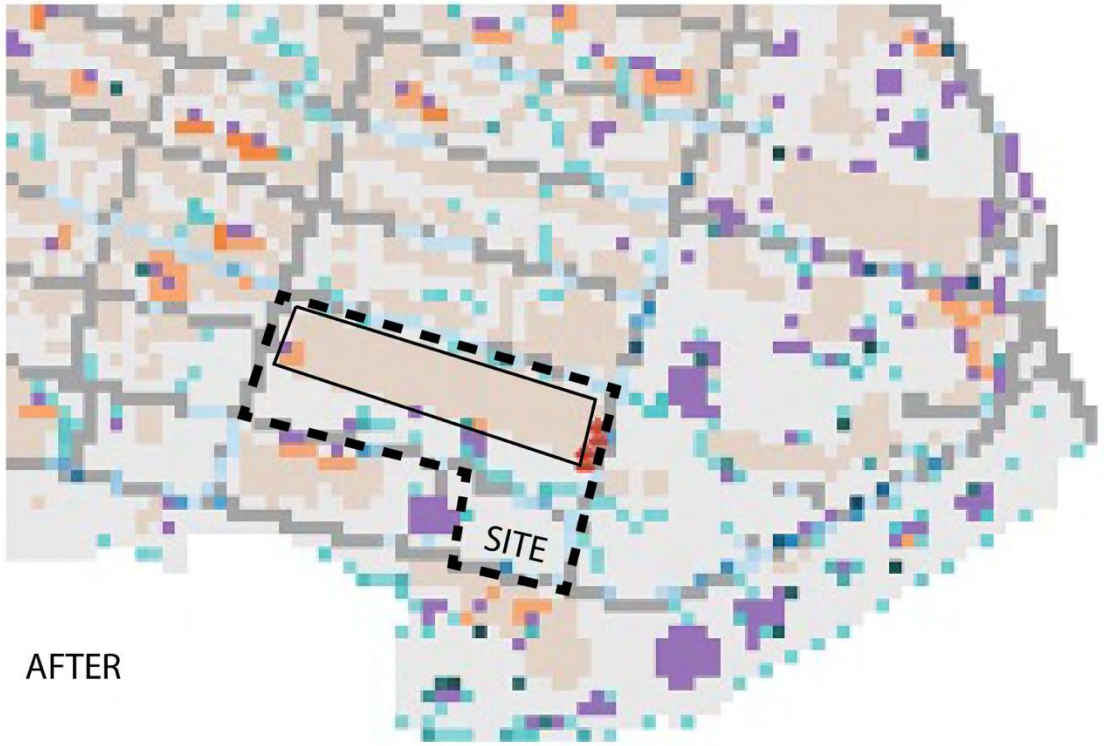

(c) Rendering courtesy of RODE Architects


(d) Rendering courtesy of RODE Architects

Before–after flood modeling of pilot site

L-grid pixels: 10m x 10m (32.8 ft x 32.8 ft)





Reduction in flooded area* post-redevelopment:
-7.5% overall (-18.9% street, -5.4% non-street)

***** Based on 38.2 ha (94.5 acres) shown

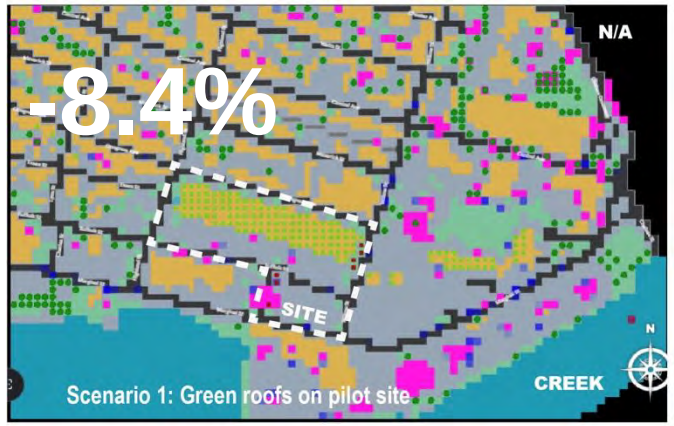
Workshop lessons

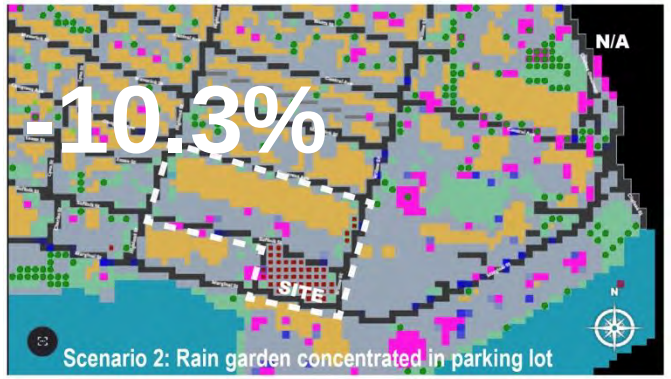
Iterating towards decentralization:

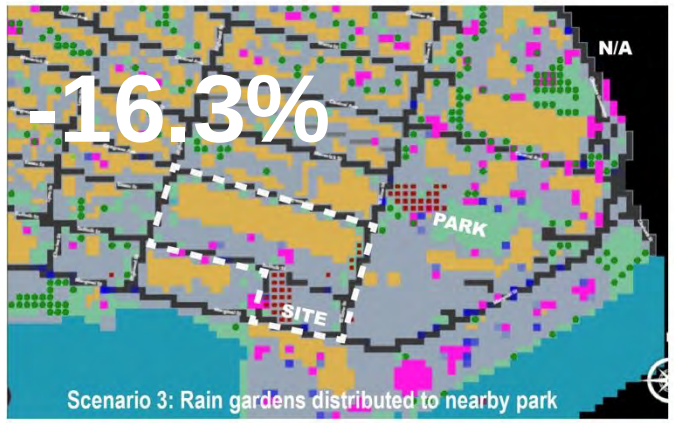
- Consistently started with concentration **“on site”**
- Followed by concentration in **“trouble spots”** (sponge)
- Landed on decentralization, in **“patches” or “stitching”**

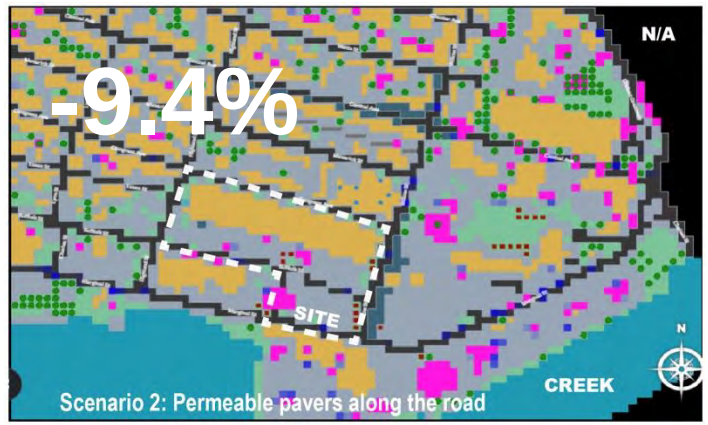
Emergence and shift of ‘Signaling’

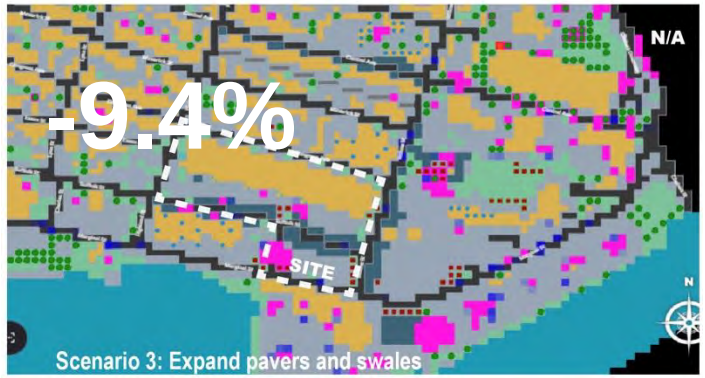
- Impulse towards centralization is aesthetic and social: investments doing more
- Distribution reframed as **cooperation,** desire to recruit even the smallest sites regardless of impact

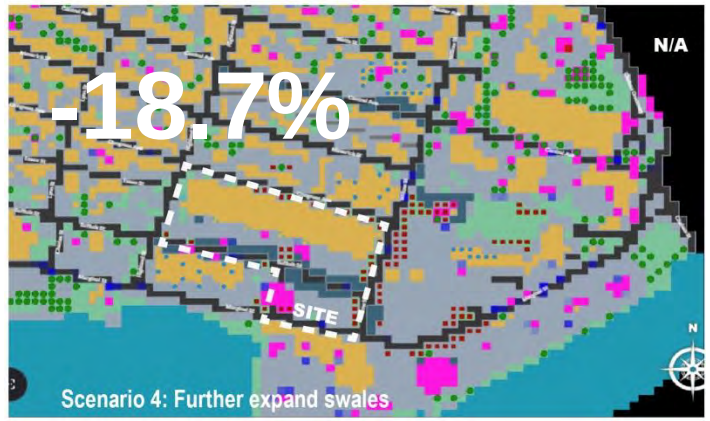












GROUP 1

GROUP 2

% REDUCTION FLOOD AREA

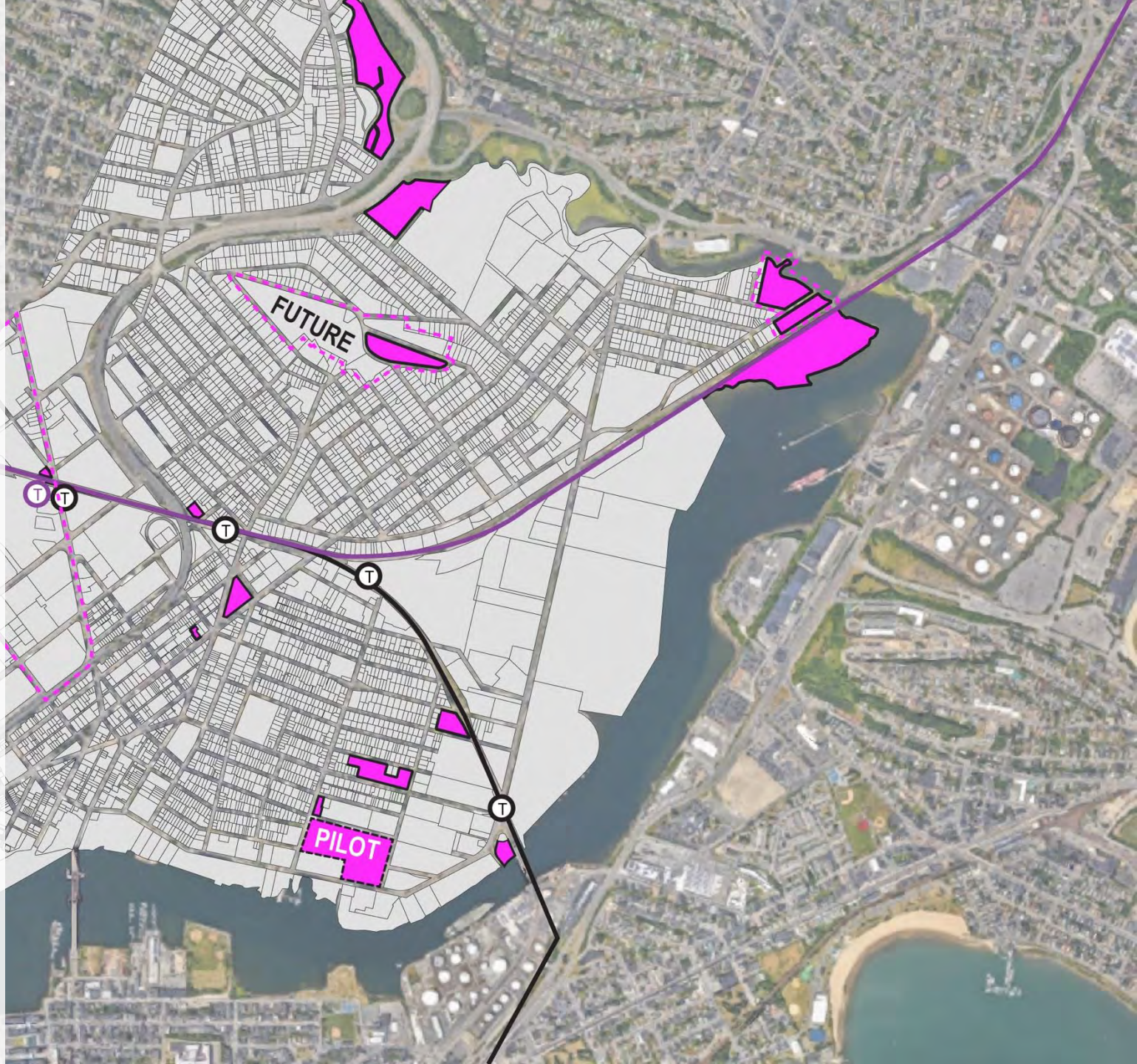
Land Cover:
- Buildings
- Roads
- Impermeable Ground
- Permeable Ground

Green Infrastructure:
- Green roof
- Swale
- Pavers
- Existing Trees

Impacts:
- Deeper flood
- Shallow ponded water

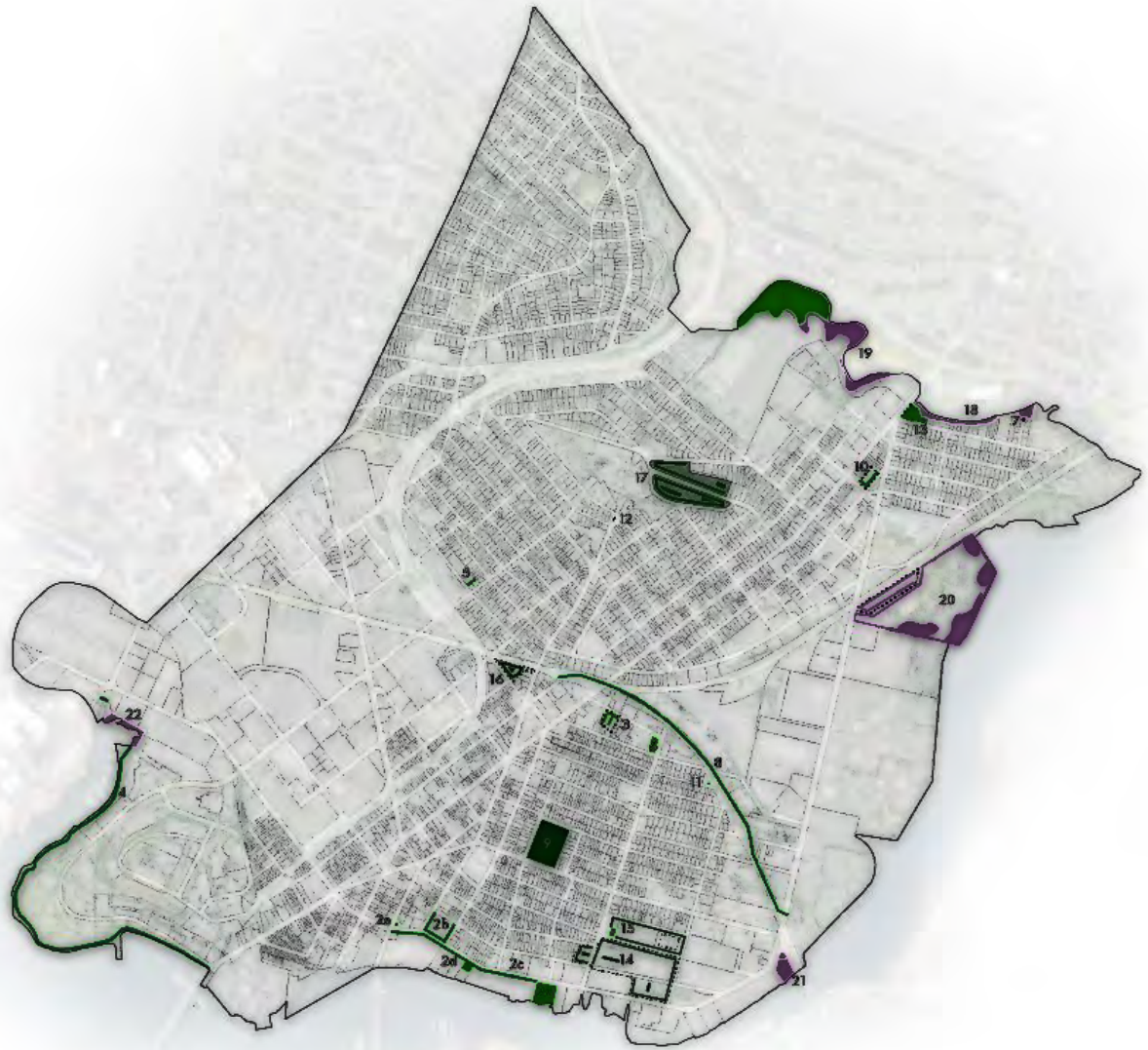
Future work

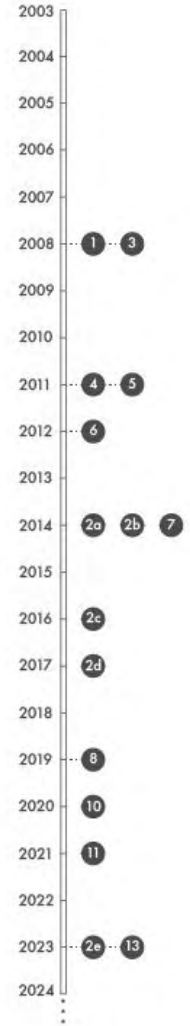
- Identified other sites of interest for the city, exploratory conversations
- Finalize models for other hazards, GI co-benefits, and multi-hazard trade-offs
  - Water quality modeling
  - Heat modeling
- Mapping GI and sensor data to validate models
- Characterize scale of GI's spatial influence
- Additional workshops to refine process



2025 - future

1. *Mill Creek Salt Marsh Restoration Project*
2. *Marginal Street Community Industry Corridor*
   a. *P.O.R.T. Park*
   b. *Tree planting*
   c. *Tree planting*
   d. *Pocket park and tree planting*
   e. *Pearl Plaza & Bus Shelter*
3. *Janus Highlands*
4. *Island End Park*
5. *Anita's Garden*
6. *Box District Park*
7. *Mace Apartments Rain Garden*
8. *Chelsea Greenway*
9. Chelsea Garden Cemetery
10. *Acadia*
11. *Marlborough Street Community Garden*
12. Forsyth Open Space
13. *1005 Broadway*
14. 22 Willow
15. Cooling Block
16. 25 Sixth Street
17. Chelsea Soldier's Home
18. *Mill Creek Flood Mitigation and Restoration*
19. *Mill Creek Parcel Park and Coastal Remediation*
20. *Chelsea Creek Nature Trail*
21. *Chelsea Street Bridge Park*
22. *Island End River Flood Resilience Project*



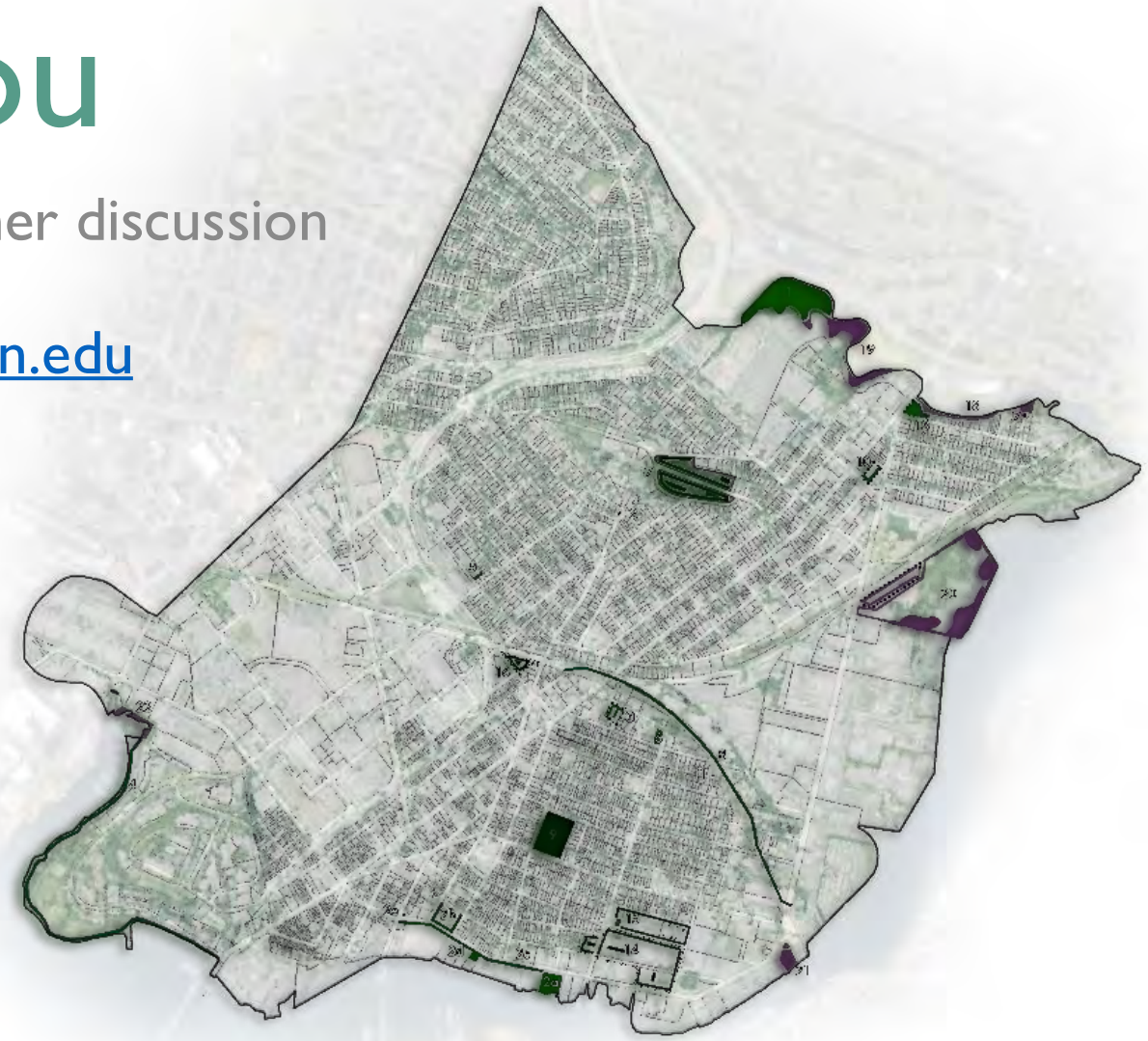


completed projects *ongoing projects* *upcoming projects*

N

Thank you

For questions or further discussion please contact
m.laboy@northeastern.edu



Appendix I:

Peer-reviewed journal article in *Environment and Planning B*, focused on workshops of green infrastructure design and flood modeling of the 22 Willow site.

Zellner, Moira L, Dean Massey, Michelle Laboy, Daniel T O'Brien, Amy Mueller, and Daniel Engelberg. "Enhancing Digital Twin Technology with Community-Led, Science-Driven Participatory Modeling: A Case in Green Infrastructure Planning." *Environment and Planning B: Urban Analytics and City Science*, February 19, 2025, 23998083251323671. https://doi.org/10.1177/23998083251323671.

Appendix J

Slides of presentations on participatory modeling based on the workshops in or about Chelsea supported in part by the Latrobe Prize. To date there are many versions of this talk, listed below; only one version is included here as an attachment (highlighted in bold below).

Invited Presentations:

Zellner, M.L.; "Participatory modeling for collaborative and equitable planning." Invited Seminar Speaker, ProSocial World; December 2024.

Zellner, M.L.; "Including all voices in decision-making through collaborative modeling and planning." Invited Meet the Scientist Speaker, Museum of Science Hispanic & Latinx Celebration Weekend, Boston, MA; October 2024.

Zellner, M.L.; "Participatory complex systems modeling for collaborative and equitable planning." Invited Inspiration Speaker, European Social Simulation Association (ESSA) Social Simulation Festival 2024; May 2024.

Zellner, M. L.; "Participatory modeling for collaborative and equitable planning: From potential to realization." Invited keynote, 2024 Annual Modeling and Simulation Conference. Washington, DC; May 2024.

Conference presentations:

Zellner, M.; "Realizing the potential of community-led, science-driven participatory modeling: A case in green infrastructure planning." Inaugural Conference of the National Sustainability Society, Seattle, WA; September 2024.

Zellner, M.; Allen, K.; "Realizing the potential of community-led, science-driven participatory modeling: A case in green infrastructure planning." Boston Area Research Initiative (BARI) Conference, Cambridge, MA; April 2024. (attached)

Zellner, M.; "Realizing the potential of community-led, science-driven modeling for collaborative planning and policy." Association of Collegiate Schools of Planning Conference, Chicago, IL; October 2023.

Zellner, M.; "Fora.ai: Reshaping How to Collaborate for Climate and Social Impact." Workshop for the 53rd Annual International Conference of the International Simulation and Gaming Association (ISAGA). Boston, MA; July 2022.

Conference workshops

Zellner, M.; "Fora.ai: Reshaping collaboration for climate and social impact." Workshop for the Intermountain Sustainability Summit; Ogden, UT; March 2025.

Zellner, M.; "Fora.ai: Reshaping collaboration for climate and social impact." Workshop for the Inaugural Conference of the National Sustainability Society, Seattle, WA; September 2024.

Northeastern University
School of Public Policy and Urban Affairs

Realizing the potential of community-led, science-driven participatory modeling: A case in green infrastructure planning

Moira Zellner (NU) and Karl Allen (City of Chelsea)

BARI Conference 2024
April 12, 2024

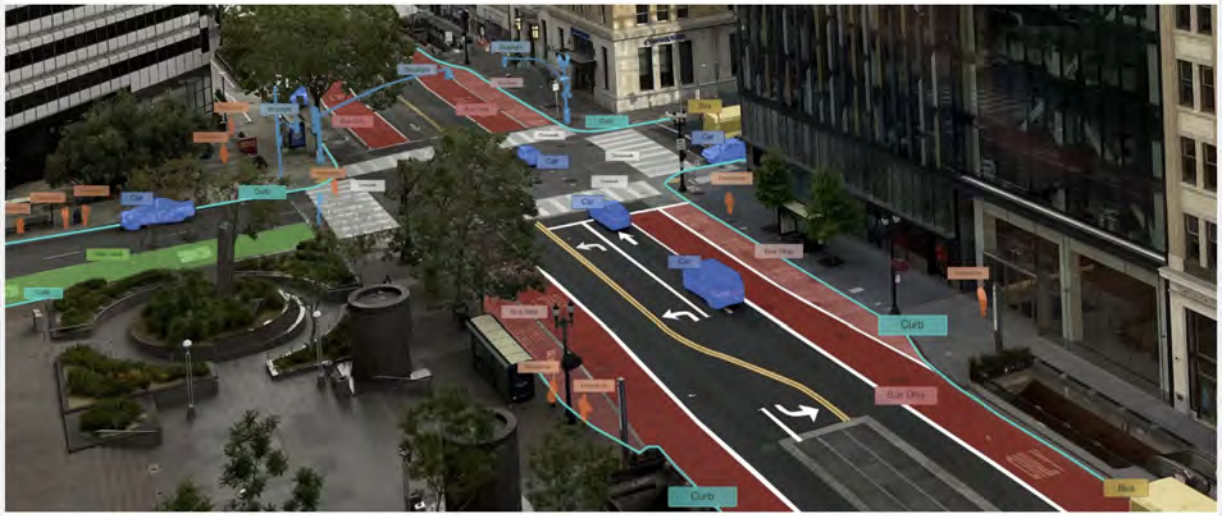
DSS, Smart Cities, now UDT…

- DSS: Decision-support systems
- Smart Cities and dashboards
- UDT: Urban Digital Twins
- A new fad…?
  - Digital technology and its promise
  - The role of private and public funding
  - A mirror?
  - Lack of social representation
- PM as a form of UDT

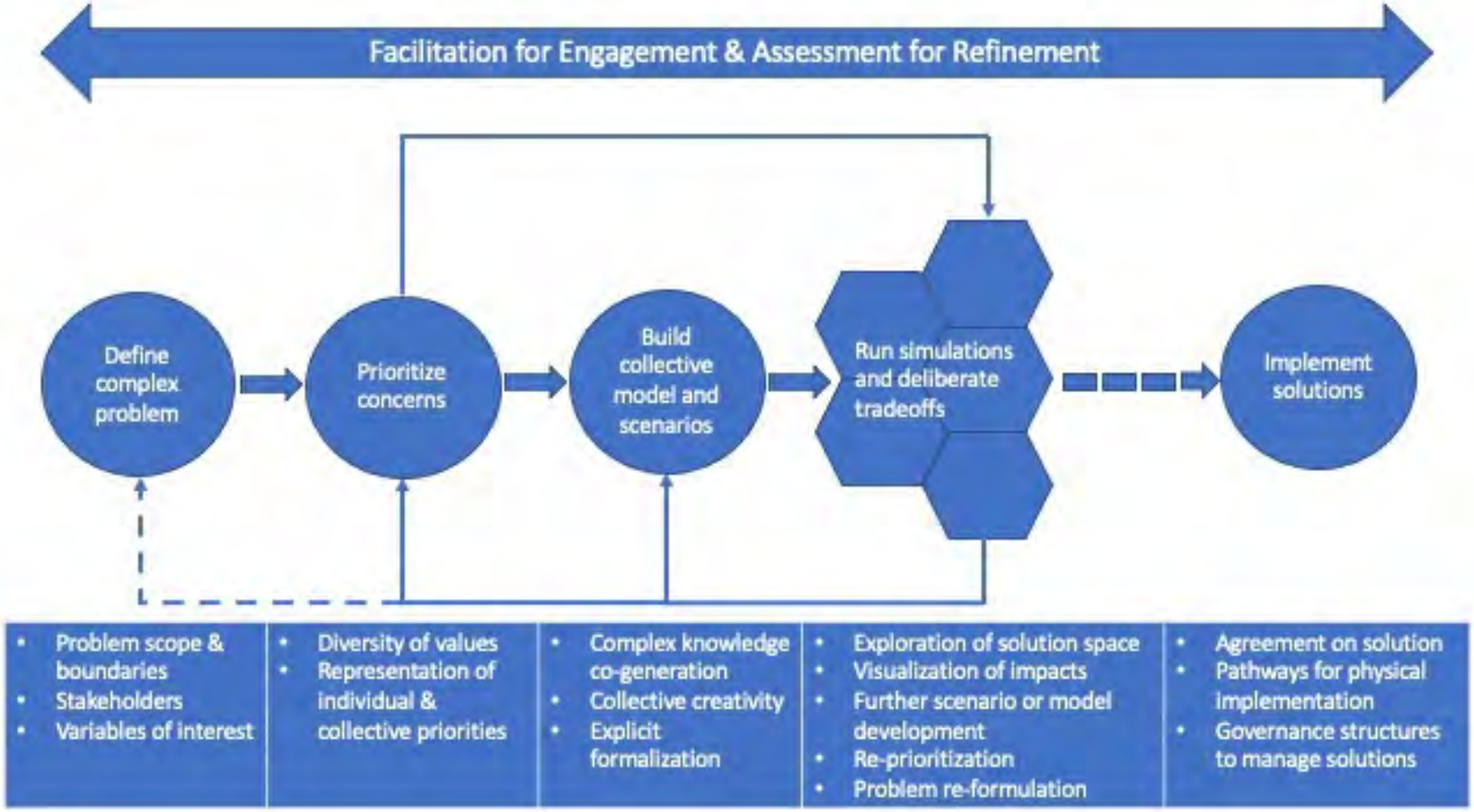
(Zellner et al., in review)

Source: www.govtech.com/sponsored/planning-urban-cities-smartly-with-digital-twins

Planning Urban Cities Smartly With Digital Twins

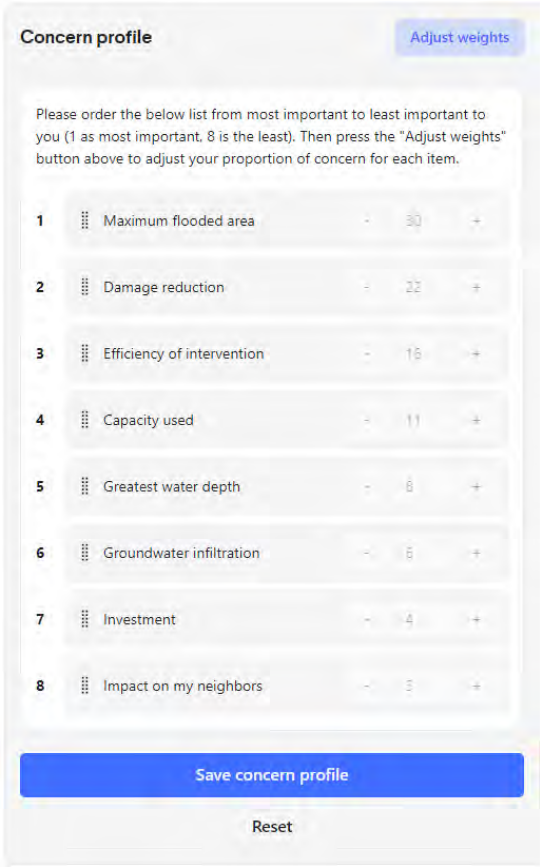


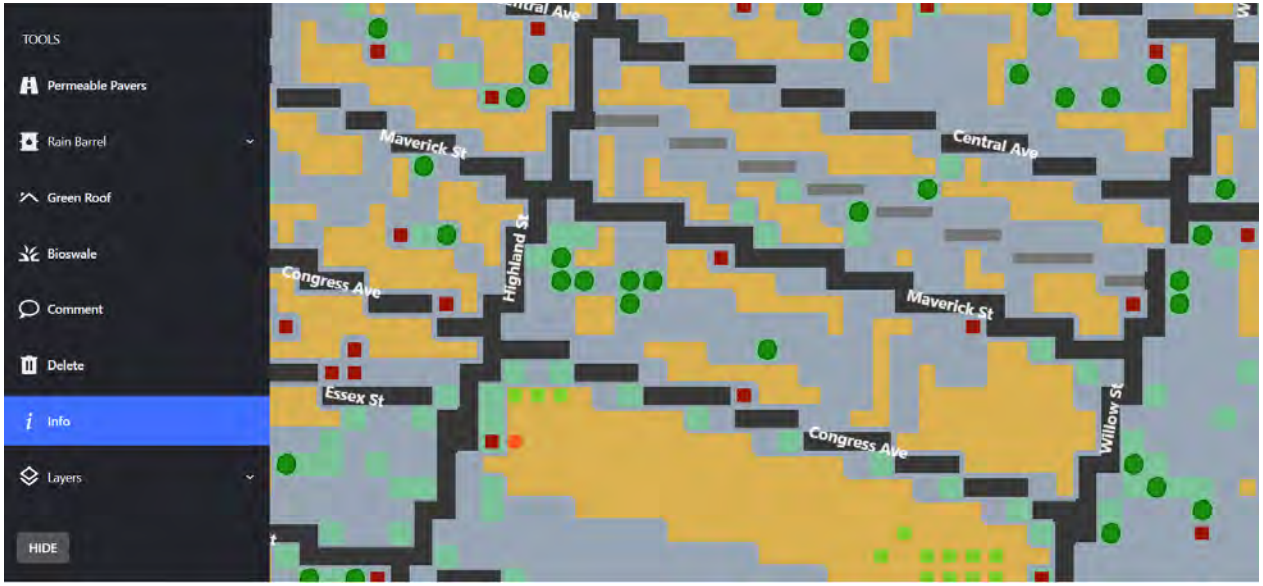
Digital twins have revolutionized the way businesses operate, and now, startups like Hayden AI are exploring new aspects of the groundbreaking technology to transform the way cities are designed and maintained, and ultimately enhance the quality of life for communities.



(Zellner. 2024)

Fora.ai





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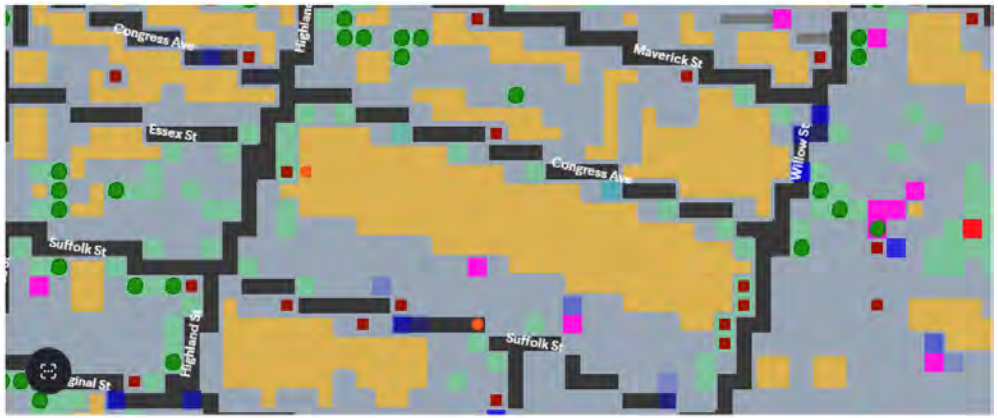
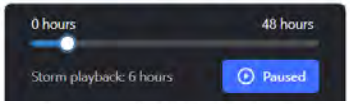
(Zellner et al., in review)

Fora.ai

Trial 3 - Flow path

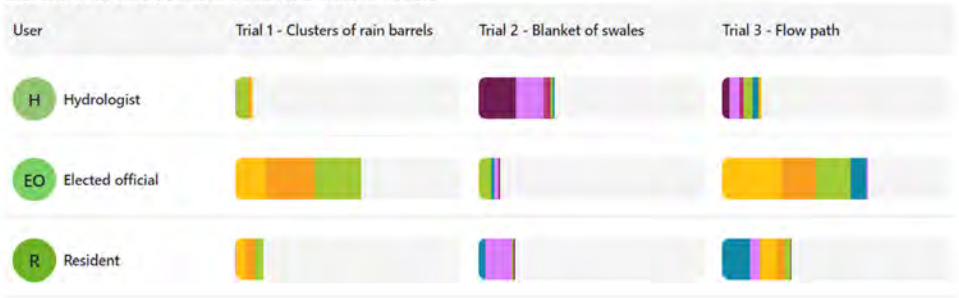




Maximum flooded area	4.2% 15.9% Better	
Baseline Total flooded: 4.9% Street flooding: 3% Non-street flooding: 5.3%	**Trial 3 - Flow path - Draft Plan** Total flooded: 4.2% Street flooding: 2.2% Non-street flooding: 4.5%	
Damage reduction	$900,000 40.9% Better	+
Efficiency of intervention	$7.87/gal	+
Capacity used	73.1%	+
Greatest water depth	21.6 inches No change	+
Groundwater infiltration	5.62%	+
Investment	$4,958,000	+
Impact on my neighbors	4.8% 7.8% Better	+

Results based on your priorities and others

Each color in the score breakdown is linked to an outcome measure



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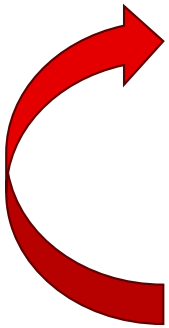
(Zellner et al., in review)

Workshop structure

1. Introductions and demo
2. Small group breakouts
   a) Goal definition
   b) Systematic exploration strategies
   c) Record expectations and reasoning behind them
   d) Record results and comparison with baseline and with expectations
   e) Plan next trial
3. Focus group discussion



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(Zellner et al., in review)

Evidence of impact

- Learning about flooding and green infrastructure

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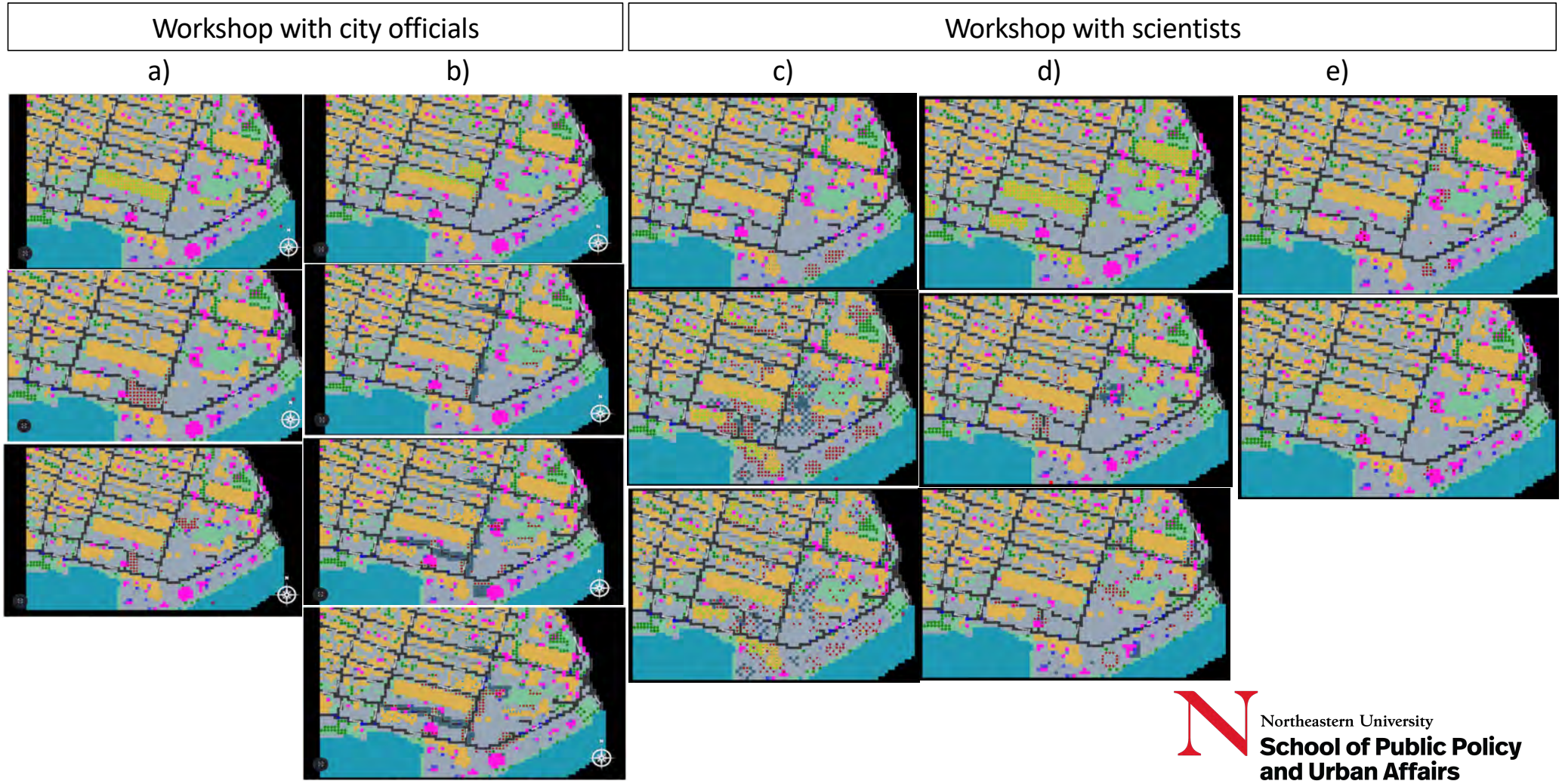
(Zellner et al., in review)



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(Zellner et al., in review)

Evidence of impact

- Learning about flooding and green infrastructure
  - *Bioswales and pavers over green roofs and rain barrels*
  - *Decentralized over clustered*
  - *Learning over getting it right*
  - *The role of facilitation and model outputs*

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(Zellner et al., in review)

Evidence of impact

- Learning about flooding and green infrastructure
- Learning about microspatial inequities
  - *Opportunistic (project-based) versus strategic (neighborhood-level) interventions*
  - *"Reactive" strategies*
  - *Connecting flows to flooding*

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(Zellner et al., in review)

Evidence of impact

- Learning about flooding and green infrastructure
- Learning about microspatial inequities
- Learning to negotiate tradeoffs

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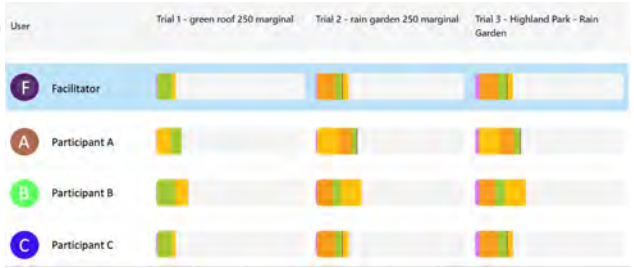
(Zellner et al., in review)

Evidence of impact

Workshop with city officials	Workshop with scientists

a)

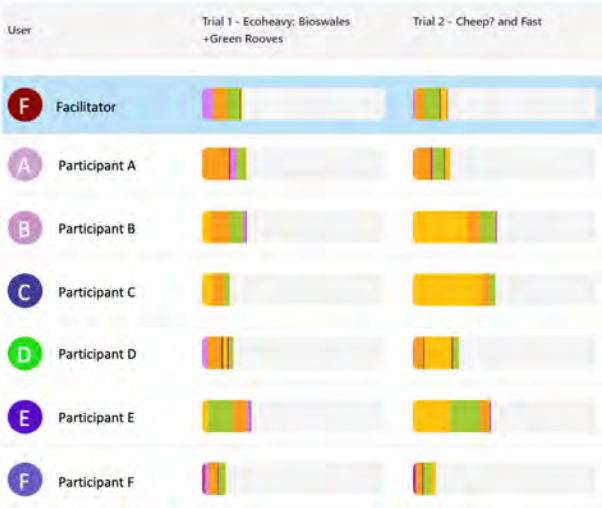


b)

c)

d)

e)



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(Zellner et al., in review)

Evidence of impact

- Learning about flooding and green infrastructure
- Learning about microspatial inequities
- Learning to negotiate tradeoffs
  - *Definitions of success across metrics*
  - *Spatial tradeoffs*
  - *No need for consensus on values to agree on solutions*
  - *But no universal "grand plan" and limitations of one-dimensional metrics of success*

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(Zellner et al., in review)

Evidence of impact

- Learning about flooding and green infrastructure
- Learning about microspatial inequities
- Learning to negotiate tradeoffs
- Innovating practices
  - *Shifting from prior beliefs about effectiveness of GI types and spatial layouts*
  - *Increased concreteness of solutions at multiple scales*
  - *Generalizable GI design principles: decentralization*
  - *No "optimal" solution: tradeoffs and co-benefits*
  - *Collaborative, iterative, and deliberative process*

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(Zellner et al., in review)

Value proposition and next steps

- Reasoning v. realism
  - Supporting collaborative learning and equitable solution-building
  - Resisting solutionism and conflict aversion
- Scaling up: Summer 2024
  - Platform
    - New version, public launch
    - Facilitation structures, debriefing
  - Models
    - L-GrID extensions for heat, coastal flooding
    - Different models (wildfire, delta and agricultural water management) and metrics (EJ)
  - Sensors
  - Communities

(Zellner et al., in review)

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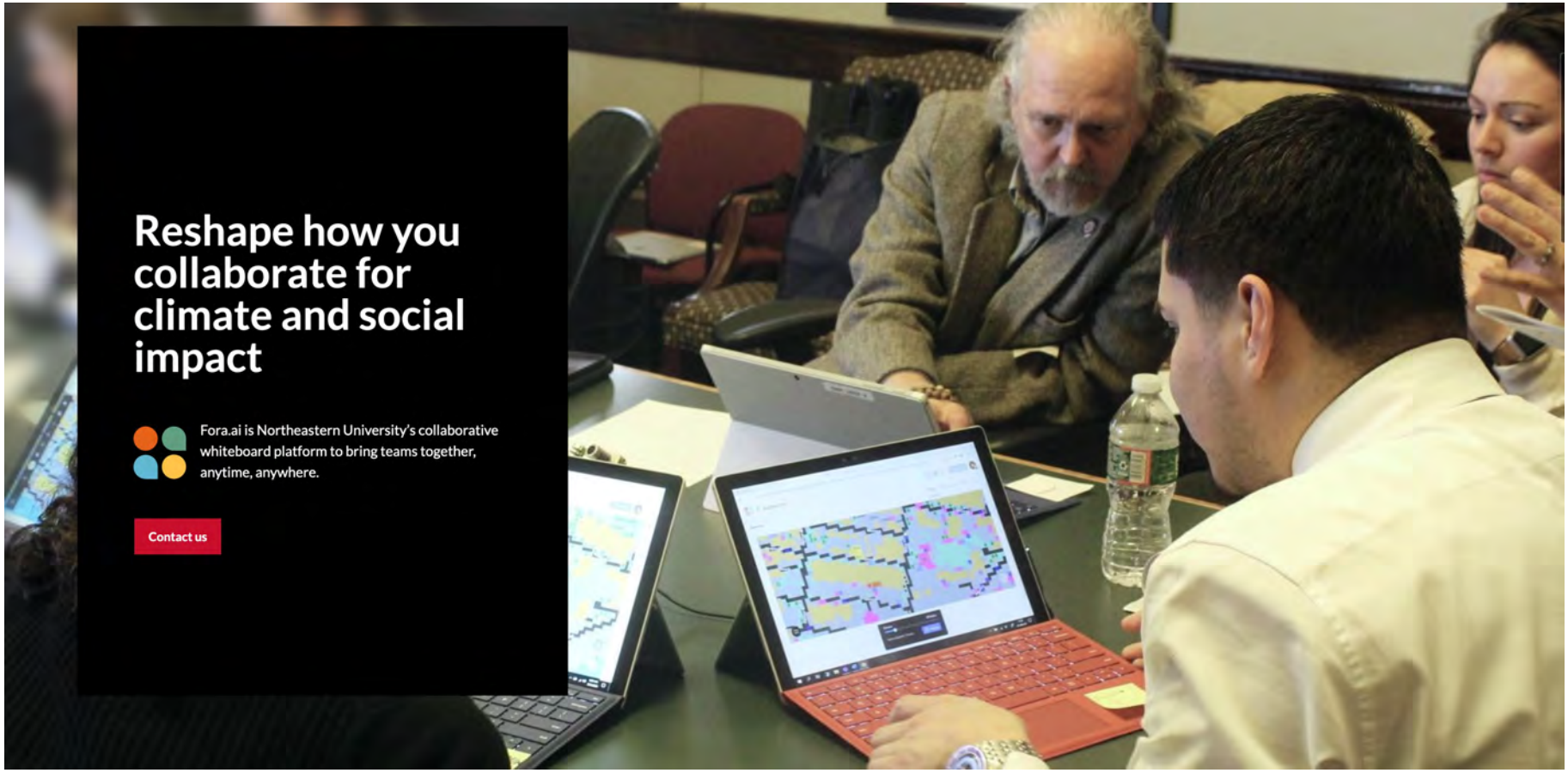
https://fora.northeastern.edu/



- CSSH and Policy School funding
- 2022 AIA Latrobe Prize
- NSF Geomatics and S&CC grants

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Appendix K

Common SENSES Playbook

Submitted to The City of Chelsea and AIA College of Fellows

CommonSENSES
Playbook

Chelsea

2025

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***Participatory Modeling and Fora.ai*, Moira Zellner**
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1

Introduction

Latrobe Prize

This project aligns with the goals of the 2022 theme “Buildings at the Intersection of Human Health and Planetary Health”.

Architecture that goes beyond the design of buildings to create positive outcomes for people and communities

Prioritizes the creation of knowledge to achieve an equitable, resilient, and healthy built environment

Affirms goal of contributing to healthy and equitable communities

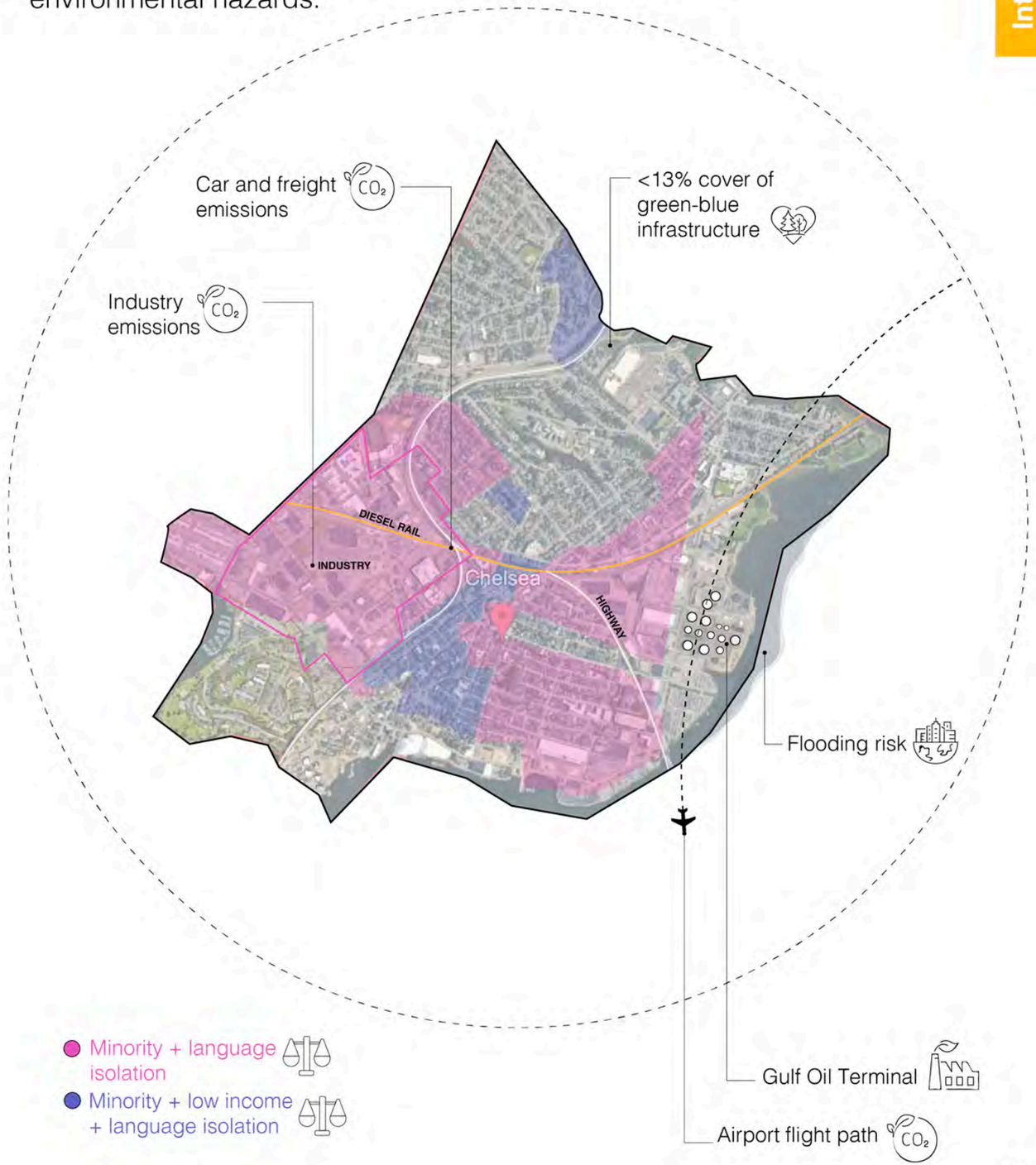
Project helps realize solutions for climate action.

Elevates research findings to be usable and applicable to Architect Practitioners in design decision-making.

Research is viewed by clients as truly “value-added”.

The American Institute of Architects College of Fellows 2022 Latrobe Prize Call for Submissions American Institute of Architects 1735 New York Ave NW Washington DC 20006-5292

Chelsea, Massachusetts is a city on Boston’s industrial harbor that is designated as an environmental justice community. Here, human health is greatly threatened by environmental hazards.

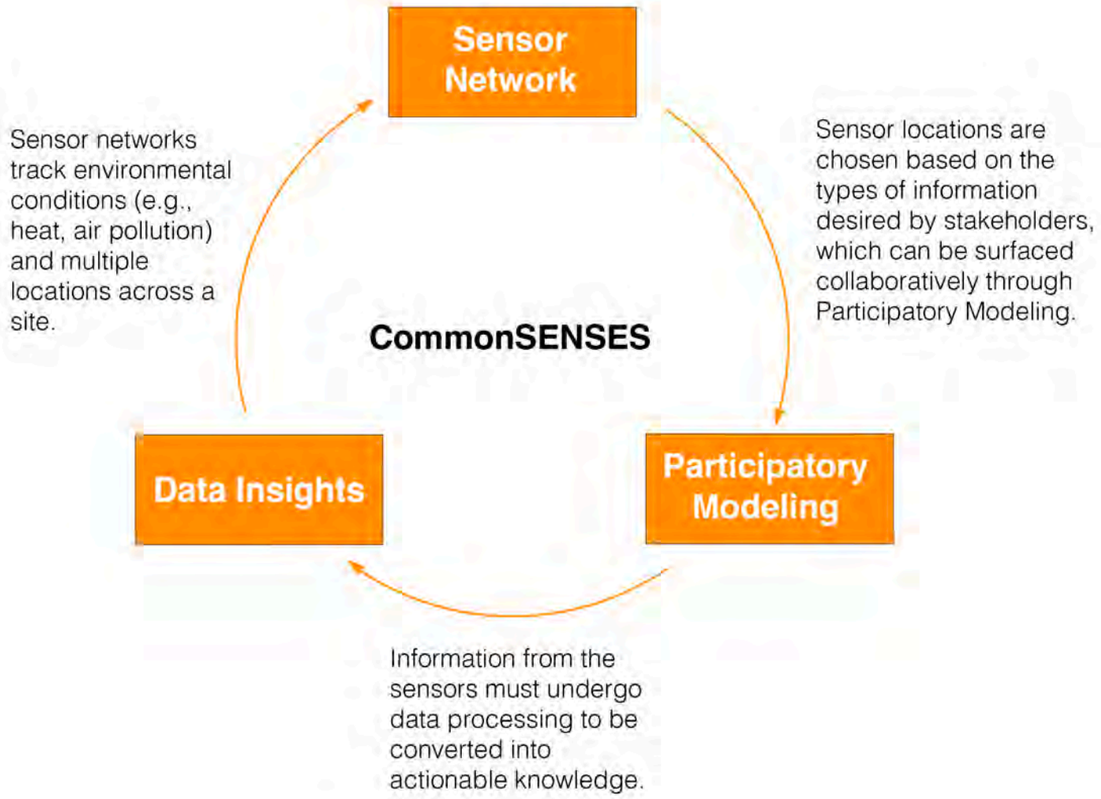


2

Transforming Practice

Transforming Practice

What is our vision?
An holistic study in which sensor networks, community engagement, and data insights are all interconnected.



Key Considerations

- Sensor-generated data is leveraged to identify, and track, and respond to microspatial inequities.
- Architects are envisioned as co-learners and co-designers within the community.
- Model empowers the community to *grasp and deliberate* the results and social impacts of the study.

What challenges for architects exist?
When we think about architecture being more integrated into green infrastructure solutions, a number of challenges become clear:

01 Climate resilience is both global and local.
→ **Data and site analysis does not yet reflect this.**

02 Buildings shape microspatial inequities.
→ **Architects lack methods to measure and mitigate impacts.**

03 Design processes need to be conscious of inequities.
→ **Sensors are an emergent but underutilized solution in design.**

04 Dynamic data is powerful.
→ **Only if easily interpreted to guide better community decisions.**

3

Site Selection

Why Chelsea?

Chelsea has proven to be at the intersection of planetary and human health, housing minority and low income communities that continually face environmental threats of flooding, extreme heat, and air quality in their home city.

The effects of climate change are felt both globally and locally; however, data and site analysis does not yet reflect this.

On a local scale, **the city of Chelsea has notably lacked sufficient green infrastructure (GI) over the last decade, improving their total vegetated land cover from 12.4% to just 14.3% between 2003 and 2024.** Burdened by transportation and industrial pollution, the city is also home to a strip of the Boston Harbor shoreline used by ships to transport jet fuel to and from the nearby Boston Logan International Airport. Chelsea showcases the impacts of overcrowded low-income housing, becoming the epicenter of COVID-19 infections, food insecurity in Massachusetts, and adding to ongoing epidemics of asthma, diabetes, and heart diseases. A result of discriminatory planning and development policies in the area, urban planners, engineers, and architects alike hold a responsibility to address these problems with the power of research and informed development.

The Chelsea community struggles with air quality, heat, and flooding on a microspatial level- its effects felt directly by residents at the block and street scale.

Key Considerations

- Select a site with inequities felt at the local level.
- Areas lacking sufficient green infrastructure can often narrow down or indicate ideal site(s) for study.

Chelsea's Green Infrastructure Developments

2003 - 2024

Total open space: **331 acres or 23%**
Total vegetated land cover: **176 acres or 12%**

In 20 years (2023):
GBI (Green-Blue Infrastructure) added/restored: **27.5 acres or 2%**

1. Mill Creek Salt Marsh Restoration Project
2. Marginal Street Community Industry Corridor
   a. P.O.R.T. Park
   b. Tree planting
   c. Tree planting
   d. Pocket park and tree planting
   e. Pearl Plaza & Bus Shelter
3. Janus Highlands
4. Island End Park
5. Anita's Garden
6. Box District Park
7. Mace Apartments Rain Garden
8. Chelsea Greenway
9. Chelsea Garden Cemetery
10. Acadia
11. Marlborough Street Community Garden
12. Forsyth Open Space
13. 1005 Broadway
14. 22 Willow
15. Cooling Block
16. 25 Sixth Street
17. Chelsea Soldier's Home

completed projects on-going projects

How can the city address microspatial inequities?

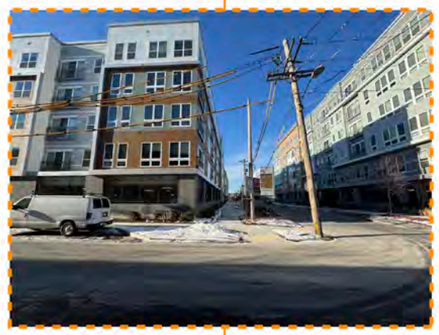
Private development could help expand green infrastructure.

The city of Chelsea is overbuilt, maintaining just over 23% open space as of 2024. Still, the city struggles with a housing crisis and lacks sufficient green infrastructure- but how can it build more housing and still work to increase GI? **Private development may be the answer.**

With limited public space remaining for development, each private project in Chelsea represents a crucial opportunity to expand green infrastructure (GI). To be effective, however, GI must be thoughtfully integrated and tailored to the specific site and project. Recognizing this, the City of Chelsea is actively working to incorporate GI into private architectural developments through strategic negotiations. While many current private projects lack public-facing green infrastructure, they hold significant untapped potential to enhance the city's overall GI network. Chelsea's broader vision is to shift from a highly privatized approach to one that prioritizes public access—bringing generous, well-designed green infrastructure back into the public realm wherever possible.

La Colaborativa leads a protest in Chelsea demanding an end to evictions and rent cancellation amid the housing crisis.

Vero Apartments, Chelsea, MA



Vero Apartments in Chelsea, MA are a prime example of a privatized approach to green infrastructure. Aerial imagery of the development shows courtyard spaces that are entirely closed off to the public. From street view, the apartments create a visual wall of separation, reinforcing exclusivity and limiting equitable access to nature. Opportunities to enhance the public streetscape, reduce urban heat island effect citywide, or support community resilience at a larger scale are overlooked in this approach. Chelsea strives to change this by advocating for a more generous green infrastructure for the public.

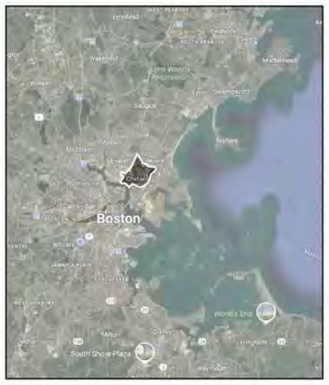
How can we make better design decisions?
Downscaled data is needed.

Data Resolution Figures

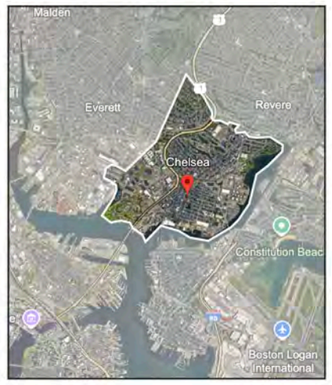
1. **Aerial Photograph →**
2. Landsat 8
3. Land Surface Temperature
4. Air Quality

While data and satellite imagery for understanding Chelsea's environmental hazards exist, few models are available to predict these significant local variations at **a high enough resolution for architects to respond**. To address this problem, the downscaling of data, i.e., ensuring regional or larger scale datasets are converted to information at the spatial resolution of the study, are needed- a way to understand the spatial implications of green infrastructure on communities and health equity. Downscaled solutions can equip architects to design and solution small interventions where they are most impactful. In the case of cities like Chelsea, this information can be used to help frame critical discussions around redevelopment: the opportunity to redevelop only happens once every few generations, and the chance to mitigate heat output and increase green infrastructure during that window is crucial.

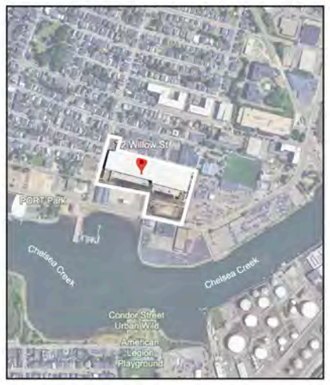
1. **Aerial Photograph**
Source: Google Earth



GREATER BOSTON REGION



CHELSEA



22 WILLOW ST

Aerial imagery for Chelsea, Massachusetts and site-specific details provide good resolution. A well-known example is Google aerial view, which presents increasingly precise information as you zoom in. This resolution depends on how much space each pixel in the image covers. Additional data sources like **satellite imagery, surface temperature, and air quality** data aim to serve the same function; however, they are not available at the same resolution. →

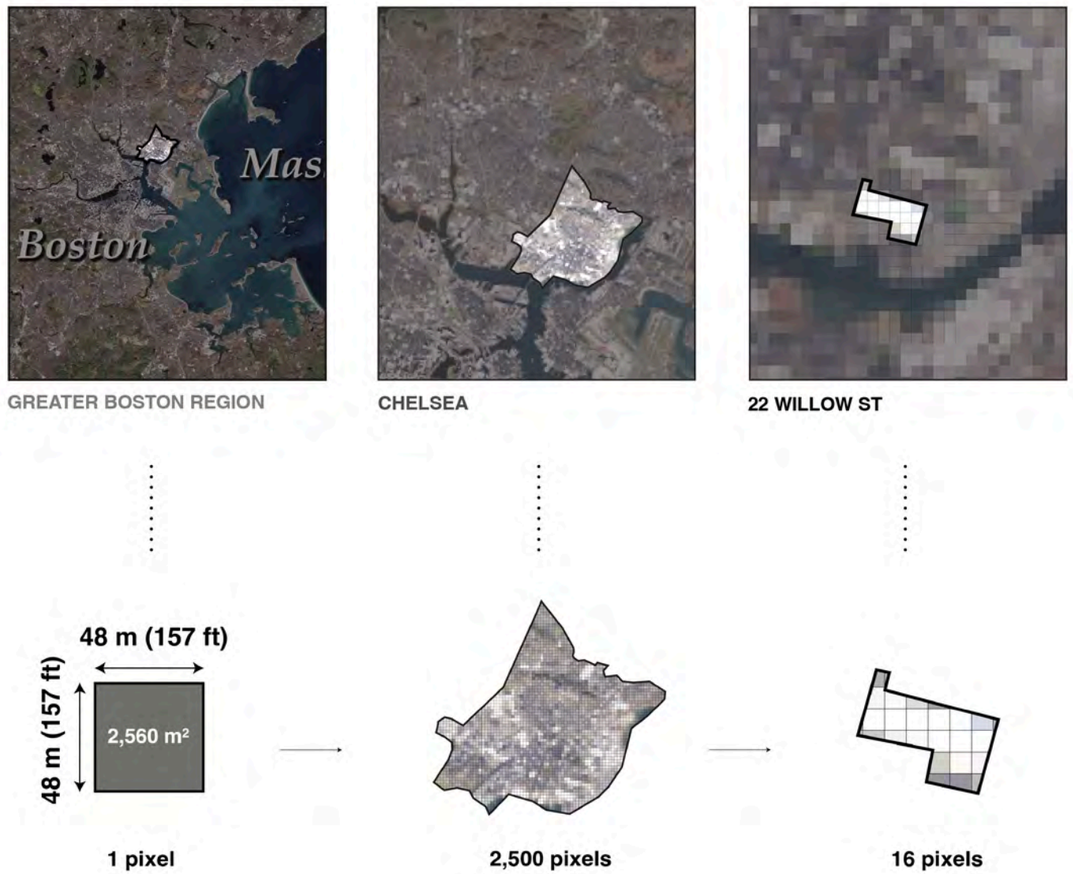
Downscaled data is needed.

Data Resolution Figures

1. Aerial Photograph
2. **Landsat 8** →
3. Land Surface Temperature
4. Air Quality

NASA uses satellite imagery to estimate the presence of impervious surfaces (i.e., pavement) in grid cells that are .03 mi x .03 mi, or approximately 50 m x 50 m. The 22 Willow Street site is composed of about **16 such grid cells**, or pixels, capturing variation in the site structure.

2 **Landsat 8**
Source: NASA



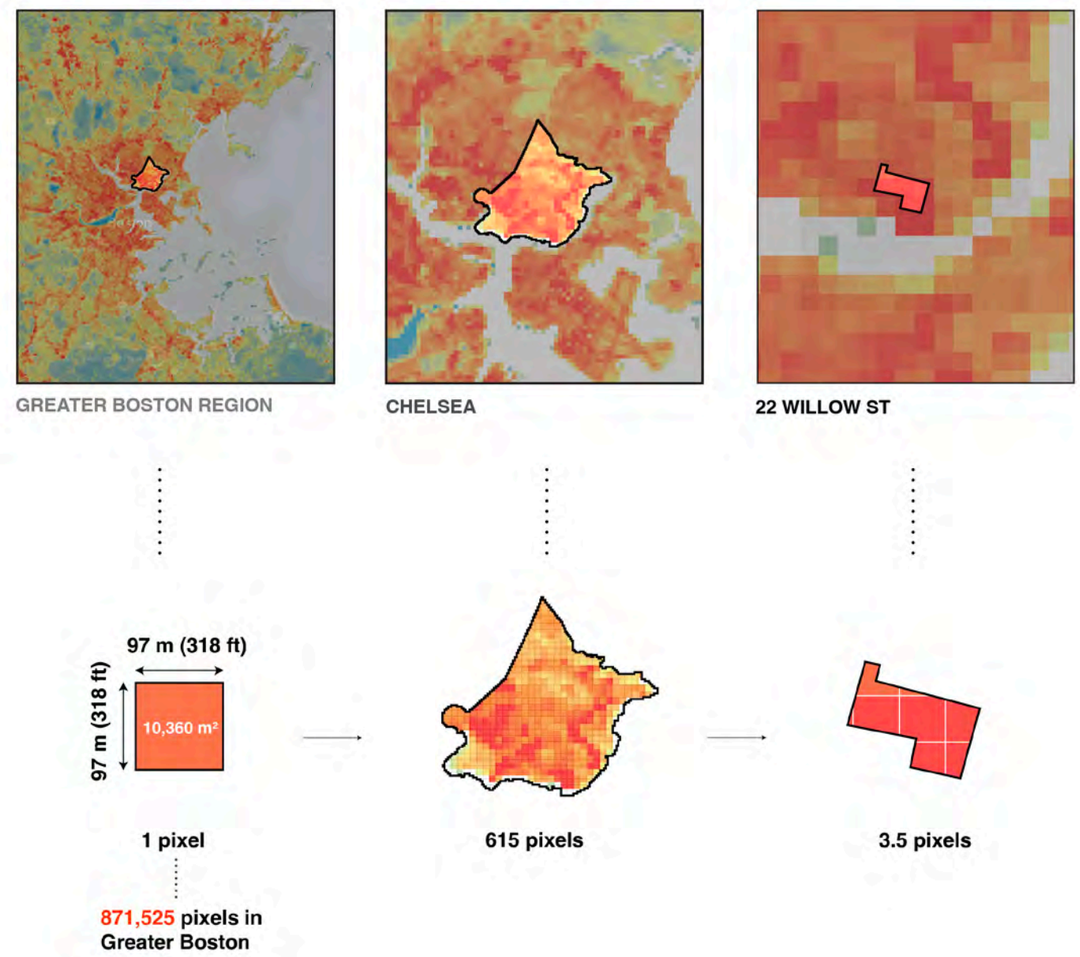
Downscaled data is needed.

Data Resolution Figures

- Aerial Photograph
- Landsat 8
- **3 BARI Land Surface Temperature →**
- TEMPO Air Quality

NASA also uses satellites to estimate land surface temperature in grid cells that are .06 mi x .06 mi, or approximately 100 m x 100 m. The 22 Willow Street site is composed of about **3.5 such grid cells**, or pixels, revealing different temperatures in a highly localized space.

3 Land Surface Temperature
Source: BARI



Downscaled data is needed.

Data Resolution Figures

1. Aerial Photograph
2. Landsat 8
3. Land Surface Temperature
4. **Air Quality** →

Finally, NASA also uses satellite imagery to estimate the level of air pollution in grid cells that are 1 mi x 3.6 mi. This resolution is much coarser that the others, and Chelsea is the size of 0.69 grid cells, or pixels divided between three of them on the map.The 22 Willow Street site covers **less than 1/20th of a single pixel**.

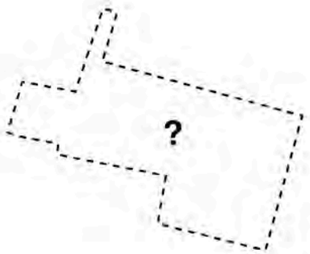
4 **Air Quality**
Source: TEMPO

4

Pilot Site

Defining the Site

Why 22 Willow?



22 Willow Street in Chelsea, MA presents a unique opportunity for study **due to its location at the intersection of residential and industrial zones.** → This distinctive site condition offers valuable insight into the environmental and social impacts experienced by nearby residents—many of whom are members of minority groups, have limited English proficiency, and/or are part of low-income communities.

The site is particularly suitable for research because a redevelopment project has already been commissioned by **RODE Architects** in collaboration with developer **Hines**. Their plans include the implementation of significant green infrastructure (GI) improvements. These planned changes create an ideal scenario for data collection and analysis, allowing researchers to assess the effectiveness of GI interventions in addressing issues such as urban heat, air quality, flooding, and environmental equity for vulnerable populations.

Key Considerations

- Ensure the site has measurable and observable changes over time, allowing for effective data collection and analysis
- Consider projects with committed stakeholders (e.g., architects, developers) that can support and sustain the study context.

22 Willow Street, Chelsea, MA

22 Willow Street lies between a densely populated residential neighborhood and an active industrial front on the Boston Harbor.

Pilot Site

22 Willow Street, *existing conditions*

22 Willow Street, *proposed green infrastructure*

Project by RODE Architects.

Planting Type

higher

impact

lower

- trees
- existing trees
- rain garden meadow mix
- native steep slope meadow mix
- shrubs
- perrenials and ornamental grasses
- lawn

Stormwater System

higher

quality

lower

- vegetated swale
- underground infiltration
- underground detention
- impermeable sidewalk
- impermeable asphalt

4

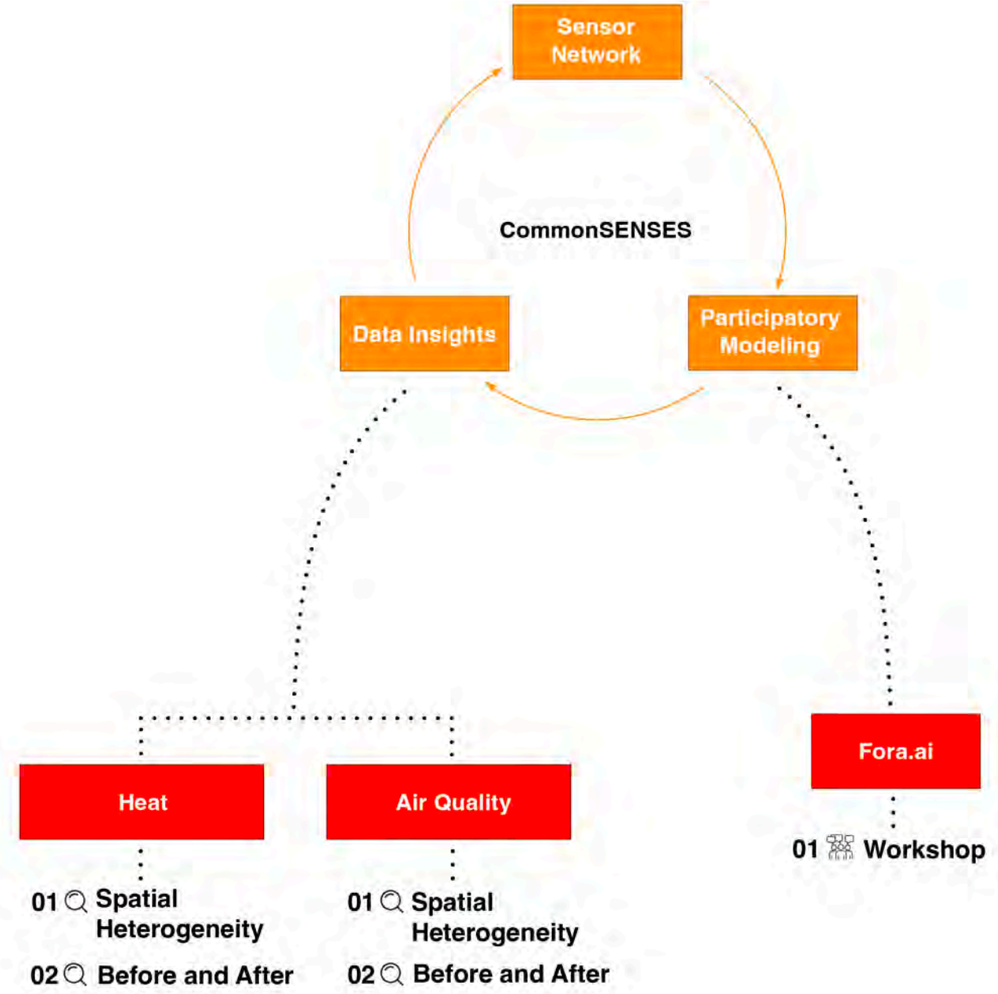
Holistic Study

Holistic Study

Addressing this research problem necessitates a holistic approach—one that simultaneously integrates community input, real-time, location-specific data, and data interpretation. **Accordingly, the study framework illustrated to the right reflects this interconnected structure: the sensor network, participatory modeling, and data insights are mutually reinforcing components.** →
In particular, participatory modeling and data insights are guided by distinct methodologies and analytical lenses that enable them to be implemented effectively and generate meaningful, value-added outcomes.

Defining these methodological lenses and approaches for community integration in advance of the study—and prior to the deployment of the sensor network—is essential to ensure that the resulting data remains aligned with the research questions and yields contextually relevant insights.

Study Breakdown
Flow chart



Participatory Modeling

What is participatory modeling?

"A purposeful learning process for decision-making that engages the implicit and explicit knowledge of stakeholders to co-create formalized and shared representation(s)."

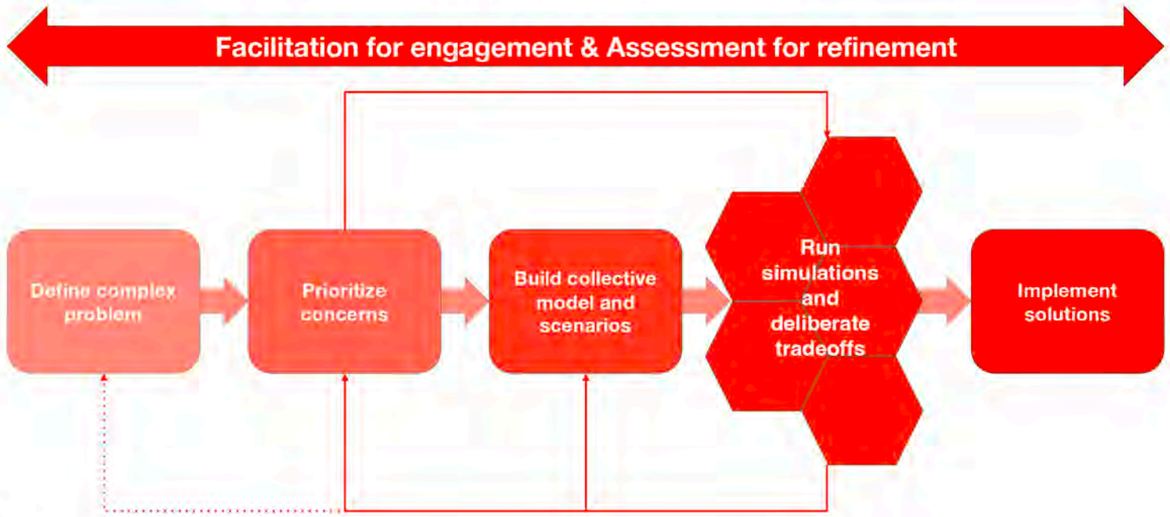
Current models of design approval and community engagement lack in approach in three main ways:

1. Input in hearings does not build understanding or deliberation
2. Speculating impacts of different iterations
3. Engineering models – slow / black box

As a result, participatory modeling— a strategy that mitigates these concerns— was the preferred alternative.

Fora.ai, an intuitive online participatory modeling platform, was created to support stakeholder engagement in the collaborative design and modeling of green infrastructure solutions to flooding using the L-GrID (Landscape Green Infrastructure Design) model.

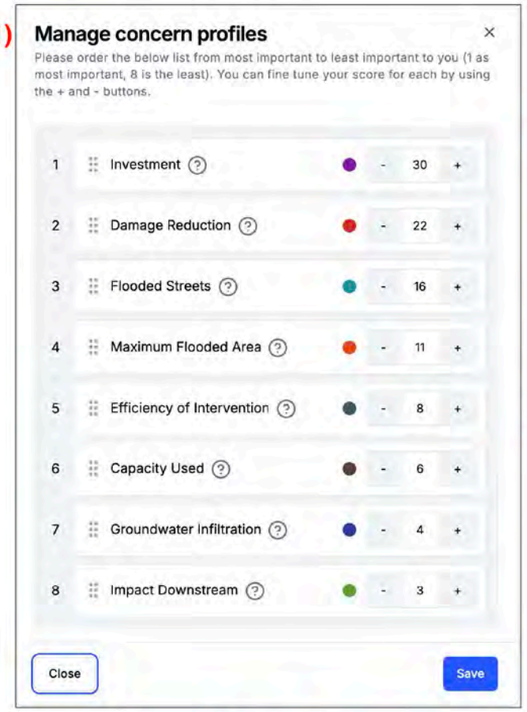
With Fora.ai, users can **1) prioritize issues, 2) build and simulate interactively, and 3) assess, deliberate, and iterate the results**. → This approach overcomes the limitations of using the results of black box models that remain foreign to most stakeholders, and are too hard to use to design and test a wide range of proposed solutions. Fora.ai helps participants understand how their proposed solutions work and visualize the tradeoffs that emerge from these solutions, to be collectively reconciled.



Fora.ai

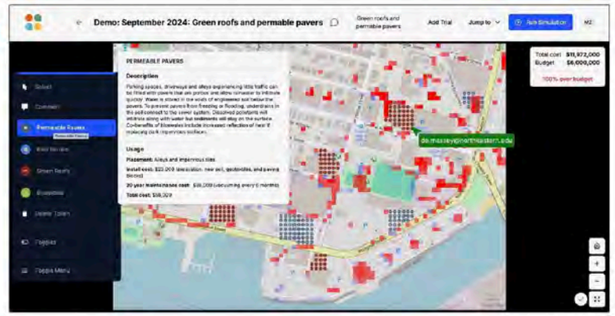
Relationship-building.

1)



Community participants navigate Fora.ai together.

2)



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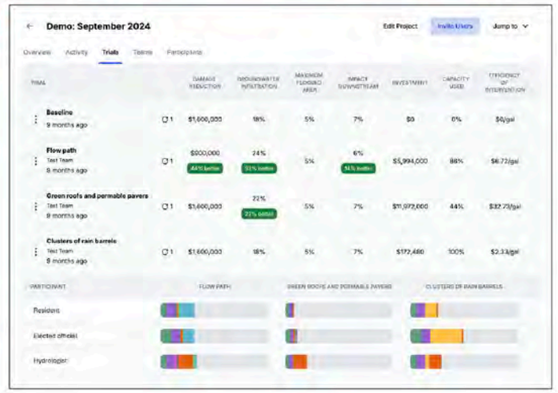


Key Considerations

- Engage early, not after the fact.
- The best designs are co-designs, which requires humility, attentive listening, and making room for other forms of knowledge.
- Participatory models and design go hand-in-hand, forming an iterative approach that combines creation with simulation and exploration and deliberation, feeding back into the next iteration of design.

Sensors

What questions might we want to ask?

Collecting field data with sensors can support answering several types of questions:

01 Are certain areas more affected?
↳ **Spatial Heterogeneity**

02 Does post-construction look different than pre-construction?
↳ **Before and After**

03 Are effects more pronounced at certain times?
↳ **Seasonality**

04 Did sensors provide information that aerial and satellite data could not?
↳ **Conclusions**

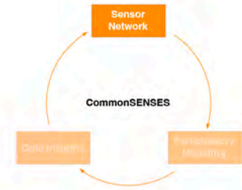
Asking these questions can help us create “lenses” for the data, or a way to define a focused view or specific perspective from a dataset. This allows for a more targeted exploration and analysis, which can be used to generate “value-added” results.

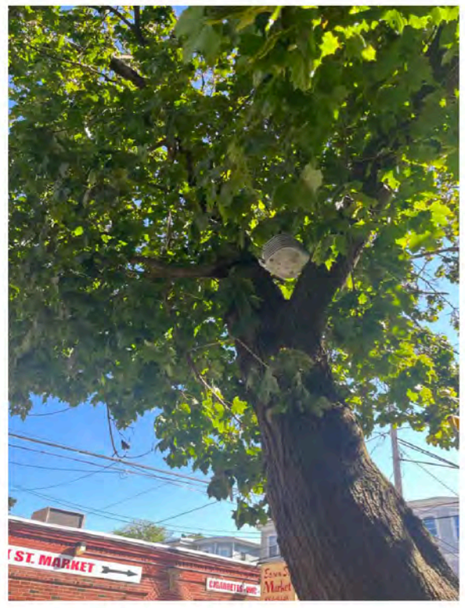
What and when?

What can we measure with sensors, and what timing is optimal?

In the cross-cutting context of green infrastructure, built infrastructure, and human health, **the most relevant environmental conditions to study are heat index (requires measuring temperature and relative humidity) and air pollution**. Commercially available sensors allow relatively easy high resolution measurements of the former with compact, battery-powered systems; for the latter, sensors are somewhat more costly but available to measure a range of air pollution components. Particulate matter, specifically $PM_{2.5}$, is a reasonable and affordable proxy for air pollution for these types of studies.

To generate the most insight it is important to have significant data about conditions both before and after any site development, which can mean **up to 1 year of data collection both pre- and post- construction**, depending on how much weather in the study area varies by season.





Sensors installed in both light poles and trees around the 22 Willow site.

Sensors

How do we design a sensor network?

The size of the network and number of sensors required can be answered by defining the spatial extent:

Depending on the size of the site and the research question, the vision for the sensor network spatial distribution may be limited to the site itself or may extend for multiple blocks in all directions into the surrounding area.

The number of sensors required will be somewhat proportional to the spatial coverage needed, but this should also be informed by the variability of the landscape itself. For instance, an undeveloped area of mostly parking lots is likely to have less spatial variability than a densely built-up area with buildings of different heights and roads of different widths and traffic loads.

Once this spatial extent of the questions has been defined, one can move on to identify the precise locations at which to install sensors.

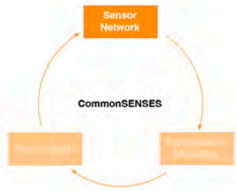
How do we identify sensor locations?

Realistically, availability of infrastructure to which sensors can be attached will constrain the study design options. Answering questions outlined above will typically require having sensors both on the site itself as well as in the surrounding area, which may or may not be owned by the same organization and could require coordination with municipal or other stakeholders.

Most ideally sensors will be installed on poles (providing a secure mounting and open air flow) at 9-10' height (to minimize interference with or by individuals).

Two frequent challenges are that poles directly on the development site may be removed or relocated frequently, and municipally owned poles of this height may be limited in some neighborhoods or city zones.

Street trees, or trees in other municipal greenspaces, may provide an alternative option for sensor mounting, avoiding issues of pole removal, relocation, or absence. However using trees as sensor "hosts" introduces different challenges: (1) shading from leaves precludes use of sensors needing solar power and (2) evapotranspiration of the trees will result in altered temperature readings relative to nearby locations.



A map of the sensor network designed for the heat analysis of 22 Willow. Sensor locations are shown overlayed on a land surface temperature heat map (BARI, 2005) which begins to indicate how urban-scale blocks are affected differently by high temperatures.

Key Considerations

- Defining the question of interest early is critical for ensuring collected sensor data will be useful in generating insight.
- Availability of infrastructure to pose as sensor "hosts" can constrain the study design. The most important consideration is consistency: install all sensors on one same type of infrastructure (e.g., either poles or trees) to enable meaningful relative comparisons. Maintain the same installation height for the same reason..

Data Insights

Heat

Spatial Heterogeneity

d16	d3	d1	d11	d13	d10	d17	d9	d15	d4	d6	d14	d7	d5	d8	d2
AERIAL/CONTEXT															
SATELLITE/LAND SURFACE TEMP															
106.0	105.4	106.1	102.8	100.4	114.6	105.9	105.9	104.6	105.6	100.7	98.8	105.4	107.1	107.1	104.7
SENSOR/HEAT INDEX															
101.1	101.6	101.9	101.9	102.8	102.9	103.3	103.8	104.2	104.5	104.5	104.8	105.0	105.2	105.9	106.9

PEAK HEAT INDEX
2024

Following data collection from the summer of 2024 for the heat sensor network, **BARI Land Surface Temperature map values were compared with peak heat values recorded by each sensor**. The surrounding context of each sensor location (shade, green infrastructure, building density) can be seen in the first row, while land surface temperature value can be observed in the second row, and the sensor's actual recorded value in the third.

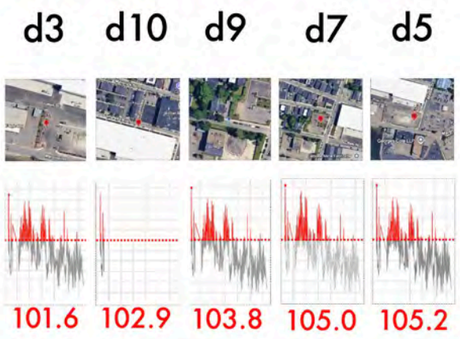
Data Insights

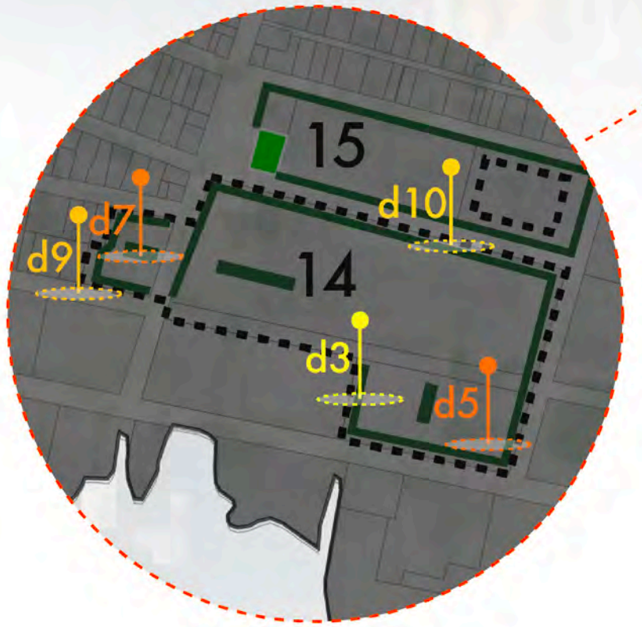
Heat
Spatial Heterogeneity

Peak Heat Index During **2024 Heat Wave,** 22 Willow

During a heat wave in 2024, our sensors recorded nearly a 6-degree range in temperature across the streets in the 22 Willow St. neighborhood. This captures meaningful spatial variability in the moment it matters most for the health and well-being of the community.

We observed nearly the same range in the streets abutting the site. ↓↗





Sensor	Peak Average Heat Index
d16	101.1
d3	101.6
d1	101.9
d11	101.9
d13	102.8
d10	102.9
d17	103.3
d9	103.8
d15	104.2
d4	104.5
d6	104.5
d14	104.8
d7	105.0
d5	105.2
d8	105.9
d2	106.9

Peak sensor temperatures recorded in degrees Fahrenheit.

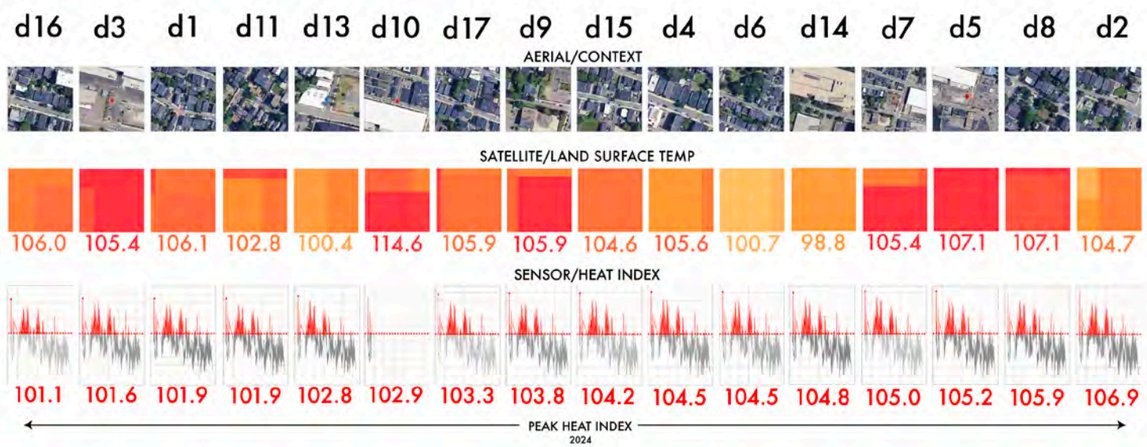
Data Insights

Heat

∴ Conclusion

The peak temperatures recorded by the sensors were universally higher that the land surface temperature estimated by NASA for the same locations. More notable, these differences themselves varied by 13.5 degrees, indicating that the estimates from NASA were only moderately effective at capturing variation across the site.

When we lay out the sensor locations and their pixels from the NASA data side-by-side, we see this mixture of agreement and disagreement between the two measurements. **A deeper analysis indicated that LandSat underestimated heat in spaces with lots of pavement. ↓↗**



Sensor	Smallest to Largest Delta
d14	21.0
d13	22.5
d11	25.5
d4	25.9
d2	26.1
d3	26.9
d8	27.3
d15	27.4
d9	27.8
d7	28.0
d10	28.0
d1	28.3
d17	28.6
d6	28.6
d16	29.3
d5	34.6

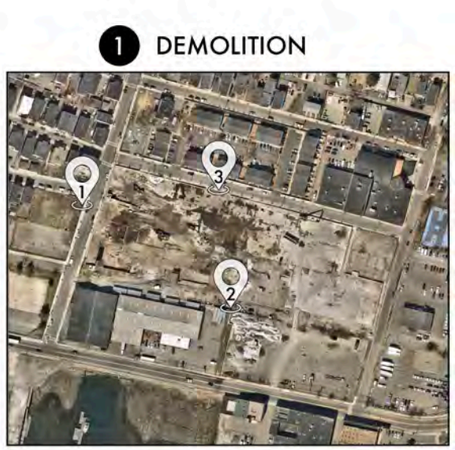
Sensors were sorted in order from smallest to largest delta, or smallest to largest difference from the land surface temperature map to the actual recorded heat temperature sensor value.

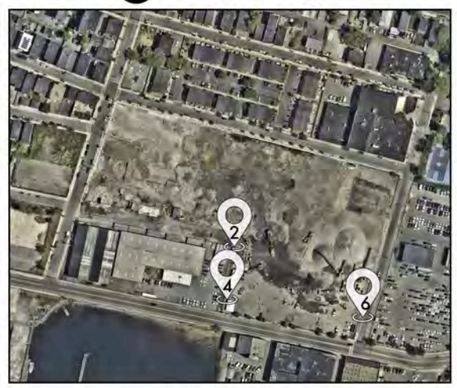
Data Insights

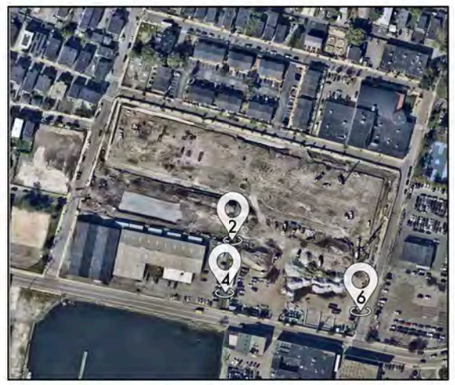
Air Quality
Before and After

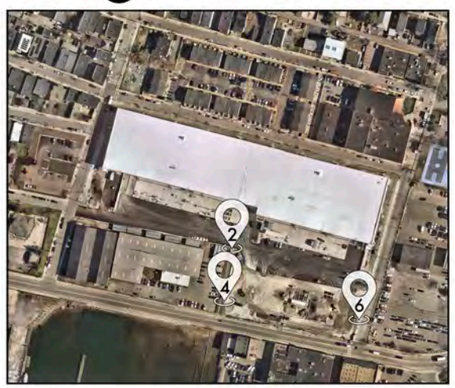
How do PM_{10} levels change before and after construction?

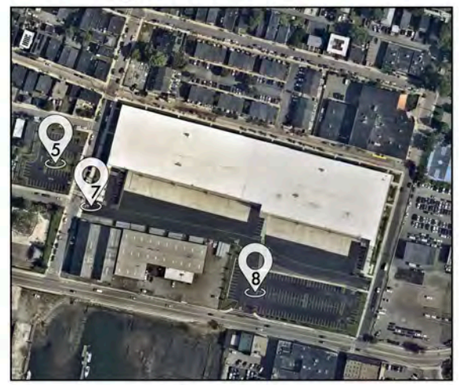
Air quality sensors tracked levels of PM_{10}, or particulate matter with a diameter of 10 micrometers or less which can be inhaled and harmful to humans, across different stages of construction.











A total of three (3) air quality sensors were utilized to track differences across the five different stages of construction shown above by moving sensor placement correspondingly.

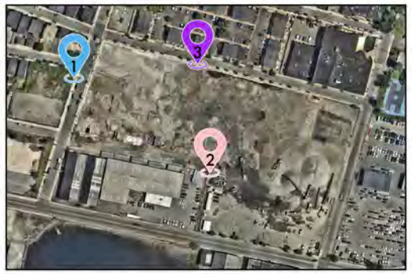
Data Insights

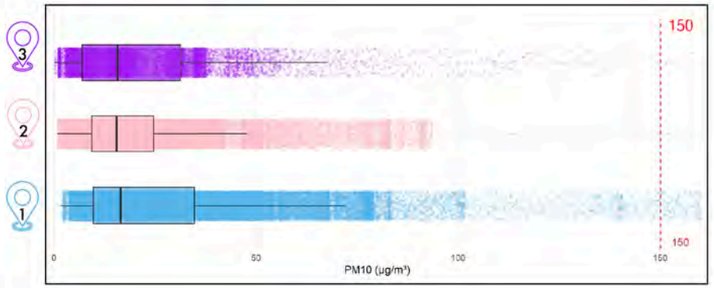
Air Quality

Before and After

2 DURING BUILDING CONSTRUCTION

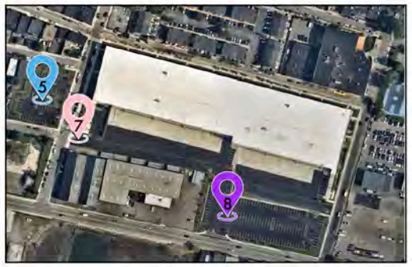
2023/07/28

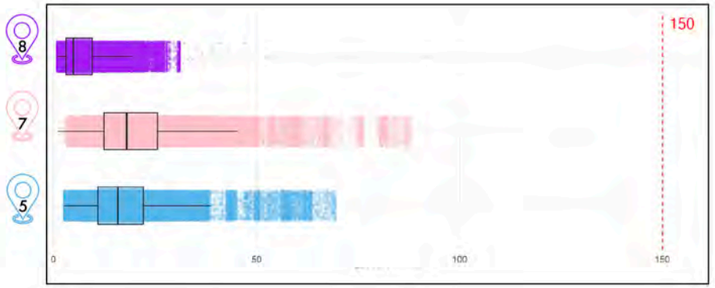




5 AFTER COMPLETION

2024/10/19





PM_{10} demonstrated the spatial and temporal effect of the design and construction of 22 Willow Street on surrounding spaces. Both during and after construction, sensors on the west side of the site (**2**, 📍) and (**5**, 📍📍), which is the main driveway for trucks, recorded the most pollution.

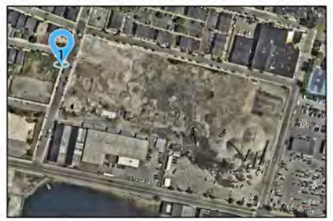
Comparison of conditions during and after construction at specific locations, however, illustrates how air pollution was higher during construction for both the main driveway on the west and the less trafficked space on the south side of the site. →

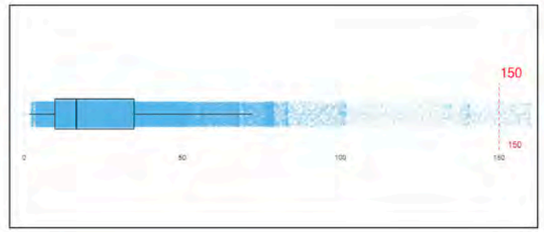
The results of the study were supported by repeated measures ANOVA, with a moderate positive correlation observed (Pearson's $r = 0.60$)

West Site

2 SENSOR 1 DURING BUILDING CONSTRUCTION

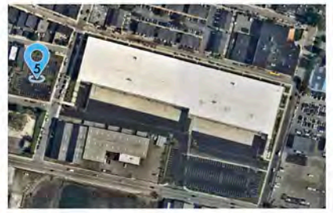
2023/07/28

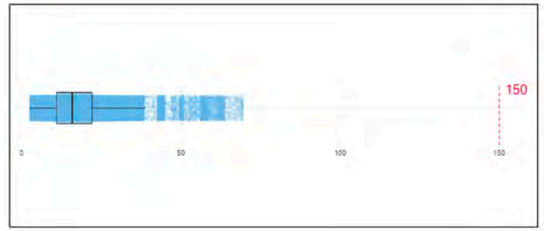




5 SENSOR 5 AFTER COMPLETION

2024/10/19

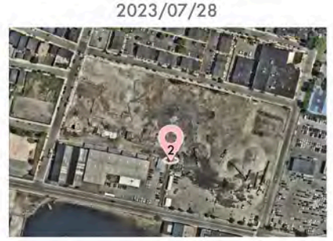




South Site

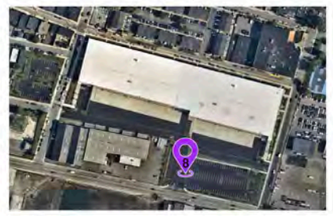
2 SENSOR 2 DURING BUILDING CONSTRUCTION

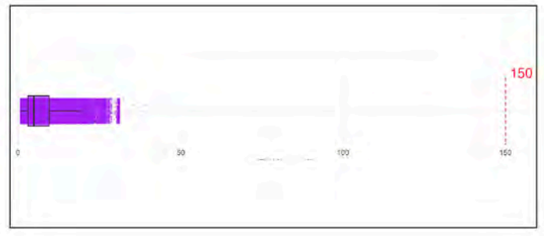
2023/07/28



5 SENSOR 8 AFTER COMPLETION

2024/10/19





5

How-To

Takeaways + Implementation

What did the data tell us?

Key Considerations

- Sensors uncovered microspatial inequities for both heat and air pollution, revealing how the design of even a single site can have disparate impacts on health and wellbeing depending on people's movements and activities.
- Sensors provided superior information to aerial and satellite data. For heat, the information was more precise because it was not reliant on proxies. For air pollution, the satellite data was too coarse to be useful at the scale of a single site.
- Sensors revealed that air pollution was greater during construction and that this impact was exacerbated at specific locations, in this case the main access point for trucks.

What's next?

Although Chelsea has limited open space available for new development, West Chelsea remains one of the few areas where such investment is still possible. This makes thoughtful, equity-driven planning in the neighborhood all the more critical. Stakeholders—including architects, engineers, developers, and city officials—can leverage insights from microspatial inequity studies to guide development strategies. By prioritizing resilient design, they can advocate for the integration of green infrastructure, mitigate urban heat island effects, and enhance air quality across both public and private spaces.

In a glance

☑ **01** Starting a microspatial inequities study
↳ **Identify an area of interest with green infrastructure, social, health, and/or economic inequities.**

☑ **02** Defining your practice
↳ **Strive to transform practice by being a co-learner and co-designer within a community. Work alongside community members to leverage, understand, and respond with the guidance of sensor technology.**

☑ **03** Selecting a site
↳ **Select a site with measurable and observable changes over time. If possible, choose a site with confirmed development plans to support and sustain study context.**

☑ **04** Performing the study
↳ **Carry out a holistic study by carefully defining the question(s) to answer and forming data lenses of interest accordingly.**

↳ **Consistency in sensor installations is critical. Height and attachment location should be consistent wherever possible. Poles are the preferred installation method, but trees can also be used.**

Sources

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