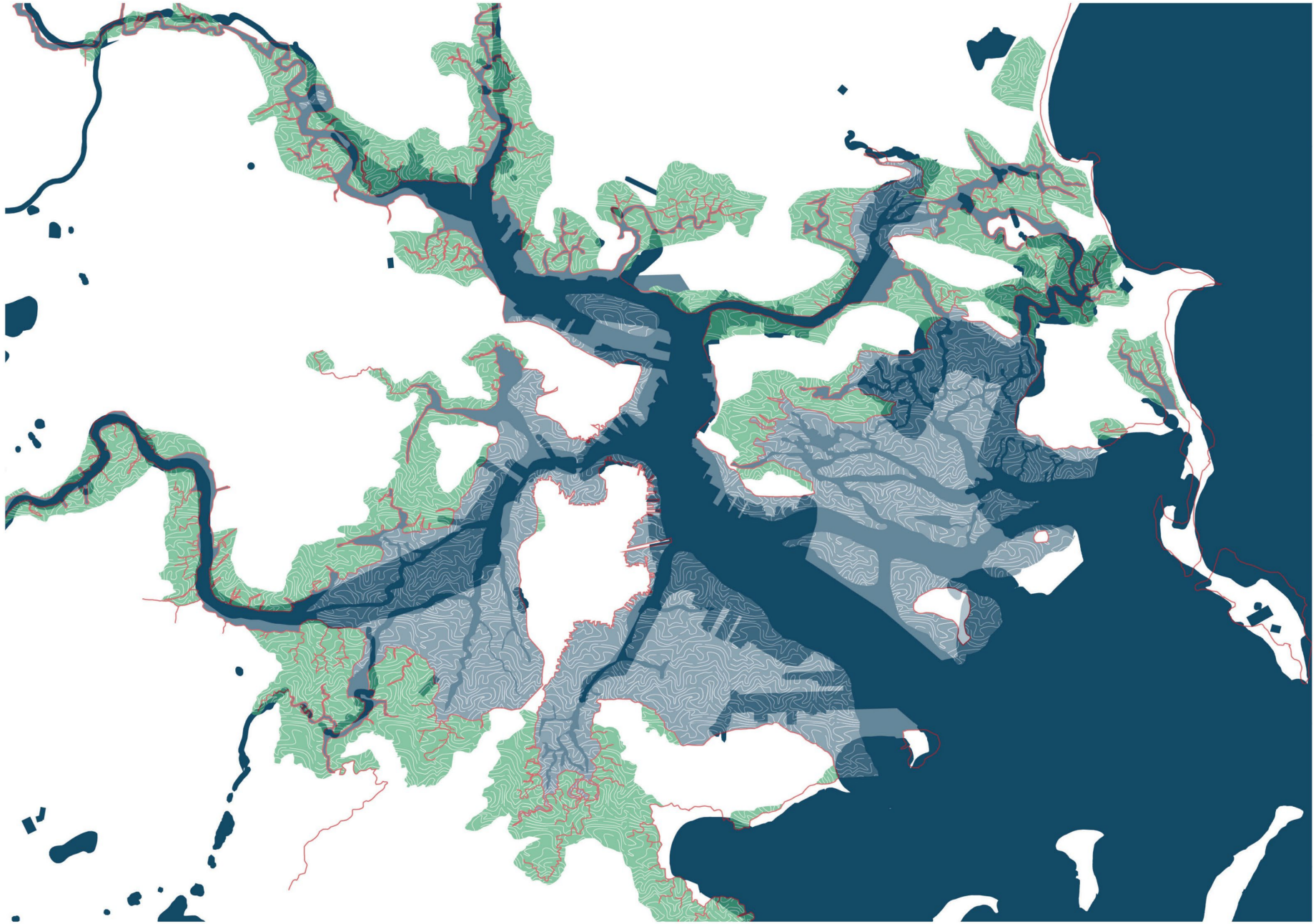
From Lost Streams to Living Landscapes

Investigating landscape-based infrastructural futures for flood adaptation in Boston

Gijs ten Bosch

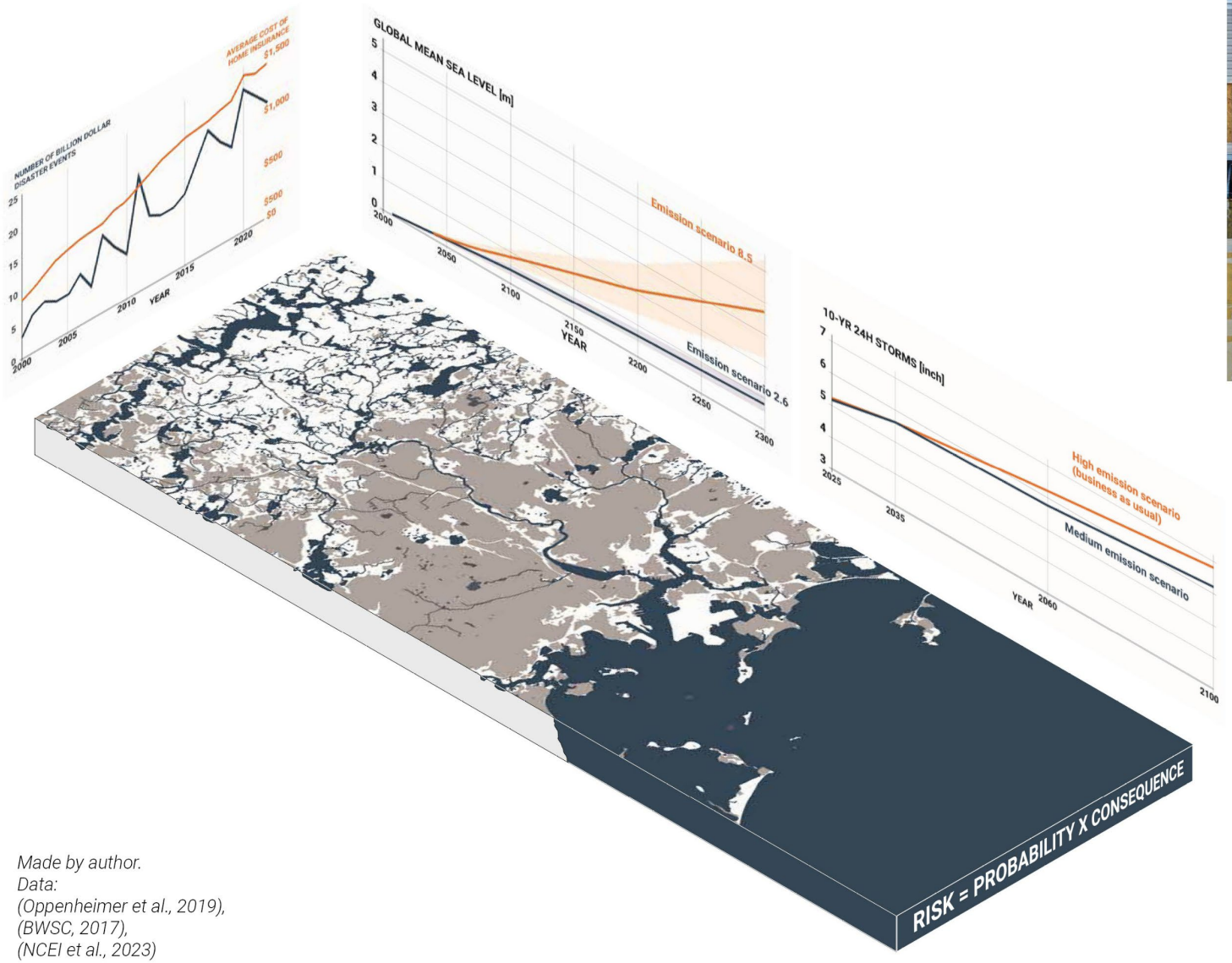


Defining infrastructure

“the basic system of essential services that support a city, a region, or a nation”

(Bélanger, 2017)

Environmental pressures

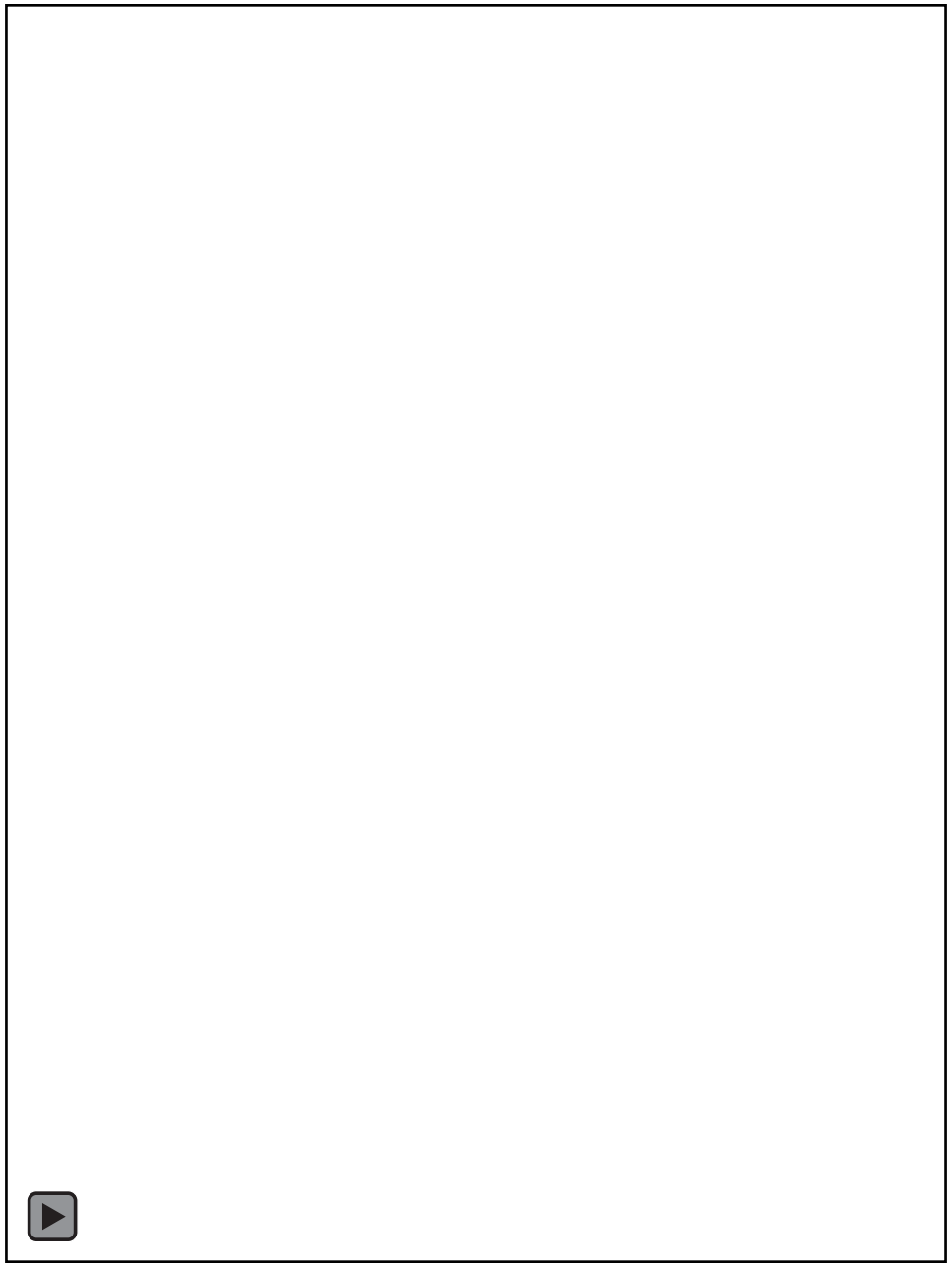


Made by author.
Data:
(Oppenheimer et al., 2019),
(BWSC, 2017),
(NCEI et al., 2023)

Halle Parker (2021)

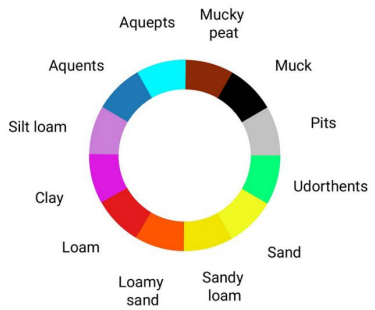
U.S. Flood management approach

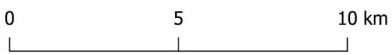
Boston’s landmaking history



Land making process over time - made by author
(Map Works, Inc., 1999)

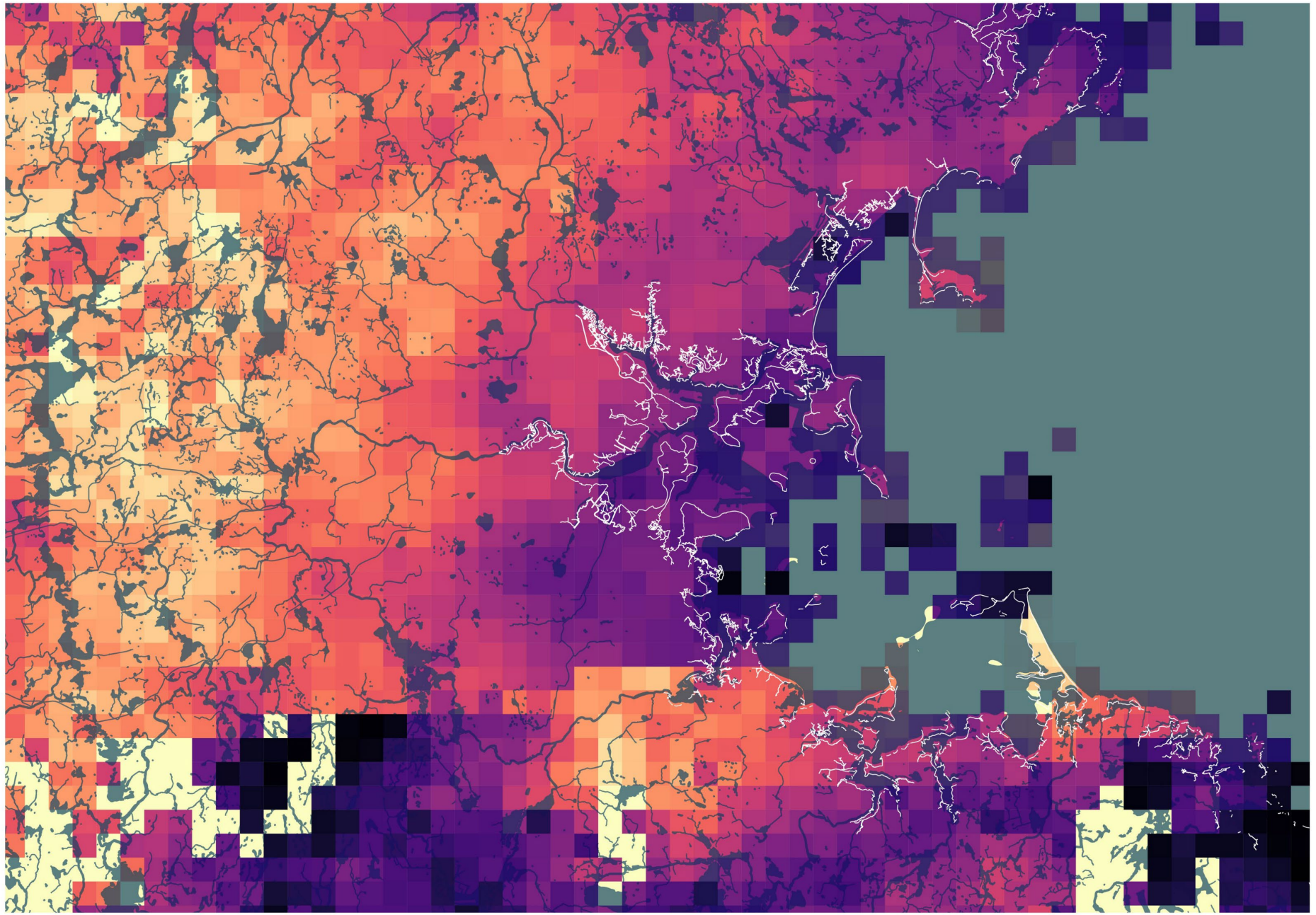
Disturbed landfill





Simplified soil types
Made by author
Data: U.S. Department of Agriculture & Natural Resources Conservation Service (2021)

Sinking shorelines



Vertical Land Motion Rates for the Boston Metropolitan Area overlaid with historic shoreline of Boston [mm/year]
Made by author
Data: Ohenhen et al. (2024)

Obsolete dams

Dam Age

- Under 50 years
- Unkown (average 64 years)
- 50 - 100 years
- 100 - 200 years
- Over 200 years

Hazard Code
in case of failure

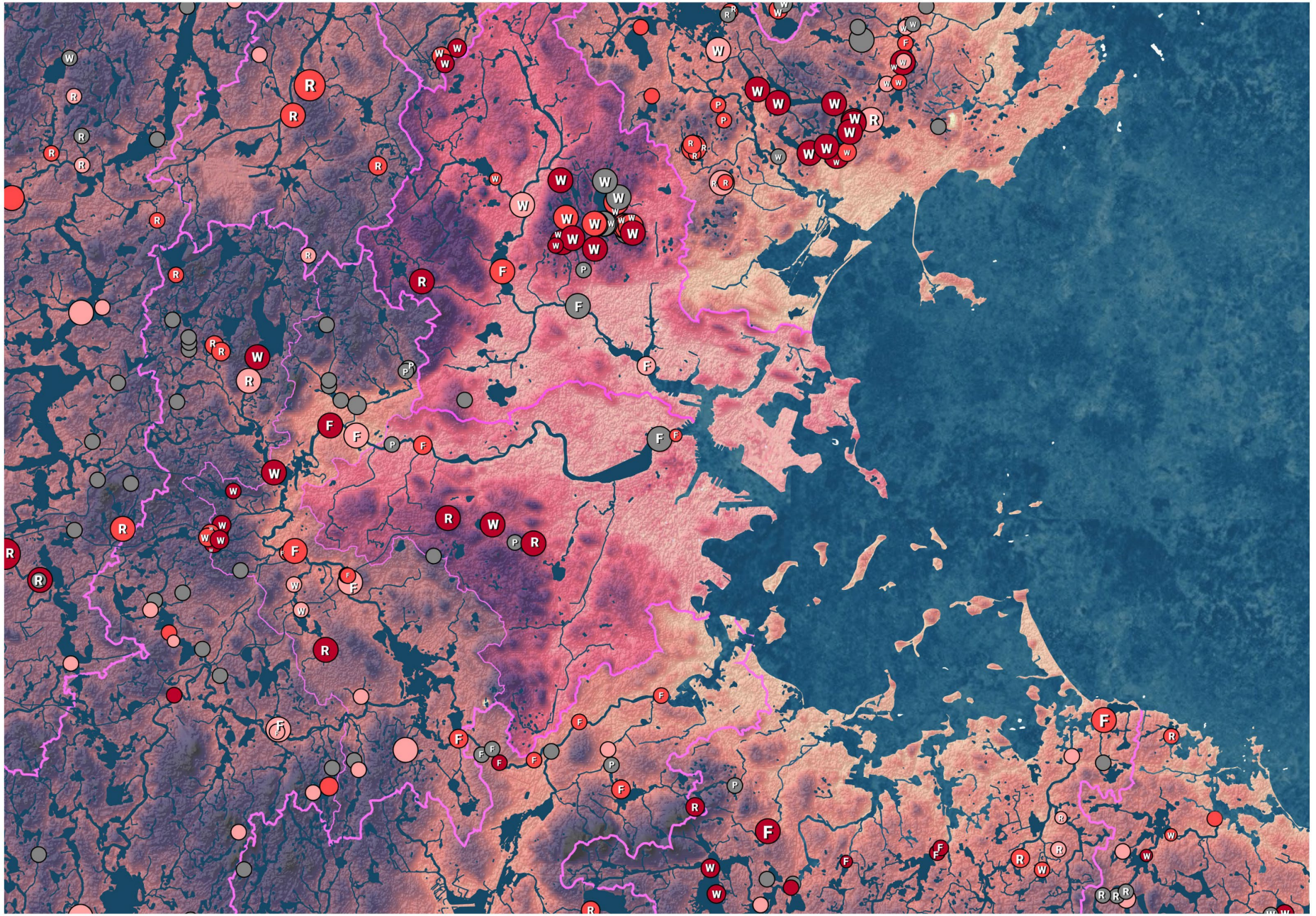
- Low
- Significant
- High
- N/A

Dam Purpose

- **F** Flood control
- **W** Water supply
- **R** Recreation
- **P** (Urban) Park

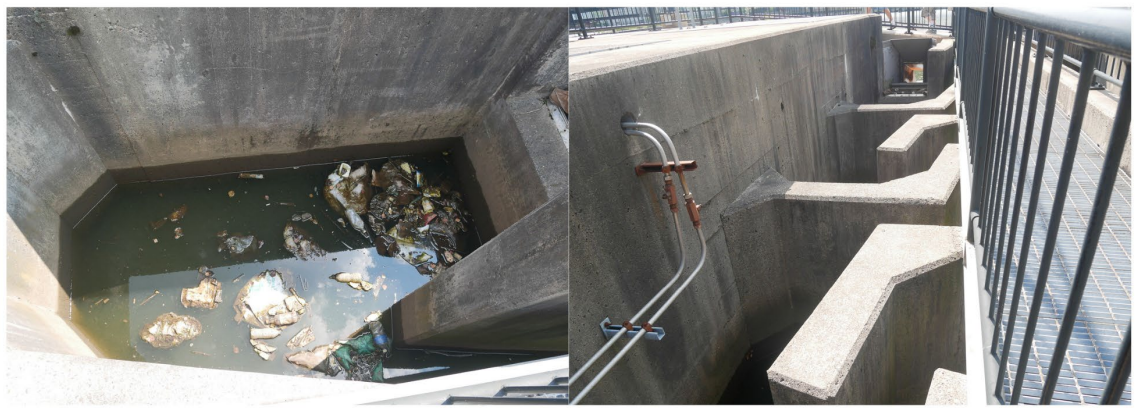
- Watershed
- Subwatershed
- Watershed of Boston Metro

0 5 10 km



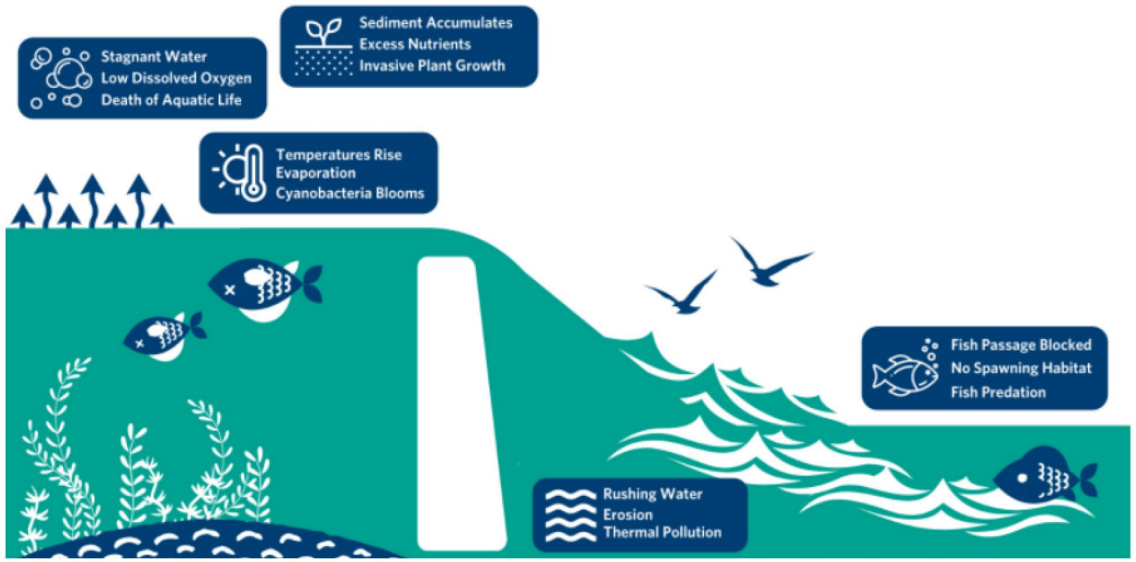
Categorization of dams by age, hazard code and purpose
Made by author
Data: U.S. Army Corps of Engineers (n.d.) & Massachusetts Office of Dam Safety (2012)

Charles River Dam



Amelia Earheart Dam & Mystic Lakes Dam

Effects



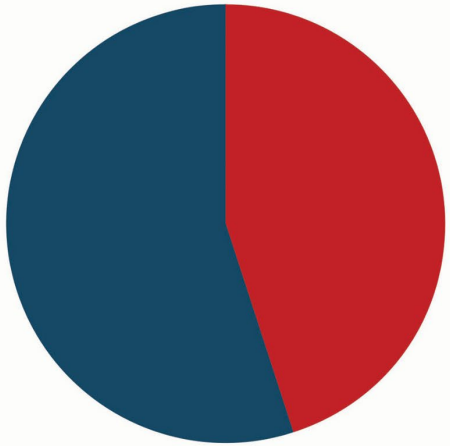
Impacts of Dams on the Charles River Ecosystem
(Charles River Watershed Organization, 2022)

Centralized infrastructural systems: Deer Island Water Treatment Plant

Collapsing infrastructure

Effects

Sewage volumes



Sewage

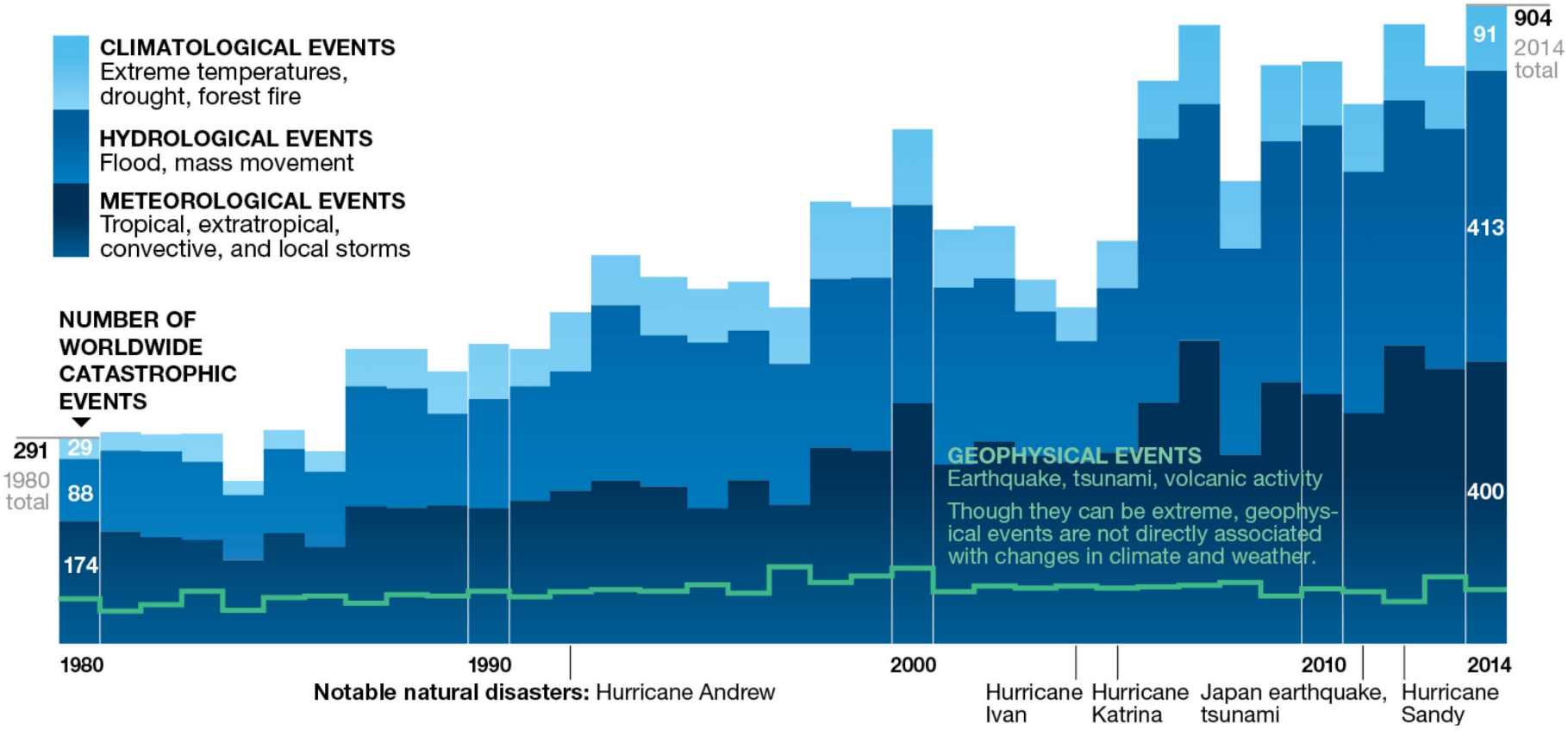
Precipitation runoff & groundwater seepage due to cracks and faulty connections of sewer system

Sewer infrastructure of the metropolitan area of Boston
Made by author
Data: MWRA Sewerage Division (1994), Boston Water & Sewer Commission (2024)

Environmental degradation

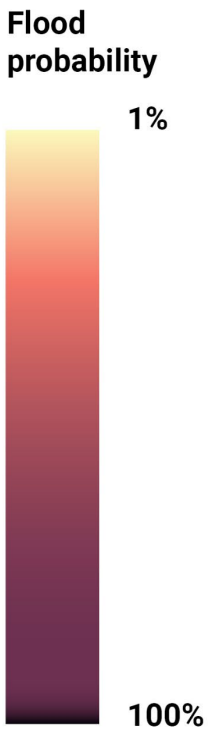
Spatial clash between critical natural landscapes and man-made infrastructures
Made by author
Data: The Nature Conservancy (2022), Central Transportation Planning Staff (2023), Massachusetts Office of Dam Safety, U.S. Energy Information Administration (2024)

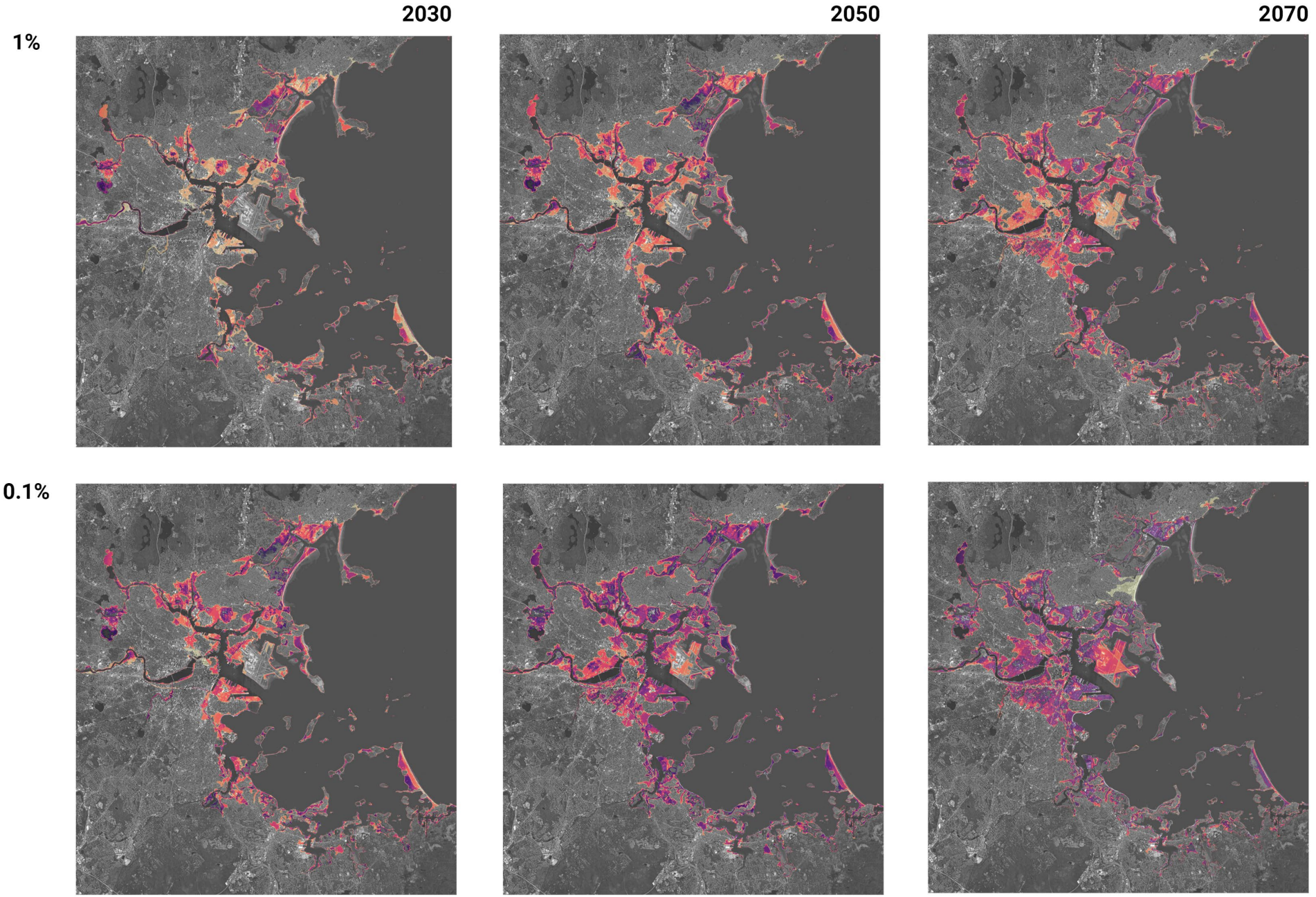
Climate change weather patterns



Climate change catastrophic events through time (National Geographic, n.d.)

Coastal floods





Made by author
Data: Woods Hole Group (2023)

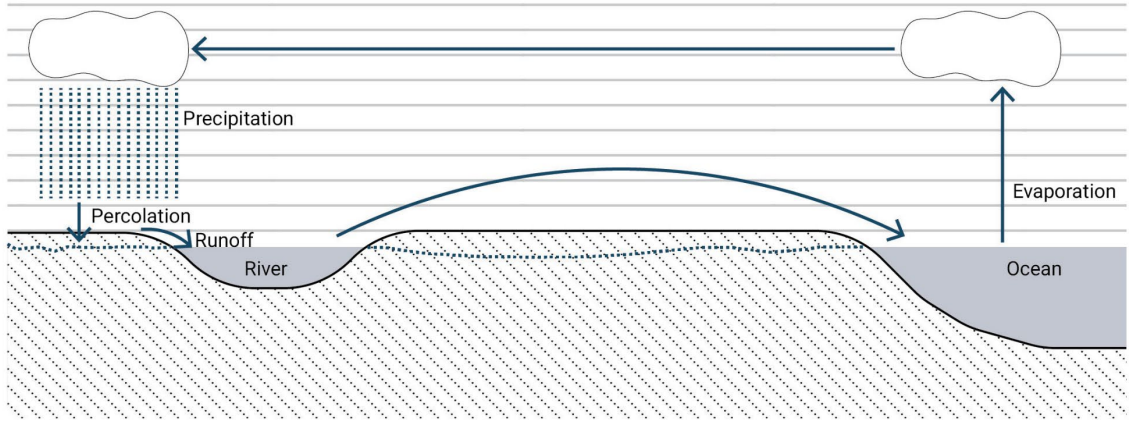
Riverine floods - Charles river

(Hopkins, 2021)

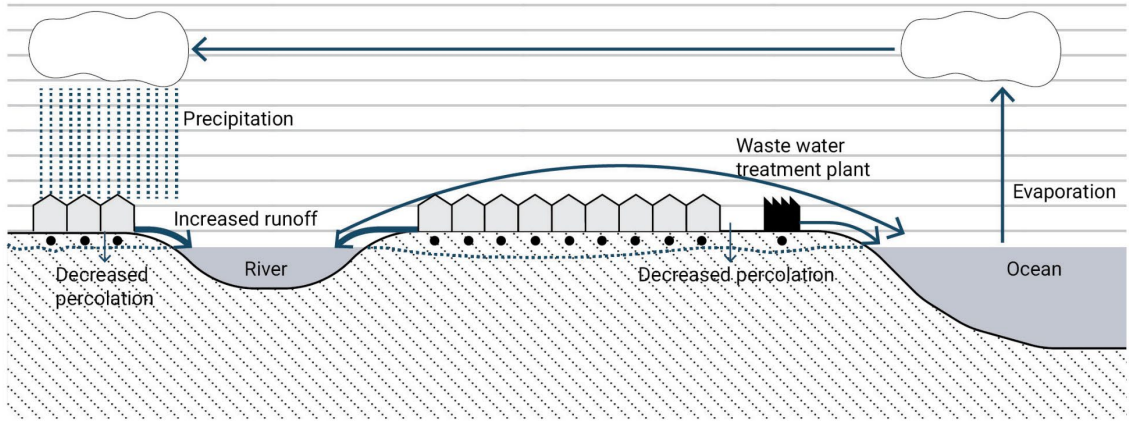
Riverine floods - Mystic river

Pluvial floods

Natural water cycle

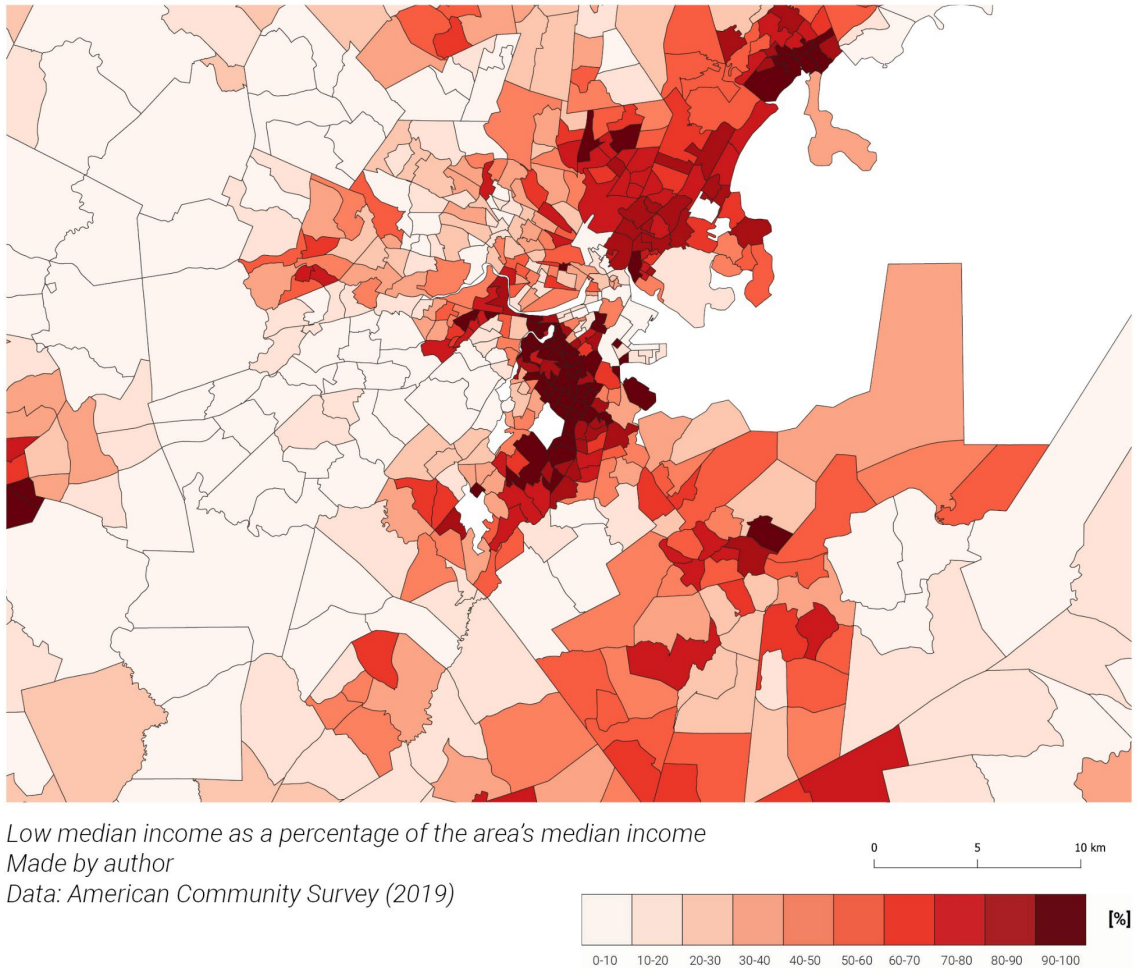


Engineered water cycle

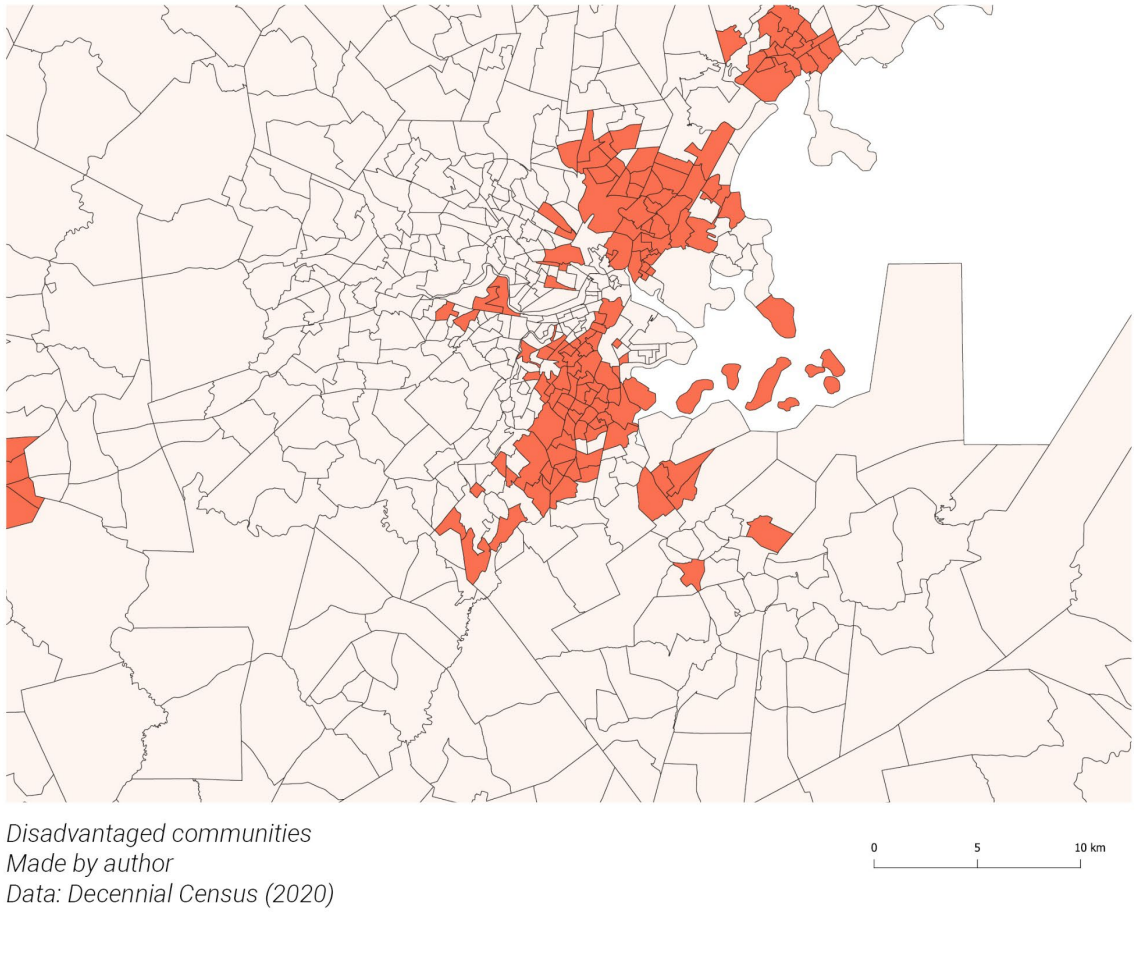


Made by author, based on (Zimmerman, 2025)

Socio-economic vulnerability

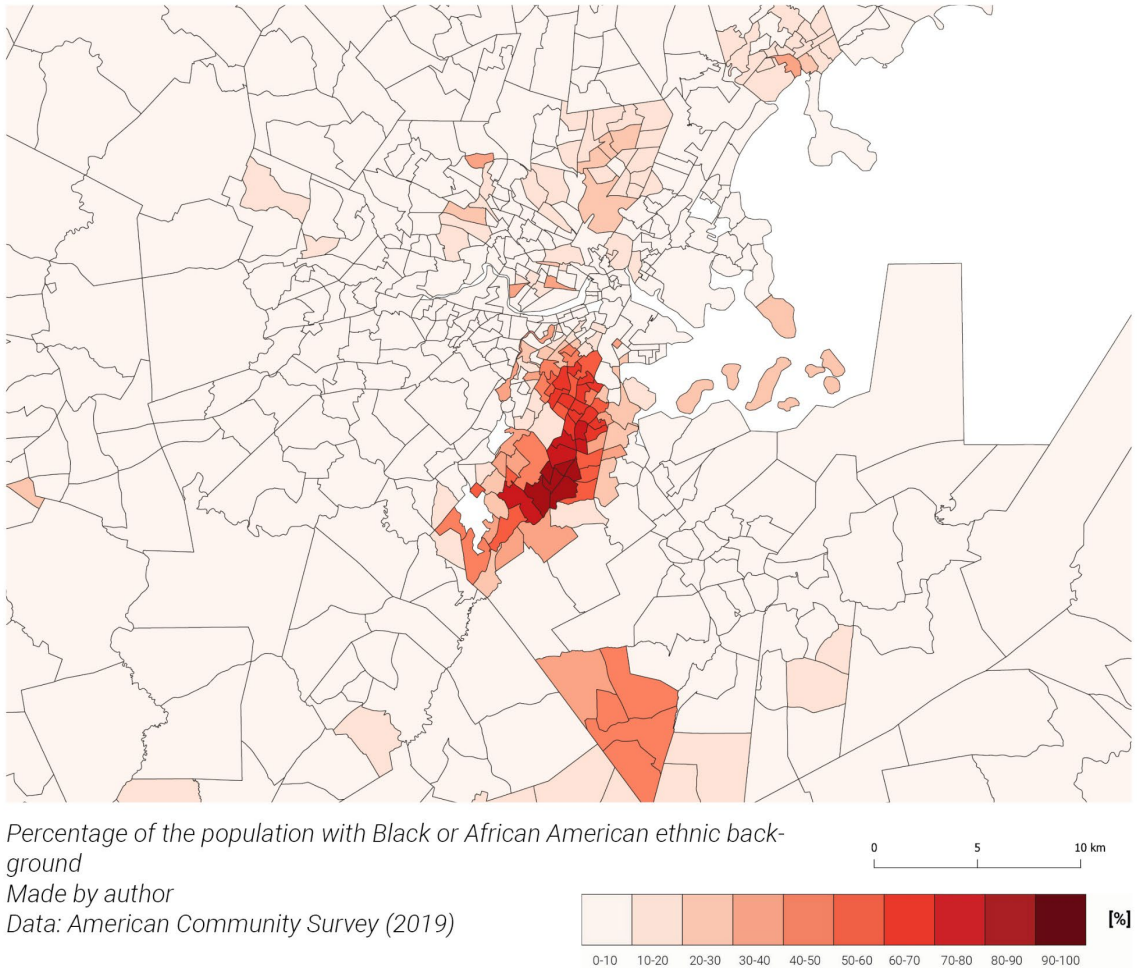


Low median income as a percentage of the area's median income
Made by author
Data: American Community Survey (2019)



Disadvantaged communities
Made by author
Data: Decennial Census (2020)

Socio-economic vulnerability



Percentage of the population with Black or African American ethnic background
Made by author
Data: American Community Survey (2019)

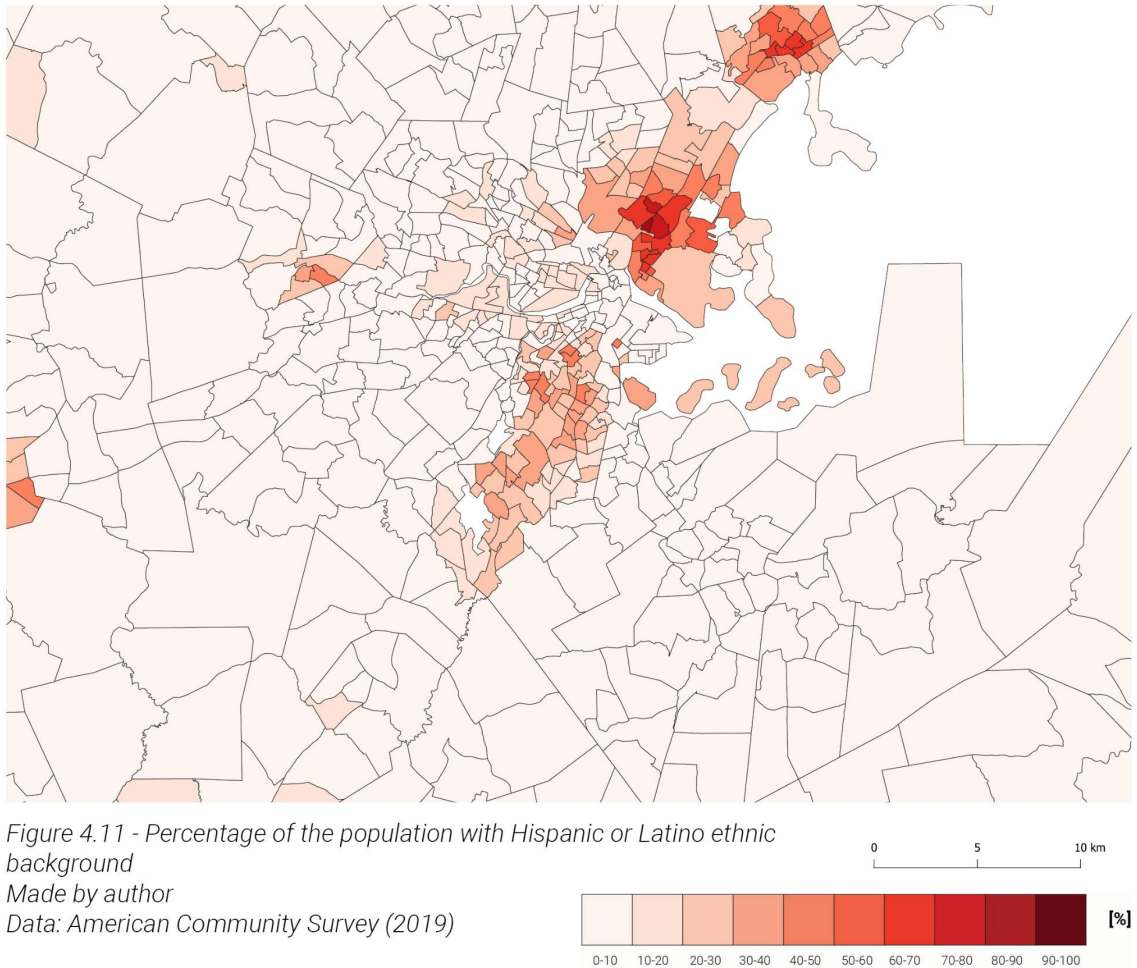
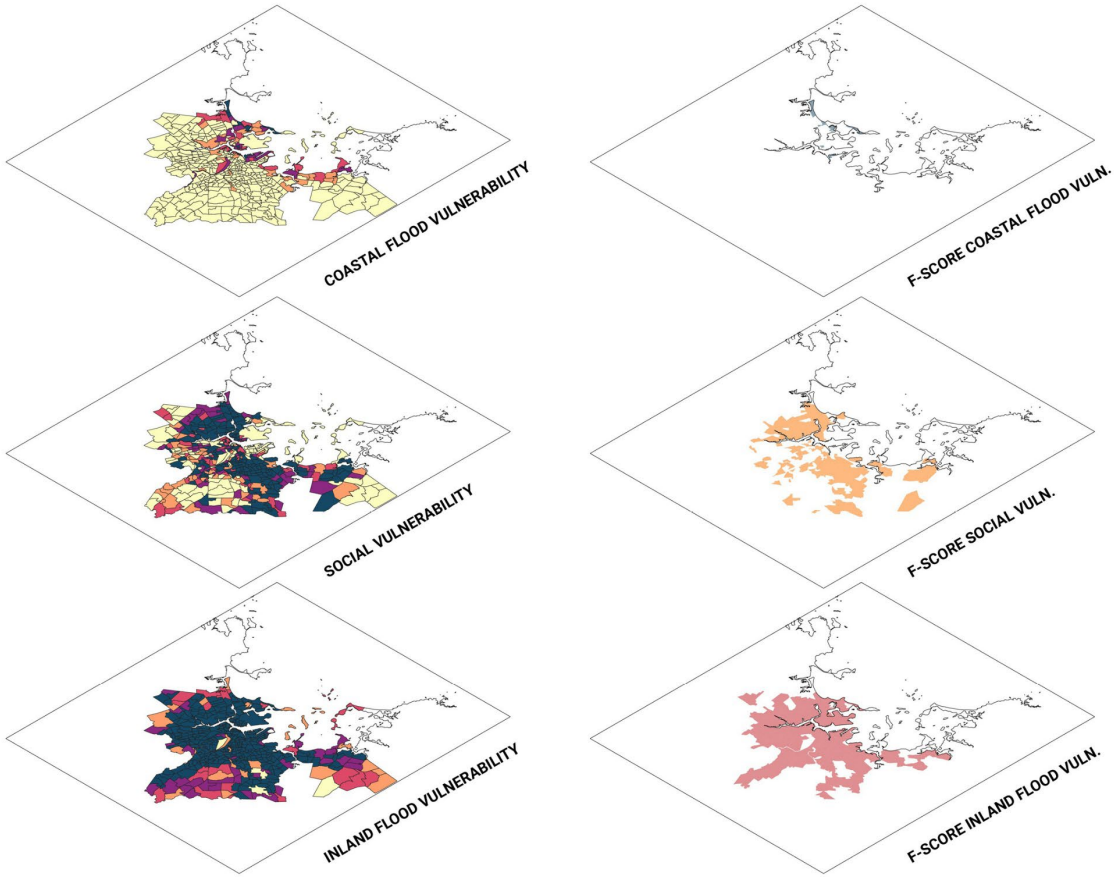
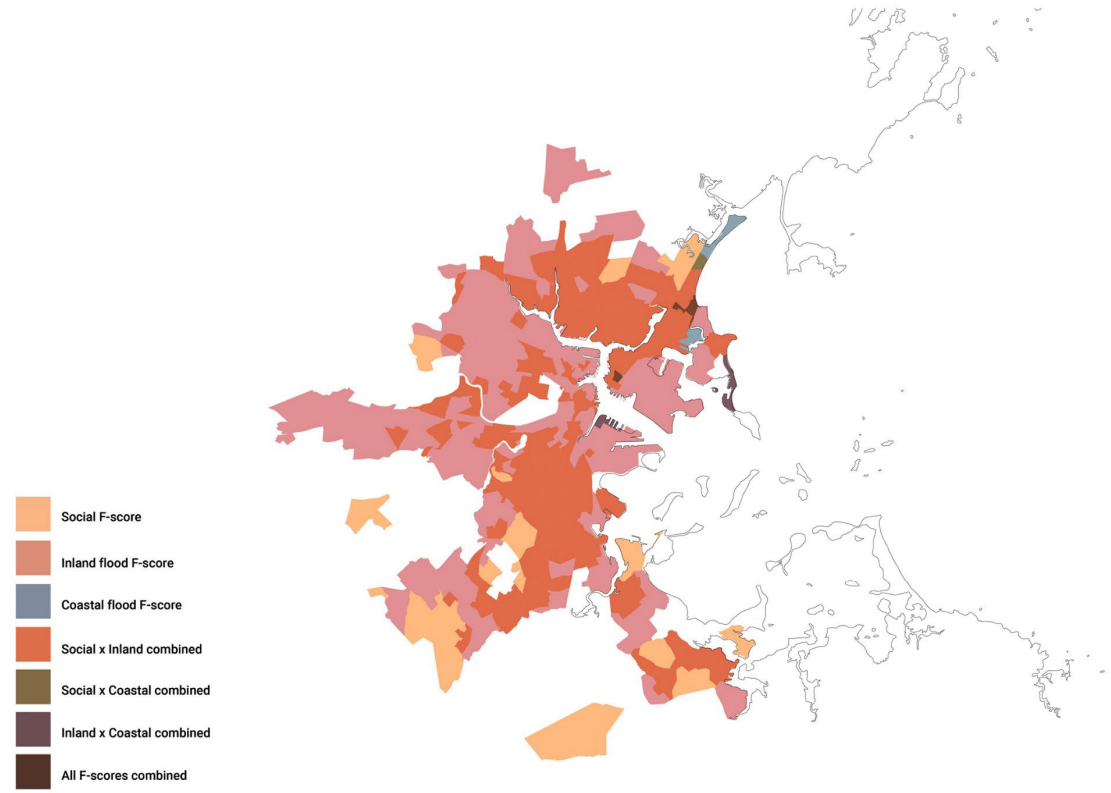


Figure 4.11 - Percentage of the population with Hispanic or Latino ethnic background
Made by author
Data: American Community Survey (2019)

Patterns of vulnerability

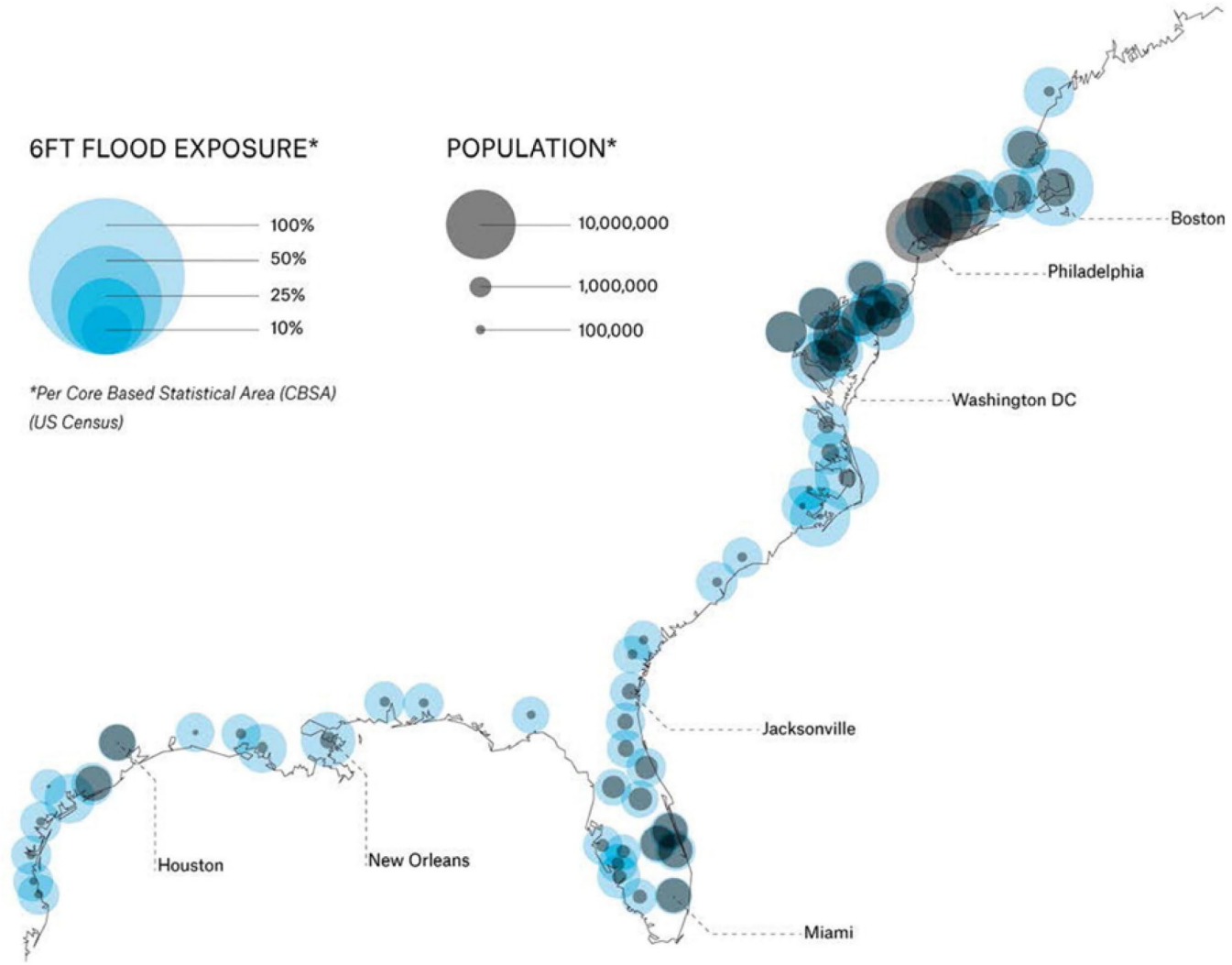


F-score axo
Made by author
Data: Trust for Public Land (2023)



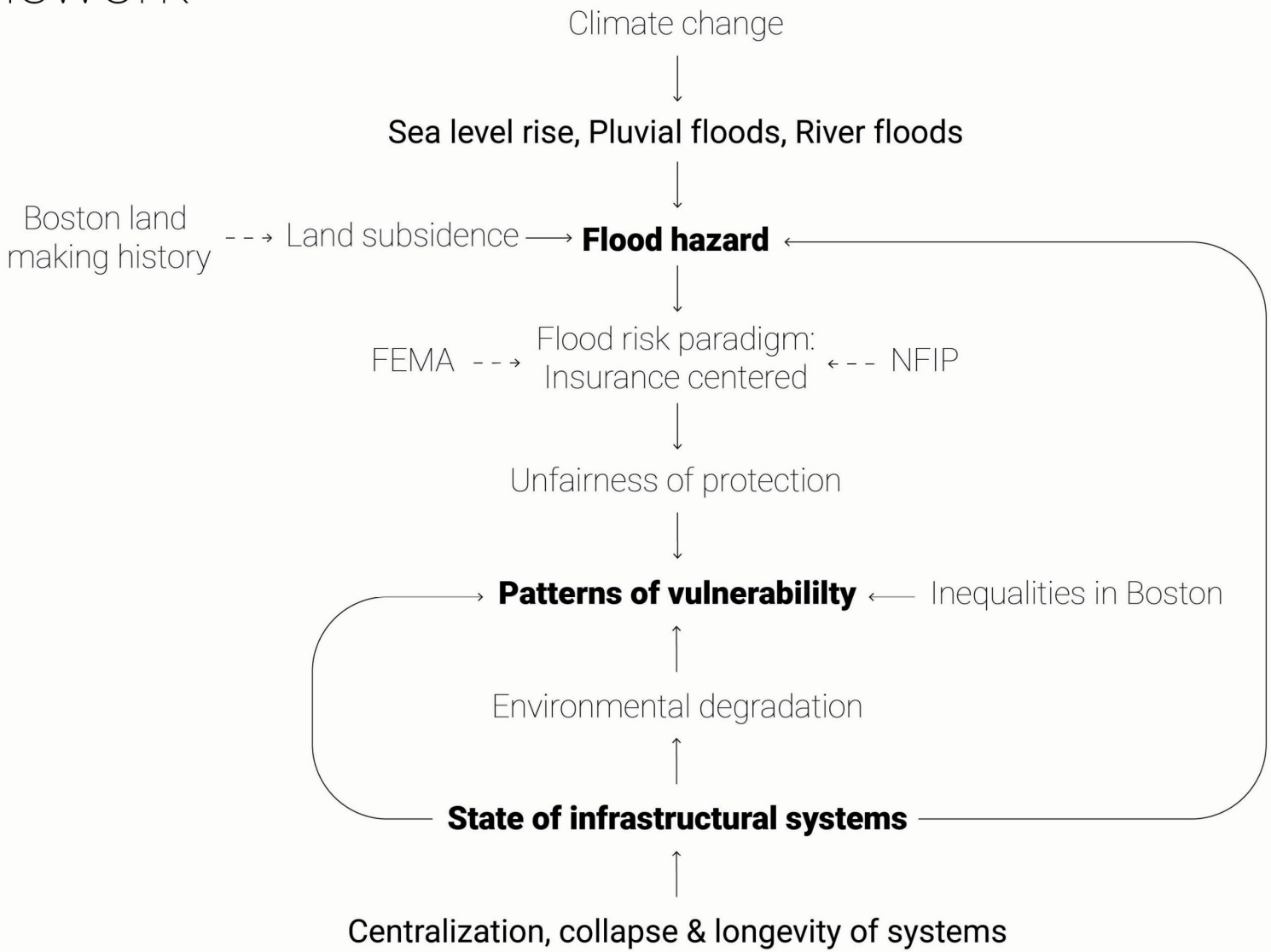
Synthesis map
Made by author
Data: Trust for Public Land (2023)

Problematization



Flooding of the Atlantic and Gulf coasts with 6 feet (1.8 m) of sea level rise
Source: (Berger et al., 2020)

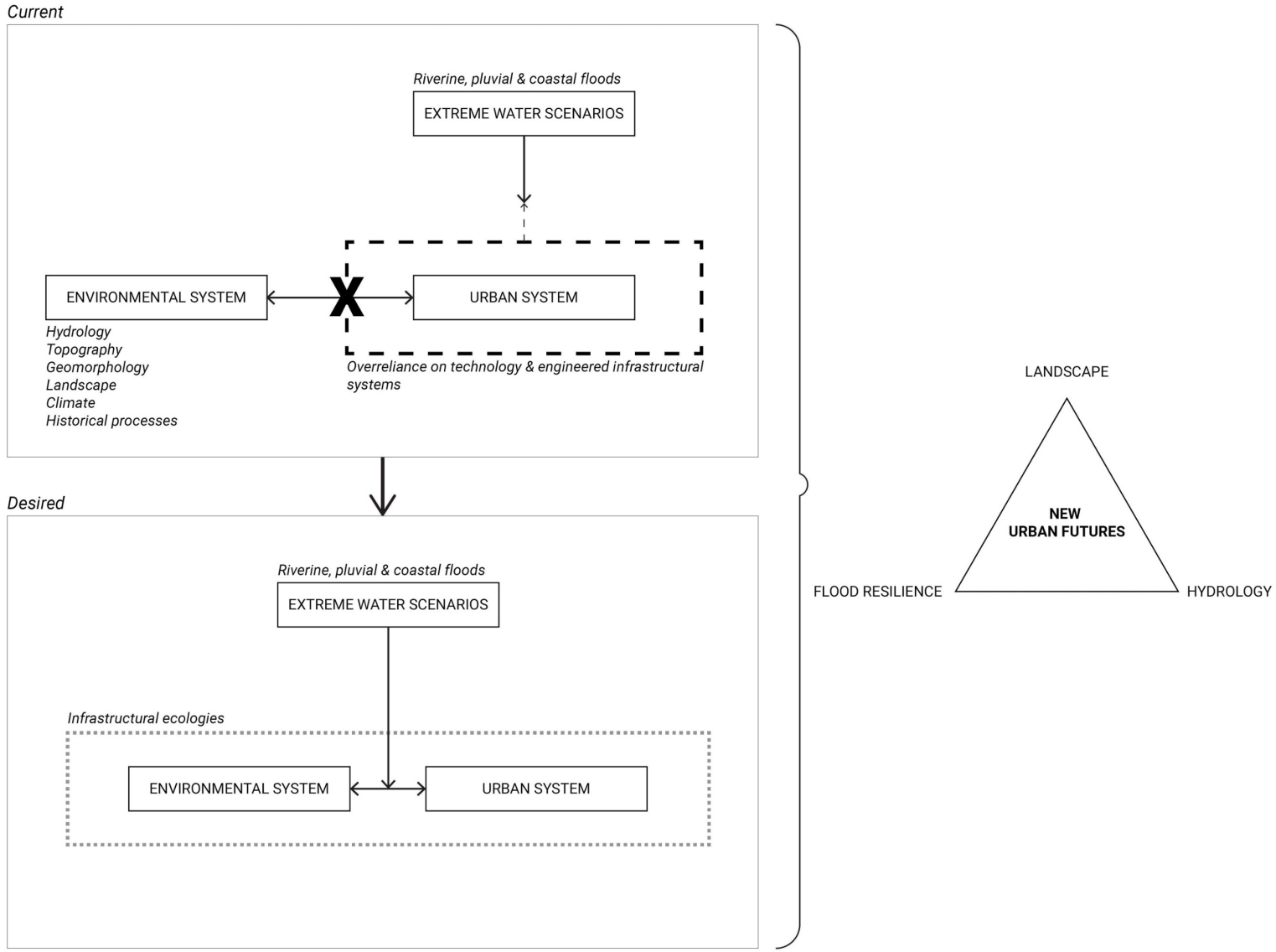
Problem framework



Problem statement

Flood hazards, combined with the U.S. **insurance system**, and the current **state** and **effects** of existing **infrastructural systems** shape vulnerable people, animals, and landscapes. **Environmental degradation**, historical land making-induced **land subsidence**, and **socio-economic inequalities** contribute to **unfair levels of protection** and **disparities** in the accessibility of essential resources and infrastructures. As urban development continues to expand without **strengthening** its **relationship** to **environmental systems**, increasing pressure is placed on already stressed landscapes, ensuring an even more vulnerable metropolitan region.

Thesis objective



Main question

How can **landscape**, understood as **infrastructure**, guide **future scenarios** of **flood adaptation** that **strengthen** the **spatial** and **ecological relationship** between **water** and **urban life** in Metropolitan **Boston**?

Sub questions

1. What is the **current condition** of Boston's **water** and **landscape infrastructures**?

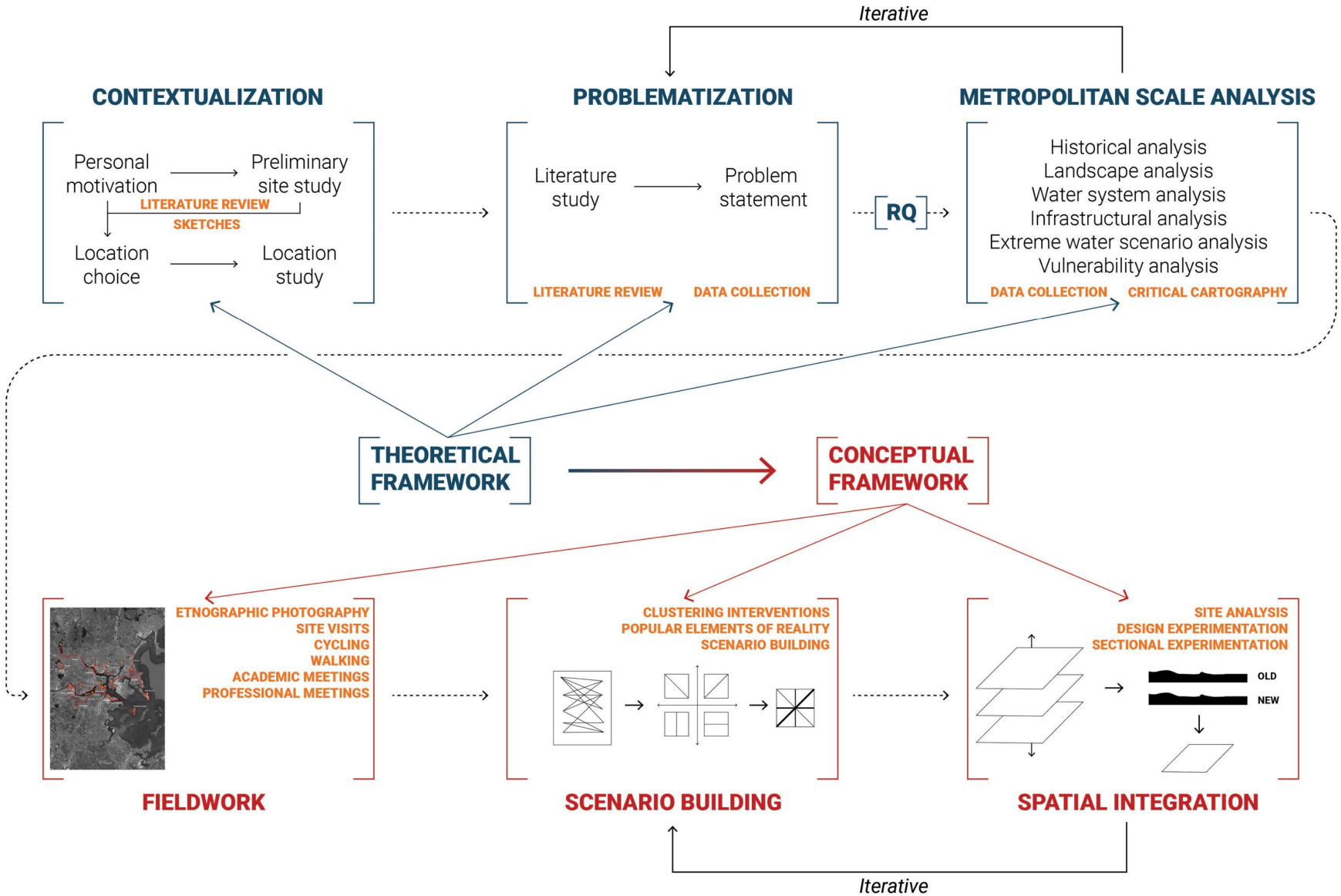
2. What are the (spatial) **implications** of **extreme water scenarios**, caused by climate change, in Metropolitan Boston?

3. How do **socio-economic vulnerabilities** intersect within Boston's **flood-prone areas**?

4. What **future scenarios** can be developed to **explore** how **landscape-based infrastructures** could **mediate** between **flood dynamics** and **urban development**?

5. How can these scenarios be spatially translated into **design strategies** that **reconnect urban form** with its **underlying land-** and **waterscapes**?

Methods


Iterative
CONTEXTUALIZATION
Personal motivation
Preliminary site study
LITERATURE REVIEW
SKETCHES
Location choice
Location study
PROBLEMATIZATION
Literature study
Problem statement
LITERATURE REVIEW
DATA COLLECTION
RQ
METROPOLITAN SCALE ANALYSIS
Historical analysis
Landscape analysis
Water system analysis
Infrastructural analysis
Extreme water scenario analysis
Vulnerability analysis
DATA COLLECTION
CRITICAL CARTOGRAPHY
THEORETICAL FRAMEWORK
CONCEPTUAL FRAMEWORK
ETNOGRAPHIC PHOTOGRAPHY
SITE VISITS
CYCLING
WALKING
ACADEMIC MEETINGS
PROFESSIONAL MEETINGS
CLUSTERING INTERVENTIONS
POPULAR ELEMENTS OF REALITY
SCENARIO BUILDING
SITE ANALYSIS
DESIGN EXPERIMENTATION
SECTIONAL EXPERIMENTATION
OLD
NEW
FIELDWORK
SCENARIO BUILDING
SPATIAL INTEGRATION
Iterative

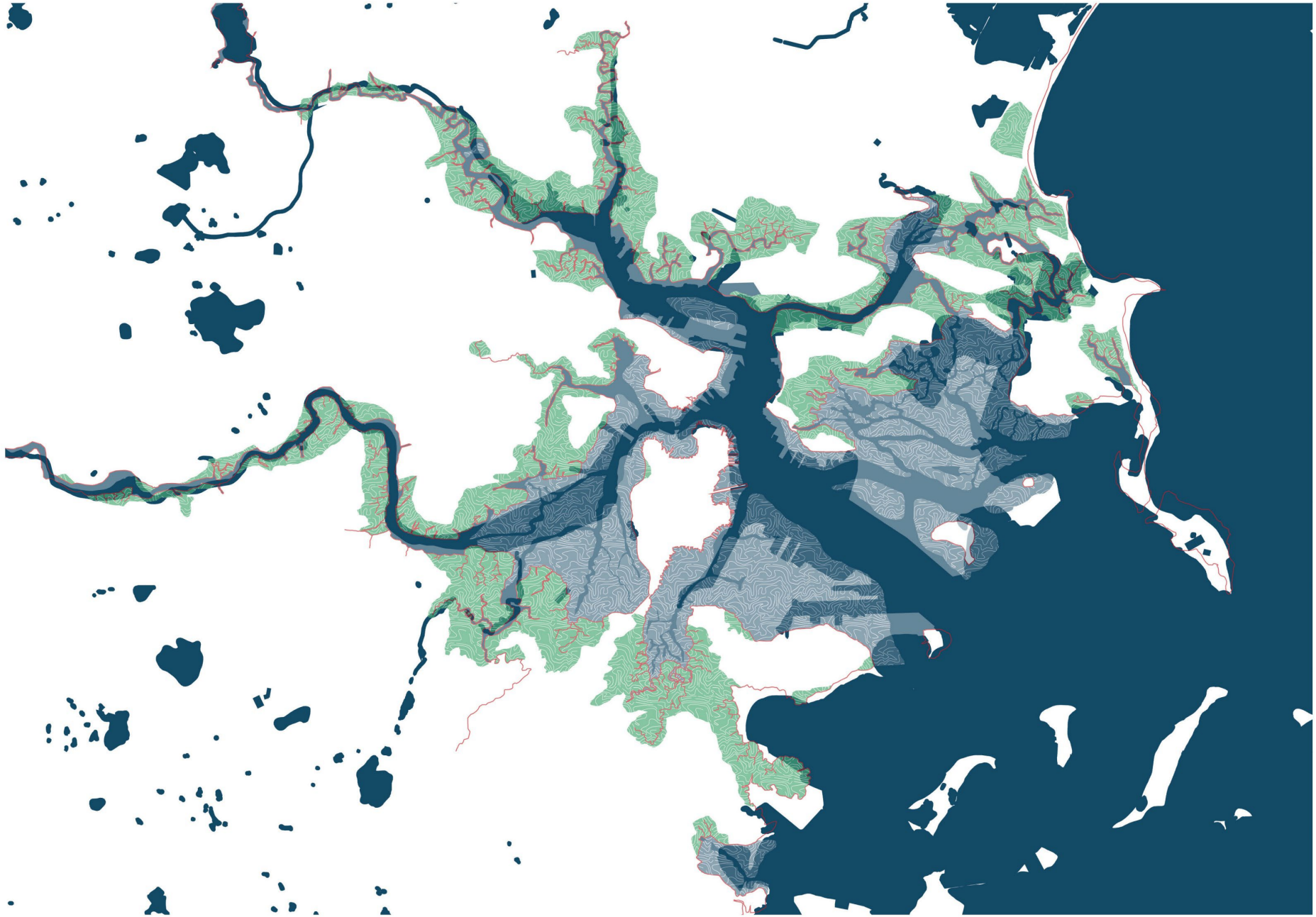
Fieldwork findings

42.368475575631976, -71.0386073093308

42.37413351446351, -71.0328299344142

42.36783935868297, -71.03914975689445

Historic hydrology

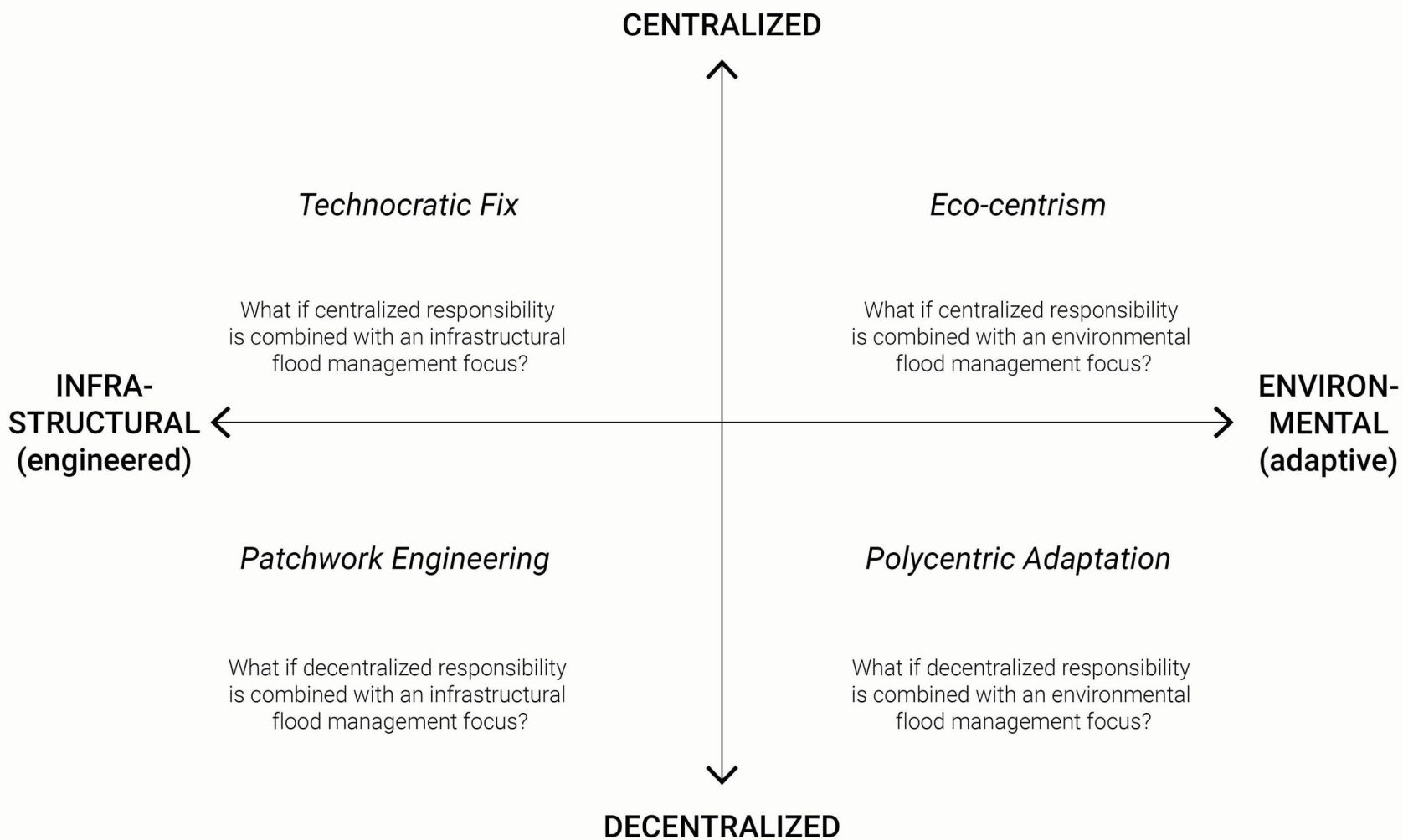


Historic Hydrology
Made by author
Data: Hills (1770-1779)

Building scenarios - popular elements of reality

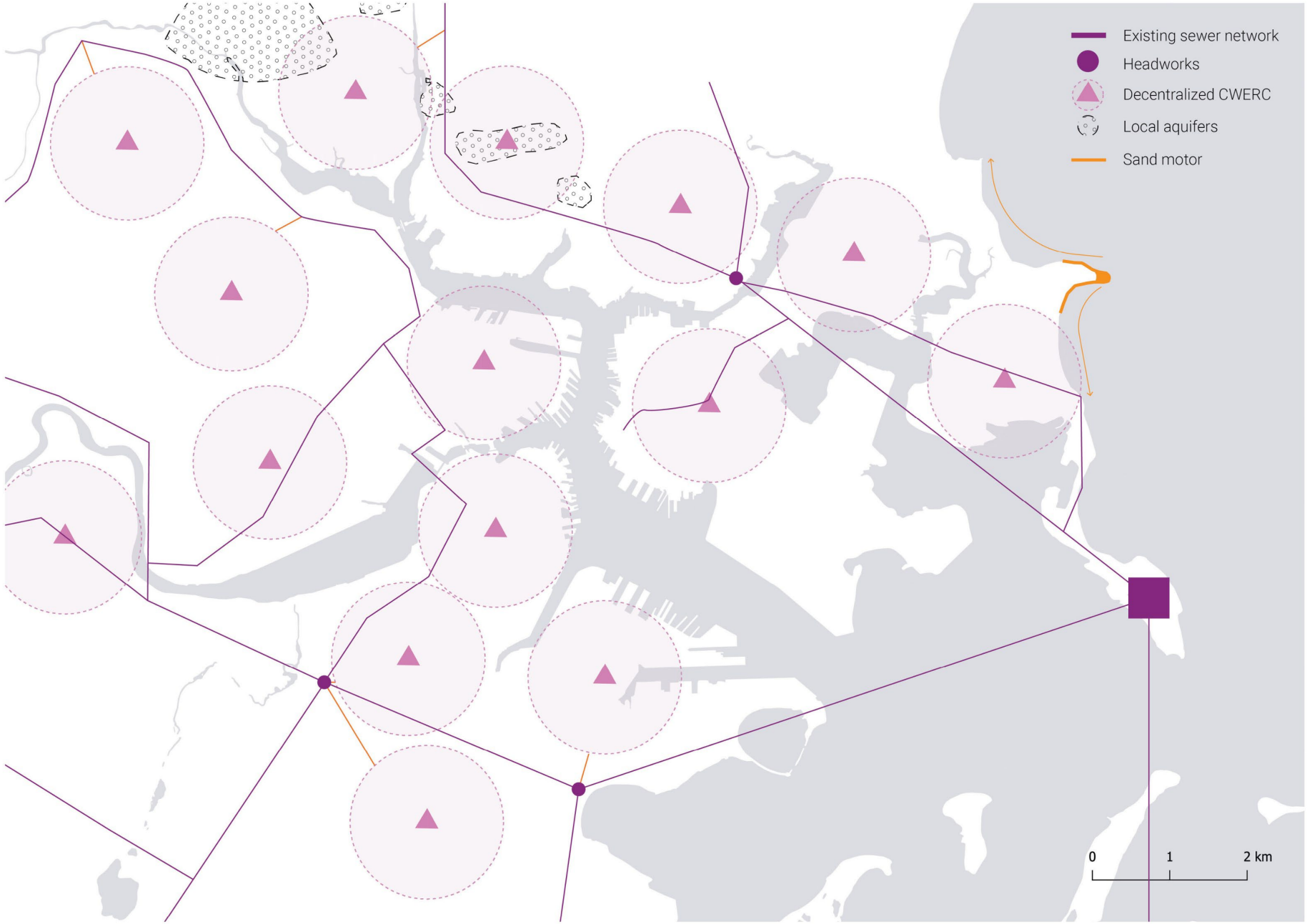
ENVIRONMENTAL	INFRASTRUCTURAL	SOCIO-ECONOMIC	INSTITUTIONAL
ENV1 Sea level rise 	**INFRA1** Infrastructural systems are aging 	**SE1** Unequal risk exposure increases 	**INSTI1** The importance of resilience & adaptation in planning is increasing 
ENV2 Storm surges increase 	**INFRA2** The potential of adaptive and decentralized infrastructure is increasing 	**SE2** Segregation/economic vulnerability increases 	**INSTI2** Community-driven adaptation is increasing 
ENV3 Extreme precipitation increases 	**INFRA3** Dam removals are increasing in the USA 	**SE3** Trust in federal flood programs is decreasing 	**INSTI3** Federal support in post-disaster recovery is decreasing 
ENV4 Land subsidence increases 	**INFRA4** Technological determinism is increasing 	**SE4** Economic & urban expansion is prioritized over environmental importance 	**INSTI4** Retreat of flood insurance providers is increasing 
ENV5 Compound floods increase 	**INFRA5** The transition to green/ hybrid infrastructural systems 		**INSTI5** Flood insurance is becoming more expensive 

Scenario axis

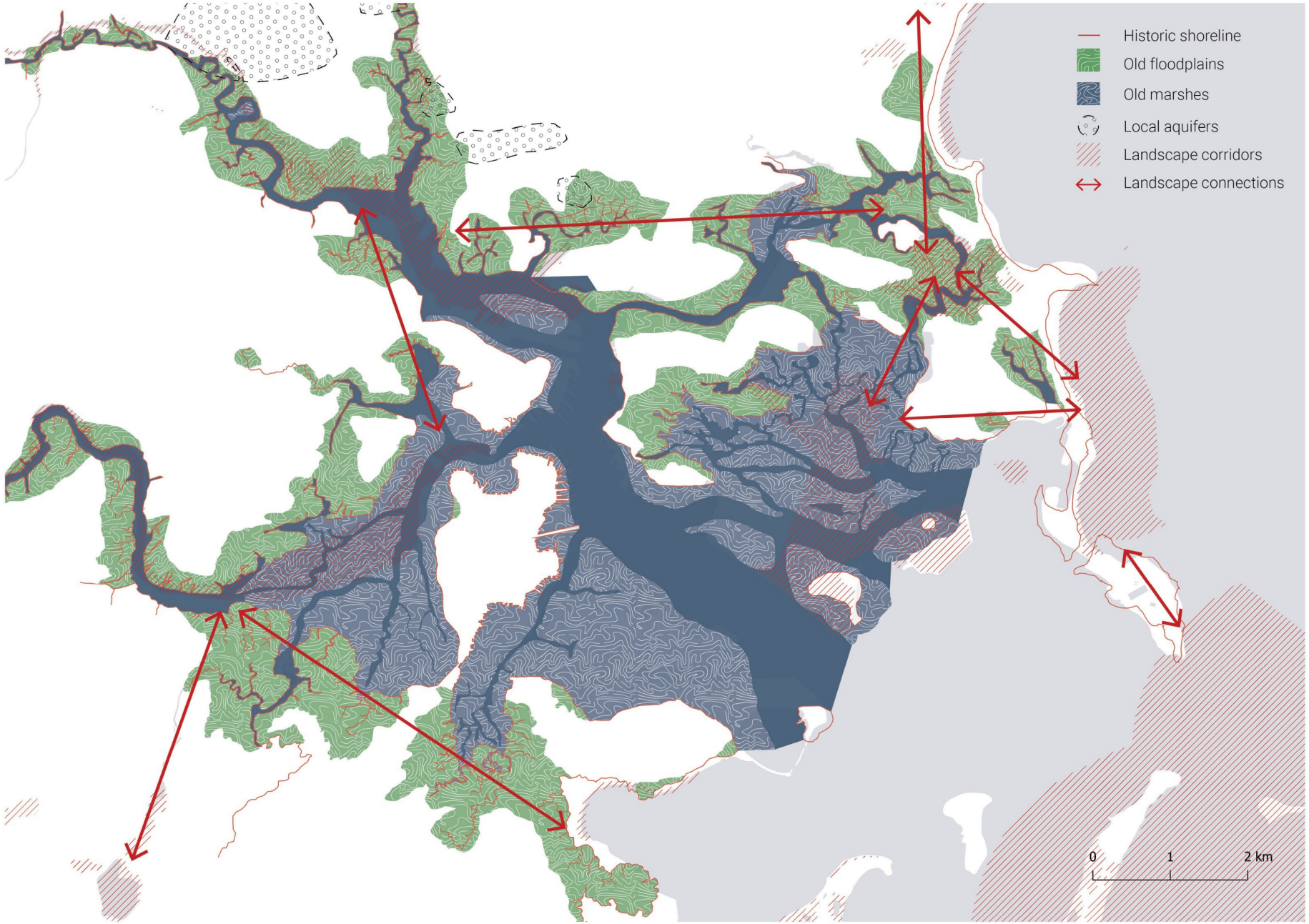


Technocratic Fix

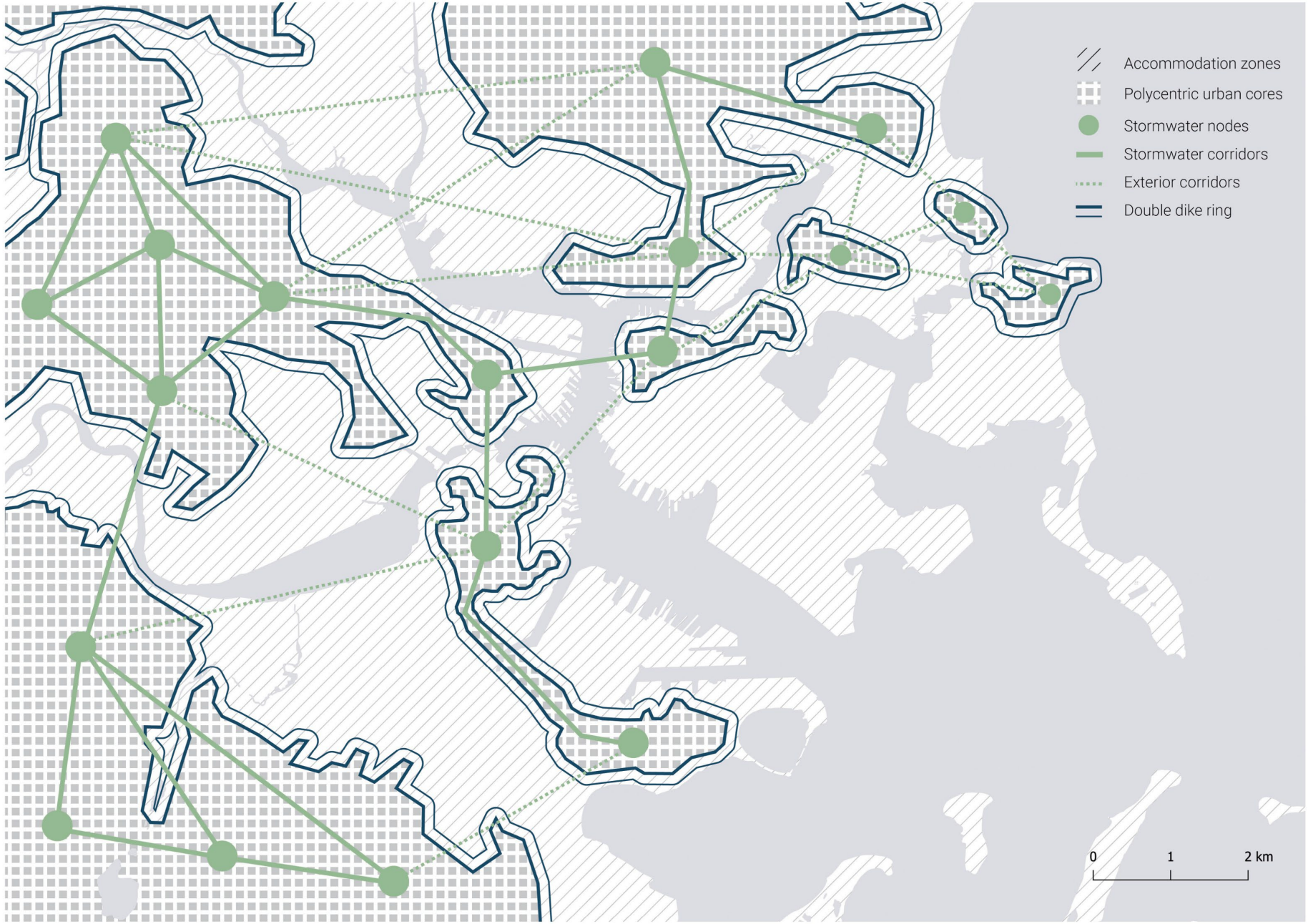
Patchwork Engineering



Eco-centrism



Polycentric Adaptation



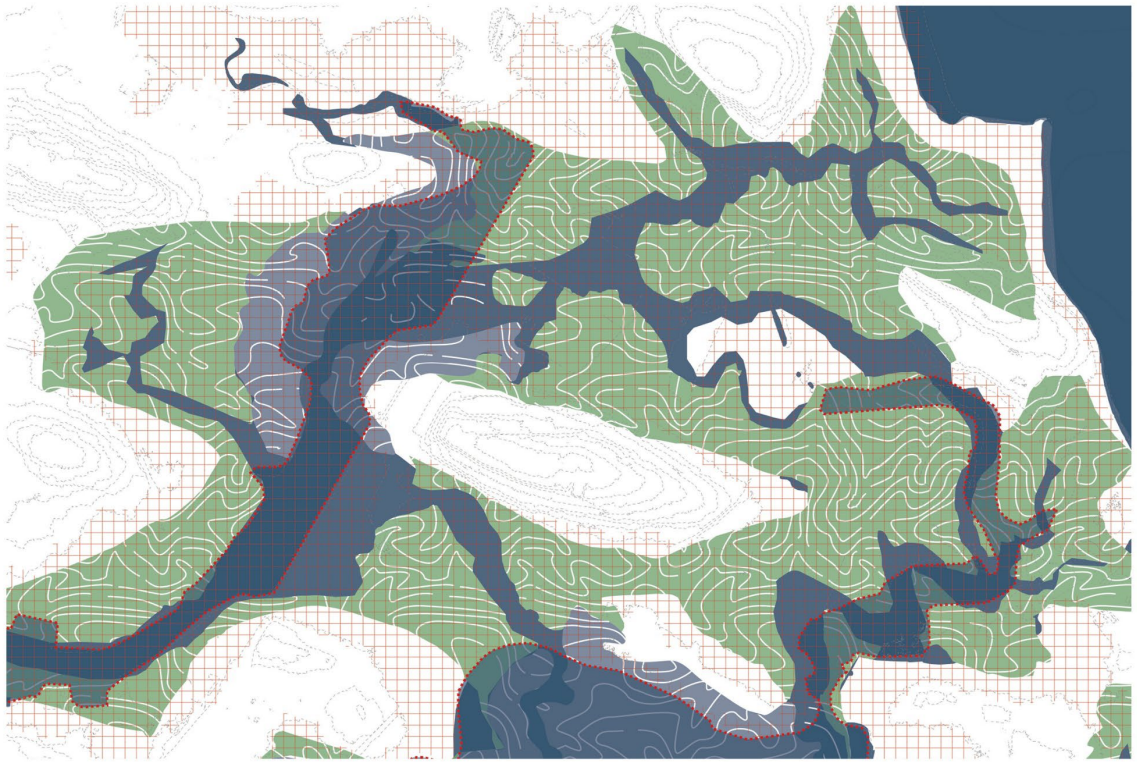
Synthesizing scenarios

Design process: local scale analysis

Belle Isle Marsh

Belle Isle Marsh

Historical analysis



Historic hydrology - Made by author (Hills, 1770-1779)

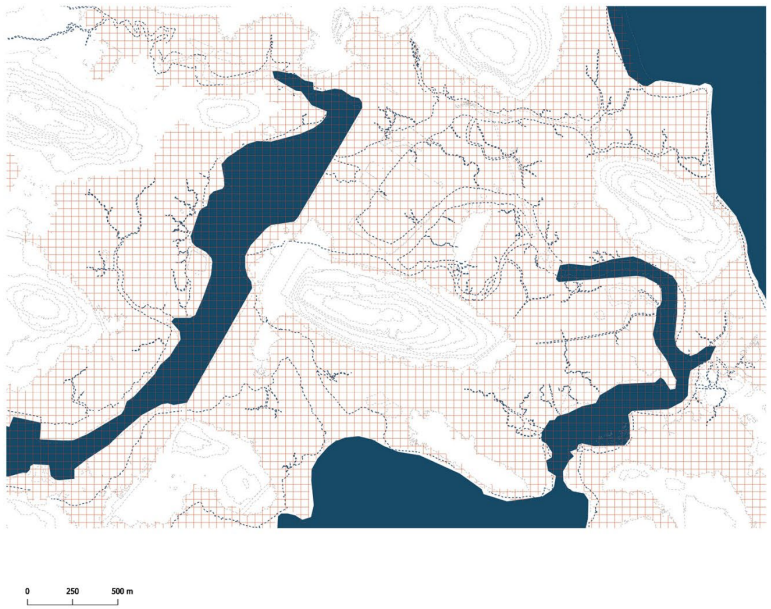
(United Coast Survey, 1857)

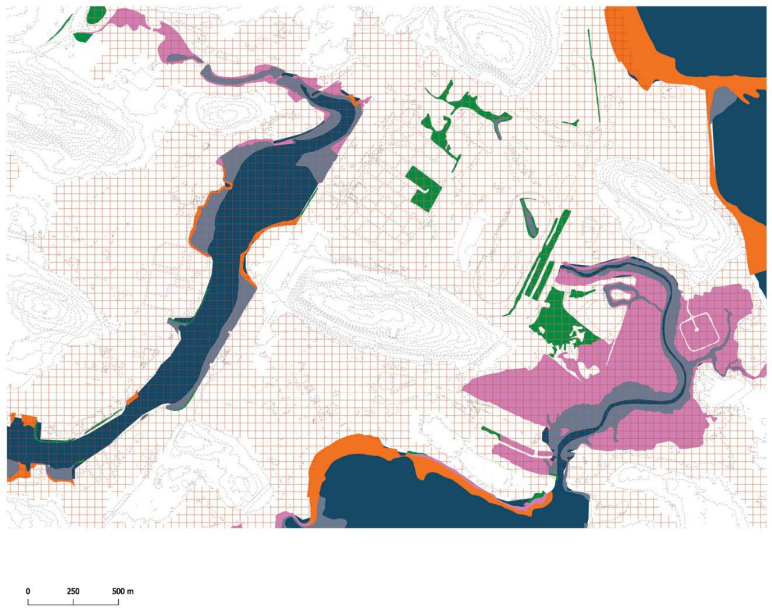
Historical analysis

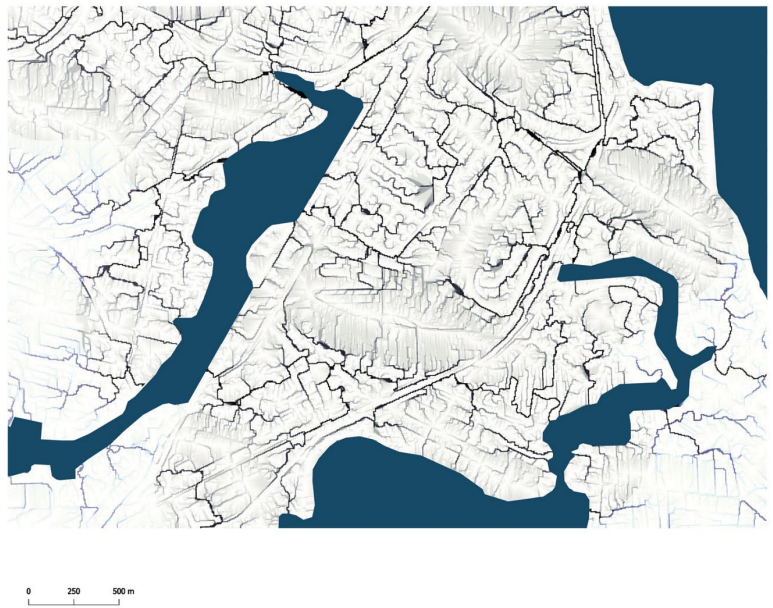
(Aero Scenic Airviews Co., 1939)

(MassGIS, 1995)

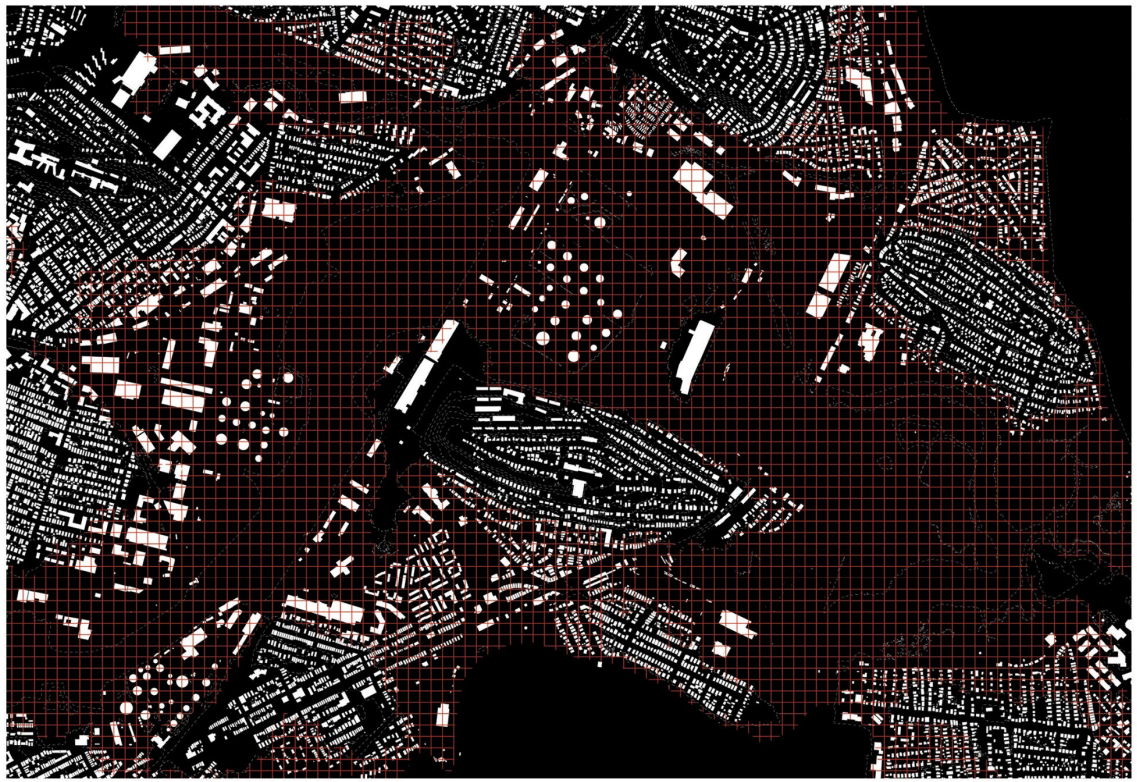
Water & Landscape analysis







Urban analysis



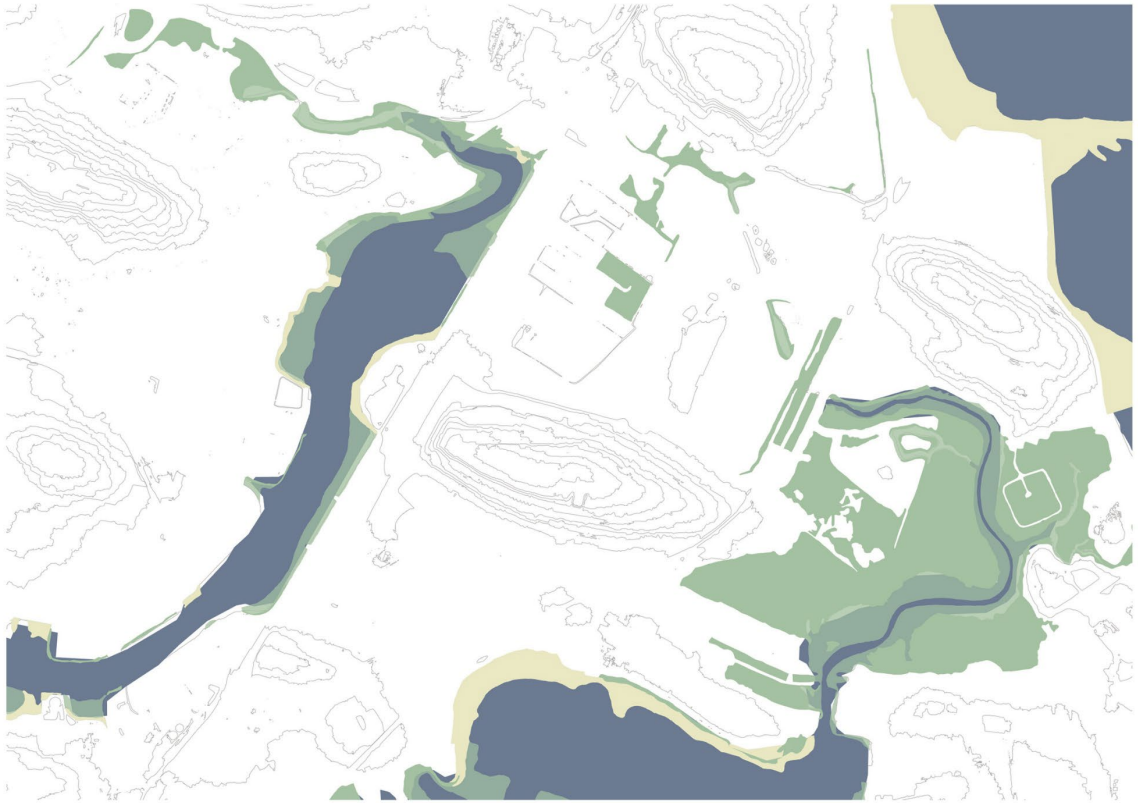
0 250 500 m

(MassGIS, n.d.)

0 250 500 m

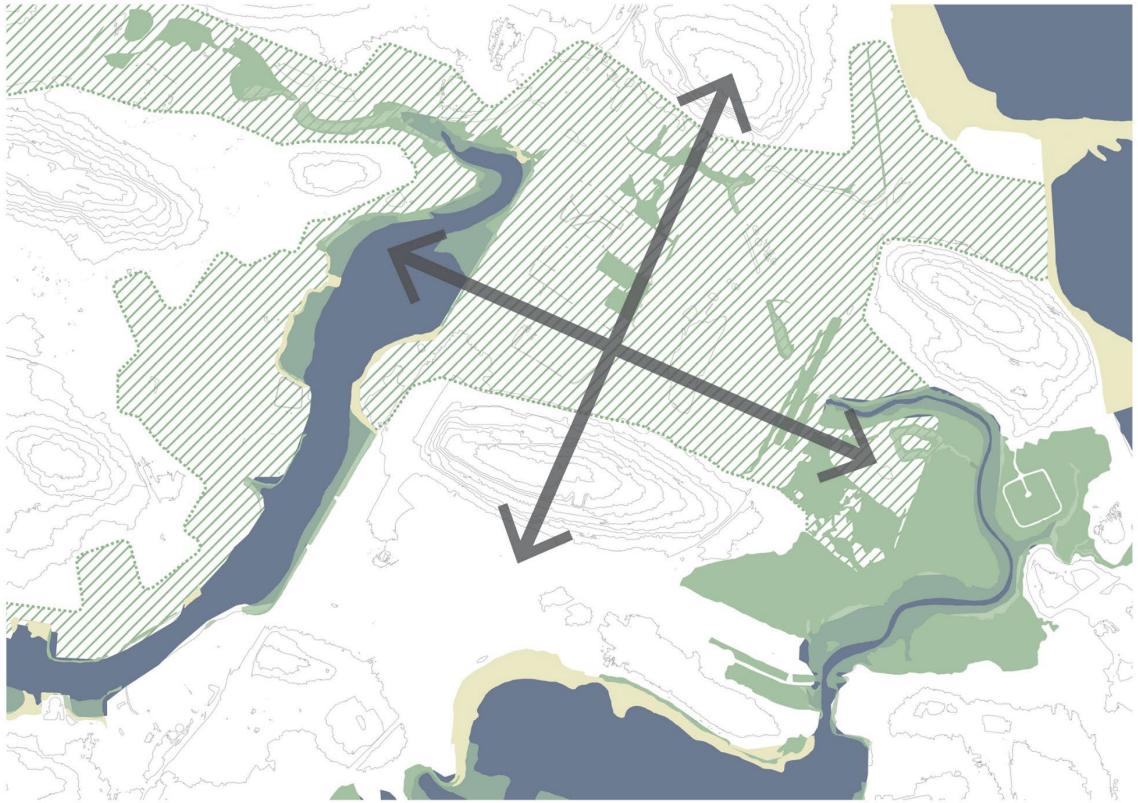
Residential
Industrial
Commercial
Trasportation
Wetland
Beach system
Vacant lots
Urban public / institutional

Analytical synthesis



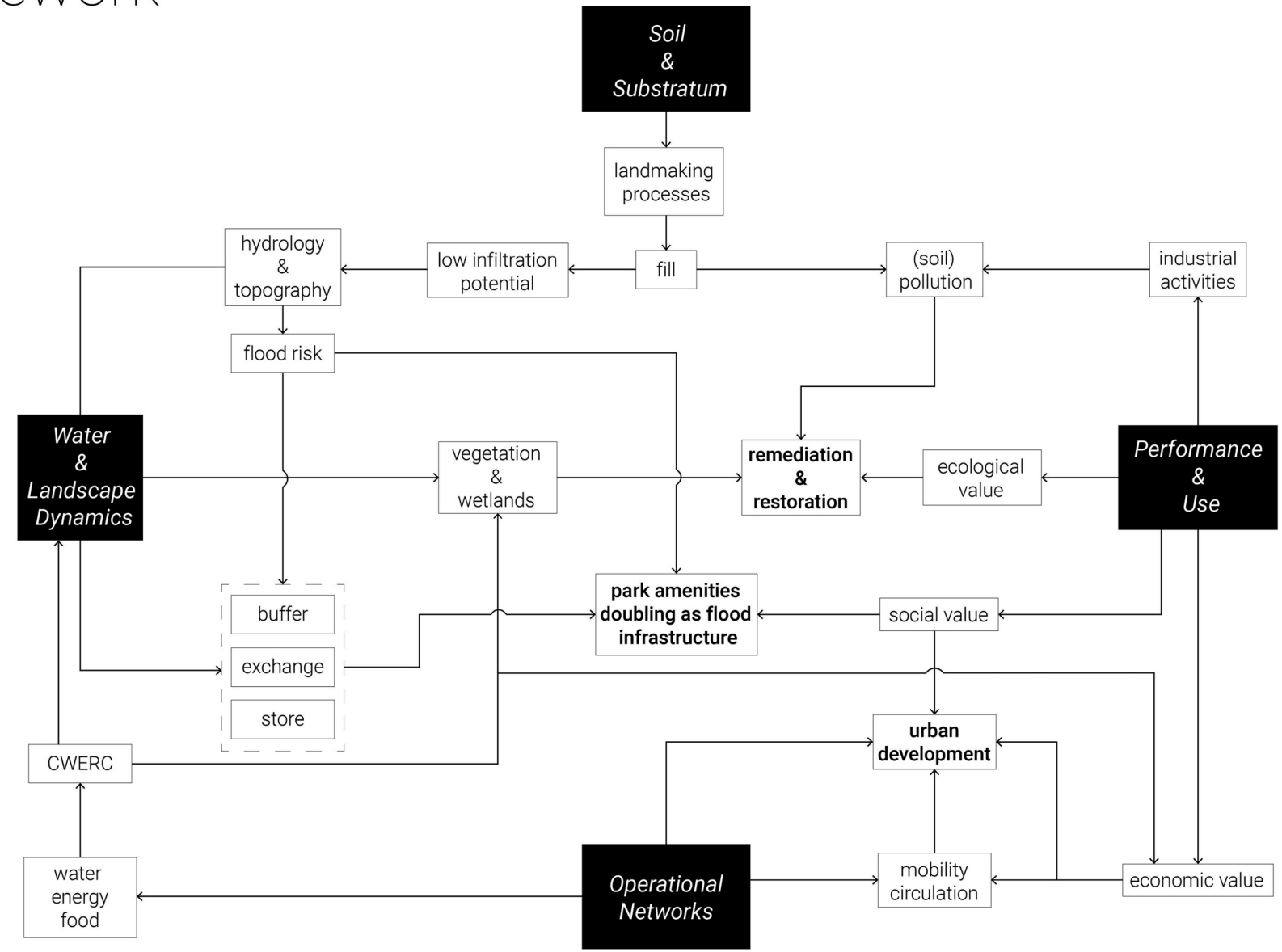
0 250 500 m

Analytical synthesis

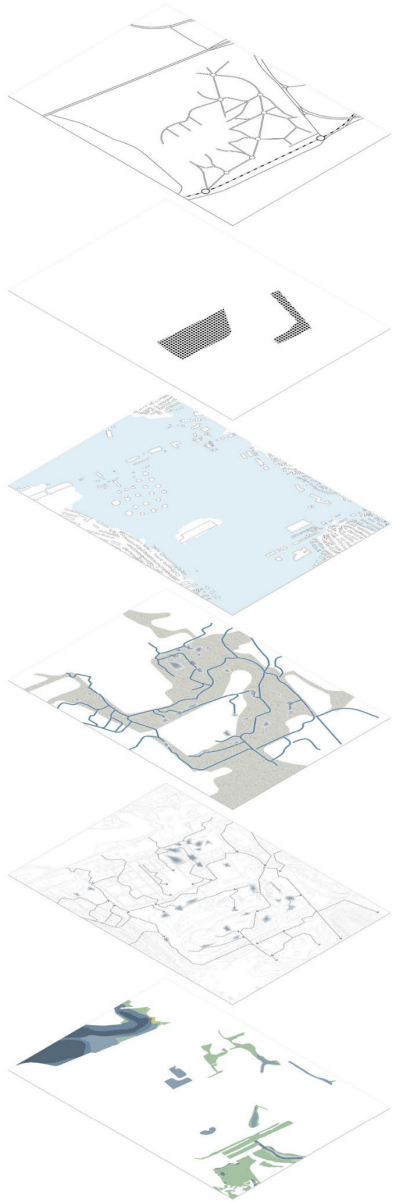


0 250 500 m

Design framework



Design framework



Networks

New urban development

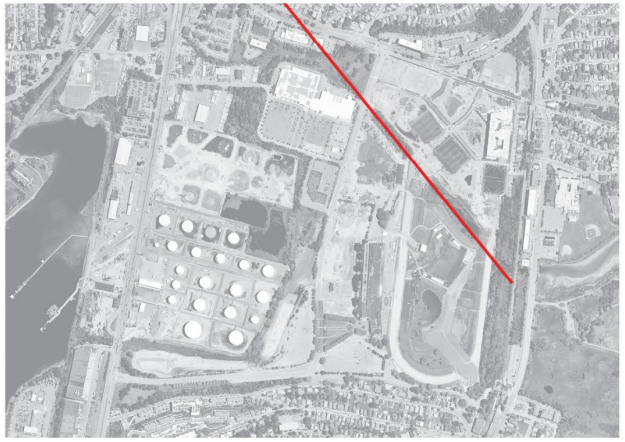
Urban flood vulnerability

Corridor

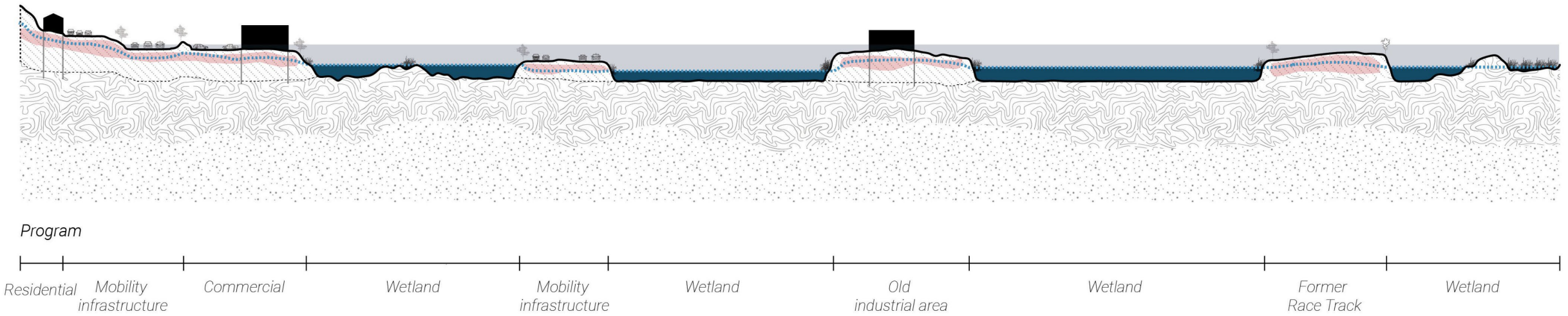
(Storm)water flow

Water & wetlands

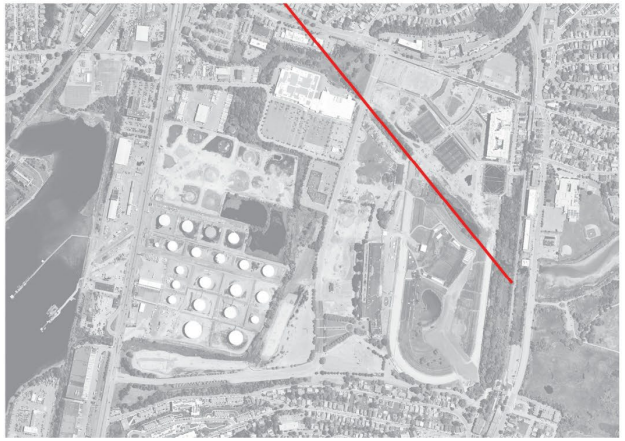
Systemic sectional exploration
Hydrological Heart



Current situation

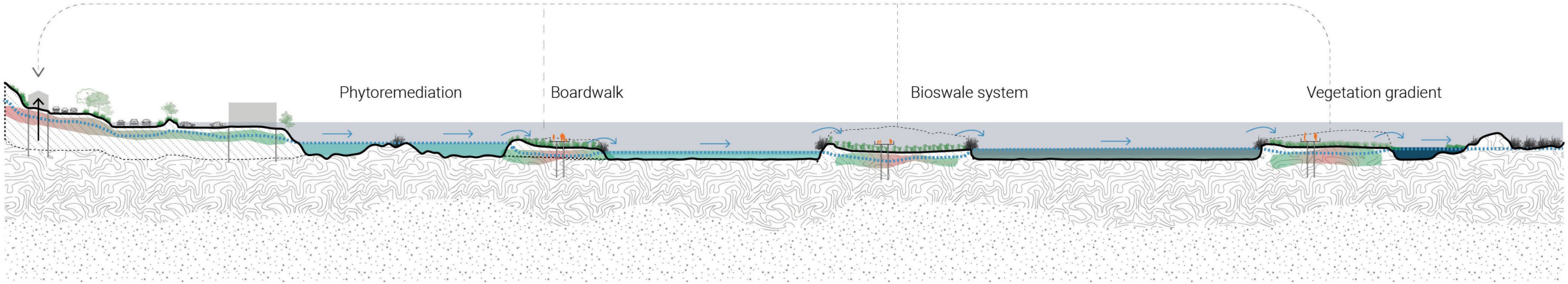


Hydrological Heart



New situation

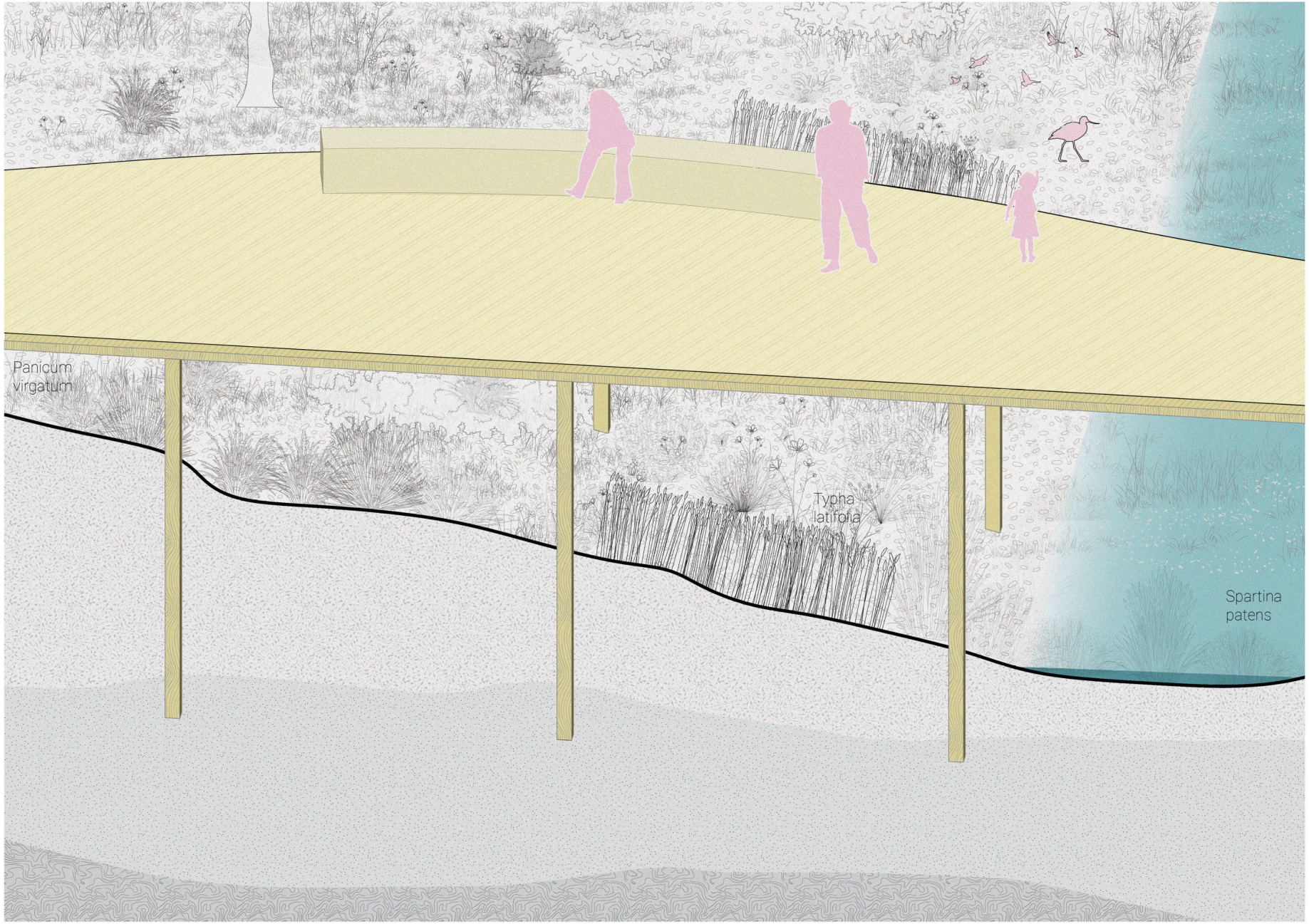
Cut soil from oil industrial and mobility arteries can be used to flood-proof urban cores by elevating them and capping the contaminated soil



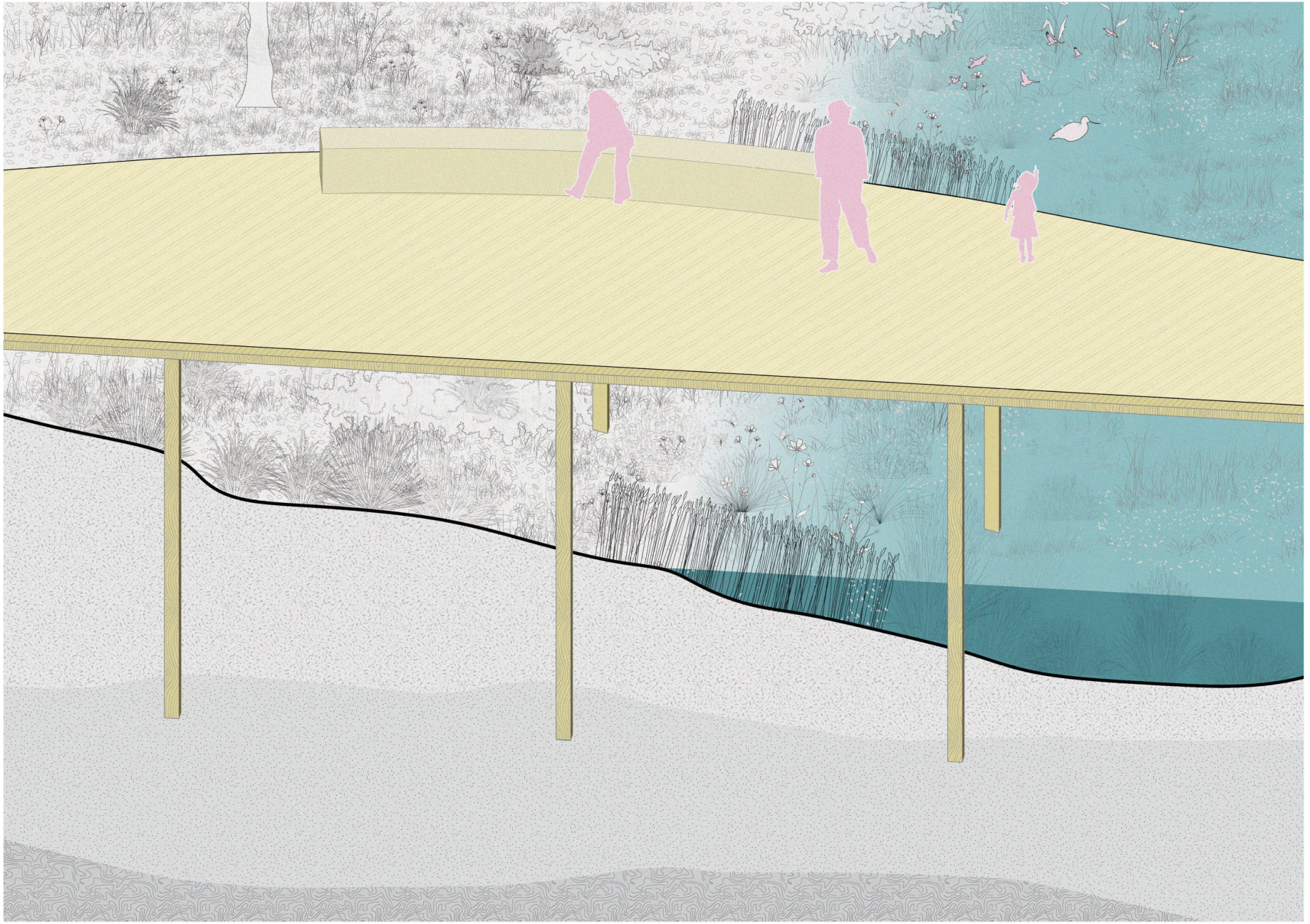
Program

Residential *Mobility infrastructure* *Commercial* *Ecological stormwater corridor (fresh - brackish - salty transition)*

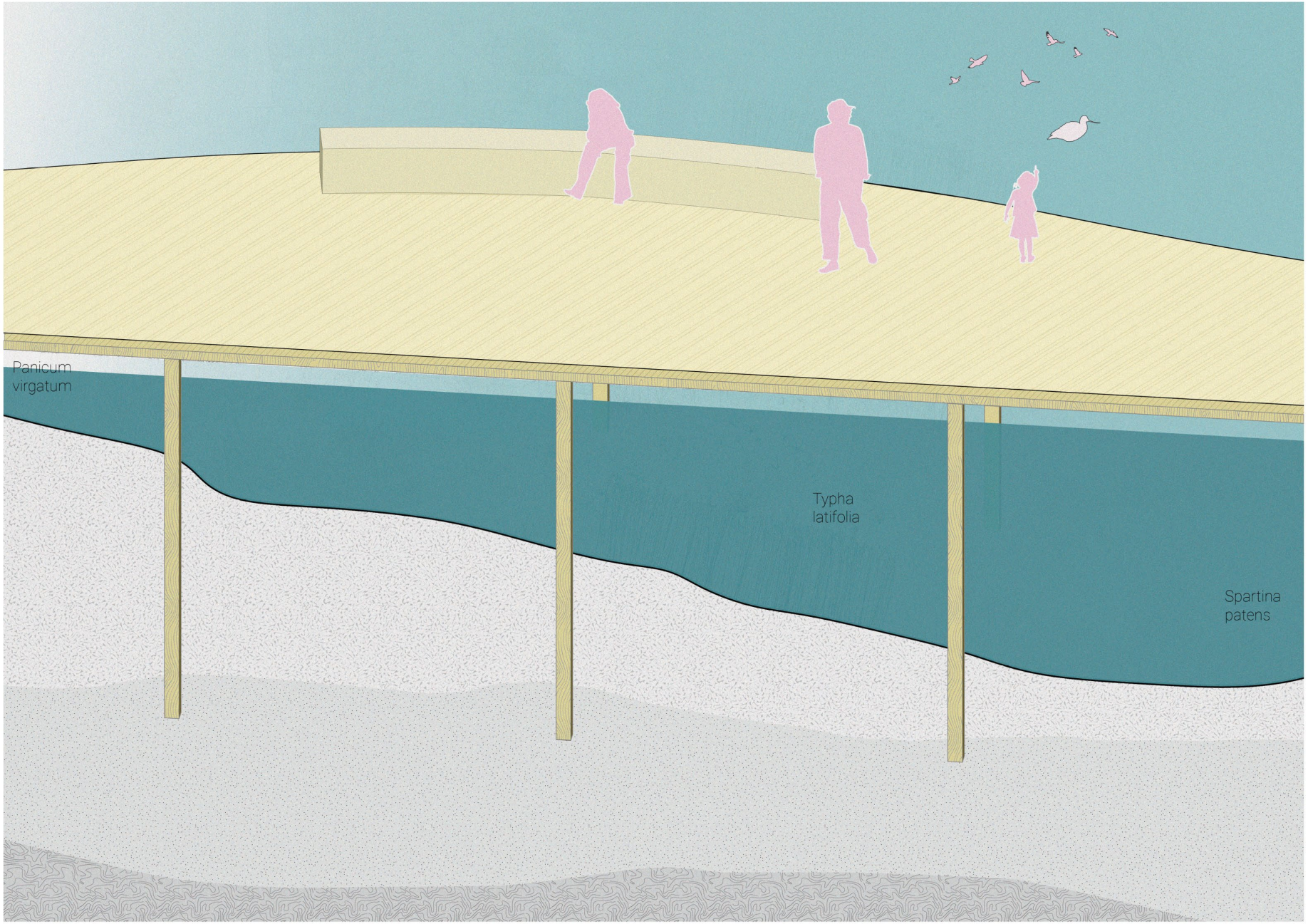
Hydrological Heart



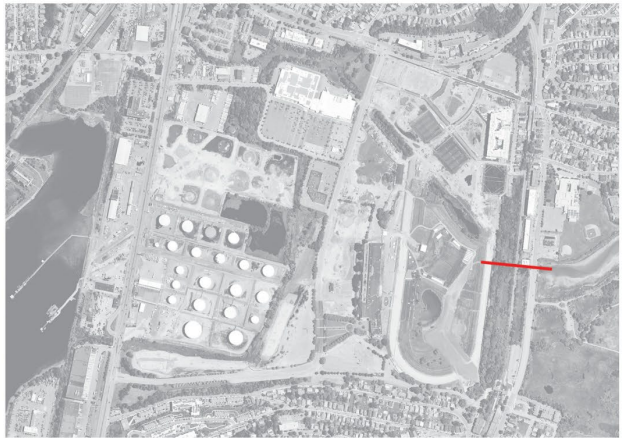
Hydrological Heart



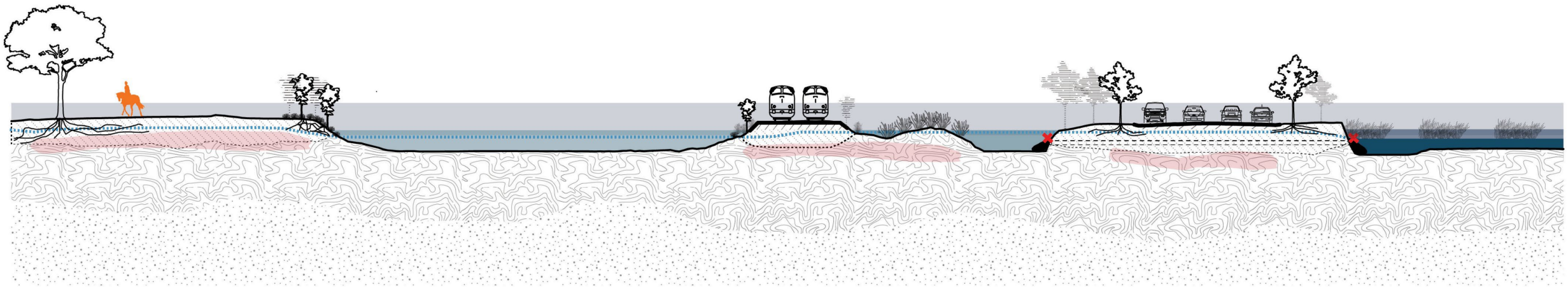
Hydrological Heart



Connecting the Heart (I)



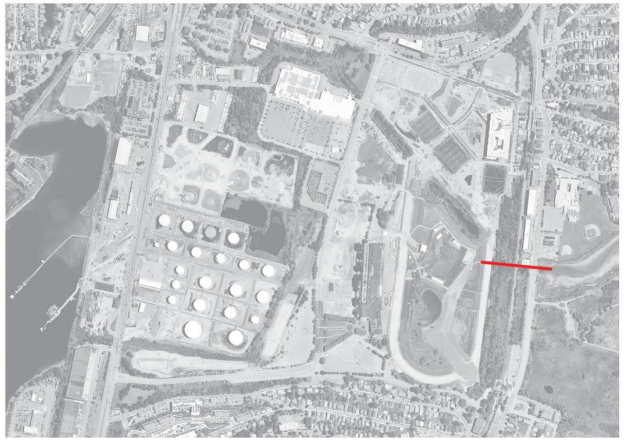
Current situation



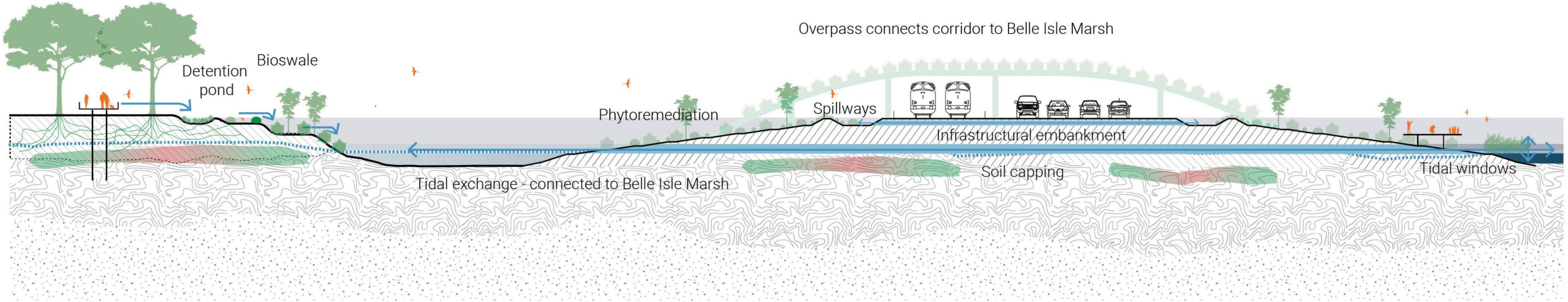
Program

Former Race Track | *Estuarine emergent wetland* | *MBTA Railway* | *Estuarine emergent wetland* | *Bennington St* | *Belle Isle Salt Marsh*

Connecting the Heart (I)



New situation



Program

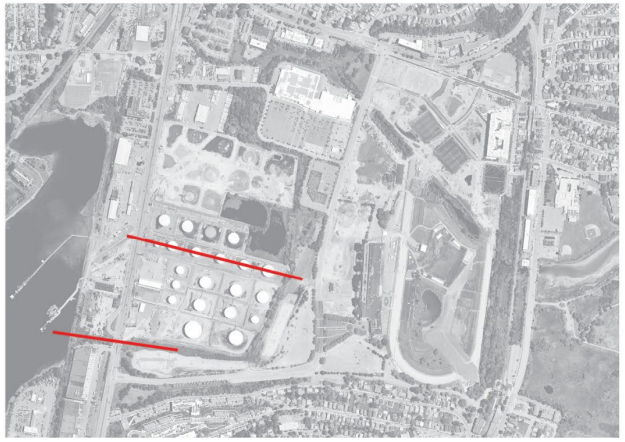
Ecological stormwater corridor

Estuarine wetland

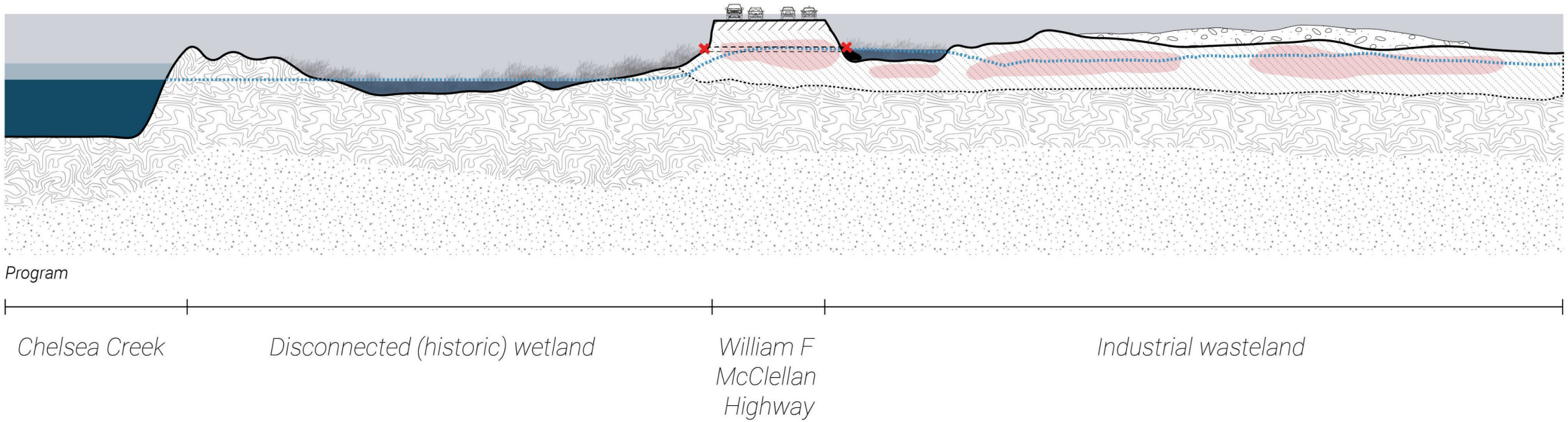
Infrastructural embankment

Belle Isle Salt Marsh

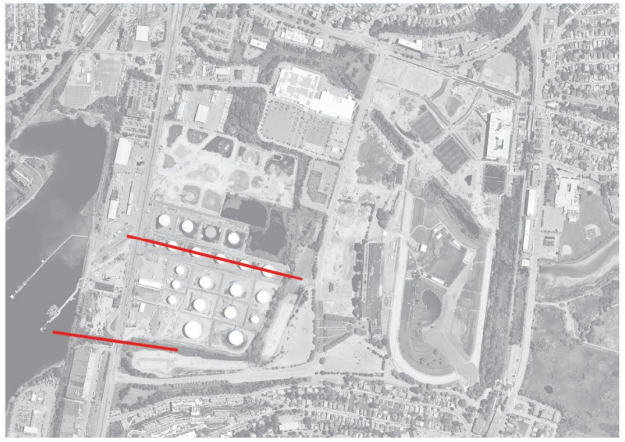
Connecting the Heart (II)



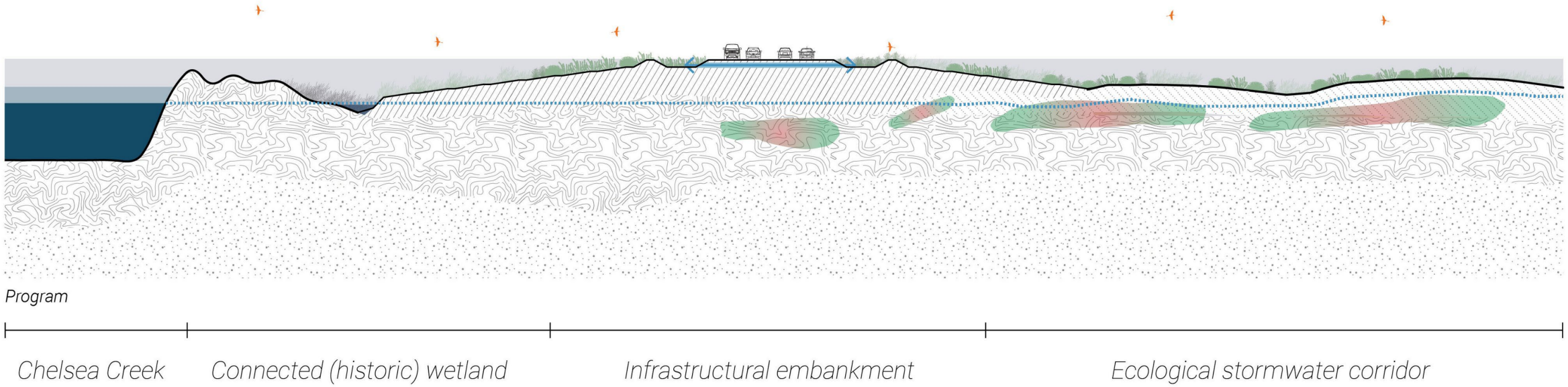
Current situation



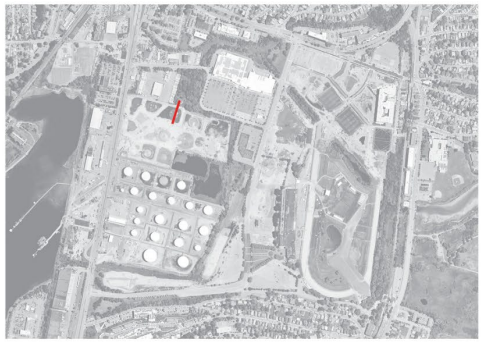
Connecting the Heart (II)



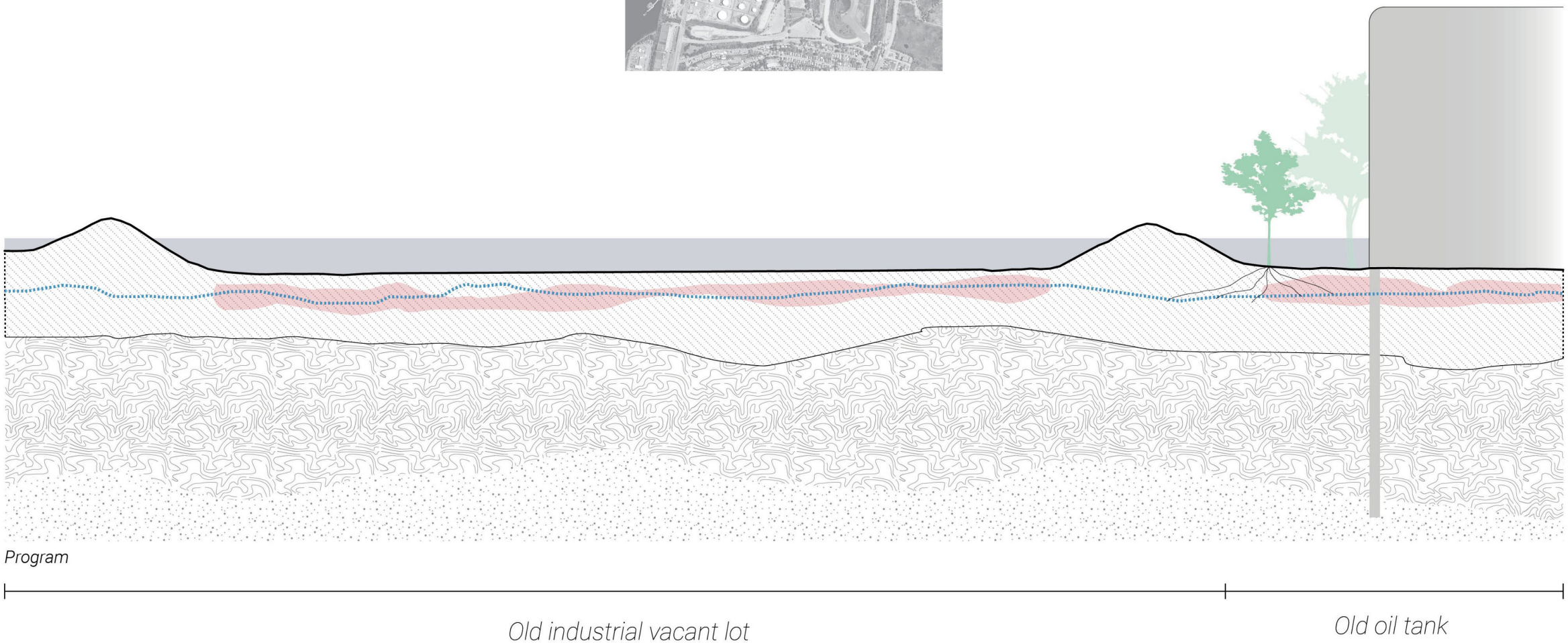
New situation



Reconnecting the past



Current situation



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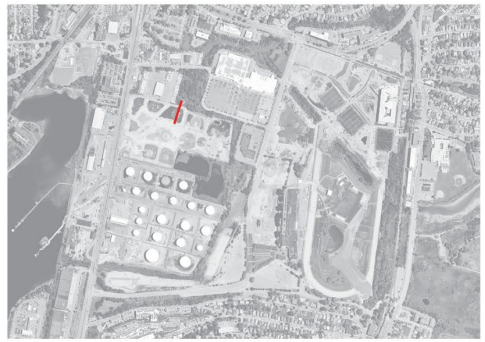
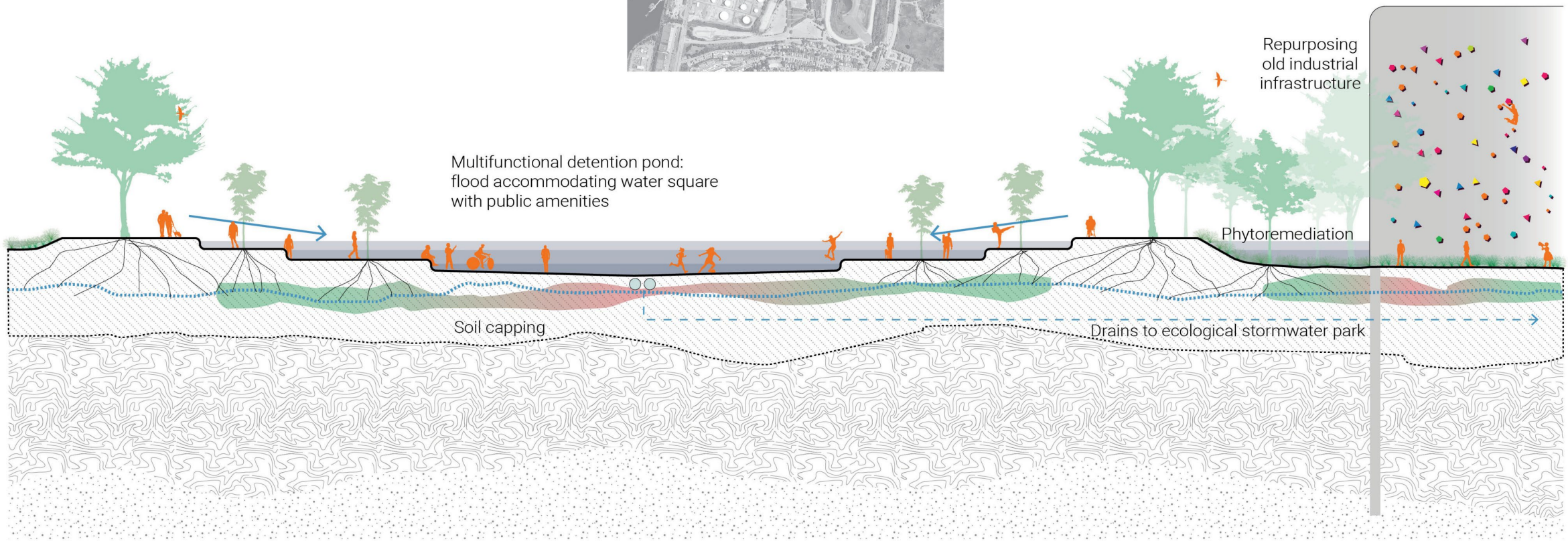


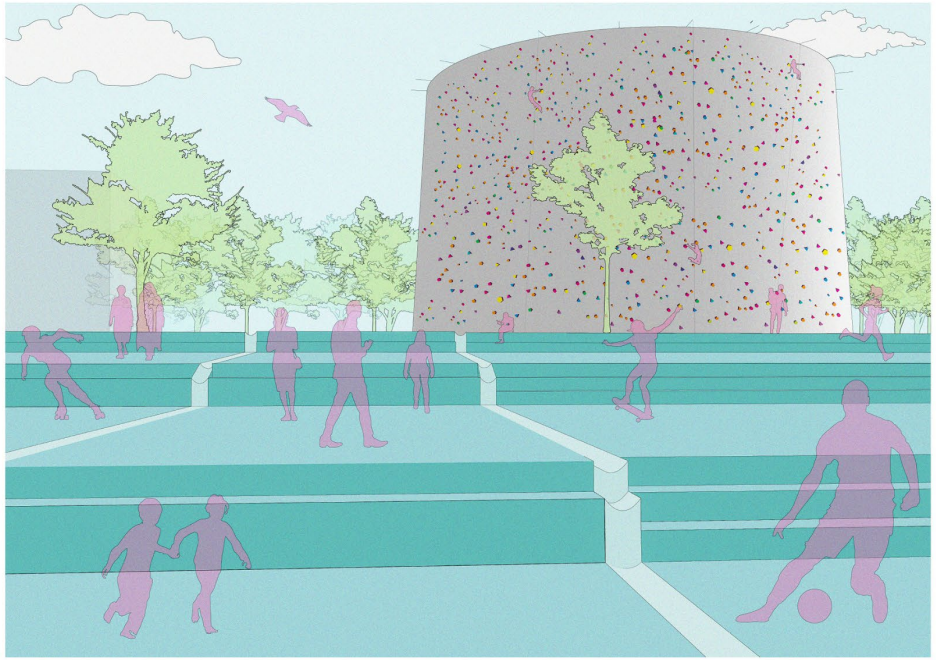
New situation

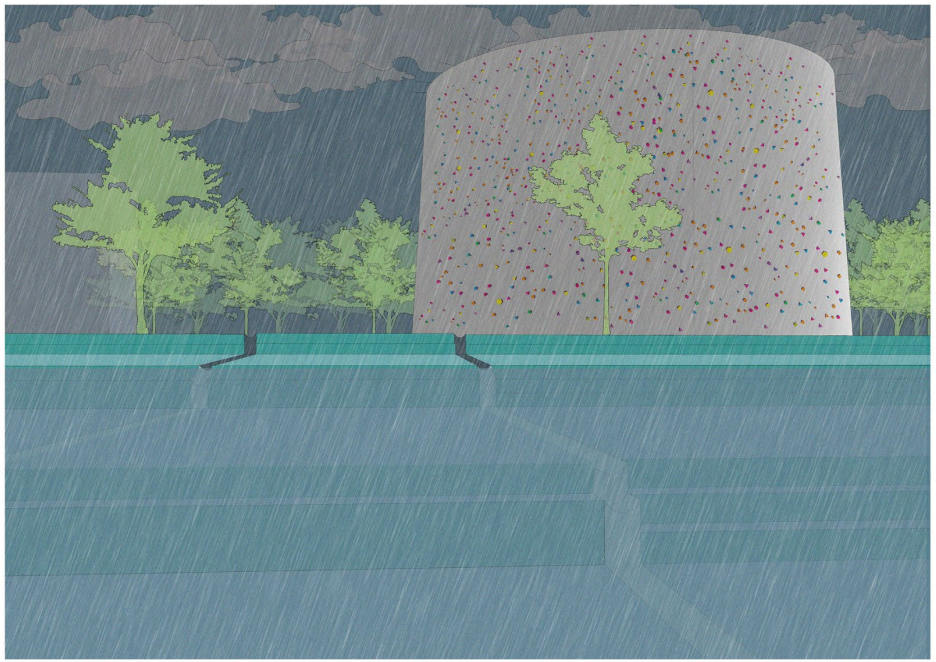


Program

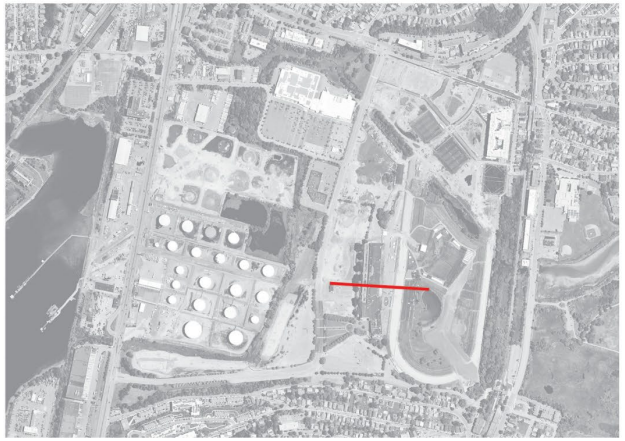
Pond Park connected to ecological stormwater corridor

Reconnecting the past

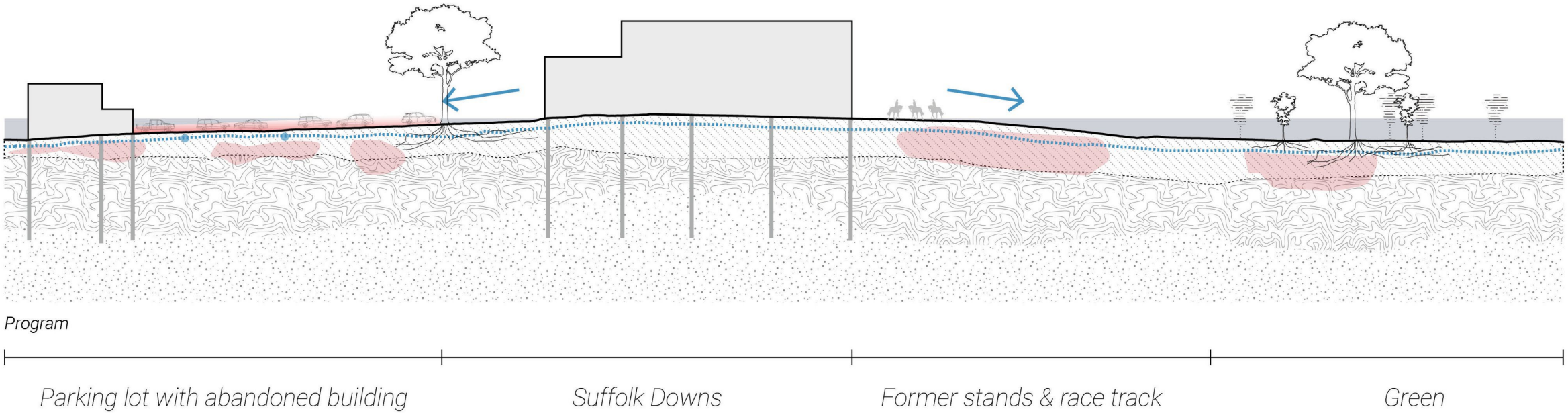




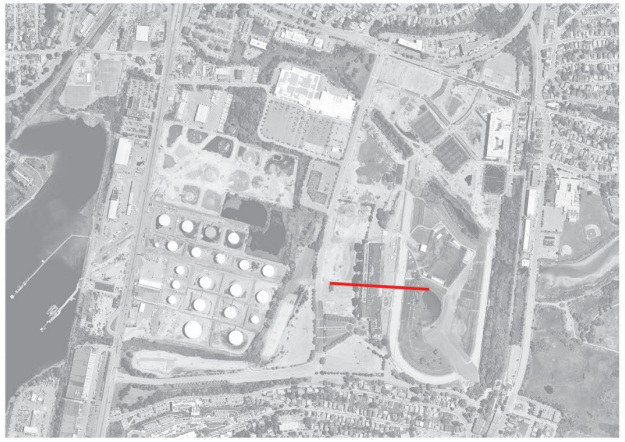
Suffolk Downs Transformation (I)



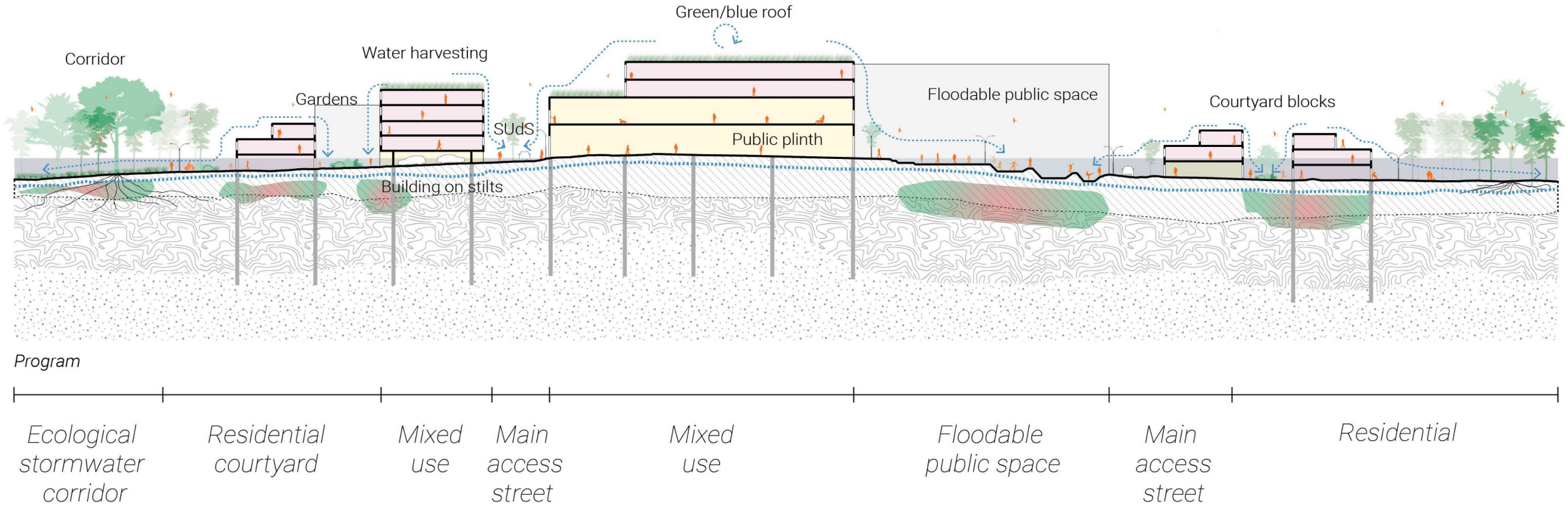
Current situation



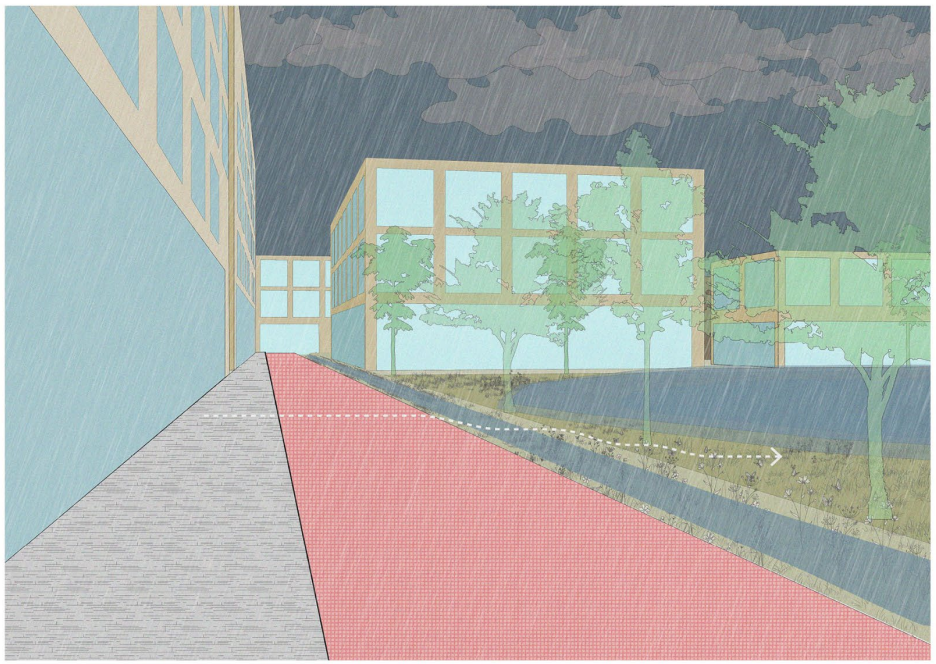
Suffolk Downs Transformation (I)



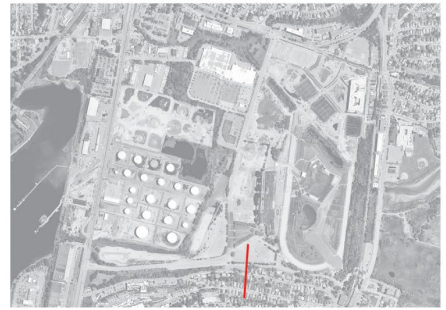
New situation



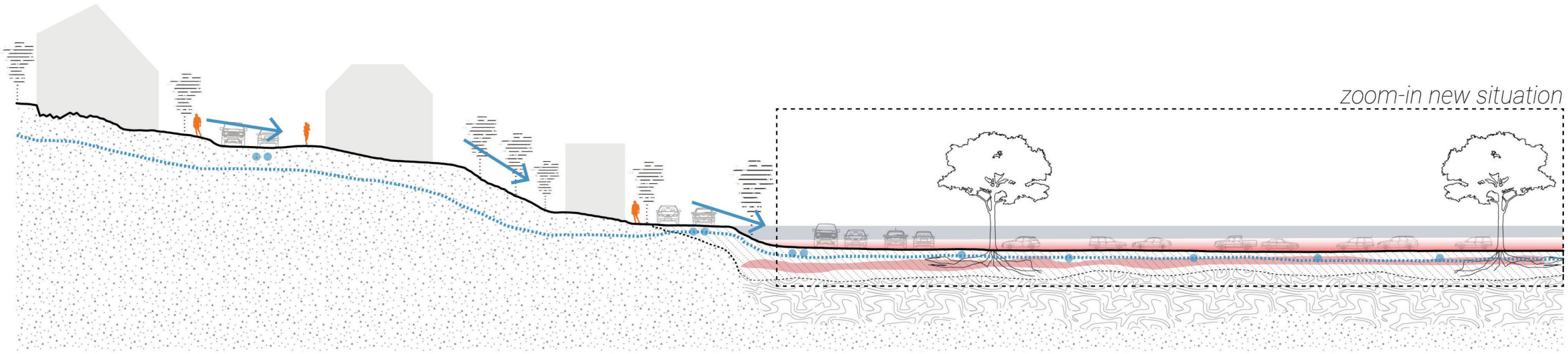
Suffolk Downs Transformation (I)



Suffolk Downs Transformation (II)



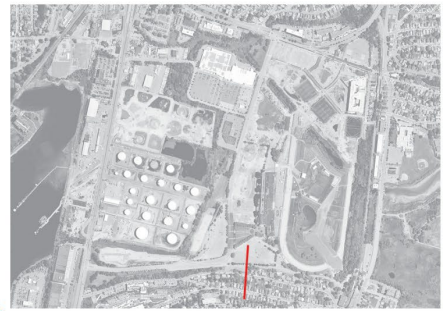
Current situation



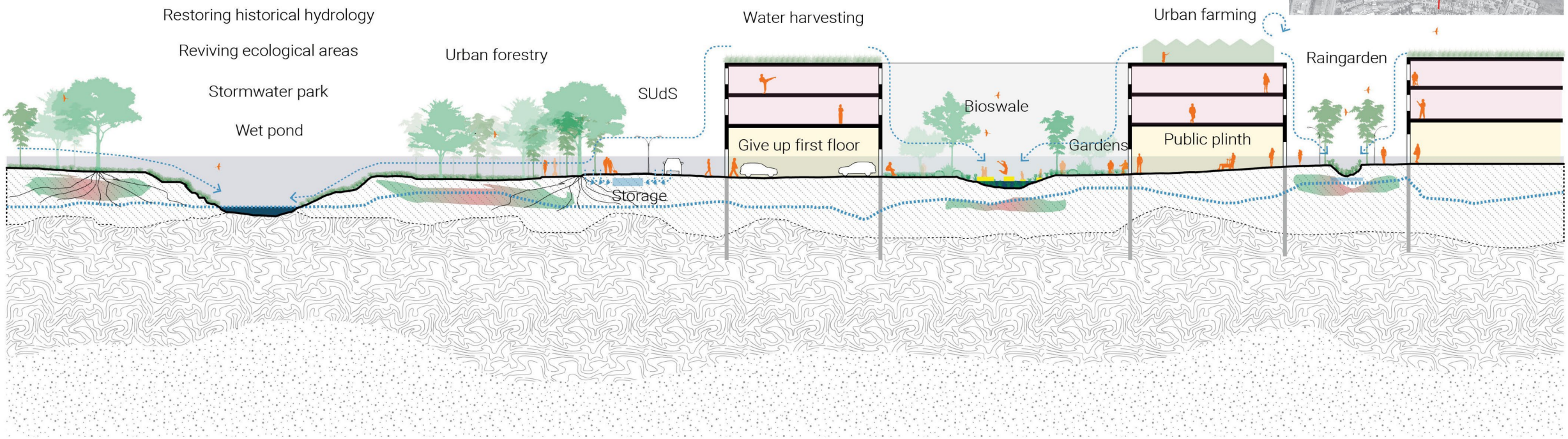
Program

Residential | *Secondary road* | *Residential* | *Secondary road* | *Primary road* | *Parking lot*

Suffolk Downs Transformation (II)



New situation

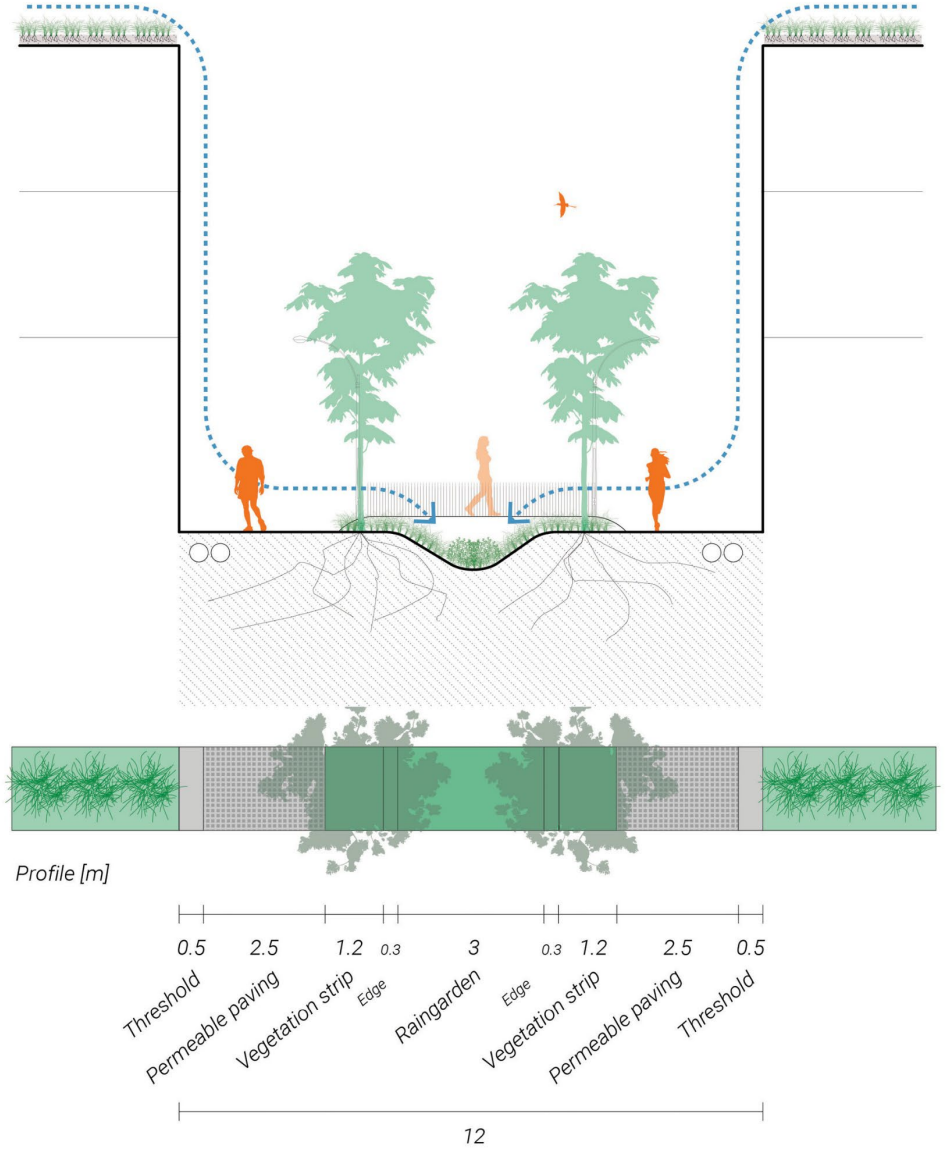


Program

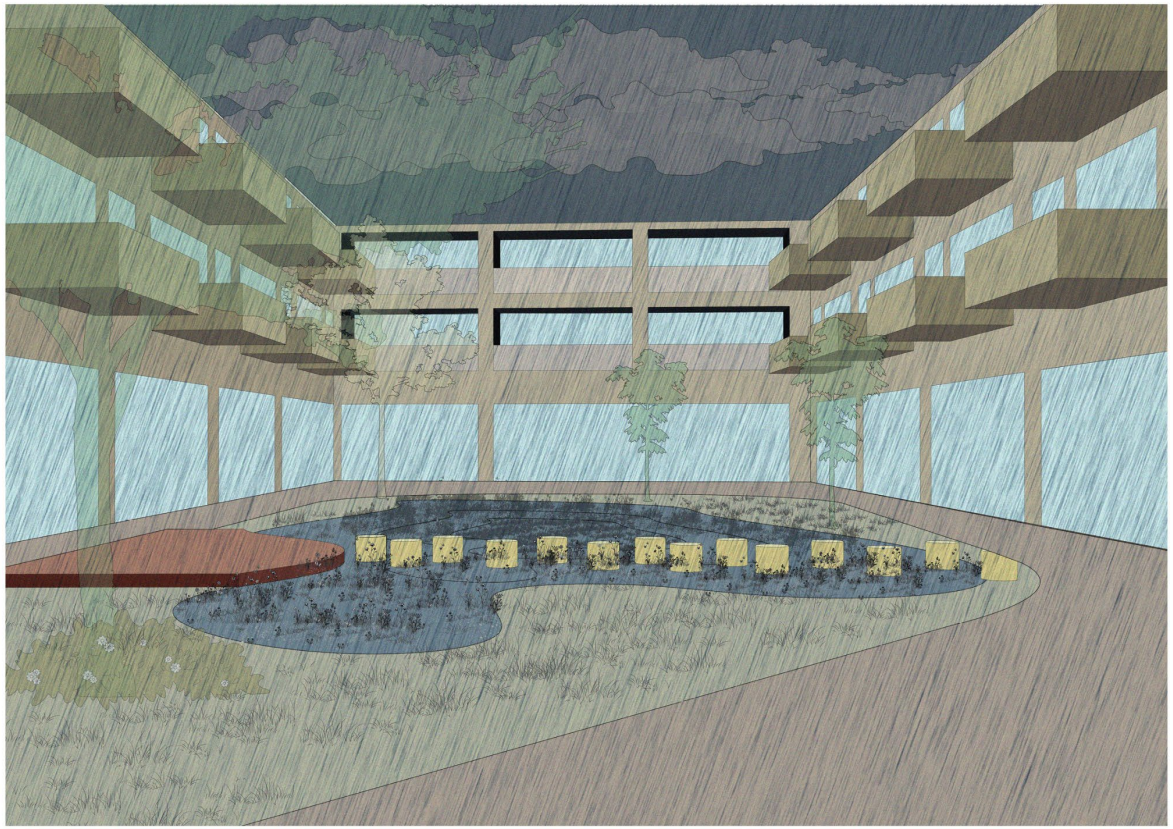
Ecological stormwater corridor | *Path* | *Main access street* | *Mixed use* | *Courtyard & Bioswale* | *Mixed use* | *Corridor Fringe* | *Mixed use*

Suffolk Downs Transformation (II)

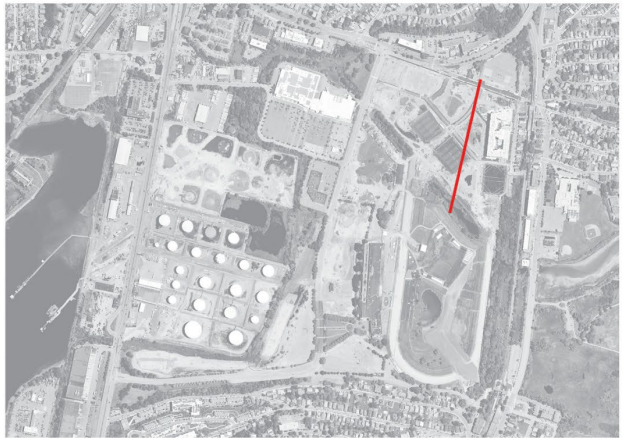
Ecological Fringe - Street profile



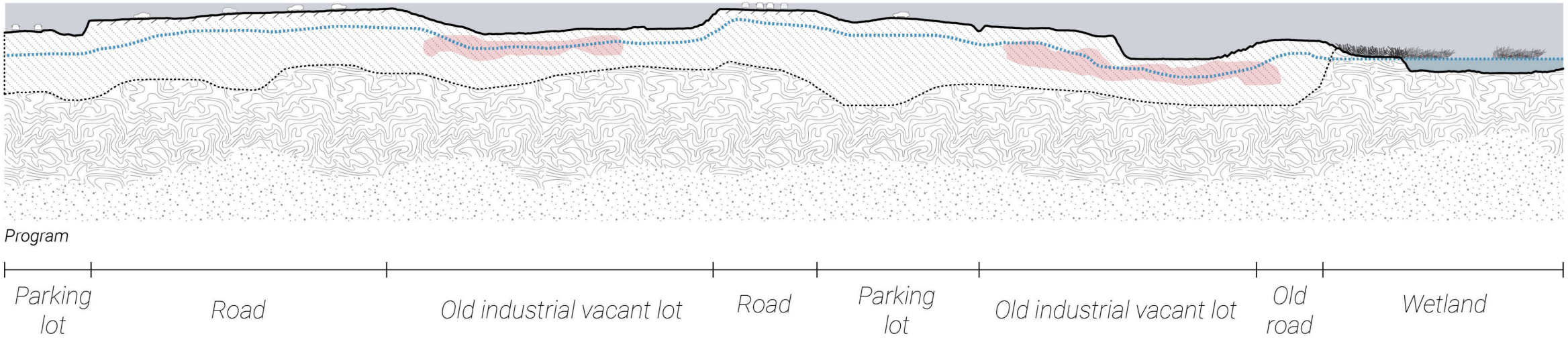
Suffolk Downs Transformation (II)



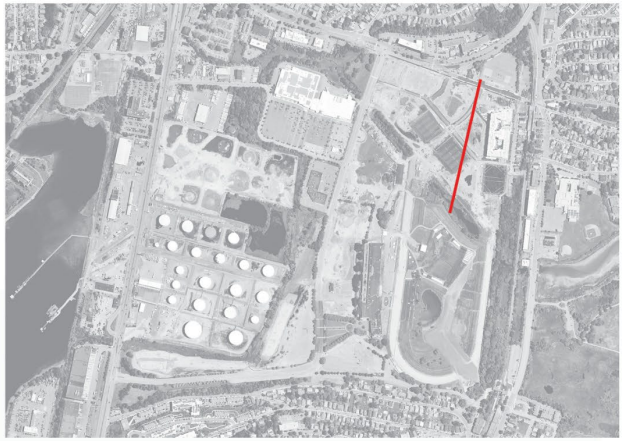
The Circular Core



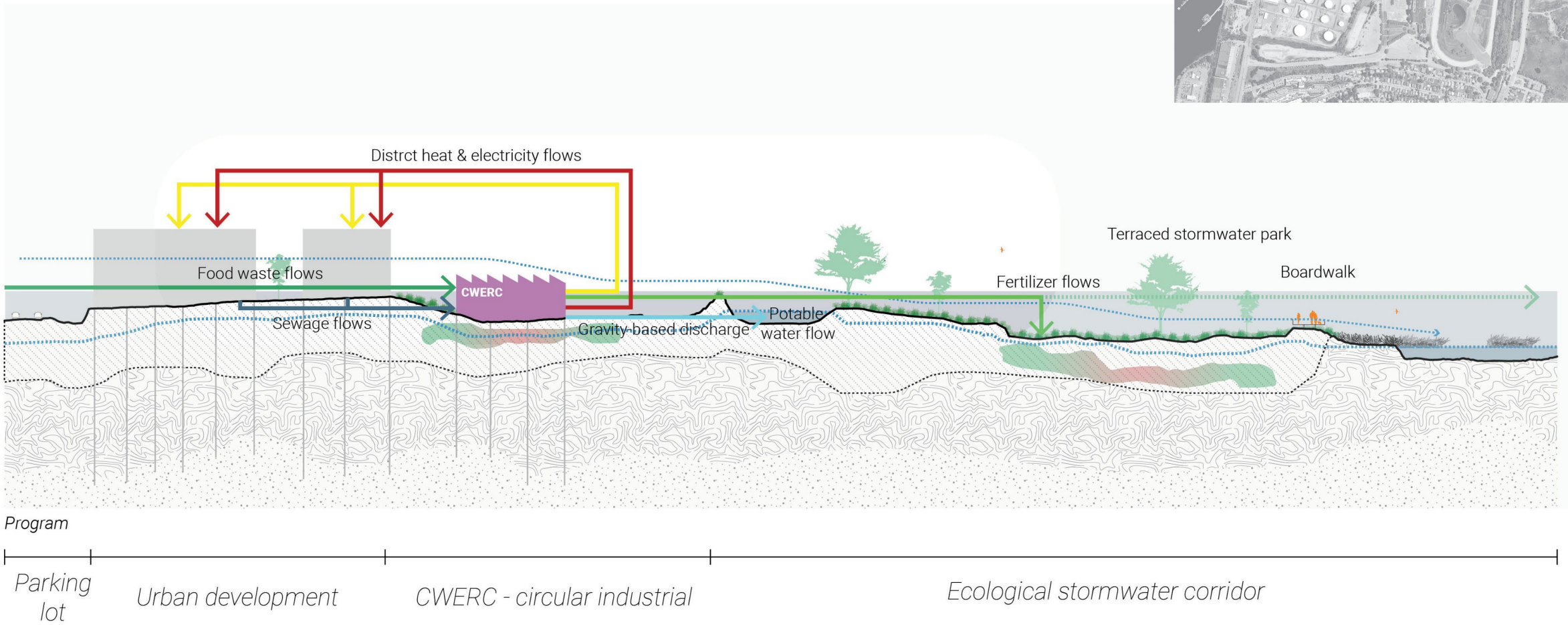
Current situation



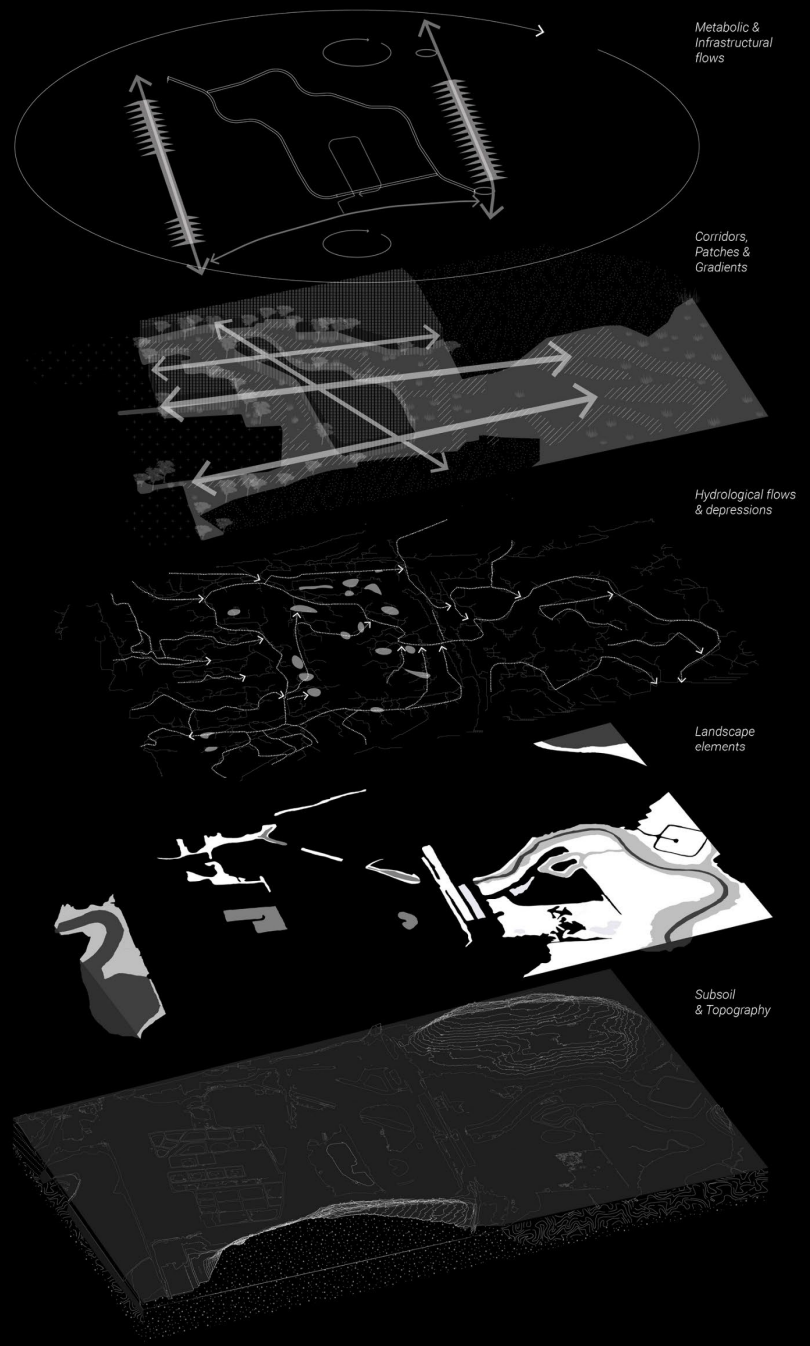
The Circular Core



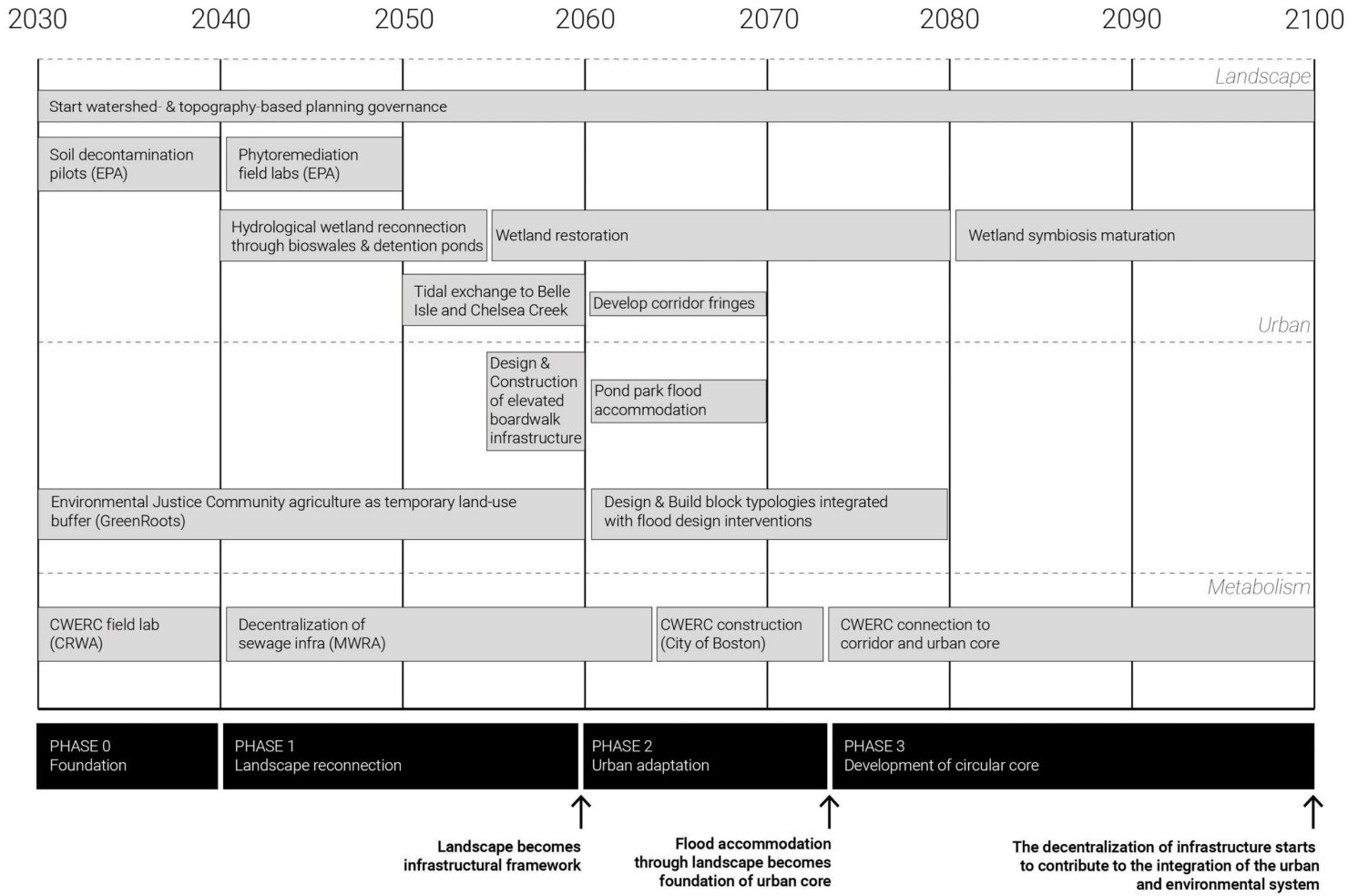
New situation



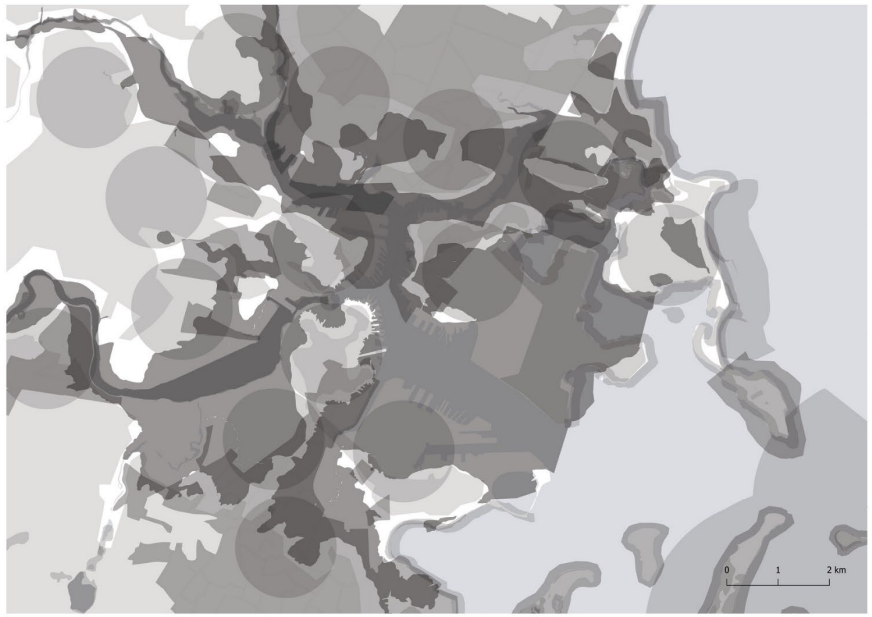
Synthesizing sections

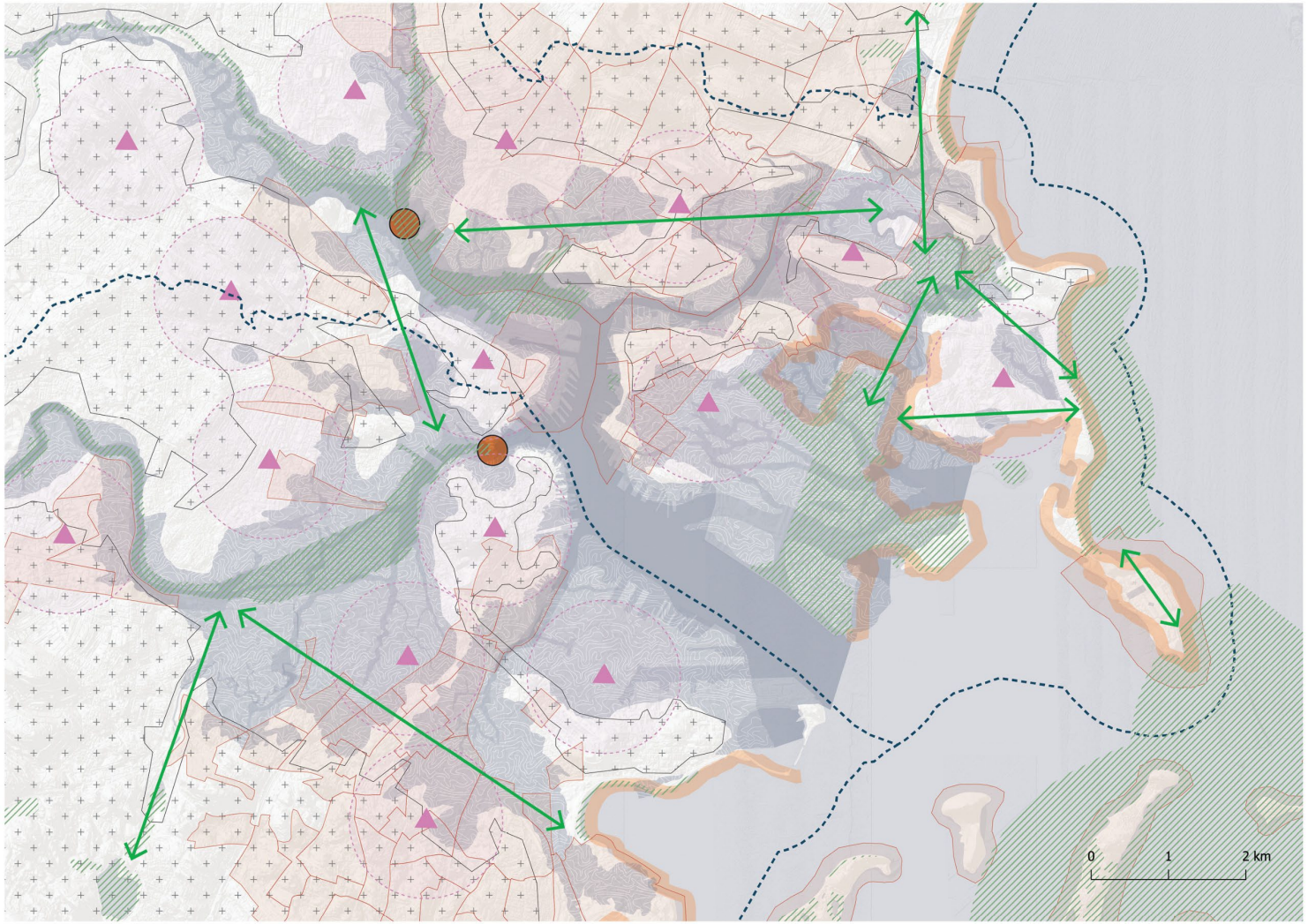


Phasing


2030
2040
2050
2060
2070
2080
2090
2100
Landscape
Start watershed- & topography-based planning governance
Soil decontamination pilots (EPA)
Phytoremediation field labs (EPA)
Hydrological wetland reconnection through bioswales & detention ponds
Wetland restoration
Wetland symbiosis maturation
Tidal exchange to Belle Isle and Chelsea Creek
Develop corridor fringes
Urban
Design & Construction of elevated boardwalk infrastructure
Pond park flood accommodation
Environmental Justice Community agriculture as temporary land-use buffer (GreenRoots)
Design & Build block typologies integrated with flood design interventions
Metabolism
CWERC field lab (CRWA)
Decentralization of sewage infra (MWRA)
CWERC construction (City of Boston)
CWERC connection to corridor and urban core
PHASE 0 Foundation
PHASE 1 Landscape reconnection
PHASE 2 Urban adaptation
PHASE 3 Development of circular core
Landscape becomes infrastructural framework
Flood accommodation through landscape becomes foundation of urban core
The decentralization of infrastructure starts to contribute to the integration of the urban and environmental system

Integral scenario





Watershed
Historic hydrology
Landscape connections
Landscape corridors
Dams
Existing flood protection infrastructure
Vulnerable communities
Urban cores
Decentralized CWERC infrastructure

Conclusion & reflection

Outcomes

- Symbiosis - urban design, ecology & flood management

- Water and landscape dynamics

- Open and multi-directional flood management approach

- Correlation between the urban and environmental systems

- The role of the urbanist

Limitations

- Financial, institutional, and jurisdictional feasibility

- The long-term performance of interventions

- Potential consequences: displacement issues

Reference for how to work, think, and design within complex climate adaptation contexts

From Lost Streams to Living Landscapes

Investigating landscape-based infrastructural futures for flood adaptation in Boston

Gijs ten Bosch