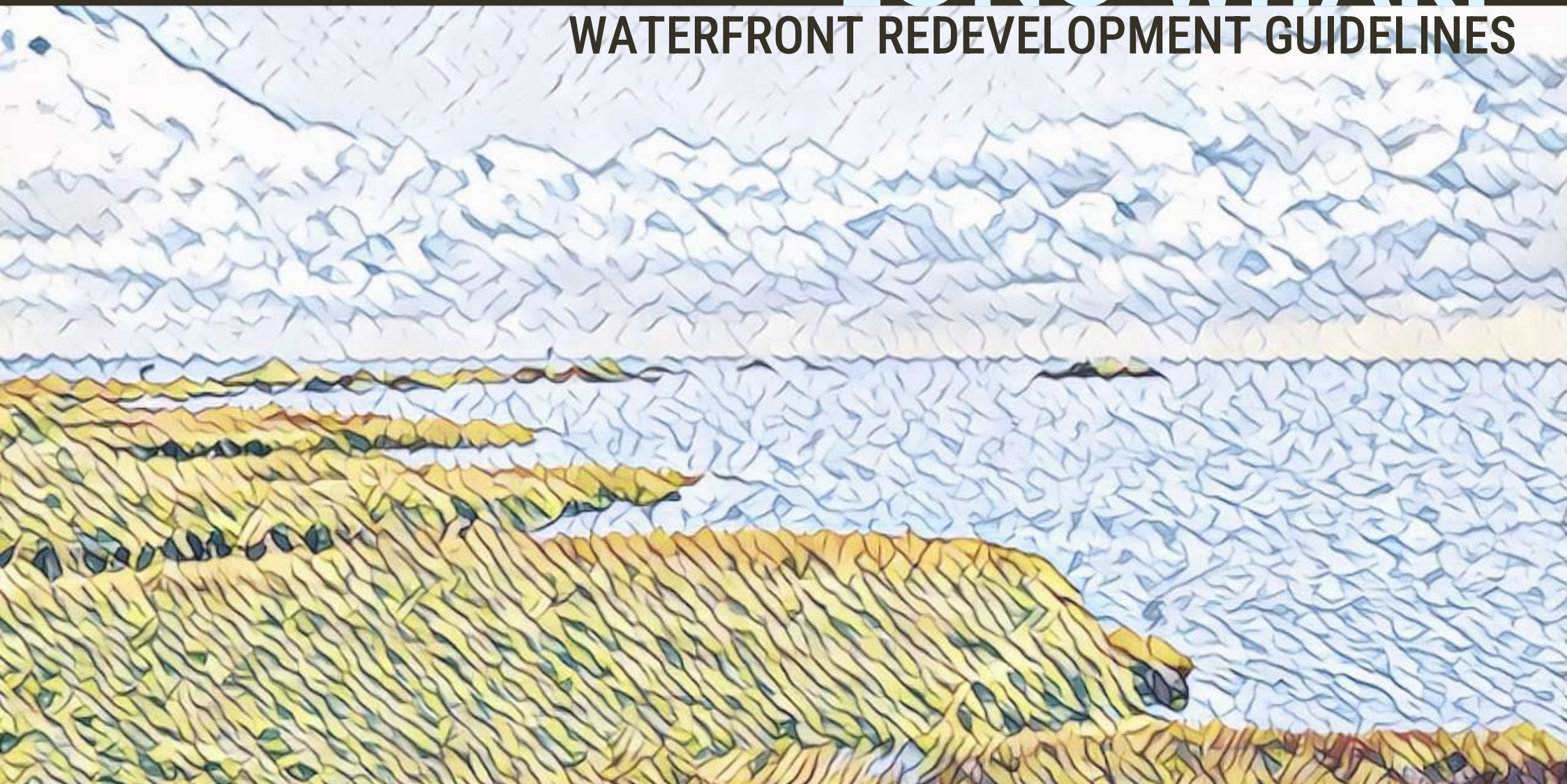
LONG WHARF

WATERFRONT REDEVELOPMENT GUIDELINES



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WATERFRONT REDEVELOPMENT GUIDELINES

New Haven, Connecticut

Connor Sullivan, McGill School of Urban Planning, 2021

ACKNOWLEDGEMENTS

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INTRODUCTION

CONTEXT & SCOPE

New Haven, Connecticut's Long Wharf is a 352-acre underdeveloped tract of land along Long Island Sound. Recognizing the potential value of this land, the City of New Haven began a consultative process to create the 2018 Long Wharf Responsible Growth Plan, which outlines a series of interrelated strategies to "support the social and economic developments of the Long Wharf District through strategic focus on coastal resiliency, progressive economic strategies, and community engagement." The plan includes schematic renderings of six unique, but complementary mixed-use districts, which aim to create a new public realm, increase market-driven residential development, increase coastal resilience, and enhance transportation systems. While the plan will enable a much-needed large-scale transformation of Long Wharf, it is critical that the site be redeveloped under ethical and holistic design and policy strategies that effectively address climate change and help dismantle existing inequities in New Haven.

Broadly speaking, urban waterfronts represent the interaction between the built and natural landscape.[16] Though the human and non-human components of built environments have traditionally been viewed in isolation from one another, our understanding of the urban environment and natural environment has shifted to recognize the dynamic relationship between them.[6] The present document represents an application of the study of urban ecology, which provides an interdisciplinary framework for understanding the structure and function of urban environments. Urban ecology describes how the living and nonliving parts of those environments relate to each other and combine to sustain urban systems.[86] This comprehensive approach toward understanding the more granular components of urban environments can help cities deliver gains in equity, livability, public health, biodiversity, and climate adaptation.[117]

The redevelopment of Long Wharf must be guided by a systemic understanding of local and regional social and ecological processes as they relate to other physical and non-physical components of New Haven's urban system. Climate-related impacts, legacies of industrialization and urban renewal, and significant socioeconomic inequality begin to characterize the obstacles that communities in New Haven face. In response, the present document outlines specific, high-impact design and policy guidelines that make sense of the context-specific socioeconomic and ecological challenges associated with the Long Wharf site. These redevelopment guidelines are a result of an exploration of academic literature, case studies, local spatial patterns, direct observations, and analysis of policy, plans, and legal systems occurring on site and within the greater New Haven region. The guidelines complement many of the goals of the Long Wharf Responsible Growth Plan but build on them by providing a much more detailed and holistic vision for the site. They aim to achieve truly sustainable development by challenging traditional development practices, prioritizing housing equity, responding to local climate change impacts, designing ecologically restorative buildings, infrastructure, and landscapes, and incorporating circularity into the management of energy, materials, and waste. The document also illustrates examples of successful approaches to waterfront revitalization to encourage their implementation at the Long Wharf site and considers implementation feasibility by connecting proposed design interventions to local and regional plans, policies, and laws.

An aerial image of greater New Haven. The Long Wharf District is outlined in red.

The Long Wharf Redevelopment Guidelines are aimed at private, public, and non-profit actors in the area to enable the implementation of contextualized policy and design interventions. The document should be used as a manual by these actors in the planning and development phases of the redevelopment to help achieve goals for sustainability and equity.

WATERFRONT REVITALIZATION OPPORTUNITIES & CHALLENGES

Urban waterfronts are filled with potential for social and environmental gains. Since the 1970s, urban waterfronts have undergone profound functional transformations, often resulting in the revival of prime urban areas. Following the downfall of industry, manufacturing, and transportation economies in many waterfront cities, waterfront spaces began to undergo changes in their use, catering now toward leisure, recreation, retail, and tourism to achieve desired social and economic outcomes.[36] The emergence of waterfront planning in mainstream literature and planning practice began in the 1980s following notable revitalizations of prime waterfront land. Projects deemed successful, such as the redevelopment of Baltimore's Inner Harbor, ushered in a wave of similar projects throughout the world.[138] By the 1990s, cities such as Toronto, Sydney, Cape Town, London, and Barcelona had embarked on their own redevelopment, which aimed to "reclaim the city" by building new cultural facilities and capitalizing on their historic and cultural value[37]. The trend of waterfront revitalization continues as cities seek to leverage the sociocultural aspects of waterfronts, including functional and aesthetically appealing open space and community-oriented mixed-use development.[15] More recently, waterfront revitalization has increasingly considered the relationship between the natural and built environment, such as climatic changes as they impact the resilience of human infrastructure.[90] However, waterfront projects have revealed a set of negative patterns and externalities which are at odds with social justice and ecological concerns.[16]

Planning conflicts related to social and environmental justice, ecology and resilience, and infrastructure create a web of challenges for cities embarking on these projects. Literature has examined waterfronts as products of neoliberal and entrepreneurial regimes, geared toward economic profitability and competitiveness, consumption, and spectacle.[16,28] Making waterfronts attractive to higher-income groups has often taken precedence over goals of improving social conditions.[16] Even when social conditions are considered, issues surrounding inclusivity, access, and affordability tend to crop up after implementation. Since waterfronts are often within proximity to poor and/or racial minority communities, gentrification and displacement are often residual outcomes of market-driven waterfront developments.[15] Moreover, the ecological value of waterfronts is often undervalued despite their uncontested environmental, cultural, and recreational co-benefits since preference is given to human activity over other factors. Ecological restoration is typically low priority for governments, despite the desperate need to adapt to changing environmental conditions.[162]

There is a wealth of literature that demonstrates the value of waterfront redevelopments as well as their unintended negative externalities, but fewer examples of successful and truly sustainable developments. Responding to both social and ecological concerns requires that local governments contextualize systemic inequities within their community so that decision makers can begin to dismantle them.[144] Though this poses a great challenge, human patterns of urbanization can strengthen and restore natural systems and decrease social inequities if designed effectively.[5] As demonstrated by many waterfront projects around the world, buildings, infrastructure, and open space can be designed in a

way that mimics nature: stormwater systems can be designed to sequester toxic soils, attract biodiversity, and serve as public space; circular planning of energy, water, and waste systems can provide positive outcomes for climate mitigation and adaptation; open space can be designed to increase ecological function and decrease fragmentation and inaccessibility from surrounding neighborhoods. The social, ecological, and economic challenges of waterfront redevelopment intersect in different ways, and therefore, clear approaches are needed to equip decision makers with a better understanding of how to plan sustainable waterfronts.[16]

The Bo01 high-density mixed-use development in Malmö, Sweden is a striking example of a highly sustainable and ecologically sound waterfront redevelopment project. Systematic planning for energy, water, and waste systems resulted in significant improvements in energy production (100% renewable) and solid waste management, and measures taken to replace and sequester toxic soils were coupled with the stormwater system and biodiversity measures.[13] Bo01 reflects an important shift in waterfront redevelopment from market-driven development to more sustainable and ecological approaches. Though waterfronts have rarely been designed to support biodiversity and other ecosystem services, the emergence of an ecological approach has begun to infiltrate urban design practices to provide these benefits.[66] As a framework, an ecological approach also has positive impacts for social justice, as it provides a system for identifying the underlying causes and effects of vulnerability, helping to determine the appropriate policy and design interventions.[5] The Kronsberg redevelopment in Hannover, Germany created a diverse social mix in the district by using a "humankind-nature-technology" approach to development, which applies "all available knowledge of ecological optimization in construction and habitation, consistently and holistically." This strategy resulted in various forms in housing finance and ownership structures in the district; 60% of the units being subsidized in some form.[77]

APPLYING URBAN ECOLOGY

Because of the conflicts that arise from a traditional approach to waterfront development, governments must shift their focus from "how to undertake waterfront redevelopments" to "how to make the process more socially and environmentally sustainable."[16] As demonstrated by projects like Bo01, issues in waterfront revitalization represent a key opportunity for using ecologically-based design, architecture, and planning in development and governance processes.[117] Cities can benefit from applying the study of urban ecology to waterfront revitalization because it provides a framework for untangling the causes, effects, and externalities in planning conflicts related to sustainability and equity.

Cities are uniquely complex systems regulated by interactions and feedback between nature and human society.[6] In the last few decades, urban planners began conceptualizing cities in a way that emphasizes systems, connecting site-level concerns to regional processes, finding synergies between "isolated" components in the urban system, and taking a long-term perspective.[81,155] In developing an understanding of the ecology of cities, human behavior as studied by social scientists and ecosystem behavior as studied by natural scientists are linked and comprise the urban ecosystem.[86] With a broad, but detailed understanding of how these interactions work, urban ecology can inform design, policy, and development processes that acknowledge linkages between anthropogenic and ecological components of a redevelopment project.[81,64] In essence, urban ecology is an antidote to the ways that cities have traditionally been planned – i.e., by various actors in silos that lack an understanding of how various system components of a place come together to interact and condition each other.

To achieve a systems perspective, city governments, planners, and designers must make sense of how certain social and environmental

processes function in relation to other components of the urban system and apply this knowledge to the technical facets of planning practice. For example, selecting an appropriate sustainable energy strategy for the site must account for future climate uncertainties and local weather patterns, energy demand and population growth, the sufficiency of the type of energy for a system's requirement in a particular context, regulatory bodies, existing grid functions, life cycle impacts, and more, as these factors impact the planning and formulation of an effective strategy.[63] Increasingly, cities have embraced coupled nature-human systems research and a more dynamic understanding of ecology by incorporating biophysical and ecological economics, industrial and natural energy flows, ecosystems services, sustainability, and resilience into an informed decision-making process.[6] Urban ecology anticipates changes within the constantly evolving urban ecosystem and acknowledges how its biotic and abiotic components interact and adapt (or fail to adapt) through time.[86]

This way of understanding has traditionally been absent in city planning, leading to unintended negative consequences. Within the New Haven context, the period of urban renewal from the 1950s through 1960s demonstrates an example of uni-dimensional planning, which ultimately compounded long-term socioeconomic challenges. The construction of housing projects intended to "improve" the city created inhuman living conditions for low-income residents, concentrated racial poverty and social distress, and drove investment away from the inner city to the suburbs.[43] This pattern of development failed to provide quality housing and drove out industry that would have provided jobs and income, which would have created desired improvements in quality of life.[86] A systems perspective could have prevented the emergence of compounding inequities as a result of short-sighted planning decisions.

However, applying urban ecology to large-scale redevelopment projects has its challenges. Urban ecological literature demonstrates that these complex interactions are highly place, site, and species-specific, making it difficult to translate them into a consistent technical and practical framework for implementation. Additionally, sustainable solutions based on a systemic understanding of place, such as enhanced ecosystem services and green infrastructure, do not guarantee an absence of unintended consequences post-implementation.[126] Ultimately, cities like New Haven seeking to implement urban ecology into redevelopment practices will need to more closely associate the field with the practice of planning, design, and governance to avoid or mitigate some of these consequences.[97] Projects like Bo01, which used an ecological perspective to redevelop waterfront land, also require a shift in governance to prioritize sustainability over profits. Even when sustainability is prioritized, cities must be vigilant to ensure housing and amenities are accessible to marginalized groups.[13]

Using urban ecology as an organizing framework to identify and diagnose urban problems, these redevelopment guidelines consider how linkages among the biophysical, socioeconomic, and behavioral dynamics of the site affect broader ecological, economic, and social outcomes in and around the New Haven community.[6] In practice, this will require that various actors coordinate their activities and constantly adjust behaviors toward achieving and maintaining a delicate balance between human and ecological functions, within the setting of locally diverse biophysical conditions and social vulnerabilities.[64] Though the task of applying urban ecology to urban development is challenging, its framework can enable the creation of novel social, ecological, and technical solutions, ensuring that urban systems are able to absorb shocks and stressors in the context of a planet with finite resources.[86] When proposing solutions to complex urban issues, using a systems approach leads to more informed decision-making.

THE LONG WHARF SETTING

New Haven, Connecticut's Long Wharf is a 352-acre (130 acres of which are underutilized) fragmented waterfront district with little sense of scale or identity. The neighborhood is a result of the partial filling of New Haven Harbor, which took place predominantly in the 1950s to make room for new development and construct Interstate 95 as a part of the national highway system. The vast tract of land was never fully developed, and now features a mix of industrial, business, and commercial uses adjacent to the harbor, which connects to Long Island Sound. The lands are highly fragmented in terms of ownership; roughly 40% of the land is publicly owned within a larger matrix of private lots owned by various entities. Apart from a narrow stretch of houses on Hallock Street, there are no residential zones. The built form includes several large commercial office spaces and retail buildings, legacy industrial and port economy structures, a hotel and theater, and transportation and shipping warehouses.

The site is loosely bounded from Water Street to the north, Interstate 95 and the harbor to the east, the New Haven railyard and Union Avenue to the west, and Hallock Avenue to the south. The site faces the harbor and active port on New Haven's western shore, owned by the New Haven Port Authority. It is the busiest port between New York City and Boston. Within Long Wharf's boundaries, the land contains significant surface parking and little to no residential space, creating dissonance from the adjacent street grid of downtown New Haven and surrounding neighborhoods. Interstate 95 creates a noteworthy barrier separating most of these structures from the only greenspace in the district – Long Wharf Park, a narrow strip of land along New Haven Harbor. Recent improvements to this park include a new separated bike path and designated space for food trucks, which are mainly owned and operated by immigrants from Central American and Caribbean countries. The

The Long Wharf District outlined in red. Surrounding neighborhoods include the Hill, Downtown, Wooster Square, East Rock, and Fair Haven.

waterfront also features a sizable wharf, which juts out into the harbor and provides the neighborhoods' namesake. The Wharf was continuously lengthened over the course of two centuries and anchors the historic ship, The Amistad – one of several cultural resources on the harbor. The Canal Dock Boat House, completed in 2018, sits adjacent to the wharf and is intended to serve as a community recreation center. Further east is the I-95 and I-91 highway interchange, a few waterfront office buildings, and oil storage tanks, which are set to be decommissioned as the site develops.

In its present state, the Long Wharf site is a massive barrier separating downtown New Haven and other residential neighborhoods from the waterfront. The site's physical attributes, including its low elevation and susceptibility to flooding, lots with industrial contamination,

and its existing older and newer buildings constrain development options, but technical applications of urban ecology can serve to remediate the land to increase livability and sustainability in the neighborhood and surrounding communities. In addition, it is necessary to understand New Haven's political ecology to implement ethical development practices. Surrounding neighborhoods, such as the Hill and Fair Haven, are predominantly low-income minority communities. These neighborhoods have lower rates of home and vehicle ownership, higher rates of chronic health conditions, and have suffered from decades of disinvestment. Regionally, there is a significant and growing wealth gap between the rich and the poor.[2] Meanwhile, the city of New Haven is in the midst of notable population and economic growth, with thousands of new apartment units and hundreds of new hotel rooms cropping up in areas in and around downtown and an expanding biotech and life sciences economy.[44] This market-driven building boom has included only limited affordable housing strategies despite the need. Additionally, the city has one of the lowest residential vacancy rates in the country – 2% – limiting housing affordability by driving up the premium people are willing to pay for suitable housing in the city.[2]

Reviving cities must include the excluded. At Long Wharf, it will be necessary to understand the systems at play that create vulnerability in nearby neighborhoods to ensure the redevelopment of Long Wharf works to empower vulnerable residents beyond the immediate site. A primary step in waterfront revitalization involves prioritizing both physical and economic access from adjacent neighborhoods to counteract the potential for eco-gentrification and displacement.[70]

THE LONG WHARF RESPONSIBLE GROWTH PLAN

Following in the footsteps of other waterfront revitalization projects, the City of New Haven has begun a 30-year process to comprehensively redevelop the Long Wharf site into a new, cohesive mixed-use neighborhood. The Long Wharf Responsible Growth Plan was released in 2018 and was developed in collaboration with various stakeholders, including a technical advisory committee and planning committee made up of City of New Haven employees, several private consulting companies, and governmental funding partners. Public consultations were a key element of the plan creation process, which involved several community presentations and workshops. As stated by the plan, the large-scale redevelopment of the site could offer significant benefits for the city by reducing vulnerability to storm surge and sea level rise, providing more housing and jobs, reconnecting people to the waterfront, creating a more diverse and dynamic public realm, improving transportation infrastructure, and ultimately create a new front door for the city.

A site plan for the new Long Wharf District as shown in the *Long Wharf Responsible Growth Plan*.

The plan proposes a series of five complimentary districts with unique uses and branding, which include the Harbor District, the Market District, the Innovation District, the Parkway District, the Gateway District, and Long Wharf Park. Its scope includes high-level schematic renderings, mobility, landscape, and stormwater site plans, and suggested uses and identity for the six new districts. The project will be managed and carried out by a team of City of New Haven employees and the site will eventually be governed by the City. Because the plan provides a high-level vision and a vague governance strategy, a complementary set of strategies are needed to detail ways to achieve this vision equitably and sustainably. As such, these redevelopment guidelines supplement the relative obscurity of original project conceptions.

While the plan lays out a more community-focused, climate-resilient vision superior to the land's current state, its emphasis on economic growth serves to limit opportunities for equitable and sustainable development. The plan proposes market-driven private development to attract investment, create jobs, and inspire innovation. Public consultation revealed citizen concerns about access to these new jobs, the affordability of new housing, and the potential for gentrification in nearby neighborhoods, which points to the need for a more nuanced development strategy. Additionally, its emphasis on creating a new striking public realm, designed to attract visitors and newcomers, must be met with goals to improve the living conditions of existing residents of New Haven.

A concept rendering showing the proposed neighborhood districts as shown in *the Long Wharf Responsible Growth Plan.*

To finance the project, the plan suggests starting with enabling projects, including greenspace creation, coastal resilience and fortification, and transportation enhancements. The plan estimates that $90 to 100 million of the enabling projects will be funded from federal or state grant sources. Funding will also come from City General funds, economic development funding, resiliency funding, and Tax Increment Financing (TIF) to cover debt service payments for the enabling projects.

The guidelines establish a strategy to ensure these investments act to dismantle systems of oppression, including gentrification, housing unaffordability, and social exclusion. They also outline landscape and building design strategies to enhance biodiversity, ecosystem services, and climate adaptation, offering co-benefits for residents and the local ecosystem and are critical components of a healthy urban system.

PROJECT DESCRIPTION AND JUSTIFICATION

The following redevelopment guidelines prioritize equitable sustainable redevelopment to equip decision makers with the tools necessary to empower marginalized groups, site interventions with ecological and social sensitivity, and design ecologically sound infrastructure that serve humans and the landscape.[164,16] The guidelines aim to characterize New Haven's urban ecosystem by accounting for both human and ecological processes, including demographics and vulnerability, regional political

context and processes, economic growth, environmental justice concerns, exposure to climate impacts and sensitivity to hazards, and current and desired adaptive capacity.[48,7] In doing so, the guidelines help decision makers grasp how the above factors and variances, both human and non-human, can translate into well-calculated infrastructure and policy strategies.

Using urban ecology as a guiding framework, the guidelines complement the vision of the Long Wharf Plan by describing "how to get there." This document's orientation toward process describes how policy and design strategies can refocus the plan toward long-term sustainability and equity. Literature supports the idea that guiding principles, ethical commitments, or negotiated agreements with local stakeholders or governments can be used to increase sustainability and just redevelopment.[28] The Long Wharf Redevelopment Guidelines embraces this idea by providing the City of New Haven, architects and developers, and other project stakeholders with an ethical redevelopment framework.

In taking a long-term perspective, decision makers create more space for the unpredictability and variability of future climate stressors and social and political environments. The changeability of human settlements requires that long-term plans shift from prescriptive economic strategies to a more dynamic and just approach. An ecological perspective anticipates the negative externalities associated with a plan focused on economic growth. Given that affordability and access are largely neglected issues in waterfront revitalization, the guidelines incorporate successful examples of highly sustainable and equitable development strategies, such as decommodified housing typologies, to encourage implementation at Long Wharf.

By illustrating examples of urban ecology manifesting itself in governance and development practices, New Haven will be better prepared to avoid conflicts that arise from conventional approaches to waterfront revitalization. Moreover, by incorporating ethical norms into the redevelopment process, the document establishes a social standard that enables Long Wharf to anchor and complement surrounding areas.[28] In effect, the guidelines describe an innovative process to help accelerate the adoption of an ecological approach.

METHODS

Various methods were used to develop the Long Wharf Redevelopment Guidelines. A review of the 2018 Long Wharf Responsible Growth Plan assessed plan strengths and weaknesses, analyzed "responsible growth" as its guiding vision, identified project priorities, and synthesized factors that were instrumental in its creation, like public consultation and economic analysis. The plan components were coded according to their relevance to the present document. This critical review analyzed whether the plan in its current state is sufficient to address climate change mitigation and adaptation, biodiversity loss, sustainable infrastructure systems, mobility and accessibility, ethical smart city applications, and social inequities. Research also included the identification and analysis of successfully implemented sustainable projects in North America and Europe, which complement several of the suggested guidelines. These case profiles encompass infrastructural and design solutions, and policy and programming that have achieved a desired level of sustainability and/or social equity.

A review of scholarly literature assessed the site context, principles of ecological design, applications of the urban ecology framework, precedents similar in scale and scope, and policy and design solutions that support sustainable development at Long Wharf. These broad topics helped answer more specific questions related to social and environmental vulnerability in New Haven and the surrounding region, urban ecology as a method to tackle large-scale waterfront redevelopment projects, sustainable infrastructure systems well-suited to the New Haven context, and innovative technologies, programming, policy, and design used to increase

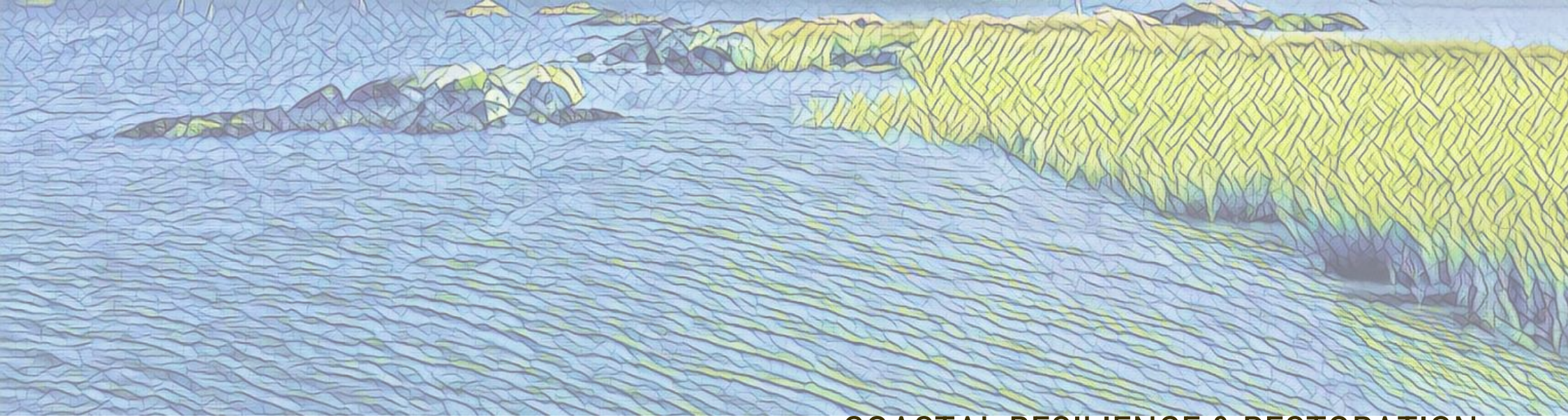
accessibility and equity. A review of local, state, and federal plans, policies, and laws assessed "enabling features" as they relate to the selection and implementation of effective, context-appropriate guidelines. This helped tie the proposed interventions to the Long Wharf site, including the identification of implementing actors. Selected policies, plans, and laws accompany each substantive theme in the guidelines book, underscoring their connections and leverage points, to help streamline the implementation process.

The process also included direct observation of six key segments within the Long Wharf site, including Long Wharf Park, the harbor district, and the future sites of the green bow stormwater park, market square, the greenway, and tech village. The observed physical attributes included current landscape and vegetation, state of coastal infrastructure and stormwater management systems, building stock, active transportation infrastructure, and other notable features. Additionally, the current function and use of each site were recorded to better understand how people interact with the site.

Finally, using data and shapefiles from the UConn Map and Geographic Information Center and Connecticut Environmental Conditions Online, GIS analyses were used to spatially understand climate-related threats, including sea level rise, storm surge inundation, watershed function, and the health of Long Island Sound as they relate to the selection of appropriate infrastructure and biodiversity interventions. GIS were also used to spatially understand zoning and land use, location of major employment centers, and critical infrastructure as they impact the placement of housing, commercial space, greenspace, and more. A spatial analysis of census data, including income per census tract and demographics, contributed toward a better understand the site's proximity to underserved and/or racial minority communities.

DOCUMENT OUTLINE

The following guidelines describe vast opportunities for holistic, sustainable, and equitable development at the Long Wharf site. The chapters are organized according to seven major themes, including (1) coastal resilience & restoration, (2) ecological landscape design, (3) ecological urban architecture, (4) housing affordability, (5) circular energy & waste systems, (6) sustainable transportation systems, and (7) a smart city framework. Each chapter reviews local and regional processes as they impact the formulation of policy and design strategies for each theme, connection to the Long Wharf Responsible Growth Plan, enabling state and local policies and laws, and short case profiles that connect selected guidelines to exemplary policy and design projects.



COASTAL RESILIENCE & RESTORATION

New Haven Harbor is an estuarine ecosystem within Long Island Sound at the nexus of the Mill and Quinnipiac rivers, which once contained extensive marshland and wetland habitats. In the 1950s, the Long Wharf district was created by filling in a large swath of New Haven harbor with dredge and other materials to make way for Interstate 95, increase development opportunities, and expand its port economy.[43] Today, the low-lying area is comprised of 60% impervious surface, with one-third of that area representing surface parking, and limited drainage infrastructure.[45] As a result, the Long Wharf district is exceptionally unable to absorb water and is highly vulnerable to coastal flooding, stormwater pooling, and inundation during severe coastal weather events.

Ecological design in flood resilience planning has been shown to enhance ecosystem function, provide quality wildlife habitat, and are more adaptable than conventionally engineered coastal infrastructure.[151] While hardscape fortifications can offer protection from rising seas and increases in extreme weather, a restorative approach to coastal resilience will encourage the production of ecosystem services that provide co-benefits for local communities and biodiversity.[22] Moreover, the redevelopment of Long Wharf represents an opportunity to manage water in a way that embraces it as a design element and amenity. Coastal landscape enhancements that are informed by ecological design can provide accommodating connections to New Haven harbor, improving opportunities for recreation. Though the Long Wharf Responsible Growth Plan mainly offers solutions that fortify against water, the following guidelines aim to leverage it to enhance ecological and spatial quality.

THE LONG WHARF RESPONSIBLE GROWTH PLAN

The Long Wharf Responsible Growth Plan aims to improve the district's resilience to coastal and stormwater flooding, detailing infrastructure remediations at several key locations. The plan relies on FEMA coastal flood maps and geospatial displays of areas threatened by a 1% chance of coastal flooding hazard to propose infrastructural solutions. Remediations focus on hardening New Haven's shoreline through the use of deployable flood barriers at strategic locations underneath highway overpasses, floodwalls along Long Wharf Park, and an elevated flood wall esplanade in the Harbor District to keep water out and accommodate future waterfront development. To a lesser extent, the plan proposes ecological design interventions by referencing the Long Wharf Flood Protection Study, which details a combination of "living shoreline" and flood protection features. The study is a response to Hurricane Irene in 2011 and Superstorm Sandy in 2012. A number of additional local, regional, and federal studies have been conducted to respond to the region's vulnerability to climate change. The following design guidelines complement the Long Wharf Responsible Growth Plan, as well as the planning and legislative work that has occurred in the wake of these storms, by integrating insights on ecological design and restoration from other sources. Beyond this, the guidelines propose additional interventions that are effective in their nature-based approach to address climate change, biodiversity loss, and community access.

The process of filling Long Wharf with dredge and other material.

GUIDELINE OBJECTIVES

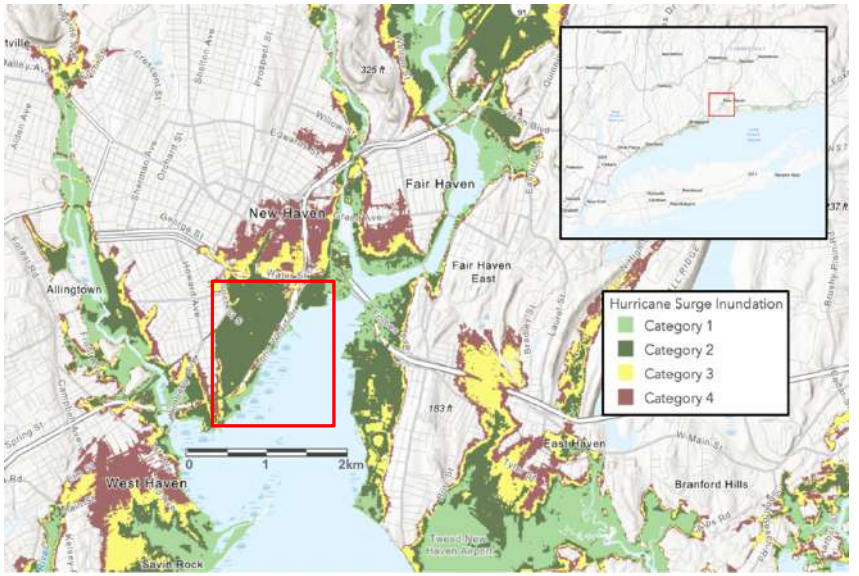
- Leverage regulatory frameworks to increase adaptive capacity
- Restore natural systems and ecological processes to protect coastal communities
- Prioritize ecological design over hardscape fortifications
- Pair green infrastructure solutions with recreation opportunities
- Harness water as an aesthetic and cultural amenity
- Enhance estuarine biodiversity through submerged nature-based features, natural protective barriers, and shoreline enhancements.

COASTAL ADAPTATION REGULATORY FRAMEWORKS

1. **Coastal setbacks**
   Position buildings and other infrastructure away from the shoreline to reduce the need for coastal protection projects.[164] Connecticut does not currently have a mandatory coastal setback requirement.[148] As a result, the City of New Haven should require a standardized setback on the Long Wharf site as a precedent for future coastal developments in the state to lessen the need for costly flood resilience infrastructure. Appropriate setbacks can be calculated using FEMA 100-year floodplain map + anticipated seal level rise. Structures should be sited beyond this elevation.[164] Developers should adhere to the setback requirement in the Harbor District, which is currently slated for an intensification of development along the shoreline.

2. **Design flood elevation**
   In areas where setbacks are not feasible in the Harbor District, all potential developers should determine the design flood elevation. This value is calculated by adding FEMA 100 year or 500-year flood plain map + 12" or 24" for critical structures + sea level rise adjustment to determine appropriate floodproofed elevation.[164]

3. **Transfer of Development Rights (TDR)**
   To encourage the conservation of existing vulnerable coastal zones and other privately-held open space, the City of New Haven may employ financial incentive programs, such as TDR.[148] Financial compensation to landowners in vulnerable coastal zones in the Harbor District redirects development to areas within Long Wharf that are better suited to accommodate growth.[127]



SLOSH model showing hurricane storm surge inundation. Long Wharf (red box) is threatened by total inundation in the event of a category 2 hurricane.

The *Southern Connecticut Regional Framework for Coastal Resilience: Legal, Policy, and Regulatory Assessment Guide* provides an overview of state jurisdictional and procedural processes, including building codes, wetlands regulation, and more to guide coastal adaptation efforts.

The Long Wharf Flood Protection Study offers detailed information on New Haven's vulnerability to climate-related changes and proposes green infrastructure solutions and concepts to help fortify the shoreline.

4. **Environmental Impact Bonds (EIB)**
   Environmental impact bonds work by raising funds from environmentally motivated investors to finance public infrastructure – a cost-saving technique for local governments. This strategy may be used during the development phase to prioritize investment through complementary city and state public incentive programs, such as Façade Improvement Grants, Environmental Assessment Fund, CT Enterprise Zone Tax Incentive, and Flood Mitigation Matching Funds. It is recommended that the City of New Haven work with investors and developers to encourage the use of these incentives and other EIBs.

NATURAL PROTECTIVE BARRIERS

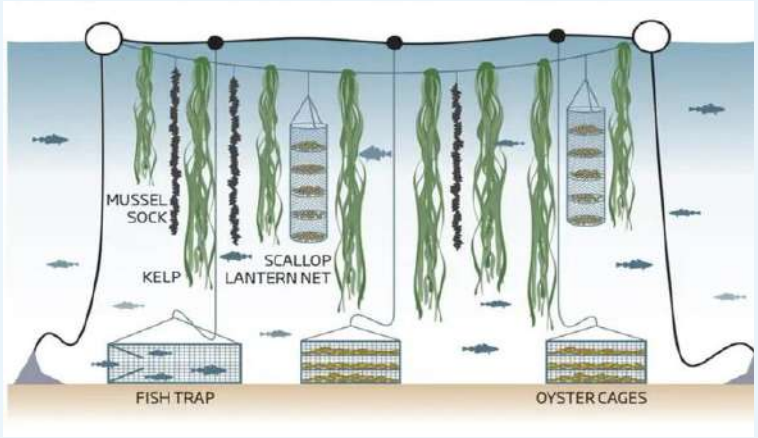
1. **Tidal marsh restoration**
   It is recommended that the City work with restoration ecologists to develop a concept plan to extensively restore tidal marsh in areas adjacent to floodwalls. Marsh and seagrass restoration efforts, or "living shorelines," usually feature a combination of stone sills or oyster castles (to anchor substrate and sandy backfill) and native sea plants. They must be able to maintain a dynamic equilibrium between natural forces to achieve long-term stability and viability.[129] Marsh restoration efforts can be unsuccessful when emphasis is placed on small-scale disjointed projects and limited attention is paid to balancing projects in the context of overall ecosystem health.[22] Therefore, tidal marshes should include a diverse mix of native coastal grasses and other vegetation to provide wildlife habitat, permit stormwater infiltration and absorption, provide storm surge protection, and enhance aesthetics.[45]

2. **Dune restoration & bank stabilization**
   In addition to marsh restoration, engineers should restore dunes at proper elevations between Long Wharf Drive and the water's edge (i.e., Long Wharf Park). Dunes are generally stabilized by a rock base and extensive plantings of native grasses and plants. Creating dunes requires the reestablishment and regrading of sandy material to create landforms. Beyond hardscape flood barriers, such as those in the Harbor District, natural landforms can be created to provide additional protection and aesthetic interest.[59]

MARSH RESTORATION IN CHESAPEAKE BAY, MARYLAND

Much of the Chesapeake Bay has been subjected to erosion, nutrient pollution, and worsening sea level rise. The implementation of "living shorelines" has served as an antidote to these challenges by restoring the coastline and enhancing wildlife habitat.[129] This was achieved through state and federally sponsored restoration efforts focused protecting existing fringe marshes and reestablishing eroded marshlands. The process involved site suitability reviews which investigated storm surge, bank height, erosion rate, site orientation, infrastructure, riparian buffers, and more to inform the appropriate ecological design features. Because of these restoration efforts and long-term nutrient pollution reductions, Chesapeake Bay now contains three times as much seagrass as it did in the 1980s.[105] There is no "one size fits all" approach to reestablishing tidal marshes and other coastal ecosystems, and therefore each community should determine its own set of project objectives and best practices.[129]

THIMBLE ISLAND OCEAN FARM



Thimble Island Ocean Farm in nearby Branford, Connecticut has the capacity to produce 30 tons of sea vegetables and 250,000 shellfish per year on one acre, with no inputs. Regenerative ocean farmer, Bren Smith, developed the farm's 3D ocean farming model, which grows seaweed and shellfish vertically using the entire ocean column.[84] This method of ocean farming mitigates climate change by sequestering carbon and nitrogen, filtering ocean water, and by creating deep barriers that help subdue storm surges.[100] The farm contributes toward a localized farming economy that has little negative impact on local ecology, as its approach to polyculture mimics native marine ecosystems.[84]

The *Connecticut Coastal Planting Guide* contains extensive information on native plant species suitable for coastal environments.

SUBMERGED NATURE-BASED FEATURES

The following strategies should be implemented through collaboration between the City and private restoration and engineering companies.

1. **Ocean farming**
   Aim to establish local ocean farms in the deep-water sections of New Haven harbor to enhance ecosystem health, promote biodiversity, and aid in the efficacy of coastal infrastructure closer to shore.[22] This will involve collaboration between the City and local ocean farming organizations, such as GreenWave. Vertical ocean farms are useful in mitigating storm surge. They also contribute toward a localized food system by producing sea vegetables and shellfish like kelp, seaweed, mussels, and oysters – offering a nod to New Haven's historically robust oystering economy.

2. **Constructed floating wetlands**
   Establish a series of floating wetlands parallel to the shoreline. In saline environments, CFWs mimic the structure and function of naturally occurring wetland ecosystems.[90] They consist of a buoyant medium planted with native plants and grasses and are often anchored with a mooring ball to accommodate tidal fluctuations and weather events.[45] They are effective water treatment devices by absorbing excess nutrients and pollutants in the water and can provide extra protection against storm surges.[129] have shown that restoration efforts are often unsuccessful when limited attention is paid toward reducing nutrient inputs.[22] As such, encouraging aquatic ecosystem health ensures that other green infrastructure systems are effective.

3. **Bioengineered breakwater (oyster reefs)**
   Plant breakwaters on the edge of the tidal flat, parallel to the shoreline along Long Wharf Park. The breakwater should be made using sustainable naturally derived materials to encourage the establishment of marine life. Oyster reefs may be used in place of solid materials to provide aquatic habitat and encourage nutrient and water filtration and can adapt to sea level rise.[133] Breakwaters function by mitigating storm surges further from shore, lessening the impact on shoreline environments and infrastructure.[45]

NATURE-BASED SHORELINE FEATURES

On drier land, layering tidal wetland planters, coastal shrubs, and native upland vegetation will provide additional protection when sited beyond flood walls, bulkheads, or the dune line. The following strategies should be adhered to by landscape designers and developers.

1. **Tidal wetland planters**
   Construct mechanical tidal wetland planters along waterfront sections of Long Wharf Park and the Harbor District to filter sea water and stormwater runoff. Wetland planters should be planted with native species, such as beach rose and switchgrass, to absorb water and filter pollutants. Tidal wetland plants can act as an intermediate zone between floodwalls and pedestrian paths.

2. **Coastal vegetated buffer**
   Plant a wide buffer of native shrub-like plantings and trees to create a coastal riparian buffer throughout the Long Wharf site. Riparian buffers have been shown to stabilize soil, decrease erosion, and offer extra protection against weather events. Plants also increase the absorption of water and decrease concentrations of pollutant discharges.[102]

Swimming embankment in Zadar, Croatia

HARDSCAPE FORTIFICATIONS

The following strategies should be implemented through collaboration between the City and infrastructural engineers.

1. **Flood walls and elevated esplanades**
   Flood walls should be constructed and reconstructed along portions of Long Wharf Park and the Harbor District. They must be able to resist high tides and storm surge and offer protection from wave overtopping. I-95 offers some elevated protection (12-20 ft) and is therefore already high enough to provide flood protection. To maintain aesthetics and access to the waterfront, floodwalls can be designed to accommodate pedestrian activity and other passive uses.[145] Flood walls can also include textured "living walls" or attached habitat baskets, which enable sea plants, crustaceans, and mollusks to colonize the walls.[45]

2. **Swimming embankment**
   Design and construct a swimming embankment near the present site of the New Haven boathouse and Harbor District to restore access to water recreation in New Haven. The embankment would serve as an aesthetically appealing break in the flood wall while offering the same mitigative protection.[145] Currently, there are no swimming areas within walkable distance from nearby neighborhoods in New Haven. Restoring this access would create a new public sphere at Long Wharf and offer respite on hot days in New Haven, which is significantly impacted by the heat island effect.[35]

3. **Quarry stone revetments**
   Revetments can provide additional protection when set up against flood walls or as a stand-alone feature. They can serve as an alternative to a floodwall or dune restoration. Quarry stone revetments should be implemented in areas of Long Wharf that are not well suited for dune restoration, as a non-ideal substitute.[90]

ECOLOGICAL LANDSCAPE DESIGN

New Haven lies on a coastal plain and features a maritime or humid subtropical climate, depending on the climate classification.[29] The influence of Long Island Sound moderates temperatures year-round and ecological communities can differ significantly from locations further inland.[65] Historically, the region featured a mix of deciduous and coniferous trees, and herbaceous flowering plants and grasses, which has gradually changed through the introduction of new species and extirpation of others.[29] Efforts over the last 40 years to improve the health of Long Island Sound and the return of forest cover throughout the state have bolstered habitat connectivity and biodiversity throughout the region.[100] However, this century will be met with greater climate-related challenges that place a strain on ecological processes and contribute toward biodiversity loss.[65]

As highlighted in the coastal resilience chapter, Long Wharf's vulnerability to stormwater inundation presents an opportunity to harness water as an aesthetic and functional asset. By using principles of ecological design that encourage biodiversity and resilience to climate impacts, the landscape can provide ecosystem services and co-benefits for humans and wildlife.[95] Estuarine environments are recognized as biodiversity hotspots, and thus by supporting the ecosystem function of coastal sites, the impact on environmental health can be significant.[100] Moreover, mimicking natural ecosystems in urban settings can offer health benefits for humans, providing greater incentive to design the landscape accordingly.[80] Through ecological landscape design, the redevelopment of Long Wharf will promote a culture of stewardship and provide enhanced opportunities for social engagement and cohesion.[29]

The redevelopment of Long Wharf is a long-term project that will continue to evolve for the next 20 to 30 years. It is being redeveloped at a time with immense climate-related challenges and social inequities. A holistic planning approach requires that the specific biophysical and socio-cultural conditions of the site are understood, and future challenges are accounted for.[153] As a result, the landscape must be able to manage current risks and future landscape-related changes.

THE LONG WHARF RESPONSIBLE GROWTH PLAN

The Long Wharf Plan features a greenspace programming concept, four typologies for stormwater management, street landscape typologies, and a short landscape plan appendix. The greenspace plan for each new district emphasizes different uses: the gateway district focuses on family programming, health and wellness; the innovation district is geared toward young professionals, festivals, and art; the market district will enable flexible and casual use of open space, the parkway district will be marked by an "ecological park" with varied landscape design elements, and the harbor district will be designed to focus on waterfront recreation. Soft edges and trails will connect each new neighborhood and feature design elements like planted berms, ponds and wetlands, a community garden, native gardens, playgrounds, and plazas. The site will also contain several green and gray infrastructure systems to manage stormwater to meet state regulations (i.e., the first one inch of rain can be stored on site). The current plan aims to surpass this required storage capacity through extensive bioswales alongside roadways and retention wetlands within certain greenspaces. It also identifies closed-loop water capture and recycling as an opportunity to explore. The landscape plan appendix provides context by suggesting design precedents, renderings, and concept drawings. However, the plan's conventional approach to landscape design does not effectively leverage natural sciences as a guide to create cohesion between the natural environment and human environments. The guidelines listed below will redirect the landscape plan to bolster ecological function and ecosystem services, support biodiversity, and encourage social cohesion through design interventions that mimic local ecology.

GUIDELINE OBJECTIVES

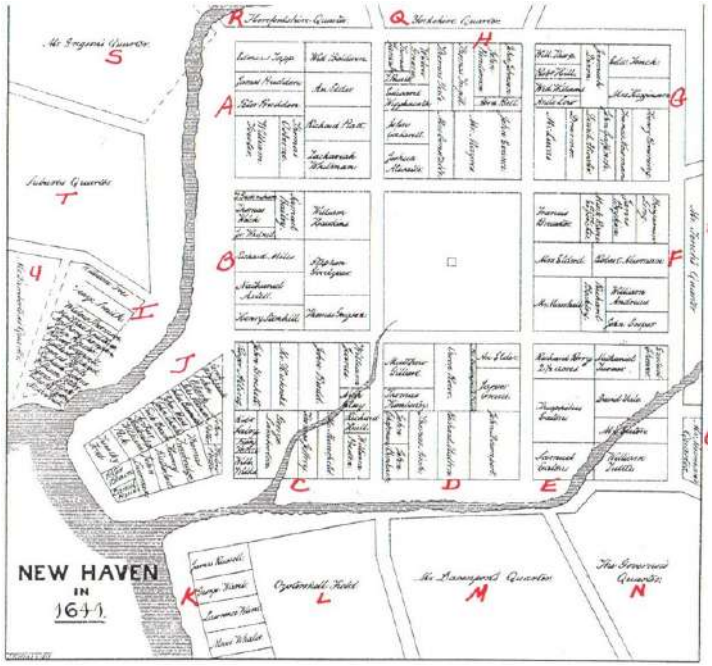
- Plan and design ecosystems rather than conventional built landscapes to sustain biogeochemical cycles and increase local biodiversity
- Enable passive use of space through flexible design interventions that promote sense of place and belonging
- Enhance human connection to the land through ongoing stewardship and restoration practices
- Account for the long-term by planning for climate-related and phenological changes

ECOLOGICAL RESTORATION

1. **Soil restoration**
   Soil that is rich in a top layer of organic matter is a substantial carbon sink. Soil restoration efforts throughout the site will involve remediation in some areas, including 6 lots within the Long Wharf site.[53] It is recommended that the City work with engineers to cap sites where the soil is contaminated. In greenspaces throughout the site, soil restoration can be achieved through ongoing stewardship practices, including erosion control, building organic matter by using cover crops instead of non-native grass, making and using compost on site, using nitrogen and phosphorus fertilizers derived from natural materials, and lessening soil compaction by improving natural drainage.[107]

2. **Streambed daylighting**
   Engineers and ecologists should collaborate to restore or create waterways or streams at strategic locations throughout the site, including the I-91 and I-95 interchange toward downtown. Daylighting streams is the process of opening up buried watercourses and restoring them to more natural conditions. Urban river valleys provide informal greenspace and have been found to improve the mental and physical health of residents. They also provide critical ecosystem services, like cleaning and filtration of stormwater, and can absorb weather-related shocks.[53,83]

3. **Allot space for changes in marsh habitat**
   Developers should account for sea level rise projections by planning waterfront spaces to allow for inland migrations of tidal marshes and coastal grass beds. This will be most relevant along Long Wharf Park where coastal paths and raised boardwalks are planned. Ensure there are setbacks in the placement of these paths.



A 1641 map of New Haven shows multiple streams that once extended well beyond the Long Wharf site and into the settlement's original nine square blocks. Streambed restoration within the Long Wharf site would result in more adaptive and resilient stormwater management

1. **Ecological plant communities**

   Natural landscapes are not uniform in their structure and composition. They are comprised of many different but complementary plant communities, depending on topography, presence of water, soil composition and pH, and exposure to elements.[130] When planning and designing landscapes across large scale-sites, a standardized approach is insufficient to ensure the health of plants, promote sustainability, and support biodiversity.[80] Therefore, landscape architects and ecologists should design site-specific pockets of forest ecosystems in all green areas on site. Creating ecological plant communities can meet the aesthetic and functional needs of users of urban landscapes while at the same maximizing sustainability and biodiversity.[92] The following native forest typologies are recommended for various locations throughout the Long Wharf site:

   Upland deciduous forest

   This forest type includes varieties of oak, maple, hickory, birch, beech. It is recommended for the elevated sections of the proposed ecology park within the parkway district, the greenway berm corridor, and the loop park and family park. A dense canopy of trees would help shield the I-95 and I-91 interchange and provide quality wildlife habitat.

   Floodplain forest and shrub swamps

   This forest type includes red maple, swamp white oak, basswood, northern bayberry. It is recommended for areas adjacent to wetlands, swales, and other freshwater features throughout the district.

   Coniferous forest

   Though native conifers, such as hemlock and white pine, are generally unsuitable for public greenspace, spruces and pines can help shield unsightly areas, like the highway, and decrease noise pollution.

   Note: siting of forest typologies is subject to change as plans for the redevelopment change (e.g. streambed restoration may impact building, street, and greenspace footprints)

2. **Habitat connectivity**

   Landscape architects should create habitat connectivity between greenspaces, meadows, wetlands and ponds, streams, and vegetation throughout all districts of the Long Wharf site. Ecological connectivity is critical for plant and animal movement and migrations and facilitates ecological processes, like pollination.[52] Habitat connectivity should physically coincide with active transportation corridors throughout the site to generate ecosystem services, like carbon sequestration, urban cooling through vaporization, and recreation opportunities.[60] Isolated habitat patches should be avoided where possible.

3. **Wildlife habitat**

   The City should integrate a "green points" system into biodiversity redevelopment goals, which establishes a minimum requirement for biodiversity interventions in greenspaces, green roofs, green walls and facades, community agriculture spaces, and residential zones.[77] The City of New Haven and Long Wharf redevelopment team may choose to model their green points system off Bo01's in Malmö, Sweden. The policy ensures developers commit to choosing at least 10 out of 35 green points from a list of biodiversity interventions. Examples include hanging bat boxes and birdhouses, planting courtyard vegetation that yields nectar and attracts pollinators, incorporating at least 2 square meters of permanent growing space on balconies, planting at least 50 species of flowering plants in public planters and gardens, dedicating entire courtyards toward growing food, mandating that landscape architects collaborate with ecologists in designing greenspaces, etc.[6]

4. **Marginal zones as biodiversity hotspots**
   Landscape architects should intensify ecological design interventions in transitional spaces between green spaces in each district and alongside large infrastructure systems, like Union Station railyard. Areas next to or near large-scale infrastructures, such as power lines and railroads, are often neglected spaces due to development restrictions and lack of aesthetic appeal. Taking advantage of these urban pockets and transitional zones by implementing biodiverse landscapes enables better ecological connectivity and healthier lifestyles through direct access to nature.[163]

5. **Pollinator gardens and urban meadows**
   Landscape architects should install pollinator gardens and meadows throughout the site to attract pollinating animals and insects. Though Connecticut has over 337 native species of bees, many are in decline. At least four native bee species have disappeared from the state in the past 20 years.[52] Moreover, the non-native honeybee provides important agricultural ecosystem services. Pollinator gardens are well suited to street landscapes and larger transitional zones. Flower belts and pollinator meadows provide hotspots for pollinator activity.

The 2015 Connecticut Wildlife Action Plan is the state's framework for the conservation of wildlife and ecosystems. Approved by the US Fish and Wildlife Service in 2016, it sets a standard for the preservation and restoration of critical habitats in the state, including those in New Haven, like tidelands, salt marshes, and estuaries. The plan notes that Long Island Sound is a biodiversity hotspot due to the mixing of freshwater and saltwater. However, hypoxia, sedimentation, toxic substances, and pollution have severely compromised water quality and have caused fish tissue contamination, having cascading impacts on the ecosystem.

CREATING BIODIVERSITY AT BO01, MALMO, SWEDEN

In the year 2000, the City of Malmö embarked on a large-scale waterfront revitalization project. The city aimed to exemplify a highly sustainable mixed-use district for an international housing exhibition. The site runs on 100% locally produced renewable energy and set precedents in the use of ecological urban design. Its carefully designed landscape features a mix of parks, courtyards, open streets, and squares with varied native foliage. Each lot within the development requires a minimum amount of greenery and a green points system ensures that ensure several biodiversity measures are incorporated, like bird nest boxes and planting of 50 species of native wildflowers. Greenspaces feature extensive ecological stormwater management systems, environmental information and education, and opportunities for stewardship. As an extremely exposed site on the sea, buildings were oriented to create outdoor microclimates that shield weather-related elements and prioritize comfort. Streets are generally car-free to enable safe and active transportation. An inland canal provides aesthetic interest, access to green and blue space, and ecological stormwater management.[137,13,25]

1. **Informal gathering spaces**
   In addition to the main community spaces in each district, landscape architects may implement a series of smaller public areas at frequent intervals in the transition zones between districts that enable the passive appropriation of space. These spaces can be marked by visual cues such as art, water features, trees, shelters, and other landscape elements. Explore the potential to permit informal vending and sharing economies. Ensure that these spaces prioritize comfort, safety, and have clear visual permeability to other places of activity.[46]

2. **Viewpoints and respites**
   It is recommended that landscape architects emphasize natural features, such as the harbor and East Rock, through landscape elements that encourage short duration stops and observation. Integrate public access with view areas, such as the planned ecology park.[46]

3. **Natural trails**
   In natural areas, landscape architects should incorporate accessible trails through wooded space that meander around natural features. Natural trails should spur off of more heavily traversed active transportation paths and should enable casual appropriation of space. Delineate sensitive ecological areas through landscape elements and minimal fencing, but allow for the formation of "desire paths."

4. **Active transportation overpass**
   The City engineering team should explore the potential to cap a portion of I-95 from the intersection of Church Street and Sargent Drive to Long Wharf Park to increase accessibility to the waterfront. Currently, access to Long Wharf Park is limited to two highway underpasses on opposite sides of the Long Wharf site. The overpass should ensure that the highway is shielded on each side, incorporate a multi-use path and nature trail, and include extensive plantings to create a welcoming and biodiverse environment.

5. **Underpasses**
   Underpasses beneath I-95 and I-91 are currently inhospitable spaces. It is recommended that landscape architects transform these spaces to include recreational amenities, like a skatepark, or water features accompanied by multi-use paths and shade plantings, as demonstrated by Houston's Sabine Promenade.

Sabine Promenade in Houston, Texas is an award-winning park underneath a highway, which contains extensive biking and walking paths, shade plantings, and water retention strategies. Its nighttime illumination changes from white to blue depending on the phases of the moon and has been dubbed an "unintentional sculpture park" because of the highway's support beams.[18]

The Potomac River Waterfront Park in Maryland is an active transportation overpass a similar context to the Long Wharf site. I-95 is a multi-lane highway that converges with I-91 on the Long Wharf site, and Long Wharf Park offers limited space for built infrastructure, similar to the Potomac River Waterfront Park. A spiral ramp toward the riverfront, as seen above, could act as a precedent project to inform the design and construction of a Long Wharf active transportation overpass. Photo credit: Maryland National Capital Park & Planning Commission

Sustainable SITES Initiative is a rating system for highly sustainable landscape design. It is recommended by the Connecticut DEEP as a toolkit to certify landscapes outside of public buildings and infrastructure.

COMMUNITY AGRICULTURE SYSTEMS

The following strategies are recommended for adherence by landscape architects and ecologists in collaboration with local community agriculture organizations.

1. **Design for food permanence and abundance**

   Using principles of permaculture and ecological design, the landscape plan should include food landscapes designed to incorporate perennial food-producing plants. Permanent food landscapes are more resilient to climate disturbances, are more restorative for the soil, and mimic natural ecosystems. Encouraging species diversity within food landscapes has the added benefit of increased macro and micronutrient composition in foods.[23] Permaculture gardens incorporate both native and nonnative species to enhance local food systems. Recommended permanent food landscapes include:

   Food forests and public orchards

   To avoid large expanses of greenspaces that are susceptible to drought, fruit trees and bushes can be planted to provide a free food source, create visual interest and shaded areas in greenspaces, and attract biodiversity.

   Agroforestry alleys

   In place of traditional street trees and in linear parks, plant species such as blight-resistant chestnut, oaks, northern pecan, walnut, apple, pear increase food access and security. Agroforestry alleys are well suited to inland locations of the long wharf site along boulevards and natural swales.

2. **Community gardens**

   Encourage a culture of stewardship in community garden beds through programming that educates residents on regenerative agriculture practices, such as no-till agriculture, water conservation, and chemical-free inputs. Community gardens are well suited to locations in the gateway district, the district, and transitional spaces. The City should actively involve vulnerable groups in the programming, such as resettled refugees, to enable the practice of culturally significant farming practices.[161]

BIORETENTION STRATEGIES

Effective bioretention facilities enable the critical physical, chemical, and biological processes to take place, offering benefits to humans and local ecology. These processes include the settling and absorption of water particles into the soil, infiltration and filtration of water and nutrients, plant transpiration and evapotranspiration, and assimilation of nutrients uptaken by plants.[71] Recognizing the importance of these ecosystem processes and their benefits, cities are increasingly adopting a large-scale bioretention strategy and are mainstreaming these efforts into holistic city planning approaches. Transforming urban landscapes into "sponges" can enable vast stormwater absorption and flexible use of outdoor spaces.[172]

1. **Adopt a holistic stormwater management approach**
   Rather than implement ad hoc stormwater infrastructure at isolated locations throughout the site, the City and redevelopment team should adopt a holistic water management strategy using "sponge city" frameworks. A sponge city is a city that has the capacity to mainstream urban water management into urban planning policies and design. In practice, a sponge city is a system of bioretention infrastructure that accounts for seasonal flooding and inundation events, without threatening or destroying urbanity.[172] This work should build on New Haven's present-day efforts to become a "bioswale city" in collaboration with the Urban Resources Initiative.

The Urban Resources Initiative is a joint Yale and community-based collective that works to promote social and ecological infrastructure within the city. Most notably, URI is responsible for the construction of New Haven's Street bioswales, which now exceed 200.

2. **Diversity in bioretention typologies**
   Landscape architects may employ the following strategies to capture, retain, and purify water.[61,71,14]

   Permeable surfaces
   Permeable surfaces should be used wherever possible. Smaller residential streets, multi-use paths, and sidewalks can use permeable pavers to encourage the infiltration of water.

   Natural swales
   Elevated swales coupled with infiltration furrows may be implemented alongside I-95 in Long Wharf Park to shield the highway and alongside the railyard and proposed biodiversity corridor.

   Wetlands
   Constructed wetlands mimic the structure and function of natural wetlands. They can provide important ecosystem services and quality wildlife habitat to support biodiversity in various greenspaces throughout the district.

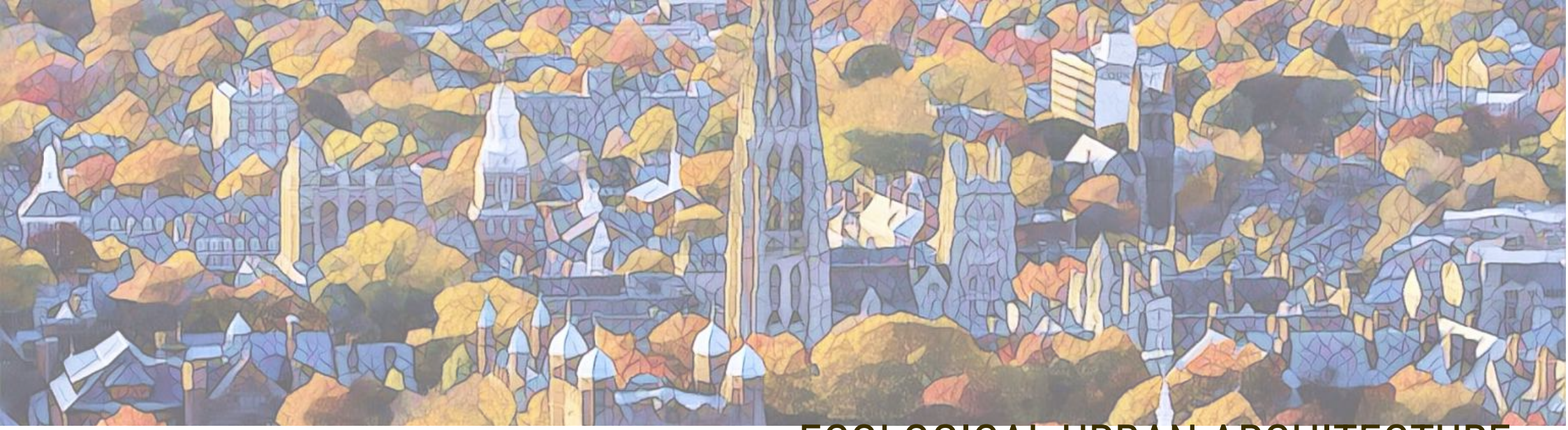
3. **Wetland plant selection**
   Landscape architects should select plant species that are able to tolerate urban stresses. Factors that should be considered are expected pollutant load; variability in soil moisture conditions; fluctuations of water levels and water ponding; soil pH and composition.[72]

4. **Water recycling**
   Detailed in Chapter 5: Circular Energy & Waste Systems.

LANDSCAPE PLANNING FOR THE LONG-TERM

1. **Phenological changes and ecosystem adaptation**
   Native landscapes have begun migrating northward in order to adapt to climate change and they will continue to do so.[139] Phenological changes are among the most sensitive biological responses to climate change. Springtime flowering and leaf out and animal migrations are examples of biological processes impacted by climate change, having cascading impacts on the broader ecosystem. Landscape architects can view phenological changes in the region as a challenge and opportunity. Though warmer temperatures threaten the health and existence of certain species and economies in Connecticut, like maple sugaring, it also provides an opportunity to plant species on site that have historically fared better further south, such as pecan, southern magnolia, black gum, and more.

2. **Site planning for potential climate migrations**
   Even with the most innovative coastal protection and green infrastructure strategies, sea level rise and extreme weather events will continue to threaten coastal communities.[108] In taking a long-term perspective at the Long Wharf site, the City must consider the possibility for inland migration to adapt to increasing frequencies of flood inundation. As a result, planners, architects, and developers must site buildings appropriately on the Long Wharf site and consider building life span as they relate to climate change. The City may also strategize the long-term densification of higher elevation neighborhoods in New Haven, which can help accommodate the potential for inland climate migrations.



ECOLOGICAL URBAN ARCHITECTURE

The Long Wharf district lacks a sense of scale and identity. The district features a mix of uses, including transportation, storage and warehousing, manufacturing and production, commercial and retail, and to a lesser extent, education and government offices. As an urban setting within close proximity to downtown New Haven, its lack of residential and commercial streets creates stark dissonance from the vibrancy, character, and density of nearby neighborhoods.

Historically, land use patterns in the region changed dramatically following the taking of Indigenous Quinnipiac land in the early 17th century. In 1638 New Haven was laid out according to a "nine-square" plan, with a central common in the middle block, making it one of the first planned cities in the United States. It gradually expanded to accommodate an industrial and manufacturing economy through the 19th and early 20th centuries, leading to prosperity at first but was followed by a period of decline once these industries moved out. In the 1950s and 1960s, urban renewal and highway construction leveled a significant proportion of New Haven's dense residential and commercial streets, however, the neighborhoods that were spared provide a model for designing human-scale and context-appropriate neighborhoods.

Because Long Wharf is roughly 60% vacant space, the project presents an opportunity to create an entirely new urban form. Regenerative urban design can pay homage to the past while setting precedents for sustainable design and socially just planning. The following guidelines detail a whole systems perspective on design approaches that reduce resource inputs and operating costs, as well as promote social and environmental gains.

THE LONG WHARF RESPONSIBLE GROWTH PLAN

The Long Wharf Responsible Growth Plan details architecture and urban design to a limited extent. The plans outlines schematic renderings of five new neighborhood districts, including the Harbor District, the Gateway District, the Innovation District, the Market District, and the Parkway District. Each new neighborhood is designed to be distinct but complementary to one another, offering "a number of environments with room to expand and change." The plan suggests that each new neighborhood will be organized around a central gathering space in the form of parks or public buildings. Existing assets and building anchors will be integrated with new mixed-use development and designed to "appeal to a broad range of users, families, young professionals, visitors, with a combination of spaces for active and passive recreation." At 352 acres, infill development is a primary mechanism proposed to fill in large swaths of vacant land. The plan states that it will rely on "market-driven staged private development informed by zoning and design guidelines" to accomplish full build-out. Though the plan sets out to create central "places rather than projects" to anchor each district, the market-driven outward expansion of the neighborhoods has the potential to hamper human-scale development, sense of identity, and social impact. As such, the following design guidelines will help the site evolve thoughtfully to create variety in scale and uses, as well as encourage highly sustainable design and construction.

Downtown New Haven and the Hill neighborhoods before and after highway construction, which set the stage for a period of urban renewal.

GUIDELINE OBJECTIVES

- Plan and design ecosystems rather than conventional built landscapes to sustain biogeochemical cycles and increase local biodiversity
- Enable passive use of space through flexible design interventions that promote sense of place and belonging
- Enhance human connection to the land through ongoing stewardship and restoration practices
- Account for the long-term by planning for climate-related and phenological changes

1. **Adopt a high-performance building standard**
   The City of New Haven should implement a high-performance building standard for all construction and renovation on the Long Wharf site. Use a combination of LEED and the context-specific guidelines listed below to guide development. Design buildings to achieve the highest LEED certification level (Platinum). Require builders and developers to include life cycle assessments, circular economy strategies, and carbon reduction strategies into building design and construction.[136]

2. **Rethink prescriptive zoning**
   To achieve a diversity of uses, unique neighborhood character, and a natural co-evolution between neighborhood population growth and building construction, the City should consider implementing a district-wide form-based zoning code.[91] Traditional Euclidean zoning creates inflexible codes and rules that hinder flexibility and adaptability in the built form; therefore, Long Wharf should set a precedent by rezoning the district to be form-based, which focuses on building use. This type of zoning embraces a more community-oriented and holistic conception of space and development.[93]

3. **Whole systems costing**
   It is recommended that builders and developers conduct life-cycle costing to help achieve sustainability goals and promote synergies between the built environment, the local environment, and human activity. Beyond determining hardline construction costs, life-cycle costing incorporates operational energy savings, human health benefits, ecosystem services, long-term maintenance, demolition/disposal costs, and social impacts into a weighted project feasibility analysis.[76,137]

4. **Adaptive reuse**
   Where possible, the City and developers should assess the potential to preserve and renovate existing industrial buildings and other structures in Long Wharf for adaptive reuse. Adaptative reuse is the process of adapting old structures for purposes other than initially intended, saving on new materials and cost.[146] It is well suited for post-industrial areas or places that will be impacted by the downturn of the fossil fuel economy.[33] This strategy is already being used at Long Wharf with the purchase of the Pirelli Tire Building, a unique brutalist building set to be converted into a hotel. Several warehouses to the northeast of Church Street may be well suited for adaptive reuse, as are industrial legacy structures in the Harbor District.

In 2019 the Connecticut General Assembly passed Public Act 19-35, titled "The Green Economy and Environmental Protection" bill, which amended the state building construction statute (CGS §16a-38k). Once in effect, this state construction standard will require state facilities and public schools to be consistent with LEED Silver (or higher) criteria. Additionally, Public Act 07-242 requires all public and private sector building projects costing more than $5 million and renovations costing $2 million or more to meet the LEED Silver standard.[114]

SITING BUILDINGS

1. **Viewsheds**
   Architects and developers should use natural topography and other desirable landscapes to inform building design. New Haven's East Rock and West Rock are natural focal points, as is Long Island Sound. Buildings and windows should be sited in a way that visually connects people to these characteristic natural landscapes.

2. **Building orientation**
   Architects and developers should site buildings to allow for solar gain in winter, cooling in summer, daylighting in interior spaces, and outdoor microclimates. Siting longer facades east to west brings the most consistent solar exposure and daylighting into a building, providing comfortable spaces for users and potential energy savings.[17] Building orientation should balance energy efficiency goals with the prioritization of viewsheds.

3. **Flood adaptation**
   See chapter on coastal resilience for more detailed information on coastal setbacks, design flood elevation, Transfer of Development Rights (TDR), and Environmental Impact Bonds (EIB).

HOLISTIC WATERFRTONT DEVELOPMENT AT DOCKSIDE GREEN

Dockside Green in Victoria, BC, has been dubbed "the most sustainable new development in the world." It was rezoned from business park to allow for mixed-use development and now serves as an example of a "complete" community. The planning phase involved the development of performance indicators to determine the project's impact on the city and region, which include criteria such as promoting active transportation and healthy lifestyles.[104] The tendering process used these indicators and other sustainability criteria to solicit smaller, more progressive development companies. Its LEED Platinum building standard has generated numerous health benefits for its residents: increased air quality from better ventilation; fewer toxic compounds from paints, glues, flooring, etc.; increased daylighting in indoor spaces; design that facilitates more human activity; mitigated indoor noise pollution and better acoustics; and easy access to greenspace and the waterfront via a network of recreation trails.[76]

1. **Achieving passive house**

To drive down operating energy demand to a level that can be met with on-site renewable sources, design all buildings to meet passive house standards.[57] With passive house design, energy demand is reduced to such a low level that the building hardly requires any heating, cooling, humidification, and dehumidification.[125] As key energy conservation thresholds are crossed in high-performance structures, operating expenditures on mechanical systems and maintenance are dramatically reduced.[57] Connecticut has the second highest electricity rate in the country, causing financial strain among New Haven's more vulnerable residents.[125] Therefore, energy demand reduction offers both environmental and social benefits. To achieve passive house, architects and developers should construct buildings in accordance with the following principles:

Airtightness

Fortify buildings with continuous insulation throughout the entire envelope, without any thermal bridging. Use high-performance triple-paned windows and seal seams appropriately to minimize energy demand and usage.[57]

Appropriate envelope for local climate

To prevent infiltration of outside air and loss of conditioned air, ensure building envelopes are airtight.[57] The selection of appropriate envelopes must carefully consider material production inputs and long-term performance.[125] In New Haven, envelopes should be able to regulate seasonal temperature variations and be able to withstand occasional extreme weather events. For external facades, use locally sourced materials that are well-suited to New Haven's climate, such as wood.

Primary energy usage

Minimize energy required to operate all buildings to achieve net-zero emissions. On-site renewable energy systems should be used to offset building energy demands. Use a balanced form of heat and moisture recovery ventilation with a minimal space conditioning system.[57]

Passive heating and cooling

Make use of solar gain and local wind patterns to reduce the need for mechanical ventilation and heating.[17] South-facing building facades and windows and angular positioning can all maximize energy gained directly from the sun during warming months. Minimize solar gain in cooling seasons through insulation, natural ventilation, and shading techniques. Landscaping and architectural features, like panels and shades, can also provide cooling.[57]

Kroon Hall, home to the Yale School of Environment, is a LEED Platinum building. Its lowest floor is built into a hillside with the south side fully exposed, providing thermal insulation and minimizing northern exposure. Concrete is used throughout the building to minimize interior temperature fluctuations, and its extensive interior red oak paneling and beams were harvested from the Yale-Myers Research Forest in northern Connecticut.[168]

The Connecticut Housing Finance Authority's Qualified Allocation Plan offers tax incentives for developers to incorporate passive house design in the construction of affordable housing. Competition for the tax credits is high, as these incentives often determine whether or not an affordable housing project moves forward.[56]

2. **Sustainable roofing**

Architects and developers are encouraged to use a variety of sustainable roofing techniques.

Harnessing rainwater

Where appropriate, collect rainwater using cisterns or roof catchment systems. This water can be treated using a simple large particle filtration system and used for irrigation or other non-potable uses.[87]

Reflective roofs

Where appropriate, design reflective roofs that absorb less heat from sunlight due to lighter colored surfaces. Reflective roofs offer benefits such as reduced energy demand from heating and cooling, longer roof life, reduced urban heat island effect, and reduced greenhouse gas emissions.[76]

Green roofs

Green roofs can be extensive or intensive. Extensive roofs are simpler, have a shallower layer of substrate, create less structural overload, are well suited for large areas, and are generally lower cost. They hold less water and vegetation than intensive roofs. Intensive roofs can hold medium and large-sized vegetation, offer more drainage, require more maintenance and structural support, and are generally more expensive.[34] Green roofs can also be used for agriculture and attract a variety of birds and insects, supporting local biodiversity.[76]

DESIGNING FOR PUBLIC HEALTH

1. **Biophilic interiors**

Interior spaces should embrace biophilic design by incorporating plants, enabling natural ventilation, avoiding toxic building materials, creating visual integration with external spaces, and leveraging natural light. When acting together synergistically, these factors create gains in air quality, occupant comfort, productivity, health and wellbeing.[31] Architects and interior designers may achieve biophilic spaces through interior green/living walls, incorporating courtyard spaces, ensuring every living and/or workspace has openable windows, etc.

2. **Flexible spaces**

It is recommended that architects and interior designers design commercial and public buildings to be flexible and adaptable in their use. Non-centralized, dispersed office spaces or co-working spaces in Long Wharf's mixed-use neighborhoods account for changes in telecommuting frequencies. Moreover, research shows that reducing the size of commercial office spaces allows for better ventilation and more controlled accesses, which is especially important in the context of pandemics.[74]

LEED (Leadership in Energy and Environmental Design) is an internationally recognized green building certification system. It includes four rating levels: certified, silver, gold, or platinum. The LEED certification process uses a points system with standardized criteria for a variety of building types.103

1. **Natural diversity in scale and massing**
   In mixed-use neighborhoods throughout the district, architecture and developers should create visual interest by embracing multiple building typologies and constructing buildings of different sizes and shapes. The City may commission a variety of architects and progressive developers using Triple Bottom Line (TBL) to develop the site at the building scale, rather than the street block scale.[104]

2. **Street walls**
   Buildings should create a consistent street wall to articulate building bases, promote a sense of place, and feelings of safety. Developers and architects should ensure that larger buildings with longer street frontages should incorporate visual design elements that create breaks in linear continuity, such as bays, recesses, and edge treatments.[47] Street walls should be located adjacent to public sidewalks and internal pedestrian pathways.

3. **Indigenous representation**
   The redevelopment process should be broadly informed by anti-colonial planning and design.[27] An acknowledgment of New Haven's original Quinnipiac inhabitants should play an active role in the ethical redevelopment of Long Wharf. The City of New Haven should commission Indigenous architects and artists to incorporate Indigenous architecture and art in buildings, public space, art installations, and/or infrastructure.

4. **Vernacular architecture**
   Architects should design buildings to match the local vernacular throughout the district. Vernacular architecture is characterized by the use of local materials and knowledge. It is design that is familiar and useful to the people in a particular geographic area and climate.[132]

5. **Public art installations**
   Use public art to increase awareness about the site's history and ecology. The City should commission local artists to enrich spaces by incorporating landscape art, light displays, street theatre, rotating exhibits, water features, etc.[47] An art display delineating New Haven's original shoreline and resources can provide site context.

A familiar feel --- Architect Wladslaw Prosol's design charette rendering of a neighboring redevelopment project, Church Street South. The design embraces human-scale buildings and local vernacular, integrating seamlessly with Union Station (background), completed in 1920.

KRONSBERG, HANNOVER, GERMANY

The Kronsberg district in the City of Hannover began construction in the 1990s in response to a serious housing shortage in the city. The project aimed to set ambitious goals for social and environmental sustainability and included the development of binding quality standards to ensure a high quality of life for neighborhood residents. These guidelines leveraged a concept known as humankind-nature-technology, which applies "all available knowledge of ecological optimization in construction and habitation, consistently and holistically." This included the incorporation of passive house design in all buildings, renewable energy systems, and greenspace that enhances species diversity and wildlife habitat. In both indoor and outdoor spaces, microclimates were created to ensure human comfort year-round. In residential buildings, various forms of housing finance and ownership ensure that the district represents a broad social mix. Nearly 50% of housing is subsidized, one-third of residents are immigrants, one-forth are under the age of eighteen; multiple apartments accommodate persons with disabilities, and 10% of the units are social housing.[76] The district is an example of balancing ecological concerns with goals for social equity.

DESIGNING FOR BIODIVERSITY

1. **Bird-friendly design**

   To reduce bird deaths caused by collisions with buildings, architects should ensure that building facades use methods of bird-friendly design. Increase building visibility by using non-reflective materials, panels, shades or screens, and reducing the appearance of clear passage to sky or vegetation. In North America, windows are considered to be one of the most significant drivers of human-caused mortality for birds.167 Moreover, New Haven lies within an important migration route, as most birds tend to avoid crossing large expanses of water and instead opt to follow the coastline.[49]

HOUSING AFFORDABILITY

New Haven is an ethnically and socioeconomically diverse community of roughly 130,000 people. In 2019, 17.8% of its residents were born outside of the United States and visible minorities made up 55.6% of the population.[159] There are stark socioeconomic disparities between neighborhoods: though 26.5% of the overall population lives in poverty, the statistic rises to as much as 39.9% in the Newhallville neighborhood.[39] In Connecticut, poverty tends to be concentrated in cities and is segregated from the wealth of suburban towns, decades after legally imposed redlining and economic segregation.[32] In the 21st century, city economic development agendas have often failed to relieve poverty in Connecticut's urban communities and suburban towns continue to fight inclusionary zoning policies. Additionally, increased land speculation and economic growth in New Haven have strained lower-income areas by increasing housing costs.[2]

The Long Wharf redevelopment is an opportunity to generate greater housing equity in New Haven by creating an entirely new residential neighborhood. However, literature has identified waterfront redevelopment as a method to turn places into products, catering only to the consumption habits of the wealthy.[150,16] When investors and developers buy and sell land at ever-increasing costs to consumers, certain groups of people are barred from being able to access housing and new amenities.[150] Developments like Long Wharf can also serve to produce spillover effects in nearby neighborhoods, increasing housing costs and displacing poorer residents.[134] Even when affordable housing is incorporated in waterfront redevelopments, policies often fail to ensure true affordability for the most vulnerable groups.[94]

Elm City Communities is the housing authority for New Haven, which manages the public housing, housing choice voucher, and low-income housing tax credit programs in the city. The authority serves 6,100 families and roughly 14,000 individuals, however, waitlists reflect a much higher eligible population. In the past two decades, Elm City Communities has worked with non-profit development companies to demolish decrepit public housing complexes throughout the city and construct more humane public housing in their place.[44] While these programs and improvements to public housing are desperately needed, the City must enact new affordable housing policies if housing access and equitable development are true concerns. A truly equitable affordable housing strategy must serve New Haven's existing vulnerable populations - not just wealthy newcomers - through decommodification and other affordability policies.

THE LONG WHARF RESPONSIBLE GROWTH PLAN

According to the Long Wharf Responsible Growth Plan, the site will be developed through staged, market-driven private development. To enable the construction of new housing in the presently housing-devoid district, zoning will be amended to allow for mixed-use development throughout the site with the ultimate goal of "increasing access and mobility to and within the district and maximize social equity for all ethnic and age groups." A series of public consultations conducted by the plan creators revealed that affordable housing, providing middle income and senior housing, generating tax revenue, and the potential for gentrification were significant concerns among community residents. The plan does not include an affordable housing strategy, however, it suggests using benchmark frameworks such as the New Haven Climate and Sustainability Framework, the UN Sustainable Development Goals for Cities, SITES, and Living Communities Challenge to guide equitable development practices. Additionally, the plan taps into Long Wharf's recent federal designation as an Opportunity Zone – i.e., a community investment tool that provides financial incentives for investors to make long-term investments in low-income urban and rural communities. A plan appendix includes details the Economic Impact Assessment to measure job growth and economic benefits for New Haven and the state as a result of redevelopment. The findings show that in addition to construction jobs, the estimated economic impact of ongoing operations at full buildout would include an increase of nearly 3,500 jobs in the Long Wharf area, with wages and salaries totaling nearly $182 million per year in 2018 dollars. Economic growth is the driving incentive for the redevelopment of Long Wharf, but this goal must respond to citizen concerns about housing affordability and access. The guidelines below process these concerns and propose anti-poverty policies that promote housing equity.

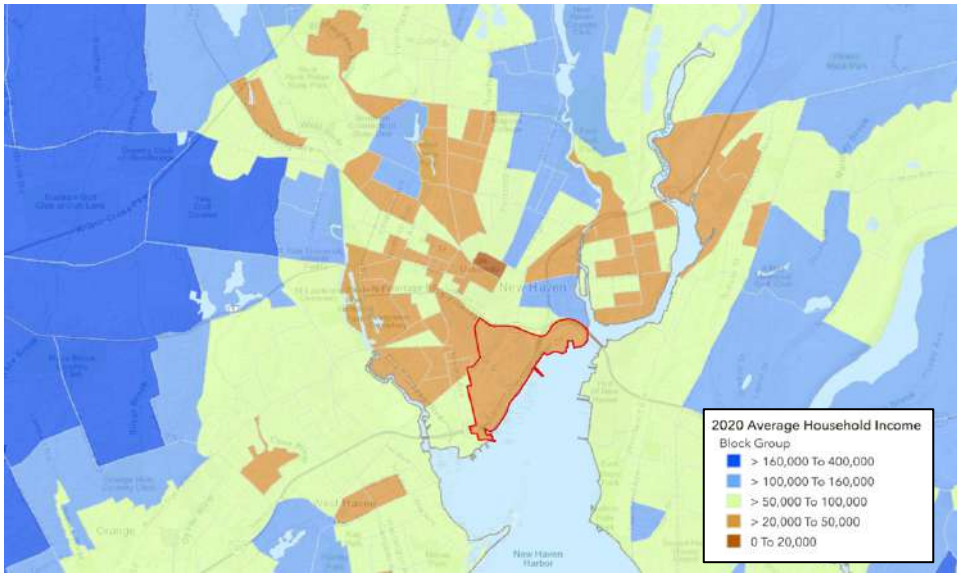
GUIDELINE OBJECTIVES

- Establish housing as a human right, prioritize decommodified and affordable housing strategies, create equitable access to new housing and amenities
- Use policy tools that counteract the potential for gentrification, spillover effects in neighboring communities, and the worsening of socioeconomic disparities
- Leverage redevelopment as an opportunity to promote housing justice in local and regional politics through mechanisms like inclusionary zoning and taxing exclusionary zoning

ESTABLISHING RESIDENTIAL DEVELOPMENT ETHICS

1. **Housing as a human right**
   As a primary development guideline, the City should ensure that the human right to housing is essential - i.e., the right to live in adequate shelter in security, peace, and dignity.[3] To achieve this, the demand for housing must be equally reflected in the supply. The Long Wharf redevelopment is an opportunity to create an urban commons as an anti-displacement and pro-social way of achieving housing for all.[27] It is a move away from the privatization of space and property by adopting decommodified and equitable housing strategies.

2. **A new definition for affordable housing**
   To ensure true affordability for New Haven's most vulnerable residents, developers should use 30% of New Haven's median yearly income - $37,508 - as the basis to determine affordable housing pricing. Currently, developers in New Haven use Connecticut's median income - $62,741 - to determine affordable unit pricing.[159,30] Additionally, New Haven has a yearly eviction rate of 4.05% - twice the national rate, highlighting the need for an adjusted affordability formula that ensures vulnerable residents can secure housing tenure.[72]



Average annual household income by census block in greater New Haven in 2020. The Long Wharf District (and census block) is outlined in red.

The Greater New Haven Community Index 2019 presents a combination of local, state and federal data to analyze wellbeing and economic opportunity in the New Haven region. The data shows significant discrepancies between suburban and urban neighborhoods on measurements of poverty, income, housing affordability burden, life expectancy, employment, health outcomes, education, food insecurity, immigration, and more. These discrepancies are deeply intertwined with race.[2]

The City of New Haven Consolidated Housing and Community Development Annual Action Plan is the city's affordable housing plan. It proposes activities to be funded by state and federal programs and grants, including public and affordable housing, as well as programs and services to promote neighborhood stability and wellbeing within the city (CNHCH). In an effort to decrease economic segregation in the state, Connecticut General Statutes, Title 8, Chapter 126a, § 8-30j now requires every municipality in the state to prepare an affordable housing plan at least once every five years. Municipalities have until July 2022 to adopt an affordable housing plan. The statute encourages suburban towns to adopt inclusionary zoning policies, which are currently rare throughout the state.[54]

1. **Community land trusts**
   The City should explore options to establish a community land trust in new residential development(s) throughout the Long Wharf district. The principle of a land trust is to take the intrinsic value of the land and endow the community with it, removing it from the commodified real estate market. In so doing, tenure is permanently secured and residents are protected from speculation that can lead to increased housing prices and displacement.[21] In most cases, a nonprofit organization or public entity acquires the land or building(s) and places it into a trust. At Long Wharf, several lots currently owned by the City or the State of Connecticut are potential candidates for the formation of a trust because the land is already "paid for." Once a lot is secured, the trust owns the land, never resells, and the homes or units are then sold or rented to individuals, families, cooperatives, or businesses. The result is genuinely affordable homes based on what people earn. Affordability is rooted permanently in the land itself – the housing comes at a lower price initially compared to the market, stays at a lower price at resale so that affordability is ensured to the next tenant. Research shows that CLTs are effective at providing affordable housing provision, have positive impacts on households and communities, and enable wealth-building for low-income homeowners, which is achieved through lower purchase prices and affordable loan access.[58,154]

2. **Deed restricted homeownership**
   Deed restrictions are a form of shared equity ownership that maintains the long-term affordability of a property by legally restricting how it may be used in the future. In most cases, a community land trust or housing authority provides an initial mortgage subsidy to a homebuyer, and caps are placed on the resale value. Upon resale, property appreciation subsidizes the future buyer's mortgage. It is important to note that deed-restricted homeownership does not enable homeowners to accrue equity, given the restriction on resale value.[58] In New Haven, homeownership is often out of reach for low-income families. The City in collaboration with Elm City Communities can help increase the share of homeowners facing by instating a deed-restricted homeownership program.

PUBLIC HOUSING TRUSTS IN TORONTO, ONTARIO

Community Land Trusts are usually instated by a non-profit organization; however, public models and hybrid models exist – each with its own set of strengths and weaknesses. The Toronto Island Residential Community Land Trust was formed in 1993 through provincial legislation and is owned by the province. It houses 620 people in one of Canada's most expensive housing markets and has guaranteed the long-term affordability of its homes. Nearby, the Parkdale Neighbourhood Land Trust uses the same public ownership concept, but at a larger and more spatially distributed scale. Publicly owned community land trusts have been found to reduce strains on community capacity by fast-tracking the acquisition of land. They also enable greater scale and expansion when public land is readily available. At the same time, a public model can potentially reduce community autonomy because of its public ownership and the fact that political support can vary through changing administrations.[123] Nonetheless, cities with publicly owned vacant land may greatly benefit from establishing trusts to increase the share of decommodified housing.

1. **Adopt an inclusionary zoning policy**

   The City and redevelopment team should implement a site-wide inclusionary zoning policy that would require private developers to set aside a portion of housing in new construction at affordable rates, including subsidized housing. Currently, New Haven does not have an inclusionary zoning policy, instead making it an optional mandate for some developments. An inclusionary zoning ordinance was one of the top recommendations from a 2019 report by the New Haven Affordable Housing Task Force.[30] To encourage equity and a mix of neighborhood residents, the development should set a precedent by ensuring a large percentage of new residential development is dedicated to public housing, affordable housing, and family housing – potentially emulating Montreal's 20-20-20 bylaw. This would appropriately respond to citizen concerns about the "missing middle" of housing and ensure the most vulnerable groups can access new residential development through significant increases in public housing. Additionally, the policy may mandate the inclusion of sheltered housing and housing for immigrants to establish a social mix at Long Wharf that is reflective of New Haven's demographic makeup. The outcomes of public consultations show that New Haven residents value providing housing for vulnerable groups, including veterans and the elderly. Sheltered housing ensures that affordable units are reserved for these groups, as well as people experiencing housing insecurity and people with disabilities.

2. **Density bonusing**

   In addition to inclusionary zoning, the City can help increase the share of affordable, income-restricted units by offering density bonuses to developers. Bonuses such as increased building height and reductions in setbacks allow developers to construct more units in exchange for more affordable units.[128] These types of bonuses may be well suited to residential zones throughout the district, as the current built form is largely a non-residential blank slate without an established character.

Montreal's 20-20-20 Bylaw to improve the supply of social, affordable, and family housing will come into force on April 1, 2021. Once in effect, developers must set aside 60% of units for each housing type (20% social, 20% affordable, 20% family). For the purpose of the by-law, social housing is defined as housing that qualifies for or receives a subsidy from a municipal or provincial social, co-op, or community-based housing program; affordable housing means that housing sale price or rent does not exceed 90% of the established market value; and family housing is defined as units with a minimum of three bedrooms and minimum square footage requirement, depending on location.[11]

Senate Bill 1024 is a proposed bill to reform exclusionary zoning in Connecticut. Zoning is currently controlled locally by each municipality in the state. The bill, introduced by the nonprofit group DeSegregate Connecticut, is aimed at increasing housing supply and diversity, lowering housing costs, and reducing sprawl in suburban communities, which traditionally have maintained a strict preference for single-family housing. It would also redefine the word "character" to mean physical site characteristics and architectural context, ensuring that it is not used to discriminate against certain groups.[62]

3. **Eliminate parking minimums**
   It is recommended that the City eliminate new development parking mandates throughout the Long Wharf district and beyond. Zoning laws in New Haven require new developments to incorporate a certain amount of parking, limiting housing construction possibilities.[38] Moreover, the American Housing Survey found that the cost of parking mandates is passed on to renters, impacting housing affordability for urban residents who often do not own a car.[158]

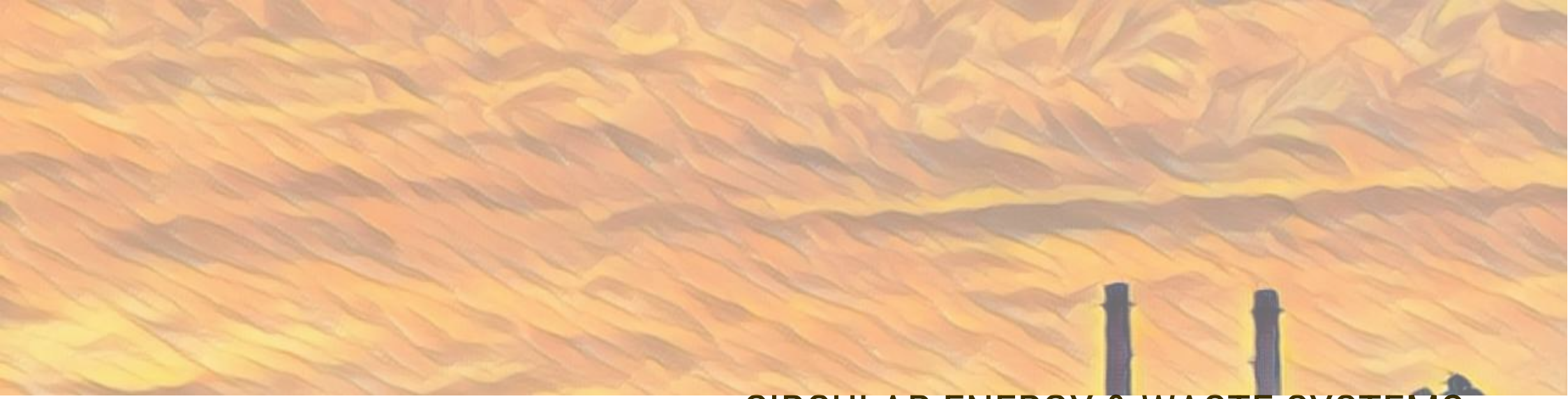
4. **Impact fees for anti-gentrification**
   Impact fees are costs that are tacked onto new residential developments to fund public improvements. The City of New Haven may mandate the use of impact fees for new residential developments on the Long Wharf site to subsidize housing for those who need it and to counter gentrification in nearby neighborhoods. Impact fees should be assessed on the square footage of a building, rather than the number of units.[128] The funding generated from impact fees can be placed into a subsidy program that is used to preserve housing affordability off site, such as the Hill and Fair Haven.

INFLUENCING STATE POLICY

1. **Tax exclusionary zoning**
   The City of New Haven in collaboration with the state housing authority may explore the option to tax towns with less than 10% affordable housing and distribute the funds to communities most severely impacted by exclusionary zoning, including neighborhoods in New Haven. Unlike most states, property taxes fund almost all local services in each municipality in Connecticut, meaning that cities with high poverty rates, like New Haven, have remarkably high tax rates compared to wealthier suburban towns.[68,62] With this increased tax revenue that does not burden lower-income communities, the construction of affordable housing can become feasible in places like New Haven. At Long Wharf, this revenue can go towards establishing community land trusts or increasing the share of subsidized housing.

ECO-CUIDAD VALDESPARTERA, ZARAGOZA, SPAIN

The Eco-Ciudad Valdespartera development is part of a larger research agenda to explore water management, energy, building methods and typologies, and waste management in the context of state-subsidized social housing.[137] Social housing makes up 91% of the housing stock, with affordable housing rentals and market-rate detached housing accounting for the remaining 6% and 3%, respectively. Private development of the 600-acre site facilitated the construction of residences in a relatively short period. The participation of co-ops and outside investors enabled financial feasibility that would not otherwise be met by the public sector.[131] Rather than a localized town center, the development follows a decentralized model of civic gathering spaces. Each cluster of housing has adjacent access to a network of community centers, open spaces, schools, hospitals, and daycares. The development has achieved significant improvements in ecological footprint and has provided a model for the organization and legal management of social housing.[137] The development now houses more than 20,000 people of diverse backgrounds and socioeconomic statuses.[131] The community selects housing candidates through an application lottery to create an intentionally heterogeneous community of residents.[137]



CIRCULAR ENERGY & WASTE SYSTEMS

Connecticut faces many challenges related to energy and waste management. 45% of the state's housing stock relies on oil or propane for space heating. State energy costs per capita are the second highest in the nation. 33% of New Haven's comprehensively measured greenhouse gas emissions come from electricity generation. The state has the highest waste incineration rate in the country – 86% – creating significant greenhouse gas emissions locally. Moreover, climate change exposes grid vulnerability. According to the New Haven Climate and Sustainability Framework, "sea level rise and extreme weather events, like Hurricane Sandy, can shut down power plants and substations, heat waves can stall power transmission, and physical distance to grid infrastructure can prevent workers from safely repairing equipment."[38]

Current plans at the local and regional scale set ambitious goals to increase energy resilience and sustainable waste management. The New Haven Climate and Sustainability Framework, Connecticut's 2020 Integrated Resources Plan, and the 2016 Comprehensive Materials Management Strategy outline the necessity to reach these targets, but the details of implementation remain to be determined. Precedent-setting projects can make these technologies and processes legible. Using principles of circularity, the redevelopment of Long Wharf can serve as a regional model for the implementation of highly sustainable and innovative energy and waste strategies that ensure these goals are met.

Selecting the appropriate energy systems at Long Wharf is complex – it is not as simple as switching from nonrenewable sources to a singular renewable system, like solar. To increase grid resilience, energy production at Long Wharf must rely on multiple integrated and renewable sources to meet demands. Diversification in energy sources means that if one system fails, backups ensure there are never complete system failures or blackouts.

With these goals and objectives in mind, local and regional stakeholders involved with the redevelopment of Long Wharf should aim to create a diversified and integrated 100% renewable energy microgrid with connections to the city grid. Waste systems can be tied in with energy systems to create a holistic management approach. A transition to a renewable and integrated microgrid would greatly reduce costs for the consumer, create energy independence, increase energy resilience, and promote equity through energy affordability.

THE LONG WHARF RESPONSIBLE GROWTH PLAN

The Long Wharf plan provides a brief overview of energy production and waste management strategies to be considered during the planning phases of the project. On the topic of energy, the plan identifies four opportunities to increase energy resilience. This includes creating an Energy Improvement District, evaluating the potential to create a microgrid, incentivizing solar energy production in commercial and residential buildings, and setting a high standard for energy efficiency in new construction. In terms of materials management, the plan cites New Haven's efforts to become "zero-waste" by reducing the production of waste and increasing opportunities for recycling and composting. At Long Wharf, this may include a community-wide composting system, providing recycling bins and community and green spaces, creating a food waste reduction program, encouraging businesses to reduce single-use packaging. These potential waste management interventions aim to achieve net-positive waste on the site, with all waste captured and reused on site. However, without a specific process to achieve net-positive waste, it is unclear how the plan's ambitions will come to fruition. Additionally, the plan does not mention wastewater (sewage) management and treatment. The stormwater management plan suggests creating a closed-loop water system "to supply all of the area's water through captured precipitation or recycling of water." The guidelines below build on these suggested interventions and provide a blueprint for a sustainable and holistic energy and waste management system.

GUIDELINE OBJECTIVES

- Aim for a diversified, integrated, and 100% renewable energy microgrid
- Create regional grid resilience through energy storage and flexibility, cogeneration, and integration with the existing grid
- Use principles of circularity to design out waste and pollution, keep products and materials in use, and regenerate and support natural systems

1. **Demand reduction**
   A primary goal in the transition to sustainable energy production is to reduce overall energy demand. Low energy demand lends itself to achieving a high proportion of renewable supply. The City and redevelopment team should set an aggressive energy demand target, as established by many sustainable redevelopment projects around the world. To align with precedent projects, this target should be 105kWh per square meter per year, or less.[77] Demand reduction can be achieved at Long Wharf in a variety of ways, such as grid flexibility and energy storage. Passive heating and cooling, as detailed in Chapter 3: ecological urban architecture, is an example of an energy-saving technique.

2. **Supply from a 100% renewable energy microgrid**
   The City in collaboration with engineers should aim to create a microgrid at Long Wharf by using a diversity of integrated sustainable energy systems, independent of the regional energy grid. A microgrid is a localized energy system. It usually includes a grouping of distributed energy sources, such as solar, wind, biomass, together with energy storage of backup generators and load management tools.[88] Though the microgrid can operate as a separate entity, it should be connected to the City of New Haven's regional grid to provide (1) energy to the city during energy surplus and (2) resilience in the event of a system failure.[116]

Connecticut General Statutes section 16a-3a requires that the Department of Energy and Environmental Protection (DEEP) prepare an Integrated Resource Plan every two years. An Integrated Resource Plan (IRP) is an assessment of the future electric needs and a plan to meet those future needs and considers supply, demand, conservation, efficiency, as well as clean energy transition. The 2020 Integrated Resources Plan focuses on "pathways to achieve 100% zero-carbon electric sector by 2040."[51] The redevelopment of Long Wharf must adhere to high sustainable energy goals to help the state reach this target.

3. **Grid flexibility**
   Energy engineers should stablish grid flexibility by employing a diversity of energy generation and storage strategies. Seasonality and weather events make some energy systems less efficient during certain times of the year. When solar electricity generation is low in the gray winter months, other systems will need to compensate to ensure 100% renewable energy generation year-round. Constant renewables, like methane and tidal energy, can complement the variability of solar and wind.[88] An adaptable grid is necessary to ensure resilience if one or more systems fail due to weather-related events and other future uncertainties.

4. **Energy storage**
   Energy engineers should integrate energy storage utilities on site to enable the adoption of non-constant renewable energy systems. Energy storage utilities conserve energy that is produced during surpluses so it is not "thrown away," and provides an energy backup during periods of minimal energy production. As it is recommended that Long Wharf employs a variety of distributed energy sources, battery storage in residential units and larger facilities on site will enable the successful conservation of energy. Traditionally, energy storage in large volumes has been overlooked. Fossil fuel-based energy production has instead relied on the intensification of power generation during demand surges, causing substantial pollution.[88]

1. **District heating and cooling**
   It is recommended that the City work with energy engineers to establish a District Energy System – i.e., networks of hot- and cold-water pipes that supply heating and cooling to a grouping of buildings. The system is more efficient than each individual building having its own boilers and chillers.[78] District energy can come from a variety of sources; examples include a biomass cogeneration plant, geothermal or seawater heat pumps, solar arrays. Heating or cooling is delivered from the central source to homes, offices, and commercial establishments.[99]

2. **Cogeneration**
   Regardless of the energy generation source, the central plant should employ cogeneration to capture residual heat and distribute it to buildings. Also known as combined heat and power (CHP), cogeneration puts waste energy produced during electricity generation to work for thermal heating at or near the site, or for use in district heating and cooling.[88] Engineers and City Planners should site a cogeneration plant at an inland location in the Long Wharf site, potentially near existing power resources near the railyard.

The MIT Cogeneration Plant produces electrical and thermal power simultaneously. The project involved adapting an existing natural gas power plant to capture residual heat for spatial heating and cooling purposes.[112]

The New Haven Climate and Sustainability Framework sets a goal to reach carbon neutrality by 2050. The framework proposes goals and actions on the topics of energy and materials management to increase sustainability and adapt to climate change. This includes energy demand reduction strategies, ways to achieve a greater share of renewable energy production, implementing city-wide zero waste programming and pay-as-you-throw program, and improving recycling and composting opportunities.[38]

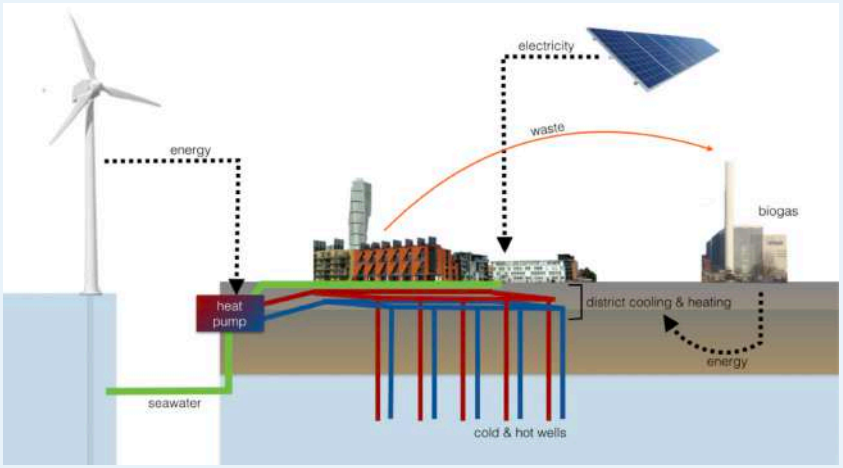
POTENTIAL ELECTRICITY GENERATORS

The following energy generation strategies are suited to the Long Wharf context but should be examined more deeply by the City in collaboration with energy consultants to determine the most cost-effective and sustainable strategy. The end goal is to ensure electricity demands on site can be met by a certain combination of the following supply strategies. Structural designers and engineers should model for building energy performance to estimate demand and determine the appropriate combination of renewable energy systems.[77]

1. **Geothermal heat pump**
   Assess the potential to install a geothermal heat pump beneath the Long Wharf district. Geothermal energy depends on heat, an underground reservoir, and water or stream to lift heat up to the surface and produce electricity.[88] New Haven lies atop a stratified drift aquifer. A 2012 study by the Massachusetts Geological Survey identified deep geothermal resource potential in Connecticut. The study found high heat production value lying beneath New Haven's surface.[79] Geothermal energy shows great promise in the state and is a constant renewable. State programs currently subsidize geothermal installations for homeowners. The Long Wharf project is an opportunity to scale up geothermal production in the state. A heat pump should be sited next to present day power infrastructure in the Long Wharf site.

2. **Methane digester**
   A methane digester leverages naturally occurring microbes present in organic waste to transform this waste into biogas (an energy source) and digestate (compost fertilizer).[88] Agricultural waste, food waste, and human waste can all be used to create biogas (a combination of methane and carbon dioxide). Biogas can be purified further into a product akin to natural gas. Though the process is generally regarded as a sustainable technology, biogas does produce some quantity of greenhouse gas emissions when burned.[160] A methane digester plant can be paired with wastewater (sewage) treatment on site. The plant should be sited away from residential zones, potentially underground, to allow for more usable human-oriented space at the site.

BO01'S RENEWABLE ENERGY MICROGRID



Bo01 in Malmö, Sweden uses wind and geothermal energy (ground and seawater heat pump plus solar) to produce noteworthy energy surpluses. It is one of the only sustainable developments in the world to have achieved 100% renewable energy production. The expansive site overlooks the Oresund Strait and is fully exposed to coastal weather elements. As such, its infrastructure, both on land and in the sea, is hardened to extreme conditions. Its location also features several favorable renewable energy production elements: good average annual wind speed, favorable solar radiation, and seawater and groundwater aquifers, which produce heat. This enables a 2-megawatt wind turbine to produce electricity for all residential units and the heat pump, which provides hot and cold water to the district. Solar panels provide additional energy for the site. Space heating comes from the heat pump, which extracts heat produced from the aquifers. In the summer, heat from buildings is extracted and stored in the aquifer, later to be uptaken by the heat pump for wintertime heating. Cold extracted from buildings in winter is stored in the aquifer until summer when the heat pump then delivers cooling to the buildings. Waste management at Bo01 was developed in tandem with the City of Malmö. This includes a plan to minimize material use, reuse materials, and recover energy from and residual products during the construction phase and in consumer households. Sewage is treated at the city's plant, which removes sludge and converts it into biogas through anaerobic digestion. The biogas is then used for cooking and electric generation. An on-site stormwater management system is composed of habitat-rich and ecologically significant retention ponds and canal that double as an urban amenity greenspace.[77]

3. **Biomass**
   Energy derived from biomass is an imperfect solution, as it is an emission-intensive energy strategy justified through carbon offsets. It harvests carbon present in plants (usually managed timber forests), burns the carbon for energy, and replenishes the forest to sequester carbon that has been emitted. The northeast United States has rich timber resources, which could enable a local and sustainable harvest. The Long Wharf project should assess whether biomass is the most suitable central power plant option against geothermal and methane digestion.

Three tidal turbines being lowered from a barge into New York City's East River in 2020 as a part of a pilot project to diversify the city's renewable energy grid

SUPPORTIVE RENEWABLES FOR MICROGRID RESILIENCE

The following energy strategies should be assessed by energy planners and engineers for their feasibility in various locations in and around the district.

1. **Microturbines**
   Microturbines are increasingly being integrated with the built environment, like tall buildings and skyscrapers, to take advantage of steadier winds.[88] Their design can differ significantly from a traditional windmill and can be designed as a seamless or artistic element in building structures. In Long Wharf, several turbines can be integrated into taller residential buildings to provide energy for residential units or other renewable energy systems, like geothermal heat pumps.[77]

2. **Rooftop solar**
   Mandate the installation of solar arrays atop new and retrofitted buildings throughout the district. Long Wharf currently boasts the largest solar array in the state, atop IKEA, which generates half of the building's energy. New residential and commercial construction and existing building anchors, like the Pirelli building, should incorporate solar arrays. Installation should make use of state programs, like Solarize CT, Energize CT, and Commercial Property Assessed Clean Energy, to subsidize installation costs.[38]

3. **Tidal**
   Tidal energy harnesses natural oceanic flows to generate electricity. Increasingly, tidal turbines are being adopted by municipalities as an out-of-sight and constant source of energy, which does not require energy storage. The northeast coast of the United States is identified as having significant tidal energy potential.[88] Though marine technologies, like tidal turbines, are still developing, a tidal turbine system could be well suited to locations in New Haven Harbor.

WASTEWATER TREATMENT AT DOCKSIDE GREEN

Dockside Green is a LEED Platinum-certified redevelopment. Sustainable waste and energy infrastructure, which includes a district wastewater treatment plant, irrigation, and stormwater management system, and a district energy system, are a superior example of fully integrated and localized energy and waste management. These systems are lauded for their level of innovation, which balanced site constraints with high sustainability aspirations. The wastewater plant receives raw sewage from the site, filters it through a two-millimeter screen, and then purifies the water through anoxic respiration, the use of naturally occurring organisms, and aeration. Afterward, the water exceeds tertiary treatment standards, but it is then treated with ultra-violet light and ozone to ensure health standards are met. 80% of the reclaimed water is sent through high- and low-pressure systems to supply irrigation, greywater toilets, and the constructed waterway that runs between residential buildings. Waste from the screens is sent to the landfill and the remaining compost is pressed into bricks and reused in landscaping. The treatment center structure is housed three stories underground, saving valuable floor space ratio density. The treated water almost meets Canadian drinking water standards, except for salinity, and sludge production is minimal and produces little odor due to the ozone gas treatment and ultra-violet light. Dockside Green has a reciprocal treatment failure agreement with the City of Victoria to provide resilience if either the city pump fails, or Dockside Green's storage capacity is exceeded. Energy for the site is produced in the district heat and hot water plant. Wood waste sourced off-site is converted into syngas (mix of carbon monoxide, carbon, dioxide, and hydrogen) via pyrolysis in a gasifier converter. The wood waste is then converted into charcoal at very high temperatures and is combusted to create steam for the hot water boiler. Hot water is distributed throughout the district for hot water and electricity needs. The waste heat produced from electricity generation is reused used for space heating and cooling in residences and other structures on site.[76]

WASTE MANAGEMENT STRATEGIES

1. **Construction waste reduction and reuse**
   The City should establish a redevelopment policy to reduce materials used during construction, decrease demolition through adaptive reuse and heritage preservation, and divert materials for reuse or recycling. Development companies that process and reuse materials on site can drastically reduce carbon emissions and contribute toward a circular economy on site.[163]

2. **On-site composting**
   The City should ensure that all organic waste and materials are diverted to district composting systems. Developers and architects can incorporate food waste vacuum systems at designated collection points, like the market district, and a food waste disposal system at each kitchen sink.[77] This may also involve a partnership with the existing local composting operation in New Haven, Peels & Wheels, or a larger industrial facility in the state to deal with district compost. Community gardens should also include a smaller-scale composting system for use on-site. If brought to a larger scale, composting can incorporate a heat recovery system for space heating needs in residential and commercial buildings.

3. **District wastewater treatment plant**
   For district wastewater and sewage treatment, it is recommended that the City and engineering team construct an anaerobic water treatment plant on the Long Wharf site. This system can be paired with methane digester technology to produce energy, if needed. This system might be modeled after Dockside Green's treatment plant, which uses anoxic respiration, aeration, ozone, and UV light treatment to purify water and sludge. Reclaimed water is used in greywater systems (e.g. toilets) and sludge is treated to be reused as compost.[115] The Dockside Green plant blends seamlessly in the built form. Long Wharf could site its plant next to existing transportation and electrical facilities.

4. **Water recycling**

   To conserve water and encourage circularity in the waste management plan, the City should establish design and development mandates for the capture and reuse of water. Water captured and purified from the wastewater treatment plant and rainwater collection systems should be used for greywater, irrigation, water-based landscape elements on site.

5. **Industrial ecology system**

   It is recommended that the City of New Haven establish an industrial ecology system for the various manufacturing and commercial tenants on the Long Wharf site. Industrial ecology aims to eliminate waste and the continual use of resources by redirecting these materials back into the supply chain in a more circular flow. Industrial systems can operate more like natural ecosystems by turning useful material or energy into forms that be used by another organism or entity.[67] At Long Wharf, the establishment of an "eco-industrial park" would involve collaboration between multiple manufacturing and service industry businesses on site to generate a more circular economy. Examples of this include shared facilities for logistics, shipping and receiving, shared parking, green technology purchasing blocks, and eliminating materials from the system that upset the flow or reuse of its components.[67] Cities throughout the world have successfully implemented in certain districts, including Kalundborg in Denmark and Burnside Park in Halifax, Nova Scotia. At Burnside Park, the consolidation of transportation facilities and common user facilities has improved efficiency and sustainability in the city's economy.[40]

The *2016 Comprehensive Materials Management Strategy: Connecticut Solid Waste Management Plan* sets a goal to reach 60% solid waste diversion by 2024. The plan identifies anaerobic digestion as a significant tool in helping to reach the target by diverting at least 300,00 tons that would otherwise be disposed of via traditional waste-to-energy or landfill.

SUSTAINABLE TRANSPORTATION SYSTEMS

New Haven faces great challenges related to transportation and access. 27% of the city's greenhouse gas emissions come from transportation, New Haven county has one of the highest annual mortality rates from ozone pollution on the east coast, and low-income neighborhoods of color adjacent to highways face the highest levels of asthma in the state.[4,38] Almost 30% of New Haven households are car-free – usually not by choice. In some low-income neighborhoods, the carless rate increases to over 60%, compared to 19% in affluent neighborhoods.[38] Most entry and mid-level jobs have spread to the suburbs, despite the fact that the majority of low-income adults live within the city. As a result of gaps in regional public transit, long-term joblessness among lower-income New Haven residents has reached all-time highs.[1]

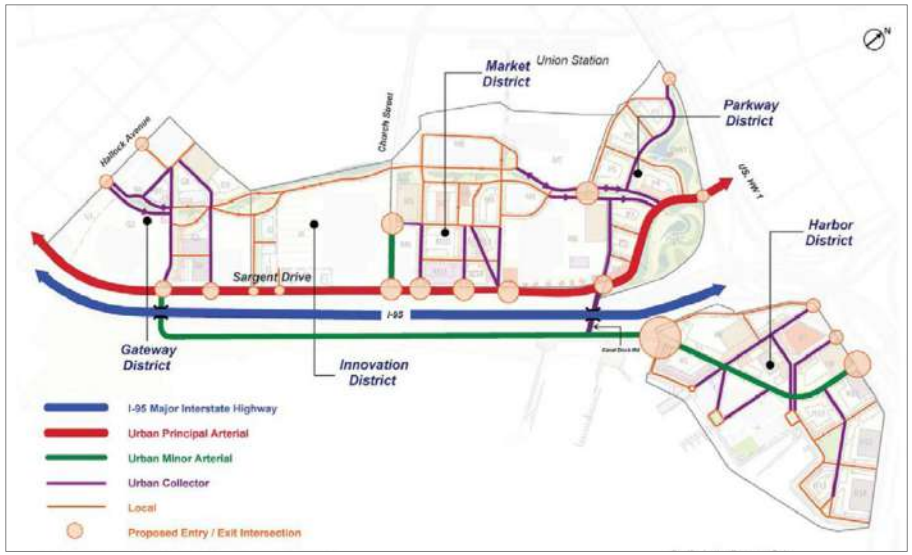
An equitable mobility strategy at Long Wharf must leverage sustainable transportation systems to counteract challenges related to equity, access, and environmental justice. In many communities, transportation enhancements occur in conjunction with economic development agendas. While increased investment can deliver efficient transportation systems for new and existing residents, it can also result in increased real estate speculation in vulnerable communities.[150,9]

The transportation portion of the Long Wharf Responsible Growth Plan relies heavily on transit-oriented development to support the city's goal to bolster "smart" growth in New Haven, as the site's direct proximity to Union Station and some of the busiest rail lines in North America is viewed as an economic lifeline. While creating efficient connections to economic powerhouses supports the financialization of the Long Wharf redevelopment, decision makers at the local scale must consider whether prioritizing investment and economic growth and attracting wealthy newcomers should take precedent over local concerns for housing justice, climate action, and community health and wellbeing.

A responsible transportation strategy considers the long-term by planning for carbon-free mobility and challenges the notion that transportation should serve economic efficiency, rather than people. At the local scale, the Long Wharf site should enhance accessibility through targeted investments in spatial quality.

THE LONG WHARF RESPONSIBLE GROWTH PLAN

Mobility is a central focus of the Long Wharf Responsible Growth Plan. The site currently contains a mix of uncoordinated land uses and a considerable amount of impervious surfaces. Roughly 60% of the site is made up of surface parking lots. The plan aims to create a series of five walkable districts connected by a multi-use parkway from Hallock Avenue to Sargent Drive, allowing for efficient travel across the district. The city will leverage the site's proximity to Union Station to create transit-oriented development (TOD), consisting of new residential buildings and public amenities, as well as hotel, retail, office, and research spaces. A new pedestrian tunnel underneath the rail yard will provide direct access to the Hartford Line, Shoreline East, and Metro North commuter rail services from Union Station. The plan includes a trip generation analysis, conducted by a consulting group, to determine the anticipated number of vehicle trips at full build-out. This analysis helped determine the roadway network, which fundamentally prioritizes efficient travel for motorists to and from the site, rather than comfortable pedestrian and bicycling environments within the site. The new parkway is set to include the provision of a new shuttle bus route that connects each neighborhood to the Harbor District and will integrate car-sharing into the built form through numerous designated pick-up/drop-off zones. Several new interior and local streets are planned; however, none are car-free. Though the plan incorporates a "complete streets" design for new and existing roadways, the roadway hierarchy and explicitly stated approach does not limit vehicular access, which could ultimately limit safe and comfortable human experiences with space.



Proposed roadway network in the Long Wharf plan area. New "local" parkways prioritize efficient automobility.

GUIDELINE OBJECTIVES

- Prioritize socially and ecologically supportive transportation strategies and infrastructure, rather than single occupancy vehicles
- Redesign the street network to enhance spatial quality and improve opportunities for active transportation
- Use a systems approach to influence a shift in regional spatial organization and transit infrastructure

1. **Equitable Transit-Oriented Development (TOD)**
   Transit-oriented developments have been found to contribute toward high quality of life indicators for residents and society, including lower rates of obesity, cardiovascular disease, asthma, driving, pollution, poverty, and unemployment. However, these developments are often not socioeconomically inclusive.[9] As a result, it is critical that the City enacts local policies to achieve equitable access to TOD at Long Wharf so that all low-income residents and residents of color can pursue and realize the positive livability and health outcomes associated with these developments. Housing affordability (as detailed in the Housing Affordability chapter), low- and middle-income job creation, and affordability of transit are critical to achieving this.

1. **Integrated active transport and public transport**
   Site planners and developers should integrate sustainable transportation modes and should be aimed specifically at facilitating seamless and multi-modal transport within the district and beyond.[157] Examples include providing ample bike parking and micro-mobility options, like bikeshare stations, next to transit stops, incorporating separated cycle tracks and pedestrian paths into the built environment, siting schools and community centers next to pedestrian and bicycling networks and facilities, and encouraging shared vehicle operators (e.g. Zipcar) to locate facilities adjacent to transit stops.[157,55]

2. **Prioritize non-motorized transport locally**
   Transit planners should design the mobility plan in a way that encourages bicycling and walking trips within the plan area and to locations elsewhere in New Haven. By raising the attractiveness, safety, and security of walking and cycling, residents of Long Wharf will be more apt to choose these modes for short trips. As a result, residents can directly benefit from the role of active transport in decreasing pollution and encouraging human health and wellbeing.[157]

4. **Balance spatial quality with efficiency**
   At the block-by-block scale, planners and developers should ensure spaces are welcoming and accommodating for pedestrians, bicyclists, and transit users. Traditional transport planning has focused on traffic flows, as demonstrated by the Long Wharf Plan. A more sustainable approach focuses on human-centered design. Mobility systems and their supportive infrastructure should create welcoming, attractive, and safe environments at the human scale.[157] Examples of aesthetic considerations include bicycling and pedestrian greenways that double as biodiversity corridors through extensive plantings, separated bike paths with medians containing a tree canopy, pedestrian bridges across busy boulevards that replace long crosswalks, using natural construction materials for transportation infrastructure such as permeable pavers, ensuring transit stops and buses are clean, and designating bus-only lanes to improve user experience.

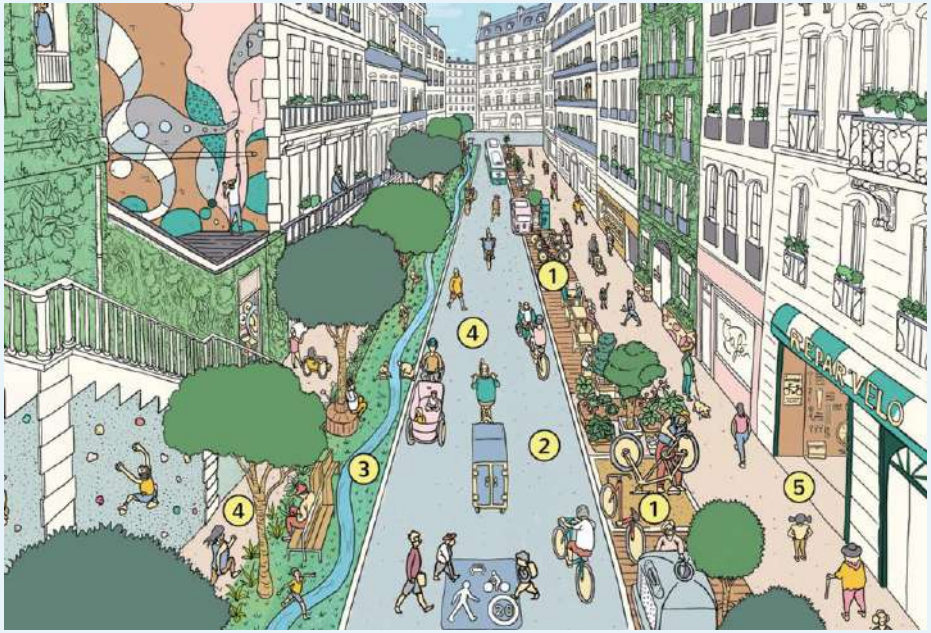
The 2018 Connecticut Statewide Long-Range Transportation Plan is a federally mandated policy document that outlines actions to address state transportation issues and needs. Transit-oriented development is underscored as a key strategy to advance smart growth and mixed-use planning in the state, as well as reduce energy demand and emissions. The plan identifies potential funding mechanisms that could be used to implement transportation improvements.

The Connecticut Active Transportation Plan provides guidance for municipalities to help plan and develop walking and bicycling networks and facilities as a key component of the state's transportation system. Urban centers like New Haven are identified as being central to the development of cycling networks.

3. **Transit supportive parking policies**
   The City of New Haven may implement the following strategies in coordination with other municipalities and the Connecticut Department of Transportation:
   - Reduce square footage devoted to parking garages, as proposed in the Long Wharf Plan, and reallocate the space for housing or greenspace. The parking structures that must be built should be treated with architectural elements that make them indistinguishable from the surrounding built form. Garages should be readily adaptable for reuse if/when they become obsolete.
   - Eliminate parking minimums for new and existing development. Bicycle parking above the requirement may be used to support reductions in parking requirements.
   - Reduce space currently dedicated to street parking and replace it with wider sidewalks, separated bike paths, rain gardens, and other biodiversity interventions.
   - Establish a baseline rate for street parking tariffs within the district as a means to fund free shuttle service.
   - Expand park-and-ride facilities outside New Haven, adjacent to transit stops, to combat single-occupancy vehicle commutes.
   - Expand the New Haven zonal parking program, which assigns variable parking rates to certain areas, depending on demand.

The CT2030 Plan is Governor Ned Lamont's 10-year transportation plan to generate quicker, more efficient travel throughout Connecticut. Of the $21.1 billion spendings foreseen by the plan, $14.2 billion will go toward widening highways and improving bridges and $7.1 billion will be invested in public transit systems. The plan's funding structure is counterintuitive to the state's goals to reduce vehicular trips, cut emissions, and increase public and active transportation modal shares.

PARKING POLICY IN PARIS, FRANCE



The imagined future of Parisian streets, as illustrated by Paris En Commun – a political group conceptualizing innovative solutions to Paris's modern equity, health, and environmental challenges.[124]

Paris has become a leader in efforts to promote sustainable parking strategies. It began when the municipal government identified easy access to parking as a major factor influencing people's daily mobility choices.[101] In 2020, the city announced it would remove half of its 140,000 on-street parking spaces to increase sustainability, improve air quality, and increase the number of people-oriented streets. The remaining parking spaces will give priority to residents and businesses, as well as people with disabilities. In place of parking, the city is currently consulting residents on design possibilities for the freed-up space. Potential improvements include more trees and gardens, vegetable plots, food composting areas, children's playgrounds, bicycle parking, and hygienic public toilets.[110] Additionally, Paris aims to have 100% cyclable streets by 2024 as a means to achieve the "15-minute city." Additional strengths include France's federal policy which prevents developers from providing more than one parking spot per housing unit, which is reduced to 0.5 when the building is within 500 meters of a transit station.[157]

1. **Electric vehicle charging stations**
   Transit planners should incorporate electric vehicle charging stations throughout the district, particularly in residential zones and areas next to amenities, like greenspace. Charging stations should be sited next to on-street parking. Planning for charging station locations should involve the producers of electric vehicles to ensure adequate infrastructure is available for users.

2. **Reduced-emissions zones**
   Reduced-emissions zones are location-specific areas in which access is restricted due to the emissions of certain road vehicles. The World Health Organization reports that 9 out of 10 people breathe air that is considered dangerous, resulting in premature death and negative health outcomes. Evidence shows well-designed low-emission zones reduce toxic air pollution by up to one-third.[120] Within the Long Wharf District, reduced emissions zones should be implemented in areas where people recreate and relax, such as outdoor dining facilities, parks, and other greenspaces. The City of New Haven should designate these zones based on the location of parking facilities and site plans.

3. **Micromobility and sharing options**
   Building on New Haven's effort to provide affordable and sustainable bike sharing, the City may assess the potential to provide additional micromobility options, such as scooters and electric bikes. It is recommended that this effort be paired with education campaigns or user agreements, which ensure users comply with city bylaws related to safety and speed limits, the Americans with Disabilities Act, and designated travel lanes (streets, bike lanes, and multi-use corridors, rather than sidewalks). Micromobility stations should be located within each new segment of the district, next to Union Station, and at Long Wharf Park.

4. **Free district shuttle**
   It is recommended that the City coordinate with CT Transit to ensure the new district shuttle line is a free service. Parking tariffs within the district may be used to fund this service.

5. **Bicycling infrastructure**
   As detailed in the mobility portion of the Long Wharf Responsible Growth Plan, extensive bicycle lanes and paths are planned for the district. Wherever possible, transit planners should prioritize the implementation of separated bike paths to reduce contact with vehicles and increase safety for bicyclists. Additionally, it is recommended that the district include a bicycle co-op, similar to the Bradley Street Bicycle Co-op in East Rock, to provide a designated community space for residents to repair or purchase bikes.

6. **Bicycling networks to the suburbs**
   New Haven has a small but active share of bicycle commuters coming from the suburbs; however, the current roadway network from these towns to New Haven does not support bicyclists.[170] It is recommended that municipalities within New Haven County form a working group to coordinate regional bicycling infrastructure improvements and increase the share of bicycle commuters coming from suburban towns. This process should build on the work of the Farmington Canal Rail-to-Trail Association and Shoreline Greenway Trail, Inc. to fill in gaps in proposed networks and create new routes to the northeast and west of New Haven.

7. **Rethink street network**

Transit planners and developers should increase the number of car-free streets in the district and incorporate more grid-like streets, rather than long boulevards. Though the proposed new parkway incorporates "complete streets," by design it prioritizes efficient travel for automobiles across the district. As a result, the parkway facilitates higher speed travel for automobiles, making it less hospitable for pedestrians and bicyclists. As an alternative, efficiency should be prioritized for active travel and public transit, rather than vehicles.

8. **Streetcar**

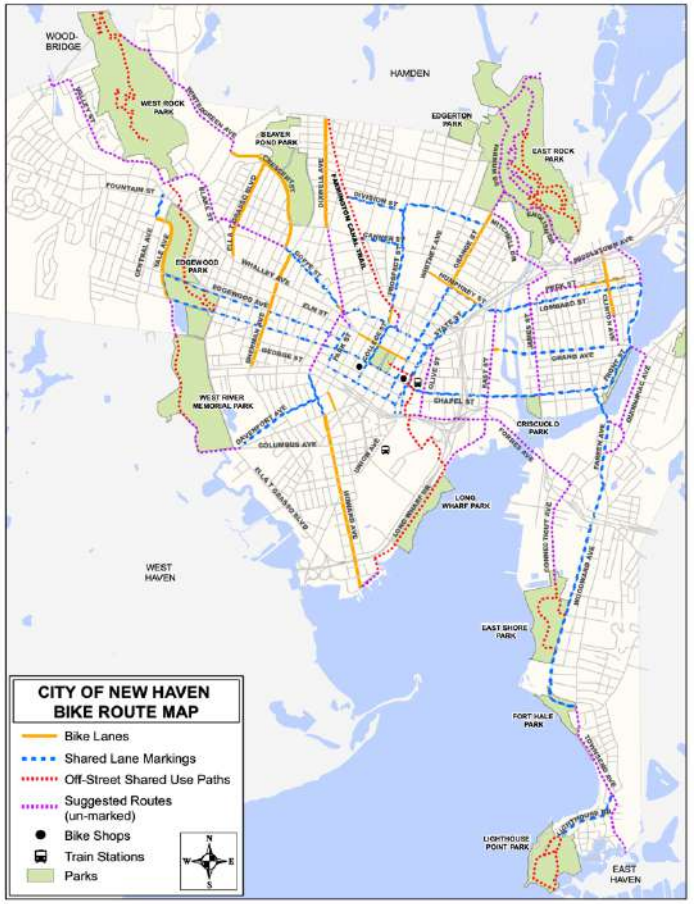
The City of New Haven in collaboration with a consulting team may assess the potential to implement a district streetcar system, which could be extended throughout the city of New Haven. This would involve redirecting cars away from city street arteries and replacing them with electrified streetcar transit. In the late 1800s and early 1900s, trolley streetcars were the primary means of transportation local and regional transportation for the New Haven area. Alternatively, the City may assess the feasibility to increase funding for CT Transit to improve local and regional bus route coverage and frequency.

9. **Intelligent transport systems**

On the Long Wharf site, public-private partnerships can act to improve the sustainability and efficiency of mobility systems. Advancements in smart mobility technologies have enabled cities to improve infrastructure for active travel modes, reduce road traffic on local streets, improve parking management, adapt roads and travel needs depending on travel demand, improve public street space, and improve the sustainability of urban freight traffic.[157] Partnerships between the city and private companies will ensure that the city can set guidelines and boundaries to avoid missteps and ensure equitable access.[75]

10. **Capping I-95**

As mentioned in the landscape chapter, capping a section of I-95 would enable greater and safer access to the waterfront. This pedestrian overpass would be an important step toward creating human-centered, rather than auto-centric urban environments.



Though the City of New Haven has made a concerted effort to increase bicycling infrastructure over the past 10 years, significant gaps remain, most bike lanes are inhospitable and unsafe for bicyclists, and numerous multi-lane one-way city streets give preference to rapid automobility. In nearby suburban towns, there are no bike lanes and extremely limited networks of shared-use trails.

TRANSPORTATION AT DOCKSIDE GREEN

Dockside Green has achieved an aesthetically appealing district mobility system through a recognition of the importance of place and providing connections to natural amenities. The creation of the "Blue-Green Spine" accompanies the natural beauty of the waterfront by creating a second layer of water access. It is comprised of an internal waterway and accompanying path, which created a natural buffer between residential and commercial uses. It runs the entire length of the development and contains extensive wetland plantings, native vegetation, and small respite areas. The waterway reduced irrigation needs for what would otherwise be underutilized intermediate zones between buildings and honored the heritage of the site by mimicking the mix of natural waterways and inlets that are abundant throughout Victoria. These features all provide efficient active mobility to other multi-use paths in the city and the amenities of downtown.[76] Dockside Green also features several progressive parking strategies. Straying from the city zoning bylaw, parking was reduced by 33%, 50%, and 60% for restaurants, residences, and bars, respectively. Bike storage facilities were provided for at least 15% of residences, bike racks and shower facilities are present in commercial, office, and industrial spaces, and the district has its own car-sharing program. Additionally, the district includes extensive pedestrian and bicycle paths that are removed from car-oriented streets and limited visitor parking spaces. The intentional lack of single-family dwellings on the site is intended to decrease patterns of sprawl that facilitate automobile use and decrease a sense of community.[76]

LONG-TERM PLANNING FOR ACCESSIBILITY

1. **Recentralization**

   Recentralization describes a process by which the urban core becomes denser and a more desirable place to live as a result of gains in equity, sustainability, and wellbeing. Increasing densities in the urban core as a part of a regional growth strategy counteracts suburban sprawl and car dependency, providing social and environmental benefits. Connecticut has significant established suburban sprawl, substantial car dependency, and stark wealth disparities from cities to suburbs. Regional political initiatives to densify New Haven through infill development at Long Wharf can counteract unsustainable suburban growth by attracting the middle class back to the urban core. This process can also increase transit ridership among diverse socioeconomic backgrounds, as is the case in many Canadian and European cities.[156]

2. **Transition to post-carbon mobility**

   Traditional transport planning has focused on the creation of short-term and medium-term plans that tend to be fixated on current transportation innovations and correcting prior infrastructural mistakes. A more sustainable approach recognizes that these plans should be a part of a long-term vision or strategy.[157] Planning for mobility at the Long Wharf site must encourage transformative change in the areas of accessibility and quality of life, social equity, public health, and environmental justice. Devoting more space to public amenities, greenspace, natural areas, and transit should take precedence over accommodating vehicles, as a transition to truly sustainable transportation systems will provide innovative mobility solutions beyond automobility.[106]

3. **15-minute city**

   The 15-minute city concept describes the accessibility of everyday services within walking distance, rather than cross-town mobility. Where present, limited travel is required between housing, offices, restaurants, parks, hospitals, and cultural amenities to provide gains in livability. Portions of New Haven already fulfill the 15-minute city concept – mainly in areas close to downtown. The city should establish a 15-minute city development standard in the Long Wharf District by designing for a mix of uses and amenities on site.

A SMART CITY FRAMEWORK

The new Long Wharf can serve as the center of innovation in New Haven and the wider region. As stated by the Long Wharf plan, smart city planning and innovation are envisioned as a driver of New Haven's economic growth and success. While innovations in information and communications technology (ICT) can provide important services on site, it is preeminent that these enhancements in service provision and efficiency are applied ethically. Smart city practices, like big data analytics and management, convening the knowledge and expertise of key area stakeholders, and engaging the community with democratic and service platforms can all contribute toward a more sustainable and equitable community when balanced with non-technical ways of understanding the urban ecosystem.[82]

Currently, the City of New Haven lacks an official smart city framework or entity. Despite the presence of notable knowledge economies and institutions, including Yale University, the local government and its institutions have yet to officially combine forces toward the development of smart city technologies. That said, the City has demonstrated interest in smart transportation technologies through participation in the U.S. Department of Transportation's *Smart City Challenge*, through which the City detailed smart mobility solutions to solve issues with congestion and efficiency, transit use and connectivity, and parking.[147] Contests like the Smart City Challenge allude to the immense potential of smart city applications on the Long Wharf site and the broader community.

At Long Wharf, local actors must be focused on generating a multitude of societal benefits through a holistic understanding of urban processes. It can also serve as an incubator site to re-envision current conceptualizations of smart city technology. Essentially, smart city technology can be applied to every major topic area of these guidelines. The City and developers must be equipped with the right set of tools to apply advances in sustainability and green technologies effectively, as well as deploy ICT justly as next-generation infrastructure and services.[10]

This chapter aims to facilitate the dialogue between city leaders, the private sector, community groups, and other key stakeholders to develop circular strategies and make use of ICTs that drive positive change. The Innovation District should be multi-faceted; its proposed physical improvements should be accompanied by digital enhancements that increase equity and a sense of belonging in this new community.

THE LONG WHARF RESPONSIBLE GROWTH PLAN

According to the plan, the Long Wharf has the potential to be New Haven's Innovation District - a place built on smart and resilient public infrastructure, offering alternate types of environment with room to grow and change. The plan identifies this strategy as being successful in places like San Francisco's Mission District, Boston's Seaport District, and Kendall Square in Cambridge. The proposed Innovation District will feature a "tech village" with pavilions and small incubator structures that can provide space for start-ups associated with ASSA ABLOY, the existing building anchor of the site focused on manufacturing and security systems. The site will also include increased open space in place of surface parking lots and recreational amenity space. Transportation Oriented Development (TOD) and smart mobility services are discussed in the plan as smart transportation strategies that will facilitate growth in the wider community. Unlike the preceding chapter topics, "smart" growth and technology were not identified in the community workshops and public consultation process that the City conducted prior to drafting the plan. Instead, this is a strategy identified by the plan creators and the City of New Haven as being imperative to achieve responsible growth. Although an Innovation District has the potential to advance collaboration and entrepreneurship in the community, the City must first and foremost use technological innovation to create a more democratic and egalitarian community. The following guidelines thoughtfully blend technical and nontechnical perspectives to provide a strategy for the ethical use of smart city technologies.[82]

GUIDELINE OBJECTIVES

- Blend technical and nontechnical perspectives to provide a strategy for the ethical use of smart city technologies
- Use smart city applications to enhance democratic processes and service provision
- Centralize ICT monitoring of energy, waste, and other intelligent infrastructure to promote environmental sustainability

1. **Centralized ICT monitoring**
   For all smart technologies on site, a centralized hub should monitor infrastructure functions, diagnose problems, and enact resolutions as necessary. The City should establish the hub as a governing entity that monitors all transportation, energy, waste, and water systems on site. For example, the wastewater treatment plant should use smart sensors and early warning systems to detect contaminants in the water and monitor changes. These sensors can measure water acidity, chlorine, heavy metals, and other chemicals and alert human operators when problems arise.[24] This hub should be located within proximity to the infrastructure that it monitors.

2. **Enhance service provision and public participation with blockchain technology**
   Public online forums and platforms can centralize key services and democratic processes within the Long Wharf district. In New Haven, established platforms like SeeClickFix facilitate problem-solving and the resolution of planning issues at the neighborhood scale. This concept can be expanded by encompassing additional administrative and democratic processes on site, including planning, budgeting, and problem solving. Increasing community involvement with legislative processes conducted by the New Haven Board of Alders through the use of accessible online platforms can increase public participation for those who are apt to use digital technologies. Research has shown that blockchain platforms can improve public service delivery and operation, making them more efficient, flexible, and transparent.[119]

3. **Cybersecurity**
   Cyber-attacks intended to manipulate or disable ICT systems are a growing issue. In response, it is recommended that a third-party security company oversees ICT platforms at Long Wharf to detect any anomalies and prevent data breaches.[8]

4. **Data collection, surveillance, privacy**
   Data is not neutral, and therefore it must only be handled in a way that does no harm. Methods of data collection, its ownership and storage, and the ways in which it is used and analyzed have implications for the welfare of particular groups of people. The framing of data as neutral can serve to legitimize the marginalization of people and processes deemed unproductive in an economic context.[98] At Long Wharf, it is recommended that the City establish a local policy to protect against the corporate surveillance of people through data collection and ensure that citizens' rights are respected. Because individuals and communities are vulnerable to the localized actions of large corporations, any data collected at Long Wharf should be managed by a public agency, rather than a private firm.

5. **Equitable access to innovation**
   While the Long Wharf Responsible Growth Plan aims to attract new residents and economies to New Haven by increasing space dedicated to innovation incubators and smart technology, the City should prioritize existing residents' access to these spaces. Programming between the City of New Haven and the proposed Innovation Hub can increase community involvement in this district, ensuring that the space is not exclusionary.

See Click Fix is New Haven's online service request platform. Broken pedestrian signals, fallen trees, illegally parked vehicles, drainage issues, signage requests, recycling pick-ups, and roadkill, are a few examples of recent service requests. Nearly 90,000 requests have been resolved since its inception.

6. **Innovation Hub**

   Forging partnerships between the City of New Haven, its universities and public schools, and local companies can aggregate resources, knowledge, and expertise to develop innovative solutions to New Haven's challenges. In this innovation hub, New Haven can coordinate the integration of resource streams between urban subsystems and focus on the delivery of services within the city (e.g. efficient public transport). Collaboration between public and private entities has been found to help achieve goals for sustainability and equity through the most efficient and cost-effective means possible.[165] The research hub should be located within the Innovation District and be open to the public to enable the exchange of information.

7. **Open innovation platforms**

   Open innovation describes a collaborative organizational strategy to achieve a common goal. It recognizes that technological innovation is not limited to well-financed corporate and government laboratories. Rather, the most effective and innovative technological innovations can come from almost anywhere and anyone. The use of open innovation platforms, like public contests, can contribute toward gains in sustainability and equity on the Long Wharf site. Open innovation has been trialed in New Haven through the Smart City Challenge aimed at solving traffic congestion in the community. With the proposed Innovation Hub, the City may expand open innovation platforms can be expanded in New Haven to cover innovations beyond transportation enhancements.

MaRS DISCOVERY DISTRICT, TORONTO

MaRS is North America's largest not-for-profit innovation hub. Based in downtown Toronto, it leverages the proximity of leading-edge anchor institutions, companies, and individuals to enable the seamless transfer of ideas and knowledge.[85] MaRS offers a range of services, such as courses, workshops, innovation challenges, an incubator space, intended to help Canadian tech ventures expand in the fields of medicine, clean technology, financial technology, and enterprise. Data science, machine learning and AI, product development, and software development are central to MaRS' knowledge expertise, which has enabled the development of many innovations in Toronto, throughout Canada, and worldwide. MaRS's collaboration and partnerships with various private and public entities have helped create smart transportation systems in Toronto, develop 5G digital infrastructure across rural regions in Quebec, deliver machine learning technologies for more effective healthcare management, finance renewable energy industry in Ontario, and more.[111] Its success underscores how central innovation hubs at municipal scales can leverage the knowledge and expertise of traditionally siloed institutions to provide a community with better service provision.[85]

ENERGY SYSTEMS

1. **Distributed generation**
   ICT can reduce energy waste and enable buildings to produce and store excess energy. Energy engineers should ensure that energy storage systems are connected to the renewable energy systems grid within the district to meet energy demands.

2. **Cloud computing frameworks**
   Smart grids or energy hubs use advanced communication, meters, sensors, and information technologies to create an automated system that delivers energy to consumers. With this technology comes a huge amount of data that must be processed and analyzed in cost-effective and efficient ways. Cloud computing and smart grid control software provides a solution to the management of energy data. At Long Wharf, systems engineers may integrate cloud computing infrastructure with the proposed centralized ICT monitoring hub to create a more efficient energy system on site.[26,142]

BUILDING DESIGN

Schools, hotels, restaurants, private homes, offices, and retail can all make use of smart technology. Smart buildings typically use sensors, meters, systems and software to monitor and control a range of building functions, including lighting, energy, water, HVAC, communications, video monitoring, intrusion detection, elevator monitoring, and fire safety.[24]

1. **Intelligent building management systems**
   Developers and architects should ensure that each residential unit at Long Wharf is fitted with smart thermostats to efficiently maintain building homeostasis. Smart meters give residents control of their energy use and empower them to make economical and sustainable decisions. Education can enable people to choose sustainable actions. New residents can be engaged with smart building systems through digital information platforms and regular community meetings.

MOBILITY

1. **Smart traffic monitoring and signaling**
   Transit engineers may incorporate a central GIS to estimate and predict traffic on the district's road segments. Real-time traffic control signals aimed at reducing congestion can be inherent to transportation systems on the Long Wharf site, improving experiences of public transit, and ensuring the prioritization of active travel modes. Over time this data can be used to guide optimizations in transit options, which can play a crucial role in enhancing quality of life indicators, like reduced pollution and the promotion of walkability.[140,24]

2. **Mobility as a service (MAAS) platform**
   Mobility services that use cloud computing software, such as bikeshare, carshare, and other micromobility options, can be integrated into a single platform with a shared payment protocol. These transportation options have been found to relieve traffic congestion, reduce noise and air pollution, and provide people with flexible transit options.[24] City collaboration with MAAS companies, such as Zipcar, can reduce car ownership and marginal use significantly. Similarly, bikeshare expansion can provide alternatives to automobile use. Reduced rates can be offered for lower-income individuals to increase accessibility for all New Haven residents.

SMART WATER POLICY

On a global scale, water is scarce, at risk, underpriced, and its infrastructure is expensive to build and maintain.[24] Even with plentiful rainfall in Connecticut, climate change poses risk to local water resources. As suggested in Chapter 5, "closing the loop" is a smart approach to water management. Capturing stormwater runoff, rainwater harvesting, and wastewater treatment for reuse as greywater optimizes the conservation of water resources. To achieve a high level of water resource conservation on the site, the following smart strategies are recommended:

1. **Collaboration between multiple stakeholders**
   Water is a regional issue, and therefore multiple partners should be involved in the conservation of water resources. The City of New Haven must collaborate with the Southern Connecticut Regional Water Authority, the state government, regulatory authorities, utilities, the private sector, agricultural organization, citizen and community groups, etc., to create a comprehensive and sustainable water management strategy.[24]

2. **Smart water policies**
   It is recommended that the City establish mandates for efficiency, water quality, and conservation to enhance the prospect for smart water. Additionally, public-private partnerships may help to finance sustainable water conservation strategies.[24]

GREEN INFRASTRUCTURE

1. **Leverage advances in climate modeling and projection**
   AI is used to estimate the impact of future climate-related disturbances and urban processes, like land-use changes, disease vectors, sea levels rise, weather extremes, and infrastructure failure.[69] To construct effective coastal infrastructure, the City of New Haven's recently formed Climate Emergency Mobilization Task Force must work with local and federal agencies to more accurately pinpoint the local impact of climate-related disturbances. Artificial neural networks (ANNs) are useful in this context because they can uncover new insights into climate variability and change, which is essential for land-use planning and to adapt infrastructure systems to become more resilient.[19,69]

CIRCULAR STOCKHOLM

The Swedish government has been a pioneer in the application of systems thinking and holistic policy-making to increase self-sufficiency and circularity within its urban districts. Stockholm's spatial plan, sustainable development strategy, and climate action plan all incorporate circular city strategies. The city's waterfront ecodistricts, Hammarby Sjostad and Stockholm Royal Seaport, have made use of "ecocycles" to create circular resource loops that integrate waste, energy, water, and transport systems. Waste to energy technology on both sites is a noteworthy component of the city's circular approach; more than 90% of the country's municipal waste is diverted from landfills and used to generate energy. In Hammarby, climate adaptive environments have been built into the district using an array of smart communication and engagement methods.[166] In the predevelopment stages of Stockholm Royal Seaport, the public was engaged through a digital platform and on-site open house. This process also engaged developers and services providers at a very early stage to create a more integrated vision. Ultimately, this collaboration set the stage for successful looping actions, a more engaged community, and ongoing digital monitoring of integrated infrastructure.[77] The two developments have generally been regarded as successful examples of modeling urban infrastructural ecologies, which shows that all parts of an urban system are connected and that infrastructure should be planned as such. This smart approach to city planning has also been bolstered by the use of ICT. Circularity inspired the technologies and service systems used in Hammarby to deliver reduced resource consumption and contribute to the promotion of sustainable lifestyles.[135]

CONCLUSION

The new Long Wharf has the potential to lead in the push toward truly sustainable and equitable communities. The present document represents one pathway forward to achieve this vision holistically.

Because waterfront redevelopments require multiple skills and hands-on attention, a natural next step in the redevelopment process establishes a strong leadership team made up of government employees, local stakeholders, and other specialists. These relationships will form the cornerstone of ongoing governance for the new Long Wharf District. This team will likely launch ongoing communication with developers, who are often a key leader in taking on complex projects, but may not be likely champions in balancing goals for sustainability and equity with profitability. Ultimately, forging meaningful relationships with a variety of specialists, from hydrologists to social scientists, makes all the difference in successful waterfront developments.[89]

The development of these guidelines was informed by an ecological understanding of New Haven's urban processes to set the stage for the next phase of the Long Wharf project. Along with an extensive exploration of sustainable approaches to waterfront revitalization, case study research on several waterfront eco-districts from North America and Europe informed recommended strategies to achieve project goals. Although this document highlights the successes of these projects, a common takeaway highlights the gap between the expectation of development frameworks and the reality of how they are implemented and perform. In many of these cases, the outcomes of sustainable development reveal that guided frameworks often only make modest progress in the shift to new, highly sustainable and equitable paradigms.[122]

Using a systems-based approach to understand New Haven's unique social and environmental conditions is valuable, but a prescriptive approach to development using guidelines can only go so far. The present document pushes sustainability and equity to their limit within current economic and political paradigms; however, guidelines do not remove the systemic barriers inherent to these paradigms. Effecting change from "the inside" intrinsically operates under the conditions of monopoly capitalism.[152] Until the fundamental causes of inequity and the climate crisis are wholly addressed, transformative justice will be difficult to achieve.

Nevertheless, the politics of urban planning are changeable, and our cities are constantly evolving. When the systems that impact our communities are made legible, it will become easier to dismantle the structures and institutions that limit truly sustainable development.

GLOSSARY

Agroforestry	Agriculture incorporating the cultivation and conservation of trees.
Anoxic (anaerobic) respiration	Anaerobic respiration transfers energy from glucose to cells and occurs when oxygen is not present. Anaerobic respiration can be used to treat waste and create energy via the natural function of microscopic organisms, bacteria, and other invertebrates.
Artificial Neural Networks (ANN)	An interconnected group of nodes, inspired by a simplification of neurons in the brain. It is the product and foundation of artificial intelligence and solves problems that would otherwise be impossible or difficult to solve by a human or statistical standards.
Berm	A natural or man-made elevated landscape feature or ridge made up of compacted soil, which channels water to a particular or desired location.
Biodiversity hotspot	A biogeographic region with significantly levels of biodiversity that is threatened by human habitation.
Bioretention	The process in which containments and sedimentation are removed from stormwater runoff.
Bioswales	Channels designed to concentrate and infiltrate stormwater runoff while removing debris and pollution.
Blockchain	A system in which a record of transactions can be made in a digital platform, potentially increasing service provision in a given community.
Breakwater	A man-made structure located in a harbor or shoreline area, which protects the shoreline from waves and choppy water.
Bulkhead	A dividing wall or barrier between the shoreline and body of water.
Capping	Capping involves covering contaminated soil with one or more layers of material, such as sand, gravel, or membranes in an effort to physically or chemically immobilize contaminants.
Carbon sink	A natural environment that can absorb carbon dioxide from the atmosphere, such as a forest, ocean, or soil.

Closed-loop	The complete path followed by a signal as it is fed back from the output of a system to the input and then back to the output (e.g. food waste converted to compost and compost generating food).
Circularity	A system of closed loops in which components of system are continuously reused and recycled and contribute toward the function of one of more interconnected systems. Circularity reduces the use of raw materials and maximizes the use and lifespan of products and components to generate long-term sustainability.
Complete streets	A transportation policy and design approach that requires streets to be planned, designed, operated, and maintained to enable safe, convenient, and comfortable travel and access for all users, regardless of their mode of transportation.
Daylighting	The illumination of buildings by natural light; or, the process of restoring a previously covered or degraded streambed.
Decommodified housing	Housing that is removed from the commodified real estate market. It operates under the belief that all people have the right to adequate shelter and housing.
Disinvestment	The withdrawal from or reduction of an investment. Often used in urban planning to describe the process through which governments and other entities fail provide adequate services for a particular place or community.
District energy	Networks of hot and cold water pipes that are used to efficiently heat and cool buildings in a given place, community, or district.
Ecological function	The capacity of an ecosystem to fulfill its natural processes.
Ecosystem services	Ecosystem services are the benefits people and society attain from ecosystems and natural resources. They are comprised of provisioning (e.g. flood control; food and water resources), cultural (e.g. recreation; spiritual value), and supporting (water purification; nutrient cycling) services.
Estuarine	Estuaries are usually coastal zones where rivers flow into the sea, resulting in a brackish water ecosystem made up of wetlands and open water. Estuaries are home to unique plant and animal communities, are extremely biodiverse, and are vulnerable to human disturbances.

FEMA	FEMA stands for the Federal Emergency Management Agency, which is a sector of the United States Department of Homeland Security and coordinates the response to a disaster that has occurred in the United States and that overwhelms the resources of local and state authorities.
Fill	Man-made deposits of natural soils and rock products, which may also include organic matter and waste materials.
Habitat baskets	Containers of various sizes that are often attached to sea walls or other submerged coastal infrastructure, which allow plants and other sea life to colonize the structure. They are used to attract biodiversity to the water's edge, which can serve to filter nutrients and pollution.
Information & Communications Technology (ICT)	An umbrella term that includes any communication device, encompassing radio, computer and network hardware, satellite systems, etc. It includes various physical hardware components that support these technologies.
Infill development	The process of developing vacant or under-used parcels within existing urban areas that are already largely developed.
Imperious surface	Surfaces or materials that impede or prevent the infiltration of water into the soil.
Income-restricted units	Apartment or housing units that have maximum income caps which determine eligibility, helping lower-income people secure housing and tenure.
Inundation	An overwhelming flow of water during an extreme weather event, such as storm surge during a hurricane, which causes flooding in areas that are typically able to manage normal water flows and precipitation events.
Life-cycle costing	The process of estimating how much money will be spent on an asset or infrastructure over the course of its useful life. Also called whole-life costing, it incorporates maintenance costs and other sustainability concerns into a costing approach to determine the true expense.
Living shorelines	A protected, stabilized coastal edge made of natural materials, usually including sea grass, coastal shrubs and plants, sand, and rocks. Living shorelines are constructed to mimic natural coastal ecosystems to provide both mitigate extreme weather and natural process and adapt to changes in coastal composition due to climate change.

Living walls	An interior or exterior wall that is covered with greenery in soil or some other type of substrate.
Microclimates	The climate of a very small or restricted area, especially when it differs from the climate of the surrounding area. Microclimates can be in both natural and/or built environments.
Micromobility	Transportation using lightweight travel modes, such as bicycles and scooters. Often electrified and part of a self-service rental program, they allow people to rent vehicles for short-duration trips within a town or city.
Nature-based features	Natural features are man-made landscape elements that mimic the structure and function of ecosystems or ecosystem components. They are created by human design and engineering and can mitigate the impacts of disturbances, as well as increase ecological function (e.g. marshland restoration to mitigate storm surge).
Oyster reefs	A structure designed to attract oysters and other sea life and mitigate waves. Also called oyster castles, they are constructed of natural or man-made material and placed at the bottom of a harbor or coastal water body and act as a breakwater in choppy waters.
Permaculture	The development of agricultural ecosystems intended to be sustainable and self-sufficient.
Pay-as-you-throw	A usage-pricing model for disposing municipal solid waste. Users are charged a rate based of how much waste and present for collection to the municipality or local authority.
Phenology	The study of cyclic and seasonal natural phenomena, especially in relation to climate and plant and animal life.
Prescriptive zoning	A zoning methodology which designates permitted uses and how development may proceed in particular locations.
Primary energy	An energy form found in nature that has not been subjected to any human engineered conversion process (e.g., sunlight’s warming potential for building interiors).
Revetments	Revetments are sloping erosion-resistant structures that stabilize soil and protect shorelines from water inundation and disturbances.

Regenerative urban design	Urban design based on an environmentally restorative and reciprocal relationship between natural systems and the components of built environment.
Setbacks	A minimum distance in which a building or other structure must be set back from a street or shoreline.
Sharing economies	An economic system in which assets or services are shared between individuals, either through a fee or another informal means of compensation.
Sills	Sills are inconspicuous mounds placed offshore to retain sediment, protect against erosion, and elevate areas close to shorelines. Sills can be made of natural or man-made materials and are typically located beyond a fringe marsh or beach.
Storm surge	Storm surge is the rise in the coastal water level as a result of an extreme weather event, such as a hurricane or nor'easter. The storm surge height is the difference between the observed storm tide and the astrological normal tide.
Swimming embankment	A hardscape fortification that serves the purpose of coastal flood control and recreation. Embankments usually slope or step down towards the water's edge to allow for swimming.
Tidal wetland planters	Human designed and engineered wetland gardens, which allow water to infiltrate into a layer of gravel and substrate and incorporate coastal wetland plant species.
Triple bottom line (TBL)	The idea in economics that companies and developers should commit to focusing on social and environmental concerns as much as profits.
Vertical ocean farms	Systems of underwater vertical gardens for the purpose of food production, which uses the length of a column of water to raise shellfish and sea vegetables.

WORKS CITED

In-text citations

1. Abraham, M. (2014). How Transportation Problems Keep People Out of the Workforce in Greater New Haven. DataHaven: Greater New Haven Job Access and Transportation Working Group. https://www.ctdatahaven.org/sites/ctdatahaven/files/DataHaven_TranspRpt_WEB_pgs.pdfhttps://www.ctdatahaven.org/sites/ctdatahaven/files/DataHaven_TranspRpt_WEB_pgs.pdf.
2. Abraham, M., Seaberry, C., Ankrah, J., Bourdillon, A., Davila, K., Finn, E., McGann, S., Nathan, A. (2019). Greater New Haven Community Index 2019. DataHaven. https://www.cfgnh.org/articles/greater-new-haven-community-index-2019#:~:text=Greater%20New%20Haven%20Community%20Index%202019%3A%20Understanding%20Well%2DBeing%2C,region%2C%20and%20uncover%20the%20opportunities.
3. The Advocates for Human Rights. (n.d). The Right to Housing. https://www.theadvocatesforhumanrights.org/right_to_housing.
4. Akbay, A., Davis, E., Morales, M., Vergara Greeno, R. (2018). Asthma: A Health Justice Issue in New Haven, CT: An overview of the asthma burden in New Haven. Yale Global Health Justice. law.yale.edu/sites/default/files/area/center/ghjp/documents/asthma_issue_brief_november_2018.pdf.
5. Albert, C., Schröter, B., Haase, D., Brillinger, M., Henze, J., Herrmann, S., Gottwald, S., Guerrero, P., Nicolas, C., & Matzdorf, B. (2019). Addressing societal challenges through nature-based solutions : How can landscape planning and governance research contribute? Landscape & Urban Planning, 182, 12-21. https://doi.org/10.1016/j.landurbplan.2018.10.003.
6. Alberti, M., Eric P Palkovacs, Simone Des Roches, Luc De Meester, Kristien I Brans, Lynn Govaert, Nancy B Grimm, Nyeema C Harris, Andrew P Hendry, Christopher J Schell, Marta Szulkin, Jason Munshi-South, Mark C Urban, Brian C Verrelli. (2020). The complexity of urban eco-evolutionary dynamics. Bioscience, (20200826). https://doi.org/10.1093/biosci/biaa079
7. Angelo, H. and Wachsmuth, D. (2015). Urbanizing Urban Political Ecology: A Critique of Methodological Cityism. International Journal of Urban and Regional Research. DOI:10.1111/1468-2427.12105
8. Appleton, J. (2020). Cyber security and data protection for smart cities. Bee smart city. hub.beesmart.city/en/strategy/the-importance-of-cyber-security-and-data-protection-for-smart-cities.
9. Appleyard, B. S., Frost, A. R., & Allen, C. (2019). Are all transit stations equal and equitable? calculating sustainability, livability, health, & equity performance of smart growth & transit-oriented-development (tod). Journal of Transport & Health, 14. https://doi.org/10.1016/j.jth.2019.100584
10. Araya D. (2015) Smart Cities and the Network Society: Toward Commons-Driven Governance. In: Araya D. (eds) Smart Cities as Democratic Ecologies. Palgrave Macmillan, London.
11. Arquin, A., Pignoly, A., and Godin, J. (2020). City of Montreal Publishes New Draft of Bylaw 20-20-20 on Social, Affordable and Family Housing. Davies. https://www.dwpv.com/en/Insights/Publications/2020/Nouveau-projet-du-reglement-20-20-20
12. August, M. & Tolfo, G. (2018). Inclusionary Zoning: Insights from international experience. Plan Canada. DOI: 10.25316/IR-15019
13. Austin, Gary. (n.d.) Case Study and Sustainability Assessment of Bo01, Malmo, Sweden. Journal of Green Building. DOI: 10.3992/jgb.8.3.34
14. Austin, G., & Yu, K. (2016). Constructed Wetlands and Sustainable Development. Routledge.
15. Avni, N., & Fischler R. (2020). Social and environmental justice in waterfront redevelopment: the anacostia river, Washington, D.C. Urban Affairs Review, 56(6), 1779–1810. https://doi.org/10.1177/1078087419835968

16. Avni, N., & Treschner, N. (2019). Urban waterfronts: contemporary streams of planning conflicts. Journal of Planning Literature, 34(4), 408–420. https://doi.org/10.1177/0885412219850891
17. Bain, L., & Sizov, C. (2013) Seattle Design Guidelines. City of Seattle Department of Planning and Development. http://www.seattle.gov/Documents/Departments/OPCD/Vault/CitywideDesignGuidelinesUpdate/SeattleDesignGuidelines.pdf.
18. Barber, M. (2018). 11 ugly urban underpasses now functioning as public parks. Curbed. https://archive.curbed.com/2017/1/9/14183876/freeway-underpass-park-public
19. Barnes, E. A., Hurrell, J. W., Ebert-Uphoff, I., Anderson, C., & Anderson, D. (2019). Viewing forced climate patterns through an ai lens. Geophysical Research Letters, 46(22), 13389–13398. https://doi.org/10.1029/2019GL084944
20. Barrett, J. (2011). Connecticut Coastal Planting Guide. Connecticut Sea Grant College Program. https://cipwg.uconn.edu/wp-content/uploads/sites/244/2013/12/CTCoastal_planting.pdf
21. Basile, P., & Ehlenz, M. (2020) Examining responses to informality in the Global South: A framework for community land trusts and informal settlements. Habitat International, 96. https://doi.org/10.1016/j.habitatint.2019.102108
22. Basso, G., Vaudrey, M.P., O'Brien, K., & Barrett, J. (2018) Advancing Coastal Habitat Resiliency Through Landscape-Scale Assessment. Coastal Management, , 46(1), 19–39. https://doi.org/10.1080/08920753.2018.1405328
23. Bernhardt, J., & O'Connor, M. (2021). Aquatic biodiversity enhances multiple nutritional benefits to humans. Proceedings of the National Academy of Science of the United States of America. 118(15). https://doi.org/10.1073/pnas.1917487118
24. Berst, J., Enbysk, L., Ebi, K., Cooley, D., & Peeples, D. (2015). Smart Cities Readiness Guide : The planning manual for building tomorrow's cities today. Smart Cities Council. http://www.estudislocals.cat/wp-content/uploads/2016/11/SmartCitiesReadinessGuide.pdf.
25. Bibri, S., & Krogstie, J. (2020). Smart eco city strategies and solutions for sustainability: the cases of royal seaport, Stockholm, and western harbor, Malmö, Sweden. Urban Science, 4(1). https://doi.org/10.3390/urbansci4010011.
26. Bitzer, B., & Gebretsadik, E.S. (2014). Cloud computing framework for smart grid applications. 2013 48th International Universities' Power Engineering Conference (UPEC), 2013, pp. 1-5. https://doi.org/10.1007/978-3-642-31656-2
27. Blomley, N. (2019) Precarious territory: Property law, housing and the socio-spatial order. Antipode, 52(1), 36–57. https://doi.org/10.1111/anti.12578
28. Bornstein, L., Leetmaa, K., 2015. Moving Beyond Indignation: Stakeholder Tactics, Legal Tools and Community Benefits in Large-Scale Redevelopment Projects. Oñati Socio-legal Series [online], 5 (1), 29-50.
29. Bouffard, L., Miley, D., Piana, M., & Strobo, R. (2011) An Ecosystem Serives Plan for Yale's Central Campus. Yale Sustainability. https://www.yumpu.com/en/document/view/36712724/an-ecosystem-services-plan-for-yales-central-campus
30. Breen, T. (2020). Crew Readies Inclusionary Zoning Push. New Haven Independent. https://www.newhavenindependent.org/index.php/archives/entry/inclusionary_zoning/
31. Brown, Z., Cole, R. J., Robinson, J., & Dowlatabadi, H. (2010). Evaluating user experience in green buildings in relation to workplace culture and context. Facilities, 28(3-4), 225–238.
32. Buchanon, M., & Abraham, M. (2015). Concentrated Wealth and Poverty in Connecticut's Neighborhoods. Data Haven. https://www.ctdatahaven.org/reports/concentrated-wealth-and-poverty-connecticuts-neighborhoods.
33. Byrne, F. (2020). Green Infrastructure and Stranded Landscapes. From Waste matters: adaptive reuse for productive landscapes (eds). Routledge.
34. Cantor, S. L., & Peck, S. W. (2008). Green roofs in sustainable landscape design (1st ed.). W.W. Norton.
35. Chakraborty, T., & Lee, X. (2019). A simplified urban-extent algorithm to characterize surface urban heat islands on a global scale and examine vegetation control on their spatiotemporal variability. International Journal of Applied Earth Observations and Geoinformation, 74, 269–280.
36. Chang, T. C., and Shirlena Huang. 2011. "Reclaiming the City: Waterfront Development in Singapore." Urban Studies 48 (10): 2085–100.
37. Cheung, Darren Man-wai, and Bo-sin Tang. (2015). Social Order, Leisure, or Tourist Attraction? The Changing Planning Missions for Waterfront Space in Hong Kong. Habitat International, 47, 231–40.
38. Climate and Sustainability Framework. (2018). City of New Haven. Retrieved from https://www.newhavenct.gov/civicax/filebank/blobdload.aspx?blobid=31458

39. CityData. (2019). Newhallville neighborhood. https://www.city-data.com/neighborhood/Newhallville-New-Haven-CT.html
40. City of Halifax. (2021). Burnside Industrial Park. https://www.halifax.ca/business/business-parks/business-industrial-parks/burnside-industrial-park
41. City of New Haven. (2017). Consolidated Housing and Community Development Annual Action Plan. https://www.newhavenct.gov/civicax/filebank/blobdload.aspx?blobid=30492.
42. City of New Haven. (2021). Greenways & Cycling Systems. (https://www.newhavenct.gov/gov/depts/city_plan/plans_n_projects/greenways_n_cycling_systems.htm
43. City of New Haven. (2021). New Haven's History. https://www.newhavenct.gov/gov/about_us/new_haven%E2%80%99s_history.htm
44. City of New Haven. (2021). Planning & Infrastructure. https://www.newhavenct.gov/gov/depts/ed/planning_n_infrastructure.htm.
45. City of New Haven & GZA GeoEnvironmental, Inc. (2017). Long Wharf Flood Protection Study Final Report. https://portal.ct.gov/-/media/DOH/Sandy_Relief_Docs/Planning_Docs/T-1-LongWharfFloodProtectionFinalReport.pdf
46. City of Tacoma, Washington. (2013). Tacoma Waterfront Design Guidelines. City of Tacoma & AECOM.https://cms.cityoftacoma.org/Planning/OneTacomaPlan/RelationshipToOthers/TacomaShorelineDesignGuidelines.pdf.
47. City of Victoria. (2016). Dockside Green Urban Design Guidelines. https://www.victoria.ca/assets/Departments/Planning~Development/Development~Services/Documents/Urban%20Design%20Guidelines%20-%20Dockside%20Green%20-%20December%202016.pdf.
48. Coastal Green Infrastructure and Ecosystem Services Task Force. (2015). Ecosystem-Service Assessment: Research Needs for Coastal Green Infrastructure. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/cgies_research_agenda_final_082515.pdf.
49. Connecticut Audubon. (n.d). Spring Migration FAQs. https://ct.audubon.org/news/spring-migration-faqs
50. Connecticut Department of Energy & Environmental Protection. (2016). 2016 Comprehensive Materials Management Strategy: the Connecticut Solid Waste Management Plan. https://portal.ct.gov/-/media/DEEP/waste_management_and_disposal/Solid_Waste_Management_Plan/CMMSFinalAdoptedComprehensiveMaterialsManagementStrategypdf.pdf.
51. Connecticut Department of Energy & Environmental Protection. (2020). 2020 Integrated Resources Plan. https://portal.ct.gov/-/media/DEEP/energy/IRP/2020-IRP/2020-CT-DEEP-Draft-Integrated-Resources-Plan-in-Accordance-with-CGS-16a-3a.pdf.
52. Connecticut Department of Energy & Environmental Protection. (2015). Chapter 2: Key Fish and Wildlife Habitats, from 2015 Connecticut Wildlife Action Plan. https://portal.ct.gov/-/media/DEEP/wildlife/pdf_files/nongame/CTWAP/CTWAPChapter2pdf.pdf
53. Connecticut Department of Energy & Environmental Protection. (2021). List of Contaminated or Potentially Contaminated Sites. https://portal.ct.gov/-/media/DEEP/site_clean_up/sites/contaminatedsitesnrpdf.pdf?la=en.
54. Connecticut Department of Housing. (2020). Planning for Affordability in Connecticut: Affordable Housing Plan and Process Guidebook. https://portal.ct.gov/-/media/DOH/AHPP-Guidebook_RPA_120120.pdf
55. Connecticut Department of Transportation. (2018). Connecticut's Statewide Long-Range Transportation Plan 2018-2050. https://portal.ct.gov/-/media/DOT/documents/dpolicy/lrp/2018lrp/FINALConnecticutSLRTP20180313pdf.pdf.
56. Connecticut Housing Finance Authority. (2021). Construction Guidelines: Project Planning & Technical Services Review. https://portal.ct.gov/-/media/DOH/2021ConstnGuidelines-ProjectPlanningTechReview.pdf
57. Corner, D.B., Fillinger, J.C., & Kwok, A.G. (2017). Passive House Details: Solutions for High-Performance Design (1st ed.). Routledge.
58. Davis, J.E. (2010). More than money: What is shared in shared equity homeownership? Journal of Affordable Housing & Community Development Law, 19(3 & 4), 259-277.
59. Davoudi, S., Cowell, R., White, I., & Blanco, H. (Eds.). (2020). The Routledge companion to environmental planning (Ser. Routledge companions). Routledge.
60. Day, C., & Gwilliam, J. P. (2019). Living architecture, living cities: soul-nourishing sustainability. Routledge.
61. Derosa, M. (2021). Wetland Design and Implementation. Ecological Landscape Alliance. https://www.ecolandscaping.org/03/designing-ecological-landscapes/wetland-design-implementation/.
62. DeSegregate Connecticut. (2021). 2021 Legislative Reforms. https://www.desegregatect.org/hb6107.

63. De, S., Bandyopadhyay, S., Assadi, M., & Mukherjee, D. A. (Eds.). (2018). Sustainable energy technology and policies : a transformational journey (Vol. Volume 2 /, Ser. Green energy and technology). Springer. https://doi.org/10.1007/978-981-10-8393-8.
64. Des Roches, S., Brans, K. I., Lambert, M. R., Rivkin, L. R., Savage, A. M., Schell, C. J., Correa, C., De, M. L., Diamond, S. E., Grimm, N. B., Harris, N. C., Govaert, L., Hendry, A. P., Johnson, M. T. J., Munshi-South, J., Palkovacs, E. P., Szulkin, M., Urban, M. C., Verrelli, B. C., & Alberti, M. (2021). Socio-eco-evolutionary dynamics in cities. Evolutionary Applications, 14(1), 248–267. https://doi.org/10.1111/eva.13065.
65. Donnelly, C. (2020). Connecticut's Forest – A Legacy of Change in Today's Forest. Connecticut Department of Energy and Environmental Projection.
66. Dyson, K. & Yocom, K. (2015). Ecological Design for urban waterfronts. Urban Ecosystems , 18(1), 189–208. https://doi.org/10.1007/s11252-014-0385-9.
67. El-Haggar, S. (2007). Sustainable Industrial Design and Waste Management: Cradle-to-Cradle for Sustainable Development. Elsevier Academic Press.
68. Elicker, J. (2020). Tax Connecticut's Segregation. Connecticut Mirror. R https://ctmirror.org/category/ct-viewpoints/lets-tax-segregation-justin-elicker/.
69. Elisabete, A. S. (2010). Artificial intelligence solutions for urban land dynamics: a review. J Journal of Planning Literature, 24(3), 246–265. https://doi.org/10.1177/0885412210361571
70. Enclosure - Global Africa Lab in conversation with Justin Moore. African Mobilities 2.0. https://africanmobilities.org/podcasts.html
71. Environmental Services Division. (2007). The Bioretention Manual. Department of Environmental Resources, Prince George's County, Maryland. https://portal.ct.gov/-/media/DEEP/p2/raingardens/BioretentionManual2009Versionpdf.pdf.
72. Eviction Lab. (2016). Top Evicting Large Cities in the US. https://evictionlab.org/rankings/#/evictions?r=United%20States&a=0&d=evictionRate&lang=en
73. Farmington Valley Trails Council & The Farmington Canal Rail-to-Trail Association. (2020). Farmington Canal Heritage Trail. https://fchtrail.org/pages/default.asp
74. Fezi, B. A. (2020). Health engaged architecture in the context of covid-19. Journal of Green Building, 15(2), 185–212. https://doi.org/10.3992/1943-4618.15.2.185
75. Fishman, T., & Flynn, M., (2018). Using public-private partnerships to advance smart cities. Deloitte. https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Public-Sector/gx-ps-public-private-partnerships-smart-cities-funding-finance.pdf.
76. Fowler, K. (2019). Dockside Green: The story of the Most Sustainable Development in the World. Tellwell.
77. Fraker, H. (2013). The hidden potential of sustainable neighborhoods: lessons from low-carbon communities. Island Press.
78. FVB Energy Inc. (2021). What Is District Energy? https://www.fvbenergy.com/what-is-districtenergy/#:~:text=District%20Energy%20Systems%20are%20networks,their%20own%20boilers%20and%20chillers.
79. Gagnon, T.K., Koteas, G.C., Steinen, R.P., Ryan, A., & Thomas, M.A. (2013). Connecticut Geothermal Energy Project: Heat Production. Connecticut Geological and Natural History Survey. https://portal.ct.gov/-/media/DEEP/geology/geothermal/HeatProdmappdf.pdf.
80. Gann, G. D., McDonald, T., Walder, B., Aronson, J., Nelson, C. R., Jonson, J., Hallett, J. G., Eisenberg, C., Guariguata, M. R., Liu, J., Hua, F., Echeverría Cristian, Gonzales, E., Shaw, N., Decleer, K., & Dixon, K. W. (2019). International principles and standards for the practice of ecological restoration. second edition. Restoration Ecology, 27, 46. https://doi.org/10.1111/rec.13035
81. Gaston, K. J. (2010). Urban Ecology (Ser. Ecological reviews). Cambridge University Press.
82. Green, B. (2020). The Smart Enough City. MIT Press
83. Green Infrastructure Ontario Coalition. (2020). An Economic Impact Assessment of the Green Infrastructure Sector in Ontario. https://d3n8a8pro7vhmx.cloudfront.net/greenbelt/pages/12304/attachments/original/1590692335/Economic-Impact-Assessment-of-GI-Sector-in-Ontario_Online.pdf?1590692335.
84. Greenwave (2020). Regenerative Ocean Farming. https://www.greenwave.org/our-model.
85. Greenwood, J. (2017). The rise of the hub: how innovation is moving downtown (Ser. Mars white paper). MaRS Discovery District.
86. Hall, M. H. P., & Balogh, S. B. (Eds.). (2019). Understanding Urban Ecology: An Interdisciplinary Systems Approach. Springer Nature.
87. Han, M., & Nguyen, D. C. (2018). Hydrological Design of Multipurpose Micro-catchment Rainwater Management. IWA Publishing.
88. Hawken, P. (Ed.). (2017). Drawdown: the Most Comprehensive Plan Ever Proposed to Reverse Global Warming. Penguin Books.
89. Hersh, B. (2012). The Complexity of Urban Waterfront Redevelopment. NAIOP Research Foundation. www.naiop.org/media/research-reports.
90. Hill, K. (2015). Coastal infrastructure: a typology for the next century of adaptation to sea-level rise. Frontiers in Ecology and the Environment, 13(9), 468-476.

91. Hirt, S. (2014) Zoned in the USA: The origins and implications of American land use regulation. Cornell University Press.
92. Hitchmough, J. (2008). New approaches to ecologically based, designed urban plant communities in Britain: do these have any relevance in the United States? Cities and the Environment. 1(2), 10-15.
93. Hong, J. (2012). Beyond Prescriptive Zoning. From Ecological Urban Architecture: qualitative approaches to sustainability (eds.). Birkhauser Architecture.
94. Imbroscio, D. (2019) Rethinking Exclusionary Zoning or: How I stopped worrying and learned to love it. Urban Affairs Review, 1-38. https://doi.org/10.1177/1078087419879762
95. Ito, K. (Ed.). (2021). Urban Biodiversity and Ecological Design for Sustainable Cities. Springer.
96. Ives, C. D., & Kelly, A. H. (2016). The coexistence of amenity and biodiversity in urban landscapes. Landscape Research, 41(5), 495–509. https://doi.org/10.1080/01426397.2015.1081161
97. James, P., Tzoulas, K., Adams, M. D., Barber, A., Box, J., Brueste, J., et al. (2009). Towards an integrated understanding of green space in the European built environment. Urban Forestry & Urban Greening. 8(2), 65–75. https://doi.org/10.1016/j.ufug.2009.02.001
98. Jefferson, B. J. (2018). Predictable policing: predictive crime mapping and geographies of policing and race. Annals of the American Association of Geographers, 108(1), 1–16. https://doi.org/10.1080/24694452.2017.1293500.
99. Karamanos, P. (1997). Cogeneration and district heating: constraints and opportunities. The Journal of Energy and Development, 22(2), 245–274.
100. Kim, J. K., Kraemer, G. P., & Yarish, C. (2015). Use of sugar kelp aquaculture in long island sound and the bronx river estuary for nutrient extraction. Marine Ecology Progress Series, 531, 155–166.
101. Küster, F. and Peters, M. (2018). Making buildings fit for sustainable mobility – Comparing regulations for off-street bicycle and car parking in Europe. European Cyclists' Federation. https://ecf.com/sites/ecf.com/files/Kuster.F_Making_Buildings_Fit_for_Sustainable_Mobility.pdf.
102. Lee, S., McCarty, G. W., Moglen, G. E., Li, X., & Wallace, C. W. (2020). Assessing the effectiveness of riparian buffers for reducing organic nitrogen loads in the coastal pla in of the chesapeake bay watershed using a watershed model. Journal of Hydrology, 585. https://doi.org/10.1016/j.jhydrol.2020.124779
103. LEED. (n.d.) LEED Certification for New Buildings. https://www.usgbc.org/leed/rating-systems/new-buildings.
104. LEES Associates, A. Berland Inc, British Columbia Provincial Health Services Authority, & Gibson Library Connections, Inc. (2007). From strategy to action: case studies on physical activity and the built environment. Provincial Health Services Authority.
105. Lefcheck, J. S., Orth, R. J., Dennison, W. C., Wilcox, D. J., Murphy, R. R., Keisman, J., Gurbisz, C., Hannam, M., Landry, J. B., Moore, K. A., Patrick, C. J., Testa, J., Weller, D. E., & Batiuk, R. A. (2018). Long-term nutrient reductions lead to the unprecedented recovery of a temperate coastal region. Proceedings of the National Academy of Sciences of the United States of America, 115(14), 3658–3662. https://doi.org/10.1073/pnas.1715798115
106. Macharis, C., & Keseru, I. (2018). Rethinking mobility for a human city. Transport Reviews, 38(3), 275–278. https://doi.org/10.1080/01441647.2018.1423612
107. Magdoff, F. & Van Es, H. (2009). Building Soils for Better Crops: Sustainable Soil Management (third edition). Sustainable Agriculture Research and Education program. University of Nebraska Press.
108. Manou, D., Baldwin, A., Cubie, D., Mihr, A., & Thorp, T. M. (Eds.). (2017). Climate Change, Migration and Human Rights : law and policy perspectives (Ser. Routledge studies in environmental migration, displacement and resettlement). Routledge.
109. UConn MAGIC Map and Geographic Information Center. (2021). Map of New Haven 1641. http://magic.lib.uconn.edu/
110. Marchant, N. (2020). Paris halves street parking and asks residents what they want to do with the space. World Economic Forum. https://www.weforum.org/agenda/2020/12/paris-parking-spaces-greenery-cities/.
111. MaRS Discovery District (2021). What we do. https://www.marsdd.com/what-we-do/
112. Massachusetts Institute of Technology (2021). MIT Central Utilities Plant. https://powering.mit.edu/project-faqs/cogeneration
113. Matsipa, M. (2017) Woza! Sweetheart! On braiding epistemologies on Bree Street. Thesis Eleven, 141(1), 31-48. https://doi.org/10.1177/0725513617720241.
114. McCarthy, K. (2008). LEED Standards and State Requirements. OLR Research Report. https://www.cga.ct.gov/2008/rpt/2008-R-0162.htm

115. McDonald, L. (2014). Dockside Green Wastewater Treatment Plant: A review of plant performance and regulatory compliance. City of Colwood. https://colwood.civicweb.net/document/82764
116. McNamara, S., Sagastume, J., Taitz, R. (2014). A People's Guide to Infrastructure in New Haven: Energy. Yale Campus Press. https://campuspress.yale.edu/infrastructurenewhaven/energy/
117. McPhearson, T., Pickett, S. T. A., Grimm, N. B., Niemelä Jari, Alberti, M., Elmqvist, T., Weber, C., Haase, D., Breuste Jürgen, & Qureshi, S. (2016). Advancing urban ecology toward a science of cities. Bioscience, 66(3), 198–212. https://doi.org/10.1093/biosci/biw002
118. McPherson, G., Simpson, J., Peper, P., Gardner, S., Vargas, K., Xiao, Q. (2007) Northeast Community Tree Guide. US Department of Agriculture and Forest Service. https://www.fs.fed.us/psw/publications/documents/psw_gtr202/psw_gtr202.pdf.
119. Moore, C., Rainwater, B., & Stahl, E. (2018). Blockchain in Cities: restoring trust and transparency in digital transactions. National League of Cities.
120. Muller, J., & Le Petit, Y. (2019). Low-Emission Zones are a success - but they must now move to zero-emission mobility. Transport & Environment. https://www.transportenvironment.org/sites/te/files/publications/2019_09_Briefing_LEZ-ZEZ_final.pdf.
121. National Disaster Weather Team (1995). Mariners Weather Log. NOAA. https://www.vos.noaa.gov/mwl.shtml
122. Oliver, A. (2018) Lessons learned from eco-district pilot projects: the importance of stakeholder relations. https://papyrus.bib.umontreal.ca/xmlui/handle/1866/21679 (PhD thesis, advisor Daniel Pearl)
123. Oranges Are Not the Only Fruit: Varieties of Housing Land Trusts. (in press). Journal of Planning Education and Research.
124. Paris En Commun. (2021). Idees en comun. https://ideesencommun.org/notre-manifeste/
125. Passive Housing Buildings. (2018). Connecticut Reaffirms Passive Affordable Housing. http://passivehousebuildings.com/magazine/fall-2018/connecticut-passive-affordable-housing/.
126. Pataki, D. (2015). Grand challenges in urban ecology. Frontiers in Ecology and Evolution. https://doi.org/10.3389/fevo.2015.00057
127. Pennsylvania Land Trust Association. (2019). Transfer of Development Rights. conservationtools.org.
128. Phillips, S. (2020). The Affordable City. Island Press.
129. Priest, W. (2019). Practical Living Shorelines: Tailored to Fit in Chesapeake Bay. In Living shorelines: the science and management of nature-based coastal protection (Ser. Crc marine science series). CRC Press/Taylor & Francis Group.
130. Rainer, T., & West, C. (2015). Planting in a post-wild world: designing plant communities for resilient landscapes (First). Timber Press.
131. Restrepo, V. (2015). Valdespartera ecodistrict, Zaragoza. Construction 21 International. https://www.construction21.org/city/h/valdespartera-ecodistrict-zaragoza.html
132. Richardson, V. (2001). New Vernacular Architecture. Laurence King.
133. Rodriguez, A. B., Fodrie, F. J., Ridge, J. T., Lindquist, N. L., Theuerkauf, E. J., Coleman, S. E., Kenworthy, M. D. (2014). Oyster reefs can outpace sea-level rise. Nature Climate Change, 4(6), 493–497.
134. Roy, A. (2019) Interview: UCLA's Ananya Roy on Housing Inequality and Market-Driven Displacement. The Planning Report, May 27, 2019.
135. Rutherford J. (2020) Infrastructure Integration and Eco-City Futures: Permeability and Politics of the Closed Loop of Hammarby Sjöstad. In: Redeploying Urban Infrastructure. Palgrave Macmillan, Cham.
136. Sakellariou, N. (2018). Life Cycle Assessment of Energy Systems: closing the ethical loophole of social sustainability. John Wiley & Sons.
137. Schröpfer Thomas. (2012). Ecological Urban Architecture: qualitative approaches to sustainability. Birkhauser Architecture.
138. SeeClickFix, Inc. (2021). New Haven, CT. (2021). https://seeclickfix.com/new-haven.
139. Serra-Diaz, J. M., Scheller, R. M., Syphard, A. D., & Franklin, J. (2015). Disturbance and climate microrefugia mediate tree range shifts during climate change. Landscape Ecology, 30(6), 1039–1053. https://doi.org/10.1007/s10980-015-0173-9
140. Shaheen, S., Cohen, A., Dowd, M., & Davis, R. (2019). A Framework for Integrating Transportation into Smart Cities. Mineta Transportation Institute. https://transweb.sjsu.edu/sites/default/files/1705-Shaheen-Framework-Transportation-Smart-Cities.pdf.
141. Shaw, Barry. (2001). History at the Water's Edge. In Waterfronts in Post Industrial Cities, edited by Richard Marshall, 160–72. Spon Press.

142. Sheikhi, A., Rayati, M., Bahrami, S., Ranjbar, A. M., & Sattari, S. (2015). A cloud computing framework on demand side management game in smart energy hubs. International Journal of Electrical Power and Energy Systems, 64, 1007–1016. https://doi.org/10.1016/j.ijepes.2014.08.020
143. Shoreline Greenway Trail, Inc. (2021). Shoreline Greenway Trail. (https://shorelinegreenwaytrail.org/
144. Sieverts, T. (2008). Improving the quality of fragmented urban landscapes – a global challenge ! In H. Von Seggern, J. Werner, & L. Grosse-Bächle (Eds.), Creating knowledge : innovation strategies for designing urban landscapes (pp. 252–264). Berlin : Studio Urbane Landschaften / Jovis Verlag.
145. Silva, M. M. (2019). Public spaces for water: a design notebook (First, Ser. Sustainable cities research series, 3). CRC Press.
146. Simons, R., DeWine, G., & Ledebur, L. (2017). Retired, Rehabbed, Reborn: the adaptive reuse of america's derelict religious buildings and schools. Kent State University Press.
147. City of New Haven. (2016). Beyond Traffic: the Smart City Challenge. https://www.transportation.gov/sites/dot.gov/files/docs/CT%20NewHaven.pdf
148. South Central Regional Council of Governments. (2017). Southern Connecticut Regional Framework for Coastal Resilience: Legal, Policy, and Regulatory Assessment Guide. https://scrcog.org/regional-planning/coastal-resilience/.
149. State of Connecticut Department of Environmental Protection. (2009). Facing our future: biodiversity and habitat adapting to Connecticut's changing climate. https://portal.ct.gov/-/media/DEEP/air/climatechange/Adaptation/090313biodiversitypdf.pdf.
150. Stein, S. (2019) Planning Gentrification. In Capital City: Gentrification and the Real Estate State. Verso.
151. Steiner, F. (2014). Frontiers in urban ecological design and planning research. Landscape & Urban Planning, 125, 304–311. https://doi.org/10.1016/j.landurbplan.2014.01.023
152. Stoner, A. M. (2021). Things are getting worse on our way to catastrophe: neoliberal environmentalism, repressive desublimation, and the autonomous ecoconsumer. Critical Sociology, 47(3), 491–506. https://doi.org/10.1177/0896920520958099
153. Tan, P. Y. (Ed.). (2018). Nature, Place & People: forging connections through neighbourhood landscape design. World Scientific.
154. Theodos, B., Pitingolo, R., Latham, S., Stacy, C., Daniels, R., Braga, B. (2017). Affordable homeownership: An evaluation of shared equity programs. Urban Institute. www.nationalservice.gov/sites/default/files/evidenceexchange/FR_CHIP%20Final%20Report_2017.pdf.
155. Tomalty, R. (2009). The ecology of cities: urban planners are starting to see cities as complex systems that ought to be conceptualized in a way that mimics natural processes. Alternatives Journal, 35(4), 18-21.
156. Tomalty, R., & Mallach, A. (2016). America's Urban Future: Lessons from North of the Border. Island Press.
157. United Nations Economic Commission for Europe. (2020). A Handbook on Sustainable Urban Mobility and Spatial Planning: Promoting Active Mobility. https://thepep.unece.org/sites/default/files/2020-10/Handbook%20on%20Sustainable%20Urban%20Mobility%20and%20Spatial%20Planning.pdf.
158. United States Census. (2011). American Housing Survey for the United States: 2011. https://www.census.gov/library/publications/2013/demo/h150-11.html.
159. United States Census. (2019). QuickFacts New Haven, Connecticut. https://www.census.gov/quickfacts/newhavencityconnecticut
160. Vermont Agency of Natural Resources: Department of Environmental Conservation. (2021). Anaerobic Digesters. https://dec.vermont.gov/air-quality/permits/source-categories/anaerobic-digesters#:~:text=Anaerobic%20digesters%20generate%20appreciable%20quantities,namely%20methane%20and%20carbon%20dioxide.&text=by%20the%20AQCD.-,The%20combustion%20of%20the%20biogas%20in%20an%20internal%20combustion%20engine,all%20three%20produce%20air%20pollution.
161. Vermont Land Trust. (2016). Pine Island Community Farm. https://vlt.org/pineisland
162. Vollmer, D. (2009). Urban waterfront rehabilitation: can it contribute to environmental improvements in the developing world? Environmental Research Letters, 4(2). https://doi.org/10.1088/1748-9326/4/2/024003.
163. Walsh, N. (2021). 6 Steps for Designing Healthy Cities. ArchDaily. https://www.archdaily.com/918940/6-steps-for-designing-healthy-cities.
164. Waterfront Alliance. (2018). New York City Waterfront Edge Design Guidelines. http://wedg.waterfrontalliance.org/wp-content/uploads/delightful-downloads/2021/02/WEDG-Manual-Categories_extended_Hi_Res_w-Appendices_190916.pdf
165. Williams, J. (2019). Circular cities: challenges to implementing looping actions. Sustainability, 11(2). https://doi.org/10.3390/su11020423

166. Williams, J. (2021). The Routledge Handbook of Waste, Resources and the Circular Economy. (T. Tudor & C. J. C. Dutra, Eds.) (Ser. Routledge international handbooks). Routledge, Taylor & Francis Group.
167. Yale Office of Facilities (2019). Yale Design Standard from Yale Office of Facilities Procedure Manual. facilities.yale.edu/sites/default/files/files/Design%20Standards/Updated%20Design%20Standards/01%20General%20Requirements/01%2083%2000%20Facility%20Shell%20Performance%20(Birds)%2019_0715.pdf
168. Yale School of the Environment. (2021 Kroon Hall. https://environment.yale.edu/kroon/design.php
169. Yale School of the Environment. (2021). Urban Resources Initiative. https://uri.yale.edu.
170. Yale Sustainability. (2020). Yale University 2019 Transportation Survey Report. (https://yale.app.box.com/s/xk8bi2xkdmpqfmdc2yx6zgz82dyp6ggx.
171. York Region, Ontario. (2016). Transportation Mobility Plan Guidelines for Development Applications. https://www.york.ca/wps/wcm/connect/yorkpublic/71d2f725-b82e-4c96-b181-132ff43f1fda/16214_Mobility_Plan_Guidelines_Accessible.pdf?MOD=AJPERES&CVID=mul36i8.
172. Zevenberg, C, Dafang, F., & Assela, P. (2018). Transitioning to sponge cities: challenges and opportunities to address urban water problems in china. Water, 10(9). https://doi.org/10.3390/w10091230.

Image citations

Page 12: City of New Haven & Perkins Eastman (2018). Long Wharf site plan. https://www.newhavenct.gov/civicax/filebank/blobdload.aspx?blobid=33676
Page 13: City of New Haven & Perkins Eastman. (2018). Long Wharf 3D site model. https://www.newhavenct.gov/civicax/filebank/blobdload.aspx?blobid=33676
Page 17: New Haven Museum. (2017). Filling Long Wharf in the 1950s. Long Wharf Flood Protection Study. https://portal.ct.gov/-/media/DOH/Sandy_Relief_Docs/Planning_Docs/T-1-LongWharfFloodProtectionFinalReport.pdf
Page 19: Cerea, C. / Audubon. (2017). Chesapeake Bay seagrass pallets. Audubon. https://www.audubon.org/news/the-ambitious-plan-save-chesapeake-bays-shrinking-saltmarshes
Pag e 20: Greenwave. (2020). Vertical ocean farming. Greenwave. https://www.greenwave.org/our-approach
Page 21: Silva, M. (2019). Swimming embankment. In Public spaces for water: a design notebook (First, Ser. Sustainable cities research series, 3). CRC Press.
Page 24: Campbell, B. (2006). Brockett Map of 1641 – New Haven streambeds. New Haven Museum. https://www.newhavenmuseum.org/library/research-guides/brockett-map-of-1641/
Page 26: Google Earth. (2021) Bo01 aerial image. Google Earth.
Page 27: The Cultural Landscape Foundation. (2020). Sabine promenade. The Cultural Landscape Foundation. https://tclf.org/landscapes/sabine-promenade
Page 28: JMT. (2020). Potomac river overpass park. JMT. https://jmt.com/projects/riverfront-park-design-rosalie-island/
Page 32: New Haven Urbanism. (n.d.) Before and after urban renewal. https://newhavenurbanism.wordpress.com/new-haven-history/paradise-lost/
Page 34: Fowler, K. (2019). Dockside canal and residences. Waterbucket. https://waterbucket.ca/wcp/2021/05/30/d
Page 35: Inhabit staff. (2012). Kroon Hall. Inhabit. https://inhabitat.com/yale-universitys-leed-platinum-kroon-hall-is-a-model-of-sustainable-architecture/2-45/
Page 37: Wladyslaw, P. (2017). Union station watercolor. Prosol Art. http://www.prosolart.com/
Page 38: Fraker, H. (2013). Kronsberg aerial view. In The hidden potential of sustainable neighborhoods: lessons from low-carbon communities. Island Press.
Page 42: Parkdale Neighbourhood Land Trust. (2021). Land trust preserves more housing. http://www.pnlt.ca/
Page 44: https://www.un.org/waterforlifedecade/water_and_energy_2014/technical_visit_valdespartera.shtml
Page 48: Flickr Creative Commons. (2019). MIT cogeneration plant. Flickr Creative Commons.
Page 49: Urban Ecology / CMU SoA. (n.d.) Bo01 energy production. https://urbanecologycmu.files.wordpress.com/2015/11/5.jpg BO01 ENERGY

Page 50: Verdant Power. (2020). tidal turbines in the East River. https://cleantechnica.com/2020/10/28/3-tidal-turbines%E2%80%A9-pop-into-new-york-citys-east-river/
Page 51: Corix. (2021.) Dockside Green wastewater treatment plant. Corix. https://www.corix.com/about-corix/experience/dockside-green
Page 54: City of New Haven & Perkins Eastman. (2018). Long Wharf mobility plan. https://www.newhavenct.gov/civicax/filebank/blobdload.aspx?blobid=33676
Page 56: Paris En Commun. (2021). Paris streets reimagined. Paris en Commun. https://ideesencommun.org/notre-manifeste/
Page 58: City of New Haven. (2021). New Haven bike routes. City of New Haven website. https://www.newhavenct.gov/gov/depts/traffic/bike_new_haven/bike_map.htm
Page 59: Inhabit staff. (2008). Dockside Green streetscape rendering. Inhabit. https://inhabitat.com/british-columbia-dockside-green/
Page 63: Whalen, A. (2020). Mars discovery district. MaRS. https://marsdd.com/media-centre/press-kit/
Page 65: Vaxelaire, A. (n.d.) Hammarby Sjostad greenspace scene. Urban Green Blue Grids.
https://www.urbangreenbluegrids.com/projects/hammarby-sjostad-stockholm-sweden/

GIS metadata

1. Hurricane Surge Inundation SLOSH model. (2008). U.S. Army Corps of Engineers. Connecticut ECO Complete Resource Guide.
2. Connecticut income per census block. (2020). Census of the United States. Connecticut ECO Complete Resource Guide.