



# Transit-Oriented Development and Health:

Update to the 2013 Health Impact Assessment  
to Inform Healthy Neighborhoods Equity Fund II

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# Overview

In 2013, the Metropolitan Area Planning Council (MAPC), in partnership with the Massachusetts Department of Public Health (MDPH) and the Conservation Law Foundation (CLF), conducted a rapid Health Impact Assessment (HIA) to explore the relationship between transit-oriented development (TOD) and health. The purpose of the 2013 assessment was to assist in the formation of Healthy Neighborhood Equity Fund (HNEF I).

The HIA defined 12 health-related pathways (and associated metrics) by using three TOD projects, and their cumulative impacts, as case studies. The HIA, and subsequent implementation of HNEF and related Healthy Neighborhood Study, has highlighted that HNEF-backed projects have significant potential to bring about social, environmental, and economic changes.

The following memorandum updates six of HNEF HIA pathways and adds three new pathways in order to inform the development of HNEF II. Where the 2013 HIA established the evidence between TOD and health, the updated literature review has refreshed this evidence and expanded on it. The following graphic summarizes findings that integrate the current review.



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Walkability / Active Transport

Create a more walkable environment, increase access to destinations, and improve State of Place score



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Safety from Traffic

Increase traffic by bringing more people into the area



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Residential Energy Efficiency

Add energy efficient homes and assist with retrofits to improve weatherization, ventilation, and energy efficiency



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Safety from Crime

Bring well-lit mixed-used developments and new commuters, residents, and employees to the area



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Affordable Housing

Add new income-restricted affordable units



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Green Space

Add new vegetation and site-specific tree plantings in public spaces and thoroughfares



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Food Access

Increase the area's access to healthy affordable foods and local, fresh produce markets



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Gentrification / Displacement

Use anti-displacement strategies and provide supports that increase housing stability



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Social Cohesion

Add space for social interactions



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Air Quality

Mitigate air pollution with the additional vehicular traffic



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Economic Opportunity

Expand economic opportunity by creating new jobs in a transit-accessible location



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Environmental Contamination

Remediate and mitigate environmental exposures to prevent future environmental exposures to residents, workers, and visitors



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Climate Change

Use environmental design and community development programs to reduce exposure and increase adaptive capacity



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Moving to Opportunity

Provide housing search and relocation assistance to families with limited incomes and assets



DIRECTION OF IMPACT:    
 LIKELIHOOD OF IMPACT:   
 MAGNITUDE OF IMPACT: 

### Ownership of Change

Build resident power in relation to neighborhood development

An understanding of evidence positions HNEF II to assess new TOD proposals and offer guidance on how developments may be more health promoting. Moreover, understanding that these pathways interact – directly and indirectly - and feedback on one another is equally important. In this way, the pathways can be coordinated to provide cumulative health benefits and avoid contributing to health risks. For example, new residential developments that reflect the vision of existing neighborhood residents and that are accompanied by anti-displacement strategies can enhance existing levels of social cohesion, ownership of change and housing stability while also bringing in new residents. Such interactions among pathways are present in each potential new development. HNEF is uniquely positioned to influence how the pathways intertwine so communities are better positioned to avoid risk and experience protective strategies that lead to healthy lives.

The following table updates the summary of recommendations offered for each pathway in the original HIA. The recommendations are offered to assist HNEF II in maximizing the health-related benefits of TOD investment.

HEALTH PATHWAY	POTENTIAL HEALTH IMPACTS	RECOMMENDATIONS
<b>Walkability/Active Transport</b>	Physical activity, mental health, chronic disease, obesity	<ul style="list-style-type: none"> <li>Promote density, mixed land-use, availability of destinations and amenities, short distances to transit, bicycle, and pedestrian accommodations, and lower ratios of on- and off-street parking into the development design.</li> </ul>
<b>Safety from Crime</b>	Injury, physical activity, mental health, real and perceived safety	<ul style="list-style-type: none"> <li>Incorporate Crime Prevention through Environmental Design (CPTED) strategies into the development design.</li> <li>Encourage developers to be aware of internal and external pathways/connections to other destinations, particularly for routes to a transit station.</li> </ul>
<b>Economic Opportunity</b>	Economic stability and mobility, mental health	<ul style="list-style-type: none"> <li>Require or encourage measures that result in construction-related employment opportunities (part- or full-time) for residents in the impacted neighborhood.</li> <li>Encourage or create job training components to assist residents to acquire skills that allow them to access job opportunities can offer higher wages and job stability.</li> <li>Prioritize ground floor commercial space for locally owned, minority owned, and women owned businesses.</li> </ul>
<b>Food Access</b>	Mental health, chronic disease, diet	<ul style="list-style-type: none"> <li>Encourage expanded access to healthy, affordable food through walking, bicycling and frequent transit connections.</li> <li>Consider use of mobile markets and farmers market as means to expand access to local, healthy foods.</li> </ul>
<b>Safety from Traffic</b>	Injury, air quality, real and perceived safety	<ul style="list-style-type: none"> <li>Support developments that promote a Complete Streets approach to accommodate safe bicycle, pedestrian, and transit trip-making for the new residential and/or commercial development.</li> <li>Encourage a context-sensitive approach for proposed roadway improvements so that new or reconstructed roads are designed with narrow travel lanes and for slower vehicular speeds.</li> </ul>

<b>Affordable Housing</b>	Economic stability	<ul style="list-style-type: none"> <li>Support developments that maintain a diverse housing stock, including affordable deed-restricted housing units for households with low incomes.</li> </ul>
<b>Residential Energy Efficiency</b>	Exposure to environmental contaminants, economic stability mental health, thermal comfort, chronic disease	<ul style="list-style-type: none"> <li>Encourage housing that meets energy efficiency standards.</li> <li>Seek opportunities to retrofit existing homes through weatherization, improved indoor ventilation and energy efficiency upgrades to existing heating and cooling equipment.</li> </ul>
<b>Green Space</b>	Physical activity, mental health, thermal comfort, social cohesion, respiratory health	<ul style="list-style-type: none"> <li>Promote expansion, upkeep, and programming of green spaces.</li> <li>Promote introduction of vegetation, including trees, low level bushes and shrubs and ground cover plants in public and private spaces.</li> <li>Design sites to reduce potential for trees to restrict dispersal of air pollutants and to contribute allergens.</li> </ul>
<b>Social Cohesion</b>	Mental health, social capital, chronic disease	<ul style="list-style-type: none"> <li>Promote developments that seek to enhance the social impact of the public spaces and social and cultural programming of these spaces.</li> <li>Promote initiatives and programs that value inclusiveness, diversity and health promotion across all ages and backgrounds.</li> </ul>
<b>Displacement/ Gentrification</b>	Air quality, asthma, other respiratory diseases, and cardiovascular disease	<ul style="list-style-type: none"> <li>Identify what types of community-level displacement forces, if any, are currently occurring in neighborhood of proposed development.</li> <li>Promote the use of anti-displacement strategies and local regulatory changes that support existing residents right to remain such as inclusionary zoning, condominium conversion ordinances, and one for one affordable housing replacement ordinances.</li> <li>Support policy and support service initiatives that increase housing stability for existing residents, such as right to counsel, rental assistance, and community wellness staff.</li> </ul>
<b>Air Quality</b>	Mental health, economic stability, social cohesion	<ul style="list-style-type: none"> <li>Encourage air quality analyses associated with increased motor vehicle use. Consider background concentrations.</li> <li>Monitor air quality during construction and after the development is complete to ensure that air quality levels do not degrade beyond projected levels.</li> <li>Consider mitigation measures such as reinforcing the bicycle/ pedestrian infrastructure or using construction equipment with diesel retrofits.</li> </ul>
<b>Environmental Contamination</b>	Exposure to environmental contaminants, childhood blood lead levels, asthma, other relevant chronic diseases	<ul style="list-style-type: none"> <li>Mitigate or remediate environmental contamination to reduce potential for exposure for residents living and/or working near the site as well as for site workers involved in remediation and construction.</li> </ul>

<p><b>Ownership of Neighborhood Change</b></p>	<p>Physical health, mental health</p>	<ul style="list-style-type: none"> <li>• Document understanding of community vision, reflecting the needs and priorities of current residents, as part of development process.</li> <li>• Promote sharing of decision-making on proposed developments with residents in the impacted neighborhood.</li> </ul>
<p><b>Climate Change</b></p>	<p>Exposure to natural hazards, Injury</p>	<ul style="list-style-type: none"> <li>• Assess project vulnerability using a community exposure, sensitivity, and adaptive capacity framework.</li> <li>• Build resiliency in neighborhoods by addressing physical environmental risks and socioeconomic factors that increase vulnerability.</li> <li>• Promote use of building designs that reduce reliance on carbon-based energy sources and minimize utility costs for residents.</li> </ul>
<p><b>Moving to Opportunity</b></p>	<p>Mental health, economic mobility, chronic disease</p>	<ul style="list-style-type: none"> <li>• Provide housing search and relocation assistance for families with children who desire to move to development located in neighborhoods with low poverty levels.</li> <li>• Promote neighborhood changes that reduce neighborhood level poverty and include housing, with potential support services, for current residents.</li> <li>• Include programming with new developments that provide opportunities for community building among new residents and current residents, for sharing of cultural and ethnic backgrounds, and that provide opportunities for youth leadership</li> </ul>

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# Introduction

Healthy Neighborhoods Equity Fund II (HNEF II) is a proposed \$50 million private equity fund to be managed by the Conservation Law Foundation (CLF) and the Massachusetts Housing Investment Corporation (MHIC). The purpose of the fund is to invest patient capital in transformative mixed-income, mixed-use development in historically disinvested neighborhoods in Massachusetts, with potential to expand to Connecticut and Rhode Island. The fund will also invest in affordable and mixed-income housing in communities with excellent public schools.

In 2013, the Metropolitan Area Planning Council (MAPC), in partnership with the Massachusetts Department of Public Health (MDPH) and CLF, conducted a rapid Health Impact Assessment (HIA) to explore the relationship between transit-oriented development (TOD) and health. The purpose of the 2013 assessment was to assist in the formation of HNEF I.

The HIA defined 12 health-related pathways (and associated metrics) by using three TOD projects, and their cumulative impacts, from the Roxbury and Mission Hill neighborhoods in the City of Boston as case studies. The HIA, and subsequent implementation of HNEF and related Healthy Neighborhood Study, has highlighted that HNEF-backed projects have significant potential to bring about social, environmental, and economic changes.

This memorandum documents the process and outputs of an update to many of HNEF HIA pathways as well as the addition of several new pathways. Where the original HIA informed the development of HNEF I, this memorandum is meant to assist in the formation of HNEF II.

## Systemic Inequities

Many of the inequities present in Greater Boston can be traced back to a long history of institutional racism. Institutional racism refers to laws, customs, and practices implemented by institutions, resulting in differential treatment of people of color. The geographic disparities across the region are closely associated with policies that created residential segregation. Federal, state, and local policies and practices, such as zoning and restrictive covenants, were used to exclude people of color from certain neighborhoods. Racial restrictions and discriminatory lending practices layered on additional limitations to where a family could live. This intentional racial segregation of communities set the stage for inequities in neighborhood conditions, as communities of color received fewer public investments and suffered greater exposure to pollution because of the siting of environmentally hazardous uses.

The impacts of institutional racism have had repercussions for families throughout generations. The accumulating nature of these socioeconomic conditions across generations makes it difficult for many individuals and families of color to reach their highest potential without private and public sectors taking the steps to address the systemic and institutional factors that continue to perpetuate inequitable outcomes. Advancing equity requires scrutiny of policies and practices that do not proactively seek to rectify a long history of institutional racism. In addition to race and ethnicity, the United States also has a legacy of institutional policies that marginalize and discriminate against women, non-Christian people, people born outside of the United States, people who don't speak English as their primary language, LGBTQ+ people, Native people, and people with disabilities. Race and ethnicity provide a

foundation to measure inequity within the region, but the problem must be addressed along many different demographic dimensions.

The original HIA addressed income inequality, displacement, and the local economy as these items surfaced as priorities for participants in the scoping sessions. Race and its relation to health did not get addressed directly in the HIA. The framing above is now provided as a foundation for the continued evolution of HNEF and how it combines research evidence with an understanding of structural racism. The fund will be a means to combat structural racism through intentional investments that increase housing choice, employment opportunities, and wealth creation for people and communities of color.

## Memorial to the Moment: COVID-19

The update to the 2013 HIA has occurred during the worst pandemic to occur in the last century. As this document is completed, the COVID-19 pandemic has resulted in millions of confirmed cases and hundreds of thousands of deaths globally, include more than 200,000 deaths in the United States alone. Assessments of the pandemic's impact demonstrate the disproportionate impact on people of color, those living with underlying chronic diseases, individuals working in essential and front line occupations, and those who experience socioeconomic deprivation. The pandemic has placed an unfair burden on these populations. The underlying fact is that pre-existing inequities have made certain populations more at risk from the virus and positioned them so that they have fewer resources to cope with health, social and economic impacts of the pandemic.

We must act remedy these pre-existing and underlying inequities so that we do not confront such a moment again and see such suffering re-occur. It is with deep sadness that we experience the current moment and we send our sympathy to those who have lost a loved one and to those whose lives have been altered by the virus. At the same time, we stand ready to move forward by employing the tools of change to transform our society into one that is strong and based on inclusiveness, sustainability, and equity.

# Guide to the Document

The document is divided into two parts. Part I provides updates on six pathways that were included in the original HIA. These are:

- Access to Healthy Affordable Foods
- Displacement/Gentrification
- Economic Opportunity
- Green Space
- Social Cohesion
- Green Housing (Residential Energy Efficiency)

Part II introduces and examines three pathways that were not originally part of the HIA. These are:

- Ownership of Change
- Climate Change
- Moving to Opportunity

These pathways were added through consultation with CLF. The pathways were identified specifically because of the experience from the first round of HNEF and in relation to emerging findings from the Healthy Neighborhoods Study.

# Methods

## Existing Pathways

The MAPC review team assessed the original HNEF HIA pathways, using the original, compiled literature review as a baseline. Based on subject matter expertise, a preliminary scan (including relevant literature identified by team), and team familiarity with recent research, a subset of the initial pathways was prioritized for updates.

For prioritized pathways, we conducted new literature reviews to understand how thinking had evolved since the 2013 HIA. Search terms varied by pathway and focused on the link between each HNEF pathway and health and well-being.

The literature reviews focused on systematic reviews or meta-analyses that had been completed between 2015-2020 (five-year period) and published in peer-reviewed scientific journals to understand how research had been synthesized over the period since completion of the HIA. Where possible, literature was further refined to study settings in the United States with a focus at the neighborhood or district (sub-municipal) geography, as we wanted to focus on research most relevant to HNEF investments.

Two exceptions to the above approach for existing pathways are: Green Housing (renamed Residential Energy Efficiency) and Gentrification/Displacement. A different approach was used for each path due to a desire to re-contextualize each of the pathways based and to integrate more substantial literature reviews that occurred concurrently to HNEF HIA literature update. The concurrent reviews were found to include valuable information that was not as well documented in the original HIA. The approaches for the two pathways are described below.

The Residential Energy Efficiency (formerly Green Housing) literature review emphasized systematic reviews published in peer-reviewed scientific journals and gray literature that summarized findings from peer-reviewed primary research. Gray literature sources included reports by governmental agencies and practitioners in the health or clean energy fields. We also reviewed a small number of new primary research studies to incorporate recent research and findings on measures not adequately covered by systematic reviews and gray literature. The review included publications from the last ten years (2010-2020) and studies occurring in the United States and other high-income countries, primarily the UK.

The Gentrification/Displacement pathway involved a scan for peer-reviewed studies and gray literature from civil society (academia, think tanks, community organizations, etc.) and government agencies regarding gentrification as a driver of residential displacement, displacement risk, and neighborhood change. The review included materials from MAPC and reports from the City of Boston that investigated residential displacement and neighborhood change. Additionally, this review adopted a broader timeframe (1978-2020) to place past and recent research in context and was limited to studies occurring in the United States.

## New Pathways

The literature review approach used for the existing pathways was modified for the new pathways.

For Climate Change, the review is an excerpt of independent research MAPC conducted in 2019 into climate change vulnerability. The literature scan that is the basis of the review includes relevant research from the past five years with a focus climate vulnerability and resiliency. The literature collected emphasized research in a US setting but was not exclusive to that geography.

The Moving to Opportunity (MTO) literature review closely tracked to the literature review used for the existing pathways. As the MTO work is more recent in nature, the search criteria were broadened beyond systematic review and meta-analyses. The MTO literature review retained a concentration on research completed between 2015-2020 and study settings in the United States and a focus at the neighborhood or district (sub-municipal) geography.

Ownership of Change is a concept that originated through Participatory Action Research (PAR), specifically the Healthy Neighborhood Study.<sup>1</sup> The concept was the result of resident researcher participation in collaborative research design. The residents identified the need to define and use a measure of a person's feelings of ownership over neighborhood-level social, economic, and physical changes such as new housing construction and creation of new jobs. As a construct, the review centered on research produced through the Healthy Neighborhood Study and consultation with project leaders, Vedette Gavin who is a co-investigator and Andrew Binet who is a doctoral student at the Massachusetts Institute of Technology (MIT).

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1 The Healthy Neighborhood Study includes nine Massachusetts communities that are struggling with health and economic growth but are also likely to experience a wave of new development in the near future. This expected growth presents the opportunity to learn how development, when done well, can create healthier neighborhoods and healthier people. With funding from the Robert Wood Johnson Foundation, CLF, Massachusetts Institute of Technology Department of Urban Studies and Planning and resident researchers will explore how new developments change neighborhood conditions, and how those changes impact the health and well-being of the people living there. <https://www.clf.org/healthy-neighborhoods-study/>

# Existing Pathways

Access to Healthy Affordable Foods

Displacement/Gentrification

Economic Opportunity

Green Space

Social Cohesion

Residential Energy Efficiency

## Access to Healthy Affordable Foods



### Key Insights

The introduction of grocery stores is associated with more positive health outcomes, but the mechanism of health benefits may not come directly from the direct change in people's diets.

Grocery stores are associated with positive changes in mental health and improved accessibility by reducing the distance between people's homes and food outlets.

The introduction of fresh food markets and mobile markets show an association between improved access to healthy foods and changes in people's diets.

### Recommendations

**Encourage expanded access to healthy, affordable food through walking, bicycling and frequent transit connections.**

**Consider use of mobile markets and farmers markets as means to expand access to local, healthy foods.**

### Literature Review

Unhealthy diets are known to be associated with poor health and chronic disease (Micha et al., 2017). Access to healthy foods that are physically available and affordable is a necessary condition for improving diet quality. Supermarkets are known to generally offer a variety of healthy foods at relatively low prices (Pitt et al., 2017). The 2013 Healthy Neighborhood Equity HNEF HIA and contemporary literature reviews identify poor supermarket access as a key barrier to healthful diets, particularly among low-income communities (Ito et al., 2013; Pitt et al., 2017; Zorbas et al., 2018). Accordingly, a popular strategy assumed to improve community food access at the neighborhood level is supermarket introduction (Afshin et al., 2015; Black et al., 2014; Cleary et al., 2018). This literature review update seeks to assess the empirical evidence compiled since 2014 on the relationship between supermarkets, diet, and health outcomes.

Over the past six years, the surge in research around supermarkets, diet, and health that began in the early 2000s has continued. Twelve literature reviews have been published since 2014 covering the extent of quantitative and qualitative research on this topic (Abeykoon et al., 2017; Afshin et al., 2015; Algren et al., 2015; Black et al., 2014; Cobb et al., 2015; Gordon-Larsen, 2014; Hollis-Hansen et al., 2019; MacMillan et al., 2018; Odoms-Young et al., 2016; Pitt et al., 2017; Woodruff et al., 2018; Zorbas et al., 2018). Despite the abundance of new studies, results remain inconclusive. Several studies found evidence of positive associations, indicating that increased supermarket exposure was related to increased diet quality and health. By contrast, other studies found evidence of negative associations, indicating that increased supermarket exposure was related to decreased diet quality and health. In general, most evidence was null, indicating either that supermarkets had no effect on diet quality and health or that insufficient evidence was found to support this association. Consequently, the current literature is inconclusive and finds no reliable correlation between increased supermarket proximity

and improved diet in the surrounding community.

It is possible that evidence thus far has been inconclusive due to study insufficiencies. Literature reviews overwhelmingly point to existing studies' inadequate design, poor quality, and variability in indicator and outcome variable measurement. This variability denied reviewers the opportunity to conduct meta-analyses. Thus, wider consensus on the nature of the relationship between supermarkets, diet, and health has not been achieved. It is also important to note that existing studies are largely cross-sectional and observational in design. Findings from such studies can only suggest correlation, not causation.

A positive dimension of this pathway, supported by several studies, involves how availability of a supermarket can influence psychological wellness and in turn a person's diet. This pathway suggests supermarket exposure may interact with mental health, which in turn influences food choices, such as reducing a positive association or feelings of satiety with fast food. Psychological wellness factors including individuals' perception of food access, neighborhood satisfaction, and mental health have been associated both with increased supermarket proximity and significant improvements in health status and diet (Abeykoon et al., 2017; MacMillan et al., 2018; Zorbas et al., 2018). This pathway supports positive connections between supermarket introduction and community wellbeing, albeit through the indirect mechanism of psychological wellness.

Mobile Markets/Farmers' Markets provide a second alternative pathway, which may be more directly associated with improved diet and health outcomes than supermarkets. One review of the literature found mobile markets and, to a lesser degree, farmers' markets to be associated with modest improvements in diet quality via increased fruit and vegetable consumption (Hollis-Hansen et al., 2019). This suggests mobile markets and farmers' markets may be more successful than supermarkets at meeting low-income individuals' needs for food affordability, accessibility, and acceptability.

Of interest to the TOD funds like HNEF, transportation was identified as a significant barrier to food access. A review of the qualitative literature on local food environments found that lack of a personal vehicle, unreliable public transportation, and the absence of supermarket walkability negatively affected food access (Pitt et al., 2017). However, it does not necessarily follow that improved transportation infrastructure would be an effective mechanism for improving diets or health outcomes. Transportation may follow the same trends as supermarkets: though poor supermarket access is a key barrier to food access and healthful diets, supermarket introduction alone thus far has not proved to be an effective solution.

In summary, increased supermarket exposure and supermarket introduction have not been found to directly affect diet quality or health outcomes. These strategies may, however, increase psychological wellbeing within communities and in turn, choice of foods. Recent literature suggests mobile markets and farmers' markets are a more promising strategy for improving healthy food access and diet quality.

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## Gentrification/Displacement<sup>2</sup>



### Key Insights

Displacement encompasses not only the physical or economic forces that drive people from their homes but also the active reduction of housing options that displaced communities face.

Housing instability can be considered the umbrella under which displacement forces exert their effect at the neighborhood scale or at larger community scales.

Household-level displacement is difficult, if not impossible, to measure comprehensively so a comprehensive tracking of neighborhood changes is critical to monitor community-level phenomena of turnover, replacement, and displacement.

Lower-income households already face significant health burdens; displacement may exacerbate these existing burdens by impacting social cohesion, increasing housing insecurity, distancing residents from needed social services, increasing stress, and contributing to housing insecurity.

### Recommendations

**Identify what types of community-level displacement forces, if any, are currently occurring in neighborhood of proposed development.**

**Promote the use of anti-displacement strategies and local regulatory changes that support existing residents right to remain such as inclusionary zoning, condominium conversion ordinances, and one for one affordable housing replacement ordinances.**

**Support policy and support service initiatives that increase housing stability for existing residents, such as right to counsel, rental assistance, and community wellness staff.**

### Literature Review

The 2013 HIA defined gentrification as the process that occurs when a neighborhood is transformed from one of low economic value to one of high economic value, typically following new private development and public investments in infrastructure. Gentrification contributes to residential displacement when current residents were forced to move from their existing homes without the possibility of finding another home they could afford in their original neighborhood. Displacement of this type was found to be associated with adverse changes in social connections, housing stability and homelessness, economic opportunity, social services, and stress.

Since the 2013 HIA, research into gentrification and residential displacement effects has grown substantially. Growing demand for housing over recent years has accelerated market rate residential and

<sup>2</sup> Adapted from Framework for Residential Displacement Research at MAPC: Definitions and Approaches. Seleeke Flingai, MAPC Research Analyst II. January 2020.

mixed use development in lower income neighborhoods that had not in recent decades experienced substantial land use and transportation investment. The type and pace of development, primarily marketed to higher income households, has reinforced earlier identified effects of neighborhood change and the potential for residential displacement. Therefore, a deeper exploration of residential displacement is necessary to recognize how displacement pressures may differentially affect housing stability as a pathway to healthier outcomes.

Residential displacement is a multifaceted process for which a single definition has been elusive. Conceptually, one definition has served as the backbone onto which subsequent definitions have been built (Grier and Grier, 1978). In their seminal report “Urban Displacement: A Reconnaissance” (sponsored by the US Department of Housing and Urban Development), the authors define residential displacement as follows:

*Displacement occurs when any household is forced to move from its residence by conditions that affect the dwelling or its immediate surroundings, and that:*

- 1) are beyond the household’s reasonable ability to control or prevent;*
- 2) occur despite the household’s having met all previously imposed conditions of occupancy; and*
- 3) make continued occupancy by that household impossible, hazardous, or unaffordable.*

To this definition, Marcuse (1985) appends many key concepts, such as “exclusionary displacement,” which he describes as the phenomenon in which households that were once able to move into a unit can no longer do so for factors out of their control (e.g., rental price increases). Marcuse notes:

*A normal movement of households occurs in any housing market within any neighborhood. When one household vacates a housing unit voluntarily and that unit is then gentrified or abandoned so that another similar household is prevented from moving in, the number of units available to the second household in that housing market is reduced. The second household, therefore, is excluded from living where it would otherwise have lived.*

In short, definitions of displacement encompass not only the physical or economic forces that drive people from their homes but also the active reduction of housing options that displaced communities face.

To that end, Marcuse argues that displacement may be a multi-step process in which abandonment and gentrification are connected to displacement. Disinvestment in neighborhoods by public and private entities can lead to the physical decline of a building or a neighborhood, initiating a “responsive” form of displacement that may not be driven by changes in rent. This first wave of displacement can ultimately facilitate gentrification, potentially jumpstarting another wave of displacement in which those “last residents” who remained after disinvestment-associated displacement are driven out by gentrification-associated pressures. These “chains” of displacement suggest that simply measuring the displacement of people from gentrifying or gentrified areas may underestimate the total amount of displacement that has taken place in a community. As such, the potential for displacement should not focus solely on gentrifying areas but also include an assessment of housing stability, public and private investment, and residential mobility in surrounding neighborhoods and possibly surrounding municipalities.

Multiple causes can interact to increase displacement pressures in various geographic contexts and among different populations. For example, neighborhood investment by public agencies (e.g. transit improvements, public art, etc.) or private actors (e.g., building rehabilitation, storefront improvements) can make an area more attractive to higher-income households who otherwise would not consider living in the area or who are now willing and able to pay more than low-income households already in the area. In other cases, changing demographics or consumer preferences may be a factor in higher-income households seeking out neighborhoods that they previously found to be less desirable. Under these conditions, a gap may develop between current rents and what the market will bear, compelling landlords to maximize profit through various actions. For example, landlords might ask for higher rents, consider converting rental units into condominiums, or harass tenants to pressure them to move on their own accord (i.e., informal evictions) to then raise rents and market housing units to residents with higher incomes.

Conversely, neighborhood and property disinvestment can lead to crumbling infrastructure, unfit housing conditions, diminished public services and employment opportunities, and landlord exploitation of low-income residents through unaffordable rents and persistent threats of eviction – all of which have been known to drive displacement (Desmond, M, and Shollenberger, 2015).

When these forces interact with exclusionary housing and zoning policies or not in my back yard efforts (NIMBYism) that restrict the development of new housing units affordable across the income spectrum (particularly for low- and middle-income households) in a surrounding region, displaced residents have fewer options to remain in the neighborhoods or cities in which they could previously live. As such, displaced residents may leave the region or state in search of more affordable housing, losing in the process many of the social and cultural ties to the places they once called home.

Residential displacement has observable effects at scales beyond the household or block level. If the household-level displacement in a given community is substantial and widespread, and if this displacement is produced by widespread marking up of home values and physical upgrading, then the aggregation of displacement events at the community level may alter the composition of multiple

neighborhoods – changes that may alter the demographic and cultural composition of a community. This community-level, gentrification-associated displacement sits in relation with other patterns of migration – namely *turnover* and *replacement* – that collectively describe the types of large-scale housing occupancy shifts that drive demographic change.

To aid understanding and analysis, the following operational definitions contextualize gentrification-associated displacement described above:

**1. Residential displacement (household level) is defined as an involuntary household move due to factors outside of the household's control.**

Potential causes include, but are not limited to, landlord-related actions such as evictions, rent increases, landlord foreclosures, building condemnations, condominium conversions, and landlord harassment; property tax increases for already-cost-burdened low-income homeowners; foreclosures; and devastating climatic events such as floods.

Residential displacement, under this definition, can occur for both renters and homeowners. Displacement can occur in areas where the housing market is strong and where rents and property values are rising. It can also occur in areas where the housing market is stable or weak, but low-income homeowners are at risk of foreclosure and renters may be evicted by cost-burdened or predatory landlords (Desmond, M., 2012). Distinguishing these differences is important due to the types of policy interventions that may be germane to different conditions.

**2. Displacement vulnerability (household level) is defined as the condition in which a household is susceptible to displacement pressures.**

Potential pressures include, but are not limited to, costs (and associated cost burden), shifting housing market dynamics, exploitative landlord behavior, and/or environmental hazards.

For example, low-income households who are at risk of formal evictions and “soft evictions” (e.g., landlord harassment) are vulnerable, as are households who have already experienced an eviction and have the blemish on their permanent record (Desmond, M, et al., 2015). Severely cost-burdened low- and moderate-income households in neighborhoods with shifting housing dynamics and rising rents are also vulnerable, as are residents in units with expiring affordability restrictions that may be redeveloped to market-rate housing. In addition, low-income older adults, particularly homeowners with mortgage debt, may face barriers to staying in place or securing housing that is accessible and affordable. Lastly, living in areas with high risks of climatic shocks such as floods can increase one’s vulnerability to displacement.

**3. Gentrification is a pattern of neighborhood change in which a previously low-income neighborhood experiences new public and private sector investments, accompanied by demographic changes (increases in higher-income and college-educated residents), increasing home values and rents, and other social and economic changes that can be associated with the physical, cultural, and political displacement of pre-existing lower-income residents.**

Gentrification occurs in places with housing stock that is relatively affordable when compared

to the rest of the municipality or the region. The process of gentrification may be promoted by public or private actions such as transit improvements, public infrastructure upgrades, the renovation of deteriorated housing, public safety improvements, financial incentives and subsidies, or real estate speculation and marketing. Whether prompted by these actions or by other cultural, economic, or political preferences, households with higher incomes and/or education levels move into the neighborhood at higher rates. Their arrival and actions prompt further public and private investments in the physical environment, services, and amenities. These improvements increase the attractiveness and corresponding real estate values of the neighborhood, making it less affordable for the existing residents, thereby increasing the risk of displacement. Gentrification stands in contrast to other forms of neighborhood reinvestment (e.g., community land trusts, flexible capital fund, preservation of naturally occurring affordable housing) which are specifically intended promote the physical, cultural, and/or political empowerment that benefit pre-existing lower-income residents.

- 4. *Gentrification-associated residential displacement (community level)*** is defined as the demographic restructuring of a neighborhood through the aggregated displacement of households with no or low income or working-class people, communities of color, and other households vulnerable to household-level displacement actions.

Displacement at the community level is a process, not a singular event (mass displacement due to environmental hazards being a notable exception). Changing neighborhood demographics driven by aggregated household-level displacements and shifts in public and private neighborhood investment patterns can induce further shifts in investments, the commercial landscape, property values, and more, all of which can introduce further displacement pressures capable of uprooting vulnerable community members and fracturing social networks. In this light, the process of gentrification-associated displacement is part of a historical lineage of land and property acquisition, government policies, landowner profit maximization, and market forces that have long benefitted people with high financial capital and social class and often neglected groups along racial/ethnic, class, and gender lines.

- 5. *Displacement vulnerability (community level)*** is defined as the condition in which many members of a community are susceptible to residential displacement due to:
- 1) *Historic and/or present discrimination that has limited the abilities of community members to accumulate the financial and social capital needed to stay in place, if desired (e.g., communities of color, particularly income-poor or working-class communities of color);*
  - 2) *environmental hazards (e.g., flood-prone neighborhoods); or*
  - 3) *limited financial resources (e.g., communities with significant numbers of seniors with fixed incomes).*
- 6. *Turnover-associated displacement (community level)*** describes the phenomenon in which significant numbers of household-level displacement actions take place within a community that appears to be experiencing residential turnover. That is, out-migrants (e.g., households that have been displaced) are of similar demographic composition to in-migrants.

While turnover may be innocuous in many scenarios, some neighborhoods experience community-level turnover and household-level displacement operating simultaneously.

For example, chronically low-income neighborhoods may be exposed to displacement mechanisms such as eviction, landlord harassment, neighborhood disinvestment, or deteriorating housing quality that drive out-migration, but in-migration by demographically similar residents may occur due to limited housing options elsewhere. What may appear as turnover at the community level due to demographic similarity between in-migrants and out-migrants may be facilitated by household-level displacement actions.

**7. Residential replacement (community level) occurs when the number, composition, and movement rationale of out-migrants does not change dramatically over a given period, but the demographic profile of in-migrants is different from those who leave.**

In a neighborhood experiencing replacement, current residents are not necessarily experiencing increased displacement pressures, but those who do move away are replaced by residents who are different from the existing demographic profile. The reasons for demographic shifts of in-migrants can be many, and their impacts on a community can vary based on context. For example, rising housing costs in a distant neighborhood may drive some of that neighborhood's residents to move and become in-migrants of a demographically dissimilar neighborhood with housing costs affordable to them. Conversely, the preferences of a given demographic group may change over time, so fewer of these households move to neighborhoods they once favored.

Cultural, political, and exclusionary displacement are not addressed, despite their importance in the holistic accounting of displacement for households or communities. Cultural displacement occurs when long-term residents feel a diminished affinity with their neighborhood's identity due to changes in social networks, institutions, and behavioral norms precipitated by the arrival of new residents, who may seek to establish new neighborhood norms, behaviors, and values (Hyra, D., 2015). Political displacement refers to the process by which long-term neighborhood residents in a gentrifying neighborhood "become outvoted or outnumbered by new residents," losing political influence and decision-making power within the neighborhood (Martin, L., 2007). Both cultural and political displacement are beyond the scope of this current analysis. Exclusionary displacement, an important concept defined earlier, is predicated on the absence of a given action (i.e., a household being prevented from residing where it otherwise would have) (Marcuse, P., 1985). Thus, exclusionary displacement is conceptually difficult to estimate.

Collectively, the community-level concepts of turnover, replacement, and displacement are interrelated, and the mechanisms that drive them, along with their impacts on communities, may involve household-level instances of displacement at varying degrees of magnitude. Both household- and community-level perspectives are critical for developing a comprehensive understanding of residential displacement. A holistic perspective helps in identifying and implementing applicable interventions to minimize displacement and its associated effects on residents and communities. To note, household-level displacement is difficult, if not impossible, to measure comprehensively since individual motivation for a move (voluntary/involuntary) is such an essential component of the definition. Therefore, to comprehensively track neighborhood change focus should be on community-level phenomena of turnover, replacement, and displacement, and complimented by qualitative surveys.

Residential displacement, and displacement vulnerability, as outlined above share much overlap with



what is often termed “housing instability.” In fact, many of the manifestations of housing instability (e.g. overcrowding, trouble paying rent, frequent moves, and evictions) can be the causes, signs, or downstream impacts of displacement or vulnerability to displacement (U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion, 2014). As such, housing instability can be considered the umbrella under which both displacement and the factors that make one vulnerable to displacement reside. This framework allows delineation, however slightly, of vulnerability factors and potential outcomes of residential displacement from the displacement itself, while allowing space to interrogate the ways in which some causes of displacement can also act as downstream impacts (and vice versa) under different circumstances (e.g., overcrowding as both cause of displacement and potential outcome). Understanding that these issues are indicators of housing instability, and that they may drive macro-level migration patterns in the aggregate, further highlights how foundational housing security, affordability, and quality are to community health.

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## Economic Opportunity

### Key Findings

A strong association has been shown between income levels and health outcomes, higher income predicts better health, better health behaviors, and reduced mortality risk.

Conversely, evidence confirms that unemployment is a stressful life with consequences for personal income, social networks, and health behaviors.

Emerging evidence around job insecurity suggests that the perceived threat of unemployment can have negative health impacts like those of unemployment.

TOD holds great potential for supporting existing employment centers and spurring new economic development.



### Recommendations

**Require or encourage measures that result in construction-related employment opportunities (part- or full-time) for residents in the impacted neighborhood.**

**Encourage or create job training components to assist residents to acquire skills that allow them to access job opportunities can offer higher wages and job stability.**

**Prioritize ground floor commercial space for locally owned, minority owned, and women owned businesses.**

### Literature Review

Jobs are crucial to health, in large part because they help determine income and access to the resources needed to stay healthy. In addition, employment status is directly linked to mental and general health. Although the literature is still nascent, there is evidence that job insecurity can have a negative effect on mental health equal to unemployment and that stable, parental employment can be protective of family and child well-being.

The 2013 HNEF HIA recognized TOD as the catalyst for economic development, creating new jobs both during construction and from new commercial space and support services. Job creation, and subsequent increases to individual income, was identified as the primary mechanism by which economic opportunity influences health outcomes. The HIA identified a strong association between higher income and better health, better health behaviors, and reduced mortality risk (Ito et al., 2013).

The 2017 Massachusetts' Small Business Technical Assistance (SBTA) Program HIA, which looked at the health impacts of economic development at both an individual level and the community-level, recognized additional pathways from economic opportunity to health. The SBTA HIA upheld the finding that income and employment status are important determinants of individual health – finding protective effects for cardiovascular disease, mental illness, and tobacco use. It additionally identified

several mechanisms by which employment influenced community-level health, health behaviors, and health outcomes. These community-wide impacts included increased private investment and more health-promoting resources; the association between high levels of unemployment and higher rates of injury, violent crime, and property crime; building of social networks; and changes to the built environment supportive of walking (Keppard et al., 2017). The current review seeks to build on these previous HIAs and assess the available evidence on the relationship between economic opportunity and both individual- and community-level health behaviors and health outcomes.

Most sources that looked at employment status explored the relationship between unemployment and mental health. As established in the 2013 and 2017 HIA, unemployment is a stressful life event that can have consequences for personal finances, social networks, and health behaviors. Much of the literature in the past few years has supported the association between unemployment and measures of mental health; although study design and lack of a unified, operationalizable definition of “unemployment” make the causal relationship less clear (Manuela, S 2016; Barelink, V H, 2019; Kim & Vom Dem Knesebeck 2015; Kim & Vom Dem Knesebeck 2016). An emerging body of research has sought to associate unemployment with biomarkers of chronic stress, like cortisol (Sumner & Gallagher, 2017), and with risk for stress-related disease, like type 2 diabetes (Varanka-Ruuska et al, 2017). Findings remain inconclusive, primarily due to the small pool of studies available to draw upon for these analyses.

As there are consequences for being unemployed against your wishes, there are also consequences for insecure employment, as explored in an emerging body of literature. Ferrie et al’s 2016 systematic assessment found that previous research supports an association between high job insecurity and an increased risk of diabetes, even after adjusting for risk factors such as obesity, tobacco use, etc. Negative associations were found between job insecurity and self-reported symptoms of poor general and mental health, with one systematic assessment finding small but consistent increased risk for depressive symptoms (Kim & Vom Dem Knesebeck 2015; Kim & Vom Dem Knesebeck 2016). Like other studies, the use of observational studies and the diversity of health outcome measures used make the strength of this relationship difficult to

The literature on parental employment status and child health and well-being is small but indicative of stable employment having a protective effect (Conrad-Hiebner & Byram, 2020; Mauno et al 2017). A review of studies on the relationship of economic insecurity and child maltreatment found that, where economic insecurity was found to reliably predict future child maltreatment, parental employment moderated the relationship, decreasing the risk of maltreatment (Conrad-Hiebner & Byram, 2020). Another source found a negative relationship between parental job insecurity and children’s well-being, motivation, and school performance (Mauno et al 2017). Yet, the evidence remains limited and is mostly from observational studies which looked at data from just one point in time.

The body of literature on employment status and individual- and community-level health is small and not without challenges. Diverse conceptualizations and definitions of employment status terms, variation in exposure and outcome measures, and age of studies and diagnostic tools were limitations for most of the literature cited in this review. One analysis that compared clinical and self-reported diagnoses of diabetes found that the negative effects of job insecurity were stronger in studies that relied upon health records (Ferrie et al., 2016). Additionally, there is evidence that the frequency and duration of unemployment may have an influence on health outcomes (Kim & Vom Dem Knesebeck, 2015), but the majority of the literature relied on point-in-time assessment of employment status.

Another limitation to the generalizability of these findings is that while each of the reviews included participants in study areas from the United States, none focused exclusively on the United States. This again spoke to the small body of existing literature on employment status and health.

Our search did not find any evidence with findings contrary to those established in the 2013 and 2017 HIA, namely, that new jobs created through development could lead to increased individual income and economic growth and, through this pathway, influence health and well-being. However, the emergence of literature around job insecurity introduced uncertainty that all jobs are equally beneficial for health. These studies suggest that the perceived threat of unemployment can have negative health impacts like those of unemployment. These findings highlight the need for further research into the relationship between job security and health, to ensure that the jobs created by development convey health benefits and do not overlook unintended health risks from employment in less secure jobs.

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## Green Space

### Key Insights

Green (vegetated) and open spaces are associated with increased social interactions and perceptions of safety and improved mental health outcomes.

Street trees and tree canopy coverage are associated with positive social and mental health outcomes, reduced crime, and protection from heat.

The relationships between green space and air quality and health impacts is nuanced by how well trees and other green element disperse, or restrict the dispersion of, air pollution.

Green space interventions, while on the whole associated with positive health benefits, should be considered holistically as they may contribute to rising land values and accelerate displacement forces from neighborhood gentrification.



### Recommendations

**Promote expansion, upkeep, and programming of green spaces.**

**Promote introduction of vegetation, including trees, low level bushes and shrubs and ground cover plants in public and private spaces.**

**Design sites to reduce potential for trees to restrict dispersal of air pollutants and to contribute allergens.**

### Literature Review

Interest in the relationship between green space and human health is increasing within a variety of fields. Though primarily reliant on observational studies, evidence suggests that green space, particularly in urban settings, interacts positively with the physical, mental, and social health of individuals and communities.

The 2013 HNEF HIA identified a variety of possible mechanisms underlying these interactions: increased levels of physical activity, decreased levels of stress, increased social interaction and cohesion, crime reduction, and improved environmental services of air quality and shade provision (Ito et al., 2013). This literature review seeks to update our knowledge on these mechanisms and others mediating interactions between green space and health by assessing empirical evidence that has surfaced since the 2013 HNEF HIA.

A majority of these sources found consistent relationships between greenness (density of vegetation) or green space use and increased levels of physical activity. This was particularly true for green space in the form of parks with activity and community programming, trails, greened streetscapes, urban gardens, playgrounds, and temporary road closures (Alderton et al., 2019; Hunter et al., 2019; James et al., 2015; Kondo et al., 2018; Sallis & Spoon, 2015; Schram-Bijkerk et al., 2018; Smith et al., 2017; Van

Hecke et al., 2018; Vanaken & Danckaerts, 2018). Green space visitation emerged as a new mechanism underlying physical activity changes for children and adolescents because these populations typically use active transport such as walking or biking to get to green spaces in addition to physical activity undertaken while there (Smith et al., 2017; Van Hecke et al., 2018).

Literature findings on the impacts of green space and reduced stress levels were generally positive. Three sources found evidence of green space being associated with reduced stress (Hunter et al., 2019; James et al., 2015; Sallis & Spoon, 2015), while one source found mixed results (Kondo et al., 2018). Support for new factors mediating the relationship between green space and mental health other than stress emerged, including reduced anxiety levels and improved restorative effects, self-esteem, mood, ADHD behaviors, and attention spans (James et al., 2015; Kondo et al., 2018; Sallis & Spoon, 2015; Schram-Bijkerk et al., 2018; Vanaken & Danckaerts, 2018). Similar to the increased physical activity effects found for children, the positive impacts of green space on mental health throughout childhood and adolescence seem to be particularly strong (Alderton et al., 2019; Vanaken & Danckaerts, 2018).

All sources investigating the relationship between green space and social health via the mechanism of increased social interaction and cohesion found positive associations (Alderton et al., 2019; James et al., 2015; Sallis & Spoon, 2015; Schram-Bijkerk et al., 2018). New mechanisms through which green space may impact social health included increased amounts of structured and unstructured play among children, community pride, and civic motivation (Sallis & Spoon, 2015; Schram-Bijkerk et al., 2018).

The relationship between green space and crime reduction was substantiated by multiple reviews (Hunter et al., 2019; Kondo et al., 2018; Sallis & Spoon, 2015). In addition to finding general associations between greenness and reduced violence, the sources implicated specific types of green space in this relationship. Sallis & Spoon (2015) found community gardens, parks, and trails to be associated with increased neighborhood safety. Hunter et al. (2019) consistently found the greening of vacant urban lots to decrease vandalism and gun violence, which resulted in improved physical, mental, and social health through the mechanisms of crime reduction and increased perceptions of safety.

Sources reviewing green space and air quality revealed nuanced relationships impacting physical health. Multiple sources found associations between green space and reduced air pollution among a wide variety of assessed benefits (James et al., 2015; Sallis & Spoon, 2015; Vanaken & Danckaerts, 2018). However, a more recent review found that greenness, such as street trees, can restrict the dispersion of air pollution particles and increase pollen emissions, contributing negatively to respiratory health (Kumar et al., 2019). Consequently, decisions related to green space at the site level need to carefully consider plant species, placement, and management in order to achieve air quality benefits.

In terms of shade provision, sources measuring this mechanism consistently indicated relationships between green space and reduced urban heat (James et al., 2015; Schinasi et al., 2018; Schram-Bijkerk et al., 2018). Schinasi et al. (2018) further tracked these effects using a meta-analysis and found urban greenness to be modestly associated with decreased risks for population morbidity and mortality.

Several sources investigated direct, unmediated associations between green space and health conditions experienced by residents (Gascon et al., 2016; Hunter et al., 2019; James et al., 2015; Kondo et al., 2018; Sallis & Spoon, 2015). Results were mixed. Strong evidence was found for the positive impacts of greened vacant urban lots on health and of green space on improved birthweights (Hunter et al., 2019; Kondo et al., 2018). On the other hand, less consistent and mixed evidence was found to support

associations between green space and general health, weight status, depression, cardiovascular mortality, lung cancer mortality, and all-cause mortality (Gascon et al., 2016; James et al., 2015; Kondo et al., 2018). When compared to the stronger associations found between green space and health-mediating factors discussed in the above paragraphs, the mixed results found between green space and direct health outcomes may be due to the long-term nature of green space impacts.

The body of literature on green space and health is varied in quality yet yields positive findings with a comfortable degree of confidence. Ten out of twelve sources found strong associations between green space and multiple dimensions of health or health-mediating mechanisms. Controversy does exist, particularly for green space's impact on general health, cardiovascular, and stress outcomes. While some sources reference the existing literature's poor study quality, more point to the limited quantity of comparable studies. This scarceness of data calls for more primary research and standardization in outcome measures for green space and health.

Overall, individual and community health seems to be promoted by green space exposure. Apart from possible negative effects of some types of green spaces on air quality, no negative health consequences were found to be substantially associated with green space. Due to its wide variety of benefits and relatively low capital expenses, green space interventions are suggested to have excellent cost effectiveness (Hunter et al., 2019). Furthermore, green space interventions may have large implications for public health equity. Two sources suggest that while traditionally marginalized populations generally reside in less green neighborhoods, their health status may benefit more from green spaces, particularly with regard to birthweight, mortality, and child mental health outcomes (Alderton et al., 2019; James et al., 2015). However, other sources indicate that green space interventions may contribute to rising land values, accelerate neighborhood gentrification, serve socioeconomically advantaged residents, and be more likely to occur in advantaged neighborhoods (Hunter et al., 2019; Sallis & Spoon, 2015; Smith et al., 2017). These findings call for a health equity perspective in the development of green space interventions to ensure their benefits are equitably distributed, unintended consequences are mitigated, and implementations are inclusive of and culturally relevant for surrounding populations.

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## Social Cohesion

### Key Insights

Higher levels of social cohesion are associated with positive health outcomes through mechanisms that include social connections, sense of belonging and trust as well as by influencing higher rates of physical activity.

Social capital is an element of social cohesion that helps maintain social norms among groups and higher levels are associated with better mental and physical health.

While higher levels of social cohesions are associated with better outcomes, it can also play a role in social contagion, where social behaviors that spread through a group can be health damaging (e.g., smoking, substance use).



### Recommendations

**Promote developments that seek to enhance the social impact of the public spaces and social and cultural programming of these spaces.**

**Promote initiatives and programs that value inclusiveness, diversity and health promotion across all ages and backgrounds.**

### Literature Review

In the first decade (1996-2006) of social cohesion research, emerging findings showed that specific aspects of social cohesion, such as community participation, social participation, and voting, are positively associated with certain health outcomes such as cardiovascular, physical, and mental health (Perez et al., 2019). This connection was explored in the 2013 HNEF HIA. The 2013 HIA sought to understand how social cohesion and its mechanisms can lead to changes in certain health outcomes. Social cohesion mechanisms explored in the HIA included levels of trust residents have for their neighbors or community members, rates of volunteerism, voting rates, and cultural vitality. Since the 2013 HIA, new literature and research have provided more nuance around the original mechanisms explored. Additionally, this new pool of knowledge has identified new mechanisms of social cohesion that were not included in the 2013 HIA and brings to light potential negative health outcomes that are associated with social cohesion.

New research and reviews have generally continued to support the positive connection between the mechanisms explored in the HIA and health outcomes with some exceptions. The social environment has been found to combine with physical environment factors to influence levels of physical activity. Research has shown consistently positive connections between one's social cohesion, social networks, and increased physical activity (Sawyer et al., 2017). Individuals that report higher levels of strong social networks (defined as a combination of social support, neighborhood networks, and socialization) were more likely to engage in moderate to vigorous physical activity (Sawyer et al., 2017). Similarly, there is evidence of association between higher reported levels of social cohesion, a reported sense of belonging to a neighborhood, and the likelihood that those individuals will engage in physical activity.

However, the correlation stems from a majority of research that includes physical environment factors (e.g., land use mix, density, walking/bike trails, etc.) that also influence levels of physical activity (Sawyer et al., 2017). Another review found that an increased level of reported social cohesion is associated with weight status among individuals, specifically males (Perez et al., 2019). Studies found that males who report a stronger sense of neighborhood and community belonging were significantly more likely to be physically active. Another mechanism of social cohesion, social interactions, is found to be consistently protective against depression (Perez et al., 2019). One review found, in three studies, a positive association between voting participation and reduced mortality rates (Rodgers et al., 2019).

A pathway that was not explored in the 2013 HIA that is closely related and interdependent with social cohesion is social capital. Social cohesion was as defined in the 2013 HIA as describing:

***The extent of connectedness and solidarity of a community which is characterized by high levels of trust and respect, participation in community activities and public affairs, and increased participation in community groups.***

Social capital refers to the resources and benefits we receive, either as individuals or as groups, through our connections with others (Kawachi et al., 2008). Social capital is an attribute of social cohesion that is often measured through mechanisms such as mutual trust, social norms, and reciprocity. The top three most common and frequently measured components of social capital are trust (54%), participation (41%), and social support (34%) (Rodgers et al., 2019). Social capital can be protective from the individual and collective perspective. For example, at an individual level, the social support a person receives from their network allows an individual to feel valued and cared for (Villalonga-Olives & Kawachi, 2017). From a group perspective, social capital enables the collective effort to maintain a social norm such as not to smoke cigarettes in public spaces (Villalonga-Olives & Kawachi, 2017).

The most researched health outcomes of social capital include mental health (e.g., depression and anxiety) and physical health, specifically cardiovascular disease, hypertension, obesity, all-cause mortality, cancer, HIV/AIDs, and STIs (Ehsan et al., 2019). In general, there is evidence to support the positive relationship between social capital and these health outcomes. A review of 145 journal articles found that social capital had the most positive/mixed association with self-rated health, cardiovascular disease, and mortality (Rodgers et al., 2019).

Although social capital is generally perceived as protective and positive for health outcomes, adverse outcomes and associations have been identified. The potential downsides of social capital were first documented by Alejandro Portes. Portes suggests social capital can have negative implications on health for several reasons:

1. higher levels of social capital can result in excessive demands placed on group members to provide support to others,
2. group members can feel a sense of restriction of freedom because of informal control,
3. social capital may result in the exclusion of others, and
4. social capital can result in “down-leveling” of norms in which the achievements of individuals can be pulled down due to the demand for group conformity (Villalonga-Olives & Kawachi, 2017; Portes, 1998).

Another review searched for empirical studies that identified an association between social capital and negative or harmful health outcomes. Along with the negative side effects Portes found, results of this review revealed two additional downsides of social capital:

1. social contagion and
2. cross level interaction (Villalonga-Olives & Kawachi, 2017).

As it relates to social contagion, social behaviors that spread through a group can either be health promoting or health damaging. For example, social organizations outside of schools, such as community sports leagues, might include older members that smoke and drink. As a result of seeing older members engage in these activities, youths might be influenced to do the same. Cross-level interaction refers to how the same exposure to social capital can affect individuals differently. For example, highly trusting individuals living in low trust communities reported worse health, and individuals with low levels of trust did not benefit from better health because of living in high trust communities (Villalonga-Olives & Kawachi, 2017).

Social cohesion has not been found to specifically relate to certain populations. Most research and studies were focused on the general population. Geographically, research around social cohesion happened within urban, suburban, and rural communities in wealthier countries like the US, UK, Scandinavian and Nordic countries, Japan, Brazil, and Spain.

Although social cohesion and social capital are positively associated with health outcomes, there are limitations with social cohesion research. A review of 182 studies revealed inconsistent terminology, definitions, and measurements of the social environment across research related to social cohesion. This inconsistency creates challenges for consistent understanding of the connections between social cohesion and health outcomes and makes it difficult to compare results across different studies (Kepper et al. 2019). The association between social cohesion and social capital and health outcomes is further muddled due to different variables researchers adjust, resulting in mixed findings even when researchers are studying the same health outcome. For example, one review highlighted two studies that examined the relationship between social capital and cardiovascular disease. Each review adjusted for different levels of variables such as income, poverty, education, unemployment. This inconsistency resulted in one study concluding states with higher levels of social capital had lower rates of cardiovascular disease and the other study showing mixed results (Rodgers et al., 2019). Lastly, another limitation to social cohesion and social capital research is the lack of uniformity in how health is defined, what specific outcomes are used to measure health, and how these outcomes are measured. Due to the varied field of research around social cohesion and social capital, findings can, at best, only provide more nuance to positive associations with specific health outcomes rather than establishing any significant relationship. This implies future research around social cohesion and social capital needs to be more specific, with objective measures of health, standard measures of social cohesion and social capital, and more rigorous study designs.

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## Residential Energy Efficiency<sup>3</sup>



### Key Insights

Home energy efficiency improves residents' perceived warmth and thermal comfort.

Most studies suggest warmer and more consistent indoor temperatures result in fewer respiratory health symptoms associated with asthma and chronic obstructive pulmonary disease (COPD) as well as mental health benefits among young to older residents.

Warmer, drier conditions in weatherized homes also reduced humidity and mold, further promoting improved respiratory health outcomes.

Lower energy bills indirectly support better health outcomes by reducing pressure on households to divert spending from food, medicine, and other necessities to pay energy bills.

### Recommendations

**Encourage housing that meets energy efficiency standards.**

**Seek opportunities to retrofit existing homes through weatherization, improved indoor ventilation and energy efficiency upgrades to existing heating and cooling equipment.**

### Literature Review

Americans spend an average of nearly 90 percent of their time indoors, and an estimated two-thirds of that time is spent inside of their home (Klepeis et al, 2001). Sub-standard housing conditions perpetuate poor health outcomes in a variety of ways – exposure to pests, pollutants, extreme temperatures, and injury risks. The 2013 HNEF HIA highlighted similar connections but through a wider lens of Green Building. We offer a narrower and deeper exploration of these health pathways below, using the frame of Residential Energy Efficiency.

Energy costs factor into housing affordability. Most standard definitions of housing affordability say that housing costs, inclusive of utility expenses, should make up no more than 30 percent of a household's income. According to 2015 figures, nearly a third of US households struggle to pay their energy bills, and one in five households reduce spending on food, medicine, and other necessities to pay an energy bill. That report also found that nearly 10 percent of households maintain their homes at unsafe temperatures to compensate for high energy costs (Barry et al., 2015). These energy cost burdens disproportionately impact communities of color, who tend to live in less energy efficient homes (Drehobl and Ross, 2016).

There is broad consensus in the literature that home energy efficiency improves residents' perceived

<sup>3</sup> Adapted from *Research Brief: Health Impacts of Home Energy Efficiency and Renewable Energy*. Jeanette Pantoja, 2020.

warmth and thermal comfort. Most studies suggest warmer and more consistent indoor temperatures result in fewer respiratory health symptoms associated with asthma and chronic obstructive pulmonary disease (COPD). Warmer, drier conditions in weatherized homes also reduced humidity and mold, further promoting improved respiratory health outcomes<sup>4</sup>. A smaller number of studies also found improvements in cardiovascular health, specifically less hypertension, and improvements in mental health related to changes in indoor temperature, humidity, and mold and pests. (E4The Future, Inc., 2016; Vermont Department of Health, 2018; Willard et al., 2015; Wilson et al. 2016).

Improvements in mental health were associated with several factors. Warmer and more consistent temperatures directly reduced stress associated with feelings of extreme cold. Residents' ability to use more rooms led to more privacy, productivity, and improved mental health as fewer residents must crowd into a single room for warmth. Studies also suggested a potential to impact educational outcomes due to fewer missed days from school for asthmatic children and more quiet places for study (Willard et al., 2015).

Indoor air environments are highly variable, which can complicate analysis of the impact of energy efficiency interventions on indoor air quality. A home's proximity to sources of air pollution, building design and materials, home appliances, and resident behaviors – cooking, smoking, opening windows, etc. – can all influence indoor air quality. However, some patterns have emerged among studies observing air quality impacts in homes with energy efficiency improvements.

Studies reported improvements across multiple indoor air pollutants:

- Particulate Matter (PM or PM2.5)
- Volatile Organic Compounds (VOCs)
- Nitrogen Dioxide (NO<sub>2</sub>)
- Carbon Monoxide (CO)
- Radon
- Mold and Allergens

The literature suggests that a comprehensive energy efficiency new build or retrofit, inclusive of ventilation, is most likely to deliver improved indoor air quality in the home. Warmer, less humid conditions, through energy efficiency features and upgrades, can deter allergens and mold, which can trigger respiratory symptoms. Tightened building envelopes also more effectively excluded outdoor air pollutants and pests, which can trigger additional adverse health outcomes. Energy efficient heating and cooking systems combined with adequate filtration and ventilation can help reduce indoor sources of pollution, including combustion by-products and chemicals that off-gas from building materials and household products (Vermont Department of Health, 2018; Underhill et al., 2018; Willard et al., 2015; Wilson et al., 2016). These indoor air pollutants, such as those listed above, are associated with various health conditions, including headaches, dizziness, nausea, respiratory disease, and cardiovascular disease. While the time span of most energy efficiency studies is too short to assess impacts on cancer, it is known that several of the listed pollutants are known carcinogens (Vermont Department of Health, 2018).

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<sup>4</sup> Weatherization improvements (insulation, air sealing, heating system upgrades) without proper ventilation can conversely result in higher humidity and mold.

Conversely, several studies found that insufficient ventilation, or over-tightening the building envelope, may concentrate allergens and air pollutants within the home. Modeling studies assumed that negative effects could be greater in homes with poor filtration and heavy cooking and/or smoking (Underhill et al., 2018). However, findings of adverse health effects from inadequate ventilation were rare, and several authors suggested that these concerns have been largely addressed within current design and implementation standards (Vermont Department of Health, 2018; Willard et al., 2015).

Some studies reported a reduction of household pests, primarily through improved air sealing. Cockroaches, rodents, and dust mites can trigger allergies and respiratory health conditions, such as asthma. Some may also contribute to the spread of infectious disease; although, the impact on infectious disease risk was largely omitted from most studies. A few of the observed programs pair energy efficiency measures with integrated pest management or other pest elimination action to specifically address these exposures (E4The Future, Inc., 2016; Vermont Department of Health, 2018; Wilson et al., 2016).

There was only brief discussion of health impacts associated with household energy costs across most of the studies and reports. Most supported the idea that lower energy costs following energy efficiency upgrades improved mental health by alleviating household financial strain. Notably, one review reported mixed results on the impact of efficiency upgrades on energy expenses. The authors theorized that the mixed results could be due to the “take-back” effect, which posits that lower energy costs encourage higher consumption (Willard et al., 2015). The “take-back” scenario may look like someone who could not previously afford to cool their home can now turn on an energy efficient cooling system during a heat wave. Considering that one in ten US households maintain their homes at unsafe temperatures to reduce energy costs, increased consumption may still be supportive of resident health (Barry et al., 2015).

Lower energy bills indirectly support better health outcomes by reducing pressure on households to divert spending from food, medicine, and other necessities to pay energy bills. One report cited a study that found that pregnant women facing this “heat or eat” dilemma are more likely to have a low birthweight baby (Vermont Department of Health, 2018). Researchers have also found that utility costs are the most common reason people use payday lending services (Levy and Sledge, 2012). Lower energy bills may also protect residents from predatory lending and the health impacts of deeper financial hardship.

There are few qualitative studies evaluating residents’ experiences and attitudes towards their homes with energy efficiency upgrades. Some researchers found that energy efficiency improvements led to improved sense of autonomy, safety, and normalcy (e.g. ability to walk around in a t-shirt) among residents in upgraded homes (Willard et al., 2015). Improved thermal comfort throughout the home provided residents with the ability to use more rooms, rather than avoid crowding into a single room for warmth or cooling. This change provided residents with more privacy and autonomy, which contributed to improved social relationships within the home and productivity. Conversely, lack of familiarity with new technology in upgraded homes undermined feelings of safety and control. Several programs appeared to address this issue through resident outreach and education.

The literature consistently supported the idea that individuals with pre-existing health conditions, particularly children, and low-income households are best positioned to experience the health im-



pacts from more energy efficiency homes. Few of the literature sources discussed impacts across race, but racial health inequities, high energy cost burdens, and the concentration of poor housing affecting communities of color suggest that energy efficiency investments – including new or retrofitted buildings with weatherization, ventilation, and insulation improvements - may be effectively deployed to reduce disparities.

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# New Pathways

Ownership of Change

Climate Change

Moving to Opportunity

## Ownership of Change

### Key Insights

Ownership of Change (OOC), an emerging concept in the planning field developed by the Healthy Neighborhoods Study, describes residents' power in relation to neighborhood development.

Surveys with higher OOC scores are associated with residents feeling they have power to those involved with neighborhood change accountable, to preserve the culture of their community, and to capture the benefits of built environment changes happening in their neighborhood.

The sharing or transfer of community visioning and decision-making from traditional authorities (e.g., public agencies, private developers) to neighborhood residents impacted by proposed neighborhood changes is one potential mechanism to produce higher levels of OOC.



### Recommendations

**Document understanding of community vision, reflecting the needs and priorities of current residents, as part of development process.**

**Promote sharing of decision-making on proposed developments with residents in the impacted neighborhood.**

### Literature Review

Ownership of Change (OOC) is an emerging concept in the planning field developed by the Healthy Neighborhoods Study (Arcaya et al., 2018). Utilizing Participatory Action Research to assess the community health impacts of development, the Healthy Neighborhoods Study is a long-term research study initiated in 2016 by CLF, MIT, and residents of nine metro Boston communities (Gavin et al., 2016). Together this consortium of partners is conducting further research and analysis to build upon initial Healthy Neighborhoods Study findings geared toward exploring OOC. A conversation with two members of the consortium, Vedette Gavin (CLF) a co-investigator and Andrew Binet (MIT), a doctoral student, on their preliminary findings provided the following insights into OOC and its significance for healthy community transformation (V. Gavin et al., personal communication, August 7, 2020).

OOC is a term describing residents' power in relation to neighborhood development. Positive OOC scores indicate that residents feel they have power to hold change agents accountable, to preserve the culture of their community, and to capture the benefits of built environment changes happening in their neighborhood. Negative OOC scores indicate that residents feel they have limited power to influence and are alienated by neighborhood changes.

OOC is an important and novel indicator of a healthy neighborhood. It is an end unto itself that should be prioritized, not only a means to achieving other public health goals. Nonetheless, OOC appears to be a contributor to better health outcomes. Preliminary analysis of the Healthy Neighborhoods Study

findings indicates that positive OOC may be correlated with better physical health, mental health, and happiness among study participants. In this way, OOC acts as a mediator of community wellbeing.

Preliminary qualitative analysis of HNS findings suggests that OOC is an expansive concept relating to, among other things:

- the role money plays in neighborhood development,
- the direct distribution of benefits and burdens of current and historic neighborhood environments, including development processes and the sense of fairness residents feel related to that distribution,
- the range of impacts changes have on residents,
- the power of the voice of residents to determine neighborhood changes,
- the personal and collective involvement of residents in decision-making around neighborhood changes, and
- the hope, or lack thereof, residents feel as a result of neighborhood changes.

Expansive, quantitative analysis indicates that two separate yes/no questions may be appropriate to measure OOC. OOC is present when residents answer 'yes' to both of the following questions:

- Are you observing change in your neighborhood?
- Are these changes for you (for your benefit)?

When asking about observed neighborhood changes, a variety of areas of change, or domains, are offered as prompts. Domains included neighborhood development of housing, retail, public spaces/amenities, economic opportunities, transportation options, and policing practices. While the OOC instrument is still being refined, the current OOC indicator is validated by its strong relationship with other known public health goods (e.g. green space, social support, and sense of belonging), as measured through covariance.

Moving from defining and measuring OOC to describing how to achieve it, higher OOC correlates with the sharing or transfer of decision-making power from traditional authorities to neighborhood residents impacted by proposed neighborhood changes. Higher OOC may therefore be enabled by neighborhood changes that are aligned with a community-generated vision for neighborhood development. Traditionally, community vision is documented by a plan (e.g., municipal comprehensive plan, community economic development plan). However, in places without the political power and resources to develop a plan, community vision may not be clearly articulated and documented. Similarly, if the planning process does not incorporate power-sharing or power-transfer to neighborhood residents, plans may misrepresent community vision. Such a misrepresentation may occur when a neighborhood master plan emerges from a rapid planning process led by a for profit developer as compared to when a neighborhood plan emerges from longer term process led by community-based organizations and residents (e.g., Equity Forward Uphams Corner).

Via OOC, neighborhood change processes must meaningfully engage residents to surface and align with a community's vision, even when that means processes must slow down or reconfigure decision making to elevate voices of existing residents. Although clarifying the mechanisms of how OOC affects health will require additional research through the Healthy Neighborhood Study and other

research, early findings suggests the concept is an important indicator of community wellbeing in the context of neighborhood change resulting from public and private developments.

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## Climate Change<sup>5</sup>

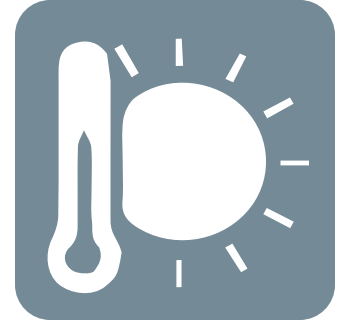
### Key Insights

Climate change poses risks to community health as a result of a warming climate.

The risks to health are multi-faceted and additive including greater risk to injuries and disruptions from extreme weather, heat-related illnesses due to longer periods of extreme heat, and greater exposure to disease vectors that can thrive in warmer environments.

Although climate health risk will play out universally, the impacts will not be distributed equally.

A vulnerability framework that includes measures of exposure, sensitivity and adaptive capacity will provide guidance to developments so that that can address various potential hazards (e.g., flooding, heat) and protect populations at heightened risk of negative health effects.



### Recommendations

**Assess project vulnerability using a community exposure, sensitivity, and adaptive capacity framework.**

**Build resiliency in neighborhoods by addressing physical environmental risks and socioeconomic factors that increase vulnerability.**

**Promote use of building designs that reduce reliance on carbon-based energy sources and minimize utility costs for residents.**

### Literature Review

The 2013 HNEF HIA did not assess the effects of climate change. The absence of that pathway reflected limitations on the number of pathways that could be assessed, and, at that time, it was not an issue that was raised prominently by community participants in the process. Its absence, however, should not be taken to mean that climate change will not have localized effects on TOD, or that TODs can contribute to climate change (e.g., building emissions and energy use). In fact, since the HIA, more has become known about both the risks to neighborhoods and community health as a result of a warming climate as well as the substantial contributions of greenhouse gases to the transportation system (Richmond & Yohe, 2014). On the latter, a goal of TOD is to reduce these emissions by supporting mass transit, walking, and biking trips.

The risks to health are multi-faceted and additive. Climate change models predict more frequent and intense weather events, meaning that precipitation may fall in shorter durations, with greater volumes and higher risk of flooding. Flooding can be expected to disrupt transportation systems and

<sup>5</sup> Adapted from Climate Vulnerability in Greater Boston. Seleeke Flingai, MAPC Research Analyst II. January 2020.

potentially isolate people in their homes. Often, extreme storms are accompanied by disruptions in electrical systems. When this occurs, heating, air conditioning, and ventilation systems can be put at risk if backup power systems are not in place. As a result, residents may face difficulties in maintaining indoor temperatures, and supplies that rely on refrigeration (e.g., perishable foods, medicine) may be negatively affected. Similarly, ongoing disruptions in air circulation, in combination with increased moisture, can lead to more indoor mold and contaminants.

Climate change is predicted to produce an overall warmer climate as well as more high heat days (i.e., temperature in excess of 90 °F in MA) (Resilient MA, 2017). Prolonged exposure to high temperatures can cause heat-related illnesses, such as heat cramps, heat exhaustion, heat stroke, and death. Extreme heat is expected to contribute to the exacerbation of chronic health conditions (Kravchenko, et al., 2013). Extreme heat also has the potential to contribute to greater levels of ground level air pollution and allergens (Balbus, J. et al., 2016).

With climate change, residents are projected to have greater exposure to disease vectors, such as Eastern equine encephalitis (EEE), West Nile virus (WNV), and Lyme disease. Massachusetts is predicted to have a general trend toward warmer temperatures, which may lead to higher mosquito and tick numbers and greater activity. This may prolong transmission seasons for related vector-borne diseases, extending the risk of transmission outside of the traditional late spring through early fall timeframe.

Although climate risk factors above will play out universally, the impacts will not be distributed equally. People may have different vulnerabilities to different types of climate change impacts depending on their age, health status, location, access to transportation, and experience with systemic barriers wrought by discrimination. For example, an older adult who lives alone may have reduced social contacts, making it more difficult to find nearby cooling centers or properly attend to medical needs during heat waves. Alternatively, multiple studies have found that federal aid payouts after floods and other natural disasters disproportionately benefit white communities and wealthy areas, exacerbating wealth inequality along racial and class lines (Howell & Elliott, 2018).

Vulnerability has been defined broadly as the susceptibility to damage (Luers, 2005); the absence of resources or assets that allow individuals or groups to deal with external shocks, stresses, or disturbances (Chambers, 1989); or the “state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt” (Adger, 2006). The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as follows:

***The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt*** (Intergovernmental Panel on Climate Change, 2014)

Conceptually, vulnerability is often characterized as encompassing three dimensions. The first is **vulnerability as exposure**. This “biophysical” perspective centers the exposure of humans to a physical hazard, suggesting that vulnerability is a function of the proximity of an individual or group to a hazard, stressor, or disturbance (Dow, 1992). The second dimension is **vulnerability as sensitivity**. Here, vulnerability is a function of the pre-existing social, economic, and political conditions of a given community and how those conditions influence access to resources and exposure to hazards (Tonmoy, El-Zein, & Hinkel, 2014). This dimension explicitly links vulnerability to social inequity and systems of power that differentially distribute resources across populations. The third dimension is **vulnerability as adaptive**

**capacity.** Here, vulnerability is a function of a group's ability (or lack thereof) to plan for and adapt to changing conditions using social or technical skills, resources, or strategies (Füssel & Klein, 2006).

A place's vulnerability to a given hazard is, by definition, dependent on the hazard. A community's vulnerability to heat shocks and stresses is in many ways different from the same community's vulnerability to flood disturbances. For example, a community in which many residents lack air conditioning units may be perfectly capable of responding to floods but utterly lacking in its capacity to withstand heat shocks. As such, the indicators used to ascertain a community's relative vulnerability to climate shocks should account not only for the attributes of the system but also the type of shock or stress affecting the system.

With this framing, it is therefore important to consider a few key principles regarding how the combination of place and its residents contributes to vulnerability and the severity of consequences climate change can have:

**Historical and Present Oppression:** Many vulnerabilities are the products of legacies of discriminatory policies, programs, and institutions that have collectively distributed risks and opportunities differentially across the population. For example, racial income and wealth gaps between White and Black Americans play a major role in each racial group's relative capacity to prepare for and recover from an extreme climate event. Some of these gaps are the direct result of policies that selectively afforded opportunities of wealth generation to White individuals while mostly excluding African Americans (Katznelson, 2006). The accumulated effects of systemic oppression combine with current manifestations that further entrench inequality. For example, Black people are more likely than Whites to pay higher interest rates for car loans (Charles, Hurst, & Stephens, 2008), which along with racial income and wealth gaps may partially explain lower car ownership rates for Black people compared to White people – a disparity that has spelled disaster during hurricane evacuations (Lui, Dixon, & Leondar-Wright, 2006). Therefore, an honest reckoning of historical discrimination, its lingering legacy, and its modern manifestations is a necessary step in adequately assessing vulnerability.

**Intersectionality:** Individuals and groups possess multiple identities, many of which can be the target of intersecting mechanisms of oppression (e.g. a Hispanic woman may be the target of racism, xenophobia, and sexism). This suggests that *within* larger societal groups or communities, there exists specific needs that should be considered to address the multiple forms of marginalization that may be experienced by members within the larger group.

**Strengths:** Vulnerable populations should not be viewed only as “vulnerable,” but as a range of individuals with various strengths that should be recognized and harnessed to improve the resiliency of the community. For example, the local knowledge of members of a vulnerable community – particularly that of older adults who have lived in the community for many years – may prove to be an asset when coordinating a response to an extreme weather event (Shih, et al., 2018).

## Assessing Vulnerability

Measures of climate change vulnerability are best represented as a composite, blending indicators of exposure, sensitivity, and adaptive capacity. Dozens of research studies, white papers, and government



reports have attempted to produce indicator-based vulnerability analyses at a variety of geographic scales and across numerous types of climate hazards (Tonmoy, El-Zein, & Hinkel, 2014).

**Exposure**

INDICATOR	HAZARD	MEASUREMENT
<b>Land surface temperature (LandSat)</b>	Heat	The average “heat island temperature increase” per housing unit in a census tract. “Heat island temperature increase” is defined as the difference between the land surface temperature and air temperature at a given parcel. Parcels for which land surface temperature was the same or lower than air surface temperature were assigned temperature increase values of zero. The total number of housing units on a parcel are multiplied by the heat island temperature increase at that parcel; this calculation was done for all parcels in a census tract and summed. The sum is then divided by the total number of housing units in the census tract, resulting in the average “heat island temperature increase” per housing unit in a census tract (MAPC analysis, 2019).
<b>Flood risk area</b>	Flood	Proportion of housing units in a census tract that are located within a FEMA Special Flood Hazard Area (based on the FEMA 2017 National Flood Hazard Layer).

**Sensitivity**

INDICATOR	HAZARD	RELATIONSHIP TO VULNERABILITY (+ = INCREASES, - = DECREASES)
<b>Proportion of occupied housing units with overcrowding (more than one occupant per room)</b>	Heat Flood	Heat (+): High density of people in enclosed spaces impacts thermal conditions of a space (Holt, 2015); groups in overcrowded accommodations are also at higher risk of adverse health effects from indoor air pollution (Vardoulakis, et al., 2015). Flood (+): Increased exposure to waterborne and vector-borne diseases in crowded housing and shelters after floods (Alderman, Turner, & Tong, 2012).
<b>Proportion of population living in group quarters</b>	Heat Flood	Heat (+): Group quarters include correctional facilities, nursing homes, and other institutions that house vulnerable populations or produce vulnerabilities due to the conditions within a given building. (USGCRP, 2016) For example, people who are incarcerated are at increased risk of heat stroke and other heat-related illnesses due to the high population density/overcrowding of jails and prisons, poor building infrastructure, and a disproportionate level of poor mental and/or physical health (Holt, 2015). Flood (+): See above.
<b>Proportion of population age 5 or below</b>	Heat Flood	Heat (+): Young children, especially those with pre-existing health conditions (e.g., asthma, diabetes), are at increased risk for hyperthermia and other heat-related illnesses. Heat-regulating mechanisms are also reduced in young children (McGeehin & Mirabelli, 2001). Flood (+): Reliance on others to move out of harm’s way; increased risk of waterborne and vector-borne diseases due to relatively-naïve immune systems (Cutter, Boruff, & Shirley, 2003) (Lane, et al., 2013).
<b>Proportion of population age 65 and up</b>	Heat Flood	Heat (+): Increases in hospital visits and death during heat events (Basu & Samet, 2002) (Lin, et al., 2009). Flood (+): May need assistance with evacuation and access to medical services but may also desire to stay in place, all of which increases risk of harm and mortality (Alderman, Turner, & Tong, 2012).

INDICATOR	HAZARD	RELATIONSHIP TO VULNERABILITY (+ = INCREASES, - = DECREASES)
Proportion of housing units built before 1960	Heat	Heat (+): Proxy for housing units without central air conditioning, a key factor in the reduction of heat-related morbidity and mortality (Weber, Sadoff, Erica, & de Sherbinin, 2015).
Proportion of housing units built in 1999 or later	Flood	Flood (-): Housing units in the 1% chance flood zone are required to have their lowest floor above the base flood level (e.g. elevation at least some level above the ground – fewer basements). Building codes began adopting provisions with this requirement were promulgated after ASCE 24 was published in 1998. Thus, buildings built before 1999 are at risk for more flood damage to buildings (ND_Gain, 2018).
Percentage of population with a disability	Heat Flood	Heat (+): Those with mobility or cognitive impairments may have greater difficulty responding to, evacuating from, and recovering from climate events, particularly when the functional needs of people with disabilities are not accounted for in risk communication and emergency response plans (USGCRP, 2016).  Flood (+): See above.
Proportion of population with cardiovascular disease	Heat Flood	Heat (+): Increases risk of cardiovascular disease-related hospital visits and deaths during heat waves (McGeehin & Mirabelli, 2001) (Lin, et al., 2009).  Flood (+): Increases in blood pressure following acute psychological stressors such as flooding can contribute to increases in cardiovascular-associated morbidity and mortality (Alderman, Turner, & Tong, 2012) (Miller & Arquilla, 2008).
Asthma hospitalization rate (cases per 100 residents)	Heat	Heat (+): Increases risk of respiratory disease-related hospital visits during heat waves (McGeehin & Mirabelli, 2001) (Lin, et al., 2009).
Proportion of population with diabetes	Heat Flood	Heat (+): Increases risk of diabetes-related hospital visits and deaths during heat waves (McGeehin & Mirabelli, 2001).  Flood (+): Destabilization of medication and diet can increase diabetes-related morbidity and mortality after natural disasters (Miller & Arquilla, 2008).
Population working outside (firefighters, construction workers, farmers, fishers, and forestry workers)	Heat Flood	Heat (+): Increased exposure leads to more heat-related deaths (Schulte & Chun, 2009).  Flood (+): Increased exposure to molds and allergens, new onset respiratory symptoms among aid workers and emergency responders, and economic disruptions (Schulte & Chun, 2009).

*Adaptive Capacity*

INDICATOR	HAZARD	RELATIONSHIP TO VULNERABILITY (+ = INCREASES, - = DECREASES)
Proportion of housing units that are renter-occupied	Heat Flood	Heat (+): Renters may be (but are not exclusively) more transient than homeowners and are likely to have lower incomes than homeowners, limiting their access to certain resources or routes toward recovery (Cutter, Boruff, & Shirley, 2003).  Flood (+): See above.
Proportion of occupied housing units that are mobile housing	Flood	Flood (+): Mobile homes are less resilient to hazards (Cutter, Boruff, & Shirley, 2003).

INDICATOR	HAZARD	RELATIONSHIP TO VULNERABILITY (+ = INCREASES, - = DECREASES)
<b>Proportion of occupied housing units with no vehicle</b>	Flood	Flood (+): Lack of transportation may reduce ability to evacuate coastal storms and floods (Lane, et al., 2013).
<b>Percentage of households without internet access</b>	Heat Flood	Heat (+): People without internet access may miss climate hazard warnings and information on available resources (e.g., cooling centers) if notifications are primarily provided on the Internet (New York State Energy Research and Development Authority, 2017).  Flood (+): Evacuation decision making may be supported by internet access at home and social media usage (Kaufman, Qing, Levenson, & Hanson, 2012).
<b>Percentage of people with a HS diploma or higher</b>	Heat Flood	Heat (-): Higher education levels are associated with increased economic resources that could assist in individual's or household's recovery from disaster (Cutter, Boruff, & Shirley, 2003).  Flood (-): See above.
<b>Unemployment rate</b>	Heat Flood	Heat (+): Unemployment (or the loss of employment after a climate event) increases stress (which increases risk of certain health impacts) and may reduce economic resources that would assist individual's or household's recovery from disaster (Lane, et al., 2013) (Cutter, Boruff, & Shirley, 2003).  Flood (+): See above.
<b>Median household income</b>	Heat Flood	Heat (-): Higher income increases individual's or household's ability to adapt and recover from climate impacts (Chow WTL, 2012)  Flood (-): See above.
<b>Poverty rate</b>	Heat Flood	Heat (+): People living in poverty may have less access to air conditioning, quality housing, health care, and other protective factors (McGeehin & Mirabelli, 2001).  Flood (+): People living in poverty have fewer economic resources to assist in recovery, have low likelihood of receiving low-interest loans, and may face greater difficulty navigating bureaucratic disaster recovery assistance protocols (Fothergill & Peek, 2004).
<b>Proportion population identifying as Hispanic</b>	Heat Flood	Heat (+) Racialization of society and racism leads to differentially distributed opportunities and risks, which can negatively impact the adaptive capacity of communities of color. (USGCRP, 2016).  Flood (+): See above.
<b>Proportion of population identifying as Black or African American</b>		
<b>Proportion population identifying as Asian</b>		
<b>Proportion of population identifying as American Indian, Alaskan Native, Native Hawaiian, Pacific Islander, some other race, or two or more races</b>		

INDICATOR	HAZARD	RELATIONSHIP TO VULNERABILITY (+ = INCREASES, - = DECREASES)
<b>Proportion of population age 65 and up living alone</b>	Heat Flood	Heat (+): Living alone may be the highest risk factor for heat-related deaths, perhaps signaling social isolation and fewer contacts with family and friends that can assist with access to cool areas or protective behaviors (e.g., adequate fluid intake) (Naughton, et al., 2002) (Semenza, et al., 1996). Flood (+): Living alone may be a consequence of social isolation and few contacts with family and friends, both of which may result in limited connections to evacuation capabilities, health care access (e.g., interruption in chronic disease management), and resource sharing (Lane, et al., 2013).
<b>Single-parent families</b>	Heat Flood	Heat (+): May have limited financial capacity, which alters ability to prepare for, respond to, and recover from climate events; for single parents ability to seek safety may be restricted by responsibilities as caregivers (Cutter, Boruff, & Shirley, 2003). Flood (+): See above.
<b>Linguistic isolation (no one over 14 speaking English very well)</b>	Heat Flood	Heat (+): Limited ability to adequately prepare for and respond to climate events, especially if climate hazard warnings and information on available resources are only made available in English (USGCRP, 2016). Flood (+): See above.
<b>Population living in different residences from 5 years prior</b>	Heat Flood	Heat (+): Social instability that may be associated with reduced social networks in a resident’s neighborhood (Chow WTL, 2012). Flood (+): See above.
<b>Proportion of population without health insurance</b>	Heat Flood	Heat (+): Lack of health insurance can reduce use of hospital services for fear of costs associated with care, leading to deferred care and greater morbidity and mortality for those with both acute and chronic health conditions (Davis, Wilson, Brock-Martin, Glover, & Svendsen, 2010). Flood (+): See above.

The vulnerability framework and indicators above provide guidance to HNEF regarding assessment of anticipated climate hazards and for populations at heightened risk of negative health effects. For example, the framework and indicators provide a method where multiple exposures – such as living in a neighborhood in a coastal flood zone that also experiences high land surface temperatures – can be identified and used to assess development proposals. Additionally, the indicators may reveal key insights about changes to proposed development that can support climate preparedness and mitigation of existing vulnerabilities.

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## Moving to Opportunity

### Key Insights

Adults who moved from higher poverty neighborhoods to lower poverty neighborhoods reported improved mental health and smaller improvements on measures of physical health and chronic diseases.

The earlier a child moves, the more health and economic benefits accrue to them over their lifetime.

Studies have found associations between physical environments that promote and protect health (e.g., greater amounts of green space) and effects such as lower health care costs born by residents and health systems.

The provision of support, such as with the housing search, finances and community building, can ensure the benefits associated with the move and reduce the potential for experiencing discrimination (racial, economic) or exposure to violence.



### Recommendations

**Provide housing search and relocation assistance for families with children who desire to move to development located in neighborhoods with low poverty levels.**

**Promote neighborhood changes that reduce neighborhood level poverty and include housing, with potential support services, for current residents.**

**Include programming with new developments that provide opportunities for community building among new residents and current residents, for sharing of cultural and ethnic backgrounds, and that provide opportunities for youth leadership.**

### Literature Review

The 2013 HNEF HIA looked specifically at the potential effects of proposed TOD in a set of neighborhoods that were served by public transit stations. In the three cases examples, households in the neighborhoods, on average, had less economic wealth and lower incomes relative to the City of Boston and suburban towns within a 30 minute drive of the proposed development sites. For example, at the time of the HIA, the neighborhoods of Roxbury and Mission Hill had median household incomes of \$27,480 and \$33,291, respectively, compared to the city of Boston's household median income of \$50,866. Similarly, around the time of the HIA, the Roxbury and Mission Hill neighborhoods experienced poverty rates more than 35% (BRA Research Division, 2014). The city of Boston, overall, had a poverty rate of 21%, with several adjacent municipalities at rates below 5%.

The HIA did not explore potential effects TOD may have if it created housing opportunities in other Boston neighborhoods or surrounding towns with higher median incomes than Boston. Specifically, the assessment did not explore what health impacts could occur if residents found new housing in



neighborhoods where poverty rates were much lower in comparison to their current neighborhoods. Since the HIA, more research and attention has been given to this concept, which is often referred to as Moving to Opportunity (MTO).

MTO was an experimental fair housing program implemented by the US Department of Housing and Urban Development. The program included 4,600 low-income families with children, a majority of whom were headed by African American or Hispanic single mothers. The families were recruited from public housing properties in five cities between 1994 and 1998. The public housing properties were located in neighborhoods identified as high poverty, meaning poverty rates were 10% or greater in these neighborhoods (NBER, 2008).

Families were randomly assigned to one of three groups. The experimental group received housing vouchers that were for use only in low-poverty neighborhoods (i.e., neighborhoods with poverty rates less than 10%), along with one-time help finding a house or apartment that qualified. The other two groups received either housing vouchers that they could use to move to any neighborhood or continued housing subsidies in the original neighborhood location (Turner et al., 2012).

The initial study of MTO found differences in health and behavioral outcomes between those who remained in their original neighborhoods and those who moved. Adults who moved to low poverty neighborhoods reported improved mental health as well as lower rates of obesity and higher rates of health promoting behaviors related to diet and exercise (NBER, 2008). The study showed improved outcomes on measures for adolescent girls, particularly related to mental health. By contrast, the study found adverse effects on adolescent boys, noting increases in risk behaviors such as substance use. In other areas, like labor market outcomes or social program participation of adults and math and reading achievement of children, the initial study did not identify changes.

In the past five years, more research has emerged about the potential health effects of growing up in or relocating to neighborhoods with low poverty rates. Such connections are identified in several of the existing pathways in the HIA including housing affordability, economic opportunity, green space, and social cohesion.

The more recent research, led by Chetty et al., includes deeper analysis of the data. Findings from the research, released in 2015, found that duration of exposure to a neighborhood affected children's outcomes (Chetty et al., 2016). Specifically, the research indicated that each additional year a childhood lives in a lower poverty neighborhood is associated with the child having greater earnings in adulthood. The research provides additional nuance to the earlier MTO findings which had not found effects on economic outcomes for adults.

More recent MTO research has sought to contextualize the findings related to the duration and effects of exposure to low poverty neighborhoods following relocation from a high poverty neighborhood. Multiple efforts reexamined the effect of neighborhood exposure through the mechanism of poverty. These came to similar conclusions, confirming a strong connection between poverty's effect on an individual's socioeconomic status (SES), social mobility (i.e., ability to exceed SES of parents), and health risks (Bergman et al., 2020; Venkataramani et al., 2020). These studies also confirmed the association between income and length of life, with higher incomes associated with greater longevity. MTO participants who moved were found to reside in places with built environment characteristics associated with better health outcomes. A study found positive associations between the low poverty

neighborhood destinations of participants and access to healthier foods, open space, and less dense developments relative to the conditions in neighborhoods where residents had lived prior (Antonakos et al., 2020). On the clinical side, one study found that earlier moves to a low poverty neighborhood and longer exposure to that neighborhood were associated with lower rates of hospitalization over a lifetime as well as lower costs related to hospitalization (Pollack et al., 2019).

A neighborhood is rarely a discrete segment of geography but rather an existing place with fluid and moving borders. Relatedly, exposure to low poverty neighborhoods has been found to involve an immediate location as well as the characteristics of surrounding places. Specifically, as compared to remaining in a neighborhood that has concentrated disadvantage within its borders and nearby, relocating to a neighborhood with higher socioeconomic characteristics predicts a significant improvement in mental health (Graif et al., 2016).

The MTO experiment provided support to those with vouchers in finding housing in low poverty neighborhoods. A study sought to examine what, if any, factors, influenced the reasons for not moving between low and high poverty neighborhoods similar those that occurred with MTO-like housing assistance. Research found that barriers to the move played a more prominent role than did a lack of preference or effort to leave a current neighborhood. That is, residents of high poverty neighborhoods may have a desire to move, but they are prevented from doing so by barriers to finding housing in other neighborhoods. When interventions provided support to find housing and access to financial assistance, similar to the initial MTO program, the result was a greater proportion of participating residents moving (Bergman et al., 2020).

At a community level, lower poverty neighborhoods may expose new residents to higher rates of racial and economic discrimination. Whereas in their original neighborhoods residents may have experienced community protection from being like their neighbors, in the new neighborhoods, there was greater potential to experience institutional racism in their housing search and interpersonal racism from their new neighbors (Osypuk et al., 2019). As a result, the discrimination experienced by residents has the potential to erode mental health gains accrued because of relocation from a high poverty neighborhood.

Assistance with the housing search process and access to financial is associated with a successful move to higher opportunity neighborhoods. The assistance may protect against potential adverse impacts, especially for those who are adolescents and adults when they move between neighborhoods. Support services, particularly those addressing mental and behavioral health, appeared to improve move-related outcomes, particularly on adverse impacts documented earlier related to adolescent males (Schmidt et al., 2017). Emerging evidence also suggests that the provision of behavioral support and community capacity-building skills helps reduce the likelihood that relocating residents experience the risk of violence as they had in their previous neighborhoods with higher concentrations of poverty (Casas et al., 2016).

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