



# The Long-Term Impact of Construction on the Health of Older Adults in New York City's Chinatown



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## Foreword

In an ever changing city such as New York, older buildings are torn down only to be replaced by taller ones. There are now towers that exceed the 984-foot limit dividing the mere skyscraper from the “supertall.” Experts are predicting that there could be at least one mile-high skyscraper by 2050. Imagine all the resources required to construct a building a mile high – the millions of cubic feet of cement, the thousands of steel beams and the countless wires cables and piping. We must also consider how these materials get to the site, and how debris is removed to landfills offsite by thousands of diesel-powered trucks, in an endless caravan that often goes on for years. Imagine also the years of demolition and construction, the noise and dust, and the interruptions in power and water. This all happens within the confines of crowded, narrow streets, flanked by small businesses, daycare centers, senior residences, schools and playgrounds. We may not have to consider a building a mile high just yet, but there are buildings that are well in excess of a thousand feet high today, and more being planned.

In dense, urban environments such as Manhattan’s Chinatown, the impact of regular construction on residents living in close proximity is already exacerbated. Long-term construction from large projects lengthens the period in which residents have to endure the noise, air pollution, traffic, sidewalk detours, disruption in services, stress and potential relocation (planned or otherwise) arising from construction. Yet very little is known about the impact of long-term construction on vulnerable populations such as the elderly. Many seniors in Chinatown live in low-income housing or attend senior centers next to development sites and cannot escape the constant construction, hence threatening their health and well-being.

This report calls attention to the health impacts of long-term construction on older adults in Manhattan’s Chinatown and the Lower East Side, and reviews them through the lens of a largely foreign-born, non-English speaking community who may be wary of interfacing with mainstream agencies and resources. The report also summarizes promising, evidence-based approaches to mitigate the health impact of long-term construction on older adults who may have complex health and social support needs. We strongly urge City representatives, private developers, and community-based organizations to take the issues and strategies highlighted in this report into consideration, so that older New Yorkers can receive the support and resources that they need in order to age in place and thrive in their homes and communities.



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## Executive Summary

Various long-term development projects are expected to break ground in Manhattan Chinatown and the Lower East Side. Our objective for this report is to present a review of the scientific published literature on the environmental and psychosocial health impacts of long-term construction on the quality of life and well-being of older adults. This report has been prepared in collaboration with community organizations and leaders to understand the potential health impact of years-long construction and to identify potential mitigation strategies.

Thirty-nine percent of the population in Manhattan Chinatown and the Lower East Side identify as Asian.<sup>1</sup> Nearly 1 in 5 residents in these neighborhoods are over the age of 65.<sup>1</sup> Among the older adult population, nearly 33% live below the federal poverty level<sup>2</sup>, 47% live with a disability<sup>3</sup>, and 37% experience ambulatory difficulties.<sup>3</sup> Long-term construction is associated with the following environmental and social consequences that may yield a greater negative impact on vulnerable and underrepresented populations, such as Asian American older adults:

- Increases in exposure to particulate matter released from construction sites, even in the short-term, can not only worsen co-morbidities, including cardiovascular and respiratory disease, but also result in hospitalizations, acute disease episodes, and/or death.<sup>4,5</sup>
- Asian Americans residing in the Northeast and Mid-Atlantic are exposed to 75% more fine particulate matter (PM<sub>2.5</sub>) compared to white residents in these same regions.<sup>6</sup>
- Nearly 3 in 4 deaths attributed to PM<sub>2.5</sub> exposure are among individuals 65 and older in New York City (NYC).<sup>7</sup>
- Exposure to unwanted noise can exacerbate hearing loss, and elicit a fight-or-flight stress response among humans, leading to the elevated release of stress hormones – an action that is associated with increased blood pressure, cholesterol, and heart rate.<sup>8</sup>
- Long-term exposure to noise is shown to increase a person's risk for hypertension<sup>9</sup>, sleep disturbances<sup>10</sup>, and cardiovascular and cerebrovascular diseases.<sup>9,11</sup>
- Unsafe sidewalk conditions may increase the risk of falling; falls are the leading cause of injury-related hospitalizations and death among older adults living in NYC.<sup>12</sup>
- Fear of falling may force older adults into reclusion, limiting their access to vital services associated with healthy aging.
- Compulsory relocation can threaten an older adult's sense of control and comfort, disrupt social networks, and impede their ability to access affordable goods, necessary services and resources.<sup>13,14</sup>

## Strategies for Mitigation

This report highlights several evidence-informed best practices for mitigating the harmful health impacts of long-term construction. These include:

1. **Engaging Community Members as Stakeholders throughout the Construction Process:** The creation of participatory spaces for community members to offer feedback, suggestions, and concerns regarding the impact of construction activity in their neighborhoods could accomplish this community engagement. These participatory spaces may take the shape of community

forums, focus groups, interviews, or listening sessions as a way to gather community input and identify resources to mitigate any construction-related health impacts.

2. **Creating an Independent Command Center for Construction-Related Activities:** This center could coordinate all construction-related activities and serve as a resource accessible for all community members. In order for services to be accessible by all residents, command center staff should be equipped with language skills specific to the community. The services offered should be culturally-tailored to fit the needs of the residents.
3. **Increasing Monitoring of Environmental Hazards related to Construction:** Routine monitoring and strengthened protocols would ensure that existing provisions to mitigate environmental hazards such as air and noise pollution would be enforced. Third-party monitoring may also help to guarantee that companies remain accountable for their actions and involvement in development projects and certify that construction sites remain compliant with city codes and regulations.
4. **Prioritizing and Adopt Strategies for Healthy Aging:** The preservation of familiar community environments is critical in maintaining key healthy aging factors such as access to health and social services, food sources, and the ability to remain physically active and maintain social relationships. Additional healthy aging factors to consider include: neighborhood walkability; improved and expanded transportation services; preservation of community spaces, social services, and local businesses; and emergency relocation and resilience training.
5. **Adapting Benchmarks related to Uniform Land Use Review Procedure (ULURP) Approval:** The benchmarks used to develop the environmental impact statement (EIS) as part of the ULURP approval should be adjusted for projects planned in neighborhoods containing populations most vulnerable to the harmful effects of major construction, such as older adults. Additionally, the city should consider how the social, economic, and environmental impacts from construction influence the entire neighborhood, compared to only the areas adjacent to construction.

## Introduction

Several long-term development projects are expected to break ground in Manhattan Chinatown and the Lower East Side. These projects pose serious potential health risks for older adults residing in close proximity. Long-term construction has been shown to increase the amount of air and noise pollution in areas surrounding the work site. Construction also disrupts a person's connectedness to their physical and social environment, which are key aspects of healthy aging. Designated by the World Health Organization as the first Age-Friendly City in 2010, New York City has made extraordinary progress in making the city a better place to grow old by promoting an 'age-in-everything' lens across all aspects of city life. Our objective for this report is to present a review of the scientific published literature on the environmental and psychosocial health impacts of long-term construction on the quality of life and well-being of older adults. This report has been prepared in collaboration with community organizations and leaders to understand the potential health impact of years-long construction and to identify potential evidence-based mitigation strategies for government decision-makers at all levels, community-based organizations, and the private sector in order to ensure that older New Yorkers are able to age with comfort and dignity in their communities.

## Background

**Manhattan Chinatown and the Lower East Side Demographics:** Manhattan Chinatown and the Lower East Side are two neighborhoods primarily situated in Community District 3 (CD3) in the Manhattan borough of New York City (shown in Figure 1), however areas of Manhattan Chinatown extend into Community District 1 and Community District 2. Community District 3 is roughly 1.7 square miles and has a population of over 160,000 residents.<sup>2, 15</sup> Thirty-nine percent of the population in this locality identify as Asian,<sup>3</sup> a rate nearly four times higher than that of New York State.<sup>2</sup> Of this population, 90% report being of Chinese descent.<sup>1</sup> Over one-third of residents (36%) in CB3 identify as foreign-born, with 69% of this group immigrating to the United States from an Asian country.<sup>2</sup> Furthermore, nearly 32% of adults in this neighborhood speak an Asian language at home.<sup>2</sup>

The Lower East Side and Chinatown neighborhoods are the third highest gentrifying districts in Manhattan, as seen through a 26.6% rent increase from 2010 to 2014.<sup>16</sup> Despite this increase in rent, over half of all households report making less than \$50,000 annually.<sup>2</sup> In fact, 1 in 4 people in CD3 live below the poverty line, a rate nearly double that of the state of New York.<sup>2</sup> Over 30,000 residents in the Lower East Side and Chinatown reside in public housing<sup>17</sup> and nearly 27% of all public housing units in Manhattan are located in these neighborhoods.<sup>18</sup>





**Figure 1: Community District 3.** Chinatown and the Lower East Side make up Community District 3 in Manhattan, New York. It is bounded by 14<sup>th</sup> Street to the north, Bowery Street to the east, and the East River along its southwest border.<sup>19</sup>

**Older Asian American Adults in Chinatown and the Lower East Side:** Asian Americans and Pacific Islanders are the fastest growing segment of the senior population in New York City<sup>20</sup> (see Figure 2). Within Manhattan Chinatown and the Lower East Side, nearly 1 in 5 residents are over the age of 65.<sup>1</sup> Of these senior citizens, nearly 33% live below the federal poverty level<sup>2</sup>, 47% live with a disability<sup>3</sup>, and 37% experience ambulatory difficulties.<sup>3</sup> Many Asian American seniors rely on social service organizations to meet social, nutritional, and informational needs.<sup>19</sup> CB3 houses 37 culturally sensitive senior centers that fit the needs of the members of the older adults residing in those neighborhoods.<sup>3</sup>

Race/Ethnic Profile	2000 Census	2016 ACS	% Change 2000-2016
White (Non-Hispanic)	533,982	489,585	-8.31%
Black	185,088	274,210	48.15%
Hispanic	138,840	248,466	78.96%
Asian/Pacific Islanders	59,056	145,973	147.18%
All Minorities	382,984	668,649	74.59%

**Figure 2: Older adults in New York City.** Among all older adults age 65 and over in New York City, the number of Asian Americans and Pacific Islanders older adults has seen a 147% increase from 2000 to 2016.<sup>21</sup>

## Health Outcomes of Long-Term Construction

Long-term construction plans and preparations should consider the impact of several key environmental factors on acute and prolonged community and individual health outcomes that result from such development. As the magnitude of the project increases, the timeline needed to complete construction will also be extended, leading to greater emission of environmental pollutants. Several environmental hazards associated with construction are detailed below.

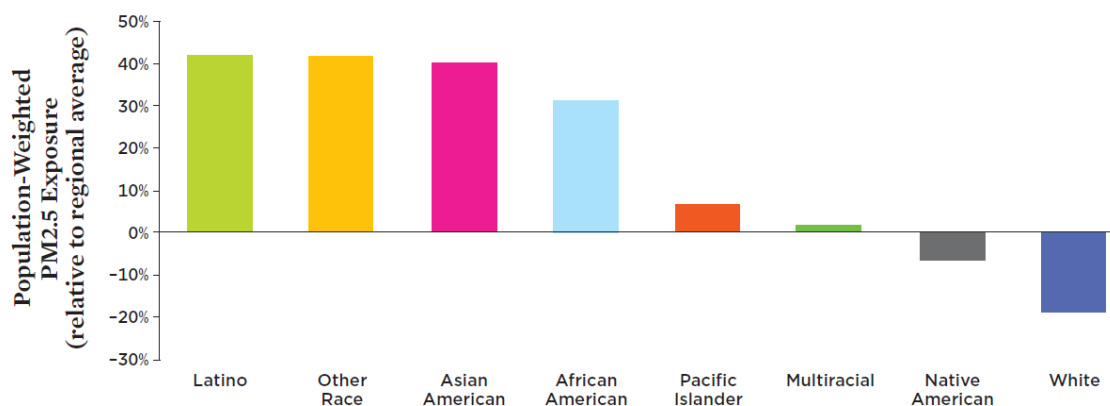


## Air Quality

Air pollution is a leading environmental health concern for people living in urban settings<sup>7</sup>, where air pollutants are most commonly produced through vehicular and industrial site emission.<sup>22</sup> Particulate matter (PM) refers to all air pollutant particles suspended in the air and are typically classified by two sizes: PM<sub>10</sub> and PM<sub>2.5</sub>. PM<sub>2.5</sub> refers to fine particles that can penetrate deep within airways, adversely affecting both respiratory and cardiovascular system functions. PM<sub>2.5</sub> can be emitted from combustion, power plant emissions, vehicle exhaust, and construction activities. The particulate matter output released into the air from construction processes is directly breathable not only by those in direct contact with the construction, but also to individuals who are regularly exposed to construction because they reside or frequent the vicinity. The New York City Department of Health and Mental Hygiene (DOHMH) estimates that nearly 3,000 deaths in NYC are attributed to PM<sub>2.5</sub> pollution.<sup>7</sup>

Older adults are highly vulnerable to the adverse effects of particulate air pollution<sup>4</sup>; preexisting cardiovascular or respiratory conditions and low socioeconomic status can further increase their susceptibility to negative PM-related health effects.<sup>23</sup> Adults older than 65 years old are 4.5 times more likely to be hospitalized for a cardiovascular event resulting from high PM<sub>2.5</sub> exposure as compared to younger adults.<sup>7</sup> A 2011 report from the New York City DOHMH asserted that nearly 3 in 4 deaths attributed to PM<sub>2.5</sub> exposure were among individuals 65 and older in NYC.<sup>7</sup> Exposure to particulate matter is also associated with an increased risk of cardiovascular disease, elevated blood pressure, lung disease, asthma, and premature death<sup>4</sup>, as well as daily cardio-respiratory mortality and acute hospital admissions.<sup>5</sup>

PM<sub>2.5</sub> emitted from vehicles that use fossil-based fuels indirectly affect minority communities; Latinx and Asian American residents residing in the Northeast and Mid-Atlantic experience 75% and 73% more PM<sub>2.5</sub> exposure respectively, compared to white residents (see Figure 3).<sup>6</sup> Additionally, research shows that neighborhoods with high proportions of Asian American residents speaking a non-English language and Asians who are US-born are at high risk of the harmful effects of carcinogenic hazardous air pollutants (HAPs).<sup>24</sup> HAPs refer to all toxic particles that are known or expected to cause cancer<sup>25</sup>; neighborhoods with higher proportions of Chinese, Korean, and South Asian residents are shown to have significantly higher cancer risk burdens compared to non-Hispanic white residents.<sup>24</sup>



**Figure 3: PM<sub>2.5</sub> exposure in the Northwest and Mid-Atlantic.** Latinx and Asian American residents are exposed to 42% and 40% more PM<sub>2.5</sub> compared to an average resident; meanwhile, white residents are exposed to 19% less

*PM<sub>2.5</sub> compared to an average resident. Thus, Latinx and Asian American residents are exposed 75% and 73% more PM<sub>2.5</sub> respectively, compared to white residents.<sup>6</sup>*

## Noise Pollution and Construction-Related Vibration

The use of heavy machinery, vehicles, and other tools often creates strong, recurrent noise. Exposure to noise is associated with significant health impacts—permanent hearing damage may occur with extended exposure to sound(s) exceeding 85 decibels<sup>26</sup>; however, noise does not have to be loud in order to be harmful to health. Exposure to any noise for an extended period can affect a person’s quality of life and mental well-being, causing mood swings and diminished productivity, and inciting social conflict.<sup>27, 28</sup> It has been hypothesized that exposure to noise elicits a fight-or-flight stress response among humans, leading to the elevated release of stress hormones, an action that is associated with increased blood pressure, cholesterol, and heart rate.<sup>8</sup> Long-term exposure to noise has been shown to increase one’s risk for hypertension<sup>9</sup>, sleep disturbances<sup>10</sup>, and cardiovascular and cerebrovascular diseases.<sup>9, 11</sup> Noise is the number one complaint among residents in CB3<sup>3</sup> and construction-related noise complaints are the second most reported noise complaint to 311 in Manhattan behind loud music and parties.<sup>29</sup> Older adults are at increased risk to noise pollution due to sensory changes that take place in the aging process. Individuals’ auditory perceptions change over time; as individuals age, their tolerance for loudness and high frequency noise decreases, and low frequency noise is magnified.<sup>30</sup>

In addition to noise, construction projects generate physical vibrations at the ground site that may not only be disruptive, but which affect people who physically feel and absorb vibration into their bodies by being present near the site. Though there is limited research on the health impact of vibrations for residents living near major construction projects, construction activities such as demolition, pile driving, and the use of power tools have been shown to lead to negative health impacts among construction workers. Vibration-related effects are classified as whole body vibration (WBV) and hand-arm vibration (HAV), both of which are associated with poor health outcomes. Whole body vibration refer to vibration that is transmitted by the surface supporting one’s entire body, such as through a seat or the floor.<sup>31</sup> Exposure to WBV can increase one’s risk for musculoskeletal disorders and cause and/or exacerbate lower back pain, motion sickness, bone damage, heart conditions, and poor balance.<sup>31</sup> HAV has been shown to cause and/or exacerbate vibration white finger, carpal tunnel syndrome, sensory nerve damage, and muscle and joint damage.<sup>31</sup> Prolonged exposure to vibration is positively associated with negative health outcomes.<sup>32</sup> These construction-related vibrations are likely to affect non-construction-related individuals, such as local residents living in close proximity to the construction site—for example, home-dwelling older adult residents of adjacent housing complexes.

## Health-Related Quality of Life

Construction disrupts aspects of the physical and social environment of the area at and surrounding the construction site. The effects of long-term construction projects may therefore negatively affect the health and well-being of older adults by reducing or altering the physical and social environments that contribute to a livable community.

**Accessing Community Resources:** Uneven sidewalks and footways combined with litter, roadside hazards, poor signage, and/or seasonal weather conditions, such as heavy rains, snow, and ice, may contribute to unsafe throughways and untenable walking conditions. Falls are the leading cause of

injury-related hospitalizations and death in older adults living in NYC.<sup>12</sup> Additionally, among oldest adults aged 85 and over, Asian Americans and Pacific Islanders have the highest rate of fall-related mortality in NYC.<sup>33</sup> Fear of falling may force older adults into reclusion and avoidance of venturing outdoors, reducing their levels of physical activity. Fear of falling may also isolate older adults from their loved ones and restrict their use of social services and senior centers. Older NYC residents who fell outdoors stated that unsafe sidewalk and street conditions increased their risk of falling.<sup>34</sup>

Fall risk is a significant concern for urban-dwelling older adults as walking is the most common type of reported physical activity among older adults; 45% of older adults report walking as a leisure-time activity.<sup>35</sup> However, uneven surfaces, can increase the imminent dangers related to falling. In 2011, New York Governor Andrew Cuomo signed the Complete Streets Act to mediate the risk of falling; the act imposed that road and sidewalk conditions must be made accessible for individuals of all ages and ability.<sup>36</sup>

Major construction projects can alter familiar community environments for urban-dwelling older adults. In a focus group of older adults at New York City-based senior centers, participants explained that unsafe sidewalk conditions have prevented them from coming to the center, resulting in some older adults staying in their apartments, afraid to venture out. Older adults expressed dismay at missing the social contact and activities at their local senior center because of poor environmental conditions.<sup>37</sup> This has a significant health-related impact on the quality of life of older adults in NYC. Those who attend senior centers often have the lowest incomes, fewest resources, poorest health, greatest social isolation, and are in most need for services. Attendance and participation in activities at their local senior center has been shown to increase physical and mental health and reduce social isolation.<sup>38</sup>

Construction may also disrupt Manhattan Chinatown's food economy, displacing numerous ethnic grocers in the area and impacting the food security of many residents who are reliant on the low-priced and culturally significant foods that these grocers carry. Chinatown's food system supplies an abundance of fresh and culturally appropriate fruits and vegetables year round<sup>39</sup> and accounts for 25% of the jobs in the area.<sup>40</sup> The displacement of these food sources by at least half a mile can negatively impact the food access and security of low-income neighborhoods, contributing to poor health outcomes.<sup>41</sup> Coupled with construction-impacted walkways, older adults and other vulnerable populations could face added barriers to gaining access to nutritious foods.

**Public Space and Green Space:** Long-term construction may impede accessibility to public spaces. Urban green space refers to parks, fields, and all other open green land situated within an urban environment.<sup>42</sup> Access to open space for physical activity has benefits not only for an older adult's physical health, but also for their psychological well-being.<sup>43</sup> Access to parks and green space is positively associated with achieving the recommended amount of physical activity among older adults<sup>44</sup> and may also help to reduce the prevalence of social isolation.<sup>45</sup> Green space also serves an additional physical function of mitigating the impact of pollutants in the air; neighborhood greenness is associated with lower personal exposure to PM<sub>2.5</sub><sup>46</sup> and PM<sub>10</sub>.<sup>47</sup>

Research also indicates that many older adults are prone to low levels of Vitamin D and may benefit from being outside in the sun. Home-dwelling older adults with low sun exposure were shown to have low serum Vitamin D deficiencies.<sup>48</sup> Healthy sun exposure has the possibility to increase Vitamin D levels, which is essential for bone health and may reduce the risk for high blood pressure, stroke, and heart attack in older adults.<sup>49,50</sup> Vitamin D deficiency is also associated with an increased risk of

autoimmune diseases such as asthma, irritable bowel disorder, multiple sclerosis, and arthritis.<sup>50</sup> In addition to being a source of Vitamin D, healthy sun exposure is associated with improved attitude and increased energy.<sup>51</sup> Older adults residing in urban environments where green space is already limited may be particularly vulnerable to reduced accessibility to public parks and similar green spaces because of construction projects.

Shadows can also negatively affect healthy sun exposure as large buildings may cast shadows that greatly influence the amount of sunlight in homes and green spaces, and on streets. Most neighborhoods in Manhattan on an average day are covered in shadows for at least half of all daylight hours<sup>52</sup>, limiting sunlight exposure for many residents. Currently, New York City has no restrictions on the amount of shadow over a location, though this is a concern of many residents and community members. In 2015, the Central Park Sunshine Task Force released a policy brief regarding the impact of shadows on the southern region of Central Park, urging for zoning changes to protect community access to areas of green space and sunlight.<sup>53</sup>

**Compulsory Relocation and Mental Health:** Community members or residents adjacent to construction sites may be asked to relocate during the construction period to reduce their exposure to poor air quality, noise pollution, and unsafe physical environment changes. Compulsory relocation resulting from long-term construction projects may threaten an older adult's sense of control by weakening social networks and dictating tenable residence options. Being able to remain independent and age in a familiar place helps a person to sustain connections to their social environment, a crucial component of healthy aging.

Compulsory relocation may reduce an older adult's access to caregiving networks, leading to further social isolation.<sup>13, 14</sup> Among individuals with dementia, involuntary relocation and displacement lead to greater accelerated cognitive decline.<sup>54</sup> Additionally, older adults forced to relocate from a long-term place of residence were more likely to pass away in the following year compared to older adults who were not asked to relocate.<sup>13</sup>

Relocation stress syndrome (RSS) is a condition characterized by feelings of loneliness, depression, anxiety, anger, and confusion. Risk of RSS can increase when relocation comes with little notice and uncertainty about where a person is being placed.<sup>55</sup> Lack of a relocation plan may lead to increased stress when asked to leave a long-term place of residence. For example, in 2009, the six-story tenement on 128 Hester Street in Manhattan Chinatown was demolished after it was damaged by the construction of the Wyndham Garden Chinatown Hotel next door. The tenants of 128 Hester Street, half of whom were older residents, were forced to evacuate their homes and did not have adequate time to collect their belongings or mentally prepare for this change. This involuntary evacuation caused some residents to lose their jobs, disrupted their access to social services, and rendered some residents homeless.<sup>56</sup>

# Strategies for Mitigation

This section highlights various strategies informed by evidence-based best practices to mitigate the health and social effects associated with long-term construction. These strategies were jointly identified by representatives and leaders from community organizations in Manhattan Chinatown and academic institutions throughout New York.

## 1. Engage Community Members as Stakeholders throughout the Construction Process

**Create Spaces for Community Input:** Community stakeholders should be engaged before, during and after the construction process through the creation of participatory spaces to offer feedback, suggestions, and concerns regarding the impact of construction activity in their neighborhoods. These spaces may take the shape of community forums, focus groups, key informant interviews, or listening sessions as a way to gather community input and identify resources to mitigate any construction-related health impacts. The comments and concerns posed by community members should be disseminated to relevant stakeholders and integrated into construction processes to ensure the safety of older residents and the preservation of their communities.

**Provision of Mitigation Resources for Community Members:** The provision of mitigation resources for community members during the period of construction may be effective in reducing the social-environmental impact of construction. These provisions may be identified during the community forums and listening sessions and would include items that community members deem as important in managing construction-related environmental hazards. Examples of resources that are effective in mitigating poor health outcomes at an individual level are listed below:

### *Air-conditioning units and HEPA filters*

Air-conditioning units and HEPA filters are effective in reducing the impact and exposure of particulate matter in the home. Among older adults 65 and older, air-conditioning prevalence at home was associated with a lower prevalence of health effects due to particulate matter exposure.<sup>57</sup> Short-term use of low-cost air filtration systems and HEPA filters are effective in reducing PM<sub>2.5</sub> exposure and lowering systolic blood pressure (SBP) among older adults living in US urban environments.<sup>58</sup>

### *Hearing protection devices (HPDs)*

Providing hearing protection devices (HPDs), such as ear plugs, to community members impacted by construction-related noise can be a cost-efficient method to reduce noise exposure.<sup>59</sup> Wearing ear plugs correctly has been shown to be effectively prevent temporary hearing loss when exposed to high amounts of recreational noise for a prolonged period of time.<sup>60</sup> In spite of these results, research indicates that older adults are significantly less likely to use HPDs though they understand the risk associated with prolonged noise exposure.<sup>61</sup> Therefore, higher level mitigation strategies, such as noise mitigation at the source or along the path of transmission, may be more effective in reducing the health impacts of noise among this population. These strategies are addressed further below.

## 2. Creation of an Independent Command Center for Construction-Related Activities

Major construction projects may take several years to complete, thus establishing a temporary command center with on-site staff representatives to inform and provide easily accessible services to the residents of Manhattan Chinatown and the Lower East Side impacted by construction-related activities is needed. To ensure that services are accessible to and useable for residents, the command center staff should be equipped with language skills specific to the community and the services offered should be culturally-tailored to fit the needs of the residents. The command center, located close to the construction site, would carry out the following objectives throughout the entire construction phase:

- (1) To provide information regarding daily road closures and construction-related activities to avert construction-related traffic congestion and accidents
- (2) To delineate clear paths of travel for pedestrians and inform pedestrians of alternative routes not impacted by construction to protect their safety
- (3) To assist community members in accessing social and medical services, such as the nearest, open senior center or medical clinic
- (4) To respond to medical and construction-related emergencies in a timely manner
- (5) To inform members of the community of possible relocation due to structural failure related to construction activity
- (6) To educate and prepare community members for the possibility of relocation
- (7) To serve as a hotline for construction-related complaints and provide status updates regarding personal grievances

The command center could be modeled after the highly successful Lower Manhattan Construction Command Center (LMCCC). LMCCC was created in 2004 to work with public and private partners involved in various revitalization projects after the events on September 11, 2001. During its time of operation, LMCCC coordinated all construction activities that took place in Lower Manhattan from 2004 until 2013, working to ensure construction compliance and mitigating any and all construction-related conflicts related to traffic, rodent control, environmental protection, and residential safety.<sup>62</sup> LMCCC managed over 22 million square feet of private and public construction projects south of Canal Street and held frequent meetings to coordinate all construction-related activities, ranging from managing day-to-day street closures to delivering construction materials to the correct site.

Involving community members and community-based organizations in the staffing and management of the proposed command center may garner community support for the development projects. LMCCC was created and sustained through federal, state, local, and private funds from the Federal Transit Administration, the Port Authority, the Metropolitan Transportation Authority, the state Department of Transportation, the City of New York, and the Lower Manhattan Development Corporation. Though LMCCC cost roughly \$17 million per year to operate, the command center was a cost effective program, saving the government and private contractors an estimated \$300 million dollars.<sup>63</sup>

### 3. Increase Monitoring of Environmental Hazards related to Construction

**On-Site Management of Construction-Related Environmental Hazards:** There are existing provisions to reduce the amount of construction-related environmental hazards exposed to New York City residents. Mitigation strategies for air, noise, and vibration are listed below:

#### *Air pollution mitigation*

Wetting and securely covering construction materials are common strategies to prevent the spread of particulate matter into the air. According to the Department of Environmental Protection (DEP), Section 1043 of the New York City Charter and Section 24-146 of the Administrative Code of the City of New York, protections must be upheld to prevent the emission of dust from construction-related activities. Chapter 13 of Title 15 of the Rules of the City of New York (RCNY) states that:

*“Provision shall be made at every construction site to control the amount of airborne dust released off site from construction operations, by wetting the construction material as necessary with appropriate spraying agents, provided wetting will not damage utility infrastructure or create any safety hazard.”* Furthermore, *“[t]rucks and other vehicles used to transport particulate matter shall be covered and any particulate matter kept on site shall be sufficiently wetted or stored to prevent particulate matter from becoming airborne.”*<sup>64</sup>

Municipal efforts to reduce PM<sub>2.5</sub> levels present in the air by 10% has shown to prevent more than 300 premature deaths, 200 hospital admissions, and 600 emergency room visits each year.<sup>7</sup>

#### *Noise mitigation*

Noise pollution may be mitigated at the source, along the path of transmission, and at the receiver end. Applying noise reduction methods at the source is the most effective strategy in reducing or eliminating noise. Noise mitigation at the source is also the easiest to oversee at construction sites, allowing construction workers and planners greater control.<sup>65</sup> Strategies for source mitigation include: synchronizing the timing of noisy operations, insulating construction components to absorb noise, using modern equipment with better engine insulation and mufflers, and restricting the time duration in which high noise operations take place.<sup>66</sup> Using a muffler to insulate and absorb noise is effective in decreasing the intensity of noise by at least 10 decibels,<sup>67</sup> which is equivalent to a 50% reduction in sound.<sup>68</sup> Using less noisy equipment is one of the most effective ways to reduce noise pollution; electric compressors are shown to be much quieter to operate compared to gasoline or diesel-engine powered compressors.<sup>69</sup> Active noise control, also known as noise cancelling, is an effective noise mitigation strategy for reducing sound resulting from the use of loud construction equipment including earth augers, vibration rollers, dump trucks, and excavators; however, this method tends to be expensive to enact and is not recommended for all construction equipment.<sup>70</sup>

For noise that cannot be controlled at the source, path control mitigation strategies may be an effective option. Sound barriers may provide a 10 to 20 decibel reduction through the absorption and reflection of sound waves.<sup>66</sup> To make the barrier more efficient at blocking noise, the physical height of the barrier should be greater than twice the distance from the source to the barrier<sup>71</sup> and the barrier should be placed as close to the source of noise as possible.<sup>66</sup>



Lastly, the effects of noise can be mitigated at the receiver end, namely to those individuals and communities who are directly impacted by construction-related noises. This could include providing hearing protection devices (HPDs) such as ear plugs to community members. Though HPDs are not very costly to supply and distribute, noise mitigation at the receiver end tends to be the most difficult and costly to enforce long-term, as it is very reliant on individual behaviors.<sup>66</sup> Among construction workers exposed to loud construction-related noise during 70% of their work day, HPDs were worn less than 20% of the time.<sup>72</sup> Therefore, in situations where noise control is dependent on mitigation at the receiver end, temporary relocation of individuals may be a more effective, long-term solution during construction, especially for home-dwelling older adults.

### *Vibration mitigation*

Conducting an initial preconstruction survey to assess the environmental conditions that could be affected by vibration may mitigate the impact of construction-created vibration on surrounding structures. This preconstruction survey should assess the soil condition underneath buildings, as well as the age and foundation of the buildings as these factors could mediate vibrational effects.<sup>30</sup> Results from the preconstruction survey should be used to determine the level of vibration monitoring and control during the construction phase.

**Routine Monitoring and Enforcement of Environmental Hazard Management:** Enforcement of routine monitoring at all construction sites is needed to ensure that prescribed environmental hazard management procedures are followed. In addition to certifying construction compliance, such routine monitoring can help gather useful data during and after the construction process to assess the impact of implementing strategies for air, noise, and vibration mitigation.

### *Air quality inspections*

In New York City, contractors who are constructing, demolishing, or operating machinery that can emit air pollutants must have a Dust Plan Mitigation Form documenting all processes of the development project that may cause the emission of air pollutants. This form must be visibly displayed on the site of development. The Department of Environmental Protection (DEP) is responsible for updating and enforcing New York City's Air Pollution Control Code. Air quality compliance inspections may occur when there are residential complaints, however, they may also occur at any point in the construction process by the DEP. Establishing a routine air quality inspection protocol may be a more effective process to ensure that all construction sites are compliant with their Dust Plan Mitigation Form. This process would be especially beneficial to impose during the phases of construction where the risk of releasing pollutants into the air is the highest.

### *Noise Mitigation Plan checks*

Similarly, contractors are also required to develop a Noise Mitigation Plan prior to beginning construction. The plan must also be visibly displayed at the construction site. If there is a construction-related noise complaint through 311, an inspector will visit the construction site and check if the mitigation plan is being followed. The inspector will also determine whether the mitigation plan requires modification to better suit the demands of the community residing at and around the construction site. Rather than a complaint-driven system, routine check-ins by city inspectors may be more beneficial for noise code compliance. Having this process in place may improve engagement for community residents,

especially in neighborhoods such as Manhattan’s Chinatown and Lower East Side, where low-English proficient residents may not know how to issue a complaint or are less likely to report a concern.

#### *Use third-party agents to monitor and enforce construction compliance*

Third-party monitoring is widely utilized to ensure partner compliance and accountability on a wide range of development projects. Evaluations of development projects that used a third-party agent to assess compliance reported benefits on project performance and impact.<sup>73</sup> Third-party monitoring should begin prior to the start of construction to establish baseline measurements for environmental hazards and continue through the post-construction phase, focusing on the following two areas:

*Air Quality:* Consumer aerosol monitors (CAMs) should be provided to community members in the areas affected by construction to monitor changes in air quality and report heightened concentrations of PM<sub>2.5</sub> to the independent command center and city officials. CAM tools also provide an actionable step, and therefore a sense of self-agency, for local residents to contribute to the public safety of their neighborhood. CAMs such as Foobot, Speck, and AirBeam retail for less than \$300, offering a cost-effective approach to provide valid measures PM<sub>2.5</sub> in the air compared to that of photometers which retail for \$6,000 to \$15,000.<sup>74</sup>

Academic institutions have previously collaborated with the city to establish baseline air quality measures prior to the start of construction and collect data throughout the construction phase to research and improve mitigation strategies. For example, after the events of September 11, the NYU Department of Environmental Medicine conducted research on the air quality in lower Manhattan and the health impacts associated with air pollutant exposures and for several years after, and made efforts to inform the public of the air pollutant exposure in the lower Manhattan area through organizing public forums and distributing newsletters with the results from their air quality research.<sup>75</sup>

*Noise Pollution:* NYC has an existing network of noise sensors and individuals for large-scale, continuous noise monitoring. There is an ongoing collaboration between city health and environmental agencies and the Sounds of New York City (SONYC) project to strategically identify and mitigate noise, and to study the public health impact of noise.<sup>76</sup> This effort could be extended to third-party monitoring of specific construction sites to ensure compliance with Noise Mitigation Plans.

## 4. Prioritize and Adopt Strategies for Healthy Aging

The preservation of familiar community environments is critical in maintaining key healthy aging and quality of life factors such as access to health and social services, food sources, and the ability to remain physically active and maintain social relationships. This includes the following factors:

**Increased Walkability and Transportation Services for Older Adults:** Unsafe sidewalk and road conditions are major deterrents for older adults as they can increase one’s risk for falling. During construction, clear signs should be provided to highlight uneven sidewalks and accessible detours for older adults to take. The focus groups and interviews suggested above can also serve to gather community input throughout the construction phase regarding walking conditions and the content and placement of signs. Having policies in place to increase outdoor walkability could mediate the risk of falling among older adults, which accounted for nearly \$50 billion in medical costs for non-fatal falls and \$754 million in medical costs for fatal falls in 2015.<sup>77</sup>

Older adults in Manhattan Chinatown and the Lower East Side area rely on public transportation services to get around the neighborhood and access senior centers, key components to maintaining social inclusion among older adults.<sup>78</sup> In 2015, 51% of older adults in New York City reported having poor transit access.<sup>79</sup> Access to public transportation for older adults, such as Access-A-Ride (AAR) services or similar paratransit services, should be expanded as approximately half of all older adults in Community Board 3 live with at least one disability.<sup>80</sup>

Additionally, creating a comprehensive transportation plan for pedestrians, Access-A-Ride, ride share services, leisure and medical appointment transportation, and emergency services transport would ensure the safe conveyance of older adults across New York City. The plan should include measures for the safe pick-up and drop off locations for older adults, and continual assessment of sidewalk and crosswalk conditions to ensure that older adults can access their neighborhood with ease throughout the construction period. The transportation plan should also include the most efficient routes to nearby hospitals in order to prevent any delays during a medical emergency. This suggested transportation plan should be compliant with the accessibility requirements outlined in the Americans with Disabilities Act (ADA) stating that:

*“[T]he path of travel to the altered area and the restrooms, telephones, and drinking fountains serving the altered area are readily accessible to and usable by individuals with disabilities [...] A “path of travel” includes a continuous, unobstructed way of pedestrian passage by means of which the altered area may be approached, entered, and exited, and which connects the altered area with an exterior approach (including sidewalks, streets, and parking areas), an entrance to the facility, and other parts of the facility.”<sup>81</sup>*

**Strengthen Social Networks and Preserve Local Businesses:** Having sustained connection to one’s social environment is crucial for healthy aging. This involves being able to access senior centers, adult day cares, grocery stores, doctors’ offices, and family and friends with ease. A focus on how construction and development may displace many local businesses and social services that are essential for the health and well-being of older adults is needed. Preserving community-owned businesses and shops allows older adult residents to maintain familiar social network ties and offers regular access to groceries, household goods, and other common services within walking distance.

Disrupting the food economy of Manhattan Chinatown has strong negative effects on the livelihood and nutritional status of many CD3 residents that rely on local grocers for affordable, culturally-significant foods. In the past 15 years, there has been a 58% reduction in produce carts, 33% fewer produce stores, and 58% fewer produce storefront vendors<sup>82</sup> in the Manhattan Chinatown area due to displacement from rising rents and more rigorous street vending enforcement. As construction activities begin, accessing neighborhood grocers may prove to be an increased challenge for older adults and vulnerable populations as they themselves or their affordable food sources may be displaced from the community.

**Creation of an Emergency Relocation Plan for Residents within the Construction Zone:** In instances where temporary relocation might be a possibility for residents during the construction phase, an emergency relocation plan is necessary. According to the NYC Administrative Code Section 26-301, it is the responsibility of the commissioner of housing preservation and development to provide and maintain tenant relocation services and make suitable accommodations for the tenants that are being relocated.<sup>83</sup> The relocation plan should be created prior to the initiation of any major construction projects and should outline not only where older adults and other residents will be temporarily

relocated, but also how the relocation process would occur. As much as possible, planners and developers should seek to replicate the current environments of residents when designing a relocation plan, particularly for the communities of Chinatown and the Lower East Side, many of whom come from minority backgrounds and have limited English capabilities.

**Resilience Education and Training in Response to Relocation:** Additionally, in the case of emergency relocation for older adults living in areas of construction, older adults should receive emergency relocation training and education prior to the start of construction. Drawing from disaster preparedness education for older adults, engaging older adults with their social networks to develop skills needed to safely age in place can help improve their disaster preparedness and resilience.<sup>84</sup> Tailoring emergency preparedness training to be culturally-responsive and meet the needs of older adults may increase their preparedness in the case of a natural disaster<sup>84</sup>, as well as ameliorate any stress, confusion, and concern over the relocation process.

## 5. Adapt Benchmarks related to Uniform Land Use Review Procedure (ULURP) Approval

The ULURP was developed in 1979 to standardize land use and development in New York City. An environmental impact statement (EIS) must be drafted before the ULURP is put in place. The EIS provides an assessment of how development would impact the surrounding construction area in terms of land use, environmental hazards, and neighborhood character both during and after the construction period. An EIS also outlines mitigation strategies in order to reduce the expected adverse impacts related to the construction project.

To understand the short and long-term impact of new development on different groups, the benchmarks used in the EIS should be adjusted for communities that are more vulnerable to the harmful effects of major construction. For example, standards deemed acceptable for the general population may not adequately protect the very elderly. Additionally, city representatives should consider how social, economic, and environmental impacts from construction influence the entire neighborhood, compared to only the areas adjacent to construction.

**Shadows:** Though the EIS evaluates the effects of shadows on public sunlight-sensitive resources, the EIS does not include an assessment of private open spaces.<sup>85</sup> For example, Chung Pak LDC is a senior housing complex that sits adjacent to the proposed Manhattan borough-based jail site. The development of the Manhattan jail site will cast a year round shadow on the rooftop garden that serves as a resource for older adults to get fresh air and sunlight. Temperatures can drop by as much as 20 degrees Fahrenheit in the winter in areas covered by shade<sup>53</sup>, leaving the rooftop garden area unusable to its residents. City planners, developers, and city representatives need to consider the impact of construction on the resources of vulnerable populations through adapting the guidelines that measure and monitor building-related shadows according to the community affected. Adopting changes to the EIS to include private open space, such as yards, patios, and private gardens as sunlight-sensitive resources may support vulnerable populations, as these may be their only exposure to sunlight and green space.

**Environmental Impact:** The 400-foot radius used in the EIS to evaluate construction-related environmental hazards should be expanded in order to more accurately assess the impact of

environmental hazards based on the vulnerable communities affected. Once airborne, particulate matter (PM) emitted from construction sites are able to stay in the air for hours or weeks depending on its size<sup>86</sup> and the wind conditions in the area. PM<sub>2.5</sub> is able to travel long distances as these particles are smaller and lighter. Four hundred feet in Manhattan is approximately only a block and a half when traveling north to south.<sup>87</sup> As stated previously, concentrations of particulate matter that are acceptable for the general population may be harmful for older adults and other vulnerable populations, and the full scope of potential environmental hazards should be accurately measured.

**Socioeconomic Impact:** When measuring socioeconomic impact, the demographic features of a community should be included in the evaluation, as socioeconomic changes could have greater impact for vulnerable and underserved communities. For example, EIS guidelines note that the displacement of businesses which collectively total less than 100 employees is not considered a significant impact, regardless of the type of business being displaced.<sup>85</sup> Anecdotal evidence support the idea that the displacement of small businesses that offer affordable goods has a strong impact on low and medium-income residents.<sup>88</sup> This was the case in the development of Myrtle Avenue in Brooklyn, New York, where longstanding locally owned businesses that served the needs of the community (a laundromat, a 99-cent store, and supermarket) were displaced due to residential high-rise building developers. This had a significant impact on community members who had to travel farther for their groceries, household goods, and complete errands, and also posed significant challenges for the older, mobility-restricted adults residing in that neighborhood.<sup>88</sup>

## Conclusion

NYC is a city where change and development are key to its identity. However, the harmful health impacts of the constant construction that accompanies the city's reinvention poses serious questions for policymakers, community-based organizations and the private sector.

The recommendations in this report are aligned with NYC's commitment to create a city environment where older New Yorkers can flourish and thrive. As the first global Age-Friendly City, New York City has made extraordinary progress in making the city a better place to grow old. This report highlights several evidence-based best practices for mitigating the health impact of long-term construction on older adults. These include the involvement of community members in the decision-making process, the creation of an independent command center for construction-related activities, the monitoring and enforcement of existing construction mitigation plans, and the prioritization of strategies to ensure that older adults can age with comfort and dignity in their communities. The wisdom and experience of older adults enrich our communities. With more people living longer than ever before, it is time to renew our commitment to older New Yorkers and ensure that they flourish and thrive in this city they helped build.

For a list of detailed action steps to implement the mitigation strategies suggested, please refer to **Appendix A**.

## About the Center for the Study of Asian American Health (CSAAH)

The NYU Center for the Study of Asian American Health (CSAAH) is a National Institute of Health (NIH) National Institute on Minority Health and Health Disparities (NIMHD) funded Specialized Center of Excellence based in the Section for Health Equity within NYU School of Medicine's Department of Population Health at NYU Langone Health.

Established in 2003 through an NIH NIMHD Project EXPORT (Excellence in Partnership, Outreach, Research, and Training) Center grant, CSAAH is the only center of its kind in the country that is solely dedicated to research and evaluation on Asian American health and health disparities. CSAAH's work is guided by a population health equity framework. In close collaboration with over 75 local and national community partners, we have evolved our mission and goals to advance health disparities research within a health equity framework.

CSAAH's guiding principles are as follows:

- We believe in systemic change through multi-pronged strategies and working with diverse stakeholders
- We believe in equitable collaboration and partnerships
- We believe in action-oriented research
- We believe in strengthening the research capacity of both community and academic partners to fully engage in the research process
- We believe in multi-cultural evaluation

For more information, please visit us at: <https://med.nyu.edu/asian-health>.

The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.



## References

1. Population FactFinder. Nyc.gov. <https://popfactfinder.planning.nyc.gov/profile/283/demographic>. Accessed on July 8, 2019.
2. U.S. Census Bureau. American community survey 1-year estimates. <http://censusreporter.org/profiles/79500US3603809-nyc-manchattan-community-district-3-chinatown-lower-east-side-puma-ny/>. Accessed on July 8, 2019.
3. The City of New York Manhattan Community Board 3. District needs statement for fiscal year 2020. <https://www1.nyc.gov/html/mancb3/downloads/cb3docs/CB3-DistrictNeeds-FY20.pdf>. Accessed on July 31, 2019.
4. Environmental Protection Agency. Health and Environmental Effects of Particulate Matter (PM). EPA.gov. <https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm>. Updated on June 20, 2018. Accessed on July 9, 2019.
5. Simoni M, Baldacci S, Maio S, Cerrai S, Sarno G, Viegi G. Adverse effects of outdoor pollution in the elderly. *J Thorac Dis*. 2015;7(1):34-45.
6. Union of Concerned Scientists. Inequitable exposure to air pollution from vehicles in the northeast and mid-atlantic. 2019.
7. Kheirbekl, Wheeler K, Walters S, Pezeshki G, Kass D. Air pollution and the health of New Yorkers: the impact of fine particles and ozone. New York City Department of Health and Mental Hygiene. 2011.
8. Goines L, Hagler L. Noise pollution: a modern plague. *South Med J*. 2007;100(3):287-294. doi: 10.1097/smj.0b013e3180318be5
9. Ising H, Kruppa B. Health effects caused by noise: evidence in the literature from the past 25 years. *Noise Health*. 2004;6(22):5-13.
10. Hume KI, Brink M, Basner M. Effects of environmental noise on sleep. *Noise Health*. 2012;14(61):297-302. doi: 10.4103/1463-1741.104897.
11. Oh M, Shin K, Kim K, Shin J. Influence of noise exposure on cardiocerebrovascular disease in Korea. *Science of the Total Environment*. 2019;651(2):1867-1876. <https://doi.org/10.1016/j.scitotenv.2018.10.081>
12. NYC Department of Health & Mental Hygiene. Bureau of Vital Statistics death records 2012-2014. Statewide Planning and Research Cooperative System (SPARCS) inpatient and emergency department visits 2012-2014.
13. Laughlin A, Parsons M, Kosloski KD, Bergman-Evans B. Predictors of mortality following involuntary interinstitutional relocation. *J Gerontol Nurs*. 2007;33(9):20-6; quiz 8-9
14. Falk H, Wijk H, Persson LO. Frail older persons' experiences of interinstitutional relocation. *Geriatr Nurs*. 2011;32(4):245-56.
15. Manhattan Community District 3. Nyc.gov. <https://communityprofiles.planning.nyc.gov/manhattan/3>. Accessed on July 8, 2019.
16. The City of New York Manhattan Community Board 3. District needs statement for fiscal year 2018. <http://www.nyc.gov/html/mancb3/downloads/cb3docs/Final%20DNS%20FY2018.pdf>. Accessed on July 9, 2019.
17. New York City Neighborhood Health Atlas. NYC Health. <https://public.tableau.com/profile/nyc.health#!/vizhome/NewYorkCityNeighborhoodHealthAtlas/Home>. Accessed on August 14, 2019.
18. NYU Langone Hospitals Board of Trustees. Community Health Needs Assessment and Implementation Plan/Community Service Plan 2019-2021. <https://www.nyulangone.org/files/chna-csp-final-8-5-19-complete.pdf>. Published June 2019. Accessed August 14, 2019.
19. Community Board No. 3. NYC.org. <https://www1.nyc.gov/html/mancb3/html/home/home.shtml>. Accessed on July 9, 2019.
20. Asian American Federation. Asian American seniors in New York City: an updated snapshot. [http://www.aafny.org/doc/Final\\_Senior\\_Report\\_3.pdf](http://www.aafny.org/doc/Final_Senior_Report_3.pdf). Published on August 26, 2016. Accessed on July 8, 2019.
21. NYC Department for the Aging. Annual plan summary (APS). NYC.org. <https://www1.nyc.gov/assets/dfta/downloads/pdf/reports/DFTAAnnualPlanSummary2018.pdf>. Published September 2018. Accessed on July 14, 2019.
22. Strosnider H, Kennedy C, Monti M, Yip F. Rural and urban differences in air quality, 2008–2012, and community drinking water quality, 2010–2015 — United States. *Surveillance Summaries*. 2017;66(13):1-10. doi: <http://dx.doi.org/10.15585/mmwr.ss6613a1externalicon>.
23. Mead MN. Who's at risk? Gauging susceptibility to air pollutants. *Environ Health Perspect*. 2011;119(4):A176. doi: 10.1289/ehp.119-a176a.
24. Grineski Se, Collins TW, Morales DX. Asian Americans and disproportionate exposure to carcinogenic hazardous air pollutants: a national study. *Soc Sci Med*. 2017;185:71-80. doi: 10.1016/j.socscimed.2017.05.042.
25. United States Environmental Protection Agency. What are Hazardous Air Pollutants? Epa.gov. <https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm>. Updated on February 9, 2017. Accessed on July 18, 2019.
26. World Health Organization. Hearing loss due to recreational exposure to loud sounds: a review. 2015.
27. Bronzaft AL, Deignan E, Bat-Chava Y, Nadler NB. Intrusive community noises yield more complaints. *Hearing Rehabilitation Quarterly*. 2000;25(116):22-34.
28. United States Environmental Health Agency. Noise: a health problem. <http://www.nonoise.org/library/epahlth/epahlth.htm>. Published August 1978. Accessed July 26, 2019.
29. NYC311 Noise Complaints. [https://maaronowen.shinyapps.io/shiny\\_NYC311\\_noise\\_app/](https://maaronowen.shinyapps.io/shiny_NYC311_noise_app/). Accessed on July 11, 2019.
30. Fucci D, McColl D, Petrosino L. Factors related to magnitude estimation scaling of complex auditory stimuli: aging. *Percept Mot Skills*. 1998;87(3 Pt 1):836-8.
31. Safe Work Australia. Whole-Body Vibration. Swa.gov.au. Published October 2016. Accessed on July 23, 2019.
32. OHS REPS. Effects of Vibration. <http://www.ohsrep.org.au/hazards/vibration/effects-of-vibration>. Accessed on July 9, 2019.
33. New York City Department of Health and Mental Hygiene. Epi Data Brief. <https://www1.nyc.gov/assets/doh/downloads/pdf/epi/databrief14.pdf>. Published April 2012. Accessed on August 7, 2019.
34. Chippendale T, Raveis V. Knowledge, behavioral practices, and experiences of outdoor fallers: implications for prevention programs. *Archives of Gerontology and Geriatrics*. 2017;72:19-24.

35. Li W, Keegan THM, Sternfeld B, Sidney S, Quesenberry CP, Kelsey JL. Outdoor falls among middle-aged and older adults: a neglected public health problem. *American Journal of Public Health*. 2006;96(7):1192-1200. doi: 10.2105/AJPH.2005.083055.
36. Department of Transportation. Complete Streets. Dot.ny.gov. <https://www.dot.ny.gov/programs/completestreets>. Accessed on July 17, 2019.
37. Denis E, Jellinick I, Nickerson A, Raveis WH. *Understanding the feasibility of health and wellness programs in NYC's senior centers*. 2011.
38. NYC Department for the Aging. Age-friendly NYC: new commitments for a city for all ages. 2017.
39. Imbruce V. *From Farm to Canal Street*. Cornell University Press; 2015.
40. McCormick L, Mao R, Tu Y. New York Chinatown's food-related cluster. 2010.
41. Ver Ploeg M, Breneman V, Farrigan T, Hamrick K, Hopkins D, Kaufman P, Lin BH, Nord M, Smith TA, Williams R, Kinnison K, Olander C, Singh A, Tuckermanty E. Access to affordable and nutritious food – measuring and understanding food deserts and their consequences: report to congress. United States Department of Agriculture. <https://www.ers.usda.gov/publications/pub-details/?pubid=42729>. Accessed on August 1, 2019.
42. Sharhri M. GreenSpace and its effects on our lives. [http://aocarastirmalari.arch.metu.edu.tr/files/2014/07/AOC\\_ARCH714MohammadShahri\\_2.pdf](http://aocarastirmalari.arch.metu.edu.tr/files/2014/07/AOC_ARCH714MohammadShahri_2.pdf). Accessed July 15, 2019.
43. Levy-Storms L, Chen L, Loukaitou-Sideris A. Older adults' needs and preferences for open space and physical activity in and near parks: a systematic review. *J Aging Phys Act*. 2018;26(4):682-696. doi: 10.1123/japa.2016-0354.
44. Huang NC, Kung SF, Hu SC. The relationship between urbanization, the built environment, and physical activity among older adults in Taiwan. *Int J Environ Res Public Health*. 2018;15(5). doi: 10.3390/ijerph15050836.
45. Loukaitou-Sideris A, Levy-Storms L, Brozen M. Placemaking for an aging population: guidelines for senior-friendly parks. UCLA Luskin School of Public Affairs. [https://www.lewis.ucla.edu/wp-content/uploads/sites/2/2015/04/Seniors-and-Parks-8-28-Print\\_reduced.pdf](https://www.lewis.ucla.edu/wp-content/uploads/sites/2/2015/04/Seniors-and-Parks-8-28-Print_reduced.pdf). Published June 2014. Accessed July 15, 2019.
46. Dadvand P, De Nazelle A, Triguero-Mas M, Schembari A, Cirach M, Amoly E, Figueras F, Basagana X, Ostro B, Nieuwenhuijsen M. Surrounding greenness and exposure to air pollution during pregnancy; an analysis of personal monitoring data. *Environ Health Perspect*. 2012;120(9):1286–1290.
47. Selmi W, Weber C, Rivière C, Blond N, Mehdi L, Nowak D. Air pollution removal by trees in public green spaces in Strasbourg city, France. *Urban Forestry & Urban Greening*. 2016;17:192-201. doi: <https://doi.org/10.1016/j.ufug.2016.04.010>.
48. Bischoff-Ferrari HA, Dawson-Hughes B, Willett WC, Staehelin HB, Bazemore MG, Zee RY, Wong JB. Effect of vitamin D on falls: a meta-analysis. *JAMA*. 2004;291(16):1999-2006.
49. Cleveland Clinic. Some sunlight may benefit your health, if you're older. <https://health.clevelandclinic.org/some-sunlight-may-benefit-your-health-if-youre-older/>. Published July 27, 2015. Accessed July 16, 2019.
50. Wright F, Weller RB. Risks and benefits of UV radiation in older people: more of a friend than a foe? *Maturitas*. 2015;81(4):425-431.
51. Levins PC, Carr DB, Fisher JE, Momtaz K, Parrish JA. Plasma beta-endorphin and beta-lipoprotein response to ultraviolet radiation. *Lancet*. 1983;2(8342):166.
52. Mapping the shadows of New York City: every building, every block. The New York Times. <https://www.nytimes.com/interactive/2016/12/21/upshot/Mapping-the-Shadows-of-New-York-City.html>. Published December 21, 2016. Accessed July 23, 2019.
53. Cafaro R, Diamond D, Ferrara J, Law-Gisiko L. Central Park Sunshine Task Force Report. Central Park Sunshine Task Force – Community Board Five. 2015.
54. Ryman FVM, Erisman JC, Darvey LM, Osborne J, Swartsenburg E, Syurina EV. Health effects of the relocation of patients with dementia: a scoping review to inform medical and policy decision-making. *The Gerontologist*. 2018. doi: 10.1093/geront/gny031.
55. Trice S. Negative impacts of major construction in senior communities and the building of New York City's borough-based jail system. Chinatown Core Block Association. 2019.
56. Chiu K. Tenants of 128 Hester St. continue to fight for justice. Metropolitan Council on Housing. [http://metcouncilonhousing.org/news\\_and\\_issues/tenant\\_newspaper/2012/september/tenants\\_of\\_128\\_hester\\_st\\_continue\\_to\\_fight\\_for\\_justice](http://metcouncilonhousing.org/news_and_issues/tenant_newspaper/2012/september/tenants_of_128_hester_st_continue_to_fight_for_justice). Published September 2012. Accessed on June 25, 2019.
57. Bell ML, Ebisu K, Peng RD, Dominici F. Adverse health effects of particulate air pollution: modification by air conditioning. *Epidemiology*. 2009;20(5):682-686. doi: 10.1097/EDE.0b013e3181aba749.
58. Morishita M, Adar SD, D'Souza J, Ziemba RA, Bard RL, Spino C, Brook RD. Effect of portable air filtration systems on personal exposure to fine particulate matter and blood pressure among residents in a low-income senior facility: a randomized clinical trial. *JAMA Intern Med*. 2018;178(10):1350-1357. doi: 10.1001/jamainternmed.2018.3308.
59. NIOSH. Hearing protection devices (HPD's). CDC.gov. <https://www.cdc.gov/niosh/mining/UserFiles/workshops/hlp1/05-HudakHearingProtectors.pdf>. Published June 2005. Accessed on July 17, 2019.
60. Ramakers FF, Kraffijenga VJ, Cattani G, van Zanten GA, Grolman W. Effectiveness of earplugs in preventing recreational noise-induced hearing loss: a randomized clinical trial. *JAMA Otolaryngol Head Neck Surg*. 2016;142(6):551-558. doi: 10.1001/jamaoto.2016.0225.
61. Eichwald J, Scinicariello F, Telfer JL, Carroll YI. Use of personal hearing protection devices at loud athletic or entertainment events among adults – United States, 2018. *MMWR Morb Mortal Wkly Rep*. 2018;67(41):1151-1155. doi: 10.15585/mmwr.mm6741a4.
62. Executive Order No. 53. NYC.gov. [http://www.nyc.gov/html/om/pdf/eo/eo\\_53.pdf](http://www.nyc.gov/html/om/pdf/eo/eo_53.pdf). Published on November 22, 2004. Accessed on July 18, 2019.
63. Shapiro J. Keep lower Manhattan construction agency opens, residents and politicians say. DNAinfo.com. <https://www.dnainfo.com/new-york/20101214/downtown/keep-lower-manhattan-construction-agency-opens-residents-politicians-say/>. Published December 14, 2010. Updated December 14, 2010. Accessed on July 18, 2019.

64. Department of Environmental Protection. Chapter 13 of Title 15 of the Rules of the City of New York. NYC.gov. <https://www1.nyc.gov/assets/dep/downloads/pdf/air/construction-dust-rules.pdf>. Accessed on July 10, 2019.
65. Webb JF. 1976. Noise control in industry. Sound Research Laboratories Limited, Holbrook Hall. Sudbury, Suffolk, U.K.
66. Gilchrist A, Allouche EN, Cowan D. Prediction and mitigation of construction noise in an urban environment. *Canadian Journal of Civil Engineering*. 2003;30(4):659-672.
67. U.S. Department of Transportation. Special Report— Measurement, Prediction, and Mitigation. DOT.gov. [https://www.fhwa.dot.gov/Environment/noise/construction\\_noise/special\\_report/hcn04.cfm](https://www.fhwa.dot.gov/Environment/noise/construction_noise/special_report/hcn04.cfm). Updated on June 28, 2017. Accessed on July 18, 2019.
68. Tontechnik-Rechner— sengpielaudio. <http://www.sengpielaudio.com/calculator-levelchange.htm>. Accessed on July 26, 2019.
69. Premier Safety Partners, LLC. Dampen noise pollution with a construction noise mitigation plan. <http://premiersafetypartners.com/construction-noise-mitigation-plan/>. Accessed on July 12, 2019.
70. Kwon K, Park M, Lee H, Ahn J, Shin M. construction noise management using active noise control techniques. *Journal of Construction Engineering and Management*. 2016;142(7).
71. Thumann A, Miller R. *Secrets of Noise Control*. Atlanta, GA. The Fairmount Press Inc.; 1976.
72. Neitzel R. Noise exposure and hearing protection use among construction workers in Washington state. *Electronic Library of Construction Occupational Safety & Health*. 2004.
73. Khawaja A, Arnold A, Chennoufi L, Smith E, Scott C. Environmental & social framework for IPF operations— third-party monitoring. The World Bank. <http://documents.worldbank.org/curated/en/578001530208566471/Environment-and-Social-Framework-ESF-Good-Practice-Note-on-Third-Party-Monitoring-English.pdf>. Published June 2018. Accessed July 16, 2019.
74. Sousan S, Koehler K, Hallett L, Peters TM. Evaluation of consumer monitors to measure particulate matter. *J Aerosol Sci*. 2017;107:123-133. doi: 10.1016/j.jaerosci.2017.02.013.
75. Department of Environmental Medicine. World Trade Center pollution. Med.nyu.edu. <https://med.nyu.edu/environmentalmedicine/research-divisions/human-exposure-and-health-effects/world-trade-center-pollution>. Accessed on July 30, 2019.
76. Keogan S. NYU launches research initiative to combat NYC noise pollution. NYU.com. [https://www.nyu.edu/about/news-publications/news/2016/november/SONYC\\_Launch.html](https://www.nyu.edu/about/news-publications/news/2016/november/SONYC_Launch.html). Published November 7, 2016. Updated November 7, 2016. Accessed August 6, 2019.
77. Bergen G. The growing health and economic burden of older adult falls— recent CDC research. STEADI. <https://www.ncoa.org/wp-content/uploads/The-Growing-Health-and-Economic-Burden-of-Older-Adult-Falls.pdf>. Accessed on July 11, 2019.
78. Scharlach AE, Lehning AJ. Ageing-friendly communities and social inclusion in the United States of America. *Ageing & Society*. 2013;33:110-136. doi: 10.1017/S0144686X12000578.
79. Transportation for America. Seniors & Transit. <http://t4america.org/maps-tools/seniorsmobilitycrisis2011/>. Accessed on July 12, 2019.
80. Rena MR. Community accessibility study for seniors and people with mobility disabilities. <https://www1.nyc.gov/html/mancb3/downloads/fellowship/Community%20Accessibility%20Study%20for%20Seniors%20and%20People%20with%20Mobility%20Disabilities.pdf>. Accessed on July 26, 2019.
81. Americans with Disabilities Act of 1990. <https://www.ada.gov/pubs/adastatute08.pdf>. Published 1990. Updated 2008. Accessed on July 10, 2019.
82. Imbruce V. Re: testimony on the borough-based jails – Manhattan. 2019.
83. NYCAC. Chapter 2 – Relocation Services. <https://nycadmincode.readthedocs.io/t26/c02/>. Accessed on July 17, 2019.
84. Shih RA, Acosta JD, Chen EK, Carbone EG, Xenakis L, Adamson DM, Chandra A. Improving disaster resilience among older adults. *Rand Health Q*. 2018;8(1):3.
85. New York City Borough-Based Jail System EIS. New York City Mayor’s Office of Environmental Coordination. Published March 22, 2019. Accessed June 19, 2019.
86. Dylos Corporation. What is particulate matter? <http://www.dylosproducts.com/whispama.html>. Accessed on July 22, 2019.
87. Pollak M. Knowing the Distance. The New York Times. <https://www.nytimes.com/2006/09/17/nyregion/thecity/17fyi.html>. Published September 17, 2006. Accessed July 23, 2019.
88. Pratt Center for Community Development. Downtown Brooklyn’s detour: the unanticipated impacts of rezoning and development on residents and businesses. [https://prattcenter.net/sites/default/files/prattcenter-downtown\\_brooklyns\\_detour.pdf](https://prattcenter.net/sites/default/files/prattcenter-downtown_brooklyns_detour.pdf). Published July 2008. Accessed on July 16, 2019.

## Appendix A: Action Steps

Our recommended action steps are divided into strategies before, during, and at the conclusion of construction. They are outlined as follows:

<b>Before Construction</b>
<ol style="list-style-type: none"><li>1. Notify Chinatown and Lower East Side residents of all upcoming long-term construction, including the timeline for construction and neighborhoods and areas impacted</li><li>2. Create spaces for community members to voice their concerns, feedback, and suggestions regarding the long-term construction impacting their neighborhoods</li><li>3. Engage with community members through listening sessions, focus groups, and interviews to assess the impact of long-term construction</li><li>4. Develop an emergency relocation plan for community members of Chinatown and the Lower East Side, being sure to identify vulnerable populations such as older adults that may need additional assistance in the event of relocation</li><li>5. Develop emergency preparedness and relocation training for older adults and community members that will be impacted by construction</li><li>6. Work with third-party agents to establish a baseline of environmental hazards associated with long-term construction, namely air pollutants and noise</li><li>7. Equip the construction area with appropriate signage in order to<ol style="list-style-type: none"><li>a. Alleviate the risk of falls</li><li>b. Support transportation services during medical emergencies, pick-up, and drop-off</li></ol></li><li>8. Establish an independent command center to monitor construction-related activities and serve as a direct contact to community members</li><li>9. Adapt Uniform Land Use Review Procedure (ULURP) guidelines to better assess the impact of construction on vulnerable populations</li></ol>
<b>During Construction</b>
<ol style="list-style-type: none"><li>1. Engage with community members through listening sessions, focus groups, and interviews to assess the impact of long-term construction</li><li>2. Monitor and enforce on-site management of air pollutants, noise, and other construction hazards to ensure that construction sites remain compliant</li><li>3. Utilize third-party monitoring methods to oversee air quality and noise pollution in the neighborhoods impacted by construction</li><li>4. Provide resources to community members to mitigate environmental hazards on the receiving end, such as air filtration devices and hearing protection devices (HPDs)</li><li>5. Utilize the independent command center to provide daily updates regarding construction and road closures, respond to medical and construction-related emergencies, inform the community of possible relocation, and provide status updates on reported grievances</li><li>6. Educate older adults and community members to develop an emergency preparedness plan, build advocacy skills, and learn to adapt in the case of relocation</li></ol>
<b>After Construction</b>
<ol style="list-style-type: none"><li>1. Continue monitoring the air quality and noise pollution in areas impacted by construction to assess any long-term impacts</li><li>2. Evaluate the effectiveness of the command center and educational campaigns</li><li>3. In the event of relocation, ensure that all residents and businesses were restored to their respective neighborhoods</li></ol>