The Red Line Transit Project Health Impact Assessment

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1 Introduction

1.1 Baltimore Red Line

The Baltimore Red Line is a proposed 14-mile transit line running east-west from the Social Security Administration headquarters in Baltimore County to Johns Hopkins Bayview Medical Center in east Baltimore. It will pass through the communities of Edmondson Village, West Baltimore, downtown, Inner Harbor East, Fells Point, and Canton. It is the only truly east-west line in the Baltimore Regional Rail System Plan. The project proposes various combinations of tunnel and surface alignments for either Light Rail Train (LRT), Bus Rapid Transit (BRT), or enhanced bus service. The Red Line plan also connects directly to the Light Rail, Metro Subway and MARC Train, thus creating a four-line system from what are now three non-intersecting rail lines.

As of December 2008, the alignment and mode for the Red Line has not been chosen. While the general route and station areas have been identified, decisions about the exact route and mode will be made in the first half of 2009. Specific plans for neighborhood changes and designs features will move forward at that time.

1.2 The Red Line Health Impact Assessment

On May 10, 2008 Mayor Sheila Dixon organized a Community Summit for Red Line. The event was the starting point for the Community Compact, an innovative agreement among the city, state, and Baltimore City residents to define success for the Red Line on community terms. For several weeks committed participants, working in partnership with the City, engaged in constructive dialogue about the Red Line transit project. They discussed how success of the Red Line includes many things beyond a transportation system. The four general topic areas that resulted from these meetings are: Putting Baltimore to work on the Red Line; Making the Red Line Green; Community centered station design, development & stewardship; and Aggressively plan & manage construction to limit community impact. The Community Compact was adopted and signed by state and city officials and more than 60 community organizations on September 12, 2008. To read the Compact, see http://www.gobaltimoreredline.com/compact.asp

During conversations about what the Red Line should do for communities, topics related to health arose repeatedly. The Community Compact identifies the creation of a "healthy and attractive environment" as one of the overarching goals for the Red Line. The core objective in the section "Making the Red Line Green" reads, "To the extent economically possible, the Red Line should improve the air and water quality, increase green space and improve the quality of life in the City compared to the conditions existing prior to implementing the Red Line".[1(p7)]

The Red Line project has the potential to significantly impact the geography and social environment across the City of Baltimore and will be a factor contributing to community health. The dialogue that occurred through the drafting of the Community Compact

allowed community members a voice in the process. They were able to express concerns about how the Red Line will affect their homes and their neighborhoods, many of which directly or indirectly relates to how the project will affect their health. In order to more fully explore how the Red Line will impact health and examine the potential to improve quality of life in Baltimore, the Baltimore City Department of Transportation and the Baltimore City Health Department joined forces to initiate a health impact assessment (HIA). The HIA aims to summarize current health conditions for the population living in the Red Line corridor, illustrate links between transportation and health in Baltimore, and recommend specific design features and mitigation strategies to maximize the project's capacity to achieve better health.

The Baltimore Red Line HIA will join a handful of HIAs around the world that examine how transportation projects impact community health. Only a few of these have looked at transit projects. The Atlanta BeltLine HIA assessed impacts of a multi-modal transportation system that includes plans for nearly 30 miles of biking and walking trails next to a 22-mile Light Rail loop.[2] An HIA from Merseyside, England evaluated the impacts of a comprehensive transport plan that included transit and road improvements.[3] A project in London reviewed the health impacts of a citywide program to reduce car traffic and promote active transport.[4] Each of these three HIAs reported similar conclusions: transportation systems that emphasize transit, walking and biking over the car result in a healthier population. These three reports also included recommendations to implement specific measures to get the most health benefits from each project.

1.3 Health and Environmental Impact Assessment

The National Environmental Policy Act of 1969 (NEPA)[5] established requirements for standardized environmental impact assessment for large-scale projects in the United States. This rule includes the priority protection of human health and outlines a holistic definition of the human environment. Yet, very few environmental impact assessments (EIA) actually include an in-depth analysis of how projects affect human health.[6] More explicit inclusion of health impacts in the EIA process would allow for greater focus on a broad scope of health issues and environmental determinants of health.[7]

As required by federal statute, an EIA has been done for the Red Line. The Draft Environmental Impact Statement (DEIS)[8] was released in October 2008. It details how construction and implementation of the project will affect the environment, including air, water, noise, and traffic volume. The lengthy report includes extensive analysis of data from Baltimore City and the region. The assessment enables informed choices to be made about the best alignment and mode for the Red Line.

The DEIS also provides an assessment of several factors that affect health—such as neighborhood cohesion, access, mobility, economic development and issues of environmental justice. However, it does not identify how these factors will impact community health through changes to the built environment. The DEIS does illustrate some of the differential health impacts, such as noise disturbances, from each of the transit options, but it not emphasize human-centric design options.

To provide a more comprehensive look at health, the HIA therefore serves as a comment to and supplemental analysis of the DEIS and identifies where the DEIS could have gone further to assess health impacts. The recommendations that follow identify which specific mode and design features of the Red Line, as it is described in the DEIS, will maximize health benefits for Baltimore communities.

1.4 Definition of Health Impact Assessment

Health Impact Assessment is a tool to describe in a qualitative or semi-quantitative fashion the impact of proposed policies, actions, or projects on human health. HIA is based upon a vision of health that considers all aspects of individuals' work, lifestyle, and environment to contribute to well-being. The HIA process uses a variety of methods to assess which communities will be affected by a new project and if those impacts benefit, reduce or have no effect on health. This could include interviews, focus groups, data collection and data analysis.[9,10]

The types of health impact assessments and goals for the process can vary. Standard steps for HIA include screening, scoping, assessment, communication of results, and evaluation.[11] Screening and scoping determine the necessity of doing a HIA and what issues should be the focus of assessment. The assessment step is conducted using current data on health status in communities and tying it to findings from the scientific literature. Then, the effects from a new project or program can be modeled quantitatively, with input from experts and community members, or using a mix of these. In the case of measuring the health impacts of a new transit line, most conclusions will be qualitative given the difficulty of modeling quantitative changes. Communicating the project's results will is key to affecting policy, as well as an important reflection back to the community. Lastly, an evaluation of the effect of the HIA can help improve the process for future projects.

2 Methods

The process of developing the Red Line HIA took place in four phases. Through a preliminary look at data, discussions with experts and initial modeling of health links, the first phase consisted of a screening of the potential health impacts. This led to a decision to perform the HIA. At this time, a choice was made to focus on City impacts only because the researchers working on the HIA represent the interests of Baltimore City residents.

The second phase consisted of scoping the project. This included a review of the Red Line proposal and the DEIS; in-depth interviews with eight residents representing each area of the proposed Red Line corridor; and a review of records of public input solicited during the drafting of the Community Compact and community meetings held by MTA., Because the Compact process had already carried out broad community outreach, it was felt that community input was already part of the project dialogue and did not have to be re-initiated as part of this phase.

An extensive literature review, along with research and analysis of census and local data on Baltimore health comprised the third phase. Synthesis of this information and the development of recommendations constituted the fourth phase. Through these steps, the HIA narrowed to focus on three main areas assessing construction and implementation of the Red Line and suggesting improvements to maximize health for residents in Baltimore City. These areas are: Improving Access and Opportunities for Safe Outdoor Activity; Construction Issues; and Improving Air Quality.

3 Baseline Health Assessment

The City of Baltimore Department of Planning has divided the city into 55 Community Statistical Areas (CSA) based on existing neighborhoods boundaries. For the most part, this HIA utilized data based on these jurisdictions. A city map showing CSA borders and which CSAs were included in this report can be seen below. Data for each CSA was drawn from the U.S. Census, Baltimore Neighborhood Indicators Alliance, Baltimore City Health Department, Baltimore City Department of Transportation, Baltimore City Department of Planning, and Maryland Department of Planning.

Community Statistical Areas have been listed in tables and figures as they lie geographically, from west to east, as if reading a map from left to right. Table 1, below, provides basic demographic and health information on the Red Line corridor communities. Such information offers some description of the population most closely impacted by the Red Line—those who will live through the construction period and start of service for the new transit line. Figure 1 illustrates how household income varies across the affected neighborhoods. Similarly, Figure 2 illustrates the vast differences in life expectancy from west to east. In addition, the following charts and tables below describe several specific aspects of transportation and health in Baltimore.

Table 1. Red Line Corridor Community Statistical Areas, listed from West to East[12]

	Population 2000	Median household income 2000	% ages 25-64 w/ ONLY high school diploma or equivalent	% population African American	Estimated Life Expectancy at Birth
Baltimore City Average	**651,154**	**$30,078**	**29%**	**64%**	**71**
Red Line Community Statistical Area					
Beechfield/Ten Hills/West Hills	12,812	$38,917	25%	75%	71
Allendale/Irvington/ South Hilton	19,129	$28,043	35%	87%	70
Edmondson Village	8,903	$33,023	36%	98%	68
Southwest Baltimore	20,965	$23,070	33%	71%	64
Greater Rosemont	21,877	$24,682	38%	98%	66
Sandtown-Winchester/Harlem	17,495	$18,924	35%	98%	65
Poppleton/The Terraces/ Hollins Market	5,364	$17,063	28%	82%	62
Upton/Druid Heights	10,404	$14,487	30%	95%	63
Washington Village / Pigtown	5,701	$22,271	36%	44%	67
Downtown/Seton Hill	4,767	$21,723	17%	56%	67
Jonestown/Oldtown	9,727	$11,162	30%	82%	68
Inner Harbor/Federal Hill	12,264	$51,615	15%	15%	79
Fells Point	8,569	$41,898	17%	10%	74
Canton	7,010	$40,235	16%	2%	78
Patterson Park N&E	15,233	$27,663	28%	51%	70
Highlandtown	6,722	$28,180	31%	8%	74
Orangeville/East Highlandtown	8,688	$28,003	33%	12%	71

Figure 1. Median Income in the Red Line Corridor by Community Statistical Area

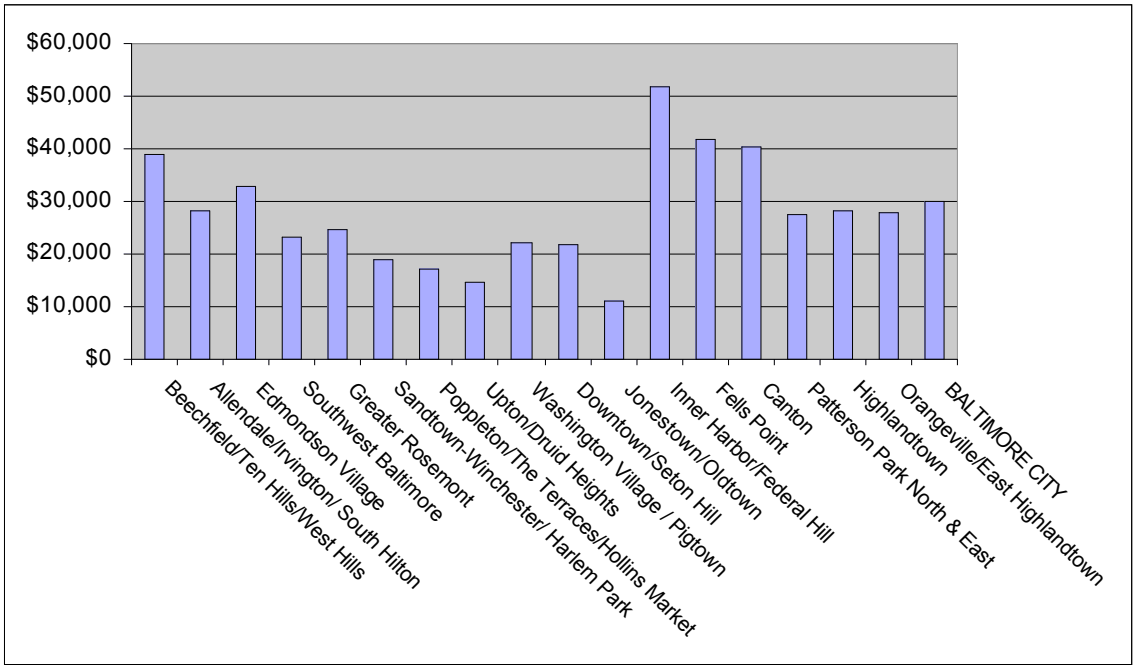


Figure 2. Average Life Expectancy in the Red Line Corridor by Community Statistical Area

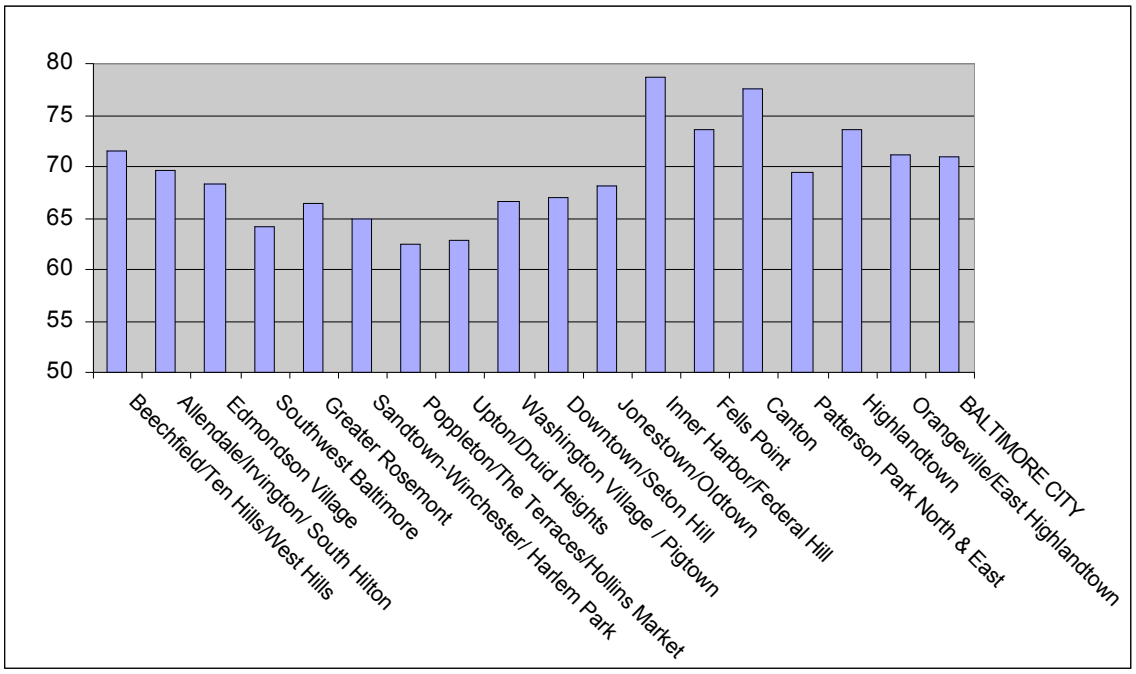


Table 2. Car access and transit use in Red Line Corridor communities, 2000

Community Statistical Area	% house-holds without access to a car	% People age 16+ who do not use car to get to work (PT, walk, bike)	% People who use Public Transit to get to work
Beechfield/Ten Hills/West Hills	15	24	21
Allendale/Irvington/South Hilton	36	24	20
Edmondson Village	28	20	20
Southwest Baltimore	58	27	20
Greater Rosemont	44	19	16
Sandtown-Winchester/Harlem	65	24	16
Poppleton/The Terraces/ Hollins Market	65	37	16
Upton/Druid Heights	70	31	21
Washington Village / Pigtown	48	33	18
Downtown/Seton Hill	48	43	7
Jonestown/Oldtown	71	35	15
Inner Harbor/Federal Hill	24	27	6
Fells Point	26	28	14
Canton	28	20	12
Patterson Park N&E	44	22	14
Highlandtown	34	23	18
Orangeville/East Highlandtown	32	32	22

Figure 3. Percent of households in Red Line corridor who do not have a car, west to east.[13]

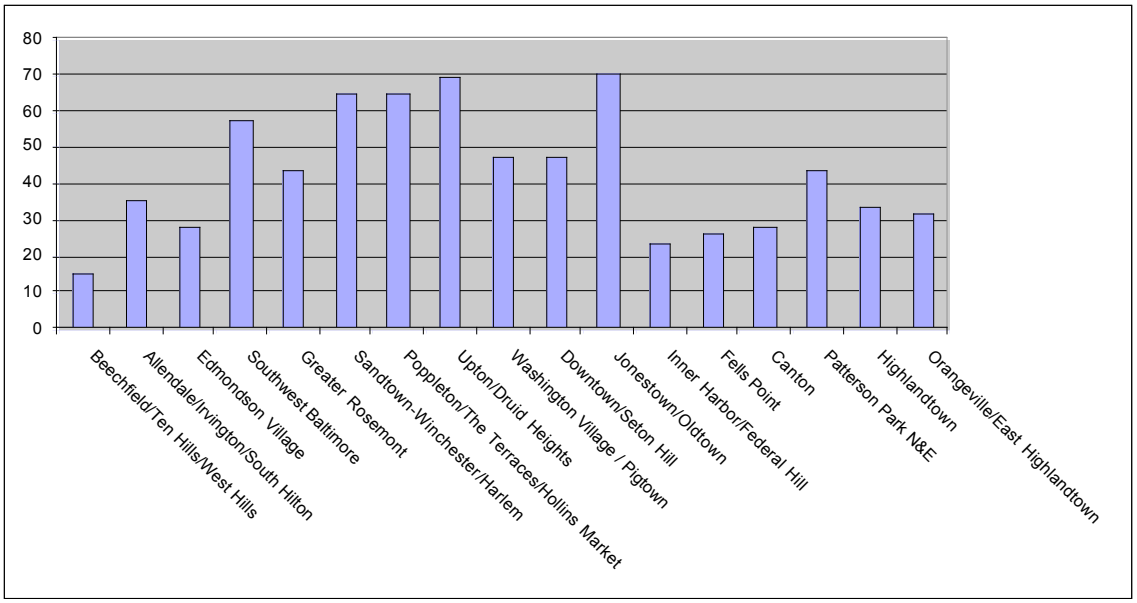


Table 3. **BALTIMORE CITY CRASHES**[14]

	2002	2003	2004	2005	2006	3 Year Average	% of statewide Crashes	% of statewide VMT
Pedestrian Involved	1,007	1,030	940	934	972	**949**	**32.50**	**6.46**
Pedal Cyclist Involved	243	215	232	210	180	**207**	**25.44**	**6.46**

Figure 4. Percent of area covered by trees, west to east, 2001[15]

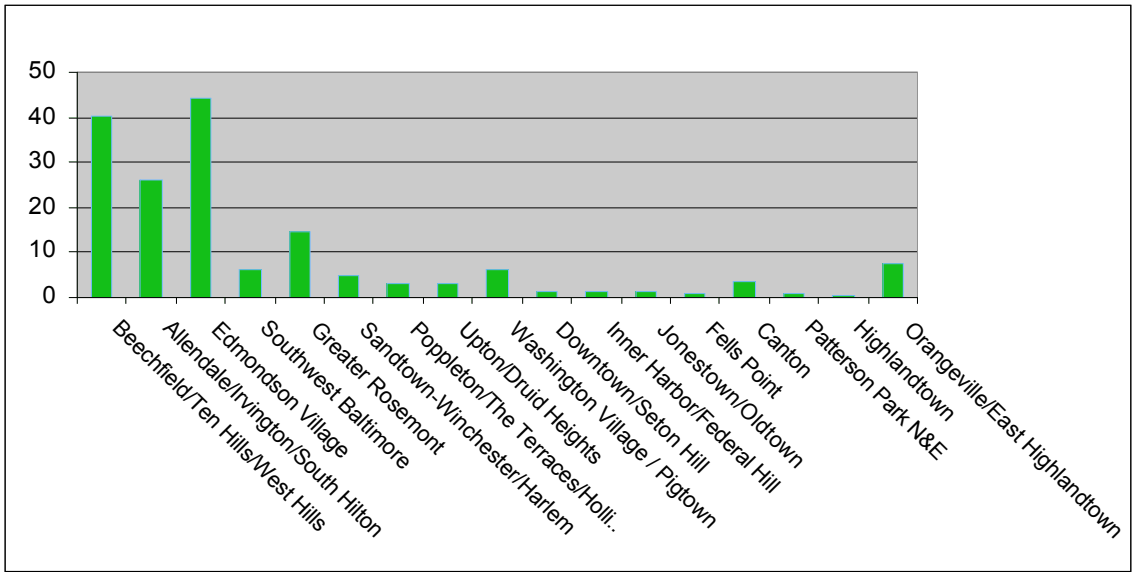
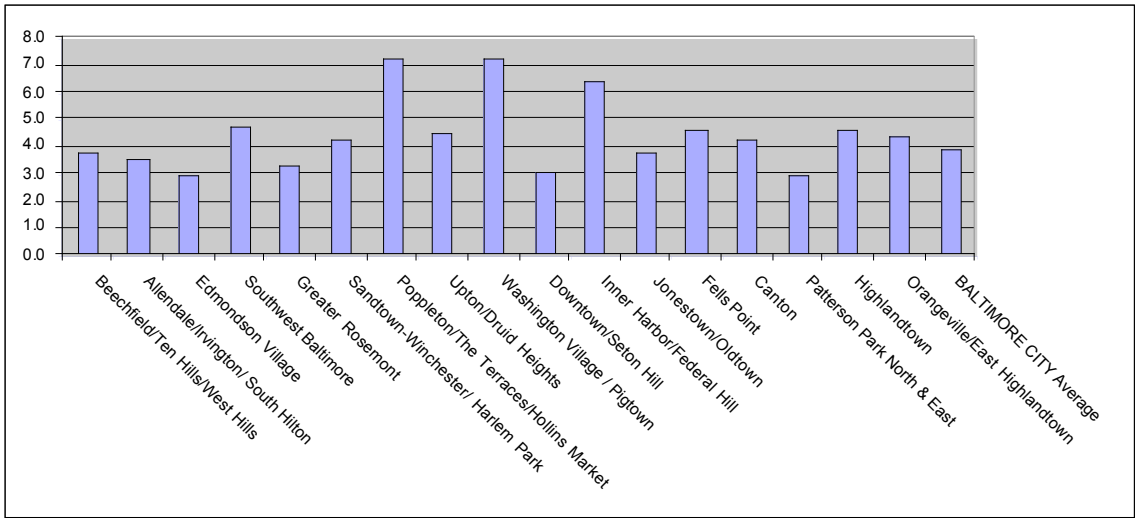


Table 4. Asthma Emergency Department Visit and Hospitalization Rates, 2004. Average Mortality Rate 2000-2004.[16]

	Emergency Room Visits 2004 (Rate per 10,000)	*Hospitalizations 2004 (Rate per 10,000)*	*Mortality 2000-04 (Rate per 1,000,000)*
Baltimore City	192.1	40.8	41.3
Maryland	65.4	16.8	16.4

Figure 5. Age Adjusted Mortality (deaths per 10,000 people) from Chronic Lower Respiratory Disease in Red Line Corridor[17]



4 The Health and Transportation Connection

The World Health Organization defines health as "A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."[18] The Healthy People 2010 definition of environmental health goes further to state that the "broad physical and social environment, which includes housing, urban development, and transportation, industry, and agriculture" shape human health outcomes.[19] Numerous studies have shown that the built environment is a significant factor influencing the physical and mental health of individuals and communities.[20,21,22] Further, the intersection between the built environment and accessible modes of transport affects health by promoting or discouraging healthy behaviors and by supporting (or not) healthful living conditions.[23]

Transportation connects to several major factors mediating health, among them neighborhood cohesion, access to services, injury, physical activity/obesity and air quality. These links involve both direct and indirect influences related to health outcomes. For example, people accessing public transit are more likely to meet the recommended amount of physical activity than people who mainly drive to work.[24] This activity can help reduce the likelihood of being overweight or obese and improve cardiovascular health. Additionally, transportation is listed as a key environmental factor influencing levels of social capital and neighborhood cohesion, elements of the social environment known to affect various components of health.[25] Lastly, traffic is one of the most significant contributors to local air pollution. The level and components of air pollution can have direct effects on respiratory and cardiovascular health, especially for vulnerable populations. Thus, providing an efficient public transit option has the potential to improve human health through a variety of means.

Still, the way a large public works project gets implemented has its own health impacts. Each phase of the project holds opportunities to maximize health benefits and minimize negative impacts. In the planning phase, prioritizing space for landscaping and safe pedestrian and bicycle facilities will improve the finished project for human health. During the construction phase, mitigating noise and dust become a focus. With the system up and running, continued oversight will ensure it remains accessible for everyone.

5 Improving Access and Opportunities for Safe Outdoor Activity

5.1 Introduction

Access to transportation options has been identified as an independent factor among social determinants of health.[26] Interviews with Baltimore residents reflected significant health concerns that relate to transportation access. These include access to jobs, healthcare services and retail services, especially grocery stores. This section will identify

how the DEIS defines access and describe the connection between issues of access and health. It will then outline some of the potential ways in which the Red Line will affect health by impacting access to neighborhoods, green space, physical activity, healthy foods, and pedestrian and bicycle safety.

5.2 The Red Line & Access

The DEIS Environmental Justice Technical Report describes impacts to "access" as changes to existing traffic patterns for motor vehicles, pedestrians and cyclists. Yet, the report only shows data related to impacts on car access and does not include an analysis of changes to bicycle or pedestrian access or access to nearby services. Such a narrow definition of access highlights only potential negative effects of the project (changing infrastructure for motor vehicle accessibility); it does not account for potential positive impacts on access to jobs, services, neighbors, or recreation.

Instead, a holistic view would look at how the Red Line will affect comprehensive access for people living along the alignment and include an analysis of health. A holistic examination becomes particularly important when assessing how the Red Line will affect low income and minority groups—known as environmental justice populations—who make up a significant percentage of Baltimore City residents in the Red Line corridor.[27]

According to the 2000 Census, on average, about one third of people living in Baltimore City neighborhoods along the Red Line corridor do not use a car to get to work (Table 2, above). Up to half of those not using cars currently rely on public transit to get to their jobs.[28] The DEIS reports that a significant percentage of households along the Red Line corridor do not have access to a car to use for any purpose. This figure ranges from 15% at the far western edge of the city up to 70% in the middle of the city.[29] See Figure 3 for detailed information. Given that many of these people walk to their destinations, pedestrian safety is an important issue. The DEIS Traffic, Parking and Transportation Technical Report does discuss the importance of crosswalks. However, recommendations emphasize facilities for crosswalks at stations only and does not address the need for better pedestrian facilities between stations and along the entire route.

5.3 Health Impact of the Red Line on Access

5.3.1 Neighborhood Cohesion and Quality of Life

As plans move forward to develop a sustainable Red Line, connecting neighborhoods and different modes of transport will be key to the success of the system. Impacts to neighborhood cohesion are described in the DEIS Environmental Justice Technical Report as effects to community interaction, residential stability, and use of community resources. The report says that neighborhood cohesion would not be adversely impacted by the majority of alignment choices, mainly through the lack of planned fencing.[30] However, by not including an analysis of why neighborhood cohesion is important, or

potential benefits to neighborhood cohesion, the report precludes key analyses of health determinants and possibilities for how design features could improve social cohesion.

The World Health Organization has identified public transportation, along with walking and cycling, as improving social cohesion.[31,26] This occurs by having more people out on the streets and traveling in groups, rather than in individual vehicles. Public transit thus enhances neighborhood connectivity and can help people associate with one another. Building neighborhood cohesion in this way has been linked to the growth of social capital, a key indicator for health.[25]

5.3.2 Accessing Green Space

For much of the Red Line corridor, neighborhoods have less than 10% tree cover (see Figure 4). In many areas, that number is below 5%. Even in areas with a fair amount of overall tree coverage, such as Edmondson Village, the vicinity around the proposed Red Line offers little shade to pedestrians and people waiting for the bus. Trees help clean the air, provide shade for people and buildings, and enhance neighborhood aesthetics. A map created by Parks & People Foundation illustrates how the areas that most lack of trees surround the proposed Red Line route.

A recent study from New York City demonstrated a compelling connection between asthma prevalence and the presence of street trees. After controlling for confounders like socioeconomic status and population density, areas with more street trees had a lower prevalence of early childhood asthma.[32] Such evidence illustrates a potentially important intervention for city neighborhoods.

Another study showed that populations of the same income level, but with higher exposure to green space, have fewer deaths from circulatory disease than those with less exposure to green space.[33] Additionally, green environments benefit psychological well-being. Exposure to trees and parks can be restorative for the brain, helping people recover from stress, fatigue, and depression.[34] Thus green space, which provides areas for recreation and mental recovery, affects health. Construction of the Red Line offers opportunities to preserve, renew, and create green space that will promote physical activity and improve neighborhood aesthetics.

5.3.3 Access to Physical activity and Healthy Foods

Both the Centers for Disease Control and Prevention and the Transportation Research Board have conducted research on how the built environment, including sidewalks, recreation areas, and street design, support or discourage physical activity.[35] Evidence shows that sidewalk availability and connectivity, the presence of playgrounds, and the proximity of services such as food outlets are partial determinants to the amount of physical activity people get.[36] The benefits of exercise include protection of cardio-vascular health, helping to maintain a healthy weight, and improving psychological well-being, each of which decrease the onset of chronic diseases such as diabetes and increase life expectancy.

Currently, half of Maryland residents do not meet the recommended amount of physical activity per week. One of the effects of little physical activity is a high prevalence of overweight and obesity. Thirty-six percent of Maryland residents are overweight and an additional 26% are obese.[37] These numbers are high, but in the City they are even higher: 35% of City residents are obese. Over the past decade, obesity prevalence among adults surveyed increased by nearly 50%. Notably, obesity affects nearly twice as many African American adults as white adults in Baltimore.[38]

Access to services such as full-service grocery stores are also vital to individual and community health. In interviews with residents, many complained of lack of healthy eating options in their neighborhoods. A recent study by the Center for a Livable Future at the Johns Hopkins Bloomberg School of Public Health assessed the availability of healthy food in the Southwest neighborhoods. These areas in the heart of the city will be an important transit node between the Red Line and the regional MARC train. Yet, of the 41 stores that sold food in this area in 2006 (mainly "corner stores"), three-quarters did not stock any fresh fruits and two-third sold no vegetables. Just over half of the stores carried only white bread; 20% of stories stocked no bread at all. Lastly, nearly two-thirds of stores sold only whole and/or 2% milk and 15% did not sell any type of milk.[39] This data compares to full-service grocery stores that regularly stock an array of fresh fruits and vegetables, bread, and low-fat milk products.

With a lack of full-service grocery stores easily accessible within neighborhoods, this study found that the greatest barrier to accessing full-service grocery stores was transportation. Further, local corner stores—the majority of which did not carry healthy food options—were the most-frequented type of store where residents purchased food. Overall, 95% of residents in the Southwest community did not eat the five daily servings of fruits and vegetables recommended by the USDA.[40]

These findings likely do not illustrate food availability for the whole corridor (hearsay from residents living in the eastern areas reported much better access to healthy foods). Nevertheless, they illustrate how transit oriented development could enhance food availability and nutrition for some residents in the Red Line corridor. Together with building infrastructure to encourage and support physical activity, the Red Line project could be an important catalyst for shifting health behaviors related to nutrition and exercise.

5.3.4 Pedestrian and Bicycle Safety

Annually nationwide, 6,000 bicyclists and pedestrians are killed in traffic.[41] The majority of pedestrian injuries and deaths happen during street crossing; a disproportionate number of incidents occur at night. Accident rates are significantly lower where marked crosswalks are provided and crossings are lighted.[42] In Baltimore City, the number of crashes involving pedestrians makes up one-third of all crashes involving pedestrians in the state (see Table 3). Likewise, crashes involving cyclists in Baltimore City make up one-quarter of all statewide crashes involving cyclists. These numbers persist despite

travel in the City accounting for only 6.5% of vehicle miles traveled (VMT) in the whole state of Maryland. In addition, among accidental injuries that result in death for Baltimore children ages 1-17, 39% are motor vehicle-related. Nearly two-thirds of these deaths involved a child who was walking or biking.[43]

A meta-analysis of studies from around the world concluded that fewer conflicts between motorists and pedestrians and cyclists occur on city streets where more people walk and cycle.[44] The demonstrated inverse relationship between the number of individuals engaging in active transport and the number of collisions showed that as cyclists and pedestrians become more visible, the streets become safer for them. Infrastructure that supports such a shift in behavior and mode choice will help reduce injury and death on Baltimore's streets.

5.3.4.1 Activity: Walking

In their policy statement recommending specific accommodations for walking and bicycling, the Federal Highway Administration asserts that "walking and bicycling emerge as an "indicator species" for the health and well-being of a community".[45] If health is to be a central object directing choices about alignment, mode and station location, the safety and comfort of pedestrians will be a top priority.

Walking and public transit are naturally connected modes of transport. An environment that encourages walking through human-scale design will help increase physical activity in neighborhoods.[46] Walking to public transit can significantly increase daily physical activity for transit riders. Further, people utilizing rail transport are more likely to walk further than those taking the bus.[24,47]

5.3.4.2 Activity: Biking

The federal Transportation Equity Act for the 21st Century (TEA-21) states that, "Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction of transportation projects, except where bicycle and pedestrian use are not permitted."[48]

Like walking, the health benefits of cycling include improved circulation, cardiovascular health, and mental health. It is also an integral element of a healthy, sustainable community through reduced vehicle congestion on streets and parking lots. In the longer term, air quality improves and land frees up for better uses. Like walking, biking and transit are complementary modes. The two systems naturally link because biking greatly enhances accessibility to transit: for those who might otherwise be too far away to access transit via walking, biking can efficiently connect riders to a fixed-route line. Often, too, the populations served by public transit and the bike network overlap.

Bicycle facilities include lanes and trails, secure parking, and showers at workplaces. They help make people feel safer riding and encourage more individuals to choose to

ride, rather than drive.[49,50] Providing bike facilities not only promotes healthy habits, they help integrate biking into a city's culture. Facilities give credibility to cyclists on the road and security for their bikes when left at stations.[51] With accommodations, both car-owners and non-car owners can increasingly use bikes to connect to transit, get to work, and do errands. Biking has the potential to improve connectivity not only for the Red Line but for the whole community. Through the Red Line project, streets designed to support walking and biking can in turn better support community development through encouraging local travel and increasing the number of people out on the street.

5.4 Conclusions: Access

Evidence has shown that infrastructure that supports opportunities for safe outdoor activity and access to healthy foods will lead to enhanced population health. Insofar as the Red Line project improves the built environment to make physical activity and services more accessible, neighborhoods along the Red Line corridor could have a healthier future than they currently experience and almost certainly a healthier future than if the Red Line were not built.

6 Construction Issues

6.1 Introduction

Because construction will have the most immediate impact on residents in the Red Line corridor, a discussion of how it will impact health is important. Construction concerns span an array of health issues, including dust, noise, rodents and the stress that comes from living or working in or near a construction zone. This section will discuss the public health effects of dust, emissions and noise from construction. It will also provide an evaluation of potential rodent problems from construction.

6.2 The Red Line & Construction Issues

The DEIS Air Quality Technical Report outlines some important actions to mitigate dust and emissions from construction activity. However, it does not describe the health affects from potential negative impacts to air quality in neighborhoods.

The DEIS Noise and Vibration Technical Report provides a comprehensive report on noise in the Red Line corridor, including local-level measurements of current ambient noise levels and projected dBA from construction equipment. The Report shows relatively high ambient noise, ranging from an average of 65 dBA in the eastern part of the line up to 71 dBA in downtown areas. At 60 dBA, sound is considered "annoying", as cited in a table of "Common Noise Levels and Typical Reactions".[52] A more thorough description about how noise annoyance affects health, however, was not presented.

Concerns about rodents have been raised repeatedly by residents. By looking to similar construction projects in other cities, such as New York and Boston,[53,54] the likelihood of rodent dispersal during construction remains high, especially considering the age of Baltimore's infrastructure and the well-established rodent population.[55] Residents living near demolition projects currently underway in one section of the proposed Red Line corridor have already noticed an increase in rats seen around their community. When ground disturbances occur from construction activities for this transit project, particularly where tunnels will be built, rats will likely become more visible in neighborhoods.

6.3 Health Impact of the Red Line on Construction Issues

6.3.1 Air Quality in Construction Zones

The control of dust and emissions from construction and demolition: Best Practice Guidance from the Greater London Authority and the London Councils offers a systematic model to assess the risk of air quality impacts based upon project specifics. Using the standards laid out in this document, the Red Line presents a High Risk project because of its size and the number of years projected for construction.[56] This designation necessitates wide-ranging mitigation measures for dust and emissions from construction.

The U.S. Environmental Protection Agency has identified emissions from construction equipment as a significant source of pollutants at the local level. This includes non-road diesel engines that release particulate matter (PM) and nitrogen oxides (NOx) into the air.[57] Further, based on extensive measurements and studies of local air quality, the Sacramento Metropolitan Air Quality Management District has concluded that levels of NOx and PM are reduced in the Sacramento region when construction engines are cleaner.[58] In Baltimore, working to minimize such emissions could have a sizeable positive impact on the health of residents living and working in areas where the Red Line will be constructed.

Dust from earth moving activity, concrete, and asphalt removal will also affect air quality in neighborhoods where construction occurs. Particulate matter can aggravate breathing difficulties for people living with respiratory problems and contribute to the development of asthma, particularly in children.

6.3.2 Noise Impacts of Construction

Equipment utilized for construction is reported to be significantly louder than ambient noise levels. With each increase of 10 decibels (dBA), loudness doubles (e.g. 80 dBA sounds doubly as loud as 70 dBA). Therefore, with ambient noise levels of 70 dBA, the use of a piece of equipment emitting 80 dBA sounds doubly as loud as normal, while equipment emitting 90 dBA is four times as loud. Despite the intermittent use of such equipment, exposure to loud noise can have a number of negative health effects on well-being and quality of life. Research shows a causal association between noise and levels of annoyance, disruptions in school children's performance, sleep disturbance, mood, heart rate, hearing loss, and stress-related health effects.[59,60] Impaired hearing can occur with

short-term exposure to high noise levels or long-term exposure to lower levels. With the sound of a jack hammer, about 85 dBA, hearing damage risk is approximately 10%. As decibel levels rise, odds of damage increases.[61]

Some effects of sleep disturbance include interruptions to brain restoration and cardiovascular respite that normally occur during sleep. Sleep disturbance can also affect mood, reduce cognitive abilities and boost epinephrine levels which contribute to stress.[62]

These health effects are important considerations during the building of the Red Line because much of construction will take place near schools and dense residential zones. Noise from construction will almost certainly directly affect groups sensitive to sound, which include children, the elderly, the sick, and shift workers.

6.3.3 Rodent Dispersal

The CDC reports that common rodents (rats and mice) spread over 35 diseases worldwide. Diseases spread through direct contact with rodents or food and water contaminated with their droppings. The ticks and fleas rodents carry also spread disease.[63] In addition, rodent dander and droppings inside homes can contribute to respiratory problems, such as asthma.[64] Aside from concerns over disease, rats make neighborhoods appear dirtier, less appealing, and uncomfortable for residents.

A comprehensive search in public health databases was unable to find documentation on the health impacts of rats in construction zones. However, the likelihood of an increase in rodents means the problem should be addressed to prevent any negative health impacts, particularly in low income neighborhoods. Starting early to plan and control for rodents will be key to maintain and improve health in neighborhoods where construction will take place.

6.4 Conclusions: Construction Issues

As described above, air quality, noise, and the presence of rodents can be unfavorably impacted from construction. Health affects include respiratory problems, disturbance of sleep and concentration, and the potentials for rodents to spread disease. Knowing the potential for such impacts in advance, however, allows for better planning and mitigation in order to diminish negative outcomes.

7 Improving Air Quality

7.1 Introduction

Air quality was at the top of many Red Line corridor residents' lists of health concerns. Pollutants from vehicle emissions are known to have negative effects on human health, especially in children, older adults, and those with compromised immunity. Longitudinal

analyses of cities across the United States illustrate a strong association between acute exposure to particulate matter and increased daily mortality one day later. The strongest association was seen for deaths from respiratory and cardiovascular disease.[65] This section will outline the known health effects of poor air, especially for populations living directly next to heavily trafficked roadways. It will then describe some of the potential health impacts the Red Line could have on health via improvements in local air quality.

7.2 The Red Line & Air Quality

The DEIS Air Quality Technical Report provides a thorough analysis of air quality standards and the region's current air quality. The report also links VMT to air quality and compares projected VMT among the build and No Build options. The technical report cites significant limitations to making quantitative statements about human health impacts from air toxic emissions.

While it is true that quantitative risk assessment for air pollution becomes difficult, this analysis could go further. Descriptions of known impacts on human health are available for multiple air toxics. A review of how indoor air quality is affected in areas with high traffic volumes was not included. Lastly, the report did not assess how aspects of the natural environment, such as trees and other landscaping, affect air quality and have the potential to counteract pollution.

The EPA has identified carbon monoxide, ozone, particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$), as well as sulfur dioxide and nitrogen dioxide as among the most important components of air pollution caused by vehicle emissions.[12] These air toxics have been implicated in cancer and damage to tissues and organ systems, including immune, neurologic, reproductive, and respiratory systems.[66] Benzene is another known carcinogen; most benzene in the air comes from vehicle emissions.[67] Additionally, living close to a major road can contribute to heart disease. A study of adults in Germany demonstrated that living within 200 meters of a major road can damage coronary arteries. Living even closer (within 150 meters) to a major road predicted coronary heart disease.[68] Such negative health effects have been seen even when levels of contaminants measure below EPA standards for air quality.[69]

Regarding child health, numerous studies have demonstrated that children living near freeways or busy roads have poorer respiratory health than children living farther away.[70,71] Toxicological and epidemiological data has shown that fine particulate matter coming from traffic is strongly associated with childhood mortality, lung development and respiratory and heart diseases.[72] Another study from Cincinnati illustrated how living within 100 meters of heavy traffic predicted wheezing in infants.[73]

Children living in urban environments have higher rates of asthma than those living in suburban or rural settings. At least two environmental factors have been linked to this condition. Living in close proximity to traffic is one strong indicator for asthma in children. Studies from around the world have demonstrated that children living near high

traffic roads can have up to twice the odds of having asthma compared with those living further away.[74,75,76,77]

Finally, indoor concentrations of traffic related air pollutants consistently correlate to outdoor levels of particulate matter, benzene and volatile organic compounds.[78] Thus, even if people spend a great deal of time indoors, this does not provide complete protection from the hazards of outdoor air pollution.

7.3 Health Impact of the Red Line on Air Quality

Currently, Baltimore City is classified as a maintenance area for most air toxics, meaning air toxin levels were once above EPA standards. The DEIS Air Quality Technical Report projects infinitesimal improvements in regional air quality between the build and No Build options.[79] However, more traffic will almost certainly result in greater air pollution in communities in the Red Line corridor, although it is difficult to measure how much without locally placed monitors.

If no new transit is built in the Red Line corridor, traffic models in the DEIS predict a 15% increase of vehicles for Cooks Lane and US 40, adding an additional 13,000 cars to the road by 2030. Downtown, traffic is expected to increase 25%. In the eastern portion of the corridor, particularly along Eastern and Boston Streets, traffic volumes are predicted to go up 33%, adding nearly 10,000 cars per day to already congested streets.[80] The EPA estimates that mobile sources comprise 44% of outdoor emissions of air toxics nationwide.[81] Without changes to transportation patterns, air quality in Baltimore will suffer and human health will be affected from increased congestion.

Because heavy traffic predominates in much of the densely residential Red Line corridor (e.g. Edmondson/Route 40, Downtown, and Eastern, Fleet and O'Donnell Streets), the health effects described above are extremely relevant for Baltimore citizens. While the Air Quality Technical Report acknowledges the difficulties of measuring local air quality, studies show that respiratory diseases in particular are worse the closer to traffic people live (see above discussion). Reducing diesel and car emissions by replacing diesel buses with Light Rail and easing motor vehicle traffic could have a significant impact on the health of those living in the Red Line corridor.

As can be seen in Table 5, above, deaths from chronic respiratory disease in some sections of the Red Line corridor are notably higher than the City average. While air pollution may not always be the foremost cause of respiratory disease, poor air quality can be detrimental for individuals who already have respiratory problems or belong to other vulnerable populations, such as children, the elderly, or people with HIV. In addition, the long term effects of air pollution on children's respiratory development make a compelling case for even modest improvements in air quality in neighborhoods.

Rates of asthma in Baltimore are difficult to quantify, but some citywide and hospitalization by zip code data are available. With approximately 10% of people who show up at the emergency room receiving an asthma diagnosis, these data show that, with

some exceptions, the middle of the city has the highest rate of hospitalizations involving asthma.[82] These are the same areas that could be most impacted by the construction of the Red Line. Overall, Baltimore City has the highest asthma prevalence, rates of asthma diagnoses and asthma-related emergency room visits compared to the state average.[83] Here are some statistics:

- In 2006, 13% of adults in Baltimore City reported having been diagnosed with asthma during their lifetime.[84]
- 24% of high-school students in Baltimore City reported having been diagnosed with asthma compared to17% of students nationwide in 2005.[85]
- During 2000-2004, deaths due to asthma in Baltimore City accounted for 31% of all asthma deaths in Maryland (Baltimore City accounts for approximately 11% of the total Maryland population).[86]
- In Maryland as a whole, "asthma and its complications continue to disproportionately affect the very young, the elderly, African-Americans, low-income individuals, and individuals in certain jurisdictions, particularly Baltimore City".[87]

7.4 Conclusions: Air Quality

Despite projections for nearly negligible improvements to regional air quality as a result of building the Red Line, improvements to local air quality could be significant. Studies show that individuals, and particularly children, living near major thoroughfares have higher rates of asthma and respiratory disease than people living farther from main roads. Without the Red Line, traffic models predict tens of thousands more cars per day traversing the corridor by 2030. Thus, a transit project that leads to traffic reductions could improve the health of residents living on and along the proposed route.

8 Recommendations

This health impact assessment has outlined how accessibility, construction, and air quality issues are key factors influencing health along the Red Line corridor. It has described how the Red Line, if it were built, can potentially impact health. As the project moves forward, we strongly urge MTA planners and engineers to use the following recommendations as a guide for designing and constructing the Red Line. Together with the Community Compact, implementing recommendations from this HIA will maximize community health benefits and help minimize—or avoid—negative impacts.

8.1 Cross-cutting Recommendations

- Build the Red Line. As described above, the Red Line transit project offers numerous potential health benefits to the communities living along the proposed corridor. Choosing the "No Build" option would eliminate the potential for these benefits. While there is the potential for some negative health impacts from

construction, this report has identified the majority of health impacts as positive for Baltimore City residents.

- Light Rail. We strongly recommend the use of LRT for the Red Line. Light Rail utilizes electricity, rather than diesel or other vehicular fuel combustion, resulting in a cleaner mode of transportation. While hybrid buses or alternative fuels may produce cleaner emissions than today's diesel exhaust, the number of buses and the unknown health effects of residue from alternative fuels still make Light Rail a much healthier option. LRT also has less impact on ambient noise levels in the Red Line corridor than does BRT. Additionally, research shows that people will travel further to access LRT than buses, making this a more viable option for sustained ridership and adding to the potential for increased physical activity.[24]

- Appoint a public health expert to serve on decision-making teams. For any committees on design and planning for stations, streetscaping and landscaping, the presence of a public health expert will help insure that health and accessibility are primary objectives for changes to the built environment.

- Increase green space. The scale of the Red Line project presents a significant opportunity to plant vegetation and arrange other landscaping to maximize health benefits. Increased green space has been linked with mental as well as physical benefits. These include lower childhood obesity rates,[88] lower asthma rates through improved air quality[32] and psychological well-being.[34] Planned green space can enhance neighborhood cohesion by providing space for community connected-ness. It promotes healthy activity through easier connections between neighborhoods and by providing a neighborhood commons for entertainment and exercise.

  Green space can help reduce summertime temperatures and provide shade and protection from the sun. Landscaping also enhances the visual appeal of the project and neighborhood aesthetics overall. This has the potential to produce a more pleasant and calming atmosphere for residents.

  Opportunities for landscaping:
  - Anywhere where the Red Line runs on the surface.
  - Around stations and areas leading to stations, such as pedestrian and bike pathways, even if stations are located underground.
  - As a mitigation measure to make up for neighborhood disruption, even in areas where the Red Line will run in a tunnel and stations will be below ground.

8.2 Recommendations for Improving Access and Opportunities for Safe Outdoor Activity

It is the responsibility of the city and state to ensure that there are transportation options for all citizens in the Baltimore region, allowing everyone access to the same jobs,

services, and other resources. Rather than promoting increased car ownership, enhancing the availability and accessibility of public transit is a more sustainable solution to the transportation challenges seen in the City of Baltimore.

- Coordinate with the Baltimore City Bicycle/Pedestrian Planner. Any planning for new or augmented pedestrian and bicycle facilities must be done in concert with the City's current Bicycle and Pedestrian Master Plans. This includes plans for "rails with trails" or bike lanes along the alignment[89] as well as planning for safe "feeder" routes for cyclists and pedestrians, and any improvements to sidewalks.

- Create an oversight committee made up of representatives from local bicycle and pedestrian advocacy groups. With the system up and running, continued oversight will ensure the system remains safe and accessible for everyone.

- Street plans should be drawn using "Complete Streets" design principles.[90] Benefits of providing such "Complete Streets" design include slower traffic, fewer crashes, especially those involving pedestrians and cyclists, and overall safer streets for children, older adults and women. Streets designed at the human scale encourage more pedestrian activity, which in turn deters crime. Not only will this increase transportation options for more people and widen the circle from which the Red Line will draw riders, it will directly benefit community health.

- Widen sidewalks to a minimum of 10 feet to accommodate current and future pedestrian traffic and allow space for landscaping. The majority of the Red Line's 14-mile route will likely run on the surface. Construction for surface alignments will necessitate re-building much of the sidewalk mileage along the route. Given the current need and the probable increase in pedestrian traffic with the new transit line, design plans should include spacious sidewalks in areas where the Red Line runs on the surface

  All sidewalks built as part of this project should enhance the pedestrian landscape. The Federal Highway Administration promotes wider sidewalks to accommodate pedestrian safety because they provide an additional buffer between pedestrians and the street.[91] Sidewalks that meet only minimum standards for width will not sufficiently serve residents. To comfortably accommodate pedestrian traffic and support and encourage walking as a transportation mode, researchers at the National Center for Smart Growth, at the University of Maryland, have identified a minimum of 10 feet to allow people to pass one another easily. When other fixtures, such as street lights, trash cans, or newspaper boxes are added, an additional 2 ½ feet of width are suggested for clearance.[92]

  For example, the DEIS[8(p15)] notes that a significant section of US 40, through Edmondson Village to Rosemont, currently has narrow sidewalks and high pedestrian volume. In residential areas such as Edmondson, wider sidewalks allow for the possibility of "extended front yards". Greater width implicitly invites more people out of their homes and cars by making sidewalks more

comfortable. This becomes particularly true for older adults, who often have limited mobility.[93] However, when more people are out, the streets are safer for everyone.[94]

- Plan for numerous, safe crosswalks. Where the Red Line will run on the surface, MTA has the opportunity to rebuild sidewalks and install safe crosswalks. Marked, lighted crosswalks can be built both at intersections and at mid-block, approximately every 100 feet. Mid-block crosswalks help calm traffic, discourage crossing between parked cars, and provide more opportunities for pedestrians to safely cross the street.[95] Providing numerous crosswalks also can enhance social cohesion between neighborhoods by improving access to schools, work, friends and family.

- Ensure the Red Line includes bike facilities to guarantee accessibility and connectivity for cyclists. The Red Line project offers an excellent opportunity to provide critical east-west connection for cyclists and to promote health and physical activity. Ensuring that space is set aside for bike facilities will be the responsibility of the MTA during the planning, design, and construction stages. Putting in place road modifications that will facilitate cycling will be a collaborative effort on behalf of the City and MTA at the time of street and sidewalk re-construction. Modifications for on-street lanes can include bike lanes as marked portions of widened sidewalks, adjacent to sidewalks at lower grade, or marked lanes in the street (on one or both sides of the street). Where the Red Line runs in off-street areas, the MTA has a chance to build bike trails.

  Suggested areas for bicycle lanes and trails include:
  - Access for "feeder" routes that safely channel cyclists towards stations, with particular focus on the more widely spaced stations in Geographic Areas (GA) 1, 2, 3, 4, 5, 8 and 9.[i]
  - Bike lanes along Eastern and Fleet, matching the proposed east-west couplet in GA 7, 8 and 9.
  - Maintaining the current bike lane along Boston street, connecting to an off-street bike trail built next to the alignment along the abandoned Norfolk Southern railroad right-of-way. A in-depth review of such rails with trails infrastructure was undertaken by the FHWA.[89]
  - Bike lanes along the alignment of Mulberry and Franklin Streets, either if the Red Line runs on the surface or in the median of Route 40 expressway (the "ditch").

- Install bicycle storage facilities. This includes bike racks and lockers at stations and hooks inside transit vehicles to safely position bikes while traveling. The Seattle Department of Transportation cites the cost of purchasing and installing one bike parking rack to be $150. They estimate the cost of constructing one standard parking space in a paved lot at $2,200, while the cost of constructing a

[i] See DEIS Vol. II, p.127 for definition of Geographic Areas.

space in a garage is $12,500. They also note that up to 20 parked bikes will fit in one car parking space.[96] The Baltimore City Department of Transportation currently plans to convert five car parking spaces in key locations throughout the city to bicycle parking. The cost for all five, including racks, railings, car stops and flexible bollards, is estimated at $5200 and will fit 50-60 bikes.[97]

Suggested locations for bike storage facilities include:

- Parking racks at every Red Line station, including downtown stations.
- In addition to racks, place bike lockers at outlying stations, specifically in GA 1, 2, 3, 4, 5, 8 and 9.
- Hooks for hanging bikes inside transit vehicles, at least four per car.

8.3 Recommendations for Construction Issues

8.3.1 Air Quality

- Provide for independent monitoring and reporting. Via project website, allow residents to register complaints about noise, vibrations, air quality, vector control, hazardous materials, and water leaks.

- Use Clean Construction models from EPA's program *Clean Construction USA*. The *Clean Construction USA* website has an extensive description of best practices, case studies, and mitigation measures at http://www.epa.gov/otaq/diesel/construction/

- Plan to insure that contractors, owners and operators of construction equipment follow the guidelines below:

  - Regularly check engine and exhaust systems and properly maintain them.
  - Re-power equipment (i.e. replace older engines with newer, cleaner engines)
  - Use ultra-low sulphur fuels and utilize particulate filters, especially for parked and off-road vehicles.
  - Limit vehicle idling.

- Follow *The control of dust and emissions from construction and demolition: Best Practice Guidance*.[56] In addition to mitigation strategies described in the Air Quality Technical Report, MTA should practice the following to control dust and limit emissions from construction equipment:

  - Dampen sites during dry weather.
  - Wash vehicles to prevent spreading dust outside construction zones.
  - Erect temporary barriers to contain dust during demolition of concrete and asphalt, as well as during dry weather.
  - Plan for minimal vehicle movements for essential vehicles only to limit earth disturbances, emissions, noise and vibrations.

8.3.2 Noise

The following noise mitigation strategies are recommended in addition to those outlined in the DEIS Noise and Vibration Technical Report:

- Place equipment as far as possible from homes, schools, and other sensitive areas. To reduce stress on people living, working, and going to school in the Red Line construction zones.

- Restrict the utilization of particularly noisy equipment and operation to daytime hours. Limiting intrusive noise at night will reduce sleep disturbance from construction.

- Use electrical motors rather than diesel engines whenever possible.

- Synchronize the timing of noisy operations. Synchronization reduces the duration of disturbance because the total noise level produced when several noisy operations occur simultaneously is not much higher than if performed separately.[98]

8.3.3 Rodents

Together with Baltimore City agencies, such as the Health Department and the Department of Public Works, MTA has the opportunity to arrest a potential rat problem with early planning and intervention. Many tactics exist for mitigating rat infestations. The city of Boston developed a comprehensive plan to address the foreseeable rat problem from the Big Dig, an extensive tunneling project through downtown.[55] Using Boston's scheme as a basis for rodent mitigation in Baltimore, key components of such a plan for the Red Line would include:

- Coordinate a core team to plan and manage strategy and phases of the program. Include community outreach and education as a central component of this plan.

- Use Integrated Pest Management techniques. This includes surveys of rat populations, public education, sanitation, rodent proofing, and baiting. During the building phase, simple strategies used at New York City construction sites also helped with the rat problem: [99]

    - Keep all food waste secure within construction zones.
    - Replace mesh trashcans with enclosed cans.
    - Remove trash regularly.

- Start early. Begin surveys, baiting, and enforcement of sanitation codes up to two years before the start of construction to free the area of rats prior to disrupting the ground.

- Define a discrete area in which management activities take place. In Boston they divided this area into three zones: Impact zone (where construction was taking place), management zone (area immediately adjacent to constructions), and buffer zone.(Colvin 1990)

- Use safe pesticides. When pesticides are necessary, contractors should use only EPA-registered rodent-killing agents and implement rodent controls that avoid hazards to humans and pets.

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