

# BALTIMORE CITY SEPARATED BIKE LANE NETWORK ADDENDUM TO 2015 BIKE MASTER PLAN UPDATE

MARCH 2017



Photo Credit: Elvert Barnes

Prepared for:



Prepared by:





## EXECUTIVE SUMMARY

This addendum to the 2015 Bike Master Plan Update uses a state of the practice understanding of who might desire to travel by bike and how they experience the road to recommend a minimum “backbone” network of bicycle facilities. The goal is to construct these facilities within two to five years, which will connect potential bicyclists of all experience levels in all parts of the city from their home to their destinations while feeling safe and comfortable the whole way.

The core methodology used to predict how bicyclists will experience the road is a tailored version of the Level of Traffic Stress analysis. Facility type selection is informed by recent research on what environments makes bicyclists feel safe and comfortable.

The resulting recommended network of 77 miles of separated is expected to cost between \$2 million and \$6 million each year over the next five years, and a potential funding strategy that leverages State and Federal grants is included in this addendum.



# ACKNOWLEDGMENTS

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## Additional Thank you to:

Liz Cornish, Bikemore

Jed Weeks, Bikemore

Patrick McMahon, Maryland Transit Administration

Kirby Fowler, Downtown Partnership of Baltimore

Louis Cardona, Downtown Partnership of Baltimore

All public meeting and online feedback participants

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**PART 1**  
**A BETTER WAY TO PLAN**  
**FOR PEOPLE ON BIKES**



ASSUME  
THEY HAVE  
THE SAME  
NEEDS AS  
EVERYONE  
ELSE





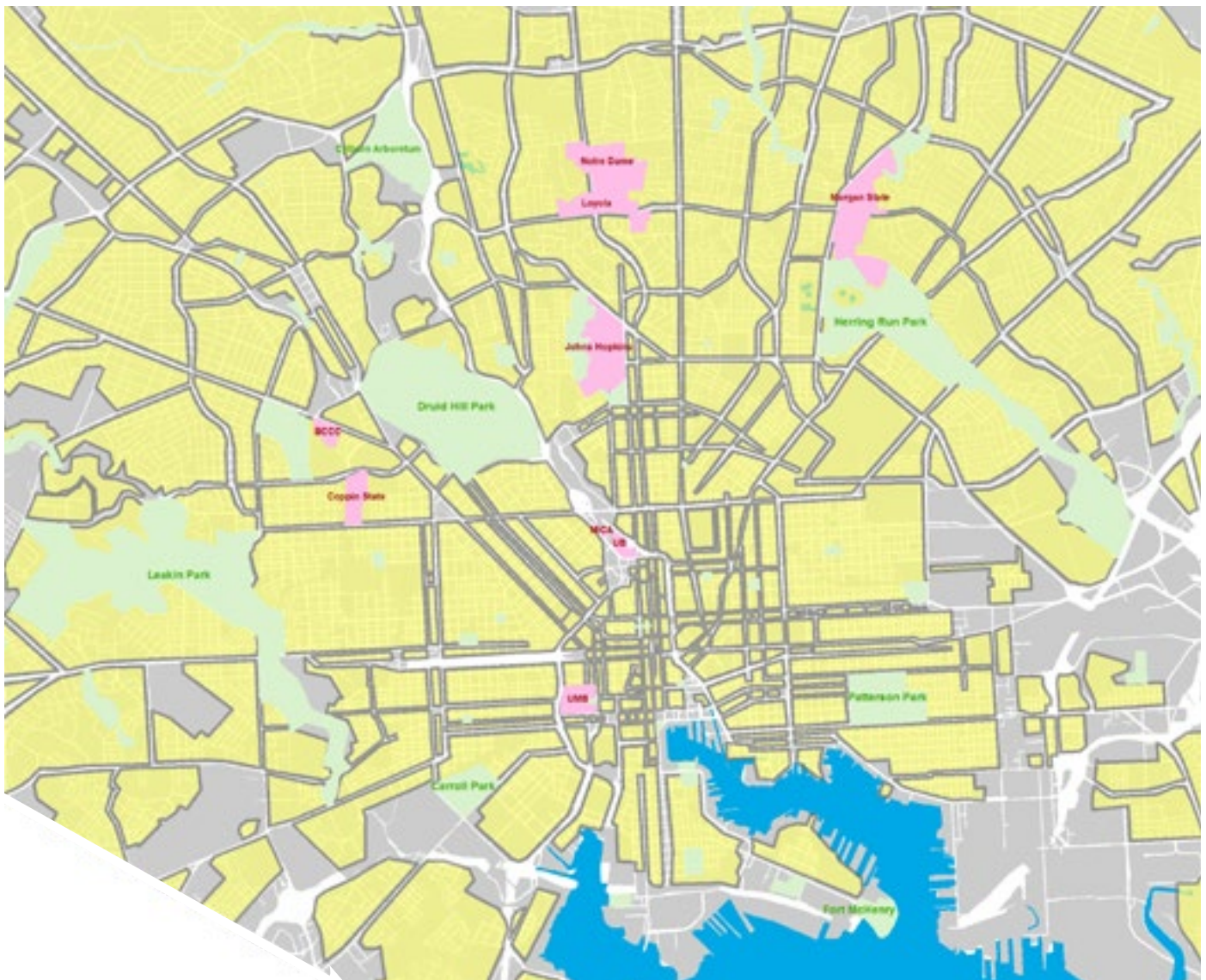
# VISUALIZING THE LOW STRESS NETWORK

## [1] Identify Existing Low Stress Streets

The effort to identify the existing low stress street network is simplified by the fact that people on bikes are vulnerable street users, and the presence of any one of several factors that make them feel unsafe is enough to render a street effectively off-limits to them. The factors that make bicyclists feel too unsafe to use a street or bike facility include:

- › Interactions with fast moving traffic (greater than 30 mph, approximately)
- › Frequent interactions with traffic of any speed (greater than 8,000 vehicles per day, approximately)
- › Obstructions in a bike facility that force a bicyclist into traffic (debris, illegally parked vehicles, vehicles creeping forward from driveways in order to make turns, etc.)
- › Dangerous pavement conditions (inadequate snow/ice removal, frequently broken asphalt, slippery gravel or maintenance plates, wheel-catching storm grates, etc.)

The most widely used methodology for determining the existing low stress network is the Level of Traffic Stress Methodology. This methodology was applied to the entire street network of Baltimore City, and then supplemented with volume data where available, to visualize all of the “islands” of connected low stress neighborhoods within the City. This visualization allows the strategic selection of corridors for low stress bike facilities based on how efficiently they connect these islands to one another and to the existing and planned Downtown Bike Network. The map below shows a section of Baltimore City’s connectivity islands, in yellow, with the barriers between them shown in white.



# LEVERAGING LOW STRESS ASSETS

## [2] Identify Strategic Corridors for Interventions

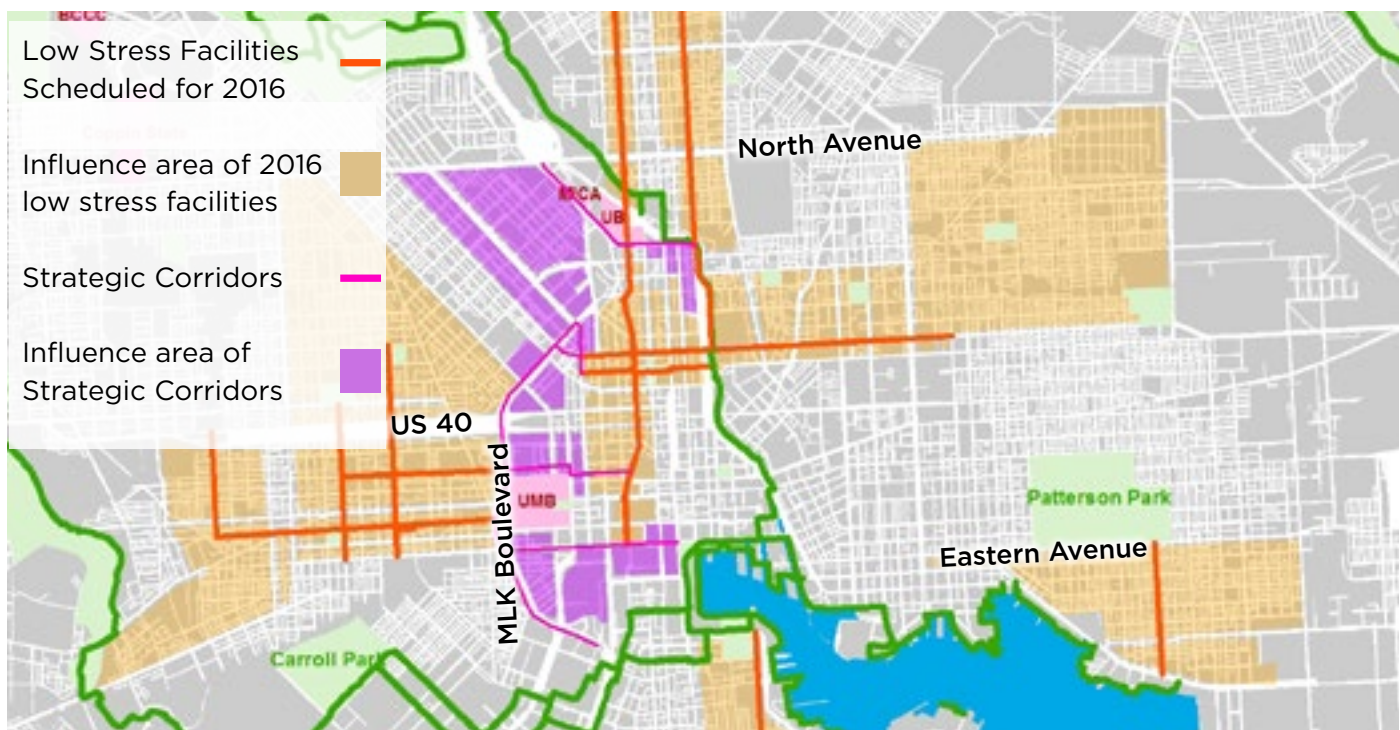
Knowing where people already feel safe riding bikes is crucial to strategic bike facility planning because it reflects the way people would actually use a bike for transportation. They will start at their home, which is likely to be on one of these low stress streets, wind through their neighborhood on streets they are familiar with and eventually hit a higher order roadway.

This higher order roadway can either serve as a barrier or a connection, depending on whether it has an appropriate and well-designed low stress bike facility.

The higher order roadways that most directly connect residential neighborhoods to job centers, downtown, and other important locations are usually in high demand as motor vehicle corridors, as well. For this reason, reclaiming some of the right of way from motor vehicle or parking usage is almost always a significant political battle. Thus, it is crucial to fight this battle on corridors that “unlock” the most network for the most potential riders. This necessity leads to a few important selection principles.

- 1. Leverage existing low stress network when planning low stress bicycle facilities.**
- 2. Carefully consider building low stress facilities that are not connected to the rest of the low stress network.** While taking advantage of opportunities to build facilities is important, it is also crucial to plan projects to connect these facilities to the wider low stress facility network so that they are accessible to more potential riders, and better connect to important destinations.
- 3. Minimize out of direct travel in the low stress bicycle network;** people on bikes travel more slowly than people in cars, so detours are a more significant deterrent to bicycle travel.
- 4. Provide comprehensive wayfinding and markings where detours are unavoidable.**
- 5. Identify opportunities to create low stress off-street bicycle connections through land uses that are barriers to auto travel** (parks, schools, city-owned parcels).

### HOW TO IDENTIFY STRATEGIC CORRIDORS



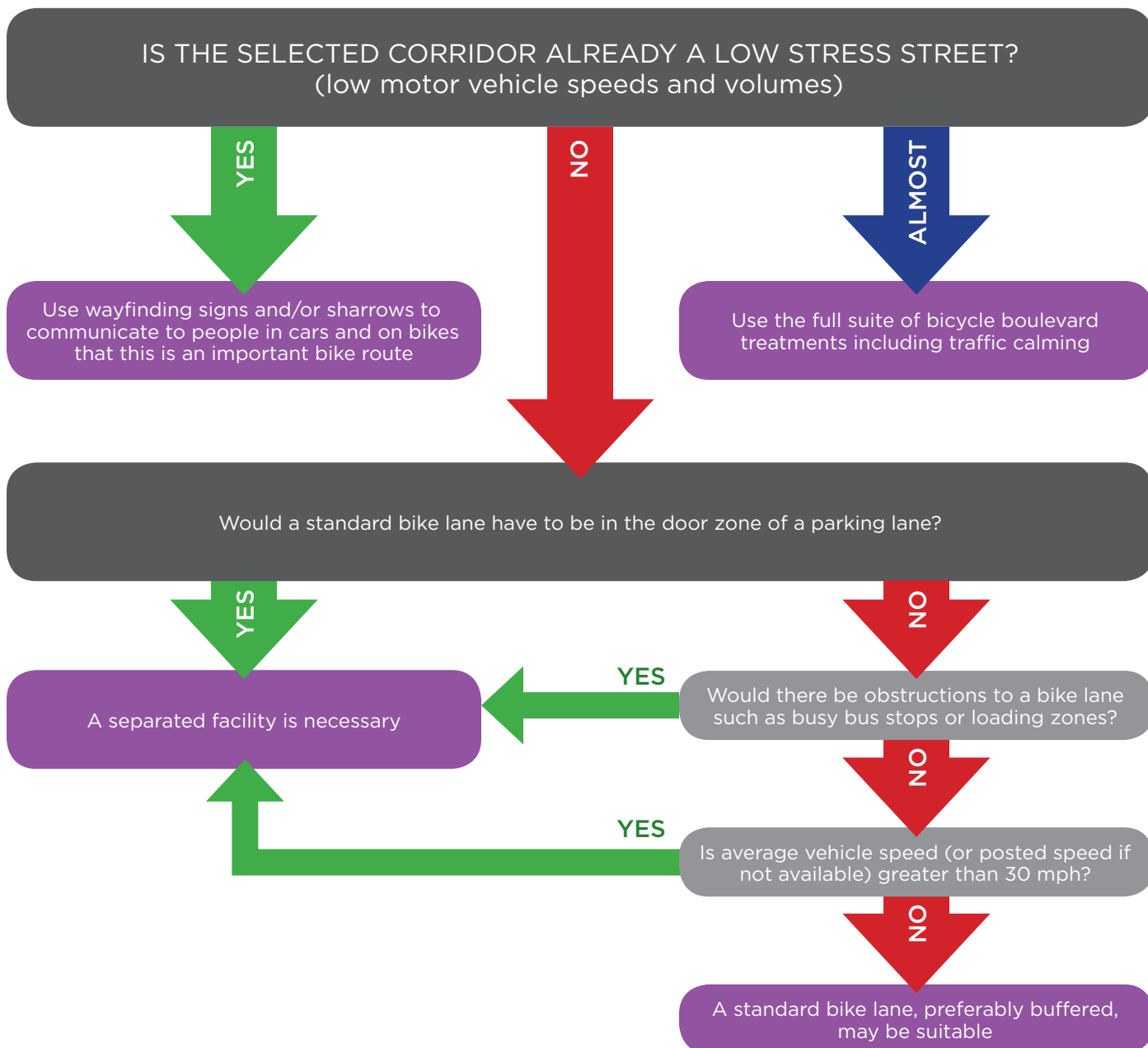
The map above shows the parts of Central Baltimore that can access a low stress bike facility (orange lines) via low stress streets. The magenta highlighted corridors are planned for low stress facilities. Strategic intervention on those corridors would enable bike travel from most of West Baltimore to Downtown and beyond.

# SELECTING LOW STRESS FACILITIES

## [3] Identify Appropriate Facility Type

Once the most strategic corridors for intervention have been determined, a facility type that will yield a low stress condition must be selected for the corridor. This is simpler in a network focused approach than in traditional approaches. Succinctly put:

- › If a street has high motor volumes, only a physically separated bicycle facility will make inexperienced bike riders feel safe and comfortable.
- › If the motor vehicle traffic on a street is fast-moving, only a physically separated bicycle facility will make inexperienced bike riders feel safe and comfortable.
- › Standard five-foot or six-foot bike lanes in the door zone of parked cars are never low stress facilities.
- › Standard or buffered non-separated bike lanes are only low stress facilities when they are next to the curb and average traffic speeds are approximately 30 mph or less; if there is space for a buffered bike lane, it is best to add a vertical element to the buffer to create a separated facility.
- › Bike lanes that buses must frequently pull through to reach their stop are not low stress facilities.





## [4] Select Where to Build First

The Level of Traffic Stress methodology and resulting mapping are useful for determining strategic corridors, but each of the resulting projects must be designed, funded, and constructed. Selecting which projects to advance through this process should first be based on a combination of technical and community factors.

The technical factors for prioritizing construction are very similar to those used to select the most crucial corridors, just with added consideration for which other projects can be assumed to be built at the time the project is constructed. If a project earlier in the implementation time line is stalled or canceled, a previously viable project may no longer provide much additional network connectivity, or may become an “orphaned” facility. Connectivity to the wider low stress facility network is critically important in prioritizing projects..

The inclusion of community factors when prioritizing projects is meant to recognize that residents are invested in the physical environment in their neighborhood, and how its transportation infrastructure is used. These decisions affect their everyday lives, and their voices should be heard. However, street space is the public realm and must be managed according to the priorities of the City as a whole, as well. The below prioritization factors will be refined with public input in February 2017.

Technical Factors	Community Factors
Number of “low stress islands” that are connected to the broader low stress network	Provides low stress bicycle access to low car ownership neighborhoods
Connection to Downtown Bike Network	Provides low stress bicycle access to low-income neighborhoods
Connection to existing low stress facilities	Provides low stress bicycle access to job centers
Connection to transit facilities (bus and rail)	Provides low stress bicycle access to neighborhood-serving retail
Connection to Baltimore Bike Share stations	Supported by community residents and businesses



**PART 2**  
**RECOMMENDATIONS FOR**  
**BALTIMORE'S LOW STRESS AND**  
**SEPARATED BIKE FACILITY NETWORK**



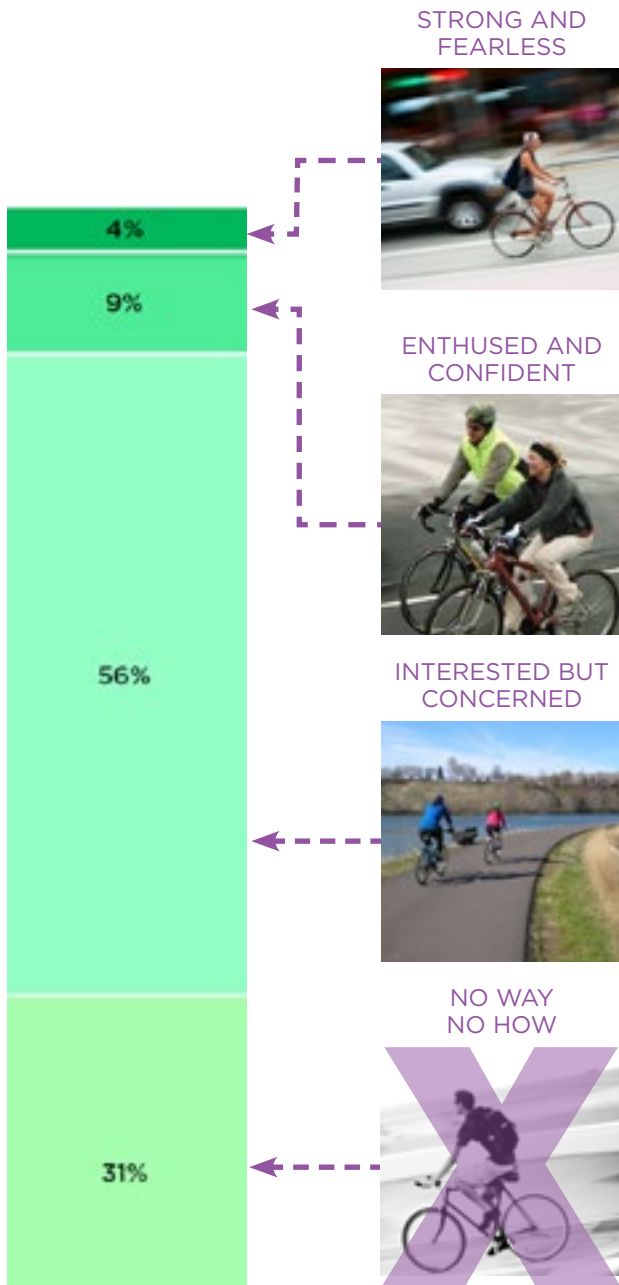


# BACKGROUND AND METHODOLOGY

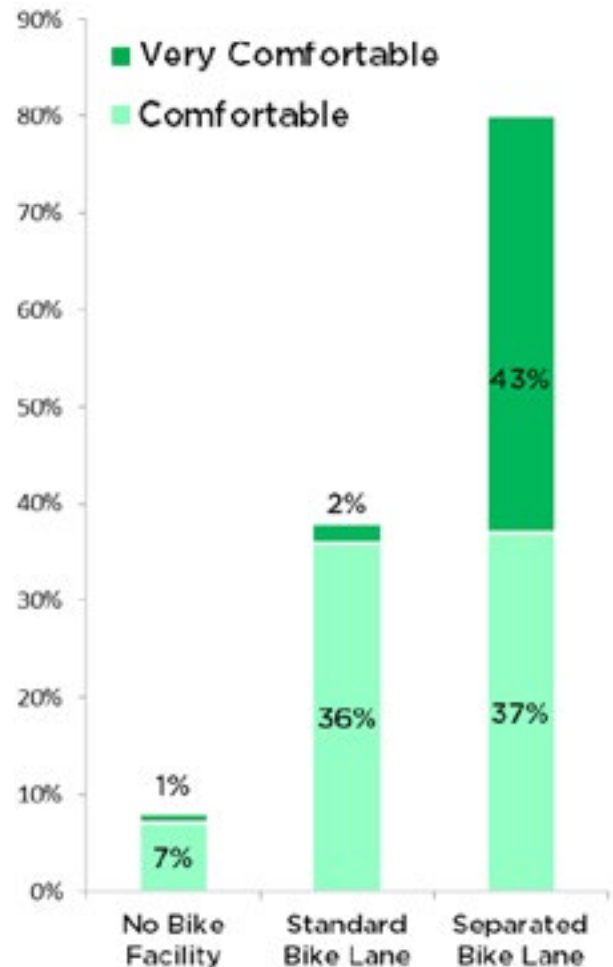
## Project Background and Methodology

The 2015 Baltimore Bike Master Plan Update is a comprehensive document with recommendations for every neighborhood in Baltimore City. This Low Stress and Separated Facility Network addendum seeks to build on that work by identifying and prioritizing a set of projects that will dramatically increase the number of people in Baltimore City who can meet many of their basic travel needs by bike over the next two to five years.

As described in Part 1, these recommendations were made using a Level of Traffic Stress analysis of the entire street grid of Baltimore City supplemented with traffic volume data. The recommendations also relied on an emerging consensus among researchers, planners, and engineers as to what types of facilities provide sufficient comfort to be utilized by the general population, as opposed to only experienced bicyclists.



COMFORT WITH DIFFERENT FACILITY TYPES AMONG "INTERESTED BUT CONCERNED" RIDERS.



According to a 2012 study conducted in Oregon, nearly 70% of people report being interested in riding a bike for some of their travel. Under current conditions, only 13% feel safe and confident doing so. (Dill and McNeil, 2012)

Over half of the general population is interested in riding their bikes, but concerned about safety; standard bike lanes do not feel safe and comfortable, but separated facilities do for this group. (Dill and McNeil, 2012)

# BALTIMORE'S LOW STRESS STREETS

## Level of Traffic Stress Analysis

The below map of Baltimore City shows every street rated using the Level of Traffic Stress Methodology. The green lines are the streets that an “interested but concerned” bicyclist would feel safe riding on, the blue lines are streets they would avoid and the red lines are streets that function as barriers to bicycle travel without a bike facility or intersection improvements to aid in crossing them.

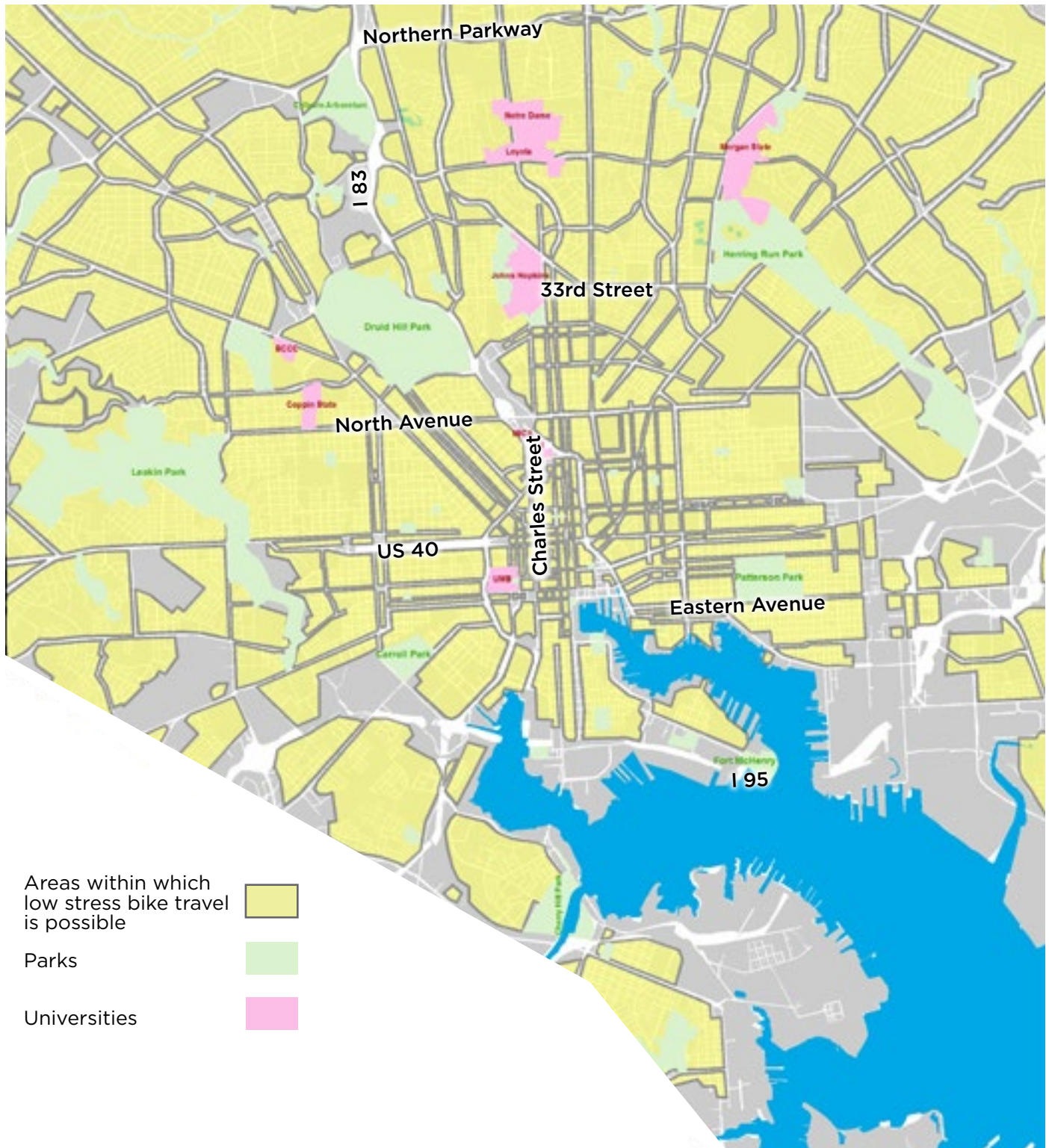




# CONNECTIVITY OF LOW STRESS STREETS

## Existing Low Stress “Islands”

Based on the existing street network in Baltimore City, “interested but concerned” cyclists experience dozens of low-stress islands of connectivity. Outlined in yellow, these areas generally provide bicycle access within neighborhoods, but prevent travel across much of the City.



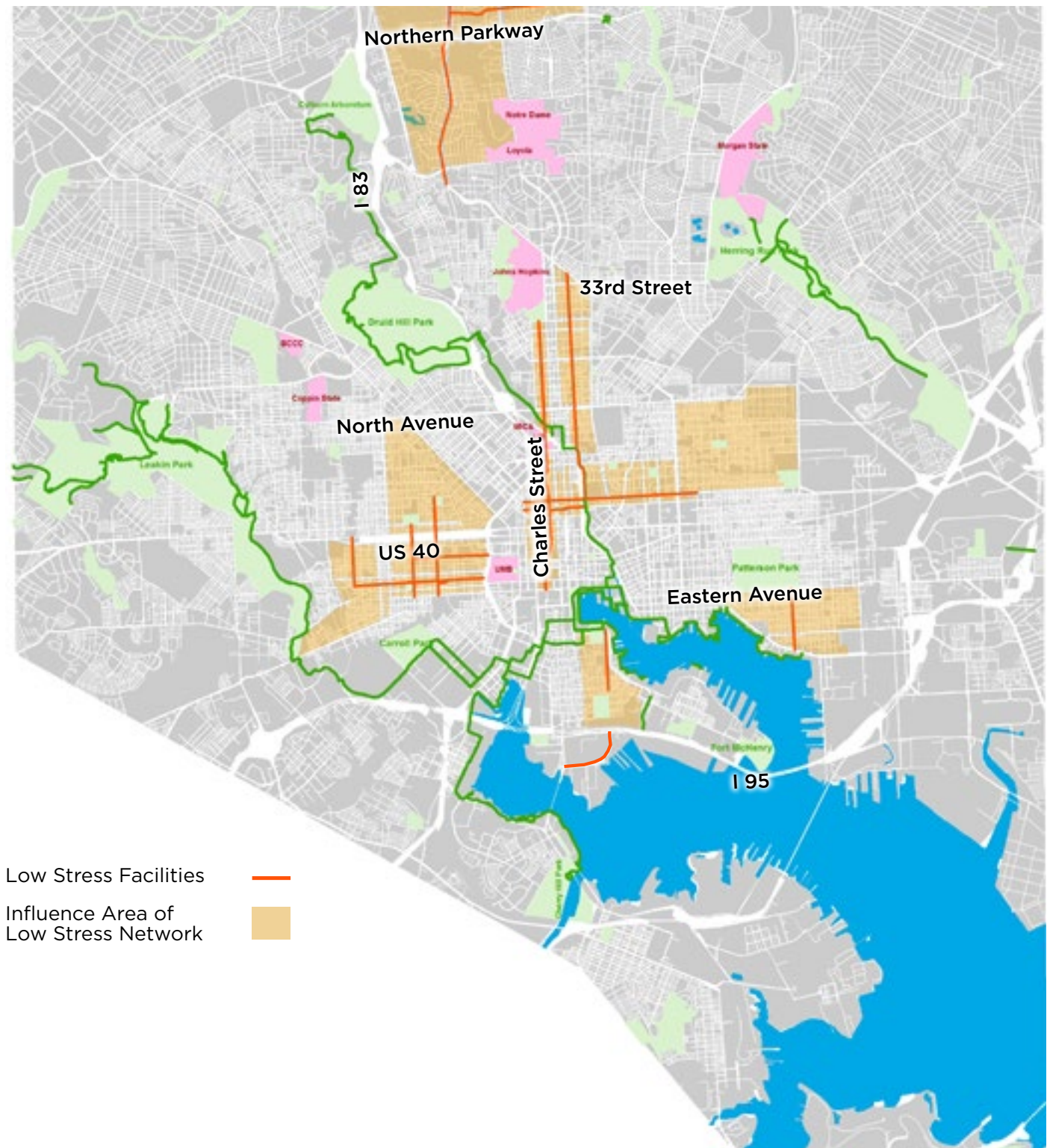




# PLANNED LOW STRESS FACILITIES AND THE PLACES THEY CONNECT

## Planned Low Stress Facilities

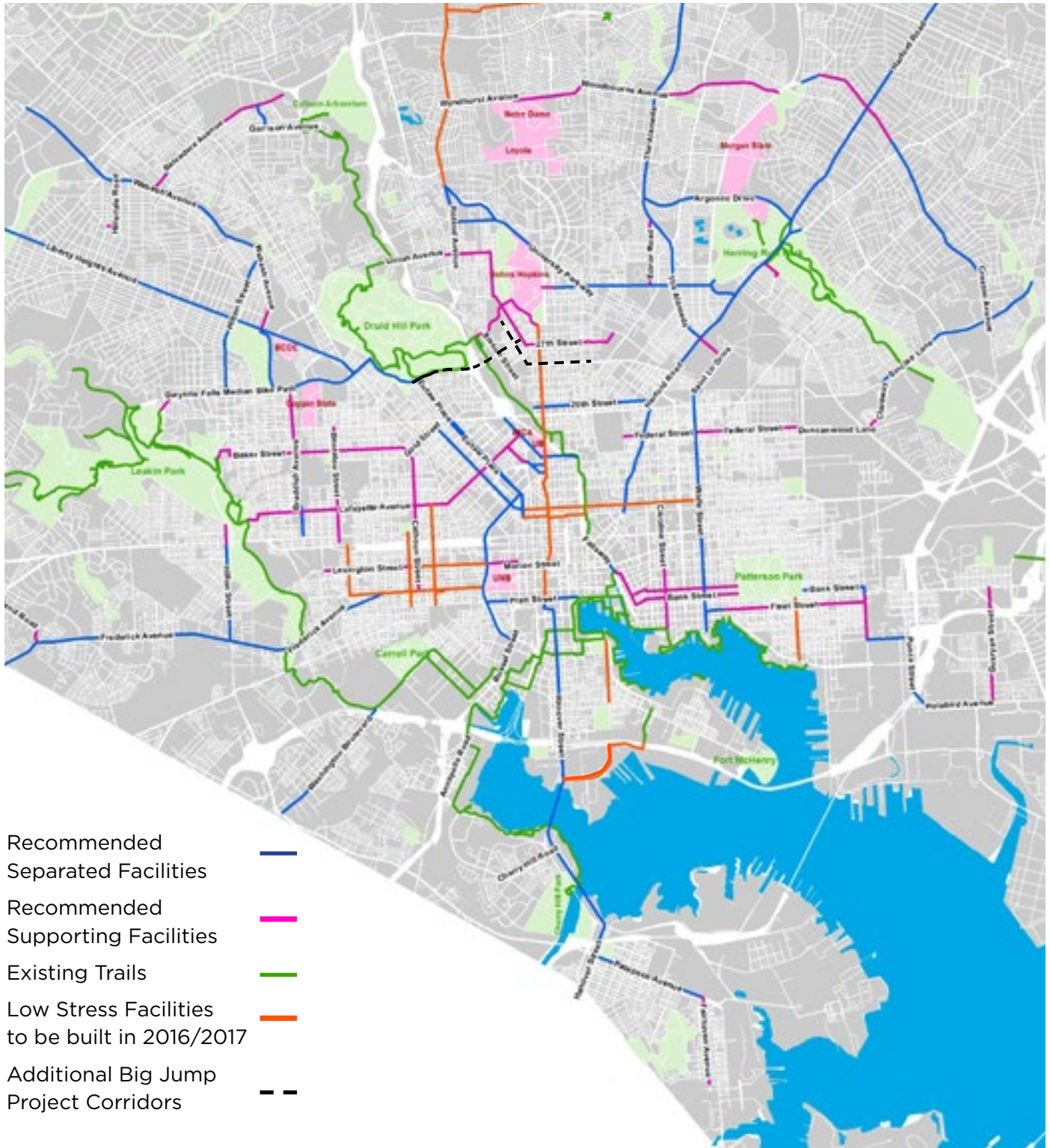
Additional low stress facilities that are planned for construction in 2016 and 2017 will further expand the areas in that can be reached by bike by less experienced bicyclists, but there are still significant gaps, as shown in the map below.



# RECOMMENDED STRATEGIC CORRIDORS

## Map of Recommendations

The network of recommendations on the map below is a subset of the corridors in the 2015 Bike Master Plan Update. It also identifies corridors for their strategic importance in “unlocking” portions of Baltimore City to low stress bike travel. Corridors that require a separated facility to become low stress are shown in purple. Those where a non-separated facility is adequate are shown in pink. The goal is to complete construction of low stress facilities on these corridors within the next two to five years. The Bike Master Plan identifies additional facilities that are needed to reduce out-of-direction travel to the low stress network and reach remaining disconnected neighborhoods.

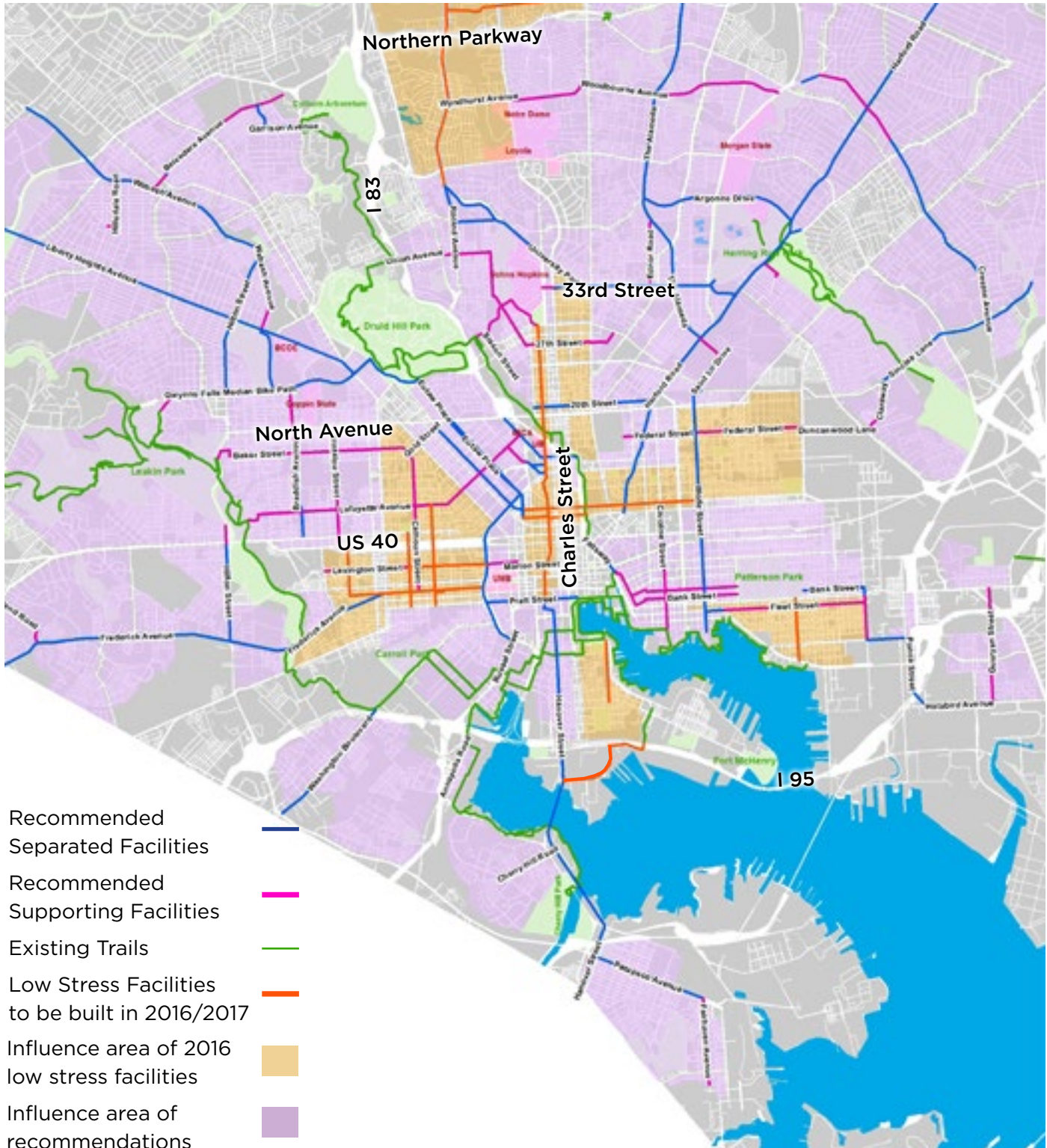




# CONNECTIVITY ADDED BY RECOMMENDATIONS

## Influence of Recommendations

The purple shaded areas on the map below indicate the potential influence of implementing the recommendations on the previous page. If the recommended facility were constructed on every corridor, a person on a bike starting anywhere in the purple shaded zone could reach any other place within that shaded zone without having to ride on a high stress roadway. Additional facilities to connect remaining disconnected neighborhoods to the low stress bike facility network will be planned for future years.



# CHOOSING APPROPRIATE FACILITIES

## Choosing Low Stress Facilities

The recommended corridors mapped on previous pages are broken into the categories of Separated Facilities and Supporting Facilities. These designations were made with the best data available, but as each project moves forward, it is useful to use the facility selection flow chart on a more fine-grained level. At all times, facility selection should be guided by the following principals:

1. People on bikes are vulnerable road users and interactions with motor vehicle traffic must be extremely limited, either by physical separation (on a higher stress roadway) or by slowing and/or diverting traffic (on a lower stress roadway)
2. Beyond providing adequate protection details such as pavement quality, intermittent obstruction and encroachment by motor vehicles have the greatest impact on a rider's experience
3. If the above two requirements are met, facility design can be creative and context sensitive; it is not necessary to adhere to a limited number of highly standardized designs especially as the state of the practice evolves

Each project that is built as a result of these recommendations should be designed with community input and to reflect the state of the bicycle design profession.

### EXAMPLE FACILITIES FOR HIGH STRESS STREETS



One way on-street cycle track separated by planters

### EXAMPLE FACILITIES FOR LOW STRESS STREETS



Sharrow on a local low stress street



Two way on street cycle track separated by curb and parking

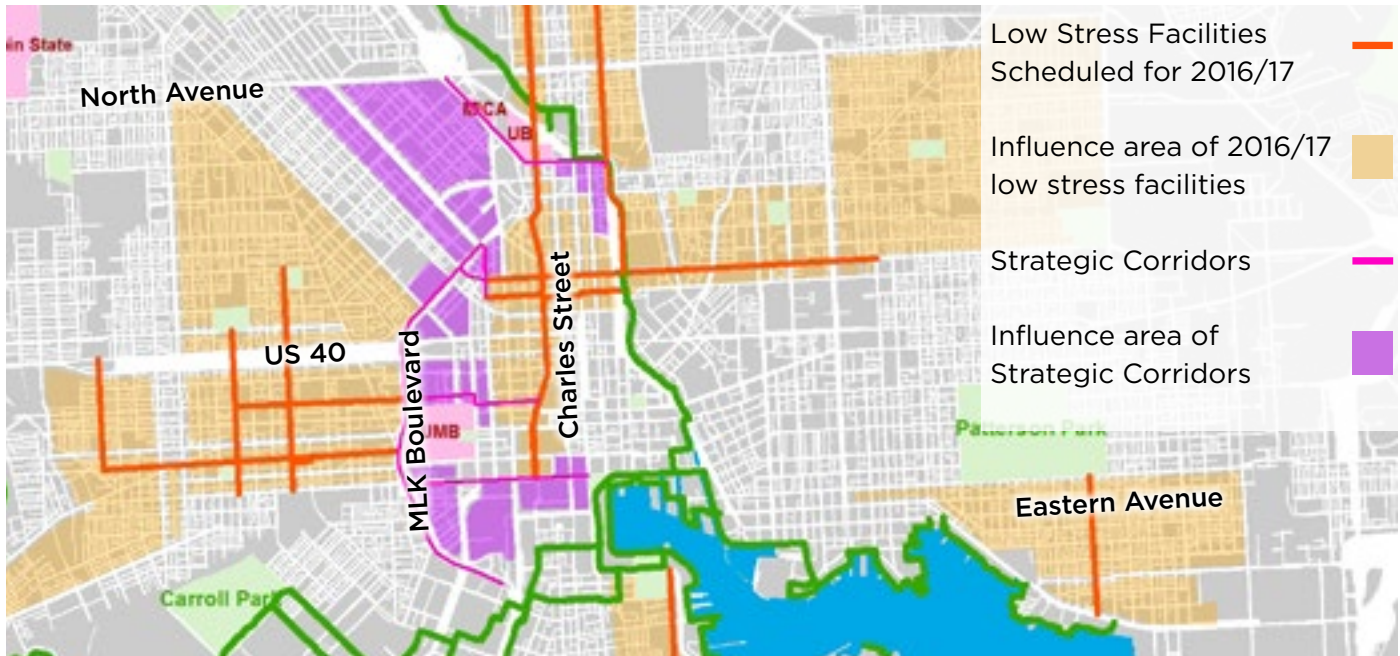


Bicycle friendly speed hump to calm traffic on a bike boulevard

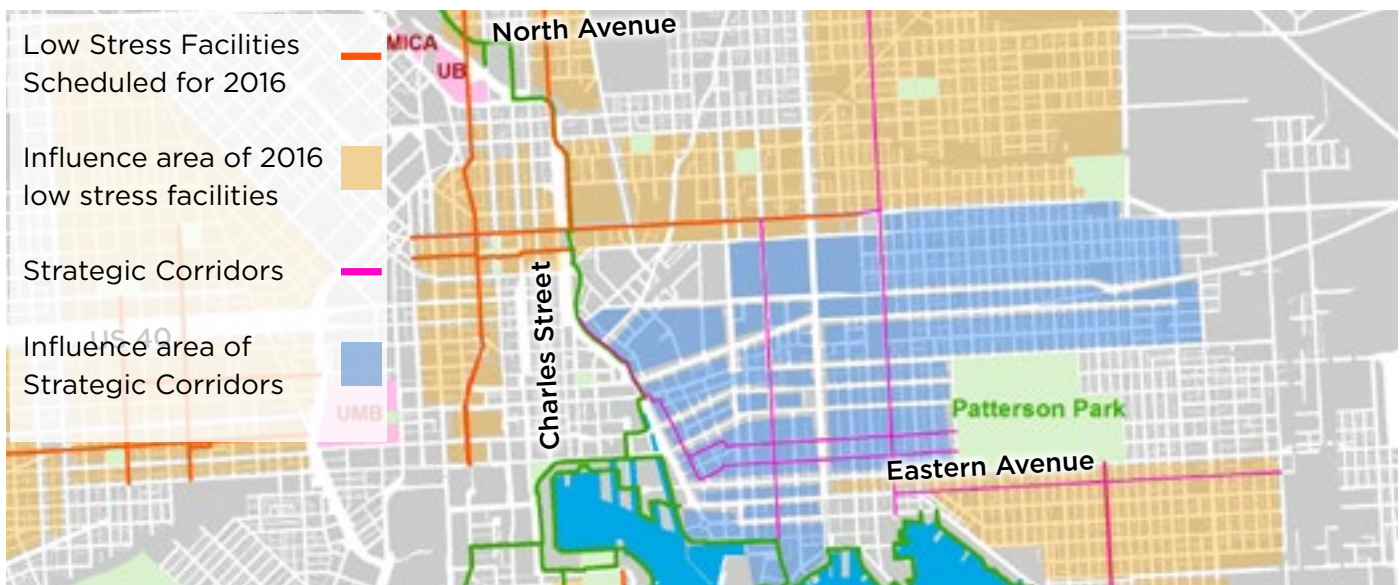


## Connect Existing Low Stress Facilities

As shown previously, there are significant areas of the city that already or will soon have access to low stress bike facilities via low stress streets. However, these areas are not connected to one another, which limits the impact of these investments. An important first step to dramatically increase bike connectivity in Baltimore City is to construct low stress connections between these existing and planned facilities. Two notable examples of high value connections are shown below.



Bike Network and West Baltimore Bike Boulevard network by enabling travel to and across Downtown from large portions of East and West Baltimore.

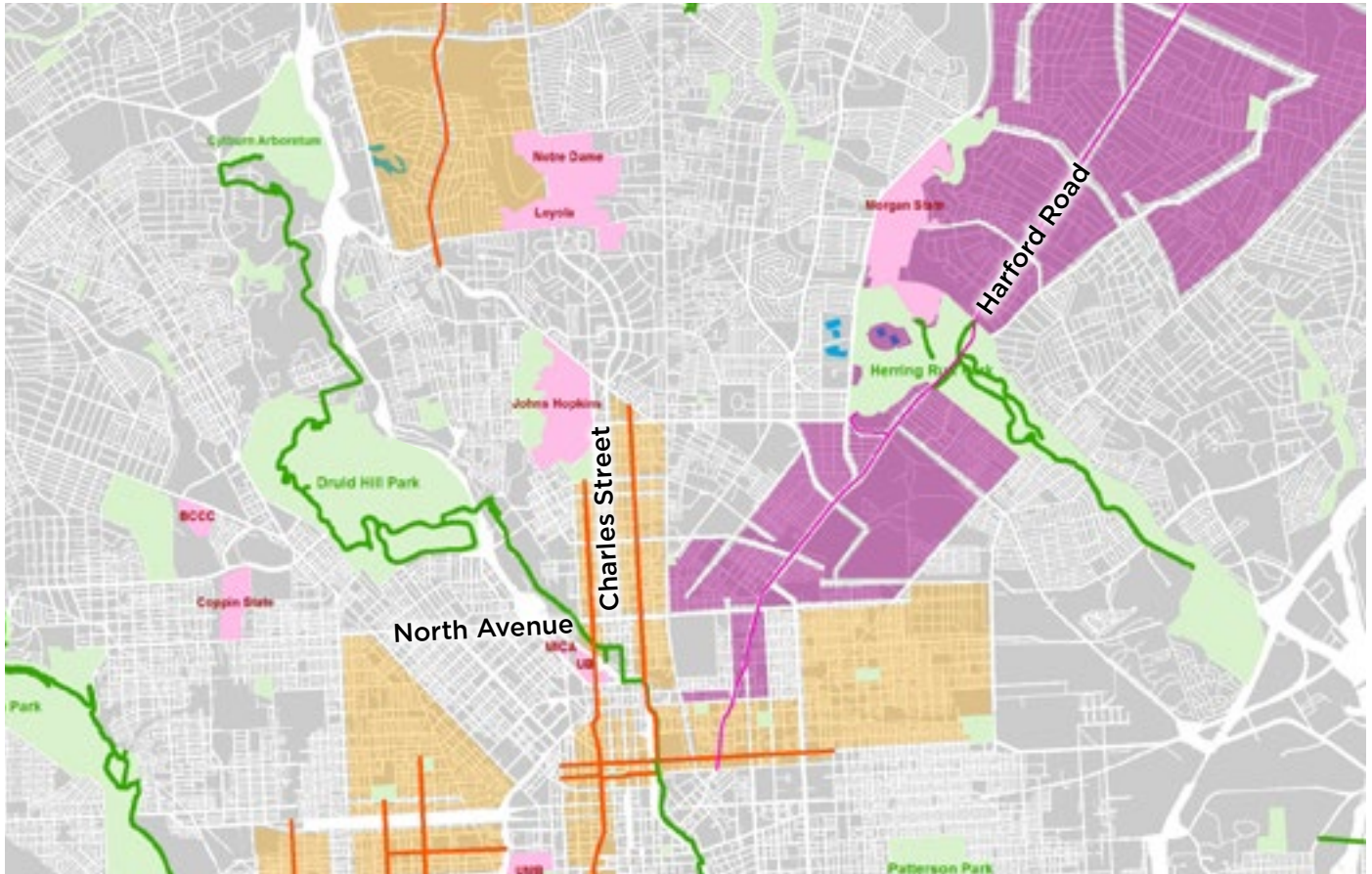


Similarly, investing in facilities on the Fallsway, Albemarle Street, Gough Street, Bank Street, Wolfe and/or Washington Street (only one is necessary if a two-way facility is designed), and Fleet Street, would connect the vast majority of East Baltimore to Downtown. If the planned investments noted above are already made, these areas will also be connected to West Baltimore.



## Choosing High Impact Connections

Technical and community factors (detailed in Part One) should be used to prioritize facilities to help expand the existing low stress network. They should connect to the existing low stress network, thus providing as much access as possible to the employment, transit, retail, and other destinations that are already connected to this network. However, community factors such as neighbors' support for the design must also be taken into account. Each project will have a thorough public input process to ensure that designs meet the needs of their neighborhoods.



Two notable high impact projects are a connection of Harford Road to the Downtown Bike Network, which would provide a connection to much of Northeast Baltimore. Baker Street, Mosher Street, Lafayette Avenue and the planned facility on Mount Royal Avenue will provide a connection from West Baltimore north of US 40 to Downtown and beyond.

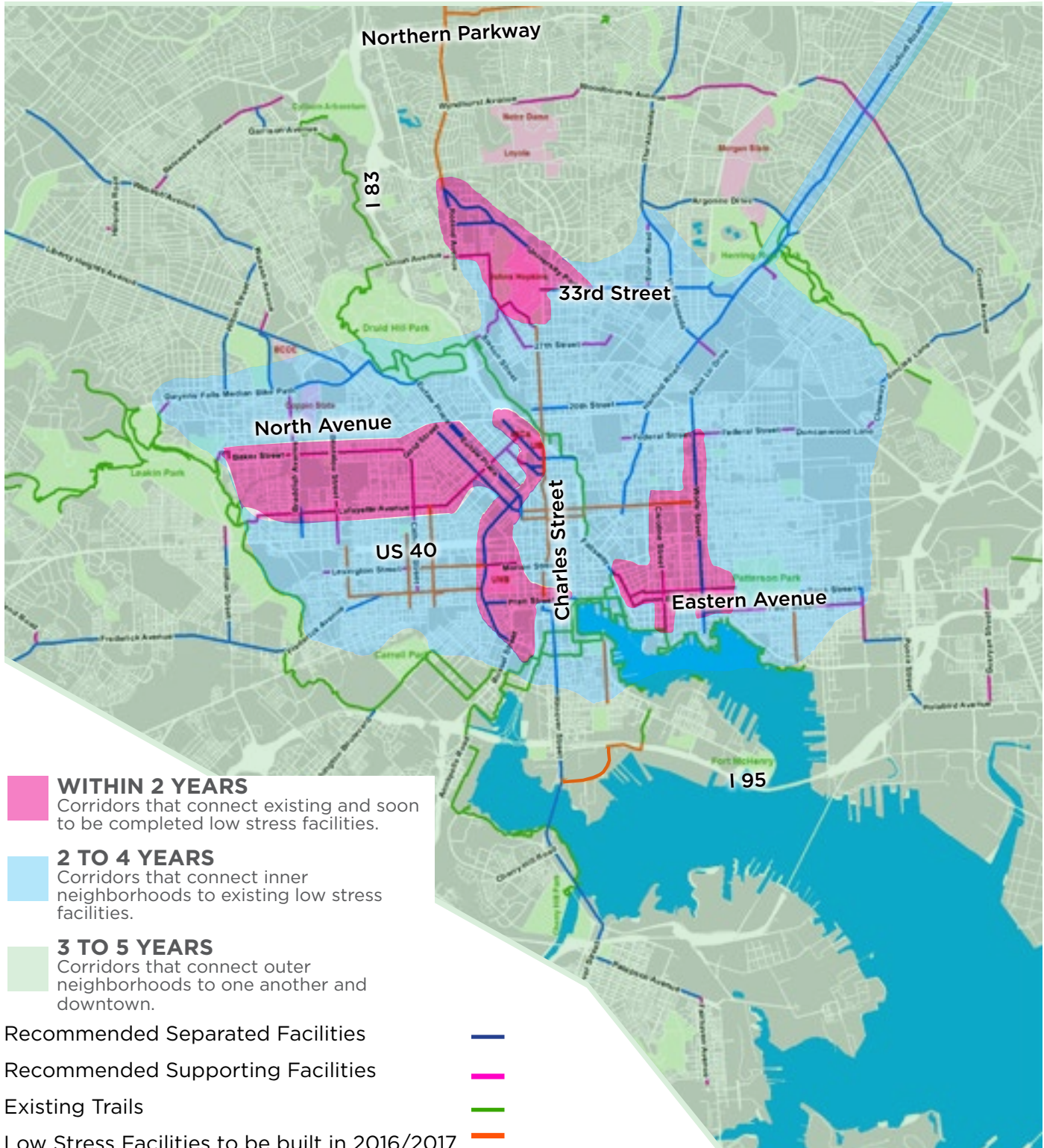




# IMPLEMENTATION

## Implementation

The map below shows three phases for project implementation. The first phase focuses on projects that directly connect existing and soon-to-be-built low stress facilities. The second phase connects inner-ring neighborhoods to downtown and to one another, and the final phase connects outer neighborhoods to one another and to downtown.



# IMPLEMENTATION

## Funding for Implementation

In order to achieve the Separated Bike Network Plan's vision to recommend Network that is implementable within 2-5 years. While there are many opportunities to leverage repaving and resurfacing projects, many of the recommended facilities will require separate funding sources. Assuming up to 10 percent of the mileage of recommendations will be completed through resurfacing and repaving projects, the below table provides a breakdown of funding per year necessary to build all of the recommendations. Note, the projects for 2017 are already funded, designed and ready to be constructed. **This plan recommends 77 miles of separated and supporting bike facilities be implemented at an estimated cost of \$27 million between 2018 and 2022. This is an average of \$5,400,000 in total investment (design and construction) per year.**

**\*Note: funding for 2017 design and construction is already secured.**

2017			2018			2019		
Facility Type	Miles	Cost	Facility Type	Miles	Cost	Facility Type	Miles	Cost
Separated	6.27	\$1,881,000	Separated	9	\$4,500,000	Separated	9	\$4,500,000
Supporting	6.6	\$396,000	Supporting	6	\$600,000	Supporting	6	\$600,000
<b>Total</b>	<b>12.87</b>	<b>\$2,277,000</b>	<b>Total</b>	<b>15</b>	<b>\$5,100,000</b>	<b>Total</b>	<b>15</b>	<b>\$5,100,000</b>

2020			2021			2022		
Facility Type	Miles	Cost	Facility Type	Miles	Cost	Facility Type	Miles	Cost
Separated	11	\$5,500,000	Separated	9	\$4,500,000	Separated	11	\$5,500,000
Supporting	5	\$500,000	Supporting	5	\$500,000	Supporting	6	\$600,000
<b>Total</b>	<b>16</b>	<b>\$6,000,000</b>	<b>Total</b>	<b>14</b>	<b>\$5,000,000</b>	<b>Total</b>	<b>17</b>	<b>\$6,100,000</b>

Funding Type	Funding Source	2018	2019	2020	2021	2022
Local Funding	General Fund and CIP Allocation	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000
State Funding	MDOT Bikeways Grant Funding	\$836,000	\$836,000	\$1,160,000	\$800,000	\$1,196,000
Federal Funding	Transportation Alternatives Programs Grant	\$3,264,000	\$3,264,000	\$3,840,000	\$3,200,000	\$3,904,000
<b>Total</b>		<b>\$5,100,000</b>	<b>\$5,100,000</b>	<b>\$6,000,000</b>	<b>\$5,000,000</b>	<b>\$6,100,000</b>



# CONCLUSION

## Using this Guidance

The construction of low stress bike facilities on the corridors recommended in this document will dramatically expand the number of Baltimore City residents and visitors that can use a bike for some of their travel, or who can take advantage of the newly installed bike share system. However, the recommended corridors are neither an exhaustive list of streets that would benefit from low stress bike facilities nor the only streets that could be used to provide connectivity to certain neighborhoods.

The principles, facility selection chart, and decision making guidance provided in this document can be used to inform future bicycle planning in order to meet the goal of allowing more Baltimore City residents and visitors to travel by bike if they so choose. These will remain relevant well beyond the two to five year time frame intended for these recommendations. They can also be used to adjust recommendations, as long as the guiding goals of providing uninterrupted low stress on-street bicycle connections between origins and destinations is still met.

While it is important that the priority corridors that are indicated in this plan or suitable substitutes receive a low stress facility within two to five years, other bicycle connectivity projects should still be built as time and funding permits



Photo Credit: Elvert Barnes

Prepared for:



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