# Chapter 4: Alternatives Analysis

## 4.0 Chapter Summary

This chapter details the alternatives analysis process to evaluate how well each alternative design addresses the study goals. Safety is evaluated first, as improving safety for all users in the study area is a primary goal that should be considered before other metrics. An alternative that does not improve safety for all users would not accomplish the purpose of the study. Similarly, improving multimodal travel is a fundamental goal of the study, so the evaluation of how well each alternative improves travel for those walking, biking, and taking transit is balanced with accommodating vehicle operations. Additional factors that are analyzed include quality of life outcomes, land use and economic development potential, environmental impacts, and cost. These are analyzed to provide a comparison across alternatives to understand which provide the most benefit compared to a Future No-Build condition.

## 4.1 Alternatives Analysis Framework

The following sections provide an overview of the framework used to analyze and compare alternatives. Section 4.2.1 summarizes the four final alternatives while section 4.2.2 details the evaluation criteria and metrics used in the evaluation.

### 4.1.1 Summary of Alternatives Considered

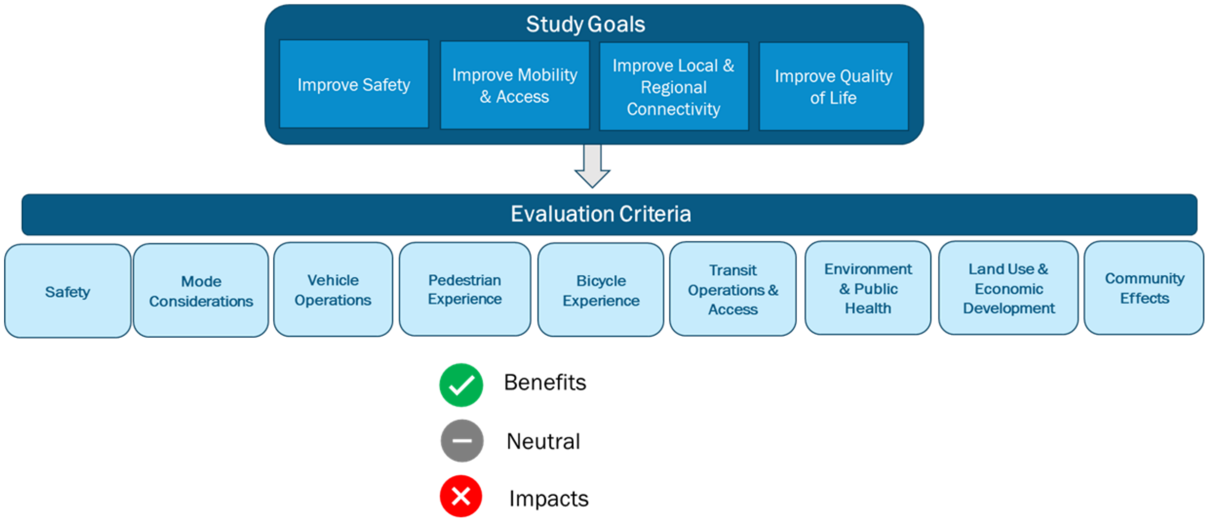
Chapter 3 reviewed the alternatives development process, where various concepts ranging from simple to advanced were evaluated to understand which options had potential to benefit Wellington Circle users. This process resulted in the development of four final alternatives for more detailed analysis:

- Short/Medium-Term (Options A and B)
- Long-Term At-Grade Dual Quadrant (Square and Triangle Concepts)
- Long-Term At-Grade Transit Enhanced Dual Quadrant
- Long-Term Grade Separated Single Quadrant

### 4.1.2 Evaluation Criteria Framework

An evaluation framework was developed to analyze each of the alternatives relative to the study goals detailed in Chapter 1, Section 1.3. The goals relate to improving safety, improving mobility and access, improving local and regional connectivity, and improving quality of life. Evaluation criteria and metrics associated with each goal are used to identify whether the alternative has a beneficial outcome, neutral outcome, or negative impact relative to maintaining the existing configuration of Wellington Circle, as summarized in Figure 4.1-1.

*Figure 4.1-1: Evaluation Criteria Framework Graphic*



While detailed methodology and analysis inform these ratings, this simplified framework enables the comparison of alternatives across goals at a high level to understand which alternative(s) would ultimately provide the most benefit or impact over the existing condition and the Future No-Build. Alternatives were also grouped into the following categories for ease of comparison across criteria:

- **Short-/Medium-Term** – includes options A and B
- **Long-Term At-Grade** – includes square and triangle concepts, unless otherwise specified
- **Long-Term At-Grade Transit Enhanced** – includes triangle concept with transit lane
- **Long-Term Grade-Separated** – includes grade-separated single quadrant

## 4.2 Alternatives Analysis

### 4.2.1 Safety

The existing Wellington Circle intersection has numerous safety issues, outlined in detail in Chapter 2, Section 5.6, including a total of 278 reported crashes over a three-year period. The existing configuration of numerous turn lanes, many possible vehicle movements, and high vehicle speeds on intersection approaches contribute to the disproportionately high number of sideswipe and angle crashes. Despite the vehicle-centric infrastructure and the lack of pedestrian and bicycle facilities (leading to limited pedestrian and bicycle activity), five crashes involving pedestrians and bicycles were reported in the three-year period analyzed.

As outlined in Chapter 3, the alternatives were developed with the project goal of improving safety for all roadway users.

#### 4.2.1.1 Safety Design Elements

The alternatives have many safety design elements in common to address multiple modes. These include, but are not limited to:

- **Pedestrians** – Incorporation of wider pedestrian facilities, enhanced pedestrian crossings, protected pedestrian phasing to minimize conflicts with turning vehicles, additional crossing opportunities, and reduced pedestrian delay.
- **Bicycles** – Provision of separated/buffered bicycle lanes and protected intersection design with physical separation between bicycles and vehicles.
- **Vehicles** – Reduction in travel lanes and intersection approach lanes that decrease the need for multiple lane changes and the associated potential for sideswipe crashes, simplified roadway geometry and progression through the intersection, prohibition of certain vehicle movements to reduce conflicts, and reduced corner and turn radii to encourage lower vehicle turning speeds.
- **Transit Users** – Accessible bus stops with enhanced multimodal connections to reduce conflicts between users.

While there are many safety design elements that the alternatives have in common, there are several differences between the alternatives regarding safety. These include, but are not limited to:

- **Short-/Medium-Term**: As this alternative is reduced in scope, size, and timeline compared to the Long-Term Alternatives, it is anticipated that this alternative would include more limited implementation of the safety design elements listed for the other alternatives.
- **Long-Term Grade-Separated**: One of the project objectives under the safety goal is to reduce vehicular speeds. Since this alternative introduces an overpass and associated on-/off-ramps, it is anticipated that the highway-like nature of the study area would be exacerbated with this alternative, whereas the other alternatives would reduce the highway-like nature of the study area. The introduction of grade-separation and associated on-/off-ramps could lead to increased vehicle speeds through the study area, conflicting with the project's objective of reducing vehicle speeds and improving safety.

Despite the differences outlined above, all alternatives are expected to reduce the number of crashes relative to the existing condition and the Future No-Build. While this section provided a qualitative discussion of the alternatives, the next sections provide a more quantitative safety comparison of the alternatives.

#### 4.2.1.2 Vehicle Conflict Points

One of the quantitative safety metrics to compare various alternatives is a vehicle conflict point analysis. Conflict points are locations where different vehicle movements intersect and these conflict points can be predictive of crash locations and types of crashes. Intersection types with fewer conflict points such as roundabouts generally have fewer crashes and lower crash severity due to the reduced number of opportunities for vehicles to cross paths. There are three types of vehicle conflicts:

- **Diverging** – Location where two vehicles traveling in the same direction split into different movements. Crashes associated with diverging movements include rear-end and side-swipe crashes.

- **Merging** – Location where two vehicles coming from different lanes or directions move into the same lane. Crashes associated with merging movements include rear-end and side-swipe crashes.
- **Crossing** – Location where two vehicles traveling in different directions intersect. Crashes associated with crossing movements include angle crashes, and these types of crashes can lead to the most severe outcomes.

The number of conflict points for the Future No-Build Wellington Circle configuration, as well as for the alternatives, was determined based on the permitted vehicle movements for each alternative. Since the configurations of the commercial driveways are anticipated to be maintained, this analysis only takes into account conflicts between vehicles at intersections. A summary of the number and types of vehicle conflict points is provided in Table 4.2-1. The comprehensive conflict point analysis is found in Appendix E.

*Table 4.2-1: Conflict Point Comparison*

| | *Vehicle Conflict Type* | | | |
|---|---|---|---|---|
| | Diverging | *Crossing* | *Merging* | *Total Conflict Points* |
| *Future No-Build* | 22 | 24 | 22 | **68** |
| *Short-/Medium-Term* | 15 | 10 | 15 | **40** |
| *Long-Term At-Grade – Square* | 17 | 25 | 17 | **59** |
| *Long-Term At-Grade – Triangle* | 15 | 24 | 15 | **54** |
| *Long-Term Grade-Separated* | 11 | 8 | 12 | **31** |

As shown in Table 4.2-1, the Future No-Build Wellington Circle intersection has 68 total conflict points, including 24 critical crossing conflicts. Each of the alternatives has fewer conflict points than Future No-Build, with the Short-/Medium-Term and Long-Term Grade-Separated having the fewest number of conflict points, 40 and 31, respectively. In terms of reduced conflict points, the Short-/Medium-Term alternative performs well against the other Long-Term At-Grade alternatives as it reduces the number of possible vehicle movements in the northern areas of the intersection. The Long-Term At-Grade alternatives introduce additional intersection nodes and accommodate more possible vehicle movements. The Long-Term Grade-Separated alternative performs the best of all alternatives in conflict point reduction, as grade-separation completely removes the eastbound and westbound through movements and their associated conflicts from the intersection.

It should be noted that while conflict point reduction is a useful metric for evaluating alternatives, it does not always consider actual operations and travel conditions. For example, while the Long-Term Grade-Separated alternative has the fewest number of vehicle conflict points, the introduction of additional highway infrastructure into the study area could lead to increased vehicle speeds and crash severity, negating the safety benefit of reduced conflict points. Similarly, the Short-/Medium-Term alternative maintains much of the multi-lane geometry, increasing the potential for side swipe crashes relative to the long-term alternatives.

#### *4.2.1.3 Crash Modification Factors*

As defined in the *MassDOT Safety Alternatives Analysis Guide*, Crash Modification Factors (CMFs) are multiplicative factors used to quantify the expected change in crash frequency for a proposed countermeasure, such as changes in the geometric design or operational characteristics of the facility. CMFs may apply to specific crash types and crash severities and can be reported as either a constant value or a function.

To compare the various alternatives and their potential to reduce crash types, a list of countermeasures and their associated CMF values based on MassDOT's State-Preferred CMF List was derived. The list of countermeasures and their associated CMF values for each alternative is provided in Appendix E. The list of countermeasures summarizes the high-level CMFs used by MassDOT in the safety alternatives analysis process; there are additional CMFs not listed on the State-Preferred CMF list or potential CMFs that may added in the future, which could be applied during the design phase of the project.

Both the Long-Term At-Grade and Long-Term Grade-Separated alternatives have similar numbers of high-level safety enhancements (between eight and ten). Due to the reduced scope of changes, the Short-/Medium-Term alternative only has six relevant safety enhancements. Overall, while the CMF analysis should not be considered predictive of exact crash rates for the proposed alternative, it is expected to reflect the general trend of the long-term alternatives providing the greatest safety benefit.

#### *4.2.1.4 Findings from Safety Alternatives Analysis*

Based on the discussion in the previous sections, all alternatives are expected to reduce the number of crashes compared to maintaining the existing Wellington Circle configuration in a Future No-Build condition. Because the scope of changes to the intersection is more limited in the Short-/Medium-Term alternative compared to the long-term alternatives, the safety benefits would be more limited under this alternative. The long-term alternatives are anticipated to offer similar roadway safety improvements; however, despite having the fewest number of vehicle conflict points, the Long-Term Grade-Separated alternative has the potential to increase crash severity compared to the other alternatives due to the anticipated increase in vehicle speeds associated with the introduction of grade-separation and high-speed vehicle infrastructure.

### 4.2.2 Mode Considerations

The Wellington Circle alternatives were evaluated to understand how different modes are accommodated. Under the existing condition and Future No-Build, most of the space within Wellington Circle is dedicated to vehicle transportation, with each approach providing between four and seven entering vehicle lanes and most approaches having one or more channelized turn lane(s). The Circle has gone through decades of iterative redesign, which has generally consisted of adding vehicle capacity to serve the regional traffic and the trips generated by auto-centric development in the surrounding areas. The added lanes and vehicle capacity have not solved vehicle congestion at Wellington Circle, as drivers continue to experience significant delays traveling through the Circle. These strategies have exacerbated safety issues with increased conflict points and increasingly complex wayfinding.

The current auto-centric configuration of Wellington Circle does not align with study goals, which include improved pedestrian and bicycle access and reduced health and environmental impacts on local users. The ideal preferred alternative for Wellington Circle would benefit every mode of transportation, without substantially impacting vehicle operations. However, each of the alternatives involves tradeoffs, particularly in balancing vehicle capacity against pedestrian and bicyclist accessibility. Figure 4.2-1 below shows an overview of the alternatives analysis process for each alternative by mode. Each alternative is graded with the three-level assessment used throughout this chapter.

*Figure 4.2-1: Mode Considerations Chart*

| | Drive | Transit | Walking | Biking |
|---|---|---|---|---|
| **Short/Medium-Term** | – | – | ✓ | – |
| **Long-Term At-Grade** | ✗ | – | ✓ | ✓ |
| **Long-Term At-Grade Transit Enhanced** | ✗ | ✓ | ✓ | ✓ |
| **Long-Term Grade-Separated** | ✓ | – | – | ✓ |

✓ Benefits
– Neutral
✗ Impacts

The selection of a recommended alternative requires balancing and prioritizing the benefits and trade-offs. The Short-/Medium-Term alternative offers improvements to pedestrians but would have neutral outcomes for motorists, transit-users, and cyclists. The Long-Term At-Grade alternatives improve pedestrian and bicycle conditions but would reduce vehicle operations and capacity. Conversely, the Grade-Separated alternative improves vehicle and bicycle outcomes but would have neutral outcomes for pedestrian and transit users.

Figures 4.2-2 to 4.2-6 show simplified cross-sections of each alternative to illustrate the relative allocation of right-of-way to each mode. A comparison cross-section between each alternative and the existing condition (also the Future No-Build) shows the middle of the existing Wellington Circle on Route 16 looking east. These series of images show that:

- The existing cross-section and Future No-Build configuration allocates most of the right-of-way to vehicles.
- The Short-/Medium-Term alternative maintains much of the space for vehicles, with only a slight reduction on the southern side of the roadway. Roadway space is reallocated to provide a separated/buffered bicycle lane and enlarged green space in the middle.
- Both the Long-Term Square and Triangle alternatives reallocate roadway space from vehicles to bicyclists and pedestrians, with the addition of two-way bicycle facilities on both the northern and southern sides and sidewalks with space for landscaping/plantings. Vehicle lanes are reduced from twelve to six with the Square alternative and to five with the Triangle alternative.

- The Grade-Separated alternative reduces total vehicle lanes to four but includes a vehicular-oriented overpass that creates a visual barrier between north and south of the Circle for pedestrians and bicyclists. This alternative does increase space for these modes through two-way bicycle facilities and buffered sidewalks on both sides. There is less open space to the north and south of the roadway than provided in the Long-Term At-Grade alternatives.
- The Transit Enhanced alternative takes the multimodal benefits of the Triangle alternative further by allocating dedicated space for transit vehicles through the addition of bus lanes on both sides. A comparison of the two alternatives on the quadrant roadway shows a reduction of one vehicle lane for the Transit Enhanced alternative with two bus lanes (resulting in one additional lane overall) but maintains bicycle and pedestrian facilities on both sides.

*Figure 4.2-2: Cross-section – Future No-Build vs. Short-Term*

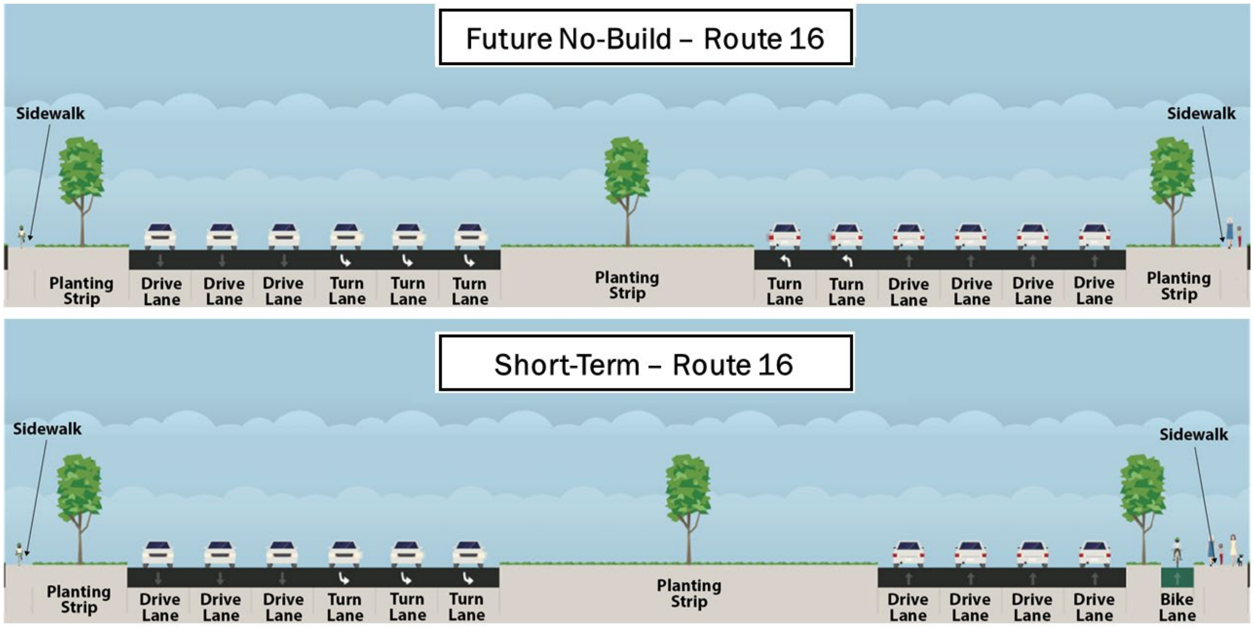


*Figure 4.2-3: Cross-section – Future No-Build vs. Square*

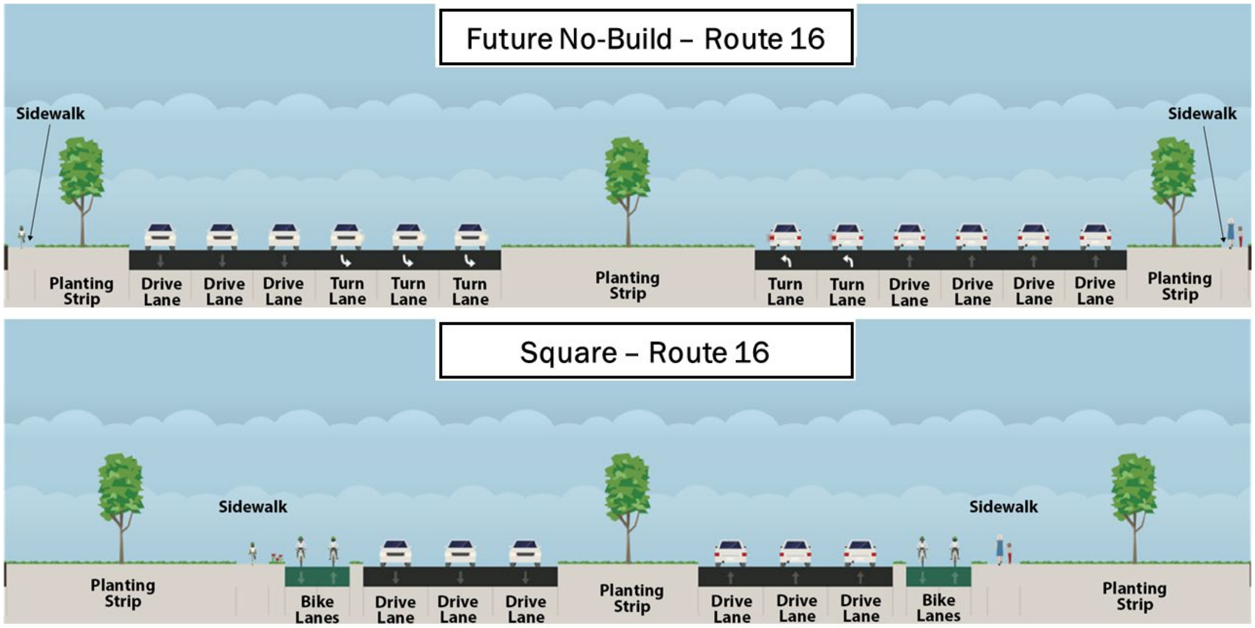


*Figure 4.2-4: Cross-section – Future No-Build vs. Triangle*

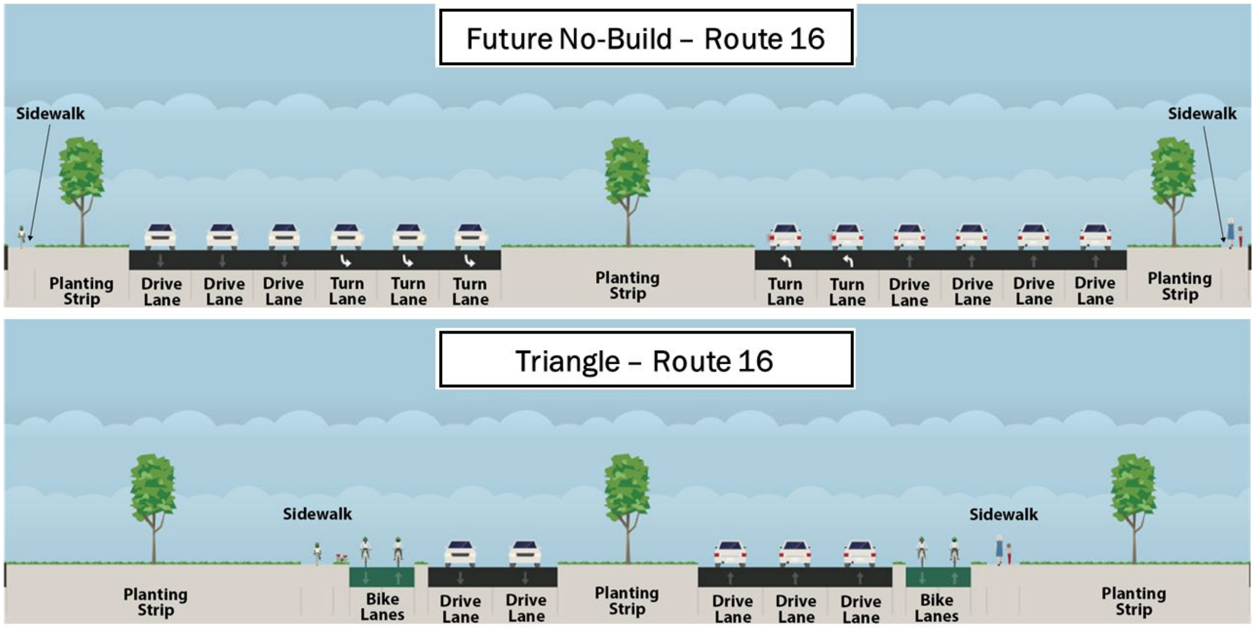


*Figure 4.2-5: Cross-section – Future No-Build vs. Grade-Separated*

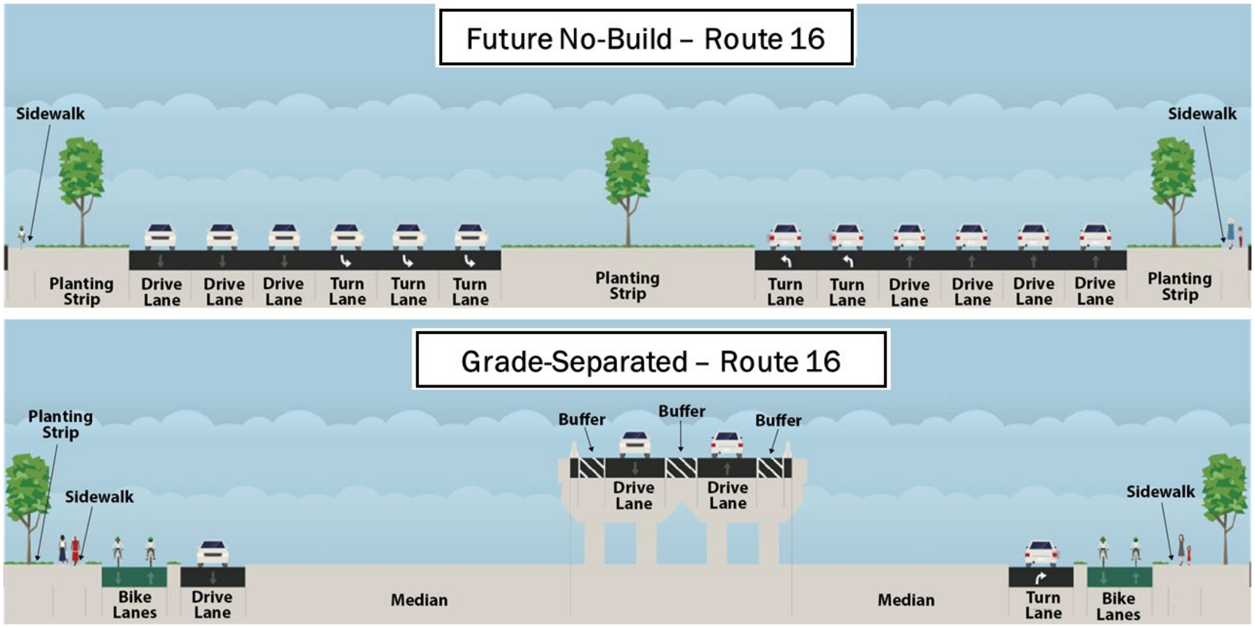
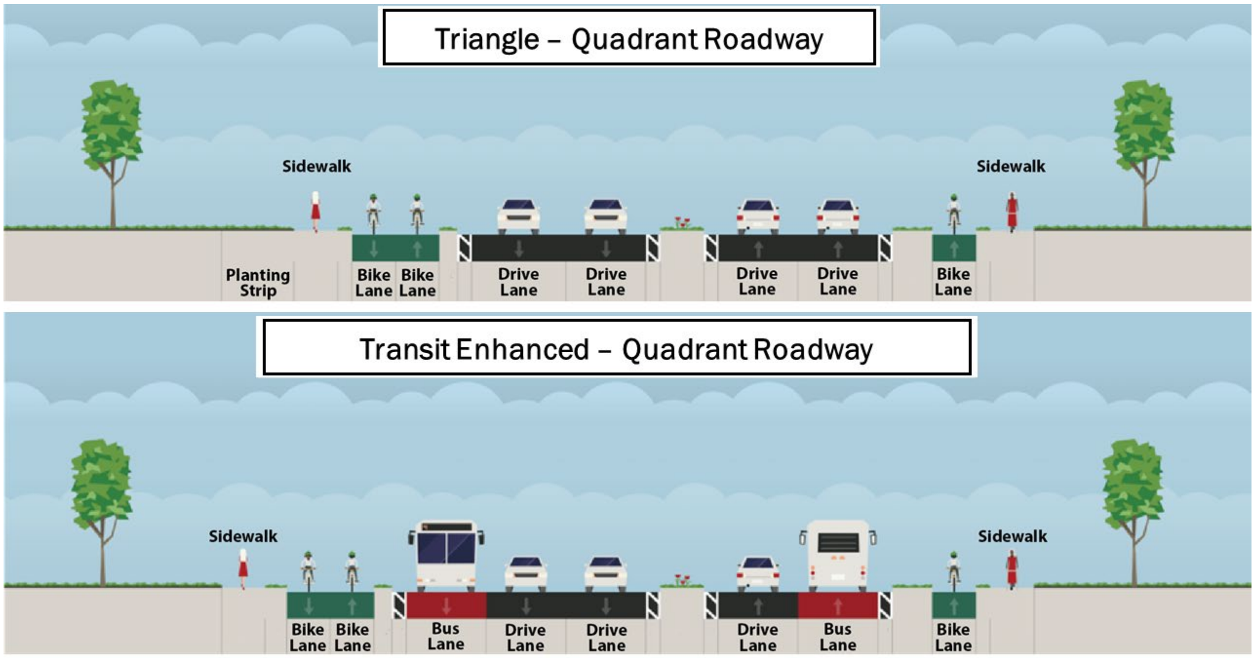


*Figure 4.2-6: Cross-section (Quadrant Roadway) – Triangle vs. Transit Enhanced*



### 4.2.3 Vehicle Operations

Vehicle operations under each alternative were analyzed using VISSIM microsimulation and Synchro capacity analysis. These methods assessed the peak hour vehicle operations under each alternative. To determine future vehicle demands on the various build alternatives, 2040 Build volume projections were developed using similar methodology that was previously outlined in Chapter 2 Section 2.5.5.2. The 2040 Build volume projections include the anticipated impacts of the geometrical and operational configurations of the alternatives on the local and regional traffic volumes, travel patterns, and mode-share. The 2040 Build volumes are included in Appendix E.

Overall, it is expected that vehicle operations at Wellington Circle would remain largely the same as under the Future No-Build with any of the alternatives in place. The overall driver experience would be expected to be safer and less confusing, though each alternative would be expected to operate with similar total vehicle capacities and delays for all vehicles. Individual movements through the Circle may have higher or lower vehicle capacities and delays.

#### *4.2.3.1 Level of Service*

Level-of-Service (LOS) is a commonly used metric based solely on average vehicle delay under a given set of roadway and traffic conditions which provides a qualitative analog for use in assessing and comparing traffic operations, graded by letters between A and F. Generally, in an urbanized area, LOS D is considered desirable. LOS E indicates that operations are approaching capacity and LOS F indicates that conditions may be at or over capacity and experiencing long delays. However, complex intersections with longer cycle lengths can experience higher average delays, even with queues clearing each cycle. While the assessment includes level-of-service, it provides a more in-depth assessment evaluating overall capacity and queuing.

Under both the existing and future conditions (Future No-Build and the Build alternatives) modeled, many movements are shown to operate at LOS F, while very few operate at LOS A or LOS B, as is common in urban areas.

To better depict the differences between alternatives, Figures 4.2-7 to 4.2-11 report operations based on both LOS and on volume-to-capacity ratios.[1] Nodes which are projected to operate at LOS D or better are shown in blue, LOS E is shown in yellow, and nodes which operate at LOS F are shown based on the proportion of movements at the node which operate over capacity (with a volume-to-capacity ratio greater than 1.00). Orange is used for nodes which operate at LOS F with no movements over capacity, red is used where some but less than half of the movements operate over capacity, and dark maroon is used where half or more of the movements are over capacity.

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[1] These graphics present an overview of Synchro capacity analysis results and modified Levels-of-Service (LOS).

*Figure 4.2-7: Level of Service Analysis Results – Existing (2020) vs. Short-Term Option A (2020)*

Existing (2020)

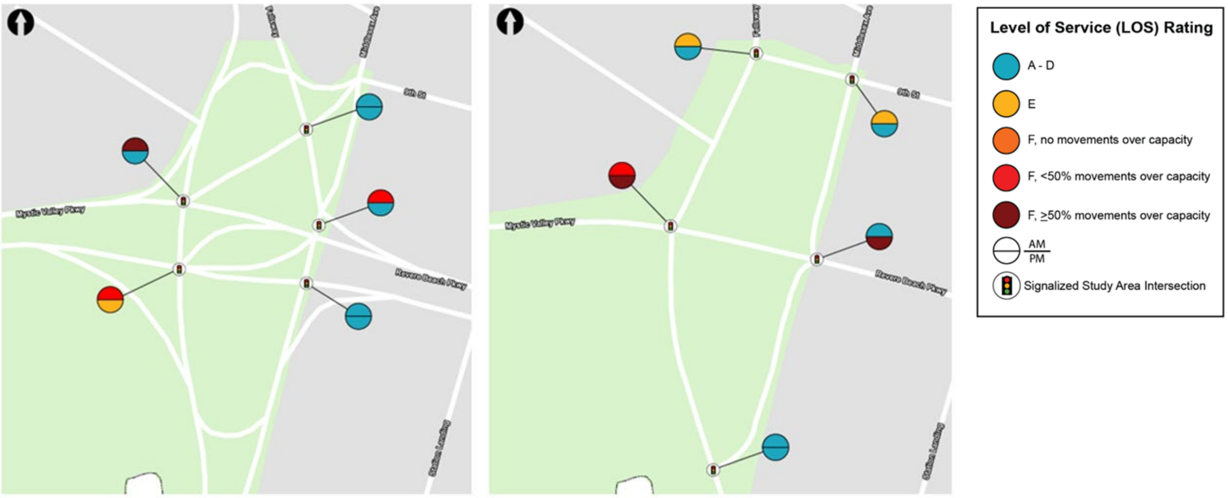
Short-Term Option A (2020)

*Figure 4.2-8: Level of Service Analysis Results – Existing (2020) vs. Future No-Build (2040)*

Existing (2020)

No Build (2040)

*Figure 4.2-9: Level of Service Analysis Results – Future No-Build (2040) vs. At-Grade Square (2040)*



No Build (2040)

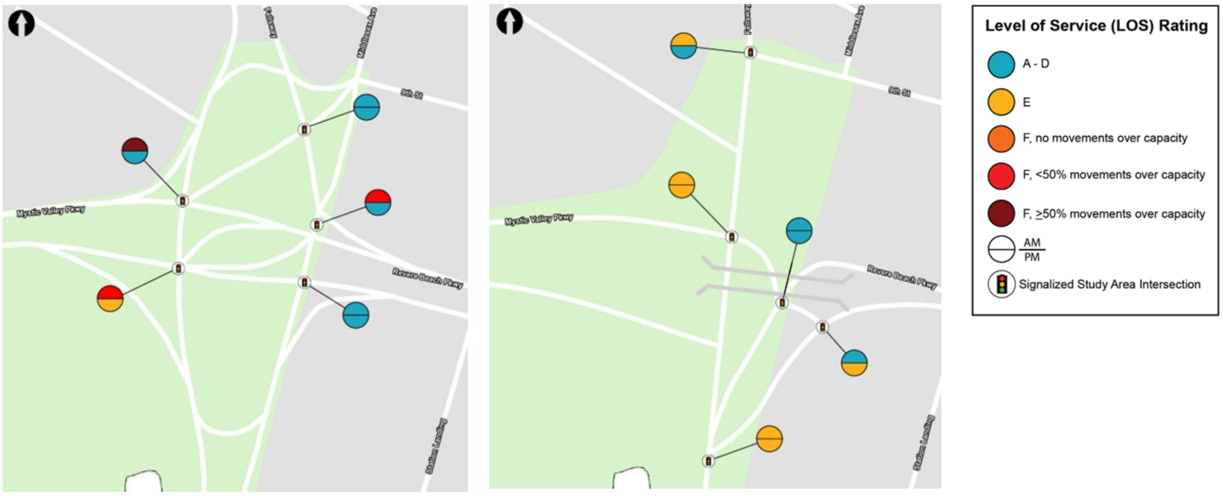
At-Grade Square (2040)

*Figure 4.2-10: Level of Service Analysis Results – Future No-Build (2040) vs. At-Grade Transit Enhanced (2040)*

No Build (2040)

At-Grade Triangle
w/ Transit Enhancements (2040)

*Figure 4.2-11: Level of Service Analysis Results – Future No-Build (2040) vs. Grade-Separated (2040)*



No Build (2040)

Grade-Separated (2040)
(surface roads only)

As shown in Figure 4.2-7, the Short-/Medium-Term Option A improvements are projected to operate with similar or slightly reduced overall LOS as the existing Wellington Circle configuration. Option A particularly shows reduced operations related to the eastbound and westbound right-turn movements.

As discussed previously, vehicle volumes were projected for each future alternative. Under Future No-Build (2040) conditions with the existing Circle configuration maintained, the change in vehicle volumes is projected to result in diminished overall vehicle operations. This is particularly notable at the intersection of the Fellsway southbound at Route 16 westbound, which decreases from overall LOS D to LOS F during the weekday morning peak hour.

Compared to Future No-Build conditions, the Long-Term At-Grade Square alternative is projected to result in overall diminished vehicle operations. This is particularly the case for the intersections along Route 16, which are projected to operate with half or more of their movements over capacity during the weekday afternoon peak hour. The Long-Term At-Grade Transit Enhanced is projected to also experience somewhat diminished vehicle operations compared to Future No-Build conditions, though to a lesser degree than the At-Grade Square. Finally, the Grade-Separated alternative is projected to experience vehicle operations which are better than the Future No-Build condition, and comparable or marginally improved compared to the existing condition (2020).

The outputs of the Synchro capacity analysis and queue diagrams for each alternative are provided in Appendix E.

### *4.2.3.2 Vehicle Volume and Speed*

Standard capacity analysis was performed using Synchro capacity analysis software, which analyzes traffic operations based on the methodologies of the Highway Capacity Manual, 6th Edition. The microsimulations were performed using VISSIM software, which analyzes traffic operations by simulating individual persons and vehicles moving through the modeled traffic network. Compared to standard capacity analysis, VISSIM analysis can better model complex networks and the interactions between multiple intersections. However, VISSIM modeling requires more time to prepare and can be susceptible to minor variations in modeling inputs or simulation events. For this reason, VISSIM analysis was only performed for a select number of the final alternatives, while Synchro analysis was performed for all the alternatives analyzed.

VISSIM microsimulation was performed for the 2020 existing condition, 2040 Future No-Build, 2040 At-Grade Square alternative, and 2040 At-Grade Transit Enhanced alternative. Because VISSIM analysis is based on simulations of a street system, it is possible to quantify typical operations for vehicles across the entire Wellington Circle intersection, instead of the node-based results provided in the Synchro capacity analysis results. The total vehicle volume traversing Wellington Circle by movement and the average travel speed for each movement are reported as outputs from the VISSIM microsimulation. Detailed outputs of the VISSIM microsimulation are provided in Appendix E.

A summary of the volume processed and average travel speed for critical movements through the Circle is shown in Table 4.2-2. During the weekday morning peak hour, the Long-Term At-Grade Square is shown to process approximately 6.5% less total vehicle traffic than the Future No-Build condition, and the Long-Term At-Grade Transit Enhanced alternative is shown to process approximately 3.4% less total vehicle traffic. During the weekday afternoon peak hour, the Long-Term At-Grade Square is shown to process approximately 4.2% more total vehicle traffic than the Future No-Build condition, and the Long-Term At-Grade Transit Enhanced alternative is shown to process approximately 10.0% more total traffic. As illustrated by the relative differences between the weekday morning and afternoon peak hour traffic being processed, the impacts of each alternative are not experienced equally by all vehicle movements; some may see an effective increase in traffic delay, while others may experience a decrease in delay. The total vehicle traffic being processed is also affected by the input volumes, which were based on CTPS modeling, and normal variance between individual VISSIM microsimulations.

*Table 4.2-2: Summary of Volumes & Average Travel Speeds*

| | | Weekday Morning Peak Hour | | | | | | | | Weekday Afternoon Peak Hour | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Existing | | No Build | | At-Grade Square | | At-Grade Transit Enhanced | | Existing | | No Build | | At-Grade Square | | At-Grade Transit Enhanced | |
| **Approach** | | **Volume** | **Speed**[1] | **Volume** | **Speed** | **Volume** | **Speed** | **Volume** | **Speed** | **Volume** | **Speed** | **Volume** | **Speed** | **Volume** | **Speed** | **Volume** | **Speed** |
| Mystic Valley Parkway | EB | *1,249* | *11.6* | *1,136* | *10.3* | *864* | *5.6* | *1,155* | *9.3* | *1,325* | *5.8* | *1,173* | *5.5* | *1,409* | *9.7* | *1,588* | *5.4* |
| Revere Beach Parkway | WB | *2,403* | *7.6* | *2,495* | *9.1* | *2,328* | *7.3* | *2,427* | *12.6* | *2,410* | *8.3* | *2,578* | *7.7* | *2,286* | *6.3* | *3,030* | *11.5* |
| Fellsway | NB | *1,180* | *11.3* | *1,415* | *9.9* | *1,581* | *9.4* | *1,510* | *11.1* | *2,447* | *9.2* | *2,378* | *7.8* | *2,722* | *8.9* | *2,494* | *7.7* |
| Fellsway | SB | *1,365* | *8.9* | *1,404* | *9.5* | *1,396* | *6.1* | *1,395* | *7.3* | *737* | *9.4* | *694* | *9.7* | *698* | *6.2* | *582* | *6.0* |
| Middlesex Avenue/ 9th Street | SWB | *879* | *6.9* | *864* | *6.3* | *666* | *4.5* | *580* | *5.1* | *628* | *5.9* | *619* | *6.8* | *641* | *5.6* | *493* | *5.2* |
| **Intersection Total** | | **7,076** | **9.1** | **7,314** | **9.2** | **6,835** | **7.0** | **7,067** | **10.1** | **7,547** | **8.1** | **7,442** | **7.5** | **7,756** | **7.8** | **8,187** | **8.4** |

[1] Average travel speed in mph

Average travel speeds through the Circle are shown to remain relatively stable under each alternative, particularly during the weekday afternoon peak hour. For the weekday morning peak hour, the fastest average vehicle speed — and in turn the lowest level of traffic delay — occurs for the Long-Term At-Grade Transit Enhanced alternative, at 10.1 miles per hour. The slowest average speed occurs for the Long-Term At-Grade Square, at 7.0 miles per hour. For the weekday afternoon peak hour, the Future No-Build is shown to experience the highest delays and lowest average travel speeds at 7.5 miles per hour, and the At-Grade Transit Enhanced alternative is shown to result in the fastest average travel speed, 8.4 miles per hour.

### 4.2.4 Pedestrian Experience

In its current configuration, Wellington Circle provides pedestrian infrastructure such as sidewalks and signalized crosswalks at most locations; however, the number of crossing locations and travel lanes, high traffic volumes, and overall size of the intersection makes Wellington Circle unwelcoming for pedestrians. One of the project goals is to improve mobility and connectivity for all transportation users, including pedestrians. This goal was prioritized as the study underwent the alternatives development process. The following sections outline how the various alternatives incorporate and compare in terms of pedestrian connectivity, travel time, and experience.

#### *4.2.4.1 Connectivity*

To assess pedestrian connectivity for the alternatives, both qualitative and quantitative assessments were used. Qualitative assessments considered the locations and the nature of the pedestrian crossings provided in each alternative. Shorter crossings, providing crossing opportunities where they don’t currently exist, and reduced vehicle conflict points at current crossings were all considered to benefit pedestrian connectivity.

In general, all the alternatives increase pedestrian connectivity, particularly on the north side of Wellington Circle where all the alternatives provide additional crossing opportunities that do not exist in the current configuration of the Circle.

Relative to the other alternatives, the Short-/Medium-Term alternative is expected to provide the least benefit to pedestrian connectivity; though strong connections are provided on the north side of the Circle and the existing crossings on the west side of the Circle are improved; the remainder of the Circle remains largely unchanged, as shown in Figure 4.2-12.

*Figure 4.2-12: Short-/Medium Term Pedestrian Connectivity*

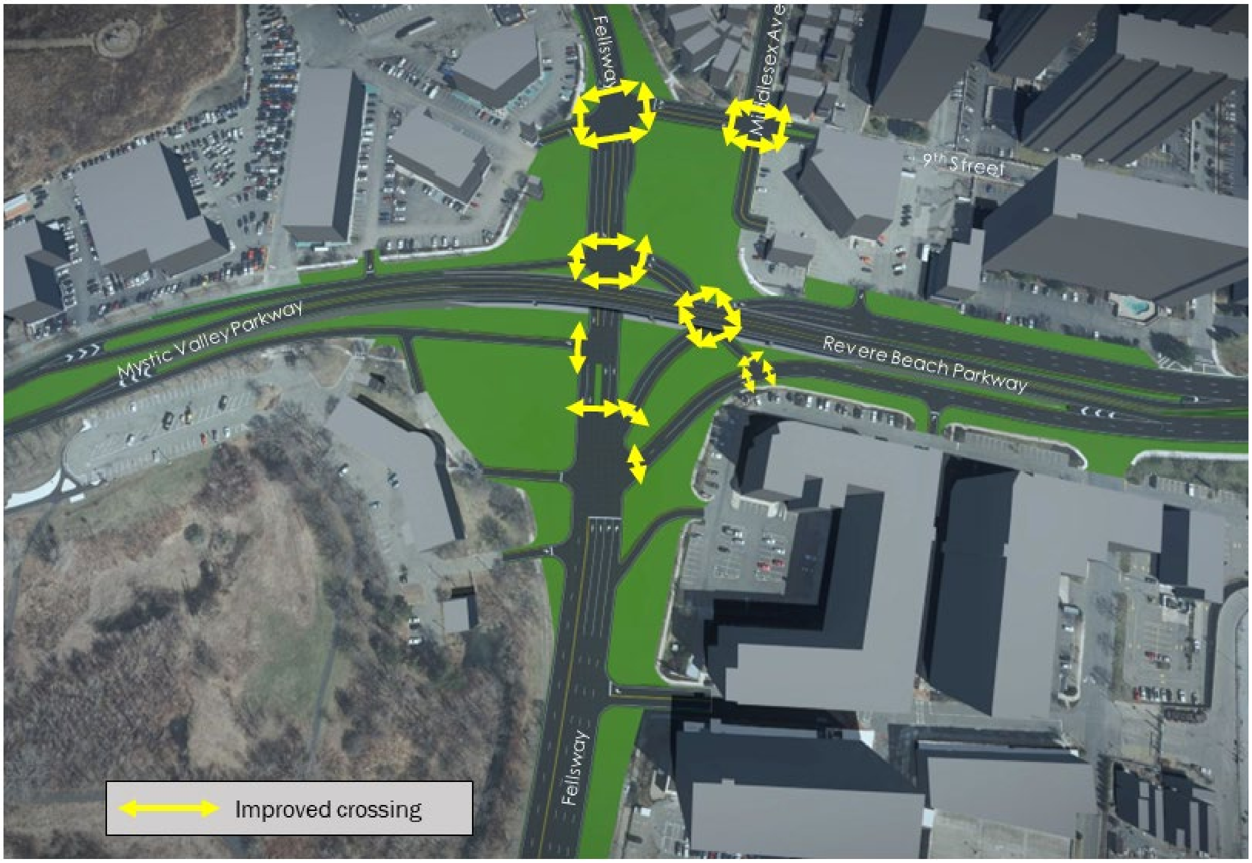
The Long-Term At-Grade alternatives provide new crossing locations on the north and south side of the Circle, and generally provide shorter pedestrian crossings through the middle of the Circle than the existing configuration. However, these alternatives still include some long crossings, defined as crossings greater than three travel lanes without a pedestrian refuge. The Long-Term At-Grade Square alternative includes four of these long crossings and the Long-Term At-Grade Transit Enhanced Alternative includes six of these long crossings. This compares to eight in the Future No-Build. Both Long-Term At-Grade alternatives also lack a crosswalk across Revere Beach Parkway on the eastern side of the Circle, as shown in Figures 4.2-13 and 4.2-14.

*Figure 4.2-13: Long-Term At-Grade Square Pedestrian Connectivity*

*Figure 4.2-14: Long-Term At-Grade Triangle Pedestrian Connectivity*

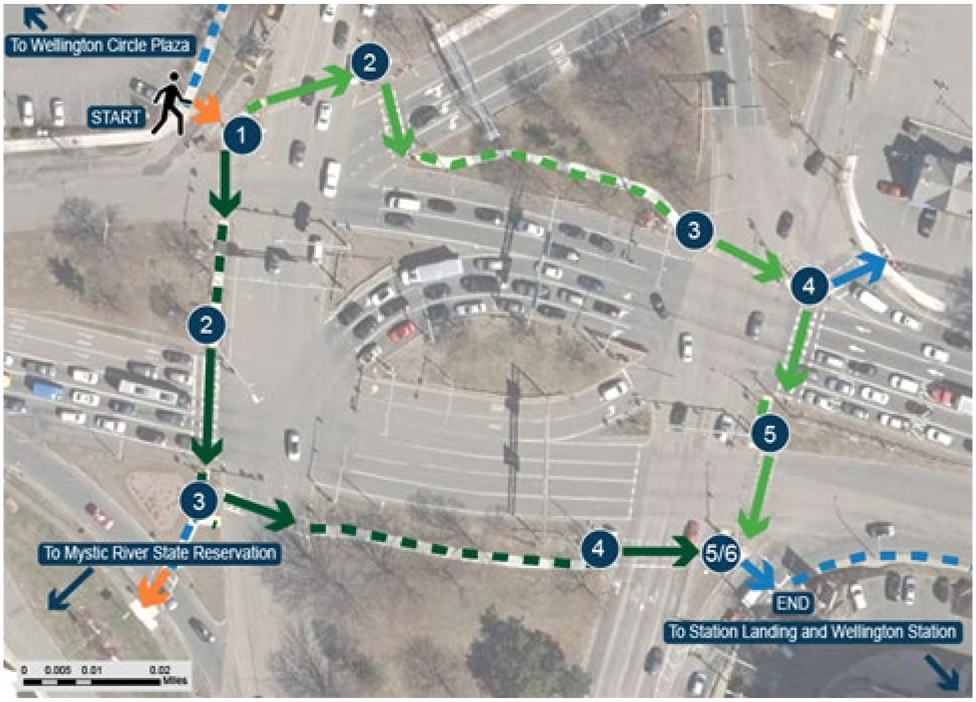
The Long-Term Grade-Separated alternative provides additional crossing points on the north and south side of the Circle, while also having shorter crossing distances throughout the Circle than the Future No-Build configuration or other alternatives. However, the overpass serves as a barrier to pedestrian connectivity by physically and visually bisecting the intersection, as shown in Figure 4.2-15.

*Figure 4.2-15: Long-Term Grade-Separated Pedestrian Connectivity*



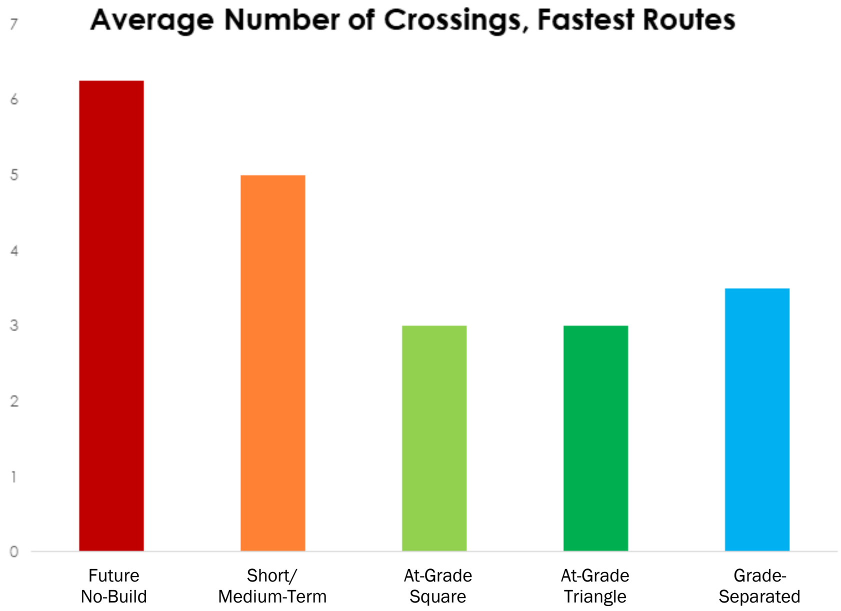
To quantify differences in pedestrian connectivity, a comparison was made for a specific pedestrian crossing route through each alternative, traveling between the Wellington Circle Plaza on the northwest corner of the Circle to Station Landing on the southeast corner, as shown in Figure 4.2-16.

*Figure 4.2-16: Representative Pedestrian Route*



For the fastest course through each alternative to complete this route, the total number of roadway crossings was counted and is presented in Figure 4.2-17. Fewer crossings reflect more direct routes and better pedestrian connectivity.

*Figure 4.2-17: Average Number of Crossings for Fastest Route*

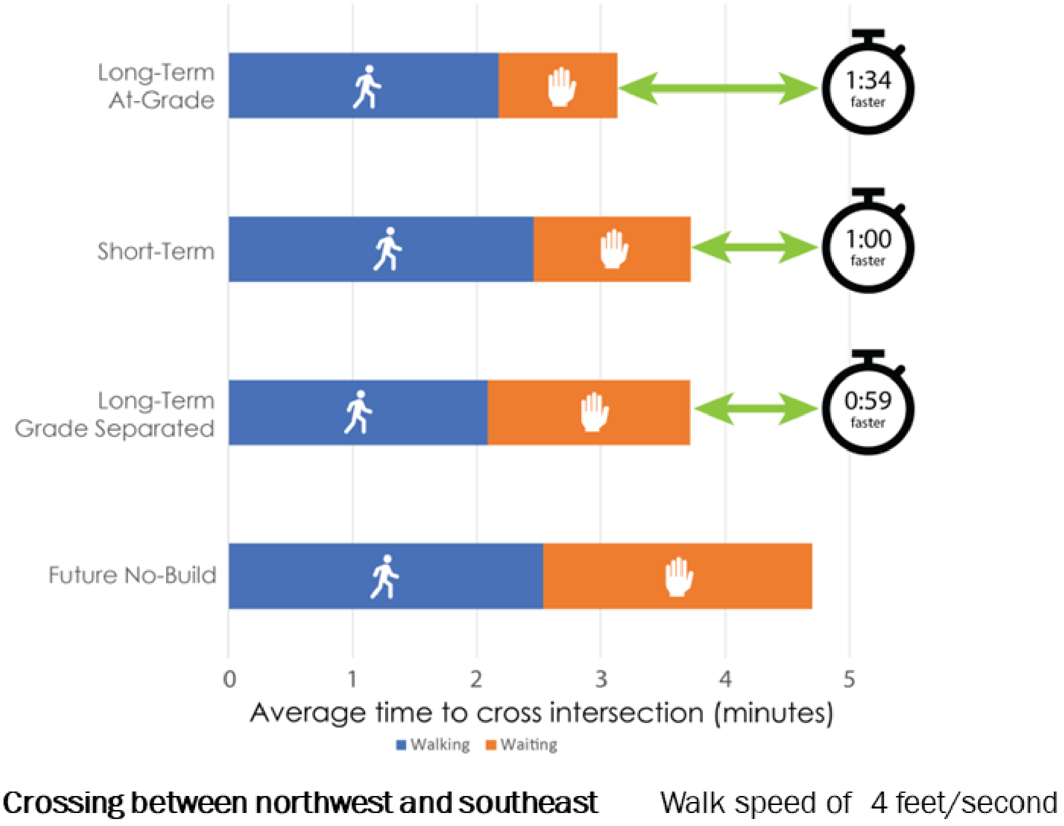


As shown in Figure 4.2-17, the existing route through the Circle is shown to require a total of six crossings. The Long-Term At-Grade alternatives are shown to perform the best by this metric, reducing the total crossings in half, while the Short-/Medium-Term and Grade-Separated alternatives provide less of a reduction in required crossings.

### *4.2.4.2 Travel Time*

To provide a quantitative assessment, travel times for the same representative route depicted in Figure 4.2-16 were utilized. Travel times were assessed based on the existing and proposed pedestrian signal timings and assumed that pedestrian crossings only occurred during the Walk portion of each pedestrian phase. The travel times were divided into the total amount of time spent walking the route and for time spent waiting at crosswalks to cross. The resulting travel times for the fastest route within each alternative are shown in Figure 4.2-18.

*Figure 4.2-18: Pedestrian Travel Times*



As shown in Figure 4.2-18, under existing conditions this representative route takes nearly five minutes to travel on foot, approximately half of which is spent waiting to cross the roadway. The Short-/Medium-Term Option A and Grade-Separated alternatives both result in about a one-minute reduction in travel time but achieve this in different ways. The Short-/Medium-Term alternative has a walking time similar to the existing condition, with nearly all of its travel time reduction coming from reduced waiting time. The Grade-Separated alternative has the lowest walking time of the alternatives, but also the longest waiting time. The at-grade alternatives show the largest decrease in pedestrian travel times, with significant reductions in waiting time and minor reductions in walking time.

#### *4.2.4.3 Experience*

While the existing Wellington Circle intersection includes sidewalks and signalized crossings, the numerous vehicle lanes, intersection approaches, and high vehicle volumes impact the pedestrian experience and limit the access to and enjoyment of the green space.

All alternatives provide opportunity for pleasant visual and landscaped surroundings. The simplification of roadway geometry and configuration, reduction in number of vehicle travel lanes, and expected speed reduction measures would allow for better use, enjoyment, and expansion of green space. The simplification of roadway geometry and vehicle movements through the intersection would reduce the need for the large highway directional signage on the intersection approaches and within the intersection; this reduced need would further emphasize the multi-modal nature of the area over the existing vehicle-centric nature.

Relative to the other alternatives, the Grade-Separated alternative would be expected to impact the pedestrian experience most significantly within the study area. The overpass structure would serve as a barrier to pedestrian experience by physically and visually bisecting the intersection.

### 4.2.5 Bicycle Experience

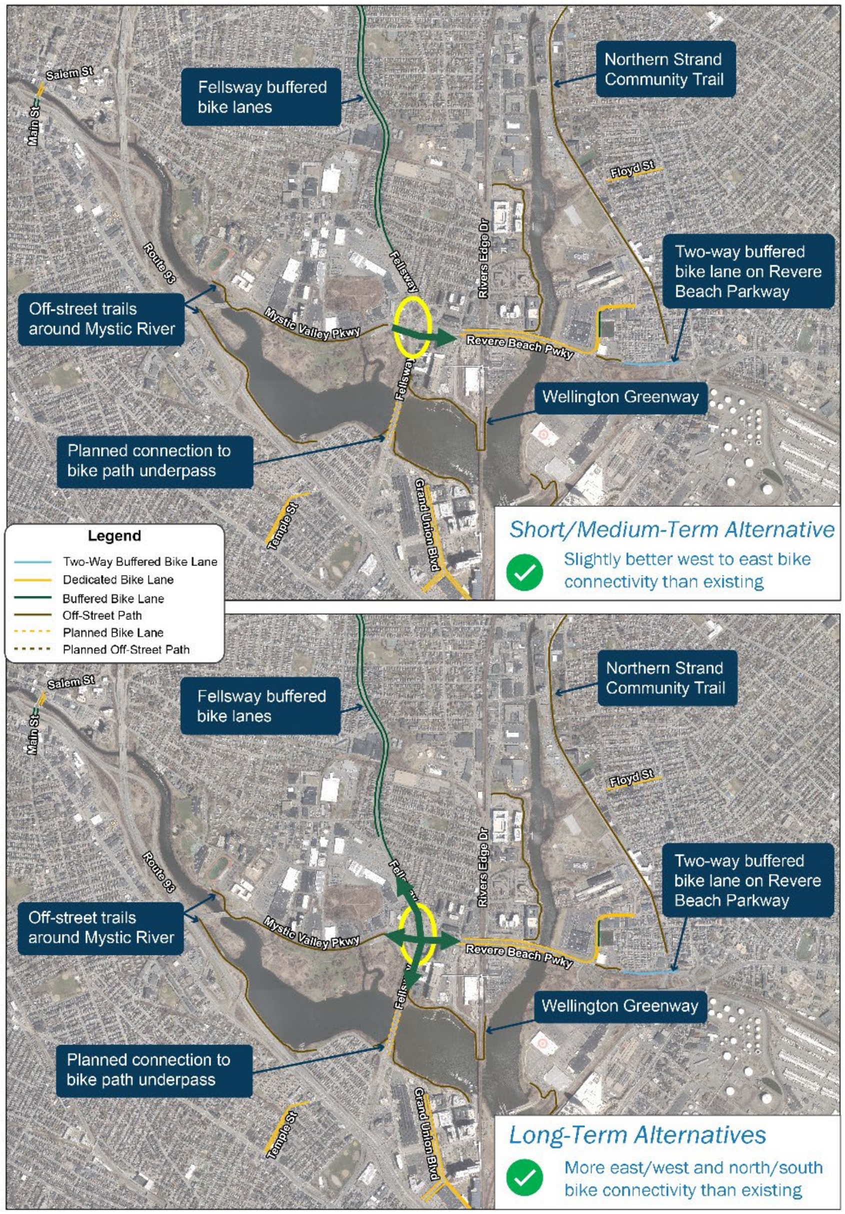
In its current configuration, Wellington Circle provides no bicycle infrastructure and is a significant gap in the local and regional bicycle network. The lack of dedicated bicycle infrastructure and the high-speed and high-volume vehicle traffic in the study area discourage bicycle use within Wellington Circle and on the surrounding roadway network. One of the project goals is to improve mobility and connectivity for all transportation users, including bicyclists. This goal was central as this project underwent the alternatives development process. The following sections outline how the various alternatives incorporate and compare in terms of bicycle connectivity and experience.

#### *4.2.5.1 Connectivity*

Bicycle connectivity between the alternatives was assessed by reviewing the existing and planned bicycle infrastructure on surrounding roadways and whether the various alternatives would provide connections to existing and planned bicycle infrastructure. In general, all alternatives are expected to increase bicycle connectivity compared to the existing configuration and Future No-Build condition of the Circle.

Relative to the other alternatives, the Short-/Medium-Term alternatives are expected to provide the least benefit to bicycle connectivity; though a high-comfort protected facility would be installed in the eastbound direction through the Circle to improve west to east connectivity, the rest of the Circle remains unchanged. Figure 4.2-19 shows a comparison of bicycle connectivity for Short-/Medium-Term alternatives and Long-Term alternatives.

*Figure 4.2-19: Bicycle Connectivity Comparison – Short-/Medium-Term vs. Long-Term alternatives*



All Long-Term alternatives are expected to provide a significant improvement in east-west and north-south connectivity compared to the existing configuration, as each approach to the intersection is expected to provide full-separated bicycle facilities that connect to the existing network in all directions.

### *4.2.5.2 Experience*

As the Future No-Build condition of Wellington Circle would not provide bicycle infrastructure, bicyclists that travel through the intersection would either ride with high-speed and high-volume vehicle traffic on the road or ride along the sidewalk. Both options are uncomfortable for bicyclists and these two options limit bicycle activity within the study area. All the alternatives provide varying levels of improvement to the bicycle experience, as shown in Figure 4.2-20.

*Figure 4.2-20: Bicycle Experience*

*Approximate percentage of approaches that have ability to provide high comfort bicycle facility

Existing – Biker on sidewalk (no bike lane)

Alternatives (separated bike lanes)

The Short-/Medium-Term alternative would provide some improvement to the bicycle experience compared to the Future No-Build but would provide the least improvement compared to the other alternatives analyzed. Under this alternative, a fully protected bicycle lane would be installed to accommodate west to east bicycle travel through the intersection; however, no other protected bicycle infrastructure would be installed elsewhere around the Circle.

The Long-Term At-Grade alternatives would provide the highest-comfort bicycle experience compared to the Future No-Build, and to the other alternatives. The complete reconfiguration of the intersection coupled with the reallocation of space from vehicles to other road users would allow for fully protected and high-comfort bicycle facilities to be installed on all intersection approaches.

The Long-Term Grade-Separated alternative would provide most of the bicycle experience benefits of the other Long-Term alternatives, with one exception. The connections between the overpass structure and the associated on-/off-ramps at the western and eastern ends of the structure could limit the availability of space for bicycle facilities, resulting in narrow and less comfortable facilities.

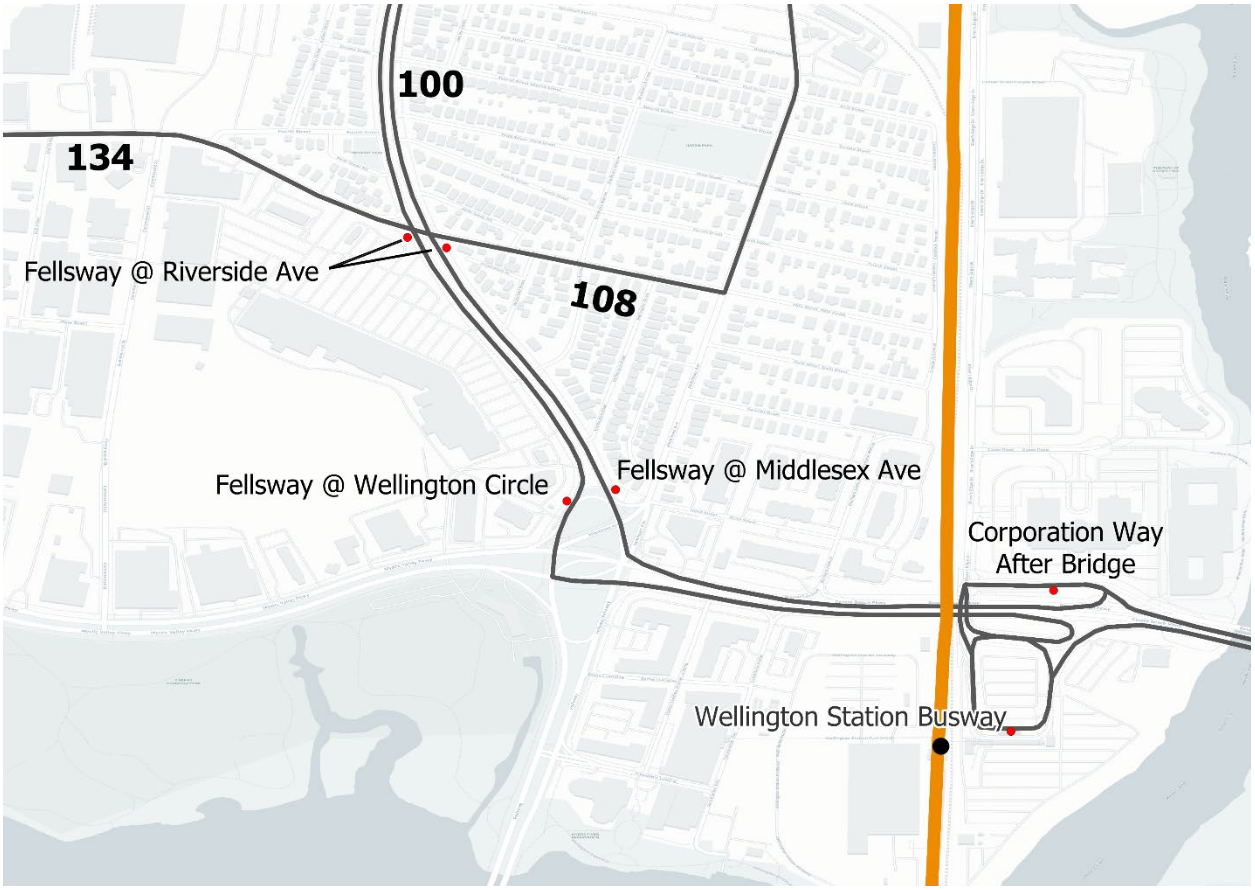
### 4.2.6 Transit Operations and Access

Two measures were used to assess the performance of each alternative with respect to transit:

- The **average transit travel time** for a round trip between Wellington Station and the MBTA bus stops on Fellsway at Riverside Avenue. These times were estimated in both the inbound and outbound directions for both the AM and PM peaks periods, with the average round trip time being calculated as one half of the sum of these four values. As shown in Figure 4.2-21, these points encompass all three MBTA routes operating to the west of Wellington Station.

- A **transit travel time Quality of Service (QOS) ranking** on an 'A' to 'F' scale for both directions of travel for both the AM and PM peaks. This metric was introduced in Chapter 2 detailing existing conditions and is evaluated for the entire section between Wellington Station and the MBTA bus stops on Fellsway at Riverside Avenue. The QOS measure is intended to represent the passenger's perception of the quality of the transit service in terms of speed.

*Figure 4.2-21: MBTA Routes Through Wellington Circle*



Transit travel times were estimated from Fall 2019 bus travel times as measured by the automatic passenger counters (APCs) on the buses. The results of the existing conditions analysis were also based on this data. For the year 2040 alternatives, the Future No-Build (2040) values were adjusted by:

- Making adjustments to reflect the intersection changes based on the control delay values estimated by the Synchro model for each alternative. Where a bus route needed to pass through different or 'new' intersections, these control delays were substituted or included.
- Adjusting for differences in the bus travel times based on link lengths, speed limits, and the time needed to accelerate and decelerate for turns, signalized intersections, and bus stops.

No changes to bus dwell times were assumed for the 2040 alternatives. The CTPS forecasts of year 2040 transit ridership, combined with likely increases in service frequency with the MBTA's Bus Network Redesign, do not suggest an adjustment to dwell times is necessary.

Transit travel time QOS was estimated from the 2040 transit travel times and supplementary values as described in Appendix G. The values of the supplementary and intermediate quantities for these calculations are presented in Appendix G. Table 4.2-3 provides a shorthand definition or interpretation of the ratings 'A' through 'F'. As with the Level of Service (LOS) ratings employed in the *Highway Capacity Manual*, a QOS difference of one rating will be noticeable to passengers.

*Table 4.2-3: Travel Time QOS Ratings*

| Travel Time QOS Rating | Interpretation |
|---|---|
| A | Superior for a local service. Typical of rapid transit service without traffic or traffic signals, when operating on a direct route, at or under capacity. |
| B | Good for a local service. Typical of semi-rapid at-grade light rail transit or bus rapid transit operating on a direct route, predominantly in arterial corridors in exclusive or reserved right-of-way, subject to traffic signal control, at or under capacity. |
| C | Typical for local service. Representative of bus service in mixed traffic on a direct route with relatively little impact from general traffic congestion. |
| D | Slow for a local service. Typical of bus service in mixed traffic with modest impact from general traffic congestion. |
| E | Very slow for a local service. Typical of bus service in mixed traffic on an indirect or circuitous route with moderate congestion, on a direct route with significant traffic congestion, or on a route operating at or over capacity. |
| F | Extremely slow. Perceived as a poor travel choice for short to moderate distances. |

Local bus services seldom achieve QOS 'A', except perhaps very early in the morning or late at night when there is little highway traffic and the buses may skip many stops because of low ridership. During peak periods, local buses in most urbanized areas operate at QOS 'C' or lower. The alternatives analysis focused on the two weekday peak periods.

#### *4.2.6.1 Short-/Medium-Term*

The Short-/Medium-Term alternative would make relatively modest changes relative to the Long-Term alternatives. Given that only the significant transit priority features of the Long-Term Transit Enhanced alternative are projected to result in noticeable improvements to transit operations, it is reasonable to conclude that the Short-/Medium-Term alternative would not offer a prospect of perceptible improvements to transit operations compared to Future No-Build.

#### *4.2.6.2 Future No-Build*

Estimated transit travel times for the Future No-Build (2040) are shown in.

Table 4.2-4 for each direction in both peak periods. Almost half of the estimated time would be attributable to control delays (principally at or approaching traffic signals). This is much higher than a 'typical urban' range of perhaps 15 to 25 percent. The remaining time would be attributable to moving time and dwell time at bus stops.

*Table 4.2-4: Estimated Transit Travel Times for Future No-Build in 2040 (seconds)*

| From | To | Peak/Direction | Control Delay | Other Time | Total Time |
|---|---|---|---|---|---|
| FELLSWAY @ RIVERSIDE AVE | FELLSWAY @ WELLINGTON CIRCLE | AM Inbound | 55.4 | 98.8 | 154.2 |
| FELLSWAY @ RIVERSIDE AVE | FELLSWAY @ WELLINGTON CIRCLE | PM Inbound | 62.4 | 23.7 | 86.1 |
| FELLSWAY @ WELLINGTON CIRCLE | WELLINGTON STATION BUSWAY | AM Inbound | 215.6 | 159.7 | 375.3 |
| FELLSWAY @ WELLINGTON CIRCLE | WELLINGTON STATION BUSWAY | PM Inbound | 114.5 | 104.4 | 218.9 |
| WELLINGTON STATION BUSWAY | CORPORATION WAY AFTER BRIDGE | AM Outbound | 34.5 | 77.4 | 111.9 |
| WELLINGTON STATION BUSWAY | CORPORATION WAY AFTER BRIDGE | PM Outbound | 67.3 | 77.4 | 144.7 |
| CORPORATION WAY AFTER BRIDGE | FELLSWAY @ MIDDLESEX AVE | AM Outbound | 177.2 | 78.4 | 255.6 |
| CORPORATION WAY AFTER BRIDGE | FELLSWAY @ MIDDLESEX AVE | PM Outbound | 66.8 | 83.3 | 150.1 |
| FELLSWAY @ MIDDLESEX AVE | FELLSWAY @ RIVERSIDE AVE | AM Outbound | 0.0 | 63.0 | 63.0 |
| FELLSWAY @ MIDDLESEX AVE | FELLSWAY @ RIVERSIDE AVE | PM Outbound | 0.0 | 65.0 | 65.0 |
| Average Round Trip Time (49% control delay) | | | 793.7 | 831.1 | 1624.8 |

In terms of travel time QOS, two of the four peak/direction pairs are rated 'E', one is rated 'D', and one (the inbound AM peak) is rated 'F'. QOS for each alternative is discussed in the following sections.

### *4.2.6.3 Long-Term At-Grade Square*

Estimated transit travel times for the Long-Term At-Grade Square alternative in 2040 are shown in Table 4.2-5 for each direction in both peak periods. As with the Future No-Build, almost half of the estimated time would be attributable to control delays.

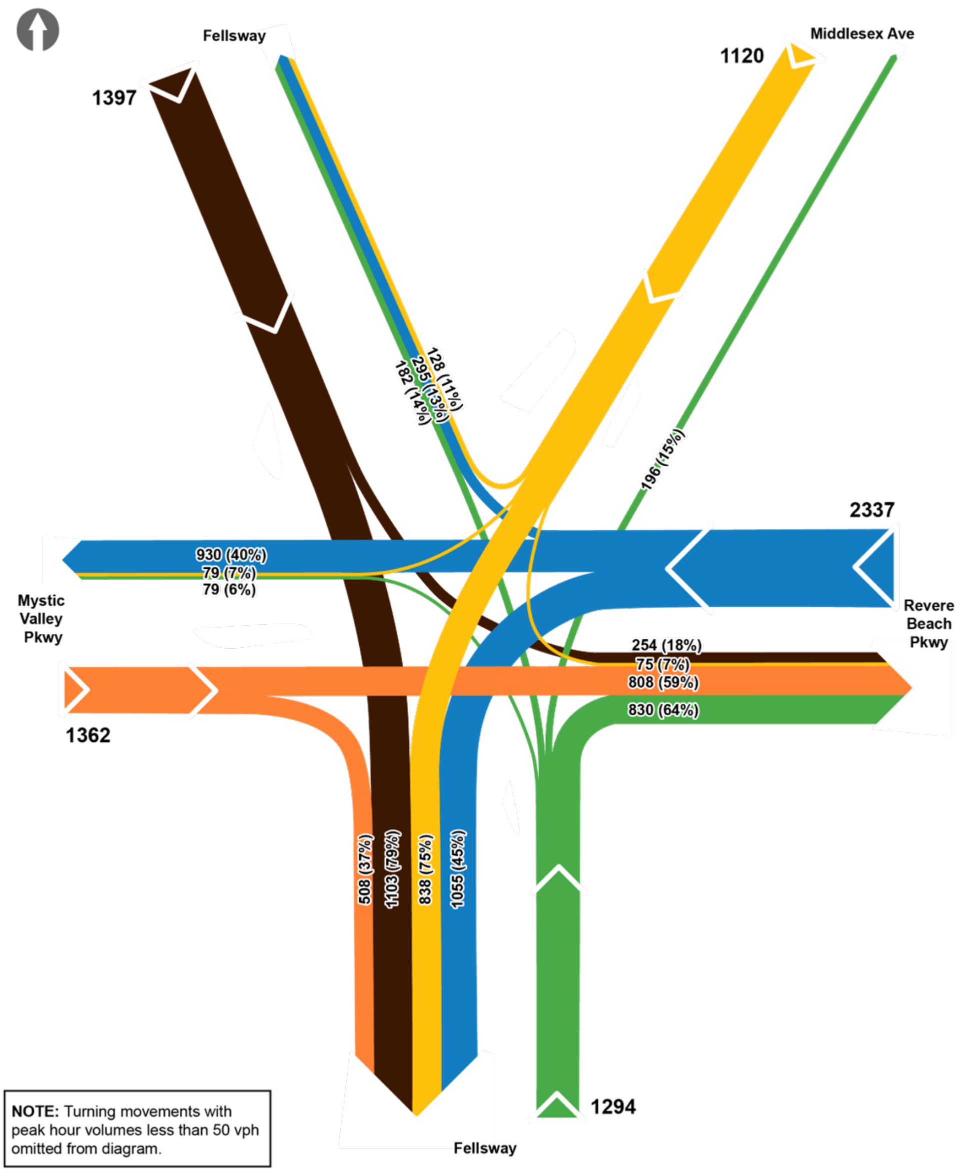
In terms of travel time QOS, the number of ratings in each category is the same as for the Future No-Build, as is the pairing (AM inbound) for which the 'F' rating occurs.

*Table 4.2-5: Estimated Transit Travel Times for Long-Term At-Grade Square in 2040 (seconds)*

| From | To | Peak/Direction | Control Delay | Other Time | Total Time |
|---|---|---|---|---|---|
| FELLSWAY @ RIVERSIDE AVE | FELLSWAY @ WELLINGTON CIRCLE | AM Inbound | 66.9 | 98.8 | 165.7 |
| FELLSWAY @ RIVERSIDE AVE | FELLSWAY @ WELLINGTON CIRCLE | PM Inbound | 50.5 | 17.4 | 67.9 |
| FELLSWAY @ WELLINGTON CIRCLE | WELLINGTON STATION BUSWAY | AM Inbound | 158.5 | 170.8 | 329.3 |
| FELLSWAY @ WELLINGTON CIRCLE | WELLINGTON STATION BUSWAY | PM Inbound | 219.7 | 115.5 | 335.2 |
| WELLINGTON STATION BUSWAY | CORPORATION WAY AFTER BRIDGE | AM Outbound | 38.0 | 77.4 | 115.4 |
| WELLINGTON STATION BUSWAY | CORPORATION WAY AFTER BRIDGE | PM Outbound | 65.2 | 77.4 | 142.6 |
| CORPORATION WAY AFTER BRIDGE | FELLSWAY @ MIDDLESEX AVE | AM Outbound | 57.5 | 82.4 | 139.9 |
| CORPORATION WAY AFTER BRIDGE | FELLSWAY @ MIDDLESEX AVE | PM Outbound | 90.4 | 97.4 | 187.8 |
| FELLSWAY @ MIDDLESEX AVE | FELLSWAY @ RIVERSIDE AVE | AM Outbound | 0.0 | 67.4 | 67.4 |
| FELLSWAY @ MIDDLESEX AVE | FELLSWAY @ RIVERSIDE AVE | PM Outbound | 0.0 | 63.2 | 63.2 |
| Average Round Trip Time (46% control delay) | | | 746.6 | 867.7 | 1614.3 |
| Round Trip Transit Time as a Percent of the Baseline | | | | | 99.4% |

Overall, the Long-Term At-Grade Square alternative would not show substantial improvement in transit performance over the Future No-Build. Although there would be a modest reduction in control delay, it would be partially offset by increased over-the-road time to travel the less direct 'Square' route. Another issue limiting improvement for transit is that traffic signal timings which would minimize total general traffic delay would take into consideration the relative size of the general traffic flows, as shown in Figure 4.2-22. By contrast, MBTA bus movements follow some of the most lightly traveled paths, between the east and the northwest. It would be difficult to try to reduce control delays for the transit movements without impacting general traffic flows.

*Figure 4.2-22: Relative Sizes of Traffic Movements Through Wellington Circle*



### *4.2.6.4 Long-Term At-Grade Transit Enhanced*

Estimated transit travel times for the At-Grade Transit Enhanced alternative in 2040 are shown in Table 4.2-6 for each direction in both peak periods. Only 34 percent of the estimated transit travel time would be attributable to control delays, the lowest such fraction among the alternatives. Because of the portions of exclusive bus lane and queue-jumping provisions on segments common to all three routes, and the more direct ‘triangular’ configuration, bus moving time would also be the fastest among the alternatives. Total bus travel time would be reduced by about 25 percent from the Future No-Build.

In terms of travel time QOS, this is the only alternative which would improve transit travel time QOS by one rating level from the Future No-Build for all direction/peak period pairings. This would be readily perceptible by passengers, although the services would still be subject to significant delays in areas where geometric treatments to favor bus movements are not provided.

*Table 4.2-6: Estimated Transit Travel Times for Long-Term Transit Enhanced in 2040 (seconds)*

| From | To | Peak/Direction | Control Delay | Other Time | Total Time |
|---|---|---|---|---|---|
| FELLSWAY @ RIVERSIDE AVE | FELLSWAY @ WELLINGTON CIRCLE | AM Inbound | 66.2 | 98.8 | 165.0 |
| FELLSWAY @ RIVERSIDE AVE | FELLSWAY @ WELLINGTON CIRCLE | PM Inbound | 46.2 | 17.4 | 63.6 |
| FELLSWAY @ WELLINGTON CIRCLE | WELLINGTON STATION BUSWAY | AM Inbound | 55.6 | 146.6 | 202.2 |
| FELLSWAY @ WELLINGTON CIRCLE | WELLINGTON STATION BUSWAY | PM Inbound | 70.9 | 91.3 | 162.2 |
| WELLINGTON STATION BUSWAY | CORPORATION WAY AFTER BRIDGE | AM Outbound | 35.3 | 77.4 | 112.7 |
| WELLINGTON STATION BUSWAY | CORPORATION WAY AFTER BRIDGE | PM Outbound | 51.4 | 77.4 | 128.8 |
| CORPORATION WAY AFTER BRIDGE | FELLSWAY @ MIDDLESEX AVE | AM Outbound | 37.6 | 91.3 | 128.9 |
| CORPORATION WAY AFTER BRIDGE | FELLSWAY @ MIDDLESEX AVE | PM Outbound | 55.1 | 96.4 | 151.5 |
| FELLSWAY @ MIDDLESEX AVE | FELLSWAY @ RIVERSIDE AVE | AM Outbound | 0.0 | 51.5 | 51.5 |
| FELLSWAY @ MIDDLESEX AVE | FELLSWAY @ RIVERSIDE AVE | PM Outbound | 0.0 | 53.3 | 53.3 |
| Average Round Trip Time (34% control delay) | | | 418.4 | 801.4 | 1219.8 |
| Round Trip Transit Time as a Percent of the Baseline | | | | | 75.1% |

### *4.2.6.5 Long-Term Grade-Separated*

Estimated transit travel times for the Long-Term Grade-Separated Alternative in 2040 are shown in Table 4.2-7 for each direction in both peak periods. About 42 percent of the estimated time would be attributable to control delays, intermediate between the At-Grade Square and the Transit Enhanced alternatives. In terms of travel time QOS, the ratings for each time period/direction pair would be the same as for the At-Grade Square alternative; specifics may be found below. In the Grade-Separated alternative, which vertically separates east-west and north-south movements, bus movements would have to follow a longer path via auxiliary and connecting roadways with multiple signalized intersections.

*Table 4.2-7: Estimated Transit Travel Times for Long-Term Grade-Separated in 2040 (seconds)*

| From | To | Peak/Direction | Control Delay | Other Time | Total Time |
|---|---|---|---|---|---|
| FELLSWAY @ RIVERSIDE AVE | FELLSWAY @ WELLINGTON CIRCLE | AM Inbound | 53.5 | 98.8 | 152.3 |
| FELLSWAY @ RIVERSIDE AVE | FELLSWAY @ WELLINGTON CIRCLE | PM Inbound | 60.8 | 23.7 | 84.5 |
| FELLSWAY @ WELLINGTON CIRCLE | WELLINGTON STATION BUSWAY | AM Inbound | 213.9 | 126.7 | 340.6 |
| FELLSWAY @ WELLINGTON CIRCLE | WELLINGTON STATION BUSWAY | PM Inbound | 98.2 | 126.7 | 224.9 |
| WELLINGTON STATION BUSWAY | CORPORATION WAY AFTER BRIDGE | AM Outbound | 40.2 | 77.4 | 117.6 |
| WELLINGTON STATION BUSWAY | CORPORATION WAY AFTER BRIDGE | PM Outbound | 53.6 | 77.4 | 131.0 |
| CORPORATION WAY AFTER BRIDGE | FELLSWAY @ MIDDLESEX AVE | AM Outbound | 35.5 | 143.1 | 178.6 |
| CORPORATION WAY AFTER BRIDGE | FELLSWAY @ MIDDLESEX AVE | PM Outbound | 115.3 | 100.7 | 215.9 |
| FELLSWAY @ MIDDLESEX AVE | FELLSWAY @ RIVERSIDE AVE | AM Outbound | 0.0 | 64.5 | 64.5 |
| FELLSWAY @ MIDDLESEX AVE | FELLSWAY @ RIVERSIDE AVE | PM Outbound | 0.0 | 93.6 | 93.6 |
| Average Round Trip Time (42% control delay) | | | 670.9 | 932.6 | 1603.4 |
| Round Trip Transit Time as a Percent of the Baseline | | | | | 98.7% |

### 4.2.6.6 Summary and Conclusions

With respect to transit performance, the Transit Enhanced alternative is the only one that would offer a clear improvement over the Future No-Build, as shown in Figure 4.2-23 and Figure 2.4-24. A 25% reduction in transit travel time would raise the overall perception of MBTA routes through the Circle from ‘very slow’ to ‘slow’. The use of exclusive lane segments and queue jumpers would be a far more effective way to improve transit times than relying on improvements to a congested general traffic stream in which buses operate.

*Figure 4.2-23: Transit Times by Alternative*

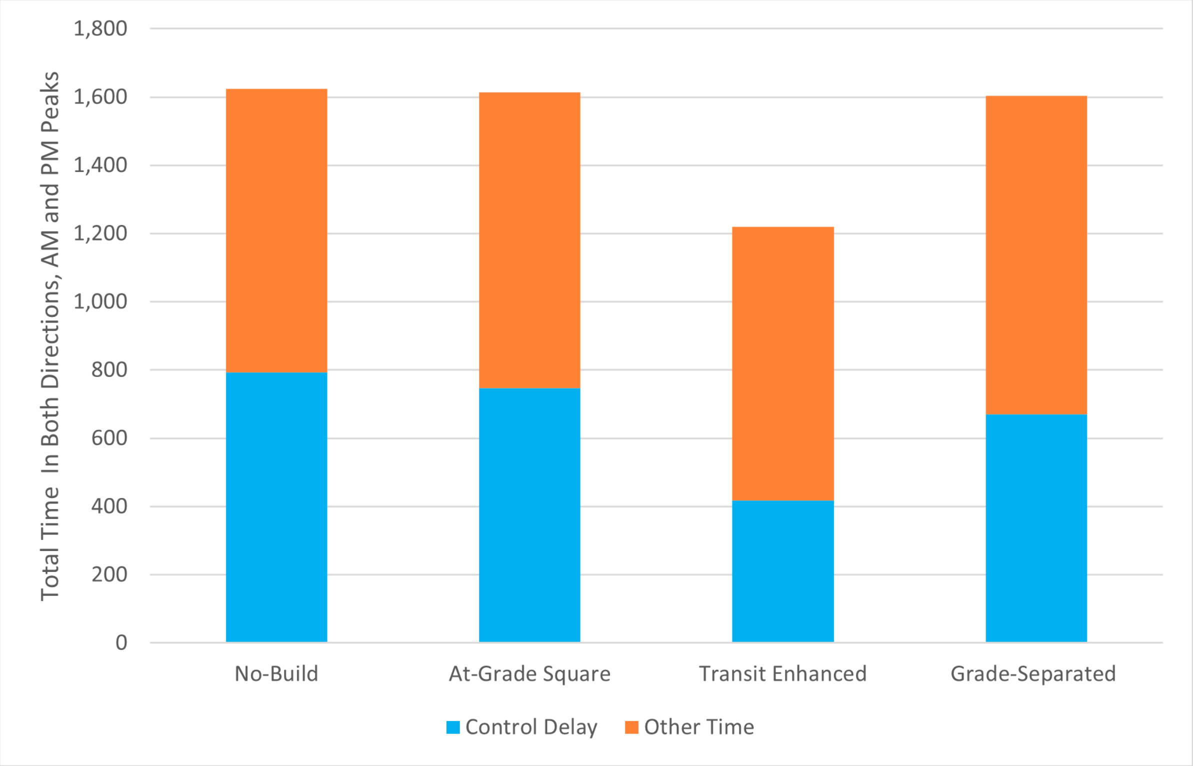
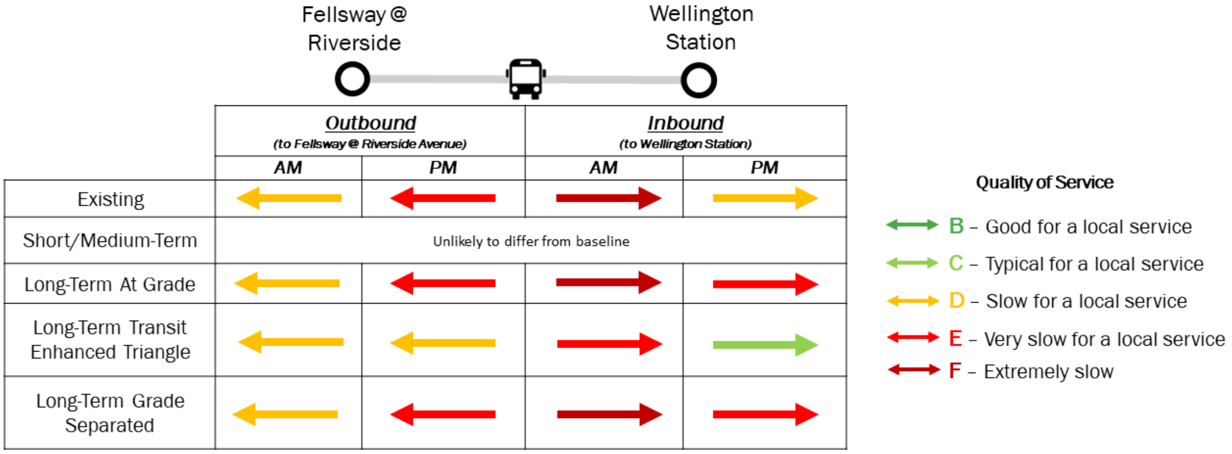


*Figure 4.2-24: Estimated Transit Travel Time QOS Between Wellington Station and the Fellsway at Riverside Avenue*



## 4.2.7 Environment

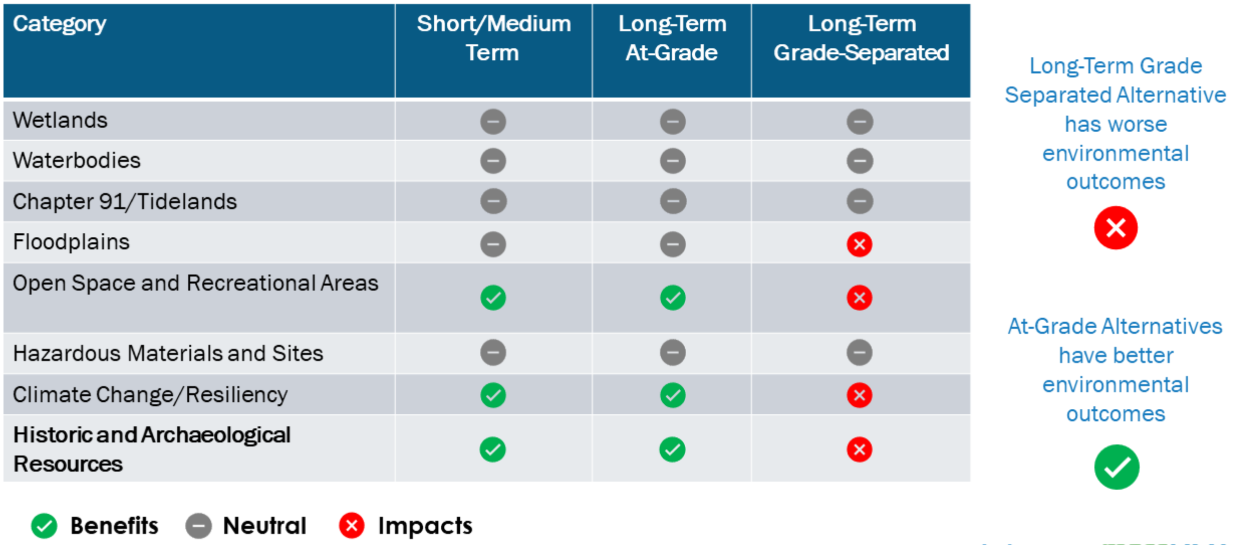
The environmental analysis considered the potential for impacts associated with the physical footprint of the alternatives, as well as those associated with traffic operations, such as air quality and noise.

### *4.2.7.1 Environmental Consequences*

The primary environmental resources in proximity to Wellington Circle include the Mystic River Reservation and Torbert MacDonald Park to the southwest of the Circle. A wetland channel draining to the Mystic River is located to the west of the Fellsway, south of Wellington Circle, within the Mystic River Reservation. The Mystic River Reservation and Mystic Valley Parkway are on the National Register of Historic Places as part of the historic Metropolitan Park System. Fellsway, Wellington Circle and Revere Beach Parkway are also on the National Register of Historic Places as early connecting parkways designed for the Metropolitan Park Commission (see Section 2.4 in Chapter 2 for additional information on environmental conditions).

The alternatives development process considered the constraints posed by the park and open space resources and focused on alternatives that could be constructed within the existing roadway right-of way, thereby reducing the potential for impact to these resources. No work is proposed in or adjacent to wetlands and waterbodies within the project study area with any of the Short-/Medium or Long-Term alternatives. See Figure 4.2-25 for a summary of the environmental consequences associated with alternatives.

*Figure 4.2-25: Environmental Consequences*



| Category | Short/Medium Term | Long-Term At-Grade | Long-Term Grade-Separated |
|---|---|---|---|
| Wetlands | ⊖ | ⊖ | ⊖ |
| Waterbodies | ⊖ | ⊖ | ⊖ |
| Chapter 91/Tidelands | ⊖ | ⊖ | ⊖ |
| Floodplains | ⊖ | ⊖ | ⊗ |
| Open Space and Recreational Areas | ✓ | ✓ | ⊗ |
| Hazardous Materials and Sites | ⊖ | ⊖ | ⊖ |
| Climate Change/Resiliency | ✓ | ✓ | ⊗ |
| **Historic and Archaeological Resources** | ✓ | ✓ | ⊗ |

✓ **Benefits** ⊖ **Neutral** ⊗ **Impacts**

Long-Term Grade Separated Alternative has worse environmental outcomes ⊗

At-Grade Alternatives have better environmental outcomes ✓

In general, the Short-/Medium-Term alternative would be neutral with respect to environmental impacts when compared to the Future No-Build. It provides some benefits to parkland/open space and historic resources by increasing the amount of green space. The additional green space would also provide opportunities to incorporate stormwater management measures to support climate change resiliency efforts. The Long-Term At-Grade alternatives (Square and Transit Enhanced) would also be neutral with respect to environmental impacts and would provide more green space than the Short-/Medium-Term alternative, with greater benefit to parkland/open space and historic resources, as well as potential climate change resiliency.

The Long-Term Grade-Separated alternative includes a bridge structure and approach ramps on fill with retaining walls. This would create a visual barrier separating the Mystic Valley Reservation and Torbert MacDonald Park from the adjacent community. The large bridge structure would also not be consistent with the historic parkway concept. In addition, the bridge approach ramps would require fill in an area that may experience flooding in the future due to sea level rise. Therefore, this alternative was found to have more potential for environmental impacts.

### *4.2.7.2 Air Quality*

#### *Environmental Consequences*

Potential air quality impact changes were evaluated for the Base Year,[2] Future No-Build, and Build alternatives across the study area. The analysis was conducted by the Central Transportation Planning Staff (CTPS) along with the Massachusetts Department of Environmental Protection (MassDEP), and the Massachusetts Department of Transportation. The analysis was based on updated and revised emissions factors in the August 2021 Technical Memorandum “MOVES Emission Factors and Travel Demand Model Application”.[3]

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[2] Base Year 2018 of the Regional Travel Demand Model

[3] Boston Regional Metropolitan Planning Organization, March 6, 2013; Revised August 15. 2021 Technical Memorandum “MOVES Emission Factors and Travel Demand Model Application”

Daily emissions for the communities of Medford, Somerville, and Everett were estimated for volatile organic compounds (VOCs), nitrogen oxides (NOx), carbon dioxide (CO2), carbon monoxide (CO), particulate matter of 10 microns (PM10) and smaller particulate matter of 2.5 microns (PM2.5) were estimated across the study area. Vehicle miles traveled (VMT) and vehicle hours traveled (VHT) were also estimated as part of the study. Table 4.2-8 shows the results of the analysis conducted by the Central Transportation Planning Staff (CTPS) using the USEPA Motor Vehicle Emission Simulator (MOVES) and traffic data of the area. The table also includes a comparison of the alternatives compared to the Future No-Build and Base Year. Specific details regarding the methodology and assumptions are included in the August 2021 Technical Memorandum, available in Appendix D.

*Table 4.2-8: Daily Emissions for the Communities of Medford, Somerville, and Everett based on the Wellington Circle Scenario*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Vehicle Miles Traveled (VMT)** | 3,034,222 | 3,331,724 | 3,305,118 | 3,314,469 | 3,302,155 | | | | 270,896 | 270,896 | 267,934 |
| **Vehicle Hours Traveled (VHT)** | 171,592 | 232,963 | 231,405 | 231,924 | 232,285 | | | | 59,813 | 59,813 | 60,693 |
| **Emissions (kg/day)** | | | | | | | | | | | |
| **VOC (kg)** | 200 | 97.6 | 97.1 | 97.5 | 97.0 | | | | (103.0) | (103.0) | (103.1) |
| **NOX (kg)** | 643 | 110.5 | 109.9 | 109.8 | 109.8 | | | | (533.5) | (533.5) | (533.6) |
| **CO2 (kg)** | 1,535,439 | 1,055,182 | 1,049,144 | 1,053,520 | 1,048,151 | | | | (486,294.4) | (486,294.4) | (487,287.9) |
| **CO (kg)** | 8,675 | 3,484.8 | 3,467.1 | 3,470.1 | 3,464.1 | | | | (5,207.4) | (5,207.4) | (5,210.5) |
| **PM25 (kg)** | 18 | 7.55 | 7.52 | 7.53 | 7.51 | | | | (10.1) | (10.1) | (10.2) |
| **PM10 (kg)** | 20 | 8.52 | 8.48 | 8.49 | 8.47 | | | | (11.4) | (11.4) | (11.4) |

Source: Emissions were generated by CTPS using the Boston MPO travel demand model.
Note: VMT, VHT and pollutant values generated by CTPS for the Proposed Alternatives were compared to the Future No-Build and Baseline conditions to illustrate potential impacts (or net changes) for each Alternative. Net change values in the table denoted in red and in parenthesis represent a reduction in the applicable variable when compared to the Future No Build or Base Year. Future net changes for each Alternative compared to the future No Build are denoted in the grey columns and net changes from the Baseline year for each Alternative are denoted in the last three columns of the table.

### *Build Alternatives Compared to the Base Year*

The CTPS results indicate that VMT and VHT would be expected to increase for the Future No-Build and alternatives compared to the Base Year due to the forecast increase in traffic expected over the time period with or without the project. The greatest increase in VMT for the alternatives compared to the Base Year would be expected for the Long-Term At-Grade Square (270,896) and the Long-Term At-Grade Transit-Enhanced alternatives (270,896) followed by the Grade-Separated alternative (267,934). For VHT, the greatest increase would be expected for the Grade-Separated alternative (60,693), followed by the Square (59,813), and Transit-Enhanced (59,813) alternatives.

All pollutant emissions would be expected to decline in the future years for the Future No-Build and alternatives when compared to Base Year. These reductions occur despite a projected increase in VMT from the Base Year to the Future No-Build and alternatives. The downward trend in emissions is a result of technological improvements (i.e., more stringent vehicle emission and fuel quality standards coupled with ongoing fleet turnover) and is achieved despite increased VMT and VHT in this period. Generally, VOC, CO2, CO, PM10 and PM2.5 show similar decreases in emissions across all the alternatives compared to the Base Year. The Long-Term Grade-Separated alternative would be expected to result in slightly higher reductions compared to the Square and Transit-Enhanced alternatives; this would not be a significant change as all alternatives are expected to show similar emission reductions.

### *Alternatives Compared to the Future No-Build*

The CTPS results estimate that VMT and VHT would be expected to decrease compared to the Future No-Build. The greatest decrease in VMT compared to the Future No-Build would be expected for the Grade-Separated alternative (-29,568) followed by the Square alternative (-26,606) and the Transit-Enhanced alternative (-17,255). For VHT, the greatest decrease is expected for the Square alternative (-1,558) followed by the Transit-Enhanced alternative (-1040) and Grade-Separated alternative (-678).

Similarly for the pollutant emissions, daily emissions would be expected to decrease slightly compared to the Future No-Build. Specifically, VOC, CO2, CO, PM10 and PM2.5 show the greatest decrease in emissions for the Grade-Separated alternative, followed by the Square alternative and the Transit-Enhanced alternative. NOx emissions decreases would be highest for the Grade-Separated alternative followed by the Transit-Enhanced alternative and the Square alternative.

It can be concluded that all alternatives would be expected to show a decrease in emissions, VMT, and VHT compared to the Future No-Build. The Grade-Separated alternative generally shows the highest decreases in emissions and VMT, however it shows the lowest decrease in VHT compared to the other alternatives. In general, the Transit-Enhanced alternative shows the lowest decrease in VMT and emissions with the exception of VHT, which is second to the Square alternative and NOx emissions reductions which is generally the same as the Grade-Separated alternative and slightly better than the Square alternative. Similarly, all pollutant emissions would be expected to decline in the future years when compared to Base Year. The downward trend in emissions is a result of technological improvements, i.e., more stringent vehicle emission and fuel quality standards coupled with ongoing fleet turnover and is achieved despite increased VMT and VHT in this period.

### *4.2.7.3 Noise*

As a continuation of the noise evaluation described in Chapter 2, Section 2.4.10, an analysis of the Future No-Build and build alternatives was completed to provide a comparative assessment of how each of the proposed alternatives may alter the noise conditions in the study area. To provide a consistent comparison with the predicted existing noise levels the noise sensitive areas evaluated for the future conditions included the following:

- The residential neighborhood north of Revere Beach Parkway between Rivers Edge Drive and Route 28 (Fellsway)
- The Mystic River Reservation south of Route 16, which includes the Torbert Macdonald Park and the River Path
- Station Landing Park located east of Route 28 (Fellsway) and south of Presidents Landing

### *Noise Prediction Model*

For the Future No-Build and alternatives analysis, future traffic noise levels were computed using the SoundPLAN® implementation of the FHWA Traffic Noise Model (TNM version 2.5).  Loudest hour traffic data for the design year 2040 build condition was calculated for input into the model for each of the roadways associated with the proposed alternatives. This data includes traffic vehicle volumes along with the estimated speeds they would be traveling. Additionally, utilizing geometric data associated with each of the alternatives, the model accounts for the effects of several variables that are pertinent to the accuracy of the predicted future noise levels. These variables include horizontal distances and elevation differences between roadways and receptors (points used within the model to identify specific noise sensitive locations) along with potential shielding from terrain and structures that affect sound propagation created by vehicles traveling the roadways throughout the study area.

Consistent with guidance found in MassDOT's 2011 noise abatement policy documents, receptors were placed at the closest location to the roadway right-of-way line where frequent human activity normally occurs to determine if the NAC is approached or exceeded. For residential land uses, receptors were placed at the edge of the building structure closest to the noise source. The locations where frequent human activity normally occurs in the Mystic River State Reservation/Torbert Macdonald Park and Station Landing Park are along the shared use pathways. Receptors were placed along the pathways at intervals of 100 feet to effectively create a grid system that is used to determine the feasibility and reasonableness of abatement/noise barriers in a standard MassDOT noise analysis. Although an evaluation of abatement is not required for this project, the consistency with MassDOT's guidance was prioritized.

### *Results*

The Long-Term alternatives were evaluated for future noise conditions in comparison to the Future No-Build. Future No-Build conditions within the study area were evaluated to assist with the comparison of predicted noise levels associated with the proposed project. Often referred to as the "without project" condition, the Future No-Build condition is an evaluation of the future predicted noise levels that would occur if the proposed project were not constructed. Figure 4.2-26 shows contours for the Future No-Build.

The noise-sensitive land uses in the study area include several apartment buildings, single-family residences, and recreation areas within the Mystic River State Reservation and Station Landing Park. For a visual comparison of predicted future noise levels, graphics were developed to show the hourly $L_{eq}$ (dBA) contours developed from the SoundPLAN® noise modeling of the future build condition for each of the alternative concepts evaluated. Figure 4.2-27 shows contours for the Square Alternative, Figure 4.2-28 shows contours for the Triangle Alternative, Figure 4.2-29 shows contours for the Transit Enhanced Alternative, and Figure 4.2-30 shows contours for the Grade-Separated Alternative.

Consistent with the contour graphic from the existing condition, the noise sensitive land uses with the highest sound levels in the Future No-Build and alternatives are also the front side of the buildings directly adjacent to the north side of Route 16 and the multi-use sidewalk in the Mystic River State Reservation paralleling the south side. These higher sound levels are shown in the orange contour areas in all four of the Figures. Additionally, three of the four alternatives include higher sound levels in the first row of homes along Route 28 north of Wellington Circle (with the exception being the Transit Enhanced Alternative). Depending on the alternative evaluated, the depth of the contours varies slightly in different areas.

*Figure 4.2-26: Contours for Future No-Build*

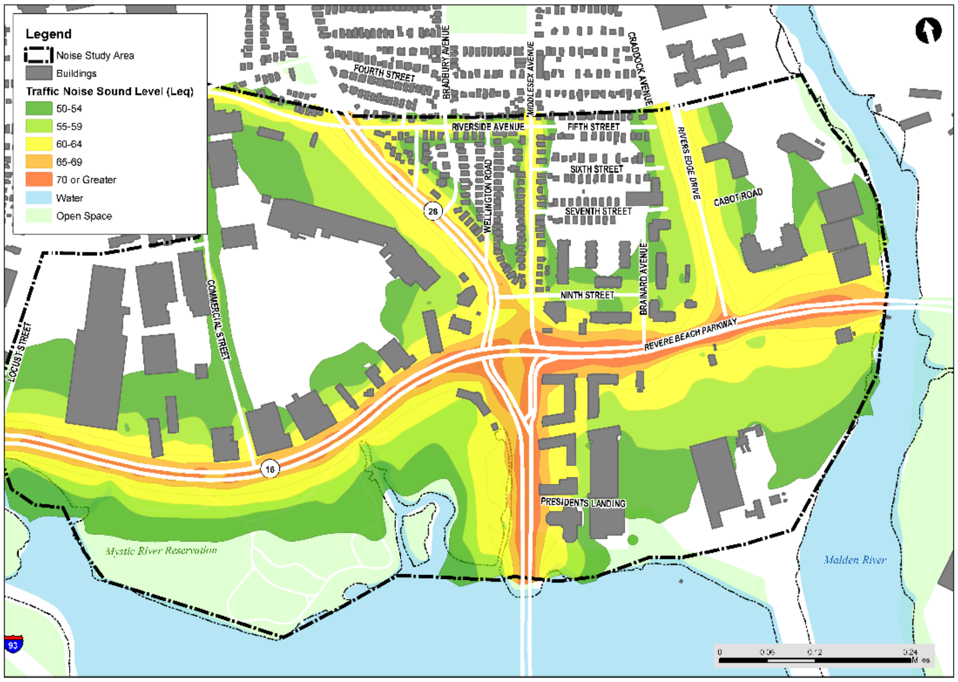


*Figure 4.2-27: Contours for At-Grade Square Alternative*

Figure 4.2-28: Contours for At-Grade Triangle Alternative

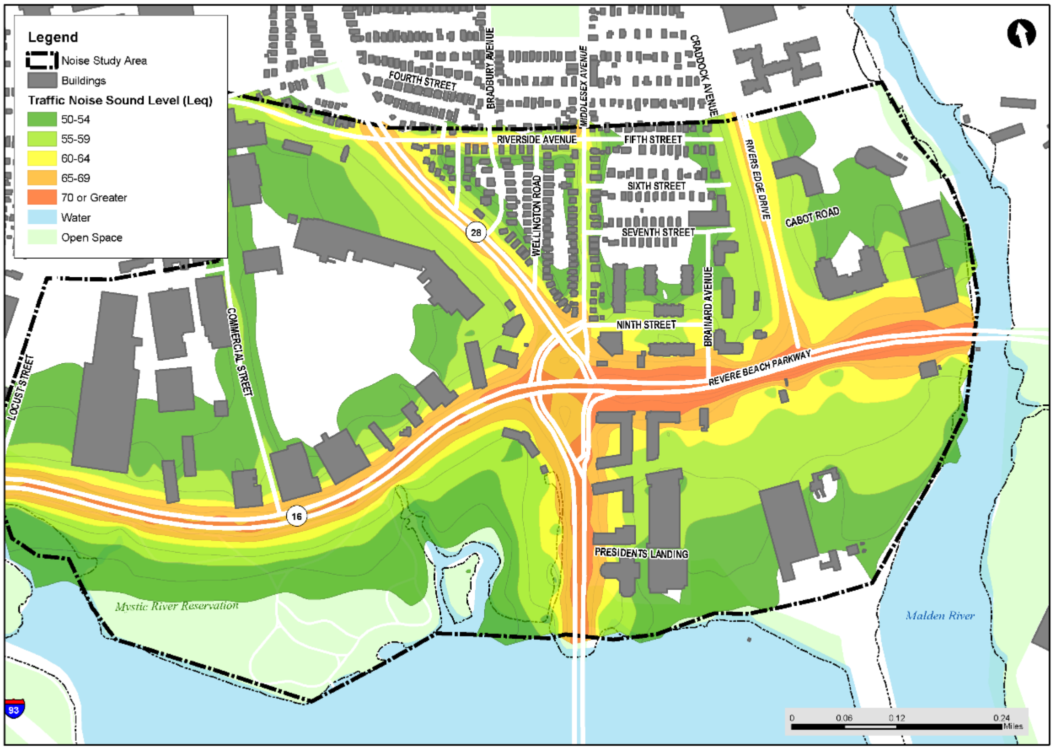
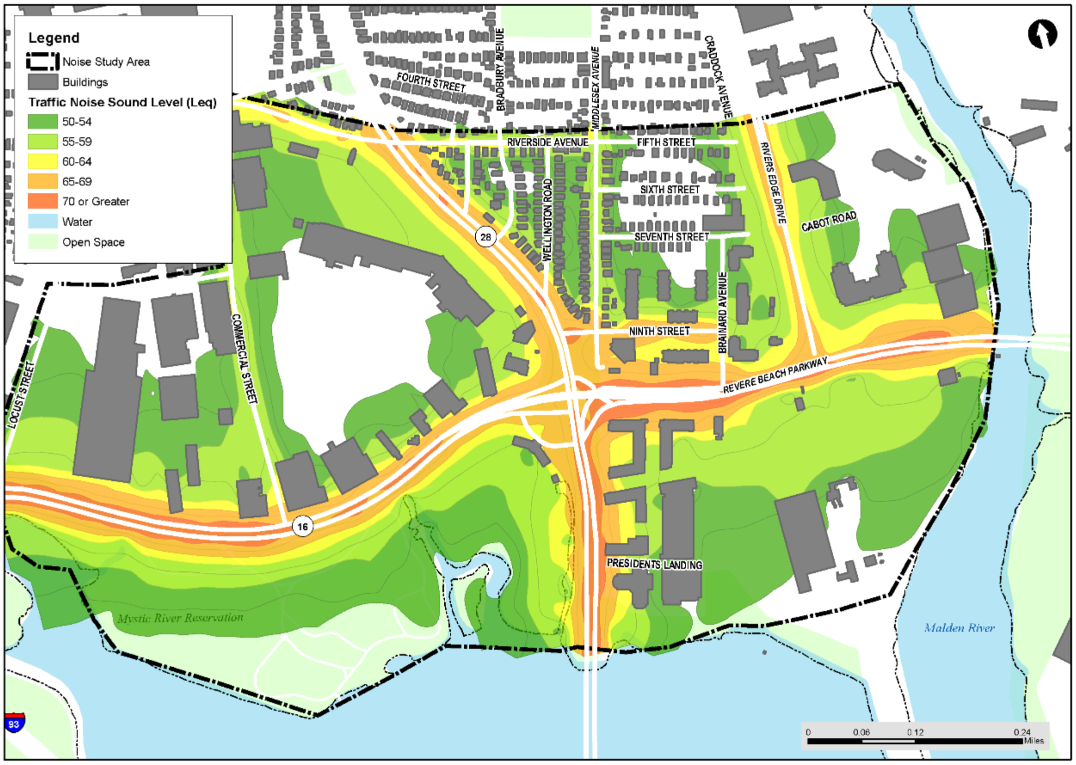


Figure 4.2-29: Contours for At-Grade Alternative Transit Enhanced Alternative

*Figure 4.2-30: Contours for Grade-Separated Alternative*



Presented in Table 4.2-9 are the results of the modeling evaluation of the existing, Future No-Build and Long-Term alternatives noise conditions. For use in a quantitative comparison discussion, this table shows the number of receptors impacted, average Leq, and maximum Leq for each of the alternatives and existing condition broken down by land use (either residential or recreational/park). There were 357 receptors evaluated in the study with 62% of them residential and 38% located in the Mystic River State Reservation and Station Landing Park.

*Table 4.2-9: Future Build and Existing Condition Results*

| Long-Term Alternative | Number of Receptors Impacted[1] | | | Average $L_{eq}$ (dBA) | | | Maximum $L_{eq}$ (dBA) | |
|---|---|---|---|---|---|---|---|---|
| | Residential | Park | All | Residential | Park | All | Residential | Park |
| Square | 28 | 36 | 64 | 55.5 | 58.1 | 56.5 | 69.1 | 72.0 |
| Triangle | 28 | 36 | 64 | 56.3 | 58.4 | 57.1 | 70.5 | 71.8 |
| Transit Enhanced | 25 | 50 | 61 | 56.4 | 58.3 | 57.1 | 70.3 | 71.8 |
| Grade-Separated | 33 | 35 | 68 | 57.9 | 59.0 | 58.3 | 68.3 | 72.1 |
| | | | | | | | | |
| *Future No-Build* | 19 | 36 | 55 | 54.9 | 59.1 | 56.5 | 67.6 | 74.3 |
| *Existing Condition* | 17 | 37 | 54 | 54.2 | 58.6 | 55.8 | 67.2 | 72.4 |

[1] Approach, meet or exceed the FHWA NAC of 67 dBA for Activity Categories B and C

As discussed in Chapter 2, Section 2.4.11.1 and shown in Table 4.2-10, FHWA & MassDOT noise policy base impacts on Noise Abatement Criteria levels by Activity Category. For Categories B and C, noise impact is assumed to occur when predicted exterior noise levels approach or exceed 67 dBA in terms of $L_{eq}$(h) during the loudest hour of the day.

*Table 4.2-10: Noise Abatement Criteria by Activity Category*

| Activity Category | Leq(h)[1] | Description of Activity Category |
|---|---|---|
| B[2] | 67 (Exterior) | Residential |
| C | 67 (Exterior) | Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings |

1.) Hourly Equivalent A-weighted Sound Level (dBA)
2.) Includes undeveloped lands permitted for this activity category

*Source: 23 CFR Part 772.*

The four Long-Term alternatives and the Future No-Build have estimated average noise levels higher than the existing condition due to future projected traffic volumes project-wide. A comparison of the Future No-Build noise levels to the alternatives; however, shows there would be higher average noise levels in all four of the Long-Term alternatives. This difference is more than likely a result of the proposed revised roadway geometries.

A comparison of the Long-Term alternatives shows the Transit Enhanced alternative would be the least impactive in relation to the NAC threshold for both the combined type of receptors and the residential receptors. The Grade-Separated alternative would be the most impactful for both the NAC threshold and average noise levels with the highest noise levels occurring at the park.[4] The At-Grade Square and Triangle alternatives are consistent with their number of NAC threshold impacts with only three additional impacts predicted for residential receptors compared to the Transit Enhanced alternative.

Overall, the At-Grade Square, Triangle and Transit Enhanced alternatives are relatively consistent with their predicted average and maximum noise levels with the Square alternative slightly less impactive for both categories in relation to residential receptors.

From a noise perception perspective, the differences between the predicted future build condition noise levels for each of the four Long-Term alternatives would be relatively minimal. The auditory response to sound is a complicated process that occurs over a broad range of frequencies and intensities. The minimum sound level variation perceptible to a human's ear is generally around 3 dBA, with a 5 dBA change clearly perceptible, and an 8-10 dBA change perceived as a doubling of loudness. The difference between the highest and lowest average noise levels predicted at all the receptors between the four alternatives is 1.8 dBA. Furthermore, if you remove the Grade-Separated alternative and compare only the Square, Triangle, and Transit Enhanced alternatives, the difference is even lower at 0.6 dBA.

The Transit Enhanced alternative would be the least impactive of all four of the alternatives. The Transit Enhanced alternative has the lowest number of impacted receptors in relation to the NAC threshold for both the combined type of receptors and the residential receptors, with the main difference being residential receptors along Route 28 north of Wellington Circle (as shown on Figure 4.2-28). Additionally, the difference in the average noise levels for residential and park receptors between the Transit Enhanced alternative and the Future No-Build is 1.5 dBA and 0.8 dBA, respectively with a difference of 0.6 dBA combined. These differences show that on average the increase in predicted noise levels between the future Transit Enhanced alternative and the Future No-Build (without project) noise condition would be hardly perceptible to people utilizing the outdoor areas surrounding Wellington Circle.

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[4] The "park" refers to the recreational land uses located in the Mystic River State Reservation/Torbert Macdonald Park and Station Landing Park, which include the shared use pathways in these locations. A park can be one receptor based on identified areas of frequent human use but in this case it consists of many receptors because the shared use path in Torbert Macdonald Park runs parallel to Route 16 for its entire length. Of the 357 receptors in the analysis, 38% are located in the Mystic River State Reservation and Station Landing Park. The number of receptors were determined based on areas along the shared use path where frequent human use is expected to occur.

### 4.2.8 Land Use & Economic Development

Land use and economic development impacts were evaluated across alternatives based on consistency with local plans. Alternatives were also evaluated for their potential to affect community cohesion, as well as the potential for additional right of way and access impacts to abutting properties.

An Enhanced Development Scenario was also designed to understand the impact of development potential within the study area as each community in the study area is planning for a future with mixed-use development at a greater density than existing conditions, particularly in areas with existing low-density auto-oriented or industrial land uses. This scenario assumed that a select set of additional lots in each community would be developed to locally established guidelines for densification.

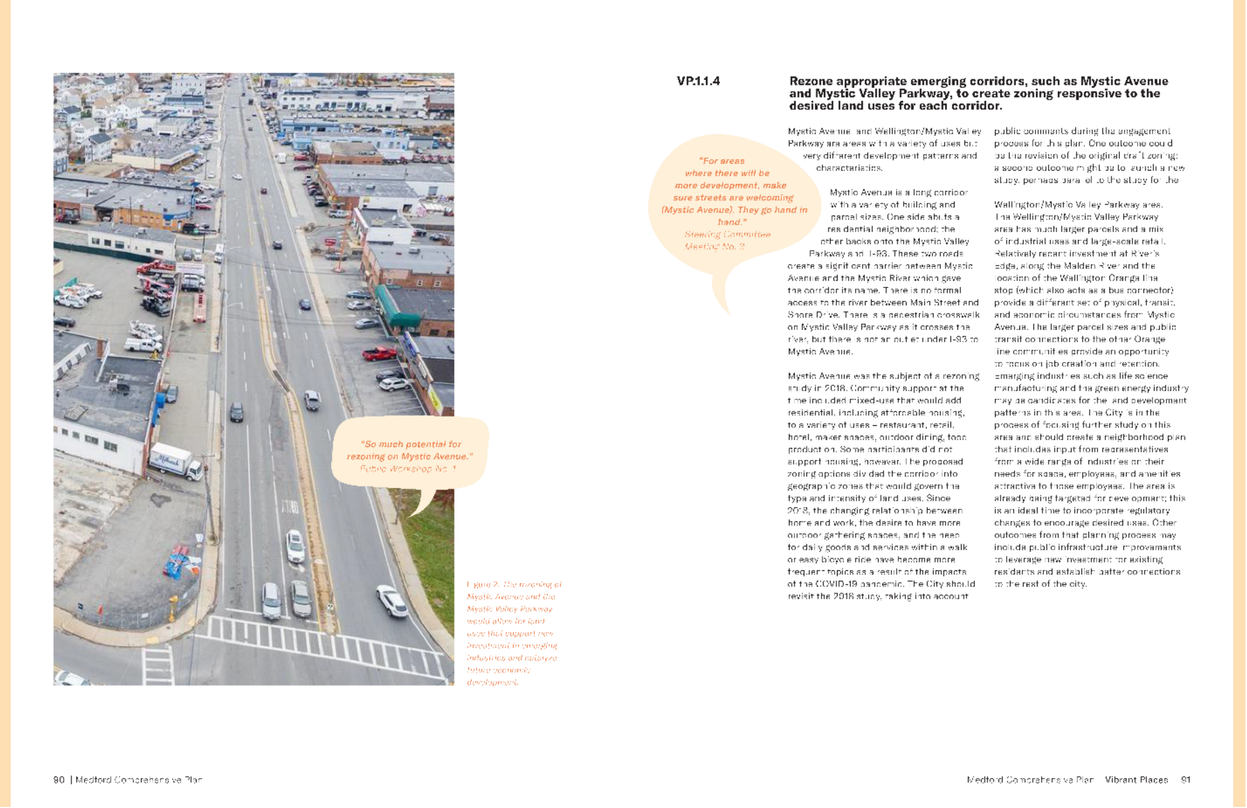
#### *4.2.8.1 Consistency with Local Plans*

The alternatives were evaluated for consistency with comprehensive plans and zoning codes for the four communities in the study area. As detailed in Chapter 2, Section 2.1, the Wellington Circle study area includes portions of Medford, Everett, Malden, and Somerville, Massachusetts. Existing land use in the study area, as shown on Figure 2.1-1 in Chapter 2, is currently characterized by single and multi-family residential neighborhoods interspersed with areas of low-density commercial/light industrial development. Land use adjacent to the Mystic and Malden rivers is primarily open space (including some residential and commercial private lawns and DCR’s Mystic River Reservation).

Looking towards the future, every one of the four communities has established a local standard for dense, mixed-use development:

- The *Medford Comprehensive Plan* is available at https://www.medfordcompplan.org/. Strategy VP1.1.4 (p. 91 and reproduced in Figure 4.2-31) calls on the City of Medford to “Rezone appropriate emerging corridors, such as Mystic Avenue and the Mystic Valley Parkway, to create zoning responsive to the desired land uses for each corridor.” Medford’s zoning code includes a “Mixed-Use Zone” (MUZ) that currently applies only to Station Landing directly adjacent to Wellington Circle. The Comprehensive Plan envisions a collaborative conversation in the community to extend density to both corridors, particularly if that density creates and retains jobs in emerging industries such as life science manufacturing and green energy.

*Figure 4.2-31: Discussion of Study Area Corridors in the Medford Comprehensive Plan*



“So much potential for rezoning on Mystic Avenue.”
Public Workshop No. 1

Figure 2. The rezoning of Mystic Avenue and the Mystic Valley Parkway would allow for land uses that support new investment in emerging industries and catalyze future economic development.

**VP.1.1.4**

**Rezone appropriate emerging corridors, such as Mystic Avenue and Mystic Valley Parkway, to create zoning responsive to the desired land uses for each corridor.**

“For areas where there will be more development, make sure streets are welcoming (Mystic Avenue). They go hand in hand.”
Steering Committee Meeting No. 3

Mystic Avenue and Wellington/Mystic Valley Parkway are areas with a variety of uses but very different development patterns and characteristics.

Mystic Avenue is a long corridor with a variety of building and parcel sizes. One side abuts a residential neighborhood; the other backs onto the Mystic Valley Parkway and I-93. These two roads create a significant barrier between Mystic Avenue and the Mystic River which gave the corridor its name. There is no formal access to the river between Main Street and Shore Drive. There is a pedestrian crosswalk on Mystic Valley Parkway as it crosses the river, but there is not an outlet under I-93 to Mystic Avenue.

Mystic Avenue was the subject of a rezoning study in 2018. Community support at the time included mixed-use that would add residential, including affordable housing, to a variety of uses – restaurant, retail, hotel, maker spaces, outdoor dining, food production. Some participants did not support housing, however. The proposed zoning options divided the corridor into geographic zones that would govern the type and intensity of land uses. Since 2018, the changing relationship between home and work, the desire to have more outdoor gathering spaces, and the need for daily goods and services within a walk or easy bicycle ride have become more frequent topics as a result of the impacts of the COVID-19 pandemic. The City should revisit the 2018 study, taking into account public comments during the engagement process for this plan. One outcome could be the revision of the original draft zoning; a second outcome might be to launch a new study, perhaps parallel to the study for the Wellington/Mystic Valley Parkway area.

The Wellington/Mystic Valley Parkway area has much larger parcels and a mix of industrial uses and large-scale retail. Relatively recent investment at River's Edge, along the Malden River and the location of the Wellington Orange line stop (which also acts as a bus connector) provide a different set of physical, transit, and economic circumstances from Mystic Avenue. The larger parcel sizes and public transit connections to the other Orange line communities provide an opportunity to focus on job creation and retention. Emerging industries such as life science manufacturing and the green energy industry may be candidates for the land development patterns in this area. The City is in the process of focusing further study on this area and should create a neighborhood plan that includes input from representatives from a wide range of industries on their needs for space, employees, and amenities attractive to those employees. The area is already being targeted for development; this is an ideal time to incorporate regulatory changes to encourage desired uses. Other outcomes from that planning process may include public infrastructure improvements to leverage new investment for existing residents and establish better connections to the rest of the city.

90 | Medford Comprehensive Plan

Medford Comprehensive Plan  Vibrant Places  91

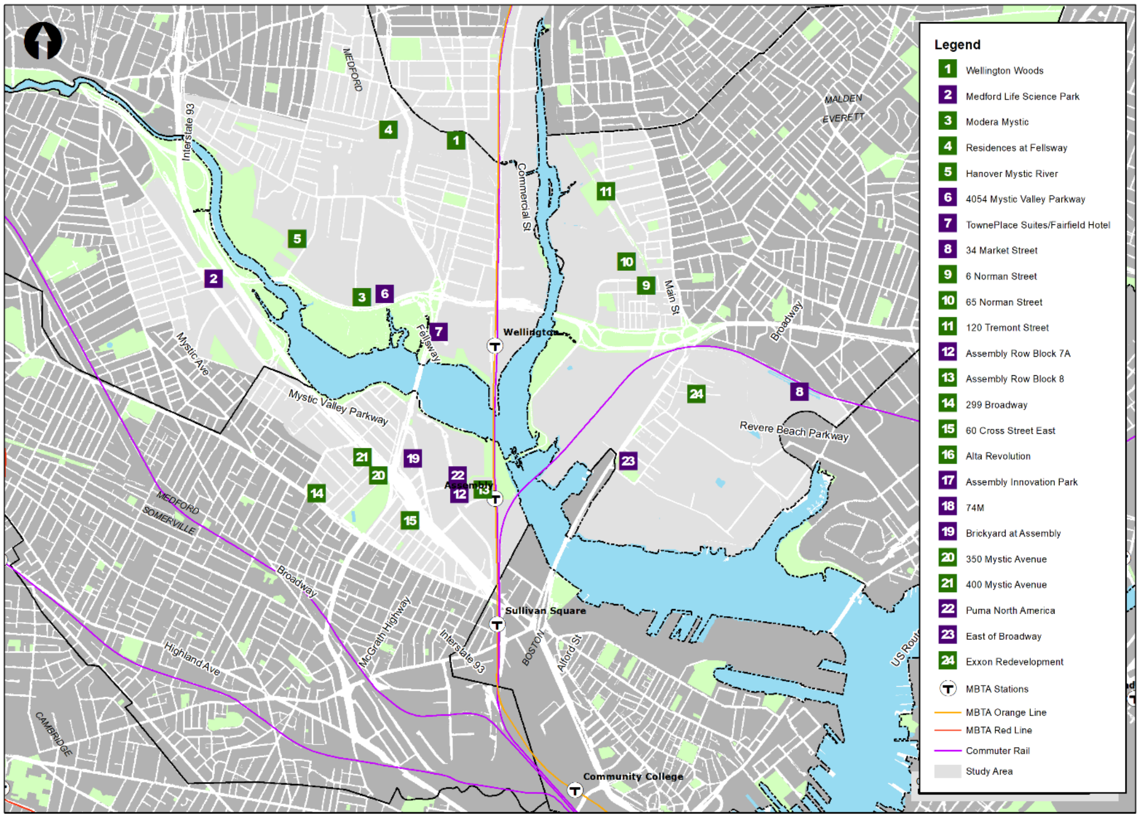
- Everett developed the Lower Broadway Urban Renewal Plan for the area including and directly adjacent to Encore Boston Harbor and has a “Riverside Overlay District” to manage densifying properties along the Malden River, including Gateway Center and Santilli Highway.
- Malden developed the Commercial Street Corridor Framework Plan for the parcels between the MBTA Haverhill Line/Orange Line and the Malden River.
- Somerville’s zoning code includes an “Assembly Square Mixed Use” (ASMD) district, informed by the ongoing master planning process for Assembly Square.
- The Short-/Medium-Term and Long-Term alternatives would be consistent with local plans for denser, mixed-use development that promote increased travel by walking, biking and transit. The Long-Term Grade-Separated alternative would have a neutral impact. Although there are additional pedestrian and bicycle facilities, the overpass structure would create a barrier in the community that would limit the extent to which people are likely to travel between neighborhoods using these active modes. This would reduce the impact that dense, mixed-use development would have on reducing vehicular trips in Wellington Circle. Increasing travel via alternative modes as this area develops would be important, as increased development has the potential to create additional travel demand and increase vehicle congestion.

### 4.2.8.2 Enhanced Development Scenario

#### Proposed and Ongoing Development

The Enhanced Development Scenario reflects each community's consideration of denser mixed-used development. Parcels of land for which development plans have been formally submitted for municipal review and/or are under construction have been included in the 2040 CTPS regional travel demand model. These development projects as of April 2022 are depicted in Figure 4.2-32 (green numbers for residential developments, purple for commercial and industrial). Population and employment projections for this scenario are provided in Appendix B.

*Figure 4.2-32: Developments Under Construction or Proposed in Study Area*



It should be noted that the City of Medford's ongoing exploration of Wellington Station Air Rights Development is not included among proposed developments. Instead, it is addressed in the densified corridors below.

#### Potential for Denser Redevelopment

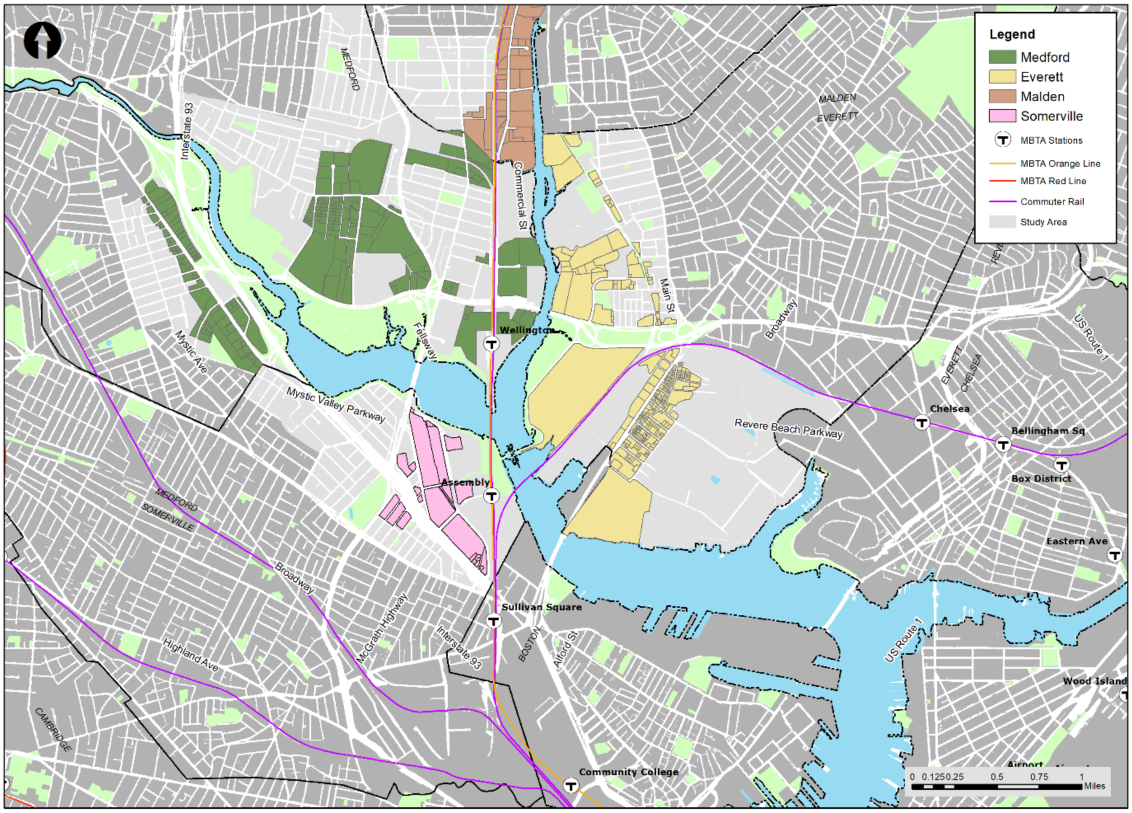
The Enhanced Development Scenario assumes that a subset of lots in each community have the potential for redevelopment to a denser use in accordance with local guidelines. This subset includes:

- Industrial and commercial lots along Mystic Valley Parkway, Mystic Avenue, River's Edge Drive and Fellsway in Medford.
- Wellington Station Air Rights parcels in Medford.

- The Lower Broadway and Riverside Overlay districts in Everett.
- The Commercial Street district in Malden.
- The Assembly Square district and adjacent Stop and Shop in Somerville.

Lots with single-family zoning or use, very small lots, and lots with existing or proposed dense development were not included in the subset. The subset is illustrated in Figure 4.2-33.

*Figure 4.2-33: Lots Identified for Enhanced Development by Community*



*Findings*

The Enhanced Development Scenario combines the impacts of proposed and ongoing development with the potential impacts of densified development on the selected parcels. Figure 4.2-34 and Figure 4.2-35 illustrate the ratio of employment and population, respectively, in the Enhanced Development Scenario versus that in 2018.[5] Deeper shades indicate more significant growth. There is expected growth in employment surrounding Wellington Circle for almost the entire study area, with a particularly dense pocket along I-93 in Somerville. Population growth is largely concentrated in Everett along the Malden River. Results from this evaluation again demonstrate the need to increase travel via alternative modes to offset the additional travel demand likely to be generated by employment and population growth surrounding the Circle.

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[5] The year 2018 represents the base year for the CTPS travel demand model. The maps shown in Figures Figures 4.2-34 and 4.2-35 provide information in accordance with the transportation analysis zones (TAZs) in the CTPS model.

Figure 4.2-34: Ratio of Employment in the Enhanced Development Scenario vs. 2018 by TAZ

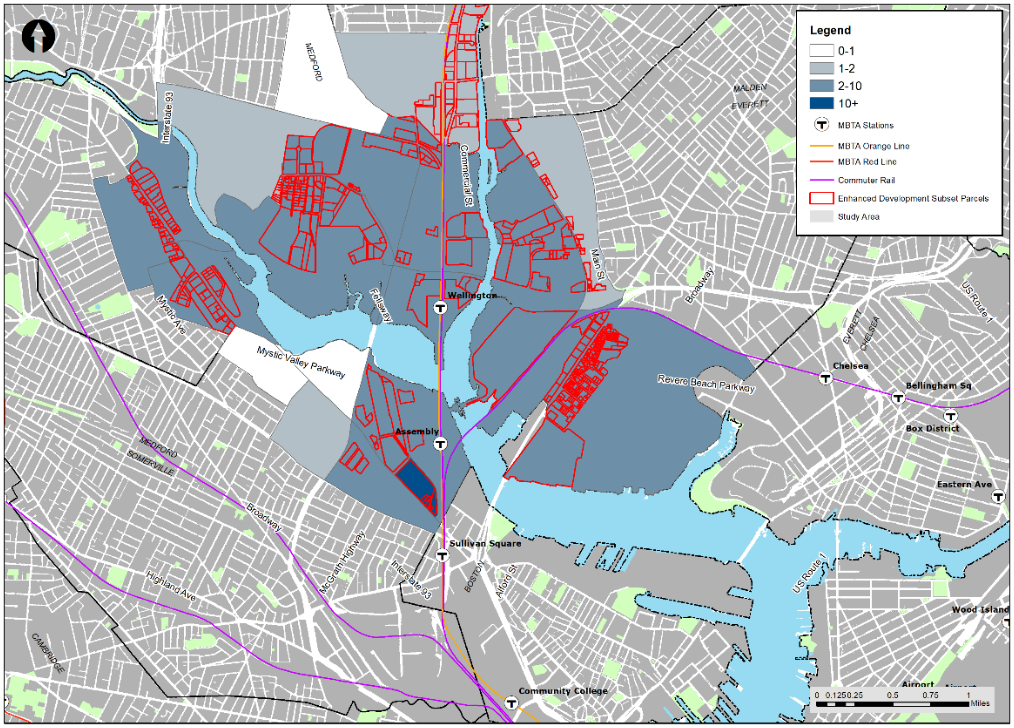
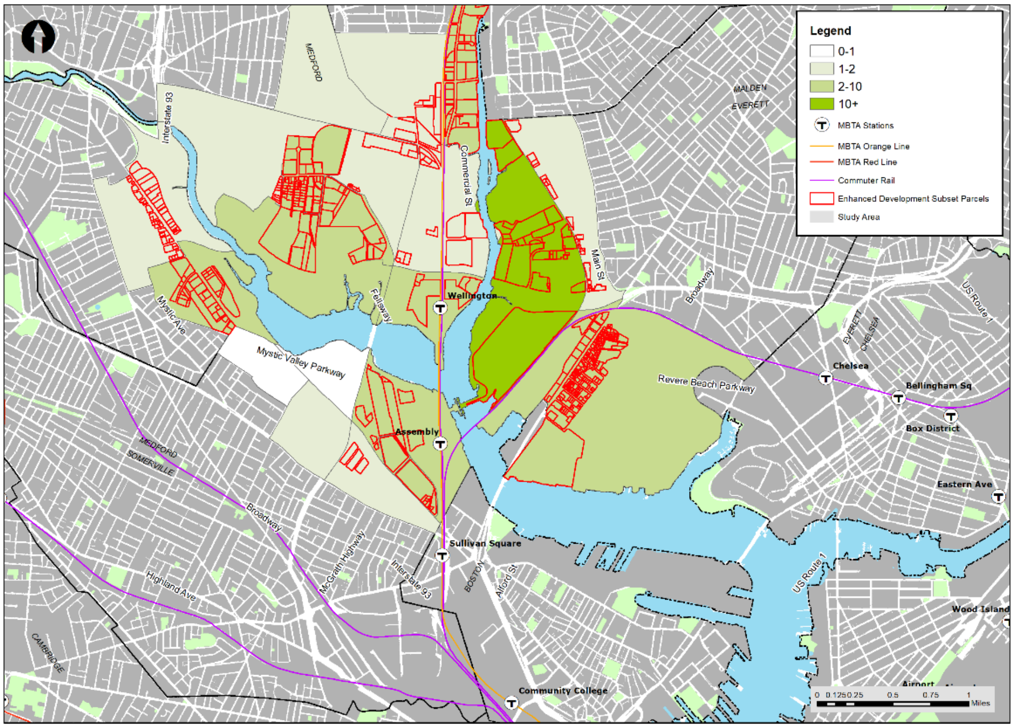


Figure 4.2-35: Ratio of Population in the Enhanced Development Scenario vs. 2018 by TAZ



### 4.2.8.3 Community Cohesion

Community cohesion was assessed as a metric to understand each alternative's ability to foster connections between neighborhoods within the Wellington Circle study area. This relates to study goals to improve mobility and access for walking and biking and accessing transit, improve multimodal connectivity and circulation, and improve quality of life by making it easier for local populations to get around.

Improvements to pedestrian facilities and bicycle facilities such as shorter crossings, enhanced crosswalks, shorter crossing times, and space to implement separated bicycle facilities would improve connectivity between neighborhoods by reducing physical barriers. This would be the case for all alternatives, as they all would provide multimodal improvements to surface roadways. Although there are reductions in barriers to mobility, the overpass for Grade-Separated alternative would create a visual barrier between neighborhoods, reducing community cohesion, as shown in Figure 4.2-36. The negative impacts to cohesion and connectivity have been experienced in other locations with overpasses dividing communities.

*Figure 4.2-36: Effect of Overpass on Community Cohesion*

Rendering of Grade-Separated Single Quadrant in Wellington Circle

Example barrier created by McGrath Highway/McCarthy Overpass in Somerville

### 4.2.8.4 Property Impacts

As conceptually designed, all alternatives are within the existing public right-of-way and are not anticipated to impact private property. The pedestrian bridge across Revere Beach Parkway, which could be an add-on to any of the Long-Term At-Grade alternatives, would require additional right-of way from the properties on the northeast and southeast quadrants of the Circle for the bridge abutments and access stairs and ramps. Survey and further design development would be required to confirm right-of way requirements.

Additionally, all existing driveways would be maintained across all alternatives. There are no anticipated impacts to driveway access for any parcel.

### 4.2.9 Public Health

For the public health analysis, the alternatives were compared to the existing conditions described in Chapter 2, Section 2.3, Public Health Conditions.

#### *4.2.9.1 Public Health Effects*

The public health alternatives analysis involves determining how each alternative may affect each of the following public health outcomes (Identified in "Impact of Built Environment on Public Health" concept map contained in Chapter 2, Section 2.3.4):

- Reduced risk of cardiovascular and respiratory diseases (asthma)
- Reduced risk of chronic diseases (diabetes, obesity)
- Fewer fatalities and injuries (See Safety Effects section 4.2.9.2)

To compare alternatives at a high level, the analysis considered how the alternatives may influence the risk factors associated with these public health outcomes. Assumptions are based on available data and require further analysis after the planning stage of the project to determine potential public health benefits of the preferred alternative.

As described in Chapter 2, Section 2.3, pediatric and adult asthma is a public health concern. The onset of asthma is often associated with exposure to various air pollutants which trigger asthma symptoms and cause asthma attacks.[6] A reduction in vehicle emissions can be expected to reduce air pollutants and result in improved air quality, thereby potentially reducing risk factors for asthma. For this project, alternatives analysis for asthma risk considered the extent to which each alternative would affect air quality in the study area.

All alternatives modeled show potential improvements to air quality due to expected reduced emissions, as shown in Table 4.2-11. Emissions reductions would be expected to occur because of more stringent vehicle emission and fuel quality standards, along with a more efficient vehicle fleet. Refer to Section 4.2.7.2, Air Quality for detailed analysis.

*Table 4.2-11: Public Health – Air Quality Emissions Reductions Summary*

| | Short-/Medium-Term | Long-term At-Grade | Long-Term At-Grade Transit Enhanced | Long-Term Grade-Separated |
|---|---|---|---|---|
| **Air Quality – Emissions Reductions** | N/A* | Benefits | Benefits | Benefits |

*CTPS regional modeling results do not include short/medium-term alternatives.

As described in Chapter 2, Section 2.3, cardiovascular diseases and chronic diseases, such as diabetes and obesity, are public health concerns in Massachusetts. Increased risk of cardiovascular disease and diabetes are associated with a variety of factors including obesity, unhealthy diet, and physical inactivity, among other factors.[7] Obesity is associated with an unhealthy diet and physical inactivity, among other factors.[8] Therefore, individuals may be able to decrease their risk of

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[6] https://www.epa.gov/sciencematters/links-between-air-pollution-and-childhood-asthma

[7] https://www.cdc.gov/chronicdisease/about/index.htm

[8] https://www.cdc.gov/obesity/index.html

cardiovascular disease and chronic diseases by adhering to a healthy diet and partaking in physical activity. For this project, alternatives analysis for cardiovascular and chronic disease risk considered the extent to which alternatives enable the built environment to promote access to opportunities for physical activity. Analysis of access to healthcare and healthy and affordable food by alternative was not available based on existing data.

Physical activity can be promoted through various aspects of the built environment. Active transportation provides opportunities for recreational exercise and builds physical activity into daily routines.[9] Walking can be encouraged by ensuring pedestrian connectivity between desired points of interest and providing safe and welcoming walking conditions. Biking can be encouraged by ensuring connectivity between existing parks and trail systems, providing protected lanes, and ensuring safe and welcoming biking conditions.

Based on analysis provided in sections 4.2.4 and 4.2.5, the Short-/Medium-Term and Long-Term alternatives would benefit the pedestrian experience whereas all Long-Term alternatives would benefit the bicycling experience (as shown in Table 4.2-12). The Short-/Medium-Term alternative would provide slightly better west to east bike connectivity through Wellington Circle than the existing condition and Future No-Build. The Long-Term alternatives would improve west to east and north to south bike connectivity, compared to existing conditions and Future No-Build as shown in Table 4.2-12. Wellington Circle is currently a major gap in the overall regional biking network and improvements would create opportunities to benefit public health outcomes.

Additionally, the extent to which each alternative would maintain or increase access to open space/ green space was analyzed at a high level. Open space and green space would provide more pleasant visual and landscaped surroundings, potentially encouraging active transportation and making conditions more welcoming for pedestrians and bicyclists.

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[9] https://www.transportation.gov/mission/health/active-transportation

*Table 4.2-12: Public Health – Built Environment Summary*

| | Short-/Medium-Term | Long-term At-Grade | Long-Term At-Grade Transit Enhanced | Long-Term Grade-Separated |
|---|---|---|---|---|
| Active Transportation – Pedestrian Experience | Benefits | Benefits | Benefits | Neutral |
| Active Transportation – Bicycling Experience | Neutral | Benefits | Benefits | Benefits |
| Bicycling Connectivity/ access to existing parks and trail systems | Benefits | Benefits | Benefits | Benefits |
| Access to open space/ green space | Benefits | Benefits | Benefits | Neutral |

#### *4.2.9.2 Safety Effects*

The analysis of safety effects sought to identify which alternatives may result in fewer fatalities and injuries related to crashes as compared to the existing and Future No-Build conditions. Design elements were incorporated into the alternative design concepts to reduce conflicts and crashes, thereby intending to improve roadway and infrastructure safety. Key design elements related to safety include:

- Wider pedestrian facilities, enhanced crossings, protected pedestrian phasing.
- Protected/buffered bike lanes to reduce conflict points.
- Accessible bus stops with multimodal connections.

All alternatives would be expected to reduce crashes relative to existing conditions, as described in section 4.2.1. Safety improvements are a result of improved clarity and reduced conflict points between transportation modes. Short-/Medium-Term improvements would be expected to result in a minor reduction in crashes. The Long-Term alternatives would reduce conflict points and offer protection to vulnerable users. Among the alternatives, the Grade-Separated alternative would result in fewer conflict points than at-grade alternatives. Overall, all alternatives would provide benefits to public health via safety improvements.

### 4.2.10 Environmental Justice

An Environmental Justice (EJ) analysis evaluates the benefits and burdens on minority and low-income populations as compared to the overall population within a study area. This involves comparing the projected impacts on minority populations to those on non-minority populations and those on low-income populations to those on non-low-income populations. Chapter 2, Section 2.2.3 provides an overview of the definition of minority and low-income populations and shows that most of the study area contains an EJ population, mainly based on the minority criterion (see Figure 2.2-8).

The Boston Region MPO completed an analysis assessing 12 metrics within three categories to evaluate impacts to EJ Populations. These categories include:

- Access to opportunities metrics – measure of the number of destinations (jobs, retail, or education) that are reachable within a given travel time by highway or transit.
- Mobility metrics – measure of door-to-door travel time for mode-specific trips.
- Environmental metrics – Assessment of congested VMT or CO emissions per square mile based on highway trips.

A full memo documenting the analysis is included as Appendix C.

The analysis compares the impacts to each EJ population to the non-EJ population for each alternative. A disproportionate burden is identified when the EJ population is projected to receive a greater burden than the non-EJ population. Similarly, if the EJ population is projected to receive less of a benefit than the non-EJ population, then a disproportionate benefit is identified. As can be seen by the results in Table 4.2-13, there would be no negative impacts or disproportionate benefits or burdens to EJ populations across metrics and across alternatives.[10] Additionally, it is anticipated that each alternative would benefit EJ populations and car-free households due to the improvements in multimodal connectivity, described in sections 4.2.4 – 4.2.6.

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[10] Short-/Medium-Term alternative not included in analysis, but expected to have no impact or disproportionate benefit

Table 4.2-13: Summary of EJ Population Impacts, Benefits, and Burdens

| | Long-Term At-Grade (Square) | | Long-Term Transit Enhanced | | Long-Term Grade-Separated | |
|---|---|---|---|---|---|---|
| | Impact on EJ Populations | Disproportionate Benefit or Burden? | Impact on EJ Populations | Disproportionate Benefit or Burden? | Impact on EJ Populations | Disproportionate Benefit or Burden? |
| Access Metrics - Highway | None | No | None | No | None | No |
| Access Metrics – Transit | None | No | None | No | None | No |
| Mobility Metrics – Highway | None | No | None | No | None | No |
| Mobility Metrics - Transit | None | No | None | No | None | No |
| Environmental Metrics | None | No | None | No | None | No |

### 4.2.11 Cost

Construction cost estimates were developed for each alternative based on present day dollars (2022). A summary of the construction cost for each alternative is provided in Table 4.2-14. As would be expected, the Short-/Medium-Term alternative would have a significantly lower cost ($6.2 million) than Long-Term alternatives. All Long-Term At-Grade alternatives would have comparable costs ($36-39 million); however, the pedestrian bridge add-on itself ($35.7 million) would be almost the same cost as each Long-Term At-Grade alternative. The Transit Enhanced alternative would have a slightly higher cost than the other At-Grade alternatives due to the additional pavement width and cost of striping and red pavement for the bus lane. The Grade-Separated alternative ($176.9 million) would be almost five times the cost of the At-Grade Long-Term alternatives, making it significantly more expensive to construct.

These costs exclude professional services costs such as Construction Management, Project Management, Engineering, etc. The scope of the costs was based on the concept drawings developed for each alternative as part of this study. The estimate is not a prediction of the final scope or cost of the final project. The estimate represents a reasonable opinion of the fair cost of construction, based on the information provided using 2022 construction costs. The complete methodology and assumptions for the cost estimate, as well as cost projections assuming a future year construction, is provided in Appendix H.

*Table 4.2-14: Construction Cost Estimates*

| Alternative | Cost Estimate (2022 dollars) |
|---|---|
| Short-/Medium-Term | $6.2 million |
| Long-Term At-Grade Dual Quadrant (Square and Triangle) | $36.7 million |
| Long-Term At-Grade Transit Enhanced | $38.3 million |
| Pedestrian Bridge Add-On | $35.7 million |
| Long-Term Grade Separated | $176.9 million |

## 4.3 Alternatives Analysis Summary

The results of the comprehensive alternatives analysis are summarized in Figure 4.3-1. The goal of the process was to identify which alternatives best meet project goals relative to the others. Improving safety in the Circle for all modes was a primary goal of the study that was important for all alternatives to achieve. Because each alternative was developed based on key design elements to reduce conflicts and crashes, such as enhanced pedestrian crossings, space for buffered/protected bicycle lanes, and accessible bus stops, each alternative improves safety over the existing Circle. Key safety improvements include:

- Protection for vulnerable road users (most protection for Long-Term alternatives)
- Reduction in crashes (modest reduction for the Short-/Medium-Term alternative)
- Fewer conflict points (fewest conflict points for the Grade-Separated alternative)

*Figure 4.3-1: Alternatives Analysis Summary Table*

| Evaluation Criteria | Short/Medium Term | Long-Term At-Grade | Long-Term At-Grade Transit Enhanced | Long-Term Grade-Separated |
|---|---|---|---|---|
| Safety | ✓ | ✓ | ✓ | ✓ |
| Vehicle Operations | ✗ | ✗ | ✗ | ✓ |
| Pedestrian Experience | ✓ | ✓ | ✓ | ⊖ |
| Bicycle Experience | ⊖ | ✓ | ✓ | ✓ |
| Transit Operations & Access | ⊖ | ⊖ | ✓ | ⊖ |
| Environment & Public Health | ✓ | ✓ | ✓ | ✗ |
| Land Use & Economic Development | ✓ | ✓ | ✓ | ⊖ |
| Community Cohesion | ✓ | ✓ | ✓ | ⊖ |
| Environmental Justice | ✓ | ✓ | ✓ | ✓ |
| Cost Estimate | $6.2 M | $36.7 M | $38.3 M | $176.9 M |

✓ Benefits ⊖ Neutral ✗ Impacts

Viewing the results of the analysis together shows that the Short-/Medium-Term and Long-Term At-Grade alternatives would have the most benefits and minimal negative impacts when compared to the Future No-Build condition, with the main impact being to vehicle operations. The main differentiators between the alternatives include:

- **Vehicle Operations**: The Short-/Medium-Term and Long-Term At-Grade alternatives would have worse outcomes for vehicle operations, as they were not designed or intended to improve or increase vehicle capacity. The trade-off is that they would provide benefits for other metrics, including safety, pedestrian and bicycle experience, public health, economic development, and community cohesion.

  The Long-Term Grade-Separated alternative would benefit vehicle operations, which should be viewed within the context of the primary goals of the study (being to improve multimodal safety, connectivity, and access). This alternative would have a lesser benefit to other modes, particularly the pedestrian experience, due to the nature of the bridge creating more of a physical and psychological barrier between neighborhoods as compared to other alternatives. The bridge structure would also have the potential for other negative impacts in areas including environment and public health, land use and economic development, and community cohesion.

- **Transit Operations and Access**: The Long-Term Transit Enhanced alternative would benefit transit operations and access, while the other Long-Term alternatives and the Short-/Medium Term alternative would have a neutral outcome for transit operations and access. While there is no measurable benefit to transit operations with the Short-/Medium- and the other Long-Term At-Grade alternatives compared to the Future No-Build, there is also no measurable impact.

- **Cost**: The Long-Term Grade-Separated alternative is significantly more costly than other alternatives, a factor that should be considered in terms of feasibility to implement. While the Short-/Medium-Term alternative has a significantly lower cost than Long-Term alternatives, it would also provide a lesser benefit to the bicycle experience and transit operations.

The alternatives analysis detailed in this Chapter provides comparison points between alternatives to understand the benefits and drawbacks to each. This allows for comparison not only between alternatives, but to a Future No-Build condition to determine which alternative best addresses study goals in the future. The results of the analysis must be considered comprehensively and within the context of improving safety, access, and connectivity for the majority of Wellington Circle users. The results of this analysis are used to determine a recommended alternative to move into the Project Development Process, detailed in Chapter 5.